Status of the LHCb Experiment

Rolf Lindner
CERN, Geneva, Switzerland
On behalf of the LHCb Collaboration

Introduction

47 institutes in 16 countries are participating in the LHCb project
> 600 collaborators

The aim of the **LHCb** experiment is to

- **study CP violation in B decays** through the precise determination of the CKM parameters
- **search for rare B-decays**

By over-constraining the Unitarity Triangle, inconsistency in this measurements would constitute an important hint to **new physics beyond the Standard Model**.

Introduction

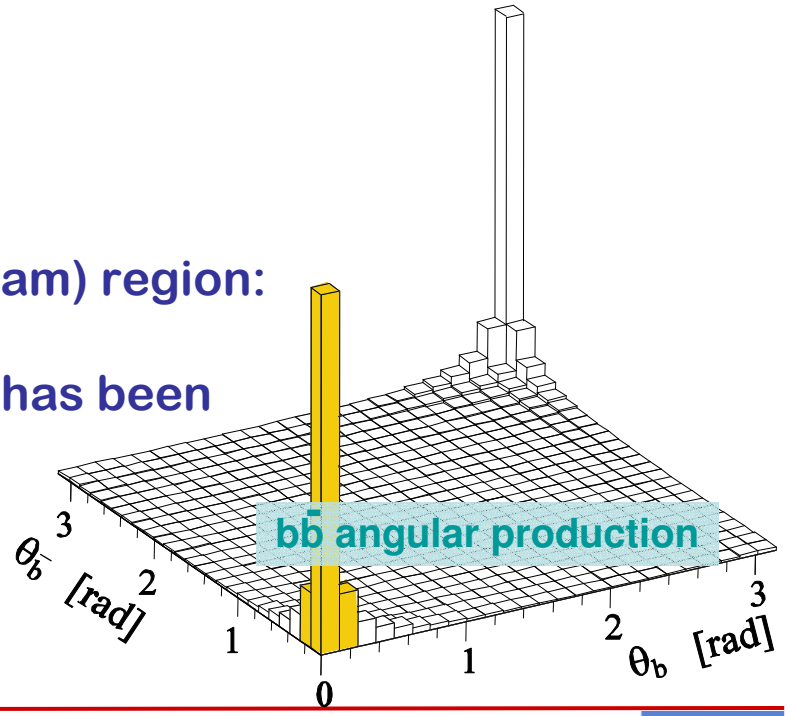
- LHC startup in summer 2007
  - pp collisions at $\sqrt{s}$ = 14 TeV, f=40 MHz.

- At LHCb, beams are less focused
  to run at a luminosity of $2 * 10^{32} cm^{-2s-1}$ and
  therefore with mostly single interaction.

- ~100k $b\bar{b}$/sec are expected and
  all b-hadron species are produced:
  B^0, B^+, B_s, B_c, b-baryons.

- B-Hadrons are produced in the forward (beam) region:

  A single arm forward spectrometer has been chosen which covers
  12 mrad<θ< 300mrad(1,9<η<4,9)

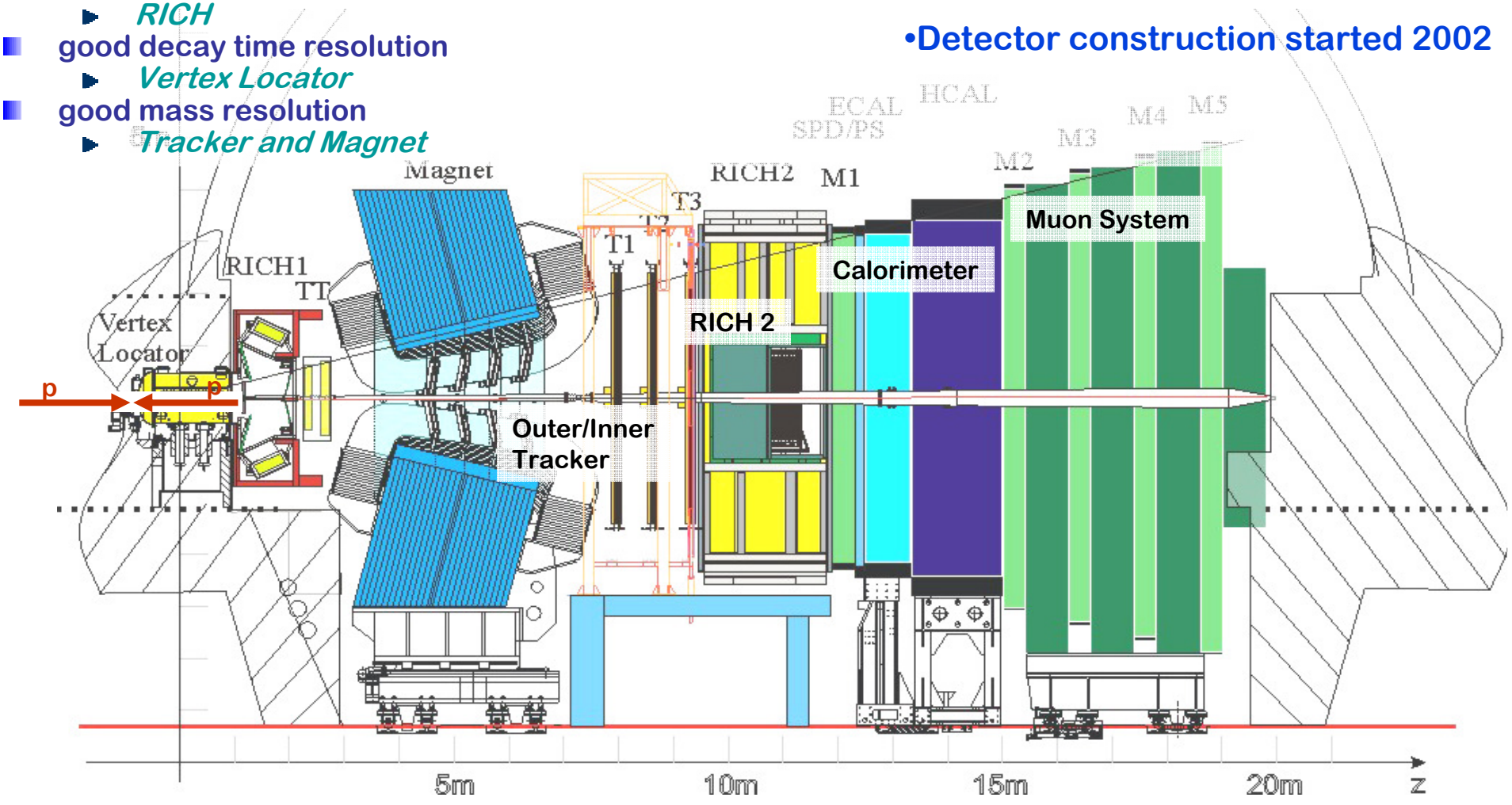


DETECTOR STATUS

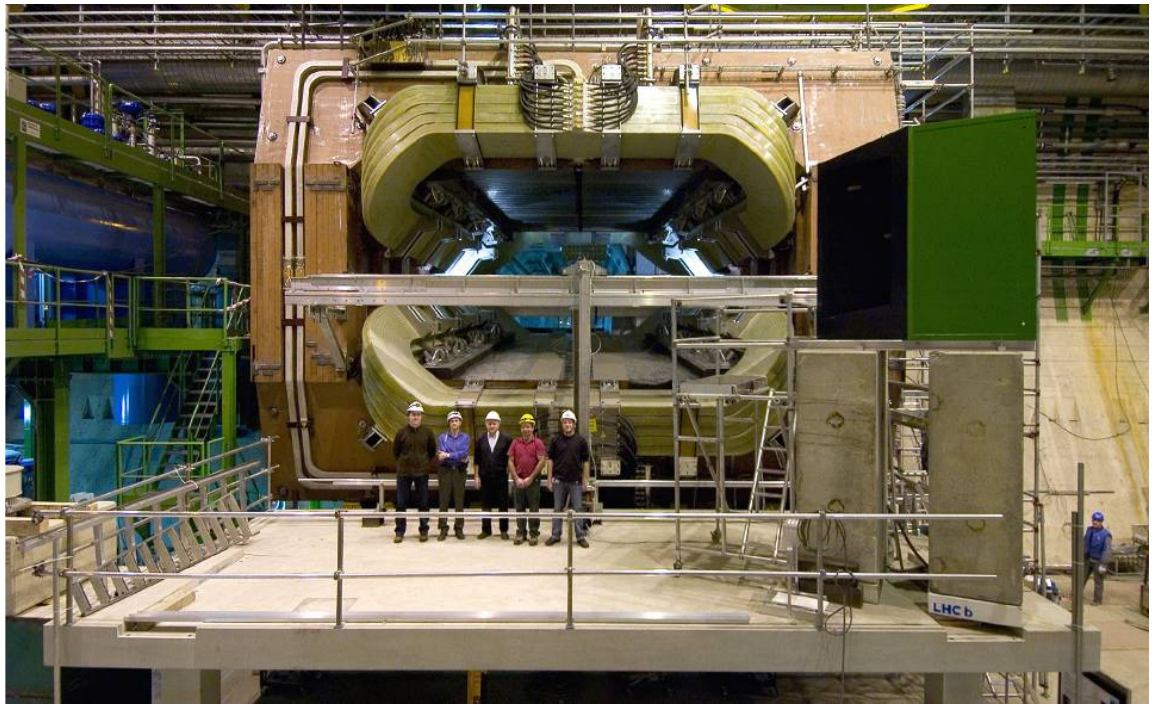
To reach the given targets the detector has to meet the following requirements:

