



# Research and Development for XENONnT and future Dark Matter Searches

**Kai Martens**

Kavli IPMU, The University of Tokyo

for the Japanese collaborators on XENONnT  
and XLZD

# FY2024 Grant



50,000 JPY granted for travel:

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



# Overview

- XENONnT Kyodo-Riyo members
- XENONnT recap...
- recent results



# 2024 Kyodo Riyo Members:

@ Nagoya: Shingo Kazama, Masatoshi Kobayashi  
M2: Ryuta Miyata

@ Kamioka: Kai Martens, Shigetaka Moriyama, Masaki Yamashita  
PD: Masashi Yoshida (ICRR) + Tianyu Zhu (IPMU)  
D1: Yoshino Kaminaga, M2: Caio Ishikawa  
Research Student: Xiaoxin Wang

@ Kobe: Kentaro Miuchi, Yasuo Takeuchi

Japan's main responsibility in XENONnT: **Neutron Veto (NV):**  
**EGADS/SK technology** adapted for neutron veto use!



# XENONnT & its Neutron Veto

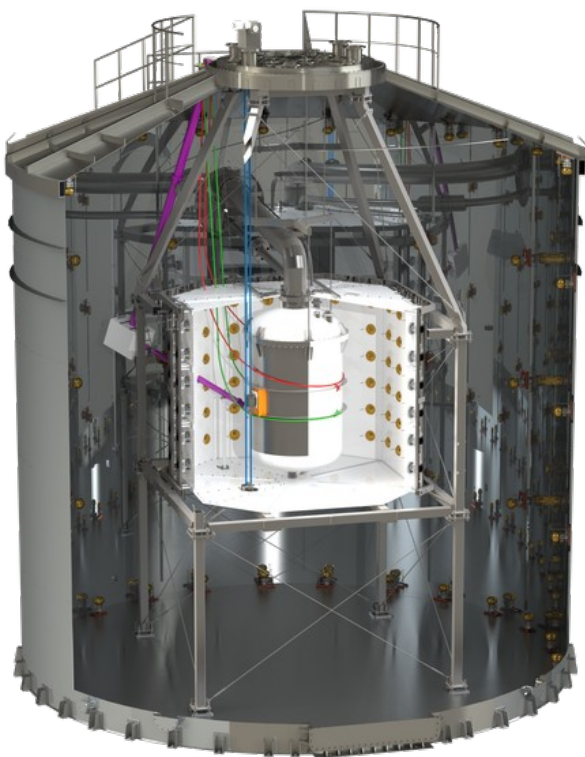
## Science goals:

Find dark matter *WIMP* particles. Also:  
 $0\nu\beta\beta$ , double weak decays, astrophysical neutrinos, axions,  
 neutrino magnetic moment, ...

## Science Run 2: *data taking continues...*

**stable operation:** both of the  
**TPC** as well as of the  
**NV** with 10% of target gadolinium loading  
 10% of target  
 = 0.05% gadolinium sulfate octahydrate or  
 = 0.02% Gd  
 full loading envisioned after potential TPC access

... and the physics results keep coming:





# 2024 XENONnT Papers:

## The Physics:

First Indication of Solar  $^8\text{B}$  Neutrinos via  
Coherent Elastic Neutrino-Nucleus Scattering with XENONnT  
PRL 133, 191002 (2024)

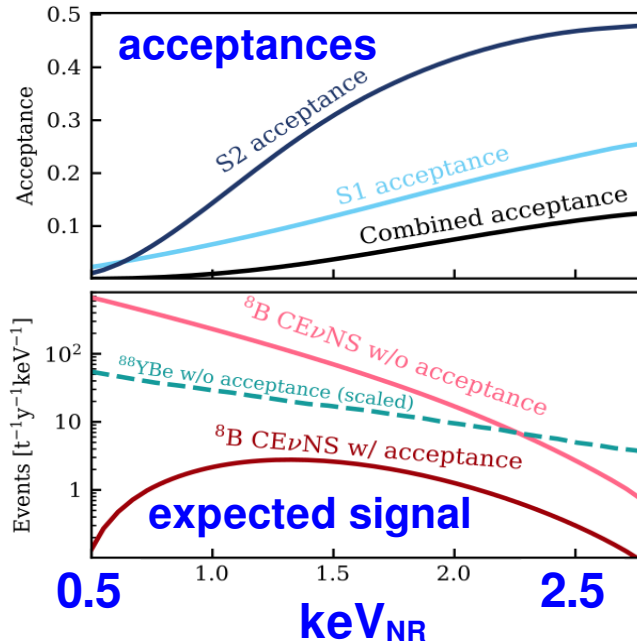
First search for light dark matter in the neutrino fog with XENONnT  
*Accepted* for publication in PRL (2025.01.21) arXiv: 2409.17868

## The Instrument:

The XENONnT dark matter experiment  
EPJ C 84, 784 (2024)

# 1<sup>st</sup> Solar <sup>8</sup>B via CEvNS:

Blind analysis: 3.51 t·y exposure → 37 events > 0.5 keV ER  
 →  $(4.7^{+3.6}_{-2.3}) \cdot 10^6 \text{ cm}^{-2}\text{s}^{-1}$  ← consistent w/SNO  
 (S1 = 2, 3 PMTs, 120 PE ≤ S2 ≤ 500 PE)



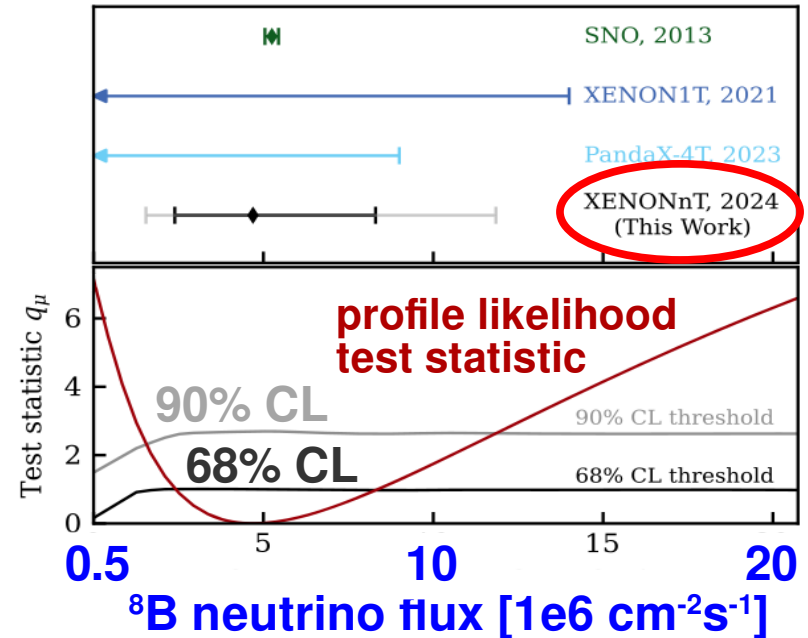
**fiducial volumes:**

SR0:  $(3.97 \pm 0.20)$  t  
 21.05.01 – 21.12.10  
 SR1:  $(4.10 \pm 0.19)$  t  
 22.05.19 – 23.08.08

**live times:**

SR0: 108.0 d  
 SR1: 208.5 d

(same holds for next page)

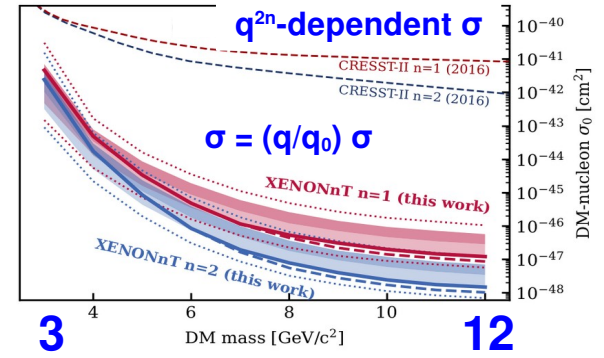
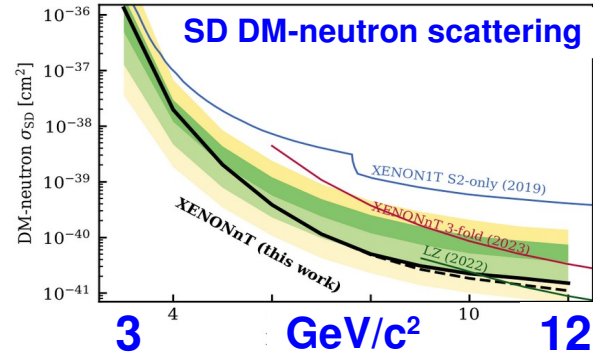
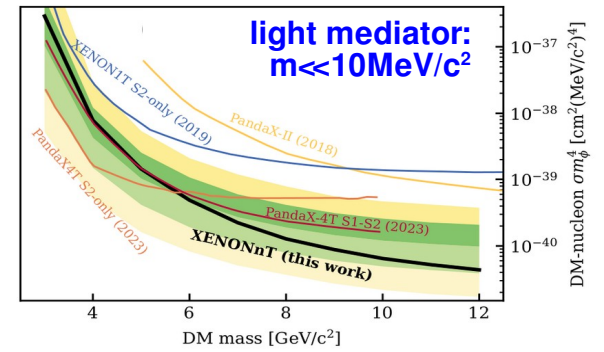
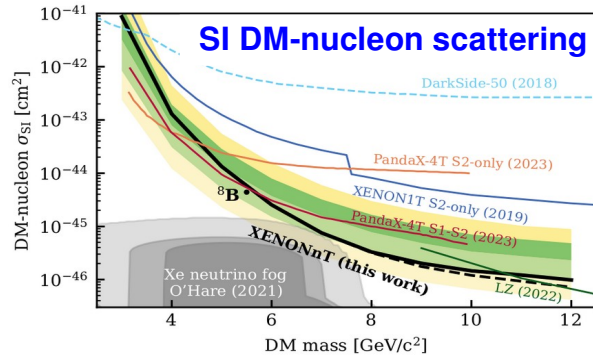
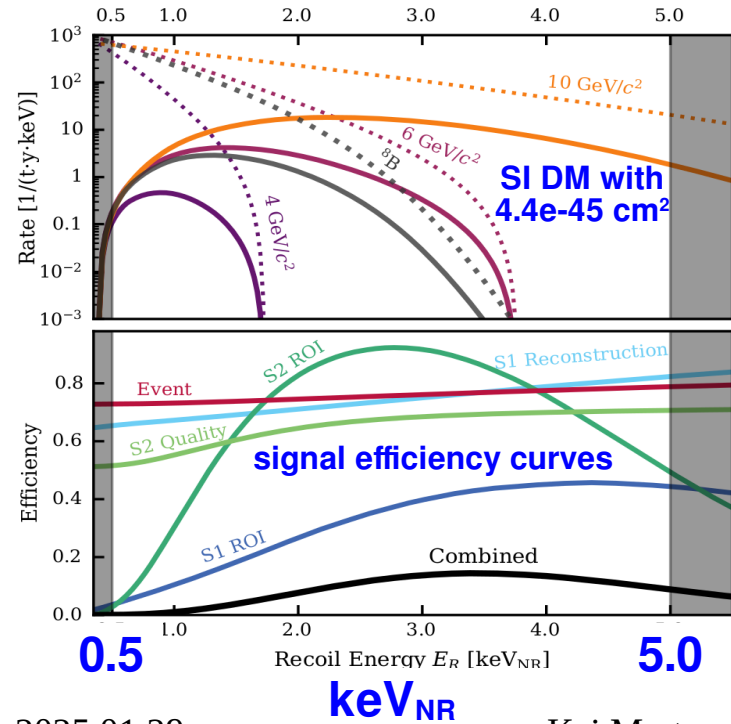


# 1<sup>st</sup>: Light DM in Neutrino Fog?

DM masses 3–12 GeV/c<sup>2</sup>, blind analysis 0.5 – 5 keV<sub>NR</sub>:

⇒ SI DM nucleon cross sections < 2.5e-45 cm<sup>2</sup> for 6 GeV/c<sup>2</sup> DM

~ 1/2 of the BG in signal region is solar <sup>8</sup>B NR...







# Summary

## XENONnT had a great year 2024:

- physics results:
  - a 1<sup>st</sup> CEvNS measurement of <sup>8</sup>B solar neutrinos !!!
  - delving into the neutrino fog:  
no dark matter seen @ 6 GeV/c<sup>2</sup>:  $\sigma_{SI} < 2.5 \cdot 10^{-45} \text{ cm}^2$
- XENONnT is taking more data: SR2 is on-going:  
(stay tuned... :-)
- towards the future: XLZD became a collaboration!  
(see Masaki Yamashita's talk)