ATLAS
Beam Conditions Monitor
“First Beams”

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CERN
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Outlook

Introduction / Reminder:

- ☑ ATLAS BCM Collaboration
- ☑ Motivation
- ☑ Measurement Principle
- ☑ Detector Material
- ☑ Detector Assembly
- ☑ Installation
- ☑ “First Collisions” Goal

First Beam(s) Results:

- ☑ Hardware Status
- ☑ The “GSM Beam”
- ☑ The “Pixel Beam”
- ☑ The First Beam
- ☑ Getting Ready for Second Beam

ATLAS BCM Collaboration

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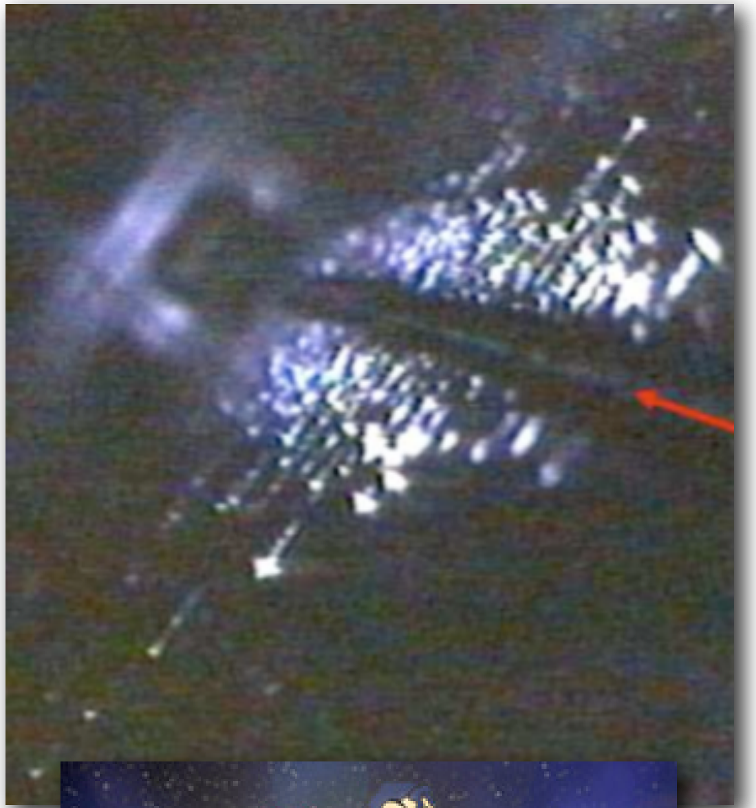
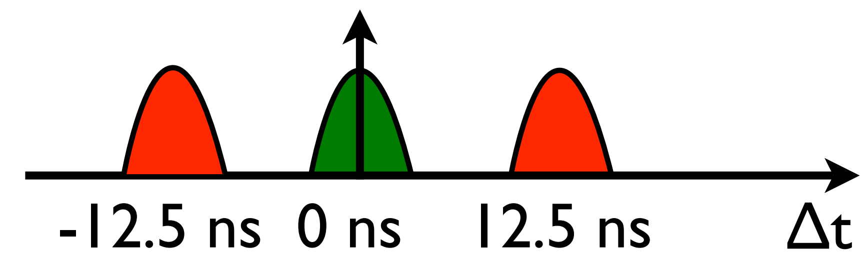
BCM web page: http://cern.ch/bcm

- SppS / LEP / RHICH / HERA / Tevatron experiences and ATLAS simulations teach to protect detectors from beam incidents
- instantaneous beam conditions measurement to distinguish each bunch crossing between:
  - ☑ normal collision
  - ☑ beam gas (tiny)
  - ☑ beam halo
  - ☑ pilot beam (5×10^9p@450GeV) loss
  - ☑ beam loss
- magnets have large time constants (~ms)
- generate warning / alarm / abort signals early enough to abort beam before incident



Measurement Principle

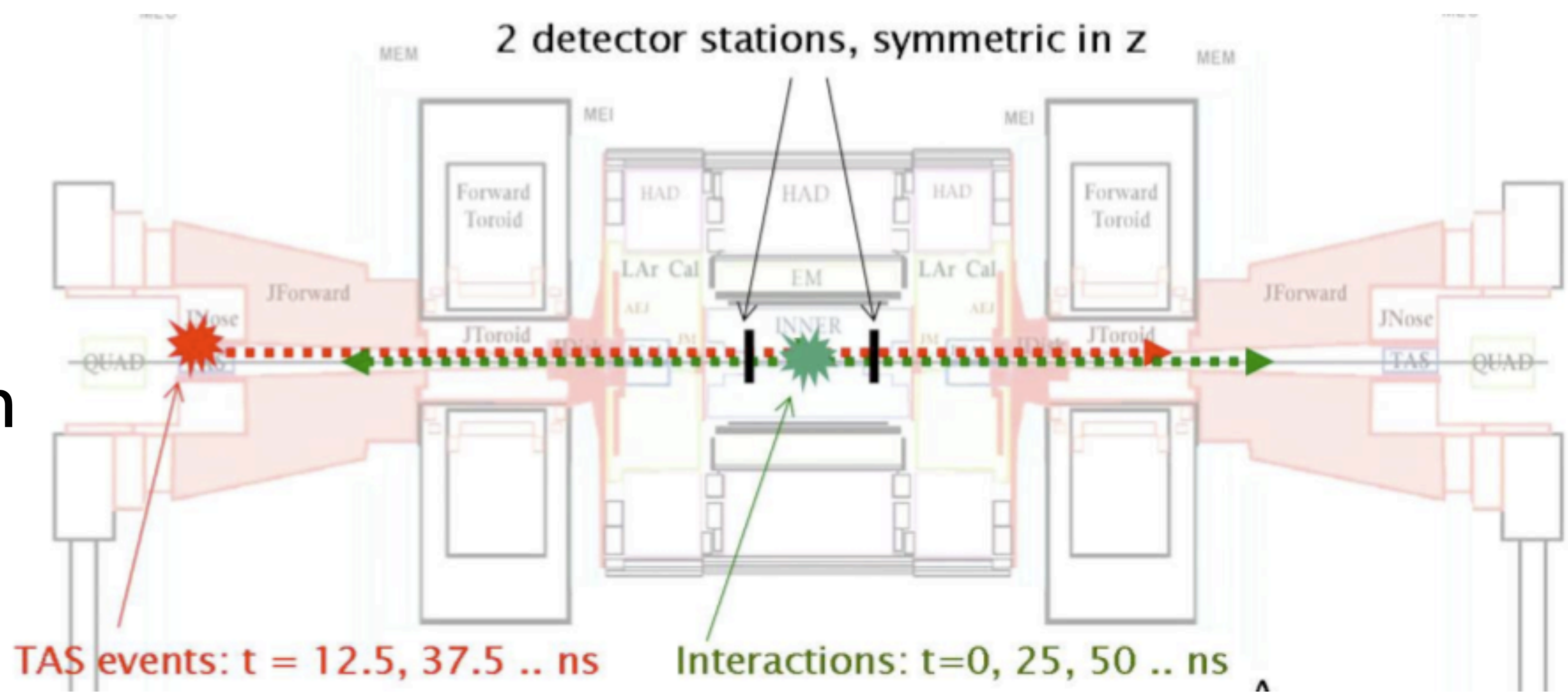
- use TOF measurement to distinguish between collisions and background events (beam gas/halo, TAS collimator scraping, ...)
- place 2 detector stations at z = ±1.84 m and r = 5.5 cm
  ⇒ Δt = ~12.5 ns and η = ~4.2



- ☑ nominal interaction at Δt = 0 ns
- ☐ TAS collimator interaction at Δt = ±12.5 ns

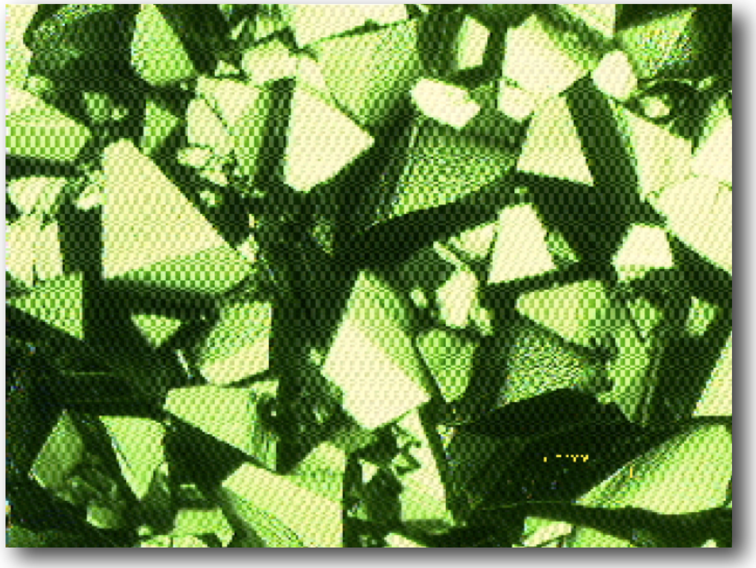
Requirements:

- ☑ 50 MRad (10a)
- ☑ 1 ns rise time
- ☑ 3 ns pulse width
- ☑ 10 ns baseline restoration



Detector Material

Diamond sensor:
pCVD (RD42)



Why diamond?

