CERN-RRB-2005-094
19 October 2005

Status of the LHCb Experiment

LHCb RRB at CERN
19 October 2005

on behalf of the LHCb Collaboration

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CERN
and
EPFL

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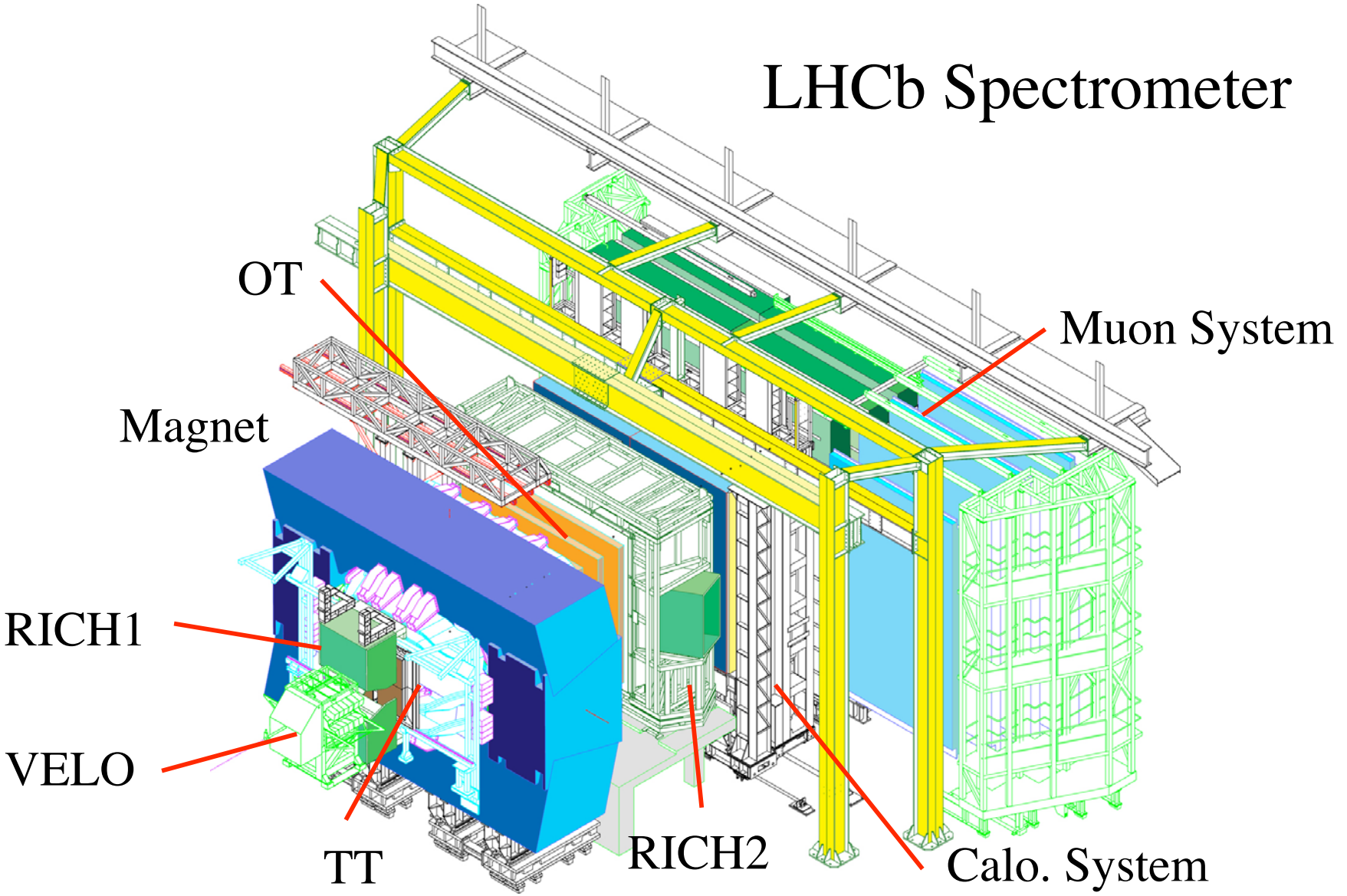
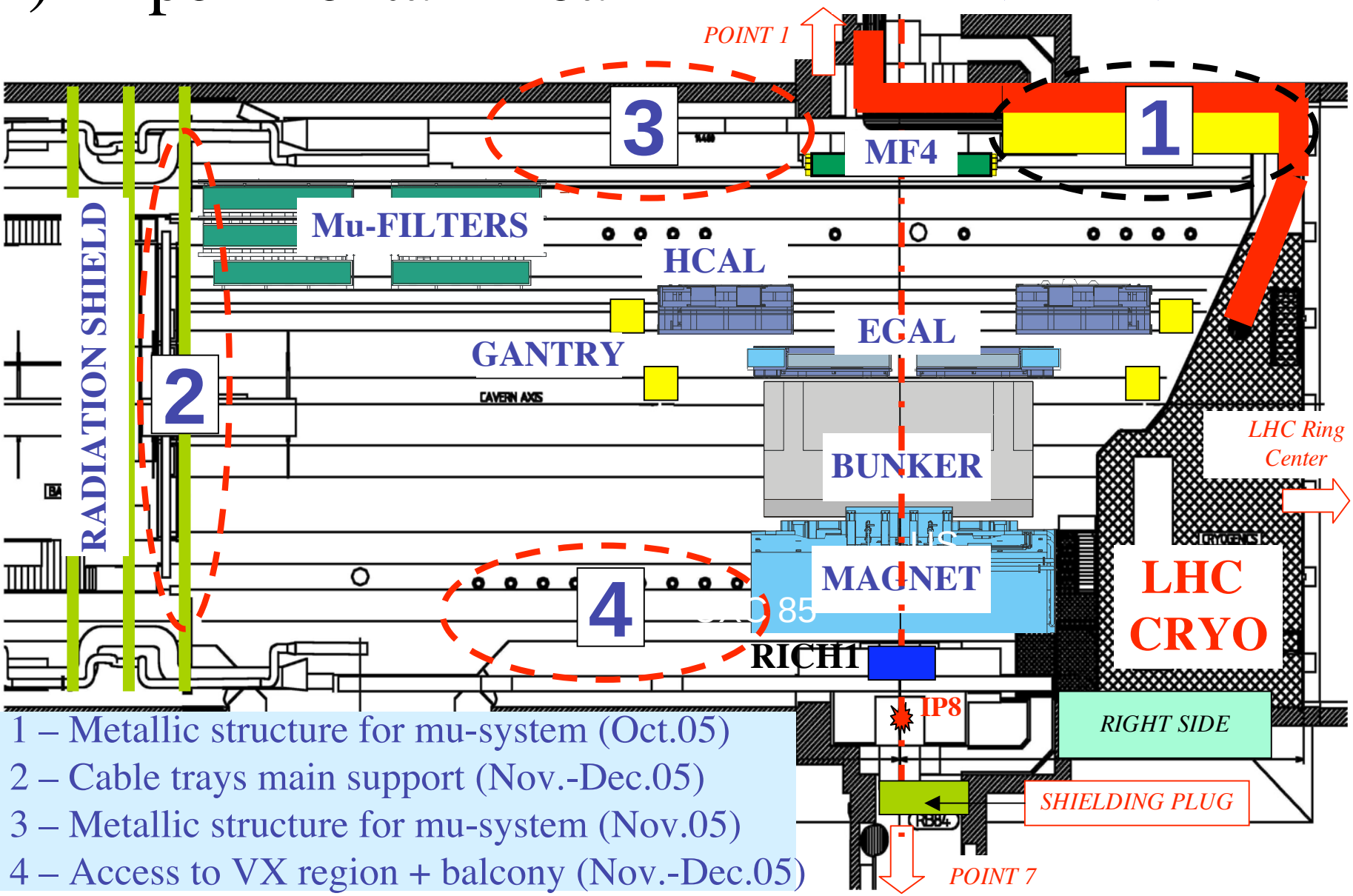
I) Construction Status



1) Experimental Area



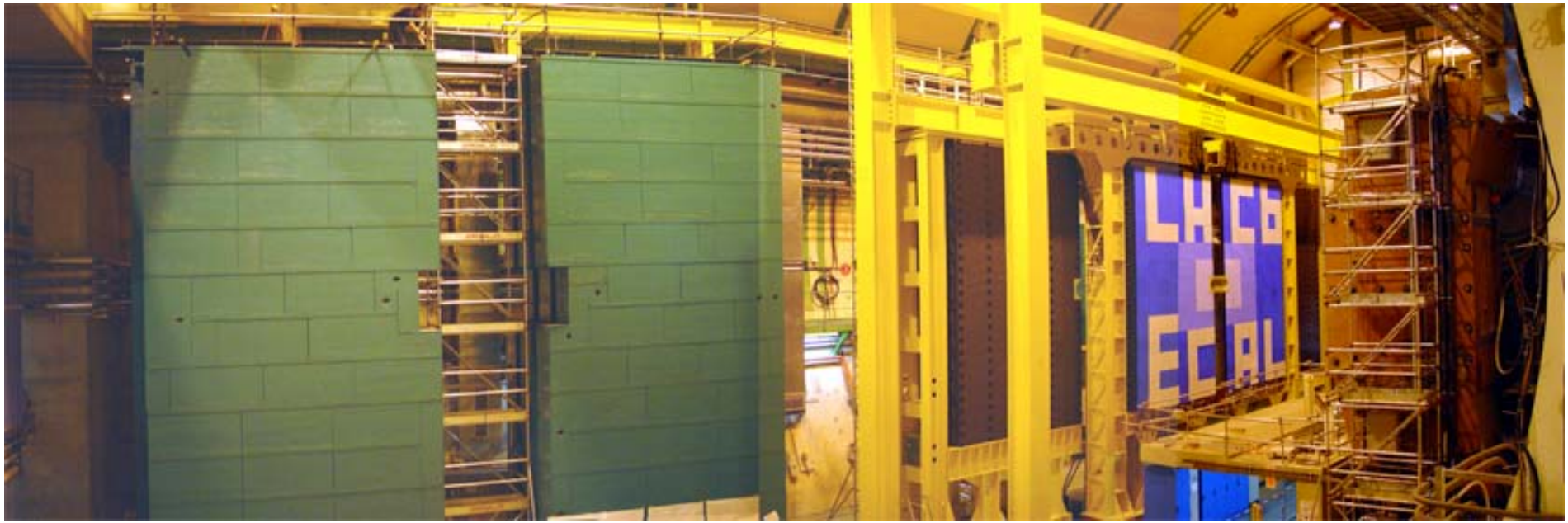
1 – Metallic structure for mu-system (Oct.05)
2 – Cable trays main support (Nov.-Dec.05)
3 – Metallic structure for mu-system (Nov.05)
4 – Access to VX region + balcony (Nov.-Dec.05)

