The XENONnT direct Dark Matter detection experiment

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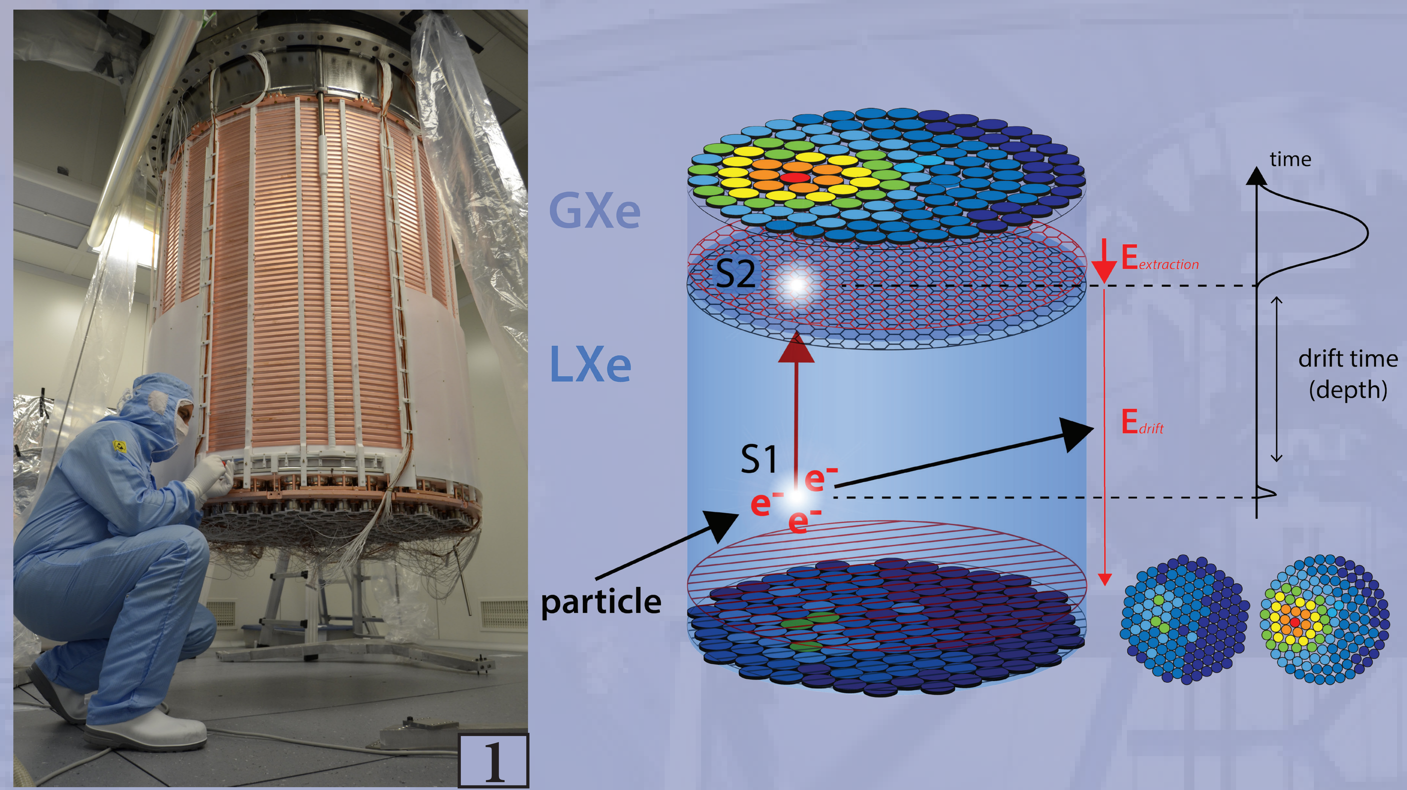
XENON Dark Matter Project

Located at LNGS underground lab, the XENONnT experiment is the upgrade to XENON1T. It is expected to improve the sensitivity by another order of magnitude for dark matter searches[(1)]. It consists of three nested detectors.



