Status of LHCb

T. Bowcock

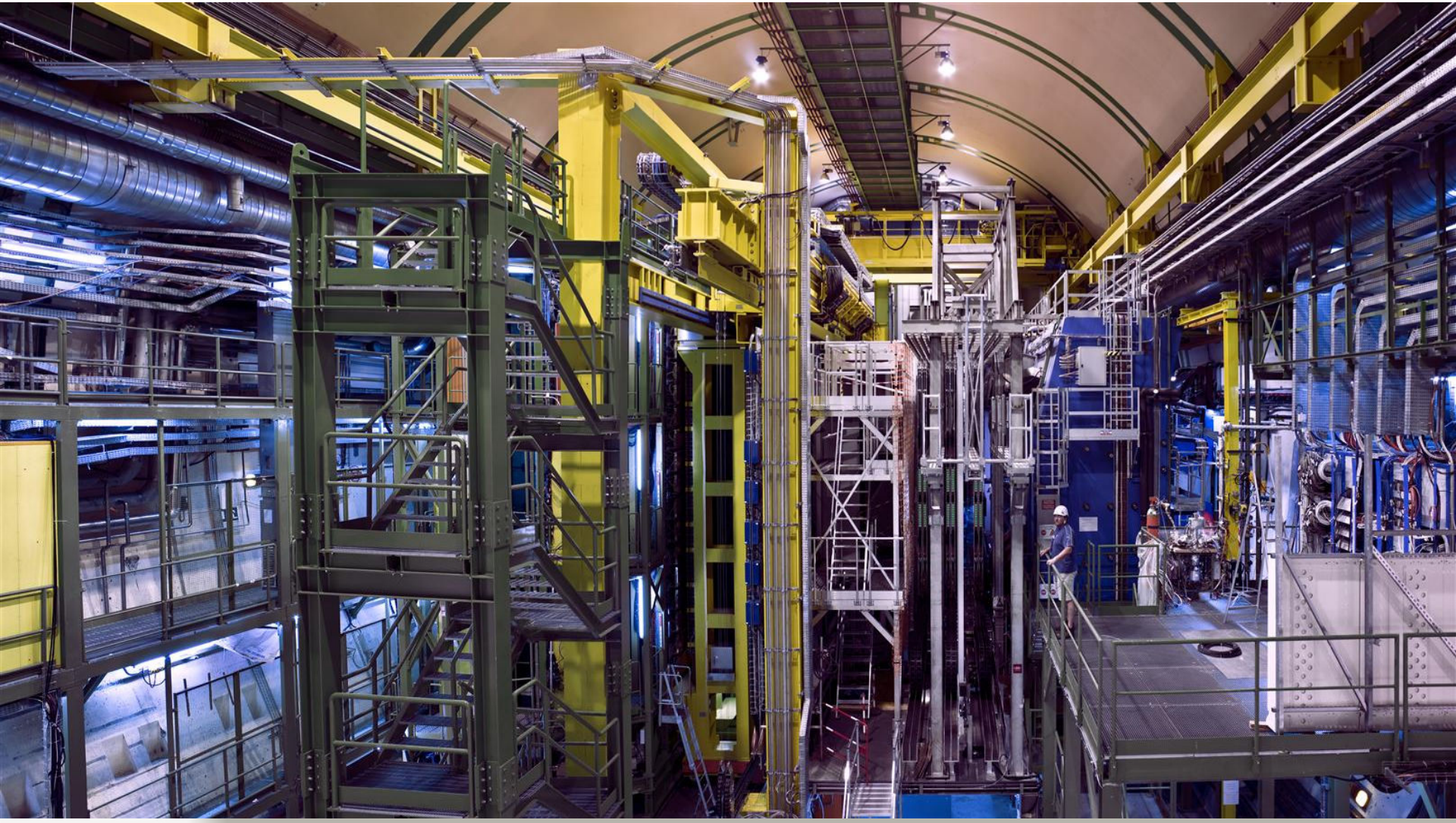
CERN & University of Liverpool

On behalf of the LHCb Collaboration

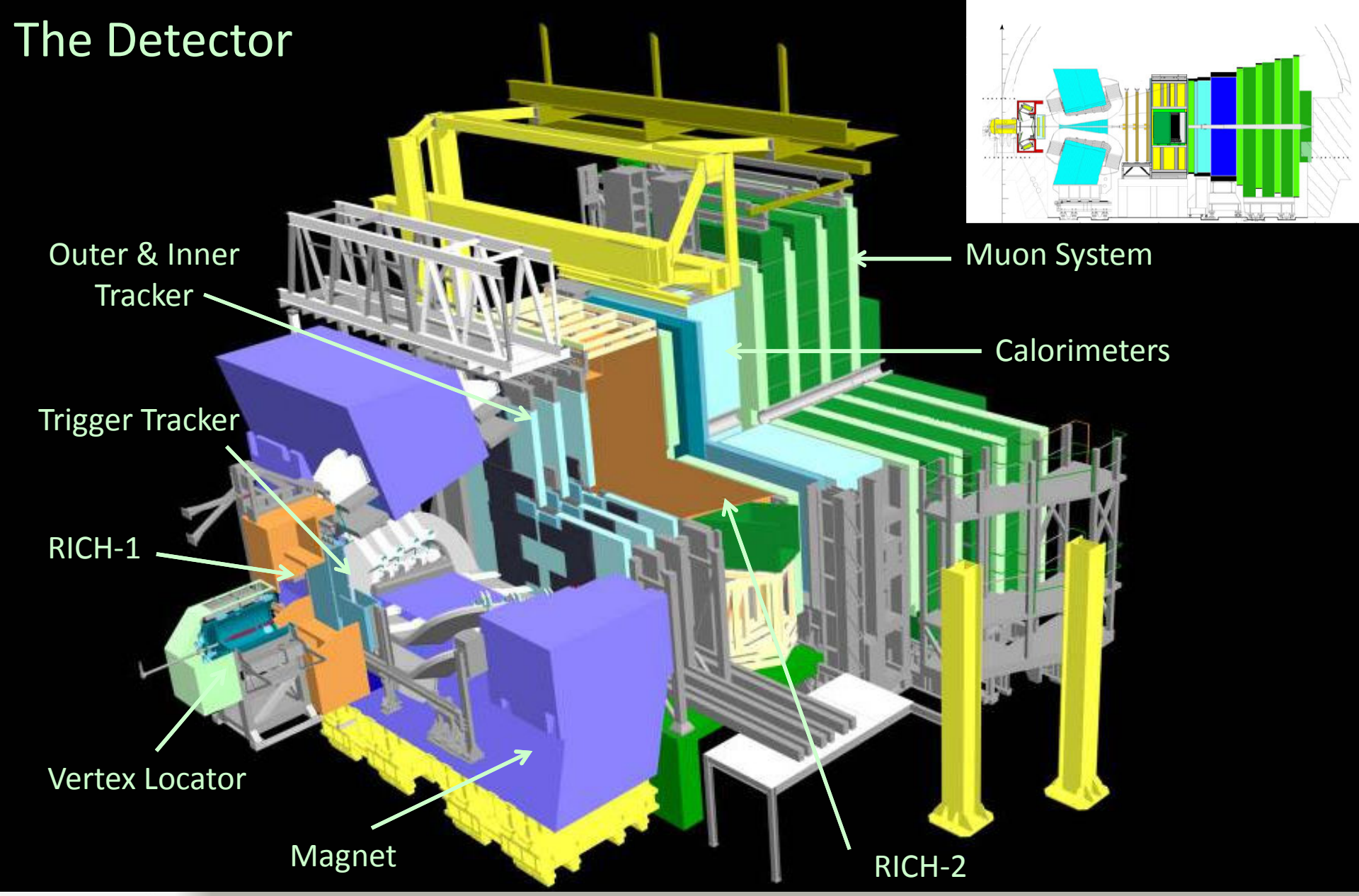
LHCb ready for data taking

Topics as reported at LHCC mini-review 7/7/09

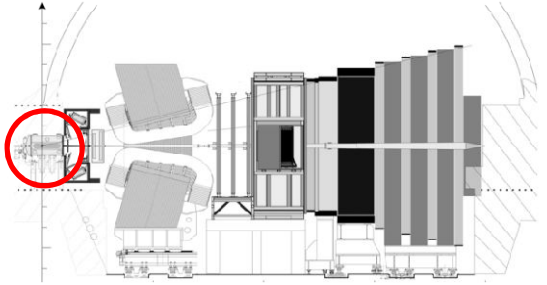
- Status/improvements to detector
- Tests before colliding beams
- Preparations for Physics



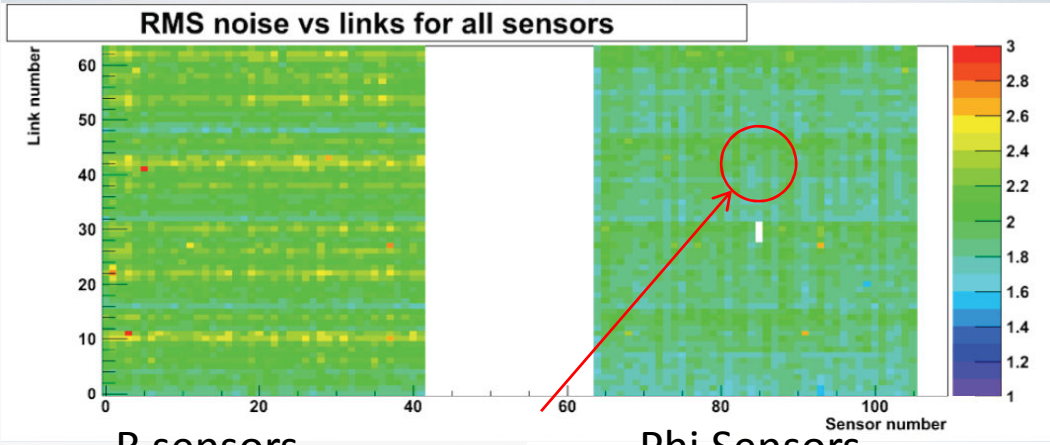
The Detector



Vertex Locator(VELO)

