XENONnT @ LNGS & Kamioka

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at the Kyodo-Riyo Science Session
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Kyodo-Riyo: XENONnT Budget

2 approved budgets for financial year 2018:

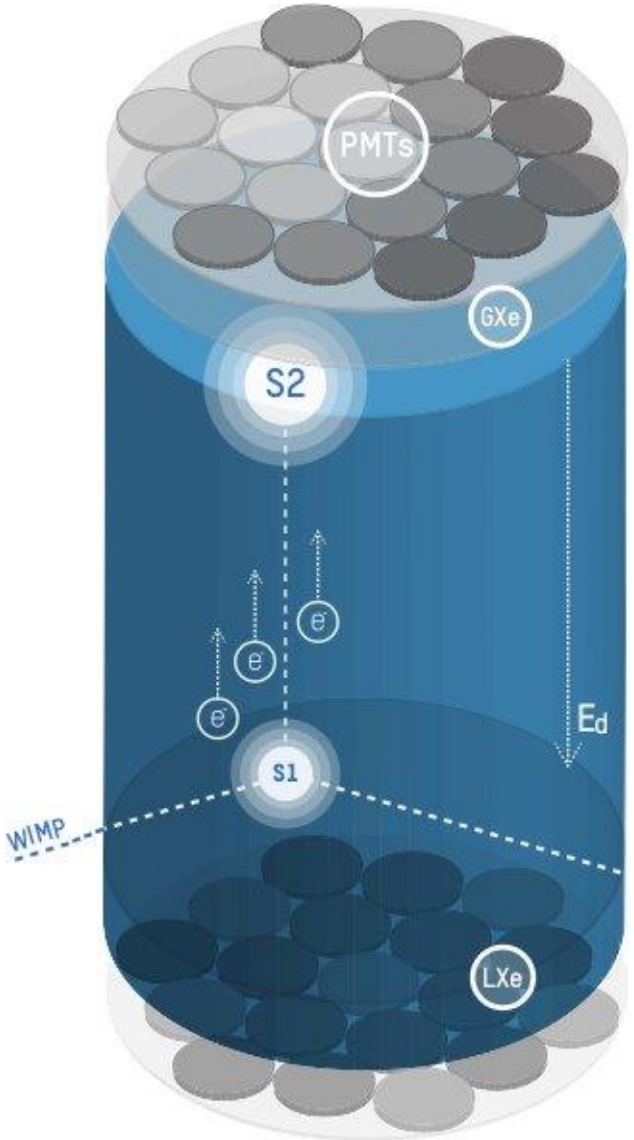
1.) **400 kJPY** for **travel** to the Kamioka Observatory:
corresponds to ~ 5x one person week in Kamioka coming from Tokyo, Nagoya, or Kobe.
Our nVeto design for XENONnT was approved in September: test bench for reflector materials (Gore-Tex, Tyvek) in pure water ready @ Kamioka now:
Todai master student and Nagoya postdoc will be the main users of the allocated funds, measuring reflectivity and finalize nVeto optical separator design at Kamioka.
Funds will be used before the end of the FY.

2.) **100 kJPY** for **computing**: (Kentaro Miuchi, Kobe University)
this support was used to travel between Kobe and Kamioka for MC discussions; used Kashiwa computers for MC check.

Overview:

- Liquid xenon (LXe) & Dark Matter (DM) direct detection:
  Why dual phase?
- The XENONnT detector:
  Physics reach and the Japanese contribution
- The XENONnT time scale:
  Building up towards discovery
- Beyond XENONnT:
  Keeping Kamioka relevant for the ultimate LXe observatory
- Summary and Outlook

XENON: Dual Phase LXe



wikipedia rendering of dual phase TPC

Dark Matter (DM) direct detection:
Weakly Interacting Massive Particle (WIMP) scattering on Xe nucleus
→ **nuclear recoil** (NR)

single phase detector: scintillation

e.g. XMASS: optimized for light collection, but very limited discrimination of NR vs. ER

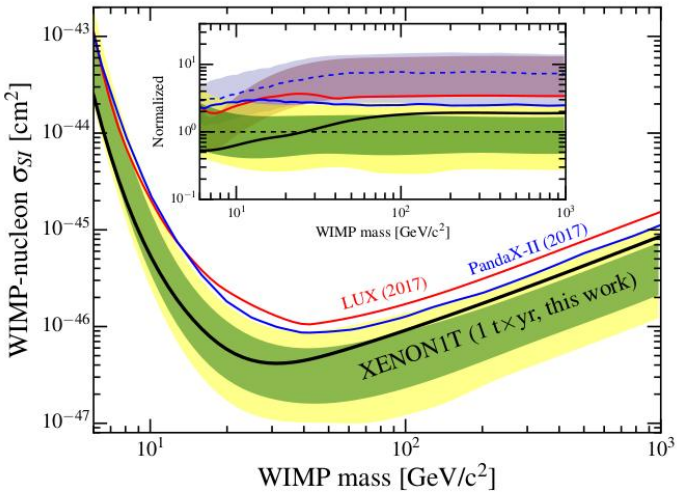
dual phase TPC: scintillation + ionisation

→ very good NR vs. ER discrimination !!!
→ very good position resolution (e^- drift time)
← *need to control electronegative impurities*!

acronyms: TPC = time projection chamber
ER = electron recoil

XENON1T: In Hall B @ LNGS

XENONnT will re-use many proven components and methods of XENON1T



← main physics result from XENON1T:
Phys. Rev. Lett. 121, 111302 (2018)
arXiv 1805.12562

Backgrounds well understood:

given the **site** (Hall B, LNGS) and **experience with XENON1T**,
the limiting **backgrounds in XnT** will be from detector materials:

1.) ^{222}Rn emanation into the LXe:
→ online Rn distillation: Xe100 technology, proven @ XENON1T

2.) **fast neutrons** from (α,n) reactions in TPC materials:
→ neutron veto (**nVeto**): Kamioka technology, proven @ EGADS

scale of the problem: ~ 10 single scatter neutron NRs in the final 20 tonne*year exposure

XENON collaboration: *We will not start XENONnT without nVeto.*

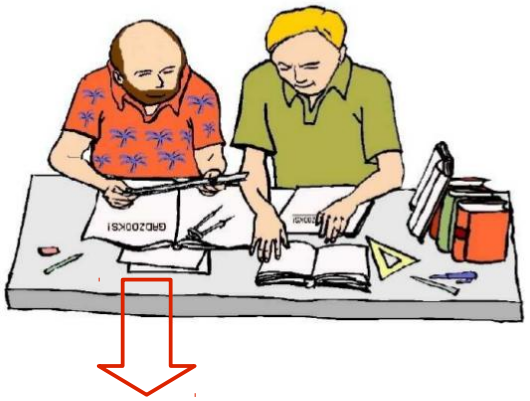
@ **LNGS**: legacy problem: Borexino dumped liquid scintillator...
underground problem: liquid scintillator is flammable...

→ XnT delay if liquid scintillator approval has to be obtained;
simulations → Kamioka Gd-water technology equally efficient !!!

