ATLAS BCM (Beam Condition Monitor) and ATLAS BLM (Beam Loss Monitor) status

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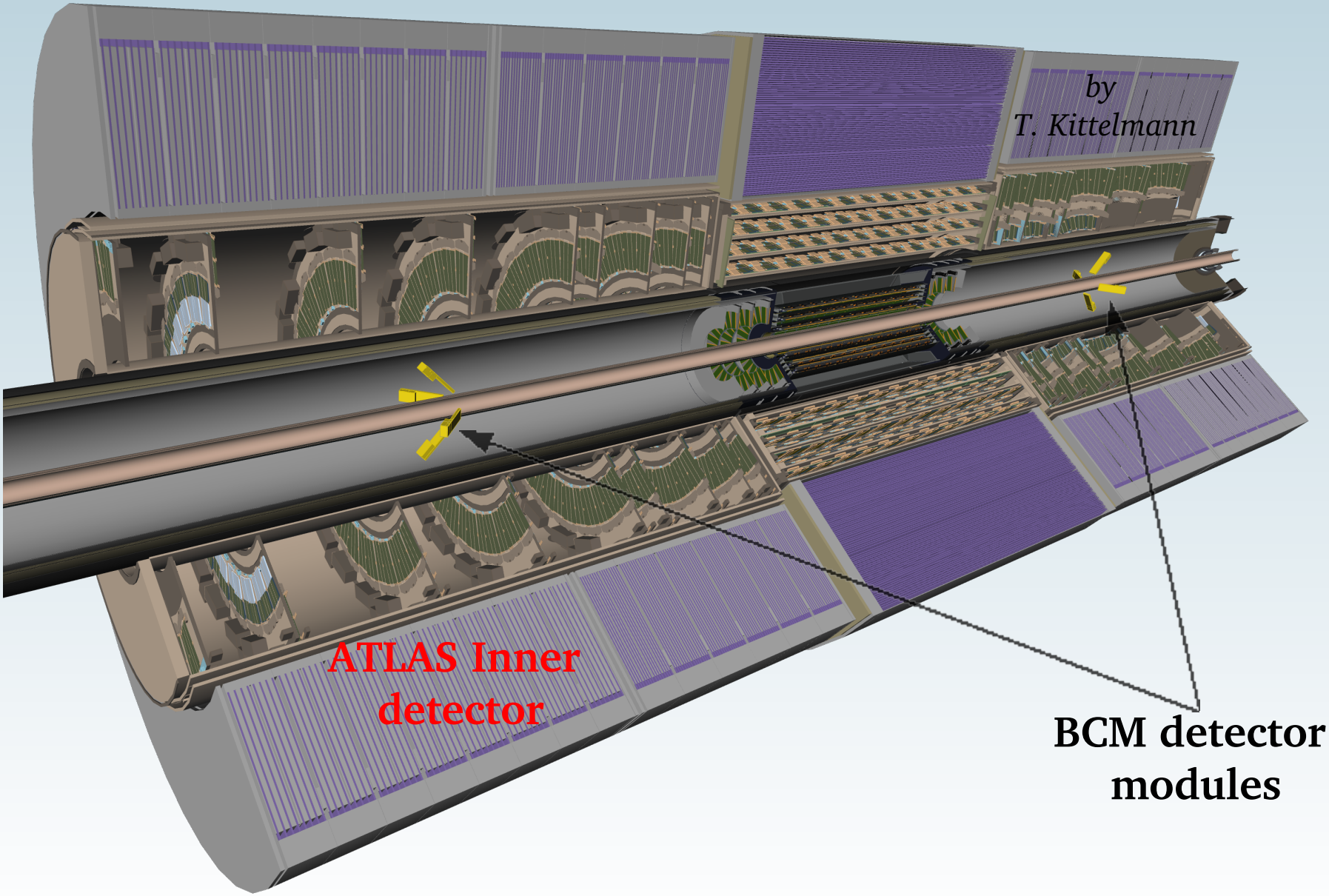
BCM: introduction

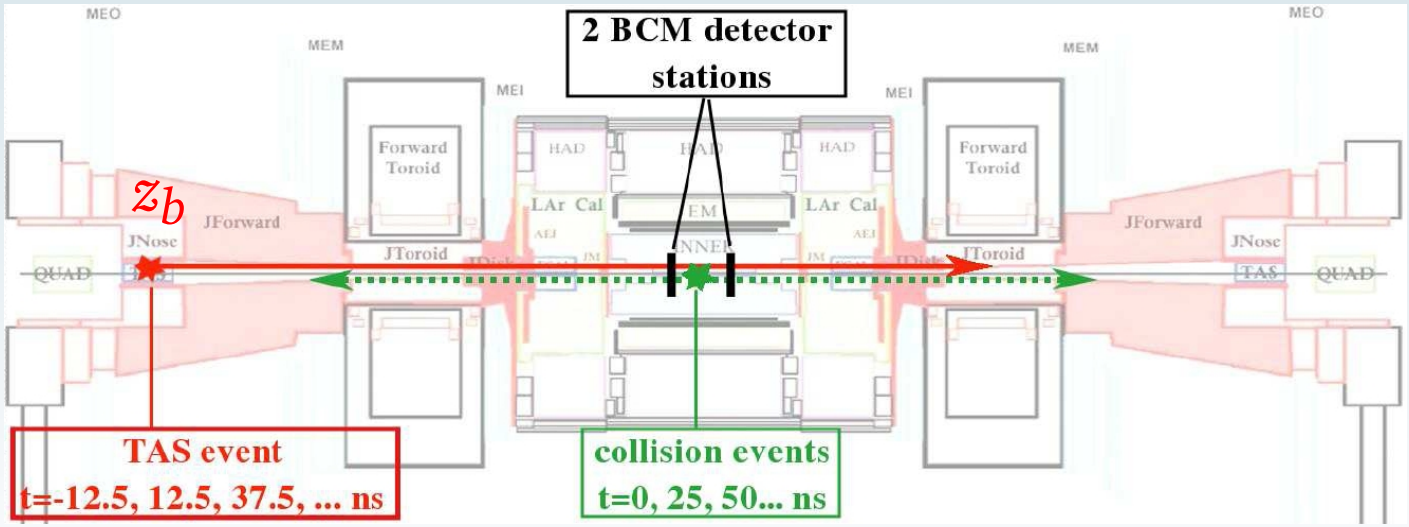
8 BCM detector modules around IP to monitor beam conditions close to the IP



