INGA & NAND Instrumentation at IUAC

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Co-authors

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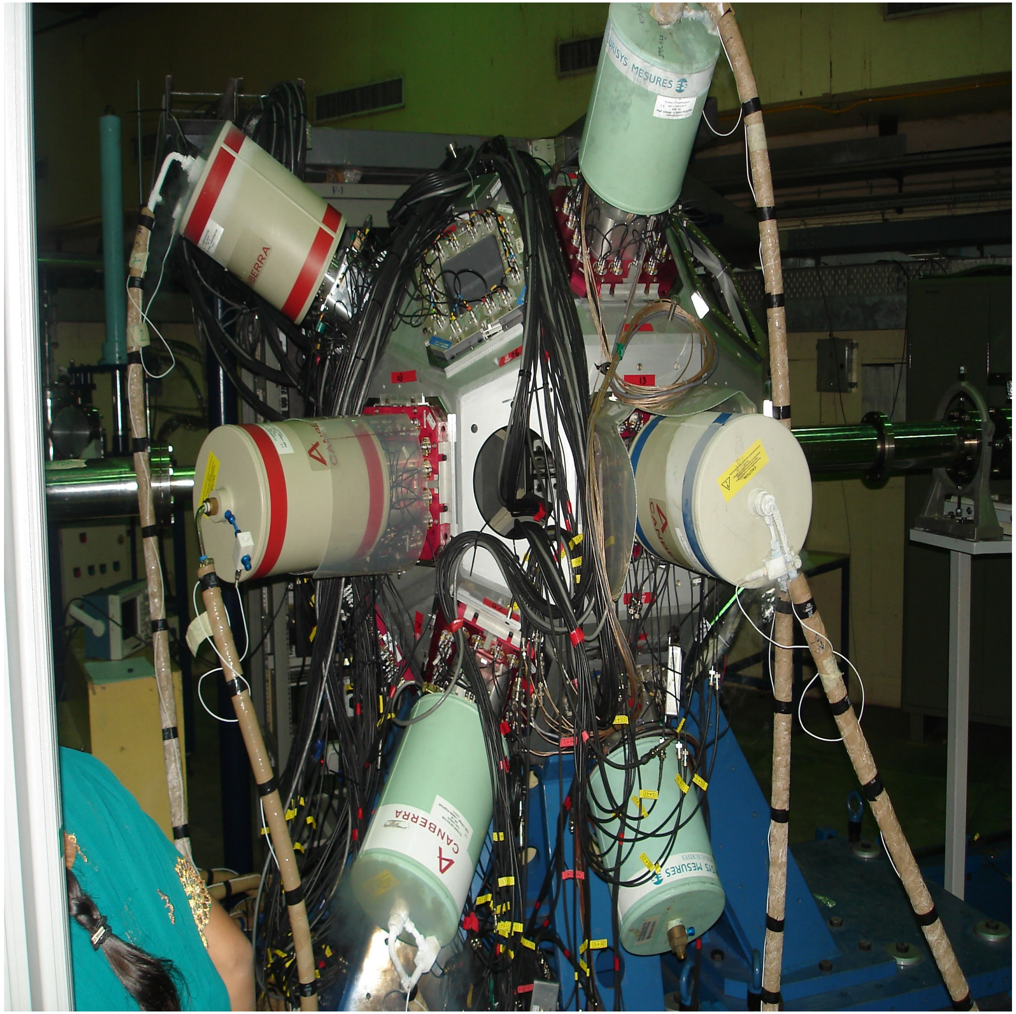
Design, Development & Implementation of

* Compact & High density Electronics
* Front end Analog & Logic circuits
* Pre-amplifiers, Shapers, TFA, CFD, TAC...
* Replacement for Commercial units
* Implementation for Large scale for Arrays
* Knowledge share & transfer

Why Develop Electronics here?

- Conventional NIM & CAMAC DAS set-up
- General purpose modules (commercial) are complex, under utilised
- Power, real estate, unreliable operation...
- Cost for large array
- Expertise.. in order to repair / maintain
- Develop Electronics as per user specifications with Performance at par commercial units
- >200 Signals (INGA), >140 signals (NAND)

INGA_ Indian National Gamma Array



- 24 Nos. Array of HPGe Clovers
- Compton Suppressed (ACS)
- National Collaborative Project
- IUAC, UGC-DAE, TIFR, BARC, SINP, VECC
- High quality signal Processing required
- Optimum utilisation of infrastructure

