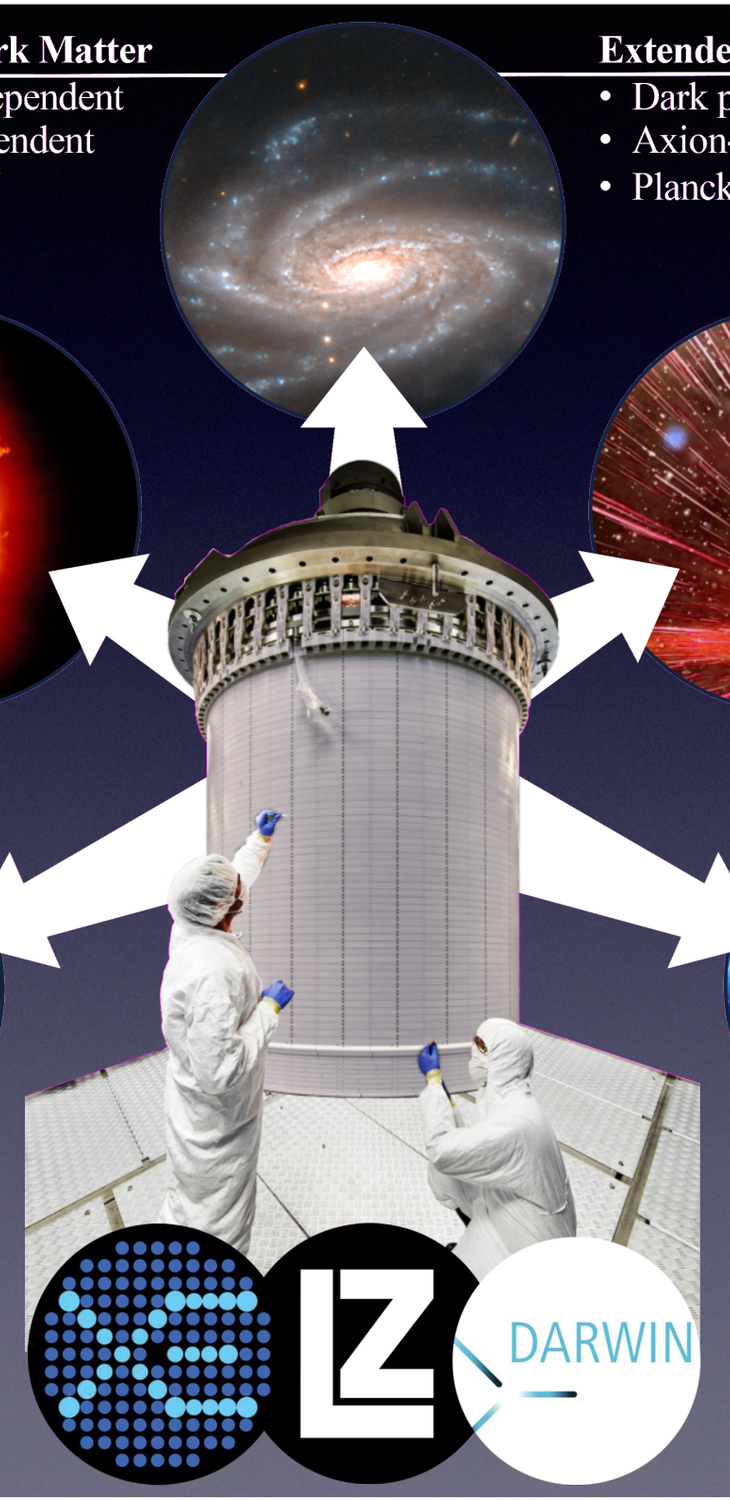
XLZD: Towards a Global Rare Event Observatory

WIMP Dark Matter
- Spin-independent
- Spin-dependent
- Sub-GeV
- Inelastic

Extended Dark Matter
- Dark photons
- Axion-like particles
- Planck mass

Sun
- pp neutrinos
- Solar metallicity
- ^{7}Be, ^{8}B, hep

Neutrino Nature
- Neutrinoless double beta decay
- Double electron capture
- Magnetic moment



