

CERN-RRB-2007-096

24 October 2007

Status of the LHCb Experiment

LHCb RRB at CERN

24 October 2007

on behalf of the LHCb Collaboration

Tatsuya NAKADA

CERN

and

EPFL

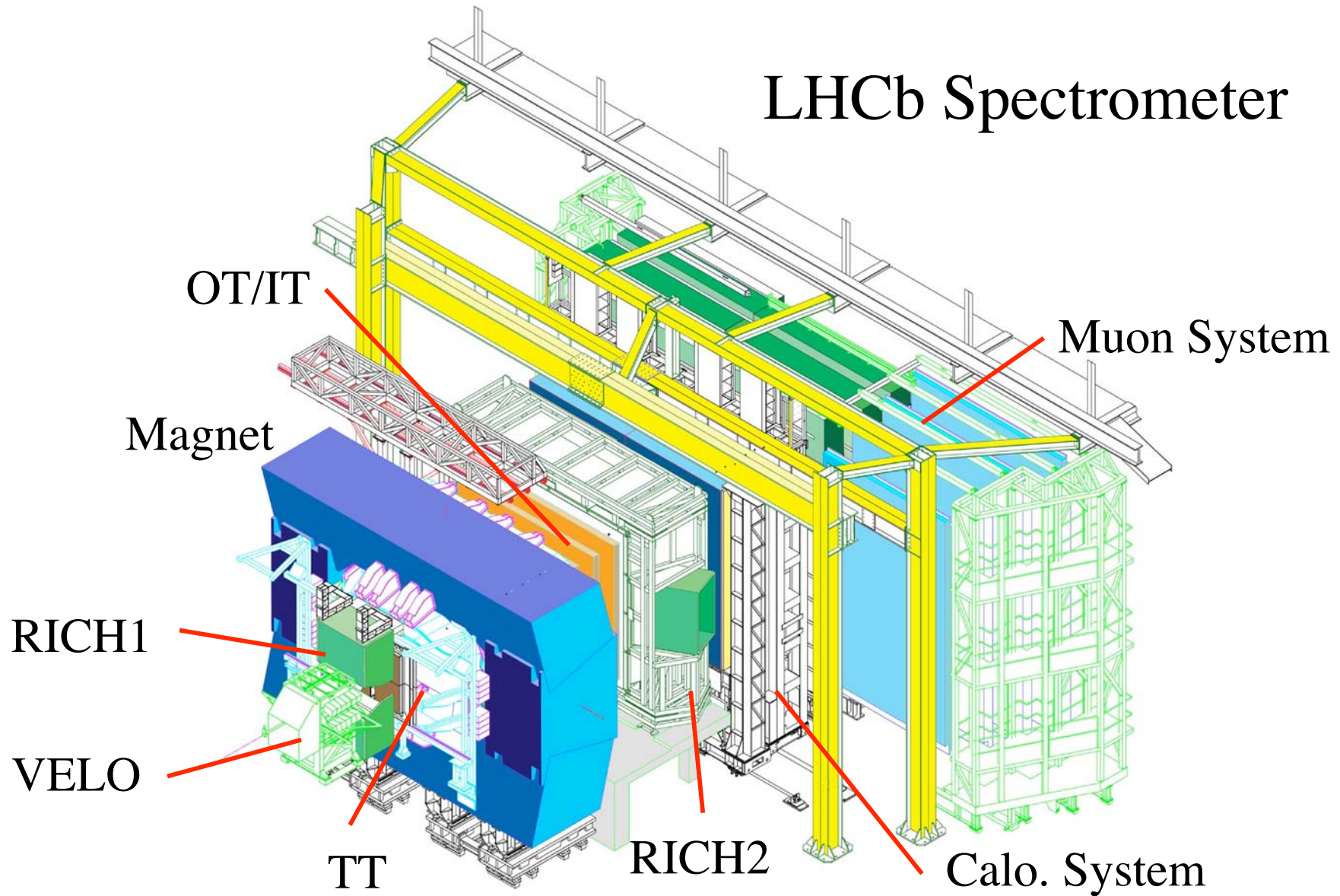


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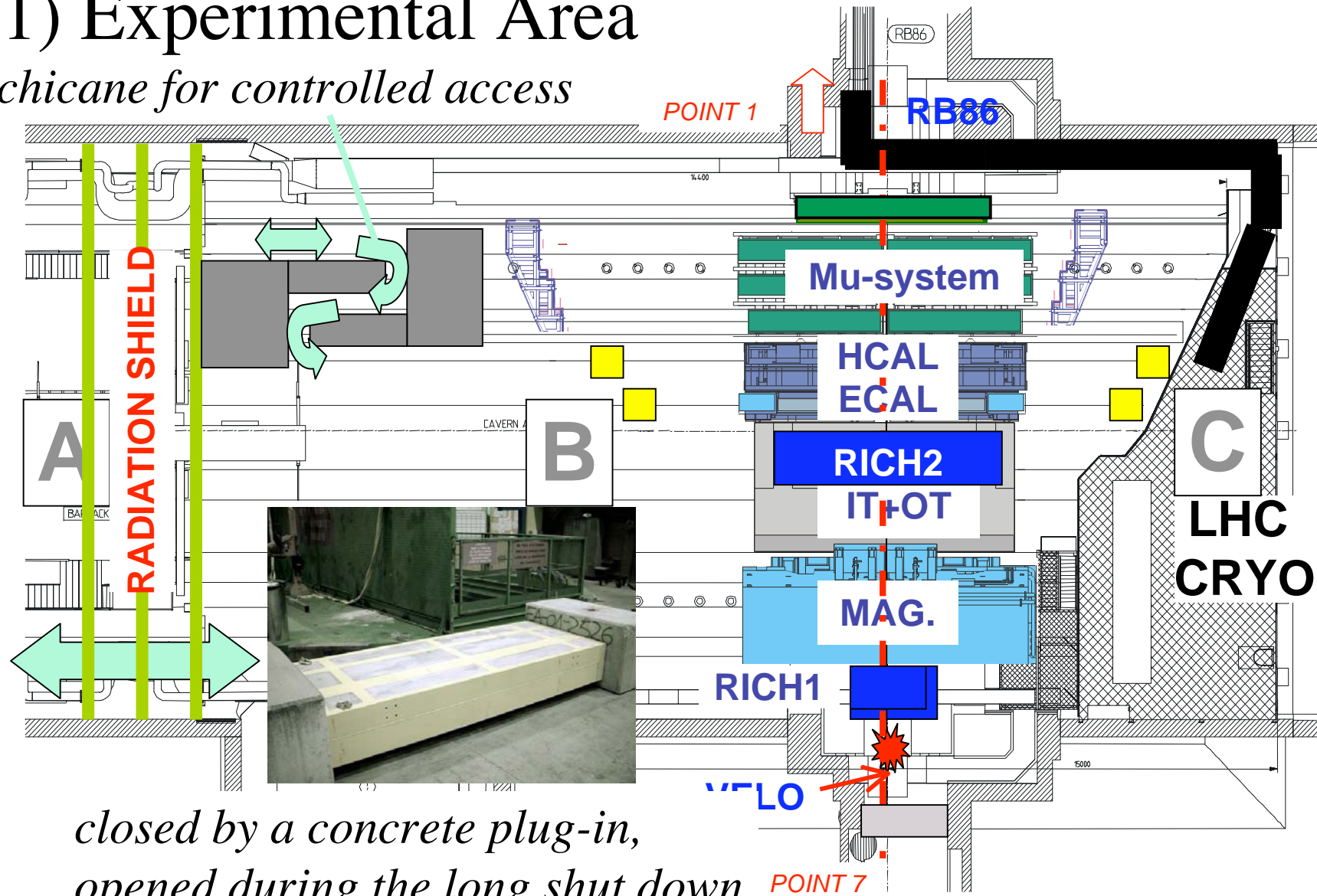
I) Construction and Installation

