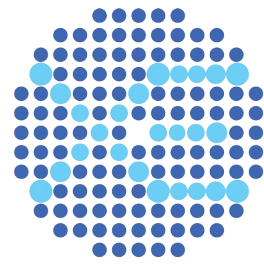


# Research and Development for XENONnT and Future Dark Matter Searches



XENON



Columbia



KIT



Nikhef



Muenster



Stockholm



Mainz



MPIK, Heidelberg



Freiburg



Zurich



Chicago



UCSD



Rice



Purdue



Subatech



Coimbra



LPNHE



Torino



Bologna



L'Aquila



LNGS



Napoli



Weizmann



Tsinghua



Tokyo



NAGOYA UNIVERSITY  
Nagoya



Kobe

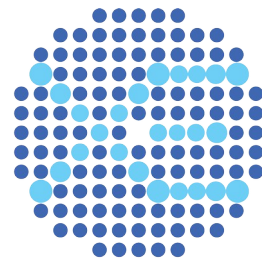


NYUAD



**Kai Martens**  
Kavli IPMU  
The University of Tokyo  
for the XENON collaboration

# Kyodo-Riyo Support in 2021



**XENON**

- 1.) Carry-over from 2020 (Covid-19): 300 kJPY
- 2.) Newly approved for 2021: 300 kJPY

**Total budget for 2021: 600 kJPY** for travel to/from Kamioka

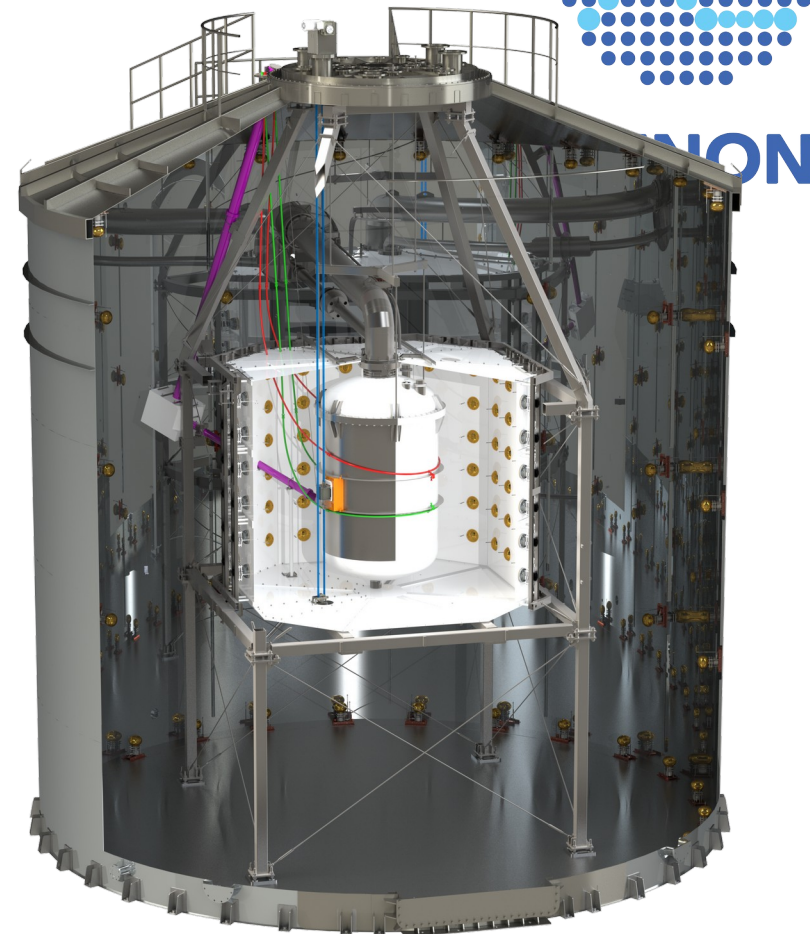
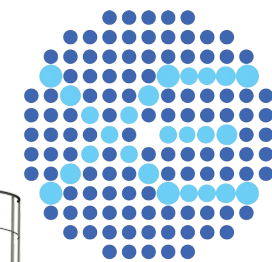
Total spent in 2021: 30 kJPY Nagoya → Kamioka

2021 Covid-19 restrictions more severe than in 2020:

→ **only 30 kJPY spent in 2021** for travel from Nagoya to Kamioka to help prepare a tritium measurement at LNGS for XENONnT

**Kyodo-Riyo support for our collaboration inside Japan between Kamioka, Nagoya, and Kobe is much appreciated and extremely important for our students and postdocs!**

