Latest results of NEXT-DEMO, the prototype of the NEXT 100 double beta decay experiment

Luis Serra, David Lorca, Justo Martín-Albo, Andrew Laing, Michel Sorel, J.J Gómez Cadenas

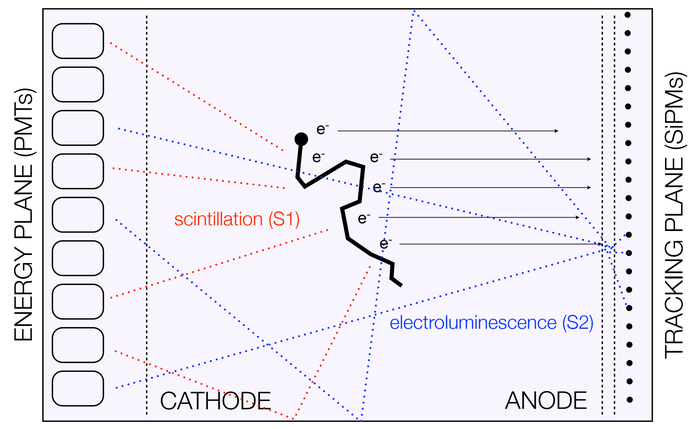
Instituto de Física Corpuscular (IFIC), CSIC-Universidad de Valencia

NEXT is a 100 kg Electroluminescence (EL) High Pressure Xenon TPC. It will search for the neutrinoless double beta decay of ^{136}Xe in the Laboratorio Subterráneo de Canfranc (LSC).

The features that make NEXT a powerful ββ0v experiment are:

- Very good **energy resolution**
- **Tracking** capability
- **Scalability** towards the 1 Ton scale

NEXT-DEMO detector



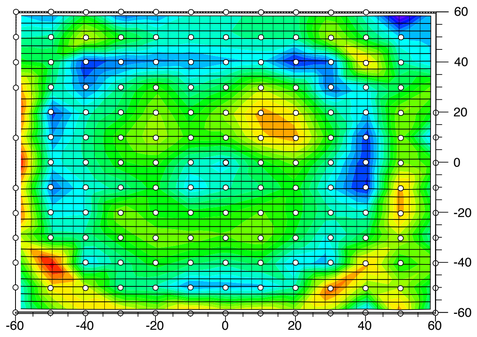
NEXT-DEMO uses the electroluminescent (S2) signal detected by 19 PMTs to measure energy; 3D tracking of the event is provided by 256 SiPMs.

NEXT-DEMO is a 1 kg prototype built to demonstrate the technology to be used in NEXT 100.

The xenon active volume of the TPC comprises a 30 cm drift region, operated at a drift voltage between 200-1000 V•cm^{-1} and a 0.5 cm EL region with a reduced electric field of 1-2 kV•cm^{-1}•bar^{-1}. The pressure is 10 bar for all the studies of this poster.

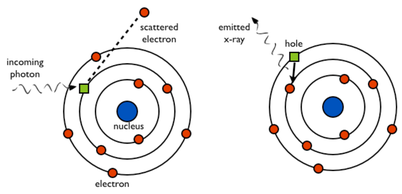
It has been running for 3 years using different radioactive sources. Some measurements made so far are :
- energy resolution
- imaging of single and double electron tracks
- xenon gas properties (drift velocity, diffusion)

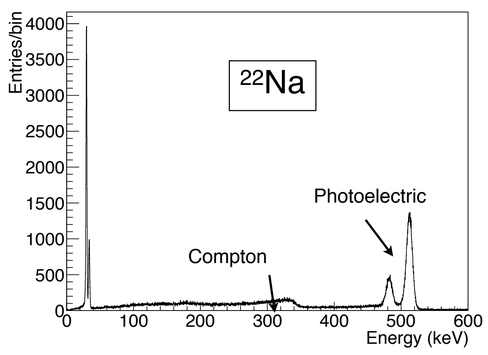
Studies with electromagnetic depositions

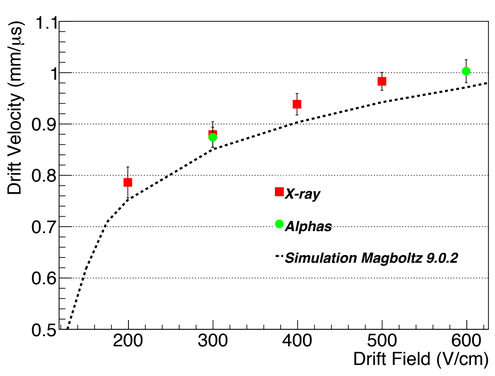


XY energy response of X-rays in NEXT-DEMO

X-ray depositions have ben used to determine the energy response of the TPC, getting the spatial calibration needed to achieve the target energy resolution.



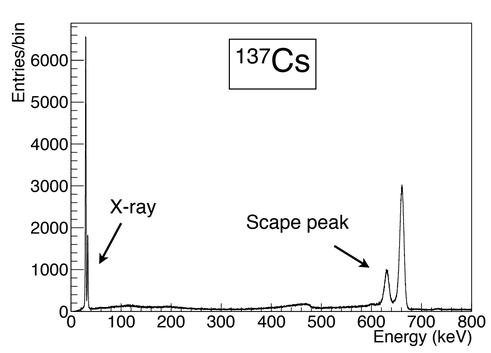




Drift Velocity as a function of Drift field.

Drift velocity is obtained by studying the temporal distribution of these events. Results are consistent with previous measurement using alpha particle depositions.

In addition, these events are used to monitor the gas quality of the detector, homogenizing the response of different data runs.



Energy released by gamma particles coming from ^{22}Na and ^{137}Cs sources have been corrected in drift direction, due to attachment, and XY according to individual PMT maps.

The corrected energy of the event is calculated by the weighted sum of the contributions of each individual PMT. This method behaves smoothly in all the energy range.

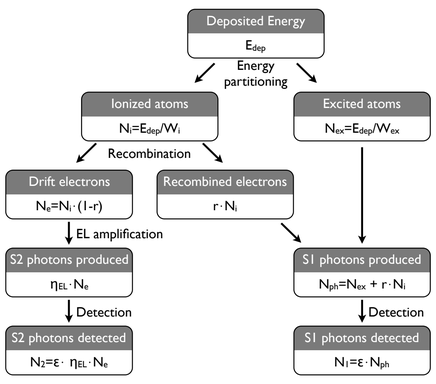
Once the energy spectrum is corrected, energy resolution of X-ray peak as well as photoelectric peak are obtained.

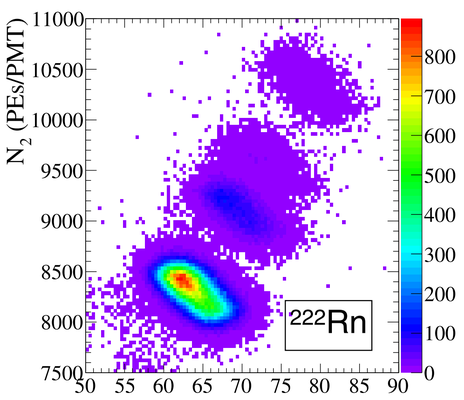
These results match the requirements for the NEXT-100 detector as they are below 1% at Qbb of ^{136}Xe.

Energy Resolution

Source	Energy (KeV)	ER(%FWHM)	ER(%FWHM@Qbb)
Cs137	30	5.54	0.61
Cs137	661.7	1.58	0.81
Na22	30	5.69	0.62
Na22	511	1.62	0.73

Studies with Alpha particle energy depositions





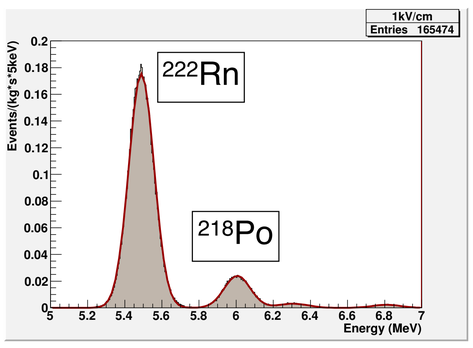
S2 vs S1 signal for 1kV/cm drift field.

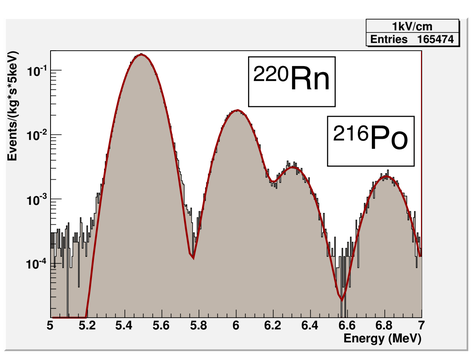
Alpha particle energy depositions can be used to study gas Xenon properties as well as detector performance. Radon is a potential background for double beta decay experiments.

In these studies we have measured Radon alpha decays coming from a ^{226}Ra source connected to the gas system of the detector with different drift voltage configurations.

The energy deposited in the chamber is divided in scintillation (S1) and ionization (S2) of the atoms in the gas. Because of the big amount of electrons generated some of the free electrons recombine and some energy moves from S2 to S1 signal.

Thus we find an anti-correlation between ionization and scintillation signals that can be used to improve the energy resolution. This effect grows when the drift field decreases.





Using the anti-correlation we have defined the energy as the sum of the S1 signal plus the S2 signal weighted by the optical gain of our detector.

$$E = \lambda(N_1 + \frac{N_2}{\eta_{EL}})$$

We have obtained an energy resolution in the peak of 5.49 MeV from ^{222}Rn of 2.83 %FWHM, compared to 8% FWHM of a previous study in NEXT[1].

We were also able to identify another natural chain of Radon that was present in the gas.

Isotope	Energy (MeV)
Rn222	5.49
Po218	6.00
Rn220	6.29
Po216	6.78

Background studies are key for double beta decay experiments like NEXT in order to achieve the best sensitivity.

1. V Álvarez et al 2013 JINST 8 P05025 doi:10.1088/1748-0221/8/05/P05025

The authors would like to acknowledge the collaboration of the members of the NEXT experiment and the support of the Ministerio de Economía y Competitividad of Spain under grants CONSOLIDER-Ingenio 2010 CSD2008-0037 (CUP), FPA2009-13697-C04-04 and FIS2012-37947-C04. Moreover, we would like to acknowledge the support of the European Research Council Advanced Grant 339787 (NEXT).