



Recent Progress on the LHCb Experiment

On behalf of the LHCb Collaboration

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and

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1) Introduction

LHCb is a dedicated experiment at LHC to study CP violation and other rare phenomena in B-meson decays.

Impressive progress by

LEP experiments

$|V_{cb}|$ ($b \rightarrow c+W$), $|V_{ub}|$ ($b \rightarrow u+W$),

$|V_{td}|$ (Δm_d), $|V_{ts}|$ ($b \rightarrow s$ penguin)

Experiments at Y(4S)

$|V_{cb}|$, $|V_{ub}|$,

$|V_{td}|$ (Δm_d), $|V_{ts}|$ ($b \rightarrow s$ penguin),

$\arg V_{td}$ (CP in $b \rightarrow c+W$),

$\arg V_{ts}$ (CP in $b \rightarrow s$ penguin)

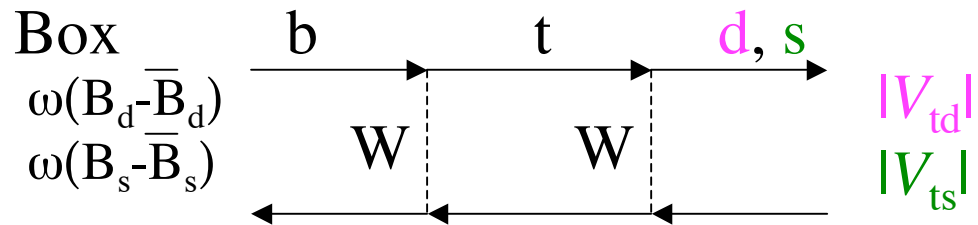
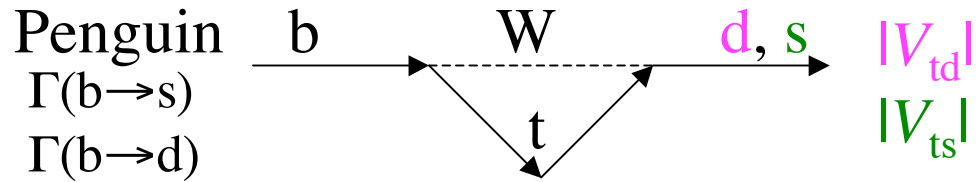
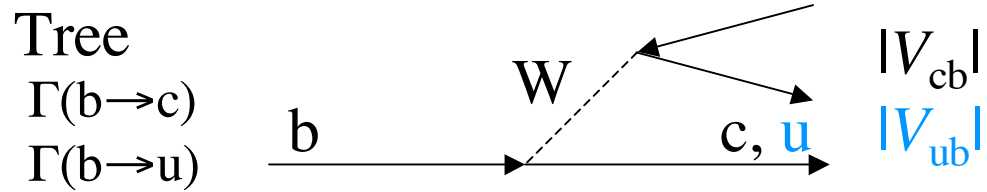
$\arg V_{ub}$ (CP in $b \rightarrow c+W \otimes b \rightarrow u+W$ via $D-\bar{D}$ mixing)

$\arg V_{ub}$ (CP in $b \rightarrow c+W \otimes b \rightarrow u+W$)

Tevatron experiments

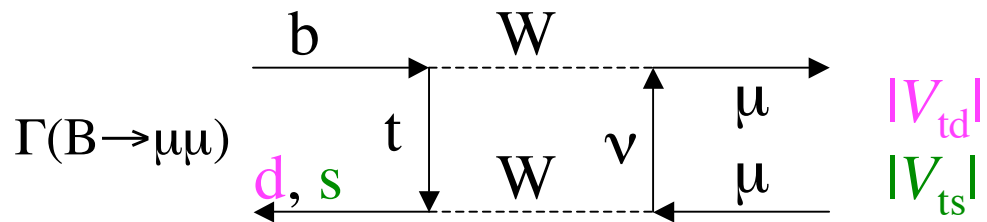
$|V_{td}|$, $|V_{ts}|$, $\arg V_{td}$

Standard Model



~~CR(Tree \otimes Box) $2 \arg V_{td} (V_{ts}) + \arg V_{cb} (V_{ub})$~~

~~CP(Peng \otimes Box) $2 \arg V_{td} (V_{ts}) + \arg V_{td}$
 $2 \arg V_{td} (V_{ts}) + \arg V_{ts}$~~



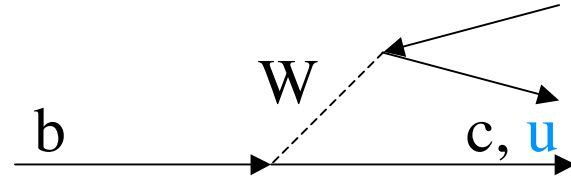
Standard Model

New Physics

Tree

$$\Gamma(b \rightarrow c)$$

$$\Gamma(b \rightarrow u)$$



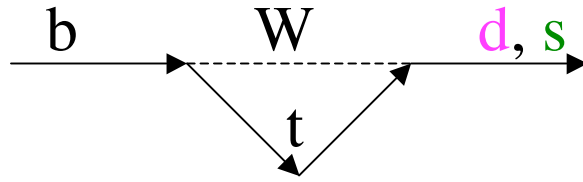
$$|V_{cb}| \text{ unaffected}$$

$$|V_{ub}|$$

Penguin

$$\Gamma(b \rightarrow s)$$

$$\Gamma(b \rightarrow d)$$



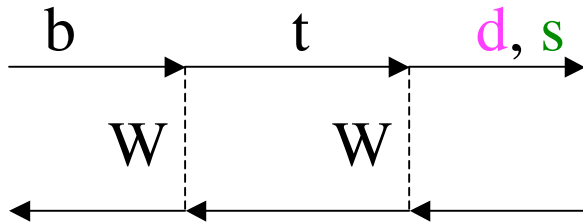
$$|V_{td}| + \Delta_{\text{peng}(d)}$$

$$|V_{ts}| + \Delta_{\text{peng}(s)}$$

Box

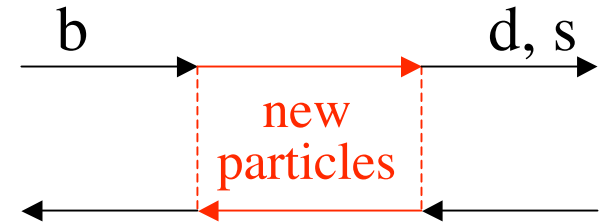
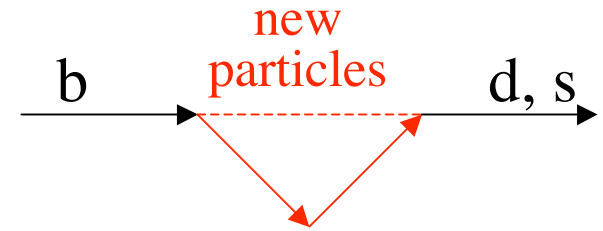
$$\omega(B_d - \bar{B}_d)$$

$$\omega(B_s - \bar{B}_s)$$



$$|V_{td}| + \Delta_{\text{box}(d)}$$

$$|V_{ts}| + \Delta_{\text{box}(s)}$$

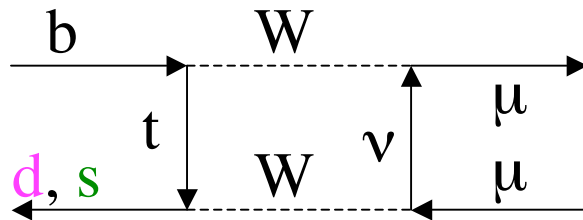


~~$$\text{CR}(\text{Tree} \otimes \text{Box}) \quad 2 \arg V_{td} (V_{ts}) + \arg V_{cb} (V_{ub}) + \Phi_{\text{box}(d)} (\Phi_{\text{box}(s)})$$~~

~~$$\text{CP}(\text{Peng} \otimes \text{Box}) \quad 2 \arg V_{td} (V_{ts}) + \arg V_{td} \quad + \Phi_{\text{box}(d)} (\Phi_{\text{box}(s)}) + \Phi_{\text{peng}(d)}$$~~

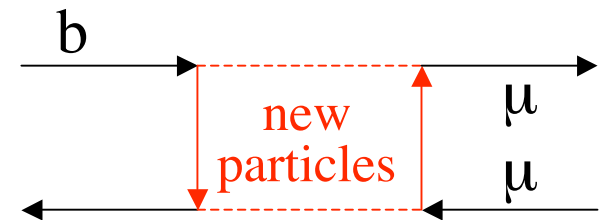
~~$$2 \arg V_{td} (V_{ts}) + \arg V_{ts} \quad + \Phi_{\text{box}(d)} (\Phi_{\text{box}(s)}) + \Phi_{\text{peng}(s)}$$~~

$\Gamma(B \rightarrow \mu\mu)$



$$|V_{td}| + \Delta_{\mu\mu(d)}$$

$$|V_{ts}| + \Delta_{\mu\mu(s)}$$



The LHCb Experiment will

-determine the CKM parameters in a model independent manner and look for new physics-

e.g.