BCM: principle of operation

Time of flight measurement to distinguish between normal collision and background events (beam gas, halo, TAS scraping) on a bunch-by-bunch basis

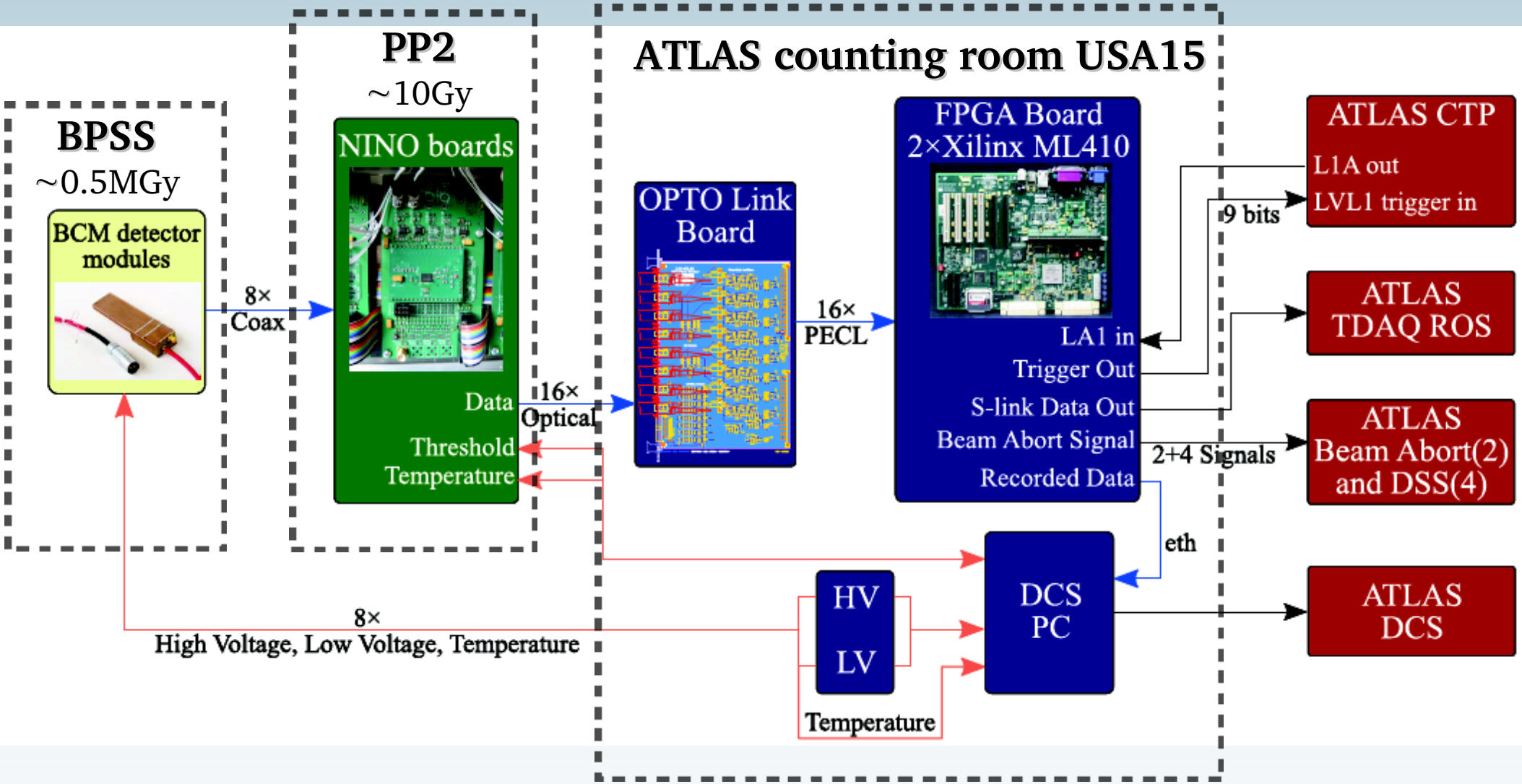
- 2 detector stations (each with 4 detector modules) at $z_{BCM} = \pm 1.84$m:
  - particles from **collisions** reach both stations at the same time → **"in time" hits, occurring every bunch crossing**
  - particles from **background** interactions occurring at $|z_b| > |z_{BCM}|$ reach nearest station 12.5 ns before particles from collisions at IP → **"out of time" hits**
- ➔ use **"out of time"** hits to identify the background events
- ➔ use **"in time"** hits to monitor luminosity (additional information provided by BCM)



Requirements:

- fast and radiation hard detector & electronics:
  - > rise time ~1ns
  - > pulse width ~3ns
  - > baseline restoration ~10ns
  - > ionization dose ~0.5 MGy, 10^{15} particles/cm^2 in 10 years
- MIP sensitivity

