The GERDA-LArGe low-background facility: A short summary

- GERDA-LArGe proposed in LoI (2004) & 'proposal to LNGS' (2004) as GERDA R&D and test facility
- Coordination: WP5 of TG1. The construction, operation and testing of the non-enriched, as well as the enriched crystals in the low-background test stand LArGe in the GdI is coordinated within work package WP5 of TG1. R&D on liquid argon scintillation light detection and pulse shape studies are as well part of this work package. (ref. e.g. report to LNGS SC committee LNGS-EXP 33/05 add. 4/07, March 2007)
- Despite early installation of the shielding system in the GDL in 2004/5, the completion of the set-up was delayed. Priority was always given to the GERDA core infrastructures or critical R&D tasks (e.g. the study of gamma-induced LC in the GDL test-benches was in conflict with installation of cryostat in GDL). Other technical problems delayed the Cu-cryostat installations (e.g. faulty stainless steel – copper welds, etc.).
- Capital investments of GERDA-LArGe facility provided through MPIK (c.f. Official GERDA cost break down table). A major component is the Cu/Pb/steel/PE shielding system made from former LENS shield. Personnel financed mainly through 3rd party funding (EU-Ilias (Zuzel), EU-Ilias-Tari (JINR/INR team), EU Intas (JINR/INR team), DFG/TR27 (Zuzel, Heisel). Institutional funding by MPIK for JINR/INR team and technical staff and workshop.
- Installation and commissioning is now (March 2010) close to completion. The work was mainly carried out by MPIK/INR/JINR team. Since Jan. 2010 support by Cracow team (Zuzel).

The GERDA-LArGe low-background facility as an R&D for GERDA phase II:

Why LAr scintillation might be needed already in phase II

- Phase II sensitivity of 100 kg·y with BI<10^{-3} cts/kg/keV/y includes operation of phase I detectors. Internal ^{60}Co decays of phase I detectors (because of HdM/IGEX cosmic ray history) ranges between (0.5-2)×10^{-3} cts/kg/keV/y, or even larger (cross section uncertainty possibly up to factor 2).
- Currently available cables and FE- electronics for 18-fold segmented phase II detectors do not meet specs of BI<<10^{-3} cts/kg/keV/y
- Background from radon in LAr only <<10^{-3}cts/kg/keV/y, if shroud and temperature gradient work as designed.

⇒ If above mentioned (or yet unknown) background sources turn out to be a limiting factor, a LAr scintillation veto would suppress efficiently those backgrounds and would lead the way to 'background free operations' of GERDA phase II

⇒ Coordinated R&D efforts using the GERDA-LArGe test facility is required to have a mature technique at hand - if needed - for the start of phase II.

⇒ Future operations and measurement program should be coordinated and shared with interested parties of collaboration ⇒It's now timely to start the discussion of the future measurement program and work sharing within GERDA collaboration

The GERDA-LArGe low-background facility as a R&D test stand for a 1 ton phase III experiment

- 1 ton experiment requires a BI<10^{-4} cts/kg/keV/y.
- Background reduction using internal discrimination (e.g. PSA) together with external discrimination (LAr veto) are complementary (e.g. ^{60}Co combined suppression factor 10^{4} – 10^{5})
- Major impact on germanium detector production & logistics (underground vs. above ground)
- Most efficient to discriminating single-Compton scattering events (SSE) of ^{208}Tl or ^{214}Bi decays
- Most efficient underground muon & secondary particle veto. Depth of LNGS then no issue.
- Suppression of degraded surface alpha events (might become relevant at BI<10^{-4} cts/kg/keV/y)
- ......

⇒ The GERDA-LArGe facility is a versatile test stand to explore performance of novel concepts & test phase III prototype modules.

Possible measurements:

1. Establish operation with high and stable scintillation light yield and a low trigger threshold.
2. Perform measurements with different types of bare HP-Ge detectors (coaxial, p-type BEGe, n-type segmented) and to study the achievable background suppression factors for different radio isotopes using gamma sources.
3. Study the complementarity of the (external to the crystal) liquid argon scintillation veto and the (internal to the crystal) MSE/SSE discrimination using gamma sources.
4. Perform long-term measurements with low-background germanium detectors to study the achievable background performance using liquid argon veto and Ge-PSA/segmentation cut.
5. Study the particle identification of beta/gammas, alphas and neutrons by pulse shape analysis of the argon scintillation light for background discrimination.
6. Measurement of the radon trace amounts (and its variations over time) in the liquid argon using delayed coincidence methods.
7. Investigate new types of low-background photo-sensors aimed to maximize the scintillation photo electron yield and to measure the vertex position.
8. Study underground muon induced background signals triggered with muon veto scintillator panels.
9. Ge-detector/FE integration tests with phase II FE candidates

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The GERDA low-background facility LARGE at LNGS: Status and plans

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Abstract

The GERDA low-background facility LARGE, located in the GERDA underground detector laboratory (GDL) at LNGS, aims to study the performance of high-purity germanium detectors operated in liquid argon with simultaneous detection of the liquid argon scintillation light for background suppression. GERDA-LARGE has been proposed as a GERDA research and development facility and described first in the letter of intent and in the proposal to the LNGS in 2004. The graded shielding system was designed and machined in 2004, and mounted in the GDL at LNGS in 2005. The GERDA-LARGE shield was machined from the former LENS shield. After completion of the GERDA phase I long-term detector tests in the GDL, the low-background copper cryostat was installed in the GDL in 2009 followed by its cryogenic commissioning phase. The GERDA-LARGE facility is expected to become fully operational during the first half of 2010. This report summarizes the design, construction and commissioning phase, and discusses the upcoming experimental activities, its possible future role in the GERDA experiment, as well as the required personel and the sharing amongst GERDA groups in the future.