CERN-RRB-2006-093
24 October 2006

Status of the LHCb Experiment

LHCb RRB at CERN
25 October 2006

on behalf of the LHCb Collaboration

Tatsuya NAKADA
CERN
and
EPFL

Contents

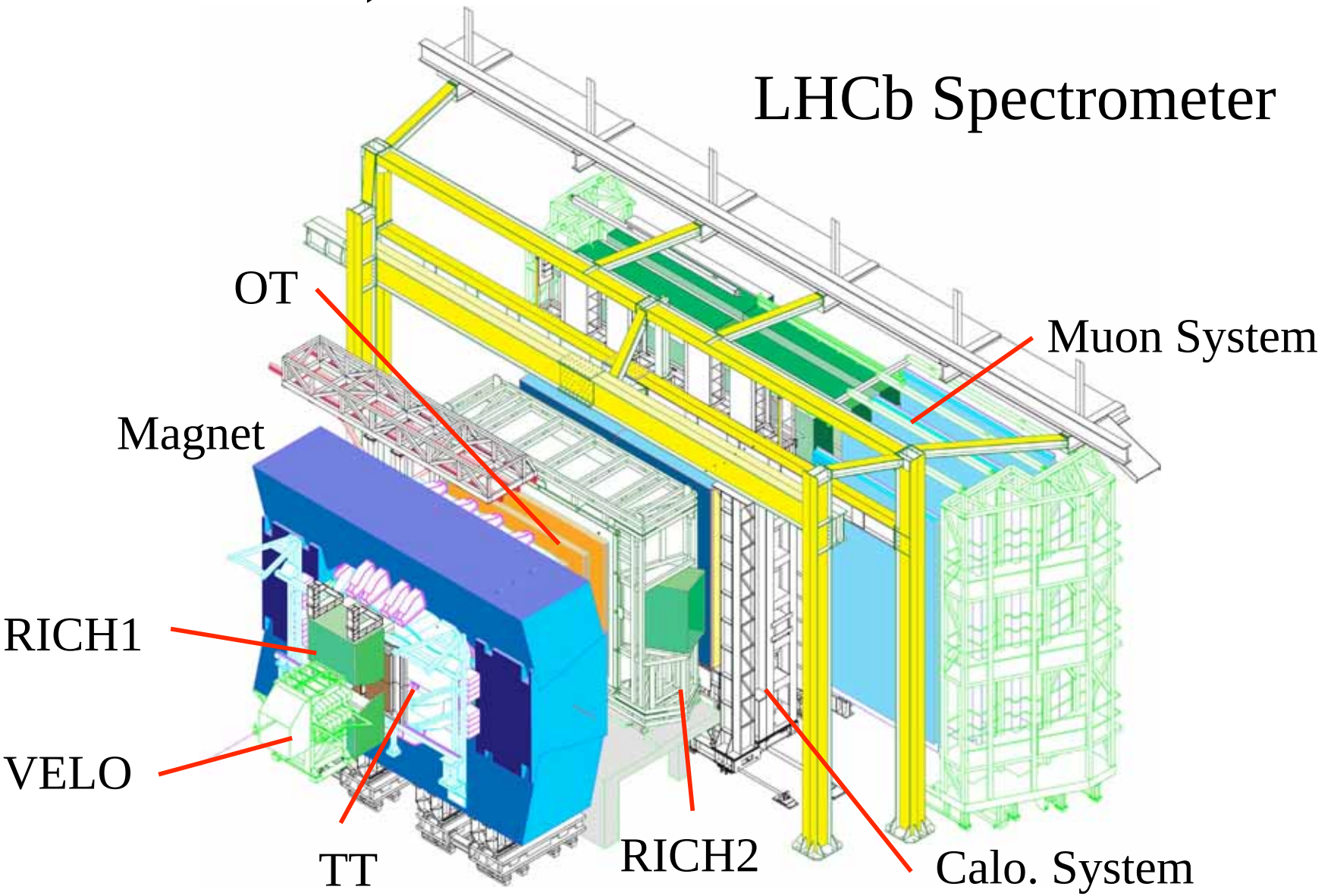
I) Construction Status

II) Physics Update

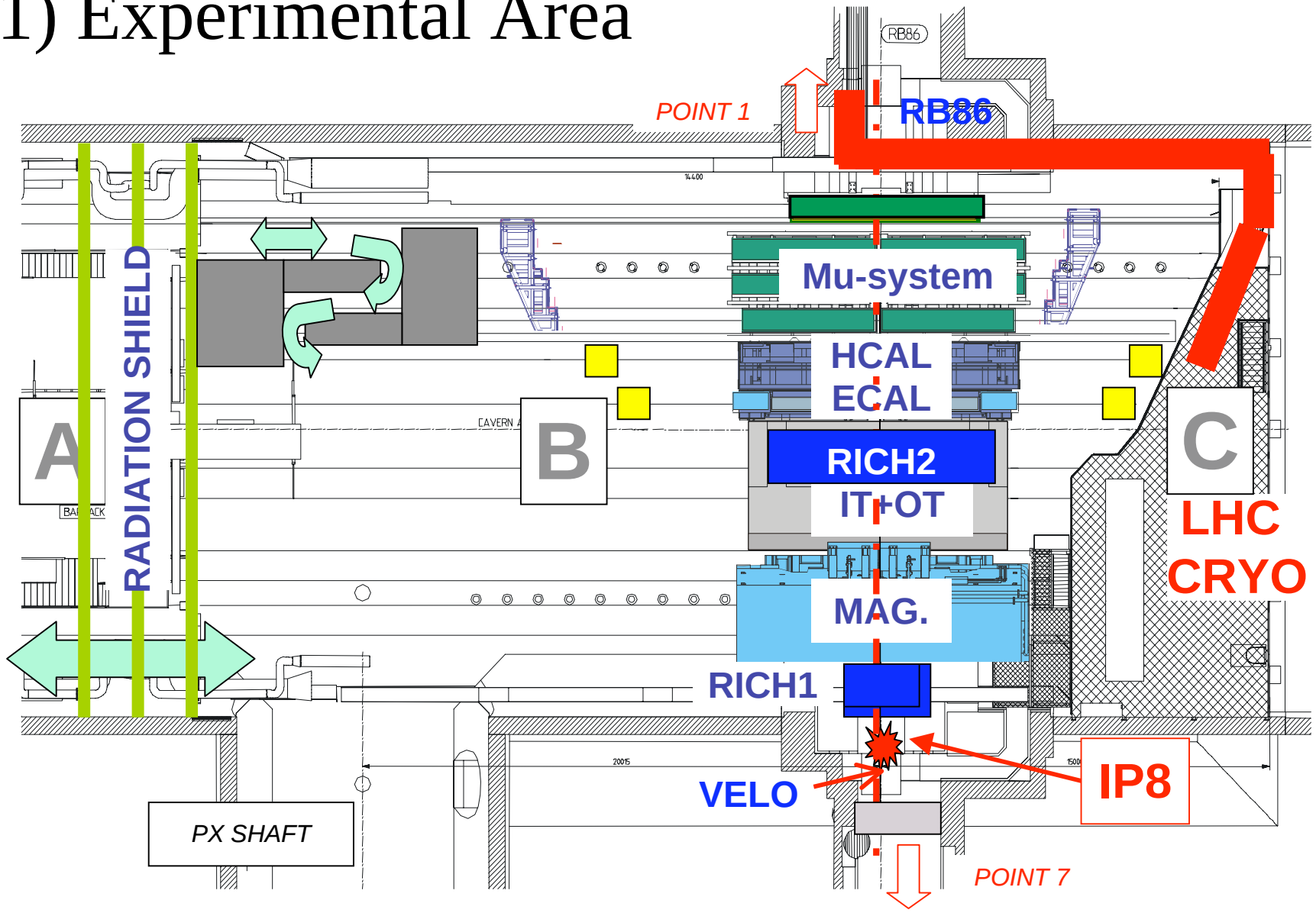
III) Cost and Funding

IV) Conclusions