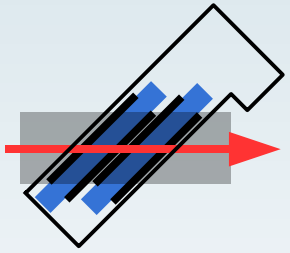
BCM: readout chain

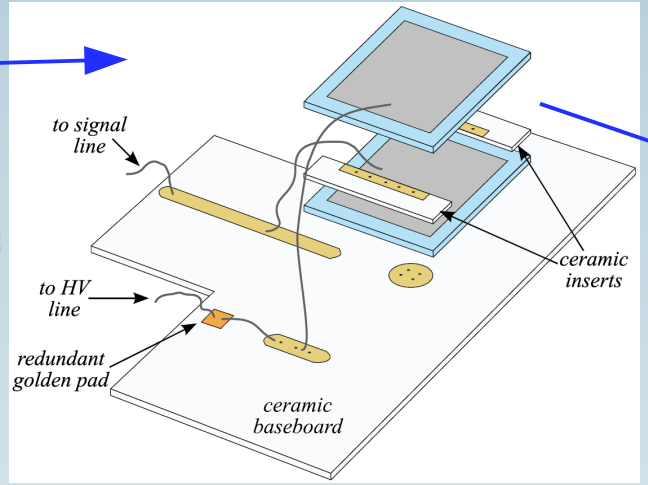


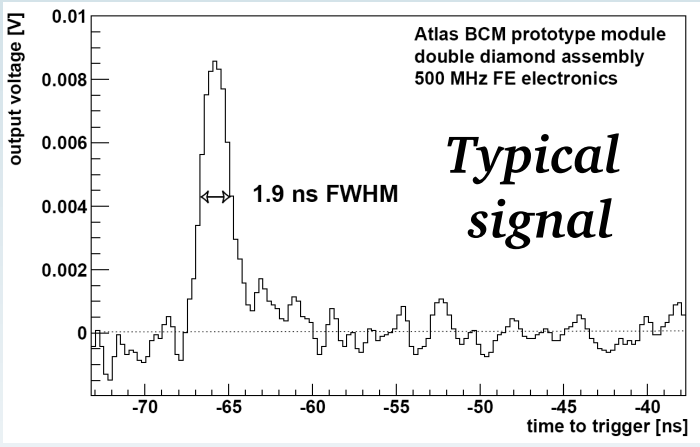
BCM: detector modules

Double – decker assembly

- signal passively summed before amplification
- 2 back-to-back pCVD diamond sensors each with
  - thickness 500µm,
  - Size: 10×10 mm^2
  - Contact size: 8×8 mm^2
    - Operated at 2V/µm (1000V)
    - → fast & short signals
- Modules titled by 45^0 towards beam