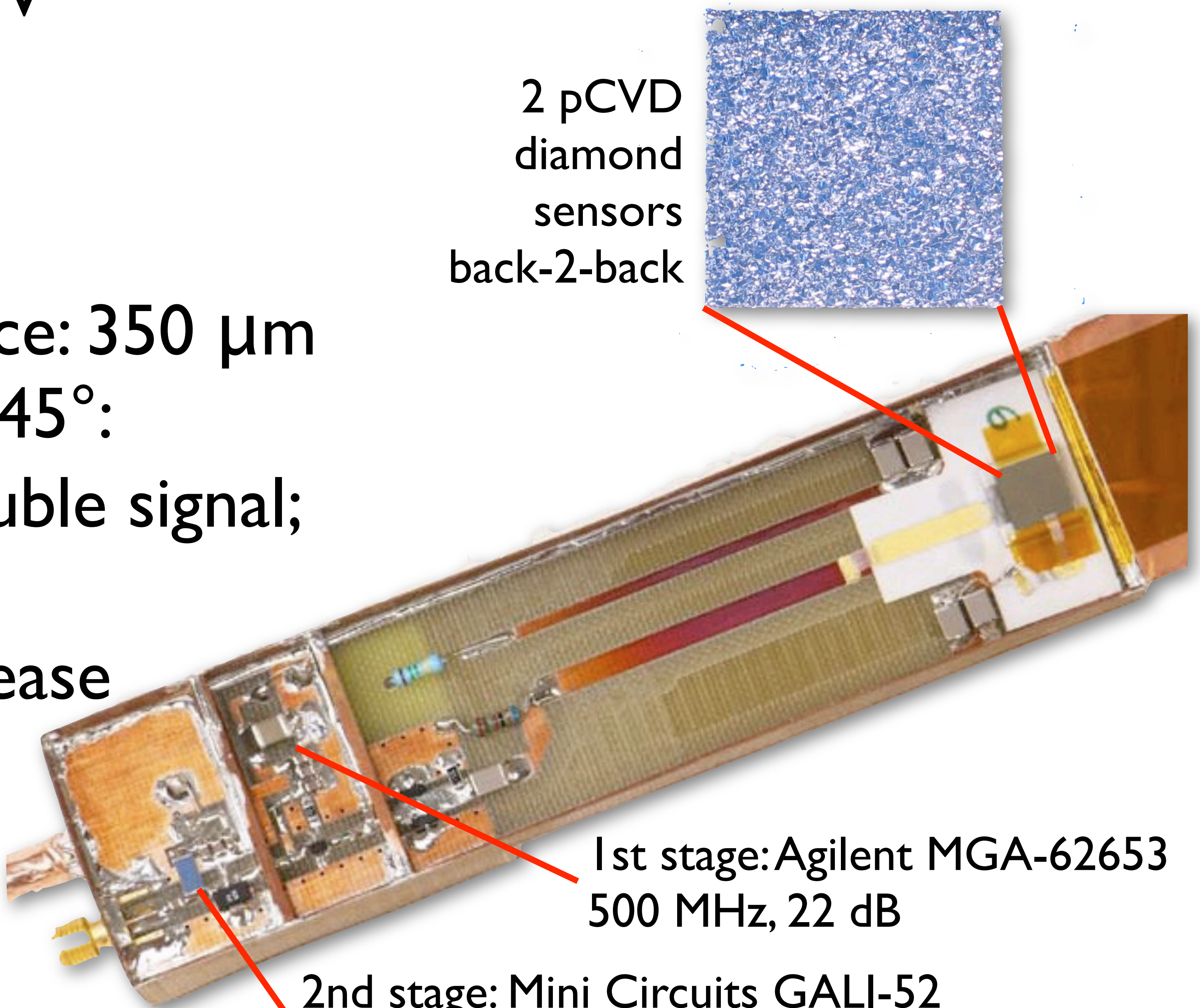
- high resistivity → high active area
- low dielectric constant → low capacitance
- low leakage current → low noise
- room temperature → no cooling
- radiation hard → no replacement

Detector Assembly

- pCVD (RD42) sensor: 10 × 10 (contacts: 8×8) mm^2 × 500 µm

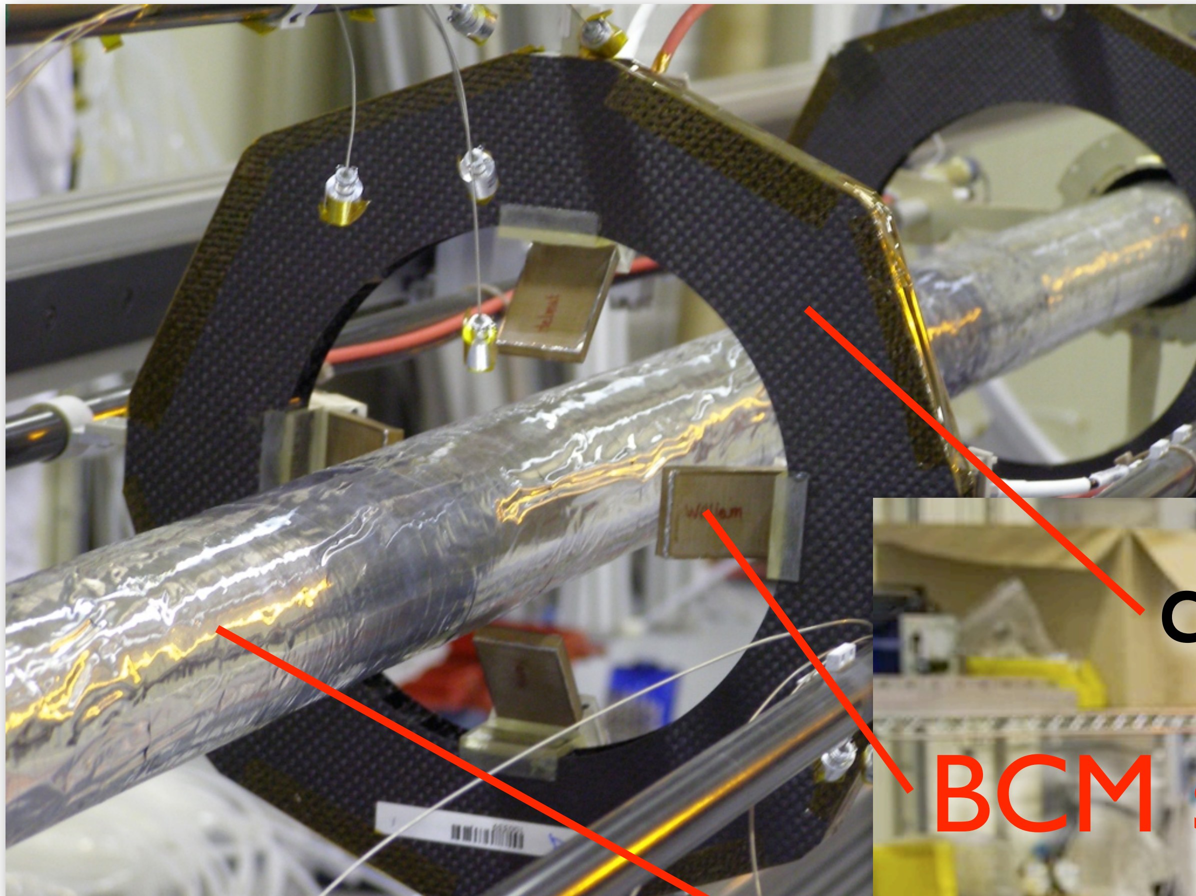
- V_{bias}: 1-2 V/µm → 1000 V
- $Q_{most\ prob.}$: 9.0 ke^- ;
- Q_{mean}: 11.3 ke^- ;
- S/N: 13
- charge collection distance: 350 µm
- 2 back-to-back sensors 45°:
  - ☑ double sensor → double signal; 30% noise increase
  - ☑ 45°→41% signal increase

