



Status of the LHCb Detector

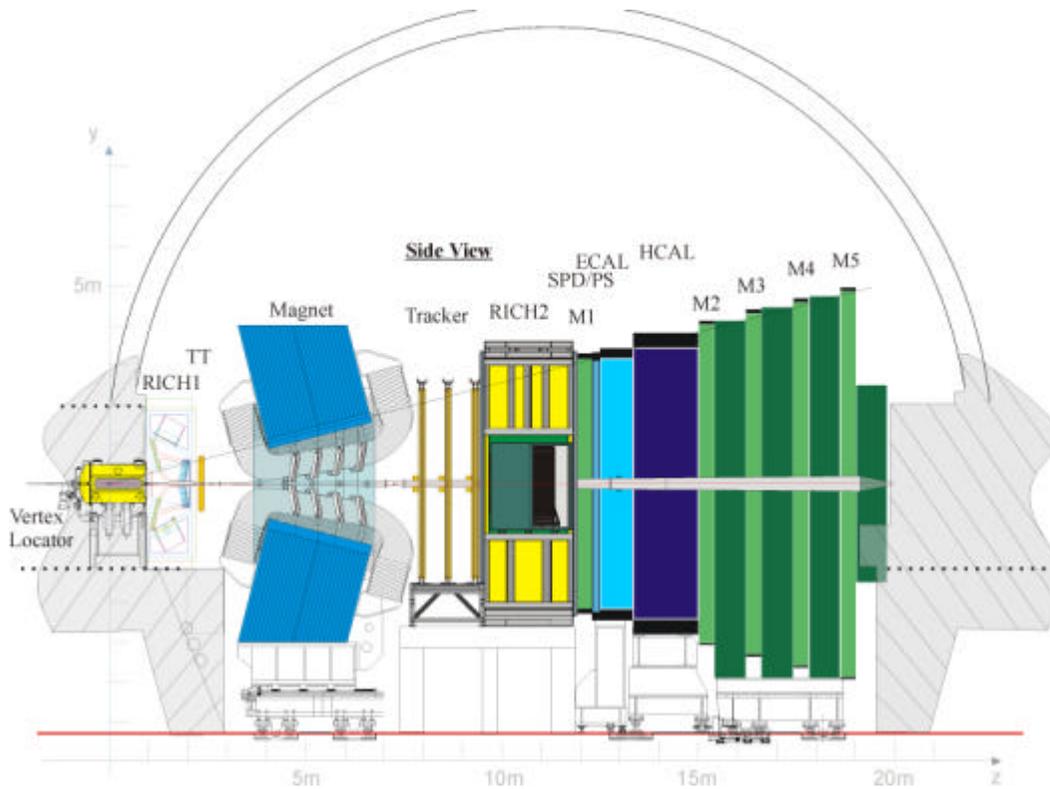
LHCC Open Session

CERN, 27 November 2002

Werner Witzeling

on behalf of the LHCb Collaboration

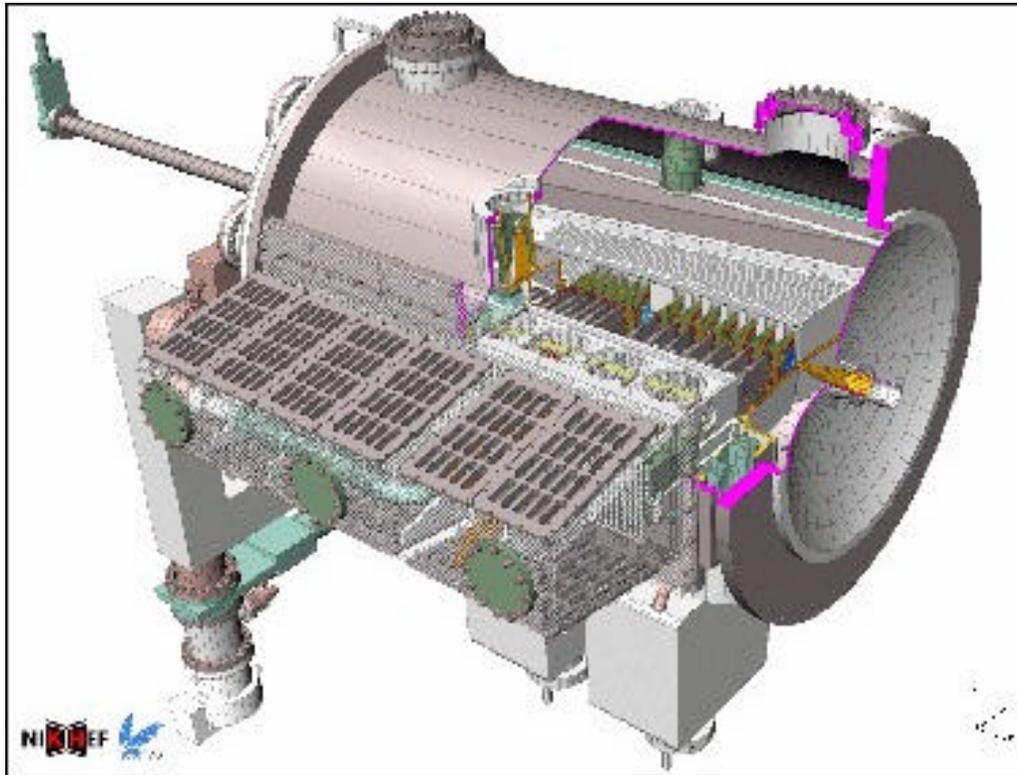
Content



Vertex Locator
Magnet
Outer Tracker
RICH2
Calorimeters
Muon Detector
Online System
Experimental area
Summary

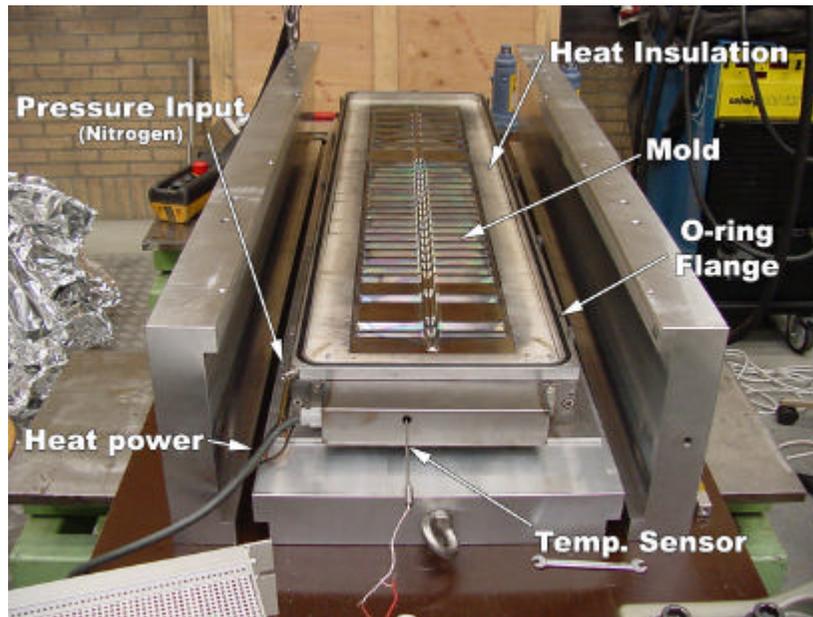
Vertex Locator (VELO)