- extracting B_d and B_s oscillation frequencies and phases: *B. Carron*
(in the Standard Model V_{td} and V_{ts})
- $B_d \rightarrow J/\psi K_S$, $B_s \rightarrow J/\psi \phi$, $B_s \rightarrow J/\psi \eta$,

- extracting $\arg V_{ub}$ from CP asymmetries in
- $B_s \rightarrow D_s K$ (+ B_s oscillation phase): *E. Rodrigues*

no hadronic uncertainties

no effect from new physics

large asymmetries

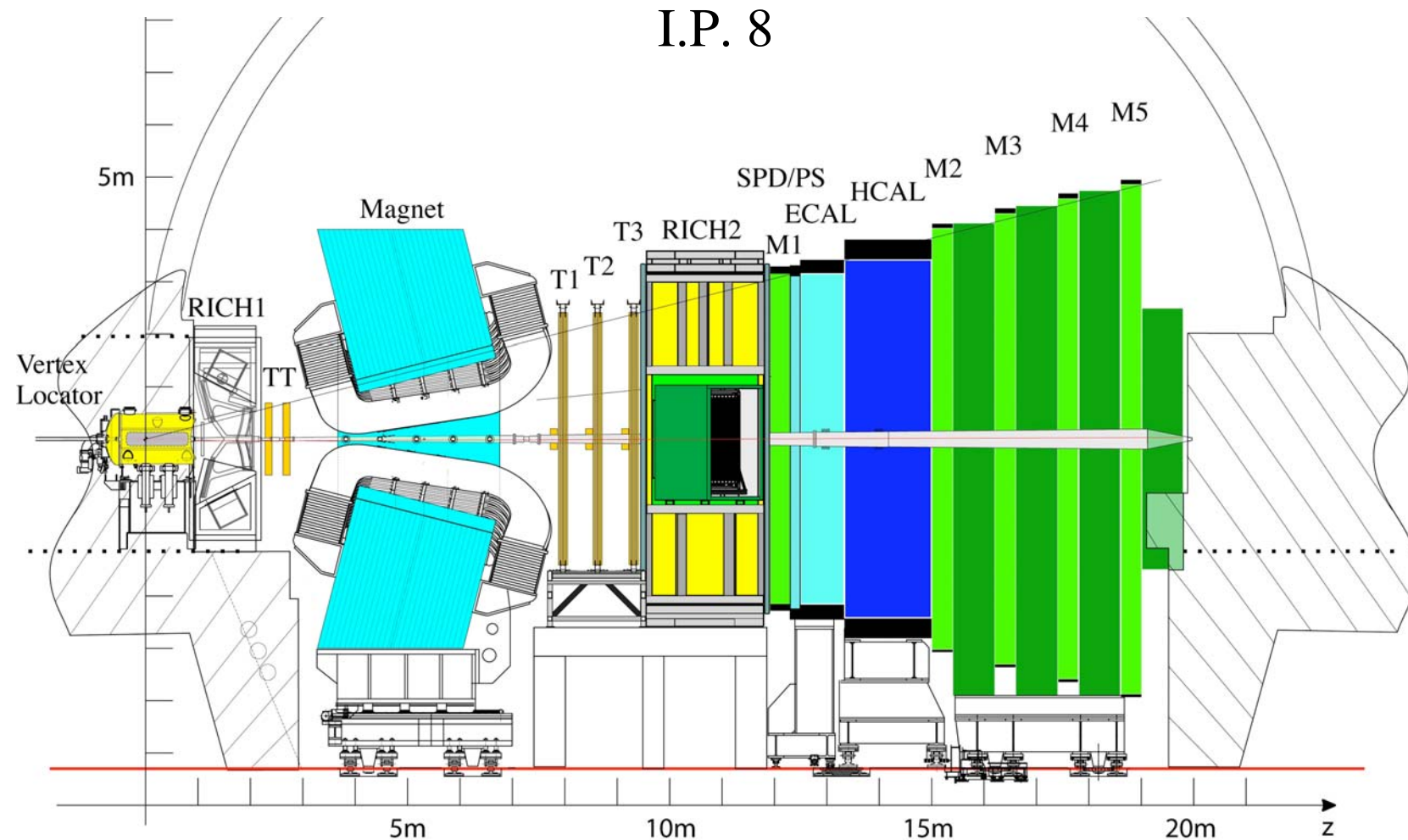
- $B_d \rightarrow \pi^+ \pi^- \oplus B_s \rightarrow K^+ K^-$ (+ B_d and B_s oscillation phase) *L. Fabbri*
hadronic uncertainties (U-spin)
affected by new physics in penguin

- $B_d \rightarrow DK^*$ *S. Amato*
affected by new physics in $D-\bar{D}$

-and look for surprises-

e.g. rare decays *I. Belyaev*

2) Status of the detector construction



Good mass and eigentime resolution: VELO + tracking system

Hadron identification: RICH system

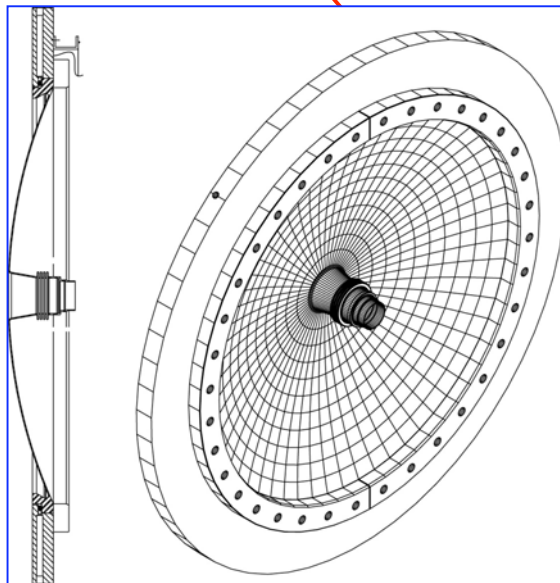
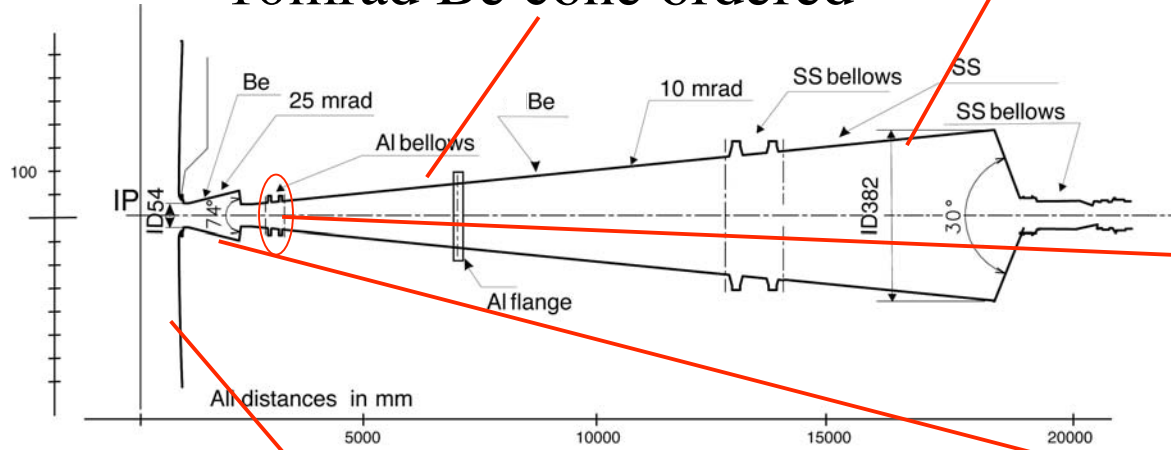
L0 Lepton and Hadron p_T trigger: Calorimeter and muon system

Beam pipe

10mrad stainless steel cone

Al bellows

10mrad Be cone ordered

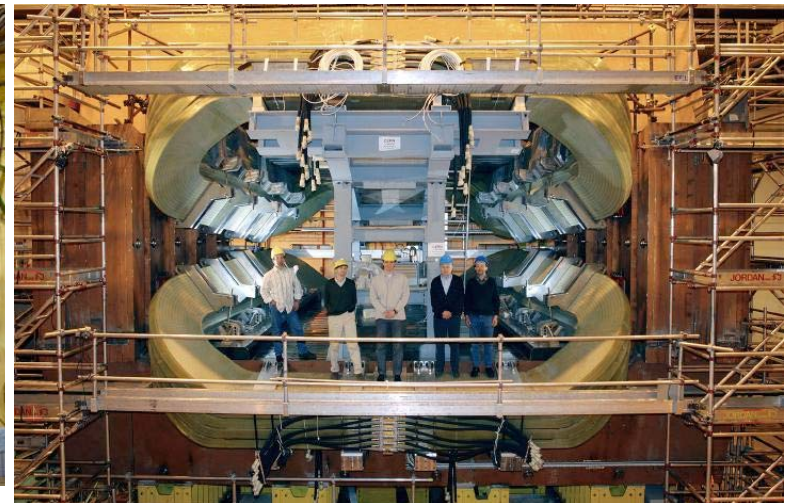
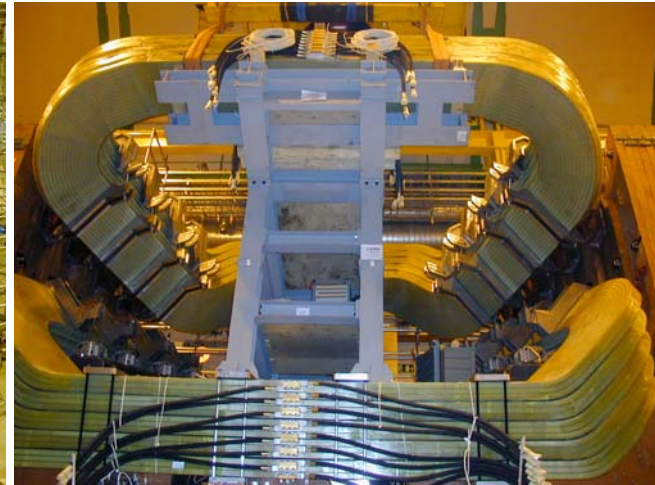
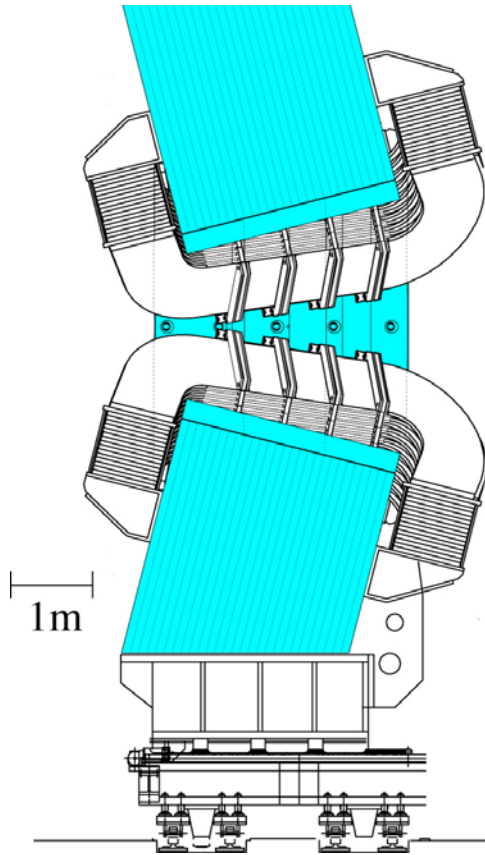