- efficient trigger for many B decay topologies
  - *Muon System, ECAL+Preshower , HCAL, Vertex Locator, Trigger Tracker*
- efficient particle identification
  - *RICH*
- good decay time resolution
  - *Vertex Locator*
- good mass resolution
  - *Tracker and Magnet*

•Detector construction started 2002



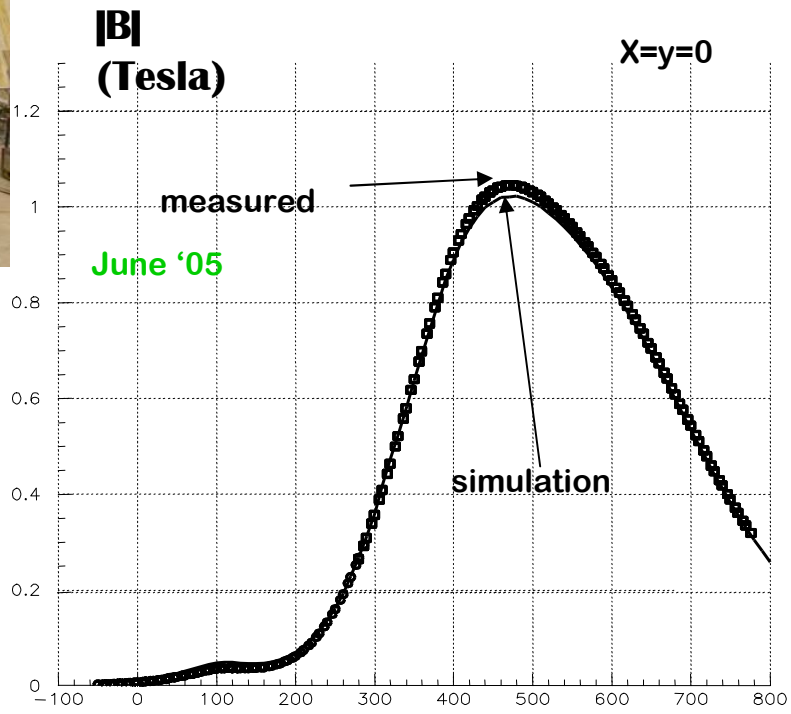
Dipole Magnet



Warm Al conductor
4 Tm integrated field
Weight = 1600 tons
Consumption 4.2 MW

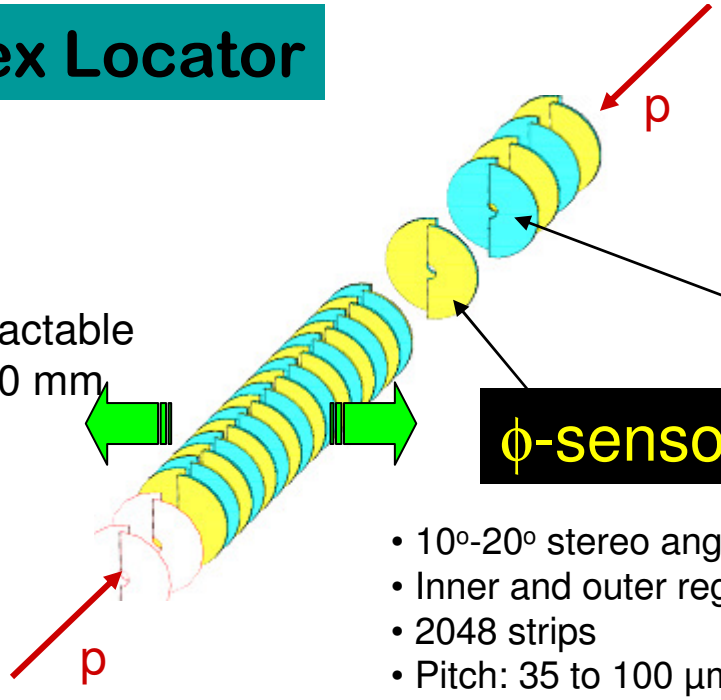
Completed and followed by commissioning in Nov 2004
First field measurements have shown agreement with simulation

Final Field measurements: November 2005



Vertex Locator

- 21 stations
- Each station measures R and Phi
- Left-Right staggered in Z to allow for overlap

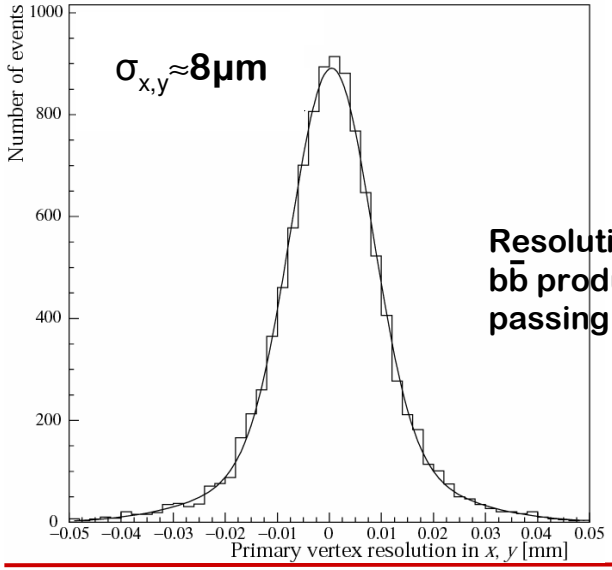


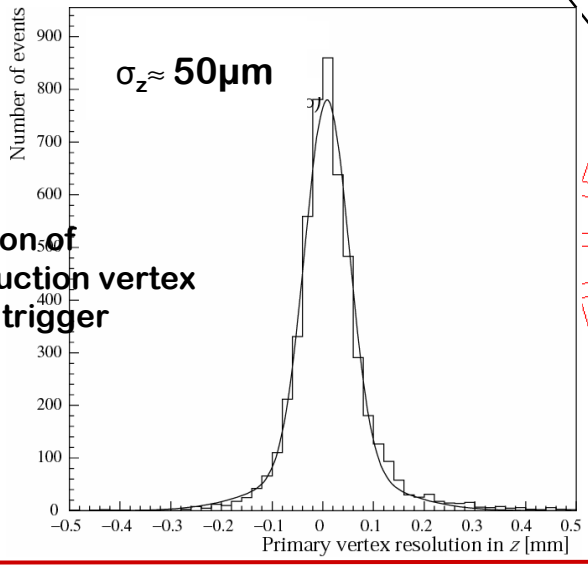
ϕ-sensors

- 10°-20° stereo angle
- Inner and outer region
- 2048 strips
- Pitch: 35 to 100 µm

