# Workshop on Xenon Detector 0νββ Searches: Steps Towards the Kilotonne Scale

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WELCOME!

SLAC NATIONAL ACCELERATOR LABORATORY

Argonne NATIONAL LABORATORY

UTA

Lawrence Livermore National Laboratory

# An ambitious but hopeful workshop!

…or have we all gone crazy?!

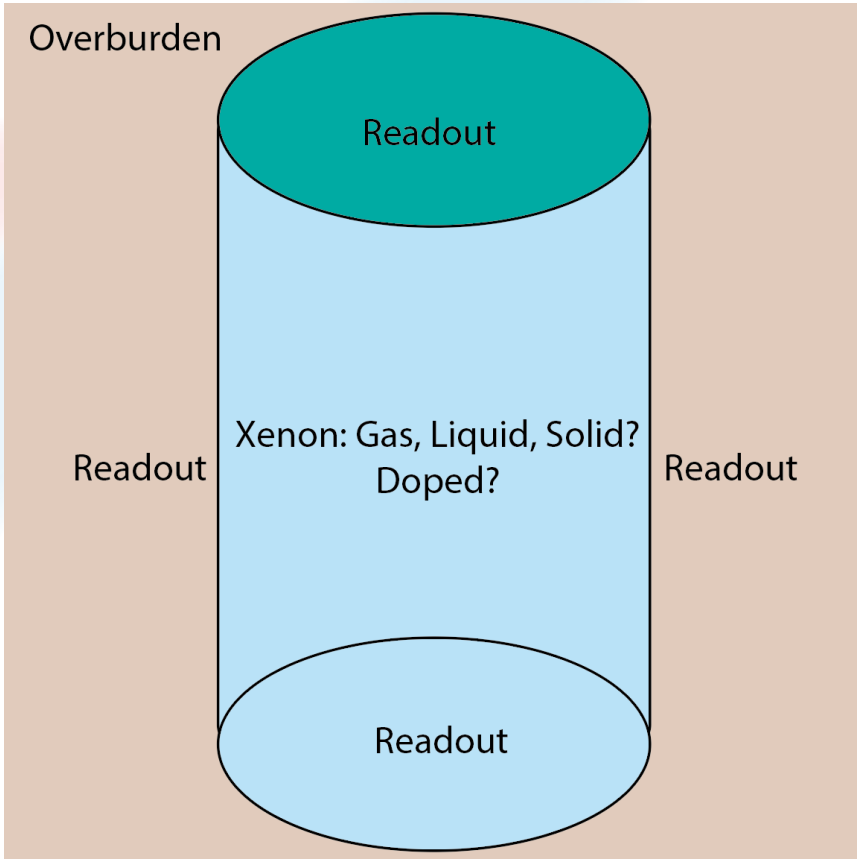
- In the next decade (tonne-scale era):
  - Current $0\nu\beta\beta$ tonne scale experiments will obtain critical sensitivity in the inverted mass ordering
  - Dark matter experiments achieving 10-100 larger sensitivities on the WIMP cross section and heading towards the neutrino fog
- Can we can make a strong physics case for going beyond this scale to kilotonne?
  - $0\nu\beta\beta$: Towards a half-life of $10^{30}$ years / meV mass scale
  - Dark Matter: Reaching the neutrino fog
- No easy feat - there are serious technological challenges to overcome at this scale with prolonged R&D programmes, collaboration, expense, procurement and careful planning,...

# A plethora of benefits

- A large kilotonne-scale detector would be capable of not just $0\nu\beta\beta$ decay or WIMP searches, but a plethora of additional physics searches will be possible:
  - Astrophysical neutrinos
  - Broader dark matter searches
  - Additional physics channels such as solar axions
- We would be building the worlds most sensitive xenon detector(s) at a kilotonne scale
- Potential for collaborative work between existing collaborations, similar to consortiums such as XLZD
- Developing new technology:
  - Acquisition of xenon at scale
  - New readouts
  - Detector designs
  - Barium tagging
  - …

