Status of the NEXT experiment for neutrinoless double beta decay searches

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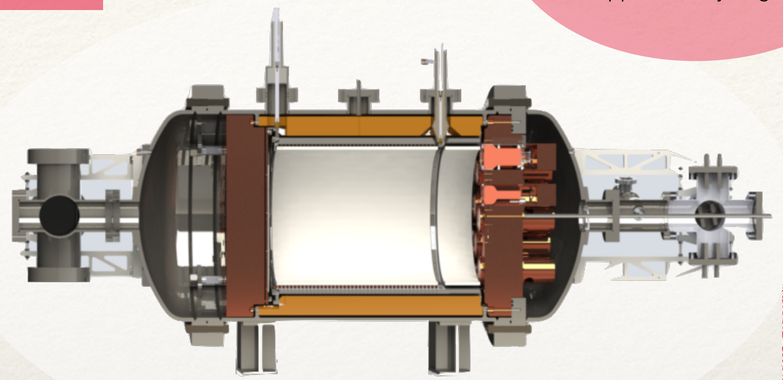
Introduction

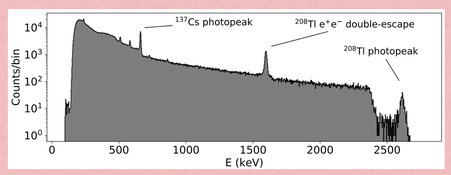
NEXT (Neutrino Experiment with a Xenon TPC) is a **neutrinoless double beta decay experiment** located at the Laboratorio Subterráneo de Canfranc (Spain). Its aim is to demonstrate that the neutrino is a Majorana particle by detecting the neutrinoless double beta decay process in xenon gas enriched in the ^{136}Xe isotope using the TPC technology.

NEXT-White detector

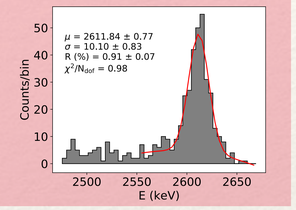
The **NEXT-White detector** is currently running at the Laboratorio Subterráneo de Canfranc (Spain) and contains an active Xe mass of approximately 5 kg.



Energy resolution



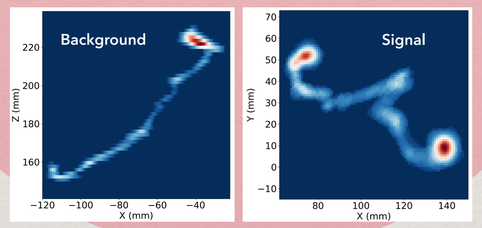
A **resolution better than 1% FWHM** has been demonstrated to be obtainable at 2615 keV [1].

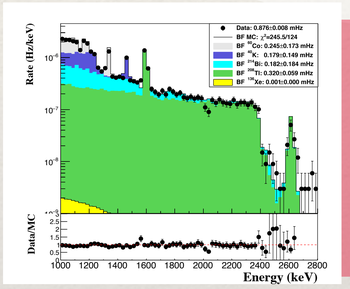


Track reconstruction

A plane of SiPMs is used to reconstruct the tracks of the particles within the detector. The topological signature of **signal events** is different from that of the background events, and several algorithms have been used to differentiate them such as Breadth First Search algorithm or deep neural networks.

A novel reconstruction through **Richardson-Lucy iterative deconvolution** provides a high definition image of the tracks, increasing the background rejection power [2].





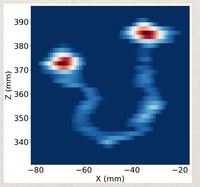
Background model

A background model based on an **extensive radiopurity campaign** has been developed and the NEXT-White data has been used to validate it [3].

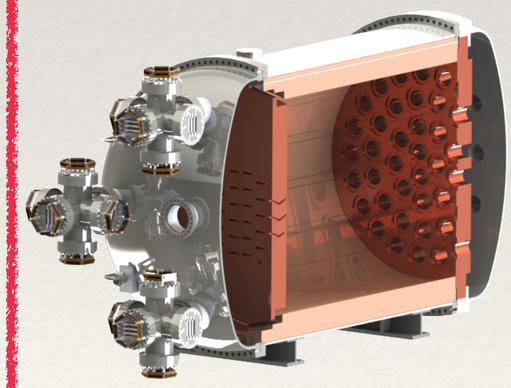
The two neutrino mode (2νββ)

Background is measured using depleted Xe, and it is **subtracted from the enriched Xe** spectrum to find the 2νββ signal.

Deconvolved 2 MeV 2νββ candidate using RL algorithm, obtained during the data taking of NEXT-White [2].

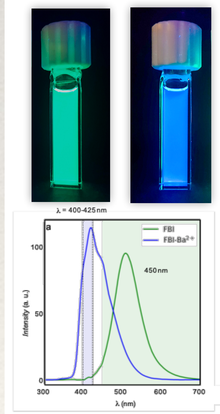


NEXT-100



The 100-kg detector is currently under construction and planned to be commissioned during 2022. The energy plane will contain 58 PMTs with 30% coverage and about 3600 SiPMs will constitute the tracking plane.

The **predicted sensitivity** to the 0νββ-decay half-life it will reach is 2.8 × 10^{25} years (90% CL) for an exposure of 100 kg·year.



NEXT-HD/BOLD and Ba tagging

The **tonne scale detector** will replace PMTs with barrel fiber optics to minimize all radiogenic and cosmogenic contributions, will achieve better energy resolution by increasing the EL gain, and will represent a **truly background free** state with Ba tagging.

The detection of the daughter atom in the decay, **Ba^{2+}, in coincidence with the two electrons,** would constitute positive evidence of the 0νββ process.

One possible approach is to synthesize a fluorescent bicolor indicator that will emit light in the blue region if the barium has been caught [4].

References

[1] *NEXT Collaboration* (2019) [JHEP10(2019)230] Energy calibration of the NEXT-White detector with 1% resolution near $Q_{\beta\beta}$ of ^{136}Xe.
[2] *NEXT Collaboration* (2020) [arXiv:2102.11931 [physics.ins-det]] Boosting background suppression in the NEXT experiment through Richardson-Lucy deconvolution.
[3] *NEXT Collaboration* (2019) [JHEP10(2019)051] Radiogenic backgrounds in the NEXT double beta decay experiment.
[4] [Nature 583, 48-54 (2020)] Fluorescent bicolour sensor for low-background neutrinoless double β decay experiments.