CERN-RRB-2005-056
20 April 2005

# Status of the LHCb Experiment

LHCb RRB at CERN
20 April 2005

on behalf of the LHCb Collaboration

Tatsuya NAKADA
CERN
and
EPFL

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I) Construction Status

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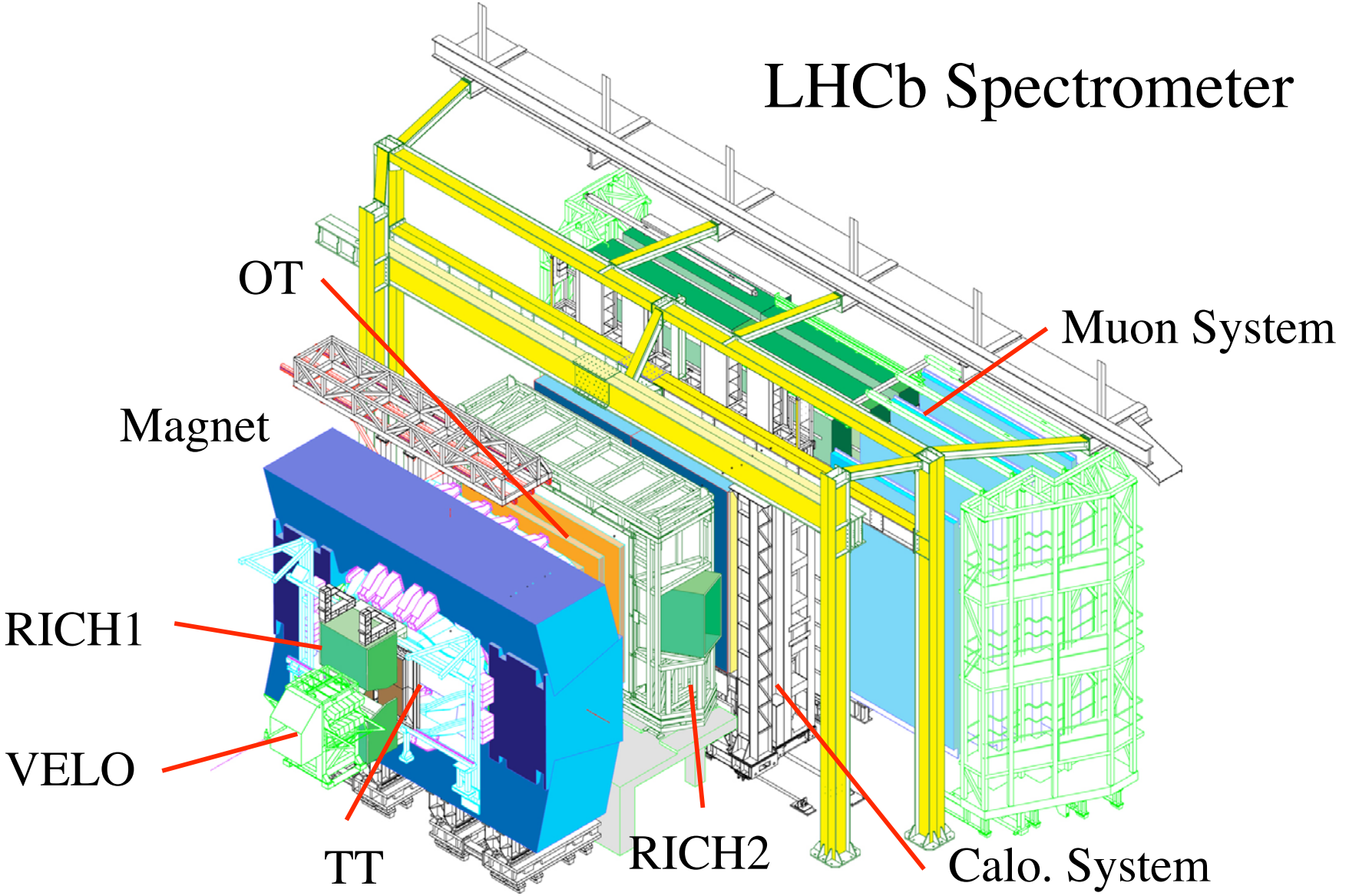
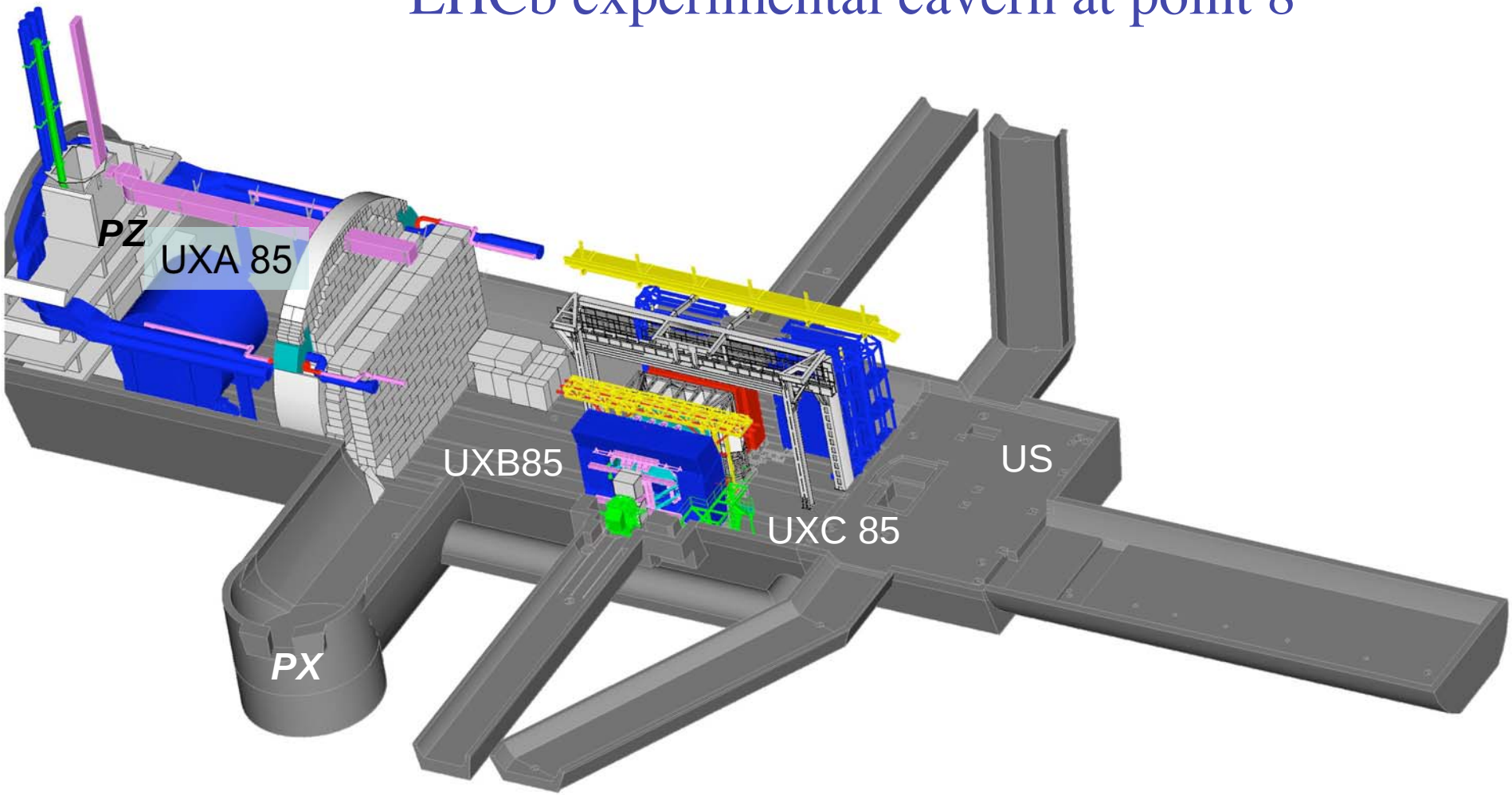
# I) Construction Status

