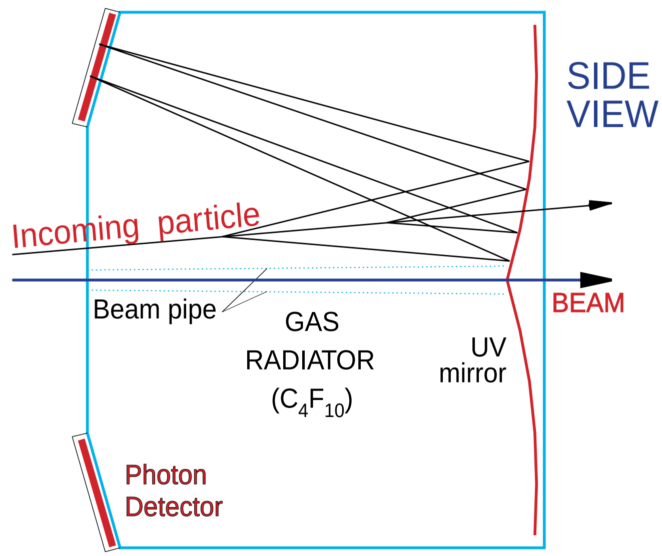
COMPASS RICH-1
Parameters I

Main requests from the experiment:

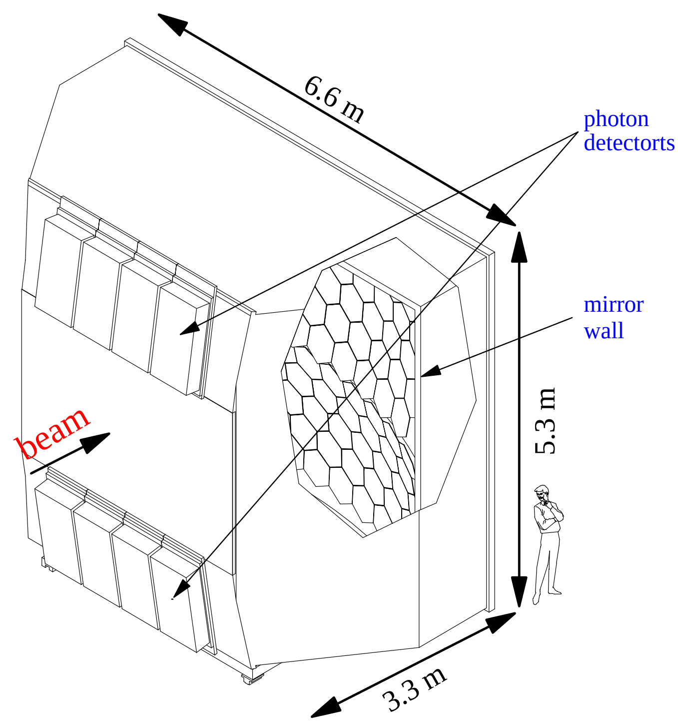
1. π/K separation up to ~ 60 GeV/c
2. Large angular acceptance:
   ± 250 mrad (H), ± 200 mrad (V)
3. Minimize materials

RICH1



Design:

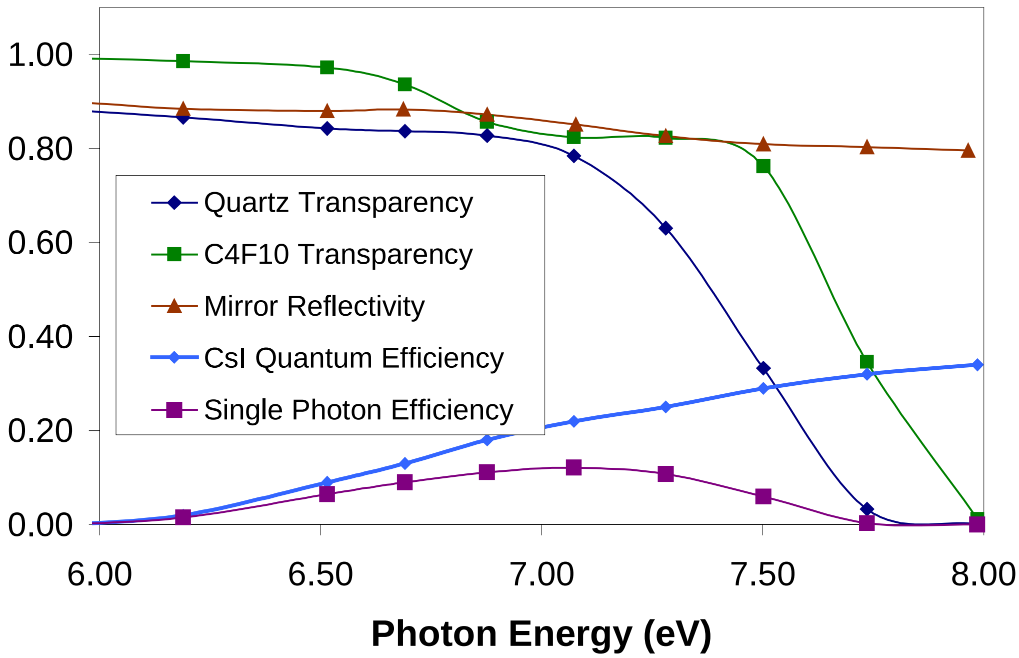
- Radiator: C_4F_{10}, length: ~ 3m
- Mirrors:
  Spherical, focal length 3.3 m
  Reflectance > 80% for λ > 165nm
  Total surface 5.3×4 m
- Photon detectors: MWPC's with CsI photocathodes, out of spectrometer acceptance
  Total surface 5.3 m^2
- Read-out electronics:
  Analog read-out
  83 K channels
  average occupancy 5%
  max data rate 2.5 Gb/sec in spill



Material Budget:

• Gas radiator C4F10	10.5%	X_0
• Mirrors	5.5%	
• Up/Downstream window	2.0/2.2%	
• Mirror mechanics	2.3%	
• Total	**22.5%**	**X_0**
• Total (Beam Line)	**1.6%**	

COMPASS RICH-1
Parameters II



Contribution to Δn:

