CERN-RRB-2004-162
27 October 2004

Status of the LHCb Experiment

LHCb RRB at CERN
27 October 2004

on behalf of the LHCb Collaboration

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CERN
and
Swiss Federal Institute of Technology Lausanne (EPFL)

Contents

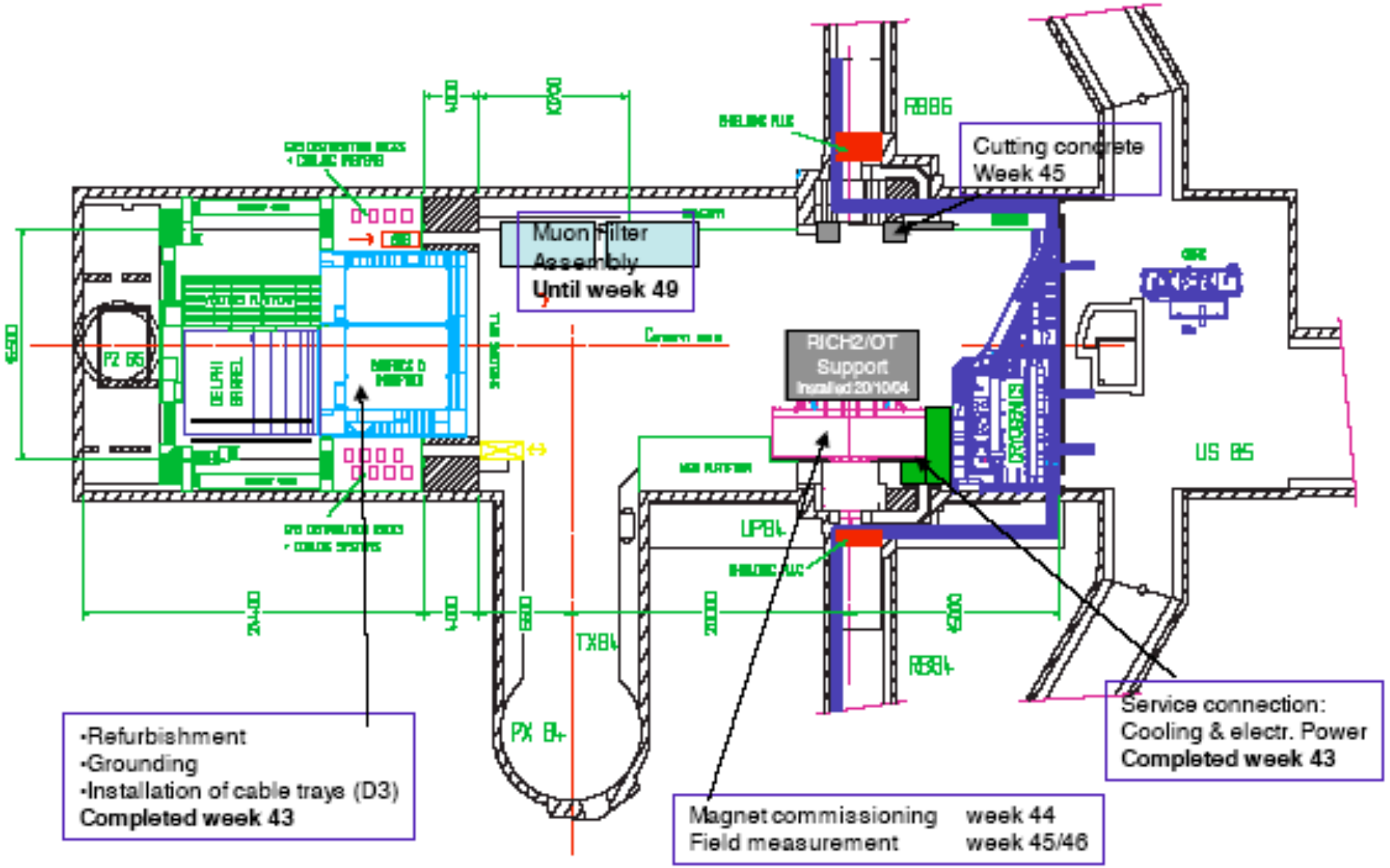
I) News

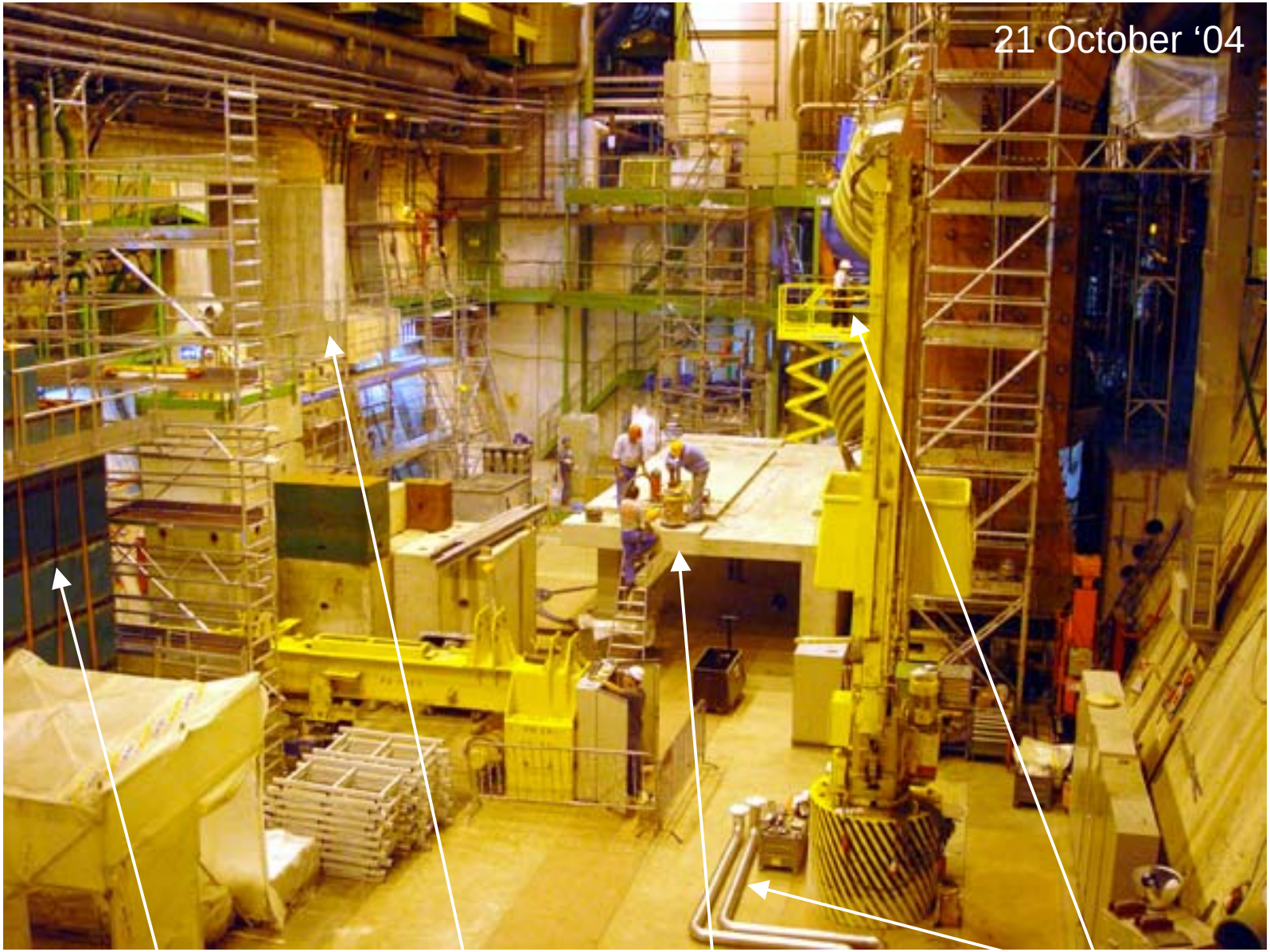
Poland has signed the construction MoU (also M&O MoU)