2mm Al exit window



25mrad Be cone completed

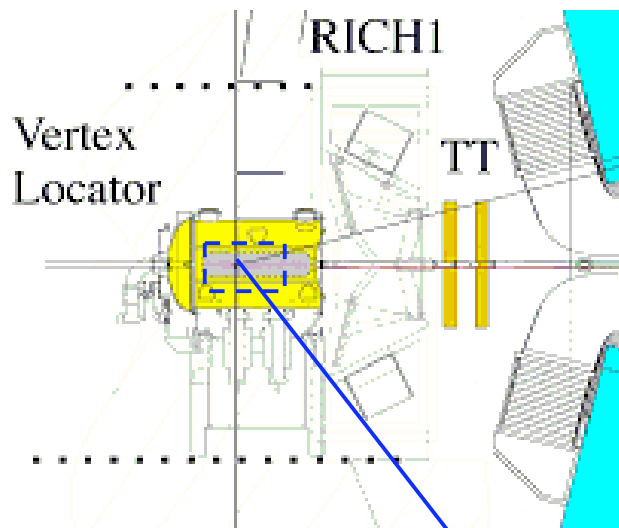
Magnet



$\int B dl = 4 \text{ Tm}$
Normal conductor (Al)
Power = 4.2 MW
Fe Yoke = 1600 t

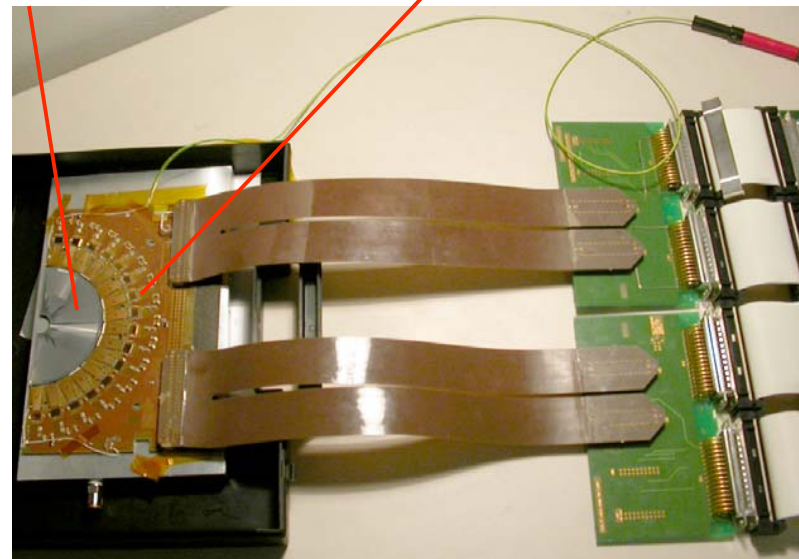
commissioning in Autumn 2004

Vertex Locator

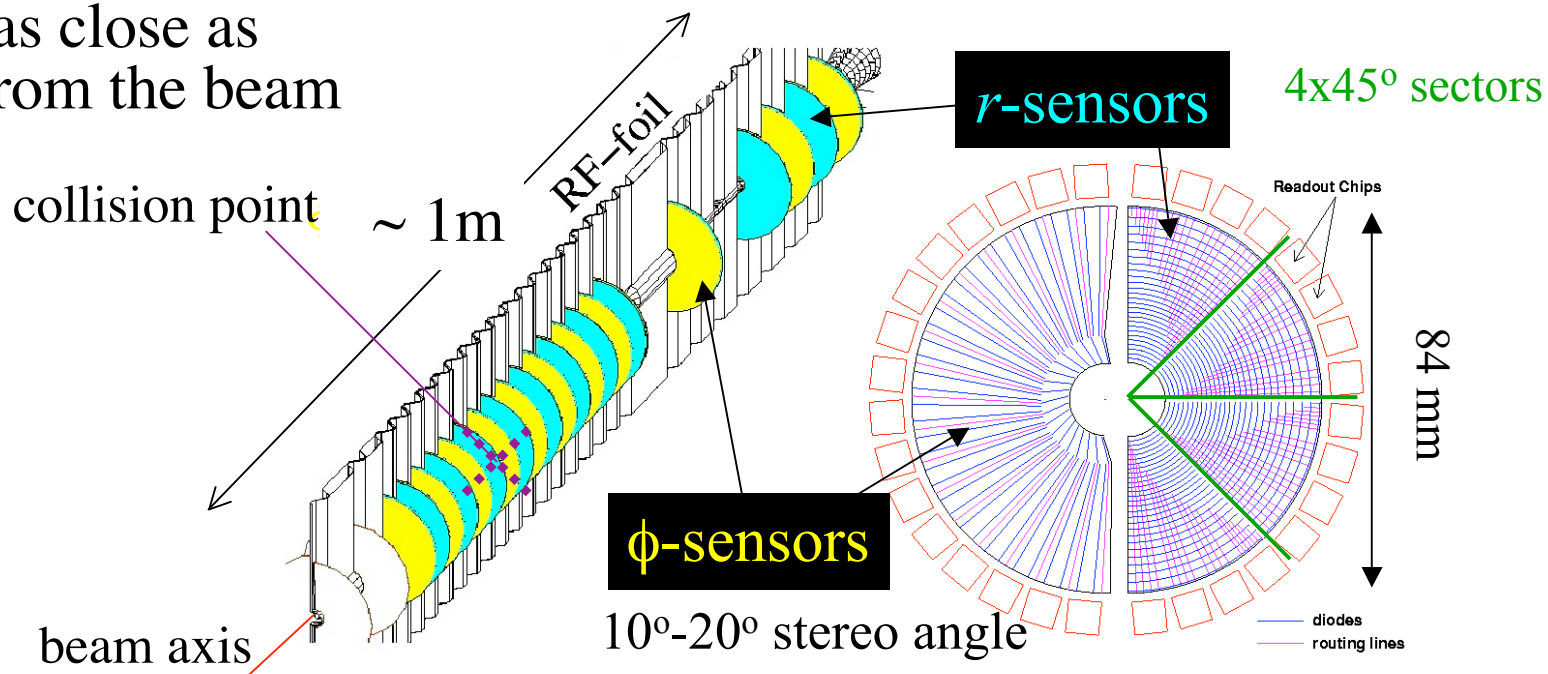


