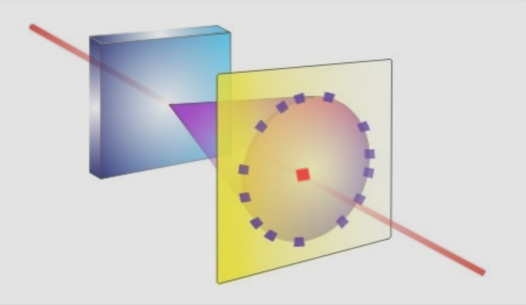
Proximity focusing CsI Hall A RICH detector and possible upgrade

F. Garibaldi (garibald@jlab.org) - CLAS12 RICH Workshop - Jlab January 29 - 08



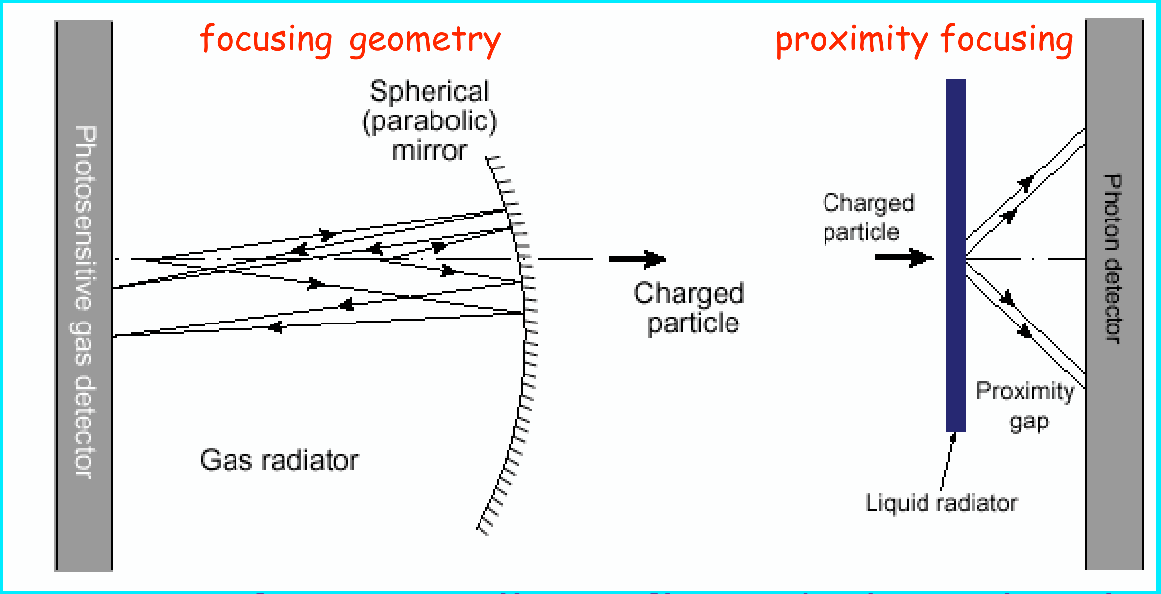
- ➢ RICH technique
- ➢ Hall A Proximity focusing CsI gas detector
- ➢ Upgrade (p_h=2.4 GeV/c for (π,K))
- ➢ VHMPID (p_h> 10 GeV/c)
- ➢ Conclusions

Cherenkov Light Imaging

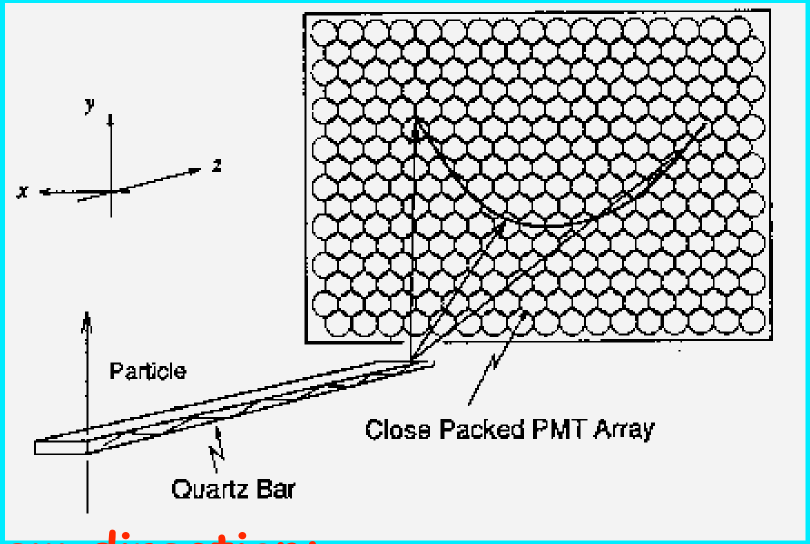
Ring Imaging

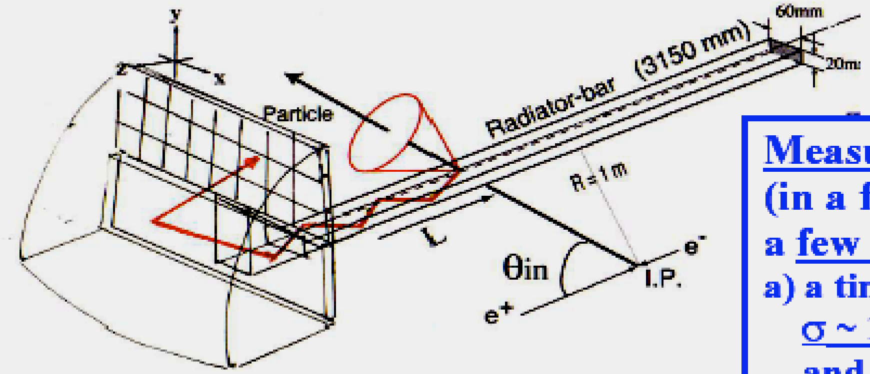
CHerenkov

counters



Detection of Internally Reflected Cherenkov light





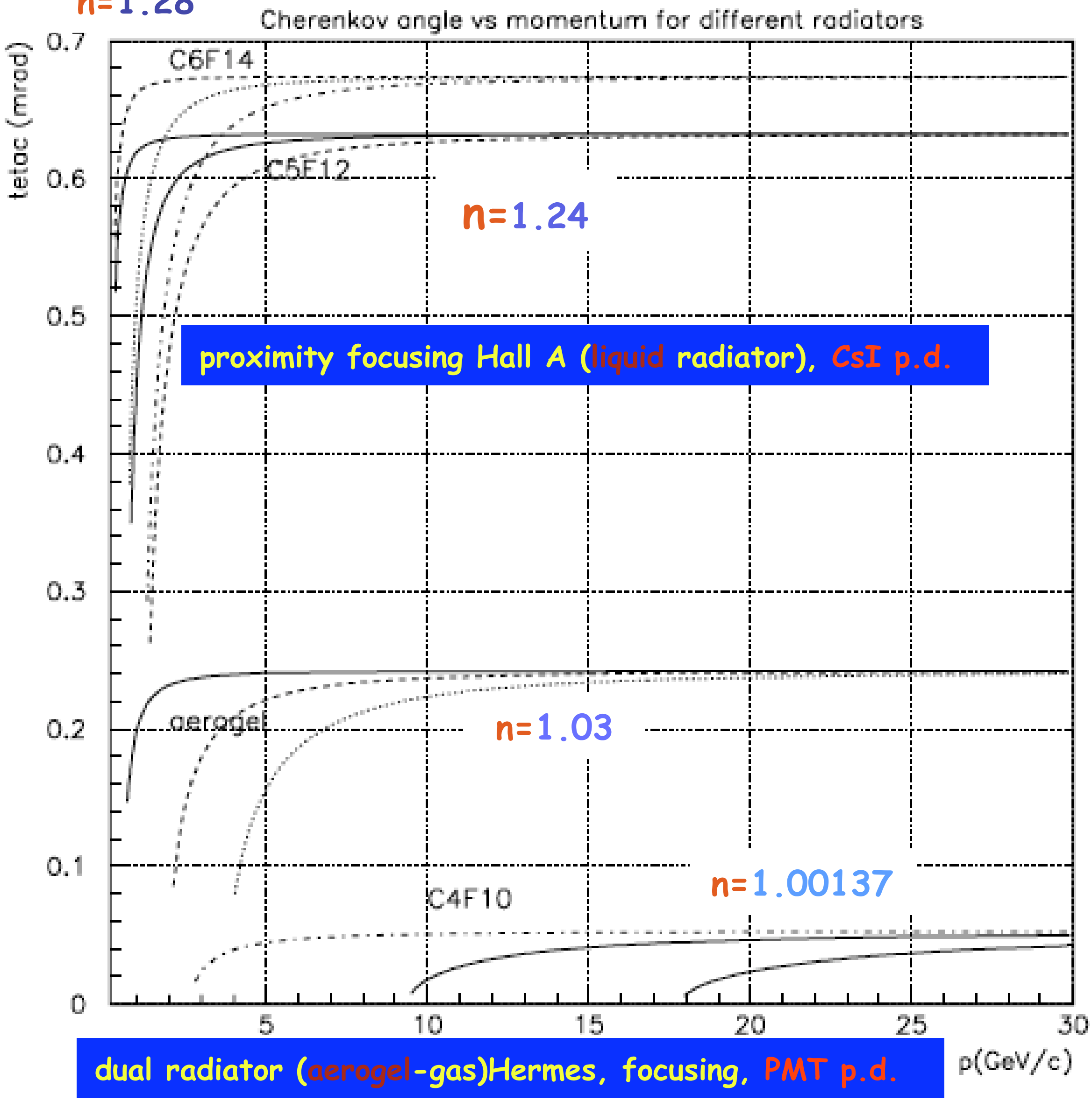
X, Y, Time

(Focusing mirror, quartz matching fluid,
Flat panel H-8500 PMT detector)

Measure
(in a field of
a few Gauss):
a) a time to
σ ~ 100ps,
and
b) photon
position in
both x & y.

new direction:
correct the chromatic error out

$$\cos(\theta) = \frac{1}{n\beta}$$



n=1.28

n=1.24

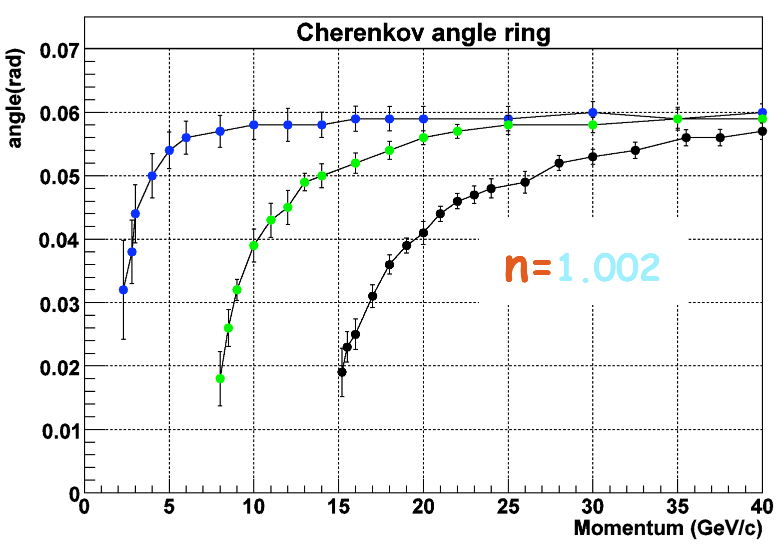
proximity focusing Hall A (liquid radiator), CsI p.d.

n=1.03

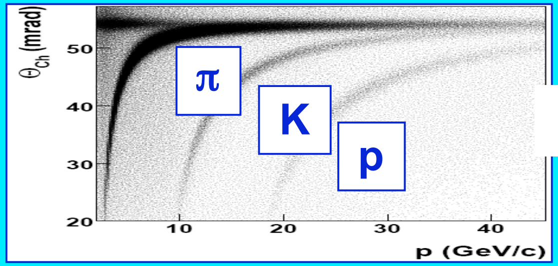
n=1.00137

dual radiator (aerogel-gas)Hermes, focusing, PMT p.d.

ALICE VHMPID CsI phot., gas (C5F12) radiator)

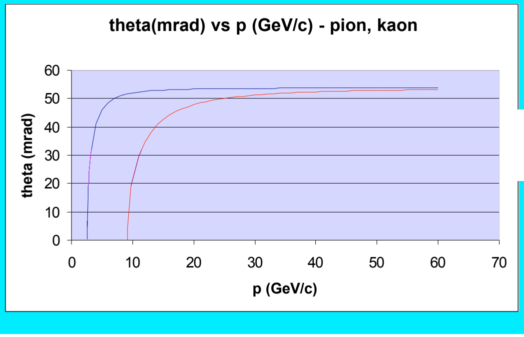


n=1.002



CsI

Compass CsI phot., gas (C4F10) radiator



PMT

Performances of the RICH detector in Hall A

JLAB Hall A RICH COLLABORATION

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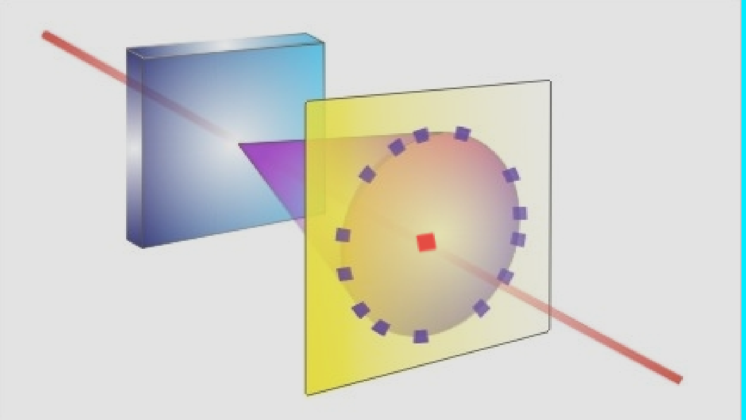
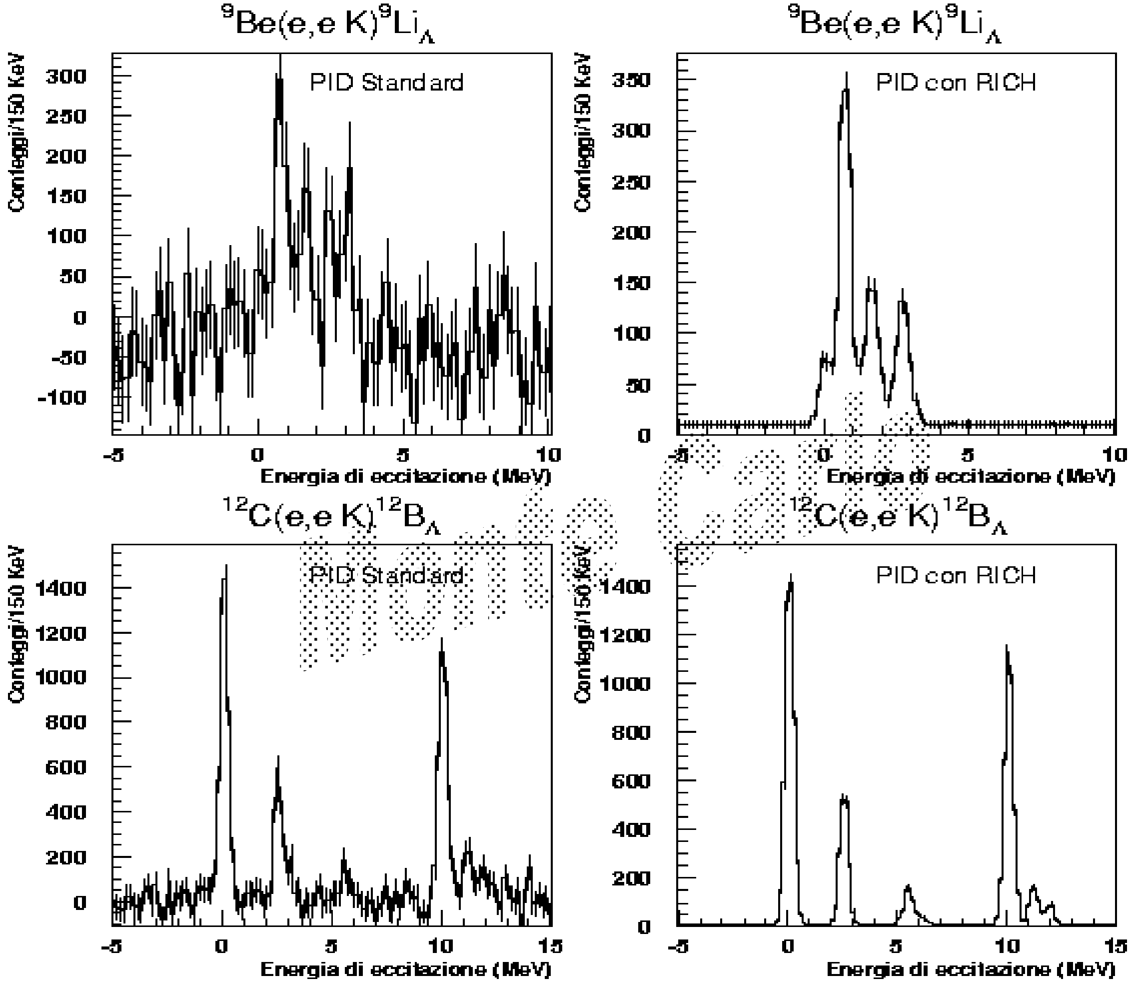


KAON Id Requirements – Physics case

Hypernuclear spectroscopy



Signal Vs. Background

	Process	Rates
signal	(e,e'K) bound state	10^{-4} – 10^{-2}
accidentals	(e,e')(e,π) (e,e')(e,p) (e,e')(e,k)	100 100 0.1

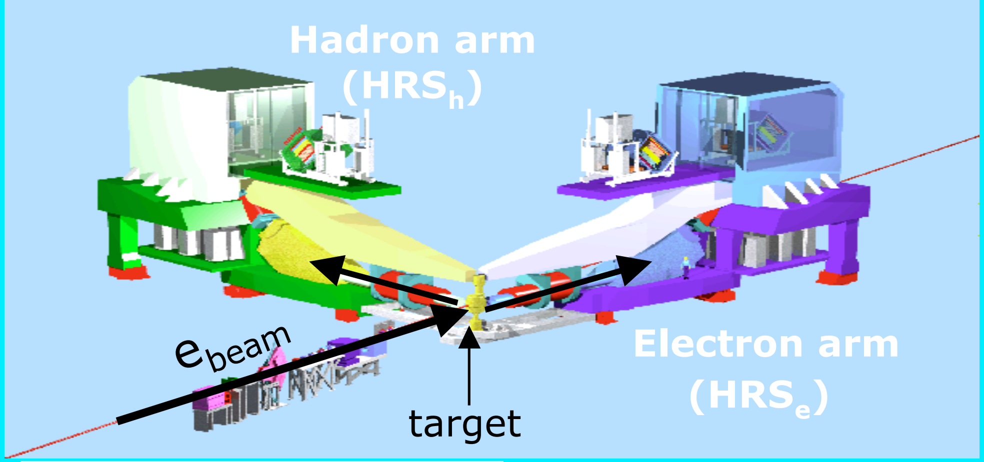
Very forward angle → high background of π and p

⇒ TOF and 2 threshold Cherenkov aerogel are NOT sufficient for unambiguous K identification

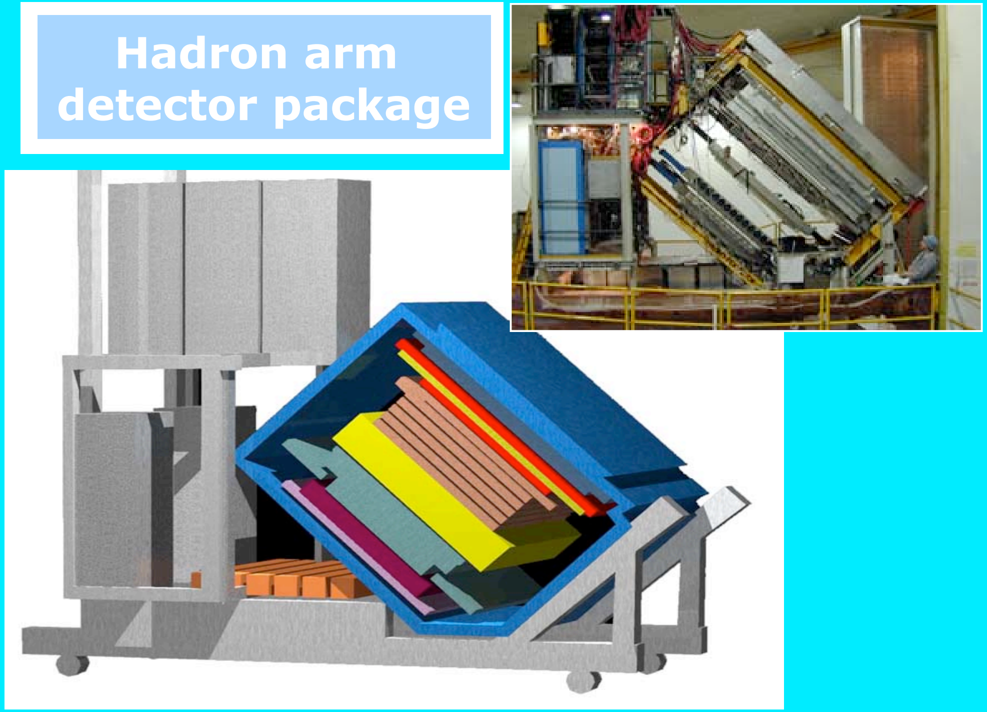
⇒ **RICH DETECTOR**

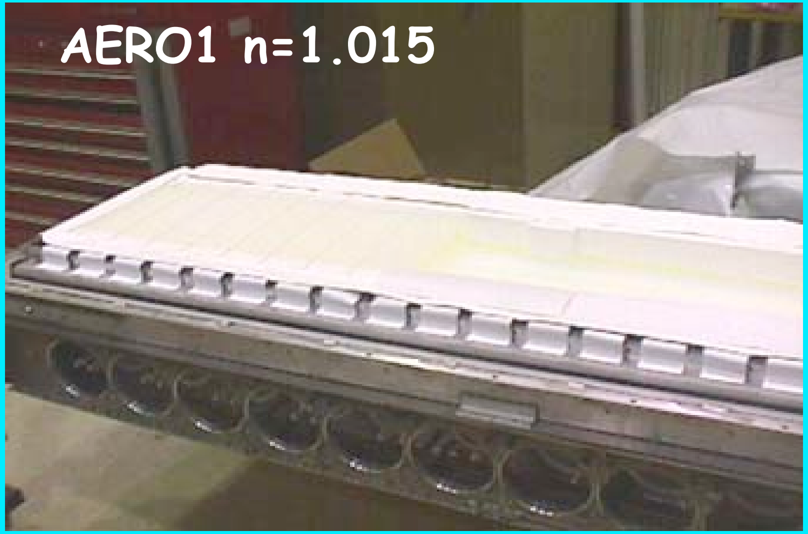
p_K = 2 GeV/c

Hall **A** Hadron Detector Package and the **K**aon Id System



Hadron arm detector package





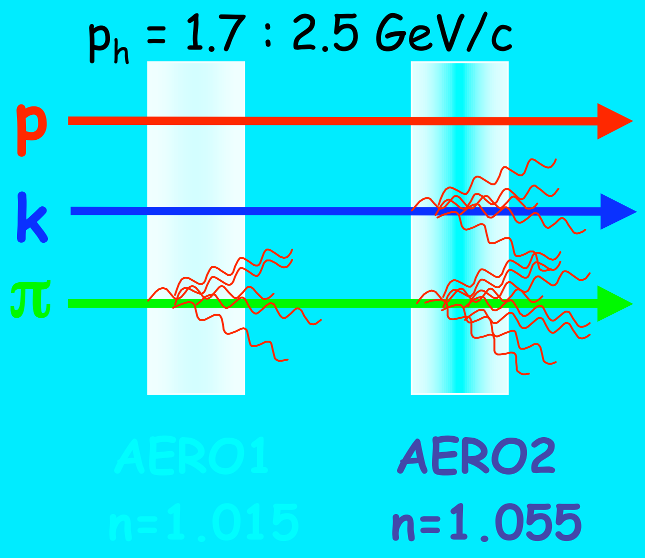
The two Aerogel Cherenkov Detectors

The PID Challenge

Very forward angle ---> high background of π and p

-TOF and 2 aerogel in not sufficient for unambiguous K identification !

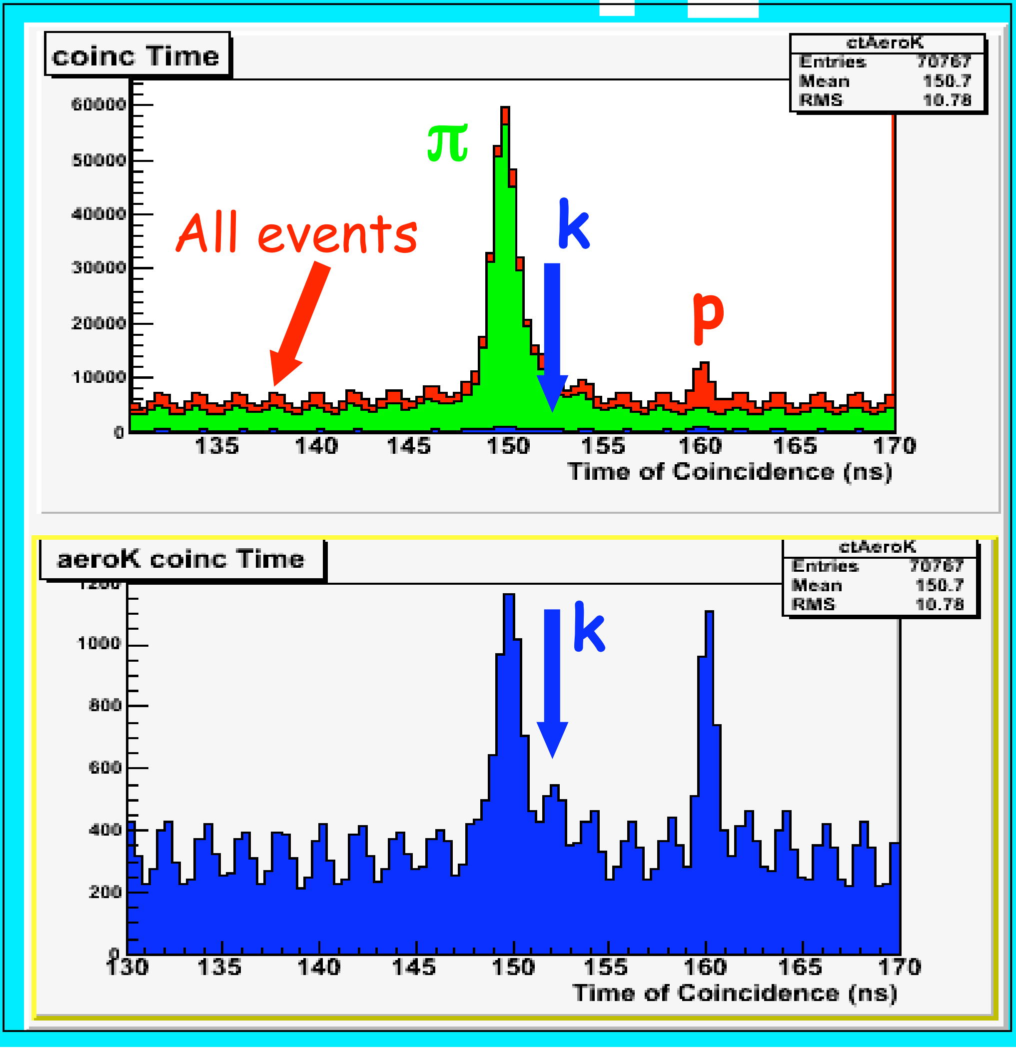
Kaon Identification through Aerogels



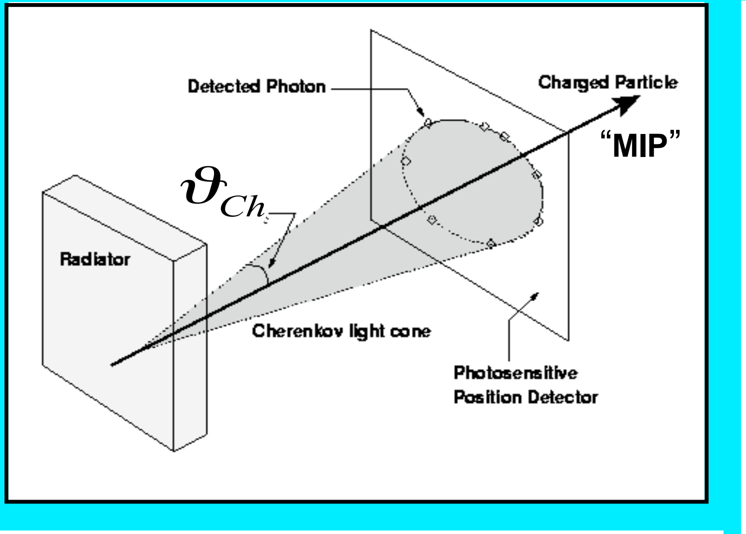
Pions = A1•A2

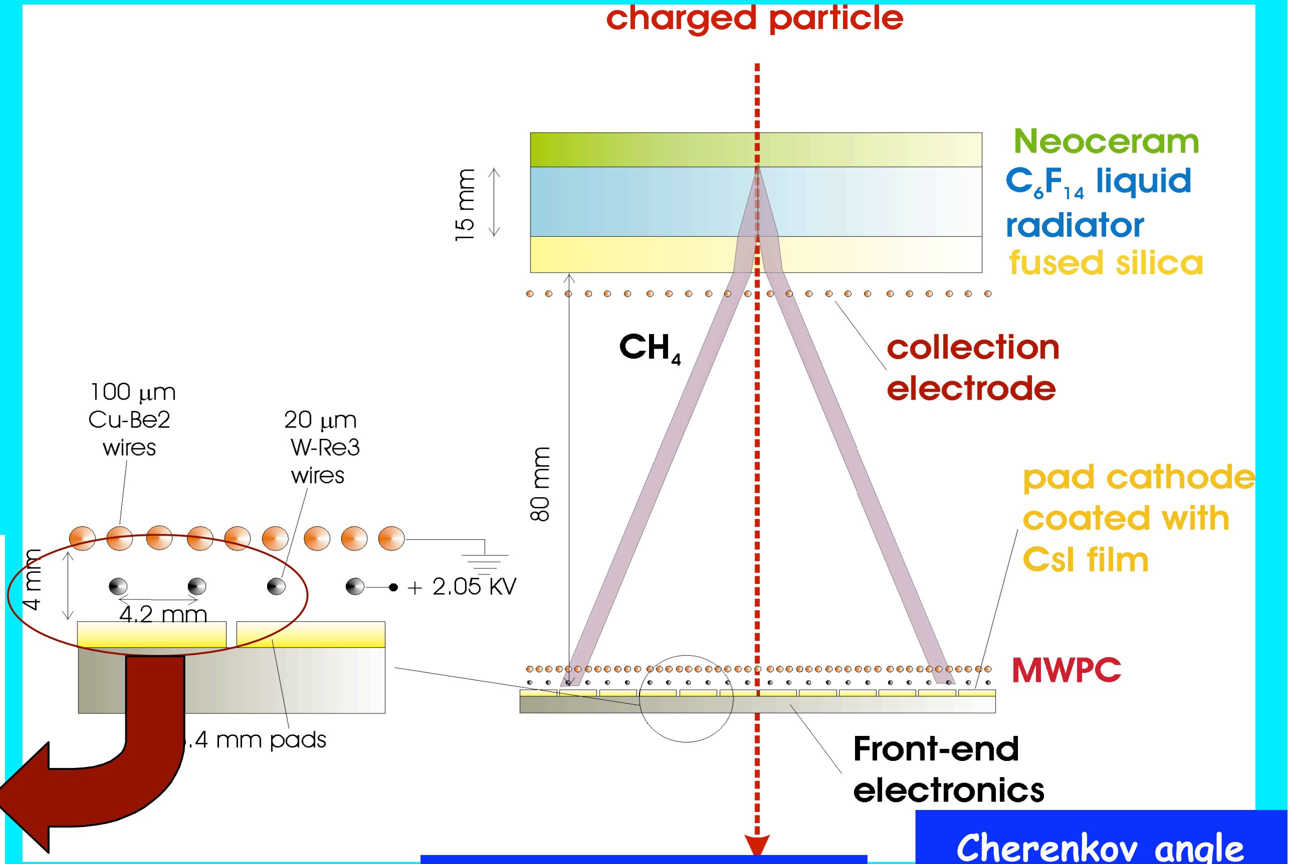
Kaons = $\overline{A1}\bullet A2$

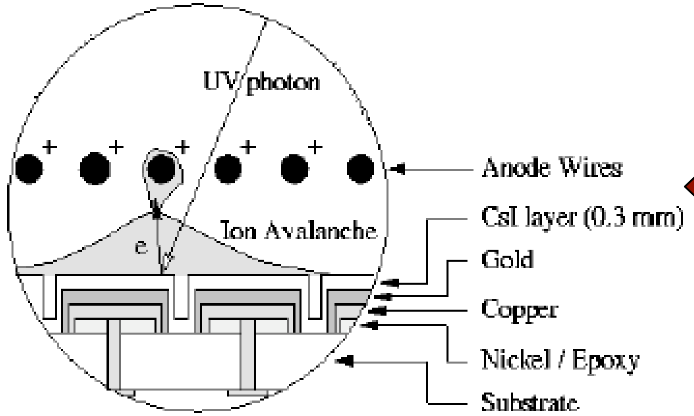
Protons = $\overline{A1}\bullet\overline{A2}$



RICH detector –C_6F_{14}/CsI proximity focusing RICH







N. of detected photoelectrons

$$N_{p.e.} = 370 L \sin^2 \overline{\vartheta}_c \prod_i \varepsilon_i \Delta E \approx 20-50$$

Separation Power

$$\vartheta_2 - \vartheta_1 = n_\sigma \sigma_{\vartheta_c}$$

Cherenkov angle resolution

$$\sigma_{\vartheta_c} = \frac{\sigma_\vartheta^{p.e.}}{\sqrt{N_{p.e.}}}$$

Performances

- $N_{p.e.}$ # of detected photons(p.e.)
- and σ_θ (angular resolution)

← maximize

← minimizee

Essential Errors in RICH measurements

Cherenkov approx. formula: $\beta = \frac{1}{n\cos\theta}$
Systematic errors on single photon β measurement:

$$\frac{\Delta\beta}{\beta} = \tan\theta\Delta\theta + \frac{\Delta n}{n}$$

$\Delta\theta \sim \Delta\theta_E \oplus \Delta\theta_D$ where:

$\Delta\theta_E$: emission error due to the finite longitudinal size of the radiator (minimized using mirrors)

$\Delta\theta_L$: localization error due to the finite size of the spatial detection elements

$\Delta n \sim \frac{\delta n}{\delta\lambda}\Delta\lambda$ is the chromatic error (depends on the λ-dispersion of the refractive index)

Detecting N Cherenkov photons, the error roughly becomes:

$$\Delta\beta_N \sim \frac{\Delta\beta}{\sqrt{N}}$$

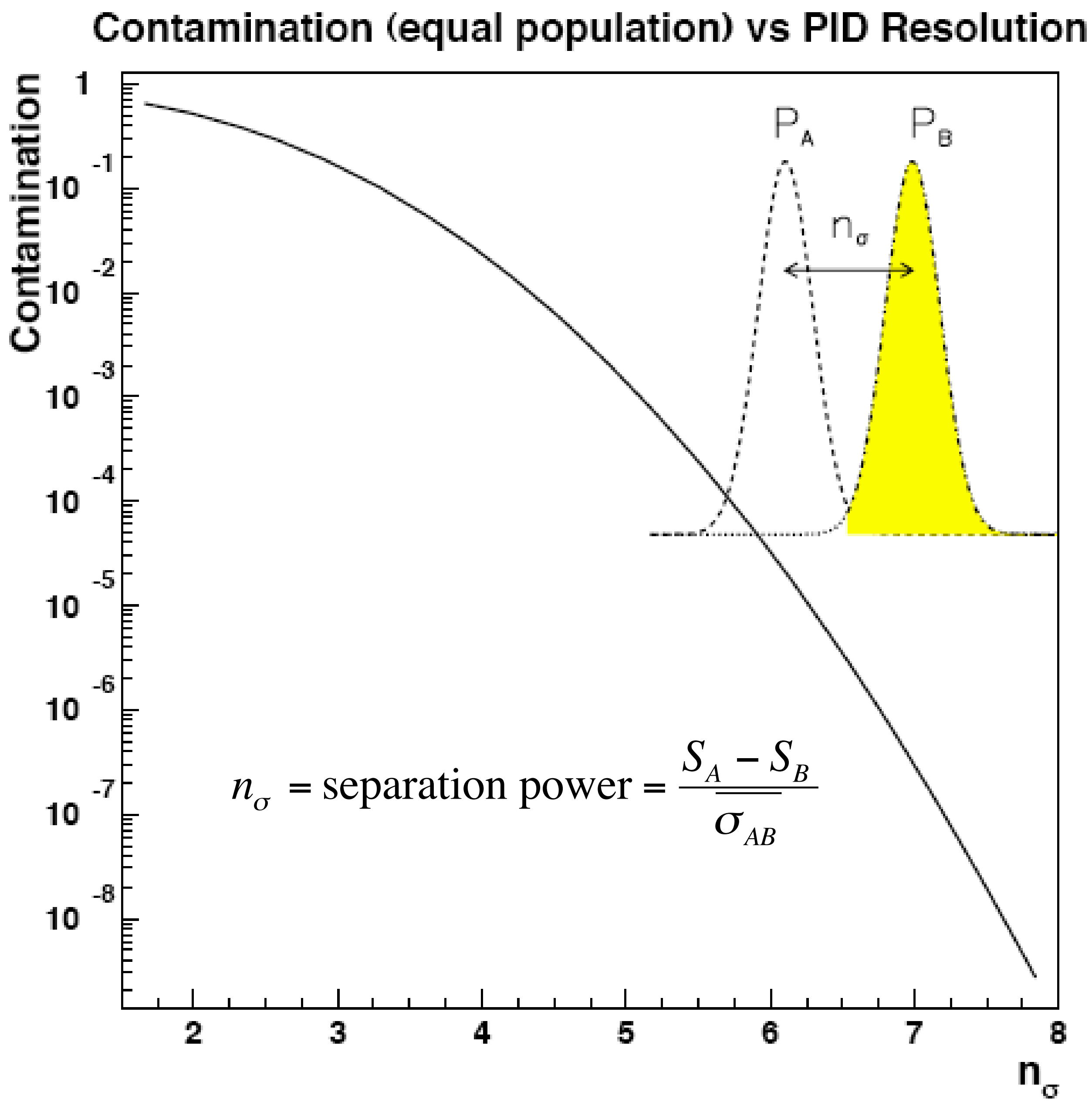
$$\sigma_\theta^{\text{p.e.}} \sim \sqrt{(\sigma_{\text{CHR}}^{\text{p.e.}})^2 + (\sigma_{\text{EMI}}^{\text{p.e.}})^2 + (\sigma_{\text{LOC}}^{\text{p.e.}})^2}$$

$$\sigma_\theta = \frac{\sigma_\theta^{p.e.}}{\sqrt{N_{p.e.}}}$$

$$\sigma_{\text{CHR}}^{\text{p.e.}} = \Delta\lambda\sqrt{0.0317 + \left[\frac{0.47\ w_q + 0.70\ w_g}{0.84\ w_f + 1.02\ w_q + 5.43\ w_g}\right]^2}$$

$$\sigma_{\text{EMI}}^{\text{p.e.}} = \frac{230\ w_f}{0.83\ w_f + 1.22\ w_q + 5.14\ w_g}$$

$$\sigma_{\text{LOC}}^{\text{p.e.}} = 1.72\ \sigma_{\text{EMI}}\ \frac{L_{PAD}}{w_f}$$

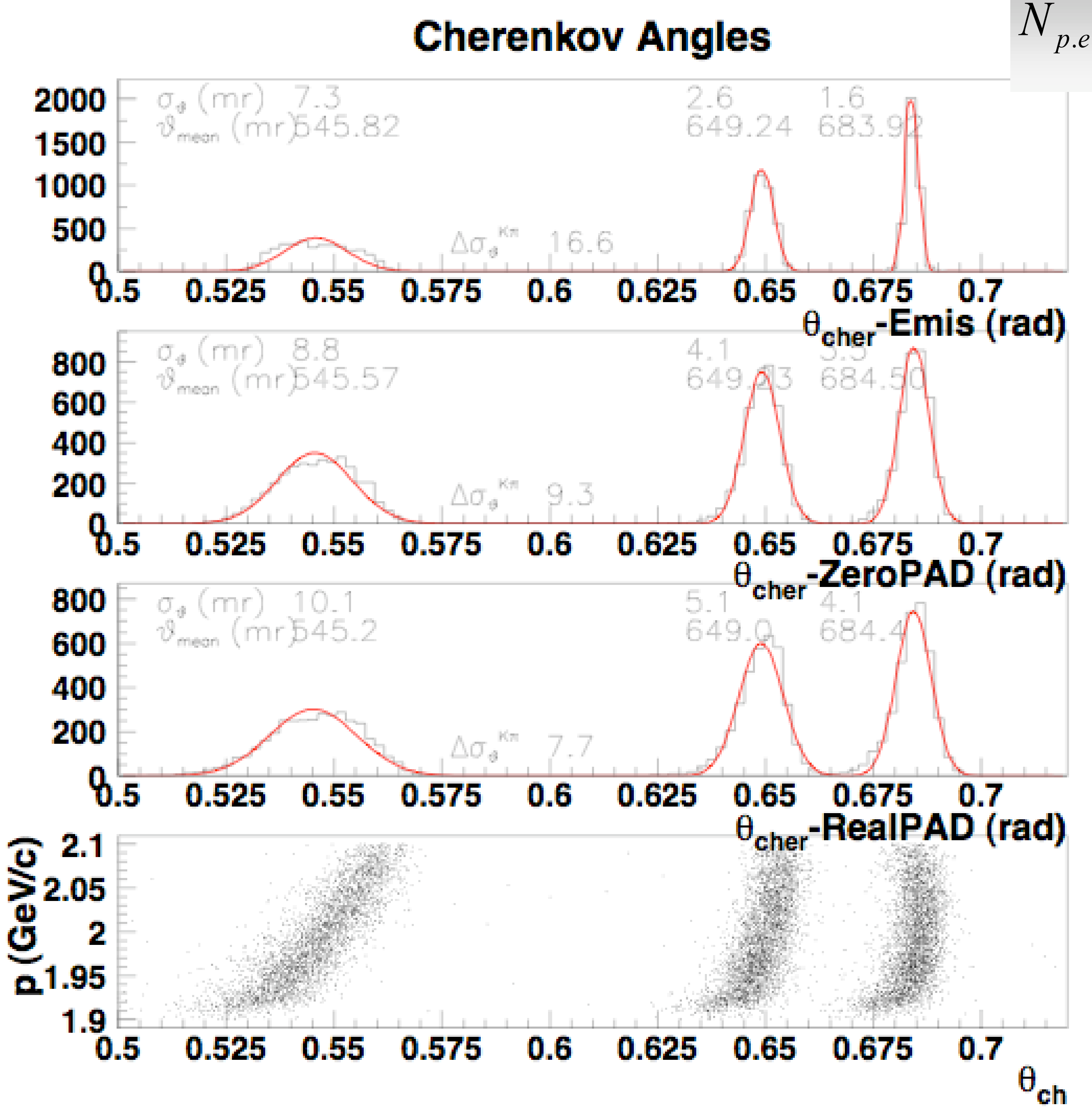


$$n_\sigma = \text{separation power} = \frac{S_A - S_B}{\sigma_{AB}}$$

Figure 1: Contamination vs PID resolution. We consider as threshold for good particle B the value of $n_\sigma/2$ before the mean value of B distribution; that is the middle point between the two distributions.

N.B.

in case of samples with different population: at a given separation power, the resulting contamination of the largest populated sample of particles in the other species will be larger by a factor equal to the ratio between the relative populations



$$N_{p.e.} = 370 L \sin^2 \bar{\vartheta}_c \prod_i \varepsilon_i \Delta E \approx 20 - 50$$

$$\mathrm{n}_\sigma = \frac{\Delta m^2 \sqrt{N}}{2p^2 tg(\theta)\sigma_\theta}$$

$$\sigma_{\vartheta_c} = \frac{\sigma_\vartheta^{p.e.}}{\sqrt{N_{p.e.}}}$$

$$\vartheta_2 - \vartheta_1 = \mathrm{n}_\sigma \sigma_{\vartheta_c}$$

π, K separated by 35 mr

σ_θ= 5.1 mr

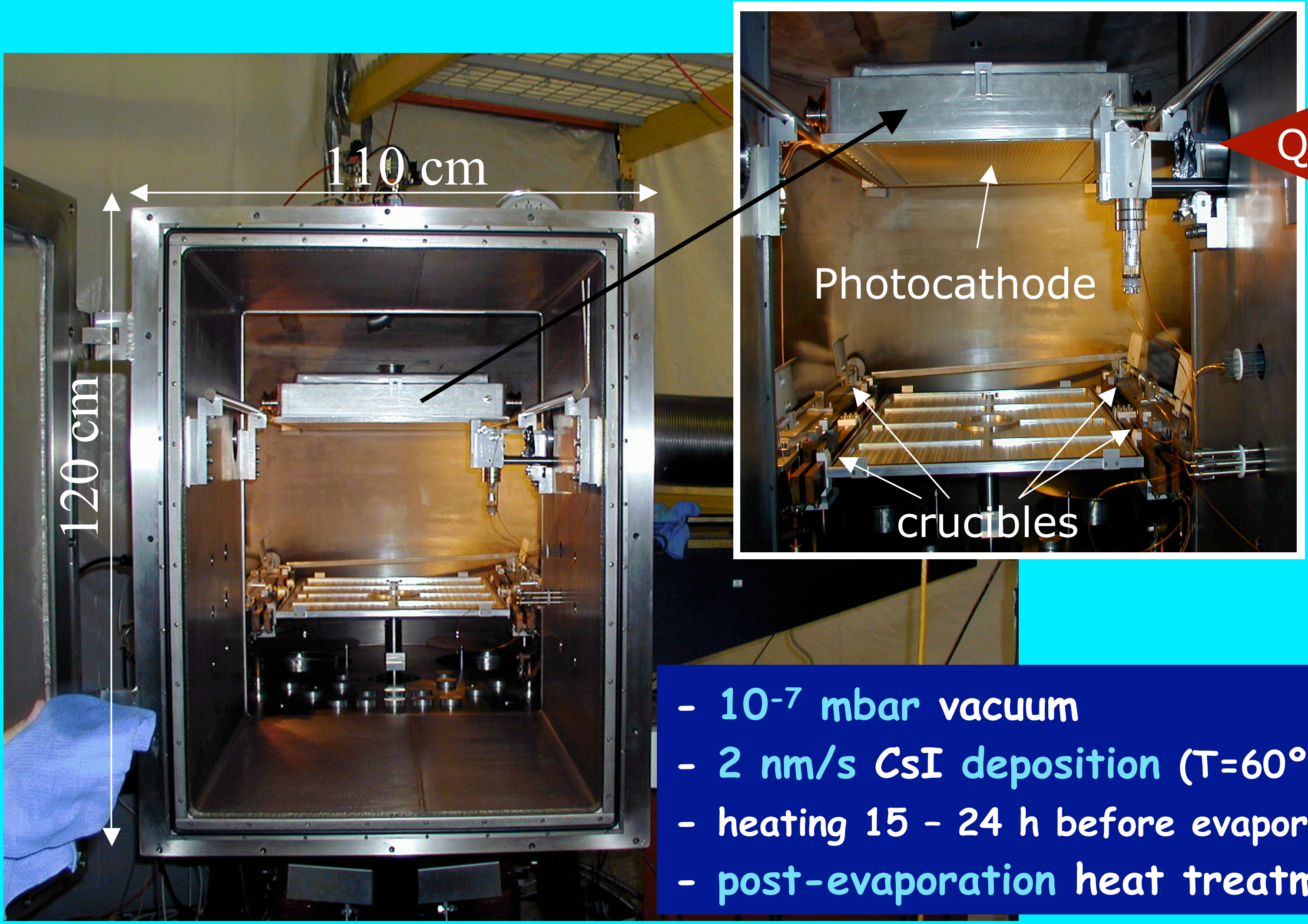
↓

6.8 σ

Photocathode positioning in the glove box

JLAB Hall A RICH: some components

JLAB Hall A RICH: the evaporation system



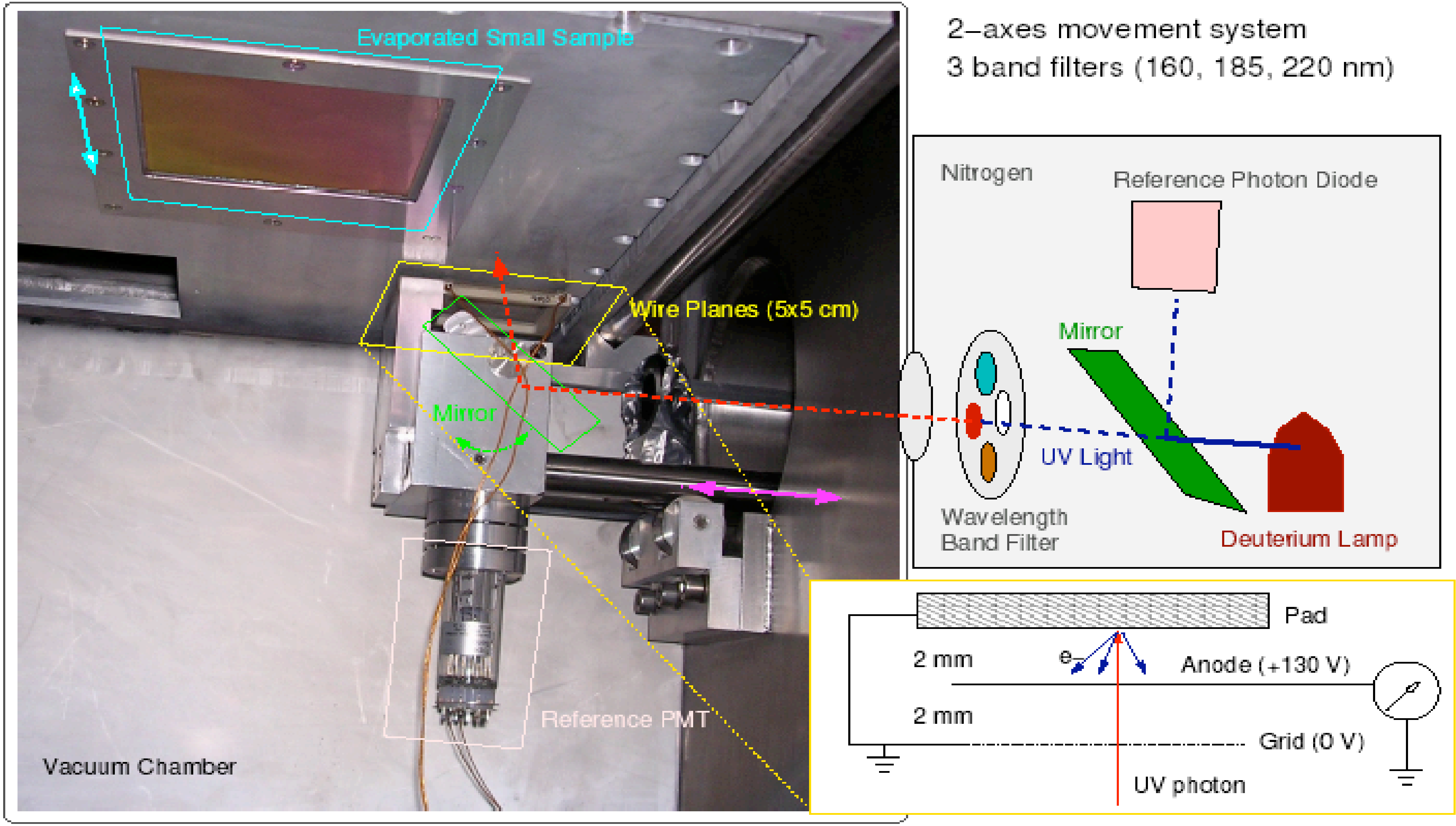
Quantum Efficiency Measurement System

details in :
F.Cusanno et al.
NIM A502(2003)251

- 10^{-7} mbar vacuum
- 2 nm/s CsI deposition (T=60°C)
- heating 15 – 24 h before evaporation.
- post-evaporation heat treatment for 12 hours.

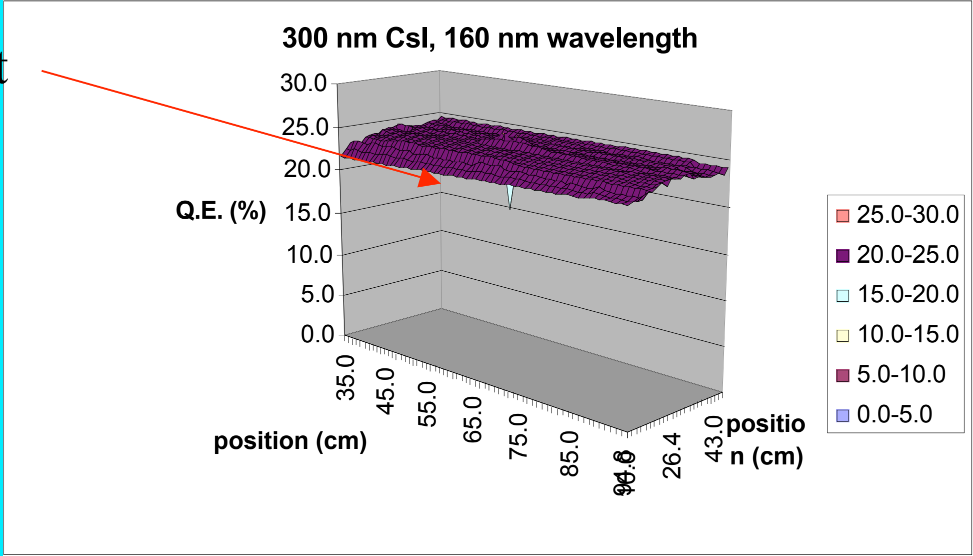
2–axes movement system

3 band filters (160, 185, 220 nm)

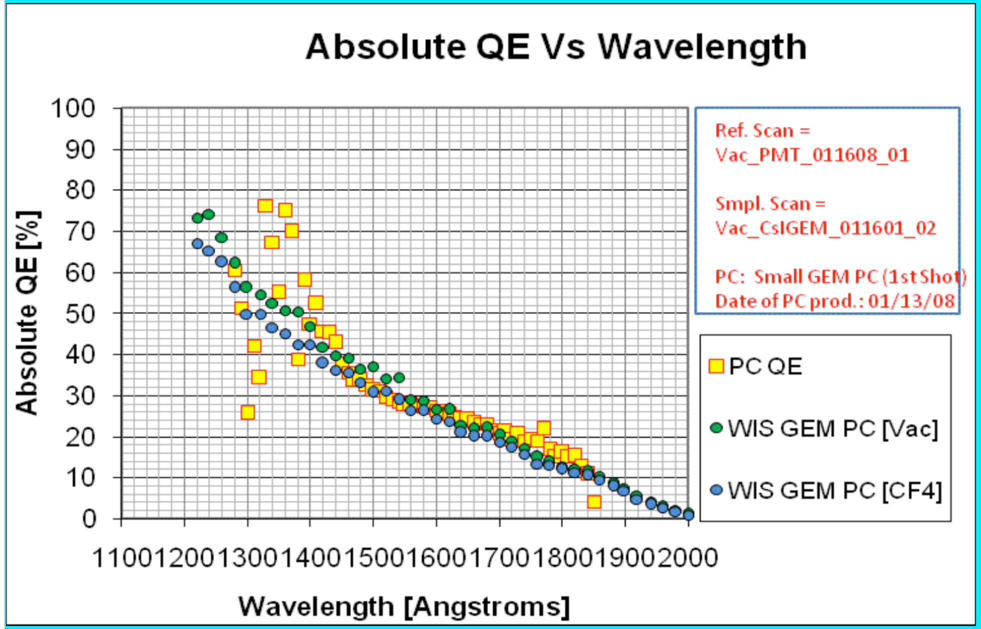


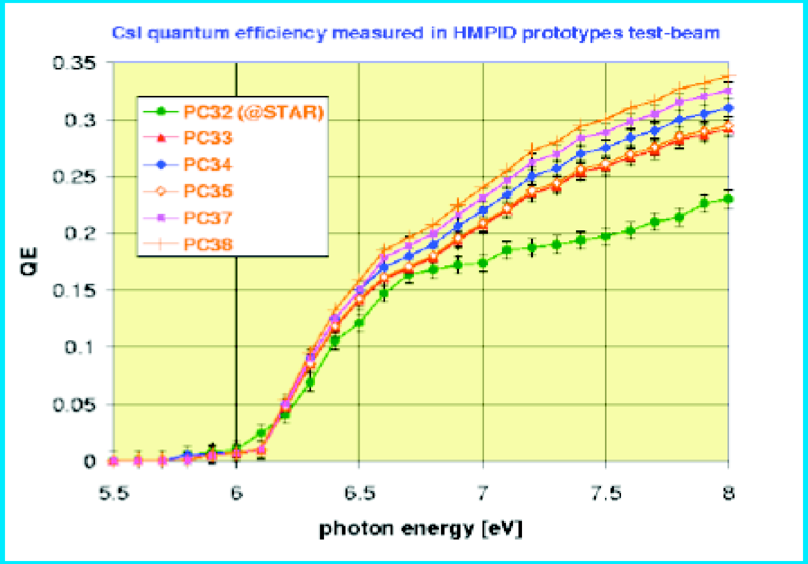
$$QE = \frac{I_{chamber}}{I_{PMT}} \cdot QE_{PMT}$$

QE measurements



Bad spot





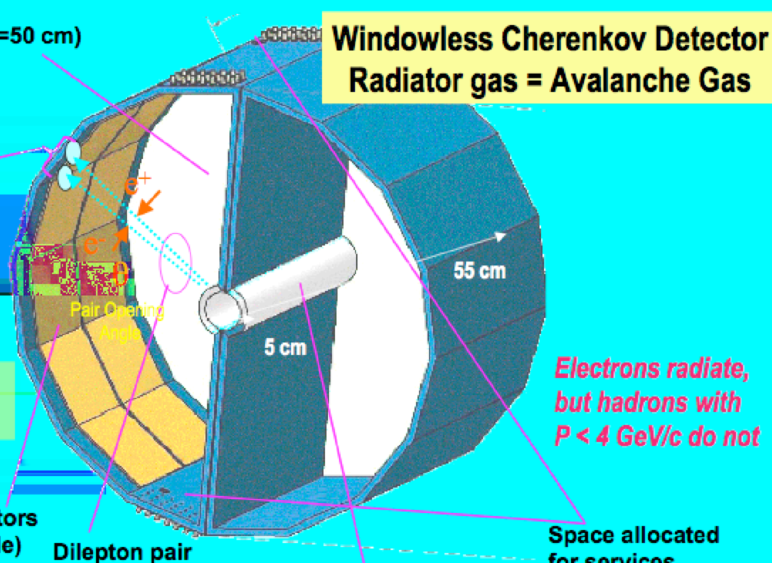
cern latest results

PHENIX

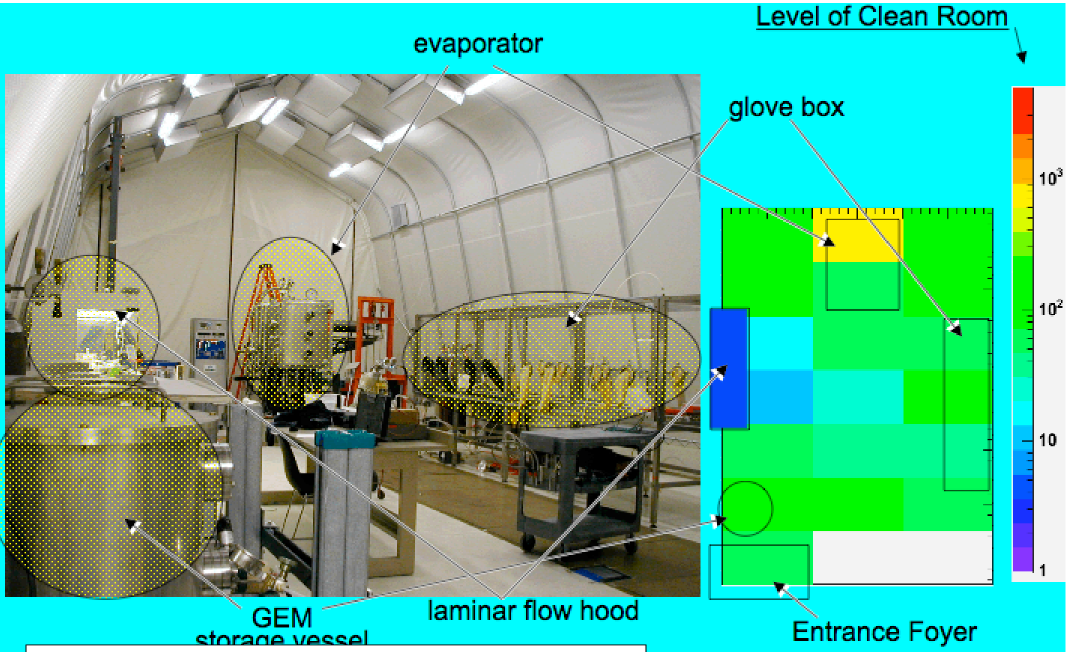
HBD Detector

HBD Gas Volume: Filled with CF_4 Radiator (n_{CF4}=1.000620, L_{RAD}=50 cm)

Windowless Cherenkov Detector
Radiator gas = Avalanche Gas

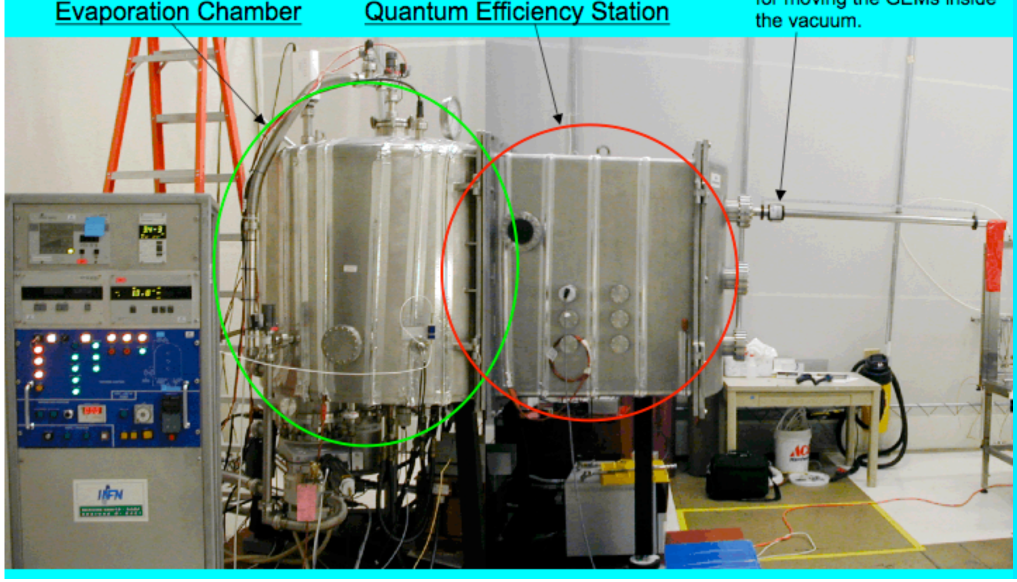


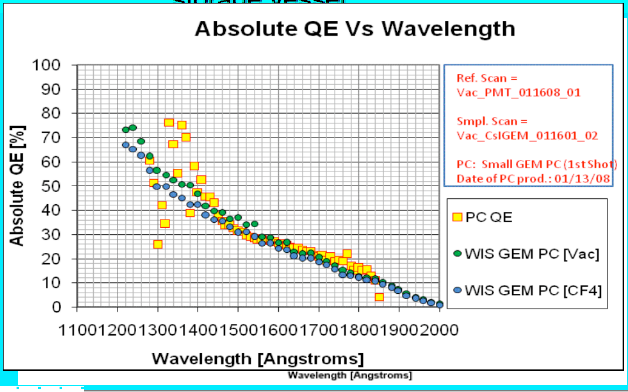
Electrons radiate, but hadrons with P < 4 GeV/c do not

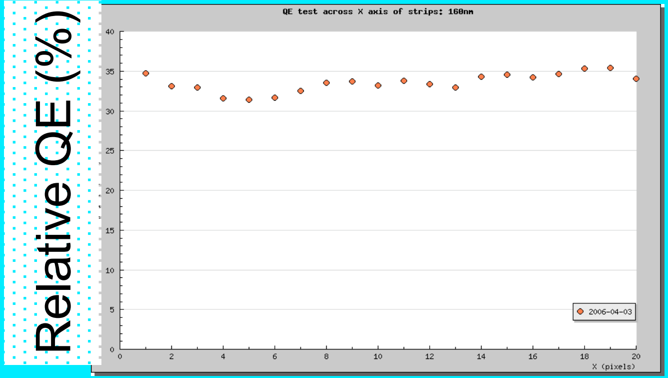


The Evaporator

on loan from INFN Roma

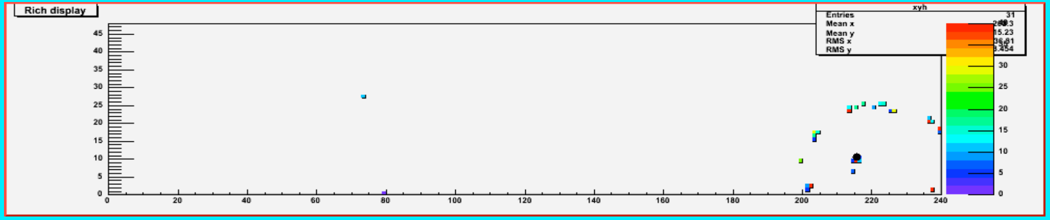




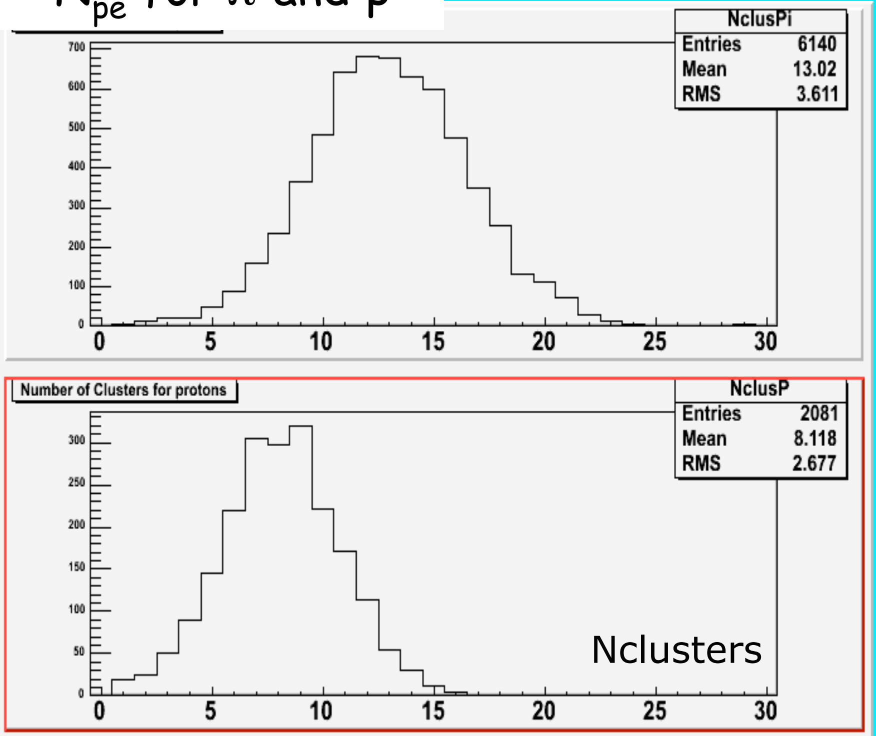


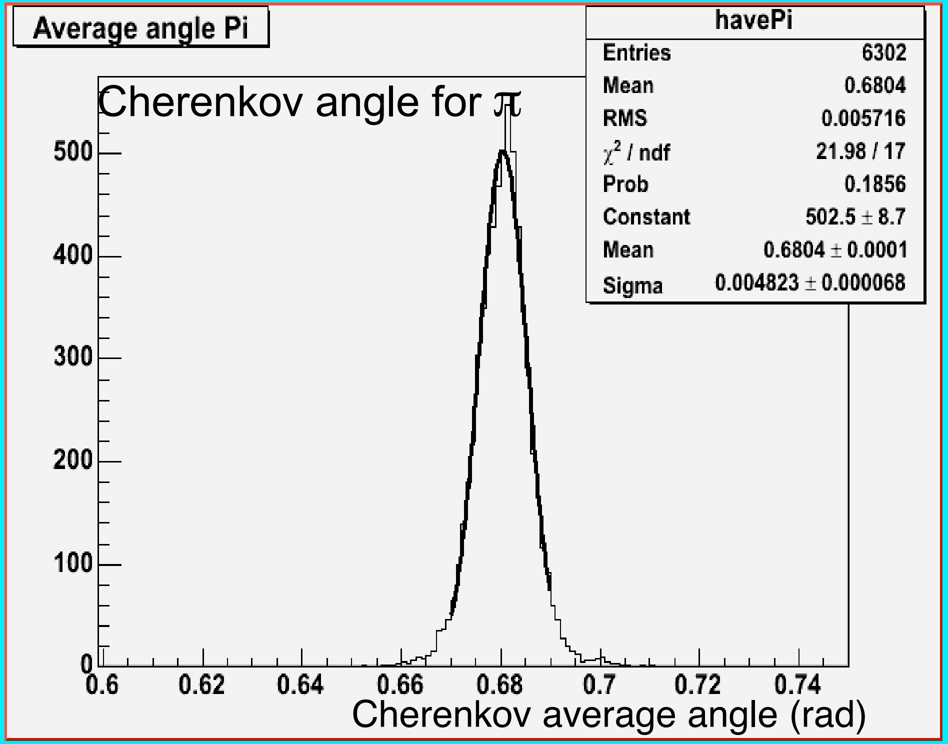
Good uniformity (±10%)and reproducibility

Rich Performances 'key parameters'



N_{pe} for π and p





N_{pe} π/p ratio:

$$\frac{N^{P}_{clus}}{N^{\pi}_{clus}} = \frac{1-\beta_P^2 n^2}{1-\beta_\pi^2 n^2} = 0.66$$

p_K= 2 GeV/c

Mean number of photoelectrons

$$N_\pi = 13$$

Angular resolution

$$\sigma_{\theta_\pi} = 5\ \text{mrad}$$

$$\Downarrow$$

$$\theta_\pi - \theta_K \sim 6 \cdot \sigma_{\theta_\pi}$$

RICH front end electronics and DAQ system

- 3 PhotoCathodes each divided in 80*48=3840 pads ⇒ 11520 tot. channels

- FEE : **GASSIPLEX** chips (for amplification, holding and multiplexing analogue signals

- Readout using CAEN System with CAEN V550 CRAMS and V551 Sequence

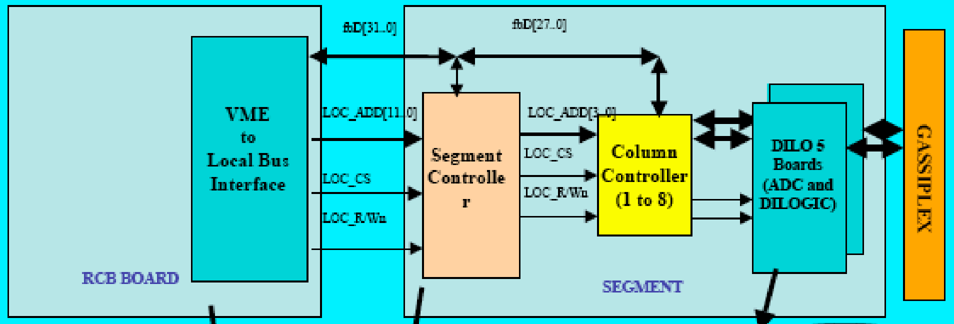
- 2 MHz clock speed. No data buffering

- Achieved performance :
  - sampling 120 ms (clock)+10 ms=130 ms
  - VME (60 hits) 54 ms
  - 200 ms deadtime per trigger

-20 - 25 % deadtime with > 1KHz random trigger

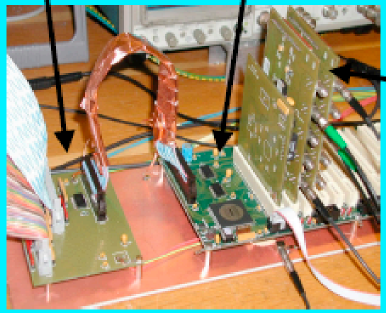
Rich electronics upgrade

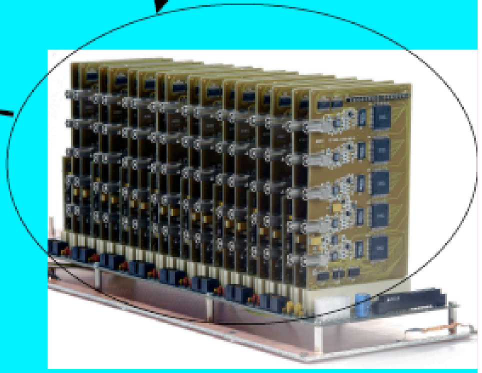
The HMPID ALICE RICH DAQ scheme



Front end digitization/ multiplexing On board

48 multiplexed channels (instead of 240)
Clock rate up to **10 MHz**

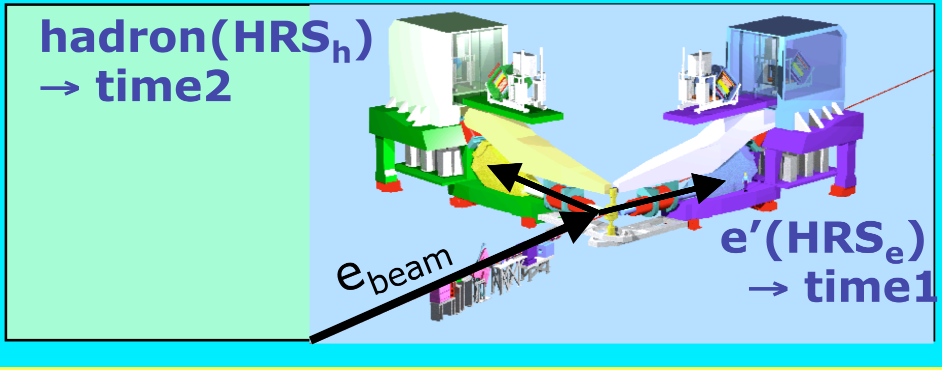


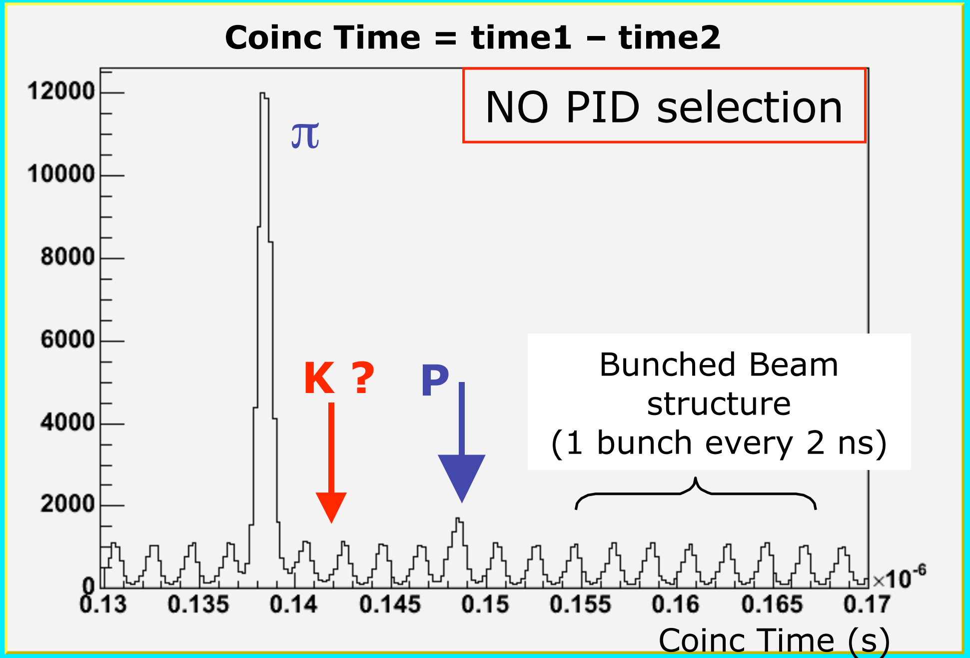


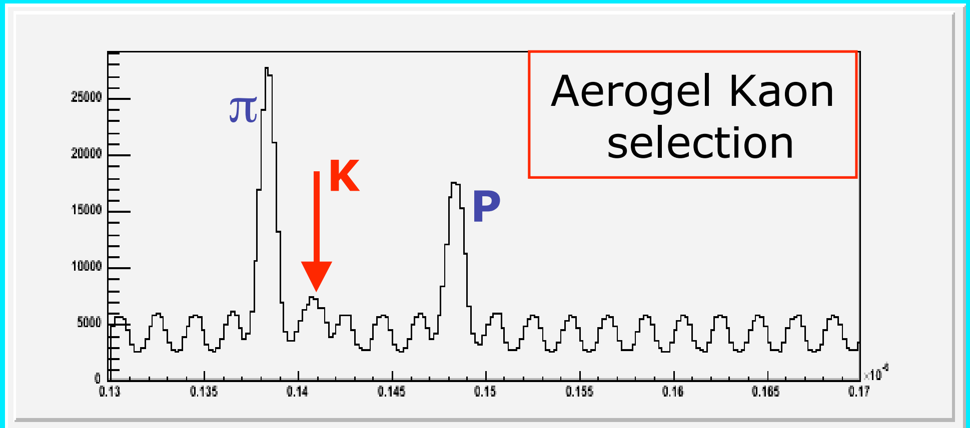
19200 ch. with the upgrade

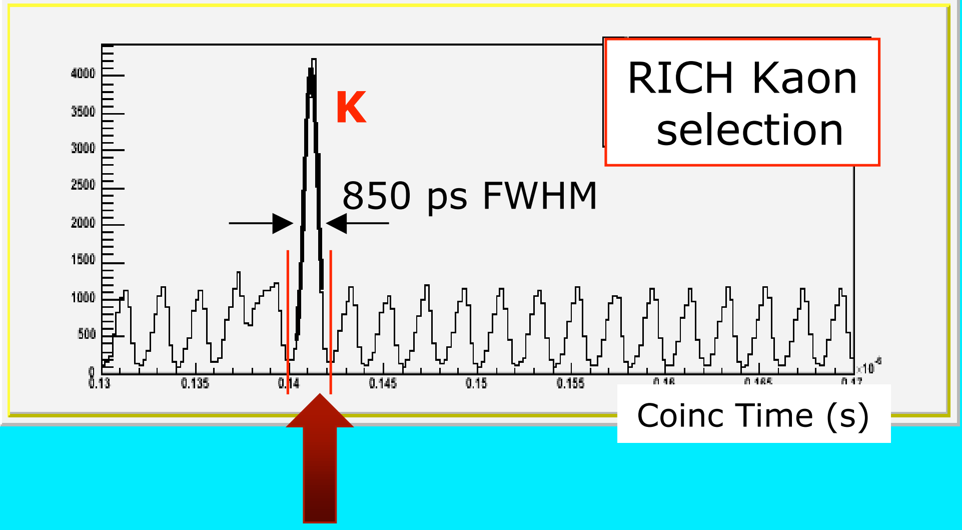
JLAB Hall A exp e94-107 Results on ^{12}C Target

e-arm Vs hadron-arm **Time of Coincidence** Spectra and Kaon Selection :