The central detector is a dual-phase liquid xenon time projection chamber (LXe TPC)

~ 8.4 tonnes of LXe with 5.9 tonnes target monitored by 494 3" PMTs (Hamamatusu R11410-21)

Prompt scintillation (S1) and delayed electro-luminescence (S2) permit a full 3D position reconstruction.

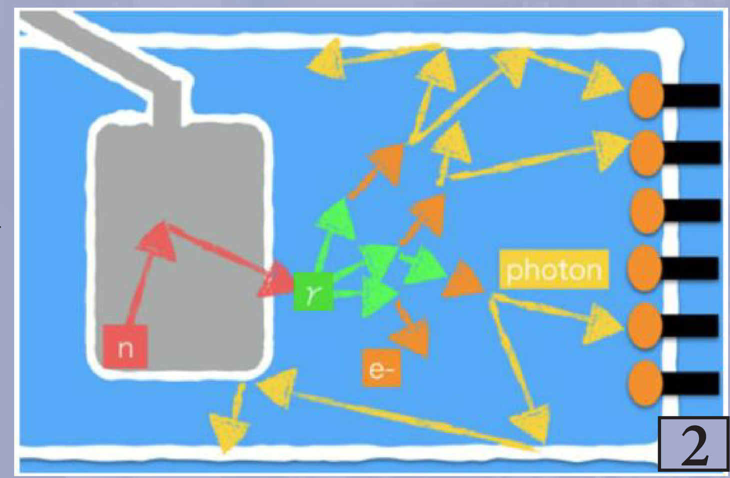
S2/S1 ratio allows discimination among electronic recoil (ER) and nuclear recoil (NR)

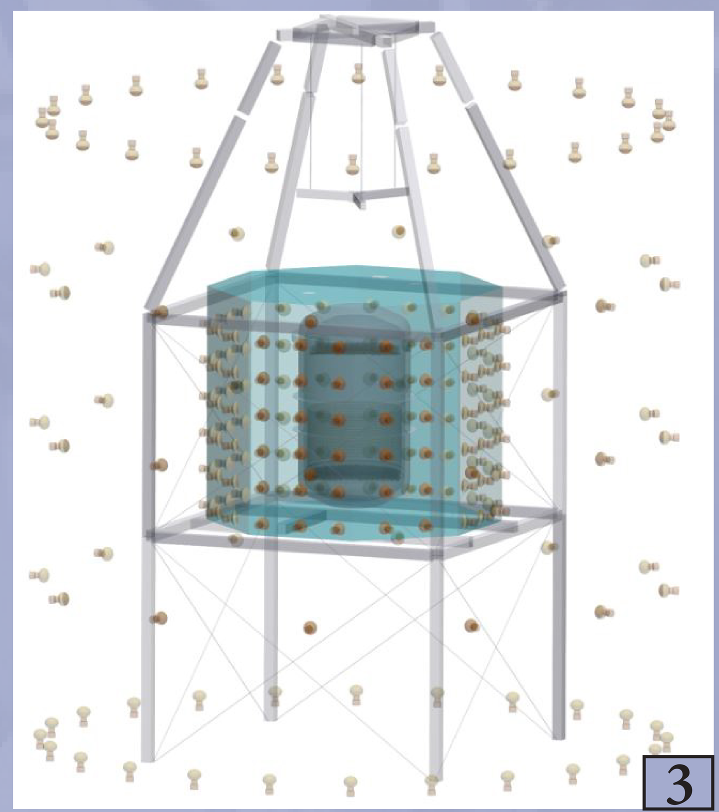
The neutron veto system in the inner region of the existing muon veto

Neutrons cause dangerous NR background

Dissolve 0.2% of Gadolinium (0.48% Gd-sulphate) into water

120 8" PMTs, efficiency tagging >80% for neutrons which have scattered once in the TPC