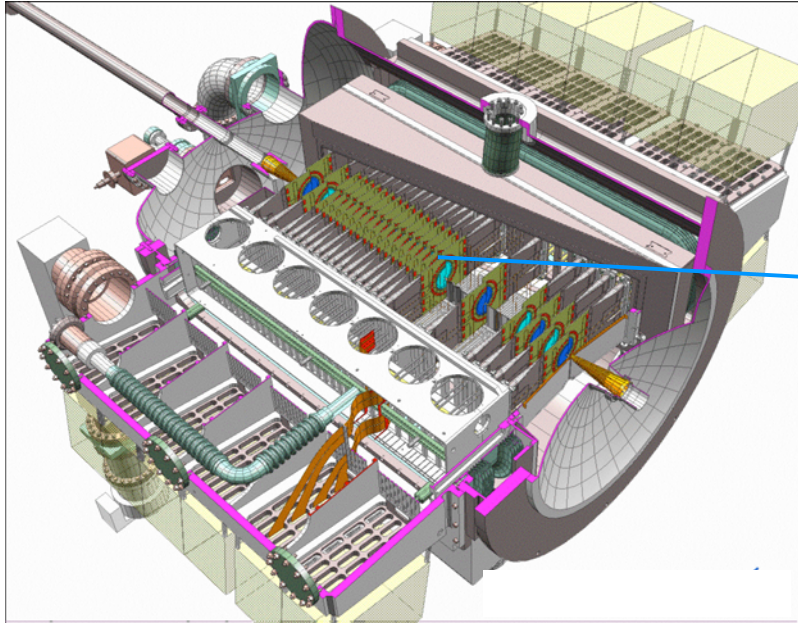
Si sensor

hybrid with readout chip

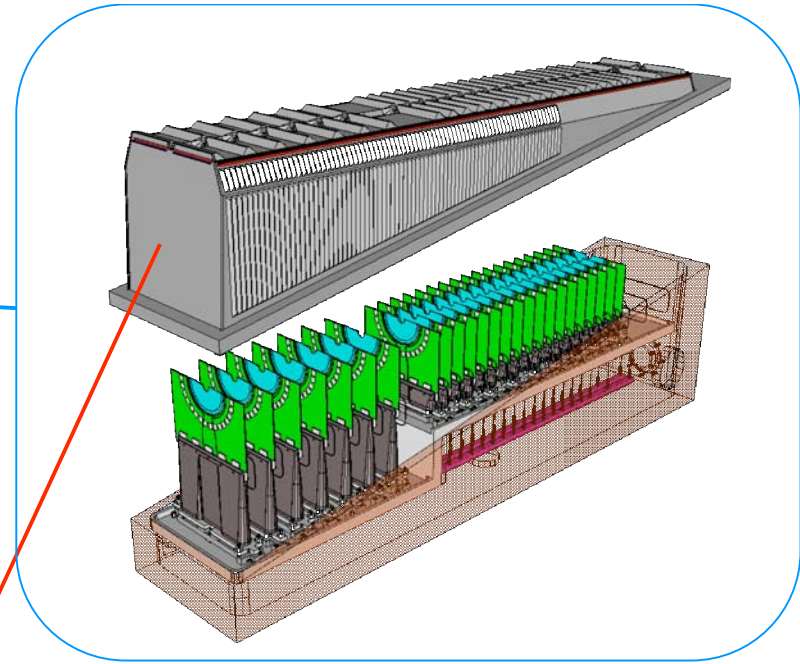


Si sensor as close as 8mm from the beam

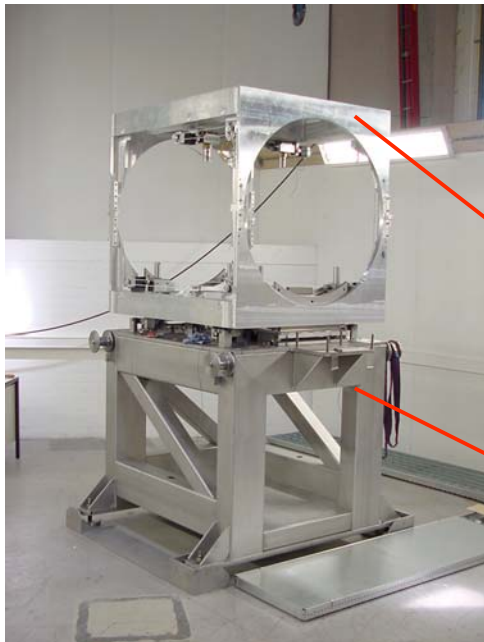




Si in secondary vacuum with the Roman pot technology



Al r.f. shielding box

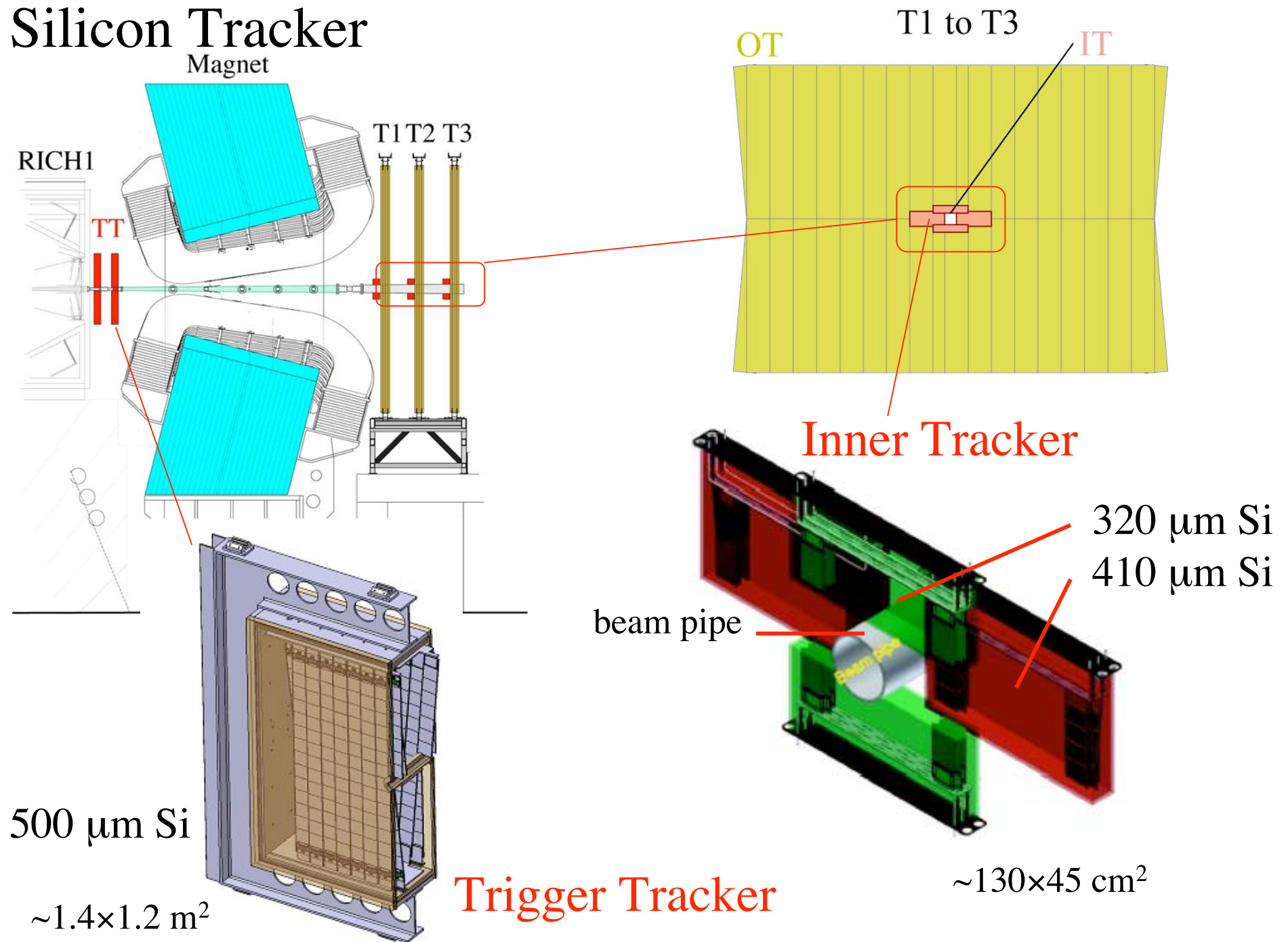


