CERN-RRB-2008-096
16 April 2008

Status of the LHCb Experiment

LHCb RRB at CERN
16 April 2008

on behalf of the LHCb Collaboration

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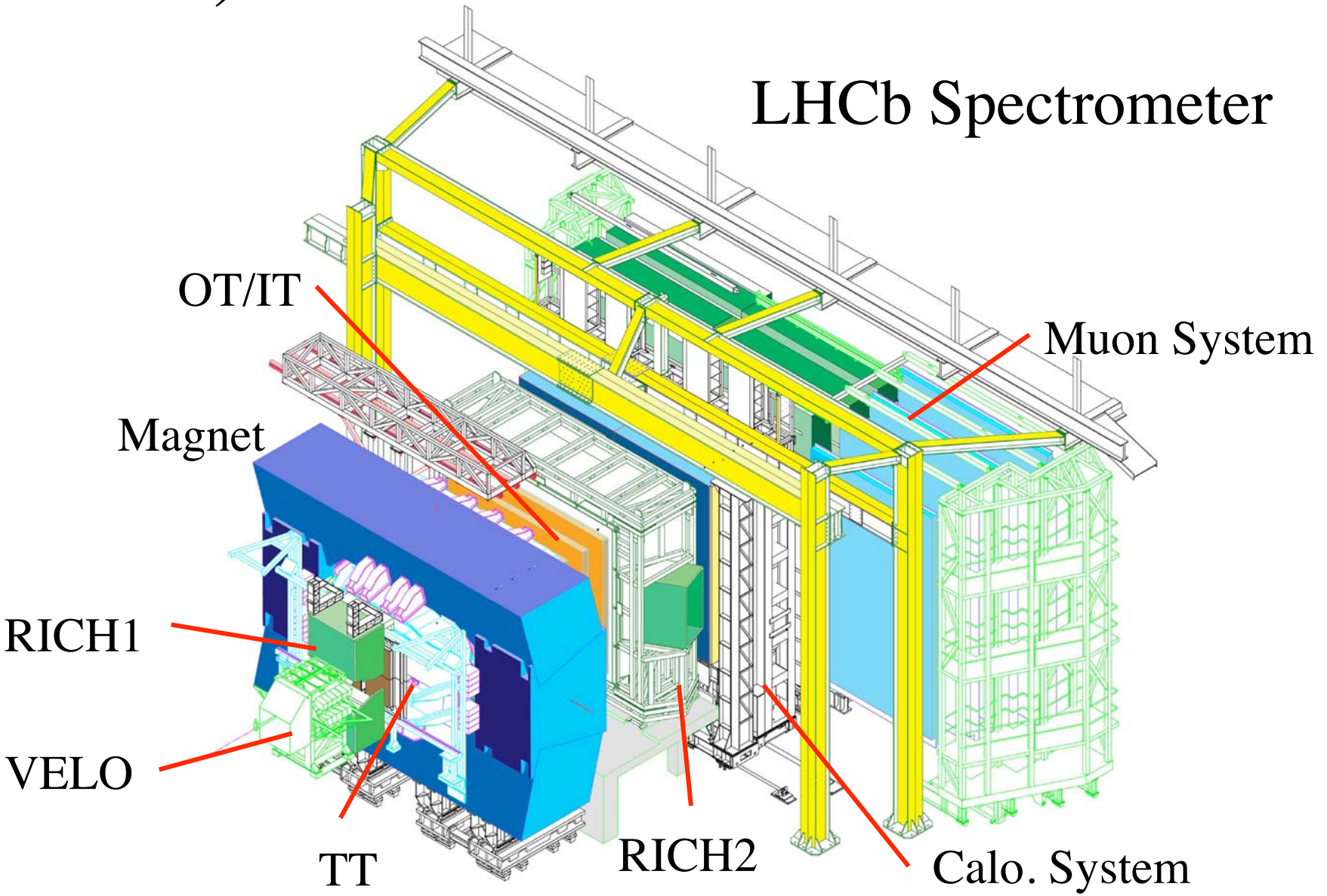
CERN
and
EPFL

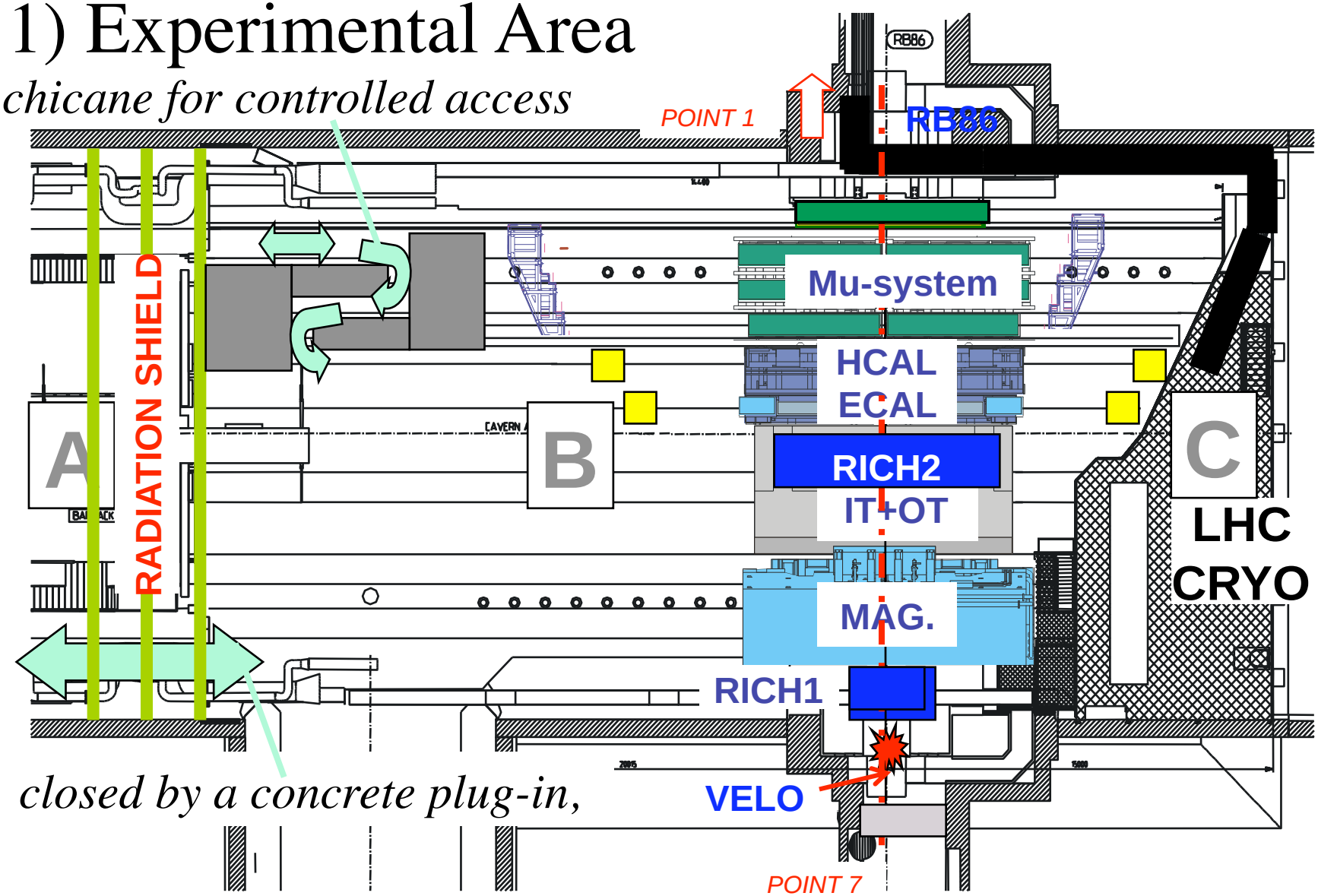
Contents

I) Construction and Installation



1) Experimental Area

chicane for controlled access



closed by a concrete plug-in,

Service infrastructure installed and safety system operational.