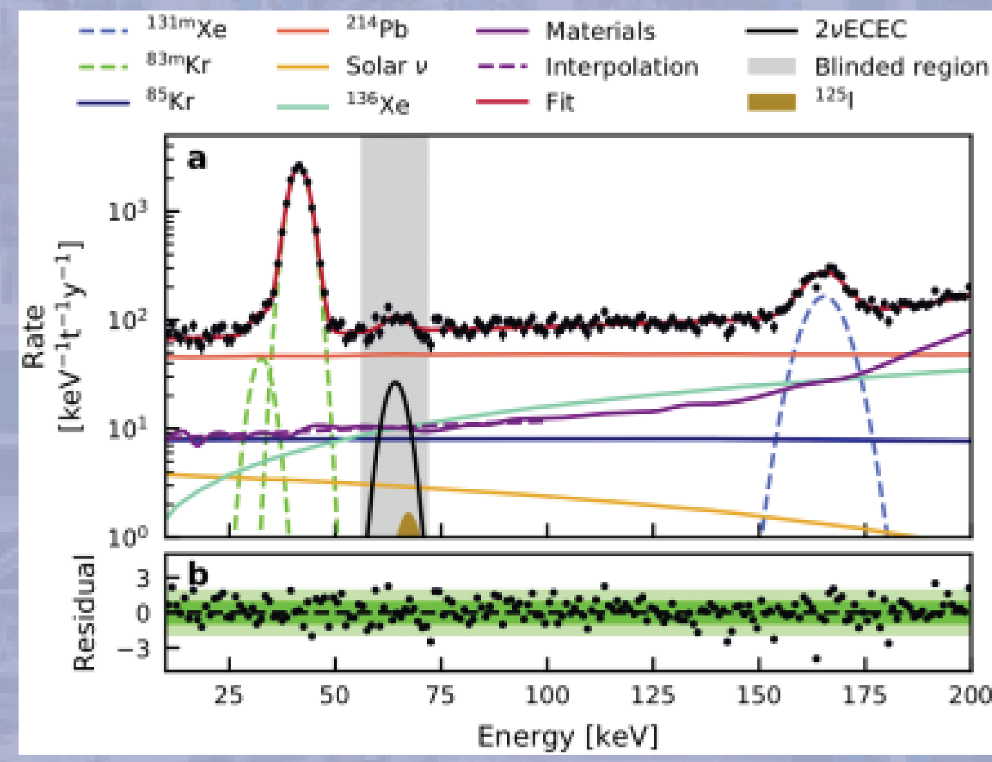
The muon veto detector for passive shield against external radioactivity

700 t of continuously purified water

Optically separate region from the inner neutron veto

Muons trigger efficiency(MC): >99.5%

The excellent sensitivity and energy resolution open up new opportunities for neutrino physics.



Nature 568 (2019) no.7753, 532-535

First direct observation of 2νECEC in ^{124}Xe with the XENON1T detector

Signal significance of 4.4σ

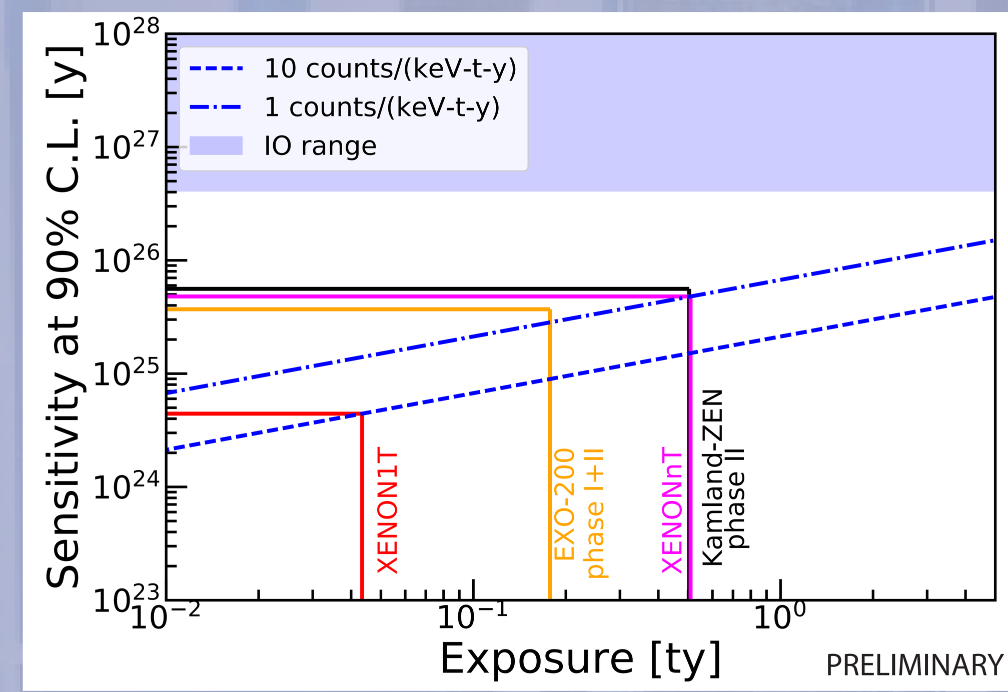
Corresponding half-life:
$T_{1/2} = (1.8 \pm 0.5 stat \pm 0.1 sys) \times 10^{22}$ y

Average sensitivity to neutrinoless double beta decay of ^{136}Xe

$^{136}Xe \rightarrow {}^{136}Ba + 2e^- + 2\bar{\nu}$

$Q_{\beta\beta}$ = (2457.83 ± 0.37) keV

Achieved energy resolution of ~1% (σ) at Q-value in XENON1T



Irreducible background in dark matter searches from CEνNS[(2)] of Boron-8 solar neutrinos

