106° CONGRESSO NAZIONALE SIF

A deep insight into the XENONnT Neutron Veto and its PMTs

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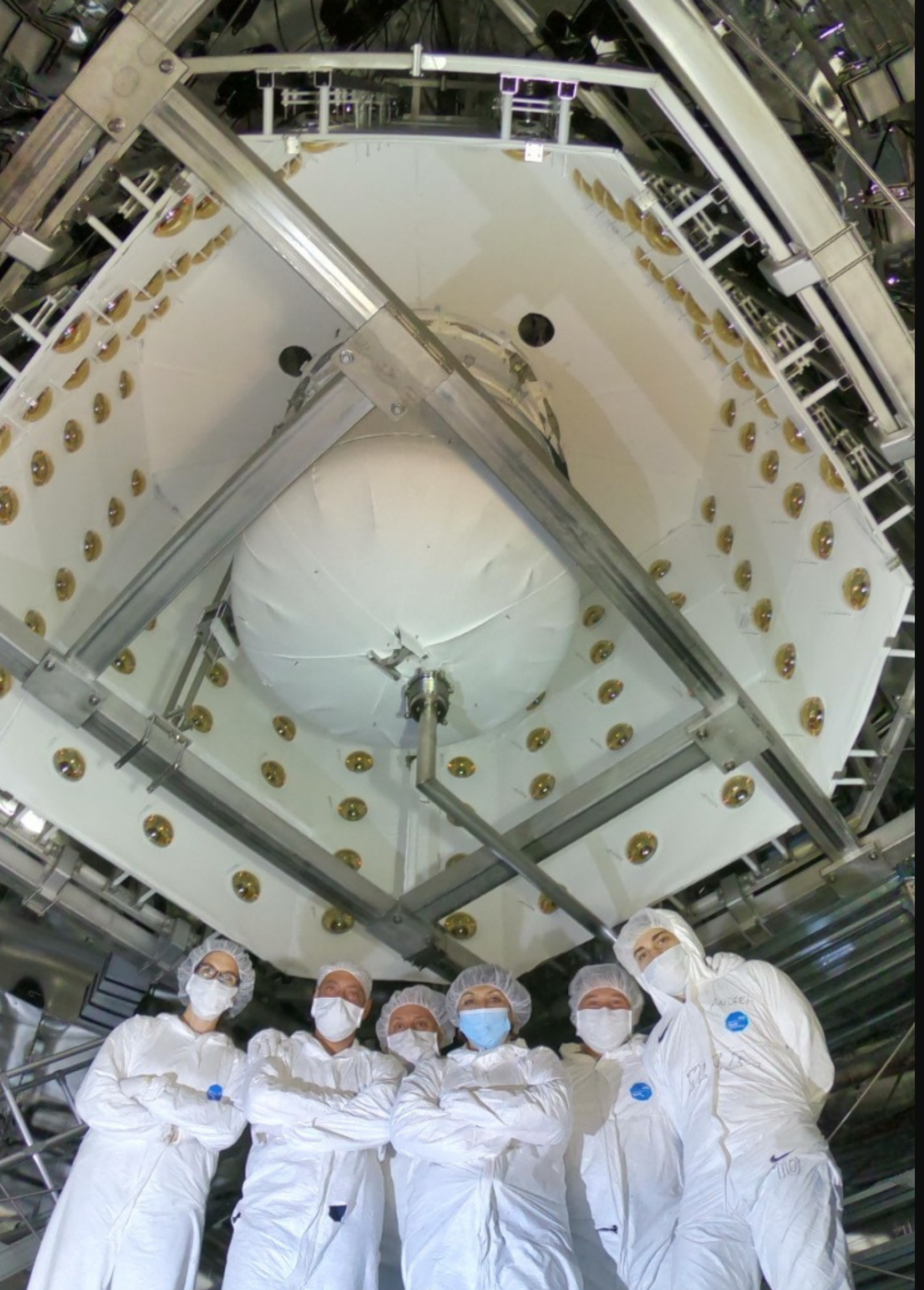


