**GERDA: a novel Ge-detector operation technology for neutrinoless ββ decay searches**


for the GERDA collaboration

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**The Gerda 0νββ experiment**

GERDA is a new experiment in search of 76Ge neutrinoless ββ decay at the Gran Sasso Laboratory (LNGS). Ge detectors made out of isotopically enriched (~90%) material inside a cryogenic fluid shield.

**Experimental procedure**

**Phased approach:**

- **Phase I:** existing detectors of former HM & ISED experiments, properly refurbished to be operated naked in LN
- **Phase II:** new detectors

**GERDA design:**

- Graded shielding: Inner liquid N/Ar shielding + external water buffer
- Water tank back, water/vacuum muon veto
- No high-z material surrounding the detectors
- Background from external x-rays can be reduced below 10^3 counts/keV ββ y

**Additional background reduction from material selection (especially for ports close to detectors), detector anticoincidence, segmentation, pulse shape analysis**

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**Phase I detectors**

- Eight enriched detectors from the former Heidelberg-Moscow and ISED experiments have been underground for more than ten years. Internal component background reduced. Total mass 17.5 kg. A procedure for the removal of their actual cryostat, re-contacting and mounting inside LNGS, while keeping their radioactivity quality has been developed.

**Detectors:**

- F616H MW: 2.54, 2.29, 2.47, 2.59, 2.21, 2.31, 2.26
- Mass (kg): 0.948, 2.206, 2.446, 2.781, 2.350, 2.394, 2.321

**ISED detectors:**

- ANG1-3

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**Segmented detectors for Phase II**

The segmentation of the diode read-out is a powerful background rejection tool, to be used in the Phase II of GERDA; each (bck) events are multi-site, while both are single-site.

**Front-end electronics: 1st solution**

**Cold BF862 JFET (inside LN bath) + warm hybrid preamplifier (outside LN bath)**

The hybrid preamplifier, typically realised with BJT, cannot work at cryogenic temperatures, but can be connected to the cryo-based set-up in LN10 bath, by using long coaxial cables.

**Front-end electronics: 2nd solution**

**Cold monolithic JFET preamplifier (inside LN bath)**

A new JFET preamplifier, developed for gamma spectroscopy in cryogenic environment has been tested at LN temperature and showed superior noise performance, and, once operated with an external input FET at first stage, activating line performance to implement PSA.

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**Front-end electronics: 3rd solution**

ASIC CMOS preamplifier in LN bath

First rule to reduce significantly background is to minimize mass of each component close to crystals into integrated front-end.

Two ASIC CMOS circuits under development: 0.8 um 5V CMOS single or differential ended preamp with:
- external input stage (JFET) or integrated input FET external feedback components

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**Digital sampling data acquisition system**

- PSA to reduce the background produced by multi-site events
- digital filters can improve detector response when signals are affected by microphonics and/or high ripple
- detector test and characterization
- building of pulse shape databases for the PSA algorithms

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Results obtained with a low-noise planar Ge detector