Supernova
- Early alert
- Supernova neutrinos
- Multi-messenger astrophysics

Cosmic Rays
- Atmospheric neutrinos

Alexandre Lindote, for the LIP Dark Matter group

XLZD

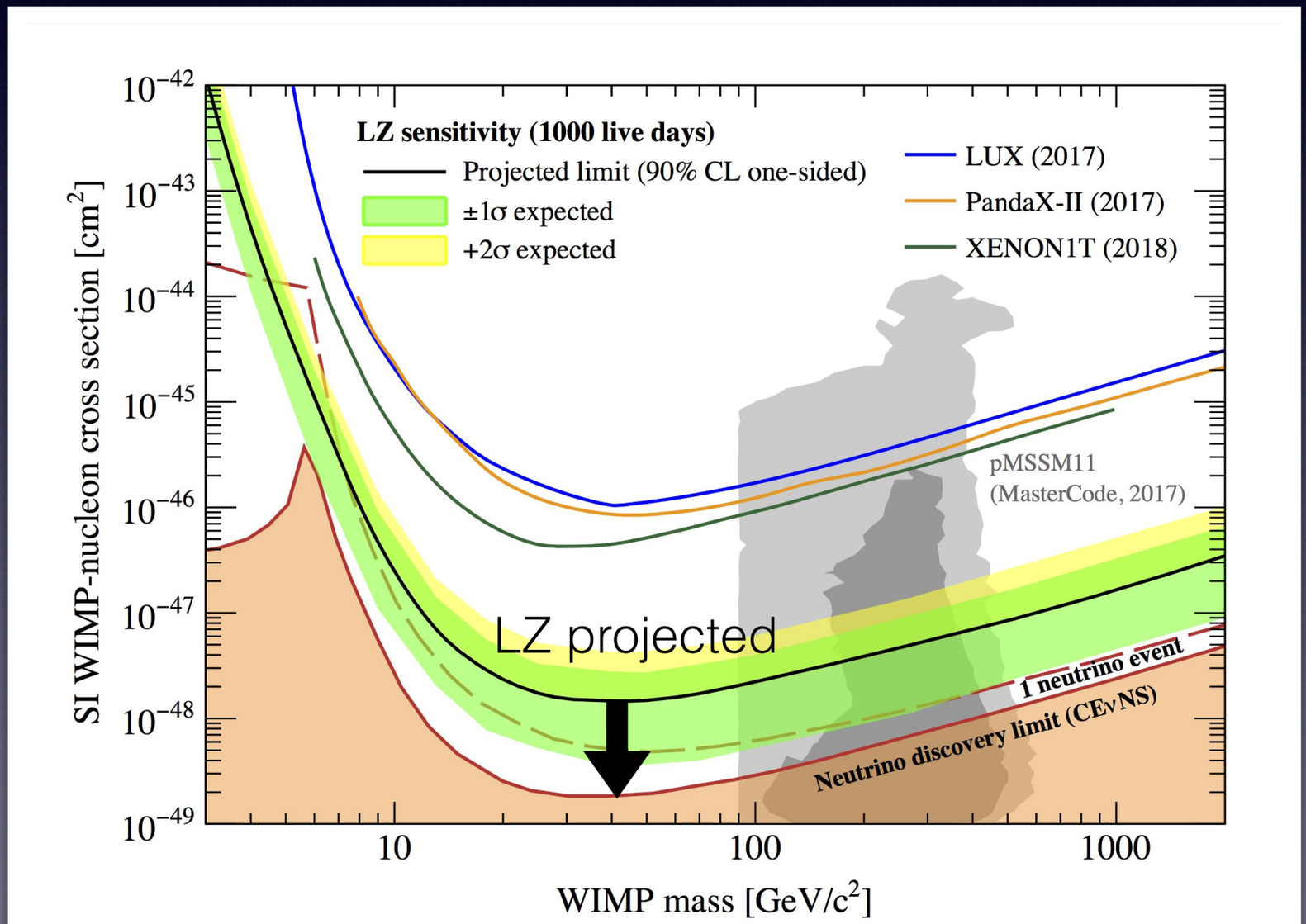
- A consortium formed by the LZ, XENON and DARWIN collaborations
  - All use detectors based on 2-phase xenon TPC technology
  - LZ and XENON lead the direct dark matter search for masses above ~10 GeV
  - DARWIN has been studying the design and science reach of a 50 tonne detector
- Present a united front immediately, to propose a large 2-phase xenon TPC project, with up to 100 tonnes of active mass
- Work towards a formal collaboration, to be formed in the next few months