Work concentrated on prototyping of critical items:



Al window,
RF foil,
Rectangular bellows,
Wake field suppressor,
Electronics,
Sensor optimization

VELO : RF foil



Superplastic forming:

Full size prototypes have been produced (0.2 and 0.3 mm aluminium), small leaks found (can be cured with Polyimide coating), deflection under 5mbar pressure is 0.3 mm (1.0 mm in non-corrugated part, improvement under study)



VELO : Mechanics



Rectangular bellow:
3rd iteration in preparation
(to solve sagging problem)

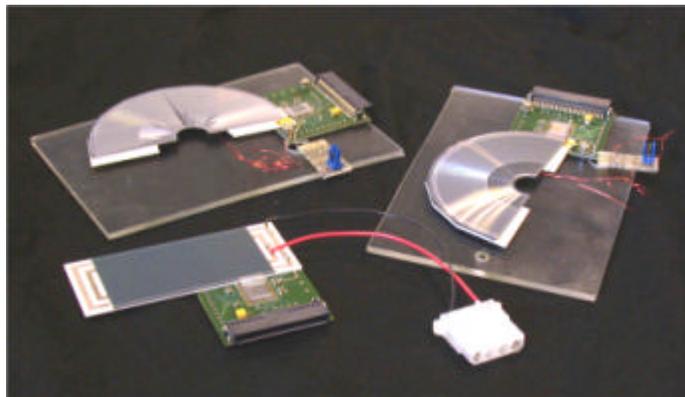
Wake field suppressor (Cu/Be):
mechanical testing (30.000 cycles) successful



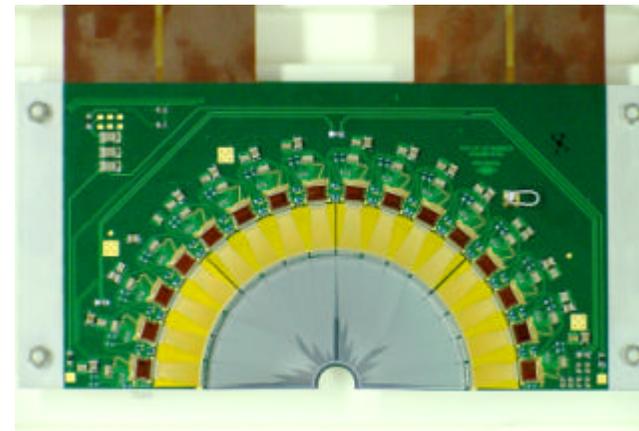
VELO : Electronics

VELO electronics review in June '02 revealed no major problems,
Level 1 proto-3 digitizer board in design stage

Both FE chip candidates, Beetle 1.1 and SCTA_VELO, have been tested
with full size hybrids and sensors in beam, final decision in January '03



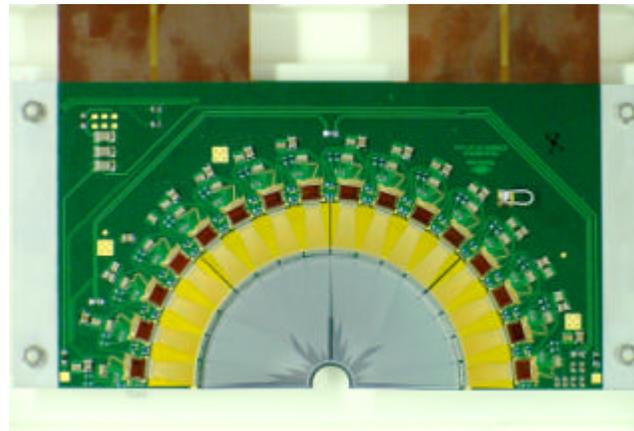
SCTA_VELO radiation tests done,
analysis in progress



Beetle 1.2 chip received,
tests started, looks okay

VELO : Sensors

Silicon sensors: New layout with an overall 45 degree strip design for the R-sensors yields better L1 trigger performance, only small loss in resolution



Near future:

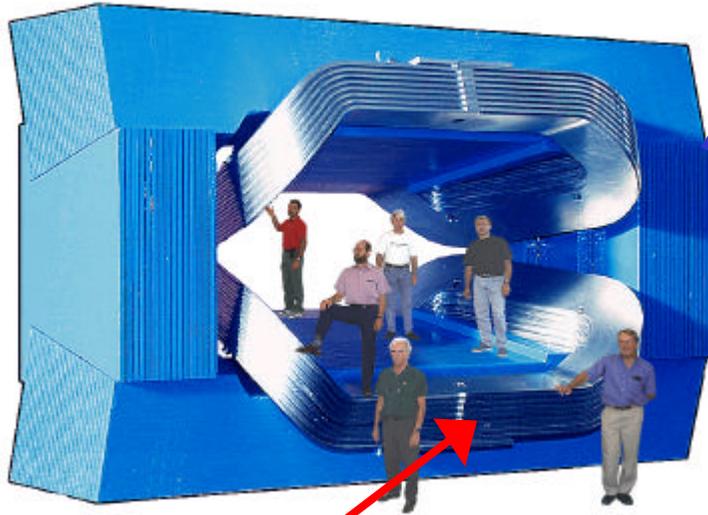
RF foil review (29 November) to define clearance to and shape of sensors

Engineering design review with LHCgroups (16 & 17 December)

Decision on FE chip (January '03)

Silicon design review (February '03)

Magnet



Yoke (1500 tons):
Steel plates in production at
Jebens, DE

Coils (SigmaPhi, FR):
27 (of 30) pancakes are wound



Winding a pancake

Magnet (2)



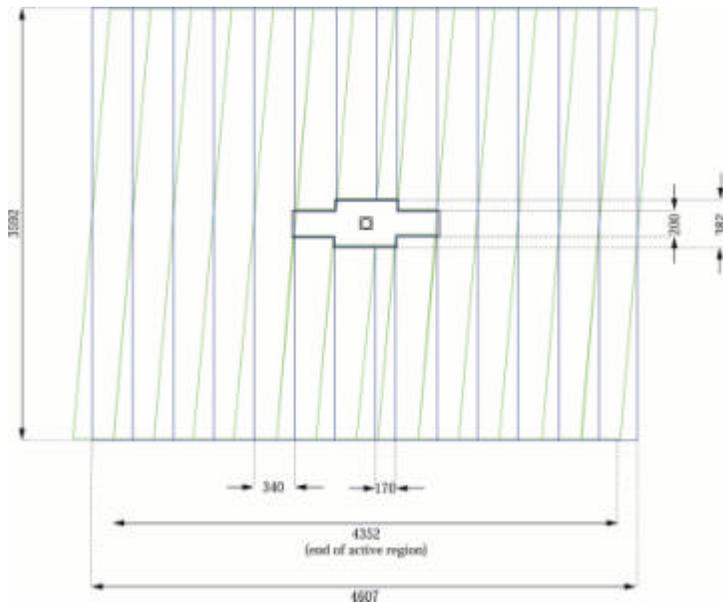
Sets of three pancakes are
molded to form one triplet:
7 triplets (of 10) are molded

Pre-assembly of triplets at
factory

Assembly of magnet in UX85 will start in January 2003
Power tests and field map from end of 2003 onwards

Outer Tracker

3 stations with each 4 layers of straw tube modules (X,U,V,X layers)



Since the approval of the TDR (Feb 2002) many details have been worked out:

New straw material (prelaminated 12 μm Al / 25 μm Kapton) \rightarrow gas tightness within specs

Improved wire locator design significantly less spurious pulses



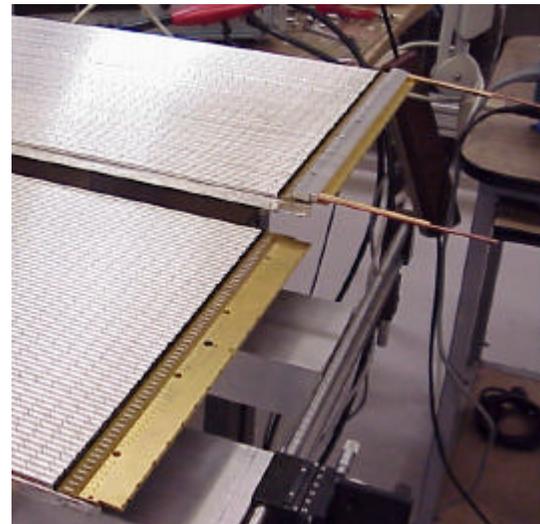
Outer Tracker (2)

- EDR is planned for May '03, preseries production in June '03
- Module production sites (clean rooms and assembly tools) getting ready in Heidelberg, NIKHEF and Warsaw
- Series production of modules to start in September '03

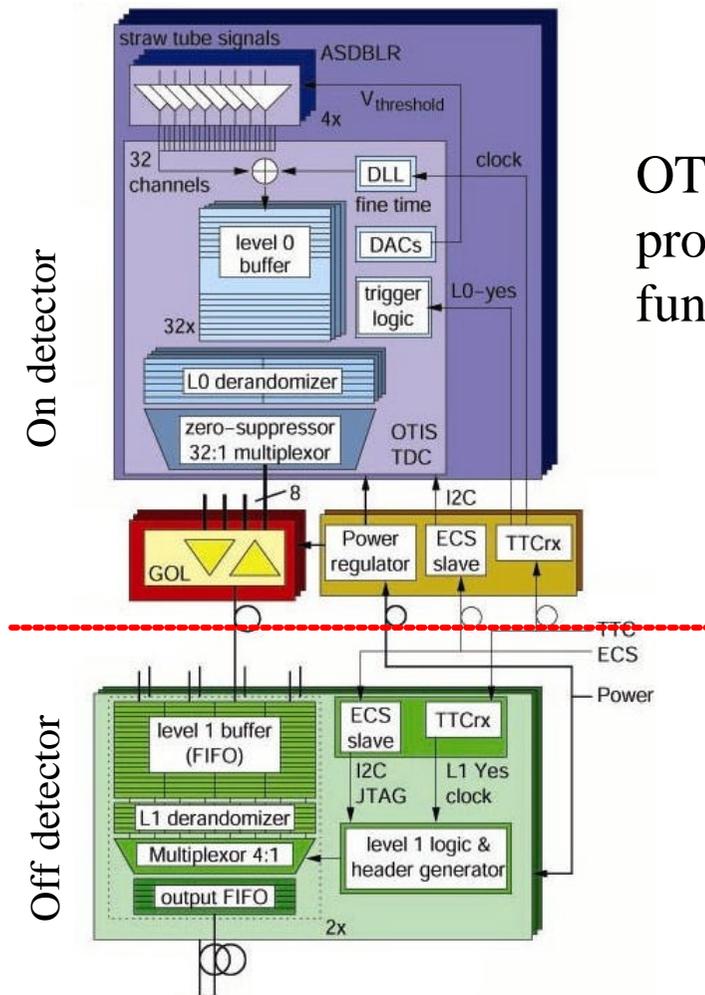


2.5 m long prototype module

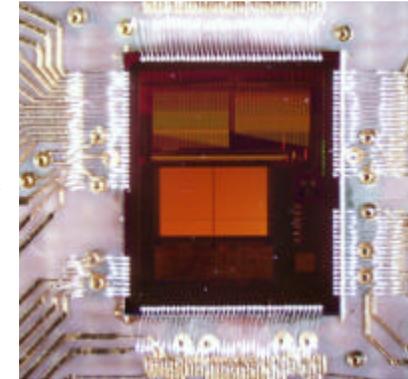
Test production of 5m long panels in Cracow successful



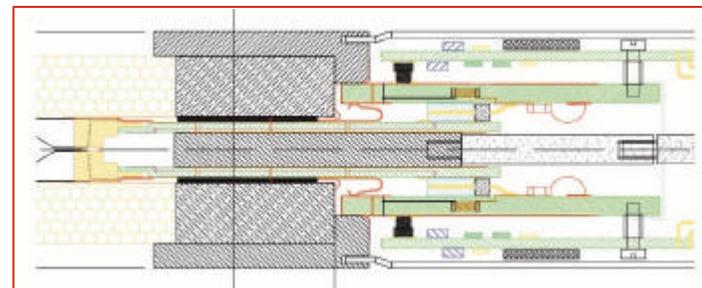
Outer Tracker Electronics



OTIS 1.0 TDC chip: first prototype with basic functionality under test

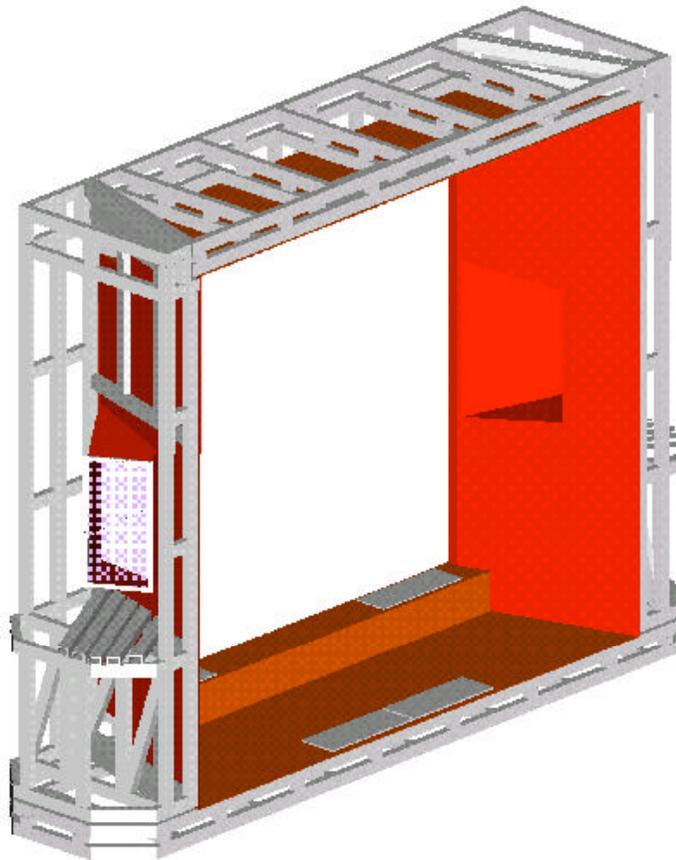


Mechanical design of FE electronics board vigorously pursued: Front-end electronics, HV and gas supply in limited space



