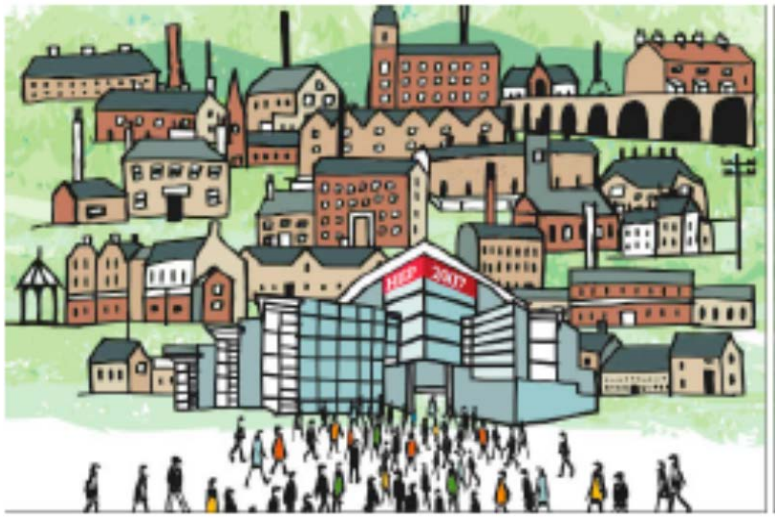
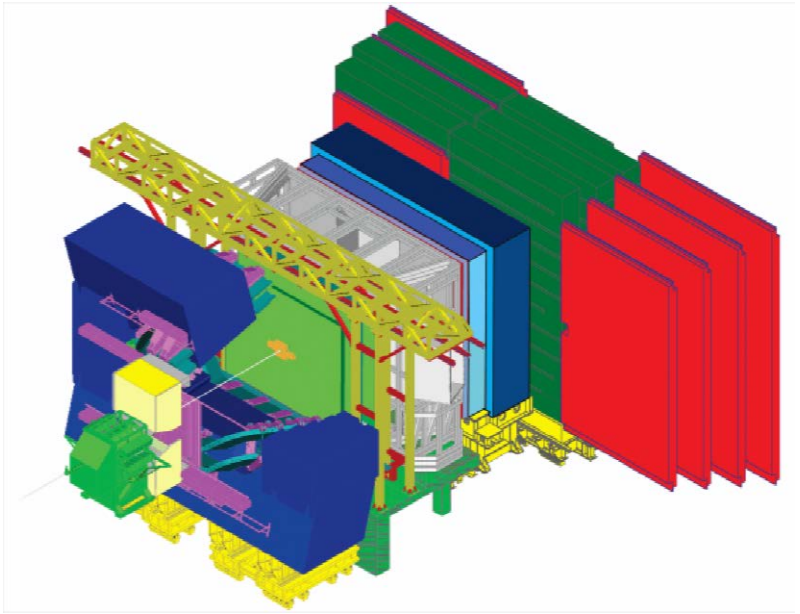


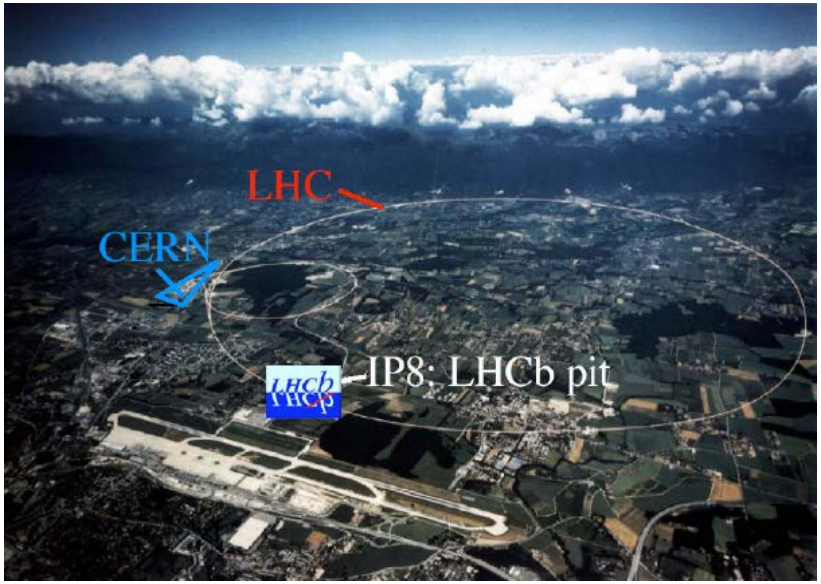


# Status of the LHCb Detector

On behalf of the LHCb Collaboration
Frédéric Machefert

# Introduction

- **LHCb is the dedicated B physics experiment at the LHC devoted to the precision study of CP violation and rare decays**
- **The collaboration includes 48 institutes from 14 countries and more than 600 members**
- **The purpose of LHCb is**
  - Extend B physics results obtained in B-factories and the Tevatron
  - Search for new physics in a complementary way to ATLAS/CMS
- **LHCb will benefit from**
  - A large bb cross-section in the forward region
    - At $L=2\times10^{32}/cm^2s$, $10^{12}$ B hadrons in $10^7$s
  - B hadrons are both likely to be in the forward accept
  - B have a momentum ~ 50 GeV
    - Good decay time resolution
    - Good background rejection

