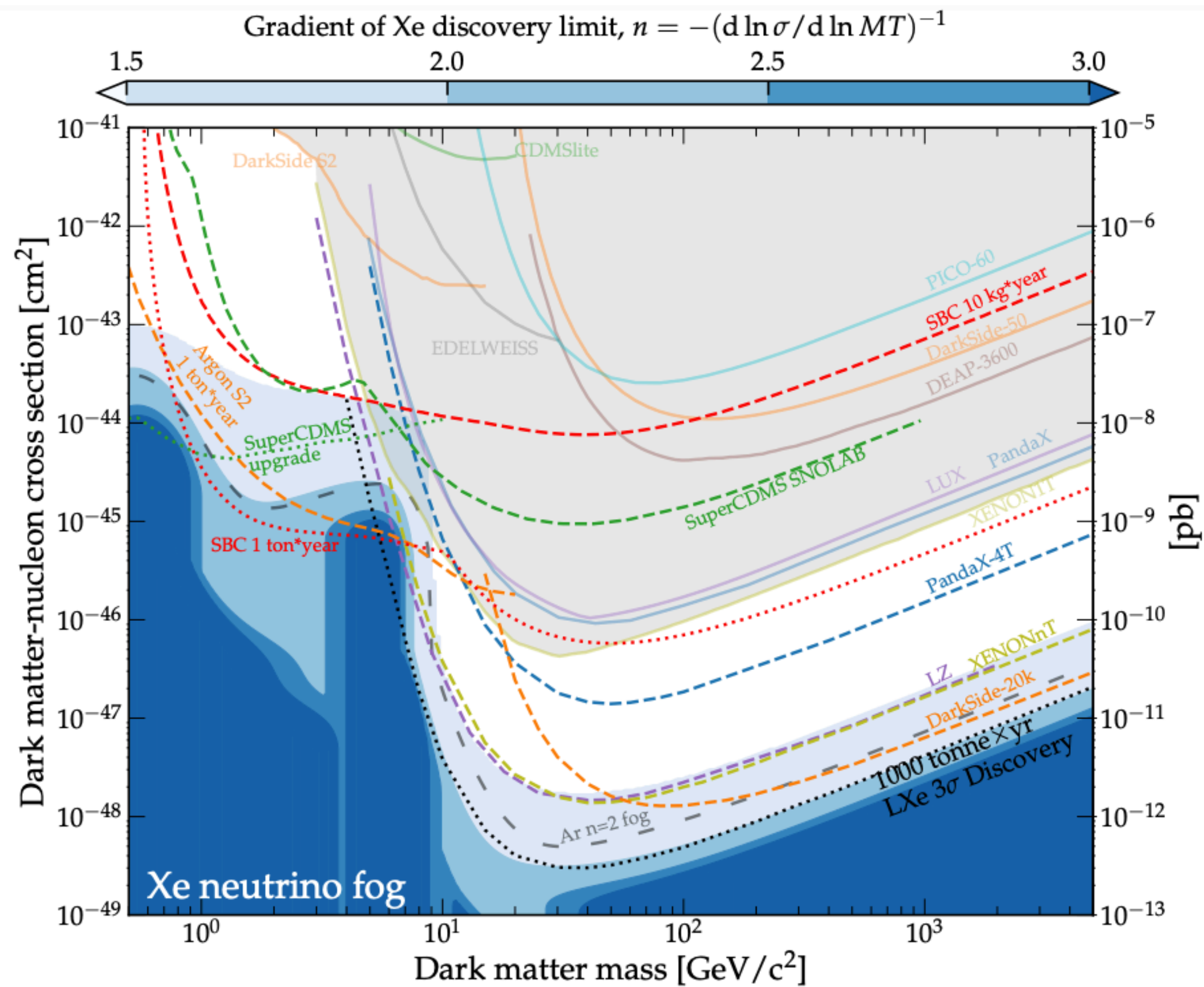# Next Generation Dark Matter Search Experiment

Xmas meeting
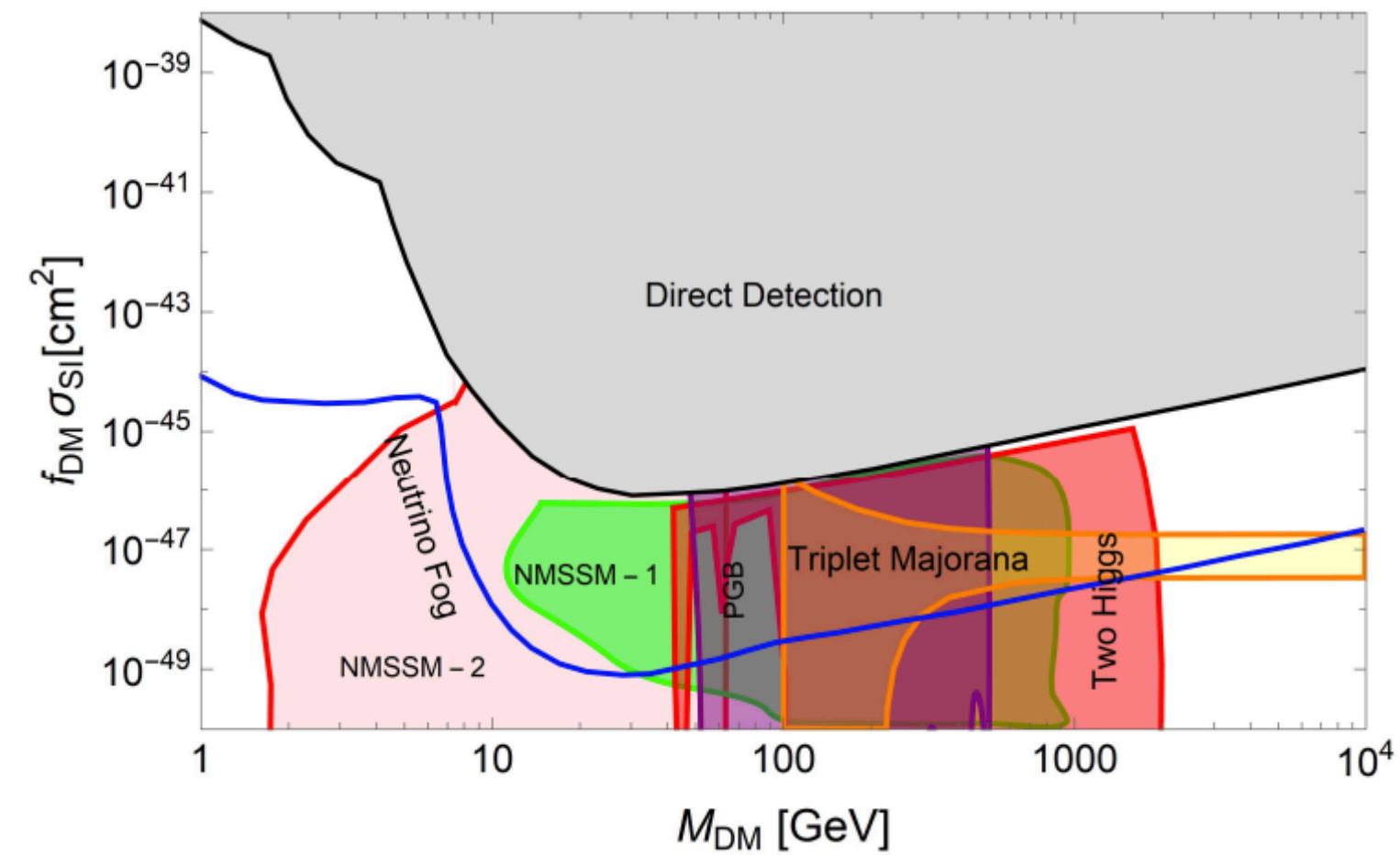
Sergey Burdin, 18 May 2023

Ultimate Detector for Dark Matter searches
After reaching Neutrino Fog level a new technology will be needed
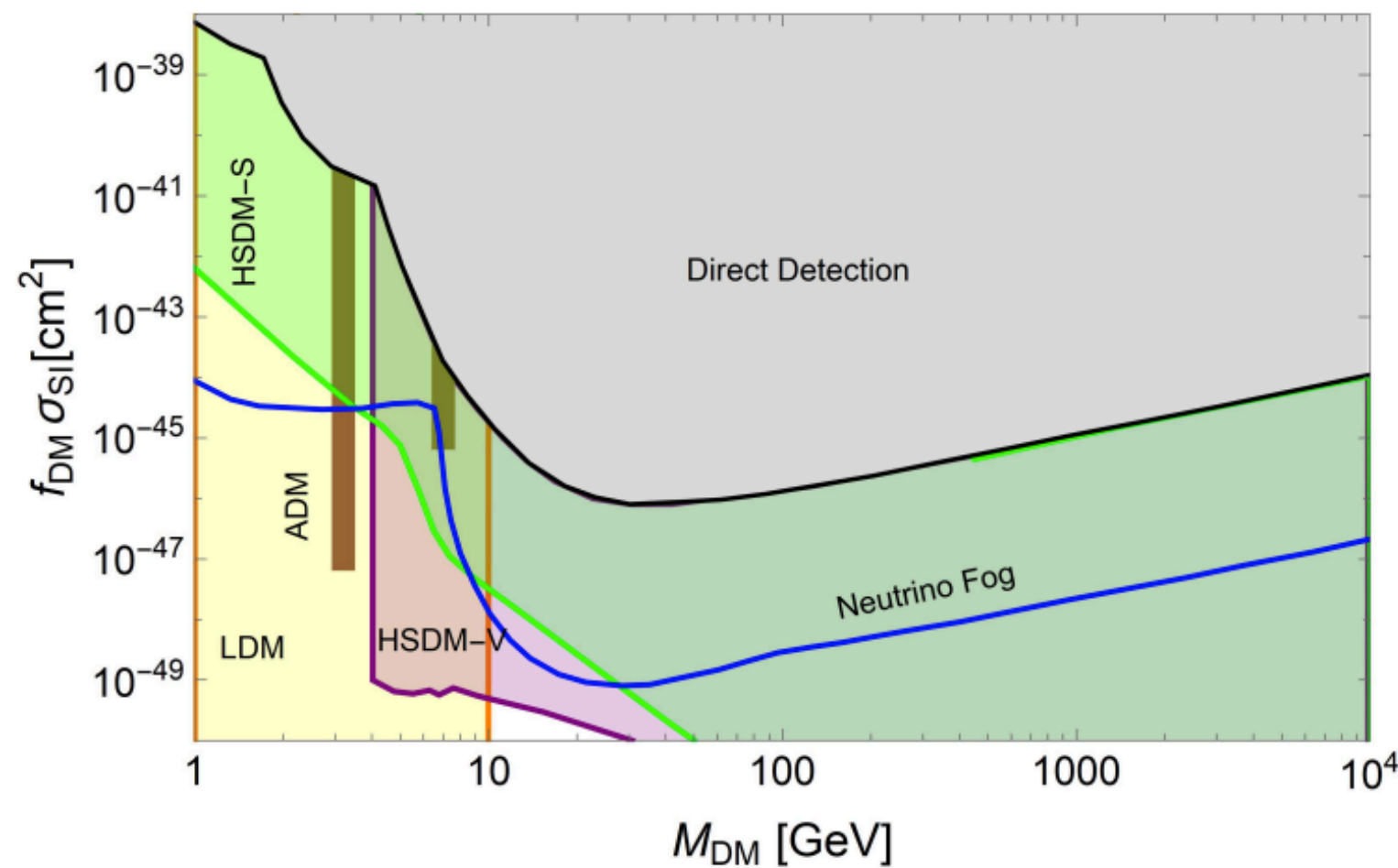
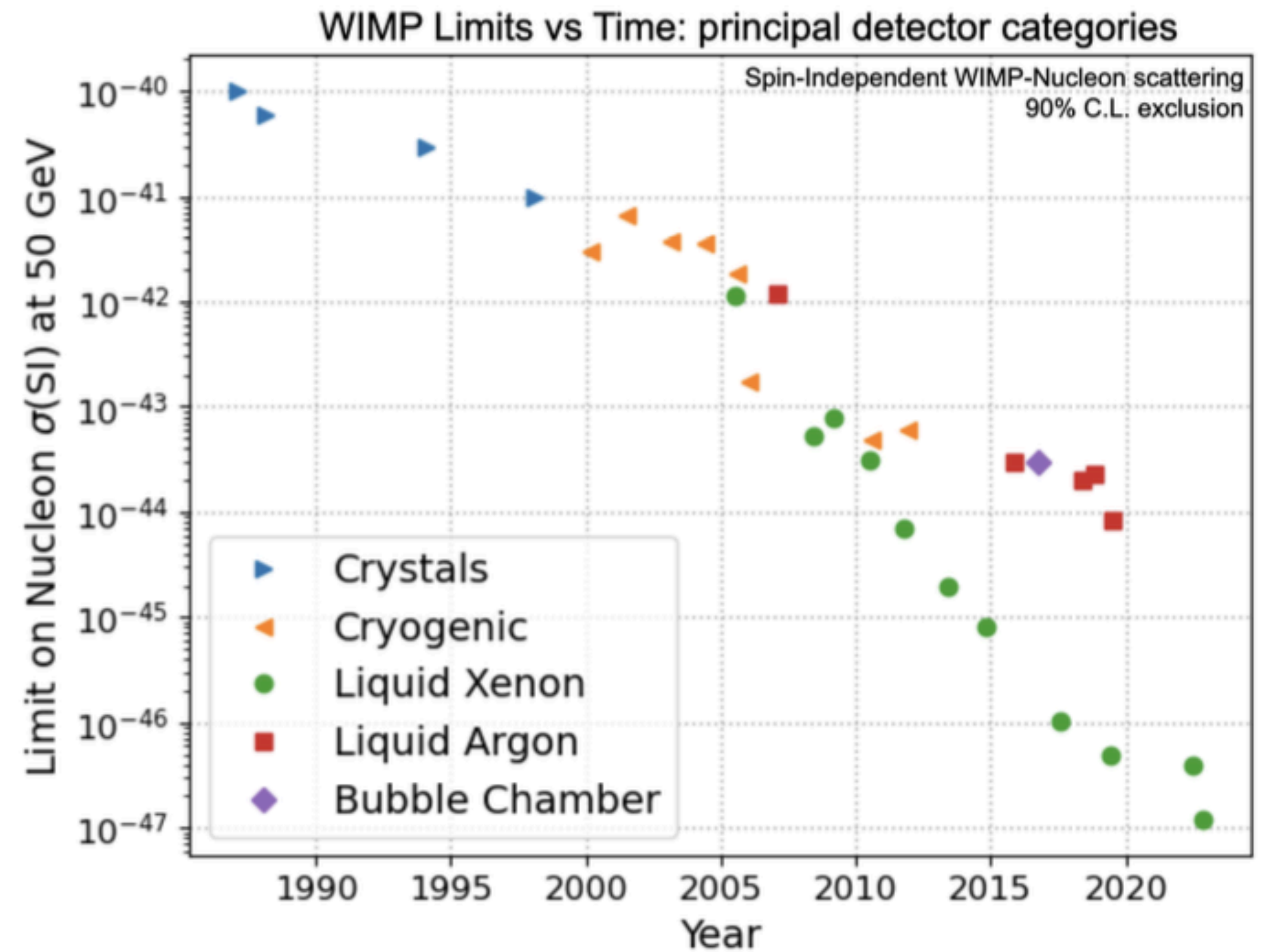Snowmass 2021 Whitepaper arXiv: 2203.08084