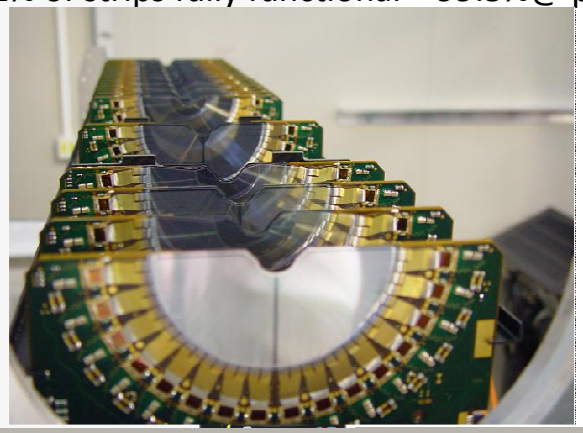


- 170k channels, 0.2m^2
- High rate irradiation tests



R sensors Phi Sensors

99.2% of strips fully functional – 99.3%@ production

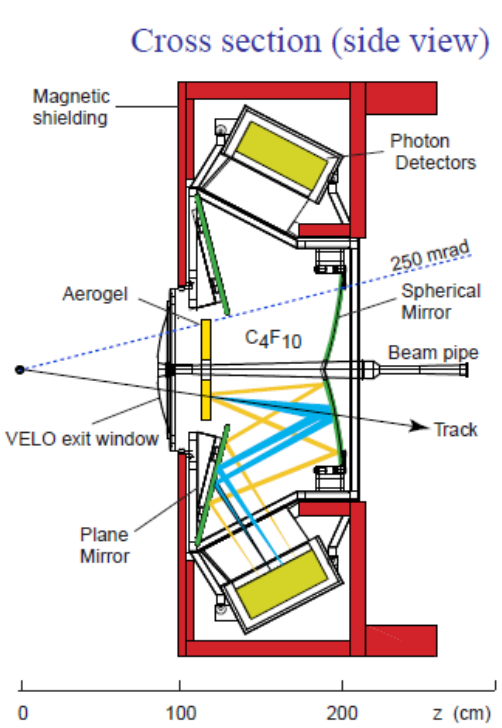


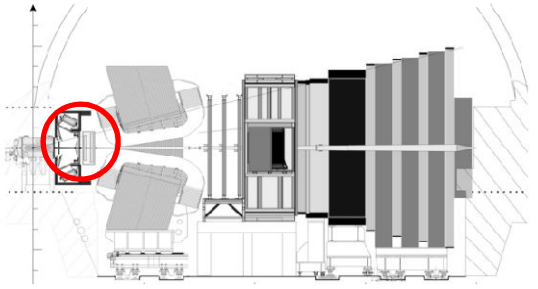
RICH1

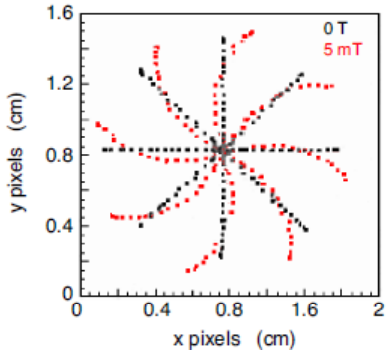
- Magnetic Distortion Monitoring Systems (MDMS) installed

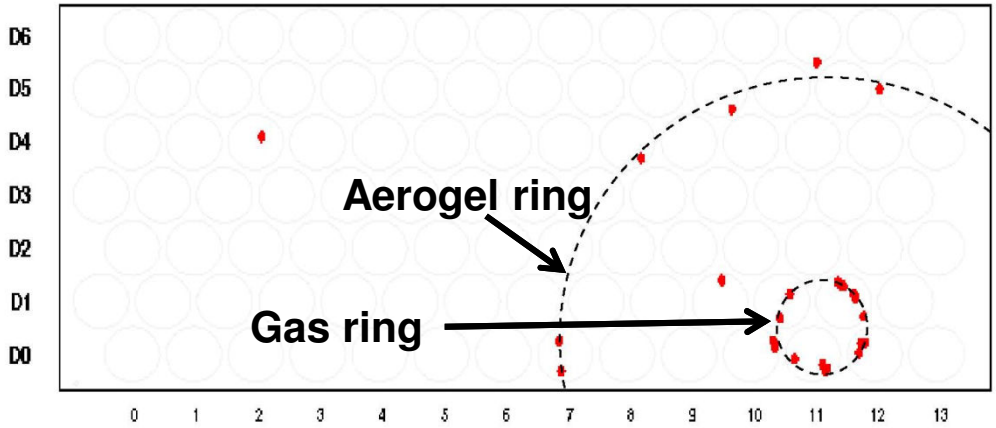
- Installed scintillators to see cosmics rings with TT in Aerogel and C_4F_{10}

- Photodetection with HPD



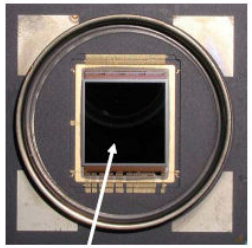




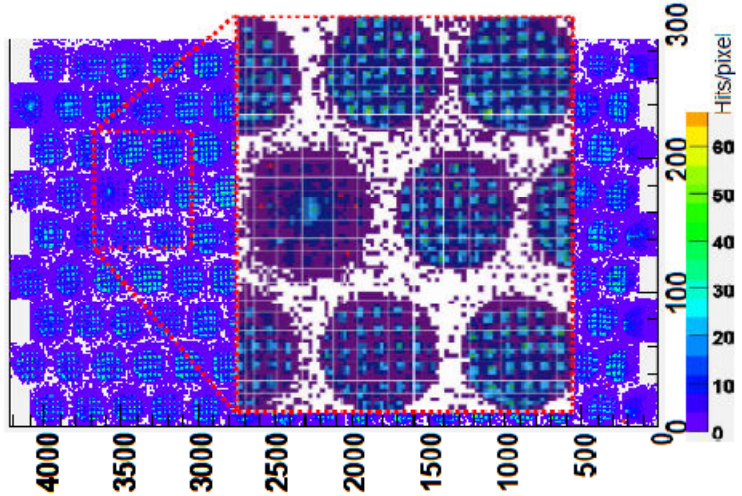


HPD

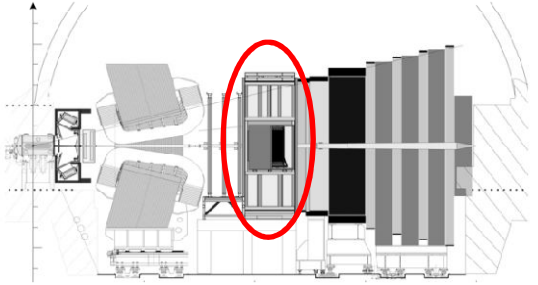
- In total 486 HPDs required for RICH-1 + RICH-2
  - Ion Feedback
  - Glowing at IFB >~5%
  - Eventually (5 years) 100 HPDs will need replacing
- Actions:
  - 60 HPDs have been removed/exchanged
  - Repair procedure ongoing
- Status:
  - 27 repaired HPDs received, more in the pipe line



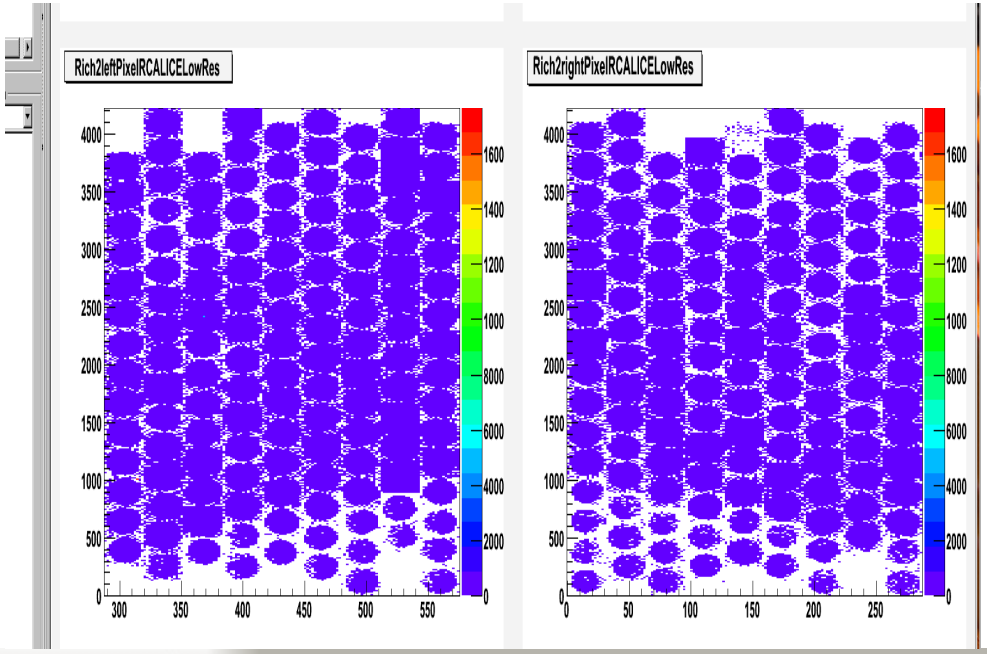
8192-channel pixel chip
8× OR → 1024 pixels
(500 × 500 µm square)

