# Research and Development for XENONnT and future Dark Matter Searches

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for the Japanese collaborators on XENONnT and DARWIN/XLZD

# FY2023 Grant

30,000 JPY granted for travel.

Contributed to a Nagoya University researcher’s trip to Kamioka for work on the tritium measurements.

# Overview

- XENONnT progress

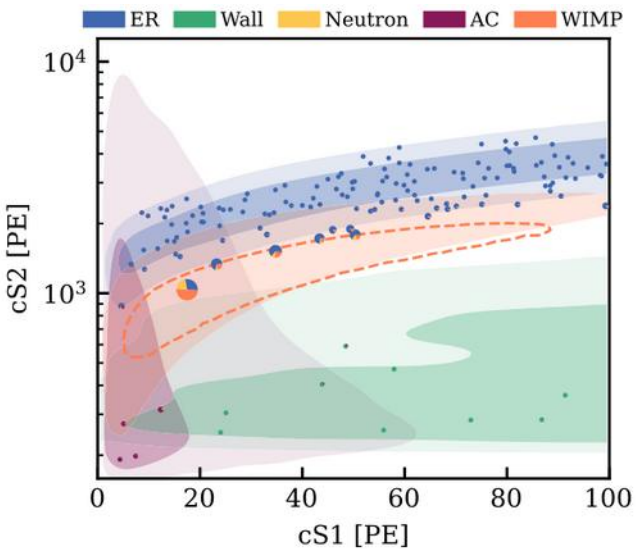
- environmental tritium @ LNGS

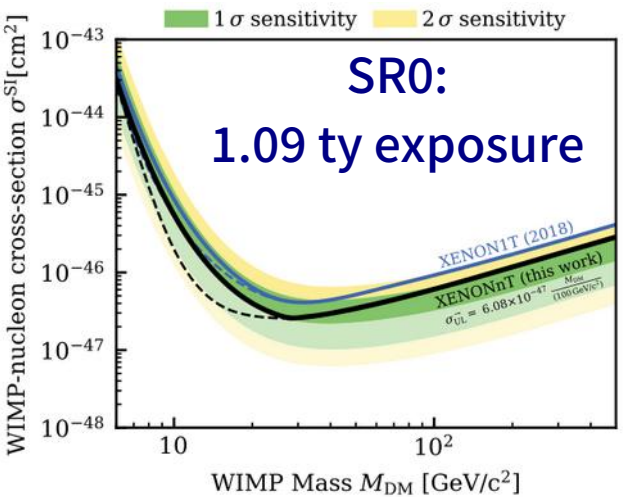
# FY2023 XENONnT Result:

## First Dark Matter Search with Nuclear Recoils from the XENONnT Experiment

PRL 131, 041003 (2023) published back-to-back with LZ´s PRL 131, 041002

(above corresponding LZ analysis: data not blinded...)



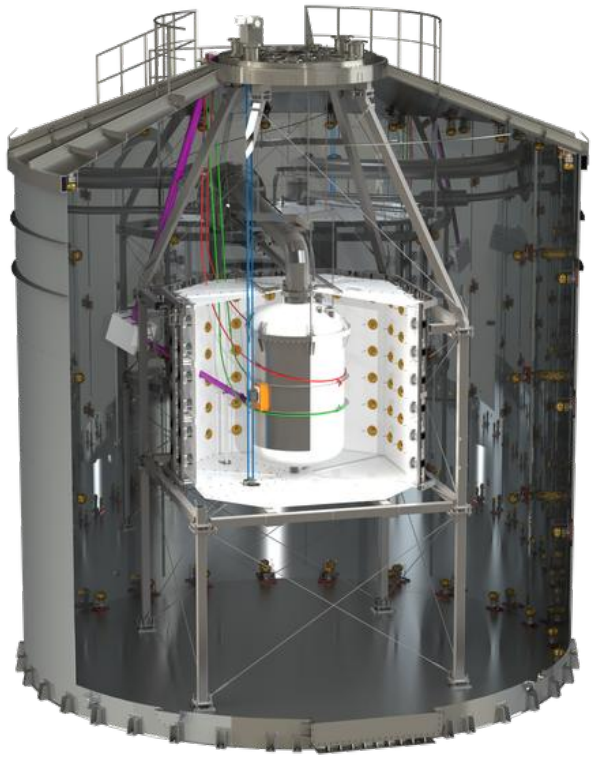
# XENONnT Data Analysis

@ Nagoya University: Shingo Kazama, Masatoshi Kobayashi,
& MS(1) student to continue to PhD

@ Kamioka: Masaki Yamashita, Shigetaka Moriyama,
Kai Martens,
& 1×MS(2) + 1MS(1) students to continue to PhD

+ Kamioka FY2024: 2 PD: Yoshida (ICRR) + Tianyu Zhu (IPMU)
1 MS (to continue to PhD)

# XENONnT Neutron Veto



is **taking science data** with 10%
of full **gadolinium sulfate** loading!
(0.05% gadolinium sulfate octahydrate, 0.02% Gd;
full loading after potential TPC access...)

Fresh on arXiv:

XENONnT instrument paper 2402.10446:
**pure water neutron tagging efficiency**
**= (53±3)%** with only 1.6% lifetime loss.

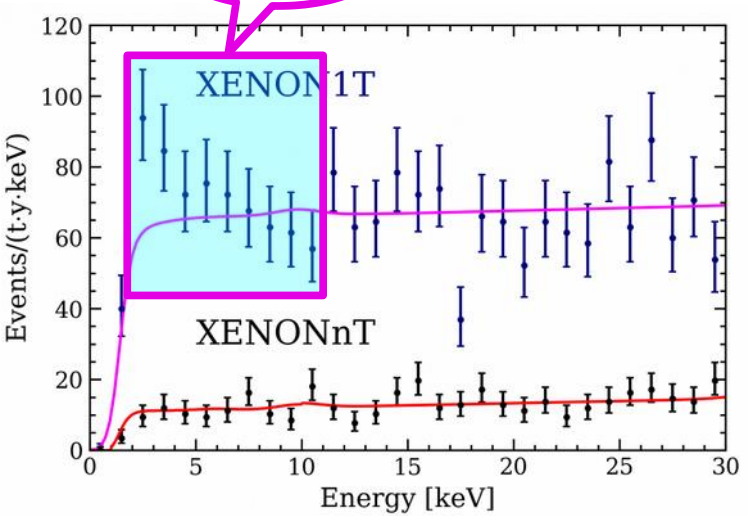
Very preliminary: AmBe data say
"10% loading efficiency increase as expected..."

# Environmental Tritium

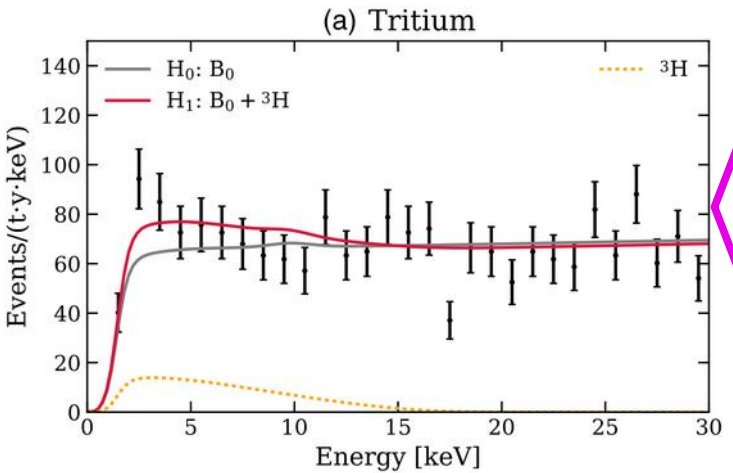
**2020: XENON1T low energy electron recoil excess ???**

**2023: XENONnT no excess...**

What was **it** ?




Tritium hypothesis already in 2020 paper:




Needs
$10^{-24}$
mol/mol
of tritium (T)

XENON1T paper:

$H_2O$ ~ 1 ppb, $O_2$ < 1 ppb

HTO/$H_2O$ ~ 10-17 mol/mol

How much underground at LNGS?

# LNGS HT/HTO measurements

## Measurements:

### Kamioka: DARWIN/XLZD

*potential* site…

### LNGS: XENON1T excess…

XnT proves site OK;

Underground being analyzed

## Sampling system

- Sampling: 3 weeks with ~7SLPM
- Amount of samples for each measurement
  - HTO : ~700-1000g
  - HT : ~14g
- Samples are sent to IES and measured with liquid scintillator

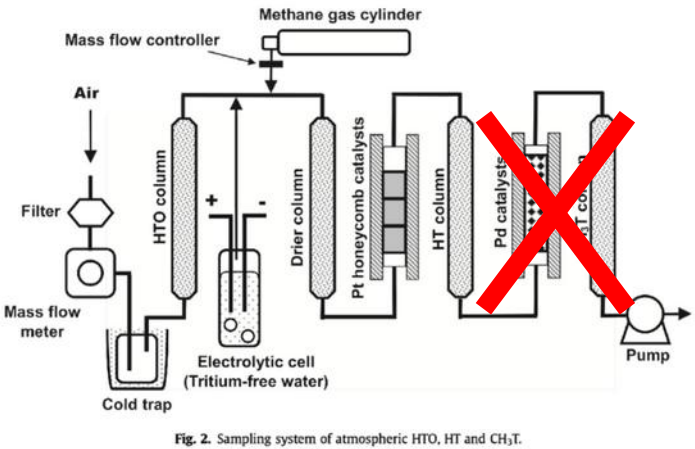



Fig. 2. Sampling system of atmospheric HTO, HT and $CH_3T$.

Journal of Environmental Radioactivity
Volume 102, Issue 9, September 2011, Pages 837-842

| | period | HTO [TU*] | HT [TU*] |
|---|---|---|---|
| Kamioka Underground | 2021/11/30-12/23 | 2.4+/-0.1 | $(1.6+/-0.02)\times10^5$ |
| Kamioka Surface | 2022/5/24-6/7 | 6.7+/-0.1 | $(1.3+/-0.02)\times10^5$ |
| LNGS・surface | 2022/1/29-2/10 | 5-10 ** | $(1.1+/-0.02)\times10^5$ |

* 1TU = $10^{-18}$

** W. Plastino et al., Radiat. Meas. 42, 68 (2007)

IES = Institute for Environmental Sciences (Aomori Pref., Dr. Kakiuchi)

# Summary

– XENONnT published its first NR paper – the only blind analysis from a G2 liquid xenon experiment so far!

– the XENONnT neutron veto now has Gd-sulfate to boost neutron induced nuclear-recoil rejection (Kamioka technology!)

– XENONnT continues taking data – more results coming…

– future analysis coordination Nagoya/Kamioka: travel support needed!

**FY2023 published XENONnT technical papers**:

Design and performance of the field cage for the XENONnT experiment
Eur. Phys. J. C 84 (2024) 138

The triggerless data acquisition system of the XENONnT experiment
JINST 18 P07054

Detector signal characterization with a Bayesian network in XENONnT
Phys. Rev. D 108, 012016