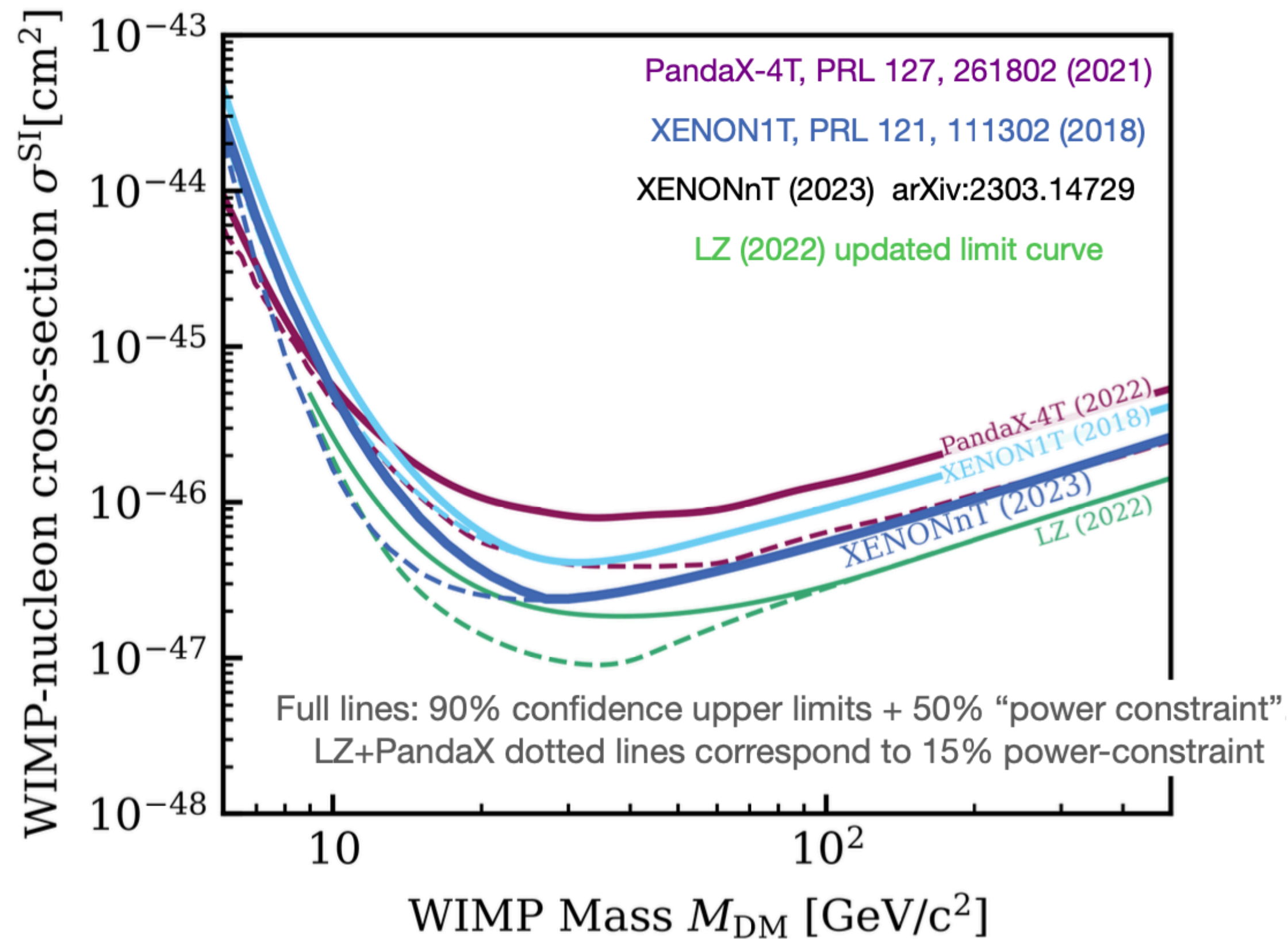Quite a few models predict DM candidates in the gap between the current limits and Neutrino Fog