Delay in completing the shielding wall →30 Apr 08

All the cooling pipes going through the chicane of the wall had to be replaced between the end of December and beginning of January due to the poor welding quality.
-detector installation and commissioning work also affected-

2) Beam Pipe and Magnet

Vacuum pipe and VELO vacuum tank fully commissioned last autumn and ready to be used.
(currently filled with ultra pure Ne)

Recently evacuated once more and vacuum quality remains good.

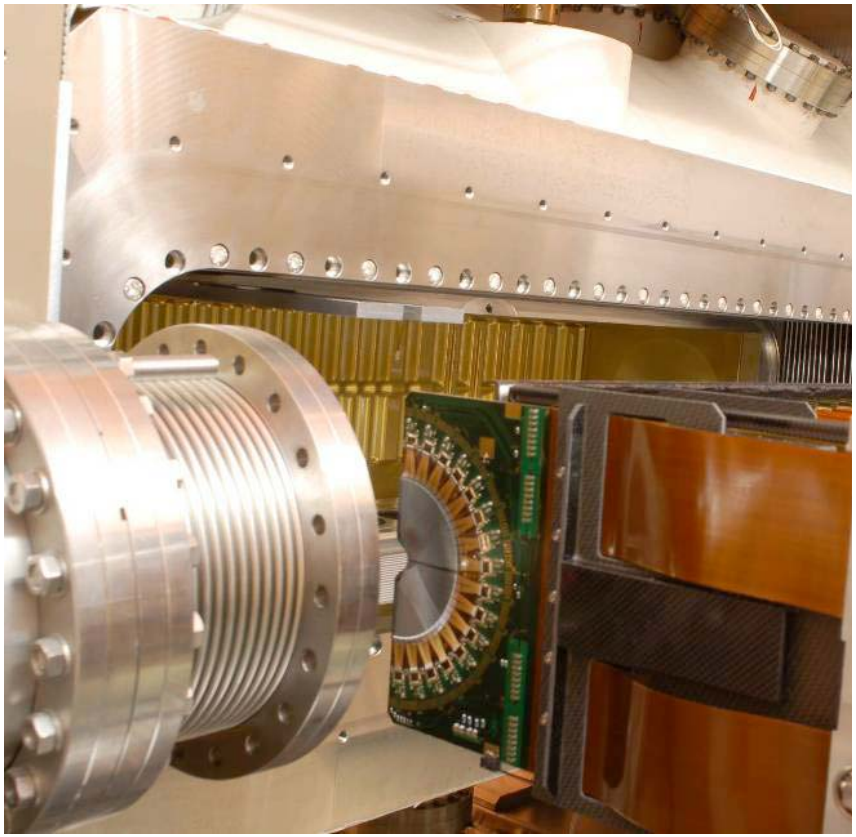
Beam Condition Monitors, produced by the Dortmund group (based on diamond detectors) installed around the beam pipe.

BCM

Magnet fully commissioned and the control has been tested from the CERN Control Centre.

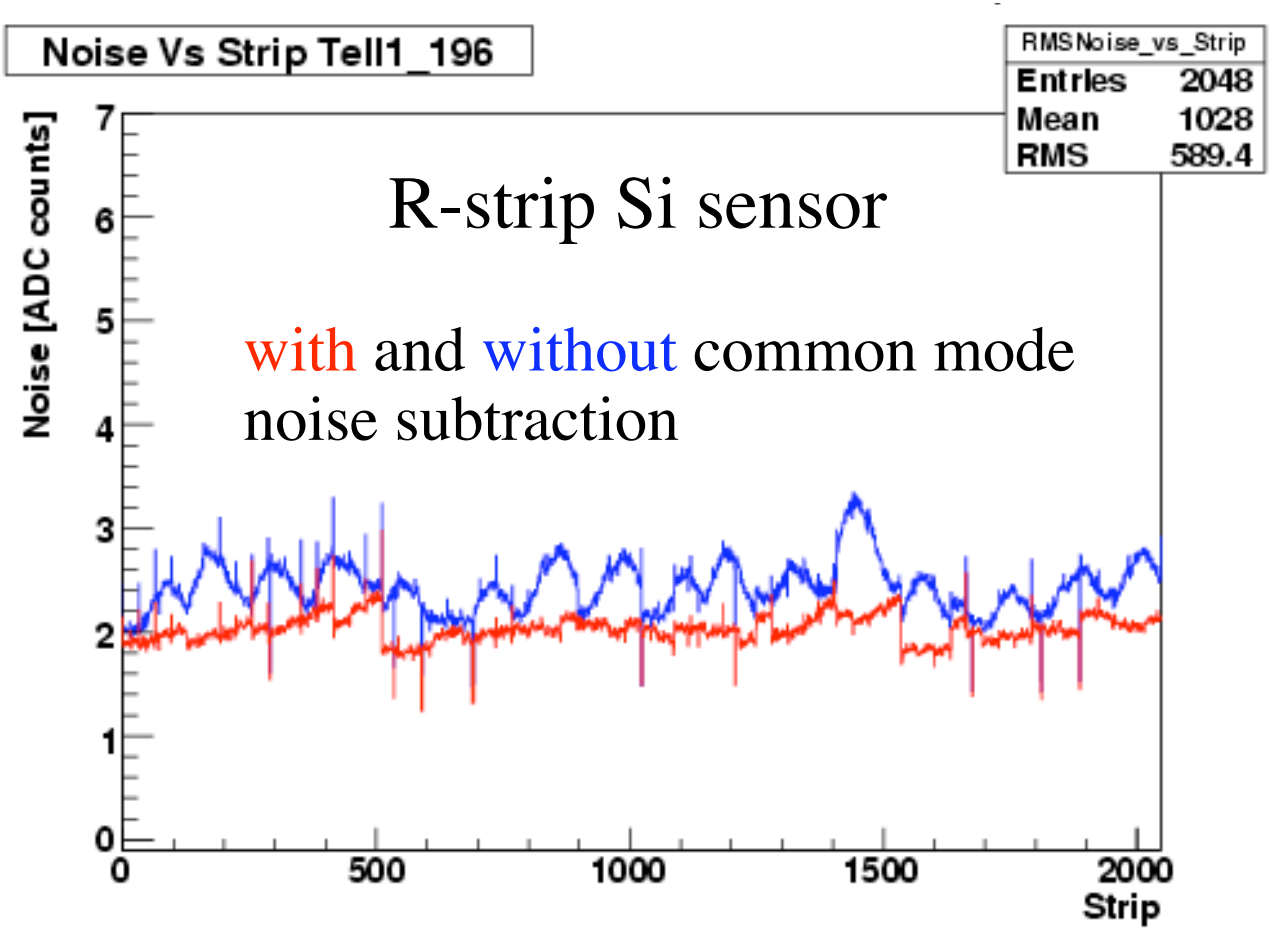
3) VErtex LOcator (funded by CH, DE, GB, NL)

Both detector halves successfully installed.



Commissioning is in progress: somewhat slower since not many modules can be switched on simultaneously, if not under vacuum.

