Search for the neutrinoless $\beta\beta$ decay in ^{76}Ge with the GERDA experiment

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Abstract. The GERmanium Detector Array, GERDA, [1] is designed to search for neutrinoless double beta ($0\nu\beta\beta$)–decay of ^{76}Ge. The importance of such a search is emphasized by the evidence of a non-zero neutrino mass from flavour oscillation experiments and by the recent claim [2] based on data of the Heidelberg-Moscow experiment. GERDA will be installed in the Hall A of the Gran Sasso underground Laboratory (LNGS), Italy. The construction of GERDA will start in 2006.

The GERDA experiment is designed to collect an exposure of 100 kg·y quasi background free, reaching a sensitivity on the ^{76}Ge half-life of about 10^{26} years. This leads to a requirement of a background index of the order of 10^{-3} counts/(kg·y·keV) at the $Q_{\beta\beta}$–value of 2039 keV. The experiment is foreseen to proceed in two phases. In the first phase, enriched detectors which were previously operated by the Heidelberg-Moscow and IGEX collaborations (about 18 kg total mass) will be redeployed. The goal of the first phase is to confirm or reject the claim from [2] with an exposure of about 20 kg·y. In the second phase, custom made detectors will be installed which are truly coaxial and segmented.

The main design feature of GERDA is to use liquid Argon as the shield against γ radiation. High purity germanium detectors are immersed directly in the cryogenic liquid which also acts as the cooling medium. The cryogenic volume is surrounded by a buffer of ultra-pure water acting as an additional γ-ray and neutron shield. The detectors are surrounded by low-Z material (water and liquid Argon) to reduce the production rate of neutrons by cosmic ray muons with respect to conventional high-Z passive shieldings (lead). Furthermore, the water buffer is equipped with photomultipliers and operated as a Čerenkov muon veto. Additional background reduction comes from the careful material selection, anti-coincidence cuts applied on signals from different detectors, segmentation and pulse shape analysis.

The existing enriched detectors to be used for the phase-I are going to be dismounted from their cryostat, re-furbished and tested inside the cryogenic liquid bath. Meanwhile, 37 kg of germanium, enriched to a level of 86% in ^{76}Ge, have been procured for the production of the new segmented detectors. The material is currently stored underground to prevent cosmogenic activation. A 18-fold segmented prototype of natural germanium is currently under test, to characterize the core/segment energy resolution and the background reduction.

Front-end electronics has been developed which is able to operate at the cryogenic temperature of liquid Argon. Its rise time and noise level that meet the GERDA specifications.

[1] Gerda Collaboration, Abt I et al., Proposal, a http://www.mpi-hd.mpg.de/ge76/home.html
[2] Klapdor-Kleingrothaus H V et al., *Phys. Lett.* B **586**, 198 (2004)