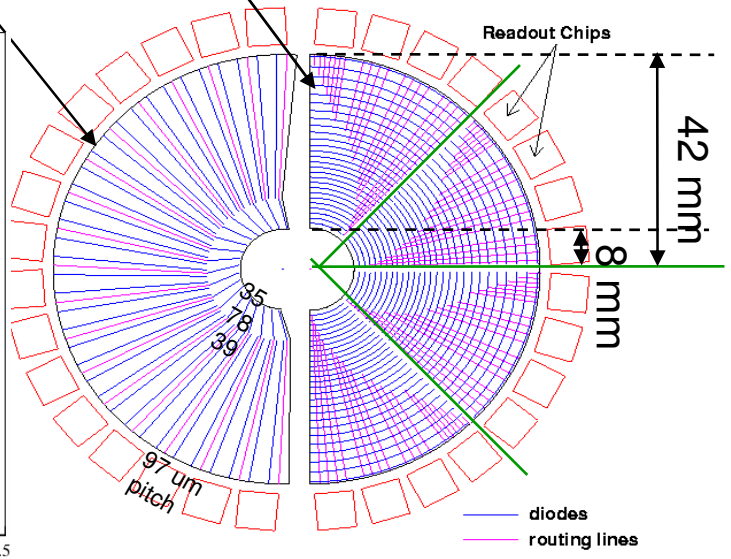
***r*-sensors**

- 4x45° sectors
- 2048 strips
- Pitch: 40 to 100 µm

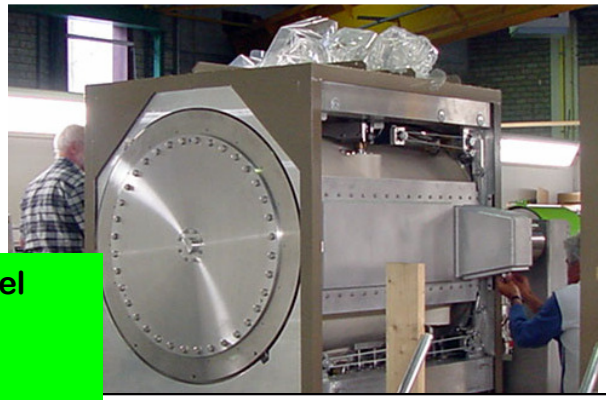




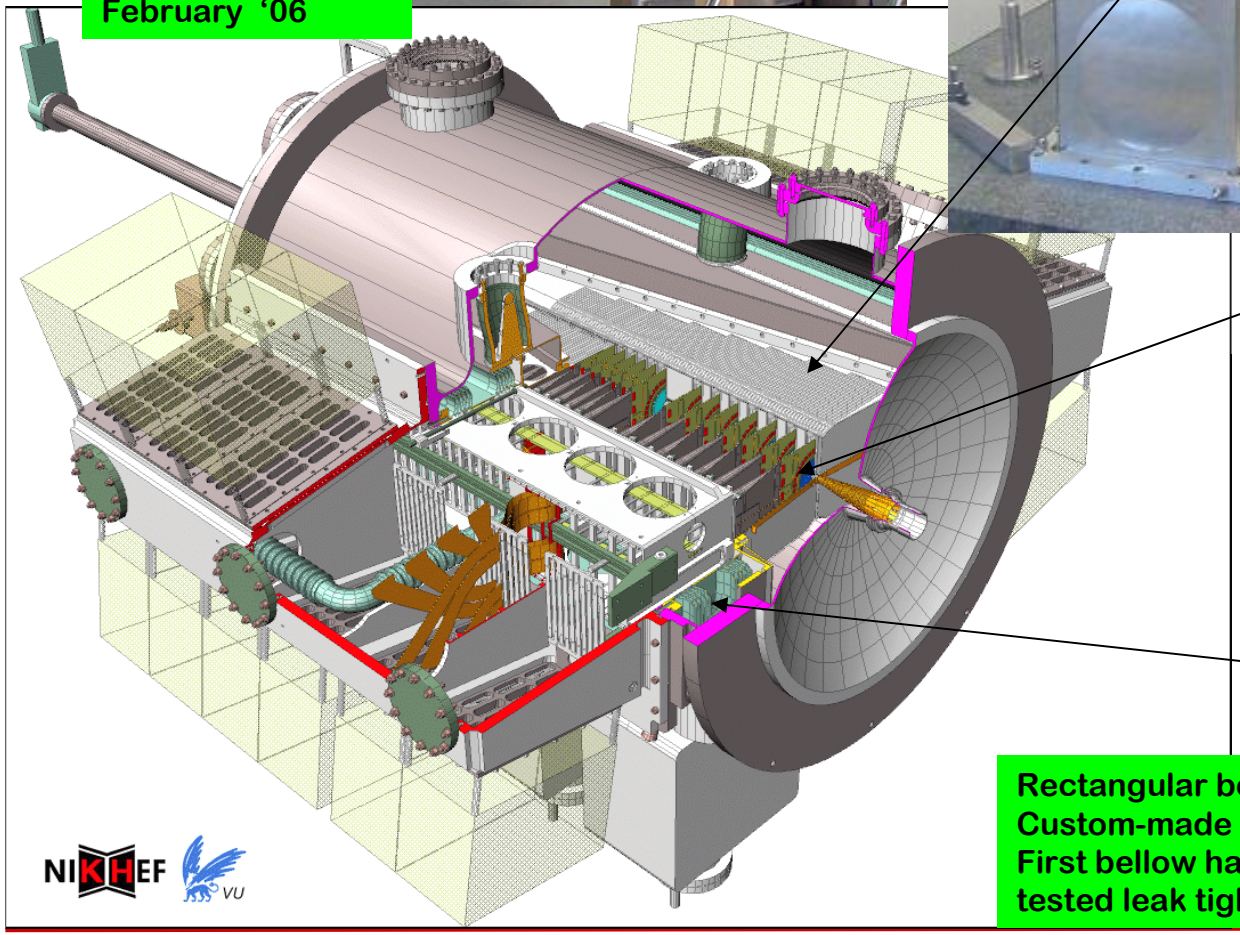
Resolution of
$b\bar{b}$ production vertex
passing trigger



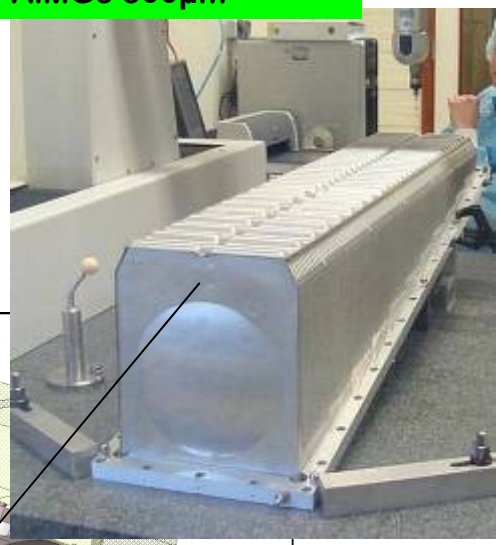
Vertex Locator



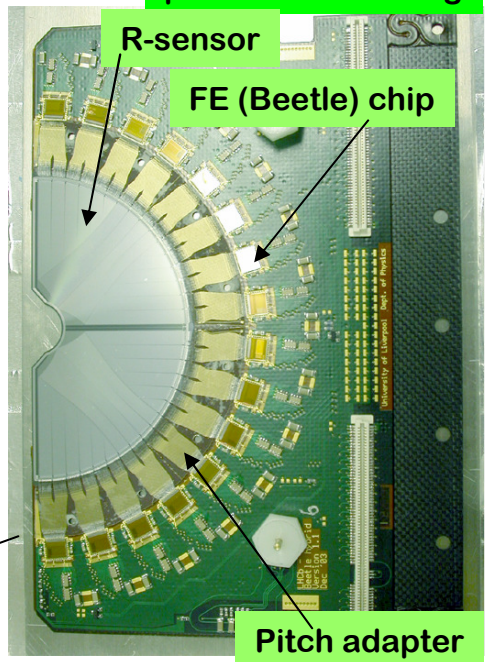
Vacuum vessel constructed
Installation in February '06



Detector vacuum box
AlMG3 300µm



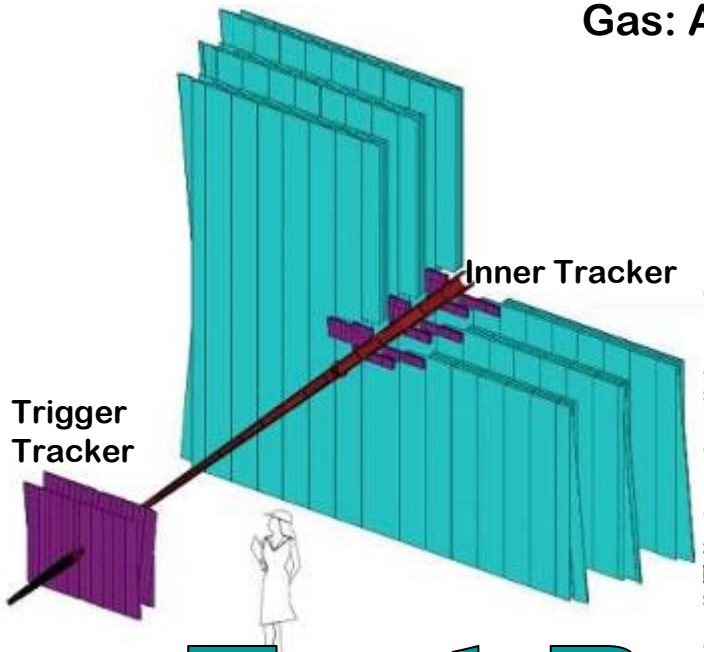
Detector Module production starting

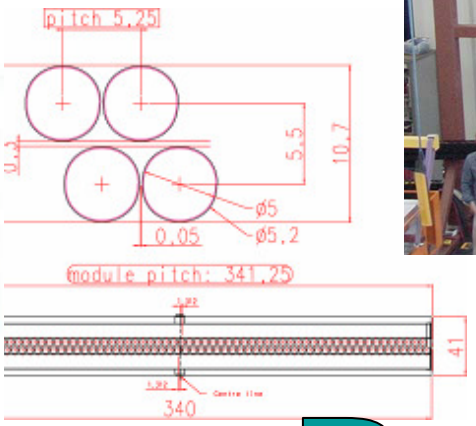


Rectangular bellow
Custom-made
First bellow has been finished and tested leak tight.