- Chromatic Dispersion: $\frac{\Delta n}{(n-1)} = \pm 1.2\%$
- C4F10 weight $\frac{\Delta n}{(n-1)} = \pm 0.25\%$
- ΔT within the vessel:

$$0.1\ \text{Deg.} \Rightarrow \frac{\Delta n}{(n-1)} = \pm 0.02\%$$

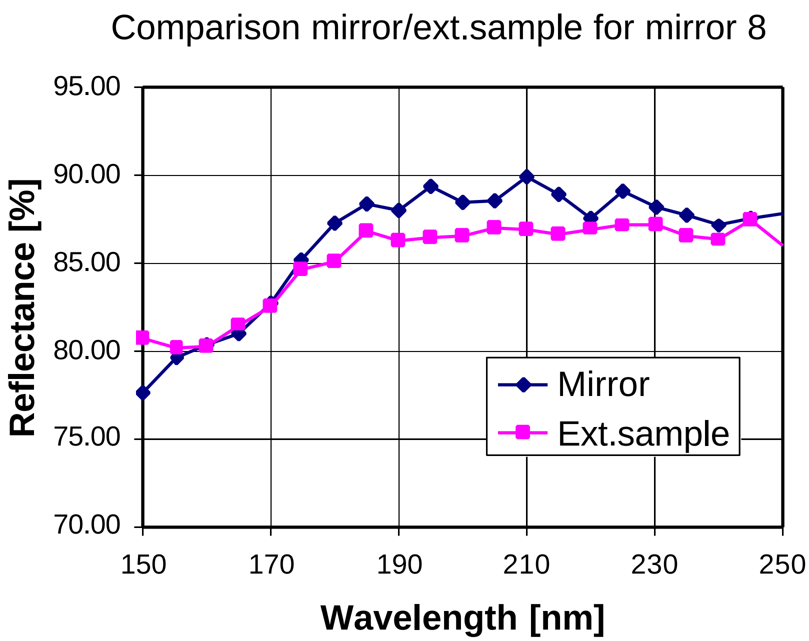
$$1.0\ \text{Deg.} \Rightarrow \frac{\Delta n}{(n-1)} = \pm 0.2\%$$

$$5.0\ \text{Deg.} \Rightarrow \frac{\Delta n}{(n-1)} = \pm 1.00\%$$

→Vessel Thermalized to keep $\Delta T \leq 1$ Deg.

Mirrors and Mirrors Support

Measured by using CERN Reflectometer (CERN/EP/TA1)