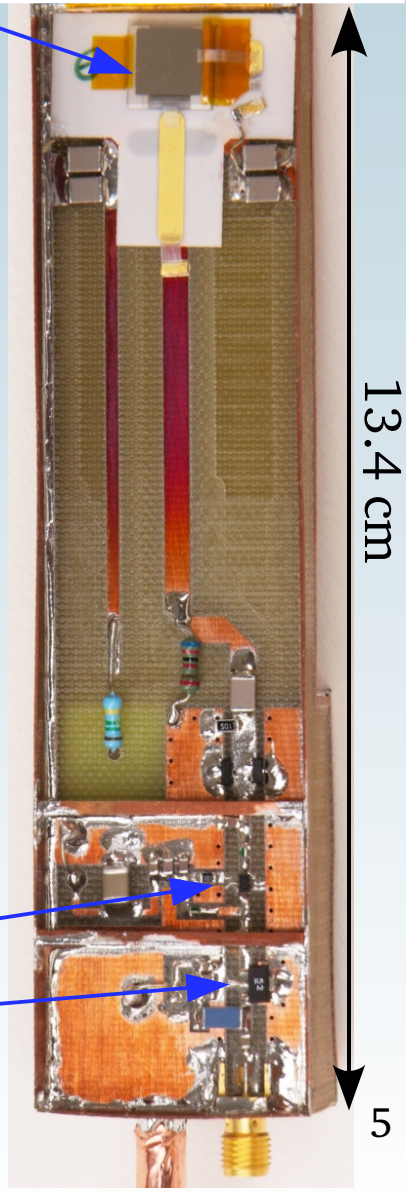




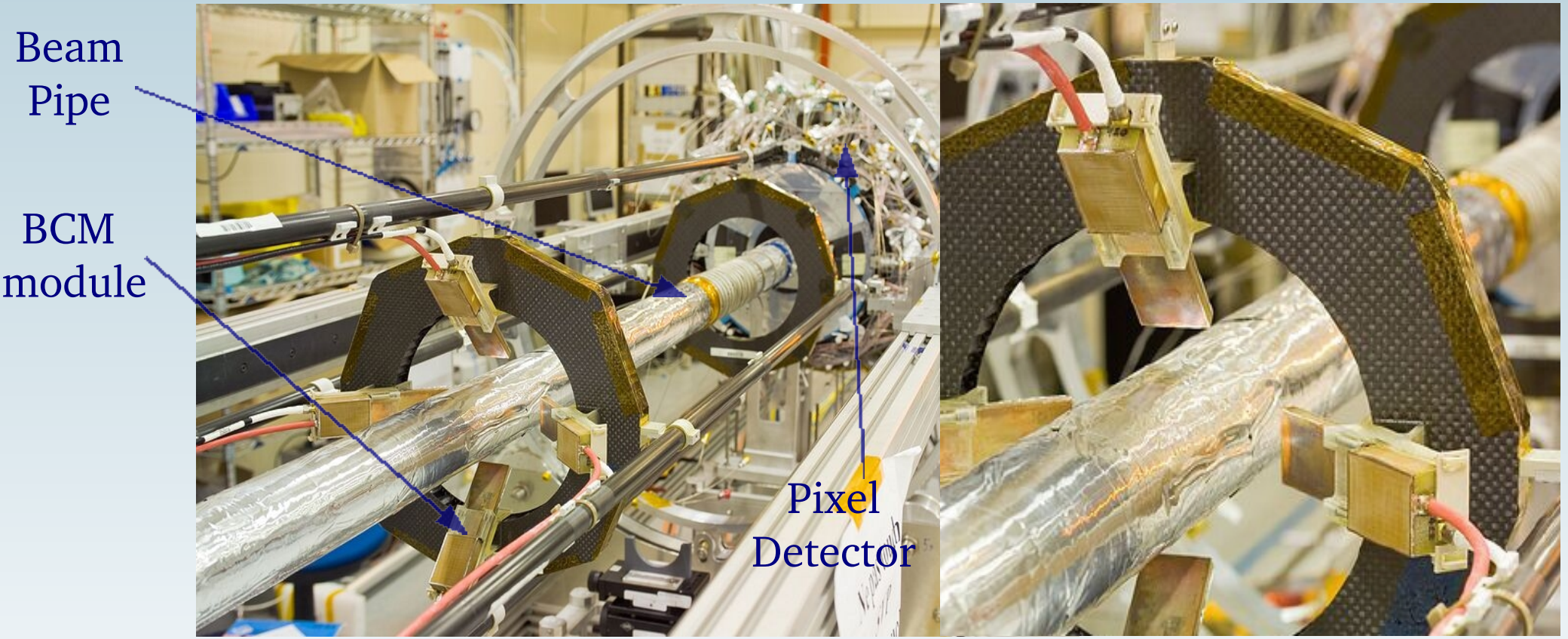
Front end electronics

- **2 stage amplifier:**
  - 1st stage: Agilent MGA-62653, 500MHz (22db)
  - 2st stage: Mini Circuit GALI-52, 1GHz (20dB)

BCM detector module



BCM: modules installed on Pixel Support Structure



BCM: NINO board

- NINO chip: Time-over-threshold amplifier-discriminator chip
- Analogue signal converted into a digital level signal at fixed time after the input signal arrival
- Output signal width correlated to the input signal amplitude
- To increase the dynamic range: analogue signals split in two channels in ratio of 1:11 before “digitisation” → 16 channels (8 low and 8 high attenuation channels)

Channels (high, low atten.)	Module position
0, 8	A +x
1, 9	A +y
2, 10	A -x
3, 11	A -y
4, 12	C +x
5, 13	C +y
6, 14	C -x
7, 15	C -y

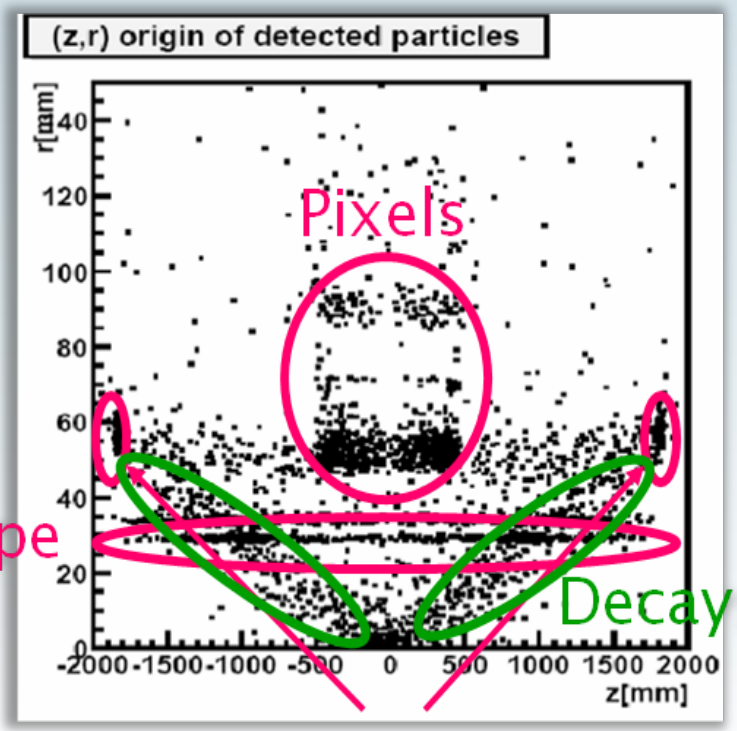
BCM: Status I

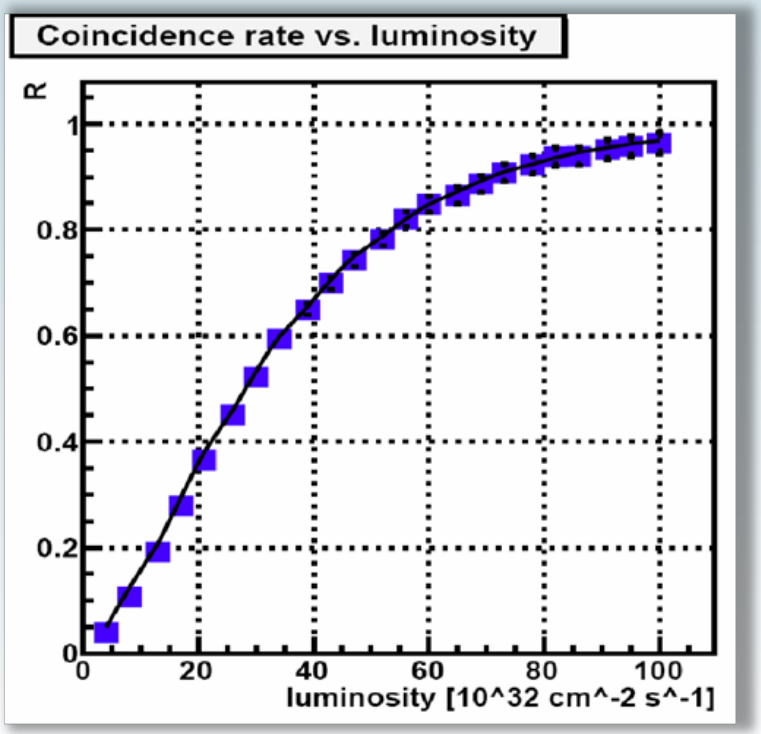
- Detector installation: done
- Electronics: all chain done (firmware upgrades planned)
- DAQ/DCS/DataBase: done (cleanup ongoing)
- DQM: histograms filled (needs some attention)
- Trigger: 6/9 bits into CTP
- Montecarlo description: done
  full detector description since Athena 12-00 (bug fixed in 15-00),
  digitization since 14-X