LHCb Spectrometer



1) Experimental Area

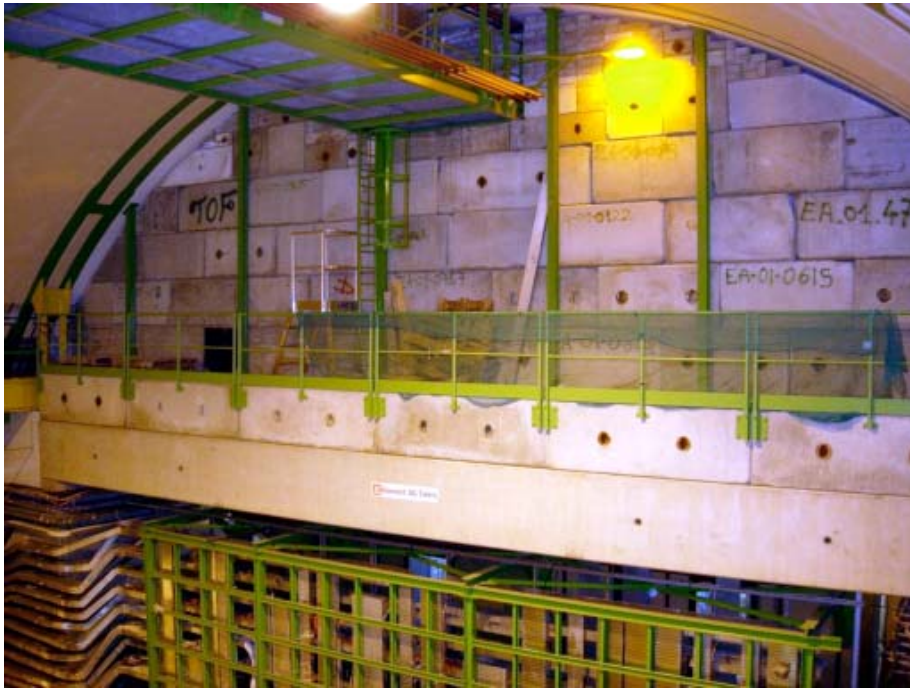
chicane for controlled access



*closed by a concrete plug-in,
opened during the long shut down*

Shielding wall

Upper part
of the radiation shield
completed

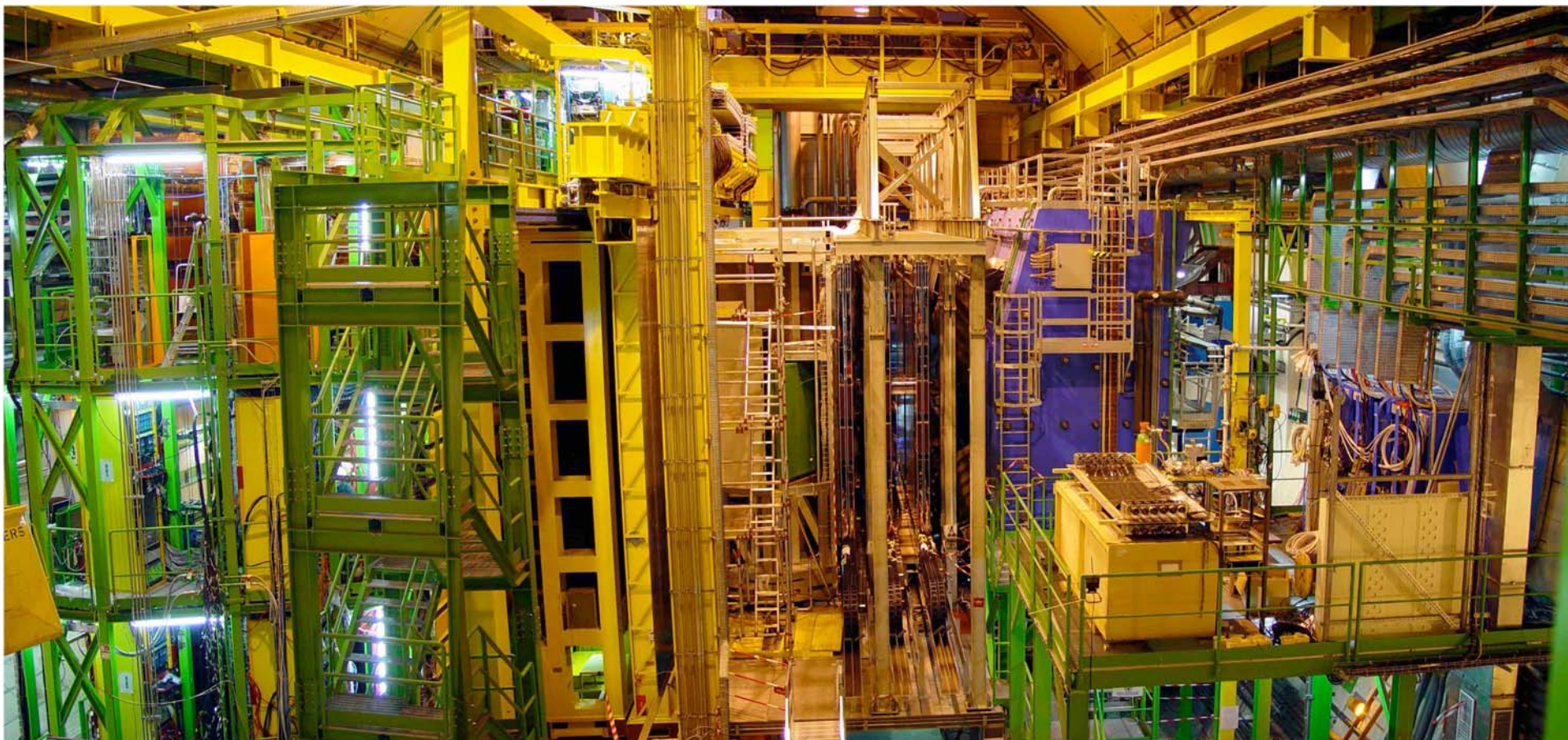


Lower part
of the radiation shield

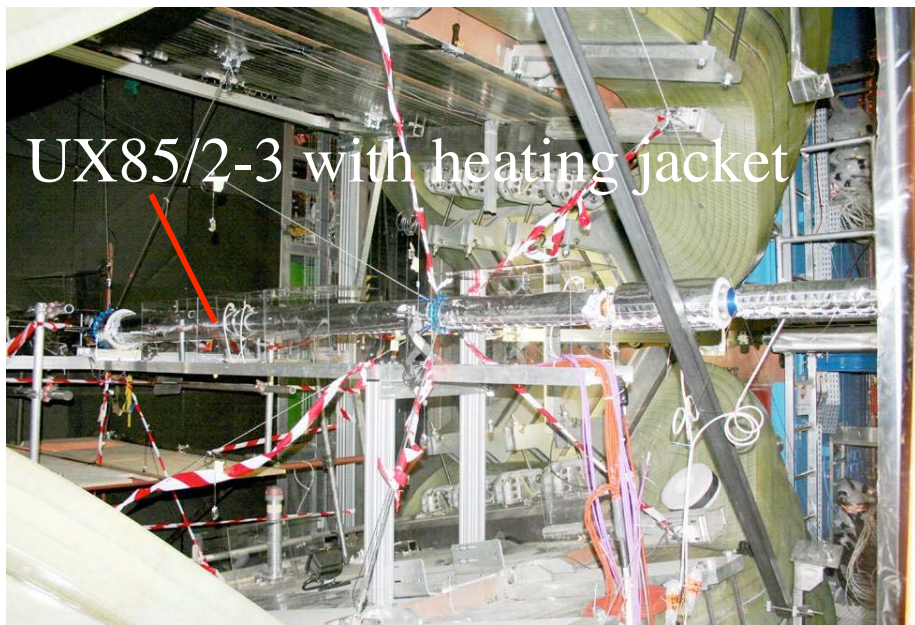
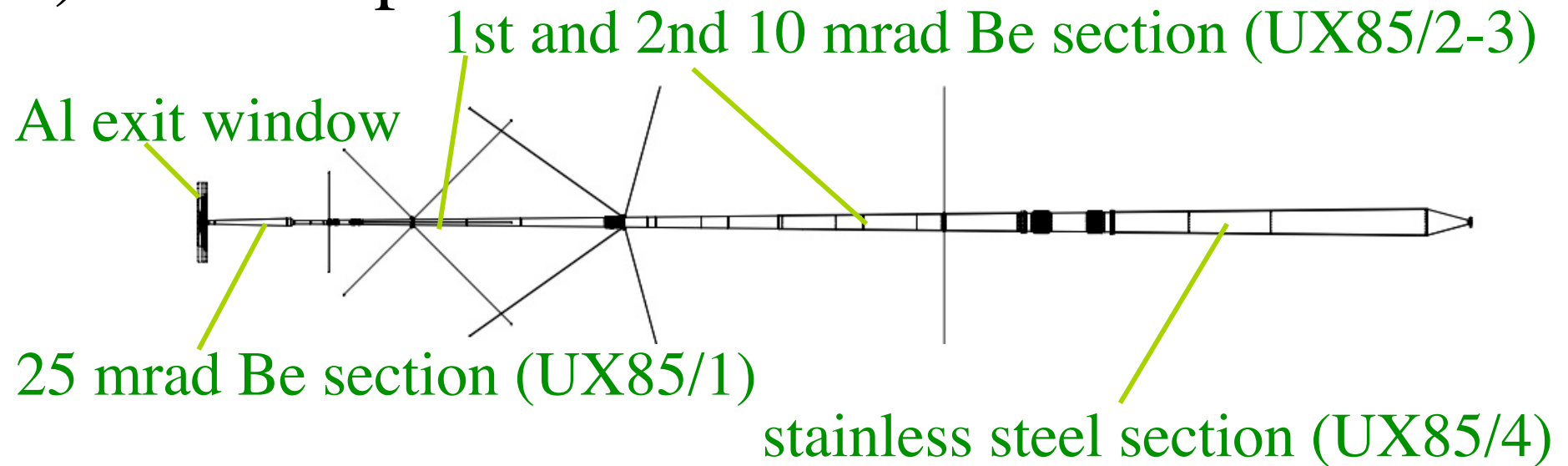