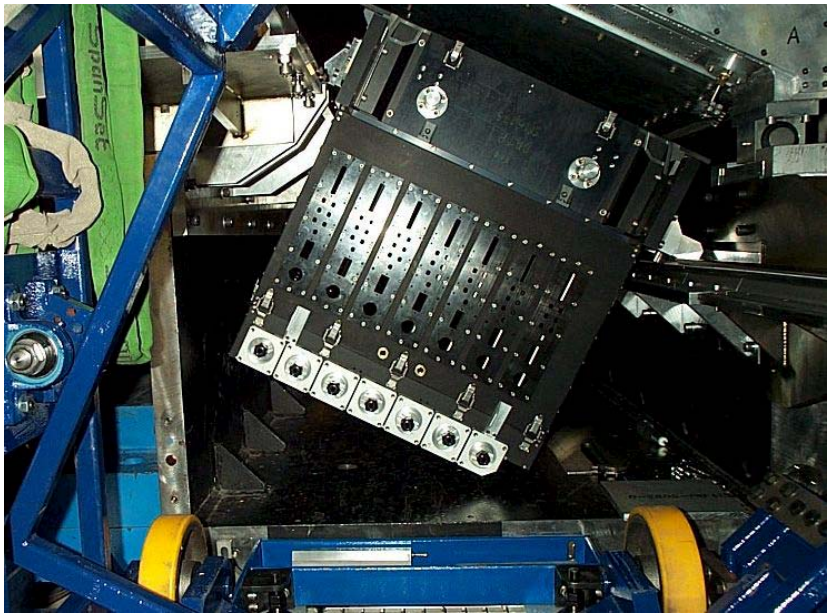
But making good progress.
S/N>20 achieved!



4) RICH (funded by CERN, CF, GB, IT)

RICH-1: remaining parts are now all at CERN,
quartz windows, photon funnels and lower HPD box.

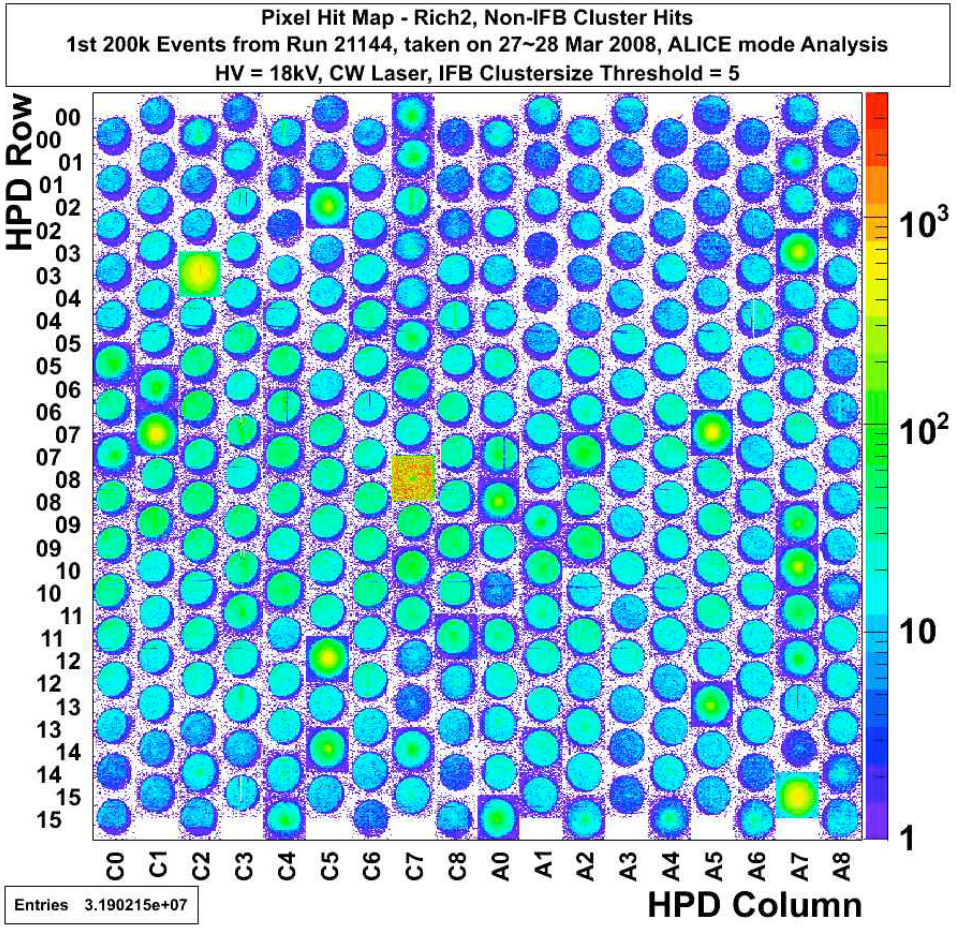
Photon funnel with B field distortion monitoring system mounted



RICH-1 lower HPD box test insertion

Installation will be completed by the end of April
HPD commissioning for the upper box started: all HPDs OK

RICH-2: Completed and commissioning in progress
17 HPD's replaced



Hits from 200k events with CW laser

NB:

A total of ~300k pixels.

No threshold tuning yet.

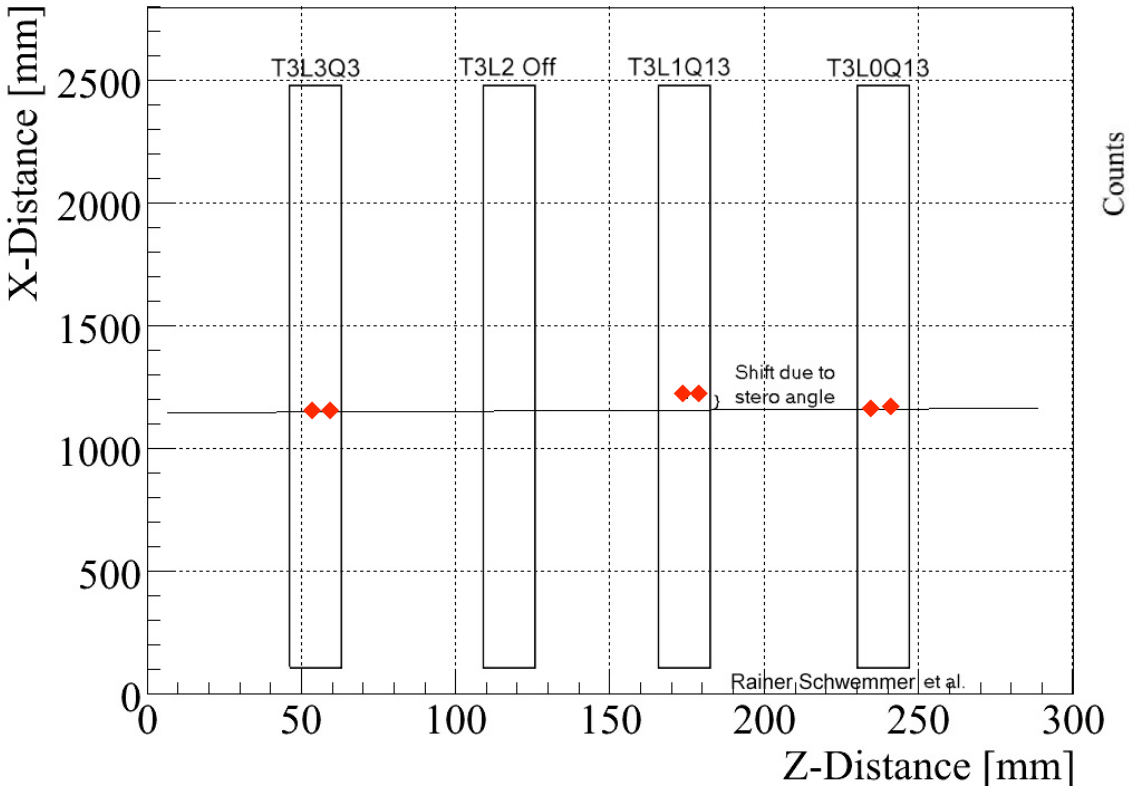
Log-scale colour coding.

A few more HPDs may need to be replaced during the 2008/09 shut down.

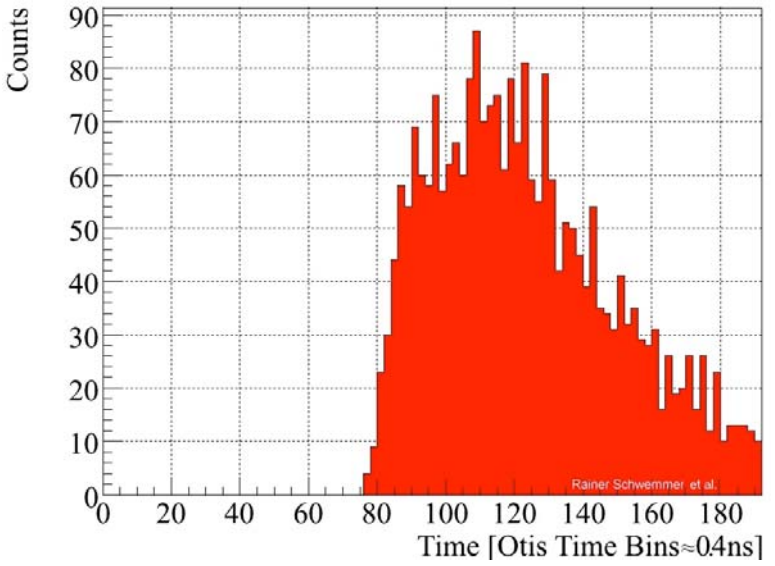
5) Outer Tracker (funded by CERN, CF, CN, DE, NL, PL)

-detector installation completed + 80% of the FE electronics boxes installed (100% by the end of April)

-commissioning with cosmic muons (special trigger)

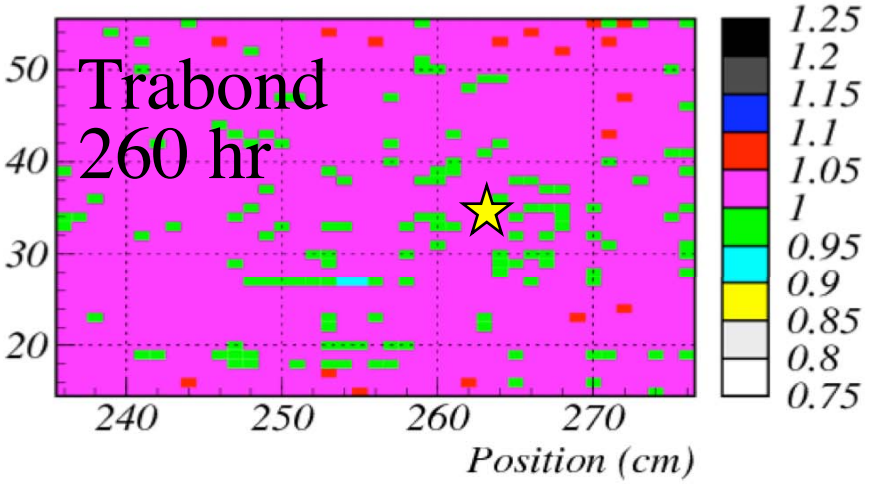


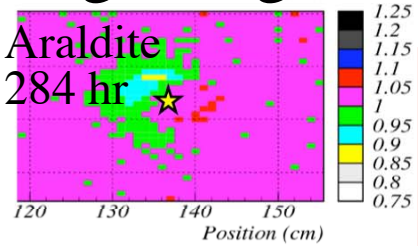
a track in the horizontal plane



drift time distribution

One long module with identical material to the production module, except using Trabond rather than Araldite, produced and being tested: so far no clear sign of gain loss seen.



