Active background suppression in Phase II of the GERDA experiment

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In Phase II of the GERDA experiment [1] additional ~20 kg of BEGe-type germanium detectors [2], enriched in ^{76}Ge, will be deployed in liquid argon (LAr) to further increase the sensitivity for the half-life of neutrinoless double beta decay of ^{76}Ge to $> 2 \cdot 10^{26}$ y. In order to reduce background to the required level of $< 10^{-3}$ cts/(keV·kg·yr), a factor of 10 below the goal of Phase I, it is necessary to employ active background-suppression techniques. Such methods include an anti-Compton veto using scintillation light detection from LAr [3], as well as a novel pulse shape discrimination (PSD) method exploiting the characteristic electrical field distribution inside BEGe detectors [4,5]. The latter technique can identify single-site events (typical for double beta decays) and efficiently reject multi-site events (typical for backgrounds from gamma-ray interactions), as well as different types of background events from detector surfaces.

Using the information from the analysis of GERDA Phase I data as well as from tracking of the Phase II detector material exposure to cosmic rays, contributions of the different components to the background of Phase II were estimated. This information was combined with active suppression factors determined both experimentally and through extensive simulations, to estimate the expected background level at the region of interest at 2039 keV, the $Q_{\beta\beta}$ energy of ^{76}Ge. This preliminary analysis showed that contributions from all expected background components can be reduced to or below the level of 10^{-4} cts/(keV·kg·yr) after all cuts, in line with the goal of GERDA Phase II.

A first analysis of low energy background region at GERDA-LArGe low background test facility [3] was presented, showing very efficient suppression of ^{39}Ar background via LAr scintillation anti-coincidence and PSD using a BEGe detector. Preliminary results show background rate of 0.05 cts/(keV·kg·d) after cuts in the region between 30 keV and 50 keV.

[1] The GERDA Collaboration, Proposal (2004), http://www-hd.mpg.de/GERDA/proposal.pdf

[2] Canberra Broad Energy Germanium (BEGe) detector, http://www.canberra.com/products/485.asp

[3] M. Heisel, Ph.D. thesis, University of Heidelberg (2011)

[4] D. Budjáš et al., JINST 4 P10007 (2009)

[5] M. Agostini et al., JINST 6 P03005 (2011)

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