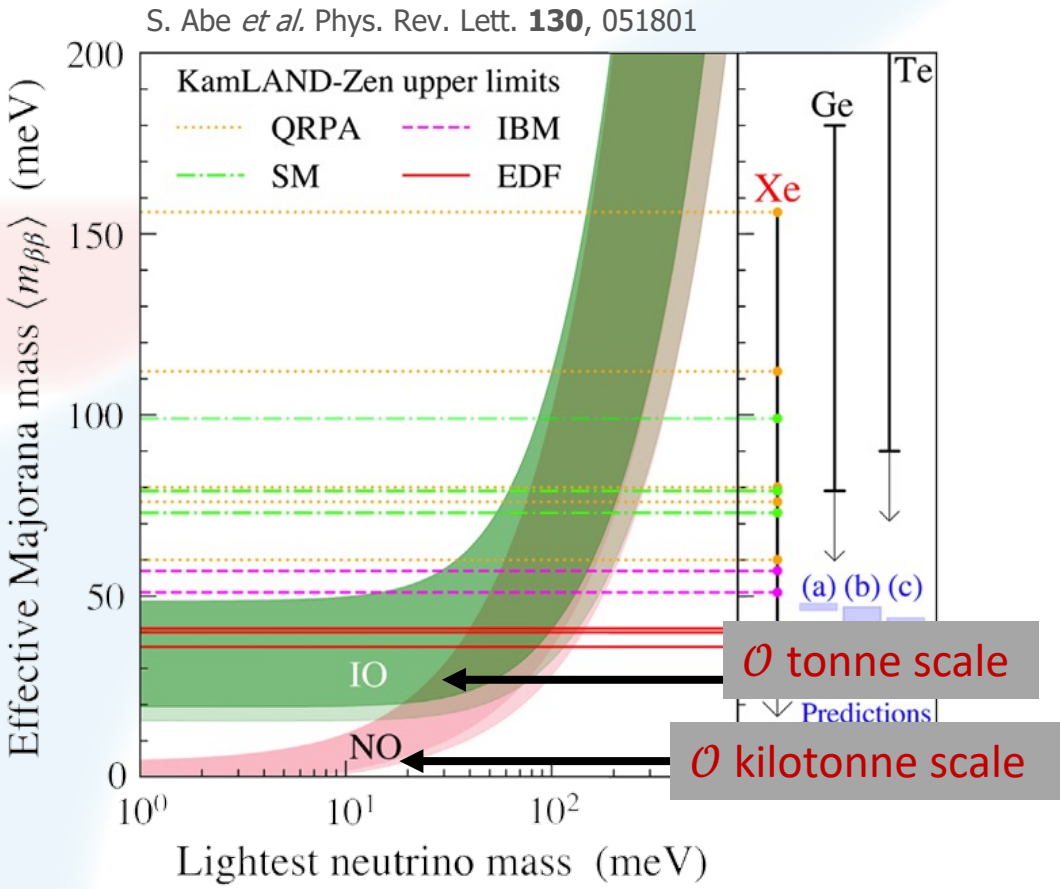
# Xenon Detectors

- Common detection medium for WIMP dark matter and $0\nu\beta\beta$
  - Most commonly in TPCs, but other technologies e.g. xenon-loaded liquid scintillator
- Common objectives and problems to solve:
  - Xenon acquisition
  - Calibration
  - Energy and topological resolution
  - Large scale
  - Ultra-low background