To be completed by the end of December

IP8 now

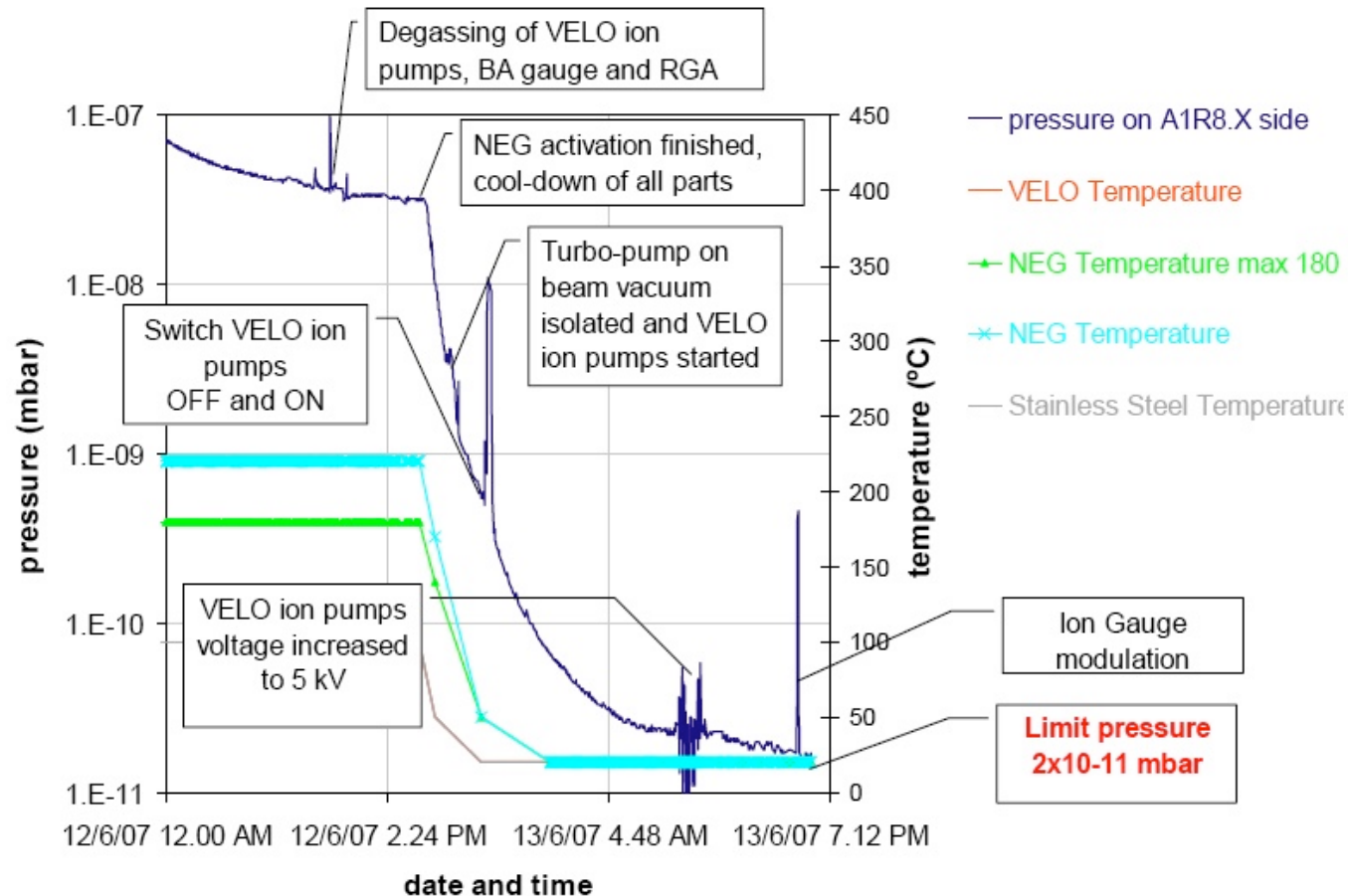


2) Beam Pipe



vacuum pipe and
VELO vacuum tank fully
baked out and filled with ultra
pure Ne, ready to be used.

residual pressure within the specification

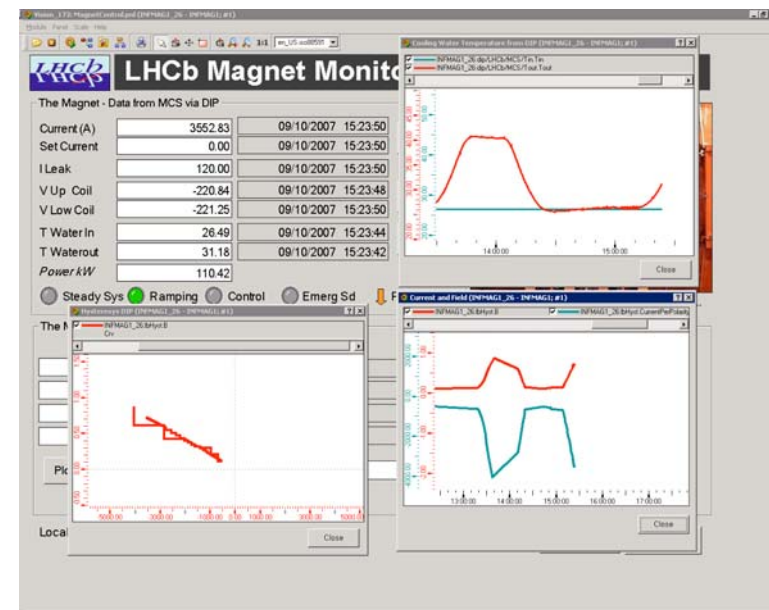
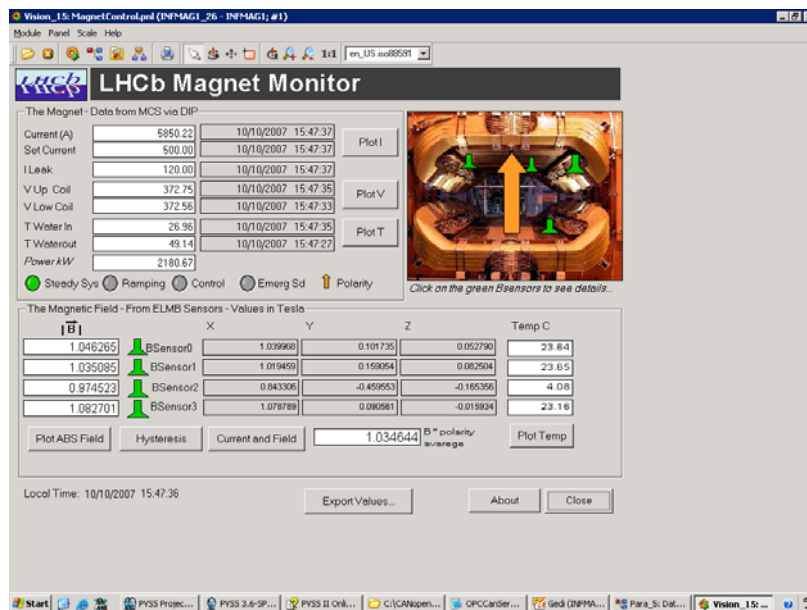


Leaks in UX85/3 repaired by varnishing
serious concern for long term stability due to radiation
LHC vacuum group (AT/VAC) requesting to prepare a replacement piece
In case of accident, Al spares for the Be sections being made by CERN

3) Magnet (funded by Common Fund)