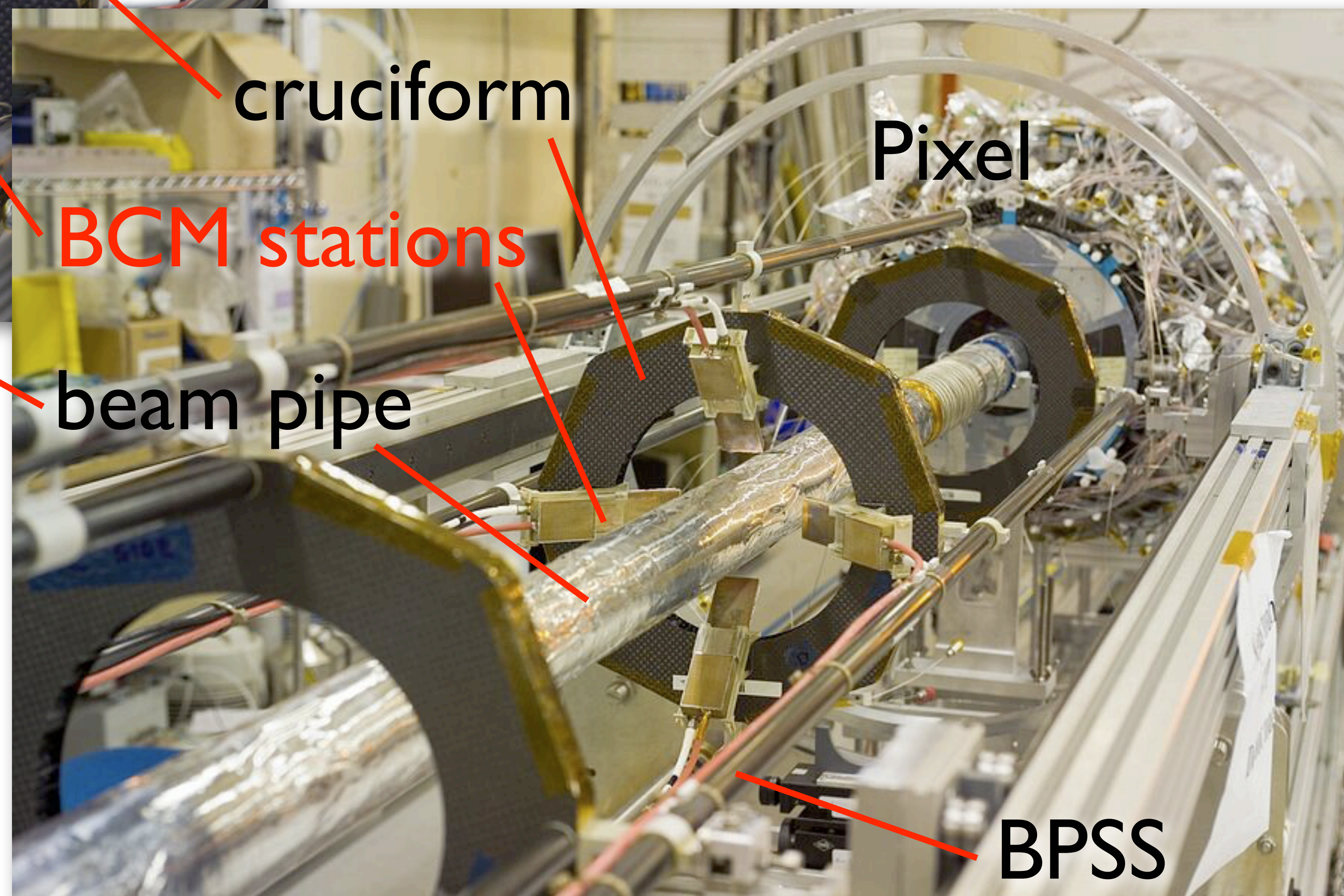
- readout: threshold
  - ☑ 2.56 GHz sampling
  - ☑ rate counters



Installation

- 4 modules installed to the middle BPSS cruciform at each detector side
- z = ±1.84 m and r = 5.5 cm

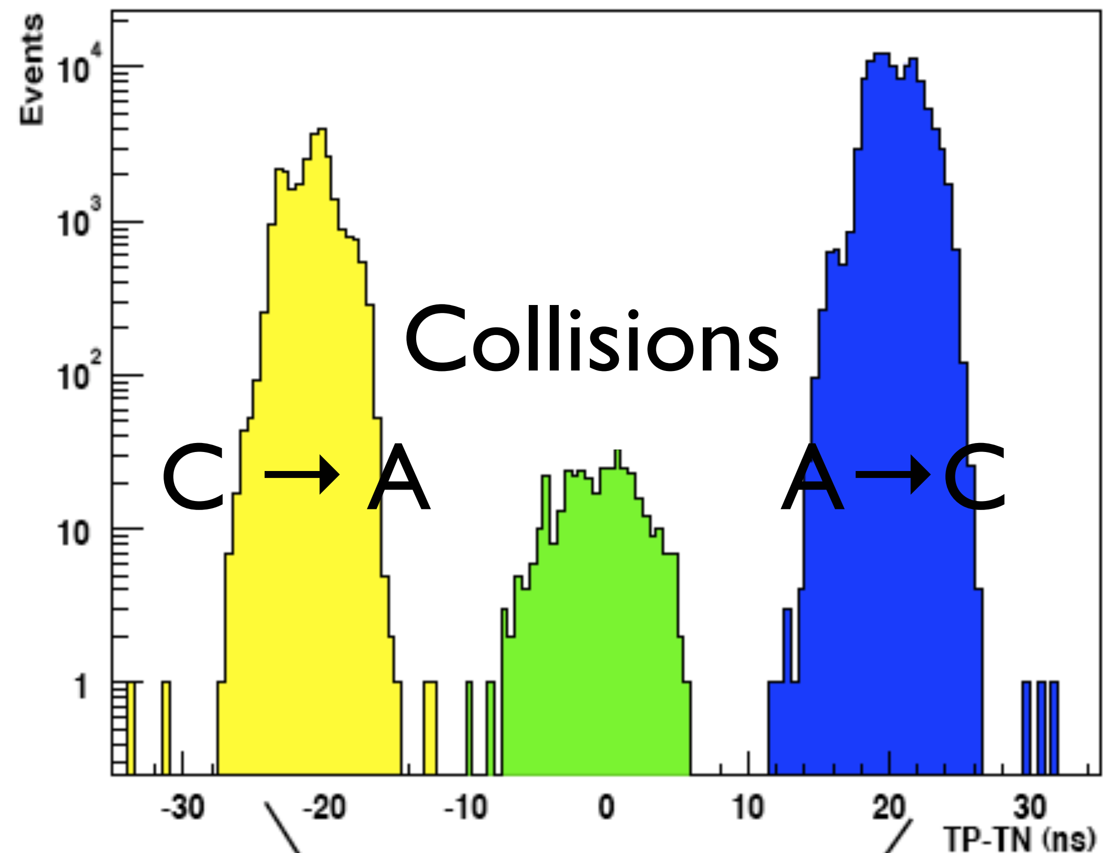




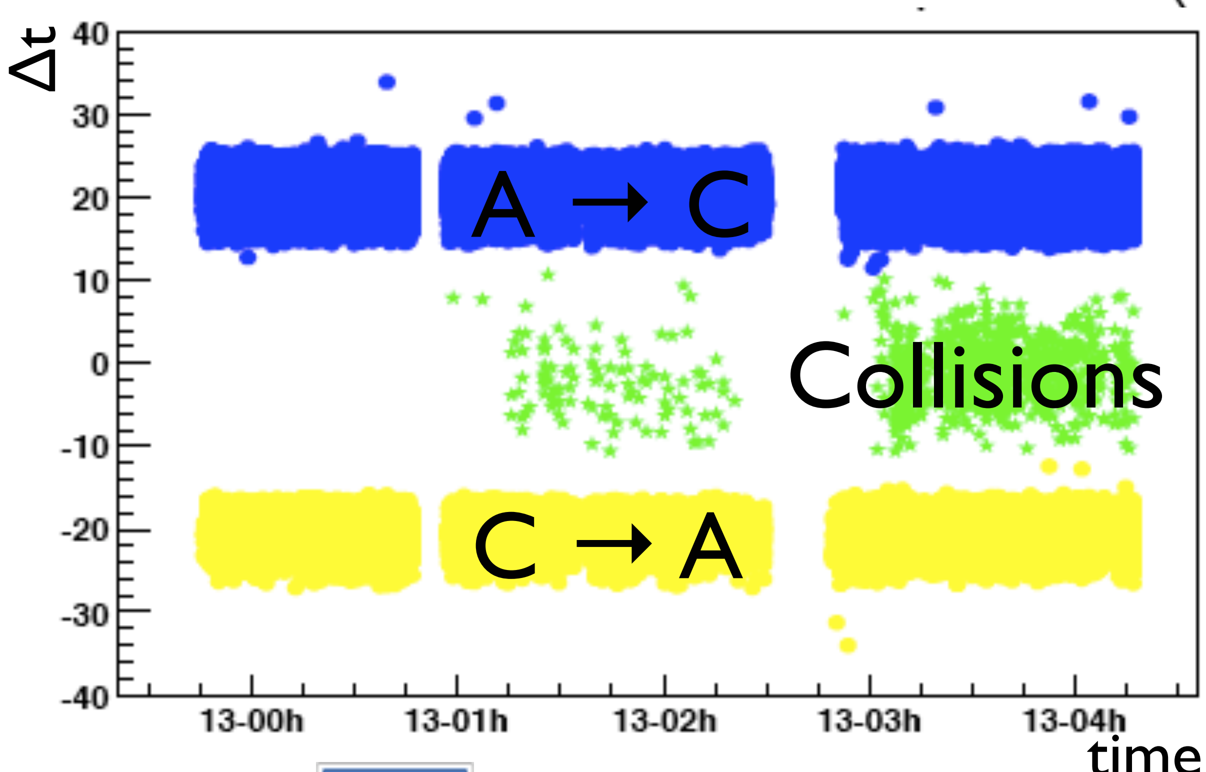
- 4 HV and 4 signal cables per detector side through Pixel PP1 end-plate

"First Collisions" Goal

- monitor "in-time" and "out of time" coincidences between A and C stations:
  - ☑ A → C
  - ☑ C → A
  - ☑ Collisions



+/- TOF distance



BREAK GLASS IN CASE OF FIRST COLLISIONS

- Example taken from RHIC/ PHOBOS experiment first day of collisions (June 30,2000)

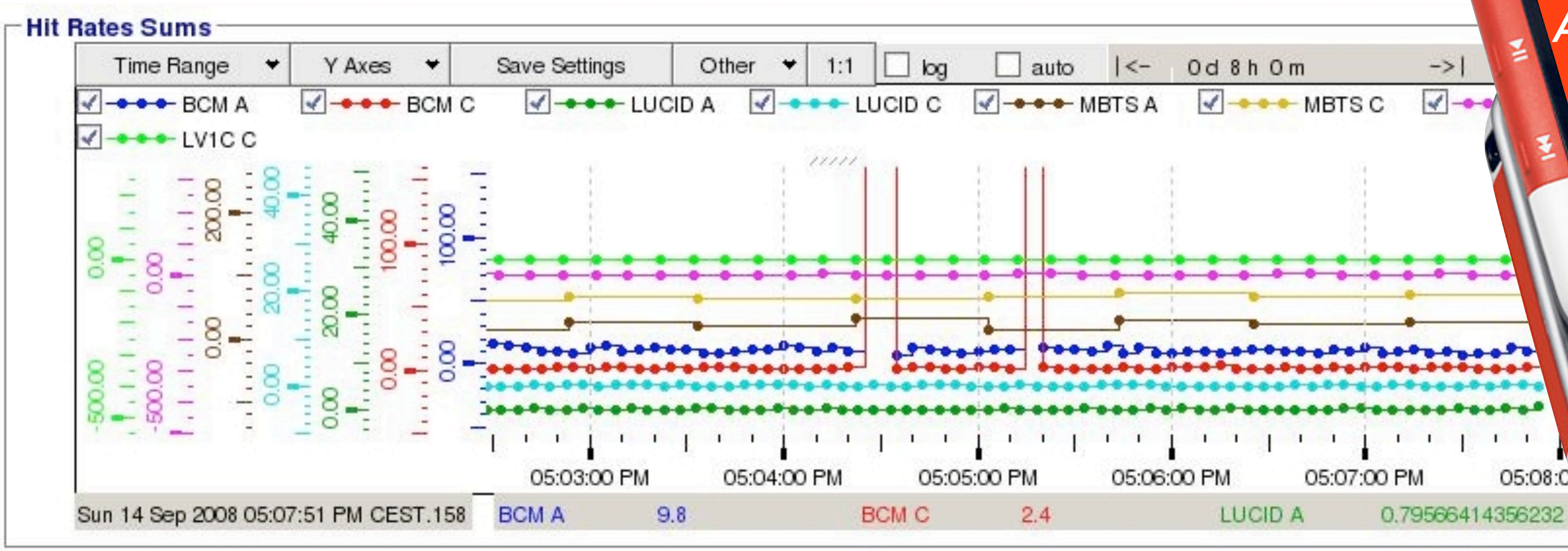
(but used ATLAS nomenclature) H. Pernegger

Hardware Status

- Detectors:
  - ☑ detectors and readout on since one month
  - ☑ 800V bias voltage with magnet field off
    1000V if solenoid is on
  - ☑ stable voltages and temperatures
  - ☑ without solenoid field occasionally (once every 3 days)
    HV trips of C-side Y- detector (erratic dark currents)
  - ☐ two data streams fixed, PP2 access before beam abort
    showed no obvious cable swap, could be easily swapped
    but waiting for access to understand problem

The “GSM Beam”

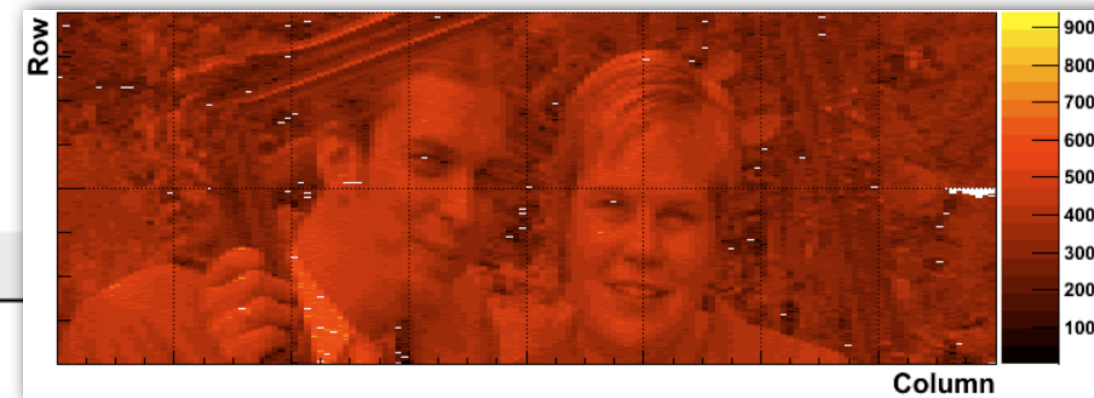
- GSM mobile phones near BCM USA15 rack:
  - ☑ very high (~100,000 Hz) count rates on high and low gain if
  - ☑ can fire one of the two beam abort logics - DSS alarm
  - ☑ significantly improved with copper tape shielding of ROD and opto- reciever →ROD connection (twisted-pair flat-ribbon)
  - ☑ effect still visible with high power phones directly on cable
  - ☐ shielding of cables and ROD case in preparation (cooling fan slots)

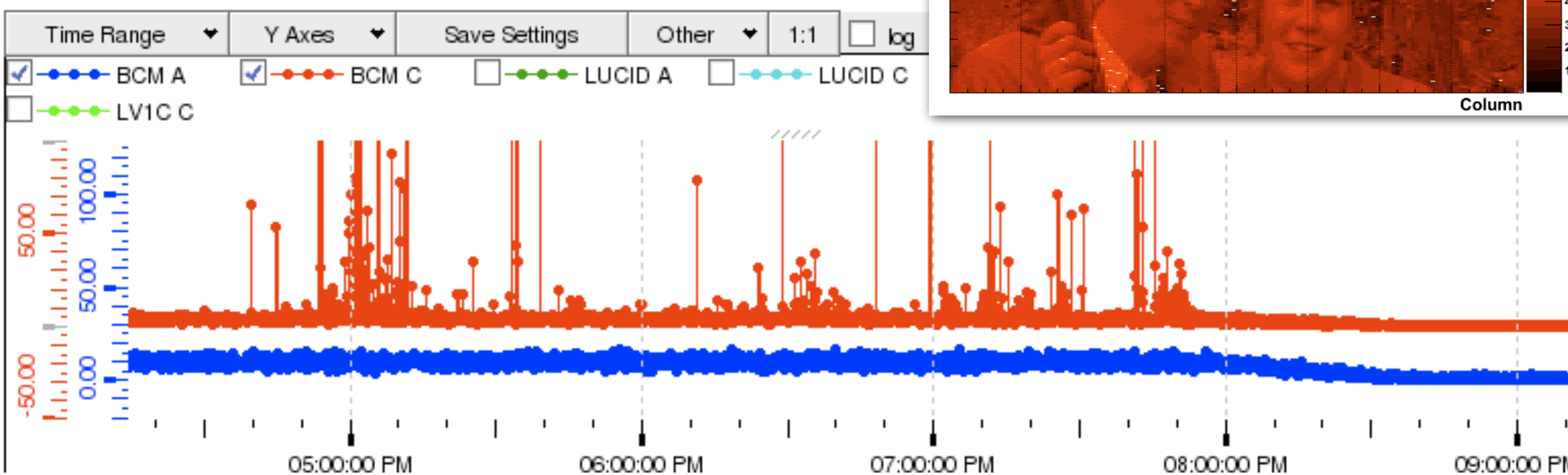


high count rates during GSM phone call next to USA15 BCM rack

The “Pixel Beam”

- pickup of Pixel calibration runs (digital scan):
  - ☑ moderate (~100 Hz) count rates on high and low gain channels when pixel performs calibration scans
  - ☑ possible to tell from BCM rates start-/stop-time, side and position of a pixel digital scan on two PP0 rows
  - ☑ no signs of any pickup during normal data taking
  - ☐ not yet fully understood

