Measurement of the ^{136}Xe ββ2ν half-life with NEXT-White

Miryam Martínez Vara on behalf of the NEXT Collaboration

PANIC 22nd edition

Introduction

NEXT is a neutrinoless double beta decay experiment located at the Canfranc Underground Laboratory in Spain.

NEXT-White, a 5-kg radiopure detector has proven the outstanding performance of the NEXT technology in terms of the energy resolution (<1% FWHM at 2.6 MeV) and the topology-based background rejection. It has also measured the relevant backgrounds for the ββ0ν search using both **^{136}Xe-depleted** and **^{136}Xe-enriched** xenon used in this analysis for the measurement of the half-life of the two neutrino mode of the double beta decay (ββ2ν).

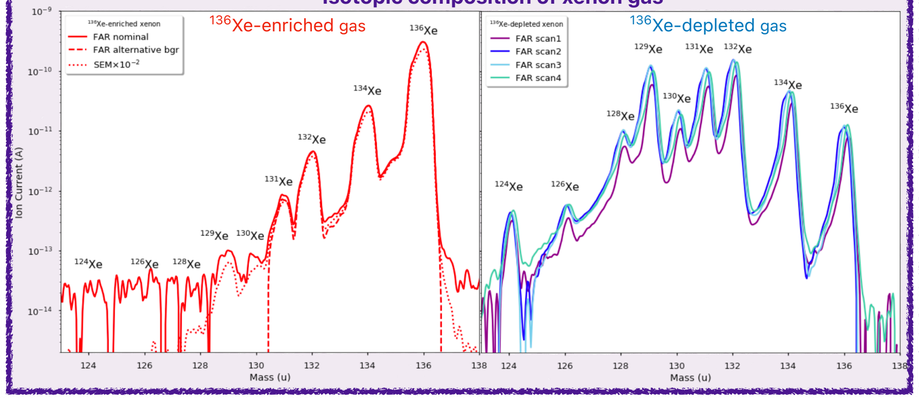
Data

The data used in the analysis is a combination of **two different data-taking periods** using **enriched and depleted ^{136}Xe**. During both periods the detector operated under the same conditions being:

Gas pressure ~10.1 bar
Drift field: 0.4 kV/cm
EL field: 1.7 kV/(cm·bar)

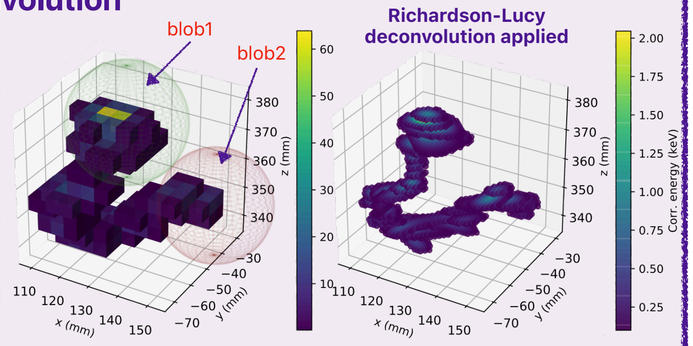
In order to compare the rates for each data taking period some **corrections** on the **gas density**, **selection efficiency** and **DAQ livetime** have been applied.

Isotopic composition of xenon gas



Richardson-Lucy deconvolution

The inclusion of this **novel technique** in the event reconstruction **removes the blurriness** of the tracks produced by the diffusion of ionization electrons at the XY plane when traveling to the anode, and the spread of light produced in the electroluminiscence process [1]. Eventually, this tool provides highly refined images of events leading us to a significant **upgrade in the signal/background discrimination**.



Selection cuts

Fundamental to increase the signal /background ratio.

Inclusive sample
Eevt > 1MeV
nS1 = 1

Background selection
nS2 = 1
R_{max} < 195mm
Z_{min} > 20mm
Z_{max} < 510mm
n_tracks = 1
rejects events with several energy depositions, simultaneous processes and fiducializes the volume

