GERDA – Germanium Detector Array

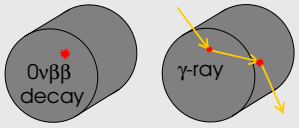
searching for the

Neutrinoless Double Beta Decay

GERDA @ LNGS

Novel background-rejection techniques distinguishing 0νββ decay events from background events.

0νββ decays create electrons with millimeter range in Ge. Background γ-rays have a range of centimeters and also can scatter more than once.



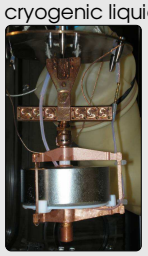
single-site event multi-site event

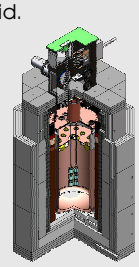
Status of GERDA Phase II detectors

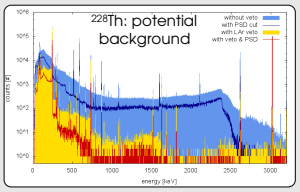
BEGe and segmented detectors were operated in liquid argon without performance loss. Procurement of Phase II enriched BEGe detectors is under preparation.

R&D for future

Liquid argon (LAr) scintillation can be used for further rejection of background. Testing is done in a setup using 1 ton of LAr with 9 photo-multiplier tubes (PMTs) and a BEGe detector operated bare in the cryogenic liquid.







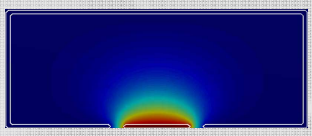
R&D is conducted to exchange the PMTs with low mass photon detection devices: Silicon Photo Multipliers. First results show similar reduction efficiencies.

GERDA Phase II detectors: Improved background recognition capabilities

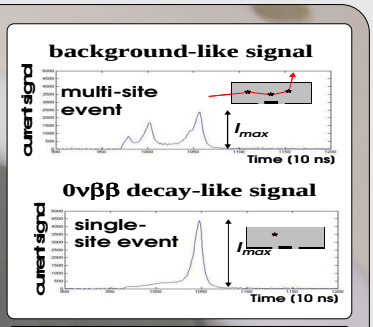
Detectors with improved pulse shapes

The GERDA Phase II baseline is the Broad-Energy Germanium (BEGe) detector. The small size of its signal electrode results in two advantages with respect to conventional detectors:

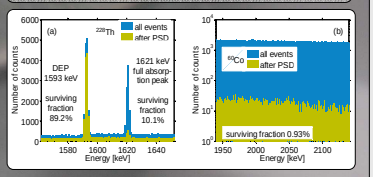
1. Low capacitance
   → improved capability of determining energy.
2. Increased field near electrode
   → advanced capability of identifying background by distinct event topologies.



The potential of a BEGe detector is localized around the point contact

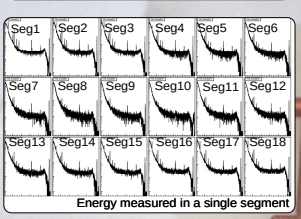


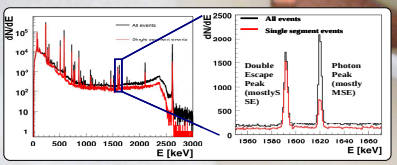
Pulse-shape discrimination:
By analysing the time development of the detector signals (pulse shapes), the 0νββ decay-like events can be distinguished from background-like events.

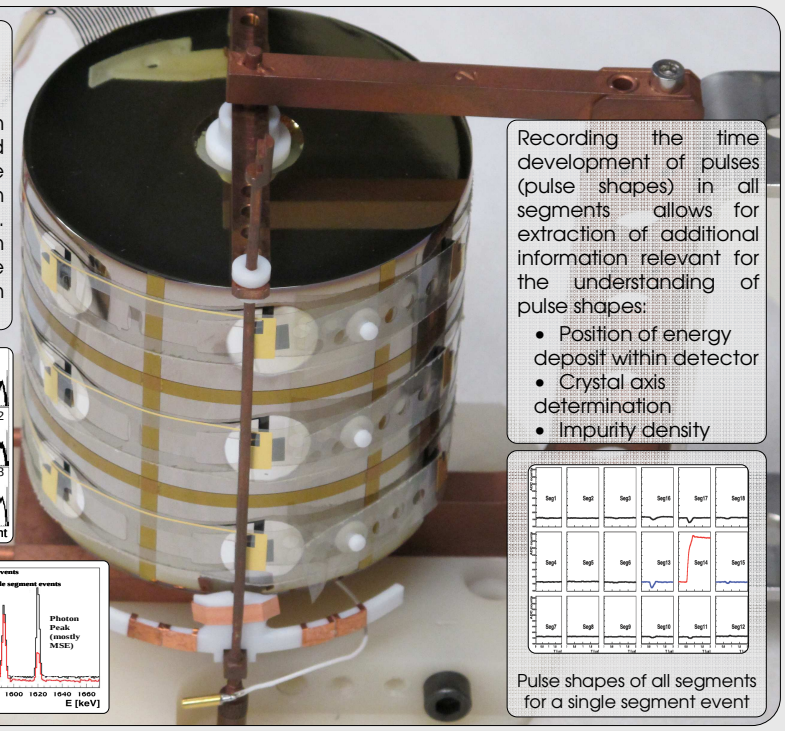


Segmentation of detectors

Single HPGe detectors can be electrically subdivided into segments. A signal like event will cause a signal in a single segment only. Events that show pulses in more than one segment are background like and can thus be discarded.







Recording the time development of pulses (pulse shapes) in all segments allows for extraction of additional information relevant for the understanding of pulse shapes:

- Position of energy deposit within detector
- Crystal axis determination
- Impurity density

Pulse shapes of all segments for a single segment event