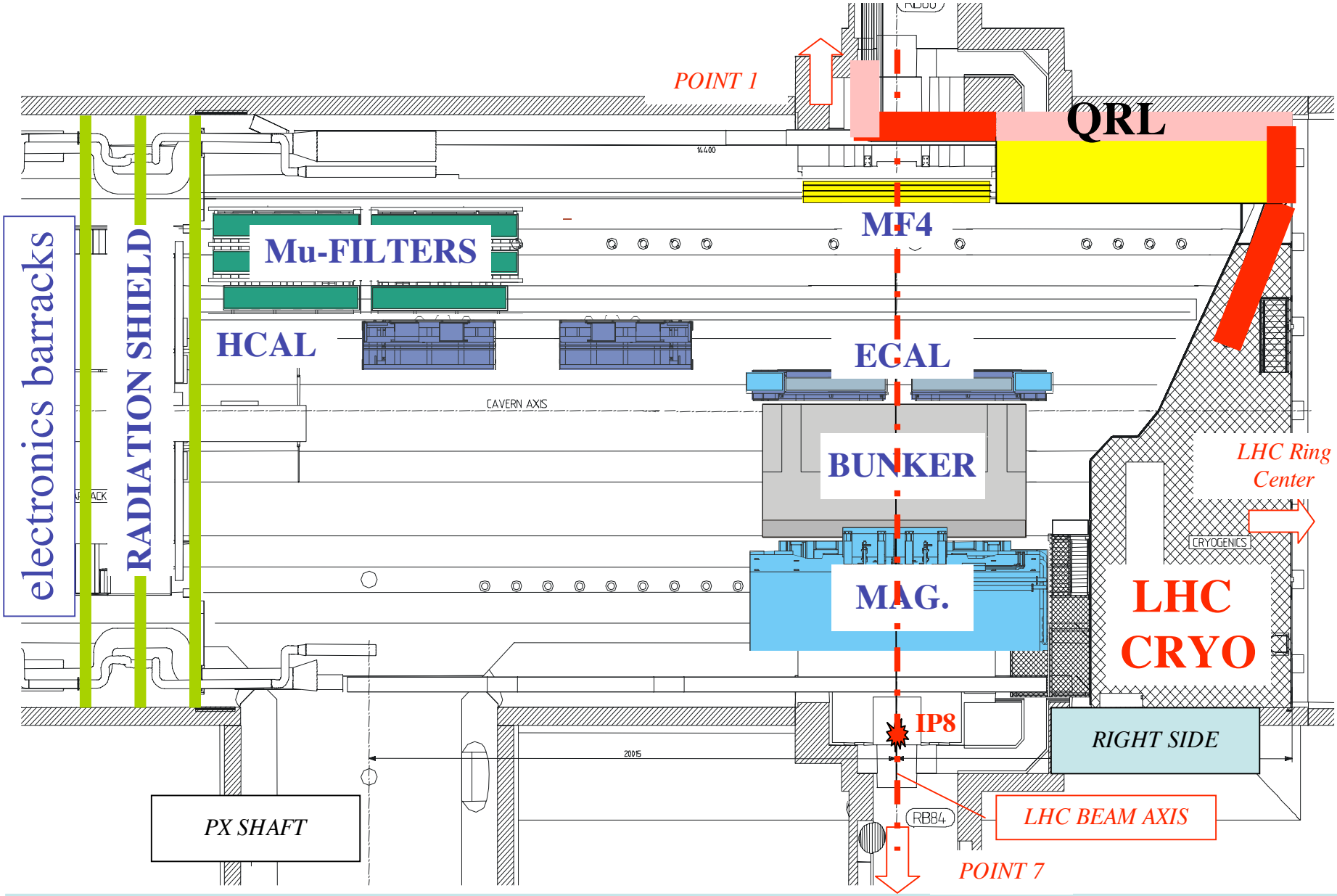


# 1) Experimental Area

## LHCb experimental cavern at point 8



# UX85 – Detector Area (April 05)



# 2) Beam Pipe

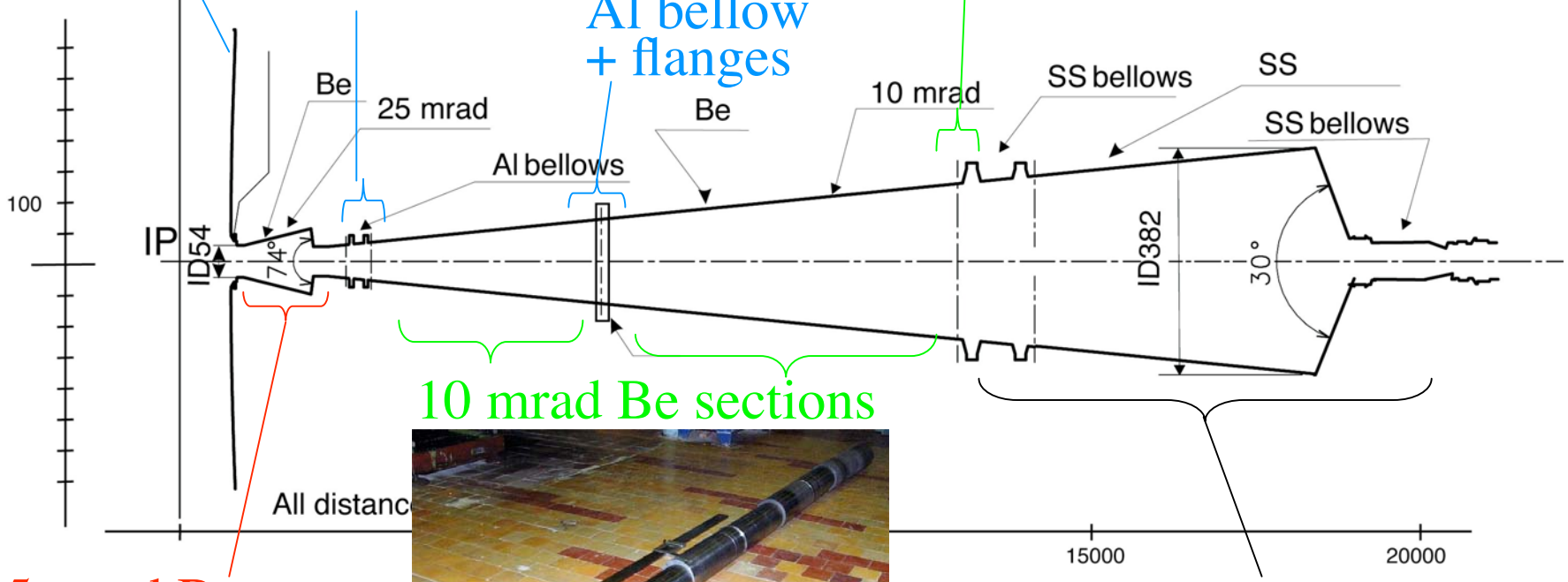
completed by industry
ready for fabrication at CERN
being fabricated by industry
being ordered

VELO vacuum tank
exit window

Al flanges and
bellows

Al bellow
+ flanges

Al-stainless steel
bimetallic flange



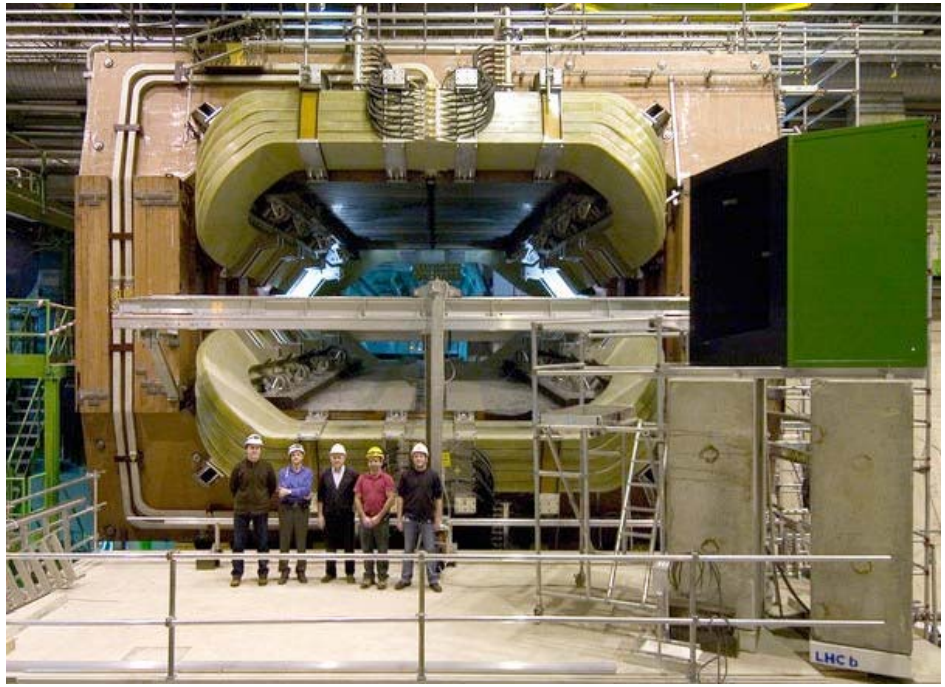

10 mrad Be sections

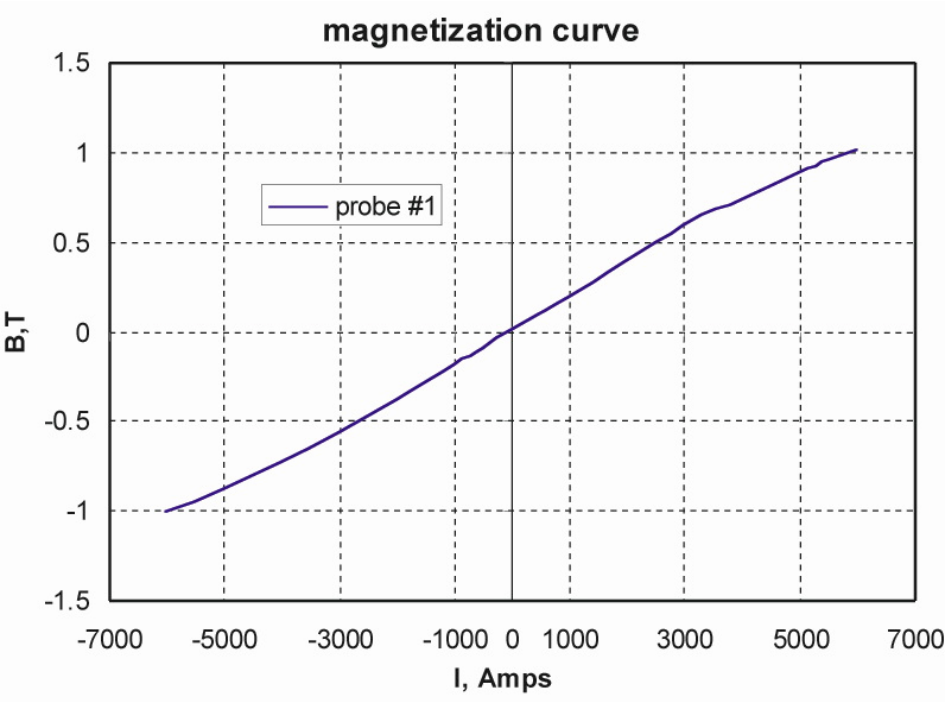
25 mrad Be
section

delivery in May and Oct '05

stainless steel bellows,
flange and beam pipe

# 3) Magnet

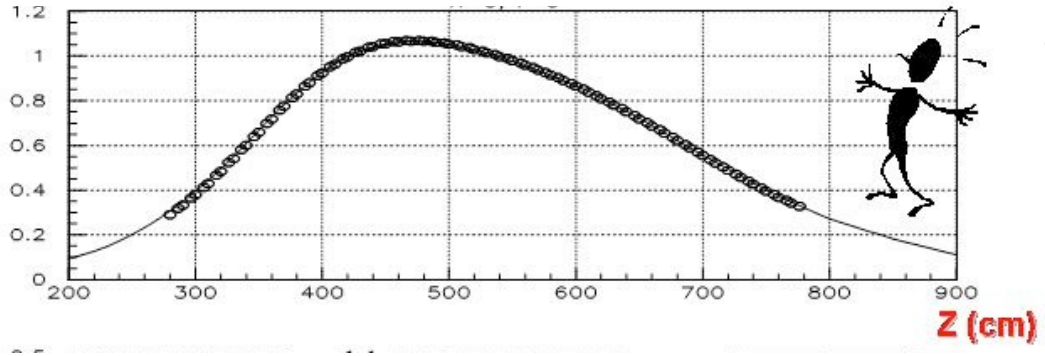



magnet assembled, positioned, aligned and switched on

# First field map in December ’04

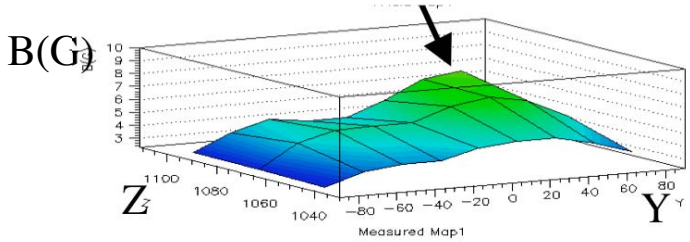
Comparison along beam axis




Inside RICH2 shielding box

Compares well with simulation

Maximum 6 Gauss




Further magnetic field measurements:

- RICH1/VELO region in May ’05 with RICH1 shielding in place
- Full field map in tracking region with all magnetic structures in place in October ‘05 before the the critical electricity period starts

timely completion of the cryo-line required

# 4) VErtex LOcator

## Mechanics; good progress

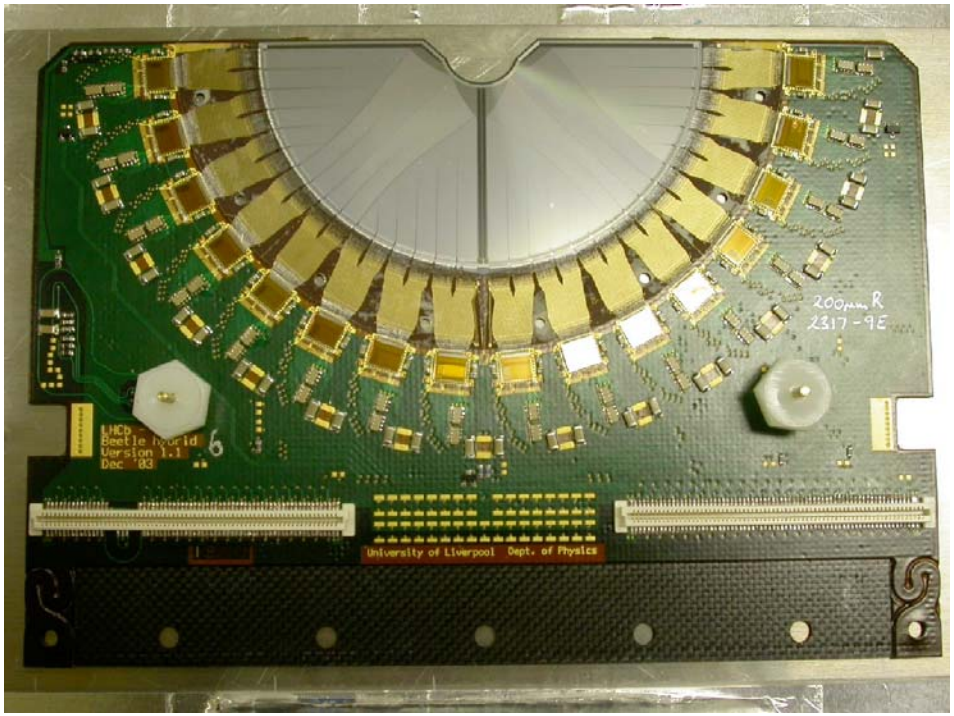
vacuum vessel arrived

support frame with moving mechanism

rectangular bellow

detector hood with transporter

# Detector Module




Production run of Beetle Chip completed (also for Silicon Tracker)
Hybrid final prototype production

Module EDR on 21 April ’05

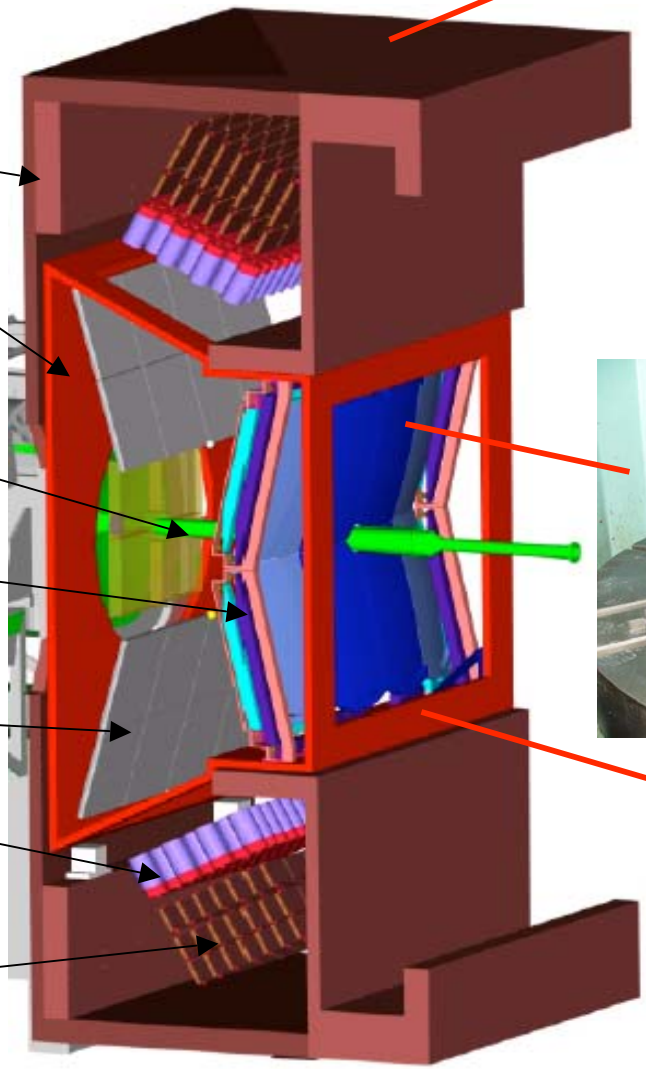
Production of modules to start in Liverpool in May ‘05

First batch of modules June ’05, last batch in Feb ’06

tight schedule

# 5) RICH

RICH1



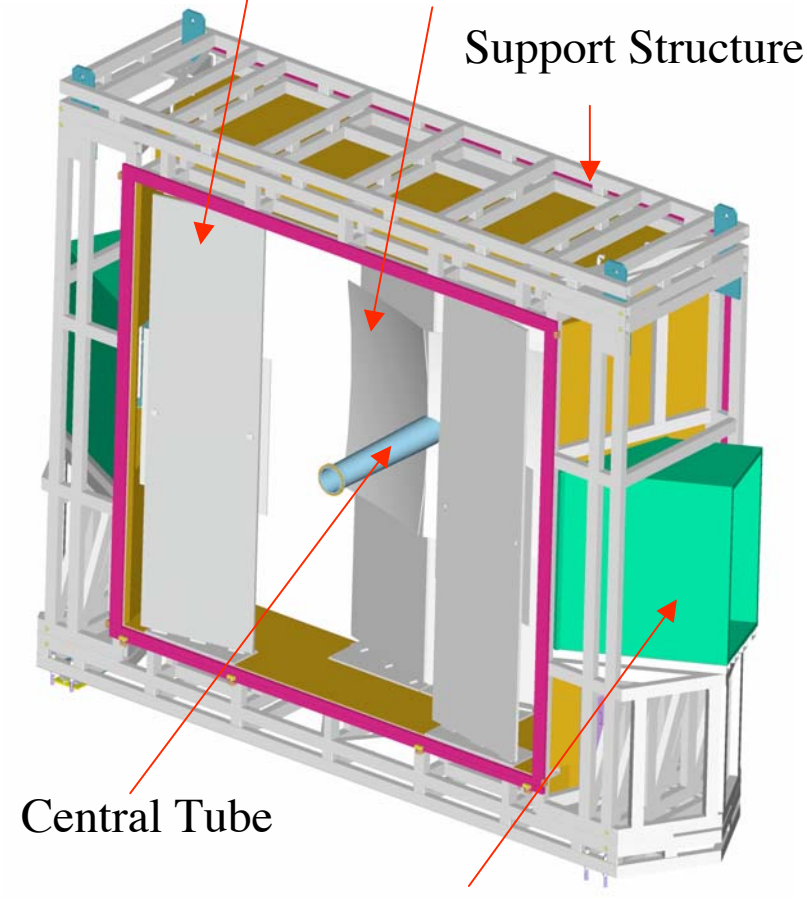

Shields at CERN

Be mirror prototype production in Russia

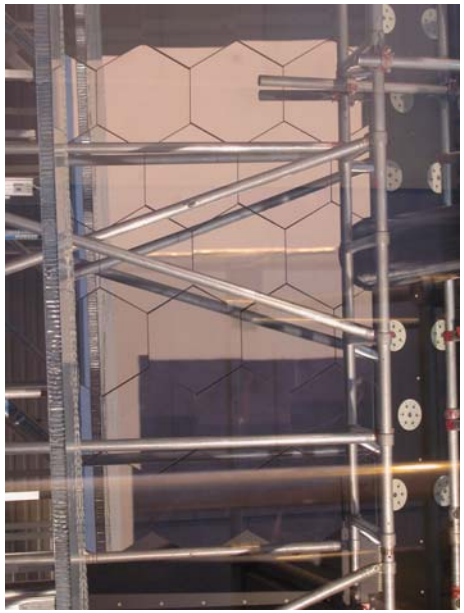
Gas enclosure tender in progress

Overall schedule very tight manpower limited

# RICH2




Shielding box



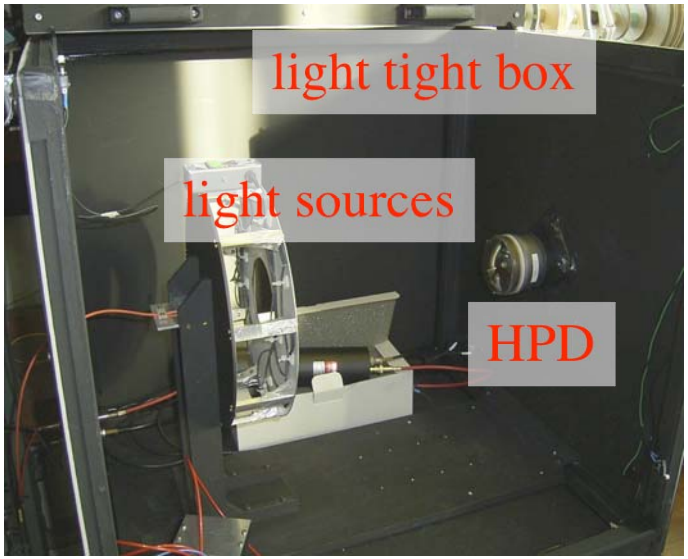
Spherical mirror

Mounting and alignment of mirrors in hall 156

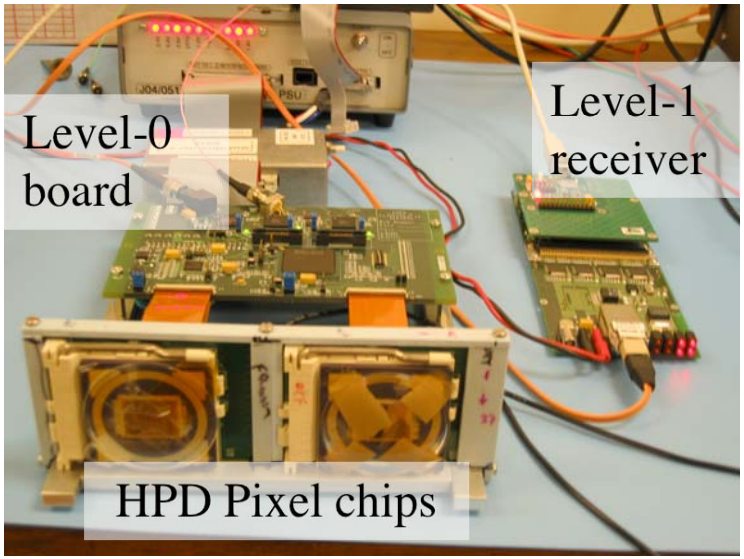
Transport and installation in UX85 in July '05