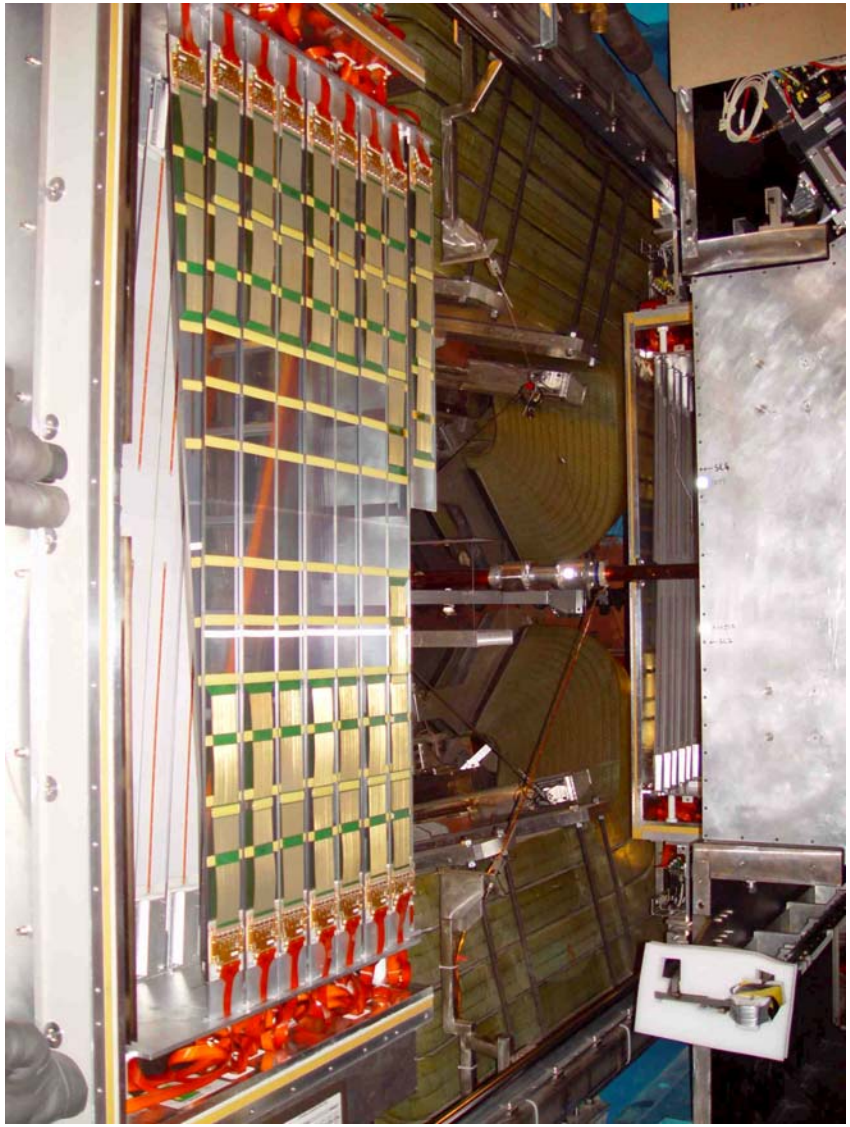


Cause of gain loss identified

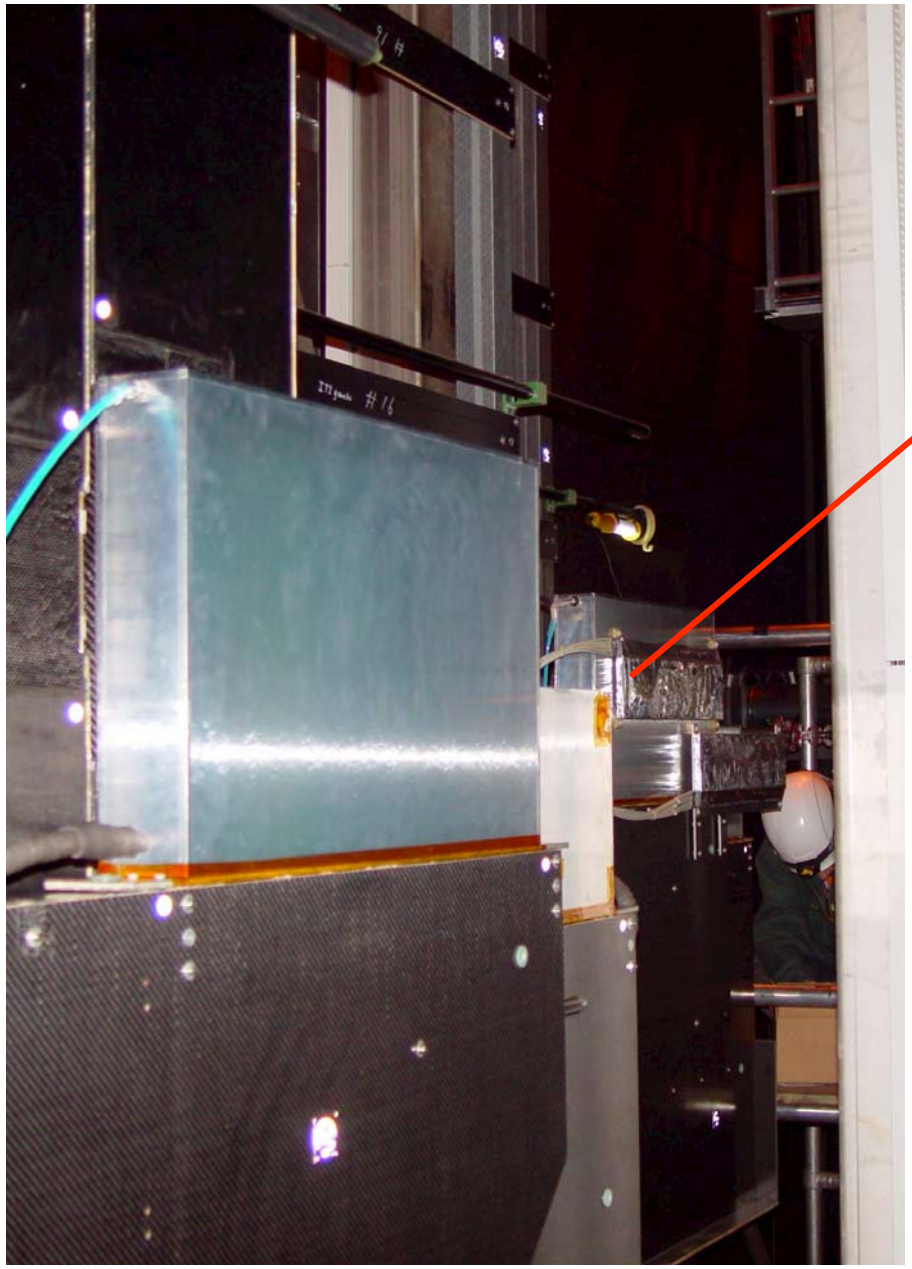
Heat treatment in-situ has started: 2 C-frames heated.

~4 C-frames by the end of April
In-situ gain measurements with source in progress

6) Silicon Tracker (funded by CERN, CH, DE, ES, UA)



TT Si sensor ladders
A side 100% installed
and tested
few connection problems
being fixed
C side 80% installed
test in progress



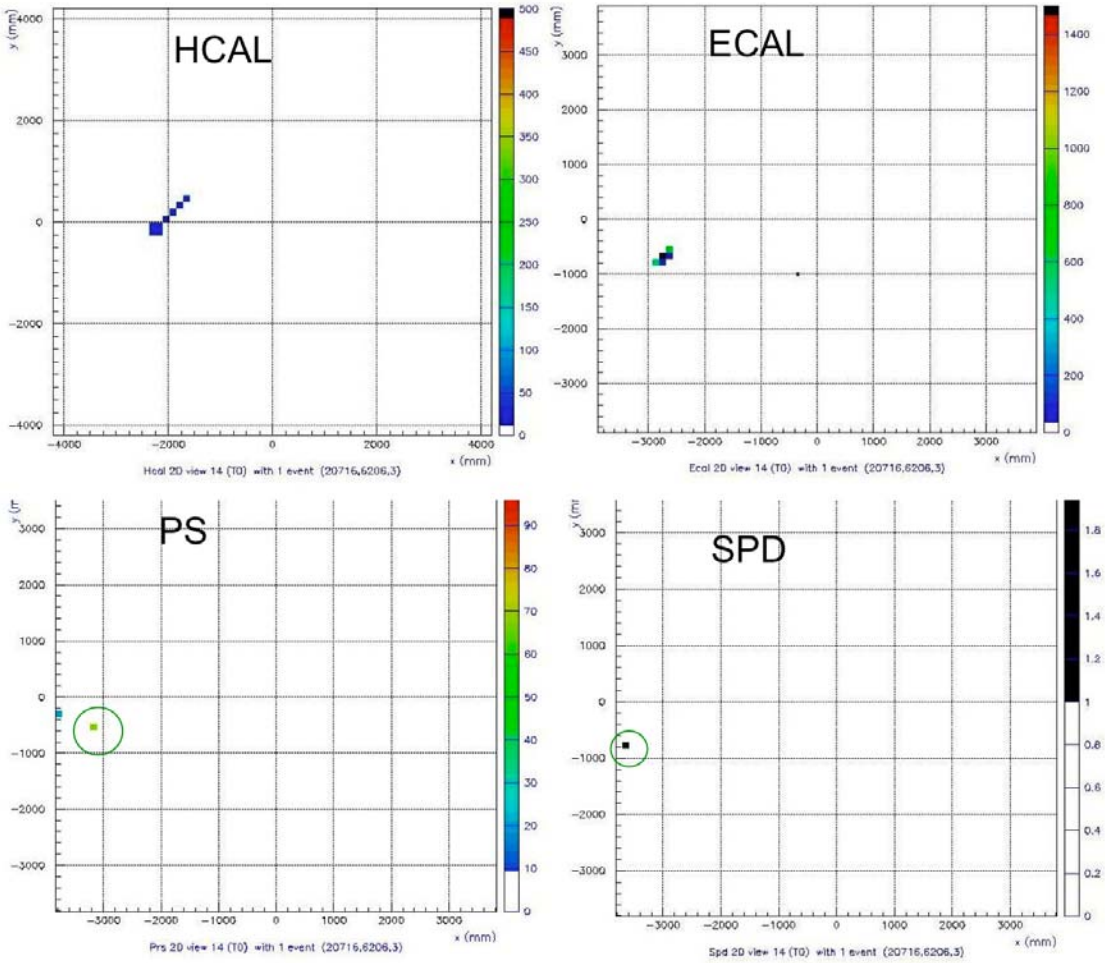
All IT sensor boxes (12) installed and connection test started.
-two already tested-

Radiation Monitoring System
Four very thin metal foil detectors (made by the Ukrainian group) installed in front of IT boxes of T2.

7) Calorimeter System (funded by CERN, CF, ES, FR, RO, RU, UA)

All the detector and electronics installed and cabled.

Commissioning well advanced.

