

Response of CdZnTe for α Particles: GEANT4 Simulations

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Introduction

The performance of CdZnTe in γ -ray and X-ray detection is extensively reported in the literature. However, there are only a few reports on its response to α particle detection [1]. This study aims to simulate the response of CdZnTe using GEANT4 Monte Carlo Simulations [2][3].

The detector is a $14 \times 14 \times 1.3\text{mm}^3$ planar CdZnTe crystal with a 100 nm thick Cr coating. The crystal is an alloy of Cadmium Telluride and Zinc Telluride, with the composition $Cd_{1-x}Zn_xTe$, where $x = 0.04$.

In this study, simulations in GEANT4 are used to estimate -

1. the range (penetration depth) in CdZnTe of α particles as a function of energy, which is then compared with results from SRIM [4];
2. the energy deposition in CdZnTe of α particles as a function of source-detector distance.

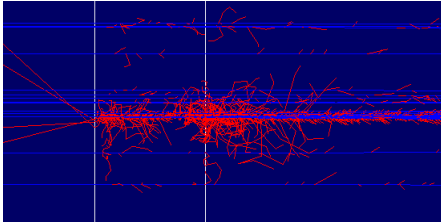


FIG. 1: Simulation of a beam of 10^3 α particles (blue) entering from left, falling on detector placed at 5mm from source; electrons (red) are generated upon interaction with detector.

Configuration of GEANT4

GEANT4 Version: 11.2.2

Physics lists used:

G4EmStandardPhysics, G4DecayPhysics,
G4RadioactiveDecayPhysics

Range cut: $0.1\mu\text{m}$

Detector dimensions: $14 \times 14 \times 1.3\text{mm}^3$

Cr coating: 100nm

Surrounding material: air-like (O 21%, N 79%), $P = 0.01\text{atm}$

1. Simulation of range

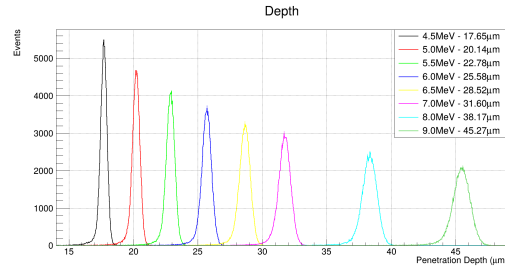


FIG. 2: Simulation of a beam of 10^5 α particles repeated 8 times with different α energies; CZT detector without Cr coating; source placed just at boundary of detector; penetration depth increases with increase in α energy.

TABLE I: Comparison of penetration depth (range) estimations from SRIM and GEANT4

E (MeV)	SRIM (μm)	GEANT4 (μm)
4.5	16.91	17.65
5.0	19.48	20.14
5.5	22.19	22.78
6.0	25.05	25.58
6.5	28.04	28.52
7.0	31.17	31.60
8.0	37.83	38.17
9.0	44.97	45.27

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2. Simulation of energy deposition

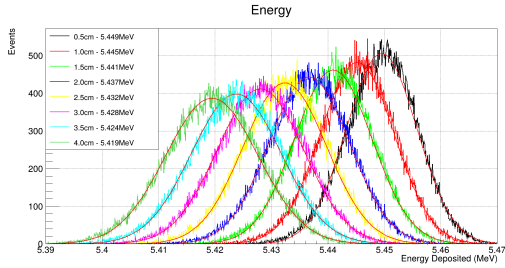


FIG. 3: Simulation of a beam of 10^5 α particles repeated 8 times with different distances of detector from source, while keeping α energy of source constant at 5.48556 MeV; CZT detector with Cr coating; energy deposited into detector decreases with increase in distance from source.

Summary

We have demonstrated the applicability of CdZnTe for α particle detection via GEANT4 simulations.

References

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- [2] L. S. Waters *et al.*, AIP Conf. Proc. **896**, 81-90 (2007).
- [3] S. Agostinelli *et al.*, Nucl. Instrum. Methods Phys. Res. Sect. A **506**, 250-303 (2003).
- [4] J. F. Ziegler *et al.*, Nucl. Instrum. Methods Phys. Res. Sect. B **268**, 1818-1823 (2010).