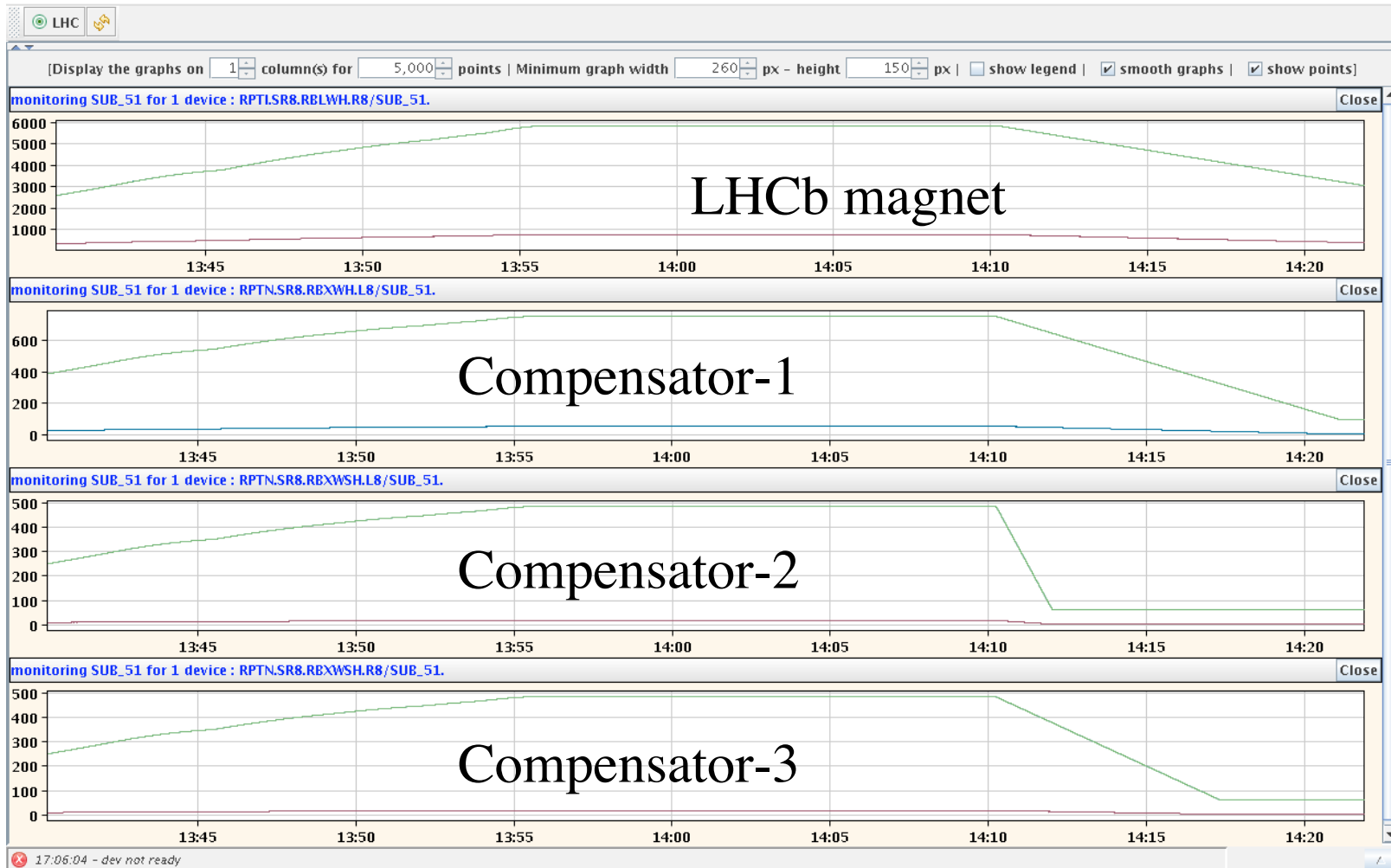
Magnet was commissioned two years ago, since then, several technical consolidations implemented

Switched on again 5th of October!



Operation being monitored by ECS

Magnet operated from CERN Control Centre (machine operation centre) together with the compensating magnets



Successfully completed!

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

Both detector halves completed and ready to be installed.

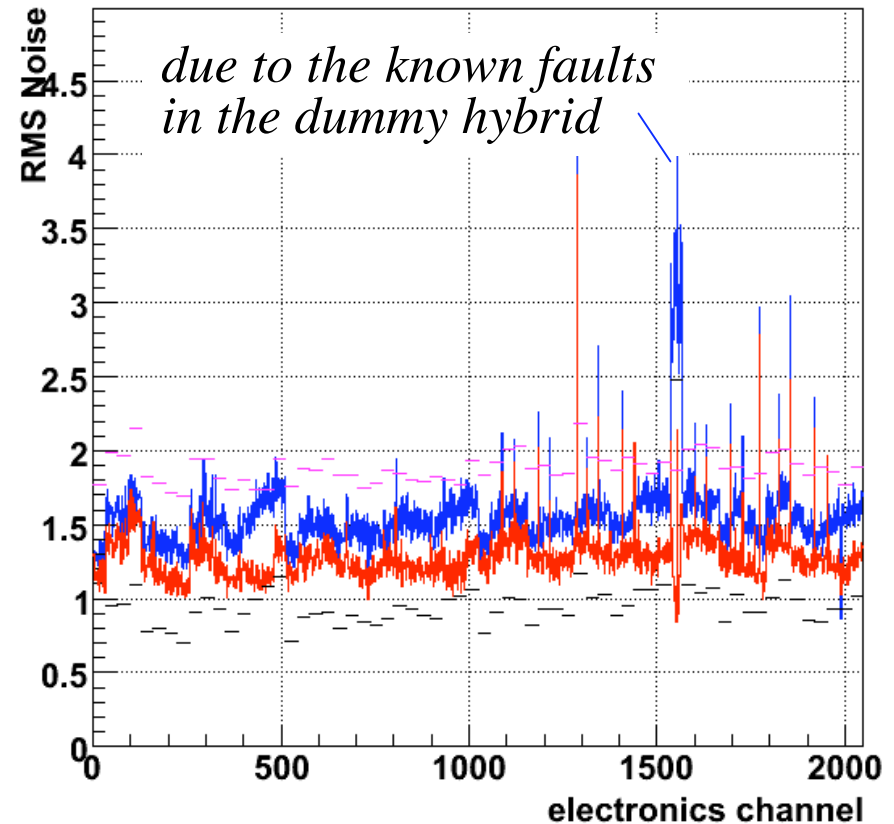


They are already down in the pit

CO₂ cooling system commissioned



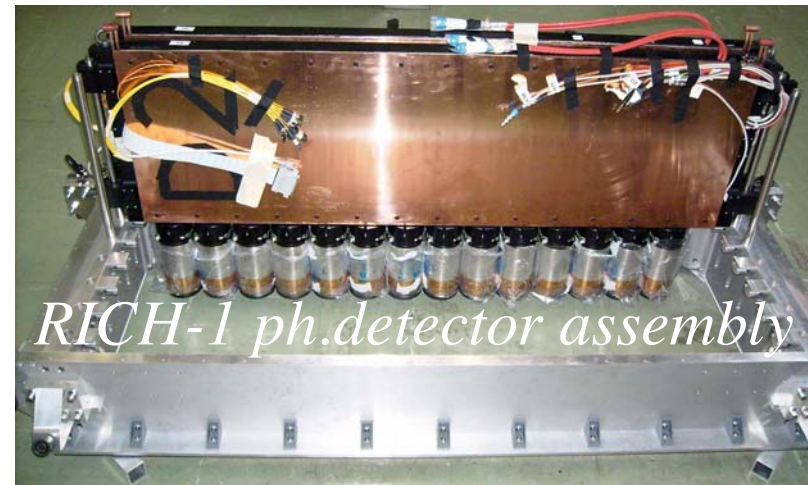
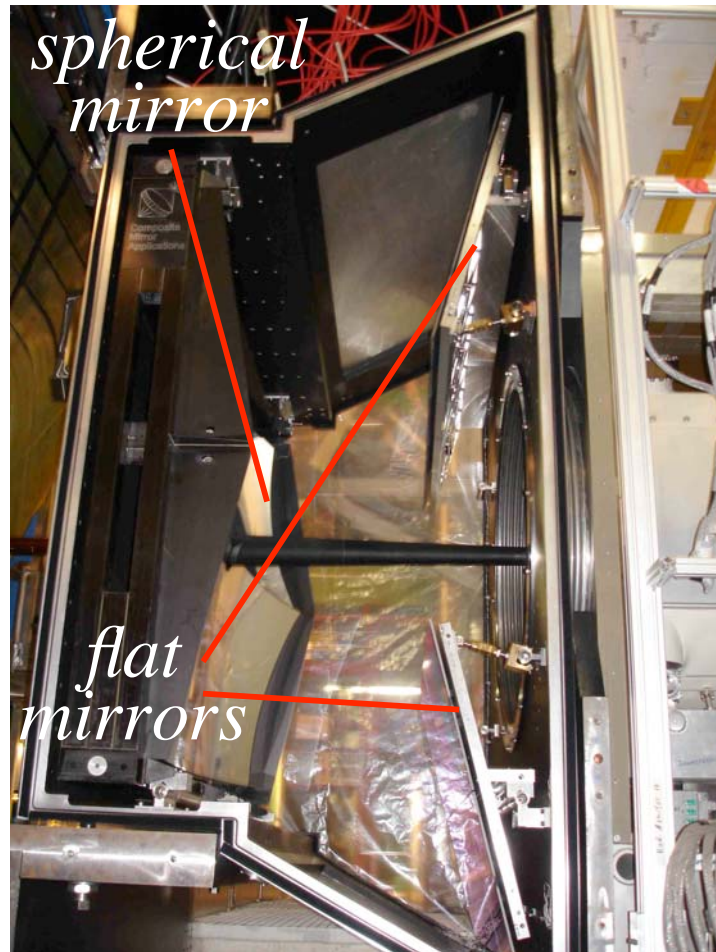
Full readout chain with a dummy hybrid