Machine work: Cryo-line installation above the M4 filter completed and scaffolding finally taken away last week

⇒introducing a delay of ~3 months to the LHCb installation

Installation of RICH-2 delayed by 2 months: firstly due to the preparation and qualification of the lifting tool, now due to the availability of transportation Hall-156 to Pit-8

⇒will delay the B field measurement



2) Beam Pipe

-25 mrad Be section completed

-10 mrad Be

1st section being tested at IHEP, Protvino

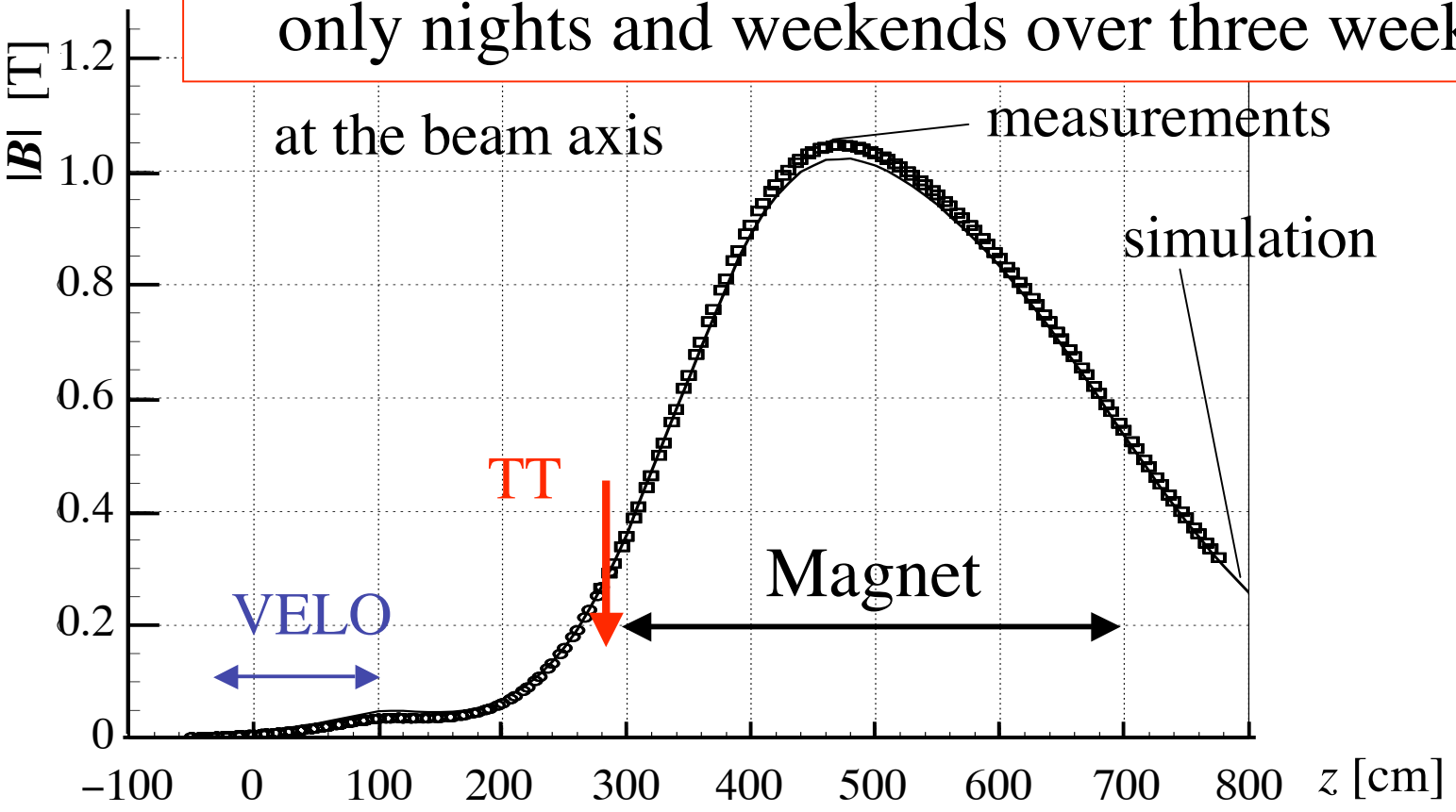
-10 mrad Be

2nd section under construction by Kompozit, Moscow

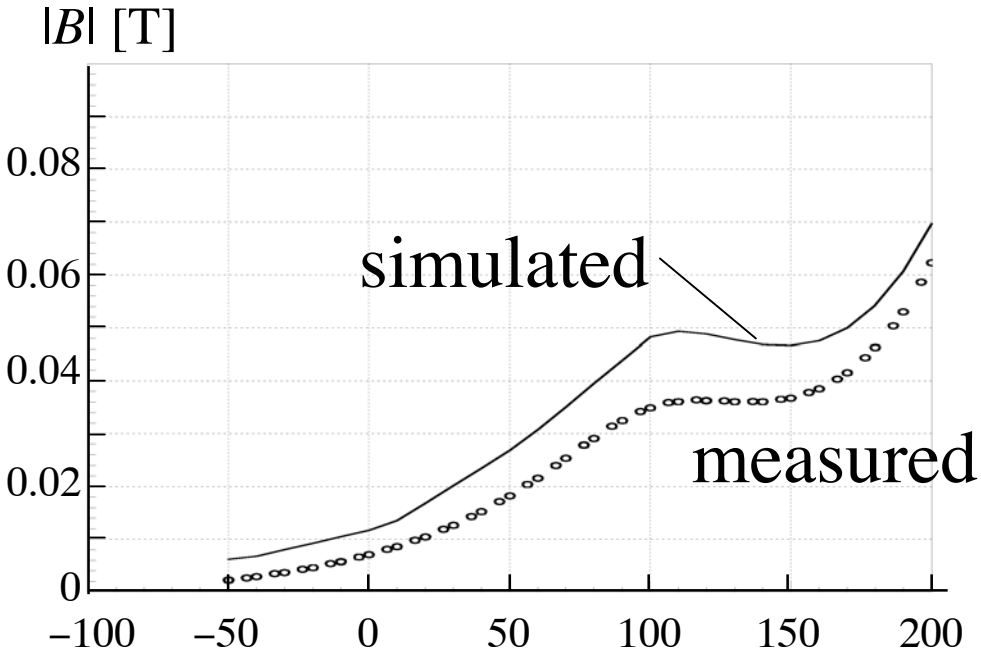
- All the other components are also under construction

3) Magnet

First systematic B field measurement in June
only nights and weekends over three weeks

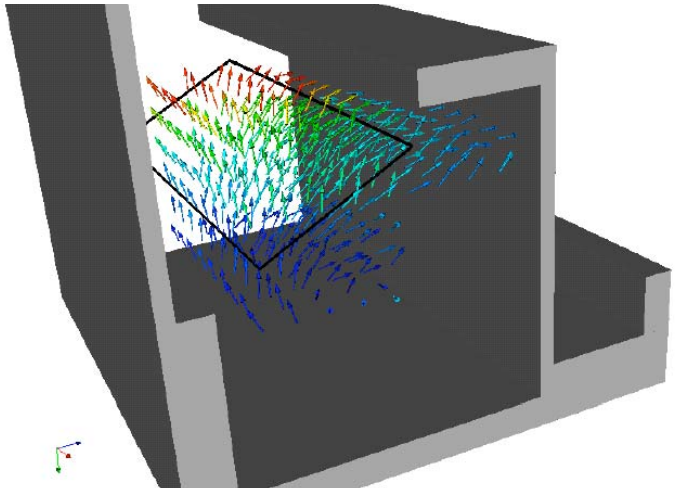


November: complete field map with all the iron structure around, day and night measurements

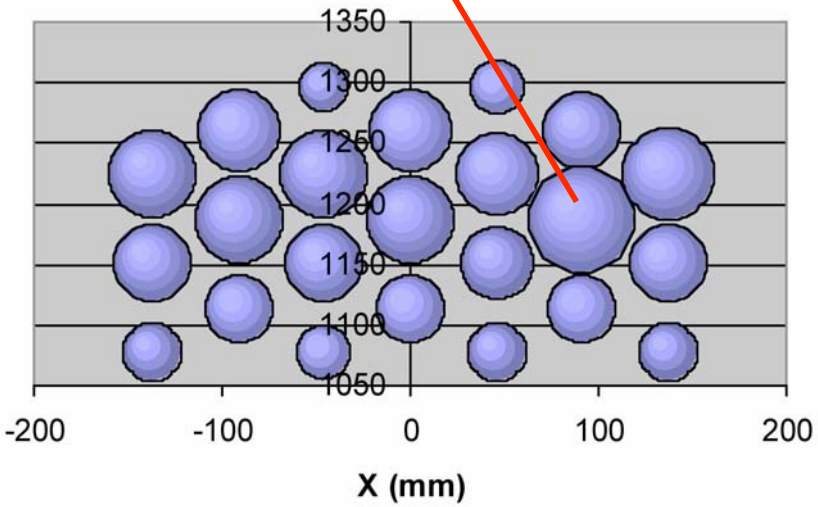


∫Bdl in VELO-TT lower by
20% compared to simulation
→ has to be taken into account
for the trigger studies