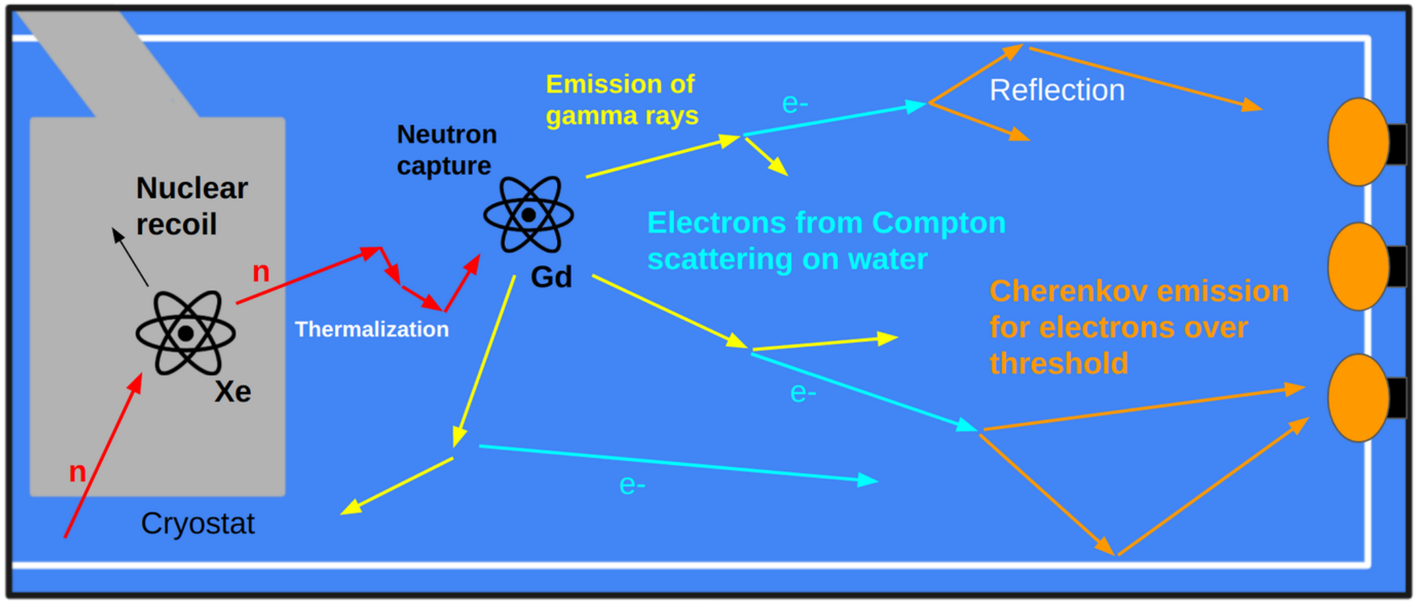
The Neutron Veto of XENONnT

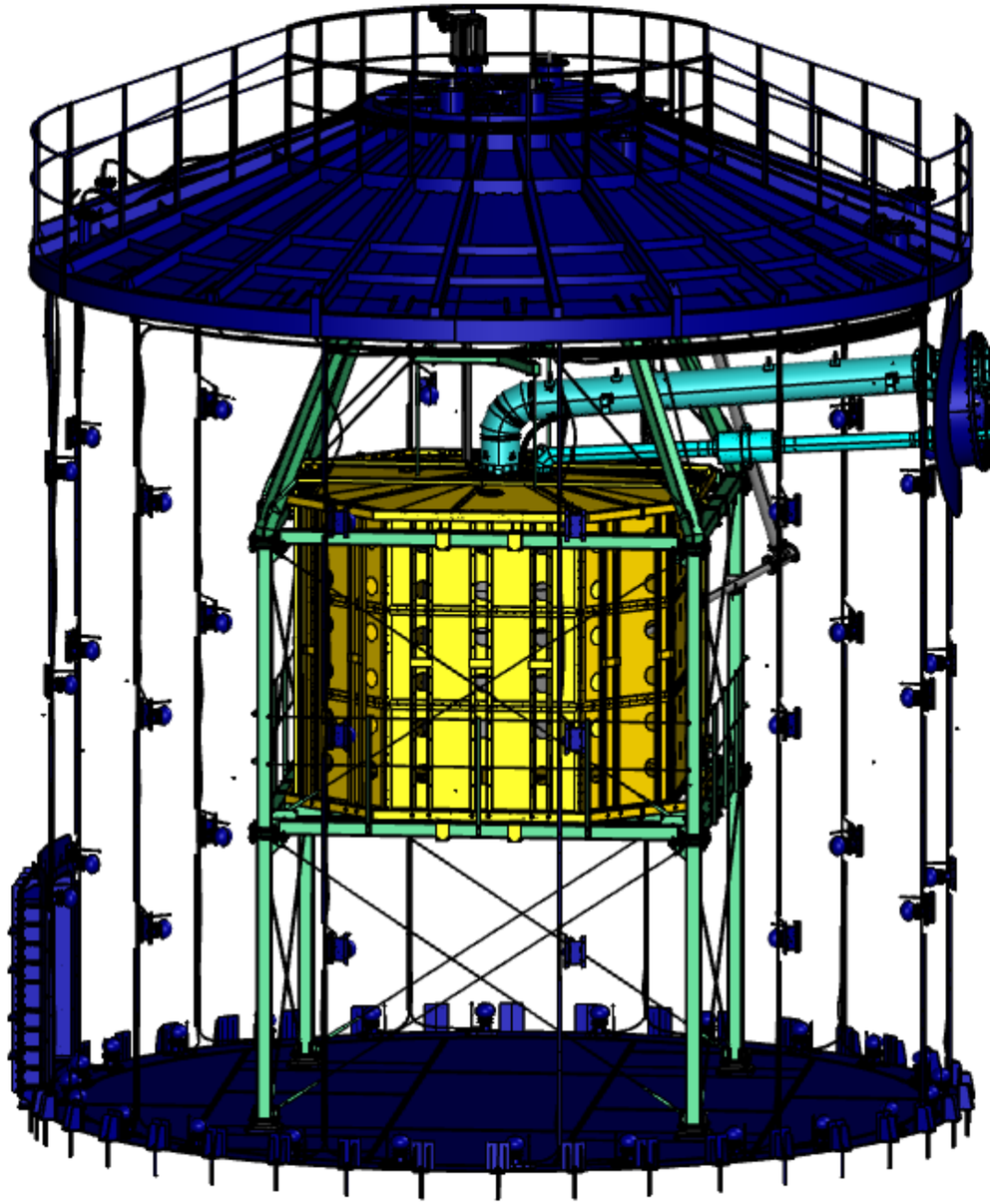
Gd-loaded water cherenkov detector

In XENONnT the dominant background component consists of radiogenic neutrons coming from detector materials.

The Neutron Veto aims to detect, with its 120 photomultiplier tubes, the neutrons leaving a WIMP-like signal inside the TPC.