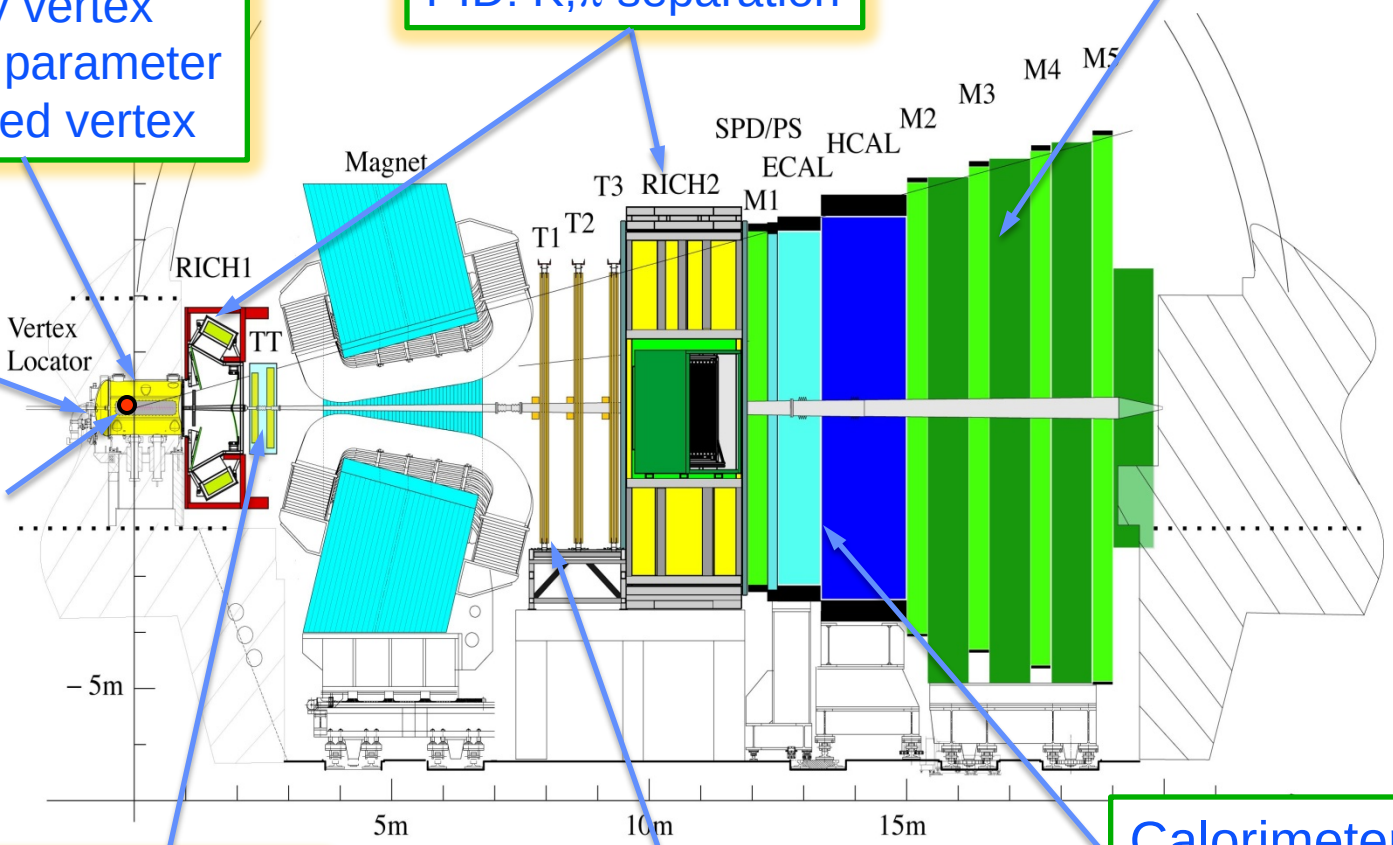


# The Infrastructures and the Beam Pipe

- **Cavern/Surface Infrastructures are almost finished**
  - Platforms, walls, balcony
  - Gas extraction / distribution
  - Cooling distribution for detectors is being done in parallel with detector installation
  - Safety equipments are in operation
  - Radiation measurements in operation
  - Radiation Shield should be closed in September
  - Still some work at the surface

- **Beam Pipe**
  - The four sections (3 in Beryllium and the last one in Z in stainless steel) are
    - Installed, interconnected, pumped down and baked out
  - Is now filled of neon (back to atmospheric pressure) to preserve the quality of the tube after bake out

# The LHCb detector




VELO:
primary vertex
impact parameter
displaced vertex

RICHES:
PID: K,π separation

Muon System

PileUp System

**Interaction region**

Trigger Tracker: p
for trigger and $K_s$ reco

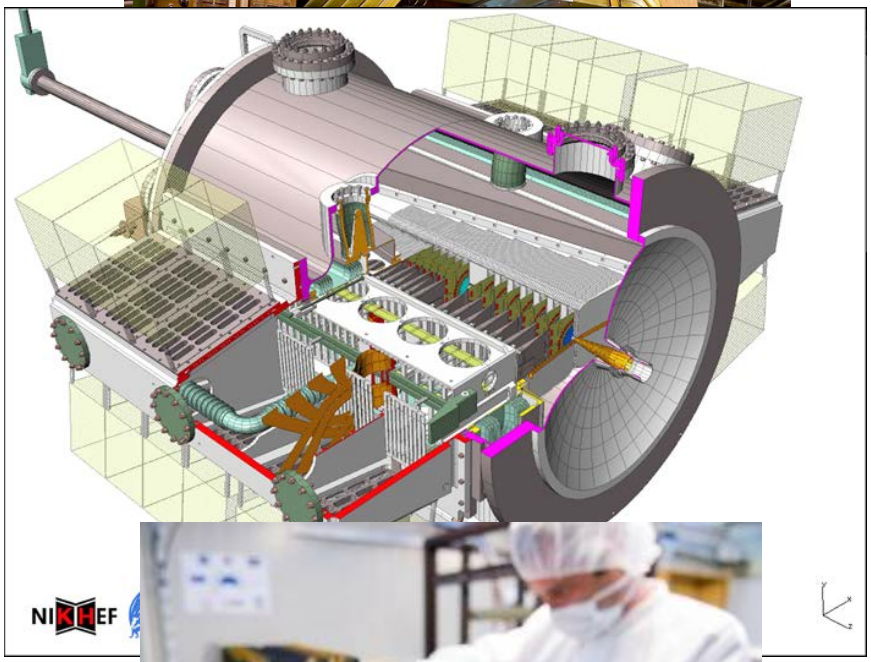
Tracking Stations:
p of charged particles

Calorimeters:
PID: e,γ, $\pi^0$

# The Tracking System : Magnet and VELO

- **The LHCb magnet**
  - is installed since 2004
  - Has reached its nominal field in November'04

- **The Vertex locator**
  - is made of 21 stations (Silicon modules)
    - R and $\phi$ layers each
    - Strip pitch from 40 to 100$\mu$m
  - Two retractable halves for injection
  - Approach the beam down to 8mm

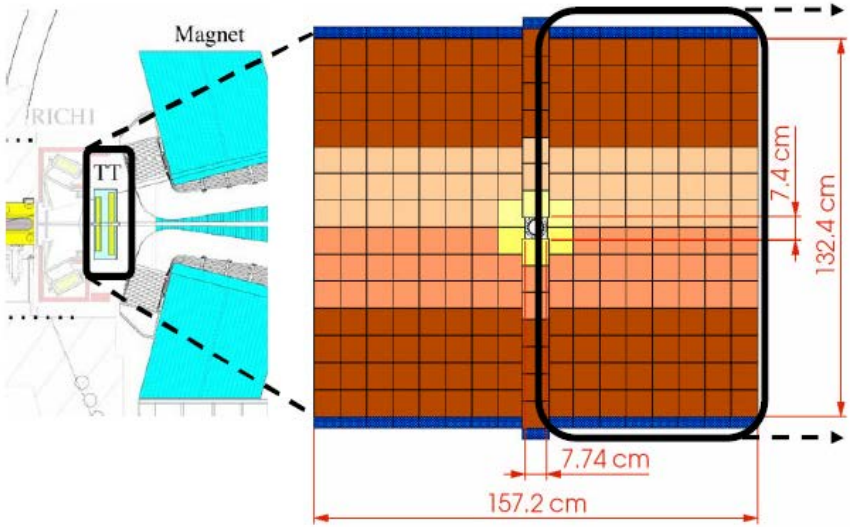



- Cabling of the detector is well advanced
- Cooling system is about to be installed and commissioned
- Movement tests have been done and show a good positioning reproducibility
- Left/Right side have electronically tested
- TFC and DAQ are installed
- Next main step is to perform a DAQ acquisition of a slice of the detector using the full data path