# HPD and electronics

Preseries modules




HPD test setup




readout chain

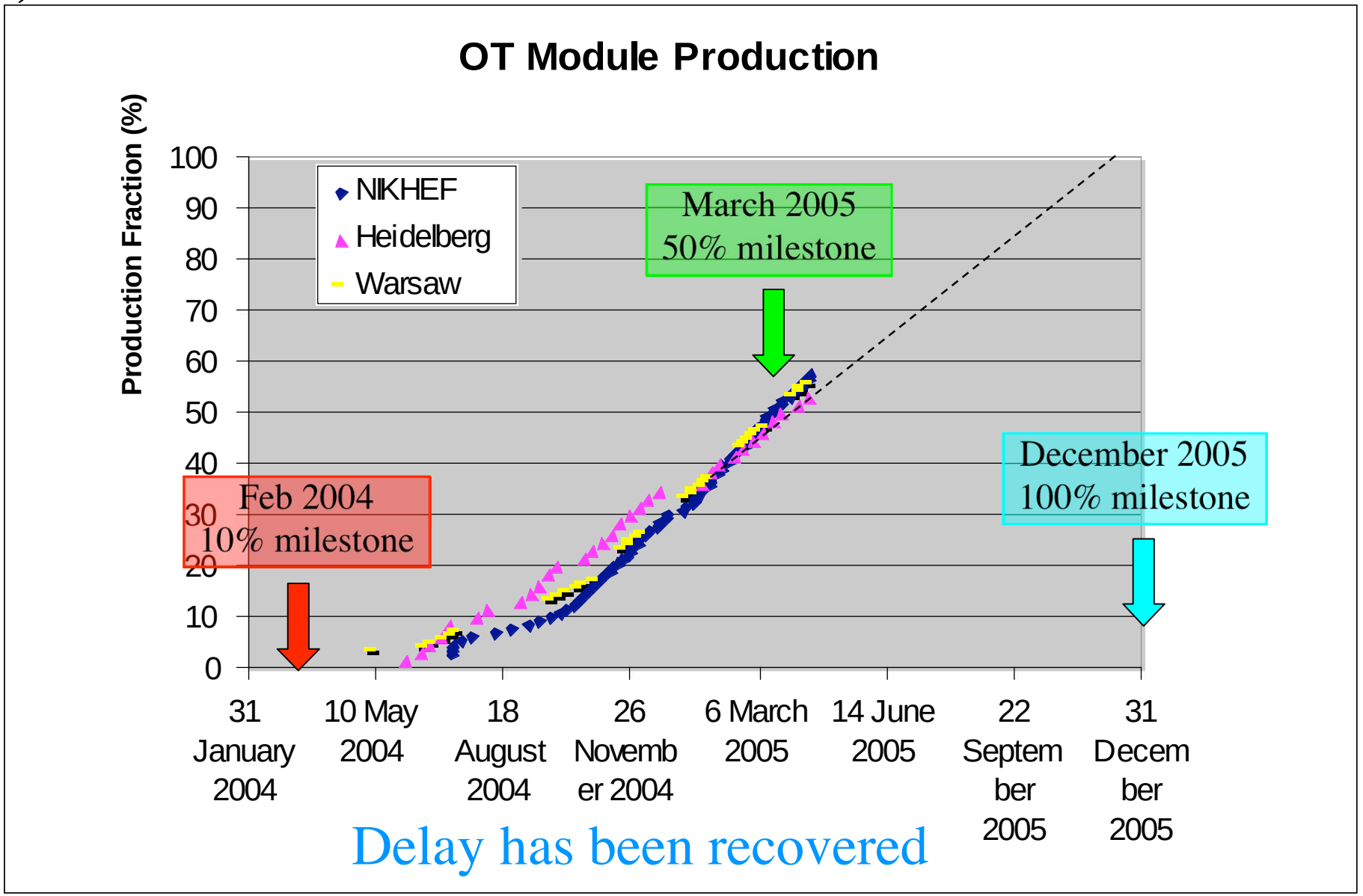
Preseries of 9 HPDs received and tested

Series production of HPDs at DEP starting
~480 tubes needed

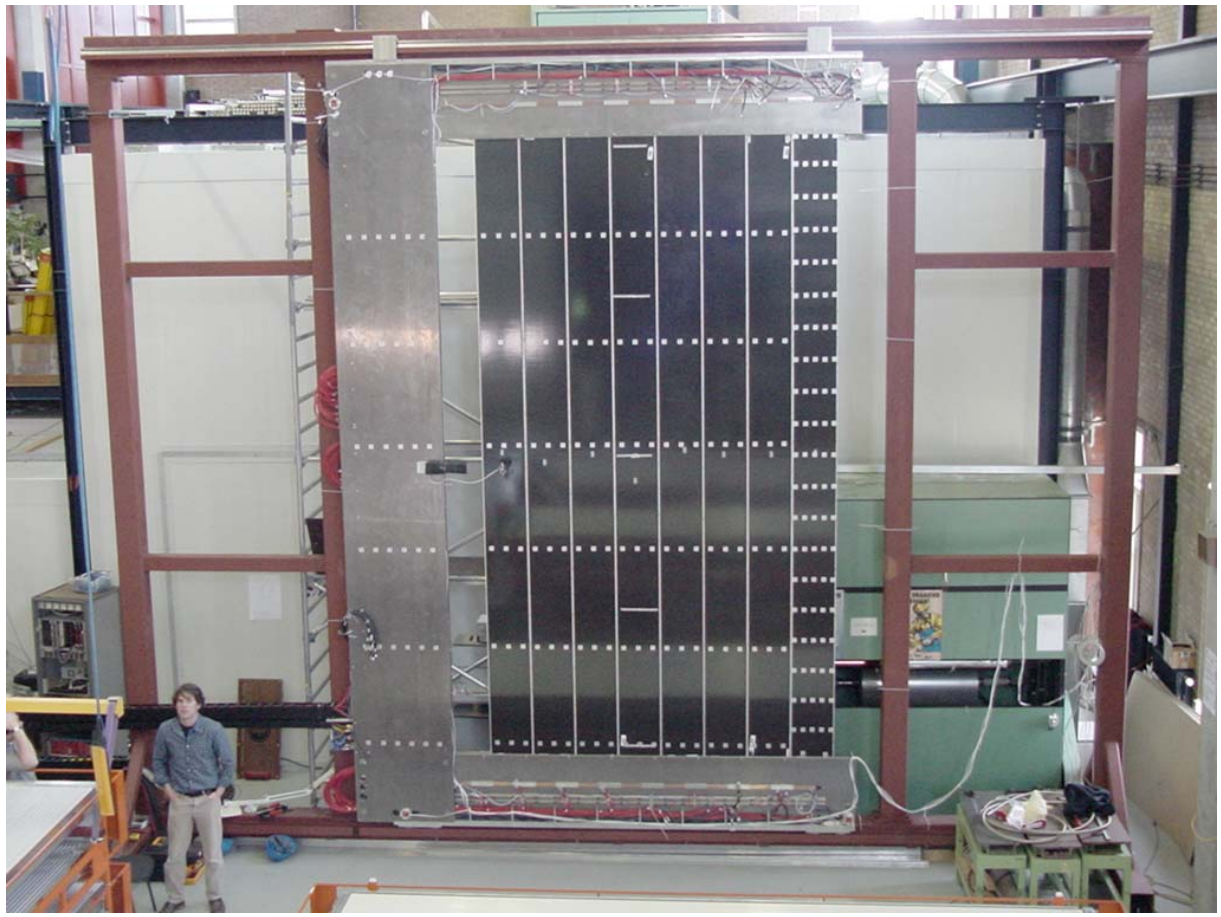
Delivery July ’05 to November ’06
~30 tubes/month planned

No margin in schedule of last tubes for installation

# 6) Outer Tracker



# Frame and support structure



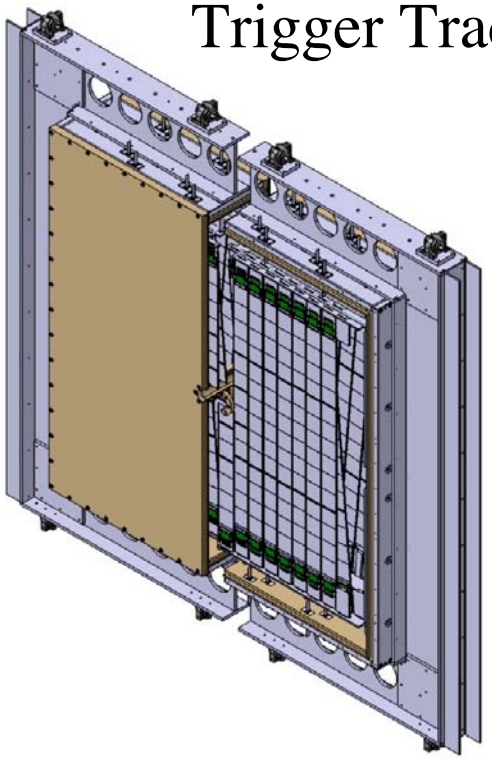
full scale prototype fully loaded

EDR in May ’05

Installation of support structures and OT half stations to start in Nov ’05

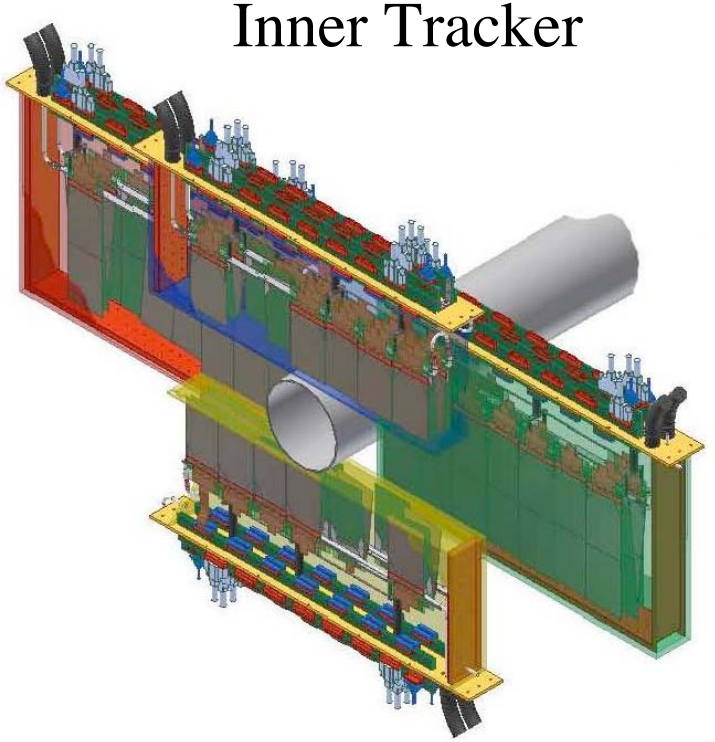
# 7) Silicon Tracker

Trigger Tracker



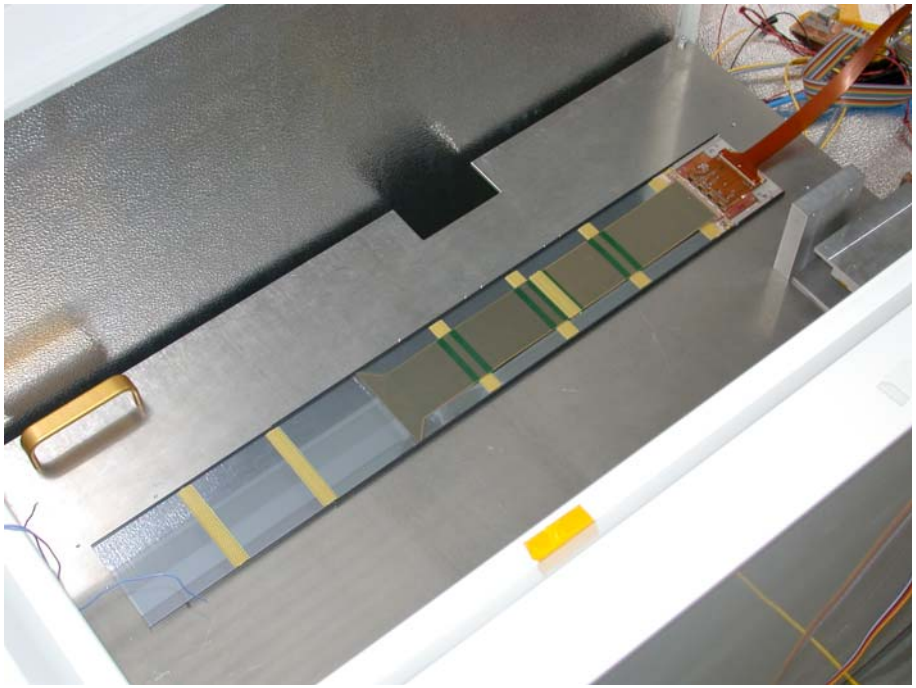
CMS OB-2 sensor (HPK)
First 100 sensors just arrived (loan from CMS),
1000 needed.