XLZD

- MoU towards a new collaboration signed in 2021
- Whitepaper signed by 600+ scientists from 150 institutions in 28 countries (2203.02309)
- Various working groups already active, with mixed teams
- First in-person meeting in Karlsruhe (Germany) last week
  - Discussions on the design, installation location, ongoing and future R&D

Ultimate goal

- Explore the remaining WIMP parameter space above the neutrino “fog”



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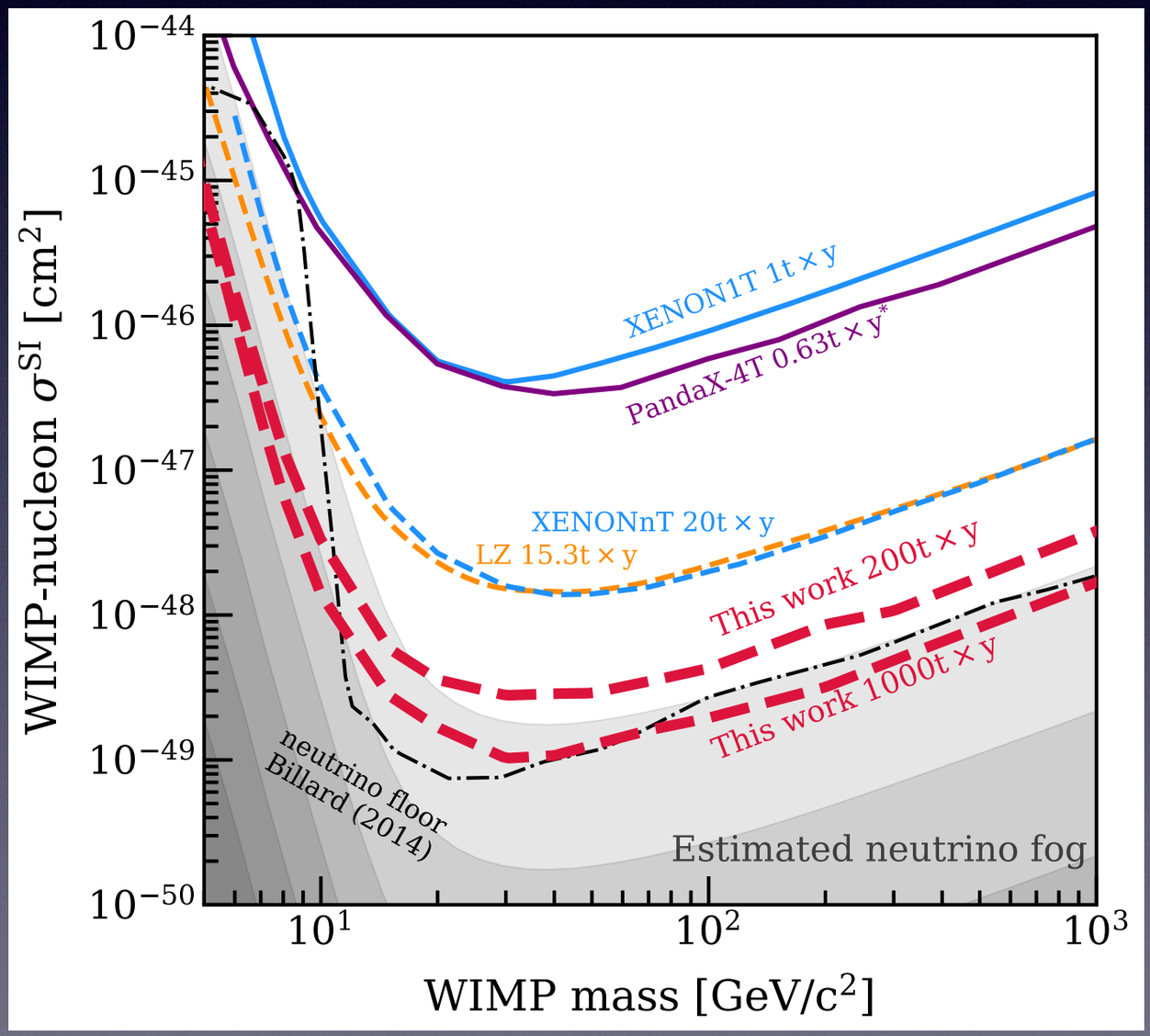