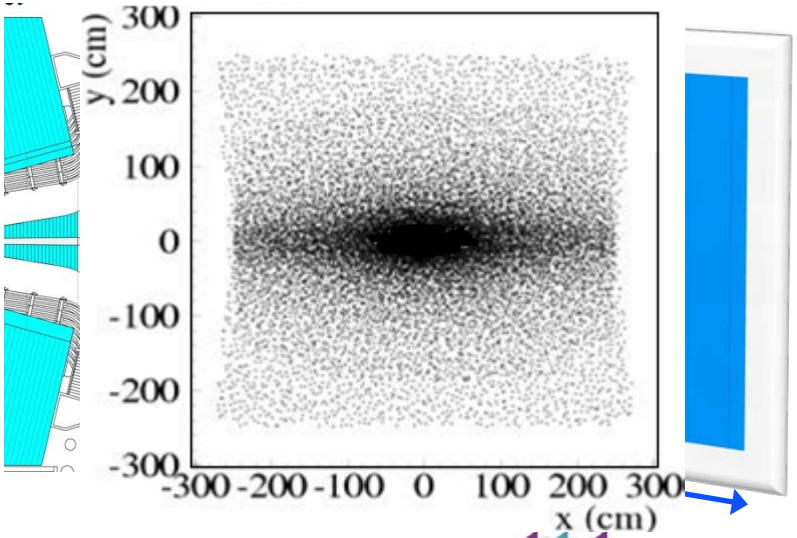
# The Tracking System : Trigger and Inner Trackers

- **Apart from the vertex locator (VELO), LHCb has three main tracking detectors**

- **The Trigger Tracker**
  - 2 double layers
    - 1 layer with stereo strips
  - Silicon microstrip sensors
    - ~200μm readout pitch
  - Sensor module production is finished
  - Installation is in progress
  - Cabling and cooling well advanced

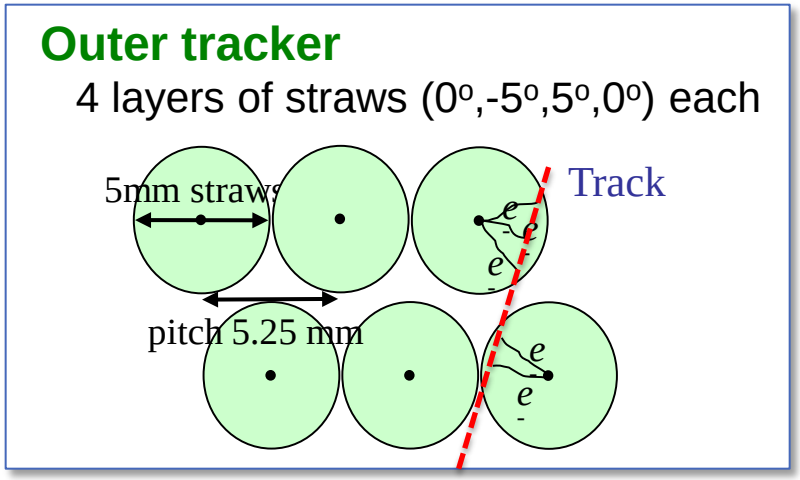


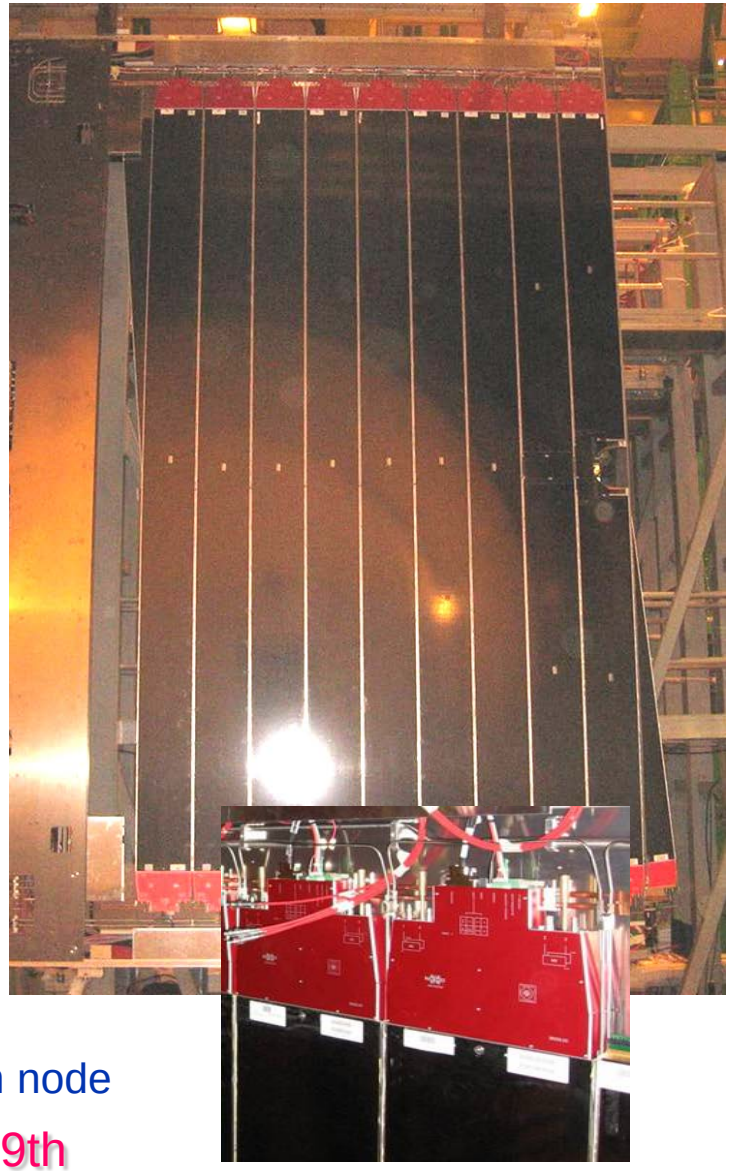

- **Inner tracker**
  - 4 layer Silicon detector
  - Inner region of the T1, T2 and T3 chambers
    - 2% of the area
    - 20% of the tracks
- Work on services is going on
  - Cables, cooling
- Will be followed by final box installation



