Rok Pestotnik
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Univerza v Ljubljani
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Vloga za prvo izvolitev v naziv docent

V skladu z 95.členom Meril za volitev v nazive visokošolskih učitelkjev, znanstvenih delavcev in sodelavcev z dne 25.10.2011 prosim za prvo izvolitev v naziv docent s področja fizika.

1. Uspešno samostojno raziskovalno delujem na področju eksperimentalne fizike osnovnih delcev, fizike okolja in medicinske fizike.
2. V letih 2005 in 2006 sem bil na podoktorskem izpopolnjevanju v tujini (CERN, Ženeva)
3. Imam več kot 20 (30) točk iz znanstvene (+strokovne) dejavnosti
4. Imam več kot 6 del objavljenih v revijah s SCI, v katerih sem prvi avtor. : 8
5. Dela s mednarodno odmevna (več kot 10 čistih citatov) : 4552
6. Bil sem vodja raziskovalnega projekta: ARRS Z1-3301
7. Preizkusnega predavanja še nisem imel
8. Vodim vaje na Fakulteti za matematiko in fiziko: od 1999
9. Predstavil sem se na kolokviju FMF 8.4.2013
10. Bil sem delovni mentor pri več diplomskih delih. Sem mentor pri enem doktoratu in delovni mentor pri dveh drugih.

Priloge:

- biografija
- točkovana bibliografija
- kopije najpomembnejših objavljenih del.
- Pregled dela in točkovalnik
- citiranost del
- zbirnik točkovanja

Ljubljana, 10.4.2013 dr. Rok PESTOTNIK

Rok Pestotnik

10.4.2013

Biografija

Rok Pestotnik

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Rojen 3.1.1972 v Ljubljani.
Poročen, oče štirih otrok (Dora 12 let, Svit 10 let, Luna 7 let, Ana 0 let)
Državljanstvo: slovensko.

Izobrazba:

- univerzitetna diploma Univerza v Ljubljani, Fakulteta za matematiko in fiziko, september 1996
- Evropska šola za fiziko visokih energij, 1998, St.Andrews, Velika Britanija.
- Daljši obiski v inštitutu Deutsches Elektronen Synchrotron, Hamburg, Nemčija, vključno s 16 meseci v obdobju 1999-2000
- doktorat fizikalnih znanosti, Univerza v Ljubljani, Fakulteta za matematiko in fiziko, Oddelek za fiziko oktober 2001
- daljši obiski v inštitutu KEK, Tsukuba, Japonska v obdobju od 2001 do 2013
- podoktorsko izpopolnjevanje v European Organization for Nuclear Research - CERN Fellowship 2005/2006

Zaposlitve:

- 1996-2001 mladi raziskovalec, Univerza v Ljubljani, Fakulteta za matematiko in fiziko, Oddelek za fiziko
- 2001- 2008 asistent z doktoratom, Institut Jožef Stefan, Odsek za eksperimentalno fiziko osnovnih delcev.
- 2005-2006 Research Fellow, European Organization for Nuclear Research - CERN, Ženeva, Švica
- 2009- znanstveni sodelavec, Institut Jožef Stefan, Odsek za eksperimentalno fiziko osnovnih delcev.

Habilitacije:

- 1999 - 2013 asistent za področje fizike Univerza v Ljubljani, Fakulteta za matematiko in fiziko
- 2001 - 2008 asistent z doktoratom, Institut Jožef Stefan, Ljubljana
- 2009 - znanstveni sodelavec, Institut Jožef Stefan, Ljubljana

Znanje jezikov:

- slovensko, materin jezik
- angleško, tekoče
- nemško, funkcionalno
- hrvaško-srbsko, tekoče
- francosko, funkcionalno

Nagrade in priznanja:

- 1986 prvo mesto na republiškem tekmovanju iz matematike, Ljubljana
- 1986 prvo mesto na zveznem tekmovanju iz fizike, Dečani, Srbija.
- 1986-1996 Zoisova štipendija za nadarjene študente
- 1996 Prešernova nagrada za študente Fakultete za matematiko in fiziko Univerze v Ljubljani za diplomsko delo

Raziskovalna področja:

- Eksperiment HERA-B, inštitut DESY Hamburg: načrtovanje, konstrukcija in kalibracija detektorja Čerenkovih obročev HERA-B RICH (od 1996 do 2001), meritve s spektrometrom
- Eksperiment BELLE, Tsukuba, Japonska: meritve s spektrometrom Belle (od 2001)
- Eksperiment Belle II: načrtovanje nadgradnje sistema za identifikacijo delcev z uporabo detektorja Čerenkovih obročev z aerogelom kot sevalcem (od 2001).
- Eksperiment ALICE, CERN, Ženeva: sestavljanje in testiranje časovno projekcijske komore eksperimenta ALICE (2005-2006)
- Razvoj detektorjev posameznih fotonov (od 1996).
- Fizika okolja: razvoj detektorja Čerenkova za merjenje nizkih koncentracij Sr-90 (od 2001 do 2009)
- Medicinska fizika: razvoj detektorjev za pozitronsko tomografijo (od 2005)

Računalniško tehnična znanja:

- Urejevalniki besedil: MS Office, Open Office, Latex.
- Simulacija in analiza eksperimentalnih podatkov: PAW, Hbook, Cernlib, Rootsys, Geant3, Geant4, GATE
- Programi za rekonstrukcijo podatkov pri ekperimentih HERA-B in BELLE.
- Zajem podatkov: National Instruments LabWindows CVI & LabView .
- Podatkovne zbirke: Berkeley DB, MySql, Postgresql
- Računalniško podprto načrtovanje: Autodesk AutoCad
- Računalniško načrtovanje vezij in FPGAjev: Altium Designer, Xilinx ISE, Altera Quartus
- Računalniški jeziki: C++, C, Fortran77, python, perl, tcltk, awk, make, php and html.
- Računalniške platforme: PC; paralelni računalniki: Cray T3E, real time: Cetia, Solaris Sparc, HP-RT.
- Operacijski sistemi: UNIX, Linux, Microsoft OS, real time: Lynx, HP-RT
- Modularni sistemi v nuklearni elektroniki: VME, CAMAC, NIM.

Opis znanstvenega dela

Moje znanstveno delo pokriva področje eksperimentalne fizike osnovnih delcev. Ukvarjam se z razvojem in uporabo detektorjev fotonov Čerenkova v fiziki osnovnih delcev, fiziki okolja in medicinski fiziki. Detektorji izkoriščajo pojav sevanja Čerenkova, ki ga v prozorni snovi povzročijo hitri nabiti delci. Ker je intenziteta in smer izsevanih fotonov odvisna od hitrosti delcev, lahko z meritvijo ob znani gibalni količini delcev določimo identiteto nabitih delcev.

Moje dosedanje raziskovalno delo je potekalo večinoma v okviru mednarodnih raziskovalnih skupin HERA-B, Belle in Belle II, delno pa tudi v okviru samostojnih raziskovalnih projektov raziskovalne skupine na IJS. V času podoktorskega izpopolnjevanja v CERNu sem se priključil raziskovalni skupini ALICE.

V začetnem obdobju med in po diplomskem delu sem deloval v okviru mednarodne skupine HERA-B, ki se je ukvarjala s študijem tvorbe mezonov B in D pri trkih visokoenergijskih protonov v mirujočo tarčo [5]. Za meritve reakcijskih produktov je bilo potrebno skonstruirati magnetni spektrometer. Moje raziskave so bile predvsem posvečene načrtovanju, izdelavi, umeritvi in delovanju enega od podsistemov, detektorja obročev Čerenkova (RICH). Detektor je bil sestavljen iz plinskega sevalca perflorobutana, fokusirnega sistema zrcal, sistema leč za povečanje izkoristka zaznane svetlobe in več kot 2300 večanodnih fotopomnoževak. V okviru doktorskega dela sem delal pri načrtovanju, izdelavi in umerjanju različnih sestavnih delov in sistemov za nadzor delovanja detektorja obročev Čerenkova [1,4]. Podrobno poznavanje delovanja mi je bilo v veliko pomoč pri študiju identifikacije nabitih delcev s pomočjo detektorjev obročev Čerenkova [4]. S 33 zaznanimi fotoni na nasičen obroč in z ločljivostjo pri meritvi kota Čerenkova 0.7 mrad s posameznim fotonom je detektor obročev Čerenkova v spektrometru HERA-B v celoti izpolnil pričakovanja po ločevanju delcev. Gre za prvi detektor obročev Čerenkova, ki je deloval pri visokih pogostostih sunkov do 1 MHz na kanal.

V obdobju po doktoratu sem se priključil raziskovalni skupini BELLE, ki se prav tako ukvarja s fiziko mezonov B in D, le da opazuje reakcijske produkte trkov elektronov in pozitronov, ki jih na asimetričnem trkalniku izmerimo s spektrometrom BELLE. Že kmalu po začetku delovanja je skupina objavila rezultate meritev majhne razlike med lastnostmi snovi (mezonov B) in antisnovi (mezonov anti-B). Razliko pripišemo kršitvi ene od osnovnih simetrij narave, imenovane simetrija CP [7]. Kršitev te simetrije je tesno povezana z očitno prevlado snovi nad antisnovjo v današnjem vesolju, potem ko sta bili ob nastanku vesolja enako zastopani. Rezultat meritve je zato predstavljal enega najpomembnejših fizikalnih rezultatov leta 2001. Leta 2007 je skupina dokazala obstoj mešanja v sistemu nevtralnih mezonov D [9]. Poleg omenjenih meritev je raziskovalna skupina odkrila obstoj vrste novih stanj, opravila pa je tudi precej precizijskih meritev redkih razpadov mezonov B in D. Stevilne meritve kršitve simetrije CP v sistemu mezonov B, ki sta jih izvedli skupini Belle in BaBar (Stanford, ZDA), so eksperimentalno potrdile napoved M. Kobayashija ter T. Maskawe, za kar sta oba teoretična fizika prejela Nobelovo nagrado za fiziko l. 2008.

Za precizijske meritve v eksperimentalni fiziki mezonov B in D je bistvenega pomena povečanje velikosti vzorca. Z nadgradnjo pospeševalnika KEKB v SuperKEKB bomo bistveno povečali pogostost interakcij, zaradi tega pa se bo povečalo tudi s curkom delcev povečano ozadje. Zaradi

tega bo potrebno nadgraditi večino sestavnih delov spektrometra. Za nadgradnjo in kasnejši zajem in analizo podatkov so se raziskovalci zbrali v mednarodni raziskovalni skupini Belle II.
Za povečanje natančnosti meritev je bistvenega pomena izboljšati identifikacijo delcev v končnem stanju. V sodelovanju s sodelavci z univerz v Nagoji in Tokiju preizkušamo nov tip krajevno občutljivega detektorja posameznih fotonov, ki naj bi izboljšal identifikacijo delcev v smeri naprej. Zaradi omejenega prostora, ki je na razpolago, smo se odločili za razvoj detektorja obročev Čerenkova brez fokusirnega sistema, ki za sevalno sredstvo uporablja kremenov aerogel [2,6]. Pričakujemo, da bo omogočil zanesljivo identifikacijo kaonov in pionov v območju gibalnih količin okoli 4 GeV/c, ki je bilo z dosedanjim identifikacijskim sistemom nepokrito. Posebej zanimiva novost je uporaba večplastnega sevalca, pri katerem se obroči Čerenkova iz večih plasti z različnim lomnim količnikom pri izbrani gibalni količini na fotonskem detektorju prekrijejo [8]. Ker predvideni prostor za detektor leži znotraj magneta, je pomembna izbira primernega detektorja fotonov, ki bo zanesljivo deloval v visokem magnetnem polju 1.5 T [10].

Pri razvoju in implementaciji identifikacijskih algoritmov [11] koristno uporabljam izkušnje, ki sem jih pridobil pri eksperimentu HERA-B. Zaradi majhnega števila detektiranih fotonov predstavlja algoritem še poseben izziv. Izboljšana identifikacija delcev v končnem stanju omogoča znižanje pogostosti dogodkov iz ozadja, kar dodatno poveča občutljivost aparature za izredno redke procese.

Izkušnje, pridobljene pri delu z razvojem detektorjev fotonov Čerenkova, sem uporabil tudi pri razvoju aparature za detekcijo radiotoksičnega stroncija Sr-90 v okolju, ki jo sestavlja števec fotonov Čerenkova s kremenovim aerogelom kot sevalcem [3,12]. Stroncij se zaradi kemijske sorodnosti prav tako kot kalcij veže v kosteh. Zaradi izjemno dolgega razpolovnega časa 28,5 let in še daljšega biološkega razpolovnega časa 49,3 let je izotop Sr-90 visoko radiotoksičen. Omenjeni izotop stroncija Sr-90 sodi med razpadne produkte iz jedrskih elektrarn, zaradi česar obstaja verjetnost, da pride do njegovega nenadzorovanega izpusta v okolje. Izotop Sr-90 in hčerinski Y-90 sta čista beta sevalca in jih s standardnimi metodami gama spektrometrije ne moremo identificirati. Identifikacijo nuklidov z uporabo beta spektrometrije otežuje dejstvo, da je spekter zvezen, z veliko prekrivajo-čimi se prispevki različnih nuklidov v vzorcu. Standardna metoda temelji na večstopenjski kemijski analizi in je časovno zahtevna in zapletena. Detektor, ki smo ga razvili, izkorišča lastnost, da le elektroni z dovolj visoko energijo sevajo fotone Čerenkova, tisti z energijo pod pragom za sevanje pa ne [3]. Na perspektivnost metode, ki jo uporablja razvita aparatura, kaže tudi velika pozornost, ki je našim rezultatom namenjena v pregledni knjigi o meritvah radioaktivnosti (M.F. L'Annunziata, Handbook of Radioactivity analysis 3rd edition, Elsevier 2012, ISBN-9780123848734).

V času podoktorskega izpopolnjevanja v CERNu sem se priključil raziskovalni skupini ALICE, ki sedaj z analizo razpadnih produktov visokoenergijskih trkov težkih jeder na Velikem hadronskem trkalniku (LHC) v CERNu v Ženevi študira plazmo kvarkov in gluonov. Meritve lastnosti te plazme bodo bistveno prispevali k razumevanju "confinementa" kvarkov in kiralne simetrije v kvantni kromodinamiki. Za rekonstrukcijo sledi in identifikacijo delcev v spektrometru skrbi časovno projekcijska komora. Zaradi velike gostote do 20000 delcev v občutljivi prostornini komore je bilo potrebno razvoju in izdelavi posameznih delov komore nameniti posebno skrb. Sodeloval sem pri načrtovanju in izvedbi sistema za kontrolo visoke napetosti, pri načrtovanju orodij za vizualizacijo podatkov iz komore, pri testiranju čitalne elektronike in pri umerjanju komore po izgradnji. Za umeritev smo uporabili sledi kozmičnih delcev, pa tudi laserskih curkov. Na podlagi rezultatov so dele komore zamenjali z nadomestnimi. Ugotovili smo, da je centralna elektroda zaradi napetosti v konstrukciji rahlo upognjena, kar deloma vpliva na popačitev sicer zelo homogenega električnega polja in posledično na rekostrukcijo sledi.

Izkušnje, pridobljene pri preizkušanju detektorjev fotonov, uporabljam tudi pri delu na področju medicinske fizike, kjer raziskujemo možnosti, ki jih za pozitronsko tomografijo, eno izmed najbolj pomembnih neinvazivnih metod za slikanje živega tkiva, ponuja nova vrsta fotonskega detektorja, silicijeve fotopomnoževalke. Tomograf, v katerem bi uporabili ta detektor, bi lahko bil bolj kompakten, bi lahko deloval v velikih magnetnih poljih (torej v kombinaciji z JMR tomografom), imel boljšo ločljivost in bi omogočal enostavnejše rokovanje. V ljubljanskem laboratoriju za razvoj detektorjev sevanja študiramo dve možnosti za povečanje prostorske in časovne ločljivosti pozitronskega tomografa [16,18,19,20]. Prva je povezana z določitvijo globine interakcije s pomočjo kristalov, ki so različno segmentirani v različnih ravninah. Druga smer razvoja je študij možnosti, da bi z meritvijo časa interakcije anihilacijskih žarkov gama omejili prispevek naključnih koincidenc in na ta način še dodatno povečali uporabnost tomografa. V pozitronskih tomografih je omejujoč faktor, ki vpliva na natančnost rekonstrukcije, časovna ločljivost scintilatorja in senzorja fotonov. Z uporabo fotopomnoževalke z mikrokanalnimi ploščami, ki ima časovno ločljivost za posamezne fotone 22 ps, bistven prispevek prinese scintilator. Z zamenjavo scintilatorja s sevalcem Čerenkovih fotonov, ki so izsevani v trenutku, smo izmerili časovno ločljivost 75ps, kar je trenutno svetovni rekord.

Najpomembnejši znanstveni interesi / dosežki

1. v okviru raziskovalne skupine HERA-B:

- meritev lastnosti večanodnih fotopomnoževalk pri detekciji posameznih fotonov (diplomsko delo) [1]
- načrtovanje, razvoj, umeritev in nadzor delovanja detektorja obročev Čerenkova v spektrometru HERA-B (tema doktorata) [4],
- testiranje in implementacija identifikacijskih algoritmov za HERA-B RICH (tema doktorata) [4]
- meritve reakcij visokoenergijskih protonov s fiksno tarčo [5]

2. v okviru raziskovalne skupine BELLE:

- razvoj detektorja Čerenkovih obročev brez fokusirnega sistema zrcal z uporabo aerogelskega sevalca. Težišče obsega načrtovanje, razvoj, umerjanje, zajemanje in analizo podatkov, ki smo jih zajeli pri:
- preizkušanju prototipa detektorja s kozmičnimi delci na IJS v letih 2001, 2007 in 2008 [2].
- preizkušanju prototipa detektorja v pionskem testnem žarku na inštitutu KEK, Tsukuba na Japonskem v letih 2001, 2003, 2004 in 2005 [6,8].
- razvoj algoritmov za identifikacijo delcev z detektorjem Čerenkovih obročev brez fokusirnega sistema zrcal z uporabo aerogelskega sevalca [11],
- meritev redkih procesov pri razpadih mezonov B in D [7,9].

3. v okviru raziskovalne skupine BELLE II:
- razvoj detektorja Čerenkovih obročev brez fokusirnega sistema zrcal z uporabo aerogelskega sevalca :
  - študij senzorjev fotonov: hibridna plazovna fotodioda , silicijava fotopomnoževalka, fotopomnoževalka z mikrokanalnimi ploščami [2,6,10,13,14,18]
  - načrtovanje in razvoj čitalne elektronike za hibridno plazovno fotodiodo [17]
  - načrtovanje in razvoj čitalne elektronike za matriko silicijevih fotopomnoževalk
  - študij delovanja hibridne plazovne fotodiode in čitalne elektronike pod sevalno obremenitvijo. [poslano v objavo]
  - študij vpliva magnetnega polja na delovanje čitalne elektronike. [15]
  - razvoj algoritmov za identifikacijo delcev z detektorjem Čerenkovih obročev brez fokusirnega sistema zrcal z uporabo aerogelskega sevalca

4. fizika okolja: razvoj detektorja za meritve nizkih aktivnosti radioaktivnega izotopa Sr-90 [3,12]
- pregled in razvoj posameznih sestavnih delov detektorja
- računalniška simulacija odziva detektorja
- izdelava prototipa detektorja
- testiranje detektorja, meritev izkoristkov za različne izvore sevanja in določanje spodnjih mej za detekcijo.

5. medicinska fizika: pozitronska tomografija
- študij pozitronskega tomografa z uporabo silicijevih fotopomnoževalk [18]
- študij pozitronskega tomografa, ki bi izkoriščal čas preleta delcev [16,20]
- študij pozitronskega tomografa za meritev časa preleta s fotoni Čerenkova [19]
- študij meritve globine interakcije z vertikalno segmentiranimi scintilacijskimi kristali.
- postavitev demonstracijske aparature za vajo v okviru predmeta Eksperimentalna medicinska fizika

Znanstvene usmeritve

Svoje znanstveno delo bom nadaljeval na področju Eksperimentalne fizike osnovnih delcev v okviru mednarodne raziskovalne skupine Belle II. Še posebej me zanima študij novih detektorjev fotonov Čerenkova, razvoj metod za identifikacijo osnovnih delcev in študij možne uporabe metod na področju medicinskih aplikacij.

Vabljena predavanja na konferencah in institucijah

- Vabljeno predavanje na European Organisation for Nuclear Resarch (CERN), Ženeva, 10.12.2004: Aerogel RICH for the upgrade of the BELLE spectrometer

Najpomembnejša dela:

[1] KRIZAN, Peter, KORPAR, Samo, PESTOTNIK, Rok, STANIC, Samo, STANOVNIK, Ales, STARIC,Marko,

MICHEL, E., OEHSER, C., SCHMIDT-PARZEFALL, W., SCHWARZ, A., HAMACHER, T., BROEMMELSIEK, D., PYRLIK, J. Tests of a multianode PMT for the HERA-B RICH. Nucl. instrum, methods phys res., Sect. A, Accel.. [Print ed.], 1997, vol. 394, str. 27-34. [COBISS.SI-ID 12670503]

[2] ADACHI, I., BIZJAK, Ilija, KORPAR, Samo, KRIZAN, Peter, PESTOTNIK, Rok, STARIC, Marko, STANOVNIK, Ales. Tests of a proximity focusing RICH with aerogel as radiator. IEEE trans. nucl. sci., 2003, vol. 50, str. 1142-1146. [COBISS.SI-ID 17855015]

[3] PESTOTNIK, Rok, DOLENC, Irena, KORPAR, Samo, KRIZAN, Peter, STANOVNIK, Ales. Cherenkov detector based on aerogel radiator and at panel PMT for detection of 90Sr. V: METZLER, Scott (ur.). 2003 IEEE : Nuclear science symposium [and] Medical Imaging Conference : conference record : 19-25 October 2003, Portland, Oregon, USA. [S.l.]: IEEE: Nuclear & Plasma Sciences Society, 2004, [COBISS.SI-ID 18242343]

[4] ARINO, I., GORISEK, Andrej, KORPAR, Samo, KRIZAN, Peter, PESTOTNIK, Rok, STARIC, Marko, STANOVNIK, Ales, SKRK, Damijan, ZIVKO, Tomi. The HERA-B ring imaging Cherenkov counter. Nucl. instrum, methods phys res., Sect. A, Accel.. [Print ed.], 2004, vol. 516, str. 445-461. [COBISS.SI-ID 17999911]

[5] HERA-B Collaboration, ABT, I., GORISEK, Andrej, KORPAR, Samo, KRIZAN, Peter, PESTOTNIK, Rok, STANOVNIK, Ales, STARIC, Marko, ZIVKO, Tomi. Limits for the central production of Theta+ and Xi-- pentaquarks in 920-GeV pA collissions. Phys. rev. lett., 2004, vol. 21, str. 212003-213003-6. [COBISS.SI-ID 18767911]

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Recenzentstvo

Sem recenzent za naslednje revije:

- Nuclear Inst. and Methods in Physics Research, A ,
- Current Applied Physics

Nosilstvo projektov

Z1-3301: Števec Čerenkovih fotonov z aerogelom kot sevalcem TRAJANJE:1.7.2001 – 30.6.2004, OBSEG: 0,26 FTE

Pedagoška dejavnost

1. **mentorstvo, ime kandidata, dosežen naziv**
   - delovni mentor pri diplomskem delu Irene Dolenc "Določanje aktivnosti Sr-90 z detekcijo fotonov Čerenkova izsevanih v aerogelu", Ljubljana, 2003
   - delovni mentor pri diplomskem delu Andreja Petelina "Identifikacija hadronov z

detektorjem Čerenkovih obročev v spektrometru Belle", Ljubljana, 2007

- raziskovalni mentor pri doktorskem delu Andreja Seljaka, predviden zaključek 2013
- mentor pri doktorskem delu Eve Ribežl, predviden zaključek 2014
- delovni mentor pri doktorskem delu Elvedina Tahiroviča, predviden zaključek 2015

2. sodelovanje pri visokošolskem in specialističnem izobraževanju

Od leta 1999 dalje sem asistent na Fakulteti za matematiko in fiziko Univerze v Ljubljani. Sodelujem pri vodenju vaj oziroma laboratorijskih vaj:

1. 1998/1999 Fizika, Fakulteta za kemijske tehnologijo, Univerza v Ljubljani,
2. 2001/2002 Fizikalni Praktikum II, Fakulteta za matematiko in fiziko Univerze v Ljubljani,
3. 2003-2013, Fizikalni Praktikum III (sedaj Fizikalni praktikum V in VI), Fakulteta za matematiko in fiziko Univerze v Ljubljani,
4. 2003-2013, Fizikalni Praktikum IV (sedaj Fizikalni eksperimenti), Fakulteta za matematiko in fiziko Univerze v Ljubljani,
5. 2004/2005, Fizikalna merjenja II, Fakulteta za matematiko in fiziko Univerze v Ljubljani,
6. 2005, Fizika II, Fakulteta za kemijo in kemijsko tehnologijo Univerze v Mariboru
7. 2010-2013, Eksperimentalna medicinska fizika: vaja pozitronska emisijska tomografija .
8. XI *ICFA* School on Instrumentation in Elementary Particle Physics, Bariloche, Argentina, 2010

V Fizikalnih praktikumih V in VI , pri Fizikalnih eksperimentih in pri Eksperimentalni medicinski fiziki skrbim za eksperimente, ki spadajo na področje fizike jedra in osnovnih delcev oziroma medicinske fizike.

Izpopolnjevanje v tujini

V okvir aktivnega sodelovanja pri delu mednarodnih raziskovalnih skupin HERA-B, BELLE in Belle II spada razvoj in priprava detektorskih sklopov, sodelovanje pri meritvah in analiza zbranih podatkov. Pri razvoju detektorja začetne meritve potekajo na IJS v laboratoriju za razvoj detektorjev fotonskih detektorjev, potem v testnih curkih delcev v tujini, med samim delovanjem pa v glavnem na kolaboracijskih spektrometrih. Poleg stalnih krajših do nekajtedenskih strokovnih izpopolnjevanj v tujini sem bil na izpopolnjevanju večkrat za daljši čas na:

- inštitutu Deutsches Elektronen Synchrotron, Hamburg, Nemčija, maj 1996 (1 mesec) – pred diplomo
- inštitutu Deutsches Elektronen Synchrotron, Hamburg, Nemčija, junij 1999 – september 2000 (16 mesecev) – pred doktoratom
- European Organisation for Nuclear Reasearch (CERN) – Felowship programme, september

2005 – avgust 2006 (12 mesecev) – podoktorsko izpopolnjevanje.

Ljubljana, 10.4.2013 dr. Rok Pestotnik

ROK PESTOTNIK [16354]

Osebna bibliografija za obdobje 1996-2013

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Datum: 08.04.2013

Opomba

Dela iz zadnje elekcijske dobe so obarvana modro, v, kjer sem prvi avtor, pa je moje ime obarvano rdeče.

1.5 Izvirni znanstveni članek

1. Peter Križan, Samo Korpar, Rok Pestotnik, Samo Stanič, Aleš Stanovnik, Marko Starič, E. Michel, C. Oehser, W. Schmidt-Parzefall, A. Schwarz, T. Hamacher, D. Broemmelsiek, J. Pyrlik, (13 avtorjev) , **Tests of a multianode PMT for the HERA-B RICH**, Nucl. instrum, methods phys res., Sect. A, Accel., (1997) vol. 394, , str. 27-34, ISBN 0168-9002, COBISS-ID 12670503, IF: 0.89, SE: RY - nuclear science & technology ; 6/34 ; četrtina: 1 ; x=0.548 ; IFmin: 0.552 ; IFmax: 4.455 UP - physics, particles & fields ; 12/16 ; četrtina: 3 ; x=1.697 ; IFmin: 0.89 ; IFmax: 1.358 OA - instruments & instrumentation ; 11/46 ; četrtina: 1 ; x=0.562 ; IFmin: 0.858 ; IFmax: 2.231 XQ - spectroscopy ; 25/35 ; četrtina: 3 ; x=1.52 ; IFmin: 0.665 ; IFmax: 1.156,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	13	22	10	18	27	15	27

2. Peter Križan, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, Tomi Živko, (25 avtorjev) , **The physics potential of the HERA-B RICH**, Nucl. instrum, methods phys res., Sect. A, Accel., (1999) vol. 433, , str. 357-365, ISBN 0168-9002, COBISS-ID 14384167, IF: 0.921, SE: OA - instruments & instrumentation ; 16/52 ; četrtina: 2 ; x=0.61 ; IFmin: 0.444 ; IFmax: 0.941 RY - nuclear science & technology ; 6/30 ; četrtina: 1 ; x=0.679 ; IFmin: 0.641 ; IFmax: 4.429 UP - physics, particles & fields ; 14/18 ; četrtina: 3 ; x=2.17 ; IFmin: 0.921 ; IFmax: 1.351 XQ - spectroscopy ; 26/34 ; četrtina: 3 ; x=1.782 ; IFmin: 0.921 ; IFmax: 1.346,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	25	3	2	3	3	2	3

3. K. Lau, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, Tomi Živko, (9 avtorjev) , **The first year of the HERA-B rich**, IEEE trans. nucl. sci., (2000) vol. 47, , str. 789-792, ISBN 0018-9499, COBISS-ID 15834663, IF: 1.06, SE: IQ - engineering, electrical & electronic ; 42/204 ; četrtina: 1 ; x=0.673 ; IFmin: 0.983 ; IFmax: 4.909 RY - nuclear science & technology ; 4/30 ; četrtina: 1 ; x=0.686 ; IFmin: 0.716 ; IFmax: 5.062,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.889	9	0	0	0			

4. Samo Korpar, Peter Križan, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Damijan Škrk, (7 avtorjev) , **Multianode photomultipliers as position-sensitive detectors of single photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2000) vol. 442, , str. 316-321, ISBN 0168-9002, COBISS-ID 15121959, IF: 0.964, SE: OA - instruments & instrumentation ; 9/52 ; četrtina: 1 ; x=0.55 ; IFmin: 0.894 ; IFmax: 1.948 RY - nuclear science & technology ; 5/30 ; četrtina: 1 ; x=0.686 ; IFmin: 0.716 ; IFmax: 5.062 UP - physics, particles & fields ; 12/19 ; četrtina: 3 ; x=1.99 ; IFmin: 0.508 ; IFmax: 1.022 XQ - spectroscopy ; 25/37 ; četrtina: 3 ; x=1.699 ; IFmin: 0.776 ; IFmax: 1.245,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.143	7	13	4	6	13	6	9

5. I. Ariño, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, Damijan Škrk, Tomi Živko, (27 avtorjev) , **The HERA-B RICH**, Nucl. instrum, methods phys res., Sect. A, Accel., (2000) vol. 453, , str. 289-295, ISBN 0168-9002, COBISS-ID 15536679, IF: 0.964, SE: OA - instruments & instrumentation ; 9/52 ; četrtina: 1 ; x=0.55 ; IFmin: 0.894 ; IFmax: 1.948 RY - nuclear science & technology ; 5/30 ; četrtina: 1 ; x=0.686 ; IFmin: 0.716 ; IFmax: 5.062 UP - physics, particles & fields ; 12/19 ; četrtina: 3 ; x=1.99 ; IFmin: 0.508 ; IFmax: 1.022 XQ - spectroscopy ; 25/37 ; četrtina: 3 ; x=1.699 ; IFmin: 0.776 ; IFmax: 1.245,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	27	9	4	6			

6. Peter Križan, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Marko Starič, Aleš Stanovnik, Damijan Škrk, Tomi Živko, (27 avtorjev) , **The performance of the HERA-B RICH at high track densities**, Nucl. instrum, methods phys res., Sect. A, Accel., (2001) vol. 471, , str. 30-34, ISBN 0168-9002, COBISS-ID 16303399, IF: 1.026, SE: OA - instruments & instrumentation ; 13/48 ; četrtina: 2 ; x=0.624 ; IFmin: 0.452 ; IFmax: 1.026 RY - nuclear science & technology ; 6/33 ; četrtina: 1 ; x=0.724 ; IFmin: 0.771 ; IFmax: 7.192 UP - physics, particles & fields ; 13/20 ; četrtina: 3 ; x=2.481 ; IFmin: 0.919 ; IFmax: 1.119 XQ - spectroscopy ; 28/40 ; četrtina: 3 ; x=1.853 ; IFmin: 0.85 ; IFmax: 1.411,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	27	2	0	0	2	0	0

7. Samo Korpar, Ilija Bizjak, Andrej Gorišek, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, (7 avtorjev) , **Surface sensitivity of multianode photomultiplier tubes : presented at Ninth International Conference on Instrumentation, Vienna, Austria, February 19-23, 2001**, Nucl. instrum, methods phys res., Sect. A, Accel., (2002) vol. 478, , str. 391-394, ISBN 0168-9002, COBISS-ID 16629543, IF: 1.167, SE: OA - instruments & instrumentation ; 9/52 ; četrtina: 1 ; x=0.619 ; IFmin: 0.885 ; IFmax: 1.893 RY - nuclear science & technology ; 5/33 ; četrtina: 1 ; x=0.759 ; IFmin: 0.948 ; IFmax: 4.808 UP - physics, particles & fields ; 11/19 ; četrtina: 3 ; x=2.523 ; IFmin: 0.891 ; IFmax: 1.167 XQ - spectroscopy ; 22/38 ; četrtina: 3 ; x=1.732 ; IFmin: 0.956 ; IFmax: 1.251,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.143	7	4	1	2	6	3	5

8. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, (308 avtorjev) , **Measurement of the bb[bar] production cross section in 920 GeV fixed-target proton-nucleus collisions**, The European physical journal. C, (2003) vol. 26, , str. 345-355, ISBN 1434-6044, COBISS-ID 17349927, IF: 3.58, SE: UP - physics, particles & fields ; 6/19 ; četrtina: 2 ; x=2.43 ; IFmin: 1.345 ; IFmax: 3.58,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	308	19	15	6	8	8	3

9. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, Tomi Živko, (309 avtorjev) , **Inclusive V° production cross sections from 920 GeV fixed target proton-nucleus collisions**, The European physical journal. C, (2003) vol. 29, , str. 181-190, ISBN 1434-6044, COBISS-ID 17855527, IF: 3.58, SE: UP - physics, particles & fields ; 6/19 ; četrtina: 2 ; x=2.43 ; IFmin: 1.345 ; IFmax: 3.58,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	309	11	6	2			

10. I. Adachi, Ilija Bizjak, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, (13 avtorjev) , **Tests of a proximity focusing RICH with aerogel as radiator**, IEEE trans. nucl. sci., (2003) vol. 50, , str. 1142-1146, ISBN 0018-9499, COBISS-ID 17855015, IF: 1.119, SE: IQ - engineering, electrical &

electronic ; 57/205 ; četrtina: 2 ; x=0.912 ; IFmin: 0.64 ; IFmax: 1.169 RY - nuclear science & technology ; 5/33 ; četrtina: 1 ; x=0.75 ; IFmin: 0.782 ; IFmax: 5.971,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	13	2	0	0	3	1	1

11. Toru Iijima, Ilija Bizjak, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, (13 avtorjev) , **Tests of a proximity focusing RICH with aerogel as radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2003) vol. 502, , str. 231-235, ISBN 0168-9002, COBISS-ID 17855271, IF: 1.166, SE: OA - instruments & instrumentation ; 10/49 ; četrtina: 1 ; x=0.728 ; IFmin: 1 ; IFmax: 2.391 RY - nuclear science & technology ; 4/33 ; četrtina: 1 ; x=0.75 ; IFmin: 0.782 ; IFmax: 5.971 UP - physics, particles & fields ; 11/19 ; četrtina: 3 ; x=2.43 ; IFmin: 0.753 ; IFmax: 1.166 XQ - spectroscopy ; 26/41 ; četrtina: 3 ; x=1.644 ; IFmin: 0.874 ; IFmax: 1.308,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	13	4	1	1	6	3	4

12. ===> Rok Pestotnik, Ilija Bizjak, Andrej Gorišek, Samo Korpar, Peter Križan, Marko Starič, Aleš Stanovnik, (7 avtorjev) , **Lens-based collection system for a proximity focusing RICH : presented Beaune 2002, Third Internation Conference on New Developments in Photon Detector, Beaune, France, June 17-21, 2002**, Nucl. instrum, methods phys res., Sect. A, Accel., (2003) vol. 504, , str. 237-239, ISBN 0168-9002, COBISS-ID 17644071, IF: 1.166, SE: OA - instruments & instrumentation ; 10/49 ; četrtina: 1 ; x=0.728 ; IFmin: 1 ; IFmax: 2.391 RY - nuclear science & technology ; 4/33 ; četrtina: 1 ; x=0.75 ; IFmin: 0.782 ; IFmax: 5.971 UP - physics, particles & fields ; 11/19 ; četrtina: 3 ; x=2.43 ; IFmin: 0.753 ; IFmax: 1.166 XQ - spectroscopy ; 26/41 ; četrtina: 3 ; x=1.644 ; IFmin: 0.874 ; IFmax: 1.308,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.143	7	1	1	1	1	1	1

13. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, Tomi Živko, (308 avtorjev) , **J/[Psi]production via X[sub]c decays in 920 GeV pA interactions**, Phys. lett., Sect. B, (2003) vol. 561, , str. 61-72, ISBN 0370-2693, COBISS-ID 17856295, IF: 4.066, SE: UI - physics, multidisciplinary ; 6/68 ; četrtina: 1 ; x=1.855 ; IFmin: 1.543 ; IFmax: 28.172,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	308	25	23	12	26	25	13

14. Iris Abt, Andrej Gorišek, Peter Križan, Samo Korpar, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, Tomi Živko, (307 avtorjev) , **Measurement of the bb[bar] production cross section in 920 GeV fixed-target proton-nucleus collisions**, The European physical journal. C, (2004) vol. 26, , str. 345-355, ISBN 1434-6044, COBISS-ID 18471207, IF: 3.486, SE: UP - physics, particles & fields ; 7/21 ; četrtina: 2 ; x=2.718 ; IFmin: 1.589 ; IFmax: 3.486,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	307						

15. I. Ariño, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, Damijan Škrk, Tomi Živko, (9 avtorjev) , **The HERA-B ring imaging Cherenkov counter**, Nucl. instrum, methods phys res., Sect. A, Accel., (2004) vol. 516, , str. 445-461, ISBN 0168-9002, COBISS-ID 17999911, IF: 1.349, SE: OA - instruments & instrumentation ; 9/48 ; četrtina: 1 ; x=0.807 ; IFmin: 1.128 ; IFmax: 2.194 RY - nuclear science & technology ; 5/31 ; četrtina: 1 ; x=0.853 ; IFmin: 0.997 ; IFmax: 6.885 UP - physics, particles & fields ; 13/21 ; četrtina: 3 ; x=2.718 ; IFmin: 0.944 ; IFmax: 1.533 XQ - spectroscopy ; 22/42 ; četrtina: 2 ; x=1.839 ; IFmin: 1.349 ; IFmax: 2.194,

STD	STK	Št.	WoS: št.	čistih	normirano št.	Scopus: št.	čistih	normirano št.

		avtorjev	citatov (TC)	citatov (CI)	čistih citatov (NC)	citatov (TC)	citatov (CI)	čistih citatov (NC)
8	0.889	9	30	8	9	33	11	13

16. Takahiro Matsumoto, Samo Korpar, Saša Fratina, Peter Križan, Rok Pestotnik, (17 avtorjev) , **Studies of a proximity focusing RICH with aerogel radiator : presented at 9th Pisa Meeting on Advanced Detectors: frontier detectors for frontier physics, 25-31 May 2003, La Biodola, Isola d'Elba, Italy**, Nucl. instrum, methods phys res., Sect. A, Accel., (2004) vol. 518, , str. 582-585, ISBN 0168-9002, COBISS-ID 18263847, IF: 1.349, SE: OA - instruments & instrumentation ; 9/48 ; četrtina: 1 ; x=0.807 ; IFmin: 1.128 ; IFmax: 2.194 RY - nuclear science & technology ; 5/31 ; četrtina: 1 ; x=0.853 ; IFmin: 0.997 ; IFmax: 6.885 UP - physics, particles & fields ; 13/21 ; četrtina: 3 ; x=2.718 ; IFmin: 0.944 ; IFmax: 1.533 XQ - spectroscopy ; 22/42 ; četrtina: 2 ; x=1.839 ; IFmin: 1.349 ; IFmax: 2.194,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	17	10	3	4	15	6	7

17. Takahiro Matsumoto, Samo Korpar, Saša Fratina, Peter Križan, Rok Pestotnik, (17 avtorjev) , **Studies of proximity focusing RICH with an aerogel radiator using flat-panel multi-anode PMTs (Hamamatsu H8500)**, Nucl. instrum, methods phys res., Sect. A, Accel., (2004) vol. 521, , str. 367-377, ISBN 0168-9002, COBISS-ID 18249511, IF: 1.349, SE: OA - instruments & instrumentation ; 9/48 ; četrtina: 1 ; x=0.807 ; IFmin: 1.128 ; IFmax: 2.194 RY - nuclear science & technology ; 5/31 ; četrtina: 1 ; x=0.853 ; IFmin: 0.997 ; IFmax: 6.885 UP - physics, particles & fields ; 13/21 ; četrtina: 3 ; x=2.718 ; IFmin: 0.944 ; IFmax: 1.533 XQ - spectroscopy ; 22/42 ; četrtina: 2 ; x=1.839 ; IFmin: 1.349 ; IFmax: 2.194,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	17	25	10	12	29	14	16

18. ===> Rok Pestotnik, Saša Fratina, Samo Korpar, Peter Križan, Marko Starič, Aleš Stanovnik, (19 avtorjev) , **Proximity focusing RICH with flat panel PMT (Hamamatsu H8500) as photon detector and aerogel radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2004) vol. 525, , str. 158-162, ISBN 0168-9002, COBISS-ID 18327847, IF: 1.349, SE: OA - instruments & instrumentation ; 9/48 ; četrtina: 1 ; x=0.807 ; IFmin: 1.128 ; IFmax: 2.194 RY - nuclear science & technology ; 5/31 ; četrtina: 1 ; x=0.853 ; IFmin: 0.997 ; IFmax: 6.885 UP - physics, particles & fields ; 13/21 ; četrtina: 3 ; x=2.718 ; IFmin: 0.944 ; IFmax: 1.533 XQ - spectroscopy ; 22/42 ; četrtina: 2 ; x=1.839 ; IFmin: 1.349 ; IFmax: 2.194,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	19	1	1	1	1	1	1

19. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (182 avtorjev) , **Limits for the central production of [Theta][sup]+ and [Xi][sup](--) pentaquarks in 920-GeV pA collissions**, Phys. rev. lett., (2004) vol. 21, , str. 212003-213003-6, ISBN 0031-9007, COBISS-ID 18767911, IF: 7.218, SE: UI - physics, multidisciplinary ; 4/67 ; četrtina: 1 ; x=2.075 ; IFmin: 1.666 ; IFmax: 32.771,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	182	54	52	25	65	64	31

20. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (190 avtorjev) , **Search for the flavor-changing neutral current decay D[sup]0 [to] [mu][sup]+[mu][sup]- with the HERA-B detector**, Phys. lett., Sect. B, (2004) vol. 596, , str. 173-183, ISBN 0370-2693, COBISS-ID 18410535, IF: 4.619, SE: UI - physics, multidisciplinary ; 7/67 ; četrtina: 1 ; x=2.075 ; IFmin: 1.666 ; IFmax: 32.771,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	190	9	7	3	10	9	4

21. A. Zoccoli, Andrej Gorišek, Samo Korpar, Peter Križan, Samo Korpar, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (189 avtorjev) , **Charm, beauty and charmonium production at HERA-B**, The European physical journal. C, (2005) vol. 43, , str. 179-186, ISBN 1434-6044, COBISS-ID 19555623, IF: 3.209, SE: UP - physics, particles & fields ; 8/21 ; četrtina: 2 ; x=2.591 ; IFmin: 1.659 ; IFmax: 3.584,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	189	12	10	4			

22. T. Iijima, Samo Korpar, Saša Fratina, Andrej Gorišek, Peter Križan, Rok Pestotnik, (22 avtorjev) , **A novel type of proximity focusing RICH counter with multiple refractive index aerogel radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2005) vol. 548, , str. 383-390, ISBN 0168-9002, COBISS-ID 19287847, IF: 1.224, SE: OA - instruments & instrumentation ; 14/52 ; četrtina: 2 ; x=0.893 ; IFmin: 0.853 ; IFmax: 1.224 RY - nuclear science & technology ; 4/32 ; četrtina: 1 ; x=0.641 ; IFmin: 0.981 ; IFmax: 1.923 UP - physics, particles & fields ; 15/21 ; četrtina: 3 ; x=2.591 ; IFmin: 0.914 ; IFmax: 1.472 XQ - spectroscopy ; 27/41 ; četrtina: 3 ; x=1.971 ; IFmin: 1.027 ; IFmax: 1.372,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	35	15	23	44	19	30

23. Peter Križan, Saša Fratina, Andrej Gorišek, Samo Korpar, Rok Pestotnik, (22 avtorjev) , **Proximity focusing RICH with flat panel PMT as photon detector and aerogel as radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2005) vol. 553, , str. 58-63, ISBN 0168-9002, COBISS-ID 19491111, IF: 1.224, SE: OA - instruments & instrumentation ; 14/52 ; četrtina: 2 ; x=0.893 ; IFmin: 0.853 ; IFmax: 1.224 RY - nuclear science & technology ; 4/32 ; četrtina: 1 ; x=0.641 ; IFmin: 0.981 ; IFmax: 1.923 UP - physics, particles & fields ; 15/21 ; četrtina: 3 ; x=2.591 ; IFmin: 0.914 ; IFmax: 1.472 XQ - spectroscopy ; 27/41 ; četrtina: 3 ; x=1.971 ; IFmin: 1.027 ; IFmax: 1.372,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	7	5	8	5	4	6

24. Samo Korpar, Saša Fratina, Andrej Gorišek, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (23 avtorjev) , **RICH with multiple aerogel layers of different refractive index**, Nucl. instrum, methods phys res., Sect. A, Accel., (2005) vol. 553, , str. 64-69, ISBN 0168-9002, COBISS-ID 19490599, IF: 1.224, SE: OA - instruments & instrumentation ; 14/52 ; četrtina: 2 ; x=0.893 ; IFmin: 0.853 ; IFmax: 1.224 RY - nuclear science & technology ; 4/32 ; četrtina: 1 ; x=0.641 ; IFmin: 0.981 ; IFmax: 1.923 UP - physics, particles & fields ; 15/21 ; četrtina: 3 ; x=2.591 ; IFmin: 0.914 ; IFmax: 1.472 XQ - spectroscopy ; 27/41 ; četrtina: 3 ; x=1.971 ; IFmin: 1.027 ; IFmax: 1.372,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	23	9	9	14	10	10	16

25. I. Adachi, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (23 avtorjev) , **Study of highly transparent silica aerogel as a RICH radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2005) vol. 553, , str. 146-151, ISBN 0168-9002, COBISS-ID 19555879, IF: 1.224, SE: OA - instruments & instrumentation ; 14/52 ; četrtina: 2 ; x=0.893 ; IFmin: 0.853 ; IFmax: 1.224 RY - nuclear science & technology ; 4/32 ; četrtina: 1 ; x=0.641 ; IFmin: 0.981 ; IFmax: 1.923 UP - physics, particles & fields ; 15/21 ; četrtina: 3 ; x=2.591 ; IFmin: 0.914 ; IFmax: 1.472 XQ - spectroscopy ; 27/41 ; četrtina: 3 ; x=1.971 ; IFmin: 1.027 ; IFmax: 1.372,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	23	10	7	11	16	11	17

26. M. Saigo, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Peter Križan, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (178 avtorjev) , **Study of the suppressed decays B[sup]- [to] [K[sup]+[pi]-][sub]Dk[sup]- and B[sup]- [to] [K[sup]+[pi]-][sub]D[pi][sup]-**, Phys. rev. lett., (2005) vol. 94, , str. 091601-1-091601-6, ISBN 0031-9007, COBISS-ID 19015463, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	178	7	5	3			

27. Heyoung Yang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (152 avtorjev) , **Observation of B[sup]+ [to] K[sub]1(1270)[sup]+ [gamma]**, Phys. rev. lett., (2005) vol. 94, , str. 111802-1-111802-5, ISBN 0031-9007, COBISS-ID 19020327, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	152	34	34	17	30	30	15

28. R. Mizuk, Urban Bitenc, Ilija Bizjak, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (158 avtorjev) , **Observation of an isotriplet of excited charmed baryons decaying to([Lambda][sub]c)[sup]+[pi]**, Phys. rev. lett., (2005) vol. 94, , str. 122002-1-12202-5, ISBN 0031-9007, COBISS-ID 19016231, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	158	33	31	16	36	34	17

29. S.-K. Choi, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (122 avtorjev) , **Observation of a near-threshold [omega]J/[psi] mass enhancement in exclusive B[to] K[[omega]J/[psi] decays**, Phys. rev. lett., (2005) vol. 94, , str. 182002-1-182002-6, ISBN 0031-9007, COBISS-ID 19175975, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	122	107	94	47	191	179	90

30. K.-F. Chen, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (183 avtorjev) , **Measurement of polarization and triple-product correlations in B [to] [phi]K[sup]* decays**, Phys. rev. lett., (2005) vol. 94, , str. 221804-1-221804-5, ISBN 0031-9007, COBISS-ID 19167527, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	183	66	63	32	70	67	34

31. K. Abe, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (164 avtorjev) , **Observation of the D[sub]1(2420) [to]D[pi][sup]+[pi][sup]- decays**, Phys. rev. lett., (2005) vol. 94, , str. 221805-1-22805-6, ISBN 0031-9007, COBISS-ID 19172647, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	5	4	2			

32. A. Drutskoy, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (165 avtorjev) , **Observation of B[bar][sup]0 [to] D[sup]*[sub](sJ)(2317)[sup]+K[sup]-decay**, Phys. rev. lett., (2005) vol. 94, iss. 6, str. 061802-1-061802-6, ISBN 0031-9007, COBISS-ID 19015207, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	165	18	14	7	22	18	9

33. Y. Ushiroda, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (164 avtorjev) , **Measurement of the time-dependent CP-violating asymmetry in B[sup]0 [to] (K[sub]s)[sup]0 [pi][sup]0[gamma] decays**, Phys. rev. lett., (2005) vol. 94, no. 23, str. 231601-1-231601-5, ISBN 0031-9007, COBISS-ID 446203, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	10	8	4			

34. G. Majumder, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (127 avtorjev) , **Evidence for B° [to] D[sup]+D[sup]- and observation of B[sup]- [to] D°D*[sup]- decays**, Phys. rev. lett., (2005) vol. 95, , str. 041803-1-041803-5, ISBN 0031-9007, COBISS-ID 19176487, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	127	6	4	2			

35. K. Sumisawa, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (135 avtorjev) , **Measurement of time-dependent CP-violating asymmetris in B° [to]K°[sub]sK°[sub]sK°[sub]s decays**, Phys. rev. lett., (2005) vol. 95, , str. 061801-061801-6, ISBN 0031-9007, COBISS-ID 19176743, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	135	11	4	2			

36. X. C. Tian, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (164 avtorjev) , **Measurement of the wrong-sing decays D[sup]0 [to] K[sup]+[pi][sup]-[pi][sup]0 and D[sup]0 [to] K[sup]+[pi][sup]-[pi][sup]+[piđ[sup]-, and search for CP violation**, Phys. rev. lett., (2005) vol. 95, , str. 231801-1-231801-5, ISBN 0031-9007, COBISS-ID 19551271, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	15	14	7	15	15	8

37. K. Abe, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (176 avtorjev) , **Measurements of B decays to two kaons**, Phys. rev. lett., (2005) vol. 95, , str. 231802-1-231802-5, ISBN 0031-9007, COBISS-ID 19550503, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	176	8	7	4	6	5	3

38. Ilija Bizjak, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, Dejan Žontar, (169 avtorjev) , **Determination of parallel to V-ub parallel to from measurements of the inclusive charmless semileptonic partial rates of B mesons using full reconstruction tags**, Phys. rev. lett., (2005) vol. 95, , str. 241801-1-241801-6, ISBN 0031-9007, COBISS-ID 19551783, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	169	18	17	9	23	22	11

39. Y.-J. Lee, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (165 avtorjev) , **Observation of B[sup]+ [to] p [Lambda][bar][gamma]**, Phys. rev. lett., (2005) vol. 95, no. 6, str. 061802-1-061802-5, ISBN 0031-9007, COBISS-ID 445947, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	165	15	10	5	17	12	6

40. R. Itoh, Urban Bitenc, Ilija Bizjak, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (179 avtorjev) , **Studies of CP violation in B [to] J/[psi]K[sup]* decays**, Phys. rev. lett., (2005) vol. 95, no. 9, str. 091601-1-091601-6, ISBN 0031-9007, COBISS-ID 445691, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	179	29	25	13	36	33	17

41. K. Abe, Urban Bitenc, Ilija Bizjak, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (190 avtorjev) , **Improved evidence for direct CP violation in B[sup]0 [to][pi][sup]+[pi][sup]- decays and model-independant constraints on [phi](2)**, Phys. rev. lett., (2005) vol. 95, no. 10, str. 101801-1-101801-6, ISBN 0031-9007, COBISS-ID 445435, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	190	18	15	8	26	23	12

42. J. Zhang, Urban Bitenc, Ilija Bizjak, Saša Fratina, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Samo Korpar, Samo Stanič, Marko Starič, Dejan Žontar, (148 avtorjev) , **Measurement of the branching fraction and polarization in B[sup]+ [to][rho][sup]+K[sup](*0) decays**, Phys. rev. lett., (2005) vol. 95, no. 14, str. 141801-1-141801-5, ISBN 0031-9007, COBISS-ID 445179, IF: 7.489, SE: UI - physics, multidisciplinary ; 4/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	148	20	17	9	28	25	13

43. K. Abe, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (108 avtorjev) , **Improved measurement of CP-violation parameters sin 2[phi][sub]1 and [lambda], B meason lifetimes, and B[sup]0 B{bar}[sup]0 mixing parameter [Delta]m[sub]d**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 71, , str. 072003-1-072003-12, ISBN 1550-7998, COBISS-ID 19226151, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	108	60	43	15	63	50	18

44. M.-C. Chang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (126 avtorjev) , **Search for B° [to] [pi][pi][bar], B[bar]° [to] [Lambda][Lambda][bar], and B[sup]+ [to] p[Lambda][bar] at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 71, , str. 072007-1-072007-5, ISBN 1550-7998, COBISS-ID 19175719, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	126	8	7	3			

45. P. Chang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (158 avtorjev) , **Measurements of brancing fractions and CP asymmetries in B [to] [eta]h decays**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 71, , str. 091106-1-091106-6, ISBN 1550-7998, COBISS-ID 19172391, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	158	12	10	4			

46. L. M. Zhang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (153 avtorjev) , **Search for B° [to] J/[psi]D[bar]°[pi][sup]+ decays**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 71, , str. 091107-1-091107-5, ISBN 1550-7998, COBISS-ID 19172135, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	153	2	2	1	21	19	7

47. A. Garmash, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (176 avtorjev) , **Dalitz analysis of the three-body charmless decays B[sup]+ [to]K[sup]+[pi][sup]- and B[sup]+ [to] K[sub]+K[sup]+K[sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 71, , str. 092003-1-092003-24, ISBN 1550-7998, COBISS-ID 19172903, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	176	66	57	20	73	62	22

48. Durga Prasad Mohapatra, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (145 avtorjev) , **Search for the b[to]d[gamma]process**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 72, , str. 011101-1-011101-5, ISBN 1550-7998, COBISS-ID 19171367, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	2	1	0			

49. J. Schümann, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (118 avtorjev) , **Observation of B[bar][sup]0 [to] D[sup]0[eta][prime] and B[bar][sup]0 [to]D[sup]([ast]0)[eta][sup][prime]**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 72, , str. 011103-1-011103-6, ISBN 1550-7998, COBISS-ID 19175463, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	118	4	3	1	14	12	4

50. Q. L. Xie, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Samo Stanič, Marko Starič, (155 avtorjev) , **Observation of B[sup]- [to] J/[psi][lambda]p[bar] and searches for B[sup]- [to] J/[psi][sigma][sup]0 p[bar] and B[sup]0 [to] J/[psi]p p[bar] decays**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 72, , str. 051105-1-051105-6, ISBN 1550-7998, COBISS-ID 447995, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	155	12	10	4			

51. D. Liventsev, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (137 avtorjev) , **Measurement of the branching fractions for B[sup]- [to] D[sup](*)+ [pi][sup]-l[sup]- ([nu][bar])[sub]l and B[bar][sup]0 [to] D[sup](*)0 [pi][sup]+ l[sup]-([nu][bar])[sub]l**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 72, , str. 051109-1-051109-7, ISBN 1550-7998, COBISS-ID 447739, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	137	7	3	1			

52. Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (286 avtorjev) , **Search for D[sup]0 - D[bar][sup]0 mixing using semileptonic decays at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 72, , str. 071101-1-071101-6, ISBN 1550-7998, COBISS-ID 447483, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	286	11	9	3			

53. M. Iwasaki, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (180 avtorjev) , **Improved measurement of the electroweak penguin process B -> X(s)l(+)l(-)**, Phys. rev., D Part. fields gravit. cosmol., (2005) vol. 72, , str. 092005-1-092005-10, ISBN 1550-7998, COBISS-ID 19554343, IF: 4.852, SE: BU - astronomy & astrophysics ; 8/46 ; četrtina: 1 ; x=2.79 ; IFmin: 3.451 ; IFmax: 18.567 UP - physics, particles & fields ; 4/21 ; četrtina: 1 ; x=2.591 ; IFmin: 4.047 ; IFmax: 6.739,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	180	89	84	30	50	50	18

54. Shohei Nishida, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (176 avtorjev) , **Observation of B[sup]+ [to]K[sup]+[ni][gamma]**, Phys. lett., Sect. B, (2005) vol. 610, , str. 23-30, ISBN 0370-2693, COBISS-

ID 19167783, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	176	16	15	8	17	17	9

55. K. Hayasaka, Urban Bitenc, Ilija Bizjak, Saša Fratina, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (142 avtorjev) , **Search for [tau] [to] e[gamma] decay at Belle**, Phys. lett., Sect. B, (2005) vol. 613, , str. 20-28, ISBN 0370-2693, COBISS-ID 19170599, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	142	23	19	10	22	17	9

56. T. Okabe, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (171 avtorjev) , **Spectra of prompt electrons from decays of B[sup]+ and B° mesons and ratio of inclusive semielectronic branching fractions**, Phys. lett., Sect. B, (2005) vol. 614, , str. 27-36, ISBN 0370-2693, COBISS-ID 19170855, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	171	3	2	1	3	2	1

57. N. Nakazawa, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (152 avtorjev) , **Measurement of the [gamma][gamma] [to] [pi][sup]+[pi][sup]- and [gamma][gamma][to] K[sup]+K[sup]- processes at energies of 2.4-4.1 GeV**, Phys. lett., Sect. B, (2005) vol. 615, , str. 39-49, ISBN 0370-2693, COBISS-ID 19167271, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	152	32	24	12	33	25	13

58. M.-Z. Wang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Peter Križan, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (162 avtorjev) , **Study of the baryon-antibaryon low-mass enhancements in charmless three-body baryonic B decays**, Phys. lett., Sect. B, (2005) vol. 617, , str. 141-149, ISBN 0370-2693, COBISS-ID 19171879, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	162	38	32	16	36	30	15

59. H. Miyake, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (184 avtorjev) , **Branching fraction, polarization and CP-violating asymmetris in B° [to]D[sup]{*+}D[sub]{*-} decays**, Phys. lett., Sect. B, (2005) vol. 618, , str. 34-42, ISBN 0370-2693, COBISS-ID 19173415, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	184	16	13	7	17	13	7

60. A. Limosani, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (155 avtorjev) , **Measurement of**

[vertical] (V[sub](ub)) [vertical] nearthe endpoint of the electron momentum spectrum from semileptonic B-meson decays, Phys. lett., Sect. B, (2005) , vol. 621, str. 28-40, ISBN 0370-2693, COBISS-ID 441339, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	155	18	18	9	23	23	12

61. C. C. Kuo, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (145 avtorjev) , **Measurement of ([gamma][gamma])[to] p(p[bar]) production at Belle**, Phys. lett., Sect. B, (2005) , vol. 621, str. 41-55, ISBN 0370-2693, COBISS-ID 441595, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	19	14	7	20	15	8

62. T. Gershon, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (170 avtorjev) , **Time-dependent C P violation effects in partially reconstructed B[sup]0 [to] D [sup](*[sup][minus plus]) [pi][sup][plus minus] decays**, Phys. lett., Sect. B, (2005) , vol. 624, str. 11-21, ISBN 0370-2693, COBISS-ID 442107, IF: 5.301, SE: UI - physics, multidisciplinary ; 6/69 ; četrtina: 1 ; x=1.997 ; IFmin: 1.76 ; IFmax: 30.254,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	170	7	5	3			

63. Špela Stres, Rok Pestotnik, (2 avtorjev) , **Study of possibilities for a spin flip in high energy elecron ring HERA**, IEEE trans. nucl. sci., (2006) vol. 53, , str. 484-490, ISBN 0018-9499, COBISS-ID 20083495, IF: 1.497, SE: IQ - engineering, electrical & electronic ; 41/206 ; četrtina: 1 ; x=0.942 ; IFmin: 1.246 ; IFmax: 4.5 RY - nuclear science & technology ; 1/32 ; četrtina: 1 ; x=0.655 ; IFmin: 0.924 ; IFmax: 1.497,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	4	2	0	0	0			

64. Peter Križan, Saša Fratina, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Aleš Stanovnik, (22 avtorjev) , **Test of the Burle 85011 64-anode MCP PMT as a detector of Cherenkov photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2006) vol. 567, issue 1, str. 124-128, ISBN 0168-9002, COBISS-ID 21168679, IF: 1.185, SE: OA - instruments & instrumentation ; 18/53 ; četrtina: 2 ; x=0.99 ; IFmin: 0.829 ; IFmax: 1.228 RY - nuclear science & technology ; 5/32 ; četrtina: 1 ; x=0.655 ; IFmin: 0.924 ; IFmax: 1.497 UP - physics, particles & fields ; 14/21 ; četrtina: 3 ; x=2.536 ; IFmin: 0.914 ; IFmax: 1.474 XQ - spectroscopy ; 26/39 ; četrtina: 3 ; x=2.028 ; IFmin: 0.851 ; IFmax: 1.438,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	14	3	5	17	4	6

65. S. Uehara, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, (146 avtorjev) , **Observation of a X'[sub](c2) candidate in [gamma][gamma][to] DD [bar] production at Belle**, Phys. rev. lett., (2006) vol. 96, no. 8, str. 082003-1-082003-6, ISBN 0031-9007, COBISS-ID 19734567, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	146	90	83	36	111	103	45

66. L. M. Zhang, Ilija Bizjak, Marko Bračko, Urban Bitenc, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (172 avtorjev) , **Improved constraints on D[sup]0-D[bar][sup]0 mixing in D[sup]0 [to]K[sup]+[pi][sup]- decays from the Belle detector**, Phys. rev. lett., (2006) vol. 96, no. 15, str. 151801-1-151801-6, ISBN 0031-9007, COBISS-ID 19834151, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	172	38	34	15	52	49	22

67. A. Somov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (172 avtorjev) , **Measurement of the branching fraction, polarization, and CP asymmetry for B° [to] [rho][sup]+[rho][sup]- decays, and determination of the Cabibbo-Kobayashi-Maskawa phase [fi][sub]2**, Phys. rev. lett., (2006) vol. 96, no. 17, str. 171801-1-171801-6, ISBN 0031-9007, COBISS-ID 19834407, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	172	32	28	12	40	36	16

68. Durga Prasad Mohapatra, Ilija Bizjak, Urban Bitenc, Marko Bračko, Boštjan Golob, Andrej Gorišek, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (183 avtorjev) , **Observation of b [to] d[gamma] and determination of [vertical]V[sub]td/V[sub](ts)[vertical]**, Phys. rev. lett., (2006) vol. 96, no. 22, str. 221601-1-221601-5, ISBN 0031-9007, COBISS-ID 20027687, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	183	17	16	7	26	25	11

69. R. Seidl, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Samo Stanič, Marko Starič, (149 avtorjev) , **Measurement of azimuthal asymmetries in inclusive production of hadron pairs in e[sup]+e[sup]- annihilation at Belle**, Phys. rev. lett., (2006) vol. 96, no. 23, str. 232002-1-232002-6, ISBN 0031-9007, COBISS-ID 20023847, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	149	28	26	11	94	92	40

70. A. Ishikawa, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (158 avtorjev) , **Measurement of Forward-Backward asymmetry and Wilson coefficients in B [to] K[sup]*l[sup]+l[sup]-**, Phys. rev. lett., (2006) vol. 96, no. 25, str. 251801-1-251801-6, ISBN 0031-9007, COBISS-ID 20024103, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	158	55	51	22	65	62	27

71. A. Garmash, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (158 avtorjev) , **Evidence for large direct CP violation in B[sup][plus minus] [to] [rho](770)[sup][compositum]K[sup][plus minus] from analysis of three-body charmless B[sup][plus minus] [to]K[sup][plus minus][pi][sup][plus minus][pi][sup][plus minus] decays**, Phys. rev. lett., (2006) vol. 96, no. 25, str. 251803-1-251803-6, ISBN 0031-9007, COBISS-ID 20264231, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št.	WoS: št.	čistih	normirano št.	Scopus: št.	čistih	normirano št.

		avtorjev	citatov (TC)	citatov (CI)	čistih citatov (NC)	citatov (TC)	citatov (CI)	čistih citatov (NC)
8	0.8	158	40	34	15	41	35	15

72. N. Gabyshev, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, (130 avtorjev) , **Observation of B[sup]+ [to] ([Lambda][sub]c)[sup]+ ([Lambda][sub]c)[sup]-K[sup]+ and B[sup][compositium] [to] ([Lambda][sub]c)[sup]+([Lambda][sub]c)[sup]-K[sup][compositium] decays**, Phys. rev. lett., (2006) vol. 97, 20, str. 202003-1-202003-5, ISBN 0031-9007, COBISS-ID 20315687, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	130						

73. C.-H. Wu, Urban Bitenc, Ilija Bizjak, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (143 avtorjev) , **Study of J/[psi] [to]pp[bar], [Lambda][Lambda][bar] and observation of [eta][sub]c [to] [Lambda][Lambda][bar] at Belle**, Phys. rev. lett., (2006) vol. 97, , str. 162003-1-162003-6, ISBN 0031-9007, COBISS-ID 20315175, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143						

74. J. Schümann, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Samo Stanič, Marko Starič, (176 avtorjev) , **Evidence for B [to] [eta]'[pi] and improved measurements for B [to][eta]'K**, Phys. rev. lett., (2006) vol. 97, no. 6, str. 061802-1-061802-6, ISBN 0031-9007, COBISS-ID 20112935, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	176	14	11	5	13	10	4

75. L. Widhalm, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Samo Stanič, Marko Starič, (150 avtorjev) , **Measurement of D[sup]0 [to] [pi] l [nu] (K l [nu]) form factors and absolute branching fractions**, Phys. rev. lett., (2006) vol. 97, no. 6, str. 061804-1-061804-6, ISBN 0031-9007, COBISS-ID 20989479, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	150						

76. P. Krokovny, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, (148 avtorjev) , **Measurement of the quark mixing parameter cos2[phi][sub]1 using time-dependent Dalitz analysis of B[bar][sup]0 [to] D[K[sup]0[sub]s[pi][sup]+[pi][sup]-]h[sup]0**, Phys. rev. lett., (2006) vol. 97, no. 8, str. 081801-1-081801-6, ISBN 0031-9007, COBISS-ID 20253223, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	148	12	10	4	14	12	5

77. R. Chistov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (163 avtorjev) , **Observation of new states decaying into ([Lambda][sub]c)[sup]+K[sup]-[pi][sup]+ and [Lambda][sub]c[sup]+K[sup]0[sup]s[pi]**

[sub]-, Phys. rev. lett., (2006) vol. 97, no. 16, str. 162001-1-162001-6, ISBN 0031-9007, COBISS-ID 20251431, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	163	63	60	26	61	59	26

78. G. Gokhroo, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (138 avtorjev) , **Observation of a near-threshold D[sup]0[bar]D[sup]0[pi][sup]0 enhancement in B [to] D[sup]0[bar]D[sup]0[pi][sup]0K decay**, Phys. rev. lett., (2006) vol. 97, no. 16, str. 162002-1-162002-5, ISBN 0031-9007, COBISS-ID 20315943, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	138				93	89	39

79. N. Gabyshev, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (156 avtorjev) , **Study of decay mechanisms in B[sup]- [to] ([Lambda][sub]c)[sup]+p[bar][pi][sup]- decays and observation of low-mass structure in the ([Lambda]sub]c)[sup]+ p[bar] system**, Phys. rev. lett., (2006) vol. 97, no. 24, str. 242001-1-242001-6, ISBN 0031-9007, COBISS-ID 20410151, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	156				13	8	4

80. K. Ikado, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Samo Stanič, (184 avtorjev) , **Evidence of the purely leptonic decay B[sup]- [to] [tau][sup]- ([nu][bar])[sub][tau]**, Phys. rev. lett., (2006) vol. 97, no. 25, str. 251802-1-251802-6, ISBN 0031-9007, COBISS-ID 20411175, IF: 7.072, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	184	122	117	51	145	140	62

81. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (195 avtorjev) , **Improved measurement of the bb[bar] production cross section in 920 GeV fixed-target proton-nucleus collisions**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, , str. 052005-1-052005-17, ISBN 1550-7998, COBISS-ID 20222759, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	195	13	6	2	13	9	4

82. Rolf Seuster, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (126 avtorjev) , **Charm hadrons from fragmentation and B decays in e[sup]+e[sup]- annihilation at [square root]s=10.6 GeV**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 3, str. 032002-1-032002-22, ISBN 1550-7998, COBISS-ID 19682599, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	126	33	33	13	38	37	15

83. K. Abe, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (165 avtorjev) , **Study of B[sup][plus minus][to]D[sub](CP)K[sup][plus minus] and D*[sub](CP)K[sup][plus minus]decays**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 5, str. 051106-1-051106-6, ISBN 1550-7998, COBISS-ID 19786279, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	165	23	19	7	27	24	9

84. S. Villa, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, (139 avtorjev) , **Search for the decay B[sup][compositium] [to][gamma][gamma]**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 5, str. 051107-1-051107-5, ISBN 1550-7998, COBISS-ID 19786023, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	139	2	2	1	2	2	1

85. F. J. Ronga, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, (160 avtorjev) , **Measurement of CP violation in B[sup][compositium] [to]D[sup](*-)[pi][sup]+ and B[sup][compositium] [to] D[sup]-[pi][sup]+ decays**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 9, str. 092003-1-092003-17, ISBN 1550-7998, COBISS-ID 19901479, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	160	13	8	3	11	7	3

86. J. Dragić, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (183 avtorjev) , **Measurement of branching fraction and direct CP asymmetry in B[sup]0 [to][rho][sup]0[pi][sup]0decays**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 11, str. 111105-1-111105-6, ISBN 1550-7998, COBISS-ID 20026663, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	183	3	1	0	3	1	0

87. E. Nakano, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Dejan Žontar, (142 avtorjev) , **Charge asymmetry of same-sign dileptons in B[sup][compositium]- B[bar][sup][compositium] mixing**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 11, str. 112002-1-112002-13, ISBN 1550-7998, COBISS-ID 20264743, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	142	19	19	7	18	18	7

88. A. Poluektov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (159 avtorjev) , **Measurement of [phi][sub]3 with a Dalitz plot analysis of B[sup]+ [to] D[sup]([ast])K[sup]([ast]+) decay**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 73, no. 11, str. 112009-1-112009-16, ISBN 1550-7998, COBISS-ID 20111911,

IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	159	50	44	17	55	50	20

89. F. Fang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (131 avtorjev) , **Search for the h[sub]c meson in B[plus minus] [to] h[sub]c K[plus minus]**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 74, no. 1, str. 012007-1-012007-7, ISBN 1550-7998, COBISS-ID 20111655, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	131	8	8	3	7	7	3

90. R. Kumar, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Rok Pestotnik, Marko Starič, Anže Zupanc, (141 avtorjev) , **Observation of B[sup][plus minus] [to] [chi][sub](c1)[pi][sup](plus minus] and search for direct CP violation**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 74, no. 5, str. 051103-1-051103-6, ISBN 1550-7998, COBISS-ID 20251943, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	141	2	0	0			

91. S. Blyth, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (162 avtorjev) , **Improved measurements of color-suppressed decays (B[bar])[sup]0 [to] D[sup]0 [pi][sup]0, D[sup]0 [eta], D[sup]0 [omega], D[sup]([ast]0) [pi][sup]0, D[sup]([ast]0) [eta] and D[sup]([ast] 0) [omega]**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 74, no. 9, str. 092002-1-092002-10, ISBN 1550-7998, COBISS-ID 20409639, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	162	6	5	2	6	5	2

92. C.-M. Jen, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Anže Zupanc, (147 avtorjev) , **Improved measurements of branching fractions and CP partial rate asymmetries for B [to] [omega]K and B [to] [omega][pi]**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 74, no. 11, str. 111101-1-111101-6, ISBN 1550-7998, COBISS-ID 20411431, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	147	4	4	2	4	4	2

93. Y. Ushiroda, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Marko Starič, Anže Zupanc, (154 avtorjev) , **Time-dependent CP asymmetries in B[sup]0 [to] (K[sub]S)[sup]0 [pi][sup]0 [gamma]**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 74, no. 11, str. 111104-1-111104-6, ISBN 1550-7998, COBISS-ID 20411687, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov	čistih citatov	normirano št. čistih citatov	Scopus: št. citatov (TC)	čistih citatov	normirano št. čistih citatov

			(TC)	(CI)	(NC)		(CI)	(NC)
8	0.8	154	16	14	6	21	20	8

94. R. Chistov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, (146 avtorjev) , **Observation of B[sup]+ [to] (([Xi][bar])[sub]c)[sup]0 ([Lambda][sub]c)[sup]+ and evidence for B[sup]0 [to](([Xi][bar])[sub]c)[sup]-([Lambda][sub]c)[sup]+**, Phys. rev., D Part. fields gravit. cosmol., (2006) vol. 74, no. 11, str. 111105-1-111105-5, ISBN 1550-7998, COBISS-ID 20411943, IF: 4.896, SE: BU - astronomy & astrophysics ; 8/45 ; četrtina: 1 ; x=2.819 ; IFmin: 3.865 ; IFmax: 16.914 UP - physics, particles & fields ; 5/21 ; četrtina: 1 ; x=2.536 ; IFmin: 3.989 ; IFmax: 6.214,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	146	7	4	2	7	4	2

95. Y. Miyazaki, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (167 avtorjev) , **Search for lepton and baryon number violating [tau][sup]- decays into [Lambda][bar][pi][sup]- and [Lambda] [pi][sup]-**, Phys. lett., Sect. B, (2006) vol. 632, no. 1, str. 51-57, ISBN 0370-2693, COBISS-ID 19551015, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	167	4	4	2	5	5	2

96. R. Mizuk, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (177 avtorjev) , **Search for the [Theta](1540)[sup]+ pentaquark using kaon secondary interactions at Belle**, Phys. lett., Sect. B, (2006) vol. 632, no 2/3, str. 173-180, ISBN 0370-2693, COBISS-ID 19550759, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	177	16	16	7	9	9	4

97. N. Soni, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (151 avtorjev) , **Measurement of branching fractions for B [to][chi][sub](c1)(2))K(K[sup][ast]) at Belle**, Phys. lett., Sect. B, (2006) vol. 634, no. 2/3, str. 155-164, ISBN 0370-2693, COBISS-ID 19737895, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	0	0	0	5	4	2

98. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (194 avtorjev) , **Measurement of the [gamma]production cross section in 920 GeV fixed-target proton-nucleus collissions**, Phys. lett., Sect. B, (2006) vol. 638, , str. 13-21, ISBN 0370-2693, COBISS-ID 20222503, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	194	9	6	3			

99. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (195 avtorjev) , **Measurement of the J/[psi] production cross section in 920 GeV/c fixed-target proton-nucleus interactions**, Phys. lett., Sect. B, (2006) vol. 638, , str. 407-414, ISBN 0370-2693, COBISS-ID 20223015, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax:

33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	195	11	7	3	10	7	3

100. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (195 avtorjev) , **Polarization of [Lambda] and [Lambda][underline] in 920 GeV fixed-target proton-nucleus collissions**, Phys. lett., Sect. B, (2006) vol. 638, , str. 415-421, ISBN 0370-2693, COBISS-ID 20222247, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	195	4	3	1			

101. Y. Miyazaki, Urban Bitenc, Ilija Bizjak, Marko Bračko, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, (130 avtorjev) , **Search for lepton flavor violating [tau][sup]- decays with a (K[sub]S)[sup]0 meson**, Phys. lett., Sect. B, (2006) vol. 639, no. 3/4, str. 159-164, ISBN 0370-2693, COBISS-ID 20027943, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	130	9	9	4	11	10	4

102. Y. Yusa, Urban Bitenc, Ilija Bizjak, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (112 avtorjev) , **Search for neutrinoless decays [tau] [to] lhh and [tau] [to]lV[sup]0**, Phys. lett., Sect. B, (2006) vol. 640, , str. 138-144, ISBN 0370-2693, COBISS-ID 20112423, IF: 5.043, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.274 ; IFmin: 1.926 ; IFmax: 33.508,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	112	14	12	5	15	13	6

103. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (195 avtorjev) , **A measurement of the [psi]' to J/[psi] production ratio in 920 GeV proton-nucleus interactions**, The European physical journal. C, (2007) vol. 49, no. 2, str. 545-558, ISBN 1434-6044, COBISS-ID 23356199, IF: 3.255, SE: UP - physics, particles & fields ; 9/24 ; četrtina: 2 ; x=2.83 ; IFmin: 1.988 ; IFmax: 3.485,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	195	16	11	4	17	13	5

104. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (195 avtorjev) , **K[sup]([ast]0) and [phi] meson production in proton-nucleus interactions at [square root] 2 = 41.6 GeV**, The European physical journal. C, (2007) vol. 50, no. 2, str. 315-328, ISBN 1434-6044, COBISS-ID 23355943, IF: 3.255, SE: UP - physics, particles & fields ; 9/24 ; četrtina: 2 ; x=2.83 ; IFmin: 1.988 ; IFmax: 3.485,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	195	13	10	4	13	11	4

105. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Damijan Škrk, Tomi Živko, (197 avtorjev) , **Measurement of D[sup]0, D[sup]+, (D[sub]8)[sup]+ and D[sup]([ast]+) production in fixed target 920 GeV proton-nucleus collisions**, The European physical journal. C,

(2007) vol. 52, iss. 3, str. 531-542, ISBN 1434-6044, COBISS-ID 21239591, IF: 3.255, SE: UP - physics, particles & fields ; 9/24 ; četrtina: 2 ; x=2.83 ; IFmin: 1.988 ; IFmax: 3.485,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	197	9	8	3	9	9	3

106. T. Mori, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (158 avtorjev) , **High statistics measurement of the cross sections of [gamma] [gamma] [to] [pi][sup]+ [pi][sup]-**, J. Phys. Soc. Jpn., (2007) vol. 76, no. 7, str. 074102-1-074102-11, ISBN 0031-9015, COBISS-ID 20896295, IF: 2.212, SE: UI - physics, multidisciplinary ; 14/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	158	30	26	10	27	23	9

107. I. Adachi, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (22 avtorjev) , **A study of proximity focusing RICH with aerogel radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2007) issue 2, vol. 580, str. 1042-1045, ISBN 0168-9002, COBISS-ID 21261351, IF: 1.114, SE: OA - instruments & instrumentation ; 23/55 ; četrtina: 2 ; x=1.034 ; IFmin: 0.832 ; IFmax: 1.384 RY - nuclear science & technology ; 4/31 ; četrtina: 1 ; x=0.663 ; IFmin: 1.008 ; IFmax: 1.643 UP - physics, particles & fields ; 18/24 ; četrtina: 3 ; x=2.83 ; IFmin: 1.114 ; IFmax: 1.801 XQ - spectroscopy ; 25/39 ; četrtina: 3 ; x=1.967 ; IFmin: 0.817 ; IFmax: 1.269,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	0	0	0	0	0	0

108. Samo Korpar, Andrej Gorišek, Peter Križan, Rok Pestotnik, (22 avtorjev) , **A novel type of proximity focusing RICH counter with multiple refractive index aerogel radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2007) vol. 572, no. 1, str. 429-431, ISBN 0168-9002, COBISS-ID 21861415, IF: 1.114, SE: OA - instruments & instrumentation ; 23/55 ; četrtina: 2 ; x=1.034 ; IFmin: 0.832 ; IFmax: 1.384 RY - nuclear science & technology ; 4/31 ; četrtina: 1 ; x=0.663 ; IFmin: 1.008 ; IFmax: 1.643 UP - physics, particles & fields ; 18/24 ; četrtina: 3 ; x=2.83 ; IFmin: 1.114 ; IFmax: 1.801 XQ - spectroscopy ; 25/39 ; četrtina: 3 ; x=1.967 ; IFmin: 0.817 ; IFmax: 1.269,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	6	3	5	5	3	5

109. Samo Korpar, Andrej Gorišek, Peter Križan, Rok Pestotnik, (22 avtorjev) , **Proximity focusing RICH with TOF capabilities**, Nucl. instrum, methods phys res., Sect. A, Accel., (2007) vol. 572, no. 1, str. 432-433, ISBN 0168-9002, COBISS-ID 21861927, IF: 1.114, SE: OA - instruments & instrumentation ; 23/55 ; četrtina: 2 ; x=1.034 ; IFmin: 0.832 ; IFmax: 1.384 RY - nuclear science & technology ; 4/31 ; četrtina: 1 ; x=0.663 ; IFmin: 1.008 ; IFmax: 1.643 UP - physics, particles & fields ; 18/24 ; četrtina: 3 ; x=2.83 ; IFmin: 1.114 ; IFmax: 1.801 XQ - spectroscopy ; 25/39 ; četrtina: 3 ; x=1.967 ; IFmin: 0.817 ; IFmax: 1.269,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	10	5	8	4	1	2

110. ===> Rok Pestotnik, Rok Dolenec, Peter Križan, Andrej Petelin, (4 avtorjev) , **Silicon photomultiplier as a position sensitive decetor of Cherenkov photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2007) vol. 581, , str. 457-460, ISBN 0168-9002, COBISS-ID 21262375, IF: 1.114, SE: OA - instruments & instrumentation ; 23/55 ; četrtina: 2 ; x=1.034 ; IFmin: 0.832 ; IFmax: 1.384 RY - nuclear science & technology ; 4/31 ; četrtina: 1 ; x=0.663 ; IFmin: 1.008 ; IFmax: 1.643 UP - physics, particles & fields ; 18/24 ; četrtina: 3 ; x=2.83 ; IFmin: 1.114 ; IFmax: 1.801 XQ - spectroscopy ; 25/39 ; četrtina: 3 ; x=1.967 ; IFmin: 0.817 ; IFmax: 1.269,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	2	4	7	5	8			

111. Ichiro Adachi, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (22 avtorjev) , **A study of proximity focusing RICH with a silica radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2007) vol. 581, issues 1-2, str. 415-418, ISBN 0168-9002, COBISS-ID 21262119, IF: 1.114, SE: OA - instruments & instrumentation ; 23/55 ; četrtina: 2 ; x=1.034 ; IFmin: 0.832 ; IFmax: 1.384 RY - nuclear science & technology ; 4/31 ; četrtina: 1 ; x=0.663 ; IFmin: 1.008 ; IFmax: 1.643 UP - physics, particles & fields ; 18/24 ; četrtina: 3 ; x=2.83 ; IFmin: 1.114 ; IFmax: 1.801 XQ - spectroscopy ; 25/39 ; četrtina: 3 ; x=1.967 ; IFmin: 0.817 ; IFmax: 1.269,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	22	1	1	2	2	1	2

112. Iris Abt, Andrej Gorišek, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Aleš Stanovnik, Marko Starič, Tomi Živko, (196 avtorjev) , **Luminosity determination at HERA-B**, Nucl. instrum, methods phys res., Sect. A, Accel., (2007) vol. 582, no. 2, str. 401-412, ISBN 0168-9002, COBISS-ID 21423911, IF: 1.114, SE: OA - instruments & instrumentation ; 23/55 ; četrtina: 2 ; x=1.034 ; IFmin: 0.832 ; IFmax: 1.384 RY - nuclear science & technology ; 4/31 ; četrtina: 1 ; x=0.663 ; IFmin: 1.008 ; IFmax: 1.643 UP - physics, particles & fields ; 18/24 ; četrtina: 3 ; x=2.83 ; IFmin: 1.114 ; IFmax: 1.801 XQ - spectroscopy ; 25/39 ; četrtina: 3 ; x=1.967 ; IFmin: 0.817 ; IFmax: 1.269,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	196	3	1	2	3	2	3

113. Peter Križan, Andrej Gorišek, Samo Korpar, Rok Pestotnik, (24 avtorjev) , **Proximity focusing RICH with TOF capabilities : [presented at 10th Topical Seminar on Innovative Particle and Radiation Detectors, 1-5 October 2006, Siena, Italy]**, Nucl. phys., B Proc. suppl., (2007) vol. 172, , str. 227-230, ISBN 0920-5632, COBISS-ID 21308711,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0	0	24				0	0	0

114. K.-F. Chen, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (200 avtorjev) , **Observation of time-dependent CP violation in B[sup]0 [to] [eta][prime] K[sup]0 decays and improved measurements of CP asymmetries in B[sup]0 [to] [phi] (K[sub]S)[sup]0, (K[sub]S)[sup]0 (K[sub]S)[sup]0 (K[sub]S)[sup]0 and B[sup]0 [to] J/[psi] K[sup]0 decays**, Phys. rev. lett., (2007) vol. 98, no. 3, str. 031802-1-031802-6, ISBN 0031-9007, COBISS-ID 20470055, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	200	71	61	24	88	82	33

115. A. Drutskoy, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (180 avtorjev) , **Measurement of inclusive D[sub]s, D[sup]0 and J/[psi] rates and determination of the (B[sub]s)[sup]([ast]) ((B[bar])[sub]s)[sup]([ast]) production fraction in b b[bar] events at the [Upsilon](5S) resonance**, Phys. rev. lett., (2007) vol. 98, no. 5, str. 052001-1-052001-6, ISBN 0031-9007, COBISS-ID 20518951, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	180	18	9	4	22	15	6

116. Galina Pakhlova, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (155 avtorjev) , **Measurement of the near-threshold e[sup]+ e[sup]- [to] D[sup](([ast])[pm]) D[sup](([ast])[mp]) cross section using initial-state radiation**, Phys. rev. lett., (2007) vol. 98, no. 9, str. 092001-1-092001-6, ISBN 0031-9007, COBISS-ID 20589863, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	155	43	36	14	74	65	26

117. M.-C. Chang, Urban Bitenc, Ilija Bizjak, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (171 avtorjev) , **Observation of the decay B[sup]0 [to] J/[psi] [eta]**, Phys. rev. lett., (2007) vol. 98, no. 13, str. 131803-1-131803-5, ISBN 0031-9007, COBISS-ID 20709927, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	171	6	4	2	5	3	1

118. O. Tajima, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (166 avtorjev) , **Search for invisible decay of the [Upsilon](1S)**, Phys. rev. lett., (2007) vol. 98, no. 13, str. 132001-1-132001-6, ISBN 0031-9007, COBISS-ID 20710183, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	166	17	16	6	22	21	8

119. S.-W. Lin, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (163 avtorjev) , **Observation of B decays to two kaons**, Phys. rev. lett., (2007) vol. 98, no. 18, str. 181804-1-181804-6, ISBN 0031-9007, COBISS-ID 20795175, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	163	10	8	3	21	20	8

120. H. Ishino, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (162 avtorjev) , **Observation of direct CP violation in B[sup]0 [to] [pi][sup]+ [pi][sup]- decays and model-independent constraints on the quark-mixing angle [phi][sub]2**, Phys. rev. lett., (2007) vol. 98, no. 21, str. 211801-1-211801-6, ISBN 0031-9007, COBISS-ID 20794919, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	162	27	25	10	35	33	13

121. Marko Starič, Boštjan Golob, Urban Bitenc, Marko Bračko, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Anže Zupanc, (188 avtorjev) , **Evidence for D[sup]0 -(D[bar])[sup]0 mixing**, Phys. rev. lett., (2007) vol. 98, no. 21, str. 211803-1-211803-6, ISBN 0031-9007, COBISS-ID 20795943, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	188	109	98	39	132	124	49

122. A. Kusaka, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (172 avtorjev) , **Measurement of CP asymmetry in a time-dependent Dalitz analysis of B[sup]0 [to] ([rho] [pi])[sup]0 and a constraint on the quark mixing matrix angle [phi][sup]2**, Phys. rev. lett., (2007) vol. 98, no. 22, str. 221602-1-221602-6, ISBN 0031-9007, COBISS-ID 20796199, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	172	16	13	5	19	16	6

123. Saša Fratina, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (157 avtorjev) , **Evidence for CP Violation in B[sup]0 [to] D[sup]+ D[sup]- decays**, Phys. rev. lett., (2007) vol. 98, no. 22, str. 221802-1-221802-6, ISBN 0031-9007, COBISS-ID 20796455, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	157	15	12	5	17	14	6

124. R. Mizuk, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (151 avtorjev) , **Experimental constraints on the spin and parity of the [Lambda][sub]c (2880)[sup]+**, Phys. rev. lett., (2007) vol. 98, no. 26, str. 262001-1-262001-6, ISBN 0031-9007, COBISS-ID 20859175, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	24	22	9	24	23	9

125. M. Shapkin, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (156 avtorjev) , **Measurement of the [tau] lepton mass and an upper limit on the mass difference between [tau][sup]+ and [tau][sup]-**, Phys. rev. lett., (2007) vol. 99, no. 1, str. 011801-1-011801-6, ISBN 0031-9007, COBISS-ID 20895783, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	156	7	7	3	12	12	5

126. S.-W. Lin, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (157 avtorjev) , **Measurements of branching fractions for B [to] K [pi] and B [to] [pi] [pi] decays**, Phys. rev. lett., (2007) vol. 99, no. 12, str. 121601-1-121601-5, ISBN 0031-9007, COBISS-ID 21056295, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	157	7	4	2	20	16	6

