PARIS

Photon Array for studies with Radioactive Ion and Stable beams

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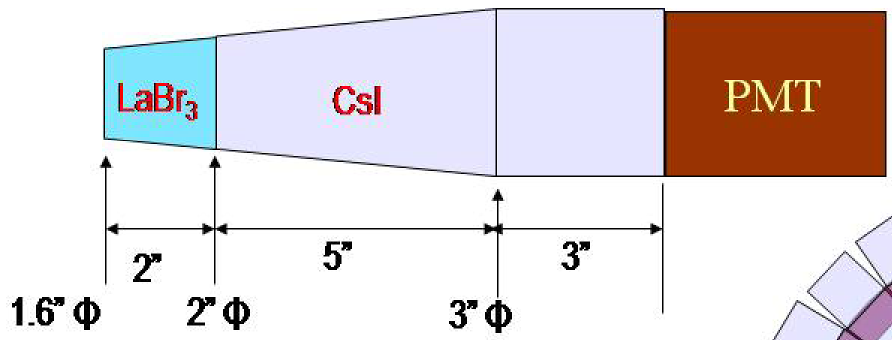
on behalf of Mumbai Group

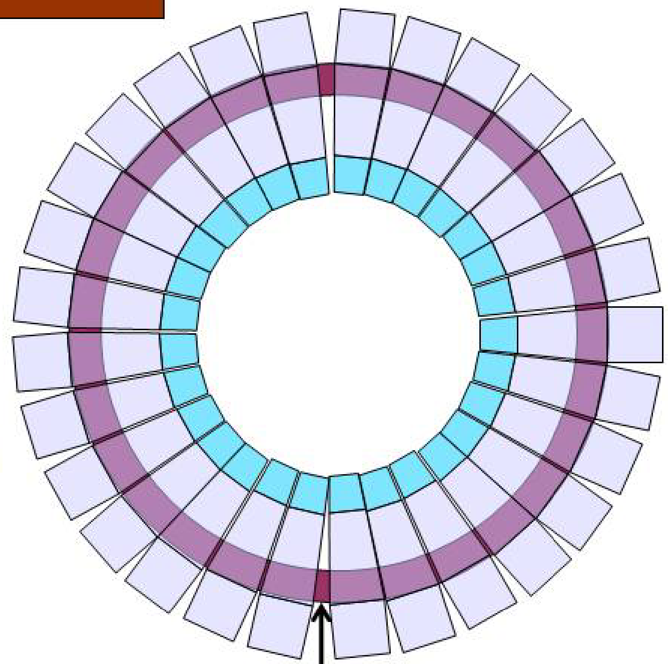
A suggestion for the array and detectors geometry

Suresh Kumar

To have radial configuration with tapering of detectors

- Provides close packing and efficient reconstruction of high energy photons
- Tapering also helps to have smaller $LaBr_3$ coupled to larger diameter CsI which should be more cost effective.
- Easy variation of distance to target without a significant loss in geometrical coverage
- For radial detectors high energy photons will be effectively confined to fewer detectors leading to better Doppler correction, better energy definition and fold construction.