Inner Tracker



Custom-made (HPK) sensors
Preseries 49 sensors arrived in January, 531 needed

Prototype ladders have been constructed with sensors from ST.



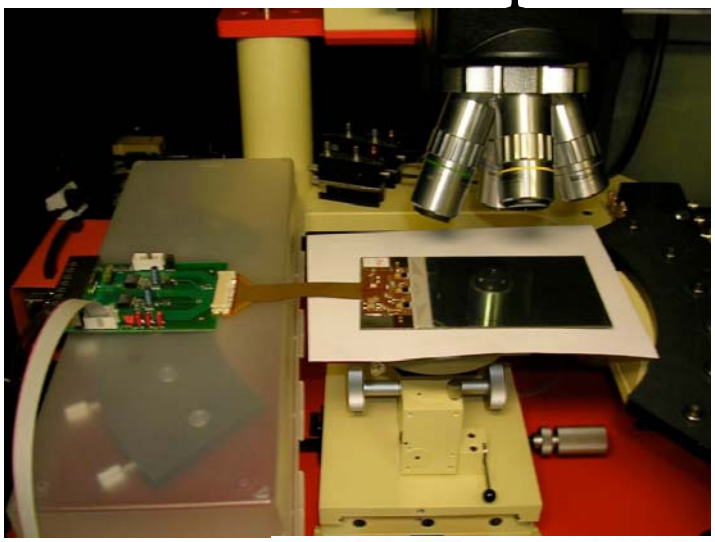
Ready for the preproduction as soon as the sensors are ready

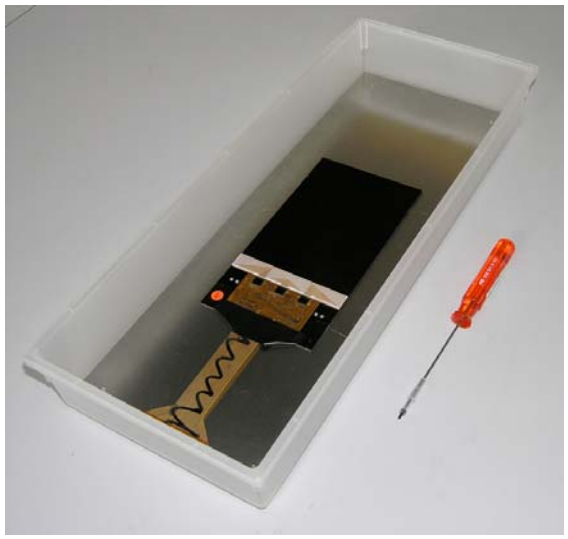
Delivery schedule is far from optimal due to the CMS order

Remaining 900 all arrive in September/October

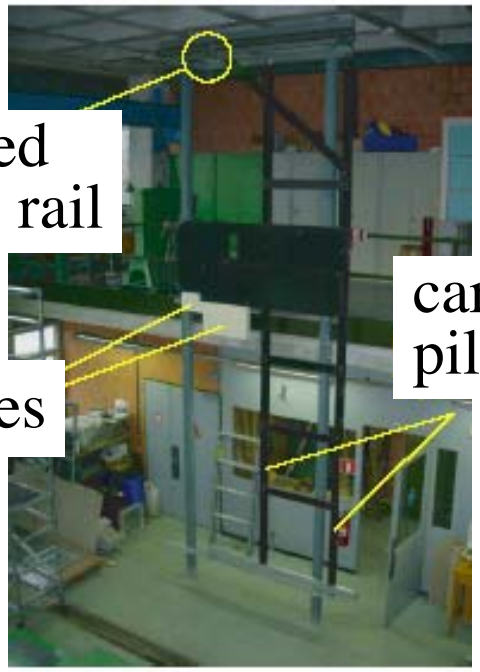
*discussion with CMS to receive further 100-200 sensors before summer*

# Inner Tracker Preproduction started



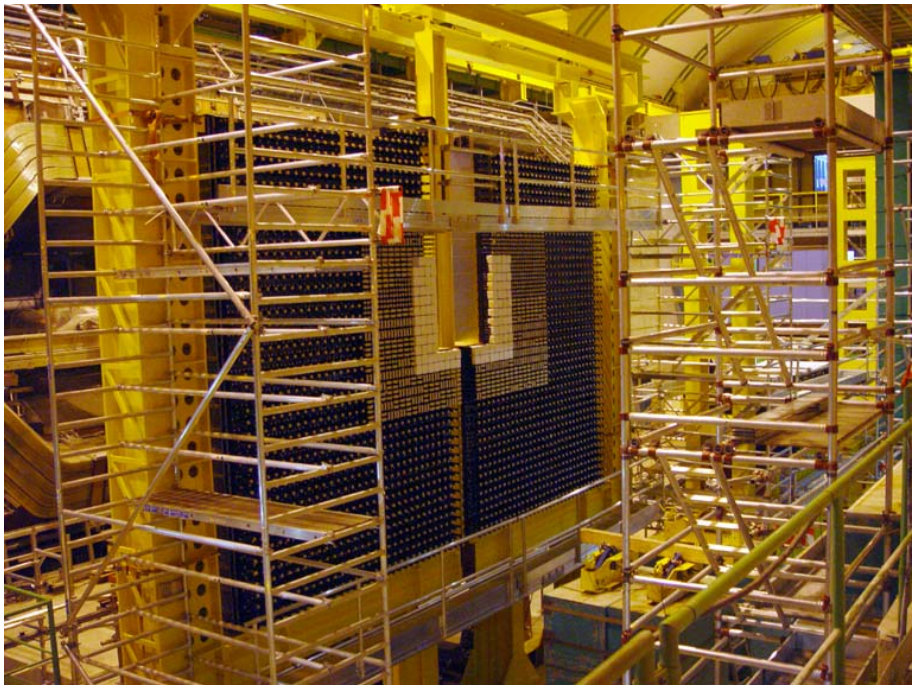


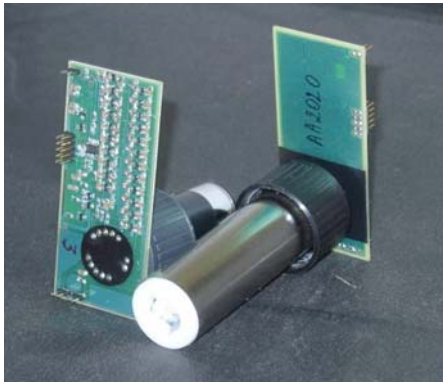
Prototype support



# 8) Calorimeter System

## E-cal and H-cal systems are being assembled in Pit-8

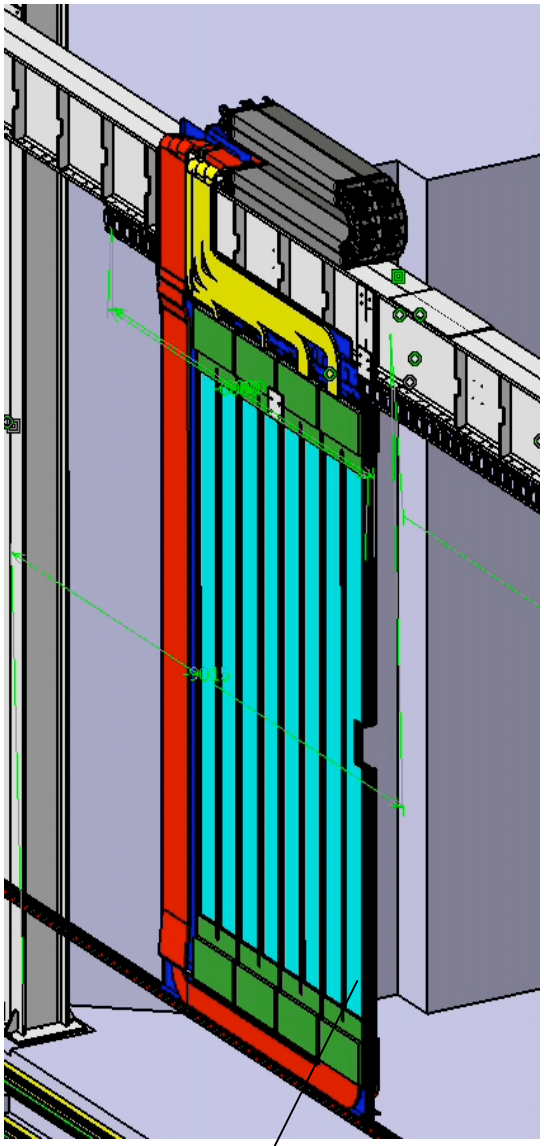




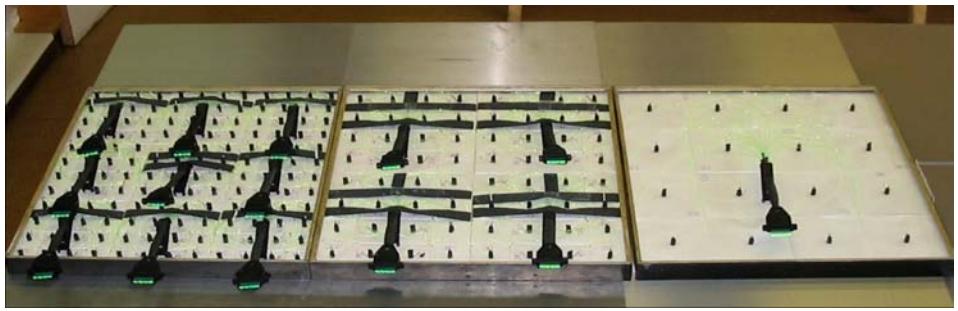
PMT +
CW base
completed

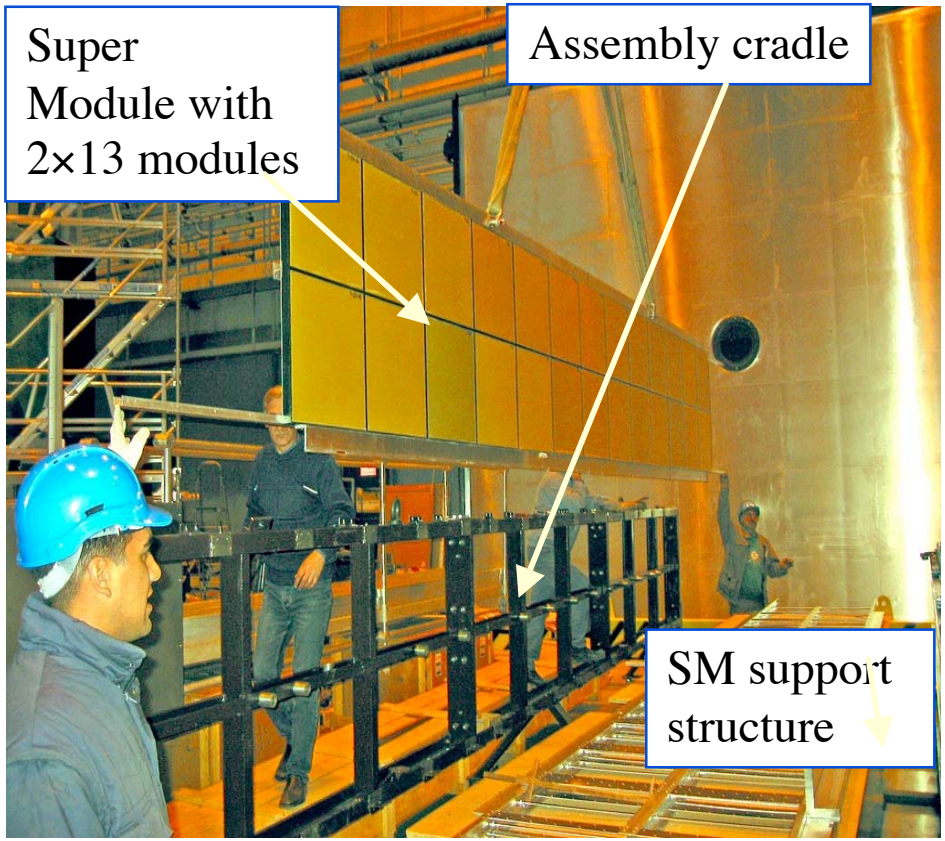
fibre bundles
for monitoring
in preparation