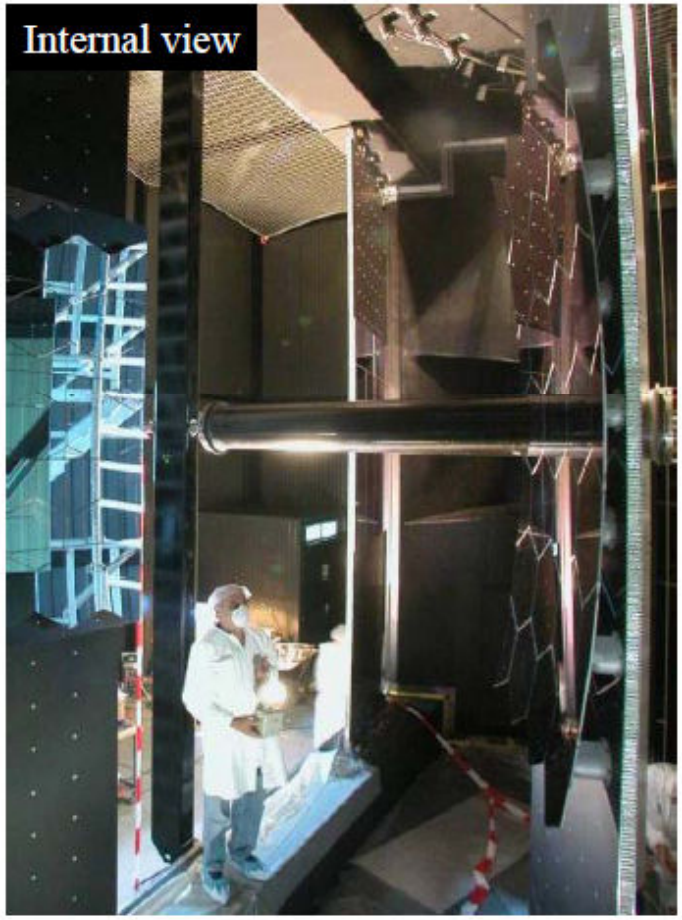


RICH2

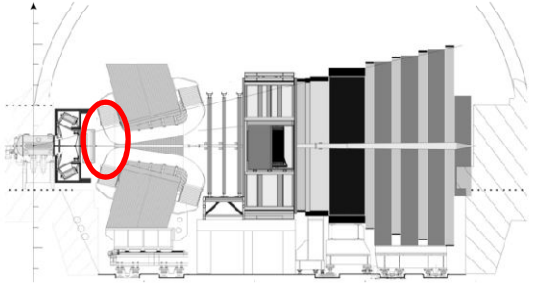


- RICH1&2 have been running smoothly for extended periods of time
- "hot" pixels at the 10^{-6} level!

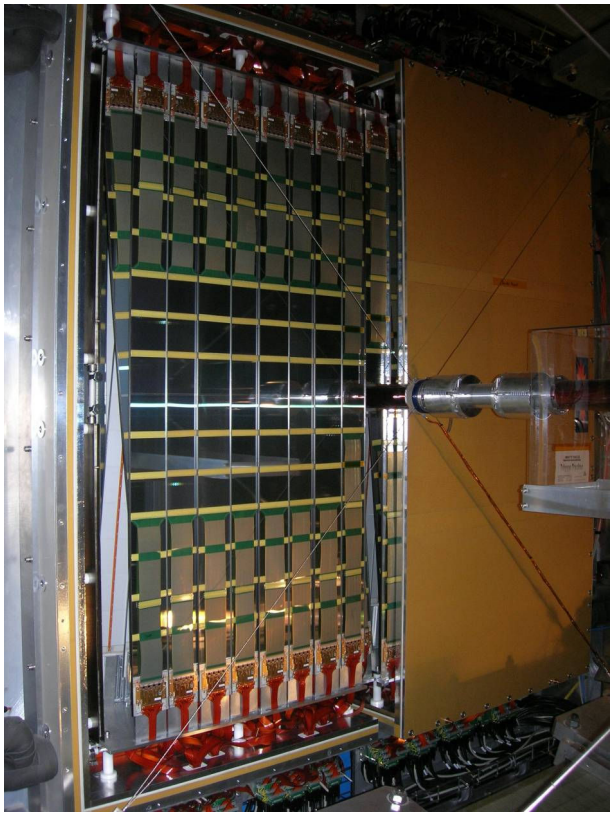




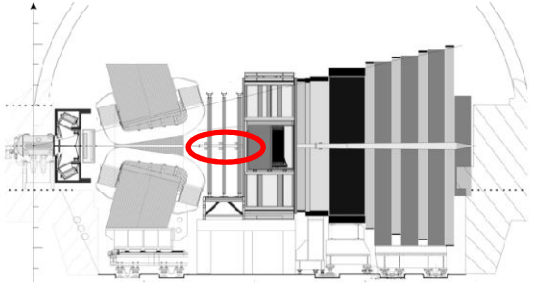
Trigger Tracker



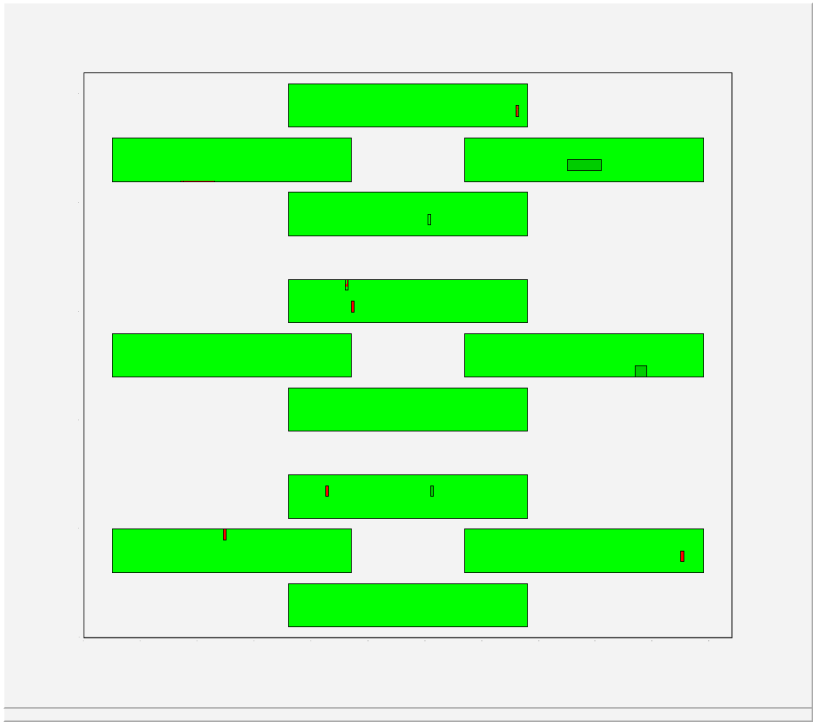
- Running cosmics with RICH1
- 99% operational strips
- 8m^2 strips (140 k)



Inner Tracker

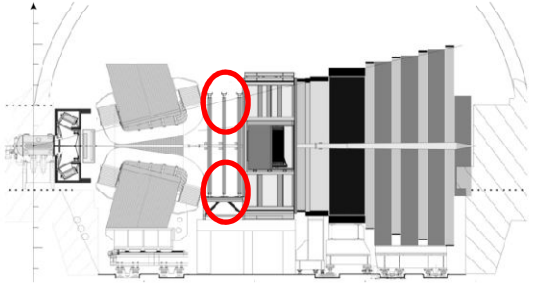


- In good shape: 99. 7% channels working)
- 4m^2, 130k channels

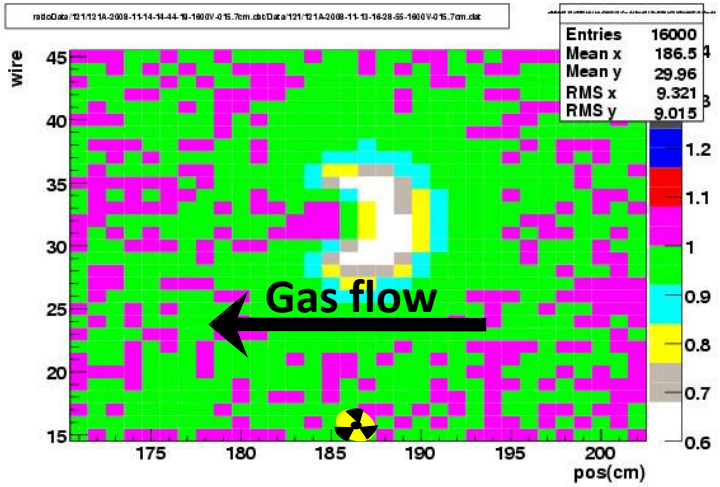


99.7 % of the detector working
[Everything but 7 Beetle ports]
Improved since the TED run…

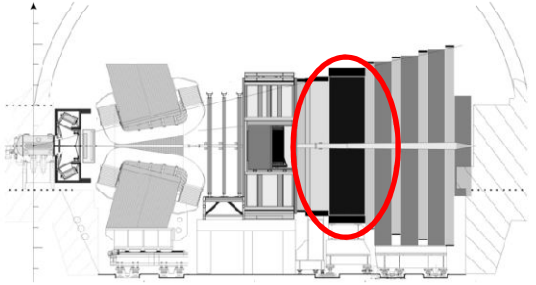
Outer Tracker



- Detector is fully installed (summer 2008)
- Gain-loss phenomenon understood:
  - Araldite glue used to glue modules
  - Croissant shape is due to O_3 formation
- Anti gain loss measures (strategy unchanged):
  - Continuous flushing
  - Heat treatment completed on all stations
  - In-situ scanning tool used to check gain loss
  - Addition of 2% O_2 decided (when luminosity gets into the critical regime); small effect on gain (15%), no effect on drift velocity
  - HV training to repair damage is possible, if needed
- Aligned to <1mm using cosmics