Inside RICH1 shielding box,
on the HPD plane with μ-metal



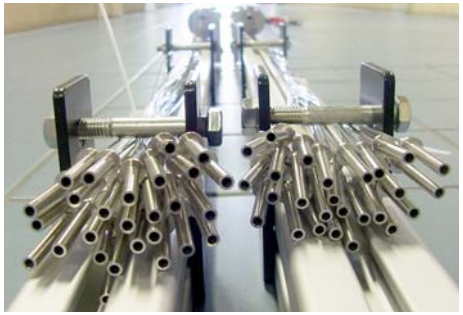
Largest circle 13.6 G
Smallest circles ~ 4G
Intermediate 7-10 G



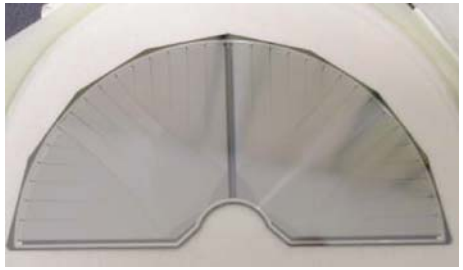
Acceptable for
the HPD operation

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

VELO tank installed in the support frame and connected to the vacuum system



CO_2 cooling capillaries



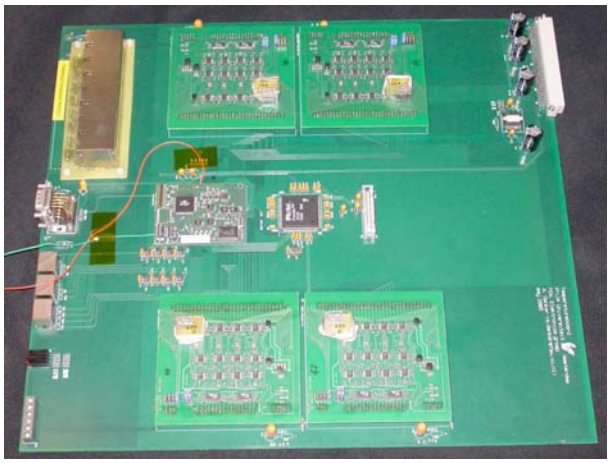
r-sensor

feedthrough flanges

All the parts are now being produced

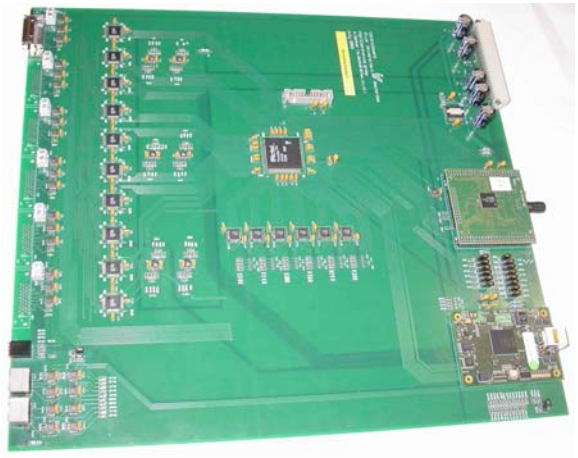
hybrid and module support

Preproduction of all the electronics cards has started

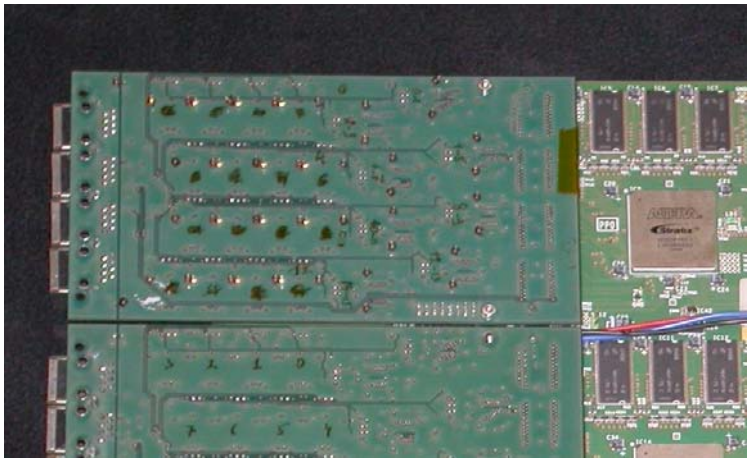


temperature card

repeater card



control cards



analogue ADC for TELL1

Concern: detector module production not yet started

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

RICH2 lifting test (28*t*) ready for the transport

RICH1 gas enclosure box

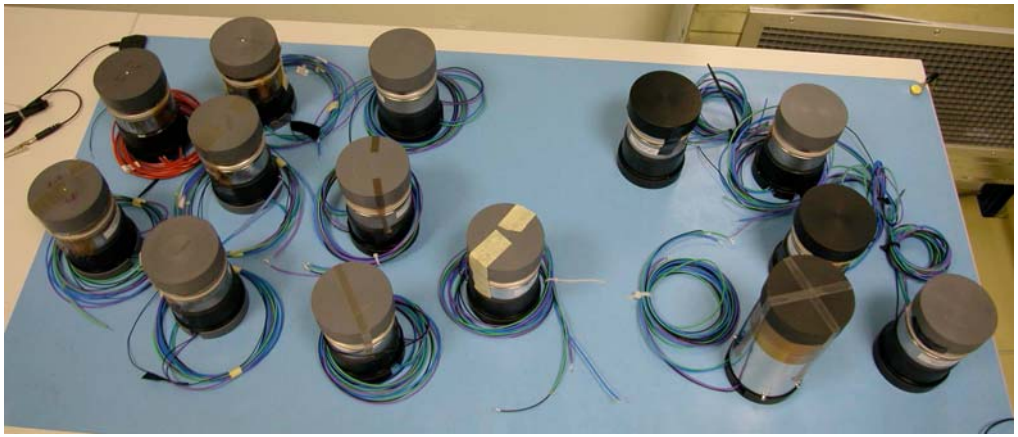
RICH1 spherical Be mirror module 0

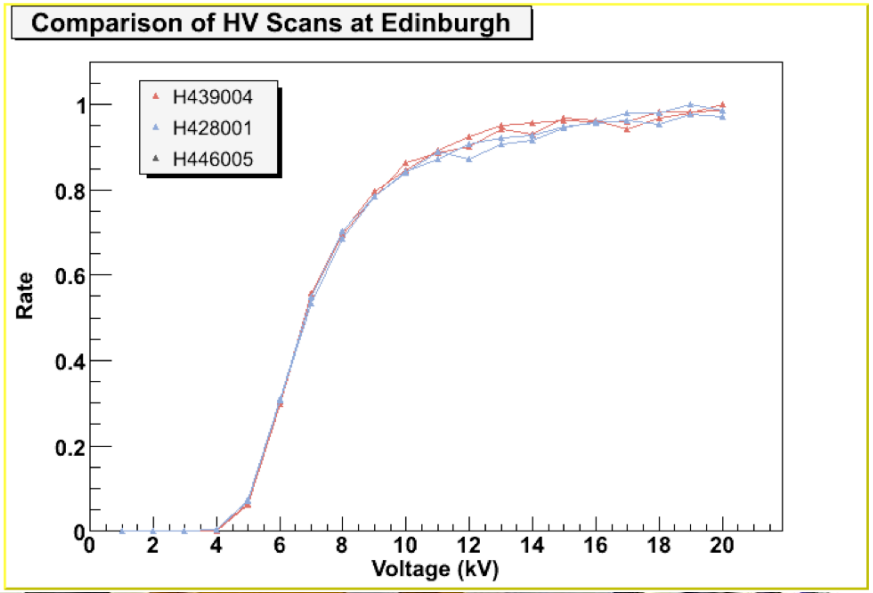
The order for the rest has been made via ISTC (IHEP, Kompozit, Vavilov)

tight schedule

First batch of the series production HPDs arrived, 21 total.