# Preshower and SPD modules

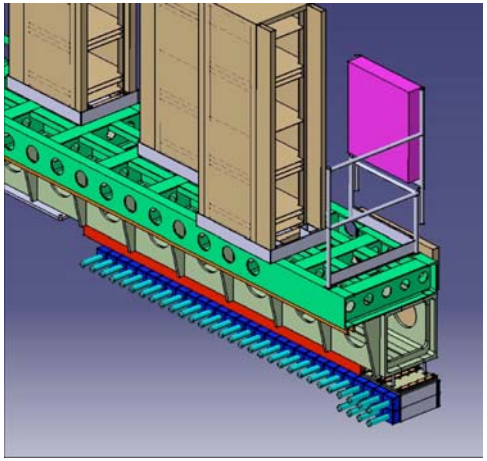


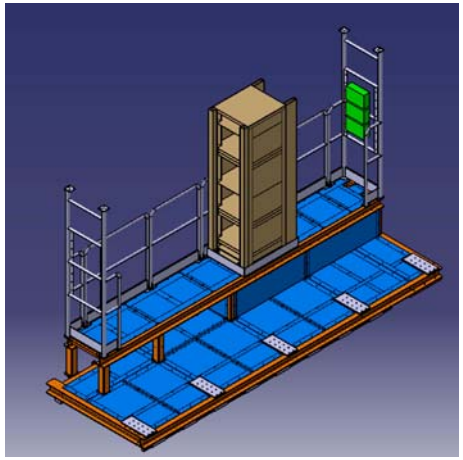
super module





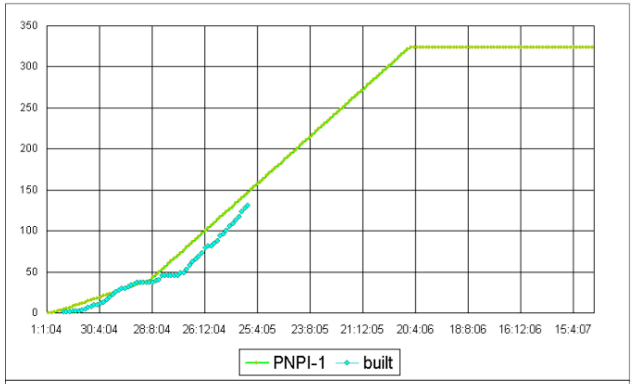
# E-cal and H-cal electronics balconies

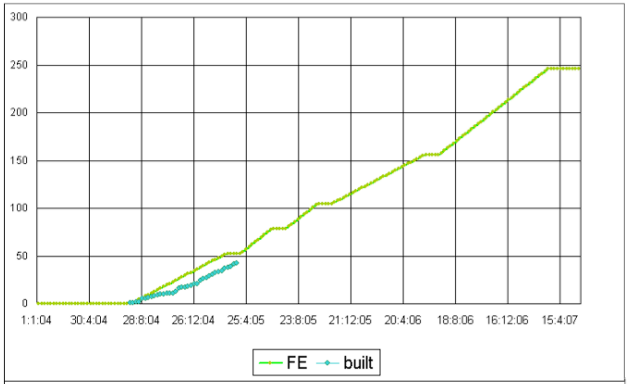


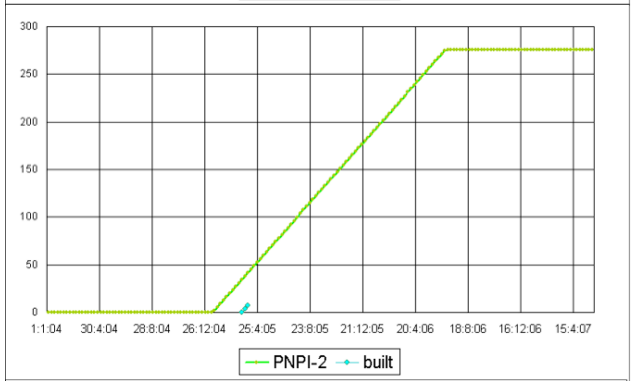


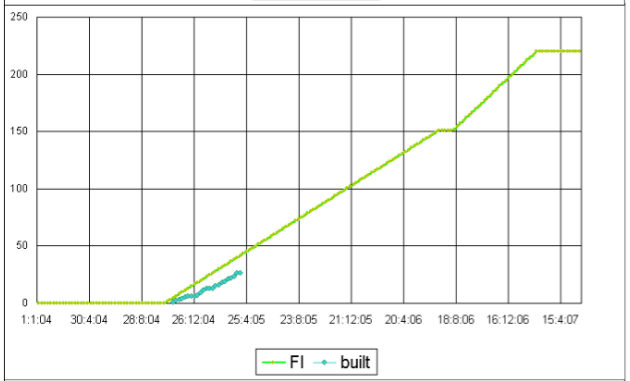
under construction

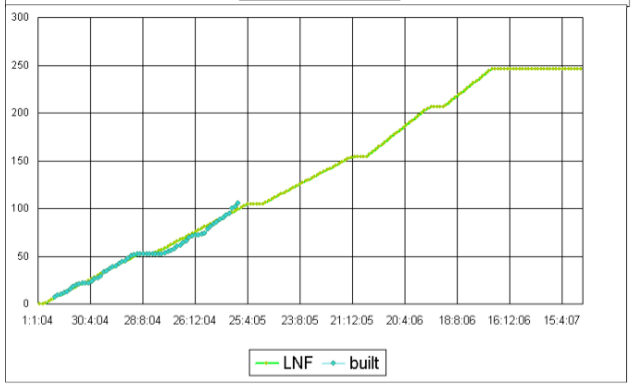
# 9) Muon System chamber production

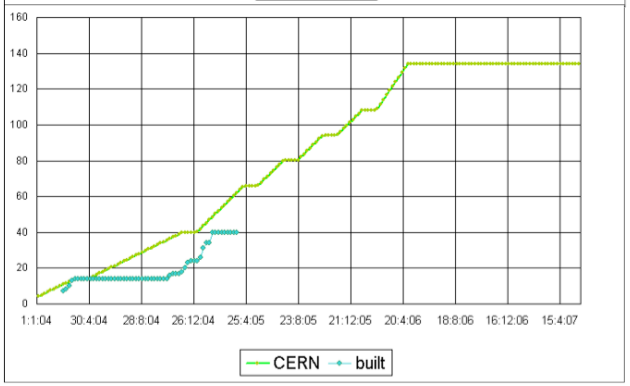


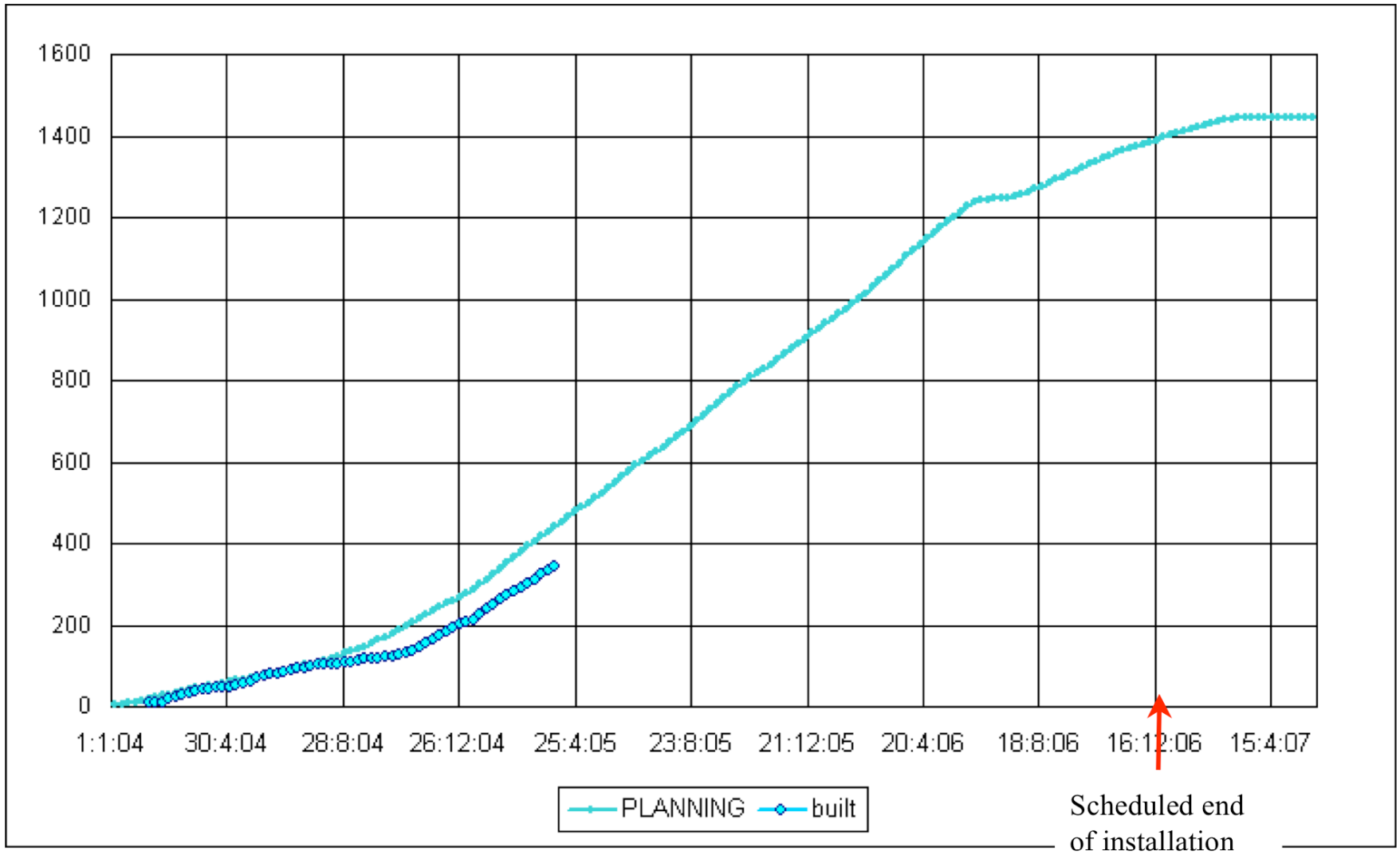



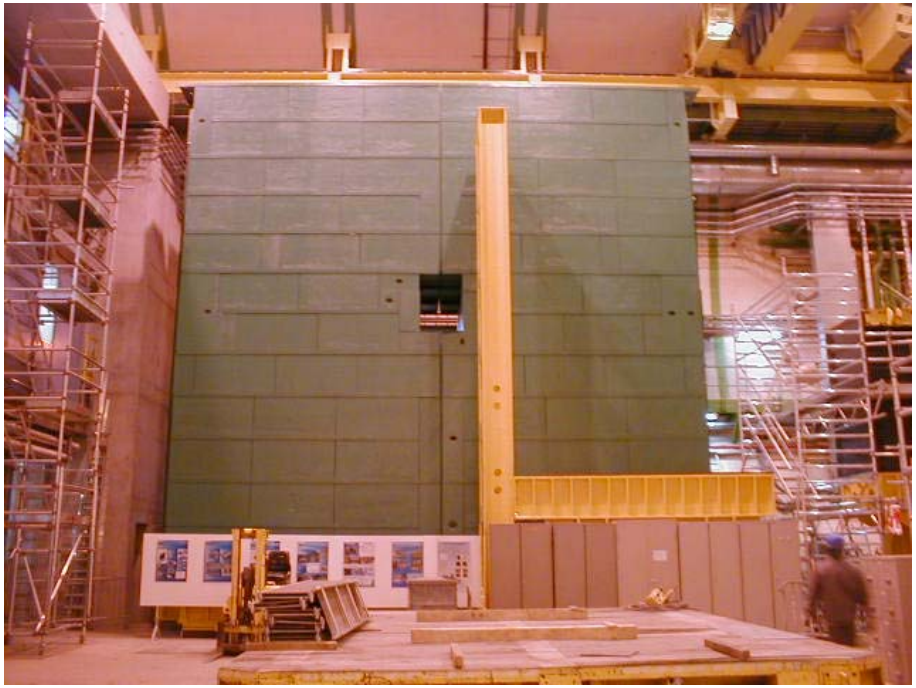






Reached the nominal production yields at all the sites

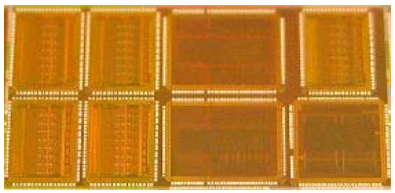
However, manpower is critical to maintain them



First three Muon filter wall assembled

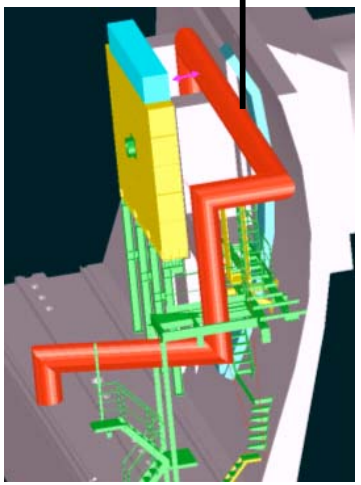
Last Muon filter against beam background

Engineering run of the three types of ASIC's successful



Installation and commissioning will continue till Q1 07

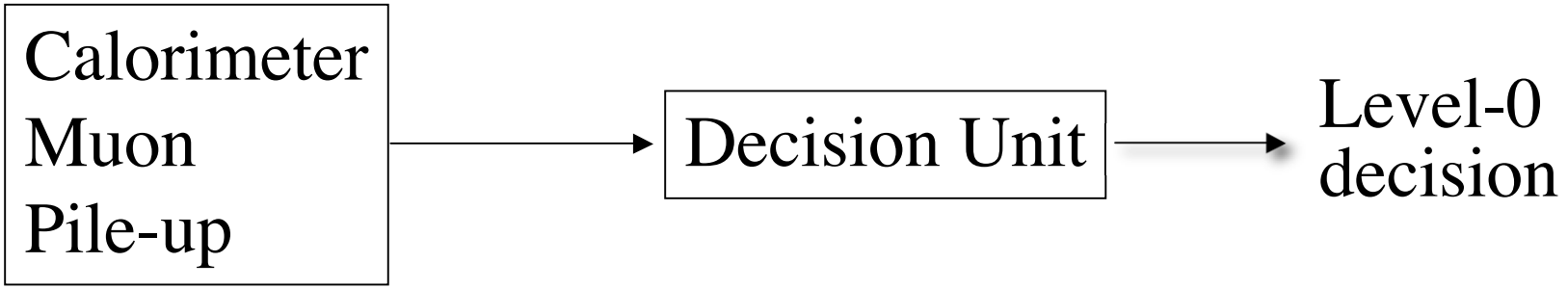
Cryo installation (LHC) in Q2 05 must be done on time



# 10) Trigger and Online

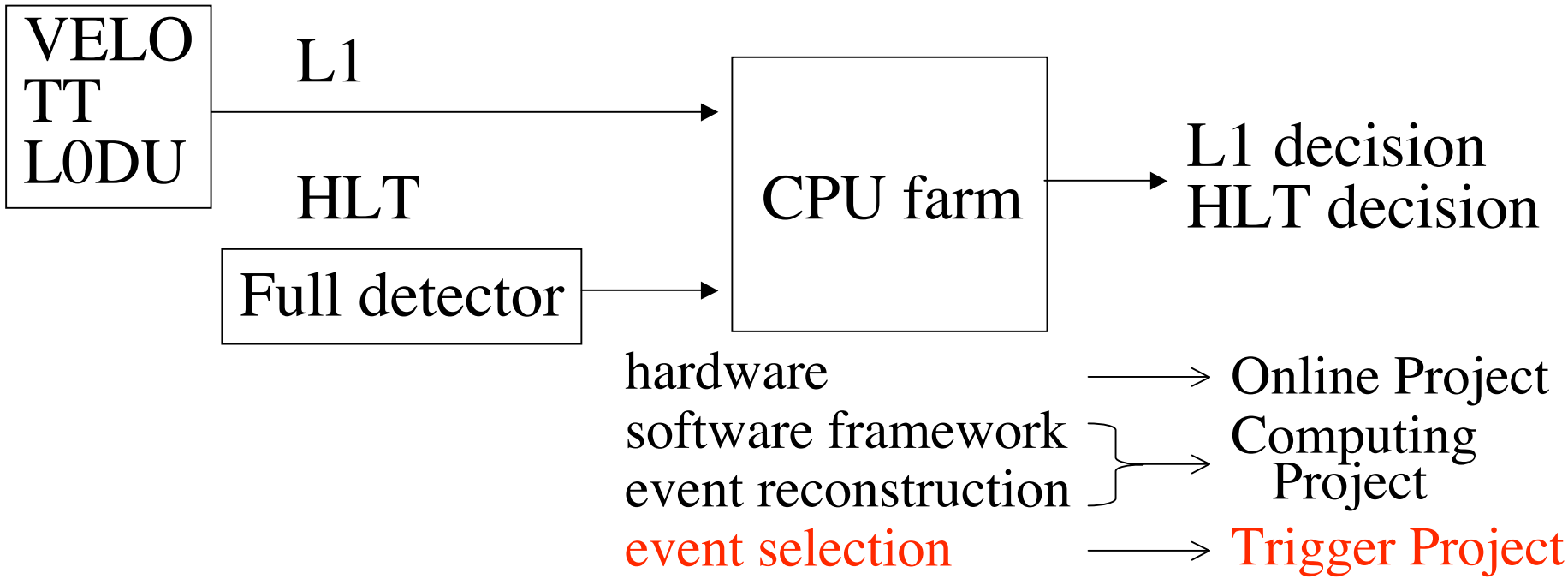
Level-0 Trigger:

hardware trigger by custom-built electronics cards




| | Calo | Muon | Pile-up | Decision Unit |
|---|---|---|---|---|
| PRR | Oct 05 | Dec 05 | Oct 05 | Dec 05 |
| Ready for commissioning | Q2 06 | Q2 06 (1 quadrant)<br>Q1 07 (4 quadrants) | Q3 06 | Q4 06 |

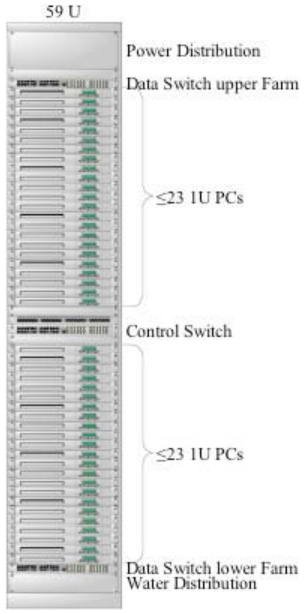
# Level-1 and High Level Trigger:
## software trigger by the DAQ CPU farm




Preparing for
-event selection algorithms
-performance monitoring
-overall trigger optimization

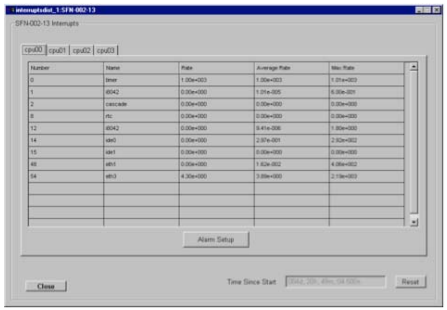
Real-time Trigger Challenge for a system test Summer 05

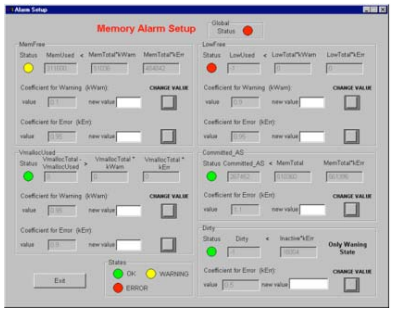
# Real-time Trigger Challenge hardware

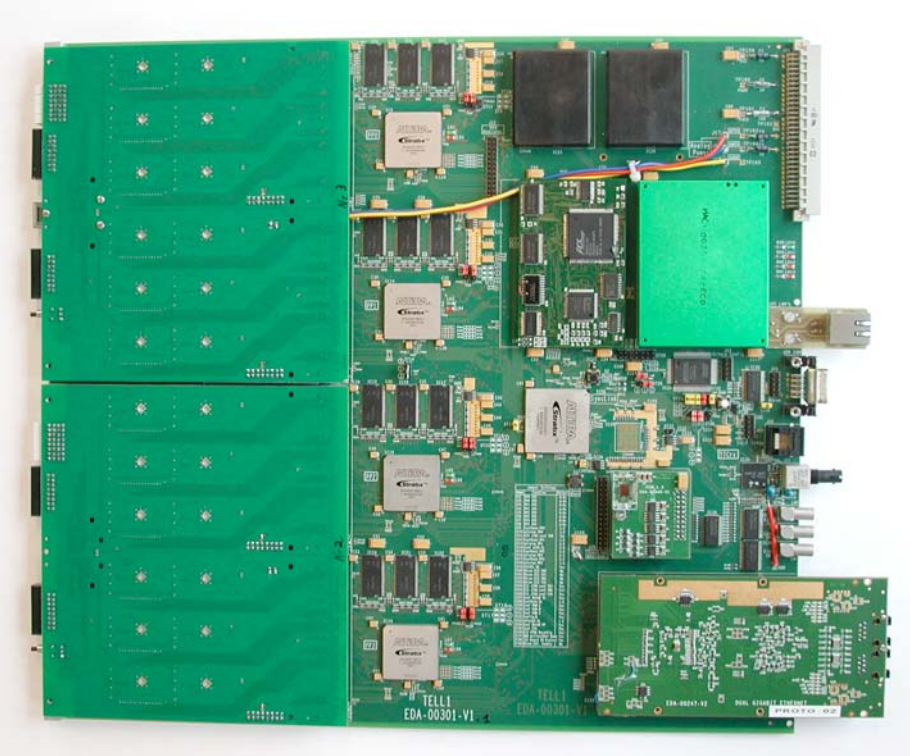

network switches CPU farm

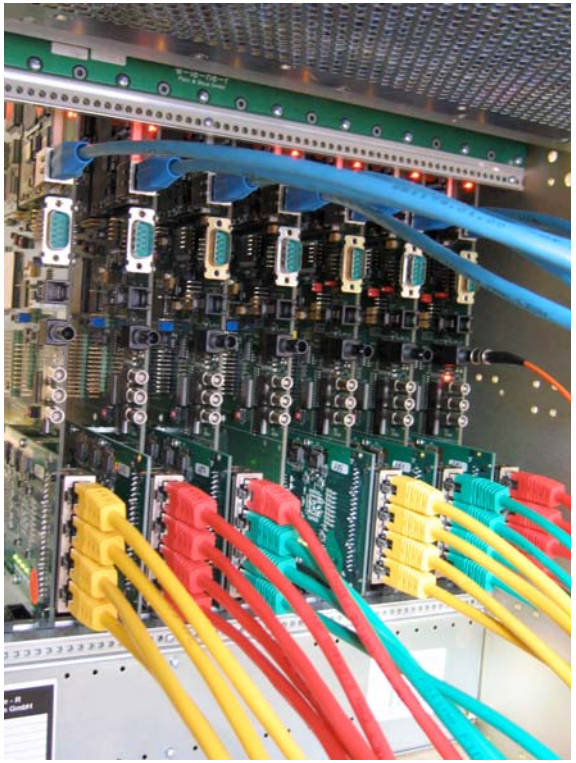
# Farm monitor and control software





# Tell1: LHCb common readout board



17 preseries board produced
working well
Subsystem specific firmware to be developed
Total number needed 350 boards

# 11) Computing

Software Framework and Distributed Computing
Computing Resource
Physics Application Software

Major ongoing work
- Adaptation of software framework to online environment
- Adaptation of distributed computing to LCG services
- LHCb computing model → Computing TDR June 05
- Framework for alignment and calibration
- Overhaul of event reconstruction

Subsystem software responsibility ⇒ subsystem projects

- -geometry
- -simulation
- -decoding
- -alignment and calibration
- -and others...

Some projects have manpower problems

Data Challenge Phase II

-fast offline selection of data at various Tier I centres-

interfacing problem between
LCG software (Storage Resource Manager)
and Tier Centres
prevented us to use LCG software
→ now solved...

# II) Current Organisation

**Recent changes**

-New CB chair (two years)

-Renewed appointment (three years) for
Spokesperson and Technical Coordinator

-Enlarging the management
Deputy Spokesperson (three years) installed

-Preparation for first day physics
Physics Planning Group chaired by Physics Coordinator

-Simplification of Trigger and Computing organisation

| | |
|---|---|
| Computing | Physics and Core Software, and offline computing resources |
| Trigger | HLT selection algorithms and overall optimization |

| | |
|---|---|
| Collaboration Board Chair | E. Aslanides (Marseille) |
| Physics and Subsystem Projects | |
| Physics Coordinator | O. Schneider (EPFL) |
| Subsystem Coordinators | |
| -VELO | J. van den Brand (NIKHEF) |
| -Silicon Tracker | O. Steinkamp (Zurich) |
| -RICH | N. Harnew (Oxford) |
| -Outer Tracker | A. Pellegrino (NIKHEF) |
| -Calorimeter | A. Schopper (CERN) |
| -Muon | G. Carboni (Rome II) |
| -L0 Trigger | R. Le Gac (Marseille) |
| -Trigger | H. Dijkstra (CERN) |
| -Online | B. Jost (CERN) |
| -Computing | N. Brook (Bristol) |
| Management | |
| Spokesperson | T. Nakada (CERN and EPFL) |
| Deputy Spokesperson | R. Forty (CERN) |
| Technical Coordinator | W. Witzeling (CERN) |
| Resource Coordinator | A. Smith (CERN) |

# III) Cost and Funding

In the construction MoU

Total cost of the experiment: 75.05 MCHF

Total requested funding: 73.30 MCHF

MoU under funded detector (MCHF)

| | Cost | Under-Funding | |
|---|---|---|---|
| IT | 5.15 | 0.11 | |
| OT | 10.10 | 0.33 | |
| Calo | 15.36 | 0.42 | |
| Muon | 7.45 | 0.62 | (without Fe) |
| DAQ | 6.80 | 0.27 | |

Signed MoU contribution is less than requested:

73.3→70.26 Total under-funding 4.79 MCHF

| | request | signed | affected |
|---|---|---|---|
| Brazil | 1.70 | 0.00 | Muon, ComF |
| China | 0.25 | 0.10 | OT, ComF |
| Germany(BMBF) | 4.80 | 3.76 | OT, ComF, Trigger, DAQ |
| Russia(+CERN) | 3.00 | 2.85 | Calo, Muon, ComF |

# Situation after re-optimization (April 2005)

| Subsystem | Cost Now | MoU-fund Requested | MoU-fund Signed | MoU funding sources Signed |
|---|---|---|---|---|
| little affected by the re-optimization | | | | |
| Calo | 14.930 | 14.940 | 14.950 | ComF CERN ES FR RO RU UA |
| Muon detector | 8.560 | 6.830 | 5.590 | BR CERN IT RU |
| Muon Fe | 4.000 | 4.000 | 4.000 | CERN |
| Magnet | 6.000 | 6.000 | 6.000 | ComF |
| Experiment infra. | 4.000 | 4.000 | 4.000 | ComF |
| L0 Trig | 2.260 | 2.630 | 2.630 | FR IT NL |
| affected by the re-optimization | | | | |
| VELO | 4.822 | 4.850 | 4.850 | CH DE GB NL |
| RICH | 9.744 | 7.700 | 7.700 | CERN GB IT |
| ST | 5.970 | 5.040 | 4.996 | CH DE ES UA |
| OT | 6.230 | 9.760 | 9.899 | ComF CERN CN DE NL PL |
| affected by all the shortfall in the common fund | | | | |
| Online | 7.996 | 7.550 | 5.642 | ComF CERN CH DE ES GB IT |
| Total | 74.512 | 73.300 | 70.257 | |

MoU cost 75.05 MCHF

We cannot avoid (unfortunately) to ask funding beyond the current funding commitments

Shortfall known now = 4.255 MCHF

Is this all?

Calorimeter, Magnet, Infrastructure, L0, VELO, ST, Online

-no indication of cost increase

OT

Infrastructure and services such as

support frame and cooling system, underestimated

-an increase of *O*(700 kCHF) to **the current cost expected**

Final overall missing funds will be ~5 MCHF

Solve first the subsystem not affected by the reoptimization

Muon system shortfall 2.970 MCHF

Our proposed solution:

- Funding reduction (Brazil and Russia+CERN): 1.240 MCHF
  - To be compensated by the common fund
- Rest 1.730 MCHF
  - Funding beyond the current MoU commitments by two groups responsible for the muon system, CERN and INFN, proportional to their original contribution

Reduce the total shortfall by 1.730 MCHF
Increasing the shortfall in Online by 1.240 MCHF

Then...

RICH system shortfall 2.044 MCHF due to
material reduction
increased cost of service items
better trigger performance (B field)

Propose to consider
-partly compensated by the common fund
(items for the overall benefit)
-partly new funding from the RICH project groups
(items under the project responsibility)
CERN, GB, IT

discussion in progress

ST shortfall 0.974 MCHF due entirely to
the increased surface of Si resulting from the reoptimization

-to be covered by the gain from OT saving

OT cost increase of ~0.7 MCHF,

-solutions are being discussed

Finally shortfall in Common Fund giving under-funding in Online Project (mainly for CPU's) to be financed by a collaboration wide effort to ask funding beyond the current commitment

## The final detector cost (~75.2 MCHF) is essentially unchanged from the MoU in 2000

For solving the funding shortfall of ~5 MCHF

we would like to request that the RRB agrees to
1) the Muon and ST solutions
2) that we put forward the RICH, OT and Online solutions in October, following the philosophy presented here

Modest luminosity required by LHCb will allow full physics programme from day one.

**→ We have to make sure that the detector construction is not delayed**

# IV) Conclusions

1) Production, installation and commissioning of many subsystems are progressing well: beam pipe, magnet, VELO mechanics, RICH2 and Calorimeter
2) Delay in the OT module production fully recovered
3) Delivery schedule for TT sensors not optimal
4) Tight schedule for VELO sensors, RICH1 mechanics and HPD's
5) Muon chamber production almost at the nominal rate, but the end of production will slip to early 2007
6) A funding short fall (~5 MCHF) to be solved
7) We are fully committed to be ready for the collisions in 2007 and see no technical problem, but manpower is critical everywhere
8) Help by RRB for 6) and 7) would be highly appreciated