Calorimeters

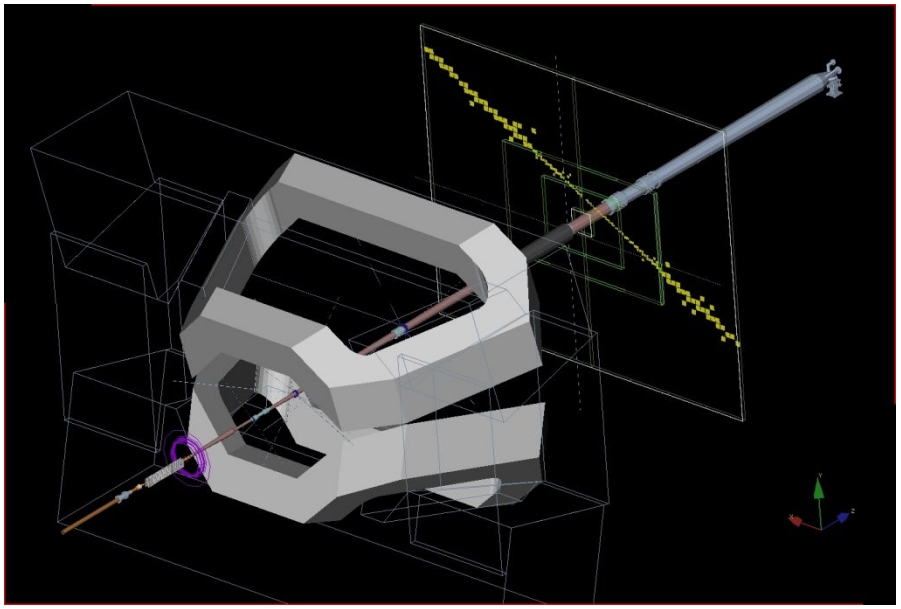


- ECal
  - Major noise reduction compared to 2008
  - Time aligned to 3ns
  - Intermodule calibration to 4% (LED)
- Hcal
  - Time aligned to 3ns
  - Intermodule calibration to 8% (Cs)
- SPD
  - Time aligned to 5ns
- PS
  - Time aligned to 3ns

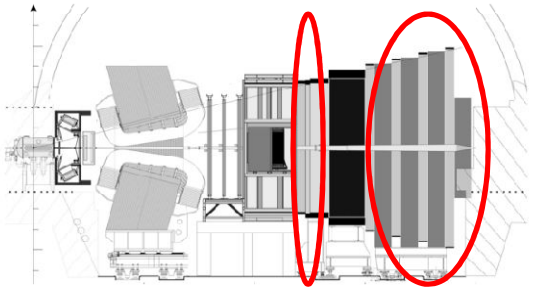
All four above:

  - Smooth operation

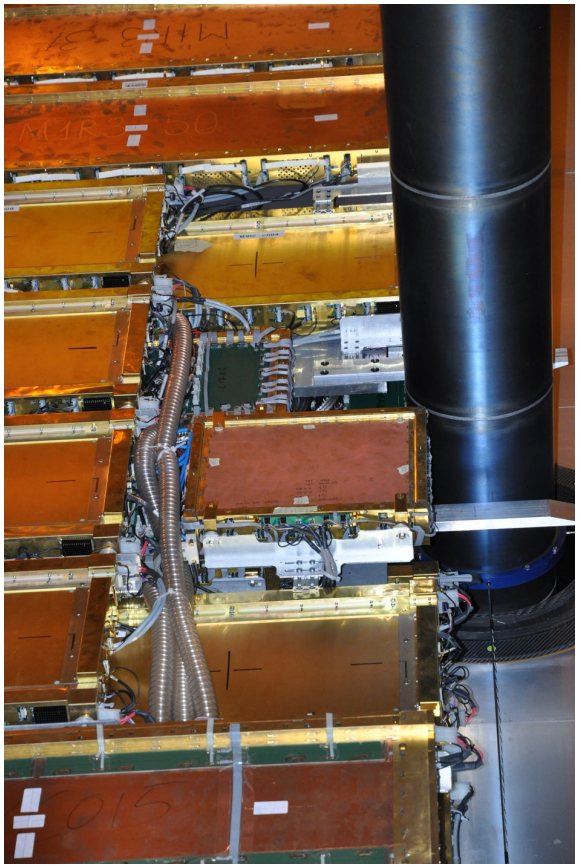
- Cosmics and Target Data (TED)



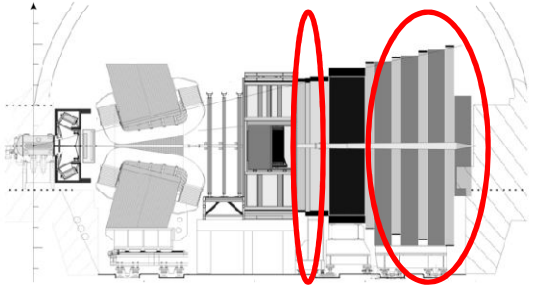
Muon System:



- M1 Installation completed on 26 June on schedule
- Testing, debugging and alignment finished
- Final positioning w.r.t. beam pipe performed
- 435m^2 (2 tennis courts)



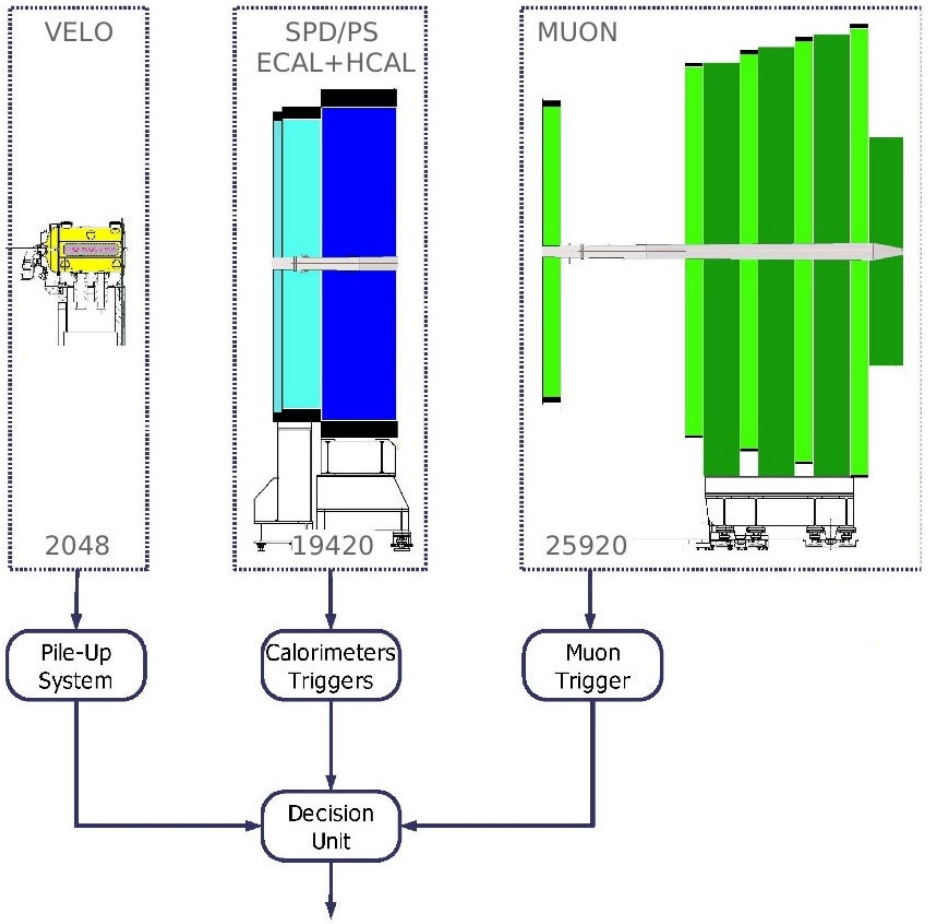
Muon System



- First data runs with M1 in “Global” i.e. with rest of detector
- Commissioning for data taking has started:
  - Noise studies for optimal threshold setting
  - Runs with cosmic rays
  - Muon L0 trigger tests
  - ~100% Channels working

Level-0 Trigger

- System complete
  - Tested successfully
  - Detailed studies ongoing
  - M1 integrated
  - Ready for data taking



HLT farm and Network

- HLT farm was increased to 550 servers from 200 servers
- Server 2nd tranche: DELL M605 blade, 2 x Intel 5420 processor (x 4 cores) (2.5 GHz), 16 GB memory
- New farm operational

Blade chassis

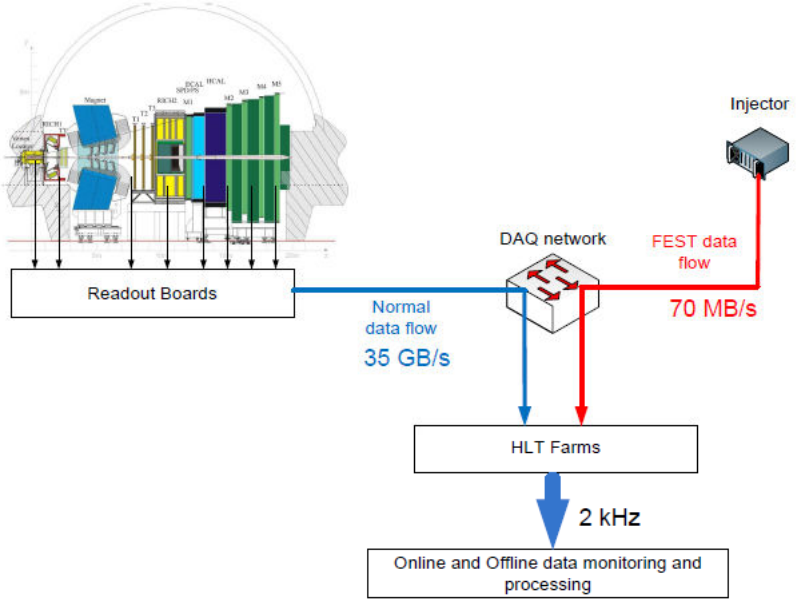
- 50 chassis installed with 7 blades / chassis
- 9 slots / chassis free (rapid install extra cards)
- Very power efficient (2.1 kW / maximum)

Network

- Network expanded to full 1 MHz capacity June 09
- New Line-cards (Force10 line-cards)

High Level Trigger (HLT)

- FEST-injector (10^8 Min B events) into HLT
  - test & monitor
- Ready for real data.
- Optimized
- Final commissioning only possible with real data.