RICH2 Detector

RICH2: Engineering Design Review in March '02 passed



First batch of mirrors being ordered

Production drawings of all components of superstructure by mid January '03, followed by tendering

Design of magnetic shield and photo detector mechanics on hold (PD choice implies minor changes)

RICH2 Detector (2)



Prototyping of the window at RAL



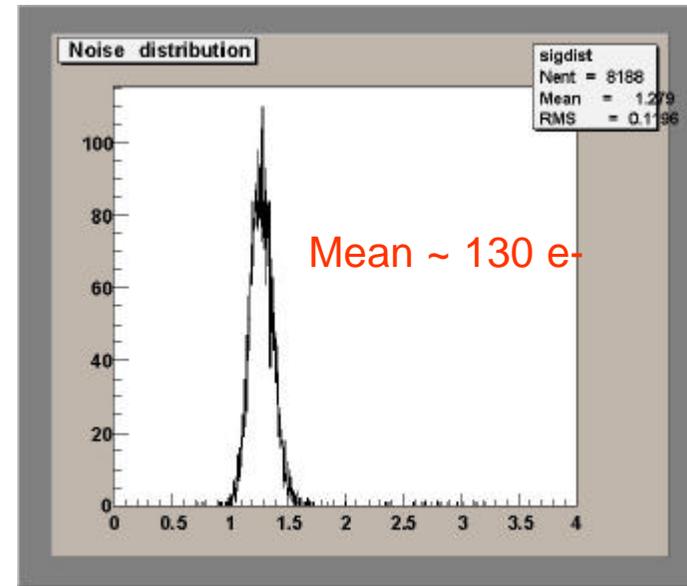
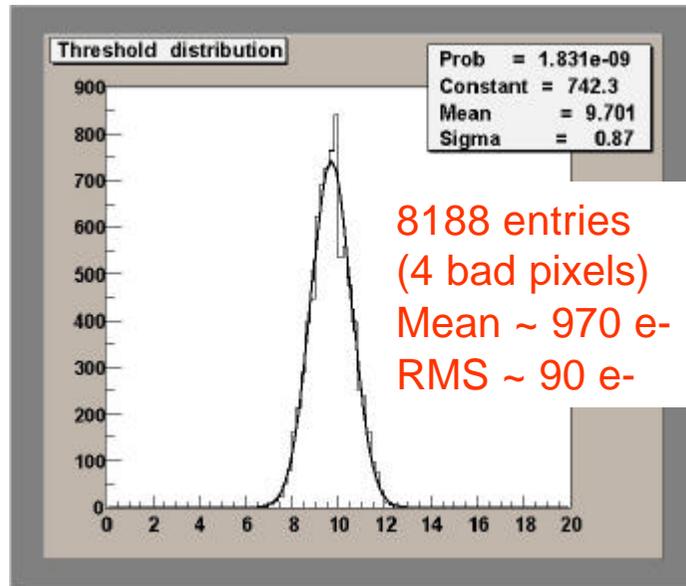
Stability test of opto-mechanics in hall 156

Next steps:

- Milestones for photon detector in Jan and Mar '03
- Manufacture of windows (9 m x 7 m) in hall 156
- Assembly of RICH2 starting in '04 in hall 156

RICH: Pixel Chip

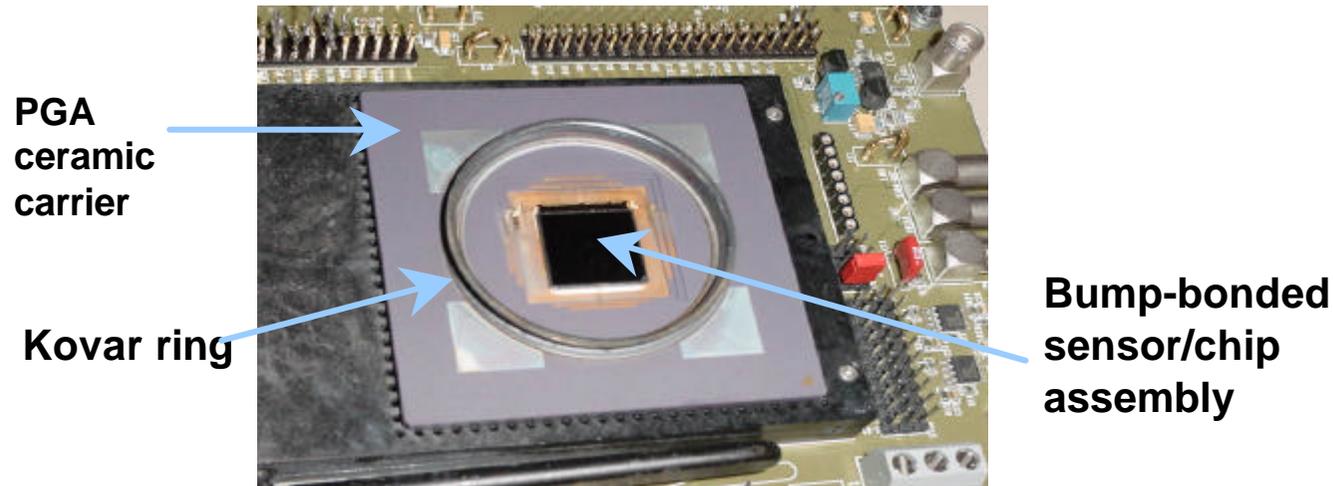
New pixel chip LHCPIX1 shows good performance at 40 MHz, all tests satisfactory



Noise and threshold characteristics at 40MHz satisfy LHCb RICH requirements: **Threshold < 2000e**, **noise < 300e**

RICH: Photon Detector

Photon detector remains a critical item.