Good progress but still tight schedule

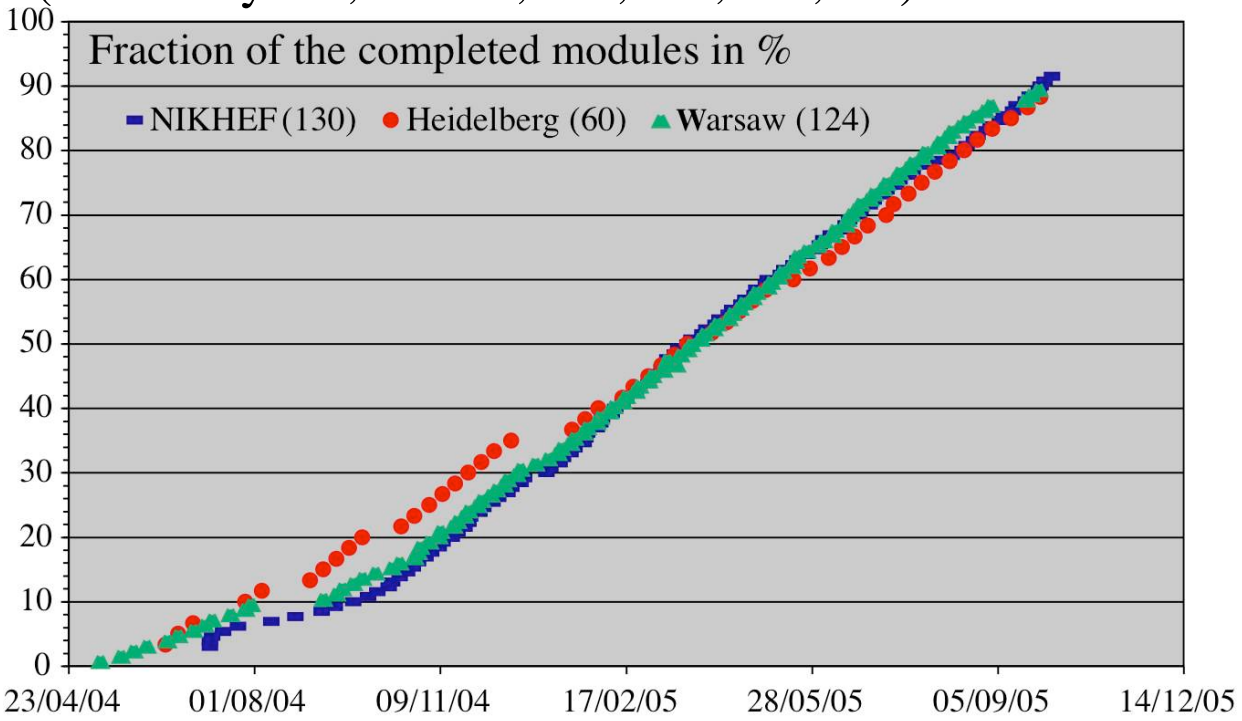




HPD test facilities at Edinburgh and Glasgow in operation

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

Straw chamber module production as planned



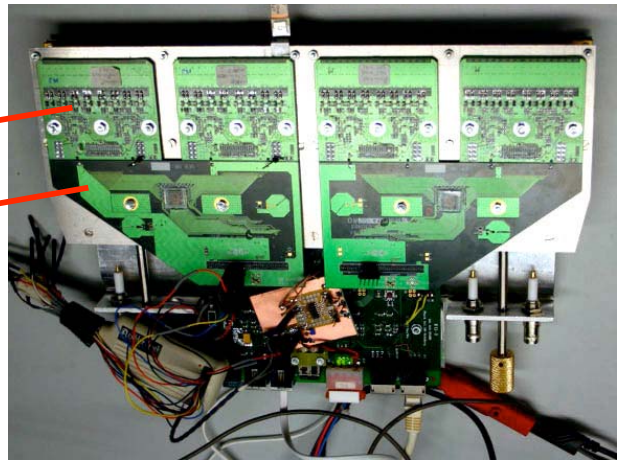
Mass production of electronics started:

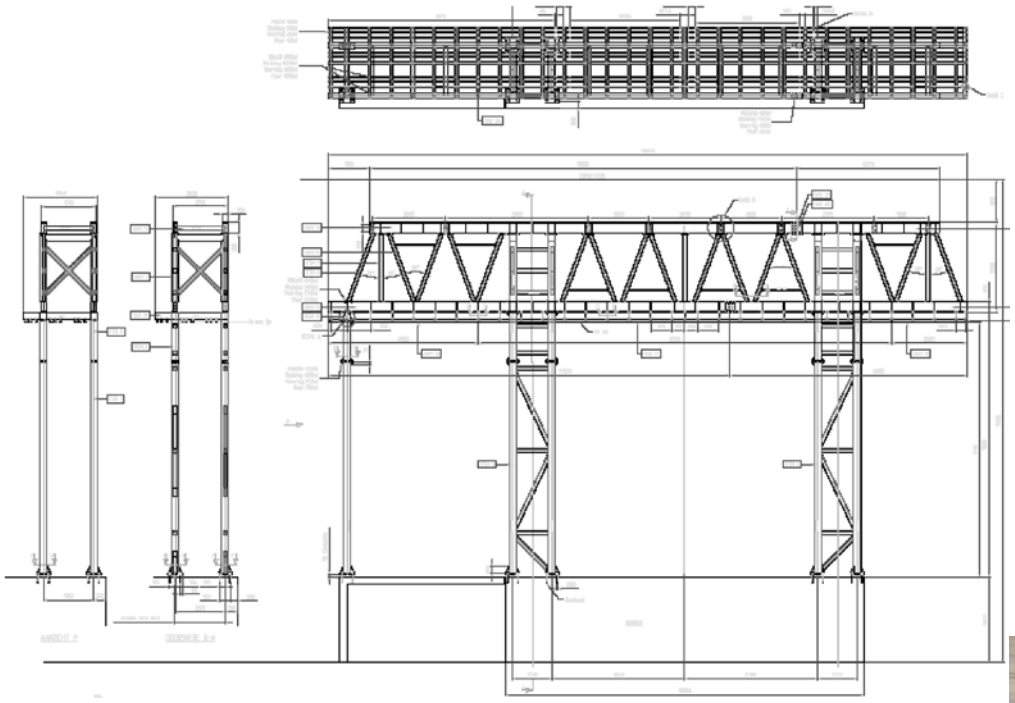
2,000 HV Boards

4,000 ASDBLR Boards

2,000 OTIS TDC Boards

500 GOL/AUX Board





Support bridge for OT and IT

Price enquiry completed
Order to be placed by end Oct
Delivery by end Jan ‘06

12 independent C-Frames; each holding two OT double layers

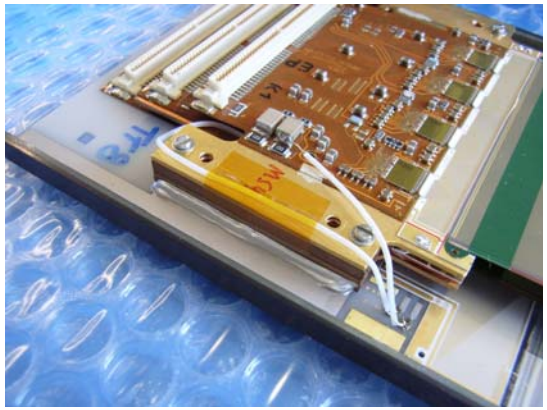
First frame delivered,
rest by the end of this year

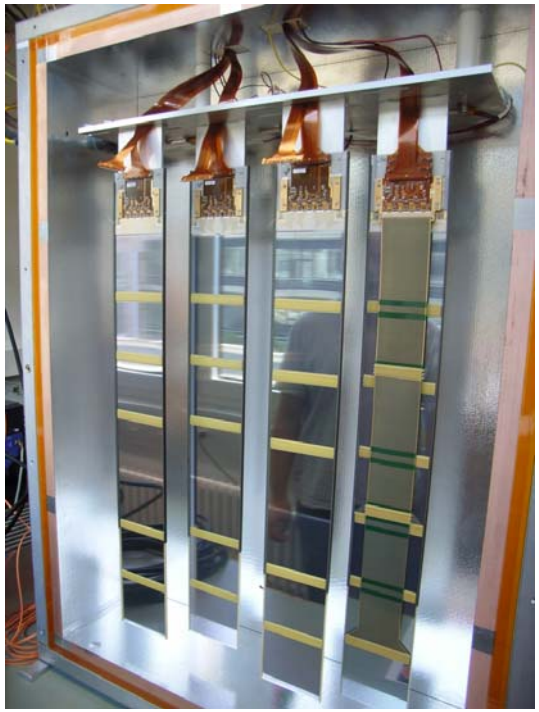
7) Silicon Tracker (funded by CH, DE, ES, UA)

Si sensors from HPK for
IT, 440 in hand (531 needed).
TT, 200 advanced loan from CMS (1000 needed)
all with excellent quality, rest by end of year

About 3600 qualified Beetle 1.3 chips in hand, 2200 needed
(NB also enough Beetle 1.5 chips for VELO)

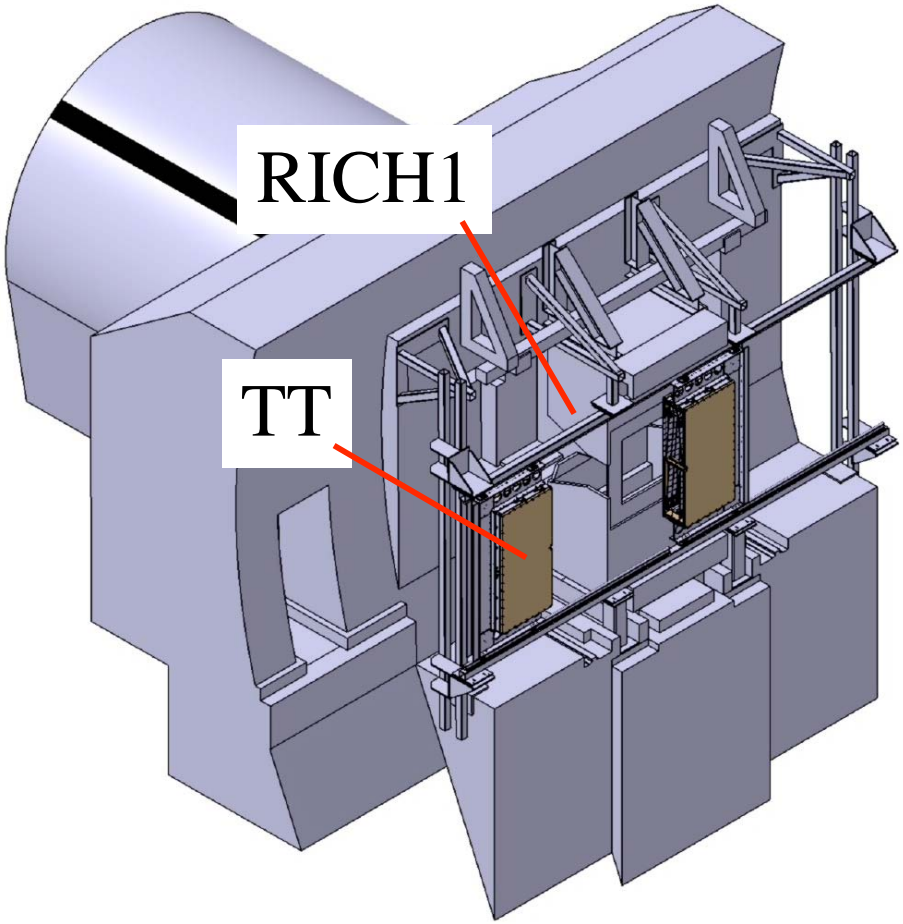
TT ladder series production started
Burning in test in progress.





