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# Searching for the neutrinoless double beta decay with GERDA

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The GERmanium Detector Array (GERDA) experiment at the INFN Gran Sasso Laboratory, Italy, is searching for the neutrinoless double beta ($0\nu\beta\beta$) decay of the isotope $^{76}$Ge. High-purity germanium crystals enriched in $^{76}$Ge are the source and the detector simultaneously. The key design feature of GERDA is that detectors are deployed directly into an ultra-pure cryogenic liquid (liquid argon), acting both as cooling medium and radiation shield against the external radiation. The signature of the $0\nu\beta\beta$ decay would be a mono-energetic peak at the $Q_{\beta\beta}$-value of the process, namely 2039 keV for $^{76}$Ge.

Data from the first phase of GERDA (Phase I), collected between 2011 and 2013, gave no positive indication of the $0\nu\beta\beta$ decay of $^{76}$Ge with an exposure of about 20 kg yr. GERDA Phase I reached a background index at the $Q_{\beta\beta}$-value of $10^{-2}$ counts/(keV kg yr) and set a lower limit on the half-life of the process of $T_{1/2} > 2.1\cdot 10^{25}$ yr (90% C.L.).

The second Phase of the experiment is taking data since 2015 with a doubled mass of enriched Ge detectors. The goal of Phase II is to collect a "background-free"exposure of 100 kg yr, thus to reduce the background to $10^{-3}$ counts/(keV kg yr). Newly developed custom-made BEGe-type Germanium detectors add 20 kg of mass and allow for a superior background rejection by pulse shape discrimination. The other key handle for the background suppression in Phase II is the instrumentation of the cryogenic liquid surrounding the detectors for light detection serving as additional active veto.

Initial results from Phase II with about 10 kg yr exposure (published in Nature vol. 544, April 6th 2017) allow to improve the limit on the half-life of $0\nu\beta\beta$ decay of $^{76}$Ge to $T_{1/2} > 5.3\cdot 10^{25}$ yr (90% C.L.) and indicate that the target background is achieved, thus making GERDA the first experiment in the field which will be "background free"up to the design exposure. A total Phase II exposure of about 40 kg yr is expected to be available at the time of the Conference. All data collected after the initial data release are "blinded", i.e. events in $Q_{\beta\beta}\pm 25$ keV are not available for analysis, in order to prevent any selection bias. Preliminary analysis of the available data outside the blinded region confirms the background performance.

This presentation will summarize the basic concept of the GERDA design, the data taking and the physics results obtained in Phase II. A special focus will be given to the background achieved at $Q_{\beta\beta}$ and to the analysis of the residual background components. A new data unblinding is foreseen to take place shortly before the Conference; if confirmed, new physics results on $0\nu\beta\beta$ decay with about 40 kg yr exposure will be also presented and discussed.

**Primary author:** PANDOLA, Luciano (INFN-LNS)

**Presenter:** PANDOLA, Luciano (INFN-LNS)

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