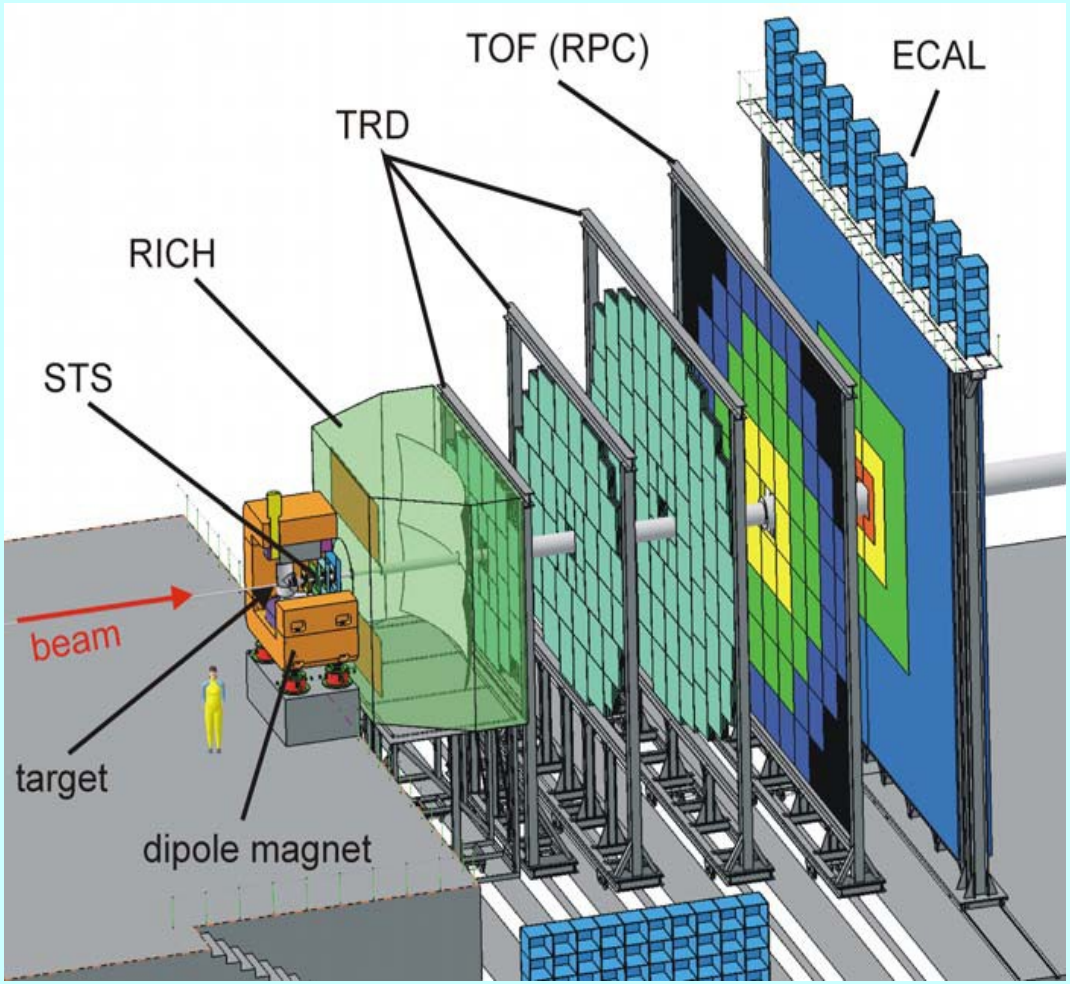
Baseline Detector Setup



Tracking: STS, TRD

Vertexing: STS

Hadron ID : TOF

Electron ID: RICH, TRD, ECAL

γ, n: ECAL

The Challenge:

- **very rare probes in Au+Au at reaction rates up to 10^7events/sec**
- **~ 1000 charged particle mult/event**

	ALICE - TRD	ATLAS - TRT
- type	(radiator+drift chamber + MWPC)	(radiator + straw tubes)
- π_{rej} (at 90% e efficiency)	~100-200	~100
- Maximum drift time	2 μs	40 ns
- Counting rates	~ 100 part/sec/cm^2	~ 10^6 part/sec/cm^2
- Granularity (channel size)	high (~6 cm^2)	low (~20cm^2)

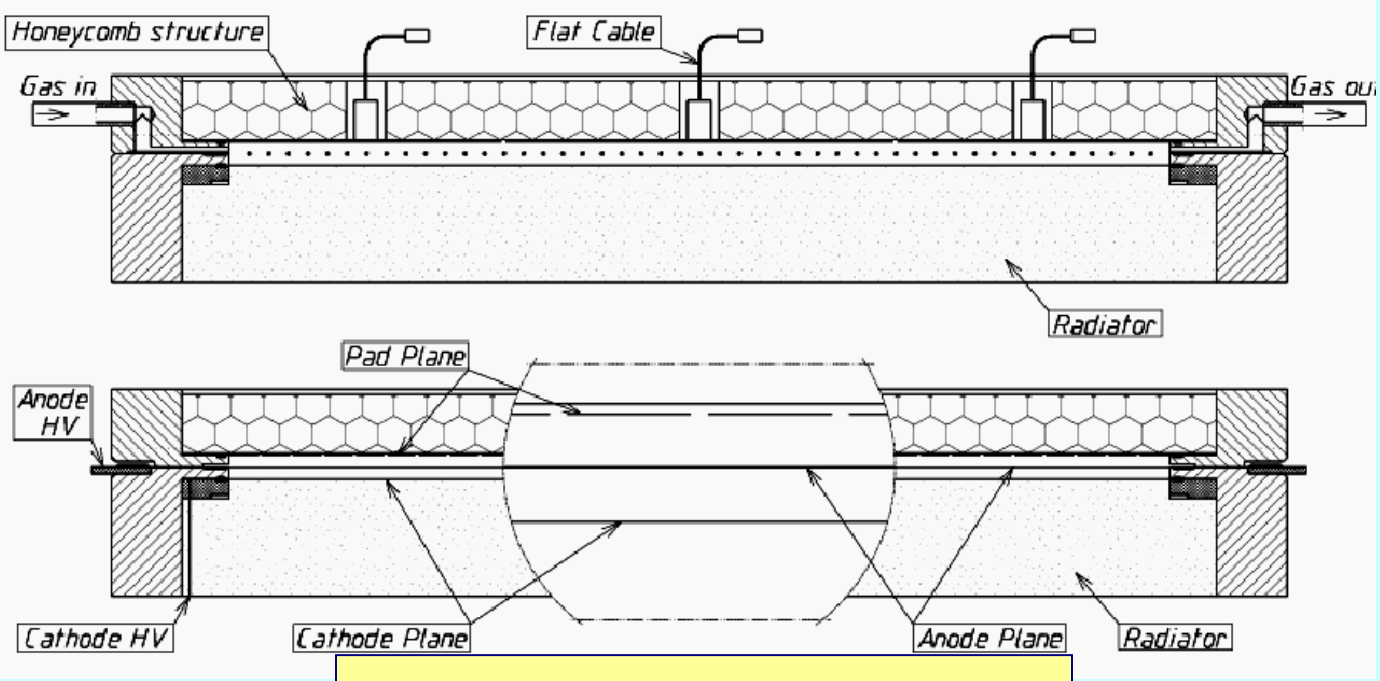
CBM - TRD

Counting rates ~ 10^5 part/sec/cm^2

High granularity

- π_{rej} (at 90% e efficiency) > 100

First HCRTRD - prototype



-type: radiator + MWPC

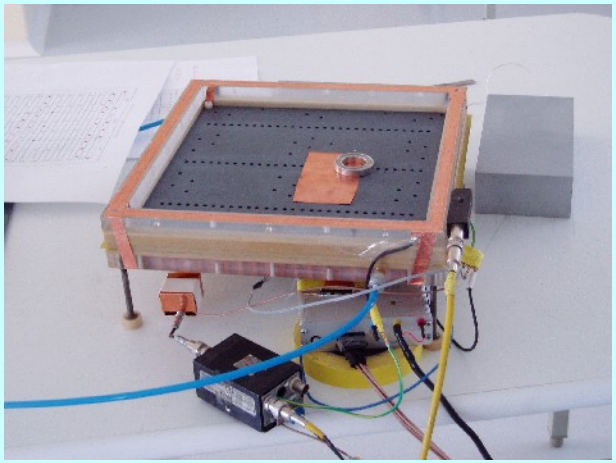
-anode-cathode distance–3 mm

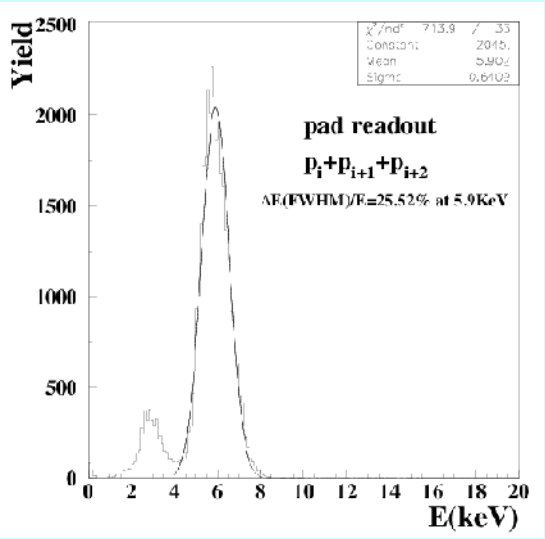
-2.5 mm anode pitch

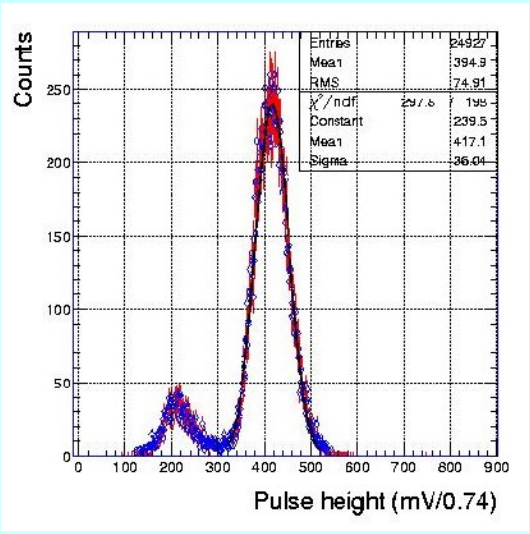
- maximum drift time ~ 100 ns

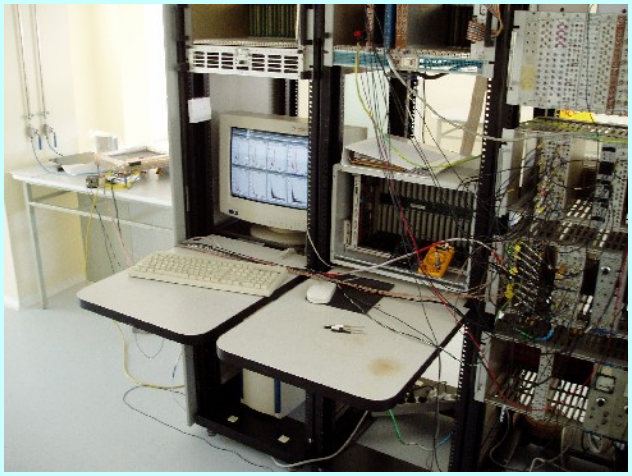
- channel size ~ 6 cm²

^{55}Fe Source Tests









NIPNE ^{55}Fe tests

30% CO_2 + 70% Ar

HV 1920 V;

Readout: PASA (2 mV/fC, 1800 e rms) + ADC Converter

Energy Resolution :

~10% (σ);

~25% FWHM

GSI ^{55}Fe tests

15% CO_2 + 85% Ar

HV 1700 V;

Readout:PASA (2mV/fC, 1800 e rms) + FADC Converter

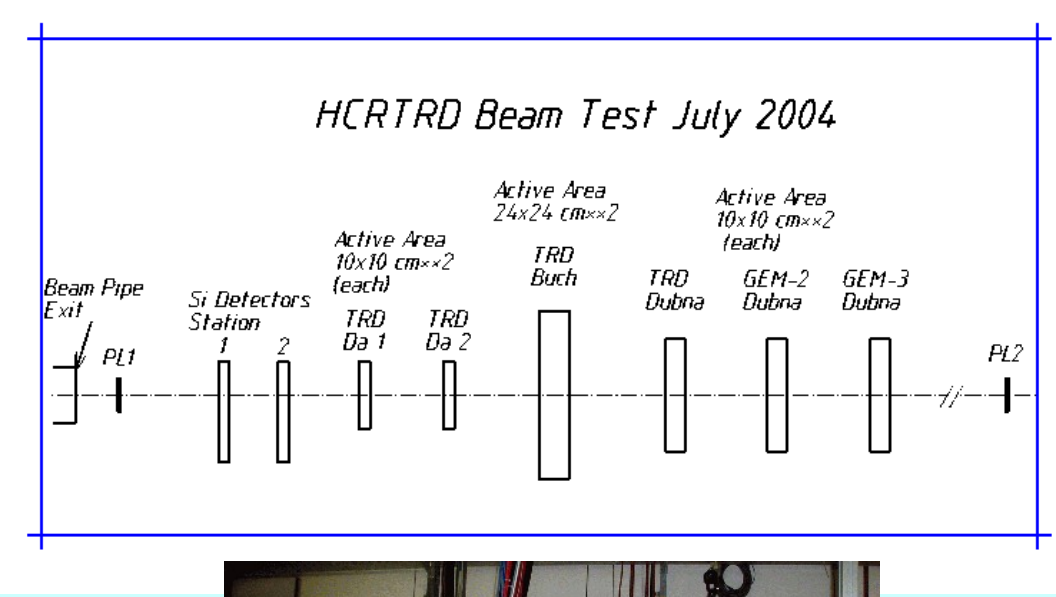
Energy Resolution:

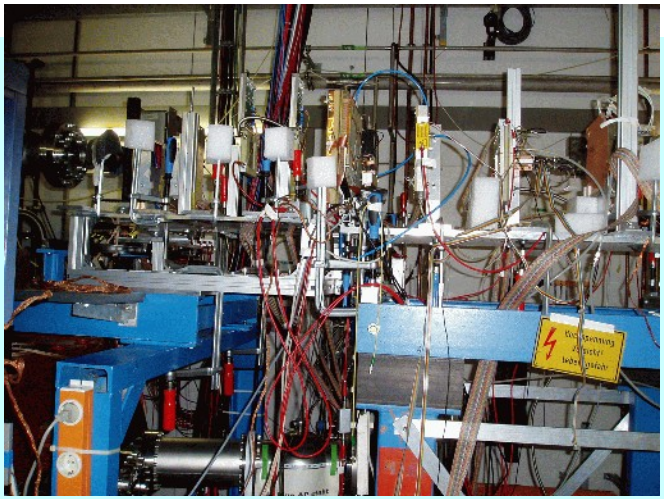
~ 8.6 % (σ);

~20 % FWHM

In beam test, July 2004

(detector performance in high counting rate environment)





Experimental Setup:

- 2 Scintillators (ToF, trigger);

- 2 Si - Strip Detectors (position information);

- 2 MWPC - GSI (10 x 10 cm²)

- 1 MWPC - Bucharest (24 x 24 cm²)

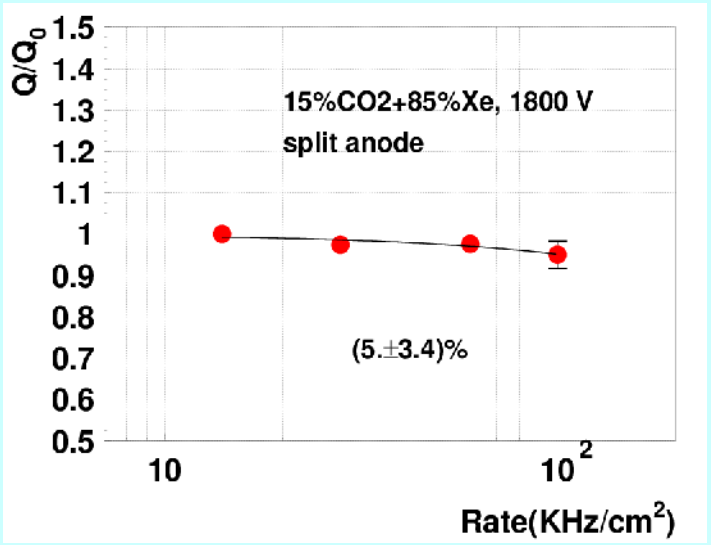
-1 MWPC - Dubna (10 x 10 cm²)

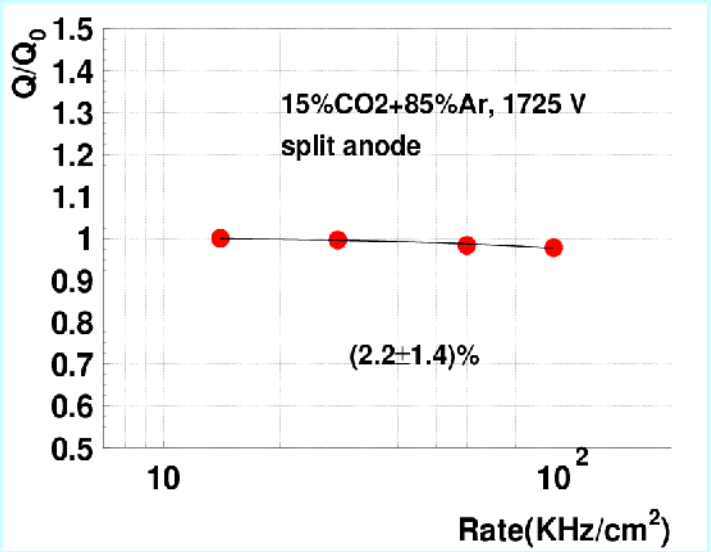
- 1 GEM - Dubna

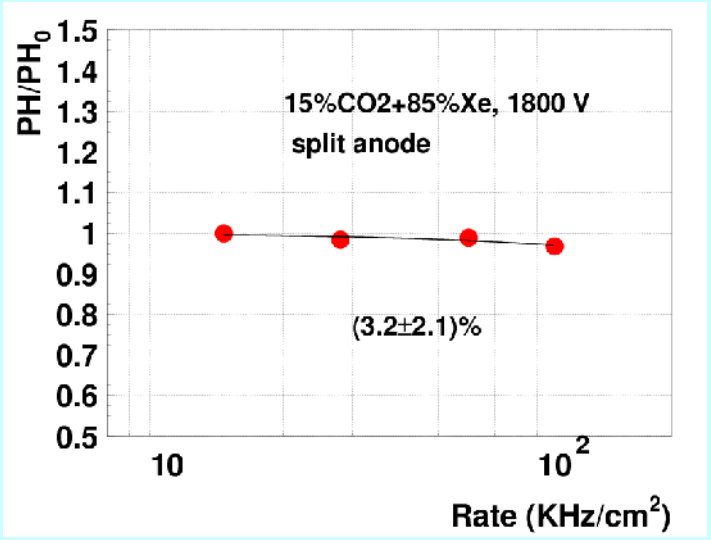
- Pb - glass calorimeter (last run)