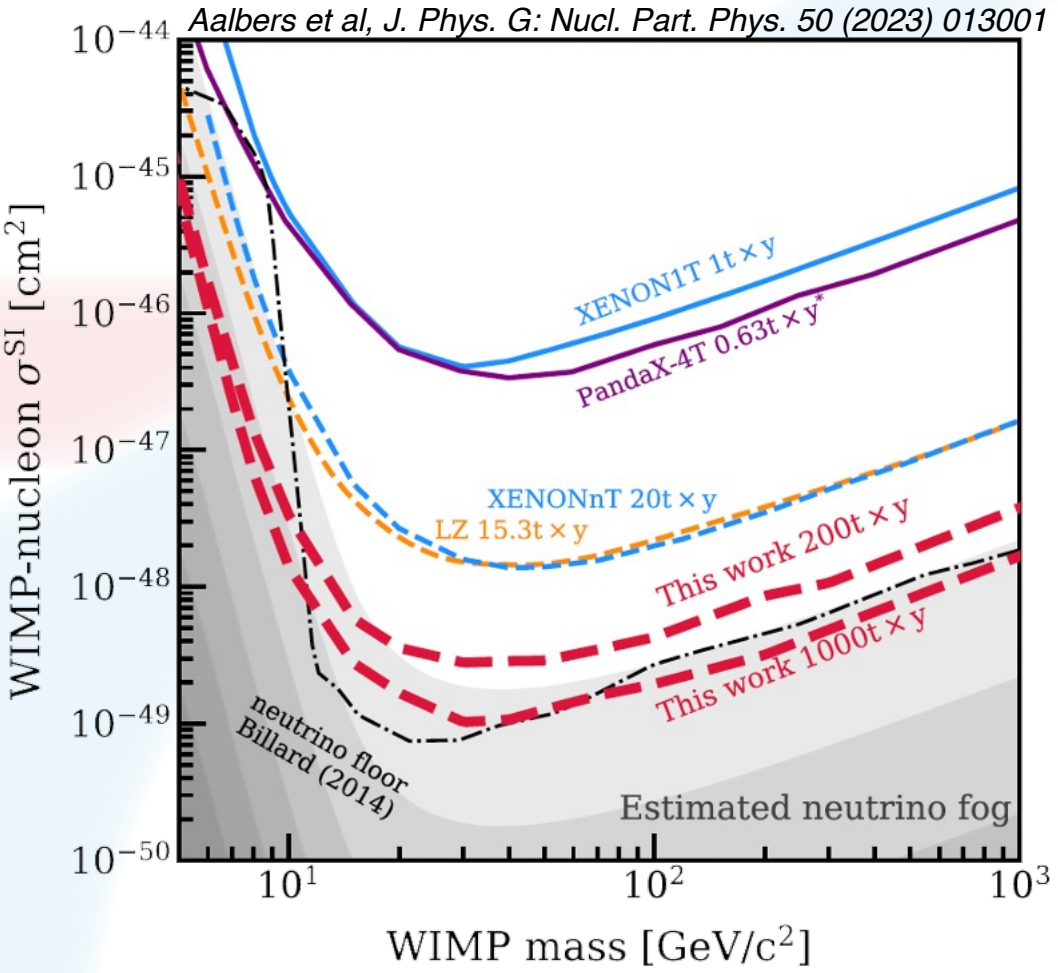
# $0\nu\beta\beta$ decay

- Forthcoming experiments are digging into the inverted hierarchy
- Reaching the normal hierarchy region in meV masses will require a kilotonne detector mass and background counts of a fraction of a count per year
- Large theoretical input on matrix element calculations



# Dark Matter WIMP

- Current and future experiments continue to carve out the deep parameter space
- Reaching deep into the neutrino floor/fog will require kilotonne scale



# This workshop

- Challenges towards the kilotonne scale
  - ⇥ Scaling detector components and architecture, calibration of large detectors, radiopurity, xenon acquisition, etc.
- Future charge and light readout
  - ⇥ Camera imaging, single electron counting, novel methods, large scale readout
- Novel detector technologies/ideas
- Barium tagging
- Physics program of a kilotonne detector
  - ⇥ Additional physics searches/programmes, theoretical perspectives and latest calculations

# Workshop Outcomes

- The workshop presentations will be summarized in a single conference proceedings (short document)
  - Organizers will start the document based on summaries taken during the workshop
  - Workshop attendees will also be sent this document to review and contribute before a deadline which will be advertised
  - Contributions and author-list is opt-in

- We hope this workshop will be productive and facilitate fruitful discussions, new ideas and build new connections

# Session Guidelines

- Each session will be steered by the session chairs
- Please upload your slides to the indico before the session begins, including remote talks
- We have a full agenda!
  - The session chair will notify you when there is a couple minutes remaining in your talk
- All questions will be taken at the end of the talk
  - Plenty of time allocated at the end of each talk
  - Zoom and slack channel will also be checked
  - Discussion sessions can be used for more extensive discussions

# Organization Team

## Organizing committee:

- Leslie Rogers (Argonne National Lab)
- Krishan Mistry (University of Texas, Arlington)
- Brian Lenardo (SLAC National Accelerator Laboratory)
- David Nygren (University of Texas, Arlington)
- Mike Heffner (Lawrence Livermore National Laboratory)

## Scientific advisory committee:

- Laura Baudis (University of Zurich)
- Thomas Brunner (McGill University)
- Jon Engel (University of North Carolina, Chapel Hill)
- Giorgio Gratta (Stanford University)
- Roxanne Guenette (University of Manchester)
- Atsuko Ichikawa (Tohoku University)
- Kunio Inoue (Tohoku University)
- Xiangdong Ji (University of Maryland)
- Kyle Leach (Colorado School of Mines)
- Justo Martin-Albo (IFIC)
- David Moore (Yale University)

Thanks for listening!