Spherical, focal length 3.3 m

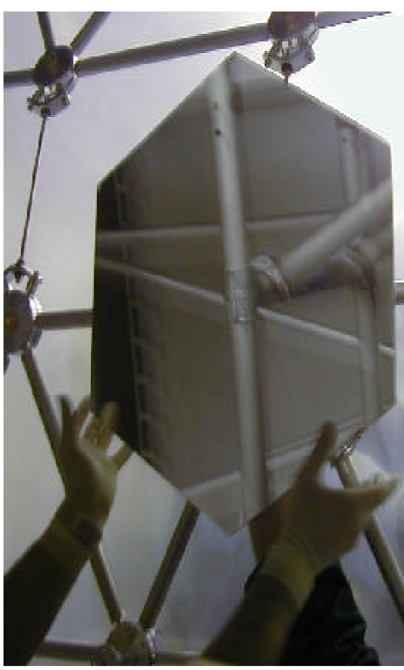
Total surface $5.6 \times 4\ m^2$

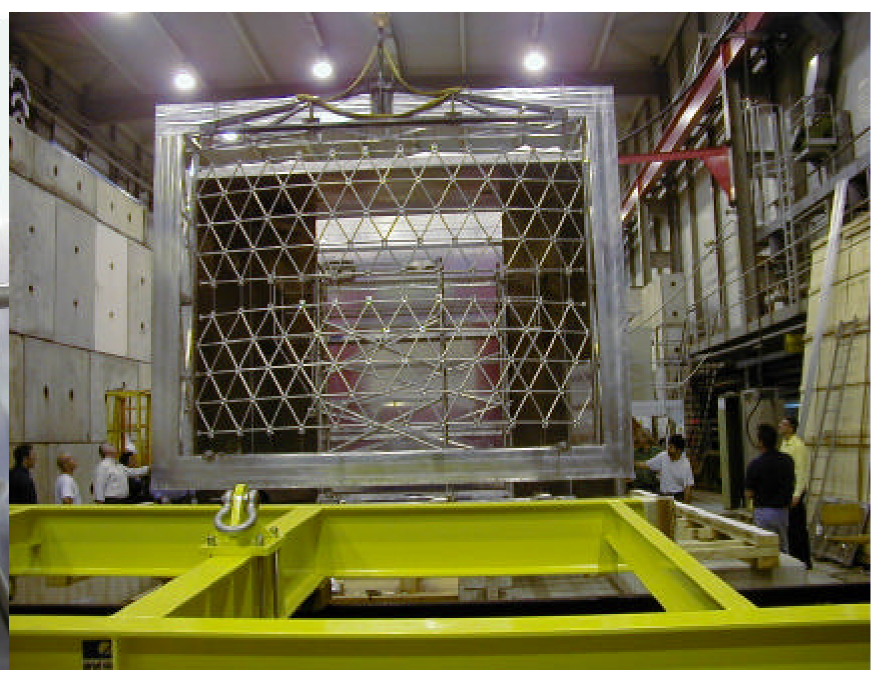
Large size: hexagons 52 cm diameter

Good reflectivity down to λ~165 nm

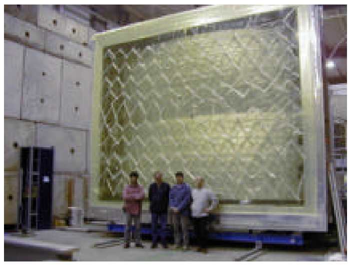
Good roughness
Figure: r.m.s. 1.6 nm

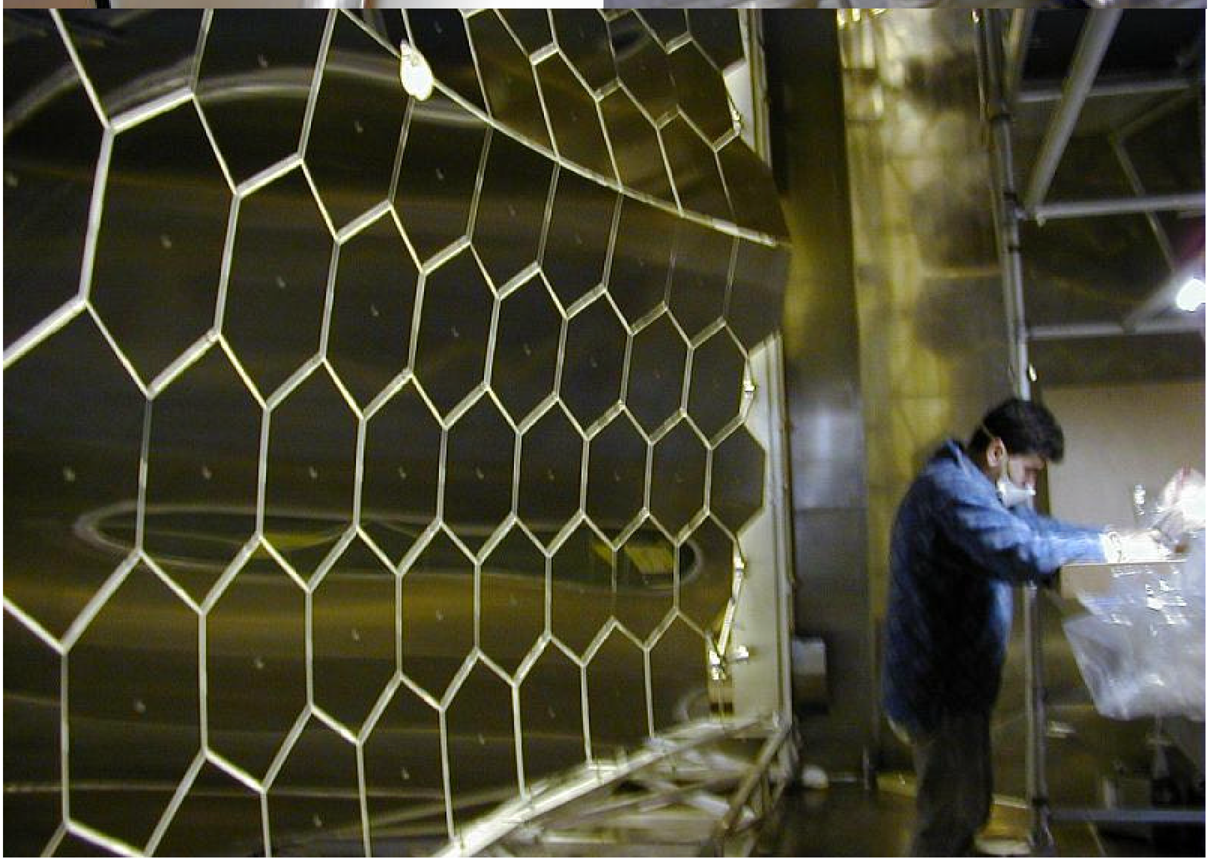
Coating: Al (~80 nm)



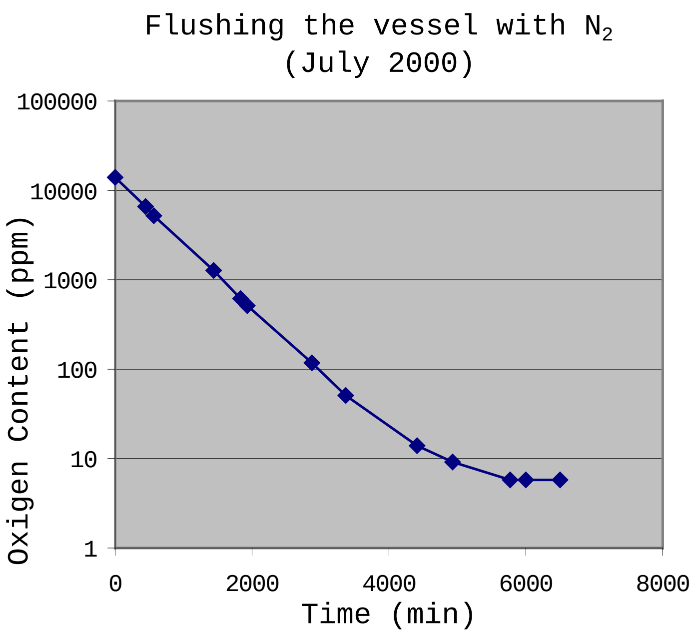


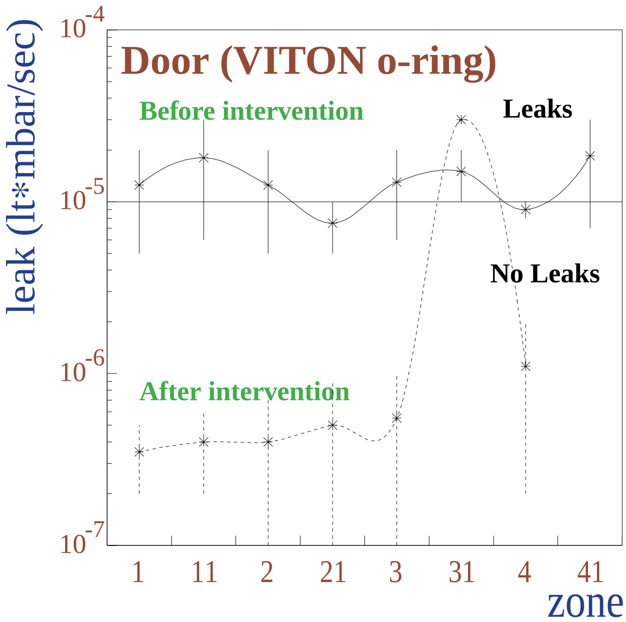
2001 Mirror Mounting



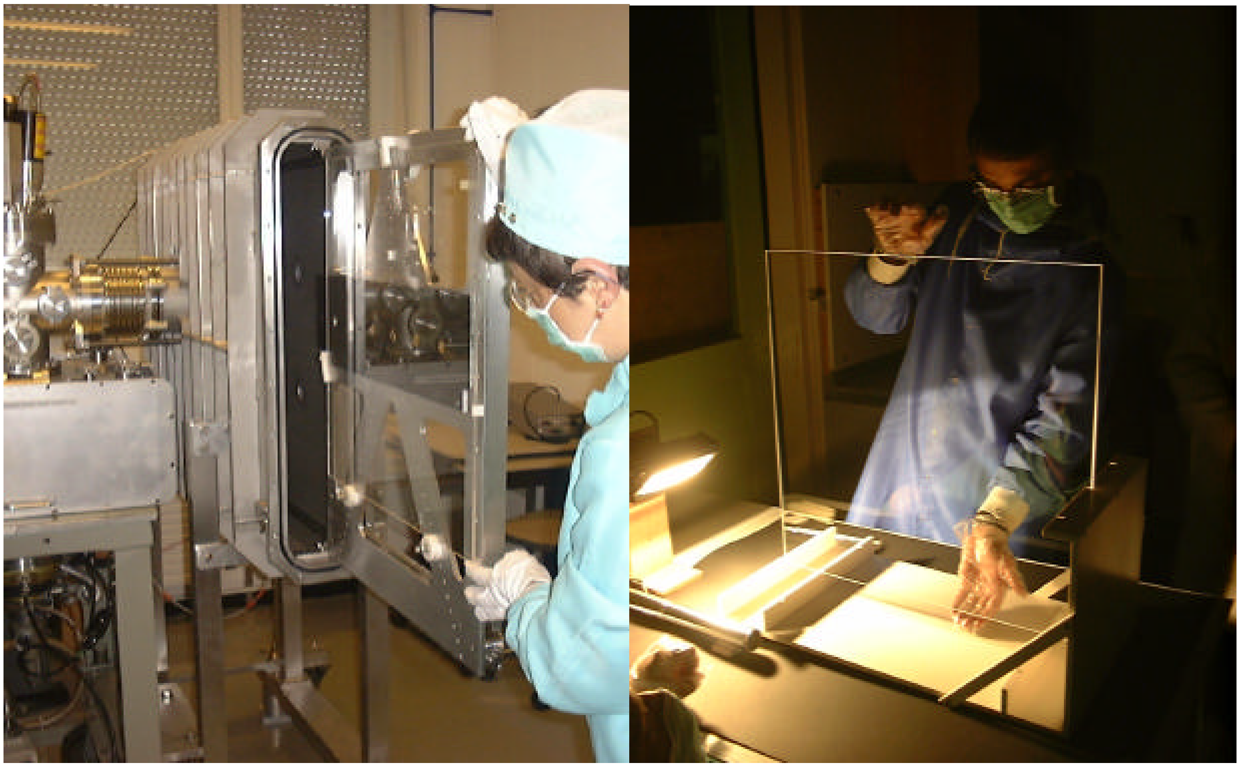


Vessel: Installation
Leak test

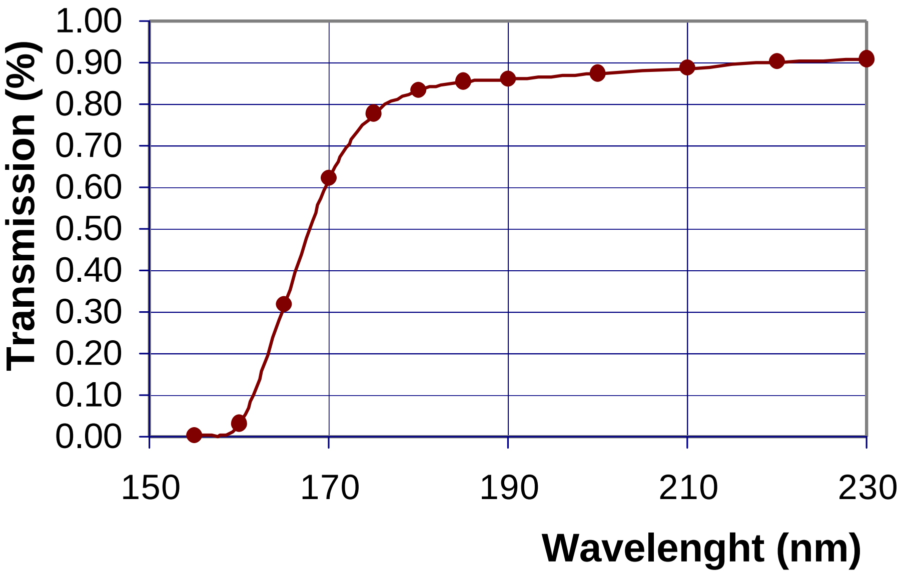




Quartz Windows Transparency

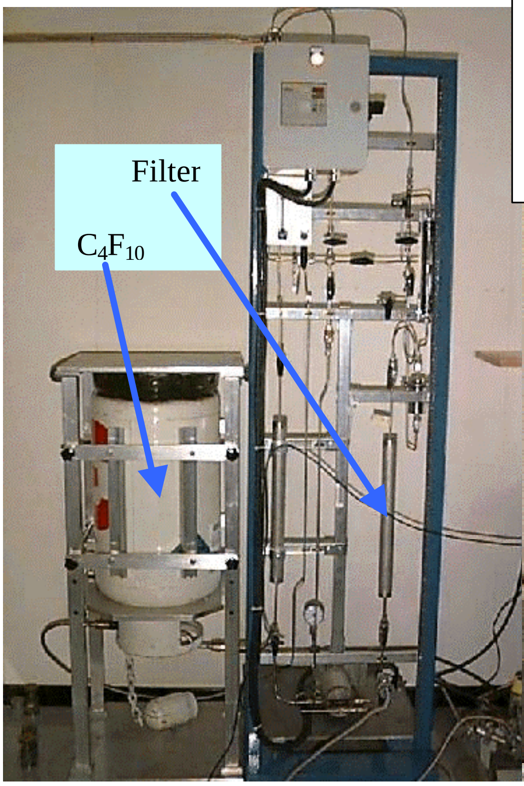


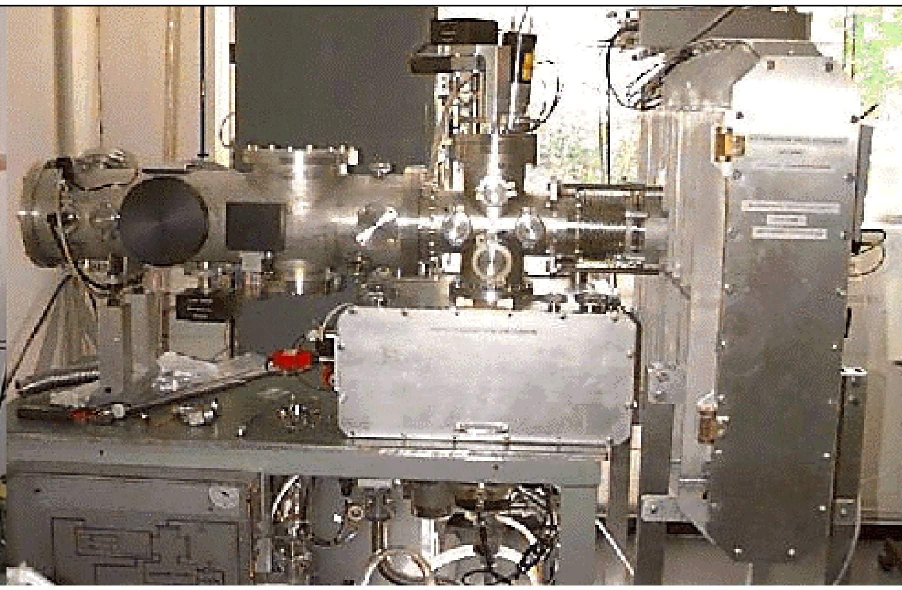
Quartz n. 14



Gas Radiator:
C_4F_{10} Pre Cleaning Set-Up

The Pre Cleaning installation allows for an on-line measurement of the C_4F_{10} transparency by using the cell installed in the reflectometer setup, and connected with the cleaning system.
Filters used for the cleaning: Copper
Active Carbon





1.5 tons of C_4F_{10} (i.e. 20 bottles of 50 l each)

The measurement of the initial transparency shows two categories of bottles:

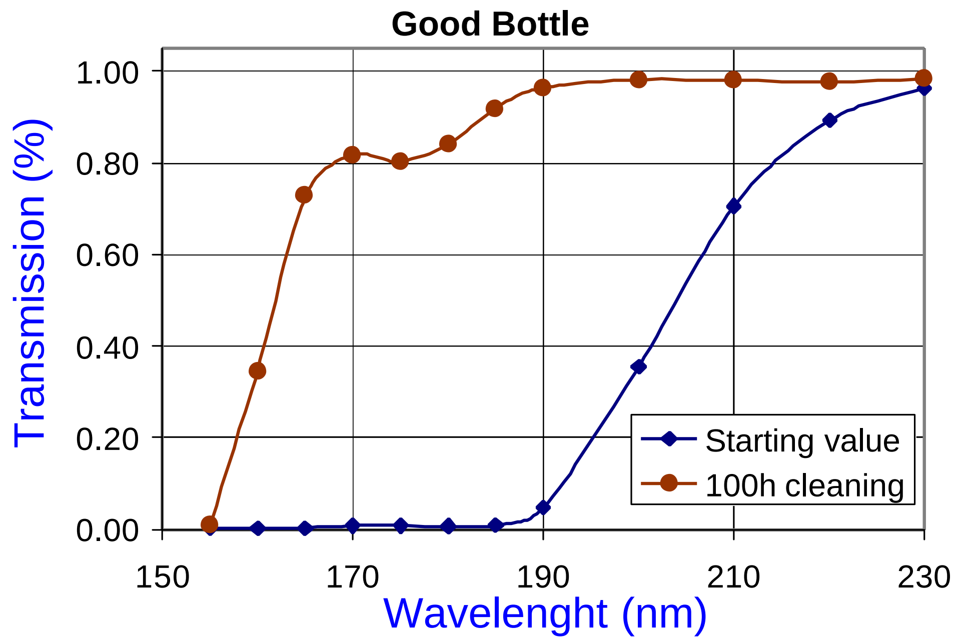
- 9 “Good Bottles” with a transparency of >95% @ 230nm
  Pre Cleaning OK ~ 1 week; 7% material loss

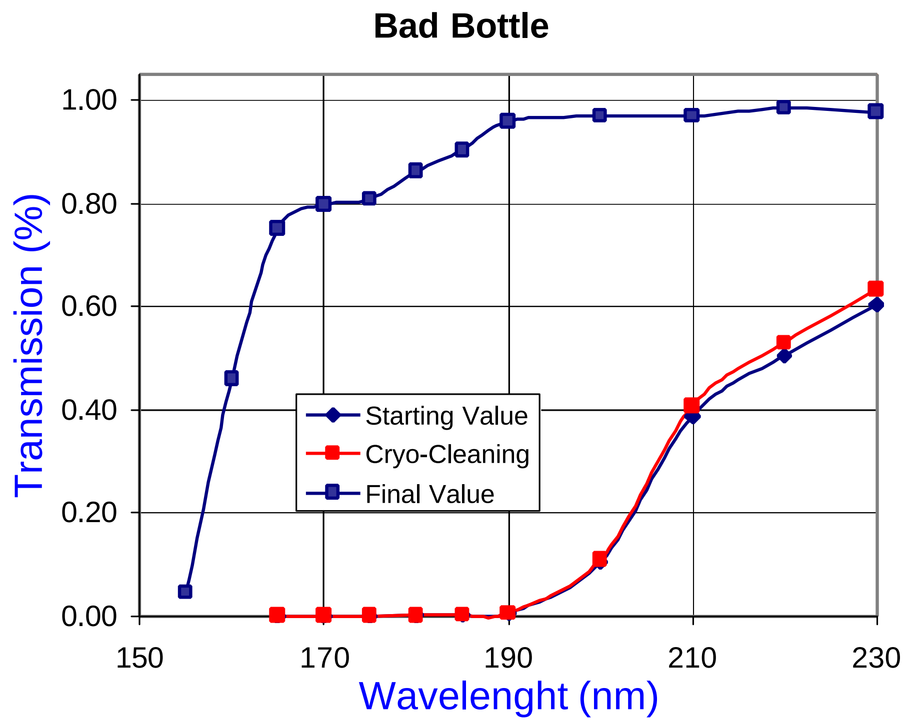
- 11 “Bad Bottles” with a transparency of <70% @ 230nm probably due to a high contamination of Air (several percents)
  Pre Cleaning OK but several weeks needed and 50% of material loss
  Need of Cryogenic Cleaning to remove O_2 before starting the standard filtering procedure

The Cryogenic cleaning uses the temperature window in which the C_4F_{10} is in the liquid phase (at atmospheric pressure) while the O_2 is still gaseous to remove the it from the bottle. One day (~8h) of cryo-cleaning allows a factor 10÷40 of O_2 reduction.

Gas Radiator II:
C_4F_{10} Cleaning Results

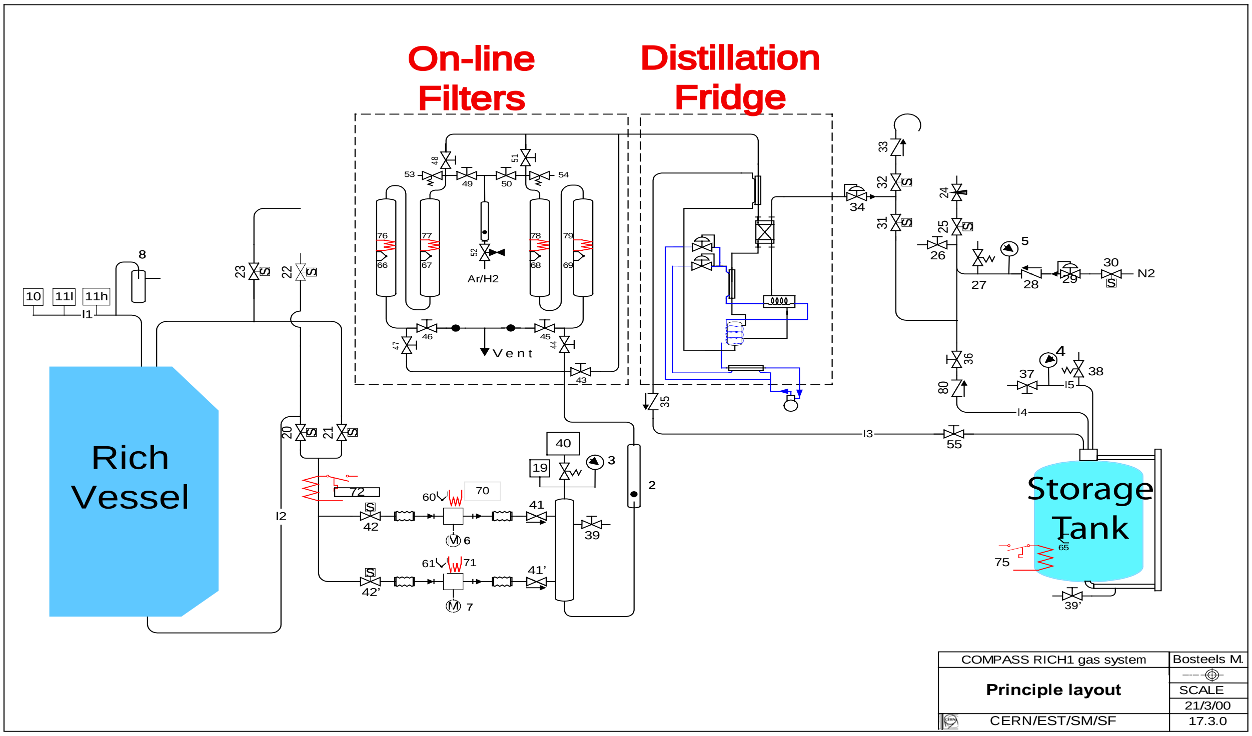
Transparency measured over 5 cm of C_4F_{10} in liquid phase (~7m of gas) scaled to 5m of gas (mean photon path length in the vessel)

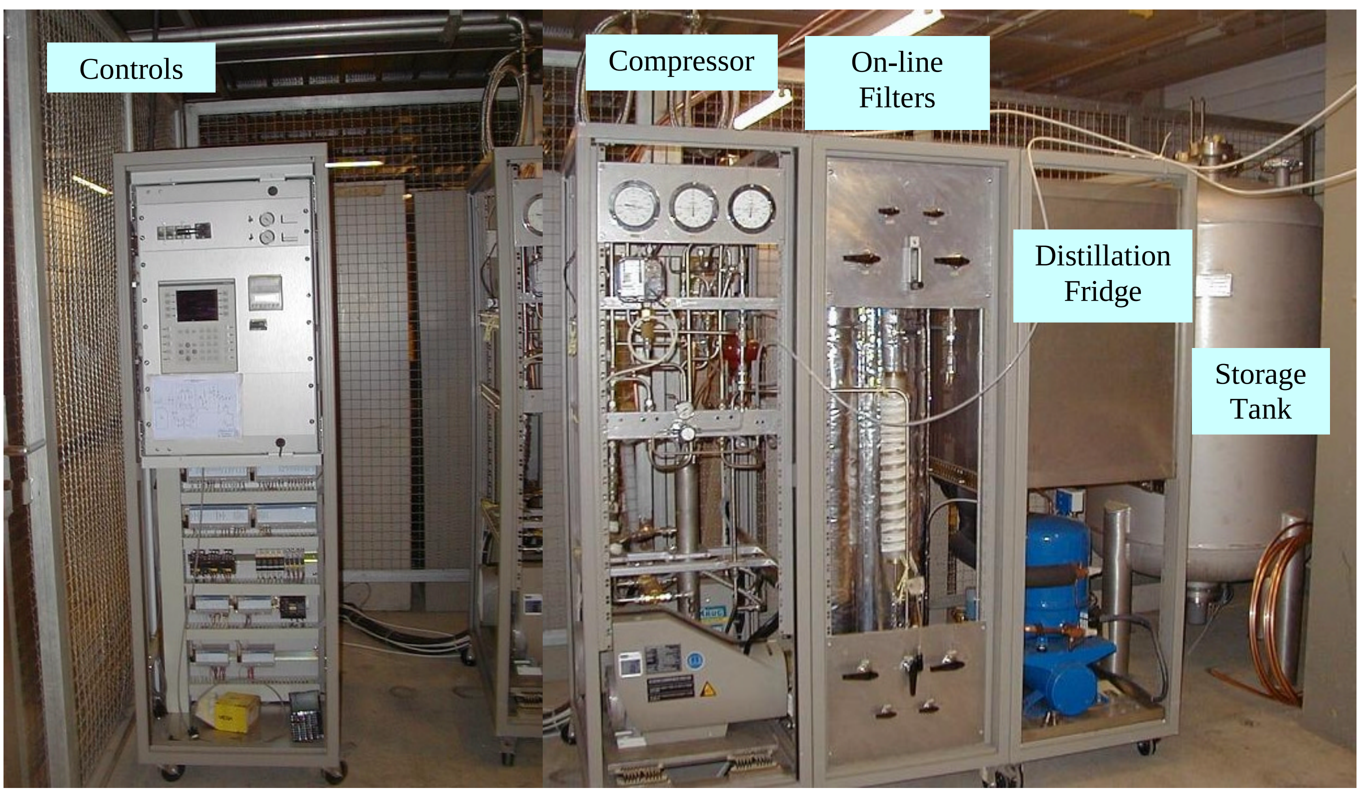




Gas Radiator
C_4F_{10} Gas System

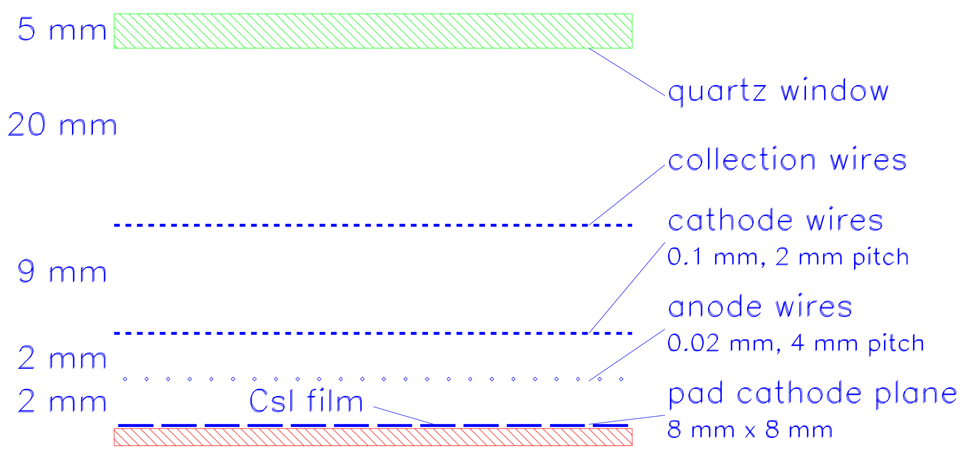
Project and Construction: CERN/ST/CV

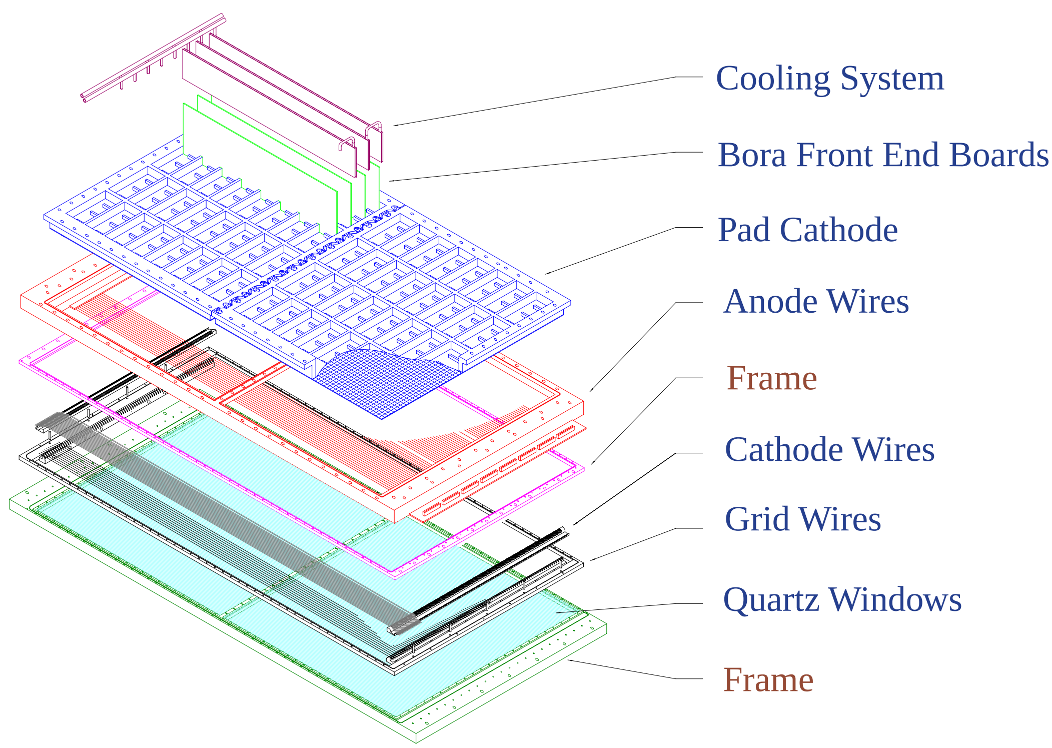




Photon Detectors I:
Working principle

Basic Geometry: RD26



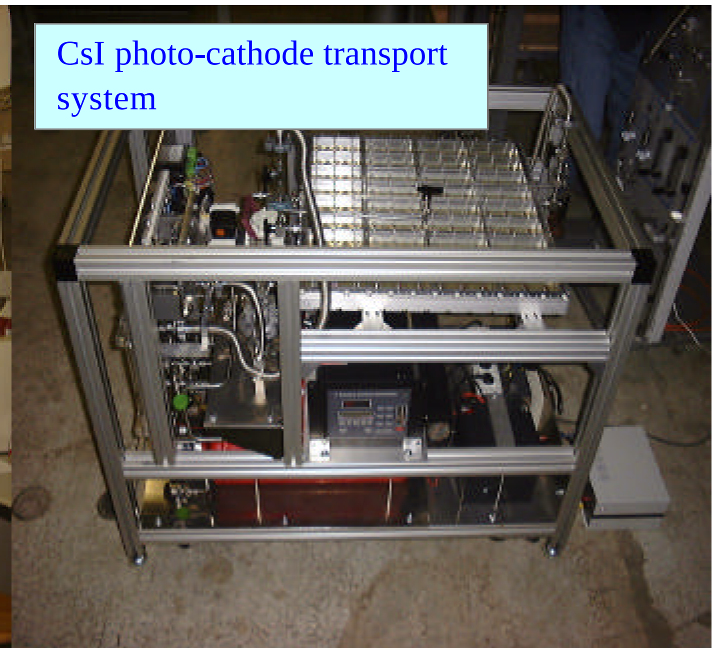


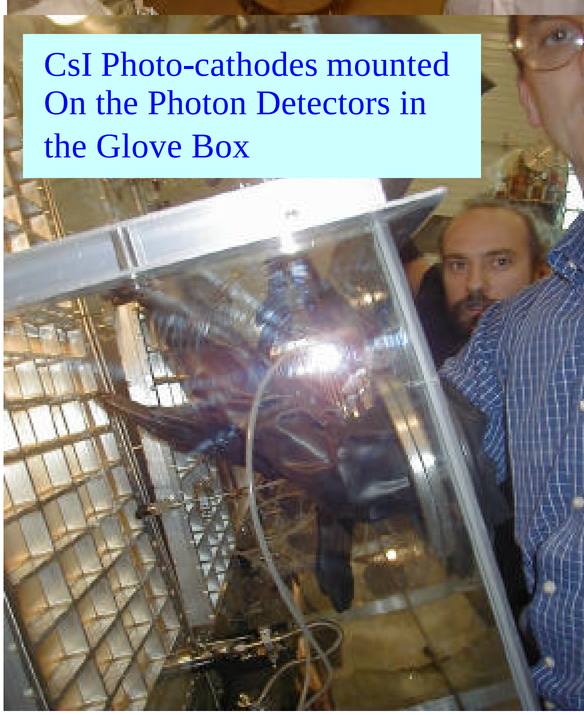
- 8 Photon detectors (total active surface: 5.3 m^2)
  - 2 Active cathodes: double layers PCBs ($58 \times 58\,cm^2$) with 5184 pads
  - Double quartz window (each $60 \times 60\,cm^2$)
  - Anode wires supported at mid length by MACOR bars with groves (max. sagitta at working voltage $80\,\mu m^2$)

Photon Detectors II: Assembly

CsI photo-cathode ⇒ the photo-cathode must be protected from H_2O and O_2, (our goal: always <100p.p.m.). Always fluxed with dry inert gas


CsI deposit on the cathode

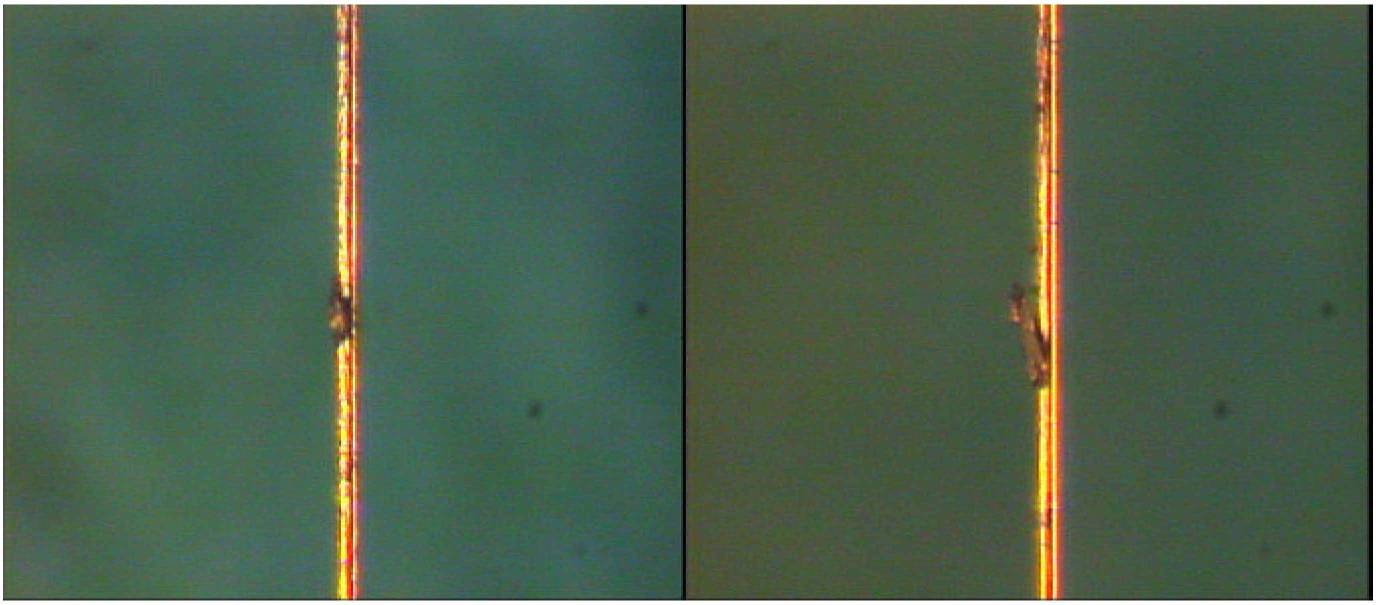

CsI photo-cathode transport system

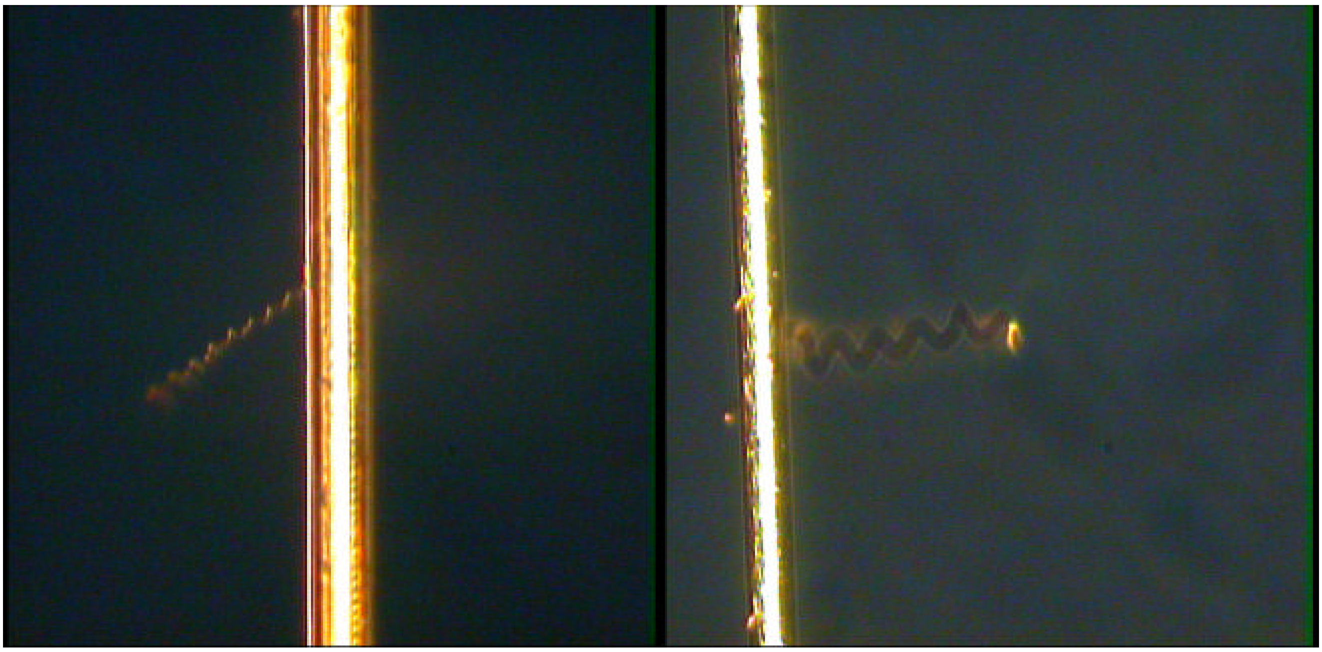

CsI Photo-cathodes mounted On the Photon Detectors in the Glove Box


Installation of 4 Photon Detectors on the RICH-1 vessel

Photon Detectors III: Problems with 20μm Wires

In y2k run we had problems of breakdowns already at a limited gain. Investigations have shown that the reason is linked to defects of the anode wires.





We have proved that the electrical instability is due to the defects of the wires by increasing the breakdown limits of several factors removing the defects. Two new planes have been produced with different wires!

Read Out:
Basic Design Parameters

Basic parameters:

i. Analog read-out
ii. Total number of channels: 83K
iii. Expected occupancy ~ 5%
iv. Total maximum data flux in spill: 2.5 GB/sec. (at the max. trigger rate of 105 Hz)

Front-end chip: COMPASS-GASSIPLEX

i. Modified version of GASSIPLEX, FE chip developed for RD26:
   Preamplifier + Shaper + Analog multiplexer
ii. Intrinsic dead time: 400nsec/ev.
iii. Peaking time: $1 \mu sec$
iv. Noise: $585 + \frac{16}{[fC]} \times C$ electrons (r.m.s.)
v. Gain: $\sim 6.5\, mV/fC$

Front-end Card: BORA BOARD

i. 192 boards for the whole RICH1
ii. It includes: F-E chip GASSIPLEX
   ADC's
   FIFO's to decouple F-E and logic stage
   FPGA for logic sequencer, threshold subtraction, zero suppression
   DSP for event packaging and on-board controls
   Optical link
iii. Event processing in $\sim 10\, \mu s$
iv. BORA BOARD (60 cm long) directly mounted on the rear side of the cathode PCB planes

Read Out:
Bora and Dolina Boards