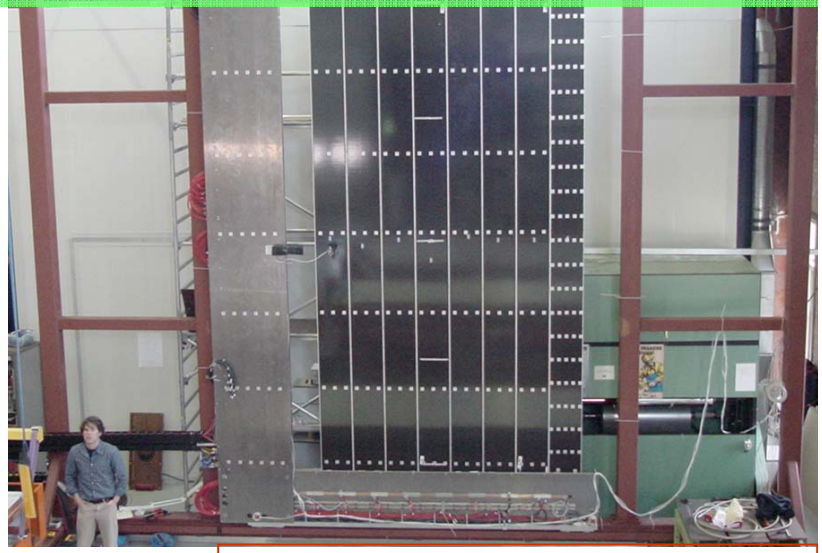
Tracking, *Outer Tracker*

3 stations, each with
4 double layers (0°, +5°, -5°, 0°)
5 mm ∅ straw tubes
Gas: Ar/CO_2 (70/30)



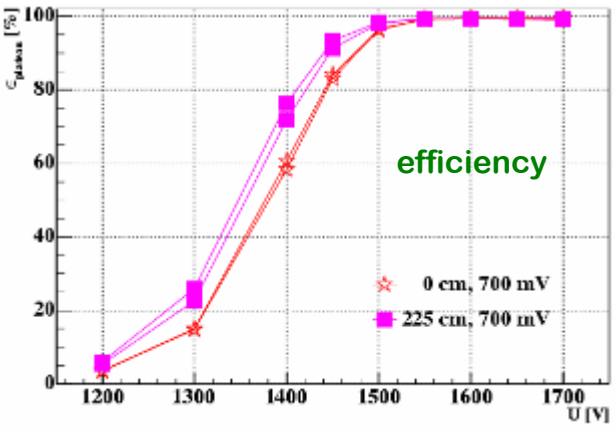


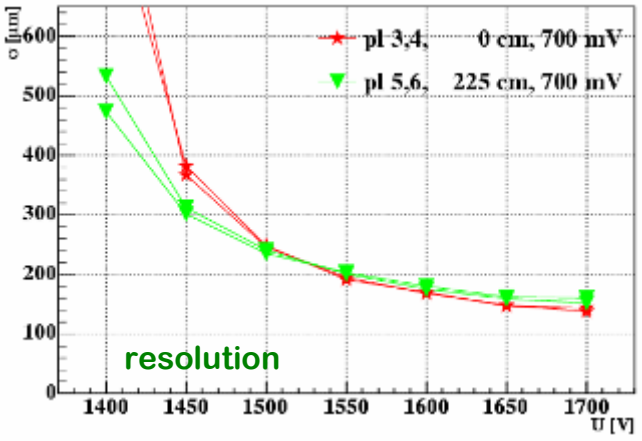
Production well advanced!
Completion of Module Production (Dec 2005)

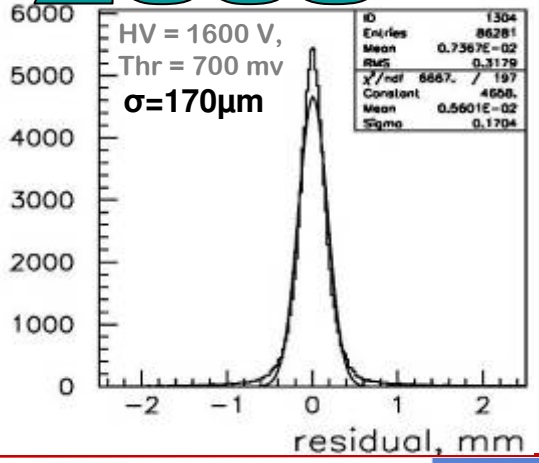


n36-2: A High-Efficiency and High-Resolution Straw Tube Tracker for the LHCb Experiment, N. Tuning,

Test Beam Data 2005



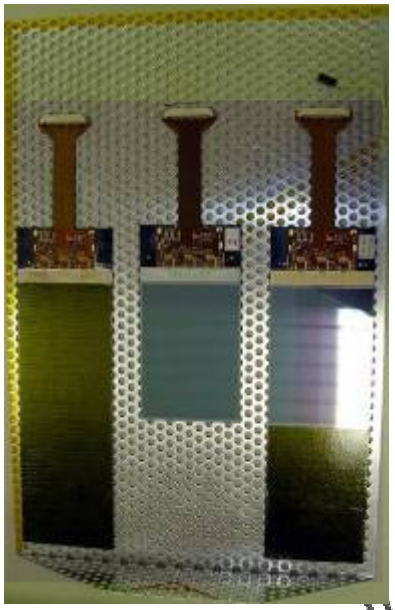




Tracking

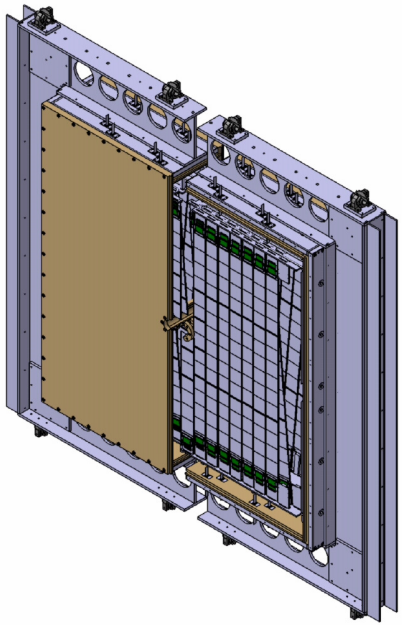
Trigger Tracker Silicon sensors:

- 4 detection layers (0°/+5°/-5°/ 0°)
- 500 μm thick
- 512 readout strips
- 91.57 mm long, 183 μm pitch

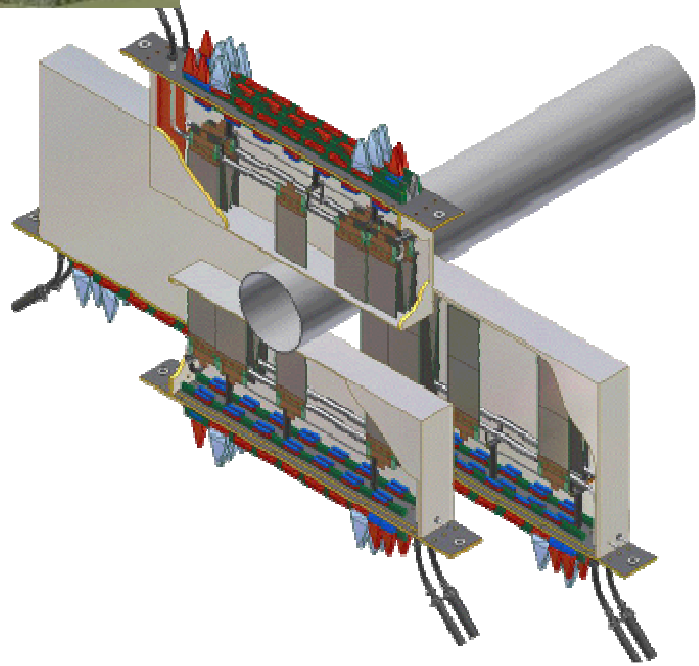


Inner Tracker Silicon sensors:

- 4 boxes per station
- 320 μm / 410 μm thick
- 384 readout strips
- 108 mm long, 198 μm pitch

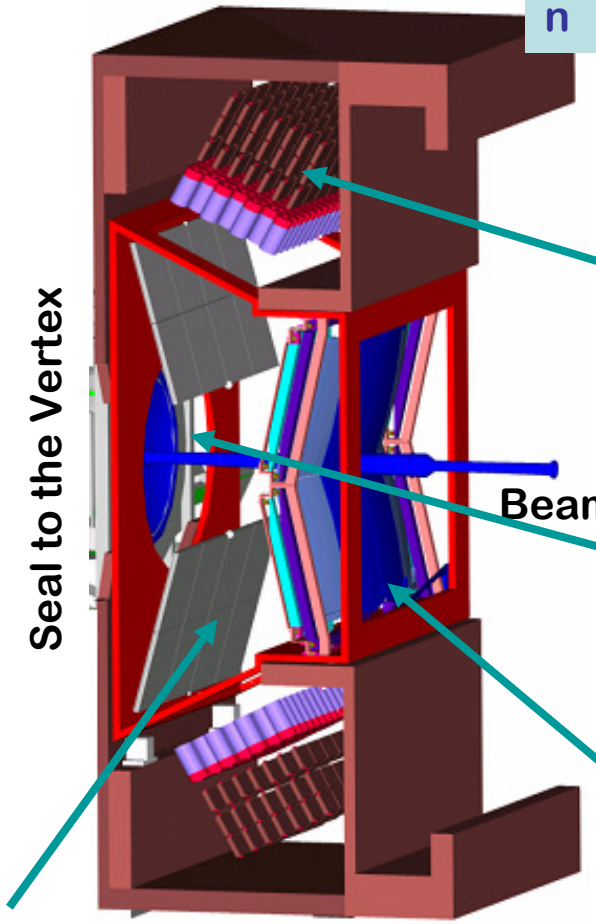


TT ladders: series production started
IT ladders: series production started

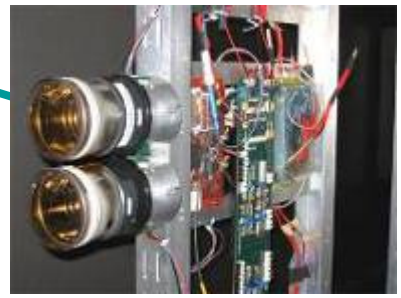


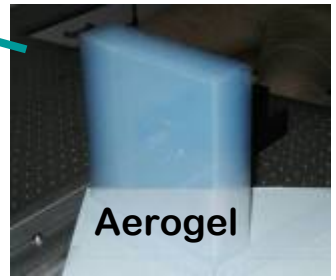
RICH 1

Two radiators	Aerogel	C4F10
π/K separation	2→10 GeV/c	up to 70 GeV/c
n	1.03	1.0014

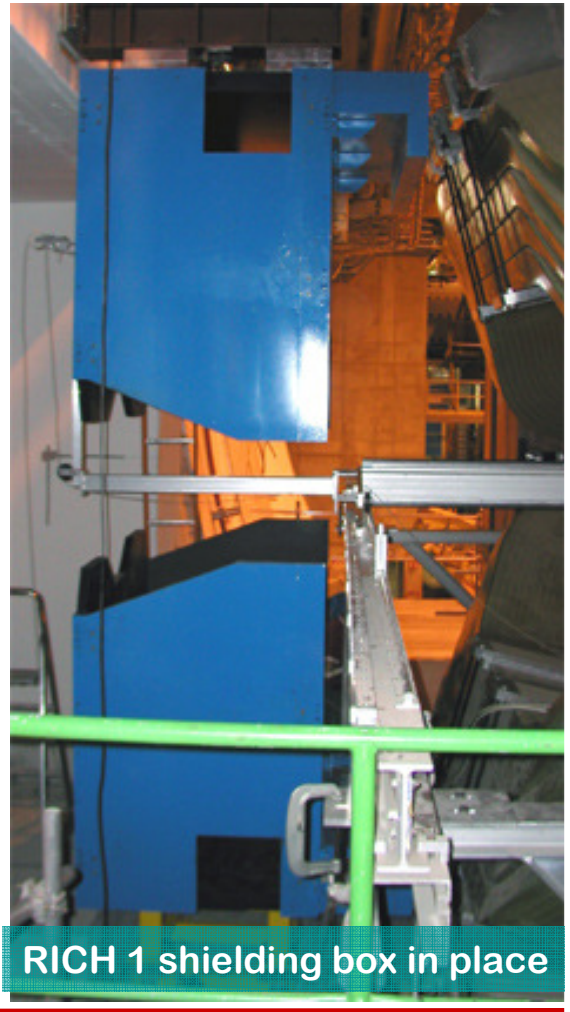


Hybrid photon detector (HPD).
Si pixel detectors encapsulated in photo-tube





Spherical Mirrors (Beryllium)


RICH 1 shielding box in place

Acceptance:
25→250 mrad (vertical)
300 mrad (horizontal)

n9-5: Production of HPDs for the LHCb Experiment
F. Muheim

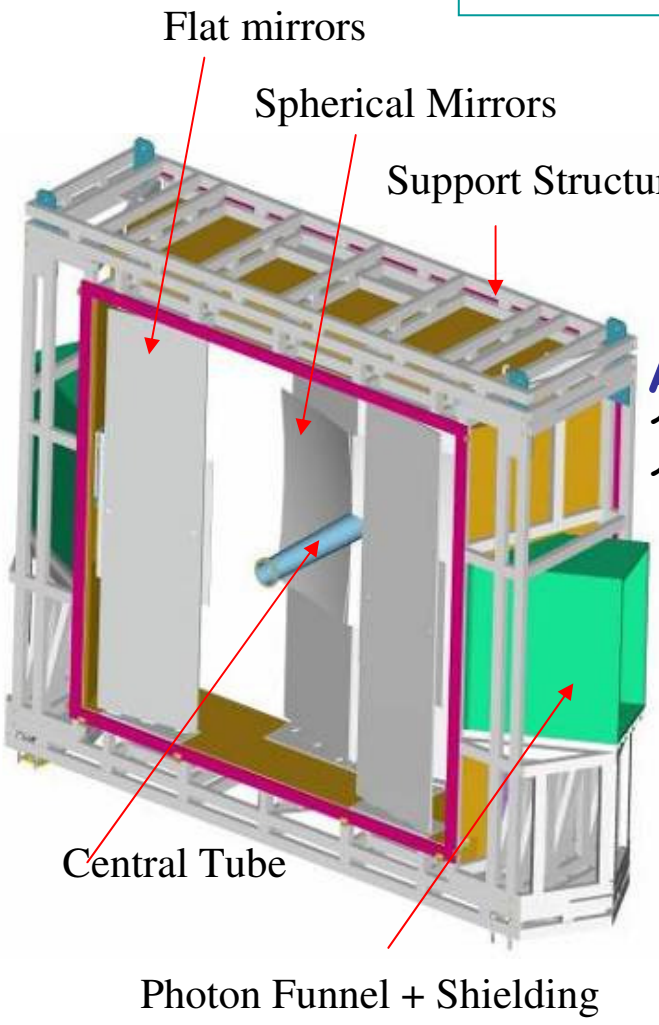
RICH 2

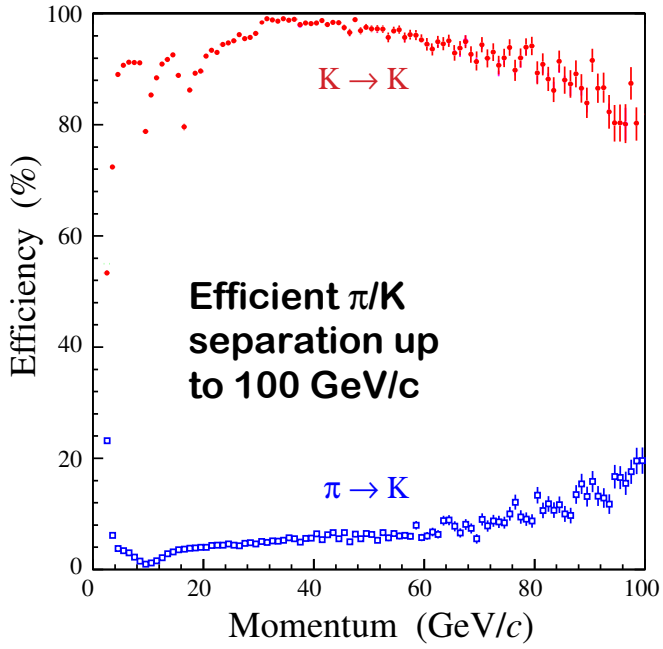
Radiator

CF_4 → ≈ 100 GeV/c

n =1.0005 (at 400 nm)

Volume: ~ 100m^3



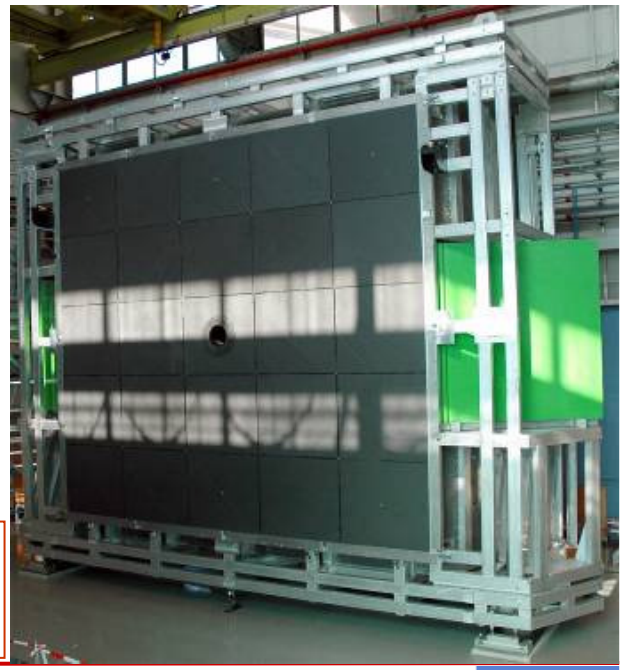


Acceptance:

15→100 mrad (vertical)

15 →120 mrad (horizontal)

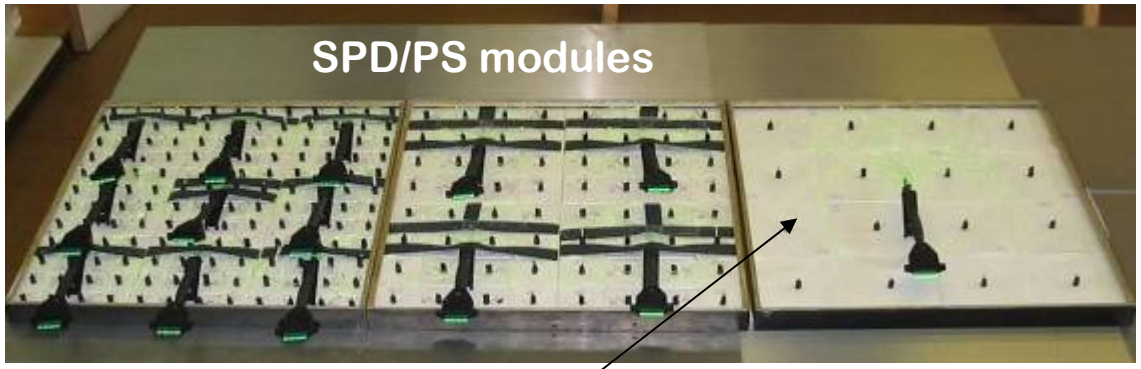
Ready to be transported to the experimental cavern

