Status of the LHCb RICH detector and the HPD

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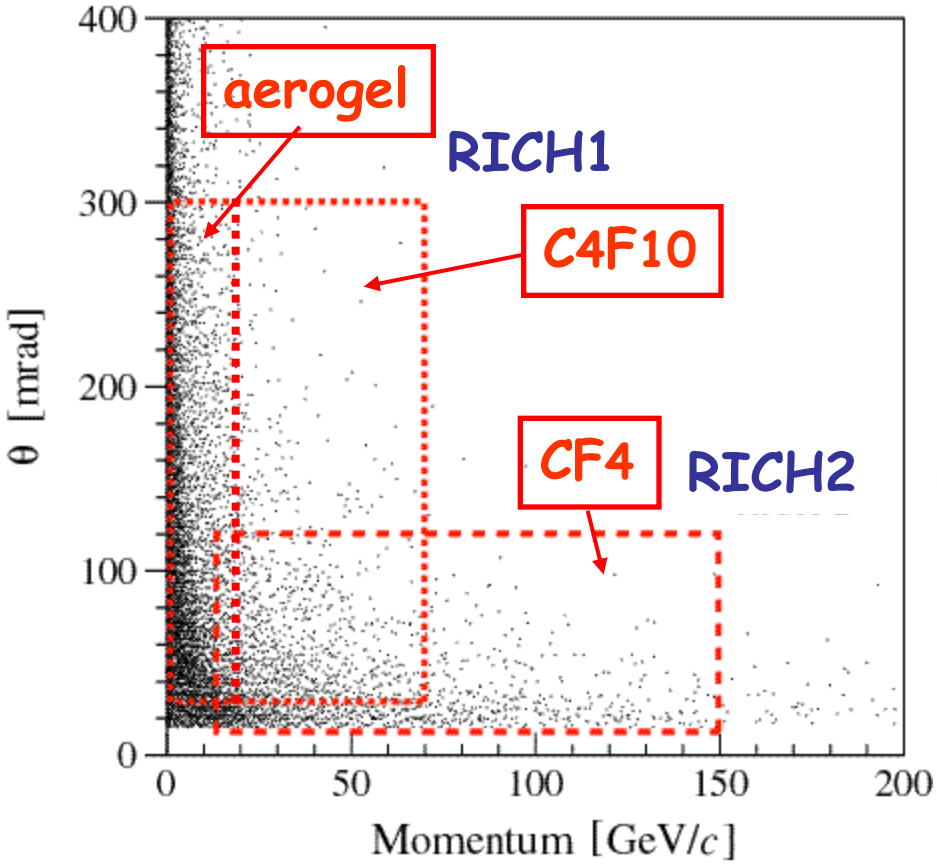
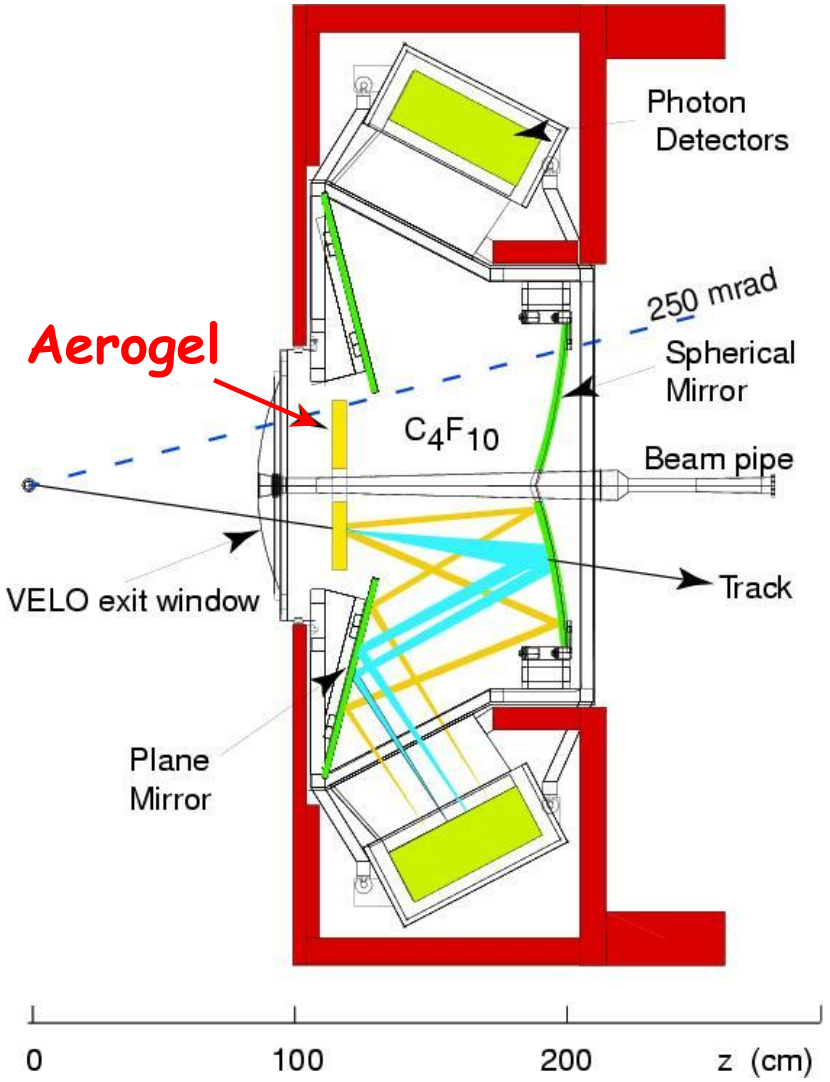
On behalf of the LHCb RICH group

The LHCb detector

Designed to study CP violation and rare decays of B-hadrons at LHC

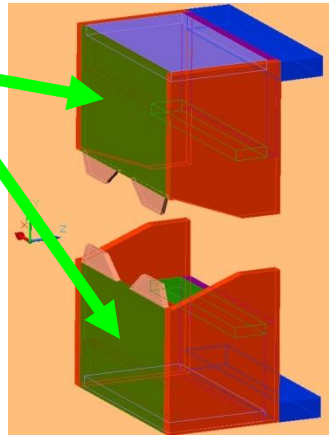
RICH 1


aerogel
RICH1
C4F10
CF4
RICH2
θ [mrad]
Momentum [GeV/c]
0
100
200
300
400
0
50
100
150
200


Photon Detectors
250 mrad
Spherical Mirror
Aerogel
C4F10
Beam pipe
VELO exit window
Track
Plane Mirror
0
100
200
z (cm)