RF boxes developed some leaks;
-between prim. and sec. vacua → **no immediate concern**
R&D for replacement boxes started

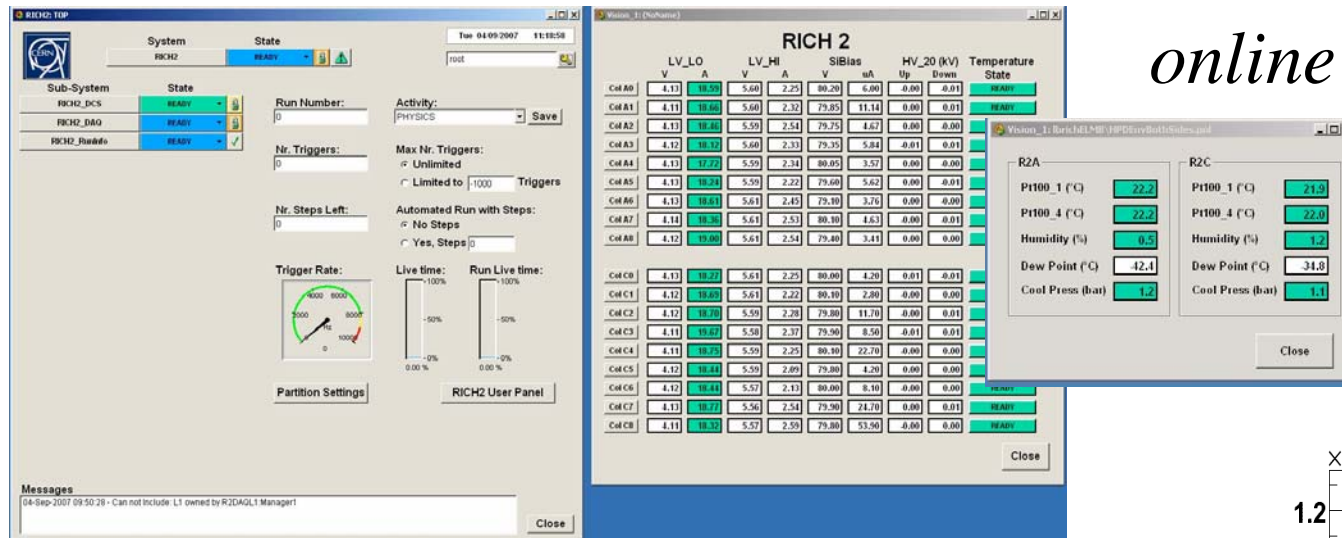
5) RICH (funded by CERN, CF, GB, IT)

RICH-1: spherical C-fibre and plane glass mirrors installed
Rails for photon detector assemblies in place

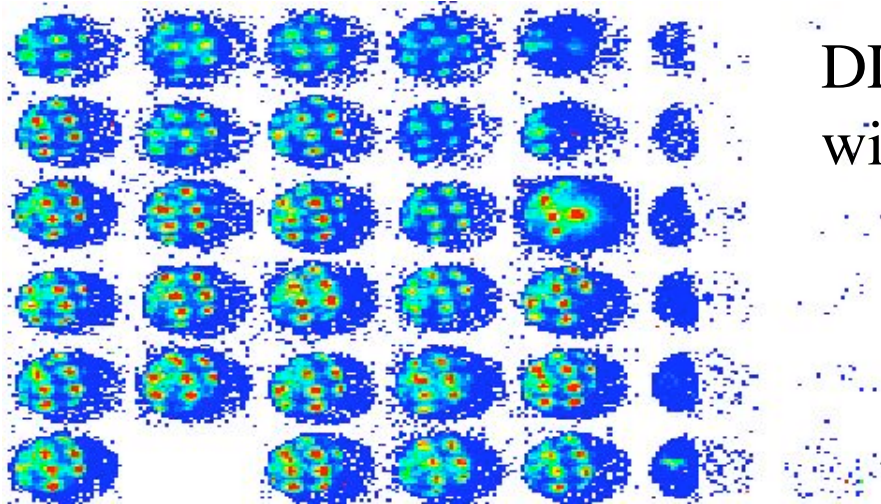


RICH-2: Completed and commissioning in progress

online ECS panels

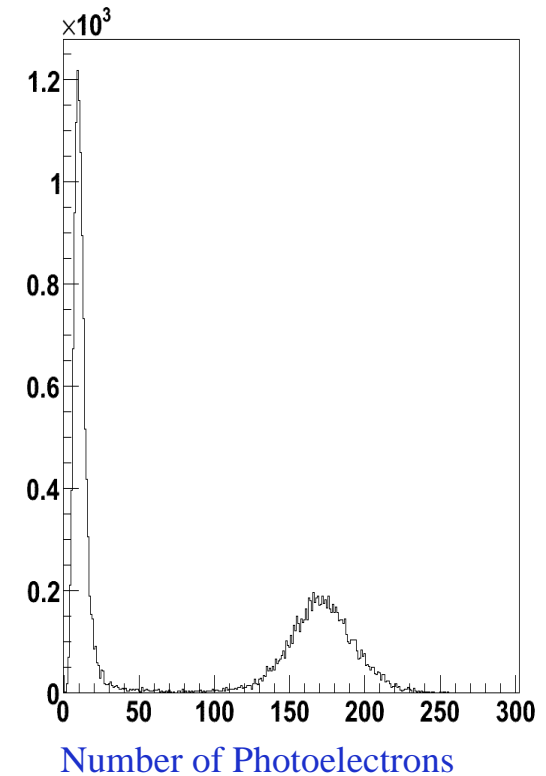


And HPD's observed light!



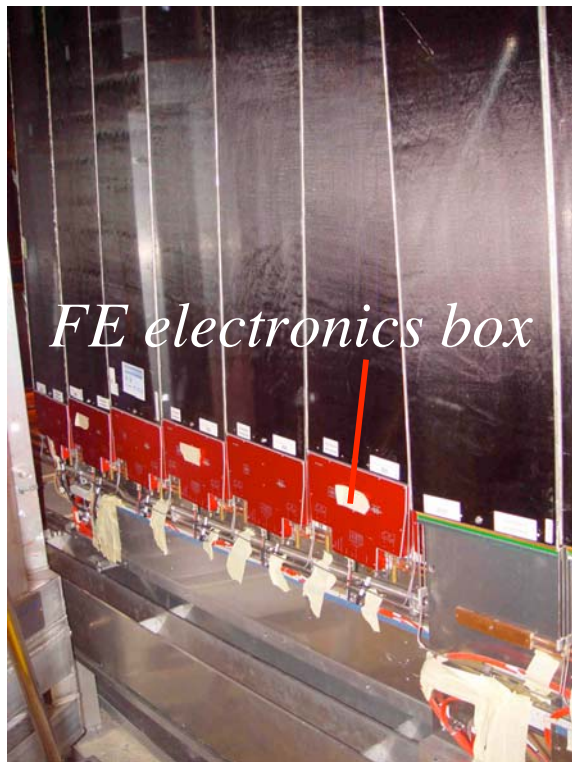
(10/288 HPD's will be replaced)

DLP projector with light spots



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

- detector installation completed, partially equipped with FE
- infrastructure completed
- full readout chain tested for a part of the detector
- dedicated cosmic trigger counters installed



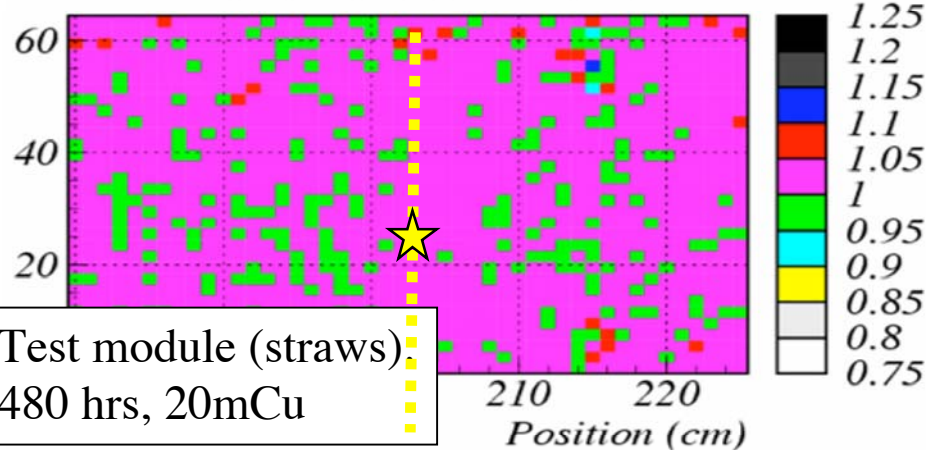
Progress on the “gain loss” issue:

With a particular rate, gain loss appeared in a short time!