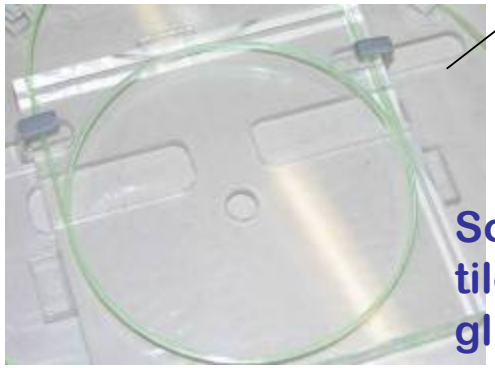


n25-7: The RICH 2 Detector of the LHCb Experiment
C. D'Ambrosio,

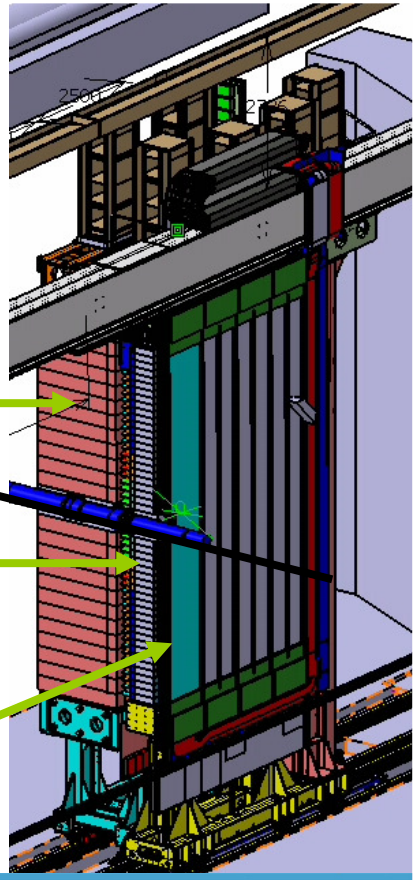
Calorimeter,
PreShower & Scintillator Pad Detector

2.5 X_0 lead converter sandwiched between two scintillator planes each with 5952 scintillating pads with thickness of 15 mm
Cell design: 40x40 mm^2, 60x60 mm^2, 120x120 mm^2





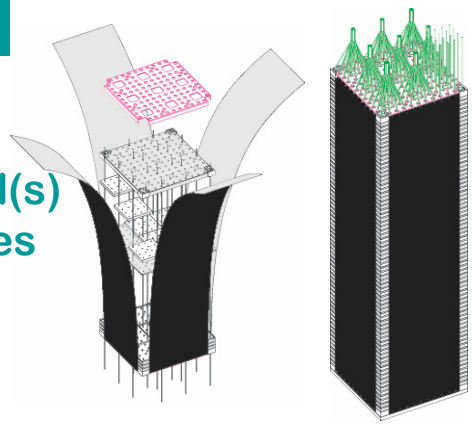
Scintillating tile with glued fibre



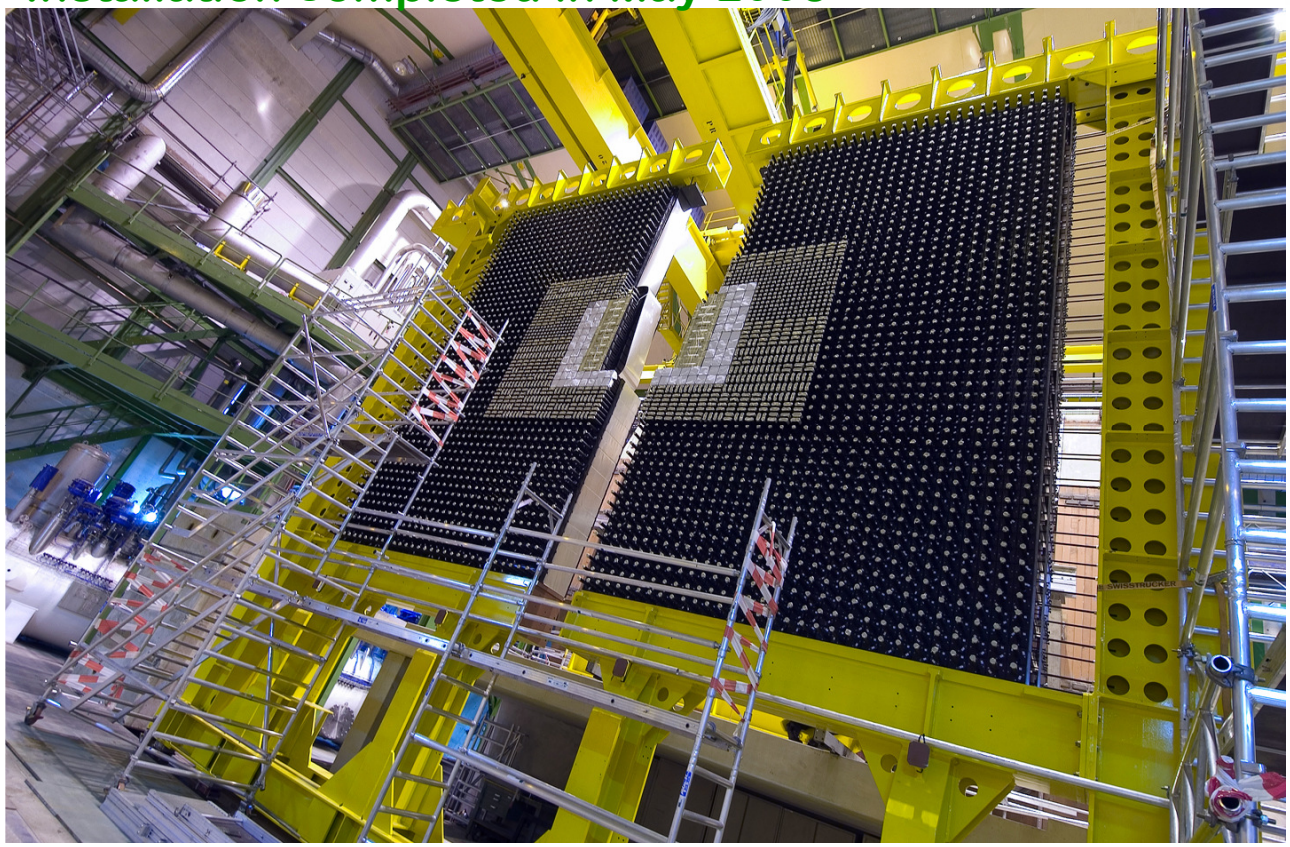
Modules will be completed this month, 4/16 super-modules are assembled.

Calorimeter, Electromagnetic

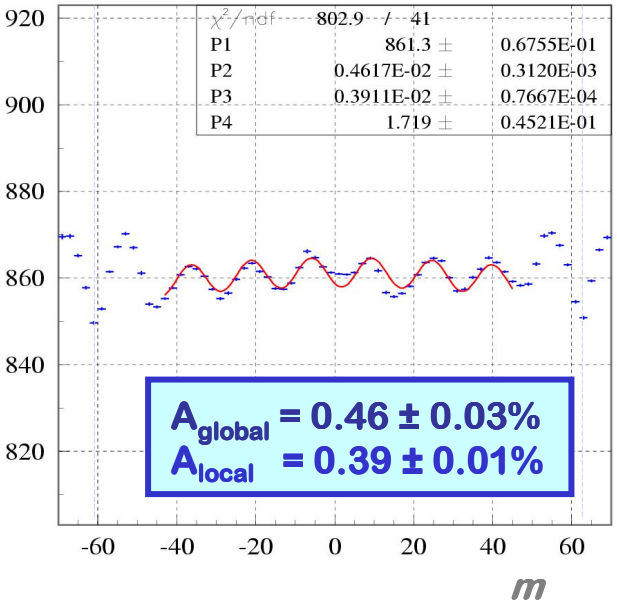
Segmented in three sections with 9, 4, 1 cell(s)
5952 channels, 25 X_0 "shashlik" type modules
66 layers of 2mm Pb/ 4mm scintillator



Installation completed in May 2005



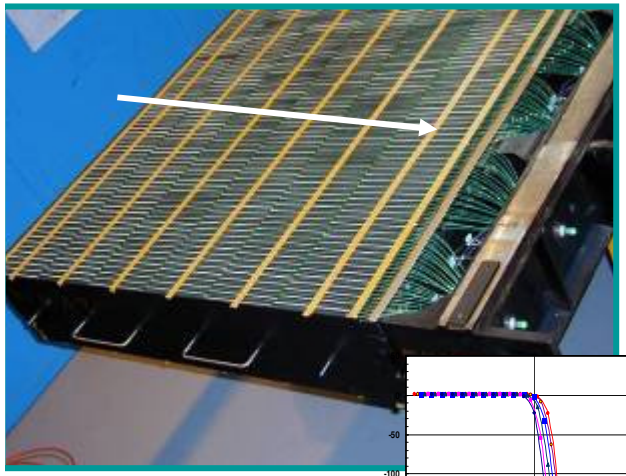
Non-uniformity of response,
50 GeV e-beam parallel to the module axis