127. A. Go, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (159 avtorjev) , **Measurement of Einstein-Podolsky-Rosen-type flavor entanglement in [Upsilon](4S) [to] B[sup]0 (B[bar])**

[sup]0 decays, Phys. rev. lett., (2007) vol. 99, no. 13, str. 131802-1-131802-6, ISBN 0031-9007, COBISS-ID 21109287, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	159	8	8	3	9	9	4

128. L. M. Zhang, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (176 avtorjev) , **Measurement of D[sup]0 - (D[bar])[sup]0 mixing parameters in D[sup]0 [to] K[sub]S [pi][sup]+ [pi][sup]- decays**, Phys. rev. lett., (2007) vol. 99, no. 13, str. 131803-1-131803-6, ISBN 0031-9007, COBISS-ID 21109543, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	176	36	33	13	65	62	25

129. X. L. Wang, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (147 avtorjev) , **Observation of two resonant structures in e[sup]+ e[sup]- [to] [pi][sup]+ [pi][sup]- [psi] (2S) via initial-state radiation at Belle**, Phys. rev. lett., (2007) vol. 99, no. 14, str. 142002-1-142002-5, ISBN 0031-9007, COBISS-ID 21143847, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	147	61	53	21	120	111	44

130. A. Matyja, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Observation of B[sup]0 [to] D[sup]([ast]-) [tau][sup]+ [nu][sub][tau] decay at Belle**, Phys. rev. lett., (2007) vol. 99, no. 19, str. 191807-1-191807-5, ISBN 0031-9007, COBISS-ID 21236007, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	16	15	6	26	25	10

131. O. Tajima, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (159 avtorjev) , **Search for the CP-violating decays [Upsilon](4S) [to] B[sup]0 (B[bar])[sup]0 [to] J/[psi] (K[sub]S)[sup]0 + J/[psi]([eta][sub]c) (K[sub]S)[sup]0**, Phys. rev. lett., (2007) vol. 99, no. 21, str. 211601-1-211601-5, ISBN 0031-9007, COBISS-ID 21253415, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	159	0	0	0			

132. K.-F. Chen, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (156 avtorjev) , **Search for B [to] h[sup](([ast])) [nu] [nu][bar] decays at Belle**, Phys. rev. lett., (2007) vol. 99, no. 22, str. 221802-1-221802-5, ISBN 0031-9007, COBISS-ID 21296167, IF: 6.944, SE: UI - physics, multidisciplinary ; 5/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	156	28	28	11	33	33	13

133. K. S. Park, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (146 avtorjev) , **Study of the charmed baryonic decays (B[bar])[sup]0 [to] ([Sigma][sub]c)[sup](++) p[bar] [pi][sup]- and (B[bar])[sup]0 [to] ([Sigma][sub]c)[sup]0 p[bar] [pi][sup]+**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 1, str. 011101-1-011101-6, ISBN 1550-7998, COBISS-ID 20443431, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	146	8	4	2	7	4	2

134. A. Garmash, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (169 avtorjev) , **Dalitz analysis of three-body charmless B[sup]0 [to] K[sup]0 [pi][sup]+ [pi][sup]- decay**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 1, str. 012006-1-012006-10, ISBN 1550-7998, COBISS-ID 20589607, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	169	31	28	11	28	25	10

135. Q. L. Xie, Urban Bitenc, Ilija Bizjak, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (159 avtorjev) , **Search for B[sup]+ [to] J/[psi] [eta][prime] K[sup]+ and B[sup]0 [to] J/[psi][eta][prime] (K[sub]S)[sup]0 decays**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 1, str. 017101-1-017101-6, ISBN 1550-7998, COBISS-ID 20497959, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	159	1	1	0	1	1	0

136. P. Urquijo, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (170 avtorjev) , **Moments of the electron energy spectrum and partial branching fraction of B [to] X[sub]c e [nu] decays at the Belle detector**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 3, str. 032001-1-032001-16, ISBN 1550-7998, COBISS-ID 20585767, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	170	10	7	3	14	11	4

137. C. Schwanda, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (146 avtorjev) , **Moments of the hadronic invariant mass spectrum in B [to] X[sub]c l [nu] decays at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 3, str. 032005-1-032005-9, ISBN 1550-7998, COBISS-ID 20586023, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	146	10	7	3			

138. T. Mori, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (154 avtorjev) , **High statistics study of the f[sub]0 (980) resonance in [gamma] [gamma] [to] [pi][sup]+ [pi][sup]- production**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 5, str. 051101-1-051101-6, ISBN 1550-7998, COBISS-ID 20628519, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP -

physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	154	38	31	12	39	33	13

139. Anatoly Sokolov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Anže Zupanc, (143 avtorjev) , **Observation of the decay [Upsilon](4S) [to] [Upsilon](1S) [pi][sup]+ [pi][sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 7, str. 071103-1-071103-6, ISBN 1550-7998, COBISS-ID 20710695, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	15	13	5	17	15	6

140. P. Chang, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (143 avtorjev) , **Improved measurements of branching fractions and CP asymmetries in B [to] [eta] h decays**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 7, str. 071104-1-071104-7, ISBN 1550-7998, COBISS-ID 20722471, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	7	5	2	11	9	3

141. Anže Zupanc, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (148 avtorjev) , **Improved measurement of (B[bar])[sup]0 [to] (D[sub]s)[sup]- D[sup]+ and search for (B[bar])[sup]0 [to] (D[sub]s)[sup]+ (D[sub]s)[sup]- at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 9, str. 091102-1-091102-7, ISBN 1550-7998, COBISS-ID 20740903, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	148	6	6	2	6	6	2

142. J. Schümann, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Search for for B decays into [eta][sup][prime] [rho], [eta][sup][prime] K[sup][ast], [eta][sup][prime] [phi], [eta][sup][prime] [omega] and [eta][sup][prime] [eta][sup](([prime]))**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 9, str. 092002-1-092002-8, ISBN 1550-7998, COBISS-ID 20795431, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	6	6	2	7	7	3

143. C. H. Wang, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (133 avtorjev) , **Measurement of charmless B decays to [eta] K[sup][ast] and [eta] [rho]**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 75, no. 9, str. 092005-1-092005-10, ISBN 1550-7998, COBISS-ID 20795687, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	133	6	6	2	6	6	2

144. A. Somov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Anže Zupanc, (141 avtorjev) , **Improved mesurement of CP-violating parameters in B [to] [rho][sup]+ [rho][sup]- decays**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 1, str. 011104-1-011104-7, ISBN 1550-7998, COBISS-ID 20896807, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	141	8	6	2	9	8	3

145. A. Drutskoy, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (137 avtorjev) , **Measurements of exclusive (B[sub]s)[sup]0 decays at the [Upsilon](5S) resonance**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 1, str. 012002-1-012002-9, ISBN 1550-7998, COBISS-ID 20896039, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	137	10	6	2	11	7	3

146. A. Kuzmin, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (164 avtorjev) , **Study of (B[bar])[sup]0 [to] D[sup]0 [pi][sup]+ [pi][sup]- decays**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 1, str. 012006-1-012006-11, ISBN 1550-7998, COBISS-ID 20988967, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	11	9	3	7	7	3

147. T. Medvedeva, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (148 avtorjev) , **Observation of the decay (B[bar])[sup]0 [to] (D[sub]s)[sup]+ [Lambda] p[bar],**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 5, str. 051102-1-051102-5, ISBN 1550-7998, COBISS-ID 21056551, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	148	3	3	1	3	3	1

148. M.-Z. Wang, Ilija Bizjak, Marko Bračko, Saša Fratina, Peter Križan, Rok Pestotnik, Marko Starič, Anže Zupanc, (138 avtorjev) , **Study of B[sup]+ [to] p [Lambda][bar] [gamma], p [Lambda][bar] [pi][sup]0 and B[sup]0 [to] p [Lambda][bar] [pi][sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 5, str. 052004-1-052004-8, ISBN 1550-7998, COBISS-ID 21091367, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	138	13	11	4	12	10	4

149. J. Dalseno, Urban Bitenc, Ilija Bizjak, Marko Bračko, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (128 avtorjev) , **Measurement of branching fraction and time-dependent CP**

asymmetry parameters in B[sup]0 [to] D[sup]([ast]+) D[sup]([ast]-) (K[sub]S)[sup]0 decays, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 7, str. 072004-1-072004-9, ISBN 1550-7998, COBISS-ID 21168935, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	128	7	5	2	8	6	2

150. Y. Chao, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (151 avtorjev) , **Measurements of time-dependent CP violation in B[sup]0 [to] [omega] (K[sub]S)[sup]0 , f[sub](980) (K[sub]S)[sup]0, (K[sub]S)[sup]0 [pi][sup]0 and K[sup]+ K[sup]- (K[sub]S)[sup]0 decays**, Phys. rev., D Part. fields gravit. cosmol., (2007) vol. 76, no. 9, str. 091103-1-091103-7, ISBN 1550-7998, COBISS-ID 21295655, IF: 4.696, SE: BU - astronomy & astrophysics ; 9/48 ; četrtina: 1 ; x=2.624 ; IFmin: 3.483 ; IFmax: 20.29 UP - physics, particles & fields ; 4/24 ; četrtina: 1 ; x=2.83 ; IFmin: 4.101 ; IFmax: 12.885,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	6	3	1	16	13	5

151. N. Satoyama, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (154 avtorjev) , **A search for the rare leptonic decays B[sup]+ [to] [mu][sup]+ [nu][sub][mu] and B[sup]+ [to] e[sup]+ [nu][sub]e**, Phys. lett., Sect. B, (2007) vol. 647, iss. 2/3, str. 67-73, ISBN 0370-2693, COBISS-ID 20740647, IF: 4.189, SE: UI - physics, multidisciplinary ; 8/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	154	6	6	2	8	8	3

152. T. Hokuue, Urban Bitenc, Ilija Bizjak, Marko Bračko, Andrej Gorišek, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (157 avtorjev) , **Measurements of branching fractions and q[sup]2 distributions for B [to] [pi] l [nu] and B [to] [rho] l [nu] decays with B [to] D[sup](([ast])) l [nu] decay tagging**, Phys. lett., Sect. B, (2007) vol. 648, no. 2/3, str. 139-148, ISBN 0370-2693, COBISS-ID 20721959, IF: 4.189, SE: UI - physics, multidisciplinary ; 8/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	157	26	25	10	26	25	10

153. Y. Miyazaki, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (132 avtorjev) , **Search for lepton flavor violating [tau][sup]- decays into l[sup]- [eta], l[sup]- [eta][sup][prime] and l[sup]- [pi][sup]0**, Phys. lett., Sect. B, (2007) vol. 648, no. 5/6, str. 341-350, ISBN 0370-2693, COBISS-ID 20722215, IF: 4.189, SE: UI - physics, multidisciplinary ; 8/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	132	17	16	6	21	20	8

154. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (197 avtorjev) , **Bottom production cross section from double muonic decays of b-flavoured hadrons in 920 GeV proton-nucleus collisions**, Phys. lett., Sect. B, (2007) vol. 650, no. 2/3, str. 103-110, ISBN 0370-2693, COBISS-ID 23355175, IF: 4.189, SE: UI - physics, multidisciplinary ; 8/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	197	4	4	2	4	4	2

155. W. T. Chen, Urban Bitenc, Ilija Bizjak, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **A study of [gamma] [gamma] [to] (K[sub]S)[sup]0 (K[sub]S)[sup]0 production at energies from 2.4 to 4.0 GeV at Belle**, Phys. lett., Sect. B, (2007) vol. 651, iss. 1, str. 15-21, ISBN 0370-2693, COBISS-ID 20896551, IF: 4.189, SE: UI - physics, multidisciplinary ; 8/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	12	5	2	13	6	2

156. D. Epifanov, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (155 avtorjev) , **Study of [tau][sup]- [to] K[sub]S [pi][sup]- [nu][sub][tau] decay at Belle**, Phys. lett., Sect. B, (2007) vol. 654, iss. 3/4, str. 65-73, ISBN 0370-2693, COBISS-ID 21143591, IF: 4.189, SE: UI - physics, multidisciplinary ; 8/69 ; četrtina: 1 ; x=2.515 ; IFmin: 1.936 ; IFmax: 38.403,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	155	34	32	13	48	46	18

157. S. Uehara, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (152 avtorjev) , **Study of charmonia in four-meson final states produced in two-photon collisions**, The European physical journal. C, ([in press] 2008) vol. 53, , 14 str., ISBN 1434-6044, COBISS-ID 21309735, IF: 2.805, SE: UP - physics, particles & fields ; 11/25 ; četrtina: 2 ; x=2.706 ; IFmin: 2.015 ; IFmax: 3.388,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	152	12	8	3	12	9	3

158. S.-W. Lin, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (187 avtorjev) , **Difference in direct charge-parity violation between charged and neutral B meson decays**, Nature (Lond.), (2008) vol. 452, , str. 332-335, ISBN 0028-0836, COBISS-ID 21553703, IF: 31.434, SE: RO - multidisciplinary sciences ; 1/42 ; četrtina: 1 ; x=2.705 ; IFmin: 1.83 ; IFmax: 31.434,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	187	54	48	18	69	63	93

159. Samo Korpar, Rok Dolenec, K. Hara, Toru Iijima, Peter Križan, Y. Mazuka, Rok Pestotnik, Aleš Stanovnik, M. Yamaoka, (9 avtorjev) , **Measurement of Cherenkov photons with silicon photomultipliers**, Nucl. instrum, methods phys res., Sect. A, Accel., (2008) vol. 594, no. 1, str. 13-17, ISBN 0168-9002, COBISS-ID 22075431, IF: 1.019, SE: OA - instruments & instrumentation ; 30/56 ; četrtina: 3 ; x=1.318 ; IFmin: 0.586 ; IFmax: 1.037 RY - nuclear science & technology ; 8/30 ; četrtina: 1 ; x=0.803 ; IFmin: 1.019 ; IFmax: 2.178 UP - physics, particles & fields ; 18/25 ; četrtina: 3 ; x=2.706 ; IFmin: 1.015 ; IFmax: 1.803 XQ - spectroscopy ; 28/39 ; četrtina: 3 ; x=2.097 ; IFmin: 0.866 ; IFmax: 1.492,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.889	9	12	5	6	14	7	9

160. Toru Iijima, Rok Dolenec, Andrej Petelin, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (23 avtorjev) , **Studies of a proximity focusing RICH with aerogel radiator for future Belle upgrade**, Nucl. instrum, methods phys res., Sect. A, Accel., (2008) vol. 595, no. 1, str. 92-95, ISBN 0168-9002, COBISS-ID 22074407, IF: 1.019, SE: OA - instruments & instrumentation ; 30/56 ; četrtina: 3 ; x=1.318 ; IFmin: 0.586 ; IFmax: 1.037 RY - nuclear science & technology ; 8/30 ; četrtina: 1 ; x=0.803 ; IFmin: 1.019 ; IFmax: 2.178 UP -

physics, particles & fields ; 18/25 ; četrtina: 3 ; x=2.706 ; IFmin: 1.015 ; IFmax: 1.803 XQ - spectroscopy ; 28/39 ; četrtina: 3 ; x=2.097 ; IFmin: 0.866 ; IFmax: 1.492,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	23	5	5	6	6	6	7

161. Samo Korpar, Rok Dolenec, K. Hara, Toru Iijima, Peter Križan, Y. Mazuka, Rok Pestotnik, Aleš Stanovnik, M. Yamaoka, (9 avtorjev) , **Silicon photomultiplier as a detector of Cherenkov photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2008) vol. 595, no. 1, str. 161-164, ISBN 0168-9002, COBISS-ID 22005031, IF: 1.019, SE: OA - instruments & instrumentation ; 30/56 ; četrtina: 3 ; x=1.318 ; IFmin: 0.586 ; IFmax: 1.037 RY - nuclear science & technology ; 8/30 ; četrtina: 1 ; x=0.803 ; IFmin: 1.019 ; IFmax: 2.178 UP - physics, particles & fields ; 18/25 ; četrtina: 3 ; x=2.706 ; IFmin: 1.015 ; IFmax: 1.803 XQ - spectroscopy ; 28/39 ; četrtina: 3 ; x=2.097 ; IFmin: 0.866 ; IFmax: 1.492,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.889	9	15	13	16	14	13	16

162. Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (4 avtorjev) , **Timing and cross-talk properties of BURLE multi-channel MCP PMTs**, Nucl. instrum, methods phys res., Sect. A, Accel., (2008) vol. 595, no. 1, str. 169-172, ISBN 0168-9002, COBISS-ID 22074663, IF: 1.019, SE: OA - instruments & instrumentation ; 30/56 ; četrtina: 3 ; x=1.318 ; IFmin: 0.586 ; IFmax: 1.037 RY - nuclear science & technology ; 8/30 ; četrtina: 1 ; x=0.803 ; IFmin: 1.019 ; IFmax: 2.178 UP - physics, particles & fields ; 18/25 ; četrtina: 3 ; x=2.706 ; IFmin: 1.015 ; IFmax: 1.803 XQ - spectroscopy ; 28/39 ; četrtina: 3 ; x=2.097 ; IFmin: 0.866 ; IFmax: 1.492,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	2	4	9	2	2	12	3	4

163. ===> Rok Pestotnik, Peter Križan, Samo Korpar, Toru Iijima, (4 avtorjev) , **Design optimization of the proximity focusing RICH with dual aerogel radiator using a maximum-likelihood analysis of Cherenkov rings**, Nucl. instrum, methods phys res., Sect. A, Accel., (2008) vol. 595, no. 1, str. 256-259, ISBN 0168-9002, COBISS-ID 22074919, IF: 1.019, SE: OA - instruments & instrumentation ; 30/56 ; četrtina: 3 ; x=1.318 ; IFmin: 0.586 ; IFmax: 1.037 RY - nuclear science & technology ; 8/30 ; četrtina: 1 ; x=0.803 ; IFmin: 1.019 ; IFmax: 2.178 UP - physics, particles & fields ; 18/25 ; četrtina: 3 ; x=2.706 ; IFmin: 1.015 ; IFmax: 1.803 XQ - spectroscopy ; 28/39 ; četrtina: 3 ; x=2.097 ; IFmin: 0.866 ; IFmax: 1.492,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	2	4	3	1	1	3	1	1

164. ===> Rok Pestotnik, Samo Korpar, Peter Križan, Rok Dolenec, (4 avtorjev) , **Cherenkov detector of [sup](90)Sr based on aerogel as radiator**, Nucl. instrum, methods phys res., Sect. A, Accel., (2008) vol. 595, no. 1, str. 278-280, ISBN 0168-9002, COBISS-ID 22075175, IF: 1.019, SE: OA - instruments & instrumentation ; 30/56 ; četrtina: 3 ; x=1.318 ; IFmin: 0.586 ; IFmax: 1.037 RY - nuclear science & technology ; 8/30 ; četrtina: 1 ; x=0.803 ; IFmin: 1.019 ; IFmax: 2.178 UP - physics, particles & fields ; 18/25 ; četrtina: 3 ; x=2.706 ; IFmin: 1.015 ; IFmax: 1.803 XQ - spectroscopy ; 28/39 ; četrtina: 3 ; x=2.097 ; IFmin: 0.866 ; IFmax: 1.492,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	2	4	0	0	0	0	0	0

165. Galina Pakhlova, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Anže Zupanc, (139 avtorjev) , **Observation of [psi](4415) [to] D (D[bar])[sup][ast] [sub]2 (2460) decay using initial-state radiation**, Phys. rev. lett., (2008) vol. 100, no. 6, str. 062001-1-062001-6, ISBN 0031-9007, COBISS-ID 21484327, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	139	27	24	10	29	26	10

166. J. Brodzicka, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (153 avtorjev) , **Observation of a new D[sub](s J) meson in B[sup]+ [to] (D[bar])[sup]0 D[sup]0 K[sup]+ decay**, Phys. rev. lett., (2008) vol. 100, no. 9, str. 092001-1-092001-6, ISBN 0031-9007, COBISS-ID 21552935, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	153	41	39	16	44	43	17

167. K.-F. Chen, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (151 avtorjev) , **Observation of anomalous [Upsilon](1S) [pi][sup]+ [pi][sup]- and [Upsilon](2S) [pi][sup]+ [pi][sup]- production near the [Upsilon](5S) resonance**, Phys. rev. lett., (2008) vol. 100, no. 11, str. 112001-1-112001-6, ISBN 0031-9007, COBISS-ID 21553447, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	44	38	15	51	46	19

168. Y. Nakahama, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Measurement of time-dependent CP-violating parameters in B[sup]0 [to] (K[sub]S)[sup]0 (K[sub]S)[sup]0 decays**, Phys. rev. lett., (2008) vol. 100, no. 12, str. 121601-1-121605-5, ISBN 0031-9007, COBISS-ID 21671207, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	2	2	1			

169. J. Wicht, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Observation of (B[sub]s)[sup]0 [to] [phi] [gamma] and search for (B[sub]s)[sup]0 [to] [gamma] [gamma] decays at Belle**, Phys. rev. lett., (2008) vol. 100, no. 12, str. 121801-1-121801-6, ISBN 0031-9007, COBISS-ID 21670951, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	16	15	6	16	15	6

170. S.-K. Choi, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (140 avtorjev) , **Observation of a resonancelike structure in the [pi][sup][pm] [psi][sup][prime] mass distribution in exclusive B [to] K [pi][sup][pm] [psi][sup][prime] decays**, Phys. rev. lett., (2008) vol. 100, no. 14, str. 142001-1-142001-6, ISBN 0031-9007, COBISS-ID 21669671, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	140	88	80	32	127	121	49

171. P. Pakhlov, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (141 avtorjev) , **Production of new charmoniumlike states in e[sup]+ e[sup]- [to] J/[psi] D[sup]^(([ast]))(D[bar])[sup](([ast])) at [square root]s [approximately equal]**

10.6 GeV, Phys. rev. lett., (2008) vol. 100, no. 20, str. 202001-1-202001-5, ISBN 0031-9007, COBISS-ID 21842471, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	141	38	35	14	59	57	23

172. L. Widhalm, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (143 avtorjev) , **Measurement of B((D[sub]s)[sup]+ [to] [mu][sup]+ [nu][sub][mu])**, Phys. rev. lett., (2008) vol. 100, no. 24, str. 241801-1-241801-6, ISBN 0031-9007, COBISS-ID 21844775, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	14	13	5	22	22	9

173. J. - H. Chen, Urban Bitenc, Marko Bračko, Boštjan Golob, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Observation of B[sup]0 [to] p p[bar] K[sup]([ast] 0) with a large K[sup]([ast]0) polarization**, Phys. rev. lett., (2008) vol. 100, no. 25, str. 251801-1-251801-6, ISBN 0031-9007, COBISS-ID 21843239, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	10	8	3	11	9	4

174. M. Iwabuchi, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (135 avtorjev) , **Search for B[sup]+ [to] D[sup]([ast] +) [pi][sup]0 decay**, Phys. rev. lett., (2008) vol. 101, no. 4, str. 041601-1-041601-5, ISBN 0031-9007, COBISS-ID 22109223, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	135	2	1	0	2	1	0

175. P. Goldenzweig, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (151 avtorjev) , **Evidence for neutral B meson decays to [omega] K[sup]([ast] 0)**, Phys. rev. lett., (2008) vol. 101, vol. 23, str. 231801-1-231801-6, ISBN 0031-9007, COBISS-ID 22373415, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	3	2	1	3	2	1

176. J. Li, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (123 avtorjev) , **Measurement of the time-dependent CP asymmetry in B[sup]0 [to] (K[sub]S)[sup]0 [rho][sup]0 [gamma] decays**, Phys. rev. lett., (2008) vol. 101, no. 25, str. 251601-1-251601-6, ISBN 0031-9007, COBISS-ID 22313255, IF: 7.18, SE: UI - physics, multidisciplinary ; 5/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	123	1	1	0			

177. Galina Pakhlova, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo

Stanič, Marko Starič, Anže Zupanc, (136 avtorjev) , **Measurement of the near-threshold e[sup]+ e[sup]- [to] D D[bar] cross section using initial-state radiation**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 1, str. 011103-1-011103-5, ISBN 1550-7998, COBISS-ID 21407271, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	136	36	33	11	7	7	2

178. V. Balagura, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (147 avtorjev) , **Observation of D[sub](s1)(2536)[sup]+ [to] D[sup]+ [pi][sup]- K[sup]+ and angular decomposition of D[sub](s1)(2536)[sup]+ [to] D[sup]([ast]+)(K[sub]S)[sup]0**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 3, str. 032001-1-032001-10, ISBN 1550-7998, COBISS-ID 21484583, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	147	9	8	3	12	11	4

179. Y. Uchida, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (138 avtorjev) , **Search for (B[bar])[sup]0 [to] ([Lambda][sub]c)[sup]+ (([Lambda][bar])[sub]c)[sup]- decay at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 5, str. 051101-1-051101-6, ISBN 1550-7998, COBISS-ID 21553191, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	138	1	1	0	1	1	0

180. S. E. Lee, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (148 avtorjev) , **Improved measurement of time-dependent CP violation in B[sup]0 [to] J/[psi] [pi][sup]0 decays**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 7, str. 071101-1-071101-6, ISBN 1550-7998, COBISS-ID 21668903, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	148	7	5	2			

181. A. Kusaka, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (143 avtorjev) , **Measurement of CP asymmetries and branching fractions in a time-dependent Dalitz analysis of B[sup]0 [to] ([rho] [pi])[sup]0 and a constraint on the quark mixing angle [phi][sub]2**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 7, str. 072001-1-072001-25, ISBN 1550-7998, COBISS-ID 21670439, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	12	12	4	12	12	4

182. H. Sahoo, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (144 avtorjev) , **Measurements of time-dependent CP violation in B[sup]0 [to] [psi](2S) (K[sub]S)[sup]0 decays**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 9, str. 091103-1-091103-6, ISBN 1550-7998, COBISS-ID 21844263, IF: 5.05, SE: BU - astronomy & astrophysics ;

8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	144	5	4	1	4	3	1

183. D. Liventsev, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (143 avtorjev) , **Study of B [to] D[sup]([ast] [ast]) l [nu] with full reconstruction tagging**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 9, str. 091503-1-091503-7, ISBN 1550-7998, COBISS-ID 21842727, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	14	14	5	14	14	5

184. Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (142 avtorjev) , **Improved search for D[sup]0 - (D[bar])[sup]0 mixing using semileptonic decays at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 77, no. 11, str. 112003-1-112003-20, ISBN 1550-7998, COBISS-ID 21844519, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	142	8	8	3	10	10	3

185. J.-T. Wei, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, Tomi Živko, (117 avtorjev) , **Search for B [to] [pi] l[sup]+ l[sup]- decays at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 1, str. 011101-1-011101-6, ISBN 1550-7998, COBISS-ID 22193959, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	117	6	5	2	5	4	1

186. Y. Liu, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, Tomi Živko, (140 avtorjev) , **Search for B[sup]0 [to] J/[psi] [phi] decays**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 1, str. 011106-1-011106-5, ISBN 1550-7998, COBISS-ID 22109991, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	140	5	5	2	6	6	2

187. C. Schwanda, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (136 avtorjev) , **Measurement of the moments of the photon energy spectrum in B [to] X[sub]s[gamma] decays and determination of [vertical]V[sub](cb)[vertical] and m[sub]b at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 3, str. 032016-1-032016-13, ISBN 1550-7998, COBISS-ID 22108967, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	136	11	10	3	11	10	3

188. V. Bhardwaj, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, Tomi Živko, (145 avtorjev) , **Observation of B[sup][pm] [to] [psi](2S) [pi][sup][pm] and search for direct CP violation**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 5, str. 051104-1-051104-6, ISBN 1550-7998, COBISS-ID 22112551, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	1	1	0	1	1	0

189. Y. Horii, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (142 avtorjev) , **Study of the suppressed B meson decay B[sup]- [to] D K[sup]-, D [to] K[sup]+[pi][sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 7, str. 071901-1-071901-7, ISBN 1550-7998, COBISS-ID 22193703, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	142	5	4	1	8	7	2

190. R. Mizuk, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, Tomi Živko, (142 avtorjev) , **Observation of two resonancelike structures in the [pi][sup]+ [chi][sub](c1) mass distribution in exclusive (B[bar])[sup]0 [to] K[sup]- [pi][sup]+[chi][sub](c1) decays**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 7, str. 072004-1-072004-14, ISBN 1550-7998, COBISS-ID 22112295, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	142	56	52	17			

191. M. Fujikawa, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, Tomi Živko, (154 avtorjev) , **High-statistics study of the [tau][sup]- [to] [pi][sup]- [pi][sup]0 [nu][sub][tau] decay**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 7, str. 072006-1-072006-22, ISBN 1550-7998, COBISS-ID 22194215, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	154	34	32	10	41	39	13

192. R. Kumar, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (130 avtorjev) , **Evidence for B[sup]0 [to] [chi][sub](c1) [pi][sup]0 at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 9, str. 091104-1-091104-6, ISBN 1550-7998, COBISS-ID 22373671, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	130	0	0	0	0	0	0

193. C. -C. Chiang, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik,

Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (147 avtorjev) , **Measurement of B[sup]0 [to] [pi][sup]+ [pi][sup]- [pi][sup]+ [pi][sup]- decays and search for B[sup]0 [to] [rho][sup]0 [rho][sup]0**, Phys. rev., D Part. fields gravit. cosmol., (2008) vol. 78, no. 11, str. 111102-1-111102-7, ISBN 1550-7998, COBISS-ID 22563879, IF: 5.05, SE: BU - astronomy & astrophysics ; 8/48 ; četrtina: 1 ; x=3.065 ; IFmin: 3.388 ; IFmax: 25.826 UP - physics, particles & fields ; 5/25 ; četrtina: 1 ; x=2.706 ; IFmin: 3.86 ; IFmax: 9.893,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	147	7	6	2	4	4	1

194. J.-T. Wei, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (149 avtorjev) , **Study of the decay mechanism for B[sup]+ [to] p p[bar] K[sup]+ and B[sup]+ [to] p p[bar] [pi][sup]+**, Phys. lett., Sect. B, (2008) vol. 659, no. 1/2, str. 80-86, ISBN 0370-2693, COBISS-ID 21407015, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	149	15	12	5	15	12	5

195. Y. Miyazaki, Urban Bitenc, Marko Bračko, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (134 avtorjev) , **Search for lepton flavor violating [tau] decays into three leptons**, Phys. lett., Sect. B, (2008) vol. 660, no. 3, str. 154-160, ISBN 0370-2693, COBISS-ID 21484071, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	134	30	29	12	35	33	13

196. K. Arinstein, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (158 avtorjev) , **Measurement of the ratio B(D[sup]0 [to] [pi][sup]+ [pi][sup]- [pi][sup]0)/ B(D[sup]0 [to] K[sup]- [pi][sup]+ [pi][sup]0) and the time-integrated CP asymmetry in D[sup]0 [to] [pi][sup]+ [pi][sup]- [pi][sup]0**, Phys. lett., Sect. B, (2008) vol. 662, no. 2, str. 102-110, ISBN 0370-2693, COBISS-ID 21671463, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	158	3	1	0	4	3	1

197. J. Wicht, Urban Bitenc, Ilija Bizjak, Marko Bračko, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (147 avtorjev) , **Search for resonant B[sup][pm] [to] K[sup][pm] h [to] K[sup][pm] [gamma] [gamma] decays at Belle**, Phys. lett., Sect. B, (2008) vol. 662, no. 4, str. 323-329, ISBN 0370-2693, COBISS-ID 21670695, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	147	2	2	1	1	1	0

198. Y. Nishio, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (135 avtorjev) , **Search for lepton-flavor-violating [tau] [to] l V[sup]0 decays at Belle**, Phys. lett., Sect. B, (2008) vol. 664, no. 1/2, str. 35-40, ISBN 0370-2693, COBISS-ID 21842983, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	135	7	6	2	12	11	4

199. T. Lesiak, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (138 avtorjev) , **Measurements of masses of the [Xi][sub]c (2645) and [Xi][sub]c (2815) baryons and observation of [Xi][sub]c (2980) [to] [Xi][sub]c (2645) [pi]**, Phys. lett., Sect. B, (2008) vol. 665, no. 1, str. 9-15, ISBN 0370-2693, COBISS-ID 21845287, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	138	3	3	1	4	4	2

200. K. Hayasaka, Urban Bitenc, Ilija Bizjak, Marko Bračko, Boštjan Golob, Saša Fratina, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (158 avtorjev) , **New search for [tau] [to] [mu] [gamma] and [tau] [to] e [gamma] decays at Belle**, Phys. lett., Sect. B, (2008) vol. 666, no. 1, str. 16-22, ISBN 0370-2693, COBISS-ID 22108711, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	158	56	56	23	53	53	21

201. H. -O. Kim, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, Tomi Živko, (140 avtorjev) , **Study of intermediate two-body decays in (B[bar])[sup]0 [to] ([Sigma][sub]c (2455))[sup]0 p[bar] [pi][sup]+**, Phys. lett., Sect. B, (2008) vol. 669, no. 5, str. 287-293, ISBN 0370-2693, COBISS-ID 22194727, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	140	0	0	0			

202. Marko Starič, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Tomi Živko, Anže Zupanc, (148 avtorjev) , **Search for a CP asymmetry in Cabibbo-suppressed D[sup]0 decays**, Phys. lett., Sect. B, (2008) vol. 670, no. 3, str. 190-195, ISBN 0370-2693, COBISS-ID 22312999, IF: 4.034, SE: UI - physics, multidisciplinary ; 7/68 ; četrtina: 1 ; x=2.484 ; IFmin: 2.073 ; IFmax: 33.985,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	148	22	18	7			

203. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (196 avtorjev) , **Angular distributions of leptons from J/[psi]'s produced in 920 GeV fixed-target proton-nucleus collisions**, The European physical journal. C, (2009) vol. 60, no. 4, str. 517-524, ISBN 1434-6044, COBISS-ID 23355431, IF: 2.746, SE: UP - physics, particles & fields ; 11/27 ; četrtina: 2 ; x=2.927 ; IFmin: 2.034 ; IFmax: 3.556,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	196	8	7	2	9	9	3

204. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (196 avtorjev) , **Kinematic distributions and nuclear effects of J/[psi] production in 920 GeV fixed-target proton-nucleus collisions**, The European physical journal. C, (2009) vol. 60, no. 4, str. 525-542, ISBN 1434-6044, COBISS-ID 23355687, IF: 2.746, SE: UP - physics, particles & fields ; 11/27 ; četrtina: 2 ; x=2.927 ; IFmin: 2.034 ; IFmax: 3.556,

STD	STK	Št. avtorjev	WoS: št. citatov	čistih citatov	normirano št. čistih citatov	Scopus: št. citatov (TC)	čistih citatov	normirano št. čistih citatov

			(TC)	(CI)	(NC)		(CI)	(NC)
8	0.8	196	13	12	4	20	19	6

205. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (196 avtorjev) , **V[sup]0 production in [rho] + A collisions at [square root]s = 41.6 GeV**, The European physical journal. C, (2009) vol. 61, no. 2, str. 207-221, ISBN 1434-6044, COBISS-ID 23348519, IF: 2.746, SE: UP - physics, particles & fields ; 11/27 ; četrtina: 2 ; x=2.927 ; IFmin: 2.034 ; IFmax: 3.556,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	196	2	2	1	0	0	0

206. Shohei Nishida, Rok Dolenec, Samo Korpar, Peter Križan, Rok Pestotnik, (20 avtorjev) , **Study of an HAPD with 144 channels for the Aerogel RICH of the Belle upgrade**, Nucl. instrum, methods phys res., Sect. A, Accel., (2009) vol. 610, no. 1, str. 65-67, ISBN 0168-9002, COBISS-ID 23400487, IF: 1.317, SE: OA - instruments & instrumentation ; 19/56 ; četrtina: 2 ; x=1.249 ; IFmin: 1.012 ; IFmax: 1.634 RY - nuclear science & technology ; 6/33 ; četrtina: 1 ; x=0.819 ; IFmin: 1.122 ; IFmax: 1.933 UP - physics, particles & fields ; 17/27 ; četrtina: 3 ; x=2.927 ; IFmin: 0.935 ; IFmax: 1.968 XQ - spectroscopy ; 27/39 ; četrtina: 3 ; x=2.112 ; IFmin: 0.986 ; IFmax: 1.542,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	20	2	2	2	1	1	1

207. Samo Korpar, Hassan Chagani, Rok Dolenec, K. Hara, Toru Iijima, Peter Križan, Y. Mazuka, Rok Pestotnik, Aleš Stanovnik, M. Yamaoka, (10 avtorjev) , **Measurement of Cherenkov photons by SiPMs with light guides**, Nucl. instrum, methods phys res., Sect. A, Accel., (2009) vol. 610, issue 1, str. 427-430, ISBN 0168-9002, COBISS-ID 516243225, IF: 1.317, SE: OA - instruments & instrumentation ; 19/56 ; četrtina: 2 ; x=1.249 ; IFmin: 1.012 ; IFmax: 1.634 RY - nuclear science & technology ; 6/33 ; četrtina: 1 ; x=0.819 ; IFmin: 1.122 ; IFmax: 1.933 UP - physics, particles & fields ; 17/27 ; četrtina: 3 ; x=2.927 ; IFmin: 0.935 ; IFmax: 1.968 XQ - spectroscopy ; 27/39 ; četrtina: 3 ; x=2.112 ; IFmin: 0.986 ; IFmax: 1.542,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	10	0	0	0	0	0	0

208. ===> Rok Pestotnik, (1 avtorjev) , **The SuperBelle project**, Nucl. phys., Sect. A, (2009) vol. 827, no. 1/4, str. 608c-613c, ISBN 0375-9474, COBISS-ID 22775079, IF: 1.706, SE: UN - physics, nuclear ; 9/22 ; četrtina: 2 ; x=1.951 ; IFmin: 1.156 ; IFmax: 1.968,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	8	1	0	0	0	0	0	0

209. R. Louvot, Urban Bitenc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (139 avtorjev) , **Measurement of the decay (B[sub]s)[sup]0 [to] (D[sub]s)[sup]- [pi][sup]+ and evidence for (B[sub]s)[sup]0 [to] (D[sub]s)[sup][mp] K[sup][pm] in e[sup]+ e[sup]- annihilation at [square root]s [approximately equal] 10.87 GeV**, Phys. rev. lett., (2009) vol. 102, no. 2, str. 021801-1-021801-6, ISBN 0031-9007, COBISS-ID 22564391, IF: 7.328, SE: UI - physics, multidisciplinary ; 6/71 ; četrtina: 1 ; x=2.572 ; IFmin: 2.616 ; IFmax: 33.145,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	139	20	16	6	19	16	6

210. B. R. Ko, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (123 avtorjev) , **Observation of the doubly Cabibbo-suppressed decay (D[sub]s)[sup]+ [to] K[sup]+ K[sup]+ [pi][sup]-**, Phys. rev. lett., (2009) vol. 102, no. 22, str. 221802-1-221802-5, ISBN

0031-9007, COBISS-ID 23037223, IF: 7.328, SE: UI - physics, multidisciplinary ; 6/71 ; četrtina: 1 ; x=2.572 ; IFmin: 2.616 ; IFmax: 33.145,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	123	4	2	1	4	2	1

211. Iris Abt, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Andrej Gorišek, Aleš Stanovnik, Marko Starič, Tomi Živko, (193 avtorjev) , **Production of the charmonium states [chi][sub](c1) and [chi][sub](c2) in proton nucleus interactions at [square root]s=41.6 GeV**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 1, str. 012001-012001-18, ISBN 1550-7998, COBISS-ID 22370599, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	193	16	14	4	14	12	4

212. A. Sokolov, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (143 avtorjev) , **Measurement of the branching fraction for the decay [Upsilon](4S) [to] [Upsilon](1S) [pi][sup]+ [pi][sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 5, str. 051103-1-051103-5, ISBN 1550-7998, COBISS-ID 22565159, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	2	2	1	1	1	0

213. Y. -W. Chang, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (123 avtorjev) , **Observation of B[sup]0 [to] [Lambda] [Lambda][bar] K[sup]0 and B[sup]0 [to] [Lambda] [Lambda][bar] K[sup]([ast]0) at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 5, str. 052006-1-052006-13, ISBN 1550-7998, COBISS-ID 23036455, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	123	6	5	2	5	4	1

214. S. Uehara, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Tomi Živko, Anže Zupanc, (104 avtorjev) , **High-statistics study of neutral-pion pair production in two-photon collisions**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 5, str. 052009-1-052009-13, ISBN 1550-7998, COBISS-ID 22565415, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	104	15	11	3	12	8	3

215. P. Pakhlov, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (136 avtorjev) , **Measurement of the e[sup]+ e[sup]- [to] J/[psi] c c[bar] cross section at [square root]s [approximately equal] 10.6 GeV**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 7, str. 071101-1-071101-7, ISBN 1550-7998, COBISS-ID 22610727, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	136	18	18	6	21	21	7

216. C. Liu, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (126 avtorjev) , **Search for the X(1812) in B[sup][pm] [to] K[sup][pm] [omega] [phi]**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 7, str. 071102-1-071102-6, ISBN 1550-7998, COBISS-ID 23036711, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	126	2	2	1	2	2	1

217. J. Dalseno, Urban Bitenc, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (131 avtorjev) , **Time-dependent Dalitz plot measurement of CP parameters in B[sup]0 [to] (K[sub]S)[sup]0 [pi][sup]+ [pi][sup]- decays**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 79, no. 7, str. 072004-1-072004-17, ISBN 1550-7998, COBISS-ID 22610471, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	131	12	11	3	13	12	4

218. R. Mizuk, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (134 avtorjev) , **Dalitz analysis of B [to] K [pi][sup]+ [Psi][sup][prime] decays and the Z(4430)[sup]+**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 3, str. 031104-1-031104-7, ISBN 1550-7998, COBISS-ID 23037991, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	134	27	26	8	37	36	11

219. S. -H. Kyeong, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (131 avtorjev) , **Measurements of charmless hadronic b [to] s penguin decays in the [pi][sup]+ [pi][sup]- K[sup]+ [pi][sup]- final state and first observation of B[sup]0 [to] [rho][sup]0 K^[sup]+ [pi][sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 5, str. 051103-1-051103-6, ISBN 1550-7998, COBISS-ID 23037479, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	131	1	1	0	3	3	1

220. J. Wiechczynski, Marko Bračko, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (128 avtorjev) , **Measurement of B [to] (D[sub]s)[sup]([ast]) K [pi] branching fractions**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 5, str. 052005-1-052005-7, ISBN 1550-7998, COBISS-ID 23036967, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	128	1	1	0	3	3	1

221. Anže Zupanc, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, (135 avtorjev) , **Measurement of y[sub]CP in D[sup]0 meson decays to the (K[sub]S)[sup]0 K[sup]+ K[sup]- final state**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 5, str.

052006-1-052006-11, ISBN 1550-7998, COBISS-ID 23038247, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	135	9	9	3	7	7	2

222. Galina Pakhlova, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (146 avtorjev) , **Measurement of the e[sup]+ e[sup]- [to] D[sup]0 D[sup]([ast] -) [pi][sup]+ cross section using initial-state radiation**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 9, str. 091101-1-091101-7, ISBN 1550-7998, COBISS-ID 23286311, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	146	16	15	5	15	14	4

223. E. Won, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (140 avtorjev) , **Measurement of D[sup]+ [to] (K[sub]S)[sup]0 K[sup]+ and (D[sub]s)[sup]+ [to] (K[sub]S)[sup]0 [pi][sup]+ branching ratios**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 11, str. 111101-1-111101-5, ISBN 1550-7998, COBISS-ID 23286567, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	140	6	2	1	6	2	1

224. P. Chen, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, Anže Zupanc, (112 avtorjev) , **Observation of B[sup]+ [to] p [Lambda][bar] [pi][sup]+ [pi][sup]- at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 11, str. 111103-1-111103-6, ISBN 1550-7998, COBISS-ID 23286823, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	112	1	1	0	1	1	0

225. K. Vervink, Urban Bitenc, Marko Bračko, Saša Fratina, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Tomi Živko, Anže Zupanc, (128 avtorjev) , **Evidence of time-dependent CP violation in the decay B[sup]0 [to] D[sup]([ast] +) D[sup]([ast] -)**, Phys. rev., D Part. fields gravit. cosmol., (2009) vol. 80, no. 11, str. 111104-1-111104-6, ISBN 1550-7998, COBISS-ID 23664935, IF: 4.922, SE: BU - astronomy & astrophysics ; 10/52 ; četrtina: 1 ; x=3.158 ; IFmin: 4.179 ; IFmax: 25.64 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.927 ; IFmin: 4.136 ; IFmax: 11.964,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	128	3	1	0	2	1	0

226. Y. Miyazaki, Urban Bitenc, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (111 avtorjev) , **Search for lepton-flavor-violating [tau] decay into a lepton and an f[sub]0 (980) meson**, Phys. lett., Sect. B, (2009) vol. 672, no. 4/5, str. 317-322, ISBN 0370-2693, COBISS-ID 22564647, IF: 5.083, SE: UI - physics, multidisciplinary ; 7/71 ; četrtina: 1 ; x=2.572 ; IFmin: 2.616 ; IFmax: 33.145,

STD	STK	Št. avtorjev	WoS: št. citatov	čistih citatov	normirano št. čistih citatov	Scopus: št. citatov (TC)	čistih citatov	normirano št. čistih citatov

			(TC)	(CI)	(NC)		(CI)	(NC)
8	0.8	111	3	3	1	5	5	2

227. K. Belous, Marko Bračko, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (119 avtorjev) , **Measurement of cross sections of exclusive e[sup]+ e[sup]- [to] VP processes at [square root]s=10.58 GeV**, Phys. lett., Sect. B, (2009) vol. 681, no. 5, str. 400-405, ISBN 0370-2693, COBISS-ID 23094311, IF: 5.083, SE: UI - physics, multidisciplinary ; 7/71 ; četrtina: 1 ; x=2.572 ; IFmin: 2.616 ; IFmax: 33.145,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	119	2	2	1	2	2	1

228. Samo Korpar, Hassan Chagani, Rok Dolenec, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (6 avtorjev) , **A module of silicon photo-multipliers for detection of Cherenkov radiation**, Nucl. instrum, methods phys res., Sect. A, Accel., (2010) vol. 613, no. 2, str. 195-199, ISBN 0168-9002, COBISS-ID 23339559, IF: 1.142, SE: OA - instruments & instrumentation ; 28/61 ; četrtina: 2 ; x=1.273 ; IFmin: 1.042 ; IFmax: 1.684 RY - nuclear science & technology ; 9/34 ; četrtina: 1 ; x=0.857 ; IFmin: 1.142 ; IFmax: 1.886 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=2.907 ; IFmin: 0.99 ; IFmax: 1.77 XQ - spectroscopy ; 28/40 ; četrtina: 3 ; x=2.301 ; IFmin: 1.103 ; IFmax: 1.729,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.333	6	4	1	1	4	1	1

229. Ichiro Adachi, Rok Dolenec, Samo Korpar, Peter Križan, Rok Pestotnik, (21 avtorjev) , **Study of 144-channel multi-anode hybrid avalanche photo-detector for the Belle RICH counter**, Nucl. instrum, methods phys res., Sect. A, Accel., (2010) vol. 623, no. 1, str. 285-287, ISBN 0168-9002, COBISS-ID 24016423, IF: 1.142, SE: OA - instruments & instrumentation ; 28/61 ; četrtina: 2 ; x=1.273 ; IFmin: 1.042 ; IFmax: 1.684 RY - nuclear science & technology ; 9/34 ; četrtina: 1 ; x=0.857 ; IFmin: 1.142 ; IFmax: 1.886 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=2.907 ; IFmin: 0.99 ; IFmax: 1.77 XQ - spectroscopy ; 28/40 ; četrtina: 3 ; x=2.301 ; IFmin: 1.103 ; IFmax: 1.729,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	21	3	1	1	2	0	0

230. Samo Korpar, Hassan Chagani, Rok Dolenec, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (6 avtorjev) , **Silicon photomultiplier based photon detector module as a detector of Cherenkov photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2010) vol. 623, no. 1, str. 333-335, ISBN 0168-9002, COBISS-ID 24017191, IF: 1.142, SE: OA - instruments & instrumentation ; 28/61 ; četrtina: 2 ; x=1.273 ; IFmin: 1.042 ; IFmax: 1.684 RY - nuclear science & technology ; 9/34 ; četrtina: 1 ; x=0.857 ; IFmin: 1.142 ; IFmax: 1.886 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=2.907 ; IFmin: 0.99 ; IFmax: 1.77 XQ - spectroscopy ; 28/40 ; četrtina: 3 ; x=2.301 ; IFmin: 1.103 ; IFmax: 1.729,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.333	6	1	1	1	1	1	1

231. Shin-Ichi Nishida, Rok Dolenec, Samo Korpar, Rok Pestotnik, (11 avtorjev) , **Development of the readout ASIC for the 144ch HAPD for aerogel RICH**, Nucl. instrum, methods phys res., Sect. A, Accel., (2010) vol. 623, no. 1, str. 504-506, ISBN 0168-9002, COBISS-ID 24017447, IF: 1.142, SE: OA - instruments & instrumentation ; 28/61 ; četrtina: 2 ; x=1.273 ; IFmin: 1.042 ; IFmax: 1.684 RY - nuclear science & technology ; 9/34 ; četrtina: 1 ; x=0.857 ; IFmin: 1.142 ; IFmax: 1.886 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=2.907 ; IFmin: 0.99 ; IFmax: 1.77 XQ - spectroscopy ; 28/40 ; četrtina: 3 ; x=2.301 ; IFmin: 1.103 ; IFmax: 1.729,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)

8	0.8	11	3	1	1	3	2	2

232. ===> Rok Pestotnik, Samo Korpar, Hassan Chagani, Rok Dolenec, Peter Križan, Aleš Stanovnik, (6 avtorjev) , **Silicon photo-multipliers as photon detectors for PET**, Nucl. instrum, methods phys res., Sect. A, Accel., (2010) vol. 623, no. 1, str. 594-596, ISBN 0168-9002, COBISS-ID 24017703, IF: 1.142, SE: OA - instruments & instrumentation ; 28/61 ; četrtina: 2 ; x=1.273 ; IFmin: 1.042 ; IFmax: 1.684 RY - nuclear science & technology ; 9/34 ; četrtina: 1 ; x=0.857 ; IFmin: 1.142 ; IFmax: 1.886 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=2.907 ; IFmin: 0.99 ; IFmax: 1.77 XQ - spectroscopy ; 28/40 ; četrtina: 3 ; x=2.301 ; IFmin: 1.103 ; IFmax: 1.729,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.333	6	2	2	2	2	2	2

233. P. Urquijo, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (131 avtorjev) , **Measurement of [vertical]V[sub](ub)[vertical] from inclusive charmless semileptonic B decays**, Phys. rev. lett., (2010) vol. 104, no. 2, str. 021801-1-021801-5, ISBN 0031-9007, COBISS-ID 23665959, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	131	7	7	3	10	10	4

234. S. Uehara, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, (118 avtorjev) , **Observation of a charmoniumlike enhancement in the [gamma][gamma] [to] [omega] J/[psi] process**, Phys. rev. lett., (2010) vol. 104, no. 9, str. 092001-1-092001-6, ISBN 0031-9007, COBISS-ID 23673127, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	118	23	19	7	23	19	7

235. C. P. Shen, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, (134 avtorjev) , **Evidence for a new resonance and search for the Y(4140) in the [gamma][gamma] [to] [phi] J/[psi] process**, Phys. rev. lett., (2010) vol. 104, no. 11, str. 112004-1-112004-5, ISBN 0031-9007, COBISS-ID 23670055, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	134	22	19	7	22	19	7

236. B. R. Ko, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (131 avtorjev) , **Search for CP violation in the decays (D[sub](s))[sup]+ [to] (K[sub]S)[sup]0 [pi][sup]+ and (D[sub](s))[sup]+ [to] (K[sub]S)[sup]0 K[sup]+**, Phys. rev. lett., (2010) vol. 104, no. 18, str. 181602-1-181602-6, ISBN 0031-9007, COBISS-ID 23678247, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	131	18	11	4	16	9	3

237. R. Louvot, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, (130 avtorjev) , **Observation of B[sub]s[sup]0 [to] D[sub]s[sup]([ast]-)[pi][sup]+ and B[sub]s[sup]0 [to] D[sub]s[sup](([ast])-)[rho][sup]+ and measurement of the B[sub]s[sup]0 [to] D[sub]s[sup]([ast]-)[rho][sup]+ polarization fraction**, Phys. rev. lett., (2010) vol.

104, no. 23, str. 231801-1-231801-6, ISBN 0031-9007, COBISS-ID 24332839, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	130	6	6	2	7	7	3

238. H. J. Hyun, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Marko Petrič, Samo Stanič, Marko Starič, (110 avtorjev) , **Search for a low mass particle decaying into [mu][sup]+[mu][sup]- in B[sup]0 [to] K[sup]([ast] 0)X and B[sup]0 [to] [rho][sup]0 X at Belle**, Phys. rev. lett., (2010) vol. 105, no. 9, str. 091801-1-091801-5, ISBN 0031-9007, COBISS-ID 24333607, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	110	6	6	2	7	7	3

239. K. Nishimura, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, Anže Zupanc, (143 avtorjev) , **First measurement of inclusive B [to] X[sub]s [eta] decays**, Phys. rev. lett., (2010) vol. 105, no. 19, str. 191803-1-191803-6, ISBN 0031-9007, COBISS-ID 24345127, IF: 7.621, SE: UI - physics, multidisciplinary ; 5/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	0	0	0	1	1	0

240. M. Fujikawa, Marko Bračko, Samo Korpar, Rok Pestotnik, Samo Stanič, Marko Starič, Anže Zupanc, (128 avtorjev) , **Measurement of CP asymmetries in B[sup]0 [to] K[sup]0 [pi][sup]0 decays**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 1, str. 011101-1-011101-7, ISBN 1550-7998, COBISS-ID 23666215, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	128	1	1	0	2	2	1

241. T. Aushev, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, Anže Zupanc, (134 avtorjev) , **Study of the B [to] X(3872) ([to] D[sup]([ast]0)(D[bar])[sup]0)K decay**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 3, str. 031103-1-031103-7, ISBN 1550-7998, COBISS-ID 23669799, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	134	12	12	4	4	4	1

242. C. -C. Chiang, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (126 avtorjev) , **Search for B[sup]0 [to] K[sup]([ast] 0) (K[bar])[sup]([ast] 0), B[sup]0 [to]K[sup]([ast] 0) K[sup]([ast] 0) and B[sup]0 [to] K[sup]+ [pi][sup]- K[sup][mp] [pi][sup][pm] decays**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 7, str. 071101-1-071101-7, ISBN 1550-7998, COBISS-ID 23678759, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	126	3	3	1	2	2	1

243. Marko Petrič, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Peter Smerkol, Marko Starič, Tomi Živko, Anže Zupanc, (124 avtorjev) , **Search for leptonic decays of D[sup]0 mesons**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 9, str. 091102-1-091102-6, ISBN 1550-7998, COBISS-ID 23679015, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	124	4	4	1	4	3	1

244. R. Wedd, Marko Bračko, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (129 avtorjev) , **Evidence for B [to] K [eta][sup][prime] [gamma] decays at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 11, str. 111104-1-111104-7, ISBN 1550-7998, COBISS-ID 24329511, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	129	1	1	0	21	21	7

245. A. Drutskoy, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (122 avtorjev) , **Measurement of [Upsilon](5S) decays to B[sup]0 and B[sup]+ mesons**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 11, str. 112003-1-112003-7, ISBN 1550-7998, COBISS-ID 24333351, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	122	7	4	1	6	6	2

246. M. J. Lee, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (147 avtorjev) , **Measurement of the branching fractions and the invariant mass distributions for [tau][sup]- [to] h[sup]- h[sup]+ h[sup]- [nu][sub][tau] decays**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 81, no. 11, str. 113007-1-113007-13, ISBN 1550-7998, COBISS-ID 24329767, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	147	4	4	1	5	5	2

247. A. Das, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Anže Zupanc, (151 avtorjev) , **Measurements of branching fractions for B[sup]0 [to] D[sub]s[sup]+ [pi][sup]- and (B[bar])[sup]0 [to] D[sub]s[sup]+ K[sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 5, str. 051103-1-051103-7, ISBN 1550-7998, COBISS-ID 24336935, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	5	5	2	6	6	2

248. C. P. Shen, Marko Bračko, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (109 avtorjev) , **Search for charmonium and charmoniumlike states in [Upsilon](1S) radiative decays**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 5, str. 051504-1-051504-6, ISBN 1550-7998, COBISS-ID 24344615, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	109	3	1	0	3	1	0

249. K. Hara, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (144 avtorjev) , **Evidence for B[sup]-[to][tau][sup]-([nu][bar])[sub][tau] with a semileptonic tagging method**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 7, str. 071101-1-071101-7, ISBN 1550-7998, COBISS-ID 24336167, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	144						

250. A. Bozek, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, Anže Zupanc, (129 avtorjev) , **Observation of B[sup]+ [to] (D[bar])[sup]([ast]0)[tau][sup]+ [nu][sub][tau] and evidence for B[sup]+[to] (D[bar])[sup]0 [tau][sup]+ [nu][sub][tau] at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 7, str. 072005-1-072005-6, ISBN 1550-7998, COBISS-ID 24334119, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	129						

251. C. C. Peng, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, (141 avtorjev) , **Search for B[sup]0[sub]s [to] hh decays at the [Upsilon] (5S) resonance**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 7, str. 072007-1-072007-6, ISBN 1550-7998, COBISS-ID 24336423, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	141	3	3	1	4	2	1

252. Y. Nakahama, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (136 avtorjev) , **Measurement of CP violating asymmetries in B[sup]0 [to] K[sup]+ K[sup]- K[sup]0[sub]S decays with a time-dependent Dalitz approach**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 7, str. 073011-1-073011-12, ISBN 1550-7998, COBISS-ID 24970535, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	136	6	6	2	7	7	2

253. K. Sakai, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (139 avtorjev) , **Search for CP-violating charge asymmetry in B[sup][pm] [to] J/[psi] K[sup][pm] decays**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 9, str. 091104-1-091104-7, ISBN 1550-7998, COBISS-ID 24344871, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov	čistih citatov	normirano št. čistih citatov	Scopus: št. citatov (TC)	čistih citatov	normirano št. čistih citatov

			(TC)	(CI)	(NC)		(CI)	(NC)
8	0.8	139	4	2	1			

254. K.-F. Chen, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (135 avtorjev) , **Observation of an enhancement in e[sup]+ e[sup]- [to] [Upsilon](1S) [pi][sup]+ [pi][sup]-, [Upsilon](2S) [pi][sup]+ [pi][sup]- , and [Upsilon](3S) [pi][sup]+ [pi][sup]- production near [square root]s=10.89 GeV**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 9, str. 091106-1-091106-6, ISBN 1550-7998, COBISS-ID 24330279, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	135				13	12	4

255. S. Uehara, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (127 avtorjev) , **Measurement of [eta] [eta] production in two-photon collisions**, Phys. rev., D Part. fields gravit. cosmol., (2010) vol. 82, no. 11, str. 114031-1-114031-21, ISBN 1550-7998, COBISS-ID 24336679, IF: 4.964, SE: BU - astronomy & astrophysics ; 7/55 ; četrtina: 1 ; x=3.09 ; IFmin: 3.491 ; IFmax: 27.444 UP - physics, particles & fields ; 5/27 ; četrtina: 1 ; x=2.907 ; IFmin: 4.025 ; IFmax: 12.625,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	127	6	4	1	5	3	1

256. Y. Miyazaki, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (129 avtorjev) , **Search for lepton flavor and lepton number violating [tau] decays into a lepton and two charged mesons**, Phys. lett., Sect. B, (2010) vol. 682, no. 4/5, str. 355-362, ISBN 0370-2693, COBISS-ID 23287079, IF: 5.255, SE: UI - physics, multidisciplinary ; 6/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	129	5	5	2	6	5	2

257. K. Hayasaka, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Tomi Živko, Anže Zupanc, (135 avtorjev) , **Search for lepton-flavor-violating [tau] decays into three leptons with 719 million produced [tau][sup]+ [tau][sup]- pairs**, Phys. lett., Sect. B, (2010) vol. 687, no. 2/3, str. 139-143, ISBN 0370-2693, COBISS-ID 23678503, IF: 5.255, SE: UI - physics, multidisciplinary ; 6/80 ; četrtina: 1 ; x=2.582 ; IFmin: 2.245 ; IFmax: 51.695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	135	23	23	9	28	28	11

258. Andrej Seljak, H. Ikeda, S. Iwata, Samo Korpar, Peter Križan, Rok Pestotnik, Shohei Nishida, T. Sumiyoshi, (8 avtorjev) , **Readout electronics for an HAPD detector**, Journal of instrumentation, (2011) vol. 6, no. 1, str. C01083-1-C01083-6, ISBN 1748-0221, COBISS-ID 24453159, IF: 1.869, SE: OA - instruments & instrumentation ; 11/58 ; četrtina: 1 ; x=1.379 ; IFmin: 1.663 ; IFmax: 9.97,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1	8	1	0	0	1	0	0

259. Andrej Seljak, Ichiro Adachi, H. Ikeda, K. Hara, Toru Iijima, S. Iwata, Samo Korpar, Peter Križan, E. Kuroda, Rok Pestotnik, Shohei Nishida, T. Sumiyoshi, H. Takagaki, (13 avtorjev) , **Readout electronics for a Hybrid Avalanche Photon Detector**, Journal of instrumentation, (2011) vol. 6, no. 12, str. C12051-1-C12051-9, ISBN 1748-0221, COBISS-ID 25652519, IF: 1.869, SE: OA - instruments & instrumentation ; 11/58 ; četrtina: 1 ;

x=1.379 ; IFmin: 1.663 ; IFmax: 9.97,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	13	0	0	0	0	0	0

260. Sunil Ahn, Marko Bračko, Rok Pestotnik, Marko Petrič, Luka Šantelj, Marko Starič, Samo Stanič, (42 avtorjev) , **The embedment of a metadata system at grid farms at the Belle II experiment**, J. Korean Phys. Soc., (2011) vol. 59, no. 4, str. 2695-2701, ISBN 0374-4884, COBISS-ID 25662759, IF: 0.447, SE: UI - physics, multidisciplinary ; 64/84 ; četrtina: 4 ; x=2.404 ; IFmin: 0.111 ; IFmax: 0.447,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
6	0.6	42	0	0	0	0	0	0

261. Ruben Verheyden, Hassan Chagani, Rok Dolenec, Rok Pestotnik, Peter Križan, Samo Korpar, Aleš Stanovnik, (7 avtorjev) , **Performance study of silicon photomultipliers as photon detectors for PET**, Nucl. instrum, methods phys res., Sect. A, Accel., (2011) vol. 628, no. 1, str. 381-384, ISBN 0168-9002, COBISS-ID 24351783, IF: 1.207, SE: OA - instruments & instrumentation ; 25/58 ; četrtina: 2 ; x=1.379 ; IFmin: 1.067 ; IFmax: 1.576 RY - nuclear science & technology ; 12/35 ; četrtina: 2 ; x=0.949 ; IFmin: 0.905 ; IFmax: 1.227 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=3.025 ; IFmin: 0.855 ; IFmax: 1.659 XQ - spectroscopy ; 28/42 ; četrtina: 3 ; x=2.255 ; IFmin: 1.012 ; IFmax: 1.547,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.143	7	1	1	1	1	1	1

262. Rok Dolenec, Hassan Chagani, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (6 avtorjev) , **Tests of a silicon photomultiplier module for detection of Cherenkov photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2011) vol. 628, no. 1, str. 398-402, ISBN 0168-9002, COBISS-ID 24553767, IF: 1.207, SE: OA - instruments & instrumentation ; 25/58 ; četrtina: 2 ; x=1.379 ; IFmin: 1.067 ; IFmax: 1.576 RY - nuclear science & technology ; 12/35 ; četrtina: 2 ; x=0.949 ; IFmin: 0.905 ; IFmax: 1.227 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=3.025 ; IFmin: 0.855 ; IFmax: 1.659 XQ - spectroscopy ; 28/42 ; četrtina: 3 ; x=2.255 ; IFmin: 1.012 ; IFmax: 1.547,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.333	6	1	1	1	0	0	0

263. ===> Rok Pestotnik, Rok Dolenec, Samo Korpar, Peter Križan, Aleš Stanovnik, (5 avtorjev) , **Module of silicon photomultipliers as a detector of individual Cherenkov photons**, Nucl. instrum, methods phys res., Sect. A, Accel., (2011) vol. 639, no. 1, str. 99-102, ISBN 0168-9002, COBISS-ID 24686631, IF: 1.207, SE: OA - instruments & instrumentation ; 25/58 ; četrtina: 2 ; x=1.379 ; IFmin: 1.067 ; IFmax: 1.576 RY - nuclear science & technology ; 12/35 ; četrtina: 2 ; x=0.949 ; IFmin: 0.905 ; IFmax: 1.227 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=3.025 ; IFmin: 0.855 ; IFmax: 1.659 XQ - spectroscopy ; 28/42 ; četrtina: 3 ; x=2.255 ; IFmin: 1.012 ; IFmax: 1.547,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.6	5	0	0	0	0	0	0

264. Ichiro Adachi, Rok Dolenec, Samo Korpar, Peter Križan, Rok Pestotnik, (19 avtorjev) , **Study of a 144 channel multi-anode hybrid avalanche photo-detector for the Belle II RICH counter**, Nucl. instrum, methods phys res., Sect. A, Accel., (2011) vol. 639, no. 1, str. 103-106, ISBN 0168-9002, COBISS-ID 24867367, IF: 1.207, SE: OA - instruments & instrumentation ; 25/58 ; četrtina: 2 ; x=1.379 ; IFmin: 1.067 ; IFmax: 1.576 RY - nuclear science & technology ; 12/35 ; četrtina: 2 ; x=0.949 ; IFmin: 0.905 ; IFmax: 1.227 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=3.025 ; IFmin: 0.855 ; IFmax: 1.659 XQ - spectroscopy ; 28/42 ; četrtina: 3 ; x=2.255 ; IFmin: 1.012 ; IFmax: 1.547,

STD	STK	Št.	WoS: št.	čistih	normirano št.	Scopus: št.	čistih	normirano št.

		avtorjev	citatov (TC)	citatov (CI)	čistih citatov (NC)	citatov (TC)	citatov (CI)	čistih citatov (NC)
8	0.8	19	0	0	0	0	0	0

265. Samo Korpar, Ichiro Adachi, Rok Dolenec, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (6 avtorjev) , **Photonis MCP PMT as a light sensor for the Belle II RICH**, Nucl. instrum, methods phys res., Sect. A, Accel., (2011) vol. 639, no. 1, str. 162-184, ISBN 0168-9002, COBISS-ID 24867623, IF: 1.207, SE: OA - instruments & instrumentation ; 25/58 ; četrtina: 2 ; x=1.379 ; IFmin: 1.067 ; IFmax: 1.576 RY - nuclear science & technology ; 12/35 ; četrtina: 2 ; x=0.949 ; IFmin: 0.905 ; IFmax: 1.227 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=3.025 ; IFmin: 0.855 ; IFmax: 1.659 XQ - spectroscopy ; 28/42 ; četrtina: 3 ; x=2.255 ; IFmin: 1.012 ; IFmax: 1.547,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.333	6	0	0	0	1	1	1

266. Samo Korpar, Rok Dolenec, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (5 avtorjev) , **Study of TOF PET using Cherenkov light**, Nucl. instrum, methods phys res., Sect. A, Accel., (2011) vol. 654, no. 1, str. 532-538, ISBN 0168-9002, COBISS-ID 25039655, IF: 1.207, SE: OA - instruments & instrumentation ; 25/58 ; četrtina: 2 ; x=1.379 ; IFmin: 1.067 ; IFmax: 1.576 RY - nuclear science & technology ; 12/35 ; četrtina: 2 ; x=0.949 ; IFmin: 0.905 ; IFmax: 1.227 UP - physics, particles & fields ; 18/27 ; četrtina: 3 ; x=3.025 ; IFmin: 0.855 ; IFmax: 1.659 XQ - spectroscopy ; 28/42 ; četrtina: 3 ; x=2.255 ; IFmin: 1.012 ; IFmax: 1.547,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	1.6	5	2	2	2	1	1	1

267. J. Li, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (167 avtorjev) , **Observation of B[sub]s[sup]0 [to] J/[psi] f[sub]0(980) and evidence for B[sub]s[sup]0 [to] J/[psi] f[sub]0(1370)**, Phys. rev. lett., (2011) vol. 106, no. 12, str. 121802-1-121802-5, ISBN 0031-9007, COBISS-ID 24959783, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	167	14	13	5	12	11	5

268. B. R. Ko, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (131 avtorjev) , **Search for CP violation in the decays D[sup]0 [to] K[sup]0[sub]SP[sup]0**, Phys. rev. lett., (2011) vol. 106, no. 21, str. 211801-1-211801-6, ISBN 0031-9007, COBISS-ID 24954919, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	131	2	1	0	2	1	0

269. Y. Horii, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Evidence for the suppressed decay B[sup]- [to] DK[sup]-, D [to] K[sup]+[pi][sup]-**, Phys. rev. lett., (2011) vol. 106, no. 23, str. 231803-1-231803-6, ISBN 0031-9007, COBISS-ID 24960039, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	8	7	3	9	8	3

270. V. Bhardwaj, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (143 avtorjev) , **Observation of X(3872) [to] J/[psi]**

[gamma] and search for X(3872) [to] [psi][prime] [gamma] in B decays, Phys. rev. lett., (2011) vol. 107, no. 9, str. 091803-1-091803-6, ISBN 0031-9007, COBISS-ID 25312295, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	9	8	3	9	8	3

271. E. Won, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (169 avtorjev) , **Observation of D[sup]+ [to] K[sup]+ [eta][sup]([prime]) and search for CP violation in D[sup]+ [to] [pi][sup]+ [eta][sup]([prime]) decays**, Phys. rev. lett., (2011) vol. 107, no. 22, str. 221801-1-221801-6, ISBN 0031-9007, COBISS-ID 25313063, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	169	4	3	1	4	3	1

272. Galina Pakhlova, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (153 avtorjev) , **Measurement of the e[sup]+ e[sup]- [to] D[sub]s[sup]((([ast])+) D[sub]s[sup]((([ast])-) cross sections near threshold using initial-state radiation**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 83, no. 1, str. 011101-1-011101-7, ISBN 1550-7998, COBISS-ID 24953895, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	153	5	5	2	4	4	1

273. H. Guler, Marko Bračko, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (121 avtorjev) , **Study of the K[sup]+ [pi][sup]+ [pi][sup]- final state in B[sup]+ [to] J/[psi] K[sup]+ [pi][sup]+ [pi][sup]- and B[sup]+ [to] [psi][prime] K[sup]+[pi][sup]+ [pi][sup]-**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 83, no. 3, str. 032005-1-032005-29, ISBN 1550-7998, COBISS-ID 1946875, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	121	6	5	2	7	6	2

274. T. Aushev, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Study of the decays B [to] D[sub](s1)(2536)[sup]+ (D[bar])[sup]((([ast]))**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 83, no. 5, str. 051102-1-051102-6, ISBN 1550-7998, COBISS-ID 24959527, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	2	2	1	1	1	0

275. H. Ha, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (143 avtorjev) , **Measurement of the decay B[sup]0 [to] [pi][sup]- l[sup]+ [nu] and determination of [vertical]V[sub](ub)[vertical]**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 83, no. 7, str. 071101-1-071101-6, ISBN 1550-7998, COBISS-ID 24954407, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št.	WoS: št.	čistih	normirano št.	Scopus: št.	čistih	normirano št.

		avtorjev	citatov (TC)	citatov (CI)	čistih citatov (NC)	citatov (TC)	citatov (CI)	čistih citatov (NC)
8	0.8	143	12	12	4	10	10	3

276. S.-K. Choi, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (177 avtorjev) , **Bounds on the width, mass difference and other properties of X(3872) [to] [pi][sup]+ [pi][sup]- J/[psi] decays**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 84, no. 5, str. 052004-1-052004-16, ISBN 1550-7998, COBISS-ID 25312551, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	177	13	13	4	14	14	5

277. H. Sahoo, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (157 avtorjev) , **First observation of radiative B[sup]0 [to] [phi] K[sup]0 [gamma] decays and measurements of their time-dependent CP violation**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 84, no. 7, str. 071101-1-071101-6, ISBN 1550-7998, COBISS-ID 25312039, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	157	0	0	0	0	0	0

278. O. Seon, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (173 avtorjev) , **Search for lepton-number-violating B[sup]+ [to] D[sup]- l[sup]+ l[sup]([prime]+) decays**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 84, no. 7, str. 071106-1-071106-7, ISBN 1550-7998, COBISS-ID 25312807, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	173	5	5	2	4	4	1

279. X. L. Wang, Marko Bračko, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (138 avtorjev) , **Search for charmonium and charmoniumlike states in [Upsilon](2S) radiative decays**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 84, no. 7, str. 071107-1-071107-7, ISBN 1550-7998, COBISS-ID 25313575, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	138	2	1	0	2	1	0

280. P. Chen, Marko Bračko, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (140 avtorjev) , **Observation of B[sup]- [to] p[bar] [Lambda] D[sup]0 at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2011) vol. 84, no. 7, str. 071501-1-071501-7, ISBN 1550-7998, COBISS-ID 25313319, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	140	1	1	0	1	1	0

281. Y. Miyazaki, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol,

Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (143 avtorjev) , **Search for lepton-flavor-violating [tau] decays into a lepton and a vector meson**, Phys. lett., Sect. B, (2011) vol. 699, no. 4, str. 251-257, ISBN 0370-2693, COBISS-ID 24954663, IF: 3.955, SE: UI - physics, multidisciplinary ; 9/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	143	1	1	0	1	1	0

282. A. Vinokurova, Marko Bračko, Boštjan Golob, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (145 avtorjev) , **Study of B[sup][pm] [to] K[sup][pm] (K[sub]S K [pi])[sup]0 decay and determination of [eta][sub]c and [eta][sub]c (2S) parameters**, Phys. lett., Sect. B, (2011) vol. 706, no. 2/3, str. 139-149, ISBN 0370-2693, COBISS-ID 25326375, IF: 3.955, SE: UI - physics, multidisciplinary ; 9/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	145	6	5	2	7	6	2

283. C.-T. Hoi, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Anže Zupanc, (127 avtorjev) , **Evidence for direct CP violation in B[sup][pm] [to] [eta] h[sup][pm] and observation of B[sup]0 [to] [eta] K[sup]0**, Phys. rev. lett., (2012) vol. 108, no. 3, str. 031801-1-031801-6, ISBN 0031-9007, COBISS-ID 25645863, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	127	0	0	0	0	0	0

284. Ichiro Adachi, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (156 avtorjev) , **First observation of the P-wave spin-singlet bottomonium states h[sub]b (1P) and h[sub]b (2P)**, Phys. rev. lett., (2012) vol. 108, no. 3, str. 032001-1-032001-6, ISBN 0031-9007, COBISS-ID 25645351, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	156	16	14	6	19	17	7

285. Marko Starič, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Anže Zupanc, (134 avtorjev) , **Search for CP violation in D[sup][pm] meson decays to [phi] [pi][sup][pm]**, Phys. rev. lett., (2012) vol. 108, no. 7, str. 071801-1-071801-6, ISBN 0031-9007, COBISS-ID 25645607, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	134	4	4	2	2	2	1

286. Ichiro Adachi, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (176 avtorjev) , **Precise measurement of the CP violation parameter sin2[phi][sub]1 in B[sup]0 [to] c c[bar] K[sup]0 decays**, Phys. rev. lett., (2012) vol. 108, no. 17, str. 171802-1-171802-7, ISBN 0031-9007, COBISS-ID 25989415, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	176	0	0	0	7	4	2

287. J. Li, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (164 avtorjev) , **First observation of B[sub]s[sup]0 [to] J/[psi] [eta] and B[sub]s[sup]0 [to]J/[psi] [eta][sup][prime]**, Phys. rev. lett., (2012) vol. 108, no. 18, str. 181808-1-181808-5, ISBN 0031-9007, COBISS-ID 25989671, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	2	2	1	3	3	1

288. Z. Q. Liu, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (164 avtorjev) , **Observation of new resonant structures in [gamma] [gamma] [to] [omega][phi], [phi][phi], and [omega][omega]**, Phys. rev. lett., (2012) vol. 108, no. 23, str. 232001-1-232001-7, ISBN 0031-9007, COBISS-ID 25989927, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	2	2	1	2	2	1

289. B. R. Ko, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (164 avtorjev) , **Evidence for CP violation in the decay D[sup]+ [to] K[sup]0[sub]S [pi][sup]+**, Phys. rev. lett., (2012) vol. 109, no. 2, str. 021601-1-021601-6, ISBN 0031-9007, COBISS-ID 25990183, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	164	1	0	0	1	1	0

290. R. Mizuk, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (174 avtorjev) , **Evidence for the [eta][sub]b (2S) and observation of h[sub]b (1P) [to] [eta][sub]b (1S) [gamma] and h[sub]b (2P) [to] [eta][sub]b (1S) [gamma]**, Phys. rev. lett., (2012) vol. 109, no. 23, str. 232002-1-232002-6, ISBN 0031-9007, COBISS-ID 26535975, IF: 7.37, SE: UI - physics, multidisciplinary ; 5/84 ; četrtina: 1 ; x=2.404 ; IFmin: 2 ; IFmax: 43.933,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	174	0	0	0	1	1	0

291. T. Higuchi, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (179 avtorjev) , **Search for time-dependent CPT violation in hadronic and semileptonic B decays**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 85, no. 7, str. 071105-1-071105-7, ISBN 1550-7998, COBISS-ID 25991975, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	179	1	1	0	1	1	0

292. M.-C. Chang, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (156 avtorjev) , **Measurement of B[sup]0 [to] J/[psi] [eta][sup]([prime]) and constraint on the [eta] - [eta][sup][prime] mixing angle**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 85, no. 9, str. 091102-1-091102-6, ISBN 1550-7998, COBISS-ID 25992231, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov	čistih citatov	normirano št. čistih citatov	Scopus: št. citatov (TC)	čistih citatov	normirano št. čistih citatov

			(TC)	(CI)	(NC)		(CI)	(NC)
8	0.8	156	2	2	1	2	2	1

293. M. Röhrken, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (163 avtorjev) , **Measurements of branching fractions and time-dependent CP violating asymmetries in B[sup]0 [to] D[sup](([ast]) [pm]) D[sup][mp] decays**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 85, no. 9, str. 091106-1-091106-7, ISBN 1550-7998, COBISS-ID 25992487, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	163	1	0	0	1	0	0

294. H. Aihara, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Peter Križan, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (161 avtorjev) , **First measurement of [phi][sub]3 with a model-independent Dalitz plot analysis of B[sup][pm] [to] D K[sup][pm], D [to] K[sup]0[sub]S [pi][sup]+ [pi][sup]- decay**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 85, no. 11, str. 112014-1-112014-17, ISBN 1550-7998, COBISS-ID 25994535, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	161	1	1	0	1	1	0

295. K. Negishi, Samo Korpar, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (138 avtorjev) , **Search for the decay B[sup]0 [to] D K[sup]([ast]0) followed by D [to] K[sup]-[pi][sup]+**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 1, str. 011101-1-011101-6, ISBN 1550-7998, COBISS-ID 25994791, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	138	0	0	0	0	0	0

296. J. H. Kim, Marko Bračko, Boštjan Golob, Samo Korpar, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (151 avtorjev) , **Search for B [to] [phi] [pi] decays**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 3, str. 031101-1-031101-6, ISBN 1550-7998, COBISS-ID 25995047, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	151	0	0	0	0	0	0

297. C. P. Shen, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Anže Zupanc, (155 avtorjev) , **Observation of exclusive [Upsilon](1S) and [Upsilon](2S) decays into light hadrons**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 3, str. 031102-1-031102-7, ISBN 1550-7998, COBISS-ID 26017575, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	155	0	0	0	0	0	0

298. C. - L. Hsu, Marko Bračko, Samo Korpar, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (156 avtorjev) , **Search for B[sup]0 decays to invisible final states at Belle**, Phys. rev., D Part.

fields gravit. cosmol., (2012) vol. 86, no. 3, str. 032002-1-032002-6, ISBN 1550-7998, COBISS-ID 25995303, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	156	1	1	0	1	1	0

299. C. C. Zhang, Samo Korpar, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, (103 avtorjev) , **First study of [eta][sub]c (1S), [eta](1760) and X(1835) production via [eta][sup][prime] [pi][sup]+ [pi][sup]- final states in two-photon collisions**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 5, str. 052002-1-052002-12, ISBN 1550-7998, COBISS-ID 26536231, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	103	0	0	0	2	2	1

300. B. Kronenbitter, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Luka Šantelj, Anže Zupanc, (162 avtorjev) , **First observation of CP violation and improved measurement of the branching fraction and polarization of B[sup]0 [to] D[sup]([ast] +) D[sup]([ast] -) decays**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 7, str. 071103-1-071103-7, ISBN 1550-7998, COBISS-ID 26536487, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	162	0	0	0	0	0	0

301. J. Stypula, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Samo Stanič, Marko Starič, Anže Zupanc, (169 avtorjev) , **Evidence for B[sup]- [to] D[sub]s[sup]+ K[sup]- l[sup]- ([nu][bar])[sub]l and search for B[sup]- [to] D[sub]s[sup]([ast] +) K[sup]- l[sup]- ([nu][bar])[sub]l**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 7, str. 072007-1-072007-7, ISBN 1550-7998, COBISS-ID 26536743, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	169	0	0	0	0	0	0

302. J. Dalseno, Marko Bračko, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Anže Zupanc, (144 avtorjev) , **Measurement of branching fraction and first evidence of CP violation in B[sup]0 [to] a[sub]1[sup][pm] (1260) [pi][sup][mp] decays**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 9, 092012-1-092012-15, ISBN 1550-7998, COBISS-ID 26535719, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	144	0	0	0	0	0	0

303. S. Uehara, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Anže Zupanc, (160 avtorjev) , **Measurement of [gamma] [gamma][sup][ast] [to] [pi][sup]0 transition form factor at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2012) vol. 86, no. 9, str. 092007-1-092007-27, ISBN 1550-7998, COBISS-ID 26535463, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	160	3	3	1	4	4	1

304. U. Tamponi, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Petrič, Peter Smerkol, Marko Starič, Luka Šantelj, Anže Zupanc, (133 avtorjev) , **Study of the hadronic transitions [Upsilon](2S) [to] ([eta], [pi][sup]0) [Upsilon](1S) at Belle**, Phys. rev., D Part. fields gravit. cosmol., (2013) vol. 87, no. 1, str. 011104-1-011104-6, ISBN 1550-7998, COBISS-ID 26537255, IF: 4.558, SE: BU - astronomy & astrophysics ; 11/56 ; četrtina: 1 ; x=3.07 ; IFmin: 3.582 ; IFmax: 26.452 UP - physics, particles & fields ; 6/27 ; četrtina: 1 ; x=3.025 ; IFmin: 4.522 ; IFmax: 17.462,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
8	0.8	133	0	0	0	0	0	0

1.1 Znanstvena monografija

305. K. Abe, Ilija Bizjak, Marko Bračko, Urban Bitenc, Boštjan Golob, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Samo Stanič, Marko Starič, (150 avtorjev) , **Letter of intent for KEK super B factory : [super KEKB task force]**, (2004) IV, 542 str. ilustr. , KEK report, 2004-4, COBISS-ID 18598695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
20	2	150						

1.3.2 Objavljeni znanstveni prispevek na konferenci (vabljeno predavanje)

306. Špela Stres, Rok Pestotnik, (2 avtorjev) , **Analysis of possibilities for a spin flip in high energy electron ring HERA**, Proceedings of the 17th International Spin Physics Symposium : Kyoto, Japan, 2-7 October 2006, Melville : American Institute of Physics, 2007, AIP conf. proc., () , , str. 885-891, ISBN 0094-243X, COBISS-ID 20964135,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	1	2				0	0	0

1.3.2 Objavljeni znanstveni prispevek na konferenci

307. Peter Križan, Samo Korpar, Marko Starič, M. Cindro, Rok Pestotnik, Damijan Škrk, (18 avtorjev) , **Photon detector for the HERA-B RICH**, 1996 IEEE Nuclear Science Symposium Conference record : November 2-9,1996, Anaheim, California, Piscataway : IEEE Service Center, 1997, () , , str. 651-654, COBISS-ID 470884,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	18						

308. Peter Križan, Samo Korpar, Marko Starič, Aleš Stanovnik, Michel Cindro, Rok Pestotnik, Damijan Škrk, A. Bulla, E. Michel, C. Oehser, P. Weyers, W. Schmidt-Parzefall, T. Hamacher, D. Broemmelsiek, J. Pyrlik, (15 avtorjev) , **Photon detectors for the HERA-B RICH : presented at 1st Conference on New Developments in Photodetection, 1996, Beaune, France, June 24-28**, Nucl. instrum, methods phys res., Sect. A, Accel., (1997) 387, , str. 146-149, ISBN 0168-9002, COBISS-ID 12576295,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	15	12	8	8	14	10	10

309. Peter Križan, Andrej Gorišek, Samo Korpar, Rok Pestotnik, Marko Starič, Aleš Stanovnik, Damijan Škrk, (25 avtorjev) , **The HERA-B RICH**, 1997 IEEE Nuclear Science Symposium, November 9 - 15, 1997, Albuquerque, New Mexico, Piscataway : IEEE, cop. 1998, () , , str. 353-356, COBISS-ID 13418279,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	25						

310. Samo Korpar, Andrej Gorišek, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, Damijan Škrk, (26 avtorjev) , **The HERA-B RICH : presented at 3rd International Workshop on Ring Imaging Cherenkov Detectors (RICH 98), Ein-Gedi, Dead sea, Israel, 15-20 November 1998**, Nucl. instrum, methods phys res., Sect. A, Accel., (1999) vol. 433, , str. 128-135, ISBN 0168-9002, COBISS-ID 14374695,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	26	14	9	9	14	10	10

311. ===> Rok Pestotnik, (1 avtorjev) , **Identifikacija delcev z detektorjem Čerenkovih obročev pri eksperimentu HERA-B**, Raziskovalno delo podiplomskih študentov Slovenije, Naravoslovje in tehnika, Ljubljana : Društvo mladih raziskovalcev Slovenije, 2000, () , , str. 291-300, COBISS-ID 17847079,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	2	1						

312. L. Garrido, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Damijan Škrk, Aleš Stanovnik, Marko Starič, Tomi Živko, (9 avtorjev) , **The HERA-B RICH**, 2000 IEEE : conference record, Piscataway : IEEE, 2001, () , , str. 11-13-11-16, COBISS-ID 16215335,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.222	9						

313. ===> Rok Pestotnik, Peter Križan, Samo Korpar, Marko Bračko, Marko Starič, Aleš Stanovnik, (6 avtorjev) , **Investigation of [sup](90)Sr detection with Cherenkov radiation in silica aerogels**, 2001 IEEE Nuclear Science Symposium Conference Record, 4-10 November 2001, San Diego, California, USA, Piscataway : IEEE, cop. 2002, () , , 3 str., COBISS-ID 16677671,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.333	6						

314. Samo Korpar, Ilija Bizjak, Marko Bračko, Andrej Gorišek, T. Iijima, M. Iwamoto, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, (10 avtorjev) , **Tests of a proximity focusing RICH with aerogel as radiator**, 2001 IEEE Nuclear Science Symposium Conference Record, 4-10 November 2001, San Diego, California, USA, Piscataway : IEEE, cop. 2002, () , , 4 str., COBISS-ID 16676903,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	10						

315. I. Adachi, Ilija Bizjak, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, Marko Starič, Aleš Stanovnik, (13 avtorjev) , **Tests of aproximity focusing RICH with aerogel as radiator**, 2002 IEEE Nuclear Science Symposium : el. optični disk : nuclear science symposium : medical imaging conference : 10-16 November, 2002, Norfolk, Virginia, USA, Piscataway : IEEE, cop. 2003, () , , 4 str., COBISS-ID 18243111,

STD	STK	Št.	WoS: št.	čistih	normirano št.	Scopus: št.	čistih	normirano št.

		avtorjev	citatov (TC)	citatov (CI)	čistih citatov (NC)	citatov (TC)	citatov (CI)	čistih citatov (NC)
2	0.2	13				0	0	0

316. ===> Rok Pestotnik, Samo Korpar, Peter Križan, Aleš Stanovnik, (4 avtorjev) , **Cherenkov detector for measuring the [sup](90)Sr activity using silica aerogel**, Zbornik radova V. simpozija hrvatskog društva za zaščitu od zračenja [s međunarodnim sudjelovanjem, Stubičke Toplice, Hrvatska, 9.-11. travnja 2003], Zagreb : HDZZ-CRPA, 2003, () , , str. 137-142, COBISS-ID 17433383,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.5	4						

317. ===> Rok Pestotnik, Irena Dolenc, Samo Korpar, Peter Križan, Aleš Stanovnik, (5 avtorjev) , **Cherenkov detector based on aerogel radiator and flat panel PMT for detection of [sup](90)Sr**, 2003 IEEE : Nuclear science symposium [and] Medical Imaging Conference : conference record : 19-25 October 2003, Portland, Oregon, USA, [S.l.] : IEEE : Nuclear & Plasma Sciences Society, 2004, () , , 3 str., COBISS-ID 18242343,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.4	5						

318. Samo Korpar, Saša Fratina, Peter Križan, Rok Pestotnik, (17 avtorjev) , **Tests of aproximity focusing RICH with aerogel radiator and flat-panel multi-anode PMTs (H8500)**, 2003 IEEE : Nuclear science symposium [and] Medical Imaging Conference : conference record : 19-25 October 2003, Portland, Oregon, USA, [S.l.] : IEEE : Nuclear & Plasma Sciences Society, 2004, () , , 4 str., COBISS-ID 18242087,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	17						

319. ===> Rok Pestotnik, Samo Korpar, Peter Križan, Aleš Stanovnik, (4 avtorjev) , **Detection of [sup](90)Sr with aerogel Cherenkov detector with low background**, 2004 IEEE Nuclear Science Symposium Conference Record : 16-22 October 2004, Rome Italy, Piscataway : IEEE, 2005, () , , 3 str., COBISS-ID 19096871,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.5	4						

320. I. Adachi, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (22 avtorjev) , **Development of new silica aerogel for the RICH radiator of the super Belle detector**, 2004 IEEE Nuclear Science Symposium Conference Record : 16-22 October 2004, Rome Italy, Piscataway : IEEE, 2005, () , , 3 str., COBISS-ID 19097127,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	22						

321. Samo Korpar, Saša Fratina, Andrej Gorišek, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (22 avtorjev) , **Tests of the BURLE 85011 micro-chanell plate PMT as the detector of Cherenkov photons**, 2004 IEEE Nuclear Science Symposium Conference Record : 16-22 October 2004, Rome Italy, Piscataway : IEEE, 2005, () , , 4 str., COBISS-ID 19096615,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	22						

322. Špela Stres, Rok Pestotnik, (2 avtorjev) , **Possibility for spin flip in high energy electron rings**, 2004 IEEE Nuclear Science Symposium Conference Record : 16-22 October 2004, Rome Italy, Piscataway : IEEE, 2005, () , , 5 str., COBISS-ID 19097383,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	1	2						

323. Shohei Nishida, Saša Fratina, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (21 avtorjev) , **Studies of a proximity focusing aerogel RICH for the Belle upgrade**, 2004 IEEE Nuclear Science Symposium Conference Record : 16-22 October 2004, Rome Italy, Piscataway : IEEE, 2005, () , , 5 str., COBISS-ID 19097639,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	21						

324. Samo Korpar, Andrej Gorišek, Peter Križan, Rok Pestotnik, (22 avtorjev) , **Proximity focusing RICH with TOF capabilities**, 2006 IEEE Nuclear Science Symposium conference record, Piscataway : IEEE, cop. 2006, () , , str. 59-62, COBISS-ID 21038119,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.2	22						

325. A. Kuratani, Andrej Gorišek, Samo Korpar, Peter Križan, Rok Pestotnik, (5 avtorjev) , **Study of RICH counter with silica aerogel radiator**, 2006 IEEE Nuclear Science Symposium conference record, Piscataway : IEEE, cop. 2006, () , , str. 476-480, COBISS-ID 21038631,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.4	5						

326. Samo Korpar, Peter Križan, Rok Pestotnik, (3 avtorjev) , **Timing and cross-talk properties of BURLE multi-chanenel MCP PMTs**, 2007 IEEE Nuclear Science Symposium & Medical Imaging Conference : October 27 - November 3, 2007, Honolulu, Hawaii, USA, Piscataway : Institute of Electrical and Electronics Engineers, 2007, () , , str. 1304-1307, COBISS-ID 21448231,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.667	3						

327. ===> Rok Pestotnik, Rok Dolenec, Samo Korpar, Peter Križan, Aleš Stanovnik, (9 avtorjev) , **Silicon photomultiplier as a detector of Cherenkov photons**, 2007 IEEE Nuclear Science Symposium & Medical Imaging Conference : October 27 - November 3, 2007, Honolulu, Hawaii, USA, Piscataway : Institute of Electrical and Electronics Engineers, 2007, () , , str. 2093-2096, COBISS-ID 21448487,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.222	9				1	1	1

328. Samo Korpar, Rok Dolenec, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (5 avtorjev) , **Timing and cross-talk properties of BURLE/photonis multi-channel MCP PMTs**, 2008 IEEE NSS/MIC/RTSD Conference record : Nuclear science symposium, Medical imaging [and] 16th Room-Temperature Semiconductor Detector Workshop, Dresden, Germany, 19-15, October 2008, 2008, () , , str. 2471-2474, COBISS-ID 22342695,

STD	STK	Št. avtorjev	WoS: št. citatov	čistih citatov	normirano št. čistih citatov	Scopus: št. citatov (TC)	čistih citatov	normirano št. čistih citatov

			(TC)	(CI)	(NC)		(CI)	(NC)
2	0.4	5				0	0	0

329. Samo Korpar, Ichiro Adachi, Hassan Chagani, Rok Dolenec, Toru Iijima, Peter Križan, Rok Pestotnik, Aleš Stanovnik, (8 avtorjev) , **Tests of a silicon photo-multiplier module for detection of Cherenkov photons**, 2008 IEEE NSS/MIC/RTSD Conference record : Nuclear science symposium, Medical imaging [and] 16th Room-Temperature Semiconductor Detector Workshop, Dresden, Germany, 19-15, October 2008, 2008, () , , str. 3115-3118, COBISS-ID 22342183,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.25	8				0	0	0

330. ===> Rok Pestotnik, Samo Korpar, Hassan Chagani, Rok Dolenec, Peter Križan, Aleš Stanovnik, (6 avtorjev) , **Silicon photo-multipliers as photon detectors for PET**, 2008 IEEE NSS/MIC/RTSD Conference record : Nuclear science symposium, Medical imaging [and] 16th Room-Temperature Semiconductor Detector Workshop, Dresden, Germany, 19-15, October 2008, 2008, () , , str. 3123-3127, COBISS-ID 22342439,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.333	6				1	1	1

331. Rok Dolenec, Hassan Chagani, Samo Korpar, Peter Križan, Rok Pestotnik, Aleš Stanovnik, Ruben Verheyden, (7 avtorjev) , **Time-of-flight with photonis multi-channel MCP-PMT using MCP signal**, 2009 IEEE nuclear science symposium : conference record, October 25-31, 2009, Orlando, Florida, USA, Piscataway : IEEE, cop. 2009, () , , str. 1558-1560, COBISS-ID 23598887,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
2	0.286	7				0	0	0

4.4 Elaborat, predštudija, študija

332. ===> Rok Pestotnik, (1 avtorjev) , **Acceptance of some light guide baesd light collection systems for the HERA-B RICH**, (1996) , IJS-F9 report, , COBISS-ID 18264103,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.5	1						

333. Samo Korpar, Rok Pestotnik, Peter Križan, (3 avtorjev) , **ASD8 chip tests with a Hamamatsu multi-anode PMT**, (1997) , IJS delovno poročilo, 7615, COBISS-ID 18264359,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.167	3						

334. Samo Korpar, Rok Pestotnik, Peter Križan, (3 avtorjev) , **Beam test of a RICH with C4F10 gas as radiator and an array of MA-PMTs for photon detection**, (1997) , IJS delovno poročilo, 7673, COBISS-ID 18264615,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.167	3						

335. Samo Korpar, Rok Pestotnik, Peter Križan, (3 avtorjev) , **Quality assessment tests of Hamamatsu M16 and M4 photomultipliers**, (1997) , IJS delovno poročilo, 7769, COBISS-ID 18265127,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.167	3						

336. Samo Korpar, Rok Pestotnik, Peter Križan, (3 avtorjev) , **Quality assessment tests of Hamamatsu M16 photomultipliers**, (1997) , IJS delovno poročilo, 7681, COBISS-ID 18264871,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.167	3						

337. ===> Rok Pestotnik, Peter Križan, Samo Korpar, Marko Starič, (4 avtorjev) , **RICH-ECAL correlation in the December 1998 and February 1999 runs**, (1999) , IJS delovno poročilo, 8033, COBISS-ID 18265383,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.125	4						

338. Irena Dolenc, Rok Pestotnik, (2 avtorjev) , **Measurement of silica aerogel transmission length**, (2003) , IJS delovno poročilo, 8761, COBISS-ID 18265639,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.25	2						

339. ===> Rok Pestotnik, (1 avtorjev) , **The scintillations of C[sub]4F[sub](10)**, (2004) , IJS delovno poročilo, 9060, COBISS-ID 18673959,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.5	1						

340. M. Bona, Samo Korpar, Rok Pestotnik, Marko Starič, (317 avtorjev) , **Super B : a higly-luminosity heavy flavour factory**, (2007) XX, 453 ilustr. , Conceptual design report, INFN/AE-07/2, SLAC-R-856, LAL 07-02, COBISS-ID 20903463,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.05	317						

341. Ichiro Adachi, Peter Križan, Rok Pestotnik, (31 avtorjev) , **sBelle design study report : year 2008 supplement update to the detector LOI**, (2008) VII, 80 str. ilustr. , KEK report, 2008-7, COBISS-ID 24376103,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.05	31						

342. T. Abe, Marko Bračko, Boštjan Golob, Samo Korpar, Peter Križan, Samo Kupper, Rok Pestotnik, Marko Petrič, Andrej Seljak, Peter Smerkol, Samo Stanič, Marko Starič, Tomi Živko, Anže Zupanc, (473 avtorjev) , **Belle II technical design report**, (2010) V, 473 str. ilustr. , KEK report, 2010-1, COBISS-ID 24375847,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0.5	0.05	473						

IZVEDENA DELA (DOGODKI)

3.14 Predavanje na tuji univerzi

343. ===> Rok Pestotnik, (1 avtorjev) , **Aerogel RICH for the upgrade of the BELLE spectrometer : invited talk**, (2004) CERN , COBISS-ID 20171815,

STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
0	0	1						

ELSEVIER

Nuclear Instruments and Methods in Physics Research A 394 (1997) 27–34

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

Tests of a multianode PMT for the HERA-B RICH

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[f] University of Texas, Austin, USA
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[h] University of Houston, Houston, USA

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Abstract

A new multianode photomultiplier tube, type H6568 manufactured by Hamamatsu company, has been tested in view of using it for measuring Cherenkov rings in the HERA-B experiment. The results of measurements of single-photoelectron pulse-height distributions, uniformity of response, cross-talk, photon detection efficiency, rate dependence of the gain and ageing will be presented and discussed. In addition, the response of the PMT to scintillations of perfluorobutane (C_4F_{10}), argon and air has been measured.