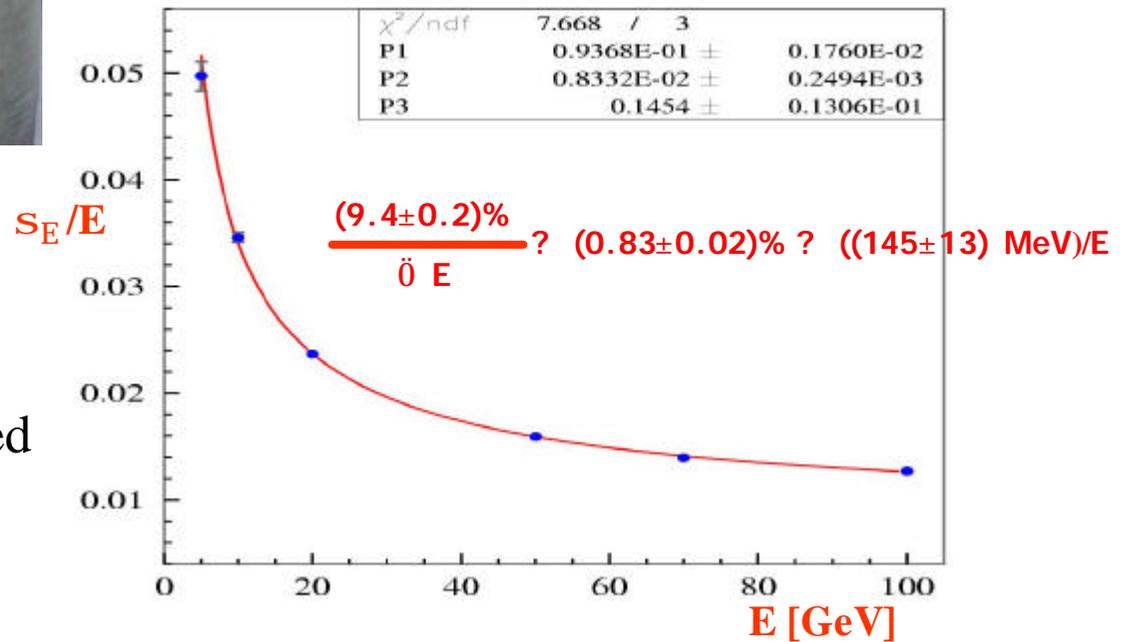


- Progress has been achieved concerning the bump bonding: Electrical contact of new ‘relaxed’ bumps in test assemblies improved: >99% (previously <80%), however still concerns on metallurgical quality. Prototype HPD tubes with ‘relaxed’ bumps to arrive next month.
- In parallel, Beetle-MaPMT version submitted for MaPMT back-up solution

Calorimeters : ECAL



Module assembly at ITEP:
 All Pb converter plates delivered
 Production of scintillator and modules
 proceeding well:
 Of a total of 3300 modules, 1200 modules
 delivered to CERN, 600 ready for transport



Energy resolution of series
 production modules measured
 in test beam

Calorimeters: HCAL

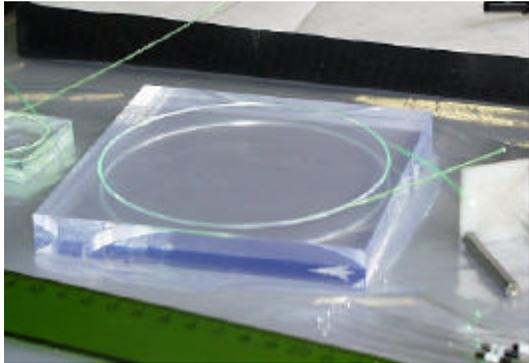
Series production of modules has started this summer at IHEP



Sub-module
production chain at
IHEP

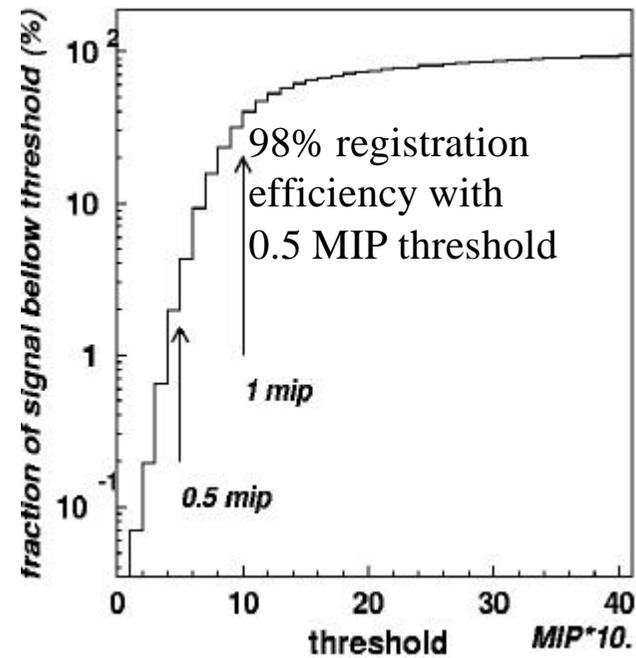
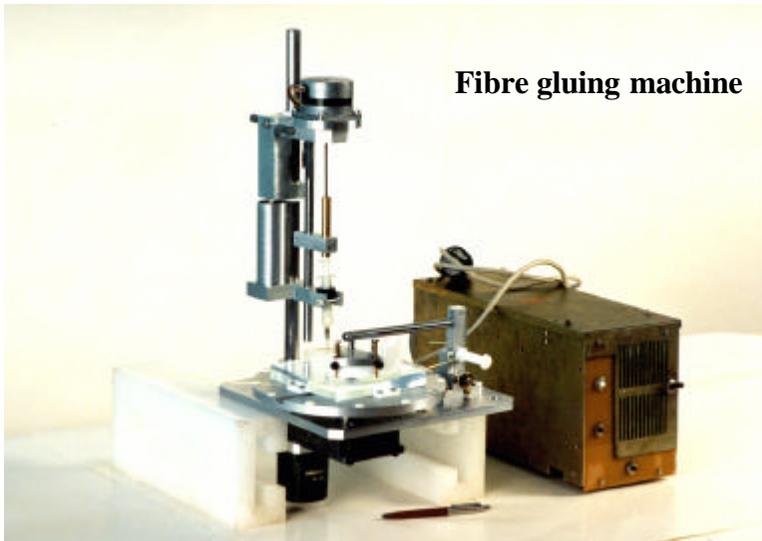
Two modules (of 52)
delivered to CERN,
four more ready.
Production rate
2 modules / month