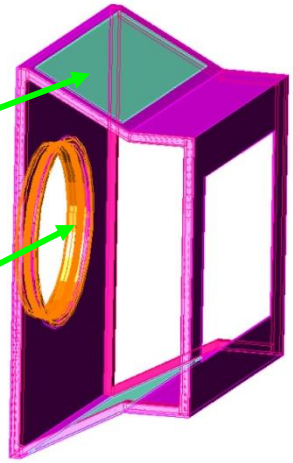
RICH 1 Mechanical Design - Overview

Magnetic shields
~8 tonnes of "Armco" iron

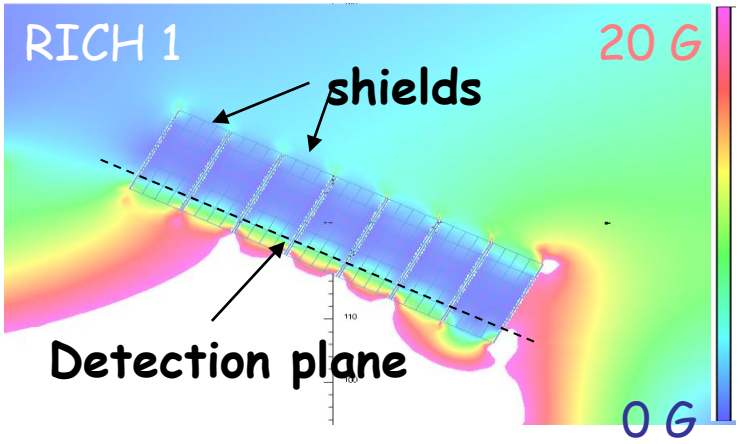


Quartz windows

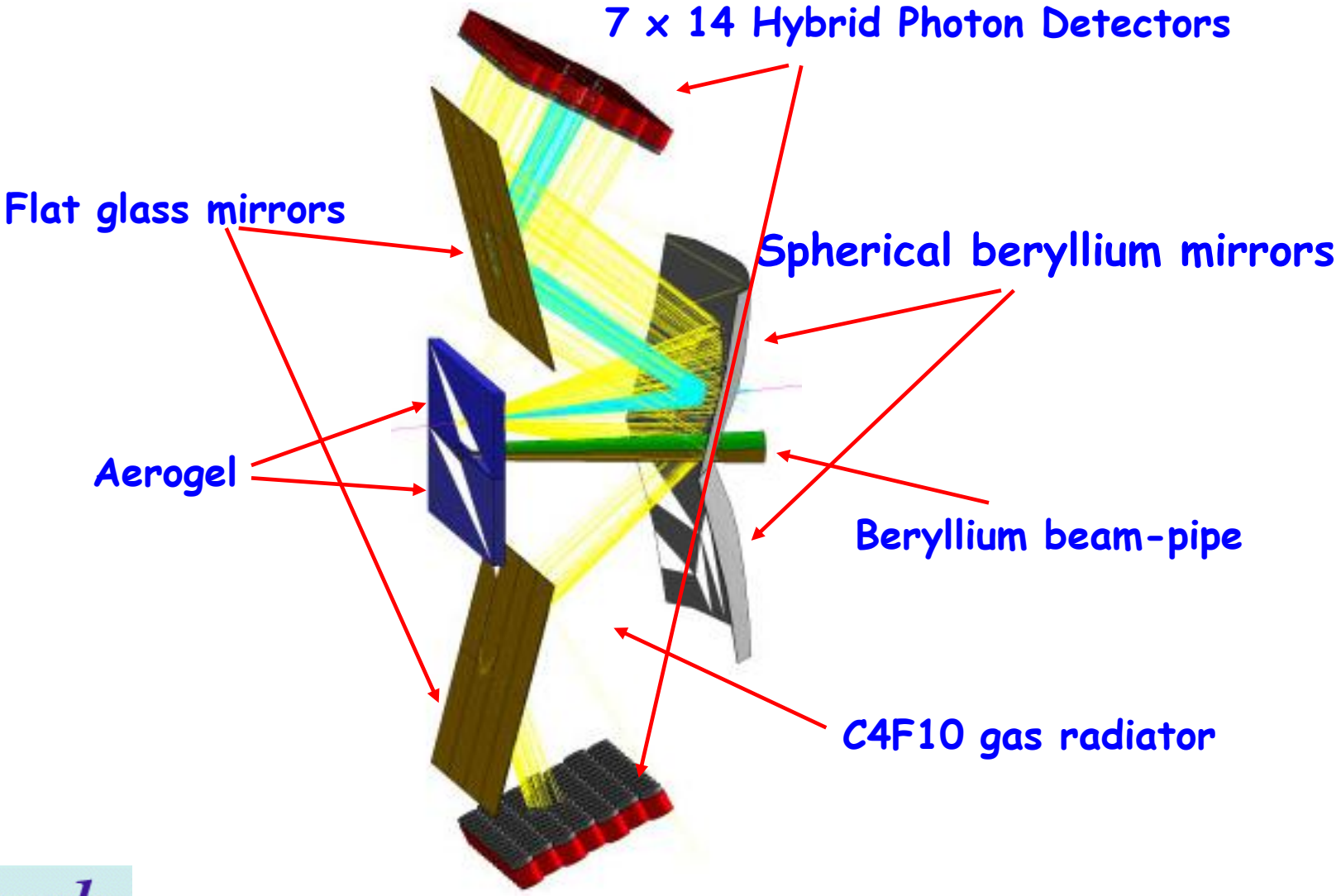
Seal directly to the
Vertex Locator exit window



Gas enclosure



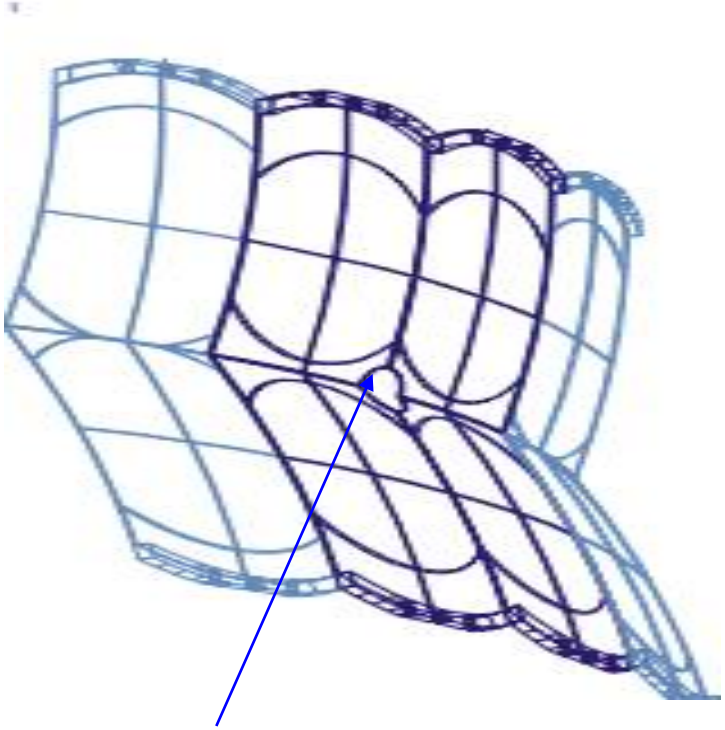
RICH 1 Optics



RICH 1 Mirrors

3mm thick Be base + 0.3mm glass surface layer coated with Al.

Radius curvature: 2700mm

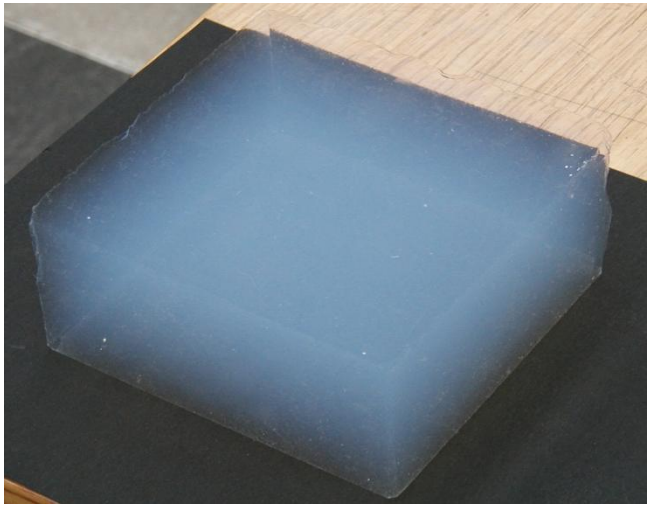


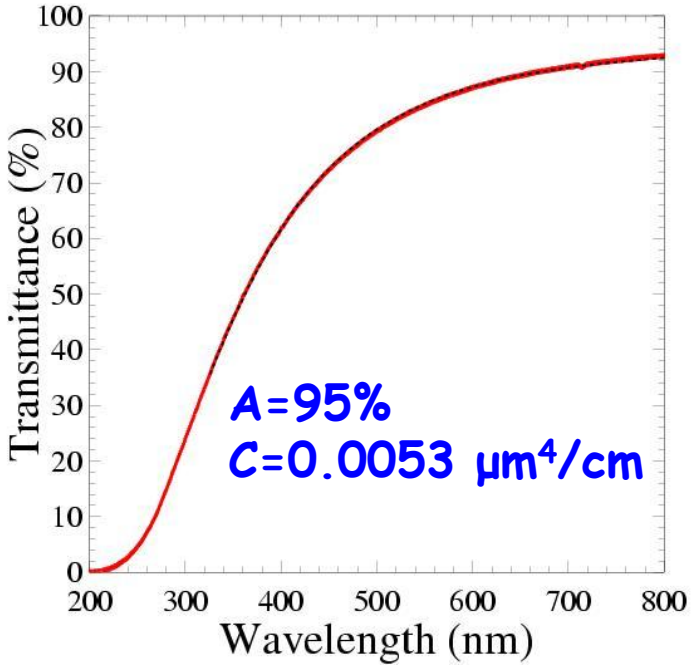
Beampipe hole

Beryllium blank

Aerogel I

linked network of SiO_2 particles
density = 0.15 g/cm^3
hygroscopic



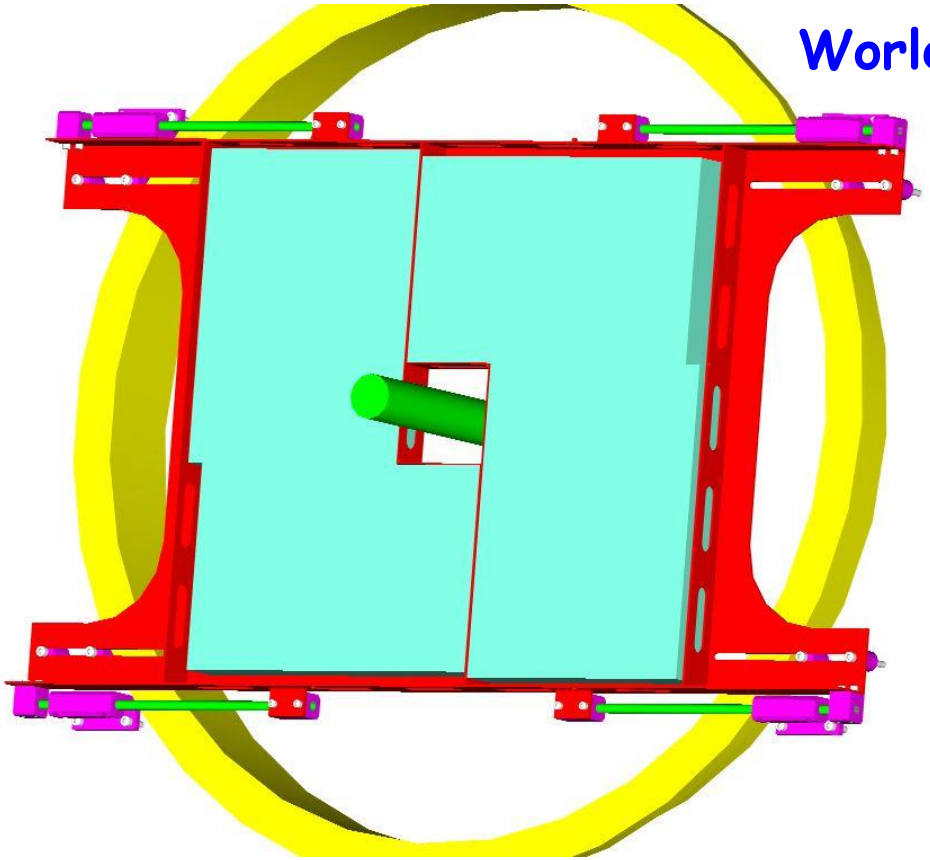


Transparent over a wide range: optical properties dominated by Rayleigh scattering:
Transmittance T, clarity factor C, surface scattering factor A, thickness t, wavelength λ

$$T = A e^{\left(-\frac{Ct}{\lambda^4}\right)}$$

Produced by the Boreskov Institute for Catalysis in Novosibirsk

Aerogel II

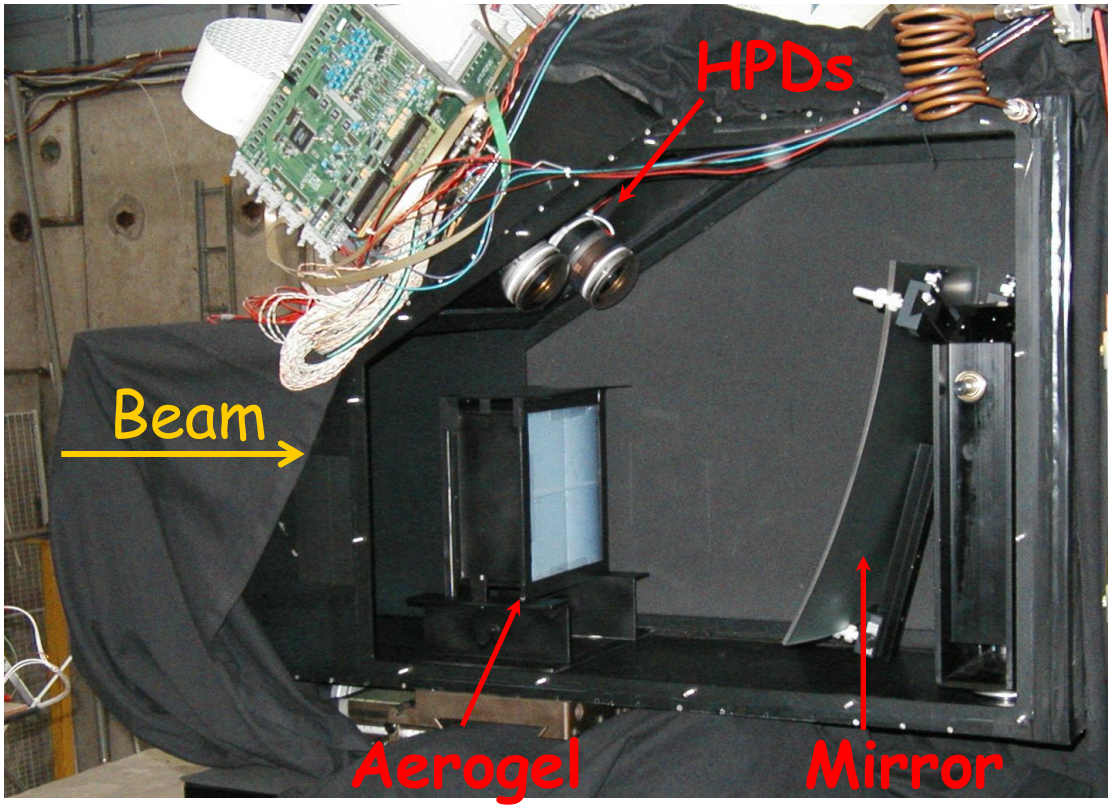


World-record 50 mm thickness and 200 mm transverse size

n = 1.030 ± 0.001
C=0.006 $\mu m^4/cm$
tested against:
radiation OK
C4F10 OK?

Pre-production OK –
4 liters inside specs

Testbeam I



Mirror curvature
R= 949 mm

Beam: PS-T9 10 GeV/c π^- (π^+, p)

Aerogel: 4 tiles 10x10x4.4 cm^3 n=1.028 C=0.0052 $\mu m^4/cm$

Testbeam II

Photon yield studies:

N_γ	HPD0	HPD1	HPD2
Data	1.19	1.00	0.86
MC	1.22	1.09	1.21

Scaling with acceptance to 2π :

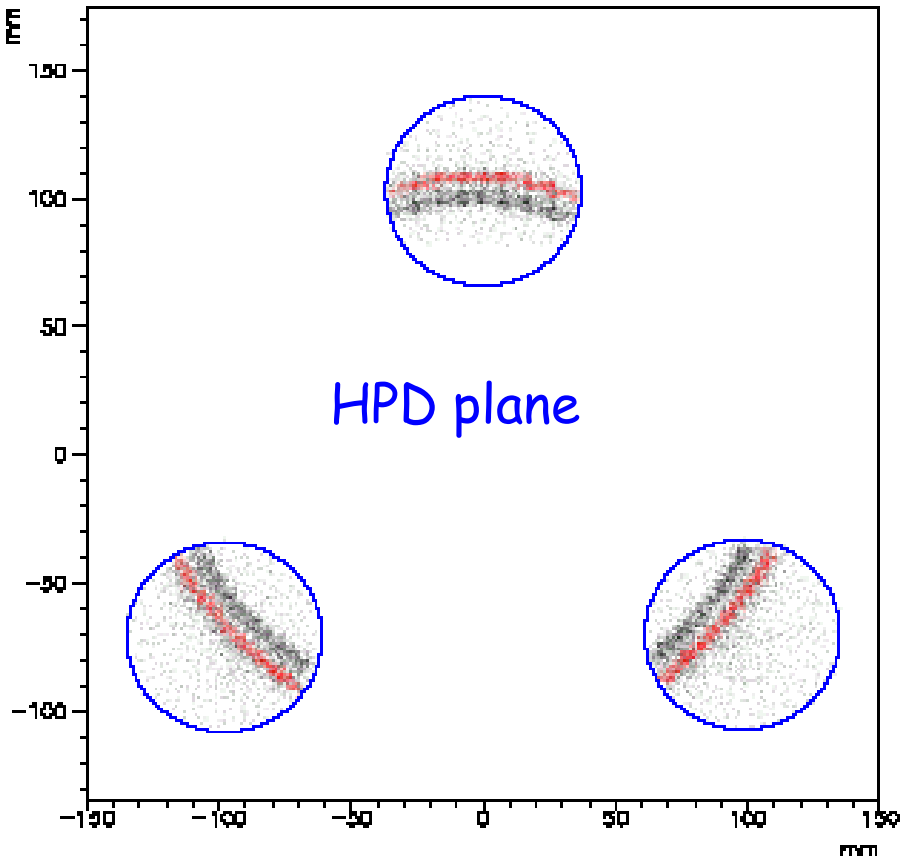
Data	11.7	9.3	9.1

Single photon resolution (mrad):