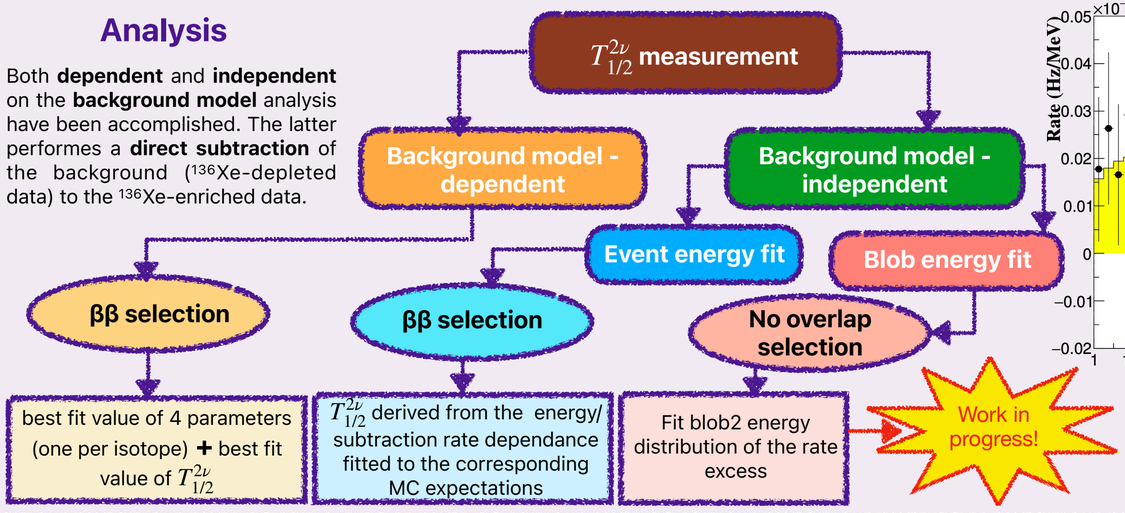
No overlap selection
overlap_energy = 0
rejects events with possible incorrect values of blob energy as a consequence of the overlapping of the tracks.

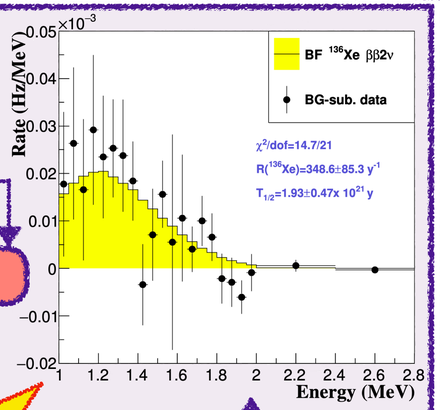
ββ selection
energy_blob2 > E_{thr}(E_{evt})
compounded by events with 2 Bragg peaks

β selection
energy_blob2 < E_{thr}(E_{evt})
background events are included in this category / 1 Bragg peak

Analysis

Both **dependent** and **independent** on the **background model** analysis have been accomplished. The latter performes a **direct subtraction** of the background (^{136}Xe-depleted data) to the ^{136}Xe-enriched data.





Background-subtracted spectrum superimposed to the best-fit 2νββ MC.

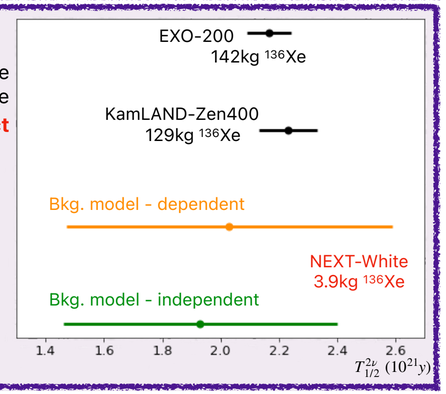
$T^{2\nu}_{1/2}$ measurement

The two obtained values are **consistent**, which assesses the robustness of the 2νββ analysis performed with the NEXT-White data, **being up-to-date the first $T^{2\nu}_{1/2}$ measurement using a direct subtraction method.**

		$T^{2\nu}_{1/2}$ (10^{21}y)	*Significance* (σ)
Bkg model-dependent		2.03 ± 0.56	3.9
Bkg model-independent	Evt energy fit	1.93 ± 0.47	4.1

statistical + systematic

Although the obtained precision on the measurement is limited by the **small amount of ^{136}Xe mass**, it is worth noticing that the NEXT-White results are **compatible with the $T^{2\nu}_{1/2}$ values provided by EXO-200 [2] and KamLAND-Zen400 [3].**



References:

[1] NEXT collaboration, Boosting background suppression in the NEXT experiment through Richardson-Lucy deconvolution, JHEP 7 (2021) 146 [2102.11931].

[2] EXO-200 collaboration, Improved measurement of the 2νββ half-life of ^{136}Xe with the EXO-200 detector, Phys. Rev. C 89 (2014) 015502 [1306.6106].

[3] KamLAND-Zen collaboration, Precision measurement of the ^{136}Xe two-neutrino ββ spectrum in KamLAND-Zen and its impact on the quenching of nuclear matrix elements, Phys. Rev. Lett. 122 (2019) 192501 [1901.03871].