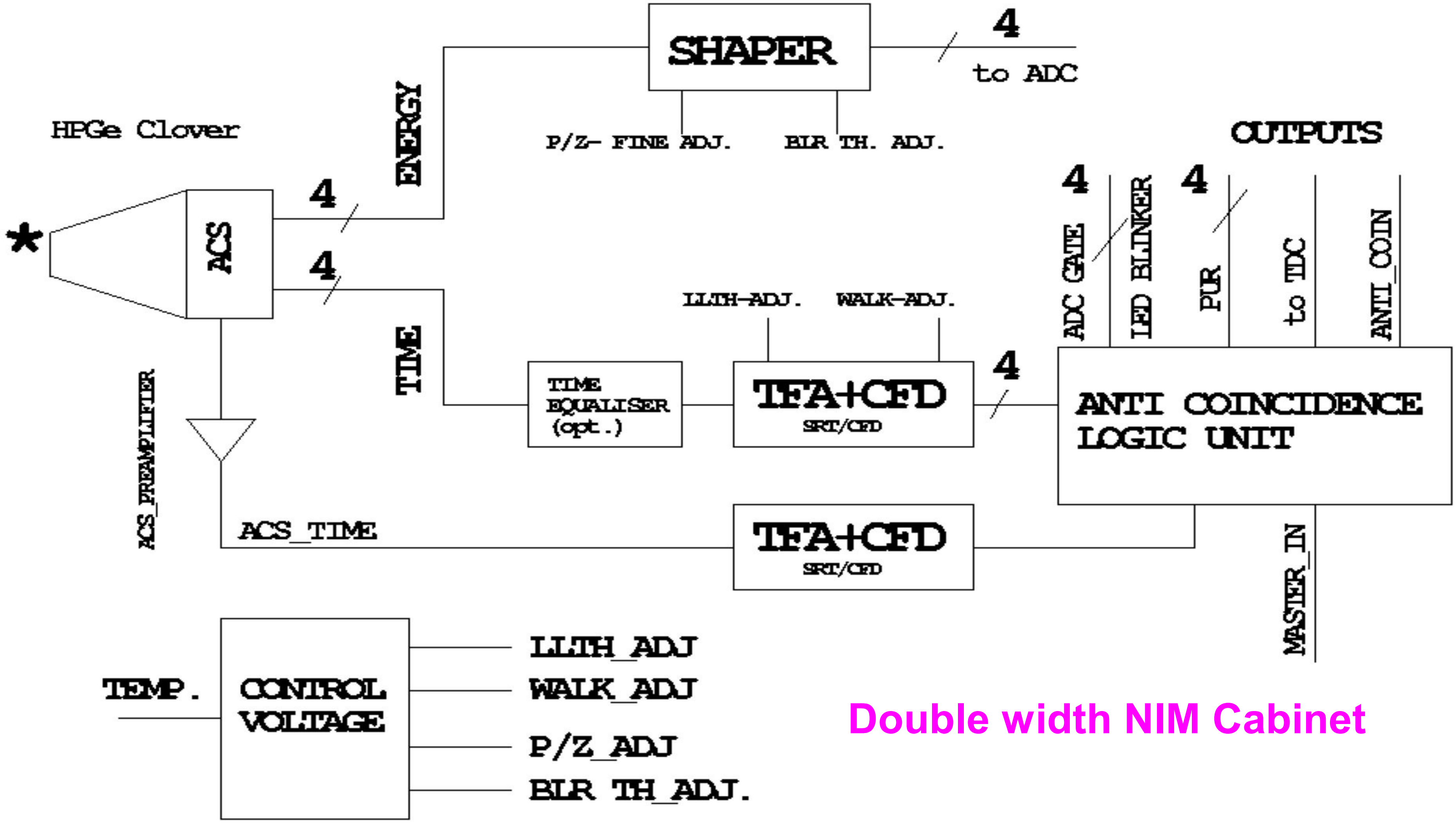
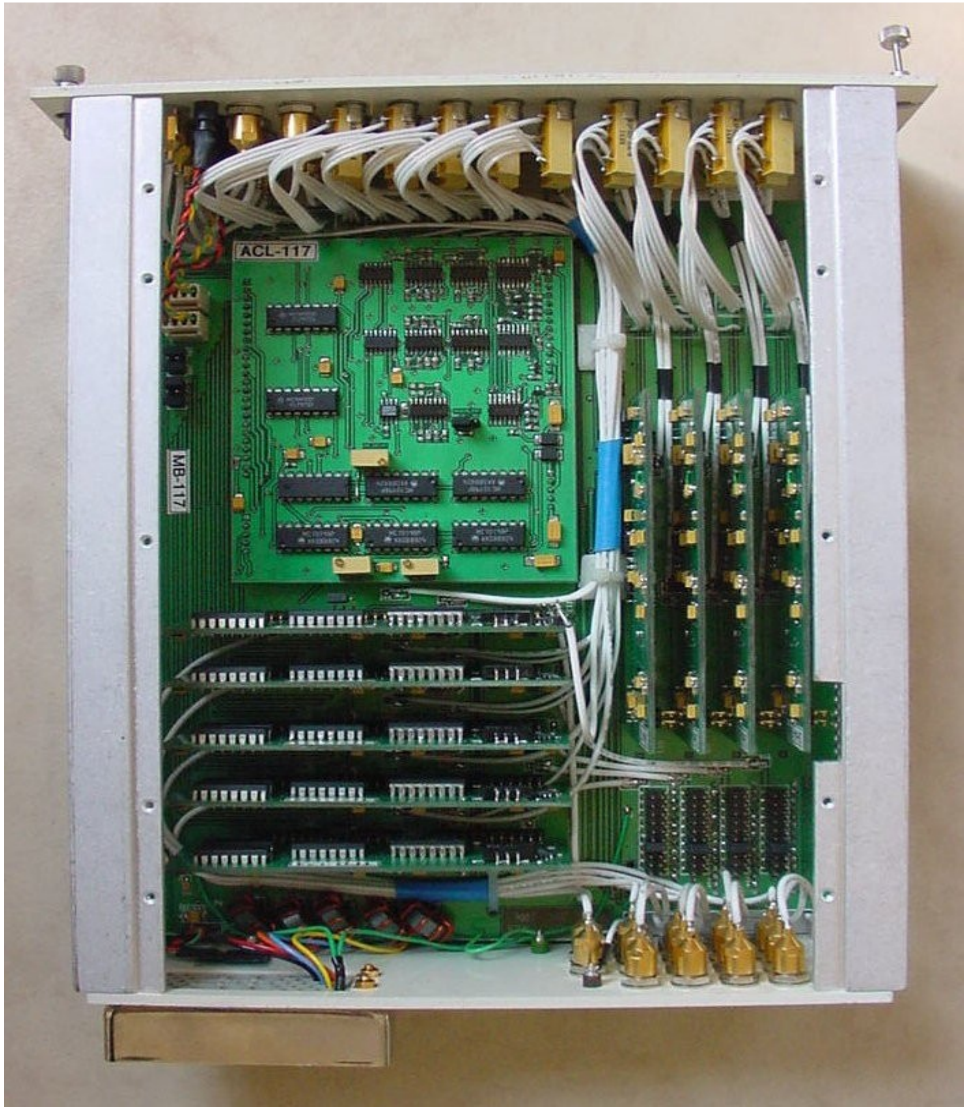


FIG: BLOCK DIAGRAM OF CLOVER ELECTRONICS

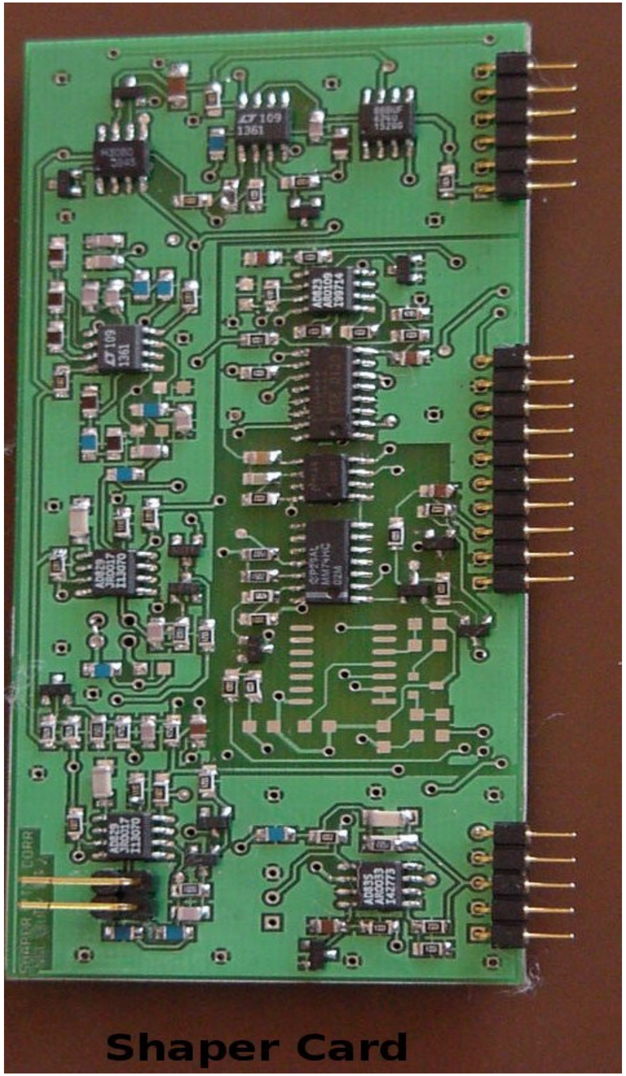
INGA-Clover Electronics Module

INGA - Clover Electronics Module



- Features
- Double width NIM module
- 4 Modules in a NIM (200W) crate
- 4 Nos. Shaper cards..
- 5 Nos. Timing Filter Amplifiers + CFD cards
- 1 Anti coincidence logic card
- Motherboard..Interconnections high stability Control voltage generation, DC distribution..
- Time equaliser- Propagation delay equalisation
- 2 Layer PCB for easy duplication

Spectroscopy Amplifier



- 3µS, semi-Gaussian shaper (uniPolar)
- 3 gain ranges (2/4/6MeV) ~10V
- OL recovery
- Gated BLR (manual setting)
- Voltage controlled parameters are BLR LLTH, P/Z Adjustment
- PUR built-in Indication Logic
- Size: 4” x 1.5” x 1/2”