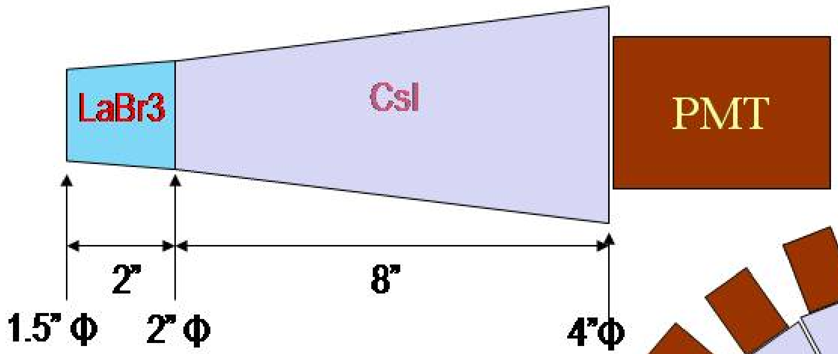


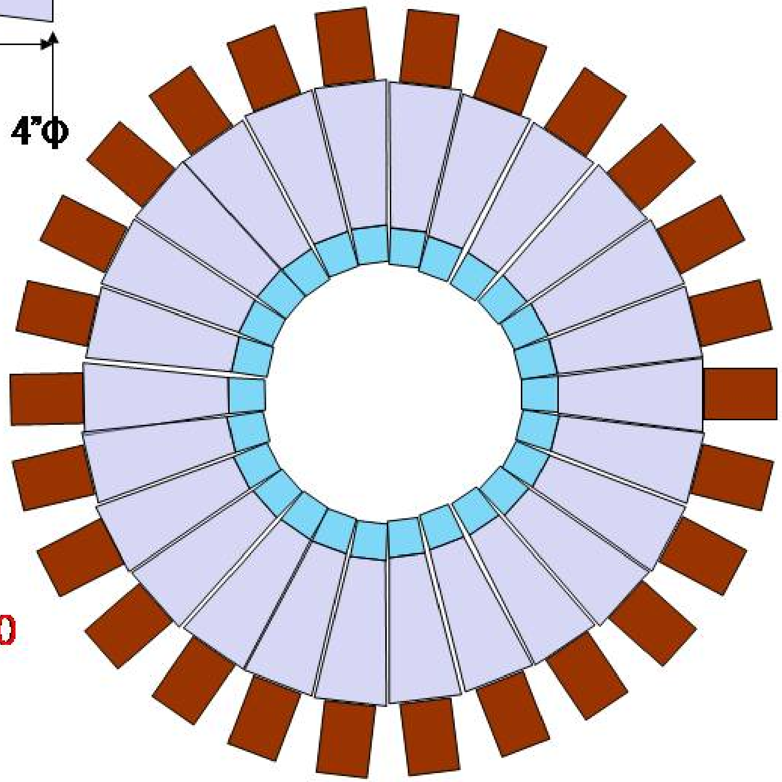


R_{inner} = 20 cm, Granularity ~300
Tappering angle ~ ±5.71°

The conical tapering may be most cost effective as crystals are grown in cylindrical form. The hexagonal tapering can be considered for close packing and hence better efficiency.

A carbon composite material or aluminum structure with matching tapering holes for inserting the detectors in place.





R_{inner} =15 cm, Granularity ~200
Tappering angle ~ ±7.1º

A simulation study with EGS

D.R. Chakrabarty

$E\gamma$= 5-25 MeV: line shape of high energy gamma rays with and without multiplicity photons

•Inner and outer shells with no gap in between, covering 4π, each element having almost equal solid angle

•Telescopic configuration (inner radius 15 cm, 5cm $LaBr_3$, 15 cm CsI), 240 detectors

•A high energy gamma ray is accompanied by multiplicity $M\gamma$, chosen randomly from a triangular distribution with M_{max}, energies of multiplicity gammas assumed to increase linearly.

For example: M_{max} =30, E_{max} =2.0

M=15, E=0 to 1.5 MeV equally spaced

M=10, E=0 to 0.67 MeV etc.

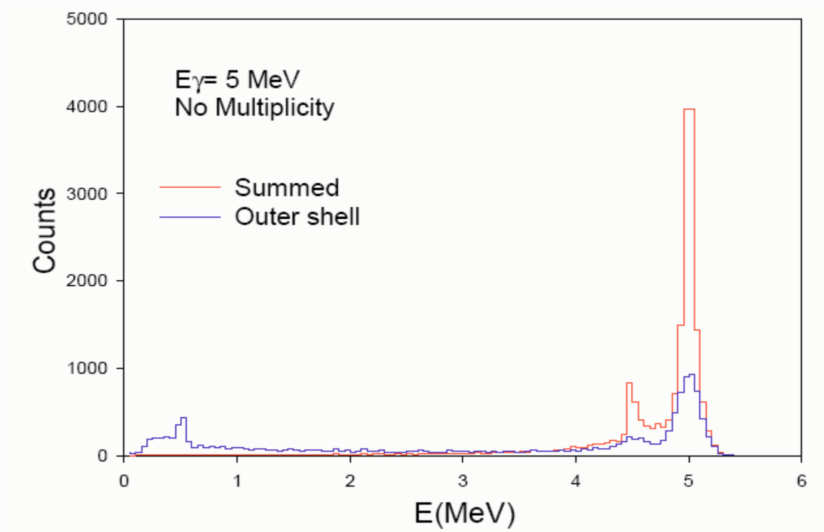
Resolution of LaBr3 ~ 3.5%, CsI ~ 13% at 662 keV

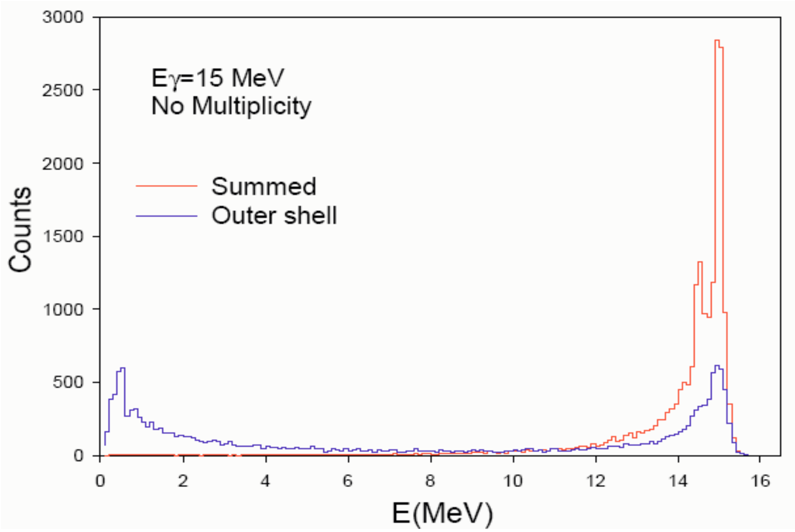
If the highest energy deposited is in inner shell, Einner (highest enegry +nearest neighbours) and corresponding Eouter are obtained.

If the highest energy deposited is in outer shell, Eouter (highest enegry +nearest neighbours) and corresponding Einner are obtained.

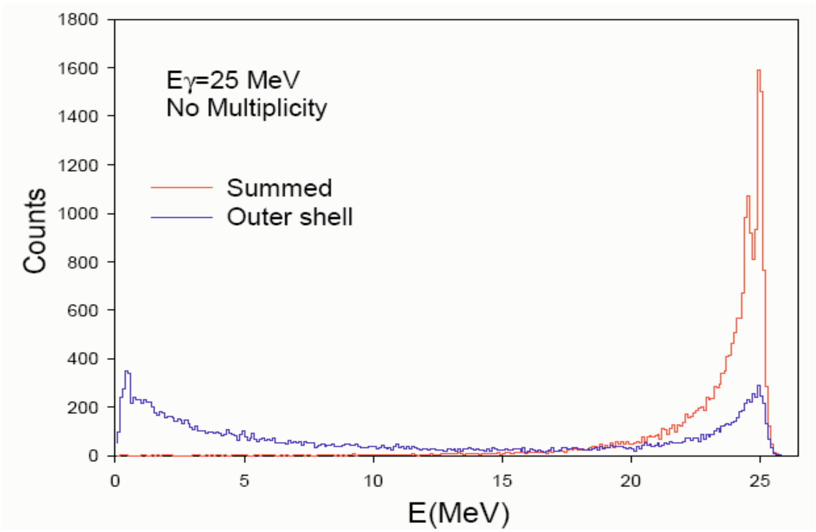
Esum= Eouter + Einner   (after folding in resolution function)

High energy gamma rays , no multiplicity

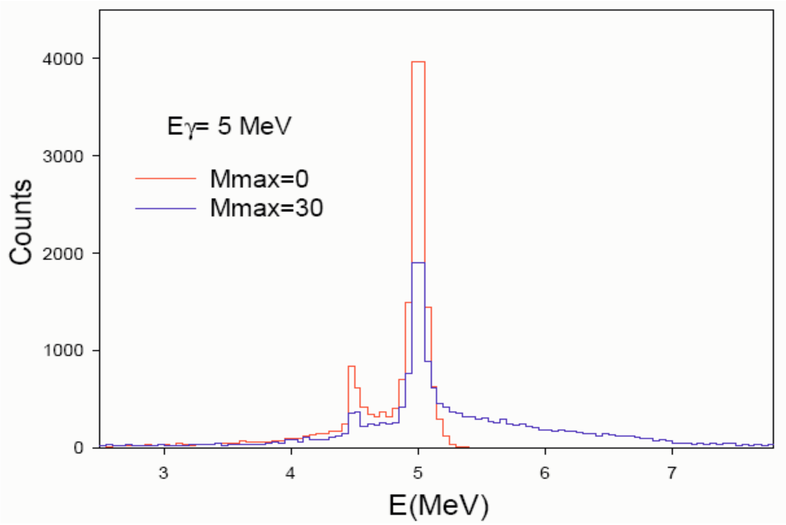


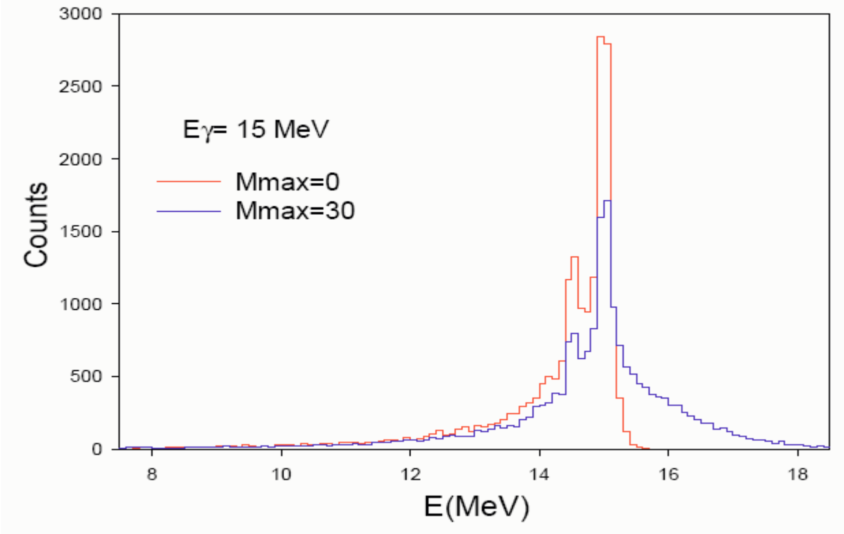


Gain in efficiency by summing

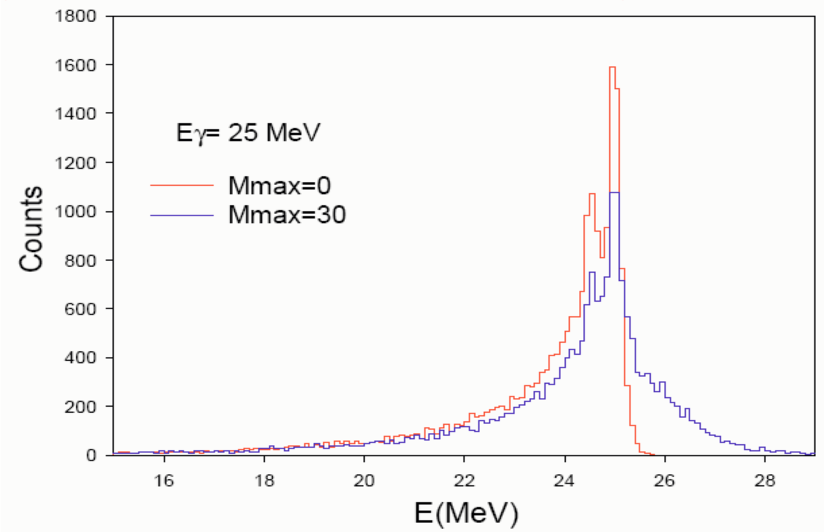


High energy gamma rays with Multiplicity



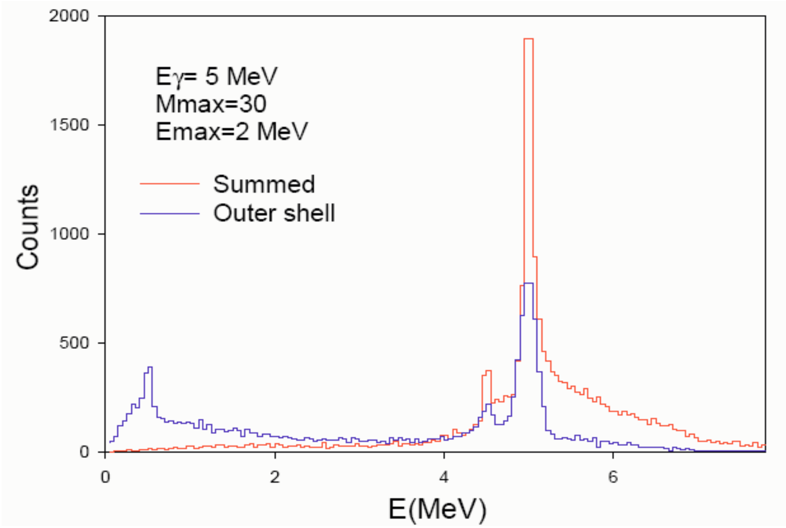


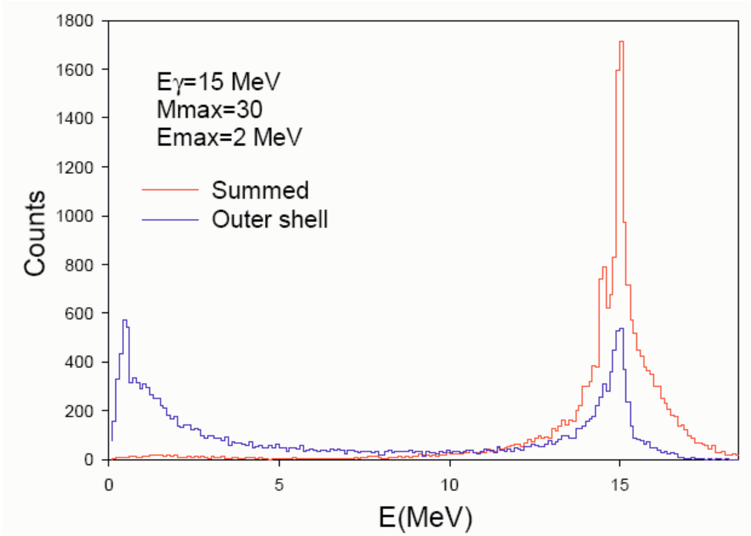
High energy tail when accompanied by Multiplicity gammas



Jan 09, spiral2 week

Tail contribution in outer shell spectra





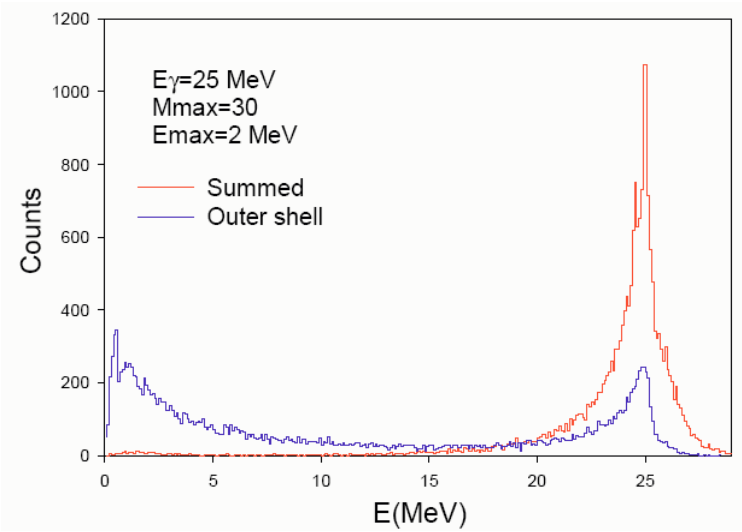


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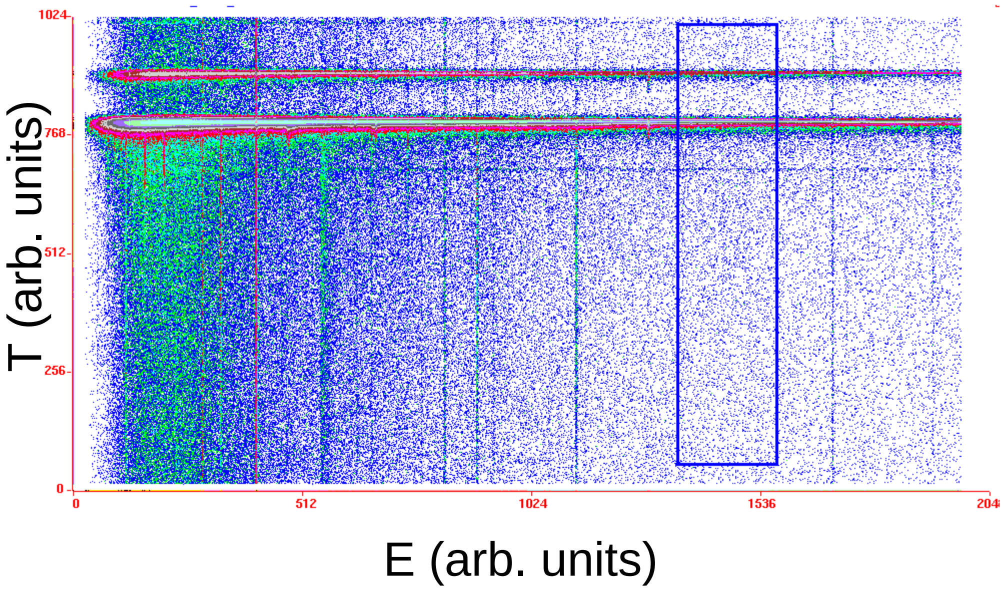
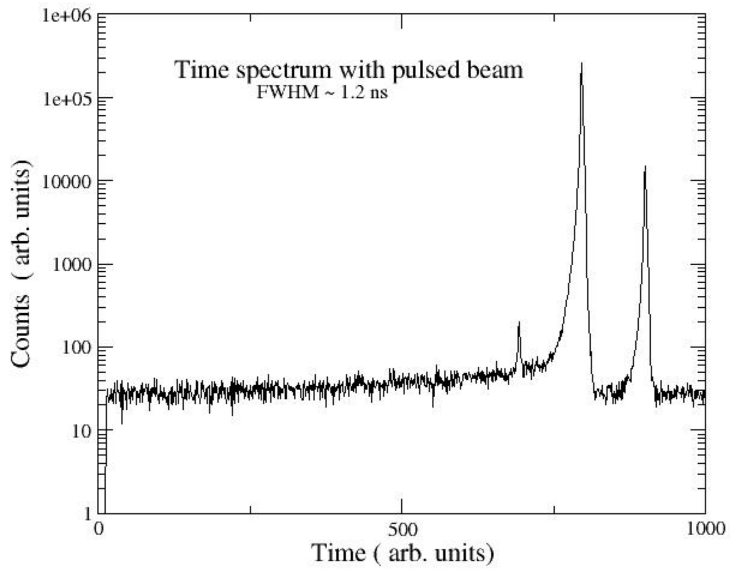
Table I: *Peak and tail efficiencies, with and without associated multiplicity, from the summed spectra (S) and that for the outer shell (O)*

Eg (MeV)	Peak Efficiency (%)	Tail Efficiency (%)	Associated Multiplicity (Y/N)
5	88 (S)	-	N
	34 (O)	-	N
	54 (S)	35	Y
	31 (O)	6	Y
15	74 (S)	-	N
	24 (O)	-	N
	56 (S)	24	Y
	21 (O)	3.5	Y
25	57 (S)	-	N
	14 (O)	-	N
	45 (S)	18	Y
	13 (O)	2.5	Y

- The multiplicity gammas are not fully stopped in the inner shell. The extent of the tail will obviously depend on the value of M_{max} and E_{max}.
- The tails in the line shape, in principle, can be included in the data analysis. However, the situation is a little difficult and one should be very careful, because the line shape depends on the multiplicity distribution.

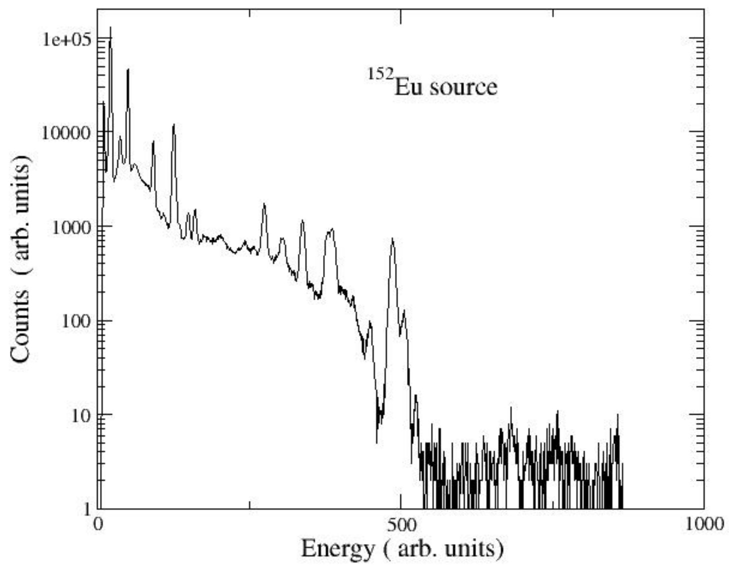
In beam Time spectra with 2” $LaBr_3$ coupled to XP2060

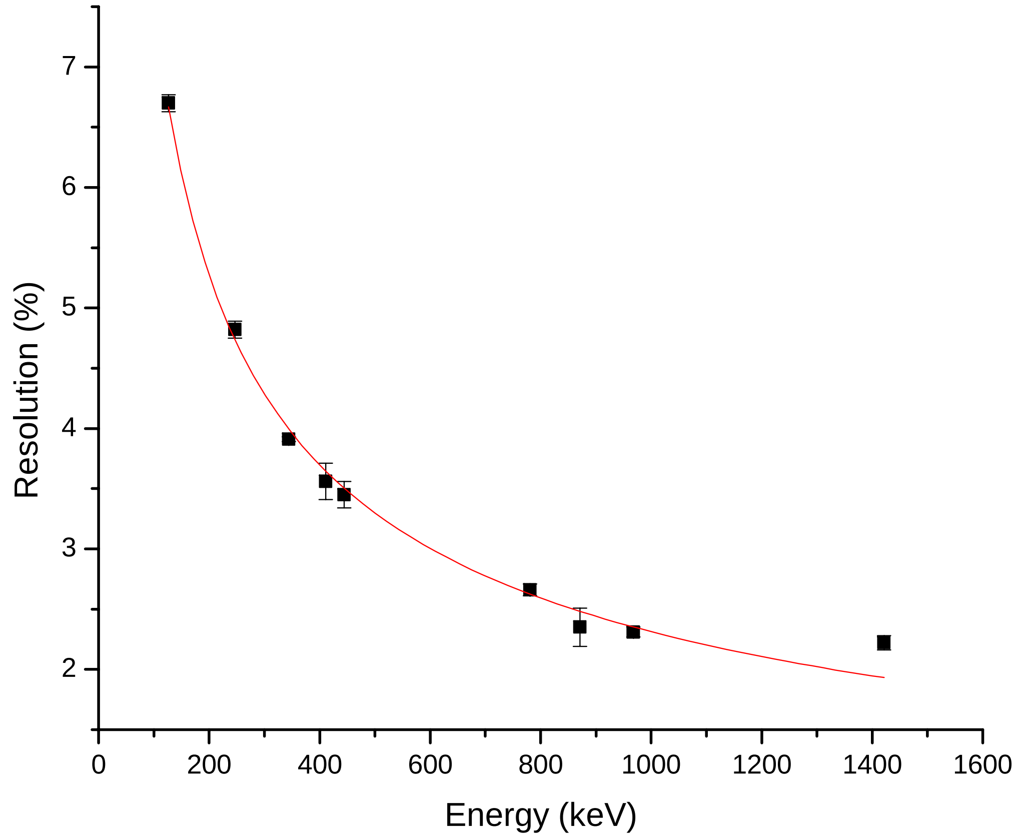




(hyperfine interaction studies)

Characterization of 1.5” $LaBr_3$ coupled to XP2060





$^7Li(p,n_1)^7Be^*$, 429 keV γ-ray

To study response of 1 m long plastic scintillator

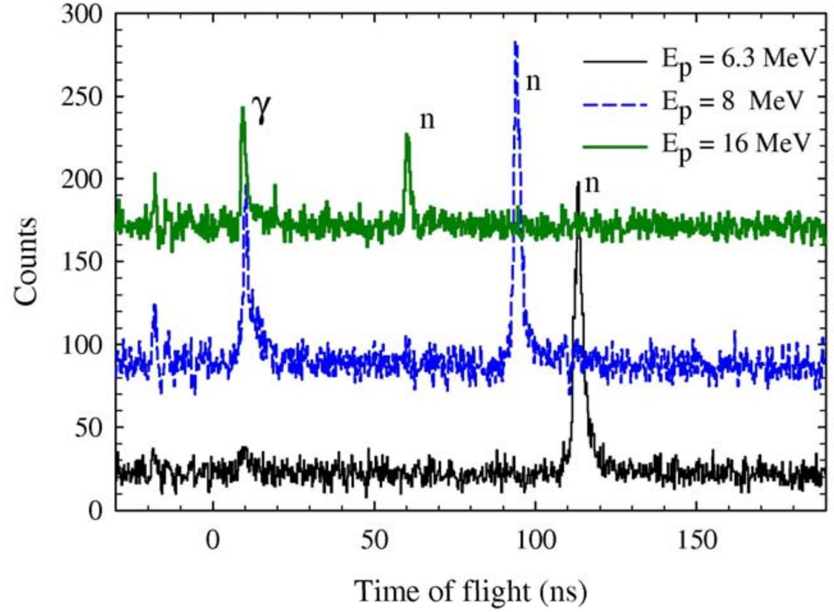


Fig. 8. TOF spectra from p + ^{nat}Li reaction at E_p = 6.3, 8 and 16 MeV. The position of the gamma and neutron peaks are indicated.

resolution.

E_p= 6.3,8,12,16,19 MeV

$\rightarrow E_n$ = 3.7, 5.3, 9.0, 12.7, 15.4

P.C. Rout *et al*. NIM A **598**, 526 (2009)

- Response of $LaBr_3$ to monoenergetic neutrons
- Pulse shape discrimination for n/gamma?
- simulations for high energy gamma line shape
- digital electronics R&D