At contour n, obtaining $10\times$ lower cross-section sensitivity requires an increase in exposure of at least 10^n

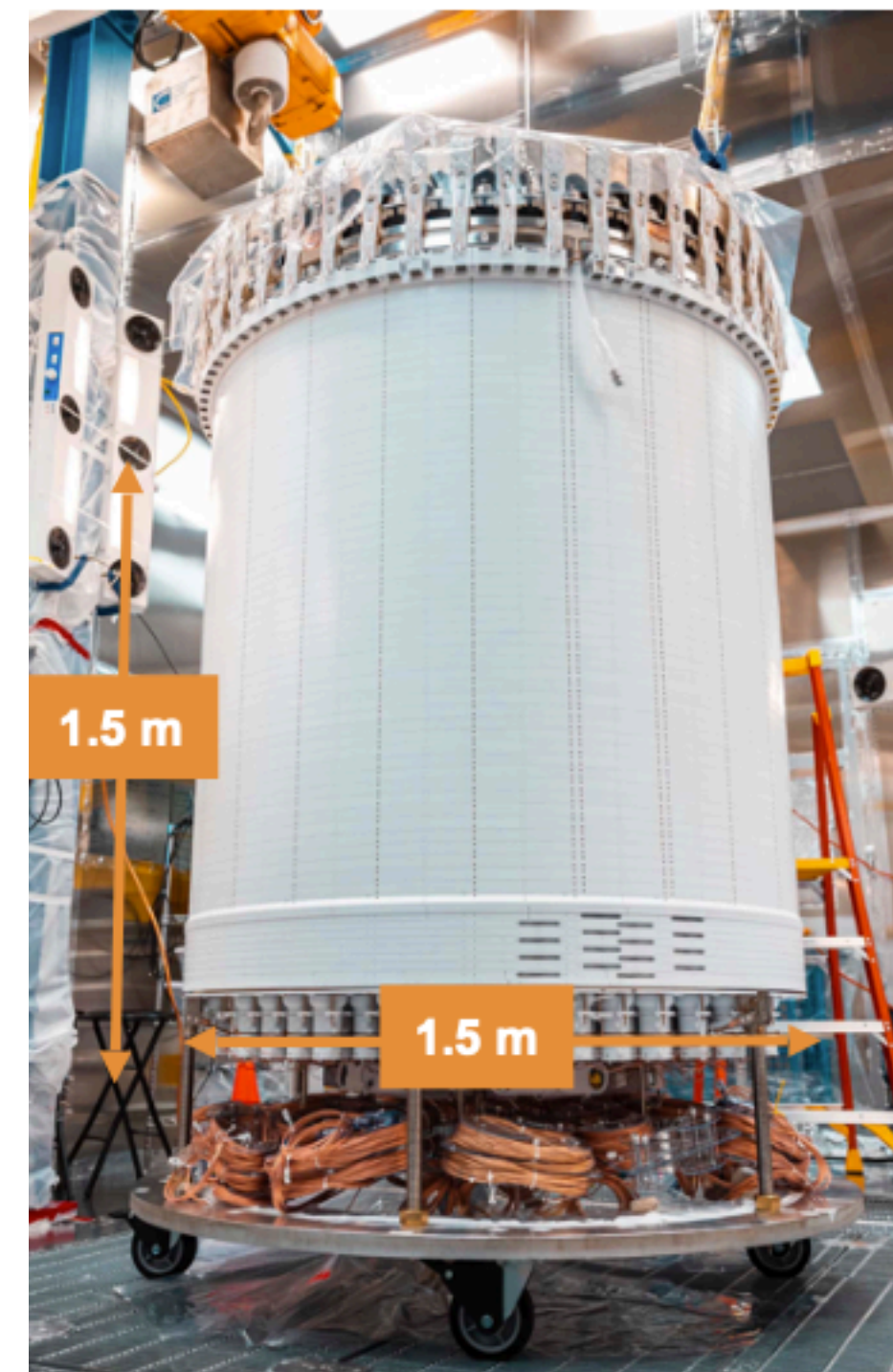# XeTPC Technology: World leading since 2007

Current Two-phase LXe TPCs for Dark Matter searches

- 3 LXe Dark Matter Search experiments are competing with each other to reach the best sensitivity

XENONnT@LNGS — 1.5 m, 1.3 m

LZ@SURF — 1.5 m, 1.5 m

PandaX-4T@JinPing — 1.2 m, 1.2 m

	XENONnT@LNGS	LZ@SURF	PandaX-4T@JinPing
Total (sensitive) mass	8.5 (5.9) tonnes	10 (7) tonnes	5.6 (3.7) tonnes
3-inch PMTs	494	494	368
Drift Field	23 V/cm	193 V/cm	93 V/cm

Future: DARWIN

outer cryostat

inner cryostat

field cage
(copper, 92 rings)

support structure
(PTFE, 24 pillars)

top sensor array
(955 PMTs, electronics,
copper + PTFE panels)

top electrode
frames (Titanium)