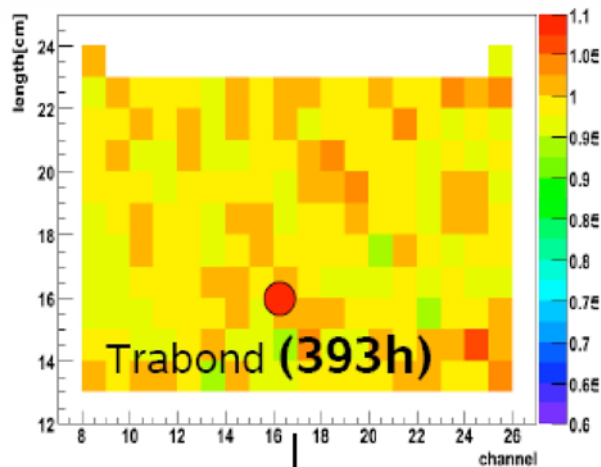
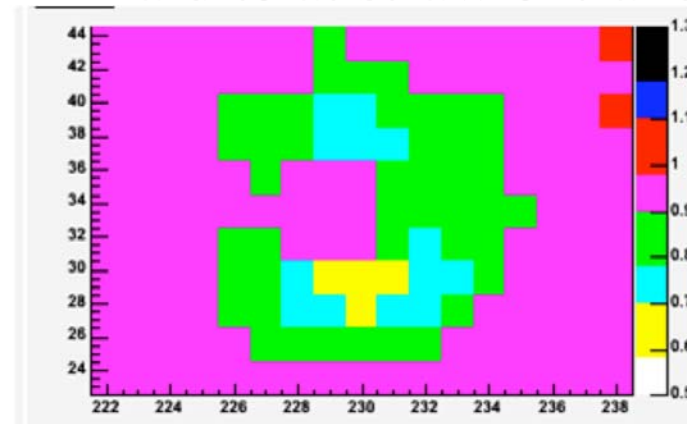
→not really “ageing”

Test chamber study →trace back to out-gassing from the glue

No araldite used:



Araldite at straw entrance:



Alternative glue found

→no gain loss with a test chamber

One full scale module will be produced to verify

Chamber will be heated soon to ~ 40 °C
In situ gain monitoring system being constructed

*In situ heating device being tested
in the pit*



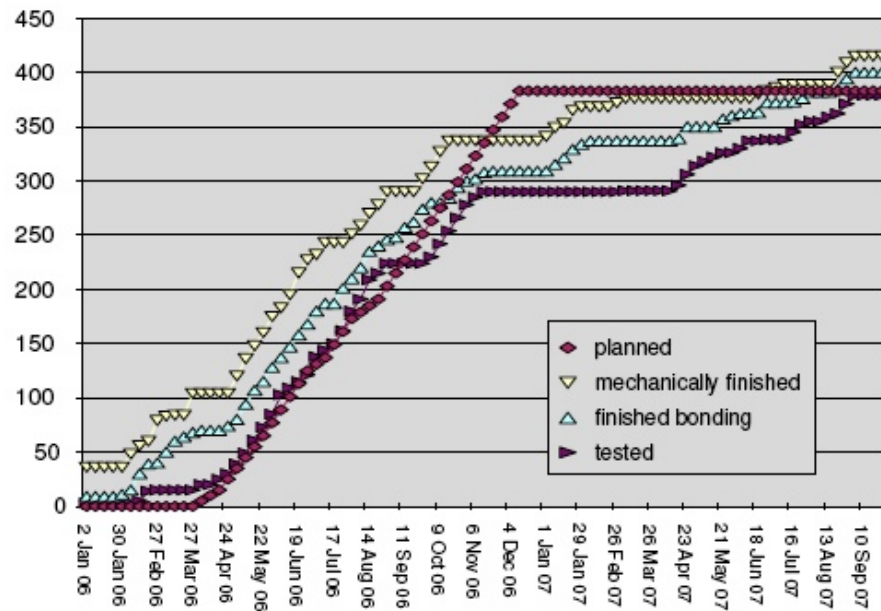
*Frame for the in situ
scanning system*



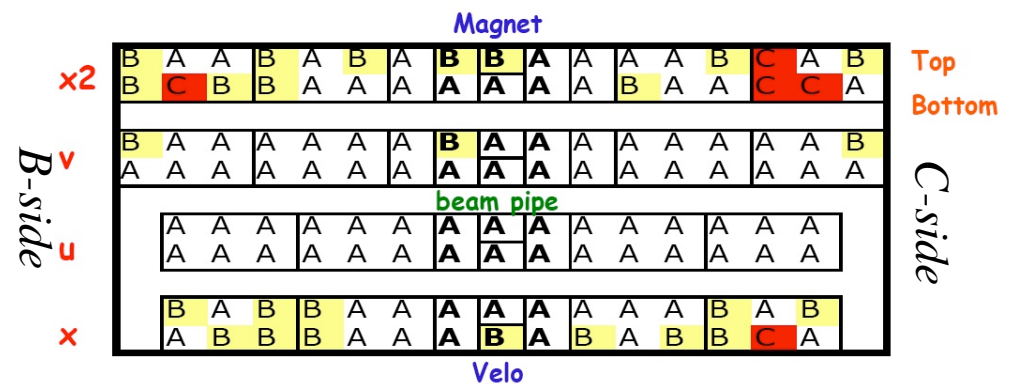
NB: module production capability will be kept for some time

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

Ladder production now completed also for IT
both IT and TT ladders are with good quality



IT ladder production



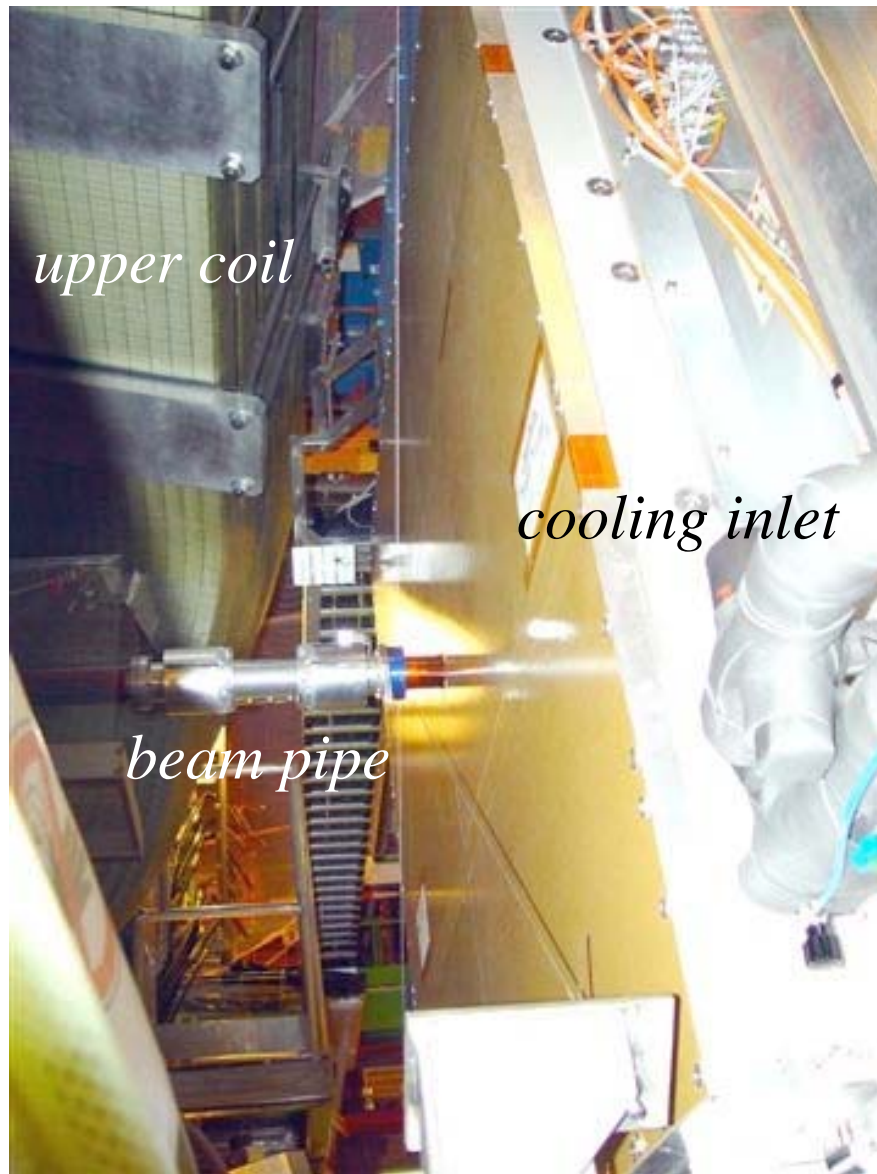
TT ladder arrangement

A: $I_{\text{leakage @ 500V}} < 2 \mu\text{A}$

A: $I_{\text{leakage @ 500V}} = 2-10 \mu\text{A}$

C: $I_{\text{leakage @ 500V}} > 10 \mu\text{A}$

TT detector box ready to receive ladders



IT digitizer cards partially installed.