IT ladder pre-series production completed

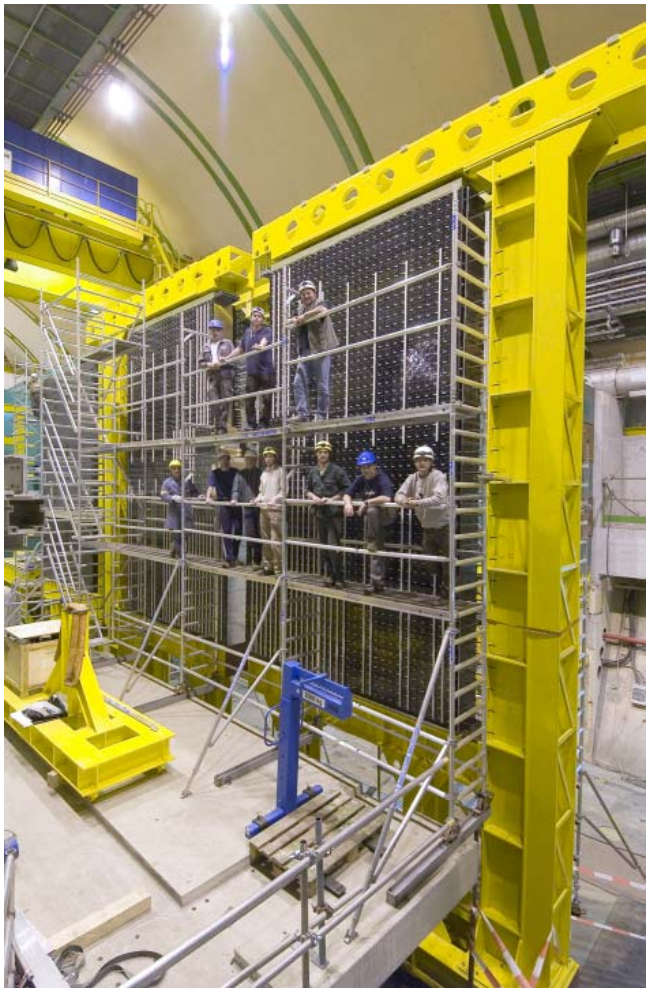
TT integration study in progress



IT integration EDR, 14 Oct

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

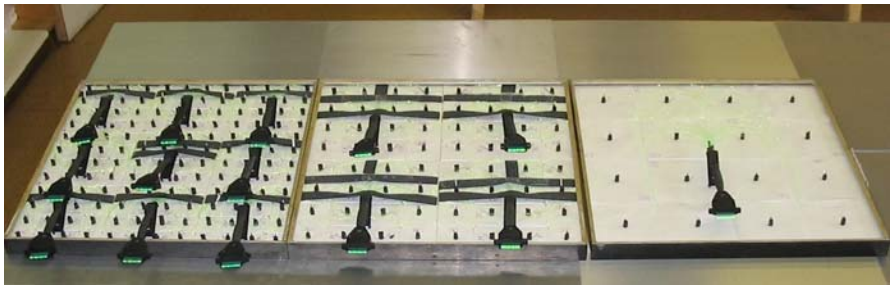
E-cal and H-cal systems have been installed in Pit-8



E-cal

H-cal

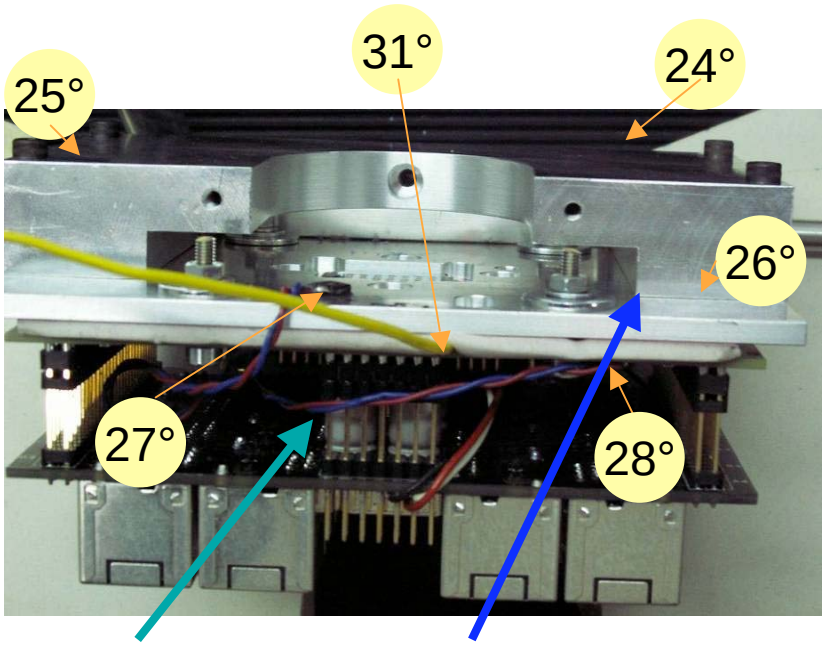
Preshower modules arriving at CERN from INR



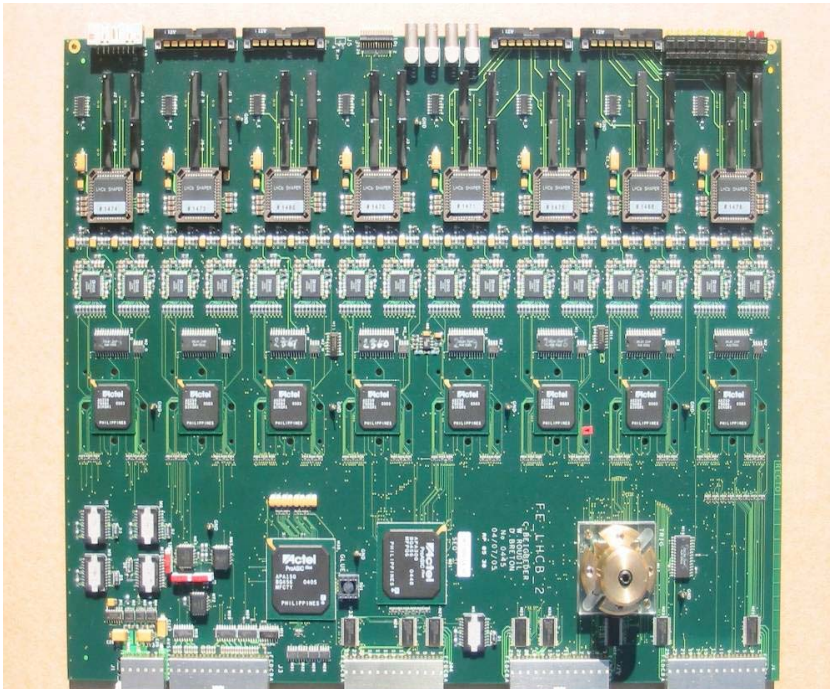
Supermodule production and fibre installation at CERN

Electronics

Cooling system for Very-FE cards redesigned (change from air to water cooling)
Frontend Boards for ECAL/HCAL and PS/SPD under test with final prototypes
CROC (Calorimeter ReadOut Card) development of final version in progress
Common Control System for HV and LED monitoring systems well advanced



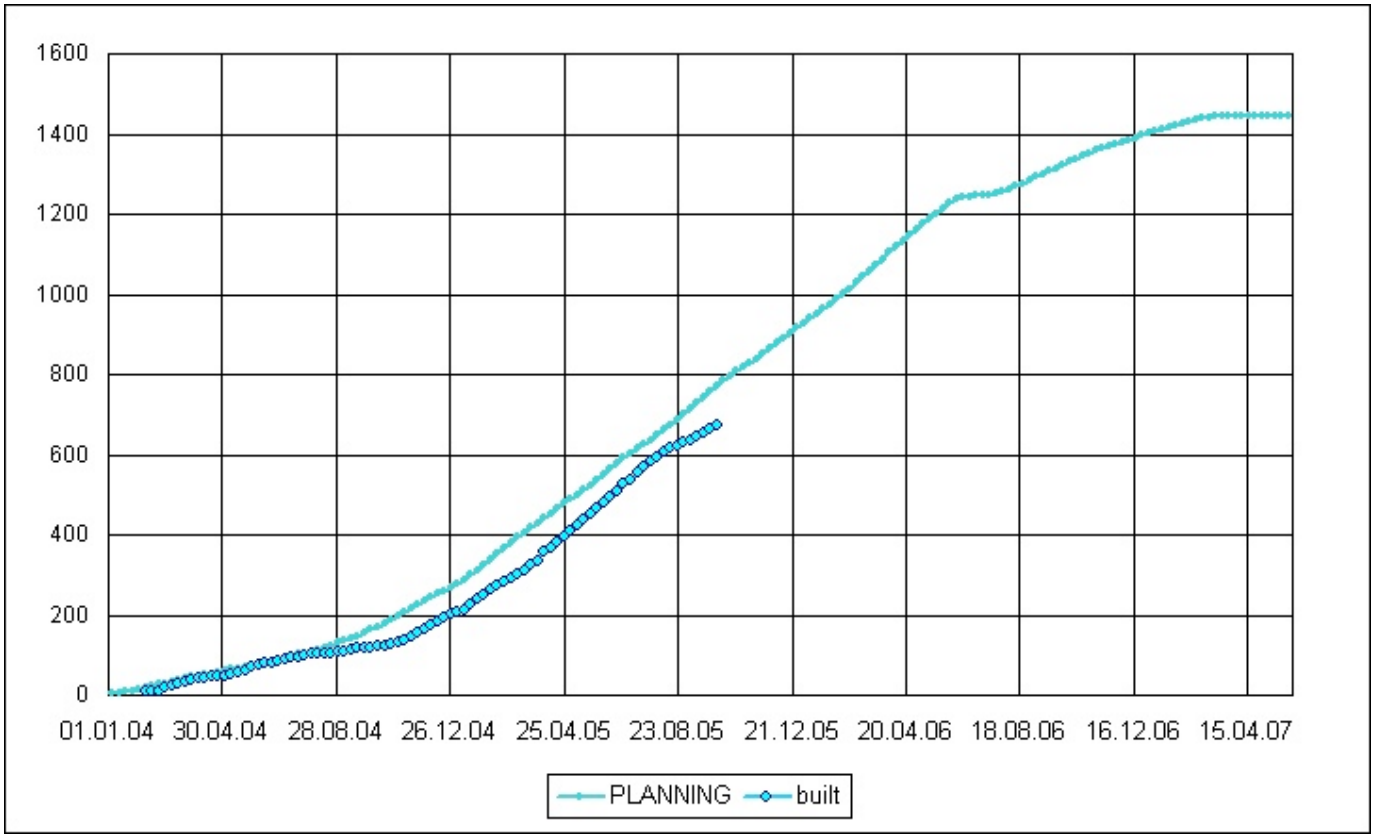
PS VFE board with new cooling system



Final prototype of ECAL/HCAL FE-card

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

chamber production



Delay has not been recovered but now progressing steadily.
1368 chambers needed and almost a half has been completed