1 MHz readout-test

- Every detector tested @ 1MHz
  - All cabling problems fixed
  - Combined test with all of LHCb
- No problem in central DAQ detected: LHCb is ready for 1 MHz readout

General Organization during the run

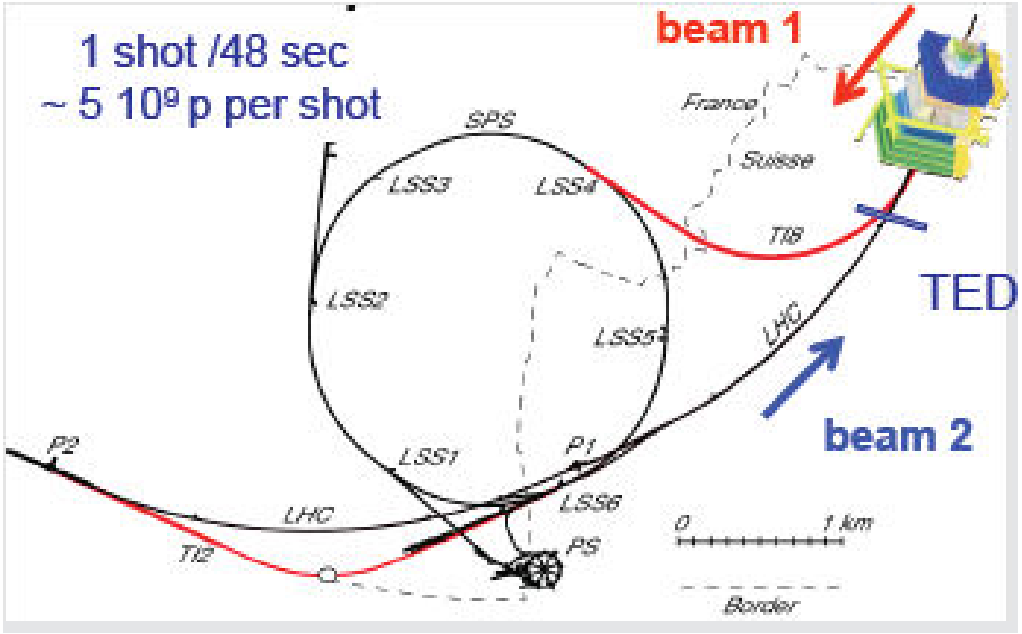
- On shift: 2 -3 persons, one of them SLIMOS
- 3 shifts / 24hrs / 7days
- On-call experts for each system 7 days /week
- Additional on-call services
  - DSS expert
  - RP expert / assistant
  - Patrol
- Shifter and SLIMOS training in place since last year

Summary Hardware

- LHCb detector complete
- Commissioning is well advanced
- DAQ and network ready for 1 MHz
- Ready for next TED run in October and for first collisions
- Remaining actions:
  - Third round of HPD exchange in October
  - Increase to final CPU power later…

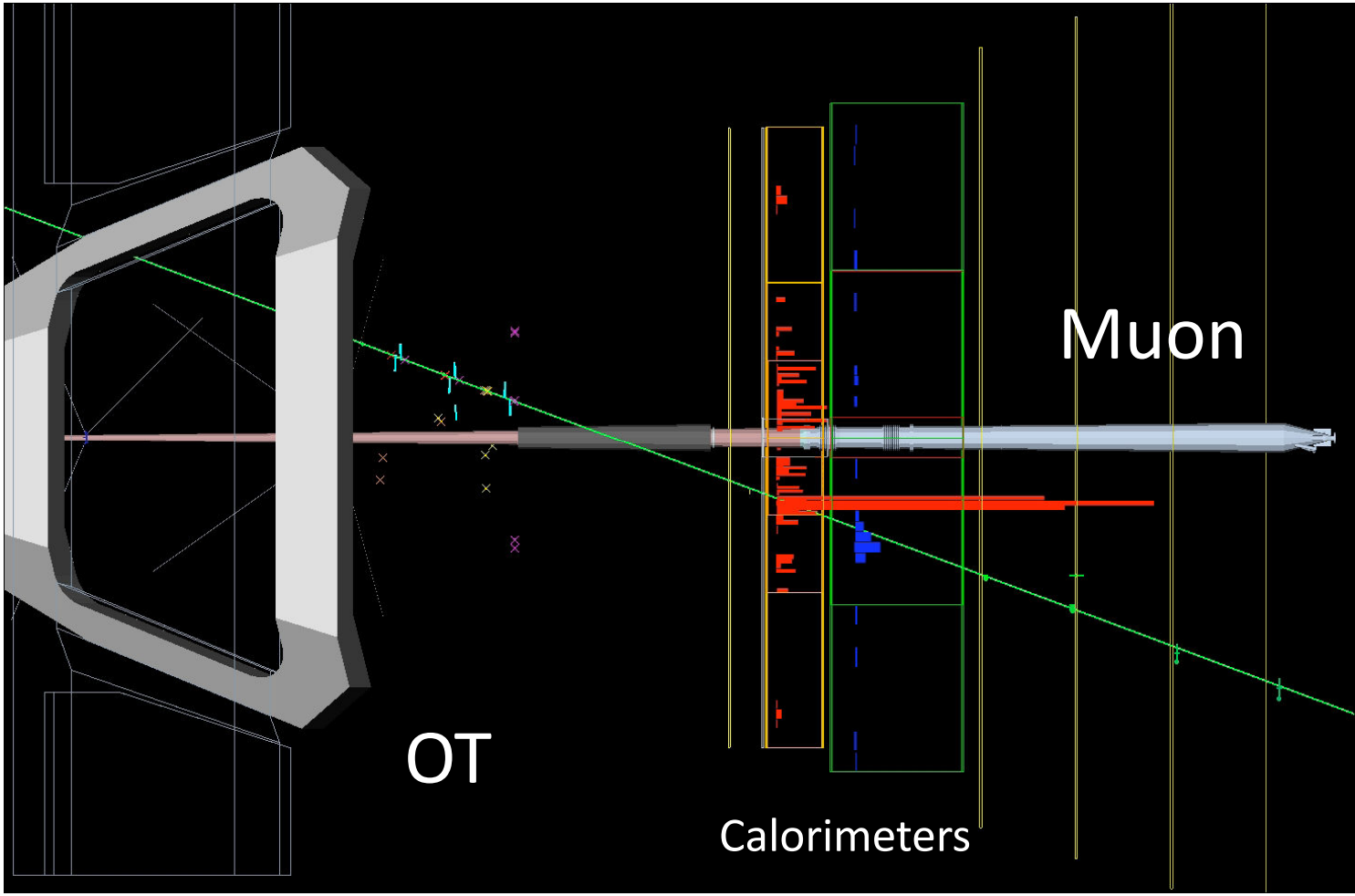
Pre-Collision Data

- Cosmics
- Transfer line External Beam Dump (TED)
  - 300m from LHCb
  - 450Gev p showers



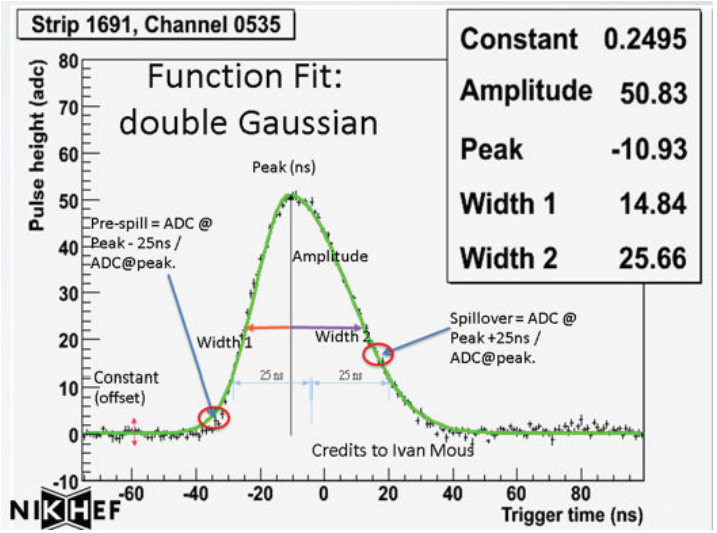
Cosmic Events

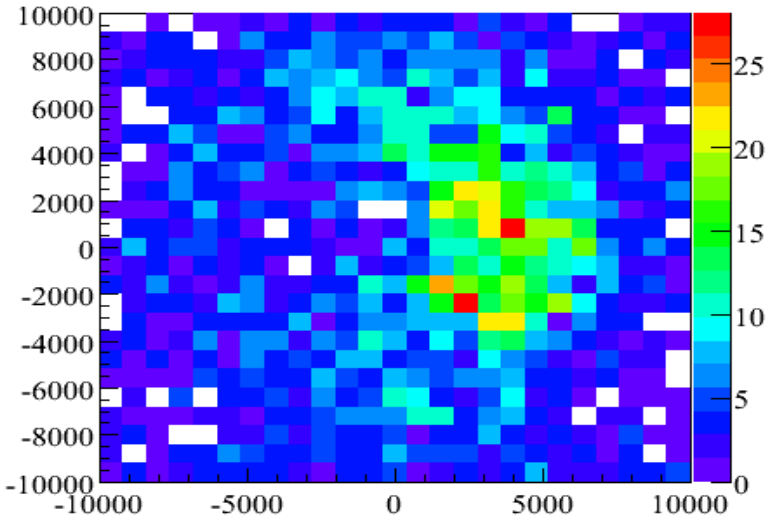
- Since 2008 >10^6 calo
- OT
- RICH/IT



TED Run(s) 2009

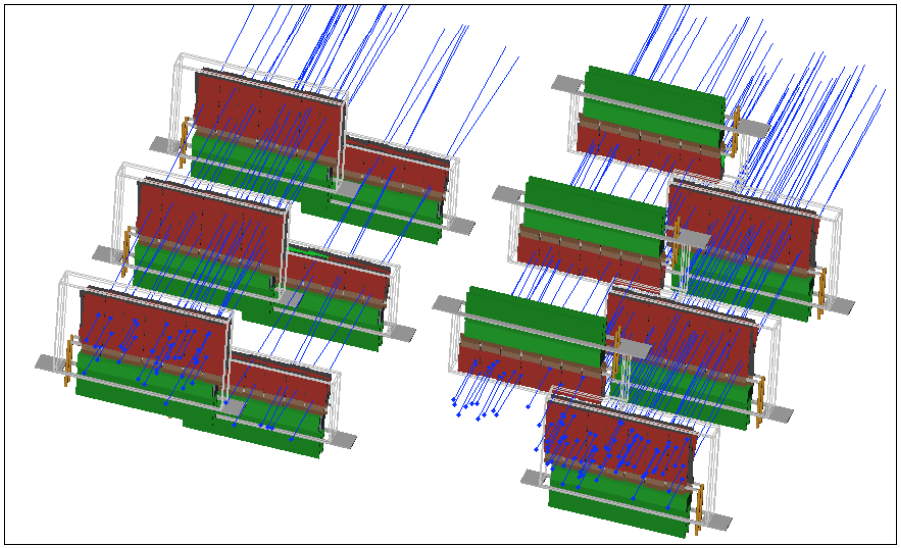
- VELO June 2009
  - Time alignment
    - to a few ns
  - Spatial alignment
    - VELO modules to 5μm
    - “stability” O(1μm) / year
    - VELO Halves to 10 μm
  - Resolution and efficiency
    - Quasi-binary for normal incidence
    - ~98% (soft tracks and tracking windows)
    - Image of the target!