TT ladder installation in Nov.
IT box installation till Dec.

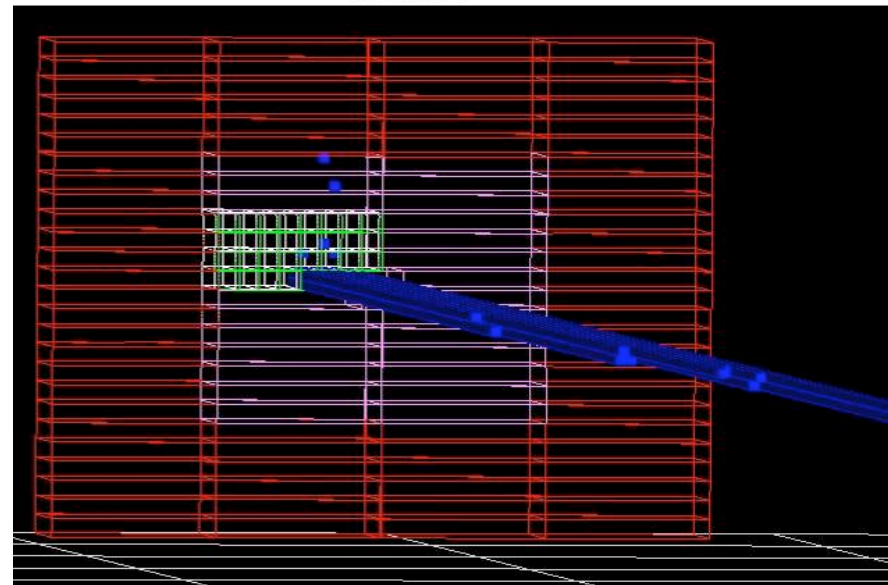
8) Calorimeter System (funded by CERN, CF, ES, FR, RO, RU, UA)

The complete calorimeter system, detector and electronics, installed and cabled. C-side being commissioned.



Full chain readout for HCAL
with LED pulse

HCAL

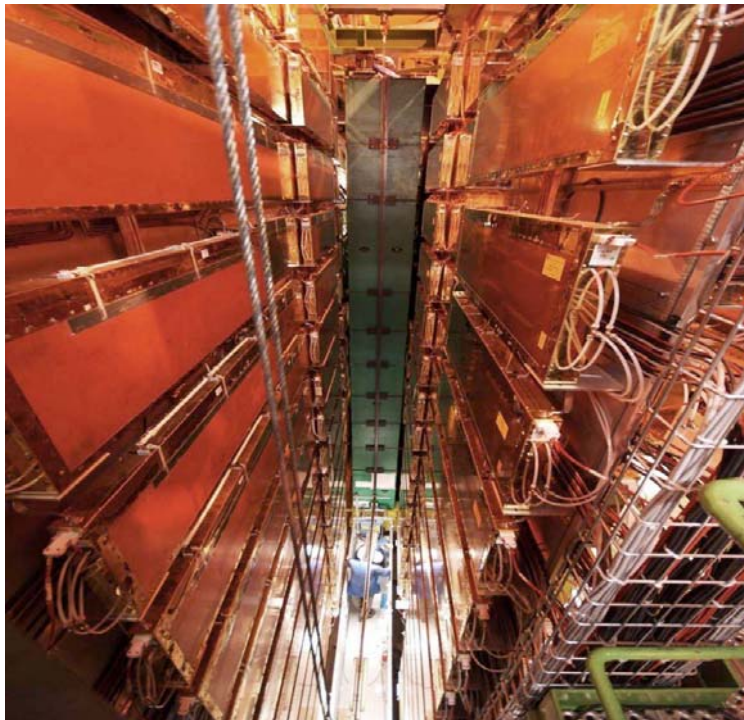


9) Muon System (funded by CERN, CF, IT, RU)

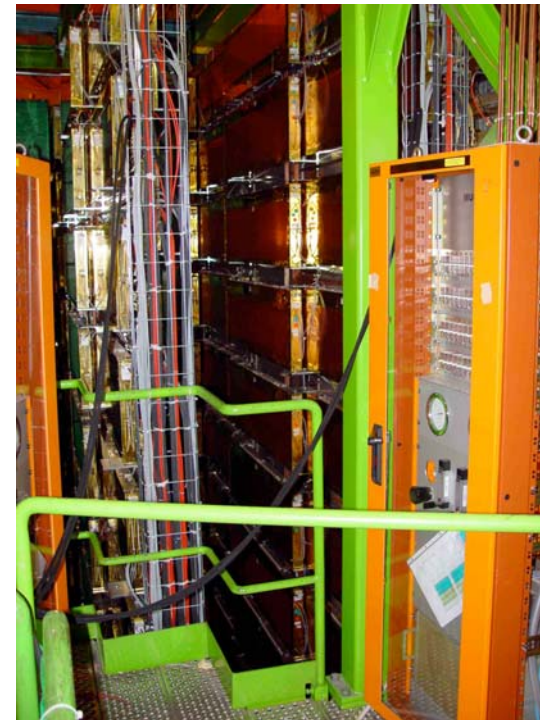
All MWPCs installed for M2-M5

Installation of the electronics and gas system in the muon towers and connection to the chambers in progress

Setting-up of the readout-chain started



muon stations and filter

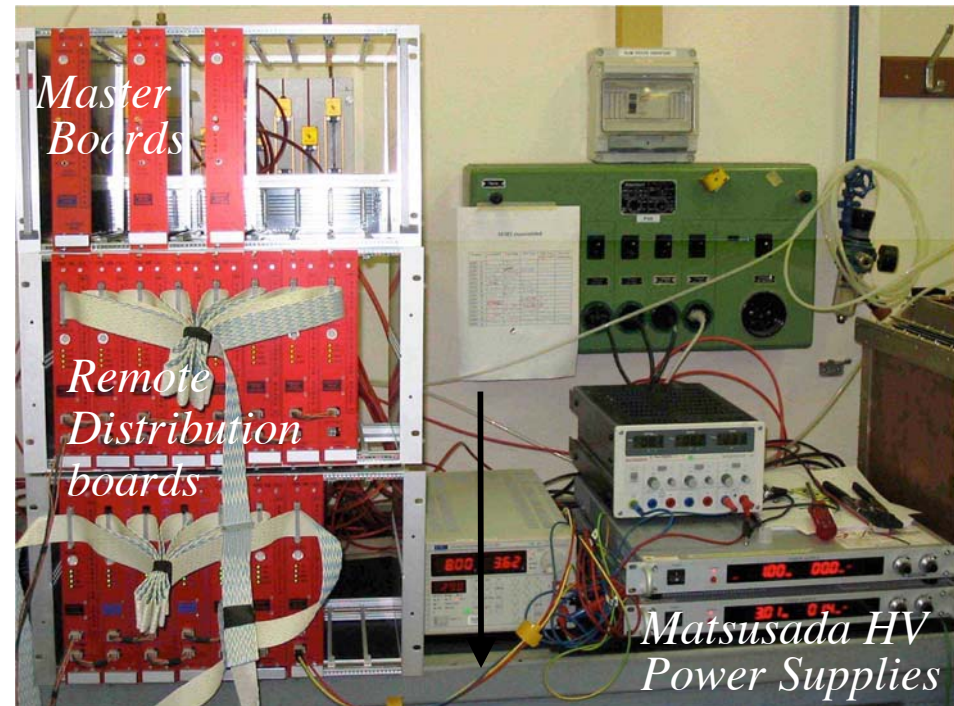


gas distribution box
in the muon tower

HV system:

CAEN 21/36 delivered (enough for M2-M5)