BCM: Status II

- Calibration/Other:
  Thresholds need to be set-up for all channels on the basis of signal

- Status of luminosity determination related effort:
  First ideas:
  http://indico.cern.ch/getFile.py/access?contribId=0&sessionId=1&resId=0&materialId=slides&confId=17599





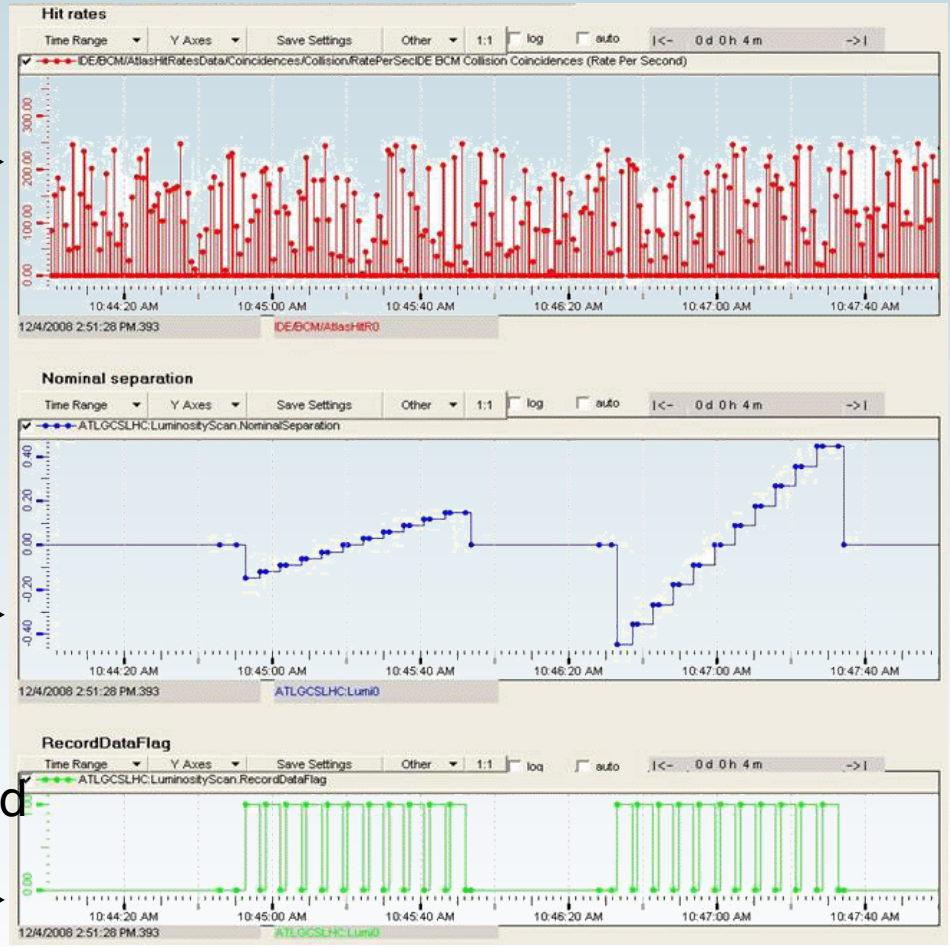
BCM: Status III

- Beam separation (Van der Meer) scans:
  - Dry run with LHC **successful** (end of November 2008).
  - Tested communication between CCC and ACR

BCM “rates”

separation
in mm (from LHC)

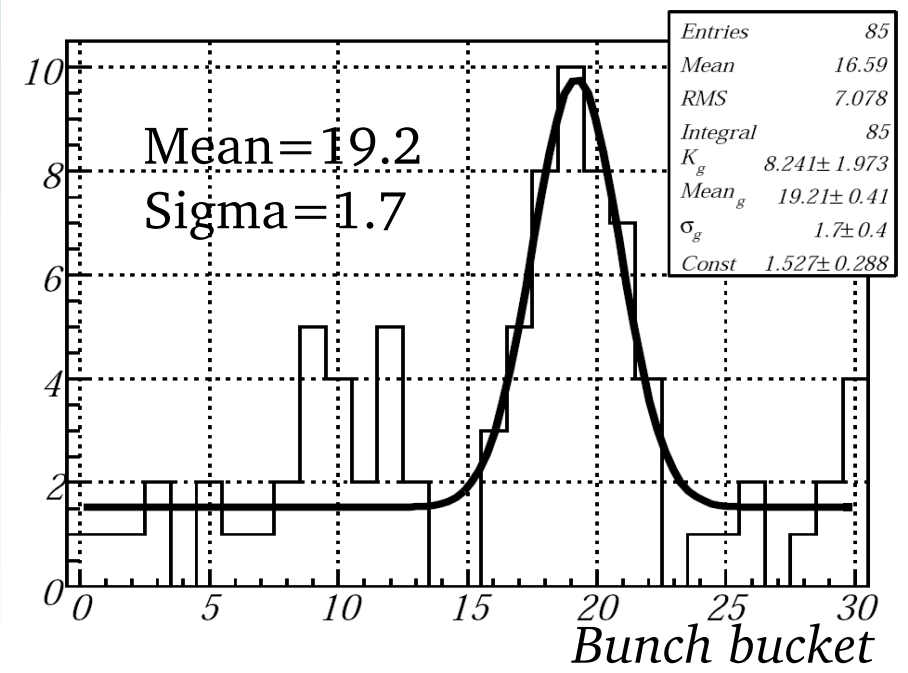
RecordDataFlag 1=Data valid
(from LHC)