I) Construction Status



1) Experimental Area



Installation of the major metallic structure completed

Gas and cooling pipes installed to the detector area

Most of the cable trays installed

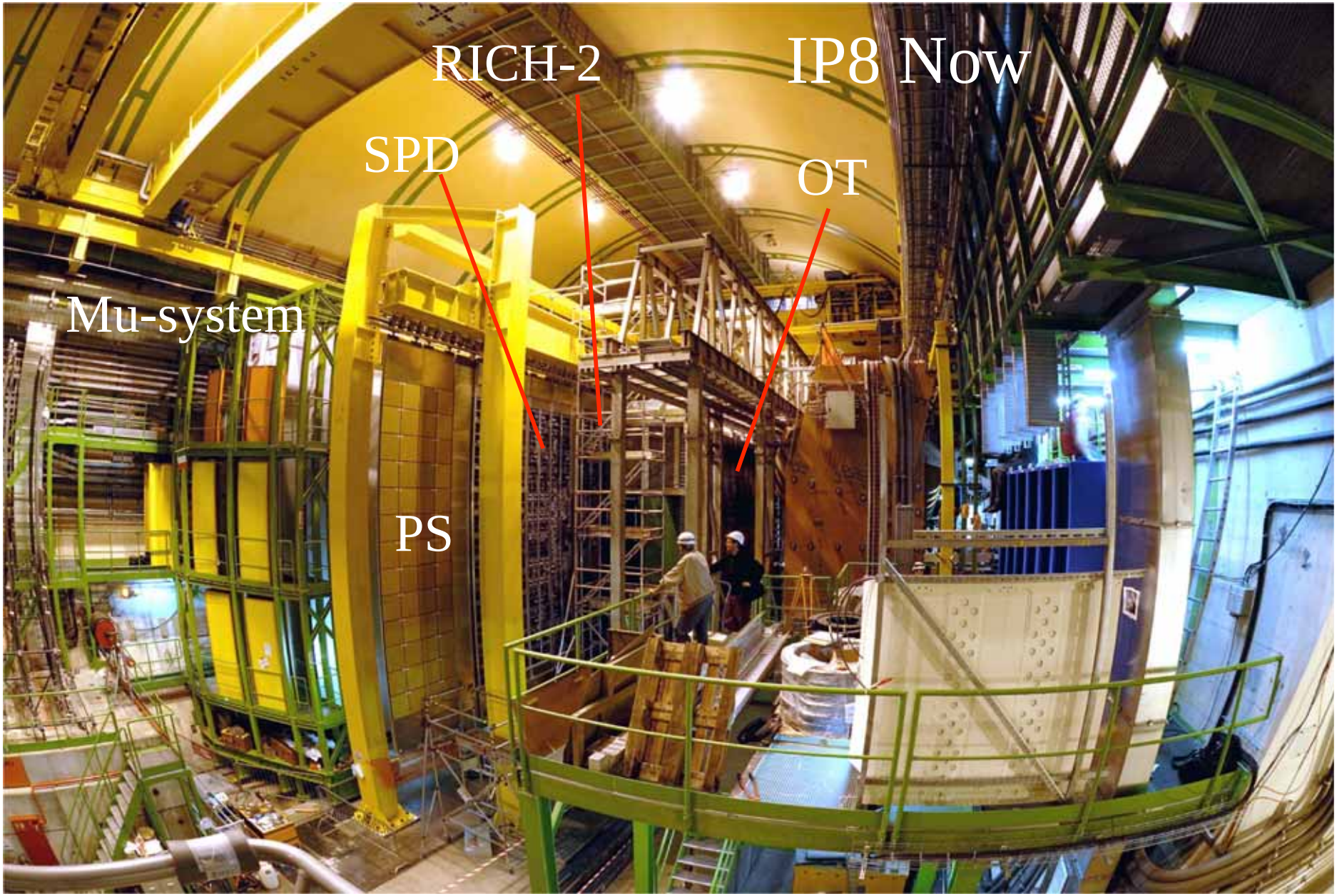
Installation of long HV, LV, ECS and signal cables and mounting of connectors in progress