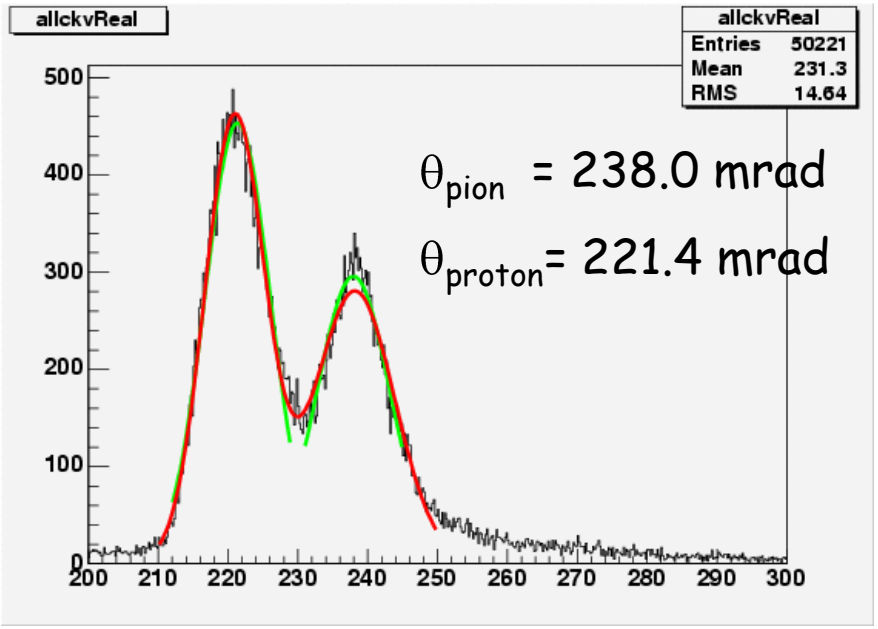
σ_θ	HPD0	HPD1	HPD2
Data	3.2	3.2	3.5
MC	2.4	2.4	2.4