Calorimeters : Pre-shower and SPD



Scintillator pads read out by WLS fibres and MaPMTs

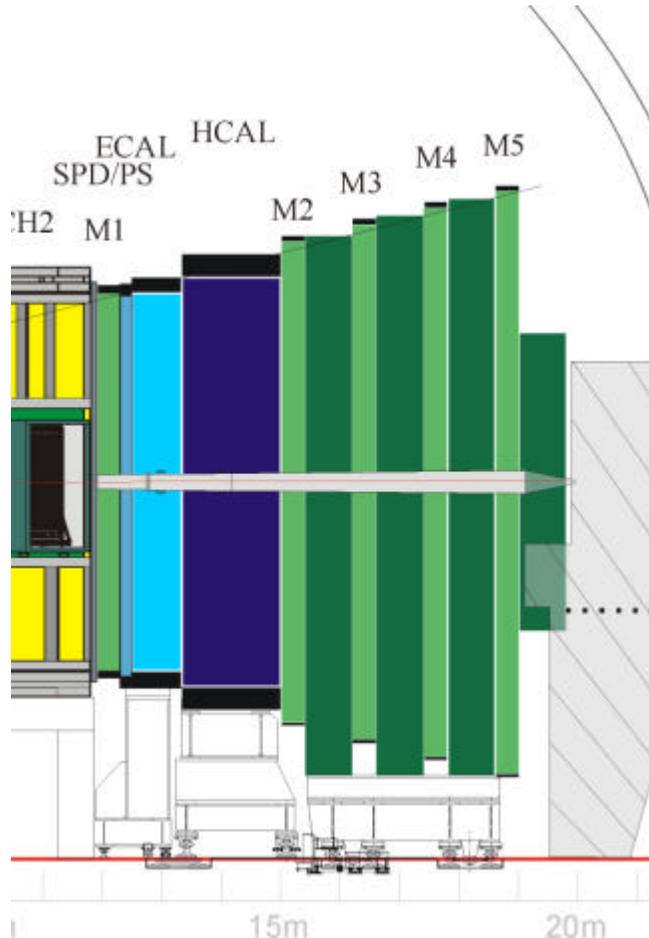
- EDR passed in March '02
- Setting-up at INR for series production
- Module-0 (16 cells) tested with beam



Calorimeter Read-out

- PMTs for ECal and HCal:
Samples tested, specification frozen, tendering started
- MaPMTs for PS and SPD:
Test bench operational, measurements of tube characteristics and aging tests ongoing
- Front-end chips:
PRR for ECal/HCal and PS chips in Dec '01
ECal/HCal chips received, testing started
PS chip validated, modification of gain under way to reduce aging of MaPMTs
- Front-end cards:
Design evolved, new anti-fuse FPGAs studied (better suited)
PRR for front-end cards planned for July '04

Muon Detector



Two changes:

1. Extensive aging tests of RPCs at GIF over two years showed a decrease of the rate capability of about one order of magnitude. This led to the decision to replace RPCs by MWPCs in stations M4 and M5 (Addendum to TDR will be submitted in Jan '03)
2. Reduction of material proposed in front of the calorimeter (LHCb-light): two detection layers only and honeycomb sandwich panels (material reduced by ~50%)

Muon Detector: Prototypes



Several prototype chambers have been produced, respectively are in production, construction details are being finalized (M3R3 chamber)

Setting-up of production lines and tooling is progressing:
Ferrara wiring machine

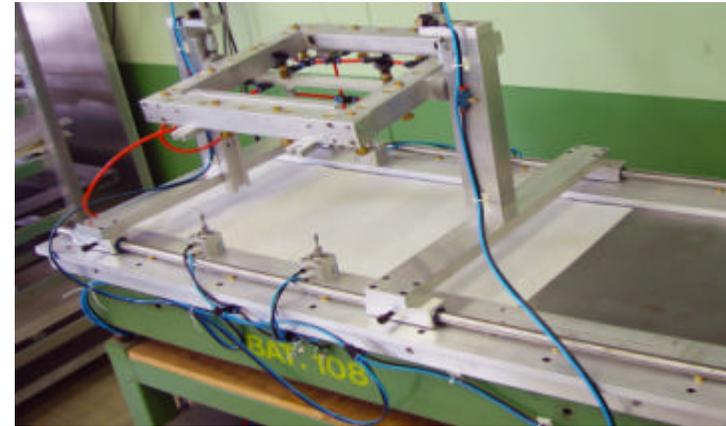


Muon Detector: Tooling

Preparation of tooling and setting-up of production lines well under way, production will start in mid '03



**Wire pitch and tension measurement
Prototype built at CERN**



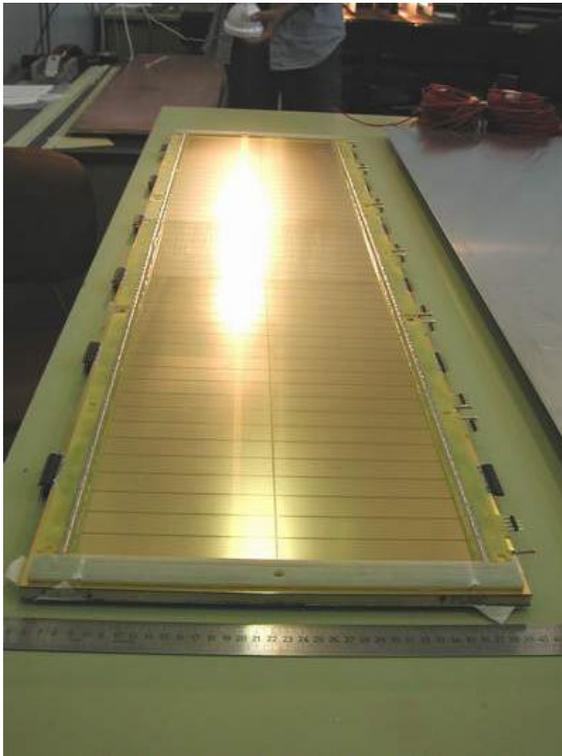
Precision gluing ($\pm 50\mu\text{m}$) of chamber elements (CERN and PNPI)



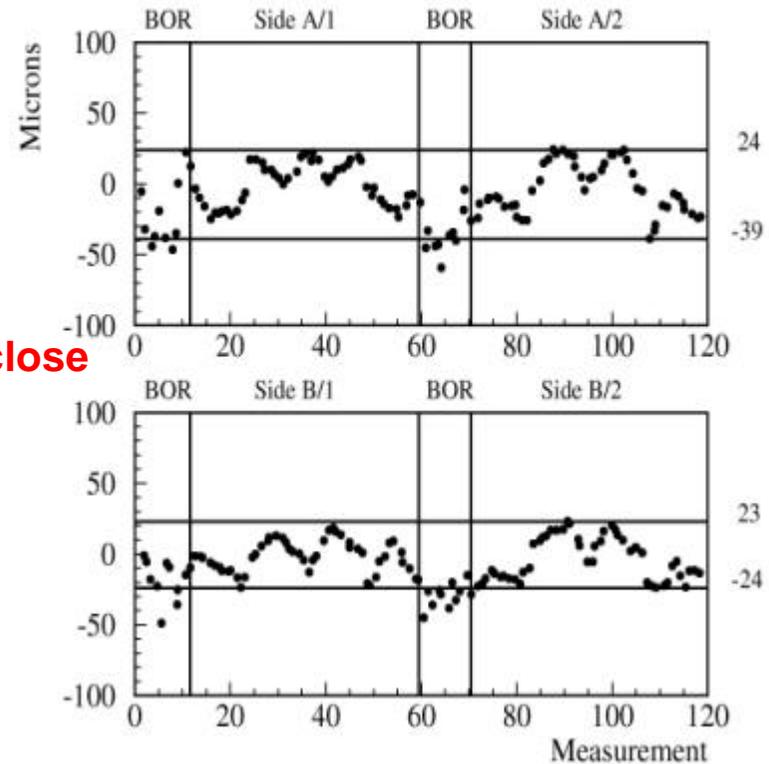
Laser wire soldering prototype built at LNF

