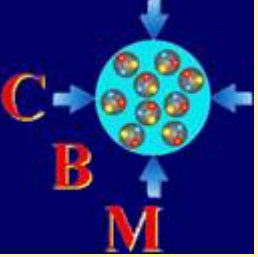
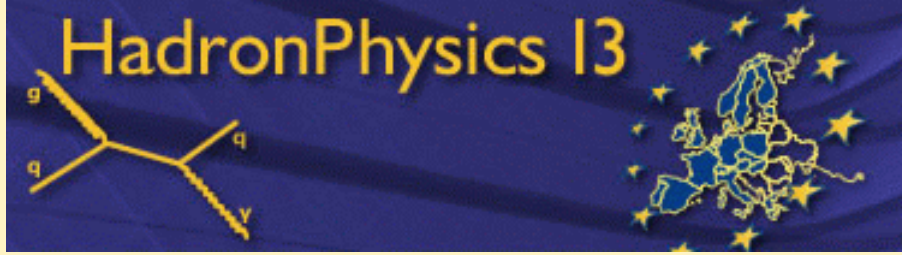




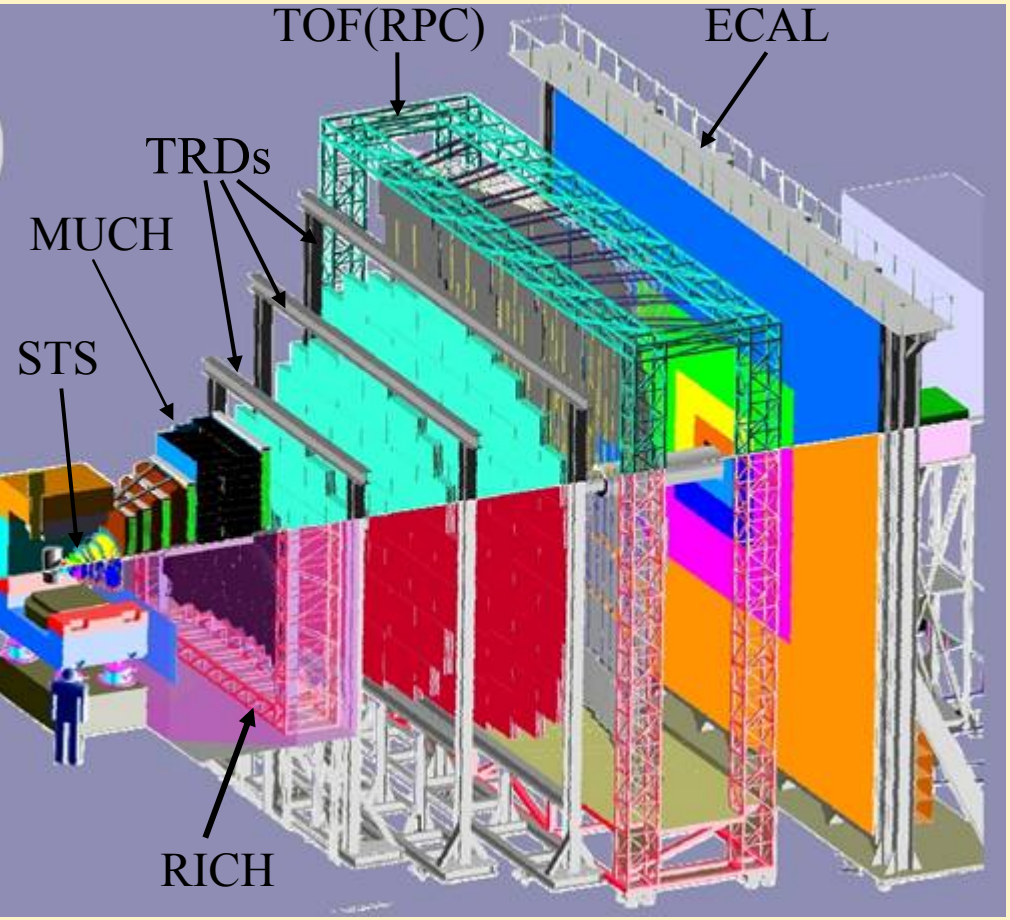
Layout and first test results of new TRD prototypes

Mariana Petris, NIPNE - Bucharest

Outline

- HCRTRD prototypes: short review
- ^{55}Fe source tests
- In beam tests:
  - ✓ e/π discrimination;
  - ✓ investigation of the rate capability
    - – pulse height and charge
    - – position resolution
- A real size prototype
  - Design and Construction
  - ^{55}Fe source tests
- Summary and Outlook

CBM Requirements



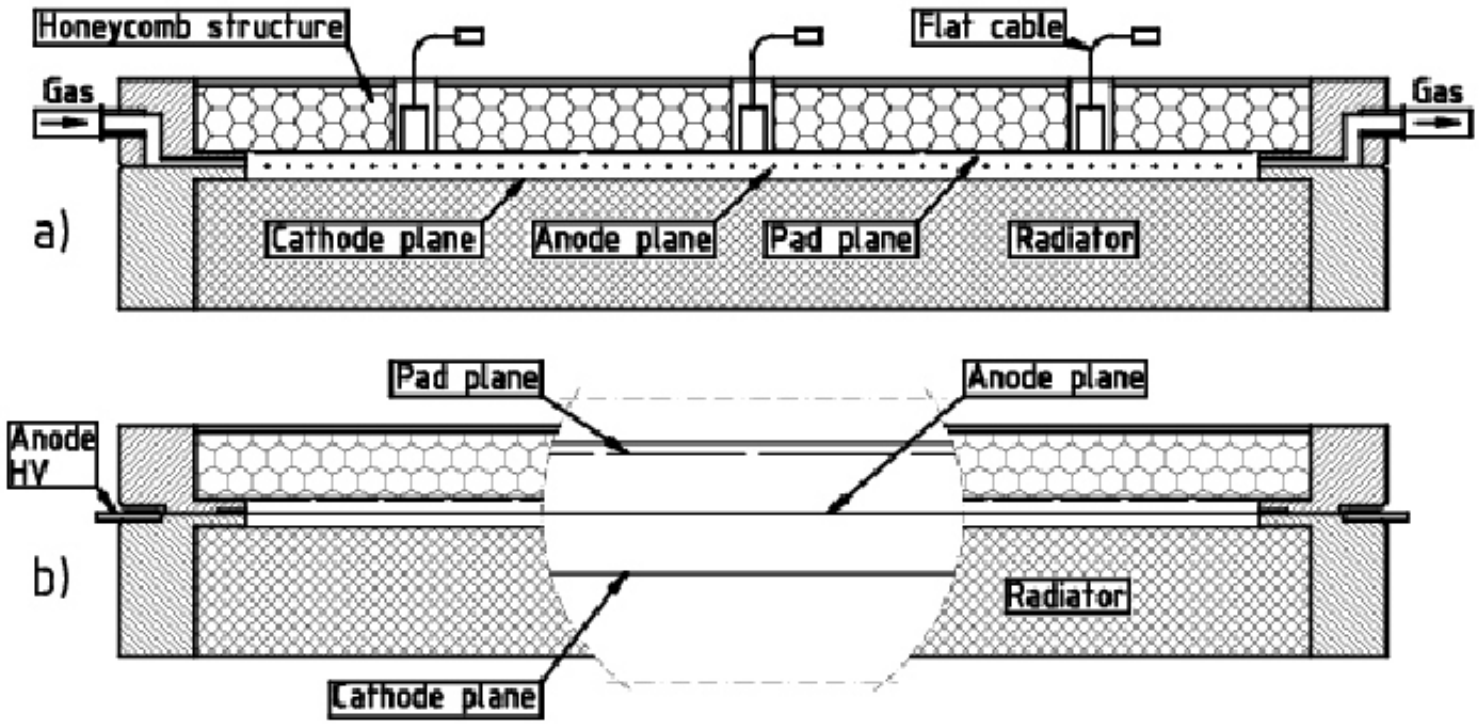
Interaction rate: **10^7Hz (~1000 tracks/event)**

TRD subdetector – possible scenario:

- *3 stations @ 4, 6, 8 m from target (3 layers each)*
- *Highly granular and fast detectors which can stand the high rate environment (up to 10^5 part/cm^2 ·sec)*
- *Identification of high energy electrons (γ > 2000); pion rejection factor > 100*
- *Tracking of all charged particles: position resolution ~ 200 – 300 μm*

HCRTRD - prototype

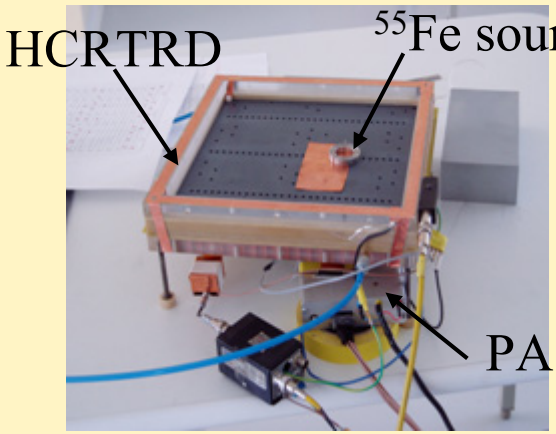
- type
- π_{rej}
- Max
- Cou
- Gra



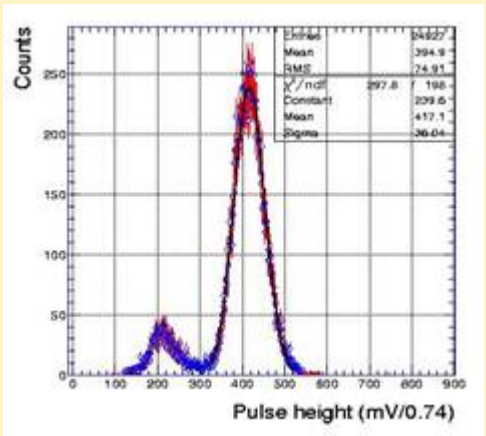
- type: radiator + MWPC
- maximum drift time < 100 ns
cell size ~ 1·6 cm2
- anode pitch = 2.5 mm

^{55}Fe Source & In Beam Tests

85% Ar + 15% CO_2 ; HV 1700 V

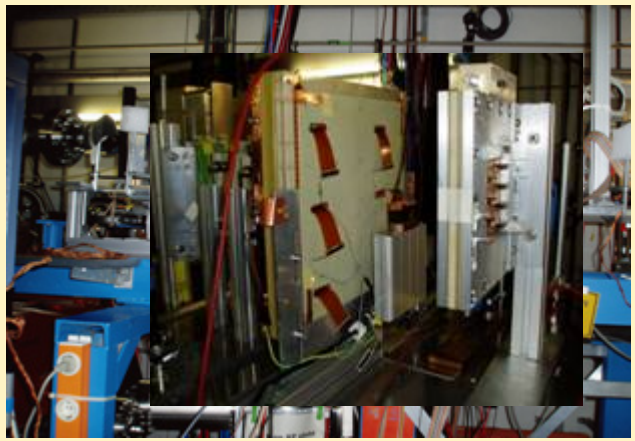


Readout: PASA (2mV/fC, 1800 e rms) + FADC Converter



Energy Resolution (pad signal): ~8.6 % (σ); ~20 % FWHM

Goal of the experiment: *detector performance in high counting rate environment*

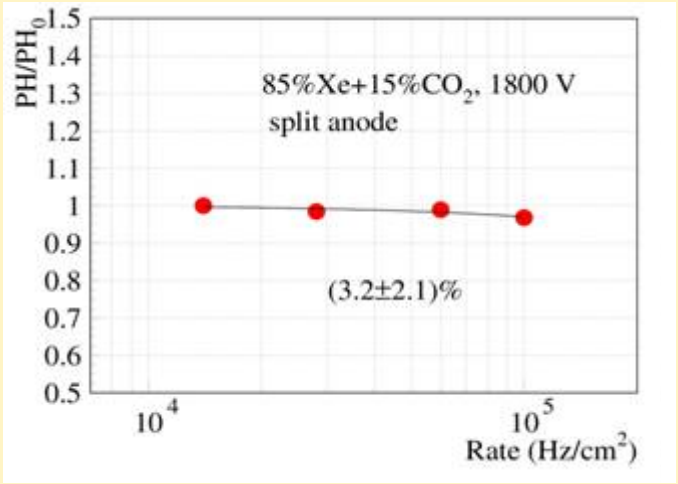


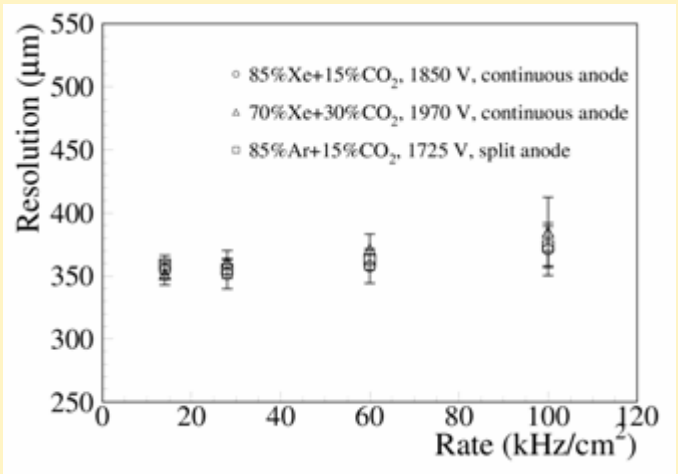
Experimental Setup

- 2 Scintillators (ToF, trigger)
- 2 Si -Strip Detectors (beam profile definition)
  - 2 MWPC - GSI (10 x 10 cm^2)
  - 1 MWPC – NIPNE (24 x 24 cm^2)
  - 1 MWPC - JINR (10 x 10 cm^2)
  - 1 GEM – JINR
- Pb - glass calorimeter
- FADC readout ; DAQ (MBS)

High Counting Rate Effect

protons, p=2 GeV/c

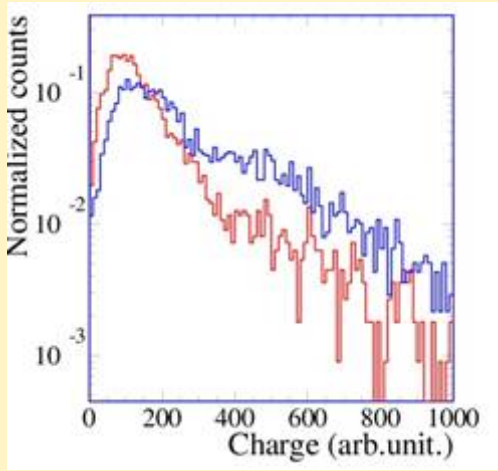


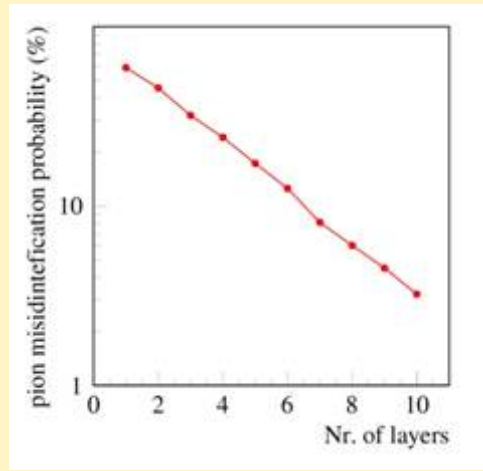


σ_{pos} = 350 μm @ 16 kHz/cm^2;
σ_{pos} = 384 μm @ 100 kHz/cm^2
Pad geometry not optimized

e/π discrimination

p=1GeV/c, U = 1900 V, Rohacell HF71 radiator,
Gas mixture: 85% Xe + 15% CO2





Pion efficiency:

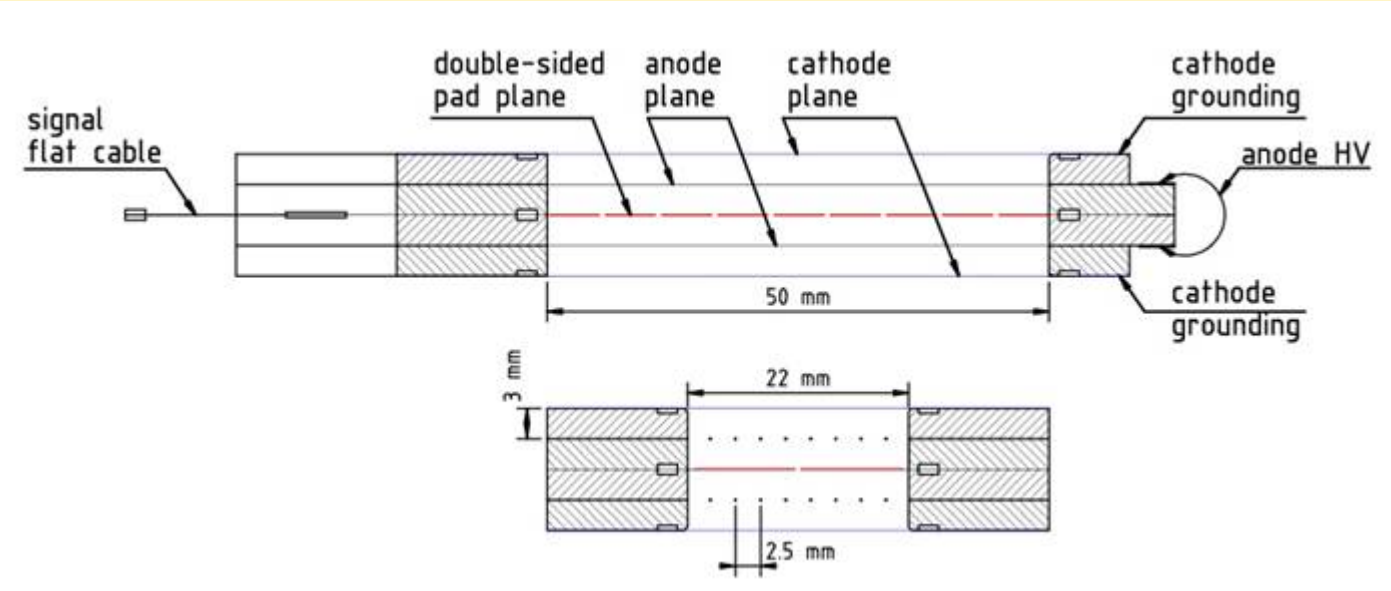
- 6 layers configuration = 12.5 %
- 10 layers configuration = 2.9 %
- Can be improved using a better radiator from the point of view of the transition radiation yield

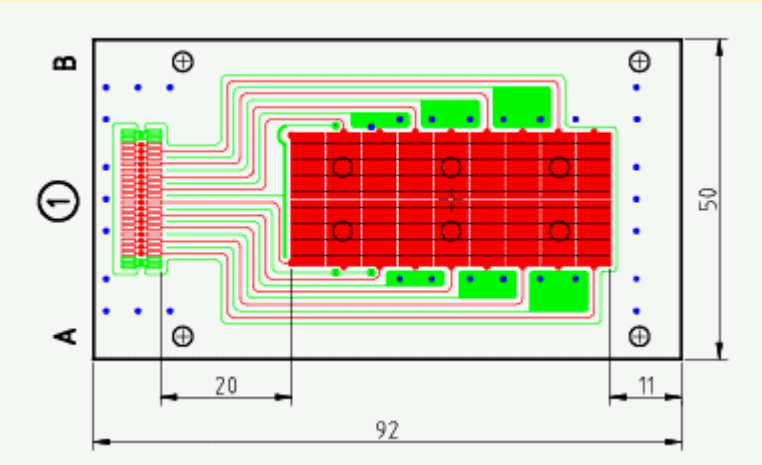
High Efficiency TRD for High Counting Rate Environment

Goal: ***to increase the conversion efficiency of the TR in one layer conserving the rate performance and the number of the readout channels of the first prototype .***

Solution: ***mirrored MWPC relative to a common double sided pad-plane electrode.***

Double - sided pad readout HCRTRD prototype





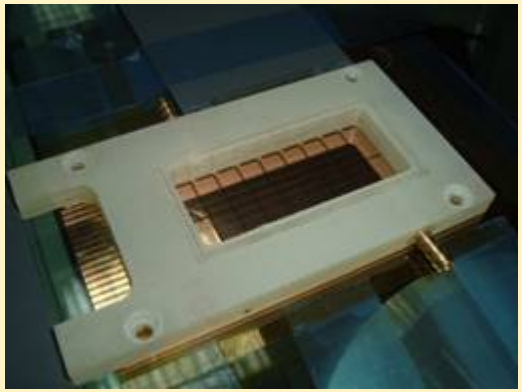
Readout electrode

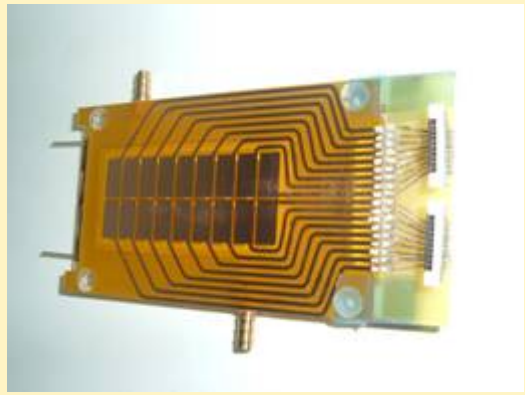
pad size: 5 x 10 mm^2

Three versions of such a prototype

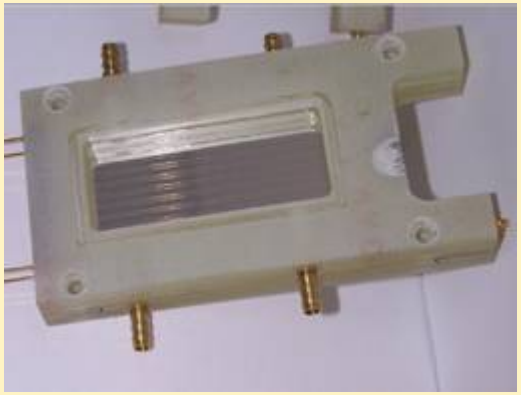
The first: *the double – sided pad readout electrode has been made from PCB of 250 μm thickness.*

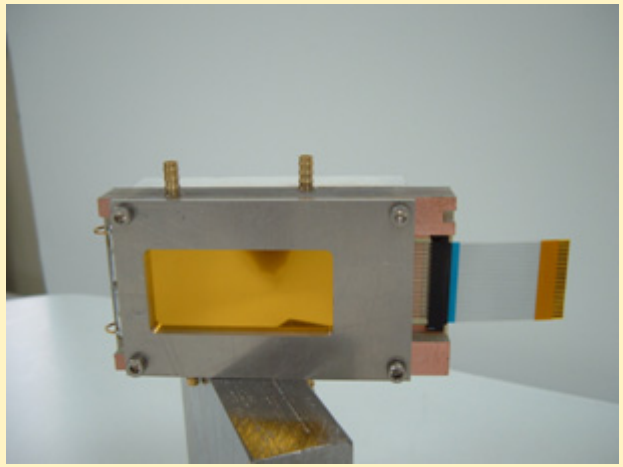
The third: *the double – sided pad readout electrode made from kapton foil of 25 μm, covered with copper on both sides.*





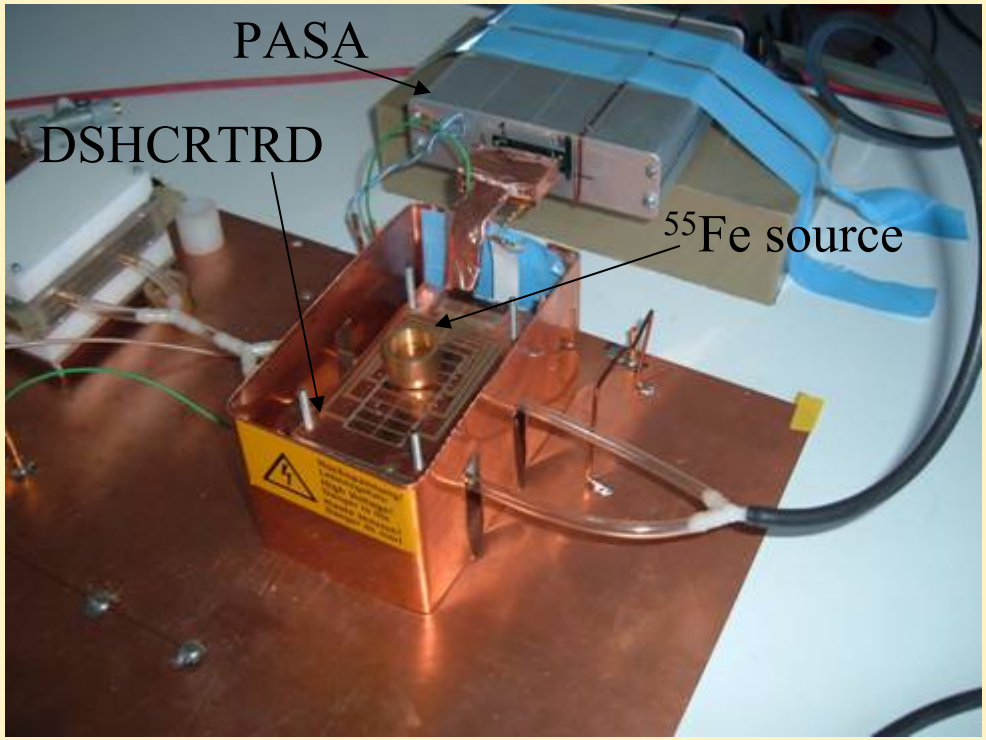
The second: *the single – pad readout electrode made from mylar foil of 3 μm thickness, aluminized on both sides.*

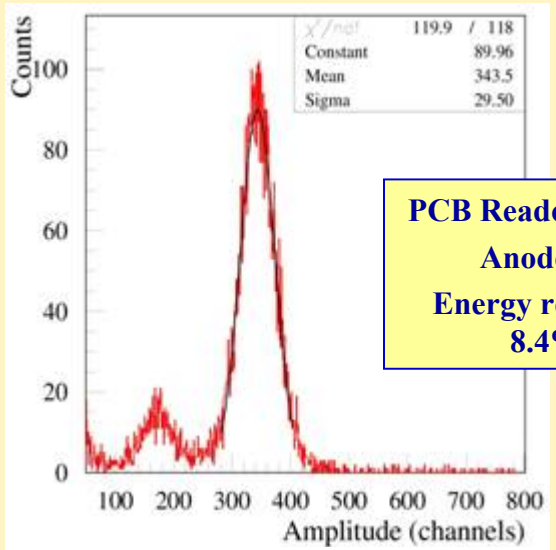




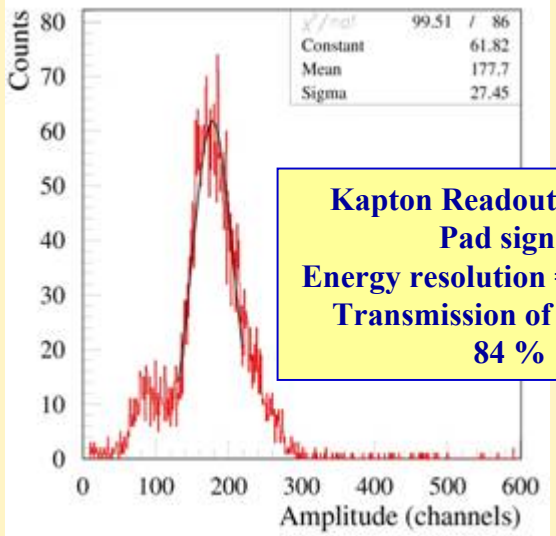
^{55}Fe source tests

70% Ar + 30% CO_2 ; HV 1700 V;





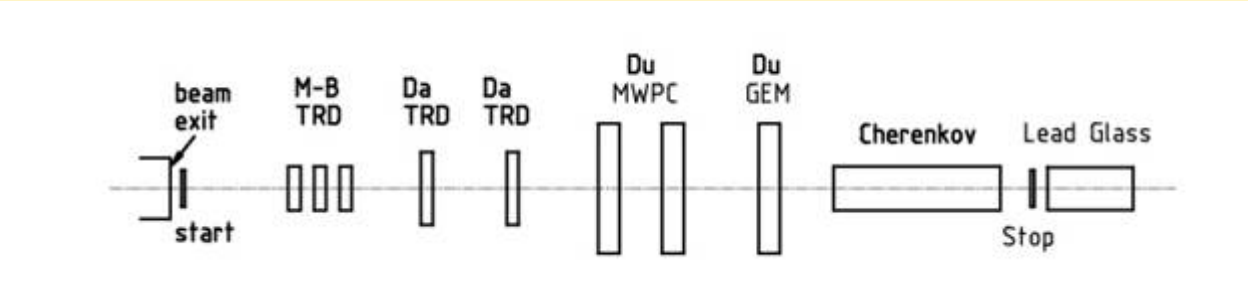
PCB Readout electrode
Anode signal
Energy resolution = 8.4% (σ)



Kapton Readout electrode
Pad signal
Energy resolution = 15.4% (σ)
Transmission of X – ray = 84 %

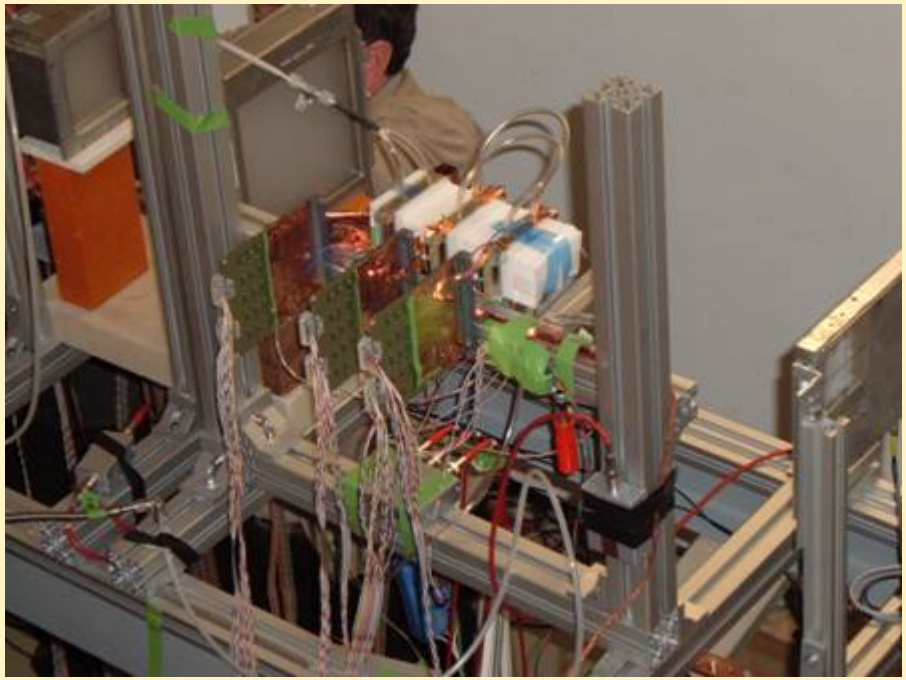
Readout: PASA (2mV/fC, 1800 e rms) + ADC Converter

Beam tests



SIS, GSI – Darmstadt

Experimental Setup



New PASA – 16 channels ASIC preamplifier - shaper

H.K. Soltveit, I.Rusanov, J.Stachel, GSI Sci. Rep. 2005-1

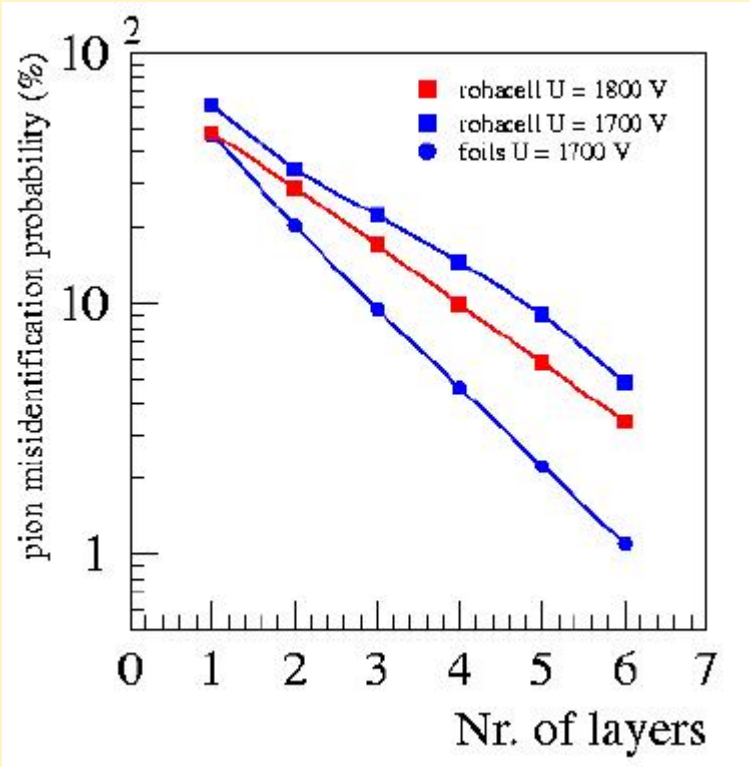
- **2 Scintillator arrays (ToF, trigger): each array - 4 scintillator paddles (4 x 1 x 0.5 cm^3 each)**
- **2 Si - Strip Detectors (beam profile)**
- **3 MWPC–IFIN-HH (18 pads with total area of ~ 22 x 50 cm^2)**
- **2 MWPC-GSI (32 pads with total area of ~ 56 x 64 cm^2)**
- **2 MWPC-JINR (active area 40 x 40 cm^2)**
- **1 GEM–JINR (active area 10 x 10 cm^2)**
- **Cherenkov detector + Pb-glass calorimeter**
- **FADC readout ; DAQ (MBS)**

e/π discrimination performance

Rohacell Radiator = 4 cm fiber (17 μm) structure + 2 cm Rohacell foam, 1800 V

Foil Radiator (20/500/120)

1.5 GeV/c; 85%Xe + 15%CO_2



Pion eff @1700 V, rohacell = 5.4 %

Pion eff @1700 V, foils = 1.1 %

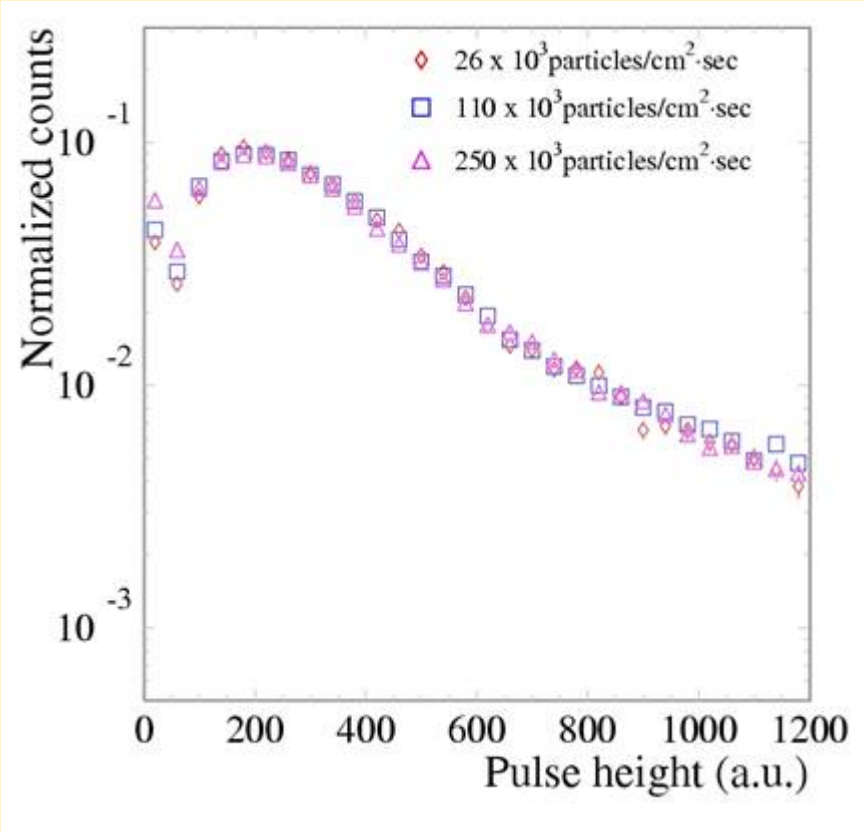
Pion eff @1800 V, rohacell = 3.3 %

Rohacell / foils = 4.9

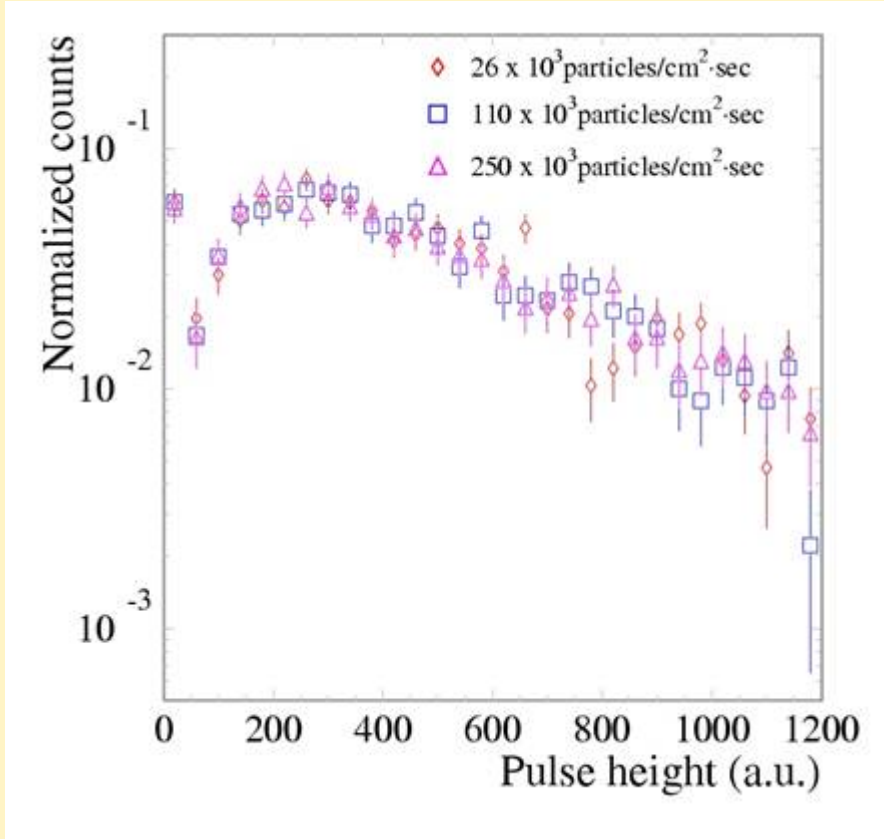
Pion eff @ 1800 V, foils = 0.7%

Rate performance

hadrons

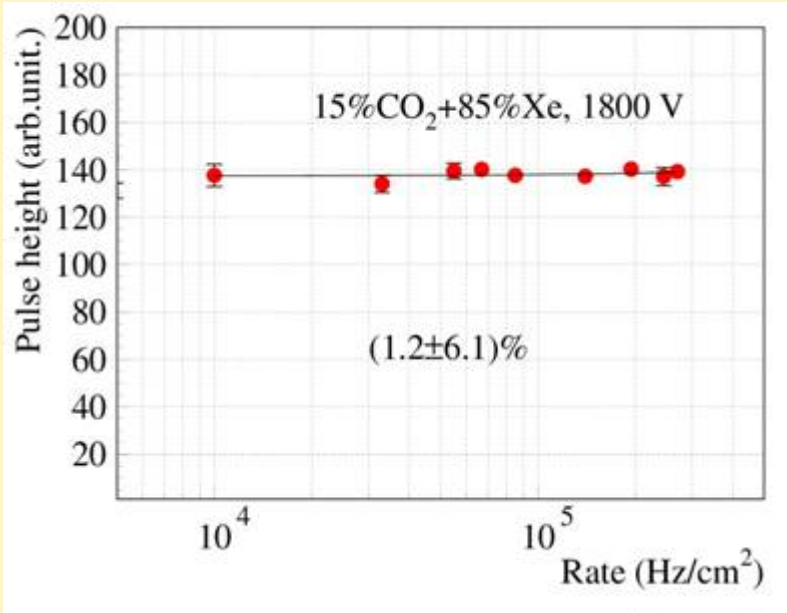


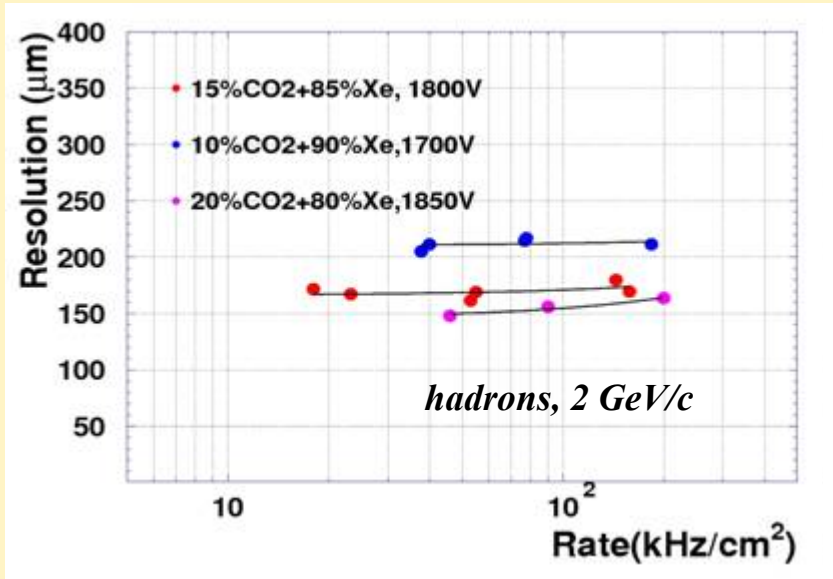
electrons



High Counting Rate Effect

p = 1.5 GeV/c





- *Negligible deterioration of the signal*

- *A good position resolution of the counter, smaller than 200 μm at low counting rate*
- *No significant degradation up to 200 kHz/cm2*

These results have been obtained in the frame of the

JRA4 - I3HP/FP6 Collaboration:

NIPNE – Bucharest

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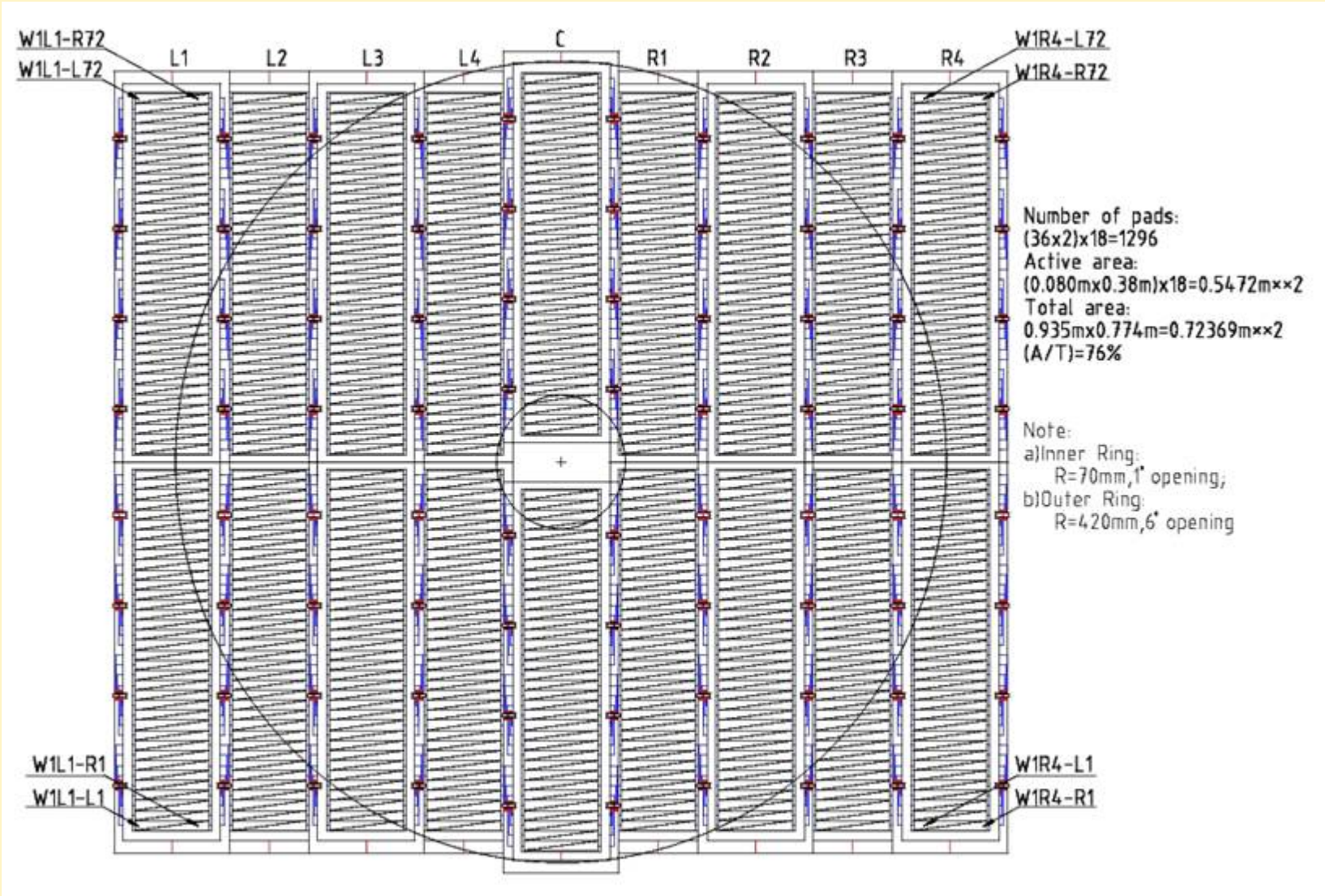
A.Wilk
J.P.Wessels

GSI – Darmstadt

A. Andronic
C. Garabatos
R. Simon
J. Hehner
F. Uhlig

Real Size Prototype



Three layers per TRD station

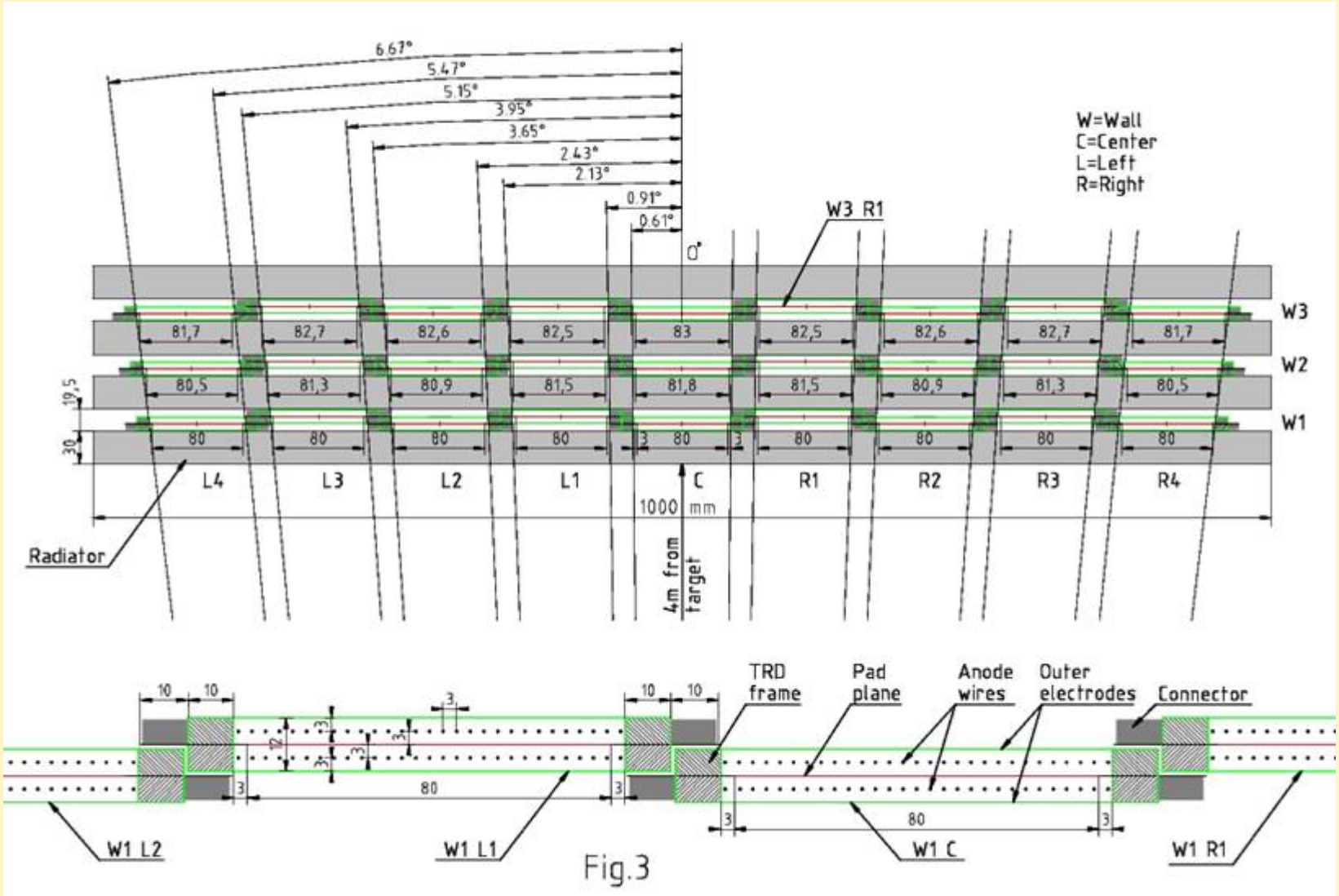
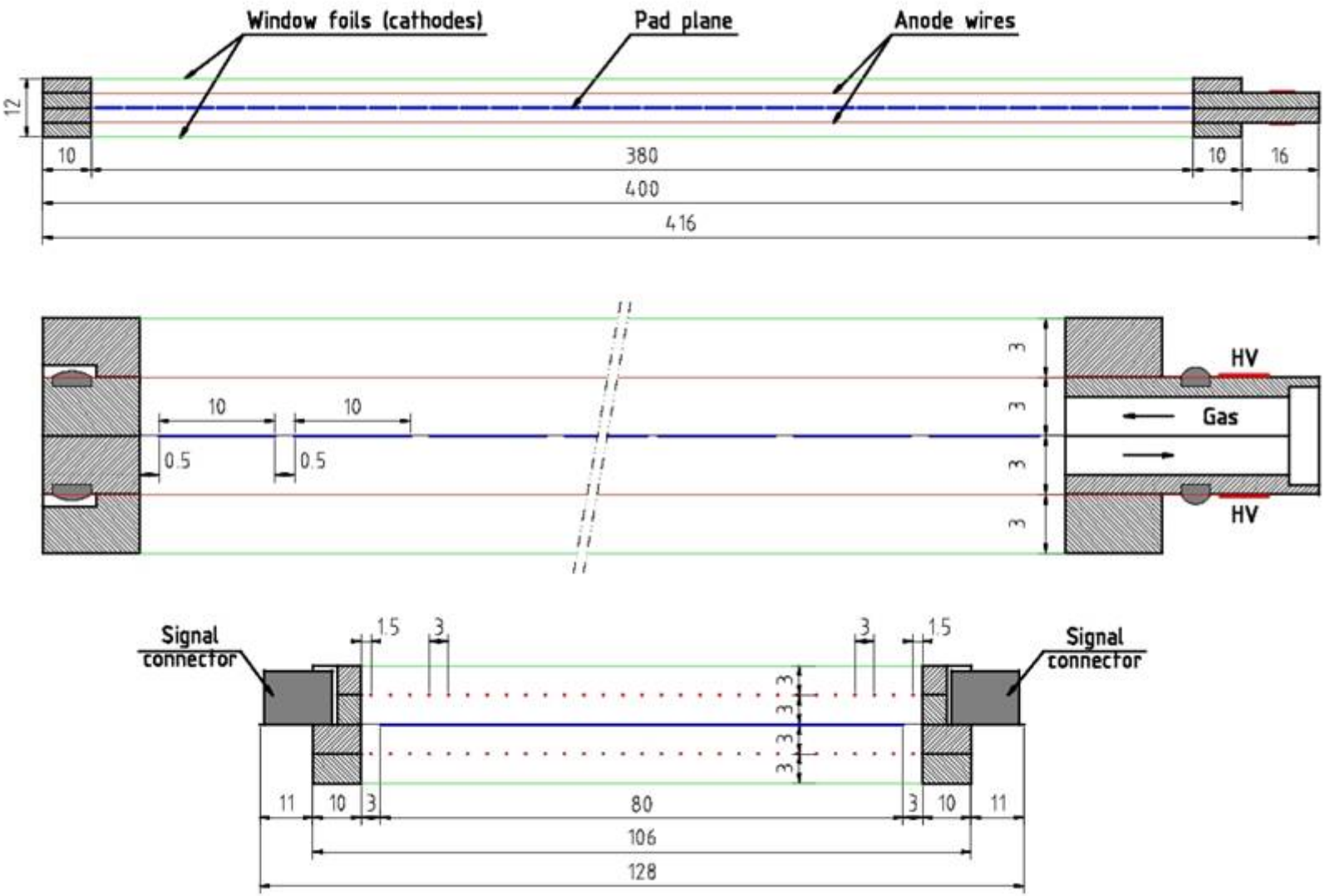
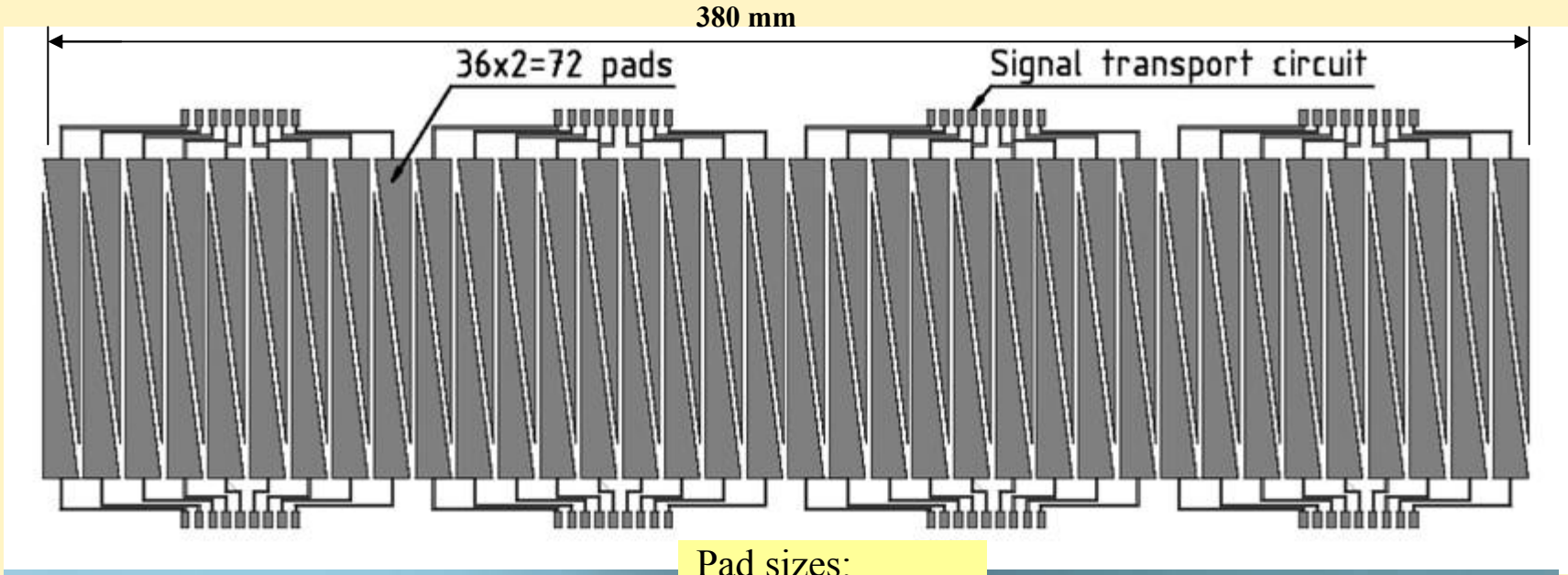


Fig.3

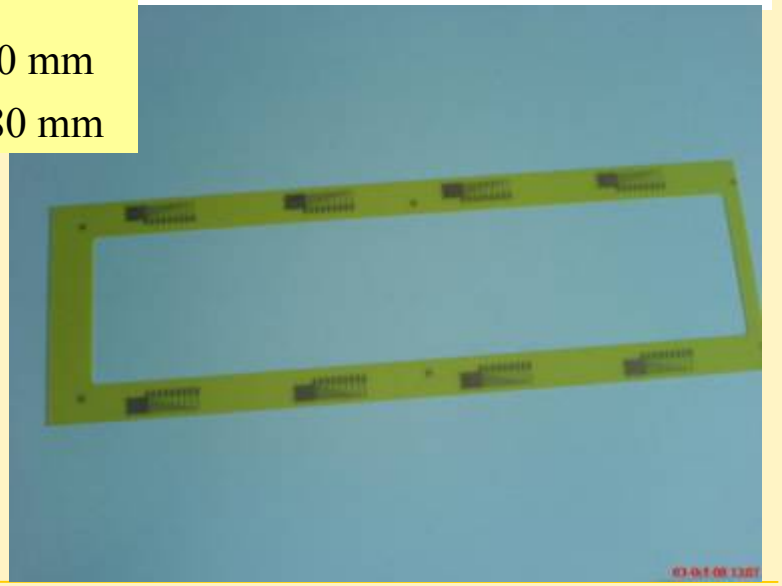
Single cell


Window foils (cathodes)
Pad plane
Anode wires
12
10
380
10
16
400
416
10
10
0.5
0.5
3
3
3
3
HV
Gas
HV
Signal connector
1.5
3
3
1.5
Signal connector
3
3
3
3
11
10
3
80
3
10
11
106
128

Readout Pad Plane Electrode

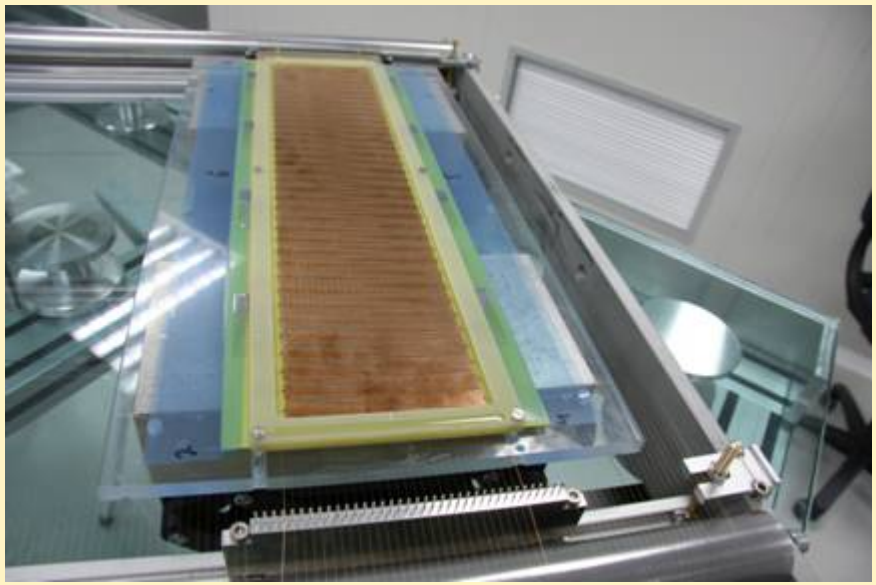


Pad sizes:
width = 10 mm
height = 80 mm



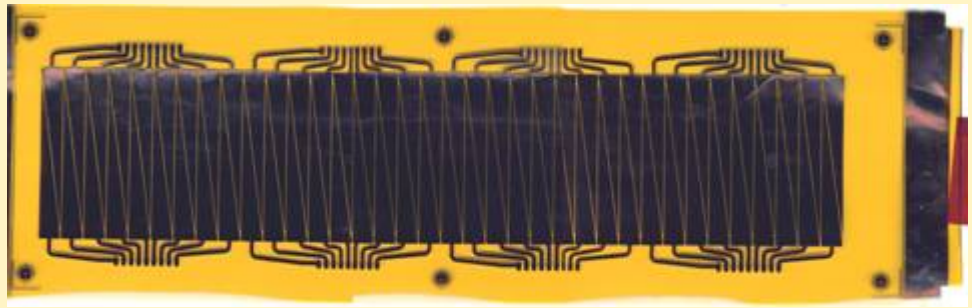
First Version of the Prototype

PCB (650 μm) readout electrode

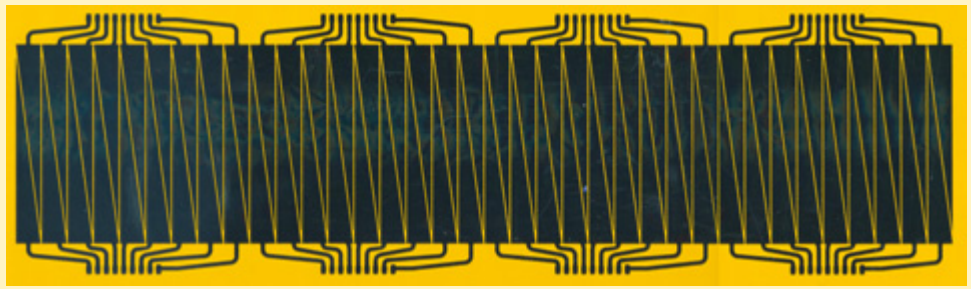


Next Versions

Copper coated kapton foil (20μm)

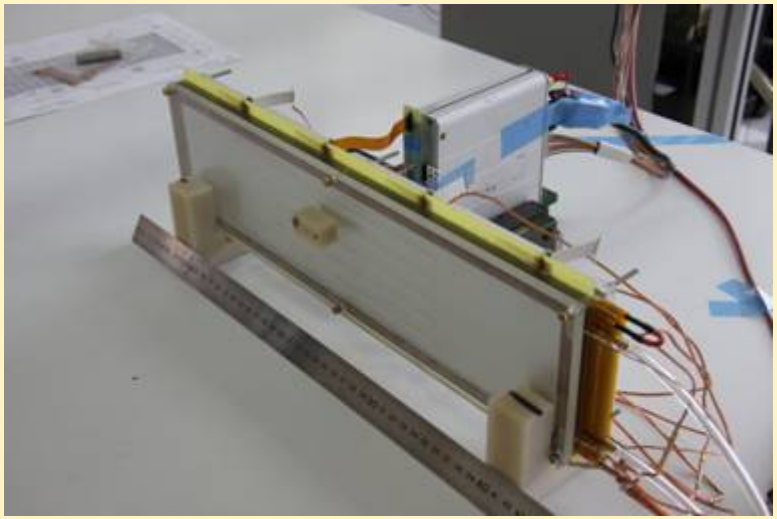


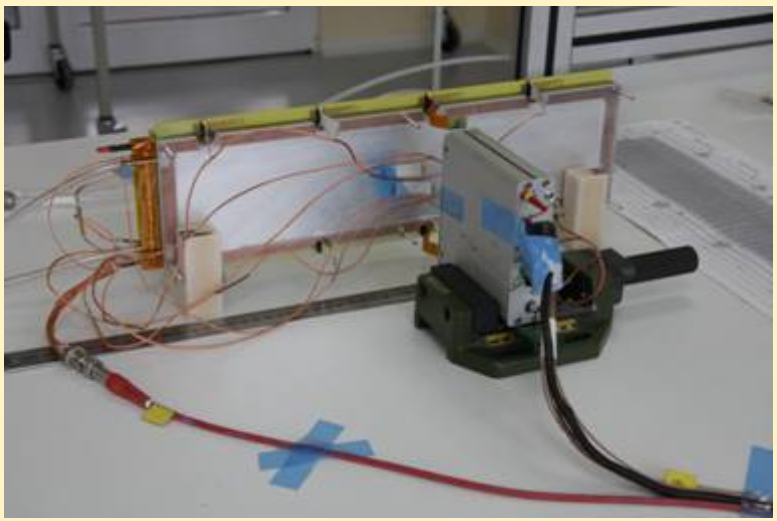
Cr(20 nm)/Al(200nm)

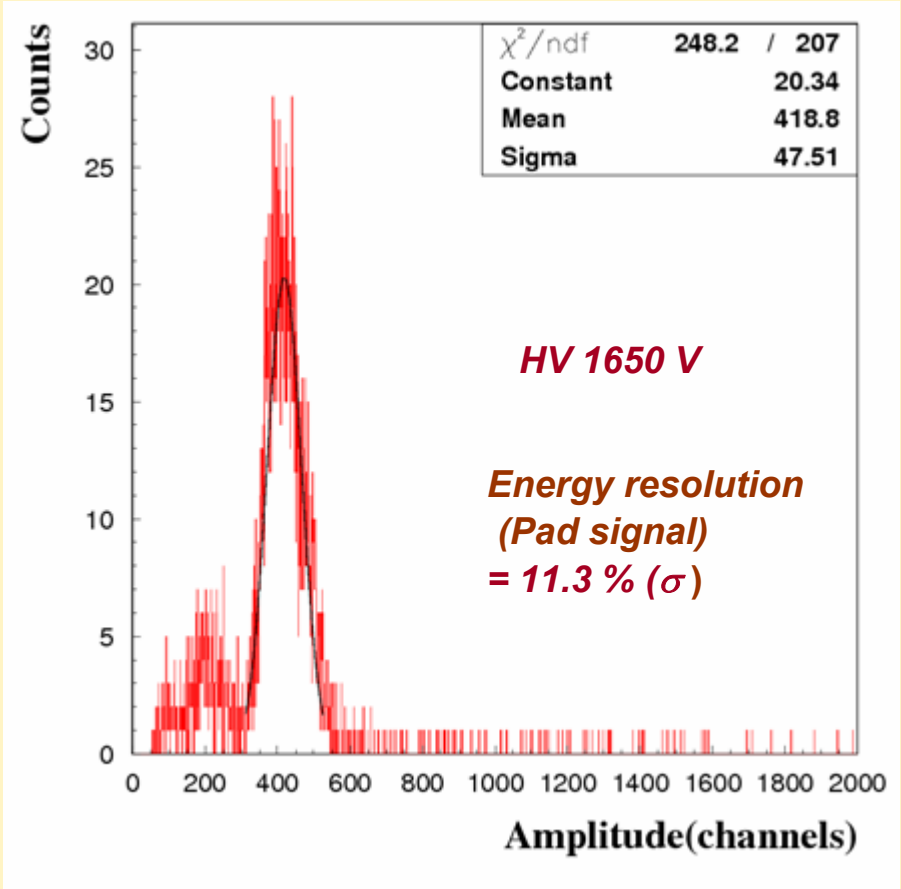


^{55}Fe source tests – PCB version

70% Ar + 30% CO_2







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

Summary and Outlook

- *The first two High Counting Rate Transition Radiation Detector prototypes fulfills the requirements in terms of:*
  - *position resolution: smaller than 200 μm;*
  - *pion efficiency: estimated 0.7% for six layers configuration @ p=1.5 GeV/c, regular periodic foil stack radiator (20/500/120), 1800 V anode voltage;*
  - *good performance up to 200 kHz/cm^2 counting rate.*
- *We designed and built a real size prototype.*
  - *Considering the present thickness of the walls and using a staggered configuration within one layer, one could reach a 76% geometrical efficiency for a polar angle range between 1 - 6 deg;*
  - *Two dimensional position information in one TRD layer can be accessed by splitting the rectangular pad on diagonal.*
  - *The first version of this prototype with a PCB double sided readout electrode was tested with the ^{55}Fe source.*
  - *Next versions with much thinner electrodes, transparent for TR, follow to be built and tested.*

Summary and Outlook

- *Peak sensing PASA CHIP is ready to be bonded and tested*
- *We will be ready in ~ two months to go for in-beam tests*
- *MIPs and uniform high counting rate flux all over the detector are mandatory*

These results have been obtained in the frame of the

JRA4 - I3HP/FP6 and the new I3HP/FP7 Collaborations:

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