Becomes 2.7 mrad scaled to RICH1 optics

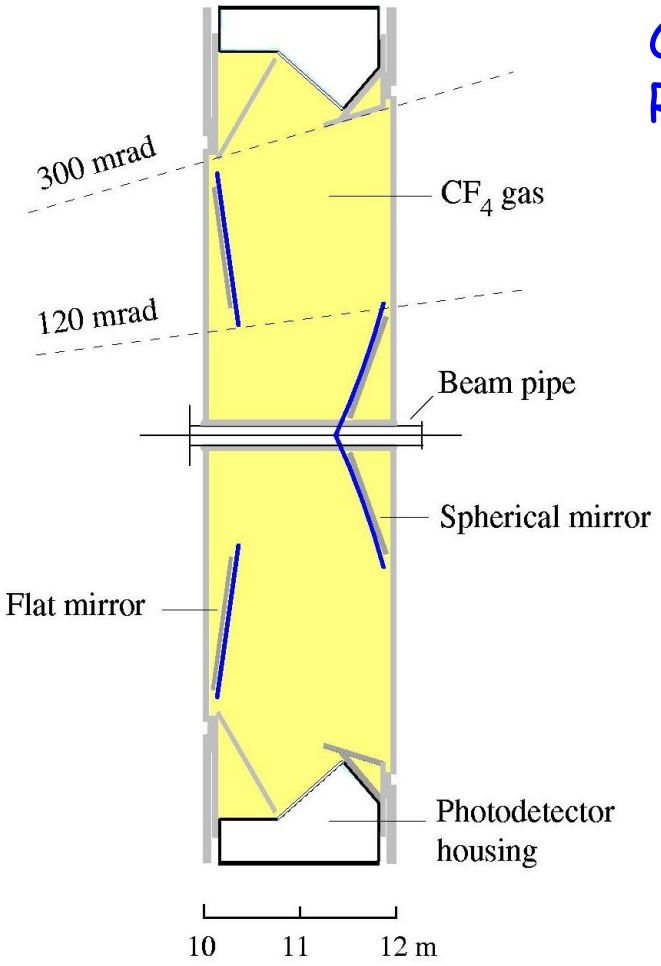
Testbeam III



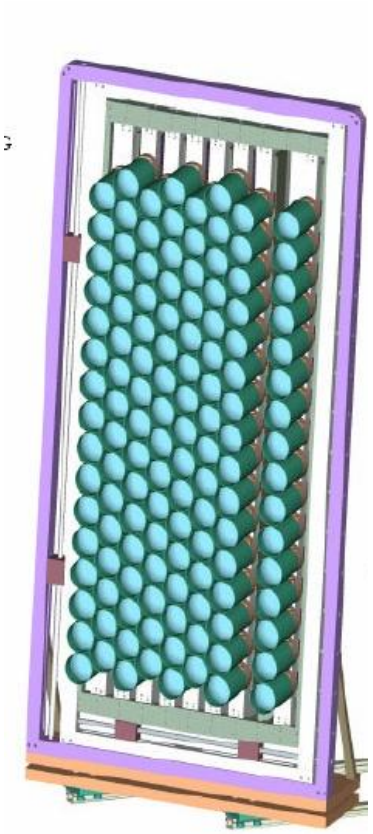
10 GeV/c π^+, p



RICH2 - software version

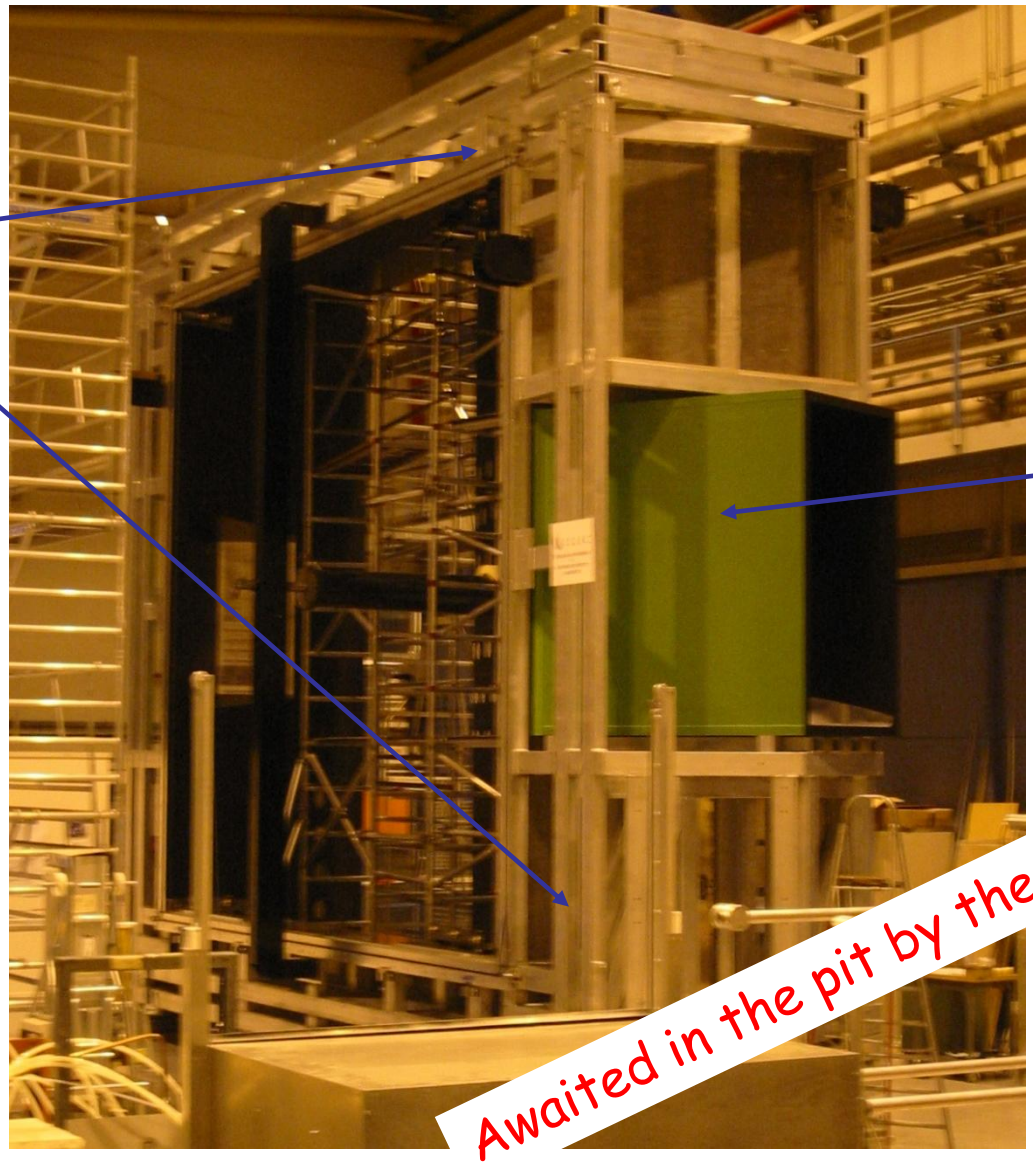


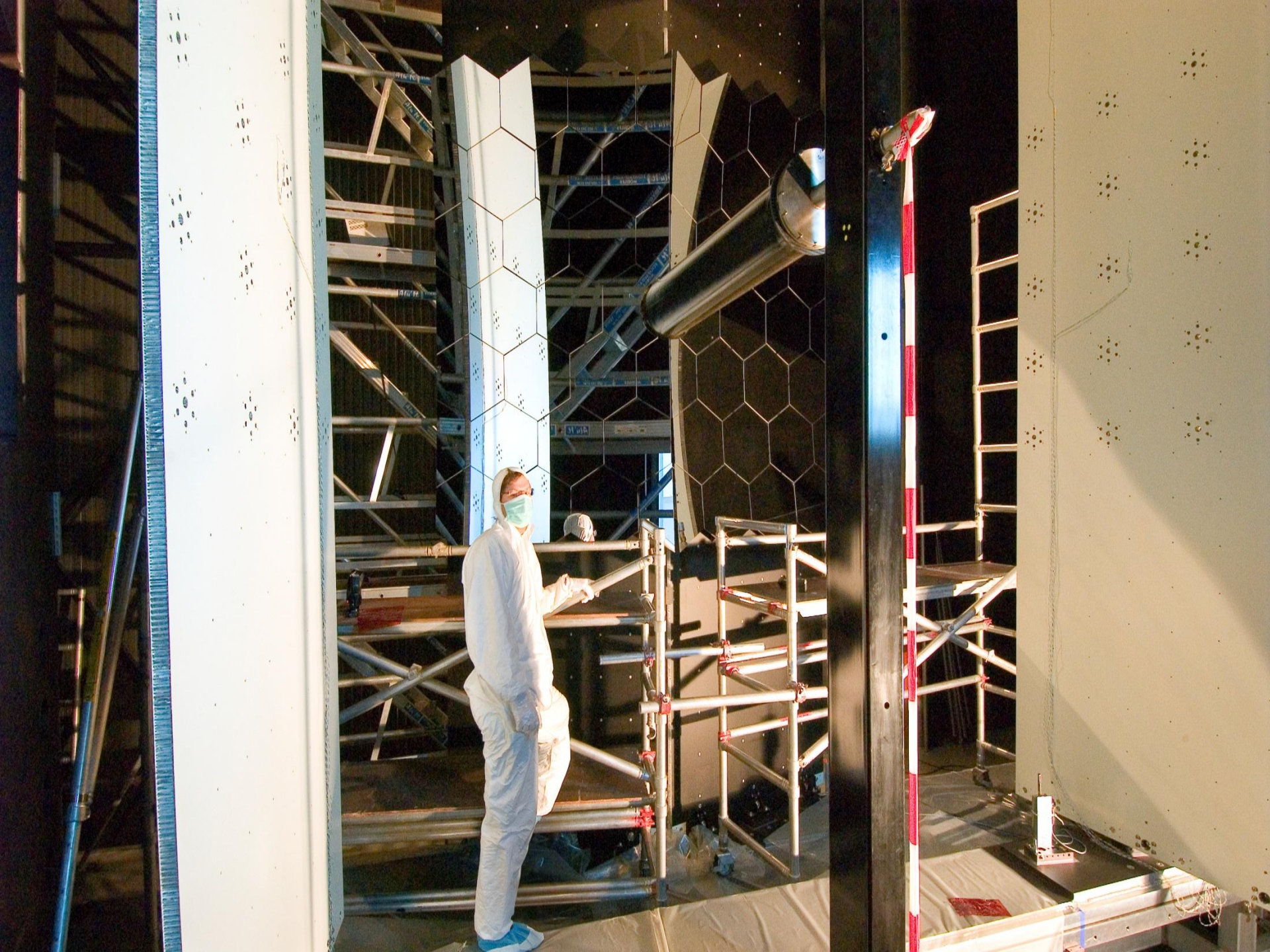
CF4 gas volume : ~100 m^3
Refractive index: n = 1.0005