Muon Detector: Panels

First long panels have been produced after few iterations Panel 29
Fire resistance, planarity, thickness OK, planarity very close



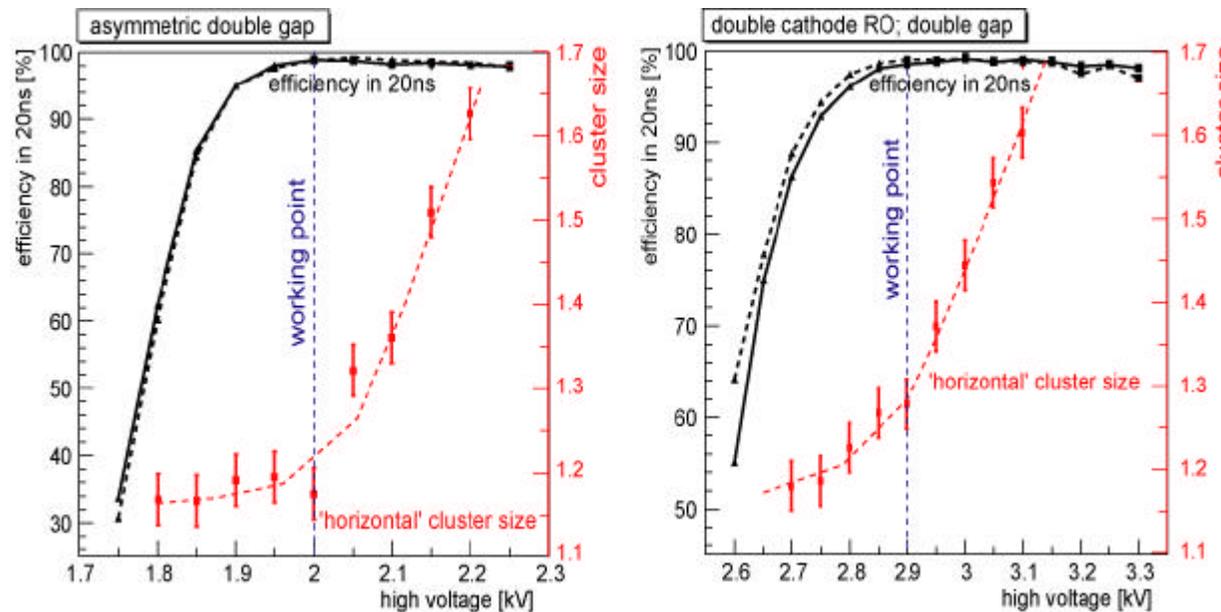
**Planarity close
To specs**



A first batch of panels was used for Module-0 prototypes
Above: M3R3 panel with pad cathodes

Muon Detector: Test Beam Results

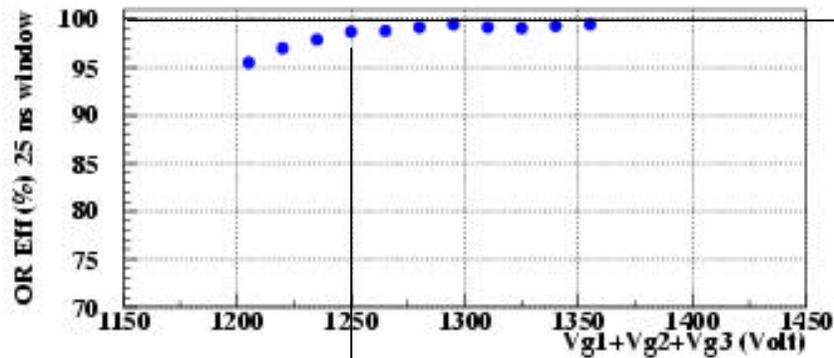
High-rate region of M1 - three options under study:
Asymmetric chamber, double cathode RO chamber and GEM



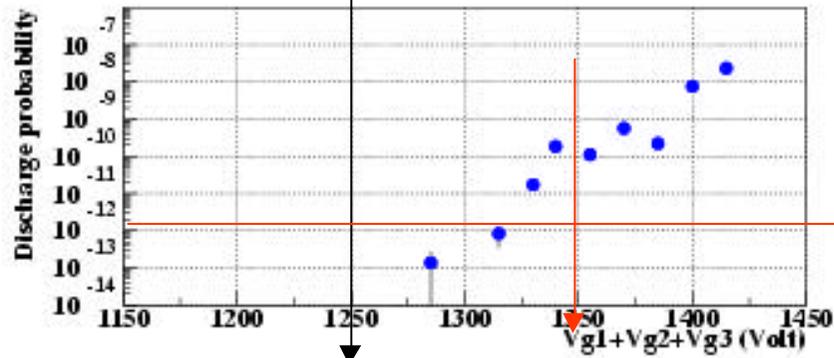
A plateau of a few hundred volts has been measured for both configurations

Test Beam Results (2) : GEM

Triple GEM chamber prototype



25 ns time window of two chambers in OR >99% efficiency



Discharge: tests show that GEMs will stand ~10 years without damage

1250 V 1315 V

65 V wide working region

Muon Detector : Electronics

Three custom ASICs required for the Front-end (all in 0.25 μm IBM CMOS):

- CARIOCA chip: development still ongoing (instability problems being worked on), aim to finish by mid 2003 [back-up: ASDQ]
- DIALOG chip: almost final version successfully tested, minor problem to be cured
- SYNC chip: design well on the way, first submission in December '02, complete chip to be submitted in February '03

All three chips to be produced in last quarter of 2003 (joint engineering and production runs)

Prototypes for required boards are almost ready for full test of read-out chain

Online System

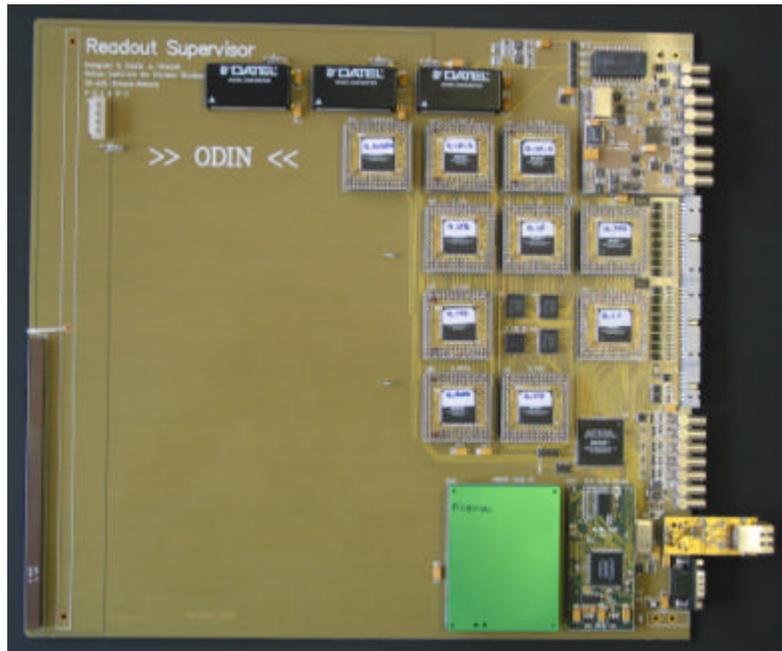


Online System TDR submitted in December 2001 and approved in April 2002

Three major sub-systems:

- Timing and Fast Control (TFC)
- Experiment Control System (ECS)
- Data Acquisition System (DAQ)

Timing and Fast Controls

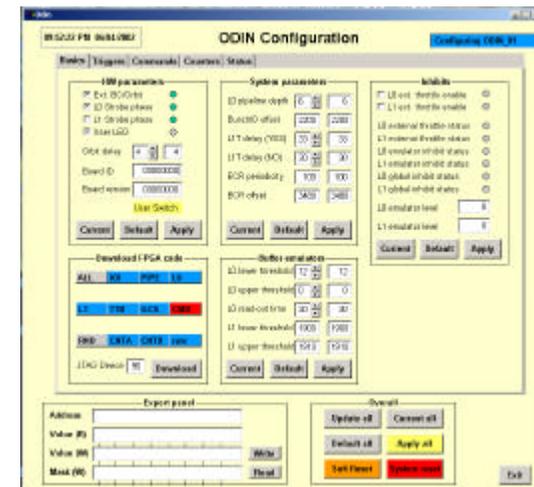


LHCb Readout Supervisor: tests on first prototype in progress, design of second prototype starting

TFC Switch: First prototype built and tested, second final prototype in production

Throttle Switch: First prototype designed

TFC software based on PVSS:
built for testing TFC system, first integration into general ECS



Experiment Control System

➤ JCOP Progress

- Successive releases of the Framework with increasing functionality
- Work on Conditions and Configuration Databases

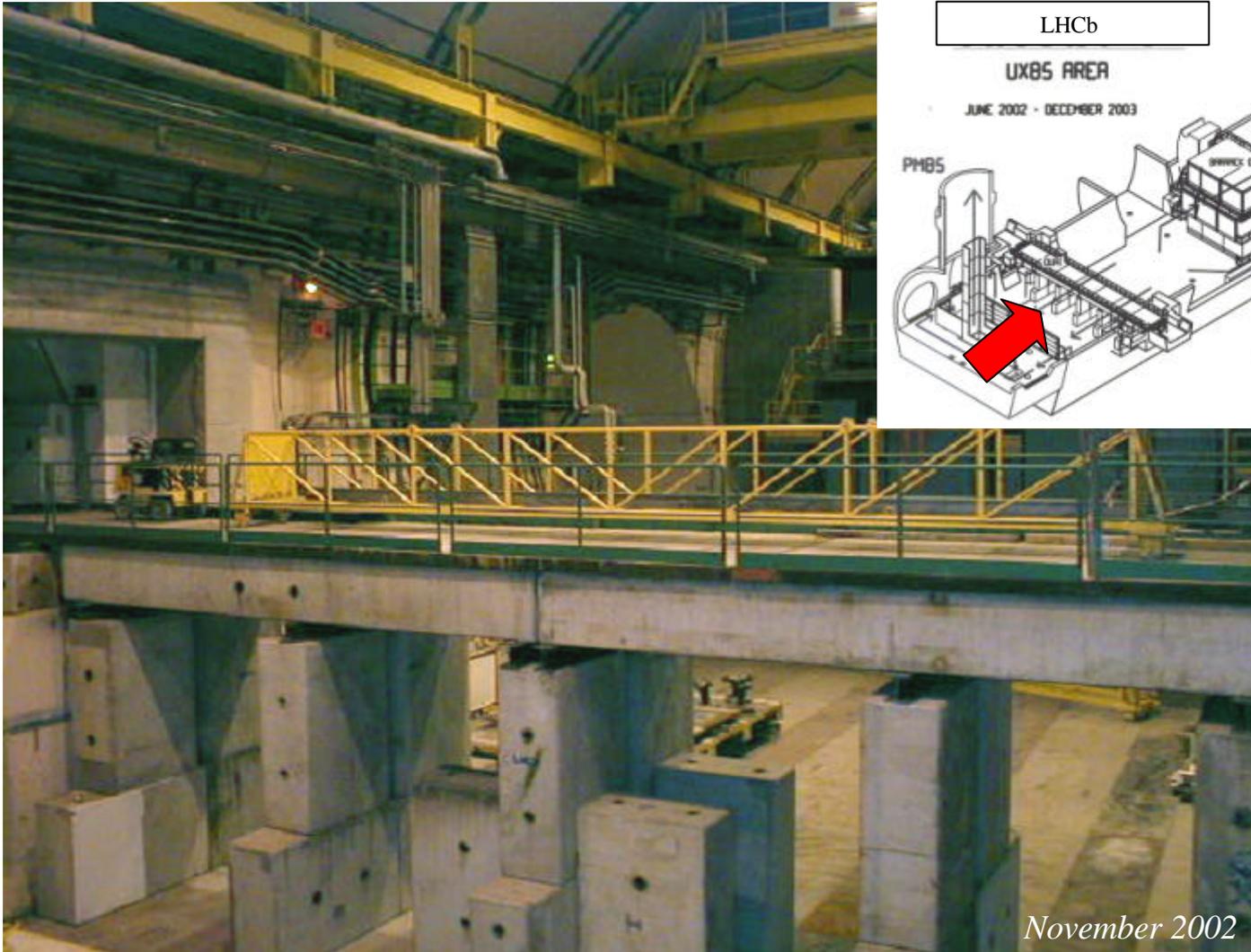
➤ LHCb Specific

- Credit-Card PC
 - **Being deployed to interested groups**
 - **Base software released**
 - **Final Glue-Card designed and prototypes being produced**
- Interface to GAUDI data processing framework developed for controlling and monitoring the Event Filter Farm
- Simulator for HV devices (to test higher level software layers) being developed

Data Acquisition System

- Revisiting the performance requirements in view of LHCb-Light.
- Network Processors: Decision to use the next version of the chip (~4x faster) available summer 2003, gives headroom for performance
- Event-Filter Farm: Event distribution to sub-farm CPUs studied -> performance sufficient

Experimental Area



Summary

- **Magnet:** Production to finish by March '03, assembly and testing in '03
- **ECal and HCal:** Detectors well into production, electronics following
- **RICH2:** first orders placed, production of components to start soon, photon detector development not finished, remains critical
- **SPD and PS:** EDR passed, production to start mid '03
- **Velo, Outer Tracker, Muon Detector:** EDRs in near future, production to start mid '03
- **Experimental Area:** Preparations progressing, start of detector installation depends on timely finishing of LHC machine installation activities