To enhance n-capture cross-section its been foreseen the employement of the Gd-loaded water Cherenkov technology.





Detection Principle

The neutron detection is based on the following processes:

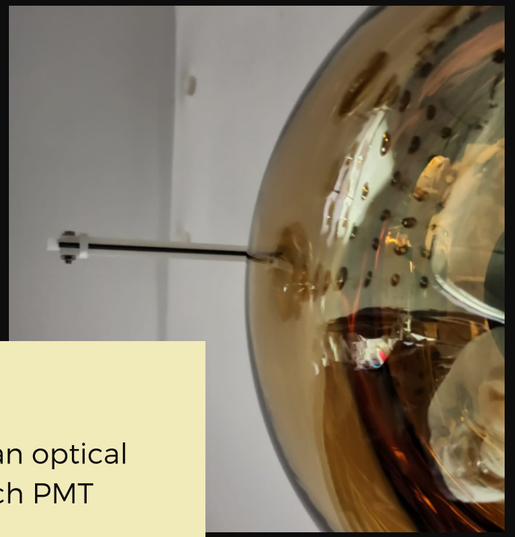
1. Thermalization of the neutrons in water;
2. Emission of gamma-rays due to neutron capture (90% on Gd / 10% on water);
3. Compton scattering of γ on the electrons;
4. Detection of the Cherenkov photons emitted in water from the electrons.