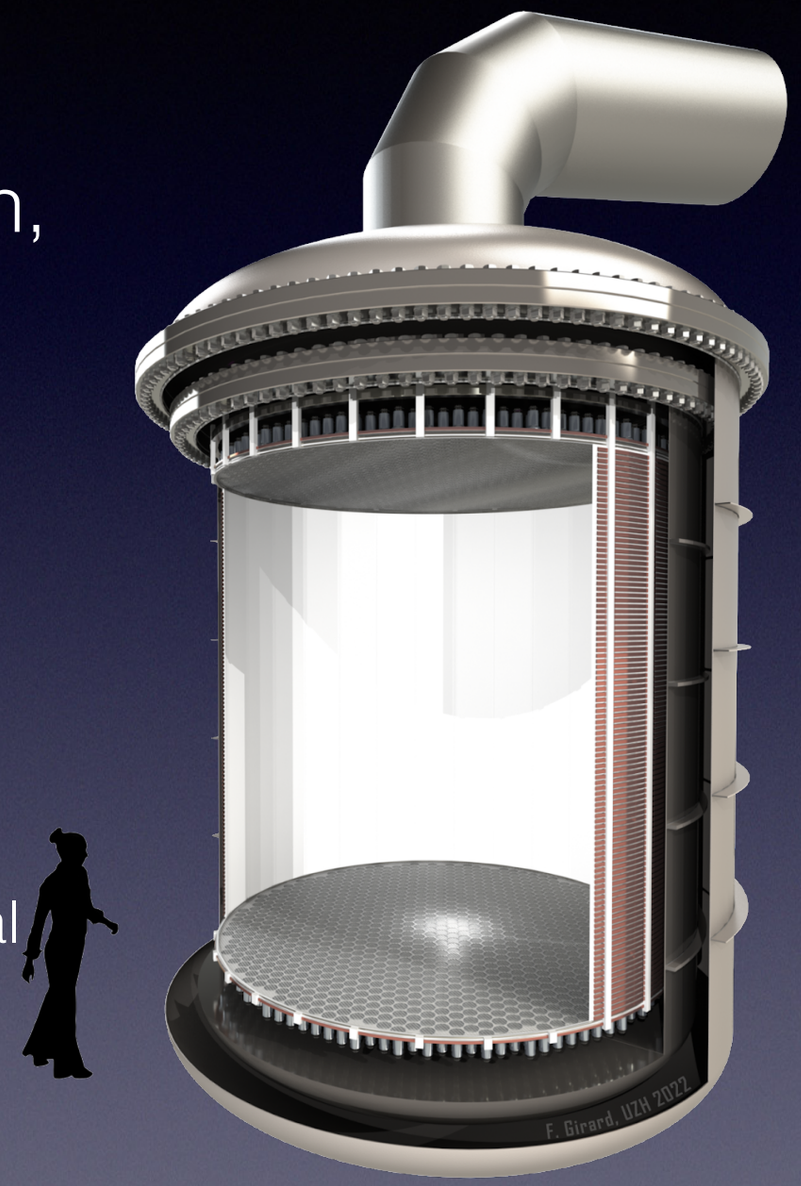
Not as close as you may think!