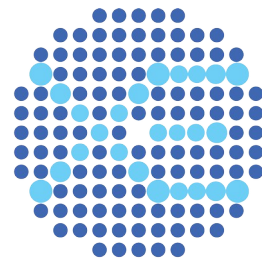
# Japan in XENON at LNGS:



## Our obligations and commitment to the XENON collaboration:

- liquid purification: based on our XMASS experience
- neutron veto: based on our SK-Gd colleagues' Kamioka technology

# 2021: Good Year for XENONnT



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## – we commissioned the TPC and its sub-systems:

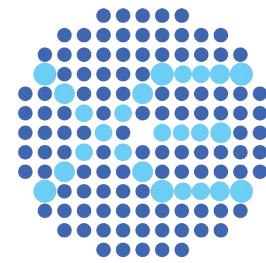
unheard of electron lifetime of < 10 ms in our TPC:

- enabled with our involvement in developing the requisite liquid purification technology!
- monitored with our purity monitor, which played a big role this year in making crucial operational decisions during data taking!

## – we took science data:

- one priority in the analysis will be to follow up on XENON1T's low energy ER excess:  
(P<sub>lease</sub> T<sub>urn</sub> O<sub>ver</sub>)

# XENON1T low-E ER excess:



Phys. Rev. D 102, 072004 (2020), arXiv: 2006.09721

## Paper summary:

“An excess is observed at low energies that is consistent with a solar axion signal, a bosonic dark matter signal with a mass of  $2.3 \text{ keV} = c^2$ , a solar neutrino signal with enhanced magnetic moment, or a possible tritium background.

We are unable to confirm nor exclude the presence of tritium at this time.”

not excluded:

best fit:

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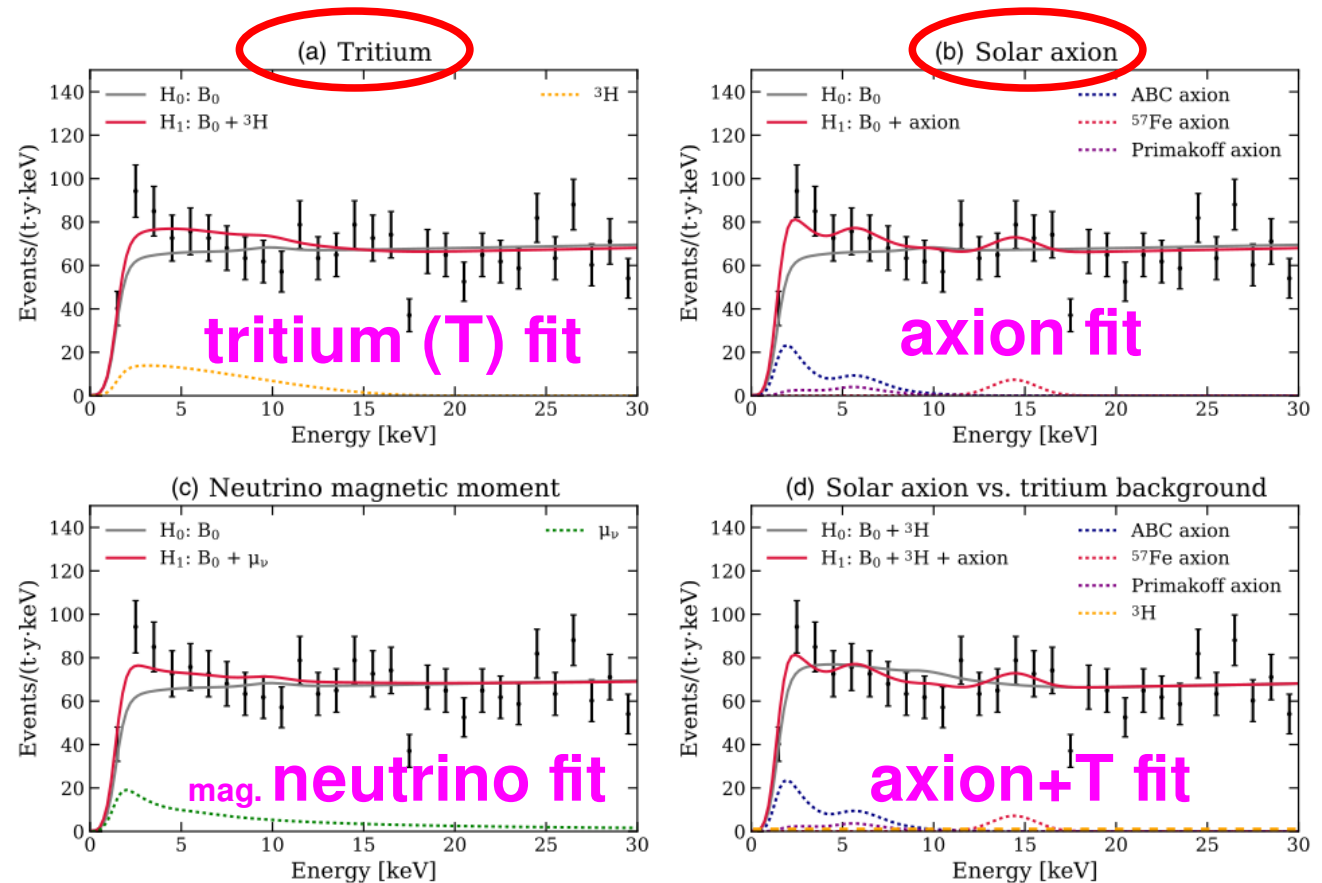
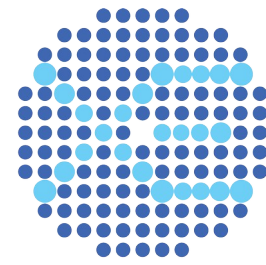


FIG. 7. Fits to the data under various hypotheses. The null and alternative hypotheses in each scenario are denoted by gray (solid) and red (solid) lines, respectively. For the tritium (a), solar axion (b), and neutrino magnetic moment (c) searches, the null hypothesis is the background model  $B_0$  and the alternative hypothesis is  $B_0$  plus the respective signal. Contributions from selected components in each alternative hypothesis are illustrated by dashed lines. Panel (d) shows the best fits for an additional statistical test on the solar axion hypothesis, where an unconstrained tritium component is included in both null and alternative hypotheses. This tritium component contributes significantly to the null hypothesis, but its best-fit rate is negligible in the alternative hypothesis, which is illustrated by the orange dashed line in the same panel.

# Measuring tritium at XENON:



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nT-JP members visited with Japanese tritium measurement specialist Kakiuchi-san at Rokkasho in Aomori to get advice and support for measuring HT and HTO in the air at XENONnT:

Yamashita-san and Kobayashi-san are currently on site at LNGS to collect the data according to the following scheme:

*N. Akata et al. / Journal of Environmental Radioactivity 102 (2011) 837–842*

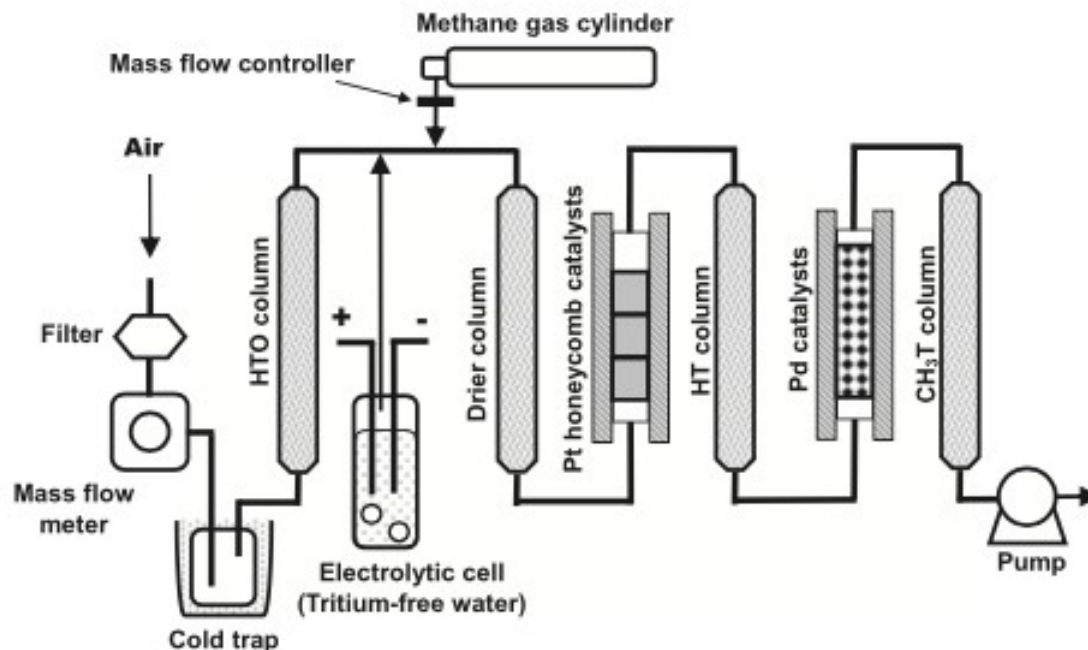
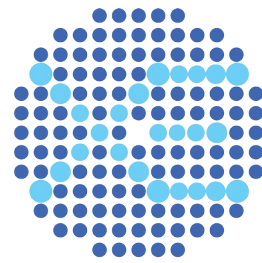


Fig. 2. Sampling system of atmospheric HTO, HT and CH<sub>3</sub>T.