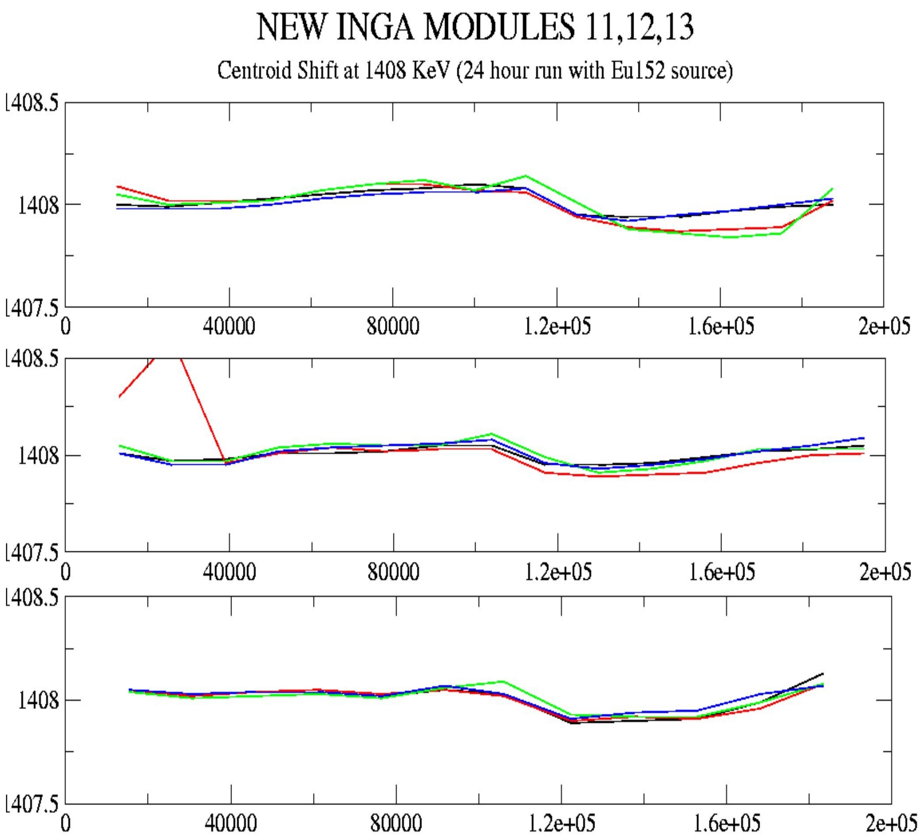
Shaper-Performances

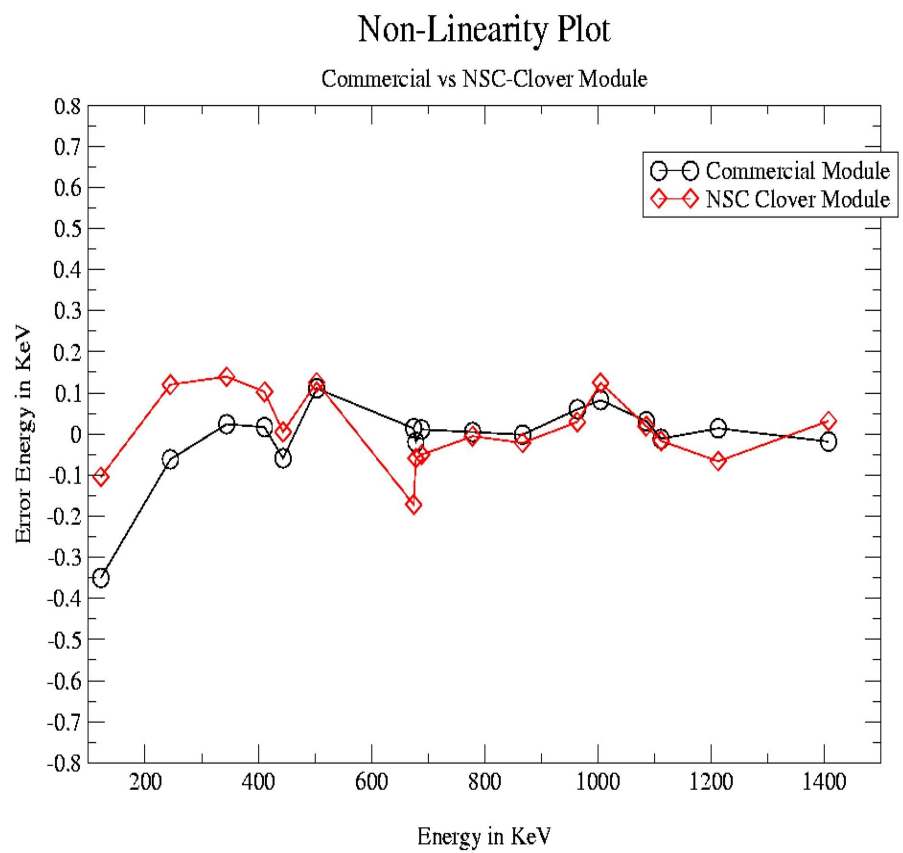
Tested with HPGe Clover- ^{60}Co, ^{152}Eu ~9Kcps

Resolution: **1.3KeV @122KeV,**
2.0KeV@1408KeV

Linearity: **+/-100eV ie. ~0.01%**

Peak Shift: **Better than 0.025%shift in 24 Hrs for 1408keV peak**





TFA + CFD Card

- Optimised for HPGe Clover
- Fixed ζi, ζd constants
- Fixed gain 1V/MeV (-2.5V)
- BLR_ Robinson diode type
- Td: 25 nS, F=0.3
- LLTH : 1:100
- Tblock = 1.5μS
- 2 Nos CFD (F_NIM)
- ACS type : Prompt only (500nS)

