

TOWARDS NEW PHYSICS: FROM LZ TO XLZD

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Imperial College London & STFC Rutherford Appleton Laboratory
(XLZD Co-Spokesperson)

29th September, 2026



OUTLINE

Part I

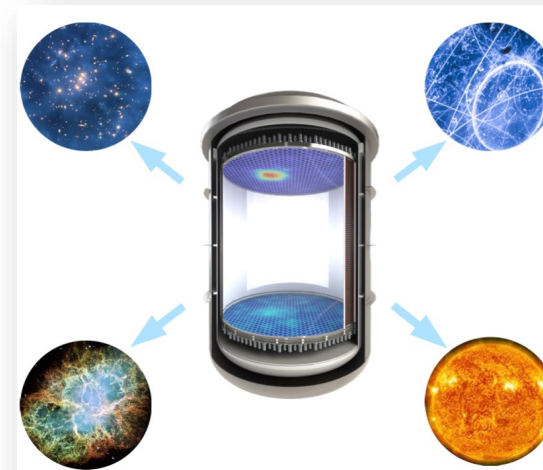
- A search for (relatively heavy) dark matter with LUX-ZEPLIN (LZ)
[arxiv:2609.02823](https://arxiv.org/abs/2609.02823)

Part II

- Towards the XLZD Rare Event Observatory for dark matter and neutrino physics
[arxiv:2410.17137](https://arxiv.org/abs/2410.17137)

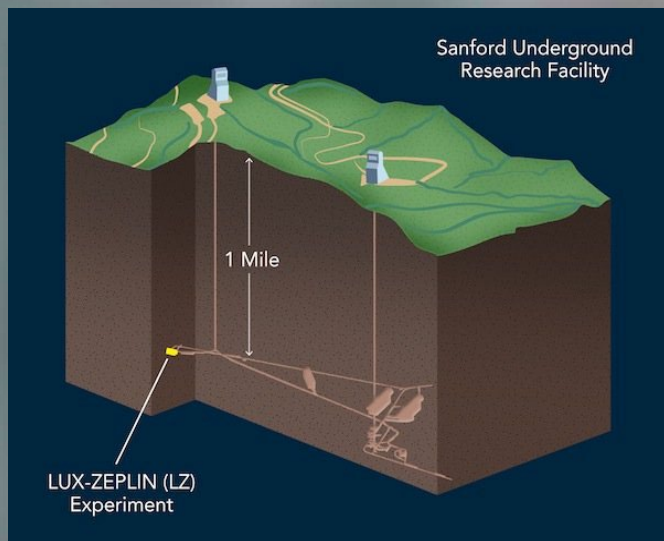


*“Dinosaur collides
with LZ detector?”*



*XLZD: observing anything
that goes “ping” in the night...*

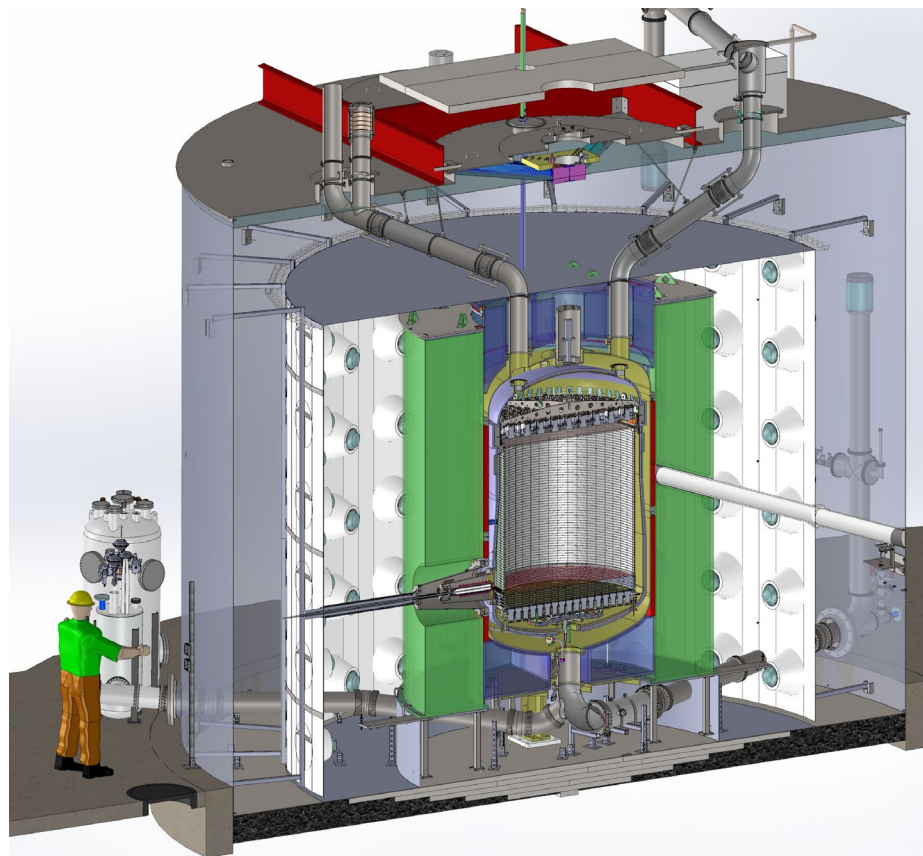
THE LUX-ZEPLIN (LZ) DARK MATTER SEARCH



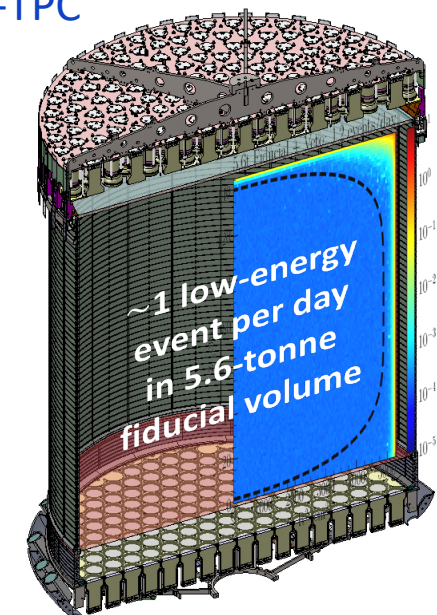
THE LZ EXPERIMENT



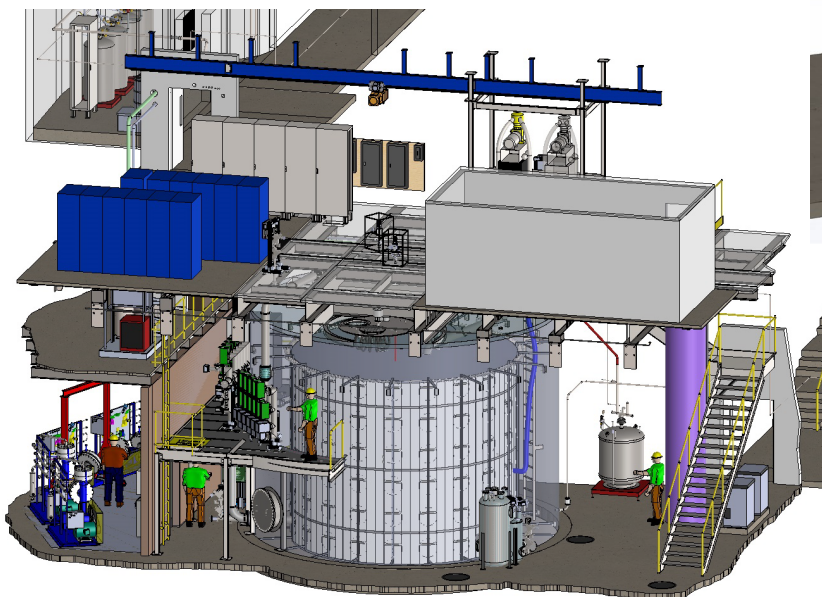
LZ Detector(s)
inside water shield



7-tonne
LXe-TPC

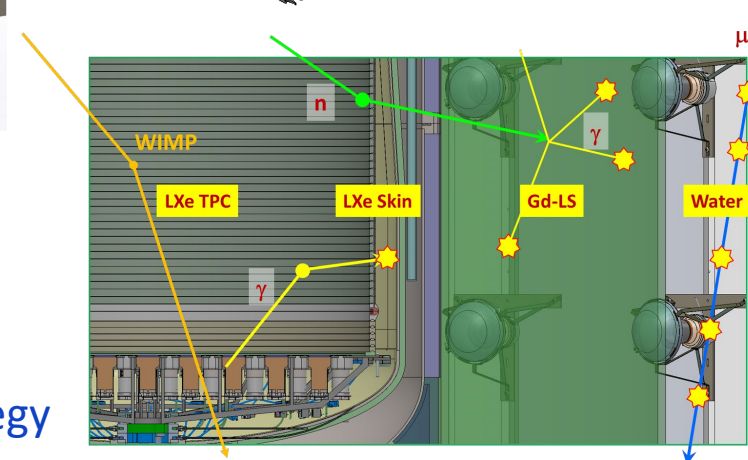


Davis Lab, SURF
1 mile underground



LZ TPD [1703.09144](#)