vacuum vessel support

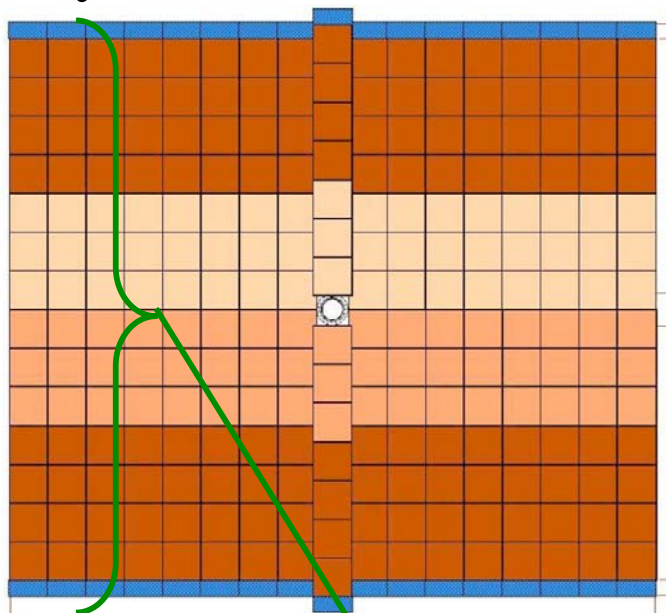
stand



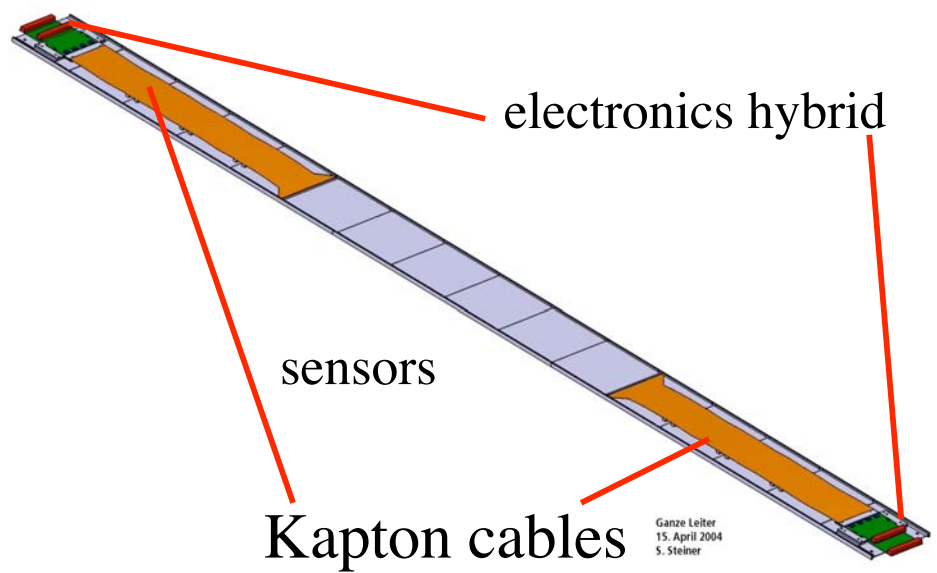
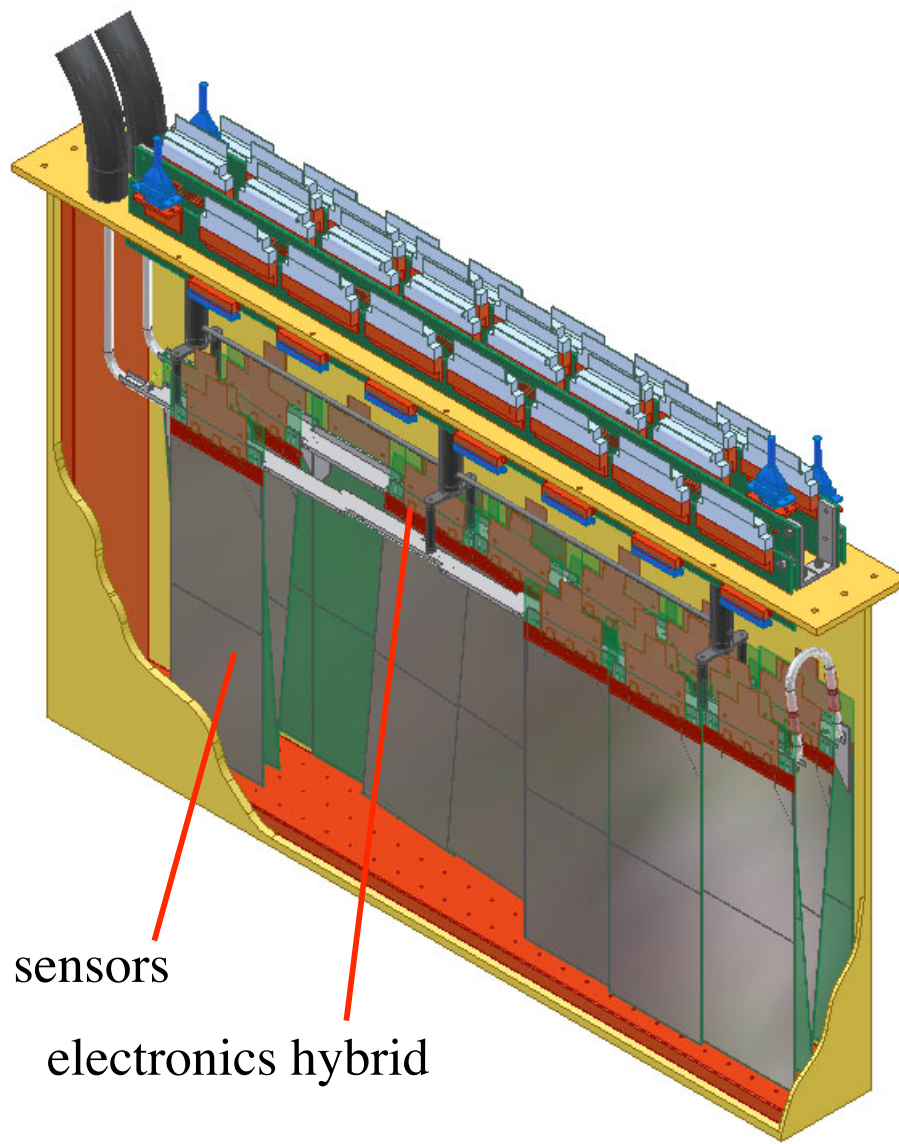
Silicon Tracker



TT layout with the CMS sensors



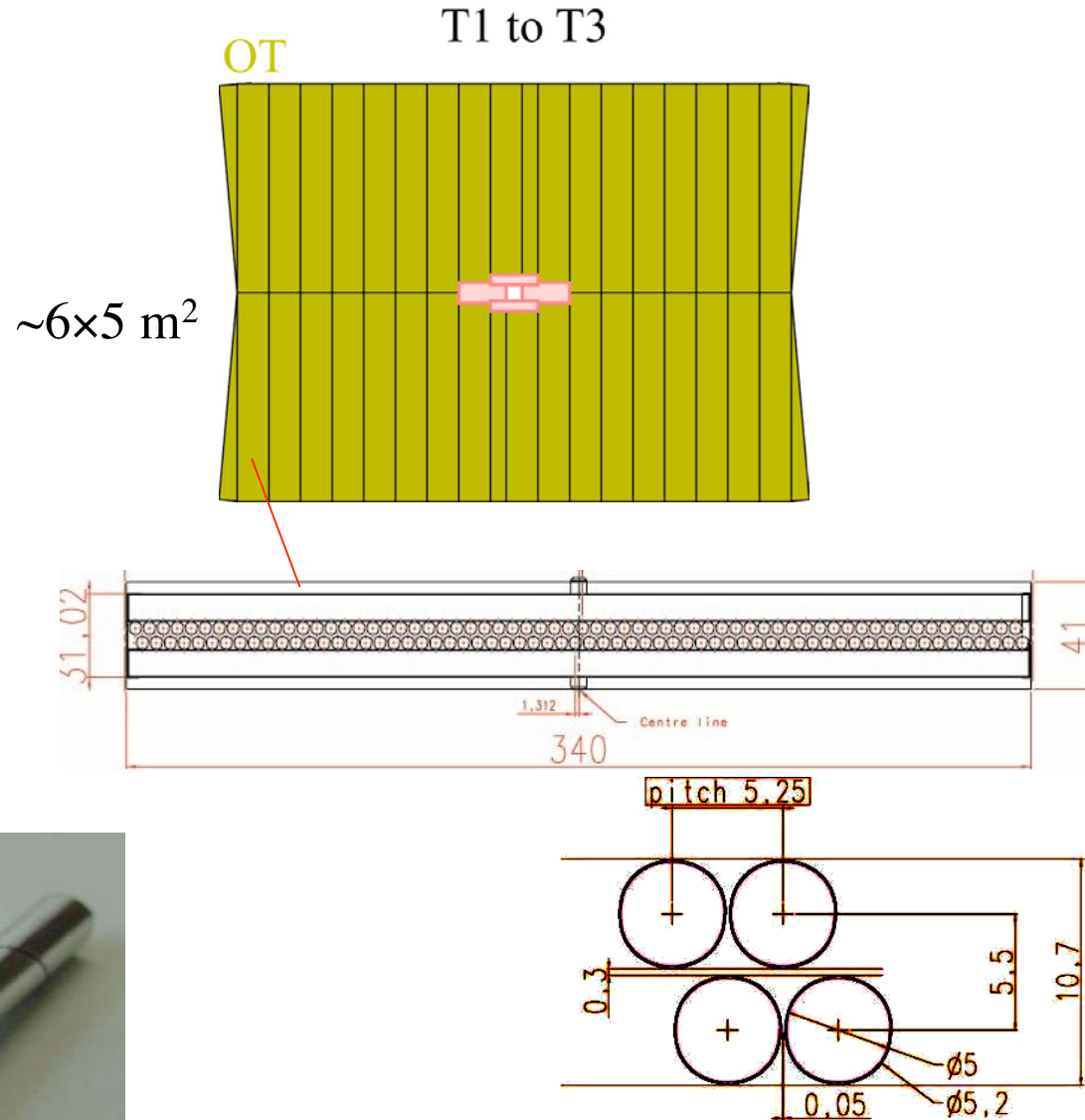
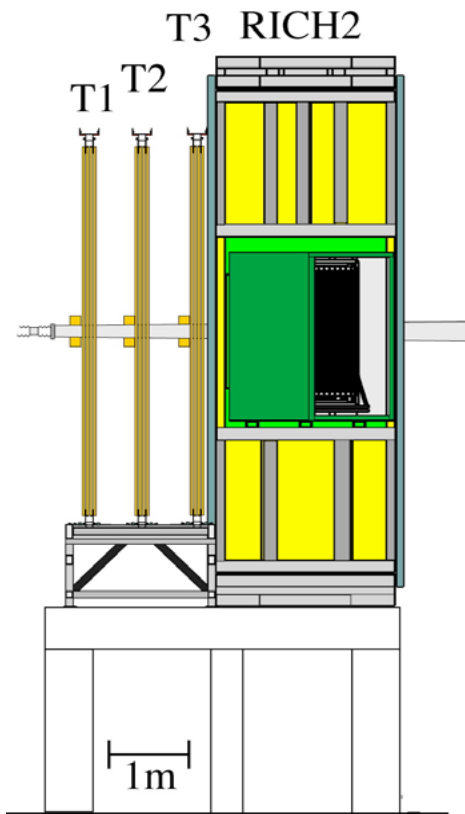
IT box mechanical design