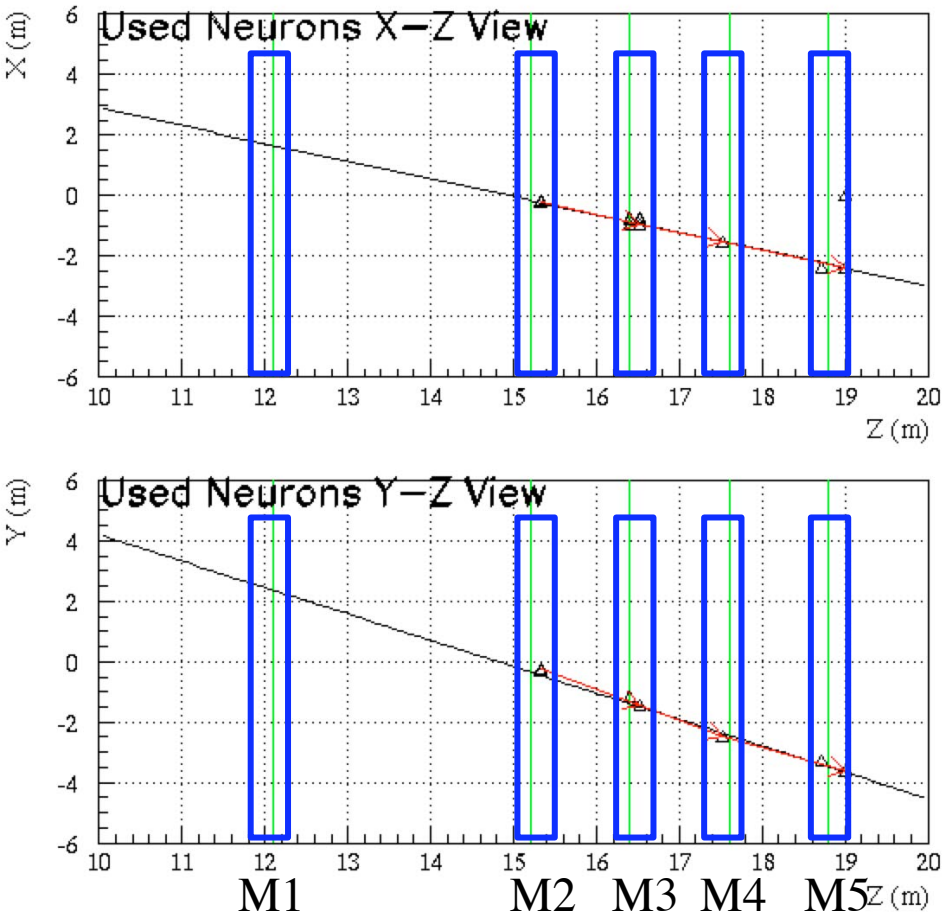


Cosmic ray seen by the all four detectors of the Calo system

Calo system is now able to provide L0 cosmic signal for the global commissioning.

9) Muon System (funded by CERN, CF, IT, RU)

All MWPCs installed for M2-M5
Commissioning work in progress: connection, timing, HV, readout, etc.



L0 cosmic signal with M4-M5 coincidence
→ clean comic ray with low number of hits

Muon system is now able to provide L0 cosmic signal for the global commissioning.

Installation of the infrastructure for the M1 wall, i.e. gas pipes and cables are in progress.

Cable chains installed.

After the installation of the signal cables, mount as many chambers as possible.

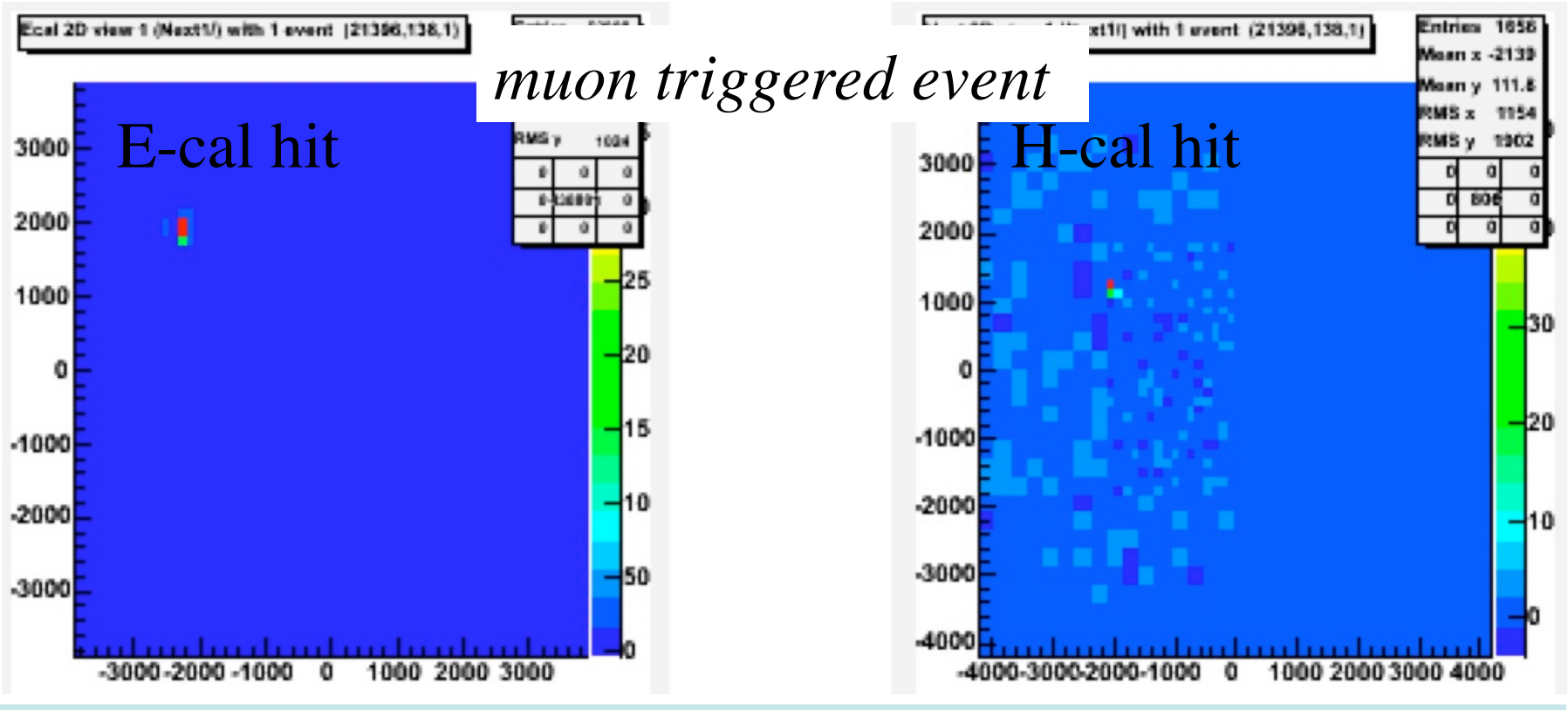
10) Trigger and Online

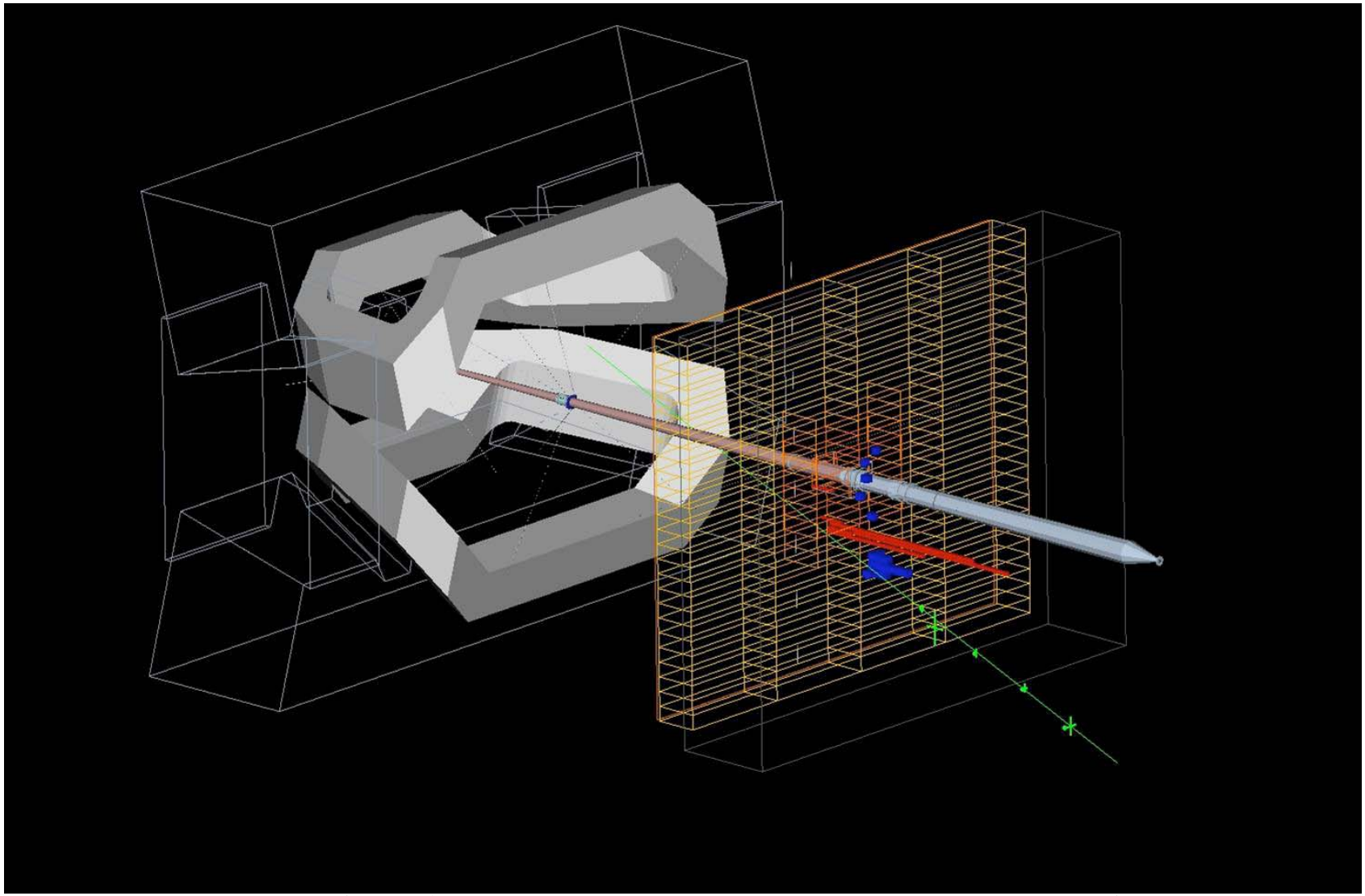
(funded by CERN, CF, CH, DE, FR, ES, GB, IT, NL)