Veto strategy





TOP PMT ARRAY

EXTRACTION REGION

TOP SKIN PMTS

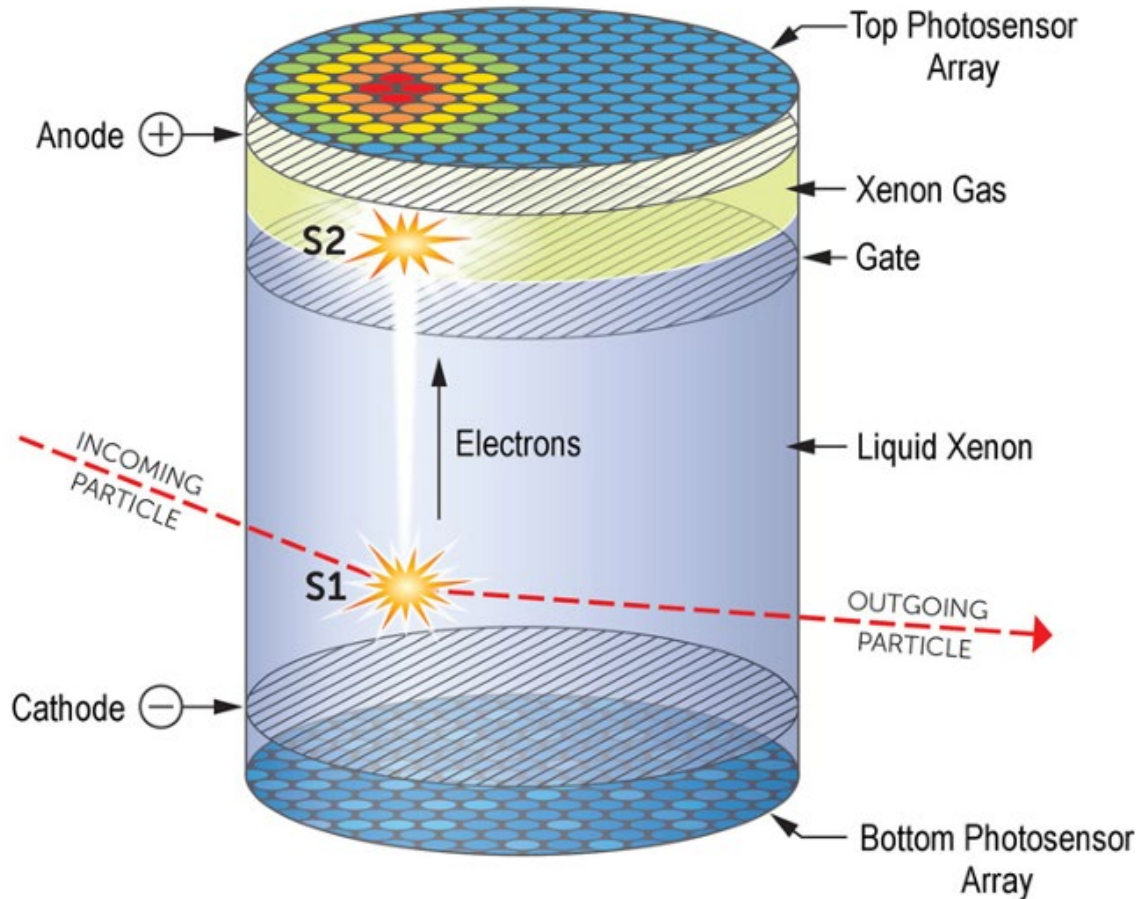
**TPC FIELD CAGE
(7 TONNES OF
ACTIVE LXE)**

CATHODE GRID

REVERSE-FIELD REGION

BOTTOM PMT ARRAY

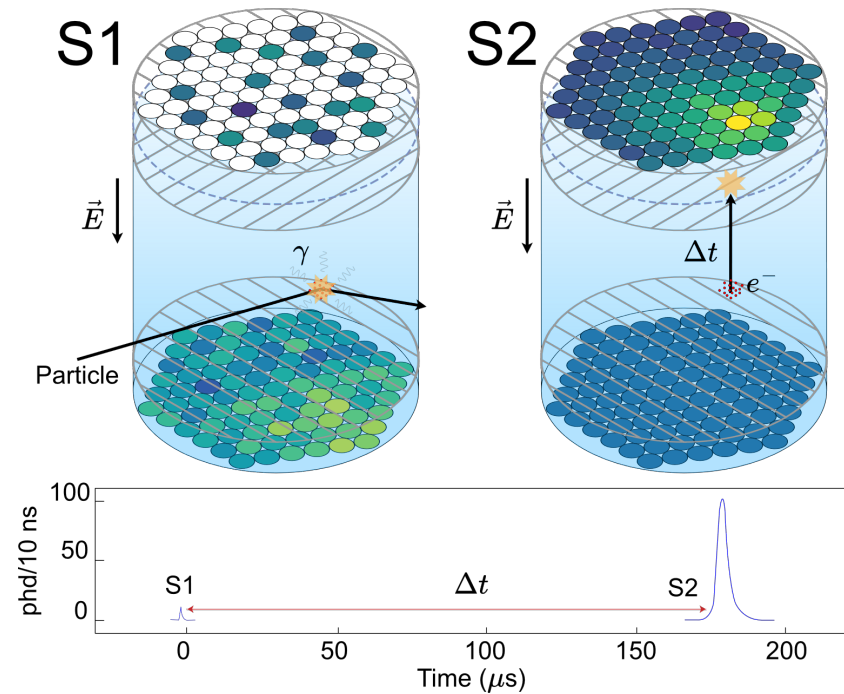
THE DUAL-PHASE XENON TIME PROJECTION CHAMBER



S1: Primary scintillation (VUV) in the liquid

S2: Secondary scintillation (electroluminescence) in the gas

Sensitive to single quanta of scintillation (S1) and ionisation (S2)



- 3D position reconstruction of interaction site, fiducialisation
- Nuclear/electron recoil discrimination