sensors
electronics hybrid

Outer Tracker

One station = X-U-V-X module planes

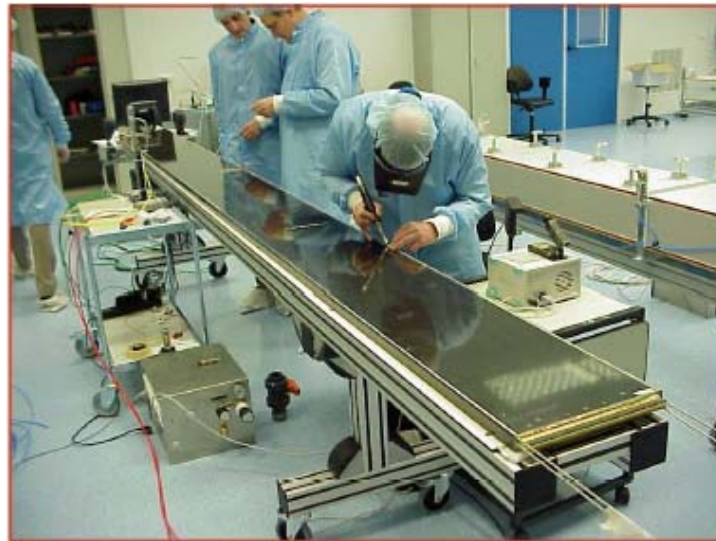


Straw drift chambers

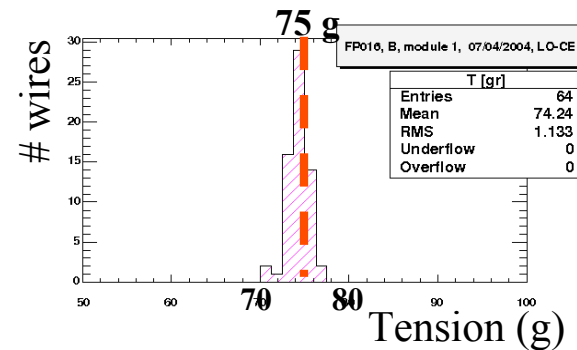


40µm Kapton XC-160
+ Laminated Kapton-Al

Serial production is starting in four production sites

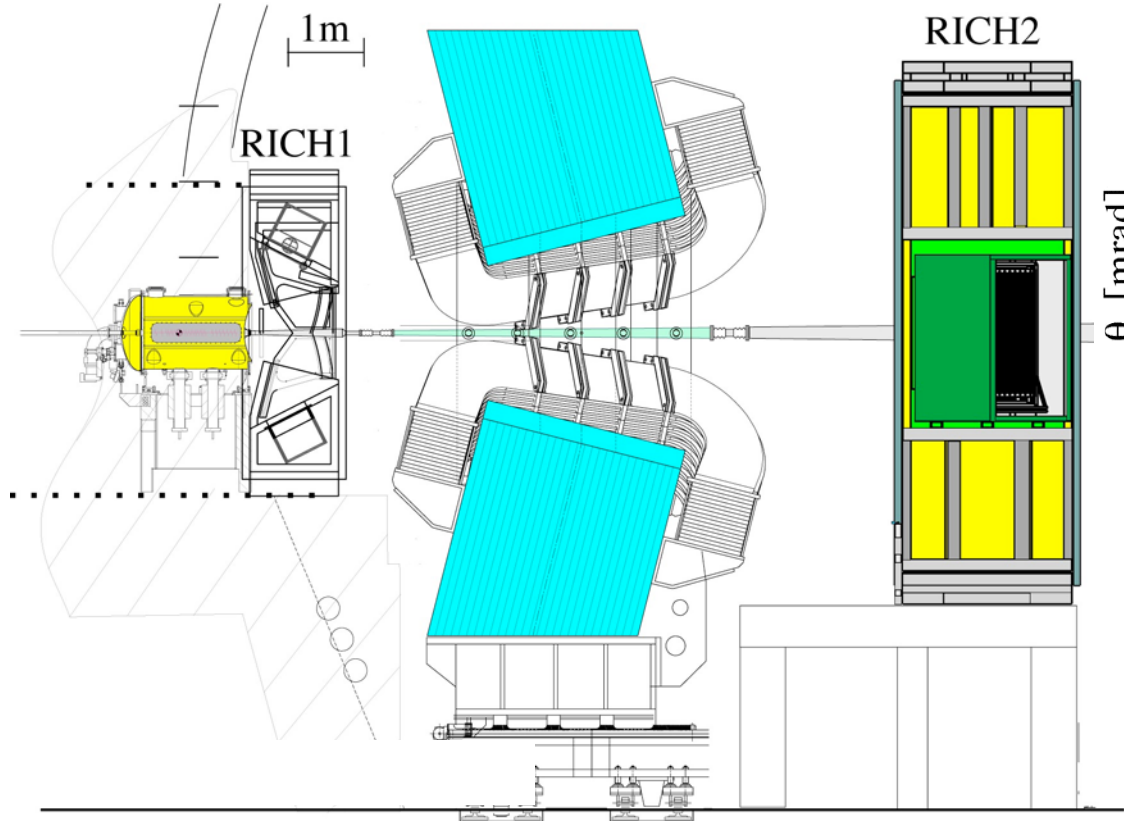


RMS of wire deviation
<100 μm



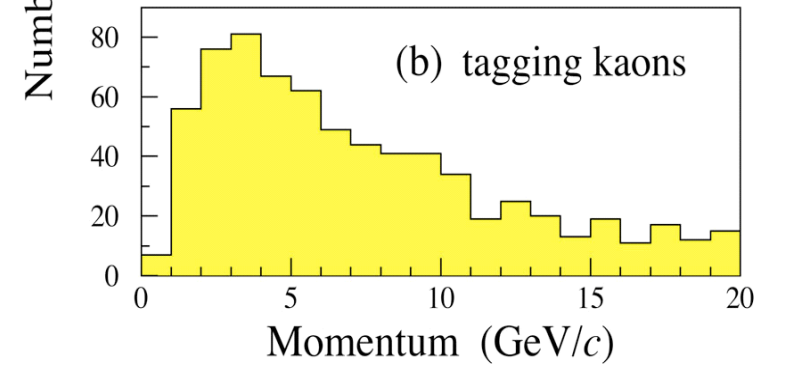
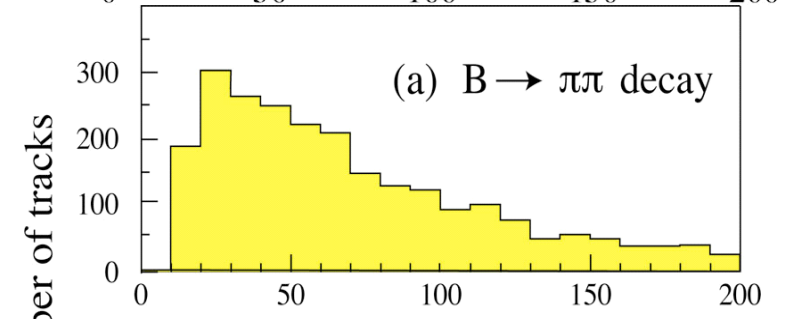
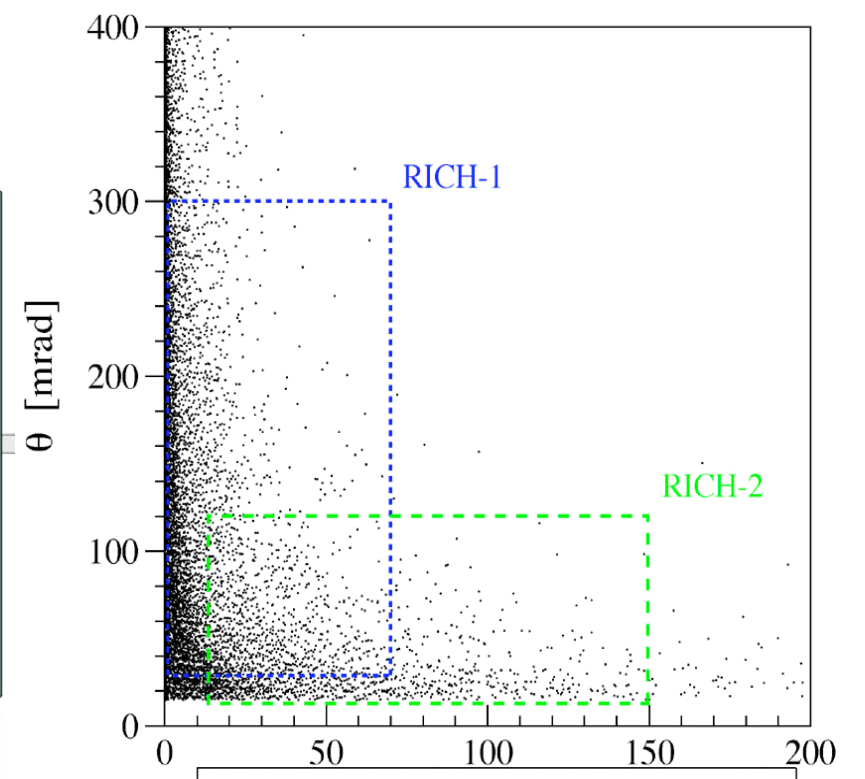
Wire tension
measurement

RICH



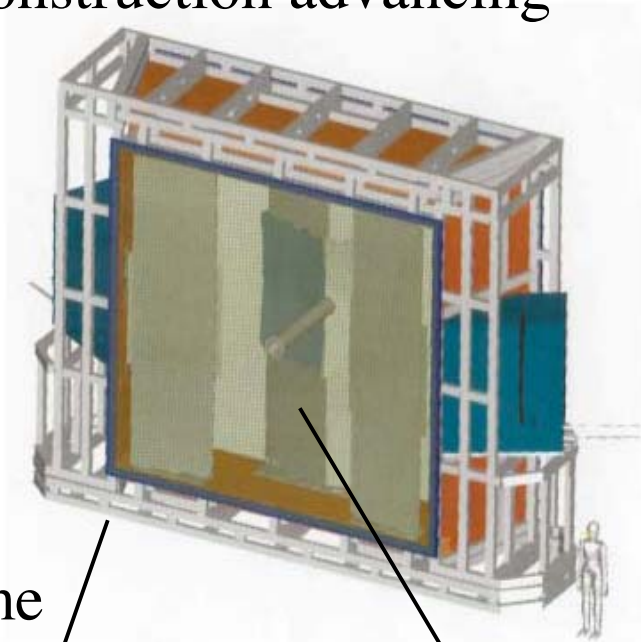
Two RICH with three radiators

Aerogel	}	RICH1 (25-300 mrad)
C_4F_{10}		
CF_4		RICH2 (15-120 mrad)