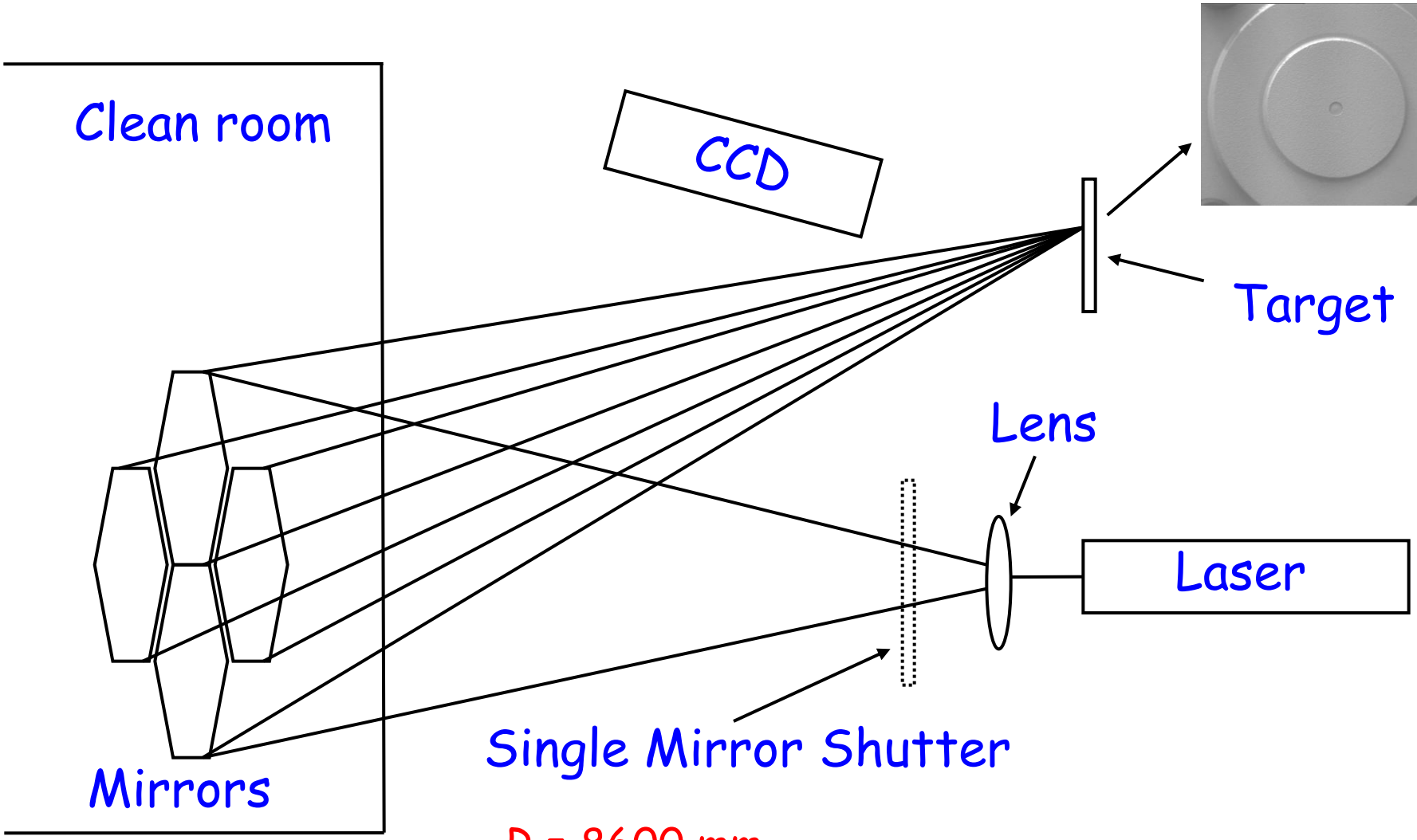
HPD plane:
9 columns,
16 tubes each

RICH 2 - hardware version



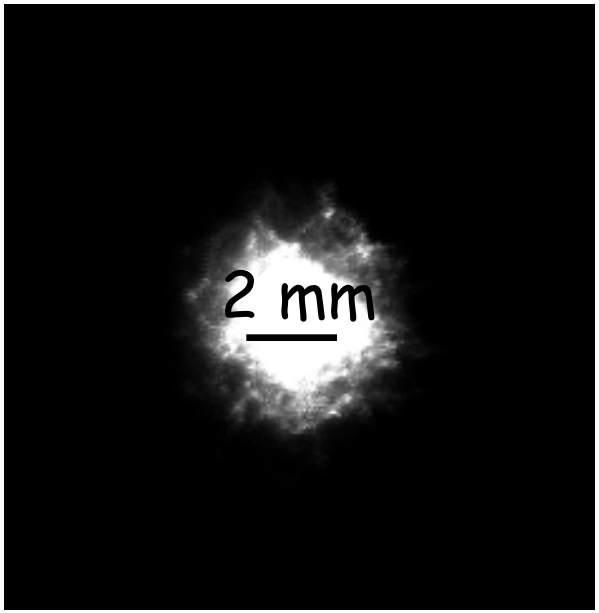


Alignment I


Clean room
CCD
Target
Lens
Laser
Single Mirror Shutter
Mirrors
R = 8600 mm

Spherical Mirrors Alignment

All mirrors from one side



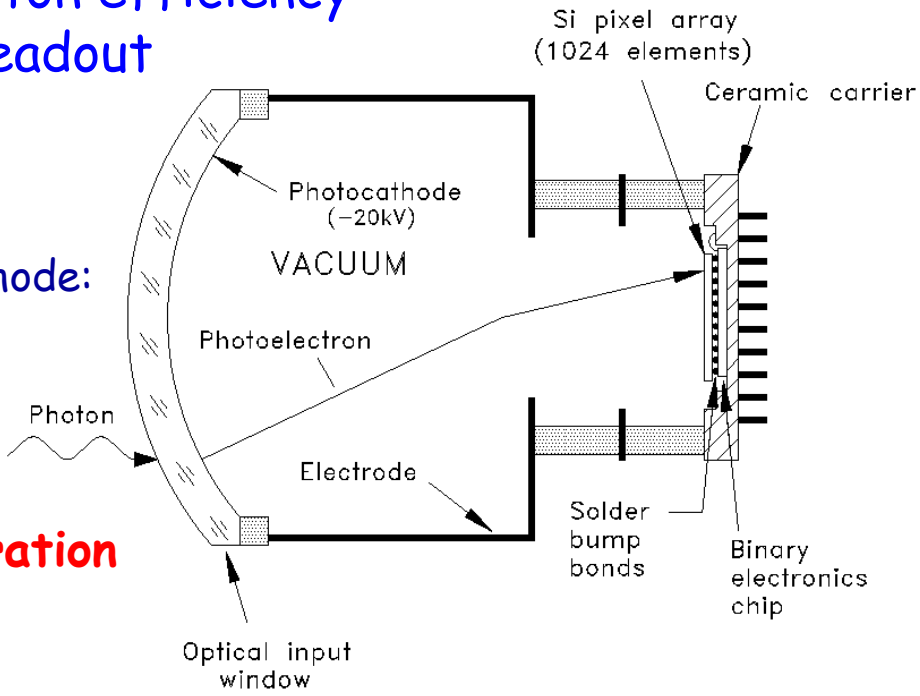
Alignment and stability set a 50 μrad contribution to the overall uncertainty in the single photon Cherenkov angle reconstruction

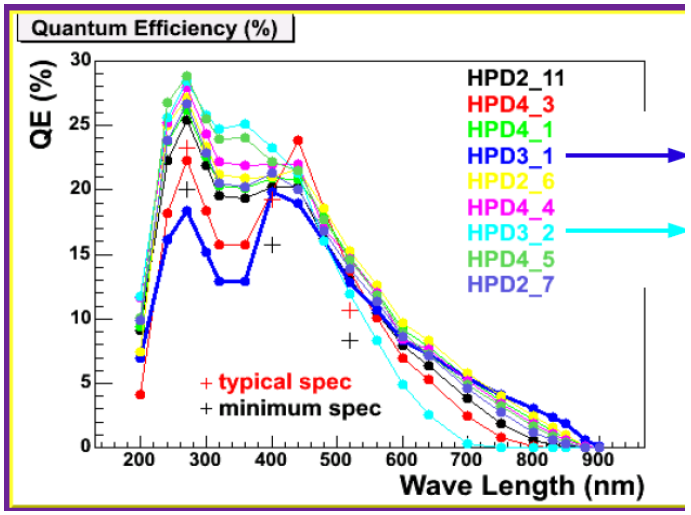
The Hybrid Photon Detector

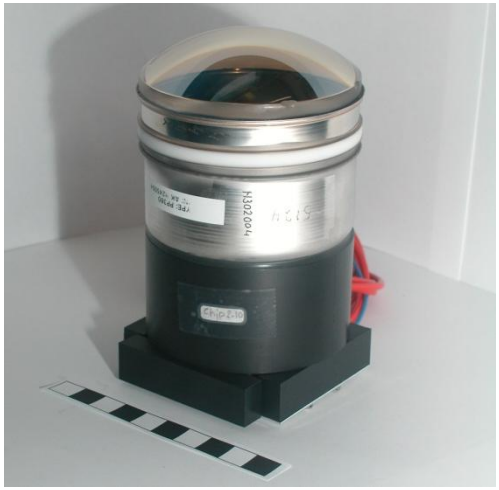
Requirements:
2.6 m² coverage with 75% active area
2.5 x 2.5 mm² granularity
Single photon efficiency
40 MHz readout

S20 photocathode: 75 mm Ø active

20 kV operation

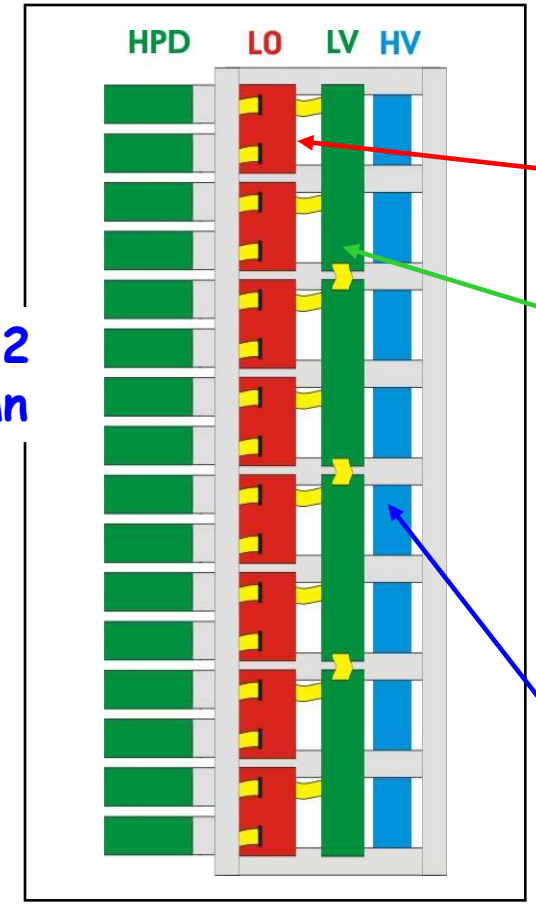




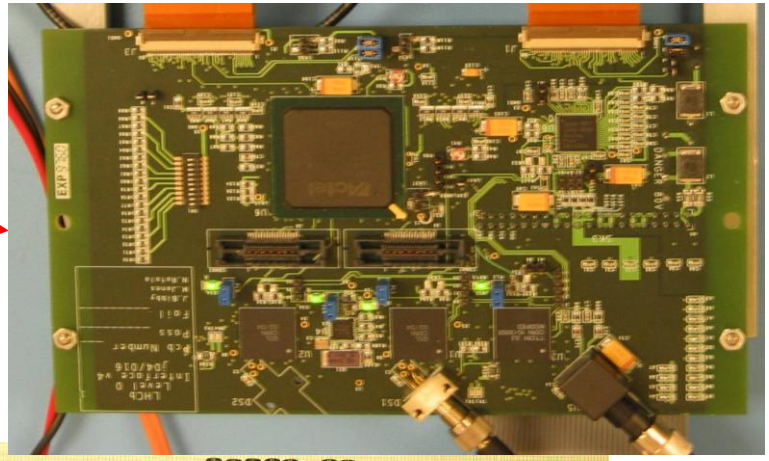


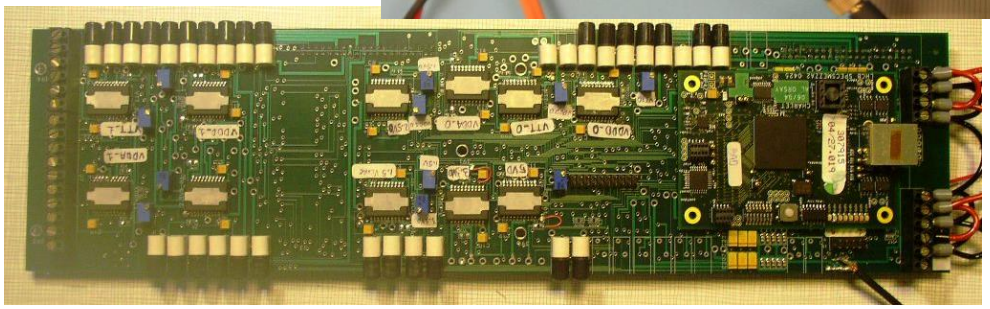
Developed by CERN/ DEP(NL) cross-focused , 83mm Ø, encapsulated binary electronics 32 x 32 pixels (500 µm x 500 µm).

