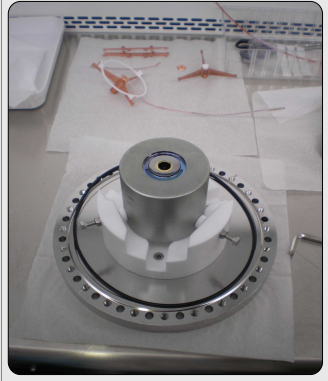
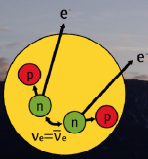


# GERDA – Germanium Detector Array

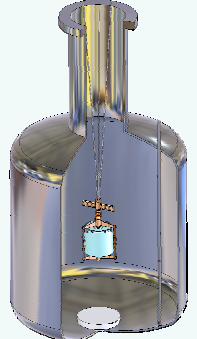
## searching for the Neutrinoless Double Beta Decay



**Phase I detectors**  
Existing high-purity Ge detectors from past experiments will be deployed:  
**8 enriched Ge detectors:**  
• 86% enrichment in  $^{76}\text{Ge}$   
• total mass 18 kg  
**6 nat Ge detectors:**  
• total mass 16 kg  
All the detectors were reprocessed to use common design, suitable for bare operation in liquid argon.



**Detector in low-mass holder**  
To achieve low background, the amount of material in the detector holder is minimized (background contribution  $\leq 10^{-3}$  cts/(kg.y.keV) at  $Q_{\beta\beta}$ ).  
All detectors were tested in LAr. They are ready for their operation in GERDA.



Test stand – detector immersed in cryoliquid

### Germanium detectors for GERDA Phase I

#### Germanium semiconductor detector operating principle

Germanium (Ge) is the predominant material for high-resolution  $\gamma$ -ray detectors. It is ideal due to its high absorption coefficient, its suitable semiconductor properties and its availability in high purity.

ionizing radiation creates e-h pairs which are drifted by the electric field

electrons drift to n+ contact

holes drift to p+ contact

n+ electrode = high voltage contact (+)

p+ electrode = signal contact

depleted region (active volume)

Read-out electronics

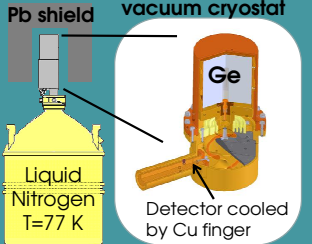
Spectrum of radiation energy depositions

Signal processing

Electric signal

Applying reverse bias voltage of typically thousands of Volts to the p-n junction removes free charges from most of the detector volume. This enables the detection of the charges created by the ionizing radiation ( $\alpha$ ,  $\beta$ ,  $\gamma$ ). Germanium detectors need to be cooled below 120 K to avoid e-hole pair creation by thermal excitation.

#### Conventional operation



#### Novel technique



#### Detector string operation in GERDA

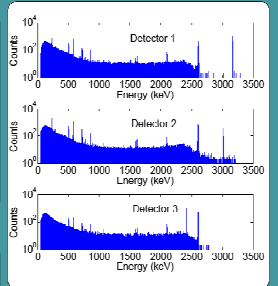


In GERDA, three detectors are assembled into a string under nitrogen atmosphere in a clean environment. The string is deployed inside the GERDA cryostat via a lock system.

The signal read-out electronics must work at cryogenic temperature. A custom made charge-sensitive preamplifier was developed for GERDA. One 3-channel preamplifier serves one detector string.

Before operating the enriched detectors, a commissioning phase with natural Ge detectors is presently ongoing to:

- Test the electronics
- Test the mechanical system
- Investigate the background



Calibration energy spectra collected with the first detector string operated in GERDA