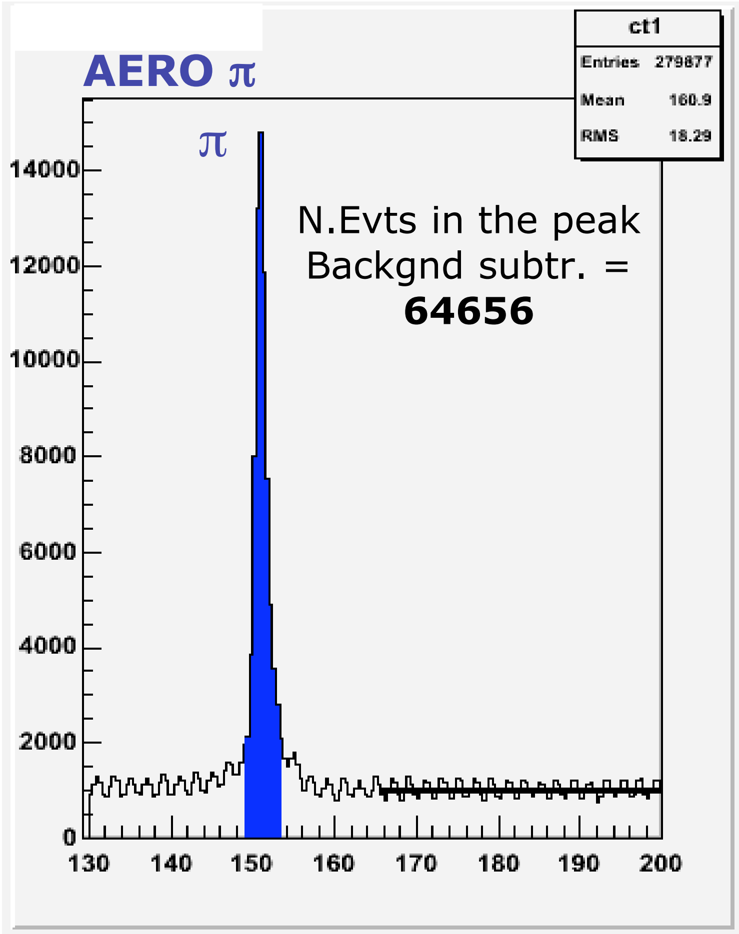




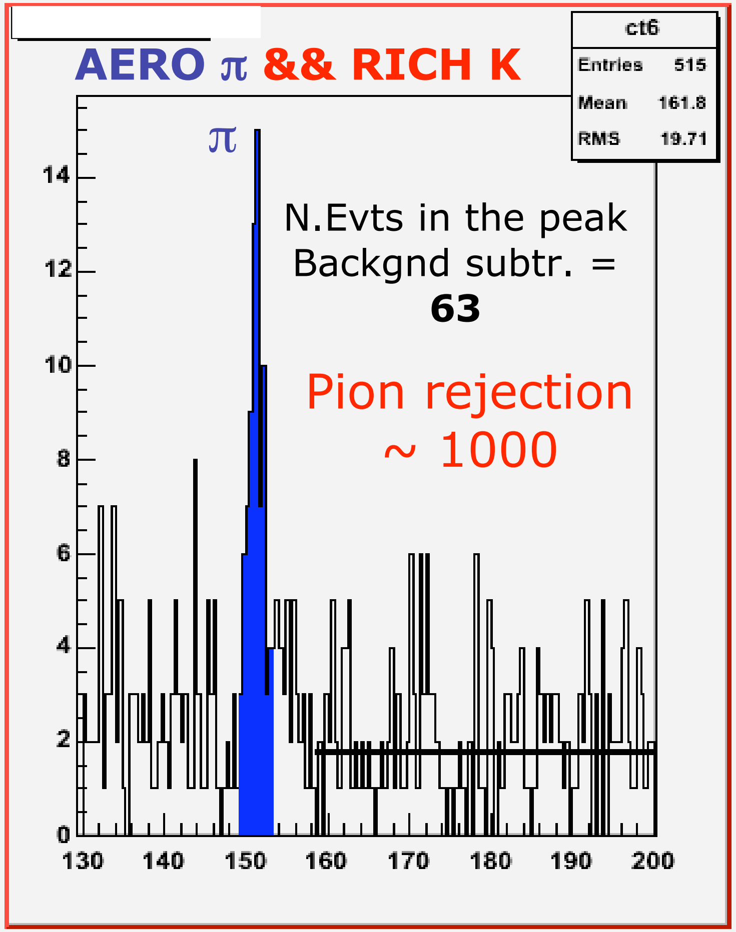
RICH Kaon Selection !

Rich – PID – Pion rejection factor :

Time of coincidence for Aerogel Selected Pions:
effect of Rich Kaon selection



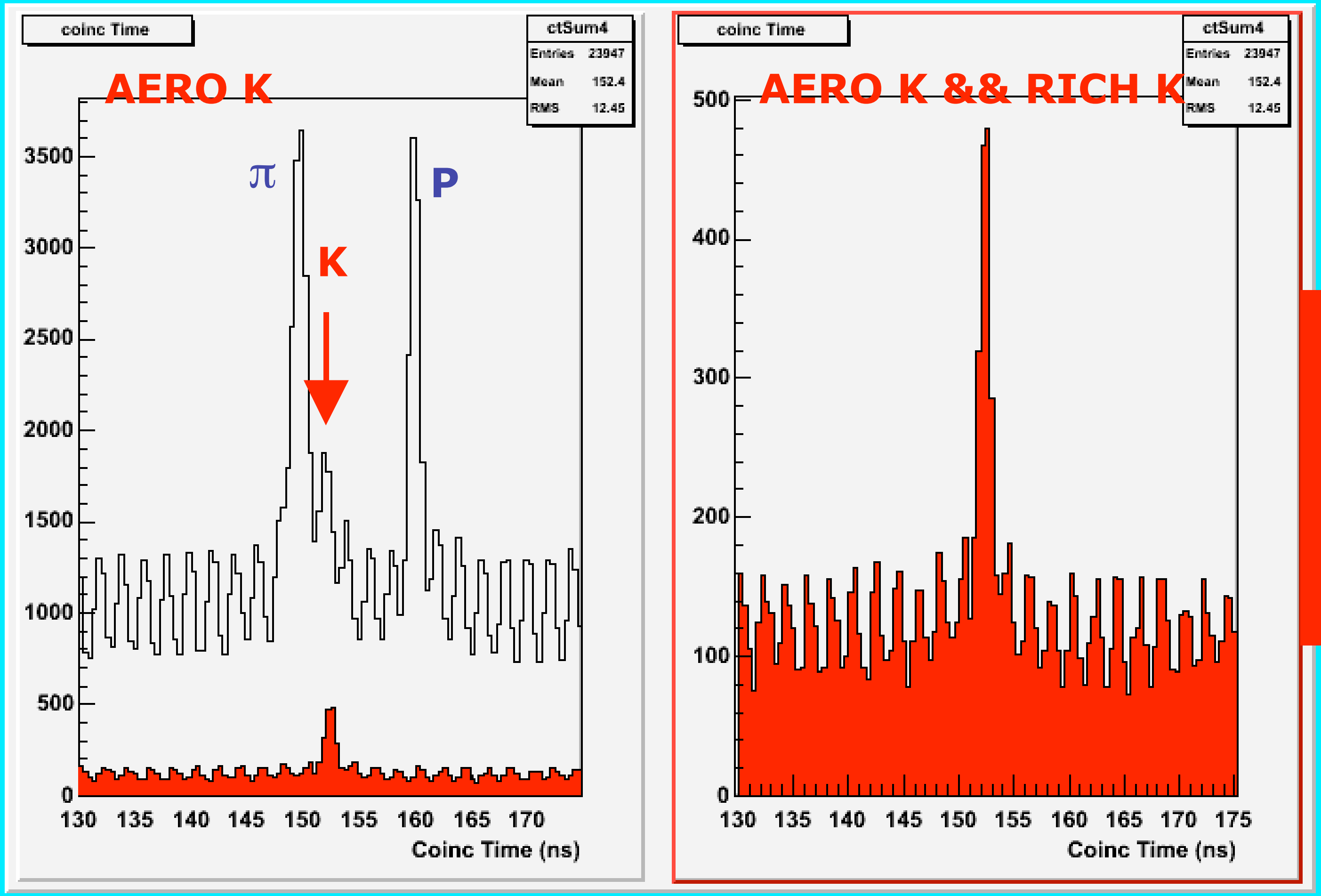
N.Evts in the peak
Backgnd subtr. =
64656



N.Evts in the peak
Backgnd subtr. =
63

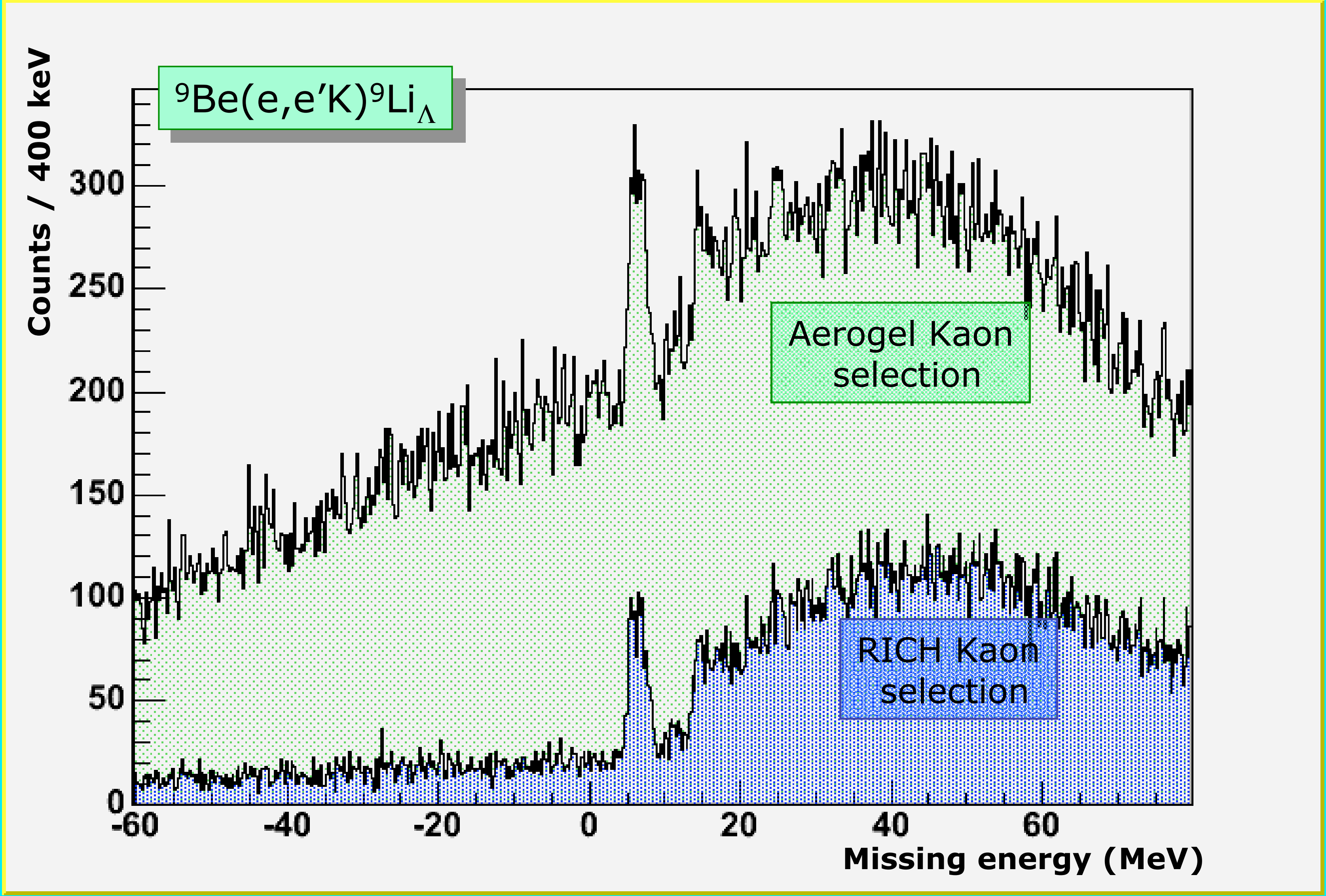
Pion rejection
~ 1000

Coincidence Time selecting kaons on Aerogels and on RICH

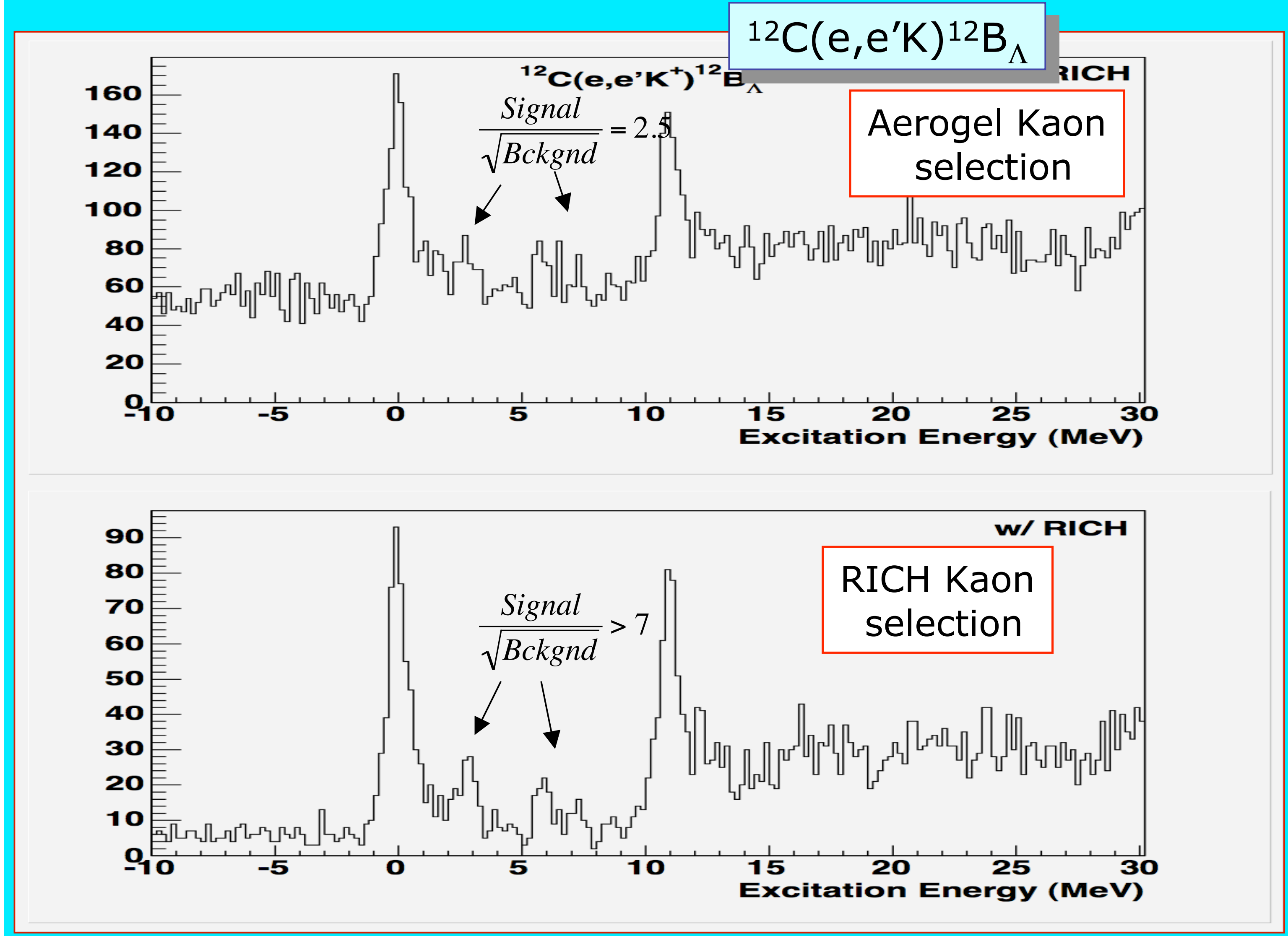


Pion rejection factor ~ 1000

JLAB Hall A E-94107: Preliminary Results on ^{9}Be target



Analysis on $^{12}B_{\Lambda}$ spectrum : Aerogel vs. RICH K-selection



$^{12}C(e,e'K)^{12}B_{\Lambda}$

Aerogel Kaon selection

$$\frac{Signal}{\sqrt{Bckgnd}} = 2.5$$

RICH Kaon selection

$$\frac{Signal}{\sqrt{Bckgnd}} > 7$$

E94-107 $^{12}C(e,e'K)^{11}{}_{\Lambda}B$

σ_{sp}= 4.47 nb/(GeV sr^2

σ_{th}= 4.68 nb/(GeV sr^2)

good agreement with theory

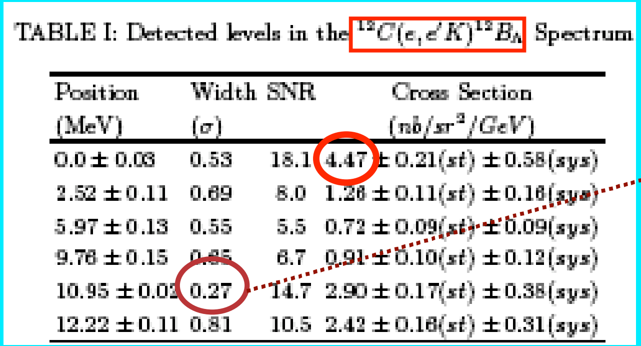
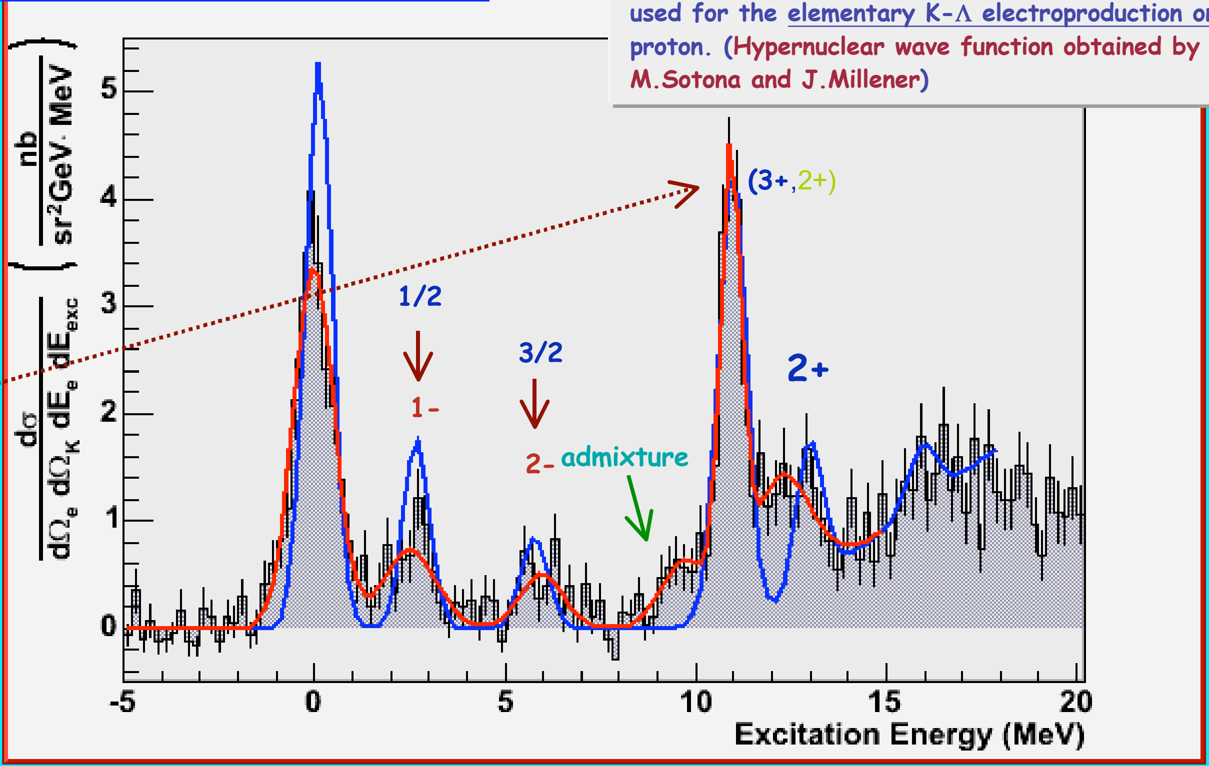


TABLE I: Detected levels in the $^{12}C(e,e'K)^{12}B_{\Lambda}$ Spectrum

Position (MeV)	Width (σ)	SNR	Cross Section ($nb/sr^2/GeV$)
0.0 ± 0.03	0.53	18.1	4.47 ± 0.21(st) ± 0.58(sys)
2.52 ± 0.11	0.69	8.0	1.28 ± 0.11(st) ± 0.16(sys)
5.97 ± 0.13	0.55	5.5	0.72 ± 0.09(st) ± 0.09(sys)
9.76 ± 0.15	0.65	6.7	0.91 ± 0.10(st) ± 0.12(sys)
10.95 ± 0.02	0.27	14.7	2.90 ± 0.17(st) ± 0.38(sys)
12.22 ± 0.11	0.81	10.5	2.42 ± 0.16(st) ± 0.31(sys)

Red line: Fit to the data ***Blue line***: *Theoretical* curve: Sagay Saclay-Lyon (*SLA*) used for the elementary K-Λ electroproduction on proton. (Hypernuclear wave function obtained by M.Sotona and J.Millener)



The energies of the 1/2- and 3/2- levels of the core are raised primarily by the S_N term because the interaction I_N. S_N changes the spacing of the core levels (the magnitude can be changed by changing S_N or changing the p-shell w.f. of the core)

-energy resolution ~ 635 KeV, the best achieved in hypernuclear production experiments

-first clear evidence of excited core states at ~2.5 and 6.5 MeV with high statistical significance

-the width of the strong p_{Λ} peak and the distribution of strength within several MeV on either side of this peak can put constraints on the hypernuclear structure calculations

-hint for a peak at 9.65 MeV excitation energy (admixture)

The RICH Upgrade

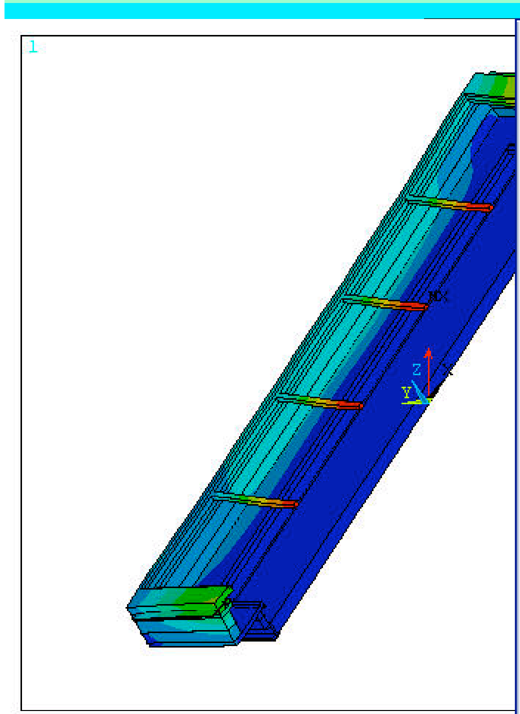
Larger proximity-focusing gap, smaller geometric error, better resolution, but larger photodetection plane is required

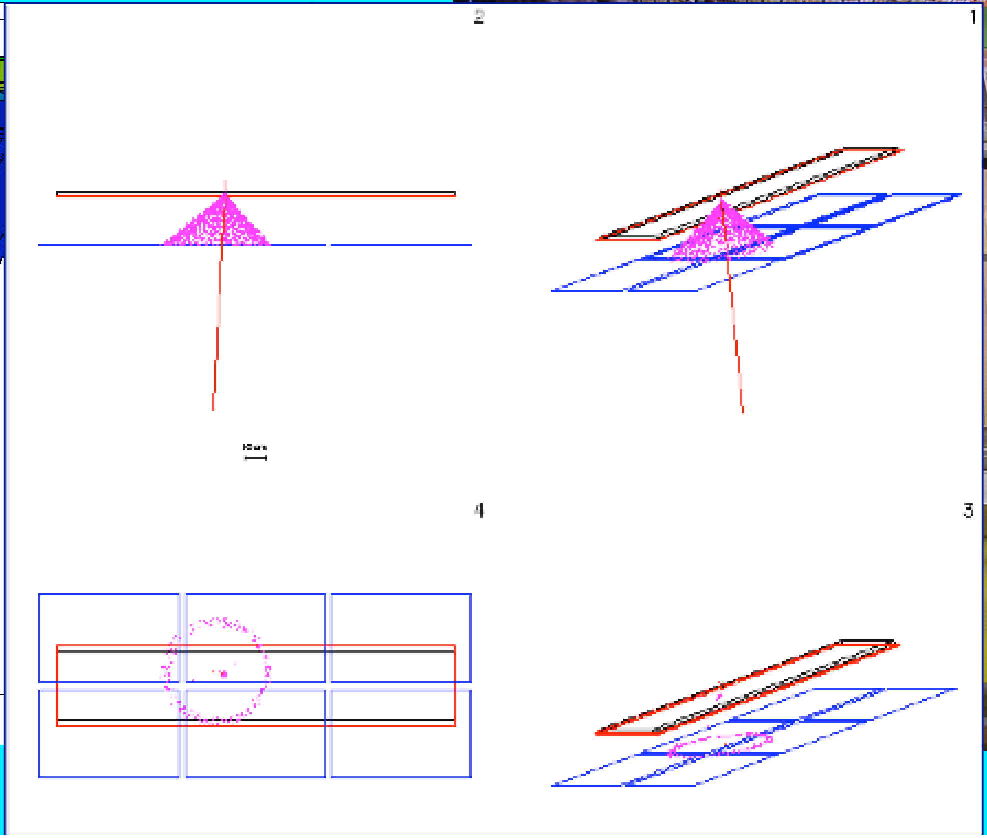
Photodetection area increased by 5/3

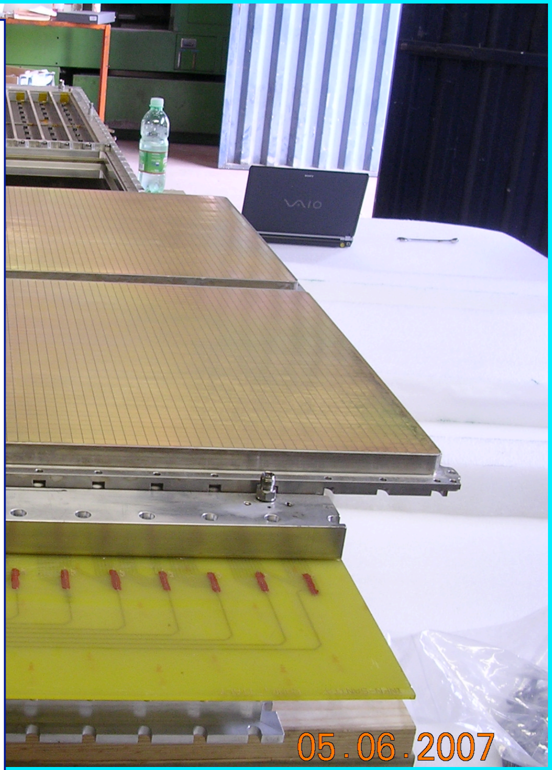
We already have electronics to readout pads separately

Different radiator to match the momentum?