All the Level-0 trigger boards in hand, being commissioned

In the global commissioning, Level-0 decision was made based on Calo or Muon L-0 cosmic signals and readout most of the detector subsystems (some are electronics only)

muon triggered event

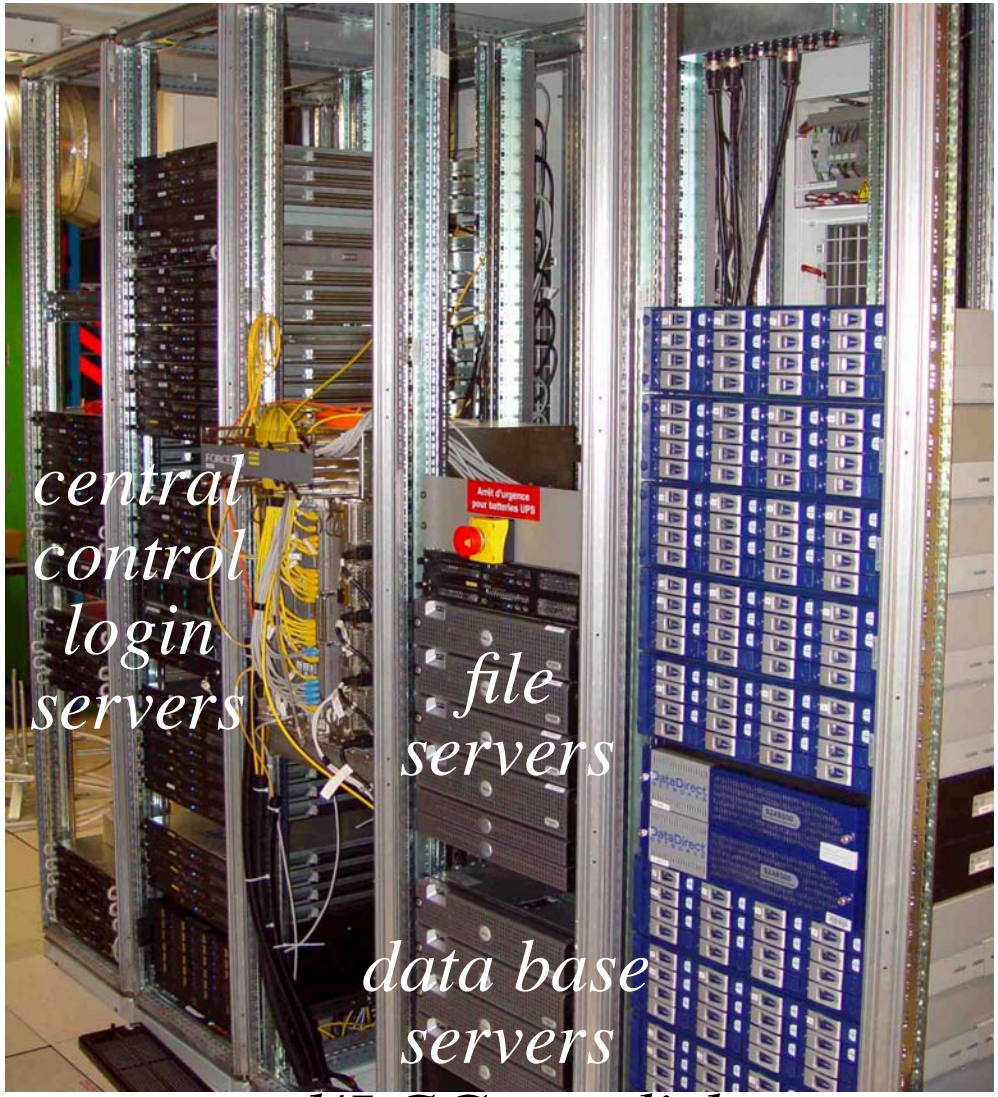




3D event display for an L0 muon triggered event

Next step is to include OT.

Online system @ surface



Online System

Consolidating the installed equipment.

Starting with 20% of network switch and CPU farm capacity.

The rest to be purchased toward the end of 2008 for the 2009 run.

Integration and improvement of online and control software through regular global commissioning.

control room @ surface

11) Computing

Physics quality software in place

Event reconstruction ready for real data,
track finding found to be robust against misalignment.

Tracking framework is now identical for offline and HLT.

Measured B field implemented and ready for test.

LHCb Common Computing Readiness Challenge

Simulating real data taking situation with four experiments
IP8-control-room → Tier-0 → Tier-1's
with nominal DAQ rate = 35 kB/event @ 2 kHz: 70 MB/sec
alternating 6 hours on 6 hours off (50% duty cycle)
start event reconstruction automatically @ Tier-1

successfully executed

II) Early Physics

Discussion on more concrete plan for the first physics with very few data, including a case for < 1 pb^{-1}, has started.

After initial calibration and alignment,
some physics can be done with <10^8 Min.Bias events
→ No HLT required

inclusive "low p_T" physics
particle ratios +/−, π/K/p, $\Lambda/\bar{\Lambda}$ vs $d\eta dp_T$
Λ polarization
hyperon production

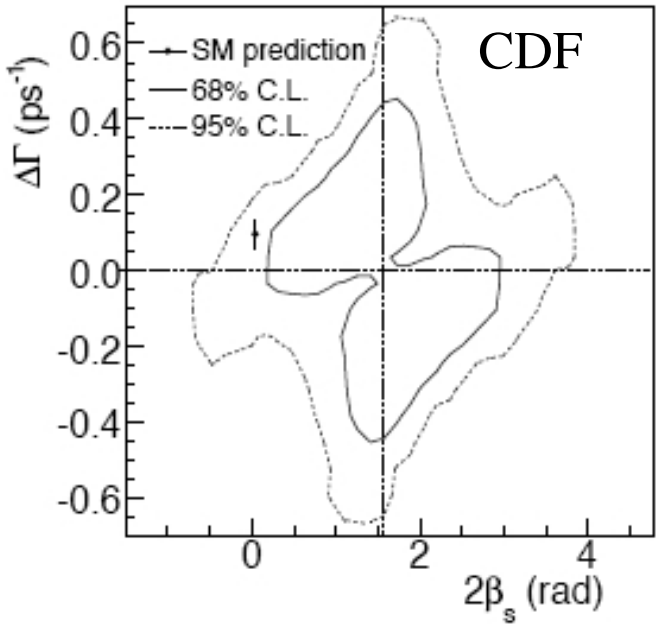
inclusive J/ψ for c and b production
and exclusive $D^0 \to K^-\pi^+$ and $D^+ \to K^-\pi^+\pi^+$
-those channels are also useful for momentum and PID calibration-