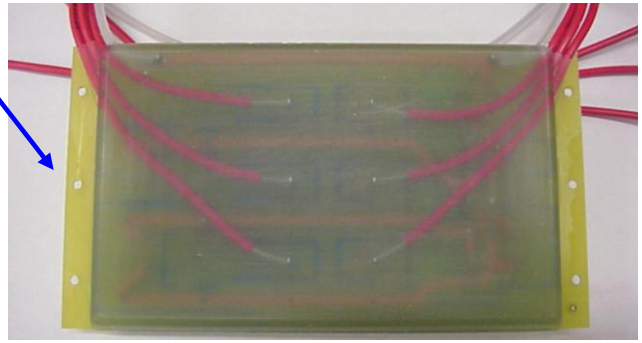
The HPD - II



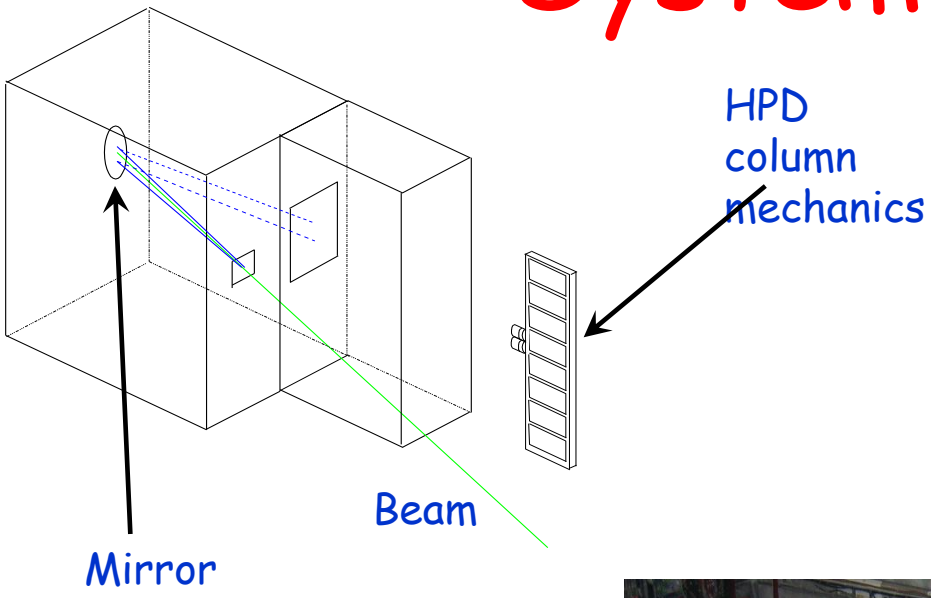
RICH2 column

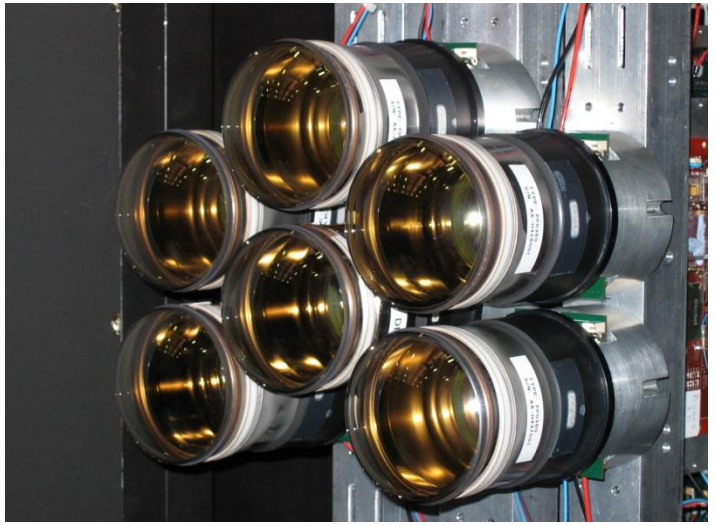


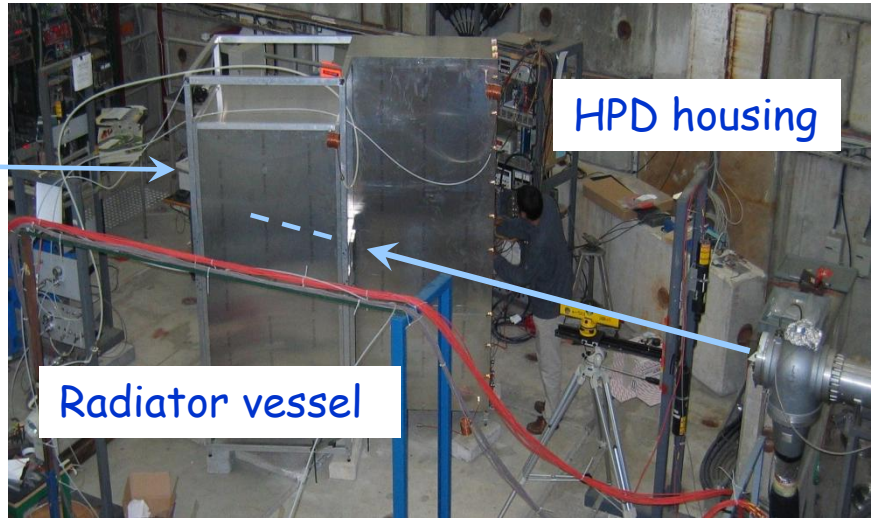




System Test I





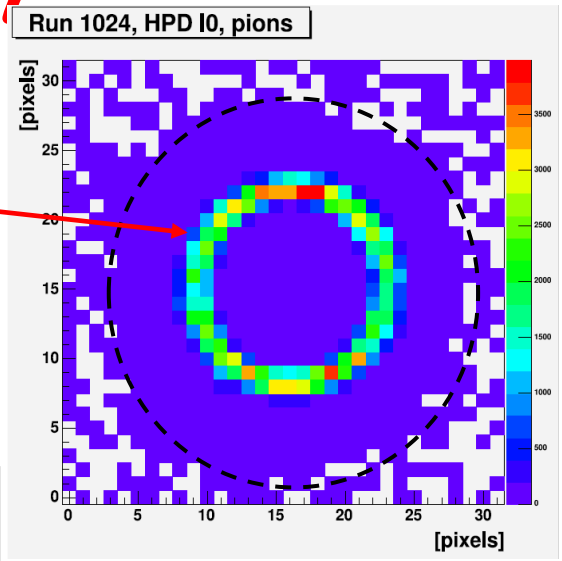


PS beam:

10 Gev/c π^- e^-

System Test II

N2 run, one HPD accumulated rings



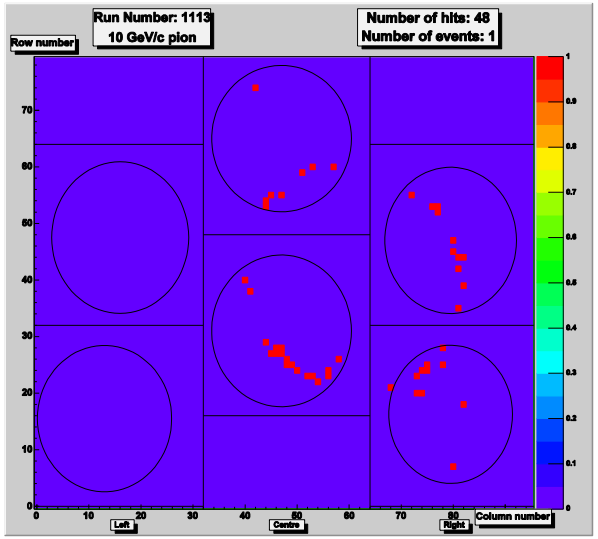
3500

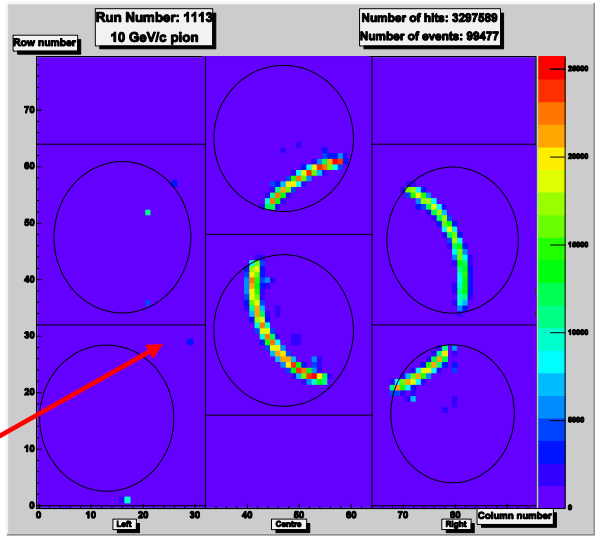
0

C4F10 run, ring on four HPDs.