remaining country: Brazil

Dresden group transferred to Dortmund

II) Experimental area




21 October ‘04
Muon filter assembly
Concrete cutting
RICH2/OT support
Magnet services

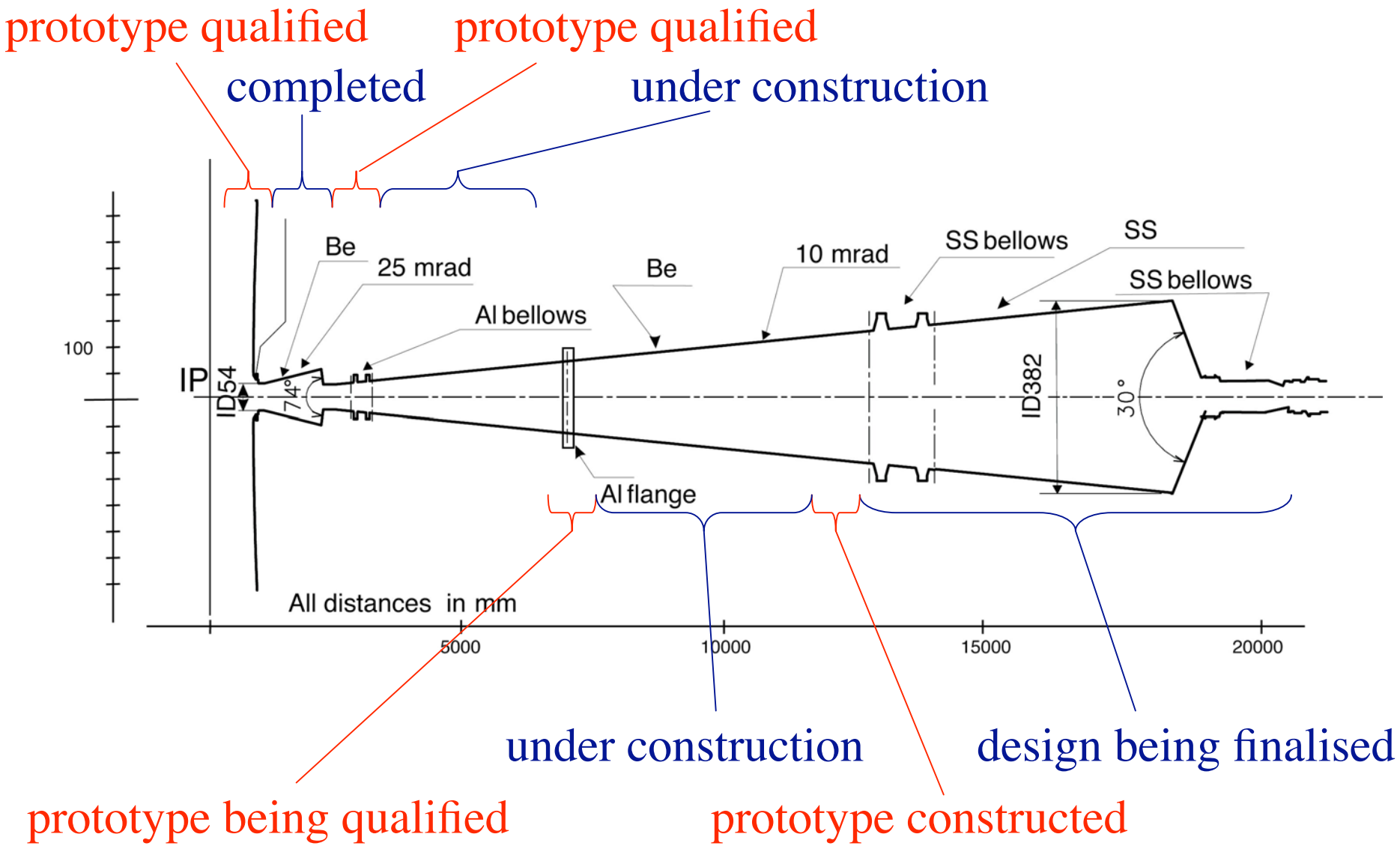
Electronics barracks

Cable trays

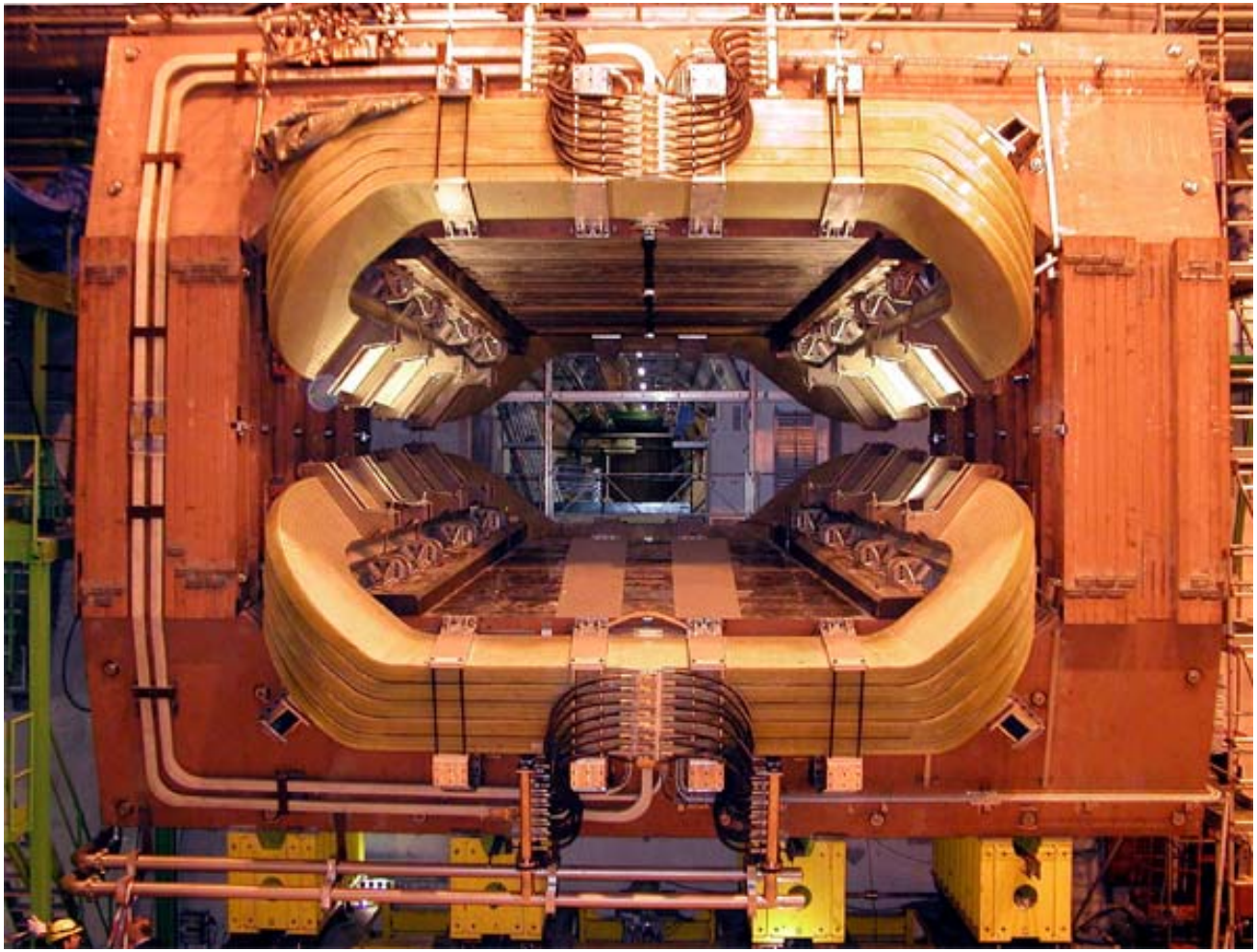
Racks

III) Detector Status

1) Beam Pipe



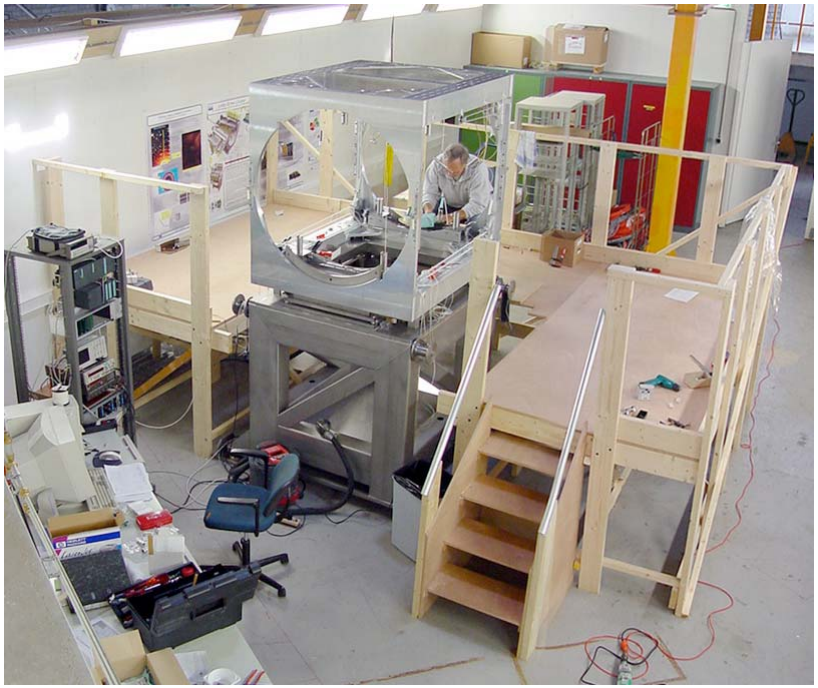
2) Magnet



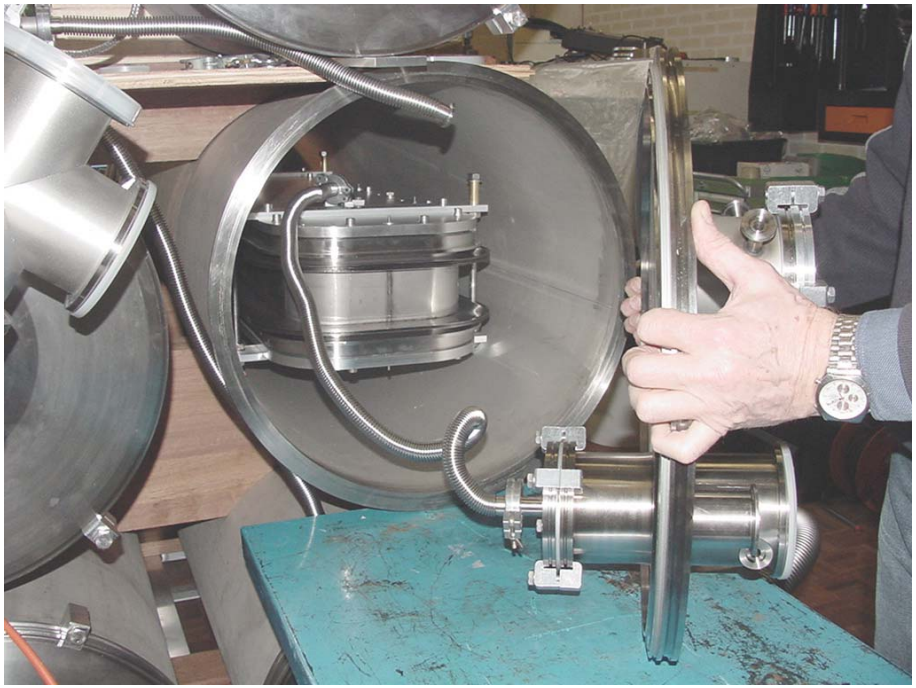
Moved to the final position and aligned. Power and cooling have been connected. Commissioning and the first field map measurement start now.

3) VELO

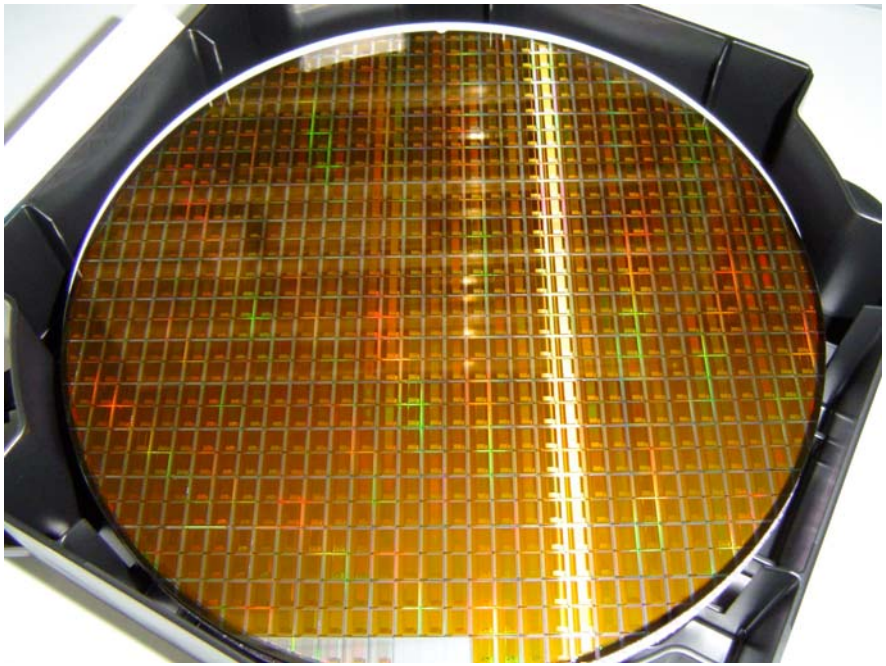
VELO mechanics are advancing well

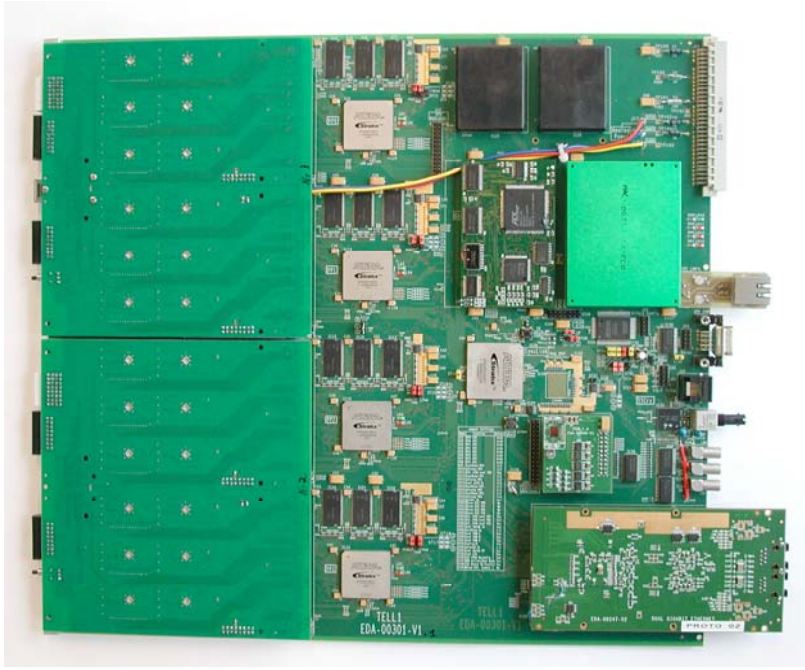


Mechanical assembly work in progress. The vacuum tank expected in November.



Testing the long term stability of the rectangular bellows.





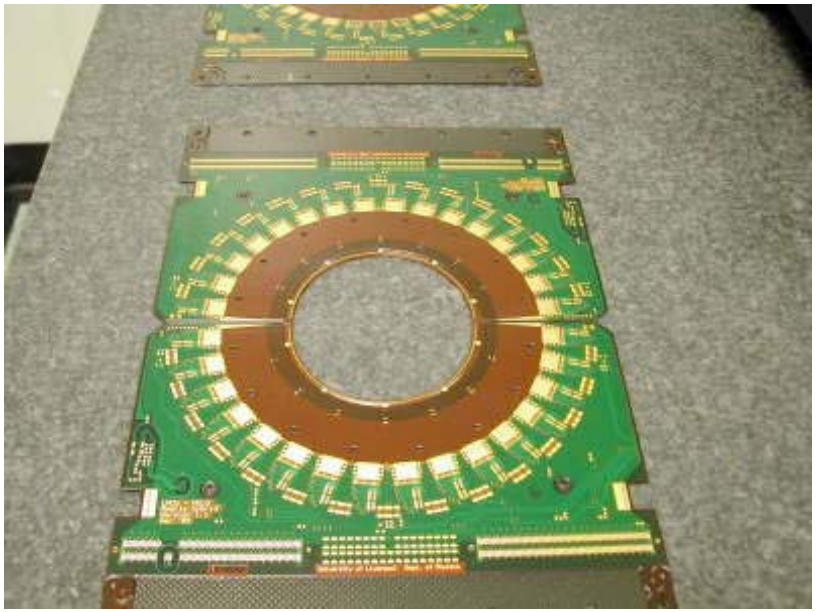
Beetle chip
-engineering run completed
-6 wafers 786×6 chips in Heidelberg
-current yield estimate 80%
-chips being evaluated and so far good

Also used by Silicon Tracker and Pile-up detector

TELL1 board
-prototype successful
-preproduction started

Also used by most of other detectors

First preproduction sensor and final hybrid



First two preproduction sensors delivered recently by Micron
with three months delay
→ being prepared for the test beam: 200/300 μm decision

An LHCb person will be stationed at Micron
in order to ensure the quality control.

4) RICH

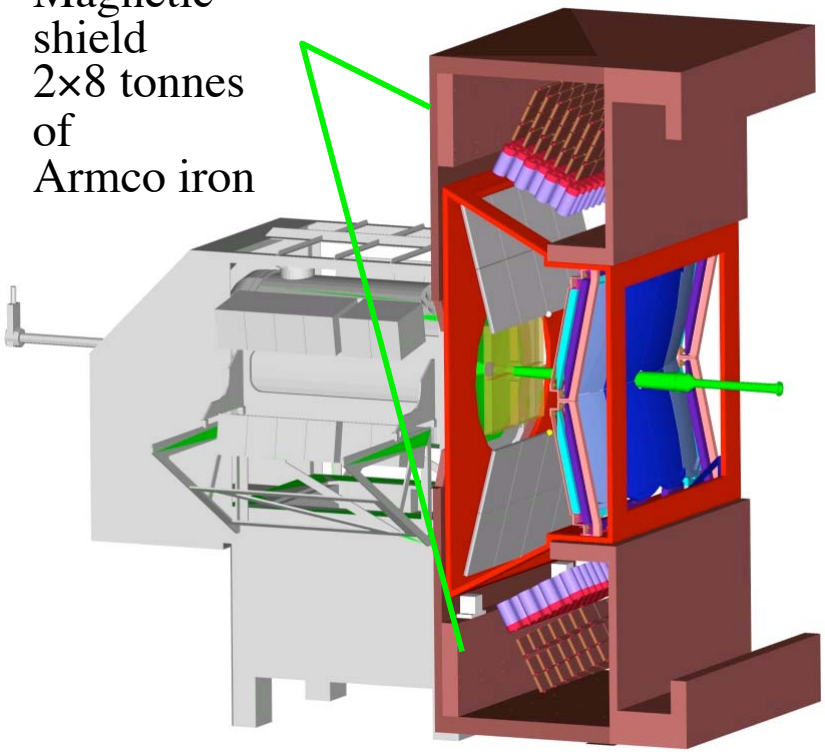
RICH1

-overall EDR completed

-magnetic shielding PRR completed

-magnetic shielding ordered

Magnetic shield 2×8 tonnes of Armco iron

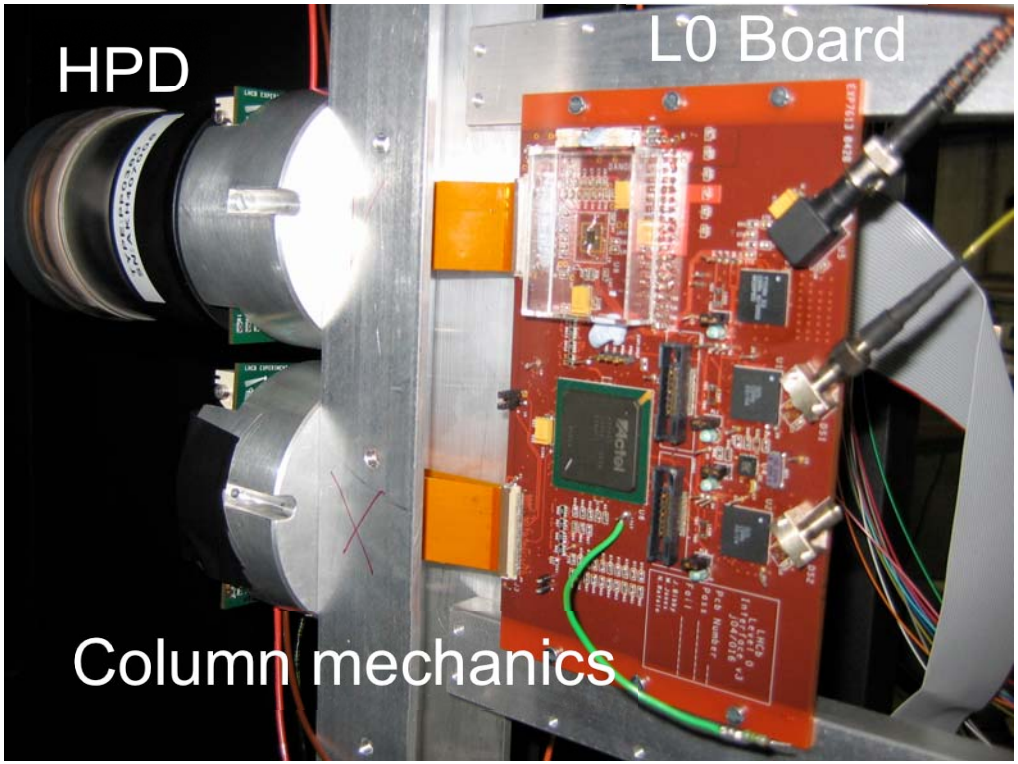


re-optimisation resulted in cost increase (shielding, mirrors, HPD coverage)

RICH2

assembly well advancing

Integration of the HPD in the RICH system together with the other necessary electronics in progress



being tested with preproduction HPD's.

HPD production

Technical problem with the sensor processing: never had before!

Compared with prototype Si sensors:

1) introducing SiO_2 passivation (front side)

2) change of the Al sputtering machine at sub-contractor (back side)

1) → photo-resist peels off (metallography)

no bump-solder deposit possible

2)→ back side Al peels off (quality control?)

no grounding possible

Solution for 1)

additional Ti/W coating → **No peeling off any more!**

Solution for 2)

sputtering to be done at the bonding factory or/and

sputtering to be done with more strict quality control

Two solutions are being tested now

A couple of months delay has been introduced: as soon as the solutions are verified, work out the overall plan→early next year.

5) Outer Tracker

Straw Chamber production

Production Readiness Review completed at all three production sites
NIKHEF, UniHD and Warsaw

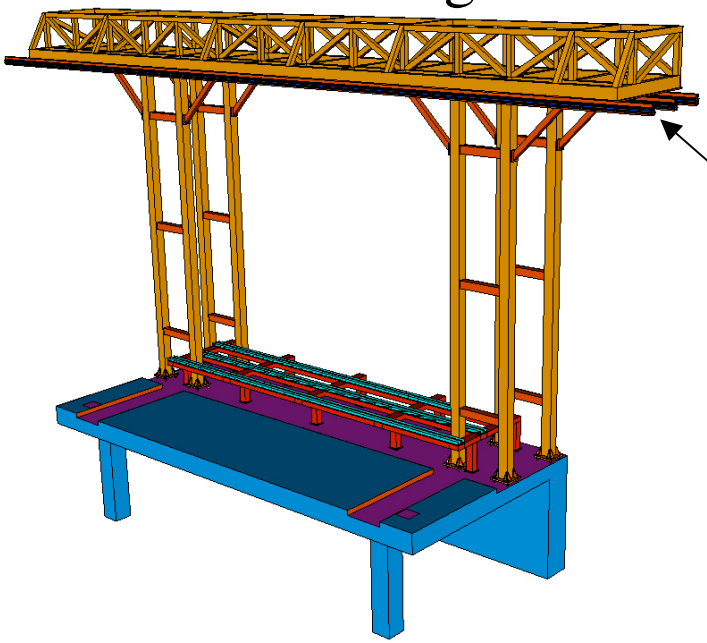
-Heidelberg: 60 modules to be produced
14 produced 1 rejected (first one)
5 days/module

-NIKHEF: 125 modules to be produced
19 produced 1 rejected (first one)
3 days/module

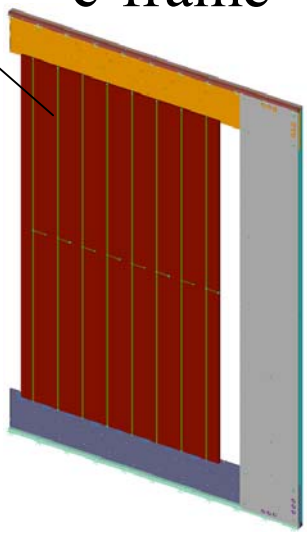
-Warsaw: 124 modules to be produce
19 produced 2 not gas tight and to be repaired
5 days/module (soon 4 day/module)

Heidelberg production rate is OK.
Warsaw production rate needs further increase → additional manpower
NIKHEF production rate is OK but can be increased to help Warsaw
→ under investigation

