Status of the neutron veto system of XENONnT

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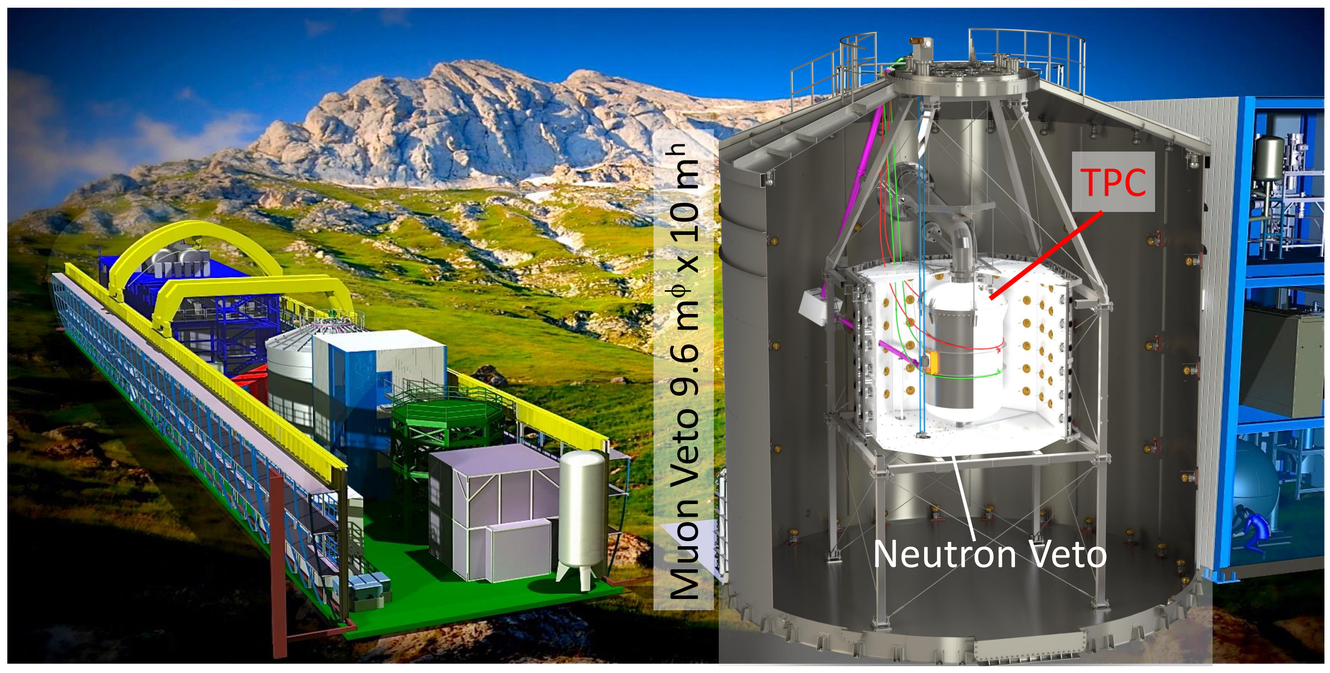


The XENONnT experiment

- Location: Hall-B, LNGS, 3600 m.w.e underground
- **T**ime **P**rojection **C**hamber filled with liquid xenon (LXe)
- Upgrade from XENON1T (1 ton·year exposure)

⇒ **<u>20 ton·year exposure</u>** operating in next **<u>5 years</u>**

- Main target: **WIMP** (and $0\nu\beta\beta$ of ^{136}Xe, 2νECEC of ^{124}Xe, …)
- **WIMP** signature: ⇒ **N**uclear **R**ecoil (NR)
- **TPC**: allows discriminate electronic recoil (ER) and NR

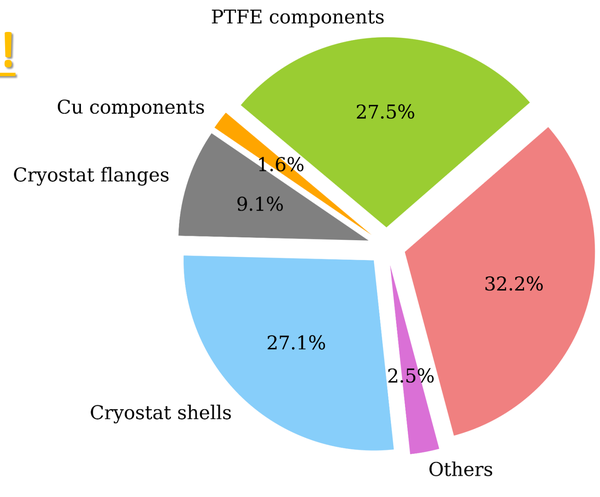
NR background for WIMP searches: <u>NEUTRONS !!!</u>

- ER background (Rn) ⇒ Rn distillation column (~1 μBq/kg)
- Radiogenic neutrons: from detector structure

⇒ scatter once in TPC, produce NR signal, mimic a WIMP

⇒ After Rn is removed, neutron becomes the dominant background in XENONnT

⇒ Introduce a neutron veto detector surrounding TPC



NR background components

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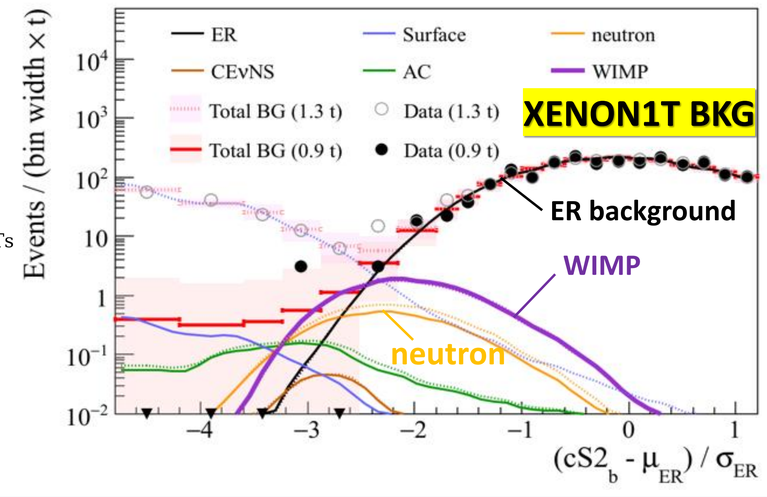
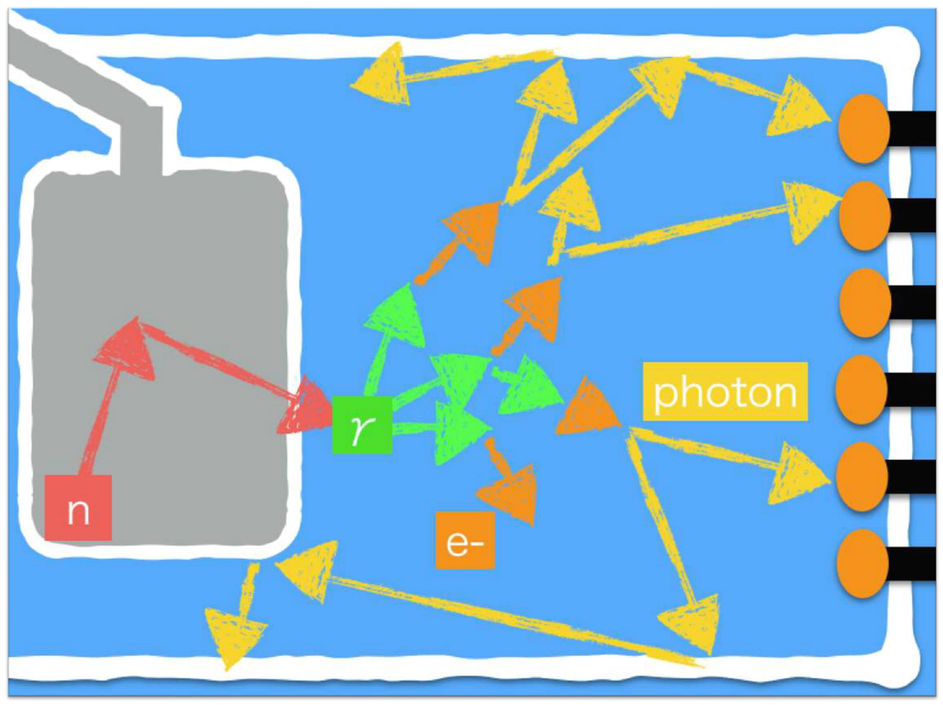




Neutron Veto (nVeto) technique

- LZ: "traditional" Gd-loaded liquid scintillator

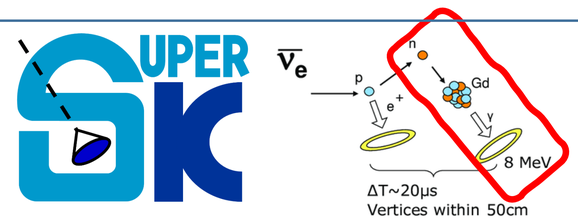
⇒ At LNGS: • liquid scintillator: NO ☹

• Water Cherenkov is accepted ☺

- Apply Gd-loaded water Cherenkov technology of Super-K and EGADS

⇒ Super-K: neutrino study

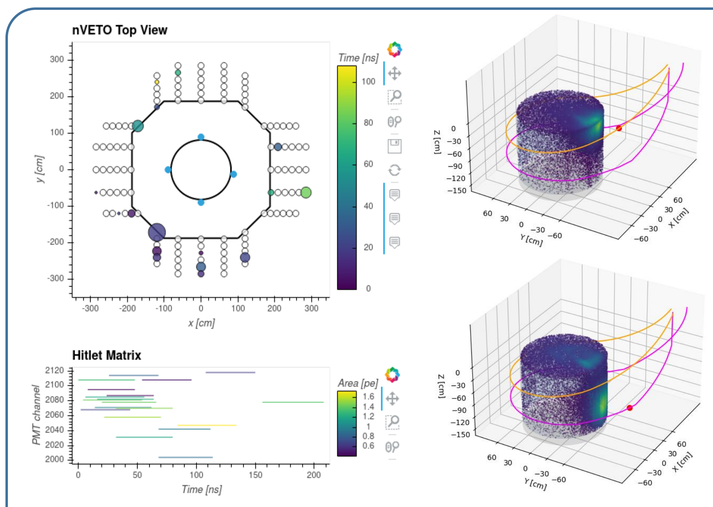
⇒ XENONnT: first application of this technology in DM direct detection



- Neutrons are captured by Gd, the **<u>largest cross-section</u>** for the thermal neutron capture.

⇒ A cascade of **<u>γ-rays with a total energy of 8 MeV</u>**.

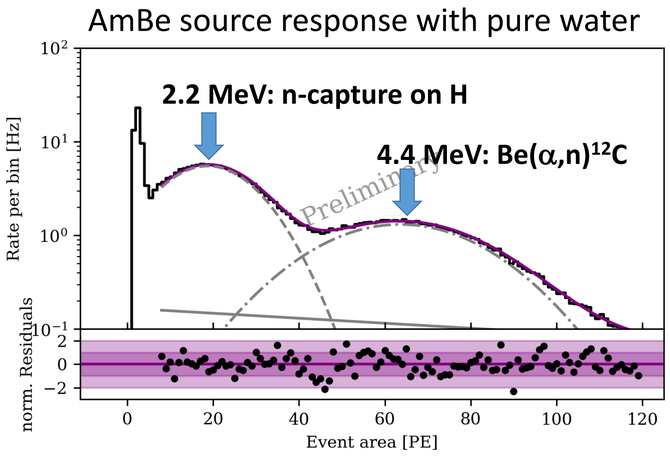
⇒ Effectively tag neutron events scattering from TPC



Interactive neutron-veto event display

Event distribution during AmBe calibration

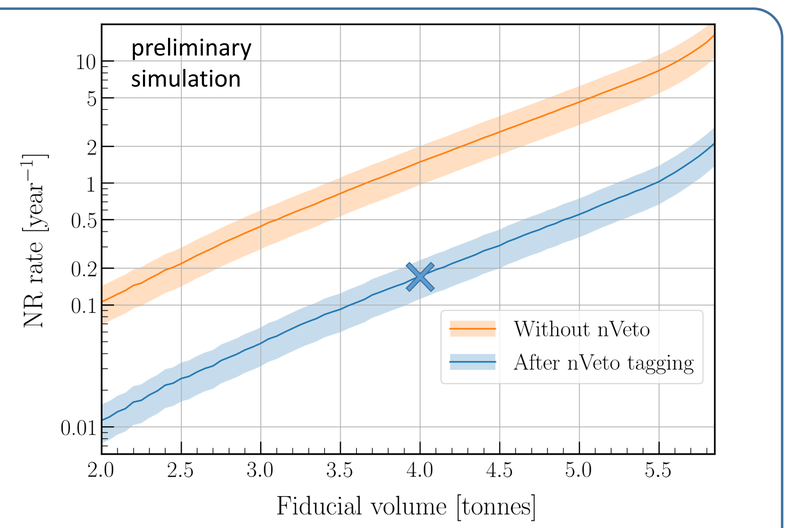
AmBe source response with pure water



nVeto system in XENONnT

- Located inside the water tank, around the cryostat
- Octagonal structure made of SS AISI304 (~700kg)
- Reflective foil: high PMT coverage & light collection efficiency
- 120 PMTs 8'' Hamamatsu R5912-100 HQE (~40%): detect Cherenkov radiations
- DAQ: CAEN V1730 digitizers 500MHz – 14 bits
- Neutron tagging efficiency (10-fold coincidence):
  - Pure water: 65% (from simulation)
  - 0.2% Gd in water: 85% (near future)
- Will dissolve: 3.4 t of $Gd_2(SO4)_3 \cdot 8H_2O$

⇒ Need GdWPS to keep good water quality and maintain the Gd concentration (ready soon…)



GdWPS: Gd Water Purification System now located at Hall-B, LNGS