The GERDA experiment. Status and results of data taking.

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Introduction

The study of neutrinoless double beta (0νββ) decay is a powerful approach to investigate fundamental properties of neutrinos. Searching for the 0νββ decay helps to understand:
• Nature of ν (Dirac or Majorana)
• Neutrino mass scale
• Neutrino hierarchy

Part of H-M Collaboration, claimed evidence for 0νββ decay observation with the best fit $T_{1/2} = 1.19 \times 10^{32}$ yr [1].

The GERDA experiment (GERmanium Detector Array) [2] is a low background experiment aims to search for the 0νββ decay of 76Ge. The aim of GERDA is to test the claim of discovery by part of Heidelberg-Moscow Collaboration, and, in a second phase, to achieve much better sensitivity than recent experiments.

Phase I: Deployed 8 existing enriched detectors (18 kg total), 3 natural HPGe detectors (in total 7.6 kg of natural Ge) and 5 enriched BEGe (3.6 kg from 7/07/2012)

Phase II: In addition new enriched BEGe detectors with total mass of about 20 kg will be incorporated together with liquid argon (LAr) scintillation veto.

Experimental setup

GERDA background reduced by:
• Usage of bare HPGe detectors, enriched by 86% of 76Ge, low mass radioactive pure holders.
• Germanium detectors deployed in a cryostat with 64 m3 LAr, which shields from the radiation and cools them down.
• Steel tank containing 590 m3 ultrapure water equipped with Cerenkov μ-veto.
• Proper material selection and avoiding irradiation of the detectors.
• Anti-coincidence between different detectors is used during the analysis.
• Location in LNGS reduces μ flux (in ~ 106 times) and neutron flux induced by cosmic radiation.

GERDA experiment located at LNGS underground laboratory (Italy). The rock overburden is equivalent to 3500 m.w.e.

Results and discussion

Resolution of enriched detectors

9/11/2011: Start Phase I in GERDA. 8 detectors HPGe coaxial detectors made from material enriched in 76Ge + 3 detectors from natural Ge were deployed. Resolution 4.2-5.3 keV at 2.6 MeV (FWHM) has been obtained. 6 enriched detectors used for analysis.

Accumulated exposure up to 02/05/2013;
Enriched coaxial: 18.6 kg-yr
Natural: 6.05 kg-yr
Enriched BEGe: 2.27 kg-yr
Exposure for enriched detectors

Energy scale stability

From analysis of first 126 days of data taking obtained half-life of the 2νββ decay:

$T_{1/2} = (1.84^{+0.09}_{-0.11} \pm 0.06 \text{ syst}) \times 10^{25}$ yr

Data blinded between 2019 keV and 2059 keV. Background index (BI) is about 10 times lower than in previous experiments with 76Ge [2].

Comparison with the previous experiments

Phase II preparations

BEGe: new HPGe detectors for GERDA Phase II:
• Better energy resolution.
• Powerful pulse shape discrimination (PSD) [4].

Pulse shape analysis of the BEGe detectors is a powerful tool to reject background events like multi-side events and surface events. Examples of the pulses from BEGe detector

\[ \text{LaGe} = \text{low background test facility to study new methods of the background suppression} [6] \]

It was demonstrated in LaGe that LAr scintillation veto can considerably reduce lot of the backgrounds, dangerous for GERDA. That is why in GERDA Phase II LAr scintillation veto together with new BEGe detectors will be implemented.

• Currently about 20 kg of enriched BEGe detectors have been produced and tested in vacuum cryostat in Hades.
• 5 of enriched BEGe have been already tested in GERDA. Average resolution of them in Phase I configuration is 3.08 keV.
• Installation of the GERDA Phase II will start in June 2013.

Blinded region will be open in June 2013!

References: