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Erratum

Erratum to: Sensitivity of the DARWIN observatory to the neutrinoless double beta decay of ^{136}Xe

DARWIN Collaboration[c]

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Abstract We correct an overestimation of the production rate of ^{137}Xe in the DARWIN detector operated at LNGS. This formerly dominant intrinsic background source is now at a level similar to the irreducible background from solar ^{8}B neutrinos, thus unproblematic at the LNGS depth. The projected half-life sensitivity for the neutrinoless double beta decay ($0\nu\beta\beta$) of ^{136}Xe improves by 22% compared to the previously reported number and is now $T_{1/2}^{0\nu} = 3.0 \times 10^{27}$ yr (90% C.L.) after 10 years of DARWIN operation.

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Detailed MC simulation studies of muon-induced neutrons [1] revealed our initial overestimation of the ^{137}Xe activation by neutron capture on ^{136}Xe in the DARWIN TPC located at LNGS. The in-situ ^{137}Xe production rate must be corrected to (0.82 ± 0.10) atoms/(t·yr), a factor of 8.4 lower than the initially estimated value. This reduces the previously-dominant intrinsic background contribution from ^{137}Xe to a level similar to the ^{8}B neutrino background via ν-e^{-}scattering. This increased importance of the formerly subdominant ^{8}B background calls for a revision of its initially simplified calculation. The neutrino flux spectrum is now convolved with the energy-dependent electron neutrino survival probability $P_{ee}(E_\nu)$, according to the MSW-LMA solution [2]. Accordingly, Table 3 and Figures 6, 7 and 8 of the initial manuscript are corrected.

The DARWIN sensitivity to the $0\nu\beta\beta$ decay of ^{136}Xe is recalculated with the updated background rates. The figure-of-merit estimator (section 6.1 of the original manuscript) projects a half-life sensitivity at 90% confidence level (C.L.) of $T_{1/2}^{0\nu} = 2.7 \times 10^{27}$ yr (1.7×10^{27} yr) after 10 (4) years of exposure. The frequentist profile-likelihood analysis (section 6.2) yields a $T_{1/2}^{0\nu}$ sensitivity limit of 3.0×10^{27} yr for a 10 year exposure with 5 t fiducial mass. The corresponding 3 σ discovery potential after 10 years is 1.3×10^{27} yr.

The now corrected intrinsic background is dominated by the β-decay of ^{214}Bi in the baseline scenario (black in Figure 8). Reducing the BiPo tagging inefficiency to 0.1% leads to a similar background contribution from ^{8}B, ^{137}Xe, and ^{222}Rn for DARWIN at LNGS (red). Combining a 0.01% inefficiency with a 50% efficient timed veto on ^{137}Xe activation (discussed in section 7) suppresses the non-neutrino intrinsic backgrounds to approximately half of the ^{8}B contribution (blue). As in the initial manuscript, the optimistic scenarios assume a reduction of the external background and improved topological discrimination.

Table 3 Expected background index averaged in the $0\nu\beta\beta$-ROI of [2435–2481] keV, the corresponding event rate in the 5 t FV and the relative uncertainty by origin

Background source	Background index [events/(t·yr·keV)]	Rate [events/yr]	Rel. uncertainty
External sources (5 t FV):			
^{214}Bi peaks + continuum	1.36×10^{-3}	0.313	±3.6%
^{208}Tl continuum	6.20×10^{-4}	0.143	±4.9%
^{44}Sc continuum	4.64×10^{-6}	0.001	±15.8%
Intrinsic contributions:			
^{8}B ($\nu - e$ scattering)	1.51×10^{-4}	0.035	±13.5%
^{137}Xe (μ-induced n-capture)	1.69×10^{-4}	0.039	±10.2%
^{136}Xe $2\nu\beta\beta$	5.78×10^{-6}	0.001	+17.0%, − 15.2%
^{222}Rn in LXe (0.1 μBq/kg)	3.09×10^{-4}	0.071	±1.6%
Total	$\mathbf{2.62 \times 10^{-3}}$	**0.603**	**±2.4%**

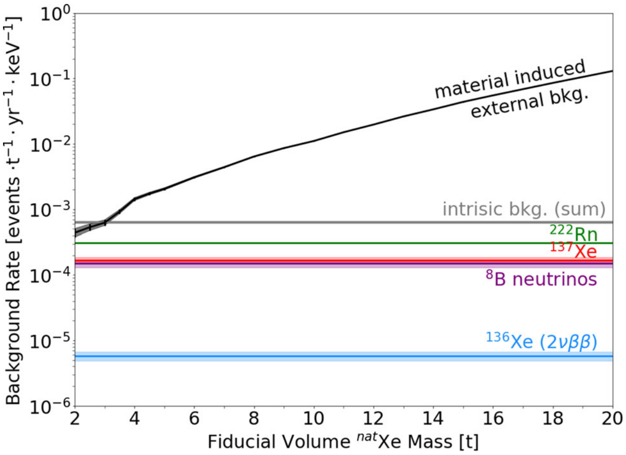

Fig. 6 Background rate in the ROI versus fiducial mass. External contributions are combined. Fiducial volume independent intrinsic sources are shown per contribution. Bands indicate ±1 σ uncertainties

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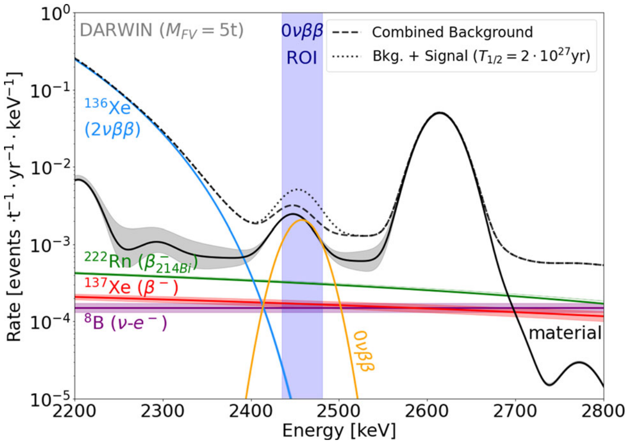

Fig. 7 Predicted background spectrum around the $0\nu\beta\beta$-ROI for the 5 t fiducial volume. A hypothetical signal of 0.5 counts per year corresponding to $T^{0\nu}_{1/2} \approx 2 \times 10^{27}$ yr is shown for comparison. Bands indicate $\pm 1\,\sigma$ uncertainties

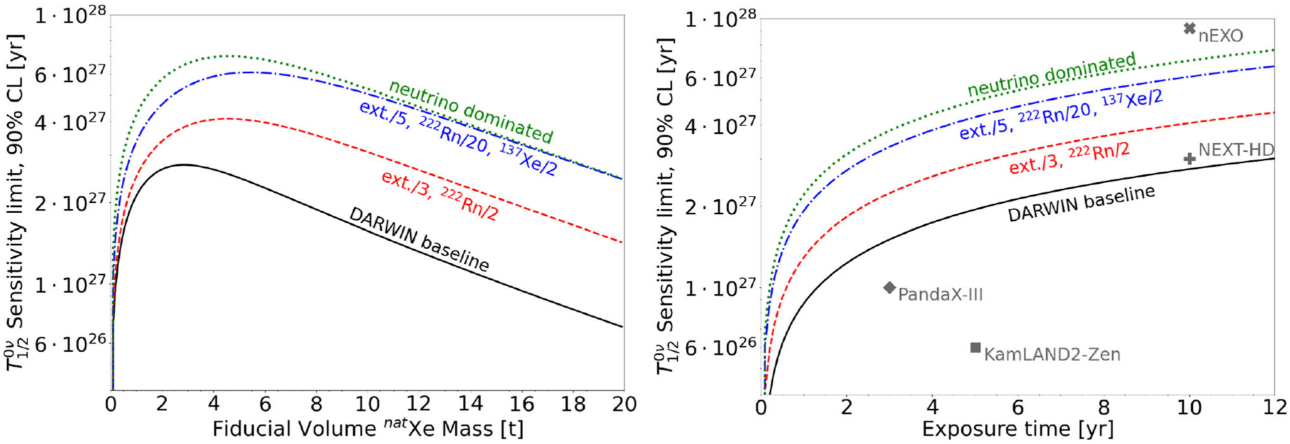

Fig. 8 DARWIN median $T^{0\nu}_{1/2}$ sensitivity at 90% C.L. as a function of fiducial volume mass for 10 years of operation (left) as well as of the time for the optimized fiducial volume (right). The baseline design is compared to different optimistic scenarios. The latter assume a reduction of the external (ext.) and the intrinsic (^{222}Rn and ^{137}Xe) backgrounds and improved spatial separation threshold of 10 mm (red) or 5 mm (blue, green). The green line assumes only irreducible intrinsic backgrounds, dominated by ^{8}B neutrinos. Sensitivity projections for future ^{136}Xe $0\nu\beta\beta$ experiments are shown for comparison

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