Installation of safety system in progress

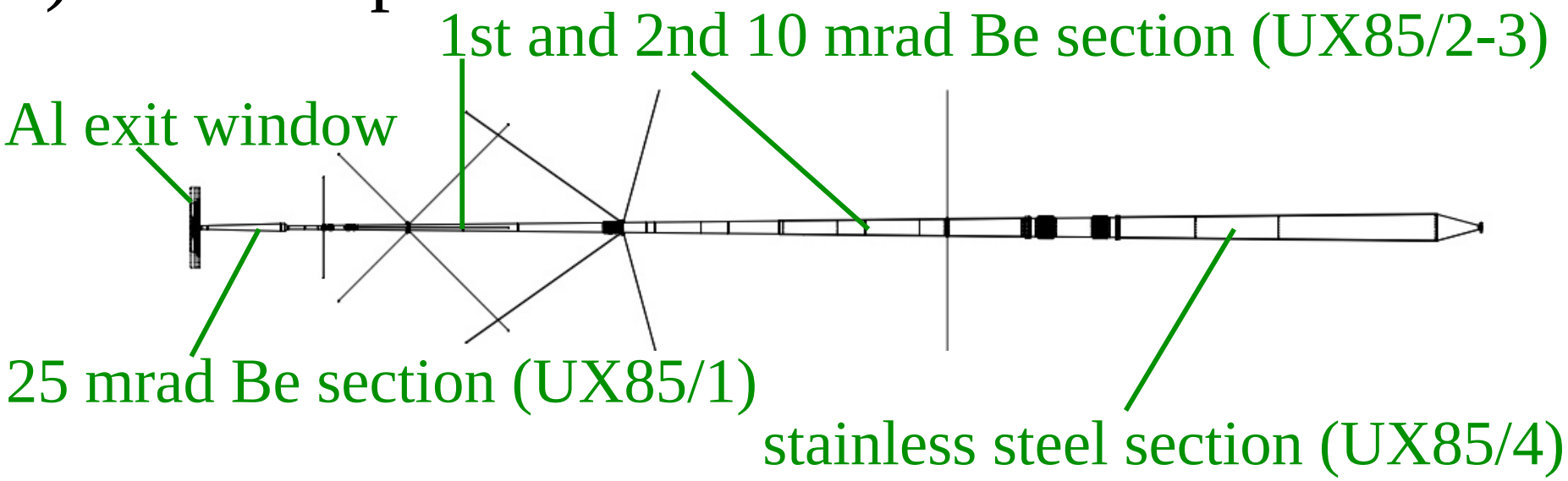
Calo access tower

cabling and connector mounting

new access gate


RICH-2
IP8 Now
SPD
OT
Mu-system
PS

2) Beam Pipe



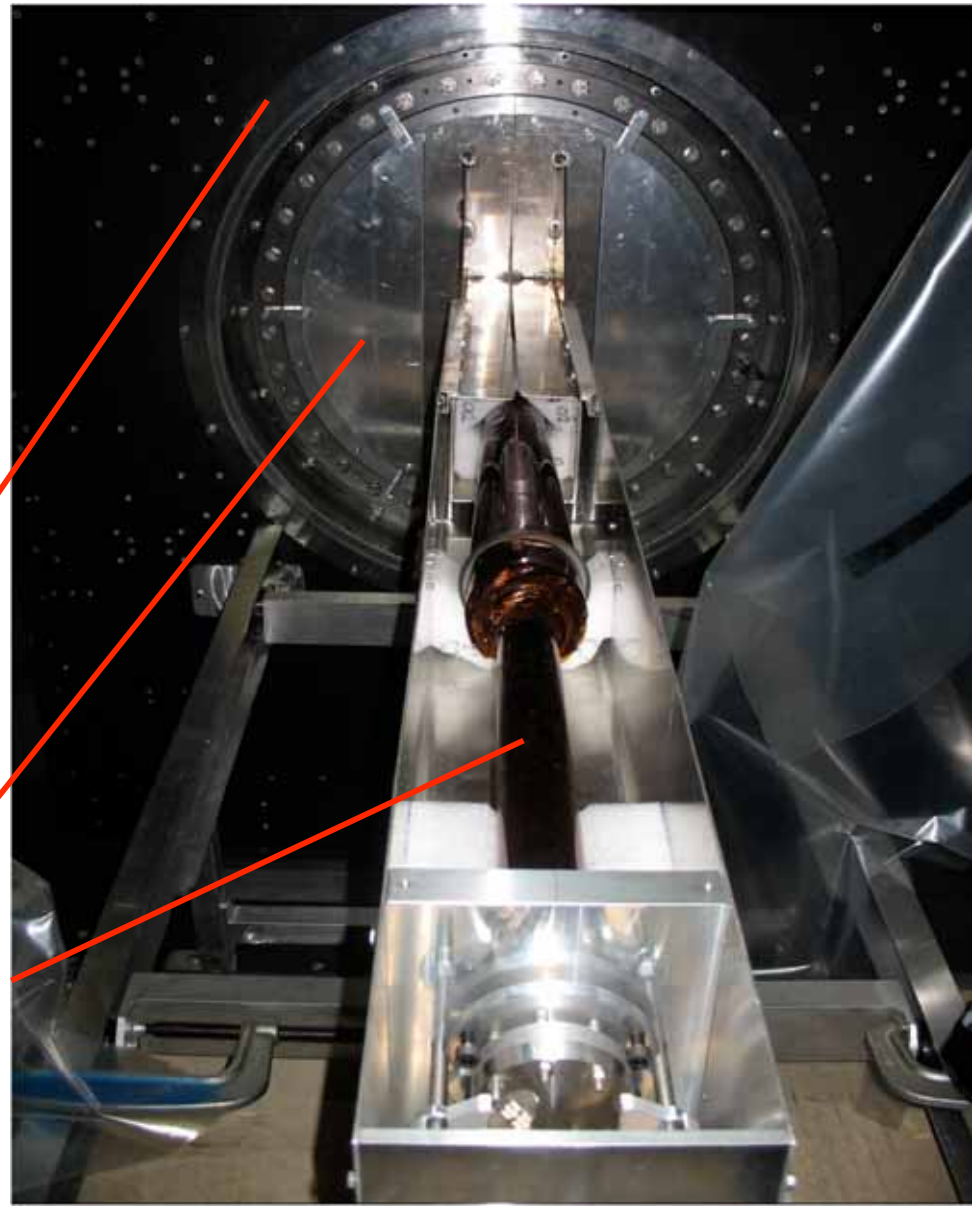
All the beam pipe components have been produced.
UX85/3, the last piece, just arrived at CERN
Except UX85/3 all passed the acceptance test
Al exit window+UX85/1 installed
Al spare beam pipe construction completed by the end of 06

Al exit window of the VELO tank
+ UX85/1 Be beam pipe section

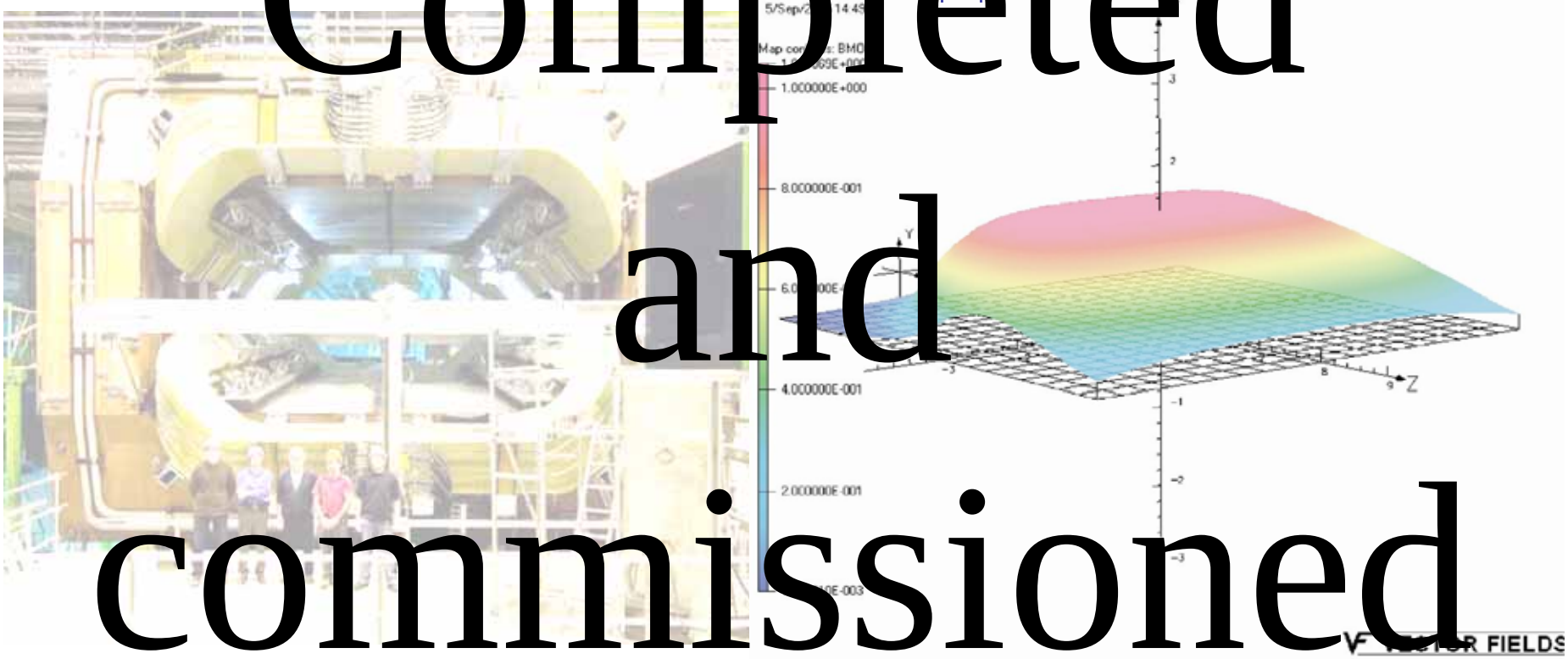
VELO vacuum tank

protection for the Al window

Be beam pipe



3) Magnet (funded by Common Fund)