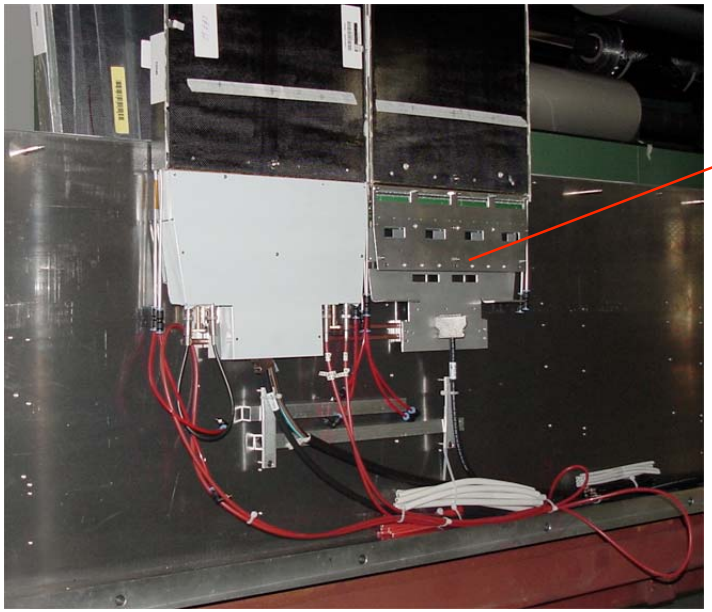
Design of the support is in progress



c-frame



c-frame prototype



front-end electronics, cooling, HV and gas connections

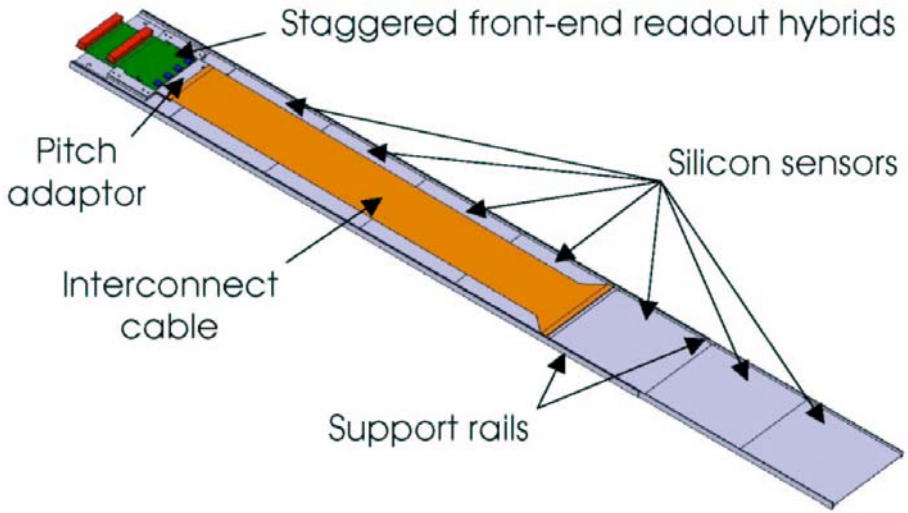
Prototype half station with 2 double layer modules being built.

Complete the study by the end of 2004.

6) Silicon Tracker

Trigger Tracker

-design being validated and finalised
-sensor order being finalised
-preparation of the production site



automatic bonding machine

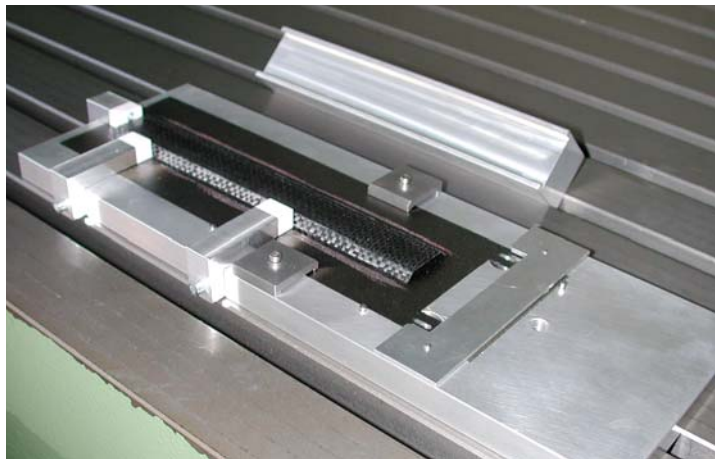
Clean room and 3D coordinate measuring machine

prototype ladder with long interconnect cable

Inner Tracker

-design being validated and finalised
-sensors ordered
-preparation of the production site

Gluing of the reinforcement and the mini-balcony



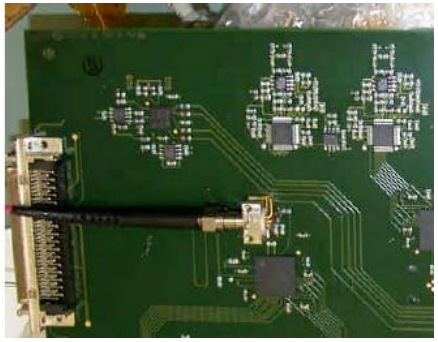
Mounting of the ladders to the cooling rod

Readout electronics is common between TT and IT

detector ⟶ service box ⟶ TELL1

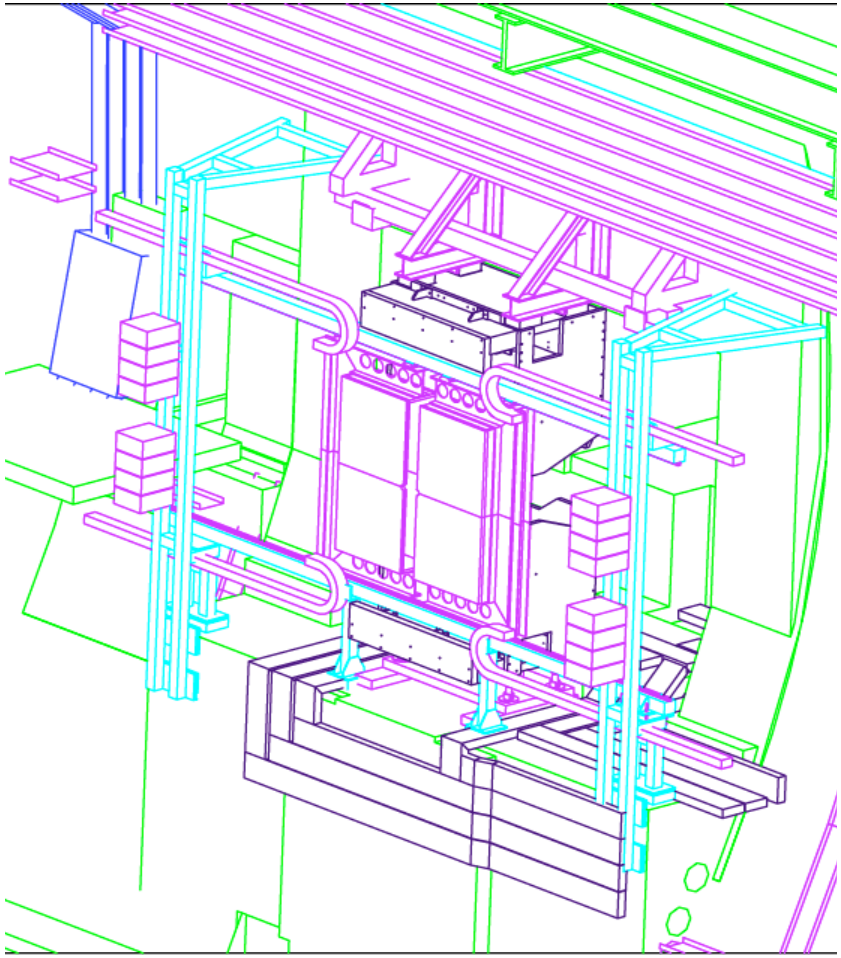
~5m analogue copper link

~100m digital optical link



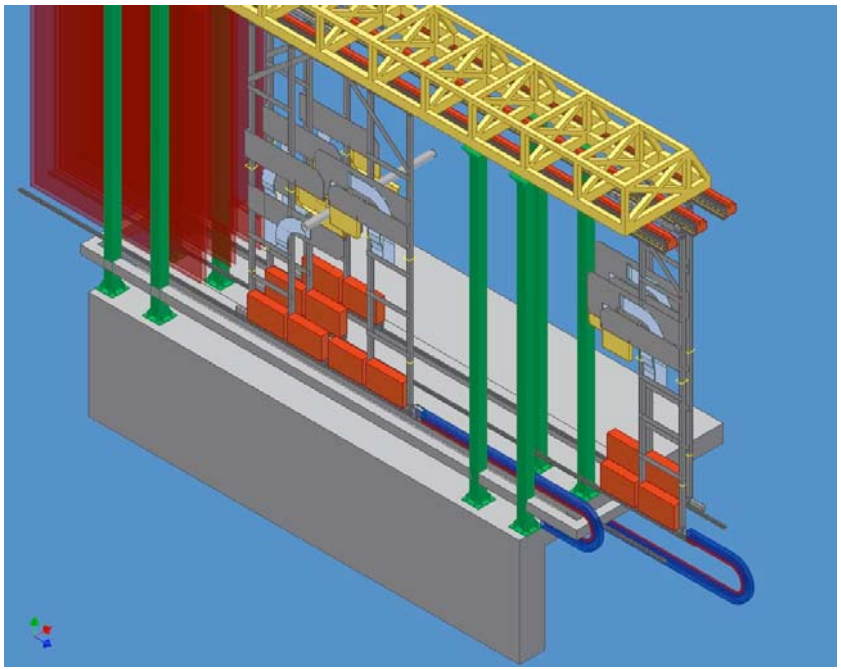
ADC+Optical transmitter

Support structures for TT and IT are being studied



TT

must fit between RICH1 and magnet



IT

must be integrated with OT

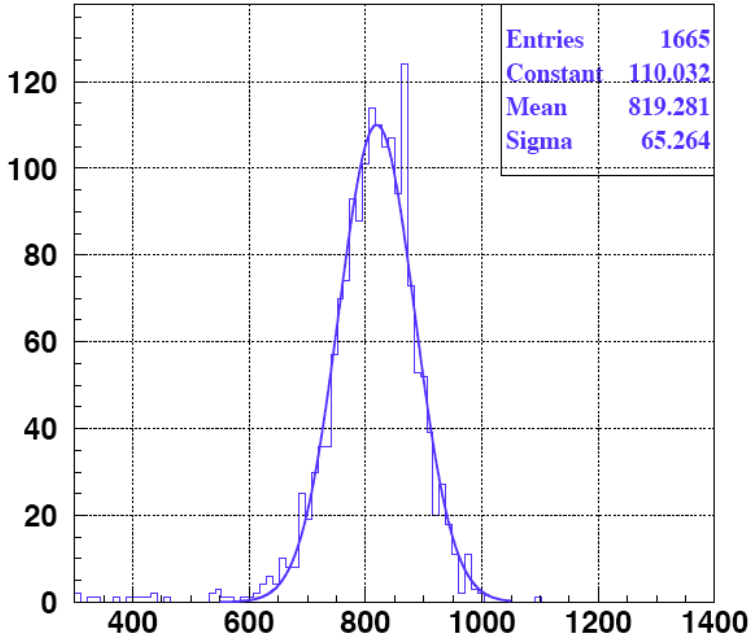
7) Calorimeter System

Preshower-SPD: more than 50% of modules completed (outer region)

PS modules

Ecal: 100% completed and being tested with the cosmic rays at CERN

ADC of MIP particles
for the inner modules



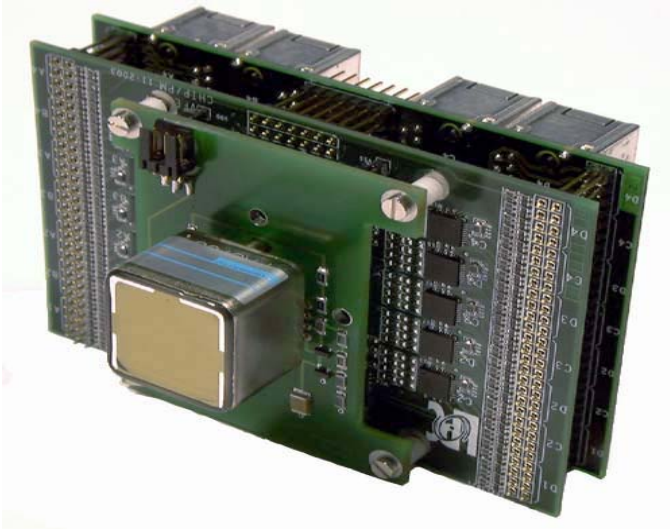
Hcal: 90% completed and being tested with ^{137}Cs at CERN

Ecal and Hcal chariots structure under construction

Ecal

Hcal

PS-SPD/Ecal and Hcal electronics prototyping close to completion

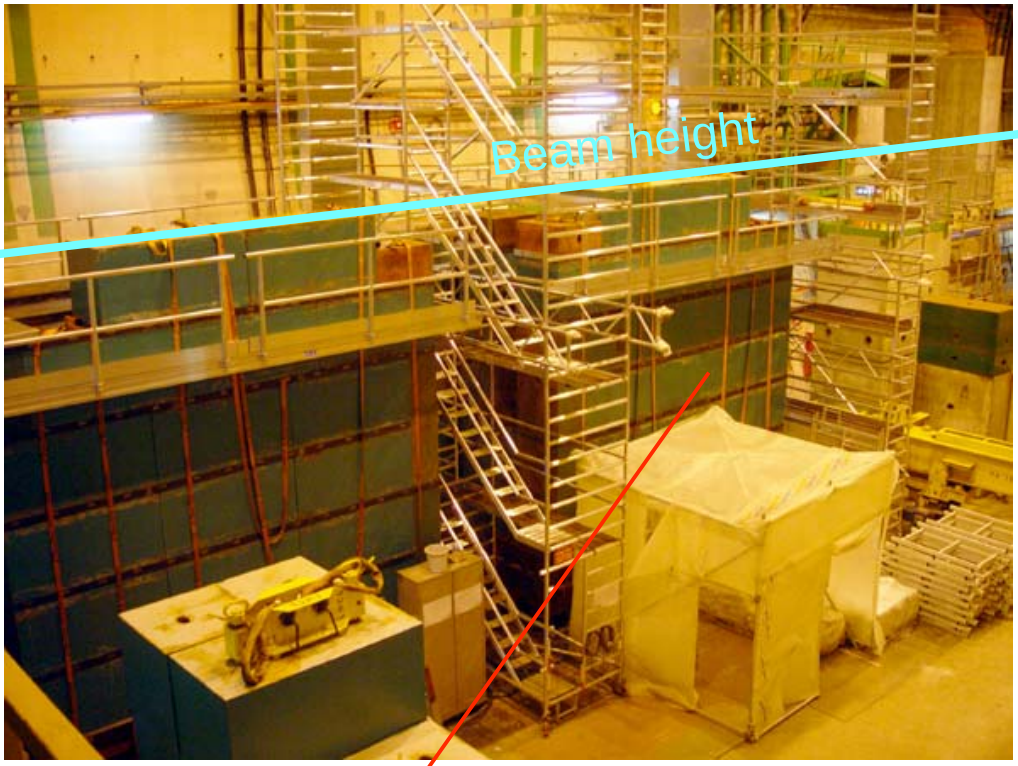


PS very front-end card

E/Hcal front-end board

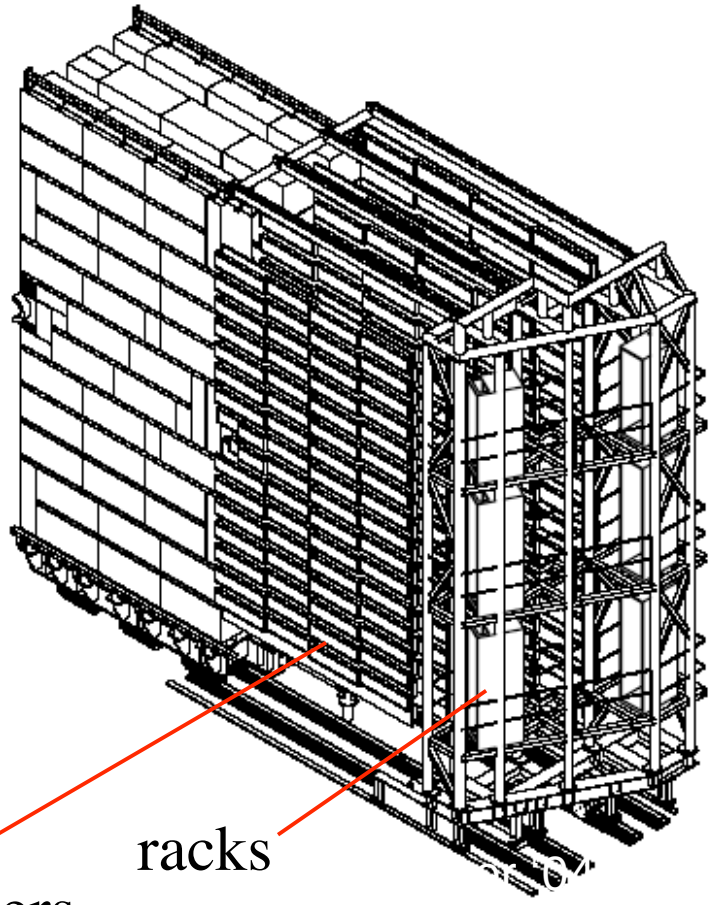
8) Muon System

Muon filter construction advancing well



one layer/week

chamber and rack
support structure



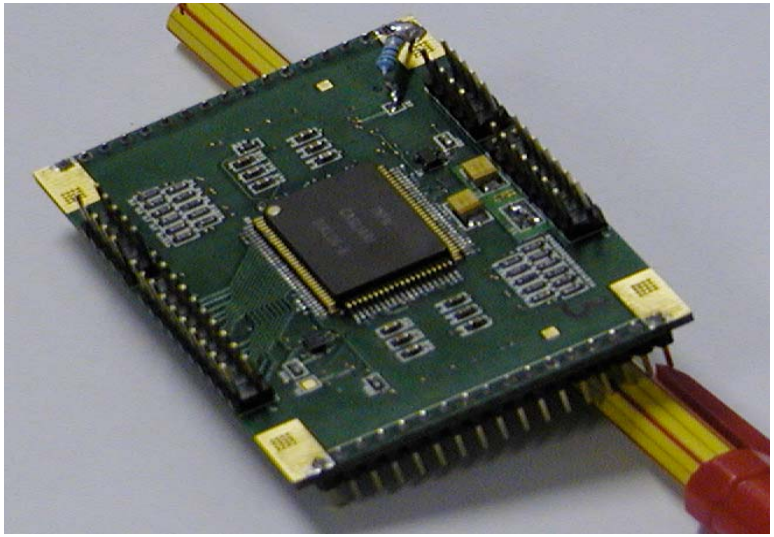
racks

chambers

EDR completed

Cost of the service equipments underestimated

Final front-end electronics (CARIOCA + DIALOG ASIC's) tested with the final chamber in GIF



all the requirements fulfilled

All the ASIC chips
CARIOCA, DIALOG and SYNC
submitted for engineering run in September.

