New detectors for GERDA Phase II: Broad Energy Germanium (BEGe) detectors for improved Pulse Shape Analysis (PSA)

BEGe detector: strongly non-linear field allows improved PSA

Signal

Point-like (single-site) energy deposition inside one Ge diode (Range: ~ 1mm)

Background

Multi-site energy deposition inside Ge diode (Compton scattering)

The BEGe production and test chain: a logistical challenge

Fast neutrons in cosmic rays produce radio-isotopes in Germanium via spallation reactions (60Co, 68Ge)

Problem: Decays of cosmogenic radio-isotopes mimic signal events

Solution: Minimize exposure of Germanium to cosmic radiation by

- Underground storage
- Transport in shielded containers

Crystal pulling and zone refinement at Canberra in Oak Ridge, USA

Underground storage in Cherokee Caverns, Knoxville

Diode production at Canberra in Olen, Belgium

Production of enriched 76GeO2 at ECP Zelenogorsk, Russia

Metal reduction and zone refinement at PPM in Langelsheim, Germany

Underground storage at Rammelsberg Mining Museum

Hades Experimental Research Of Intrinsic Crystal Appliances (HEROICA):

Detector characterization tests at HADES underground facility in Mol, Belgium

Automated scanning measurements of top and lateral surface with collimated 244Am source:

- Charge collection efficiency
- Homogeneity of dead layer
- Position dependence of pulse shapes

Production resolution

Fixed uncollimated sources:

- 60Co: energy resolution, HV scan, active mass measurement
- 224Am and 228Ba: dead layer thickness
- 228Th: PSA parameters

Energy resolution

Resolution as function of HV

PSA parameter

Top scan

Dead layer thickness with 244Am

Selection of articles:

D. Budjas et al., JINST 4 (2009) P10007
M. Agostini et al., JINST 6 (2011) P04005
M. Agostini et al., JINST 5 (2010) P10007