Detector Development Activities at IUAC

AKHIL JHINGAN

Inter University Accelerator Centre (IUAC), New Delhi

jhinganakhil@gmail.com, akhil@iuac.es.in

Advanced Detectors for Nuclear, High Energy and Astroparticle Physics
Bose Institute, Kolkata, 15-17 February 2017

Introduction

Inter University Research Centre set up by UGC
Involved in research in area of Nuclear Physics, Atomic Physics, Material Physics
Using 15MV Tandem Accelerator
Accelerates beam from Proton to Gold (1 MeV/A to 8MeV/A)

Accelerator Augmentation

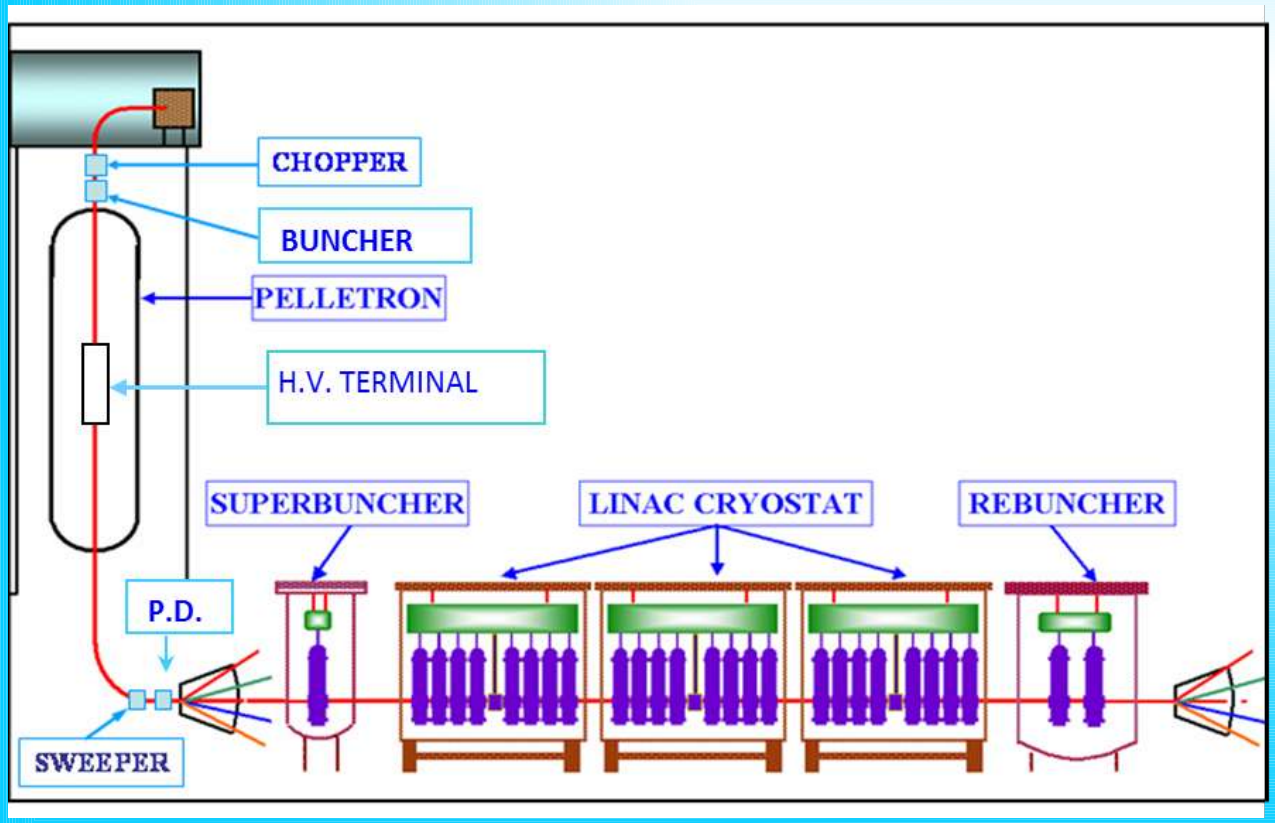
Super Conducting LINAC (being commissioned)
Boost energies from Tandem
Accelerate beams like Ti, Ni upto 6MeV/A

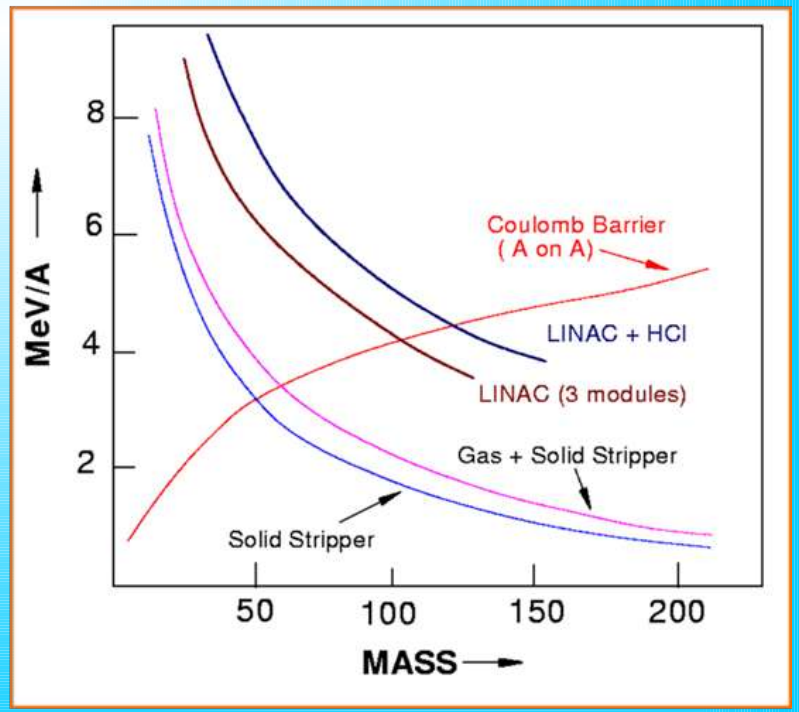
High Current Injector – Drift Tube LINAC combination
To replace Tandem

New experimental facilities commissioned in beam hall II
for experiments with LINAC

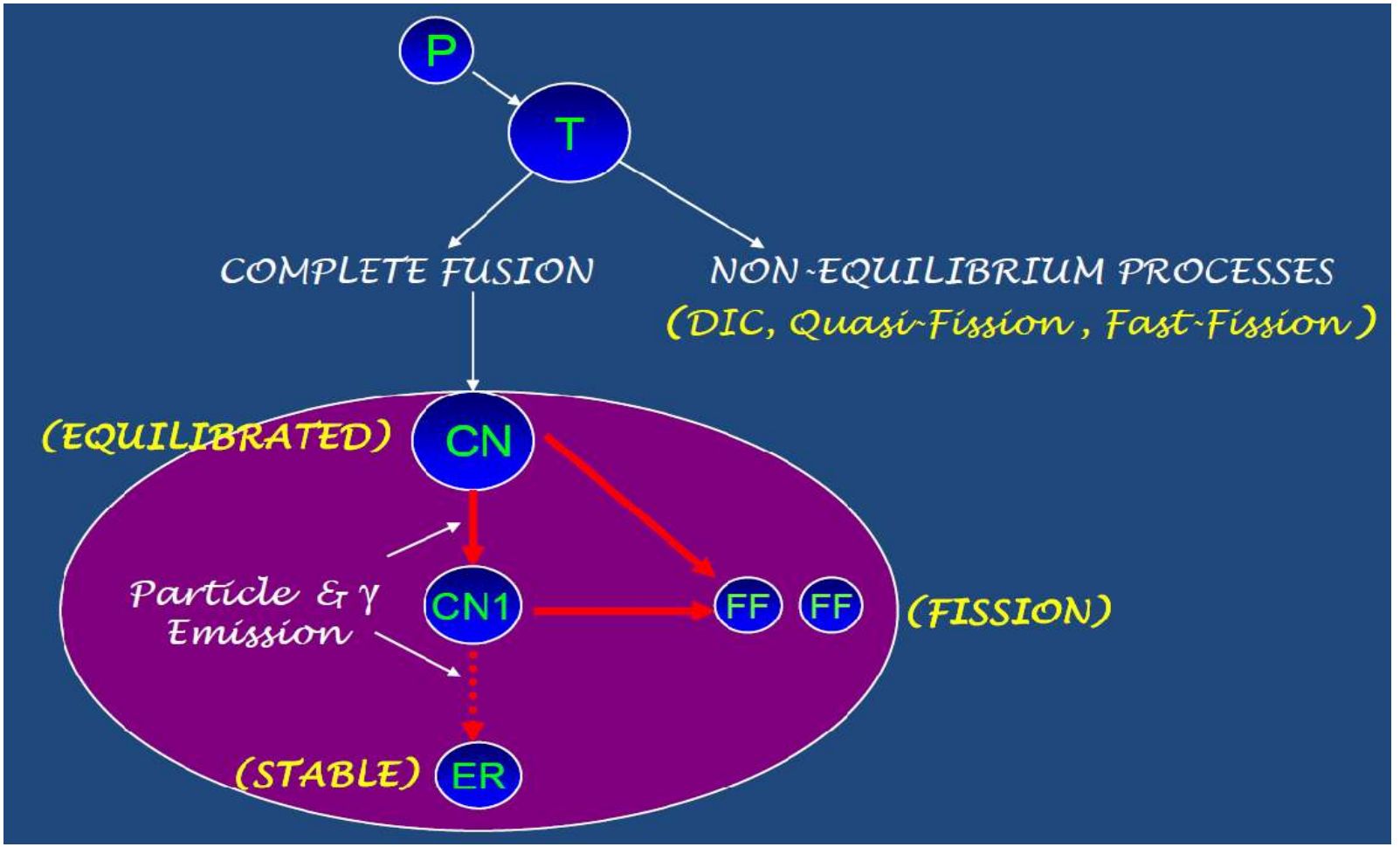
Accelerator

- IUAC is equipped with a 15 UD Pelletron accelerator
- Delivers beams from H-Pb with energies from tens to hundreds of MeV (wide velocity range)
- With Pelletron energy, coulomb barrier for symmetric system can be achieved up to mass ~50
- Decided to boost up the energy so that the energy to exceed Coul. Bar. will be extended up to ~Ag (107) and that demands to double the energy obtained from Pelletron.





Nuclear reactions around Coulomb barrier



Experiments

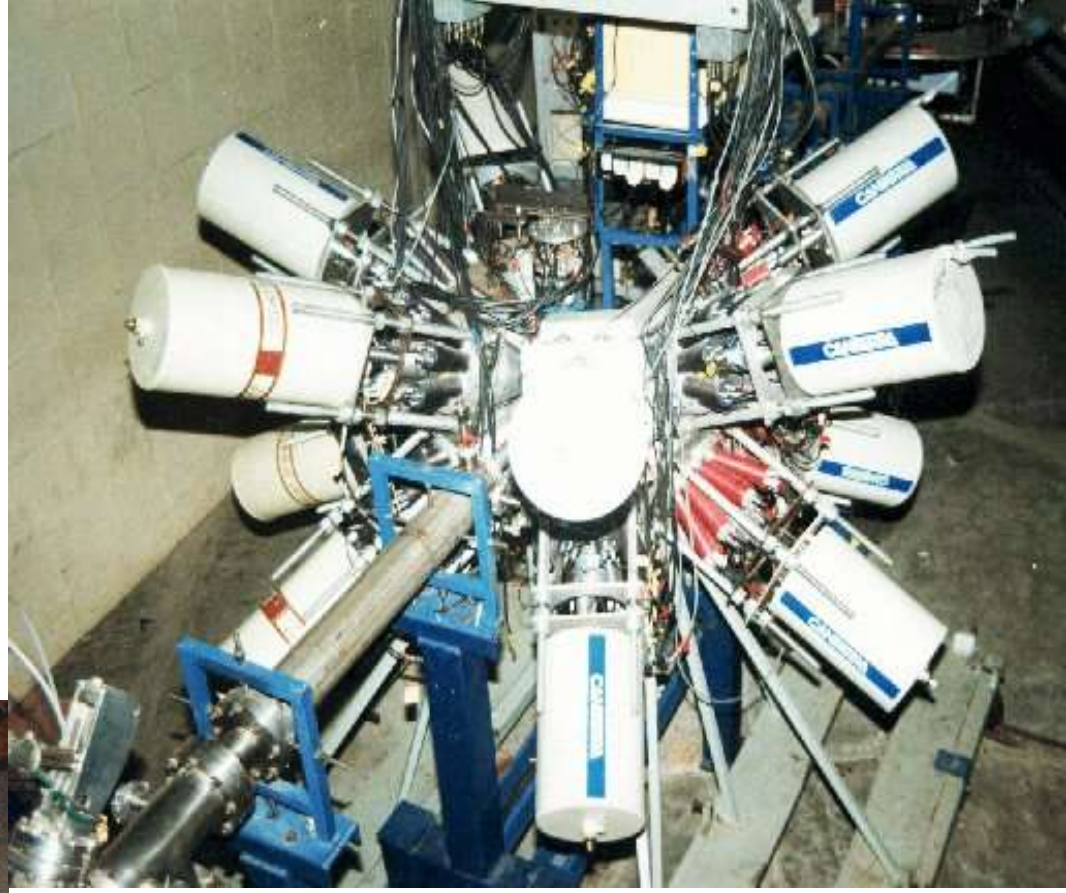
Fusion
ER cross section experiments, Barrier distributions etc

Transfer reactions and their angular distributions

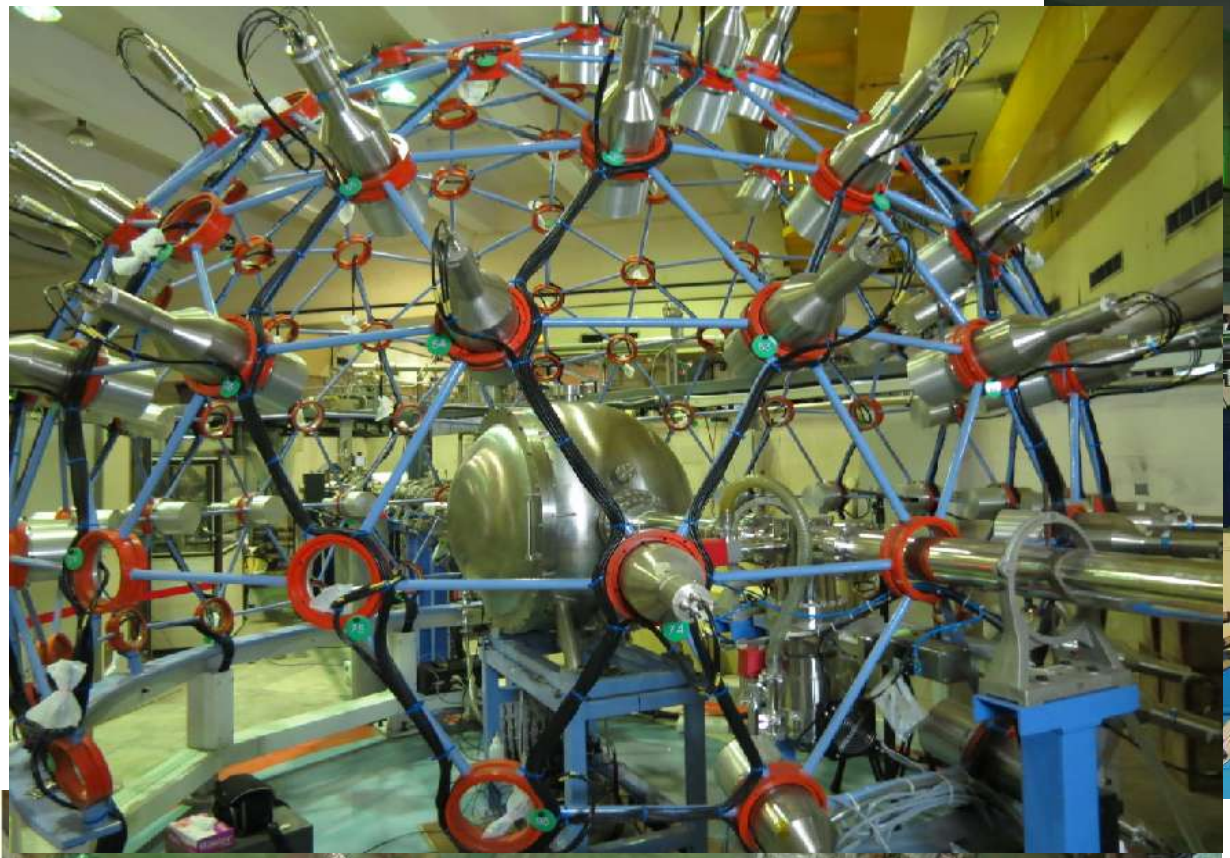
Fission
Mass distributions, Angular Distributions,
Mass gated Neutron multiplicity, Charge Particle Multiplicity

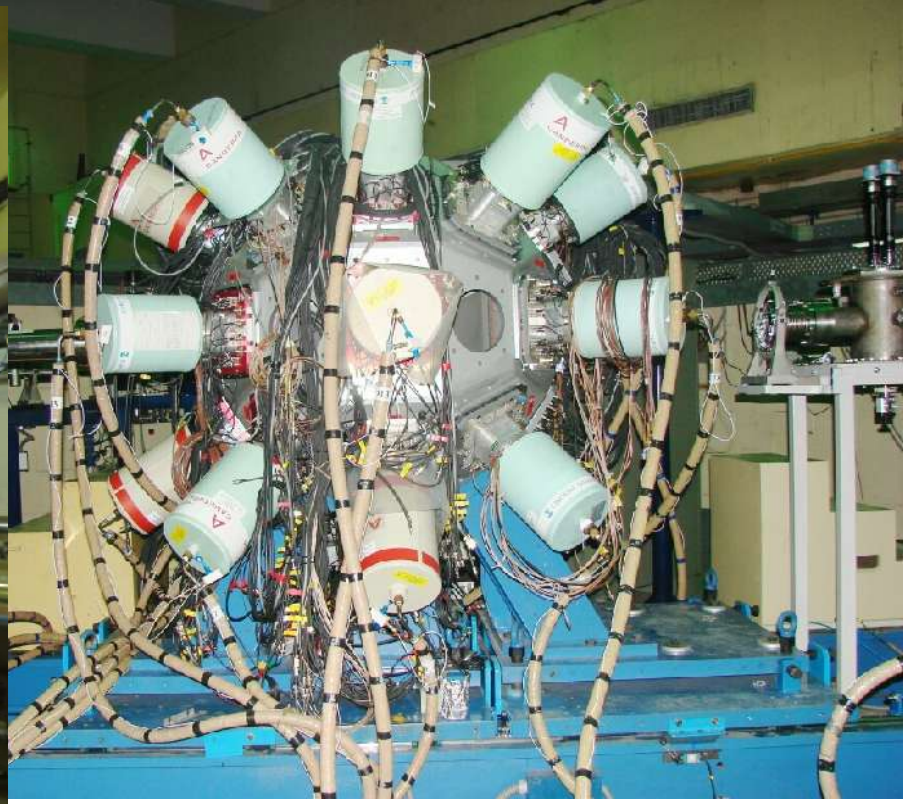
Coulomb Excitation

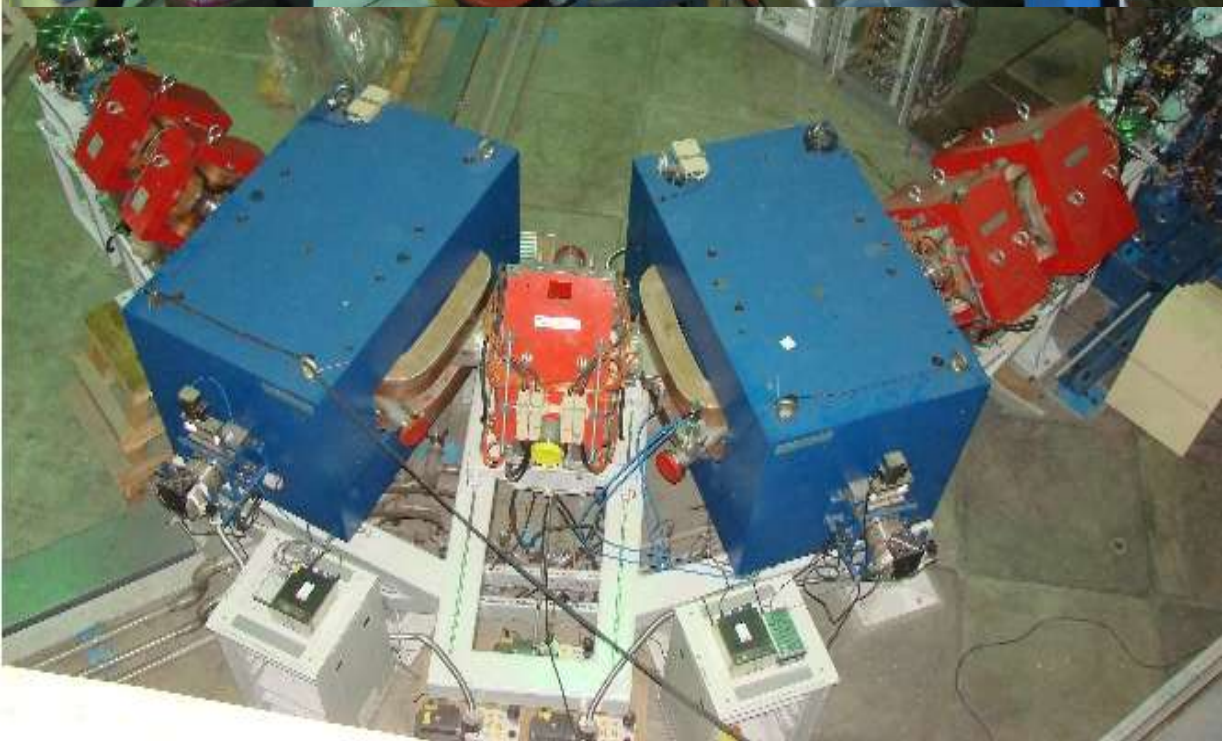
Gamma spectroscopy



Beam Hall I facility







Beam Hall II Facilities

Nuclear Physics Group

S.Muralithar, N. Madhavan, P. Sugathan, R.P. Singh, T. Varughese, A. Jhingan, S.Nath, R.Kumar, K. S. Golda, J. Gehlot, I.Bala, N. Saneesh, Mohit Kumar

Former Members

R. K. Bhowmik, A. Roy, S. K. Datta, J. J. Das

Collaborators : S. K. Mandal(DU), B. R. Behera(PU), A. Kumar(PU), S. Mukherjee (MSU Baroda), A. Saxena(BARC), B. K. Nayak (BARC), R. G. Thomas (BARC), R. Palit (TIFR), S. Roy (SINP)

Students

S. Barua(GU), Hardev Singh (PU), S. Kalkal(DU), Varinderjit Singh(PU), Rohit(PU), P. Shidling(KU), S. Appanababu (MSU, Baroda), E. Prasad(Calicut Univ.), G. Mohanto(IUAC), Gurpreet Kaur (PU), Ruchi Mahajan (PU), Meenu Thakur (PU), Priya Sharma (PU), Tathagata Banerjee(IUAC), Kushal Kapoor (PU)

Detector Development for Nuclear Physics experiments

Gas Detectors
Multi Wire Proportional Counters (MWPC)
Gas ionization Chambers for particle identification

Silicon detector systems
Position sensitive silicon detectors
Gas – Silicon Hybrid telescopes for particle identification

Scintillators
CsI coupled to photo-diode
Liquid Scintillators (BC 501) for Neutron detection

Preamplifiers for these detectors

Charge sensitive Preamplifiers for energy measurement
Voltage sensitive for Timing measurements

MWPC

2/3/4/5 electrode geometries, active area : flexible

Electrodes : Wire frames / Aluminized Mylar / PCB

Electrode pitch : 1.6/2.4/3.2 mm

Wire frames : Au-W wires --> 10-20 μm diameter

Wire pitch : 0.63/1.27 mm

PCB : strips 1mm wide, 1.27 mm pitch

Entrance window 0.9/0.5 μm Mylar, Iso-Butane gas at 2-7 mbar

Position extraction : delay line technique

IC

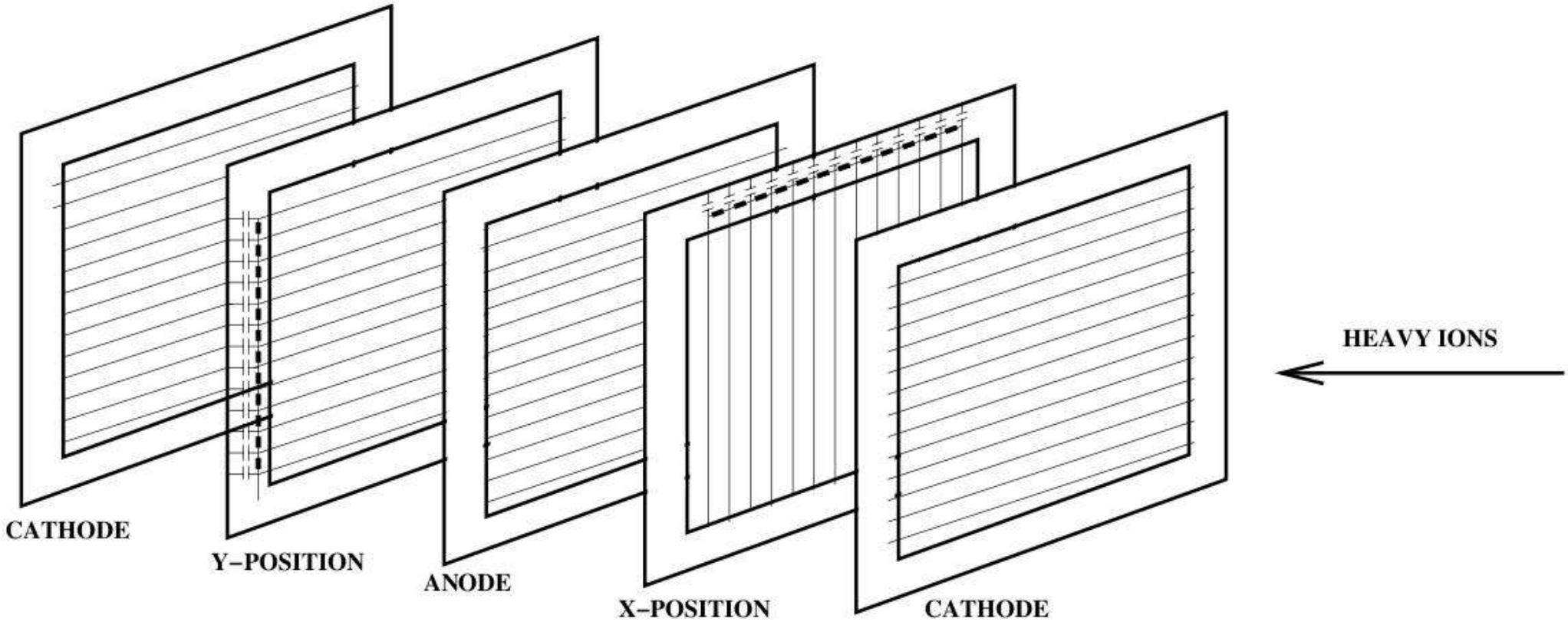
Active area : flexible

Geometry : Transverse field and Axial field

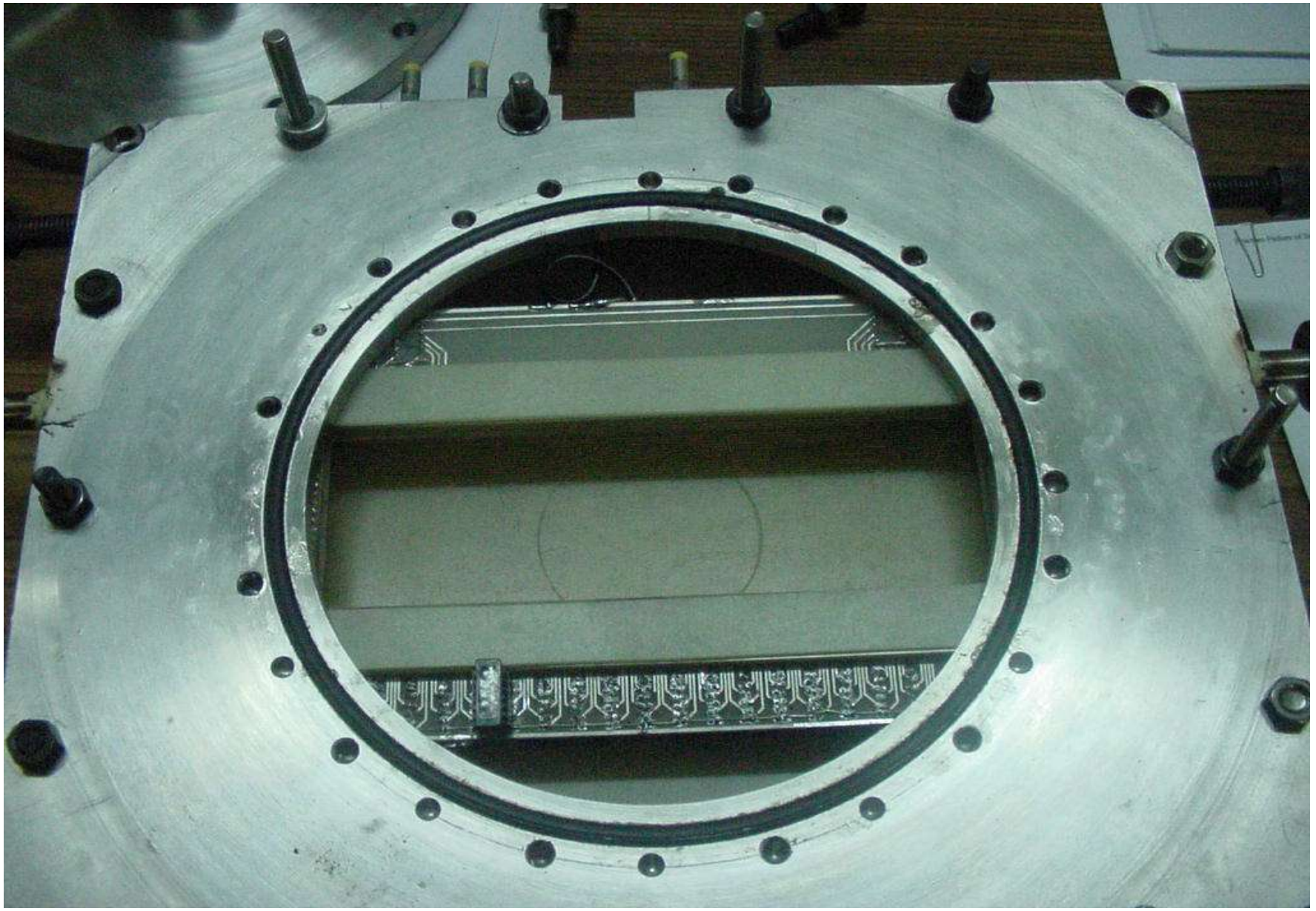
Transverse field : 3 electrode --> cathode, frisch grid, anode
Split anode for particle identification

Axial field : 3 electrodes --> Anode sandwiched between 2 cathodes
Used as ΔE detector with silicon as stopping detector

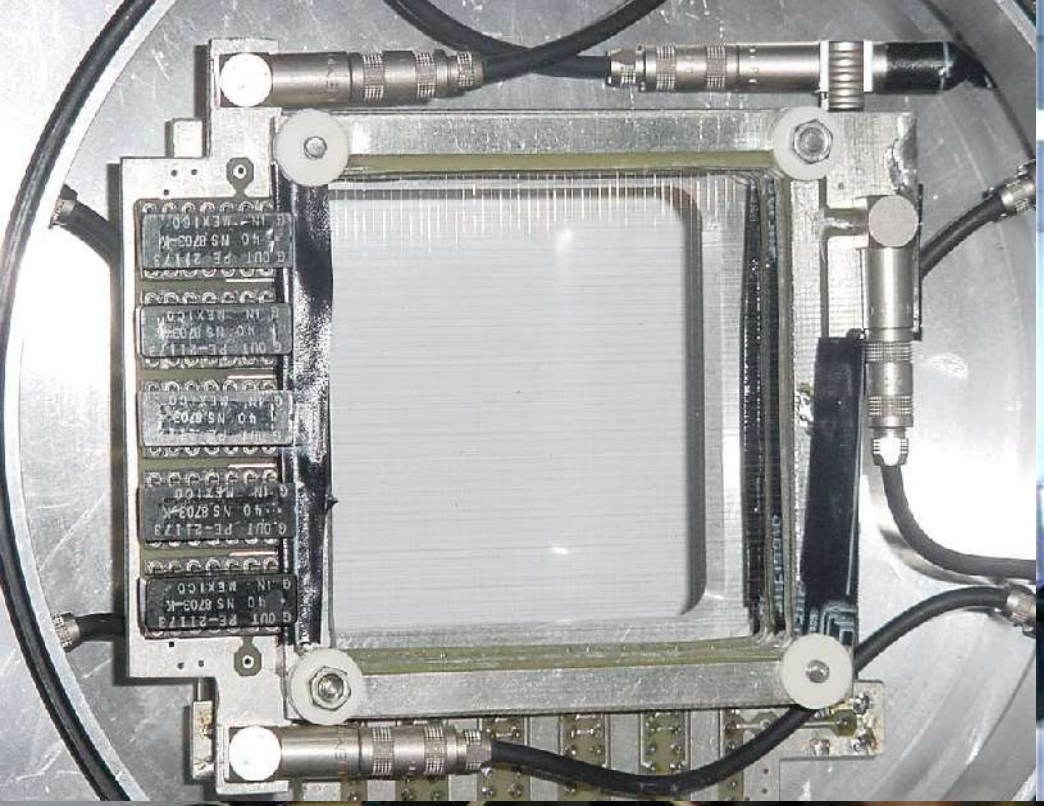
Entrance window 0.9/0.5 μm Mylar, Iso-Butane gas at 10-100 mbar

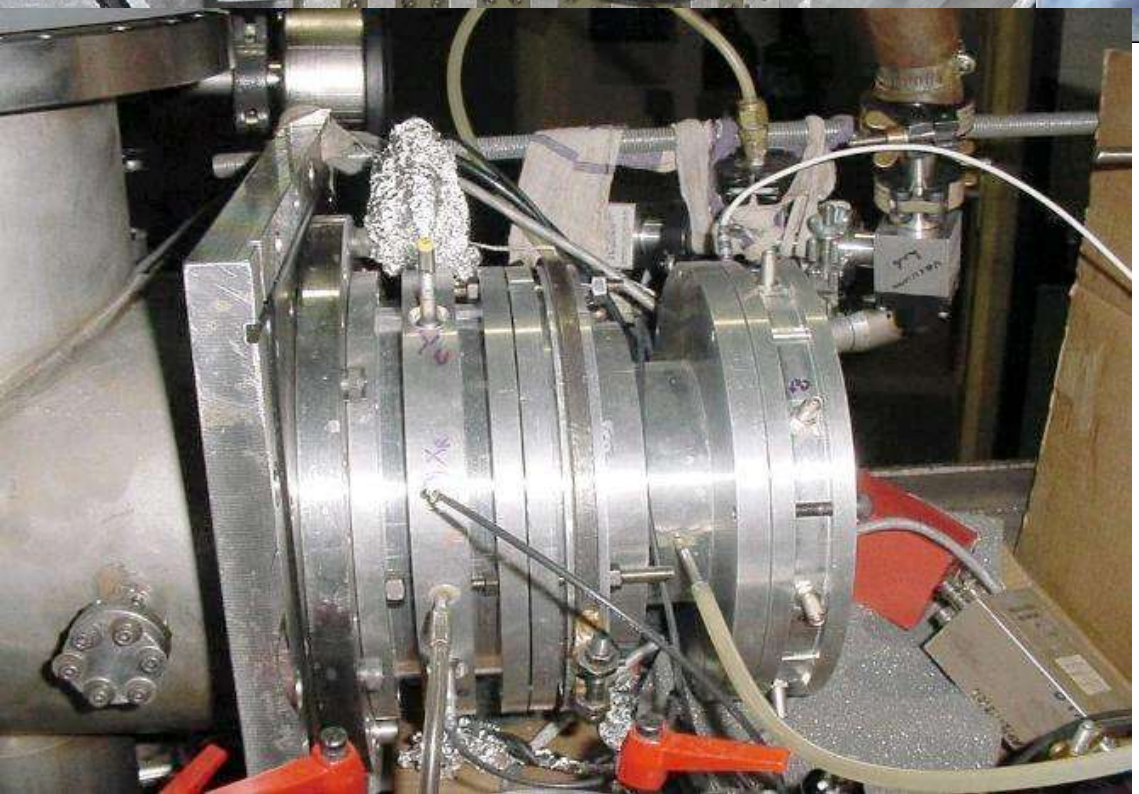


Multi-step 5 electrode MWPC



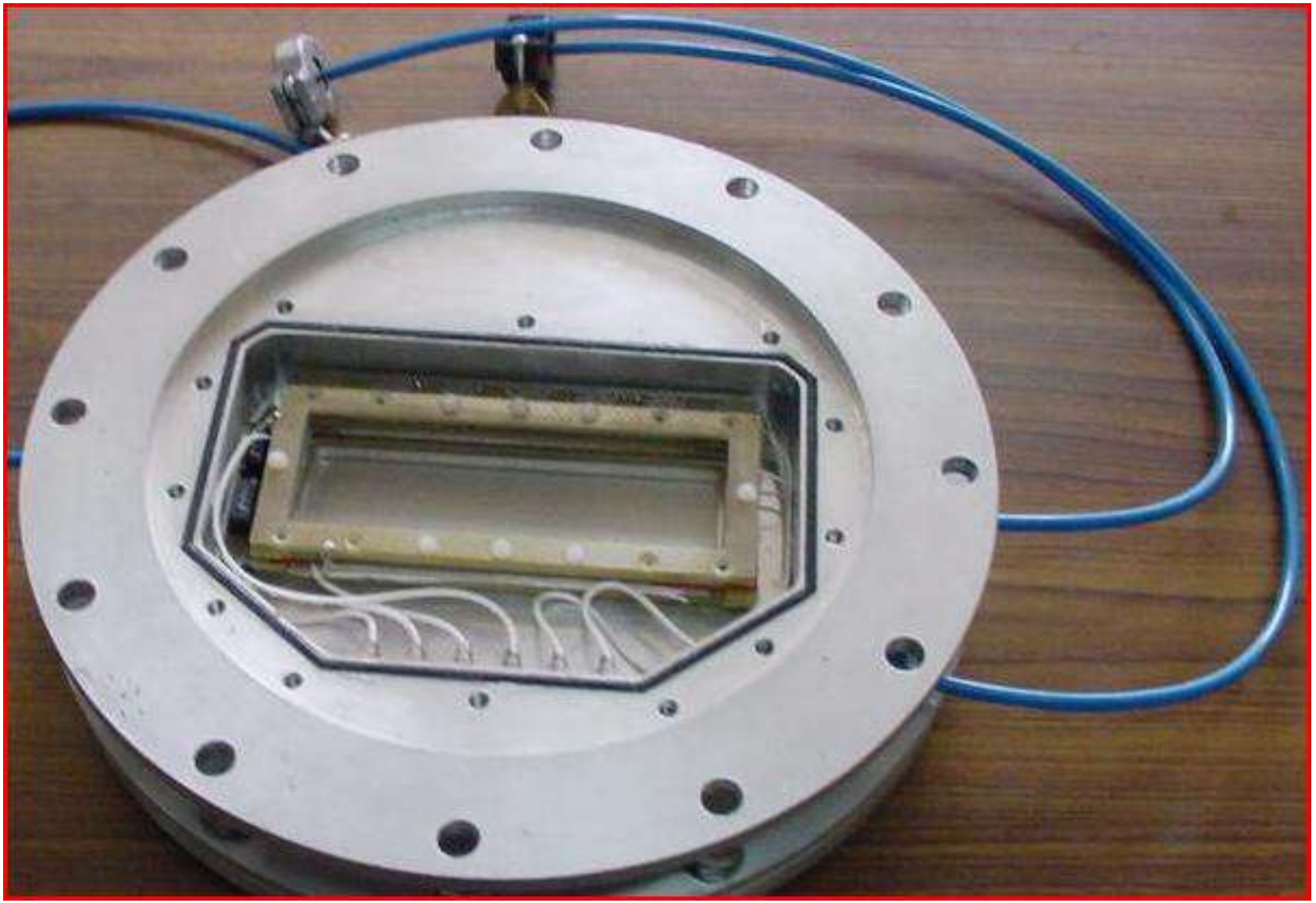
1st MWPC in IUAC (NSC) at HIRA focal plane with 3 electrodes (7" x 2"
D. O. Kataria et al., NIM A 372 (1996) 311.





5 electrode MWPC for RIB expt.
Followed by hybrid telescope.
Area : 2" x 2"

A. Jhingan et al.,
NIM A 526 (2004) 376.



5 electrode MWPC (6" x 2", 1.27 mm wire pitch) at HIRA focal plane

A. Jhingan et al., Proc. DAE-BRNS Symp. Nuc. Phys. 52(2007)585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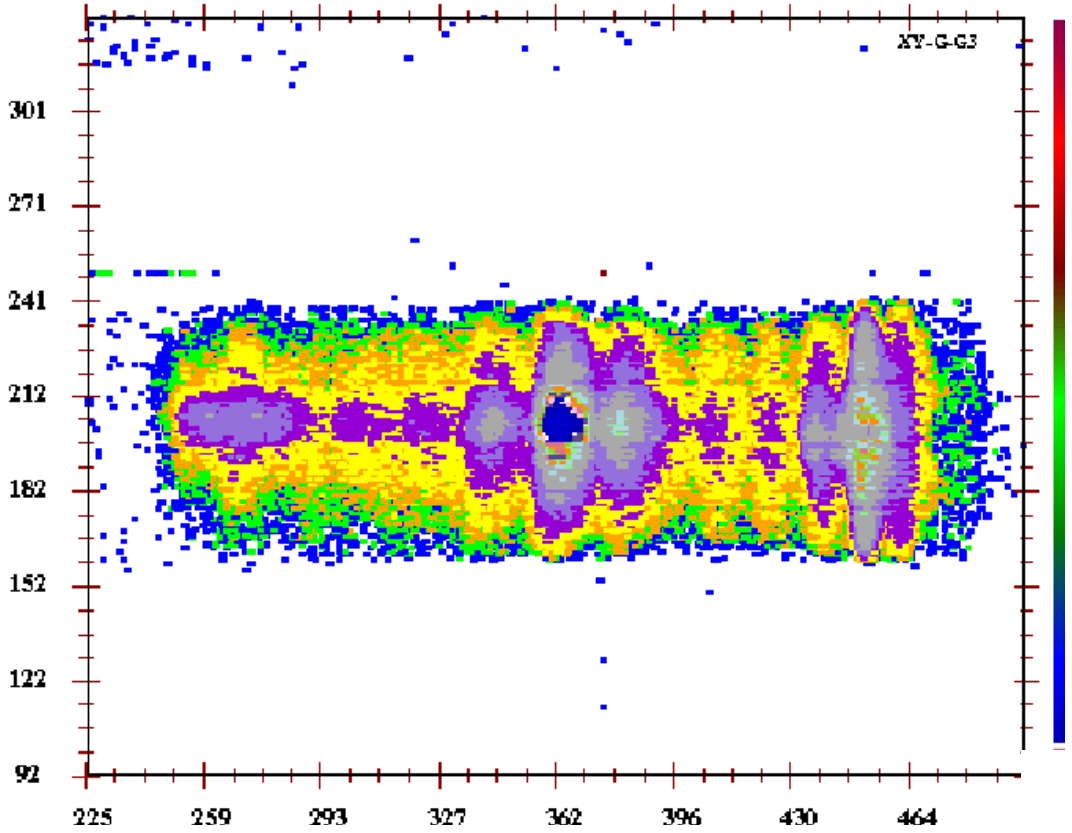
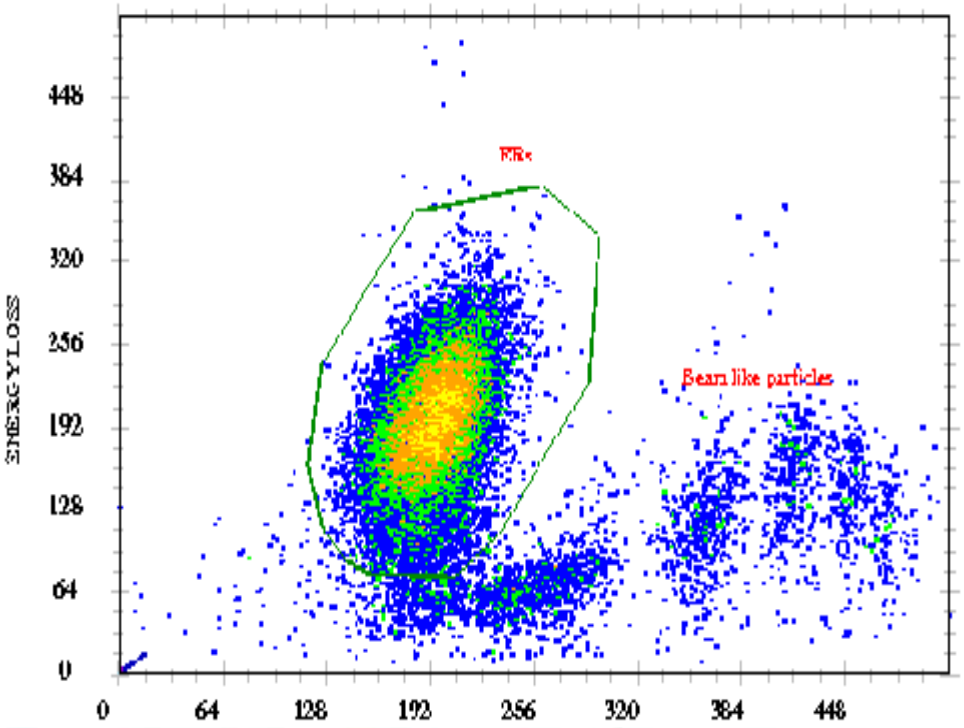
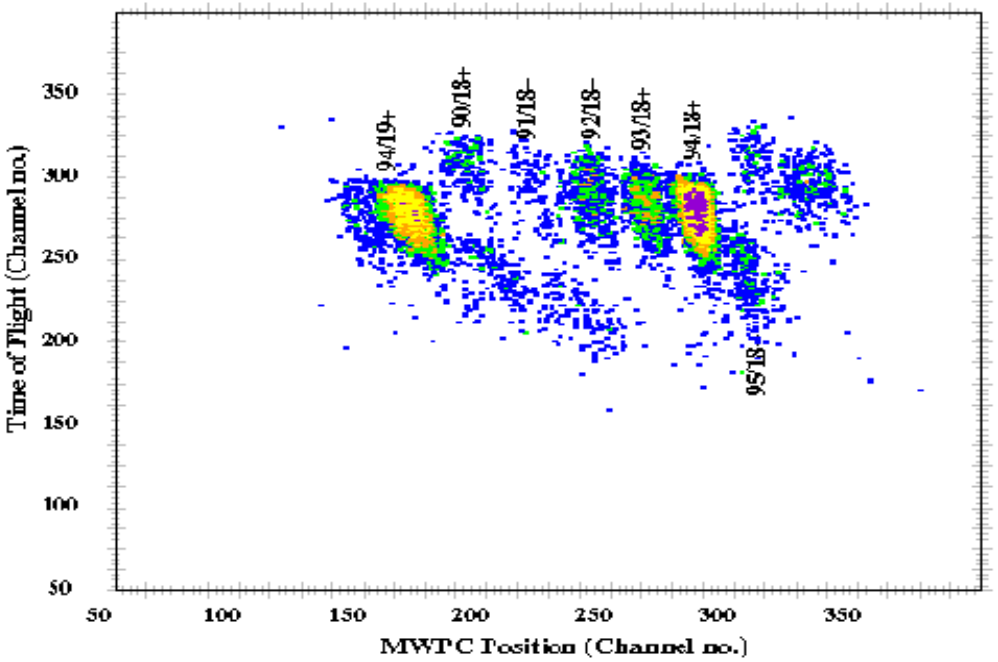
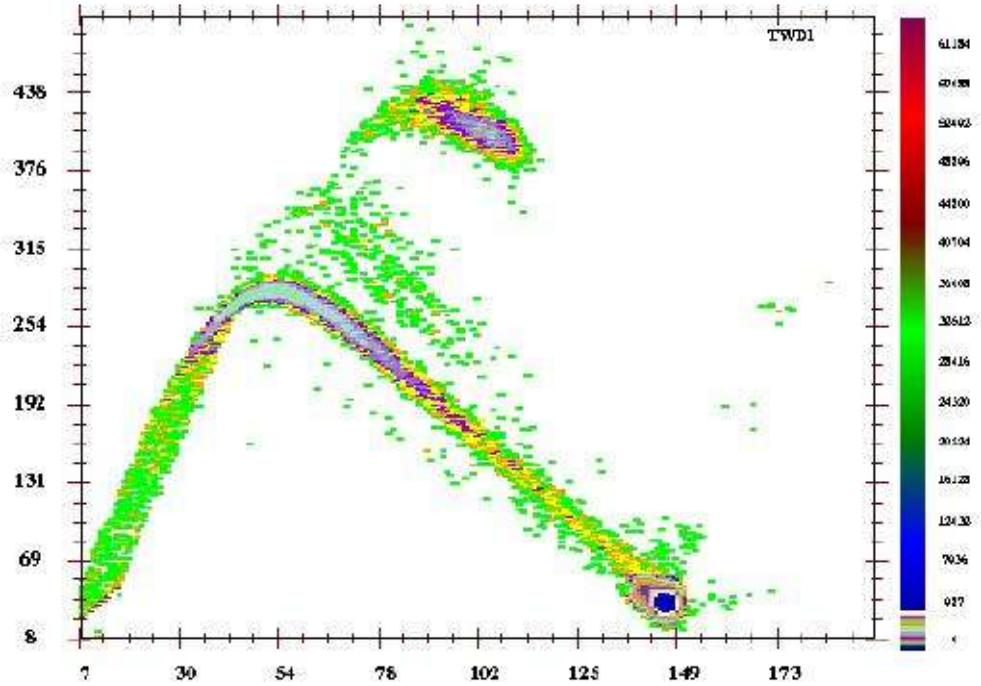

XY-G-G3
301
271
241
212
182
152
122
92
225
259
293
327
362
396
430
464


ENERGYLOSS
448
384
320
256
192
128
64
0
0
64
128
192
256
320
384
448
ERs
Beam like particles

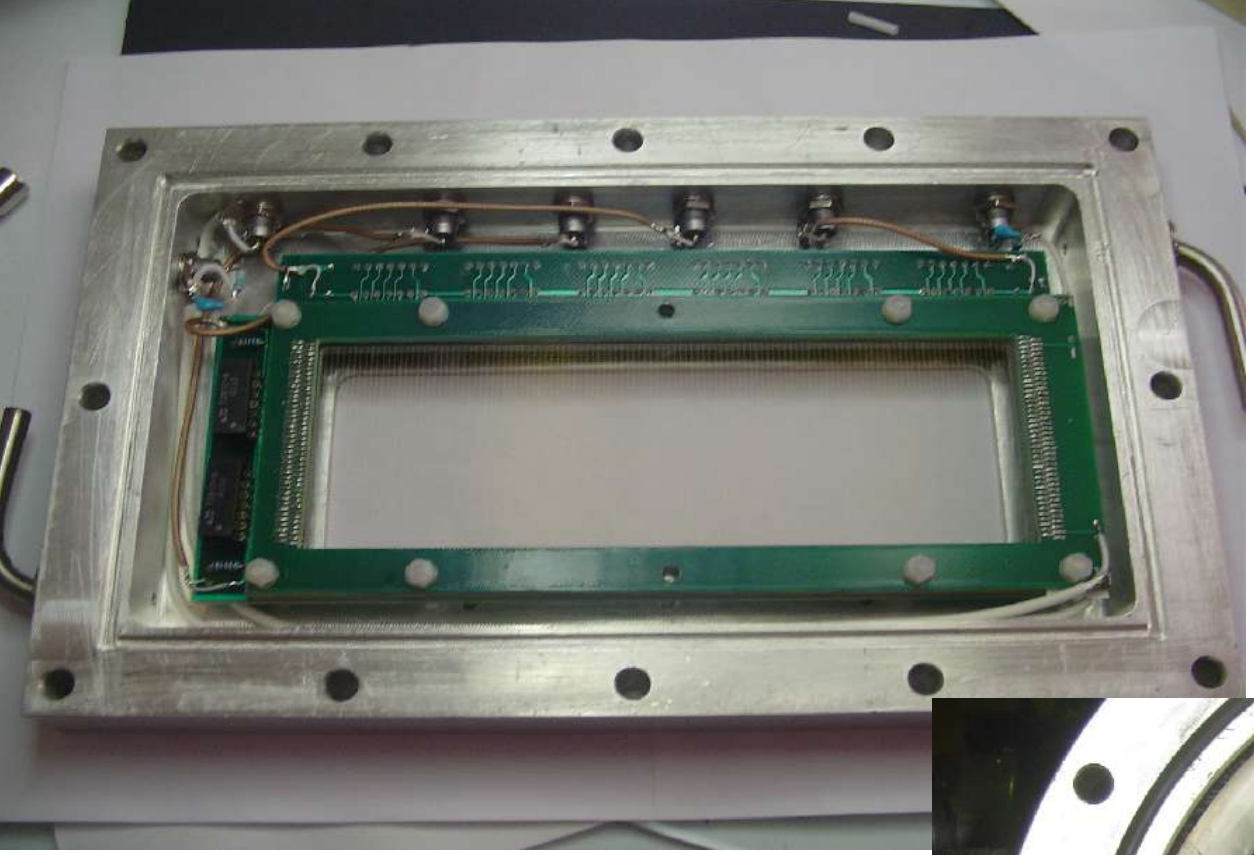

Time of Flight (Channel no.)
350
300
250
200
150
100
50
50
100
150
200
250
300
350
MWPC Position (Channel no.)
94/19+
90/18+
91/18-
92/18-
93/18+
94/18+
95/18-

