

Title: Operation of bare high-purity germanium detectors in LAr/LN₂ for the GERDA experiment

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The GERmanium Detector Array, GERDA, is designed to search for the neutrino-less double beta decay of ⁷⁶Ge. The experiment will be installed in Hall A of the National Gran Sasso Laboratory (LNGS) of the INFN. GERDA is designed to collect an exposure of about 100 kg·y with a background of 10⁻³ counts/(kg·y·keV) at the Q_{ββ} value of 2039 keV. The main design feature of GERDA is the use of liquid Argon as a shield against gamma radiation¹, the dominant background in earlier experiments^{2,3}. To reduce the background to the required level, bare high purity germanium detectors enriched in ⁷⁶Ge are immersed directly in the cryogenic liquid, which also acts as the cooling medium. The cryostat is located in a stainless steel tank containing ultra-pure water providing an additional shield against external backgrounds. In GERDA Phase-I, reprocessed enriched-Ge detectors, which were previously operated by the Heidelberg-Moscow and IGEX collaborations, will be redeployed. In this work we shall present the results of an extensive experimental work, ongoing since beginning of 2006 at the GERDA underground Detector Laboratory (GDL) at LNGS, aiming to test the Phase-I detector assembly, the detector handling protocols, the refurbishment technology and to study the long-term stability in LAr. It has been observed that improper handling can damage the passivation layer of the detector. It leads to an intolerable increase in leakage current which can be healed by a repair of the passivation layer. The leakage currents in LAr and LN₂ have been extensively studied under varying gamma irradiation conditions. In total three non-enriched high-purity p-type prototype germanium diodes using different technologies have been operated successfully. The detectors are biased at or above their operational voltages and the leakage currents, continuously monitored with high accuracy, are at a few tens of pA, as measured at the detector manufacturer. During two years of operation, we have carried out more than 50 warming and cooling cycles, defining the detector handling procedure. The detector performance is stable over the long-term measurements. Operations, measurements and results of the GERDA Phase-I prototype detector tests will be summarized.

¹G. Heusser, Ann. Rev. Nucl. Part. Sci. 45 (1995) 543.

²A. Balysh et al., Phys. Rev. D, Vol.55, No.1 (1997), pp.54-67.

³C. E. Aalseth et al., Phys. of Atomic Nuclei, Vol.63, No.7 (2000), pp.1225-1228.