PNPI/Florida 100% produced and 50% ready to be installed



HV will be switched on in mid Nov

M1 support panels mounted and infrastructure to be installed

10) Trigger and Online

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

Level-0 trigger consists of four components

Pile-up

most of the boards produced



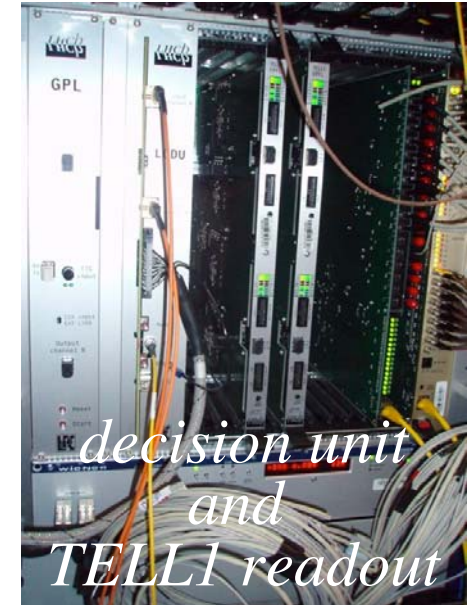
L0
Calorimeters

all produced and largely installed



L0
Muon

L0
Decision
Unit
installed

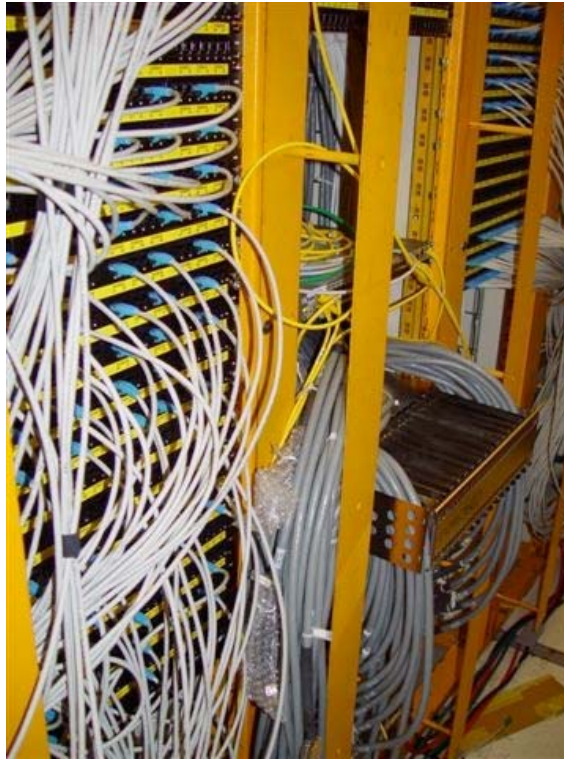


HLT first complete software release by the end of October

Installation of the online equipment and necessary cabling almost completed, except network switch and CPU farm, where both will start with ~20% capacity in 2008



*signal from the detector
(TELL1 system)
in D3 barracks*



*patch panels and
network switch
in D2 barracks*



*CPU farm
in D1 barracks*

Online system is already used by the subsystems for their commissioning.

Overall run control is being prepared for the global commissioning

The screenshot displays the LHCb TOP control interface. At the top, the system is identified as 'LHCb' and is in a 'RUNNING' state. The date and time are 'Mon 22/10/2007 13:31:53'. The user is logged in as 'root'. A table lists the sub-systems and their states: DCS (READY), HV (READY), DAI (READY), DAO (RUNNING), TFC (RUNNING), TRG (RUNNING), and INF (READY). Run parameters include Run Number (568), Nr. Triggers (54012), and Nr. Steps Left (0). The activity is set to 'PHYSICS'. The trigger rate is shown as a gauge with a current value of 6101 Hz. Live time and Run Live time are both at 98.24% and 96.45% respectively. Sub-detectors include VELO, ST, OT, RICH, CALO, and MUON, all in a 'RUNNING' state. The interface also includes buttons for 'Partition Settings', 'LHCb User Panel', and 'Close'.

Sub-System	State
DCS	READY
HV	READY
DAI	READY
DAO	RUNNING
TFC	RUNNING
TRG	RUNNING
INF	READY

Sub-Detectors	State
VELO	RUNNING
ST	RUNNING
OT	RUNNING
RICH	RUNNING
CALO	RUNNING
MUON	RUNNING

11) Computing

Physics quality software in place

Reconstruction package being constantly improved, e.g. charged track efficiencies, particle ID performance

Unified approach for off- and online pattern recognition

Constant progress in alignment work but not yet ready for Global challenge this year

LHCb computing model validated

MC production using GRID

Tier-0→Tier-1 followed by reconstruction

Analysis at Tier-1 using GRID

However, stripping still encounters difficulty in data access. SRM v2.2 is crucial → same for all the experiments

Stable operation of Tier-1's will be crucial in 2008

II) Cost and Funding

Change from the last RRB in April 2007

Cost: No change 75.341 MCHF

Funding: New contributions
US-NSF

extra contribution to the CPU's via Syracuse
envisaged instalment

200 kUSD ~Nov 2007

200 kUSD ~Nov 2008 (subject to funding availability)

I.e. total US contribution \approx 1.040 MCHF

Total funding 75.324 MCHF

\Rightarrow Shortfall in CPU has been solved

Thanks to the funding agencies!

October 2007

(in MCHF)	No. of institutes	Signed MoU contribution	Extra detector contribution	Extra CPU contribution	Total contribution
Brazil	2	0.000	0.000	0.055	0.055
China	1	0.100	0.000	0.000	0.100
France	5	7.500	0.000	0.800	8.300
Germany	3	-	-	-	-
BMBF	-	3.757	0.381	0.300	4.438
MPI-HD	-	2.200	0.000	0.000	2.200
Italy	9	10.000	0.847	0.000	10.847
Netherlands	2	6.300	0.381	0.000	6.681
Poland	3	0.500	0.000	0.000	0.500
Romania	1	0.300	0.000	0.000	0.300
Russia	5	2.500	0.000	0.000	2.500
Spain	2	2.000	0.000	0.020	2.020
Switzerland	2	7.900	0.000	0.000	7.900
UK	8	10.300	0.044	0.400	10.744
Ukraine	2	0.200	0.000	0.000	0.200
US	1	0.000	0.000	1.040	1.040
CERN	1	16.700	0.799	0.000	17.499
Total	47	70.257	2.452	2.615	75.324

Total cost of the experiment: **75.341** MCHF

-Issue of the VELO full replacement detectors

100% of 42 sensor modules needed after $\int L dt = 6 \text{ fb}^{-1}$

(already specified in TDR)

far beyond typical spares: 10 to 15%

→ reasonable to be partly shared by the collaboration

1000 kCHF material cost

+ 300 kCHF additional cost related to accelerated
production to be ready by early 2010.

VELO group contribution: 800 kCHF

UK: 300 k approved and 200 k to be requested

CH-EPFL: 300k requested

(plus UK-Liverpool covers infra. and manpower $\approx 2.3 \text{ MCHF}$)

Remaining 500 kCHF

Our proposal: to be shared pro rata over 5 years

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

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
require two new detector bases (~900 kCHF total)

Decision should be taken in a couple of years with a
better knowledge of the irradiation at LHC

-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 to be operational
no long term guarantee under irradiation

Together with the CERN Vacuum Group (responsible for the procurement and operation), we are discussing

- 1) with the original manufacturer, using better material: R&D needed possibly with Russian funding
- 2) with an alternative manufacturer

if 1) successful, the cost can be covered by CERN,
if 2), additional funding might be needed.

Plan to clarify by the RRB April 2008

III) Collaboration issues

New collaborator: University College Dublin, Ireland

2 faculty members, 3 Post-docs and PhD students

Team leader: R. McNulty with CDF experience

Since 2003, worked as Technical Associate for technical projects, mainly online related issues
wanted to participate in physics with data

M&O contribution secured

Manpower contribution to core software

Possible contribution to the VELO replacement
ceramic pitch adapter (~72kCHF) to be requested

NB: No established HEP programme in Ireland

Official participation in the LHCb experiment would help to develop HEP activities and funding

New spokesperson elected in September 2007:
Andrey Golutvin, ITEP Moscow, Russia
will start from 1 May 2008

IV) Conclusions

1) Remaining installation for VELO modules, TT ladders, RICH-1 photon detectors and IT boxes by the end of 2007, and M1 chambers by the end of March 2008.
Commissioning has started for many subdetectors.
Computing and physics preparation for data ongoing.

2) **Schedule is still tight**, in particular, for the installation of IT, RICH-1 mechanics integration, and M1 installation

3) With further additional contributions of 400 kUSD from US-NSF, the CPU farm is basically financed.

→ **no missing funds for the initial detector**

However, vacuum pipe replacement may require additional money, depending on the manufacturer, and VELO replacement modules for running beyond 6 fb^{-1} needs 500 kCHF from the collaboration.