# Outer Tracker

- **4 double layers**
  - Kapton and Aluminium Straws



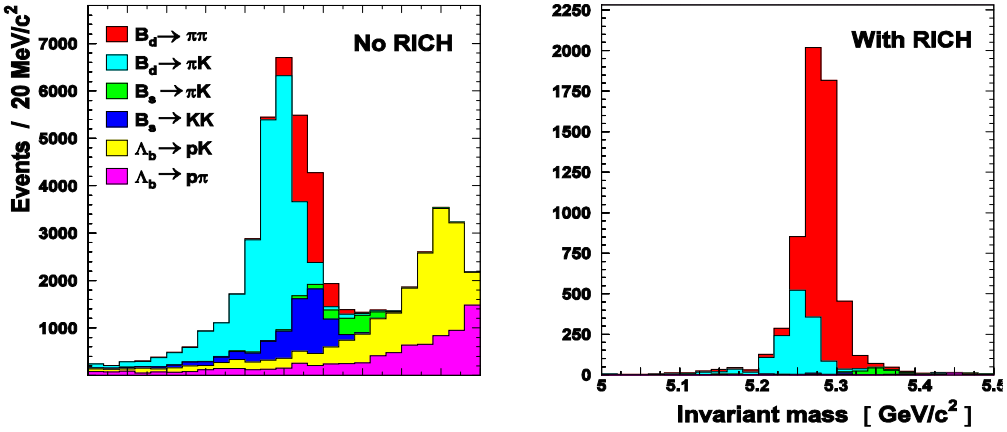
- The modules and the frames have been installed
- Front-end electronics is being installed in the frames
- Services are installed
- Cooling has been commissioned
- Final gas system will be commissioned in August or September

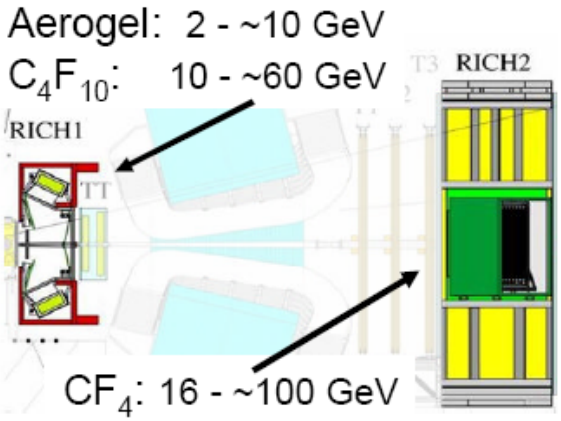
- Entire and final readout chain has been tested on a farm node

See presentation by H. Terrier on Thursday 19th

# RICH1 and RICH2

- **Cerenkov detectors based on the HPD technology**
  - 3 medium for good K/π separation up to 100GeV



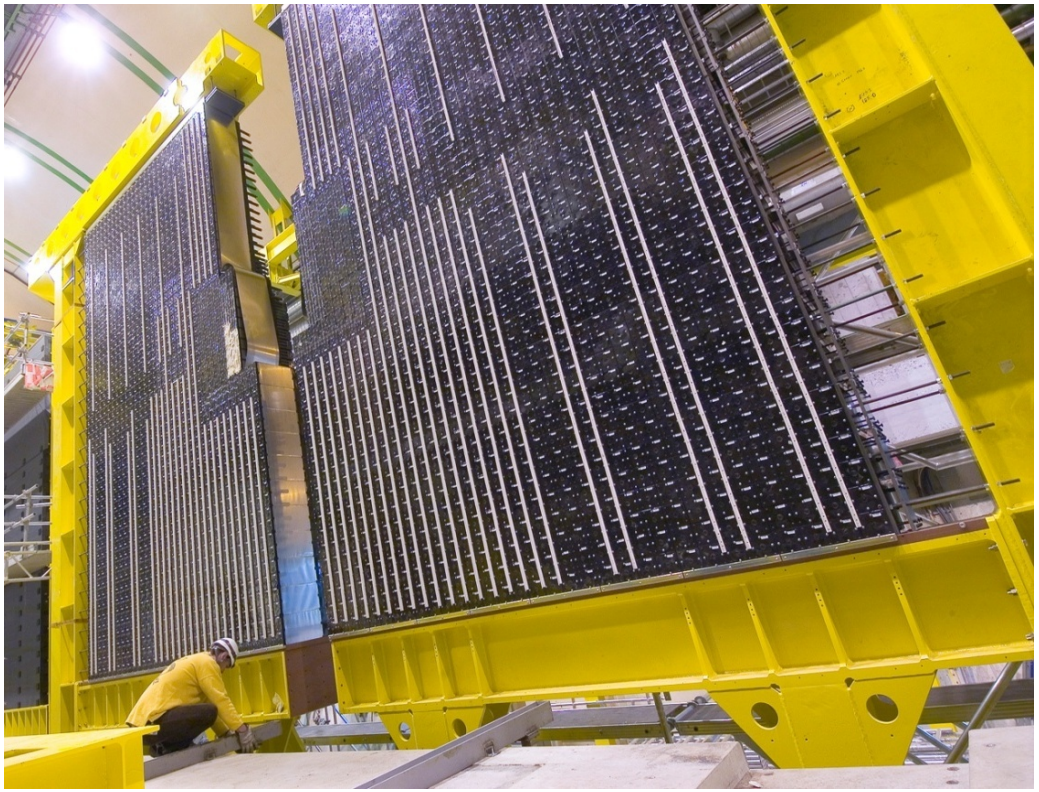



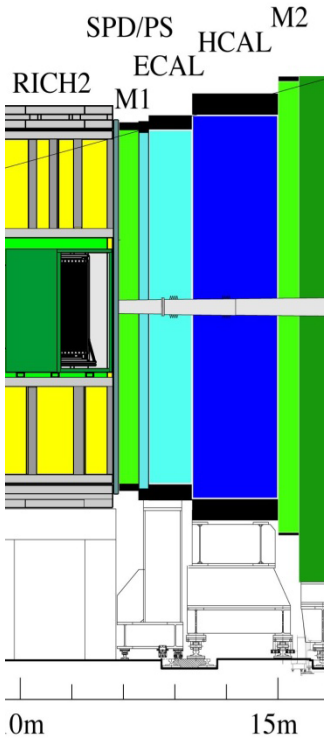

- All the HPDs have been delivered and qualified
- RICH 1
  - structure has been tested (leak)
  - Mirror alignment is underway
- RICH 2
  - In the commissioning phase (all columns/boxes installed)
  - Readout performed with pulsed

See presentation by U. Kerzel on Friday 20th

# The Calorimeter System

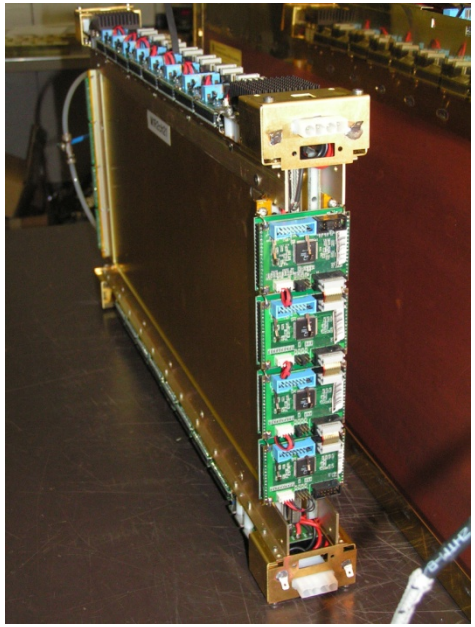
- **The calorimeter system is made of 4 sub-detectors**
  - SPD/PRS (Pb/Scintillator)
  - ECAL/HCAL
    - Pb/Scintillator shashlik and Fe/Scintillator tiles