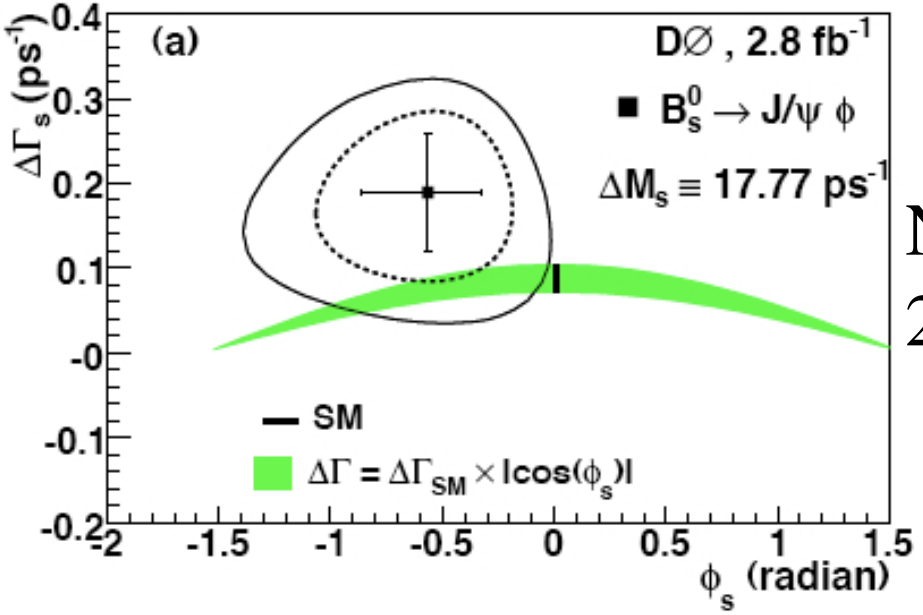
Physics with exclusive B decays requires HLT
5σ observation of "rare" decays needs up to 2 pb^{-1}

Lumi(pb^{-1})	Channel	MinBias events
0.009	$B_d \to D^{*-}\mu^+\nu$	$9.0 \cdot 10^8$
0.039	$B_u \to J/\psi(\mu^+\mu^-)K^+$	$3.9 \cdot 10^9$
0.046	$B_d \to D^+\pi^-$	$4.6 \cdot 10^9$
0.062	$B_d \to J/\psi(\mu^+\mu^-)K^{*0}$	$6.2 \cdot 10^9$
0.418	$B_d \to K^+\pi^-$	$4.2 \cdot 10^{10}$
0.427	$B_s \to J/\psi(\mu^+\mu^-)\phi$	$4.3 \cdot 10^{10}$
0.500	$B_s \to D_s^-\pi^+$	$5.0 \cdot 10^{10}$
1.176	$B_d \to K^*\gamma$	$1.2 \cdot 10^{11}$
1.490	$B_s \to K^+K^-$	$1.5 \cdot 10^{11}$
2.101	$B_d \to \pi^+\pi^-$	$2.1 \cdot 10^{11}$

And with more data…

CDF and D0 studied time dependent CP asymmetries in $B_s \to J/\psi\phi$: very small in the standard model





NB

$2\beta_s = -\phi_s$

NB: If there were indeed New Physics as suggested by M. Bona et al. (arXiv:0803.0659), who combined all the CDF and D0 results, LHCb would see a 5σ observation of $\not{CP}$ in $B_s \to J/\psi\phi$ with ~200 pb^{-1}, i.e. 10% of nominal year of data.

III) Cost and Funding

No change since the last RRB in October 2007

i.e.

Cost: 75.341 MCHF

Funding: Fully funded, with the second instalment from US-NSF for the extra contribution to the CPU's via Syracuse (200 kUSD) expected by Nov 2008

-Issue of the VELO full replacement detectors

As already presented during the last RRB,
100% of 42 sensor modules needed after $\int L dt = 6$ fb^{-1}
due to the irradiation (cf. nominal LHCb physics 10 fb^{-1})

50% of them (21 modules) already required as spares in case of a severe beam related accident, covered by VELO groups

Remaining 50% can be considered as a common item according to the MoU for M&O, Annex 7

Annex 7 : LHCb Common Items for M&O Costs

For M&O costs, the following subsystems shall be treated as Common items:-

The Magnet
Infrastructure
Data Handling (DAQ & DCS)
plus other items as listed in Annex 9 below.

If radiation damage necessitates the replacement of certain detectors, these detectors may become a Common Item regarding M&O.

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-Our proposal:

Share the investment cost for the 21 modules (496 kCHF), pro rata, over 5 years (corresponds to 4.5% increase of M&O Cat. A)

Item	Cost (kCHF)
Si	180
Pitch adapter	70
Hybrids	65
TPG substrates	38
Kapton flat cables	23
Other items (transport, additional tooling, etc.)	120

NB:
A document including the cost estimate submitted and endorsed by LHCC

NB: after $\int L\ dt = 6\ fb^{-1}$

Si sensors and detector bases will be activated

may need to follow lengthy radiation safety procedures for the replacement operation: e.g. cool down period, limited working hours, restricted working space, etc.

→ replacement operation might take longer than the normal annual shutdown period…

pre-mounted two detector halves would be an advantage

would require two new detector bases with cables etc.

Decision to be taken in future once we have a better knowledge of the irradiation at LHC and of shutdown scenario, and if required, funding method would then need to be discussed

-Issue on the replacement for UX85/3

(3rd Be section of the beam pipe)

Leaks due to the non-conformal Be material

Fixed currently by varnishing and operational

However, no long term guarantee under irradiation

→ CERN vacuum group (AT-VAC) has requested to procure replacement piece

Investigation being continued in collaboration with AT-VAC

-finally responsible for the procurement and operation-

Current indication is:

procurement could be possible within the available funds from CERN

IV) Collaboration issues

New collaborator: Moscow State University, Russia

- 3 PhD's and PhD students
  - Team leader: P. Ermolov

Area of contribution:

- Muon and VELO, where manpower needed
- Additional Tier-2 activity

NB

- Russia: in the LHCb experiment since the beginning
  - CORE contribution, 2.5 MCHF
  - Crucial role in the detector construction for
    - Muon (PNPI), Calo (BINP, IHEP, INR, ITEP) and Radiation Calculation (BINP)
  - Computing (Tier-2 federation) and physics

New management will take over from 1 May 2008

Spokesperson:
Andrey Golutvin, Imperial College (since 4/2008) and ITEP

Deputy Spokesperson:
Andreas Schopper, CERN

Technical Coordiator
Werner Witzeling, CERN

Resource Coordinator
Olav Ullaland, CERN

} unchanged

V) Conclusions

1) All the subsystems needed for the 2008 run have been installed, except 1/4 of TT ladders and RICH-1 mechanics (quartz windows, photon funnels and the lower HPD box). Expected to be complete by the end of April.

2) M1 installation will continue as long as possible.

3) Commissioning work is in progress and Level-0 trigger now provides cosmic muons (with Calo- or Muon system).

4) Preparation for early physics is underway.

5) Eagerly looking forward to the first data in summer.

6) VELO replacement modules for beyond 6 fb^{-1} needs from the collaboration 496 kCHF. LHCb would like the RRB to agree in principle to the pro rata share of this, spread over the coming 5 years, i.e. 4.5% of M&O Cat.A.