LZ: 15.3 t×y
5.6 tonnes
1000 days

Need ~1000 t×y

Detector design

- Final detector size still under discussion, driven mostly by ^{136}Xe 0ν2β sensitivity
  - Likely 60 - 80 tonnes active (75 - 100 t total)
- Typical TPC arrangement
  - Large active region of liquid xenon defined by electrode grids
  - Xenon self-shielding guarantees negligible external backgrounds for WIMP search
  - Two light sensor arrays in the top and bottom
  - Possibility to use SiPMs on the top array for improved position resolution (ongoing R&D)

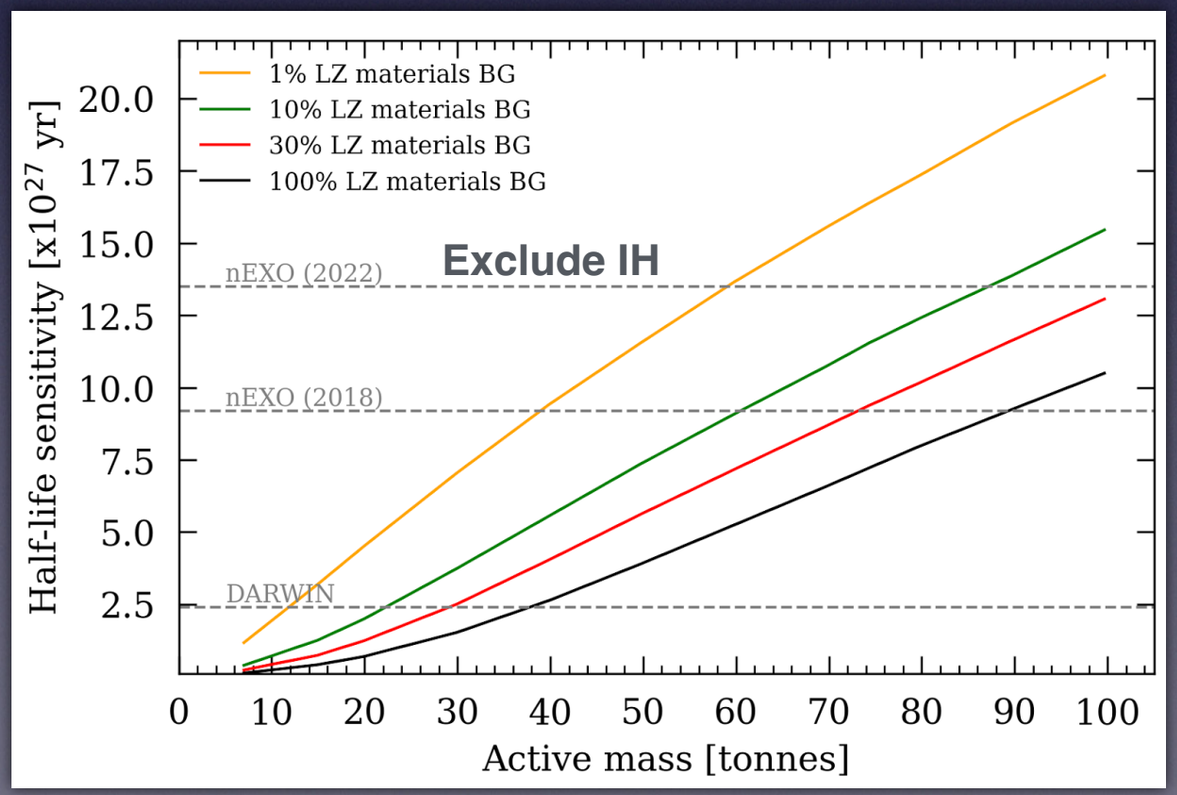


60 t active (75 t total), 3 m Ø, 3 m tall

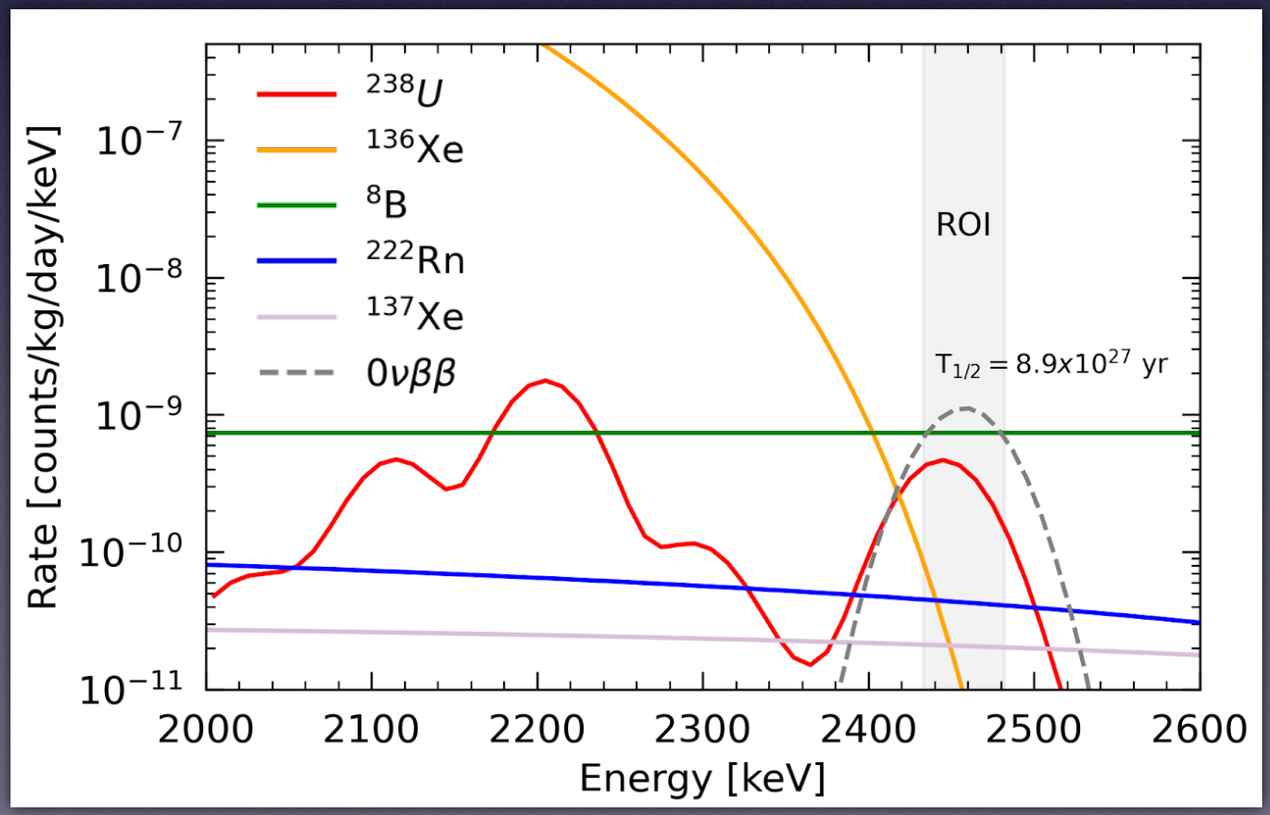
Installation location

^{136}Xe 0ν2β

- A detector with 60 tonnes is enough for WIMP search
- Going for 80 - 100 tonnes can make it extremely competitive for 0ν2β (even with no ^{136}Xe enrichment)
- Can exclude the inverted hierarchy (IH) scenario for the neutrino masses



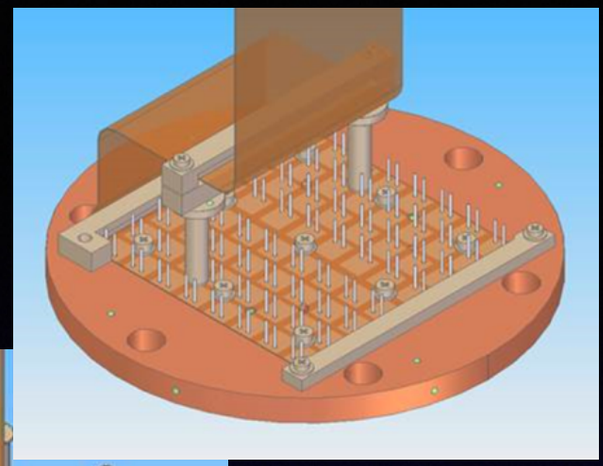
10 yr exposure, installation at SURF



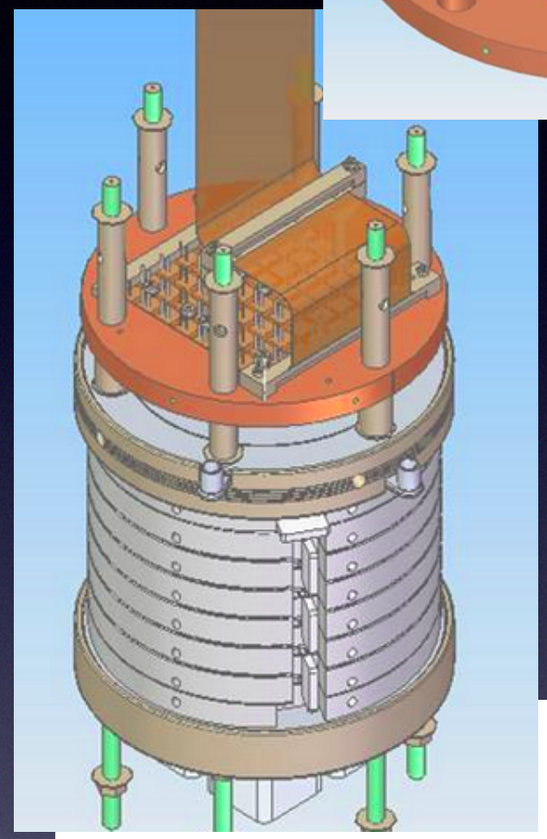
100 tonne active mass, installation at SURF

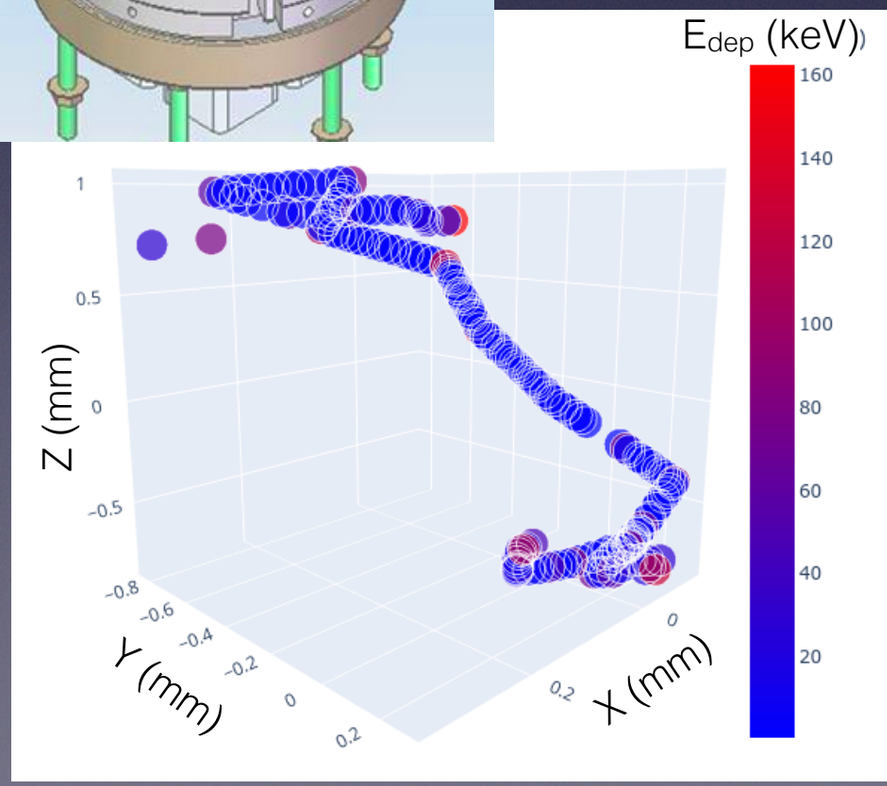
R&D

- Using SiPMs in the top array can significantly improve the position resolution
  → boost $0\nu2\beta$ sensitivity
  - Reduce the background by excluding multiple scatters of high energy gammas
  - Possibility to reconstruct the tracks of the two electrons
- Doping the xenon with H_2 or D_2 to reduce electron diffusion
- Collaboration with UK institutions (ICL, RAL, UCL, etc.)
- Prototype chamber under construction
- Preliminary simulations show that a resolution of 120 µm is possible
  (see poster by Fátima Alcaso for more details)



8x8 SiPM array
(3x3 mm^2 each)





Thank you!