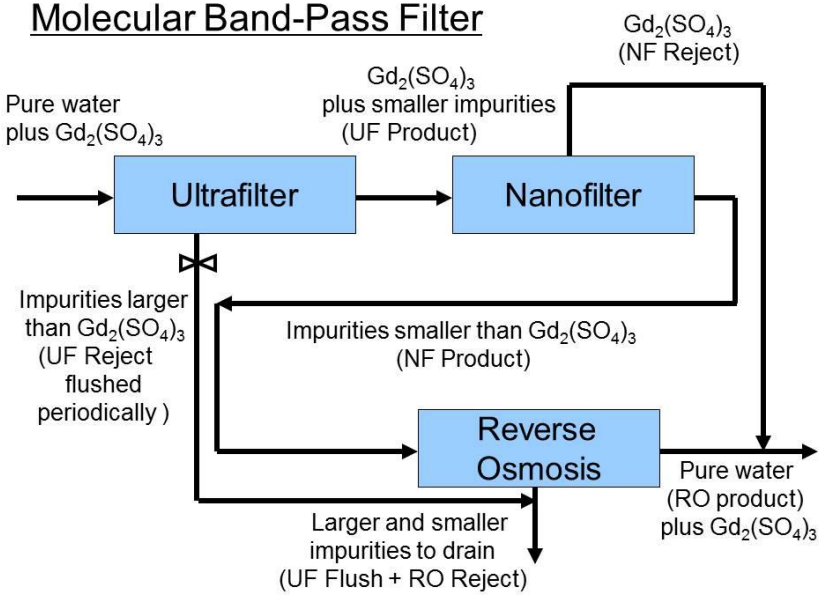
→ → Japan brings nVeto to XENONnT ← ←

SK-Gd Technology

Gd-water idea (2004):
Mark & John

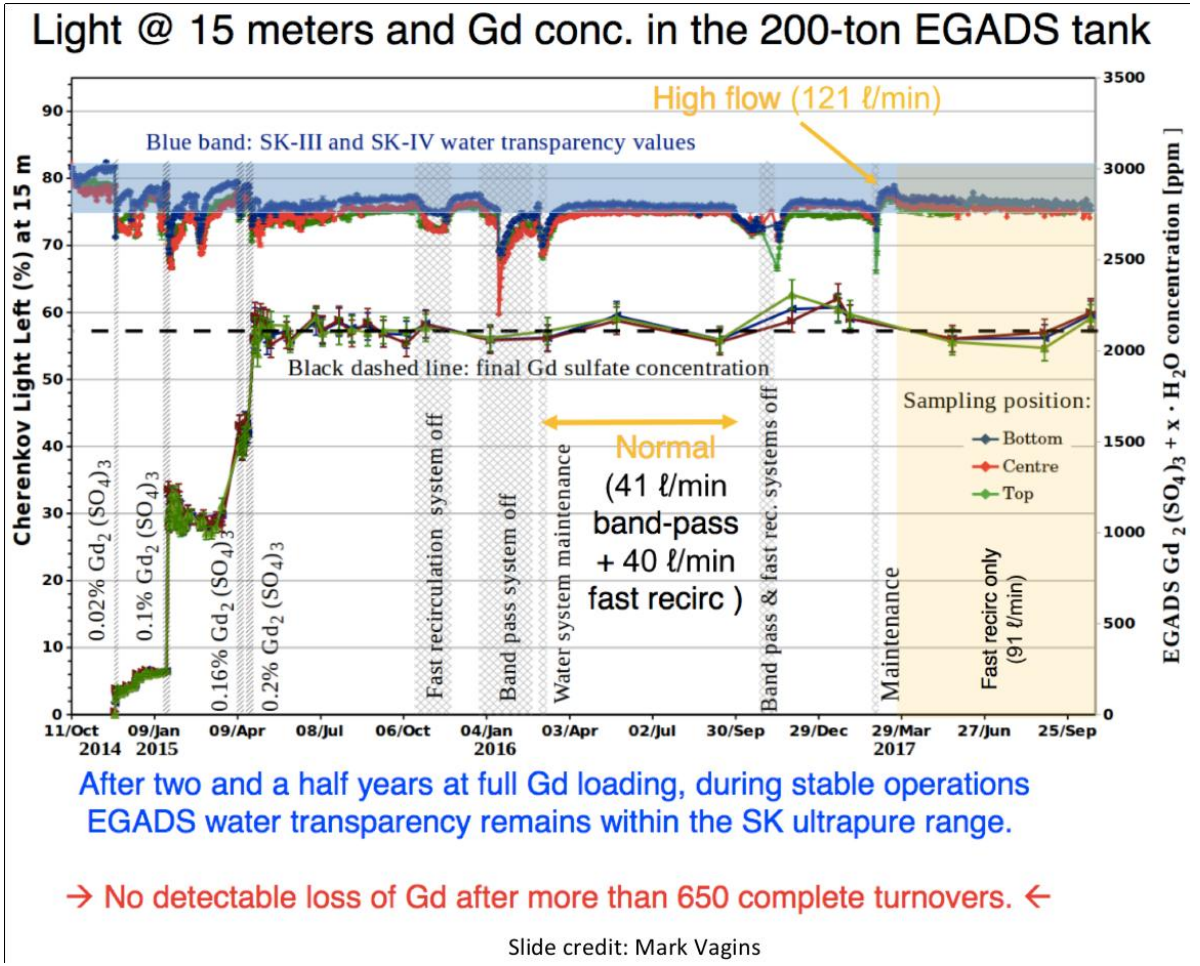


Molecular Band-Pass Filter



implement, understand and improve the technology:

EGADS:



After two and a half years at full Gd loading, during stable operations EGADS water transparency remains within the SK ultrapure range.