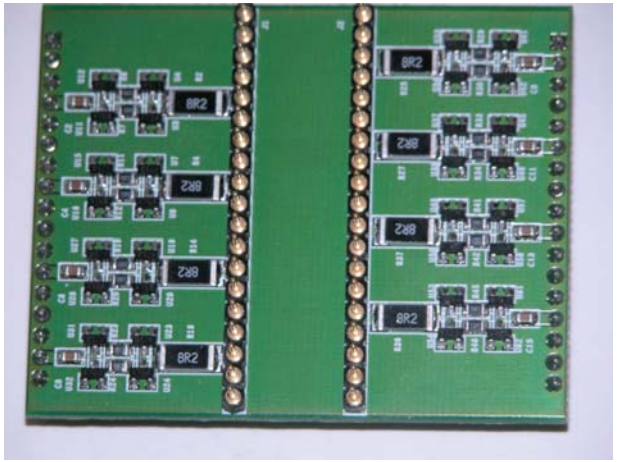
Electronics

All the ASIC chips are produced and being packaged and tested

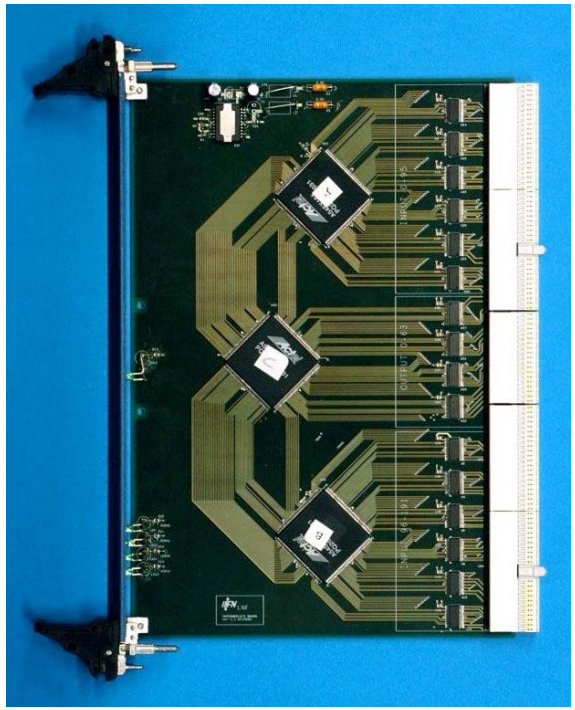
Production of Spark Protection Boards completed.

Intermediate Boards and Service Boards in production

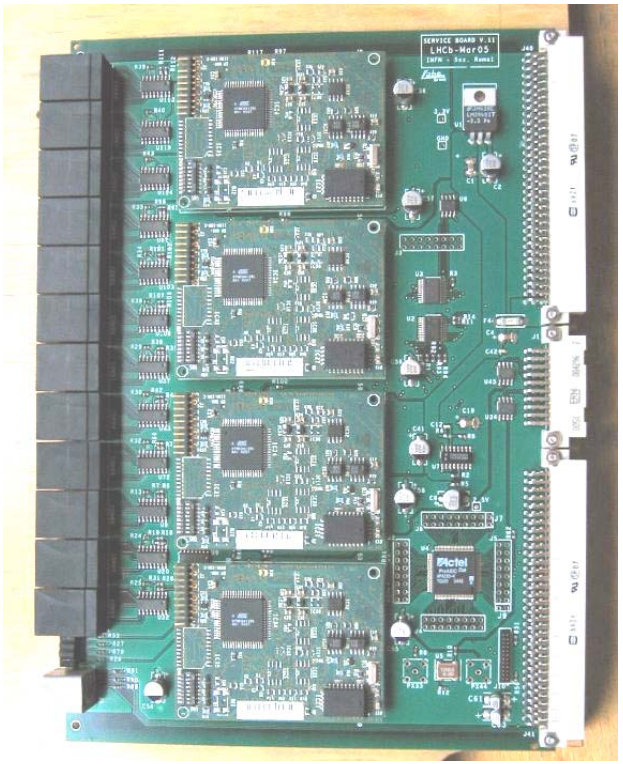
Production still to be launched for ODE and CARDIAC



Protection Board



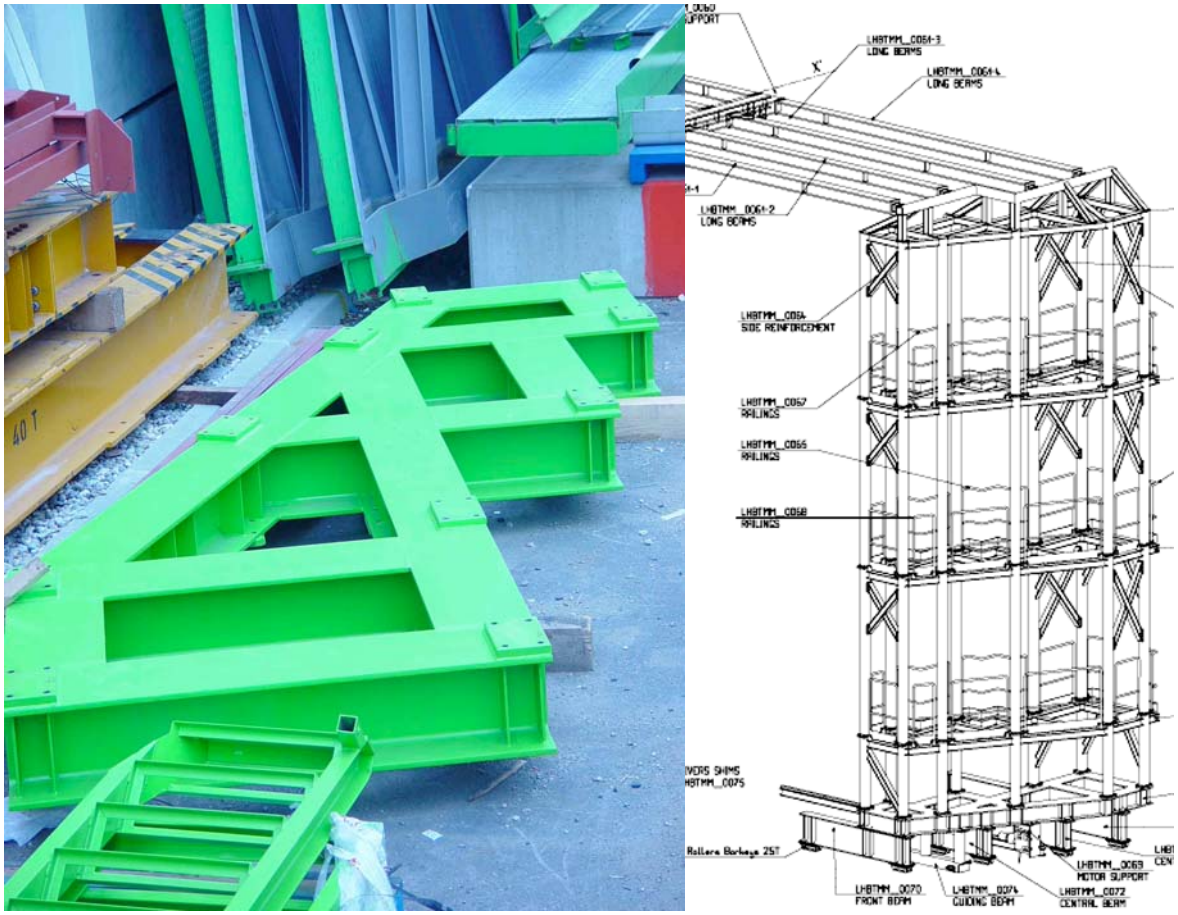
Intermediate Board



Service Board

Materials for the muon tower are arriving

Base with rollers



Frame material

10) Trigger and Online

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

Real Time Trigger Challenge in July:

Test all the features of the complete DAQ/CPU-farm system

-hardware for the data flow:

switches, sub-farm controller, CPU, ...

-hardware and software for the system control

ECS farm control, monitoring, ...

Verify the necessary CPU budget to execute L1/HLT

Also more strict coding required, i.e. no memory leak etc.

Hardware setup
Network switch
One full rack with 2 × 2.8 GHz Xeon CPU 1U (44) servers
ECS control system

Successfully verified power, cooling, control and monitoring of farm nodes. Benchmarked trigger algorithms for L1 and HLT

Trigger timing measurements

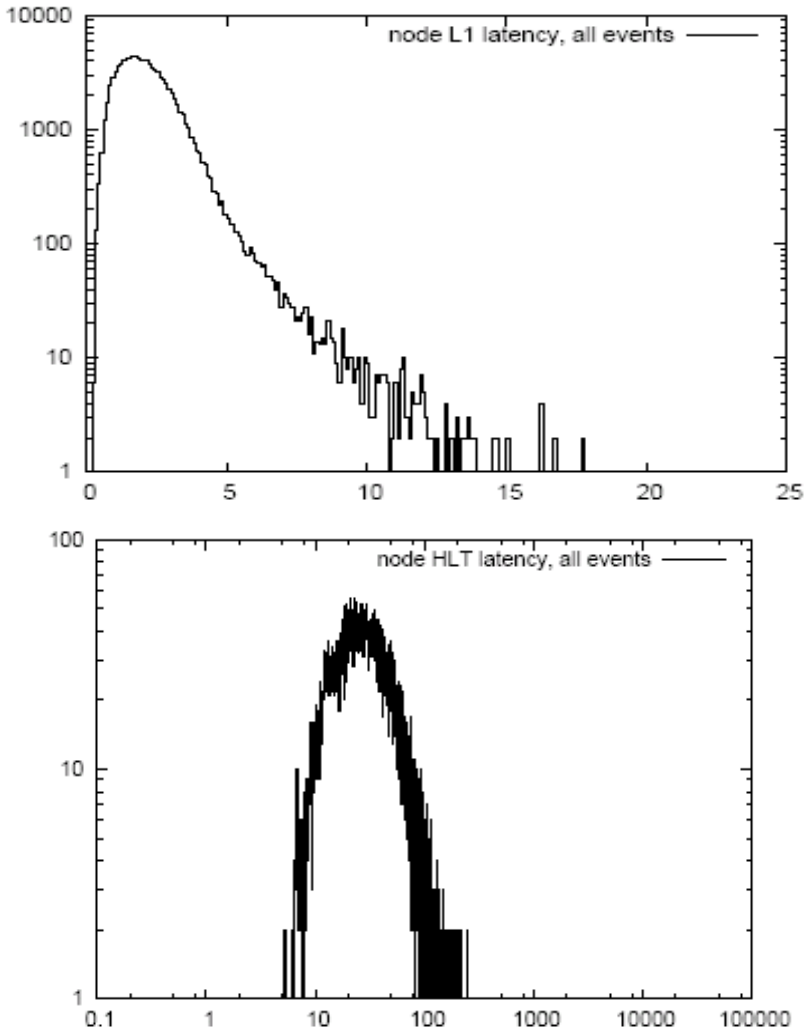
The Trigger TDR plan for 2007:

1 ms for L1 with 1000 CPUs
@ 1 MHz

10 ms for HLT with 400 CPUs
@ 40 kHz
(+200 CPUs for quasi offline)

Measured in RTTC (2005):
2.21 ms for L1
56 ms for HLT

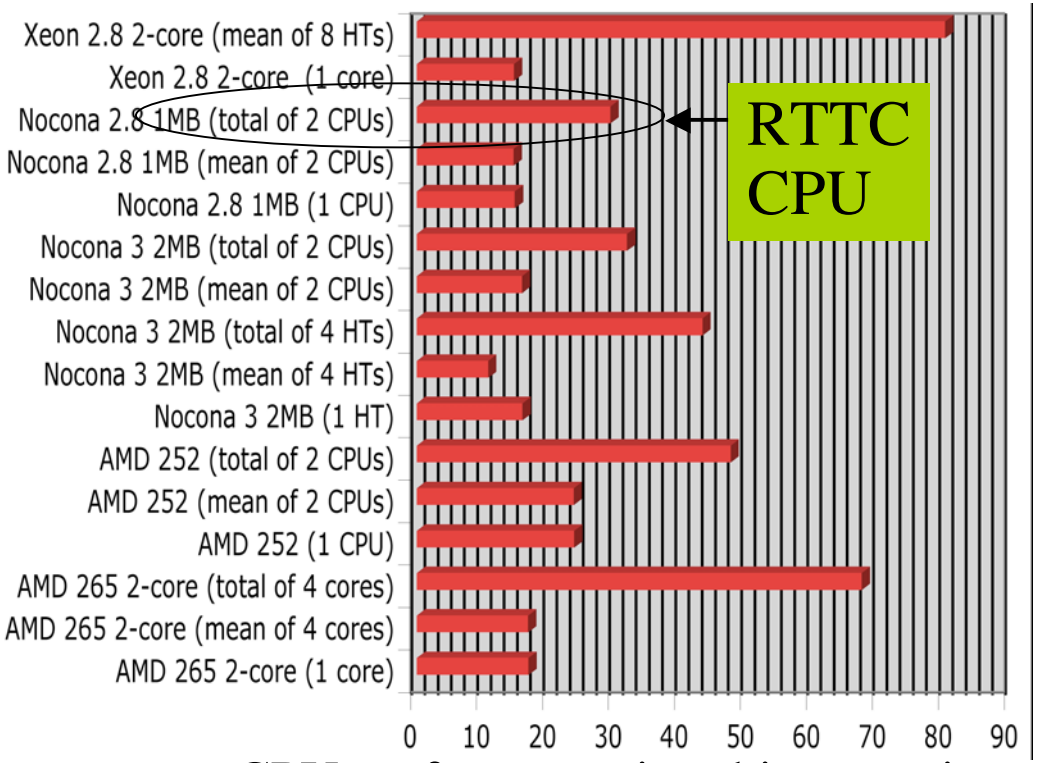
If we build a system now, 4450 CPUs needed for the trigger
(2225 boxes)



The infrastructure at Pit-8 can accommodate 2000 boxes.
The DAQ/CPU farm budget foresees 1800 boxes, assuming RTTC CPU price

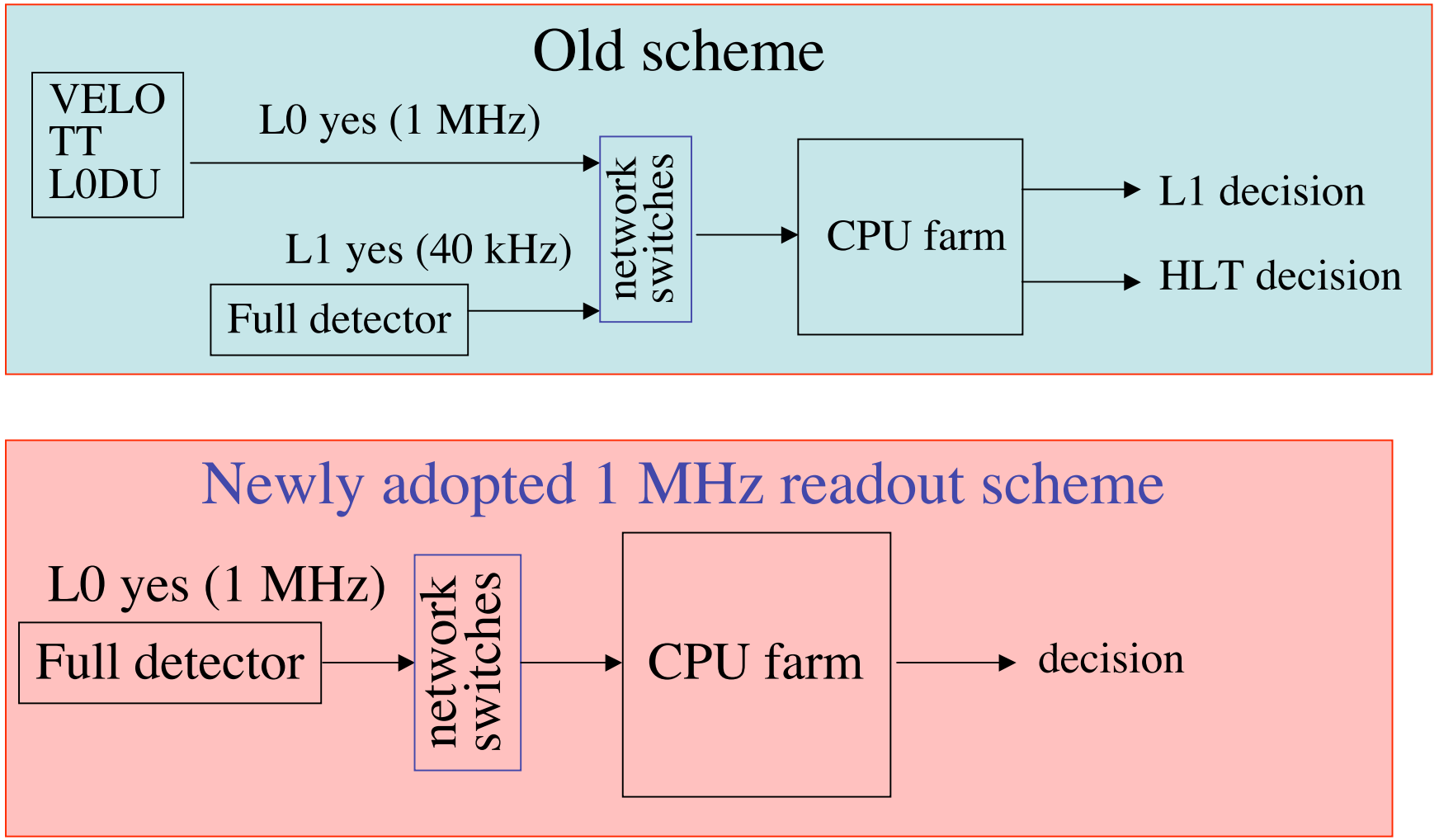
CPU evaluation shows that there already exist CPU-boxes with required performance but are still expensive
Costs will drop by 2007

⇒ Should be possible to build a required CPU farm within the budget in 2007



CPU performance in arbitrary unit measured by running HLT.

L-1 and HLT hardware now completely unified



This was foreseen as an upgrade, but the cost of the network switches has dropped faster than anticipated.

11) Computing

Computing TDR submitted in June 05

Computing model for
simulation, reconstruction and analysis

Resource requirement at Tier-1s and Tier-2s

Software environment

Service Challenge III has started

Phase 1 (October)
Demonstrate Data Management tools to meet the requirements of the Computing Model

Phase 2 (November)
Demonstrate the full data processing sequence in real time

Demonstrate full integration of the Data and Workload Management subsystems

Demonstrate the distributed analysis on the grid

II) Collaboration Issues

New Collaborator

Syracuse University (USA), funded by NSF and the university
It was the leading member of the BTeV experiment
6 PhD equivalent

Due to the Congressional restriction, not able to fund the current detector construction:

Funding for
→ CPUs for the event reconstruction farm in Pit-8
M&O
Remaining and future R&D
Upgrade

Contributing to the areas where more manpower is needed:
→ global alignment, trigger monitoring, analysis framework, VELO R&D and test beams and HPDs in the B field

Organization Issue

Commissioning Task Force installed

Chaired by Commissioning Coordinator; O. Callot (LAL, Orsay) with representatives from all the subsystems

Mandate;

-Defining the mode of operation for data taking, and identifying, producing, implementing and testing all the tools necessary for this operation;

-Commissioning the sub-systems;

-Preparing the detector for steady data taking, through global commissioning, including the pilot run.

