Technology development for XENONnT @ Kamioka

XENON

Columbia · KIT · Nikhef · Muenster · Stockholm · Mainz · MPIK, Heidelberg · Freiburg · Zurich · Tsinghua

Chicago · UCSD · Rice · Purdue · Tokyo · Nagoya · Kobe · NYUAD

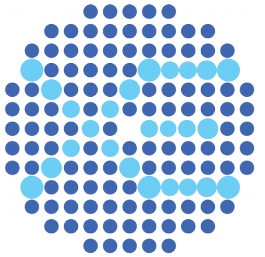
Subatech · Coimbra · LPNHE · IJCLab · Torino · Bologna · L'Aquila · LNGS · Napoli · Weizmann

Kai Martens, Kavli-IPMU, The University of Tokyo

for the FY 2020 Kyodo-Riyo Science Session

Kyodo-Riyo Support for nT-JP

in FY 2020



approved: 300 kJPY for nT-JP travel to and from Kamioka

carry-over: 100 kJPY; despite COVID-19 we use(d) 200 kJPY !!!

Japan (= nT-JP) has two major responsibilities towards XENONnT:

1) Neutron Tagging around the Liquid Xenon (LXe) Target: Kamioka's EGADS/SK-Gd technology is the basis for our XENONnT water-Cherenkov neutron veto. Kyodo-Riyo support ensures that both sides – XENON and Kamioka – learn from this new implementation of Kamioka's technology.
2) Liquid purification of xenon: XMASS expertise and technology development with our Japanese colleagues at Kamioka are supporting as well as informing continuing improvements vital for XENONnT's success and putting us ahead of our competition.

This year COVID-19 has hindered but not stopped us or XENONnT!

Overview

XENONnT:

– where at ?

the last in-person collaboration meeting @LNGS before Corona Sept. 2019 →

– upgrade of ?

– Japan improved what with Kyodo-Riyo support ?

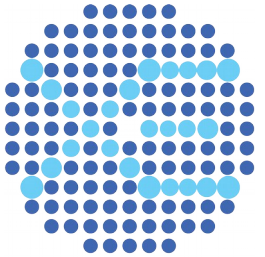
- liquid phase xenon purification
- neutron tagging in scintillophobic environment

– first XENON papers with Japanese co-authors !

XENON @ LNGS in Italy

Pictures taken last two weeks here:

XENONnT: XENON1T Upgraded



The XENON1T core:

– proven, well characterized	HARDWARE	!
– a proven, well established	COLLABORATION	!!
– proven, experienced	PEOPLE	!!!

+ the upgrades:

– ***signal*** oriented:
- larger **target mass**
- **xenon purification** in the liquid phase

– ***background*** oriented:
- ER: continuous **Rn distillation**
- NR: **neutron** tagging

Green is where **Japan** – and **Kyodo-Riyo support** – comes in !!

Time Projection Chamber (TPC)

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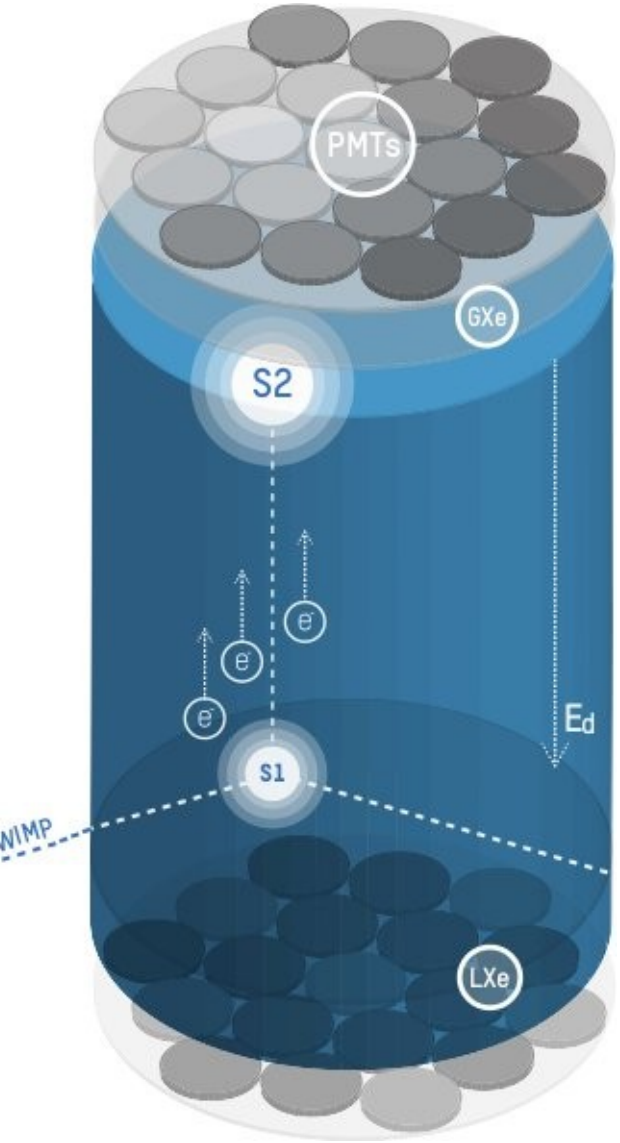
Wikipedia graphic:



... and our point is:

larger target mass

⇓

longer **electron drift** towards gas phase

→ **signal S2**

⇑

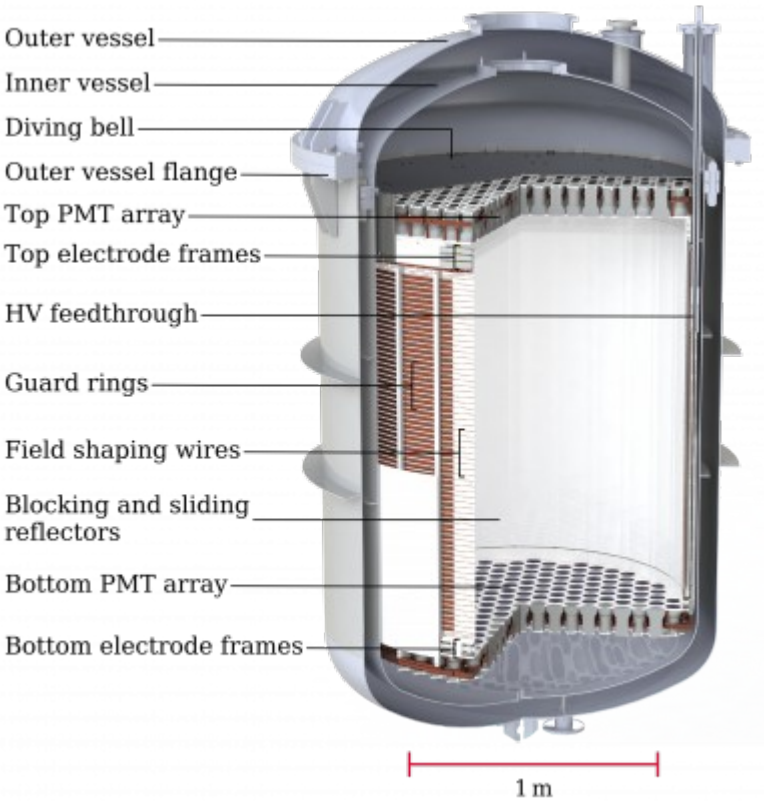
electronegative impurities in LXe exponentially reduce the signal along the way...

⇑

liquid phase ← !!! purification

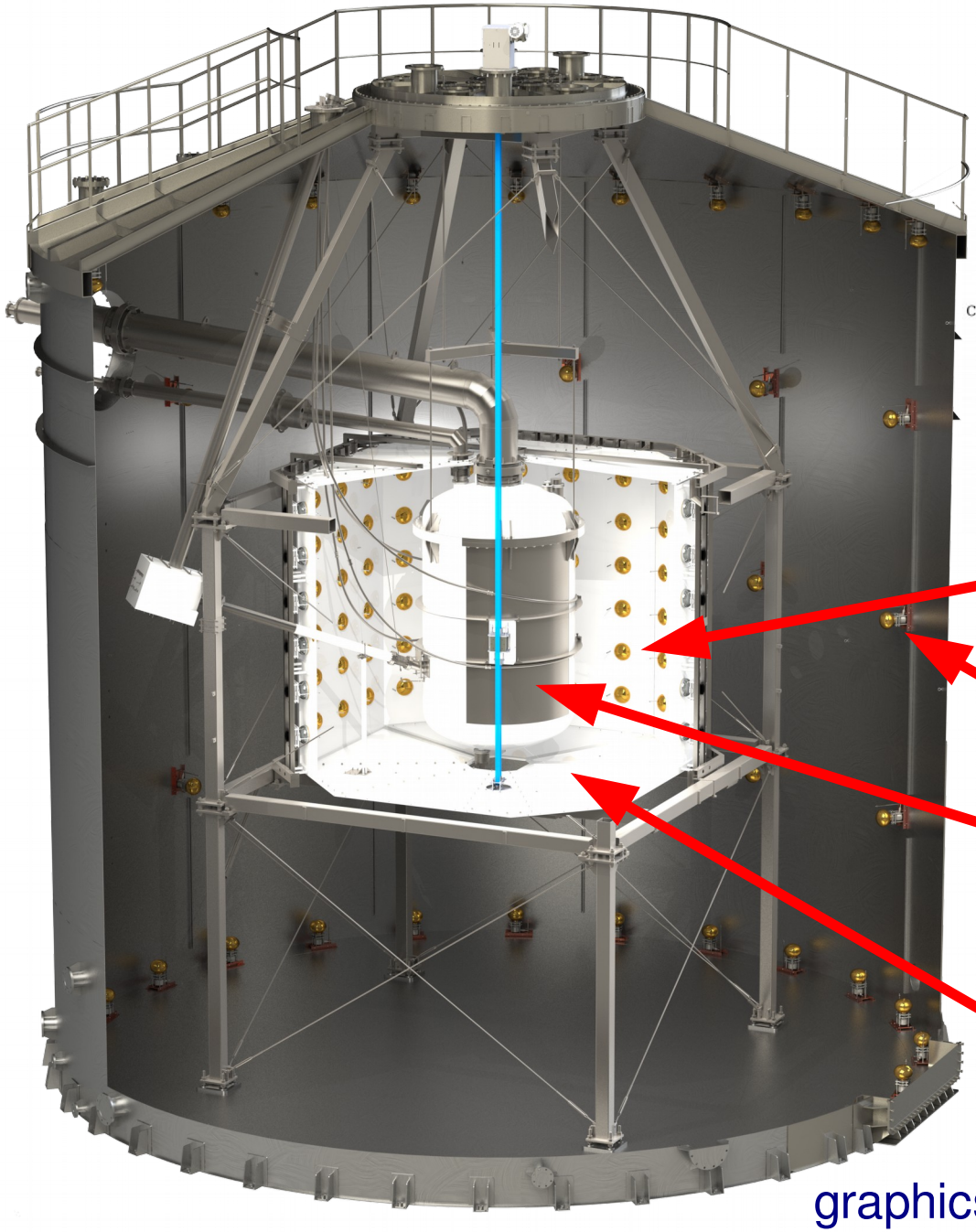
(to handle the volume!)

our graphic: arXiv:2007.08796

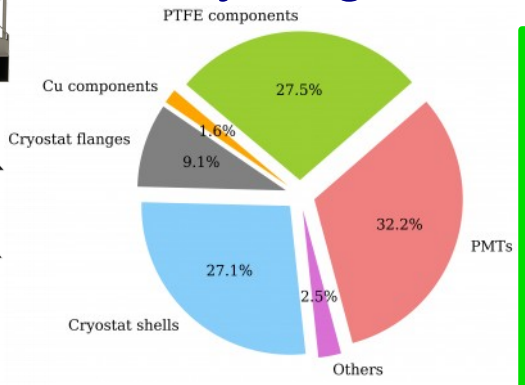


the “Inner vessel” is the xenon containment vessel

The XENONnT Neutron Veto



radiogenic neutrons in XENONnT by origin:



neutron veto
PMT
muon veto

cryostat with **TPC** inside

>99% relective ePTFE

graphics J. Pienaar, XENON

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XENON nVeto:

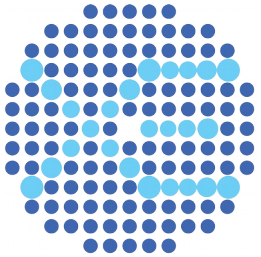
a variation on a proven Kamioka "scheme":

collect light from neutron capture on $Gd_2(SO_4)_3$ by Cherenkov light reflection, not by photocathode alone

⇓

control 20 t•y of exposure to radiogenic neutrons !!!

Member's Roles in XENON:



XENON Collaboration Board:

co-chair: M. Yamashita (1 of 2)
members: Y. Itow, K. Miuchi, S. Moriyama, K. Martens

XENON Analysis Coordinator:

S. Kazama (1 of 3)

XENON Working Group Co-Leader (Liquid Purification):

M. Yamashita (1 of 2)

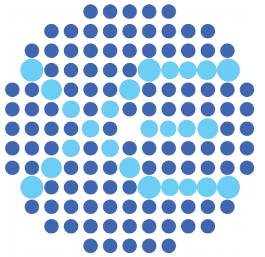
XENON Editorial Board:

members: K. Miuchi, K. Martens

XENON Public Relations Team:

member: K. Martens

Peer Reviewed Publications



Energy resolution and linearity of XENON1T in the MeV energy range

XENON Collaboration, Eur. Phys. J. C (2020) 80:785. arXiv:2003.03825

Excess Electronic Recoil Events in XENON1T

XENON Collaboration + X. Mougeot

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

Projected WIMP Sensitivity of the XENONnT Dark Matter Experiment

XENON Collaboration, JCAP 11 (2020) 031,arXiv:2007.08796

Search for coherent elastic scattering of solar ^{8}B neutrinos in the XENON1T dark matter experiment

XENON Collaboration, (accepted for publication in PRL), arXiv:2012.02846

XENONnT will follow up on ALL OF THE ABOVE TOPICS and more!

