Characterisation of the new HPGe detectors at INPP/NCSR "Demokritos"
…and future (n,2n) reactions to be studied

Maria Peoviti[1], Michail Axiotis[2], Efstathia Georgali[1],
Sotiris Harissopulos[2],
Anastasios Lagoyannis[2], Nikolas Patronis[1]

[1] *Department of Physics, University of Ioannina, 45110 Ioannina, Greece*
[2] *Tandem Accelerator Laboratory, Institute of Nuclear and Particle Physics, N.C.S.R. "Demokritos",*
Aghia Paraskevi, 15310 Athens, Greece

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Maria Peoviti
University of Ioannina   *marpeoviti@gmail.com*

Introduction

The present work concerns three identical coaxial CANBERRA detectors with a very thin layer of carbon epoxy window and a very thin dead layer, that allow the record of low energy photons. The efficiency characterisation was used for a feasibility study of three future (n,2n) activation measurements on isotopes of I, Cs, and Ce.

The three CANBERRA detectors

Target nucleus	Abundance	Product nucleus	Half life	E_γ (keV)	I_γ (%)
^{127}I	100%	^{126}I	(12.93 ± 0.05) d	388.6	35.6
^{133}Cs	100%	^{132}Cs	(6.480 ± 0.006) d	667.7	97.59
^{136}Ce	0.185%	^{135}Ce	(17.7 ± 0.3) h	265.6	41.8

Characterisation process

The efficiency characerisation was performed following the next steps:
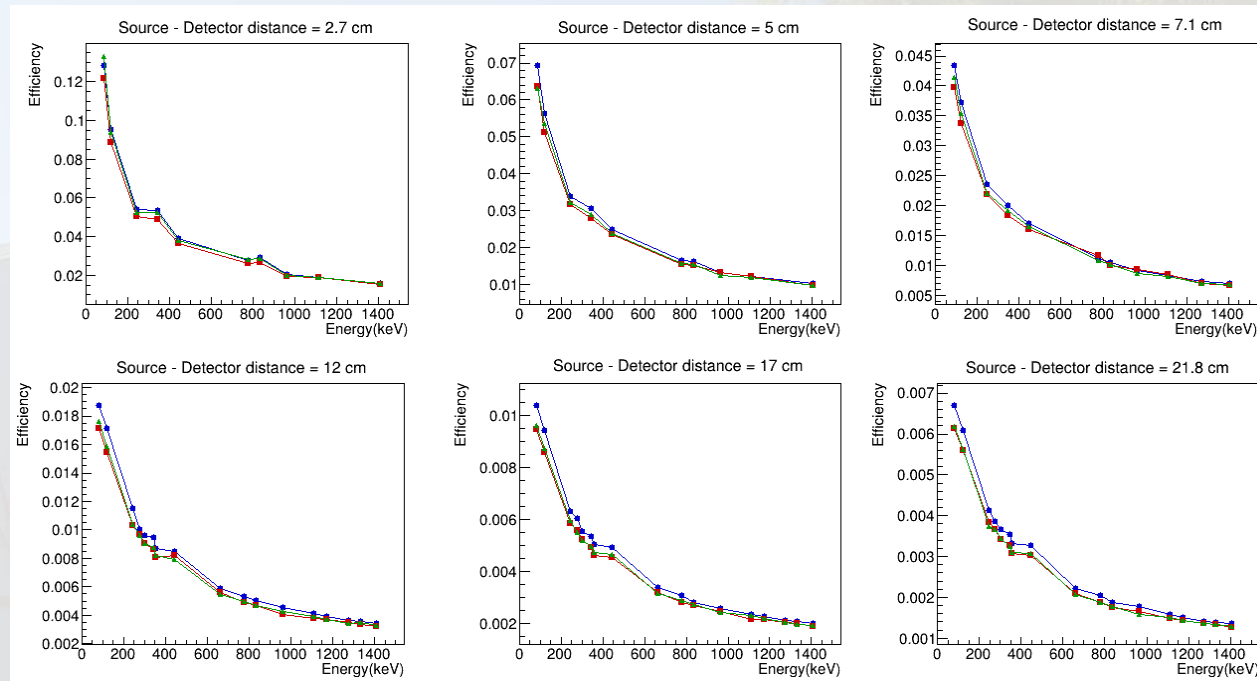
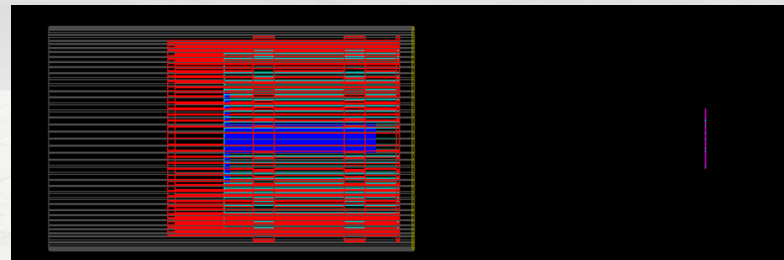1. Efficiency curves (seven point sources: 80 – 1408 keV, six source-to-detector distances: 2.7 – 21.8 cm)

Comparison of the efficiency of the three detectors
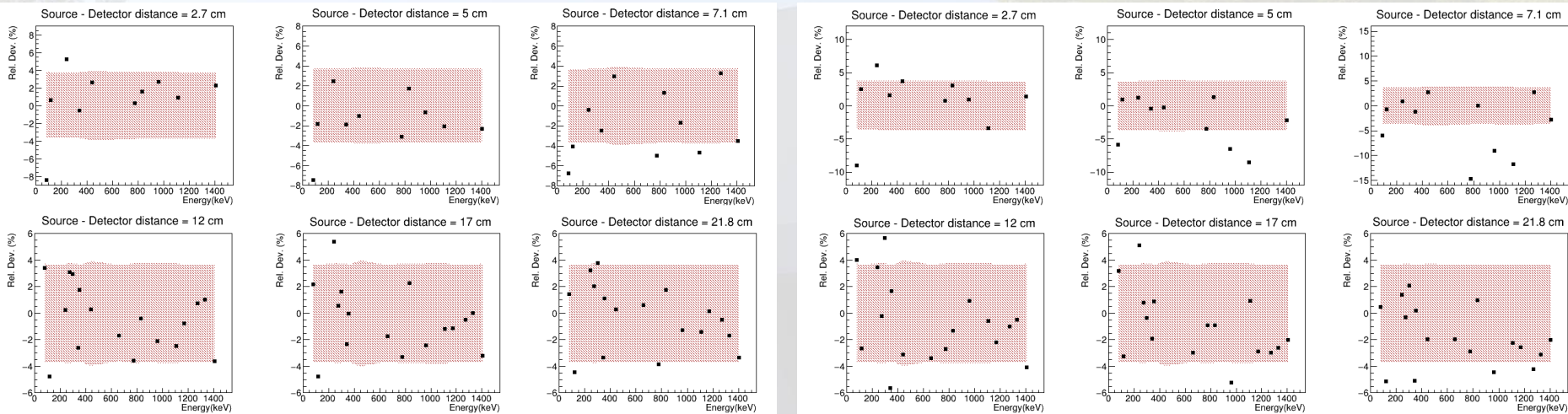
2. Simulation of the system using GEANT4

Visualisation of the simulation

3. Fine tuning of the simulation parameters

Results

After the tuning of different simulation parameters an excellent agreement between the simulation and the experimental results was achieved

	Specification's sheet	GEANT4 tuned
Gap (mm)	6	10.5
Crystal radius (cm)	7.8	7.56
Crystal length (cm)	7.18	6.88

	Specification's sheet	GEANT4 tuned
Gap (mm)	6	10.1
Crystal radius (cm)	7.4	7.3
Crystal length (cm)	7.45	7.34

Results

	Specification's sheet	GEANT4 tuned
Gap (mm)	6	9.5
Crystal radius (cm)	7.49	7.25
Crystal length (cm)	7.45	7.3
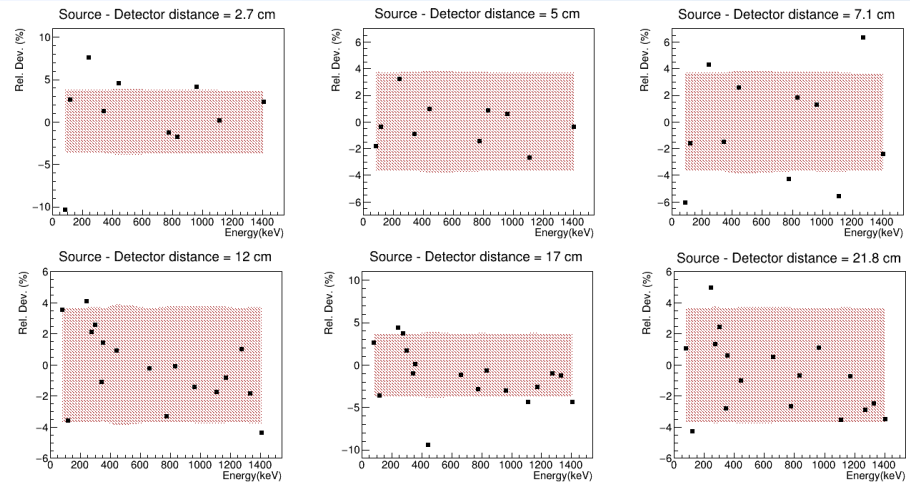
The expected counting rate of the reactions $^{127}I(n,2n)^{126}I$, $^{133}Cs(n,2n)^{132}Cs$ and $^{136}Ce(n,2n)^{135}Ce$ was calculated using the cross-section formula from the activation technique

Calculated for different irradiation, waiting and measuring times

$$\sigma = \frac{\boxed{counts} \cdot CF \quad \textbf{1}}{N_T \cdot \Phi \cdot \varepsilon \cdot I_\gamma \, (1 - e^{-\lambda t_m}) e^{-\lambda t_w} \cdot f_B}$$

$$f_B = \frac{1 - e^{-\lambda t_{irr}}}{\lambda} t_{irr}$$

The calculations showed that the three reactions under study are feasible

Conclusions

In the present work:
- The efficiency curves of the three HPGe were constructed
- The detectors were characterised successfully in terms of their efficiency using GEANT4
- The characterisation was used for a feasibility study of three neutron induced reactions
- Based on the cross-section formula from the activation technique, the expected counting rate was calculated for different experimental conditions. The calculations indicate that all three reactions are feasible.