Anti-Coincidence Logic

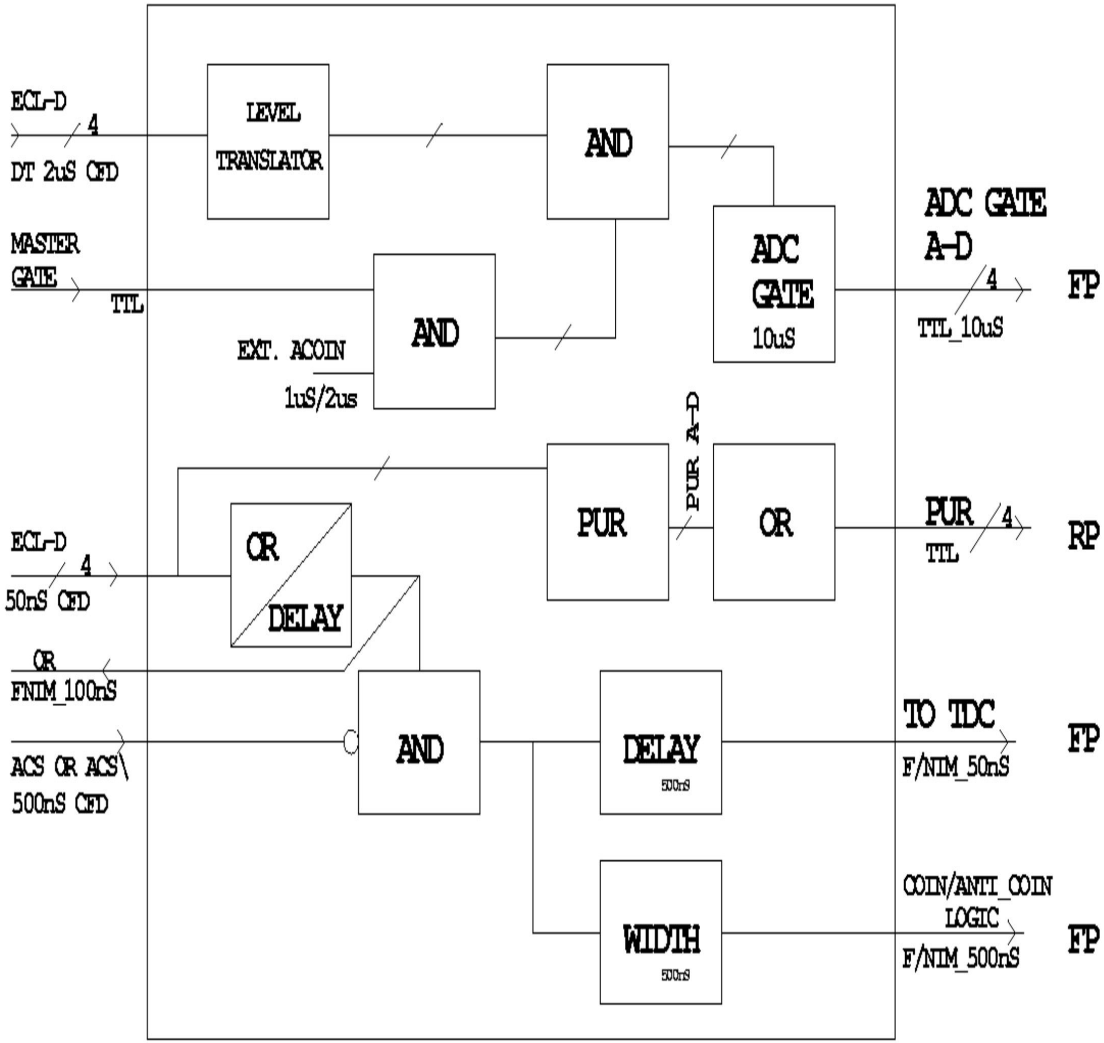
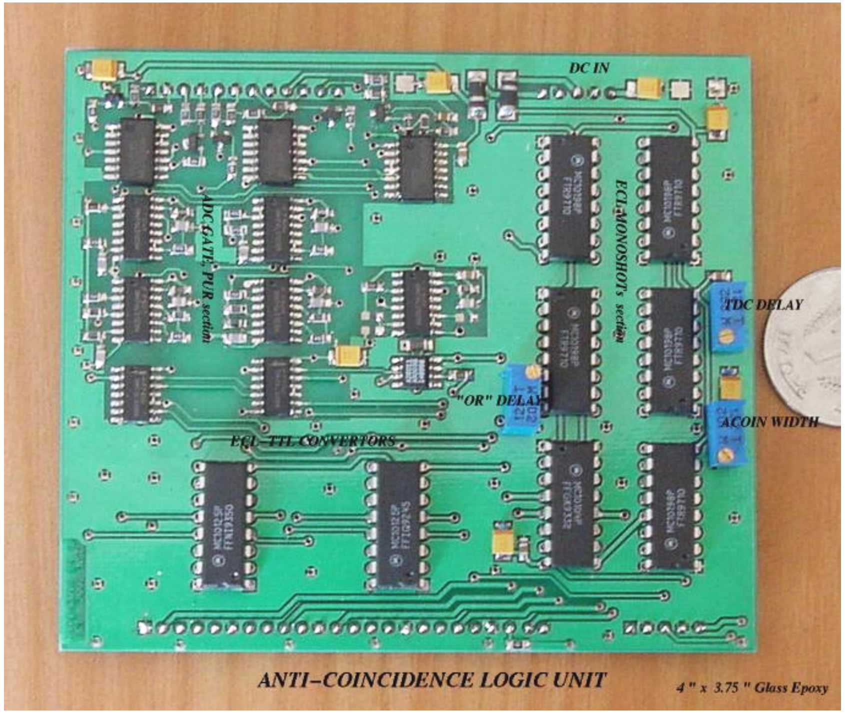
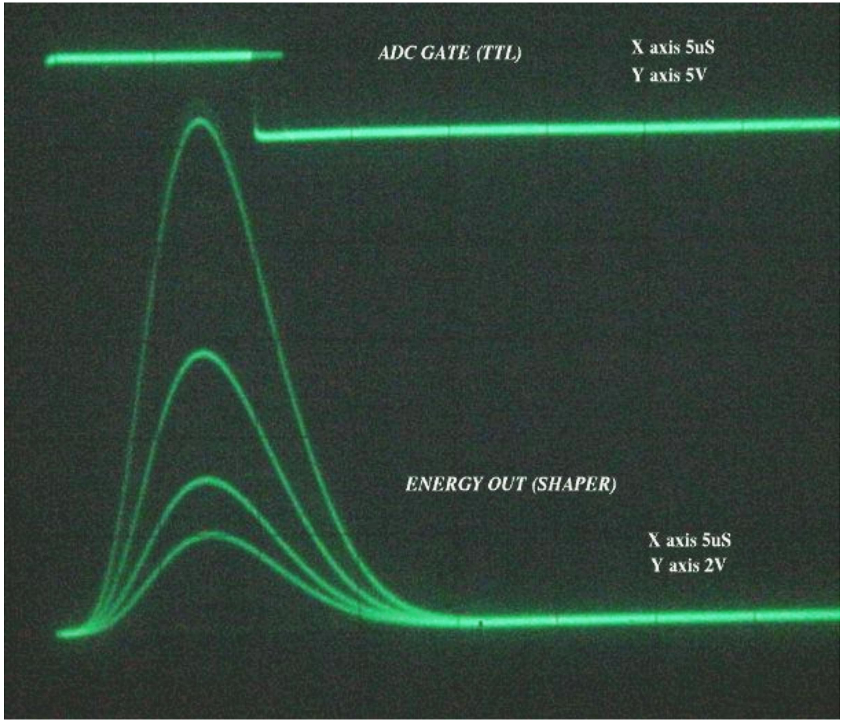


FIG: BLOCK DIAGRAM OF COIN/ANTI_COIN LOGIC CIRCUIT

- Raw Timing HPGe & ACS are processed for PTR
- Anti-coincidence between HPGe - AC Shield is indicated
- MASTER GATE Accepted
- OR_ Prompt, TOF logic generated
- Individual ADC GATE, PUR logic
- LED indication





ACLogic card, ADC Gate, Unipolar output

IUAC INGA
7
INGA
CLOVER ELECTRONICS
BUSY
P/Z_M
BLR
P/Z_ADJ
ENERGY
WALK_M
LLTH_M
WK_ADJ
LLTH
TIMING
TFA_M
ACS
LOGIC
OR
A_COIN
TDC
MASTER_IN
GATE
EOUT
IUAC
LABEL HERE
19
4
16
TEMP.
WARNING
POWER
ON

Status

- Successfully used with INGA campaign at VECC
- Part of Super clover detector at GSI, Germany
- Modified version have added features
- Mass produced with better exterior finishing for INGA at IUAC
- Know-how shared with collaborators
- Superior quality Shaper for LEPS being developed