Stay tuned!

Conclusion:

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XENONnT is being commissioned.

(I am giving this talk remotely from Italy,
where I am on shift @ XENONnT)

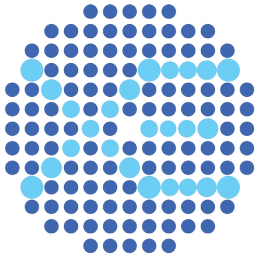
The fruits of our labor will be on display in due time...

in the meantime:

"Keine Atempause, Geschichte wird gemacht, es geht voran!"

(German Rock Band "Fehlfarben", 1980)

oh, and: Kyodo-Riyo support is greatly appreciated and needed into the future:
We – nT-JP – need to continue to optimize performance of liquid purification and the neutron veto



Backup

XENONnT Background sources

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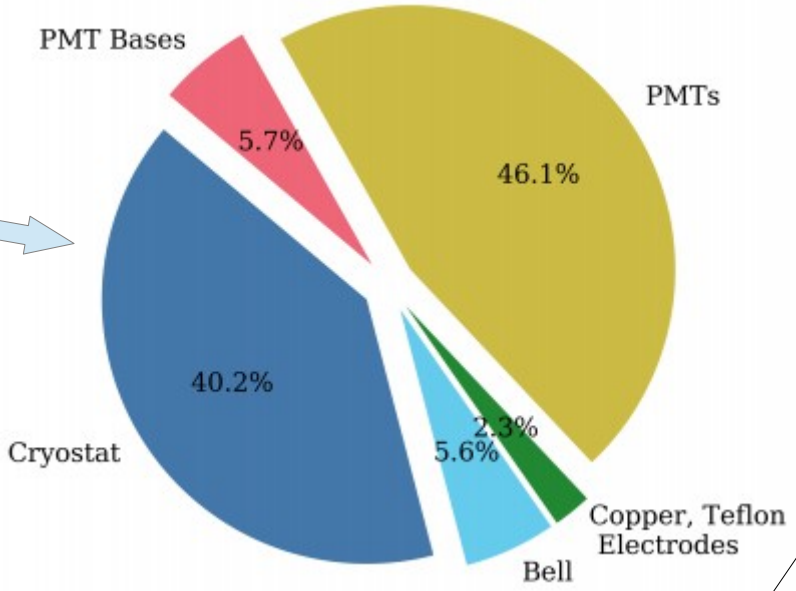
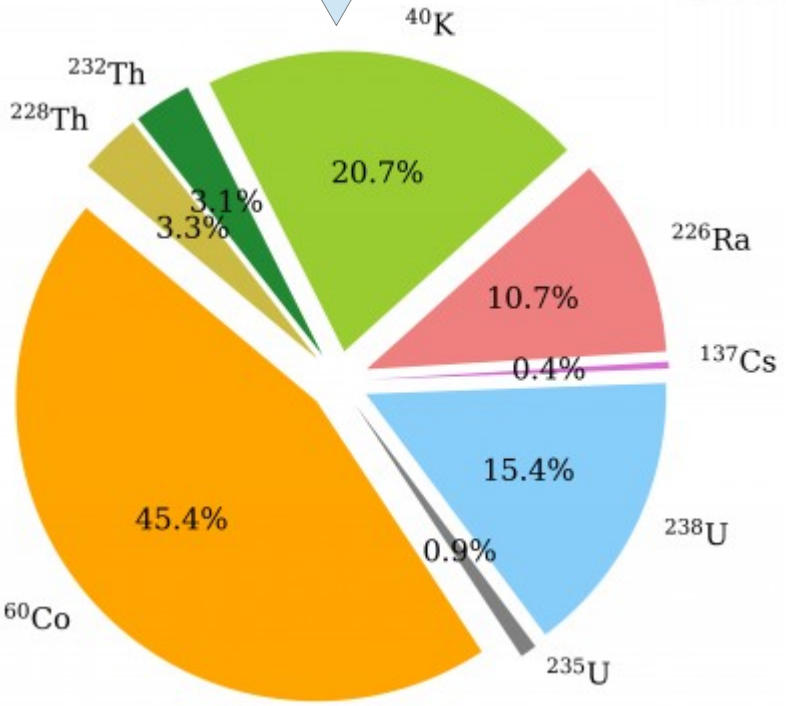
Electron Recoil background sources:

by hardware

by isotope





Nuclear Recoil background (neutron) sources: