

# Performances and first results of the Neutron Veto of XENONnT.





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# The Experiment

 Gd loaded Water Cherenkov detector instrumented with 84 PMTs • Passive water shield against environmental radioactivity

### **Neutron Veto**

Gd loaded water Cherenkov detector Instrumented with 120 PMTs Optically separated from the MV by high reflectivity ePTFE panels

### **Neutron Veto of XENONnT**

Aims to reduce the background of radiogenic neutrons coming from the detector materials



- Water Cherenkov detector, currently operated with demi-water; in the next phase we will dope with 0.5% Gd-sulphate (Gd-Water purification system currently under commissioning).
- Inner region optically separated from the Muon Veto through high reflectivity ePTFE panels
- Instrumented with 120 low-radioactivity, high-QE PMTs





# **PMT Performances**

### Dark Rate & Noise





## Variations of Dark Rate have been justified by temperature variations in the water tank



Example of Single PE Waveform

- Self-trigger DAQ mode: "acquire all the signals below 15 ADC Counts threshold"
- 15 ADC counts ~ 0.25 pe
- Low threshold possible because of the low electronic noise (Baseline std ~ 2.5 ADC Counts)

### **PMT Performances**

Dark Rate & Noise

Monitoring of the background rate (+AC rate from dark rate) by requiring the coincidence of 4/10 PMTs in a 300 ns window





- Stability of the background rate used also for the data quality selection during SRO
- 4-fold coincidence rate showing a decreasing trend, consistent with the Dark Rate trend.

# **PMT Performances**

### Gain & SPE response

weekly basis

- The gain was determined by fitting the SPE distribution with a Gaussian + skewed Gaussian.
- The Gain of the PMTs was stable for most of the PMTs in SRO, with fluctuations of less than 5%
- The average SPE acceptance during SRO was 91%







### The charactherization of the nVeto PMT single photoelectron response is obtained from dedicated LED calibration performed on a

### Calibration with radioactive sources

Gamma Calibration  ${}^{232}Th$ 



- Estimated detection efficiency of 2.6 MeV gamma with 10–fold requirement: ~70%
- From the measurement of the time profile, we can derive the effective water transparency and use this value in the MC







- Record gamma in TPC and look for neutrons in nVeto
- Look for gamma in nVeto and NR singlescatter in TPC.
- Search for delayed neutron capture in nVeto

 $\eta =$ number of 4.4 MeV gammas seen by the TPC



# Neutron tagging efficiency



- Look for gamma in nVeto and NR single-scatter in TPC.
- Search for delayed neutron capture in nVeto

Compute area spectra for ROI and background and subtract

Search of coincident events and definition of Background region and ROI





**NR Band Selection** 

# Neutron tagging efficiency



Tagging Efficiency =  $\frac{\text{number of neutrons}}{\text{number of triggering NR}}$ 

# Summary

The XENONnT Experiment is currently taking SR1 data as the SRO is over and most of the analysis are on-going

The performances of the nVeto PMTs during the SRO have been monitored with weekly calibrations; the PMTs main parameters (Dark Rate & Gain) as well as the background rate were stable during the SRO. The PMTs' HV configuration during SR1 has been tuned in order to enhance the SPE acceptance.

During SRO we performed several calibration with radioactive sources; with the Th–232 sources we calibrated the optical properties of the detector, while with the AmBe sources we estimated the Neutron tagging & detection efficiencies. The results are:

Tagging Eff. = 
$$(0.682 \pm 0.026)$$
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To our knowledge this is the highest neutron-detection efficiency ever achieved in a water Cherenkov detector

etection Eff. =  $(0.813 \pm 0.013)$