RICH2 construction advancing

design

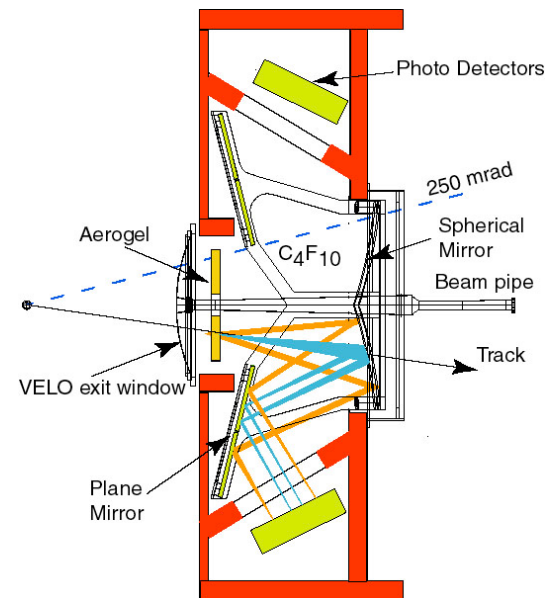


Space frame

mirror support



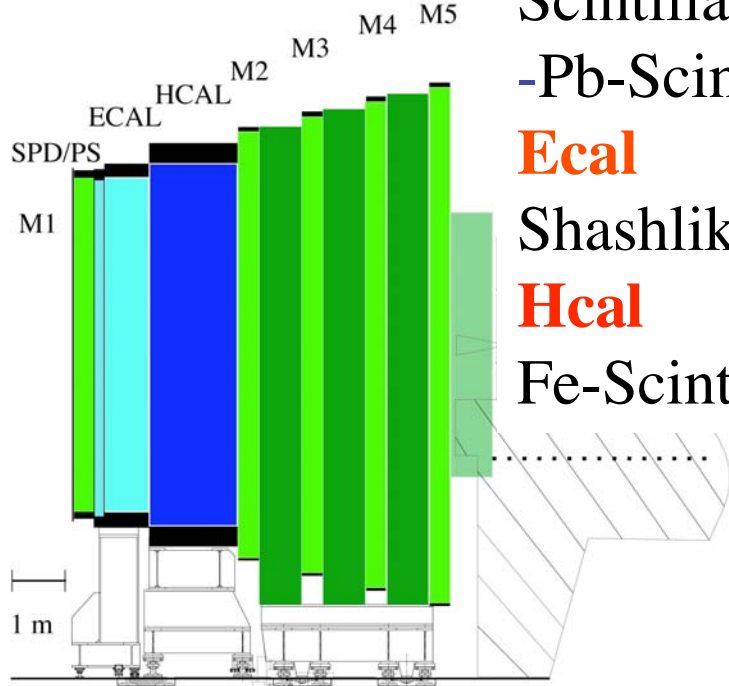
RICH1 design advancing



Photon detector for both: HPD



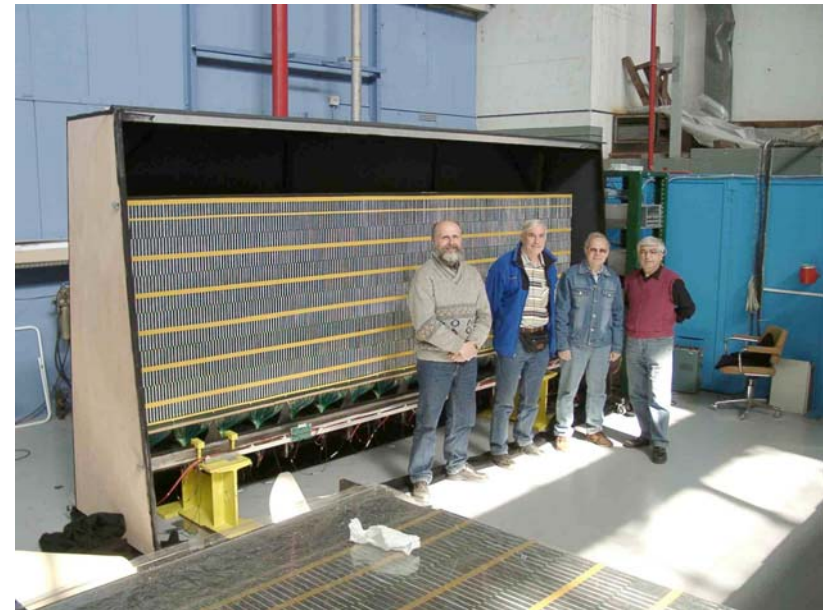
Calorimeter



- SPD/PS**
- Scintillator
- Pb-Scintillator
- Ecal**
- Shashlik
- Hcal**
- Fe-Scintillator tile



Production well advanced
100 % of E-cal
70 % of H-cal
modules delivered to CERN.

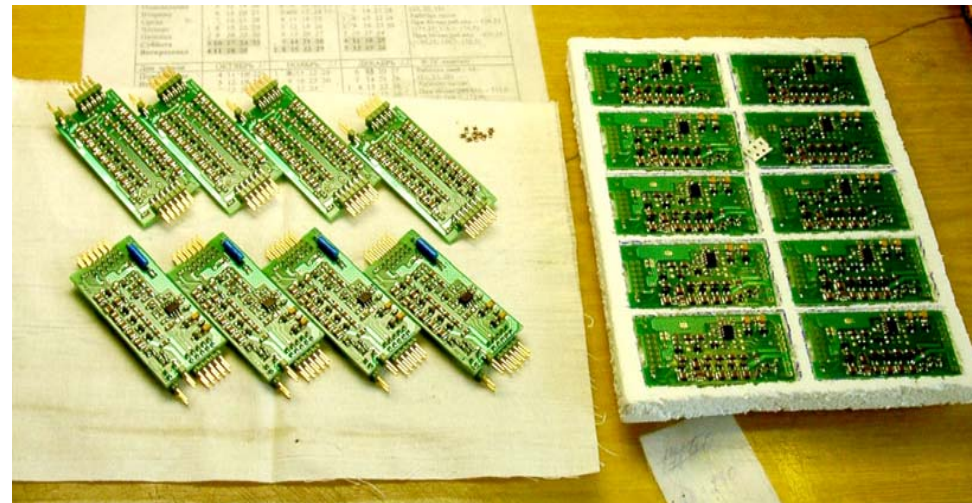


H-cal optical assembly at CERN advancing

30% of SPD/PS
modules produced

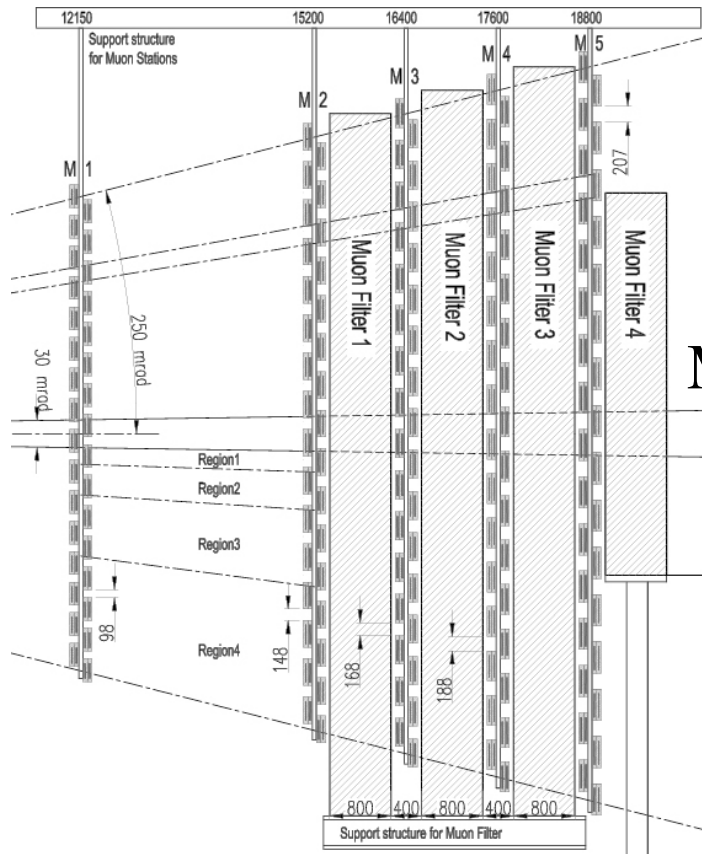


SPD/PS superstructure
mechanical test



Preproduction of CW PM base for
E- and H-cal

Muon



Projective pad readout based on MWPC's.

A total of 1368 chambers with various types



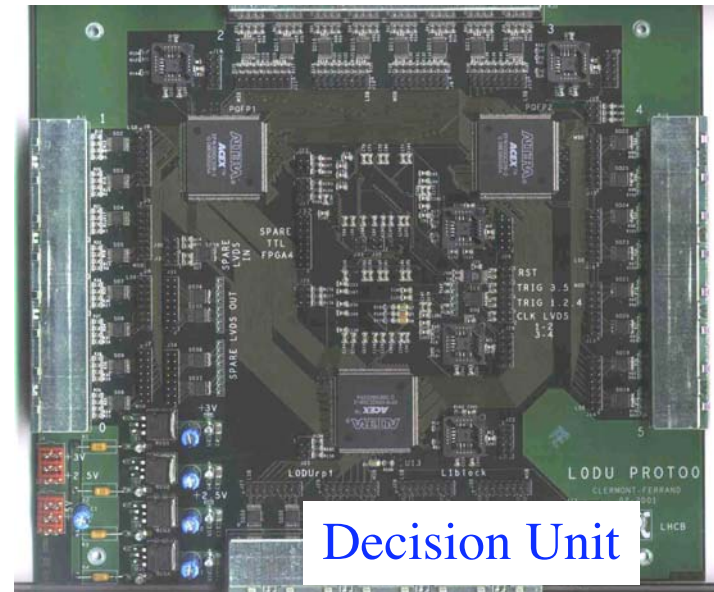
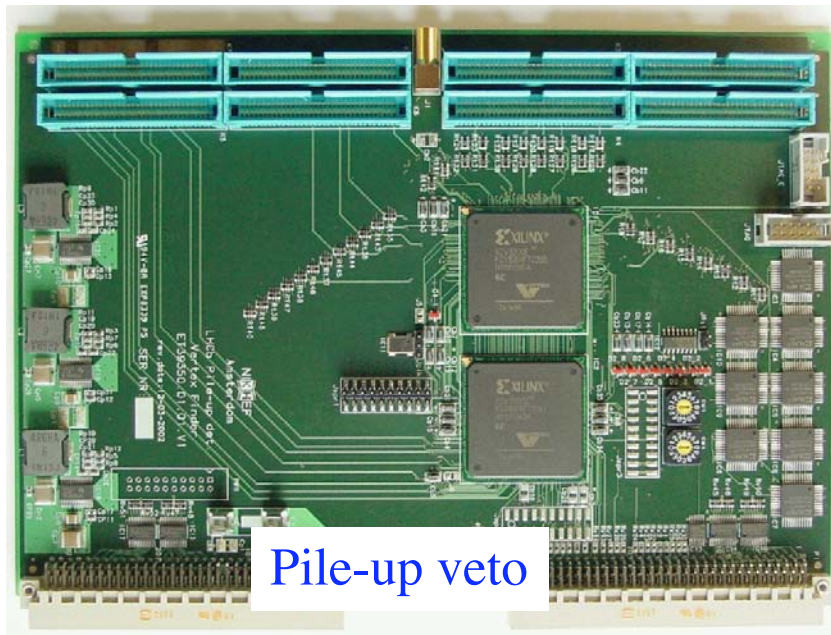
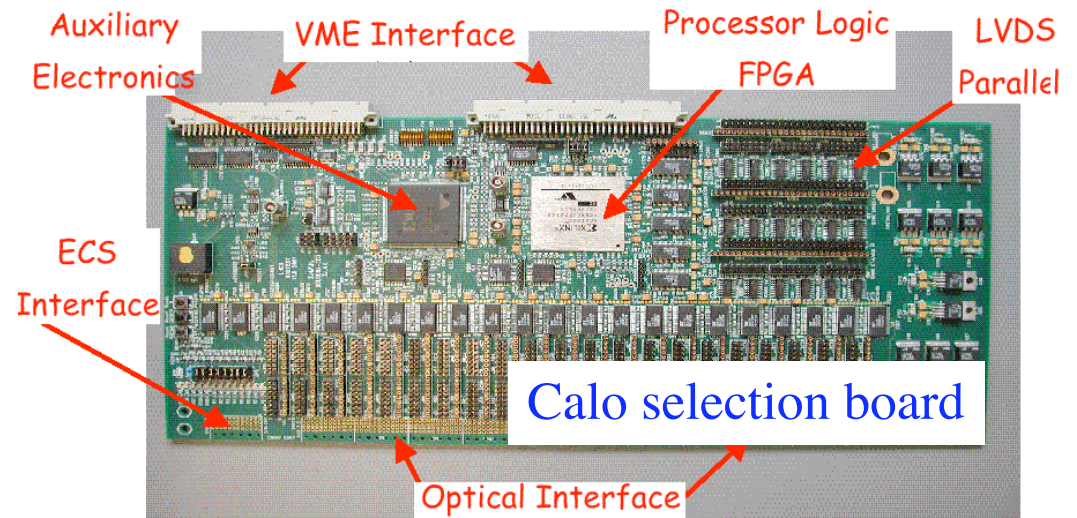
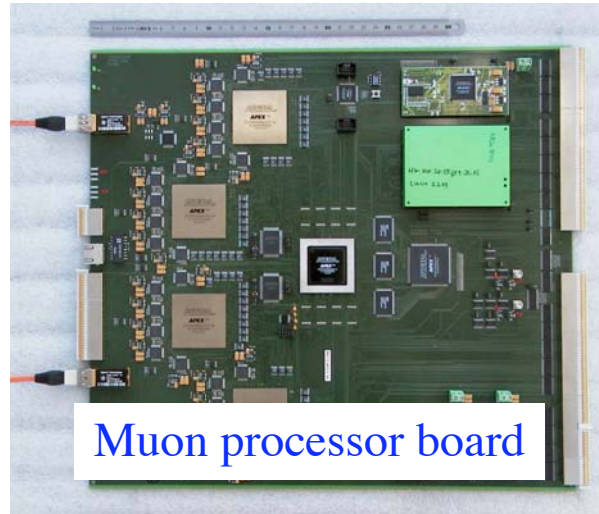
MWPC production has started in various sites.



Muon filter chariot being delivered.
(filter: a total of 2000 t Fe)

Level-0 Trigger

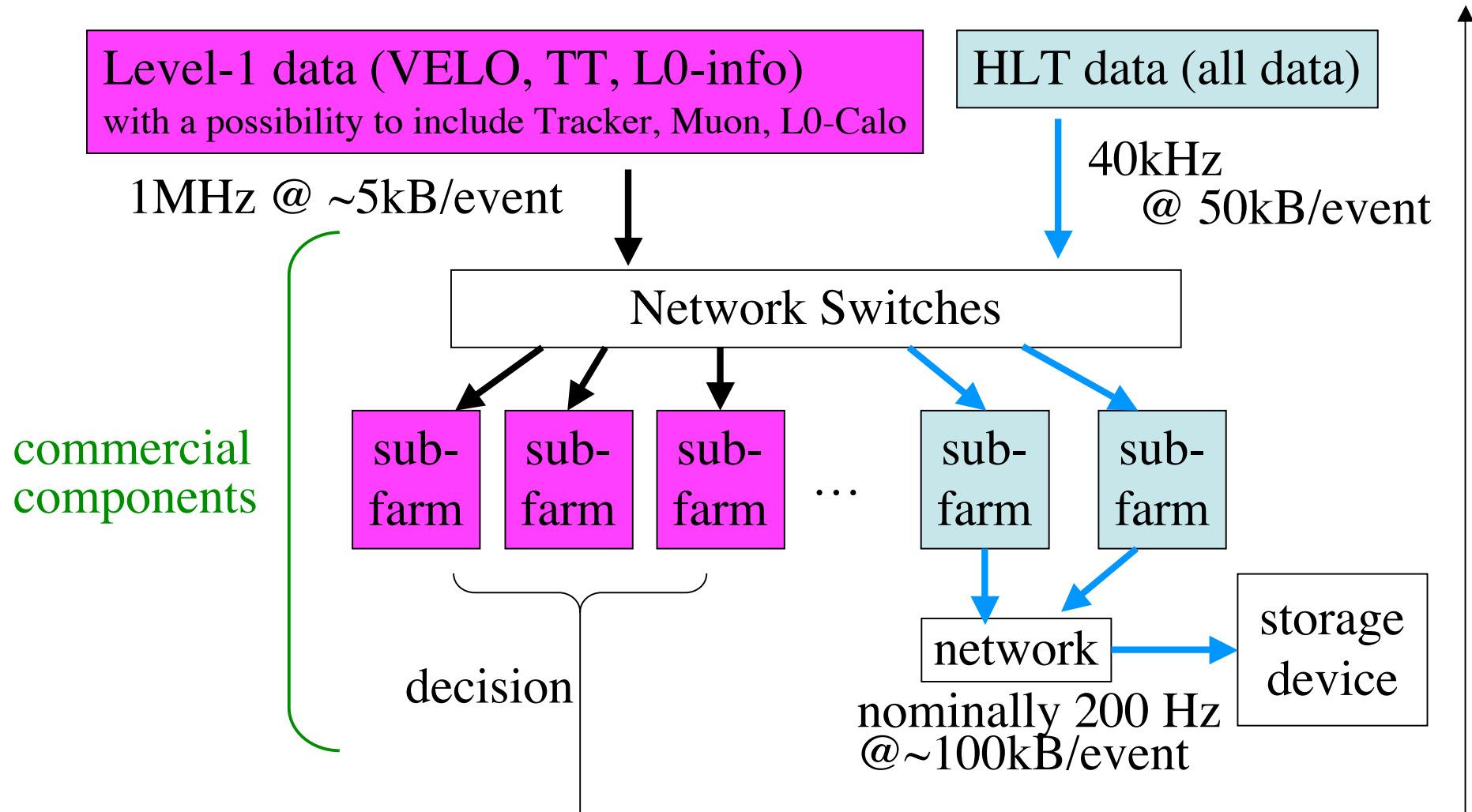
Level-0: Muon, Calorimeter (e, h, γ , π^0), Pile-up veto, Decision Unit prototype work advancing.



Level-1/High Level Trigger and DAQ

Level-0: 40 MHz → 1 MHz

Level-1: 1 MHz → 40 KHz



Real Time Trigger Challenge: a vertical slice planned in 2005
Testing both hardware and software

Software and computing

2003: Production version of software

framework based on C++

most of the event reconstruction and analyses in C++

PYTHIA and GEANT3: FORTRAN

MC Production tool for distributed computing

DIRAC job scheduling and submission, data transfer
data catalogue, etc.

A total of > 40M events generated for physics/trigger studies

2004: Production version of software

all C++ (transition to GEANT4) except

PYTHIA

Incorporating LCG middle-ware in the production tool

Goal to produce ~5 times more data than 2003

Do analysis with distributed computing

Summary

LHCb is design to study CP violation and rare decays using a large sample of different b hadrons (B^\pm , B_d , B_s , B_c , Λ_b , etc.) in order to look for a sign on New Physics:

-a complementary approach to ATLAS/CMS-
Expected performance in the afternoon talks!

Detector construction is advancing.

Physics potential can be fully exploited with the initially expected LHC luminosity

i.e. LHCb needs $\sim 2 \times 10^{32}$,
LHC will start with $\sim 10^{33}$