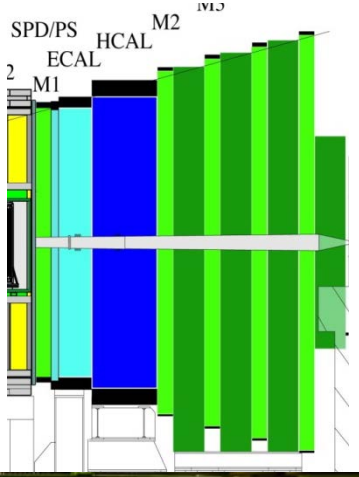


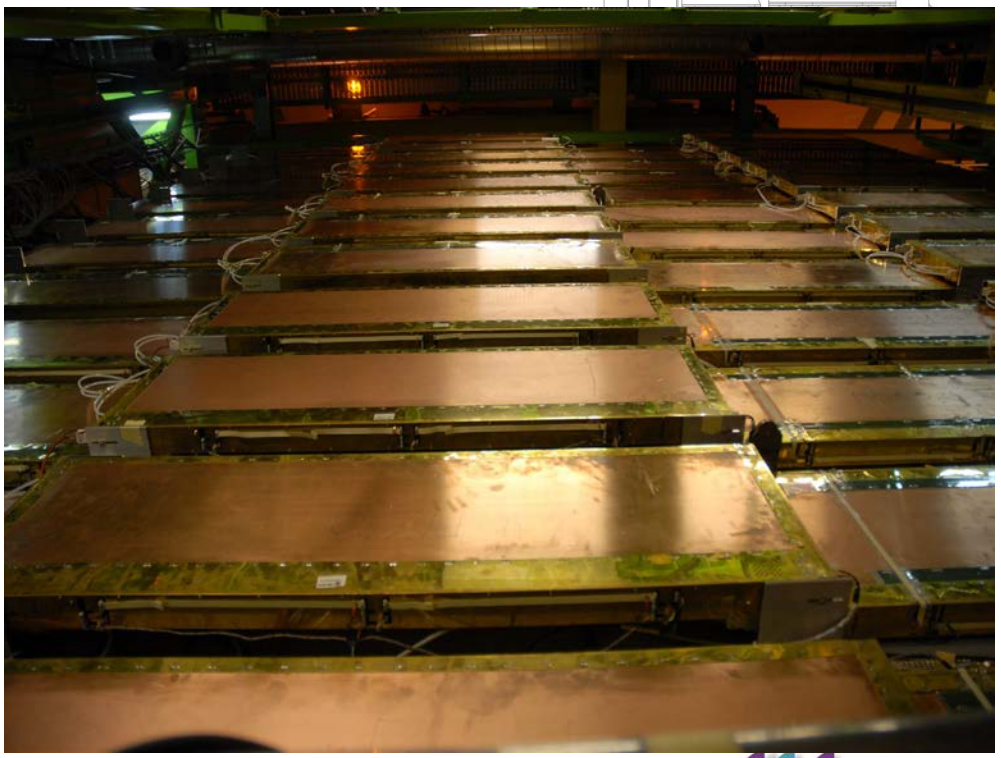

- All the modules have been installed
- Front-end is being installed/tested
  - Mostly done for ECAL/HCAL
- Cabling and cooling well advanced
- Commissioning phase started

# Muon System : Chamber Status



- **1368 MWPCs**
  - M2-M5 chambers (4 detection layers) and outer M1 (2 layers) region
- **24 3-GEMs**
  - In the central region of M1

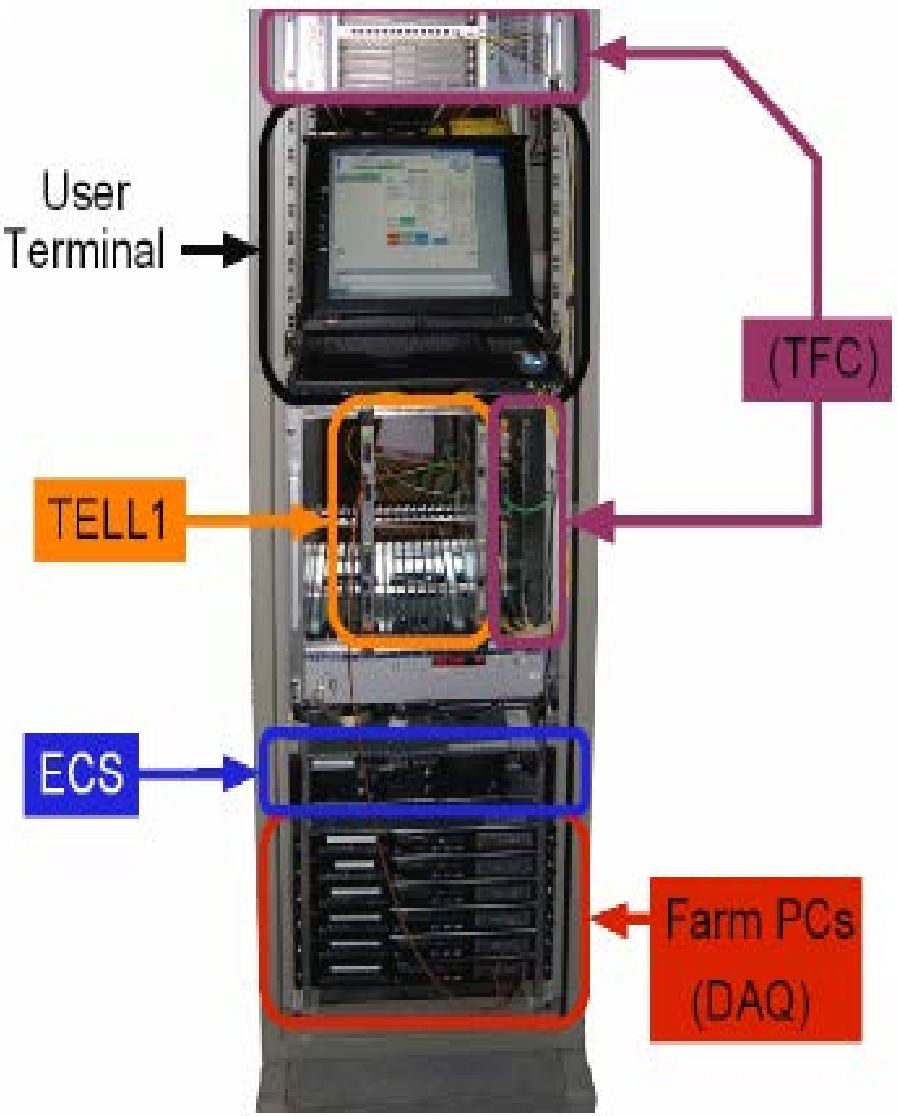


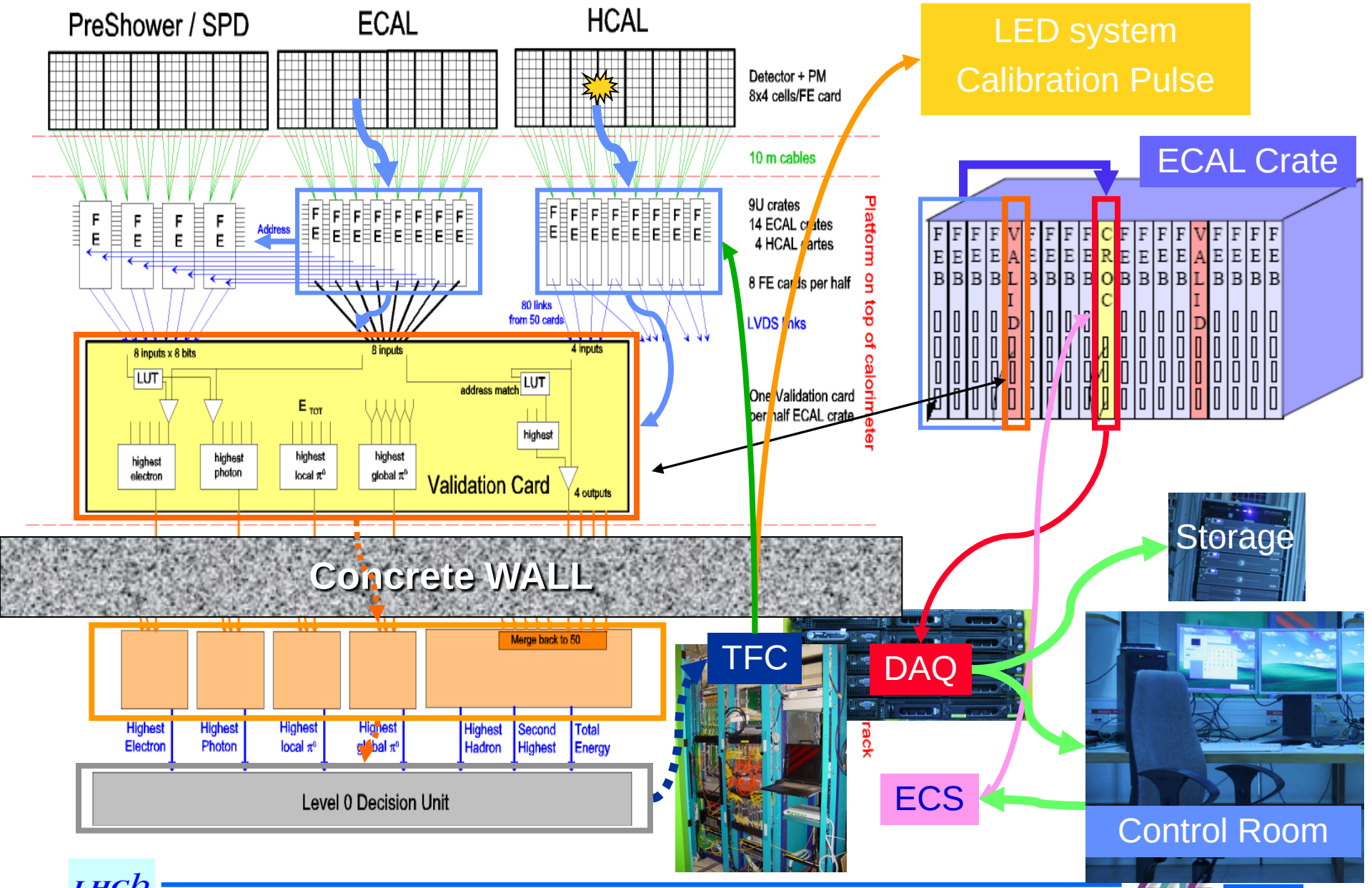
- 3-GEM detector parts are ready
  - Chamber dressing is done
  - Installation planned in Autumn
- M2-M5 chambers mostly installed, tested and pre-aligned
- M1 chamber was a bit delayed
  - Work should completed by march 2008

# Commissioning Strategy

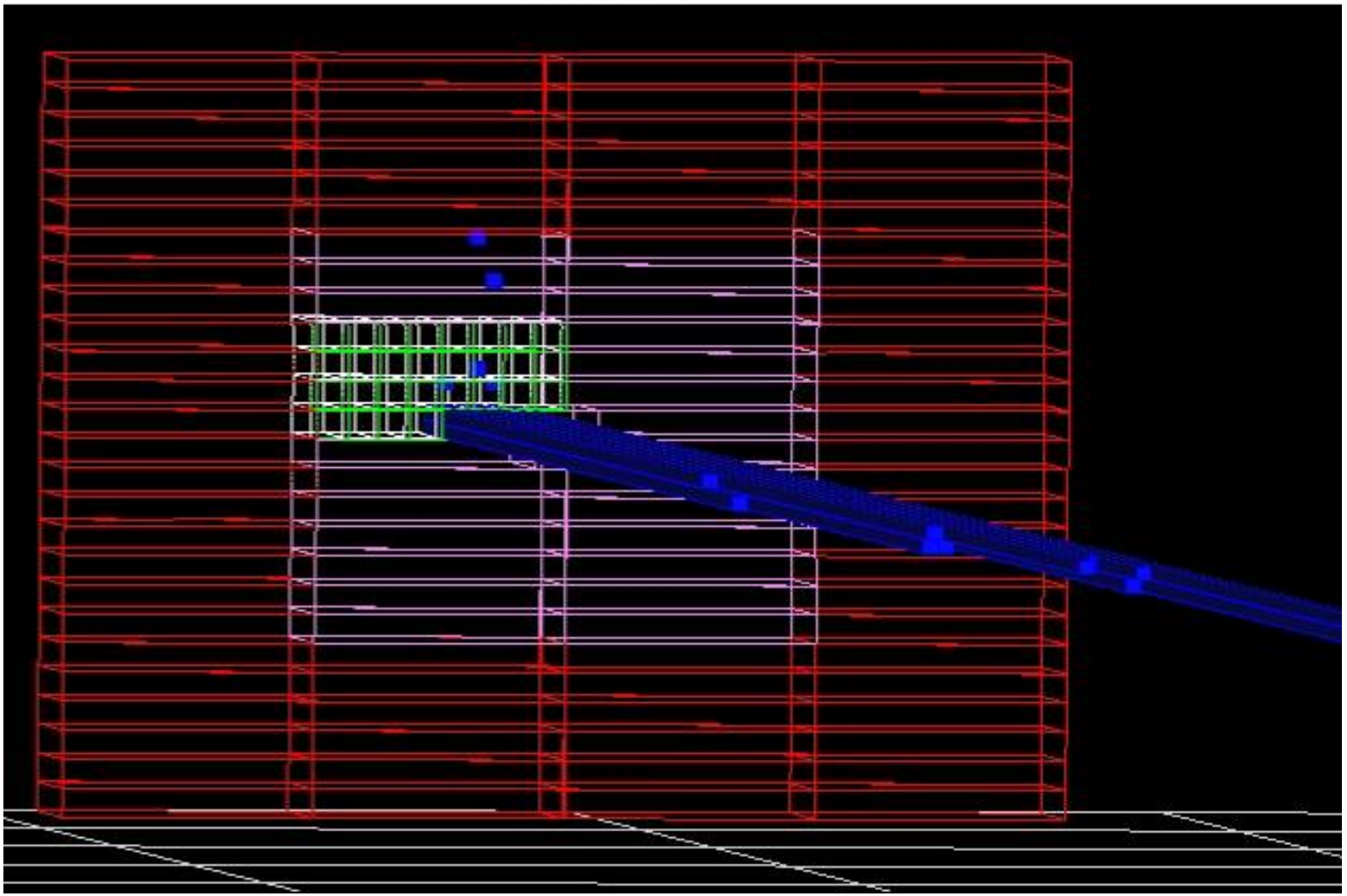
- **Commissioning started this year**
  - each detector independently
    - Was done in parallel
  - Controls
  - Safety
  - Front-end to DAQ
  - Calibration systems
- **Use of cosmics is envisaged**
  - LHCb geometry is not adequate
  - Still we may think of
    - Tuning the relative timing between
      - ECAL/SPD/PRS/HCAL
      - Tracking (T1-T1-T2)
      - Muon chambers
- **Particles are required to complete the commissioning of the detector**