Not practical not needed



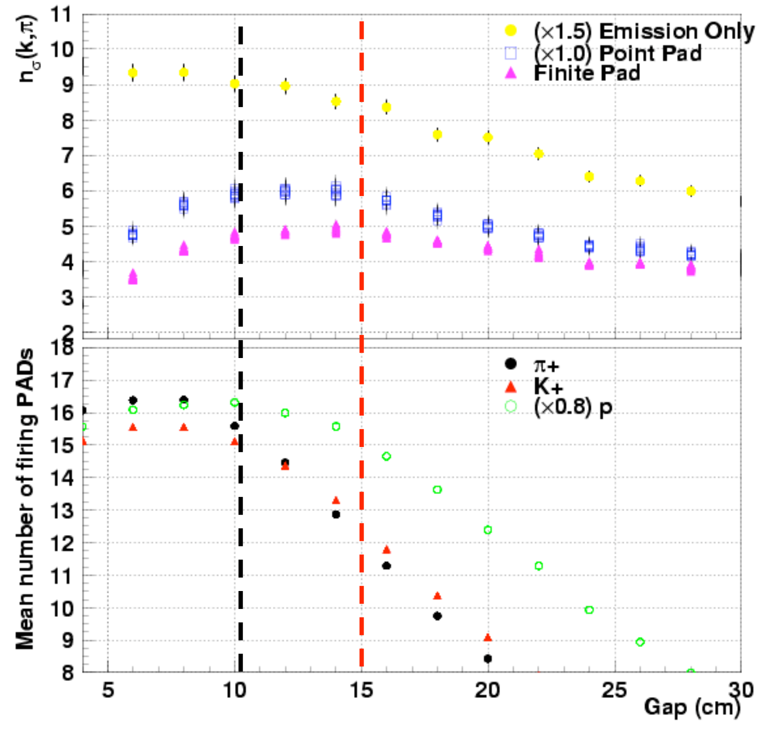


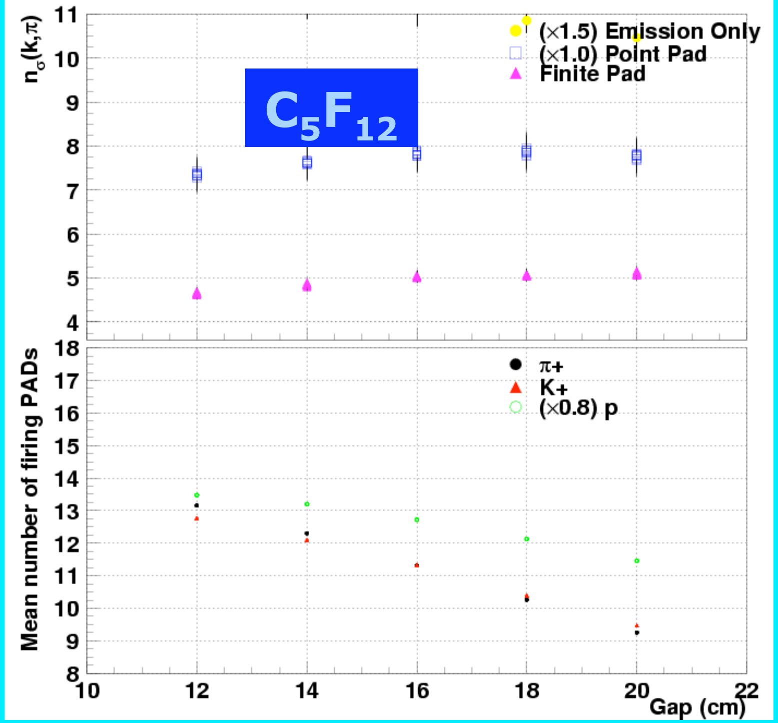


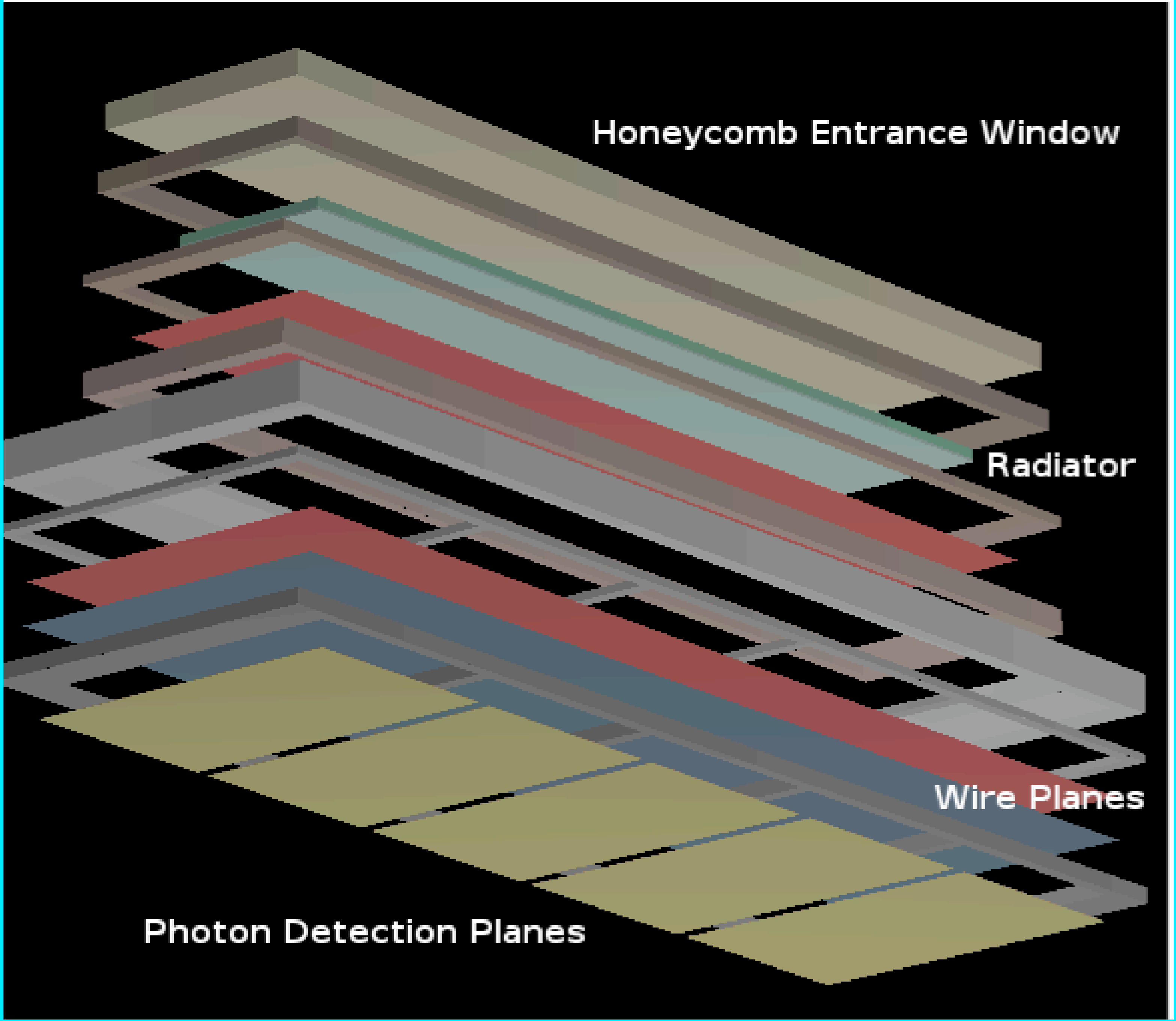
RICH Upgrade

Transversity needs: $\pi : K$ rejection $\sim$ 1:1000 at 2.4 GeV/c

Original RICH at 2.4 GeV/c: $\Delta\theta \sim 4.1\sigma \Rightarrow \pi : K \sim 1 : 140$





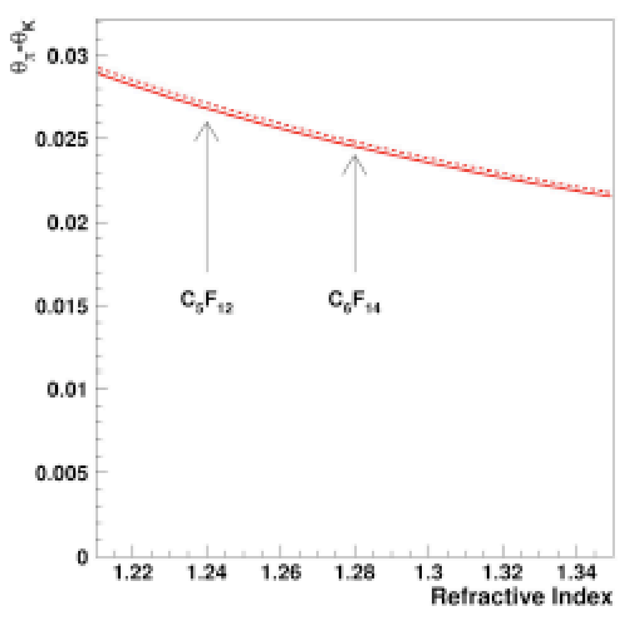

Honeycomb Entrance Window
Radiator
Wire Planes
Photon Detection Planes

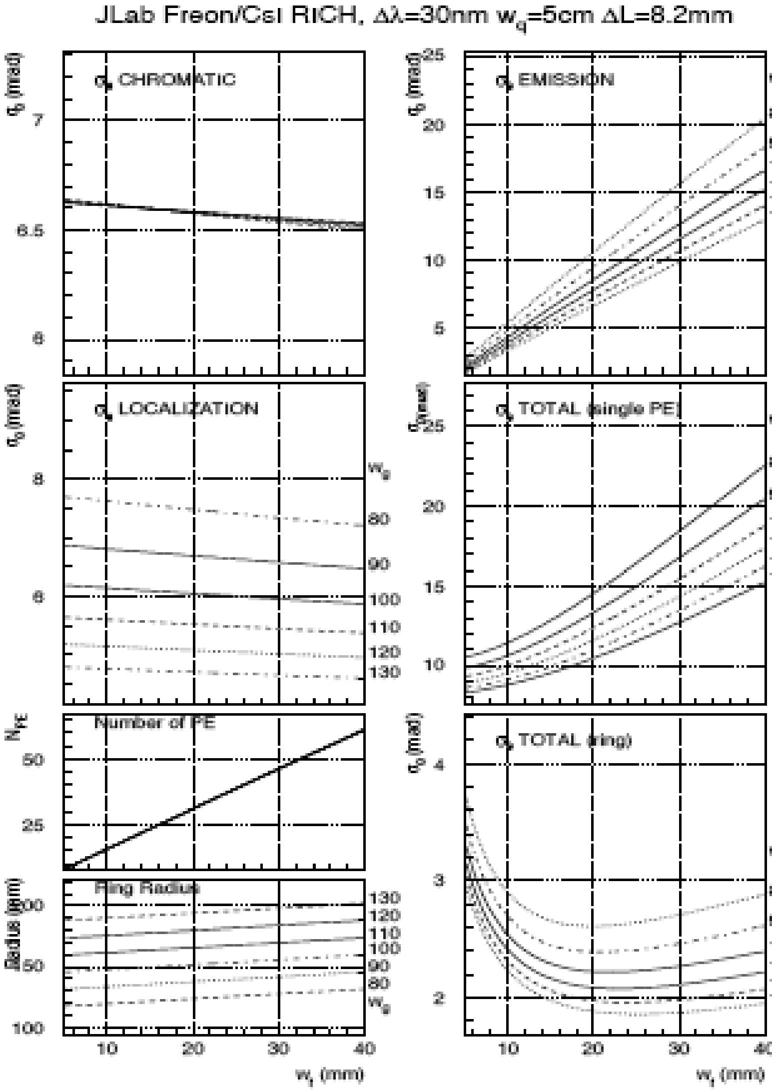
Relevant parameters in Proximity Focusing RICH id

$$\Delta\theta_{LOCAL.} \sim L_{PAD}/(w_f + w_g)$$
$$\Delta\theta_{EMIS.} \sim w_f / w_g$$

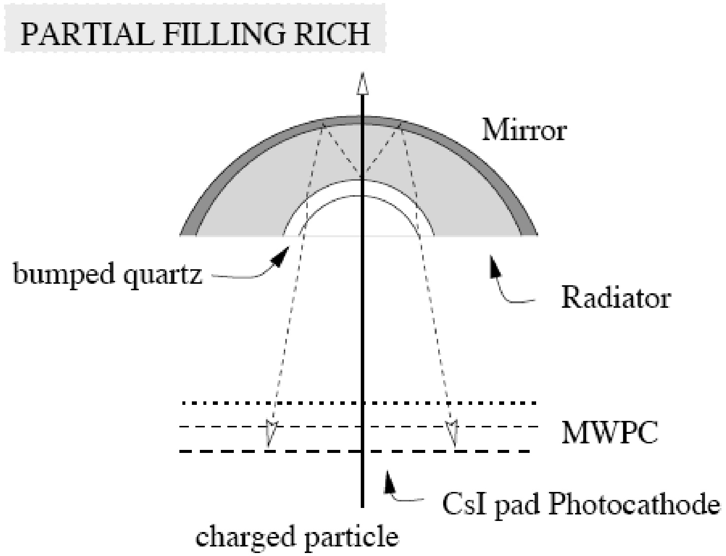
(L_{PAD} pad size; w_f, w_g freon, gap widths)

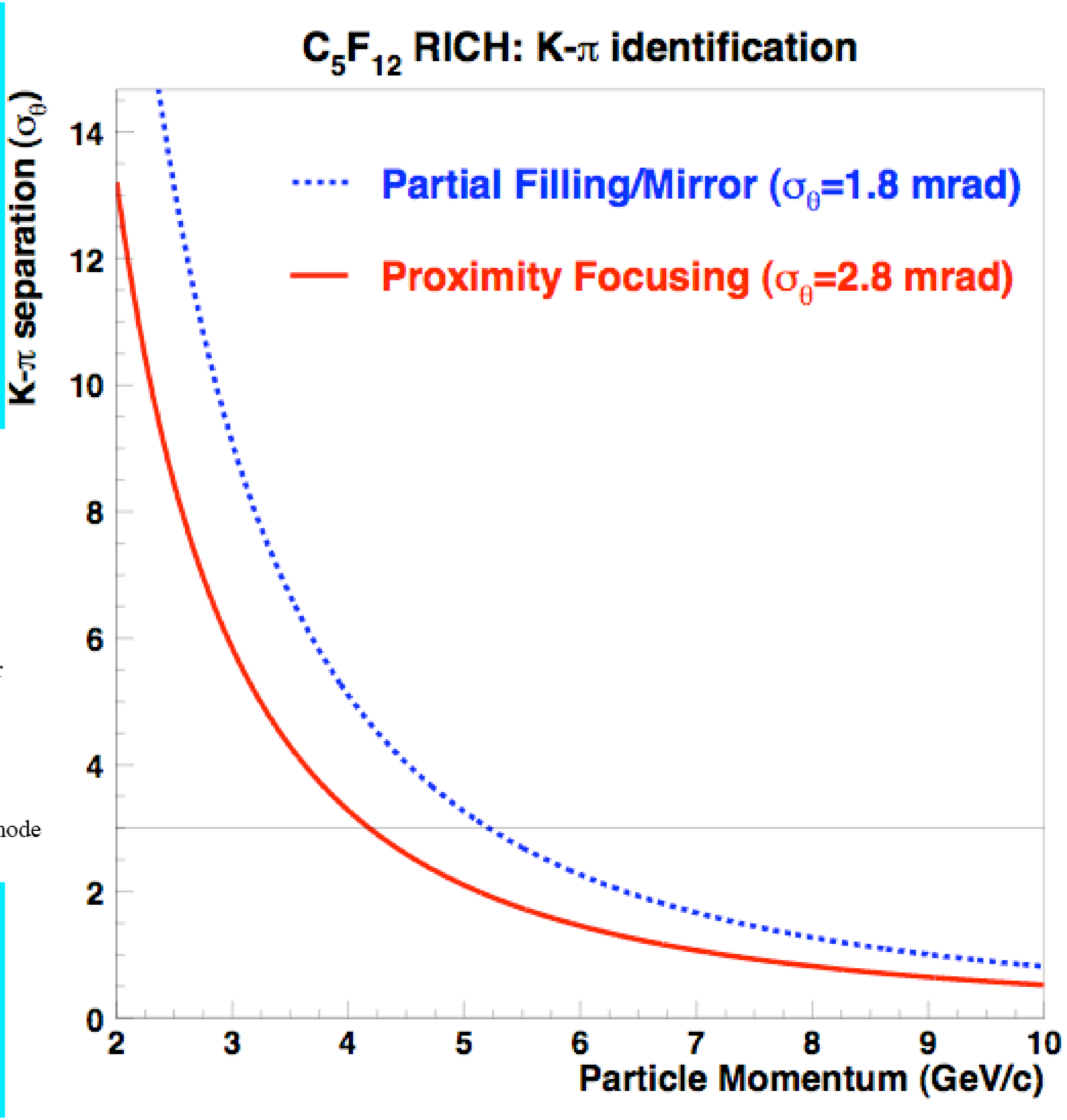
θ_K - θ_π (depends from n for fixed p)



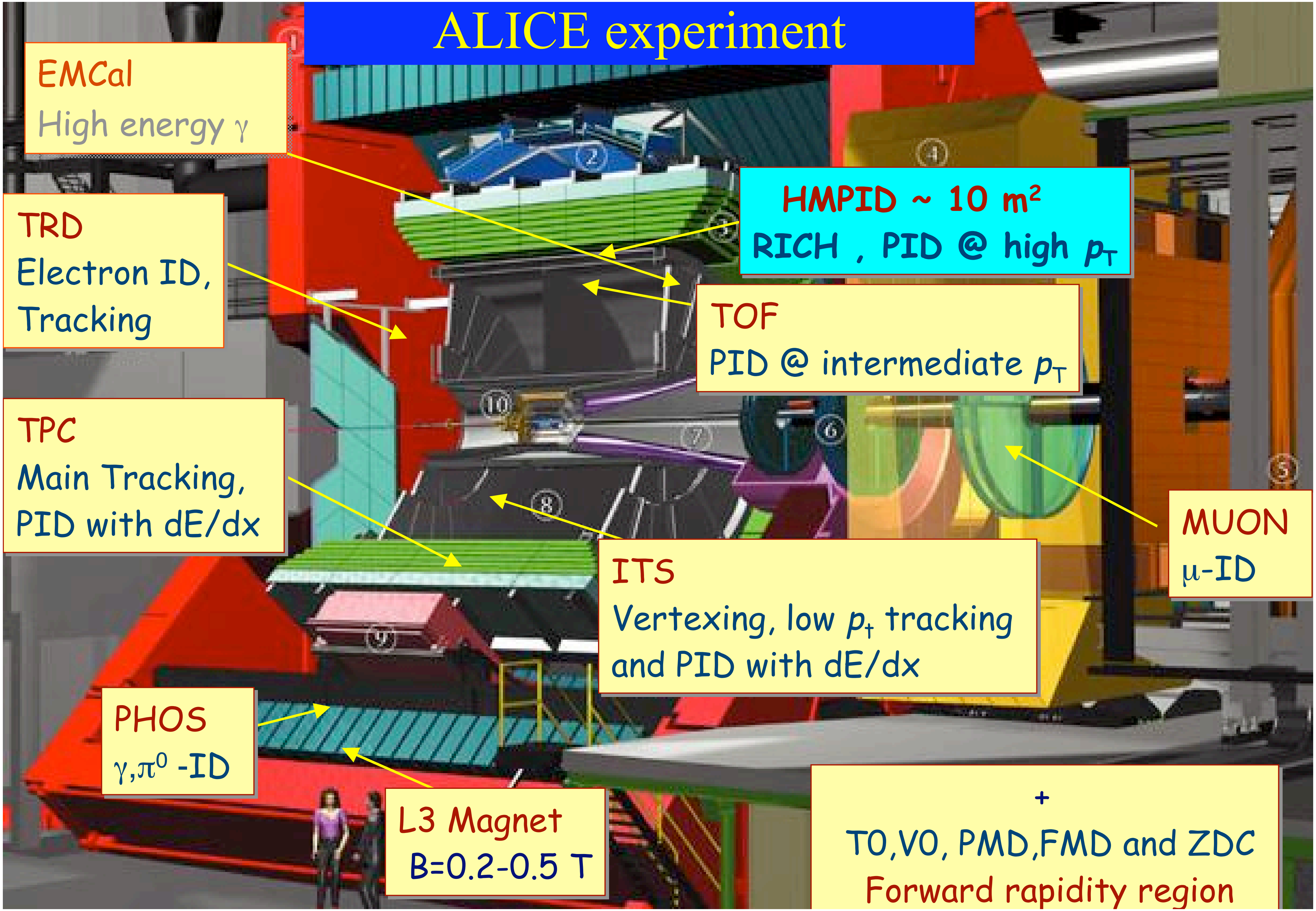


(Smaller n) or (longer gap) or (smaller pad) ⇒ better identification


PARTIAL FILLING RICH
Mirror
bumped quartz
Radiator
MWPC
CsI pad Photocathode
charged particle


C_5F_{12} RICH: K-π identification
K-π separation (σ_θ)
0
2
4
6
8
10
12
14
2
3
4
5
6
7
8
9
10
Particle Momentum (GeV/c)
Partial Filling/Mirror (σ_θ=1.8 mrad)
Proximity Focusing (σ_θ=2.8 mrad)

ALICE experiment



EMCal
High energy γ

TRD
Electron ID,
Tracking

TPC
Main Tracking,
PID with dE/dx

PHOS
γ,π^0 -ID

HMPID ~ 10 m^2
RICH , PID @ high p_T

TOF
PID @ intermediate p_T

MUON
μ-ID

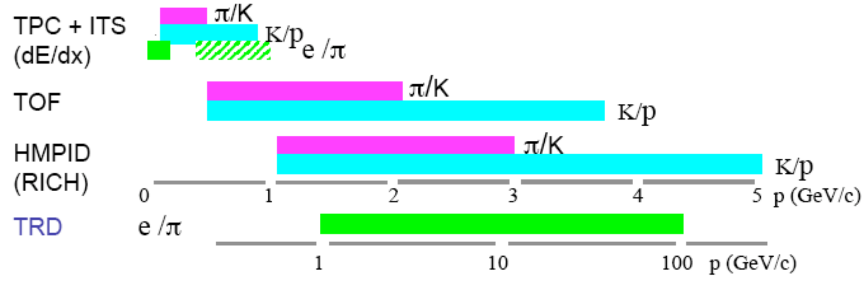
ITS
Vertexing, low p_t tracking
and PID with dE/dx

L3 Magnet
B=0.2-0.5 T

+
T0,V0, PMD,FMD and ZDC
Forward rapidity region

ALICE VHMPID

presently →



- **HMPID cannot identify charged particles with momentum above $p > 5$ GeV/c**

- **ALICE-HMPID collaboration is studying the possibility to built a new detector to identify charged particles with momentum $p > 10$ GeV/c → VHMPID (Very High Momentum Particle Identification Detector).**

- **Energy loss o Time of Flight measurements don't allow to identify track-by-track in such momentum range. Cherenkov counters represent the only solution;**

- **A combination of a gas with low value of refractive index, with the proven concept of large area CsI photocathodes, has been considered.**

VHMPID

Radiator gas

- CF_4 ($n \approx 1.0005$, $\gamma_{th} \approx 31.6$) has the drawback to produce scintillation photons ($N_{ph} \approx 1200$/MeV), that increase the background.
- C_4F_{10} ($n \approx 1.0014$, $\gamma_{th} \approx 18.9$) is no more commercially available.
- **C_5F_{12}** ($n \approx 1.002$, $\gamma_{th} \approx 15.84$) **has been chosen**. This gas is used in the DELPHI RICH detector.

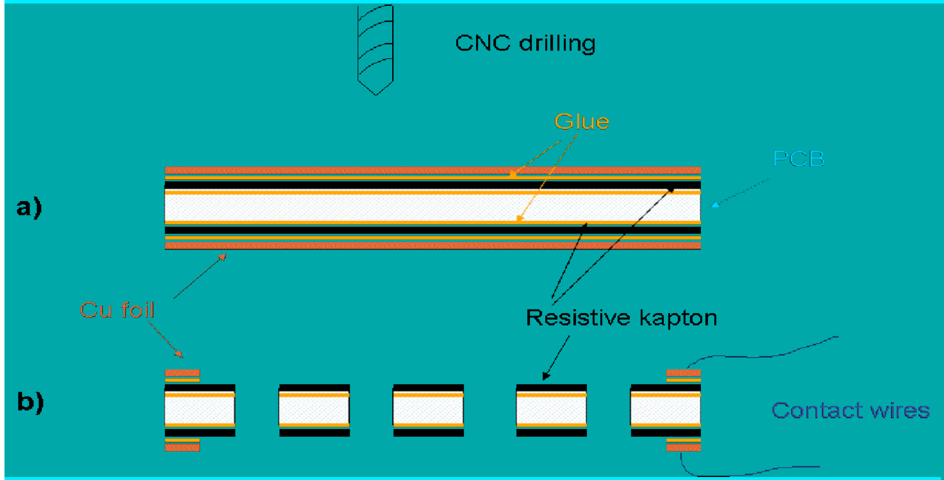
Photon detector

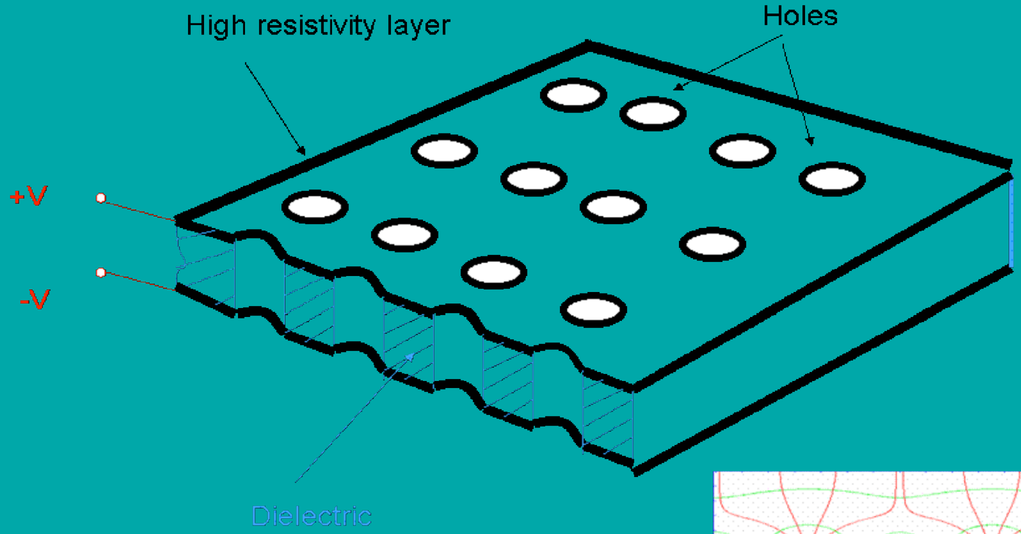
. Pad-segmented CsI photocathode is combined with a MWPC with the same structure and characteristic of that used in the HMPID detector.

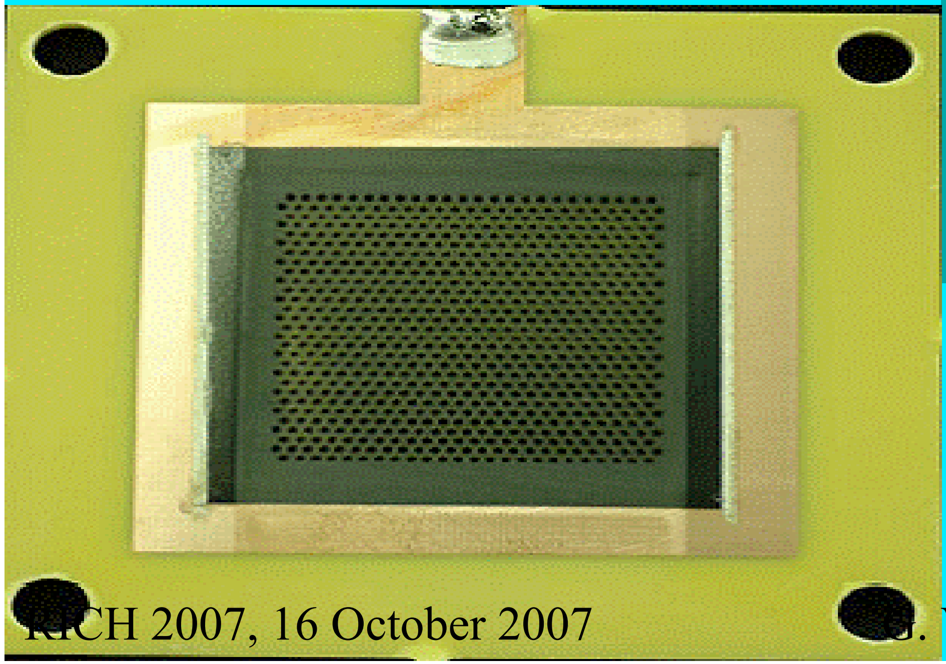
- The gas used is CH_4, the pads size is $0.8x\ 0.84\ cm^2$ (wire pitch 4.2 mm), and the average single electron pulse height is of 34 ADC channels (1 ADC = 0.17 fC ≈ 1000 e^-) at 2050 V.
- The chamber is separated from the radiator by a CaF_2 window (4 mm of thickness).

Photon detector

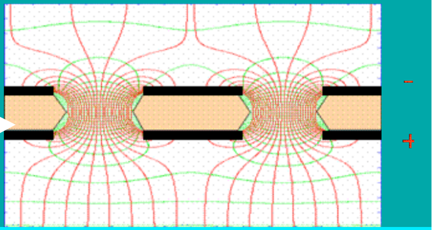
An other option for the photon detector could be a GEM-like detector combined with a CsI photocathode (higher gain, photons feedback suppression).







Principles of operation



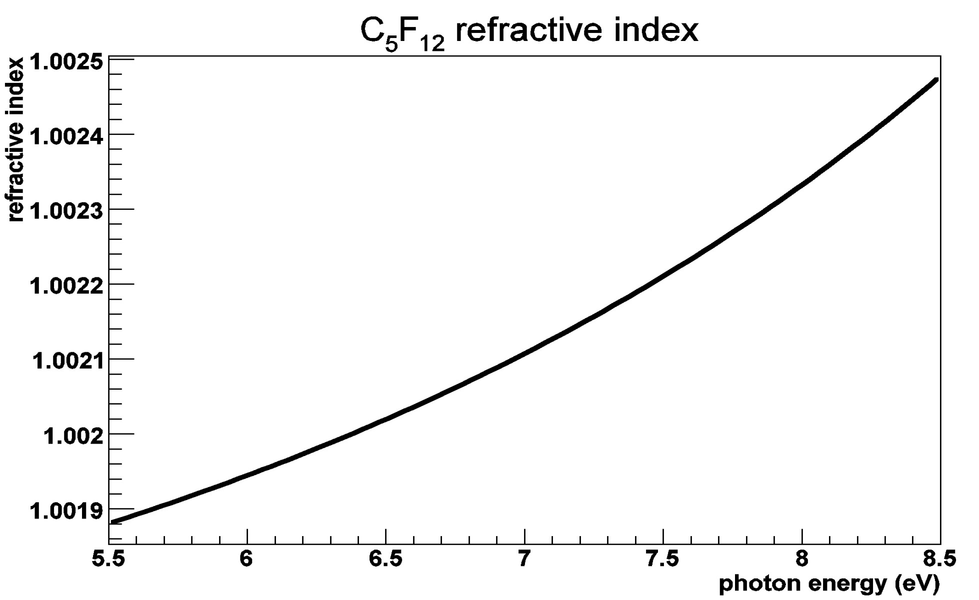
(V. Peskov)

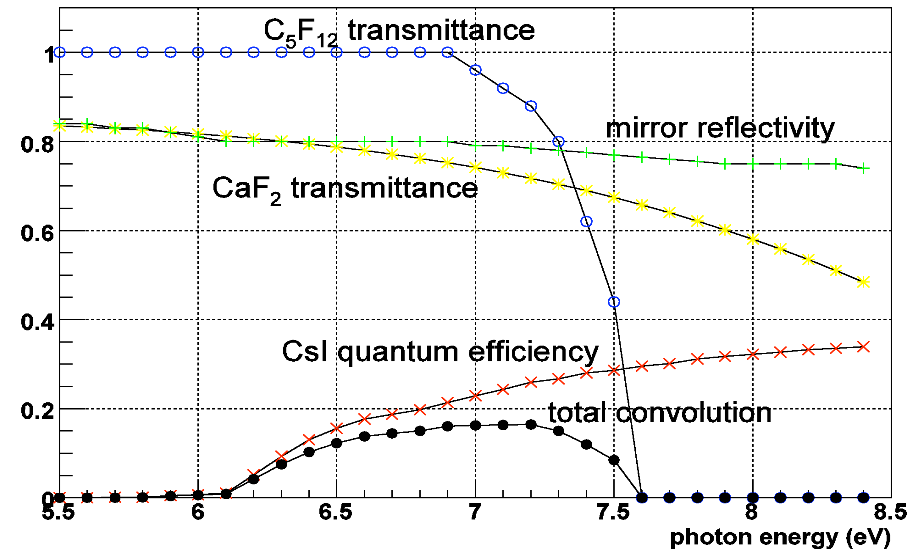
VHMPID

The simulation has been executed using AliRoot, the official simulation framework of the ALICE experiment.

C_5F_{12} refractive index as a function of photon energy

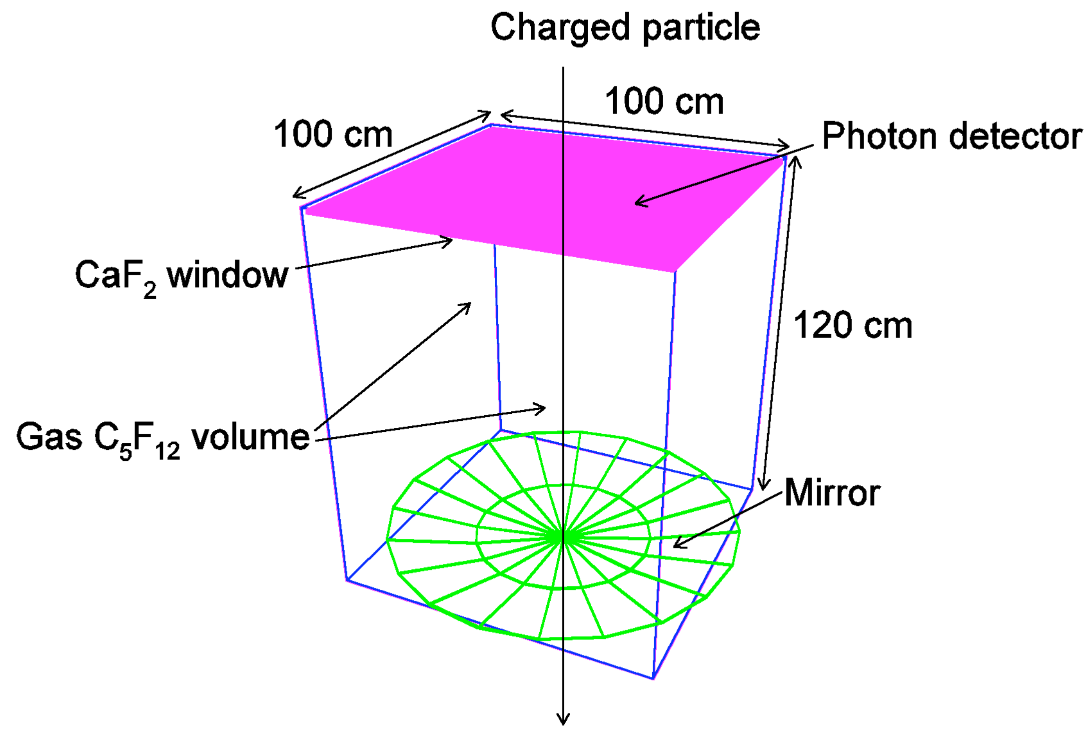
Material photon transmittances and CsI photocathode quantum efficiency





Studied setup

Focusing setup: the focusing properties of a spherical mirror of radius R = 240 cm, are exploited. The photons emitted in the radiator are focused in a plane that is located at R/2 from the mirror center, where the photon detector is placed.



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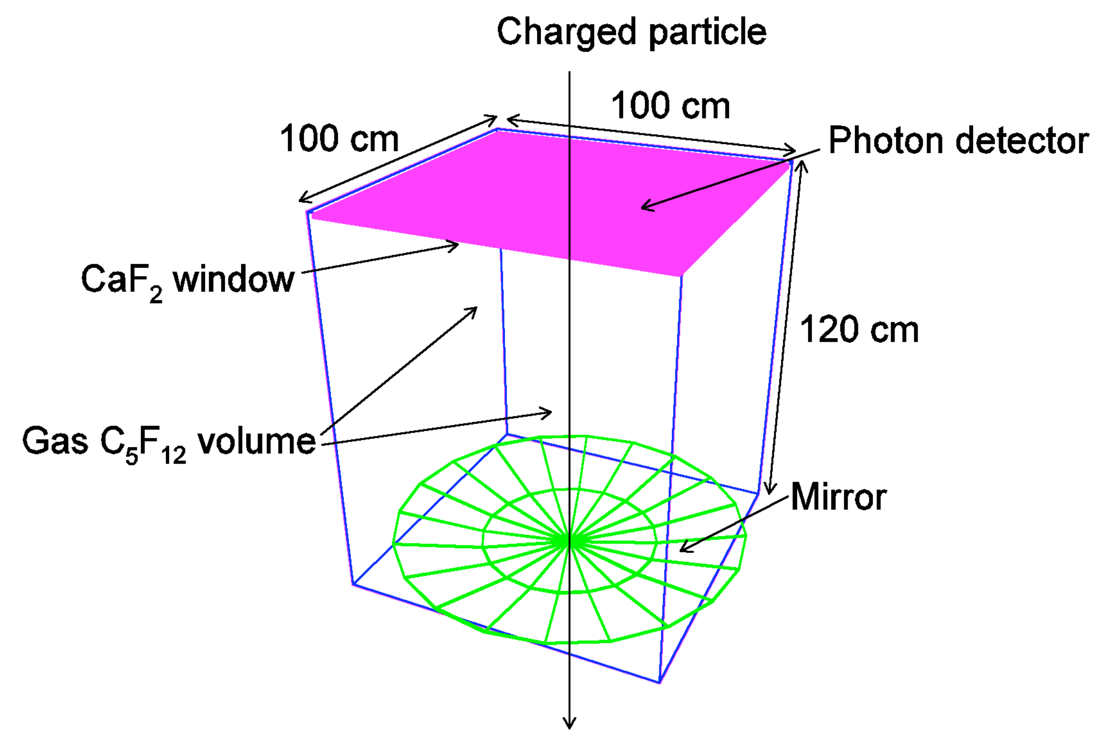
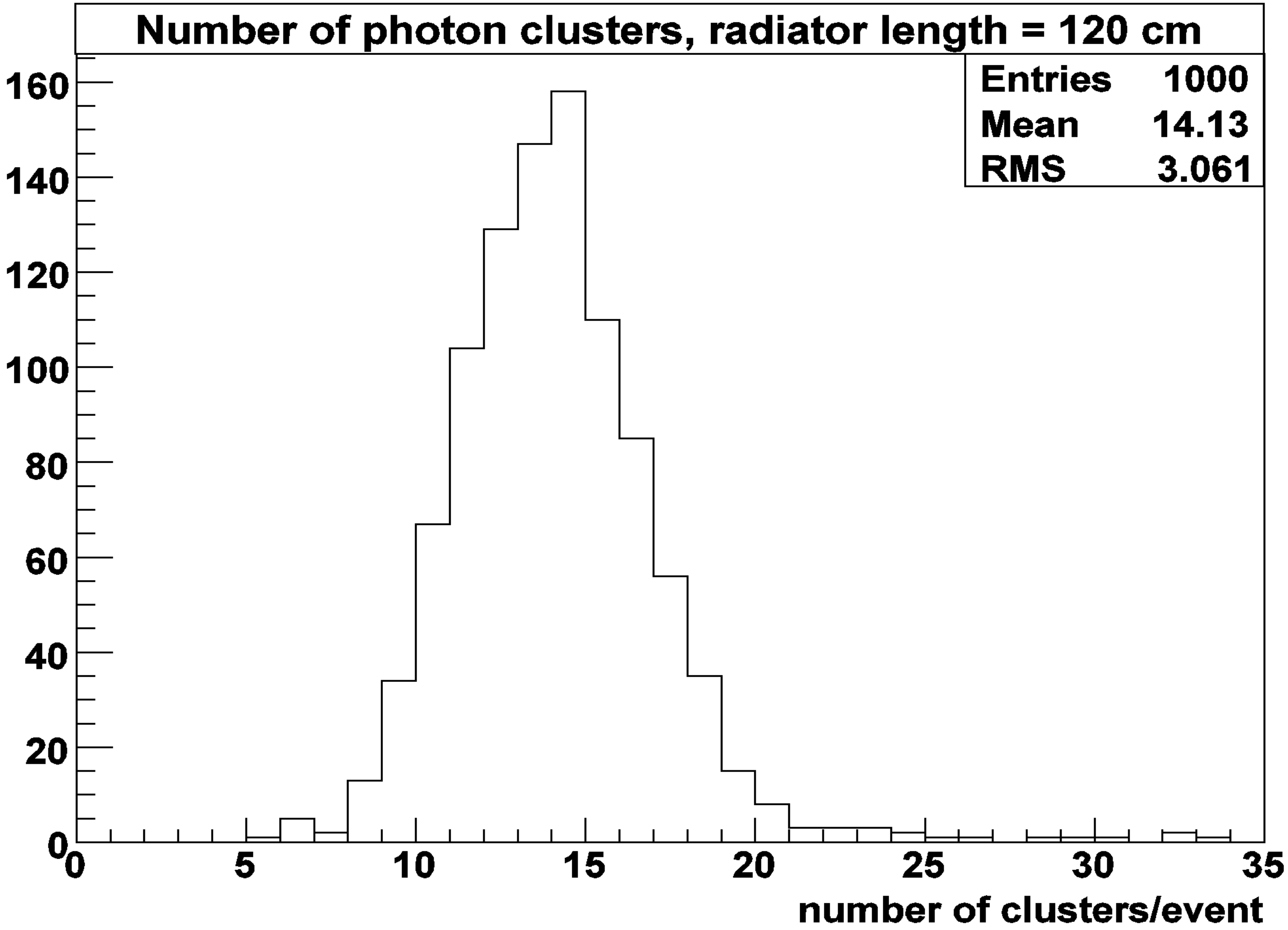
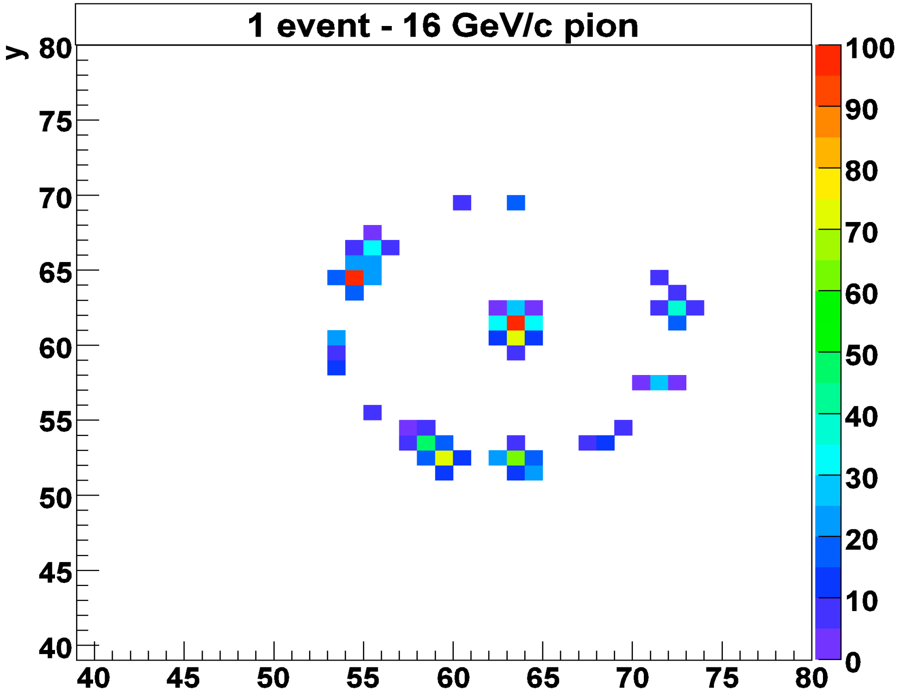
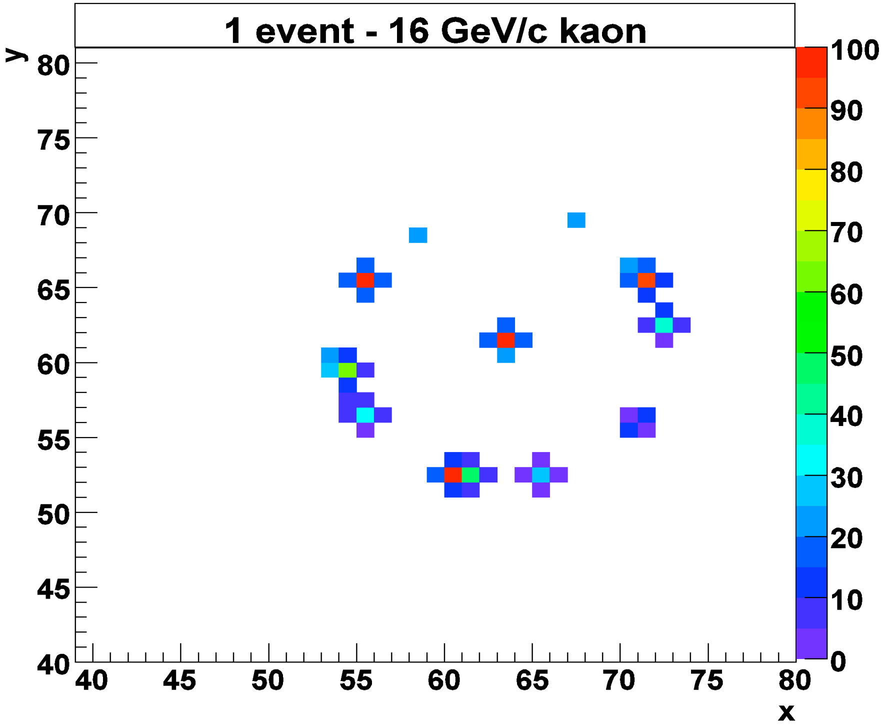


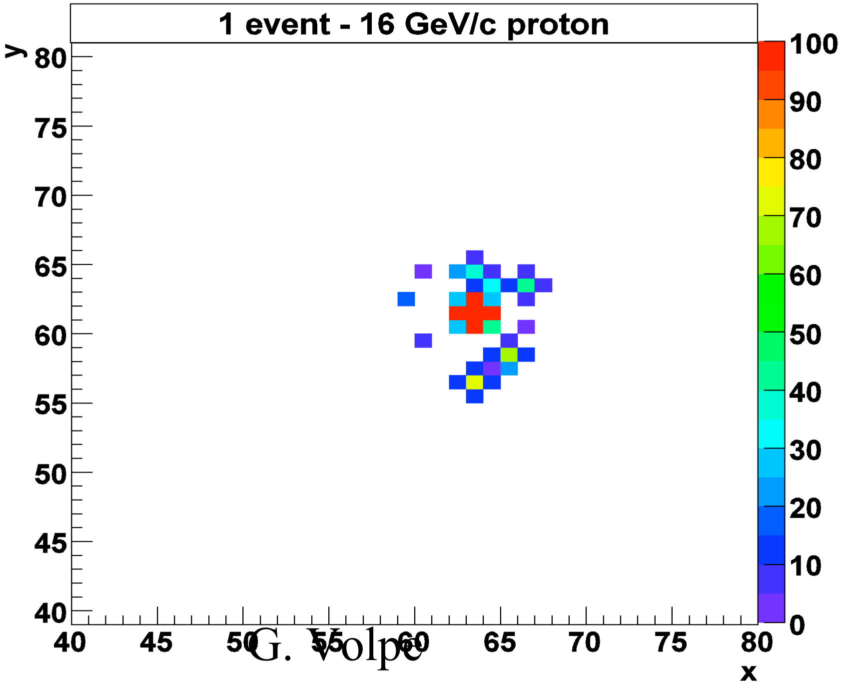
Photon ring topology: focusing setup

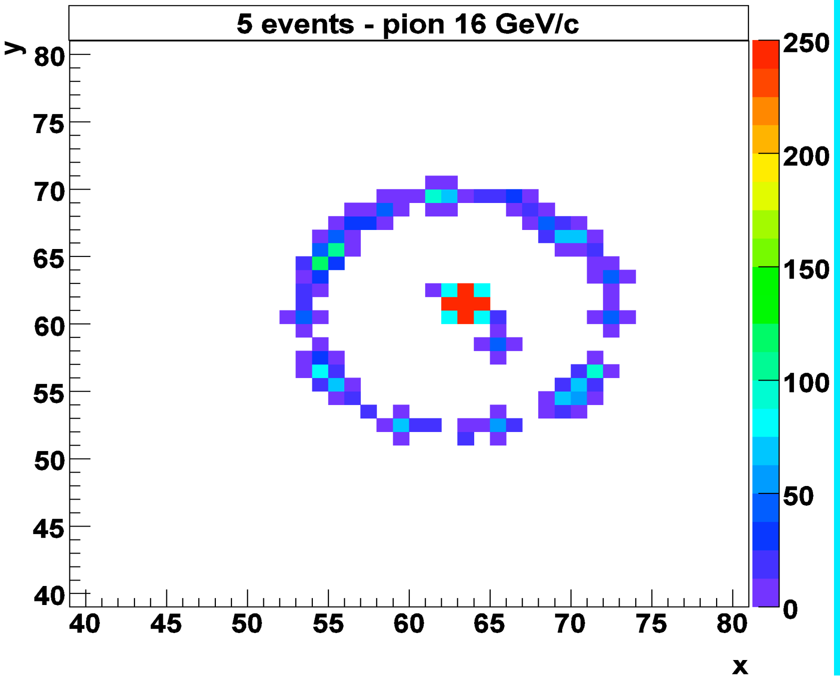
$N_{ph}(\beta = 1) \approx (1.4\ \mathrm{eV}^{-1}\mathrm{cm}^{-1})\cdot(3\ \mathrm{eV})\cdot(120\ \mathrm{cm}) \approx 500$

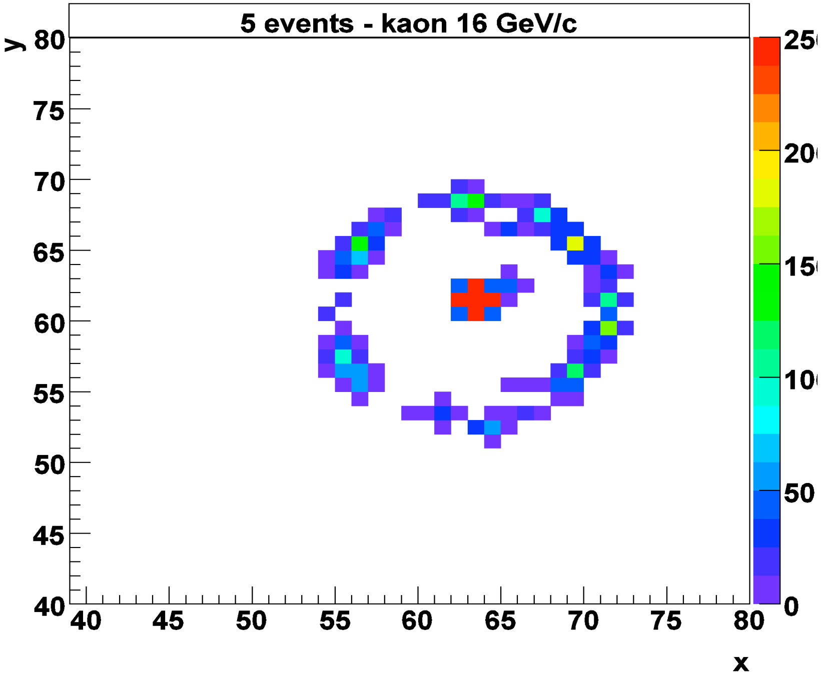


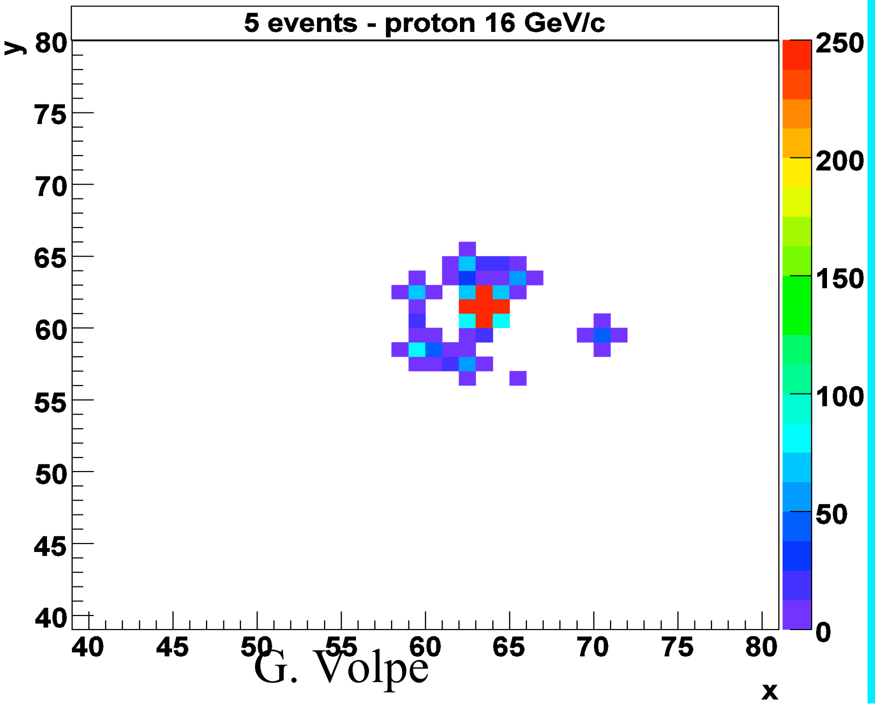

1 event - 16 GeV/c pion


1 event - 16 GeV/c kaon

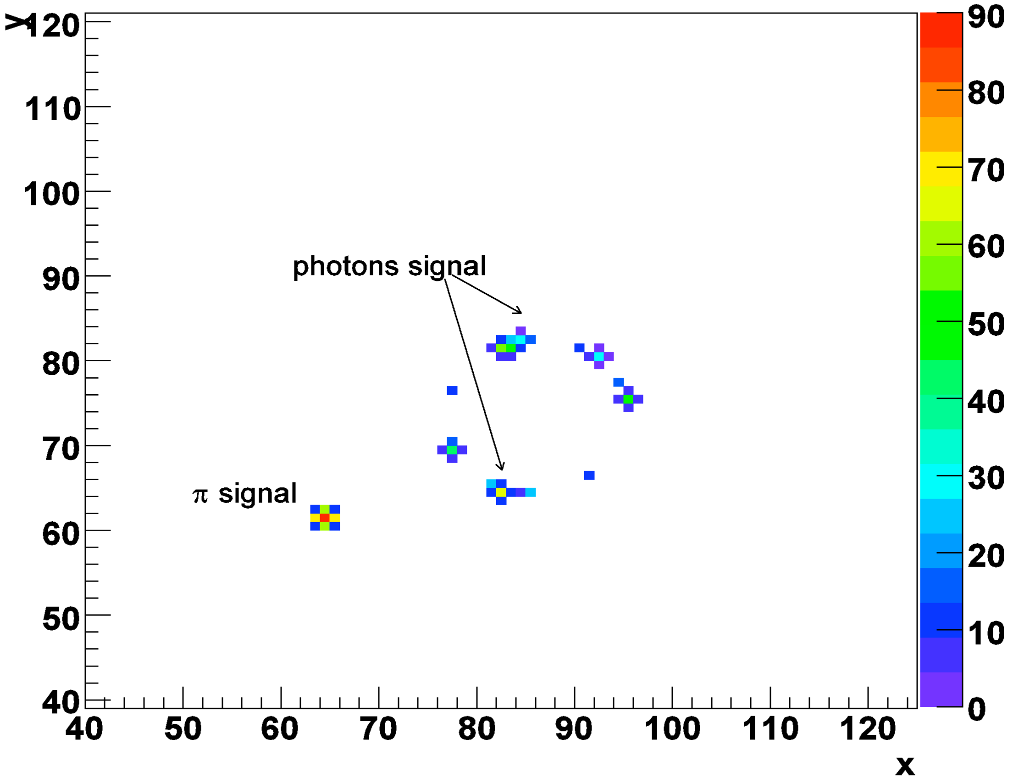

1 event - 16 GeV/c proton

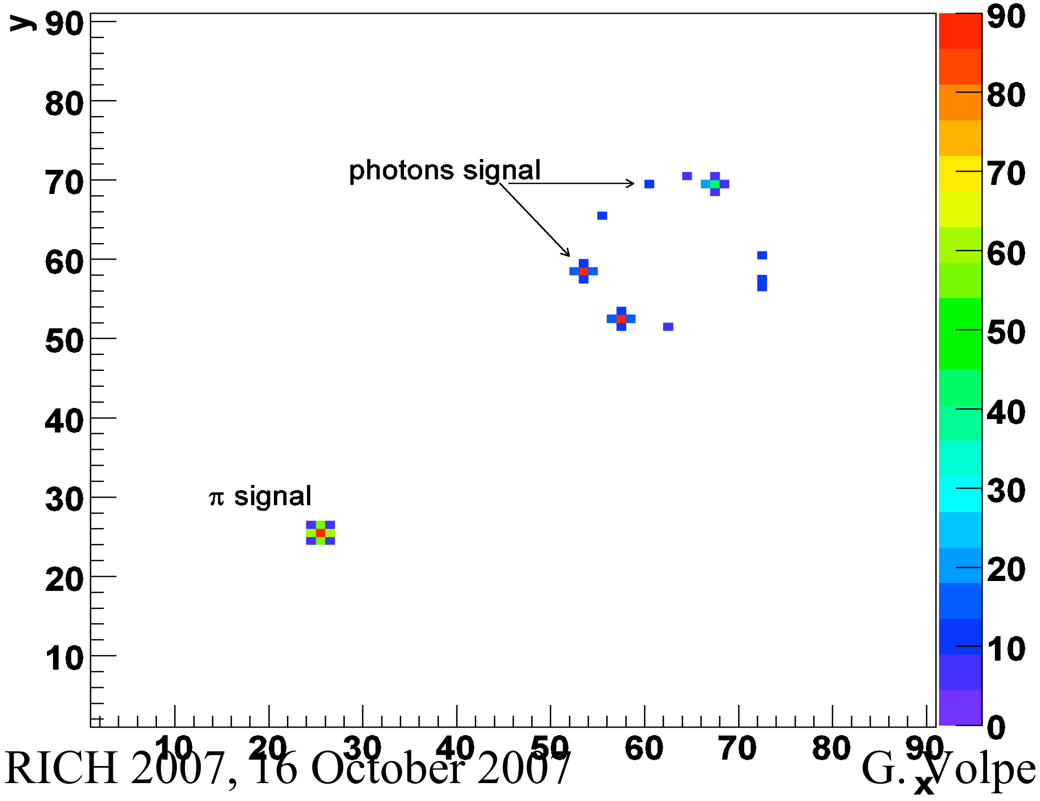

5 events - pion 16 GeV/c


5 events - kaon 16 GeV/c


5 events - proton 16 GeV/c

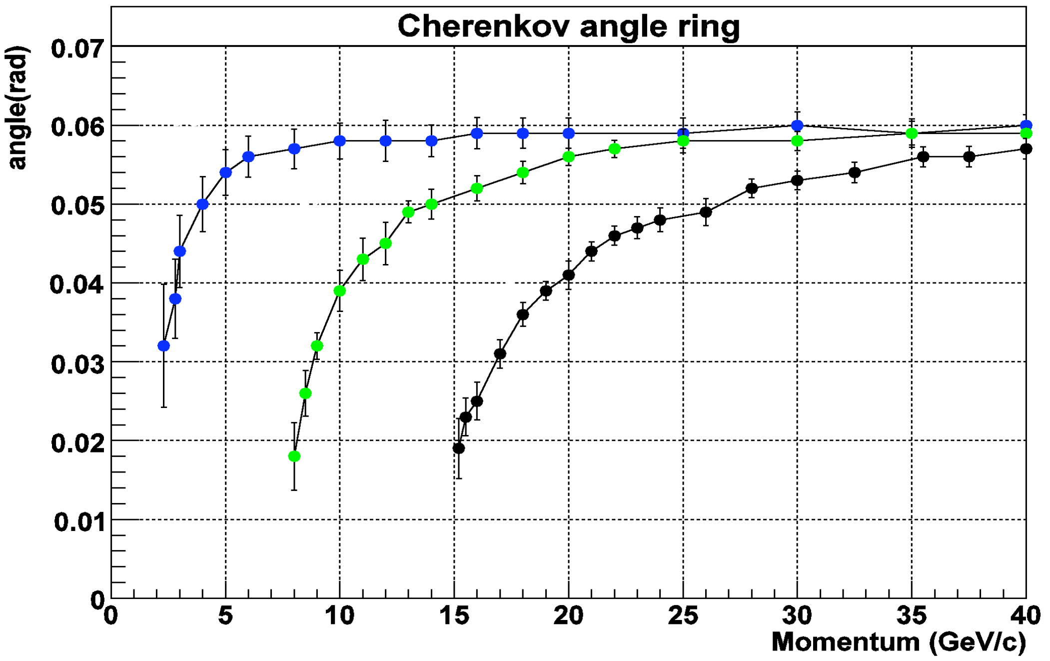
Track inclination angle = 10°





Orthogonal track displaced 40 cm from the detector center.

Simulation results: Cherenkov angle



The points and the bars in the plot correspond to mean and RMS of a sample of 100 events, respectively

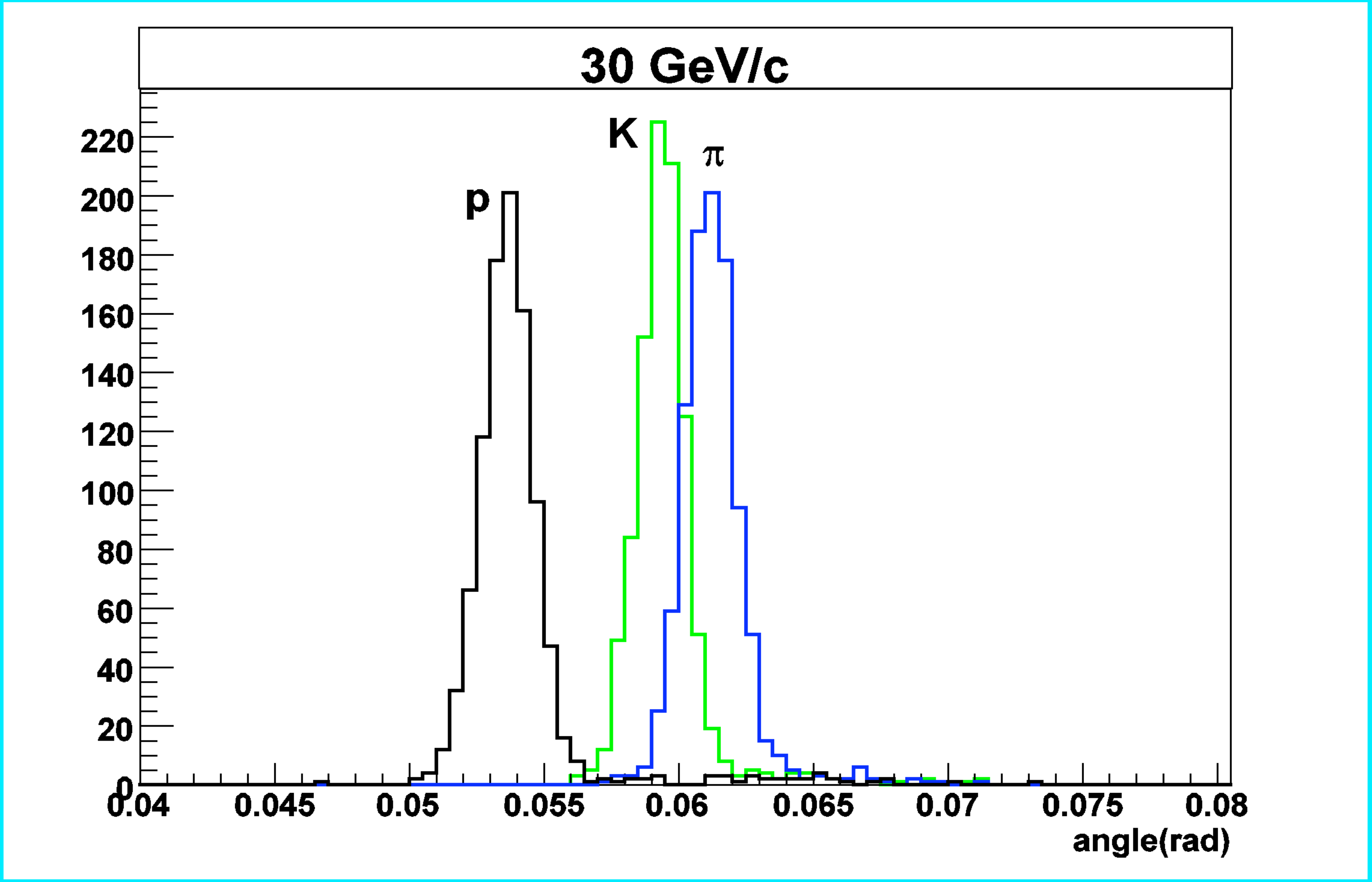
π

K

p

Momentum	C_5F_{12}	Particle Id.
< 2.5 GeV/c	0	?
2.5< p < 8 GeV/c	1	π
2.5 < p < 8 GeV/c	0	K, p
8 < p < 15 GeV/c	1	π, K
8 < p < 15 GeV/c	0	p
15 < p < 30 GeV/c	1	p

Simulation results: Cherenkov angle



Conclusions

- The RICH detector has been successfully operated in Hall A during the hypernuclear experiment at Jlab (π/K rejection ratio ~1000)

- Upgrade underway to increase momentum range (2.4 GeV/c) for π/K

(separation (1:1000) (~ p = 5.5 GeV/c (or more (fine tuning of different parameters)) is the limit (π,K) with possible further upgrade (radiator thickness + focusing) (higher p if separation with 3 or 4 sigma))

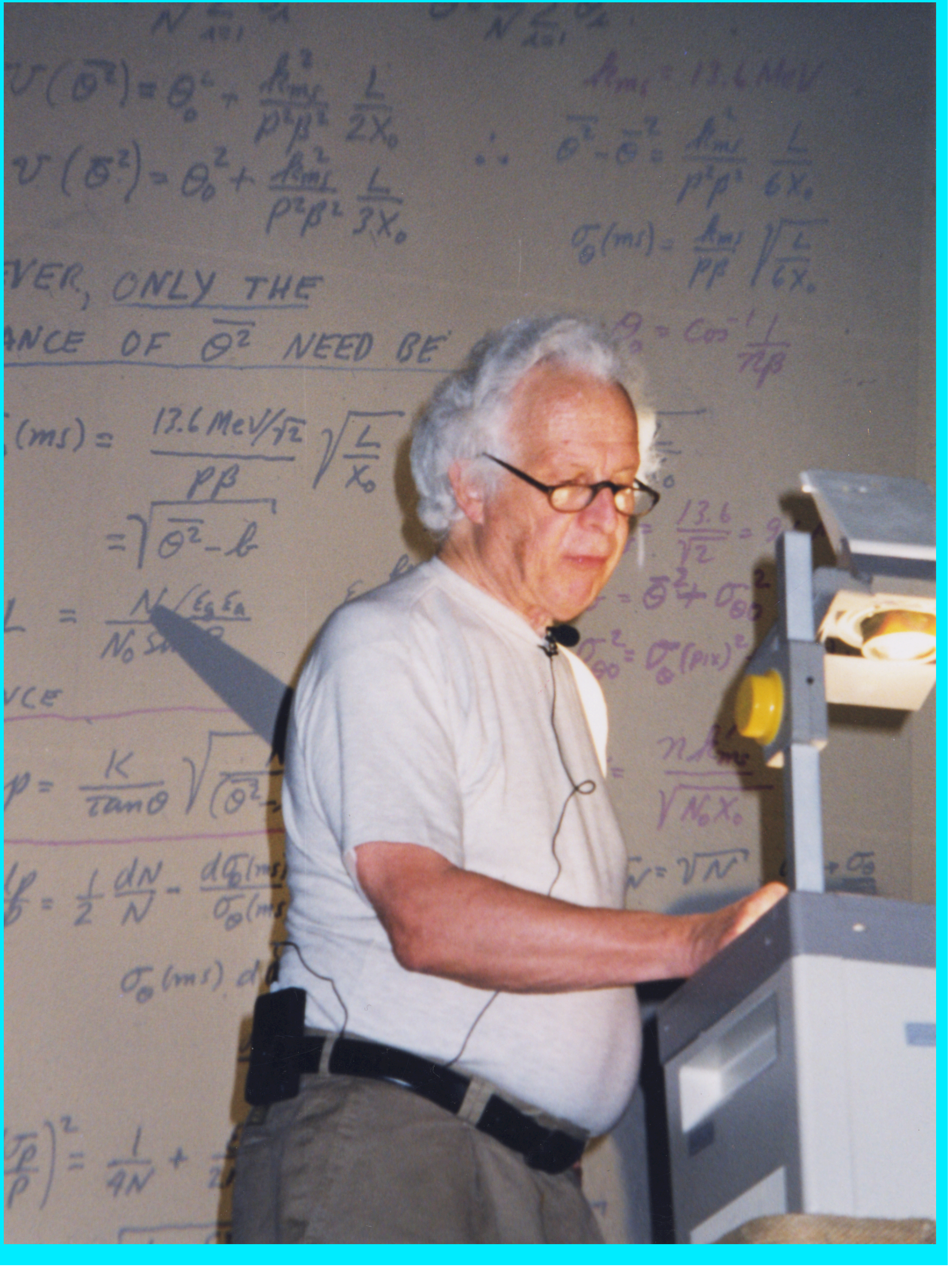
- Many parameter parameters to be monitored (radiator purity,air/humidity etc) but technique(s) well under control (successfully exploited (CERN, Jlab, GSI (HADES))

- Advantages
  - Cost of photocathodes ~ 1/10 (at least) of solid state detectors (PMT's) -
  - Insensitive to magnetic field

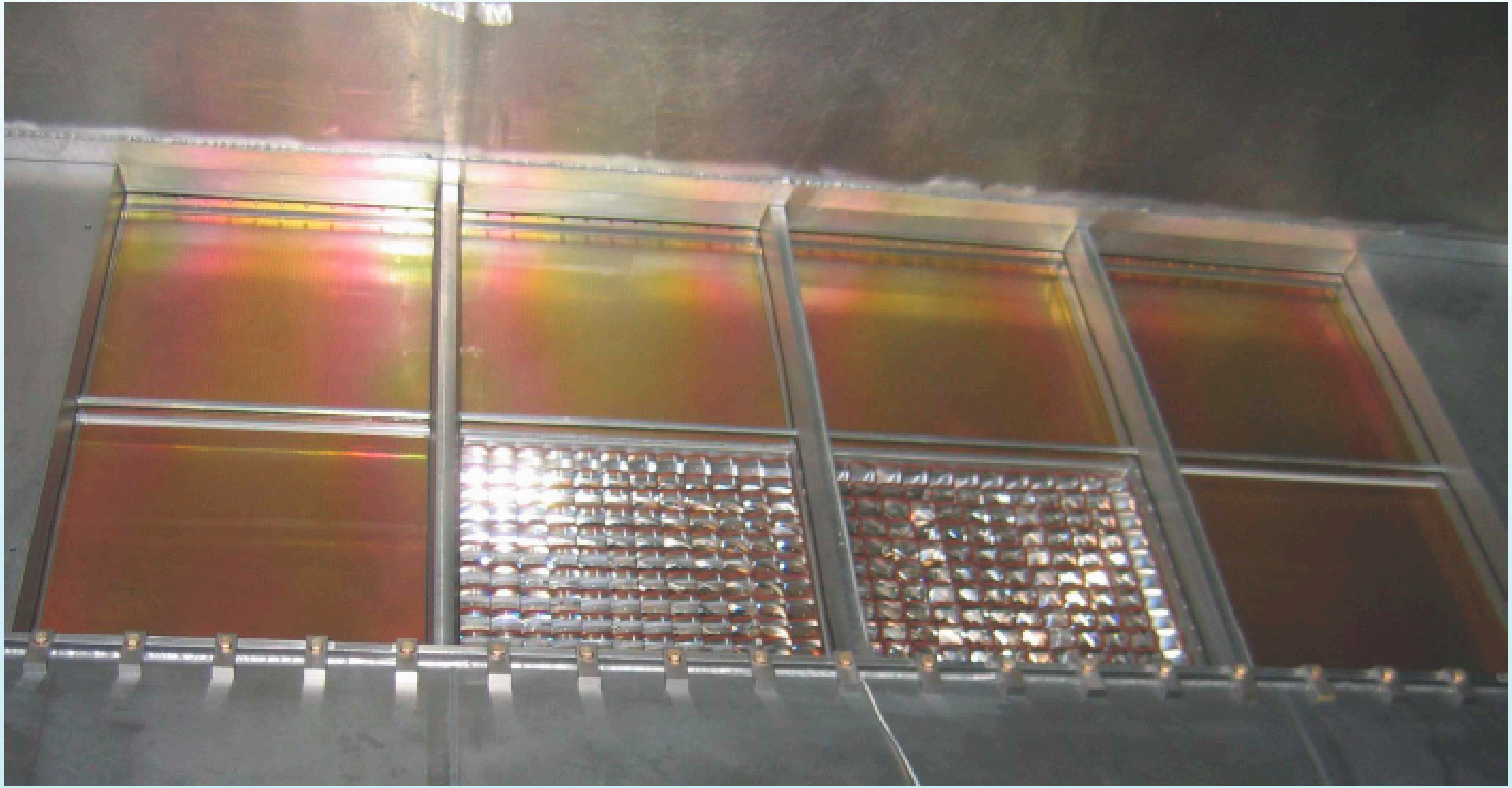
- Limitations
  - Stability at high rates (see Compass) but can be greatly improved by using GEM (see talks at RICH 2007 Conference)
  - Np.e, chromatic error

Development of **Cherenkov Light Imaging Techniques** is a lively and fertile field of research with beneficial feedbacks in many other scientific sectors.

It **would not have advanced** to thepresent state **without Tom Ypsilantis's ideas**, enthusiasm, constructive arguments andoutstanding achievements.



Compass RICH upgrade



UPGRADED RICH PERFORMANCES

INFN Istituto Nazionale di Fisica Nucleare

Sezione di Trieste

much more information in the talk by Federica Sozzi

→ **N_{ph} / ring: almost 60 ($\beta \approx 1$)** *IN THE CENTRAL REGION* **2004 Nph/ring = 14**

→ **σ_{ring} ~ 0.3 mrad ($\beta \approx 1$)** (2004: **σ_{ring} = 0.6 mrad)**

→ **2 σ π/** (2004: **2 σ π/K p=43 GeV/c)**

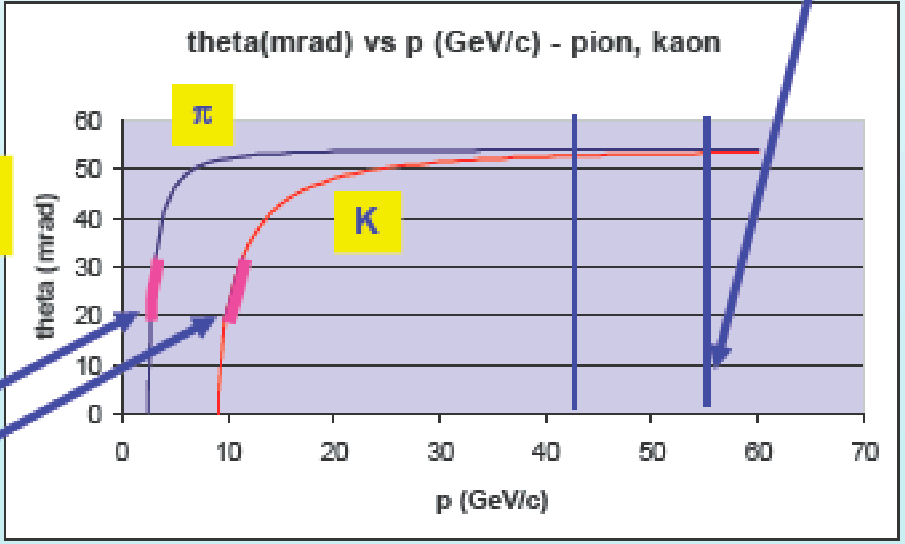
→ **effect**

→ **Time**
(see t

- *photons / ring ($\beta \approx 1$, complete ring in acceptance) : 14*
- *$\sigma_{\theta\text{-}ph}$ ($\beta \approx 1$) : **1.2 mrad***
- *σ_{ring} ($\beta \approx 1$) : **0.6 mrad***
- *2σ π - K separation @ **43 GeV/c***
- *PID efficiency **> 95%***
  (θ_{Ch} > 30 mrad)

except for the very forward region

PID capability extended with the upgrade


theta(mrad) vs p (GeV/c) - pion, kaon

Rich – PID Strategy:

Particle Identification is also based on the following (correlated) quantities :

- Single photon χ^2 distribution (Prob(χ^2 ,n_{dof}))
- log-likelihood function ***L***

For all measured tracks different particle hypothesis (π,K,P) are made, and the corresponding central Cherenkov angles are computed ($\Theta_{\pi/K/P}$)

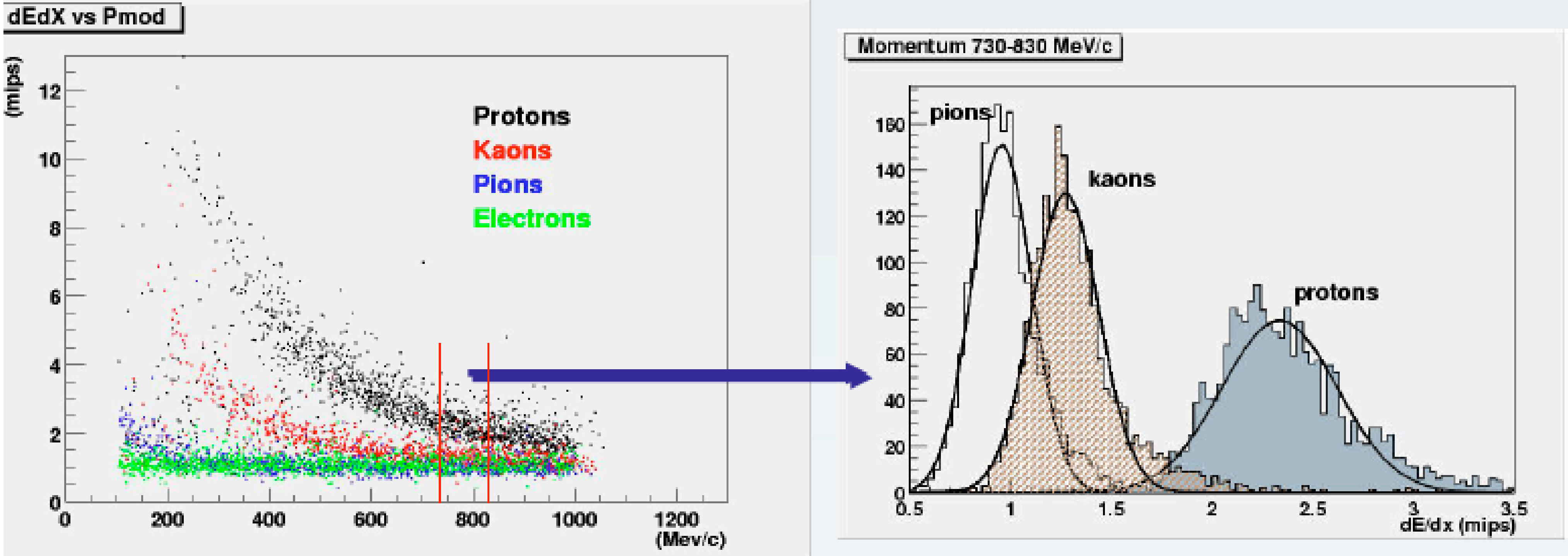
$$\chi^2_{\pi/K/P} = \sum_{cluster\ i} \frac{(\vartheta_i - \theta_{\pi/K/P})^2}{\sigma_{\vartheta_i}{}^2}$$

$$L_{\pi/K/P} = \frac{1}{N} \sum_{cluster\ i} \log\left(1 + \frac{1}{\sqrt{2\pi}\sigma_{\vartheta_i}} e^{-\frac{(\vartheta_i - \theta_{\pi/K/P})^2}{2\sigma^2_{\vartheta_i}}}\right)$$

$$N = \log\left(1 + \frac{1}{\sqrt{2\pi}\sigma_{\vartheta_i}}\right)$$

$L_{\pi/K/P} = n$

Weighted number
of reconstructed hits



(example: ALICE-ITS simulati

$$\mathit{fficiency} = \varepsilon_{A\rightarrow A} = N_{A-identified} \big/ N_{A-total}$$

$$\mathbf{ontamination} = \varepsilon_{B\rightarrow A} = \sum_{B,B\neq A} N^{B}_{A-identified} \,/\, N_{A-identified}$$

higher efficiency -> larger contaminat

purity= 1-contamination

RICH Upgrade

Transversity needs: $\pi : K$ rejection ~ 1:1000 at 2.4 GeV/c

Original RICH at 2.4 GeV/c: $\Delta\theta \sim 4.1\sigma \Rightarrow \pi : K \sim 1 : 140$

⇒ RICH upgrade required:

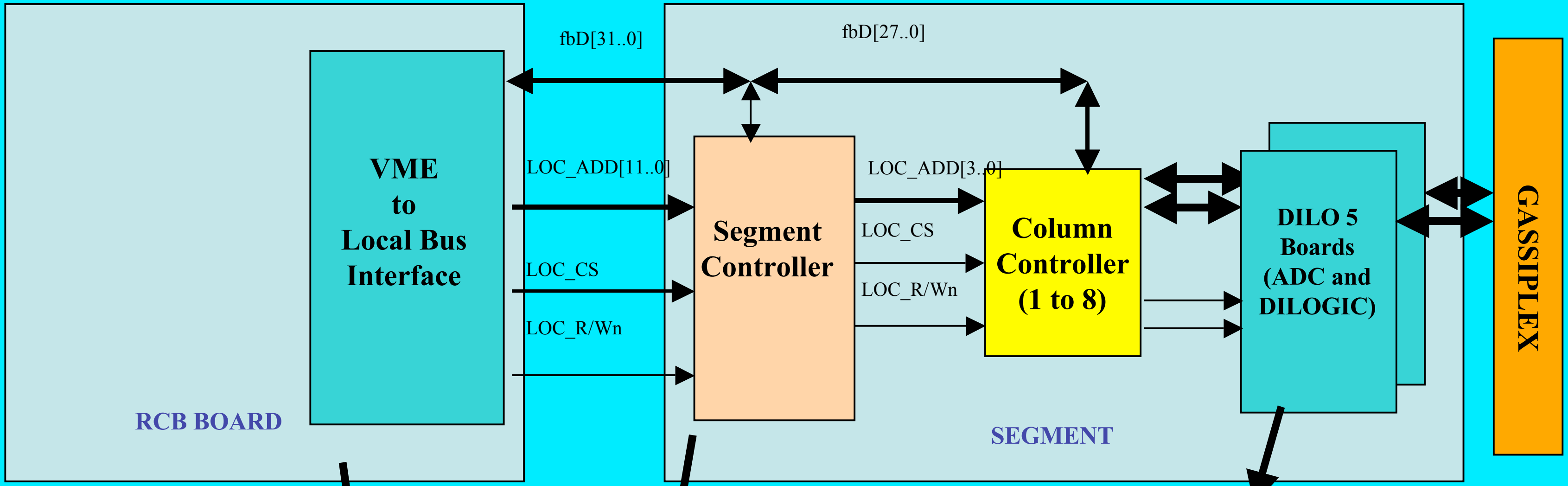
① ✓ 60% larger photon detection area (more photons collected)
✓ 75% longer proximity gap (smaller geometric error)

② The JLab RICH is a sandwich of:

- 6 Al frames (3 preserved, 3 new - largest work)
- a radiator (preserved)
- 3 wire planes (one preserved)
- pad panels (preserved + spare, rotated 90°)

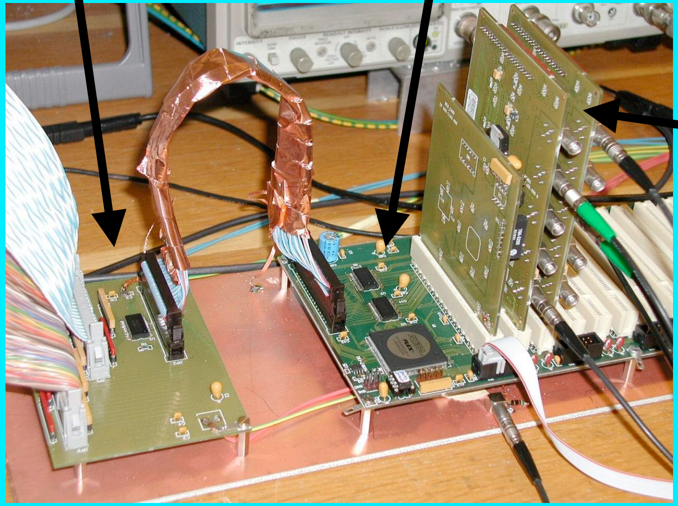
③
- Use original electronics + new version (available): 19200 total channels!
- Finite Model and MonteCarlo Analyses (based on the real data of the original RICH) show very small mechanical deformation and achievement of the π:K rejection needs.

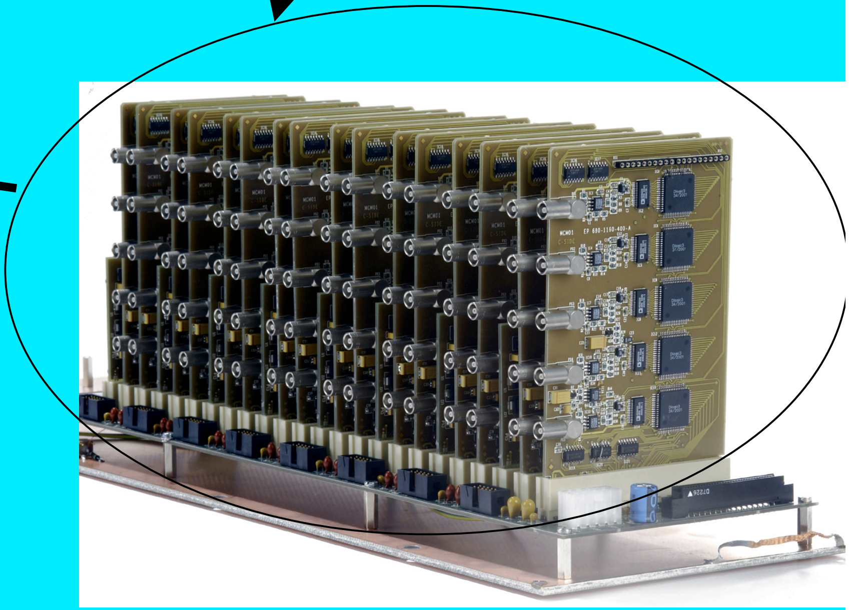
Rich electronics upgrade : The HMPID ALICE RICH DAQ scheme

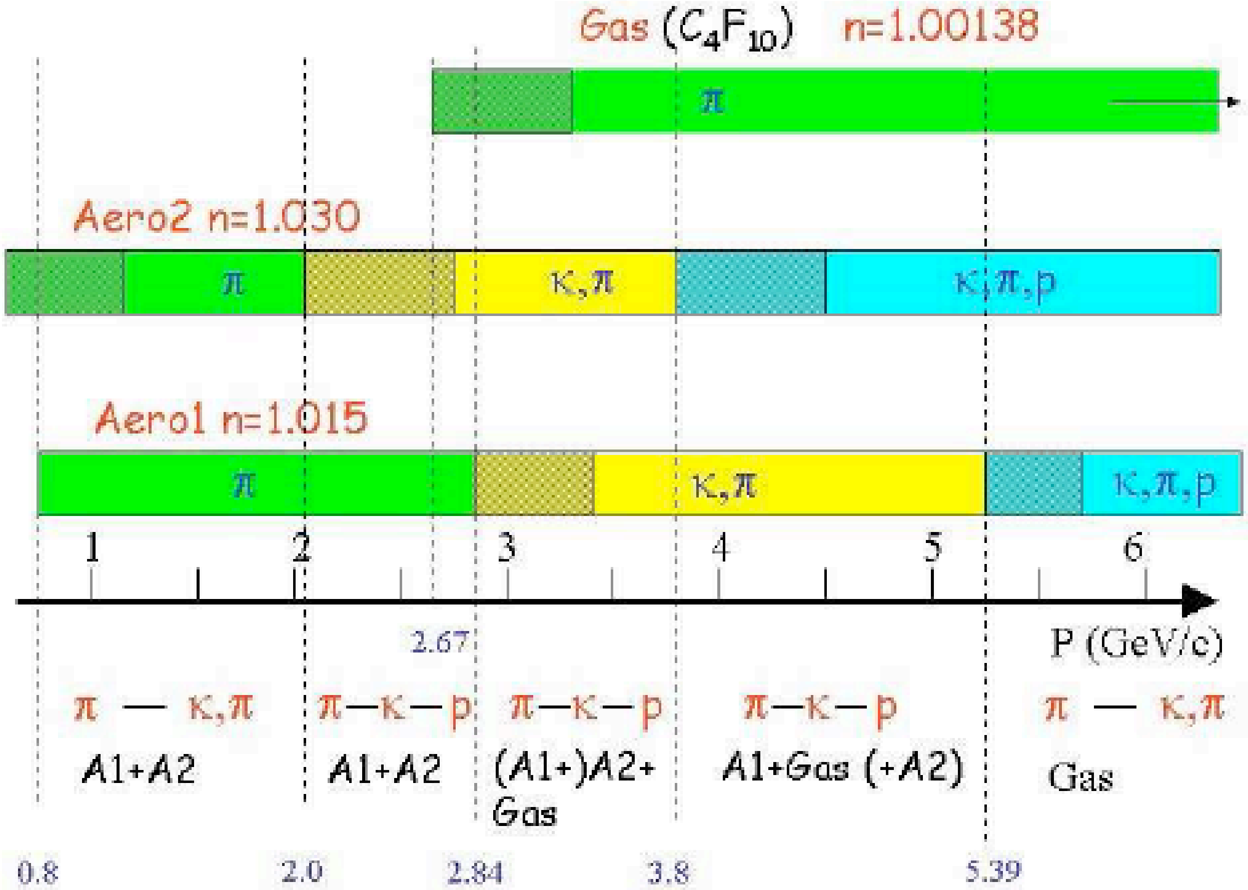


Front end digitization/ multiplexing On board

48 multiplexed channels (instead of 240) Clock rate up to **10 MHz**






Gas (C_4F_{10}) n=1.00138
π
Aero2 n=1.030
π
K,π
K,π,p
Aero1 n=1.015
π
K,π
K,π,p
1
2
3
4
5
6
2.67
P (GeV/c)
π — K,π
A1+A2
π—K—p
A1+A2
π—K—p
(A1+)A2+ Gas
π—K—p
A1+Gas (+A2)
π — K,π
Gas
0.8
2.0
2.84
3.8
5.39

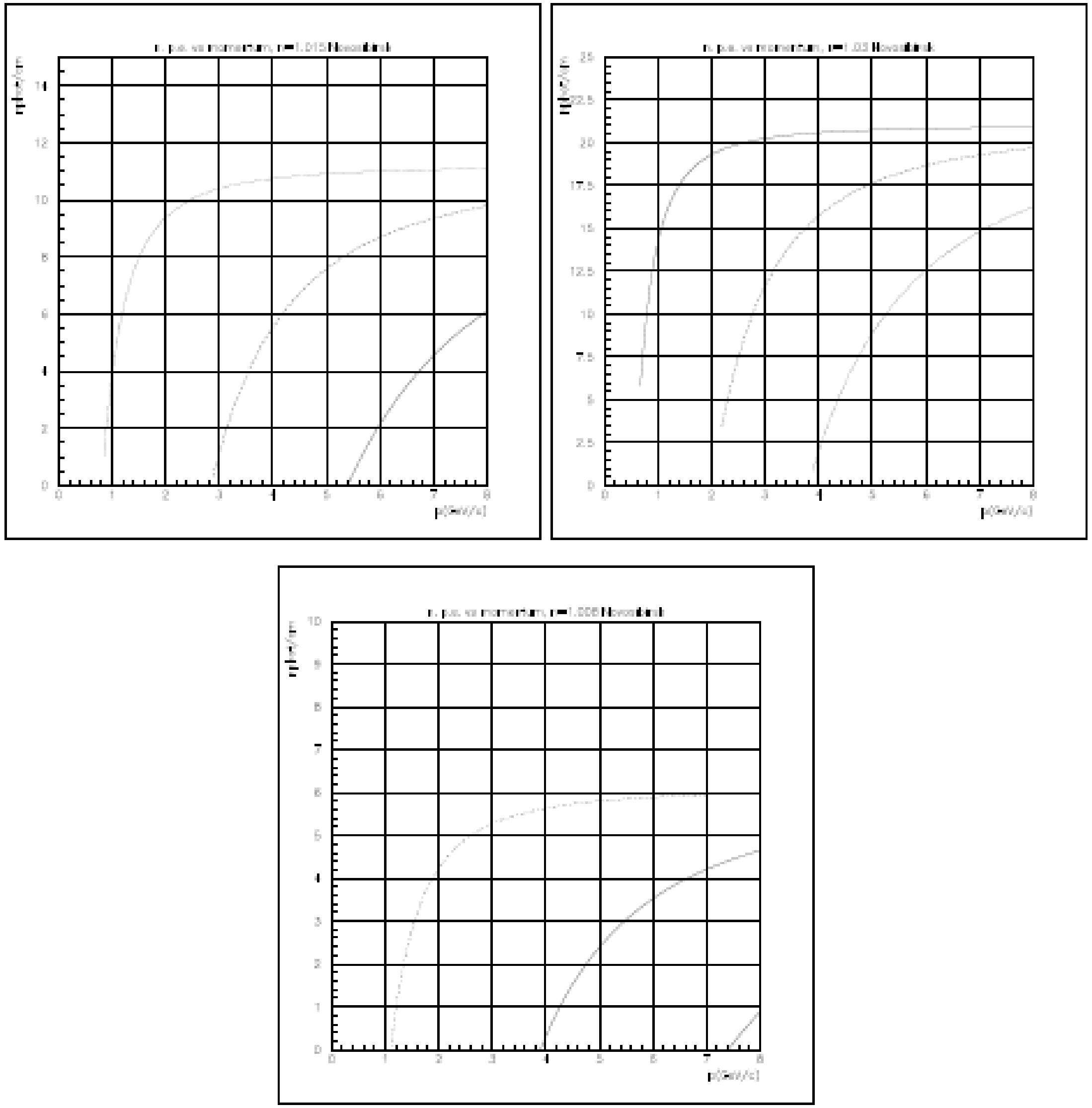
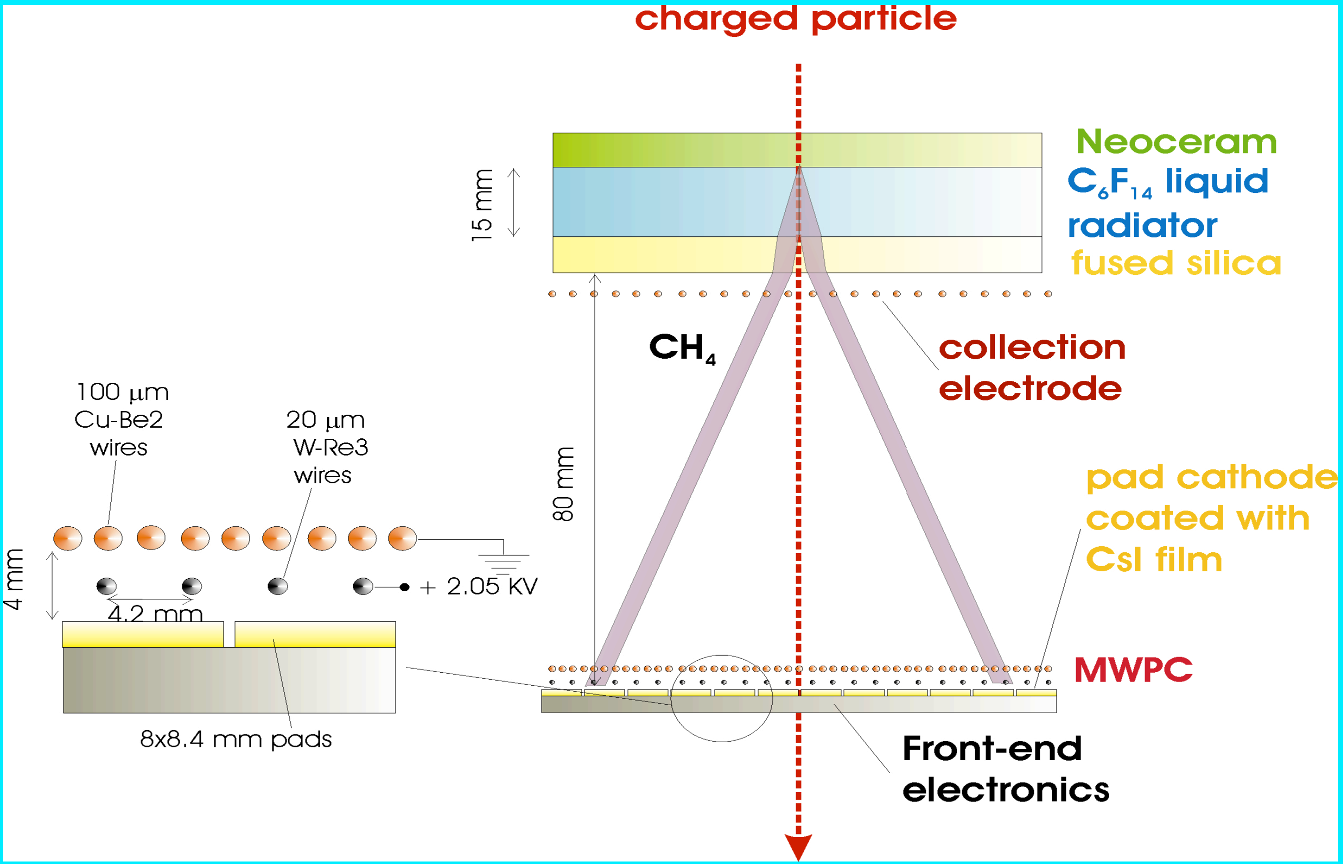


Figure 6: N. of p.e./cm for Novosibirsk aerogel: **(a)** n=1.015 **(b)** n=1.03 **(c)** n=1.008.

JLAB Hall A RICH layout – similar to ALICE HMPID RICH



Freon Radiator:
1800x400x15 mm^3
single box with quartz windows glued on neoceram housing

Grid plane:
100 µm positive wires (collects electrons ionized in the gap)

Wire chamber :
composed by **20 µm** anode wires plane sandwitched between a cathode plane formed by 100 µm wires and the cathode plane formed by the photocathodes

Three Photocathodes :

403x640 mm^2 each, divided in **8.4 x 8 mm^2 size pads** evaporated with a **300 nm CsI** layer