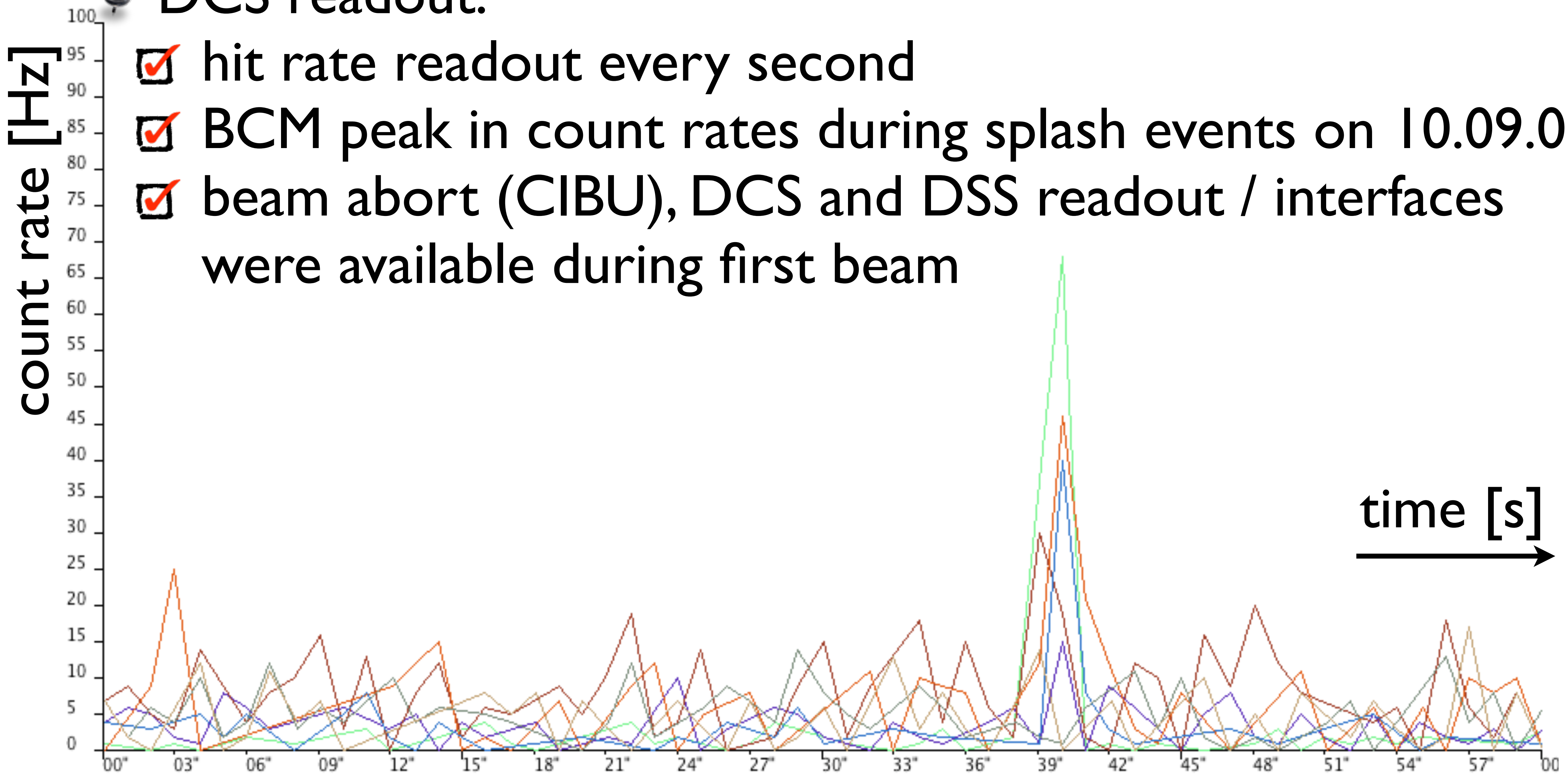




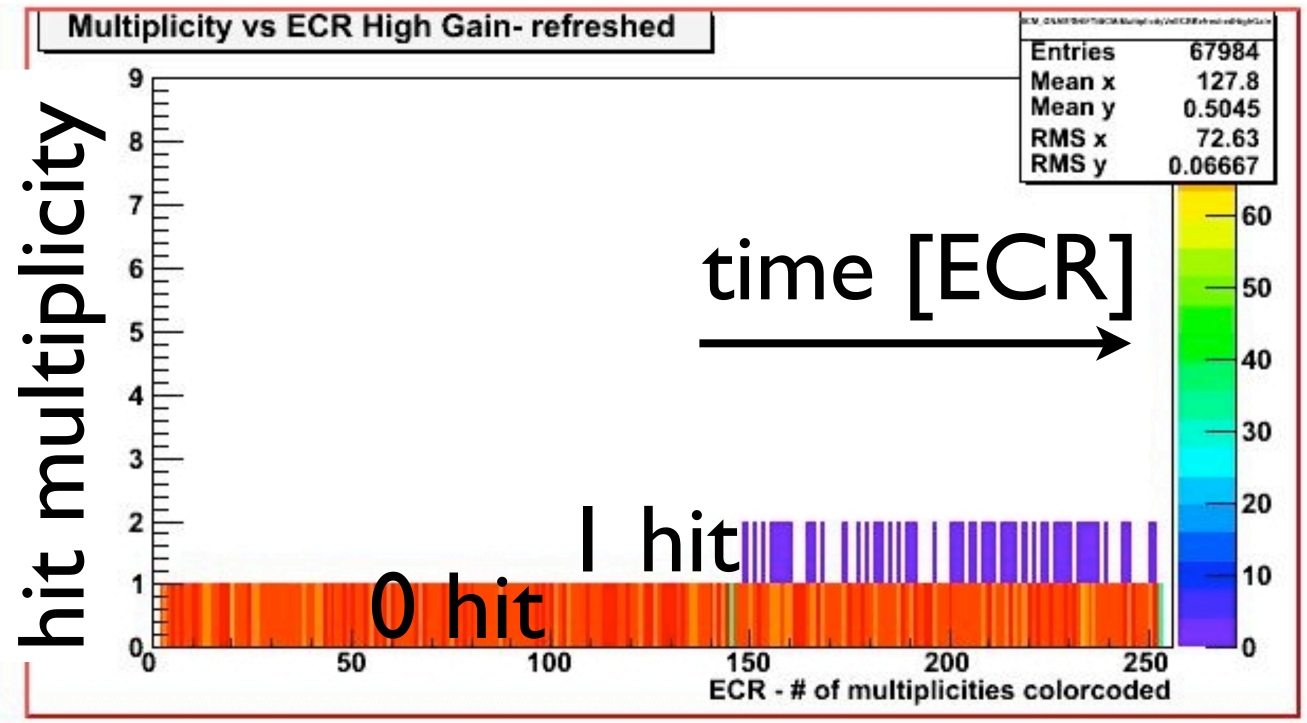
high count rates during Pixel digital scan