# HCAL/ECAL/L0Trigger Commissioning Test



# Commissioning : up to the event display



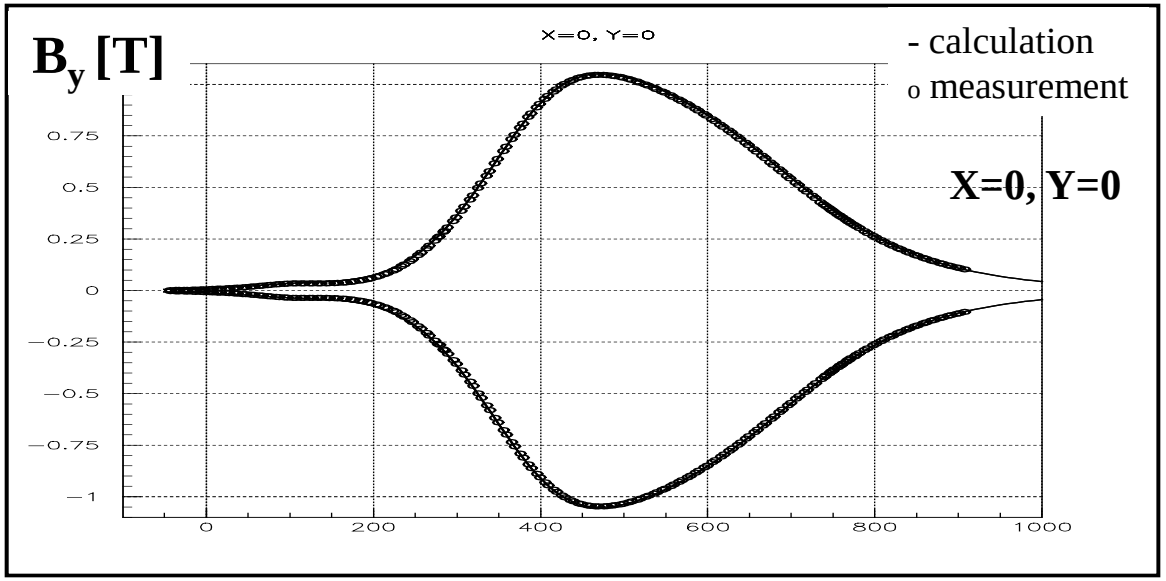
# Time and Space alignment with Beam

- **Reasonable initial delay will be defined**
  - during commissioning tests (using test pulses for most of the detectors)
    - We may expect an accuracy of a few ns
  - But we also need to correlate the sub-detectors
- **HCAL as the first trigger system**
  - The L0 trigger will select any event with activity in the HCAL
  - The TFC system will be in a specific mode
    - Acquisition of 5 consecutive events, 2 before and 2 after
  - Delays have to be adjusted to minimize the amount of spill-over/optimize the signal
- **Tracking is the first element to be aligned with beam**
  - Tracking system position is surveyed
    - Alignment is measured at the ~ 0.5mm level (~0.3mm for VELO box)
      - Particles will be used to improve the knowledge on the position of the detectors
- **The first collisions will be done without magnetic field**
  - Energy is obtained from the calorimeter
- **Calorimeter and muon have been positioned (installation) with ~1mm precision**
  - Use electrons and hadrons for calorimeters and muons for muon system

# Momentum and Energy Calibration

- **Momentum**
  - Momentum resolution sensitive to B-field inhomogeneities/misalignement
    - Field map for both polarities has been measured in 2005
      - Uncertainty < 0.03% (negligeable effect on the momentum)

- **B-field polarity will be regularly flipped during data taking**
  - Reproducibility within measurement accuracy
  - Mass resolution will give a cross-check : $K_s$, $J/\psi$