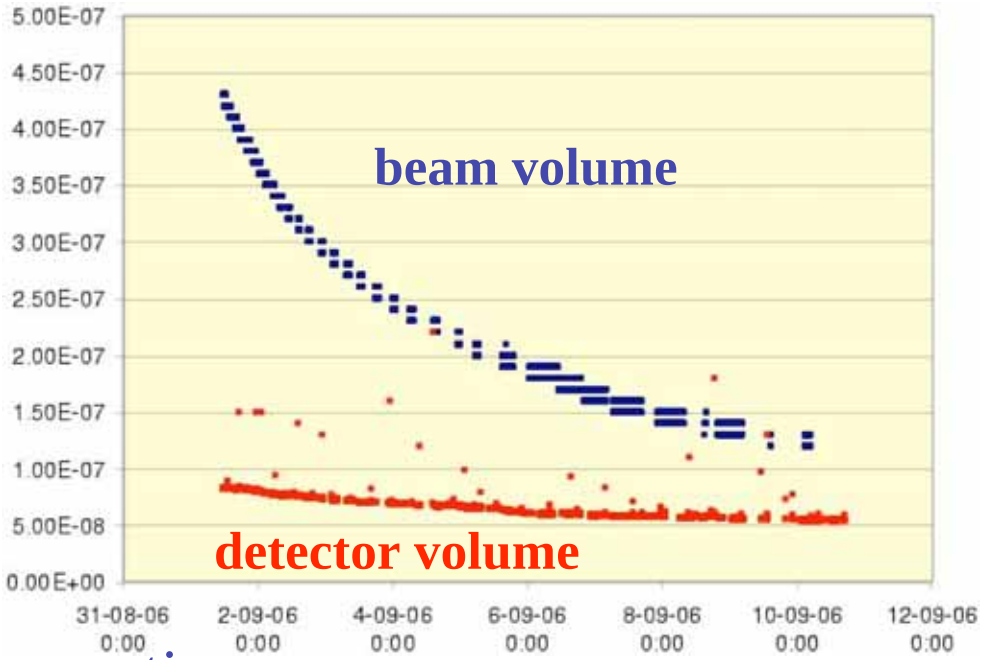
Completed and commissioned

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

VELO tank and its vacuum system installed at IP8 and vacuum leak tested

Al exit window (down stream) together with the first section of the beam pipe connected

Al window and wake field supp



evacuation curve

Upstream side of the vacuum tank at IP8

Sensor module production in progress: 15 modules completed
Assembly of the Right Detector Half has started
Full readout system tested in the test beam
with three sensor modules
November RDH test beam with 10 modules
tight schedule

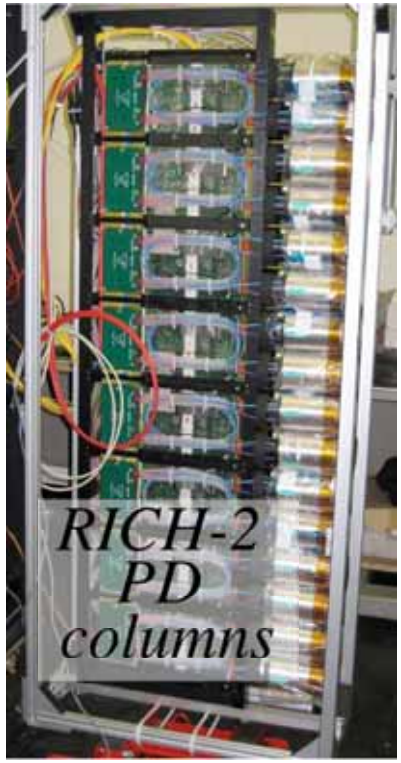
right detector half box with thermal camera for testing

test beam set-up with all the readout chain

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

RICH-2: In place and waiting for the Photon Detector
Photon Detector column assembly in progress

RICH-1: Mag. shielding box, gas enclosure in place, gas shielding bellow connected to the VELO tank
C-fibre mirror prototype test successful, production in progress

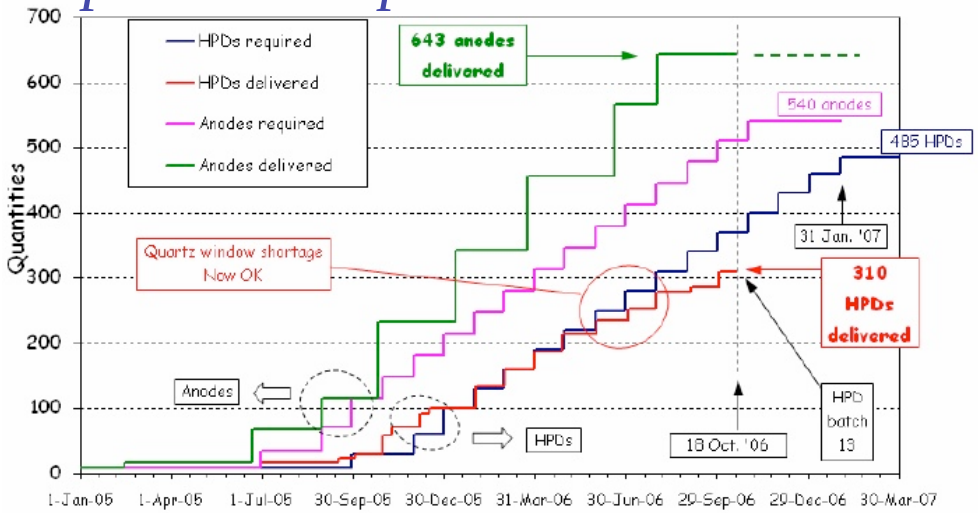


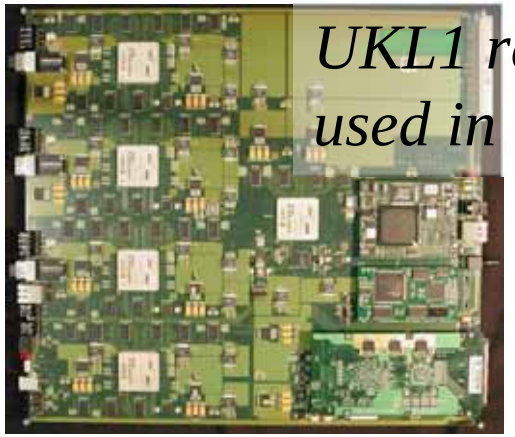
mandrel for the final mirror

310 HPD's delivered out of 485 ordered (+65 option),
2 months delay ⇒ recovery plan agreed with DEP
only 3% failed the acceptance test, very good quality

Test beam with the full readout chain successfully completed

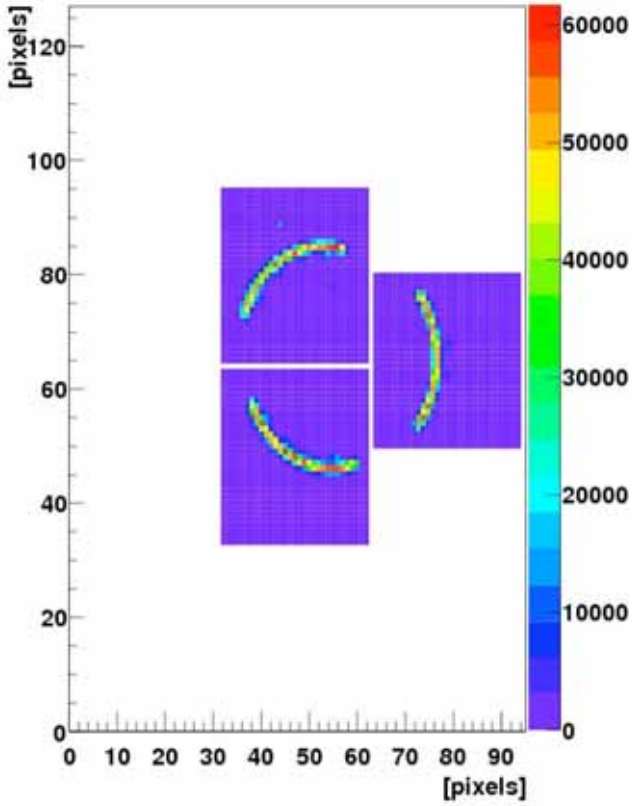
HPD production plot





UKL1 readout board used in the test-beam

test-beam CF_4 ring

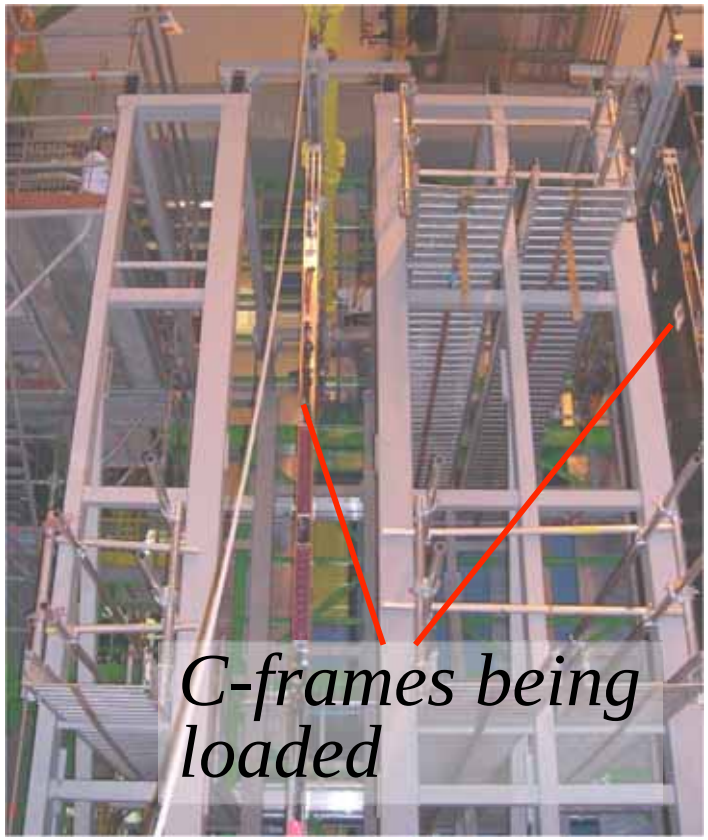


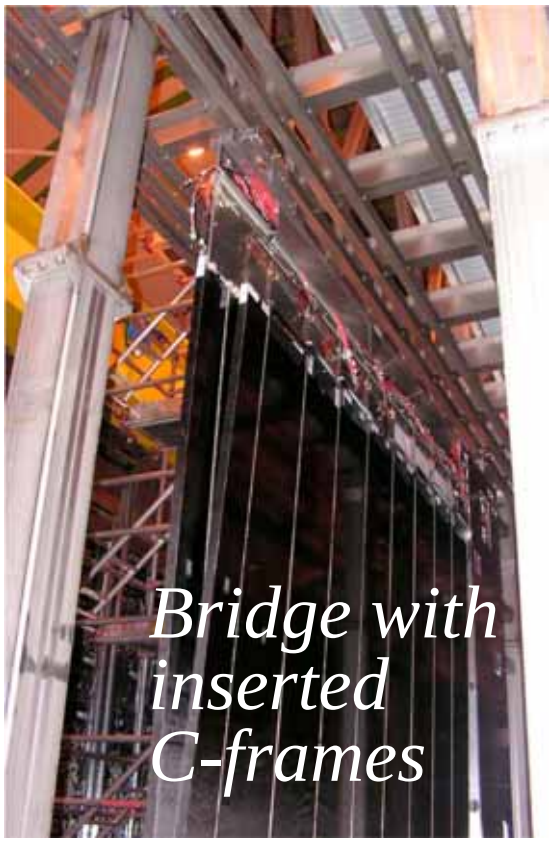
6) Outer Tracker (funded by CERN, CF, CN, DE, NL, PL)

Metal support structure (Bridge) for OT and IT assembled and aligned at IP8

Loading of C-frames with the detector modules in progress

Insertion of the loaded C-frames to the cryo-side started.





Comments on the aging issue:

Various prototype modules have been tested with strong sources, X-rays and particle beams (accelerated test)

⇓

Showed no problem for 10 years of operation with Ar/CO_2

Accidentally, gain loss was observed for production modules at very small dose with weak sources

Large effort for investigation, including regular “workshops” with participation of external experts

No definite conclusion for the cause but strong indications for the out-gassing effect

Gain loss reduced drastically by flushing the module at a higher temperature of ~40 ℃

⇓

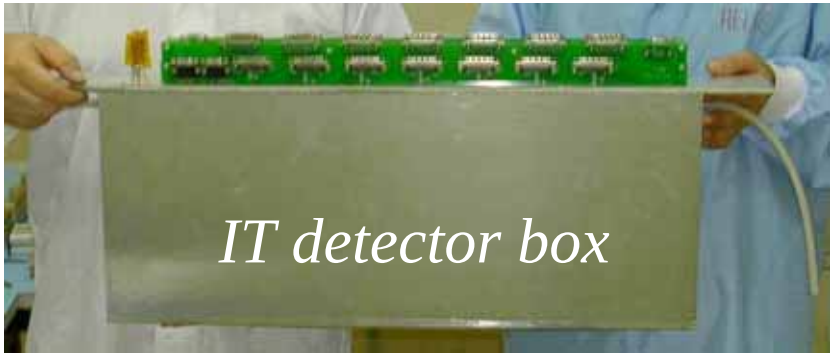
Necessary tools and infrastructure for warming and flushing the modules before loading and in situ in preparation

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

Ladder production in progress:
>90% for TT and >60% for IT completed

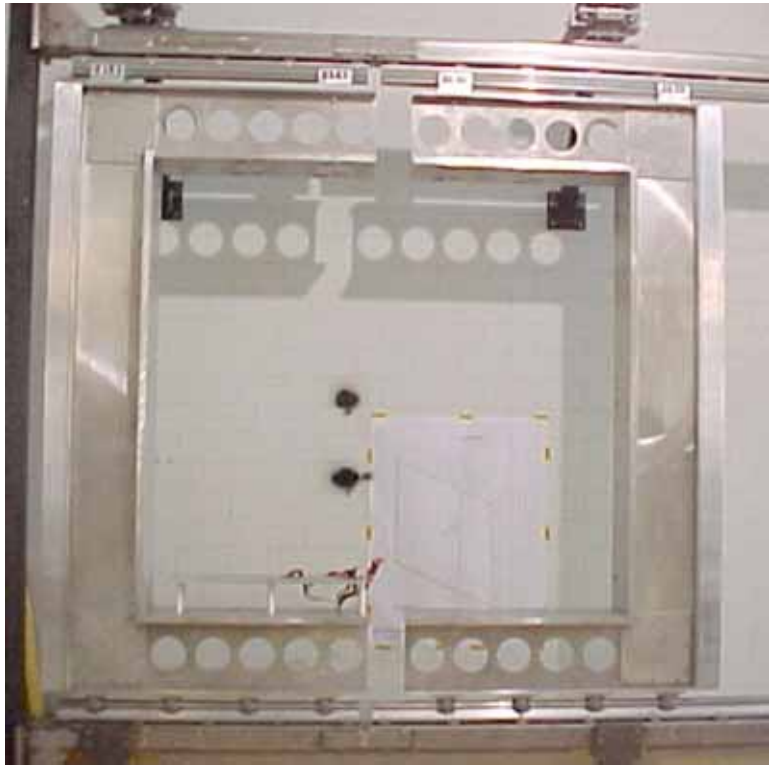
First IT detector box assembled and being tested now

Construction of the TT detector frame in progress



IT detector box

inside of the box



TT detector frame

TT support rail installed and aligned
First IT support frame inserted to the Bridge

TT upper support rail

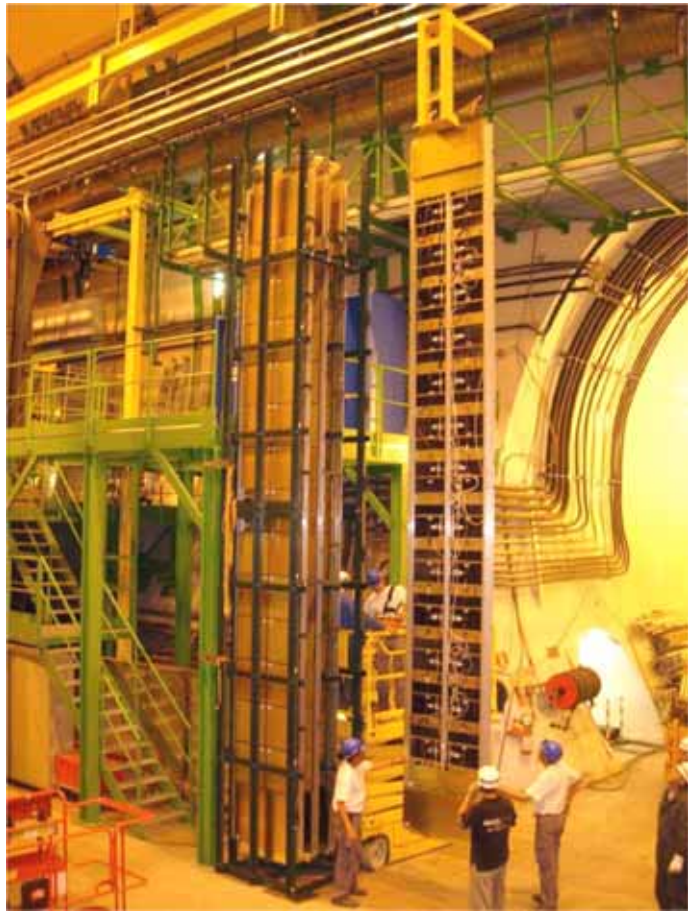
TT lower support rail

IT support frame with cables

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

E-cal and H-cal installed and commissioning work on going

Scintillator Pad Detector/Preshower installation completed



Insertion of the SPD super modules

Completed SPD/PS

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

>90% of MWPCs produced and tested

Dressing at CERN (CERN and PNPI chambers) and in Frascati (IT chambers) in progress

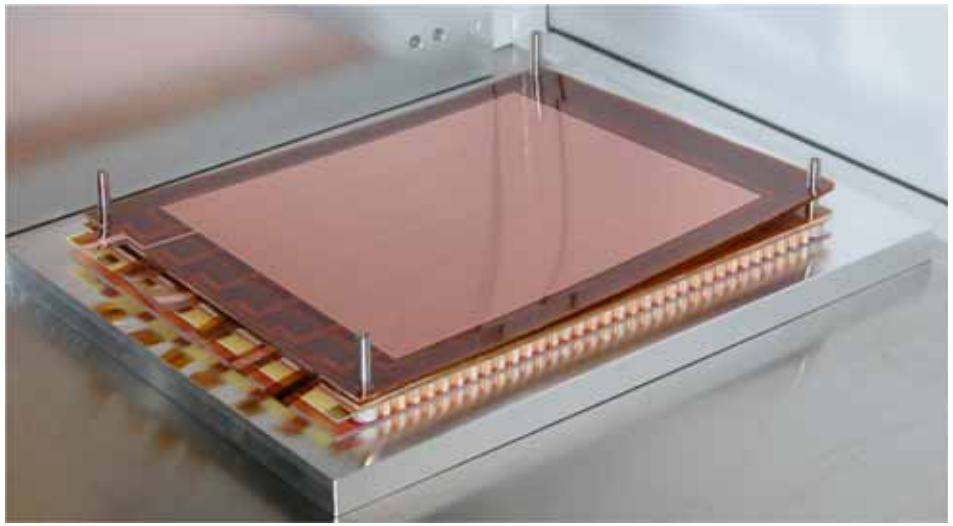
M5 chambers are at CERN to be ready for the installation

>50% of 3-GEM chambers for M1/R1 constructed

Full readout chain test in test beam completed

M5 chambers

3-GEM construction



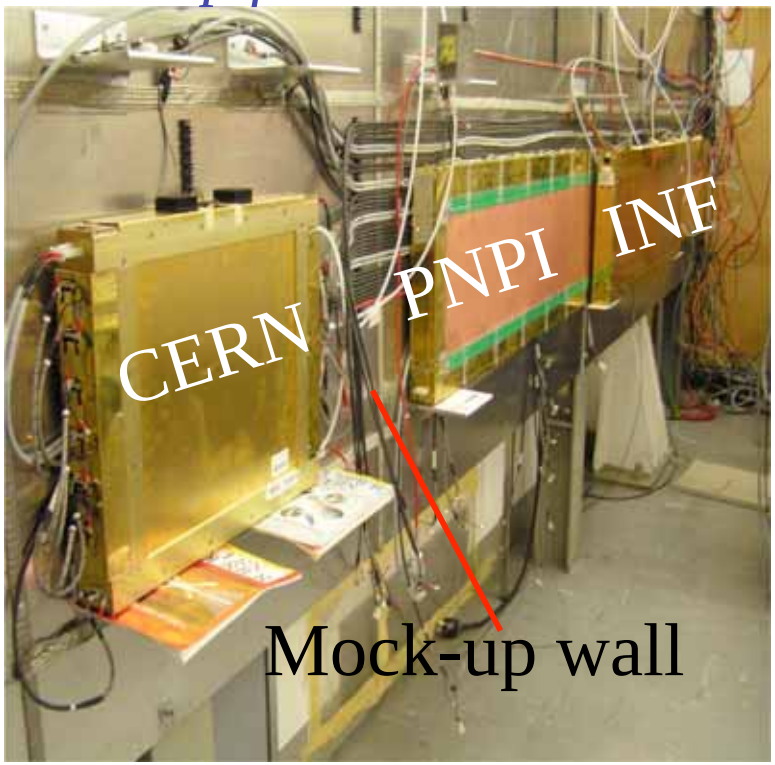
Chamber support wall for M2-M5 assembled and necessary infrastructure (gas, cable, etc.) being installed

Preparation for the chamber installation in progress

Start of chamber installation delayed by several months: minor but different delays in infrastructure
parallel installation planned, manpower will be the problem

Muon wall preparation

Mock-up for installation test



10) Trigger and Online

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

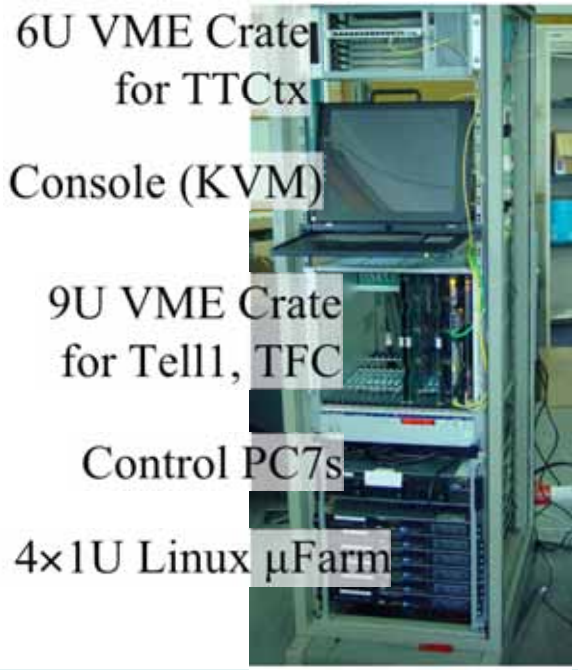
L0 Muon processor link tested in the muon chamber test-beam

Infrastructure of the electronics huts at IP8 ready

CPU's and servers necessary for the commissioning arrived

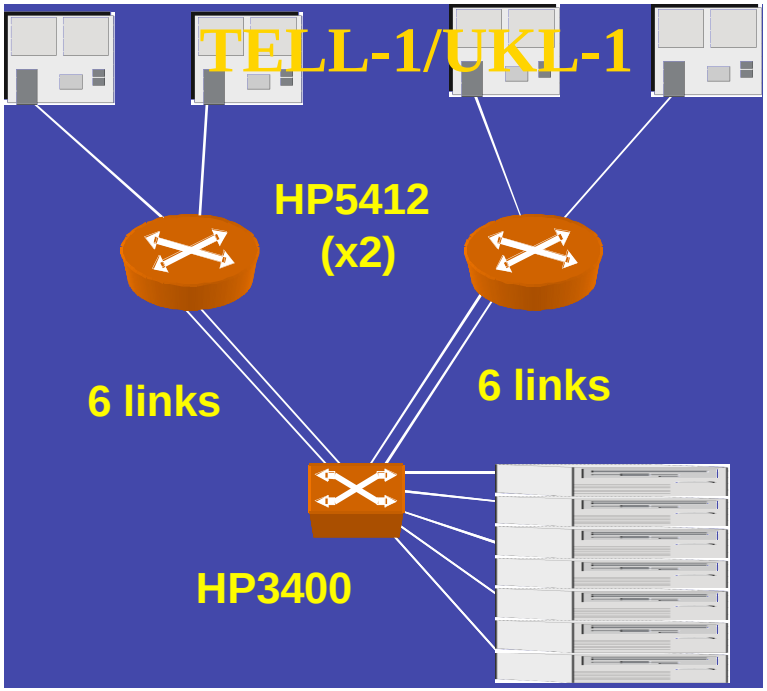
In order to ease the commissioning of the subsystems,
Commissioning Racks with TFC and scaled down DAQ are prepared

L0 Muon processor at test beam



Start-up configuration for the DAQ system revised reflecting the LHC plan of collision with 900 GeV → bandwidth and CPU needs are very limited:

ECS system now being used by several subsystems in their test-beam set-up with full readout chain



Core network switch is two mid range HP switches (“borrowed”) and 80 CPU nodes for the farm

Delay the purchase of expensive Force-10 Linecards and CPU’s

Final Switch can be easily introduced during the Jan-Mar/08 shutdown

11) Computing

Continuous improvement of software

- Track reconstruction now adapted to the new event model and detector geometry description
- Tuning of the tracking and particle identification performance in progress
- Alignment strategy established and implementation started global alignment challenge in early 2007

Data Challenge 06 on going

- Event generated and stored in relevant Tier-1's
- Full chain of event reconstruction close to completion initial problem in data access has now been largely solved
- Triggering automatically stripping job after the event reconstruction is functional

II) Physics Update

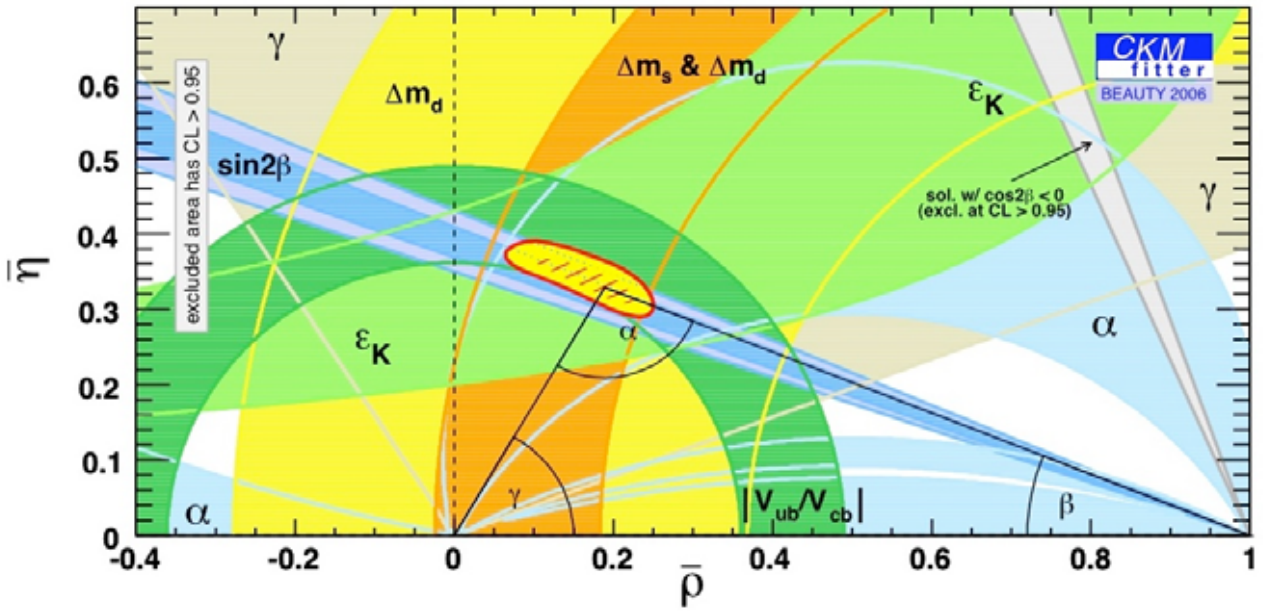
CDF updated their Spring result on the B_s oscillation
Established now as an "observation" with >5σ significance

$$\Delta m_s = 17.77 \pm 0.10 \text{ (stat)} \pm 0.07 \text{ (syst) ps}^{-1}$$

→ this was anticipated already at the time of TP

The error on $(1-\rho)^2 + \eta^2$ in the η-ρ plane is reduced to the level close to that of the $\rho^2 + \eta^2$ from $|V_{ub}|$.

Both errors are dominated by the theoretical uncertainties



Very large New Physics contribution to the B_s-$\overline{B}_s$ oscillation now excluded

Due to large theoretical uncertainties, to identify a small NP contribution in Δm_s is very difficult

The phase of B_s-$\overline{B}_s$ transition amplitude needs to be measured with CP violation in $B_s \rightarrow J/\psi\phi$, $J/\psi\eta$, ...

Sensitive to new physics (SM contribution is small) and very small theoretical uncertainties, like $B_d \rightarrow J/\psi K_S$

CDF 260 pb^{-1} Run 2 data: 203 untagged $B_s \rightarrow J/\psi(\mu\mu)\,\phi$
D0 450 pb^{-1} Run 2 data: 513 untagged $B_s \rightarrow J/\psi(\mu\mu)\,\phi$
$\Rightarrow$ ~10 k events by the end of 2009

cf. LHCb 2 fb^{-1} (10^7 s data): 130k untagged $B_s \rightarrow J/\psi(\mu\mu)\,\phi$
$\Rightarrow$ We must be ready to fully exploit the 2008 data taking!

and others, e.g. reducing the error on γ to ~5°, $B_s \rightarrow \mu\mu$ down to 10^{-9}etc.

III) Cost and Funding

As reported last time

Cost: All the effort was made to stay in the MoU cost,
only 0.4% increase 75.341 MCHF

Funding: Committed by the MoU signatures
(all countries signed except BR) 70.257 MCHF

Additional contributions to the subdetectors
CERN (799 kCHF), DE BMBF (381 kCHF)
GB (44 kCHF), IT (847 kCHF), NL (381 kCHF)
New contribution to the CPU farm
for the event filtering and monitoring at the pit
FR (500 kCHF), US (400 kCHF)

i.e. Total income 73.609 MCHF
Missing funds 1.732 MCHF
for the CPU farm

Since the last RRB

New contributions to the CPU farm approved by

DE-BMBF 300 kCHF

US-NSF 130 kCHF for 2007

Current missing funds for CPU 1.302 MCHF

(38% of CPU cost)

Pending requests for new contributions for the CPU farm

ES (20 kCHF)

GB(400 kCHF)

IT(200 kCHF)

US-NSF(450 kCHF for 2008-2009)

} 1.070 MCHF

GB and IT: depends on the overall requirements from all LHC experiments, known by Spring 2007?

US-NSF: depends on the peer review result, by Summer 2007

Seeking further extra funds for the CPU farm

→ some discussion took place with BR, CH, NL

to be followed up

Re-optimising the deployment plan for the DAQ system and CPU farm in view of the new LHC start-up plan delaying the expensive purchasing as late as possible

→ possible gain from the Moore's law

However, a large fraction of the missing funds must be committed by the end of 2007 in order to have sufficient CPU power for the event filtering and monitoring essential for the 2008 physics run

IV) Conclusions

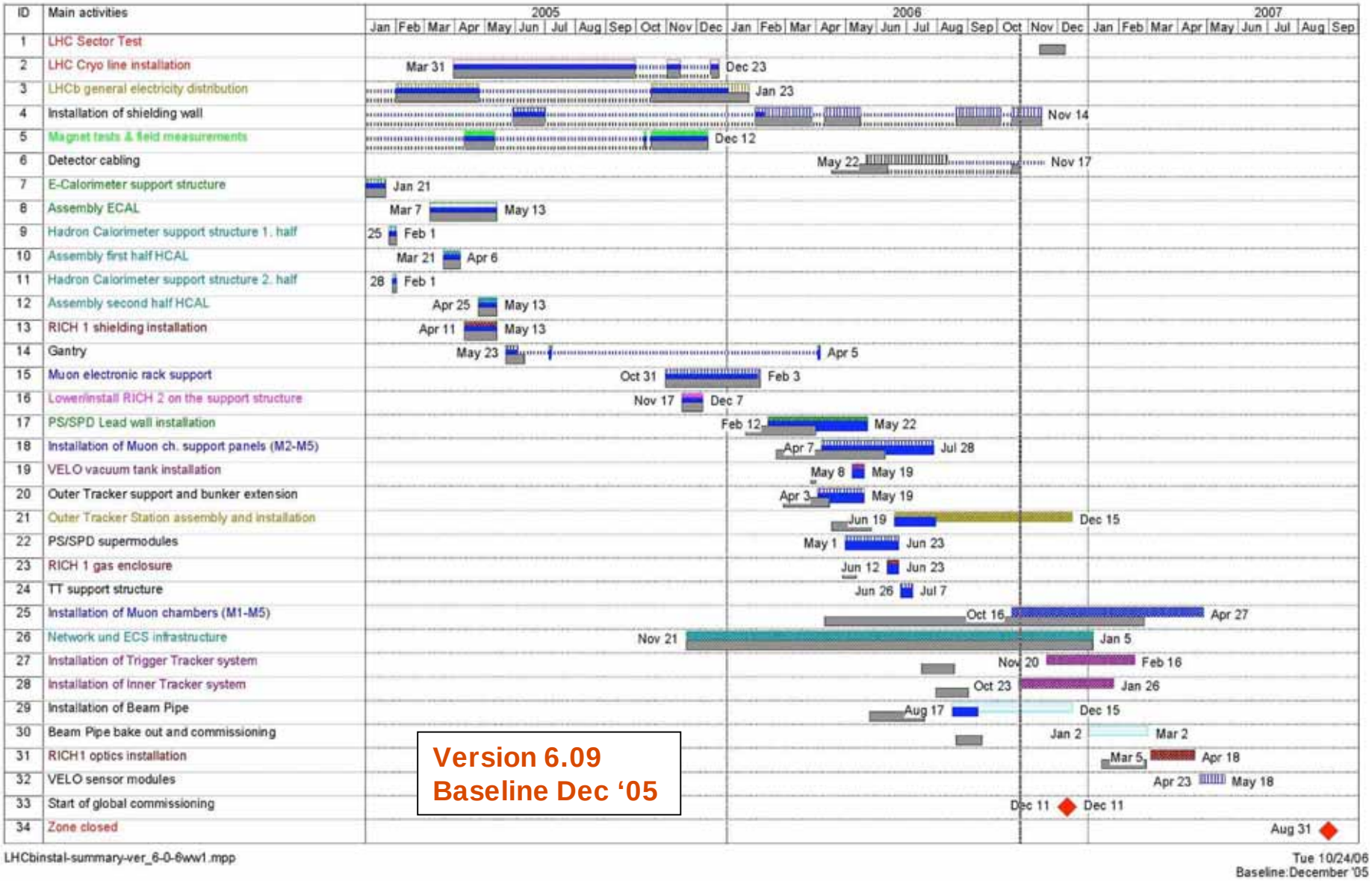
LHCb is fully committed to be ready for the 2007 pilot-run with the complete detector

1) Currently, Magnet ready. VELO tank, RICH-2 mechanics, and Calo installed. RICH-1 mechanics and OT being installed. TT ladder, Muon chamber production almost completed.

2) Schedule is very tight, in particular, for the production of the Si modules (VELO and IT), RICH-1 mirrors and Muon chamber installation → more manpower needed

3) Additional contributions approved for the CPU farm
300 kCHF (DE-BMBF), 130 kCHF (US-NSF)
→ 1302 kCHF still missing for the CPU farm
Pending request for 1070 kCHF (ES, GB, IT, US)
No problem for 2007, but need most of the commitment by the end of 2007 for the physics run in 2008

Installation summary schedule



LHCC milestone plot