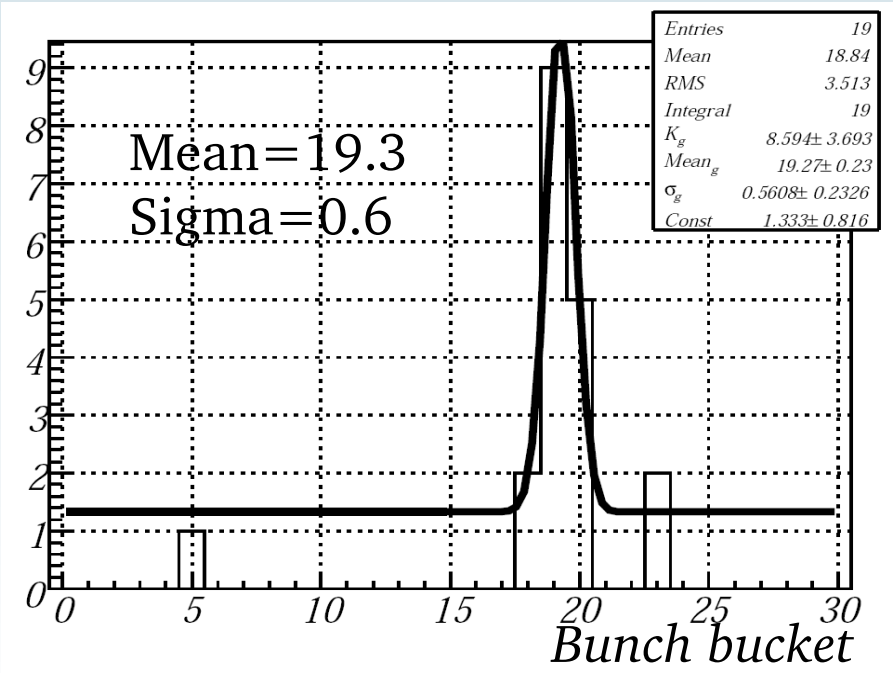
BCM: first results

- ID combined cosmic run (December 2008)
- Checked BCM data in two ATLAS DAQ trigger streams (TRT, RPC):
  - Trigger timing plots: BCM hit distribution over 31 bunch buckets (bunch crossing intervals-25ns)
  - Signal seen in timing plots for both streams

