Development and installation of the GERDA experiment

The main goal of the GERDA experiment is searching for neutrinoless double beta decay of $^{76}$Ge with considerable reduction of background and increasing sensitivity in comparison with predecessor experiments.

Main GERDA experimental concepts

The main conceptual design of the GERDA experiment is to operate with "naked" HPGe detectors (encased in Ge76) submerged in high purity liquid argon supplemented by a water shield. "Naked" detector means a bare Ge crystal without traditional cryostat. Minimizing the support material should provide considerable reduction of the inner background. Using of ultra pure LAr (instead of LN4) both as a cooling medium and shielding material is the other idea of the GERDA. In this case (Phase II) anticonfinement with LAr shielding should reduce both the inner and external background of HPGe detectors.

Expected GERDA sensitivity

GERDA phase I:
- background 0.01 cts / (kg · keV · y)
- to scrutinize KXCD result within 1 year

GERDA phase II:
- background 1 cts / (ton · keV · y)
- to cover the degenerate neutrino mass hierarchy $m_{\nu_\alpha} < 0.08 - 0.29$ eV

Phase III:
- GERDA - MAJORANA collaboration
- background 0.1 cts / (ton · keV · y)
- to cover the inverted neutrino mass hierarchy $m_{\nu_\alpha} > 10$ meV

General Infrastructure of the GERDA set up

A stainless steel cryostat (PS 1) with internal Cu shield (20 t) contains 90 t of liquid argon. The cryostat is immersed in a water tank (56 t of water). A cleanroom and radon tight lock on top of the assembly allow to insert and remove individual detector strings, without contaminating the cryogenic volume.

The Ge detector array is made up of individual detector strings and is situated in the central part of the cryostat.

The ultrapure water buffer serves as a gamma and neutron shield and as a Cherenkov detector for vetoing cosmic muons with the efficiency of more than 99%.

Plastic scintillator panels (20 m², 20 x 2 = 40 modules) on top of the detector will tag muons which enter the cryostat through the neck with the vetoing efficiency of about 50%.

Testing of detectors in LAr

Long-term stability tests of naked HPGe detectors were performed in test benches filled with liquid Argon. The detector parameters FWHM = 2.5 – 2.9 keV at 1332 keV do not deteriorate after one year of continuous operation in LAr even after irradiation with intensive-gamma sources. This shows the feasibility of the overall GERDA project.

In the Phase I all 8 reprocessed detectors made from $^{76}$Ge (in total 18 kg) from the previous Heidelberg-Moscow and IGEX experiments, and 6 reprocessed Ge detectors made from natural Ge (in total 15 kg) from GENIUS II will be deployed in strings.

Preamplifiers and cabling

Several reprocessed germanium detectors with preamplifiers were produced and investigated with the naked Ge inside the LAr test bench.

Material screening

The resistivity of all construction materials was measured by several low background gamma spectrometers situated in different underground laboratories as well as by the high resistance systems for an excitation measurement.

Installation of the GERDA set up

In the Phase II new segmented or BeBe detectors (20 kg of $^{76}$Ge) made from $^{76}$Ge will be added. In total: 40 kg of $^{76}$Ge + 15 kg of $^{76}$Ge.

Several detectors from depleted in 76Ge material will be incorporated too.

Active cooling system

In the Phase II all 8 reprocessed detectors made from $^{76}$Ge (in total 18 kg) from the previous Heidelberg-Moscow and IGEX experiments, and 6 reprocessed Ge detectors made from natural Ge (in total 15 kg) from GENIUS II will be deployed in strings.