III) Cost and Funding

In the construction MoU (November 2000)

Total cost of the experiment: 75.045 MCHF

Total requested funding: 73.30 MCHF

Now (October 2005)

Total cost of the experiment: 75.341 MCHF

Total MoU signed funding; 70.257 MCHF

-MoU was signed by all the countries except Brazil

No cost increase, but funding shortfall of 5.084 MCHF

→ require extra resources

Strategy adopted by the LHCb collaboration for the proposed solution:

1) Complete the detector and electronics first and start the experiment with reduced CPU power
→ full CPU power would not be needed in 2007

Examine the sub-detectors with funding shortfall:

Case A

Shortfall due to reasons "outside" of the subsystem
Covered by the Common Fund (or CERN if appropriate)

Case B

Shortfall due to the "internal" reasons
Solution to be found within the groups responsible for the subsystem.

2) Ask extra funding for the CPUs, which will be needed for 2008

Subsystems with funding shortfall

Muon system

Case A: Defaulting of the Brazilian contribution
⇒Filled by the common fund
Case B: Other cost increase of the detector
⇒Increased contribution to Muon by Italy and CERN

OT system

Case A: More complicated support structure to hold IT as well as OT and ease the installation of the tracking system as a whole
⇒Filled by CF and reinstalling a part of the CERN contribution
Case B: Other cost increase of the detector
⇒Increased contribution to OT by Germany (BMBF) and Netherlands

RICH system

Case A: Introduction of B field in the RICH1 region increasing the photodetector coverage and introducing Fe shielding
⇒Filled by the common fund
Case B: Other cost increase of the detector
⇒Increased contribution to RICH by CERN, Italy and UK

Countries requiring modification to MoU

Germany: request to increase the total contribution 3.757 → 4.138 MCHF

New contribution to OT, 381 kCHF

Italy: request to increase the total contribution 10.0 → 10.847 MCHF

From the saving in the L0-Calo cost (Bologna), 800 → 430 kCHF

Move 370 kCHF to Muon

Cancel the original contribution to DHA, 500 kCHF

Move 172 kCHF to RICH, 328 kCHF to muon

New contribution to Muon, 847 kCHF

Netherlands: request to increase the total contribution 6.3 MCHF → 6.681 MCHF

New contribution to OT, 381 kCHF

UK: request to increase the total contribution
10.3 → 10.344 MCHF

No commitment to DAH anymore, move 600 kCHF to RICH
New contribution to RICH, 44 kCHF

CERN: request to increase the total contribution
12.7 → 13.499 MCHF

New contribution to Muon, 185 kCHF
New contribution to RICH, 614 kCHF

If the new requests for the increased funding are approved, all the subsystems are fully funded, except CPUs.

Total of requested funding to cover the subsystem shortfalls:

2452 kCHF

2632 kCHF still missing for CPUs

Total cost of the DAQ/CPU farm: 5.1 MCHF
- DAQ and farm infrastructure: 1.680 MCHF
- CPU: 3.420 MCHF

Current contributions: 2.468 MCHF
- Switzerland, 500 kCHF
- CERN, 1486 kCHF
- CF, 482 kCHF

Syracuse contributes 400 kCHF for CPU

Remaining shortfall in CPU = 2.232 MCHF

We can equip 35% of the CPUs

→ Enough for 2007

We ask extra contribution for the CPUs to the LHCb funding agencies so that in 2008 we will have the full CPU power.

→ Requested amount 2.232 MCHF

Discussion with funding agencies has started to find a fair sharing of this remaining shortfall

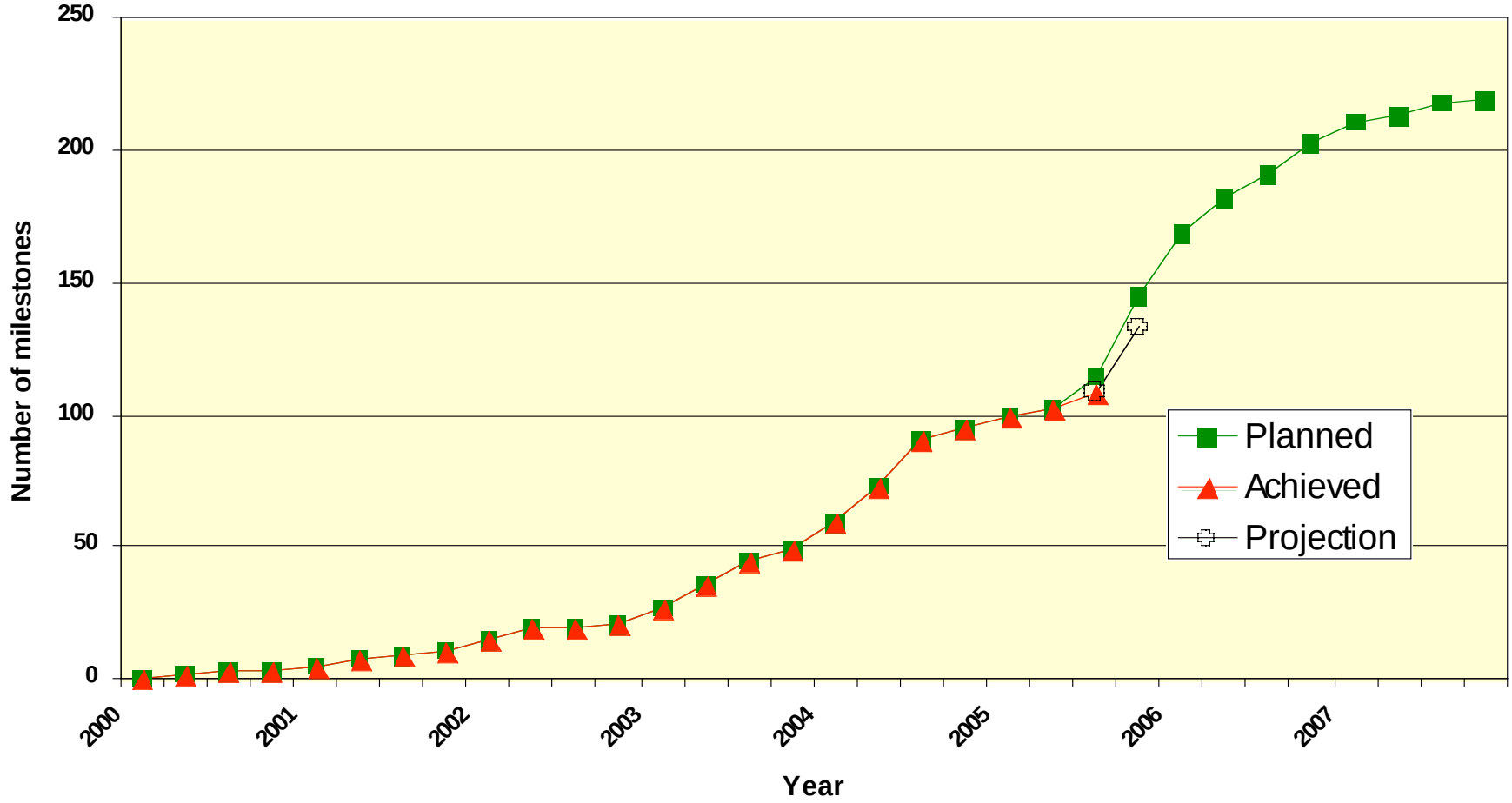
Summary Table for October 2005 RRB in kCHF

Funding agencies	Total funding	Common Fund funding	Project funding	VELO	ST	OT	RICH	CALO	Muon detector	L0	DAQ CPU farm	ECS, TFC Comp. infrastru.	Magnet	Infra-structure
Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0
China	100	28	72	0	0	72	0	0	0	0	0	0	0	0
France	7500	2100	5400	0	0	0	0	3820	0	1580	0	0	0	0
Germany-BMBF	4138	864	3274	370	356	2548	0	0	0	0	0	0	0	0
Germany-MPG	2200	834	1366	0	1366	0	0	0	0	0	0	0	0	0
Italy	10847	2850	7997	0	0	0	1172	0	6395	430	0	0	0	0
Netherlands	6681	1800	4881	1250	0	3381	0	0	0	250	0	0	0	0
Poland	500	140	360	0	0	360	0	0	0	0	0	0	0	0
Romania	300	90	210	0	0	0	0	210	0	0	0	0	0	0
Russia	2500	700	1800	0	0	0	0	1370	430	0	0	0	0	0
Spain	2000	570	1430	0	800	0	0	430	0	0	0	200	0	0
Switzerland	7900	2250	5650	2142	2508	0	0	0	0	0	500	500	0	0
UK	10344	2940	7404	1060	0	0	6344	0	0	0	0	0	0	0
Ukraine	200	60	140	0	70	0	0	70	0	0	0	0	0	0
CERN	13499	3520	9979	0	770	289	1614	3740	495	0	1486	1585	0	0
Funding sum	68709	18746	49963											
CF contribution				0	0	900	687	5290	1240	0	482	0	5774	4373
CF usage sum			18746											
Project Funding			68709	4822	5870	7550	9817	14930	8560	2260	2468	2285	5774	4373
Muon-filter in kind contribution from CERN			4000											
Project Funding with CERN in kind			72709											
Project Cost			71341	4822	5870	7550	9817	14930	8560	2260	5100	2285	5774	4373
Muon-filter			4000											
Project Cost with Muon filter			75341											
Balance			−2632	0	0	0	0	0	0	0	−2632	0	0	0

US contribution to CPU-farm	400

Total					
Cost	75341	Funding	73109	Balance	−2232

LHCC Milestones (October 2005)



IV) Conclusions

1)Production, installation and commissioning of all the subsystems are progressing well

2)No problem with the TT and ST sensor delivery any more

3)Still tight schedule for VELO sensors, RICH1 mechanics, HPD's and Muon chambers

4)A solution for the funding shortfall (~5 MCHF) proposed
-Revised cost-funding matrix to complete the subsystem, affecting the funding of DE(BMBF), GB, IT, NL, CERN
-New contribution to be asked for the missing CPU part (2.232 MCHF), ~2/3 of the final scale.

5)The LHCb collaboration requests the RRB to approve the new cost-funding matrix, and to give positive reactions for the extra contribution to install the remaining CPUs in 2008