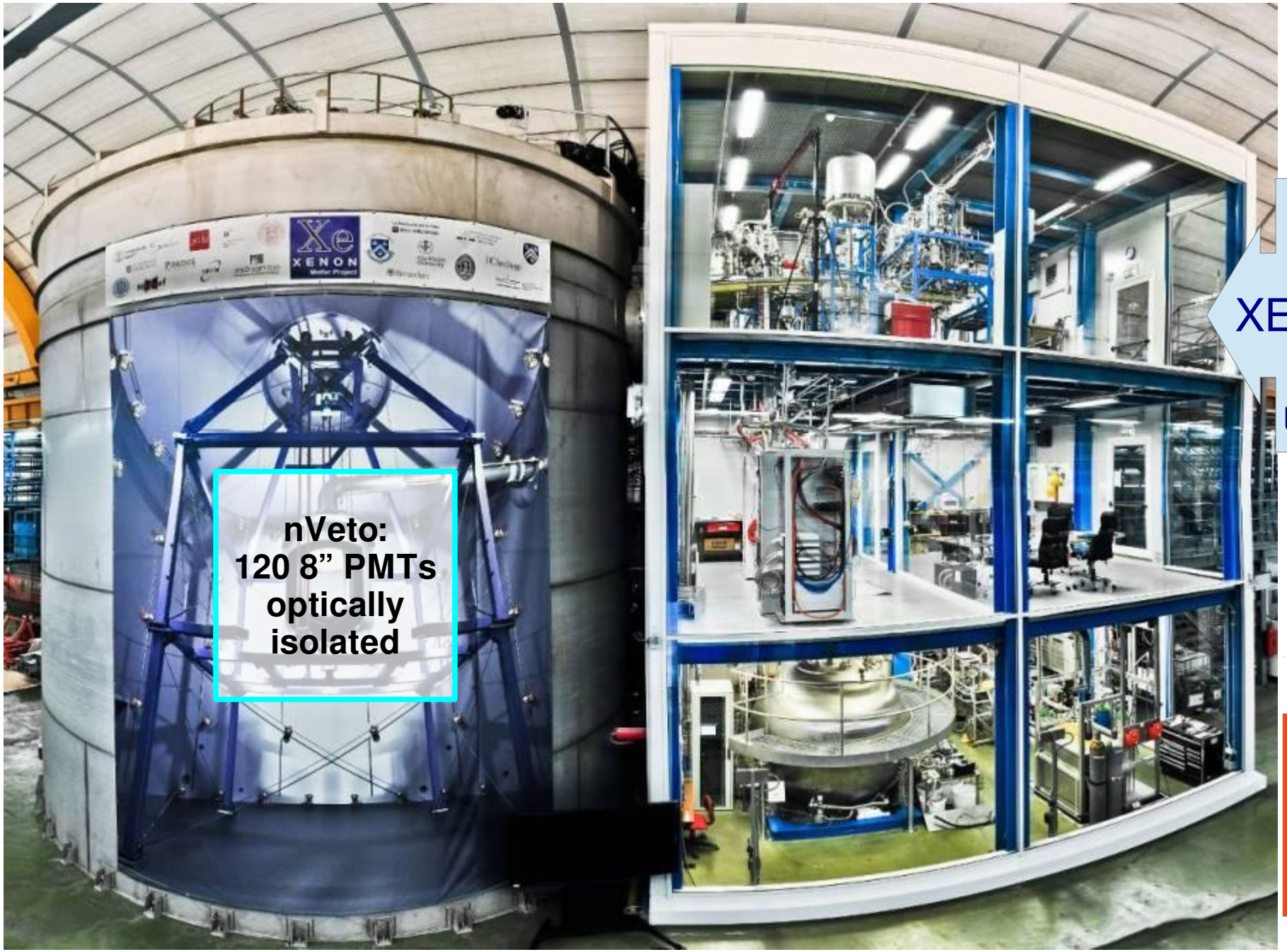
→ No detectable loss of Gd after more than 650 complete turnovers. ←

Slide credit: Mark Vagins

optimization different:

SK-Gd → maximum transparency, huge volume
XENONnT → maximum efficiency, small volume

XENONnT (XnT): Starting in 2019 !!!



Picture of: XENON1T reuse or upgrade:

veto tank, cryostat, electronics, cryogenics, ...

proven & debugged:

XnT

early start!

Massive Targets: Liquid Purification

LXe purification of LXe from **electronegative contaminants**:

- large volumes mean long drift
- long drift requires ultra-low contaminant concentration
  (so that we do not loose ionization signal)

Two Kamioka efforts:

- testing of absorbents in LXe
- making and testing a "purity monitor":
  - measures electron lifetime in the liquid
  - is ready for shipment to LNGS and installation at XnT →

This effort is future oriented:

a **G**eneration**3** ~30 tonne LXe fiducial volume (50 tonne LXe total) absolutely needs extremely efficient liquid purification:

→ **Kamioka is further developing its XMASS expertise for G3 !!!**

Summary and Outlook

- XENON has started the transition from XENON1T to XENONnT
- Japan is part of XENONnT, contributing crucial Kamioka expertise:
  - → SK-Gd/EGADS technology to veto fast neutrons
  - → liquid purification technology further developed from XMASS
- the Japanese XENONnT effort is an offshoot of XMASS:
  - → it is based in Kamioka and wishes to continue to use Kamioka Observatory facilities below and above ground and XMASS equipment *as far as it is not used otherwise*.
- XENONnT is a stepping stone to a future ~ 30 tonne LXe observatory:
  - → stay connected with the international community and
  - → develop required new technologies (large scalepurification)

Kyodo-Riyo support is much appreciated for this Japanese contribution to direct Dark Matter detection: It is our declared aim to

be the first to detect Dark Matter particles!