The nVeto Photomultiplier tubes

HAMAMATSU R5912

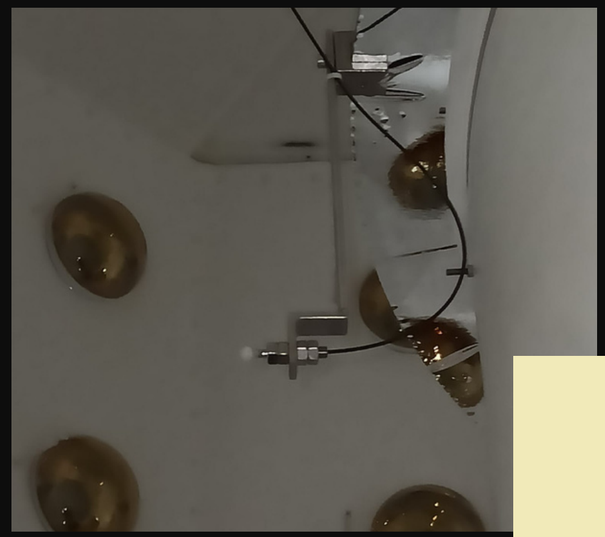
- **8-inches PMTs;**
- **30 meters Coaxial HV-signal cables;**
- **Low Radioactivity glass;**
- **High Quantum Efficiency (~40%).**

Calibration of the PMTs



Optical Fiber

To calibrate the PMT response, an optical fiber it's been installed for each PMT



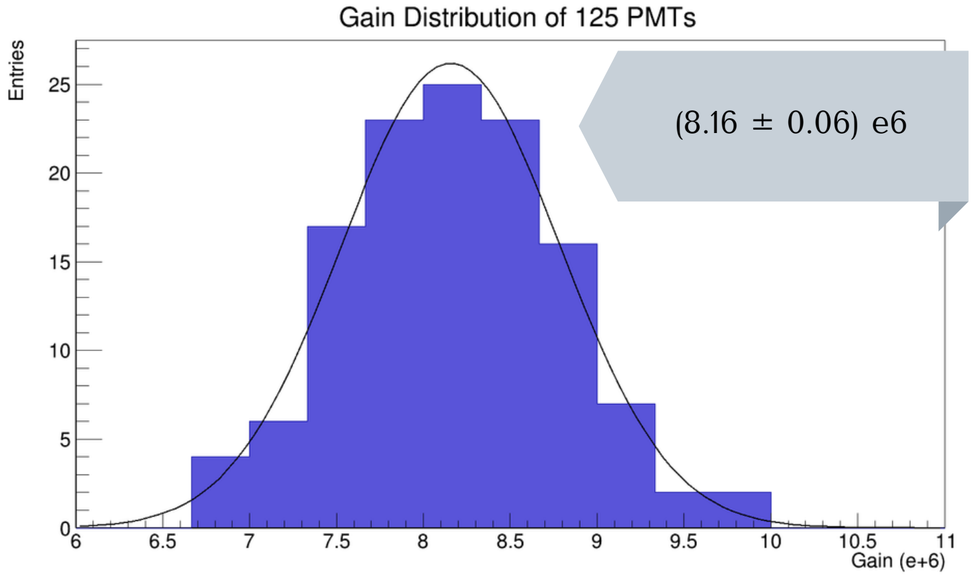
Diffuser Ball

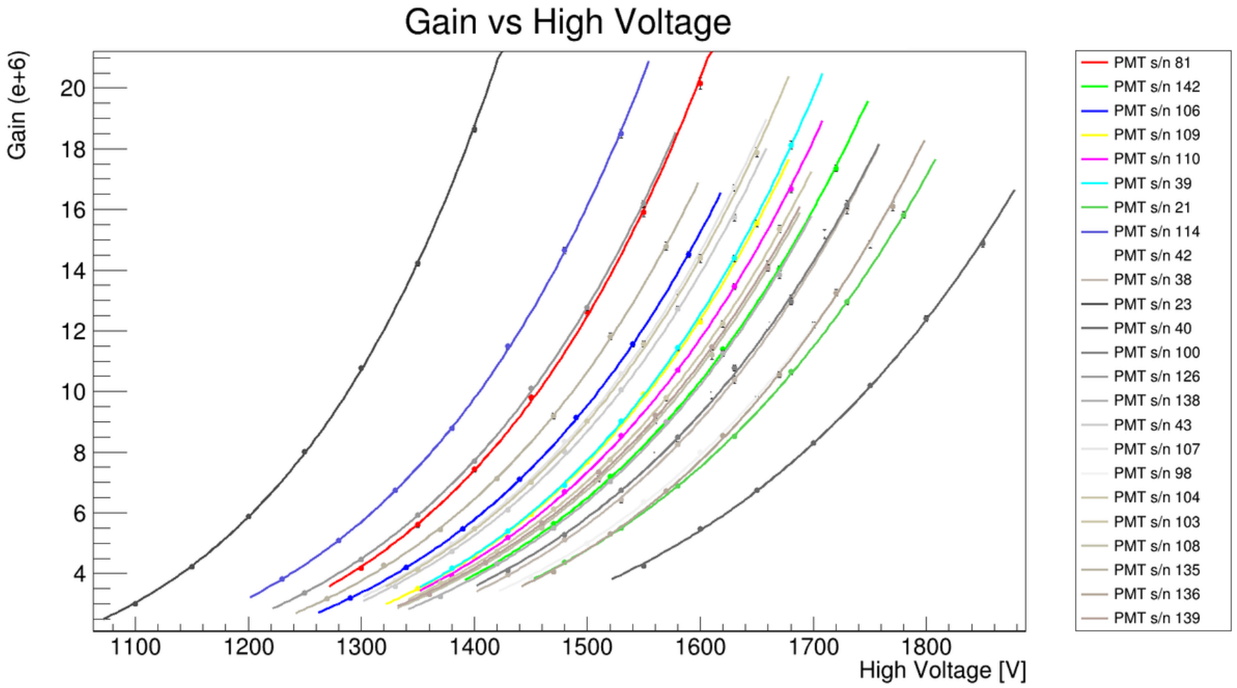
4 diffuser balls were installed on the cryostat, pointing towards the PMTs

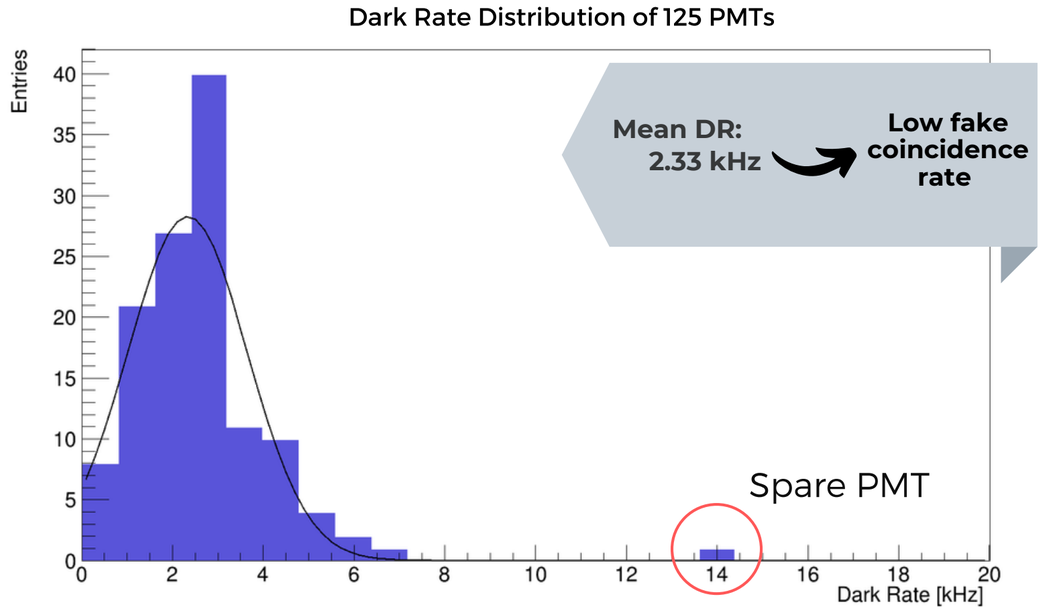
PMT performances

Results of preliminary test with a dedicated setup.

125 Photomultipliers were tested both in Air and Water with the so-called Small Water Tank setup.
The PMTs were tested in terms of Gain, Dark Count Rate and Transit Time.
Among the photomultiplier tested, the ones that showed high noise are considered as spare.





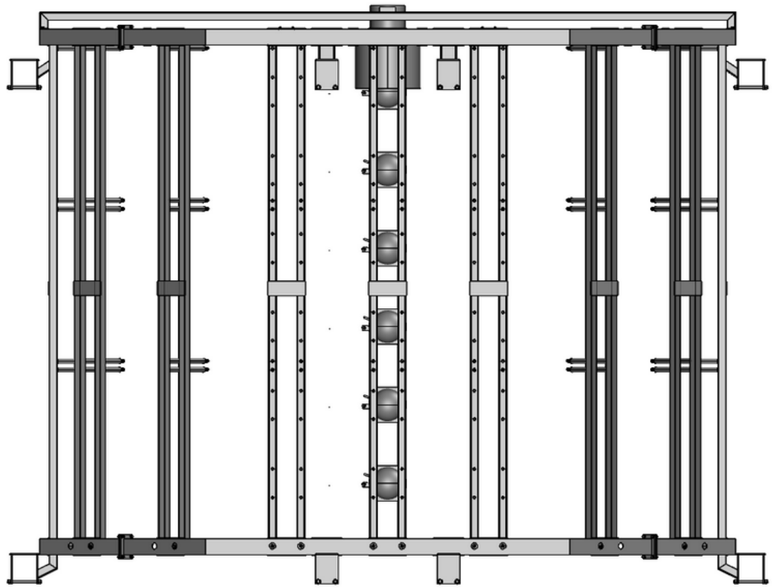


Neutron Veto Design

Two main components:

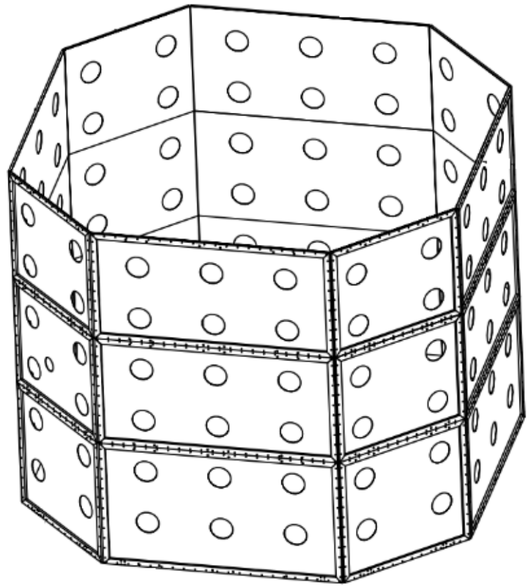
Which represents the skeleton of the apparatus also including the holders of the PMTs instrumenting the nVeto system