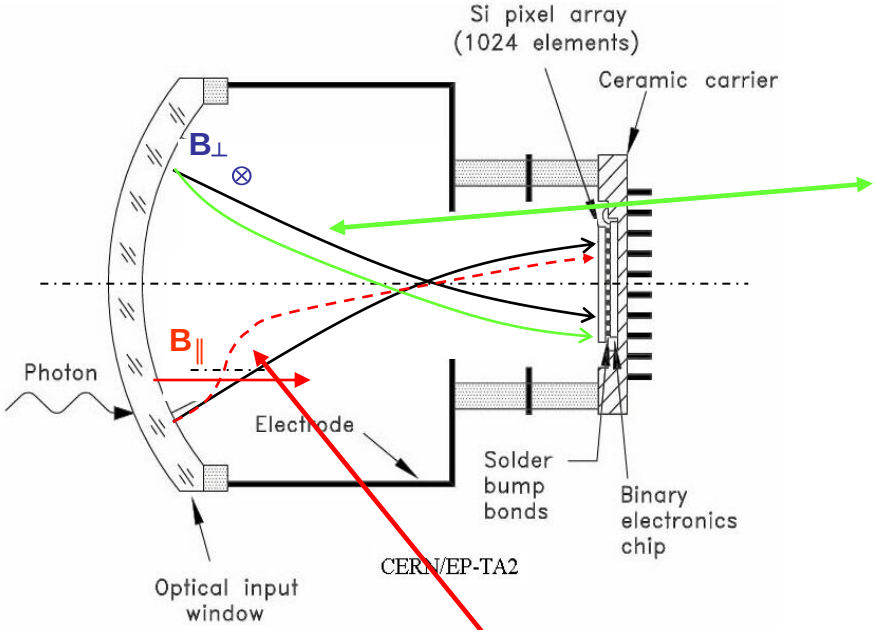
single event

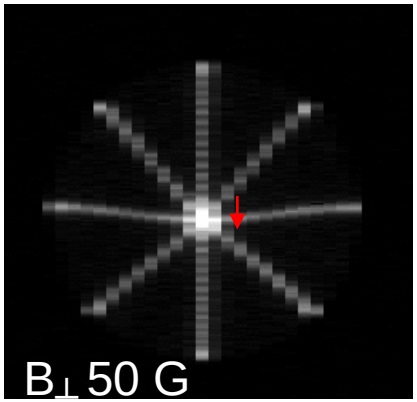
accumulated rings

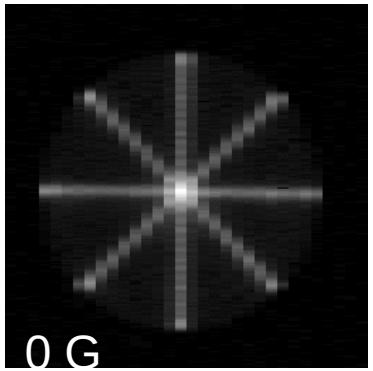


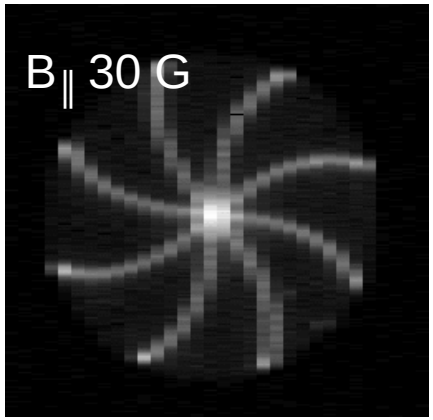


Magnetic distortions…







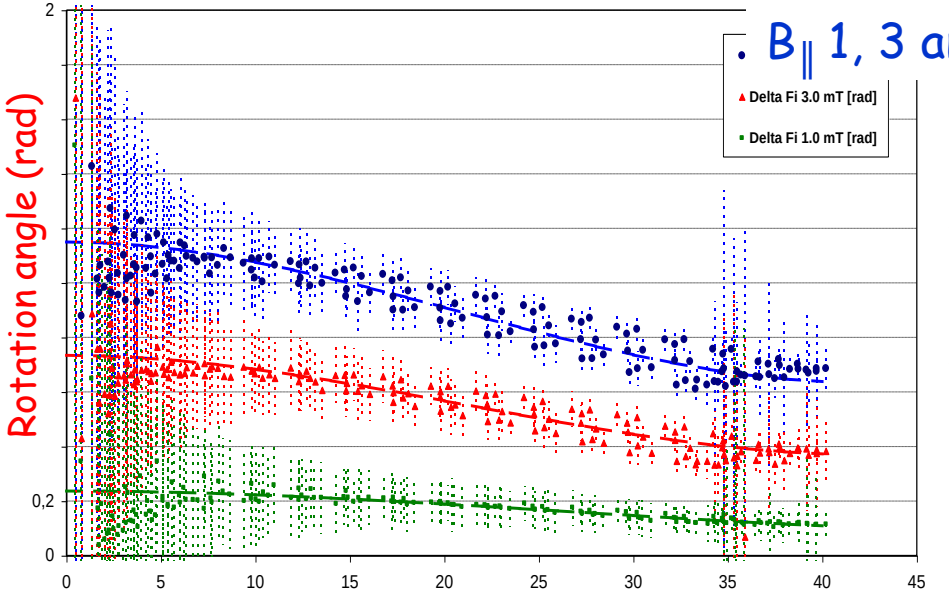


...and corrections

Calibration and distortion monitoring system in both RICHes to allow corrections

Non uniform rotation (S-distortion)
Third order polynomial fit

Image rotation vs radius of entrance point

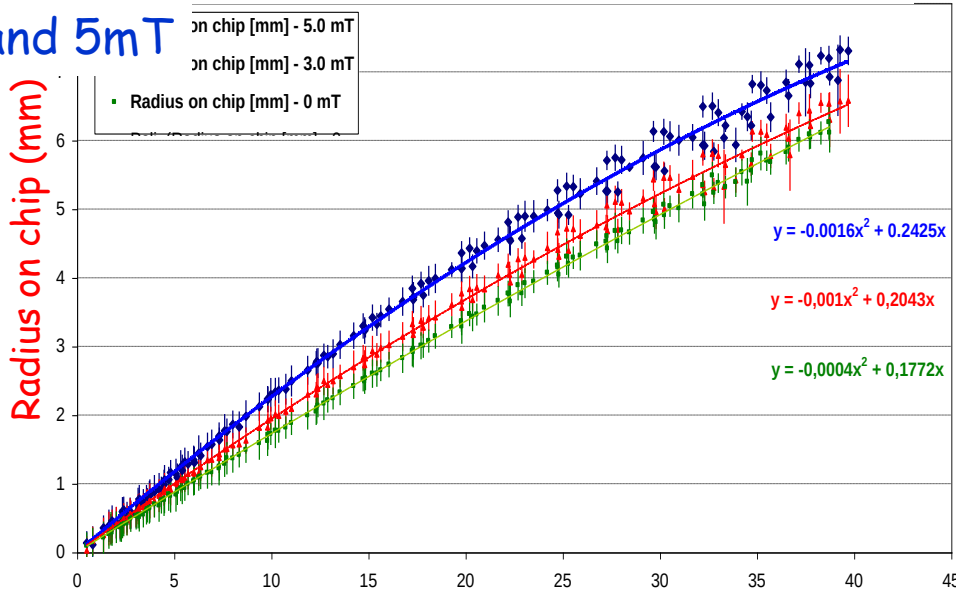


Entrance plane radius (mm)

- $B_{\parallel}$ 1, 3 and 5mT

Non uniform radial dilatation
Second order polynomial fit

Radius on chip vs radius of entrance point



Entrance plane radius (mm)

Parameterisation under control for both axial and transverse field distortions

Conclusions

- The RICH project is healthy and advanced
- Construction is under way - almost over for RICH2
- The photon detector is understood in both detection issues and data-flow
- Eager for first collisions in 2007