TPC reflector
(PTFE, 24 panels)

bottom electrode
frames (Titanium)

bottom sensor array

pressure vessel
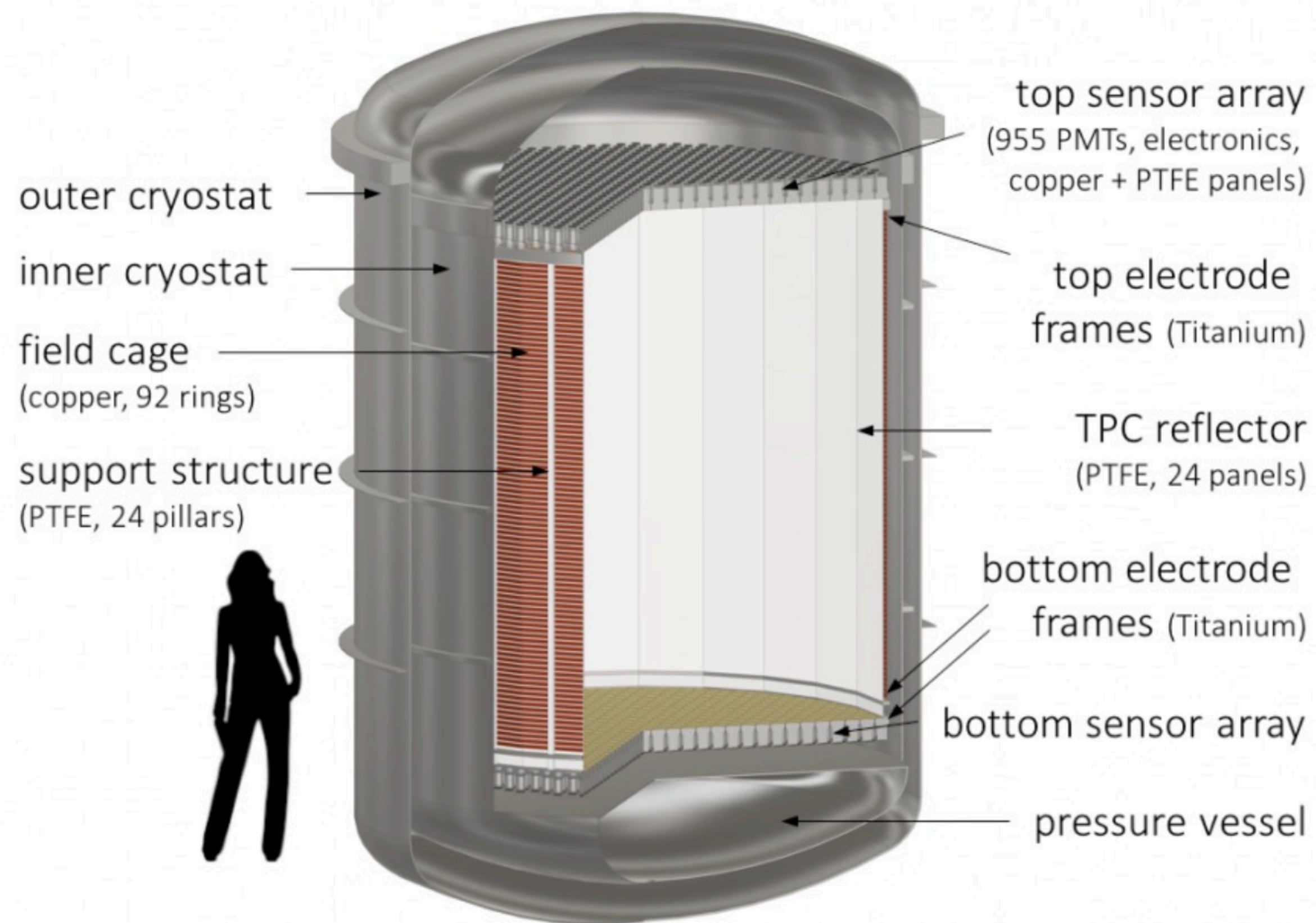
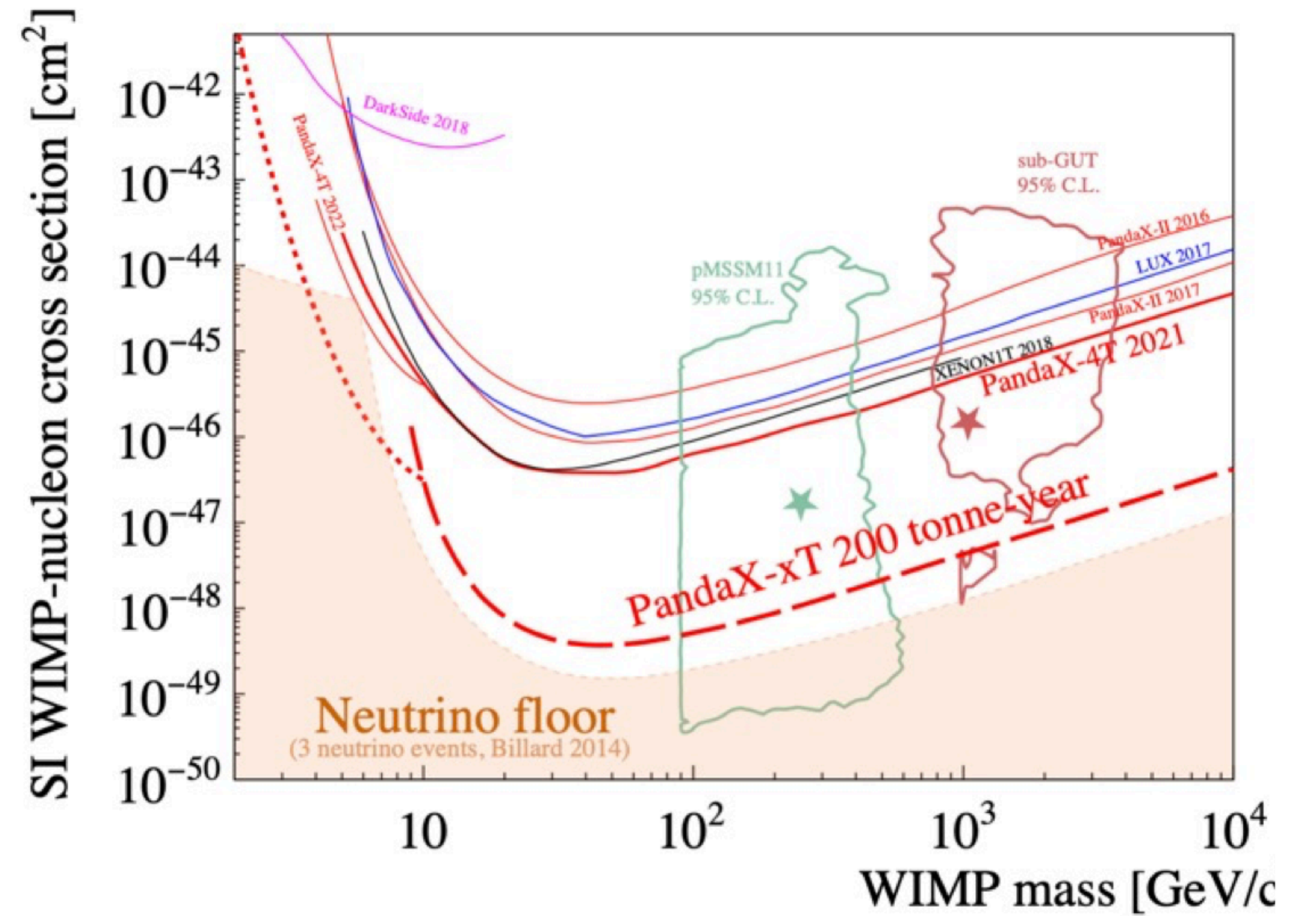- Preparation for the next multi-tonne LXe detector was ongoing for quite some time within the DARWIN collaboration