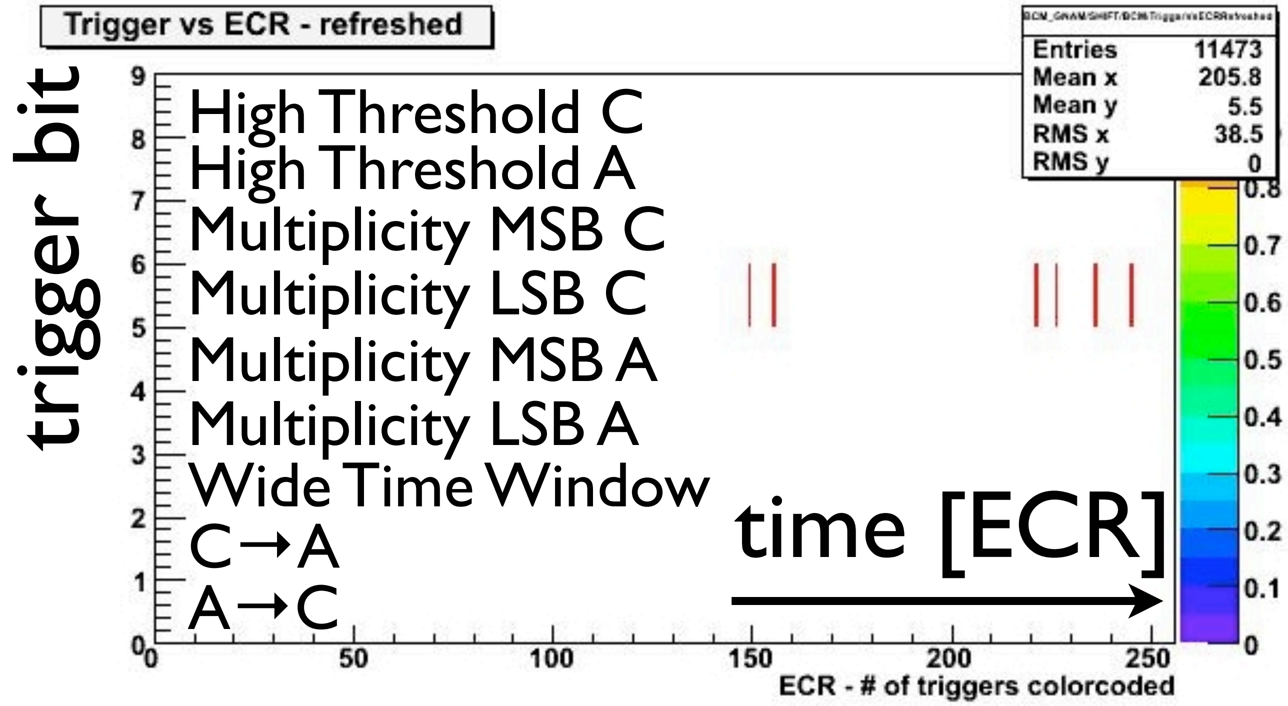
The First Beam

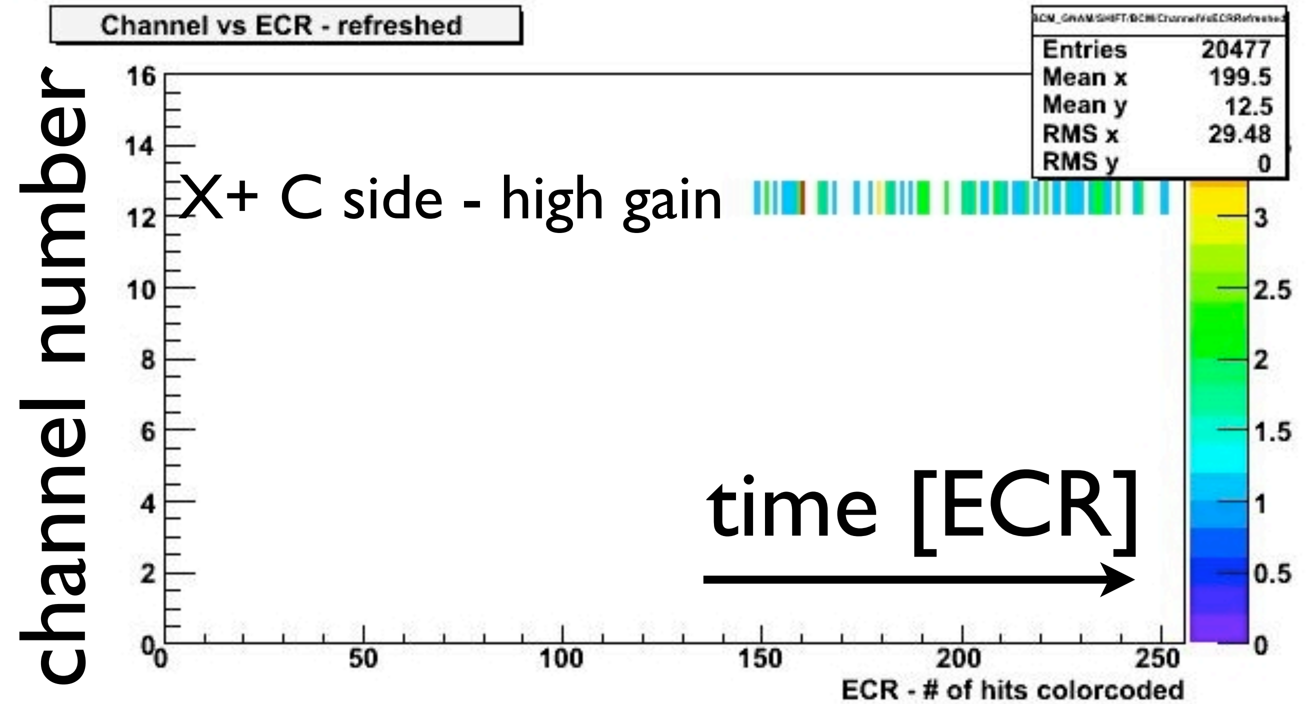
- TDAQ chain needed new firmware with additional latency:
  - ☐ ready on morning of first beam - after quick test and seen slight instability decided to go back to stable version
- DCS readout:
  - ☑ hit rate readout every second
  - ☑ BCM peak in count rates during splash events on 10.09.08
  - ☑ beam abort (CIBU), DCS and DSS readout / interfaces were available during first beam



- first BCM self-triggered and readout events at 14.09.08:
  - ☑ BCM_AtoC : Halo trigger
  - ☑ BCM_CtoA : Halo trigger
  - BCM_Wide : Wide time cuts for non-IP collision
  - ☑ BCM_Comb (3 bits of multiplicity)
- generated from 9 trigger bits