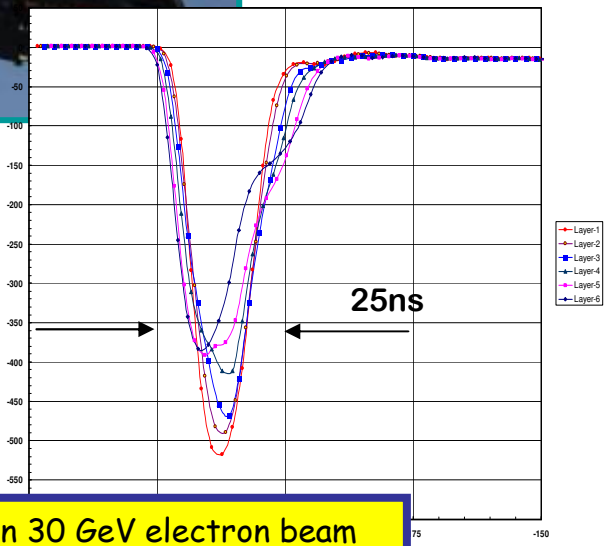


Calorimeter, Hadronic

Installation completed in June 2005

52 modules, 1468 channels, longitudinal-tiles, 5.6 λ_I
6mm master/4mm spacer, 3mm scintillator



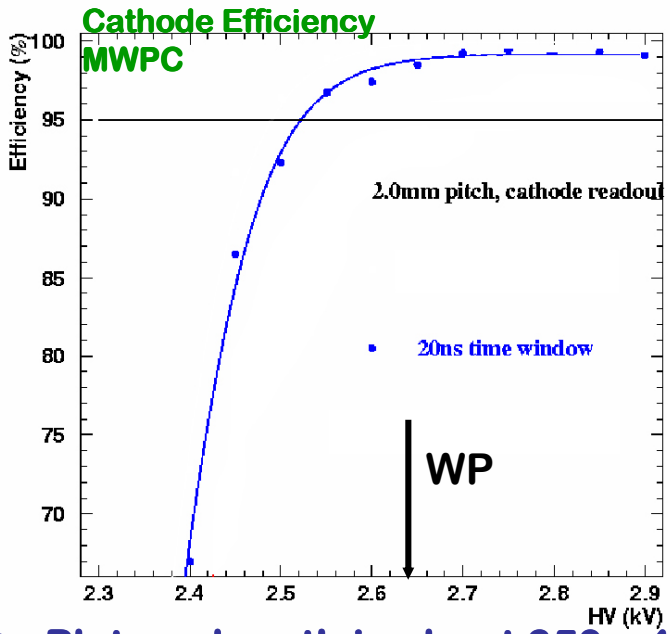


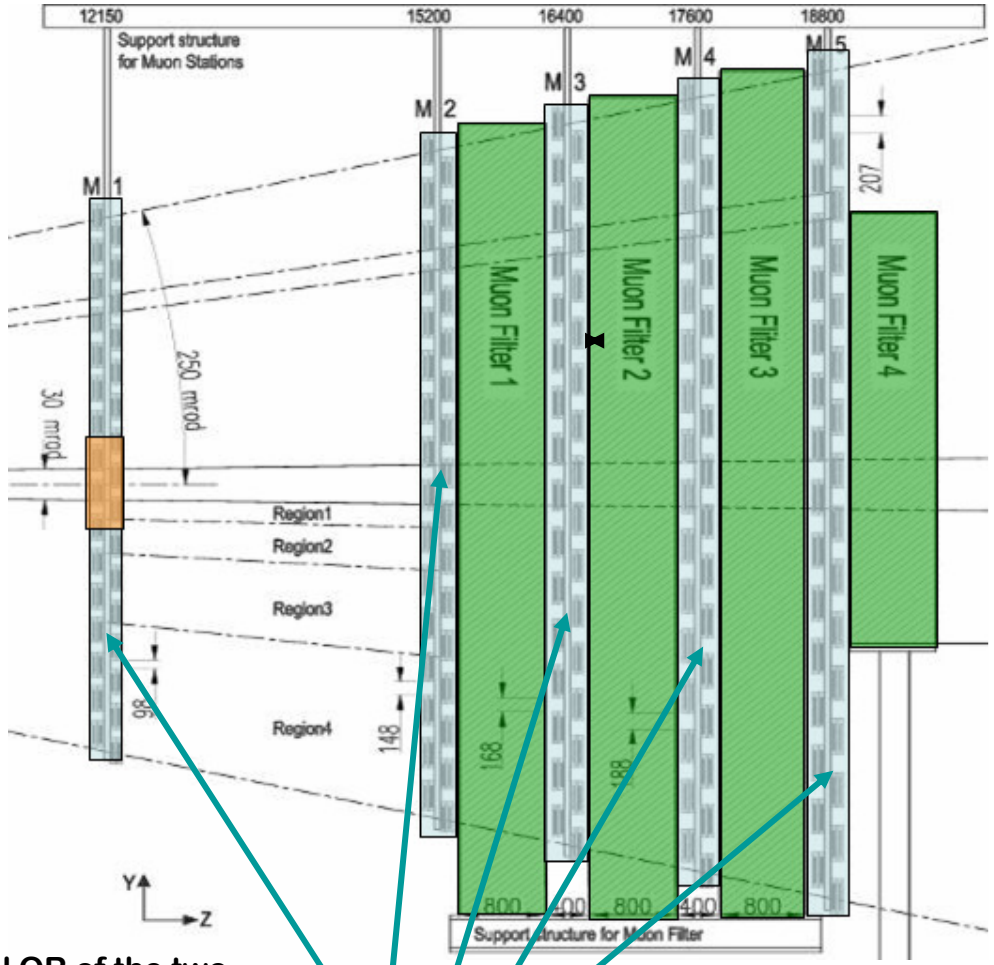
A pulse shape study on 30 GeV electron beam for 6 different layers in depth of the HCAL: 25 ns pulse shaping

Muon System

5 stations (M1-M5), each with four regions(R1-R4)
435 m² Detector area
1368 MultiWireProportionalChambers
24 3-GEM (M1, R1) 0.6m²
4-gap chambers in M2-M5. 2-gap in M1 (R2-R4).

Gas mixture:
MWPC: Ar/CO2/CF4 (40/55/5)
Triple-GEM: Ar/CO2/CF4(45/15/40)

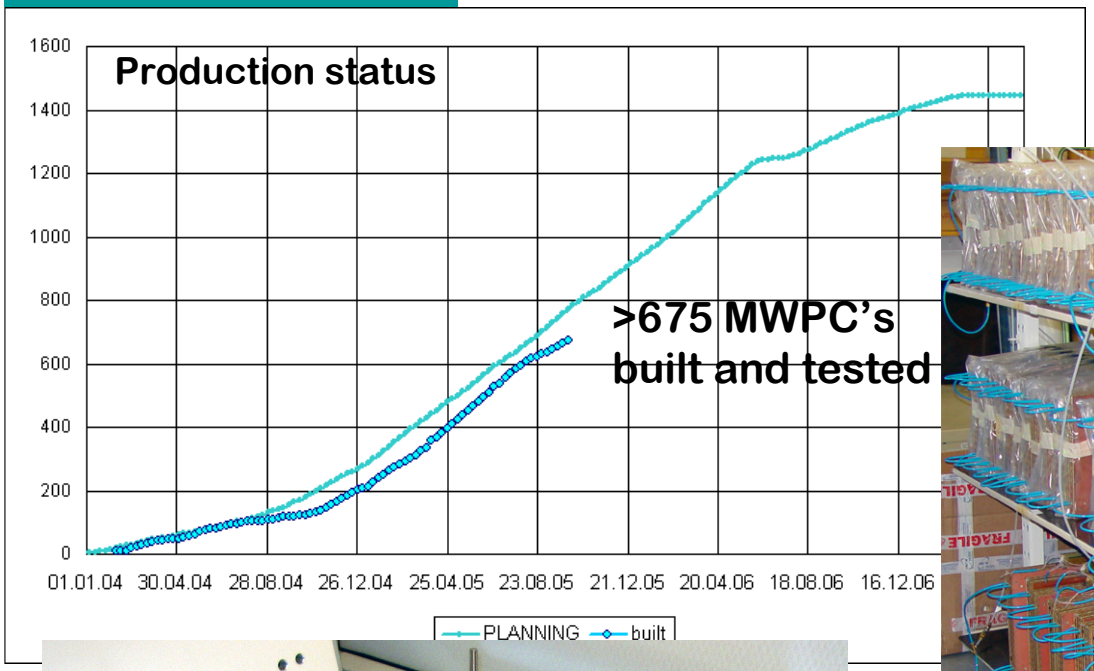


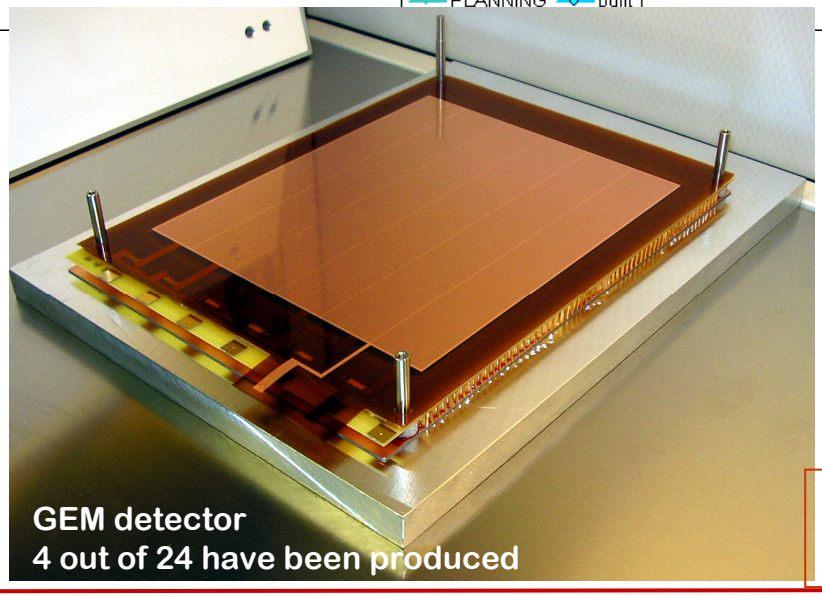


The logical OR of the two double gap ensures that ε > 99.8% per station will be reached.