N. Akata et al.  
Journal of  
Environmental  
Radioactivity  
102 (2011)  
837-842

# Summary and Outlook:



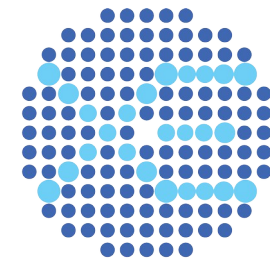
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## XENONnT has taken first data:

- nT-JP members are measuring **tritium at XENONnT**:
  - input for the upcoming XENONnT low energy ER paper
  - **Kyodo-Riyo supported tests @ Hall C in Kamioka !!!**
- with the start of serious **data analysis**, in person meetings @ Kamioka, Nagoya, and Kobe will become increasingly important in FY2022
  - **Kyodo-Riyo enables our local Japanese in person meetings!**

## Expectations for FY2022:

- more **XENONnT data taking**
- loading of **Gd sulfate into the neutron veto** for full efficiency

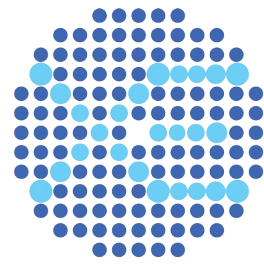


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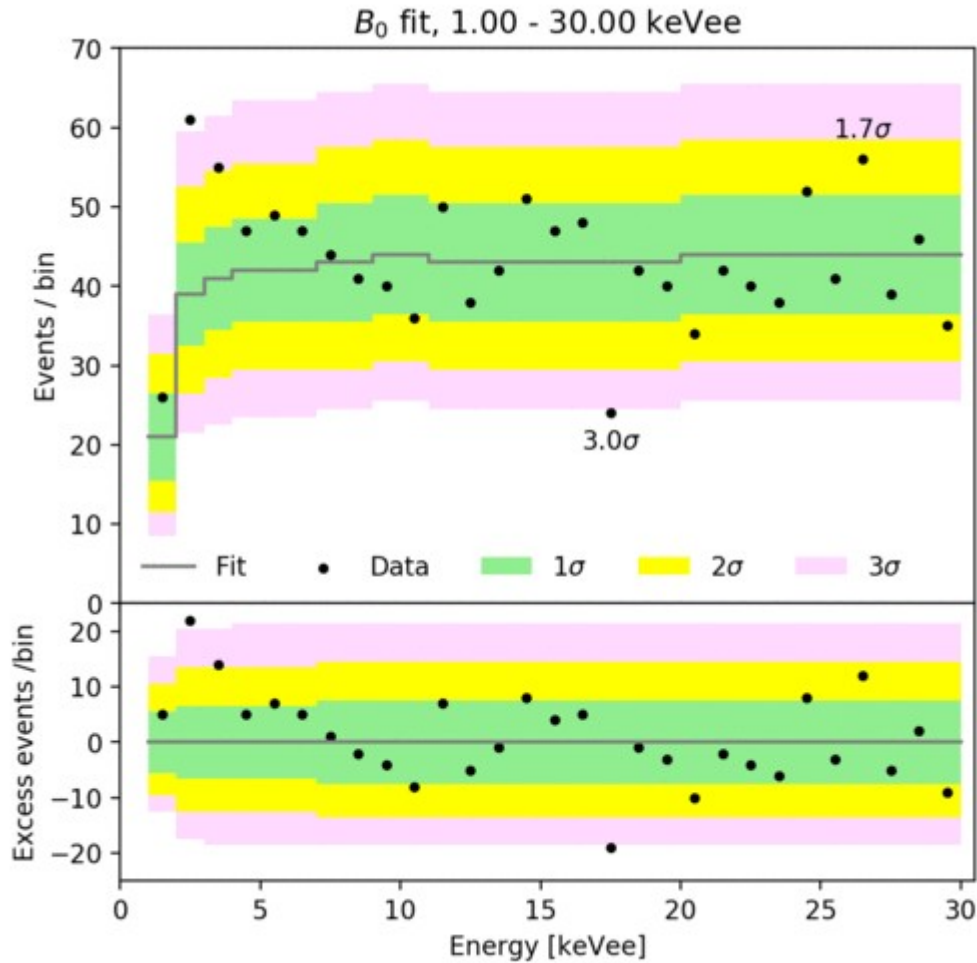
# Backup



# Low Energy ER Binning:



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change of low energy ER  
bin contents  
as binning shifts