Octagonal SS support structure

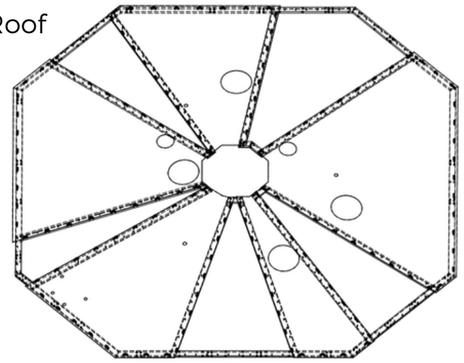


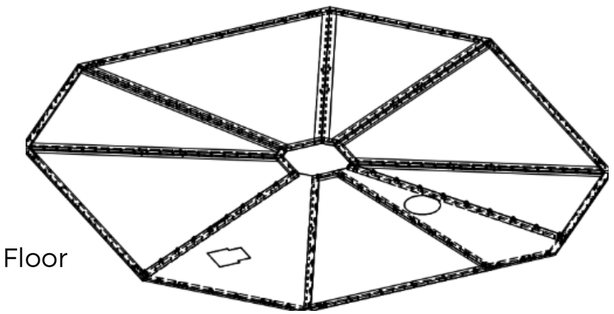
Which define the nVeto volume around the cryostats.
The panels are made of polyethylene frames on which a 1.5 mm-thick expanded-PTFE foil is installed

ePTFE reflective panels



Roof



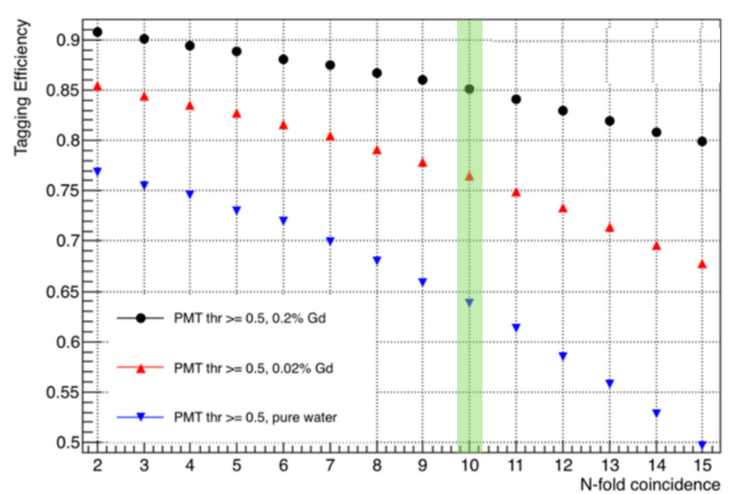


Floor

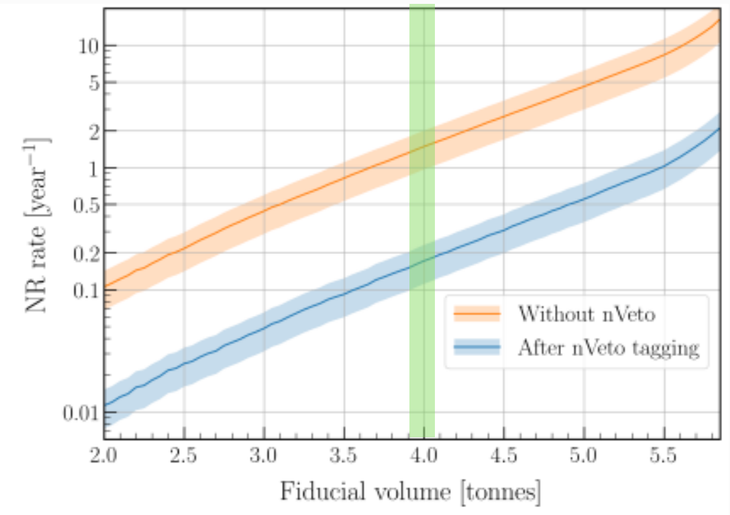
The e-PTFE reflectivity larger than 99% for the wavelength of interest ($\lambda > 300$ nm) !

Neutron Veto performances

With a 10-fold coincidence of the PMTs signal and with 0.2% in mass of Gd, the expected neutron tagging efficiency stands >85%.



Thus, the Nuclear Recoil background suppression achieved would be of a factor 6.



Construction Phase

- Wrapping of the cryostat with the reflective ePTFE foil
- Building of the otctagonal support structure
- Installation of the PMTs
- Installation of the reflective panels

Conclusions

- The Neutron Veto is fundamental to suppress the neutron background and to achieve the best discovery potential with XENONnT;
- The Neutron Veto is instrumented with 120 Photomultipliers featuring high quantum efficiency, high gain and low noise;
- The construction of the detector is ongoing and almost completed.

Our Team

Thanks for your attention