Chamber Production

CERN:	134 chambers to be built 18 chambers built, 1 chamber/week
Frascati:	248 chambers to be built 54 chambers built, 2 chambers/week
PNPI:	600 chambers to be built 47 chambers built, 4 chambers/week (second production site will start in January 2005)
Ferrara:	246 chambers to be built 10 chambers built, 1.5 chambers/week
Firenze:	218 chambers to be built still training phase

Goal: complete the chamber production before the end of 2006

Frascati and PNPI look more or less OK (Frascati can be increased to help others)
CERN has to achieve the production rate to ~2 chambers/week
Ferrara has to achieve the production rate to ~2.5 chambers/week
Firenze has to achieve a production rate of ~2.5 chambers/week by 1/05

→ must be followed carefully

cost increase

9) Trigger and Online

Level-0 trigger: custom electronics

muon p_T unit
calorimeter p_T unit
pile-up unit
L0 decision unit

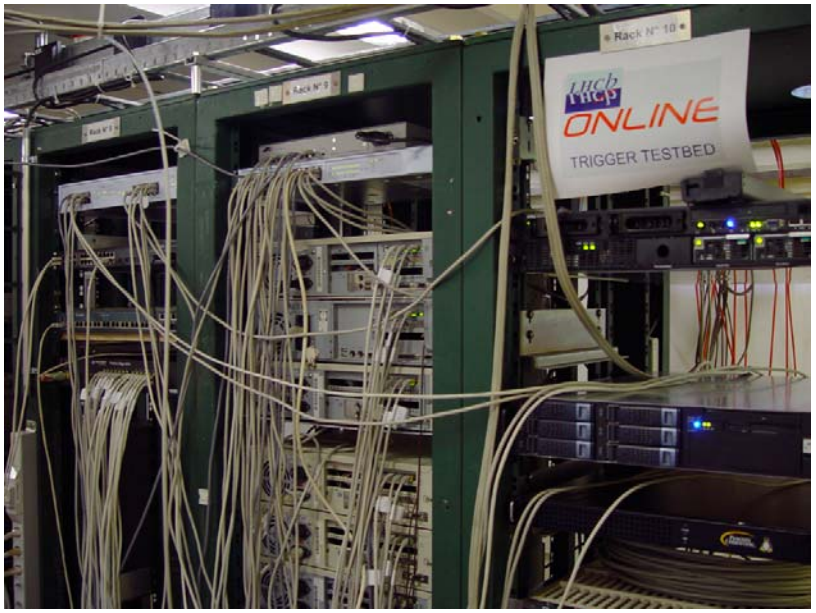
prototype study in progress
finalising the design

Level-1 and High Level trigger: commercially available switches and CPU's

Level-1 selection with VELO, TT and L0 information
HLT with all the data

improving the selection algorithms
bench marking the efficiency and latency
e.g. Level-1
efficiency improved by 15% compared to TDR with an average latency well below the allocated time

DAQ-CPU farm test bed installed



Testing of the full system:

hardware

network switches, sub-farm controllers, CPU's, storage, racks

software

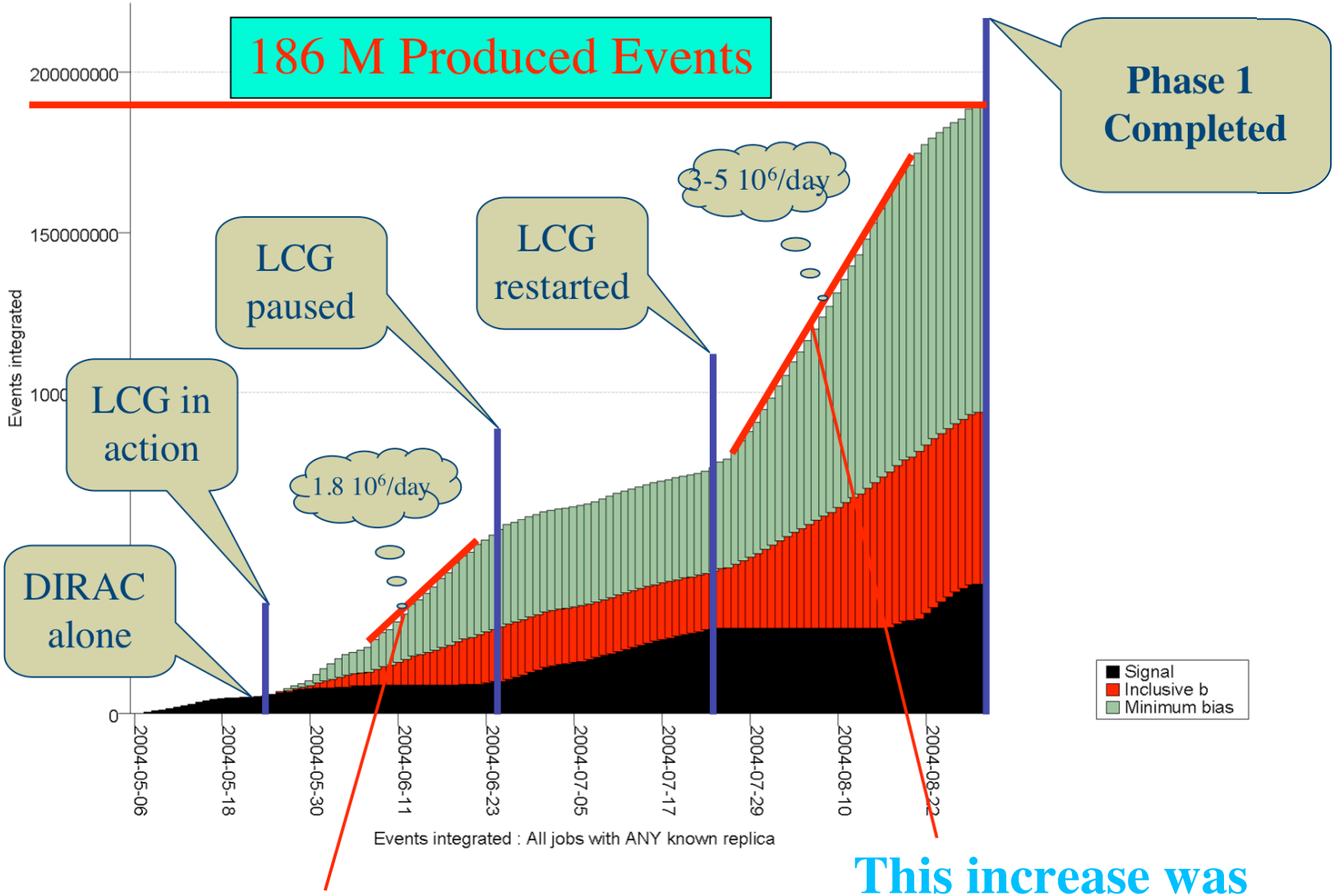
data transfer, online version of GAUDI, event selection

ECS

DAQ and farm control and monitoring

10) Computing

Phase I Data Challenge 2004 achieved the initial goal



This increase was due to the DIRAC sites producing minimum bias events

This increase was due to the LCG sites

Statistics for the LHCb related and other countries

Site	Total Jobs	CPU Time (h)	Events	O.Data (GB)	Events
USA	56	1408	32500	13	0.02%
Israel	77	2493	64600	21	0.03%
Brasil	247	4489	231355	83	0.12%
Switzerland	813	19826	726750	235	0.39%
Taiwan	595	8332	757200	216	0.41%
Canada	1148	21286	1204200	348	0.65%
Poland	1418	24058	1224500	403	0.66%
Hungary	1817	31103	1999200	592	1.08%
France	5888	135632	4997156	1967	2.69%
Netherlands	6408	131273	7811900	2246	4.21%
Russia	10059	255324	8999750	3388	4.85%
Spain	13378	304433	13687450	4189	7.38%
Germany	17101	275037	17732655	6235	9.56%
Italy	25626	618359	24836950	7763	13.39%
United Kingdom	46580	917874	47535055	14567	25.62%
CERN	52940	960470	53708405	18948	28.95%
All Sites	184151	3711397	185549626	61214	100.00%