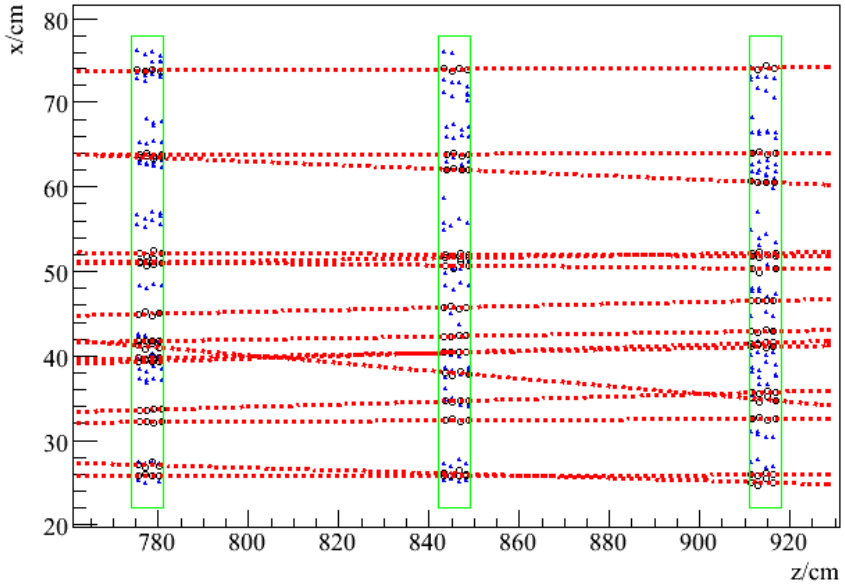




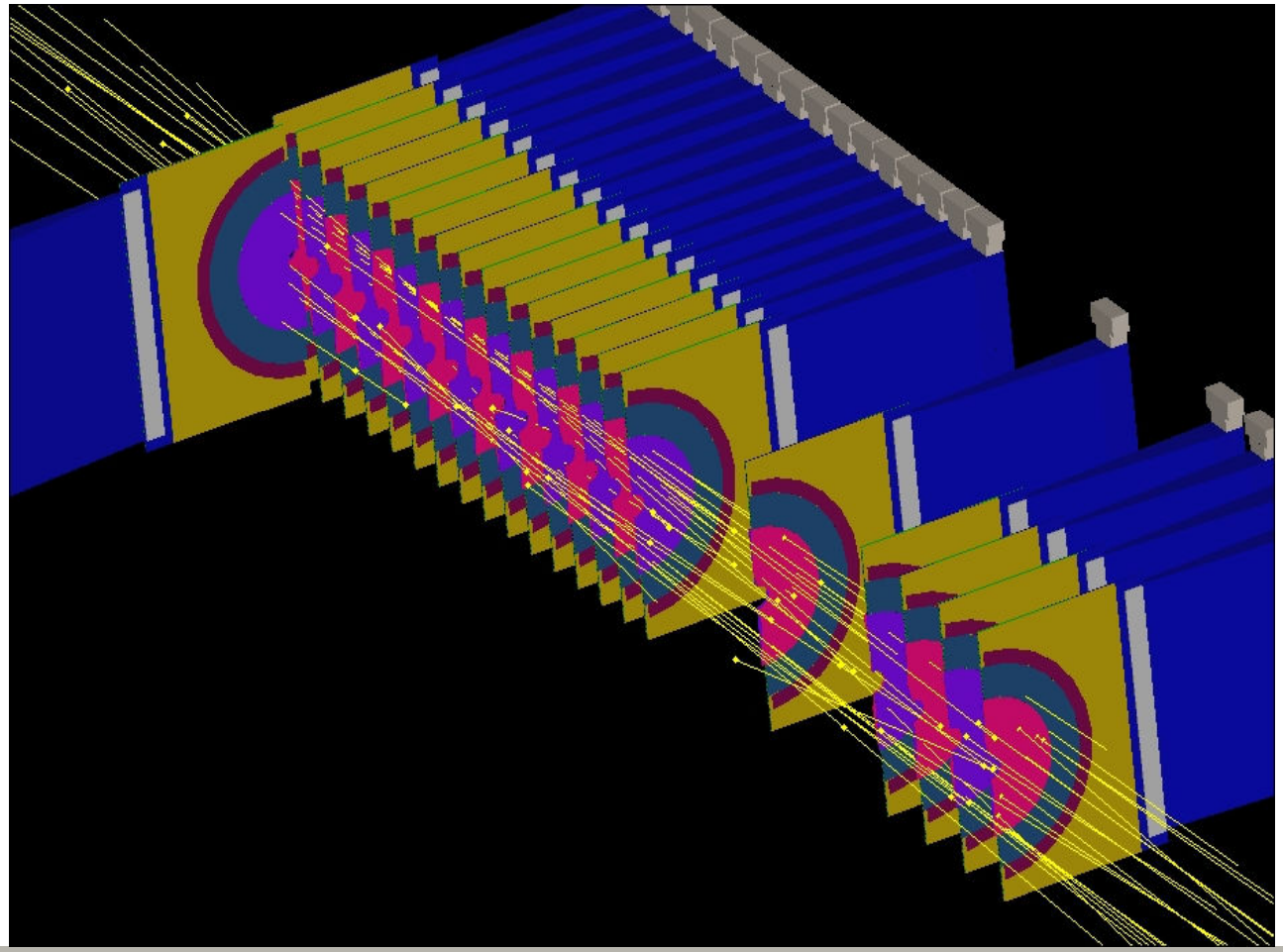
TED Run(s)2009

- For IT
  - Alignment to 15µm
  - Efficiencies O(98%)