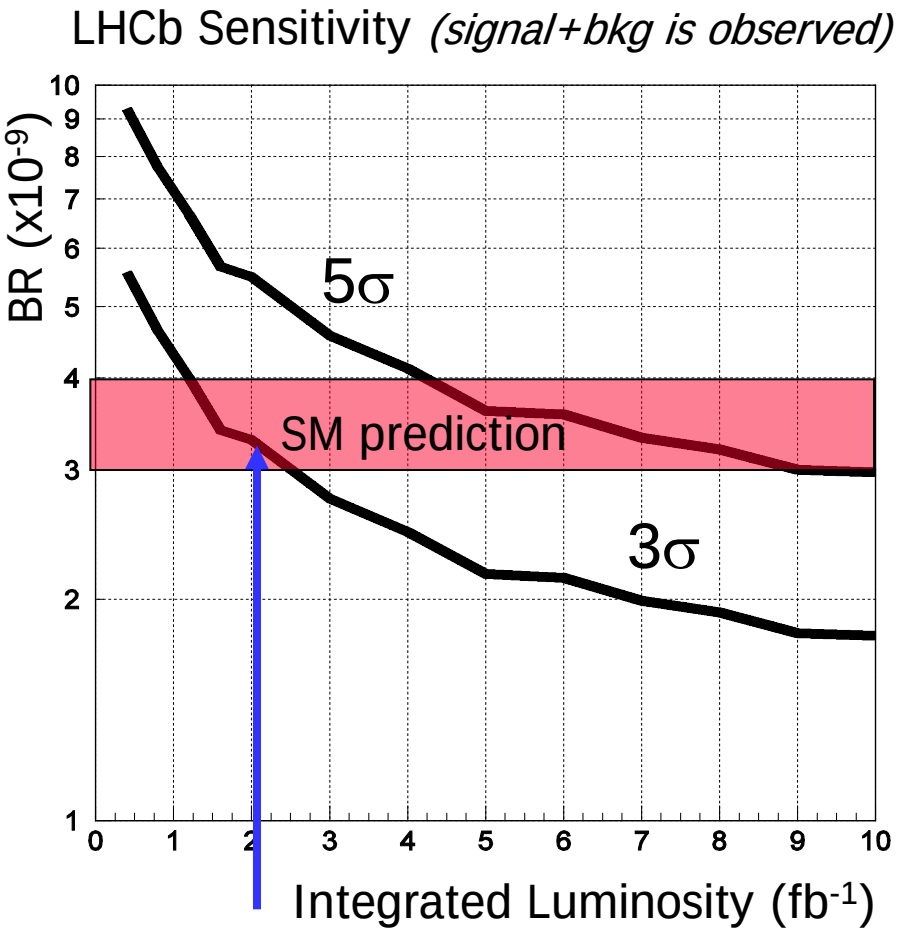



- **ECAL energy**
  - Cosmics allowed to reach 10% calibration
  - Energy flow methods should provide a few %
  - Iterative methods being developped to reach better than 1% level
    - Resolved pi0 mass reconstruction (calibration runs of O(10 minutes) for all areas)

# Physics Preparation : First Data

- **J/ψ production**
- **sin(2β) with $B^0 \rightarrow J/\psi\ Ks$**
- **$\phi_s$ and $\Delta\Gamma_s$ with $B_s \rightarrow J/\psi\ \phi$**
- **$B_s \rightarrow \mu\ \mu$**
  - SM Branching ratio may be highly enhanced (SUSY) : BR(SM)~$3.5 \times 10^{-9}$
  - LHCb should be able to set limits down to $1 \times 10^{-8}$ with less than 0.2 $fb^{-1}$

See presentation by S. Eisenhardt Friday 20th




**With $L=2fb^{-1}$**

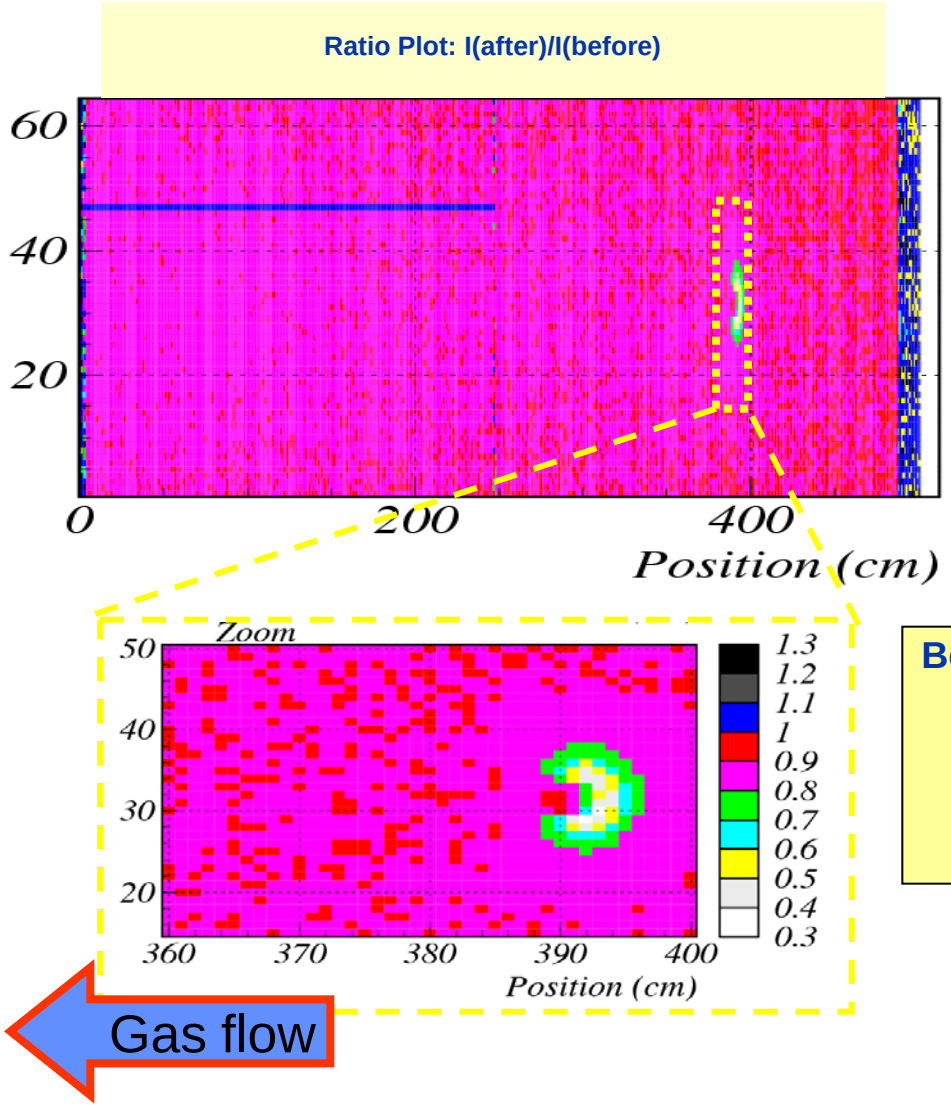
**$3\sigma$ observation if at SM value**

# Conclusion

- **Installation of detectors, services and DAQ system are getting close to completion**
- **Detector commissioning is ongoing**
  - Either in parallel with commissioning dedicated systems
  - Or using the full LHCb ECS/DAQ standard systems at the pit
- **LHCb will be ready**
  - To collect data with its full detector at LHC start-up in 2008
  - To exploit the large B meson cross-section at LHC
- **LHCb will be ready to discover new physics signals !**
  - With an excellent mass, decay-time resolution and particle identification
  - With a flexible and robust trigger dedicated to B physics

# Backup Slides

# Outer Tracker Aging




- **Problem was a gain loss in the neighbourhood of the irradiation point**
  - This was in fact NOT due to the accumulated dose
  - Out gassing of the Araldite

**Beneficial effects:**

- Flushing
- HV Training
- Heating

**In situ heating procedure of the modules is under study**