Interesting channel as a probe of non-standard neutrino-sector

Unique opportunity to observe it with XENONnT full exposure

Radon reduction compared to XENON1T

Courtesy by AG Weinheimer, WWU Münster

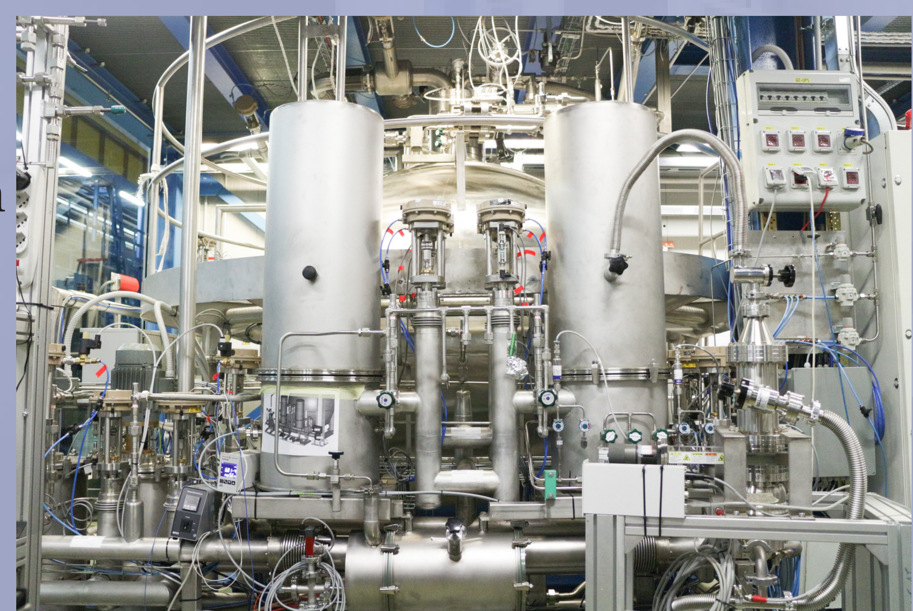
Radon is the main backround

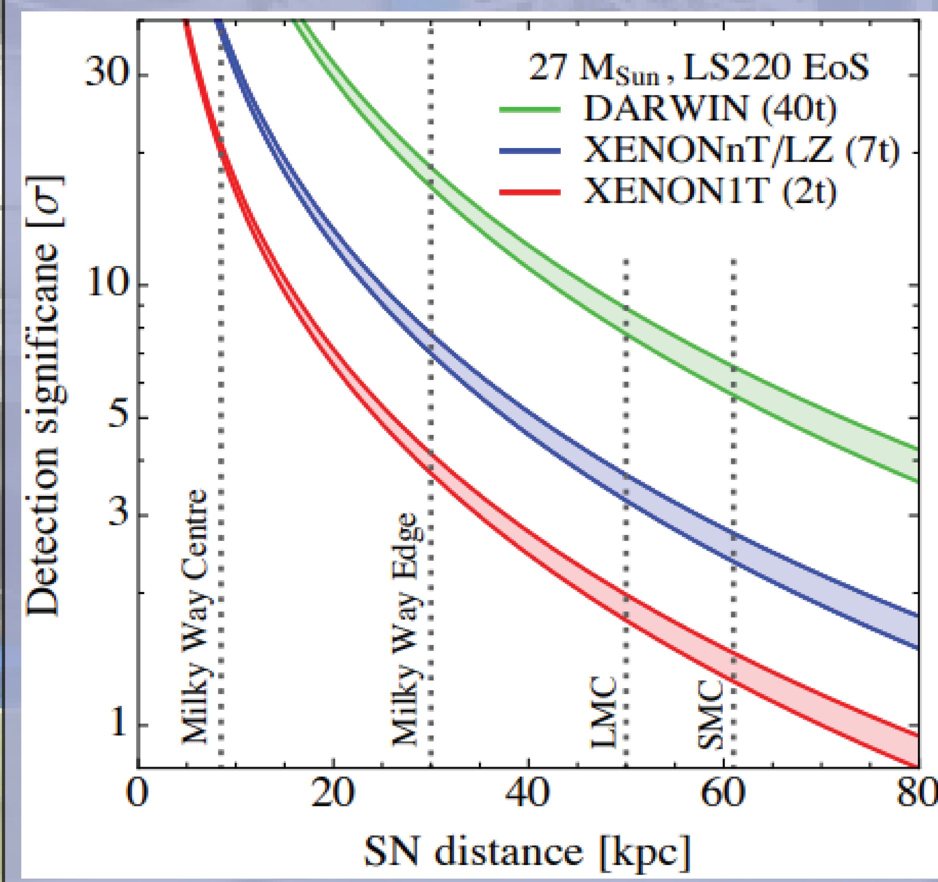
Aim for the reduction by a factor of 10 w.r.t. XENON1T down to 1 μBq / kg by:
- screening and avoiding radon
- meticulous cleaning campaigns
- better surface-to-volume ratio
- high-flux radon distillation column

Improvements in Liquid Xenon Purification

Electronegative impurity removed in the purification line to increase the amount of free charges detected

Planned recirculation flow:
- ~3 L/min (LXe) (>1500 slpm GXe)





Phys. Rev. D 94 (2016) no.10, 103009

XENONnT will be sensitive to CEνNS from Supernova neutrinos

Viable detector to deploy a real-time SN trigger and be an active member of SNEWS[(3)]

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(1) $\sigma_{Spin\ Independent} = 1.6 \times 10^{-48} cm^2$ @ 30 GeV/c^2 PRL 121, 111302 (2018)
(2) Coherent neutrino-nucleus scattering
(3) SuperNova Early Warning Systems