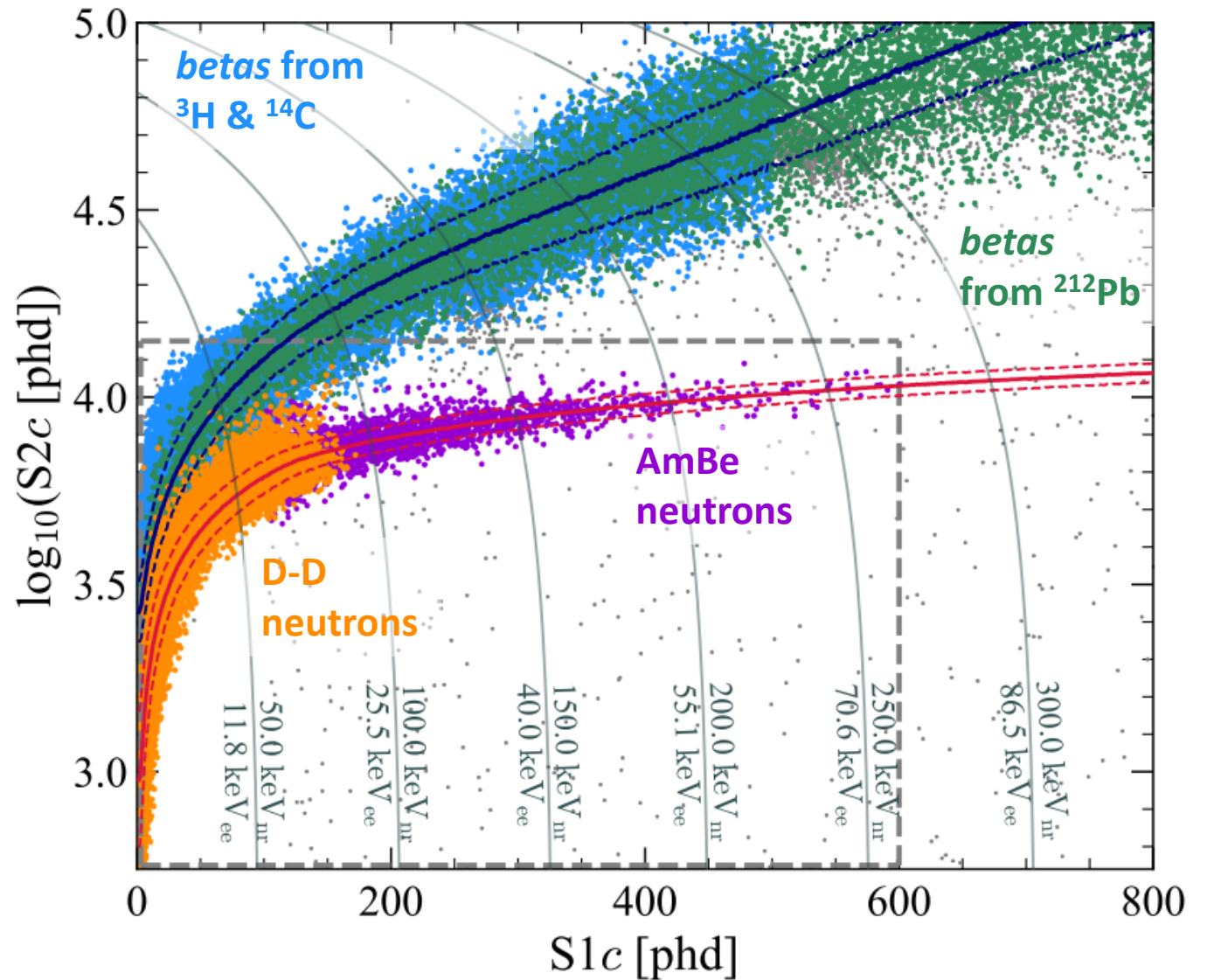
CALIBRATIONS

Electron recoil calibrations

- Tritiated methane injection
 - ^3H $\beta_{\text{max}} = 18.6 \text{ keV}$
 - ^{14}C $\beta_{\text{max}} = 156 \text{ keV}$
- Radon-220 injection
 - ^{212}Pb $\beta_{\text{max}} = 569 \text{ keV}$
- Monoenergetic sources
 - $^{83\text{m}}\text{Kr}$ $32.1 + 9.4 \text{ keV}$
 - $^{131\text{m}}\text{Xe}$ 164 keV

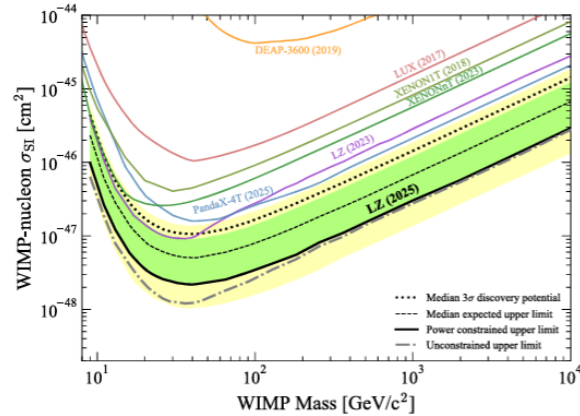
Nuclear recoil calibrations

- D-D neutrons 74 keV endpoint
- AmBe neutrons $(350 \text{ keV endpoint})$



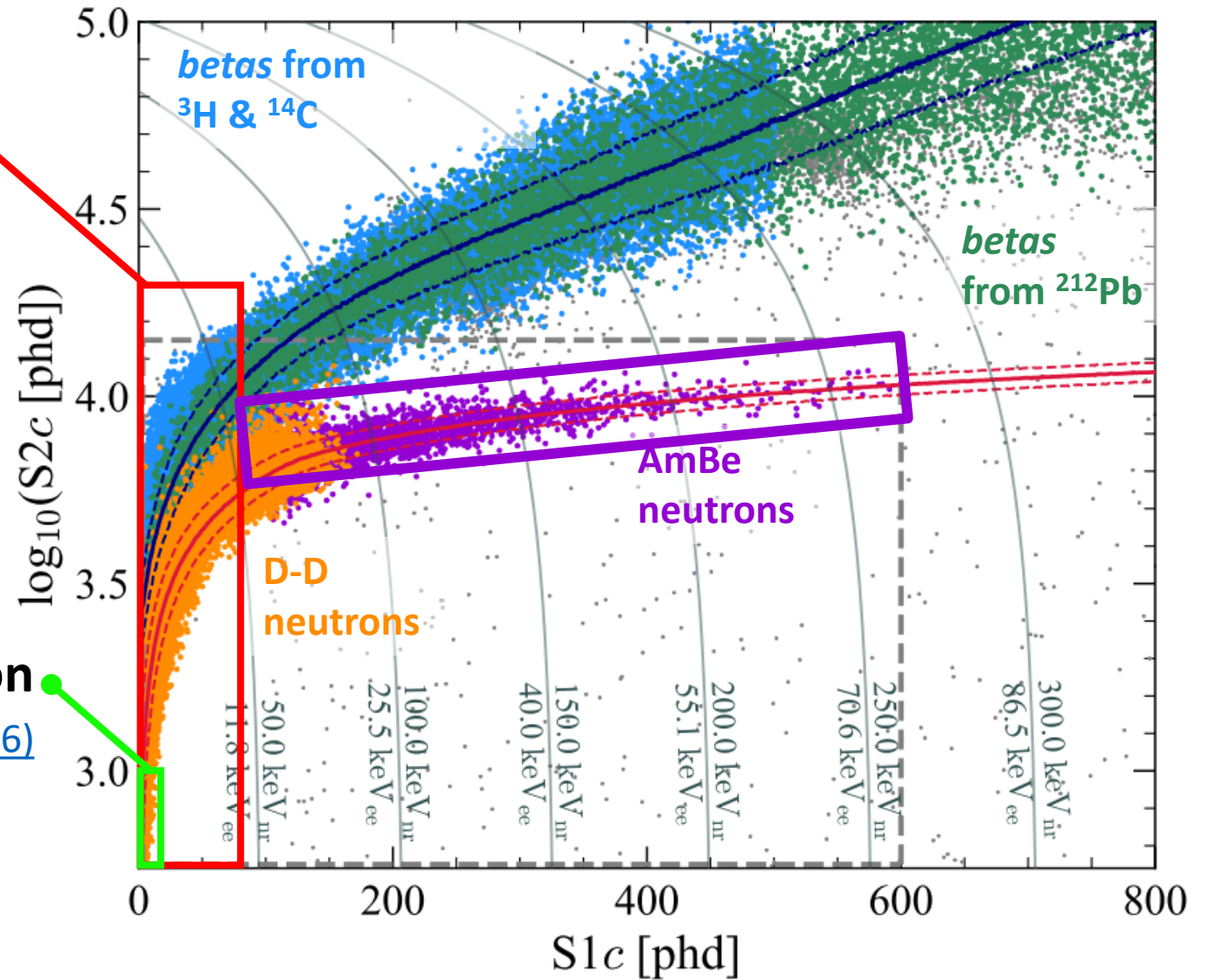
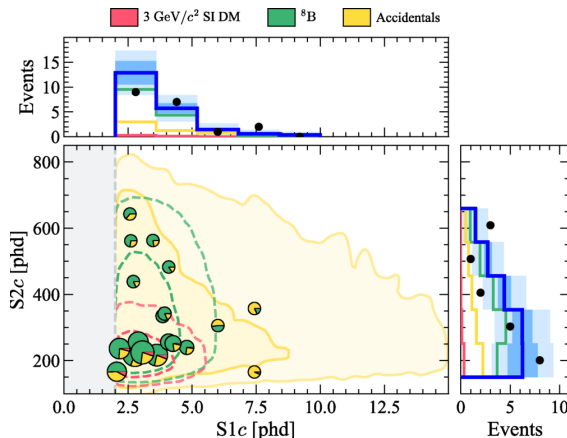
PREVIOUS HIGHLIGHTS

- “Standard” SI/SD WIMP scattering [PRL 135, 011802 \(2025\)](#)



- Light-WIMP scattering & ⁸B detection

[PRL 137, 091806 \(2026\)](#)



- WS2022 HENR analysis [PRD 109, 092003 \(2024\)](#), [PRL 133, 221801 \(2024\)](#)

HIGH-ENERGY NUCLEAR RECOIL SEARCH

DM scattering models

Can result in recoil spectra peaked at higher energies if:

- Elastic interaction has momentum-dependent coupling
- Inelastic interaction with nearly-degenerate mass states separated by a small δ

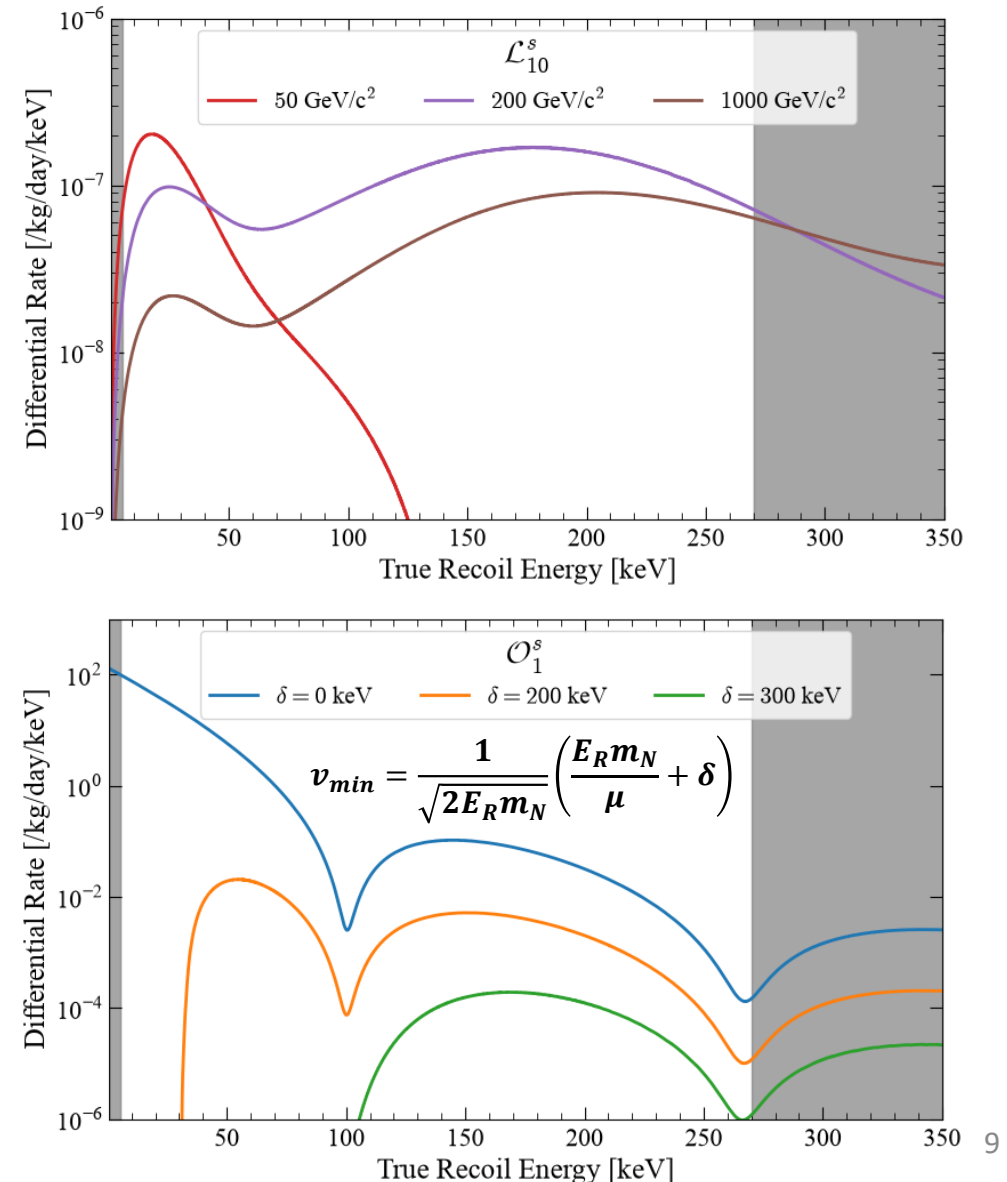
We have performed a search for

- Signals described by non-relativistic EFT, 616 models in total, $\mathcal{L}_1 - \mathcal{L}_{20}$
- Inelastic SI ($\mathcal{O}_1$) + inelastic SD ($\mathcal{O}_4$)

[Fitzpatrick et al. J. Cosmol. Astropart. Phys. 02, 004 \(2013\)](#)
[Smith et al. Phys. Rev. D 64, 043502 \(2001\)](#)
[Bramante et al. Phys. Rev. D 94, 115026 \(2016\)](#)
[Anand et al. Phys. Rev. C 89, 06551 \(2014\)](#)

Henrique Araújo

*See talk by
Motoko Fujiwara
for a nice review of the
theoretical landscape*



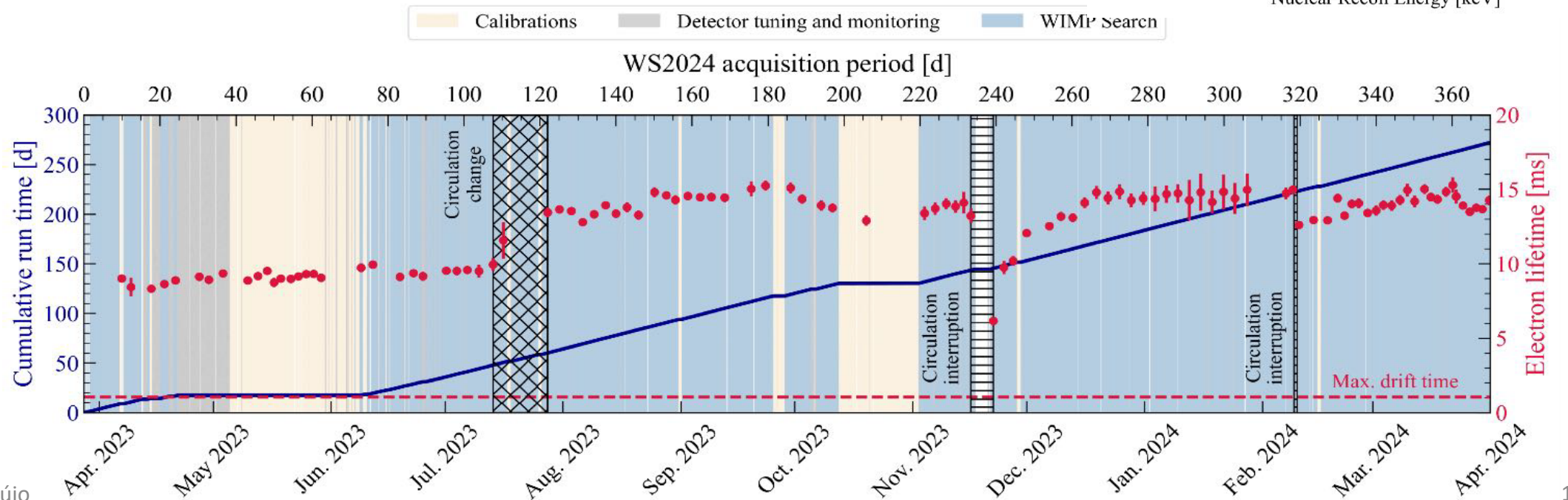
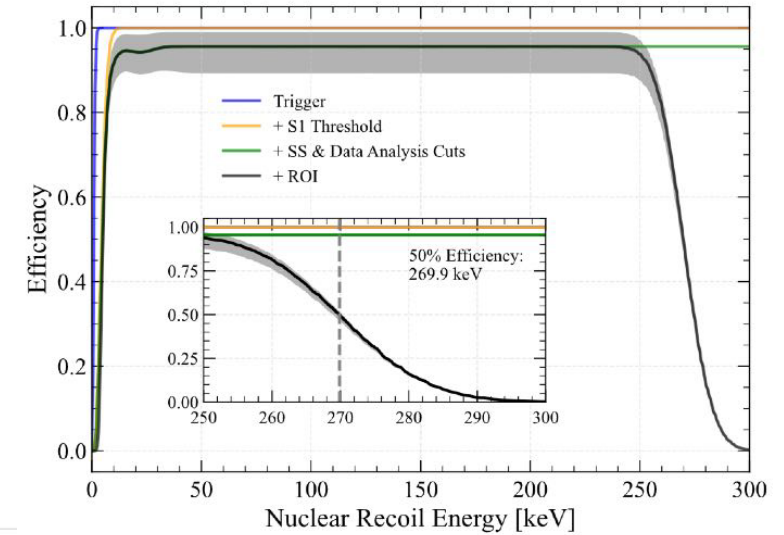
HIGH-ENERGY NUCLEAR RECOIL SEARCH

Dataset

- 370 calendar days (220 live-days): 27 March 2023 to 1 April 2024; same exposure as standard WS2024

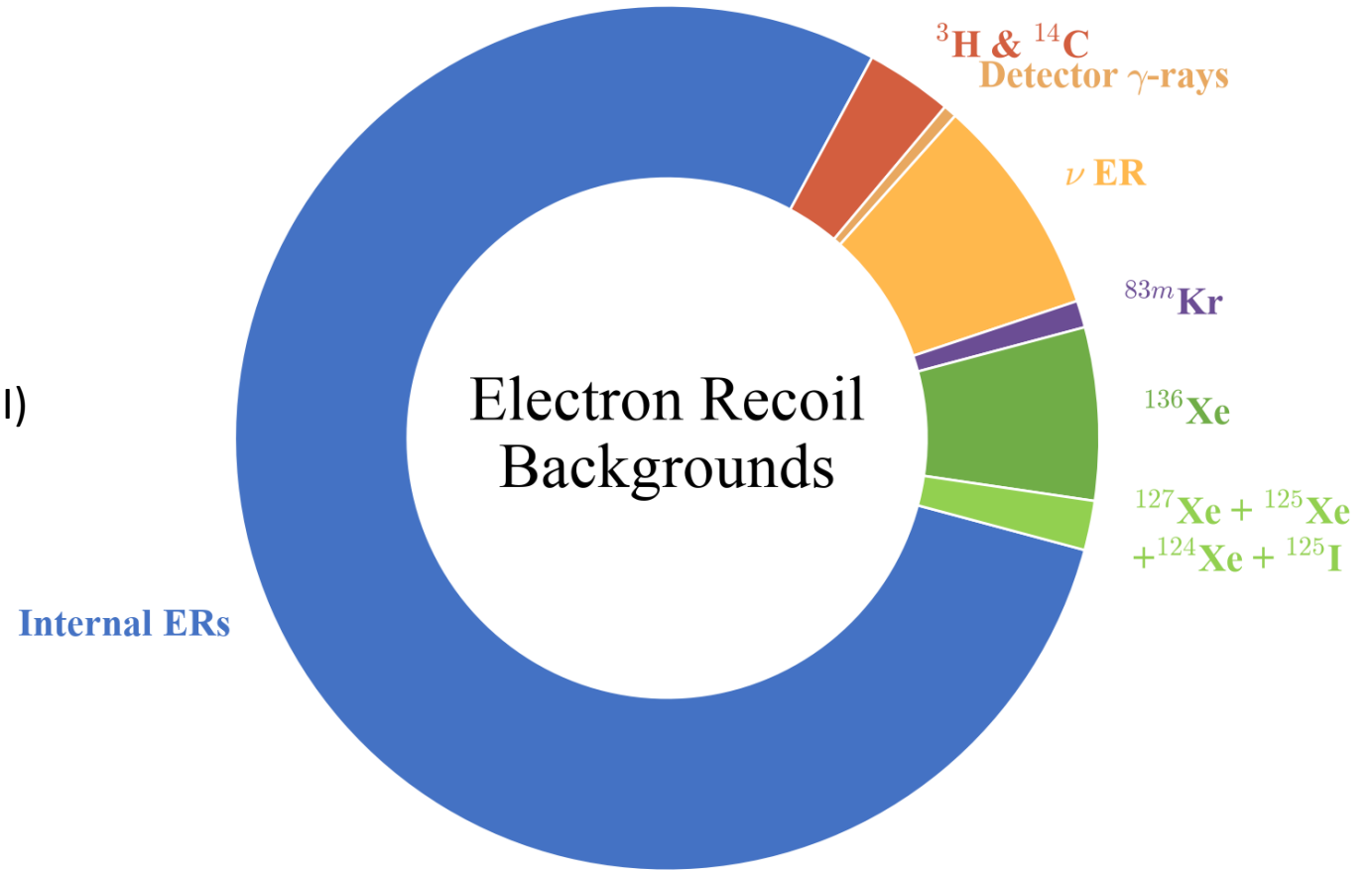
Region of Interest

- S1c = 3—600 detected photons ($\lesssim 270 \text{ keV}_{\text{nr}}$)



EXPECTED BACKGROUNDS

- **Internal β emitters**
 - ^{214}Pb , ^{212}Pb , ^{85}Kr , ^{136}Xe
- **Internal EC decays**
 - Neutron activation: ^{127}Xe , ^{125}Xe , ^{125}I
 - Double EC of ^{124}Xe
- **Instrumental**
 - Accidentals coincidences
 - Multiple Scintillation, Single Ionisation (MSSI)
 - (Wall events)
- **Solar neutrinos**
 - ER: $\text{pp} + ^7\text{Be}$
 - NR: $^8\text{B} + \text{hep}$, atmospheric
- **Detector components (long-lived γ -ray sources)**
 - ^{238}U chain, ^{232}Th chain, ^{40}K , ^{60}Co
- **Calibration (residual)**
 - Injected: $^{83\text{m}}\text{Kr}$, ^3H , ^{14}C
- **Neutrons from detector materials**
 - Spontaneous fission, (α, n) , (muon-induced)



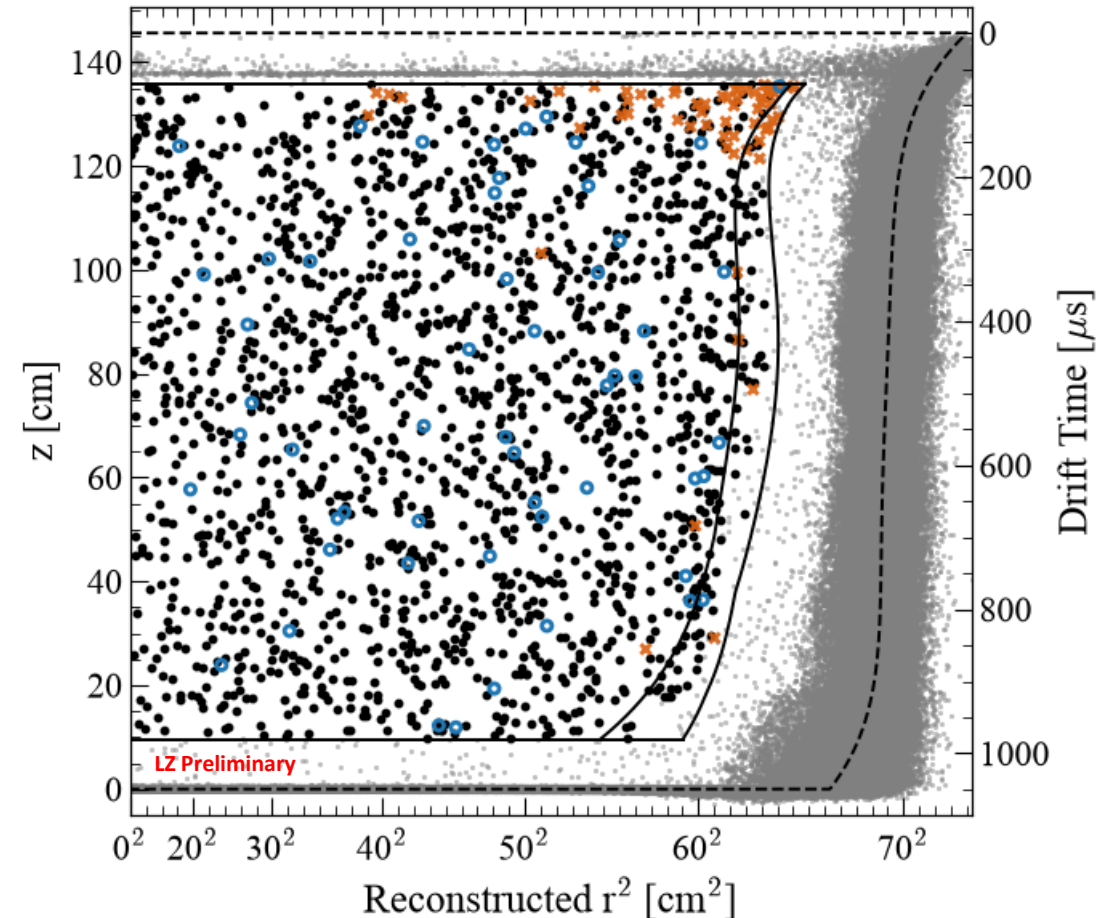
FIDUCIAL VOLUME

Smaller fiducial volume than in previous analysis to mitigate against backgrounds from detector materials, radon progeny plate-out, and effect of non-uniform electric fields near the edges

- **Wall backgrounds**
 - Limit wall contribution to $< 10^{-4}$ events in exposure
 - At least 4 MFP for γ -rays from the dominant MSSI source (352 keV from ^{214}Pb)
- **Cathode**
 - At least 4 MFP for γ -rays from the dominant MSSI source (352 keV from ^{214}Pb)

Analysis fiducial volume

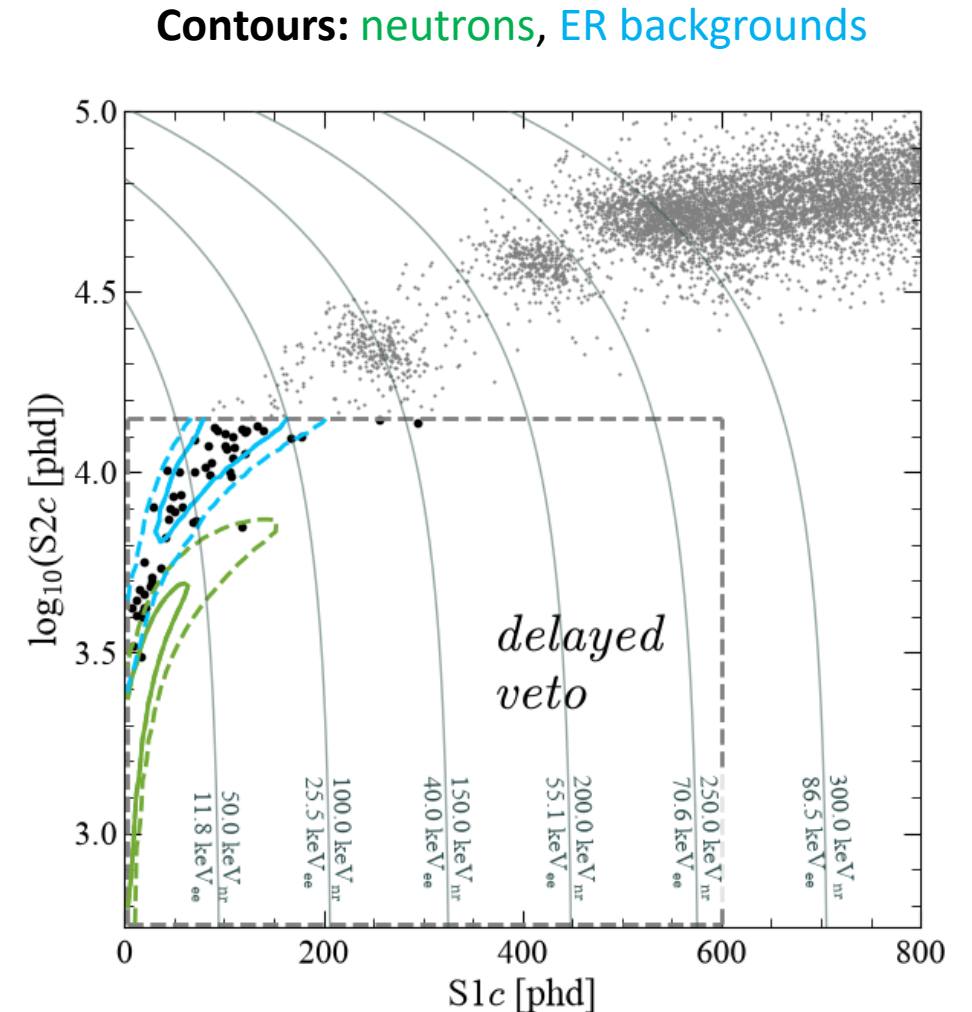
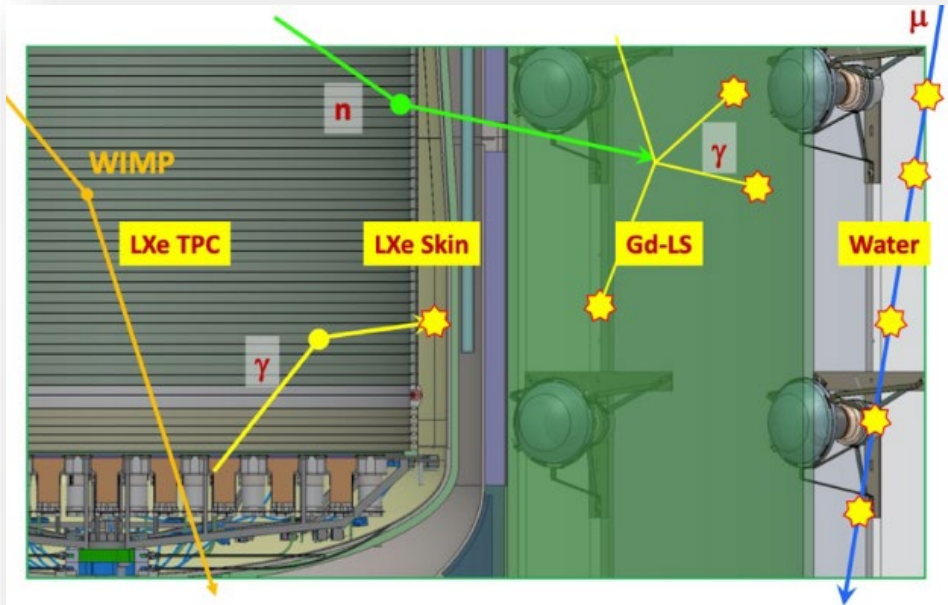
- 4.7 ± 0.2 tonnes
- Analysis exposure: 2.8 tonne-years



THREE DATA SAMPLES: DELAYED VETO (I)

