

NEXT first results and future plans

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The context

- * What is NEXT?
 - * NEXT is a neutrino-less double beta decay experiment.
 - * **NEXT** is a high pressure Xe TPC with an EL region
 - * NEXT is an international collaboration
 - NEXT detector is operated at Canfranc Underground Laboratory (Spain)
- * About this talk and other thanks in the venue:
 - Francecs Monrabal (U. of Texax, Arlington) will present the construction and operation of the TPC
 - Here, I will revisit the physics, first results and some future plans

The neutrinos always so mysterious...

***** There was New Physics!

- * The **neutrinos have mass!** *Nobel Laureate* 2015 to McDonald (SNO) and Kajita (SuperKamionande) for the discovery of Neutrino oscillations.
- * Now to complete the SM? **How to provide mass to neutrinos?**

* Open questions about neutrinos

- Current limits on the neutrino mass (0(1) eV), why is so small compared with the other leptons and quarks?
- * *Neutrinos can be pure neutral particles*! What is the nature of the neutrino: is its own antiparticle (is Majorana) or is a normal fermion (is Dirac)?
- * Have the neutrinos and impact in the observed matter-antimatter asymmetry in our Universe?





isotopes and effective mass

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* bb0nu life-time:

Expected decay rate: $(T_{1/2}^{0\nu})^{-1} = G^{0\nu}(Q,Z) |M^{0\nu}|^2 \langle m_{ee} \rangle^2$ Phase space integral Nuclear matrix element $\langle m_{ee} \rangle = \left| \sum_i U_{ei}^2 m_i \right|$ Effective neutrino mass U_{ei} Elements of (complex) PMNS mixing matrix

* A posible list of isotopes:

2000

* There is no 'best' isotope



- mbb dependes on nuetrino mass hierarchy and
- mixing parameters
- * Next generation try to explore allowed IH region











Next of NEXT

* Economy of scale!

signal < Volume, but background < Surfaces</p>



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NEW (10 kg)NEXT-100NEXT-nT(2016-2018)(2018-2022)(2023-)





















NEW, the construction









NEW, the construction



NEXT main goals

F. Monrabal's talk

D. Gonzalez's talk

- * **NEW Run-I** (2016):
 - * commissioning of the detector, first operation
 - * very preliminary results with X-rays
- * NEW Run-II (2017):
 - * NEW has been operated at 7-9 bar and has been stable during 2017
 - * Detector has been calibrated using ⁸³Kr, ²²Na, ⁶⁰Co, ¹³⁷Cs, ²⁰⁸Tl sources
 - * Results on energy are excellent (extrapolated **0.8** % at **Qbb**)
 - * Results on tracking on-going, but very promising

* NEW Run-III (2018-2019)

- * Measure of the **background spectrum**
- * Measure spectrum with ¹³⁶Xe, measure T_{1/2} of **bb2nu**!

* NEXT-100 (2018-2024):

- Construction of NEXT-100. Operation of NEXT-100, calibration, reconstruction, background model, measurement of T_{1/2} of ¹³⁶Xe bb0nu!
- * Operation after 2010

* NEXT-nT (2018-20?)

- * Design studies: SiPM full coverage, low temperature, sensibility
- *** Detector improvements:** Gas mixtures and EL tiles

First results of NEW

- * Run-II main goals:
 - * Estimate the lifetime (electron attachment of the chamber) or gas purity
 - * Map the response of the chamber (using ⁸³Kr decays)
 - * Measure the energy resolution for different energies (¹³⁷Cs, ²⁰⁸Tl)
 - * Estimate the **topology** signature (²⁰⁸Tl double scale peak)

electron attachment



NEW calibration-Kr

- * ⁸³Kr: point like deposition 41.5 keV, 1.8 h half-lifetime
- * Measure the response of the chamber (map) and estimate the energy resolution
- * large statistics 0(M) trigger, specific trigger
- * internal source, mixed with the Xe gas

G. Martinez's Ph.D thesis

NEW calibration-Kr

- * ⁸³K Study lifetime as a function of (x, y)
 - * Lifetime shows a top-bottom dependence (possibly due to flow circulation)
- * Map energy response: light collection depends on (x, y) position of the EL grid
 - * geometrical effect
 - * 'valley' at top left part of the EL

lifetime

calibration factors

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NEXT-NEW calibration-Kr

- * ⁸³Kr Energy resolution, after correction by geometrical effects and lifetime
- * Resolution in the full chamber 4.7% @ 41.5 keV, 0.6% @Qbb
- * Resolution in the inner region, (no lifetime effect), 3.7% @ 41.5 keV, 0.5% @ Qbb

NEW X-rays, Na, Cs, Tl

- * Use response map (from ⁸³Kr) to correct energy deposition in (x, y)
- * Measured spectrum with 22Na 511 keV gamma, and Xenon X-rays (~30 keV)
- * Measured a combined spectrum 137Cs (662 keV) and 208Tl (~1600 keV double scape peak)

NEW tracking

* Tracking plans:

- * Reconstruct the original track using an iterative likelihood method (used in *PET Medical Imaging*), **RESET**, that maps energy deposition to individual sensor responses.
- * Use Deep Neural Networks (DNN) to identify signal (2 electrons), respect (1 electron)
- * ²⁰⁸Tl double scape peak (e-e+ pair) used as candle to estimate signal efficiency.

NEW Rn background

* ²²²Rn is everywhere, degas of components, In its decay chain there are several alphas and 'dangerous' ²⁴¹Bi daughters that produces a 2.6 MeV gamma!
* We have measured the Rn rate in NEW, and the expected bkg contamination is very low < 10⁴ count/(kg keV y)!

Earth is a very radioactive

NEW bkg and bb2nu

* NEW Run-II (2018)

- * Operation and stability of the detector.
- * Measure the **background spectrum** and with enriched xenon **bb2nu** spectrum

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Expected (MC) energy spectrum NEW

NEXT-100

*** NEXT-100** (2018-2024):

Construction of NEXT-100. Operation of NEXT-100, calibration, reconstruction, background model, measurement of T_{1/2} of ¹³⁶Xe bb0nu!

Conclusion

- * **NEXT is** neutrino-less double beta decay.
- * NEXT detector is a HP Xenon TPC with EL gap
- *** NEXT-100** can define the technology for the Next Generation
 - bb0nu experiment!
- *NEW prototype first results:
 - * Excellent energy resolution (0.6-0.8% @ Qbb)
 - * Still working on topology but preliminary results are
 - encoruging.
- *Scale: from NEXT-100 (150 kg) to NEXT-nT

Neutrinos are too mysterious, stay tuned, they can surprise us again!