RPC

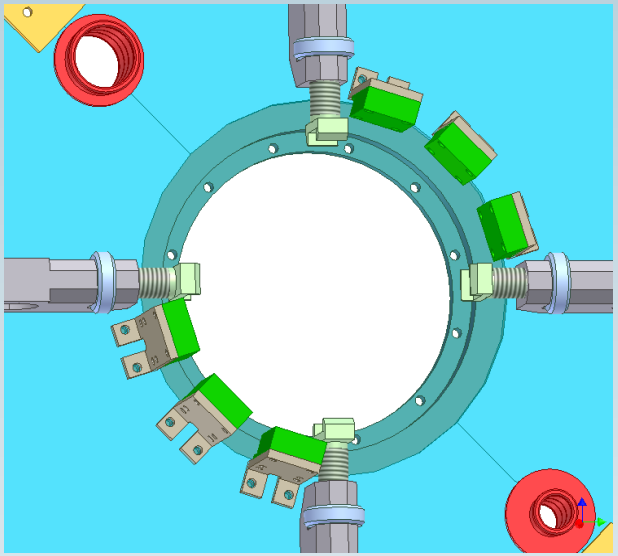


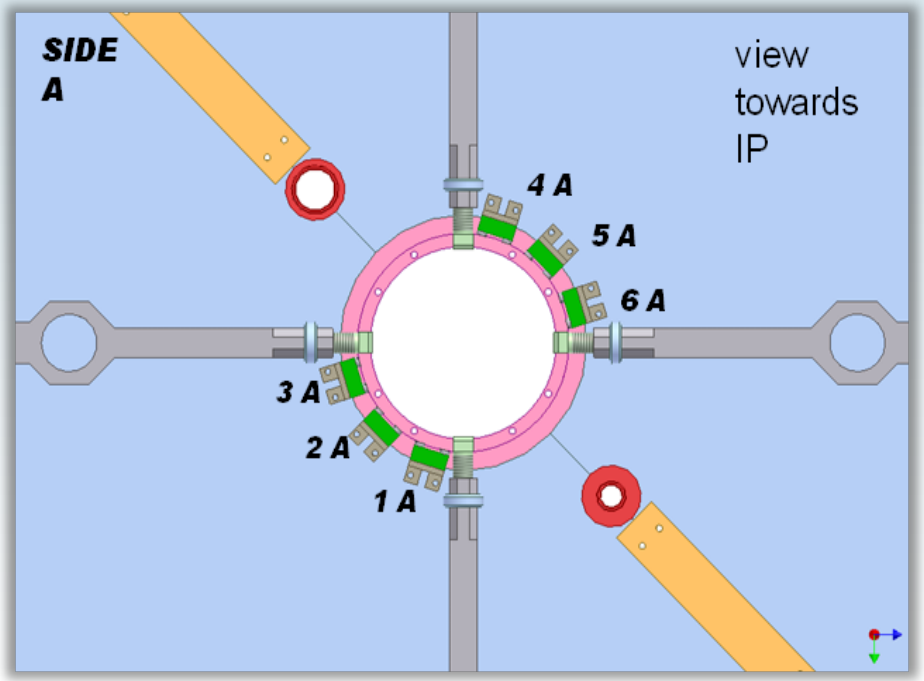
TRT

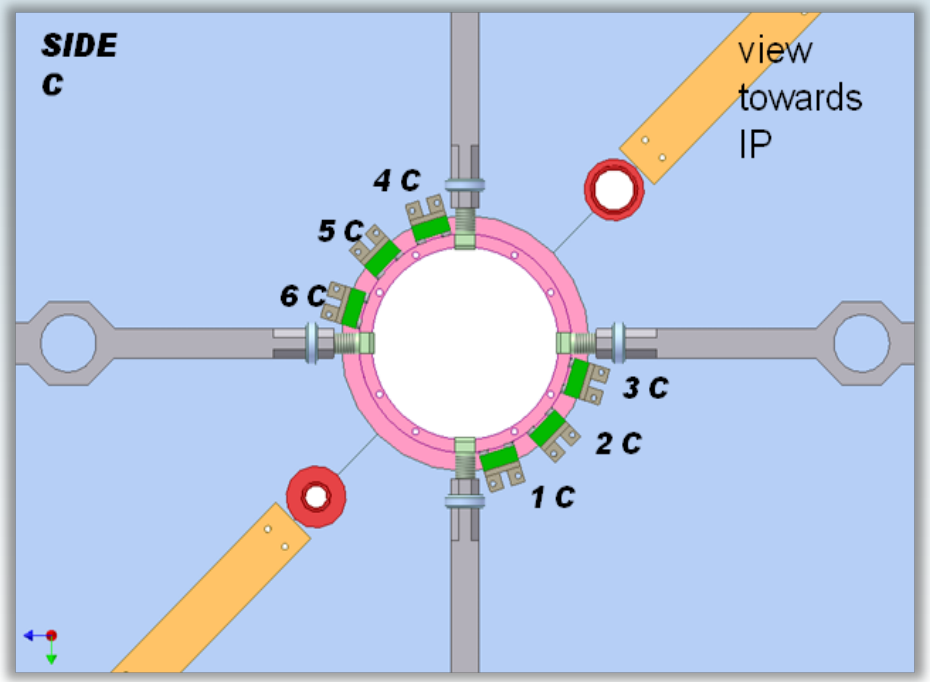


BLM: introduction

- 6 detector modules (with diamond sensors) on each side of IP, installed on the Inner Detector End Plate (IDEP)
  - z~3450mm, r~65mm
  - installed modules measured with SMU (IVs + long term bias: *ATL-IC-TR-0007)*