Delayed veto coincidence

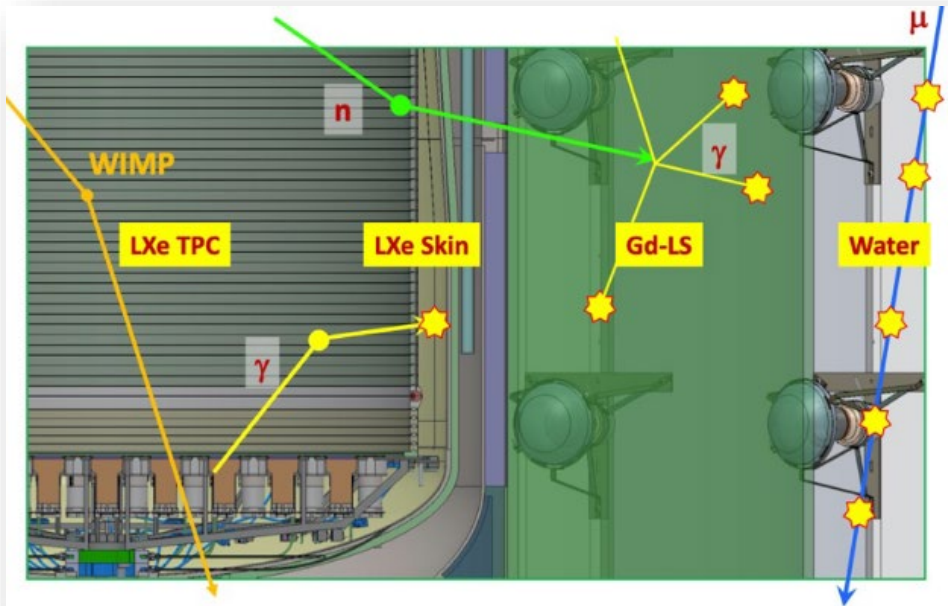
- Skin signal > 300 keV or OD signal > 200 keV
- Within $600 \mu\text{s}$ of prompt S1 time
- Tags/constrains neutrons



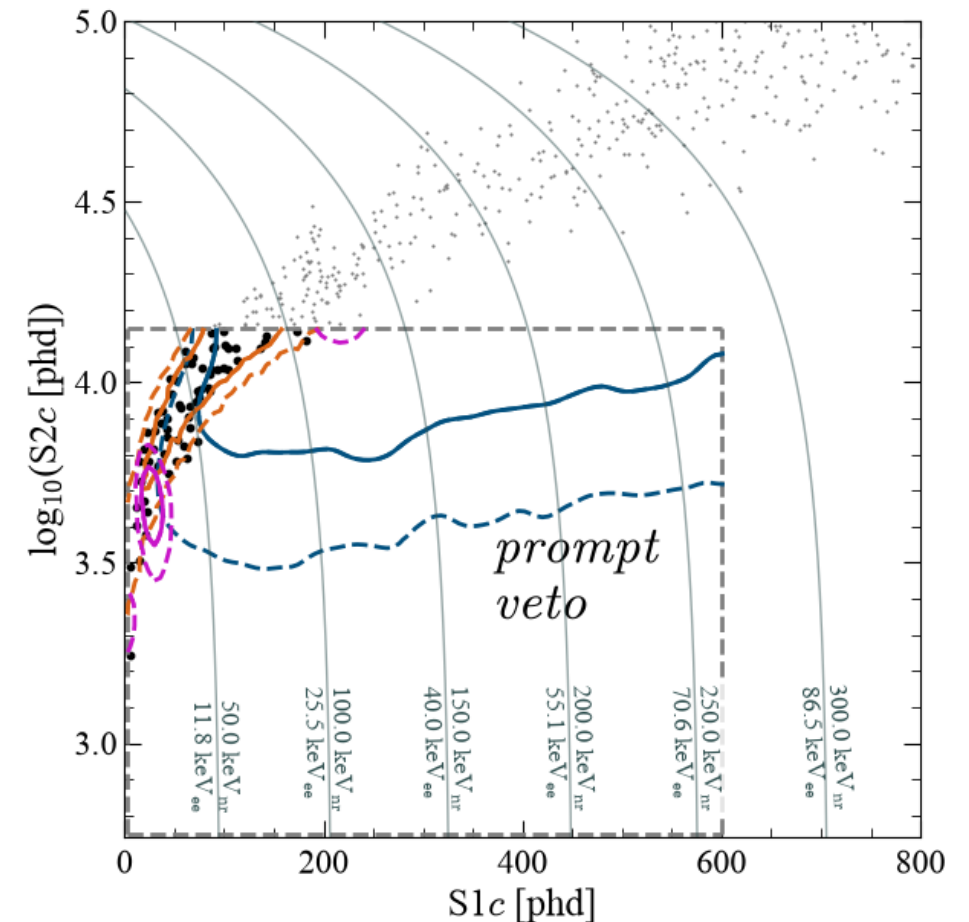
THREE DATA SAMPLES: PROMPT VETO (II)

Prompt veto coincidence

- Skin signal > 2.5 phd and within $S1 \pm 0.25 \mu\text{s}$
- OD signal > 4.5 phd and within $S1 \pm 0.3 \mu\text{s}$
- Tags/constrains γ -rays, ^{127}Xe , MSSl, neutrons