NAND-National Array of Neutron Detectors

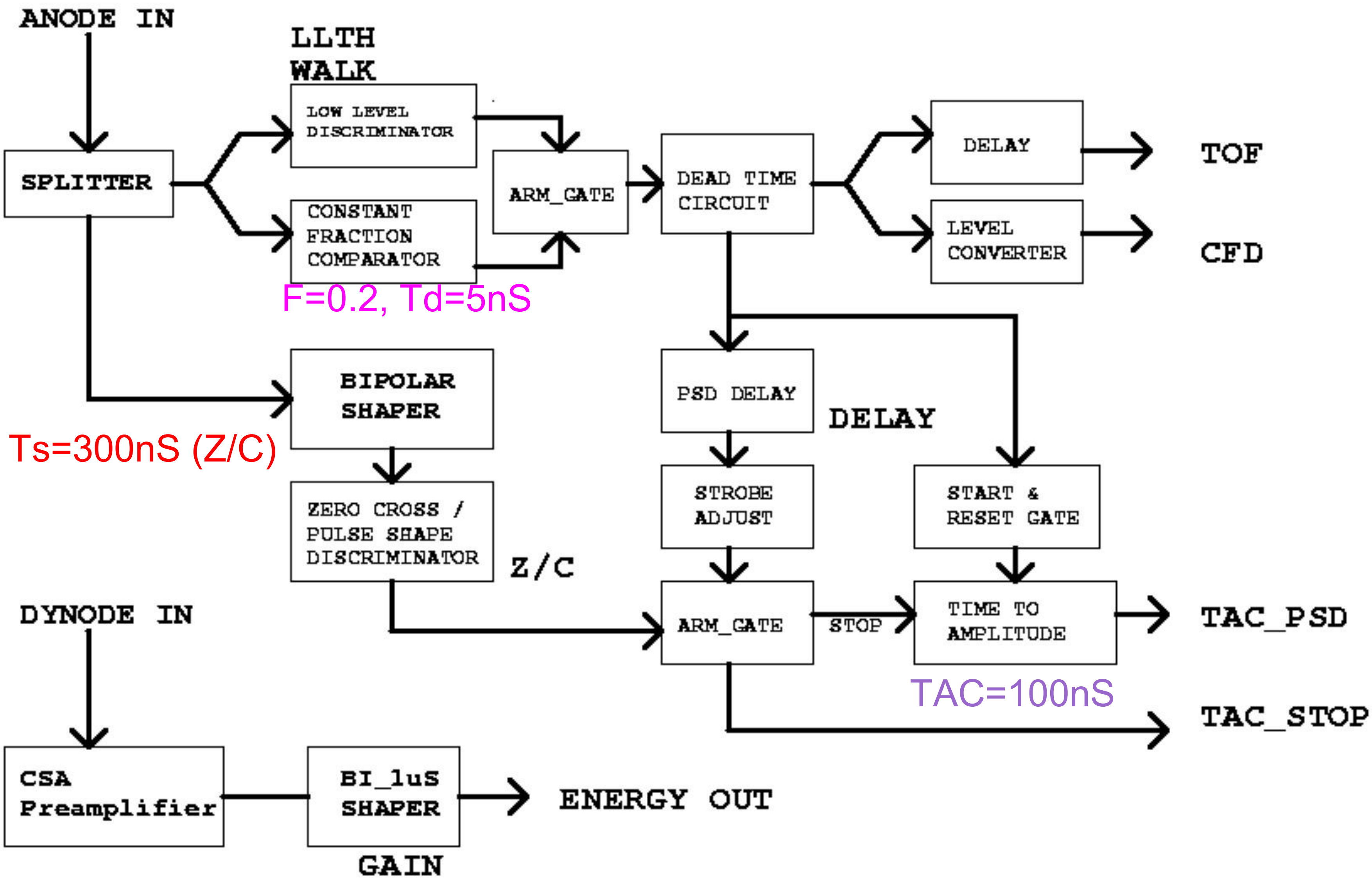
- ~30nos. Neutron detectors with LINAC
- 5"x5" NE213 Scintillation detector, PMT: XP-4512B (Philips)
- High quality gamma, neutron separation
- Zero-cross technique PSD
- Compact (1W-NIM), cost effective electronics

NAND Electronics Module

- 1 width NIM Module, 2 Channels
- Energy & Timing signals processed
- Shaper for Dynode signal- 'E'-Calibration
- C F Discriminator
- Pulse Shape Discrimination (Z/C method)
- GDG, Built-in TAC$, TOF Logic

  – $ **BARC developed BMC 1522 (BEL) ASIC**

Fig: Block Diagram of PSD Electronics_IUAC

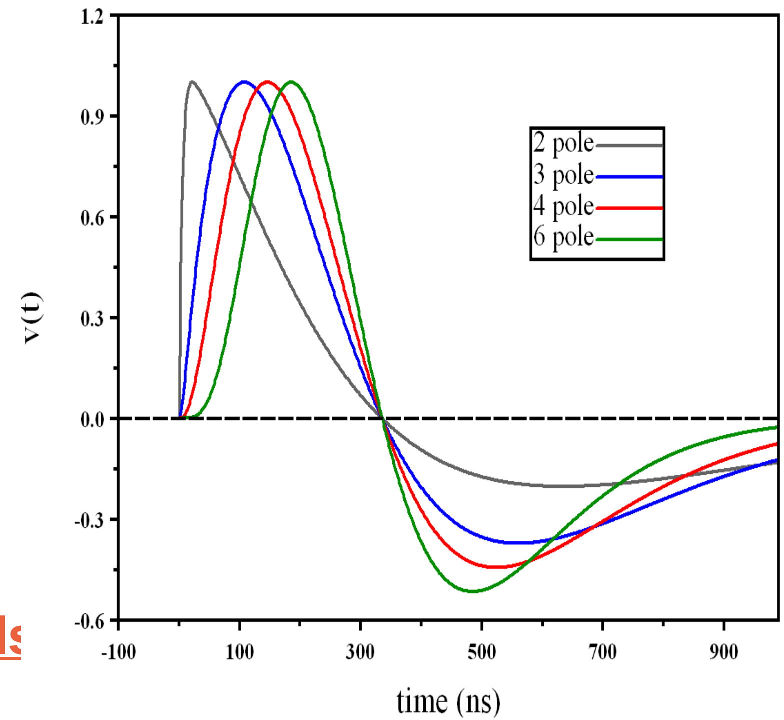


Zero Cross Method

* Large Dynamic range

* Requires Timing electronics

* Incorporates TOF measurements



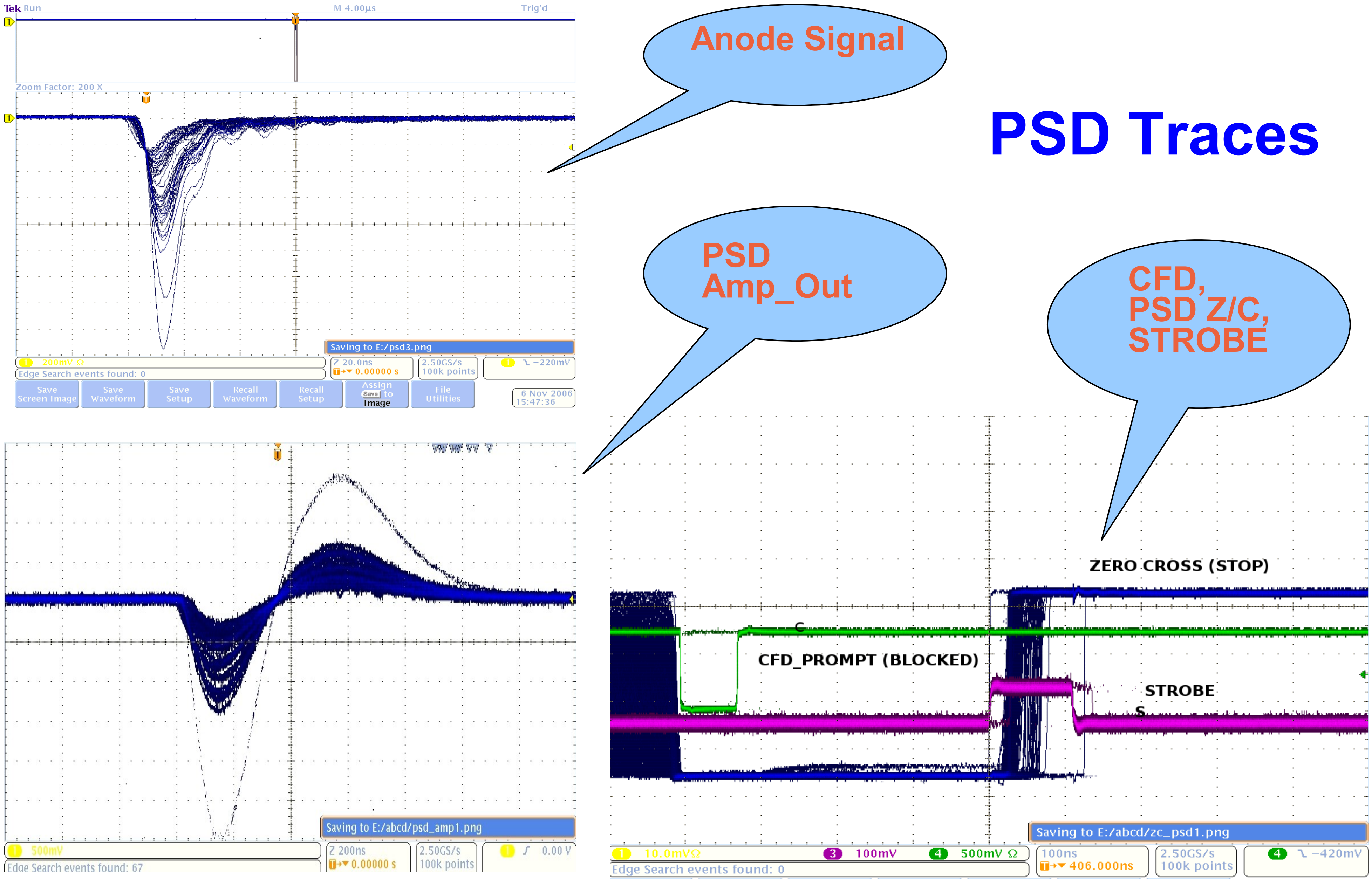
Differentiation- Bipolar & Zero cross over Puls

Different ζdecay pulses cross ZERO LINE @ different times
Optimum Pulse shape ~300nS (ζs-Z/C) generate STOP for TAC

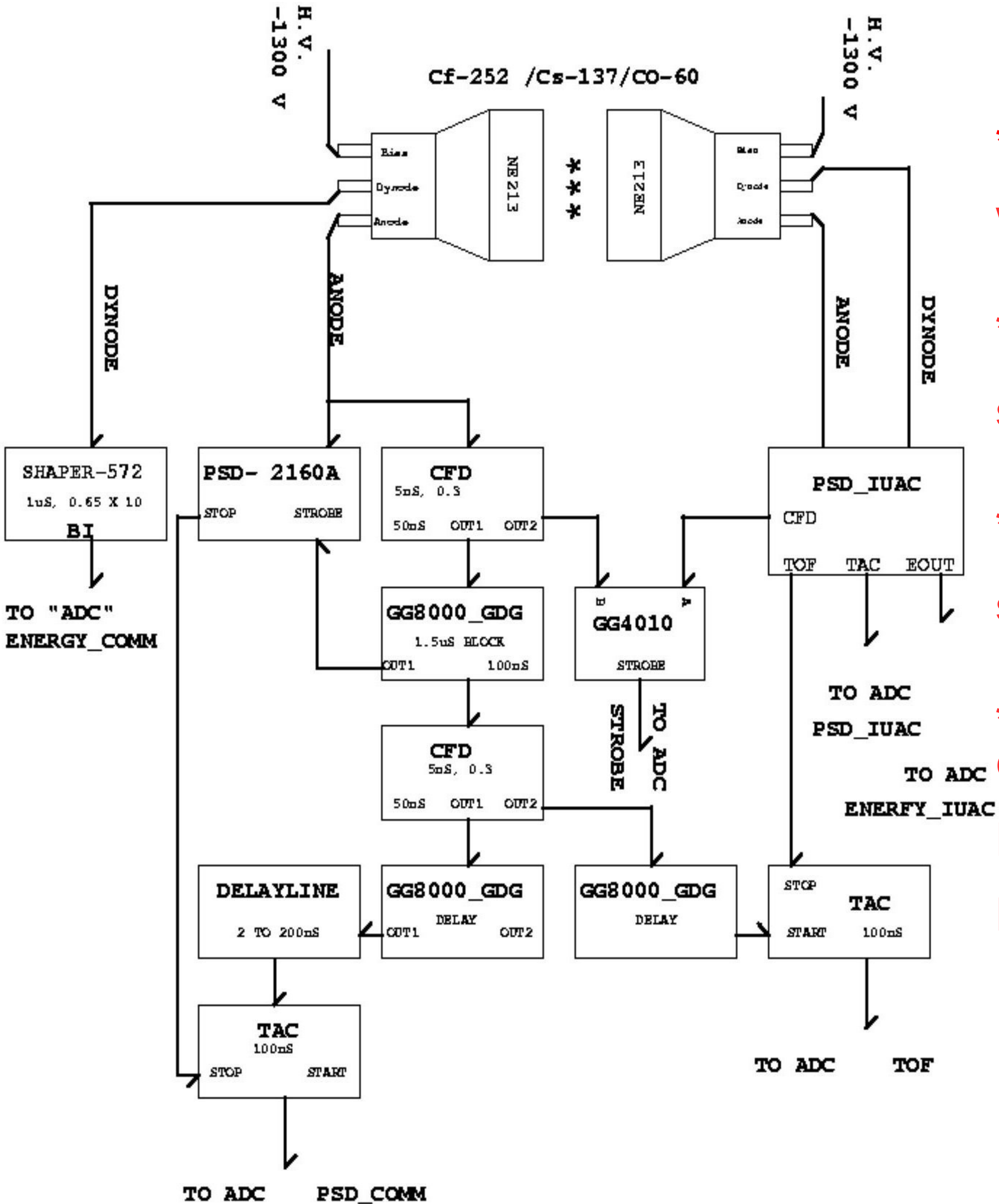
TIME Reference: CF Discriminator for START/GATE generation

TAC: Linear Spectrum corresponding to gamma & neutron

PSD Traces



Anode Signal
PSD Amp_Out
CFD, PSD Z/C, STROBE
Tek Run
M 4.00µs
Trig'd
Zoom Factor: 200 X
Saving to E:/psd3.png
200mV
Edge Search events found: 0
Z 20.0ns
0.00000 s
2.50GS/s
100k points
-220mV
Save Screen Image
Save Waveform
Save Setup
Recall Waveform
Recall Setup
Assign Save to Image
File Utilities
6 Nov 2006
15:47:36
Saving to E:/abcd/psd_amp1.png
500mV
Edge Search events found: 67
Z 200ns
0.00000 s
2.50GS/s
100k points
0.00 V
ZERO CROSS (STOP)
CFD_PROMPT (BLOCKED)
STROBE
Saving to E:/abcd/zc_psd1.png
10.0mV
100mV
500mV
100ns
406.000ns
2.50GS/s
100k points
-420mV
Edge Search events found: 0



PSD Test Setup

* Pulse shape discrimination studied with ^{252}Cf spontaneous fission source

* Light out put calibration done with standard γ sources (^{137}Cs, ^{60}Co, ^{22}Na)

* Timing performance tested in TOF set up with fast plastic scintillator

* Compared performance with commercial modules

Figure of Merit (FOM) is

Peak separation / Fwhm γ + Fwhm η

PSD for Gamma and Neutron with different threshold

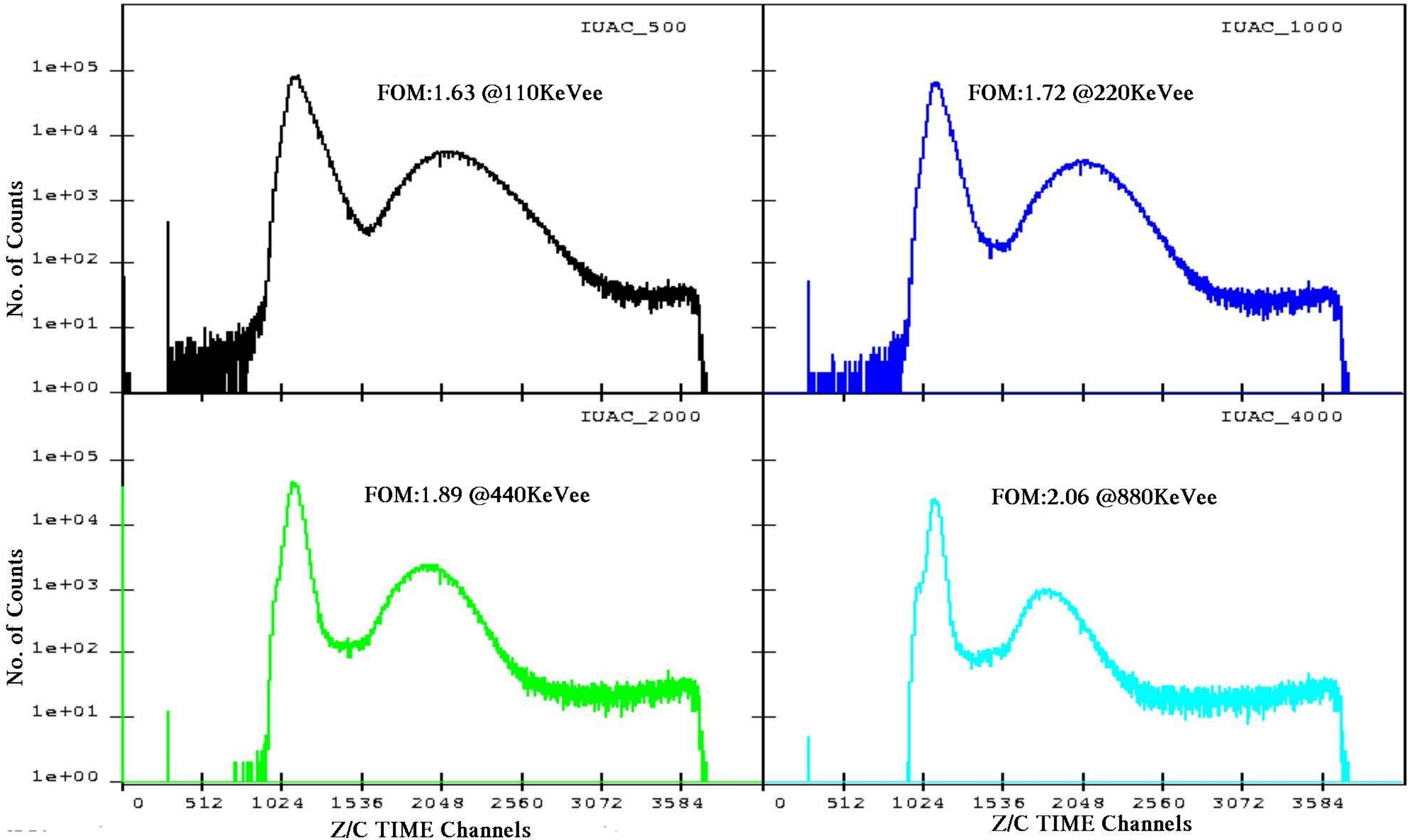


Table: FOM obtained with PSD electronics at different energy thresholds compared with commercial and other arrays

Eee	Neutron Wall	IUAC[$]	DEMON*	Comm[#]
50 keV	-	1.4	-	1.27
110 keV	1.15	1.6	1.09	1.24
240 keV	1.54	1.82	-	1.65
300 keV	-	-	1.65	-
500 keV	1.84	1.89	-	1.75
1 MeV	2.1	2.06	2.05	1.91

* Demon: Charge Comparison method used

Canberra 2160A

$ Calibration :120 keVee ~ 500 keV ηeutron energy

Reference: O.Skeppstedt et al NIM (A) 421 (1999) 531-541

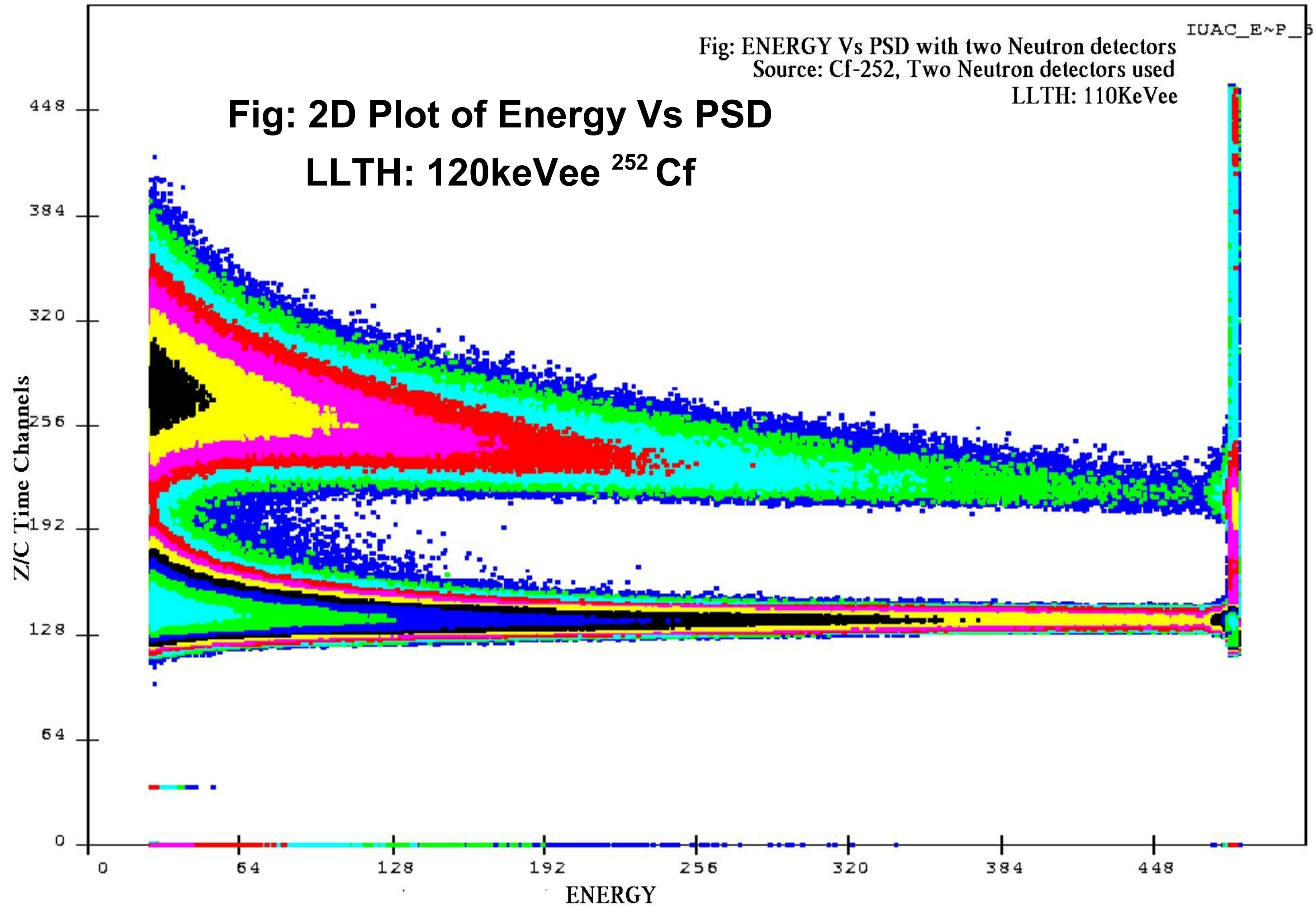
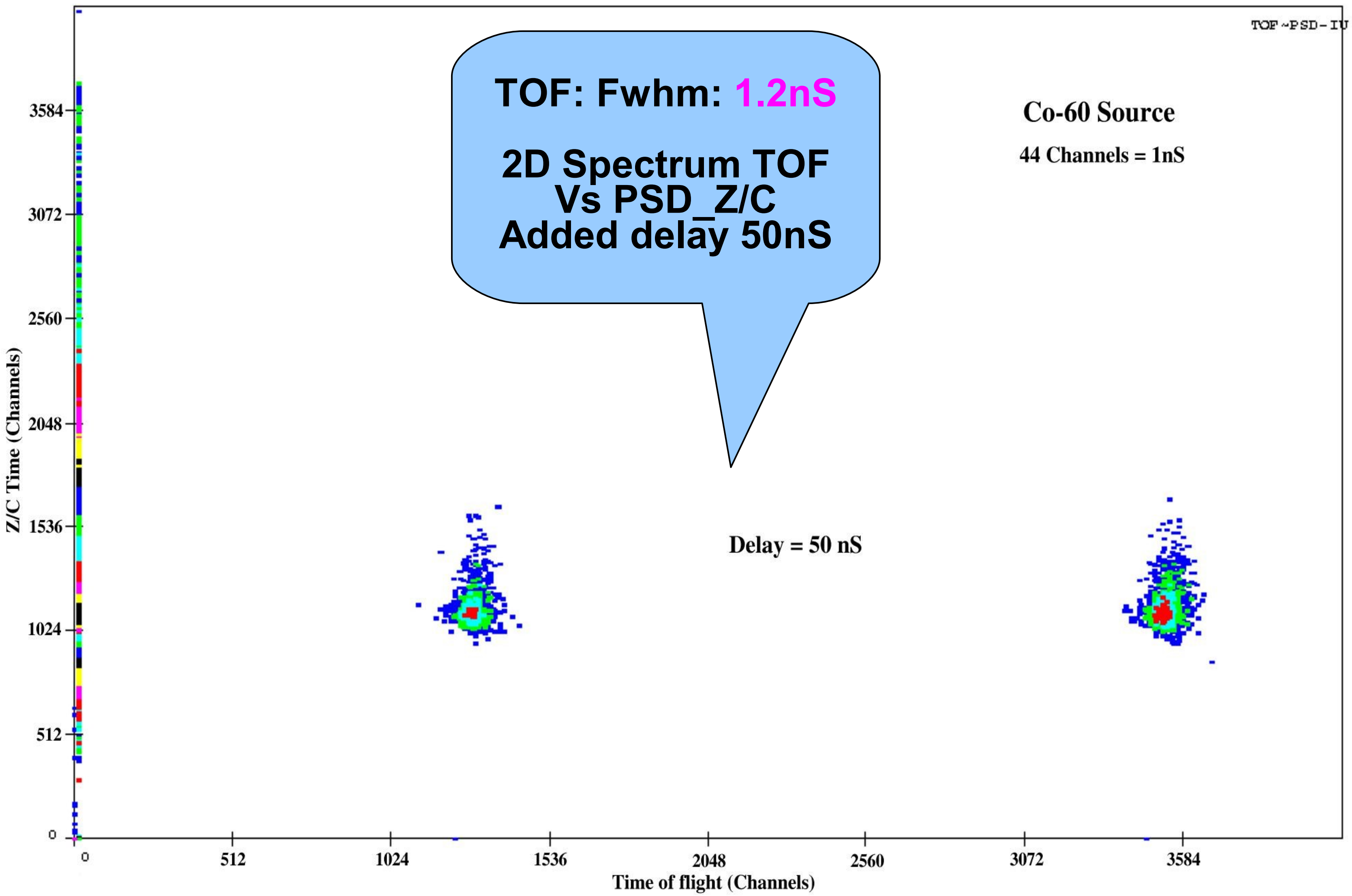


Fig: 2D Plot of Energy Vs PSD

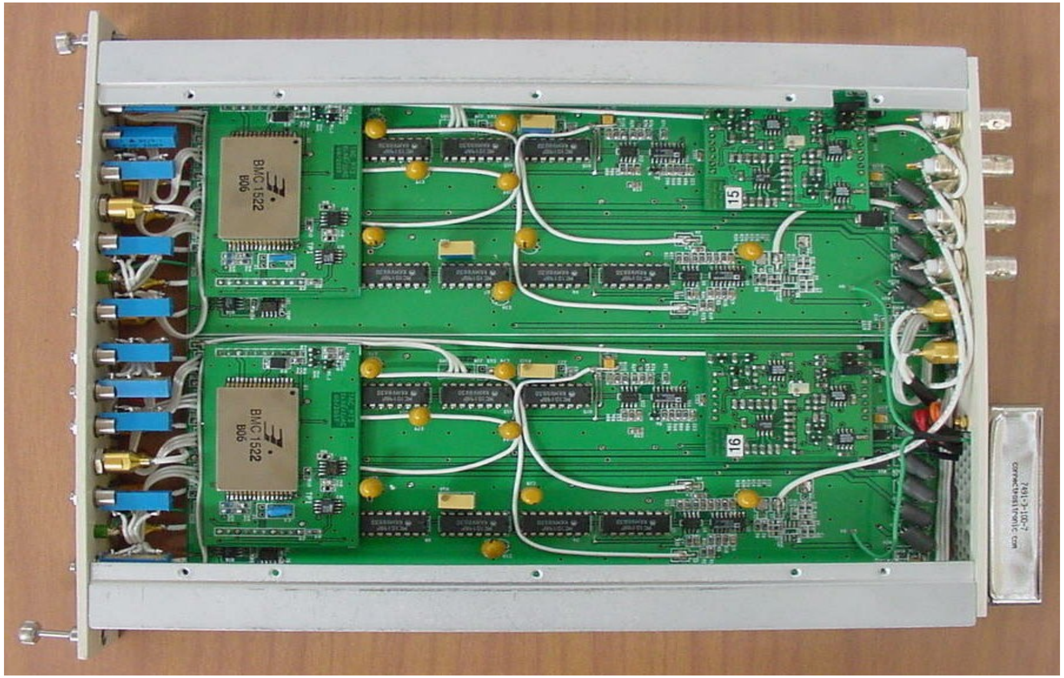
LLTH: 120keVee ^{252}Cf

Time of Flight with Plastic Detector (START)

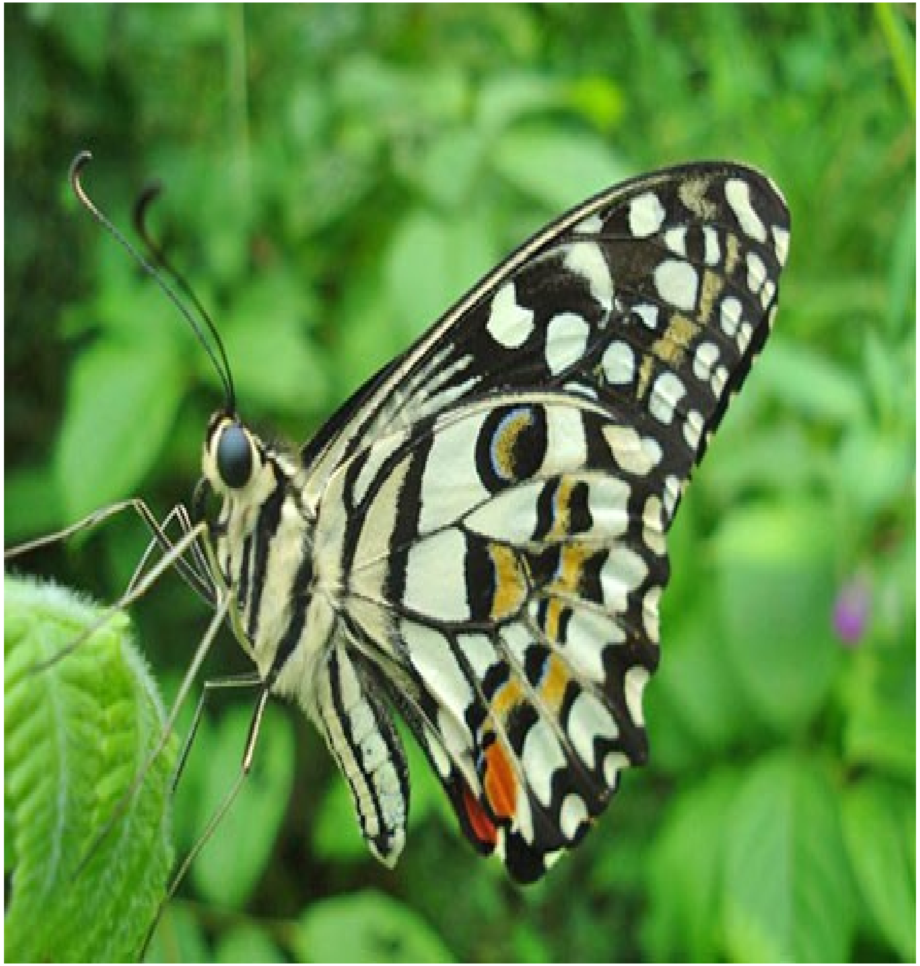


Status

- Adopted for existing NAND array of ~30 Detectors
- Successfully implemented and used with Linac beam
- Modified module to be adopted for BARC - Si PAD detector



Acknowledgement



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