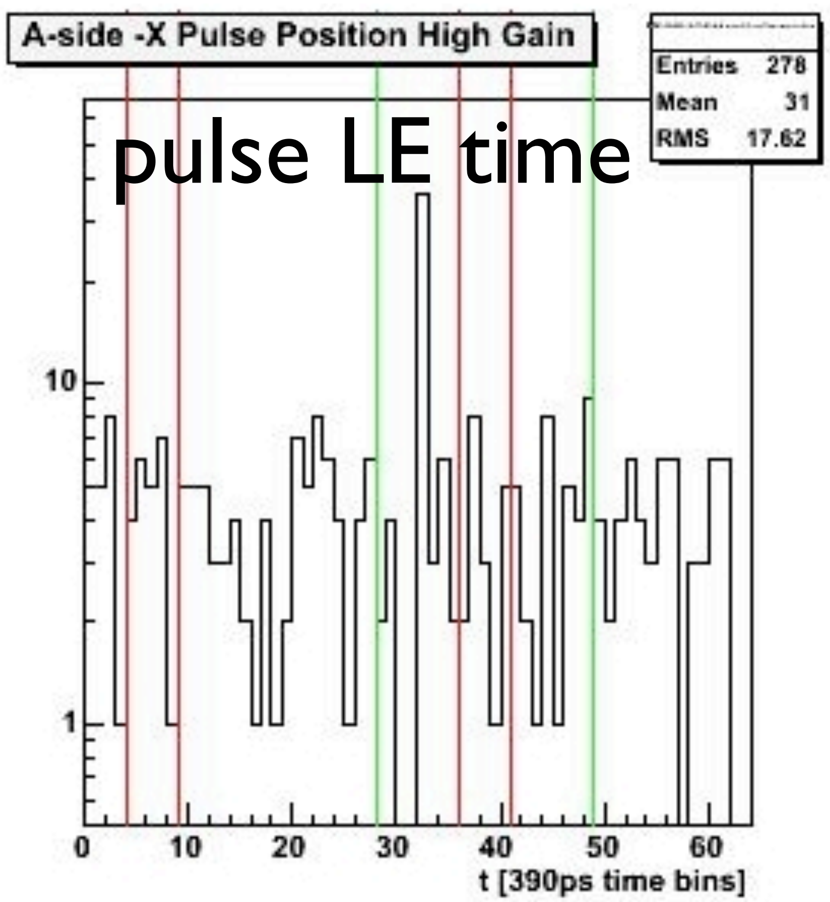


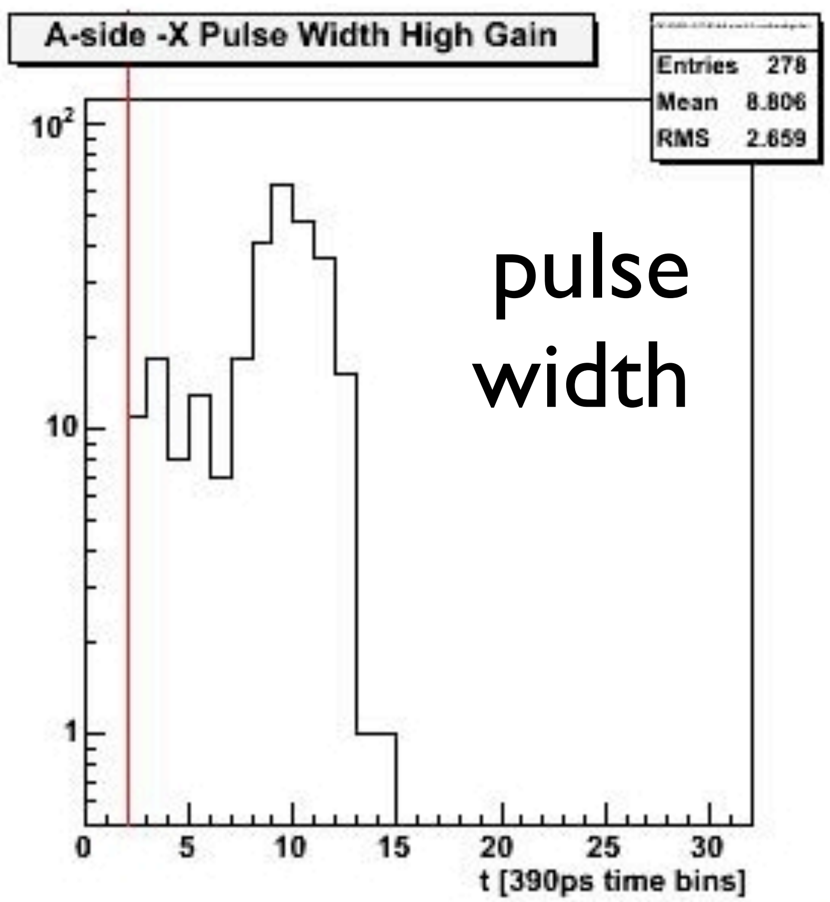


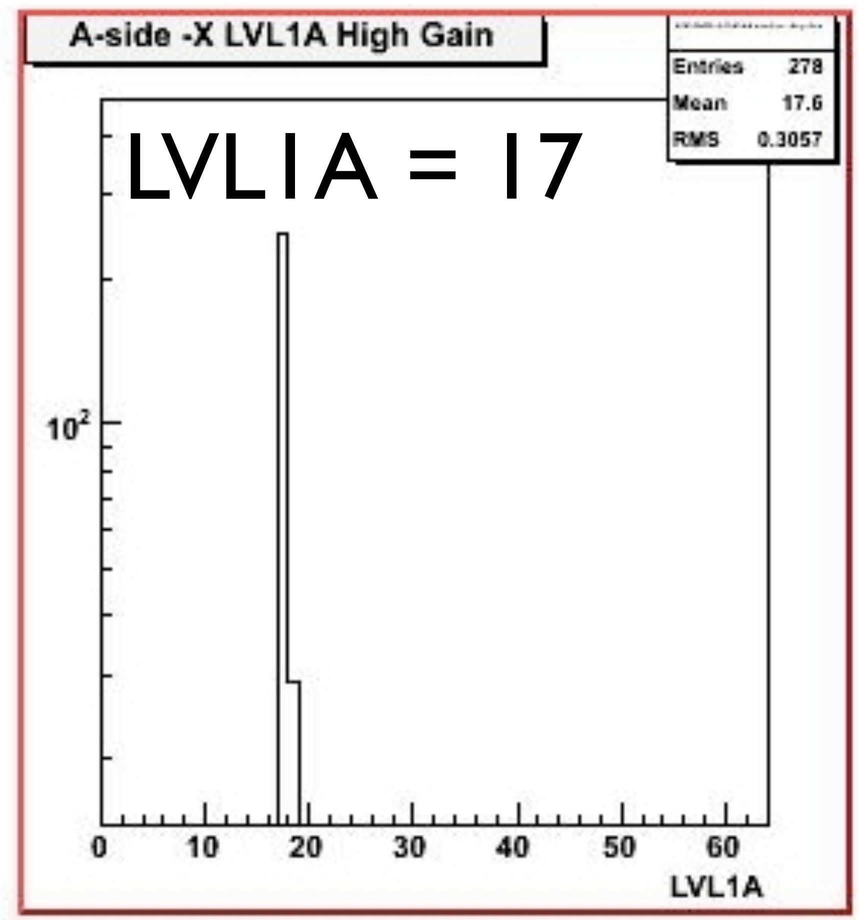


Getting Ready for Second Beam

- BCM individual channel self-triggered timing runs 15.09.08:
  - ☑ reading out 31 BCs: measured self-triggered delays for all eight detectors (Loop: ROD -> CTP -> ROD)
  - ☑ pulse LE time flat (known bug at time bin 32)
  - ☑ pulse width peaks at 3.5 ns
  - ☑ latency 59 - LVL1A 17 = 42! - one off wrt. calculation (16)
  - ☑ hits concentrated on one BC (~1/10)

