Extending the use of the GERDA setup for the search of neutrinoless double beta decay of ^{76}Ge

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The GERDA collaboration is searching for neutrinoless double beta ($0\nu\beta\beta$) decay of ^{76}Ge by deploying germanium detectors in 64 m^3 of liquid argon. Argon shields against external radiation and so does a surrounding water Cherenkov shield. Currently, the second phase of the experiment is under preparation with the goal to reduce the background at the Q value of the decay to 0.001 cts/(keV·kg·yr). With a planned exposure of 100 kg·yr and a signal window of typically 5 keV (2×FWHM) only 0.5 background events are expected and the sensitivity for a 90% C.L. limit on the half-life is $1.5 \cdot 10^{26}$ yr. Under these almost background free conditions, the sensitivity scales linearly with the exposure, while for large number of background counts, it only scales with the square root. The low background and excellent energy resolution allow GERDA not only to set limits that are competitive to those from experiments with much larger target mass but to have a clear and simple signature of a signal in case of discovery of $0\nu\beta\beta$ decay.

The expected background can be roughly divided into "far" and "close" sources. Neutrons produced in muon interactions could be an important far contribution at a level of 10^{-4} cts/(keV·kg·yr). Close sources like ^{214}Bi decays or ^{42}K surface events are expected to dominate the background. It is therefore conceivable that the latter can be further reduced in the future by using for example cleaner construction material, an improved argon scintillation light veto or by novel techniques to limit ^{42}K surface events. For a factor of five reduction in background and an exposure of 1000 kg·yr we would expect one event in the signal window. The experimental sensitivity in half-life in such a scenario will grow almost linearly with exposure to $1 \cdot 10^{27}$ yr. The germanium detector mass should be increased by about a factor of 5 to 150-200 kg.

One possibility to implement the additional germanium mass into the GERDA cryostat is to increase the number of strings to 19. Such an array would fit into the existing cryostat. Alternative implementations are also considered. Beside the R&D for the lower background, cabling and mechanic support for the detectors and the liquid argon veto need additional design efforts.

Since the big components like the cryostat and the water tank exist, the schedule and costs of such an upgrade is dominated by the germanium enrichment and detector fabrication. Such an upgrade could be realized in a reasonable amount of time. The discussed project is beyond the current scope of the GERDA agreement. It is conceived in view of a staged approach towards an even larger germanium mass experiment as part of a world-wide collaboration.