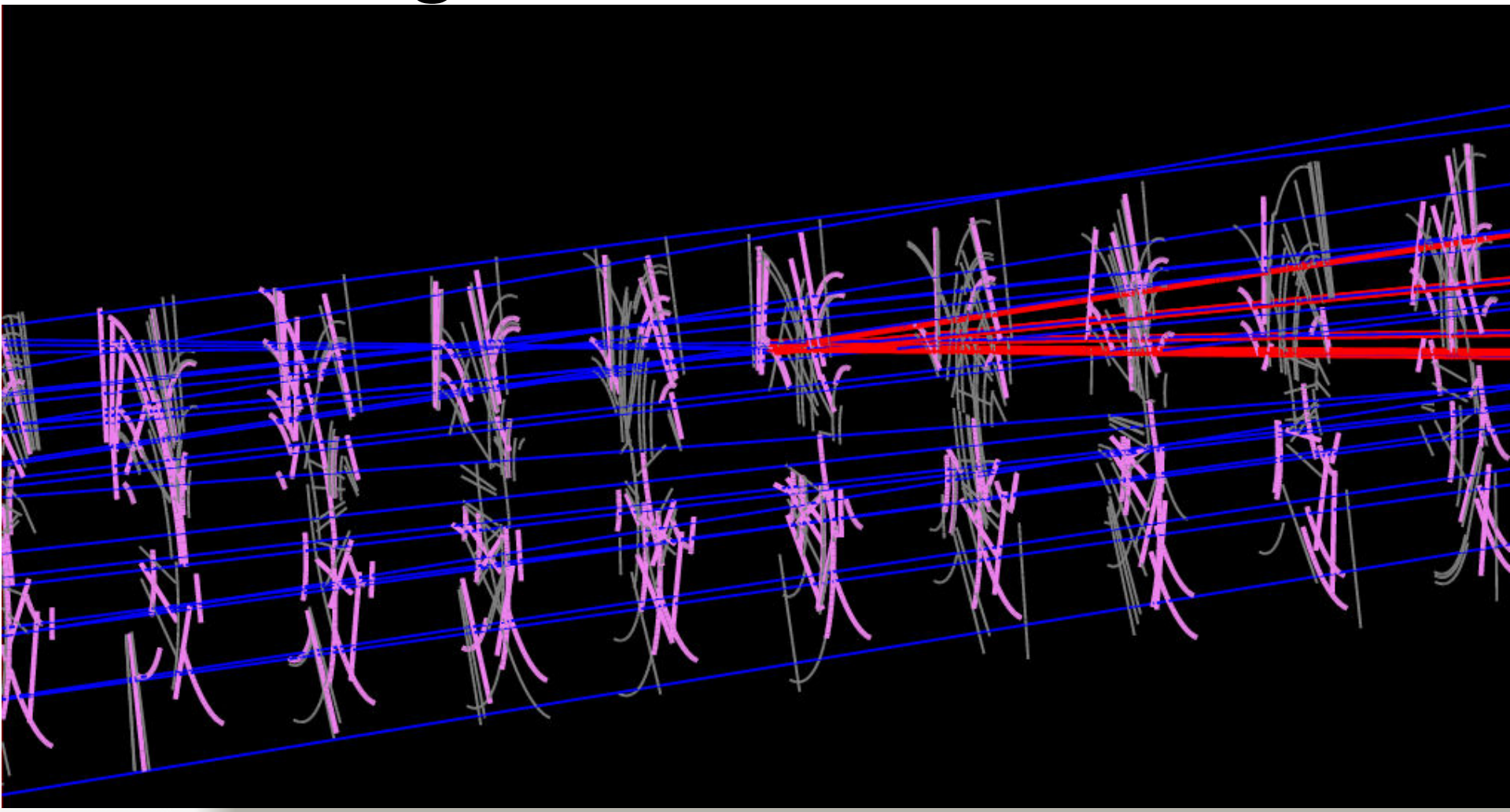




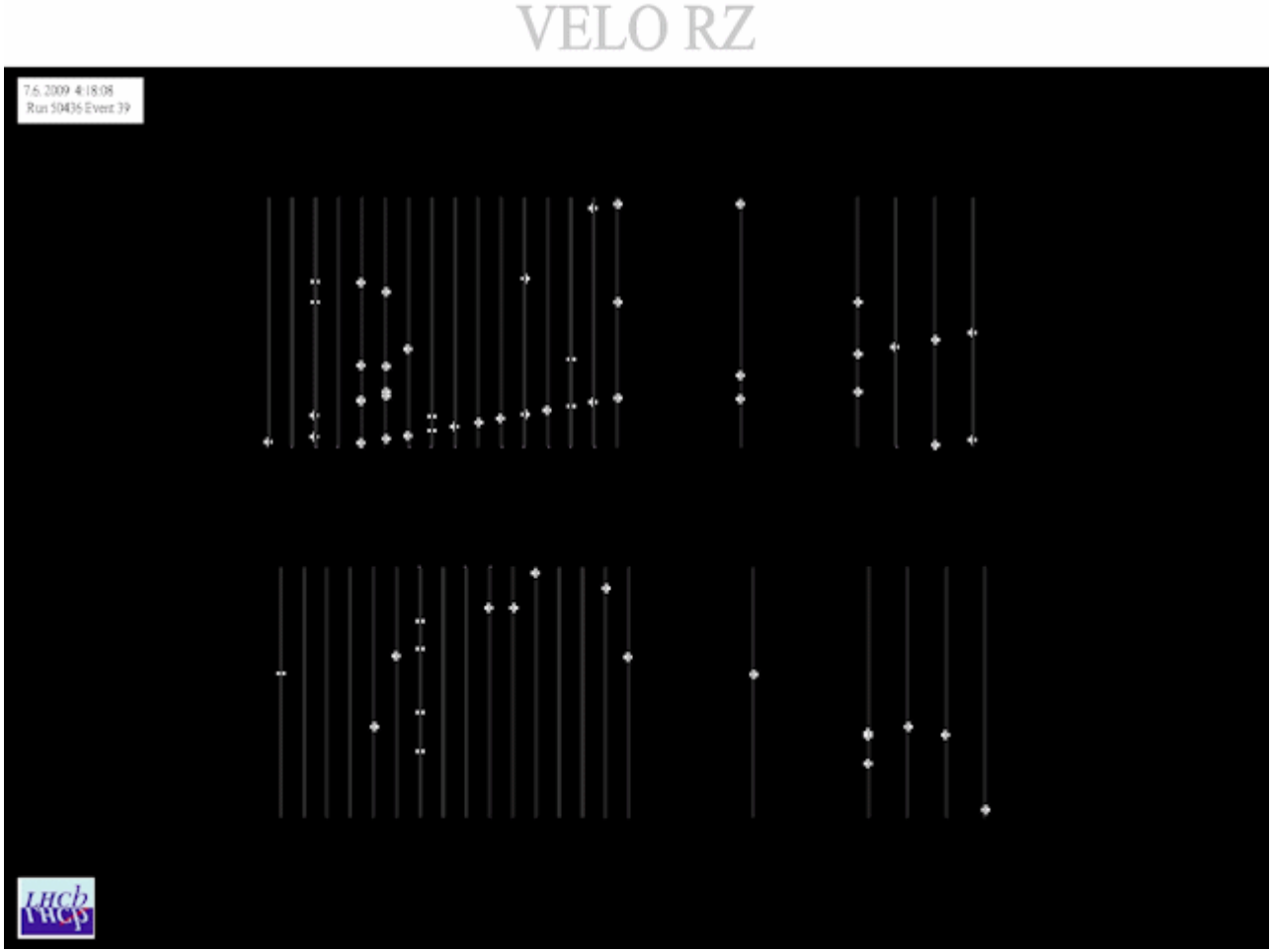
Event in VELO



Searching for vertices



A few more events…



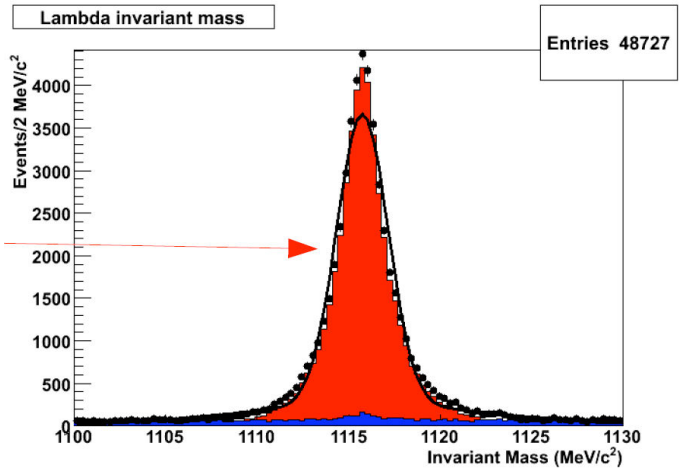
Dedicated October 2009 TED Run

- Major users VELO and IT/TT
- Run VELO in final configuration
  - Vacuum (freedom to move)
  - Cooled to -25C
  - Establish the operational fingerprint prior to data
- IT/TT continue tracking and alignment studies with larger data samples

Preparation for Physics

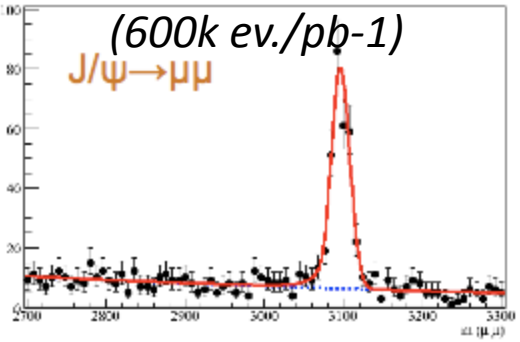
Getting Started with Collisions…

- Earliest Measurements
  - Simple (Random)Trigger
  - Calibration of tracking and PID
  - Study Key channels
    - $K_s \to \pi\pi$, $\Lambda \to p\pi$
  - Plan to analyse 10^8 events(~10hrs@2khz!)
- J/ψ
  - Trigger with single muon
  - Other muon "unbiased" for momentum, PID



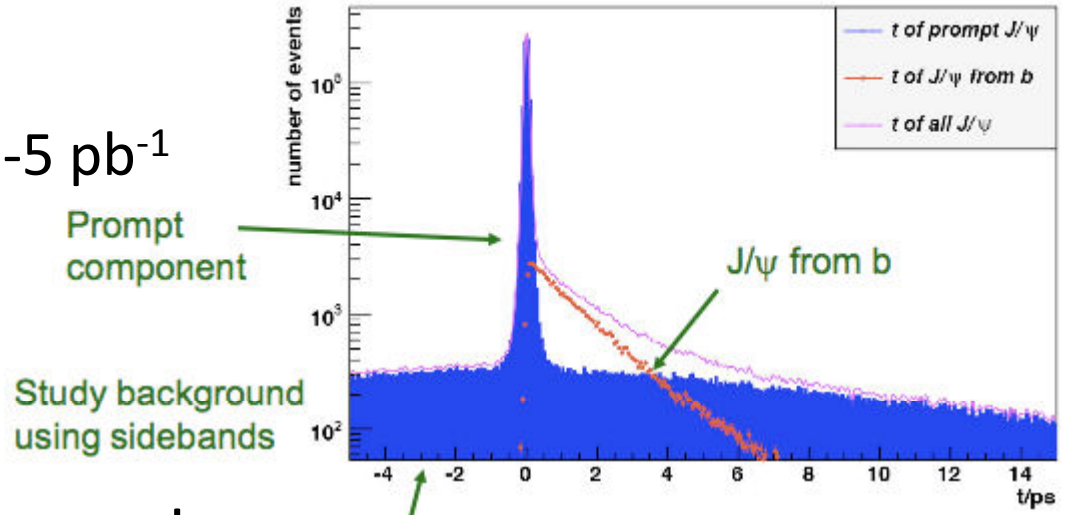
40 mins @ 10^{31}
With 2 kHz random trigger
95% purity with kinematic/vertex cuts

J/ψ signal in 19 million min bias events with L0 trigger applied (1.1s at nominal lumi)



Early Days…

- *J/ψ basics*
  - Cross-sections 1-5 pb^{-1}
    - Prompt
    - From b
    - Backgrounds
- Forward measurements
  - Ensuring the tracking and efficiencies make sense
  - Identify other SM processes e.g. W/Z



2010 – Analysis Commissioning

- Preparing for B programme
  - D→hh (rehearsal for B → hh). Separate Kπ, KK, ππ and DCS Kπ
  - B Vertex and mass resolutions
  - B Lifetimes
- Accumulate samples of B → D(Kπ)π
  - Study background environment
  - Look for any evidence of B+ / B- asymmetries