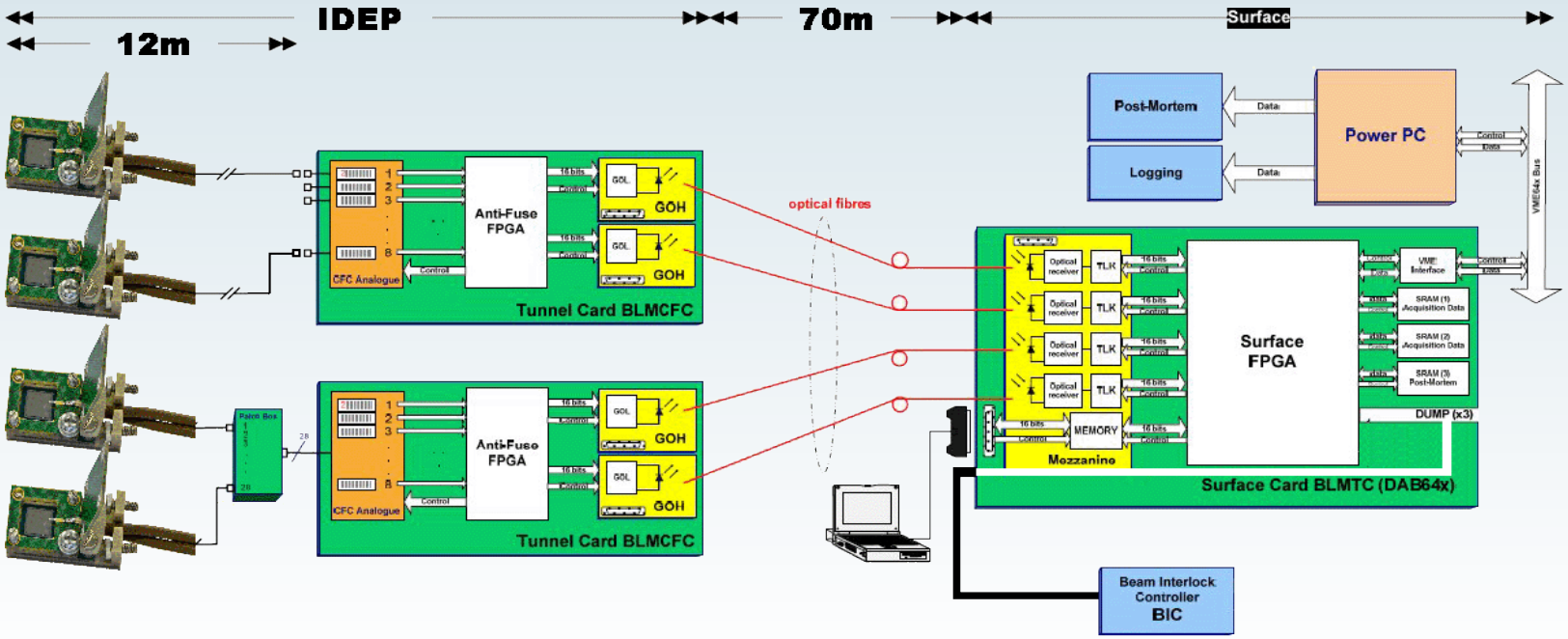






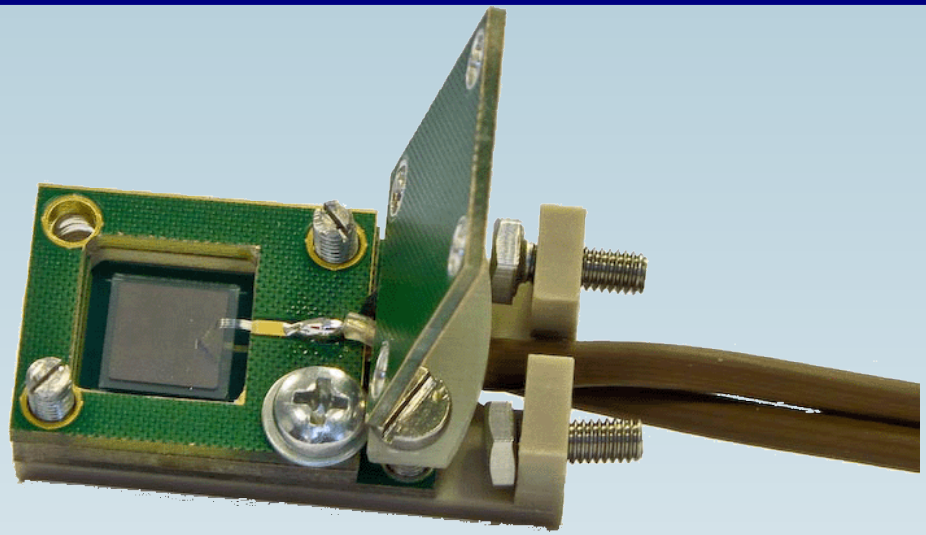
BLM: readout

- Partially adapted from the LHC BLM developed by AB/BI group
- Modules readout by 2 “tunnel cards”: BLMCFC
  - BLMCFC converts current into frequency and sends encoded data over optical link to the “surface card”: BLMTC
  - Integration times ranging from 40μs to 84s
- BLMTC:
  - inserted in BCM VME crate
  - VME bus used for monitoring rates and recording the postmortem buffer
  - Modified BLMTC FPGA firmware to output beam dump signal on the front panel LEMO outputs



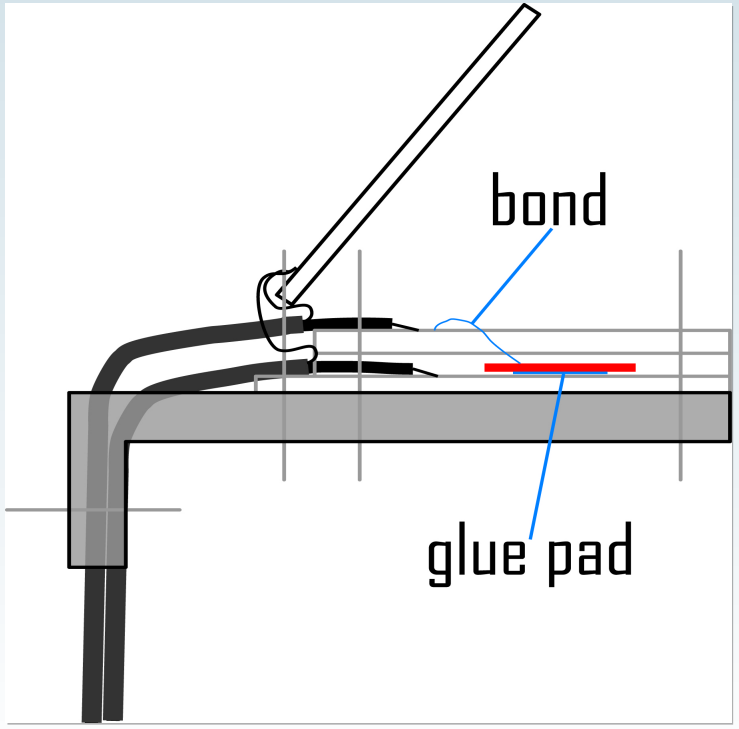
BLM: detector module

- Mechanical support
  - rad-hard PEEK plastic support
  - standard double sided PCB – mechanical rigidity and electrical insulation
  - layers screwed together with M3 screws



- Sensor:
  - 8x8 mm^2 0.5 mm pCVD diamond (by DD Ltd.)
  - metallised at OSU
  - operated at 500V

- Assembly:
  - conductive glue, bonding, soldering



BLM: status

- BLMCFC crates modified and assembled with modified PS module and backplane
- BLMTC card will be modified to output beam dump signal on the front panel
  - Communication between SBC and BLMTC trough USB bridge established
  - ready to bring back the module for FPGA firmware upgrade to AB/BI

setup in the lab (161 01-023)

Summary

- **BCM**
  - Installed and operational
  - Seen first signals from cosmic data in December 2008

- **BLM – ready**
  - Detector modules installed in 2008
  - All parts of hardware available
- **BLM – to-do**
  - Install BLMCFC (PP2)
  - Install all parts of PS and control chain (USA15)
  - Develop code for monitoring rates (running sums) and acquiring postmortem (beam dump) buffer