- Baseline configuration

  - 1,910 3" PMTs (955 Top and Bottom Arrays)

  - 50t LXe detector volume

  - 0.1 $\mu Bq/kg$ ^{222}Rn

  - Gran Sasso

Future: PandaX-xT

Outer Vessel

IVETO

Inner Cu Vessel

Top PMT Array

Active Volume

Bottom PMT Array
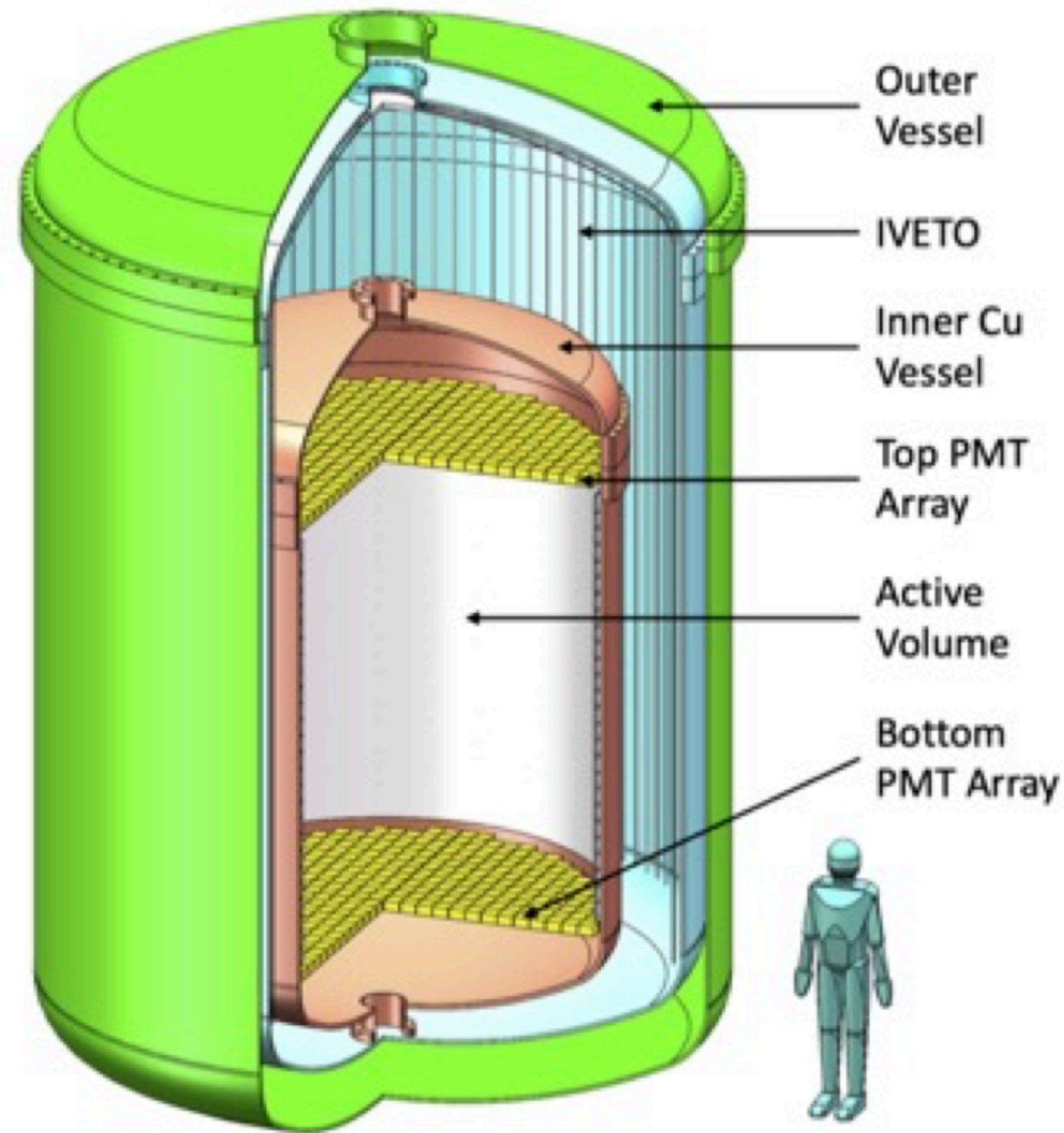
>30t sensitive volume

LOI sent to Chinese funding agency
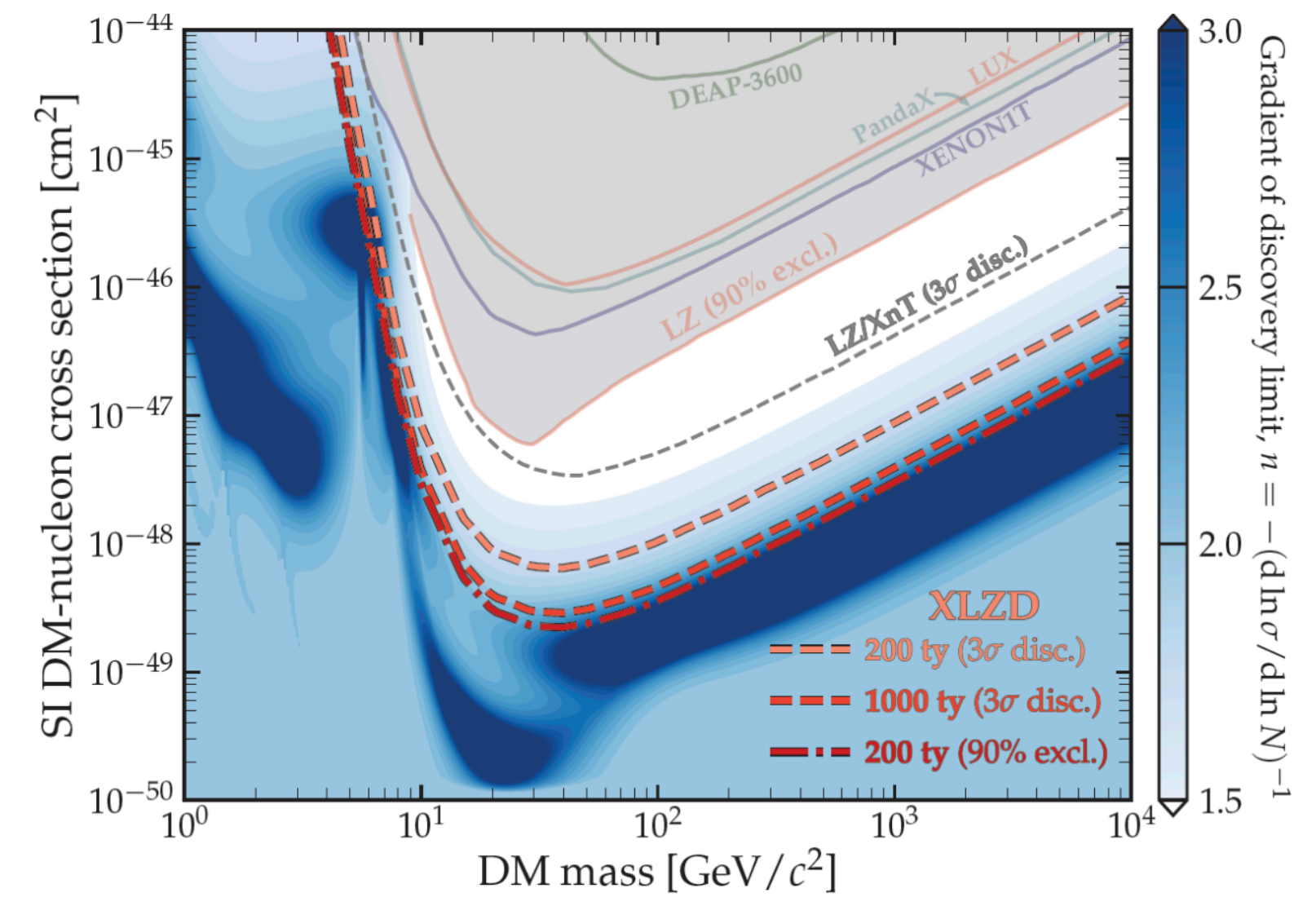
XLZD Consortium

LZ, XENON and DARWIN collaborations have created XLZD consortium in 2021 to work toward a G3 xenon observatory
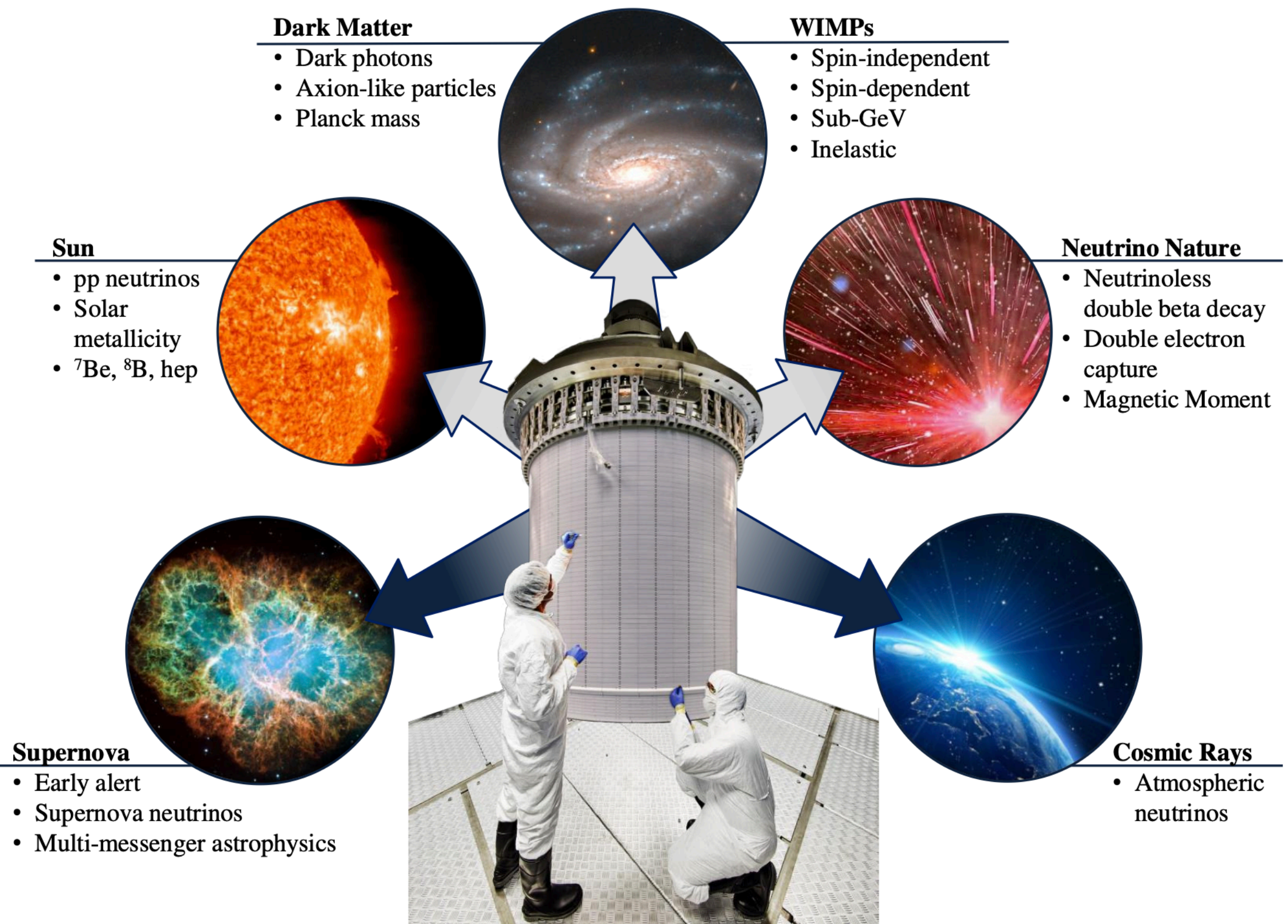
XLZD - Rare Event Xenon Observatory