1. Introduction

The HERA-B detector at the HERA e–p collider at DESY in Hamburg, will measure CP violation parameters in the B-meson system using thin-strip, fixed targets in the halo of the 820 GeV proton beam [1,2]. B-mesons will be thus produced in proton-nucleus collisions and their decays to $J/\psi\ K^0_S$ will be measured. Tagging of the B-meson flavour will be performed by identification of the charged kaon into which the associated B-meson decayed. For this purpose a Ring Imaging Cherenkov (RICH) counter will be used. The RICH detector will consist of 2.7 m of perfluorobutane (C_4F_{10}) gas radiator, spherical mirrors of 5.7 m focal length and about 6 m^2 of photon detectors with a pixel size of approximately 1 cm^2. In order to separate kaons from pions up to about 50 GeV/c, the RICH would have to detect at least 20 photons per Cherenkov ring. In addition, the RICH signals should be collected in less than the 96 ns bunch crossing time in HERA. The proton–nucleus reaction rate, necessary to detect a few thousand $B \to J/\psi K^0_S \to l^+l^-\pi^+\pi^-$ events in one year, also poses extra demands on the photon detectors. The most exposed parts of the detector will have to operate at a few MHz per pixel, which could cause ageing or rate problems.

Previous studies have been concerned with CsI photocathodes in an asymmetric multiwire chamber [3] and with a TMAE based photon detector [4]. The attempts to routinely produce and maintain the CsI photocathodes with a sufficiently high quantum efficiency were unfortunately unsuccessful. At larger accumulated charges ($\sim$10 mC/cm^2), the TMAE based photon detector showed signs of ageing in the form of prohibitive loss of anode wire gain [5]. A third possibility for position sensitive photon detection in HERA-B is studied in this work. Results of various measurements of the new Hamamatsu multianode photomultiplier tube (MA-PMT) H6568 are presented.

2. The experimental apparatus

The PMT has been tested with single daylight photons as well as with Cherenkov radiation emitted by ^{90}Sr β-electrons in a crystal radiator (Fig. 1) and by 3 GeV/c beam electrons in 5 m of argon gas radiator (Fig. 2).

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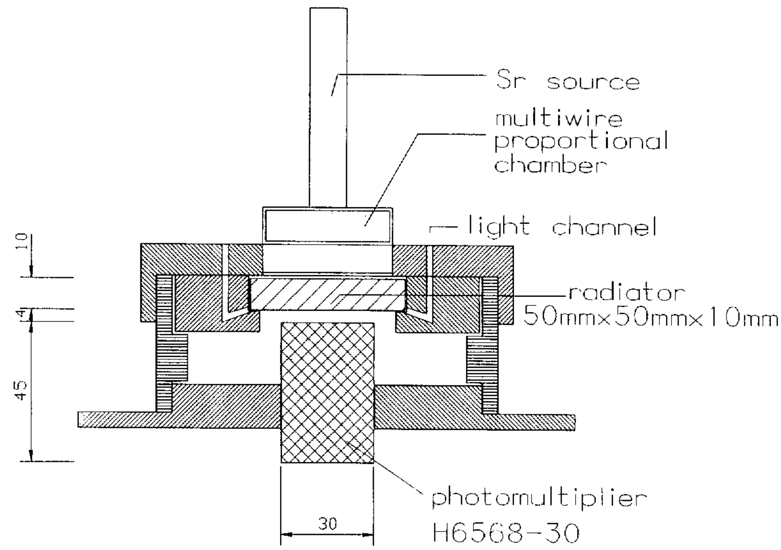

Fig. 1. The set-up for measuring Cherenkov photons emitted by ^{90}Sr β particles in a crystal radiator.

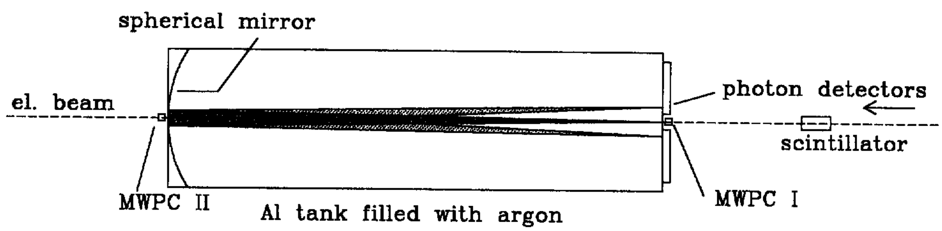

Fig. 2. The set-up for measuring Cherenkov photons emitted by 3 GeV/c, test-beam electrons in a 5 m long, argon gas radiator. The photons are reflected from a spherical mirror on the downstream flange and focused onto the detectors on the upstream flange. The read out is triggered by two tracking MWPCs and a scintillator. The set-up is situated at the T24 test beam at DESY.

A special container has been constructed for the measurement of the scintillations of C_4F_{10} gas. The gas flows through the gas tight container into which an ^{241}Am source can be inserted or removed. The scintillations induced by the α particles are seen by the photomultiplier at the opposite end of the container.

The height of the anode pulses has been measured with a 12-channel LeCroy CAMAC analog-to-digital converter (ADC 2249A). In some cases, when the ADC was not available a CAMAC 16-channel discriminator (Philips 7106) or a 16-channel time-to-digital converter (Lecroy 4291B) were used for pulse counting. A trigger pulse on the ^{90}Sr β-electrons was provided by a miniature $18 \times 18\,mm^2$ MWPC (Fig. 1), while for the beam measurements, the read out was triggered by coincident signals in two tracking MWPCs and one scintillator (Fig. 2).

The new Hamamatsu H6568 multianode photomultiplier has a bialkali photocathode with the anode divided into 16 pads of $4 \times 4\,mm^2$ each. The outer dimensions of the PMT are $30 \times 30\,mm^2$, so the photocathode occupies only about

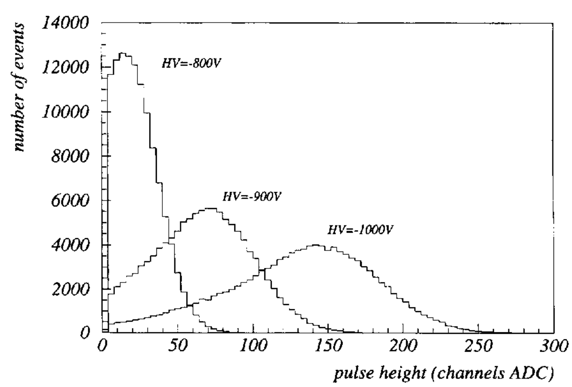

Fig. 3. The measured pulse-height distributions of the H6568 PMT due to single photoelectrons for different high voltage values.

30% of the surface. The 12-stage, metal-foil dynode system [6] allows for good single-photoelectron resolution as may be seen in Fig. 3. The quantum efficiency of the H6568

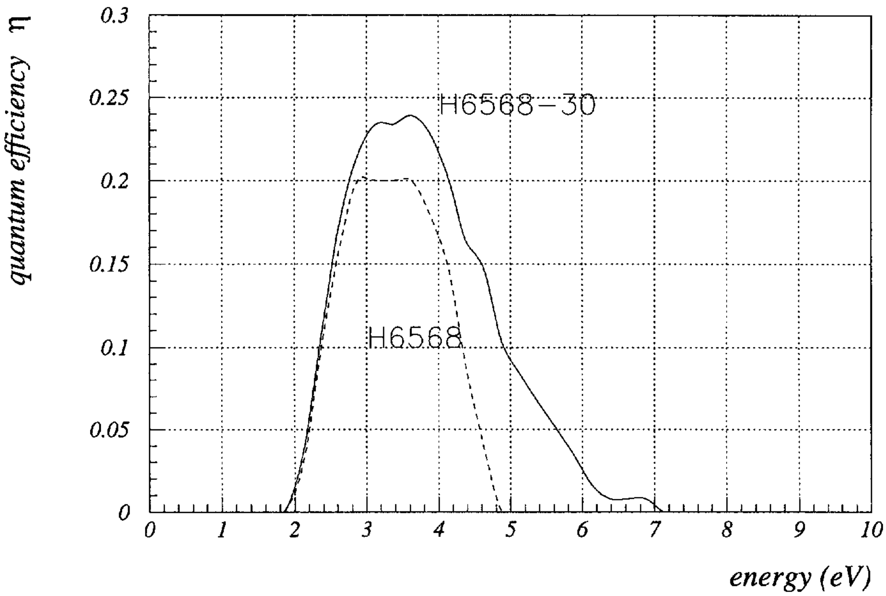

Fig. 4. The quantum efficiency of the H6568 PMT with borosilicate window (dotted line) and of the H6568-30 PMT with a quartz window (full line) [7].

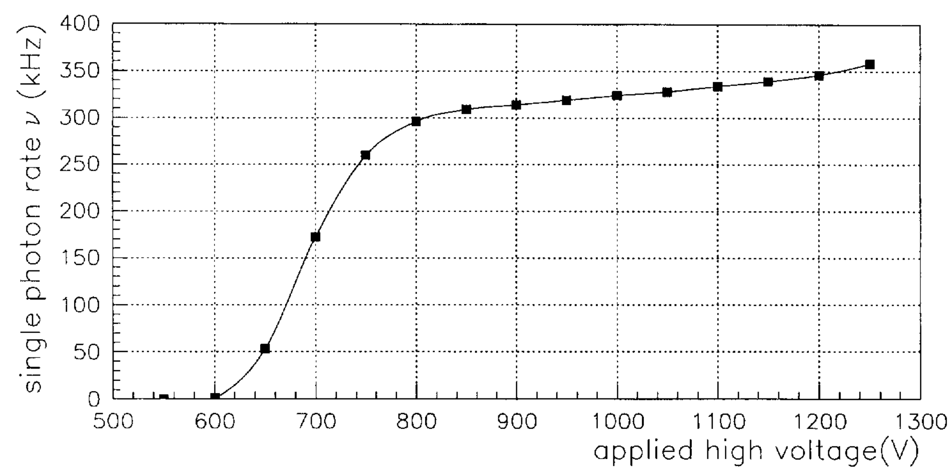

Fig. 5. The plateau curve of the single photon count rate for one channel of the MA-PMT versus high voltage (for constant illumination, amplification 200 and discrimination at 30 mV).

photocathode, with borosilicate window, has a broad plateau in the wavelength region between 300 and 500 nm with a maximum value of 20% (Fig. 4). The UV-extended version H6568-30 has a quartz window, which seems to improve the quantum efficiency as shown in Fig. 4. In the present tests, the photocathode quantum efficiencies of Fig. 4 were assumed in calculations in which an additional multiplication factor was allowed. This factor is attributed to the photoelectron collection efficiency and is adjusted for best agreement between calculations and results of measurements. The other PM characteristics such as the required cathode high voltage (≤ 1000 V), the current amplification (10^7), dark current (~ 1 nA), pulse rise time (0.8 ns), transit time spread (0.3 ns), etc. also seem to be satisfactory [6].

3. Measurements and results

Three multianode PMTs were tested; one with borosilicate glass window (Ser. No. 6A19C4) and two with quartz

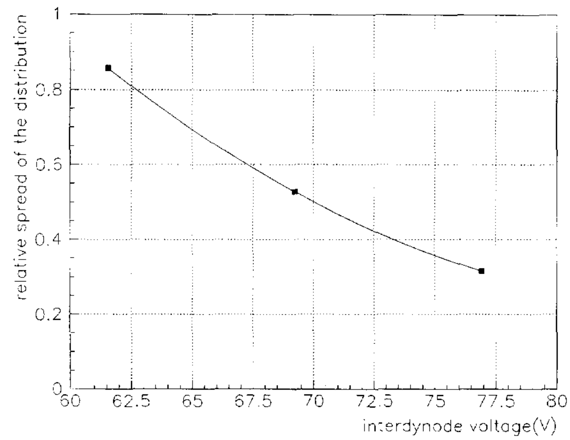

Fig. 6. The relative width of the single-photoelectron peak as a function of the voltage between successive dynodes.

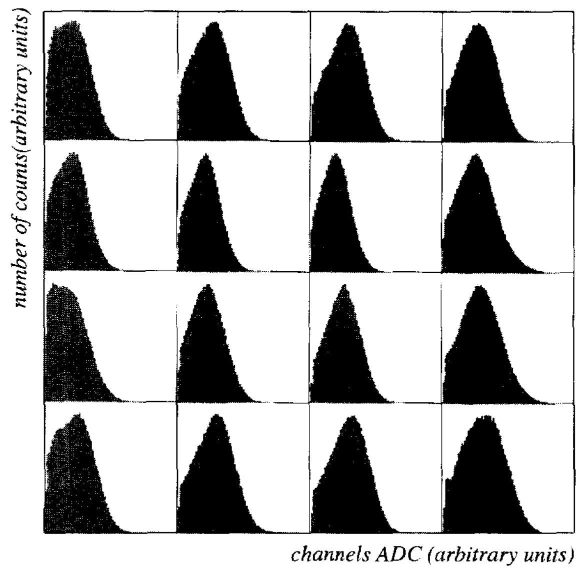

Fig. 7. The single-photoelectron pulse height distributions for all 16 channels of the H6568 PMT.

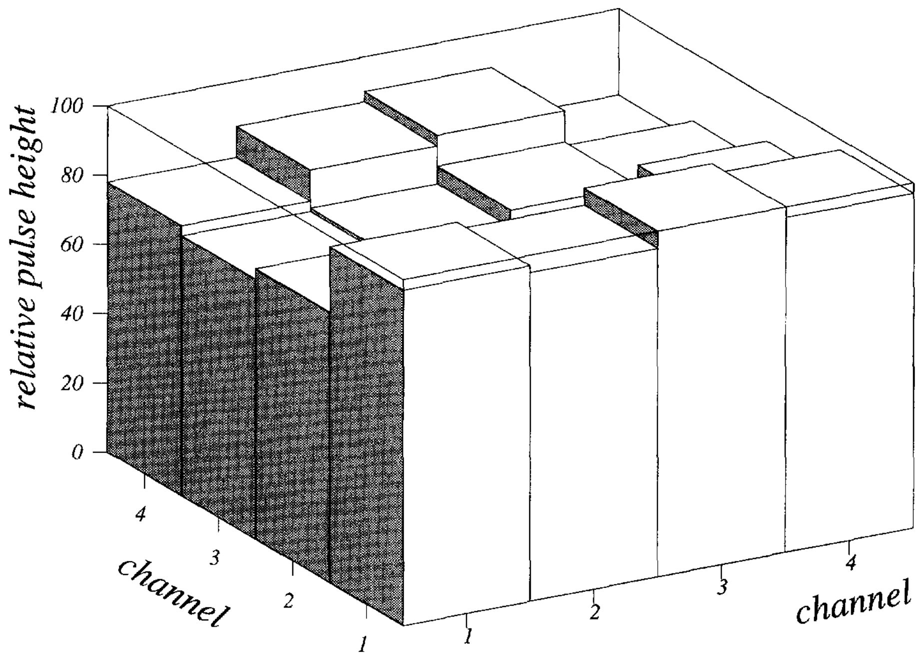

Fig. 8. Lego plot of the average single-photoelectron pulse-heights normalized to the pad with the largest average pulse height.

windows (Ser. No. 5M26C6 and Ser. No. 6C22C5). The single-photon count rate versus high voltage and the relative width of the single-photoelectron peak for one PMT are shown in Figs. 5 and 6, respectively. The pulse-height distributions on the 16 pads of one photomultiplier for single photoelectrons are shown in Fig. 7 and the average pulse height on each pad is shown in Fig. 8. These data were obtained by allowing a small leak of daylight into the crystal radiator from which the photon reached the photocathode more or less uniformly illuminating its surface.

Cross talk has been estimated by observing simultaneous pulses on adjacent pads, when the pulse on one pad has been recorded to be above a certain threshold. The pulse-height spectra, triggered by pad number 7 are shown in

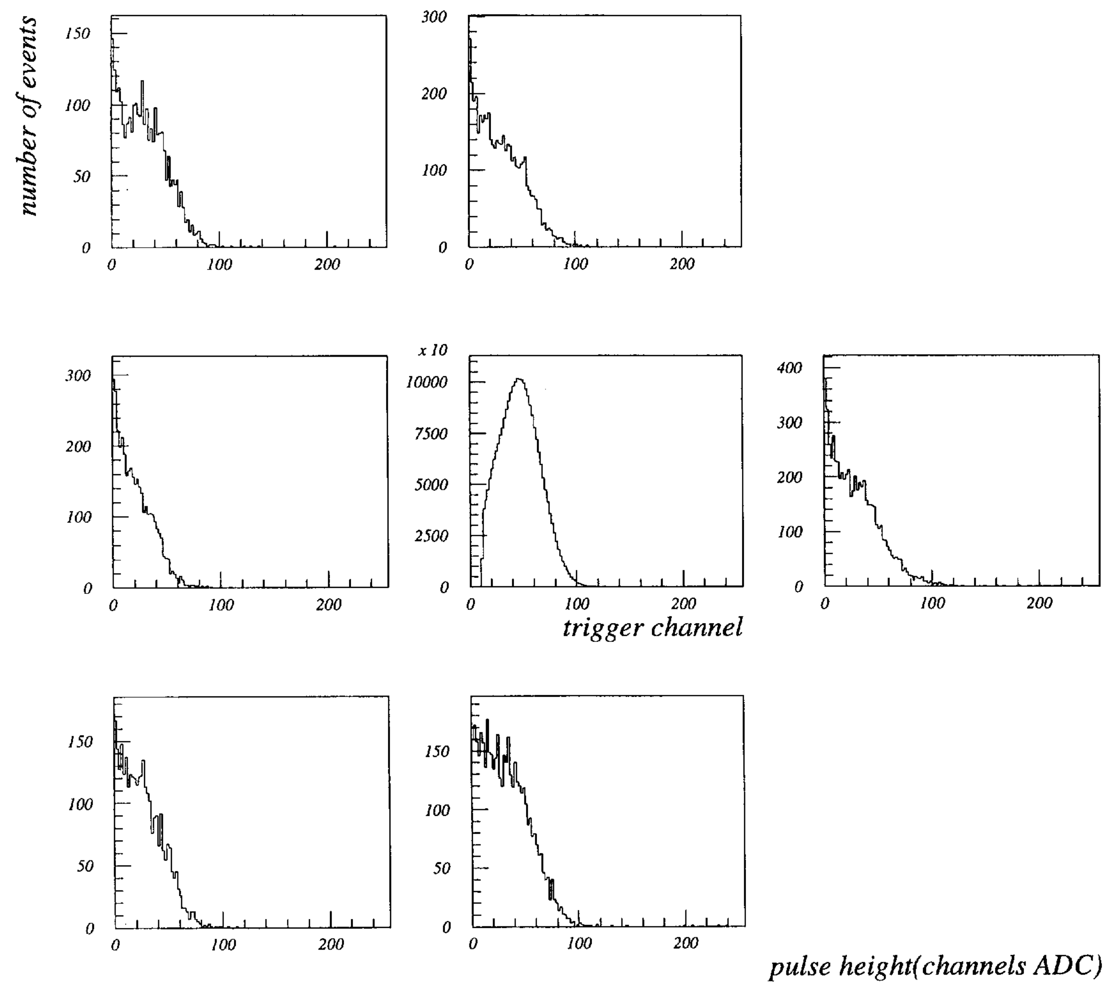

Fig. 9. Cross talk has been measured by triggering on channel 7 and observing simultaneous pulses on the neighbouring channels.

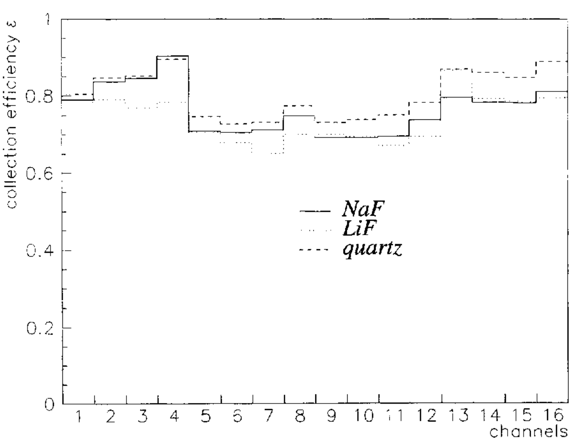

Fig. 10. Histograms of the photoelectron collection efficiency (see text) for all the pads, measured by detecting Cherenkov photons from three different crystal radiators.

Fig. 9. The cross talk is estimated from this figure to be 0.2% between direct neighbours and only 0.1% between diagonal neighbours.

The photon detection efficiencies of the multianode photomultiplier tubes have been determined by comparing measured and simulated numbers of detected Cherenkov photons. The Cherenkov photons have been generated by β particles from a ^{90}Sr source in NaF, LiF or quartz crystal radiators (Fig. 1). The simulation takes into account all the known parameters of the source, the crystal radiator and the detector. In particular, the photocathode quantum efficiencies used in simulation were those shown in Fig. 4. By dividing the measured number of hits per β-electron which triggered the multiwire chamber, with the corresponding number of simulated Cherenkov photons detected by each pad, one obtains an estimate of the performance of the individual anode pad expressed as an additional

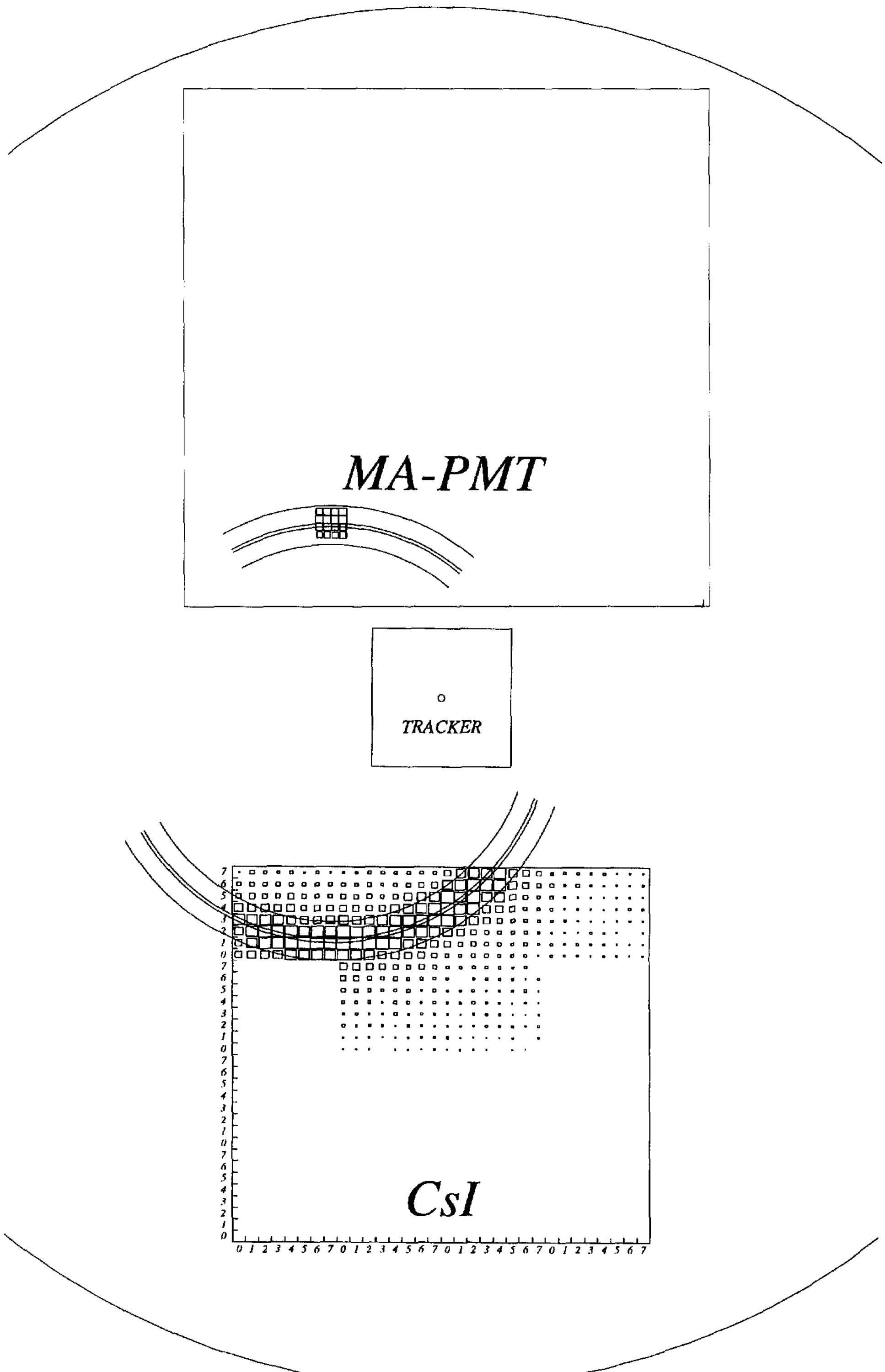

Fig. 11. The Cherenkov rings due to 3 GeV/c electrons in 5 m of argon gas, measured by the CsI-MWPC and the H6568 PMT in the set-up shown in Fig. 2. The insert shows the distribution of hits on the MA-PMT.

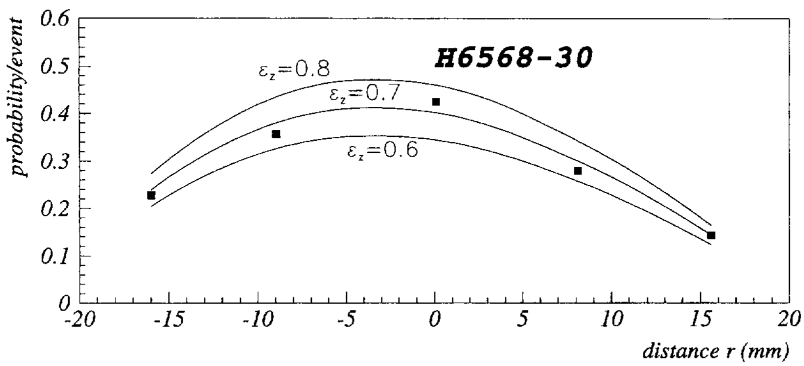

Fig. 12. The average number of hits per event as a function of position of the Cherenkov ring relative to the PMT (at $r = 0$ the ring passes through the PMT photocathode centre). The best agreement of the measured data points and the calculations (full lines) is obtained for $\varepsilon_c = 0.7$. The upper and lower curves correspond to ε_c values increased and decreased by 0.1.

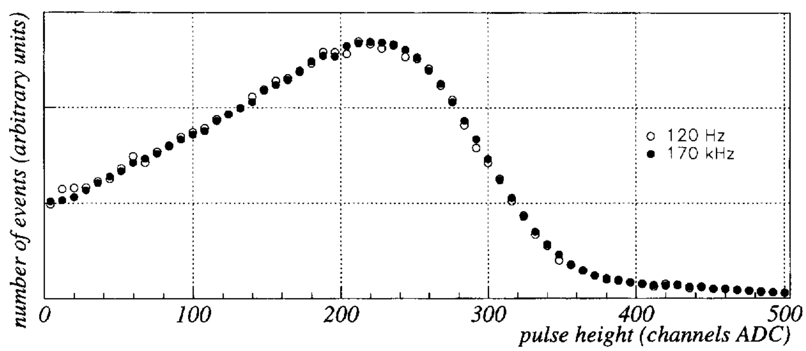

Fig. 13. Normalized pulse height distributions for Cherenkov signals caused by β-electrons from two different ^{90}Sr sources resulting in count rates of 120 Hz/pad (empty circles) and 170 kHz/pad (full circles).

efficiency factor. This additional efficiency factor ε_c is presumably due to less than perfect collection of the photoelectrons by the metal-foil dynode system. Fig. 10 shows the photoelectron collection efficiencies obtained for three different crystal radiators.

An independent estimate of the MA-PMT photon detection efficiencies has been obtained from measurements with 3 GeV/c beam electrons (Fig. 2). The average number of photons detected per beam electron has been measured for different positions of the Cherenkov ring with respect to the multianode PMT. The relative position of the Cherenkov ring has been varied by tilting the spherical mirror on the inside of the downstream flange and has been measured with the CsI-MWPC (Fig. 11). The average number of detected Cherenkov photons has also been calculated from the known geometry, the parameters of the argon gas radiator, mirror reflectivity, photocathode quantum efficiency given in Fig. 4 and for different values of the photoelectron collection efficiency. The collection efficiency of the photomultiplier has been thus determined from the best agreement between the measured and the calculated values (Fig. 12). The number of Cherenkov photons, that would be detected if the entire Cherenkov ring is intercepted by the sensitive photocathode surface (i.e. no dead space), would be 23 for the H6568 ($\varepsilon_c = 0.85$) and 31 for the H6568-30 ($\varepsilon_c = 0.7$) PMT. If instead of 5 m of argon, the radiator is 2.7 m of C_4F_{10} gas, as in the HERA-B RICH, these two numbers would increase to 55 and 74 detected photons/ring, respectively. Just by closely packing the MA-PMTs without any collection or focusing of light, the dead surface would reduce the number of detected Cherenkov photons for about 70%. Different light guides are being studied in order to collect the photons from a larger surface and concentrate them on the PMT photocathode pads.

At high rates, one might expect a reduction of gain and consequently of pulse height, due to large currents through the last dynode stages. Pulse height spectra at counting rates of 120 Hz and 170 kHz have been measured. No significant difference in their shape has been observed, as may be seen in Fig. 13.

Ageing was studied by illuminating the photocathode pads with a 5 W neon bulb through a small hole at one side of

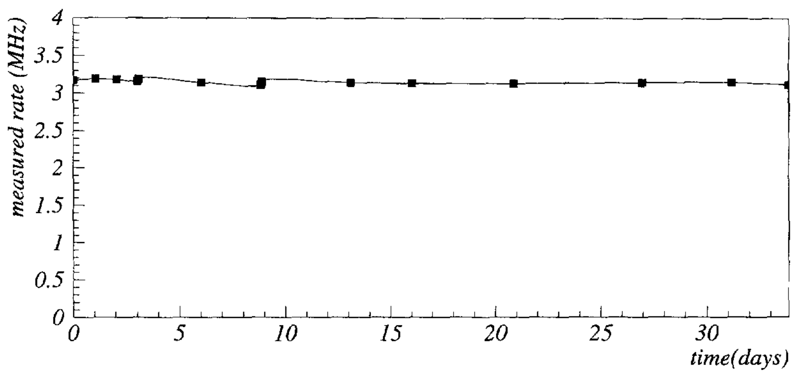

Fig. 14. The count rate as a function of time for one of the 16 channels illuminated with a neon lamp. No ageing effects have been noticed during one month of operation at 3 MHz/channel.

a 1 m long, 10 cm diameter black plastic tube with the PM on the other side. The counting rate as a function of time for one of the channels is shown in Fig. 14. As can be seen from the figure, no reduction of the 3 MHz counting rate has been observed over a 30 d period of continuous illumination and operation.

Measurements of the scintillation yields for argon, air and perfluorobutane (C_4F_{10}) have been made with two PMTs. For the H6568 PMT, the results for C_4F_{10} (0.4 detected photons per GeV of deposited energy) and for air (0.45 photons/GeV) are approximately equal and are both 4 to 5 times lower than for argon gas (1.8 photons/GeV). For the H6568-30 UV extended PMT, C_4F_{10} (1.5 photons/GeV) gives about two times more counts than air (0.7 photons/GeV), but about 8 times less counts than argon (11.2 photons/GeV). Taking into account the ratio of solid angles of the HERA-B photon detector to the solid angle of the apparatus for scintillation measurements and for $\sim$2 GeV of energy absorbed per event by the C_4F_{10} gas radiator, one expects to detect a few scintillation photons/event, which is negligible in comparison with the number of Cherenkov photons detected for each HERA-B event.

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Tests of a Proximity Focusing RICH With Aerogel as Radiator

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***Abstract*—Using aerogel as radiator and multi-anodephotomultiplier tubes (PMTs) for photon detection, a proximity focusing Cherenkov ring imaging detector has been constructed and tested with beams containing pions, muons, and electrons. The aim is to experimentally study the basic parameters such as resolution of the single photon Cherenkov angle and number of detected photons per ring. The resolution obtained is well approximated by estimates of contributions from pixel size and emission point uncertainty. The number of detected photons per Cherenkov ring is in good agreement with estimates based on aerogel and detector characteristics. The values obtained turn out to be rather low, mainly due to Rayleigh scattering and to the relatively large dead space between the photocathodes. A light collection system or a higher fraction of the photomultiplier active area, together with better quality aerogels are expected to improve the situation. The reduction of Cherenkov yield, for charged particle impact in the vicinity of the aerogel tile side wall, has also been measured.**

***Index Terms*—Aerogel, belle spectrometer, cherenkov counters, multi-anode photomultiplier tubes (PMTs).**

I. Introduction

AEROGELS are materials with density and refractive index in the region between gases and liquids or solids. Already some time ago, Cantin *et al.* [1] proposed that Cherenkov radiation from silica aerogels could be used for detection of particles. Besides particle detectors like for example TASSO [2], such threshold counters found applications also in other fields [3]. With improved manufacturing techniques, aerogels of higher transparency, i.e., less Rayleigh scattering became available, permitting their consideration as radiators in ring imaging Cherenkov (RICH) counters [4]. Ypsilantis and Seguinot [5] proposed a combined aerogel + gas, mirror-focused RICH counter for the LHC-B experiment at CERN. The HERMES team [6] constructed and operated such a ring imaging detector at DESY. The present paper reports on experimental investigation of an aerogel based RICH detector not requiring mirrors, i.e., of the proximity focusing type. Such a detector is being considered in connection with a possible upgrade of the BELLE particle identification system at KEK [7], [8].

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II. Experimental Setup

Initial tests of the apparatus with cosmic rays were reported recently [9]. The present paper describes measurements and results obtained with the $\pi 2$ beam at KEK. A beam particle—pion, muon, or electron—traversing the apparatus is signaled by two $5 \times 5\ \mathrm{cm}^2$ scintillation counters which determine the time of arrival. Two CO_2 gas Cherenkov counters produce signals only upon the passage of electrons so these signals could be used either to select or to exclude electrons.

The aerogel radiator and the position sensitive, single photon detector are contained in a light tight box (Fig. 1), of which the entrance and exit sides each have a multiwire proportional chamber for measuring the track of the incident particle. These $5 \times 5\ \mathrm{cm}^2$ MWPCs, with 15 $\mu\mathrm{m}$ diameter, gold-plated tungsten anode wires at 2 mm pitch and with 90% Ar + 10% CH_4 gas flow, are read out by delay lines on the x and y cathode wires.

After passing through the entrance MWPC, the charged particle hits the aerogel radiator in which it emits Cherenkov photons. Measurements have been made mainly with 2 cm thick aerogel slabs of $n = 1.029$, $n = 1.05$ and $n = 1.07$, produced by the method described in [10]. The position sensitive detector of Cherenkov photons is situated 17–29 cm downstream of the aerogel, depending on the refractive index value of the specific aerogel. The detector is a 6 × 6 array of 16 channel multi-anode photomultiplier tubes (Hamamatsu PMTs type R5900–00-M16 with borosilicate window [11]) at 30 mm pitch. The sensitive surface of the M16 PMT is divided into 16 $(= 4 \times 4)$ channels, each covering $4.5 \times 4.5\ \mathrm{mm}^2$. It follows that only 36% of the detector area is occupied by the photosensitive channels, the rest being dead space. The photon detection system and the aerogel radiator tile may be rotated around an axis perpendicular to the beam direction, enabling measurements of angular acceptance, i.e., measurements of the number of detected Cherenkov photons as a function of the charged particle incident angle.

The photomultiplier tubes (PMTs) are plugged into voltage divider boards inside the light tight box with signals passing through connectors to the readout system located outside the box. The PMT anode signals are first discriminated and then recorded by CAMAC multihit, multichannel time-to-digital converters (TDCs), for which the common STOP is provided by

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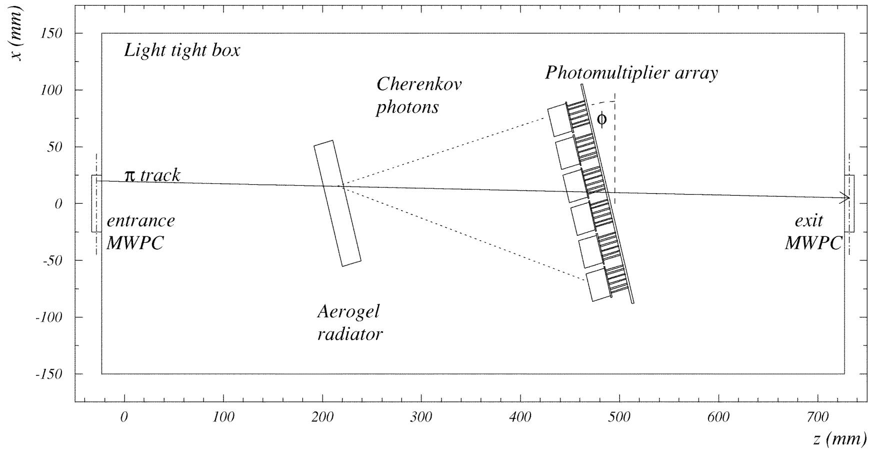


Fig. 1. The experimental setup.

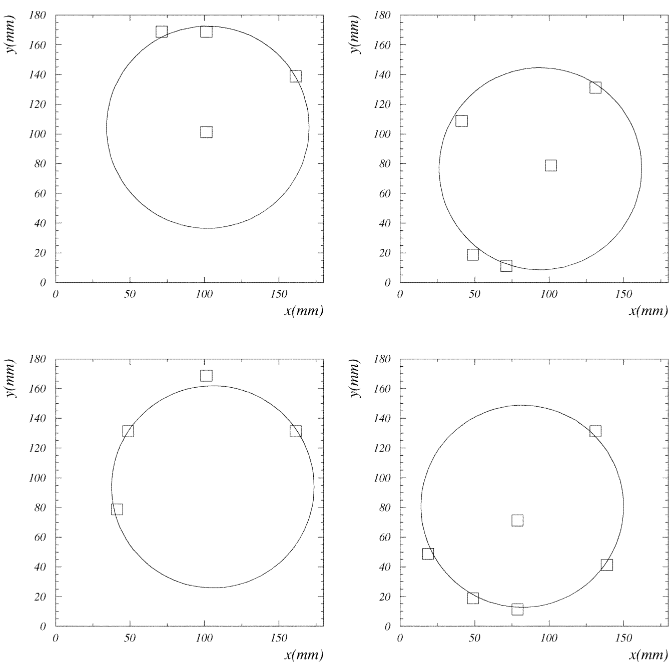


Fig. 2. Some examples of event hit patterns. The circle corresponds to the Cherenkov ring of a 3 GeV/c pion given by the measured track position.

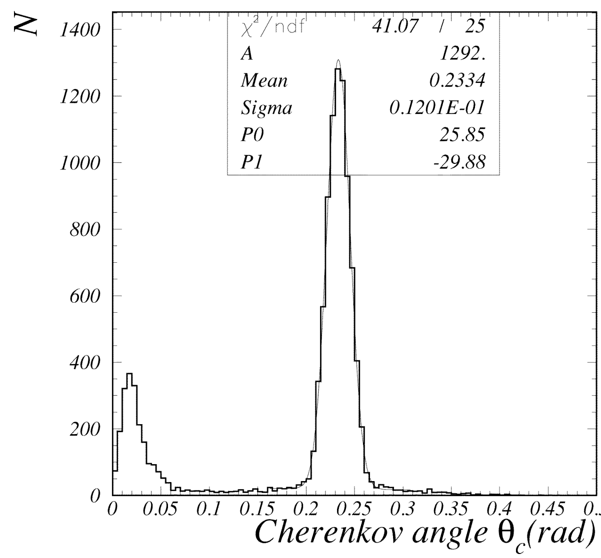


Fig. 3. The distribution of Cherenkov angles measured for 3 GeV/c pions, radiating in an $n = 1.029$ aerogel radiator.

the scintillation counter signals. The TDC information is stored for later analysis in a personal computer.

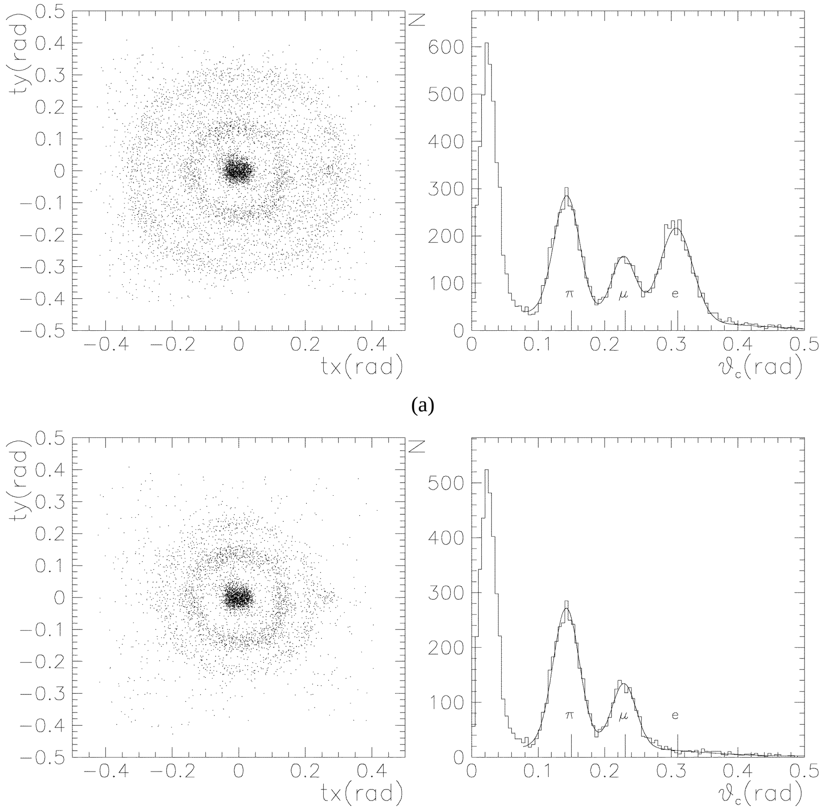
As only 192 readout channels were available for the 576 PMT anode outputs, only part of the system could be read out with the 4.5 mm pixel size. However, by connecting 4 $(= 2 \times 2)$ anodes to one readout channel, the entire system could be read out with 9 mm pixel size.

III. Measurement and Results

A few typical events are displayed in Fig. 2. From the photon hit position and the measured direction of the incident charged particle, the Cherenkov angle is calculated. Accumulated distributions of hits, depending on their Cherenkov angles, are plotted in Figs. 3 and 4. Peaks and rings, corresponding to pions, muons, and electrons, are clearly visible. Signals from the gas Cherenkov counters may be used for either selecting or excluding electrons. Fitting these distributions with Gaussian peaks and linear backgrounds yields the average values and standard deviations of the measured Cherenkov angles.

The main contributions to the resolution in Cherenkov angle as determined from a single photon (standard deviations of the peaks in distributions of Figs. 3 and 4) come from pixel size and from uncertainty in the emission point. For normal incidence of tracks the first contribution could be estimated as $\sigma_{\rm pix} = d \cdot \cos^2\theta_{\rm ch}/X\sqrt{12}$, where d is the pixel size, $\theta_{\rm ch}$ is the Cherenkov angle and X is the distance from aerogel to detector. The second contribution is $\sigma_{\rm emp} = L \cdot \sin\theta_{\rm ch}/X\sqrt{12}$, where L is the aerogel thickness. The uncertainty in the track direction is negligible at 3 GeV/c, but increases at lower momenta. The error due to dispersion in the radiator (chromatic error) should also be negligible, but contributions could arise due to possible nonuniformities of the aerogel (position variations in refractive index), nonflat aerogel surface, forward scattering of photons, etc.

The measured Cherenkov angle resolution, i.e., the standard deviation of peaks in distributions of photon hits versus the value of aerogel refractive index, is shown in Fig. 5 for 3 GeV/c pions. Different data points in the figure refer to different values of parameters such as the radiator thickness, the radiator-to-



(a)

(b)

Fig. 4. Distribution of hits in the Cherenkov x, y space (left), and versus the Cherenkov polar angle (right) for 0.5 GeV/c beam particles into an $n = 1.05$ aerogel radiator. (a) All beam particles. (b) Gas Cherenkov has been used to veto the electrons.

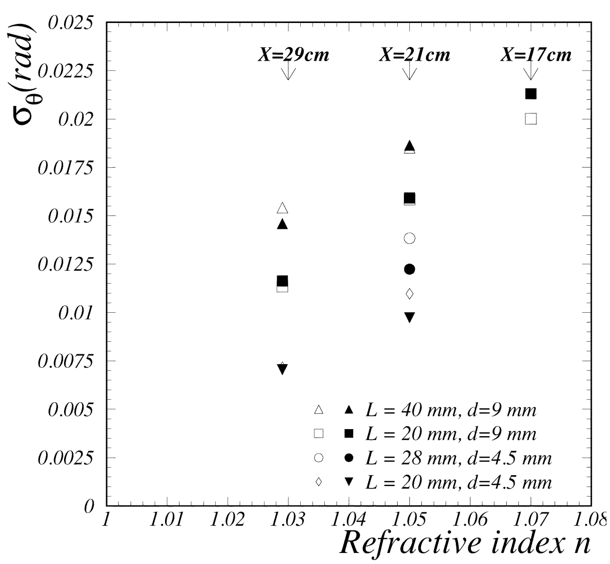


Fig. 5. The resolution, i.e., the standard deviation of the single Cherenkov photon angular distribution for different values of the detector parameters, for a 3 GeV/c pion beam. Full symbols correspond to the measured values, empty ones to estimates of contributions from pixel size and emission point uncertainty only. X is the radiator-to-photon-detector distance, L is the radiator thickness and d is the photon detector pixel size.

photon-detector distance and the photon detector pixel size. The measured values are represented by full symbols, with different symbol shapes indicating different combinations of parameter values. Using the above expressions for the contributions of pixel size and emission point uncertainty and summing them in quadrature, one obtains estimates for the resolution, represented with empty symbols in Fig. 5. It may be seen from the figure that such estimates give a good approximation to the measured resolution.

The other important parameter of a RICH counter is the number of detected photons per incident charged particle. This is usually parametrized as $N_{\mathrm{det}} = N_0 \cdot L \cdot \sin^2\theta_{\mathrm{ch}}$, where θ_{ch} is the Cherenkov angle, L is the radiator thickness and N_0 is a figure of merit depending on the radiator and system transparency, geometrical acceptance of photons (area and angle), quantum efficiency, photoelectron collection efficiency, etc. Due to Rayleigh scattering, the aerogel transparency has a strong wavelength dependence in the region of R5900-M16 PMT quantum efficiency, so one may expect a sensitivity of the number of detected photons on the particular aerogel sample, i.e., on the production procedure. The number of detected photons per Cherenkov ring is shown in Fig. 6 for 3 GeV/c pions. First, one notices that the number of photons does not increase with refractive index as may be expected for $\beta = 1$ particles; $N_{\mathrm{det}} \propto \sin^2\theta_{\mathrm{ch}}$. Then it is also obvious that the 4 cm thick aerogel radiator does not produce two times as many photons as does the 2 cm thick aerogel. And, finally, we see that the 2.8 cm thick aerogel tile, produced in a different process [12], yields more Cherenkov photons than the 4 cm thick aerogel [10]. That a higher refractive index of the aerogel sample does not necessarily produce more photons, is observed also in Fig. 7. Although the threshold for $n = 1.05$ is reached, as expected,

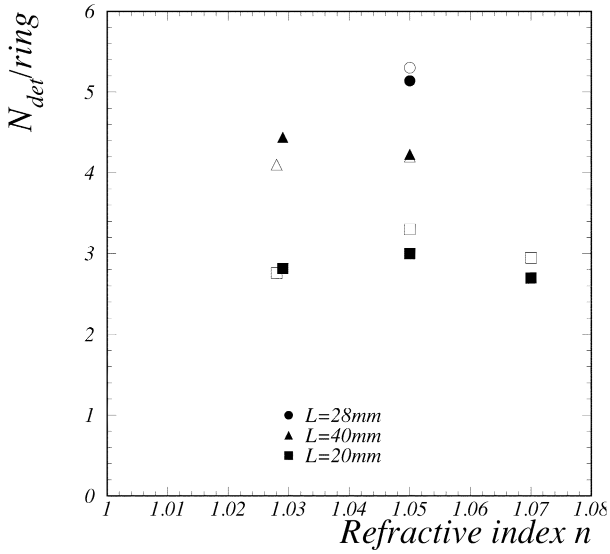


Fig. 6. Number of detected photons per Cherenkov ring for different aerogels, for a 3 GeV/c pion beam. L is the aerogel radiator thickness. Full symbols correspond to the measured values, empty ones to estimates.

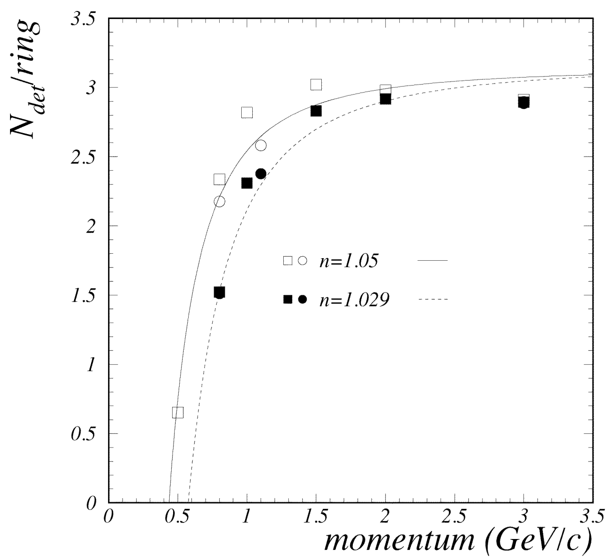


Fig. 7. Number of detected photons per Cherenkov ring depending on the charged particle momentum for two different aerogel radiators, with $n = 1.05$ (open symbols) and $n = 1.029$ (full symbols). Squares and circles correspond to different granularities of the photon detector. The curves are fits to corresponding data.

at lower particle momenta than for $n = 1.029$, the saturated number of detected photons per Cherenkov ring is more or less the same for both radiators. The above discrepancies can be well understood and have been estimated from the known aerogel attenuation lengths and the response of the counter (Fig. 6). The attenuation lengths at 400 nm for the samples of Fig. 6 are 36 mm, 15 mm and 7 mm for the aerogel samples with $n = 1.029$, $n = 1.05$ and $n = 1.07$, respectively, and 36 mm for the 28 mm thick Novosibirsk sample with $n = 1.05$.

It has been already noted by the HERMES group [6], that a loss of Cherenkov photons occurs at the side wall boundaries between adjacent aerogel tiles. We have confirmed this finding by measuring the number of photons on the Cherenkov ring as a function of the distance of the charged particle impact point from the boundary between two tiles. The measurement is shown in Fig. 8, where a dip is seen at the tile boundary $x = 0$ mm. In order to eliminate other geometrical factors, like for example the acceptance of the photon detector, the measured yield was normalized to the yield obtained with one tile covering the entire range. The result clearly indicates the reduction of yield when the charged particle is closer than about 5 mm to the boundary of a 2 cm thick $n = 1.05$ aerogel tile. It is worth noting that a simple model, where all photons hitting the boundary between the two tiles get lost, accounts for most of the observed dependence.

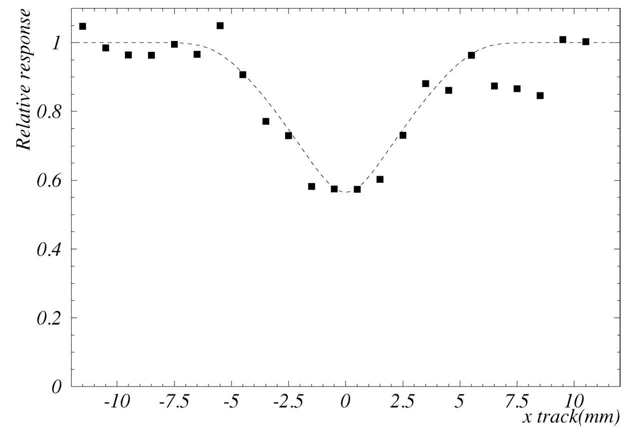


Fig. 8. The relative number of Cherenkov photons detected on the ring, as a function of the charged particle impact point distance from the side wall of the aerogel tile. The values shown are normalized to the measured values in case of a single tile covering the full range. Also shown is the estimate of a simple model (dashed curve).

IV. Conclusion

We have constructed and tested a proximity focusing RICH detector module with aerogel as radiator and multi-anode PMTs as position sensitive detectors of individual Cherenkov photons. The measured values of the basic parameters, i.e., the single photon Cherenkov angle resolution and the number of photons detected per Cherenkov ring, look promising. The resolution is in relatively good agreement with estimates based on pixel size and emission point uncertainty. The number of detected photons, however is sensitive to the particular aerogel used. It seems that these differences are due to Rayleigh scattering, which reduces the aerogel transparency mainly in the wavelength region of maximal photocathode sensitivity. Photomultipier tubes with a higher fraction of active area, possibly combined with a light collection system, consisting of lenses or light guides, are expected to increase the number of detected Cherenkov photons by reducing the dead space of the photon detector. The increase in photon yield, however, is in the latter case at the expense of an increase in the effective pixel size, so a compromise, optimizing the final resolution of the charged particle Cherenkov angle should be found.

The information obtained from the results of the present tests suggests that a proximity focusing aerogel RICH as required by the BELLE particle identification upgrade is feasible, so investigations of optimal detector parameters are being continued.

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Cherenkov detector based on aerogel radiator and flat panel PMT for detection of ^{90}Sr

Rok Pestotnik, Irena Dolenc, Samo Korpar, Peter Križan, Aleš Stanovnik

***Abstract*— New developments in production of silica aerogels and single photon detectors offer possibilities to improve a method for detection of ^{90}Sr in environmental samples. The method is based on detection of Cherenkov photons emitted by the ^{90}Y beta particles in an aerogel of suitable refractive index. Preliminary results are presented.**

***Index Terms*— Cherenkov detectors, silica aerogel radiators, multichannel photomultiplier tubes, Sr-90 radioactivity analysis**

I. INTRODUCTION

STRONTIUM ^{90}Sr is a very radiotoxic isotope because it accumulates in bone tissue, has a rather long half-life of 28.2 years and its daughter ^{90}Y emits β particles of 2.27 MeV end-point energy. It is a fission product, so it may pollute the environment either as a result of a nuclear power plant accident or of a nuclear weapon explosion, both of which have unfortunately happened in the previous century.

^{90}Sr and its daughter ^{90}Y are pure beta emitters so they cannot be detected by standard and accurate methods of gamma ray spectroscopy. Other beta emitters in the sample, with overlapping spectra, will lead to erroneous results in total beta counting or would complicate matters in the usual β spectroscopy. Cherenkov radiation offers the possibility of a well defined β-energy cutoff by choosing an appropriate refractive index of the Cherenkov radiator. In addition, it has been demonstrated [1], [2] that the counting efficiency rises steeply above threshold. Not very many isotopes have β end-point energies above 2 MeV, so ^{90}Y, the daughter of ^{90}Sr, with E_γ^{max} = 2.27 MeV, seems well suited for detection through Cherenkov radiation.

Recent progress in production techniques has led to improved properties of aerogels [3], [4], most important of which is greater transparency for Cherenkov photons in the wavelength region of highest photomultiplier sensitivity. On the other hand, Hamamatsu has developed 64 channel, flat panel detectors of single photons with photosensitive area of 49×49 mm^2 [5], which allow counting of the number of Cherenkov photons for each incident β particle. In the present paper we report on preliminary results obtained with such an improved detector.

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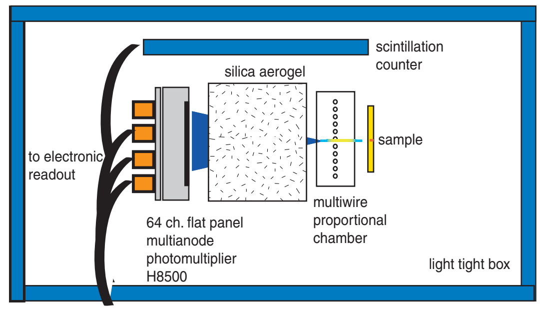

Fig. 1. Experimental setup

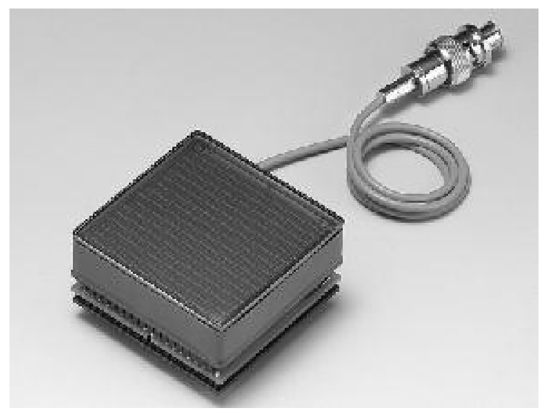

Fig. 2. The Hamamatsu 64-channel flat panel PMT (H8500).

II. THE APPARATUS

The apparatus (Fig.1) is enclosed in a light tight box. It consists of the sample or source of β particles, a thin (8 mg/cm^2) 2×2 cm^2 multi-wire proportional chamber (MWPC), a stack of two 5×5 cm^2 and 2.5 cm thick aerogel radiators with refractive index n= 1.047 [6] and a 49×49 cm^2 Hamamatsu H8500 flat panel, 64 channel photomultiplier [5](Fig.2). An additional scintillation counter provides veto pulses for background-contributing cosmic particles coming from above. The MWPC, with its high efficiency for charged particles ($\sim$ 99%) and low efficiency for gamma rays ($\sim$ 0.1%) signals an incoming β particle, distinguishing it from events where a gamma photon from the source generates an energetic electron in the aerogel Cherenkov radiator or in the PMT glass window.

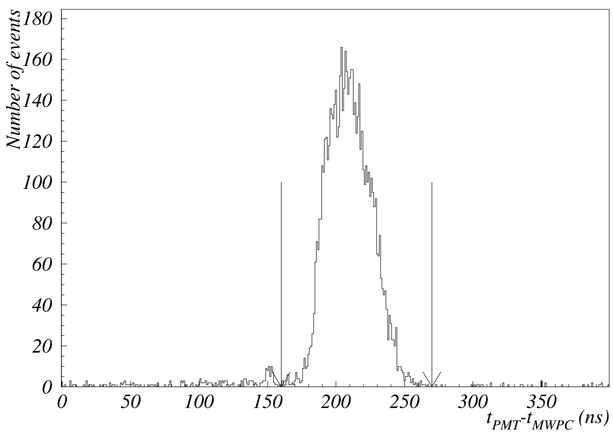

Fig. 3. Time difference between the PMT and MWPC signal. The 100 ns window for photons generated by beta particles is indicated.

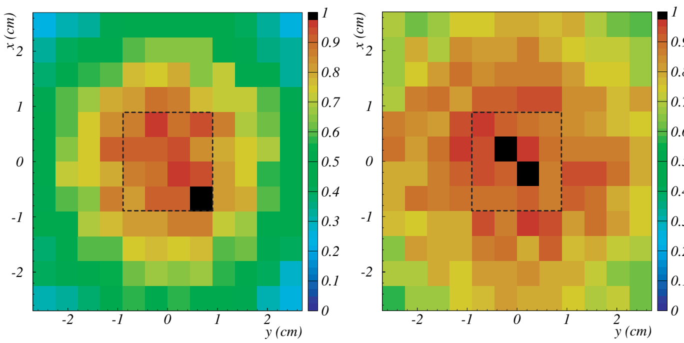

Fig. 4. Distribution of Cherenkov photons on the aerogel exit side without (left) and with (right) the aluminized mylar reflector. The position of one R5900-M16 PMT is indicated by the dashed line.

The electron kinetic energy threshold in the aerogel radiator (n= 1.047) is 1.21 MeV.

A coincidence-anticoincidence circuit triggers a time-to-digital converter for each channel in which the Cherenkov photons appear as peaks in the PMT-MWPC time difference (Fig.3). Appropriate time windows permit counting of the number of photons in each event as well as an estimate of the background count rate.

III. Analysis and Results

Simulation calculations have been performed in order to investigate the effect of an aluminized mylar reflector surrounding the aerogel radiator on all sides except the one at the PMT entrance window. The distribution of the number of Cherenkov photons on the photon exit side of the aerogel is shown in Fig.4 for the case without and with the reflector. Previous measurements performed with one 16 channel Hamamatsu R5900-M16 PMT with photosensitive area of 18×18 mm^2 [7] may obviously be improved by covering a larger surface. A step in this direction was made by using four R5900-M16 PMTs and

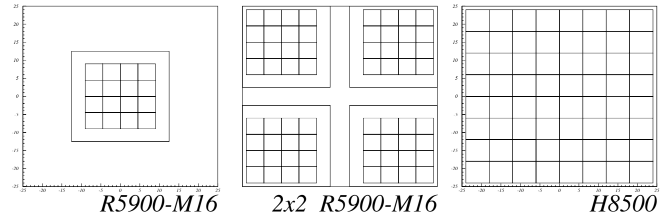

Fig. 5. Three different configurations of Cherenkov photon detectors.

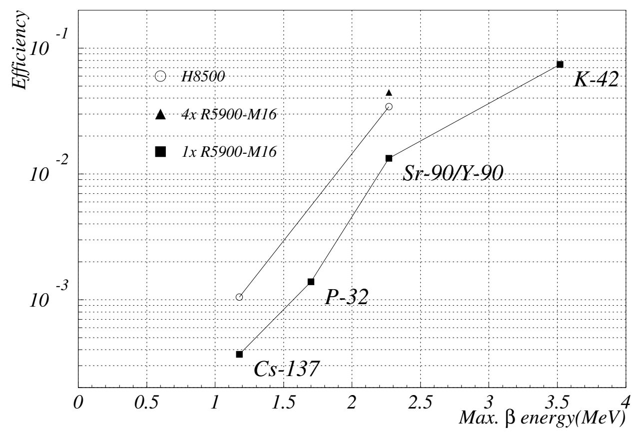

Fig. 6. Efficiency defined as count rate divided by appropriate activity as a function of beta spectrum end-point energy for the three configurations of Fig.5.

a factor of about 3 increase in efficiency was obtained. In order to cover also the gaps between the photocathodes of these four PMTs (Fig.5), they were substituted with a Hamamatsu H8500 64 channel, a flat panel PMT with the active area of 49×49 mm^2. The result however, was not the expected increase in efficiency (Fig.6), possibly due to a lower collection efficiency of the H8500 dynode system. This question will be further investigated.

The efficiencies obtained with the three configurations of Fig.5, are given in Fig.6. Although the ^{137}Cs β end point energy is below the Cherenkov threshold, some counts have been registered also for this isotope. That they are due to photons coming from the aerogel, has been verified by covering the aerogel photon exit window with black paper which resulted in a considerable reduction of the count rate. A possible explanation could be scintillations in the aerogel generated by the β particles.

Monte Carlo simulation and measurement also do not quite agree in the distribution of the number of events versus the number of detected photons produced by a single β particle. From Fig.7, it is seen that simulation does not reproduce events with large numbers of detected photons. This and other open questions are the subject of further studies, which will hopefully produce answers required for an efficient detector of low level ^{90}Sr activity as required for environmental samples.

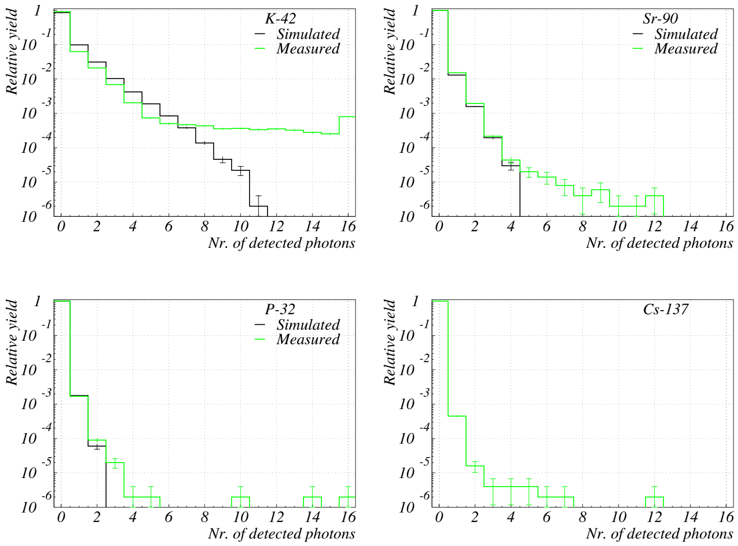

Fig. 7. Simulated and measured distribution of the number of hit channels per triggered particle: ^{42}K (top left), ^{90}Sr/^{90}Y (top right), ^{32}P (bottom left) and ^{137}Cs (bottom right).

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The HERA-B ring imaging Cherenkov counter

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Abstract

The HERA-B RICH uses a radiation path length of 2.8 m in C_4F_{10} gas and a large 24 m^2 spherical mirror for imaging Cherenkov rings. The photon detector consists of 2240 Hamamatsu multi-anode photomultipliers with about 27 000 channels. A 2:1 reducing two-lens telescope in front of each photomultiplier tube increases the sensitive area at the expense of increased pixel size, resulting in a contribution to the resolution which roughly matches that of dispersion. The counter was completed in January of 1999, and its performance has been steady and reliable over the years it has been in operation. The design performance of the Ring Imaging Cherenkov counter was fully reached: the

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average number of detected photons in the RICH for a $\beta = 1$ particle was found to be 33 with a single-hit resolution of 0.7 and 1 mrad in the fine and coarse granularity regions, respectively.
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Keywords: Ring imaging Cherenkov detectors; Photomultiplier tubes; HERA-B

1. Introduction

HERA-B, a fixed target experiment (see Fig. 1) at the HERA storage ring at DESY, was designed [1] to measure rare processes in the decays of B mesons. The B mesons are produced in collisions of 920 GeV/c protons with a fixed target, which consists of eight wires which can be individually inserted into the halo of the proton beam in order not to disturb experiments measuring e–p collisions. One of the essential components of the spectrometer is the Ring Imaging Cherenkov counter (RICH) [1–4]. The main purpose of the RICH counter is the identification of charged hadrons, in particular kaons from decays of B mesons. Identifying charged kaons essentially means separating them from pions in the momentum range between 3 and about 50 GeV/c at an interaction rate of up to 40 MHz.

This paper is organized as follows. We shall first discuss the design criteria and their implementation. The components of the counter will be presented, as well as the monitoring and analysis programs. Finally, results of measurements made with the counter will be discussed, and the performance of the RICH as an identification device, and also as a tracking device, will be presented.

2. Design criteria

In a fixed target experiment such as HERA-B where one has to deal with an intense flux of charged particles, the design choices of a RICH are governed by the following criteria. To achieve the necessary performance, a sufficient number of Cherenkov photons (at least 20) has to be detected per ring image of a $\beta = 1$ particle [1]. This requirement fixes the length of a gas radiator to a few meters. The high rate capability of the photon detector requires a detector with pad readout, which limits the resolution to a few millimeters. This, in turn, together with the

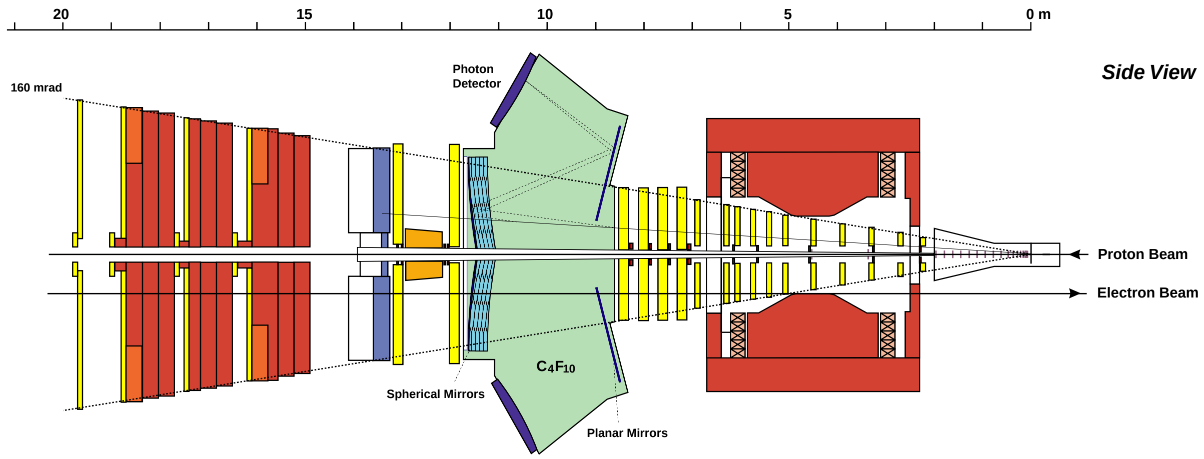

Fig. 1. A side view of the HERA-B detector.

required high resolution in the measurement of the Cherenkov angle for single photons (better than 1 mrad) sets the mirror focal length value to several meters. Last but not least, the requirement that single photons are efficiently detected with low background, forces the photon detector to be kept out of the solid angle for charged particles and conversion products.

3. Implementation

3.1. Radiator

Perfluorobutane gas (C_4F_{10}) was chosen for the HERA-B RICH radiator, since it combines a relatively high refractive index, $n = 1.00137$, and low dispersion (5% variation in $n-1$ over the spectral acceptance from 300 to 600 nm [5]). In this gas, the Cherenkov radiation threshold momenta for pions and kaons are 2.7 and 9.6 GeV/c, respectively. For $\beta = 1$ particles, the Cherenkov angle is 52.4 mrad, while the $\pi - K$ difference in Cherenkov angle is 0.9 mrad at 50 GeV/c. The r.m.s. angular spread due to dispersion amounts to 0.33 mrad. Since some freons are known to scintillate considerably (e.g. CF_4), we have studied C_4F_{10} scintillation [6] and found that this contribution to background is less than 0.2 detected photons per charged particle.

The radiator vessel, made from stainless-steel plates with 1 mm aluminum particle entrance and exit windows (see Fig. 2), is placed about 8.5 m downstream of the target (see Fig. 1). Two beam shrouds made of carbon fiber-reinforced epoxy resin CFK close the gas volume around the two beam pipes for protons and electrons. The Cherenkov light exits the vessel through 2-mm-thick UV grade Plexiglass windows [7]. The vessel is filled with 108 m^3 of C_4F_{10} gas, which is being circulated in a closed system with liquefaction stages for cleaning and buffering [8]. Requirements on impurities are moderate due to operation in the visible and near UV part of the Cherenkov spectrum. The radiator gas is kept at 2.5 mbar overpressure relative to ambient pressure. Additionally, a bubbler with a 10 mbar pressure difference threshold is attached to the vessel.

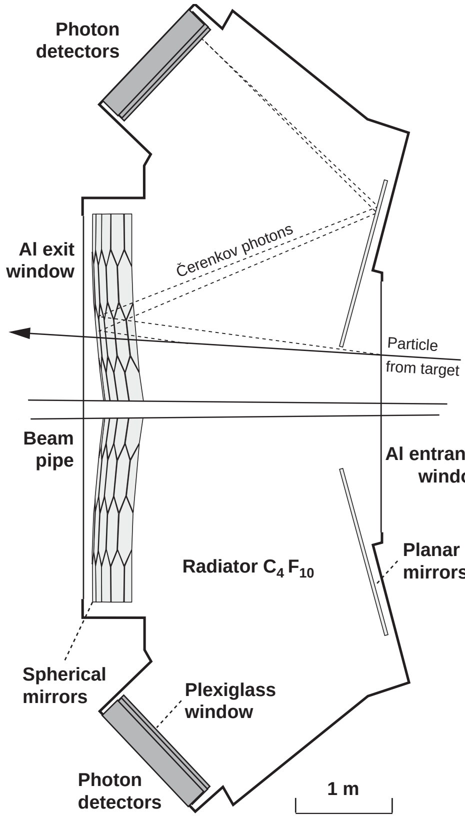

Fig. 2. Scheme of the RICH. Rays emitted by a particle and their paths to the photon detector are indicated.

3.2. Mirrors

The main imaging device is a spherical mirror placed inside the radiator vessel with the center of the sphere near the target and a radius of curvature of 11.4 m. The mirror, a 6 m × 4 m rectangular cutout from the sphere, consists of 80 full or partial hexagons made from 7-mm-thick Pyrex glass, coated with 200 nm of aluminum and 30 nm of MgF_2 (see Fig. 3). To be able to place the focal surface outside the particle flux (± 160 mrad vertically), the mirror is split horizontally and both halves are tilted by 9° away from the beam-line. A set of two planar mirrors, composed of 18 rectangular elements each, translates the focal surface to the photon detector area above and below the radiator vessel (see Fig. 2). The planar mirrors are made of float glass, thus being significantly cheaper than Pyrex mirrors at the

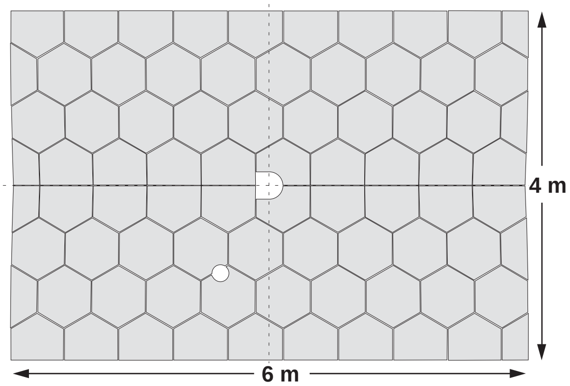

Fig. 3. Distribution of spherical mirror polygons. The holes in the array are for the proton and electron beam pipes.

required optical quality. All 80 spherical and 36 planar mirrors are mounted on a rigid, low-mass support structure inside the radiator volume and can be individually adjusted by stepper motors from the outside.

The mirror quality was determined upon delivery by measuring for each segment the radius of curvature and the fraction of reflected light, and by recording a Ronchi image to check the homogeneity of the mirror surface [9]. The reflectivity was required to exceed 85% in the wavelength interval from 250 to 600 nm. From the data gathered, the mirror segments were grouped in a tiling scheme according to their optical quality and resolution requirements.

All mirrors were aligned to better than the required precision by surveying them inside the vessel. An off-line data-based algorithm was developed for monitoring of the positions of the mirror segments during the measurement [10].

3.3. Photon detector

Two types of wire chamber-based photon detectors were initially considered, a CsI photocathode in an MWPC, and a TMAE detector with 10 cm deep, 8×8 mm^2 unit cells. After considerable success of on-the-bench and beam tests [11–13], the detectors were tested in a high-rate environment, as expected in the HERA-B experiment. Both detectors had to be abandoned; the TMAE detector showed a prohibitive decrease of avalanche gain due to aging effects [14,15], while the CsI photocathode could not be routinely produced and maintained with sufficiently high quantum efficiency, in addition to problems with rates in excess of a few kHz per pixel [16,17].

The actual photon detector consists of Hamamatsu multi-anode R5900-00-M16 and R5900-03-M4 photomultiplier tubes (PMTs). In what follows, they are denoted by M16 and M4. The M16 version has 16 pads of 4.5×4.5 mm^2 each, with a 12-stage, metal-foil dynode system.[7] The M4 version has four pads of 9×9 mm^2 each, and 10 dynodes. The quantum efficiency of the M16 photocathode with borosilicate window has a broad plateau in the wavelength region between 300 and 500 nm and a maximum value about 20%. The M4 tubes have a UV-transparent window, which shifts the low-wavelength cut-off to about 250 nm. The other PMT characteristics, such as the required cathode high voltage ($\leqslant 1000$ V), current amplification (10^7), dark current (~ 1 nA), pulse rise time (0.8 ns), transit time spread (0.3 ns) are also satisfactory (see footnote 7). In the initial set of on-the-bench measurements [18], the single photon counting properties of the PMT were investigated, in particular the efficiency for single photon detection as well as the background count rate. It was established that the PMT allows for a good single photoelectron detection efficiency (above 98%), with very small cross-talk (below 0.2%), low background rate (few Hz per channel, Fig. 4), and acceptable uniformity as shown in Figs. 5 and 6 [19].

The PMTs have the outer dimension of 28×28 mm^2 with an active area of 18×18 mm^2. They are positioned on a 36×36 mm^2 grid. To increase the fraction of the active area, a two-lens demagnification system (2:1) was designed, as shown in Fig. 7 [20]. The lenses are made of UVT perspex[8] with high transparency over most of the wavelength region where the photocathode is sensitive (Fig. 8). The angular acceptance of the optical system is also satisfactory and is uniform

[7] Hamamatsu Data Sheets for R5900-M16 and R5900-M4 Photomultipliers.

[8] Lenses were manufactured by Wahl Kunststoffoptik GmbH, the material used was PMMA UV.

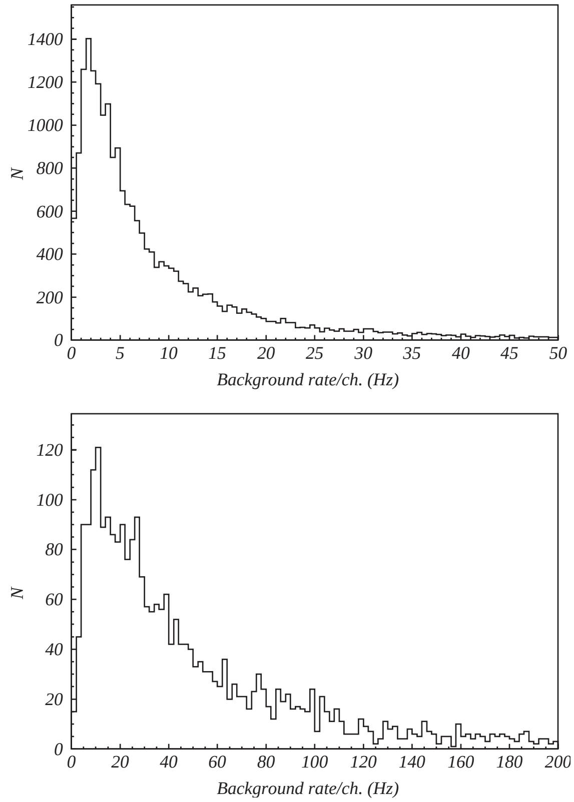

Fig. 4. Distribution of the number of PMT channels depending on the background rate per channel for M16 (top) and M4 (bottom) PMTs, as measured after the tubes were kept in a light tight box for 15 min.

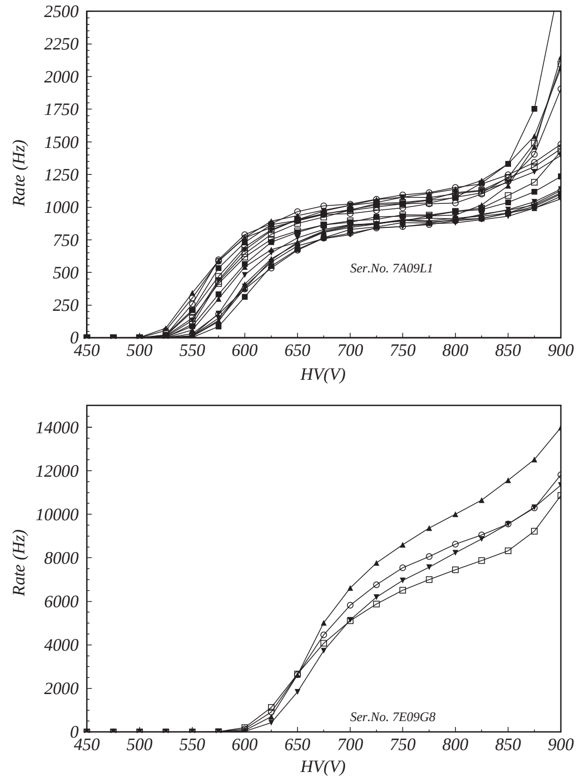

Fig. 5. The plateau curves, i.e., the dependence of measured rate as a function of the high voltage for all channels of a representative M16 (above) and M4 (below) PMT.

for incident angles below about 110 mrad [21]. The increase in the photodetector active area is achieved at the expense of increasing the pixel size from the $4.5 \times 4.5\,\text{mm}^2$ PMT pad size to $9 \times 9\,\text{mm}^2$ pixel in the central detector region. The resulting angular measurement error (0.46 mrad) slightly exceeds the spread due to dispersion (0.33 mrad). For the outer detector region, with lower track densities and lower typical track momentum, the photon flux is smaller, and the resolution requirements looser. In order to reduce the detector cost, this detector part uses the M4 version of the tube with two times larger pads ($9 \times 9\,\text{mm}^2$). The same lens system thus results in $18 \times 18\,\text{mm}^2$ pixels which correspond to an angular measurement error of 0.92 mrad.

In order to reduce the contribution of spherical aberration to the overall resolution of the Cherenkov angle, an optimal surface of the Cherenkov photon detector was calculated [22,23]. Each half-detector (upper and lower) consists of five flat supermodules placed to approximate the optimal surface, which is close to the shape of a flattened (ellipsoidal) cylinder. Such an arrangement also ensures better acceptance for the Cherenkov photons, which should be incident onto the flat supermodules at angles below 110 mrad. The supermodules are rectangular $1.1 \times 0.4\,\text{m}^2$ boxes containing a grid made from 1-mm-thick soft iron sheets that serve as magnetic shield and mounting structure for the PMT base-boards and the light collection system. The two types of photomultipliers were arranged according to occupancy and reconstruction requirements as indicated in Fig. 9. Altogether 1488 M16 PMTs and 752 M4 PMTs are used to cover the detector surface, thus totaling 26 816 read-out channels.

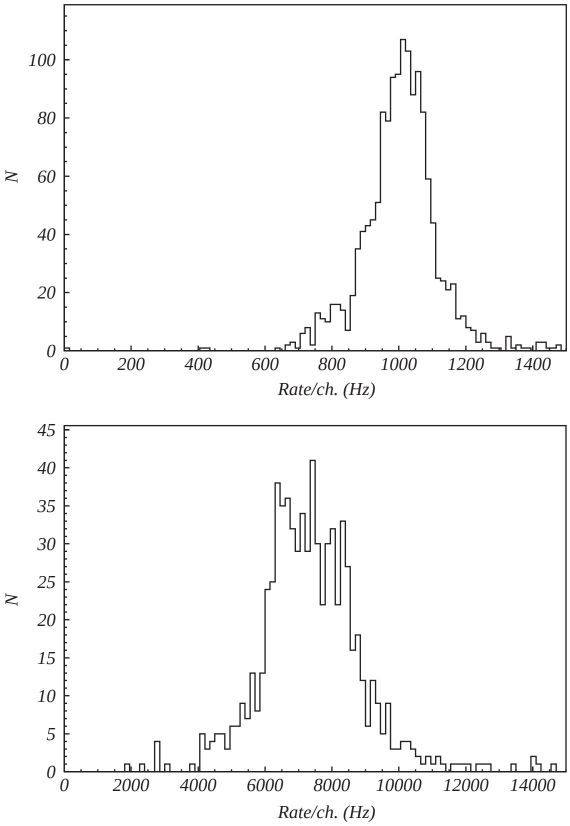

Fig. 6. Distribution of the number of PMT channels depending on the rate per channel for the M16 (top) and M4 (bottom) PMTs at the optimum high voltage, as determined in the quality assessment tests with uniform illumination.

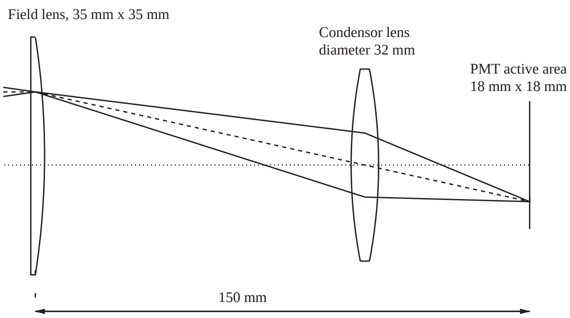

Fig. 7. The optical system for light collection and demagnification. The two rays shown in full line correspond to photons with incident angles of ±100 mrad with respect to the dashed line (normal incidence).

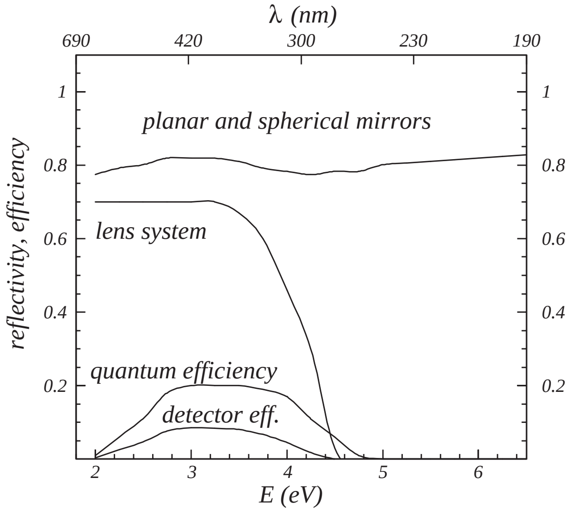

Fig. 8. Transmission of the lens system, reflectivities of the mirrors, quantum efficiency and overall detector efficiency of the PMTs as a function of photon energy and wavelength.

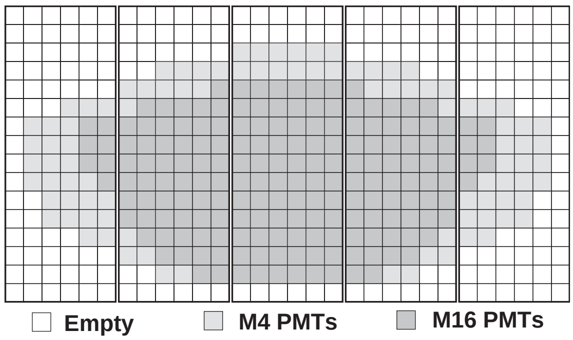

Fig. 9. Arrangement of M4 and M16 type basic units on the five supermodules of the upper focal plane.

Prior to the installation in the photon detector tests of all the 2305 acquired PMTs (1543 M16s and 762 M4s) were made in the laboratory [24]. Cherenkov photons produced in a 1-cm-thick quartz window by β particles from a ^{90}Sr source were used as a stable light source [25]. Four PMTs were tested simultaneously, of which one was used as a reference. For each PMT, the source and background rates were recorded as a function of high voltage and threshold setting. On the basis of these tests, the photomultipliers were grouped according to similar high-voltage characteristics, allowing all PMTs within a group to be connected to the same high voltage, thus minimizing the number of independent HV channels [26]. The results obtained for the optimal high voltage as well as for the relative PMT sensitivity were compared to values provided by the manufacturer, and good agreement was found [24]. The count rates of the reference M4 and M16 photomultipliers, recorded during the quality assessment tests and also continually measured after the tests, were used in order to obtain an estimate of the long-term stability. The count rate decrease in 2 years of operation is consistent with the known decay rate of the ^{90}Sr source.

3.4. Read-out and monitoring

To mount, power, and read out the photomultipliers, two types of base-boards were developed, one for M4 and one for M16 PMTs. Each base-board is a light-tight, four-layer (M16) or two-layer (M4) circuit card, $70 \times 70\ \mathrm{mm}^2$ in size, equipped with surface mount components. One side of the board holds four custom-designed sockets and voltage divider chains, appropriate for the particular type of PMT; the other side contains one (M4) or four (M16) connectors for the 16-channel read-out cards, attenuation circuitry, and two daisy-chainable high-voltage connectors. The voltage divider chain is composed of a sequence of 1 MΩ and 560 kΩ resistors that was optimized for single photon counting at high rates. The base-boards are mounted in such a way that the PMTs are positioned at centers of the $36 \times 36\ \mathrm{mm}^2$ grid (see Fig. 10). A photograph of a fully equipped basic module for the M16 photomultiplier tubes is shown in Fig. 11.

Between two and five base-boards, with their PMTs selected for similar optimal operating voltage (ranging from 750 to 890 V), are powered by a single output of a 160-channel CAEN SY527 high-voltage supply [26].

The front end electronics board employed in the system is a 16-channel board [27] based on the ASD8, an amplifier, shaper, and discriminator chip [28]. The board was developed for the Outer Tracker (OTR), the main tracking system of the HERA-B spectrometer. Since the PMT signals are typically considerably higher than the pulses for

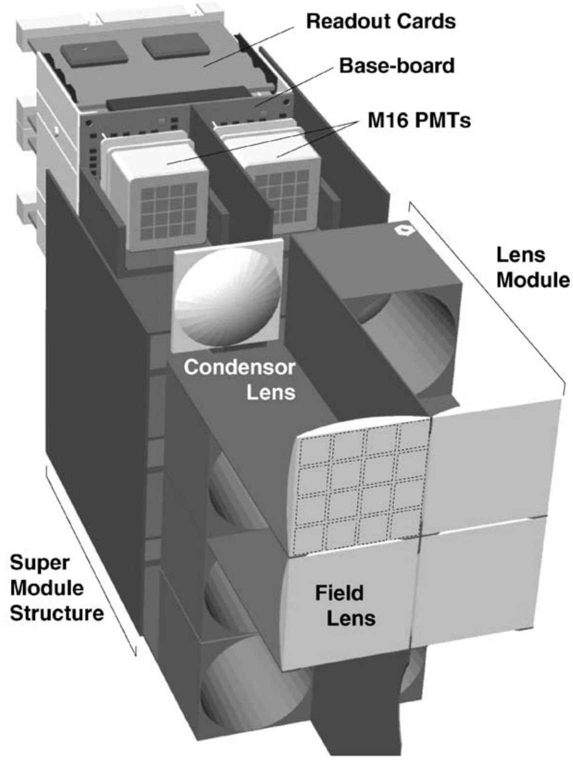

Fig. 10. Scheme of part of a supermodule of the RICH photon detector.

drift chambers, a charge divider was added in front of the ASD8 board (1:10 for M16, and 1:5 for M4 PMTs). The front end electronics boards were arranged according to their optimal threshold voltage by using test data which were obtained by varying pulse height and threshold voltages [29]. The same test was also used to reject faulty boards.

The low-voltage supply system for the ASD8 boards is powered by four KEPCO ATE 6-100M supplies, delivering voltages of $+3$ and -3 V separately to the upper and lower photon detector halves [30]. Analog outputs of 16 photon detector channels are transmitted to the electronics hut for diagnostic purposes.

The signals from the ASD8 cards are transmitted over 7.5 m-long 16-channel twisted pair cables to the Front End Drivers (FEDs). For each FED set there are four daughter cards with 16 cable connections, and one mother card, such that

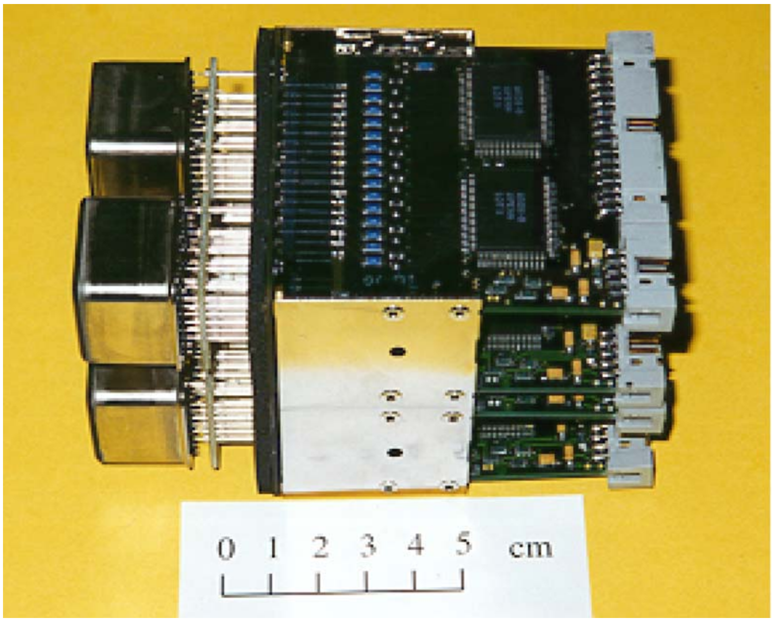

Fig. 11. Fully equipped photomultiplier basic module housing Hamamatsu R5900 PMTs type M16.

each FED set can accomodate up to 1024 channels [31]. The RICH uses 28 such sets. The FED mother board provides the interface to the HERA-B Fast Control System, which provides a clock signal for synchronization as well as triggers to indicate event forwarding. The mother board also provides the interface to the HERA-B DAQ System via the SHARC protocol [32], as well as a ring buffer memory capable of storing 128 events, pending the First Level Trigger decision.

A sizable fraction of the operating parameters of the RICH counter (low voltage and threshold for the front end electronics boards, temperatures at the photon detector and power supplies) are controlled by a Field Point [33] based system. Two separate systems are used for monitoring the high voltage [26] and steering the gas system. The overall control of these systems is implemented with a server–user interface system. The server process is running on a VME computer connected to the Field Point system through an RS232 cable. In the case of a malfunction (if the temperature, threshold, or low voltage are out of range), the server switches off the low-voltage power supplies. The parameters can be monitored and set via a tcl/tk and BLT-based graphical user interface program running on a linux PC and communicating with the server through a TCP-IP-based protocol. The RICH low- and high-voltage slow control systems are integral parts of the overall HERA-B slow control system [34].

As a triggerable light source for testing the photon detector in the periods without beam-induced reactions, a system of light-emitting diodes (LED) was installed at the sides of the photon detector windows [35]. The system provides good illumination over the whole photon detector area.

3.5. Expected performance

The number of detected photons on a ring measured by a Cherenkov detector is often parametrized as $N = N_0 L \sin^2\theta_c$, where $L = 2.82$ m is the length of the radiator, θ_c is Cherenkov angle, and N_0 is the detector response parameter. From the data available on the quantum efficiency (see footnote 7), mirror reflectivities [9], window and optical system transmissions [20], one calculates the merit factor

Table 1
Contributions to the single-photon angular resolution for M4 and M16 PMTs

Error source	M16 PMT	M4 PMT
Photon detector resolution	0.50 mrad	0.93 mrad
C_4F_{10} dispersion	0.33 mrad	
Optical errors	0.25 mrad	
Multiple scattering	$\frac{3.5\text{ mrad}}{p\ (\text{GeV}/c)}$	
Total intrinsic resolution	$0.65\text{ mrad} \oplus \frac{3.5\text{ mrad}}{p(\text{GeV}/c)}$	$1.02\text{ mrad} \oplus \frac{3.5\text{ mrad}}{p(\text{GeV}/c)}$

$N_0 = 41\ \text{cm}^{-1}$. Accordingly, the expected number of photons for particles approaching the velocity of light ($\theta_c = 52.4$ mrad) amounts to 32.

Individual contributions to the expected single-photon resolution are summarized in Table 1. The optical error includes contributions from spherical aberration, mirror quality and alignment of mirrors, while photon detector resolution is dominated by detector granularity with a small contribution of the alignment of photon detector components. The contribution of multiple scattering in the RICH counter [36] depends on momentum and is given by $3.5\ \text{mrad}/p(\text{GeV}/c)$. The resulting single-photon resolution, $0.65\ \text{mrad} \oplus (3.5\ \text{mrad}/p(\text{GeV}/c))$ and $1.02\ \text{mrad} \oplus (3.5\ \text{mrad}/p(\text{GeV}/c))$ for the regions covered by M16 and M4 PMTs, respectively, does not include the contribution from the track direction as given by the tracking system, and will therefore be referred to as intrinsic resolution.

4. Data analysis

Several computer programs were developed for the analysis and monitoring of the data collected by the RICH counter. In the initial phase of the commissioning of the HERA-B spectrometer, when major parts of the main tracking system were not yet available, a stand-alone ring search algorithm was employed [9,37]. The program searches for rings with a given ring radius, starting at the maximum value and scanning down to 70% of the maximal ring radius. Only rings with a sufficiently high signal over background ratio are stored, and the corresponding hits are excluded from further ring search. As described in Section 6, the reconstructed ring center gives information that can be used in tracking. The algorithm is routinely used to monitor the current maximal value of the Cherenkov angle [9] which is, in turn, used as the input for all particle identification algorithms. Small variations of refractive index and thus of the Cherenkov angle are caused by pressure and temperature variations of the radiator gas. We note that several alternative ring search algorithms were also tested on the data [38].

For highly populated events, typical for the reactions recorded in the HERA-B spectrometer, additional information helps to improve the particle identification capabilities. The information from the tracking system, track direction and momentum, is used to determine the expected position of the ring center and the expected ring radius for various particle hypotheses. To evaluate the likelihood for each individual hypothesis, extended maximum likelihood methods [39] are applied, either directly [40] or combined with an expectation-maximization algorithm [41,42]. The latter is described in more detail in Section 5.

Another way to take the track information into account is to perform a seeded ring search in regions given by the track direction and momentum [9]. Since only restricted regions corresponding to five hypotheses are scanned, this approach is quicker than the stand-alone ring search. Recently, a new particle identification method was developed which maximizes the likelihood value by allowing the track direction to vary within errors given by the track fit [43].

5. Measurements and results

5.1. Photon detector performance

In the first step of the commissioning of the system, some basic parameters were investigated. Fig. 12 gives the count rate versus high voltage for a representative photomultiplier. It is shown that the curves measured in situ with the HERA proton beam agree nicely with the ^{90}Sr source measurements. The time-averaged occupancy is shown in

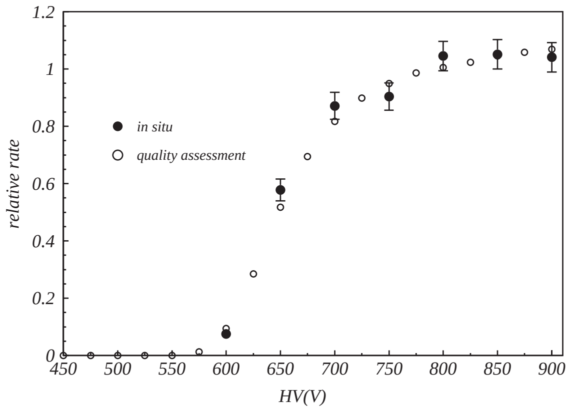

Fig. 12. The plateau curve for a typical M16 tube. The data labeled 'in situ' represent values measured during the photon detector testing in its final position, while the curves labeled 'quality assessment' correspond to measurements made in the laboratory during on-the-bench quality tests. The two sets of data are normalized to the average of the three points at 750, 800 and 850 V.

Fig. 13, where the region occupied by M16 PMTs is clearly distinguished from the region occupied by M4 PMTs. The fraction of dead channels is about 2%, and is partly due to missing PMTs and partly due to PMTs which were damaged during the installation phase. Only about 0.3% of the 26 816 channels were found to be noisy, and were excluded from the analysis. As a result, very clean rings can be observed in low-multiplicity events such as the one shown in Fig. 14. The absence of random hits in the event also confirms the earlier result that the background due to scintillation in the radiator gas is negligible.

5.2. Number of photons

In order to obtain the basic RICH parameters from the data, initially only events with a small number of Cherenkov rings were analyzed [30].

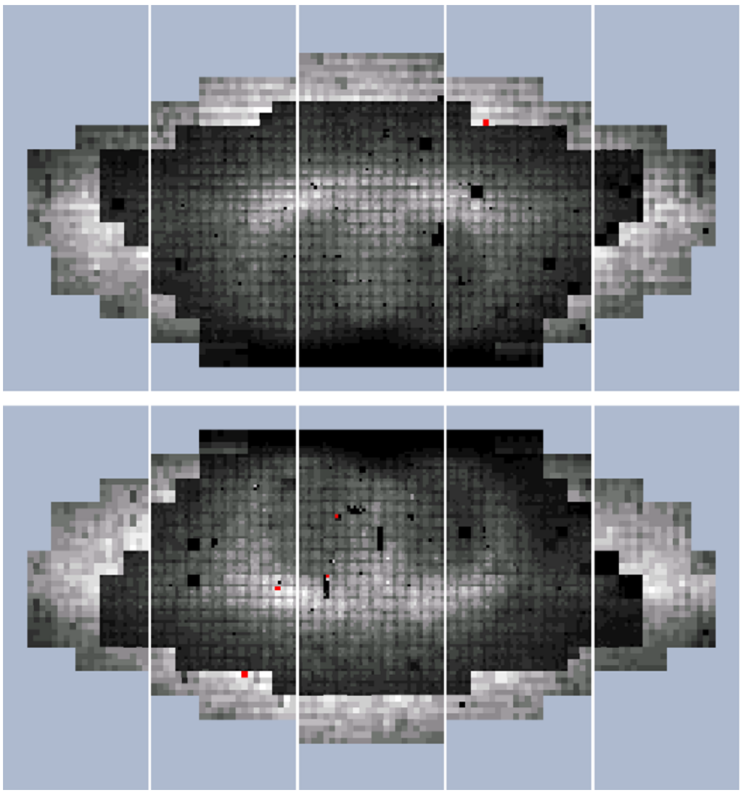

Fig. 13. The occupancy of the upper and lower photon detectors shows the region occupied by M16 (inner region) and M4 PMTs (outer region). The peak values, shown in white, correspond to rates around 1.5 MHz/channel.

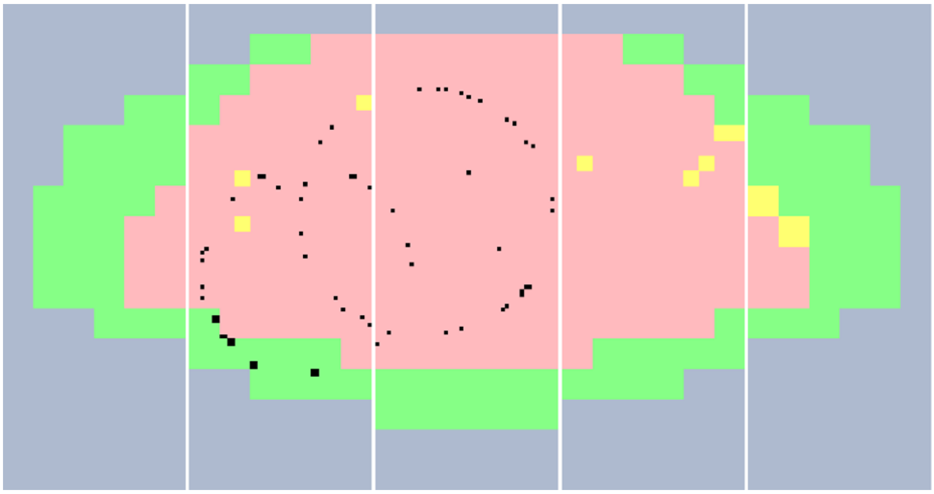

Fig. 14. Event with two Cherenkov rings on the lower photon detector.

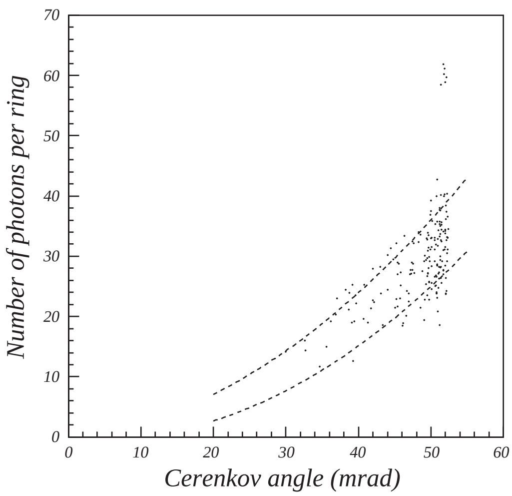

Fig. 15. Number of photons on a ring versus the corresponding Cherenkov angle. The points represent measurements of individual rings, while the dashed lines correspond to one sigma deviations from the predicted dependence. The small group of events at $\theta_c = 52$ mrad, which has about two times the number of photons per ring, probably corresponds to overlapping e^+e^- pairs.

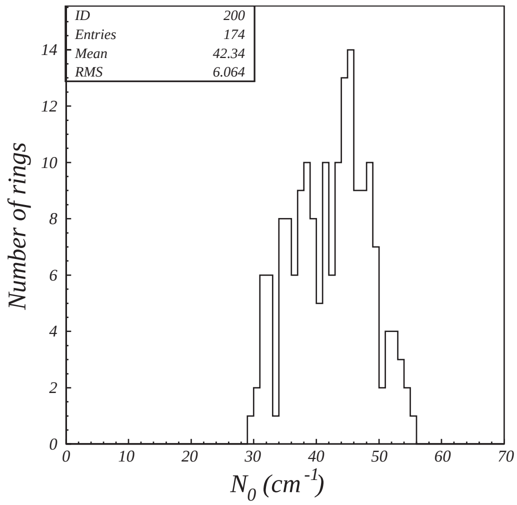

Fig. 16. Distribution of the RICH response parameter N_0 obtained from measured individual Cherenkov rings (see text).

For each ring, the number of photon hits was counted and the Cherenkov angle was determined, obtaining a point in Fig. 15. It is seen that the observed rings follow the expected dependence of the number of photons versus the Cherenkov angle. The largest measured Cherenkov angle of 52.4 mrad also corresponds to the expectation for $\beta = 1$ particles ($\cos\theta_c = 1/n$). The parameter N_0 was calculated for each of the isolated rings and the distribution is plotted in Fig. 16, from which it is seen that the mean value is 42 cm^{-1}. This value corresponds to 33 detected Cherenkov photons for $\beta = 1$ particles.

5.3. Angular resolution

To determine the Cherenkov angle uncertainty given by a single Cherenkov photon, tracks with known identity (e.g., muons from J/ψ decays, identified in the muon chamber system) are selected. For each track within a given momentum interval, one fills a histogram with the photon hits at their reconstructed Cherenkov angle, so that the hits due to Cherenkov rings should show up as a peak, as shown in Fig. 17. The distribution was fitted with a Gaussian function and polynomial background. The resulting momentum dependence of the single-photon resolution is shown in Fig. 18. As expected, the single-photon resolution depends on the particle momentum. For the high-momentum tracks, the resolutions of 0.81 and 1.0 mrad were measured for the regions covered by M16 and M4 PMTs, respectively. The difference between the measured single-photon resolution and the expected intrinsic resolution (as shown in Fig. 18) is attributed to the error in the measurement of charged particle trajectory, which was not taken into account in the calculation of the expected intrinsic Cherenkov angle uncertainty (Table 1).

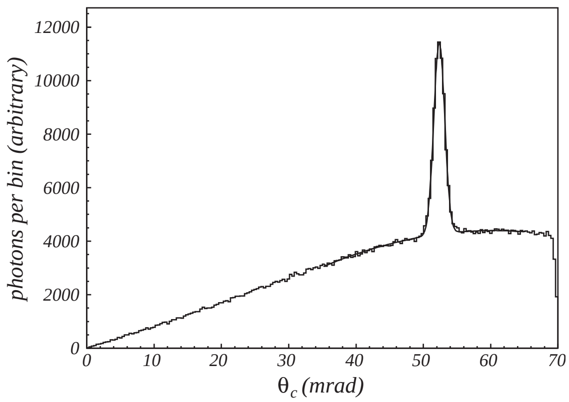

Fig. 17. Single-photon resolution for M16 PMTs: distribution of the measured Cherenkov angle for individual hits in the case of muons (from J/ψ decays) with momenta above 40 GeV/c. The background below the peak comes from wrong track–photon combinations. A fit with a Gaussian function and a second-order polynomial gives $\sigma = 0.81$ mrad.

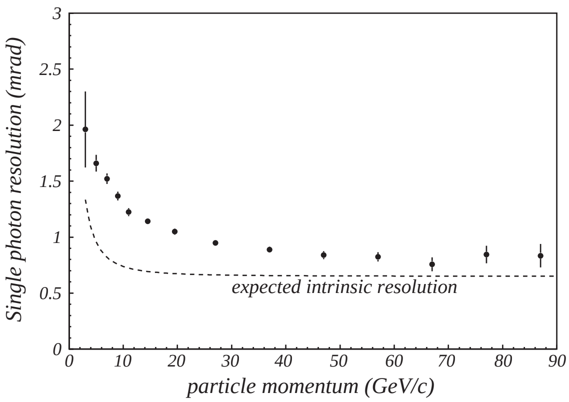

Fig. 18. The measured single-photon Cherenkov angle resolution versus particle momentum for the region covered by M16 PMTs.

The intrinsic resolution of the RICH counter was studied by the stand-alone ring search analysis [44], and turned out to be consistent with the expected values. The intrinsic resolution in Cherenkov angle given by a single Cherenkov photon was also obtained with the aid of hits in the electromagnetic calorimeter [45]. For the selected set of tracks with cluster energy above 50 GeV, the center of the Cherenkov ring is accurately determined from the straight line connecting the center of the cluster with the wire target (the magnetic field was off for this measurement). The single Cherenkov photon resolutions obtained correspond to $\sigma = 0.7$ mrad ($\sigma = 1.0$ mrad) for the M16 (M4) PMTs, in good agreement with expected values given in Table 1.

The particle identification capabilities are affected by the high multiplicity of rings in a single event. Typically, 50 overlapping rings are present in an event of which about $\frac{1}{3}$ could be associated with measured tracks, while the rest belong to tracks coming from secondary interactions. As a result, channel occupancies in some regions are as large as 25%. We note that in such an environment the resolution in the Cherenkov angle measurement of a track does not simply scale with the inverse of the square root of the number of detected photons per ring.

6. Particle identification performance

To illustrate the particle identification capabilities, a maximum likelihood fit was performed on Cherenkov angle distributions for individual tracks. Fig. 19 shows the resulting bands for different particles in the plot of reconstructed

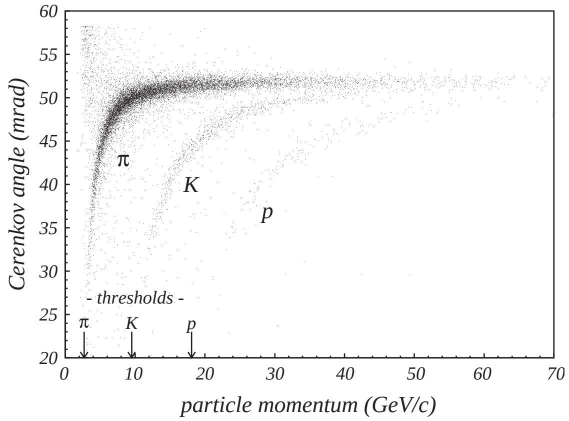

Fig. 19. Reconstructed Cherenkov angle versus particle momentum. Bands for pions, kaons and protons are clearly visible.

Cherenkov angle versus momentum, as obtained by analyzing a sample of measured data.

Two methods are routinely used for particle identification, a ring search-based and a track-based algorithm. The ring search-based particle identification combines the stand-alone and seeded approach discussed in Section 4. In the first step, the stand-alone reconstruction is attempted and rings found are matched with tracks. In the next step, tracks found by the vertex detector and the tracking detectors, that were not matched with a RICH ring, are used as seeds in a seeded ring search.

For the track-based particle identification, the extended likelihood method is used [39], combined with the expectation-maximization algorithm. The method is described in detail in Refs. [41,42]. The first step in the method is the calculation of Cherenkov angle (as described in Ref. [22]) for all track–photon pairs with the Cherenkov angle smaller than 70 mrad. The Cherenkov angles of the pairs are stored in a list, together with a probability (weight, w_i) that the photon from a pair is emitted by the track of that pair. Initially the weights are set to $1/N_{\mathrm{track}}$, where N_{track} is the number of tracks corresponding to a specific photon hit. In the next step the expectation-maximization algorithm is applied to the list of pairs. The result of the algorithm is a set of new values of weights w_i. In this way, the track–photon pair which is more likely to be the right one, gets a larger weight.

In the last step, the extended likelihood probabilities are calculated for six possible hypotheses for the identity of a track: *electron*, *muon*, *pion*, *kaon*, *proton* and *other*. The last one represents the case, where the distribution of Cherenkov angles of photons for a given track is consistent with the background. The resulting likelihood probabilities have the range of values between 0 and 1 and are normalized so their sum equals to 1. We note that the background level is determined on an event-by-event basis for each individual track.

The selection of tracks belonging to a particular particle type is made by applying a cut on the appropriate likelihood. For easier use, three levels of selection are defined: soft, medium and hard. The levels are set to 0.05 (soft), 0.50 (medium) and 0.95 (hard) for pion selection and 0.05 (soft), 0.30 (medium) and 0.95 (hard) for kaon or proton selection.

To determine the efficiencies and misidentification probabilities from the measured data, an a priori knowledge of particle types is required. The following reconstructed decays were used: (1) $K^0_S \rightarrow \pi^+\pi^-$, as a source of pions, (2) $\Lambda \rightarrow p\pi^-$ and $\bar{\Lambda} \rightarrow \bar{p}\pi^+$ as a source of protons, antiprotons and pions, and (3) ϕ (1020)$\rightarrow K^+K^-$, as a source of kaons. For the first two decays, a very clear signal in the invariant mass plot is obtained by cutting on the secondary vertex distance and removing the reflections (Λ, $\bar{\Lambda}$ in K^0_S, and similarly for Λ and $\bar{\Lambda}$). The ϕ decay products come from the primary vertex together with roughly 10 other particles. The invariant mass plot shows a huge combinatorial background. To reduce the background, one of the particles was used to tag the decay by identifying it as a kaon. The other one was used for efficiency and misidentification evaluation. In all cases, the number of particles of a given type surviving the selection criteria, and the number of all particles of the same type in a selected momentum bin were obtained by fitting a Gaussian plus a linear function to the invariant mass plots.

The results are presented in Fig. 20. At medium selection criteria, kaon identification efficiency for momenta between 10 and 60 GeV/c lies in a range

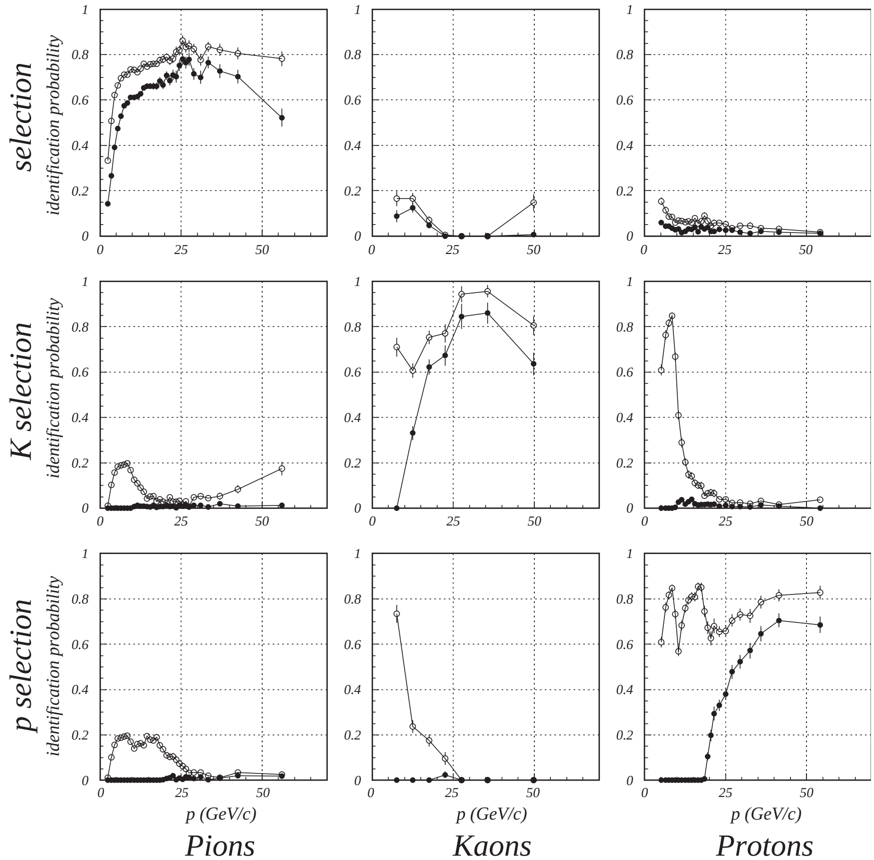

Fig. 20. Momentum-dependent identification probability plots for medium (open circles) and hard (full circles) selections. Plots on the diagonal show the efficiency, plots left or right to the diagonal show the mis-identification probability.

from 60% to 95%, with typically about 5% pion mis-identification probability. The corresponding proton identification efficiency for momenta from 20 to 60 GeV/c lies in a range between 60% and 80% with less than 5% pion mis-identification probability. In the region below kaon and proton Cherenkov threshold, the efficiencies are 70% for kaons (from 5 to 10 GeV/c), and from 60% to 80% for protons (momentum region between 5 and 20 GeV/c) with less than 20% pion mis-identification. Below 5 GeV/c the performance is degraded due to track direction uncertainty caused by multiple Coulomb scattering, and a small number of Cherenkov photons for pion tracks.

Examples of performance and impact on physics analyses are shown in Figs. 21–23. From Figs. 21 and 22, it is seen that the inclusion of the requirement that both tracks are identified improves the signal-to-background ratio in the $\phi \rightarrow K^+K^-$ and $\Lambda \rightarrow \pi^- p$ decays. By using the particle identification as provided by the RICH counter, a measurement of hadron fractions was performed [42]. The results shown in Fig. 23, agree with Monte Carlo predictions.

7. RICH as a tracking device

The RICH can also serve as a tracking device [45]. This turned out to be very useful in the initial phase of the HERA-B experiment when the main tracking system was not available. From the centers of the rings found on the photon detector by the stand-alone ring search algorithm, track

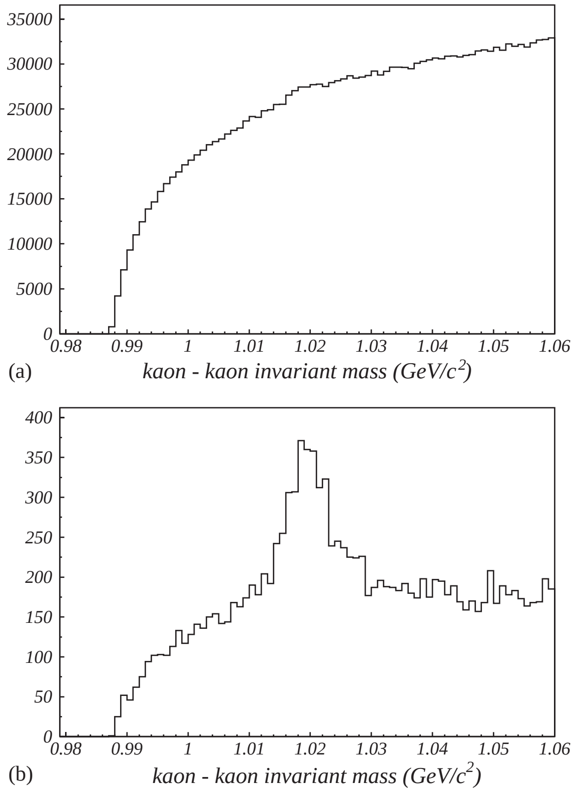

Fig. 21. Improvement of signal to background for invariant mass distribution of $\phi \to K^+K^-$: before (a) and after applying hard selection on both kaons (b).

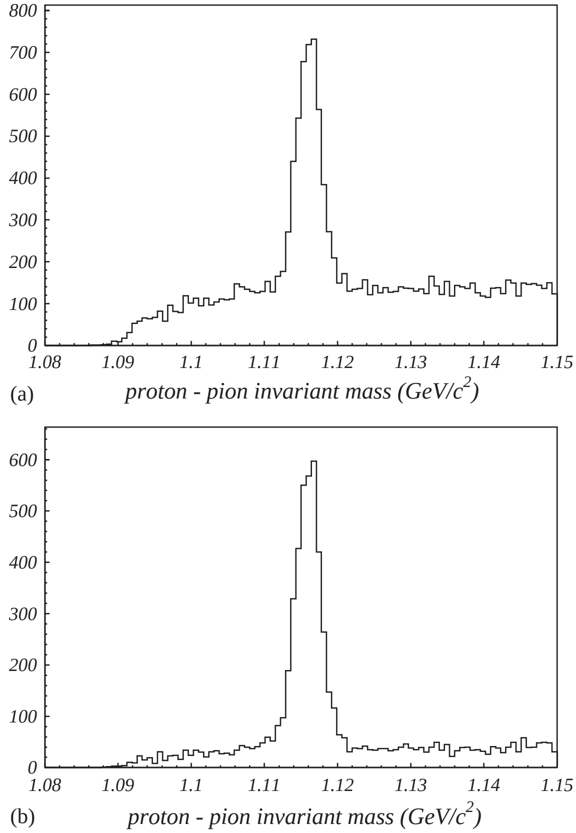

Fig. 22. Improvement of signal to background for invariant mass distribution of $\Lambda \to \pi^- p$ in the kinematic region where the $K^0_S \to \pi^+\pi^-$ hypothesis cannot be excluded: (a) no particle identification, (b) for the positively charged particle, the proton likelihood was required to exceed the pion likelihood.

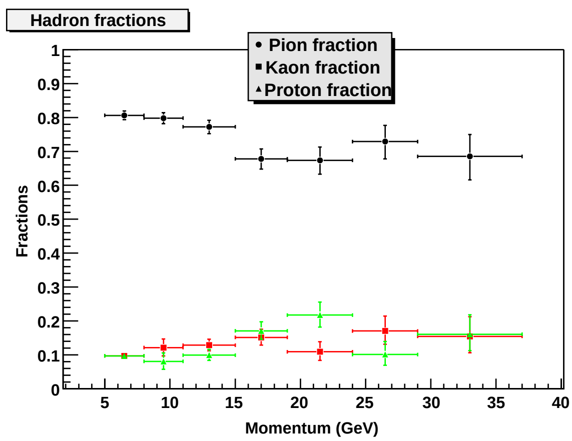

Fig. 23. Measured hadron fraction as a function of particle momentum.

directions were deduced. In the non-bending plane, they were matched with track candidates from the silicon vertex detector. From the deflection in the bending plane the momentum of the particle could then be determined. With both the Cherenkov angle and momentum deduced from the data, an excellent particle identification was possible even without the main tracking system, as illustrated in Fig. 24.

8. Summary

The HERA-B ring imaging Cherenkov detector behaves as expected in all respects. The detector parameters, 33 detected photons for $\beta = 1$ particle, $N_0 = 42$ photons/cm and single-photon resolutions of $\sigma = 0.7$ mrad (1.0 mrad) for regions with finer (coarser) granularity, are in very good

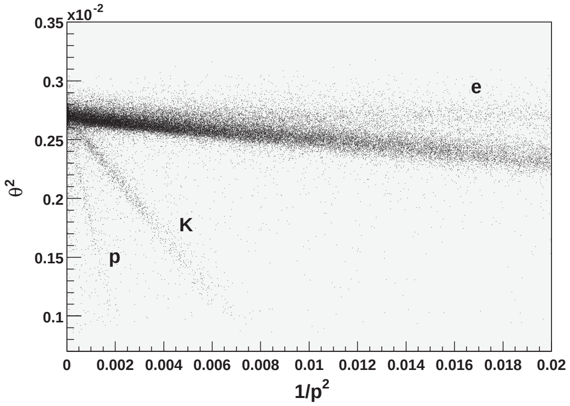

Fig. 24. θ_c^2 versus $1/p^2$ plot in which particles of a given mass should lie on a straight line. Both the Cherenkov angle and the momentum were deduced from each individual ring found on the photon detector.

agreement with design values. Estimates of the basic parameters obtained from measurements of physical properties of RICH components agree well with the direct measurements. Therefore, we conclude that the functioning of the counter is well understood. Results on particle identification of highly populated events are also satisfactory and meet the requirements. Finally, it is worth adding that during the 4 years the detector has been in operation, not the least degradation of performance has been observed.

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Limits for the Central Production of Θ^+ and Ξ^{--} Pentaquarks in 920-GeV pA Collisions

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We have searched for $\Theta^+(1540)$ and $\Xi^{--}(1862)$ pentaquark candidates in proton-induced reactions on C, Ti, and W targets at midrapidity and $\sqrt{s} = 41.6$ GeV. In 2×10^8 inelastic events we find no evidence for narrow ($\sigma \approx 5$ MeV) signals in the $\Theta^+ \to pK_S^0$ and $\Xi^{--} \to \Xi^-\pi^-$ channels; our 95% C.L. upper limits (UL) for the inclusive production cross section times branching fraction $\mathcal{B}\, d\sigma/dy|_{y\approx 0}$ are (4–16)$\mu b/N$ for a Θ^+ mass between 1521 and 1555 MeV, and $2.5\mu b/N$ for the Ξ^{--}. The UL of the yield ratio of $\Theta^+/\Lambda(1520) < (3\text{–}12)\%$ is significantly lower than model predictions. Our UL of $\mathcal{B}\,\Xi^{--}/\Xi(1530)^0 < 4\%$ is at variance with the results that have provided the first evidence for the Ξ^{--}.

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Recent experimental evidence suggests not only that pentaquarks (PQs), i.e., baryons with at least five constituent quarks, exist but that their production in high energy collisions is common. After the possible discovery of the Θ^+ PQ ($uudd\bar{s}$) at 1540 MeV in the $\gamma n \to K^- K^+ n$ process on carbon [1], more than 10 experiments using incident beams of photons, electrons, kaons, protons or (anti)-neutrinos have observed resonances within ± 20 MeV of this mass in either the nK^+ [2] or the pK_S^0 [3–5] decay channels; the measured widths have all been consistent with the experimental resolutions ranging from 20 to 2 MeV [5]. The Θ^+ interpretation is based on a prediction [6] of the chiral soliton model (CSM) according to which the Θ^+ is expected to have a mass of 1530 MeV, a width of less than 15 MeV, and to decay into the KN channel. In both the CSM and the correlated quark model [7], the Θ^+ is a member of an antidecuplet with two further exotic isospin 3/2 states of $S = -2$, the Ξ^{--} ($ddss\bar{u}$) and the $\Xi^+_{3/2}$ ($uuss\bar{d}$). In pp collisions at $\sqrt{s} \approx$ 18 GeV, narrow candidate resonances for both the Ξ^{--} and its neutral isospin partner have been found in the $\Xi^-\pi^-$ and $\Xi^-\pi^+$ final states at the mass of 1862 MeV [8]. Theoretically, PQs are not restricted to the strange sector, and experimental evidence for an anticharmed PQ, Θ_c^0 ($uudd\bar{c}$), with a mass of 3.1 GeV has recently been reported [9]. In this context also earlier already "forgotten" $c\bar{c}$ PQ candidates [10] have been recalled [11].

On the other hand, criticism addressed to some of the reported PQ signals includes the problem of kinematic reflections [12], of spurious states [13], and of low statistics [14]. Other puzzles include the surprisingly narrow width of the Θ^+ [15], the large and systematic [16] spread of measured Θ^+ masses, and the nonobservation of the Θ_c^0 in an equivalent experiment [17]. Hence, for establishing the existence and character of the new resonances, high statistics mass spectra are needed as well as measurements of spin, parity, width and cross sections. In addition, considering the results of high statistics studies which have found neither the Θ^+ signal in $\psi(2S)$ and J/ψ hadronic decays [18] nor the Ξ^{--} signal in Σ^--induced reactions on nuclear targets [19], the need for a thorough understanding of the PQ production mechanism has been emphasized [20]. Benchmarks for PQ production exist based on statistical hadronization models; they typically predict particle ratios such as $\Theta^+/\Lambda(1520)$ in heavy ion [21–23] and pp [23–25] collisions. Taking advantage of a large data sample with good mass resolution (see Table I) HERA-B can contribute significantly to many of these topics. The simultaneous study of $\Theta^+ \to pK_S^0 \to p\pi^-\pi^+$ and $\Xi^{--} \to \Xi^-\pi^- \to \Lambda\pi^-\pi^-$ decays in proton-nucleus collisions at $\sqrt{s} = 41.6$ GeV allows a test of these theoretical predictions and a comparison with earlier experimental results including the possible first confirmation of the Ξ^{--} signal.

HERA-B is a fixed target experiment at the 920 GeV proton storage ring of DESY. It is a forward magnetic spectrometer with a large acceptance centered at midrapidity ($y_{\rm cm} \approx 0$), featuring a high-resolution vertexing and tracking system and excellent particle identification [26]. The present study is based on a sample of 2×10^8 minimum bias events which were recorded at $\sqrt{s} =$ 41.6 GeV using carbon (C), titanium (Ti), and tungsten (W) wire targets during the 2002/03 run period.

With standard techniques described in [26], signals from $K_S^0 \to \pi^+\pi^-$, $\Lambda \to p\pi^-$, and $\bar{\Lambda} \to \bar{p}\pi^+$ decays are identified above a small background without particle

TABLE I. Statistics and experimental resolutions σ of the relevant signals (charge-conjugate modes indicated by c.c.).

Signal	C target	All targets	σ/(MeV)
K_S^0	2.2M	4.9M	4.9
Λ [c.c.]	440k [210k]	1.1M [520k]	1.6
$\Lambda(1520)$ [c.c.]	1.3k [760]	3.5k [2.1k]	2.3
Ξ^- [c.c.]	4.7k [3.4k]	12k [8.2k]	2.6
$\Xi(1530)^0$ [c.c.]	610 [380]	1.4k [940]	2.9

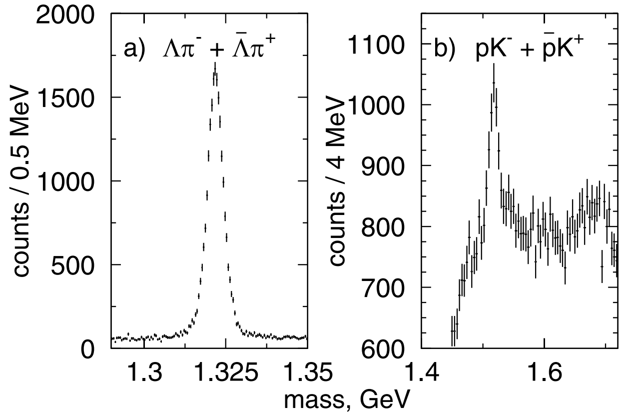

FIG. 1. Signals of (a) $\Xi^- \rightarrow \Lambda\pi^-$ and $\bar{\Xi}^+ \rightarrow \bar{\Lambda}\pi^+$ (all targets), and (b) $\Lambda(1520) \rightarrow pK^-$ and $\bar{\Lambda}(1520) \rightarrow \bar{p}K^+$ (C target).

identification (PID) requirements. Similar clean signals from $\Xi^- \rightarrow \Lambda\pi^-$ and c.c. decays [Fig. 1(a)] are obtained by requesting the $\Lambda\pi^-$ vertex to be at least 2.5 cm downstream of the target and the event to exhibit a cascade topology: a further downstream Λ vertex and the Ξ^- pointing back to the target wire (impact parameter $b <$ 1 mm). Table I summarizes the statistics of these signals, together with their measured mass resolutions σ. These resolutions are about 20% larger than those of the Monte Carlo (MC) simulation, while all mass values agree within <1 MeV with the nominal masses. For all particle selections, invariant masses are required to be within $\pm 3\sigma$ of the respective nominal mass.

For the search for $\Theta^+ \rightarrow pK^0_S$ decays, events with at least one reconstructed primary vertex were selected. The proton PID was provided by the ring-imaging Cherenkov counter (RICH) with a misidentification probability of less than 1% in the selected momentum range from 22 to 55 GeV/c [27]. The Λ and $\bar{\Lambda}$ contaminations [13] were removed [26] in the K^0_S sample. The invariant mass spectrum of the pK^0_S pairs is shown in Fig. 2(a) for the $p + C$ data. The solid line represents the background determined from event-mixing after normalization to the data. The spectrum exhibits a smooth shape in the mass region from 1.45 to 1.7 GeV. Using the prescription of Ref. [28], we have calculated from these data upper limits (UL) at 95% confidence level, UL(95%), for the inclusive production cross section of a narrow resonance at midrapidity, $\mathcal{B} \cdot d\sigma/dy|_{y\approx 0}$, [Fig. 2(b)]; the $y_{\rm cm}$ interval is ± 0.3. The data have been fitted with a Gaussian plus a background of fixed shape. The mean of the Gaussian was varied in steps of 1 MeV but fixed in the fit; its width was fixed to the MC prediction multiplied by 1.2 and increased from 2.6 to 6.1 MeV over the considered range. At the Θ^+ mass, the width was 3.9 MeV. The reconstruction efficiencies have been determined by MC simulations assuming a flat rapidity distribution and a p_t^2 distribution proportional to

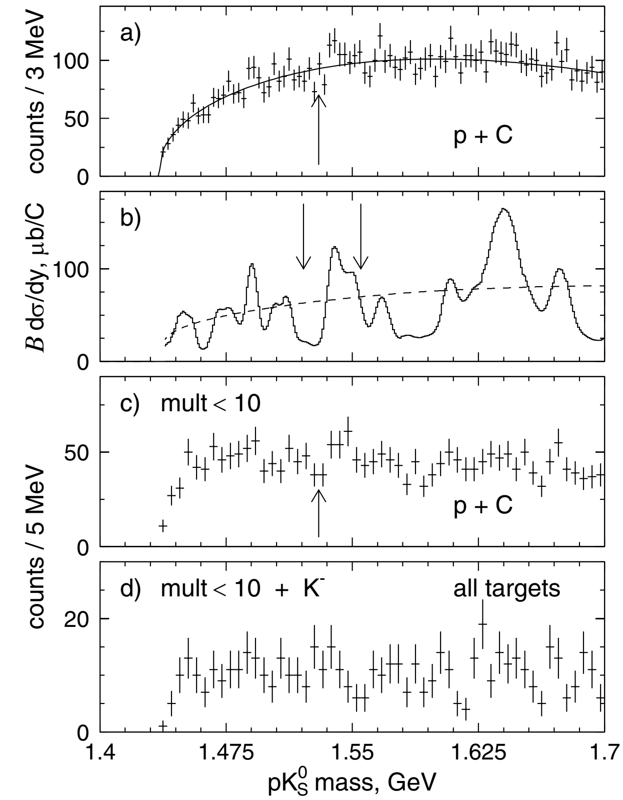

FIG. 2. The pK^0_S invariant mass distributions: (a) data from the $p + C$ collisions and the background estimate (continuous line); (b) deduced UL(95%) for the $p + C$ inclusive cross section at midrapidity; the dashed line shows our 95% C.L. sensitivity; (c),(d) same as (a) but requiring (c) a track multiplicity of <10, and (d) in addition a K^- particle in the event. The arrows mark the masses of 1521, 1530, and 1555 MeV.

$\exp(-B p_t^2)$ with $B = 2.1({\rm GeV}/c)^{-2}$ [26]. Assuming an atomic mass dependence of $A^{0.7}$ for the production cross section, the UL(95%) of $\mathcal{B}\, d\sigma/dy$ varies from 3(4) to 22(16) μb/nucleon (N) for a Θ^+ mass between 1521 and 1555 MeV from the C (all target) data. A systematic error of 14% was taken into account. For the Θ^+ mass of 1530 MeV (about the average of the mass values observed in the pK^0_S final state [16]), our limit is $\mathcal{B}\, d\sigma/dy < 3.7(4.8)\ \mu b/N$.

Further search strategies were tried including (i) a cut on the track multiplicity of the event [Fig. 2(c)] which would otherwise peak at ≈ 13, (ii) the request of a tagging particle such as a Λ, Σ, or K^- in the event, or (iii) both conditions [Fig. 2(d)]. None yielded a statistically significant structure in the Θ^+ mass region. Also, the effect of lowering the cut on the RICH proton likelihood and the corresponding increase of the proton momentum acceptance has been systematically studied without yielding a Θ^+ signal. On the other hand, as shown in Fig. 1(b), when the same proton PID requirement used to produce Fig. 2 is applied to pK^- candidates, a strong $\Lambda(1520)$ signal results, further demonstrating the capabilities of the RICH which selects kaon momenta from 12 to 55 GeV$/c$. With the same cut on the K_S^0 momenta, and assuming a branching ratio of $\mathcal{B}(\Theta^+ \rightarrow pK_S^0) = 0.25$, the UL(95%) of the particle ratio $\Theta^+(1530)/\Lambda(1520)$ at $y_{cm} \approx 0$ is 2.7%.

Both doubly charged and neutral $\Xi_{3/2}$ PQ candidates as well as their antiparticles have been searched for in the $\Xi\pi$ channels. The pion candidates were required to originate from the primary vertex. The background was further reduced by weak cuts on the PIDs from the electromagnetic calorimeter and RICH which eliminated all the tracks with a positive electron, proton, or kaon PID. The histograms of Fig. 3(a) show the resulting $\Xi\pi$ invariant mass spectra obtained from the C target data. The smooth lines are the background estimates from event-mixing normalized to the data. In the neutral channels the $\Xi(1530)^0$ resonance shows up as a prominent signal of $\approx 10^3$ events (see Table I). The observed width ($\approx$9.5 MeV) of the $\Xi(1530)^0$ agrees with MC simulations which imply an experimental resolution of 2.9 MeV. None of these mass spectra shows evidence for the narrow, less than 18 MeV (FWHM) wide PQ candidates at 1862 MeV reported by the NA49 Collaboration [8] nor for any other narrow state at masses between 1.6 and 2.3 GeV. Figure 3(b) shows the sum of the four spectra of Fig. 3(a) after background subtraction and can be compared directly to Fig. 3 of Ref. [8]. The corresponding ULs(95%) of the production cross sections $\mathcal{B}\, d\sigma/dy|_{y\approx 0}$ per carbon nucleus at midrapidity [Fig. 3(c)] have been obtained in the same way as described above for the pK_S^0 channel; here the y_{cm} interval is ± 0.7, the experimental resolution increases from 2.9 to 10.6 MeV in the considered mass range, and is 6.6 MeV at 1862 MeV. At this $\Xi^-\pi^-$ mass, the UL(95%) of $\mathcal{B}d\sigma/dy$ is 2.5 $\mu b/N$; the corresponding limits in the $\Xi^-\pi^+$, $\bar{\Xi}^+\pi^+$, and $\bar{\Xi}^+\pi^-$ channels are 2.3, 0.85, and 3.1 $\mu b/N$. With an $A^{0.7}$ dependence, the ULs from all targets are 2.7, 3.2, 0.94, and 3.1 $\mu b/N$, respectively.

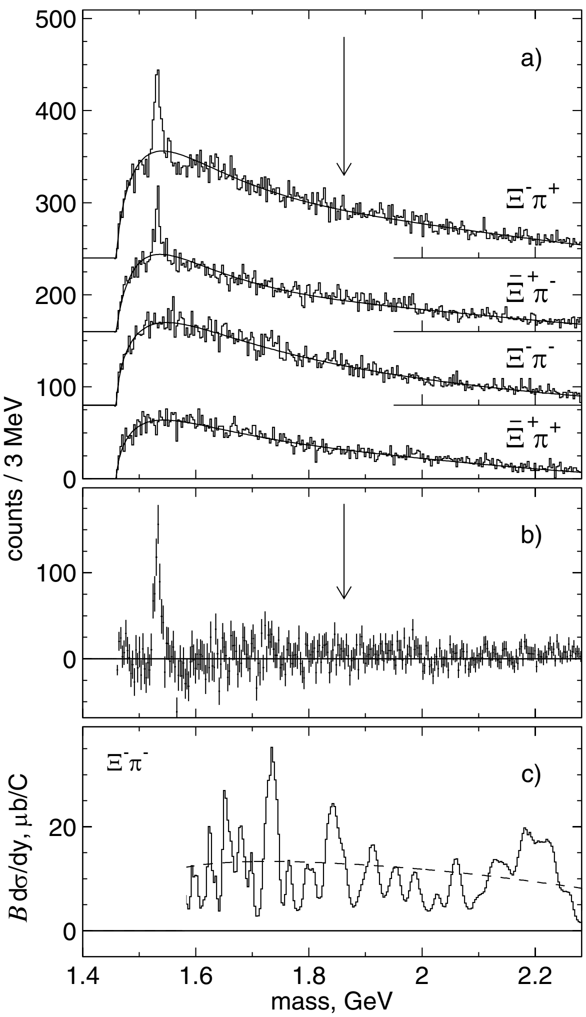

FIG. 3. The $\Xi\pi$ invariant mass distributions: (a) data from the $p + C$ collisions in indicated neutral and doubly charged channels and the background estimates (continuous lines); (b) sum of all four $\Xi\pi$ spectra with the background subtracted, and (c) deduced UL(95%) for the $p + C$ inclusive cross section at midrapidity. The dashed line shows our 95% C.L. sensitivity. The arrows mark the mass of 1862 MeV.

Table II lists our ULs(95%) of various relative yields for the Θ^+ and Ξ^{--}. Reference states for the Θ^+ are the Λ and the $\Lambda(1520)$, and for the Ξ^{--}, the Ξ^- and the $\Xi(1530)^0$. The Θ^+ and Ξ^{--} widths are assumed to be equal to our experimental mass resolution and their momentum distributions are assumed to be the same as those of the reference states. Table II lists also predictions of various statistical hadronization models for the respective ratios. We note that these ratios show no significant variation between $17 < \sqrt{s} < 40$ GeV, nor is there a significant difference between predictions for pp and AA collisions. We find our UL for $\Theta^+(1530)/\Lambda(1520) < 2.7\%$ to be more than 1 order of magnitude lower than the model predictions. Also, the UL of $\Theta^+(1530)/\Lambda < 0.92\%$ is lower than all predictions including the model which uses the Gribov-Regge approach for describing the Θ^+ production and its $\sqrt{s}$ dependence in pp collisions [25]. Our UL of the Ξ^{--}/Ξ^- yield ratio is compatible with the model predictions. No theoretical value is yet available for the $\Xi^{--}/\Xi(1530)^0$ ratio, but our UL of $<4\%/\mathcal{B}$ should be compared with the value from the NA49 experiment which, however, is not explicitly quoted in the original paper [8] which reports only the number of 38 Ξ^{--} events. According to Ref. [14], the number of $\Xi(1530)^0$ events is about 150 leading to a yield ratio [29] in contradiction to our UL unless the relative efficiencies for $\Xi(1530)^0$ and Ξ^{--} of NA49 (unpublished) differ markedly from those of HERA-B.

In conclusion, having found no evidence for narrow Θ^+ and Ξ^{--} signals, we have set UL(95%) for the central production cross sections of resonances in the pK_S^0 and $\Xi^-\pi^-$ final states with widths less than our

TABLE II. Our 95% C.L. upper limits on the relative yields of $\Theta^+(1530)$ and $\Xi^{--}(1862)$ PQs at $y_{cm} \approx 0$ and predictions for pp and AA collisions. For a Θ^+ mass of 1540 MeV, the quoted values have to be multiplied by ≈ 4 (all target data).

Reaction	$\sqrt{s_{NN}}$ [GeV]	Θ^+/Λ [%]	$\Theta^+/\Lambda(1520)$ [%]	Ξ^{--}/Ξ^- [%]	$\Xi^{--}/\Xi(1530)^0$ [%]	Ref.
pA, $y \approx 0$	42	<0.92	<2.7	$<3/\mathcal{B}$	$<4/\mathcal{B}$	This work
pp, $y = 0$	18	2.3				[25]
pp	20/40	6.3/5.0		2.5/3.6		[24]
pp	17	4.7	57			[23]
AA	20	3–10	50–200	0.4–1		[22]
	40	3–7	44–140	0.4–1		[22]

experimental resolution of $\approx$5 MeV. For the $\Theta^+(1530)$ and the $\Xi^{--}(1862)$ the respective ULs of $\mathcal{B}d\sigma/dy|_{y\approx 0}$ are 3.7 and 2.5 $\mu b/N$. For the Θ^+ candidate observed in pA collisions at $\sqrt{s} = 11.5$ GeV, the total cross section for $x_F \geq 0$ was estimated to be 30 to 120 $\mu b/N$ [4]. A decrease of the central Θ^+ production with increasing $\sqrt{s}$ could be understood if the Θ^+ is produced by disintegration of forward/backward peaked remnants [25]. On the other hand, our UL(95%) for $\Theta^+/\Lambda(1520) <$ 2.7% is significantly lower than statistical hadronization predictions which yield a ratio of ≥ 0.5 in agreement with experiments in which the Θ^+ candidate and $\Lambda(1520)$ showed similar yields [30]. Our UL(95%) of $\mathcal{B}\Xi^{--}/\Xi^- < 3\%$ is not low enough to contradict the theoretical predictions. It is, however, inconsistent with the previously published [8] observation of the $\Xi^{--}(1862)$ at midrapidity which is based on a data sample of lower statistics (1.6k vs 12k Ξ^-) and comparable mass resolution (7.6 vs 6.6 MeV).

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Studies of proximity focusing RICH with an aerogel radiator using flat-panel multi-anode PMTs (Hamamatsu H8500)

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Abstract

A proximity focusing ring imaging Cherenkov detector using aerogel as the radiator has been studied for upgrading the Belle detector at the KEK-B-factory. We constructed a prototype Cherenkov counter using a 4×4 array of 64-channel flat-panel multi-anode PMTs (Hamamatsu H8500) with a large effective area. The aerogel samples were made with a new technique to obtain a higher transmission length at a high refractive index ($n = 1.05$). Multi-channel PMTs are read-out with analog memory chips. The detector was tested at the KEK-PS $\pi 2$ beam line in November, 2002. To evaluate systematically the performance of the detector, tests were carried out with various aerogel samples using pion beams with momenta between 0.5 and 4 GeV/c. The typical angular resolution was around 14 mrad, and the average number of detected photoelectrons was around 6. We expect that pions and kaons can be separated at a 4σ level at 4 GeV/c.
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Keywords: Aerogel; Flat-panel PMT; Ring imaging Cherenkov counter; Proximity focusing; Particle identification; Belle

1. Introduction

Silica aerogel is a unique material with a refractive index (n) in the range between gases and liquids or solids. Its refractive index can be easily controlled from $n = 1.01$ to 1.06. As a result, the refractive index of the aerogel can be chosen such that for a given momentum interval in the few GeV/c region charged pions radiate Cherenkov photons, while kaons stay below the Cherenkov radiation threshold [1]. In the Belle experiment at KEK [2], a threshold type Cherenkov detector

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(Belle-ACC) [3] which uses aerogel as a radiator, is operated, providing at 3.5 GeV/c a kaon identification efficiency of 88% with a pion misidentification probability of 8% [4].

A new production method of hydrophobic aerogel with a high-transmission length and n in the interval between 1.01 and 1.03 was developed during the construction period of Belle-ACC [5]. The improvement in quality allows the use of an aerogel radiator in a ring imaging Cherenkov counter (RICH) [6]. In the HERMES experiment at DESY, a RICH counter is used with a dual-radiator (aerogel and gas), and mirrors to focus the Cherenkov photons [7]. A similar detector is also designed for the LHCb experiment at CERN [8].

We are studying the feasibility of a RICH counter with an aerogel radiator for the Belle-ACC in the forward end-cap region [9]. Since this part is now optimized for the pion/kaon separation needed for tagging of the B flavor, and covering the momentum range below 2 GeV/c, separation at high-momentum region of around 4 GeV/c is not adequate. This kinematic region is, however, very important for the studies of two-body decays such as $\mathrm{B}\to\pi\pi, \mathrm{K}\pi$. In order to achieve a π/K separation for a wider momentum range, a ring imaging-type of detector is needed. Due to spatial restrictions, such a counter has to be of the proximity focusing type. To cover the identification in the lower momentum region (around 0.7 GeV/c) as well as in the region up to 4 GeV/c, the aerogel has to have a refractive index around $n = 1.05$. The first beam test of such a detector was carried out in 2001 at the KEK-PS $\pi 2$ beam line [10]. These tests used an array of multi-anode PMTs (Hamamatsu R5900-M16) for photo-detection. The detected number of photoelectrons was 2.7 per ring for a 2 cm thick aerogel tile with $n = 1.05$, and the Cherenkov angle resolution per photon was 10 mrad. These results were consistent with expectations. The number of detected photons was, however, rather low, partly because only 36% of the detector surface was covered by the photo-cathodes, and partly because the transmission length of the aerogel with $n = 1.05$ could not be made large enough. For the second beam test, we improved the aerogel transmission by optimizing the materials used in the production process. The active area fraction of the photon detector was increased by employing recently developed flat-panel PMTs, Hamamatsu H8500. Although this type of PMT is not immune to magnetic field, and therefore cannot be applied in the Belle spectrometer, we consider this device as an intermediate step in our development. The paper is organized as follows. We first present the experimental set-up with flat-panel PMTs, briefly review the improvement in aerogel production, describe the measurements, and finally discuss the results.

2. The experiment set-up

2.1. Flat-panel PMT

The photon detector for the tested prototype RICH counter employed 64 channel multi-anode PMTs (Hamamatsu H8500, so called flat-panel PMT) because of their large effective area. Sixteen PMTs were used in a 4×4 array and aligned with a 52.5 mm pitch, as shown in Fig. 1. The surface of each PMT is divided into 64 (8×8) channels with a $6.0 \times 6.0\ \mathrm{mm}^2$ pixel size. Therefore, the effective area of photon detection is increased to 84%. At the back of each PMT, an analog memory board is attached to read out multi-channel PMT signals, as described below. Among 16 PMTs, 8 PMTs were delivered in January, 2002, and the remaining PMTs were delivered in October, 2002. Since the manufacture method of the PMT was still under development, they exhibit a large variation in quantum efficiency and gain. The quantum efficiency at 400 nm varies between 16% and 25%; the gain varies from 1×10^6 to 6×10^6 when the maximal allowed high voltage of -1100 V is applied to the photo-cathode.[1] The PMTs from the later batch show a slightly better performance.

2.2. Aerogel radiator

The hydrophobic form of the aerogel radiator from Novosibirsk [11] is known to have a long transmission length. However, we prefer

[1] Hamamatsu Photonics K.K.

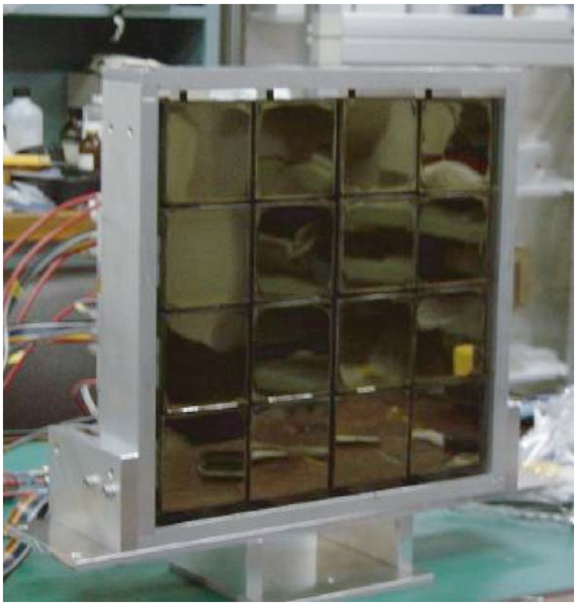

Fig. 1. Photon detector, an array of 16 H8500 PMTs, mounted at a 52.5 mm pitch.

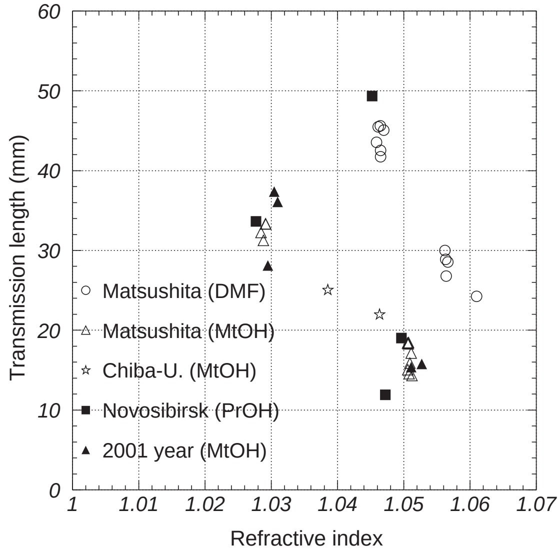

Fig. 2. Transmission length at 400 nm and refractive index at 405 nm for the aerogel samples used in the test.

hydrophobic aerogel to the hydrophilic one for the application to a collider experiment. With a low refractive index ($n = 1.01 - 1.03$), such an aerogel was developed for the Belle-ACC, and is characterized by a high-transmission length ($\sim$40 mm at a wavelength of 400 nm) which was not achieved before. However, the transmission length of aerogel with a higher refractive index of $n = 1.05$ fell below one-half the value compared to the aerogel with $n = 1.03$. Therefore, we reexamined the aerogel production technique in a joint development with Matsushita Electric Works Ltd. As a result, we found that the important factors determining the transmission length are the solvent and selection of the precursor to be used for its production. Originally, we used methyl-alcohol for the solvent, and methyl-silicate as a precursor [5]. When we applied di-methyl-formamide (DMF),[2] and changed the supplier of the precursor, we could improve the transmission length of the aerogel.

[2] Matsushita Electric Works Ltd. has a Japanese patent (No. 2659155) for usage of DMF as solvent to make aerogel.

Fig. 2 shows the refractive indices of aerogel and the relation to transmission length for samples which were used in this beam test. The refractive index was determined by measuring the deflection angle of laser light (laser diode: 405 nm) at a corner of each aerogel tile; the transmission length was measured with a photo-spectrometer (Hitachi U-3210). In addition to the samples produced with the new technique at Matsushita Electric Works Ltd. and Chiba University, samples from BINP (Novosibirsk) were tested [11]; for comparison, we also tested the samples used in the previous beam test. The thicknesses of the prepared aerogel samples ranged from 10 to 25 mm. Various thicknesses of up to about 50 mm were tested by stacking these samples. Note that in the production of the aerogel samples at BINP propenol was used as the solvent, and the resulting aerogel was hydrophilic. Also note that the Matsushita aerogel samples produced with the new technique have a very similar transmission length as the BINP samples. The transmission length for $n \sim 1.05$ samples used in the first beam test was around 15 mm, but was increased to 45 mm for the Matsushita sample with the new production method.

2.3. Beam set-up

For the beam test, pions with momenta between 0.5 and 4 GeV/c were used. Besides the RICH detector under study, counters for triggering, tracking and particle identification were employed.

The set-up of the aerogel RICH is shown in Fig. 3. Two RICH counters were placed in a light-shield box and tested simultaneously. Each RICH was composed of a layer of aerogel radiator and a photo-detection plane, parallel to the radiator face at a distance of 20 cm. The upstream Cherenkov counter was the detector under study; the downstream counter was the one employed in the previous beam test. Since the latter uses a well-known photo-detector, the multi-anode PMTs Hamamatsu R5900, we regarded it as a reference.

Particle identification was done to remove particles other than pions. Two CO_2 gas Cherenkov counters in the beam line were used to exclude electrons. Also, an aerogel counter was equipped and used to exclude protons for the high-momentum region. This detector was also used to exclude muons for the low-momentum region around 0.5 GeV/c.

The particle trajectories were measured with multi-wire proportional chambers (MWPC) at the upstream and downstream ends of the light-shield box. These $5 \times 5\ \mathrm{cm}^2$ MWPCs, with 20 μm diameter, gold-plated tungsten anode wires at 2 mm pitch and with 90% Ar + 10% CH_4 gas flow, were read out by delay lines on the x and y cathode strips.

The trigger signal was generated as a coincidence of signals from several $5 \times 5\ \mathrm{cm}^2$ plastic scintillation counters and anode signals from the MWPCs to ensure valid tracking information.

2.4. Readout electronics

For the beam test, a new read-out system was designed by using analog memory chips. The analog memory chip is based on a chip developed by Ikeda [12] for a cosmic-ray experiment. We borrowed the chips from National Space Development Agency of Japan (NASDA), and developed the chip control system. In the analog memory chip, the signals of 32 channels are preamplified, sampled in 1 μs intervals, and stored in an 8 steps deep analog pipeline. Fig. 4 shows a schematic view of the readout system with these analog memories. Two 32 channel analog memories are attached to each 64 channel PMT. The memories corresponding to four PMTs are controlled by a 256 channel memory controller. When the gate pulse is formed from the trigger signal, a control signal is sent from the controller to the analog memories. The difference in the value of the analog memory between the latest and the first memory content is fed to the output. The obtained output values of 256 channels are clocked into one signal train with a period of 10 μs per channel.

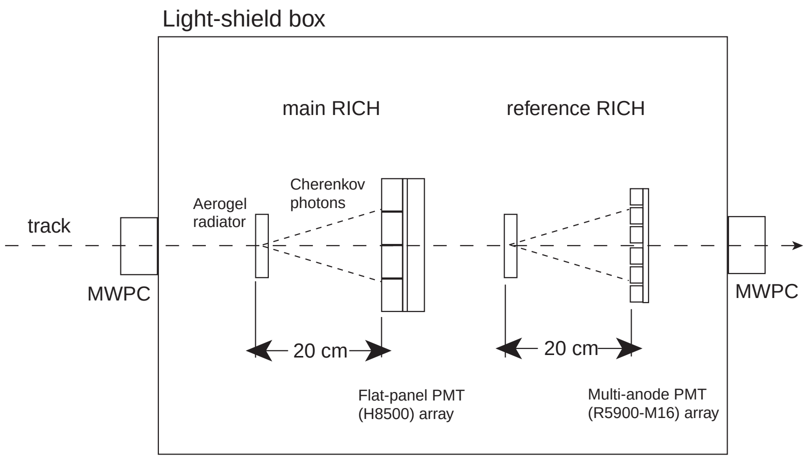

Fig. 3. Experimental set-up.

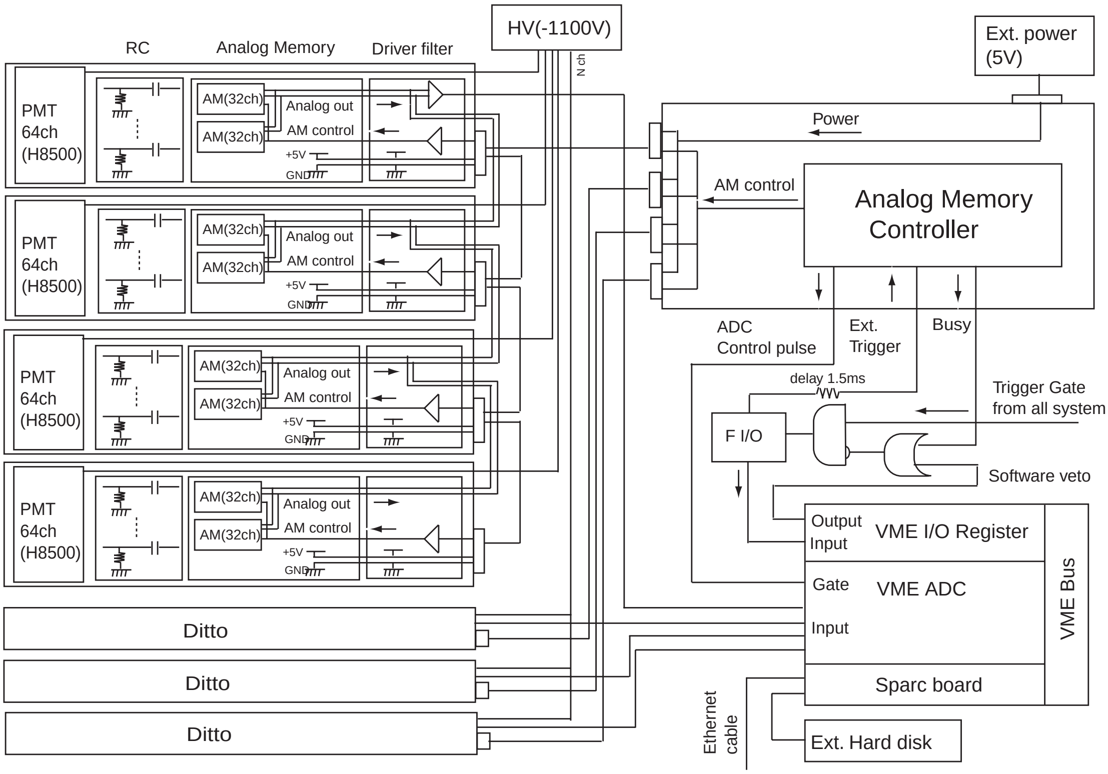

Fig. 4. Schematics of the read-out system for the flat-panel PMTs.

Each analog memory controller outputs the serial signal together with synchronized control signals. These signals are then read by a 12-bit VME ADC (DSP8112, MTT Co.) with a conversion time of 5 μs.

2.5. Reference RICH

A reference RICH was instrumented with multi-anode PMTs, Hamamatsu R5900-M16, the same photon detector as used in the previous test [10]. The quantum efficiency of the PMTs is around 26% (at 400 nm), and the gain was around 6×10^6 with -900 V applied to the photo-cathode. The PMTs were grouped in a 2×6 array at a 30 mm pitch. Due to a limited number of available PMTs and read-out channels, only a part of the Cherenkov ring was covered with photon detectors.

3. Measurement and results

Most of the test measurements were performed with a π^- beam at 3 GeV/c. To systematically evaluate the detector performance, data were taken with different aerogel samples with various transmission lengths and thicknesses. Data were also taken by varying the π^- momentum in the range from 0.5 to 4.0 GeV/c.

A few typical events are displayed in Fig. 5. The hits on PMTs can be associated with the expected position of the Cherenkov ring. The hit near the center of the ring is due to Cherenkov radiation generated by the beam particle in the PMT window. The distribution of accumulated hits is shown in Fig. 6. Cherenkov photons from the aerogel radiator are clearly seen with a low background level. The background hit distribution on the photon detector is consistent with the assumption that it originates from Cherenkov

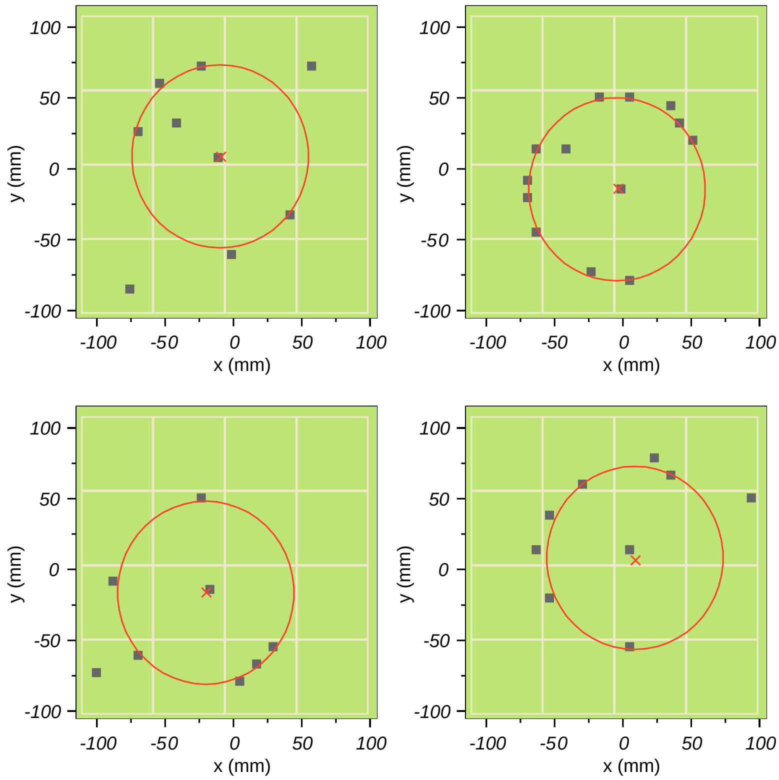

Fig. 5. Some examples of event hit patterns for 3 GeV/c pions. The circle corresponds to the Cherenkov ring as expected from the measured beam particle track. The dot corresponds to the impact point of the track upon the PMT window.

photons which were Rayleigh scattered in the radiator.

The pulse-height distribution of the Cherenkov photons detected in one of the flat-panel PMT is shown in Fig. 7. The raw data were corrected as follows. A common-mode fluctuation of the base line was subtracted and signals due to cross-talk in the read-out electronics were removed. The signal mainly containing one photoelectron is clearly separated from the pedestal peak. Note, however, that this distribution differs considerably from tube to tube because of the large variation in performance, as described before. For further analysis we also applied a threshold cut to suppress the pedestal noise contribution.

3.1. Cherenkov-angle resolution for single photons

Fig. 8(a) shows a typical distribution of the Cherenkov angle for single photons. The angular resolution was obtained from a fit of this distribution with a Gaussian signal and a linear function for the background. Fig. 9 shows the resolution in the Cherenkov angle for the π^- beam at 3 GeV/c and 20 mm thick aerogel samples. The resolution was around 14 mrad, independent of the refractive index. The main contributions to the resolution of the Cherenkov angle come from the uncertainty in the emission point and from the pixel size of the PMT. The first contribution is estimated to be $\sigma_{\mathrm{emp}} = d \sin\theta_{\mathrm{c}} \cos\theta_{\mathrm{c}}/L\sqrt{12}$, where d is the aerogel thickness, θ_{c} is the Cherenkov angle and L is the distance from an average emission point in the aerogel to the surface of the PMT. The second contribution is $\sigma_{\mathrm{pix}} = a\cos^2\theta_{\mathrm{c}}/L\sqrt{12}$, where a is the pixel size. The measured variation of the resolution with the thickness of aerogel is shown in Fig. 10. By comparing the measured resolution and the expected values, we observed a rather good agreement. There was, however, a discre-

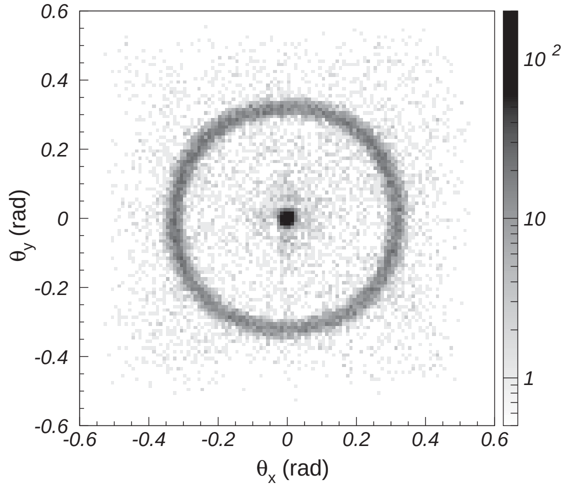

Fig. 6. Distribution of PMT hits in the Cherenkov x, y space for 3 GeV/c pions.

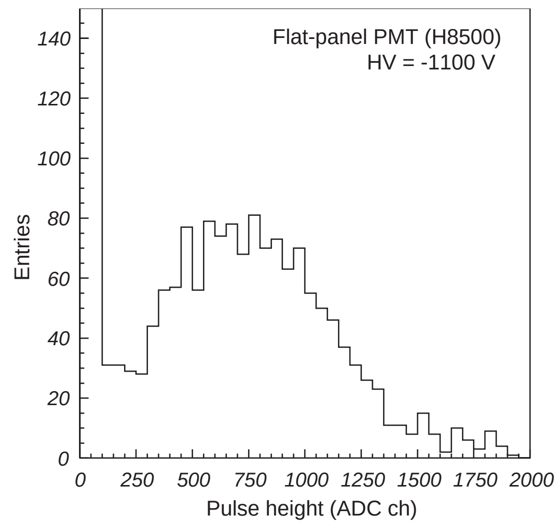

Fig. 7. Pulse-height distribution for the flat-panel PMT (H8500) for the hits in the region within 3σ of the mean Cherenkov angle. Data were corrected with the procedure described in the text. In this figure, the pulse-height distribution for the high sensitive PMT is shown.

pancy between the two, which can be accounted for by a contribution of about 6 mrad. The discrepancy could arise from the effect of aerogel (non-flat aerogel surface and possible non-uniformities in the refractive index due to position variation and chromatic dispersion), which are subject to further investigation. The uncertainty in the track direction is expected to be negligible at 3 GeV/c, but increases considerably at low momenta (0.5 GeV/c) due to the effect of multiple scattering, as can be seen in Fig. 11.

3.2. Photoelectron yield

Fig. 8(b) shows a typical distribution of the number of hits within $\pm 3\sigma$ from the average Cherenkov angle. The number of hits for the signal region was estimated by subtracting the background from the fits to the Cherenkov-angle distribution. The number of detected photons (N_{pe}) depends on the aerogel thickness and the effect of scattering. It is expressed as $N_{pe} = C\int_0^d \int \varepsilon(\lambda)\lambda^{-2}\sin^2\theta_c \exp(-x/\Lambda(\lambda)\cos\theta_c)\,\mathrm{d}\lambda\,\mathrm{d}x \approx C'\sin^2\theta_c \Lambda\cos\theta_c(1-\exp(-d/\Lambda\cos\theta_c))$ where Λ is the transmission length of the aerogel at an average wavelength of 400 nm and $\varepsilon(\lambda)$ is the quantum efficiency of the PMT. Fig. 12 shows the dependence of the number of detected photons on the aerogel thickness. As expected from the above expression, the number of photons does not linearly increase with the aerogel thickness, but saturates due to the scattering effect in aerogel. Fig. 13 shows the dependence of the number of photons with transmission length. From the figure the benefit of the improvement in the transmission length of the $n = 1.05$ aerogel from around 15 mm, as used in the previous beam test, to 45 mm using the new production technique becomes evident. The dependence on the pion momentum, displayed in Fig. 14, is fitted with the form expected from the Cherenkov relations, and shows a good agreement. For pions with momenta above 1 GeV/c, the number of detected Cherenkov photons was typically around 6 for aerogel samples with $n = 1.05$.

The performance of the RICH counter under study was compared in the same set-up with the performance of the reference counter with a well-known photon detector, Hamamatsu R5900-M16 multi-anode PMTs. Since the two counters have a different active area fraction (84% for the flat-panel PMTs, and 36% for the R5900-M16 PMTs) and a different acceptance, the comparison of the photon yields was made by normalizing to the full

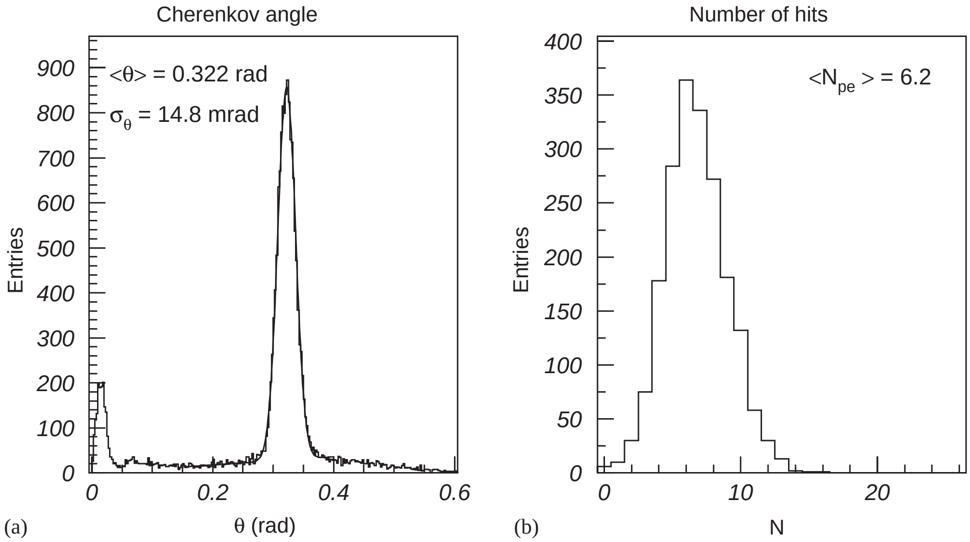

Fig. 8. (a) Distribution over the Cherenkov angle for single photons, and (b) the number of detected photons per ring, for a 20 mm thick aerogel radiator sample with $n = 1.056$ and a transmission length of 30 mm.

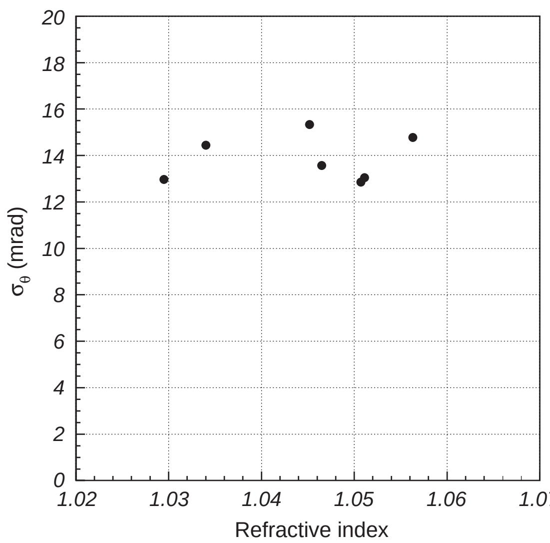

Fig. 9. Typical single photon resolution for 20 mm thick aerogel samples.

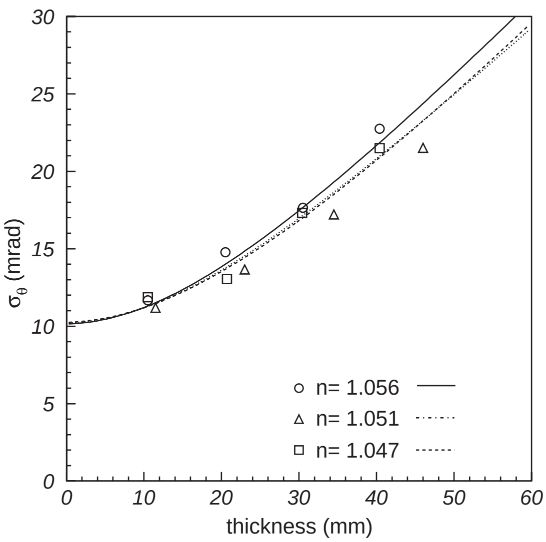

Fig. 10. Angular resolution as a function of the aerogel thickness. The symbols correspond to the data for the different samples and the curves are function described in the text.

active surface. While the flat-panel yield for a particular case was 6.2, which resulted in 7.8 if extrapolated to the full active area, the corresponding number for the R5900-M16 was 12. It appears that this difference is mainly due to the rather low quantum efficiency and amplification of some of the flat-panel tubes employed. This, in turn, causes inefficiencies in single photon detection with a given threshold. If the best tube in the set is normalized to the full acceptance, the corresponding number increases to 10, and we would expect about 8 photons per ring.

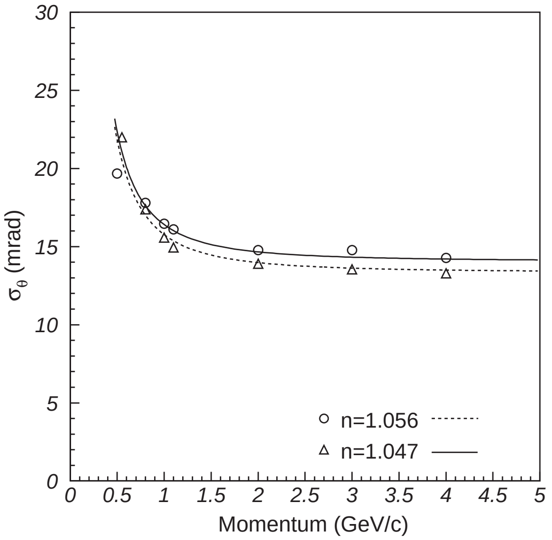

Fig. 11. Angular resolution as a function of the charged particle momentum for two different samples. The symbols correspond to the data and the curves are fits including the effect of multiple-scattering.

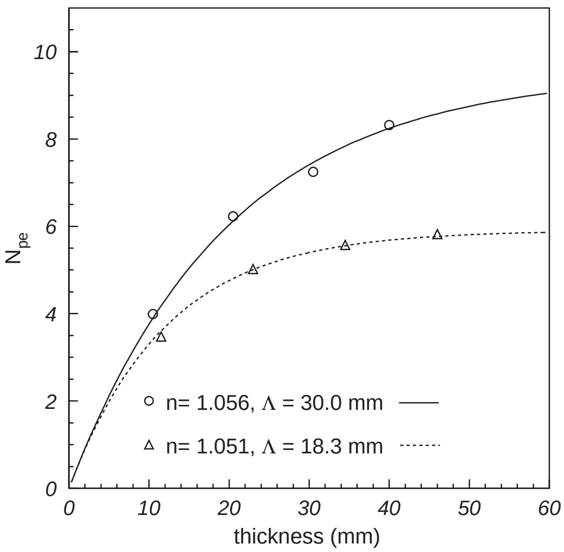

Fig. 12. Number of detected photons per Cherenkov ring as a function of the aerogel thickness. The symbols correspond to the data and the curves are fits described in the text.

3.3. Particle identification

Finally, we estimate the performance of pion/kaon separation in the momentum range of

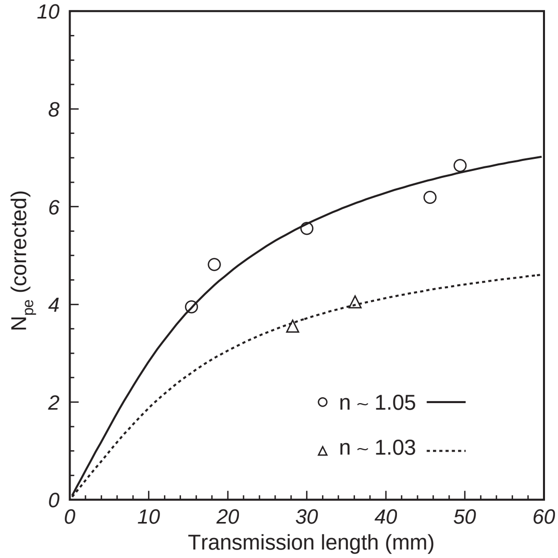

Fig. 13. Number of detected photons per Cherenkov ring (N_{pe}) for 20 mm thick aerogel samples as a function of the transmission length. N_{pe} is corrected for the refractive index to $n = 1.05$ and 1.03, respectively. The symbols correspond to the data and the curves are fits described in the text.

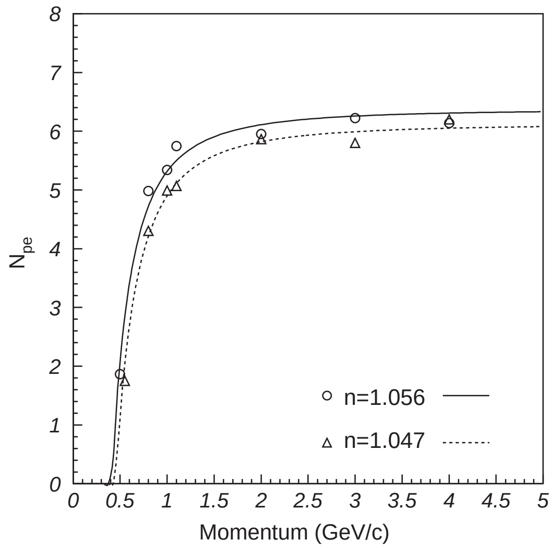

Fig. 14. Number of detected photons per Cherenkov ring as a function of the charged particle momentum. The symbols correspond to the data and the curves are fits described in the text.

around 4 GeV/c, which is of considerable importance for the Belle experiment. If we take into account a typical measured value for the single-photon angular resolution, $\sigma_c \sim 14$ mrad, and the number of detected photons $N_{pe} \sim 6$, typical for 20 mm thick aerogel samples with $n = 1.05$, we can estimate the Cherenkov angle resolution per track to be $\sigma_c/\sqrt{N_{pe}} = 5.7$ mrad. This naive estimate is also confirmed by the direct measurement shown in Fig. 15. Here, the track-by-track Cherenkov angle is calculated by taking the average of the angles measured for hits around the predicted position of the Cherenkov ring. From this we can deduce that at 4 GeV/c, where the difference of Cherenkov angles for pions and kaons is 23 mrad, a 4σ separation between the two is possible. As an additional cross check, we have also collected data with the pion beam of 1.1 GeV/c, which can be used to represent a kaon beam of 4 GeV/c (apart from a slightly larger sigma due to multiple scattering). As can be seen from Fig. 15, the two peaks are well separated. Thus, the proximity focusing aerogel RICH seems to be promising for the upgrade of the Belle PID system at the forward region.

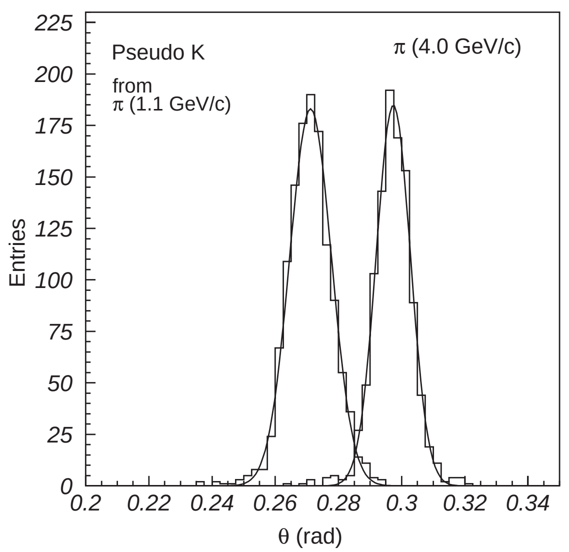

Fig. 15. Cherenkov angle per track for pions of 4.0 and 1.1 GeV/c. Pions at 1.1 GeV/c are used to represent the kaon beam of 4 GeV/c. The angular resolutions for 4.0 and 1.1 GeV/c are 5.4 and 6.7 mrad and two peaks are separated by 4.2σ.

4. Conclusions

We report on the test beam results of a proximity focusing RICH using aerogel as the radiator. To obtain larger photoelectron yields, we used flat-panel multi-anode PMT with a large effective area, and aerogel samples produced with a recently developed method which have a higher transmission length than before. We also developed a multi-channel PMT read-out system using analog memory chips. A clear Cherenkov ring from the aerogel radiator could be observed, and the number of photons was enhanced compared to that in previous tests. We performed a systematic study of the detector using various samples of the aerogel. The typical angular resolution was around 14 mrad and the number of detected photoelectrons was around 6. The pion/kaon separation at 4 GeV/c is expected to be around 4σ.

However, we still have some issues which have to be solved for implementation in the Belle spectrometer. The most important item is the development of a PMT which can be operated under a strong magnetic field (1.5 T). An example of a candidate for such a device is a multi-anode hybrid photodiode (HPD) or hybrid avalanche photodiode (HAPD). Of course, for a good candidate, its ability to efficiently detect single photons on a large active area has to be demonstrated. The other item is mass production of the aerogel tiles. While we have demonstrated that the new production method significantly increases the transmission length of the $n = 1.05$ aerogel, the production method has to be adapted to stable good-quality manufacturing. We will study these items at the next stage towards construction of a real detector.

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Improved measurement of *CP*-violation parameters $\sin 2\phi_1$ and $|\lambda|$, *B* meson lifetimes, and B^0-$\overline{B}^0$ mixing parameter Δm_d

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We present a precise measurement of the standard model CP-violation parameter $\sin 2\phi_1$, the direct CP violation parameter $|\lambda|$, the lifetimes of charged and neutral B mesons and their ratio, and the B^0-$\overline{B}^0$ mixing parameter Δm_d based on a sample of 152×10^6 $B\overline{B}$ pairs collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy e^+e^- collider. One of two B mesons is fully reconstructed in a CP-eigenstate or a flavor-eigenstate decay channel. The flavor of the accompanying B meson is identified from its decay products. From the distributions of the time interval between the two B meson decay points, we obtain $\sin 2\phi_1 = 0.728 \pm 0.056(\text{stat}) \pm 0.023(\text{syst})$, $|\lambda| = 1.007 \pm 0.041(\text{stat}) \pm 0.033(\text{syst})$, $\tau_{B^0} = [1.534 \pm 0.008(\text{stat}) \pm 0.010(\text{syst})]$ ps, $\tau_{B^+} = [1.635 \pm 0.011(\text{stat}) \pm 0.011(\text{syst})]$ ps, $\tau_{B^+}/\tau_{B^0} = 1.066 \pm 0.008(\text{stat}) \pm 0.008(\text{syst})$ and $\Delta m_d = [0.511 \pm 0.005(\text{stat}) \pm 0.006(\text{syst})]$ ps^{-1}. The results for $\sin 2\phi_1$ and $|\lambda|$ are consistent with the standard model expectations. The significance of the observed deviation from unity in the lifetime ratio exceeds 5 standard deviations.

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I. INTRODUCTION

In the standard model (SM), CP violation arises from an irreducible phase in the weak interaction quark-mixing matrix (Cabibbo-Kobayashi-Maskawa (CKM) matrix) [1]. In particular, the SM predicts a CP-violating asymmetry in the time-dependent rates for B^0 and $\overline{B}^0$ decays to a common CP eigenstate f_{CP}, where the transition is dominated by the $b \to c\overline{c}s$ process, with negligible corrections from strong interactions [2]:

$$A(t) \equiv \frac{\Gamma[\overline{B}^0(t) \to f_{CP}] - \Gamma[B^0(t) \to f_{CP}]}{\Gamma[\overline{B}^0(t) \to f_{CP}] + \Gamma[B^0(t) \to f_{CP}]} = -\xi_f \sin 2\phi_1 \sin(\Delta m_d t), \quad (1)$$

where $\Gamma[B^0(t), \overline{B}^0(t) \to f_{CP}]$ is the rate for B^0 or $\overline{B}^0$ decay to f_{CP} at a proper-time t after production, ξ_f is the CP eigenvalue of f_{CP}, Δm_d is the mass difference between the two B^0 mass eigenstates, and ϕ_1 is one of the three interior angles of the CKM unitarity triangle, defined as $\phi_1 \equiv \pi - \arg(V_{tb}^* V_{td}/V_{cb}^* V_{cd})$. Nonzero values for $\sin 2\phi_1$ have been reported by the Belle and BaBar collaborations [3–5]. Belle's latest published measurement of $\sin 2\phi_1$ is based on a 78 fb^{-1} data sample (data set I) containing 85×10^6 $B\overline{B}$ pairs produced at the $\Upsilon(4S)$ resonance. In this paper, we report an improved measurement incorporating an additional 62 fb^{-1} (data set II) for a total of 140 fb^{-1} (152×10^6 $B\overline{B}$ pairs). A precise knowledge of $\sin 2\phi_1$ is essential for testing the Kobayashi-Maskawa model of CP violation.

The $\sin 2\phi_1$ measurement requires a determination of a proper-time resolution function and of the wrong-tag fractions using a large sample of exclusively reconstructed flavor-eigenstate decays. We perform a precise measurement of the mixing parameter Δm_d and of the neutral (charged) B meson lifetime τ_{B^0} (τ_{B^+}) as a by-product of this procedure. Our previous results are based on a 29.1 fb^{-1} data sample [6–8]; thus our new measurements with a 140fb^{-1} data sample provide significant improvements.

Changes exist in the analysis with respect to our earlier results. We apply a new proper-time resolution function

*On leave from Nova Gorica Polytechnic, Nova Gorica that reduces systematic uncertainties. We introduce b-flavor-dependent wrong-tag fractions to accommodate possible differences between B^0 and $\overline{B}^0$ decays. We also adopt a multiparameter fit to the flavor-eigenstate samples to obtain Δm_d, τ_{B^0}, τ_{B^+}, the resolution parameters and wrong-tag fractions simultaneously. There are other improvements in the estimation of background components that are made possible by the increased statistics.

The data were collected with the Belle detector [9] at the KEKB asymmetric-energy e^+e^- collider [10], which collides 8.0 GeV e^- on 3.5 GeV e^+ at a small ($\pm$ 11 mrad) crossing angle. We use events where one of the B mesons decays to f_{CP} at time t_{CP}, and the other decays to a self-tagging state $f_{\rm tag}$, which distinguishes B^0 from $\overline{B}^0$, at time $t_{\rm tag}$. The CP violation manifests itself as an asymmetry $A(\Delta t)$, where Δt is the proper-time interval between the two decays: $\Delta t \equiv t_{CP} - t_{\rm tag}$. We also use events in which f_{CP} is replaced by a flavor eigenstate $f_{\rm flv}$; the decay chain in this case is $\Upsilon(4S) \to B^0\overline{B}^0 \to f_{\rm flv}f_{\rm tag}$. The time evolution is described as $e^{-|\Delta t|/\tau_{B^0}}/(4\tau_{B^0})\{1 \pm \cos(\Delta m_d \Delta t)\}$, where the plus (minus) sign is taken when the flavor of one B meson is opposite to (the same as) the other.

At KEKB, the $\Upsilon(4S)$ resonance is produced with a boost of $\beta\gamma = 0.425$ nearly along the z axis defined as antiparallel to the positron beam direction, and Δt can be determined as $\Delta t \simeq \Delta z/(\beta\gamma c)$, where Δz is the z distance between the f_{CP} and $f_{\rm tag}$ decay vertices, $\Delta z \equiv z_{CP} - z_{\rm tag}$. The average value of Δz is approximately 200 μm.

The Belle detector [9] is a large-solid-angle spectrometer that includes a silicon vertex detector (SVD), a central drift chamber (CDC), an array of aerogel threshold Čerenkov counters (ACC), time-of-flight (TOF) scintillation counters, and an electromagnetic calorimeter (ECL) comprised of CsI(Tl) crystals, all located inside a superconducting solenoid coil that provides a 1.5 T magnetic field. An iron flux-return located outside of the coil is instrumented to detect K_L^0 mesons and to identify muons (KLM).

II. EVENT SELECTION AND RECONSTRUCTION

A. Reconstruction of $B^0 \to$ charmonium $K^{(*)0}$ decays

We reconstruct B^0 decays to the following CP eigenstates [11]: $J/\psi K_S^0$, $\psi(2S)K_S^0$, $\chi_{c1}K_S^0$, $\eta_c K_S^0$ for $\xi_f = -1$ and $J/\psi K_L^0$ for $\xi_f = +1$. We also use $B^0 \to J/\psi K^{*0}$ decays with the subsequent decay $K^{*0} \to K_S^0\pi^0$. Here the final state is a mixture of even and odd CP, depending on the relative orbital angular momentum of the J/ψ and K^{*0}. We find that the final state is primarily $\xi_f = +1$; the $\xi_f = -1$ fraction is $0.19 \pm 0.02(\rm stat) \pm 0.03(\rm syst)$ [12].

The reconstruction and selection criteria for all f_{CP} channels used in the measurement are described in detail elsewhere [3]. J/ψ and $\psi(2S)$ mesons are reconstructed via their decays to $\ell^+\ell^-$ ($\ell = \mu, e$). The $\psi(2S)$ is also reconstructed via $J/\psi\pi^+\pi^-$, and the χ_{c1} via $J/\psi\gamma$. The η_c is detected in the $K_S^0K^-\pi^+$, $K^+K^-\pi^0$, and $p\overline{p}$ modes. For the $J/\psi K_S^0$ mode, we use $K_S^0 \to \pi^+\pi^-$ and $\pi^0\pi^0$ decays; for other modes we only use $K_S^0 \to \pi^+\pi^-$. For reconstructed $B \to f_{CP}$ candidates other than $J/\psi K_L^0$, we identify B decays using the energy difference $\Delta E \equiv E_B^{\rm cms} - E_{\rm beam}^{\rm cms}$ and the beam-energy constrained mass $M_{\rm bc} \equiv \sqrt{(E_{\rm beam}^{\rm cms})^2 - (p_B^{\rm cms})^2}$, where $E_{\rm beam}^{\rm cms}$ is the beam energy in the center-of-mass system (cms) of the $\Upsilon(4S)$ resonance, and $E_B^{\rm cms}$ and $p_B^{\rm cms}$ are the cms energy and momentum of the reconstructed B candidate, respectively.

Candidate $B^0 \to J/\psi K_L^0$ decays are selected by requiring ECL and/or KLM hit patterns that are consistent with the presence of a shower induced by a K_L^0 meson. The centroid of the shower is required to be within a 45° cone centered on the K_L^0 direction inferred from two-body decay kinematics and the measured four-momentum of the J/ψ.

B. Reconstruction of flavor-eigenstate samples

1. $B^0 \to D^{*-}\ell^+\nu$

We use the decay chain $B^0 \to D^{*-}\ell^+\nu$, $D^{*-} \to \overline{D}^0\pi^-$, where $\overline{D}^0 \to K^+\pi^-$, $K^+\pi^-\pi^0$ or $K^+\pi^-\pi^+\pi^-$. We require associated SVD hits and radial impact parameters $dr < 0.2$ cm for all tracks. Track momenta in the laboratory frame for $\overline{D}^0 \to K^+\pi^-\pi^+\pi^-$ decays are required to be larger than 0.2 GeV$/c$, while no additional requirements are applied for the other modes. Charged kaons are identified by combining information from the TOF, ACC and dE/dx measurements in the CDC. Photon candidates are defined as isolated ECL clusters of more than 20 MeV that are not matched to any charged track. π^0 candidates are reconstructed from pairs of photon candidates with invariant masses between 124 and 146 MeV$/c^2$. A mass-constrained fit is performed to improve the π^0 momentum resolution. A minimum π^0 momentum of 0.2 GeV$/c$ is required. For $\overline{D}^0 \to K^+\pi^-$ and $K^+\pi^-\pi^+\pi^-$ candidates, we use daughter combinations that have an invariant mass within 0.013 GeV$/c^2$ of m_{D^0}; for $\overline{D}^0 \to K^+\pi^-\pi^0$ we expand the mass window to -0.037 GeV$/c^2$ and $+0.023$ GeV$/c^2$. For $D^{*-} \to \overline{D}^0\pi^-$ decays, we combine $\overline{D}^0$ candidates with a low-momentum π^- (slow pion) that is reconstructed using a vertex constraint and require the mass difference between the D^{*-} and $\overline{D}^0$ candidates, $M_{\rm diff}$, to be within 1 MeV$/c^2$ of the nominal value. We reject D^{*-} candidates with cms momentum greater than 2.6 GeV$/c$, which is beyond the kinematic limit for B meson decays.

For the associated lepton, we use electrons or muons with a charge opposite to that of the D^{*-} candidate. Electron identification is based on a combination of CDC dE/dx information, the ACC response, and the energy deposition of the associated ECL shower. Muons are identified by comparing information from the KLM to extrapolated charged particle trajectories. We require 1.4 GeV$/c < p_\ell^{\rm cms} <$ 2.4 GeV$/c$, where $p_\ell^{\rm cms}$ is the cms momentum of the lepton. The cms angle of the lepton with respect to the direction of the D^{*-} candidate is also required to be greater than 90°. For $B^0 \to D^{*-}\ell^+\nu$ decays, the energies and momenta of the B meson and the $D^*\ell$ system in the cms satisfy $M_\nu^2 = (E_B^{\rm cms} - E_{D^*\ell}^{\rm cms})^2 - |\vec{p}_B^{\rm cms}|^2 - |\vec{p}_{D^*\ell}^{\rm cms}|^2 + 2|\vec{p}_B^{\rm cms}||\vec{p}_{D^*\ell}^{\rm cms}|\cos\theta_{B,D^*\ell}$, where M_ν is the neutrino mass and $\theta_{B,D^*\ell}$ is the angle between $\vec{p}_B^{\rm cms}$ and $\vec{p}_{D^*\ell}^{\rm cms}$. We calculate $\cos\theta_{B,D^*\ell}$ setting $M_\nu = 0$. The signal region is defined as $|\cos\theta_{B,D^*\ell}| < 1.1$. We also require the candidate $D^{*-}\ell^+\nu$ decays to be outside the signal region when we artificially reverse the lepton momentum vector; this ensures that entries in the signal region after the reversal, which are used for the background estimation, do not contain $D^{*-}\ell^+\nu$ events.

2. Hadronic modes

B^0 and B^+ mesons are fully reconstructed in the following decay modes: $B^0 \to D^-\pi^+$, $D^{*-}\pi^+$, $D^{*-}\rho^+$, $J/\psi K^{*0}$, $B^+ \to \overline{D}^0\pi^+$, and $J/\psi K^+$. We also use $B^0 \to J/\psi K_S^0$ decays, which are described in the previous section, with no flavor assignment. D^{*-} and $\overline{D}^0$ candidates are reconstructed in the same decay modes that are used for the $D^{*-}\ell^+\nu$ mode. Charged D candidates are reconstructed in the $D^- \to K^+\pi^-\pi^-$ channel. For D and D^{*-} candidates, we apply mode-dependent requirements on the reconstructed D mass (ranging from ±15 MeV$/c^2$ to ±50 MeV$/c^2$) and the $M_{\rm diff}$ (ranging from ±3 MeV$/c^2$ to ±12 MeV$/c^2$), in a similar way as for the $D^{*-}\ell^+\nu$ mode. Candidate $K^{*0} \to K^+\pi^-$ decays are required to have an invariant mass within 75 MeV$/c^2$ of the nominal K^{*0} mass. ρ^+ candidates are selected as $\pi^+\pi^0$ pairs having invariant masses within 150 MeV$/c^2$ of the nominal ρ^+ mass.

To reduce background from $e^+e^- \to q\bar{q}$ ($q = u, d, s$ or c) continuum events, a selection based on the ratio of the second to zeroth Fox-Wolfram moments [13] and the angle between the thrust axes of the reconstructed and associated B mesons is applied mode by mode.

C. Flavor tagging

For neutral B to f_{CP} and $f_{\rm flv}$ decays, charged leptons, pions, kaons, and Λ baryons that are not associated with the reconstructed decay are used to identify the b-flavor of the accompanying B meson. The tagging algorithm is described in detail elsewhere [14]. We use two parameters, q and r, to represent the tagging information. The first, q, has the discrete value $+1$ (-1) when the tag-side B meson is likely to be a B^0 ($\overline{B}^0$). The parameter r corresponds to an event-by-event flavor-tagging dilution that ranges from $r = 0$ for no flavor discrimination to $r = 1$ for an unambiguous flavor assignment. It is determined from a large number of events generated by Monte Carlo (MC) simulation, and is used only to sort data into six intervals of r, according to estimated flavor purity. We determine directly from data the average wrong-tag probabilities, $w_l \equiv (w_l^+ + w_l^-)/2$ ($l = 1, 6$), and differences between B^0 and $\overline{B}^0$ decays, $\Delta w_l \equiv w_l^+ - w_l^-$, where $w_l^{+(-)}$ is the wrong-tag probability for the $B^0(\overline{B}^0)$ decay in each r interval.

D. Vertex reconstruction

The vertex position for the f_{CP} decay is reconstructed using leptons from J/ψ decays or charged hadrons from η_c decays. Each vertex position is required to be consistent with the interaction-region profile (IP), determined run-by-run, smeared in the r-ϕ plane to account for the B meson decay length. With the IP constraint, we are able to determine a vertex even with a single track; the fraction of single-track vertices is about 10% for z_{CP}.

The vertex position for the $f_{\rm flv}$ decay that includes a D meson in its decay products is reconstructed using the D meson trajectory, a track other than the slow π^- candidate from D^{*-} decay, and the IP constraint. For the $B^+ \to J/\psi K^+$ and $B^0 \to J/\psi K^{*0}(K^+\pi^-)$ decays, we use leptons from J/ψ decays and the IP constraint, in the same way as for the f_{CP} decay.

The vertex position for the $f_{\rm tag}$ is obtained with the IP constraint and with well reconstructed tracks that are not assigned to f_{CP} or $f_{\rm flv}$. The algorithm is described in detail elsewhere [15]. The fraction of single-track vertices is about 22% for $z_{\rm tag}$.

We only use events with vertices that satisfy $|\Delta t| < 70$ ps and $\xi < 100$, where ξ is the χ^2 of the vertex fit calculated only in the z direction [15]. The overall vertex reconstruction efficiency is $87.1 \pm 0.7\%$ for $B^0 \to J/\psi K_S^0$ candidates.

The proper-time interval resolution function $R_{\rm sig}(\Delta t)$ is formed by convolving four components: the detector resolutions for z_{CP} and $z_{\rm tag}$, the shift in the $z_{\rm tag}$ vertex position due to secondary tracks originating from charmed particle decays, and the kinematic approximation that the B mesons are at rest in the cms [15]. A small component of broad outliers in the Δz distribution, caused by misreconstruction, is represented by a Gaussian function.

E. Signal yields

After flavor tagging and vertexing, we find 5417 f_{CP} candidates in total in the signal region; these are used for the $\sin 2\phi_1$ determination. Table I lists the numbers of candidates, $N_{\rm ev}$, and the estimated signal purity for each f_{CP} mode. Figure 1 shows the $M_{\rm bc}$ distribution after applying mode-dependent requirements on ΔE for all B^0 candidates except for $B^0 \to J/\psi K_L^0$. There are 3085 total entries in the signal region defined as 5.27 GeV$/c^2 < M_{\rm bc} < 5.29$ MeV$/c^2$. Figure 2 shows the $p_B^{\rm cms}$ distribution for $B^0 \to J/\psi K_L^0$ candidates. We find 2332 entries in the 0.20 GeV$/c \le p_B^{\rm cms} \le 0.45$ GeV$/c$ signal region.

TABLE I. Numbers of reconstructed $B \to f_{CP}$ candidates after flavor tagging and vertex reconstruction, $N_{\rm ev}$, and the estimated signal purity, p.

Mode	ξ_f	$N_{\rm ev}$	p
$J/\psi K_S^0(\pi^+\pi^-)$	-1	1997	0.976 ± 0.001
$J/\psi K_S^0(\pi^0\pi^0)$	-1	288	0.82 ± 0.02
$\psi(2S)(\ell^+\ell^-)K_S^0$	-1	145	0.93 ± 0.01
$\psi(2S)(J/\psi\pi^+\pi^-)K_S^0$	-1	163	0.88 ± 0.01
$\chi_{c1}(J/\psi\gamma)K_S^0$	-1	101	0.92 ± 0.01
$\eta_c(K_S^0K^-\pi^+)K_S^0$	-1	123	0.72 ± 0.03
$\eta_c(K^+K^-\pi^0)K_S^0$	-1	74	0.70 ± 0.04
$\eta_c(p\overline{p})K_S^0$	-1	20	0.91 ± 0.02
All with $\xi_f = -1$	-1	2911	0.933 ± 0.002
$J/\psi K^{*0}(K_S^0\pi^0)$	$+1(81\%)$	174	0.93 ± 0.01
$J/\psi K_L^0$	$+1$	2332	0.63 ± 0.03

Table II lists $N_{\rm ev}$ and the purity for each $f_{\rm flv}$ mode after the vertexing. The total number of $f_{\rm flv}$ candidates is 177368 with a purity of 81%. Figure 3 shows the $\cos\theta_{B,D^*\ell}$ distribution for the $D^{*-}\ell^+\nu$ candidates. Figure 4 shows the $M_{\rm bc}$ distributions for B^0 and B^+ decays to $f_{\rm flv}$ states.

According to a MC simulation study, there is a small fraction of background (less than 1% for f_{CP} and 3% for $f_{\rm flv}$ candidates) from other B decays peaking in the $M_{\rm bc}$ signal region. The effect of the peaking background is treated as a systematic error.

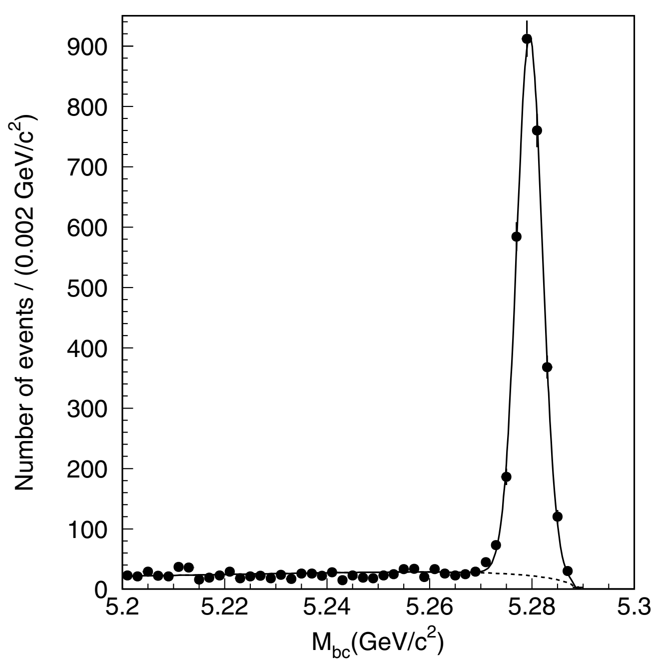

FIG. 1. Beam-energy constrained mass distribution within the ΔE signal region for all f_{CP} modes other than $J/\psi K_L^0$. The solid curve shows the fit to signal plus background distributions, and the dashed curve shows the background contribution.

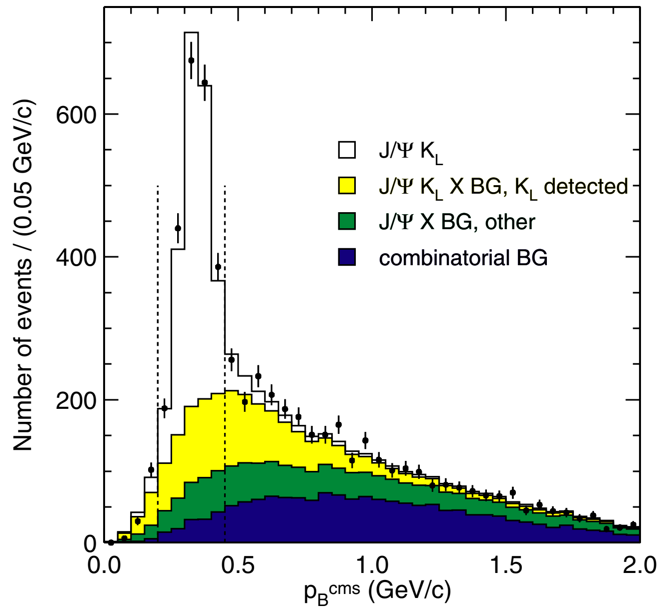

FIG. 2 (color online). $p_B^{\rm cms}$ distribution for $B^0 \to J/\psi K_L^0$ candidates with the results of the fit. The dashed lines indicate the signal region.

III. FIT RESULTS WITH FLAVOR-EIGENSTATE SAMPLES

We perform a multiparameter fit to flavor-eigenstate samples to obtain the B meson lifetimes, the B^0-$\overline{B}^0$ mixing parameter Δm_d, wrong-tag fractions, and parameters for the resolution function simultaneously. We use $B^0 \to D^{*-}\ell^+\nu$, $J/\psi K^{*0}(K^+\pi^-)$, $D^{*-}\pi^+$, $D^-\pi^+$, $D^{*-}\rho^+$, and $J/\psi K_S^0(\ell^+\ell^-)$ (for τ_{B^0} and resolution parameters only) for B^0 decays, and $B^+ \to \overline{D}^0\pi^+$ and $J/\psi K^+$ for B^+ decays. The fit uses 32 parameters; 12 for wrong-tag fractions, 14 for the resolution function, 3 for the B^+ background in B^0 decays, and 3 physics parameters Δm_d, τ_{B^0} and τ_{B^+}. We

TABLE II. Numbers of reconstructed $B \to f_{\rm flv}$ candidates after vertex reconstruction, $N_{\rm ev}$, and the estimated signal purity, p. $J/\psi K_S^0$ candidates are used with no flavor assignment.

Mode	$N_{\rm ev}$	p
$D^{*-}\ell^+\nu$	84823	0.781
$D^{*-}\pi^+$	11921	0.888
$D^-\pi^+$	11156	0.899
$D^{*-}\rho^+$	8767	0.763
$J/\psi K^{*0}(K^+\pi^-)$	3681	0.954
$J/\psi K_S^0(\pi^+\pi^-)$	2001	0.976
B^0 total	122349	0.809
$\overline{D}^0\pi^+$	46248	0.783
$J/\psi K^+$	8771	0.966
B^+ total	55019	0.812
$B^0 + B^+$ total	177368	0.810

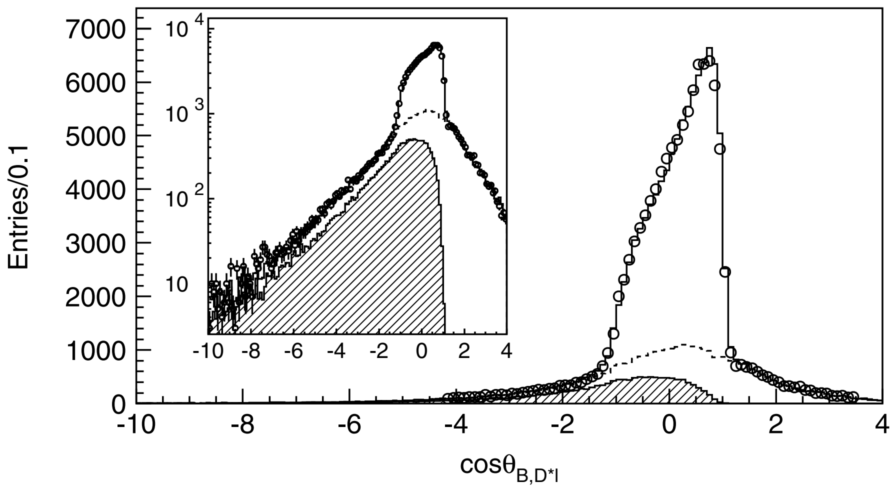

FIG. 3. $\cos\theta_{B,D^*\ell}$ distribution for the $D^{*-}\ell^+\nu$ candidates. The circles with errors show the data. The solid line is the fit result. The total background and the $D^{**}\ell\nu$ component are shown by the dashed line and the hatched area, respectively. The inset shows the same figure with a logarithmic vertical scale.

also obtain the lifetime ratio, $r_{\tau_B} \equiv \tau_{B^+}/\tau_{B^0}$, by repeating the fit in which τ_{B^+} is replaced with $r_{\tau_B}\tau_{B^0}$. Two of the 14 parameters for the resolution function are newly added to the resolution function described in [15] to improve the description of the effect of charmed particle decays on the $f_{\rm tag}$ vertex.

The probability density function (PDF) expected for the signal distribution for B^0 decays to $f_{\rm flv}$ is given by

$$\mathcal{P}^{\rm OF[SF]}_{\rm mix}(\Delta t, q, w_l, \Delta w_l) = \frac{e^{-|\Delta t|/\tau_{B^0}}}{8\tau_{B^0}}\{1 - q\Delta w_l + [-](1-2w_l)\cos(\Delta m_d \Delta t)\}, \tag{2}$$

where OF (SF) denotes $B^0\overline{B}^0$ (B^0B^0 or $\overline{B}^0\overline{B}^0$), i.e. a state with the opposite (same) flavor. The signal PDF for B^+ decays is given by

$$\mathcal{P}^{B^+}_{\rm sig}(\Delta t) = \frac{e^{-|\Delta t|/\tau_{B^+}}}{2\tau_{B^+}}. \tag{3}$$

The signal PDFs are convolved with the $R_{\rm sig}(\Delta t)$ to account for the detector resolution.

The background PDF for the hadronic modes is modeled as a sum of exponential and prompt components,

$$\mathcal{P}_{\rm bkg}(\Delta t) = (1 - f_\delta)\frac{e^{-|\Delta t|/\tau_{\rm bkg}}}{2\tau_{\rm bkg}} + f_\delta \delta(\Delta t), \tag{4}$$

$(1 - f_\delta)$ is the fraction of the exponential component with the effective lifetime $\tau_{\rm bkg}$, and $\delta(\Delta t)$ is the Dirac delta function. It is convolved with a sum of two Gaussians, which is used as the background resolution function. The parameters for the background PDF are determined using

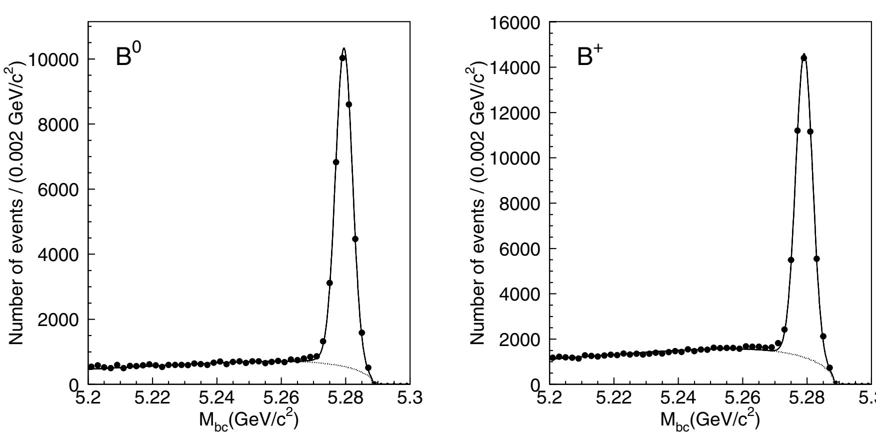

FIG. 4. Beam-energy constrained mass distributions in the ΔE signal region for flavor-eigenstate candidates in neutral B meson decays (left) and in charged B meson decays (right). The solid curves show the fits to signal plus background distributions and the dashed curves show the background contributions.

the ΔE-$M_{\rm bc}$ sideband region for each decay mode. For $B^+ \to \overline{D}{}^0\pi^+$ decays, using events outside the signal region, the value for f_δ is determined to be 0.49 ± 0.01 (0.45 ± 0.03) for events with multitrack (single-track) vertices and the effective lifetime $\tau_{\rm bkg}$ is found to be 0.93 ± 0.03 ps. The parameters for other $B \to f_{\rm flv}$ decays that include a D meson as a decay product are similar to those for the $B^+ \to \overline{D}{}^0\pi^+$ decay. A similar procedure for $B^+ \to J/\psi K^+$ decays yields $f_\delta = 0.86 \pm 0.05$ (0.75 ± 0.08) for events with multitrack (single-track) vertices and $\tau_{\rm bkg} = 1.55 \pm 0.22$ ps. The parameters for $B^0 \to J/\psi K_S^0$ are similar to those for $B^+ \to J/\psi K^+$. The value for f_δ in $B^0 \to J/\psi K^{*0}(K^+\pi^-)$ decays is found to be small; f_δ is 0.07 ± 0.05 for events with multitrack vertices and is fixed at zero for events with single-track vertices. The effective lifetime $\tau_{\rm bkg}$ is 1.50 ± 0.05 ps.

The background for the $D^{*-}\ell^+\nu$ decay is divided into four components: $B \to D^{**}\ell\nu$ events ($8.7 \pm 0.3\%$); fake D^* mesons ($8.0 \pm 0.1\%$); random combination of D^* mesons with leptons with no angular correlation called "uncorrelated background" ($2.5 \pm 0.1\%$); continuum events ($2.7 \pm 0.2\%$). Here D^{**} consists of charmed mesons heavier than the D^* meson and nonresonant $D^*\pi$ components. The PDF for the $B \to D^{**}\ell\nu$ background is given by a sum of B^0 and B^+ components,

$$\mathcal{P}^{OF[SF]}_{D^{**}\ell\nu}(\Delta t) = (1 - f_{B^+})\mathcal{P}^{OF[SF]}_{\rm mix} + f_{B^+}\mathcal{P}^{OF[SF]}_{B^+}, \quad (5)$$

where f_{B^+} is the B^+ fraction in the $B \to D^{**}\ell\nu$ background. The $\mathcal{P}^{\rm OF[SF]}_{B^+}$ is given by $\mathcal{P}^{\rm OF}_{B^+}(\Delta t) = (1 - w^l_{B^+})P^{B+}_{\rm bkg}(\Delta t)$ and $\mathcal{P}^{\rm SF}_{B^+}(\Delta t) = w^l_{B^+}P^{B+}_{\rm bkg}(\Delta t)$, where $w^l_{B^+}$ is the wrong-tag fraction determined from the $B^+ \to \overline{D}{}^0\pi^+$ sample and $\mathcal{P}^{B^+}_{\rm bkg}$ is given by

$$\mathcal{P}^{B^+}_{\rm bkg}(\Delta t) = (1 - f_{\tau'_{B^+}})\frac{e^{-|\Delta t|/\tau_{B^+}}}{4\tau_{B^+}} + f_{\tau'_{B^+}}\frac{e^{-|\Delta t|/\tau'_{B^+}}}{4\tau'_{B^+}}. \quad (6)$$

Here $f_{\tau'_{B^+}}$ and τ'_{B^+} are the fraction and the effective lifetime for events in which an additional π^+ from the D^{**} decays contaminates the $f_{\rm tag}$ vertex reconstruction. The parameters f_{B^+}, $f_{\tau'_{B^+}}$ and τ'_{B^+} are determined in the final fit. To determine these parameters precisely, events in $-10 < \cos\theta_{B,D^*\ell} < -1.1$, where the $D^{**}\ell\nu$ background events are dominant, are also included in the fit. The fit yields $f_{B^+} = 0.51 \pm 0.04$, $f_{\tau'_{B^+}} = 0.56 \pm 0.10$ and $\tau'_{B^+} = 0.74 \pm 0.14$ ps.

For continuum and uncorrelated backgrounds, the same functional form as that of the hadronic background PDF is used. The parameters for continuum are determined from off-resonance data to be $f_\delta = 0.55 \pm 0.09$ (0.58 ± 0.11) for events with multitrack (single-track) vertices and $\tau_{\rm bkg} = 0.80 \pm 0.08$ ps. For the uncorrelated background, a fit to the sample outside the signal region yields $f_\delta = 0.15 \pm 0.08$ and $\tau_{\rm bkg} = 1.23 \pm 0.06$ ps.

The PDF of the fake D^* background is given by Eq. (3) with a mixing component added to account for oscillation in the background. A fit to events in the $M_{\rm diff}$ sideband yields $f_\delta = 0.13 \pm 0.02$ (0.04 ± 0.03) for events with multitrack (single-track) vertices, $\tau_{\rm bkg} = 1.49 \pm 0.03$ ps and $\Delta m_{\rm bkg} = 0.54 \pm 0.05$ ps^{-1}, where $\Delta m_{\rm bkg}$ is the effective mixing parameter. The fraction of the mixing component and wrong-tag fractions are determined for each of the six intervals of the flavor tag quality r. The wrong-tag fractions range from 0.50 ± 0.01 for the lowest r region to 0.20 ± 0.01 for the highest r region. The fraction of the mixing component for the lowest r region is fixed at 0. Values for the other r intervals range from 0.39 ± 0.12 to 0.84 ± 0.09.

We test the fit method and parameterization with a large number of MC events, and obtain results consistent with the input values. The wrong-tag fractions obtained with the MC events are also found to be correct.

The unbinned maximum-likelihood fit to data yields

$$\tau_{B^0} = [1.534 \pm 0.008({\rm stat}) \pm 0.010({\rm syst})]\ {\rm ps}, \quad (7)$$

$$\tau_{B^+} = [1.635 \pm 0.011({\rm stat}) \pm 0.011({\rm syst})]\ {\rm ps}, \quad (8)$$

$$\tau_{B^+}/\tau_{B^0} = 1.066 \pm 0.008({\rm stat}) \pm 0.008({\rm syst}), \quad (9)$$

$$\Delta m_d = [0.511 \pm 0.005({\rm stat}) \pm 0.006({\rm syst})]\ {\rm ps}^{-1}. \quad (10)$$

The results are consistent with our previous measurements [6–8] and supersede them. Figure 5 shows the flavor asymmetry, $\mathcal{A}(\Delta t) = [{\rm N_{OF}}(\Delta t) - {\rm N_{SF}}(\Delta t)]/[{\rm N_{OF}}(\Delta t) +$

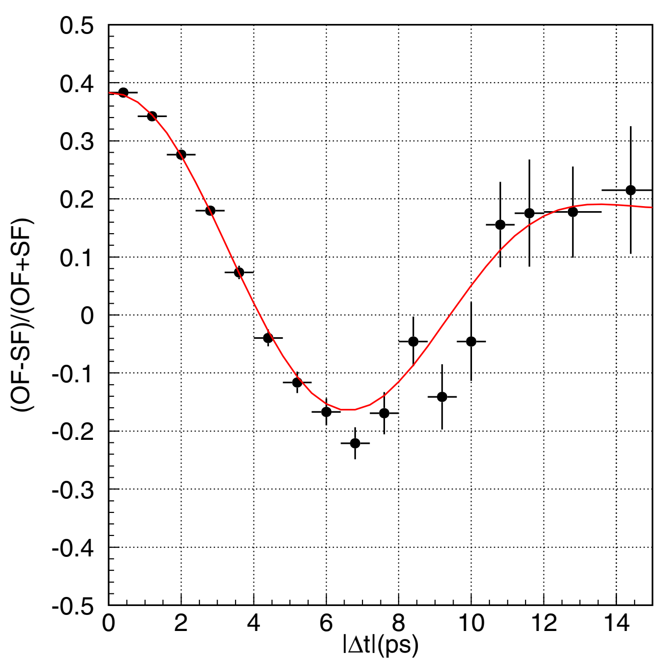

FIG. 5 (color online). Time-dependent flavor asymmetry for flavor-eigenstate decays. The curve is the result of the unbinned maximum-likelihood fit.

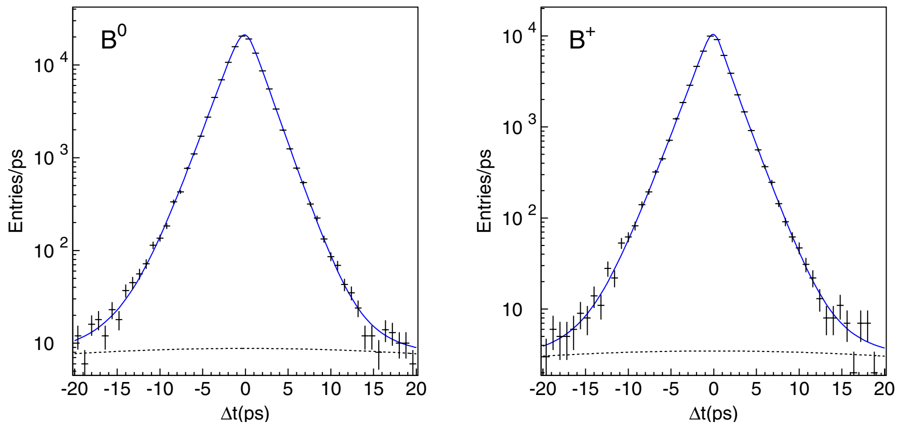

FIG. 6 (color online). Δt distributions of neutral B meson pairs (left) and charged B meson pairs (right). The solid lines represent the results of the unbinned maximum-likelihood fit. The dashed lines correspond to the outlier components.

TABLE III. Summary of the systematic errors on the measurement of τ_{B^0}, τ_{B^+}, τ_{B^+}/τ_{B^0} and Δm_d.

Source	τ_{B^0}	τ_{B^+}	τ_{B^+}/τ_{B^0}	Δm_d
Vertex reconstruction	0.005	0.007	0.003	0.003
Resolution function	0.004	0.005	0.004	0.001
Possible fit bias	0.003	0.004	0.003	0.002
$D^{**}\ell\nu$ background	0.004	0.003	0.002	0.004
Other background fraction	0.001	0.006	0.003	0.001
Background Δt shape	0.006	0.003	0.005	0.002
Total	0.010 (ps)	0.011 (ps)	0.008	0.006 (ps^{-1})

$N_{SF}(\Delta t)$], where $N_{OF(SF)}$ denotes the number of OF (SF) events. The results of the lifetime measurements for neutral and charged B meson decays are shown in Fig. 6.

Systematic uncertainties are listed in Table III. The method to determine the systematic errors due to the vertex reconstruction follows the same procedure as for the $\sin 2\phi_1$ measurement, which will be explained later. We estimate the contribution due to uncertainties in the resolution function by comparison of different parametrizations, as well as by changing parameters that are derived from MC to model the effect of nonprimary tracks [15]. A possible bias in the event reconstruction and fitting procedure is checked with a large number of MC events. We find no bias and take the statistical error in MC as a systematic error. Several D^{**} components are used in this analysis to model the $\cos\theta_{B,D^*\ell}$ shape for the $D^{**}\ell\nu$ background. To estimate the systematic errors due to uncertainties of the fractions of the D^{**} components, we set the fraction of each component to unity (with all other components set to zero) and repeat the analysis; for each measurement, we take the largest variation on the result as the systematic error. Systematic errors that arise from uncertainties in other background fractions and from the background Δt shape are obtained by varying each parameter individually, repeating the fit procedure, and adding each contribution in quadrature. In the nominal fit, we do not include a mixing component in the background PDF for the hadronic decays. We repeat the fit with a background PDF including a mixing term. Uncertainties in the overall z scale of the detector arising from the measurement error and thermal expansion during the operation are found to be negligible.

The same fit also yields wrong-tag fractions that are summarized in Table IV. The total effective tagging efficiency is determined to be $\epsilon_{\rm eff} \equiv \sum_{l=1}^{6} \epsilon_l (1-2w_l)^2 = 0.287 \pm 0.005$, where ϵ_l is the event fraction for each r

TABLE IV. Event fractions ϵ_l, wrong-tag fractions w_l, wrong-tag fraction differences Δw_l, and average effective tagging efficiencies $\epsilon^l_{\rm eff} = \epsilon_l(1-2w_l)^2$ for each r interval. The errors include both statistical and systematic uncertainties.

l	r interval	ϵ_l	w_l	Δw_l	$\epsilon^l_{\rm eff}$
1	0.000 – 0.250	0.398	0.464 ± 0.006	-0.011 ± 0.006	0.002 ± 0.001
2	0.250 – 0.500	0.146	0.331 ± 0.008	$+0.004 \pm 0.010$	0.017 ± 0.002
3	0.500 – 0.625	0.104	0.231 ± 0.009	-0.011 ± 0.010	0.030 ± 0.002
4	0.625 – 0.750	0.122	0.163 ± 0.008	-0.007 ± 0.009	0.055 ± 0.003
5	0.750 – 0.875	0.094	0.109 ± 0.007	$+0.016 \pm 0.009$	0.057 ± 0.002
6	0.875 – 1.000	0.136	0.020 ± 0.005	$+0.003 \pm 0.006$	0.126 ± 0.003

interval determined from the $J/\psi K_S^0$ simulation and is listed in Table IV. The error includes both statistical and systematic uncertainties.

We find that the average Δt resolution is $\sim$1.43 ps (rms). The width of the outlier component is determined to be (39 ± 2) ps; the fractions of the outlier components are $(2.1 \pm 0.6) \times 10^{-4}$ for events with both vertices reconstructed with more than one track, and $(3.1 \pm 0.1) \times 10^{-2}$ for events with at least one single-track vertex.

IV. RESULTS OF *CP* ASYMMETRY MEASUREMENTS

Figure 7 shows the observed Δt distributions for the $q\xi_f = +1$ and $q\xi_f = -1$ event samples (top), the asymmetry between two samples with $0 < r \leq 0.5$ (middle) and with $0.5 < r \leq 1.0$ (bottom). The asymmetry in the region $0.5 < r \leq 1.0$, where wrong-tag fractions are small as shown in Table IV, clearly demonstrates large *CP* violation.

We determine $\sin 2\phi_1$ from an unbinned maximum-likelihood fit to the observed Δt distributions. The PDF for the signal distribution is given by

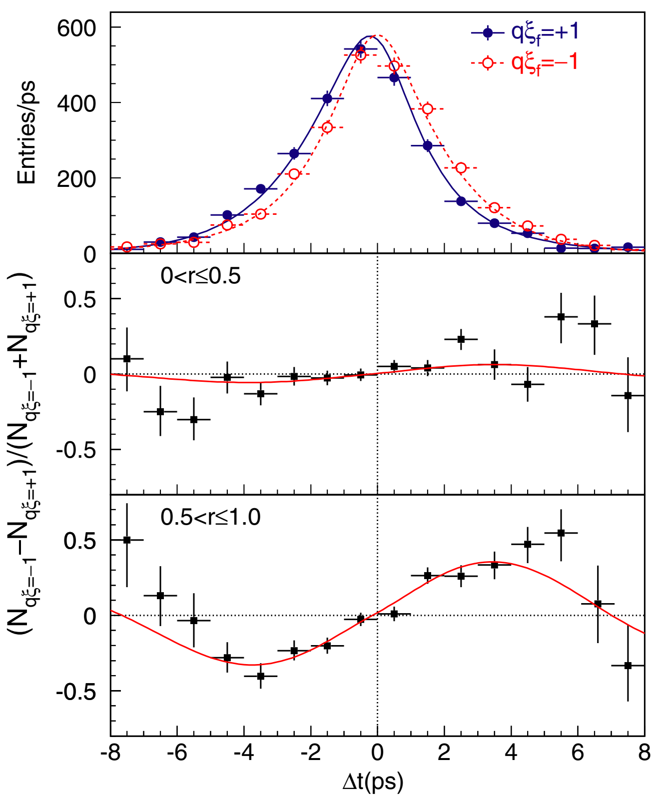

FIG. 7 (color online). Δt distributions for the events with $q\xi_f = -1$ (open points) and $q\xi_f = +1$ (solid points) with all modes combined (top), asymmetry between $q\xi_f = -1$ and $q\xi_f = +1$ samples with $0 < r \leq 0.5$ (middle), and with $0.5 < r \leq 1$ (bottom). The results of the global unbinned maximum-likelihood fit ($\sin 2\phi_1 = 0.728$) are also shown.

$$\mathcal{P}_{\rm sig}(\Delta t, q, w_l, \Delta w_l, \xi_f) = \frac{e^{-|\Delta t|/\tau_{B^0}}}{4\tau_{B^0}}[1 - q\Delta w_l - q\xi_f(1 - 2w_l)\sin 2\phi_1 \sin(\Delta m_d \Delta t)], \tag{11}$$

where we fix the B^0 lifetime τ_{B^0} and mass difference Δm_d at their world average values [16]. Each PDF is convolved with the appropriate $R_{\rm sig}(\Delta t)$ to determine the likelihood value for each event as a function of $\sin 2\phi_1$:

$$P_i = (1 - f_{\rm ol}) \int_{-\infty}^{+\infty} [f_{\rm sig}\mathcal{P}_{\rm sig}(\Delta t')R_{\rm sig}(\Delta t - \Delta t') + (1 - f_{\rm sig})\mathcal{P}_{\rm bkg}(\Delta t')R_{\rm bkg}(\Delta t - \Delta t')]d\Delta t' + f_{\rm ol}P_{\rm ol}(\Delta t), \tag{12}$$

where $f_{\rm sig}$ is the signal fraction calculated as a function of $p_B^{\rm cms}$ for $J/\psi K_L^0$ and of ΔE and $M_{\rm bc}$ for other modes. $\mathcal{P}_{\rm bkg}(\Delta t)$ is the PDF for combinatorial background events, which is modeled as a sum of exponential and prompt components. It is convolved with a sum of two Gaussians, $R_{\rm bkg}$, which is used as the background resolution function. We assume no asymmetry in the background Δt distribution.

For $B^0 \to J/\psi K_L^0$ and $J/\psi K^{*0}$ decays, in addition to the combinatorial background, background events from other B decays and their *CP* asymmetries are considered. The background in the $J/\psi K_L^0$ mode is dominated by the following $B \to J/\psi X$ decays: $J/\psi K_S^0$ having $\xi_f = -1$ $(10 \pm 2\%)$; $\psi(2S)K_L^0$, $\chi_{c1}K_L^0$ and $J/\psi\pi^0$ having $\xi_f = +1$ $(4 \pm 1\%)$; $J/\psi K^{*0}(K^{*0} \to K_L^0\pi^0)$ $(20 \pm 2\%)$, which is a mixture of $\xi_f = -1$ (81%) and $\xi_f = +1$ (19%); other non-*CP* modes $(66 \pm 1\%)$. The fraction of each component is obtained from a MC simulation study. For $J/\psi K^{*0}(K_S^0\pi^0)$ decays, we include in our PDF contaminations from other $B \to J/\psi K^*$ decays $(7.1 \pm 0.3\%)$ and nonresonant $B^0 \to J/\psi K_S^0\pi^0$ decays $(6.3 \pm 0.5\%)$ in the $M_{\rm bc}$ peak. The background fractions are obtained from MC and the K^* mass sideband [12]. We use the signal PDF with no *CP* asymmetry for these components.

To account for a small number of events that give large Δt in both the signal and background, we introduce the PDF of the outlier component, $P_{\rm ol}$, and its fraction $f_{\rm ol}$. The only free parameter in the final fit is $\sin 2\phi_1$, which is determined by maximizing the likelihood function $L = \prod_i P_i$, where the product is over all events. We obtain

$$\sin 2\phi_1 = 0.728 \pm 0.056({\rm stat}) \pm 0.023({\rm syst}). \tag{13}$$

The result is consistent with the value in our previous publication [4] and supersedes it with a reduced error.

The signal PDF for a neutral B meson decaying into a *CP* eigenstate [Eq. (11)] can be expressed in a more general form as

$$\mathcal{P}_{\rm sig}(\Delta t, q, w_l, \Delta w_l) = \frac{e^{-|\Delta t|/\tau_{B^0}}}{4\tau_{B^0}}\Big\{1 - q\Delta w_l + q(1 - 2w_l)[S\sin(\Delta m_d \Delta t) + \mathcal{A}\cos(\Delta m_d \Delta t)]\Big\}, \quad (14)$$

where $S \equiv 2\mathrm{Im}(\lambda)/(|\lambda|^2 + 1)$, $\mathcal{A} \equiv (|\lambda|^2 - 1)/(|\lambda|^2 + 1)$, and λ is a complex parameter that depends on both B^0-$\overline{B}^0$ mixing and on the amplitudes for B^0 and $\overline{B}^0$ decay to a CP eigenstate. The presence of the cosine term ($|\lambda| \neq 1$) would indicate direct CP violation; the value for $\sin 2\phi_1$ reported above is determined with the assumption $|\lambda| = 1$, as $|\lambda|$ is expected to be very close to 1 in the SM. In order to test this assumption, we also performed a fit using the expression above with $a_{CP} \equiv -\xi_f \mathrm{Im}(\lambda)/|\lambda|$ and $|\lambda|$ as free parameters, keeping everything else the same. We obtain

$$|\lambda| = 1.007 \pm 0.041(\mathrm{stat}) \pm 0.033(\mathrm{syst}), \quad (15)$$

and $a_{CP} = 0.728 \pm 0.056(\mathrm{stat})$. This result is consistent with the assumption of no direct CP violation used in our analysis and the a_{CP} term is in good agreement with the $\sin 2\phi_1$ value obtained with the one-parameter fit.

Table V lists the systematic errors on $\sin 2\phi_1$ and $|\lambda|$. The total systematic error is obtained by adding each of them in quadrature. The largest contribution for $\sin 2\phi_1$ comes from vertex reconstruction. The systematic error due to the IP constraint in the vertex reconstruction is estimated by varying ($\pm 10\mu$ m) the smearing used to account for the B flight length. The track selection criteria are also varied to search for possible systematic biases. The effect of the vertex quality cut is estimated by varying the cut to $\xi < 50$ and $\xi < 200$. We vary the $|\Delta t|$ range by ± 30 ps to estimate the systematic uncertainty due to the $|\Delta t|$ fit range. Small biases in the Δz measurement are observed in $e^+e^- \to \mu^+\mu^-$ and other control samples. Systematic errors are estimated by applying special correction functions to account for the observed biases, repeating the fit, and comparing the obtained values with the nominal results. Systematic errors due to imperfect SVD alignment are determined from MC samples that have artificial misalignment effects to reproduce impact-parameter resolutions observed in data. In these studies, whenever required, we repeat the fit to the $f_{\rm flv}$ samples, update resolution function parameters and wrong-tag fractions, and perform the fit to CP-eigenstate event samples using the updated parameters so that the uncertainties in question are treated in a consistent way.

Systematic errors due to uncertainties in the wrong-tag fractions given in Table IV are studied by varying the wrong-tag fraction individually for each r region. Possible differences of the tagging performance between f_{CP} and $f_{\rm flv}$ events are estimated using MC events.

Systematic errors due to uncertainties in the resolution function are estimated by varying each resolution parameter obtained from data (MC) by $\pm 1\sigma$ ($\pm 2\sigma$), repeating the fit and adding each variation in quadrature. We also divide the entire data set into two and prepare two sets of resolution parameters to consider a possible difference in the detector performance. We repeat the fit with these resolution parameters and assign the difference from the nominal result as a systematic error. We also include other sources examined for the fit to the flavor-eigenstate samples, which are explained in the previous section.

A possible fit bias is examined by a fit to a large number of MC events. We find no bias and take the statistical error from the MC as a systematic error.

Systematic errors from uncertainties in the background fractions and in the background Δt shape are estimated by varying each background parameter obtained from data (MC) by $\pm 1\sigma$ ($\pm 2\sigma$). The systematic error due to CP content in the $J/\psi K_L^0$ backgrounds is checked by varying the parameters obtained from the MC by $\pm 2\sigma$.

The small peaking background in the $M_{\rm bc}$ signal region of f_{CP} modes other than $J/\psi K^{*0}$ is neglected in the nominal analysis. The effect of the fractions and their CP asymmetries is studied with MC simulation and is included in systematic errors.

Each physics parameter (τ_{B^0}, Δm_d, $J/\psi K^{*0}$ polarization) is also varied by its error; for Δm_d, we also use our result ($\Delta m_d = 0.511$ ps^{-1}), repeat the fit and take the larger change as the systematic error.

Finally, we investigate the effects of interference between CKM-favored and CKM-suppressed $B \to D$ transitions in the $f_{\rm tag}$ final state [17]. A small correction to the PDF for the signal distribution arises from the interference. We estimate the amount of correction using the $B^0 \to D^{*-}\ell^+\nu$ sample. We then generate MC pseudoexperiments and make an ensemble test to obtain systematic biases in $\sin 2\phi_1$ and $|\lambda|$. We find that the effect on $\sin 2\phi_1$ is negligibly small, while a possible shift

TABLE V. Summary of the systematic errors on $\sin 2\phi_1$ and $|\lambda|$.

Source	$\sin 2\phi_1$	$|\lambda|$
Vertex reconstruction	0.013	0.012
Flavor tagging	0.007	0.008
Resolution function	0.008	0.004
Possible fit bias	0.008	0.006
Background fraction ($J/\psi K_L^0$)	0.011	0.003
Background fraction (except for $J/\psi K_L^0$)	0.007	0.007
Physics (τ_{B^0}, Δm_d, $J/\psi K^{*0}$)	0.003	0.001
Background Δt shape	0.002	0.001
Tag-side interference	0.002	0.028
Total	0.023	0.033

TABLE VI. Numbers of candidate events, $N_{\rm ev}$, and values of $\sin 2\phi_1$, $|\lambda|$ for various subsamples (statistical errors only).

Sample	$N_{\rm ev}$	$\sin 2\phi_1$	$\vert\lambda\vert$
$J/\psi K_S^0(\pi^+\pi^-)$	1997	0.67 ± 0.08	0.98 ± 0.06
$J/\psi K_S^0(\pi^0\pi^0)$	288	0.72 ± 0.20	1.18 ± 0.27
$\psi(2S)K_S^0$	308	0.89 ± 0.20	0.94 ± 0.14
$\chi_{c1}K_S^0$	101	1.54 ± 0.49	0.76 ± 0.22
$\eta_c K_S^0$	217	1.32 ± 0.28	1.10 ± 0.30
All with $\xi_f = -1$	2911	0.73 ± 0.06	0.99 ± 0.05
$J/\psi K_L^0$	2332	0.77 ± 0.13	1.04 ± 0.08
$J/\psi K^{*0}(K_S^0\pi^0)$	174	0.10 ± 0.45	1.11 ± 0.33
$f_{\rm tag} = B^0$ $(q = +1)$	2717	0.72 ± 0.09	0.89 ± 0.09
$f_{\rm tag} = \overline{B}^0$ $(q = -1)$	2700	0.74 ± 0.08	1.17 ± 0.11
$0 < r \leq 0.5$	2985	0.95 ± 0.26	1.18 ± 0.22
$0.5 < r \leq 0.75$	1224	0.68 ± 0.11	1.11 ± 0.09
$0.75 < r \leq 1$	1208	0.73 ± 0.07	0.95 ± 0.05
Data set I (78 fb $-$ 1)	3013	0.72 ± 0.07	0.95 ± 0.05
Data set II (62 fb $-$ 1)	2404	0.74 ± 0.09	1.09 ± 0.07
All	5417	0.728 ± 0.056	1.007 ± 0.041

in $|\lambda|$ becomes the largest contribution to the systematic error.

Several checks on the measurement are performed. Table VI lists the results obtained by applying the same analysis to various subsamples. All values are statistically consistent with each other. Figure 8 shows the raw asymmetries and the fit results for $(c\bar{c})K_S^0$ (top) and $J/\psi K_L^0$ (bottom). A fit to the non-*CP* eigenstate modes $B^0 \to D^{*-}\ell^+\nu$ and $J/\psi K^{*0}(K^+\pi^-)$, where no asymmetry is expected, yields "$\sin 2\phi_1$"$= 0.012 \pm 0.013$(stat).

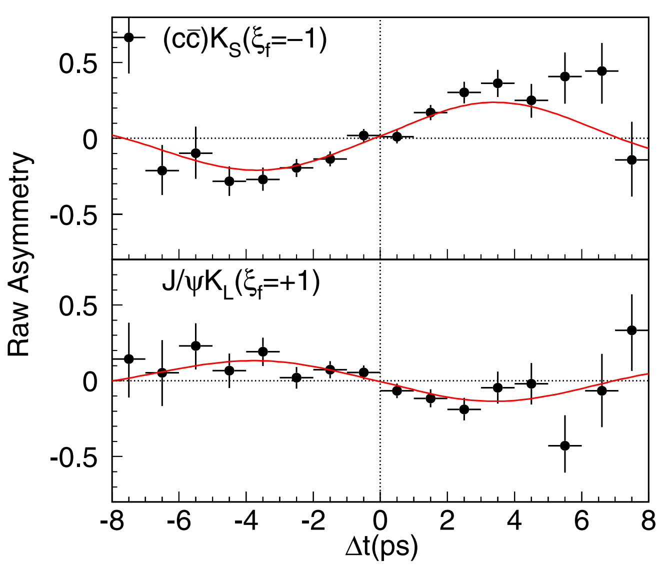

FIG. 8 (color online). Raw asymmetries for $(c\bar{c})K_S^0$ $(\xi_f = -1)$ (top) and $J/\psi K_L^0$ $(\xi_f = +1)$ (bottom). The curves are the results of the global unbinned maximum-likelihood fit.

V. SUMMARY

Using 152×10^6 $B\overline{B}$ pairs collected at the $\Upsilon(4S)$ resonance with the Belle detector at the KEKB asymmetric-energy e^+e^- collider, we have measured the *CP*-violation parameters $\sin 2\phi_1$ and $|\lambda|$, B meson lifetimes and their ratio, and the mixing parameter Δm_d. These are basic parameters of the standard model. The results are summarized as follows:

$$\begin{aligned}
\sin 2\phi_1 &= 0.728 \pm 0.056(\text{stat}) \pm 0.023(\text{syst}),\\
|\lambda| &= 1.007 \pm 0.041(\text{stat}) \pm 0.033(\text{syst}),\\
\tau_{B^0} &= [1.534 \pm 0.008(\text{stat}) \pm 0.010(\text{syst})]\ \text{ps},\\
\tau_{B^+} &= [1.635 \pm 0.011(\text{stat}) \pm 0.011(\text{syst})]\ \text{ps},\\
\tau_{B^+}/\tau_{B^0} &= 1.066 \pm 0.008(\text{stat}) \pm 0.008(\text{syst}),\\
\Delta m_d &= [0.511 \pm 0.005(\text{stat}) \pm 0.006(\text{syst})]\ \text{ps}^{-1}.
\end{aligned}$$

All results are significant improvements in precision from the previous measurements, and are in agreement with the standard model expectations. The significance of the observed deviation from unity in the lifetime ratio exceeds 5 standard deviations for the first time by a single measurement.

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NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH Section A

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A novel type of proximity focusing RICH counter with multiple refractive index aerogel radiator

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Abstract

A proximity focusing ring imaging Cherenkov detector, with the radiator consisting of two or more aerogel layers of different refractive indices, has been tested in 1–4 GeV/c pion beams at KEK. Essentially, a multiple refractive index aerogel radiator allows for an increase in Cherenkov photon yield on account of the increase in overall radiator thickness, while avoiding the simultaneous degradation in single photon angular resolution associated with the increased uncertainty of the emission point. With the refractive index of consecutive layers suitably increasing in the downstream direction, one may achieve overlapping of the Cherenkov rings from a single charged particle. In the opposite case of decreasing refractive index, one may obtain well separated rings. In the former combination an approximately 40% increase in photon yield is accompanied with just a minor degradation in

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single photon angular resolution. The impact of this improvement on the π/K separation at the upgraded Belle detector is discussed.
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Keywords: Ring imaging Cherenkov counter; Proximity focusing; Aerogel; Particle identification; Belle

1. Introduction

Proximity focusing ring imaging Cherenkov (RICH) counters with non-gaseous radiators have the advantage of smaller size and are thus well suited as particle identification devices within more complex particle spectrometers with tight space constraints. Such a detector with aerogel as radiator is envisaged for the upgrade [1] of the particle identification system of the Belle spectrometer at the KEKB collider [2,3]. In the present Belle detector, a threshold-type Cherenkov detector (ACC) [4] enables a good π/K separation. However, ACC does not provide sufficient separation for high momentum particles around 4 GeV/c in the forward end-cap region, and a proximity focusing RICH with aerogel as radiator is being studied as a candidate for the detector upgrade.

Different aerogel radiators as well as different photon detectors have been investigated in search of an optimal counter, which would provide the required 4–5 σ pion-kaon separation in the 1–4 GeV/c momentum range [5]. Good velocity resolution of a charged particle track requires good resolution of the Cherenkov angle of a single photon and many detected photons. The number of photons may be increased by increasing the radiator thickness, but the price to pay is an increased uncertainty of the emission point, i.e. single photon angular resolution. However, by judiciously choosing the refractive indices of consecutive aerogel radiator layers, one may achieve overlapping of the corresponding Cherenkov rings on the photon detector. This represents a sort of focusing of the photons within the radiator, and eliminates or at least considerably reduces the spread due to emission point uncertainty. Another possibility is the opposite, i.e. to obtain separate rings from separate aerogel layers in which the emission point uncertainty is given by the thickness of the corresponding layer. One may also try combinations of the two main schemes. Note that such a tuning of refractive index for individual layers is only possible with aerogel, which may be produced with any desired refractive index in the range 1.006–1.06.

While the principle was first discussed in Ref. [6], the present work reports on measurements made with different combinations of aerogel radiator layers. First we present estimates of the relations between the radiator thicknesses and refractive indices in order to obtain either overlapping of the Cherenkov rings or their adequate separation. Next the experimental apparatus is described and the results of measurements and analysis are given. Finally, we discuss the possibilities of such a detector to meet the expectations for the upgrade of the Belle particle identification system.

2. RICH with multiple refractive index radiator

The key issue in the performance of a proximity focusing RICH counter is to improve the Cherenkov angle resolution per track $\sigma_{\mathrm{track}} = \sigma_\theta/\sqrt{N_{\mathrm{p.e.}}}$. By using a thicker aerogel radiator, the average number of detected photons $N_{\mathrm{p.e.}}$ can be increased, but the single photon Cherenkov angle resolution σ_θ degrades due to the increased uncertainty in the photon emission point. As can be seen from Fig. 1, the optimal thickness should be around 20 mm, which was also verified in previous investigations [5].

One way to solve this problem is to use a ‘‘dual radiator’’ scheme, where one images Cherenkov photons from two aerogel radiators with different refractive indices as shown in Fig. 2. In the first

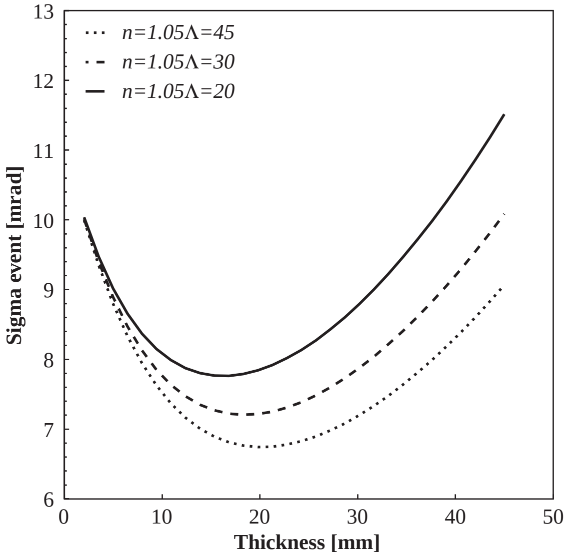

Fig. 1. The variation of the figure of merit, $\sigma_\theta/\sqrt{N_{\mathrm{p.e.}}}$, with radiator thickness in the case of a single radiator, proximity focusing RICH, for three different transmission lengths at 400 nm (Λ in mm).

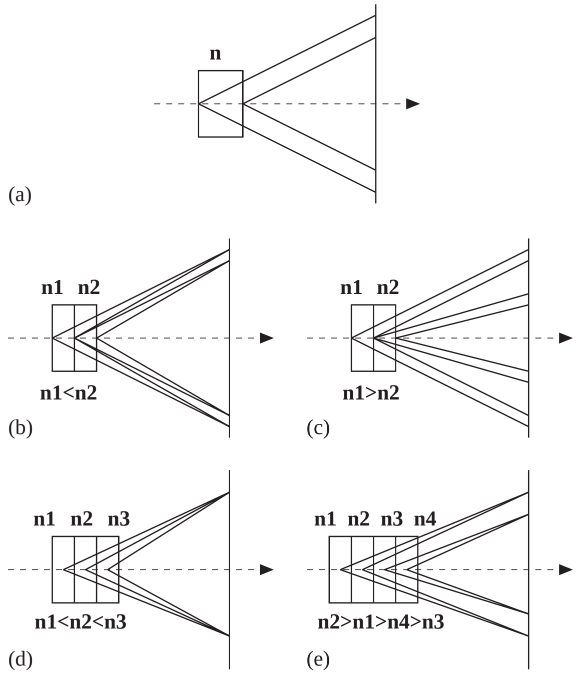

Fig. 2. Principle of dual radiator and multiple radiator ring imaging Cherenkov counter: (a) single radiator, (b) focusing dual radiator, (c) defocusing dual radiator, (d) focusing multiple radiator and (e) defocusing multiple radiator RICH. Only photons from the middle of the radiator are shown in (d) and (e).

combination (Fig. 2b) two aerogel radiators are used with slightly different indices, where the one with the lower refractive index is positioned upstream. If the indices of the two radiators are well adjusted, the corresponding two rings overlap. In the following this combination will be referred to as "focusing combination".

The other possibility is a "defocusing combination", in which the aerogel with higher index is positioned upstream (Fig. 2c). If the difference of the indices of the two aerogel tiles is appropriately chosen, the two radiators produce two well separated rings with good resolution.

A naive extension of the dual radiator combination is to use more than two aerogel radiators ("multiple radiator"). For the focusing combination, the indices of aerogels should gradually increase from the upstream to the downstream layer. Again, if the index of each layer is well chosen (Fig. 2d), the angular resolution of the ring will not be appreciably deteriorated in spite of a thicker radiator. The defocusing dual radiator may be extended to four radiators by introducing the focusing combination in every two layers as shown in Fig. 2e. In this case, the RICH has four radiators with different indices where the first two radiators in the upstream position create a larger ring, and the other two radiators a smaller ring.

3. Radiator parameters and expected performance

The relation between the refractive indices in the focusing combination in the dual radiator case is derived as follows. Neglecting the refraction at aerogel boundaries and denoting the thickness of a single radiator tile as d, the distance between the center of the downstream radiator and the photon detector plane as L, and the Cherenkov angles in both upstream and downstream radiator as θ_1 and θ_2, respectively, the condition that the two rings should overlap can be written as $L \tan\theta_2 = (L+d)\tan\theta_1$. From this condition the following approximate relation can be derived:

$$n_2 - n_1 = \frac{d}{n_1 L}\left[n_1^2 - 1 - \frac{(mc)^2}{p^2}\right]$$

where m and p are the pion mass and momentum.

The optimization of the radiator parameters thus clearly depends on the kinematical region the counter should cover. In the case of the upgrade of the Belle particle identification system, the indices are optimized for tracks with $p = 4\,\mathrm{GeV}/c$, the highest particle momenta from two-body B decays. As can be seen from Fig. 3, the overlap of the two rings remains sufficiently good even at lower momenta, so that the emission point error (full line) does not significantly increase with respect to the single radiator case of half the thickness (dashed line).

Similarly, since the relation derived above is valid only for perpendicularly incident tracks, the performance has to be checked also as a function of incidence angle. As shown in Fig. 4, only a modest increase in the emission point error is expected up to the maximal angle of incidence in the present application to the Belle upgrade (around 30°).

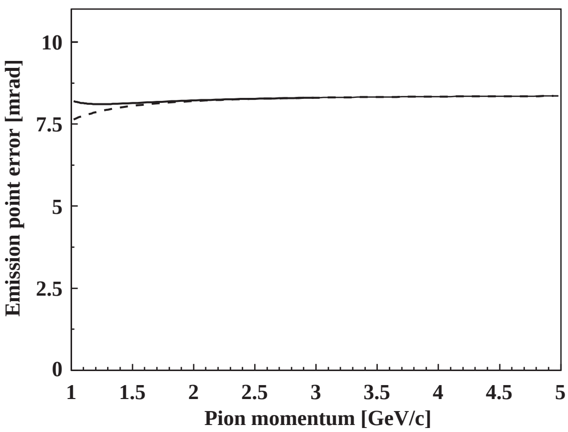

Fig. 3. Emission point error for a focusing combination (two 2 cm thick tiles with refractive indices 1.05 and 1.042 at a distance of 18 cm from the photon detector) as a function of momentum for perpendicularly incident pions (full line) compared to the single radiator of half the thickness (dashed).

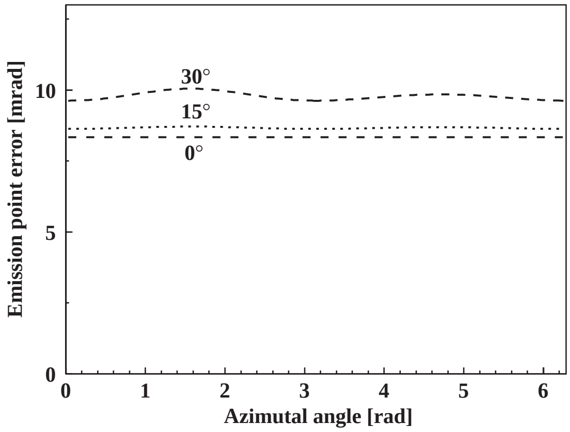

Fig. 4. Emission point error for the focusing combination (same as in Fig. 3) as a function of the azimuthal angle around the track direction for $4\,\mathrm{GeV}/c$ pions entering the counter at different angles of incidence (0° full line, 15° dash–dotted, 30° dotted).

For the dual radiator in the defocusing combination, the requirements are much less demanding. The two rings have to be well separated, and none of them should coincide with the ring corresponding to the other particle species. If one requires for the case of π/K separation that the kaon ring from the upstream radiator (corresponding to the angle $\theta_1(K)$) is separated by $k\sigma_\theta$ from the pion ring from the downstream radiator tile (corresponding to the angle $\theta_2(\pi)$), one arrives at the following expression
$(1 + d/L)\tan\theta_1(K) - \tan\theta_2(\pi) = k\sigma_\theta/\cos^2\theta_2(\pi)$,
from which one may derive a relation between n_1 and n_2. For a specific example with $d/L = 0.1$, $n_1 = 1.05$, $p = 4\,\mathrm{GeV}/c$ and $\sigma_\theta = 14\,\mathrm{mrad}$, values typical for such a counter, we get $n_1 - n_2 = 0.031$ for $k = 10$.

Note that for both the focusing and defocusing combinations the performance of the counter can be further optimized by varying the ratio of the thicknesses of the two radiators and the total thickness of the radiator.

4. Experimental apparatus

We have performed two beam tests in March and June 2004. The tests were carried out at the

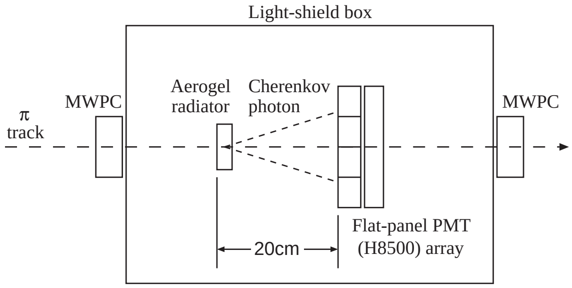

Fig. 5. The experimental set-up.

KEK-PS $\pi 2$ and T1 beam lines, where pions with momenta up to $4\,\mathrm{GeV}/c$ are available. The experimental set-up shown in Fig. 5 is basically the same as in the previous beam test [5]. The counter is composed of one or more layers of aerogel radiator and a photon-detection plane, parallel to the radiator face at a distance of 20 cm.

Multi-anode PMTs (Hamamatsu H8500) were used as photo-detectors. A total of 16 PMTs were positioned in a 4×4 array and aligned at a 52.5 mm pitch. The surface of each PMT is divided into 64 (8×8) channels with $6.08\,\mathrm{mm} \times 6.08\,\mathrm{mm}$ pixel size. This type of PMT is not immune to the magnetic field and cannot be applied in the Belle spectrometer, so this device is considered as an intermediate step in our development. For the final design, we plan to use the Hamamatsu HAPD or the BURLE Micro-Channel Plate PMT [7].

As radiators the same set of aerogel samples was used as in the tests with single refractive index radiators [5]. These aerogels have indices between 1.01 and 1.05; the transmission lengths at 400 nm (Λ) are around 30–40 mm. In addition, newly produced aerogels with refractive indices up to 1.07 were used, as well as two-layer aerogel samples [8], where a single tile is comprised of two layers with different indices.

5. Measurements and results

A typical distribution of accumulated hits on the photon detector is shown in Fig. 6. Cherenkov photons from the two aerogel radiators are clearly seen as a single ring with a low background level.

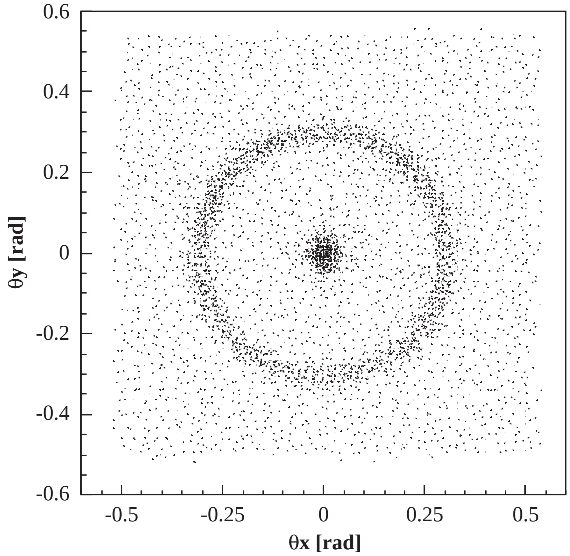

Fig. 6. A typical distribution of PMT hits in the Cherenkov x, y space with two 20 mm thick radiators ($n = 1.047$ and $n = 1.057$) in the focusing combination.

The hits near the center of the ring are due to Cherenkov radiation generated by the beam particle in the PMT window.

5.1. Test results with dual radiators

We first tested the focusing dual radiator combination with aerogel tiles of $n = 1.047$, $\Lambda = 34\,\mathrm{mm}$ in the upstream position, and $n = 1.057$, $\Lambda = 25\,\mathrm{mm}$ in the downstream position. Both radiators have a thickness of 20 mm. Fig. 7 shows the resulting distribution of the Cherenkov angle for single photons. Note that the Cherenkov angle is calculated by assuming that the photon is emitted in the middle of the combined radiator. The basic parameters of the counter, the resolution and the number of detected photons, are obtained by fitting to this distribution a Gaussian function for the signal and a second order polynomial for the background. The resulting single photon resolution σ_θ is 14.4 mrad, while the average number of detected photons amounts to $N_{\mathrm{p.e.}} = 9.6$. The Cherenkov angle resolution per track is calculated to be 4.8 mrad, corresponding to a 4.8σ π/K separation at $4\,\mathrm{GeV}/c$.

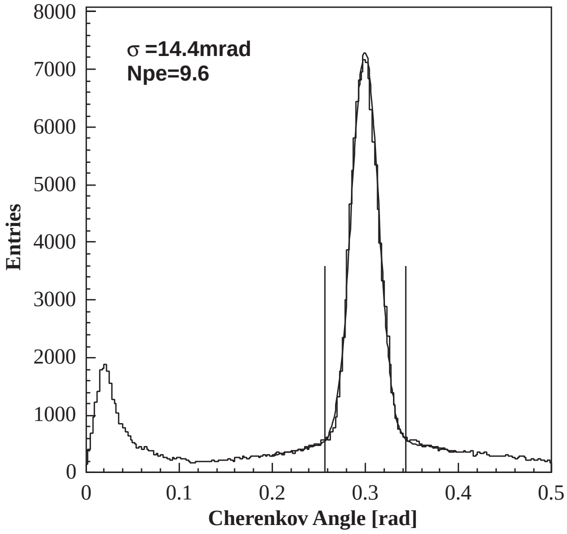

Fig. 7. Distribution of the Cherenkov angle for accumulated single photons from $4\,\mathrm{GeV}/c$ pions in the case of a focusing dual radiator combination with 20 mm thick radiators ($n = 1.047$ and $n = 1.057$).

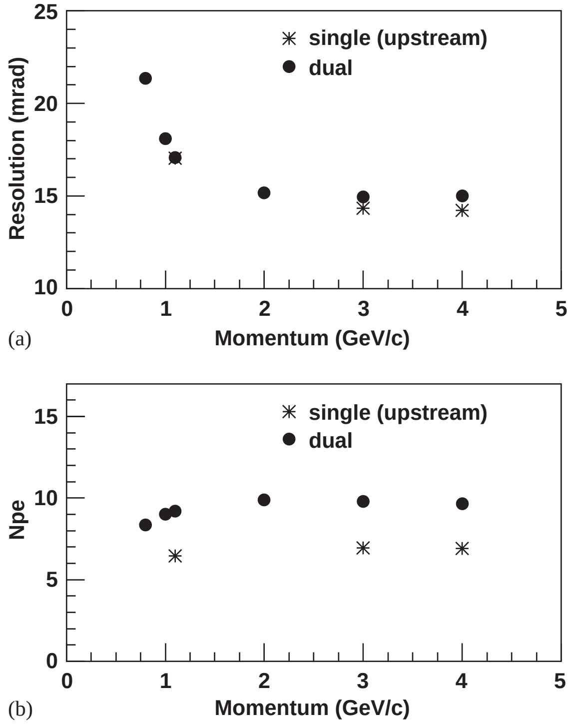

Fig. 8. Momentum dependence of the single photon resolution (a) and the number of detected photons (b) for the dual radiator focusing combination compared to the single radiator.

For comparison, measurements were also performed for single radiator cases when only the upstream or the downstream aerogel tile of the dual radiator is used. For the upstream and downstream radiator, the measured yield was 6.9 and 7.5 photons per ring, respectively. The single photon resolution was 13.8 mrad for the single radiator in the upstream position.

The single photon resolution $\sigma_\theta = 14.4\,\mathrm{mrad}$ for the dual radiator is similar to that for the single radiator of half the thickness, while the number of detected photons is larger for the dual radiator. In the dual radiator RICH, a fraction of photons emitted in the upstream radiator is scattered in the downstream aerogel. Therefore, the photoelectron yield is expected to be $N_{\mathrm{p.e.}} \sim N_1 \exp(-d_2/(\cos\theta_1 \Lambda_2)) + N_2 = 10.6$, where N_1 (N_2) is the number of the detected photons in the single radiator RICH with only upstream (downstream) radiator, θ_1 is the Cherenkov angle in the upstream radiator, while d_2 and Λ_2 are the thickness and transmission length of the downstream radiator. This is consistent with the measured value of 9.6.

We also measured the momentum dependence of $N_{\mathrm{p.e.}}$ and σ_θ as shown in Fig. 8. Note that although the overlap of the rings from two radiators is optimized for a certain momentum, the variation of σ_θ is for the dual radiator RICH similar to that of the single radiator RICH over the full kinematic range. The increase in σ_θ at lower momenta is consistent with the contribution from multiple scattering.

For the defocusing dual radiator set-up, we used a combination of radiators with $n = 1.057$ and $n = 1.027$. Each radiator had a thickness of 20 mm. The single photon Cherenkov angle distribution for this combination is shown in Fig. 9. Two well separated rings are clearly seen. The sum of the number of photons from the two rings is larger than that from a single radiator with a thickness of 20 mm, while the resolutions are almost the same. Note that unfortunately the transparency of the downstream radiator was low ($\Lambda = 19\,\mathrm{mm}$) in this particular measurement; the use of a typical sample of $n \approx 1.03$ with the

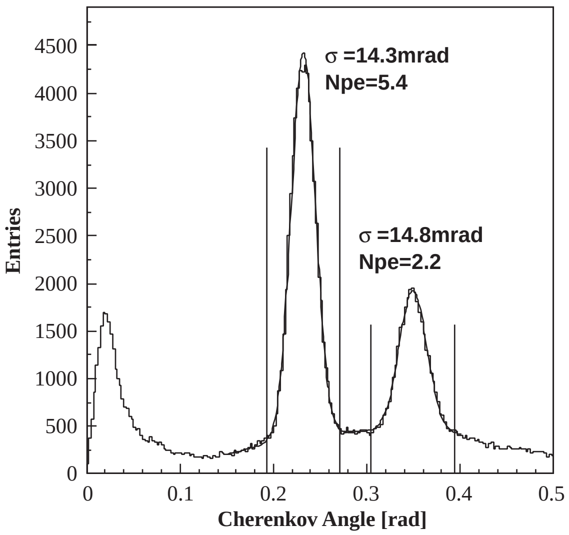

Fig. 9. Distribution of the Cherenkov angle of single photons from 4 GeV/c pions for a defocusing dual radiator RICH with $n_1 = 1.057$ and $n_2 = 1.027$.

transmission length around 30 mm would considerably increase the light yield at the outer ring.

We also tested a two-layer aerogel tile with indices of 1.060 and 1.030 in the defocusing combination. We could observe two well separated rings on the photon detector. However, the photon yield was rather low because of a short transmission length of the radiator. This is due to the production procedure for such kind of tiles, which has not been optimized yet.

5.2. Tests with multiple radiators

In order to study the multiple radiator RICH in the focusing combination, we prepared a dual radiator configuration with indices of 1.046 and 1.051, and a triple radiator configuration with indices of 1.046, 1.051 and 1.056. The thickness of each radiator was 10 mm, such that the dual radiator is 20 mm thick, and the triple radiator is 30 mm thick. The performance of these set-ups is compared with the single radiator combination with $n = 1.046$ and radiator thickness of 10, 20 and 30 mm.

Fig. 10 shows σ_θ, $N_{\mathrm{p.e.}}$ and σ_{track} distributions against the thickness of the radiators. $N_{\mathrm{p.e.}}$ increases as the radiator becomes thicker, and there is no significant difference of $N_{\mathrm{p.e.}}$ between single and multiple radiator combinations. On the other hand, σ_θ of the single radiator RICH increases considerably as the radiator gets thicker, but σ_θ for the multiple radiator case increases only slightly. As a result, σ_{track} is improved by introducing the multiple radiator combination, and the triple radiator with 30 mm gives the best σ_{track} of 4.5 mrad.

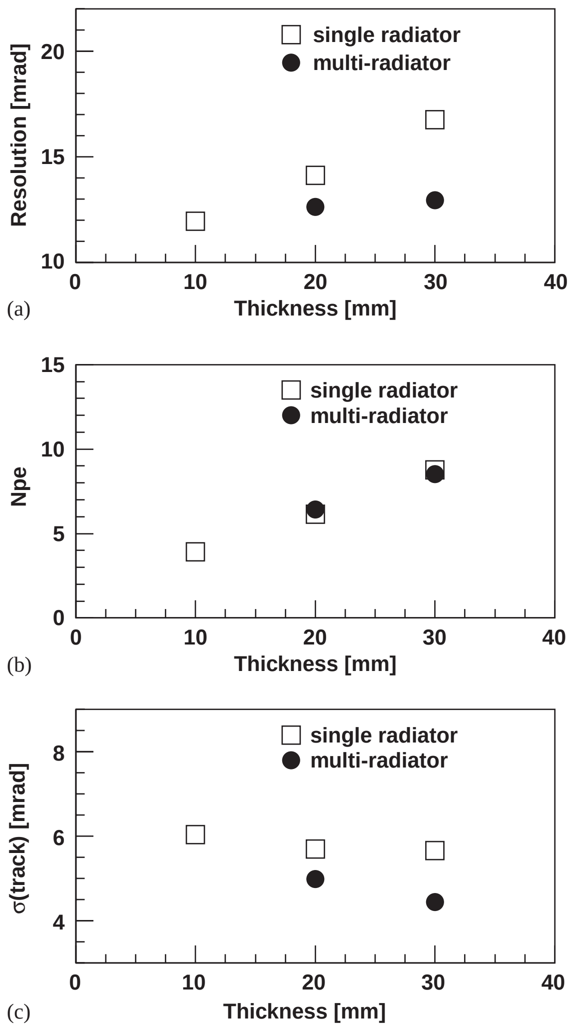

Fig. 10. Single photon resolution (a), number of detected photons (b) and single track resolution (c) for the focusing multiple radiator RICH combinations. The multiple radiator with a 20 mm thick radiator is a dual radiator, while that with 30 mm is a triple radiator.

Table 1
Performance of the defocusing combination: single photon angular resolution and photon yield for the multiple radiator and dual radiator combinations

RICH	Inner ring	Outer ring
Dual radiator	$\sigma_\theta = 15.0\,\text{mrad}$ $N_{\text{p.e.}} = 4.6$	$\sigma_\theta = 14.6\,\text{mrad}$ $N_{\text{p.e.}} = 1.7$
Multiple radiator	$\sigma_\theta = 13.7\,\text{mrad}$ $N_{\text{p.e.}} = 3.8$	$\sigma_\theta = 13.0\,\text{mrad}$ $N_{\text{p.e.}} = 2.1$

We also tested a defocusing multiple radiator with four radiator indices of 1.051, 1.056, 1.029 and 1.034 in a combination shown in Fig. 2e. We compared it with a defocusing dual radiator RICH with radiators of $n = 1.056$ and 1.025. The total thickness of aerogel radiators was 40 mm in both cases. The measured values of σ_θ and $N_{\text{p.e.}}$ are listed in Table 1. As expected, we find that the multiple radiator RICH has a better overall angular resolution at roughly the same photon yield.

6. Conclusion

We have studied dual and multiple radiator combinations of the proximity focusing aerogel RICH detector. For the focusing combination, we confirmed that the number of detected photons could be increased without deteriorating angular resolution compared to the single radiator RICH. In the triple radiator configuration we have achieved a Cherenkov angle resolution per track of $\sigma_{\text{track}} = 4.5\,\text{mrad}$, which corresponds to a 5.1σ K/π separation at $4\,\text{GeV}/c$.

In the defocusing dual radiator RICH, we observed two rings with good angular resolution that were well separated. We also succeeded to improve the resolution of each ring with a RICH with four radiators.

Although the dual and multiple radiator proximity focusing RICH looks promising both in the focusing and defocusing combination, further studies are needed before deciding which of the two combinations should be employed, and how many radiators should be used in the final design for the upgraded Belle detector. The method of reconstruction and the effect of background will be studied in detail, especially for the defocusing combination where two rings are produced. We also plan to test the multiple radiator RICH with even more layers, and investigate the production of multi-layer aerogel tiles with a large transmission length.

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Evidence for D^0-$\bar{D}^0$ Mixing

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We observe evidence for D^0-$\bar{D}^0$ mixing by measuring the difference in the apparent lifetime when a D^0 meson decays to the CP eigenstates K^+K^- and $\pi^+\pi^-$ and when it decays to the final state $K^-\pi^+$. We find the relative difference of the lifetimes y_{CP} to be $[1.31 \pm 0.32(\mathrm{stat}) \pm 0.25(\mathrm{syst})]\%$, 3.2 standard deviations from zero. We also search for a CP asymmetry between D^0 and $\bar{D}^0$ decays; no evidence for CP violation is found. These results are based on 540 fb^{-1} of data recorded by the Belle detector at the KEKB e^+e^- collider.

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The phenomenon of mixing between a particle and its antiparticle has been observed in several systems of neutral mesons [1,2]: neutral kaons, B_d^0, and most recently B_s^0 mesons. In this Letter, we present evidence for D^0-$\bar{D}^0$ mixing [3].

The time evolution of a D^0 or $\bar{D}^0$ is governed by the lifetime $\tau = 1/\Gamma$ and the mixing parameters $x = (M_1 - M_2)/\Gamma$ and $y = (\Gamma_1 - \Gamma_2)/2\Gamma$. $M_{1,2}$ and $\Gamma_{1,2}$ are the masses and widths of the mass eigenstates, respectively, and $\Gamma = (\Gamma_1 + \Gamma_2)/2$. For no mixing, $x = y = 0$. Within the standard model (SM), the rate of D mixing is expected to be small due to the near degeneracy of the s and d quark masses relative to the W mass and the small value of the b quark couplings. Predictions for x and y are dominated by nonperturbative processes that are difficult to calculate [4,5]. The largest predictions are $|x|, |y| \sim \mathcal{O}(10^{-2})$ [5]. Loop diagrams including new, as-yet-unobserved particles could significantly affect the experimental values [6]. CP-violating effects in D mixing would be a clear signal of new physics, as CP violation (CPV) is expected to be very small in the SM [7].

Both semileptonic and hadronic D decays have been used to constrain x and y [1]. Here we study the decays to CP eigenstates $D^0 \to K^+K^-$ and $D^0 \to \pi^+\pi^-$; treating the decay-time distributions as exponential, we measure the quantity

$$y_{CP} = \frac{\tau(K^-\pi^+)}{\tau(K^+K^-)} - 1, \tag{1}$$

where $\tau(K^+K^-)$ and $\tau(K^-\pi^+)$ are the lifetimes of $D^0 \to K^+K^-$ (or $\pi^+\pi^-$) and $D^0 \to K^-\pi^+$ decays [8]. It can be shown that $y_{CP} = y\cos\phi - \frac{1}{2}A_M x \sin\phi$ [9], where A_M parametrizes CPV in mixing and ϕ is a weak phase. If CP is conserved, $A_M = \phi = 0$ and $y_{CP} = y$. To date, several measurements of y_{CP} have been reported [10]; the average value is ~ 2 standard deviations (σ) above zero. Our measurement yields a nonzero value of y_{CP} with $>3\sigma$ significance. We also search for CPV by measuring the quantity

$$A_\Gamma = \frac{\tau(\bar{D}^0 \to K^-K^+) - \tau(D^0 \to K^+K^-)}{\tau(\bar{D}^0 \to K^-K^+) + \tau(D^0 \to K^+K^-)}; \tag{2}$$

this observable equals $A_\Gamma = \frac{1}{2}A_M y \cos\phi - x \sin\phi$ [9].

Our results are based on 540 fb^{-1} of data recorded by the Belle experiment [11] at the KEKB asymmetric-energy e^+e^- collider [12], running at the center-of-mass (c.m.) energy of the $\Upsilon(4S)$ resonance and 60 MeV below. To avoid bias, details of the analysis procedure were finalized without consulting quantities sensitive to y_{CP} and A_Γ.

The Belle detector is described in detail elsewhere [11]: It includes, in particular, a silicon vertex detector [13], a central drift chamber, an array of aerogel Cherenkov counters, and time-of-flight scintillation counters. We reconstruct $D^{*+} \to D^0 \pi_s^+$ decays with a characteristic slow pion π_s, and $D^0 \to K^+K^-$, $K^-\pi^+$, and $\pi^+\pi^-$. The charge of the $\pi_s^\pm$ determines the flavor of the produced neutral D meson. Each track is required to have at least two associated vertex detector hits in each of the two measuring coordinates. To select pion and kaon candidates, we impose standard particle identification criteria [14]. D^0 daughter tracks are refitted to a common vertex, and the D^0 production vertex is found by constraining its momentum vector and the π_s track to originate from the e^+e^- interaction region; confidence levels exceeding 10^{-3} are required for both fits. A D^* momentum greater than 2.5 GeV$/c$ (in the c.m.) is required to reject D mesons produced in B-meson decays and to suppress combinatorial background. The proper decay time of the D^0 candidate is then calculated from the projection of the vector joining the two vertices $\vec{L}$ onto the D^0 momentum vector $t = m_{D^0} \vec{L} \cdot \vec{p}/p^2$, where m_{D^0} is the nominal D^0 mass. The decay-time uncertainty σ_t is evaluated event by event from the covariance matrices of the production and decay vertices.

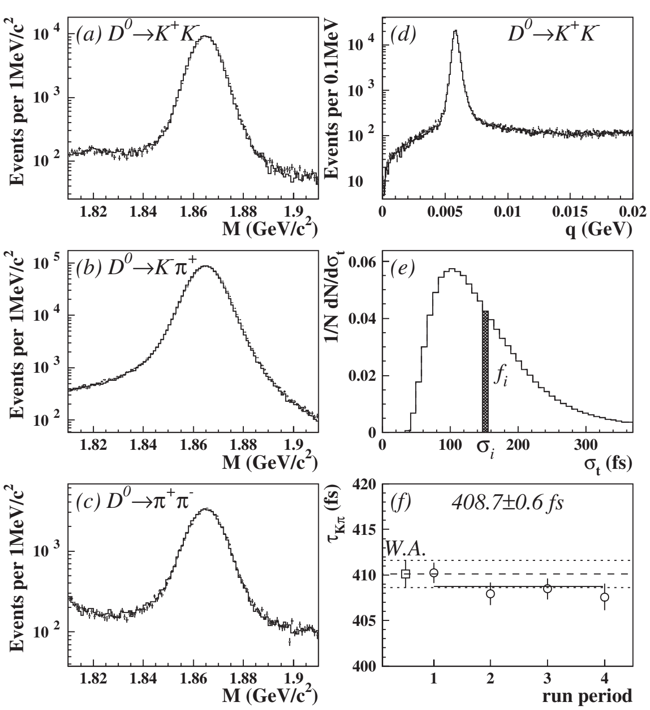

FIG. 1. M distribution of selected events (with $|\Delta q| < 0.80$ MeV and $\sigma_t < 370$ fs) for (a) K^+K^-, (b) $K^-\pi^+$, and (c) $\pi^+\pi^-$ final states. The histogram shows the tuned MC distribution. (d) q distribution (with $|\Delta M|/\sigma_M < 2.3$ and $\sigma_t < 370$ fs) for the K^+K^- final state. (e) Normalized distribution of errors σ_t on the decay time t for $D^0 \to K^-\pi^+$, showing the construction of the resolution function using the fraction f_i in the bin with $\sigma_t = \sigma_i$. (f) Fitted lifetime of D^0 mesons in the $K^-\pi^+$ final state in four running periods with slightly different conditions and the result of a fit to a constant. The world average value (W.A.) is also shown.

Candidate D^0 mesons are selected using two kinematic observables: the invariant mass of the D^0 decay products M and the energy released in the D^{*+} decay $q = (M_{D^*} - M - m_\pi)c^2$. M_{D^*} is the invariant mass of the $D^0\pi_s$ combination, and m_π is the π^+ mass.

According to Monte Carlo (MC) simulated distributions of t, M, and q, background events fall into four categories: (i) combinatorial, with zero apparent lifetime; (ii) true D^0 mesons combined with random slow pions (this has the same apparent lifetime as the signal); (iii) D^0 decays to three or more particles; and (iv) other charm hadron decays. The apparent lifetime of the latter two categories is 10%–30% larger than τ_{D^0}. Since we find differences in M and q distributions between MC simulation and data events, we perform fits to data distributions to obtain scaling factors for the individual background categories and signal widths and then tune the background fractions and signal shapes in the MC simulation event by event.

The sample of events for the lifetime measurements is selected using $|\Delta M|/\sigma_M$, where $\Delta M \equiv M - m_{D^0}$, $|\Delta q| \equiv q - (m_{D^{*+}} - m_{D^0} - m_\pi)c^2$, and σ_t. The invariant mass resolution σ_M varies from 5.5–6.8 MeV$/c^2$, depending on the decay channel. Selection criteria are chosen to minimize the expected statistical error on y_{CP}, using the tuned MC simulation: We require $|\Delta M|/\sigma_M < 2.3$, $|\Delta q| < 0.80$ MeV, and $\sigma_t < 370$ fs. The data distributions and agreement with the tuned MC distributions are shown in Figs. 1(a)–1(d). We find $111 \times 10^3 K^+K^-$, $1.22 \times 10^6 K^-\pi^+$, and $49 \times 10^3 \pi^+\pi^-$ signal events, with purities of 98%, 99%, and 92%, respectively.

The relative lifetime difference y_{CP} is determined from $D^0 \to K^+K^-$, $K^-\pi^+$, and $\pi^+\pi^-$ decay-time distributions by performing a simultaneous binned maximum likelihood fit to the three samples. Each distribution is assumed to be a sum of signal and background contributions, with the signal contribution being a convolution of an exponential and a detector resolution function:

$$dN/dt = \frac{N_{\rm sig}}{\tau} \int e^{-t'/\tau} R(t - t') dt' + B(t). \qquad (3)$$

The resolution function $R(t - t')$ is constructed from the normalized distribution of the decay-time uncertainties σ_t [see Fig. 1(e)]. The σ_t of a reconstructed event ideally represents an uncertainty with a Gaussian probability density: In this case, we take bin i in the σ_t distribution to correspond to a Gaussian resolution term of width σ_i, with a weight given by the fraction f_i of events in that bin. However, the distribution of "pulls," i.e., the normalized residuals $(t_{\rm rec} - t_{\rm gen})/\sigma_t$ (where $t_{\rm rec}$ and $t_{\rm gen}$ are reconstructed and generated MC decay times), is not well described by a Gaussian. We find that this distribution can be fitted with a sum of three Gaussians of different widths $\sigma_k^{\rm pull}$ and fractions w_k, constrained to the same mean. We therefore choose a parametrization

$$R(t-t') = \sum_{i=1}^{n} f_i \sum_{k=1}^{3} w_k G(t-t'; \sigma_{ik}, t_0), \qquad (4)$$

with $\sigma_{ik} = s_k \sigma_k^{\rm pull} \sigma_i$, where the s_k are three scale factors introduced to account for differences between the simulated and real $\sigma_k^{\rm pull}$, and t_0 allows for a (common) offset of the Gaussian terms from zero.

The background $B(t)$ is parametrized assuming two lifetime components: an exponential and a δ function, each convolved with corresponding resolution functions as parametrized by Eq. (4). Separate $B(t)$ parameters for each final state are determined by fits to the t distributions of events in M sidebands. The tuned MC simulation is used to select the sideband region that best reproduces the timing distribution of background events in the signal region. We find good agreement between the tuned MC simulation and data sidebands, with a normalized χ^2 of 0.85, 0.83, and 0.83 for KK, $K\pi$, and $\pi\pi$, respectively.

The $R(t-t')$ and background parametrizations are validated using MC simulation and the large $D^0 \to K^-\pi^+$ sample selected from data. In the simulation, the ratio of scale factors s_k ($k = 1, 2, 3$) is consistent between decay modes, within small statistical uncertainties. The offset t_0 is also independent of the final state, but it changes slightly for simulated samples describing different running periods. Four such periods, coinciding with changes to the detector, have been identified based on small variations of the mean t value for $D^0 \to K^-\pi^+$ in the data. We perform a separate fit to each period and average the results to obtain the final value of y_{CP}. The free parameters of each simultaneous fit are τ_{D^0}, y_{CP}, the three s_k factors for the $K^-\pi^+$ mode, two terms that rescale the s_k values in the K^+K^- and $\pi^+\pi^-$ channels, the offset t_0, and normalization terms for the three decay modes. Fits to the $D^0 \to K^-\pi^+$ sample show good agreement with the parameters of $R(t-t')$ obtained from simulation.

For the second running period, we modify Eq. (4) to add mode-dependent offsets Δt between the first two Gaussian terms, making the resolution function asymmetric; these three parameters are also left free in the fit. We find that such a function is required to yield the $D^0 \to K^-\pi^+$ lifetime consistent with that in the other running periods. (This behavior has been reproduced with a MC model including a small relative misalignment of the vertex detector and the drift chamber. While small changes in the shape of the resolution function, as described below, influence the individual measured lifetimes, they have a very small effect on the value of y_{CP}.) The lifetime fit results are shown in Fig. 1(f): The mean $\tau_{D^0} = [408.7 \pm 0.6(\mathrm{stat})]$ fs is in good agreement with the current world average (410.1 ± 1.5) fs [1].

Fits to the $D^0 \to K^+K^-$, $K^-\pi^+$, and $\pi^+\pi^-$ data for the four running periods are shown in Figs. 2(a)–2(c), by summing both the data points and the fit functions. Averaging the fit results, we find $y_{CP} = [1.31 \pm 0.32(\mathrm{stat})]\%$, 4.1 standard deviations from zero. The agreement between the data and the fit functions is good: $\chi^2/n_{\rm dof} = 1.08$ for $n_{\rm dof} = 289$ degrees of freedom. Fitting $K^+K^-/K^-\pi^+$ and $\pi^+\pi^-/K^-\pi^+$ events separately, we obtain $y_{CP} = [1.25 \pm 0.39(\mathrm{stat})]\%$ and $y_{CP} = [1.44 \pm 0.57(\mathrm{stat})]\%$, respectively, in agreement with each other. The y_{CP} values for the four running periods are also consistent, with $\chi^2/n_{\rm dof} = 1.53/3$.

To measure the CPV parameter A_Γ, we separately determine the apparent lifetimes of D^0 and $\bar{D}^0$ in decays to the CP eigenstates; the data are fit in four running periods as for y_{CP}. As the scale factors s_i are now determined from the K^+K^- and $\pi^+\pi^-$ samples rather than (mainly) from the large $K^-\pi^+$ sample, to ensure convergence of the fits we fix the scale factor s_3 for the widest Gaussian to the value obtained from the y_{CP} fit. We obtain $A_\Gamma = [0.01 \pm 0.30(\mathrm{stat})]\%$, consistent with zero; the quality of the fit is good, with $\chi^2/n_{\rm dof} = 1.00$ for $n_{\rm dof} = 390$. Separate fits to the two CP eigenstates find compatible values: $A_\Gamma = [0.15 \pm 0.35(\mathrm{stat})]\%$ for K^+K^- and $-[0.28 \pm 0.52(\mathrm{stat})]\%$ for $\pi^+\pi^-$.

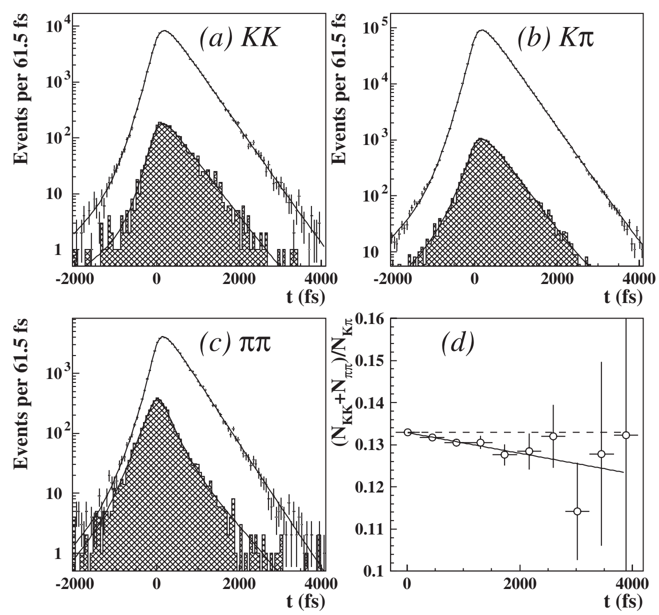

FIG. 2. Results of the simultaneous fit to decay-time distributions of (a) $D^0 \to K^+K^-$, (b) $D^0 \to K^-\pi^+$, and (c) $D^0 \to \pi^+\pi^-$ decays. The cross-hatched area represents background contributions, the shape of which was fitted using M sideband events. (d) Ratio of decay-time distributions between $D^0 \to K^+K^-, \pi^+\pi^-$ and $D^0 \to K^-\pi^+$ decays. The solid line is a fit to the data points.

The behavior of the fits has been tested in various ways using MC simulation. Fits to signal events simulated with $y_{CP} = 0$ reproduce this value (and the generated τ_{D^0}) even for a sample much larger than the data, with $(\chi^2/n_{\rm dof}, n_{\rm dof}) = (1.112\,85)$. Using samples of the same size as the data, with background included, we find a satisfactory fit, $(\chi^2/n_{\rm dof}, n_{\rm dof}) = (1.182\,89)$, with a statistical uncertainty in agreement with the error from the fit to the data. Results obtained on reweighted MC samples that cover a wide range of y_{CP} values agree with the input within $\pm 0.04\%$.

The effect of the resolution function on the measured y_{CP} has been tested by replacing the parametrization in Eq. (4) with a single Gaussian. This describes the data poorly and leads to a 3.9% shift in the fitted τ_{D^0} for a simulated $D^0 \to K^-\pi^+$ sample; however, the corresponding shift in y_{CP} is only 0.01%. This shows that the y_{CP} value returned by the fit is robust against imperfections in the parametrization of $R(t - t')$.

The estimated systematic uncertainties are summarized in Table I. We test for acceptance variations with decay time by fitting the generated decay times of reconstructed MC events. We find no deviation but conservatively assign the MC statistical error on y_{CP} ($\pm 0.12\%$) to this source. Another contribution is due to the choice of equal t_0 offsets in different decay modes: Relaxing this assumption leads to y_{CP} changes of $\pm 0.14\%$. Variation of the D^0 mass windows changes y_{CP} by less than $\pm 0.04\%$. The effect of differences between backgrounds in the signal and sideband regions is studied by repeating the fits using MC backgrounds from signal regions; small shifts in the data sidebands used to determine $B(t)$ are also made. The largest resulting change in y_{CP}, $\pm 0.09\%$, is quoted as the systematic error due to the background description. Potential correlations between apparent lifetimes and opening angle distributions (which differ between modes) have a small effect on y_{CP}: $\pm 0.02\%$.

The uncertainty due to the finite number of sideband events, $\pm 0.07\%$, is estimated by varying bin contents according to Poisson statistics and repeating the fits.

TABLE I. Sources of the systematic uncertainty for y_{CP} and A_Γ.

Source	$\Delta y_{CP}[\%]$	$\Delta A_\Gamma[\%]$
Acceptance	0.12	0.07
Equal t_0	0.14	0.08
M window position	0.04	<0.01
Signal/sideband background differences	0.09	0.06
Opening angle distributions	0.02	⋯
Background distribution $B(t)$	0.07	0.07
(A)symmetric resolution function	0.01	0.01
Selection variation	0.11	0.05
Binning of t distribution	0.01	0.01
Total	0.25	0.15

Comparing alternative fits where all running periods use the symmetric resolution function (4), and the asymmetric function presently used for the second period, we assign an additional uncertainty of $\pm 0.01\%$. Varying selection criteria produces observable effects only in high statistics MC samples, in the σ_t and $|\Delta M|/\sigma_M$ cases. The resulting $\pm 0.11\%$ changes in y_{CP} are conservatively assigned as systematic errors. Finally, varying the binning of the decay-time distribution produces a small effect, $\pm 0.01\%$. Adding all terms in quadrature, we obtain a systematic uncertainty on y_{CP} of $\pm 0.25\%$. The same sources dominate for A_Γ but yield a smaller total systematic uncertainty, $\pm 0.15\%$.

In summary, we measure the relative difference of the apparent lifetime of D^0 mesons between decays to CP-even eigenstates and the $K^-\pi^+$ final state to be

$$y_{CP} = [1.31 \pm 0.32(\text{stat}) \pm 0.25(\text{syst})]\%. \tag{5}$$

Combining the errors in quadrature, we find a confidence level of only 6×10^{-4} for the $y_{CP} = 0$ hypothesis. We interpret this result as evidence for mixing in the D^0-$\bar{D}^0$ system, regardless of possible CPV. The effect is presented visually in Fig. 2(d), which shows the ratio of decay-time distributions for $D^0 \to K^+K^-, \pi^+\pi^-$ and $D^0 \to K^-\pi^+$ decays. We also search for CP violation by separately measuring decay times of D^0 and $\bar{D}^0$ mesons in CP-even final states. We find an asymmetry consistent with zero:

$$A_\Gamma = [0.01 \pm 0.30(\text{stat}) \pm 0.15(\text{syst})]\%. \tag{6}$$

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Measurement of Cherenkov photons with silicon photomultipliers

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ABSTRACT

In addition to their other advantages, silicon photomultipliers (SiPMs) are insensitive to magnetic fields, so they would be attractive as photon detectors for ring imaging Cherenkov counters inside large magnetic spectrometers. In view of the foreseen upgrade of the particle identification system of the Belle spectrometer, we have investigated the possibilities offered by these new photon detectors. Cherenkov photons emitted by cosmic ray particles in an aerogel radiator have been detected with SiPMs for the first time. Estimates and tests show that light concentrators may improve the detection efficiency, thus showing promise for an SiPM based RICH detector.

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1. Introduction

Silicon photomultipliers (SiPMs) are novel semiconductor photosensitive devices consisting of an avalanche photodiode (APD) matrix on a common silicon substrate, working in the limited Geiger mode [1–3]. They are proving to be competitive to traditional detectors of photons. Among their advantages is the insensitivity to magnetic fields, low supply voltage, they are relatively robust, do not require much space and their single photon detection efficiency typically exceeds that of vacuum photomultiplier tubes. However, the relatively large dark noise rate represents a difficulty for measurements of weak light signals, especially of single photons as is required in Cherenkov ring imaging. If one measures only signals in a sufficiently narrow time window, one might reduce the dark counts while preserving the detected Cherenkov photons. The signal-to-noise ratio can be further improved by using light concentrators to increase the effective active area. It is therefore a challenge to attempt to use SiPMs for detection of Cherenkov rings.

The intended upgrade of the particle identification system of the Belle spectrometer will include a ring imaging Cherenkov counter (RICH), which is required to separate kaons from pions up to a momentum of 4 GeV/c [4]. Due to limited space, the best option seems to be a proximity focusing RICH detector with aerogel as Cherenkov radiator. Multianode PMTs with metal foil dynode structure, micro-channel plate PMTs and hybrid avalanche photodiodes (HAPDs) have been studied as possible detectors of Cherenkov photons [5–7]. The appearance of SiPMs, with their promising characteristics, offers new possibilities. This work represents an effort towards an evaluation of these options.

2. Experimental set-up

The experimental set-up for measurement of Cherenkov photons is shown in Fig. 1. After generating a trigger signal in a scintillator, the cosmic ray particle is registered by three multi-wire proportional chambers, from which the track coordinates are obtained by delay line readout of cathode plane signals. The charged particle then enters a light tight box, inside which a 2.5 cm thick aerogel radiator ($n = 1.045$) and photon detectors are mounted on appropriate supports (Fig. 2). The photon detector consists of an array of 12 multianode PMTs (Hamamatsu R5900-M16) and six SiPMs (also by Hamamatsu). The M16 PMTs have been previously used by our group [8,9], their characteristics are well known, so they serve as a reference against which we compare the parameters of the SiPMs. The silicon PMs are of type Hamamatsu MPPC S10362-11-100U with 1 mm^2 area and 100 μm pixels [10]. The larger pixel size (100 μm) compared to SiPMs with smaller pixels (50 and 25 μm) was preferred because the positive effect of increased photon detection efficiency (due to increased fraction of sensitive area) outweighs the negative effect of

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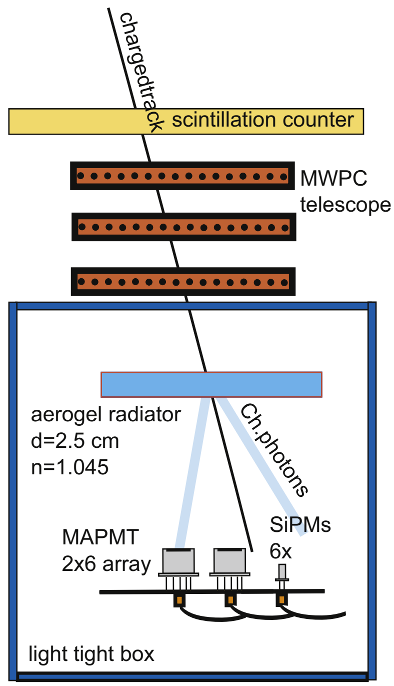

Fig. 1. The experimental set-up.

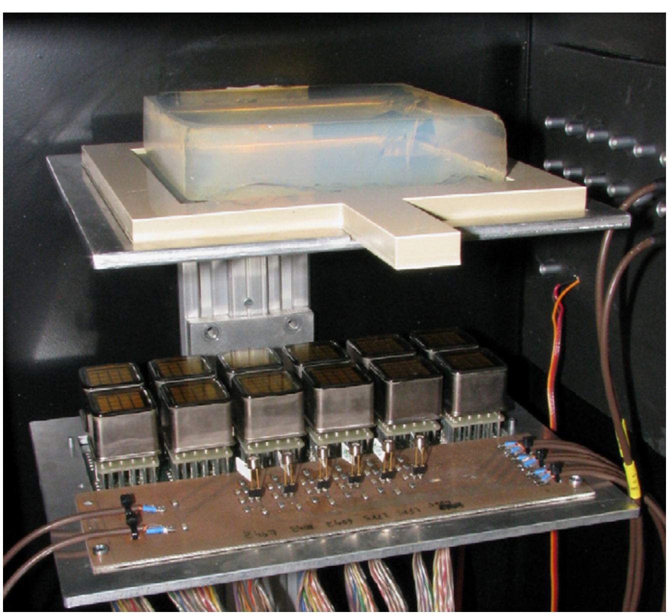

Fig. 2. A close-up view of the aerogel radiator and the photon detectors on their supports in the dark box.

increased noise rate. The circuit through which voltage was applied and the signal was read out is shown in Fig. 3.

The signals from the SiPMs are amplified (Ortec FTA820), discriminated (EG&G CO8000, used in the leading edge mode) and registered by multi-hit VME TDCs (CAEN V673A). So for each hit, the time of arrival is measured in addition to information of the hit position given by the position of the particular photon detector channel.

3. Results

The raw distribution of all SiPM signals, with respect to time relative to the scintillation counter trigger signal, is shown in

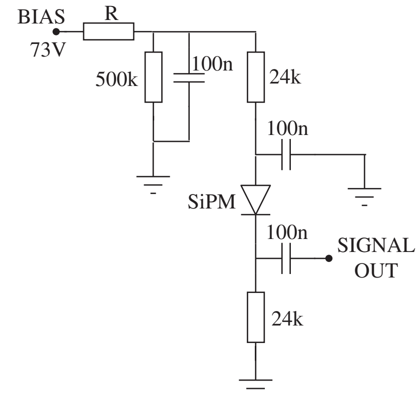

Fig. 3. The circuit diagram for connecting the silicon photomultipliers; the resistor *R* was adjusted for each individual SiPM.

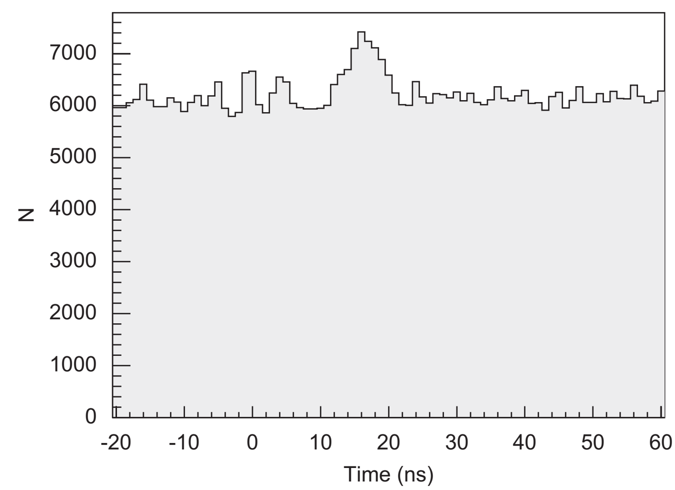

Fig. 4. The raw measured time spectrum of all signals registered by the silicon photomultipliers.

Fig. 4. Although on a relatively high background, there is clear evidence of a peak in the time distribution. By correcting for the time offset of individual SiPMs and plotting only those signals which correspond to a hit in the range of $\pm 2\sigma$ within the expected Cherenkov angle relative to the charged particle track, we obtain the time distribution of Fig. 5. It is seen that the peak of Cherenkov photons is better pronounced and the background is considerably reduced, mainly on account of the reduction of dark noise. The distribution of hits as a function of their Cherenkov angle is shown in Fig. 6, for the MA-PMTs (Fig. 6a), for the SiPM signals that are out of the peak time window (Fig. 6b) and for the SiPM signals that fall within a 3 ns time window of the peak (Fig. 6c). Since the resolution of the Cherenkov angle is in the present set-up dominated by the uncertainty in determination of the charged particle track parameters, the widths of the Cherenkov photon peaks in both types of detectors should be about equal. Therefore, the fitting of the SiPM distribution (Fig. 6c) has been performed by fixing the peak position and width to the values obtained from the MA-PMTs (Fig. 6a), and by fixing the background shape to that of the out-of-time spectrum (Fig. 6b), so only the normalization was allowed to vary. This procedure results in 597 photons detected by the SiPMs, while about 67,000 photons were detected by the MA-PMTs. As the area covered by the SiPMs is only 6 mm^2, whereas the area covered by the MA-PMTs is 3645 mm^2, this means that 5.4 ± 0.2 times more photons are detected per unit area of the SiPMs than per unit area of the MA-PMTs. Such a result

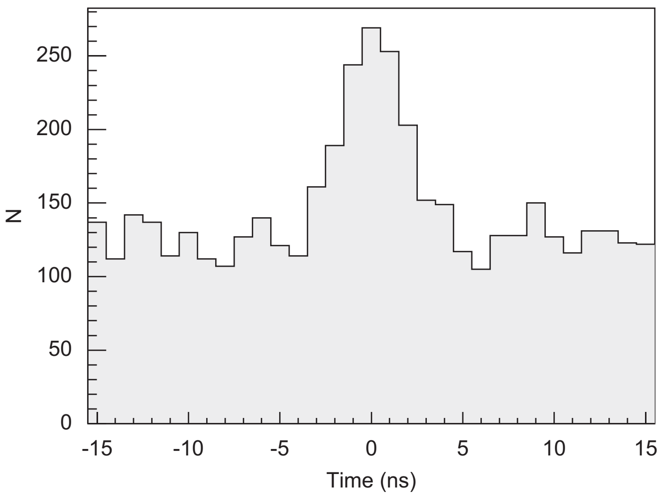

Fig. 5. The offset-corrected time spectrum for only those SiPM signals that correspond to a Cherenkov angle within 2σ of the expected value.

agrees with the expected ratio of 5.1, based on photon detection efficiencies provided by the manufacturer [10].

The ratio of the sensitive surface to the overall area occupied by the SiPM detector could be increased by using light concentrators in order to gather the Cherenkov light from a larger surface. This technique would increase the number of detected photons at unchanged level of dark noise, and would therefore improve the signal-to-noise ratio. We have tested a hemispherical light concentrator obtained by removing the cap from a blue light emitting diode. The system of SiPM and a hemispherical light concentrator is shown schematically in Fig. 7. The position dependent response for perpendicularly incident light (Fig. 8) shows a fourfold increase in the sensitive area (from $1 \times 1\,\mathrm{mm}^2$ to $\approx 2 \times 2\,\mathrm{mm}^2$). With six such light guide and SiPM detectors (Fig. 9), we have measured Cherenkov photons emitted by cosmic particles in a silica aerogel radiator. A clear improvement resulting from the addition of the hemispherical light concentrators may be seen in the plots of hits for the cases without and with the light guides (Fig. 10). The measured increase in light yield is 3.6 ± 0.2, which is in good agreement with the simulated value of 3.3.

Simulation calculations indicate that an even better configuration is obtained with a light guide in the form of a truncated pyramid, possibly with a focusing entry window and reflective side walls [11]. However, such a light guide produces a relatively large divergence of photons at the exit window. In connection with the gap between the SiPM glass entry window and its sensitive volume (Fig. 7), this divergence would reduce the acceptance. Further investigations will therefore include SiPM detectors with a considerably reduced gap and with pyramidal light guides.

4. Conclusions

With silicon photomultipliers we have detected Cherenkov photons radiated by cosmic particles in a 2.5 cm thick aerogel radiator. The accumulated distribution of hits shows a peak in the raw time spectrum. By selection of events within a narrow time window, the signal-to-background ratio is improved, so the number of detected Cherenkov photons could be extracted by fitting the distribution versus Cherenkov angle. We found about 5 times more Cherenkov photons per unit area of the sensitive surface for SiPMs than for the MA PMTs. This is in agreement with estimates based on quantum efficiencies provided by the

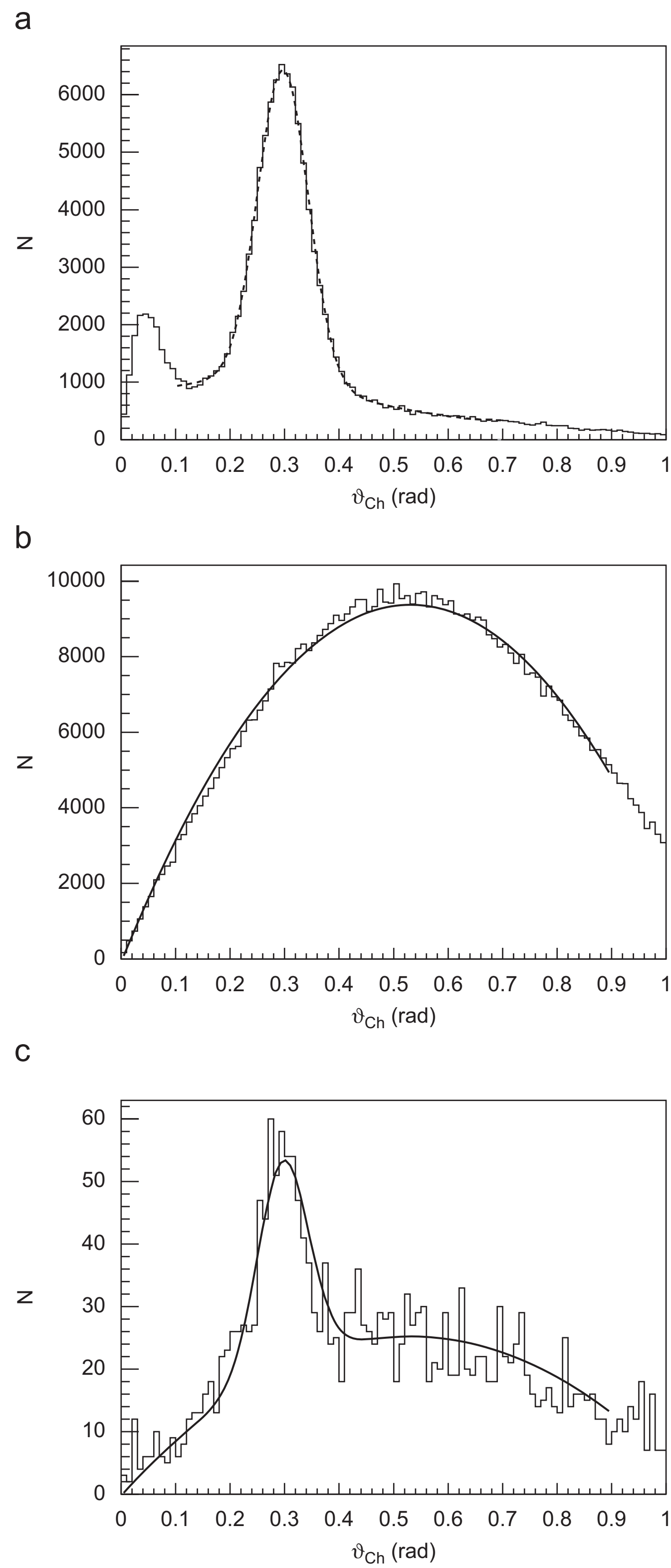

Fig. 6. (a) The distribution of MA-PMT hits with respect to their corresponding Cherenkov angle and the fitted distributions (Gaussian + polynomial). (b) The distribution of SiPM hits, that are outside of the Cherenkov time window, as a function of the corresponding angle relative to the charged particle track. The fit is 2nd order polynomial. (c) The distribution of SiPM hits, that are inside of the Cherenkov time window, as a function of the Cherenkov angle. Except for normalization factors, the fit parameters are taken from the fits to distributions in (a) and (b).

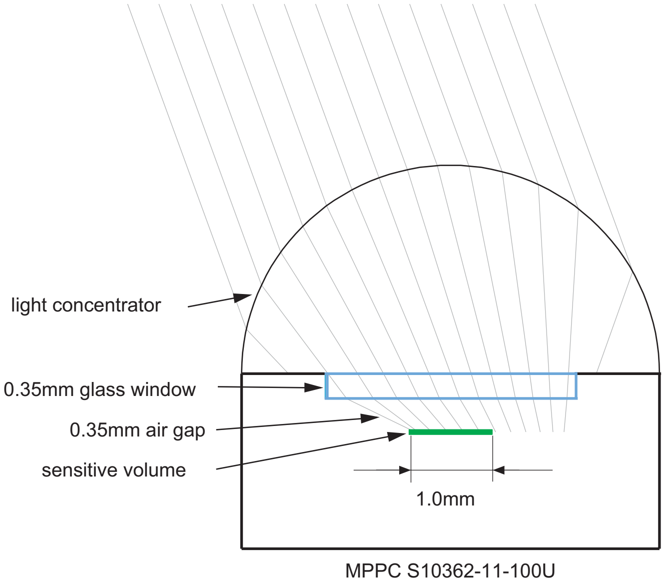

Fig. 7. A hemispherical light concentrator; also shown are the main elements of the SiPM, the sensitive volume, the glass window, the air gap and the metal package.

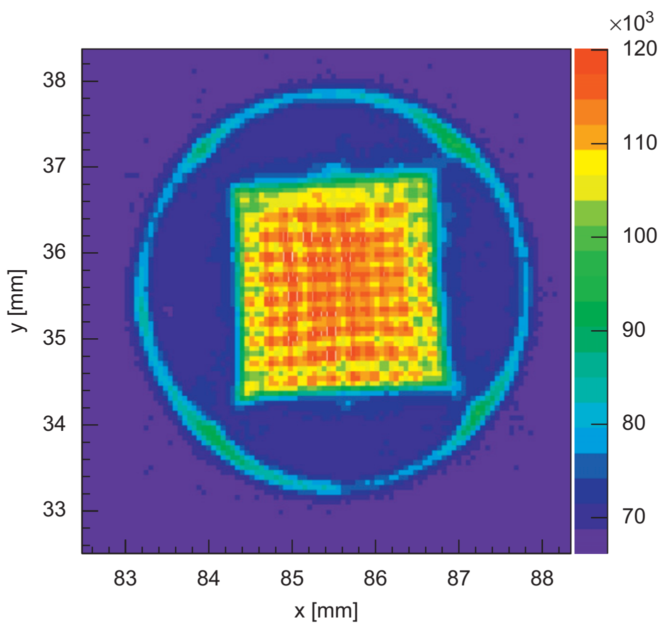

Fig. 8. Position dependent sensitivity of the SiPM with a hemispherical light concentrator, for perpendicularly incident light ($\lambda = 610\,\mathrm{nm}$). The observed structure reflects the internal segmentation of the SiPM.

manufacturer [10]. Cherenkov rings in the accumulated hit distributions were observed in both types of detectors.

We have also succeeded in increasing the SiPM detection efficiency by increasing the surface from which photons are collected with simple hemispherical light concentrators. Although an increased detection efficiency has been achieved, the limiting factor seems to be the SiPM protective structure in front of the sensitive layer. A further considerable improvement is expected with the new SMD mounted SiPM type (e.g., Hamamatsu S10362-11-100P) with a greatly reduced protective layer thickness.

Finally, we believe that we have demonstrated that despite the relatively large dark noise of the SiPM detectors, they are

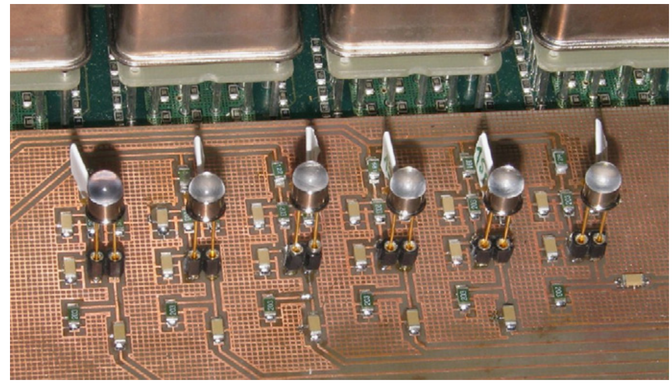

Fig. 9. The SiPMs equipped with light guides.

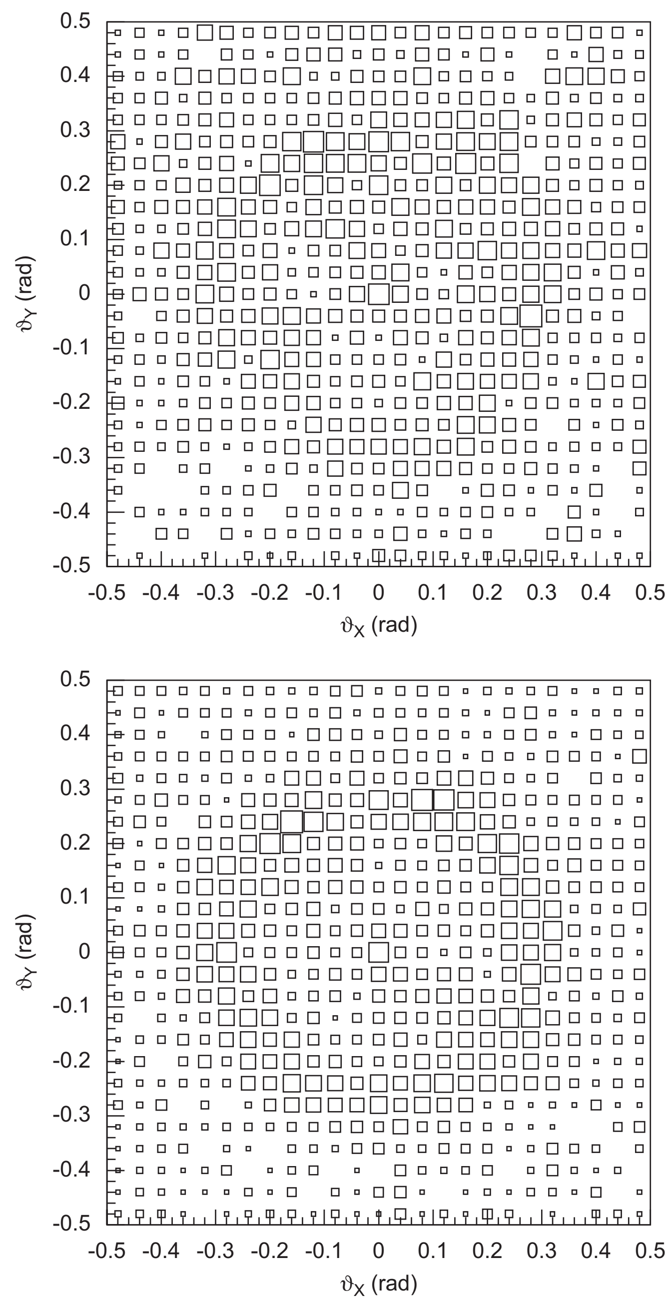

Fig. 10. Plots of hits in Cherenkov angle space for the SiPMs without (top) and with (bottom) the hemispherical light guides.

promising as detectors of Cherenkov photons inside large magnetic spectrometers.

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Design optimization of the proximity focusing RICH with dual aerogel radiator using a maximum-likelihood analysis of Cherenkov rings

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ABSTRACT

The use of a sequence of aerogel radiators with different refractive indices in a proximity focusing Cherenkov ring imaging detector has been shown to improve the resolution of the Cherenkov angle. In order to obtain further information on the capabilities of such a detector, a maximum-likelihood analysis has been performed on simulated data, with the simulation being appropriate for the upgraded Belle detector. The results show that by using a sequence of two aerogel layers with different refractive indices, the K/π separation efficiency is improved in the kinematic region above 3 GeV/c. In the low momentum region, the focusing configuration (with n_1 and n_2 chosen such that the Cherenkov rings from different aerogel layers at 4 GeV/c overlap) shows a better performance than the defocusing one (where the two Cherenkov rings are well separated).

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1. Introduction

The forthcoming upgrade of the Belle detector at KEK requires an improved particle identification system [1]. The limited available space has led to the decision for a proximity focusing ring imaging Cherenkov detector (RICH) with aerogel as radiator for the forward endcap region. Investigations of the performance of such a detector have given promising results [2]. In particular, the new technique of using two or more aerogel radiators with different refractive indices has improved the resolution of the Cherenkov angle [3]. Essentially, this is achieved by increasing the overall radiator thickness, i.e. photon yield, while avoiding the simultaneous degradation of resolution due to the increase of the emission point uncertainty [4]. Although different combinations of multiple radiators have been experimentally studied, the present analysis is concerned mostly with the case of two radiators. These can be either in a focusing or in a defocusing configuration (Fig. 1). In the former case, the aerogel layer with the higher refractive index is positioned downstream, so that both Cherenkov rings of a single charged particle overlap on the photon detector. On the other hand, in the defocusing configuration the higher refractive index is positioned upstream, so that two well separated rings are obtained for a single charged particle. In both cases an improved overall resolution of the particle velocity is obtained.

We studied the K/π separation efficiency for different aerogel configurations by varying several detector parameters. Our results are based on the data from a GEANT4 simulation [5] of the simple proximity focusing RICH with aerogel as radiator. The detector hits are used to evaluate the likelihood function for different particle hypotheses. The separation efficiencies for different aerogel configurations are presented in Section 4.

2. Simulated data

The charged particle transport and generation of Cherenkov photons in the aerogel layers, Rayleigh scattering in aerogel (with 40 mm transmission length at $\lambda = 400$ nm) and propagation of the photons to the photosensitive plane were simulated using the simulation toolkit Geant4 [5]. The simulated detector is similar to the apparatus used in test measurements [3]. It consists of layers of aerogel layers with a fixed distance (20 cm) between the entrance surface of the radiators and the front surface of the photon detector. The photons are detected with Hamamatsu H8500 PMTs, which have a 2 mm thick quartz window (Fig. 1).

The data have been simulated for a single charged particle traversing perpendicularly the Cherenkov ring imaging detector. In simulation we assumed a photon detector consisting of 6.1×6.1 mm pads [3] with positionally uniform response of the bialkali

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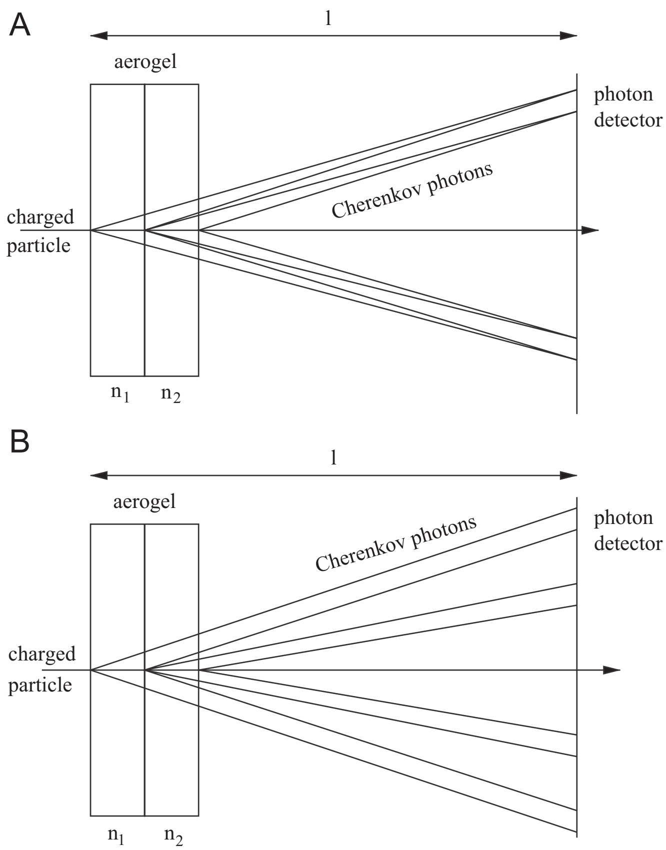

Fig. 1. Simulated counters: in the focusing configuration with refractive indices of the 15 mm thick layers $n_1 = 1.043$ and $n_2 = 1.05$ (A), the Cherenkov rings emitted from different radiators overlap on the photon detector. In the defocusing configuration with refractive indices of the 15 mm thick layers $n_1 = 1.05$ and $n_2 = 1.03$ (B), the Cherenkov rings from different aerogel layers are well separated. The counters were compared to the configuration where a single radiator layer of $n = 1.05$ with the same total thickness of 30 mm was used.

photocathode [6]. We adjusted the photodetection efficiency in such a way that the resulting number of detected photons per ring agrees with the measured average number of detected photons ($N_{\text{p.e.}} = 6$) for 2 cm aerogel with refractive index 1.05 [2]. To account for other contributions to the resolution, the emission direction of Cherenkov photons is smeared by 8 mrad [2,7]. In such a way the resulting simulated resolution ($\sigma_\theta = 14$ mrad) also agrees with the measurements. We also neglected any cross-talk between neighboring pads and we assumed binary electronics, i.e. no distinction was made between cases when a channel is hit by one or by multiple photons.

Single tracks are simulated for kaons and pions with momenta up to 5 GeV/c, which is above the kinematic limit of the decay products in the Belle spectrometer [1].

In addition to the Cherenkov photons from charged particles, background hits are simulated uniformly over the detection surface with a density of up to 125 hits/m^2. This is a factor of 4 higher than what is expected during the operation of the detector.

3. Likelihood function

The construction of a likelihood function follows Baillon [8] and Forty [9]. With a given hypothesis h for the charged particle mass (either pion or kaon) and for given track geometry, a likelihood function is constructed for each track. This consists of the product of probabilities p_i of individual pixels i being hit:

$$L = \prod_{\text{all pixels}} p_i. \tag{1}$$

The probability of pixel i recording m_i hits is Poissonian:

$$p_i = \frac{e^{-n_i} n_i^{m_i}}{m_i!} \tag{2}$$

where n_i is the expected, i.e. calculated average number of hits on the particular pixel. Obviously, n_i will depend on the hypothesis h for the particle type. Probabilities for a pad to be hit ($m_i > 0$) or not ($m_i = 0$) are

$$p_i = \begin{cases} e^{-n_i} & \text{for } m_i = 0 \\ 1 - e^{-n_i} & \text{for } m_i > 0. \end{cases} \tag{3}$$

We take the logarithm of the product of likelihoods, separate contributions of hit and non-hit pixels and constrain the number of expected hits N for a given hypothesis to the sum of expected average number of hits on the detector [9] to obtain

$$\ln L = -N + \sum_{\text{hit } i} \ln(e^{n_i} - 1). \tag{4}$$

The obvious advantage of this procedure is that one now has to calculate the average number of hits, i.e. the hit probabilities n_i only for the hit pixels.

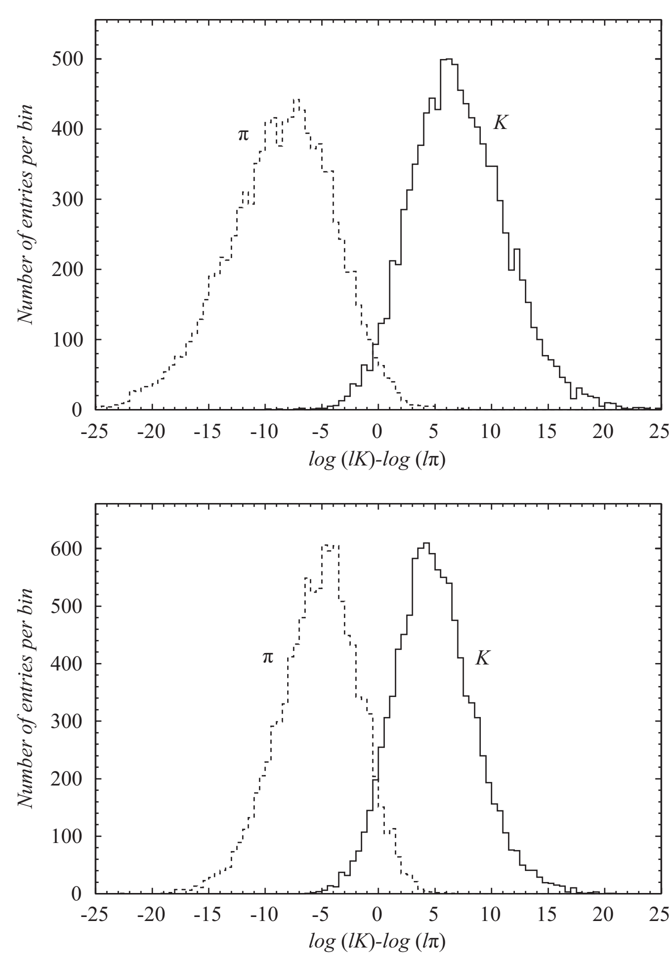

Fig. 2. The log likelihood difference of the kaon and pion hypotheses for pions (dashed line) and kaons (full line) at 4 GeV/c for the focusing dual radiator (top) and a single radiator configuration (bottom).

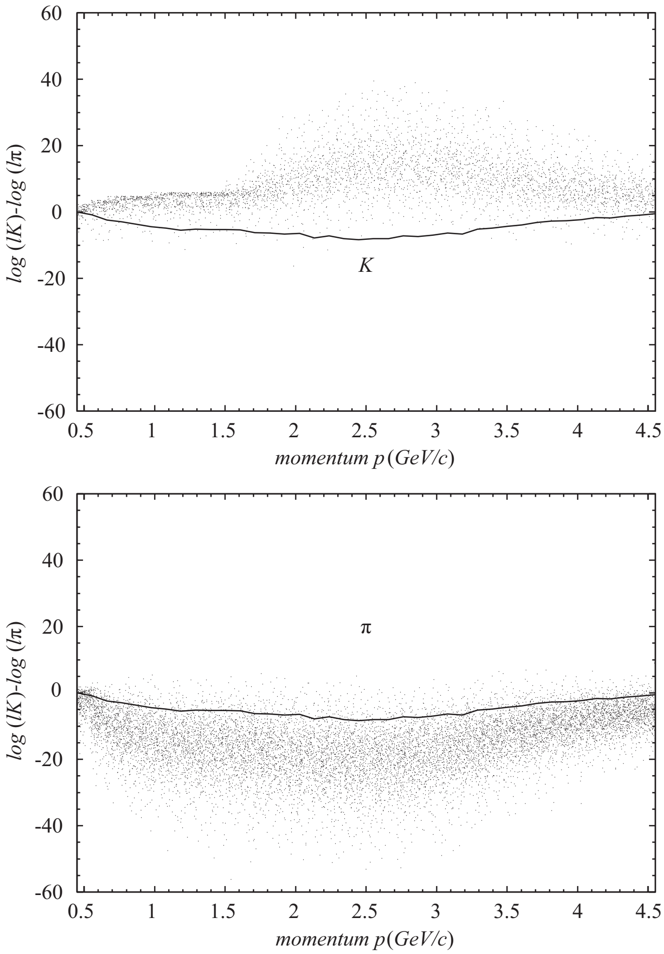

Fig. 3. Momentum dependence of the log likelihood difference of the kaon and pion hypotheses for kaons (top) and pions (bottom) for the focusing configuration. The solid line represents a cut for which $\approx 1\%$ of the pion events would be misidentified as kaons.

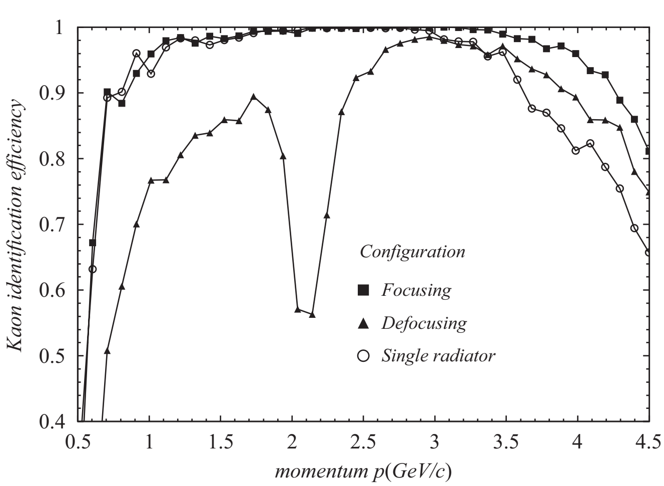

Fig. 4. The kaon identification efficiency as a function of momentum for different configurations: the focusing (squares), the defocusing (triangles) and the single radiator configuration (open circles) for 1% pion misidentification probability.

4. Results

We first illustrate the improvement in the K/π separation obtained with the dual radiator in the focusing configuration (Fig. 2). The number of particles is plotted as a function of the difference of the logarithms of the likelihoods for the kaon and pion hypotheses. By comparing the focusing configuration to the single radiator configuration, the advantage of the focusing configuration becomes obvious. For 1% probability to misidentify a pion, 96% of the kaons are correctly identified in the focusing configuration compared to 87% in the homogeneous radiator case.

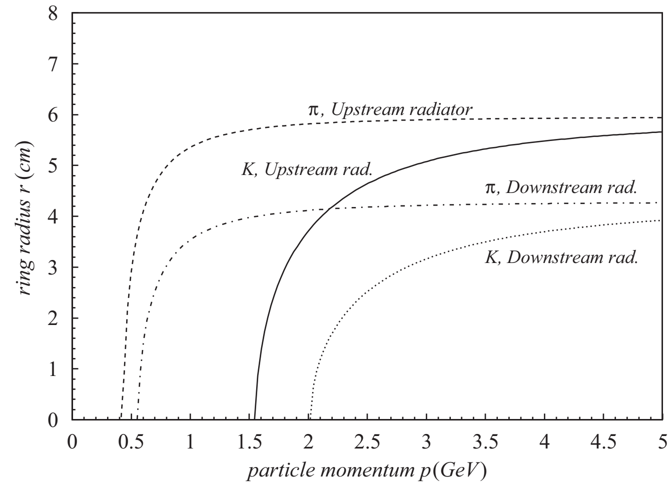

Fig. 5. The variation of ring radii with momentum for pions and kaons for the defocusing configuration. Note the overlapping of Cherenkov rings from different radiator layers above 2 GeV/*c*.

The difference in the logarithm of the likelihood as a function of particle momentum is shown for the focusing configuration in Fig. 3. For particles known to be pions, the distribution seems to be well separated from those known to be kaons. Fig. 4 shows the efficiency for kaons to be properly identified for 1% probability to misidentify a pion for different configurations: the focusing and the defocusing dual radiator configuration and the single radiator configuration. Note the dip in the kaon identification efficiency of the defocusing configuration slightly above 2 GeV/*c*, which can be attributed to the overlap of pion rings from one radiator with the kaon rings from the other radiator (Fig. 5).

It can also be seen that both focusing and defocusing configurations are significantly better than the single aerogel configuration in the region above 3 GeV/*c*. For the low momentum region, however, the focusing configuration as well as the homogeneous radiator perform better than the defocusing configuration. The reason can be attributed to the fact that Cherenkov threshold for kaons is at 2.0 GeV for one of the layers in the defocusing radiator ($n = 1.03$), thus leading to only approximately half of the photons being detected below 2.0 GeV. Since the Cherenkov rings are separated, it is also more sensitive to the random background.

5. Conclusions

To study the particle identification performance of various configurations of the proposed proximity focusing RICH with aerogel as the radiator, we have constructed and evaluated the likelihood function for different particle hypotheses. The results show that by using a sequence of two aerogel layers with different refractive indices, the K/π separation efficiency is increased in the kinematic region above 3 GeV/*c*. A dual layer configuration seems to perform better than the defocusing one, which has a dip in the efficiency, where the rings for pion and kaon hypothesis from different radiator layers overlap.

Acknowledgments

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Cherenkov detector of ^{90}Sr based on aerogel as radiator

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ABSTRACT

^{90}Sr is a highly radiotoxic fission product, which may pollute the environment following an accident in a nuclear power plant. It is a pure β emitter and thus difficult to detect by standard methods. Recent progress in silica aerogel production, as well as the new multianode photomultiplier tubes (PMTs), offer possibilities for the detection of ^{90}Sr, based on Cherenkov radiation of β particles emitted by its daughter ^{90}Y. An appropriate choice of the aerogel refractive index (produced in the range between 1.005 and 1.06) determines the threshold for Cherenkov radiation and thus separates between higher and lower energy β particles. Multianode PMTs permit the determination of the Cherenkov photon yield, offering additional discrimination. An apparatus was constructed for the detection of the relatively higher energy β particles emitted by ^{90}Y ($E_{max} = 2.28$ MeV) and the detector performance was studied.

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1. Introduction

Strontium ^{90}Sr is a very radiotoxic isotope because it accumulates in bone tissue. It has a rather long half-life of 28.2 years. Its daughter ^{90}Y emits β particles of 2.27 MeV end-point energy. It is a fission product, so it may pollute the environment as a result of either a nuclear power plant accident or a nuclear weapon explosion.

^{90}Sr and its daughter ^{90}Y are pure β emitters so they cannot be detected by standard and accurate methods of gamma ray spectroscopy. Other β emitters in the sample, with overlapping spectra, will lead to erroneous results in total beta counting or would complicate matters in the usual β spectroscopy. Cherenkov radiation offers the possibility of a well-defined β-energy cutoff by choosing an appropriate refractive index of the Cherenkov radiator. In addition, it has been demonstrated [1,2] that the counting efficiency rises steeply above threshold. Not very many isotopes have β end-point energies above 2 MeV, so ^{90}Y, the daughter of ^{90}Sr, with $E_{\gamma}^{max} = 2.27$ MeV, seems well suited for detection through Cherenkov radiation.

Recent progress in production techniques has led to improved properties of aerogels [3,4], most important of which is the greater transparency for Cherenkov photons in the wavelength region of highest photomultiplier sensitivity. On the other hand, multianode photomultipliers allow counting of the number of Cherenkov photons for each incident β particle. In the present paper we report on the results obtained with such an apparatus.

2. The apparatus

The apparatus (Fig. 1) consists of sample holder attached to a multiwire proportional chamber (MWPC), a light reflector with an aerogel radiator, a multianode PMT array and a scintillation detector. All the parts are enclosed in a light tight box.

The $5 \times 5\,\mathrm{cm}^2$ large MWPC consists of anode wire plane positioned between two aluminized mylar cathode planes. With such a light design, it has a high efficiency for charged particles (∼99%) within the acceptance η_a and low efficiency for gamma rays (∼0.1%). The acceptance η_a for electrons from sample amounts to 0.36. The MWPC signals a charged particle, distinguishing it from events where a gamma photon from the source generates an energetic electron in the aerogel Cherenkov radiator or in the PMT glass window.

The radiator consist of a block of $5 \times 5 \times 5\,\mathrm{cm}^3$ aerogel with a refractive index of $n = 1.047$ and 40 mm transmission length at $\lambda = 400$ nm [6]. The electrons with kinetic energy above threshold (1.21 MeV) emit Cherenkov photons, which are collected by an array of 2×2 16 channel Hamamatsu R5900-M16 multianode photomultipliers with 18 mm × 18 mm active area each [5]. To increase the light yield, the radiator walls are covered with the aluminized mylar foil.

A 30 cm × 30 cm large scintillation detector is placed on top of the apparatus to detect and vetos background-contributing cosmic particles.

All the channels are amplified, discriminated and registered on the VME CAEN V673A multihit TDC unit. To reduce the number of electronic channels, four neighbouring channels from the multianode PMTs are connected together. The data are read out by a program running on the PC and stored on disk for further analysis.

The data acquisition is triggered by a hit in the MWPC.

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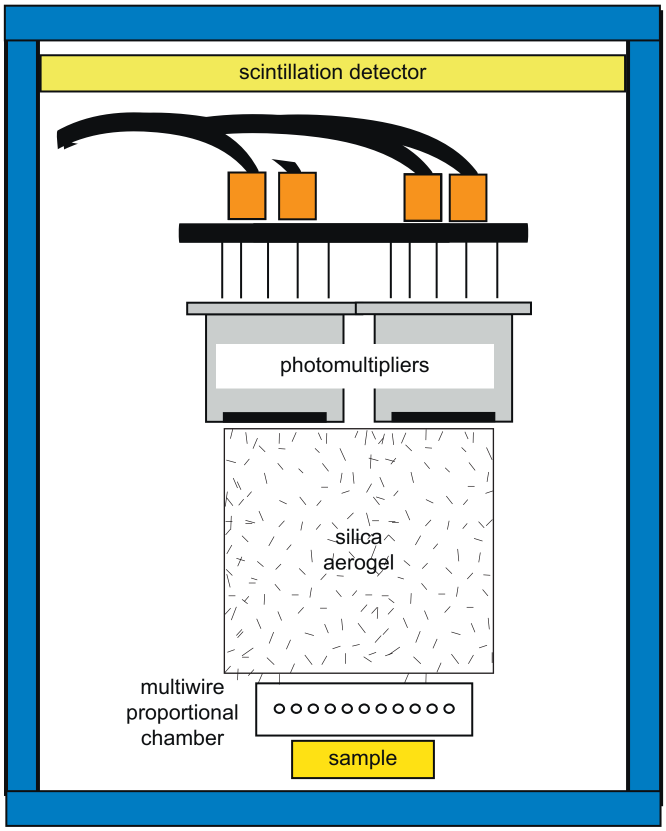

Fig. 1. The apparatus for measuring the ^{90}Sr activity.

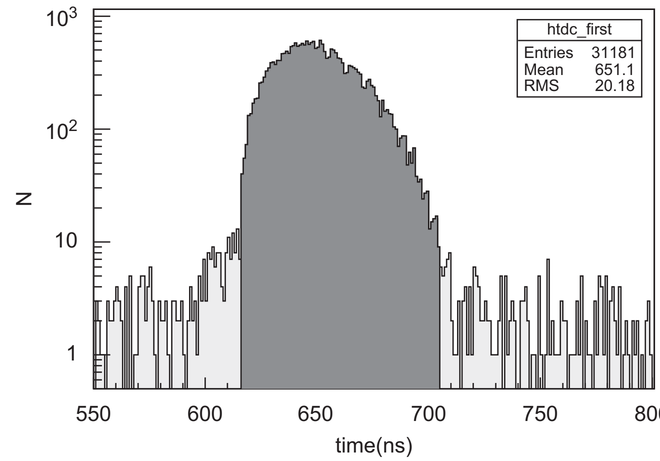

Fig. 2. Time difference of an individual channel between the PMT and MWPC signal. The shaded region indicates coincidence hits in the analysis.

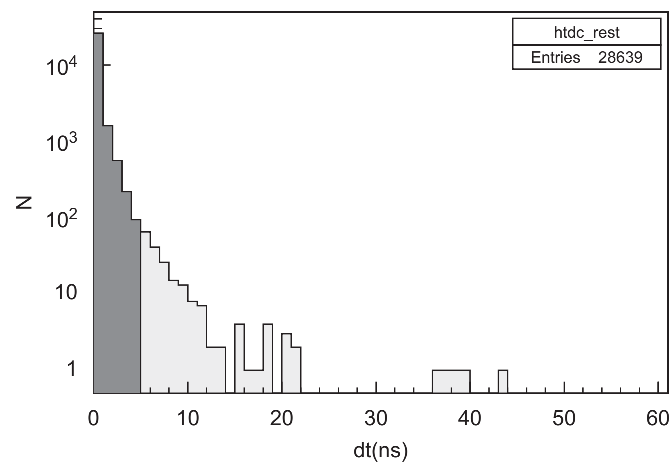

Fig. 3. Time difference between individual channels on the detector array. Only the hits with the time difference relative to the first hit of less than 5 ns are used in further analysis.

3. Analysis and results

Cherenkov photons appear as peaks in the PMT-MWPC time difference of the first PMT hit (Fig. 2). The number of hit PMT channels is determined by counting the number of hits within a 90 ns time window, which corresponds to ($\pm 2\sigma$). An additional cut has been made on the time difference between the first hit and the concerned hit on the PMT (Fig. 3). Since all the Cherenkov photons are prompt, the off time hits which might be attributed to nonsimultaneous cross-talk hits are thus suppressed.

For ^{90}Sr source the distribution of a number of hit channels per event is shown in Fig. 4a. The number of random coincidences is consistent with an estimate based on the count rate on the MWPC and the dark current count rate on the PMTs (around 10 Hz per channel), and can be neglected. The apparatus is, however, also triggered by cosmic charged particles. While the particles within the geometrical acceptance are detected by the scintillation detector (70%), the others still contribute to the signal. To account for this, the data were also collected without the source. The distribution of the number of hit channels per event is shown for events without a signal in the scintillation detector in Fig. 4b. Note that it has a higher mean number of hits than the distribution of the ^{90}Sr source.

The resulting background rate of the events without the scintillation signal amounts to 40 events per hour and can be neglected for high activity samples, while it remains the reason for the relatively high minimum detectable activity [7]:

$$A_{\min} = \frac{3 + 3.29\sqrt{N_b t}}{\eta_a t} \tag{1}$$

which is determined for measurement time t, background rate N_b and MWPC geometrical acceptance η_a. For the case of realistic 3 h measurement it amounts to 0.3 Bq. The normalized background distribution should be thus subtracted from the low activity sample distribution.

Four sources were used in order to calibrate the system. ^{42}K and ^{32}P were produced by neutron activation with the TRIGA reactor at the Jožef Stefan Institute, while ^{90}Sr/^{90}Y and ^{137}Cs were purchased from Amersham. Activities were estimated from data given by the producers as well as from the MWPC count rates and the corresponding solid angle. Among the sources used, ^{32}P are ^{90}Sr/^{90}Y are pure β-emitters, while ^{137}Cs and ^{42}K also emit the γ's. The resulting distribution of the number of hit channels per event is show in Fig. 5. All but the ^{137}Cs distribution agree with the simulation. Although the ^{137}Cs β end-point energy is below the Cherenkov threshold, some counts have been registered also for this isotope. They are due to photons coming from the radiator box, as has been verified by covering the aerogel photon exit window with black paper which resulted in a considerable reduction of the count rate.

The relative efficiency for the detection of particular source is determined by dividing the number of events with hits by the total number of events registered by the MWPC. The resulting efficiency for tested sources is shown in Fig. 6; for detecting ^{90}Sr it amounts to 0.024. Note that the efficiency is a steep function of the beta spectrum end-point energy.

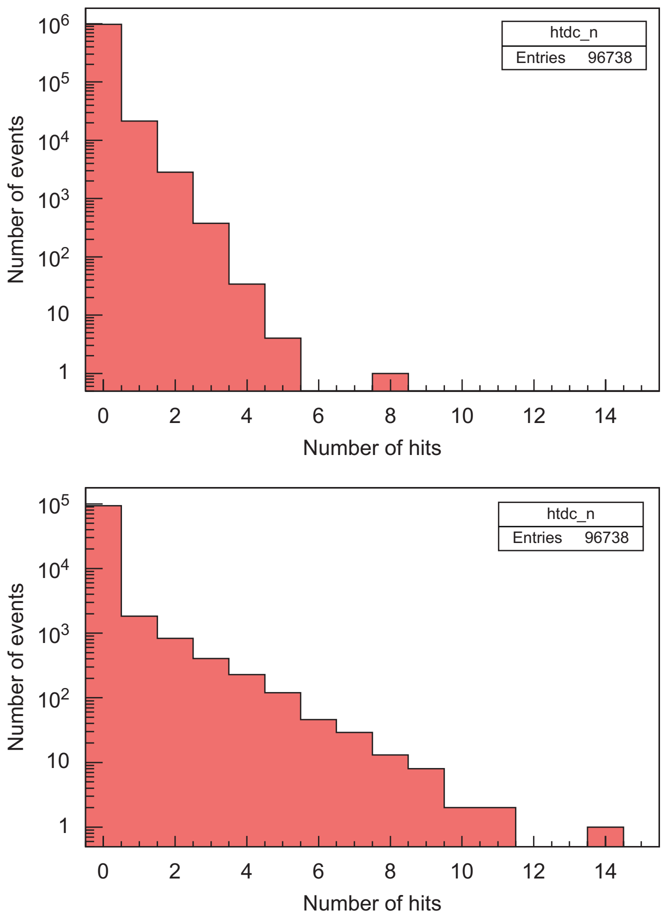

Fig. 4. Distribution of the number of the hit channels for the ^{90}Sr source (top) and for the background events (bottom).

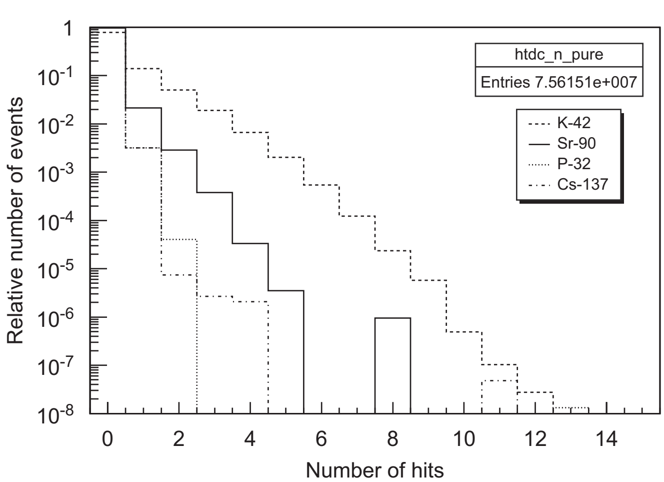

Fig. 5. Distribution of the background subtracted number of the hit channels per event for the 1 mio. of ^{90}Sr, 42 mio. of ^{42}K, 19 mio. of ^{32}P and 75 mio. of ^{137}Cs events. The distributions are all normalized to the same number of events.

4. Conclusions

An apparatus was constructed for the detection of ^{90}Sr/^{90}Y in environmental samples with Cherenkov radiation of β-particles in silica aerogels. The Cherenkov photon detection is performed with

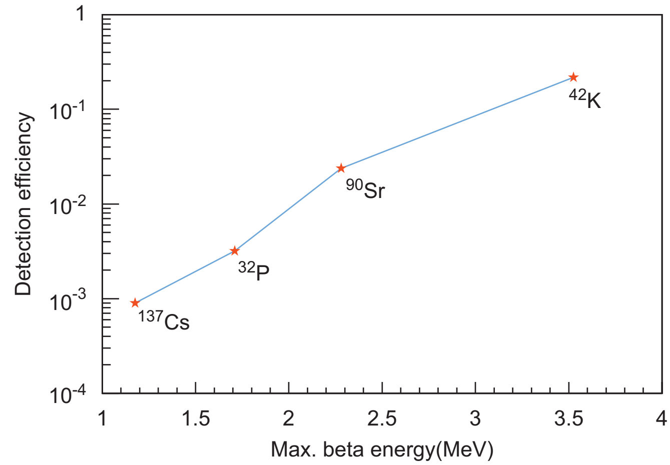

Fig. 6. Efficiency defined as count rate divided by appropriate activity as a function of beta spectrum end-point energy.

a multianode photomultiplier (Hamamatsu R5900-00-M16). With the signal from a thin wire chamber in coincidence and a cosmic ray background veto from a scintillation counter, the efficiency for the detection amounts to 0.024 with the minimal detectable activity of about 0.3 Bq.

To further remove the cosmic ray background, a larger scintillator should surround the MWPC and the aerogel. We expect that such an apparatus would be an efficient detector of ^{90}Sr of activity below 0.1 Bq.

Acknowledgement

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The SuperBelle Project

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Abstract

To search for deviations from the Standard Model in flavour physics and to distinguish between different new physics models by a close examination of the flavour structure, we plan a major upgrade of the KEKB electron-positron collider (SuperKEKB). The design luminosity of 8x10^{35} cm^{-2}s^{-1}, which is 50 times larger than the peak luminosity achieved with KEKB, will allow studies of rare processes in B, D and tau decays to be performed with unprecedented precision. The current Belle detector will be upgraded to take full advantage of the high luminosity of SuperKEKB. Despite substantial beam backgrounds, the SuperBelle detector should, at the end, perform at least as well as the present Belle detector.

Key words: B factory, luminosity frontier, Standard Model, rare B decays
PACS: 29.20.-c, 29.30.Aj

1. Introduction

Comprehensive studies of B meson decays in the clean e^+e^- environment provide an ideal tool to distinguish between different new physics models by a close examination of the flavor structure. Such studies are complementary to the experiments at the Large Hadron Collider (LHC) or the future linear collider [1–3]. If, e.g., supersymmetric partners of elementary particles are found at LHC, the pattern of supersymmetry breaking can be investigated at a Super B factory.

The past experiments at asymmetric e^+e^- B factories KEKB and PEPII have yielded important results. The main task of B factories was to measure CP violation in the system of B mesons, i.e. perform various measurements of complex elements of the CKM matrix. The obtained results are in good agreement with the Kobayashi Maskawa model of CP violation. The other important results are the observation of direct CP violation in

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B decays, measurements of rare decay modes (e.g., $B \to \tau\nu$, $B \to D\tau\nu$), and observation of D meson mixing. In addition, many new hadronic states have been observed. The Belle experiment, operating at the KEKB e^+e^- collider, proved its ability to measure a number of decay modes of the B meson and to extract many interesting observables. By the 2008 summer shutdown, Belle had accumulated data with an integrated luminosity of 800 fb^{-1} at the $\Upsilon(4S)$ resonance, corresponding to 840 million $B\bar{B}$ pairs.

However, many questions still remain unanswered. Are there new CP-violating phases? Are there new right handed currents? Are there effects from new Higgs fields? Are there new flavor violations? Is there a new flavor symmetry to explain the CKM hierarchy? The answers are only possible with precision measurements, for which a much larger sample of B mesons is required. A factor of 50 improvement would greatly enhance the possibility to discover new physics or at least to constrain new physics models. The physics motivation does not dependent on the LHC results. If LHC finds physics outside the Standard Model, precision measurements in flavour physics are compulsory. If no deviations from the Standard Model are found, a high statistics sample of B and τ decays would be a unique way to search for the TeV scale physics.

This paper presents one possible scenario of enlarging the existing sample of B mesons by upgrading the KEKB collider and the Belle spectrometer. Since the Letter of Intent [2], many R&D studies have been performed on the fundamental performance of the sensors, material structure and geometry of the collider and the detector. In what follows, the design of both will be summarized [4].

2. The collider

The SuperKEKB collider will replace the current KEKB collider. The luminosity will be increased by increasing the number of bunches and the beam currents, and by optimizing the beam optics in the interaction region. In the first phase the luminosity will be increased by a factor of 10. This will be realized by installing the crab cavities in front and behind the interaction region, by a redesign of the interaction region, by increasing the beam currents in the machine and by installing new beam pipes with an ante-chamber. A further increase of the luminosity to 8 $\times 10^{35}$ $\mathrm{cm}^{-2}\mathrm{s}^{-1}$ is planned by installing a damping ring for positrons and by increasing the beam currents. A total integrated luminosity of 50 ab^{-1} in 8 years of operation will enable us to collect a 50 times larger sample of $B\bar{B}$ and $\tau\bar{\tau}$ pairs as compared to the present Belle data.

3. The Detector

Some of the accelerator changes will increase the level of the beam-induced background (scattering of the beam on residual gas, Touschek scattering, synchrotron radiation, back scattering of synchrotron radiation and the electron-positron interactions at the interaction point) by about a factor of 20. The current Belle detector [5] will be upgraded to operate in such an environment that will result in much higher occupancies of the detectors. Due to up to ten times higher event rate, also the trigger, the data acquisition and the computing facilities will have to be be redesigned.

The detector performance should be at least as good as the performance of the current Belle spectrometer. In addition, it should provide low momentum μ identification to

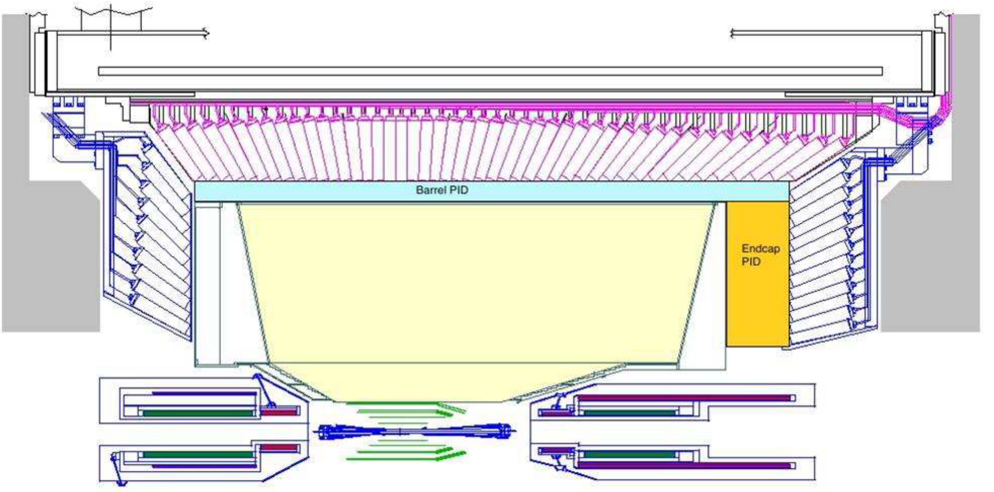

Fig. 1. Cross section of the inner part of the SuperBelle spectrometer.

increase the $s \to \mu\mu$ reconstruction efficiency. To allow for neutrino reconstruction from the missing energy and momentum, the detector should be hermetic. The SuperBelle detector will be a general purpose spectrometer inside a solenoid with 1.5 T magnetic field. It will consist of a vertex detector that measures the decay-vertex positions of long-lived beauty, charmed and strange hadrons, a central tracker that measures the momentum and dE/dx of charged tracks, a super conducting solenoid that provides a strong and uniform magnetic field, barrel and end-cap calorimeters that measure the energy and direction of photons, electrons and neutral pions, barrel and end-cap particle identification devices that distinguish kaons from pions and muons, and, a K_L/μ detector that is instrumented in the flux return yoke. A fast and reliable trigger and data acquisition system will record the signals from detectors. The computing and data storage will be distributed globally.

3.1. *Vertex detector*

The vertex detector is indispensable for precise determination of the vertex position of the interaction products. It plays an important role in reducing the track reconstruction errors, which is beneficial in many analyses. The foreseen detector will be built around a 1.5 cm beam pipe and and will consist of 6 layers of double-sided silicon strip sensors. This will enable a more robust particle tracking and higher K_S reconstruction efficiency compared to the present 4 layer design of the Belle vertex detector. To reduce the occupancy coming from the beam background, the VA1TA readout chips will be replaced with APV25 [2]. A pipeline chip readout will be implemented. To increase the vertex resolution, the sensors of the innermost layer might be later replaced with pixel sensors and moved closer to a distance of 1 cm from the beam-pipe.

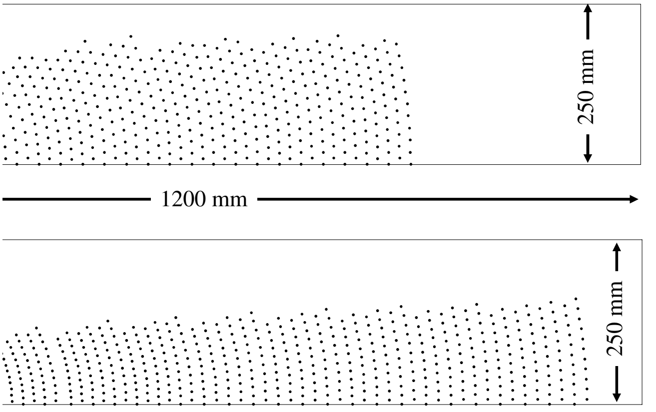

Fig. 2. Configurations of CDC sense wires in the present (top) and the upgraded (bottom) CDC.

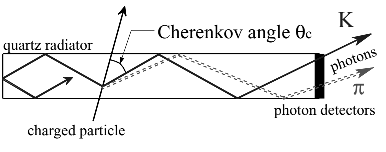

Fig. 3. Principle of measurement in the Time-Of-Propagation counter.

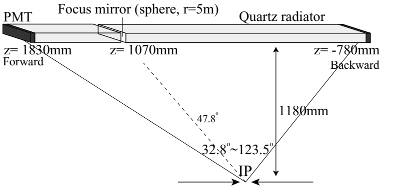

Fig. 4. TOP counter quartz bar.

3.2. *Central Drift Chamber*

The present Central Drift Chamber (CDC) has been working well since the beginning of the experiment. It is used to reconstruct charged tracks with good momentum resolution due to its low mass, and hence reduced multiple scattering. It also provides particle identification based on the characteristic energy loss (dE/dx). In addition, it provides a powerful trigger signal with a latency of a few μs.

To avoid the severe beam background, the inner radius of the central drift chamber will be increased and the volume replaced by two layers of the vertex detector (Fig. 2). The outer radius of the chamber will be larger because the barrel part of the particle identification device will be thinner. The cell size of the inner layers will be smaller (change from 12 mm to 8 mm) to reduce the occupancy. As a result, by using more stereo layers three-dimensional track reconstruction will be improved.

New readout electronics will be used to reduce the dead time. ASIC chips with a shorter shaping time will be used for signal amplification, shaping, and discrimination. The drift time and the pulse height will be measured separately by using pipelined TDCs and slow FADCs.

3.3. *Particle identification system*

To extend the K/π separation capability up to momenta of 4 GeV/c, to cope with the higher background, to make the system more homogenious and to reduce the amount of material in front of the calorimeter, the currently installed Aerogel threshold Cherenkov counters and the time-of-flight system will be replaced by two Cherenkov ring imaging detectors: a time-of-propagation (TOP) counter in the barrel region, and a proximity focusing Cherenkov ring imaging counter with aerogel radiators (ARICH) in the forward end-cap region.

In the Time-Of-Propagation (TOP) counter (Fig. 4) the time of propagation of the Cherenkov photons internally reflected inside a quartz radiator is measured (Fig. 3). The Cherenkov image is reconstructed from the two-dimensional information provided by measuring one of the coordinates (x) and precise timing, which is determined by position sensitive micro-channel plate (MCP) photomultipliers at the end surfaces of the quartz bar. The array of 18, 2 cm thick quartz bars of 40 cm width will surround the outer wall of the Central Drift Chamber. In order to reduce the possible degradation of resolution due to chromatic dispersion, each radiator bar in one module is subdivided into one 185 cm and one 75 cm long piece.

Due to limited space in the Belle end-cap, a proximity focusing RICH counter with aerogel radiator and expansion distance of 20 cm is foreseen [6]. To increase the separation capabilities, 3 layers of silica aerogels [7], each 10 mm thick, with different refractive indices between 1.045 and 1.055 will be used as Cherenkov radiators. Cherenkov photons will produce overlaping images on the photon detector surface, as shown in Fig. 5. The photon detector, sensitive to single photons and working in the high magnetic field of 1.5 T, will be chosen among three candidates, a hybrid avalanche photon detector (HAPD), MCP PMT or Geiger mode avalanche photo-diode. The excellent timing resolution of $\tilde{5}0$ ps of the MCP-PMT allows an additional time-of-flight measurement by using the Cherenkov photons from the entrance window of the MCP-PMT [7]. With this additional information one can positively identify kaons with momenta below the Cherenkov threshold in aerogel (≈ 1.5 GeV/c).

3.4. *Electromagnetic Calorimeter*

The performance of the present electromagnetic calorimeter would be degraded due to an order of magnitude larger background resulting in fake clusters and pile-up of noise. The shaping time of the new front-end electronics will be shortened from 1 μs to 0.5 μs. In addition, waveform sampling with 2 MHz sampling frequency will be implemented. The signal amplitude and timing will be extracted in the on-board FPGA. Because of expected radiation damage in the most exposed parts of the end-caps, the present Thallium doped CsI crystals, with scintillation decay time constant of about 1 μs, will be replaced with pure CsI crystals with a fast time constant of 30 ns. The signal output will be read by fine-mesh photomultipliers with a small number of multiplication stages.

3.5. *K_L and μ detector*

The performance of the currently installed resistive plate counters (RPCs) will be degraded due to neutrons, which are the dominant background in the K_L and μ detectors.

In the barrel, the degradation of performance will be reduced by changing the gas mixture of the RPC's to Ar/C_4H_{10}/HFC134a/SF6 in proportion of 50/8/37/5 and by replacing the innermost RPC layer with a 4 cm thick passive polyethylene absorber.

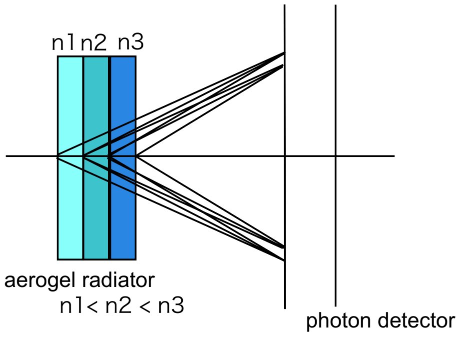

Fig. 5. Proximity focusing RICH with multiple layer of aerogel radiators.

In the end-caps, where the beam background effects are most disturbing, the RPCs will be replaced with scintillation counters with wave-length-shifting (WLS) fiber read-out. Each super-layer consists of two independent and orthogonal planes of scintillator strips extruded from granulated polystyrene. The light will be read out by Geiger mode avalanche photo diodes at one edge of the strip.

4. Conclusions

B factories have proven to be an excellent tool for flavour physics. They have shown a reliable long term operation and were constantly improving their performance. With a major upgrade of the KEKB accelerator between 2009 and 2012, we plan to build a Super B factory, with luminosity up to 40 times higher than the current KEKB machine. Although the new spectrometer will be built by using parts of the Belle spectrometer, the SuperBelle is essentially a new project. Due to much larger backgrounds, most of the components of the existing spectrometer will have to be replaced. To perform the upgrade and for later operation of the spectrometer, a new collaboration has been formed. The first open meeting of the new collaboration has been held in KEK, Tsukuba, in December 2008; further meetings are planned in March and July 2009. By using the proposed spectrometer, we expect a new, exciting era of discoveries, complementary to LHC.

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Study of a 144 channel multi-anode hybrid avalanche photo-detector for the Belle II RICH counter

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ABSTRACT

A new hybrid avalanche photo-detector has been developed as a photon sensor for the Belle II RICH counter. Single-photon response was investigated in the presence of a magnetic field and excellent performance was demonstrated. In addition, the radiation damage due to the neutron dose was studied. By building a prototype consisting of six photo-detectors, a test beam experiment was carried out. We successfully obtained a single-photon Cherenkov resolution of 13.5 mrad with 15.3 photoelectrons and achieved a π/K separation of more than 6σ at 4 GeV/c.

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1. Introduction

Excellent particle identification, in particular, π and K separation, is of prime importance in a B-factory experiment [1]. For the Belle II experiment at KEK, a proximity focusing RICH counter with a silica aerogel radiator has been studied to extend π/K separation capability beyond 4σ at 4 GeV/c in the end-cap region. A proximity focusing arrangement featuring a 200-mm expansion distance is a unique choice because the space available is acutely limited owing to the present Belle end-cap structure. In case that silica aerogel having a refractive index (n) of 1.05 is used as the radiator, the Cherenkov angle difference between π and K at 4 GeV/c is calculated as 23 mrad.

The photon sensor is one of the most critical components of this RICH counter, and it should satisfy the following requirements: (1) high sensitivity to a single photon, (2) large active area, (3) pixel size of $5\times5\,mm^2$, and (4) proper operation under a magnetic field. To fulfill these requirements, we have been developing a new hybrid avalanche photo-detector (HAPD) with Hamamatsu Photonics K.K. (HPK). This device is a vacuum tube coupled with the solid state sensors of the avalanche photo-diodes (APDs). Fig. 1 shows the schematic of the HAPD operation. Cherenkov photons emitted from a silica aerogel radiator enter a bi-alkali photocathode through a quartz window to generate photoelectrons. These photoelectrons are accelerated via an electric field generated by a high voltage of -7 to -8 kV applied to the vacuum tube. The accelerated photoelectrons are bombarded on the APD chips, each of which is pixelated into 6×6 pixels with a pad size of $5\times5\,mm^2$. The APD sensor further amplifies the input signal ~50 times via an avalanche process owing to the application of a reverse bias voltage. Four APD chips are housed in one HAPD; hence, there are 144 channels in total. Therefore, the overall gain is obtained to be 10^4-10^5 as a product of bombardment gain and avalanche gain. New HAPDs have been delivered since 2008 from HPK and detailed studies have been carried out.

In this paper, the fundamental characterizations including a test under a magnetic field are described in Section 2. Section 3 is devoted to the effect of neutron radiation damage on the HAPD. The results from a test beam experiment are presented in Section 4. Finally, in Section 5, we summarize the paper.

2. HAPD development and bench test

In an HAPD, the typical quantum efficiency (QE) at a wavelength (λ) of 400 nm is around 20–25%. A new technique,

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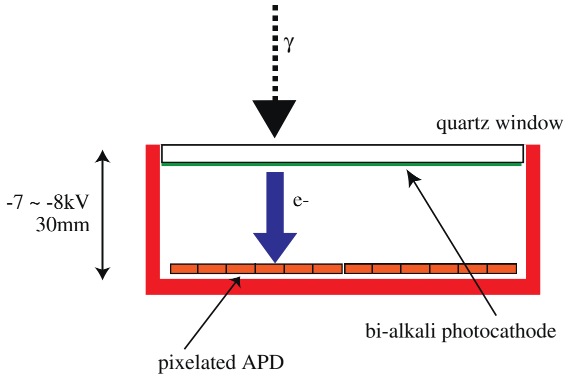

Fig. 1. Schematic view of HAPD operation.

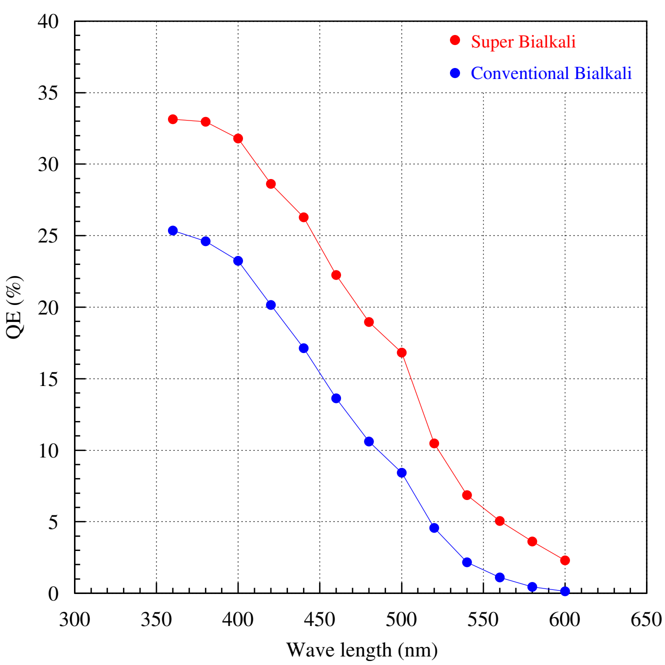

Fig. 2. Quantum efficiencies (%) as a function of wavelength (nm), where measurements were carried out using a Xenon lamp followed by a monochromator. The red and blue curves denote the high QE sample and the conventional one, respectively. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

which is used to fabricate the so-called "super bi-alkali" photocathodes, was applied to HAPD photocathode fabrication for the first time at HPK. As a result, peak QE was enhanced and 33% at $\lambda = 360$ nm was achieved, as shown in Fig. 2.

By illuminating with a blue LED, the single-photon response was investigated. Fig. 3 shows the pulse height distribution for multiple photons. As can be seen, a clear single-photon peak was detected. The total gain of this device was measured to be 9.1×10^4. The signal-to-noise (S/N) ratio derived by dividing the gain by a σ value obtained from a Gaussian fit to the pedestal peak was 16.4.

The detailed response of all the HAPD channels was investigated using a custom-made readout system based on ASIC technology. This electronics involves signal amplification and digitization; the threshold values can be externally loaded [2], and only digitized data are recorded using a personal computer. In our study, the threshold was set to be ~ 0.5 photoelectrons. A laser light source ($\lambda = 440$ nm) was placed on the movable stage, which can be remotely controlled. The position of the incident light was moved in a two-dimensional way so as to cover the entire HAPD surface and hence check all the pad responses. We performed this scan with and without an axial magnetic field of 1.5 T, and the obtained results were compared with each other. Fig. 4 shows the

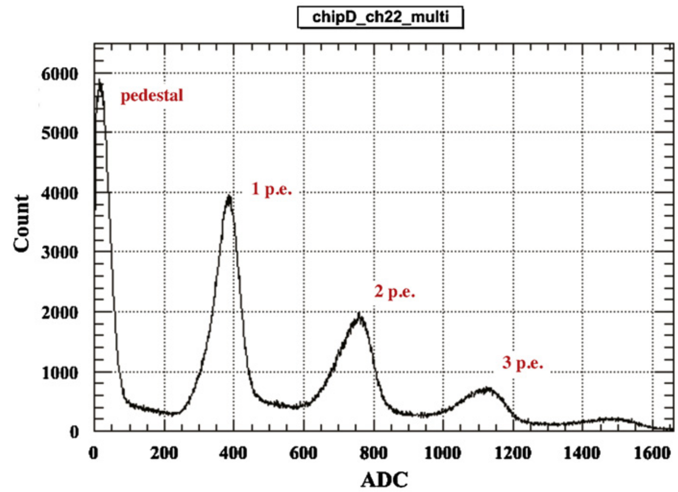

Fig. 3. Pulse height distribution for multiple photons.

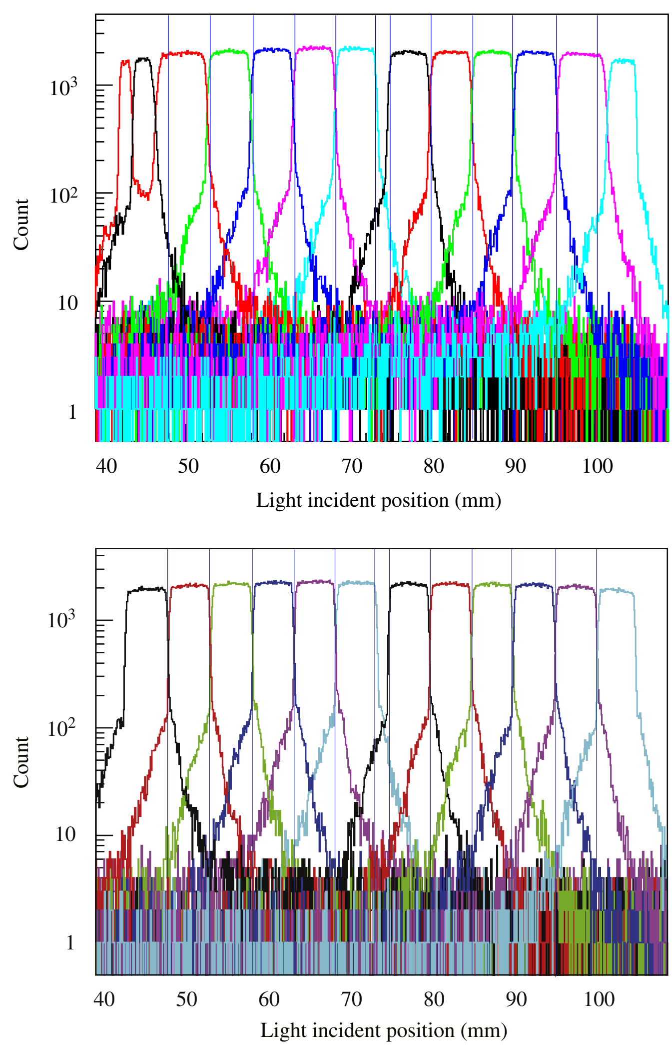

Fig. 4. Hit distribution for one HAPD row scan without (top) and with (bottom) a magnetic field of 1.5 T.

hit distributions obtained by scanning one HAPD row with and without a magnetic field. The distinct response from each APD pixel was measured in both cases, and no degradation in the photon sensitivities was observed in the presence of the magnetic field. The unusual response observed in the leftmost pixel in the absence of the magnetic field was caused by electric field distortion near the HAPD tube edge; this response was eliminated on the application of the magnetic field.

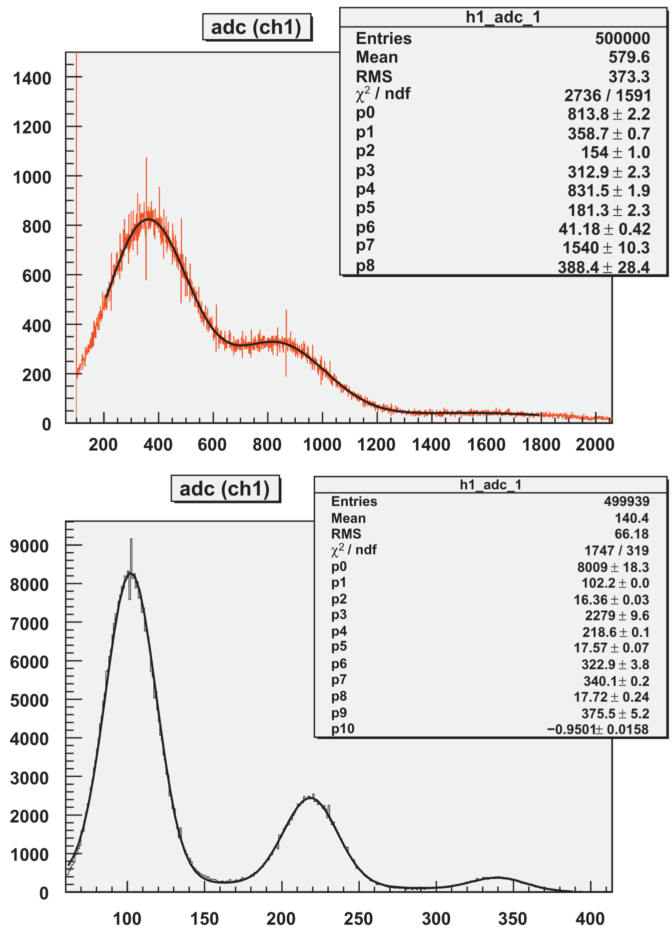

Fig. 5. Pulse height distributions of HAPD after 5×10^{11} neutrons/cm^2 irradiation with a peaking time of 1 μs and HV of −7 kV (top) and a peaking time of 20 ns and HV of −8.5 kV (bottom).

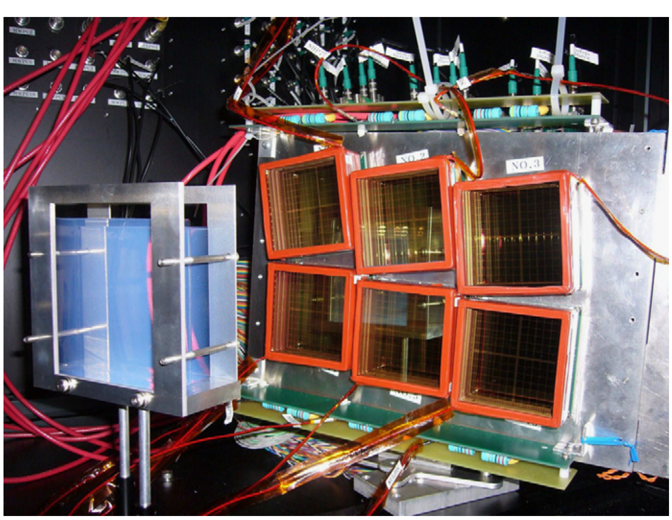

Fig. 6. RICH prototype counter.

3. Neutron radiation damage

In the Belle experimental environment, the neutron background turned out to be one of the most serious hindrances to the operation of our detector. From a naive extrapolation at the present value, a neutron flux of 1×10^{11} neutrons/cm^2 is estimated for a Belle II year [3]. In the case of an HAPD, the silicon device of the APD chips could get damaged due to neutron exposure and an increase in the APD leakage current could result in further generation of noise and hence a degraded single-to-noise ratio. To examine this effect, we performed several neutron irradiation tests using the "Yayoi" nuclear reactor [4]; the average neutron energy is 370 keV. We irradiated the HAPDs up to 5×10^{11} neutrons/cm^2, corresponding to a 5-year operation of the Belle II, and checked the quantum efficiency and single-photon sensitivity. No degradation was found in the quantum efficiency, however, an increase in the APD leakage current was observed in

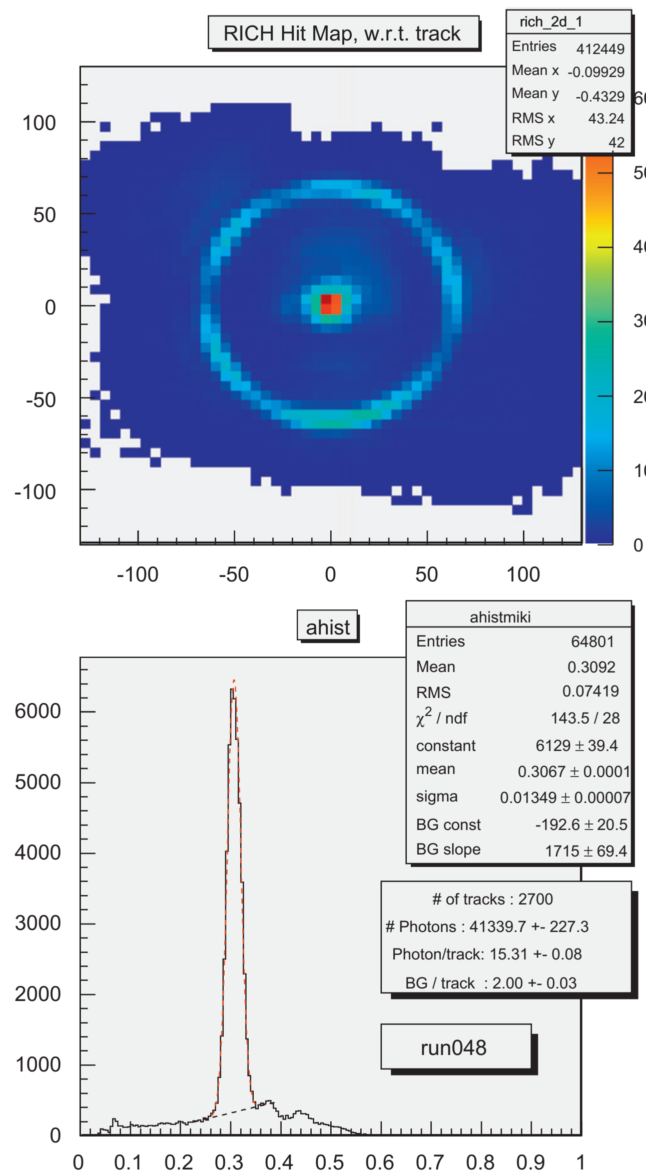

Fig. 7. Obtained Cherenkov image and Cherenkov angle distribution.

the irradiated sample. A degradation in the signal-to-noise ratio was then detected, as shown in Fig. 5 (top). Initially, S/N was ~ 17. However, after the neutron exposure of 5×10^{11} neutrons/cm^2, S/N was ~ 3; the single-photon signal was barely distinguishable from the pedestal peak. This can be rectified by shortening the peaking time adopted in the readout electronics. As an ultimate case, the response using a peaking time of 20 ns is shown in Fig. 5 (bottom), where HV is also increased to -8.5 kV. The single-photon peak can be clearly observed and S/N is calculated to be about 7.

By optimizing the parameters of the readout electronics, i.e. by shortening the peaking time, the radiation damage can be mitigated for the practical HAPD operation. Further tests by irradiating with 1×10^{12} neutrons/cm^2 are in progress. In addition, as an alternative approach, a new radiation-tolerant APD sensor is being developed at HPK. New radiation-tolerant HAPDs will be fabricated this year, and they will be irradiated to examine their performance.

4. Test beam experiment

To carry out a test beam experiment, we built a RICH prototype counter using silica aerogel radiators. The photon detector system was configured as a 2×3 array of HAPDs, as shown in Fig. 6. The readout electronics was the same as the one described in Section 2. The remaining experimental setup was almost identical to that mentioned in Ref. [5]. The incident track parameters were determined by two multi-wire proportional chambers located upstream and downstream of the prototype RICH counter. The KEK Fuji test beam line, where 2-GeV/c electrons are available, was used.

As Cherenkov radiator, two layers ($n=1.054$ and 1.065), each of which was a 20-mm-thick silica aerogel tile, were placed with keeping the expansion distance to be 200 mm. Their refractive indices were selected so that the two Cherenkov ring images generated from each layer overlapped onto the HAPD surface plan [5]. The transmission lengths at $\lambda=400$ nm were 47.8 mm for $n=1.054$ and 55.2 mm for $n=1.065$. The production procedure and optical quality measurements for these samples can be found in Ref. [6].

A clear Cherenkov image was obtained, as shown in Fig. 7 (top). The Cherenkov angle distribution is also shown (Fig. 7, bottom); a single-photon angle resolution (σ_0) was extracted to be 13.5 mrad by fitting this peak to a Gaussian. By integrating the fitting function over a $\pm3\sigma$ area, the photoelectron yield N_{pe} was calculated to be 15.3, where the background was assumed to be a one-dimensional polynomial. Based on a naive calculation, one can expect the angle resolution per track to be $\sigma_0/\sqrt{N_{pe}}=$ 3.5 mrad, corresponding to 6.6σ π/K separation capability at 4 GeV/c.

5. Conclusions

A new HAPD was developed as a photon sensor for the Belle II RICH counter with HPK. Excellent single-photon sensitivity was demonstrated with and without a magnetic field, and recent improvement in quantum efficiency was achieved to be more than 30% at peak. Possible damage due to the neutron dose was investigated; our HAPD can detect single-photon signals up to 5×10^{11}/cm^2. Further studies to realize single-photon detection after exposure to a neutron flux of 10^{12}/cm^2 are in progress. The test beam results indicate that a full size detector will achieve π/K separation of more than 6σ.

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Photonis MCP PMT as a light sensor for the Belle II RICH

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ABSTRACT

We report about on-the-bench studies of Photonis multi anode micro-channel plate (MCP) PMTs, as candidate photodetectors for the aerogel RICH counter of the Belle II spectrometer. This photosensor is fast enough to be used also as a time-of-flight counter, which would complement the kinematic range of the aerogel RICH counter.

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1. Introduction

For the particle identification system of the Belle II spectrometer [1], a proximity focusing RICH detector with aerogel as radiator is being considered. One of the candidates for the detector of Cherenkov photons is a microchannel plate PMT. With its excellent timing properties, such a counter could serve in addition as a time-of-flight counter. In this latter case, precise timing would be provided by Cherenkov photons emitted in the PMT window as illustrated in Fig. 1. A prototype of this novel device using two 64-channel Photonis 85011 [2] microchannel plate PMTs was tested several years ago in a test beam at KEK. Excellent performance of the counter could be demonstrated. In particular, a good separation of pions and protons was observed in the test beam data with a time-of-flight resolution of 35 ps [3,4].

The present study was devoted to measuring the performance in high magnetic fields, determining timing properties of the common electrode signal, the second stage MCP output, and to measuring ageing properties (operation after long term and high rate illumination), and thus complements our previous on-the-bench studies of this sensor type [3,5], as well as the studies by Jerry Va'vra et al. [6]. The tube used in the present tests had 64 channels (8×8) and microchannel plates with 10 μm pores.

2. Tests in magnetic field

Since the sensor is required to operate in a high magnetic field of 1.5 T, we have performed measurements of gain, uniformity of response and cross talk in a magnet at KEK with a magnetic field of up to 1.5 T. As a photon source we used a picosecond laser with a 439 nm head (Hamamatsu Picosecond Light Pulser). The laser light was first attenuated by neutral density filters and guided into a light tight box along an optical fiber (Fig. 2). The light was collimated onto the photocathode of a MCP-PMT to a spot diameter of ≈ 500 μm. The position of the light spot was set by a computer controlled 2D stage. Signals from the anodes were amplified by an Ortec FTA820 amplifier, and recorded by a CAMAC charge sensitive ADC.

The MCP PMT gain as a function of magnetic field for different operation voltages and as a function of applied voltage for different magnetic fields is shown in Fig. 3. At 1.5 T, the operating voltage has to be increased by roughly 200 V to achieve the same gain as without magnetic field.

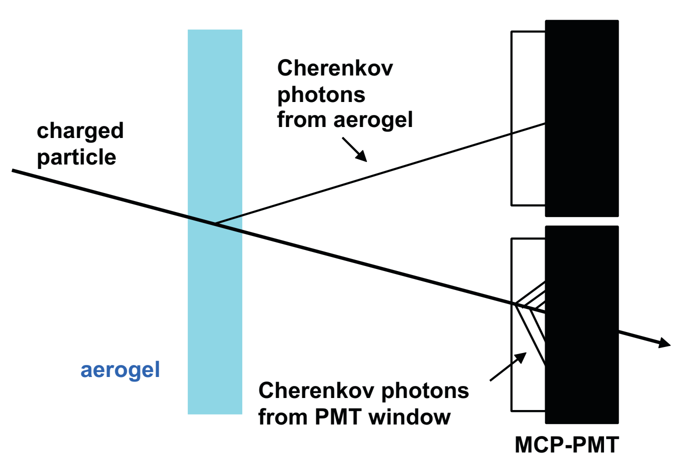

Fig. 1. MCP PMT as a photon detector in a proximity focusing Cherenkov counter.

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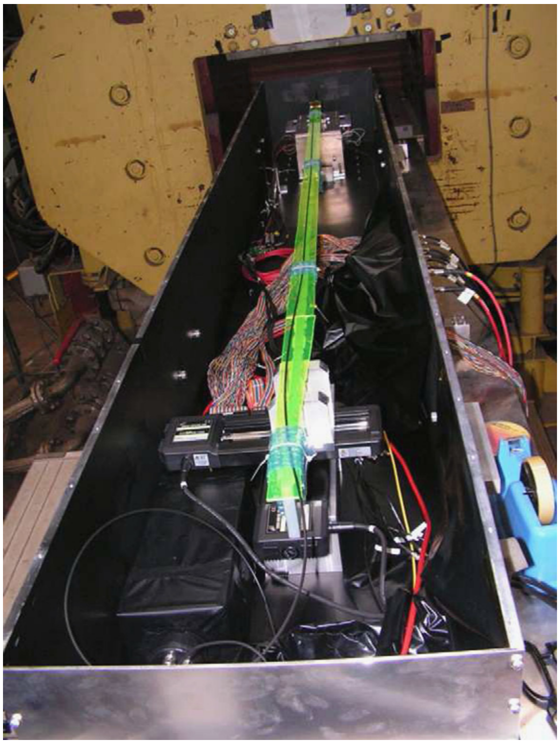

Fig. 2. Apparatus for the measurement of MCP-PMT properties in magnetic field: from the 2d stage, laser light is led over a long lever arm to the MCP PMT front window inside the magnet gap.

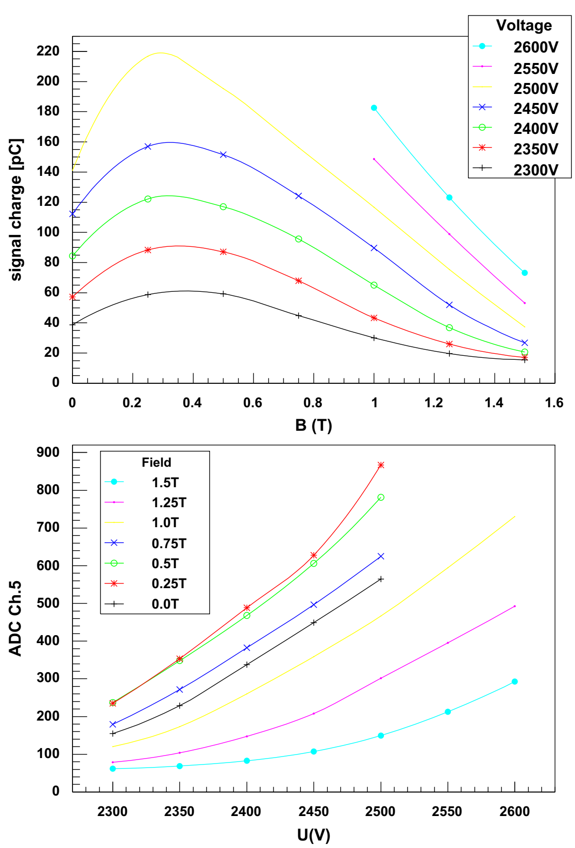

Fig. 3. MCP PMT operation in magnetic field: gain (arbitrary units) as a function of magnetic field (top) and as a function of high voltage for different magnetic fields (bottom).

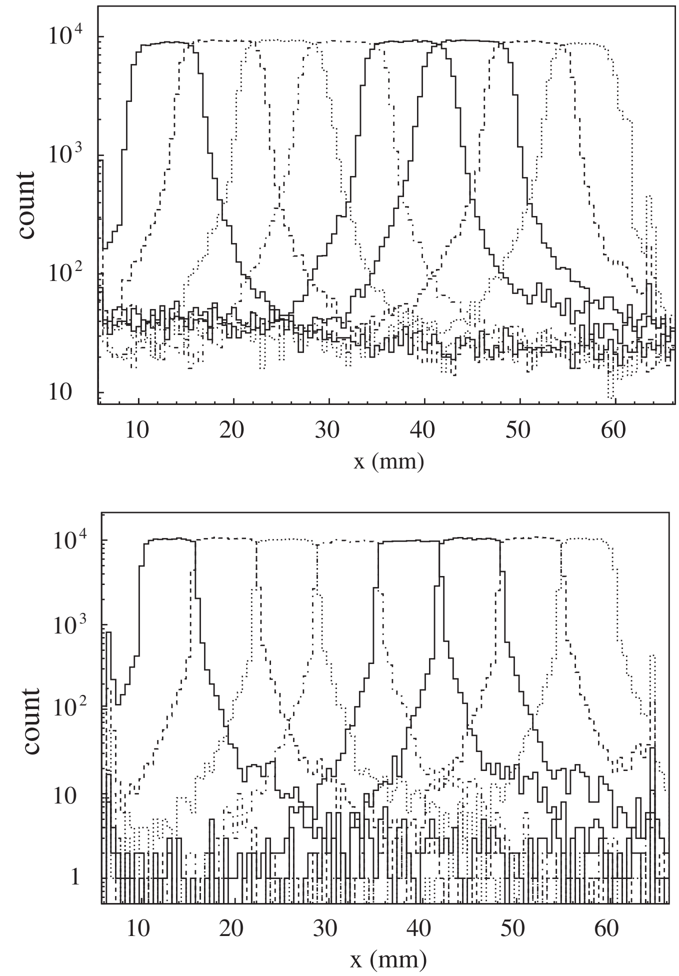

Fig. 4. Scans across a 64 channel PMT without (top) and with magnetic field (bottom). Number of detected hits on individual channels is shown as a function of the light spot position.

By scanning the laser spot across the PMT surface, the position dependence of sensitivity could be studied. As can be seen from Fig. 4, the response of the PMT is fairly uniform. Multiple counting is observed at pad boundaries due to charge sharing. In addition, a long range cross talk can be observed due to photoelectron back-scattering. The origin of the cross talk between the channels was investigated in several preceding studies by studying the correlations between signals on neighboring pads, their amplitudes and time of arrival [5]. The contributions of cross talk are relatively small, but extend to about 12 mm beyond the pad boundary in accordance with the estimated maximum range of photoelectrons backscattered on the multichannel plate (Fig. 4, top). In the presence of a magnetic field, however, charge sharing and cross talk due to long range photoelectron back-scattering are considerably reduced because of the curling up of electron trajectories along the axial magnetic field, as demonstrated in the bottom plot of Fig. 4.

3. Precise timing with the common output from the second MCP stage

As reported in previous studies of this sensor type, the anode output has excellent timing properties for single photons, with r.m.s. resolutions better than 40 ps [5]. If, however, the MCP PMT is employed for time-of-flight measurements (Fig. 1), use is being made of the fact that if a charged particle passes the 2 mm thick

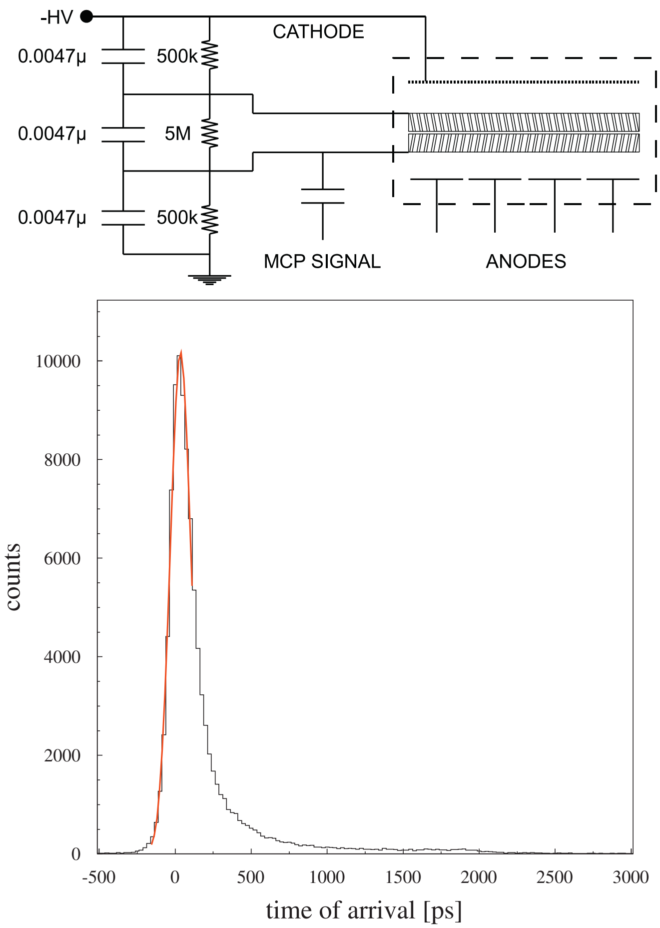

Fig. 5. Timing with a signal from the second MCP stage: schematics (top), distribution of signals from the second MCP stage (bottom).

quartz PMT window, about 10 Cherenkov photons are detected in the MCP PMT. They are distributed over several anode channels. It would be advantageous, if the time of arrival of these photons were read out for the whole device from a single common electrode of the second MCP stage, while 64 anode channels are used for position measurement of Cherenkov photons from the aerogel.

To test this idea, we have studied the timing properties of this common electrode. Signals from the second MCP stage were amplified by an Ortec FTA820 amplifier. After amplification, each signal was split in two branches; one for the timing and the other for the signal amplitude measurement. The timing signal was discriminated either by a Phillips 708 leading edge or an Ortec 9327 constant fraction discriminator, and used as a stop signal. The time of the pulse was measured by the Kaizu Works KC3781A TDC (CAMAC) with 25 ps per channel. A common start signal was determined by the laser control unit. The signal pulse height was registered in a CAEN V965 charge sensitive ADC (VME). In such a set-up, a σ of 65 ps for the MCP signals was observed with a constant fraction discriminator in case of single photons, as shown in Fig. 5; the resolution includes the time jitter of the laser source and the electronics. With 10 detected photons, a time-of-flight resolution of around 30 ps is expected [7], which would allow a $3\sigma\pi/K$ separation up to about 2.8 GeV/c at a flight length of 2 m.

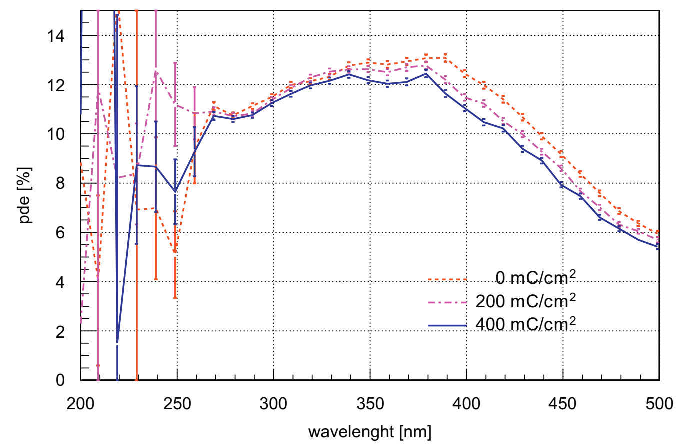

Fig. 6. MCP ageing studies: photon detection efficiency as a function of wavelength at the start of the study, after 200 and 400 mC/cm^2 of accumulated charge on the anode.

4. MCP PMT ageing studies

To ensure stable, long term operation of the photon sensor in a high luminosity experiment like Belle II, it is mandatory to check its ageing properties. In a dedicated test set-up, the whole photo-sensitive surface was exposed to high rate illumination by a LED. A pulsed laser was used to monitor the amplification, and a reference PMT is used for periodic QE measurements with a monochromator in the same set-up. As shown in Fig. 6, the results of this test are quite promising. After the charge accumulated at the anode reached 400 mC/cm^2, corresponding to the dose expected for the full Belle II lifetime, the efficiency dropped only by about 10% which is of no problem for the operation of the experiment.

To conclude we note that the observed properties of the MCP PMT are in very good agreement with expectations. They show that the present tube is an excellent candidate for the photon sensor of the aerogel RICH detector in the Belle II spectrometer, capable of successful operation in the high magnetic field throughout the full duration of the experiment.

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Silicon photo-multipliers as photon detectors for PET

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ABSTRACT

A novel photon detector, the Silicon Photomultiplier (SiPM), has been tested in view of a photosensitive device for Positron Emission Tomography (PET), which is one of the most important non-invasive methods for in-depth and in vivo imaging of tissue. Such a device offers advantages over existing ones, including application in a magnetic field, better resolution and easier operation. Two PET modules have been constructed by coupling an array of Hamamatsu 3 mm × 3 mm Multi-pixel photon Counters (MPPCs) and Photonique 2.2 mm × 2.2 mm Solid-state Photomultipliers (SSPMs) to LYSO scintillation crystals. The results of studies of the two module prototypes are presented.

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1. Introduction

Positron Emission Tomography (PET) is a non-invasive method for in-depth and in vivo imaging of tissue. In contrast to X-ray tomography (CT) and that with Nuclear Magnetic Resonance Imaging (MRI), which give information about tissue structure and pathological variations in the morphology, PET detects physiological, biochemical and pathological processes in the living organism. The positron emitted in a β^+−decay of the nucleus slows down in the tissue and subsequently annihilates with a nearby electron. The annihilation gamma-rays of 511 keV are usually detected indirectly, through scintillation in inorganic crystals. Photon detectors, like Photomultiplier Tubes (PMTs), detect the scintillation light. The majority of PET devices use PMTs, but due to their size, relatively poor ratio of active to total surface and high price, which is a significant fraction of the total cost of the device, it is worthwhile to search for alternative detectors of visible photons. The sensitivity of PMTs to magnetic fields, and the increasing requirement to unify different image modalities in one measurement, provide an additional reason to search for new detectors. One would like to incorporate a PET apparatus inside a MRI magnet for simultaneous imaging of tissue function and of density. Semiconductor sensors, photodiodes and avalanche photodiodes seem to be much closer to an ideal detector. In particular, a new type of semiconductor detector, the Silicon Photomultiplier (SiPM) looks very promising [1–3].

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2. The apparatus

In this study two PET modules have been constructed by coupling a 4 × 4 array of LYSO scintillator crystals at a pitch of 4.5 mm to an array of SiPMs of the same pitch using optical grease. The scintillation array consisted of 4.3 × 4.3 mm^2 LYSO scintillation crystals of length of 20 mm encased in $BaSO_4$ reflector. In the first module the 2.2 mm × 2.2 mm Photonique 0607 SSPMs (packaged on 4 mm × 4 mm printed circuit board with two pins) and in the second the 3 mm × 3 mm Hamamatsu S10931-100P surface mount type MPPCs were used (see Table 1 and Fig. 1). The main advantages of the latter are higher efficiency and larger sensitive area. Such a PET module with SiPMs is much more compact than existing ones, offers lighter mechanical design, works in a magnetic field, has a better resolution and is easier to operate.

The printed circuit boards which house the SiPMs contain a single bias voltage connector and the outputs for all the channels (Fig. 1). Due to large variation of the working voltage of the delivered Photonique SSPMs (0.76 V RMS), the voltage divider circuit was integrated on the board to adjust the correct bias voltage (Fig. 2). The delivered Hamamatsu MPPCs have much smaller variation of the working voltages of 0.1 V RMS.

Fig. 3 shows the signals due to interaction of 511 keV photons in the LYSO scintillators. Due to smaller capacitance, the signals in the SiPMs by Photonique are on average 10 times smaller than the signals in Hamamatsu MPPCs. The pulse shapes from SiPMs by Photonique exhibit in addition to the scintillator decay time of about 50 ns also the second much slower one of the order of about 1 μs, which might be due to internal quenching resistance.

Table 1
Parameters of the SiPMs used in the PET module.

Producer SiPM type	Photonique 0607	Hamamatsu S10931-100P
Package type	printed circuit board with pins	surface mount
Size (mm^2)	2.2×2.2	3×3
Operating voltage(V)	25	70
Gain	$7.5\ 10^5$	$2.4\ 10^6$
Terminal capacitance (pF)	320	320
Number of pixels	1700	900
Pixel size (μm)	40	100
Peak PDE	0.25	0.75

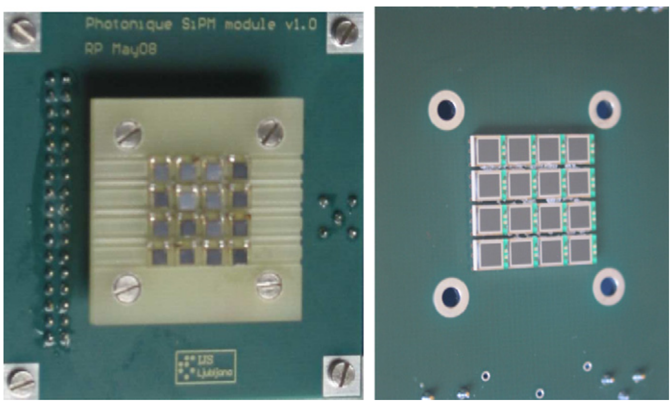

Fig. 1. 4×4 array of the Photonique 0607 SSPMs (left) and Hamamatsu S10931-100P MPPCs (right) arranged in a matrix with a pitch of 4.5 mm.

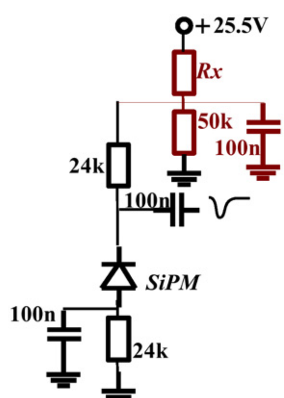

Fig. 2. An electronic scheme of the single SiPM channel in case of the Photonique SSPMs. The resistances R_x are adjusted individually to match the recommended working voltage.

3. Results

Due to large area and consequently higher noise rate, the single photon signals cannot be distinguished from the background at room temperature. We have therefore measured several 1 mm^2 devices obtained by the same producers.

The surface sensitivity is assessed by exposing smaller 1 mm^2 SiPMs of the same pixel size to a pulsed 5 μm wide laser beam of intensity at the single photon level. The SiPM is moved relative to the light source to produce two-dimensional scans of the count rate over the surface of the silicon photomultiplier. The measured sensitivity shows that it is fairly uniform across the SiPM surface. Scans over a smaller area reveal the inner structure of individual pixels (Fig. 4).

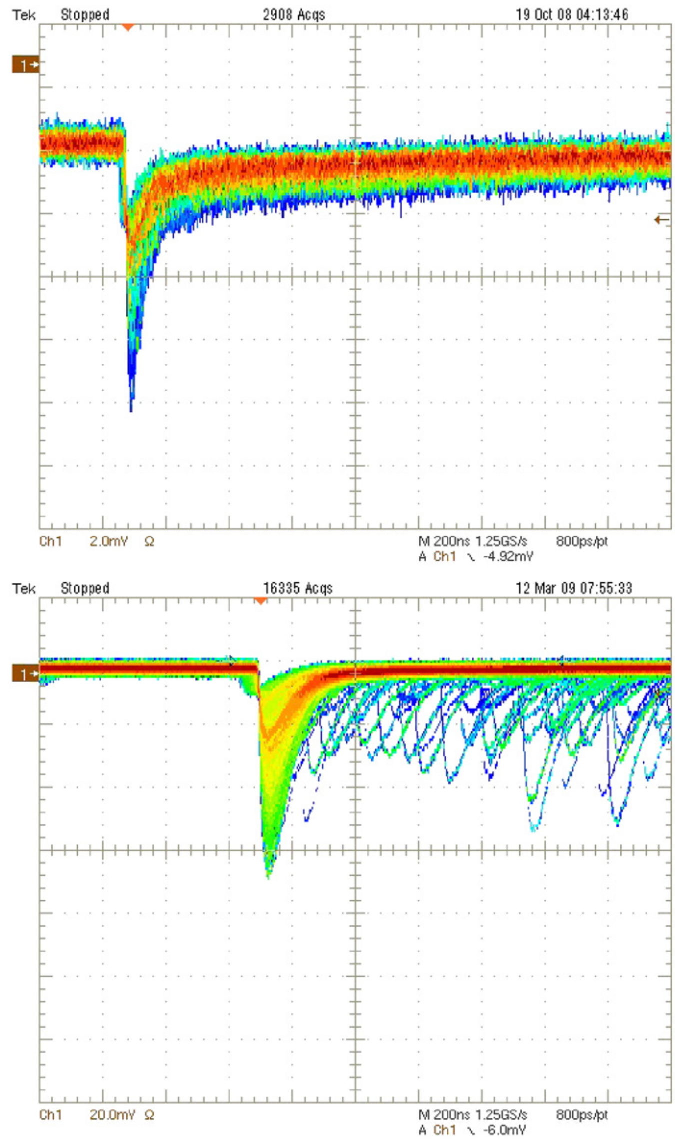

Fig. 3. The SiPM signals due to 511 keV photons: Photonique SSPM (top) and Hamamatsu MPPC (bottom).

In PET scanners, the time difference between two back-to-back photons yields information about the position of positron-electron annihilation in the patient's tissue. This information improves the image quality due to better background rejection. Therefore, the accurate determination of the position of an event depends on the time resolution.

Although not as fast as for example a micro channel plate PMT, the single photon time resolution of the measured SiPM's amounts to 100–200 ns. The measurements of the time resolution at different wavelengths (405 and 635 nm) show that all the SiPMs give a better time resolution in the blue light region (Table 2).

Unamplified signals were fed to the CAEN V965 Dual range QDC. The charge distribution of one Hamamatsu SiPM channel is shown in Fig. 5. Due to the finite number of pixels the energy response of this module is not linear. By using different radioactive sources, we obtained the energy calibration curve in Fig. 6. The measured dependence is well approximated by an exponential approach to a saturation value. Closer inspection reveals a 4% RMS variation of the position of the 511 keV photopeak among the 16 channels of the module. This is much

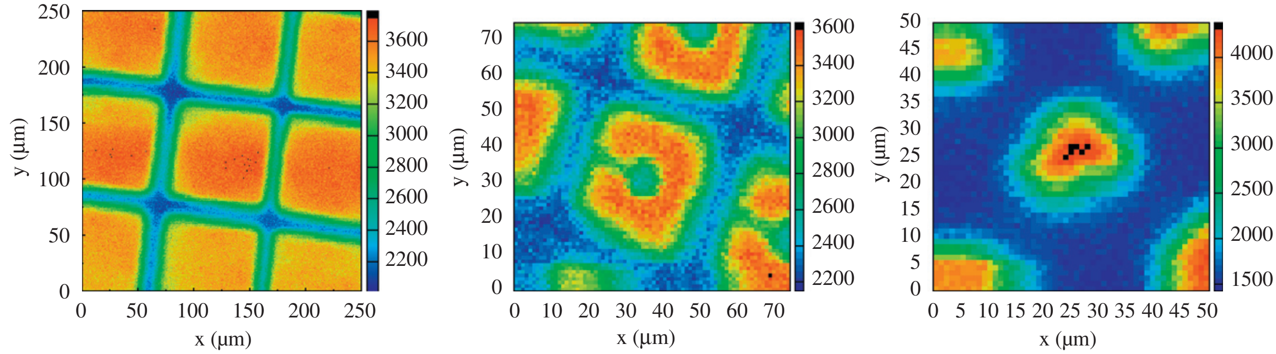

Fig. 4. Two-dimensional scans of the surface sensitivity: HC100 from Hamamatsu (left), S137 by Photonique/CPTA (middle) and E407 by MepHi (right).

Table 2
The time resolution after time-walk correction for different SiPMs.

SiPM Producer	E407 MepHi	S137 Photonique	H100C Hamamatsu
σ_{red}(ps)	127	182	145
σ_{blue}(ps)	97	151	136

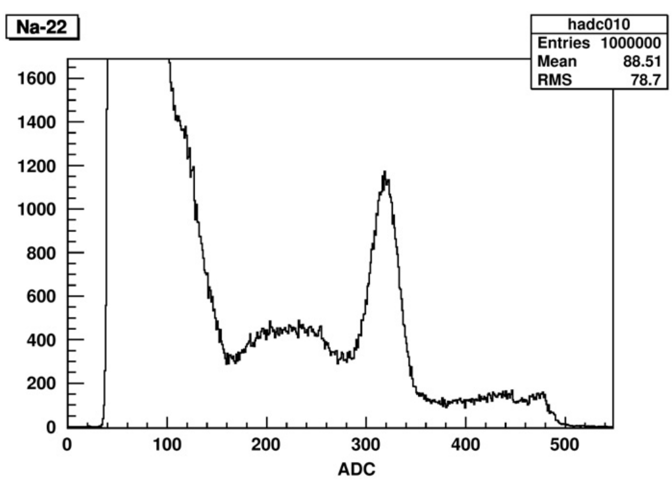

Fig. 5. The single channel response of the PET module from Hamamatsu MPPCs to a ^{22}Na source.

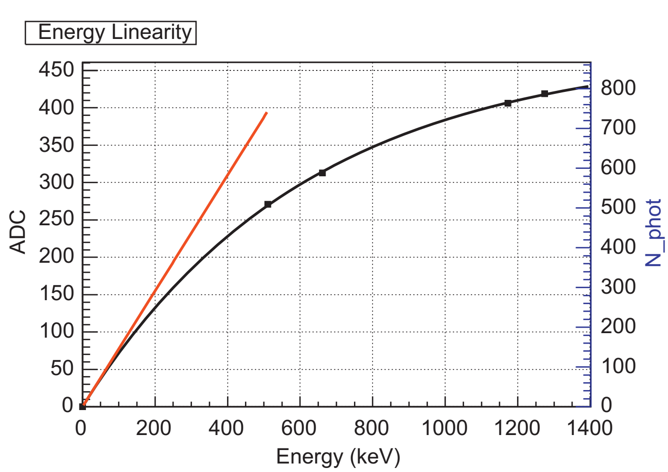

Fig. 6. Energy response of a particular channel of the PET module with Hamamatsu MPPCs.

less than the 16% RMS spread for the PET module of Photonique SSPMs.

Both PET modules were then tested by using the coincidence anihillation γ from an ^{22}Na source. The data acquisition was triggered by a sufficiently large signal from a single SiPM from the other module. The energy resolution of 10% FWHM was measured with Hamamatsu MPPCs. This was better than the best energy resolution of 21% FWHM measured with Photonique SSPMs. We mostly attribute this to the smaller photon detection efficiency, smaller area and also to the not very well controlled coupling of the SiPMs to the crystal matrix.

4. Conclusions

Silicon photomultipliers seem to be a very promising detector for PET. The main advantages are their insensitivity for magnetic fields and their compactness. We have constructed two PET modules using arrays of 4×4 SiPMs in two different packages (printed cicuit board with two pins—Photonique andsurface mount type—Hamamatsu) coupled to a LYSO matrix with pitch of 4.5 mm. The energy resolution of such modules has been investigated. The PET module from Hamamatsu MPPCs performed better than the Photonique one. This might be due to the coupling of the crystals to the SiPMs. We obtained good 10% FWHM energy resolution with little variation between the channels of the Hamamatsu MPPCs. However, due to the limited number of pixels, the response to gamma rays of different energy is not linear. We expect to obtain a better timing resolution for SiPMs with larger pixels. The good energy resolution and fast response might enable a reduction of background in PET imaging and thus improve the image quality. Systematic studies of the module will be performed in the future and the possibility to use the module in the NMR-PET will be explored.

Acknowledgements

We thank the Slovenian Research Agency for the support given by Grants nos. J1-9840 and J1-9339.

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Readout electronics for a Hybrid Avalanche Photon Detector

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Readout electronics for a Hybrid Avalanche Photon Detector

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ABSTRACT: This article presents the development of readout electronics for a Hybrid Avalanche Photon Detector (HAPD), the baseline photon sensor for the Belle II Ring Imaging Cherenkov Detector (RICH). The HAPD sensor with the readout electronics enable will enable position sensitive detection of single photons. An overview of the RICH readout system is given.

KEYWORDS: Cherenkov detectors; Data acquisition circuits; Modular electronics; Front-end electronics for detector readout

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1 Introduction

The successful physics program of the Belle experiment at KEK, Tsukuba, Japan, resulted in an upgrade of the KEKB machine and of the Belle detector. The aim of the Belle II experiment is to collect about 40 times larger sample of B mesons which would allow measurements of rare decays of B and D mesons with unprecedented precision. In the forward direction (given by the center-of-mass direction of the products), the proximity focusing RICH with an aerogel radiator will efficiently separate kaons from pions up to a particle momentum of 4 GeV/c [1].

The RICH consists of an aerogel radiator, an expansion volume and a position sensitive detector of single photons [2]. To maximize the kaon-pion separation efficiency, the detector's area of approximately 4 m^2 requires position sensitive single photon sensors with granularity of about $5 \times 5\,mm^2$. The sensor and the readout electronics for the RICH detector have to fit into a limited available space of about 25 cm in length between the central drift chamber and the electromagnetic calorimeter. They should operate in a 1.5 T magnetic field perpendicular to the detector plane and should sustain elevated radiation levels. In ten years of operation a fluence of 10^{12} cm^{-2} of 1 MeV equivalent neutrons is expected in the detector area.

2 Photon detector and readout electronics

A 144 channel Hybrid Avalanche Photon Detector (HAPD) is our candidate for the sensor of single photons ([2, 3]). It is 76×76 mm^2 in area with 67% of active area. The total amplification of the sensor is of the order of 50000. In order to fit the electronic readout into the available volume which extends 50 mm behind the HAPD sensor, the readout system was designed on a 12 layer FR4 glass-reinforced epoxy laminate (figures 1, 2) [4].

The SA02 readout board has 4 SA02 ASIC chips [2] and an HAPD connector on the top side, while the FPGA (Xilinx Spartan 6), used for data processing and communications, is placed on the bottom side between the two extension connectors (figure 1). The power for the electronics and

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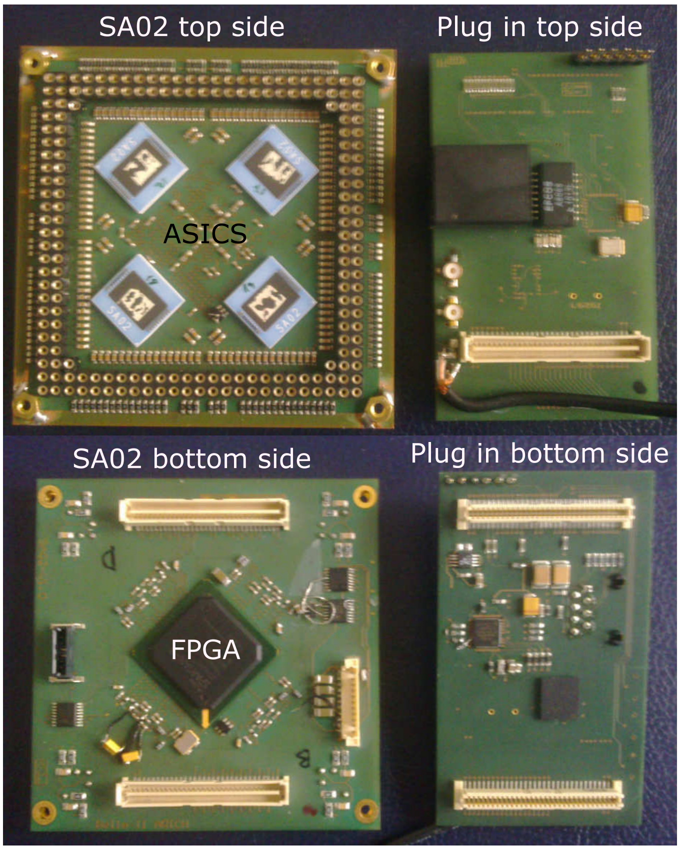

Figure 1. SA02 board and Plug in board.

bias voltage for the APDs are fed to the laminate via two independent connectors, while the high voltage is connected directly to the HAPD.

The SA02 ASIC chip packed in a LTCC BGA package, measures 13 mm $\times$ 13 mm and has 36 input channels. It is responsible for the digitization of signals from the HAPD sensor. Each channel line consists of a charge sensitive preamplifier (CSA), a second order shaper circuit and one bit comparator for digitalization. Its output is a single ended 1.65 V signal, with the width equal to time over threshold. Threshold levels are equal for all channels, but channel offsets can be set individually in steps of 3 mV. The ASIC has a separate single output for monitoring signals at different stages in the front end. The amplification factor of the charge sensitive preamplifier and the shaping time allow adjustments to optimize the signal to noise ratio.

A supplementary Plug in board (figure 1, 2) provides firmware boot, control, monitoring and acquired data transmission from the SA02 board, where the SiTCP protocol is used for communication over the Ethernet network [5].

The detector works as a single photon counter. The implemented readout core on the FPGA consists of bit shifting serial input serial output (SISO) registers for each of the 144 channels and supplementary logic for communication and data transfer. The digitized analog signals are fed to a state transition detection circuit. The detected events are introduced in the SISO shift register with adjustable shifting clock. At trigger event, the last four bits stored in the SISO registers are sent to the data acquisition system.

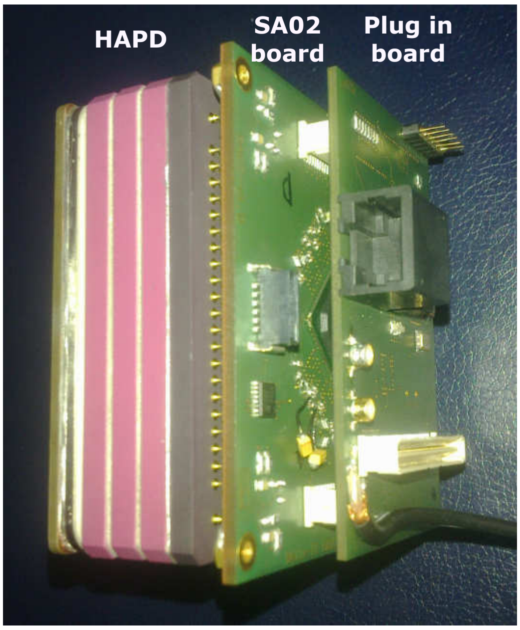

Figure 2. HAPD equipped with SA02 and Plug in board.

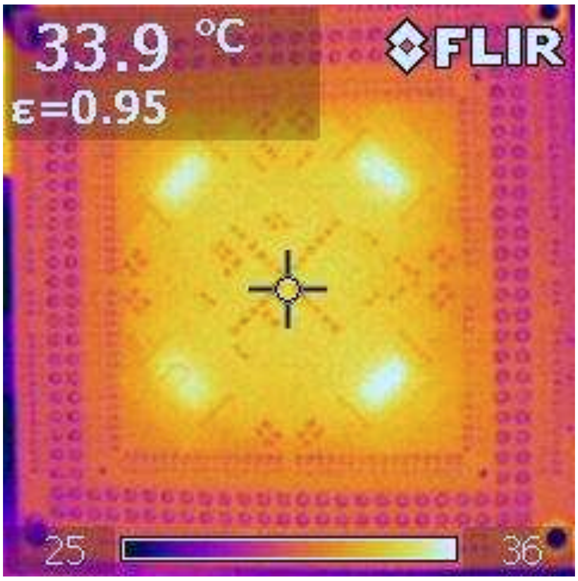

Figure 3. Thermal image of an SA02 board.

For operation the SA02 board requires several different low voltages to power the FPGA and ASIC chips. The power consumption of both electronic boards amounts to about 1 W, of which 300 mW is due to the Ethernet controller. Most of the power is dissipated on the ASIC chips. At an ambient temperature of 25°C, we made an infrared image of the SA02 board in the thermal equilibrium state (figure 3). The figure shows the temperature distribution on the board with the maximum temperature on the ASICs chips. With no cooling except for the surrounding air, the maximum temperature on the SA02 board reached 36°C.

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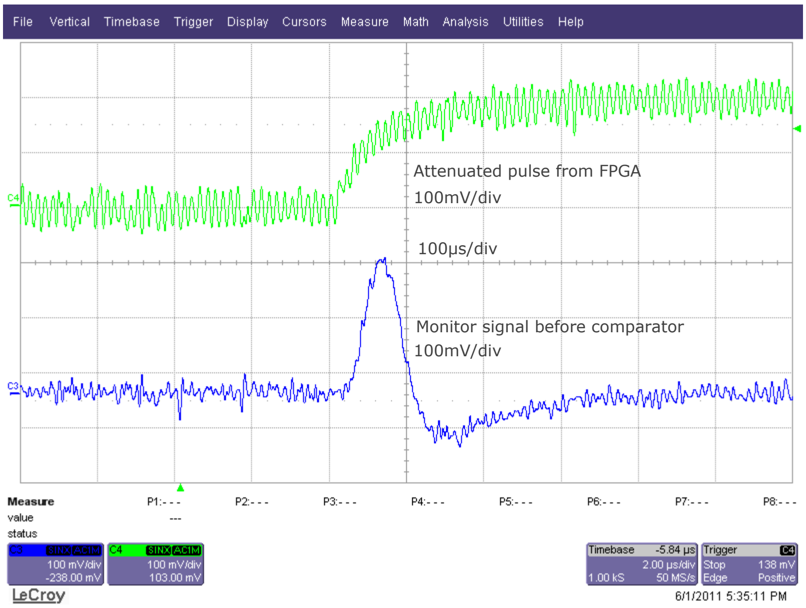

Figure 4. An ASIC response (blue trace) to the the attenuated signal generated by FPGA (green trace).

For internal tests, the SA02 board incorporates a variable amplitude step generator. One of the FPGA outputs is fed trough a digitally controlled resistor and a 0.1 pF capacitor into the SA02 ASIC. The amplified and shaped signal response is shown in figure 4.

3 Bench test — Single photon measurements

The test measurements with single photons are made by using light emitted from a blue LED. With the collimated beam, we scanned the surface of the HAPD, mounted on the computer controlled translation stage. The high voltage and bias voltages for the HAPD are set to the manufacturer's nominal values. A signal generator generates a trigger signal for the readout electronics and the LED at a rate of about 1 kHz. Blue light, emitted from the power controlled LED, is fed into the box using a multimode optical fiber. The frame with the optical fiber and the collimator is attached to the translation stage 1 cm away form the detector's surface.

We first verified the operation of an arbitrary pad on the sensor, where multiple photons can be observed as seen in figure 5. The oscilloscope screen image shows the analog amplified and shaped signals from the observed channel. A threshold scan of the corresponding measurement is shown in figure 6.

With the LED light emission reduced, to a level where mostly single photons are observed, an area 10 mm $\times$ 10 mm of the HAPD was scanned in steps of 300 μm with the light beam of about the same width. The HAPD sensitive area is clearly seen in figure 7.

4 Belle II aerogel RICH readout system

The aerogel RICH detector will consist of 456 HAPD sensors. The analog signals will be amplified and digitized by the SA02 board. The Merger board, built around Virtex 5 FPGA, is intended to

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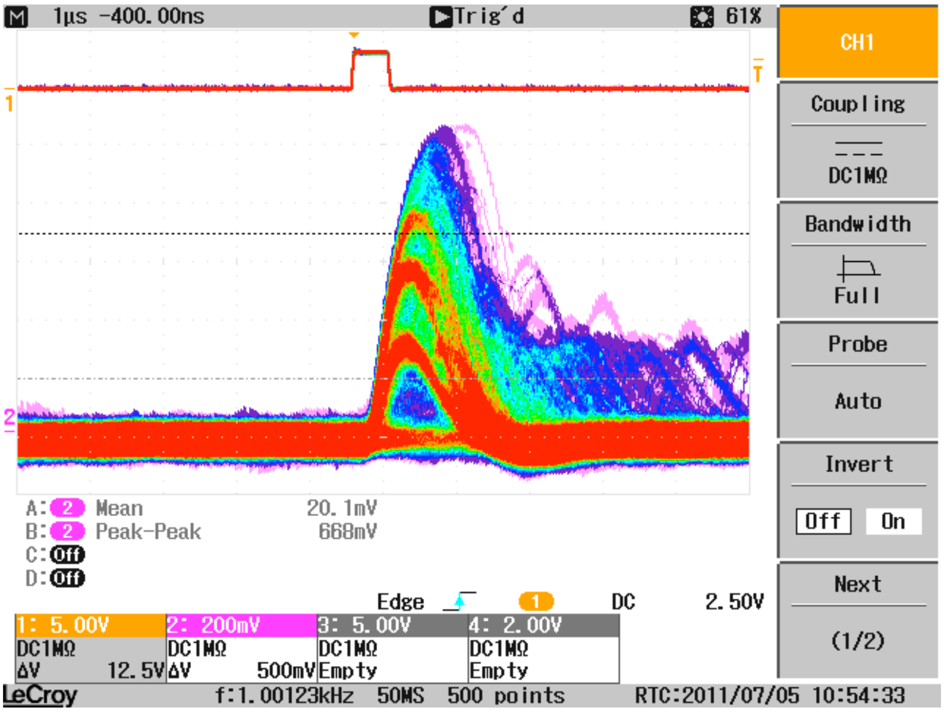

Figure 5. Accumulated of response to a multiphoton illumination. The single channel signals are first amplified and shaped. Electrical signals from single, double and triple detected photons are clearly visible.

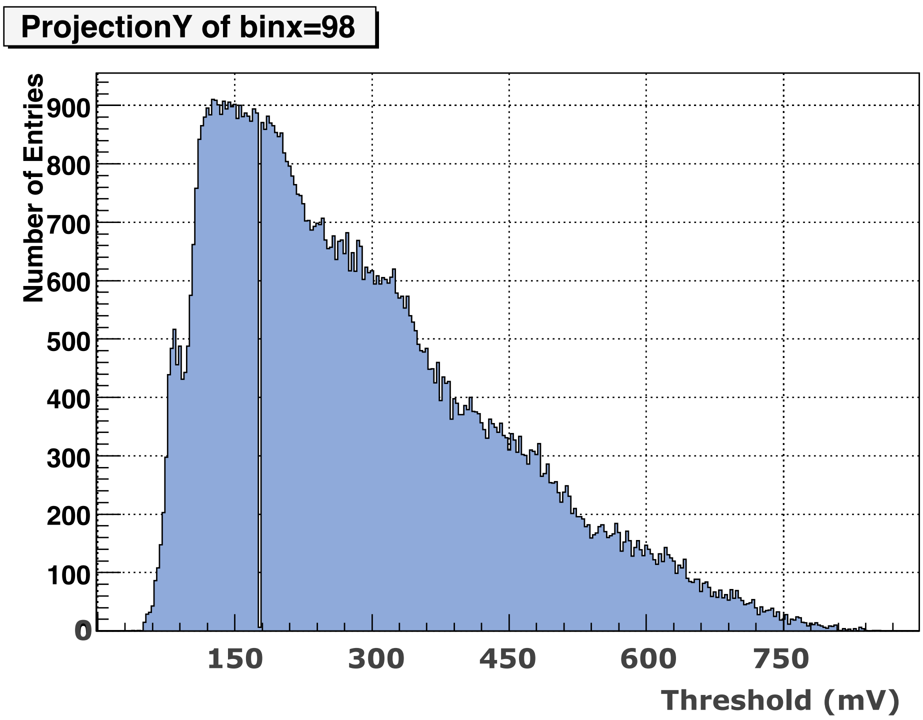

Figure 6. Number of detected hits as a function of the threshold.

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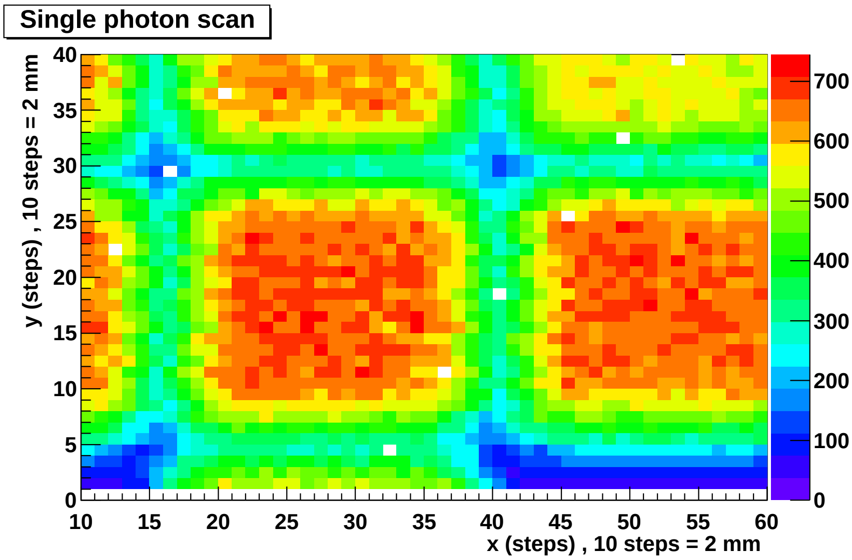

Figure 7. Response of the HAPD to single photons.

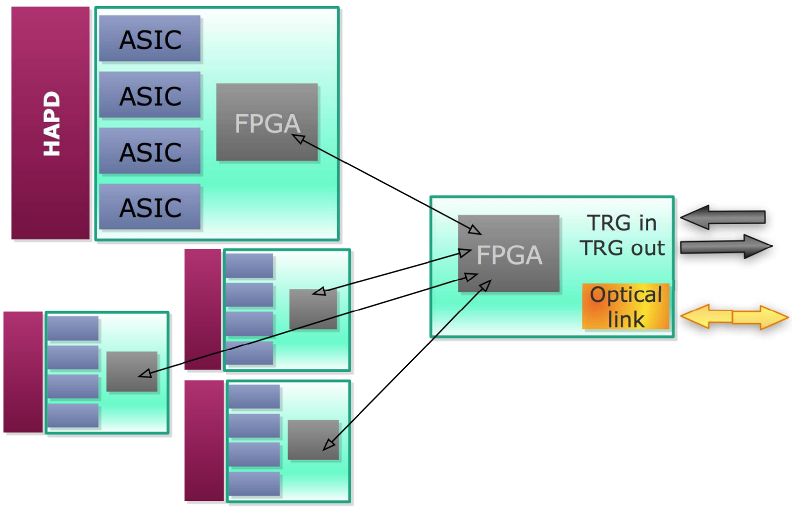

Figure 8. Scheme of the Belle II RICH readout system.

collect and process data from up to six SA02 boards (figure 8). The Merger board will replace the current Plug in board used for laboratory tests. It will be used for loading of the FPGA firmware to multiple SA02 boards, clock and trigger distribution, slow control and to perform compression on the acquired data. In the present prototype, the Merger board receives the trigger and clock signals via Ethernet cable. A small form-factor pluggable transceiver (SFP) slot using fiber optic link is used to transmit commands and send the data to the central DAQ [6].

The current version of SA02 board with the Plugin board was tested in the aerogel RICH prototype with six HAPD sensors at the CERN SPS H6 beamline with 120 GeV/c pions. Preliminary results from the beam test show good performance of the redesigned device.

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5 Summary

We are developing readout electronics for the Aerogel RICH of the Belle II spectrometer. The readout electronic system should fit in to the small gap (50 mm) at the rear end of the HAPD sensor. It is based on the SA02 readout board which incorporates four ASIC SA02 chips and an FPGA. The data will be transfered from six SA02 boards to the Merger board, which will send data via optical link to the common DAQ. The readout board performs according to expectations and allows efficient detection of single photons. In the future, a tolerance to radiation and operation in a magnetic field of the SA02 readout board will be tested. Future study will include the design of power supply distribution design, cabling and algorithms for data compression.

Acknowledgments

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Module of silicon photomultipliers as a detector of individual Cherenkov photons

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ABSTRACT

We have studied the possibility of using silicon photomultipliers as single photon detectors in a proximity focusing RICH with aerogel radiator. Such a counter is considered for the upgrade of the Belle detector. The main advantage of silicon over conventional photomultiplier tubes is their operation in high magnetic fields. Their disadvantage is the relatively high dark noise count rate ($\approx$ MHz/mm^2) which can be overcome by using a narrow time window in the data acquisition. A module, consisting of 64 (8×8) Hamamatsu MPPC S10362-11-100P silicon photomultipliers, has been designed, constructed and tested with Cherenkov photons emitted in an aerogel radiator by 120 GeV/c pions from the CERN T4-H6 beam. To increase the signal-to-noise ratio, i.e. to increase the effective surface on which light is detected, light concentrators have been employed.

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1. Introduction

We are studying the proximity focusing ring imaging detector with aerogel radiator for particle identification at the foreseen upgraded Belle spectrometer [1,2]. Several photon detector candidates have been studied [3,4], none of which are completely immune to the high magnetic field present inside the Belle spectrometer. Silicon photomultipliers (SiPMs) [5] may change the situation. In addition to their insensitivity to magnetic fields, they are also small, robust and do not require high voltages. Among their disadvantages is the relatively high dark count rate (≈ 1 MHz/mm^2) and a low fraction of sensitive surface compared to the full area covered by the photon detector. These deficiencies may be reduced with light concentrators collecting light from a larger surface. In this way the geometric acceptance of the detector as well as the signal-to-noise ratio may be increased. The present measurements with a SiPM module follow the initial successful investigations of the performance of individual SiPM detectors, i.e. a smaller number of them, in a ring imaging Cherenkov counter [6].

2. Experimental setup

A module of 64(8×8) Hamamatsu MPPC S10362-11-100P silicon photomultipliers has been constructed (Fig. 1). The module consists of two printed circuit boards (Fig. 2). The main board houses the voltage divider chain, the filtering capacitors and the signal outputs, while the "piggy" board has silicon photomultipliers soldered on one side in a 8×8 matrix at 2.54 mm pitch. On the main board four neigbouring SiPM's are connected together, so that the module has 16 electronic readout channels. The voltage divider chain is adjusted with individual resistors such that all the SiPM have approximately equal gain. The output signals are amplified by the fast amplifier (Ortec FTA820), then discriminated (CAEN V814) and finally fed to a time to digital converter (CAEN V673A). A typical signal is shown in Fig. 3.

The module has been used as a photon detector in a proximity focusing Cherenkov detector (Fig. 4) with a 1 cm thick aerogel radiator ($n = 1.03$ and 1.4 cm attenuation length at 400 nm). The detector was tested in a 120 GeV/c pion beam at the CERN T4 H6N beam line. The arrival of a beam particle was triggered by a scintillation counter and its trajectory was registered with two multiwire proportional chambers (MWPCs). The incident particle hit coordinates were obtained by delay line readout of the cathode wire planes.

In the aerogel, pions radiate Cherenkov photons at an angle relative to their track direction. These photons were detected by a photon detector plane at a distance of 115 mm from the aerogel upstream surface. As the SiPM sensitive area is 1 mm^2 and the pitch is 2.54 mm, the geometric acceptance of a pad is only 15.5%.

The rather low geometric acceptance of the SiPM detectors within an array can be increased by employing light guides. We have studied light guides in the form of truncated pyramids (Fig. 5). The geometric parameters for the simulation have been

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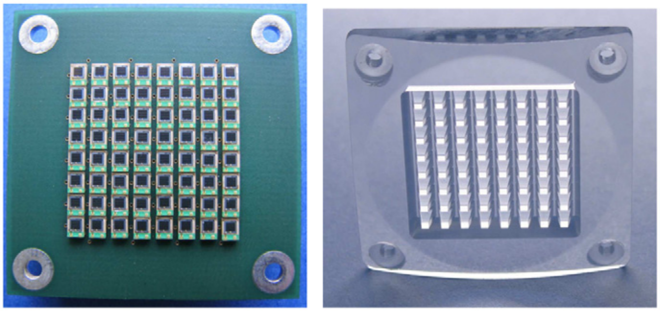

Fig. 1. The photon detector module consisting of 64 SiPMs (left) and the pyramidal light guides (right). Four SiPMs are grouped into a single readout channel.

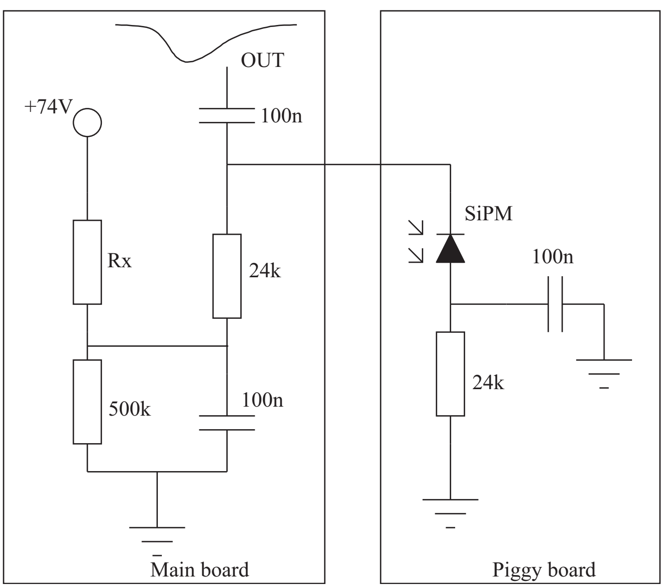

Fig. 2. The printed circuit boards schematic of electrical connections. The resistors Rx were chosen such that all the SiPM gains were approximately equal.

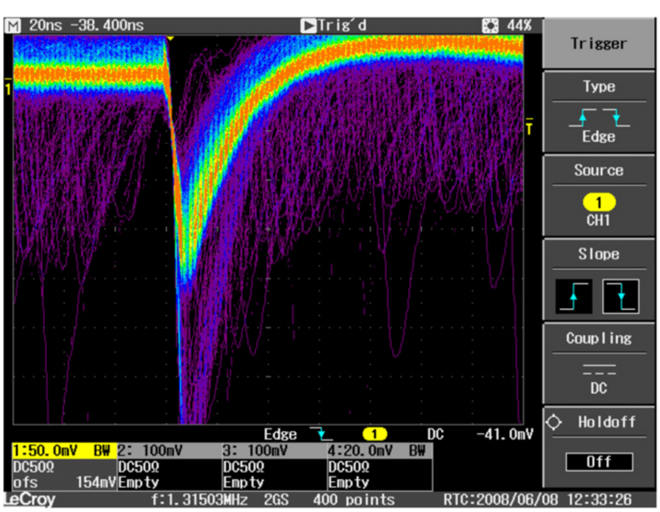

Fig. 3. The SiPM signal output corresponding to dark counts amplified by the Fast timing amplifier (Ortec FTA820).

such that the inclination of the pyramid lateral planes, as well as the size of the entrance window have remained fixed, while the length of the light guide has been varied. Photons have been

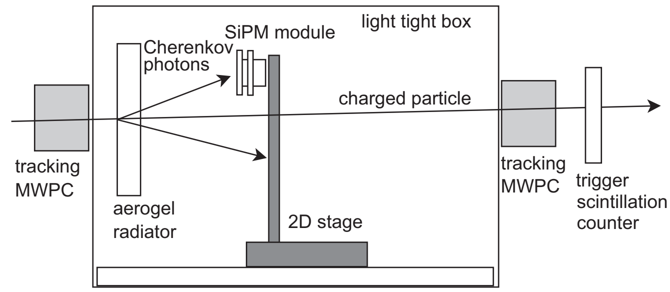

Fig. 4. The experimental setup: Cherenkov photons emitted by the charged pion in the aerogel slab are registered by the silicon photomultiplier module. The particle trajectory is measured by two multiwire proportional chambers and the data acquisition is triggered by the plastic scintillation counter.

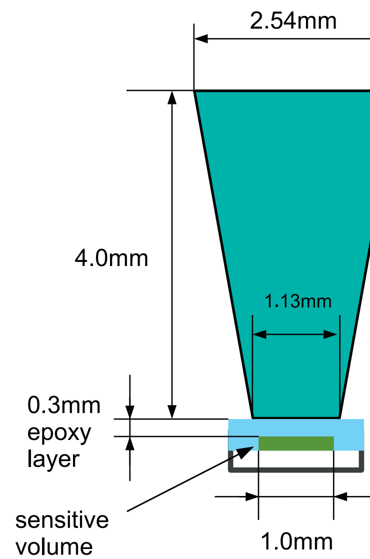

Fig. 5. A pyramidal light guide with dimensions optimized by simulation. Also shown are the main elements of the Hamamatsu MPPC S10362-11-100P, the protective epoxy layer and the sensitive volume.

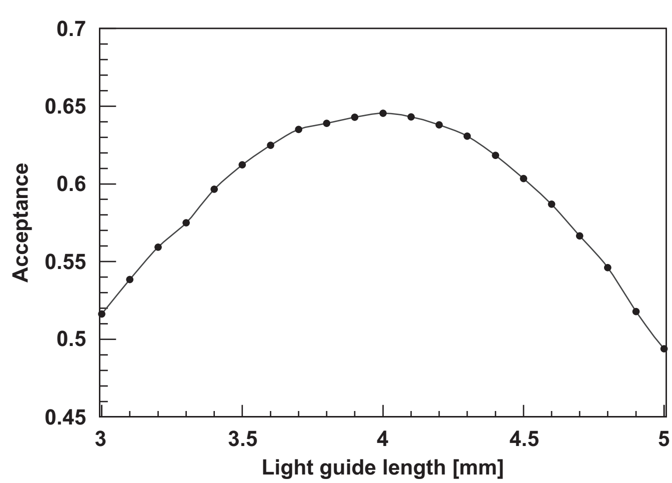

Fig. 6. Light guide acceptance as a function of light guide length.

generated with isotropic incident angle distribution up to $\vartheta = 30^{\circ}$ and with a uniform distribution over the surface of the light guide entry window. The acceptance as a function of light guide length is shown in Fig. 6. The loss of 35% of the photons is mainly due to

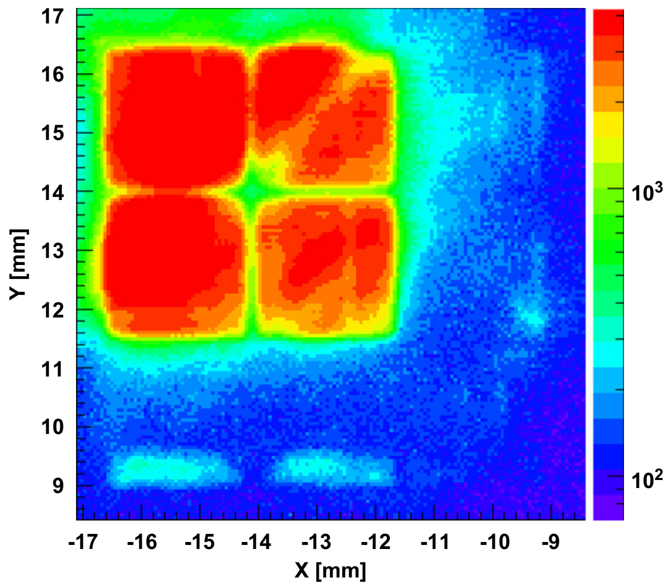

Fig. 7. The response to a perpendicular light beam of one of the electronic channels of the SiPM module with the light guides. The measured average acceptance increase for the module with the light guides is 2.4 for light incident at an angle of 18° (typical angle of Cherenkov photons in the beamtest setup).

the 0.3 mm gap between the light guide exit window and the sensitive volume of the SiPM (Fig. 5) and, to a lesser extent, also to refraction out of the light guide and to absorption. Therefore, the acceptance of an ideal light guide is about 65%, which is about four times larger than the bare geometric coverage of the SiPM sensitive surface in a module as described above. In order to test these estimates, we have manufactured a light guide array matching the array of SiPM detectors (Fig. 1). The array has been machined out of a UV grade perspex lens, used in the HERA-B RICH [8]. Due to a limitation of the available machining procedure, the final entry window of the light guide was 2.3 mm × 2.3 mm instead of 2.54 mm × 2.54 mm and the length 4 mm; these changes resulted in a somewhat lower expected acceptance of 54%. A two-dimensional scan with the single photon light beam over the surfaces of the light guides (Fig. 7) shows that the response is uniform.

3. Results

We have measured a proximity focusing RICH prototype with a silicon photomultiplier module, with and without a light guide array. In Fig. 8, the time spectra of the SiPM pulses are shown for an equal number of triggered events, where a clear improvement with the light guide system may be observed. The light guides have increased the number of detected Cherenkov photons, while not affecting the number of dark pulses. Selecting pulses only within a narrow time window, e.g. 5 ns around the peak, will further increase the signal-to-noise ratio, to the level at which a measurement of Cherenkov rings is possible.

Due to the small size of the detector, data were acquired in eight positions on a 3 × 3 grid, with the central position excluded. For the module without the light guide the distribution of hits with respect to their corresponding Cherenkov angle is shown in Fig. 9 for hits within a 5 ns time interval. The background hits corresponding to the hits out of coincidence with the Cherenkov pulse were subtracted. By fitting the Cherenkov peak one obtains 1.6 detected photons per ring without the light guides and 3.7 detected photons per ring with the light guides for the case when the full ring is covered by the detector.

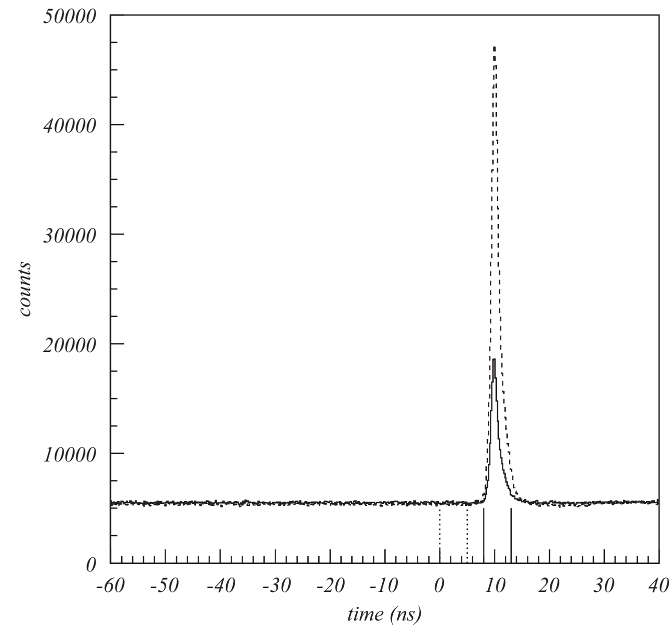

Fig. 8. The time spectra for the SiPM pulses in the case without (full line) and with (dashed line) the light collection system. The indicated cuts correspond to 5 ns time windows.

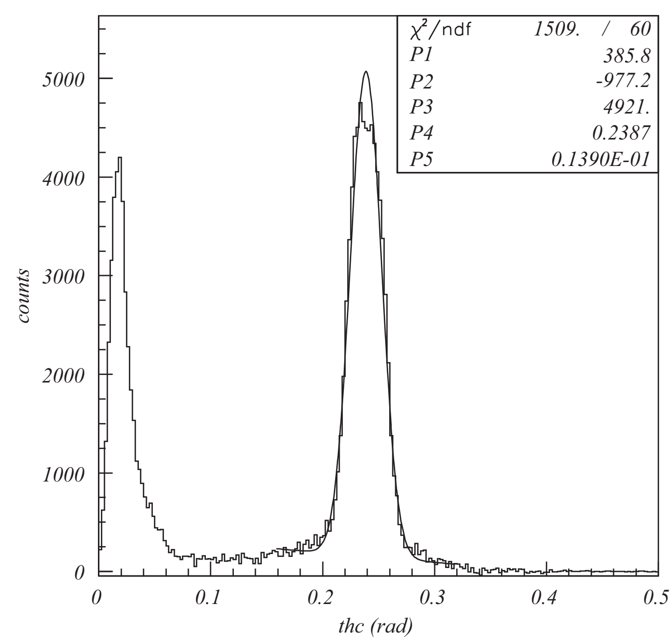

Fig. 9. The distribution of hits in Cherenkov angle with noise distributions subtracted. The plot is for the case with the light guides.

The width of the Cherenkov photo peak ($\sigma \approx 14$ mrad) roughly agrees with the expectation based on estimates of photon position resolution, i.e. pad size, emission point uncertainty due to aerogel radiator thickness and tracking accuracy.

4. Discussion

From estimates based on the photon detection efficiency of the MPPC S10362-11-100P supplied by the producer [7], geometric coverage and electronic efficiency, we would expect to detect about 2.3 Cherenkov photons per ring, while the actually

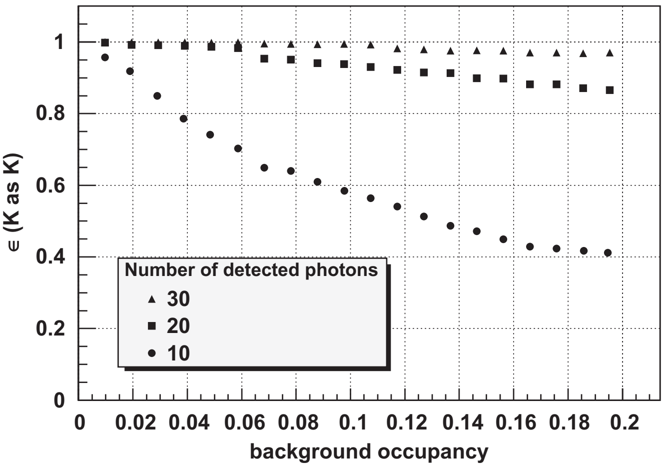

Fig. 10. Simulated identification efficiency at 1% misidentification probability for kaons at 4 GeV/c as a function of background level for three different yields of detected photons per ring. The simulated proximity focusing Cherenkov detector with an aerogel radiator consists of a focusing radiator [11] ($n_1=1.043$, $d_1=15$ mm and $n_2=1.05$, $d_2=15$ mm and attenuation length of 40 mm at 400 nm) and square photon detector array of SiPM modules at a distance 200 mm from the radiator. The background is simulated uniformly over the detector area.

measured number is 1.6 photons/ring. Most of the discrepancy can be explained by an overestimation in the manufacturer data on photon detection efficiency of the SiPM, which includes effects of crosstalk and afterpulses. This is in agrement with other authors [9] who also indicate that the manufacturers data are too optimistic.

The measured improvement by a factor of 2.3 due to light concentrators with perspex pyramids is also less than the estimated factor of 3.5, which is the ratio of the expected acceptance of 54% to the bare geometric coverage of 15.5% of the SiPM sensitive surface in the module. This discrepancy is probably partly due to non-specular reflection and refraction on the side walls of the light guide and is in agreement with the bench tests (Fig. 7). An additional contribution to the discrepancy could come from less than perfect overlap of the light guide exit window with the SiPM sensitive surface. Also reflection on the light guide exit window and effects of inaccurate cutting have not been accounted for in the calculated acceptance [10].

We hope to gain a factor of 5 in photon yield by increasing the radiator thickness to 3 cm and simultaneously switching to $n=1.05$ aerogel with 5 cm attenuation length. Optimistically, another factor of 2 might be obtained by improved production of the light guides and their coupling to SiPMs.

We have also simulated detector response for prototype proximity focusing Cherenkov detector using different numbers of detected photons N_{det} and different backgrounds for pions and kaons [12,13]. $N_{det}=10$ corresponds to the use of conventional photomultipliers, and $N_{det}=20$ and 30 correspond to the detector with higher detection efficiency, e.g. to SiPM's. The kaon identification probability at 1% misidentification rate considerably improves with the increase of the number of photons (Fig. 10). For a typical background occupancy of 0.1 (1 MHz/mm^2 background rate and 10 ns detection time window) the kaon identification efficiency for $N_{det}=30$ is well above 95%.

We conclude that our investigations have demonstrated that such a proximity focusing ring imaging Cherenkov detector is feasible.

Acknowledgments

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Study of TOF PET using Cherenkov light

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A B S T R A C T

This work investigates the possibilities of improving the measurements of arrival time difference of the two 511 keV photons arising from annihilation of a positron in positron emission tomography (PET). The new technique of detecting the prompt Cherenkov light, produced by absorption of the annihilation photon in a suitable crystal, could considerably improve the image quality. A simple apparatus with PbF_2 crystals and microchannel plate photomultipliers (MCP PMTs) has been constructed and coincidence resolutions of 71 ps FWHM and 95 ps FWHM have been achieved with 5 and 15 mm thick crystals, respectively. Simulation calculations are in agreement with the experimental findings.

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1. Introduction

Positron emission tomography (PET) is an important modality in medical imaging, used to detect the position of tumors and to observe biochemical processes in the body. The contrast of images obtained with PET can be significantly improved by measuring the time difference between the arrival of two annihilation photons. The amount of improvement in the image depends on the time resolution, which is usually limited by the decay time of the scintillations and the time resolution of the photodetector. Using the microchannel plate photomultiplier, a photodetector with excellent timing [1,2], to detect prompt Cherenkov photons, has the potential of providing a big improvement in the time-of-flight resolution. For the upgrade of the Belle II detector, we have already investigated how a MCP PMT could be used for detection of Cherenkov photons, produced by pions or kaons in an aerogel radiator and in the entrance window of a MCP PMT [3]; some other studies of time-of-flight measurements for charged particles also showed very good performance [4,5]. In the present work we consider the possibility of using a very fast MCP PMT to measure the time-of-flight difference of 511 keV annihilation gammas. Some early studies of this approach have achieved time-of-flight resolutions of 170 ps FWHM [6], 183 ps FWHM (our first study [7]) and 250 ps FWHM [8]. In the present study we have considerably improved the timing resolution and found a good agreement with Monte Carlo simulation.

Below, we first describe the principles of the detection method. In the third section we present the experimental apparatus and then we discuss the results of measurements of time resolution for two coincident 511 keV gamma photons absorbed in PbF_2 crystals. Next, we compare our measurements with simulation calculations, which also included a study with $PbWO_4$ crystals in order to investigate possible improvements of the design. The last section contains a short discussion of the results and some conclusions.

2. Detection method

To obtain Cherenkov photons for time-of-flight measurements of 511 keV gammas, we need a material in which the annihilation gammas efficiently transfer their energy to electrons. Photons with energy of 511 keV interact with matter either through the photoelectric effect or by Compton scattering. Here the former is preferred, since all of the photon's energy are deposited in one interaction, which results in a photoelectron with the maximum kinetic energy possible. The material used as a Cherenkov radiator should have a high index of refraction i.e. low Cherenkov threshold, so that many electrons are produced above the Cherenkov threshold. It should also have a high stopping power for 511 keV gammas. All this suggests a high density and high-Z material. Also, the material must have good transmission for light in the

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blue to near UV region, where most of the detectable Cherenkov photons are produced. Most promising candidates are high lead content crystals, such as lead fluoride (PbF_2) and lead tungstate ($PbWO_4$). Some of their properties are summarized in Table 1.

Even though the Cherenkov photons are produced promptly, a significant contribution to the timing resolution can be expected from the Cherenkov photon travel time spread in the crystal. A very simple estimate of the time resolution can be obtained by considering the difference between the shortest and the longest time from the moment that the 511 keV gamma enters the crystal to the moment that the resulting Cherenkov photon reaches the photodetector. The shortest time is obtained, when the gamma enters the crystal perpendicularly to the entry surface and causes the production of a Cherenkov photon at the very end of the crystal. Assuming no reflections from the crystal sides, the longest time is obtained for a gamma, which is absorbed as soon as it enters the crystal and a Cherenkov photon, which travels to the photodetector under a large angle relative to the entry surface normal. In the case of our measurements this angle is limited by detector geometric acceptance and amounts to approximately 30°. For a crystal with thickness $d=15$ mm and index of refraction of $n=1.8$ (PbF_2), the difference between the shortest time, $t_{min}=d/c_0=50$ ps and the longest time, $t_{max}=(d/\cos 30^\circ)(n/c_0)=104$ ps, is 54 ps. This would result in a r.m.s. spread of about $\sigma\approx 20$ ps. If we combine this rough estimate with the typical photon detection time resolution ($\sigma\approx 20$ ps), we see that the best coincidence timing resolution we can expect is $\sigma\approx\sqrt{2*(20^2+20^2)}$ ps $=40$ ps, which translates to r.m.s. ≈ 6 mm in spatial resolution along the line of response.

The above analysis suggests that considerable benefits and improvements of PET image quality may be obtained by detecting annihilation photon coincidences via the prompt Cherenkov light they produce in suitable radiators. In order to experimentally verify these estimates we have constructed a simple apparatus, with which we have confirmed the optimistic expectations.

Table 1
Properties of two promising Cherenkov radiators [9–13].

	PbF_2	$PbWO_4$
Index of refraction ($\lambda=400$ nm)	1.8	2.3
Density (g/cm^3)	7.77	8.28
Cherenkov threshold for e^- (keV)	104	56
Optical transmission cutoff wavelength (nm)	250	350
Scintillation light yield (photons/MeV)	–	200
Scintillation decay time (ns)	–	6/30
Scintillation emission peak (nm)	–	440/530

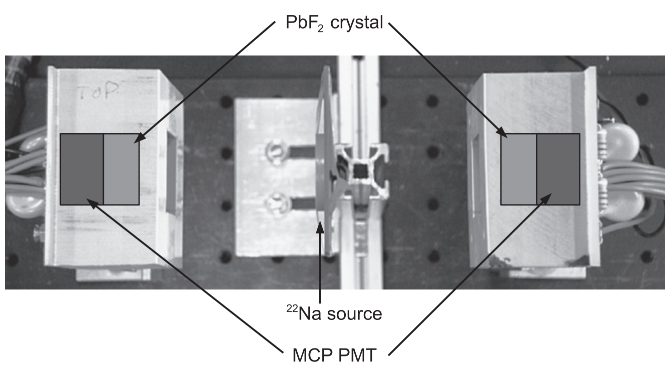

Fig. 1. The experimental set-up: two Hamamatsu 16 channel MCP PMTs coupled to lead crystals in a back-to-back configuration, with ^{22}Na source positioned between the two detectors. MCP PMTs and the crystals are enclosed in plastic support frames, which are fully open in the source direction.

3. Experimental set-up

The experimental set-up consisted of two detector modules in a back-to-back configuration, separated by 140 mm, with a ^{22}Na point source positioned between them (Fig. 1). The PbF_2 crystals [14] were coupled with optical coupling grease to Hamamatsu 16 channel MCP PMTs, with an active surface area of 23×23 mm^2 and 1.5 mm thick borosilicate windows (prototypes based on the MCP PMT presented in Ref. [15]). The pairs of unsegmented crystals used for these measurements were $25\times 25\times 15$ or $25\times 25\times 5$ mm^3 in volume. The surfaces of the crystals were polished and were either wrapped in white reflective Teflon tape or painted black. In this study, only two channels per MCP PMT, located near the center of the device, were read out individually. The signals from the other 14 channels of each MCP PMT were summed into two channels and used to suppress crosstalk background in the two individually connected channels, by selecting events where the individually connected channels had the largest charge measurement. The signals were amplified (ORTEC FTA 820A), discriminated (Philips leading edge discriminator model 708) and timed with a TDC (Kaizu Works KC3781A). The pulse charge was measured with a charge sensitive ADC (CAEN QDC V965). The four signals from each MCP PMT were ORed and the

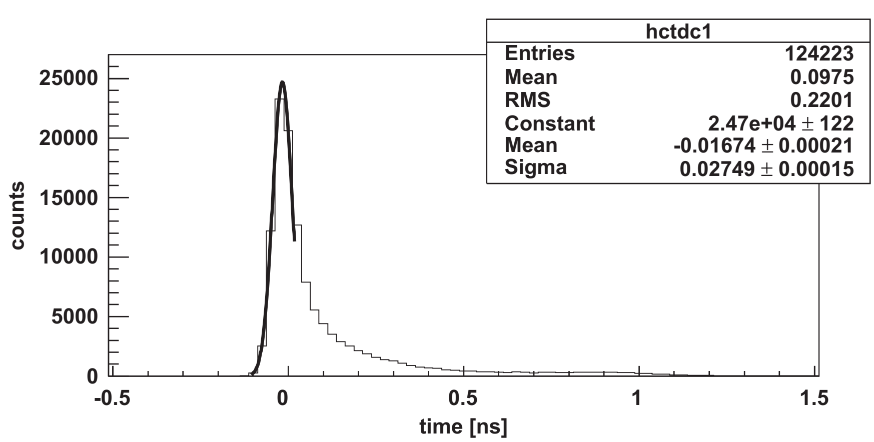

Fig. 2. The time distribution for single photoelectrons obtained for one of the prototype MCP PMT samples. The approximately 1 ns long tail, trailing the main peak, is due to the backscattering of photoelectrons from the front MCP surface. The shape of the distribution is described in more details in Ref. [1].

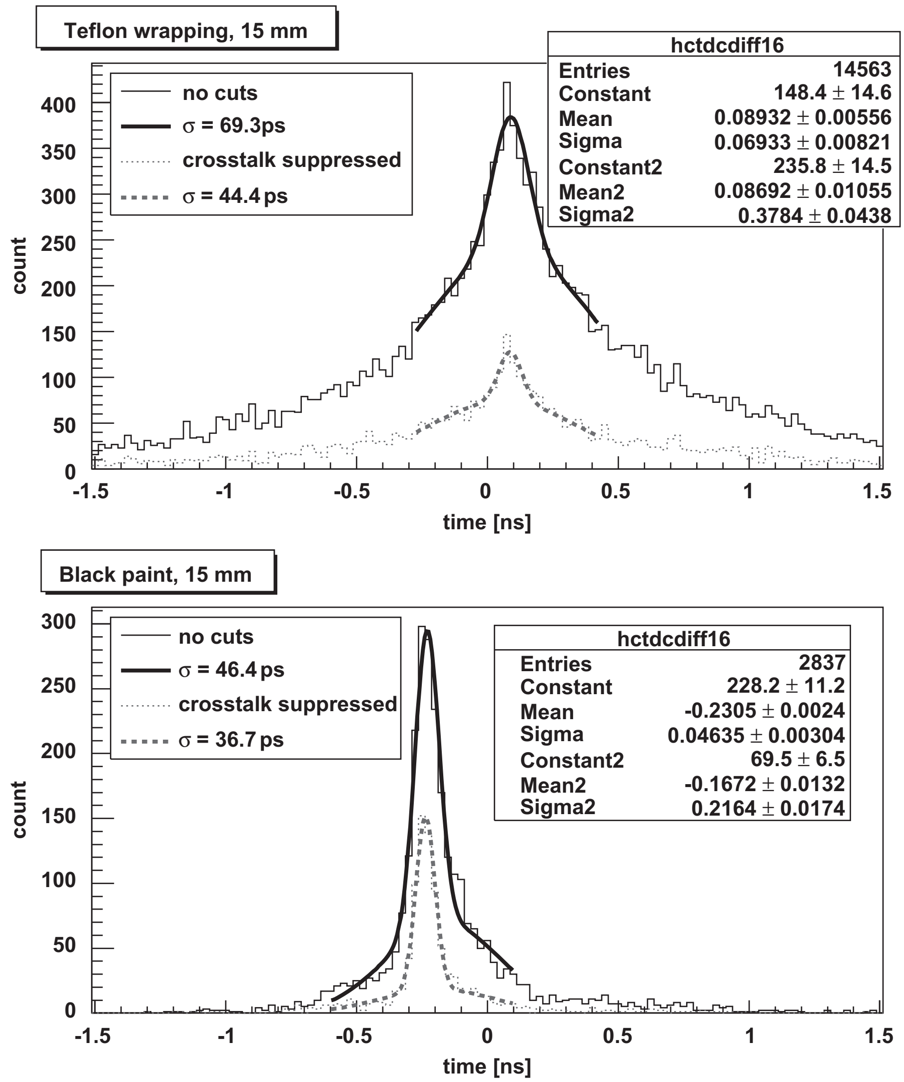

Fig. 3. The coincidence timing distributions obtained with 15 mm thick PbF_2 crystals, in the case of Teflon wrapped (top) and black painted (bottom) surfaces. The histograms of all events (solid line) and the crosstalk suppressed histograms (dashed line, see text for explanation) are fitted with a sum of two Gaussian functions.

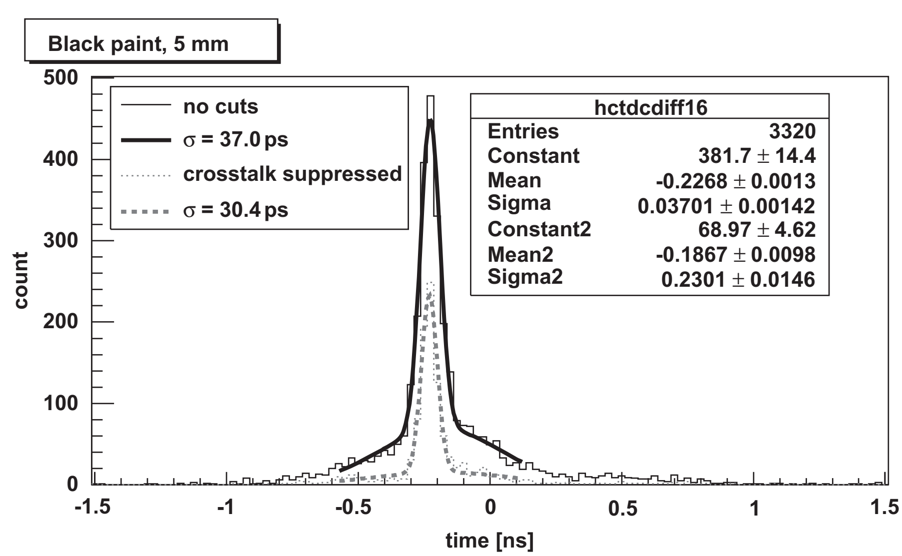

Fig. 4. The coincidence timing distribution obtained with 5 mm thick PbF_2 crystals with black painted surfaces.

Table 2
Experimental results: coincidence time resolutions for different PbF_2 crystals and surface treatments, obtained from the narrow peak of the double Gaussian functions.

	Time resolution σ (ps)	
	Without crosstalk suppression	With crosstalk suppression
15 mm thick, Teflon wrapping	69	44
15 mm thick, black paint	46	37
5 mm thick, black paint	37	30

measurement was triggered by a coincidence between the two resulting signals.

The time resolution of the Hamamatsu MCP PMTs was measured in an independent study by illuminating the MCP PMT with single photon pulses, generated by a PiLas diode laser system EIG1000D. The laser output was attenuated to the single photon level by neutral density filters, while the laser control unit also provided the trigger signal. We obtained an excellent time resolution with $\sigma \approx 27$ ps for both MCP PMTs, which includes the contributions from the laser jitter (15 ps r.m.s.) and electronics (approximately 11 ps r.m.s.). Fig. 2 shows the time distribution obtained for one of the MCP PMTs.

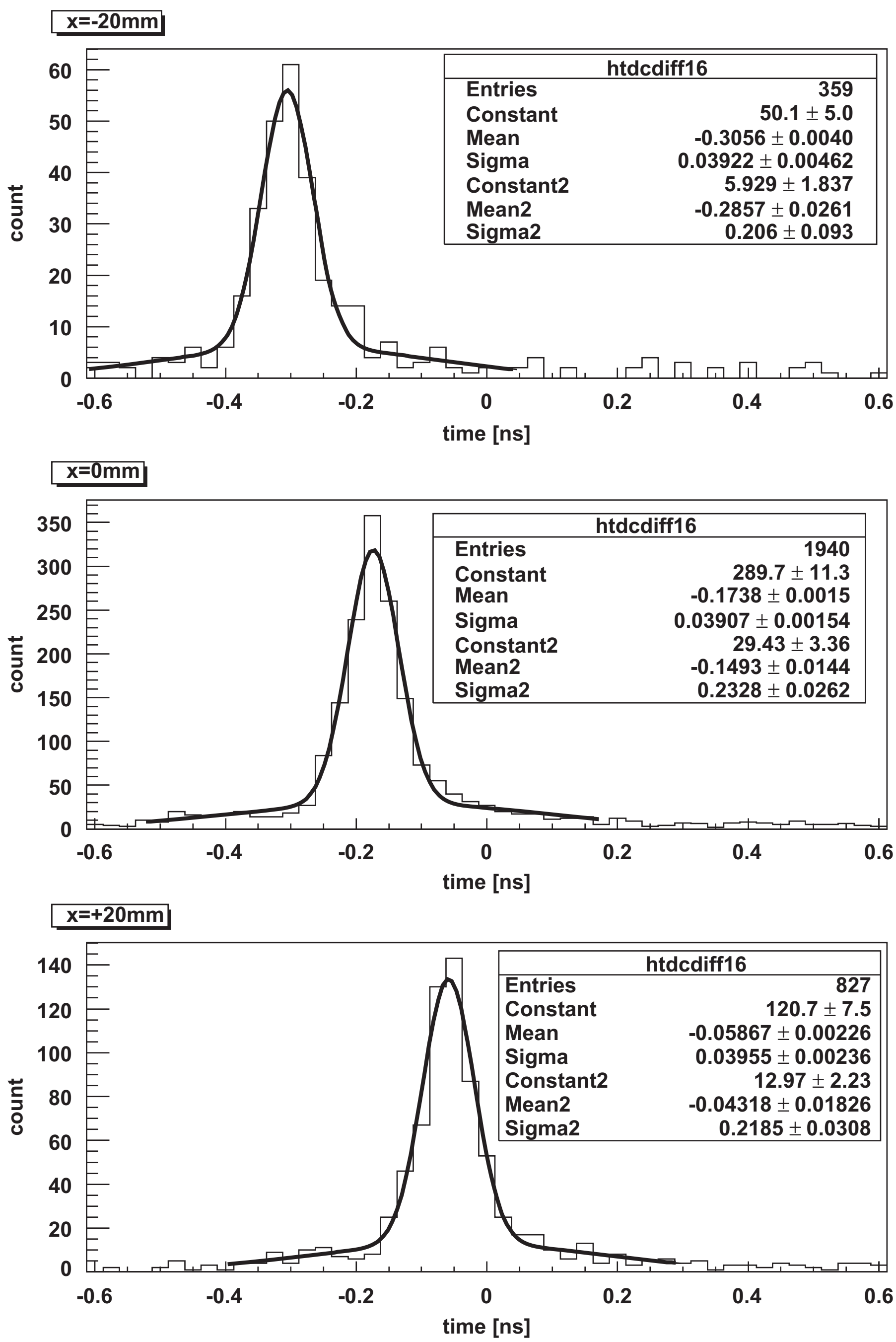

Fig. 5. The coincidence timing distributions obtained with 15 mm thick crystals with surfaces painted black, for the source positioned at -20 mm from the central position (top), for the source in the central position (middle) and for the source positioned at $+20$ mm from the central position (bottom).

4. Measurements

The corrections for leading edge discrimination time-walk were obtained from a correlation of the pulse time versus pulse height and applied to the TDC measurements. The coincidence timing distributions were obtained by histogramming the difference in corrected pulse arrival times from two selected individually connected channels. The MCP PMTs used in our measurements exhibit some crosstalk between the anode channels [1], which can lead to delayed detection of fake signals on channels neighboring the channel with the true hit. To demonstrate improvements possible by suppressing crosstalk, Figs. 3 and 4 also include histograms containing only the events where both selected channels had the maximum charge of their MCP PMT.

Fig. 3 shows the coincidence timing distributions obtained with 15 mm thick PbF_2 crystals. Painting the surfaces of the crystal black, instead of wrapping them in Teflon, removed the wider contributions, corresponding to photons which undergo one or more reflections before reaching the photodetector. The narrow peak which is due to the photons that reach the photodetector without any reflections remained. This resulted in a significant improvement in the time resolution (Table 2). The remaining tails are mainly due to the backscattering of photoelectrons from the front MCP surface (Fig. 2 and Ref. [1]).

We obtained further improvement in time resolution by using thinner crystals, as shown in Fig. 4 for 5 mm thick PbF_2 crystals with black painted surfaces. Reducing crystal thickness reduces the variation in photon travel times at the expense of gamma absorption efficiency. Some coincidences are also due to detection of Cherenkov photons produced in the 1.5 mm thick borosilicate windows of the MCP PMTs. According to our Monte Carlo simulation, the fraction of such events is below 10% even in the case of 5 mm thick crystals.

To demonstrate how the excellent time-of-flight resolution of the detector can be used for source position reconstruction, we also performed measurements with 15 mm thick crystals, when the ^{22}Na point source was displaced from the central position. Fig. 5 shows the measured time difference distributions for three source positions, spaced by 20 mm along the axis connecting the two detectors. Here, the crosstalk suppressed distributions of time-of-flight difference are used. The average time resolution of the three measurements has $\sigma = 39$ ps, while for the 20 mm shifts the peak position mean value changed by 124 ps on average. This means that we achieved a very good spatial resolution of $\sigma \approx 6$ mm along the line of response only from the time-of-flight measurements.

5. Simulations

The simulations were performed in the GEANT4 framework [16] for a simple back-to-back detector arrangement, corresponding to the set-up used in the experiments. For the estimate of the coincidence time resolution, the active surface area of the photodetector was simulated to be $10.8 \times 10.8\ \mathrm{mm}^2$, to take into account the geometric acceptance of the individually connected central channels. For the estimate of the detection efficiencies, the active surface was covering the whole crystal exit surface ($25 \times 25\ \mathrm{mm}^2$). The simulation parameters used for crystal properties and photon generation are summarized in Table 1, while Fig. 6 shows the optical transmission curves of PbF_2 and $PbWO_4$ crystals and the photocathode quantum efficiency, used in the simulation. Simulation also included dispersion of the refractive index [11,13]. Teflon wrapping was simulated by a white diffusive reflector.

Table 3 summarizes the simulation results concerning photon production and detector efficiency, while Fig. 7 shows the wavelength distributions of the first detected photons.

The back-to-back timing distributions were obtained as the difference in time between the first photons reaching the central channels of the two photodetectors. The response time spread of the photon detection was not taken into account. The obtained coincidence timing distributions, shown in Fig. 8 for PbF_2 and in Fig. 9 for $PbWO_4$ crystals, were fitted with a sum of two Gaussian functions. The coincidence time resolutions, summarized in Table 4, were obtained as the sigmas of the narrower Gaussian function. Detection efficiencies were calculated as the number of events, where both photodetectors detected at least one Cherenkov photon, divided by the number of 511 keV gamma pairs generated within the detector solid angle.

The results of simulations are in qualitative agreement with our measurements. Black paint on the surfaces of the crystal stops most

Table 3
Simulation results for 15 mm thick crystals: fraction of electrons, which are produced with kinetic energy above the Cherenkov threshold; the average number of Cherenkov photons produced per generated gamma; the average number of Cherenkov photons detected with single photodetector per generated gamma in case of crystals wrapped in white diffusive reflector or painted black.

	PbF_2	$PbWO_4$
Fraction of e^- above Cherenkov threshold	0.77	0.88
Cherenkov photons produced/γ	10.2	15.8
Cherenkov photons detected/γ (white reflector)	0.11	0.068
Cherenkov photons detected/γ (black paint)	0.070	0.044

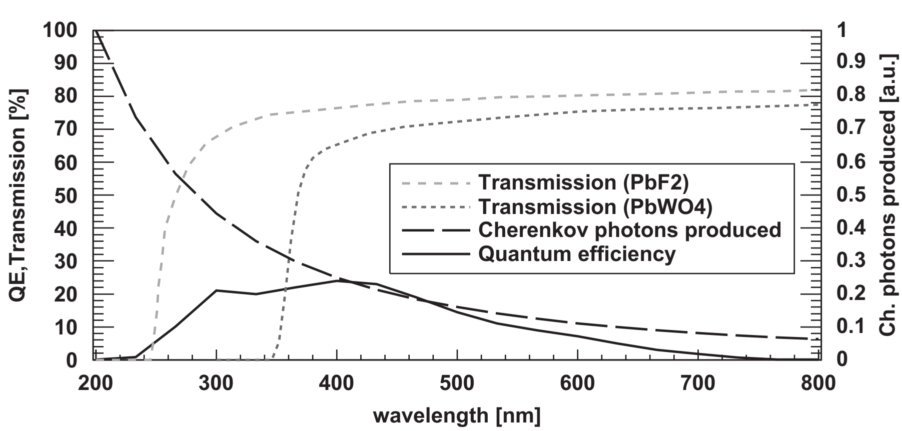

Fig. 6. Wavelength dependence of relevant quantities used in simulation: bialkali photocathode quantum efficiency, optical transmissions of PbF_2 (for 25 mm thick sample, [10]) and $PbWO_4$ (for 230 mm thick sample, [12]) and the $1/\lambda^2$ distribution, which indicates the wavelength dependence of produced Cherenkov photons.

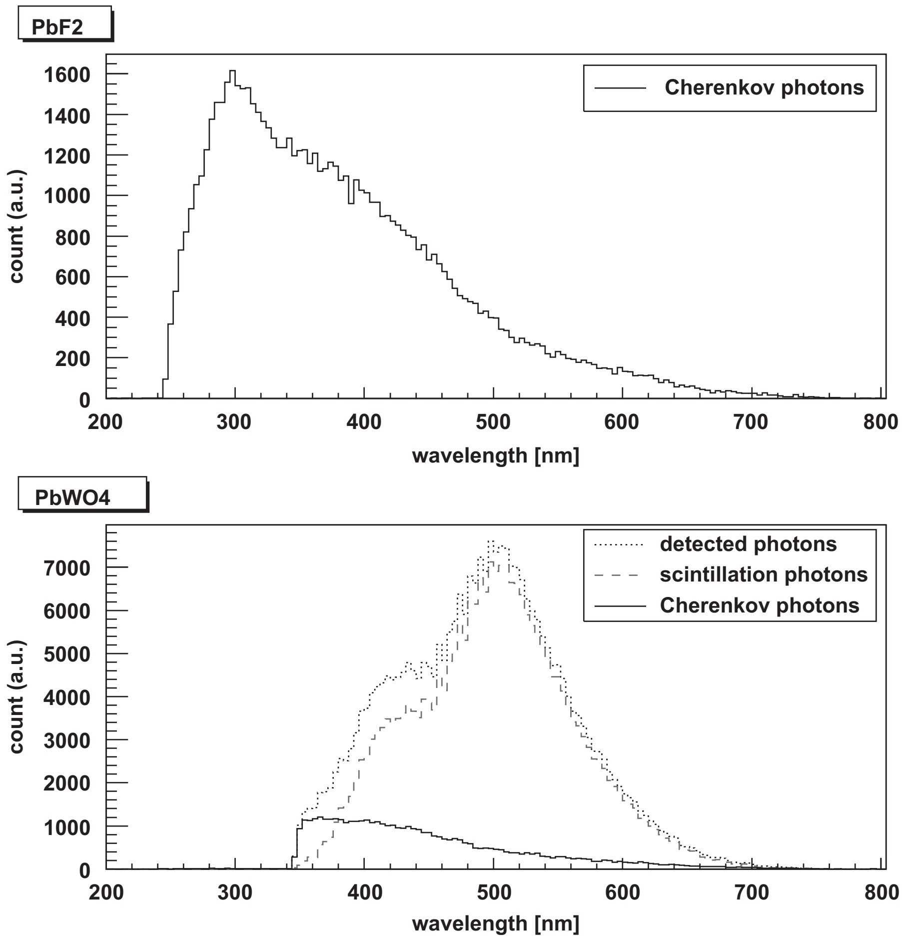

Fig. 7. The wavelength distribution of first detected photons resulting from the simulation, in the case of PbF_2 (top) and $PbWO_4$ (bottom) crystal.

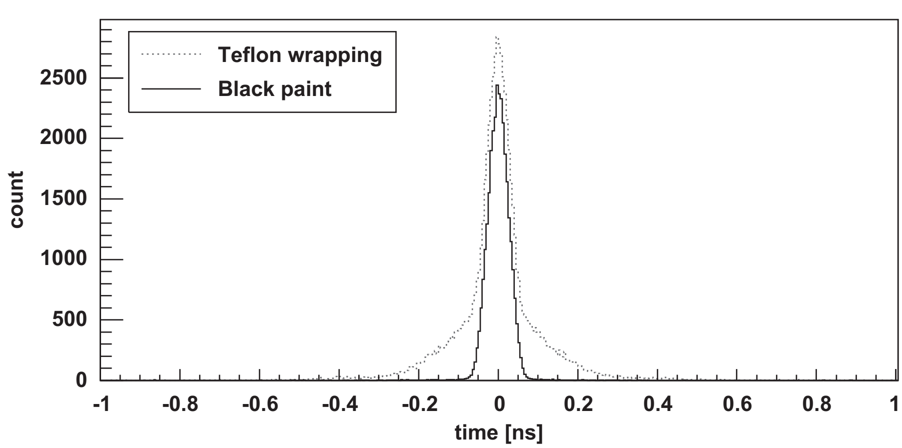

Fig. 8. The simulated coincidence timing distributions for 15 mm thick PbF_2 crystals wrapped in white diffusive reflector (dashed line) and painted black (solid line). These distributions do not include the response time spread of the photodetector.

of the reflections (some total internal reflections remain), leaving only the narrow central peak, corresponding to photons that reach the photodetector without time delays caused by reflections. Although wrapping the crystal in white reflector results in improved efficiency, most of the additional photons are detected with bad timing, since they are reflected. The simulations did not reproduce the long tails of the measurements (Fig. 3), which can be attributed to the photodetector time response, which is not included in the simulations.

The $PbWO_4$ crystal is better than PbF_2 in terms of the number of produced Cherenkov photons (Table 3), due to its higher index of refraction (Table 1). However, because of its higher cutoff wavelength, less photons reach the photodetector. Simulation results obtained with $PbWO_4$ also indicate that the higher index of refraction actually degrades the time resolution, since the Cherenkov photon velocity is lower. Another possible problem with $PbWO_4$ is the scintillation photons, which represent an almost constant background on the time scale of a few ns. According to our simulation, near the central peak this background has approximately the same number of events per 1 ns as there are fast events, produced by Cherenkov photons (Fig. 9).

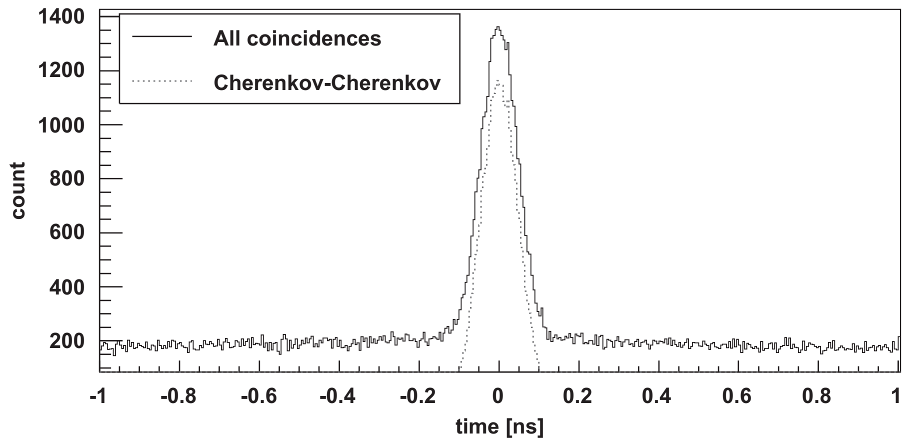

Fig. 9. The simulated coincidence timing distributions for black painted, 15 mm thick $PbWO_4$ crystals. The solid line shows the coincidences produced by any combination of Cherenkov or scintillation photon detection. The dashed line shows the coincidences, caused by detection of Cherenkov photons on both photodetectors. These distributions do not include the response time spread of the photodetector.

Table 4
Simulation results: coincidence timing resolution, only including Cherenkov photon travel time variation (σ_{photon}), also including photodetector time response of $\sigma = 22$ ps (σ_{total}), and coincidence detection efficiency. The efficiencies of $PbWO_4$ include only Cherenkov photons without the scintillations.

	σ_{photon} (ps)	σ_{total} (ps)	Efficiency
PbF_2, 15 mm, white reflector	28	42	1.76
PbF_2, 15 mm, black paint	25	40	0.75
PbF_2, 5 mm, black paint	13	34	0.32
$PbWO_4$, 15 mm, black paint	44	54	0.27
$PbWO_4$, 5 mm, black paint	19	36	0.08

Since scintillation events are indistinguishable from Cherenkov events and are characterised by worse timing, they unavoidably degrade the timing resolution.

6. Conclusion

The use of prompt Cherenkov photons for time-of-flight PET is very attractive, especially with a very fast photodetector, such as the MCP PMT. However, for 511 keV gamma detection the very low number of photons produced in available Cherenkov radiators presents a challenge. The timing resolution obtainable is so good that the photon travel time variation in the crystal becomes the most important contribution. For the best possible timing, photon reflections need to be suppressed by painting the crystal surfaces black, which in turn reduces the number of photons available for detection. Our GEANT4 simulations show that the majority of events are produced by single Cherenkov photons being detected with the photodetectors.

Using two Hamamatsu MCP PMTs in a back-to-back configuration we measured a coincidence timing resolution of $\sigma = 30$ ps (71 ps FWHM) with 5 mm thick and $\sigma = 37$ ps (95 ps FWHM) with 15 mm thick PbF_2 crystals painted in black. Such an excellent timing resolution enabled us to demonstrate a spatial resolution of $\sigma \approx 6$ mm along the line of response.

Admittedly, the efficiency of a detector with an improved timing resolution would be rather low (as seen in Table 4). It was the aim of the present work to investigate mainly the achievable timing resolution and to proceed later on, in a second stage, to optimize other detector parameters. We believe that there is room for improvement of the efficiency. Namely, a superior efficiency could be obtained with a super bialkali photocathode, by using a PMT with a high transmission quartz window and with a Cherenkov radiator transparent down to wavelengths of about 160 nm. In addition, an excellent timing resolution localizes the positron emitting nucleus to about 6 mm r.m.s. along the line of response, therefore introducing a large improvement of image quality. By using a suitably modified reconstruction method, this might require less statistics for a comparable image, thus compensating to a degree the reduced efficiency. Investigations of all these effects are in progress and we hope that this work will stimulate further research, also of other groups, with the aim at the end, of producing a PET apparatus with improved performance.

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Performance study of silicon photomultipliers as photon detectors for PET

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A R T I C L E I N F O

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Positron emission tomography
Geiger mode APD
Silicon Photomultiplier
LYSO scintillator

A B S T R A C T

The use of Silicon Photo-Multipliers (SiPMs) as photon detectors in Positron Emission Tomography (PET) modules offers significant advantages over conventional light sensors, including application in a magnetic field, better resolution and easier operation. Different types of SiPMs have been tested: Photonique, $2.1 \times 2.1\,\text{mm}^2$, Hamamatsu $3 \times 3\,\text{mm}^2$ and STMicroelectronics $3.5 \times 3.5\,\text{mm}^2$. Dark noise, surface sensitivity, photon detection efficiency and linearity at low light intensities have been measured. A LYSO crystal was coupled to a SiPM to test the performance as a photon detector for PET. We will present the results of the measurements for different samples and types.

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1. Introduction

Positron Emission Tomography (PET) is a non-invasive method for in-depth and in vivo imaging of tissue. The positron emitted in a β^+–decay of the nucleus slows down in the tissue and subsequently annihilates with a nearby electron. The annihilation gamma-rays of 511 keV are usually detected indirectly, through scintillation in inorganic crystals. Photon detectors, like Photomultiplier Tubes (PMTs), detect the scintillation light. The majority of PET devices use PMTs, but due to their size, relatively poor ratio of active to total surface and high price, which is a significant fraction of the total cost of the device, it is worthwhile to search for alternative detectors of visible and infrared photons. The sensitivity of PMTs to magnetic fields and the increasing requirement to unify different image modalities in one measurement, provides an additional reason to search for new detectors. One would like to incorporate a PET apparatus inside a MRI magnet for simultaneous imaging of tissue function and density. A new type of semiconductor detector, the Silicon Photomultiplier (SiPM) looks very promising [1–4]. Results for the surface sensitivity, energy resolution and linearity, as well as timing resolution for several SiPM samples are presented.

2. Surface sensitivity

Surface sensitivity is assessed by exposing each SiPM to a pulsed $\sim 5\,\mu\text{m}$ wide laser beam. The SiPM is moved relative to the light source to produce two-dimensional scans (Fig. 1) of the count rate over the surface of the silicon photomultiplier. Only SiPM pulses corresponding to the single photon pulse height and coincident with the laser pulse within a ~ 10 ns time window are selected. Surface sensitivity for different SiPMs (Hamamatsu H100C, CPTA/Photonique S137 and STMicroelectronics) were measured and found that they are fairly uniform across their surfaces. More detailed surface scans of the SiPMs, shown in Fig. 1, reveal the pixelated structure of the SiPMs and reflect the internal structure of quenching resistors and diode cells for every SiPM.

The Hamamatsu H100C and CPTA/Photonique S137 SiPM used for the surface scans were $1\,\text{mm} \times 1\,\text{mm}$ sized samples. However, larger sized samples of these companies use the same technology as the small ones so the results should be similar. It is important also to note that the SiPMs from STMicroelectronics have additional thin trenches filled with oxide and metal surrounding the individual cells. Such a trench serves to reduce the electro-optical coupling between individual micro-cells. One disadvantage of this trench is the reduction of the fill factor ($\sim 36\%$) of this SiPM compared to SiPMs from other manufacturers (H100C $\sim 75\%$ and S137 $\sim 60\%$).

3. Energy resolution

The energy resolution of the SiPMs has been measured by coupling a LYSO crystal from Sinocera [5] (Fig. 2) to the SiPMs and measuring the coincidence annihilation γ's from a ^{22}Na source. The LYSO crystal has a fast decay time (40–44 ns), a high light yield (75% of NaI), an intrinsic energy resolution of 20%, and a peak emission wavelength at 428 nm. The crystal was wrapped

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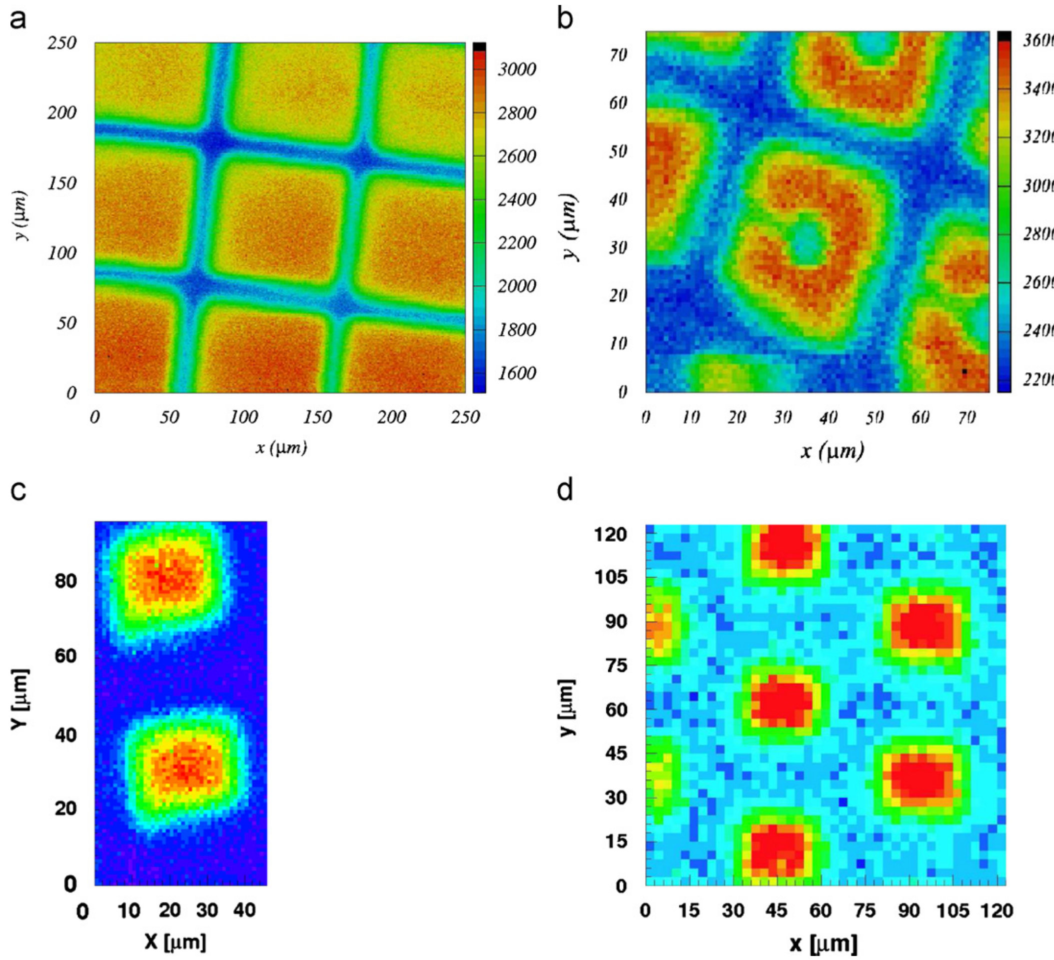

Fig. 1. Two-dimensional scans for (a) Hamamatsu H100C, (b) CPTA/Photonique and (c) and (d) STMicroelectronics. Surface scans are valuable to assess the surface sensitivity of SiPMs, (a)–(c) were performed with a step size of 1 μm and clearly show the structure of individual SiPM cells. (d) shows a part of a larger surface scan (STMicroelectronics with a step size of 3 μm).

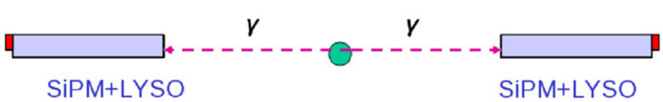

Fig. 2. Schematic of the setup used to measure the energy resolution of single SiPMs. A LYSO crystal coupled to a SiPM was used as triggering detector for the coincidence measurement.

with teflon and attached to the SiPM using optical grease to ensure a good optical coupling between the crystal and the SiPM. Fig. 3 shows the results for the three SiPMs, exhibiting a $\sim 19\%$ FWHM for CPTA/Photonique and STMicroelectronics, and 10% FWHM for Hamamatsu H100C. The energy resolution measurements are limited due to the intrinsic energy resolution of the crystal. Note that the results for the energy resolution were not corrected for the non-linear behaviour due to the finite number of cells.

Photonique and STM offer smaller pitch ($\sim 50 \times 50\,\mu m^2$) compared to the used Hamamatsu H100C SiPM which has a larger cell size ($100 \times 100\,\mu m^2$). Hamamatsu also offers SiPMs with a smaller cell size, however a larger cell size, using the same technology, results in a higher geometrical efficiency (higher PDE) and higher gain (better timing). On the other hand, it also reduces the number of cells per mm^2, and thus effectively reduces also the dynamical range. This becomes manifest in the non-linear response of the Hamamatsu SiPM due to the total number of scintillation photons from the LYSO crystal exceeding the number of cells as shown in Fig. 4a. For the Hamamatsu H100C (900 cells/$3 \times 3\,mm^2$) energy linearity was evaluated (see Fig. 4a) by measuring the energy spectrum for three different radioactive sources (^{22}Na, ^{137}Cs, and the ^{176}Lu background of the LYSO crystal).

For the STMicroelectronics (4900 cells/$3.5 \times 3.5\,mm^2$) a uniform illumination from a laser was used to study the linearity. The laser light intensity was controlled by using neutral density filters.

The results for linearity of the Hamamatsu and STMicroelectronics samples (Figs. 4a and b) are in agreement with the expected behaviour due to the number of pixels. Devices with a larger number of pixels/mm^2 provide a better linear response over a wider dynamic range.

4. Timing resolution

In PET scanners, the time difference between two back-to-back photons yields information about the position of positron–electron annihilation in the patient's tissue. This information can be used to improve the imaging resolution due to much higher background rejection. Therefore, the accurate determination of the position of an event is dependent on the time resolution.

One of the issues is whether the intrinsic timing resolution of SiPMs limits the coincidence timing. Therefore the intrinsic timing resolution of two Silicon photomultipliers from different

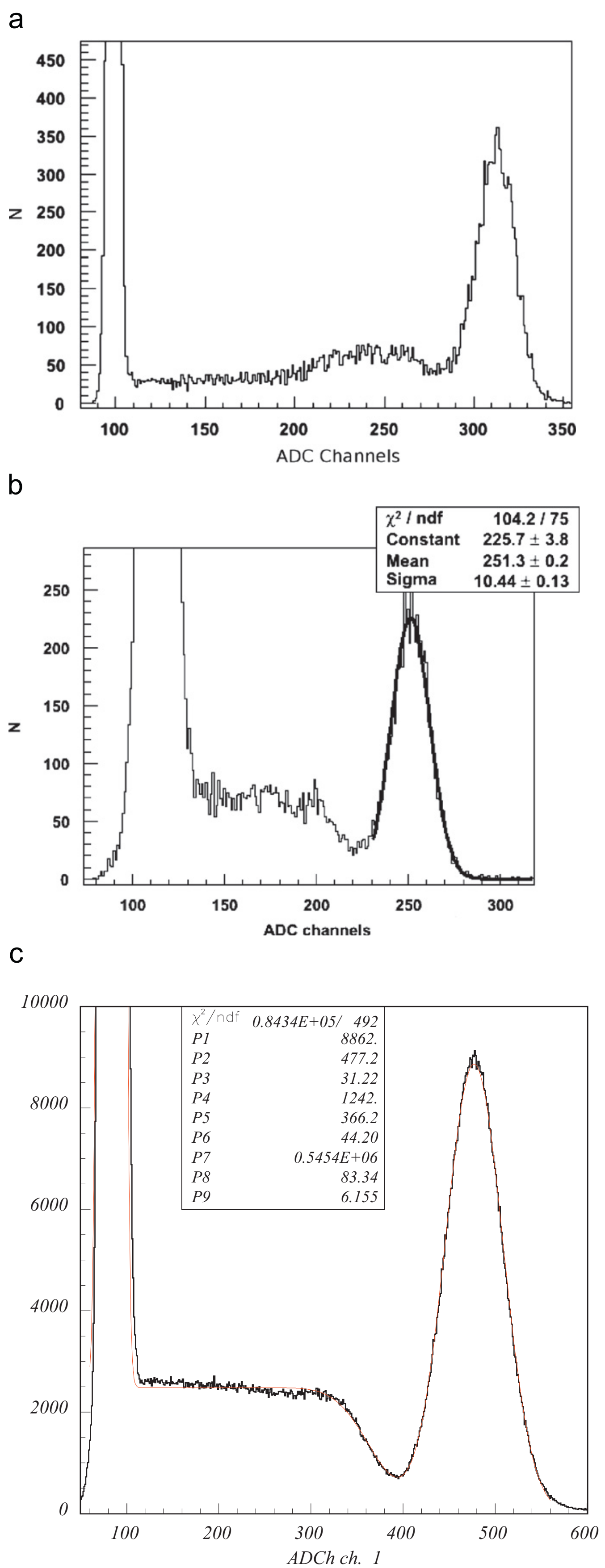

Fig. 3. Energy spectra for three different SiPMs: (a) Hamamatsu H100C. (b) CPTA/Photonique S137 and (c) STMicroelectronics.

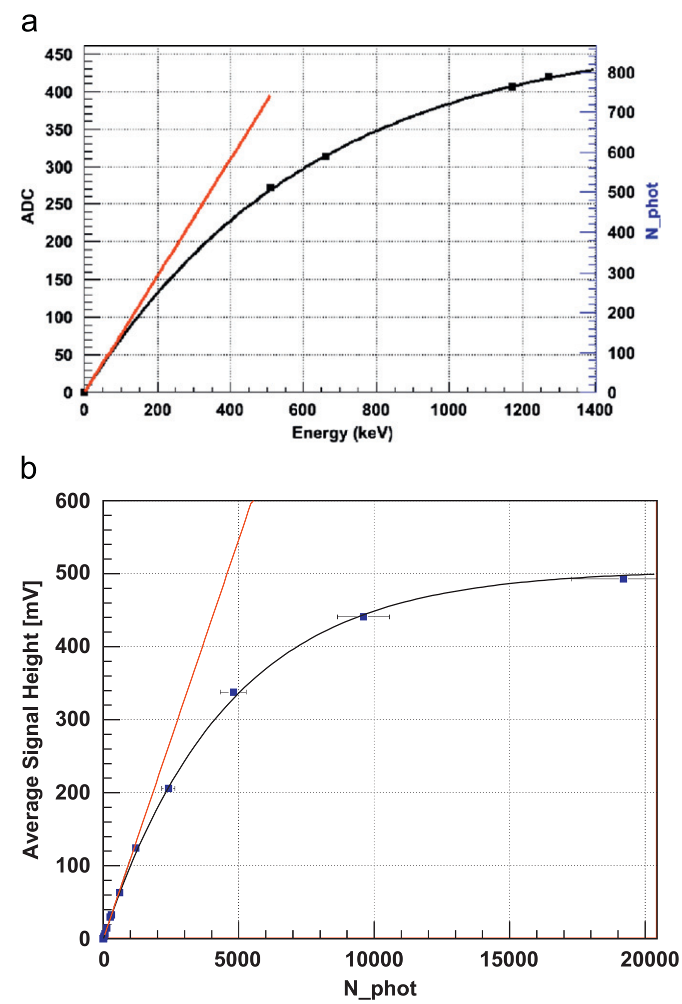

Fig. 4. Energy linearity for two different SiPMs: (a) Hamamatsu H100C clearly shows a non-linear behaviour. (b) The STMicroelectronics SiPM shows a good linearity up to several thousands of photons.

Table 1
The time resolution after time-walk correction for different SiPMs.

1 mm^2 SiPM	S137	H100C
σ_{red} (ps)	182	145
σ_{blue} (ps)	151	136

producers was measured by exposing the samples to very weak light pulses (~ 10 ps width) from a PILAS [6] laser. The laser light intensity was controlled with neutral density filters and was set to the single photon level.

Although not that fast as for example a microchannel plate PMT, the time resolution of the measured samples amounts to 100–200 ps (Table 1). The measurements of the time resolution at different wavelengths (blue 405 nm, and red 635 nm) show that the measured samples give a better time resolution in the blue light region. This makes them good candidates to be used together with the LYSO crystal (peak emission at 428 nm).

First measurements with Hamamatsu 3×3 mm^2 SiPMs of back-to-back γ's resulted in a timing resolution of ~442 ps (Fig. 5). This result can be attributed to the expected slower behaviour of the used larger sample size due to its higher capacitance. This larger capacitance results in a slower rise-time which in turn worsens the timing resolution of the SiPM. Another

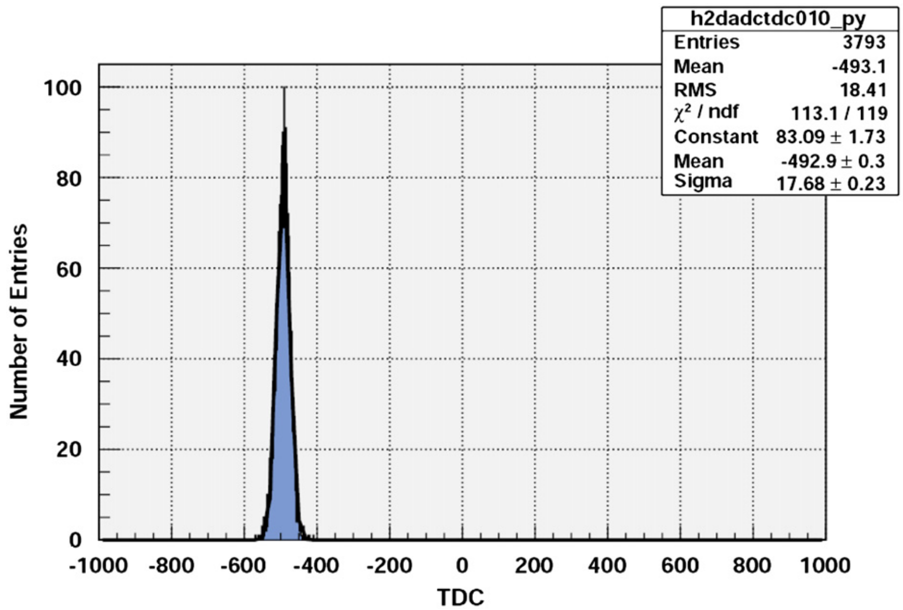

Fig. 5. Timing resolution for back-to-back γ's (25 ps/bin $\rightarrow \sigma_t \sim 442$ ps). Hamamatsu 3×3 mm^2 SiPMs were used for this measurement.

limiting factor is a relatively high discrimination level at about 10 photo-electrons. Using fast pre-amplifiers with a wide dynamic range would enable the single photo-electron timing discrimination and improve the timing resolution.

5. Conclusions

Silicon photomultipliers seem to be a very promising detector for PET. The main advantages are their insensitivity for magnetic fields and their compactness. Surface sensitivity, energy resolution and timing resolution of several SiPMs have been evaluated. The relatively good energy resolution and fast response might enable to reduce the background in PET imaging and thus to improve the resolution. Further studies will be performed using SiPMs in a PET module to assess the possibility of using SiPMs as photon detectors in a NMR-PET combination. All three measured SiPM samples show a reasonable performance to be used for PET.

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PREGLED DELA IN TOČKOVALNIK

Ime in priimek : Rok Pestotnik

Naziv: asistent za področje fizike

Zaprošeni naziv: docent za področje fizike

	Štev.del		**Štev.točk**	
	Skupaj	**V zadnji elekc. dobi**	**Skupaj**	**V zadnji elekc. dobi**
1. ZNANSTVENO RAZISKOVALNA DEJAVNOST	331	78	291.3	81.2
1.1. Monografija (do 20 točk)	1	0	2	0
1.2. Del monografije (do 8 točk)				
1.3. Dokumentirani objavljeni referati na kongresih, simpozijih in znanstvenih seminarjih				
1.3.1. Domači (do 1 točke)				
1.3.2. Mednarodni (do 2 točki)	26	0	10.7	0
1.4. Uvodno, objavljeno plenarno predavanje				
1.4.1. Na sestankih z domačo udeležbo (do 2 točki)				
1.4.2. Na sestankih z mednarodno udeležbo ali v tujini (do 5 točk)				
1.5. Članki z recenzijo v revijah				
1.5.1. Članki z recenzijo (do 8 točk)				
I. skupina I	303	77	263.0	65.6
II. skupina II	1	1	0.6	0.6
III. skupina III				
IV. skupina IV				
V. skupina V				
VI. skupina VI				
1.5.2. Indeks citiranosti (po SCI, SSCI) kandidata več kot 20 (15 točk)			15	15
1.6. Objavljene recenzije v obliki članka (do 2 točki)				
2. UMETNIŠKA DEJAVNOST				
2.1. Javna izvedba ali predstavitev umetniškega dela (do 0.5 točke)				
2.2. Javna izvedba, objava ali predstavitev umetniškega dela z objavljeno kritiko (do 2 točki)				
2.3. Javna izvedba, objava ali predstavitev umetniškega dela na pomembnih predstavitvah nacionalnega pomena (do 4 točke)				
2.4. Javna izvedba, objava ali predstavitev umetniškega dela na mednarodni ravni (do 5 točk)				
2.5. Javna izvedba, objava ali predstavitev umetniškega dela, ki ga stroka opredeljuje kot vrhunski dosežek nacionalnega pomena (do 8 točk)				
2.6. Javna izvedba, objava ali predstavitev umetniškega dela, ki ga stroka opredeljuje kot vrhunski dosežek v mednarodnem prostoru (do 20 točk)				
(Umetniško delo pomeni avtorsko delo na ustvarjalnem in poustvarjalnem področju)				

3. PEDAGOŠKA DEJAVNOST				
3.1. Univerzitetni učbenik z recenzijo (do 10 točk)				
3.1.1. Nova, dopolnjena izdaja (do 5 točk)				
3.2. Ostali učbeniki (do 5 točk)				
3.3. Študijsko gradivo (do 1 točke)				
3.4. Gostujoči profesor (do 8 točk)				
3.5. Mentorstvo (komentorstvo)				
3.5.1. Pri diplomah (do 0.5 točke)				
3.5.2. Pri študentskih raziskovalnih nalogah (do 0.5 točke)				
3.5.3. Pri Prešernovih nagradah (fakultetnih) (do 1 točke)				
3.5.4. Pri Prešernovih nagradah (univerzitetnih) (do 2 točki)				
3.5.5. Na podiplomskem študiju (pri magisterijih in specializaciji) (do 2 točki)				
3.5.6. Pri doktoratih (do 3 točke)				
4. STROKOVNA DEJAVNOST	**11**	**1**	**2.2**	**0.1**
4.1. Poljudno-znanstvena knjiga				
4.1.1. Doma (do 3 točke)				
4.1.2. V tujini (do 6 točk)				
4.2. Urednik ali sourednik revije, knjige				
4.2.1. Domače (do 3 točke)				
4.2.2. Tuje (do 6 točk)				
4.3. Strokovni članki (do 1 točke)				
4.4. Objavljeni prikazi, poročila, ekspertize (do 0.5. točke)	**11**	**1**	**2.2**	**0.1**
4.5. Poljudno strokovni članki (do 0.1 točke)				
4.6. Ostala dokumentirana strokovna dejavnost po presoji strokovnih komisij (do 20 točk)				

ZBIRNIK : DELA IN TOČKE

	Štev. del		**Št. pomemb.del**		**Štev. točk**	
	skupaj	**v zadnji elek. dobi**	**skupaj**	**v zadnji elek. dobi**	**skupaj**	**v zadnji elek. dobi**
1. Raziskovalna dejavnost	331	78	8	2	291.3	81.2
2. Umetniška dejavnost						
3. Pedagoška dejavnost						
4. Strokovna dejavnost	11	1			2.2	0.1
Skupaj						

5. POMEMBNA DELA V SKLADU S KRITERIJI IZ 12. ČLENA SO V BIBLIOGRAFIJI ZAPISANA POD ZAPOREDNIMI ŠTEVILKAMI:

znanstveni članki : 11 17 109 162 163 207 231 262
udeležba na konferencah: 310 312 315 316 318 326 329

6. VODSTVENO - ORGANIZACIJSKA DEJAVNOST

- **vodja laboratorija za razvoj fotonskih detektorjev Odseka za eksprimentalno fiziko osnovnih delcev IJS (od 2006)**
- **vodja projekta Števec Čerenkovih fotonov z aerogelom kot sevalcem (2001-2004)**
- **recenzent: Nuclear Inst. and Methods in Physics Research, A , Current Applied Physics**

7. NAGRADE IN PRIZNANJA

- 1986 prvo mesto na republiškem tekmovanju iz matematike, Ljubljana
- 1986 prvo mesto na zveznem tekmovanju iz fizike, Dečani, Srbija.
- 1986-1996 Zoisova štipendija za nadarjene študente
- **1996 Prešernova nagrada za študente Fakultete za matematiko in fiziko Univerze v Ljubljani za diplomsko delo**

8. ČLANSTVO V STROKOVNIH IN ZNANSTVENIH ZDRUŽENJIH

__DMFA____

Datum: _11.4.2013____________________________

Podpis kandidata:

Podatke in točkovanje preveril:

Citiranost

http://www.sicris.si/search/rsr.aspx?lang=slv&id=9410

Citiranost bibliografskih zapisov v COBIB.SI, ki so povezani z zapisi v WoS in/ali Scopus
povezani
zapisi: 297/278, citati: 4173/4763, čisti citati: 3526/4211, povprečje čistih citatov: 11,87/15,15

Raziskovalec: Dr. Rok Pestotnik [16354]

Število citatov po letih (za vse kategorizirane bibliografske enote):

Leto	Vseh citatov	Avtocitatov	Čistih citatov	Normiranih citatov
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1998	4	2	2	3
1999	10	2	8	10
2000	13	1	12	17
2001	13	8	5	7
2002	9	2	7	10
2003	16	8	8	8
2004	33	17	16	13
2005	133	14	119	61
2006	339	35	304	146
2007	616	99	517	237
2008	777	123	654	302
2009	947	121	826	387
2010	843	76	767	342
2011	676	71	605	273
2012	672	57	615	261
2013	87	1	86	48
Skupaj	5189	637	4552	2126

Ljubljana, 11.4.2013

Rok Pestotnik

Rok Pestotnik

Zbirnik za 1.1 Monografija

Št. dela	Leto izdaje	STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
305	2004	20	2	150						
Št. dela	**Leto izdaje**	**STD/ število del**	**STK**	**Št. avtorjev**	**WoS: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**	**Scopus: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**
Vsota celotno obdobje		**1**	**2.0**							
Vsota zadnje izv. obdobje										
Prva avtorstva										

Pomembna dela:

Zbirnik za 1.5.1 Članki z recenzijo

Št. dela	Leto izdaje	STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
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4	2000	8	1.143	7	13	4	6	13	6	9
5	2000	8	0.8	27	9	4	6			
6	2001	8	0.8	27	2	0	0	2	0	0
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8	2003	8	0.8	308	19	15	6	8	8	3
9	2003	8	0.8	309	11	6	2			
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11	2003	8	0.8	13	4	1	1	6	3	4
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13	2003	8	0.8	308	25	23	12	26	25	13
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25	2005	8	0.8	23	10	7	11	16	11	17
26	2005	8	0.8	178	7	5	3			
27	2005	8	0.8	152	34	34	17	30	30	15
28	2005	8	0.8	158	33	31	16	36	34	17
29	2005	8	0.8	122	107	94	47	191	179	90
30	2005	8	0.8	183	66	63	32	70	67	34
31	2005	8	0.8	164	5	4	2			
32	2005	8	0.8	165	18	14	7	22	18	9
33	2005	8	0.8	164	10	8	4			
34	2005	8	0.8	127	6	4	2			
35	2005	8	0.8	135	11	4	2			
36	2005	8	0.8	164	15	14	7	15	15	8
37	2005	8	0.8	176	8	7	4	6	5	3
38	2005	8	0.8	169	18	17	9	23	22	11
39	2005	8	0.8	165	15	10	5	17	12	6
40	2005	8	0.8	179	29	25	13	36	33	17
41	2005	8	0.8	190	18	15	8	26	23	12
42	2005	8	0.8	148	20	17	9	28	25	13
43	2005	8	0.8	108	60	43	15	63	50	18
44	2005	8	0.8	126	8	7	3			
45	2005	8	0.8	158	12	10	4			
46	2005	8	0.8	153	2	2	1	21	19	7
47	2005	8	0.8	176	66	57	20	73	62	22
48	2005	8	0.8	145	2	1	0			
49	2005	8	0.8	118	4	3	1	14	12	4
50	2005	8	0.8	155	12	10	4			
51	2005	8	0.8	137	7	3	1			
52	2005	8	0.8	286	11	9	3			
53	2005	8	0.8	180	89	84	30	50	50	18
54	2005	8	0.8	176	16	15	8	17	17	9
55	2005	8	0.8	142	23	19	10	22	17	9
56	2005	8	0.8	171	3	2	1	3	2	1
57	2005	8	0.8	152	32	24	12	33	25	13
58	2005	8	0.8	162	38	32	16	36	30	15
59	2005	8	0.8	184	16	13	7	17	13	7
60	2005	8	0.8	155	18	18	9	23	23	12
61	2005	8	0.8	145	19	14	7	20	15	8
62	2005	8	0.8	170	7	5	3			

63	2006	8	4	2	0	0	0			
64	2006	8	0.8	22	14	3	5	17	4	6
65	2006	8	0.8	146	90	83	36	111	103	45
66	2006	8	0.8	172	38	34	15	52	49	22
67	2006	8	0.8	172	32	28	12	40	36	16
68	2006	8	0.8	183	17	16	7	26	25	11
69	2006	8	0.8	149	28	26	11	94	92	40
70	2006	8	0.8	158	55	51	22	65	62	27
71	2006	8	0.8	158	40	34	15	41	35	15
72	2006	8	0.8	130						
73	2006	8	0.8	143						
74	2006	8	0.8	176	14	11	5	13	10	4
75	2006	8	0.8	150						
76	2006	8	0.8	148	12	10	4	14	12	5
77	2006	8	0.8	163	63	60	26	61	59	26
78	2006	8	0.8	138				93	89	39
79	2006	8	0.8	156				13	8	4
80	2006	8	0.8	184	122	117	51	145	140	62
81	2006	8	0.8	195	13	6	2	13	9	4
82	2006	8	0.8	126	33	33	13	38	37	15
83	2006	8	0.8	165	23	19	7	27	24	9
84	2006	8	0.8	139	2	2	1	2	2	1
85	2006	8	0.8	160	13	8	3	11	7	3
86	2006	8	0.8	183	3	1	0	3	1	0
87	2006	8	0.8	142	19	19	7	18	18	7
88	2006	8	0.8	159	50	44	17	55	50	20
89	2006	8	0.8	131	8	8	3	7	7	3
90	2006	8	0.8	141	2	0	0			
91	2006	8	0.8	162	6	5	2	6	5	2
92	2006	8	0.8	147	4	4	2	4	4	2
93	2006	8	0.8	154	16	14	6	21	20	8
94	2006	8	0.8	146	7	4	2	7	4	2
95	2006	8	0.8	167	4	4	2	5	5	2
96	2006	8	0.8	177	16	16	7	9	9	4
97	2006	8	0.8	151	0	0	0	5	4	2
98	2006	8	0.8	194	9	6	3			
99	2006	8	0.8	195	11	7	3	10	7	3
100	2006	8	0.8	195	4	3	1			
101	2006	8	0.8	130	9	9	4	11	10	4
102	2006	8	0.8	112	14	12	5	15	13	6
103	2007	8	0.8	195	16	11	4	17	13	5
104	2007	8	0.8	195	13	10	4	13	11	4

105	2007	8	0.8	197	9	8	3	9	9	3
106	2007	8	0.8	158	30	26	10	27	23	9
107	2007	8	0.8	22	0	0	0	0	0	0
108	2007	8	0.8	22	6	3	5	5	3	5
109	2007	8	0.8	22	10	5	8	4	1	2
110	2007	8	2	4	7	5	8			
111	2007	8	0.8	22	1	1	2	2	1	2
112	2007	8	0.8	196	3	1	2	3	2	3
113	2007	0	0	24				0	0	0
114	2007	8	0.8	200	71	61	24	88	82	33
115	2007	8	0.8	180	18	9	4	22	15	6
116	2007	8	0.8	155	43	36	14	74	65	26
117	2007	8	0.8	171	6	4	2	5	3	1
118	2007	8	0.8	166	17	16	6	22	21	8
119	2007	8	0.8	163	10	8	3	21	20	8
120	2007	8	0.8	162	27	25	10	35	33	13
121	2007	8	0.8	188	109	98	39	132	124	49
122	2007	8	0.8	172	16	13	5	19	16	6
123	2007	8	0.8	157	15	12	5	17	14	6
124	2007	8	0.8	151	24	22	9	24	23	9
125	2007	8	0.8	156	7	7	3	12	12	5
126	2007	8	0.8	157	7	4	2	20	16	6
127	2007	8	0.8	159	8	8	3	9	9	4
128	2007	8	0.8	176	36	33	13	65	62	25
129	2007	8	0.8	147	61	53	21	120	111	44
130	2007	8	0.8	145	16	15	6	26	25	10
131	2007	8	0.8	159	0	0	0			
132	2007	8	0.8	156	28	28	11	33	33	13
133	2007	8	0.8	146	8	4	2	7	4	2
134	2007	8	0.8	169	31	28	11	28	25	10
135	2007	8	0.8	159	1	1	0	1	1	0
136	2007	8	0.8	170	10	7	3	14	11	4
137	2007	8	0.8	146	10	7	3			
138	2007	8	0.8	154	38	31	12	39	33	13
139	2007	8	0.8	143	15	13	5	17	15	6
140	2007	8	0.8	143	7	5	2	11	9	3
141	2007	8	0.8	148	6	6	2	6	6	2
142	2007	8	0.8	145	6	6	2	7	7	3
143	2007	8	0.8	133	6	6	2	6	6	2
144	2007	8	0.8	141	8	6	2	9	8	3
145	2007	8	0.8	137	10	6	2	11	7	3
146	2007	8	0.8	164	11	9	3	7	7	3

147	2007	8	0.8	148	3	3	1	3	3	1
148	2007	8	0.8	138	13	11	4	12	10	4
149	2007	8	0.8	128	7	5	2	8	6	2
150	2007	8	0.8	151	6	3	1	16	13	5
151	2007	8	0.8	154	6	6	2	8	8	3
152	2007	8	0.8	157	26	25	10	26	25	10
153	2007	8	0.8	132	17	16	6	21	20	8
154	2007	8	0.8	197	4	4	2	4	4	2
155	2007	8	0.8	145	12	5	2	13	6	2
156	2007	8	0.8	155	34	32	13	48	46	18
157	2008	8	0.8	152	12	8	3	12	9	3
158	2008	8	0.8	187	54	48	18	69	63	93
159	2008	8	0.889	9	12	5	6	14	7	9
160	2008	8	0.8	23	5	5	6	6	6	7
161	2008	8	0.889	9	15	13	16	14	13	16
162	2008	8	2	4	9	2	2	12	3	4
163	2008	8	2	4	3	1	1	3	1	1
164	2008	8	2	4	0	0	0	0	0	0
165	2008	8	0.8	139	27	24	10	29	26	10
166	2008	8	0.8	153	41	39	16	44	43	17
167	2008	8	0.8	151	44	38	15	51	46	19
168	2008	8	0.8	145	2	2	1			
169	2008	8	0.8	145	16	15	6	16	15	6
170	2008	8	0.8	140	88	80	32	127	121	49
171	2008	8	0.8	141	38	35	14	59	57	23
172	2008	8	0.8	143	14	13	5	22	22	9
173	2008	8	0.8	145	10	8	3	11	9	4
174	2008	8	0.8	135	2	1	0	2	1	0
175	2008	8	0.8	151	3	2	1	3	2	1
176	2008	8	0.8	123	1	1	0			
177	2008	8	0.8	136	36	33	11	7	7	2
178	2008	8	0.8	147	9	8	3	12	11	4
179	2008	8	0.8	138	1	1	0	1	1	0
180	2008	8	0.8	148	7	5	2			
181	2008	8	0.8	143	12	12	4	12	12	4
182	2008	8	0.8	144	5	4	1	4	3	1
183	2008	8	0.8	143	14	14	5	14	14	5
184	2008	8	0.8	142	8	8	3	10	10	3
185	2008	8	0.8	117	6	5	2	5	4	1
186	2008	8	0.8	140	5	5	2	6	6	2
187	2008	8	0.8	136	11	10	3	11	10	3
188	2008	8	0.8	145	1	1	0	1	1	0

189	2008	8	0.8	142	5	4	1	8	7	2
190	2008	8	0.8	142	56	52	17			
191	2008	8	0.8	154	34	32	10	41	39	13
192	2008	8	0.8	130	0	0	0	0	0	0
193	2008	8	0.8	147	7	6	2	4	4	1
194	2008	8	0.8	149	15	12	5	15	12	5
195	2008	8	0.8	134	30	29	12	35	33	13
196	2008	8	0.8	158	3	1	0	4	3	1
197	2008	8	0.8	147	2	2	1	1	1	0
198	2008	8	0.8	135	7	6	2	12	11	4
199	2008	8	0.8	138	3	3	1	4	4	2
200	2008	8	0.8	158	56	56	23	53	53	21
201	2008	8	0.8	140	0	0	0			
202	2008	8	0.8	148	22	18	7			
203	2009	8	0.8	196	8	7	2	9	9	3
204	2009	8	0.8	196	13	12	4	20	19	6
205	2009	8	0.8	196	2	2	1	0	0	0
206	2009	8	0.8	20	2	2	2	1	1	1
207	2009	8	0.8	10	0	0	0	0	0	0
208	2009	8	8	1	0	0	0	0	0	0
209	2009	8	0.8	139	20	16	6	19	16	6
210	2009	8	0.8	123	4	2	1	4	2	1
211	2009	8	0.8	193	16	14	4	14	12	4
212	2009	8	0.8	143	2	2	1	1	1	0
213	2009	8	0.8	123	6	5	2	5	4	1
214	2009	8	0.8	104	15	11	3	12	8	3
215	2009	8	0.8	136	18	18	6	21	21	7
216	2009	8	0.8	126	2	2	1	2	2	1
217	2009	8	0.8	131	12	11	3	13	12	4
218	2009	8	0.8	134	27	26	8	37	36	11
219	2009	8	0.8	131	1	1	0	3	3	1
220	2009	8	0.8	128	1	1	0	3	3	1
221	2009	8	0.8	135	9	9	3	7	7	2
222	2009	8	0.8	146	16	15	5	15	14	4
223	2009	8	0.8	140	6	2	1	6	2	1
224	2009	8	0.8	112	1	1	0	1	1	0
225	2009	8	0.8	128	3	1	0	2	1	0
226	2009	8	0.8	111	3	3	1	5	5	2
227	2009	8	0.8	119	2	2	1	2	2	1
228	2010	8	1.333	6	4	1	1	4	1	1
229	2010	8	0.8	21	3	1	1	2	0	0
230	2010	8	1.333	6	1	1	1	1	1	1

231	2010	8	0.8	11	3	1	1	3	2	2
232	2010	8	1.333	6	2	2	2	2	2	2
233	2010	8	0.8	131	7	7	3	10	10	4
234	2010	8	0.8	118	23	19	7	23	19	7
235	2010	8	0.8	134	22	19	7	22	19	7
236	2010	8	0.8	131	18	11	4	16	9	3
237	2010	8	0.8	130	6	6	2	7	7	3
238	2010	8	0.8	110	6	6	2	7	7	3
239	2010	8	0.8	143	0	0	0	1	1	0
240	2010	8	0.8	128	1	1	0	2	2	1
241	2010	8	0.8	134	12	12	4	4	4	1
242	2010	8	0.8	126	3	3	1	2	2	1
243	2010	8	0.8	124	4	4	1	4	3	1
244	2010	8	0.8	129	1	1	0	21	21	7
245	2010	8	0.8	122	7	4	1	6	6	2
246	2010	8	0.8	147	4	4	1	5	5	2
247	2010	8	0.8	151	5	5	2	6	6	2
248	2010	8	0.8	109	3	1	0	3	1	0
249	2010	8	0.8	144						
250	2010	8	0.8	129						
251	2010	8	0.8	141	3	3	1	4	2	1
252	2010	8	0.8	136	6	6	2	7	7	2
253	2010	8	0.8	139	4	2	1			
254	2010	8	0.8	135				13	12	4
255	2010	8	0.8	127	6	4	1	5	3	1
256	2010	8	0.8	129	5	5	2	6	5	2
257	2010	8	0.8	135	23	23	9	28	28	11
258	2011	8	1	8	1	0	0	1	0	0
259	2011	8	0.8	13	0	0	0	0	0	0
260	2011	6	0.6	42	0	0	0	0	0	0
261	2011	8	1.143	7	1	1	1	1	1	1
262	2011	8	1.333	6	1	1	1	0	0	0
263	2011	8	1.6	5	0	0	0	0	0	0
264	2011	8	0.8	19	0	0	0	0	0	0
265	2011	8	1.333	6	0	0	0	1	1	1
266	2011	8	1.6	5	2	2	2	1	1	1
267	2011	8	0.8	167	14	13	5	12	11	5
268	2011	8	0.8	131	2	1	0	2	1	0
269	2011	8	0.8	145	8	7	3	9	8	3
270	2011	8	0.8	143	9	8	3	9	8	3
271	2011	8	0.8	169	4	3	1	4	3	1
272	2011	8	0.8	153	5	5	2	4	4	1

273	2011	8	0.8	121	6	5	2	7	6	2
274	2011	8	0.8	145	2	2	1	1	1	0
275	2011	8	0.8	143	12	12	4	10	10	3
276	2011	8	0.8	177	13	13	4	14	14	5
277	2011	8	0.8	157	0	0	0	0	0	0
278	2011	8	0.8	173	5	5	2	4	4	1
279	2011	8	0.8	138	2	1	0	2	1	0
280	2011	8	0.8	140	1	1	0	1	1	0
281	2011	8	0.8	143	1	1	0	1	1	0
282	2011	8	0.8	145	6	5	2	7	6	2
283	2012	8	0.8	127	0	0	0	0	0	0
284	2012	8	0.8	156	16	14	6	19	17	7
285	2012	8	0.8	134	4	4	2	2	2	1
286	2012	8	0.8	176	0	0	0	7	4	2
287	2012	8	0.8	164	2	2	1	3	3	1
288	2012	8	0.8	164	2	2	1	2	2	1
289	2012	8	0.8	164	1	0	0	1	1	0
290	2012	8	0.8	174	0	0	0	1	1	0
291	2012	8	0.8	179	1	1	0	1	1	0
292	2012	8	0.8	156	2	2	1	2	2	1
293	2012	8	0.8	163	1	0	0	1	0	0
294	2012	8	0.8	161	1	1	0	1	1	0
295	2012	8	0.8	138	0	0	0	0	0	0
296	2012	8	0.8	151	0	0	0	0	0	0
297	2012	8	0.8	155	0	0	0	0	0	0
298	2012	8	0.8	156	1	1	0	1	1	0
299	2012	8	0.8	103	0	0	0	2	2	1
300	2012	8	0.8	162	0	0	0	0	0	0
301	2012	8	0.8	169	0	0	0	0	0	0
302	2012	8	0.8	144	0	0	0	0	0	0
303	2012	8	0.8	160	3	3	1	4	4	1
304	2013	8	0.8	133	0	0	0	0	0	0
Št. dela	**Leto izdaje**	**STD/ število del**	**STK**	**Št. avtorjev**	**WoS: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**	**Scopus: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**
Vsota celotno obdobje		**304**	**263.6**		**4252**	**3604**	**1608**	**4602**	**4068**	**1904**
Vsota zadnje izv. obdobje		**77**	**66.2**		**324**	**280**	**106**	**339**	**296**	**111**
Prva avtorstva		**8**	**18.9**		**14**	**10**	**13**	**7**	**5**	**5**

Pomembna dela:

11 17 109 162 163 207 231 262

Zbirnik za 1.3.2 Dokumentirani objavljeni referati na mednarodnih kongresih

Št. dela	Leto izdaje	STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
306	**2007**	2	1	2				0	0	0
307	1997	2	0.2	18						
308	1997	2	0.2	15	12	8	8	14	10	10
309	1998	2	0.2	25						
310	1999	2	0.2	26	14	9	9	14	10	10
311	2000	2	2	1						
312	2001	2	0.222	9						
313	2002	2	0.333	6						
314	2002	2	0.2	10						
315	2002	2	0.2	13				0	0	0
316	2003	2	0.5	4						
317	2004	2	0.4	5						
318	2004	2	0.2	17						
319	2005	2	0.5	4						
320	2005	2	0.2	22						
321	2005	2	0.2	22						
322	2005	2	1	2						
323	2005	2	0.2	21						
324	2006	2	0.2	22						
325	2006	2	0.4	5						
326	2007	2	0.667	3						
327	2007	2	0.222	9				1	1	1
328	2008	2	0.4	5				0	0	0
329	2008	2	0.25	8				0	0	0
330	2008	2	0.333	6				1	1	1
331	2009	2	0.286	7				0	0	0
Št. dela	**Leto izdaje**	**STD/ število del**	**STK**	**Št. avtorjev**	**WoS: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**	**Scopus: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**
Vsota celotno obdobje		**26**	**10.7**		**28**	**19**	**19**	**28**	**20**	**20**
Vsota zadnje izv. obdobje										

Prva avtorstva		**7**	**4.3**		**2**	**2**	**2**			

Pomembna dela:

310 312 315 316 318 326 329

Zbirnik za 4.4 Objavljeni prikazi, poročila, ekspertize

Št. dela	Leto izdaje	STD	STK	Št. avtorjev	WoS: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)	Scopus: št. citatov (TC)	čistih citatov (CI)	normirano št. čistih citatov (NC)
332	1996	0.5	0.5	1						
333	1997	0.5	0.167	3						
334	1997	0.5	0.167	3						
335	1997	0.5	0.167	3						
336	1997	0.5	0.167	3						
337	1999	0.5	0.125	4						
338	2003	0.5	0.25	2						
339	2004	0.5	0.5	1						
340	2007	0.5	0.05	317						
341	2008	0.5	0.05	31						
342	2010	0.5	0.05	473						
Št. dela	**Leto izdaje**	**STD/ število del**	**STK**	**Št. avtorjev**	**WoS: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**	**Scopus: št. citatov (TC)**	**čistih citatov (CI)**	**normirano št. čistih citatov (NC)**
Vsota celotno obdobje		**11**	**2.2**							
Vsota zadnje izv. obdobje		**1**	**0.1**							
Prva avtorstva		**3**	**1.1**							

Pomembna dela:

331 336 338

Ljubljana, 11.4.2013

Rok Pestotnik