LCG success rate 61 %

Phase 2

Stripping (pre-selection) starts soon

Run 65 Tbytes of Data distributed over four sites:

CERN, CNAF(IT), FZK(DE), PIC(ES),

with “small” CPU requirements

Phase 3

End user analysis in a GRID environment will follow

GANGA tools in preparation

IV) Cost and funding

Subsystems which are within the MoU cost

VELO

MoU cost 5.1 MCF incl. pile-up veto trigger
Current cost estimate 4.82 MCHF (pile-up moved to trigger)
MoU request 5.1 MCHF: DE, NL, CH, GB

Tracking

MoU cost 15.25 MCHF for the complete tracking system
Current cost estimate 12.1 MCHF
changed due to re-optimization
less number of stations with more robust configuration
(larger silicon coverage)

MoU request 14.80 MCHF: CH, CN, DE, ES, NL, PL,
UA, CERN, ComF

Calorimeter

MoU cost 15.36 MCHF

Current cost estimate 14.93 MCHF

cost reduction due to saving effort

MoU request 14.94 MCHF: FR, RO, RU, ES, UA, CERN, ComF

Trigger and Data Handling

MoU cost 10.2 MCF without pile-up veto trigger

Current cost estimate 10.26 MCHF (pile-up moved from VELO)

L1 and HLT are now one CPU farm

MoU request 9.93 MCHF: DE, FR, GB, IT, NL, CH, CERN, ComF

Magnet:

MoU cost 6 MCHF

well within the budget, final cost after commissioning

MoU request 6 MCHF: ComF

Infrastructure

MoU cost 4 MCF

Current cost estimate 4 MCHF

MoU request 4 MCHF: ComF

Subsystems which got more expensive

RICH

MoU cost 7.7 MCF

Current cost estimate 9.81 MCHF

cost increase largely due to the re-optimisation

MoU request 7.7 MCHF: GB, IT, CERN

Muon

MoU cost 7.45 MCHF + 4 MCHF Fe filter CERN in kind

Current cost estimate 8.56 MCHF + 4 MCHF Fe filter

increase of the chamber production cost

service equipment cost underestimated

MoU request 6.83 MCHF: BR, IT, RU, CERN

+ 4 MCHF: CERN Fe filter

Funding side (in MCHF)

Country	request	signed	Comments
Brazil	**1.7**	**0**	**MoU not signed**
China	0.25	0.1	MoU by Tsinghua University
FR(IN2P3)	7.5	7.5	***extra engineering effort by Annecy***
DE(BMBF)	4.8	3.76	MPI request to BMBF partly not approved
(MPG)	2.2	2.2	
Italy	10	10.6	***extra contribution to Muon***
NL	6.3	6.3	
Poland	0.5	0.5	
Romania	0.3	0.3	
Russia	3	2.5	shifted to machine, CERN partially compensates
Spain	2	2	
Switzerland	7.9	7.9	
GB	10.3	10.3	
Ukraine	0.2	0.2	
CERN	16.35	16.7	incl. muon Fe and Russian compensation
Total	73.3	70.86	

Summary

MoU cost	75.05 MCHF
Current cost	74.48 MCHF
MoU funding request	73.30 MCHF
Current funding	70.86 MHCF

Missing fund mainly in

RICH: cost increase largely due to re-optimisation

Muon: cost increase and no funding from Brazil

(also help from the special Italian contribution)

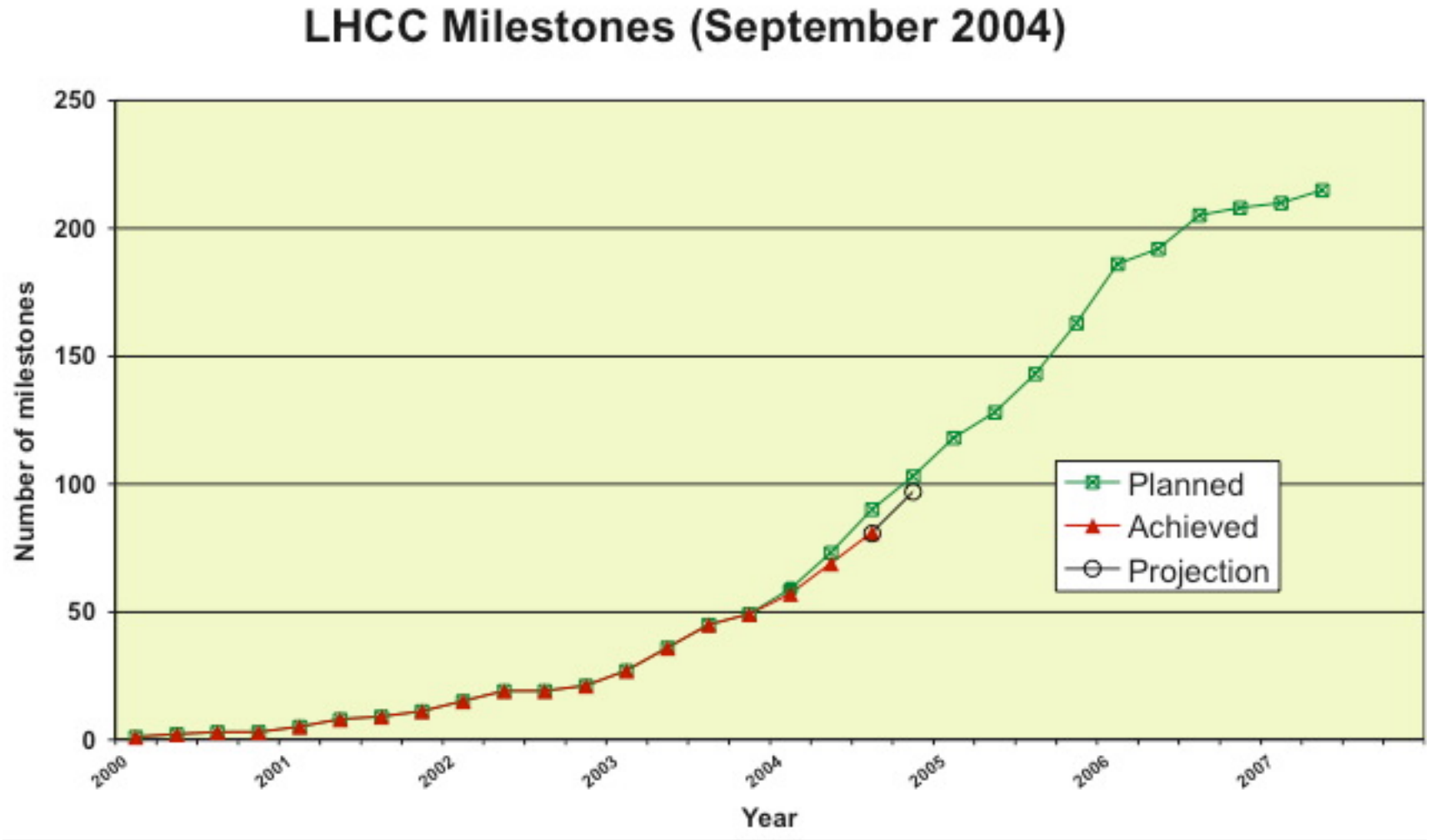
Solution is being worked by

1) re-distributing the saving from Tracking
2) shifting fund from the CPU's of the L1/HLT processor farm
   by staging them (money needed in >2006)
3) bidding additional requests to the corresponding funding agencies
   RICH: GB, IT and CERN
   Muon: IT and CERN

New cost-funding matrix being aimed for the April 05 RRB

V) Summary

1) Production of the large sub-systems, i.e. Calorimeter System, RICH-2, Outer Tracker and Muon System, advancing
2) Delay in the Muon chamber production, must be followed carefully
3) HPD production encountered unforeseen problems. Solutions are believed to be found. Situation to be reviewed by early next year.
4) Production of VELO and Silicon Tracker System is expected to take off during the coming half year.
5) Trigger and online work progressing well
6) Phase I Data Challenge 04 completed successfully
7) Compared to the MoU, Tracking and Calorimeters cost less and RICH and Muon cost more. The total cost is still less than MoU, however 3.62 MCHF shortfall in funding. Try to solve by staging CPU's, which can be bought later, and bidding additional funds for the concerned sub-systems.


LHCC Milestones (September 2004)
Number of milestones
250
200
150
100
50
0
2000
2001
2002
2003
2004
2005
2006
2007
Year
Planned
Achieved
Projection