- A detector with 50-100 tonnes of LXe to chase WIMPs to the neutrino fog and search for other new physics

- Science case: arXiv:2203.02309

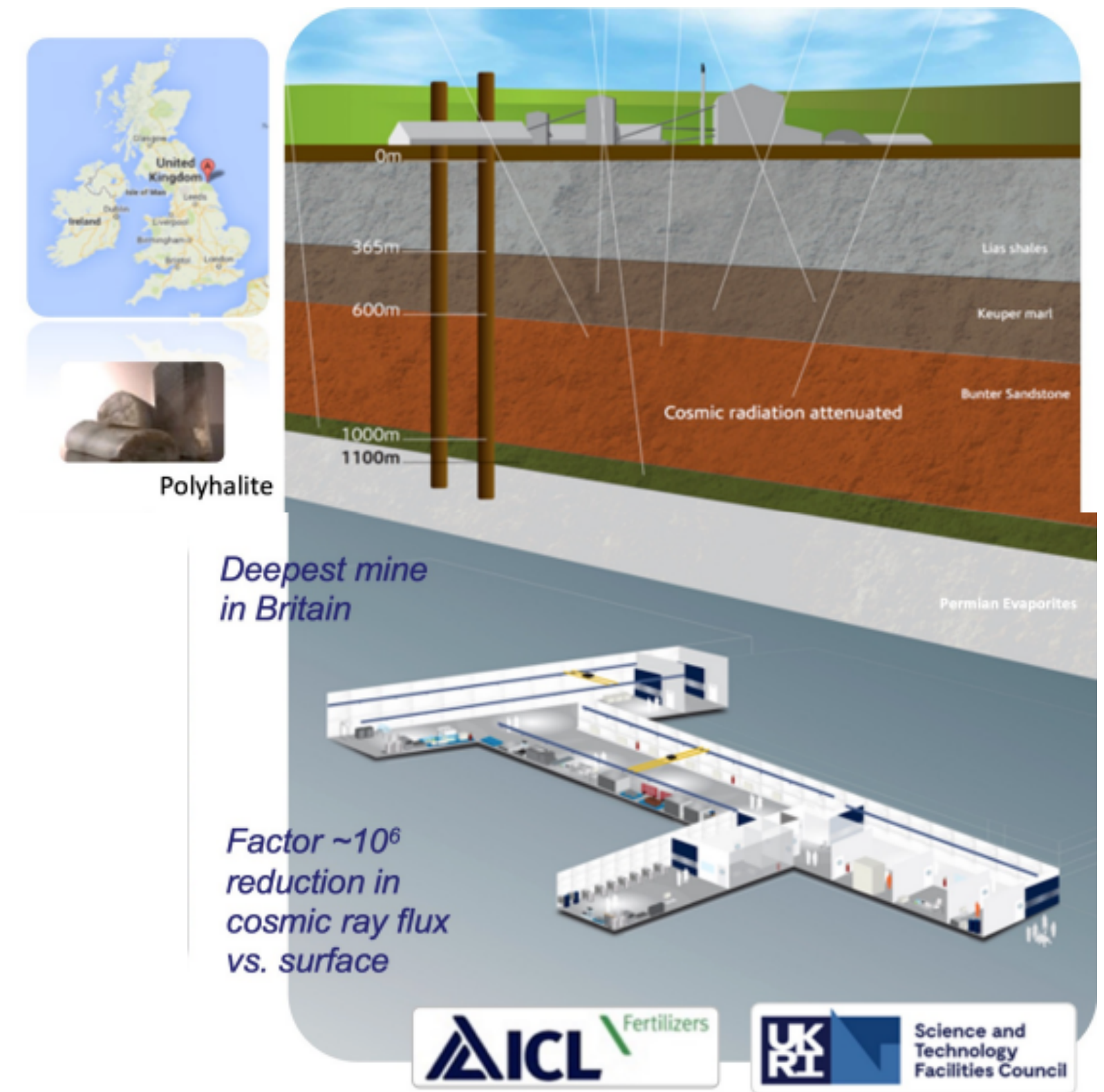- Possible locations: SURF, LNGS, Boulby, SNOLAB, Kamioka

XLZD @ Boulby Opportunity

XLZD@BOULBY:
HOSTING THE DEFINITIVE
UNDERGROUND RARE-EVENT OBSERVATORY
IN THE UK

Polyhalite

Deepest mine in Britain

Factor ~10^6 reduction in cosmic ray flux vs. surface

From M.Thomson presentation @ IOP 2023:
Future of Boulby Underground Lab
Based on one of the STFC Strategic Delivery Plan Priorities

- Launched a design study for a greatly expanded underground science facility in the NE, with the potential to host a major international science infrastructure, with projected construction completion date in 2030/31

Underground Facility

Surface Facility

Experiment

Zepllin III

DARWIN

UK Scope & Timeline

UK to contribute 1/3 of total project cost

- **Major systems naturally suited for host nation, including: the Outer Detector, the ULB cryostat, and elements of the Xenon Detector**

  → **BUTTON, LZ Outer Detector**

  → **Xenon Futures, Darkside**

- **Contribution to the xenon stock**

- **Centres based at Boulby focused on skills to deliver: engineering and technical effort, (radio-)clean manufacture and underground science, data centre and on-site computing**

  → **BUTTON, strong workshop**

  → **LEGEND**

Synergy @ Liverpool with

XLZD@BOULBY:
HOSTING THE DEFINITIVE
UNDERGROUND RARE-EVENT OBSERVATORY
IN THE UK

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Statement of Interest to the STFC Science Board
23rd January, 2023

Science Board recommended that the proposal should progress through the Visions or UKRI Infrastructure Fund processes

PROJECT PHASES: R&D EXT (1y) + PRE-CONSTRUCTION (3y) + CONSTRUCTION (5y) + OPERATIONS (10y+)