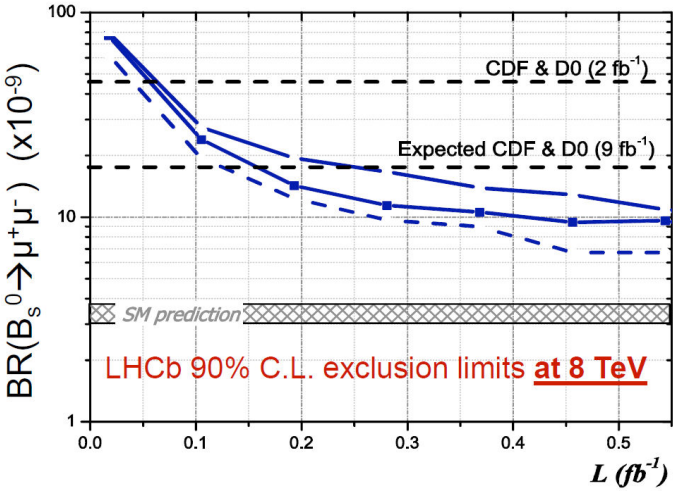
Channel	Yield / 10 pb^{-1}
$B^0 \to K\pi$	340
$B \to D(K\pi)X$	31k
$B^+ \to D(K\pi)\pi^+$	1900
$B^+ \to D(K\pi)K^+$	160
$B_s \to D_s\pi^+$	320

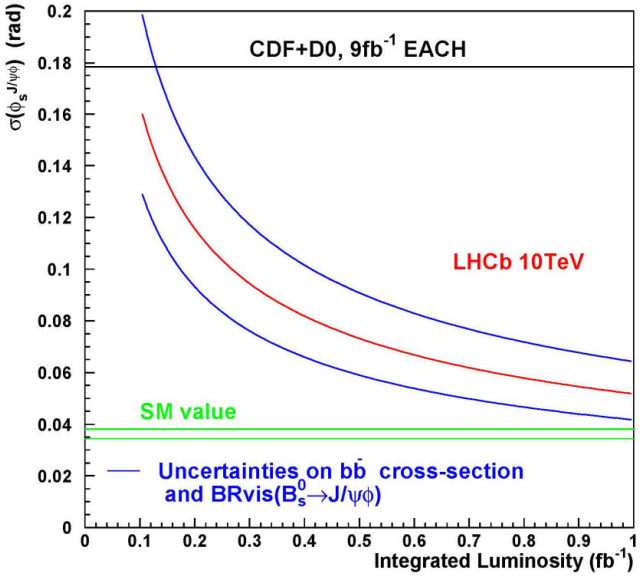
2010 – Charm Studies

- Preparation for B's
  - order of magnitude higher production cross section
    - Vertex/Lifetime
    - Modes with π^0
    - HLT performance
- Interesting in own right
  - flavour tagged D0 → KK events for measuring yCP and corresponding CP asymmetry
    - $y = \tau(D0 \rightarrow K\pi) / \tau(D0 \rightarrow KK) - 1$
- State of the art
  - LHCb can collect ~ 10^5 flavour tagged KK events with 20 pb^{-1} (same statisticsas BELLE with 0.5ab-1).

B Physics 2010

- With data sample of ~200 pb^{-1}
  - Bs → μμ
    - Improve Tevatron sensitivity for Bs → μμ
  - Φs
    - 'central' value from Tevatron would confirmed at 5σ level





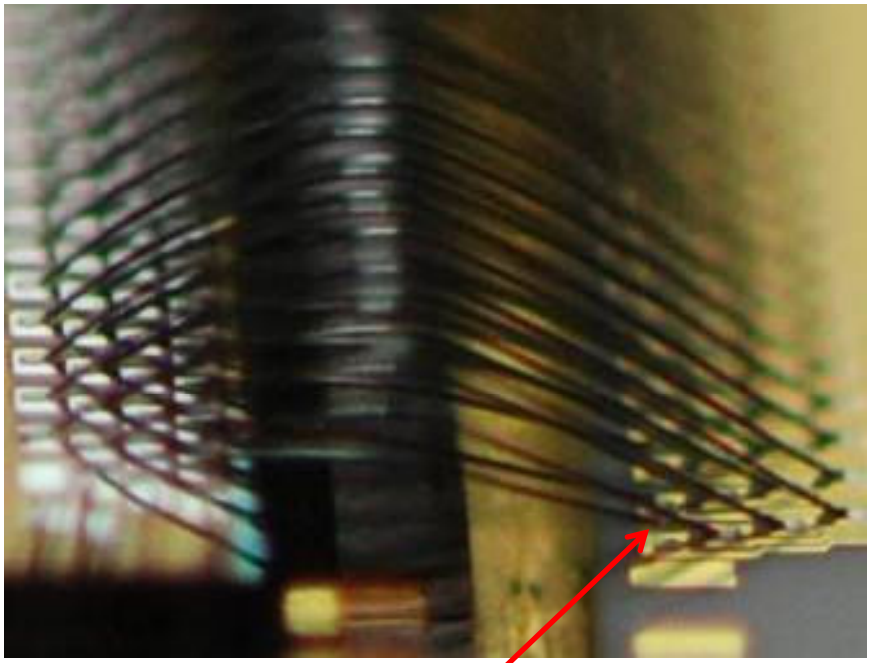
Summary

- LHCb Detector Ready for Physics
- Software Tools Ready for real data analysis
  - LHCb welcomes maximum possible integrated luminosity, even at 'low' energy !
    - as long as E_b>2 TeV – we need to close VELO)
- LHCb Physicists Ready!

Backup

TT broken bonds

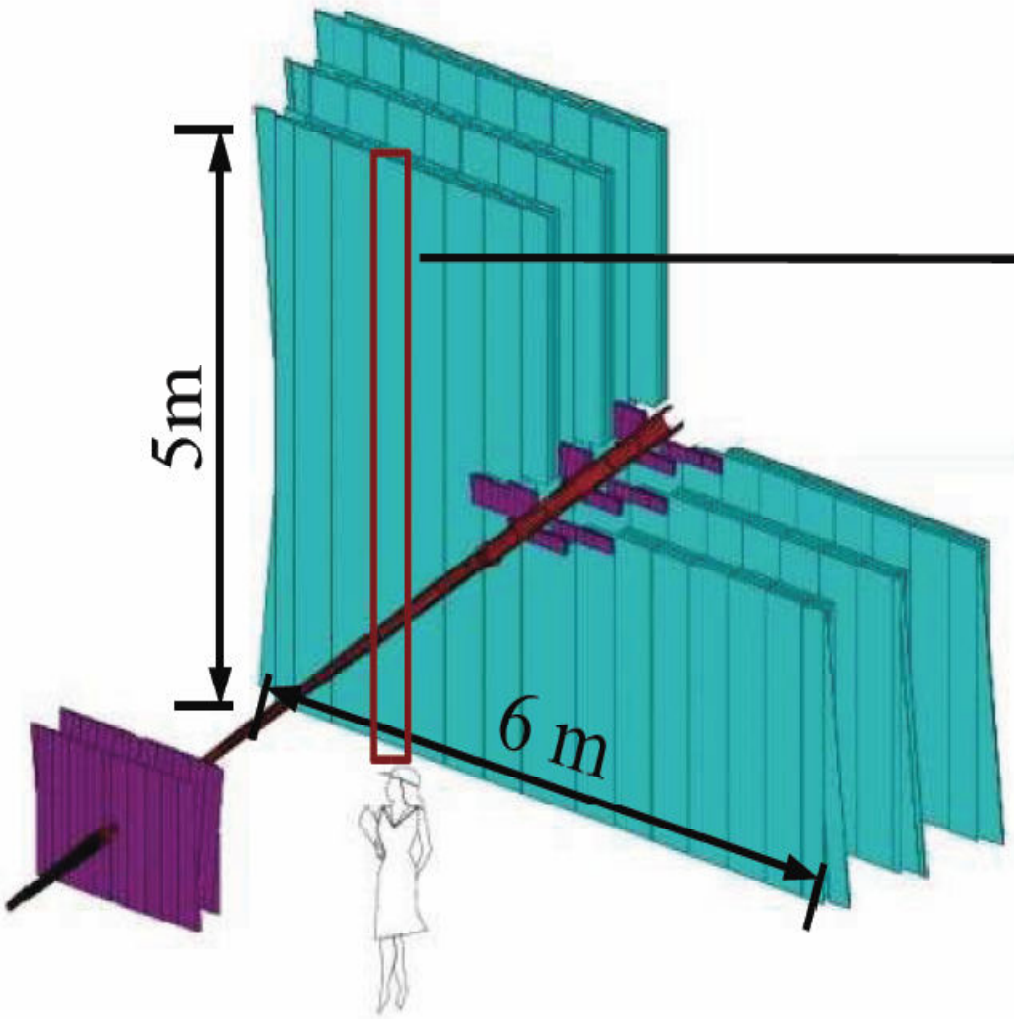
- A few modules (7)
  - Wire bonds “unzip”
  - 6 modules replaced
- Ingredients needed to explain breaking:
  - Initial crack, and/or
  - Low loop height, and
  - Stress on the wire (e.g. thermal cycling, vibrations)
- Gluing doesn’t seem to help
- Replacement possible when problem understood

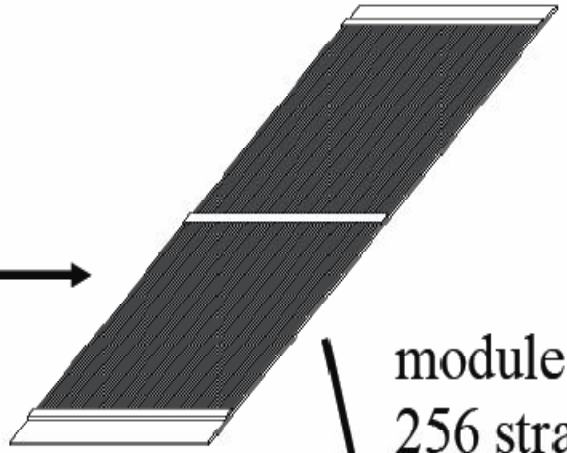


Example

Straw Outer Tracker

55000 Straws





module:
256 straws