-> Plateau length is about 350 – 450 V

Muon System

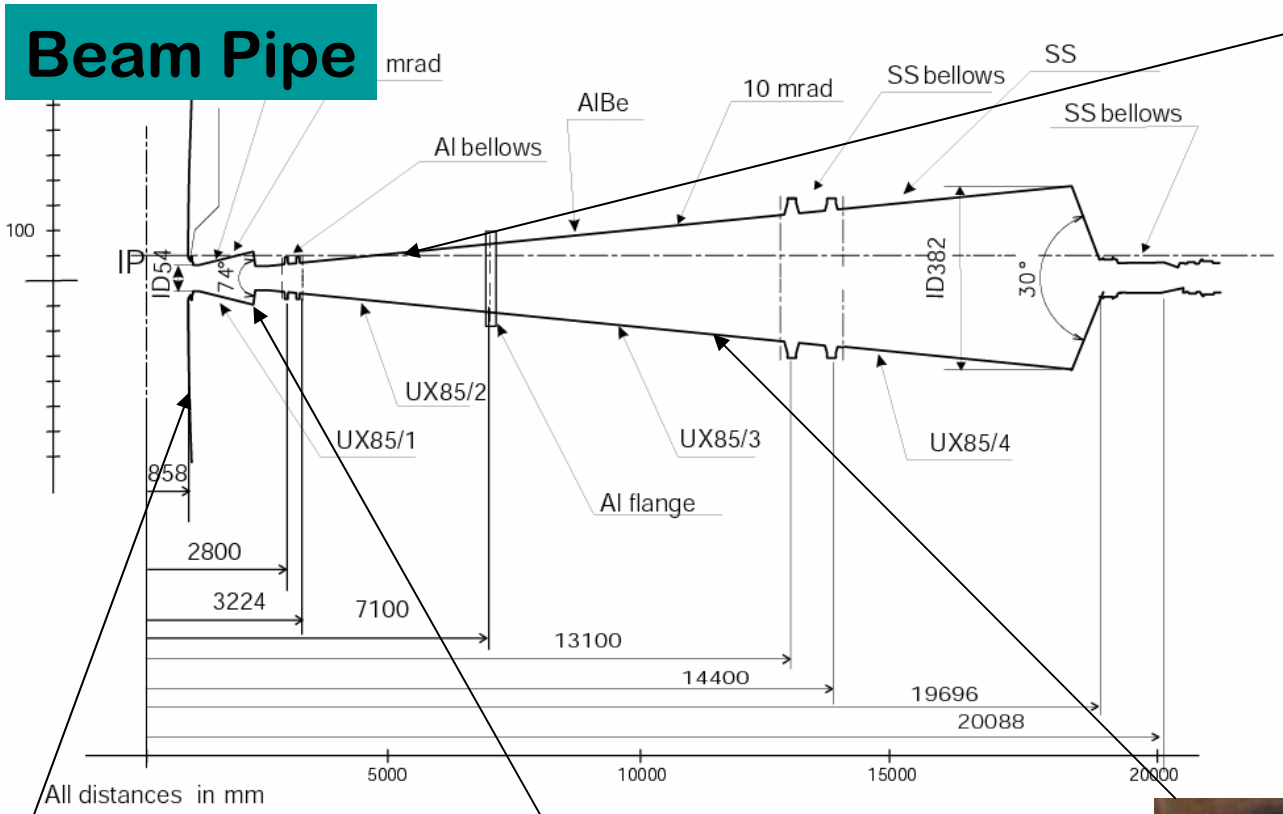




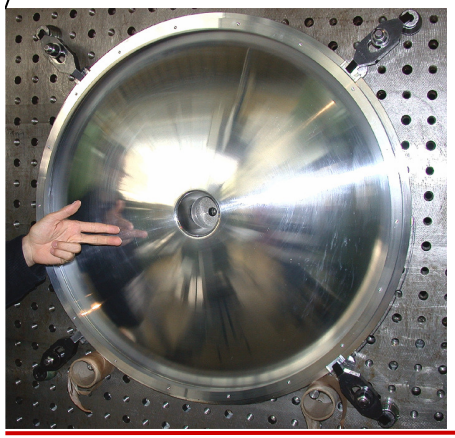
n36-7: The Triple-GEM Detector for the M1R1 Muon Station of the LHCb Experiment, G. Bencivenni1

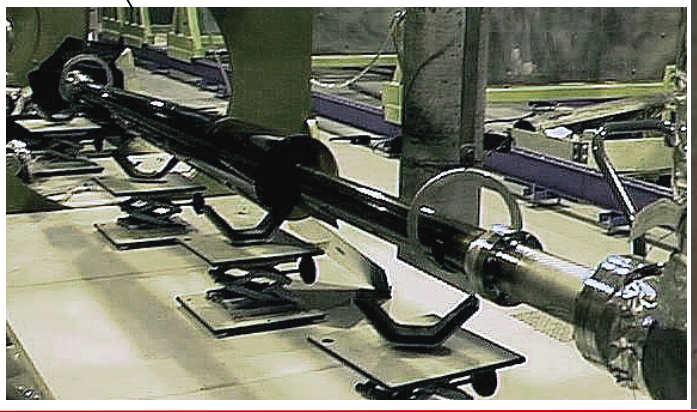
n36-7: Conditioning of MWPCs for the LHCb Muon, K. Mair

Beam Pipe


mrad
AlBe
10 mrad
SS bellows
SS
SS bellows
Al bellows
100
IP
ID54
74°
ID382
30°
UX85/2
UX85/1
UX85/3
UX85/4
858
Al flange
2800
3224
7100
13100
14400
19696
20088
5000
10000
15000
20000
All distances in mm


Delivery to CERN October '05
UX85/2: Be beam pipe with the aluminum bellows inside transport protection





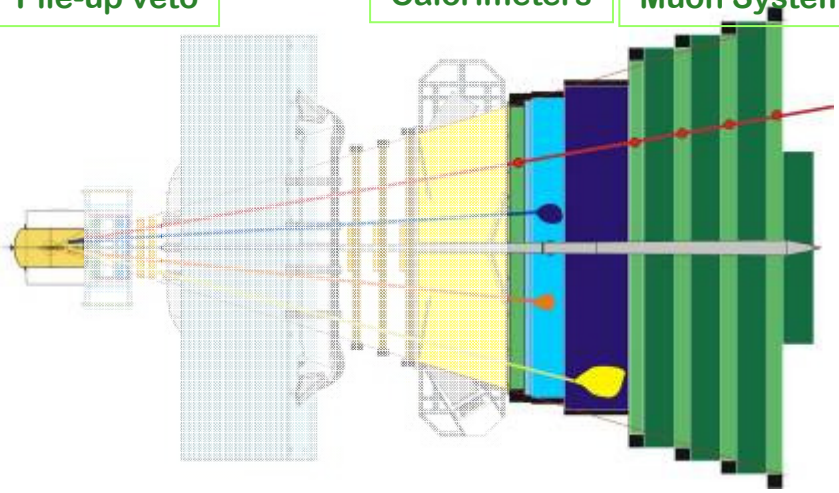

UX85/3: 3 out 12 tubes machined and ready for welding

Trigger

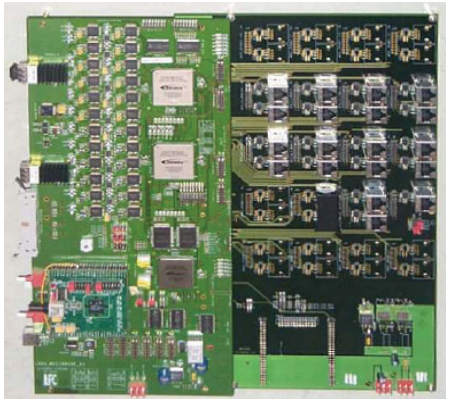
Level-0 at 40 MHz

synchronized Hardware Trigger

Pile-up veto | Calorimeters | Muon System



p_T of
μ , h, e, γ



Prototype of L0 decision unit

'High Level' Trigger at 1 MHz

asynchronous Software Trigger

All data related to all events selected by L0 trigger will be sent to the processor farm.

Start with high impact parameter and large p_T (VELO and TT), before using:

Full detector information

Storage at 2 kHz

Real Time Trigger Challenge:
Software trigger application was running in an environment as realistic as possible.
-> basic principles are valid

Summary

Production:

Sub-detectors are well advanced, several have been or are close to be completed.

Installation:

First detectors have been installed.

Global commissioning will start in December 2006.

LHCb will be ready for beam in summer 2007.