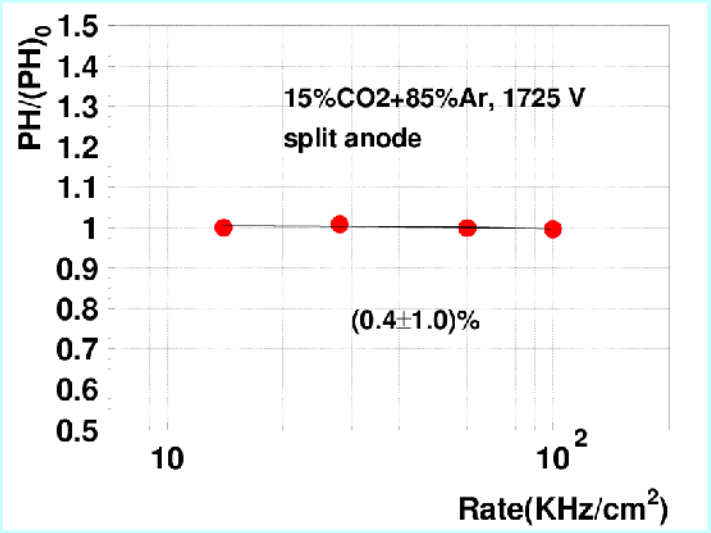
- FADC readout ; DAQ (MBS)

High Counting Rate Effect
p-2GeV/c

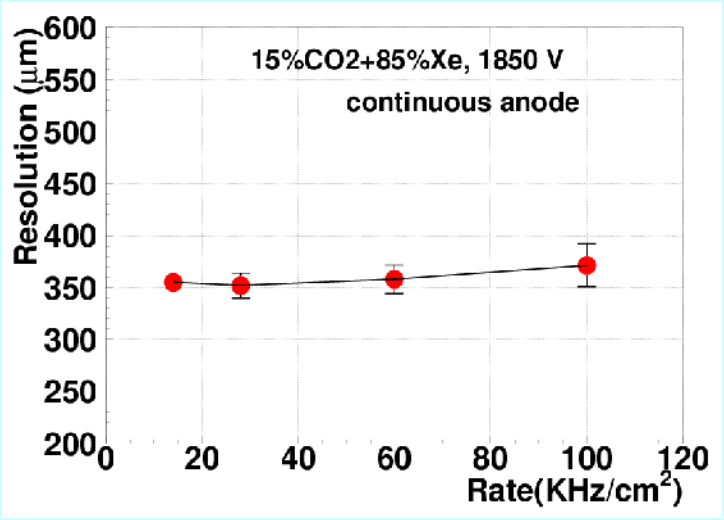


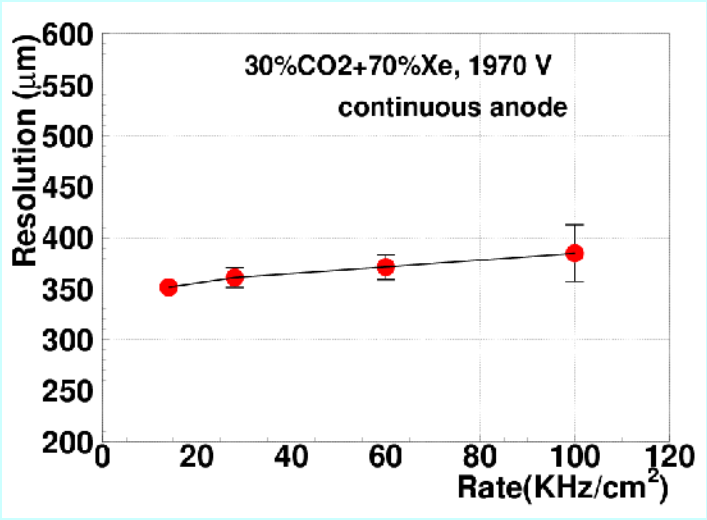


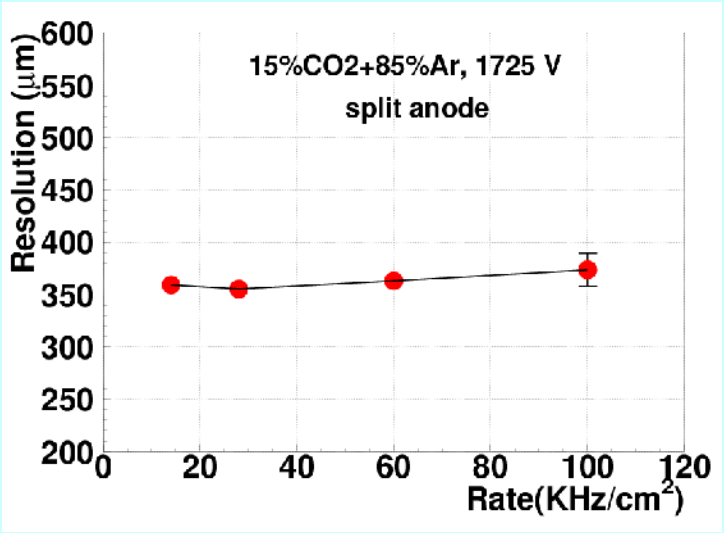




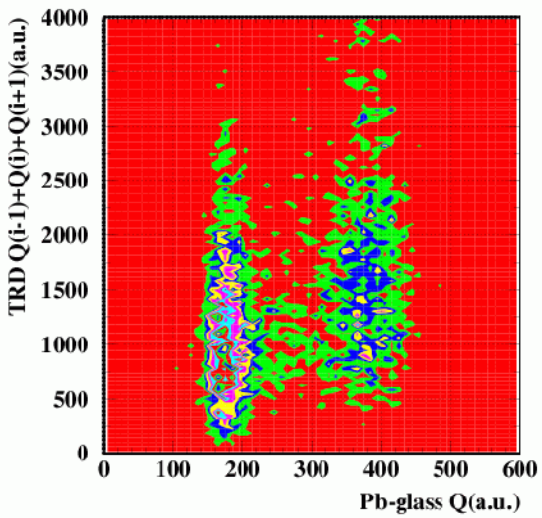
High Counting Rate Effect
Position Resolution (p-2GeV/c)

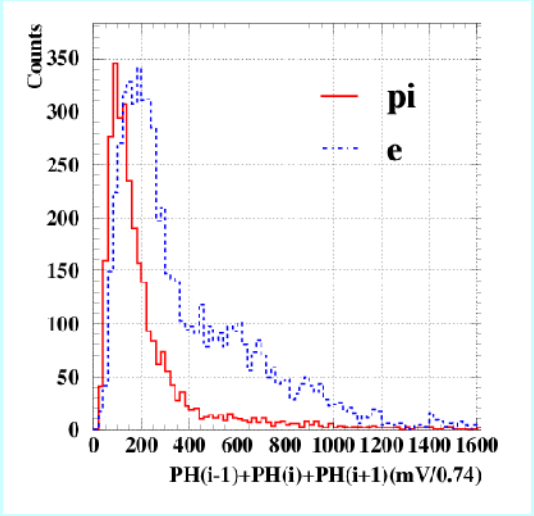


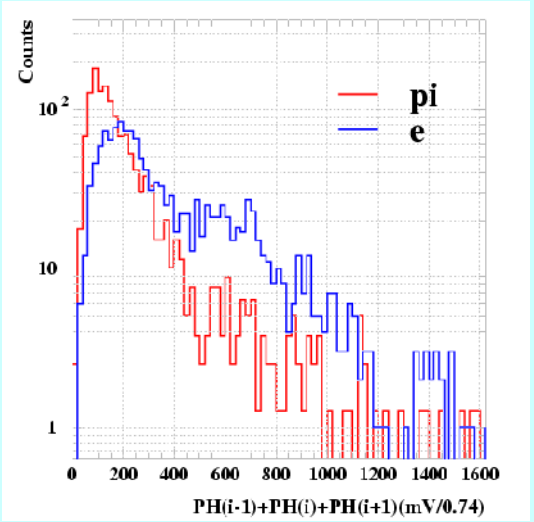


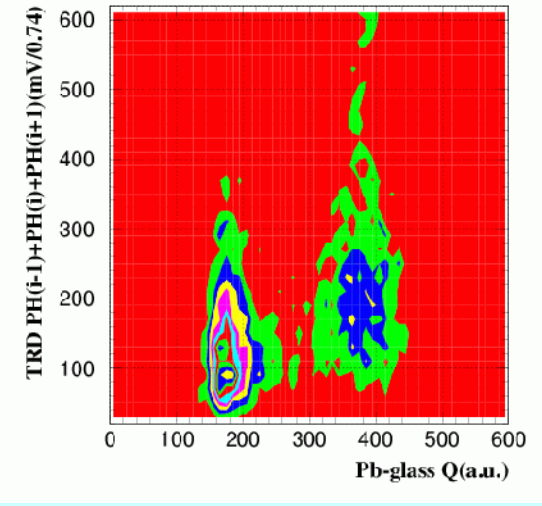


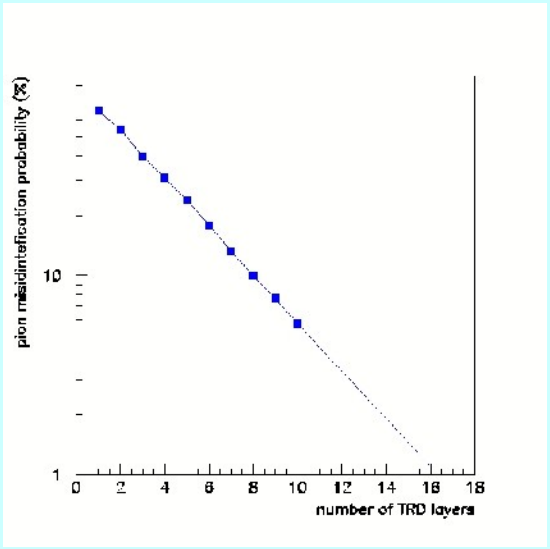
e/π Discrimination











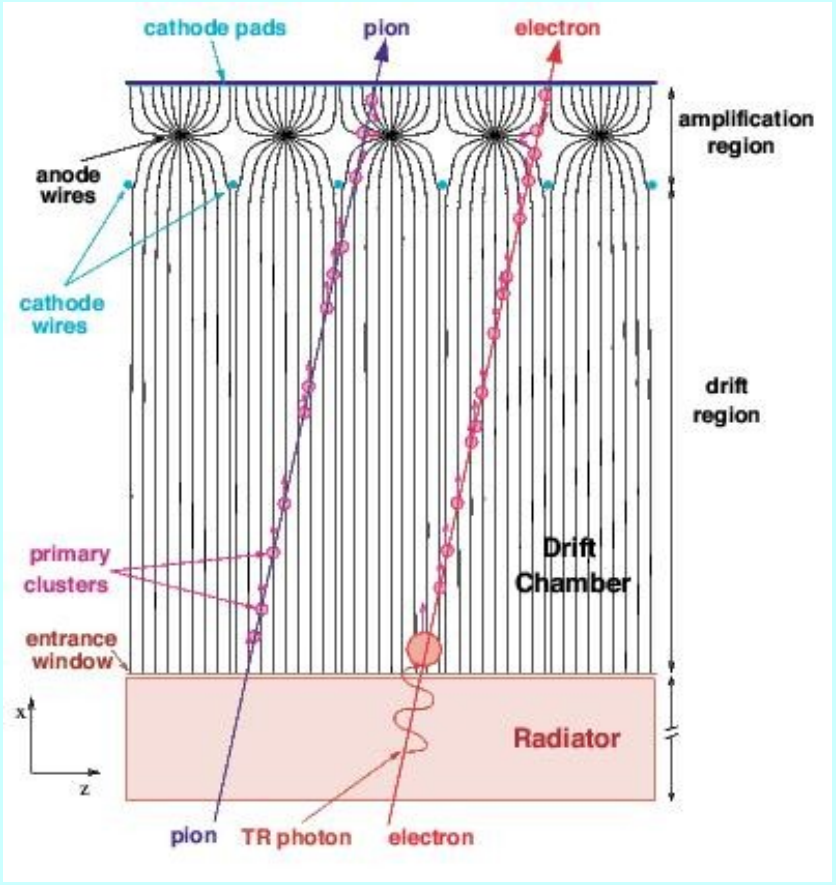
1 GeV/c

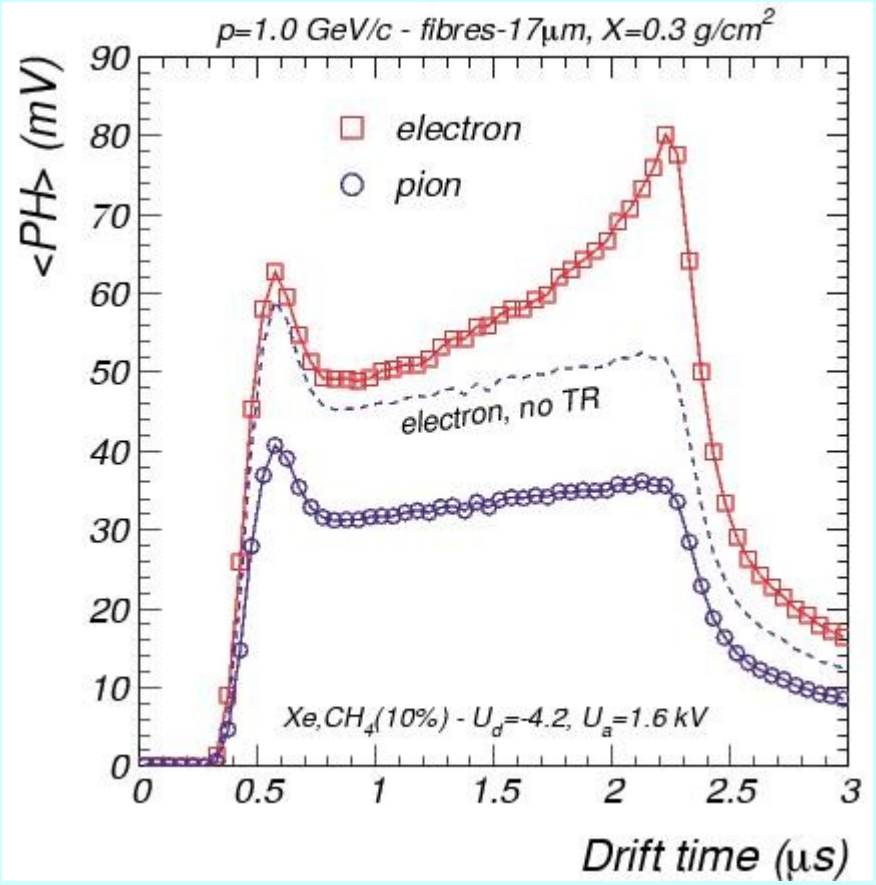
U_A = 1900 V

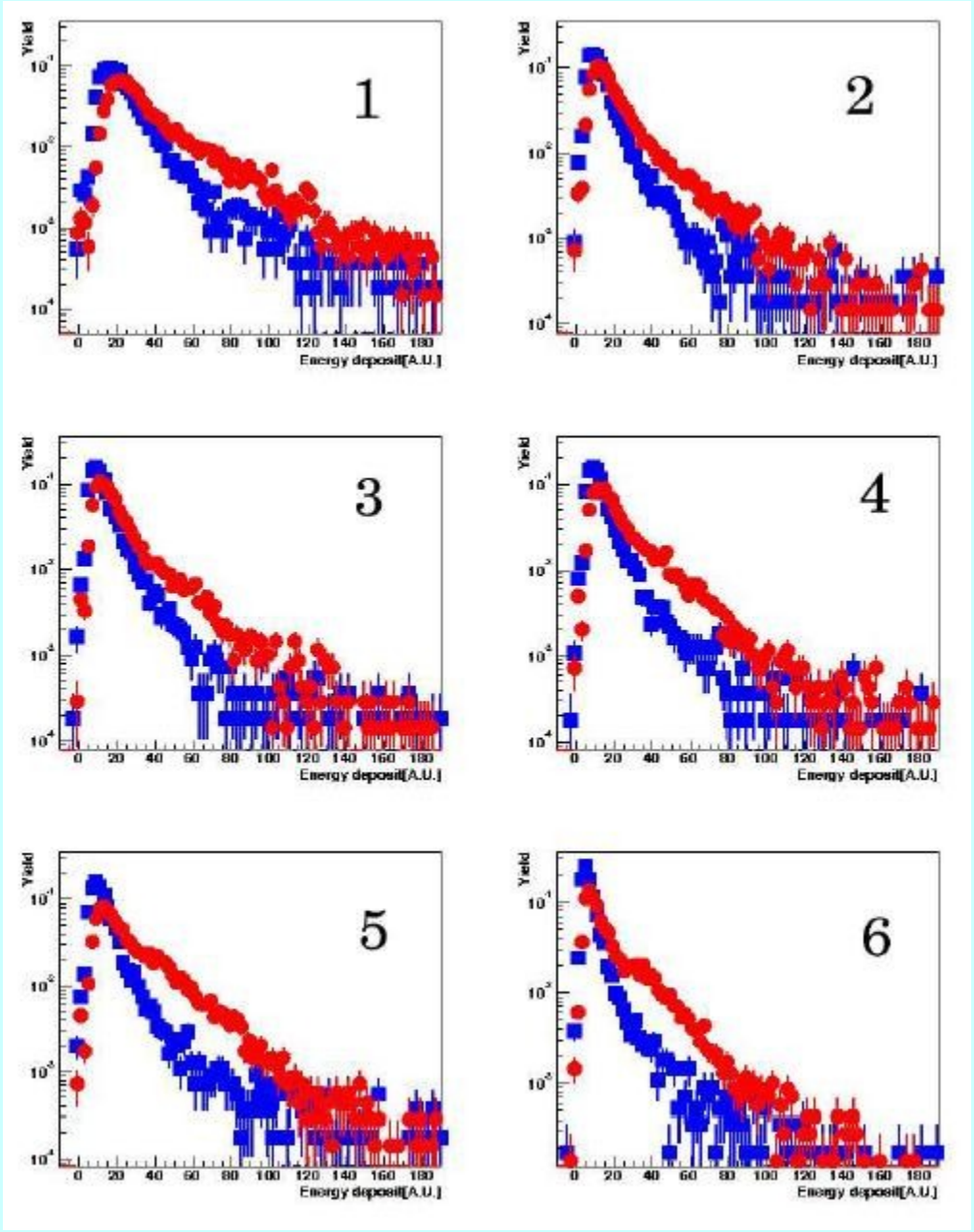
Xe,CO_2 (15%)

Rohacell

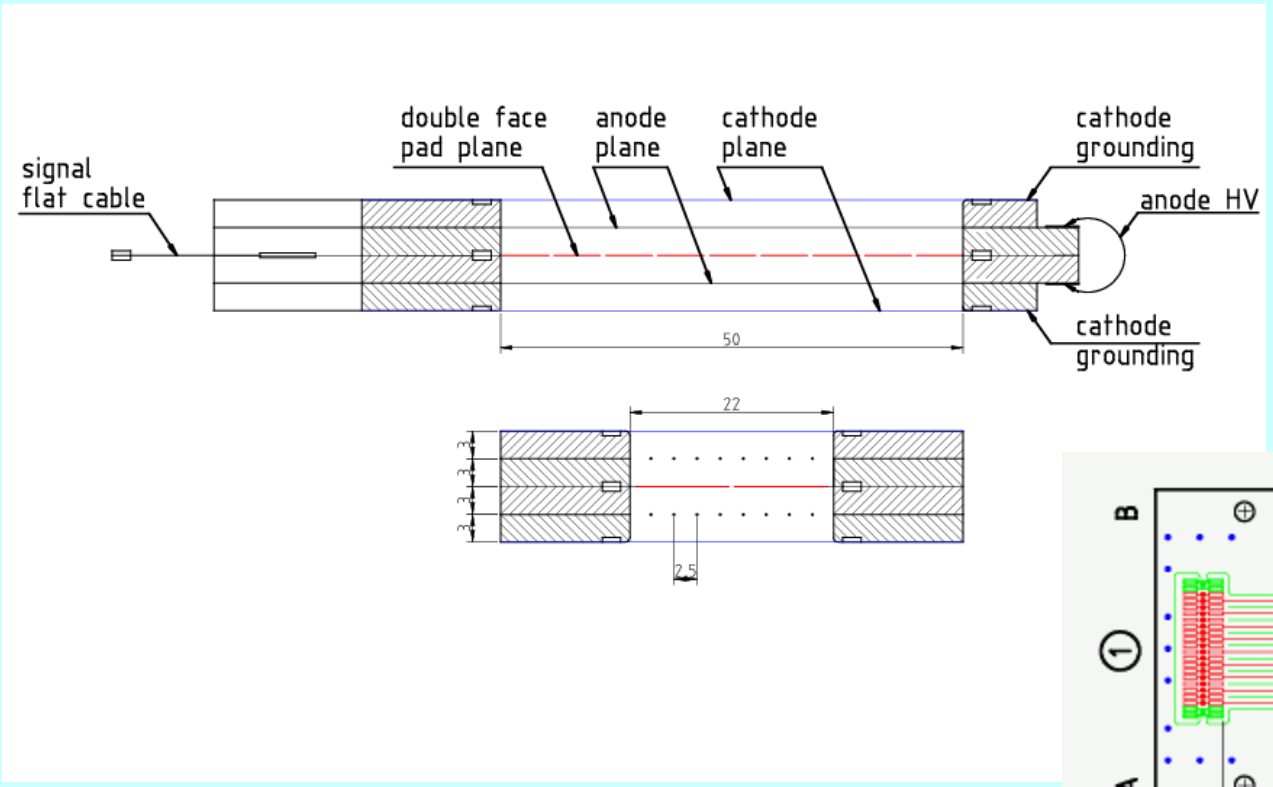
ALICE-TRD


cathode pads
pion
electron
amplification region
anode wires
cathode wires
drift region
Drift Chamber
primary clusters
entrance window
Radiator
x
z
pion
TR photon
electron


p=1.0 GeV/c - fibres-17μm, X=0.3 g/cm²
<PH> (mV)
electron
pion
electron, no TR
Xe,CH₄(10%) - U_d=-4.2, U_a=1.6 kV
Drift time (μs)
0
10
20
30
40
50
60
70
80
90
0
0.5
1
1.5
2
2.5
3


1
2
3
4
5
6
Yield
Energy deposit[A.U.]

Double - sided pad plane
HCRTRD prototype



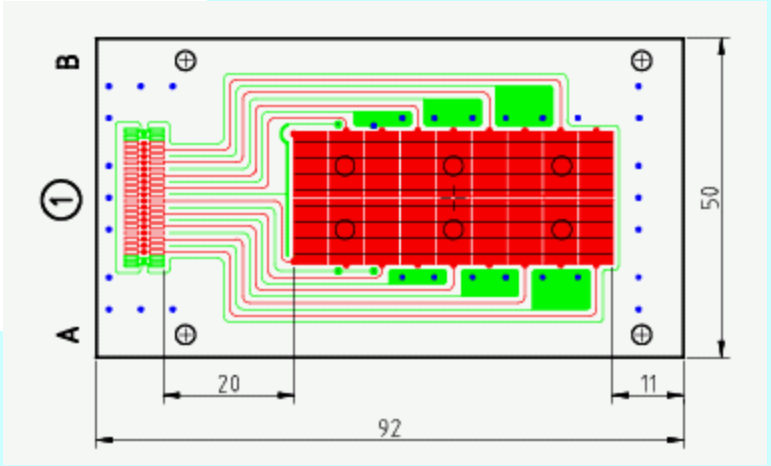
Readout electrode

pad size: 5 x 10 mm^2

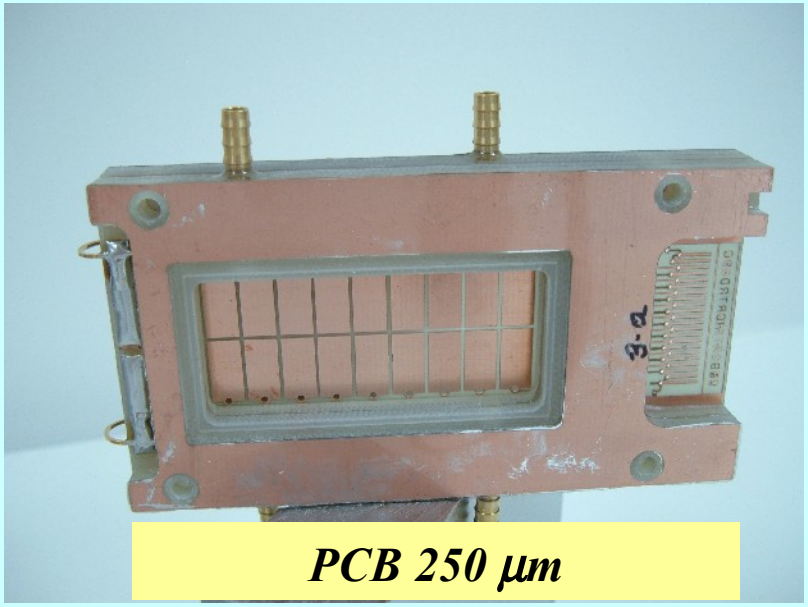
Anode

20 µm , WAu

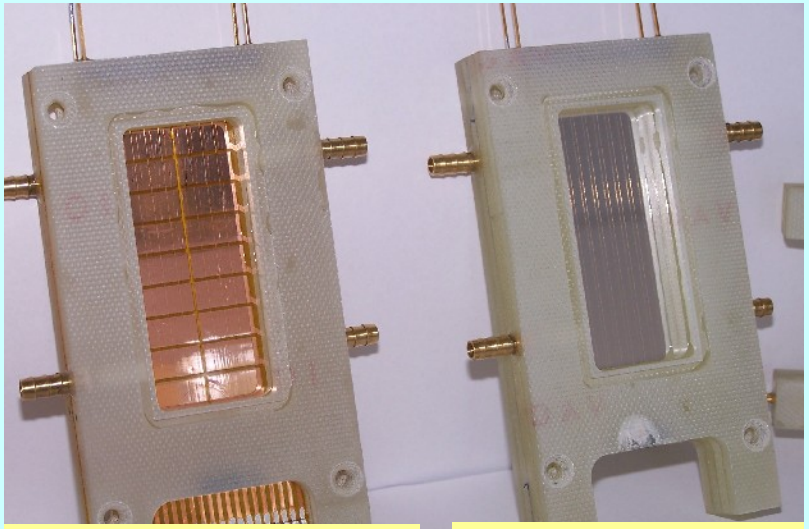
2.5 mm pitch



3 type of prototypes



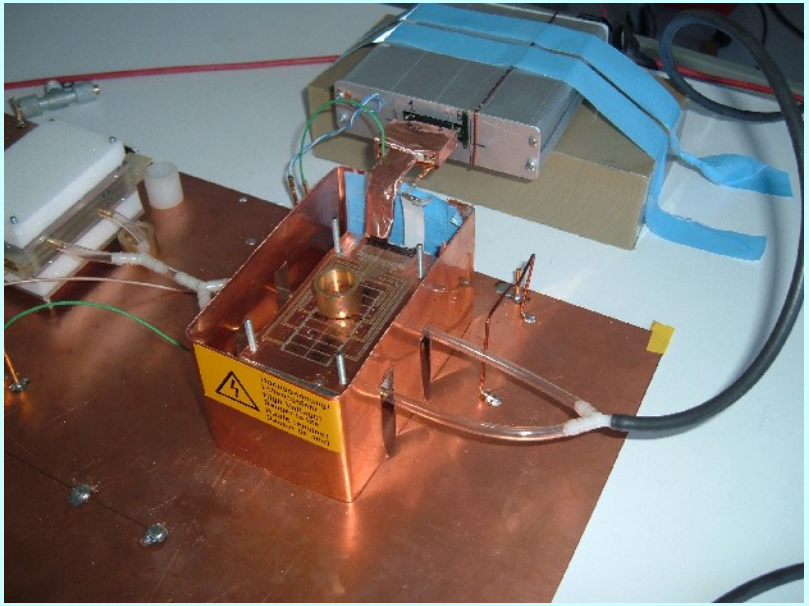
PCB 250 µm



Kapton 25 µm

Mylar 3 µm

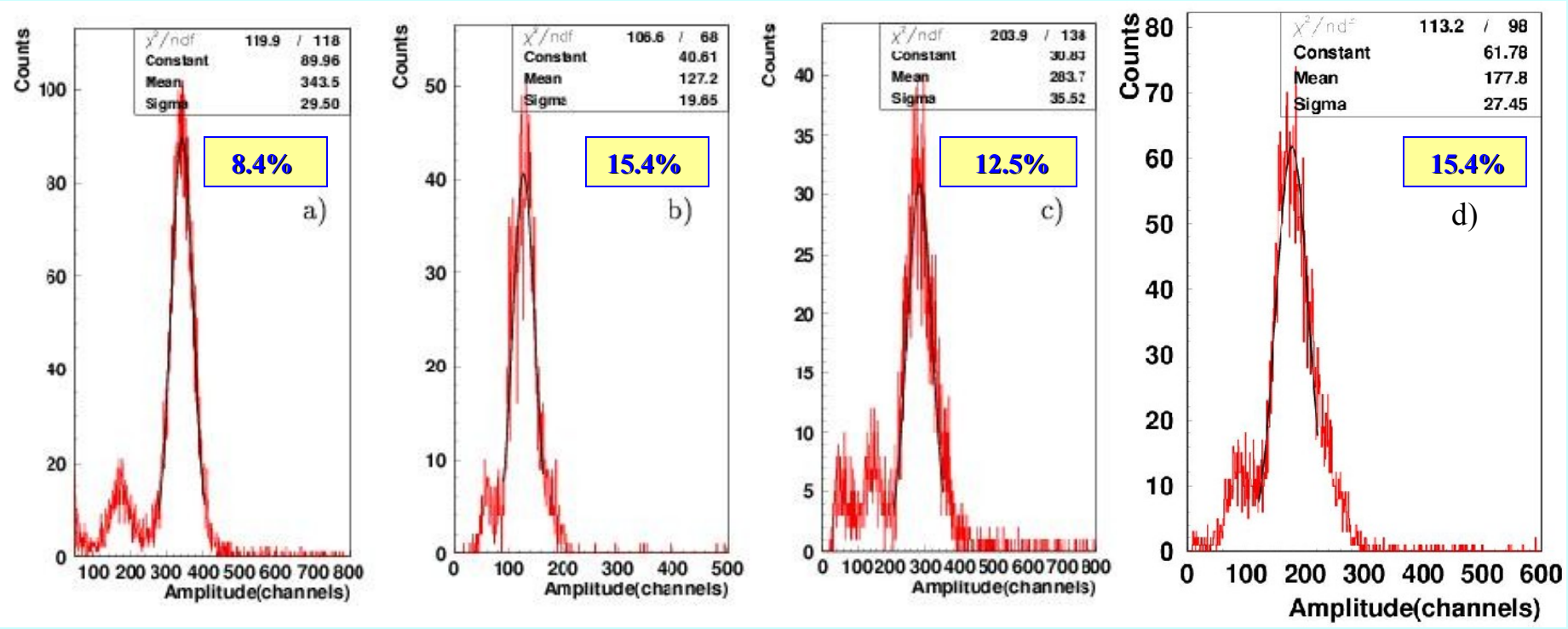
Kapton 25 µm



^{55}Fe Source Tests

98.5% transm

84% transm



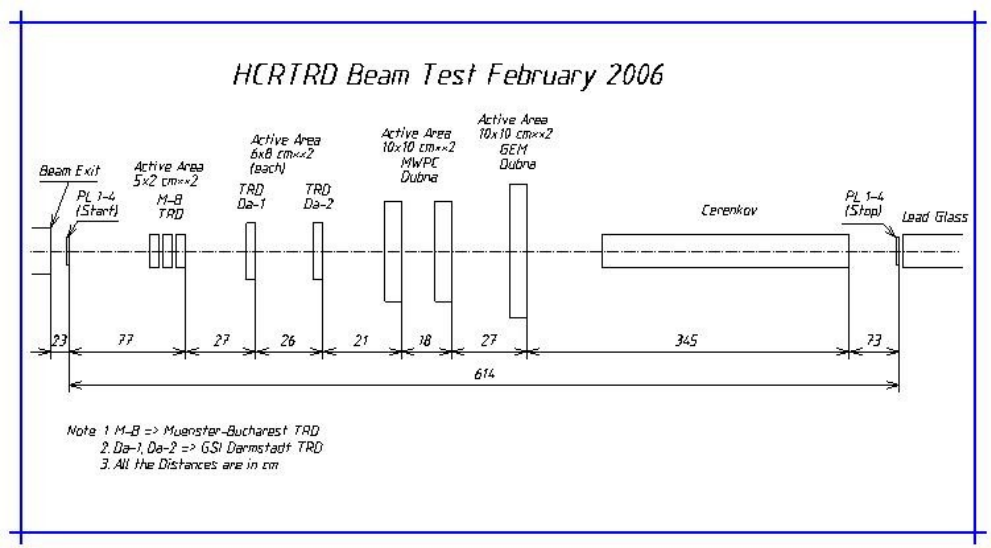
Anode signal

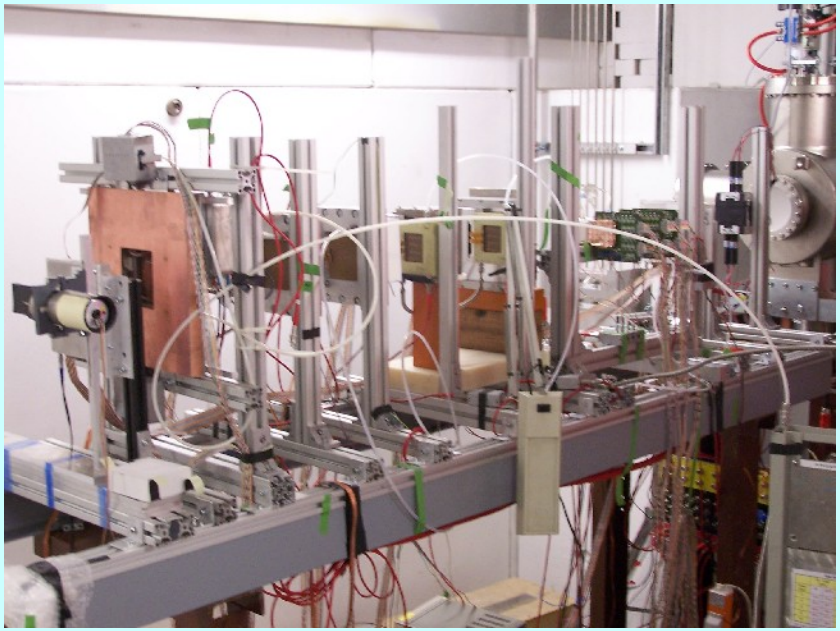
PCB 250 µm

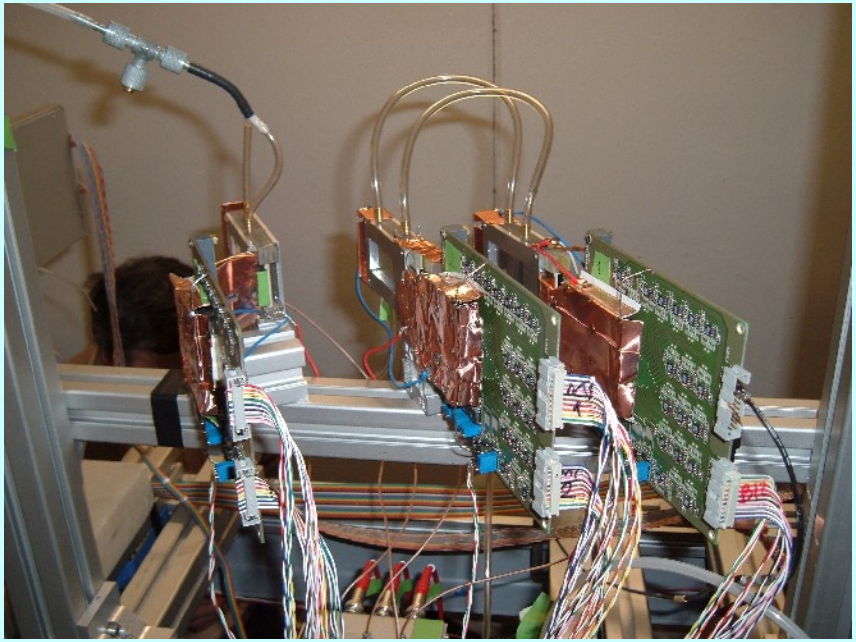
Mylar 3 µm

Kapton 25 µm

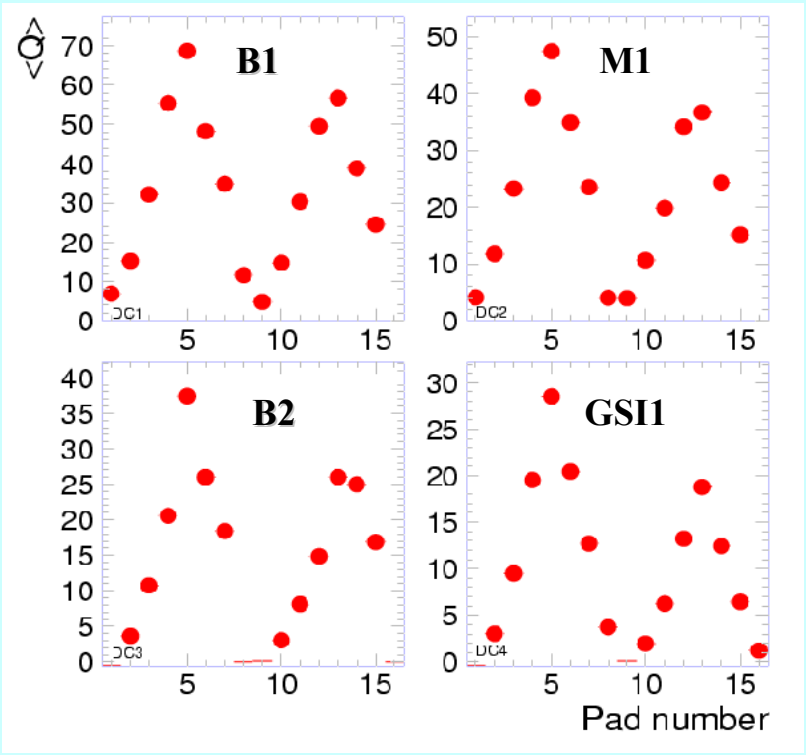
In beam experimental setup

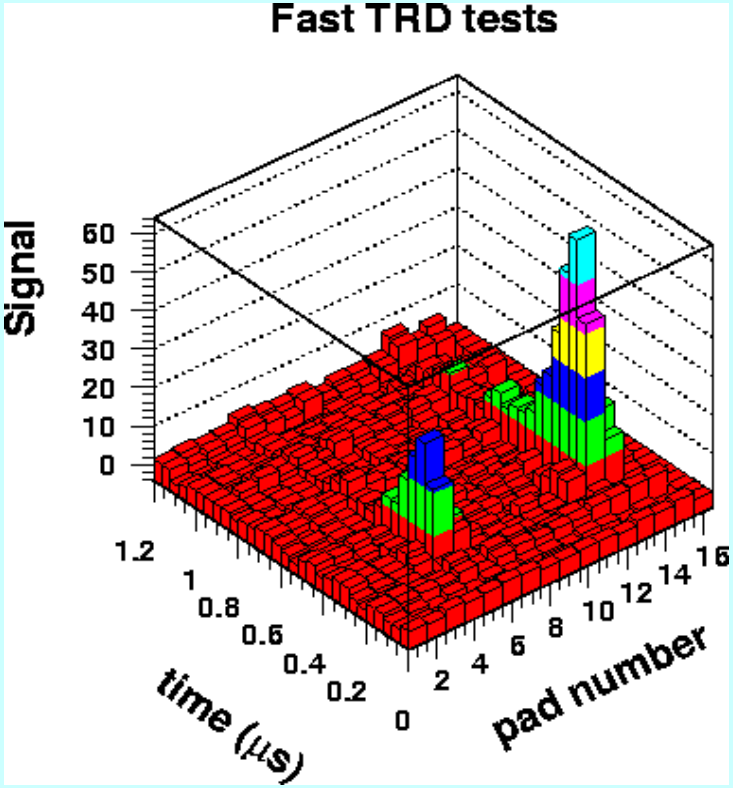






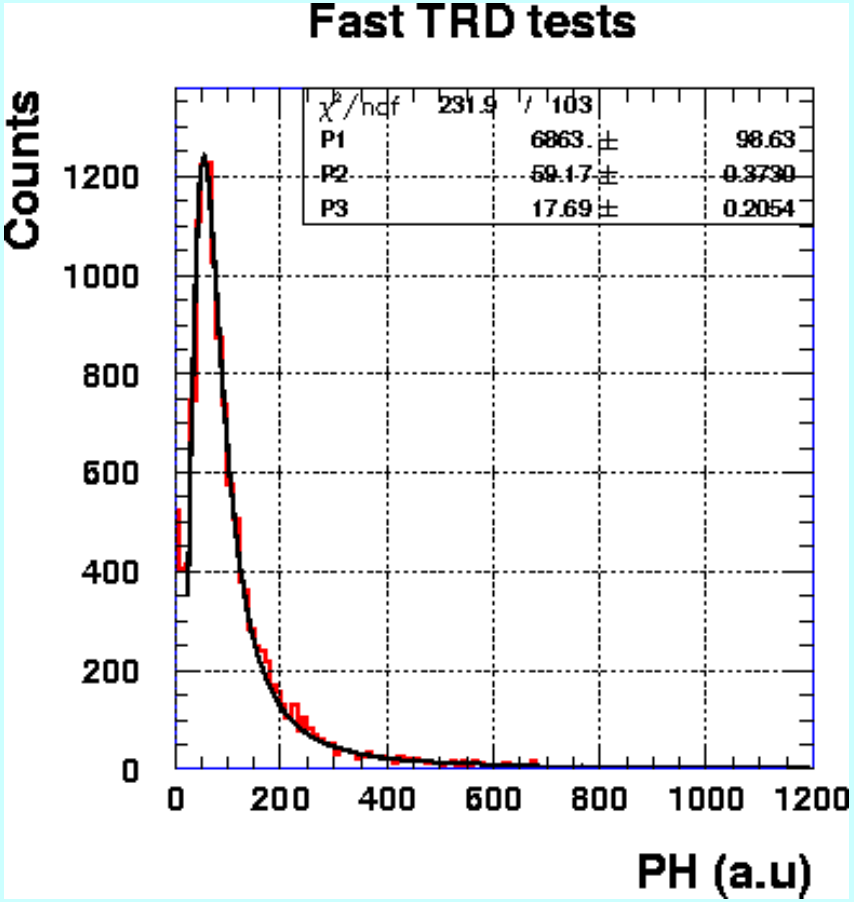
Average Charge Distribution on pads

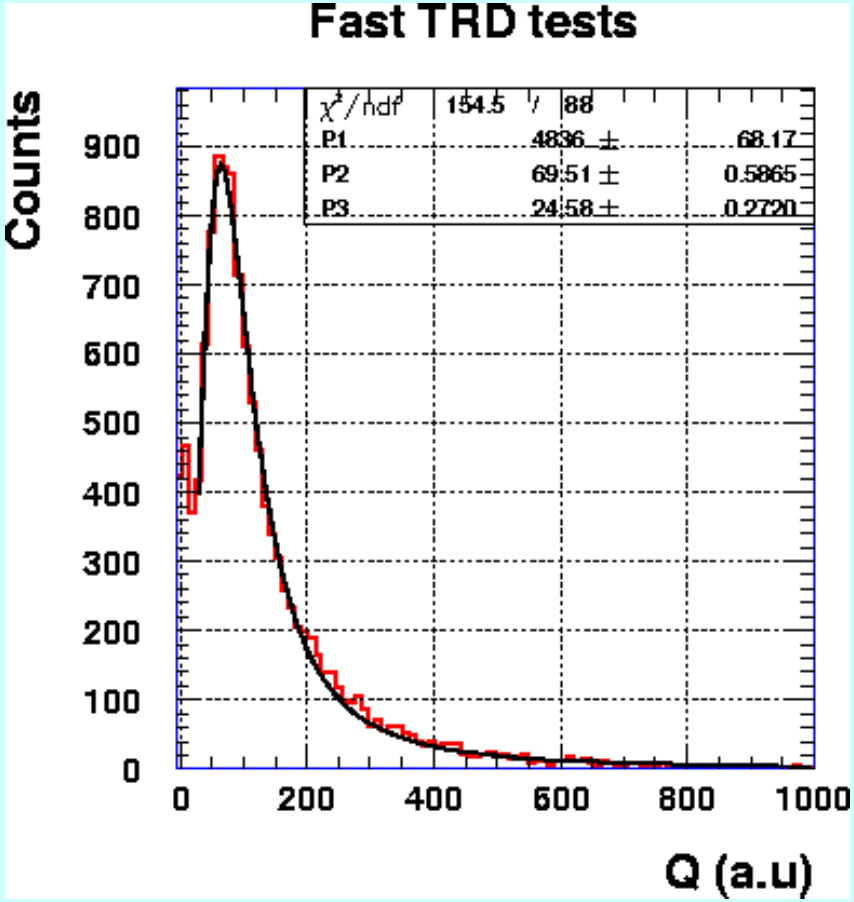




2 rows of 8 pads each readout for each detector

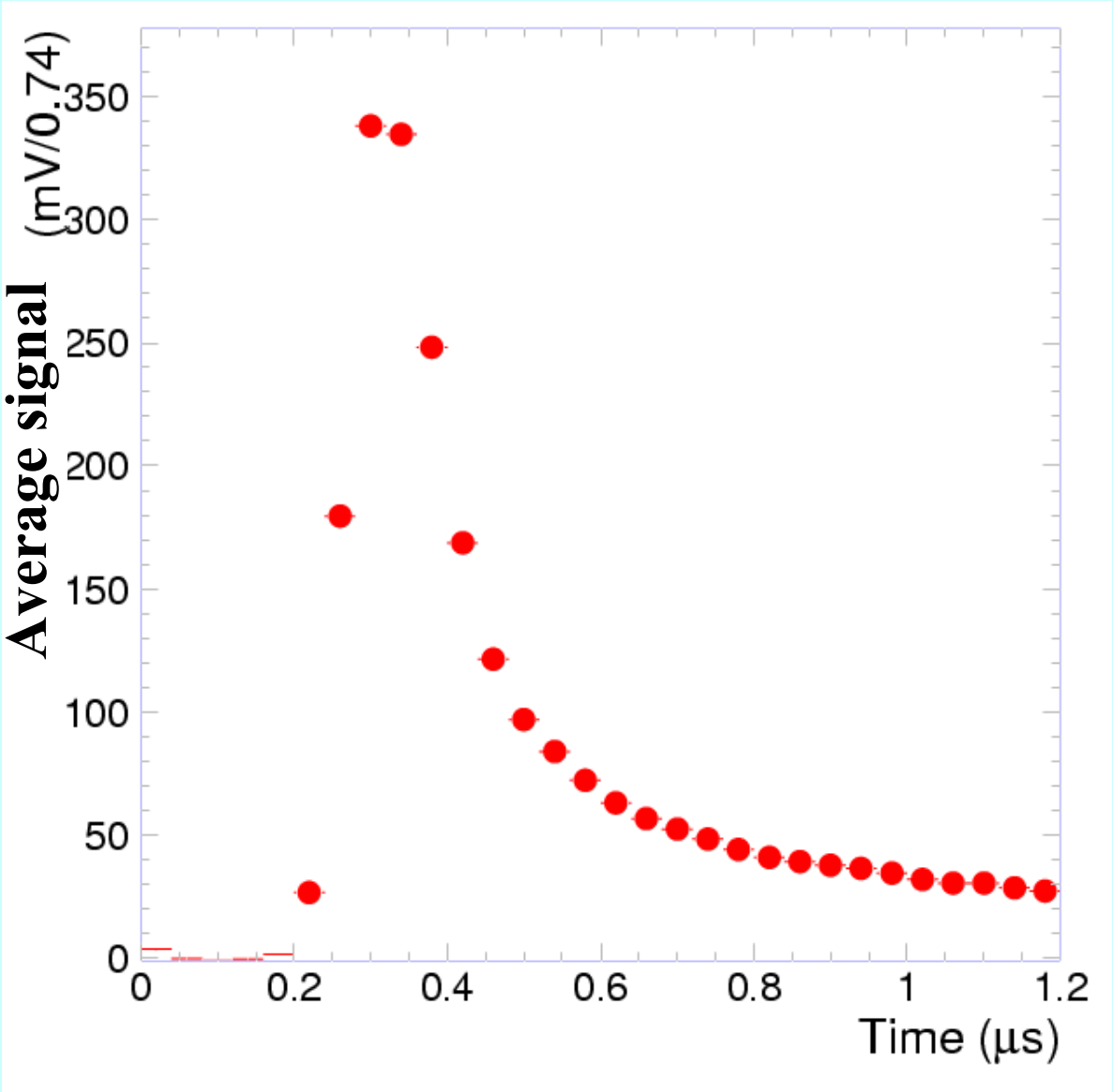
Pulse Height and Charge Spectra



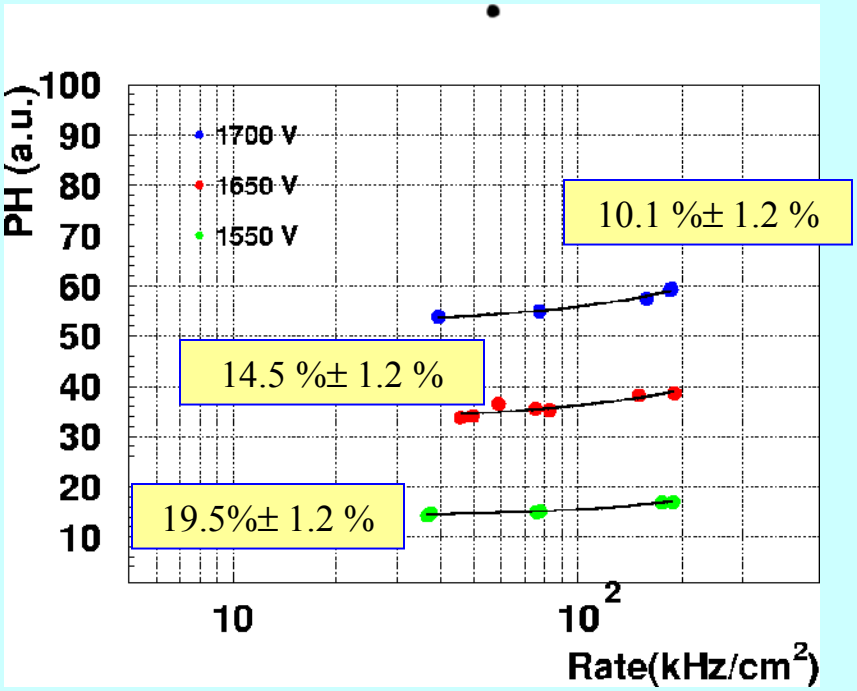


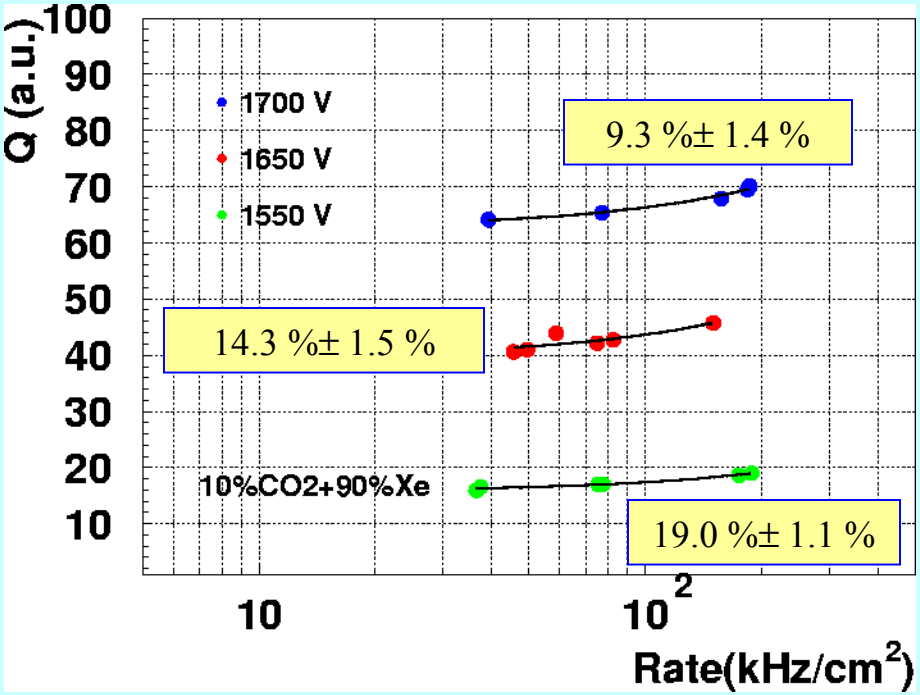
Xe,CO_2(10%)

1700 V

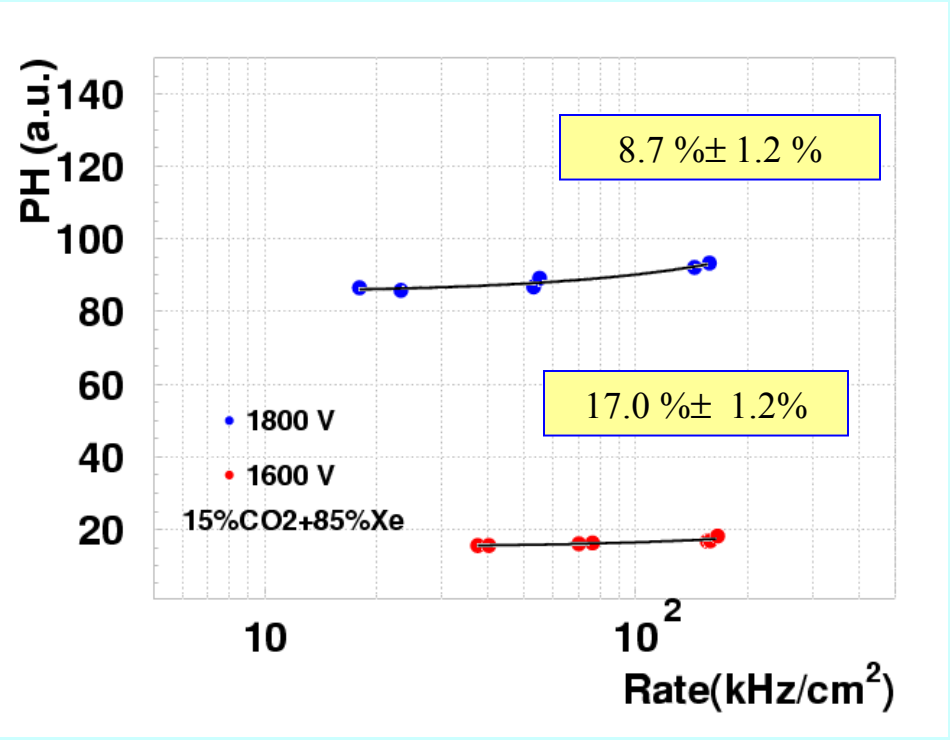

Average signal
(mV/0.74)
350
300
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
Time (μs)

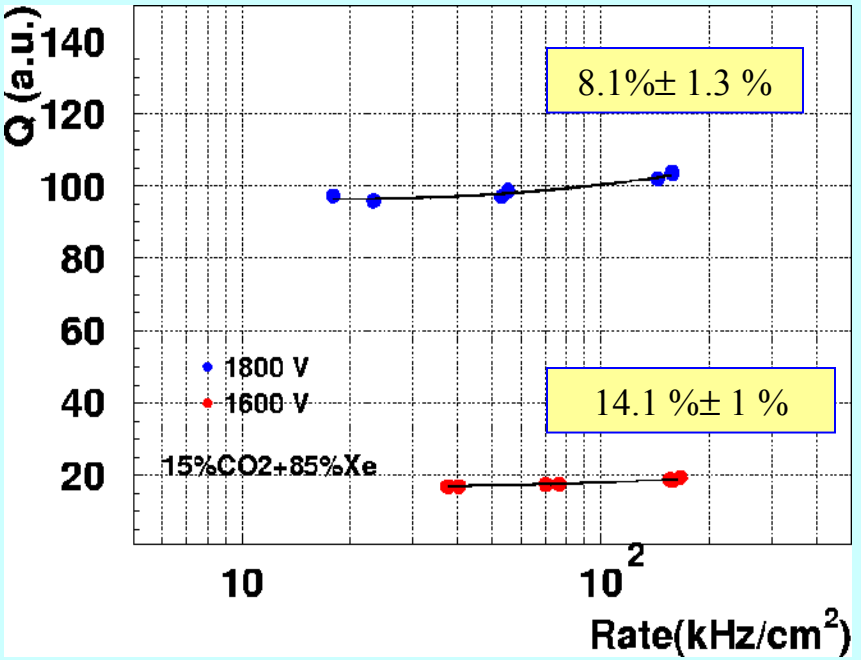
High Counting Rate Effect
Xe,CO_2(10%), p-2 GeV/c



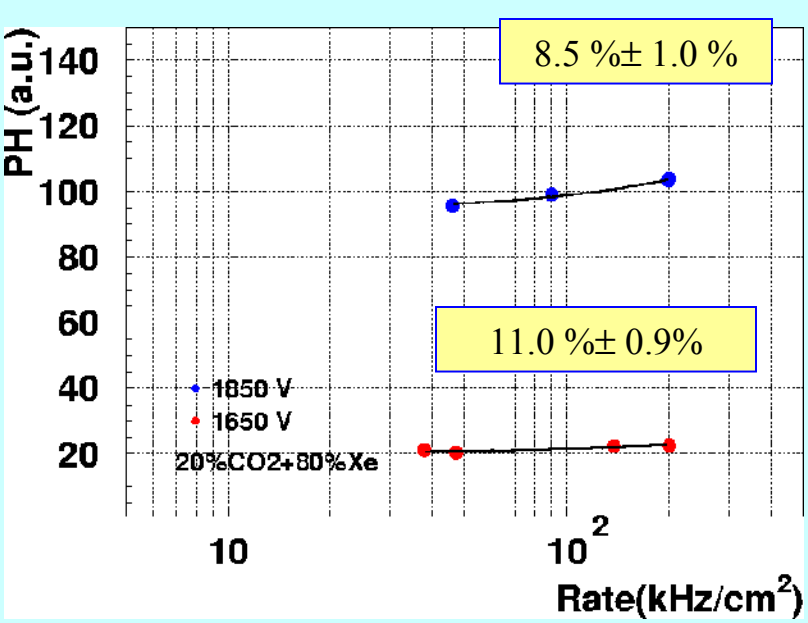


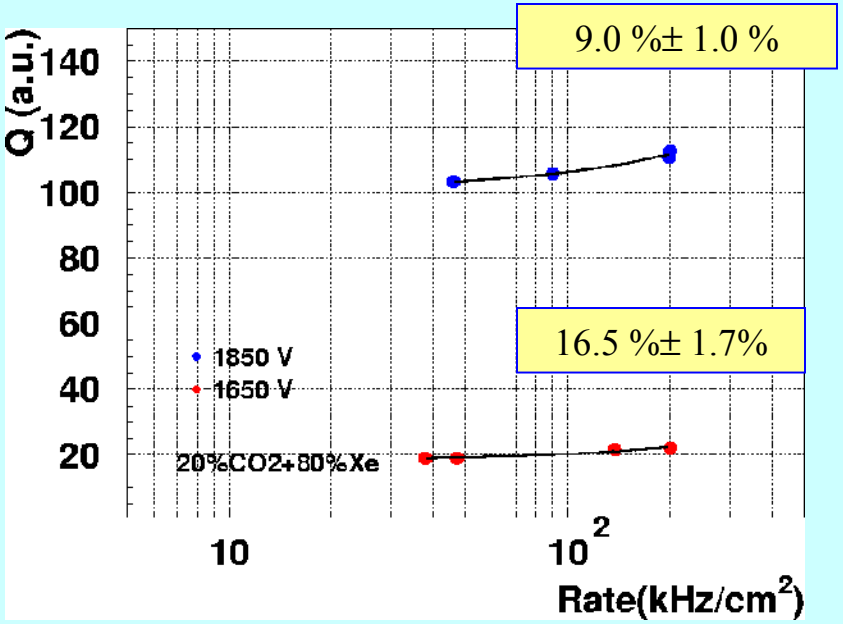
High Counting Rate Effect
Xe,CO_2(15%), p-2 GeV/c

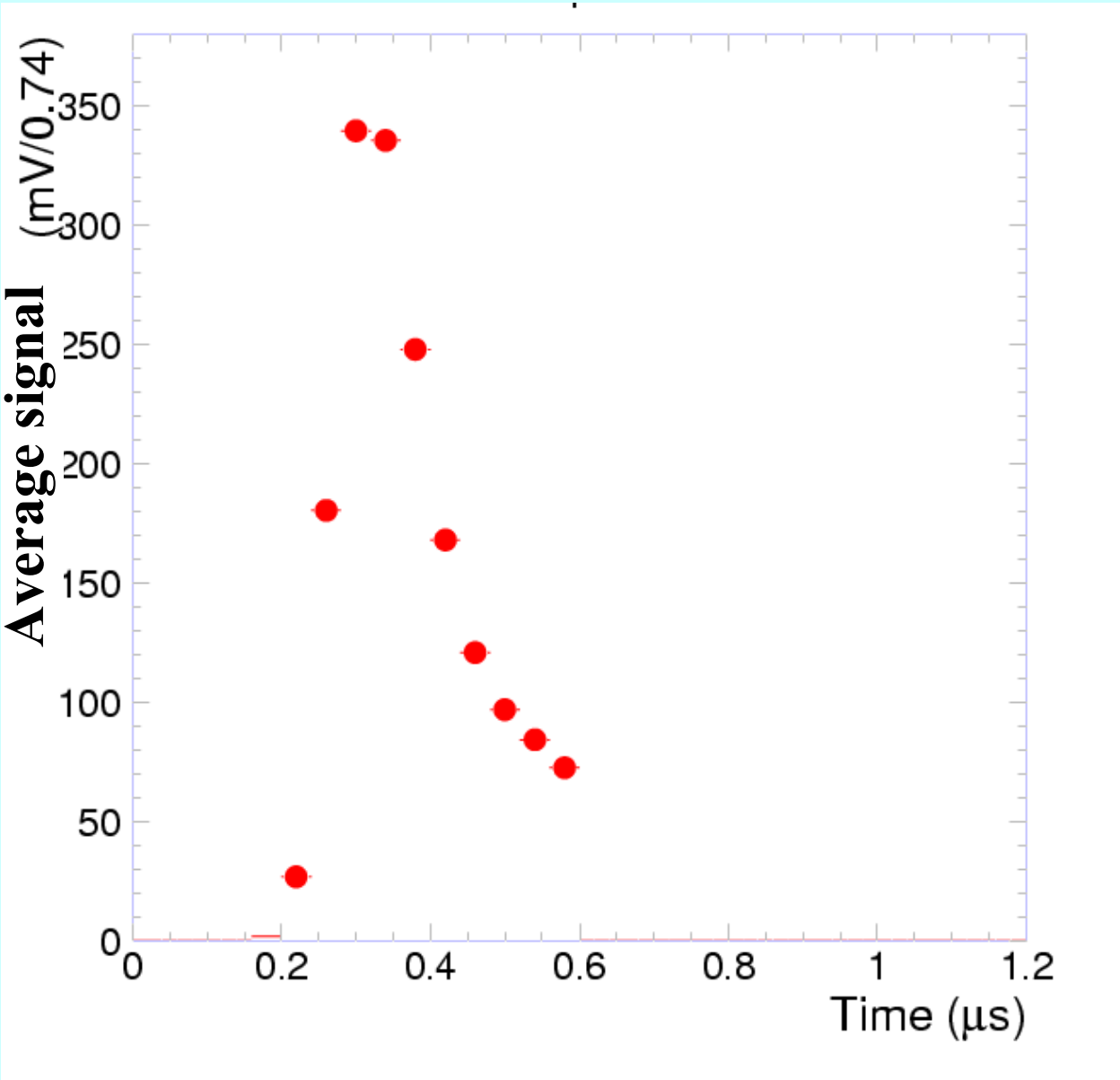




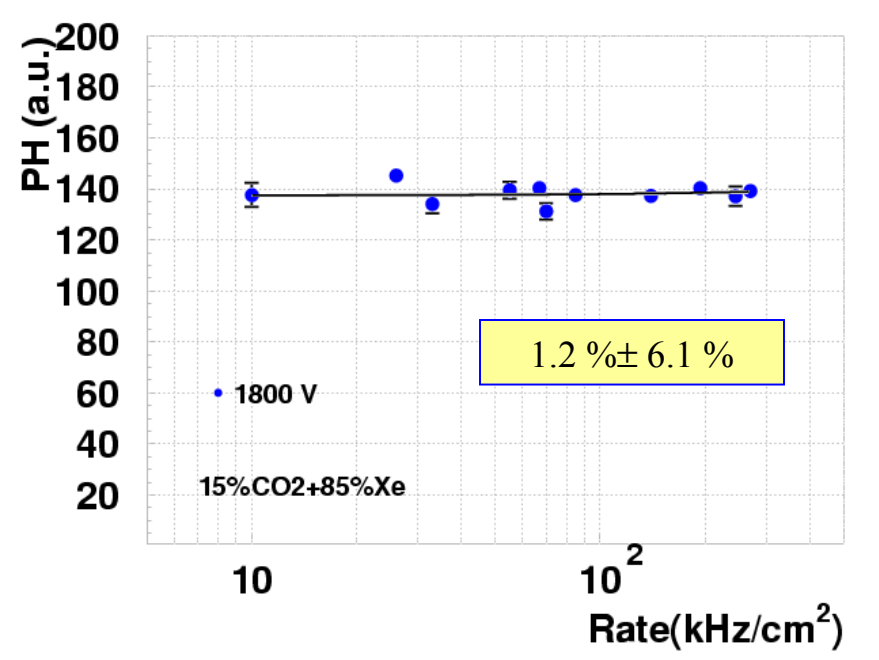
High Counting Rate Effect
Xe,CO_2(20%), p-2 GeV/c

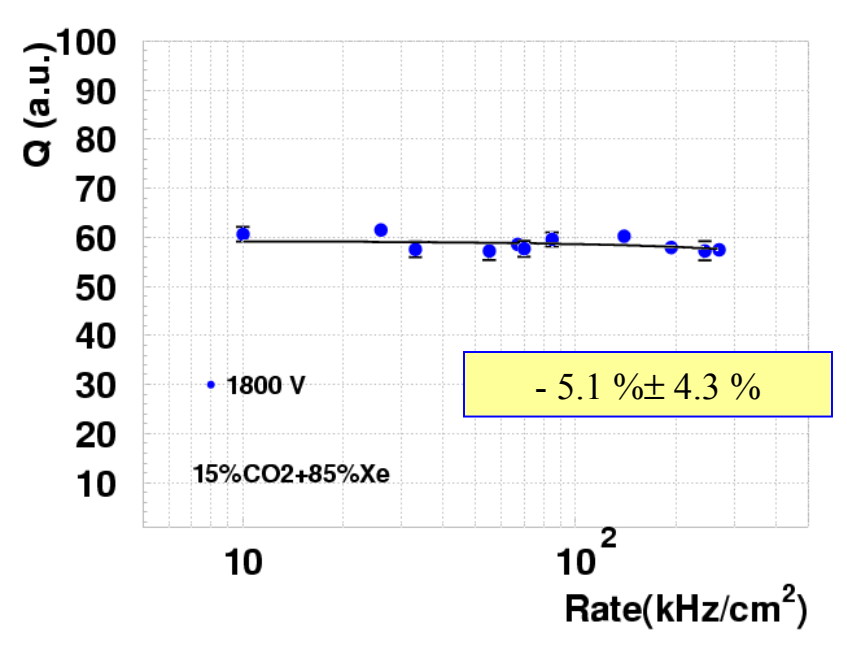




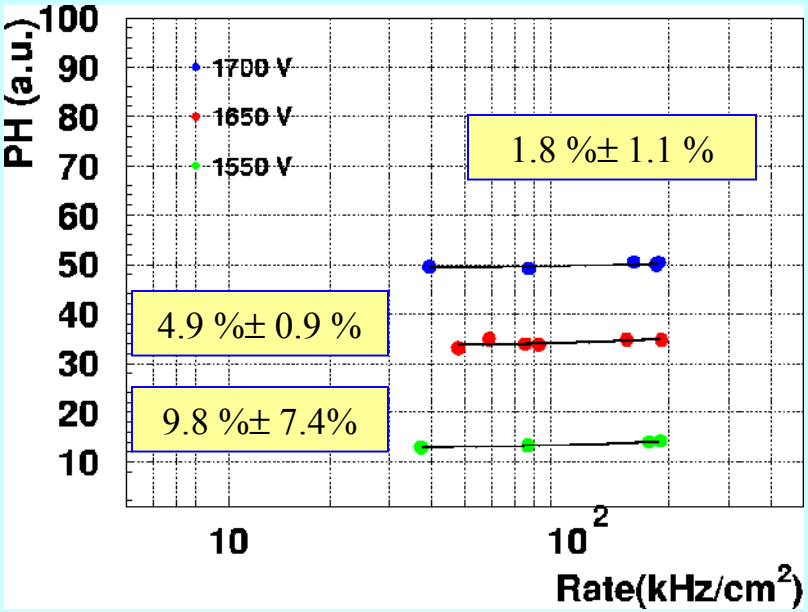

Average signal
(mV/0.74)
350
300
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
Time (μs)

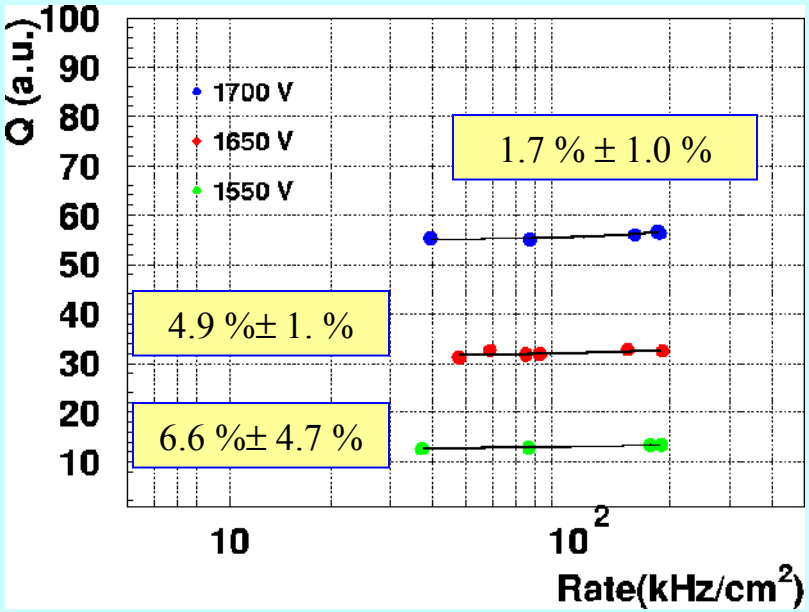
High Counting Rate Effect
Xe,CO_2(15%), p-1.5 GeV/c



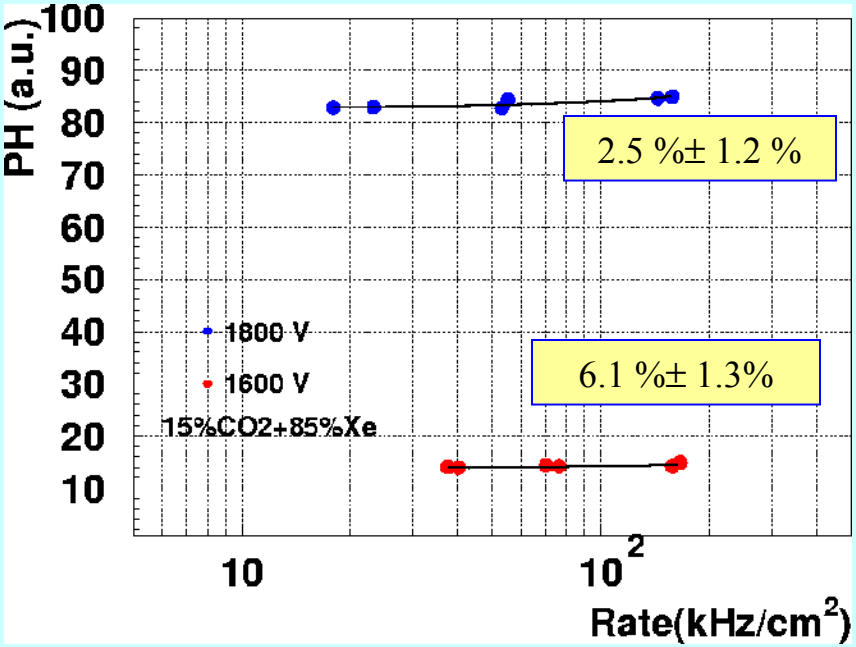


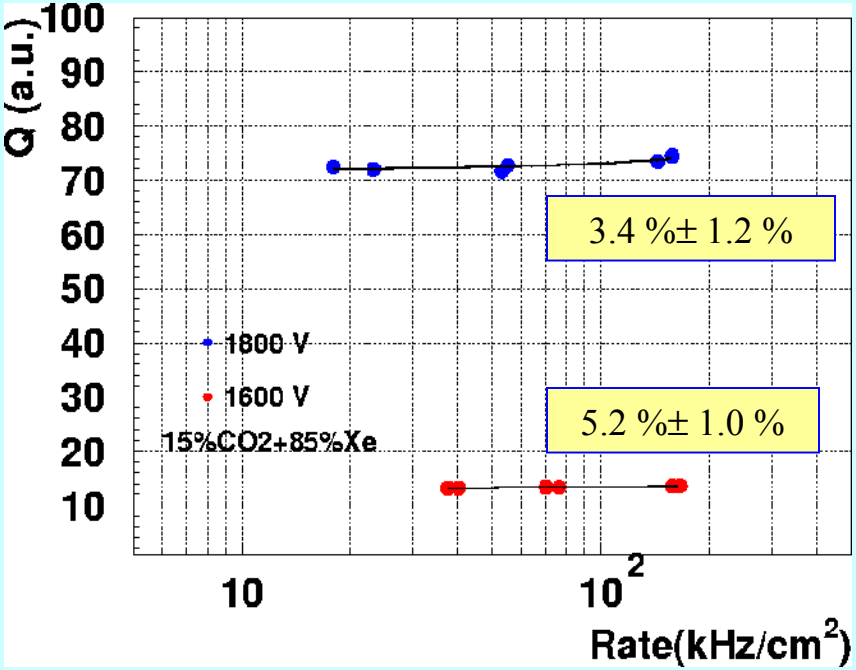
High Counting Rate Effect
Xe,CO_2(10%), p-2 GeV/c



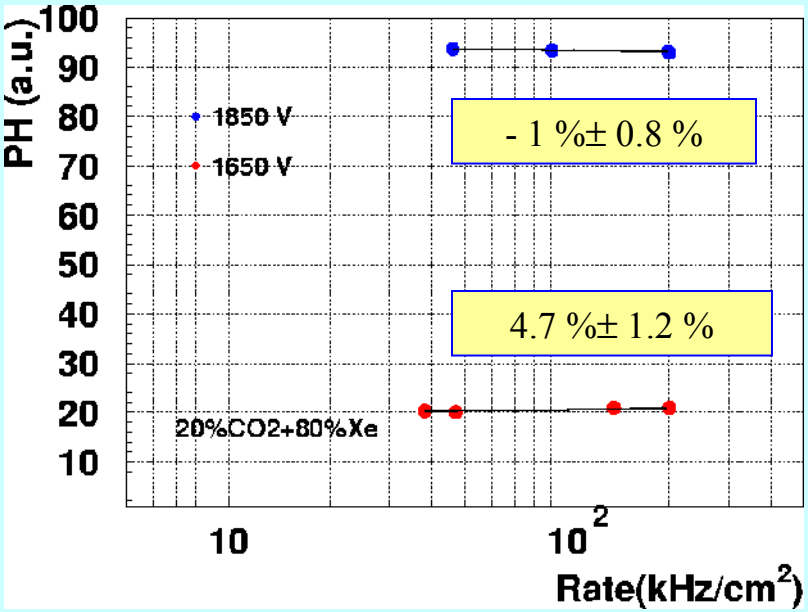


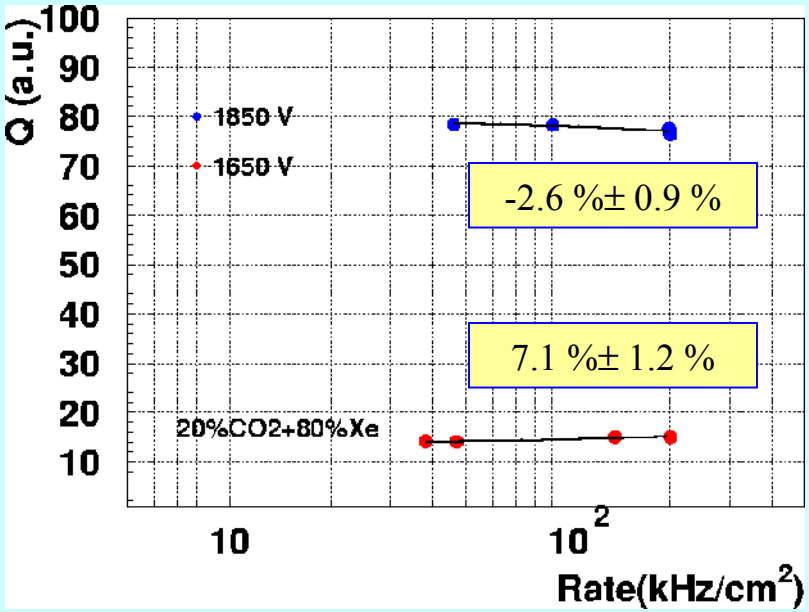
High Counting Rate Effect
Xe,CO_2(15%), p-2 GeV/c



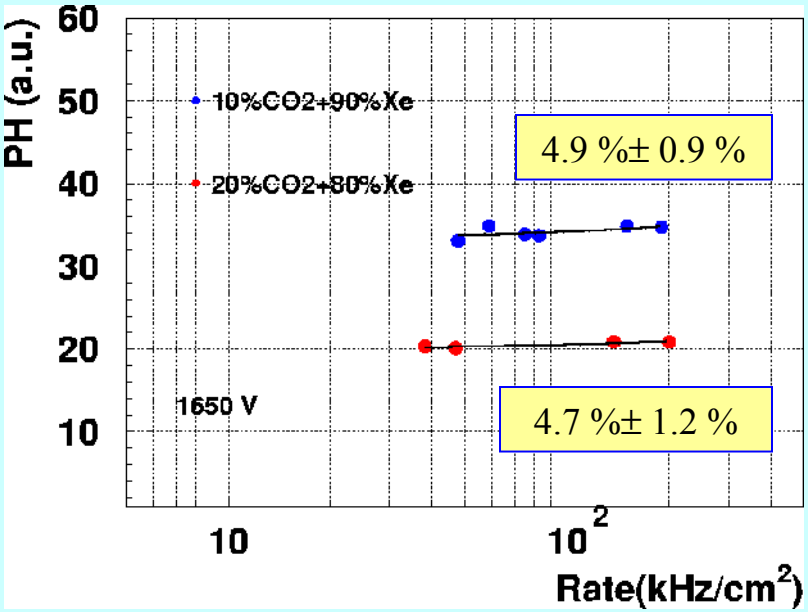


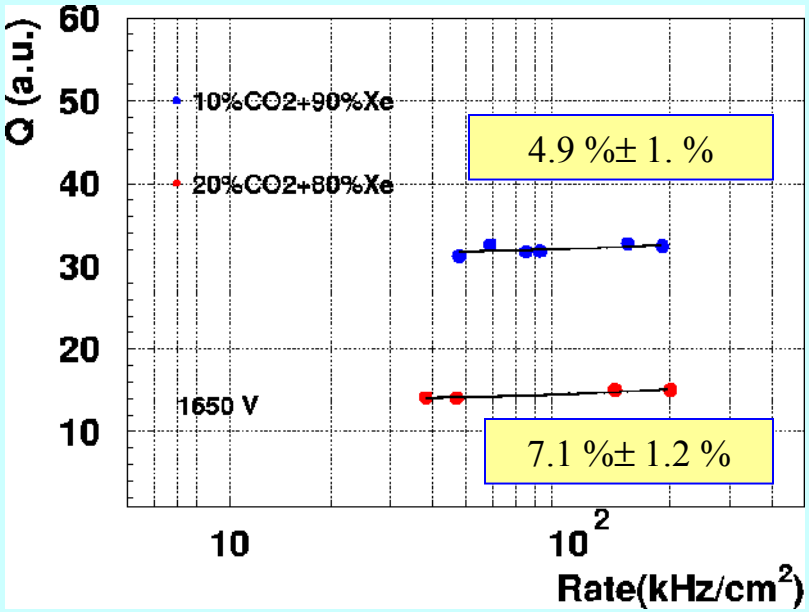
High Counting Rate Effect
Xe,CO_2(20%), p-2 GeV/c





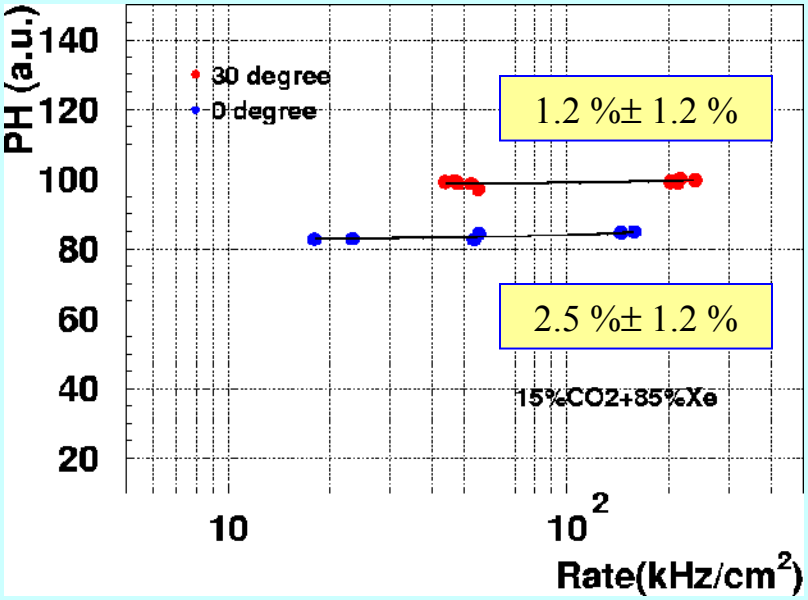
2 GeV/c, U=1650 V, $Xe,CO_2(10\%)$, $Xe,CO_2(20\%)$

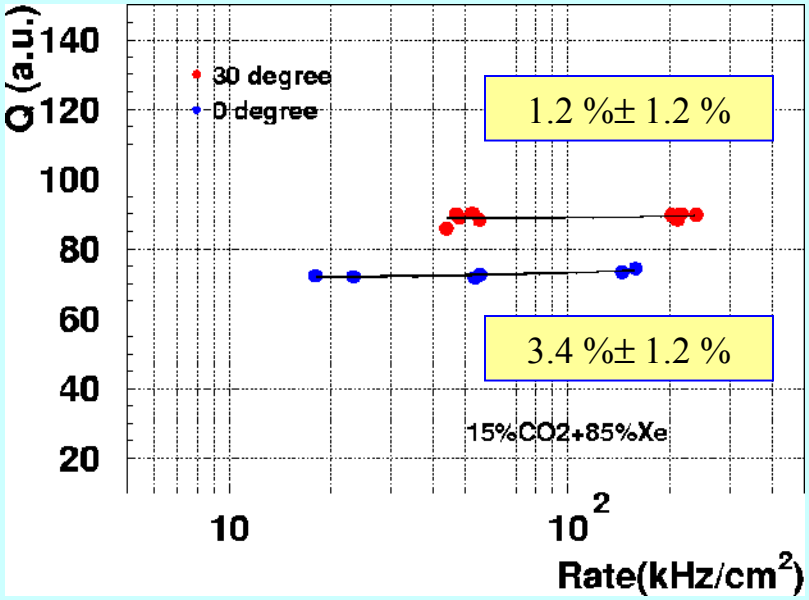




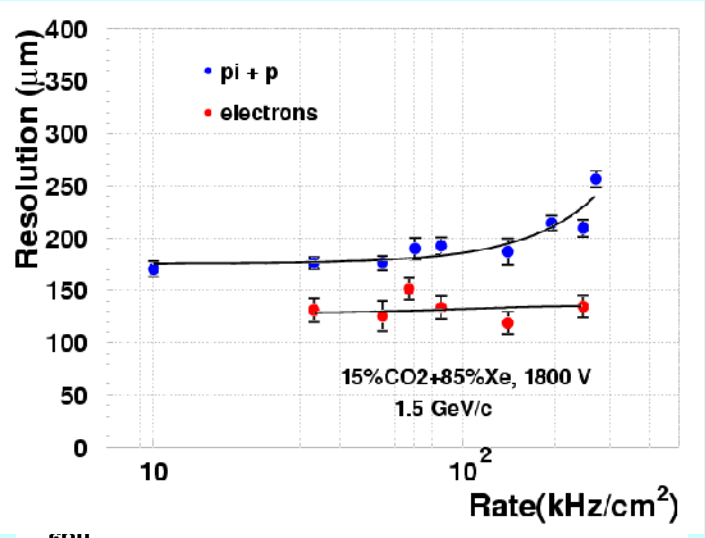
Rate Dependence for 30^0 Tilted Chamber

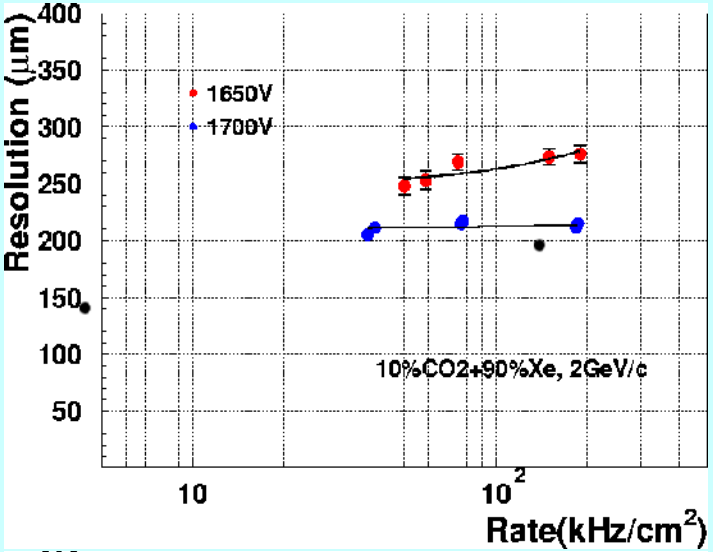
1800 V

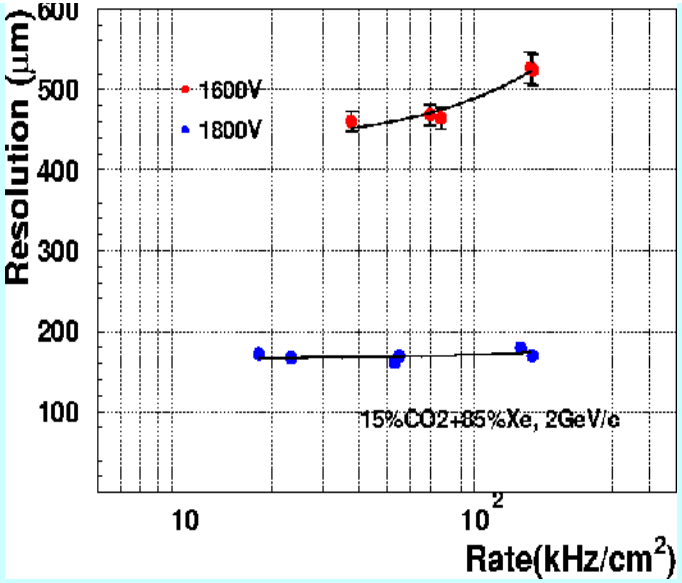


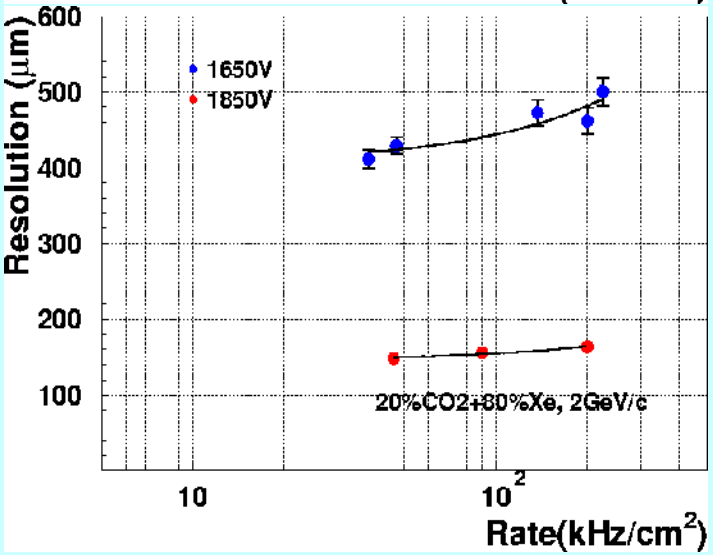


Rate Dependence of the Position Resolution





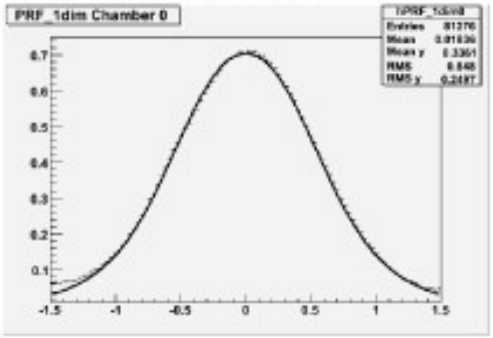




Rate Dependence of the Position Resolution

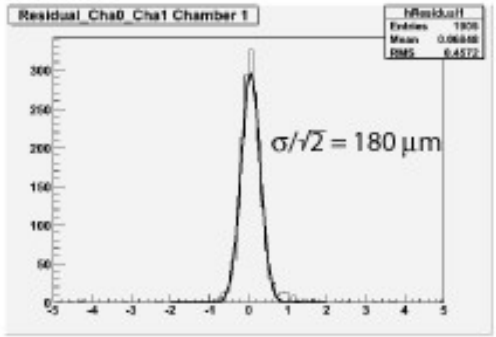
Independent analysis (M. Hoppe, Münster) supports results:

Pad Response Function
with empirical formula (no fit)
(Mathieson NIM A270 (1988) 602)

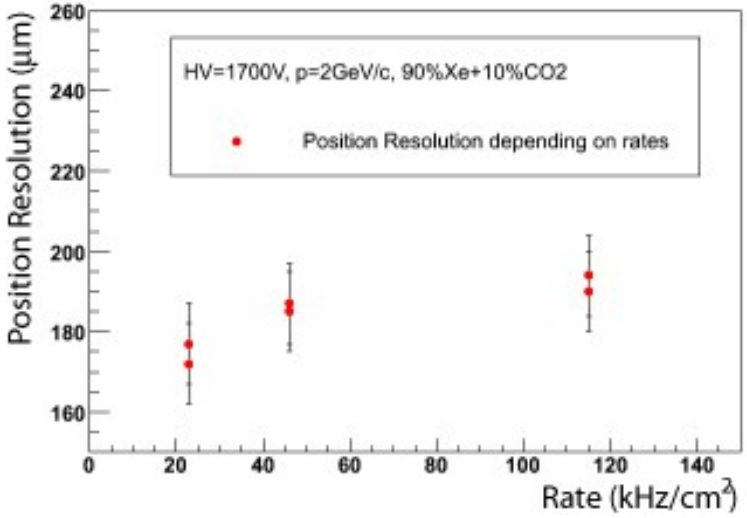


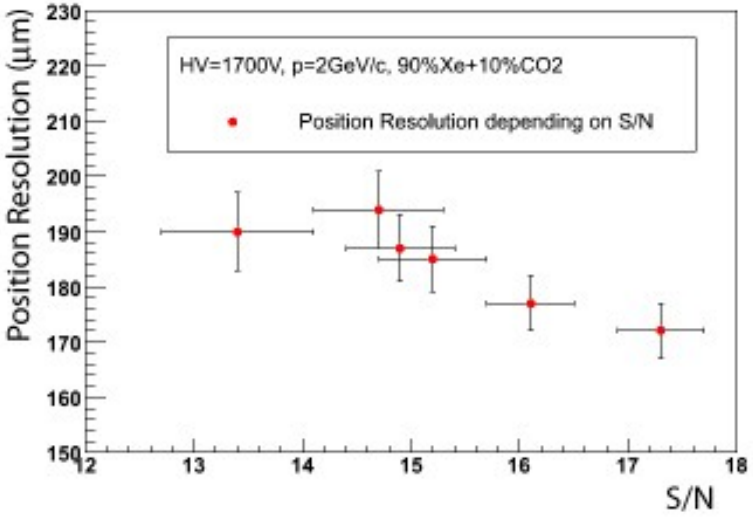
PRF (Pad units)

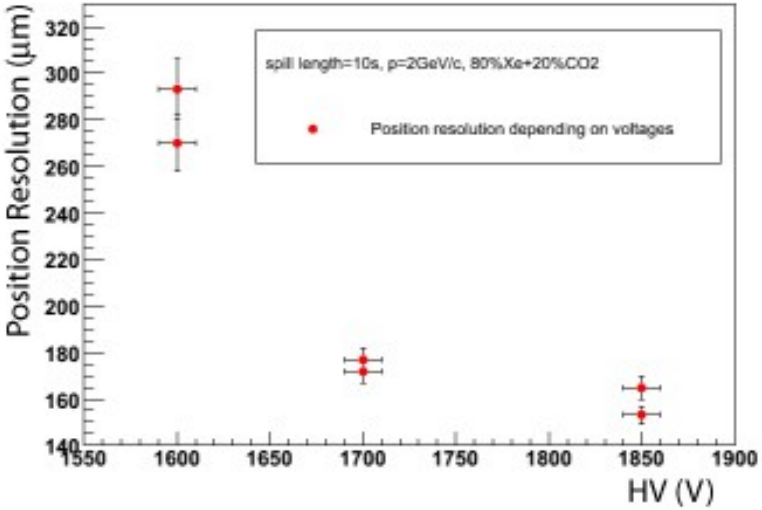
Residuals



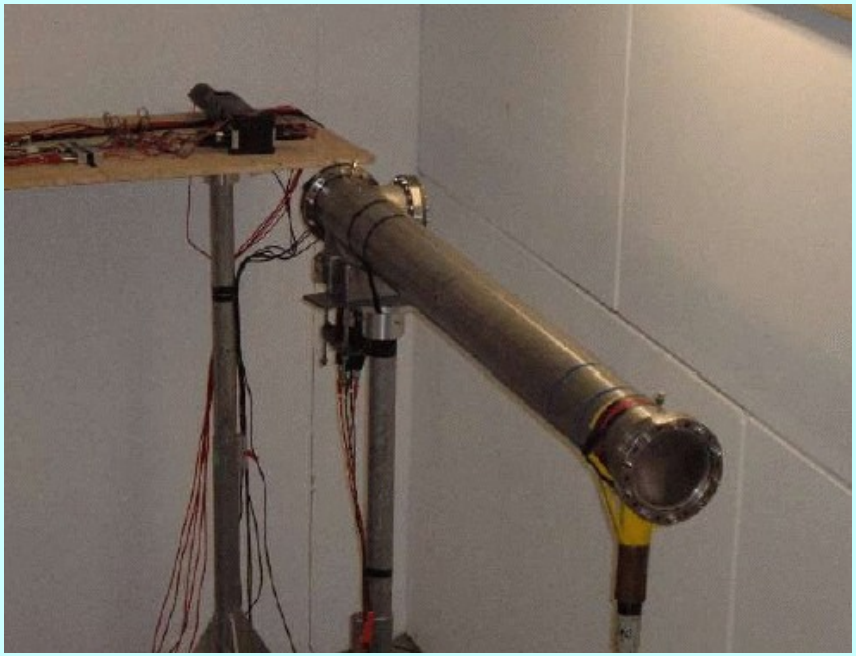
Residuals (mm)

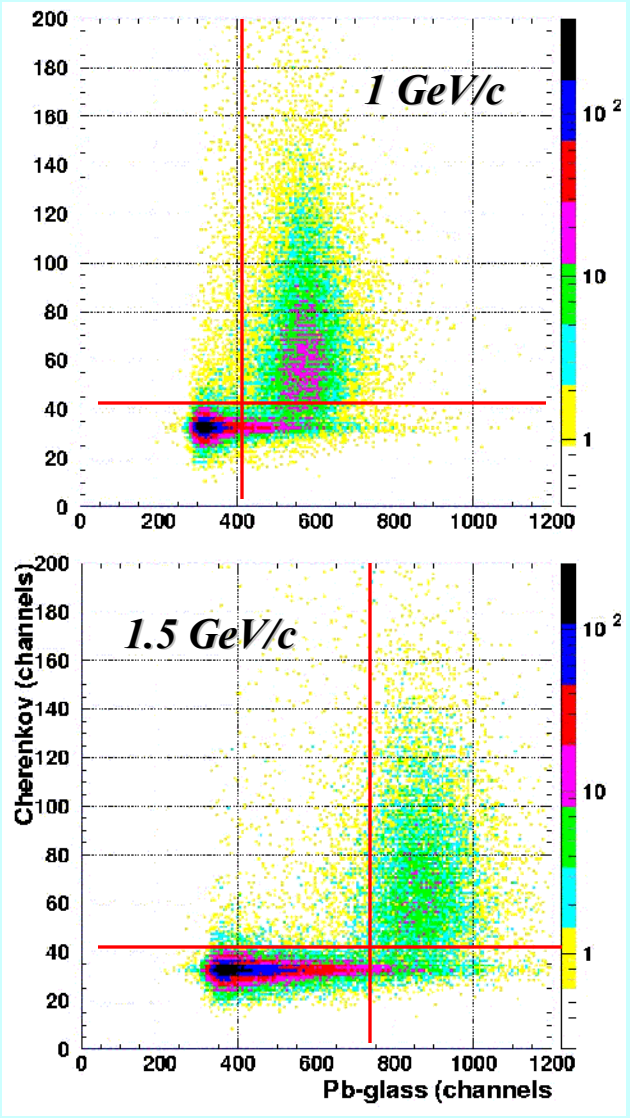






Electron Identification



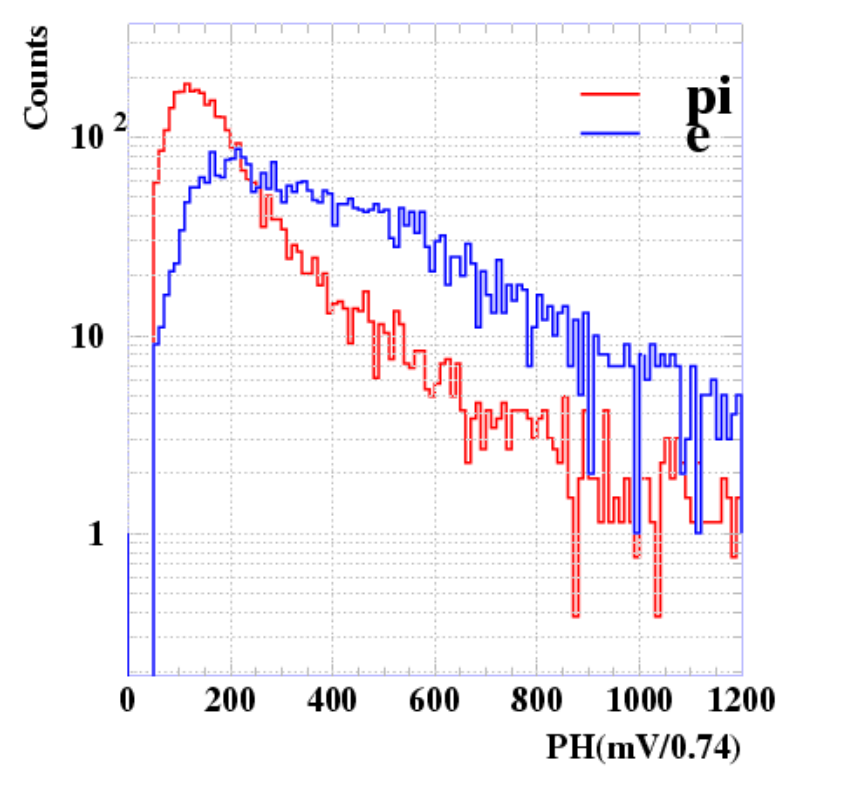


e/pi discrimination performance

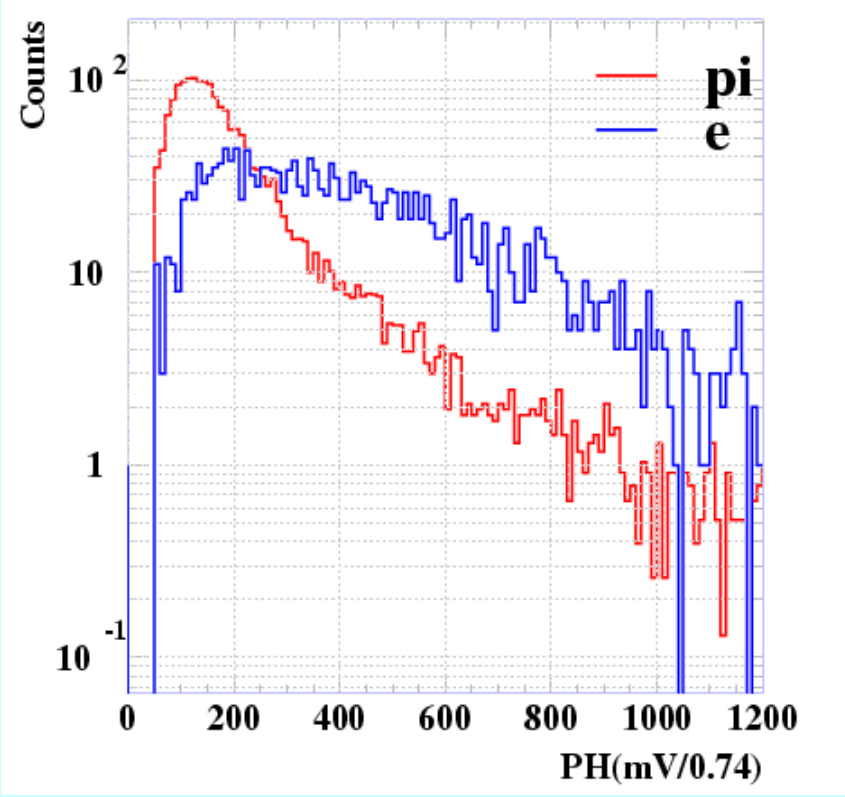
Xe,CO2(15%)

1800 V

1 GeV/c

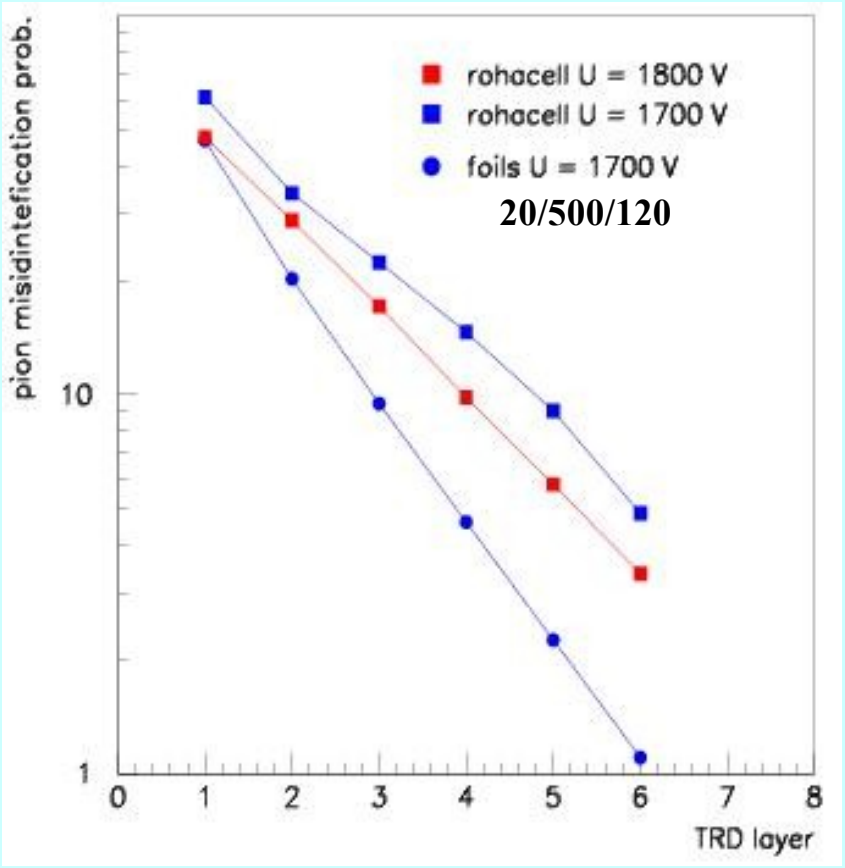


1.5 GeV/c

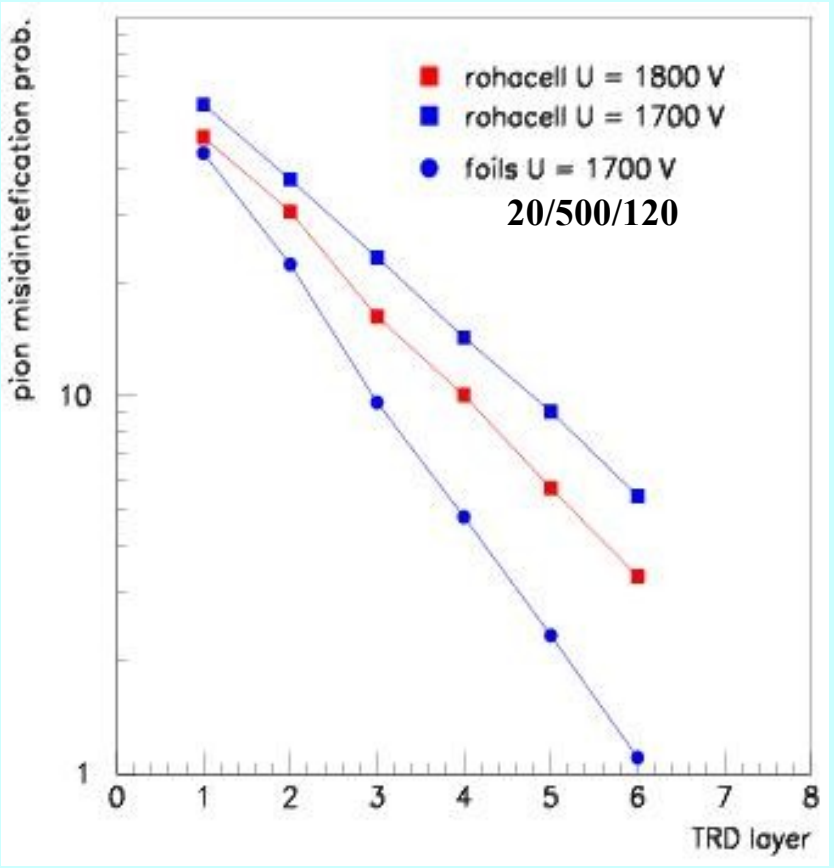


e/π discrimination performance 1.5 GeV/c

$\log(p_e/p_\pi)$



$p_e/(p_e + p_\pi)$

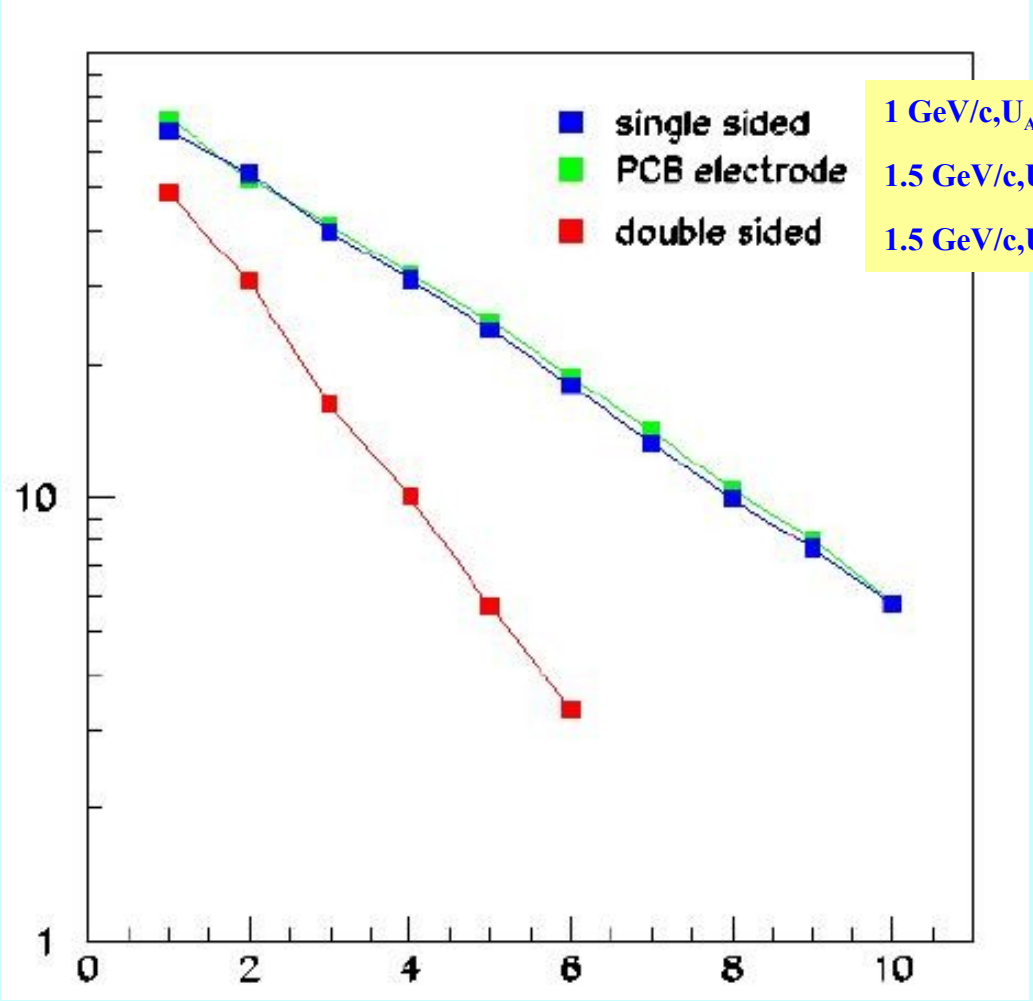


⇒ 1800 V, foils, ~ 0.7 % π rejection

20/500/120 ⇒ 20/200/220, 1.4 better

e/π discrimination performance

Xe,CO2(15%)

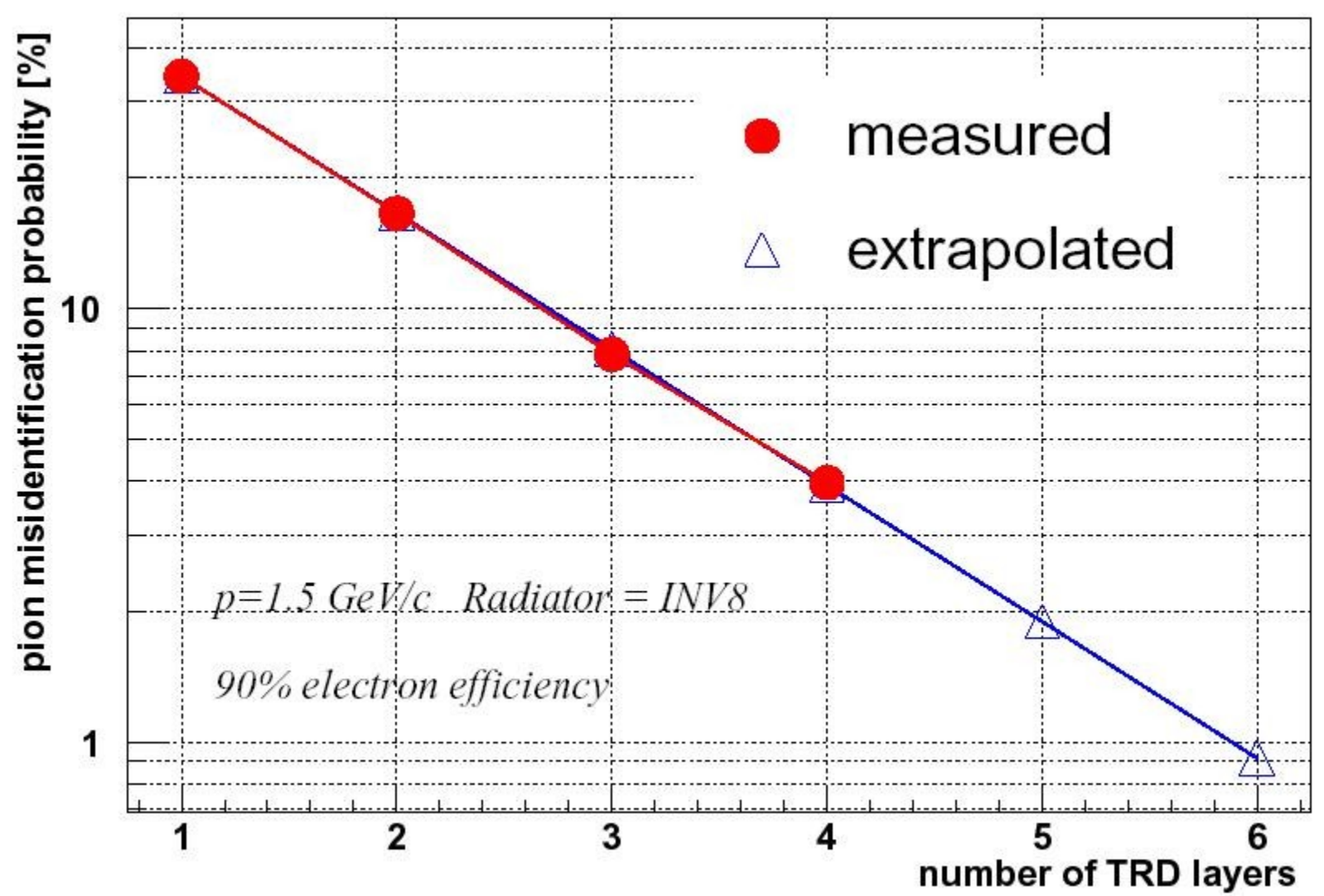


1 GeV/c,U_A = 1900 V

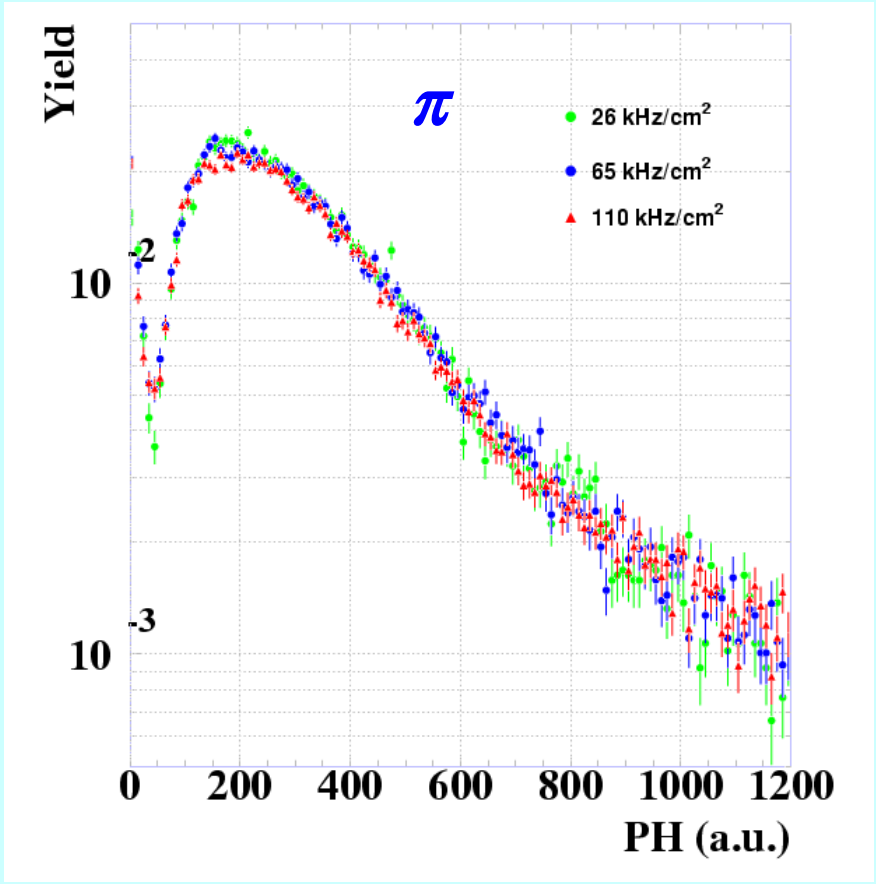
1.5 GeV/c,U_A = 1800 V

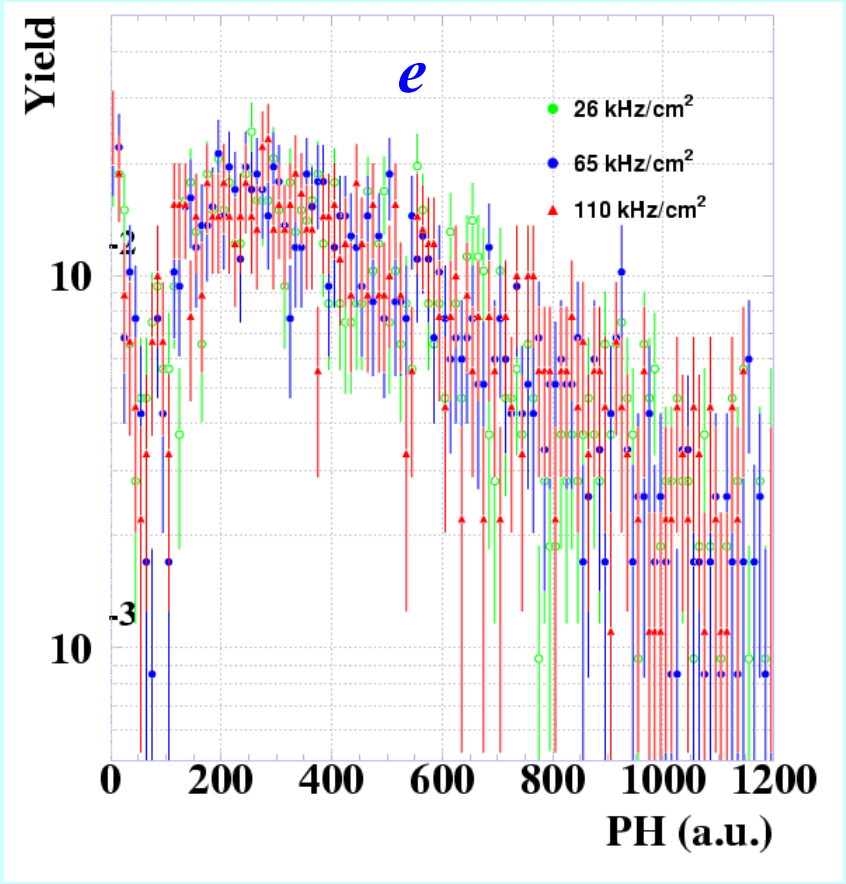
1.5 GeV/c,U_A = 1800 V

e/π discrimination performance
ALICE - TRD

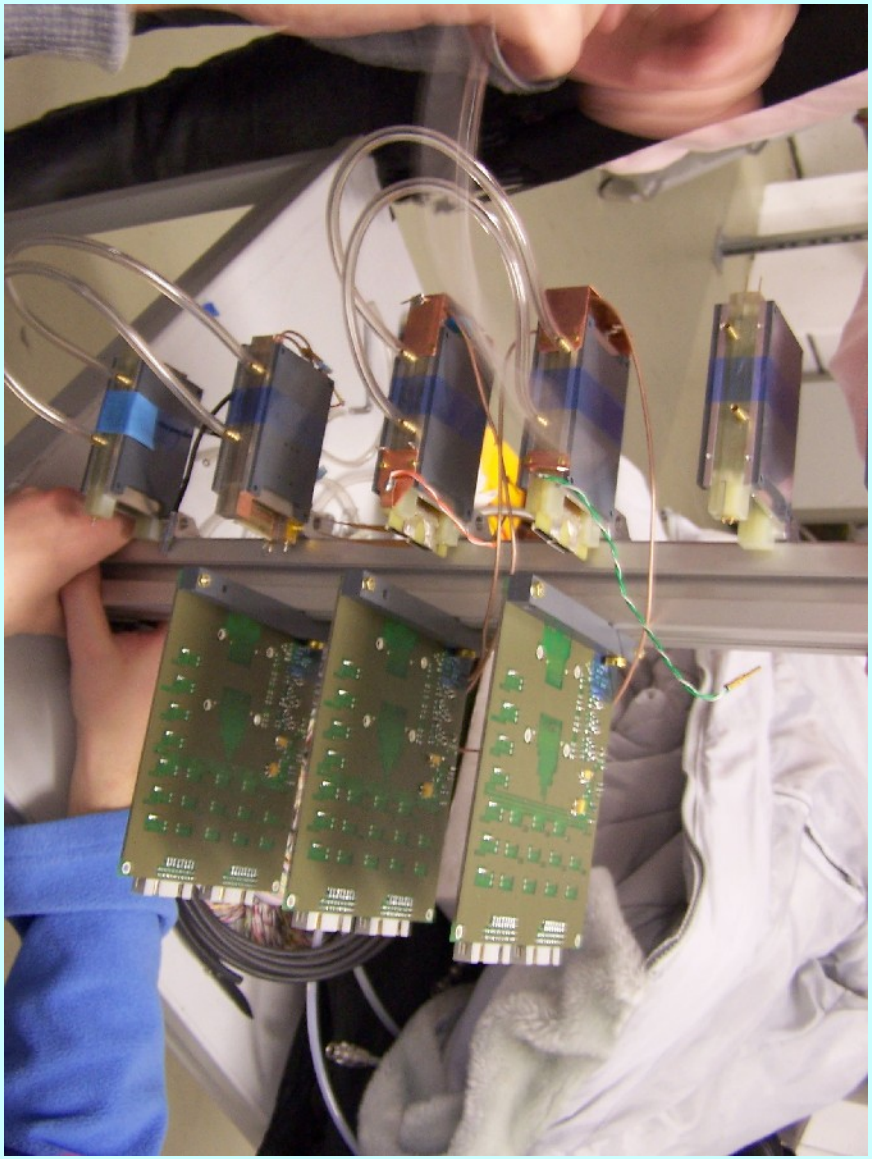


e/π discrimination – counting rate dependence





3 single cell 3 μm mylar not tested



Conclusions

- *TRD based on compact geometry MWPC works up to > $2 \cdot 10^5$ particles/cm^2/sec with negligible change of pulse height or charge (~2-3%)*
- *The position resolution at low rate is ~160 μm; the observed degradation is ~20 μm at $2 \cdot 10^5$ particles/cm2/sec;*
- *A double-sided pad readout electrode brings the performance of these TRD at a π rejection factor of ~200 for 6 layers using appropriate foil stack radiator.*

⇓

The solution for:
-high counting rate
- high granularity
- high e/π rejection factor
- minimum material budget
- minimum electronic channels

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Double sided read-out pad plane electrode prototype :

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