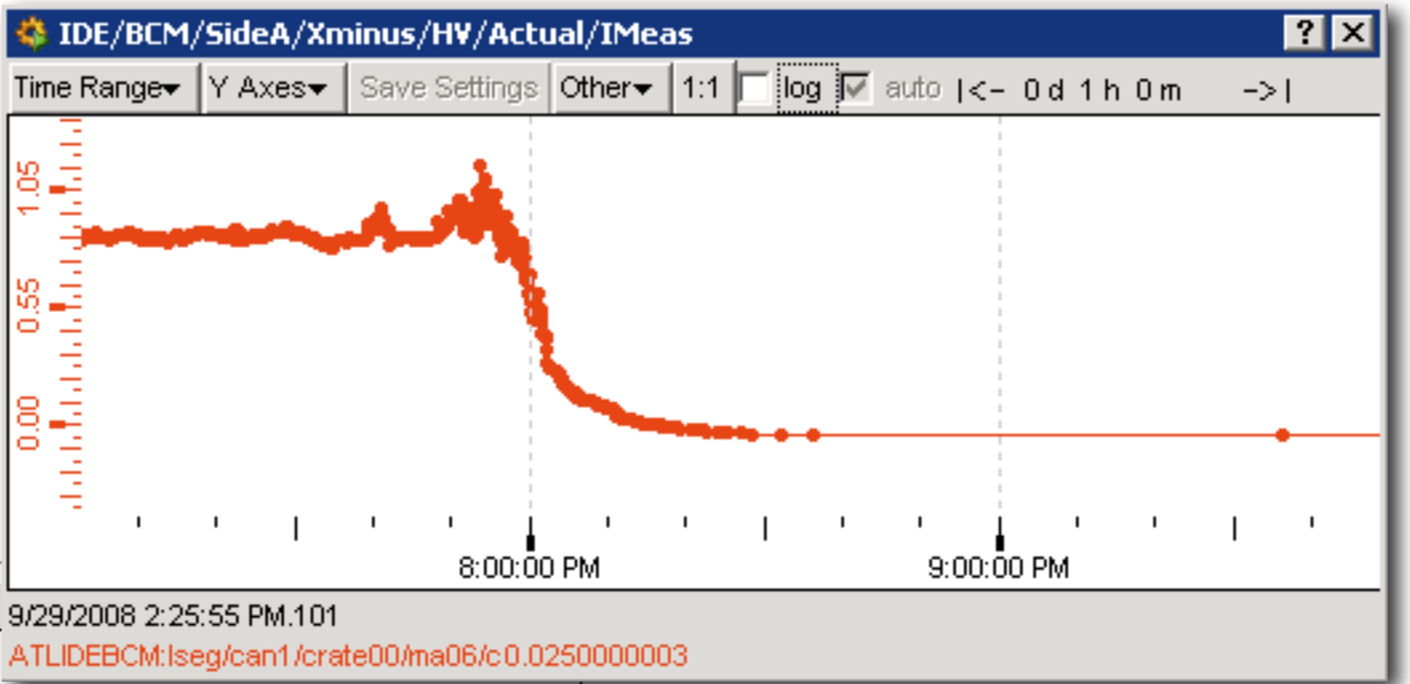


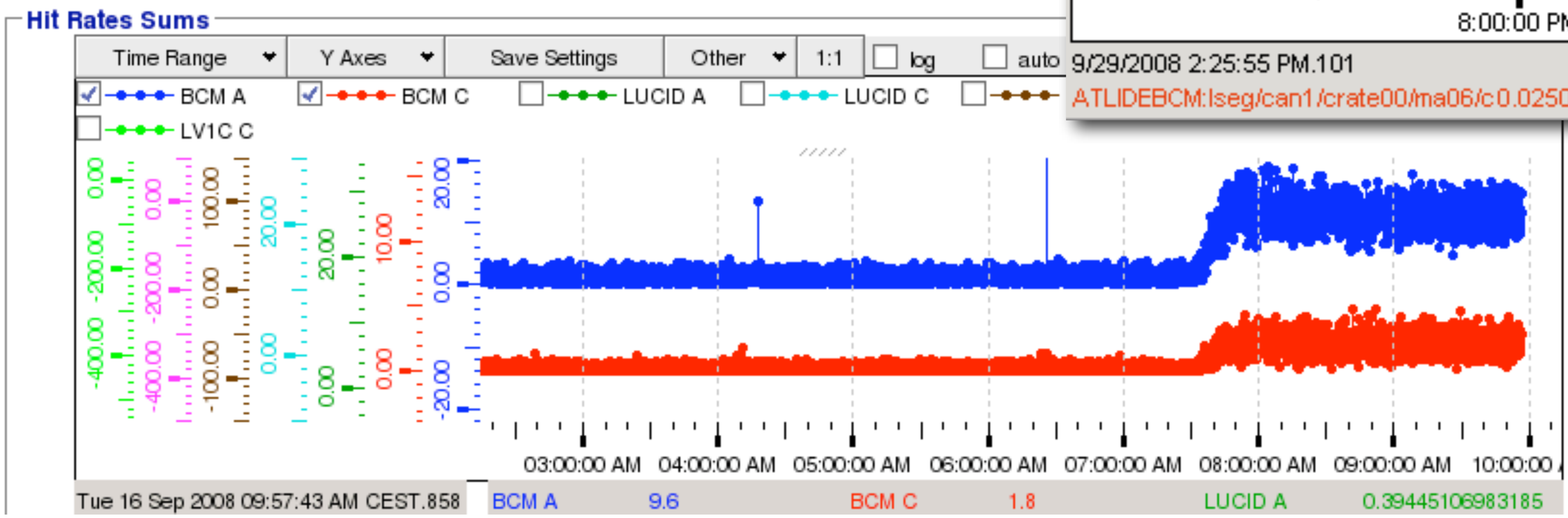




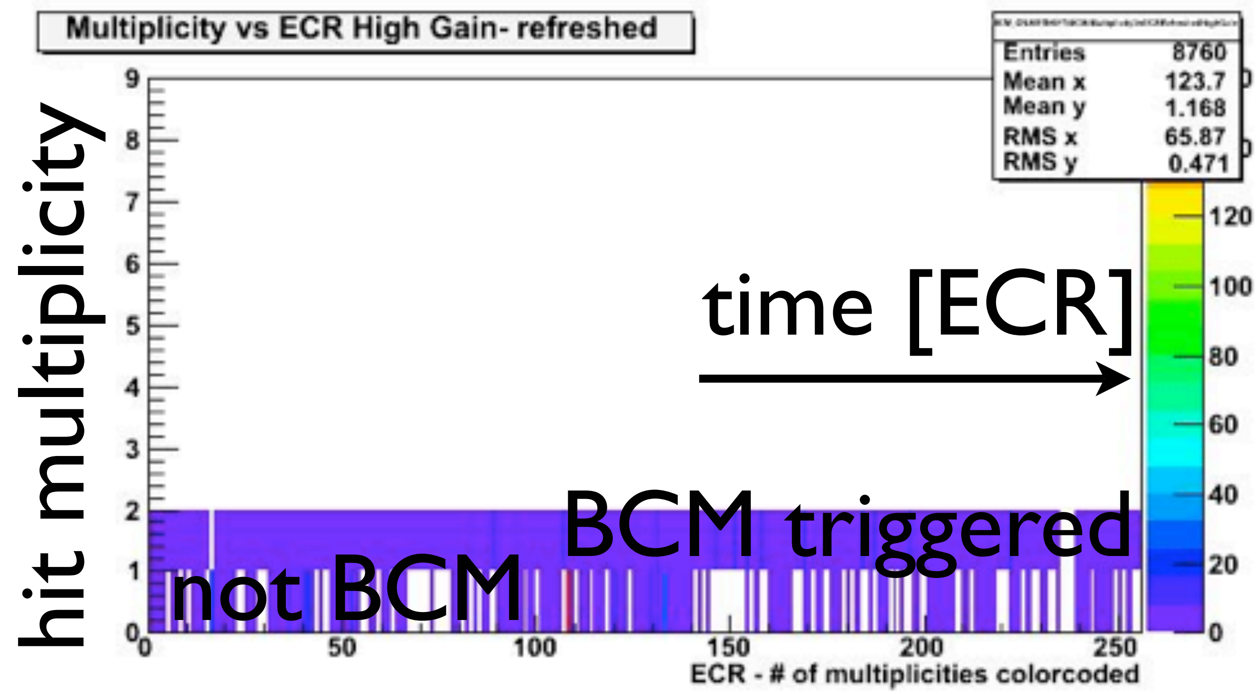
Getting Ready for Second Beam

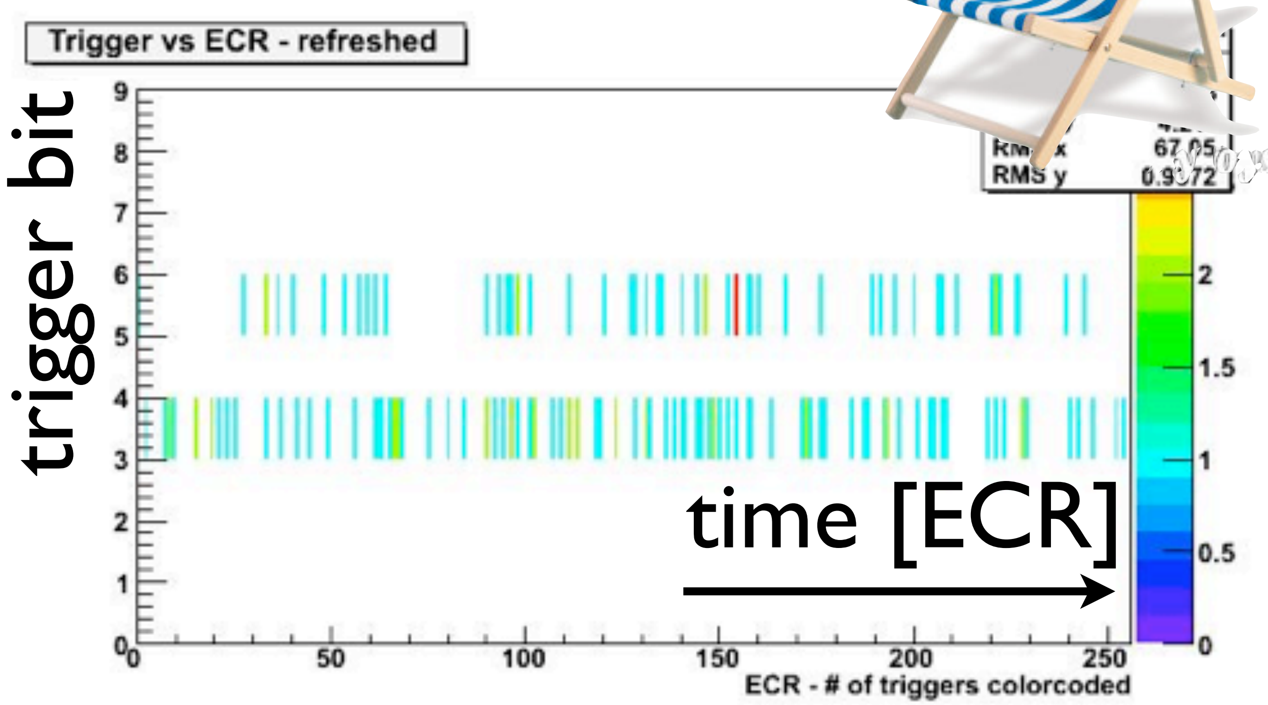
- seeing first effect of solenoid field on 16.09.08:
  - ☑ A-side average hit rates decreased by about 10 counts/s
  - ☑ C-side average hit rates decreased by about 2 counts/s
  - ☑ leakage current decreased for worst module from 0.8 μA to 0.025 μA
  - ☑ returns to original leakage currents and hit rates with switching solenoid off

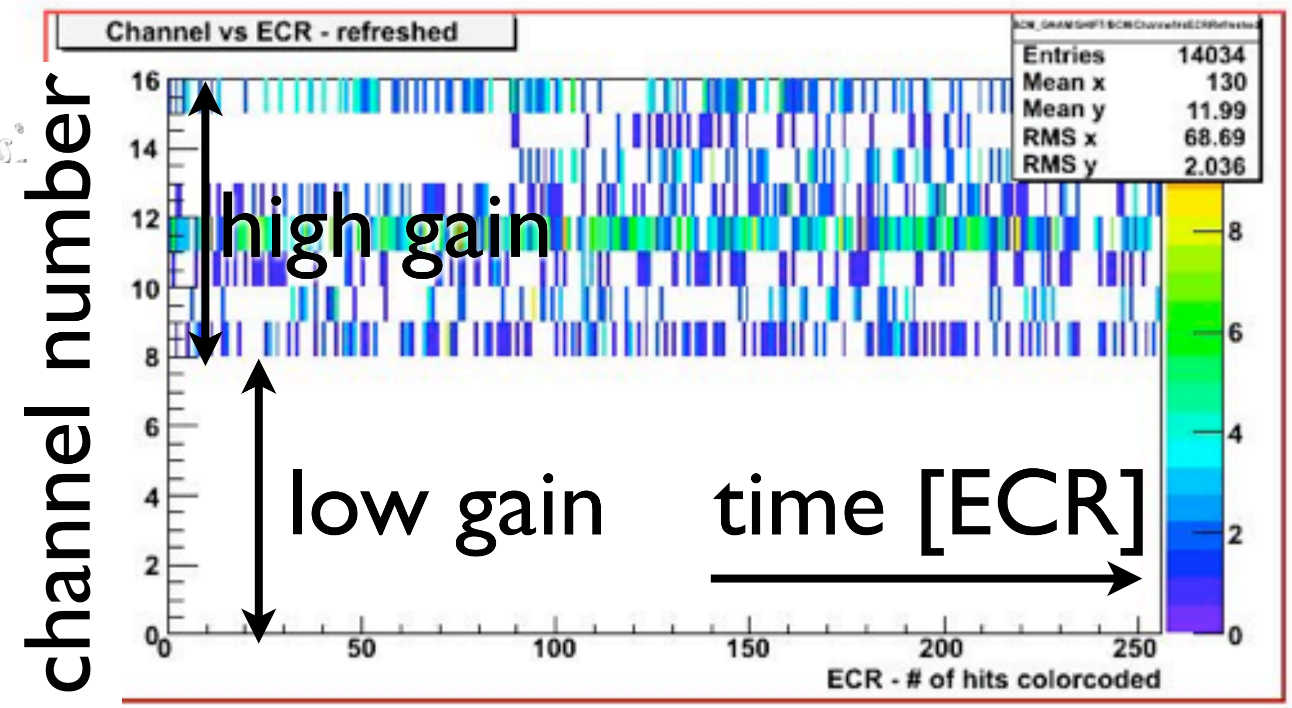




- all BCM channels self-triggered and readout at 17.09.08:
  - ☑ LHC PostMortem signal debugged 15.10.
  - ☑ BCM ready and timed in for beam on 17.09.
  - ☑ improving stability and operation comfort in the last weeks







- comics difficult due to low acceptance