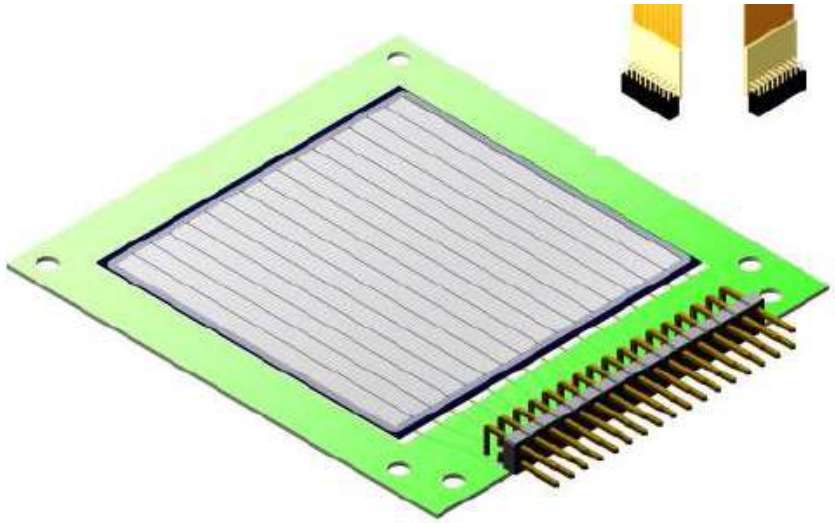

TWD1
438
376
315
254
192
131
69
8
7
30
54
78
102
125
149
173

Large area MWPC followed by Double sided Silicon strip detector

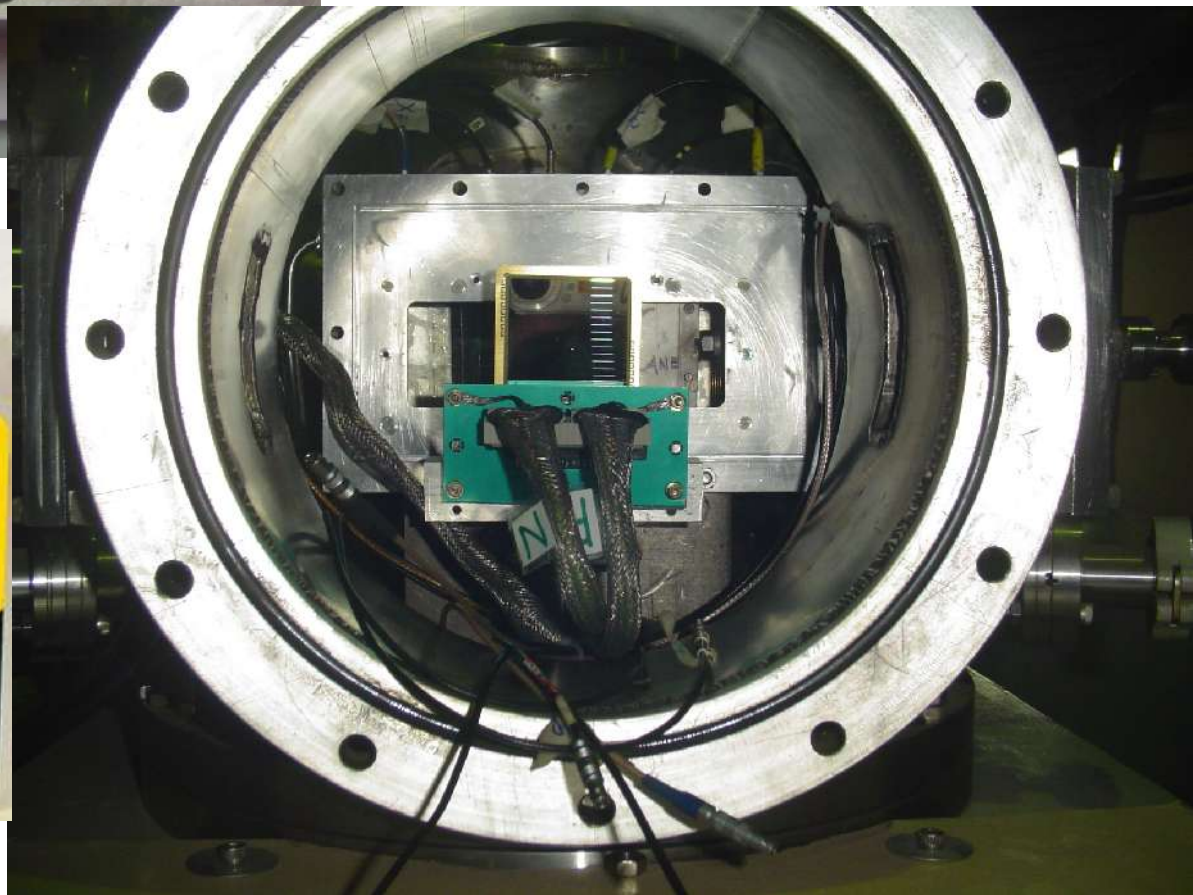
MWPC
Active area : 150mm X 50mm
Config : Four electrode Geometry (All wire frames)
Inter Electrode separation : 2.4 mm,
Wire Pitch : 0.63 mm (Anode & Cathode), 1.27 mm for positions
Wire : Gold plated tungsten, 10um for anode, 20um for remaining electrodes
Position extraction : Using Delay line technique
Position resolution : 1mm, Time resolution : ~ 1 ns
Gas : Isobutane – 1.5 Torr, Isolation Foil : 0.5u mylar

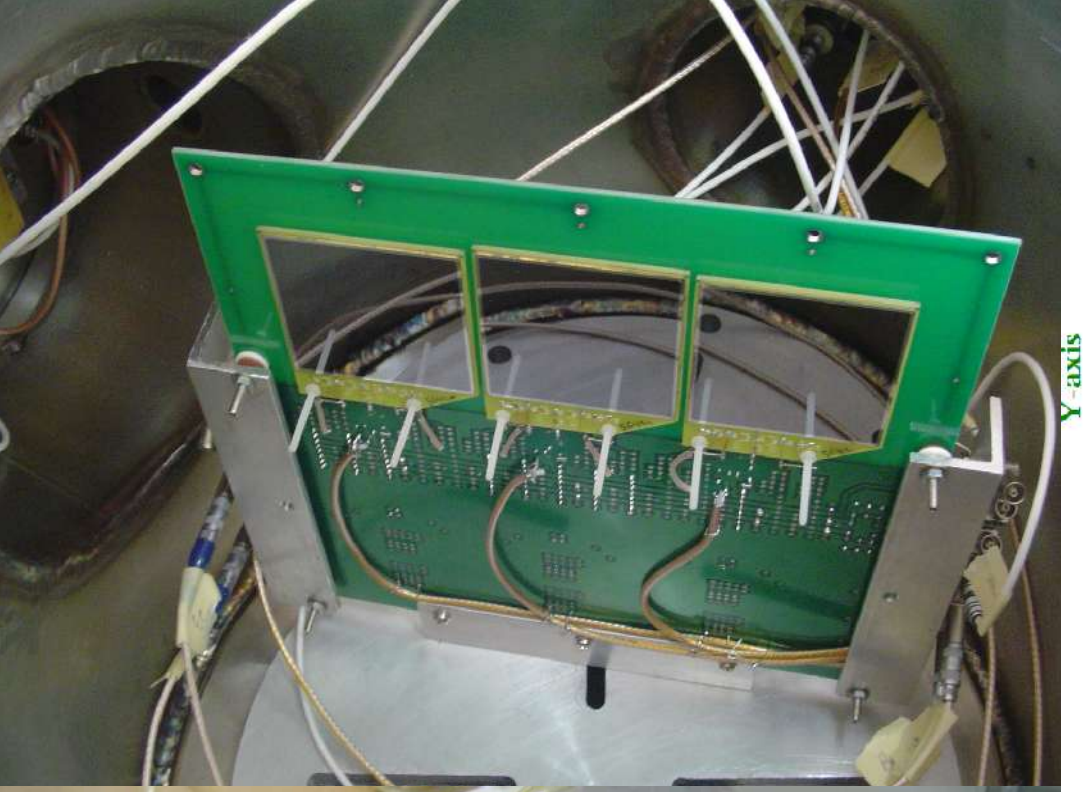
Silicon Strip detector (design W from *Micron Semiocnductors, UK***)**
Strip detectors : 16 x16 strips (50 mm x 50 mm)
Readouts : 32
Front end electronics : Mesytec amplifiers followed by Phillips CAMAC ADC)
Energy resolution : ~30 keV

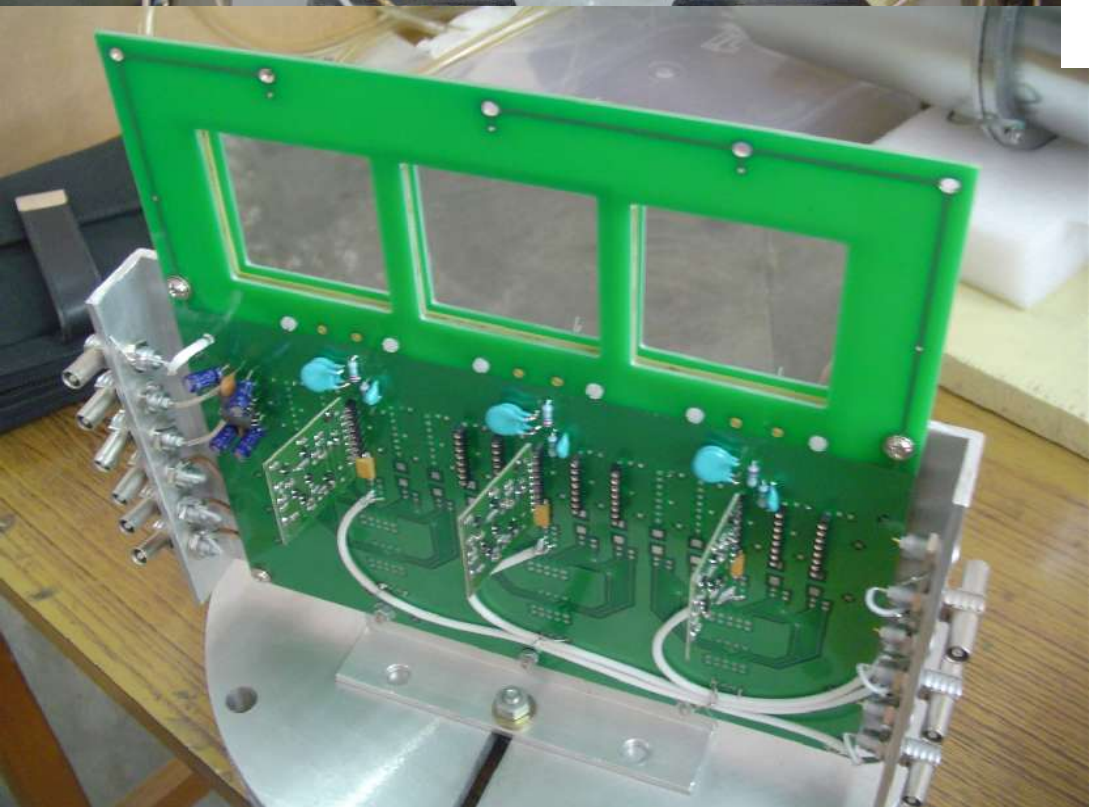


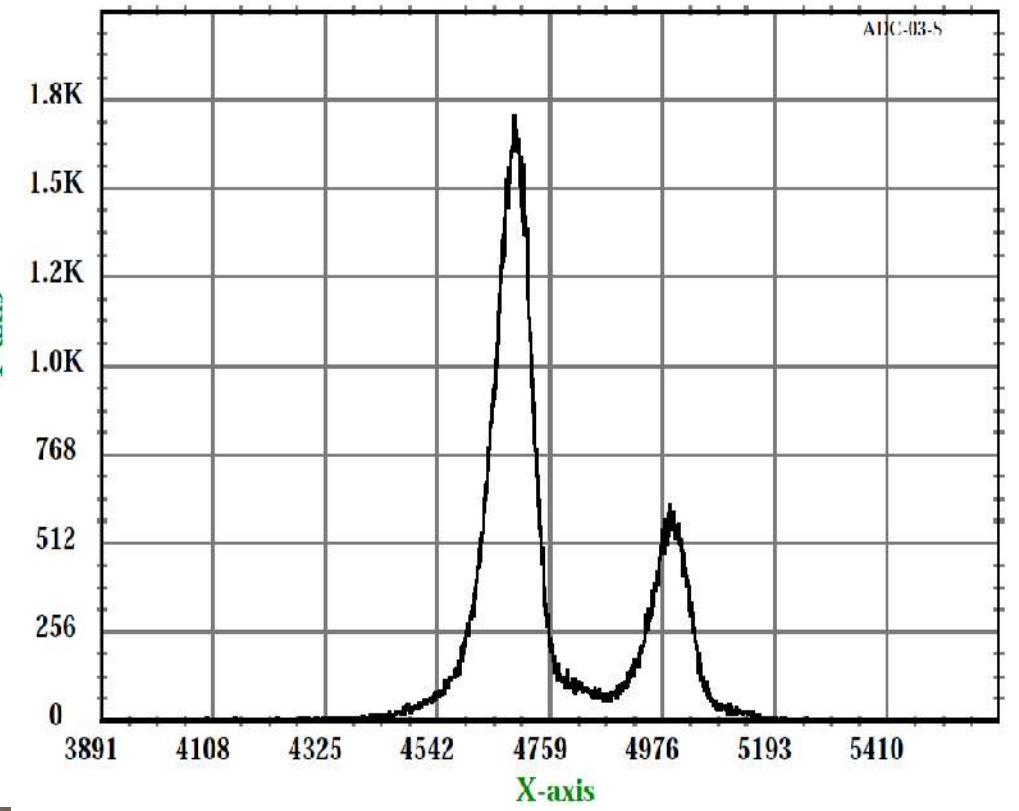


HYRA focal plane set up









Tested with Pu-Am source

Resolution ~ 75 keV @5.48 MeV

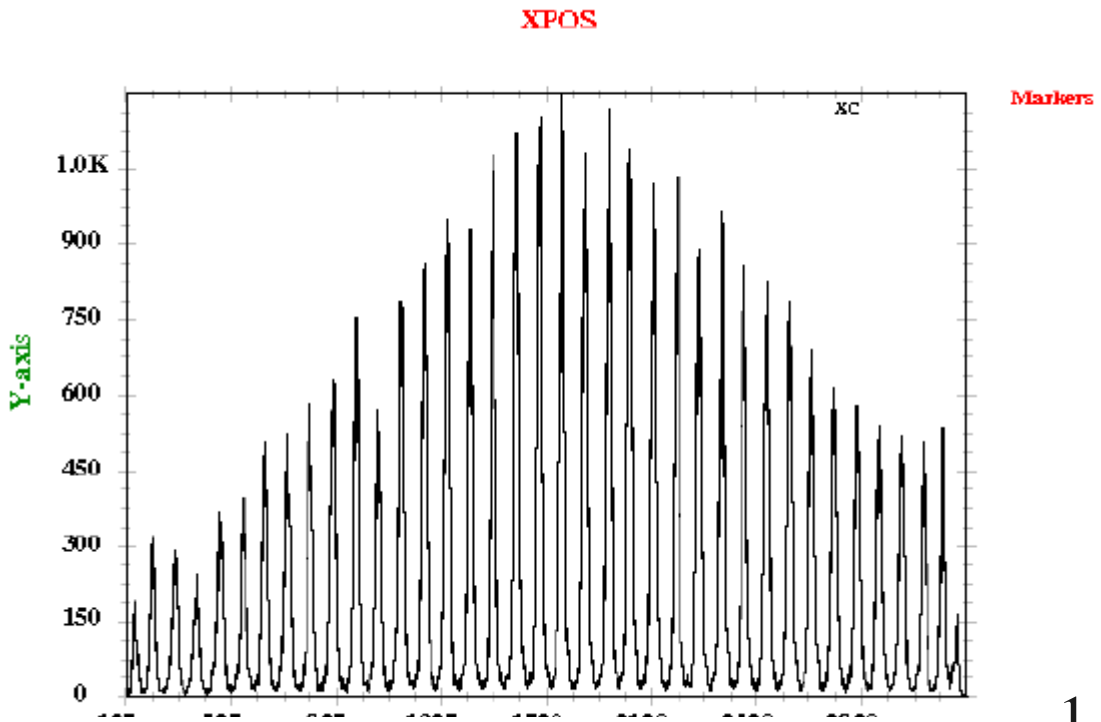
TOF detector system for fission Mass Distribution

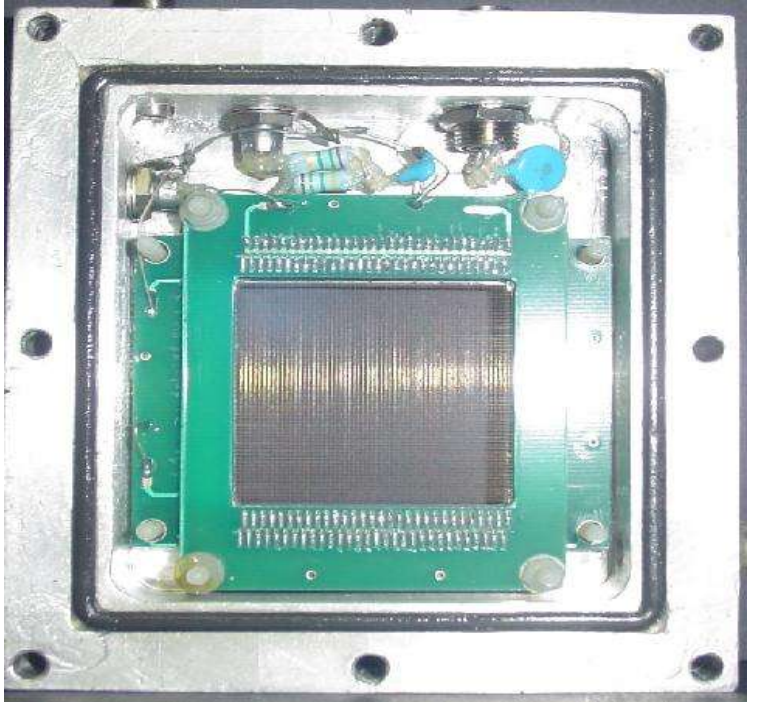
Facility – GPSC

Two Position sensitive MWPC at folding angles
Active area : 200 mm x 100 mm
4/5 electrode geometry : Cathode, X – Pos, Anode, Y – Pos, cathode
Electrode separation : 3.2 mm
Wire pitch : 20 μm wire at 50 mil (1.27 mm) spacing
Higher gains at low gas pressures, Geometrical transmission ~ 93 %
Rise times ~ 10 ns
TOF res. : ~ 1 ns (fwhm), Position res. : ~ 1 mm (fwhm)

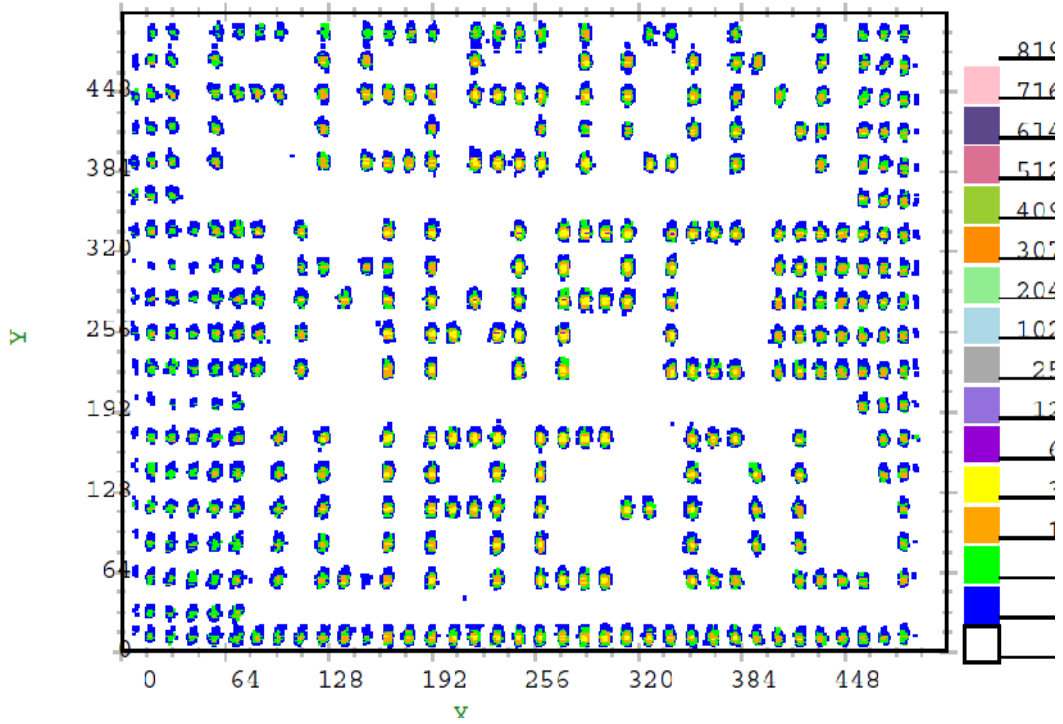
Master start/time zero detector
Transmission MWPC with active area 40 mm x 40 mm
Four electrode with 25 mil (0.63 mm)wire pitch
Electrode separation : 2 mm
Entrance & exit window : 0.5 μm mylar
Rise times ~ 3.5 ns, TOF resolution estimated : ~ 100 ps (fwhm)

Mass Resolution expected : ~ 4 mass units (fwhm)



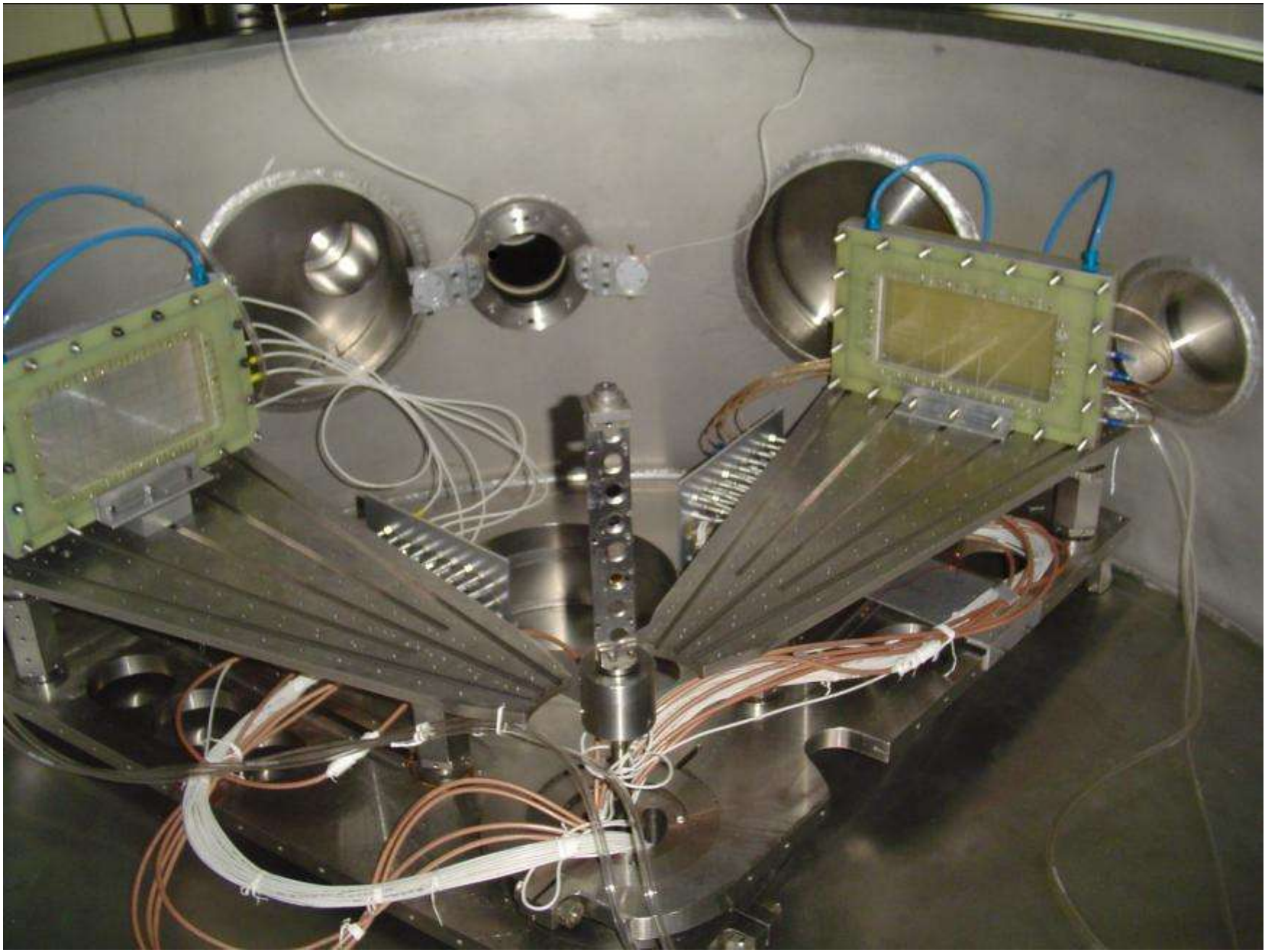


1.5" x 1.5", 0.63 mm pitch, 4 electrode

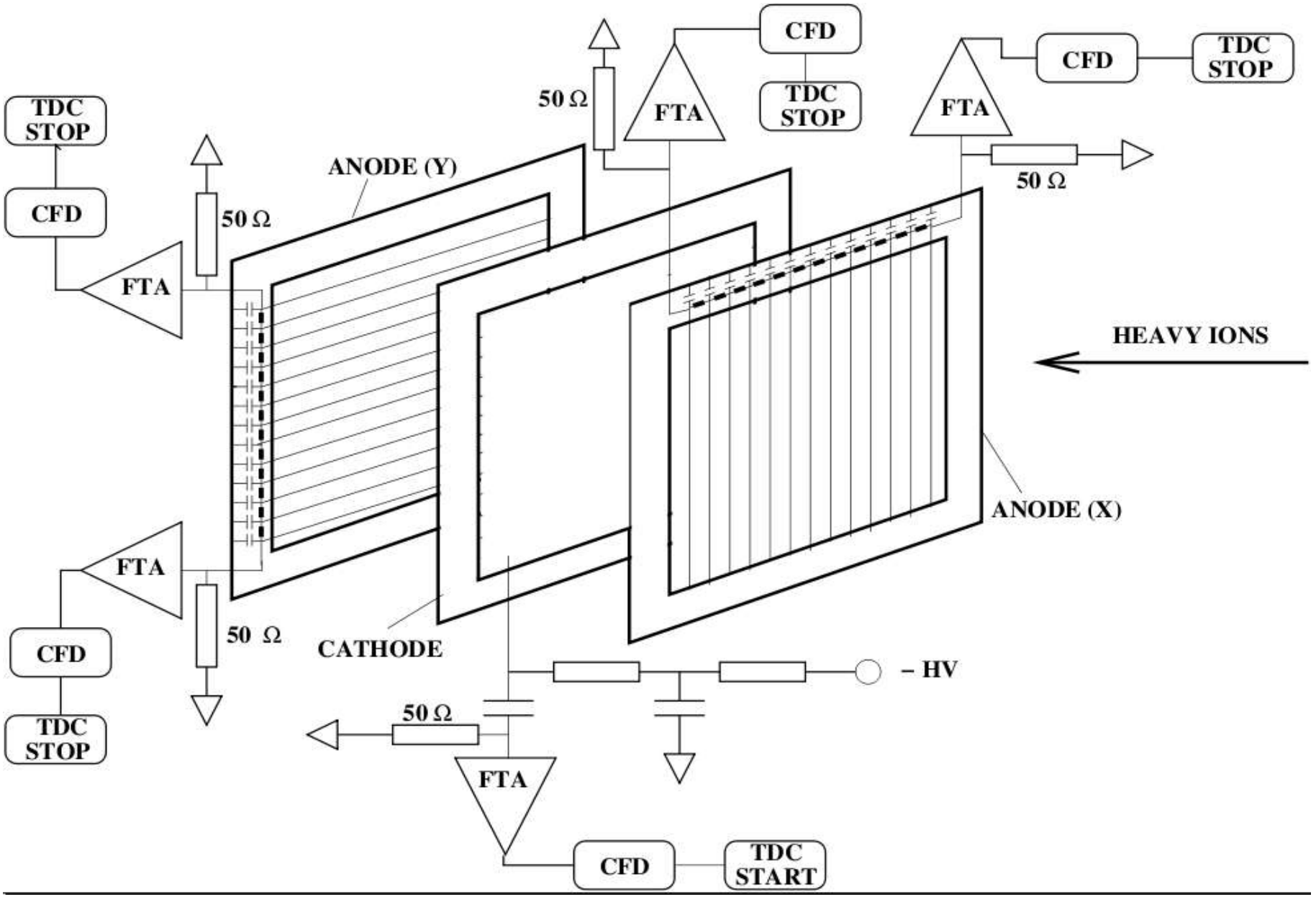


5 electrode, 8"x4", 1.27 mm for GPSC

Akhil Jhingan et al RSI 80(2009)123502



MWPC set up in GPSC for fission experiments



Schematic of 3 electrode MWPC with signal processing scheme

MWPC for NAND

Two new MWPC fabricated and installed in NAND

Three electrode geometry, Active area : 16 cm x 11 cm

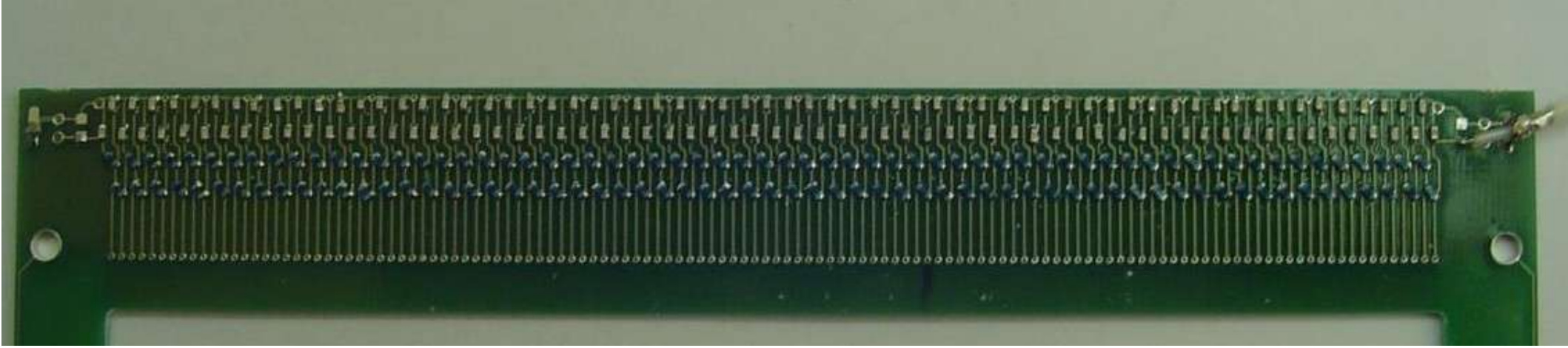
1.5 μm thick Mylar (Aluminized on both sides) as Cathode
Sandwiched between two anodes (X and Y positions).

X-electrode : 10 μm dia. Au-W wire frame at 0.63 mm pitch, delay : 1.27 mm/ns

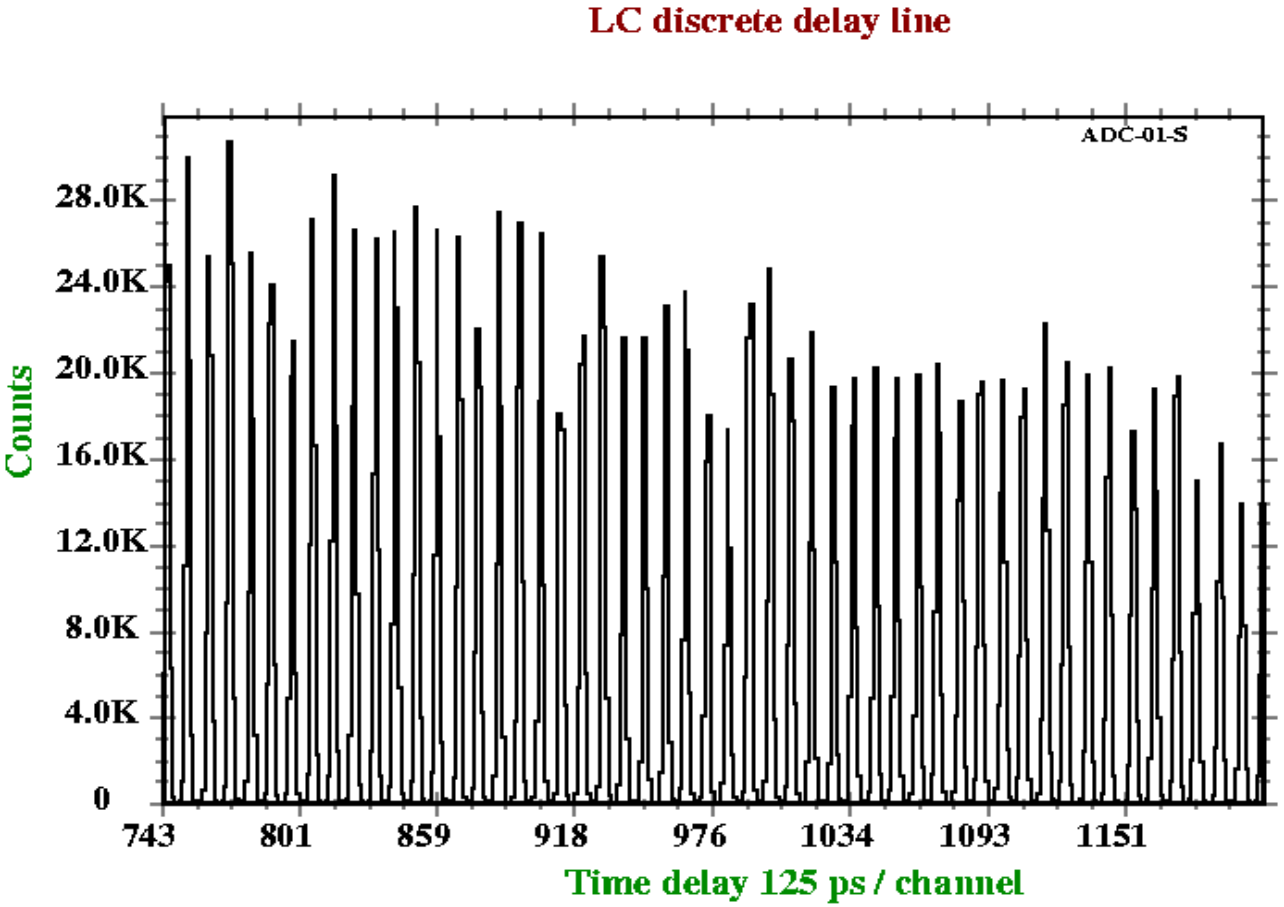
Y-electrode : Au plated strips on PCB (strip width 1mm, pitch 1.27 mm), delay, 1.27 mm/ns

Entrance window 0.9 μm Mylar, Iso-Butane gas at 3-7 mbar

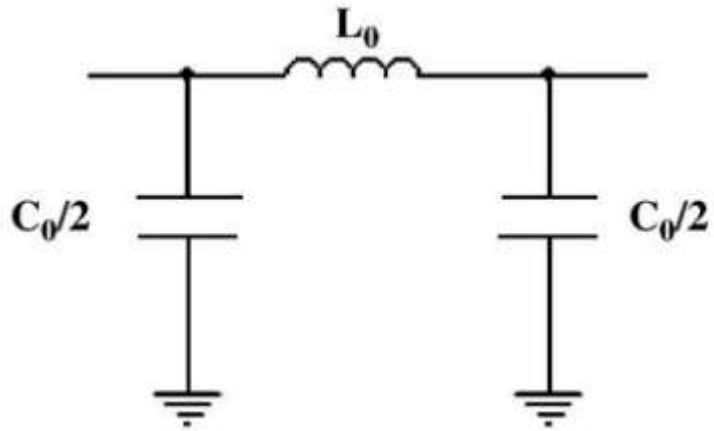
Positions extractions using discrete delay line fabricated in-house
End to end delay : 130 ns and 90 ns for X & Y respectively.
Delay line fabricated using 0603 package LC.
Delay : 1 ns /tap, Z = 50 Ω



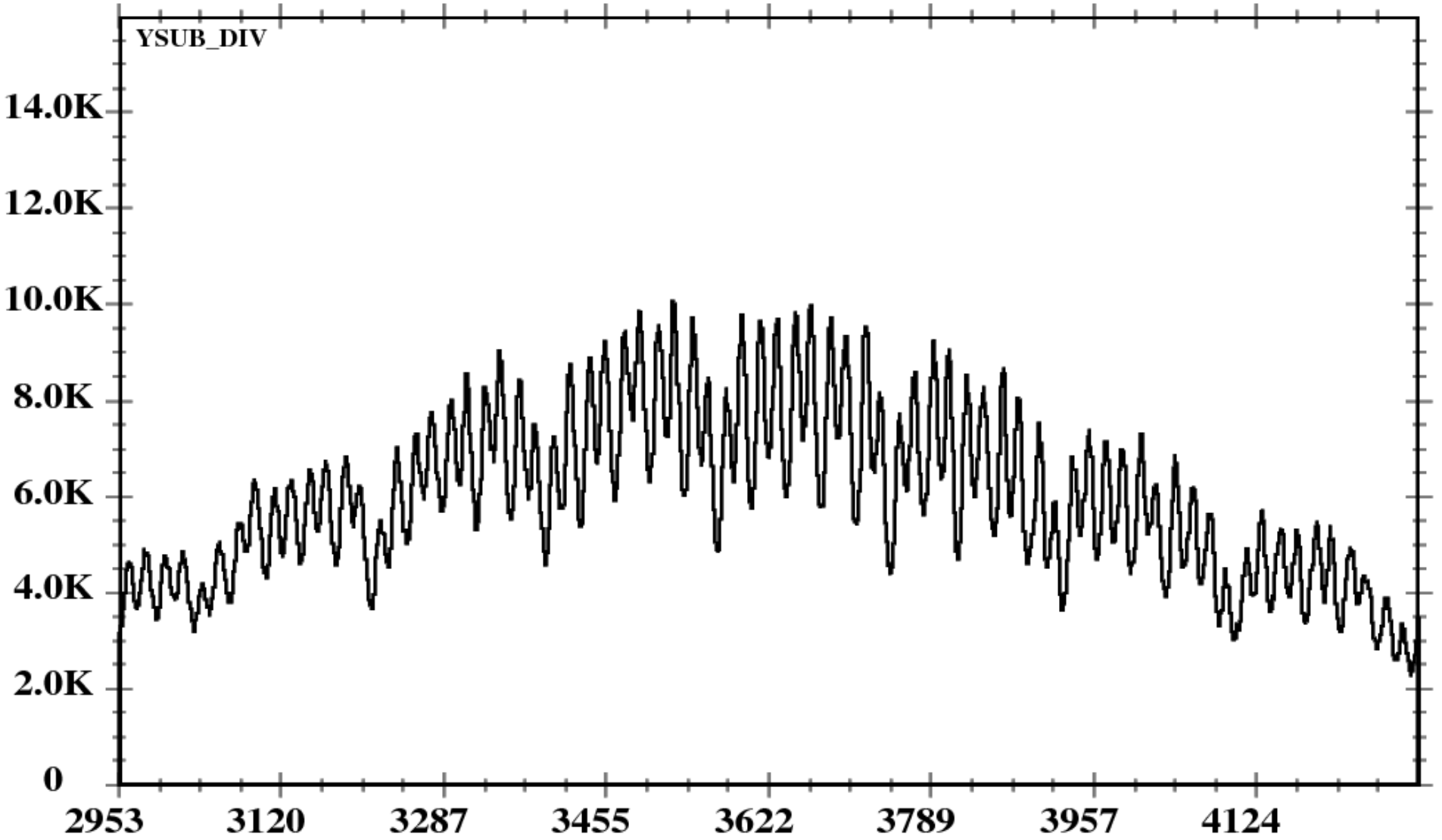
X-position wire frame delay line



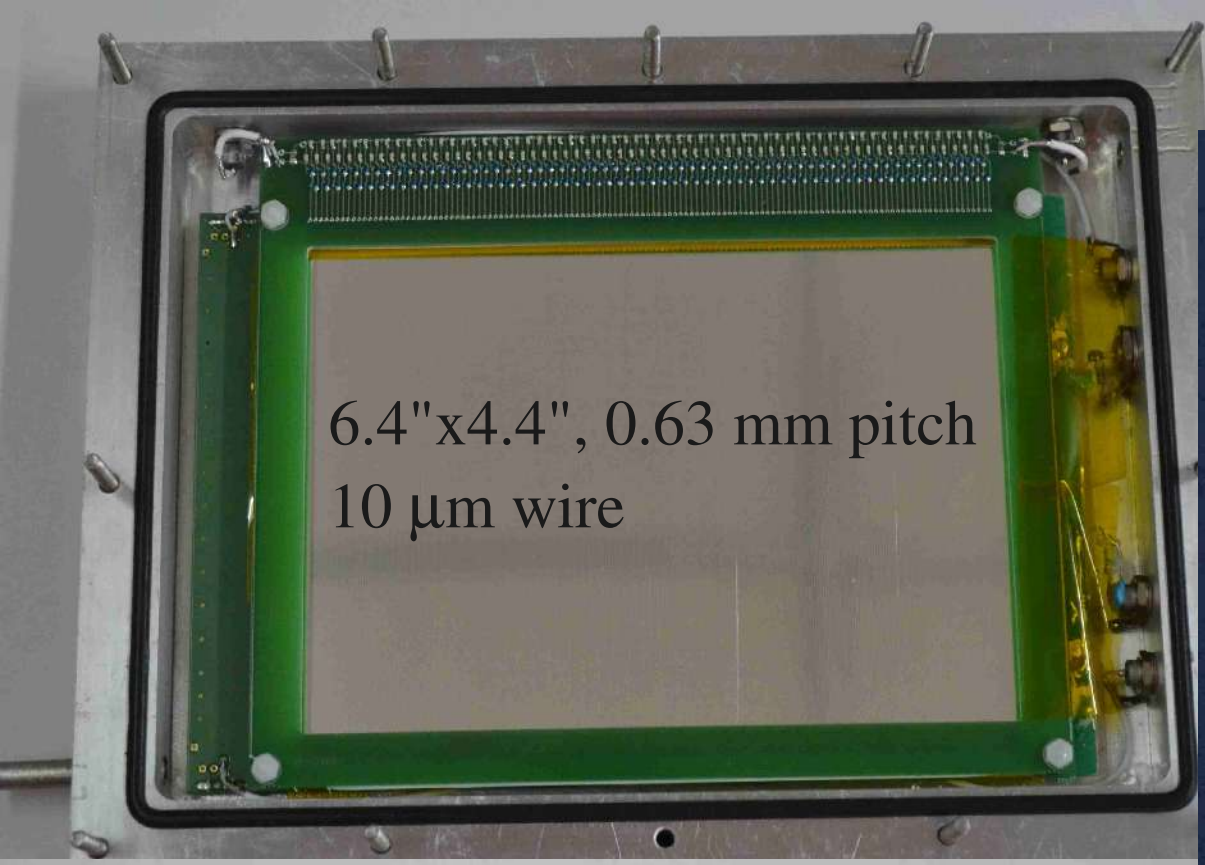
Phillips 7120 charge time calibrator

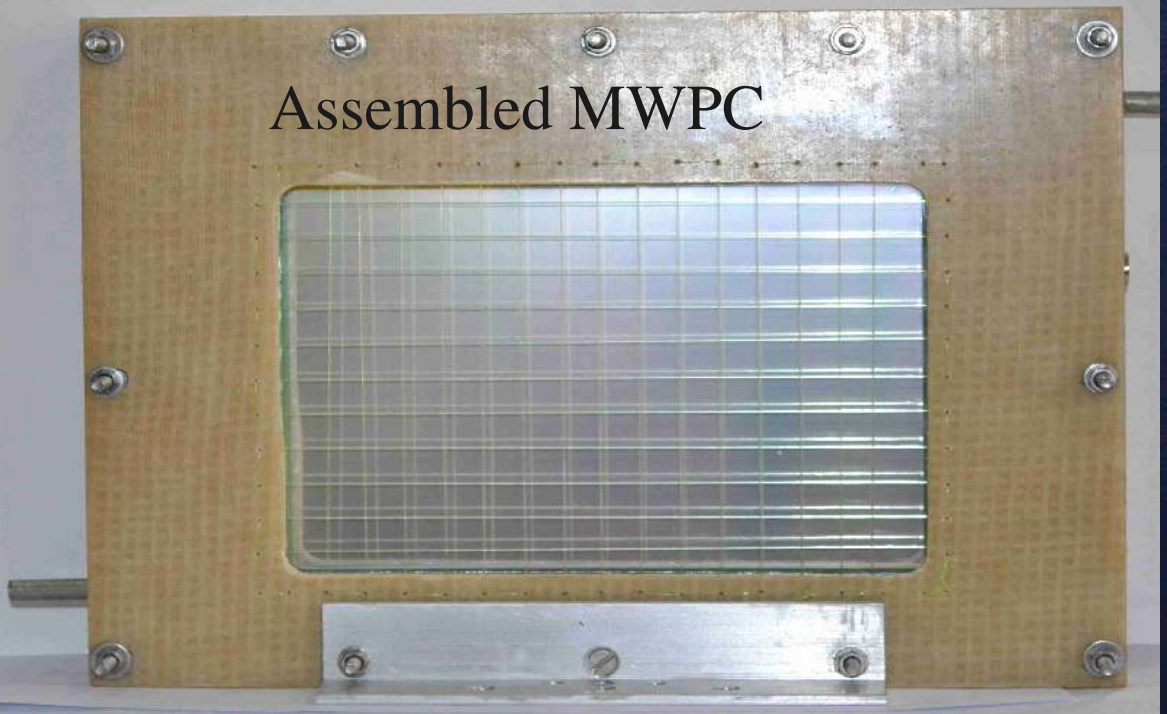


Electrical scheme of a
Single delay line cell

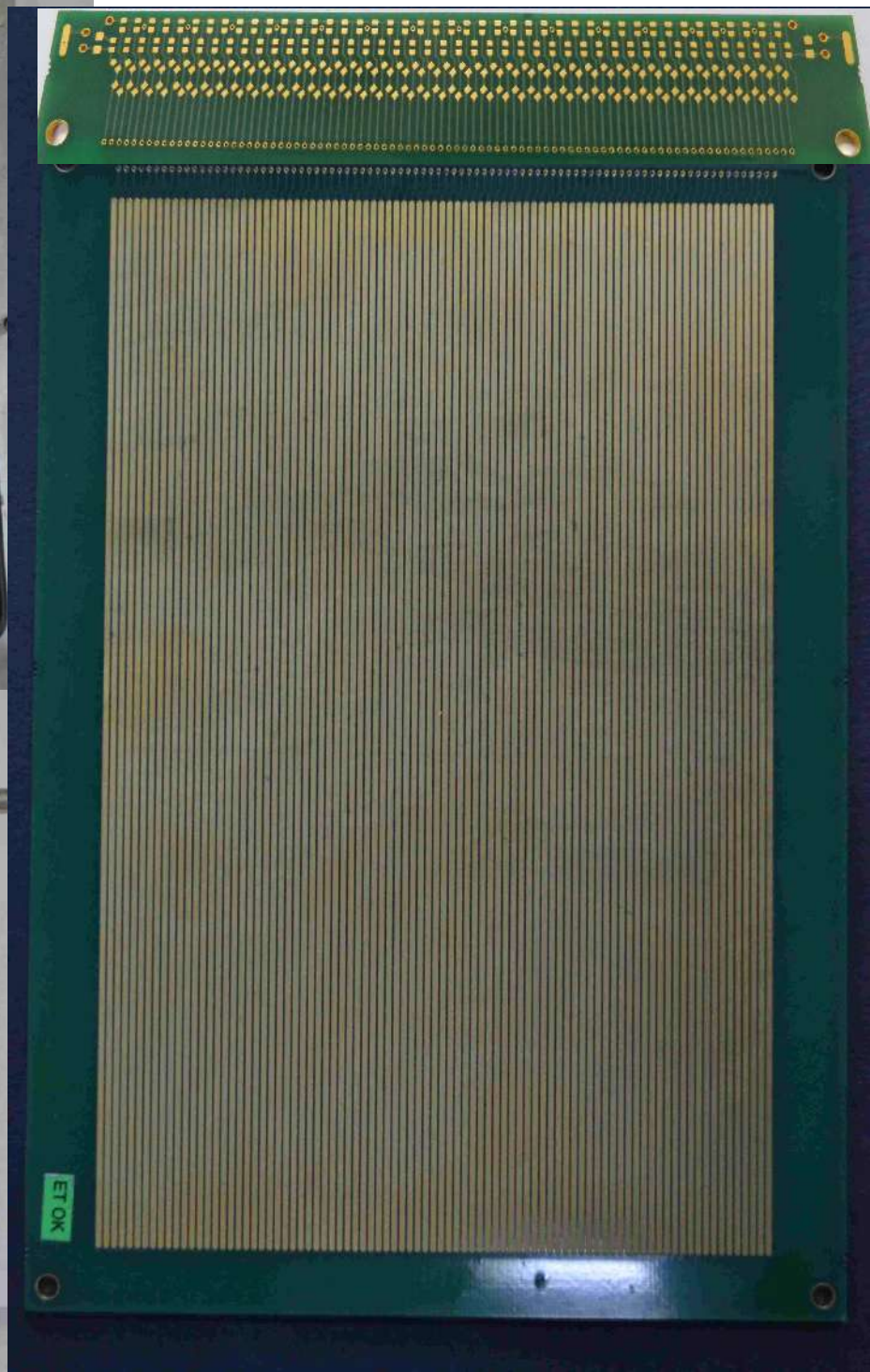


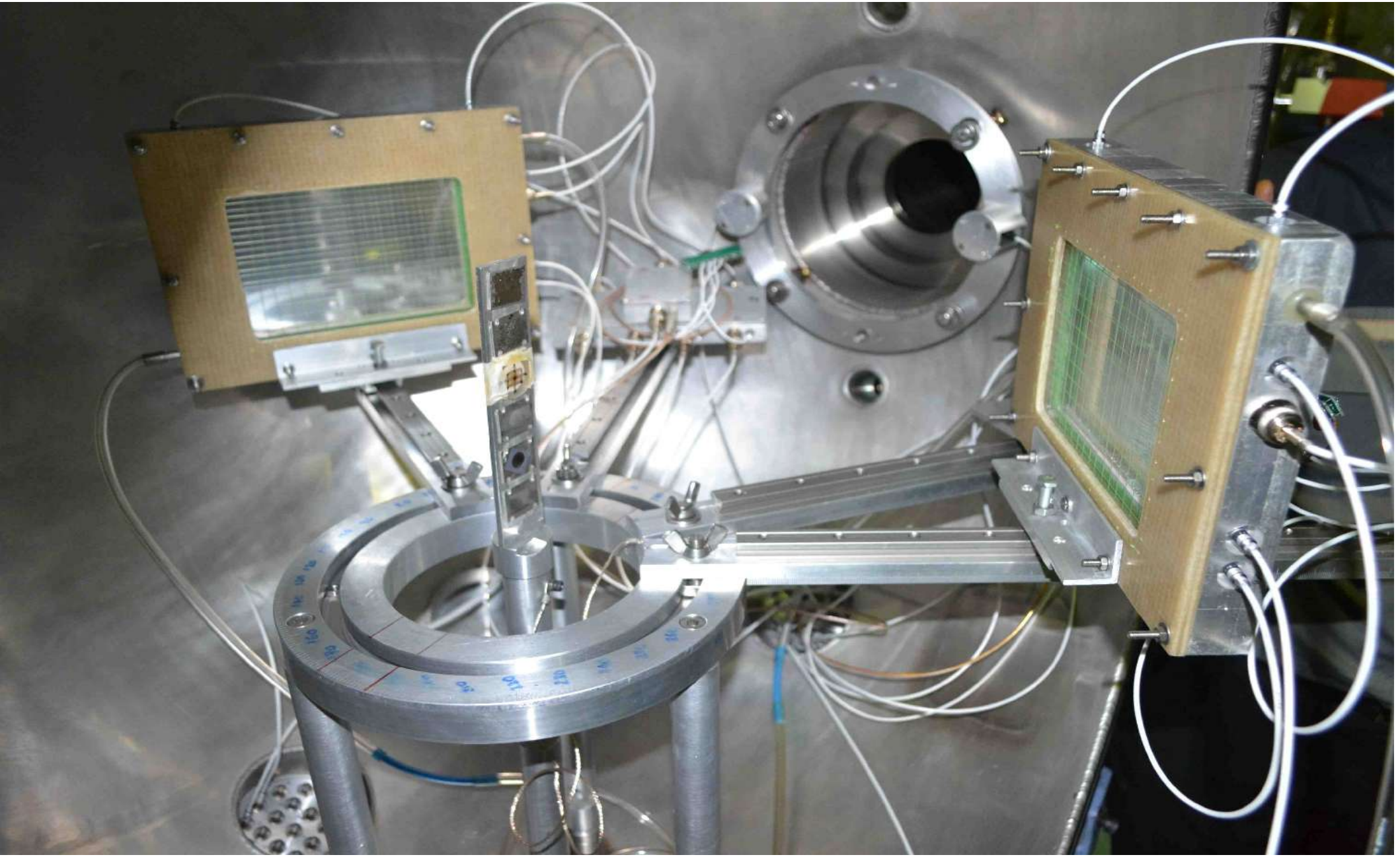
X-position spectra with 241Am alphas
FWHM of each peak ~ 500 ps



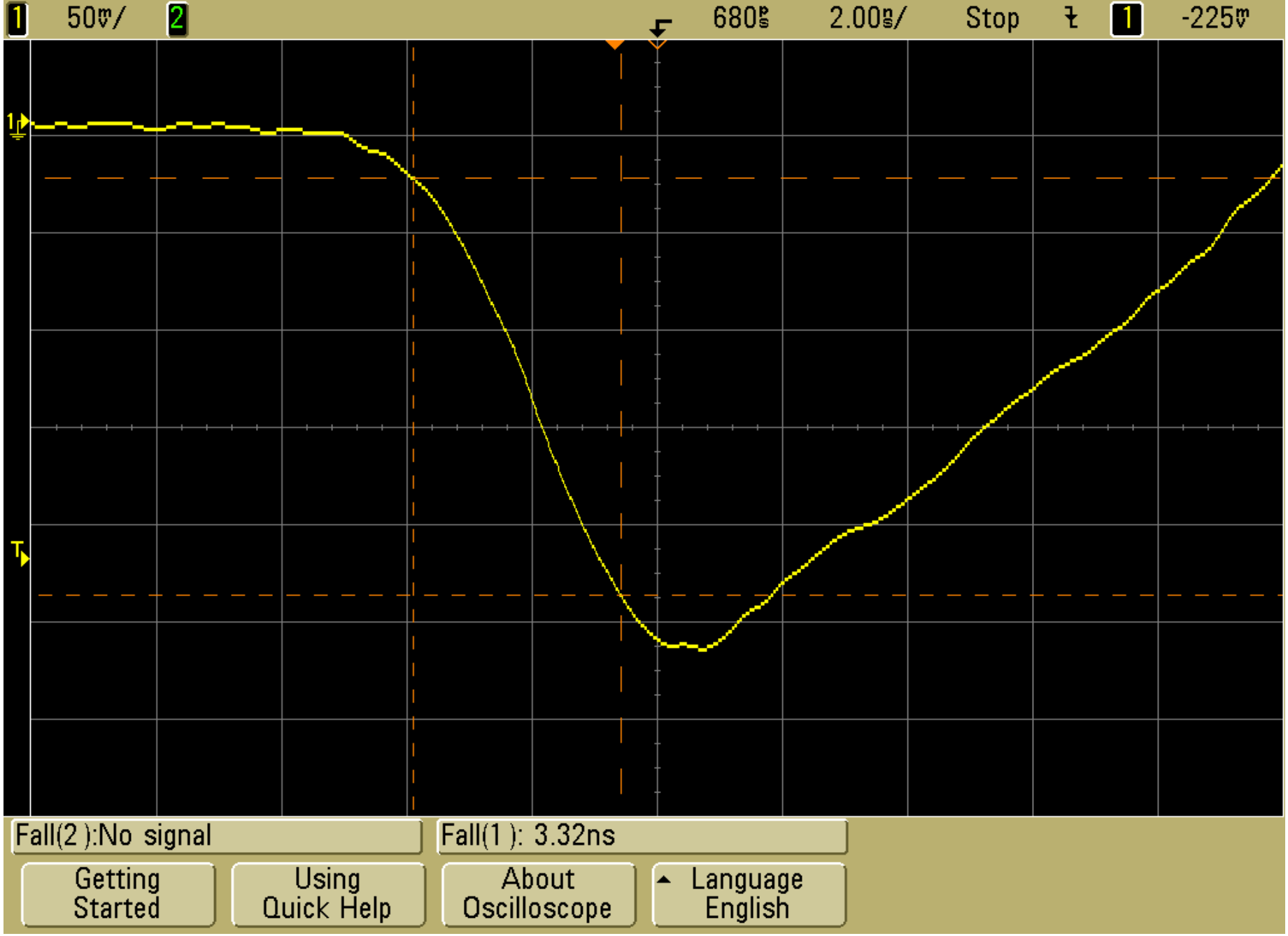


Y-electrode of MWPC

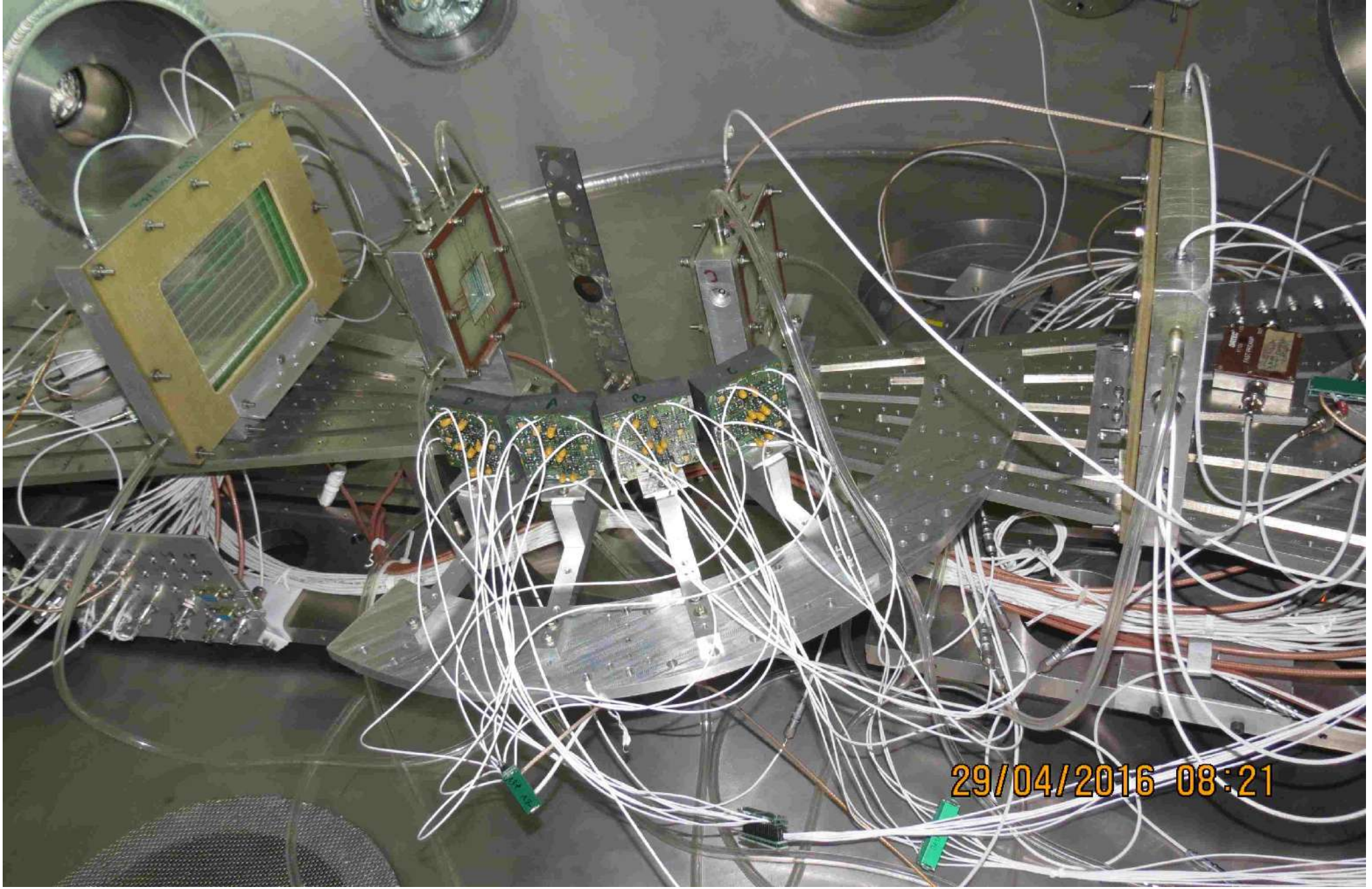




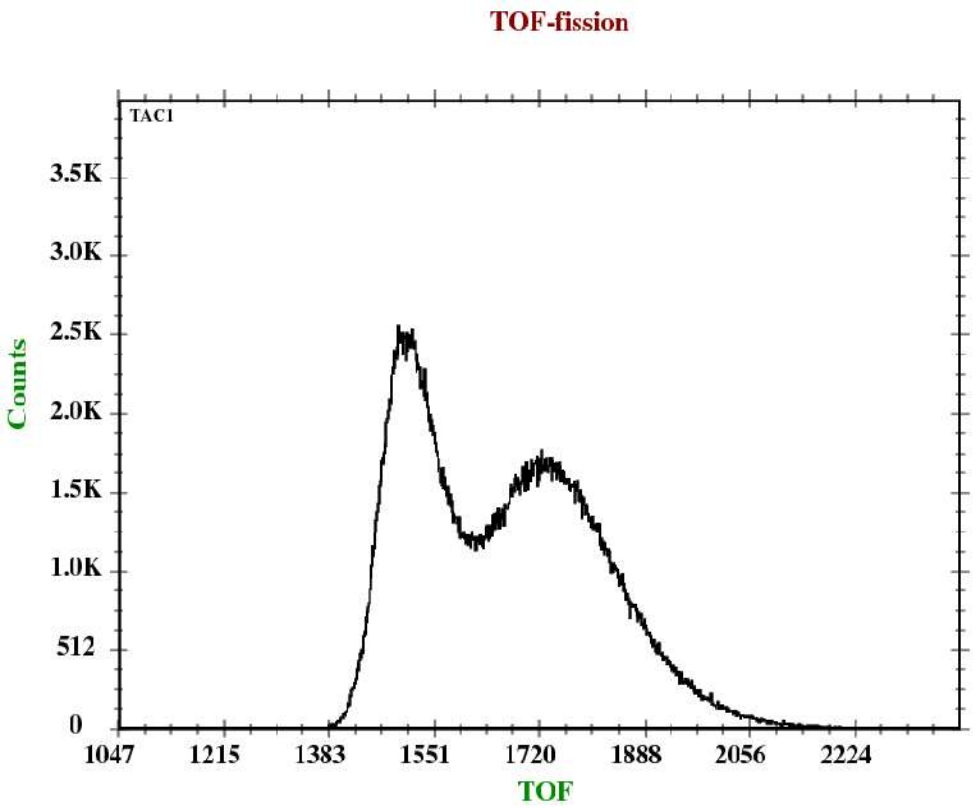
MWPC set up in NAND



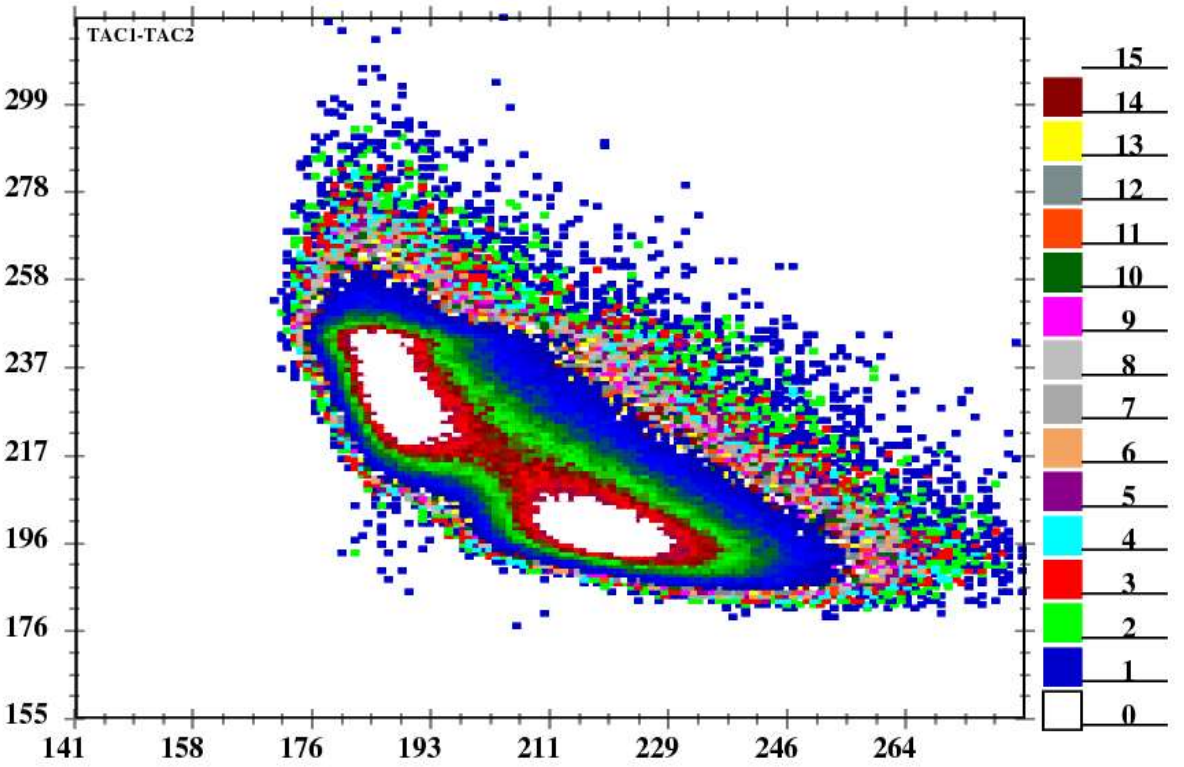
CRO trace from MWPC for 28Si on 197Au @ 100 MeV
Outside GPSC chamber : 2 m of cable.

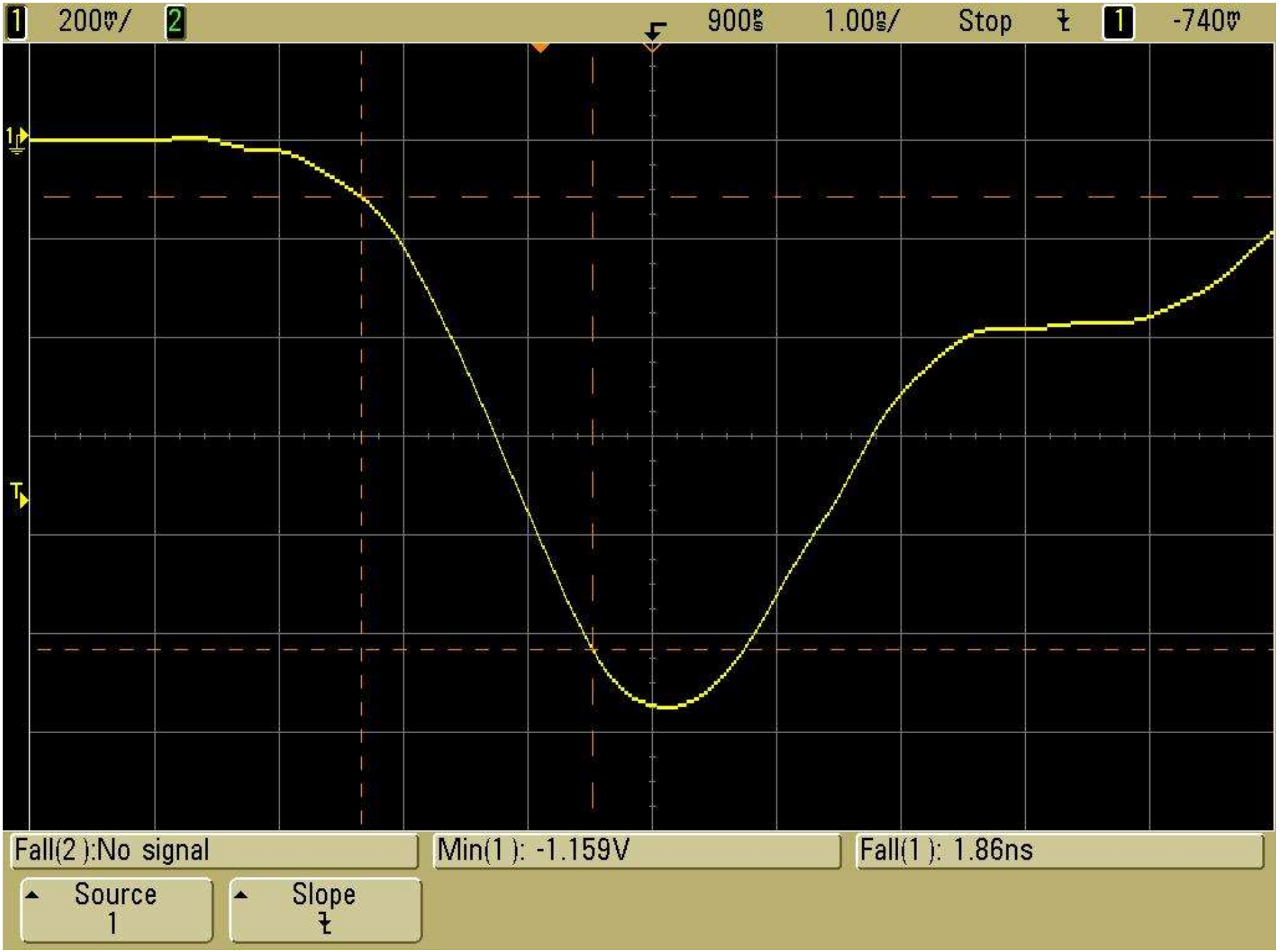


Double Arm fission TOF set up at GPSC-IUAC

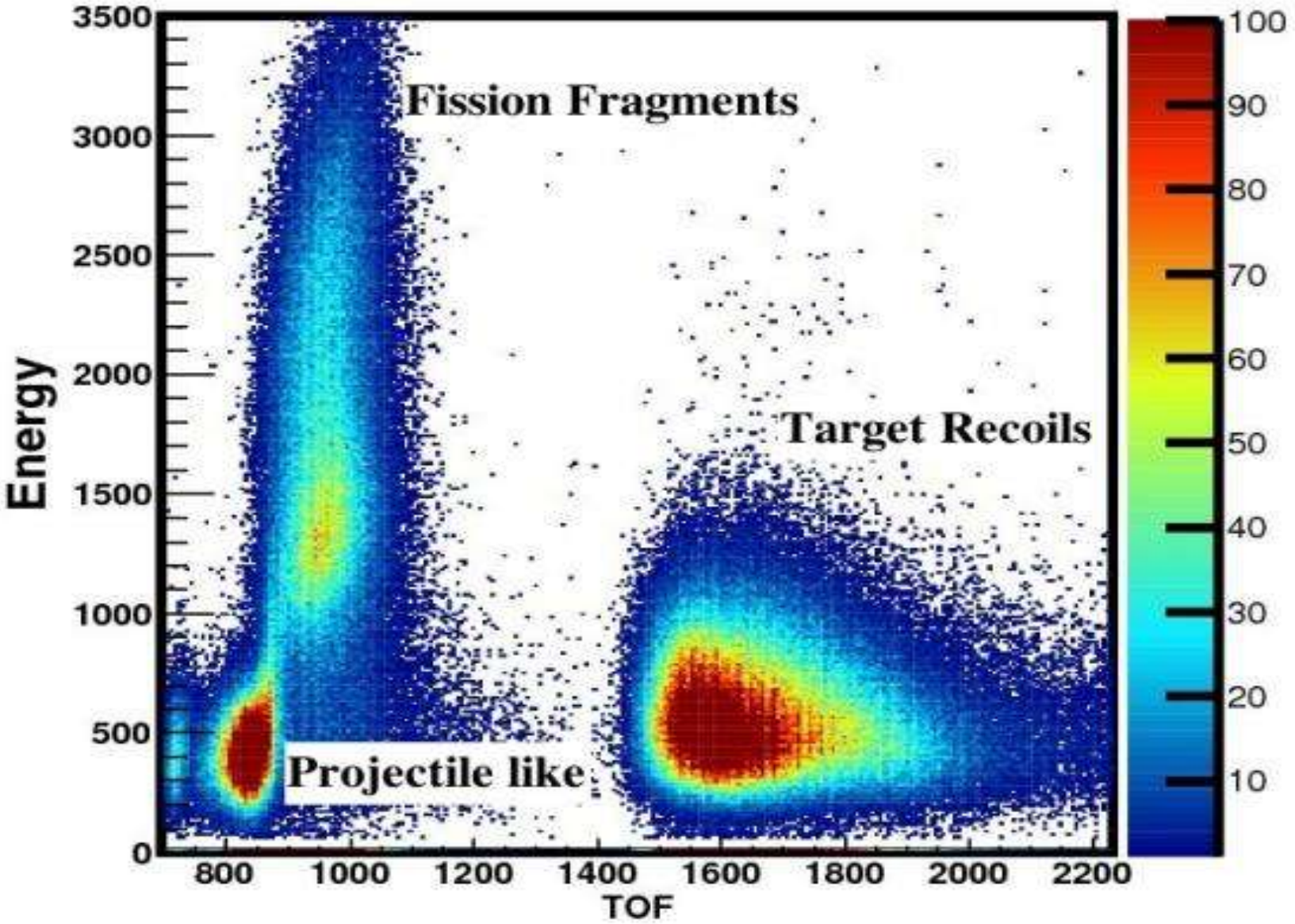

TOF-fission
TAC1
3.5K
3.0K
2.5K
2.0K
1.5K
1.0K
512
0
Counts
1047
1215
1383
1551
1720
1888
2056
2224
TOF

TOF spectra


TAC1-TAC2
299
278
258
237
217
196
176
155
141
158
176
193
211
229
246
264
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

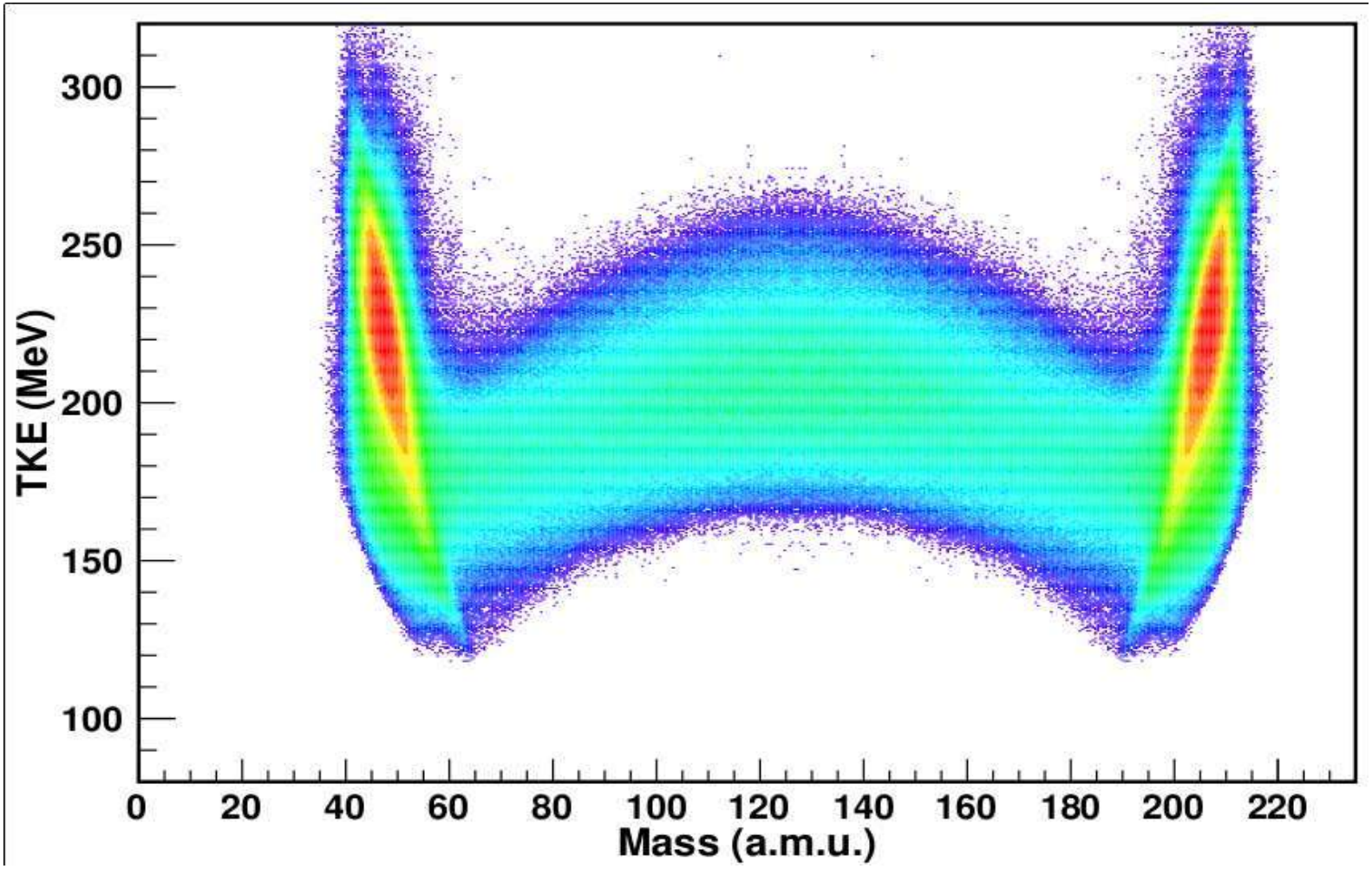


Fission fragment signal from start detector

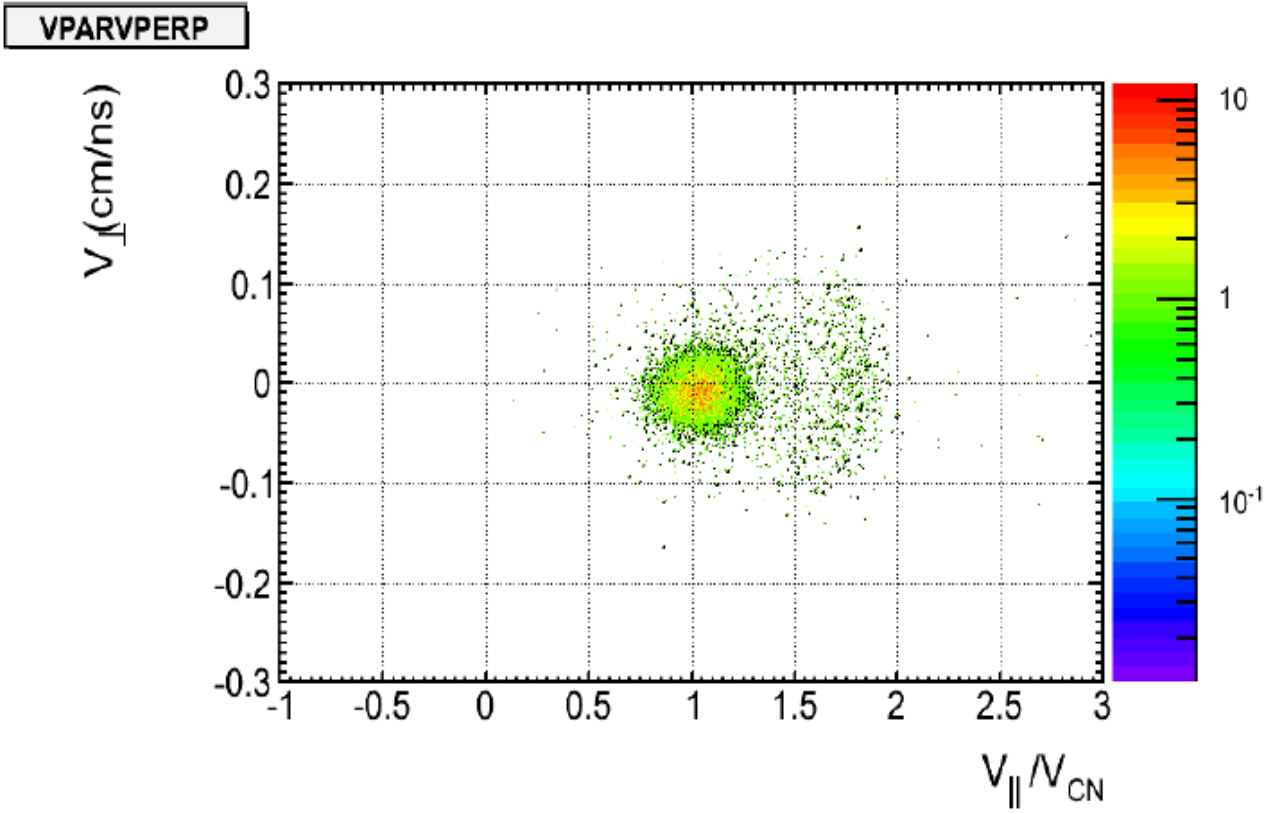


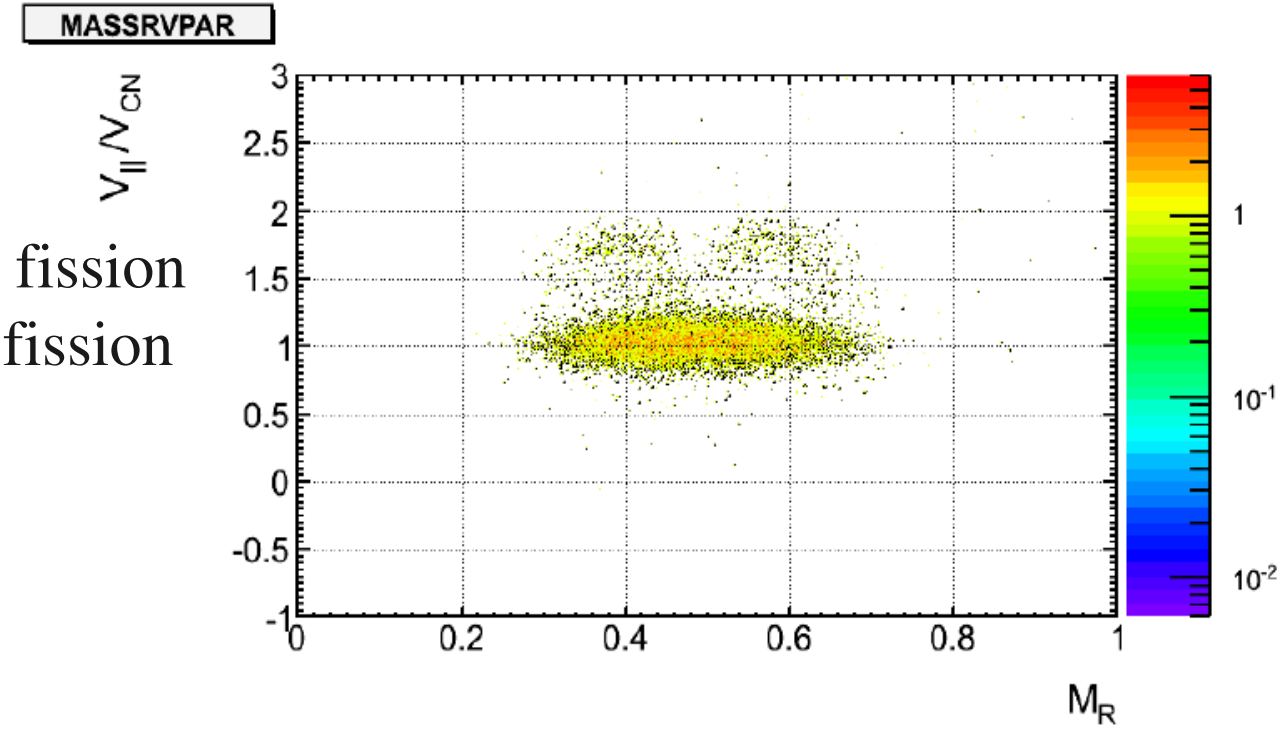
TOF w.r.t. RF from the Accelerator 20 cm flight path

48Ti + 208Pb

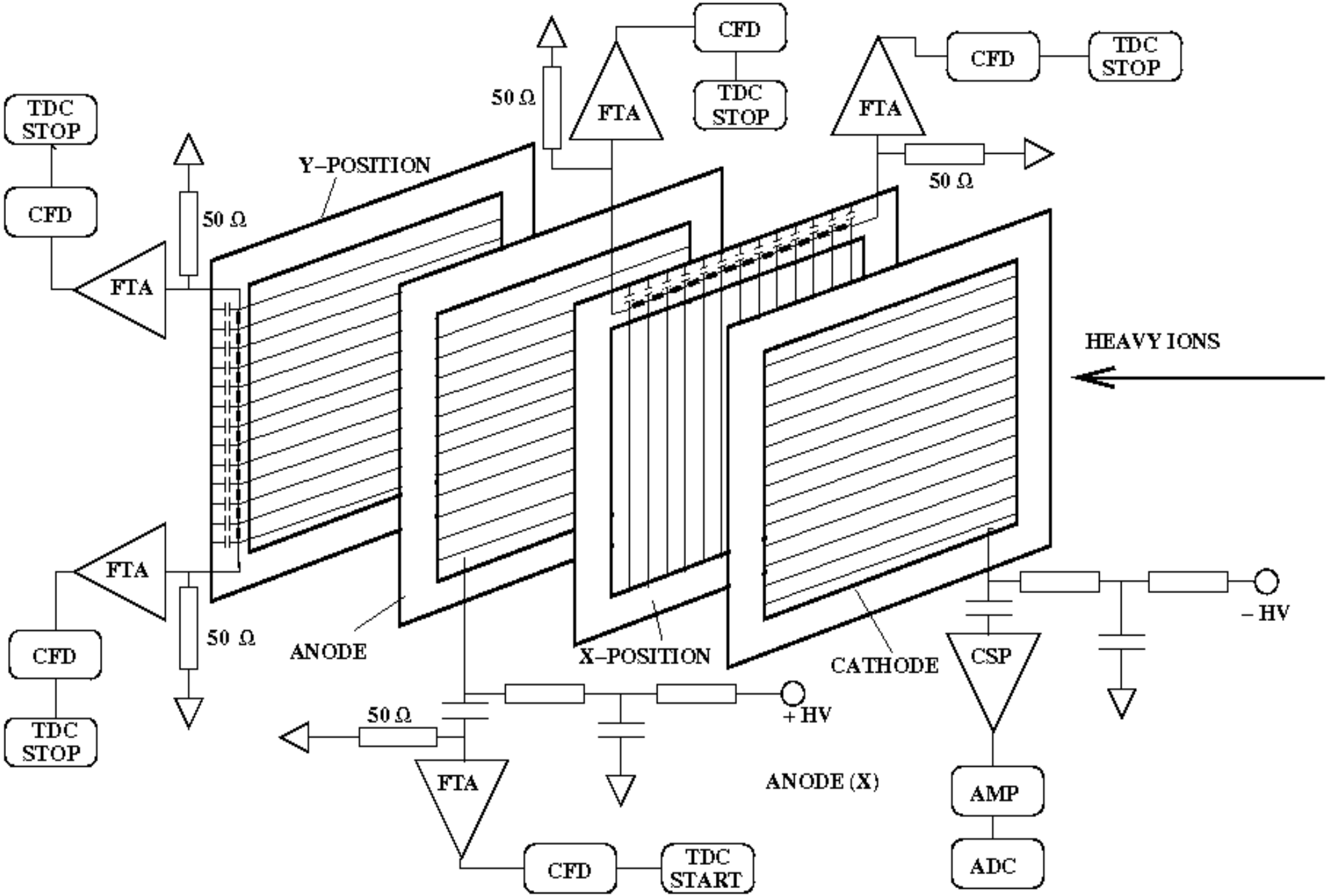


Plot of fission fragment mass (one fragment) against total kinetic energy for Neutron emission from near super-heavy nuclei 256Rf
Meenu Thakur et al, Proc. DAE-BRNS Symp. on Nucl. Phys. 60(2015)358





Separation of transfer induced fission events from Compound nuclei fission in the $^{18}O + ^{232}Th$ reaction



Schematic of 4 electrode MWPC with signal processing scheme

Detector system for Transfer experiments in GPSC

Requirements :

Time resolution: < 500ps, Positon : < 0.5mm

Two position sensitive MWPCs (2”X 2”)-Breskin 4 electrode geometry

Central Anode :Au plated W wires – 10u diam at 25mil pitch

Position Electrodes : Au plated W wires – 20u diam at 25mil pitch

Pair of wire shorted and connected to one tap of delay line chip (TZB 12-5)

Chip inductors and capacitors required for individual wires

Electrode separation : 2mm

Rise times ~ 3.5ns

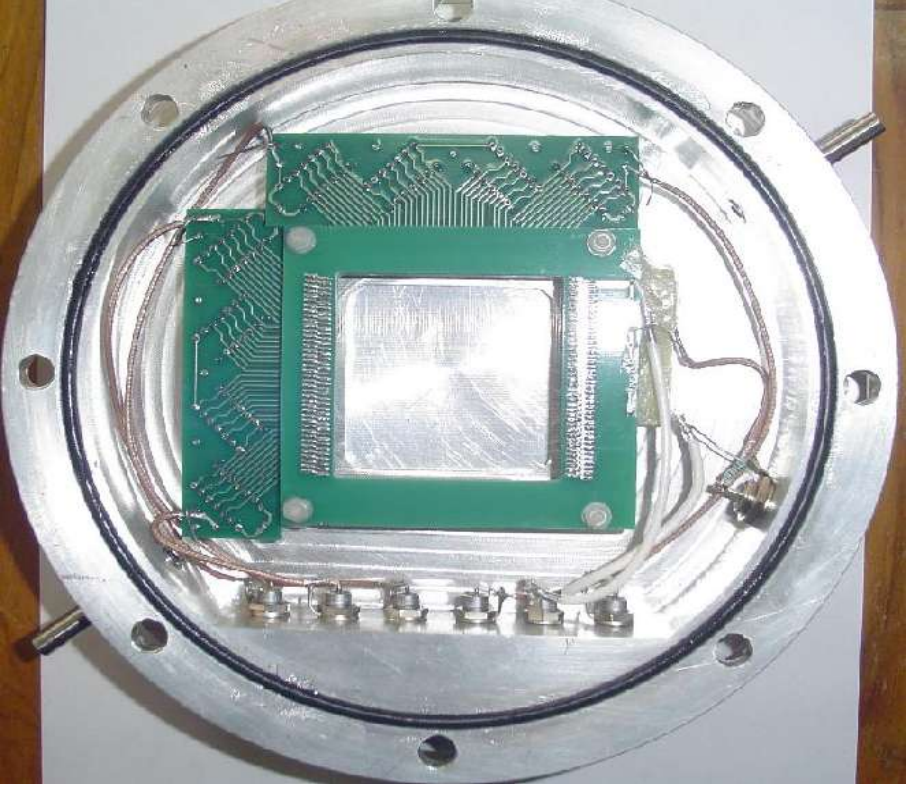
Detectors could handle count rates of ~100kHz

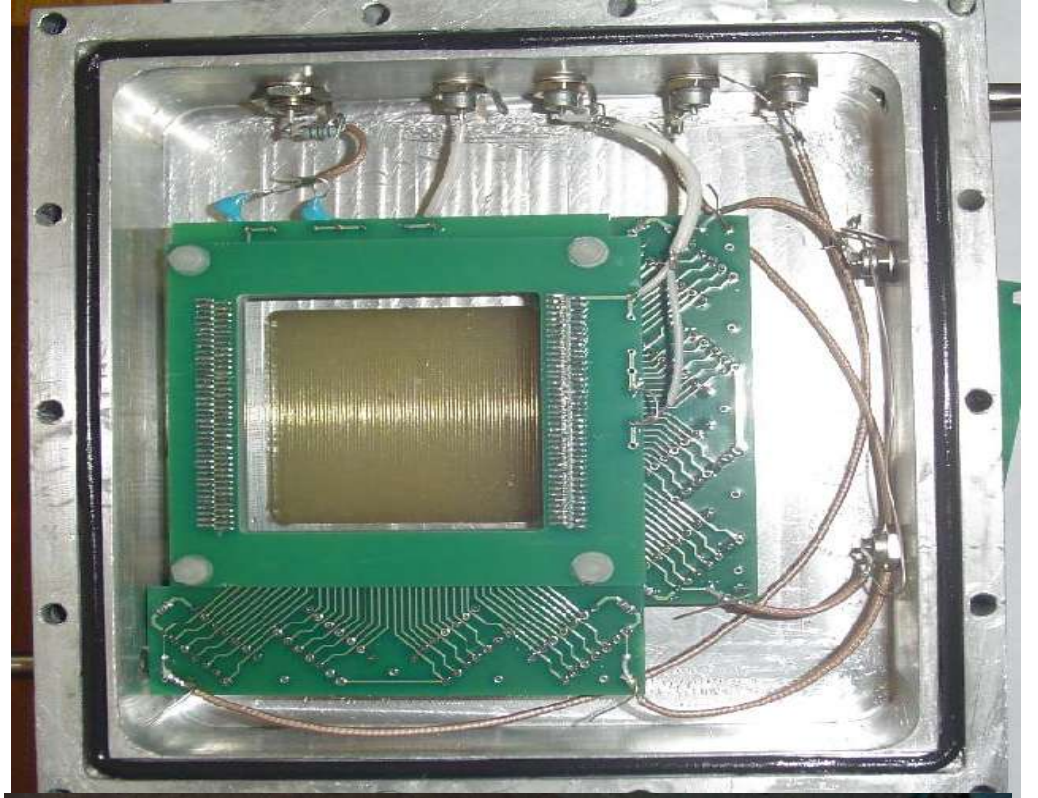
Ionization Chamber

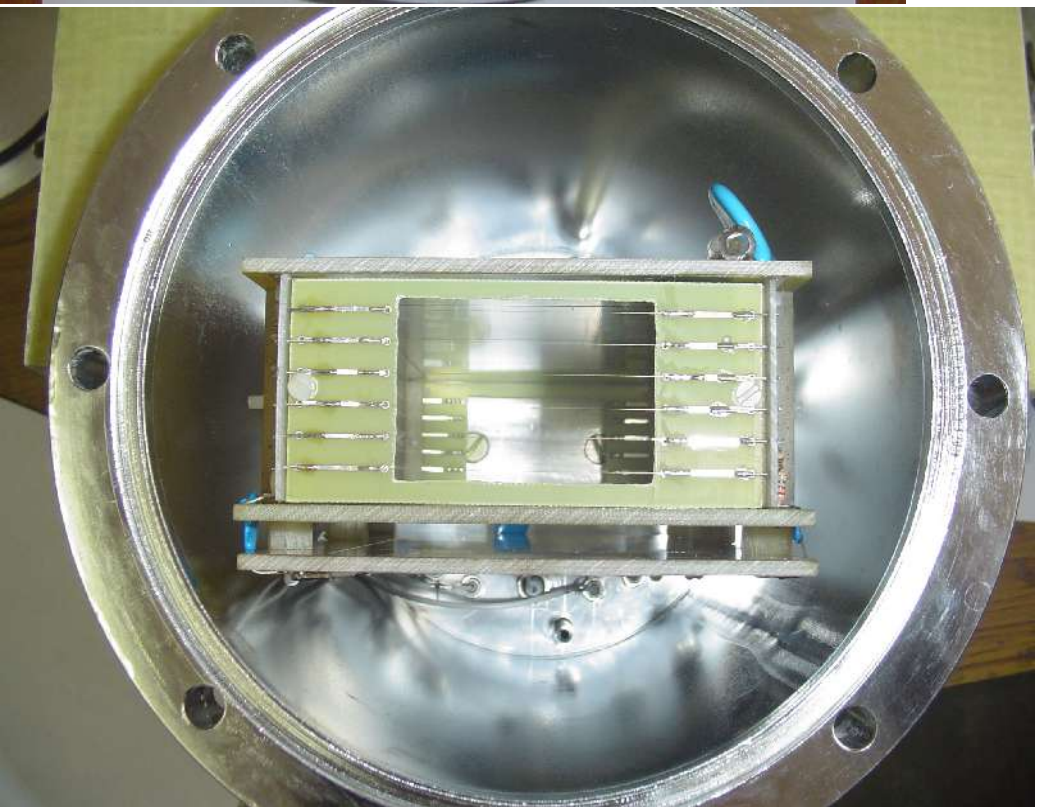
Transverse Electrode Geometry

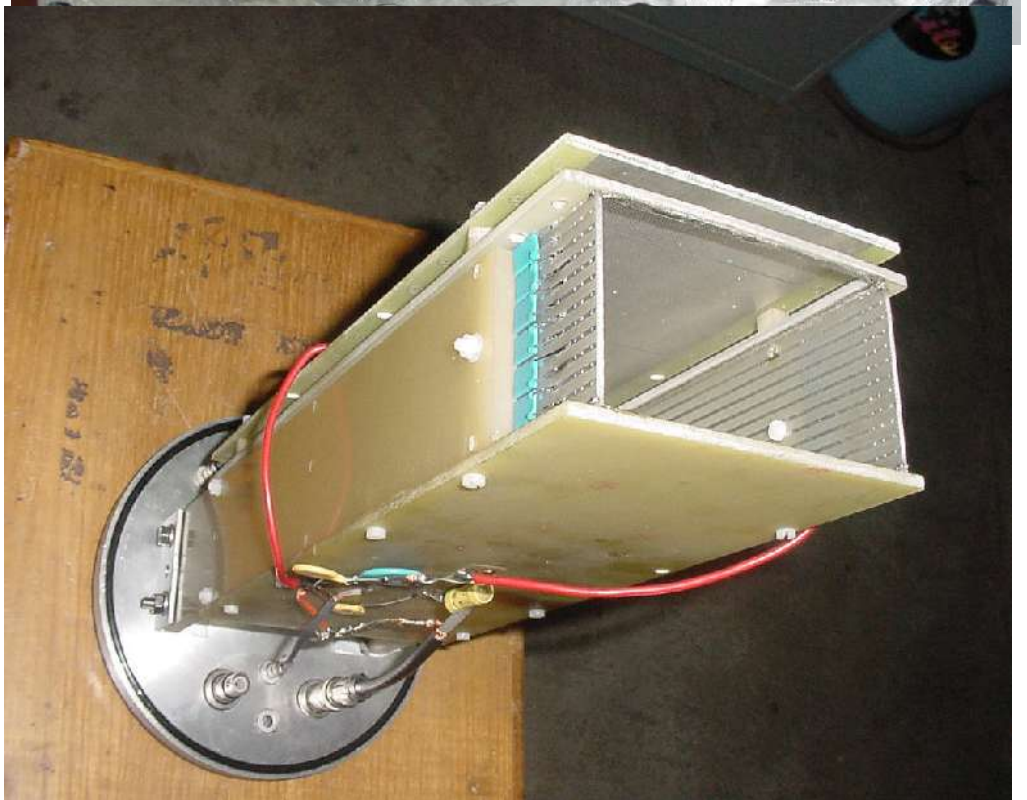
Segmented Anode - 4, Frisch grid, Cathode

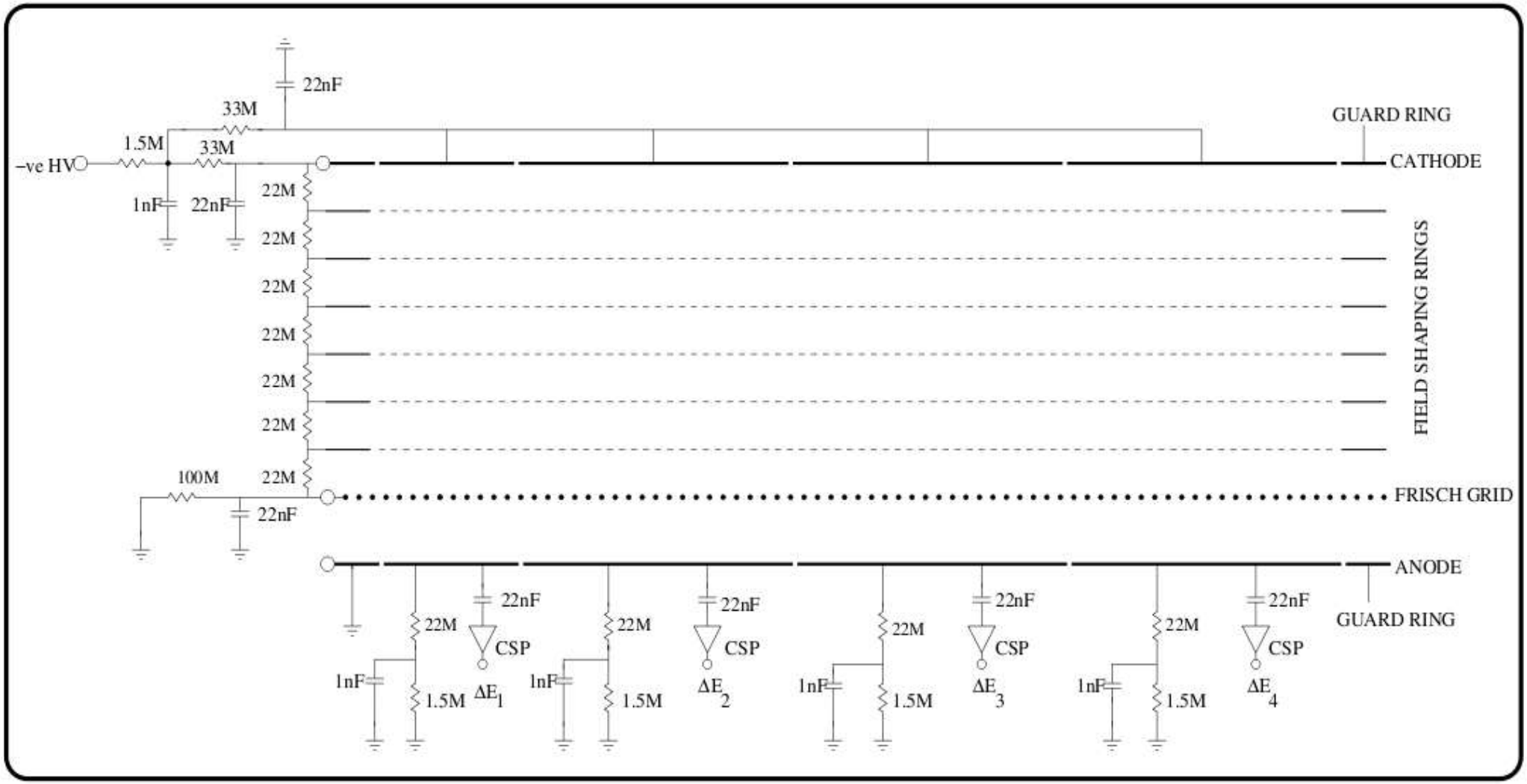
Frisch Grid : Au plated W wires – 20u diam at 40mil pitch





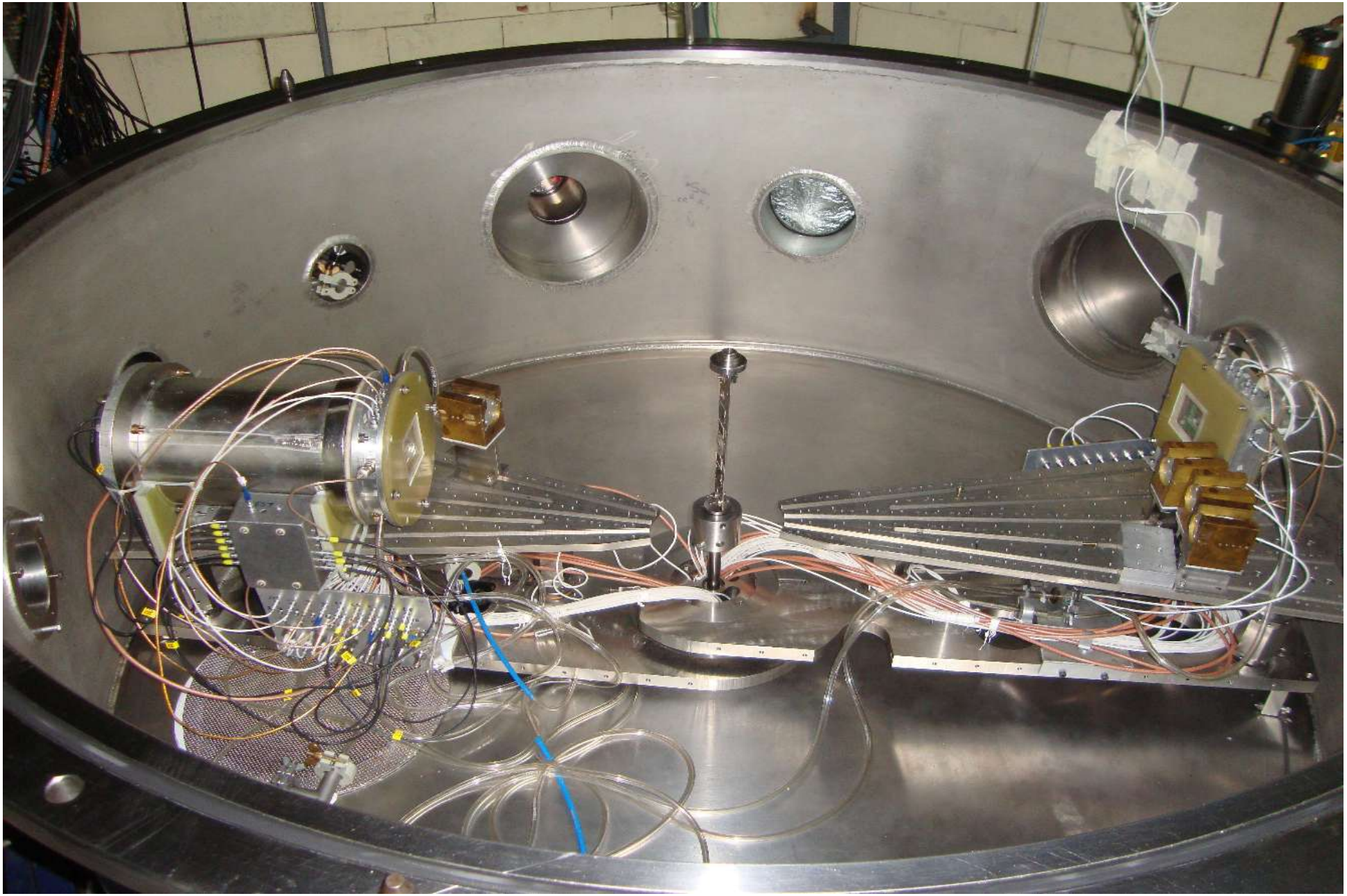




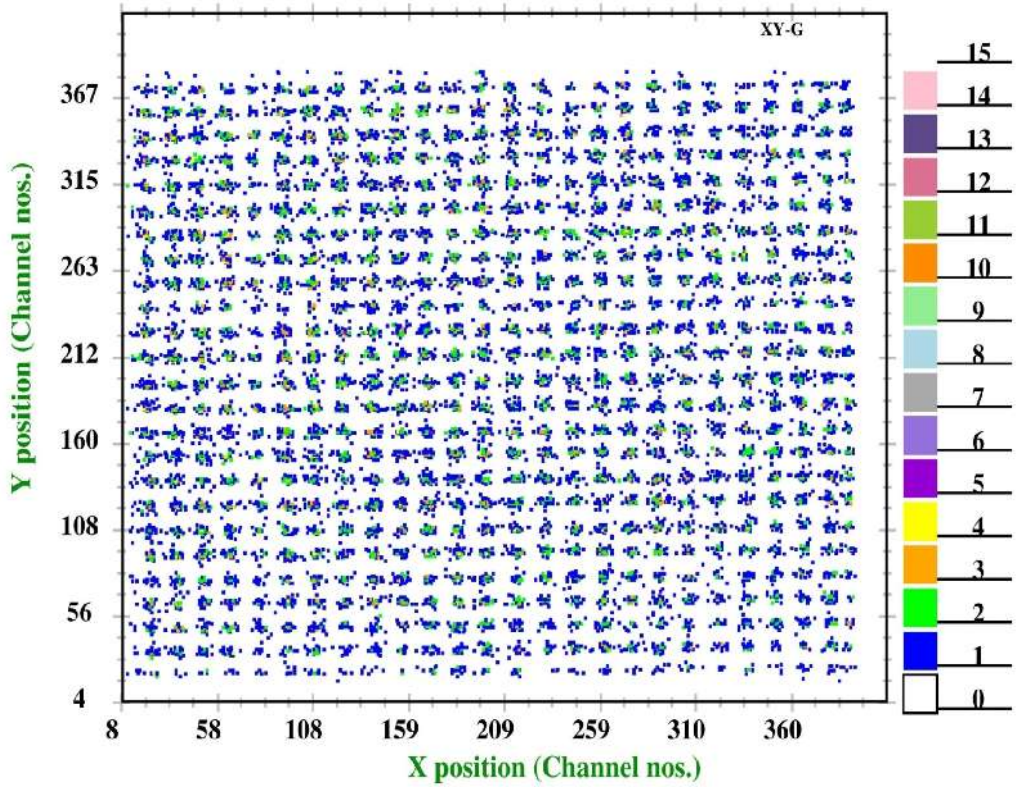


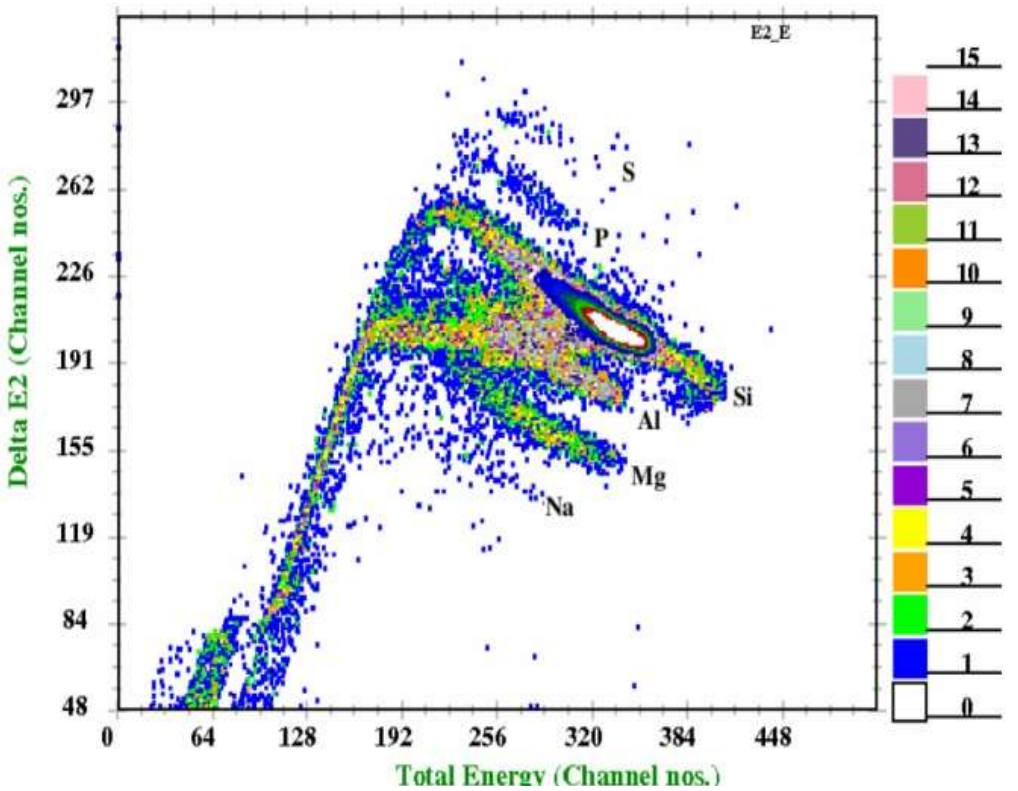
Schematic of split anode IC with electrical layout

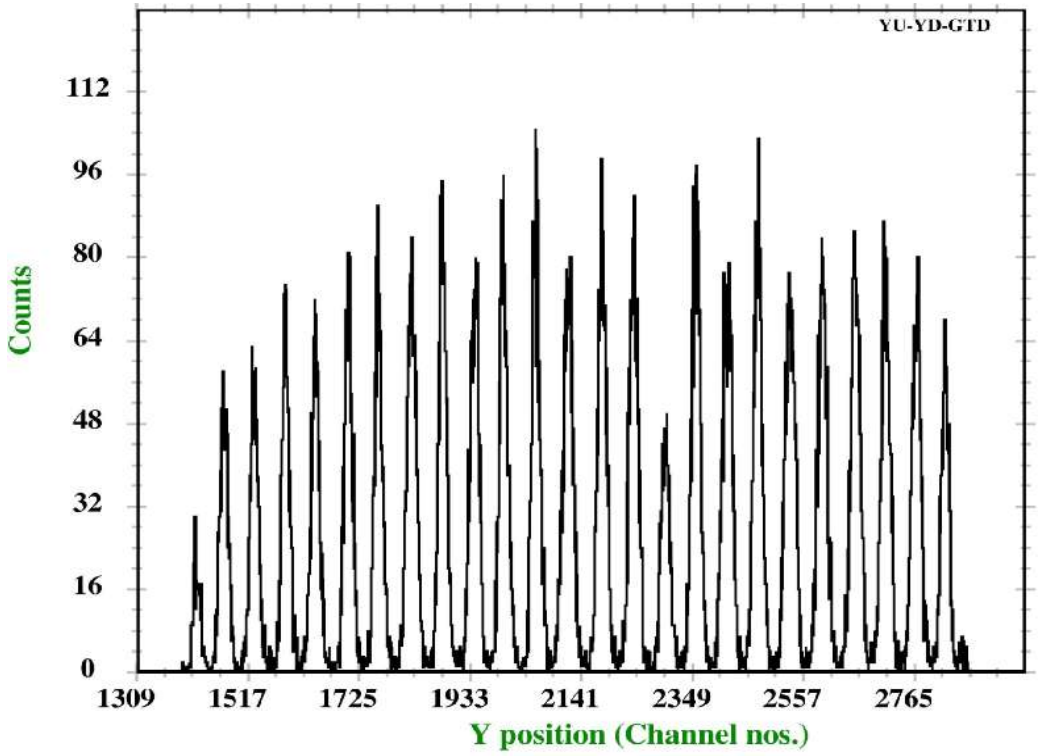
Akhil Jhingan et al, NIM A 745(2014)106

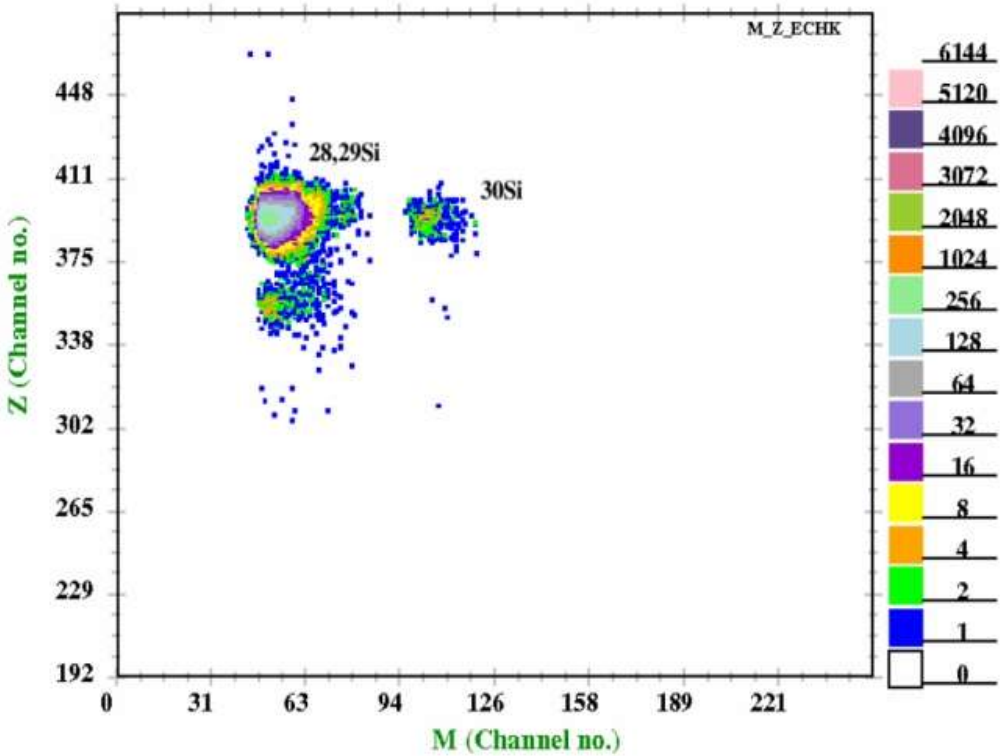


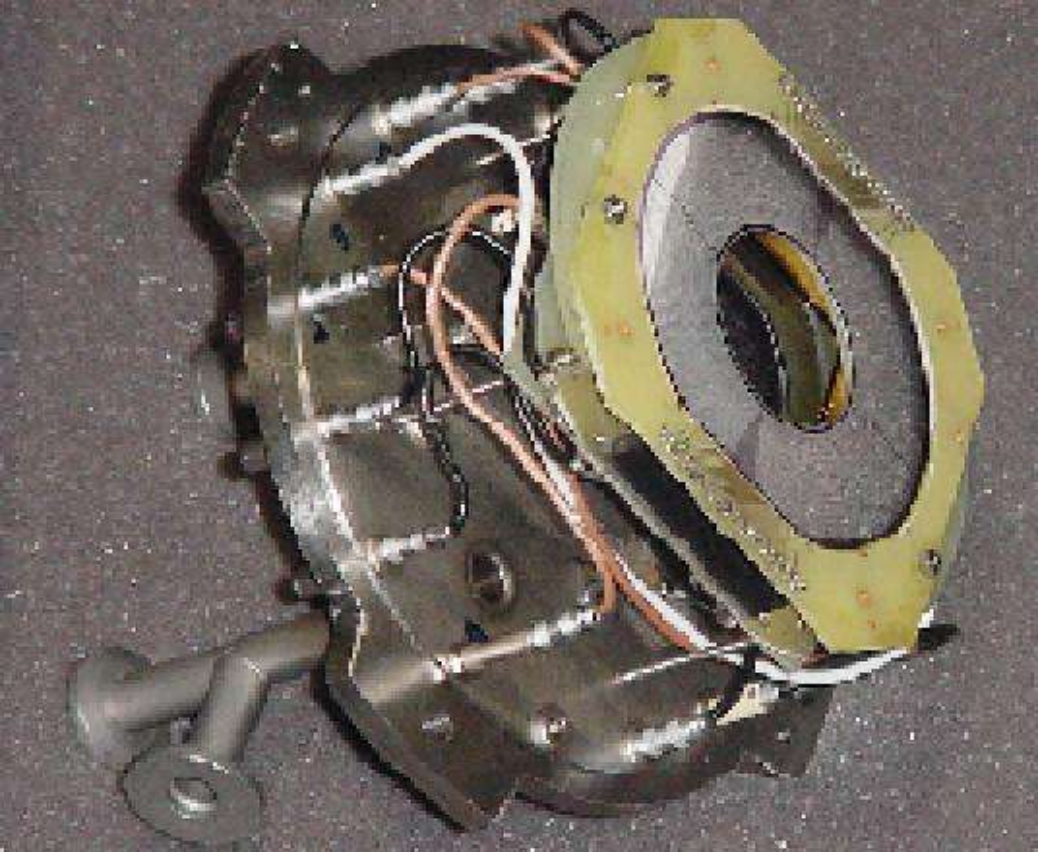
$^{28}Si + {}^{90,94}Zr$ S. Kalkal et. al. PRC 85, 034606 (2012)

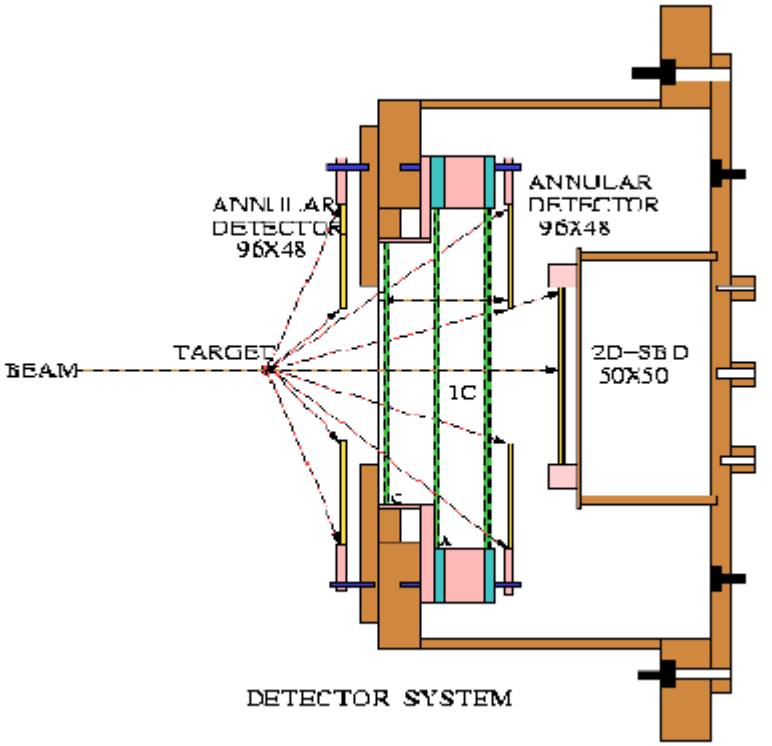

XY-G
Y position (Channel nos.)
X position (Channel nos.)
4
56
108
160
212
263
315
367
8
58
108
159
209
259
310
360
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0


E2_E
Delta E2 (Channel nos.)
Total Energy (Channel nos.)
48
84
119
155
191
226
262
297
0
64
128
192
256
320
384
448
S
P
Si
Al
Mg
Na
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0

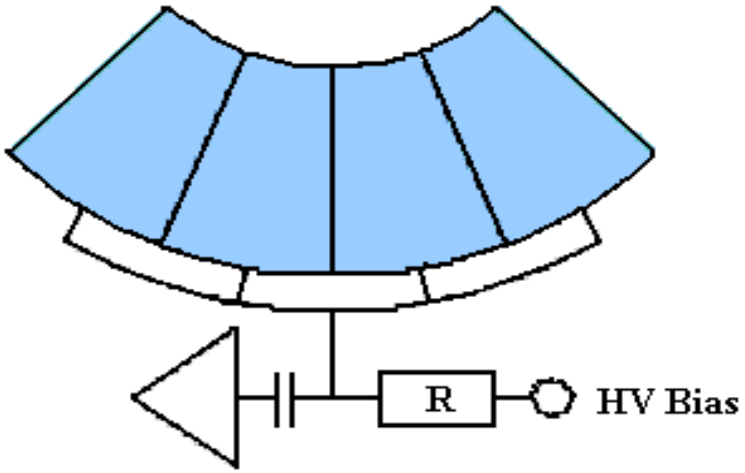

YU-YD-GTD
Counts
Y position (Channel nos.)
0
16
32
48
64
80
96
112
1309
1517
1725
1933
2141
2349
2557
2765

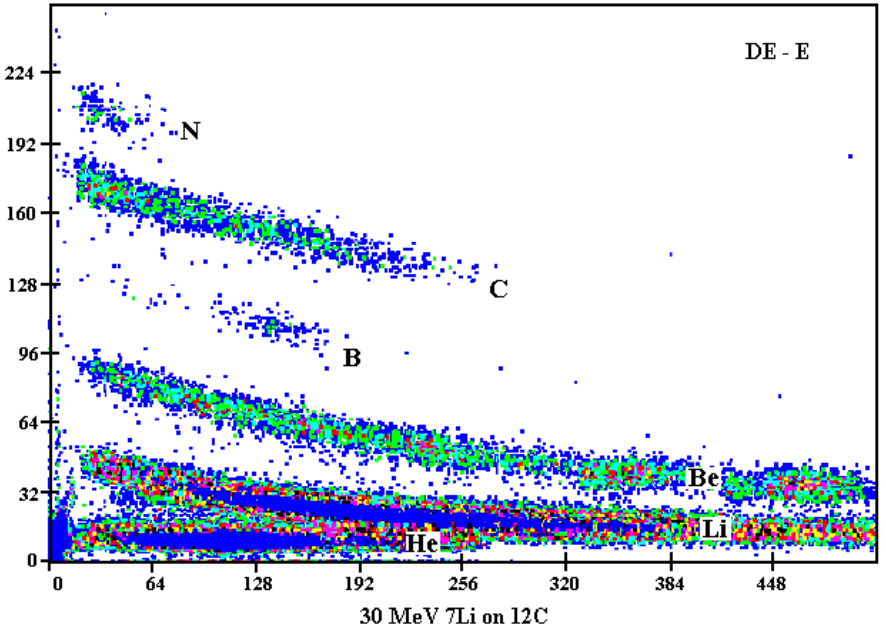

M_Z_ECHK
Z (Channel no.)
M (Channel no.)
192
229
265
302
338
375
411
448
0
31
63
94
126
158
189
221
28,29Si
30Si
6144
5120
4096
3072
2048
1024
256
128
64
32
16
8
4
2
1
0

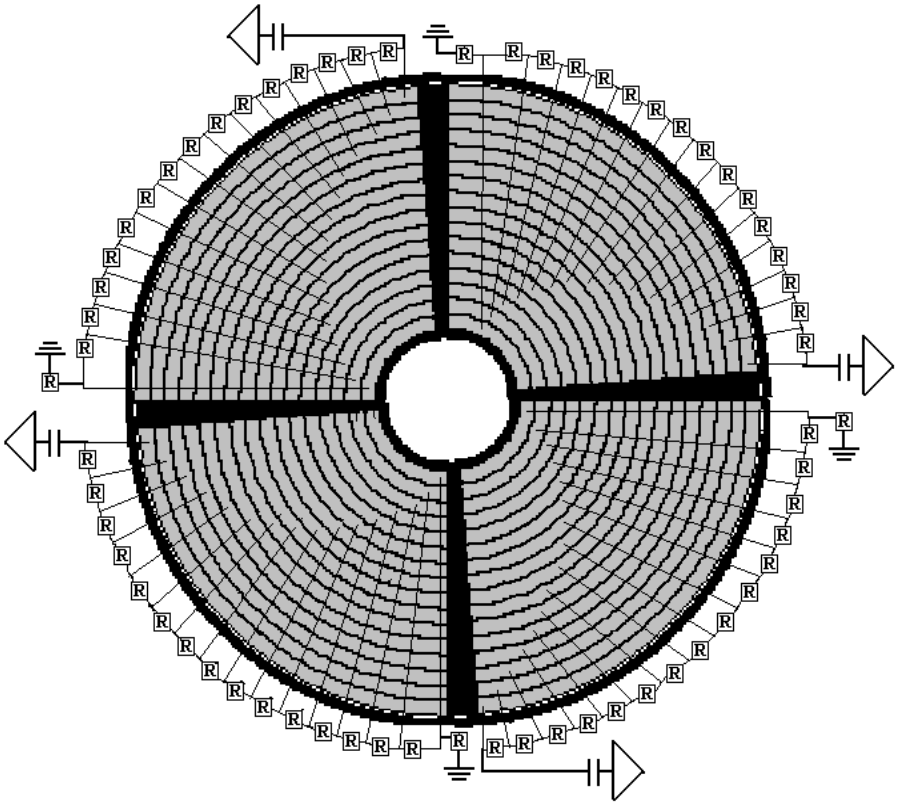




DETECTOR SYSTEM

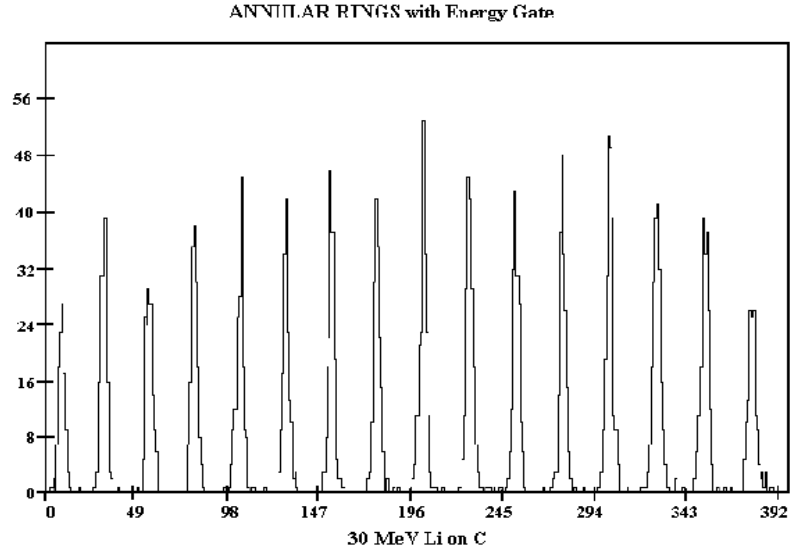






Schematic of the resistive charge division readout for the rings in front side

Akhil Jhingan et al
NIM A 539 (2005) 269



HYTAR in NAND & GPSC

The detector system is composed of **Sixteen** hybrid telescopes having a gas ionization chamber (IC) followed by a Silicon detector.

The IC provides differential energy loss △E signals used for nuclear charge or Z identification. Silicon detector acts as a stopping detector and provides the residual energy.

Detectors grouped in three parts :

Four detectors in a **ring** at 173 degree

Eight detectors placed in an **arc** from 165-95 degree on one arm of NAND

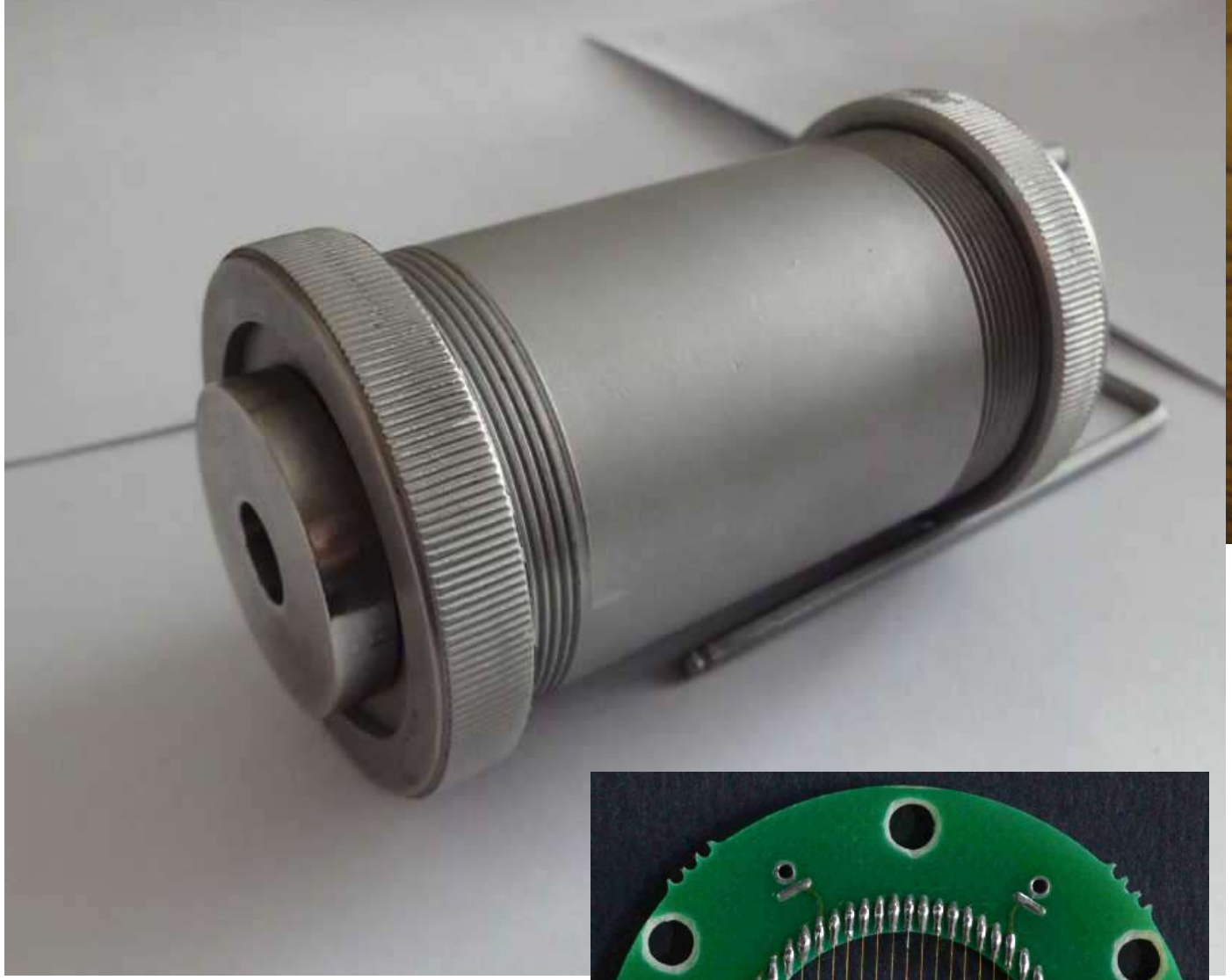
Four detectors placed at 90-60 degree on second arm of NAND

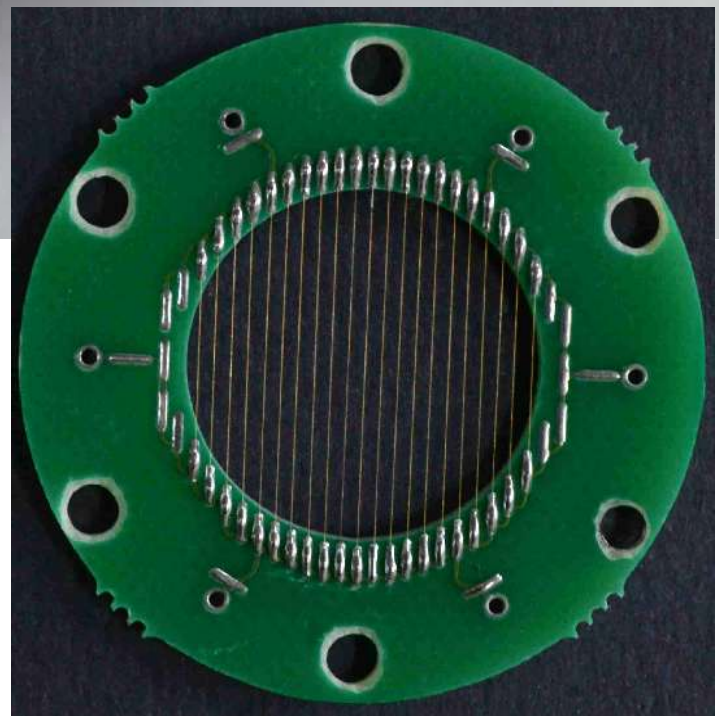
Ionization Chamber

Axial or longitudnal field geometry
Three Electrode Geometry : Central Anode sandwiched between two Cathodes
Central Anode : Gives the energy signal
Two Cathodes : Grounded
Active area ~ 450 sq. mm (25 mm diameter)
All electrodes made from Gold plated Tungsten wires stretched on 1.6/3.2 mm PCB
Wire Diameter : 20μm
Wire pitch : 1 mm
Wire frame separation – 9 mm
Active depth : 18 mm
Entrance window --- 0.9 μm mylar foil

Operating gas : Isobutane gas
Pressure : 100 mbar
100 mbar isobutane @ 18mm length = 2.5 μm Silicon thickness

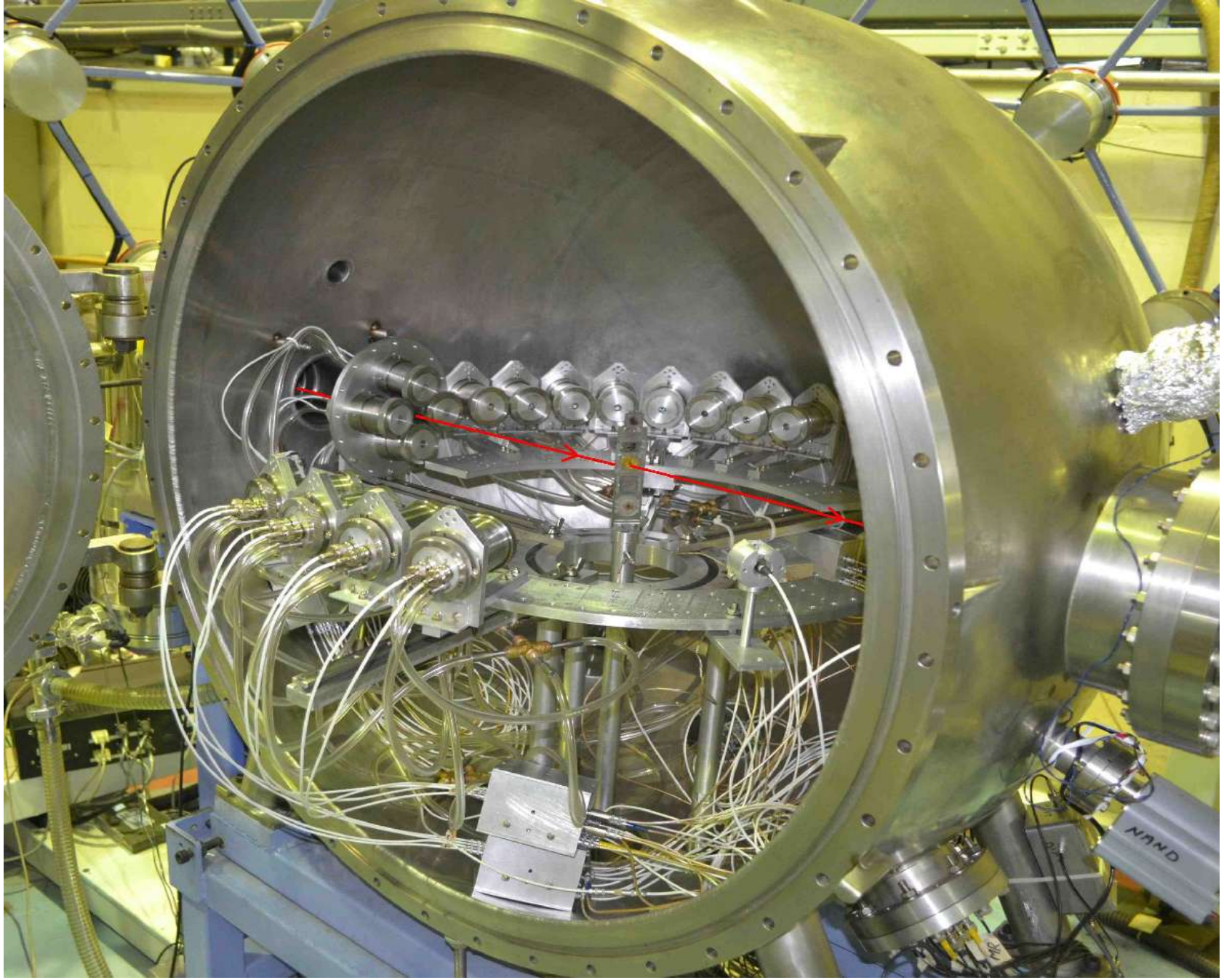
Fields : 2V/mbar





Various parts of
Hybrid telescope

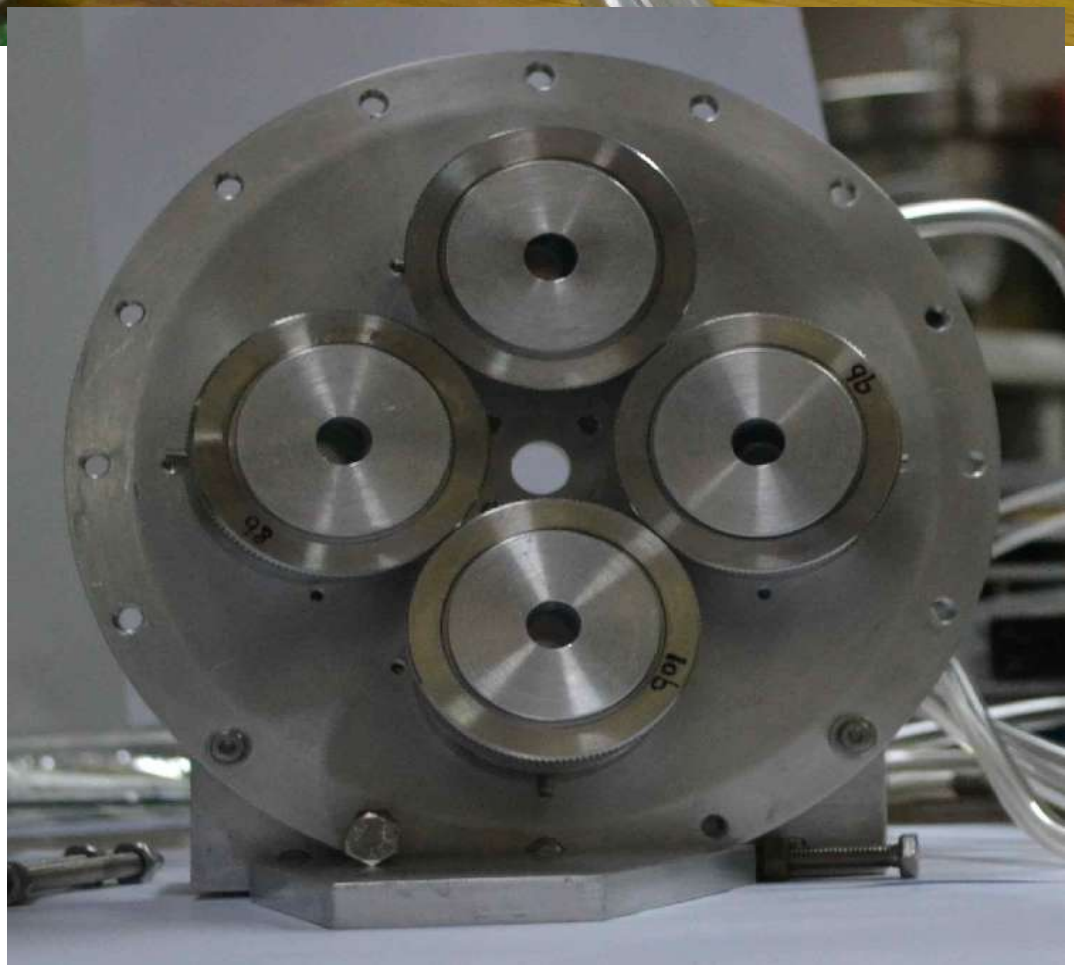
Setup for quasi-elastic scattering and angular/barrier distribution 2014

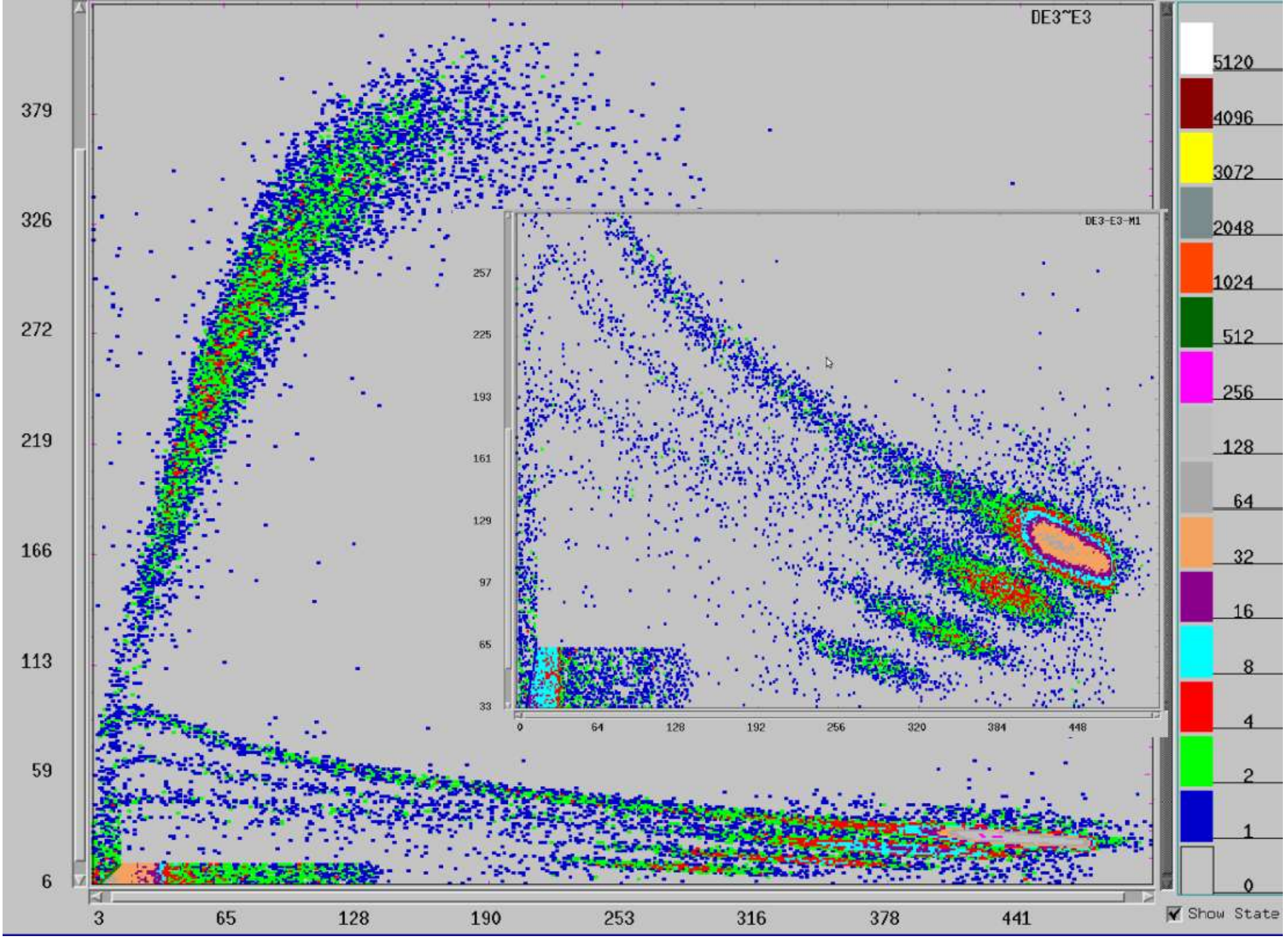


HYTAR in NAND

Quasi-elastic scattering measurements for $^{48}Ti+^{232}Th$ leading to super-heavy element $^{280}Cn_{112}$

Gurpreet et al, Proc. DAE-BRNS Symp. on Nucl. Phys. 60 (2015)386


qb
qb
qb



$^{19}F + {}^{194,196,198}Pt$ Varinderjit Singh et al (to be communicated to PRC)

Annular PPAC

Coulomb excitation, transfer reactions, fission reactions, ER detector

Features

Design Inspired by the Annular PPAC of GSI, Germany used for Coulomb Excitation
Position Sensitive in Theta and Phi
Two Electrode geometry,
Cathode (Aluminized Mylar- 2 micron thick) for Phi (azimuthal angles), Anode(PCB) for theta (polar angles)
OD – 25cm ID – 5cm, Active area ~ 420 sq.cm
Theta coverage 15^{O} to 45^{O} , Segmented in two halves, Delay line readout (40 rings) with 2.54mm pitch
Phi Resolution (22.5^{O}) – 16 segments
Total 20 readouts : 4 for anode(delay line) and 16 for cathodes

COULEX Experiments at IUAC

IUAC (India) – GSI (Germany) – RIKKEN (Japan) – POLAND collaboration

Rakesh Kumar (Spokesperson) – IUAC

H. J. Wollersheim – GSI

Pieter Doornebal – RIKKEN

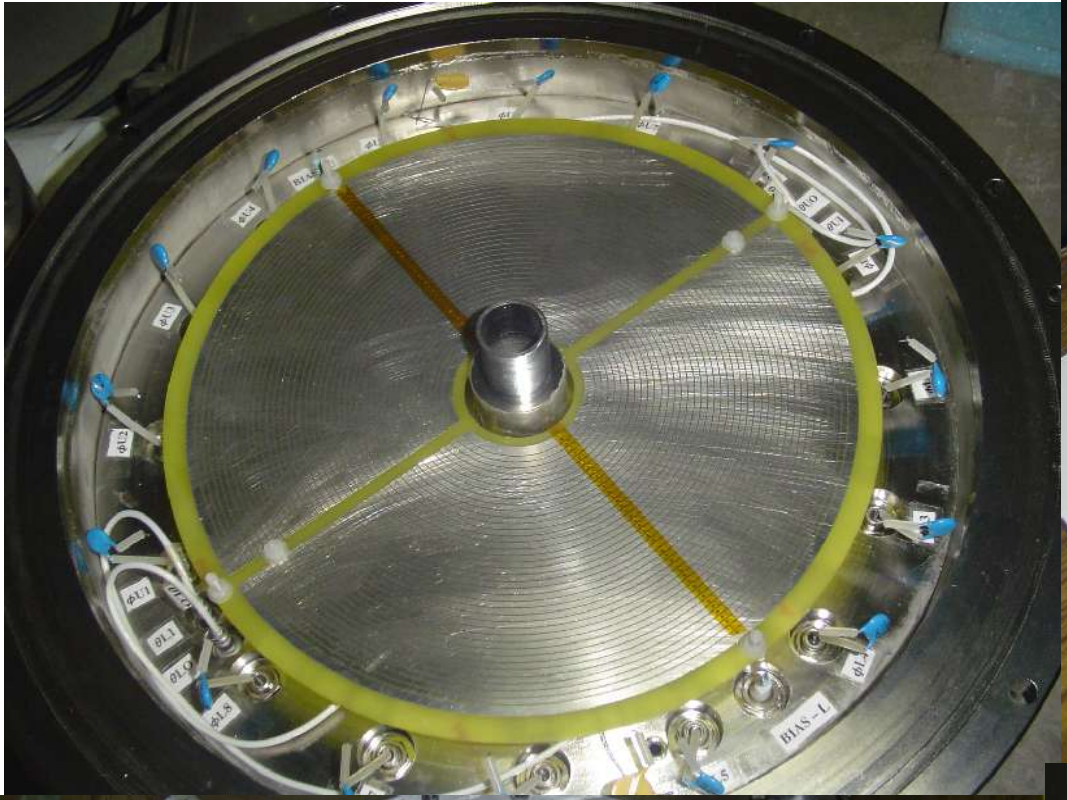
P. Napiorkowski – (Warsaw, Poland)

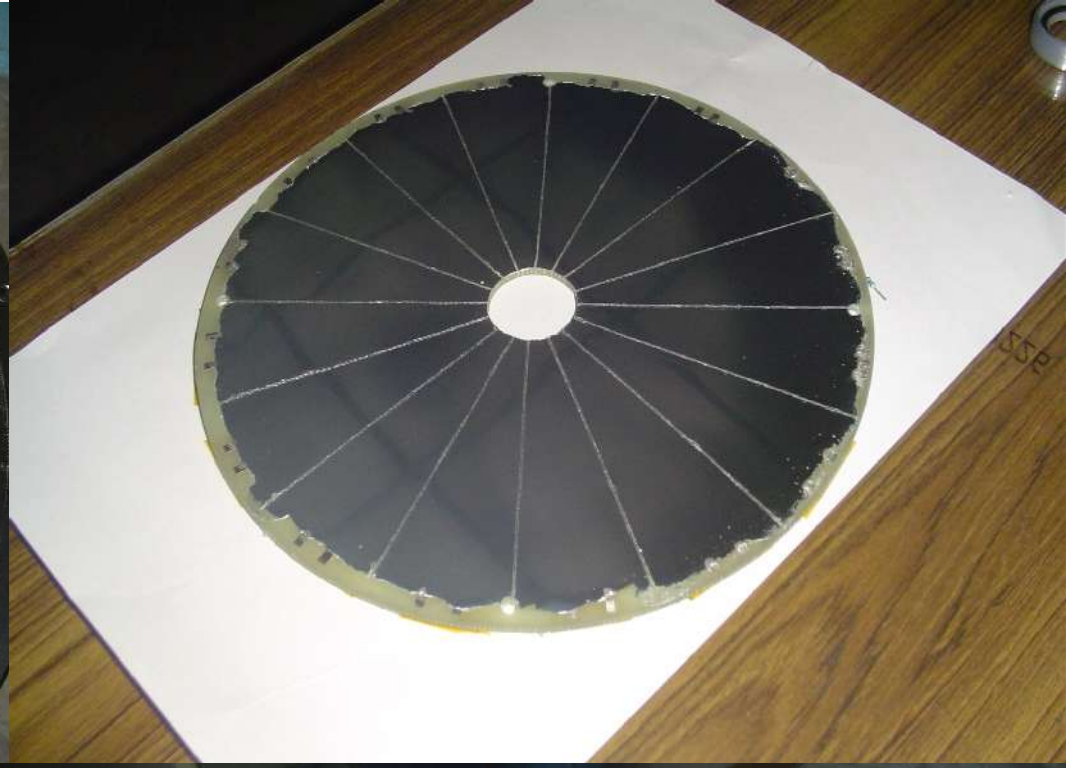
Experiments : Study of B(E2) transitions in :

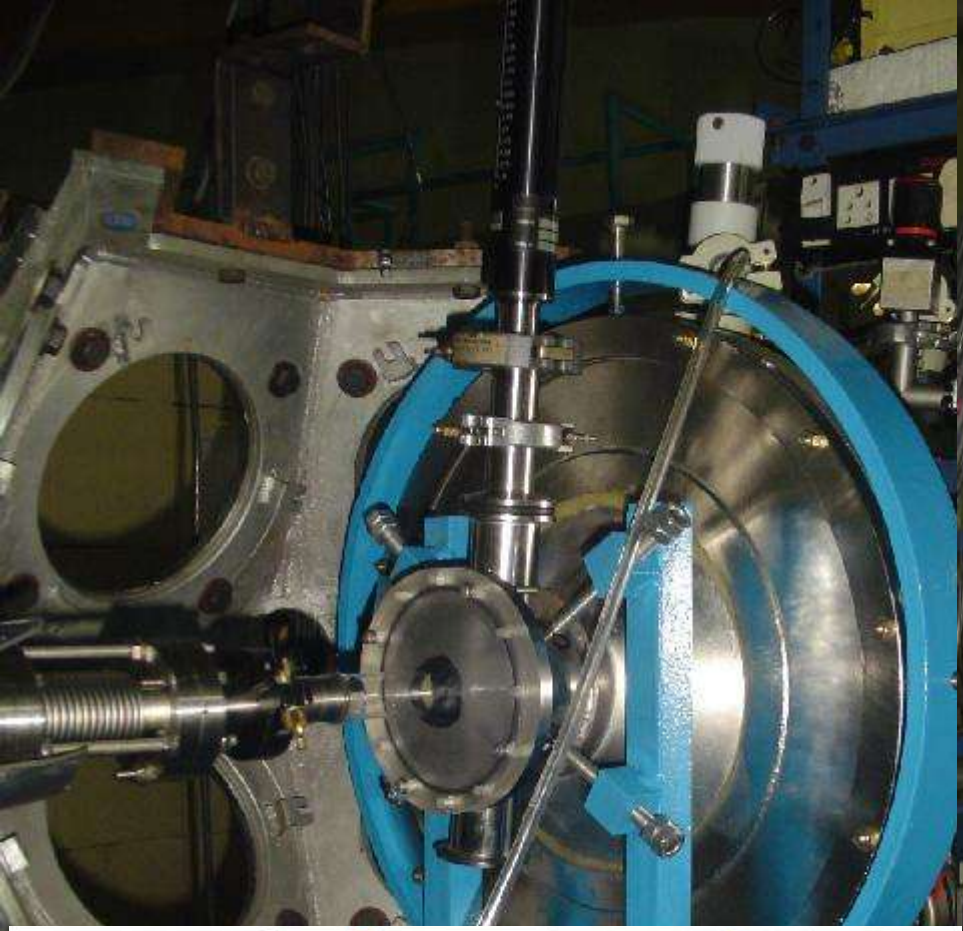
^{58}Ni + ^{114,116,118,120,122,124}Sn @ 175 MeV 58Ni

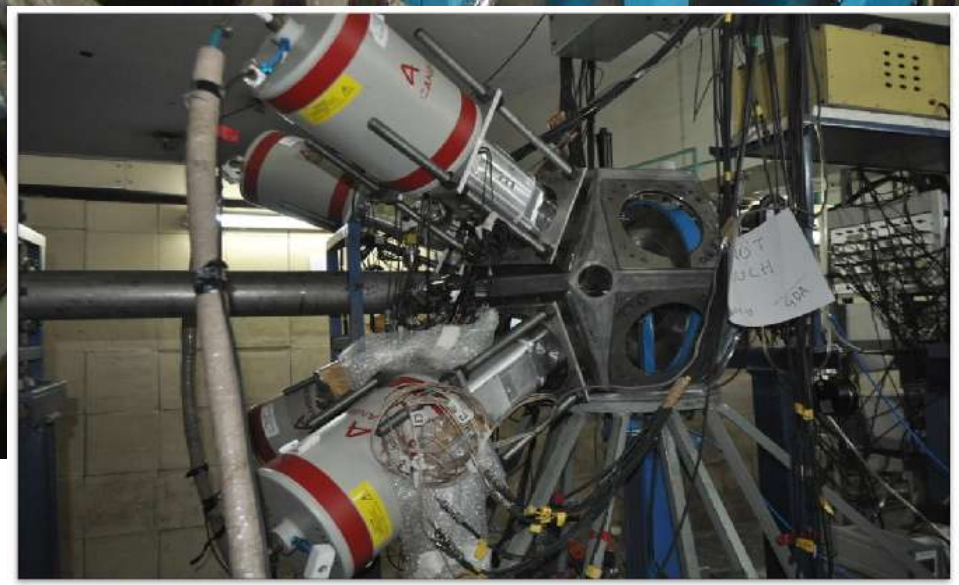
^{58}Ni + ^{122,124}Te @ 175 MeV 58Ni

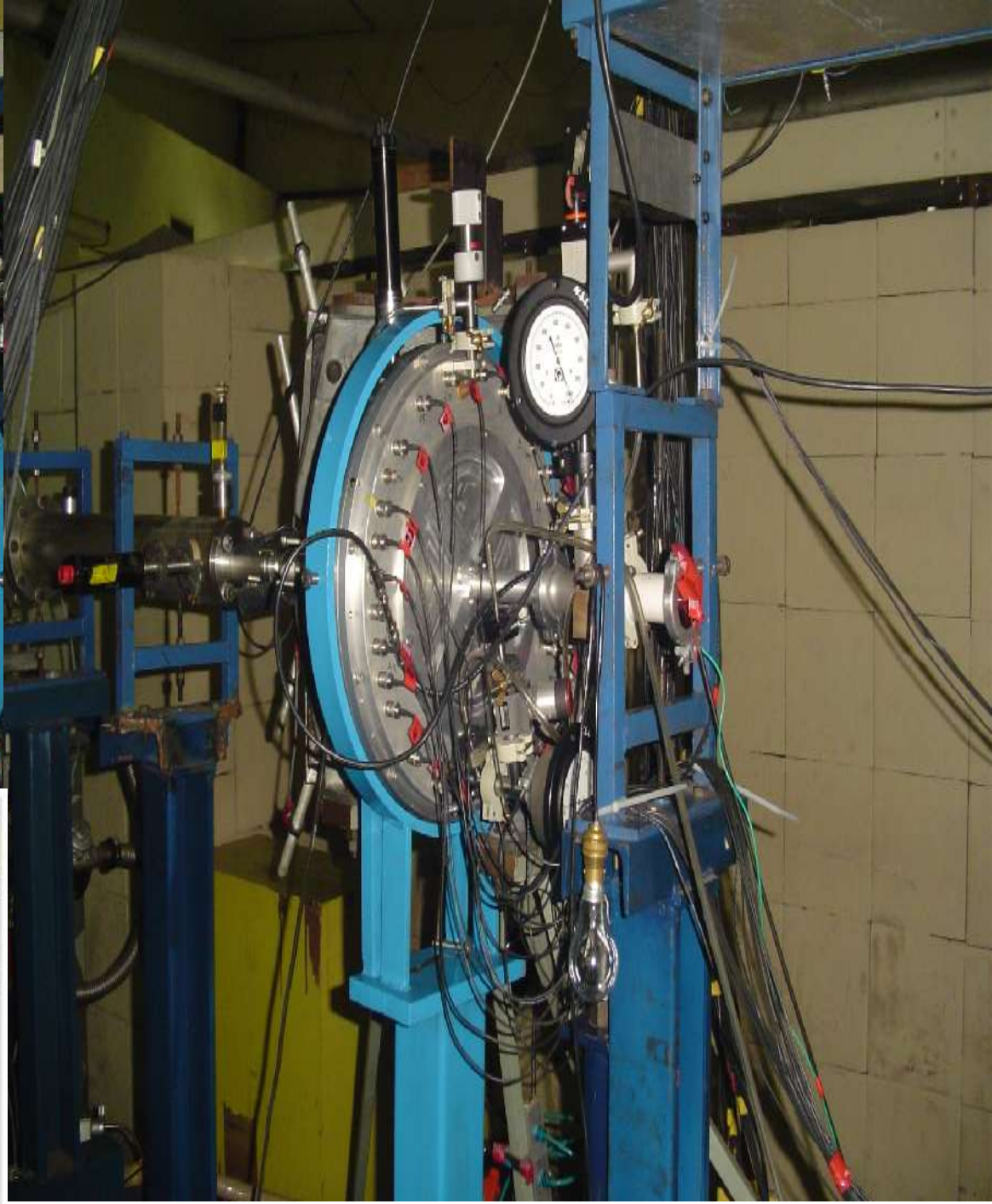
^{58}Ni + ^{132}Ba @ 175 MeV 58Ni


BIAS-L

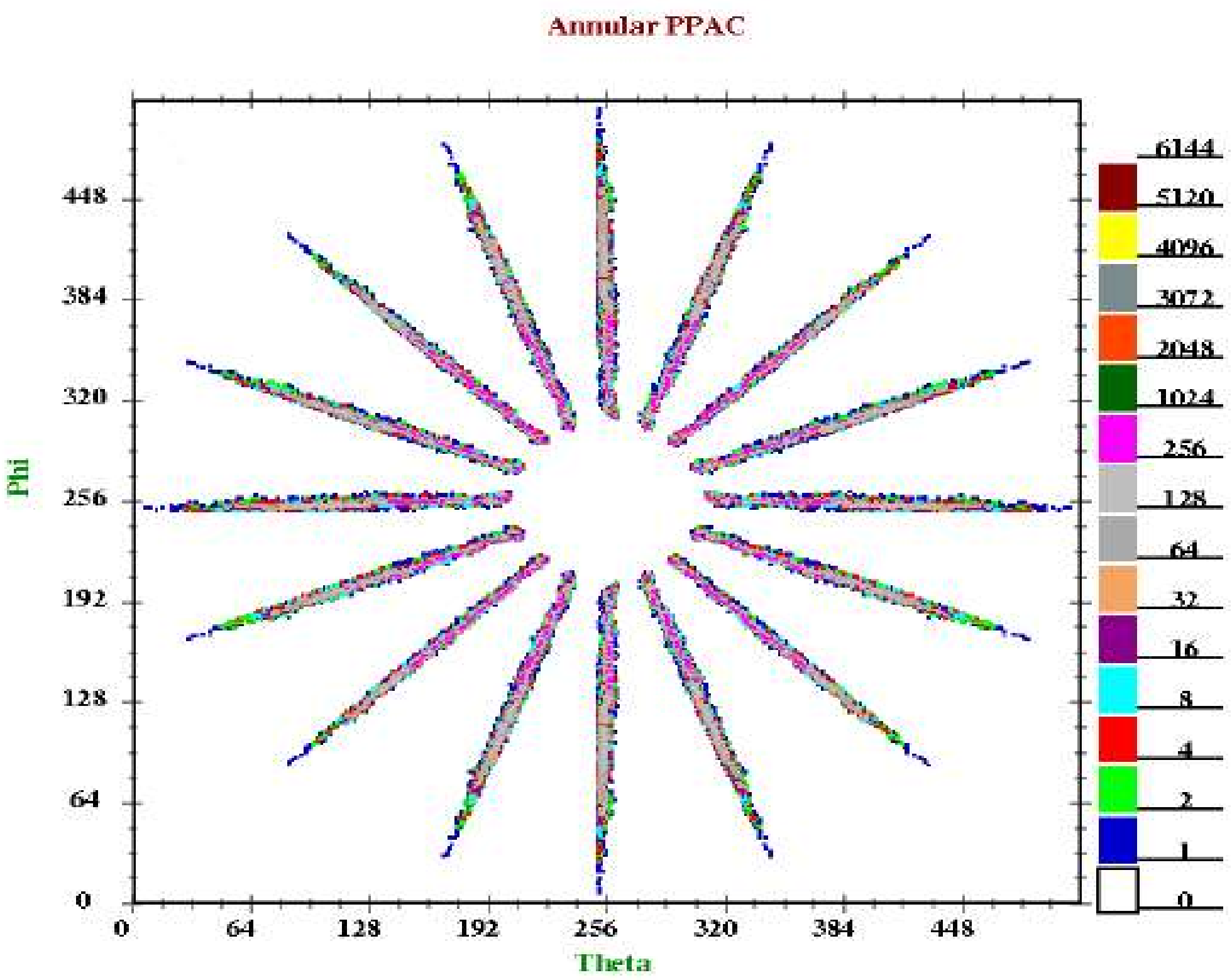


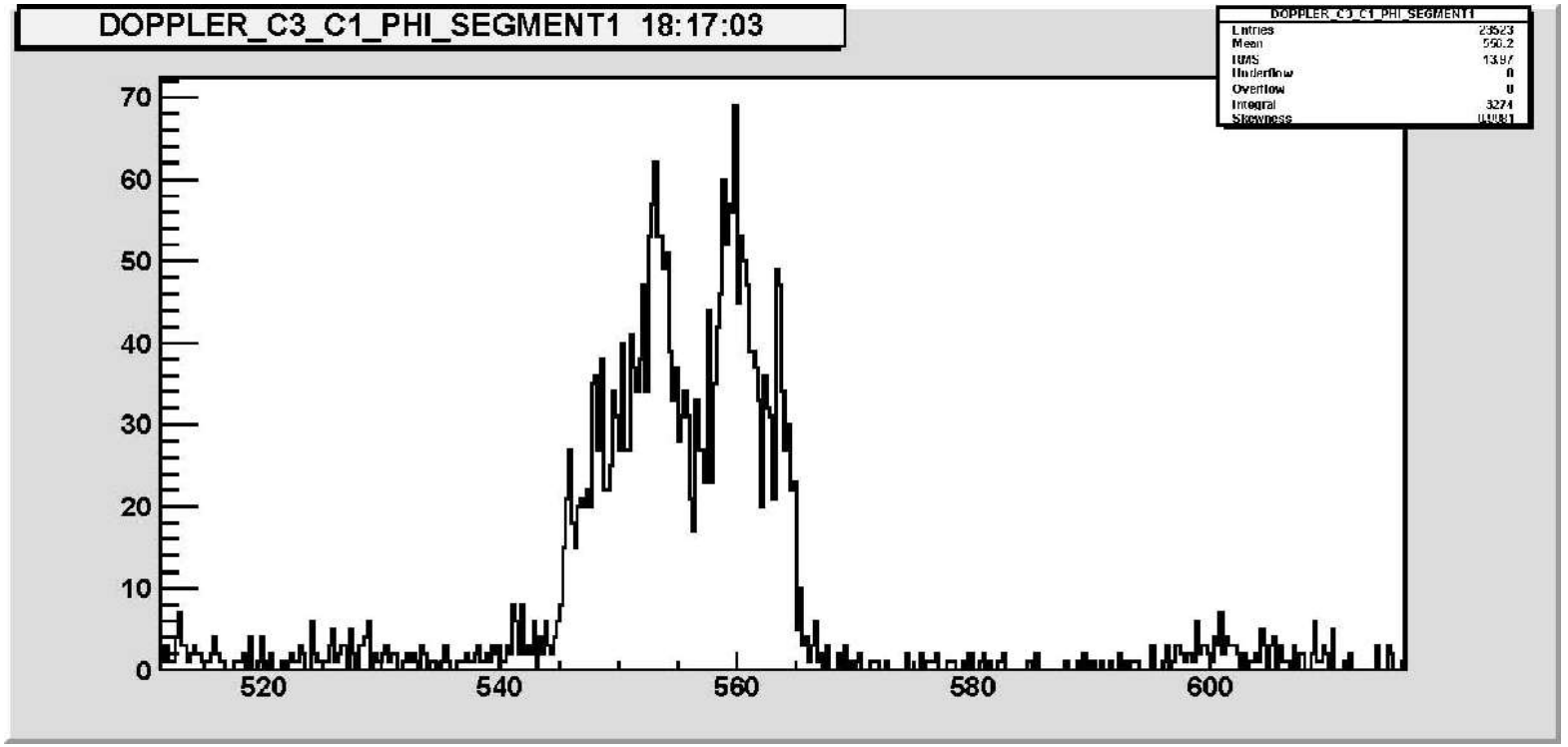


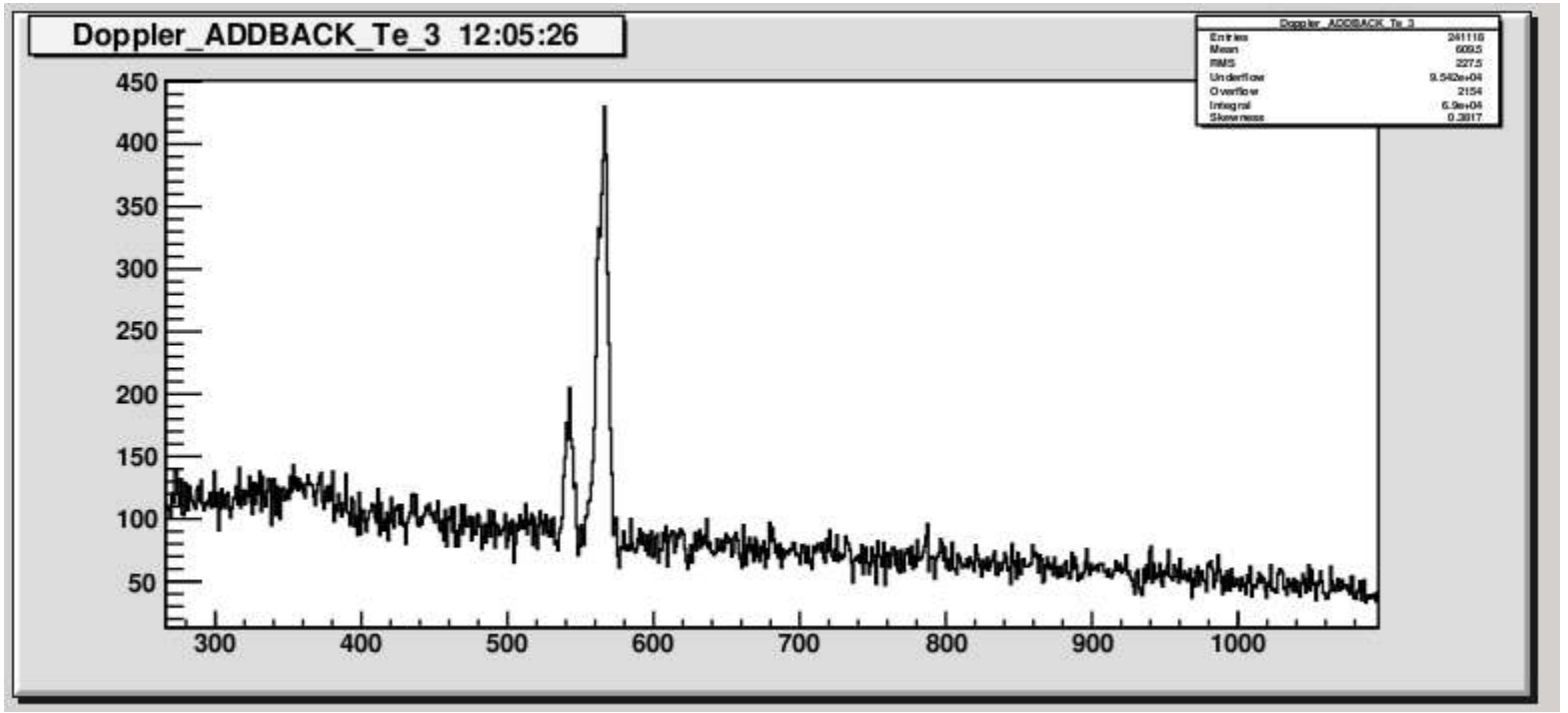




Coulex set up at GDA, IUAC


Annular PPAC
Phi
Theta
0
64
128
192
256
320
384
448
6144
5120
4096
3072
2048
1024
256
128
64
32
16
8
4
2
1
0


DOPPLER_C3_C1_PHI_SEGMENT1 18:17:03
DOPPLER_C3_C1_PHI_SEGMENT1
Entries 28523
Mean 550.2
RMS 13.97
Underflow 0
Overflow 0
Integral 3274
Skewness 0.0081
70
60
50
40
30
20
10
0
520
540
560
580
600


Doppler_ADDBACK_Te_3 12:05:26
Doppler_ADDBACK_Te_3
Entries 241116
Mean 609.5
RMS 227.5
Underflow 9.542e+04
Overflow 2154
Integral 6.9e+04
Skewness 0.2817
450
400
350
300
250
200
150
100
50
300
400
500
600
700
800
900
1000

Charged particle multiplicity set up in GPSC

Fission gated charged particle multiplicity for the system

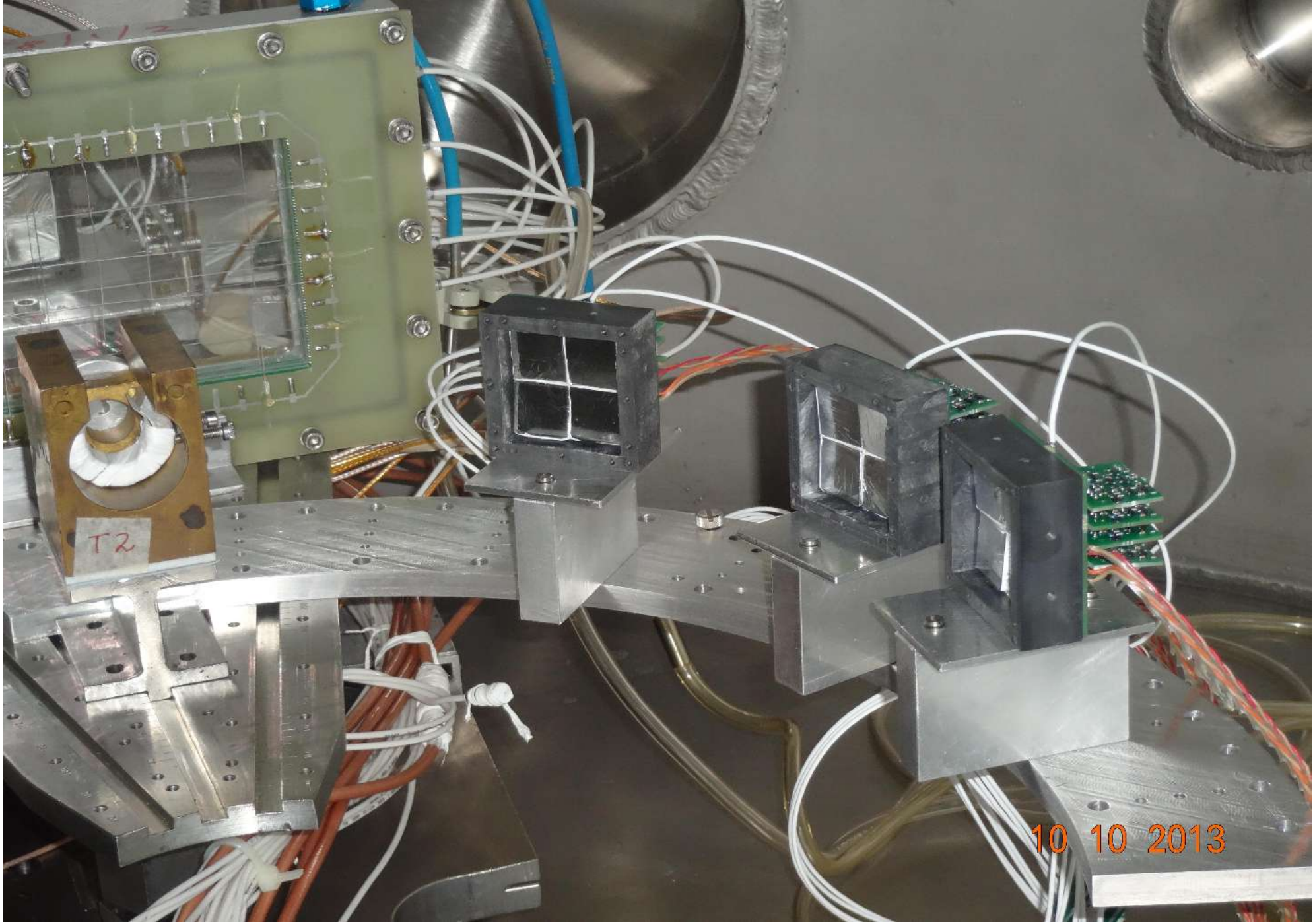
$^{16}O + {}^{196}Pt$

Two MWPC, 16 CsI, 3 BC501 liquid scintillator

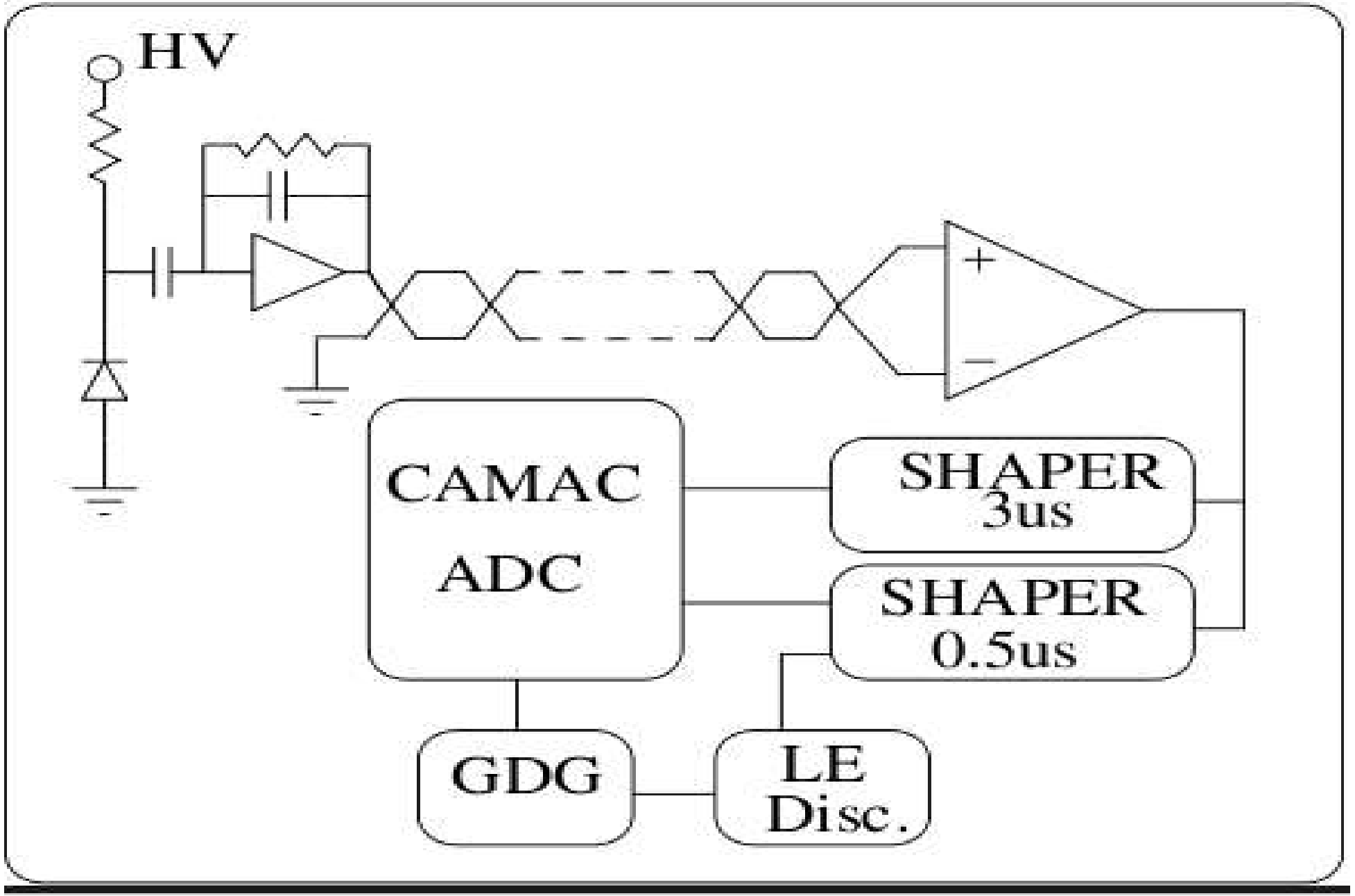
New sets of CSPA for CsI, daughter cards eliminated

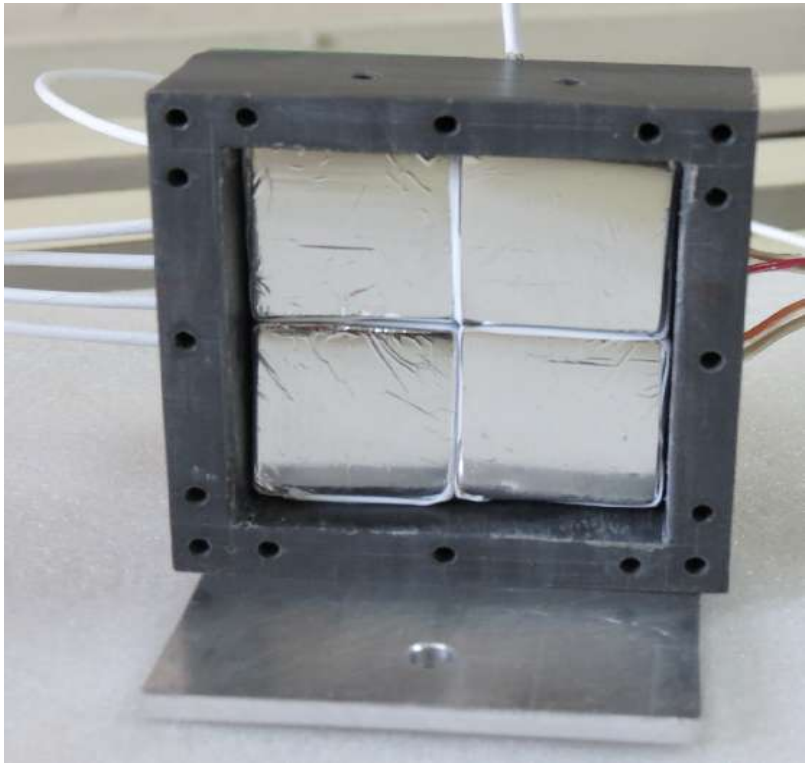
Size 1.6 cm x 1.6 cm

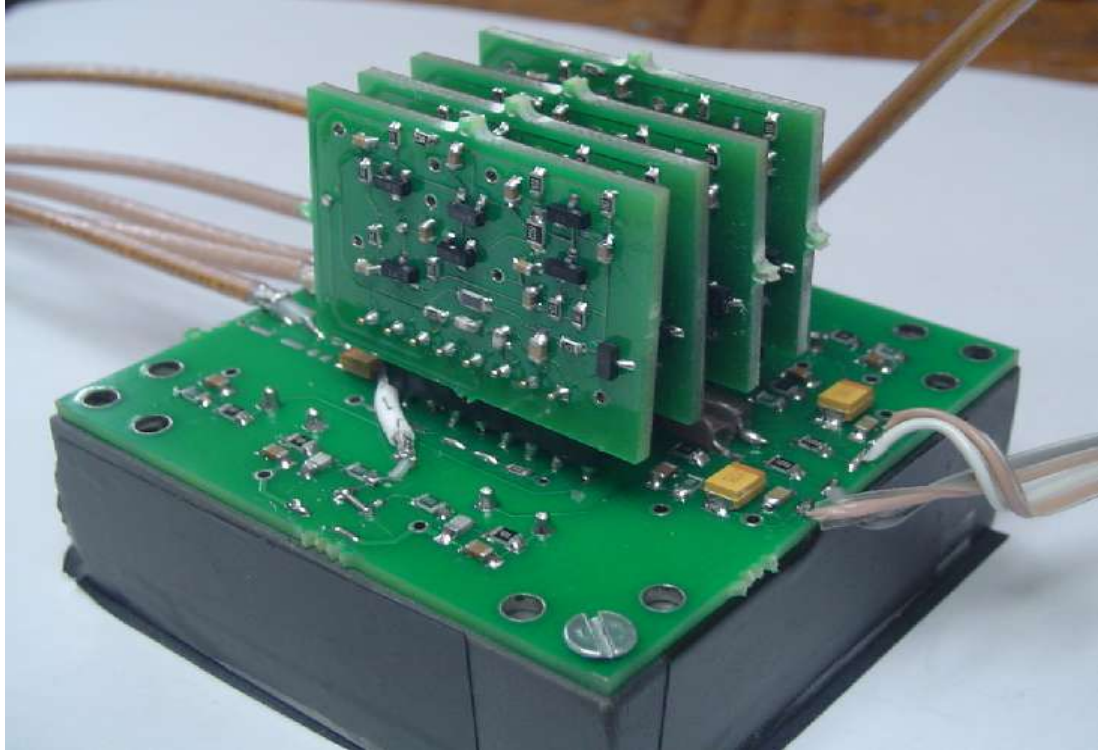
New sets of cables and feedthrough flange fabricated
Eliminates the need of lemo cables and lemo feedthroughs.

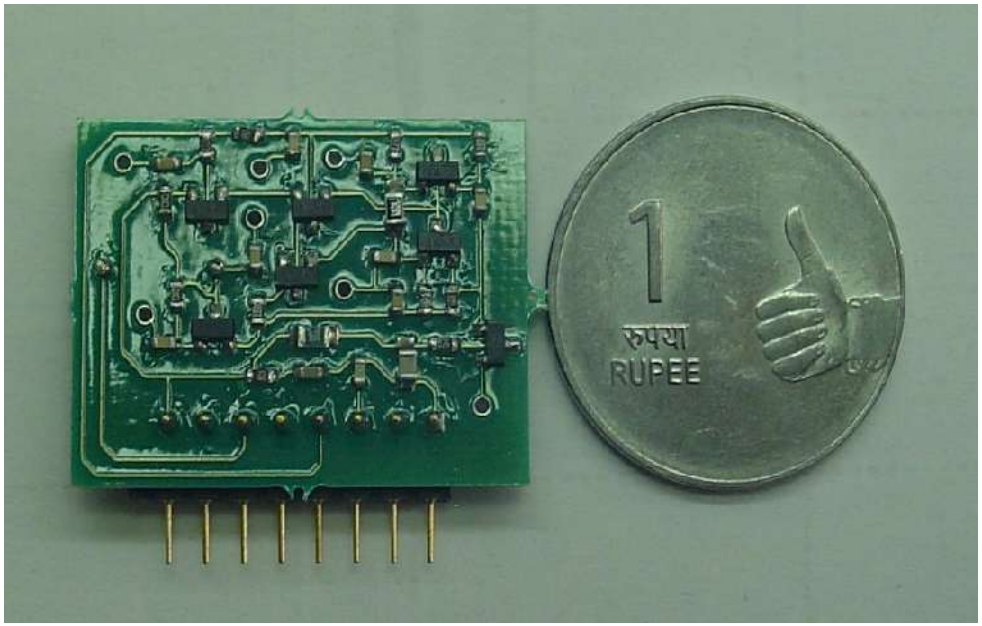


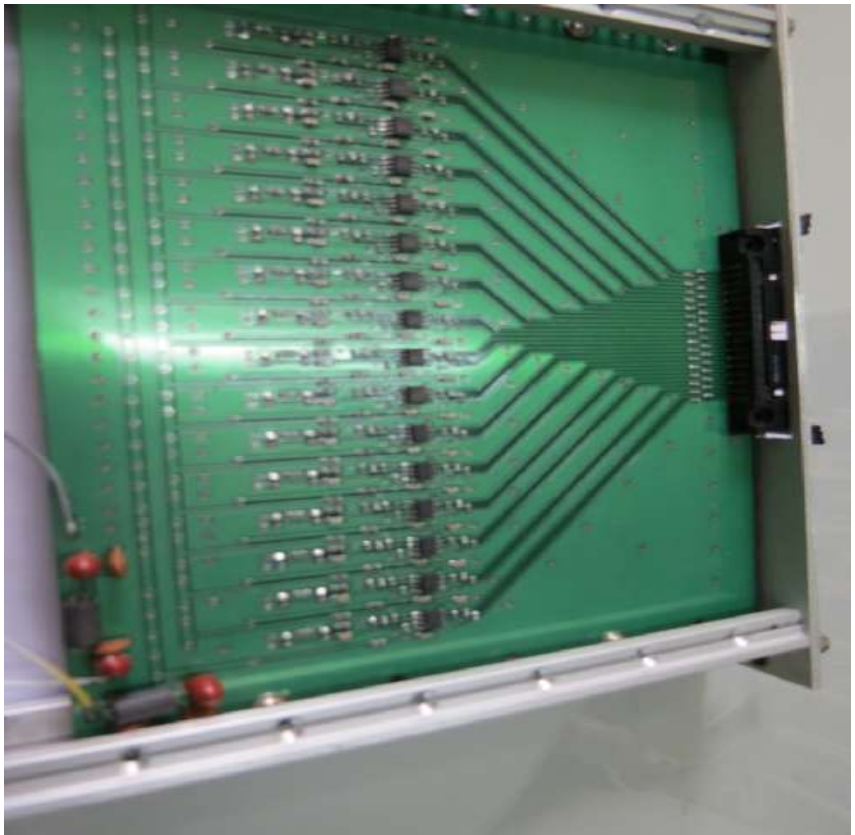
Set up for Pre-Scission charged particle Multiplicity experiment

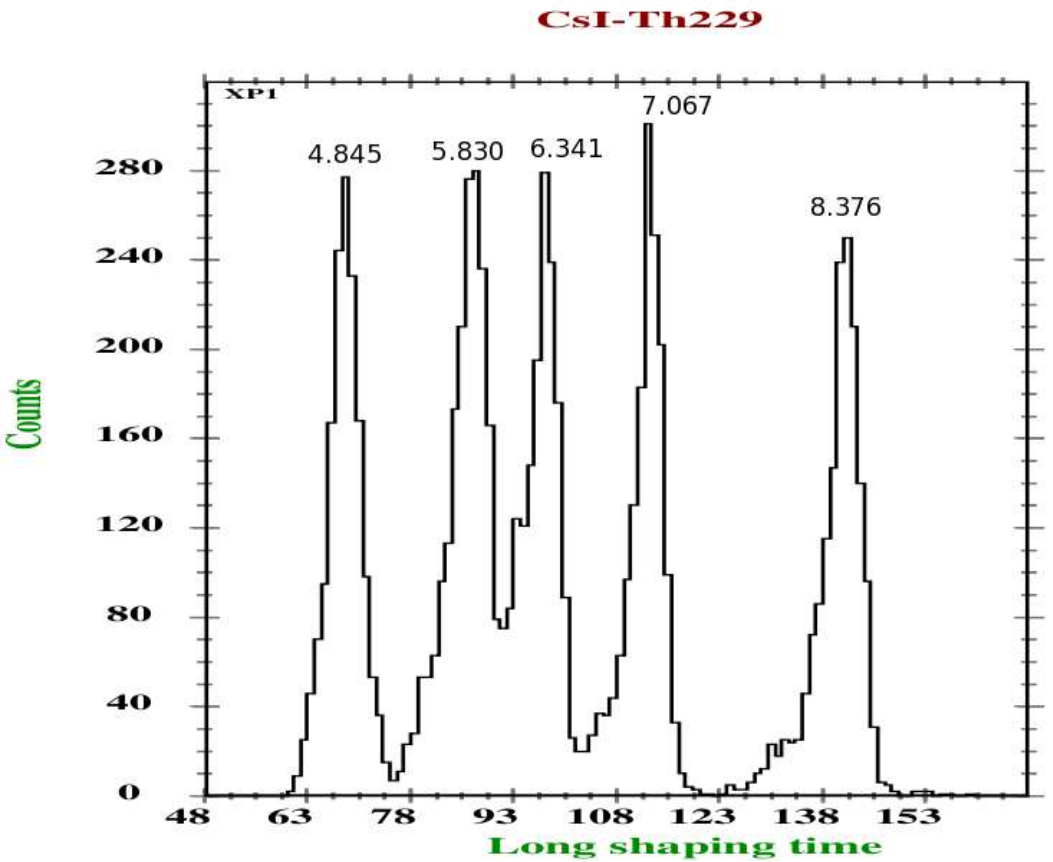

HV
+
−
CAMAC
ADC
SHAPER
3us
SHAPER
0.5us
GDG
LE
Disc.

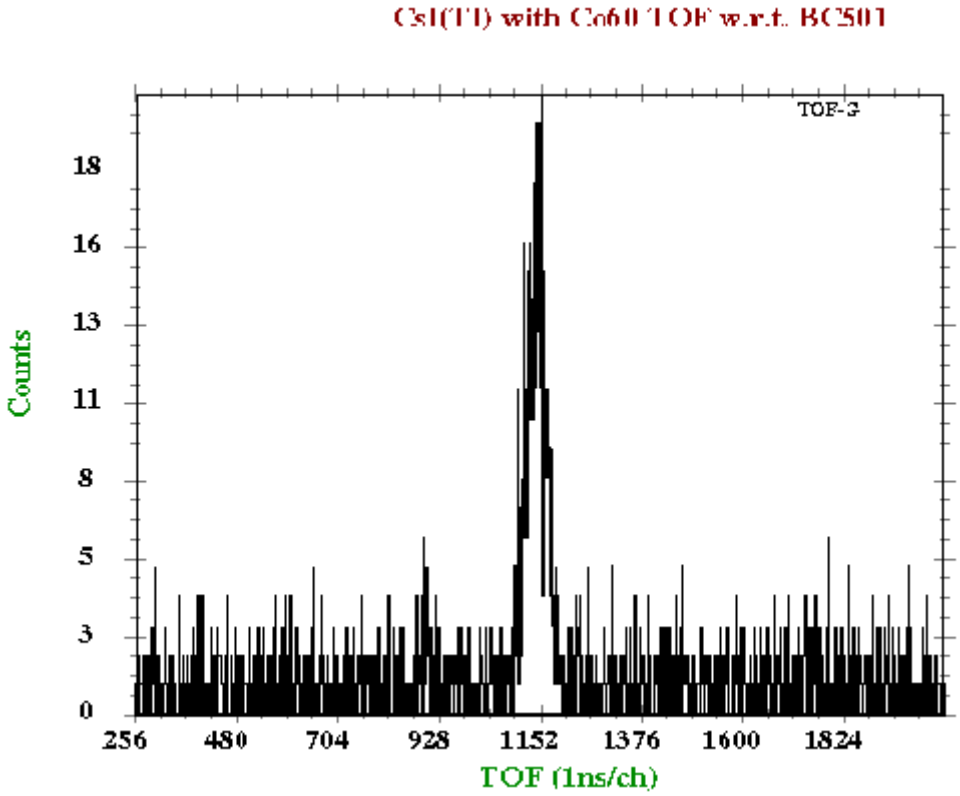


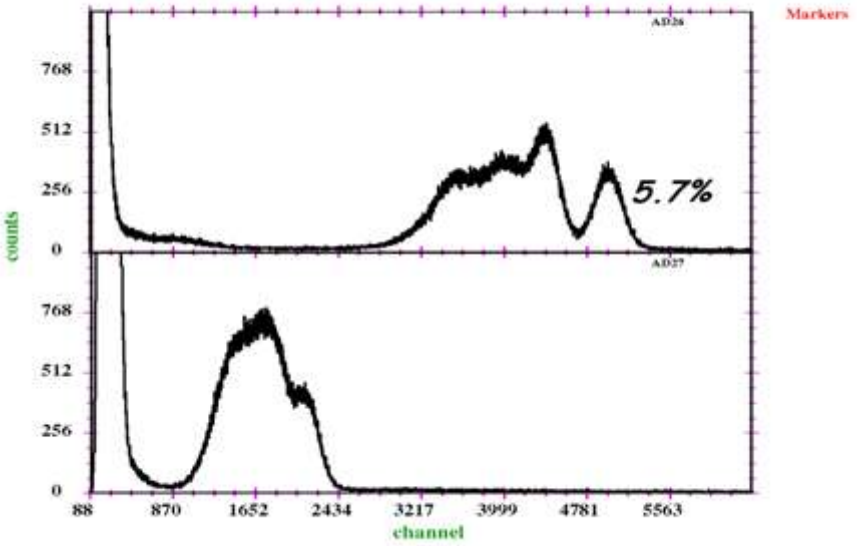


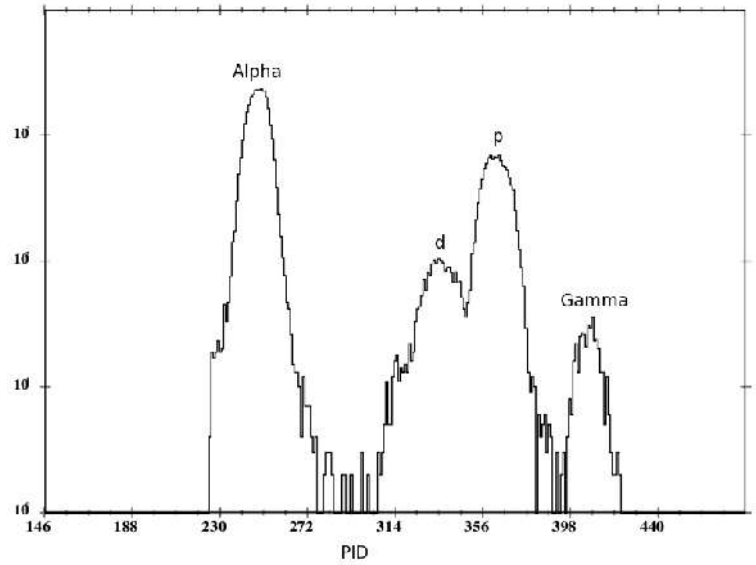

1
रुपया
RUPEE

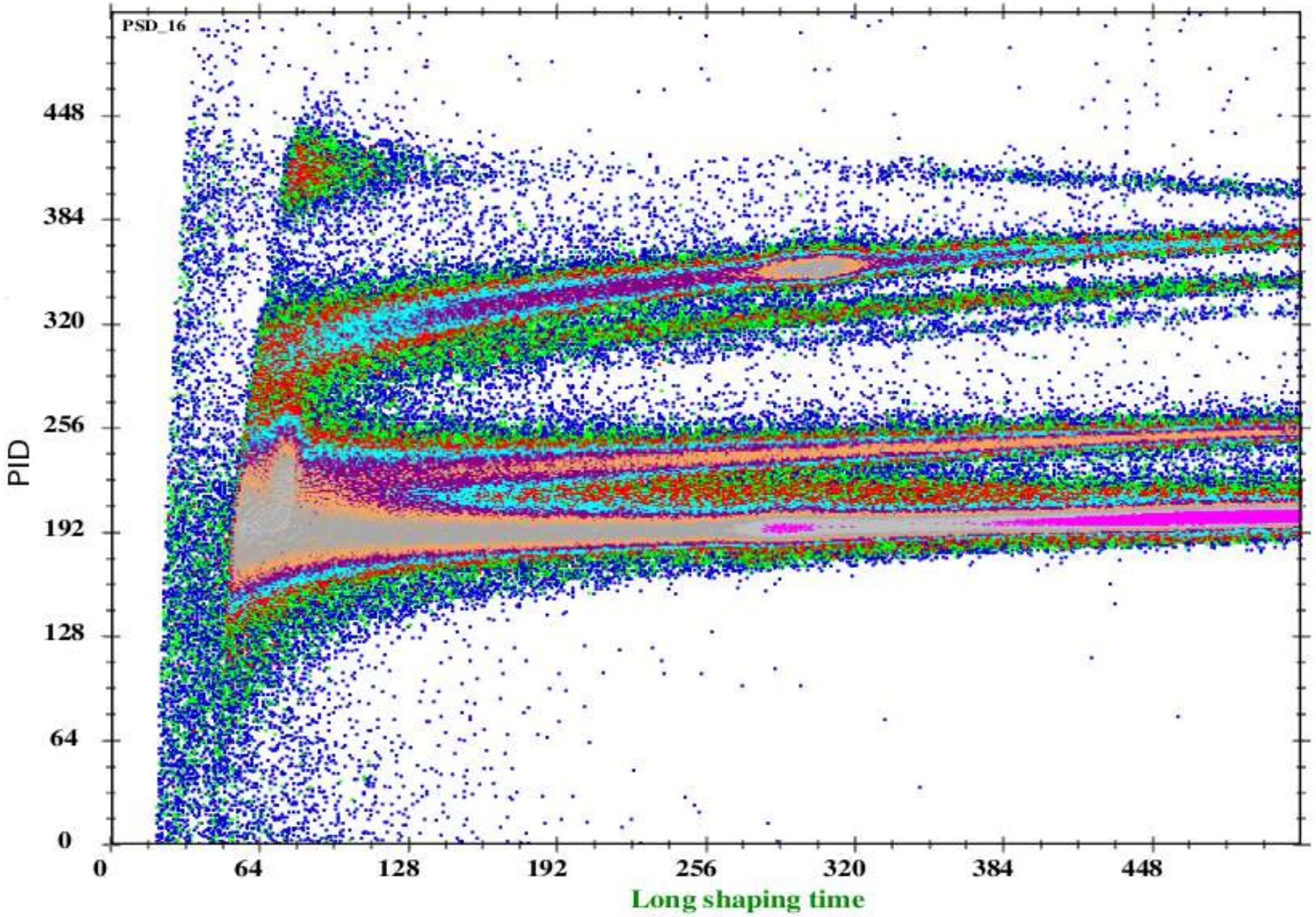


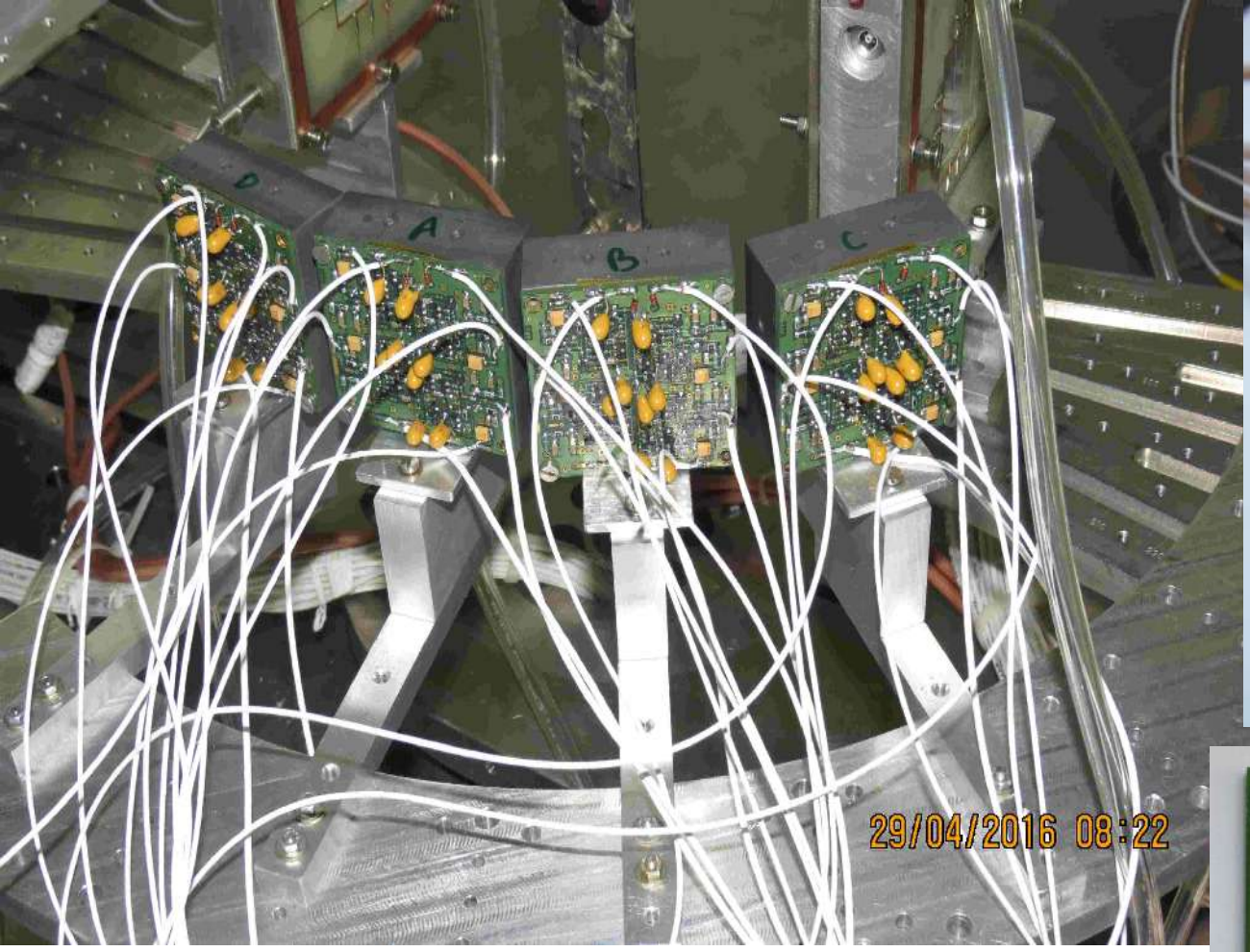

CsI-Th229
XP1
4.845
5.830
6.341
7.067
8.376
Counts
Long shaping time

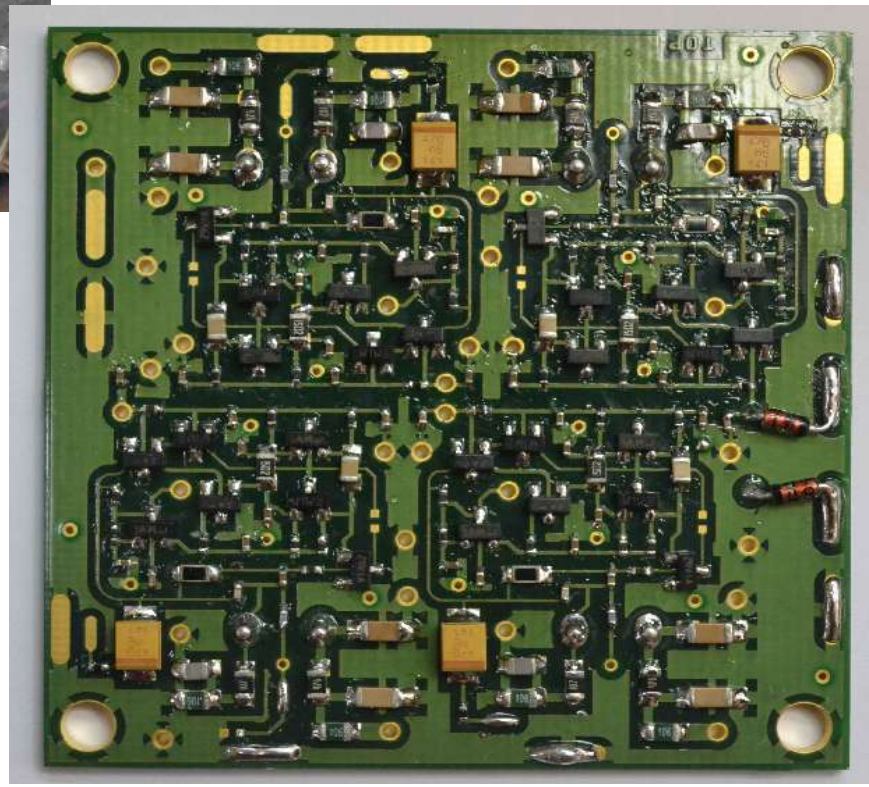

CsI(Tl) with Co60 TOF w.r.t. BC501
TOF-3
Counts
TOF (1ns/ch)


Markers
5.7%
counts
channel


Alpha
d
p
Gamma
PID

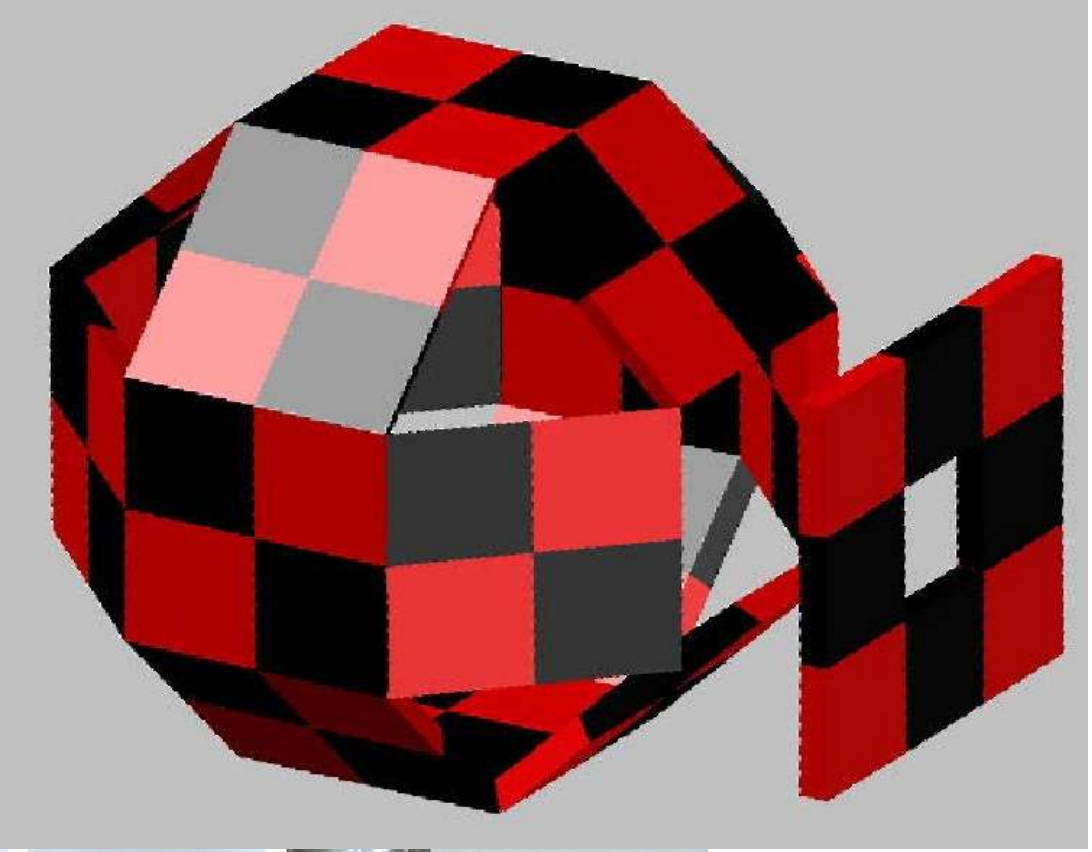

PSD_16
448
384
320
256
192
128
64
0
PID
0
64
128
192
256
320
384
448
Long shaping time

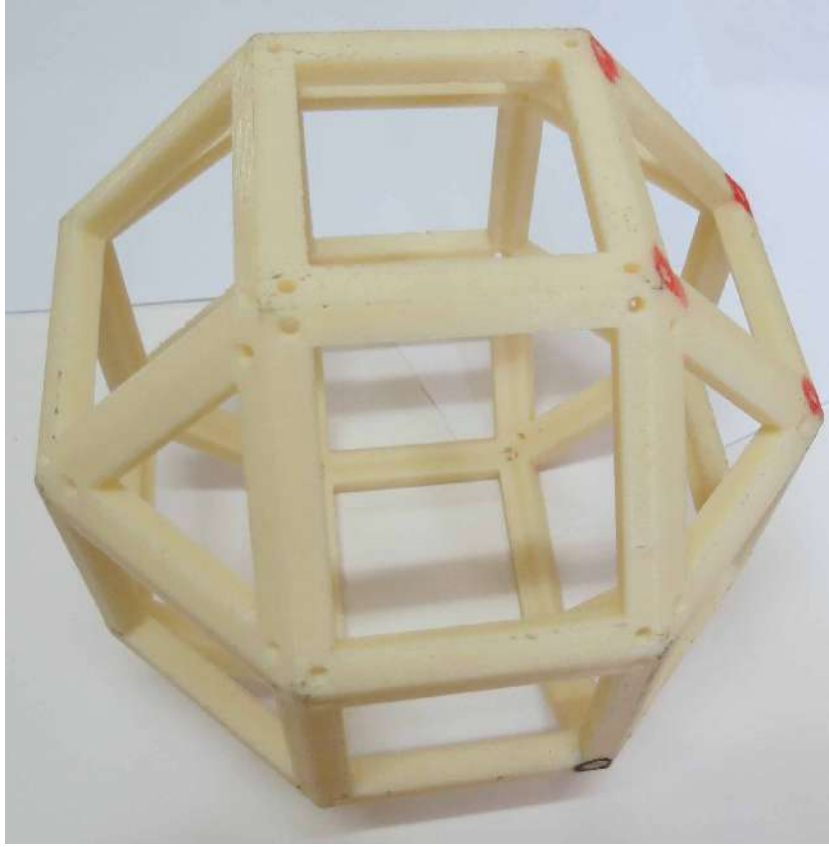




CSPA for CsI-photo-diode detectors
4 channels with bias ckt., test inputs
Area 5.5 x 5.5 cm2
Fabricated using 0402 Resistor/Capacitor

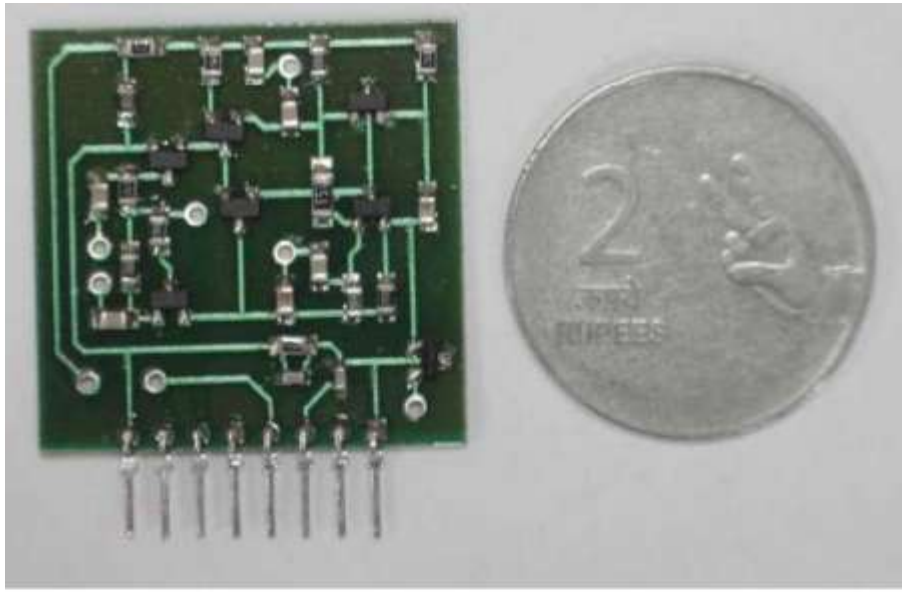
Detector target distance 15 cm

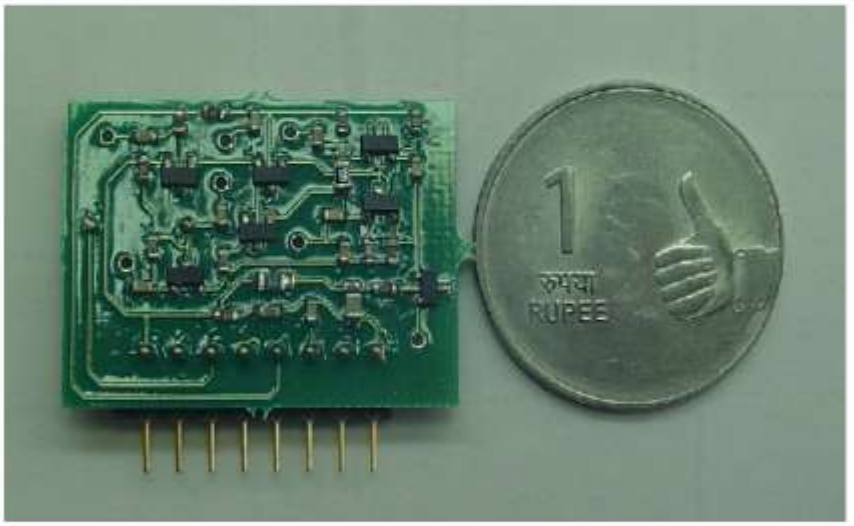


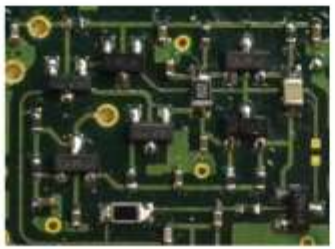


Proposed configuration of Rhombicuboctahedron
Structure for mounting CsI for NAND and INGA

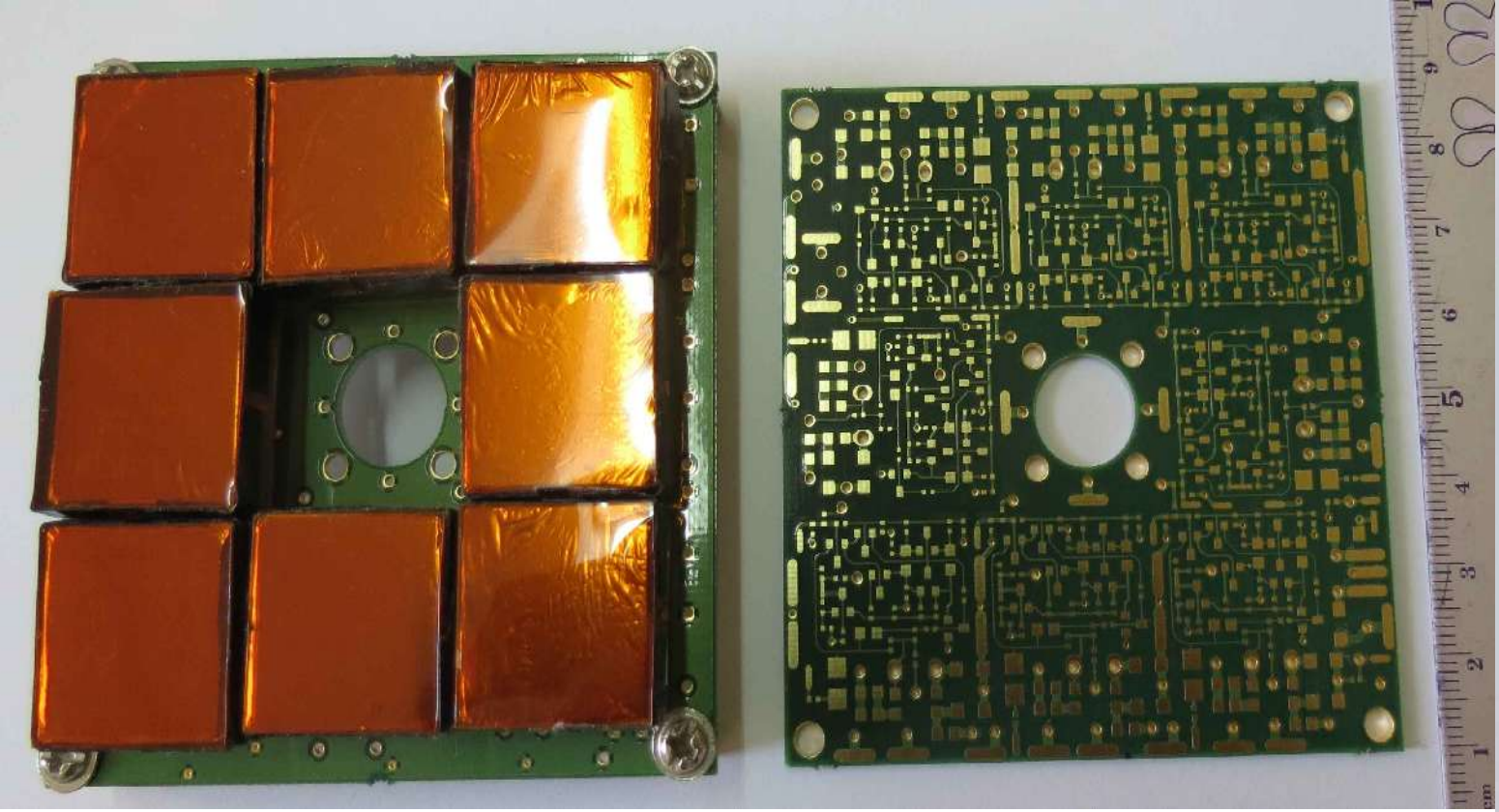
Similar to DIAMANT at GANIL

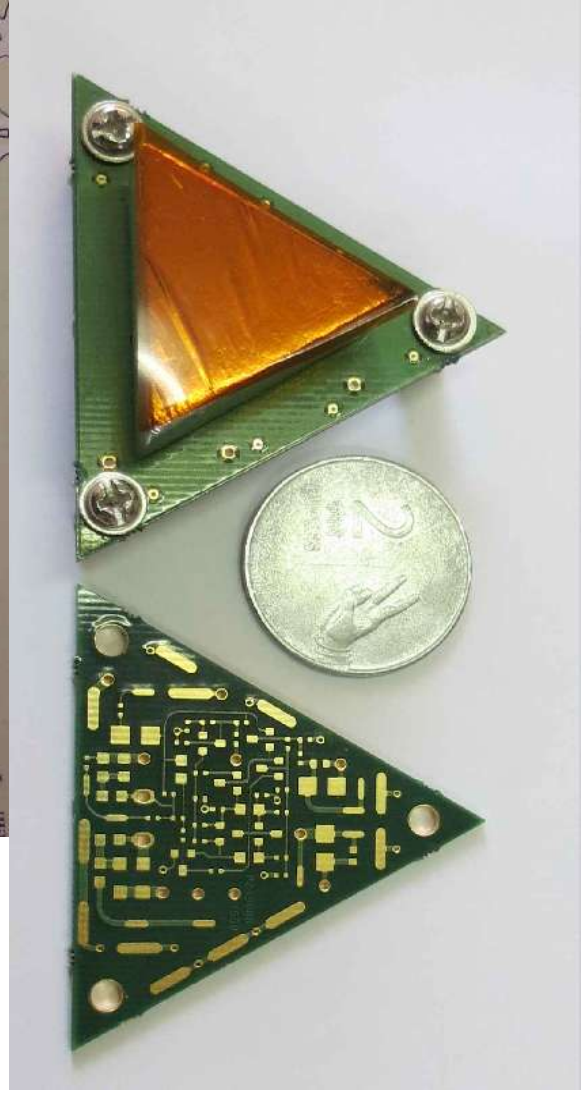


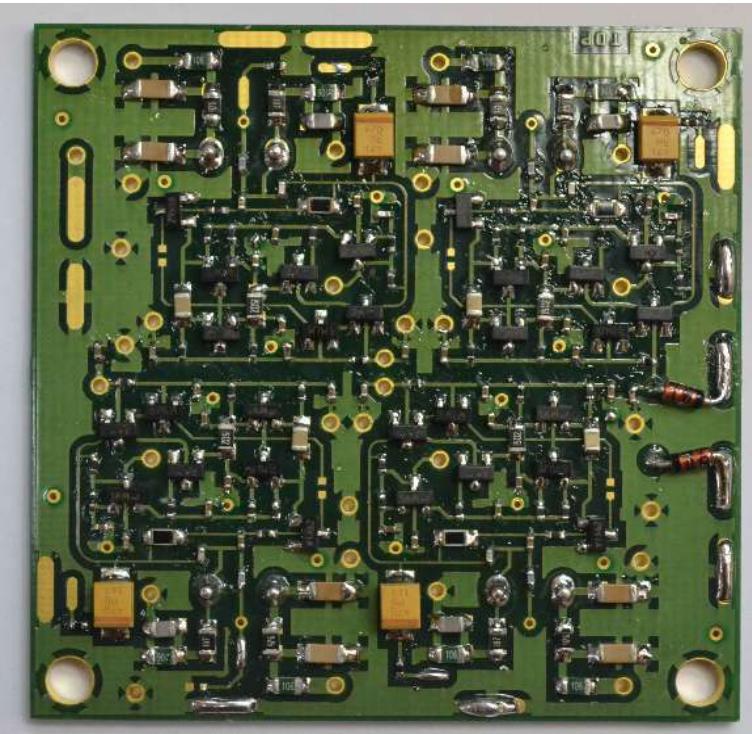




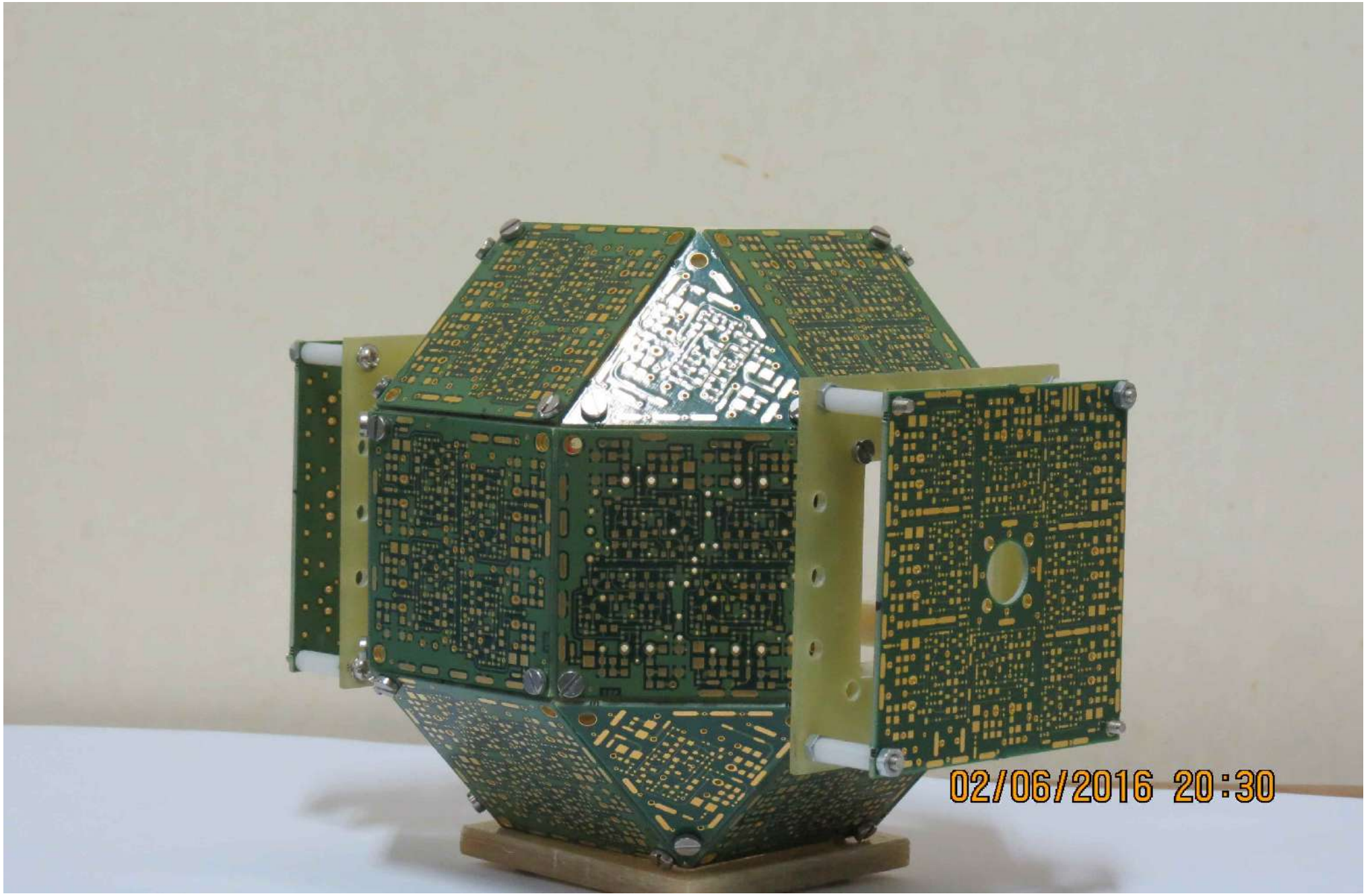
CSPA Hybrids







Assembly Config. of CsI coupled to Photo diode



Rhombicubeoctahedron structure for CsI

Front end electronics development for detectors

Developed by Electronics, Computer, Beam transport and INGA group

INGA

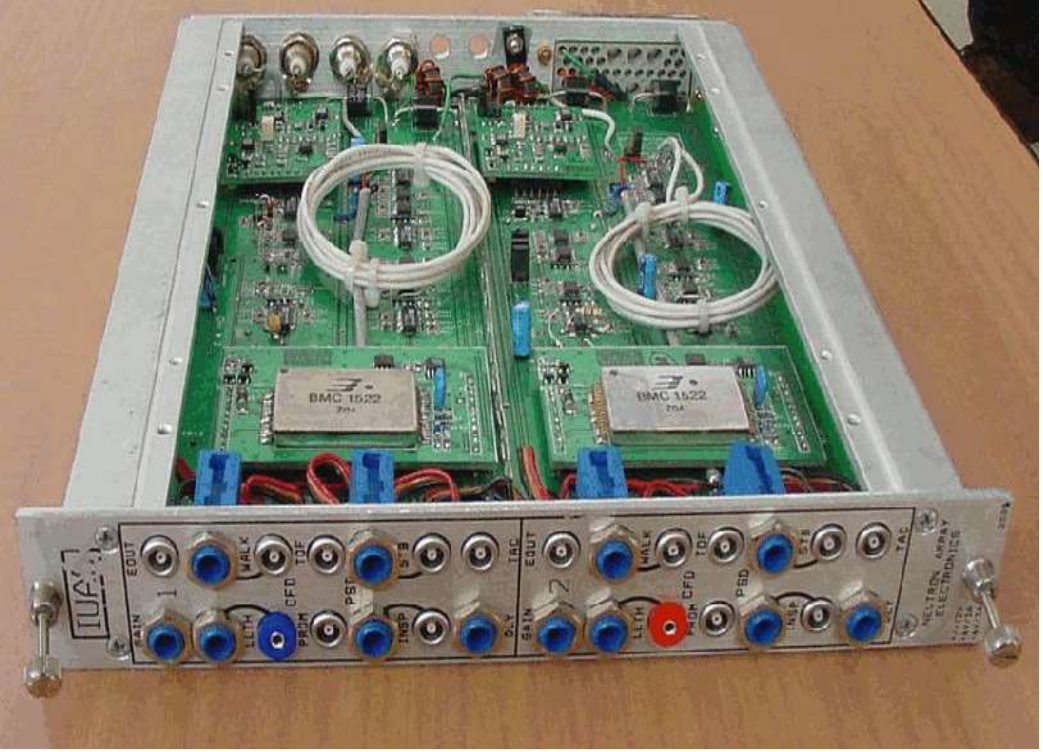
Custom designed Clover module, high voltage power supplies, Automatic LN2 filling system
Data Acquisition : 14 bit high resolution ADC, LPCC, GEM Module

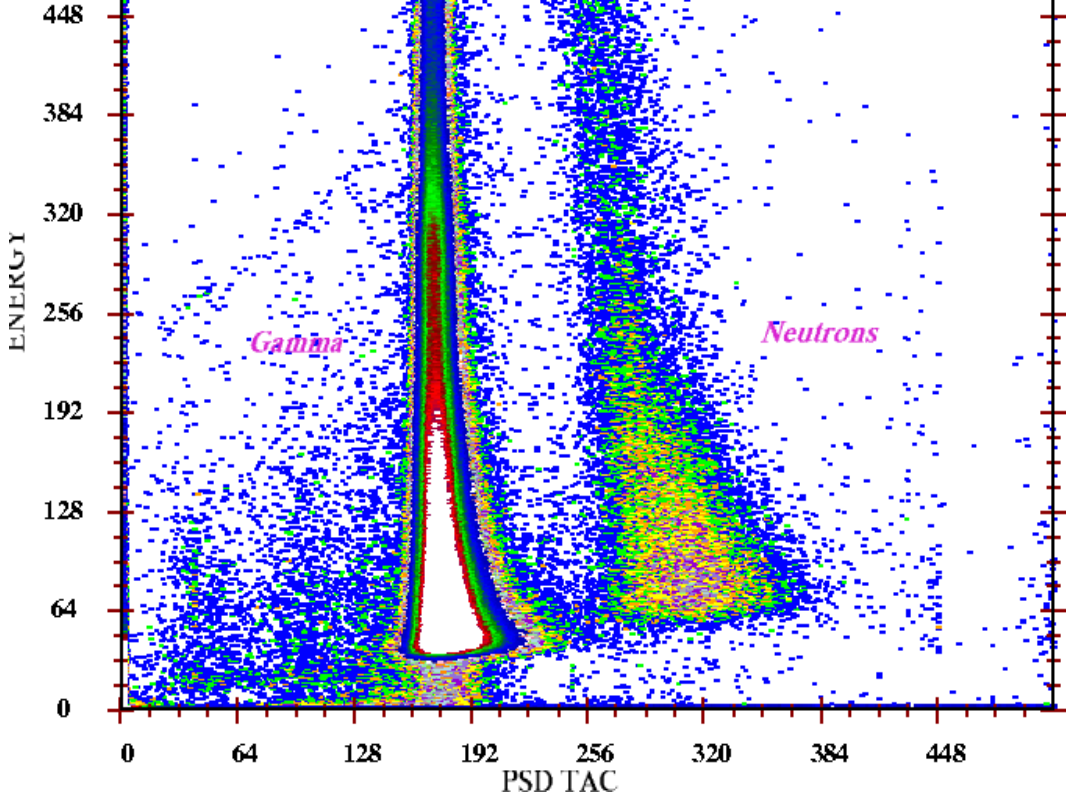
HYRA

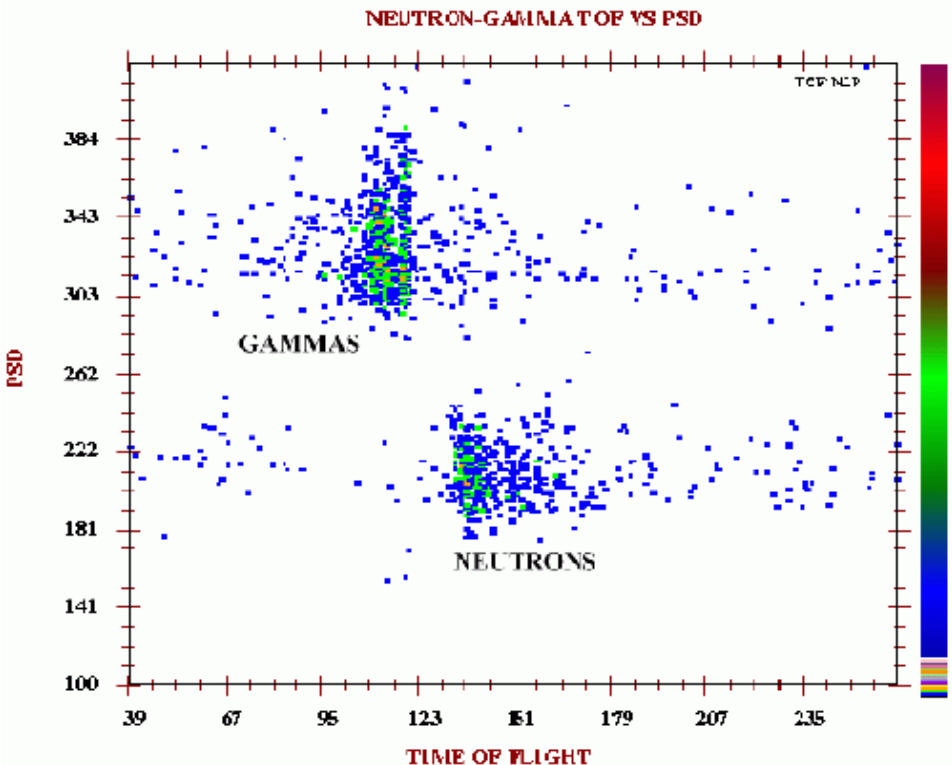
Magnet power supplies developed by Beam transport group in house

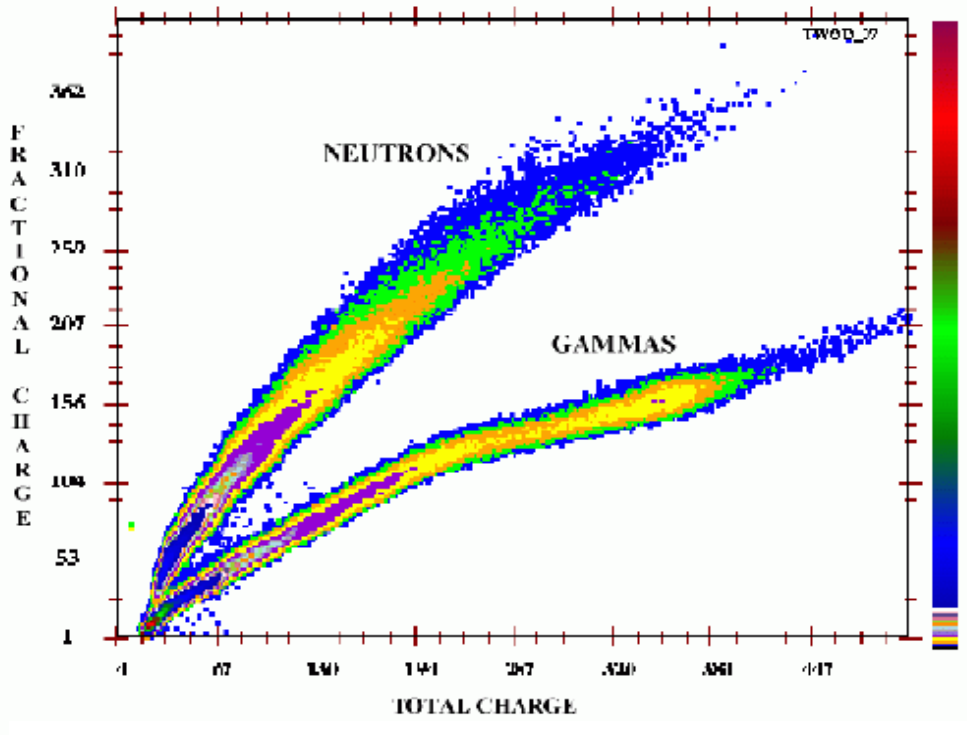
NAND

Front end electronics required to discriminate neutrons and gammas for 100 detectors
Needs to generate time of flight
Custom designed Pulse shape discriminator module developed in house
Two Channels
Based on Zero crossing technique logic
Generates Energy, TOF, PSD TAC output
Eight channel Gate & Delay generators
Multichannel CFD for MWPC
Amplifier with built in discriminators for Silicon SBD

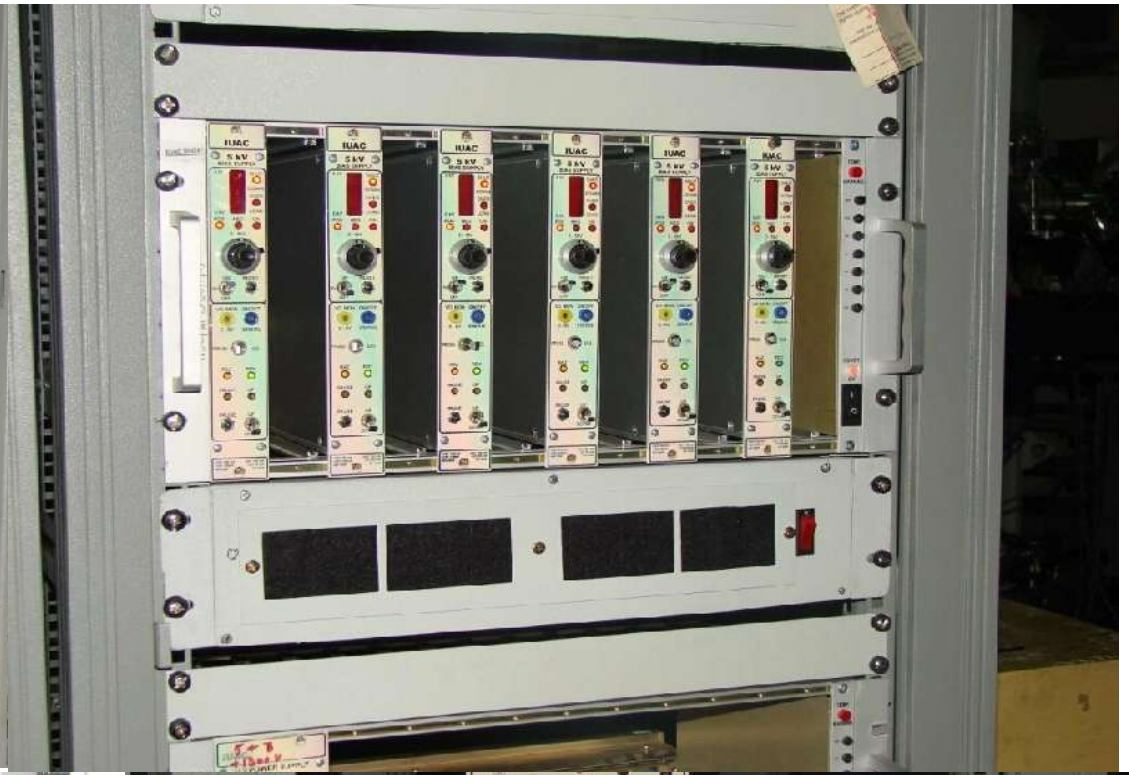

BMC 1522
BMC 1522

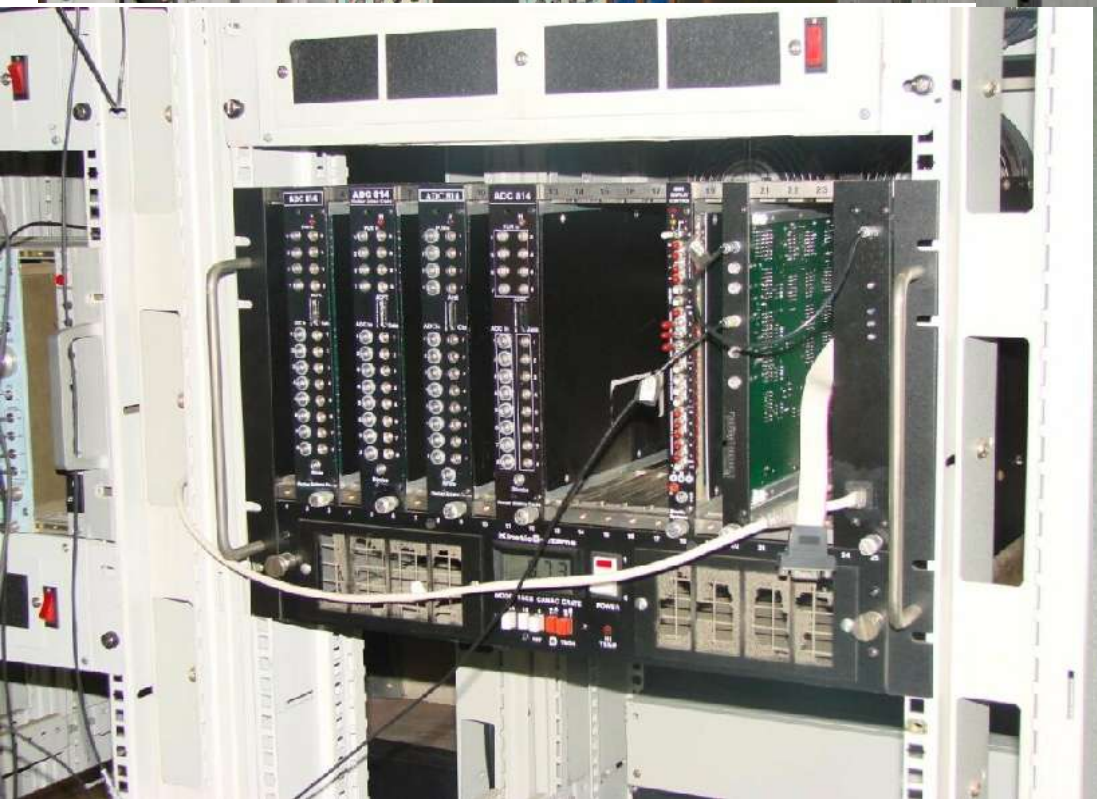

ENERGY
PSD TAC
Gamma
Neutrons
0
64
128
192
256
320
384
448

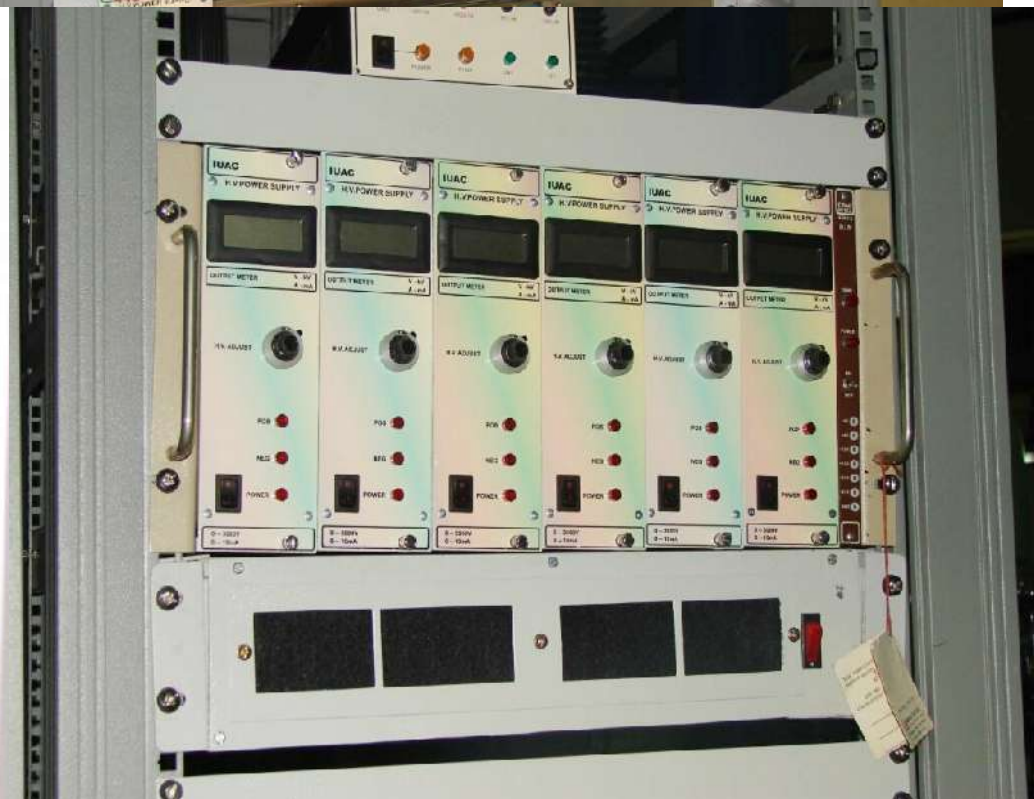

NEUTRON-GAMMA TOF VS PSD
PSD
TIME OF FLIGHT
GAMMAS
NEUTRONS
100
141
181
222
262
303
343
384
39
67
95
123
151
179
207
235

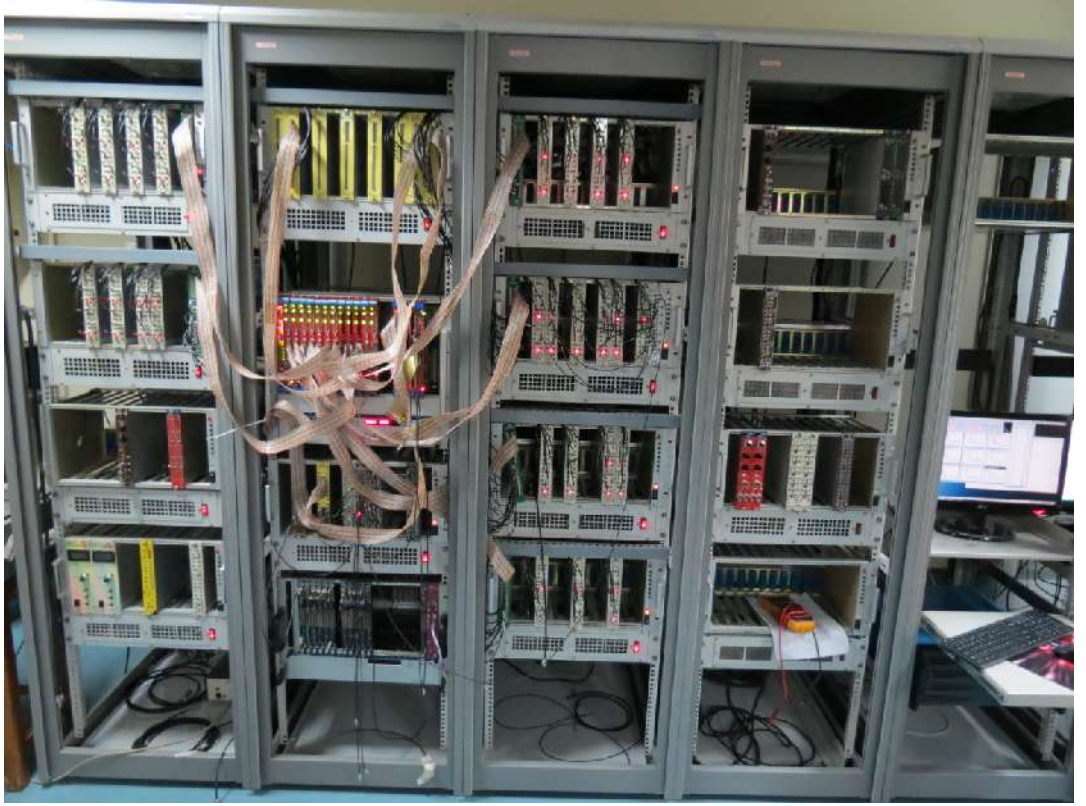

FRACTIONAL CHARGE
TOTAL CHARGE
NEUTRONS
GAMMAS
1
53
104
156
207
259
310
362

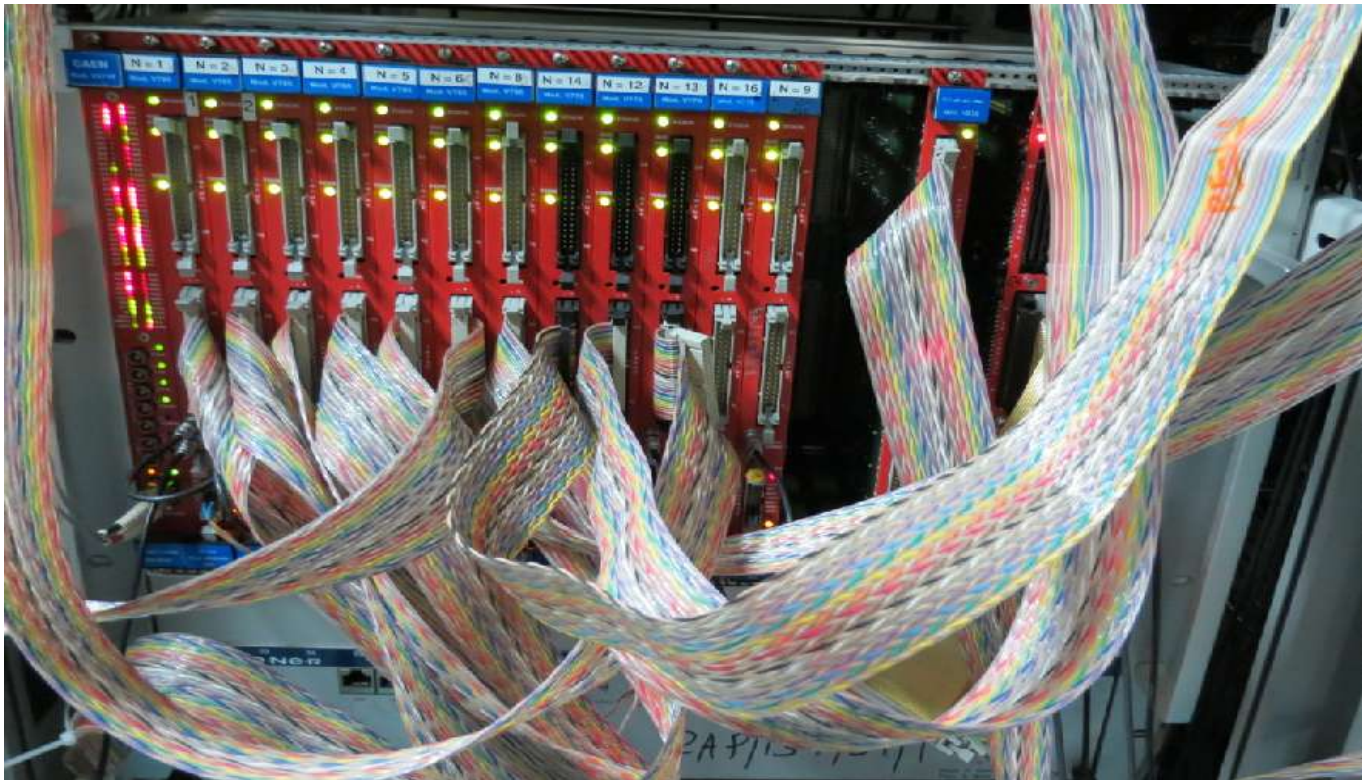

INGA
CLOVER ELECTRONICS
IUAC

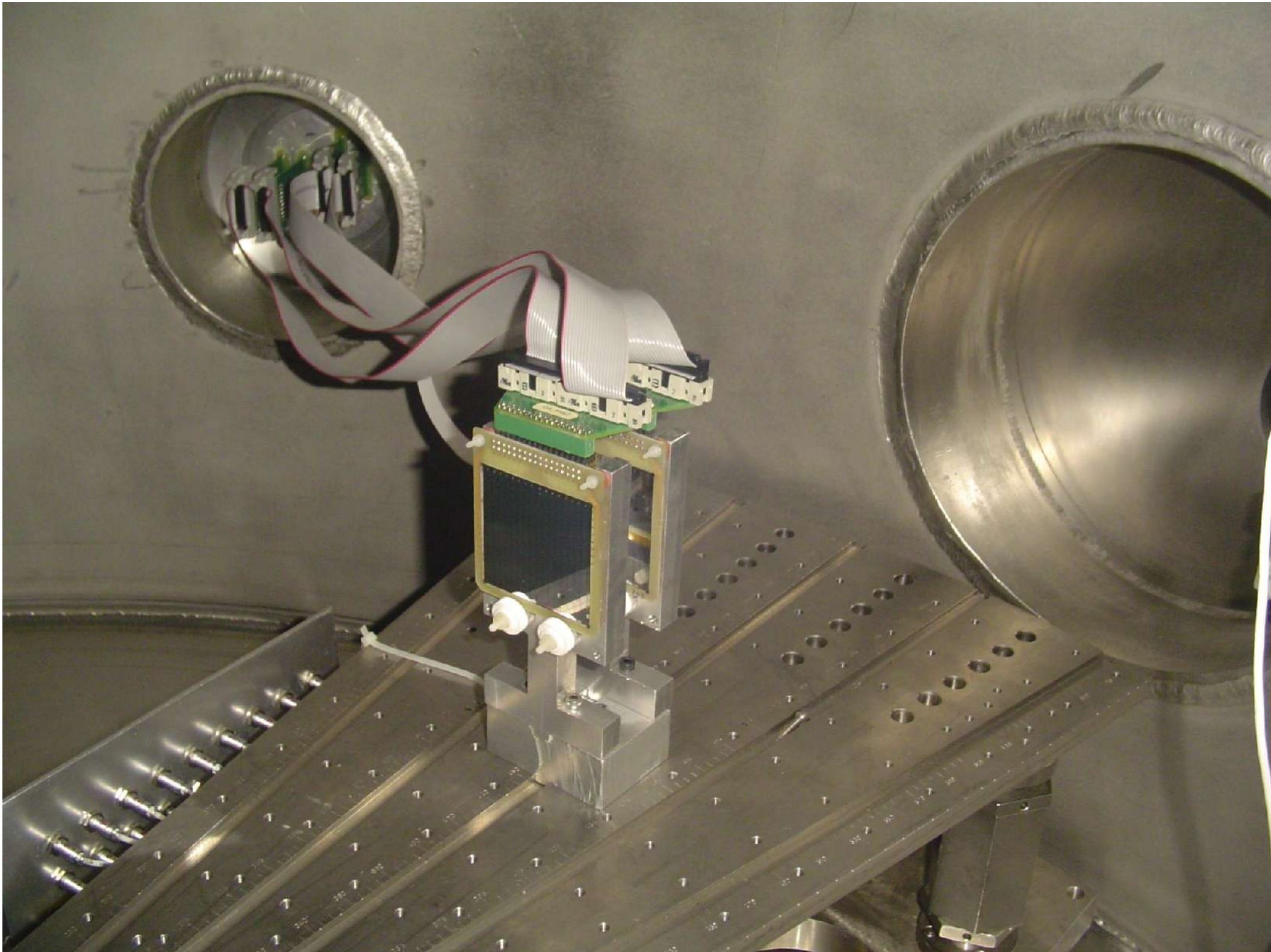

IUAC

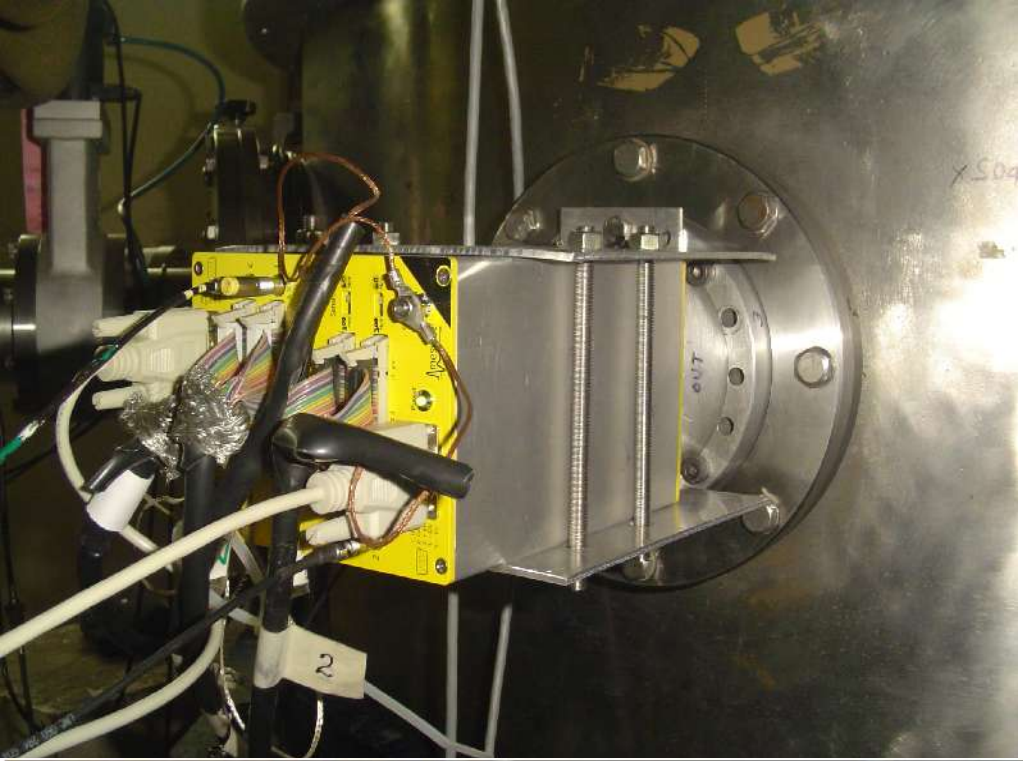

ADC 814

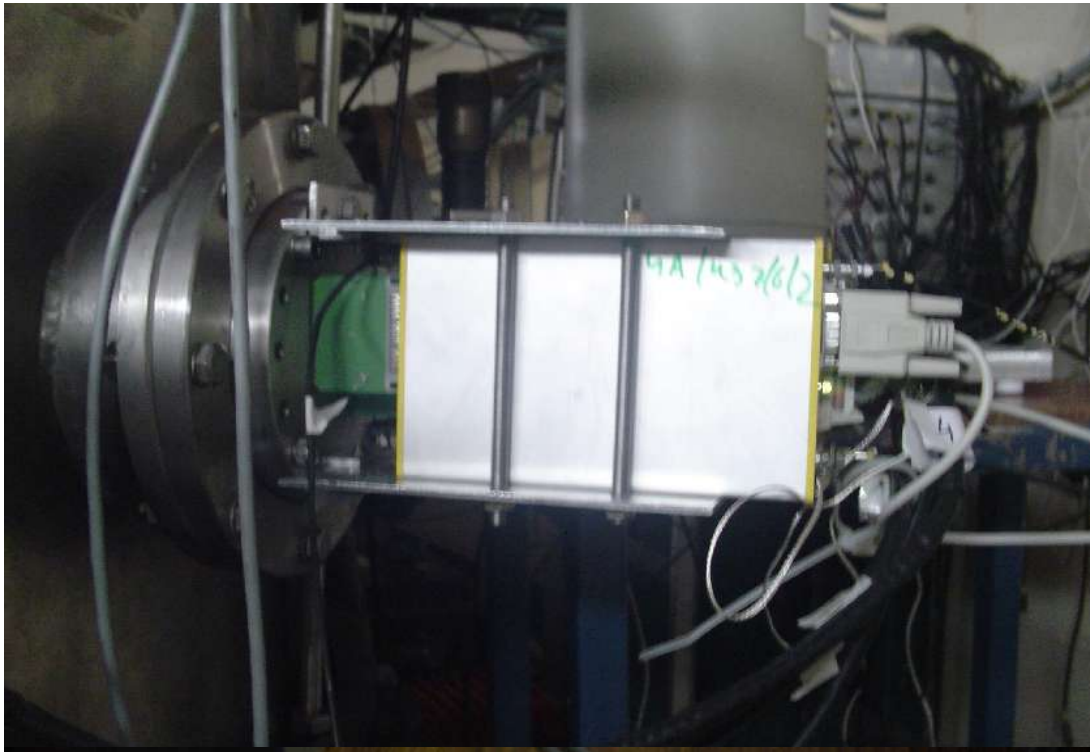

IUAC
H.V.POWER SUPPLY

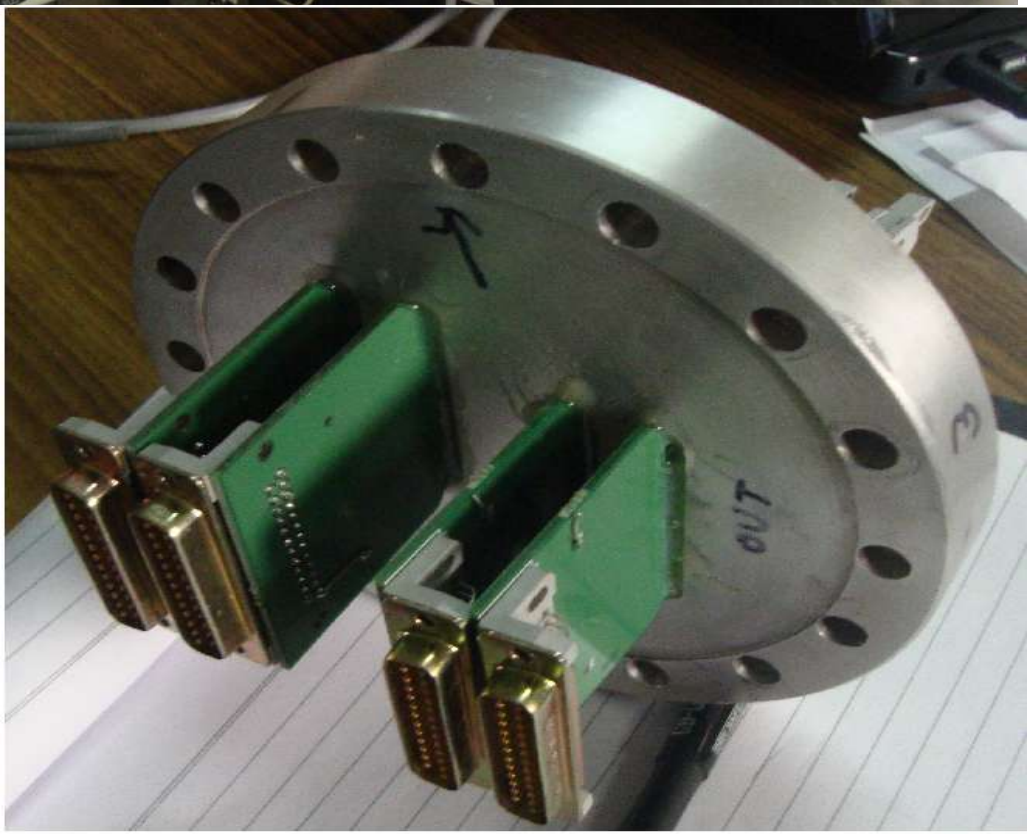


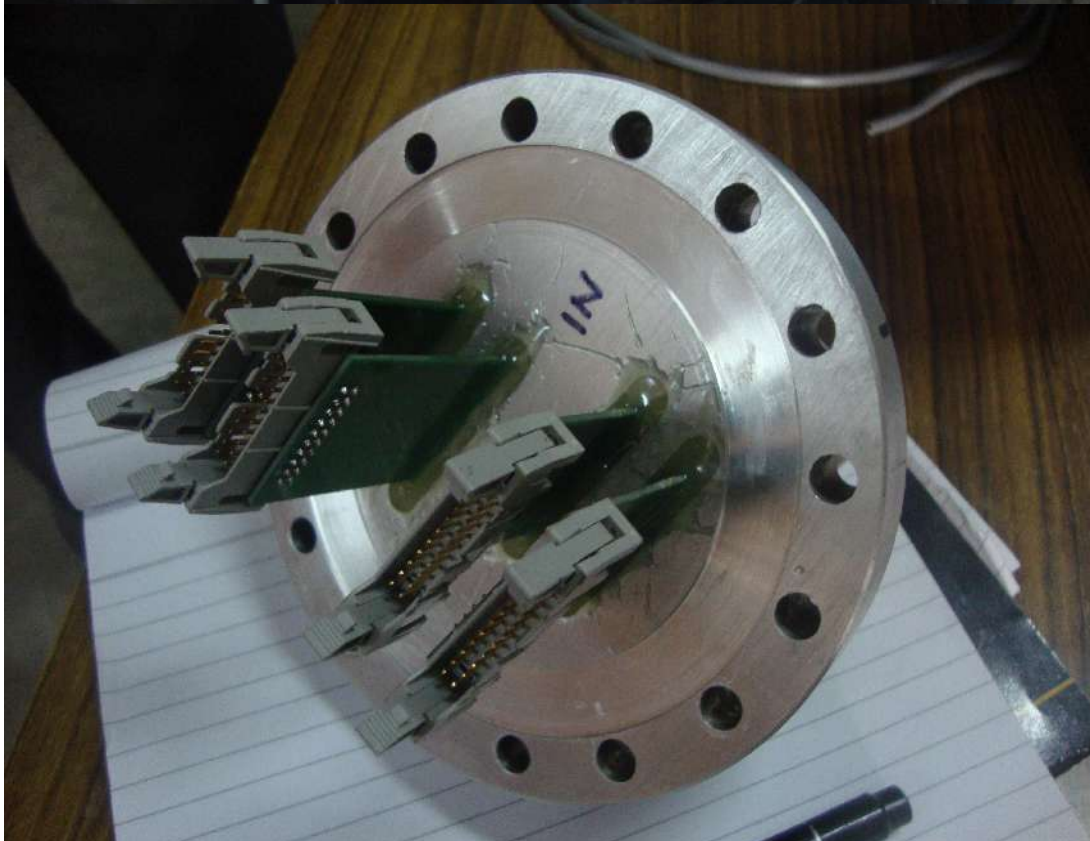




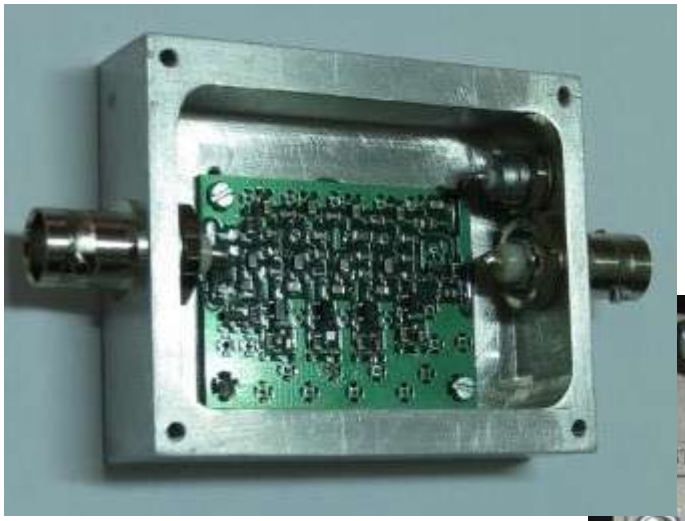

OUT
2

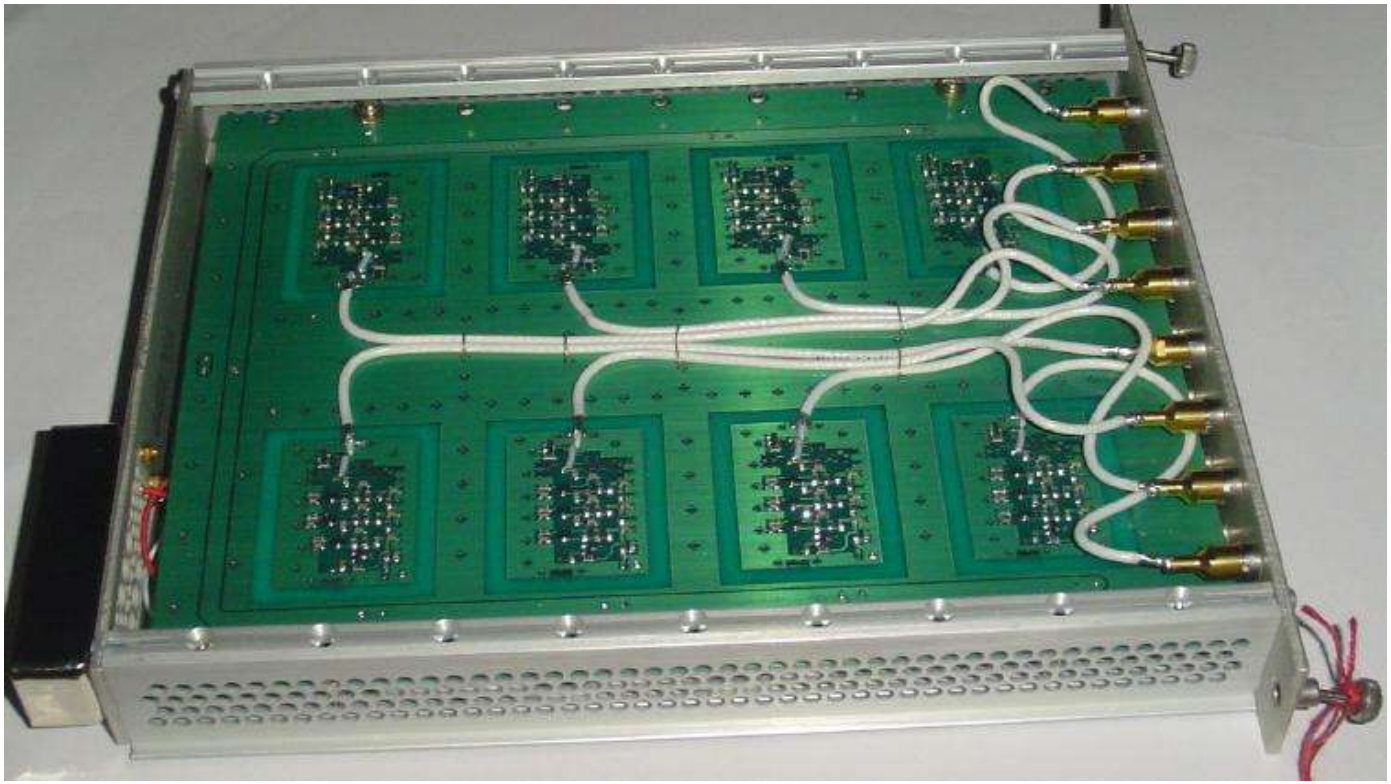


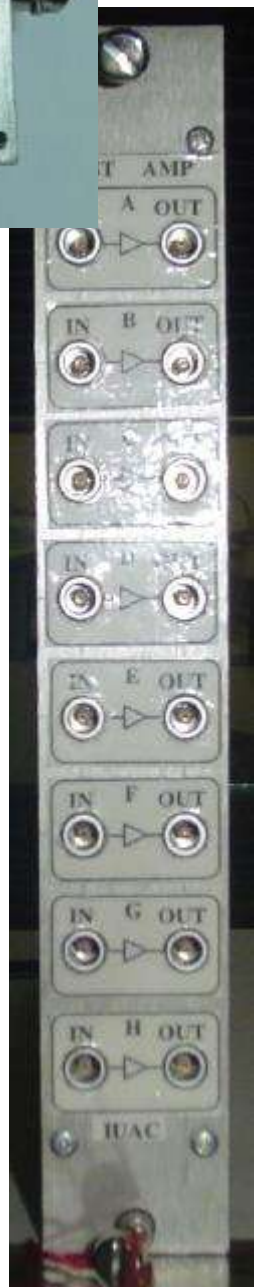

OUT

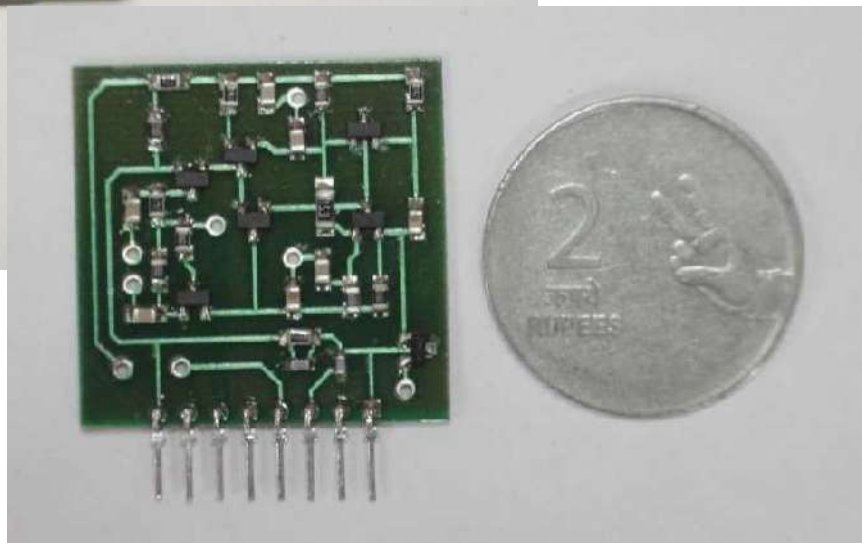

IN

Fast timing preamplifiers of PPAC readout

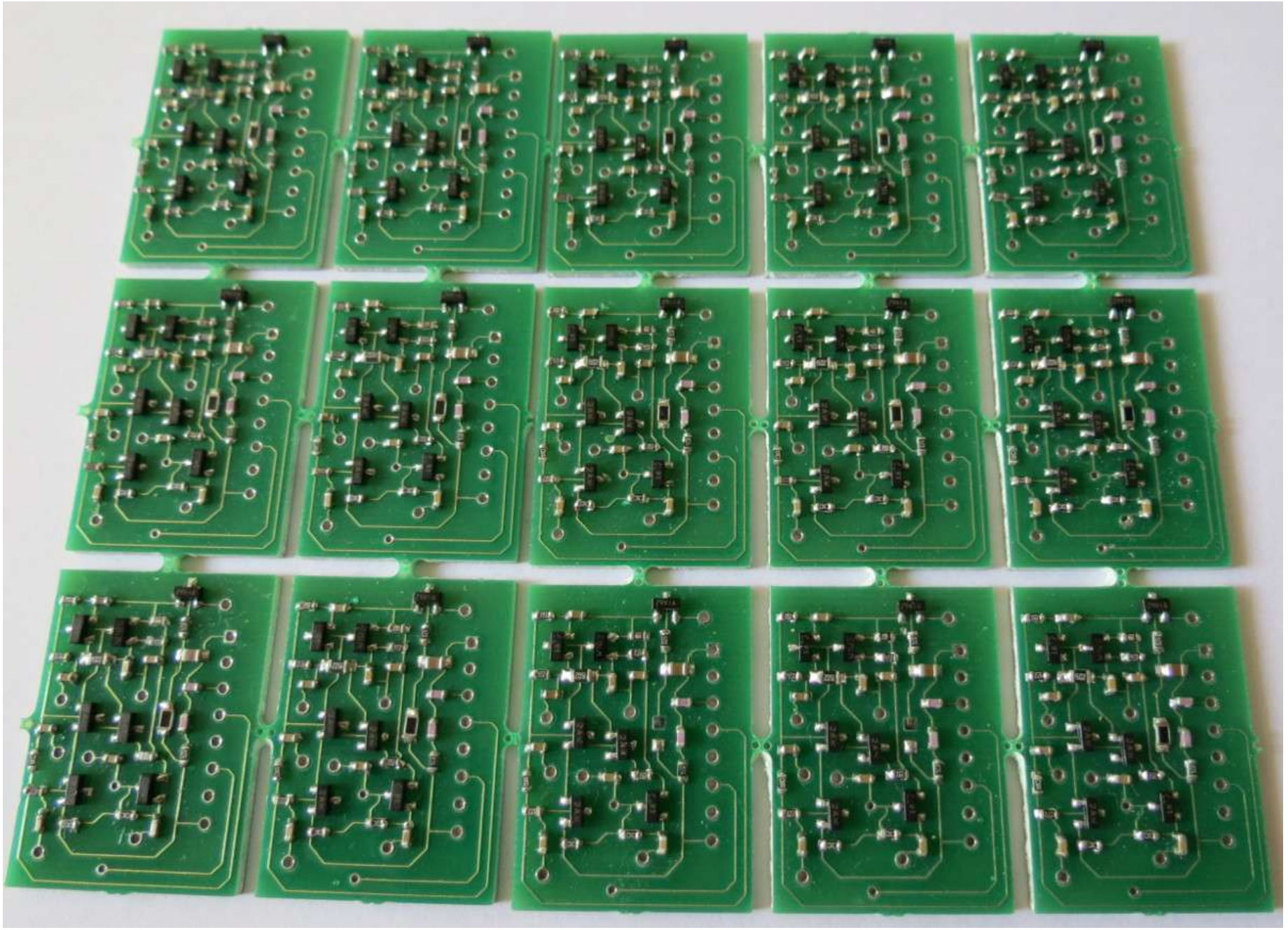


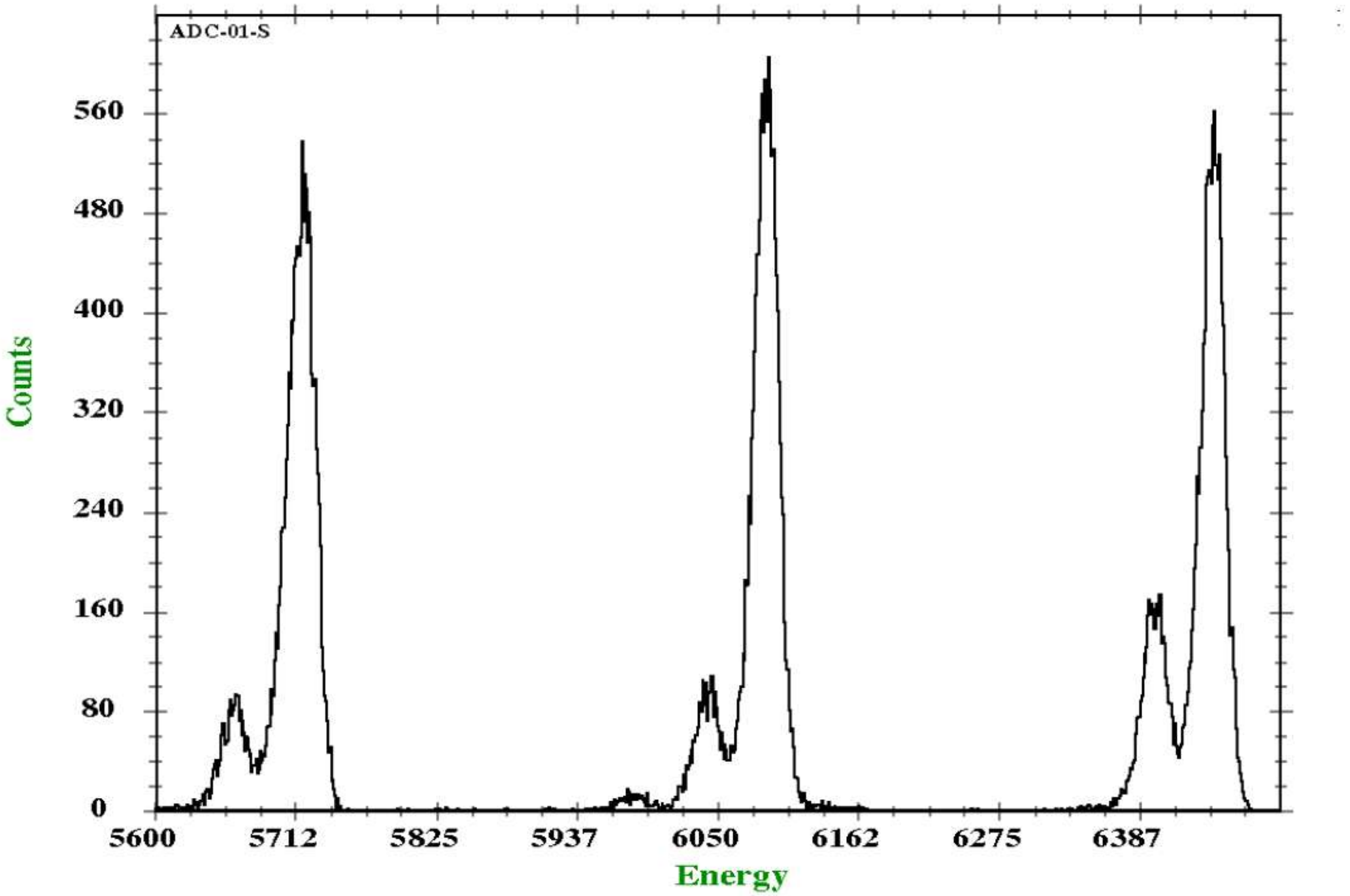






Charge Sensitive Preamplifiers




Pu-Am-Cm mixed alpha source
ADC-01-S
Counts
560
480
400
320
240
160
80
0
5600
5712
5825
5937
6050
6162
6275
6387
Energy

outline

Motivation for Building the Detector System

Technical support from GSI

Relevance in the Indian Context

Budget & Time Scale

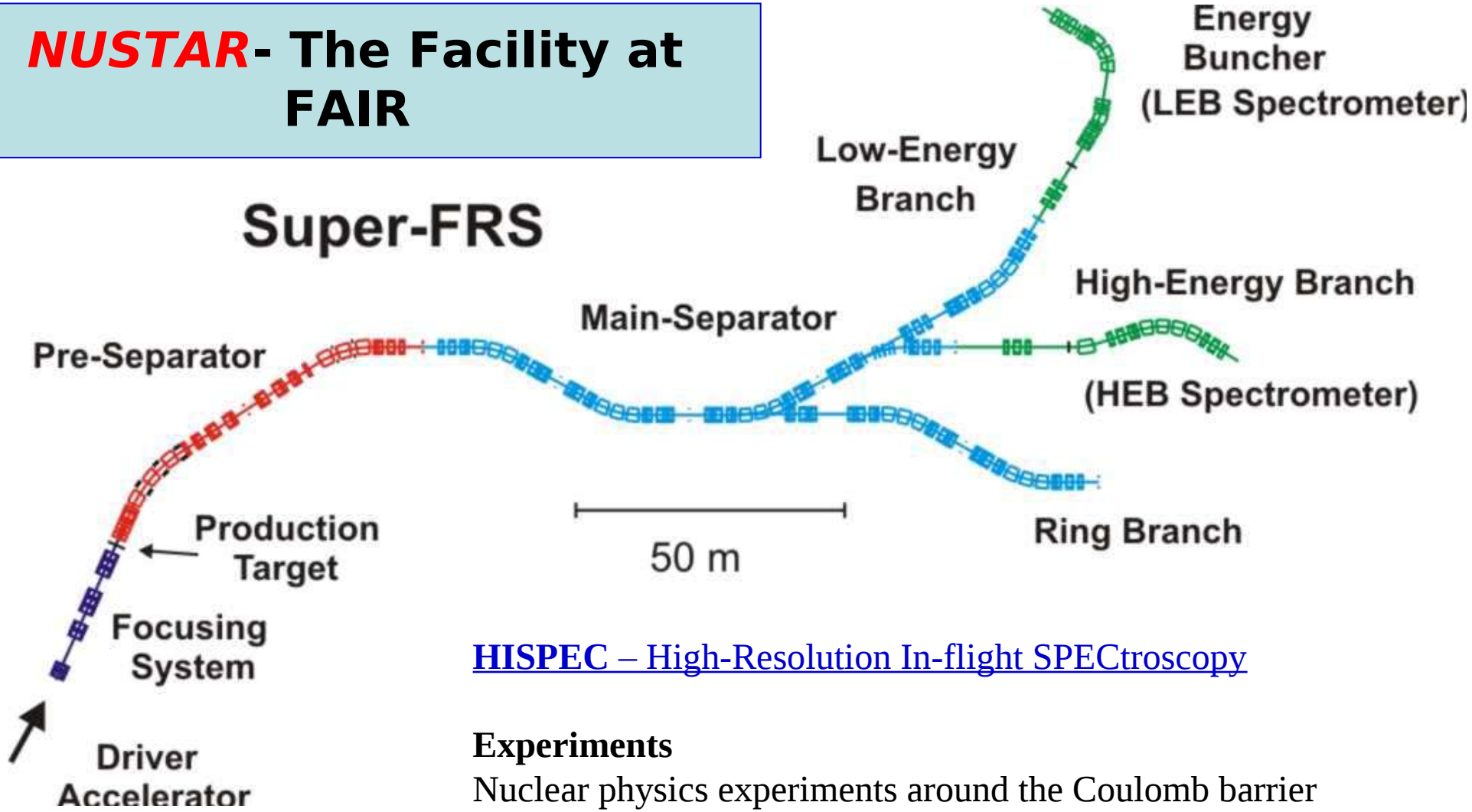
Infrastructure to be extended by Host Institute (IUAC)

Collaborators

Akhil Jhingan (IUAC)
P. Sugathan (IUAC)
N. Madhavan (IUAC)
S. Mandal (Delhi Univ.)
B. R. Behera (Panjab Univ.)

J. Gerl (GSI)
M. Gorska (GSI)
P. Boutachkov (GSI)
H. Schaffner (GSI)
I. Kojouharov (GSI)
H. J. Wollersheim (GSI)

NUSTAR- The Facility at FAIR



HISPEC – High-Resolution In-flight SPECtroscopy

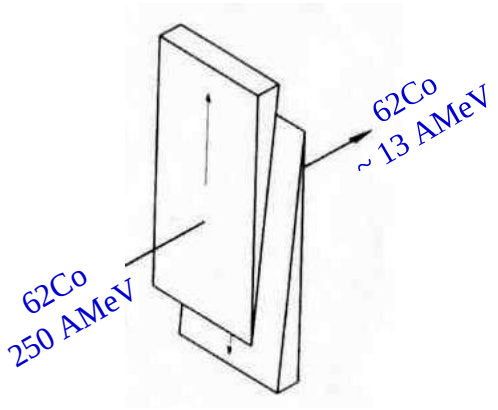
Experiments

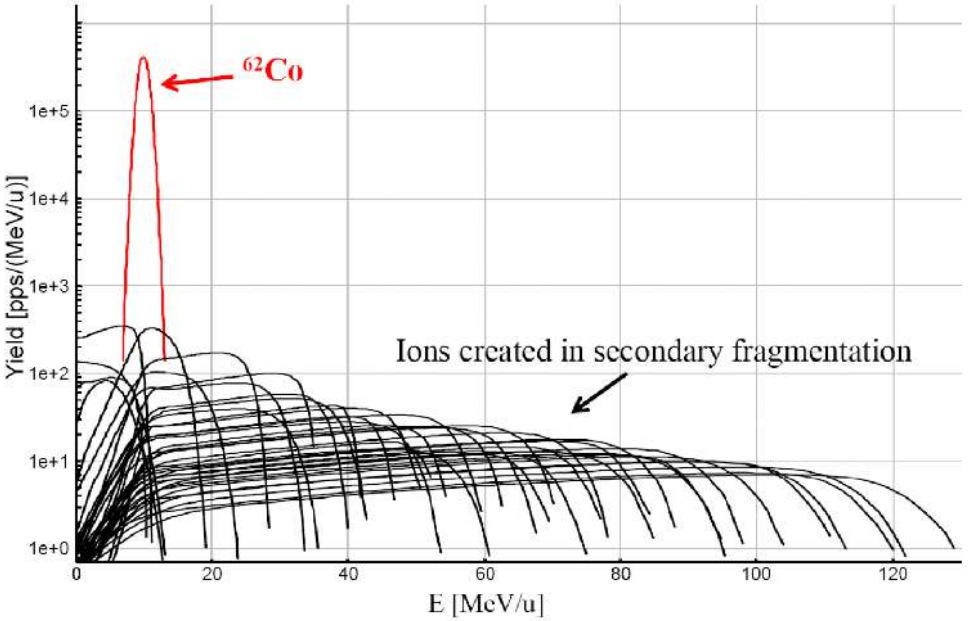
Nuclear physics experiments around the Coulomb barrier using slowed down beams (poor beam quality)

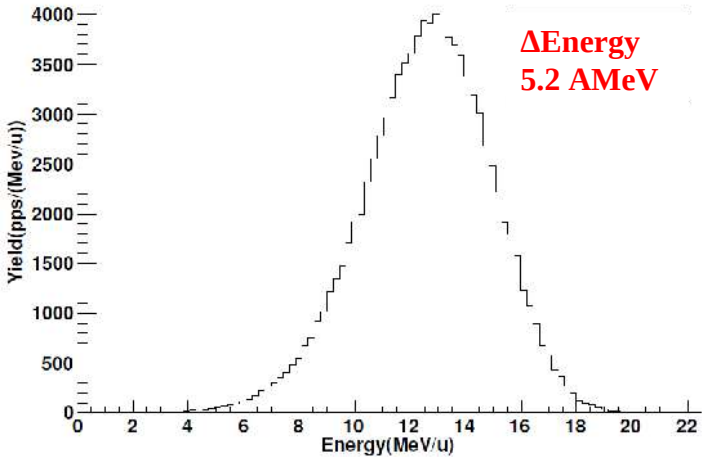
Type of experiments planned:

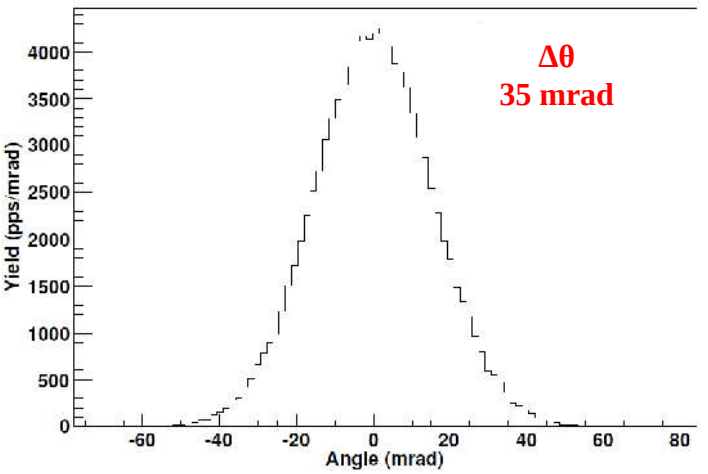
- Multi-Nucleon Transfer
- Deep-Inelastic Scattering
- Coulomb Excitation

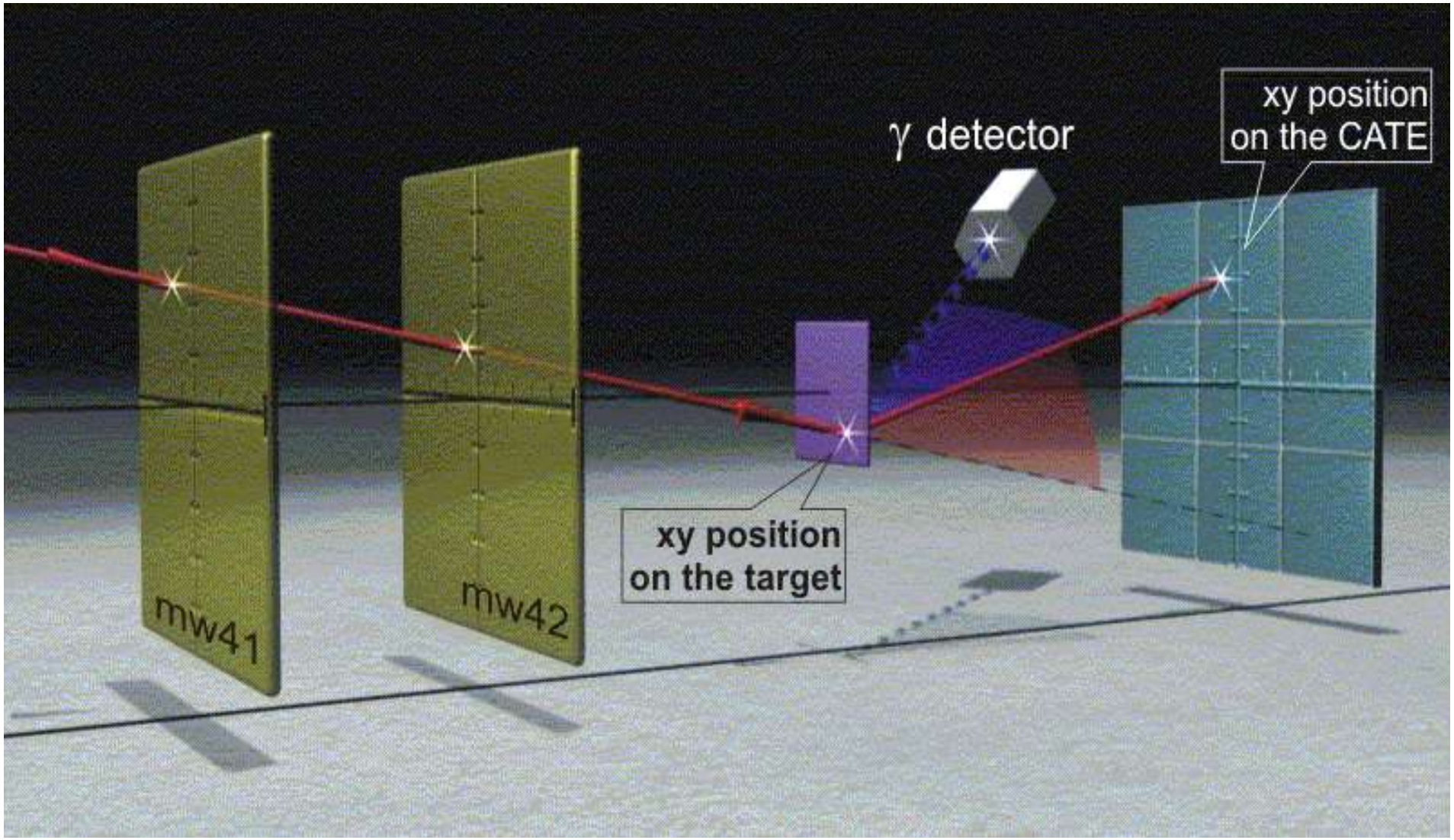
Slowed down beams - beam characteristics





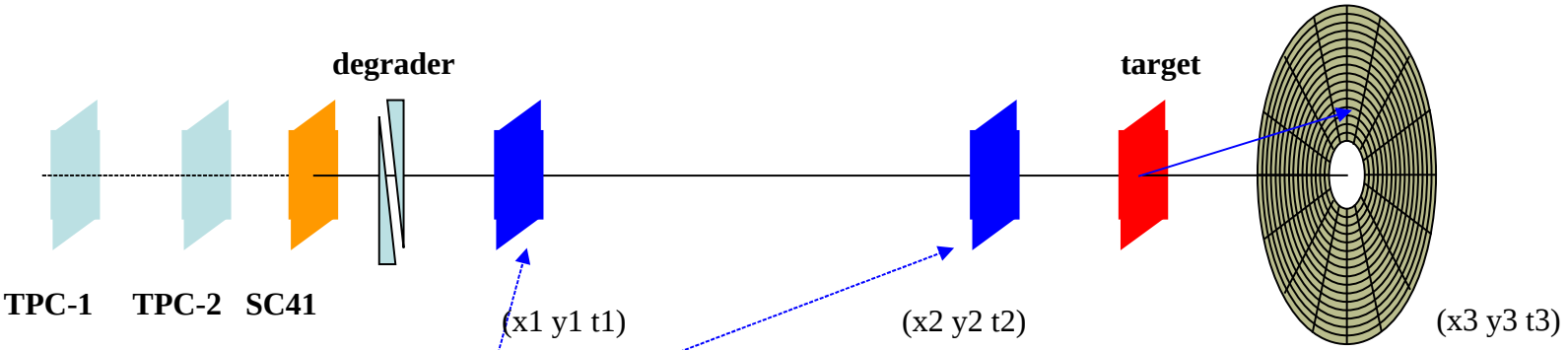


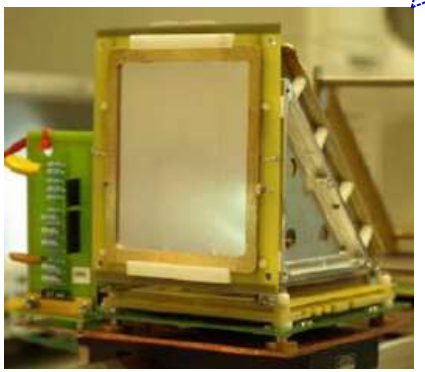




Tracking secondary beam and secondary reaction products
Event by event

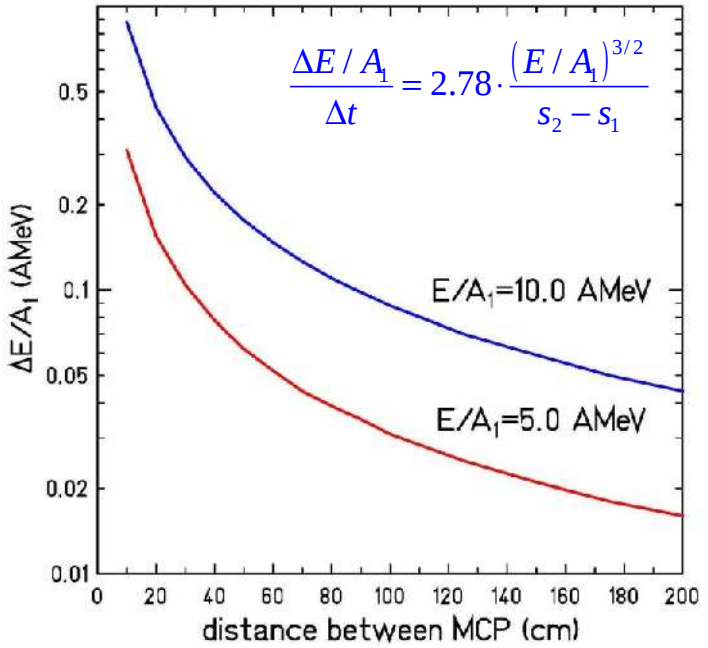
Slowed down beams - beam energy measurement





electrostatic mirror + MCP detector

position resolution ~ 1 mm
time resolution ~ 100 ps



experimental results:

velocity β
beam energy E/A1
scattering angle θcm

Beam Tracking Detectors

Characteristics Desired

Timing Resolutions ~ **100 ps** (fwhm)

Energy Resol. (from TOF) : **1 MeV** fwhm @ 5-6MeV/A, (A ~ 60)

Two dimensionally position sensitive

Position Resolutions : ~ **1 mm**

High Count Rate Handling capability : **1 MHz**

Area : At least 10 cm x 10 cm

Transmission type with very small straggling

Flight Path : 2 – 3 meters

Detectors for Beam Characterization

Micro-channel Plate (MCP) Detectors

OR

Muti Wire Proportional Counters (MWPC)

For generating spatial and TOF (Energy) information

MCP as position sensitive & Transmission type Secondary electron emission detector

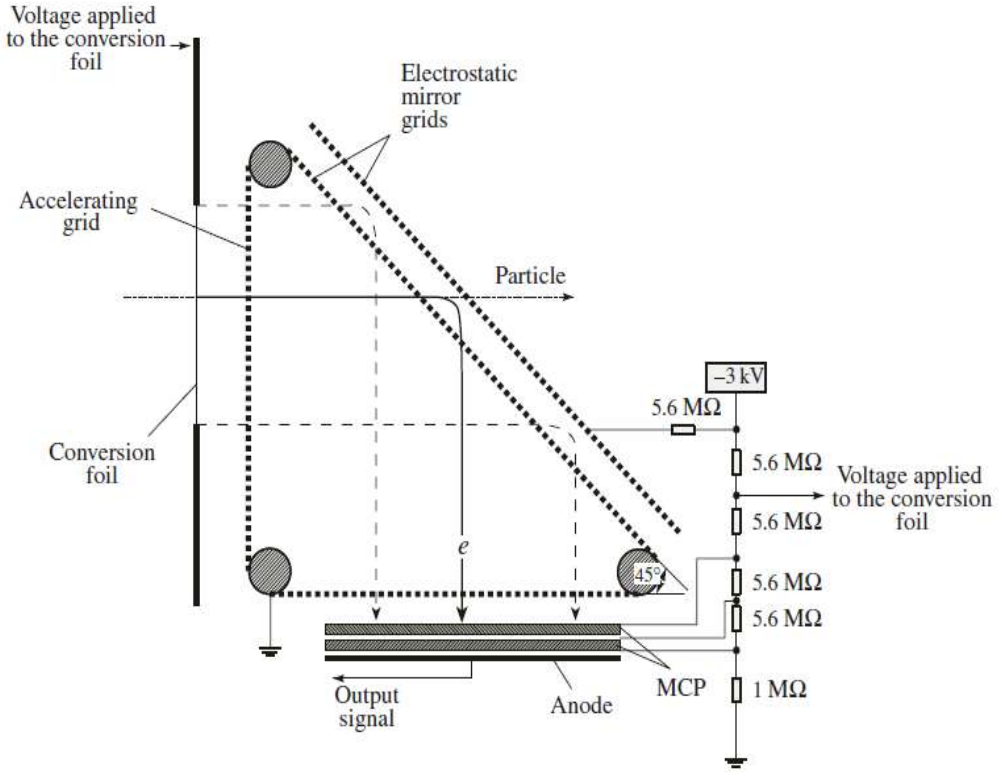
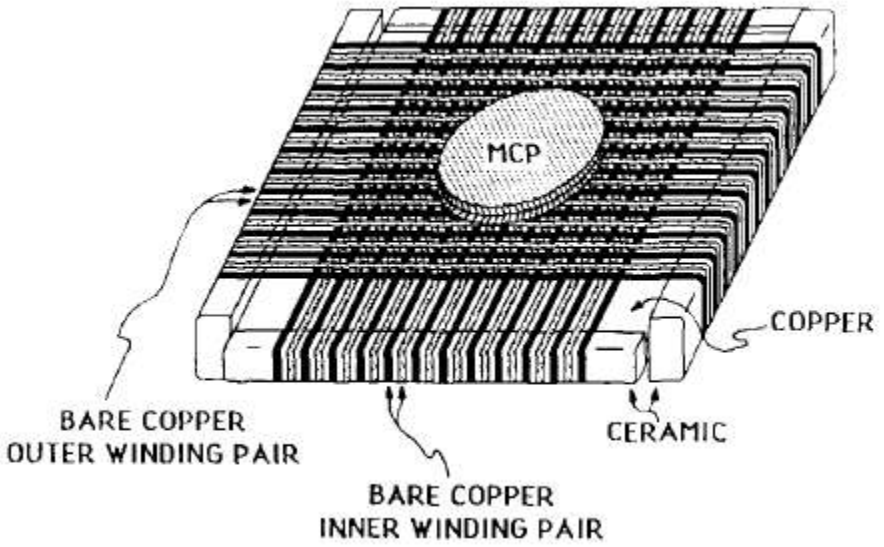
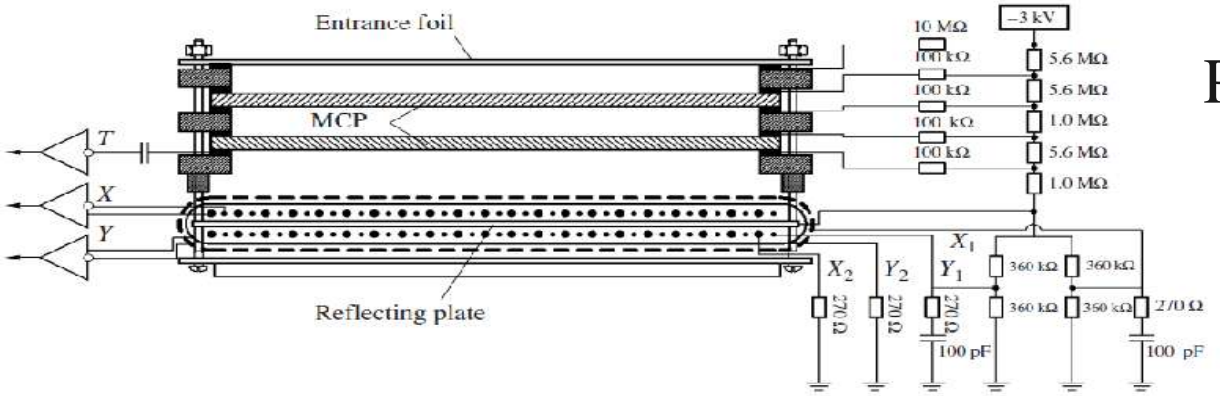
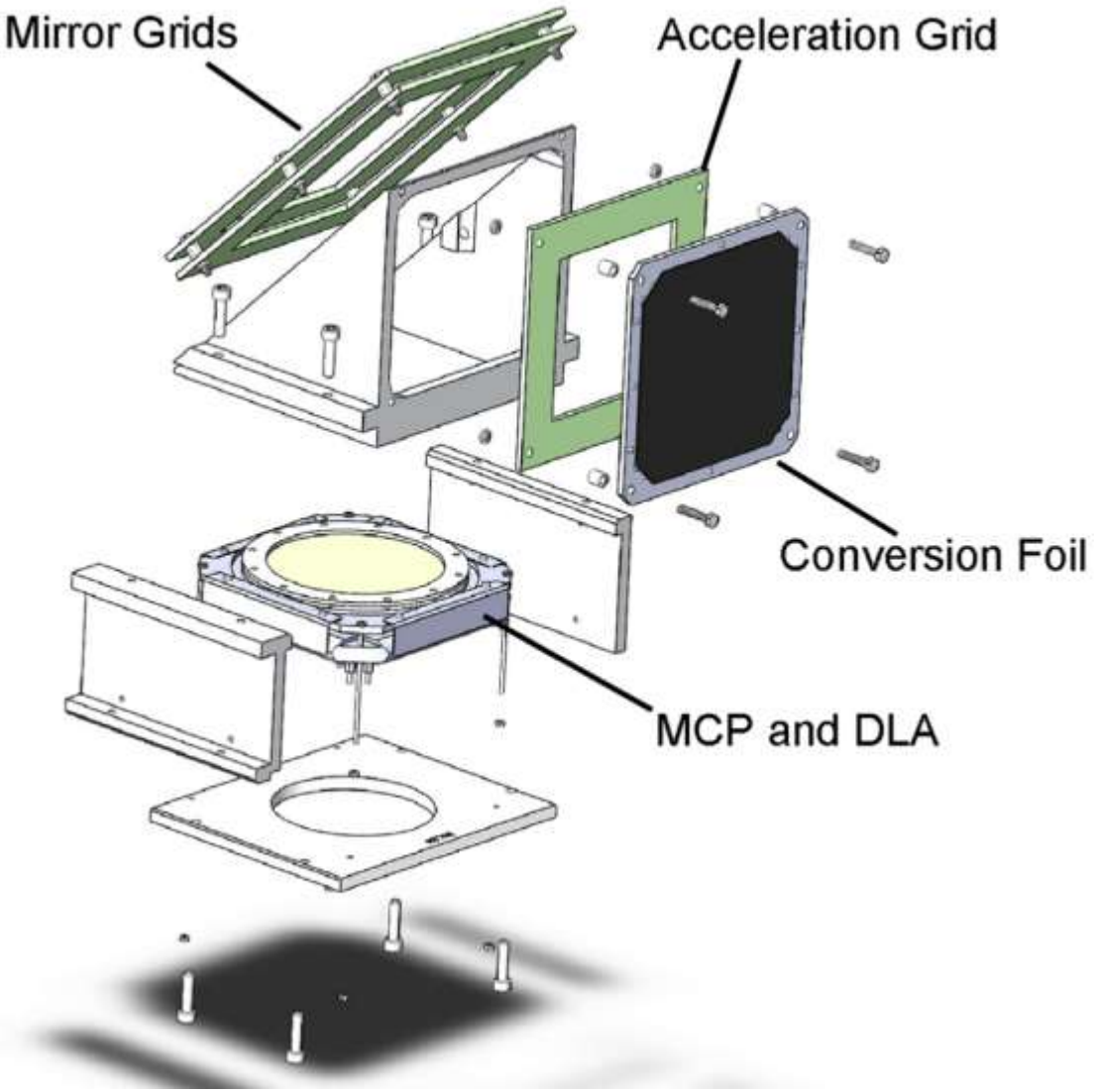


Fig. 2. Schematic diagram of the detector with an electrostatic mirror.

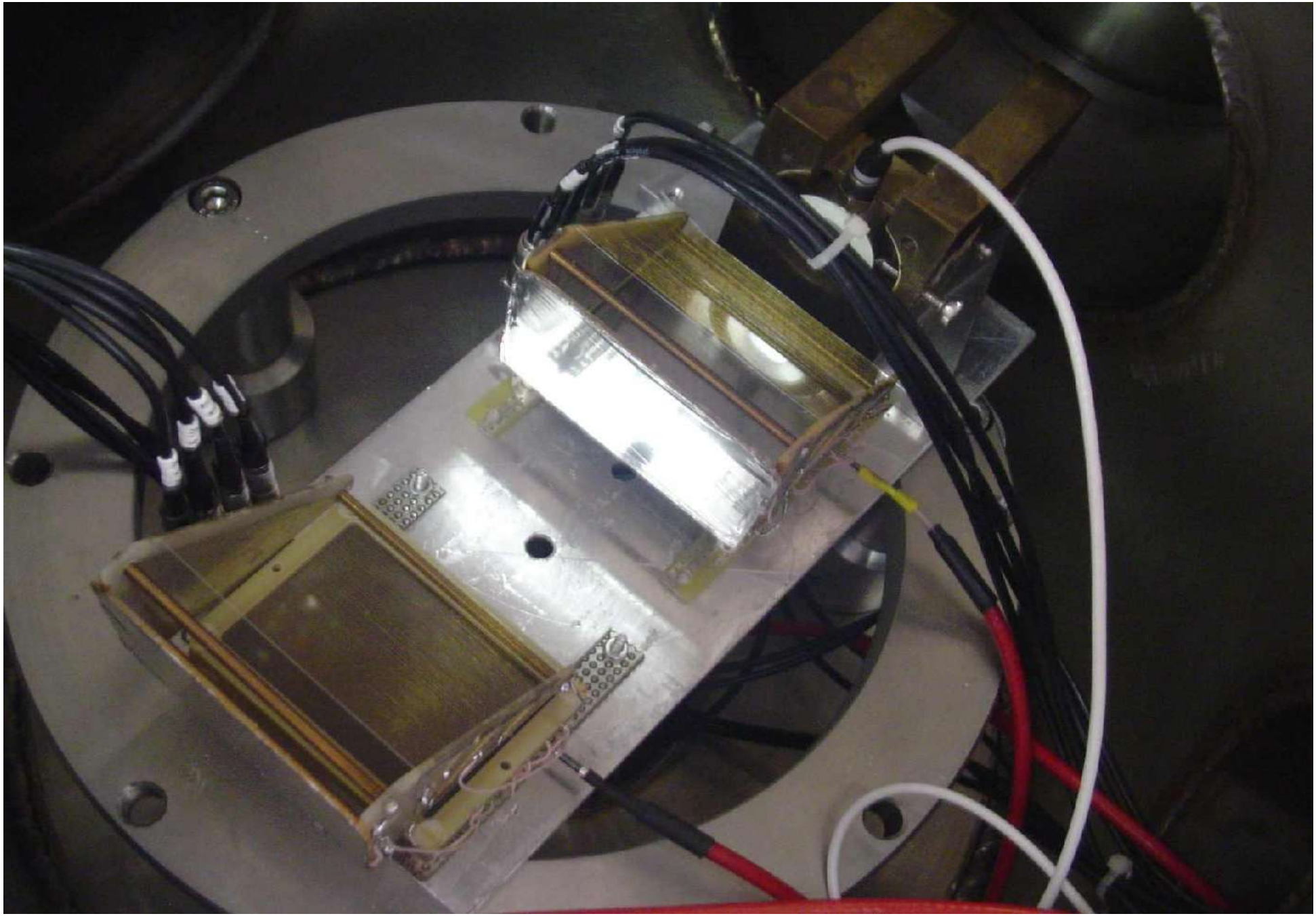




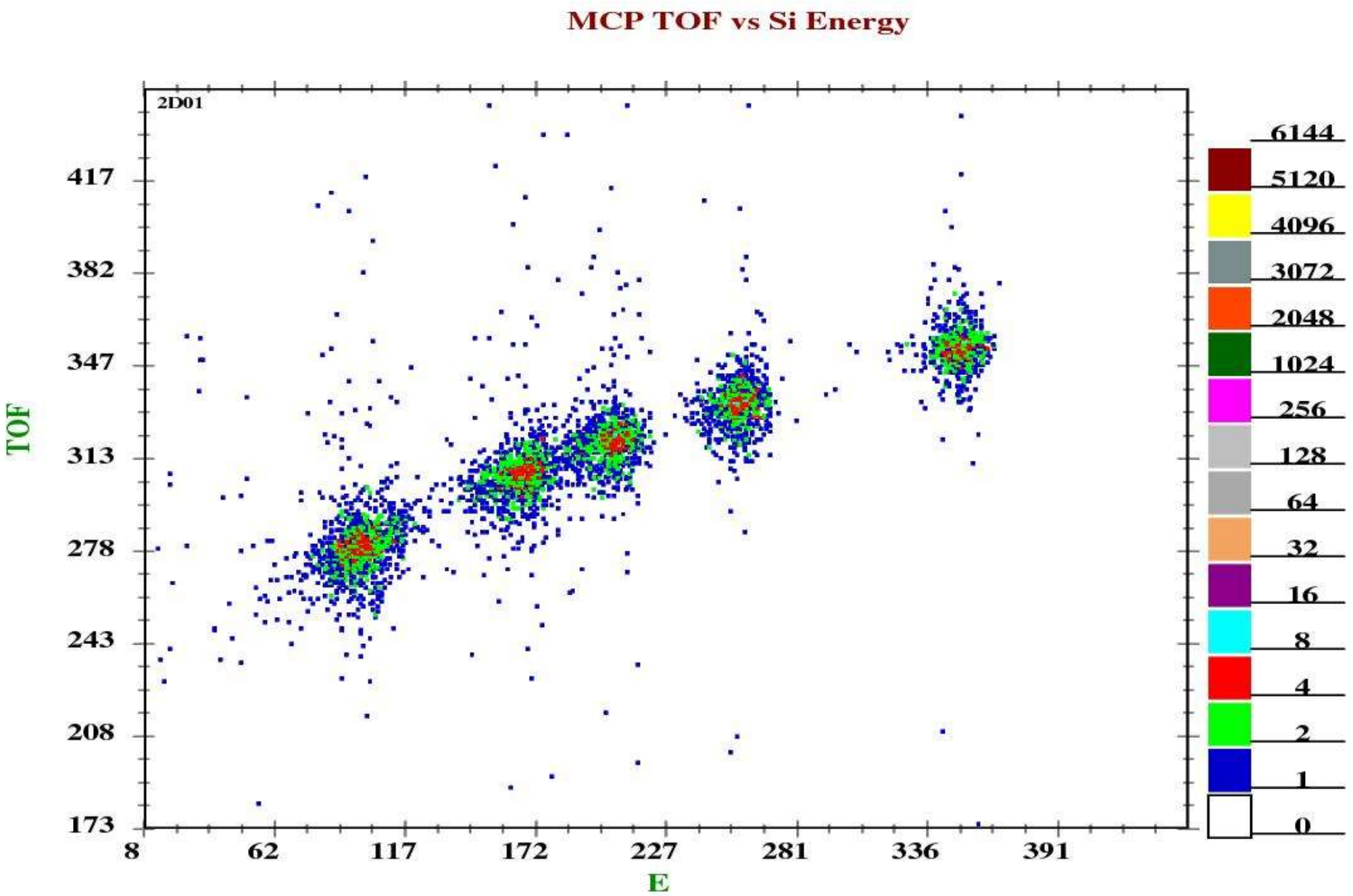
Position resolution < 1 mm



Mechanical Assembly of the MCP



MCP-TOF setup : Area 60 x 40 mm^2, backed by silicon detector



TOF-Energy plot at 12 cm flight path with 229Th alphas

Development of 16 channel fast timing amplifier (FTA) for SSD

FTA realized as a hybrid fabricated using SMD components.

0402 package R and C used.

Inverting three stage CE amplification

16 channels assembled on 4 layer PCB (8 x 5 cm^2)

8 channels each on top and bottom layer (3 cm x 1 cm for each channel)

Gain ~ 50, Input impedance 50 Ω
Sensitivity : ~ 3 - 5 mV/MeV (Detector capacitance dependent)

Power consumption : 1.6 W (100 mW/channel) @ + 6V supply.

Designed for SSD design W from Micron Semiconductors, UK

FRC 34 pin socket as input connector

Testing of 16 channel FTA

FTA tested with SSD of thickness 20 μm, 40 μm and 300 μm.

SSD directly integrated with FTA eliminating cables

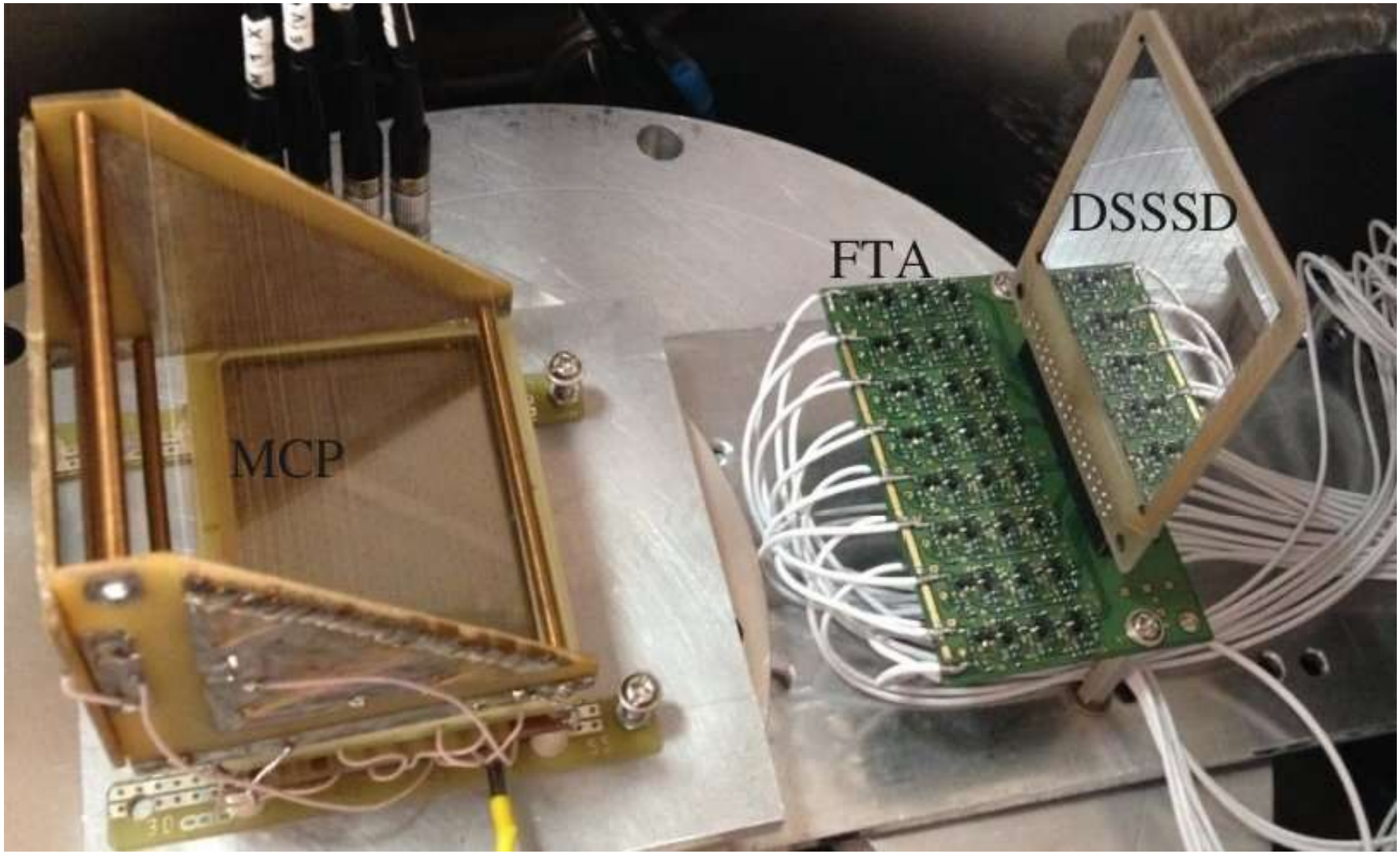
Timing signals from junction side and energy from ohmic side

Mesytec MPR-32 used for energy signals.

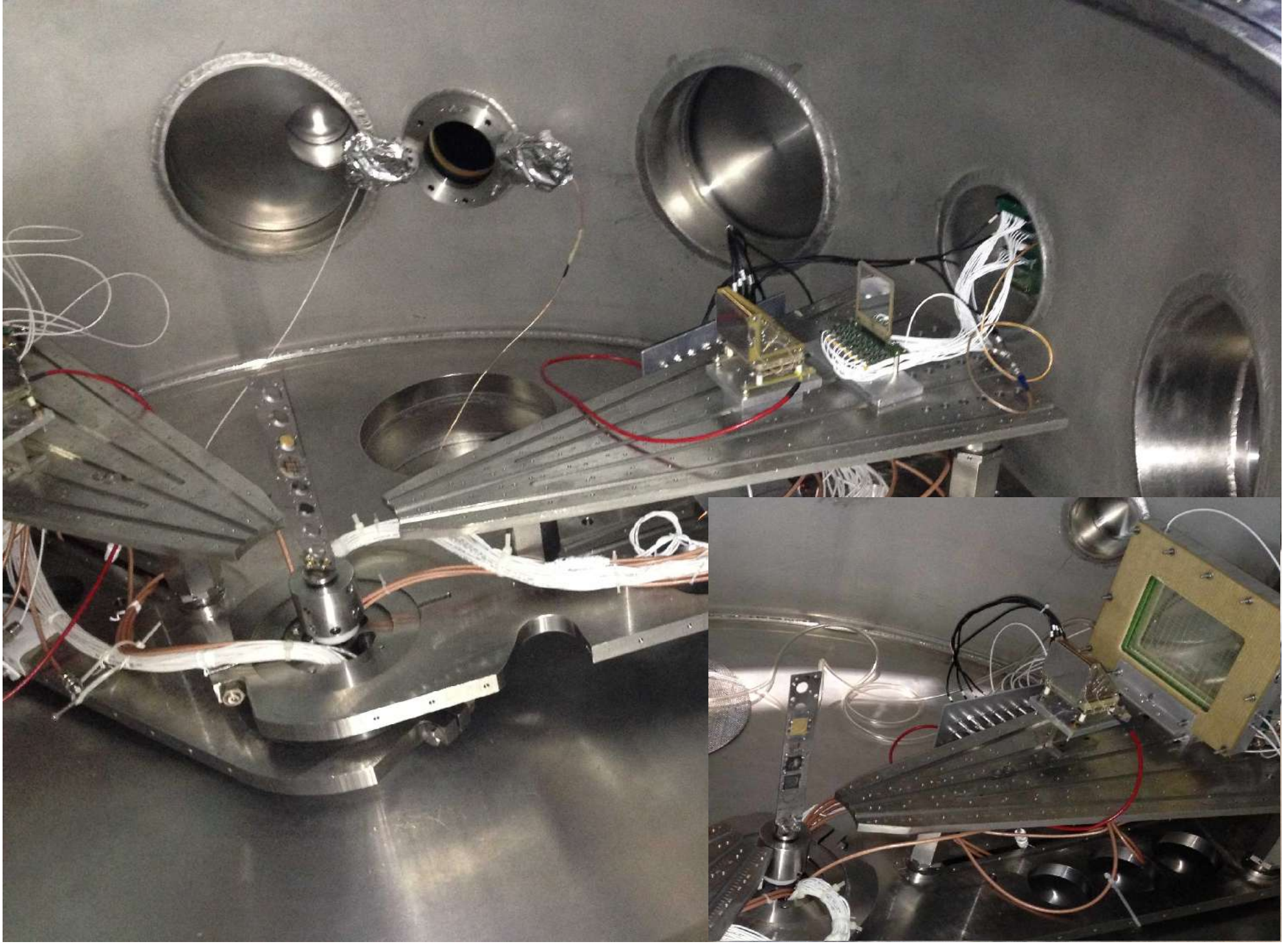
Signal transmission through multi-pin miniature coaxial cables (50 Ω)

Special flange with PCB based ribbon connectors

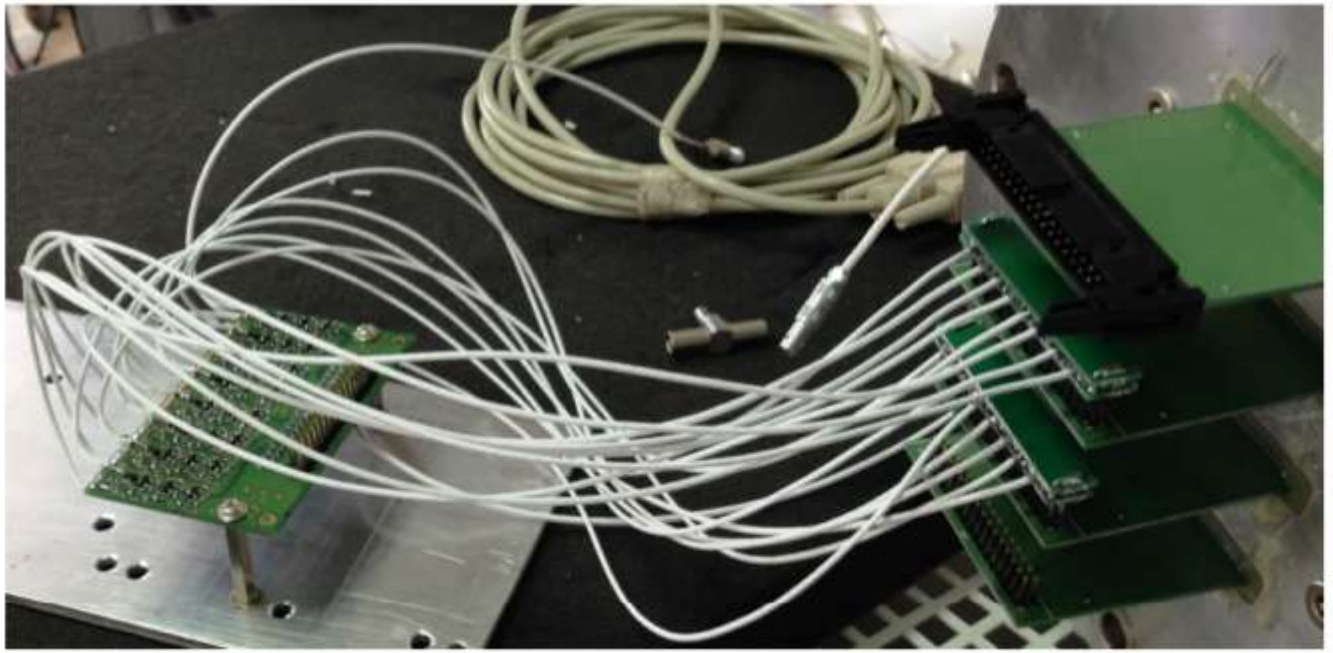
Special cables FRC – LEMO, FRC-Dpin, FRC-FRC adaptors

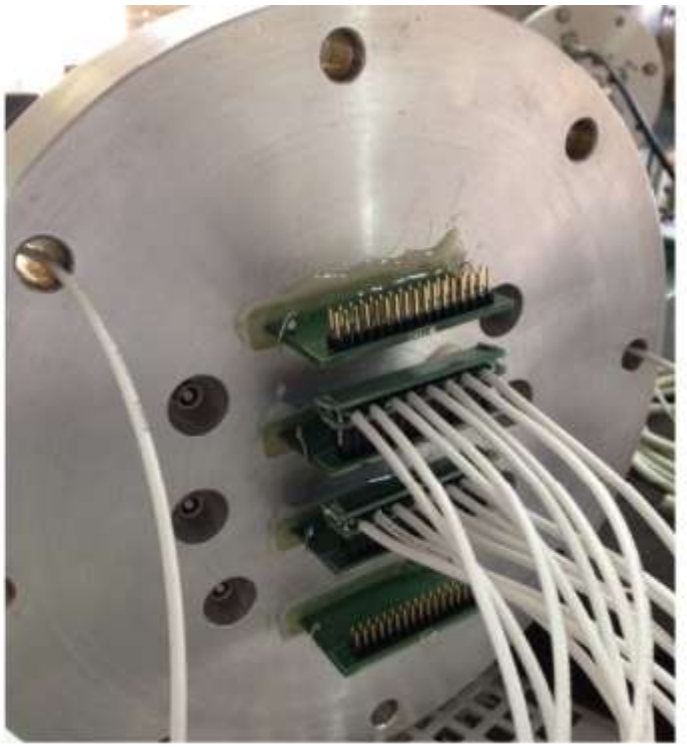


TOF set up with alpha source

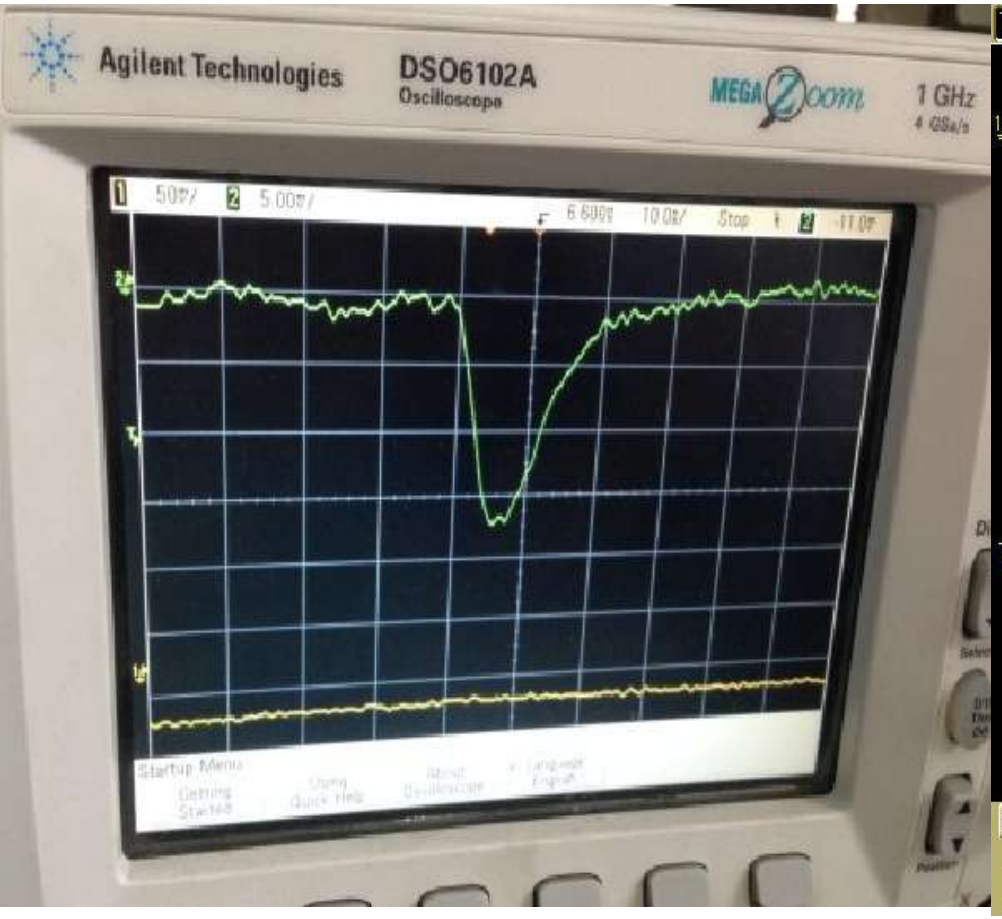


Set up in GPSC, TOF detectors at 60 degree

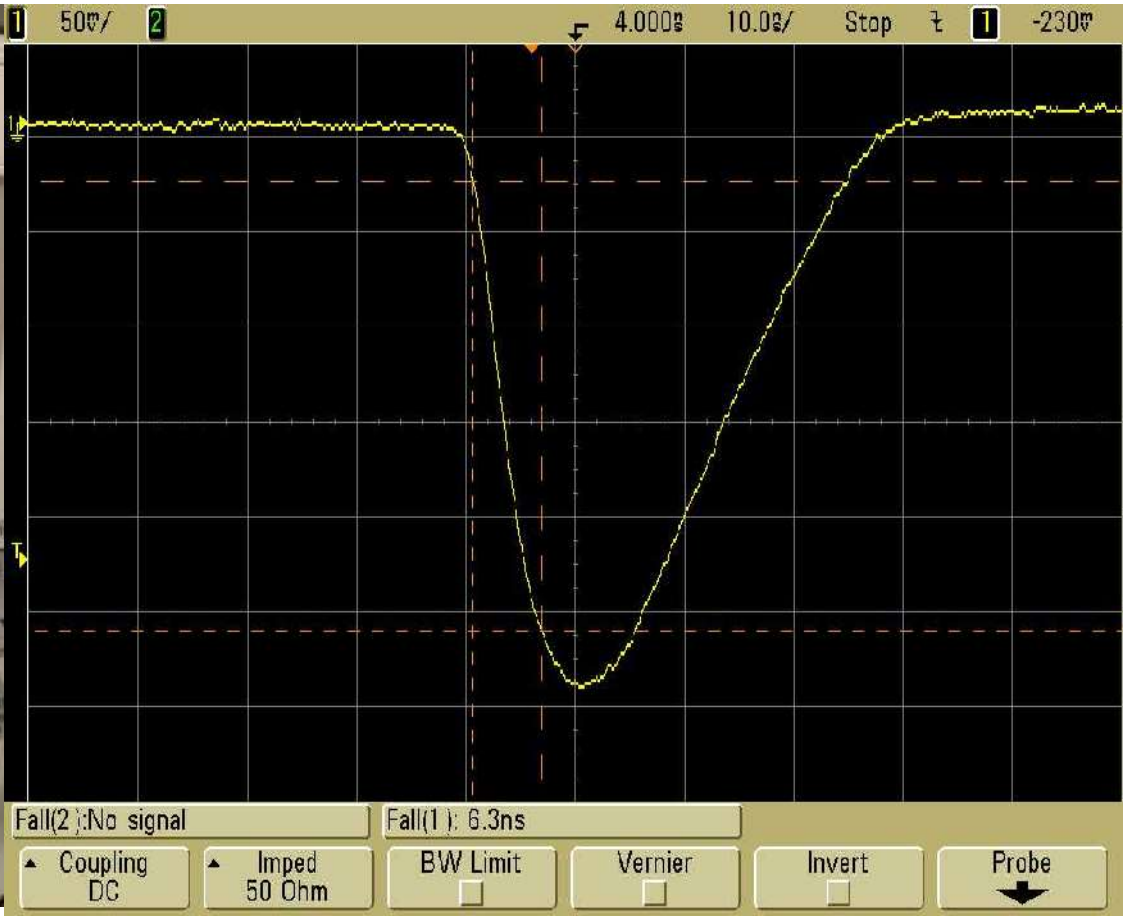




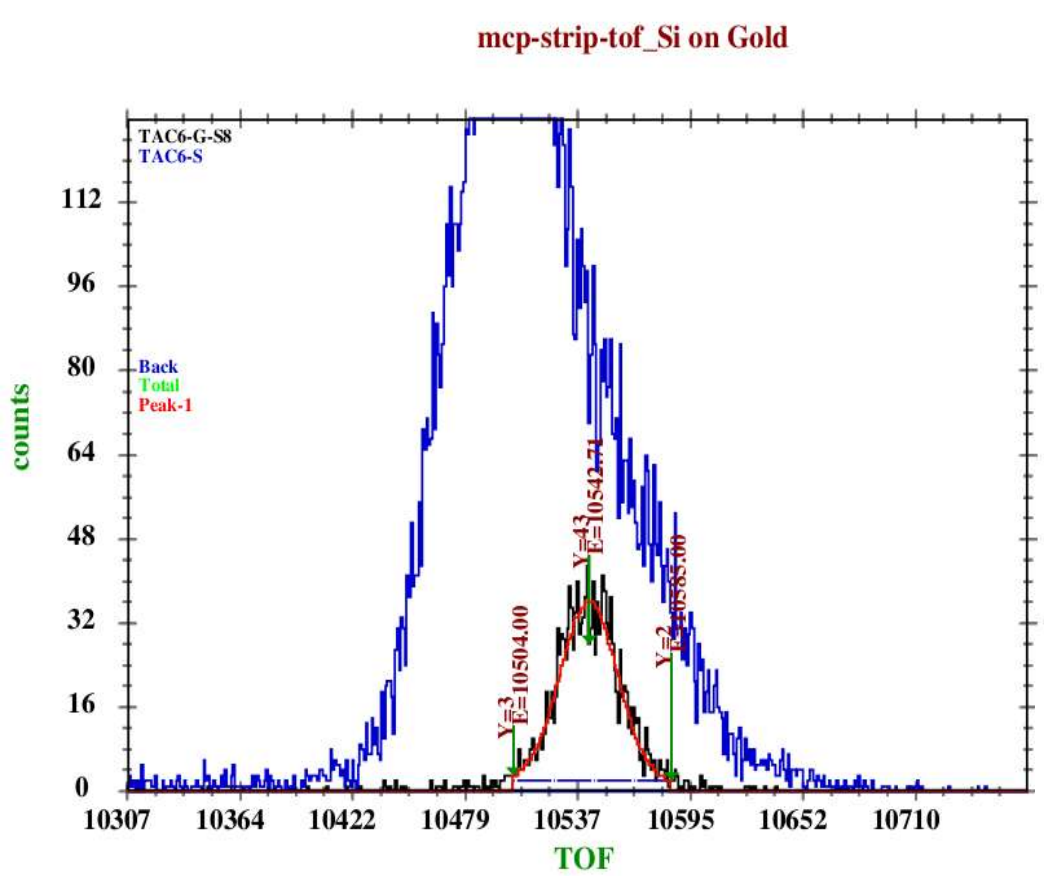
Feedthrough Flange



Alpha particles

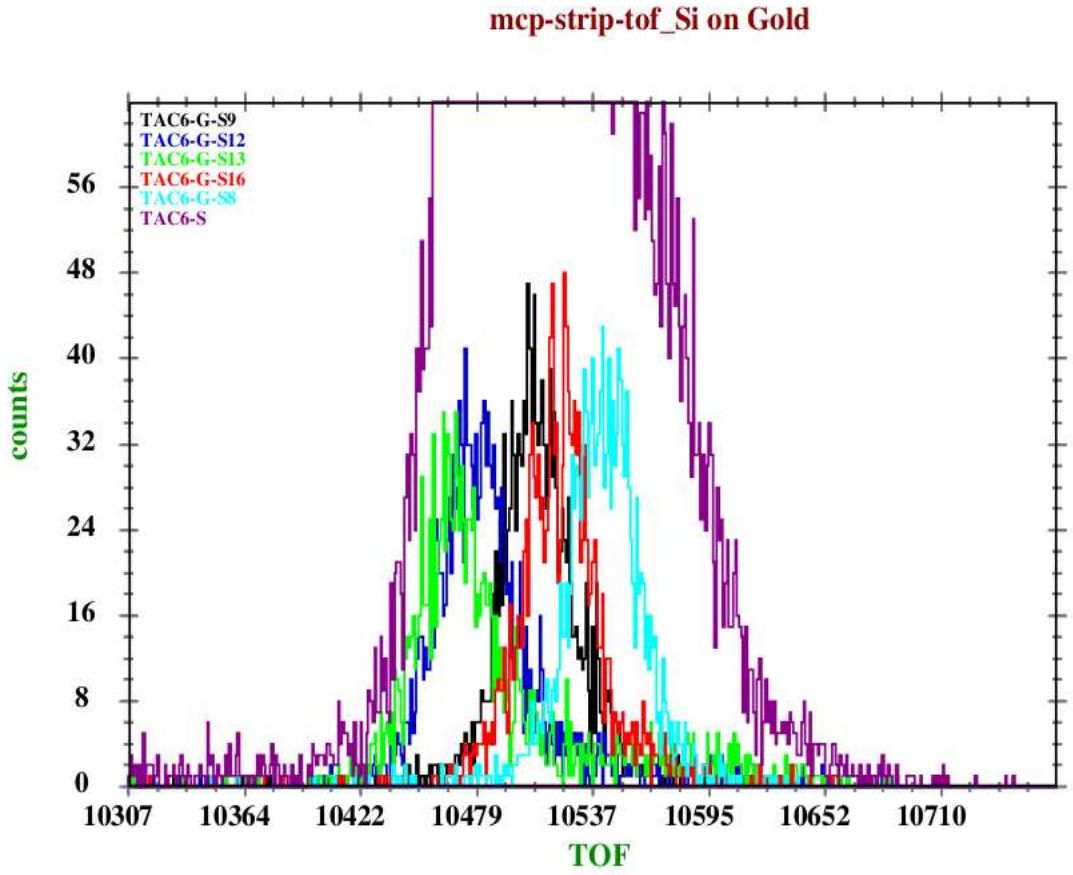


Silicon Beam



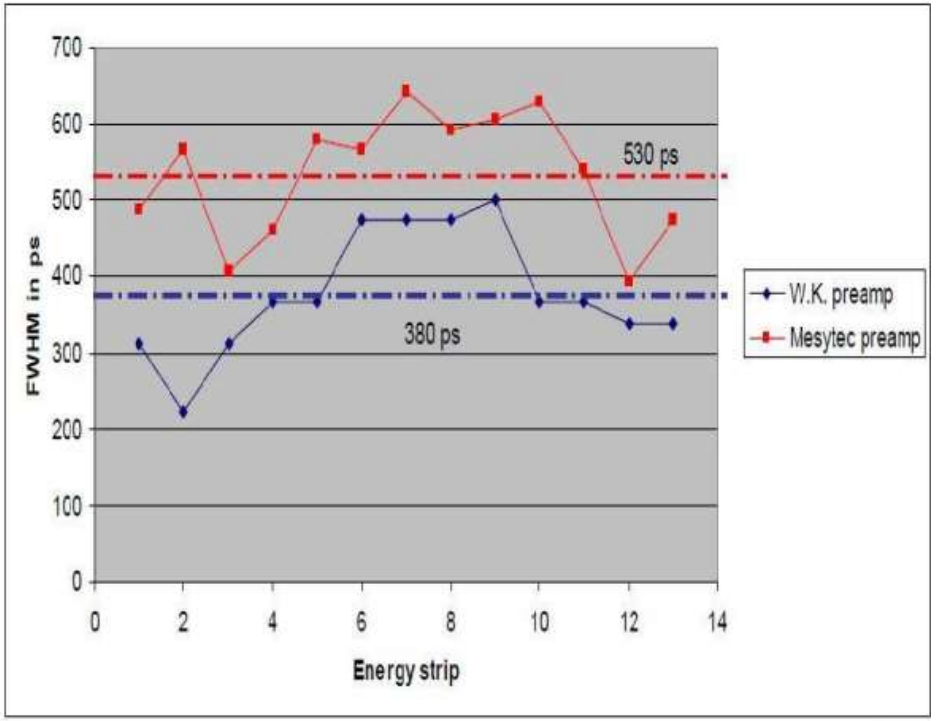
122 MeV 28Si on 197Au
Flight path 15 cm

Propagation delay from
Pixel to pixel observed



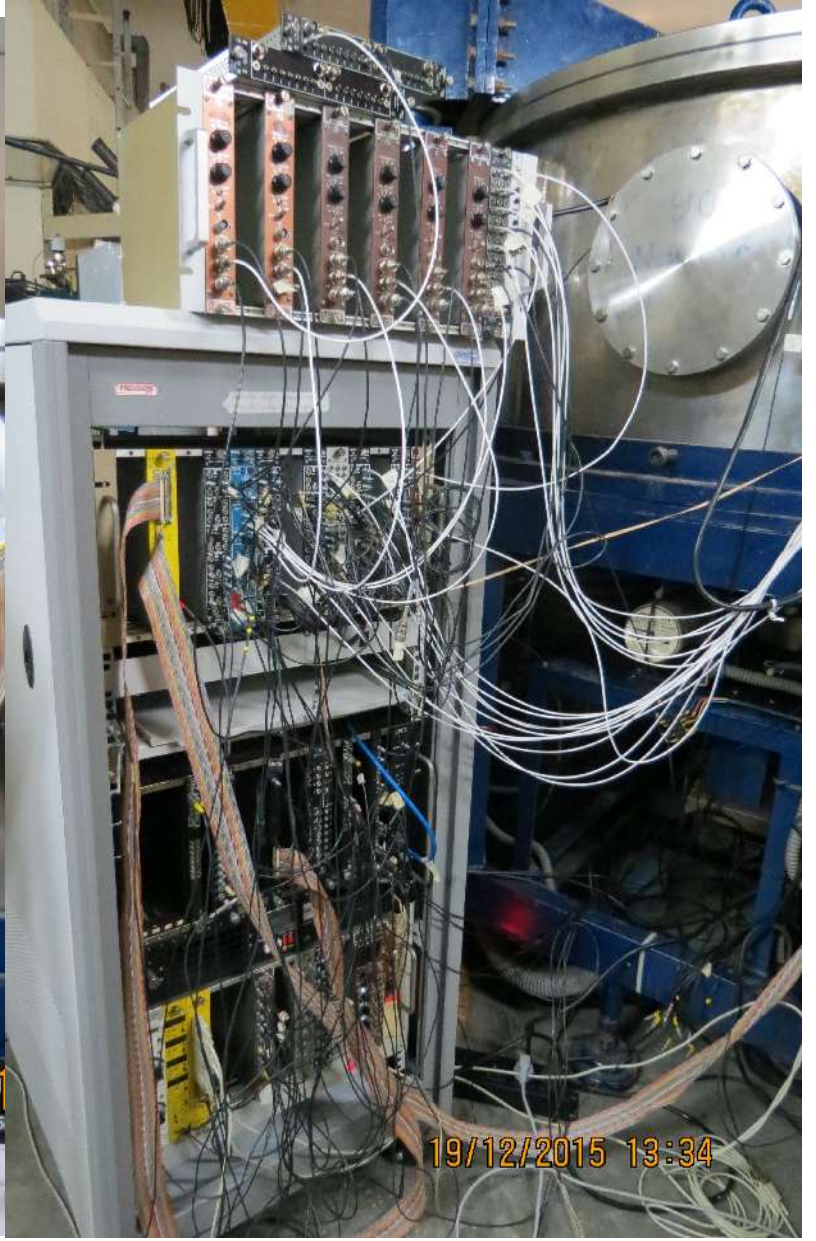
TOF res. for 1 pixel ~ 210 ps (fwhm)
MCP res. : 140 ps (fwhm)
Pixel res. : ~ 170 ps (fwhm)

Fast timing with Si-detectors



- MFA-32, Mesytec
- 32ch fast preamplifier
- Eight fast outputs
- Position obtained through readout of a resistive chain

Measurements performed with 265 MeV 48Ca on 197Au at 20 degree X7, UNILAC, GSI



Local DAS in GPSC

Test Measurements

Test measurements perfromed at CAVE 'C' facility GSI

124Xe beam at 200 MeV/A provided by UNILAC-SIS18 synchrotron

Beam intensity – 10^5 – 10^6 pps

Beam exits accelerator through 50 um SS window.

Beam travels in air through plastic scintillator and Al degrader

Plastic scintillator provides master start for TOF signals

Al degrader thickness ~ 650 mg/cm^2

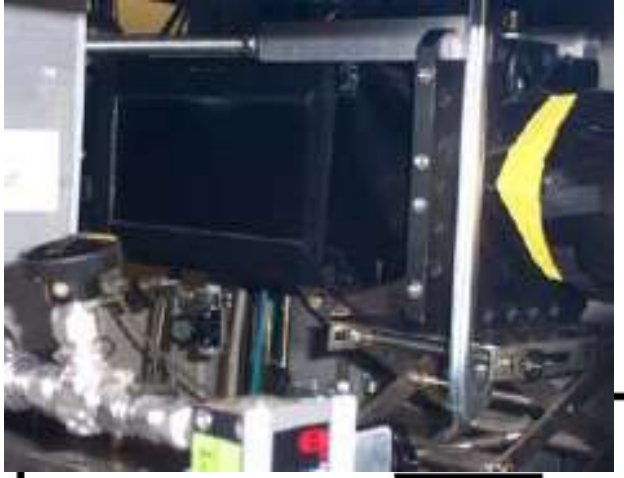
Enters detector chamber through 125 um Ti window

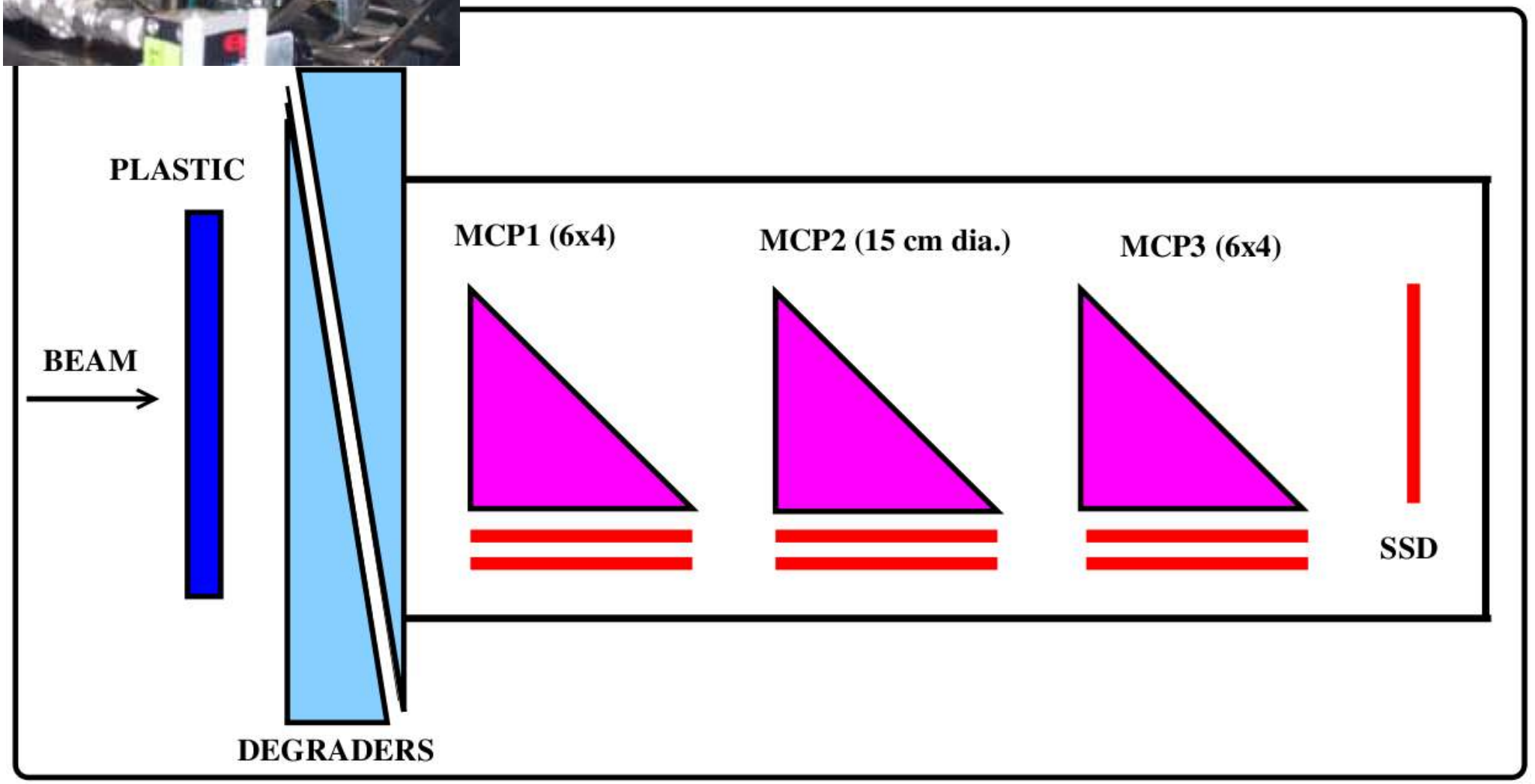
Detector chamber has 3 MCP detectors and one Si detector.

Si detector : 300 um (5 x 5 cm2) for one measurement

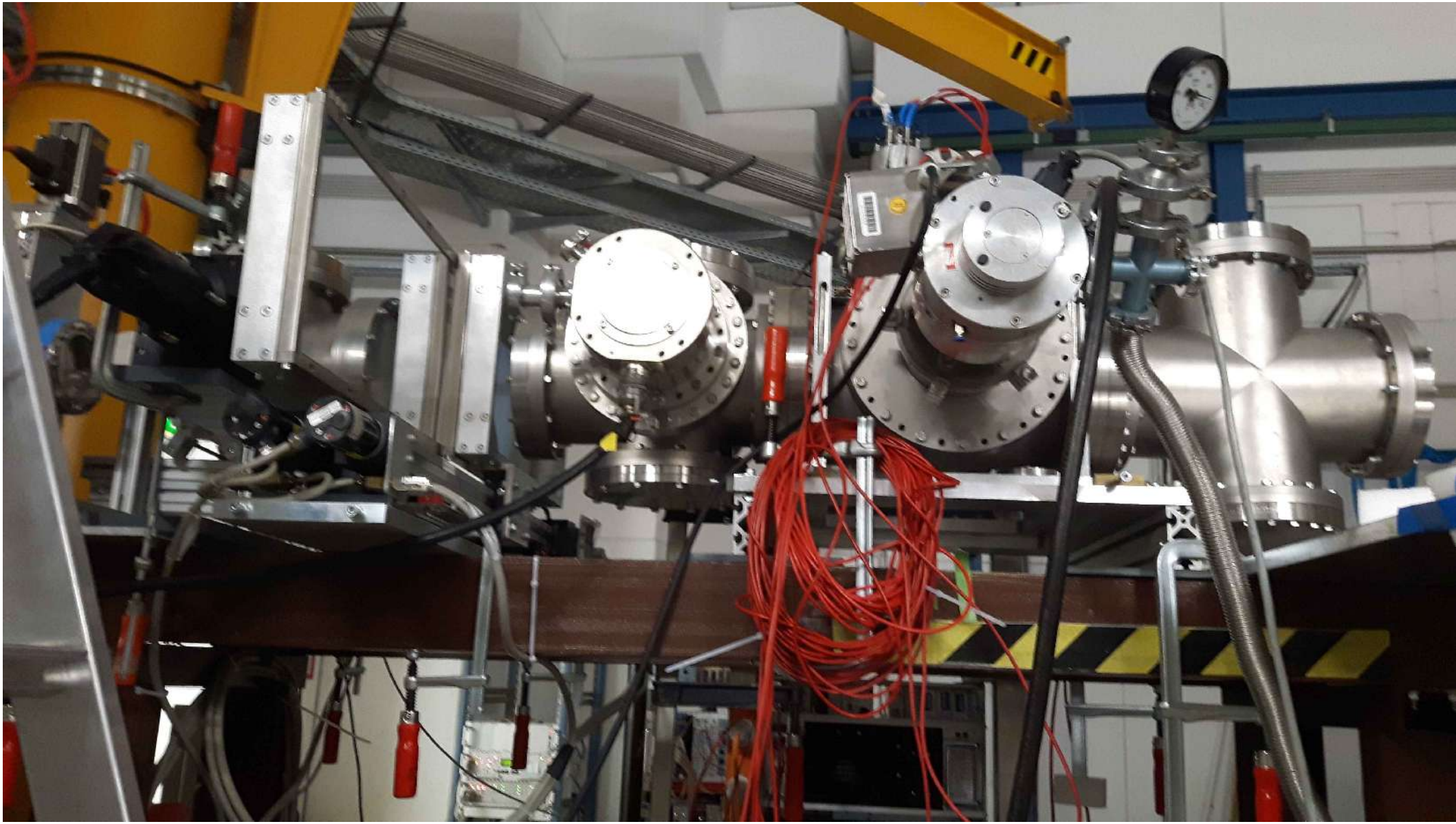
20 um SSSD for second measurement

20 um SSSD : 16 strips on junction side, back side plane.

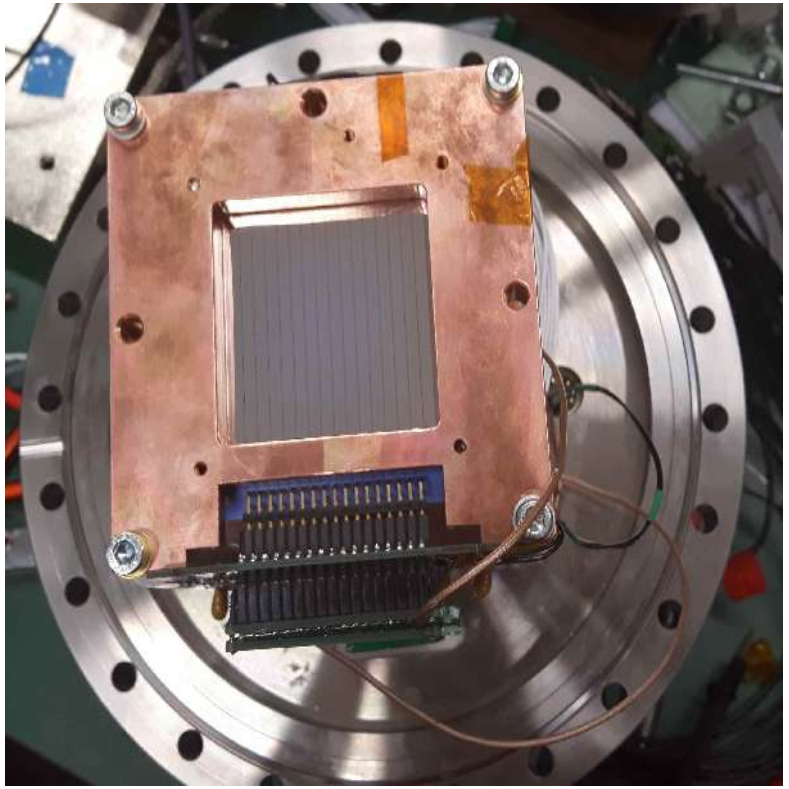


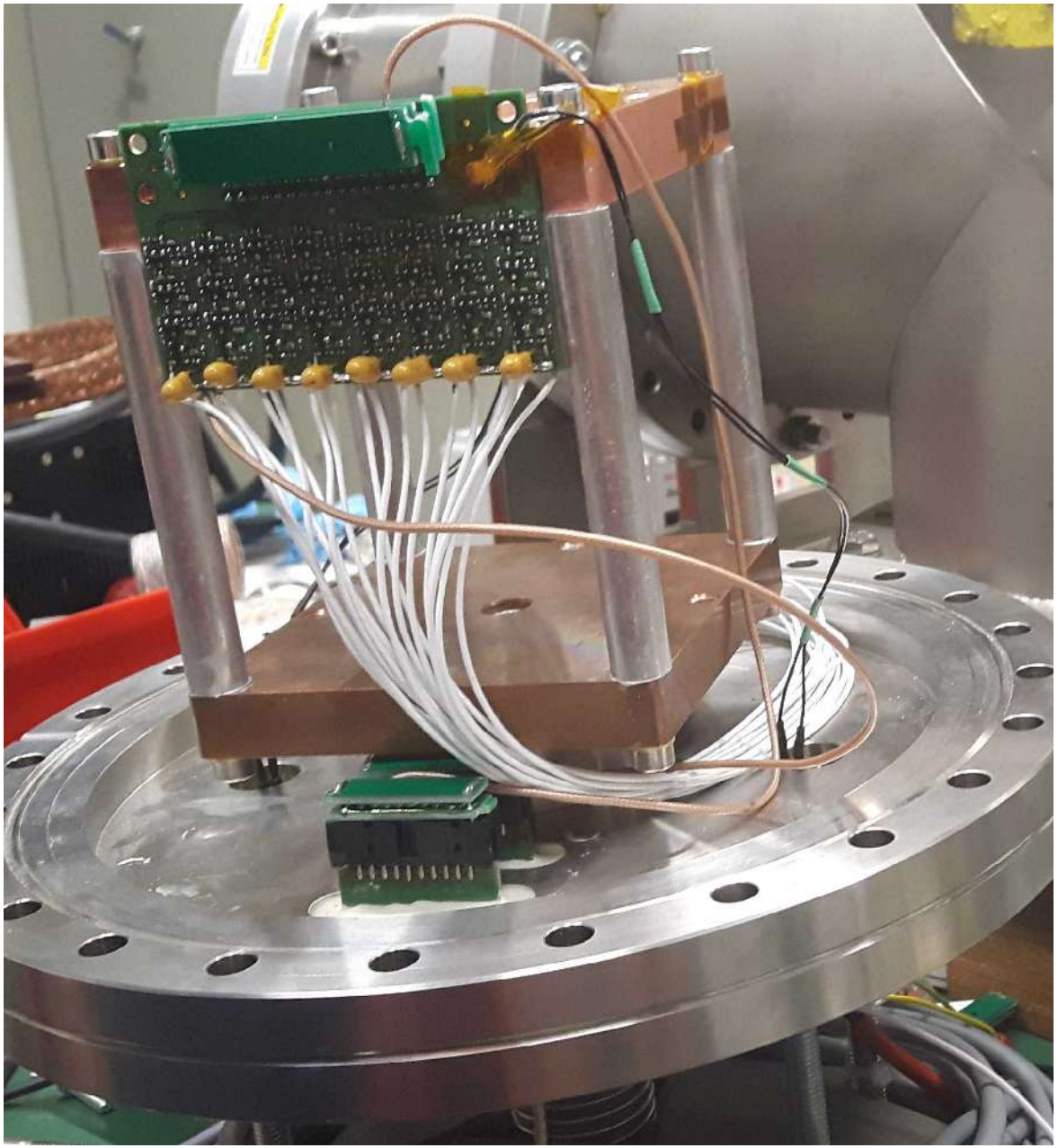


Schematic of the test set up at CAVE'C' at GSI with 200 MeV/A 124Xe beam
Beam Intensity : 100,000 pps

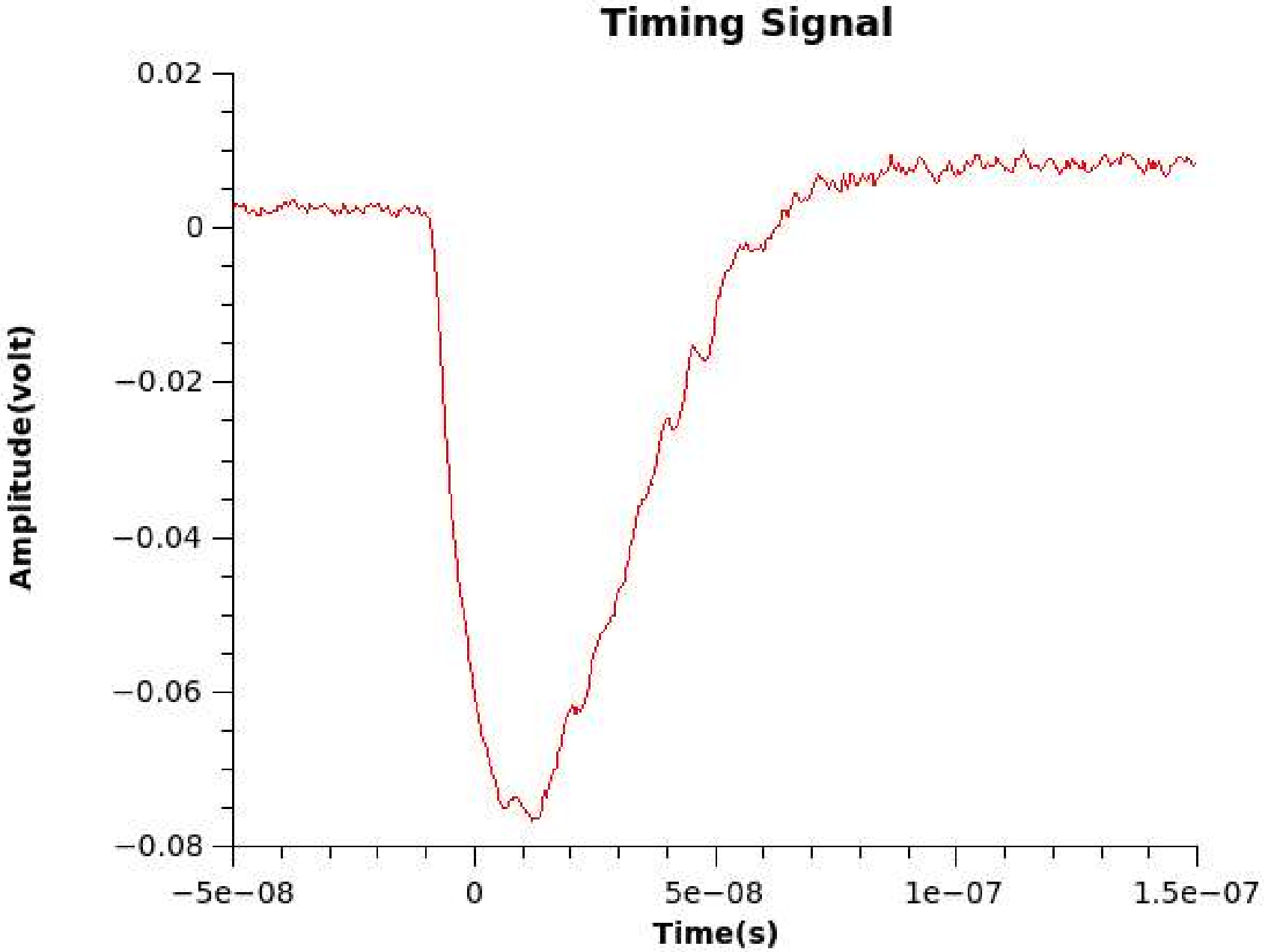


Setup at CAVE 'C' after SIS 18 at GSI

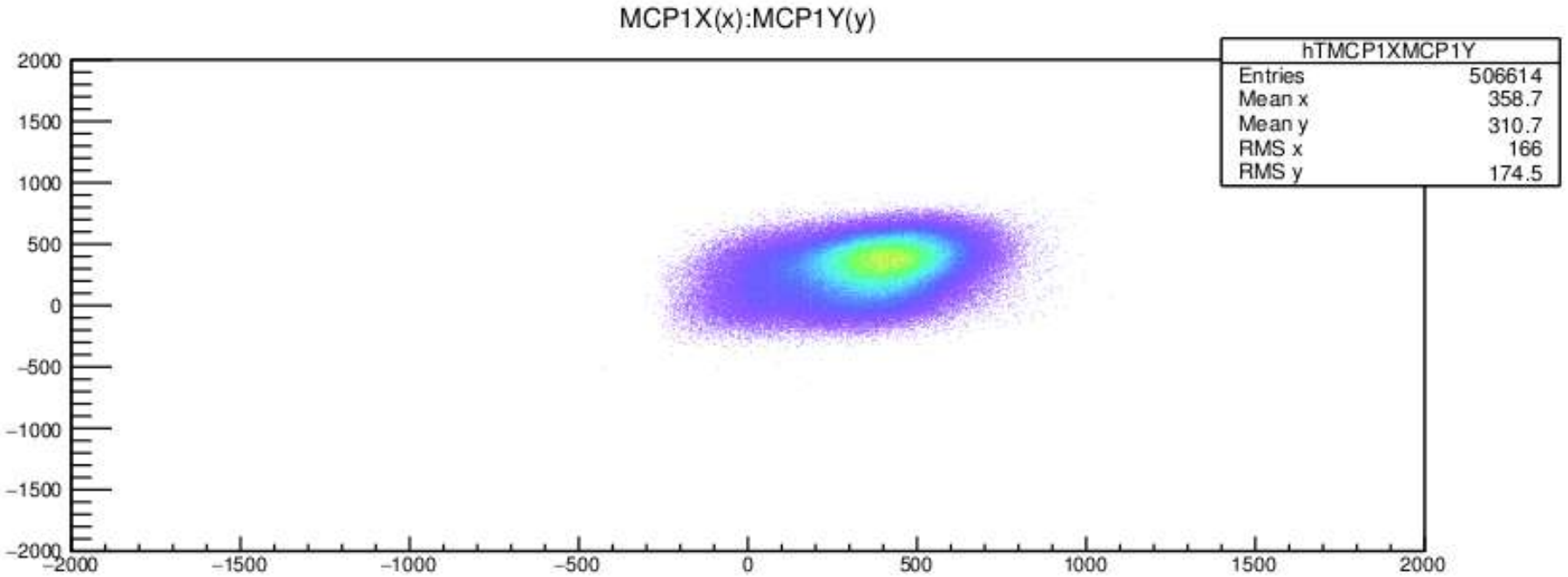


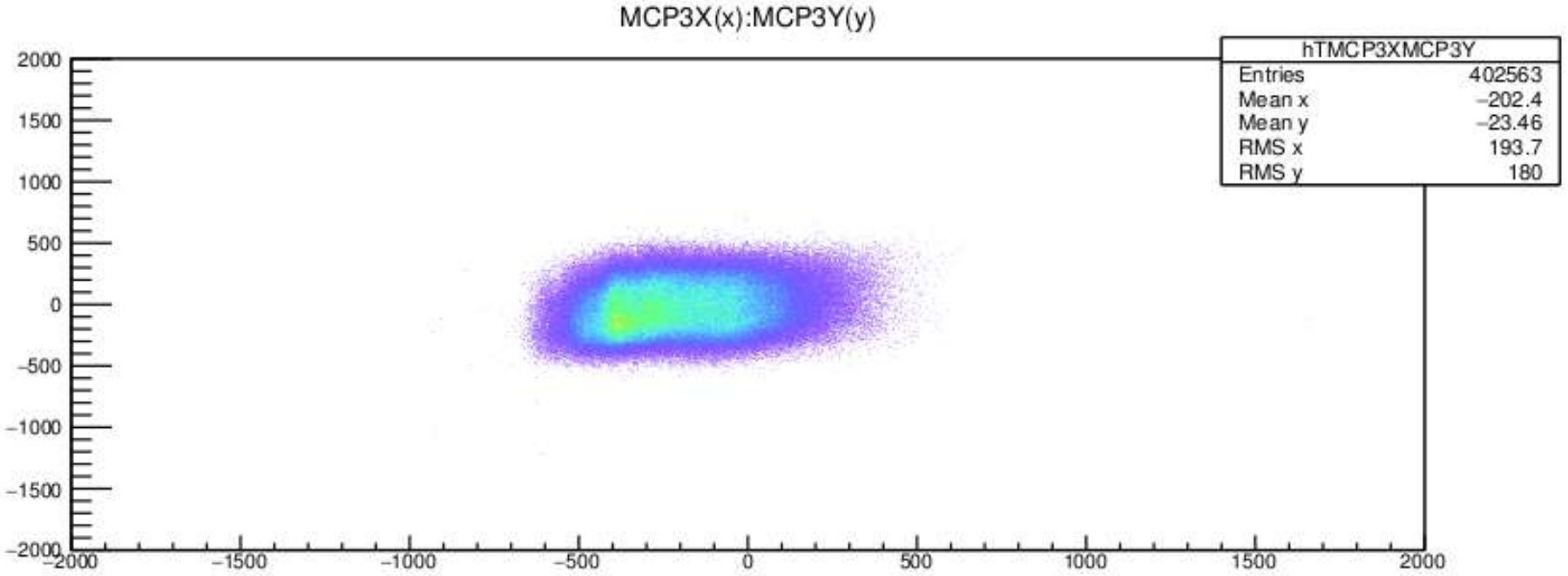


20 um SSSD with cooling arrangement



Timing signal from 124Xe beam with 20um SSSD

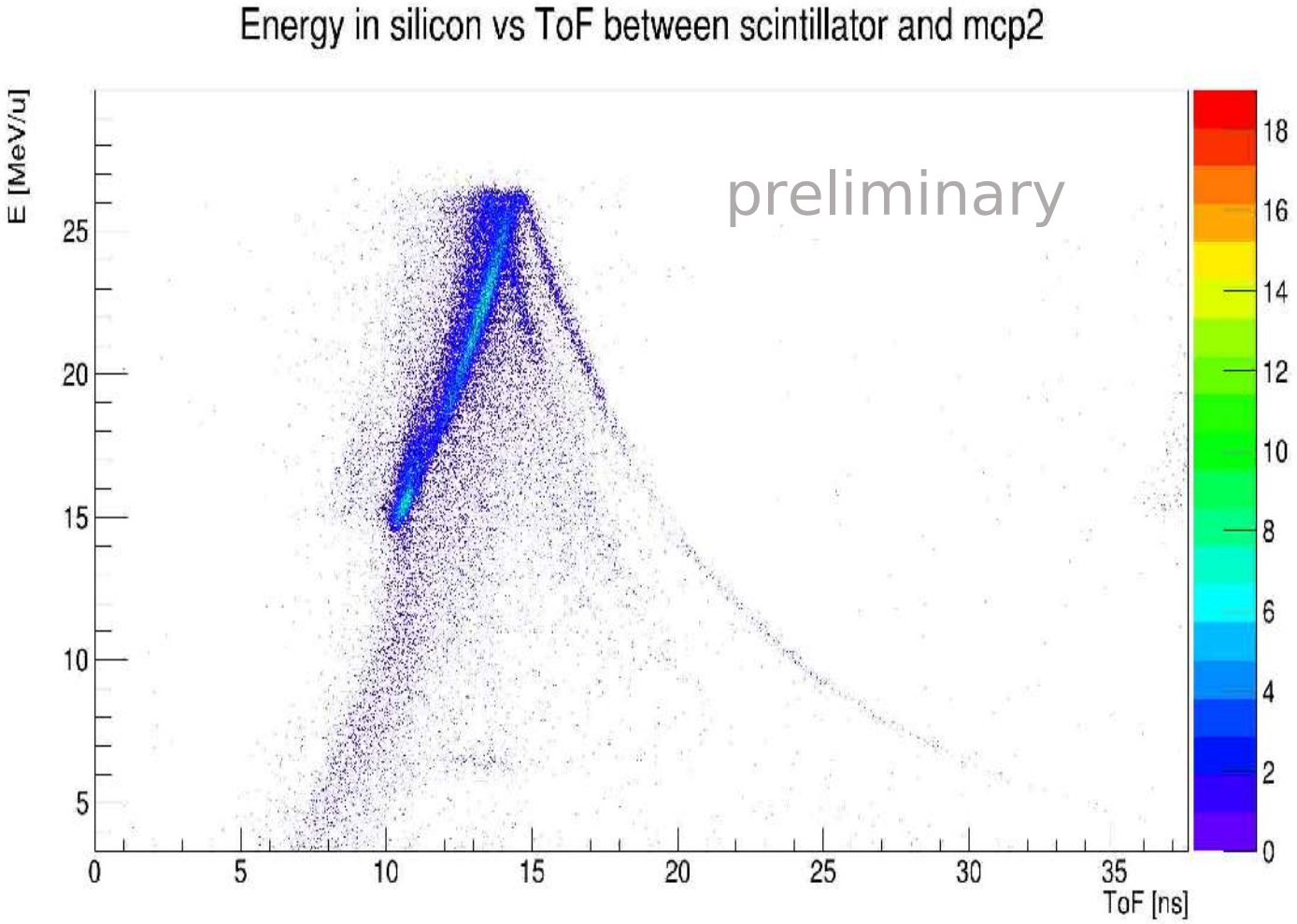




Position plots from the MCP

Result of degrader scanning

- 124Xe Beam slowed down from 200 MeV/u in Al degrader



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