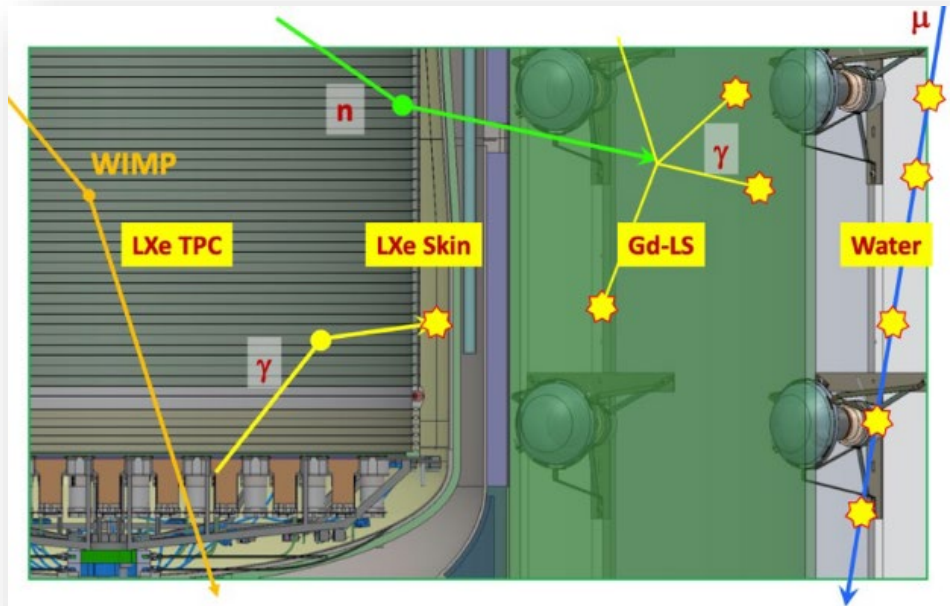
Contours: detector ER, ^{127}Xe , MSSl



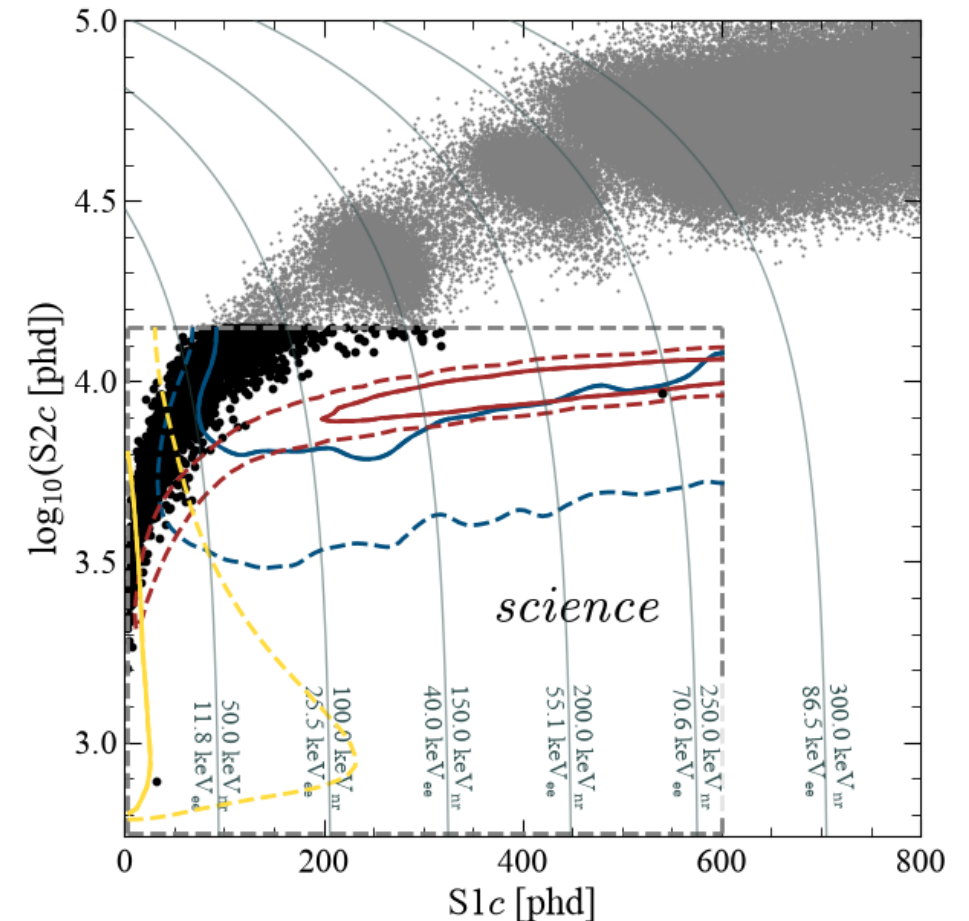
THREE DATA SAMPLES: SCIENCE (III)

Science (in anticoincidence with vetos)

- No tag in either veto system



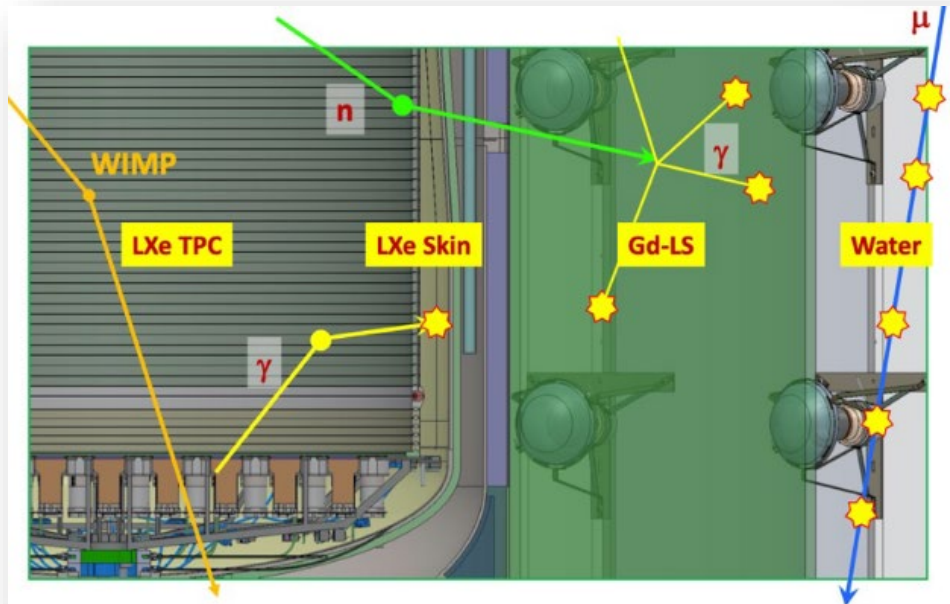
Contours: L10s 1000 GeV/c^2 , accidentals, MSSl



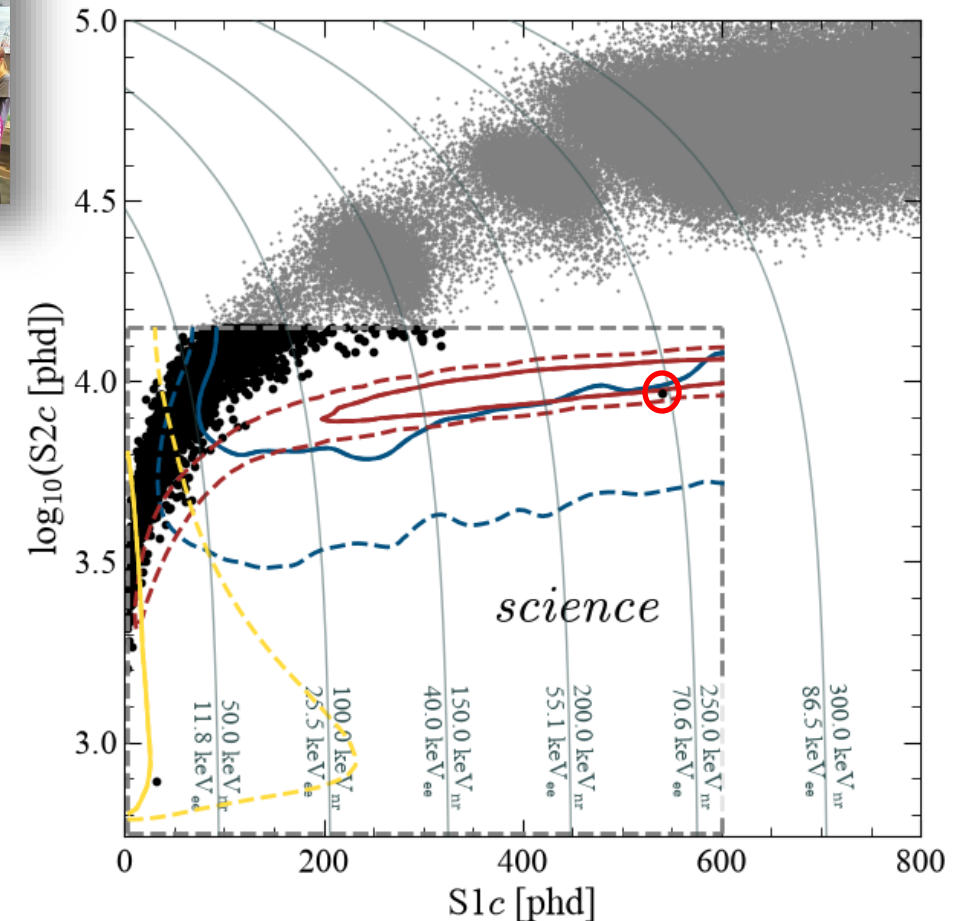
ONE EVENT OF NOTE OBSERVED... LZ230616

LZ230616: 16 June 2023, 21:22:39 UTC

- $S1c = 540.1$ phd, $S2c = 10^{3.98}$ phd



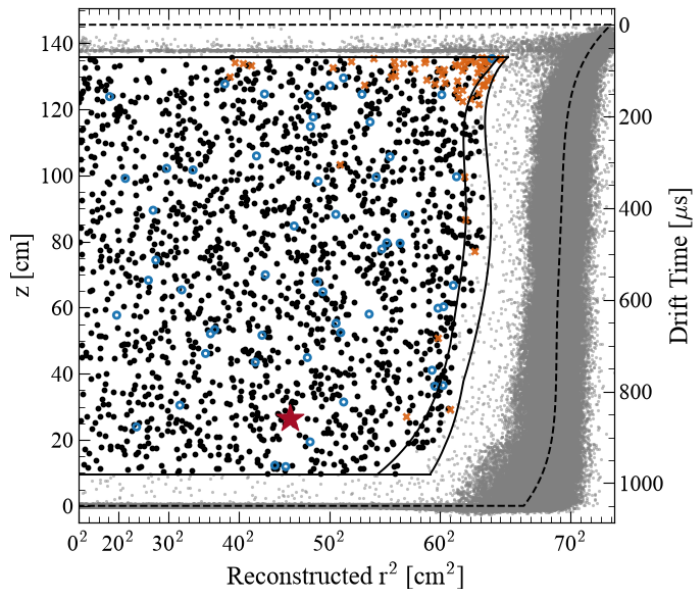
Contours: L10s 1000 GeV/c^2 , accidentals, MSSl



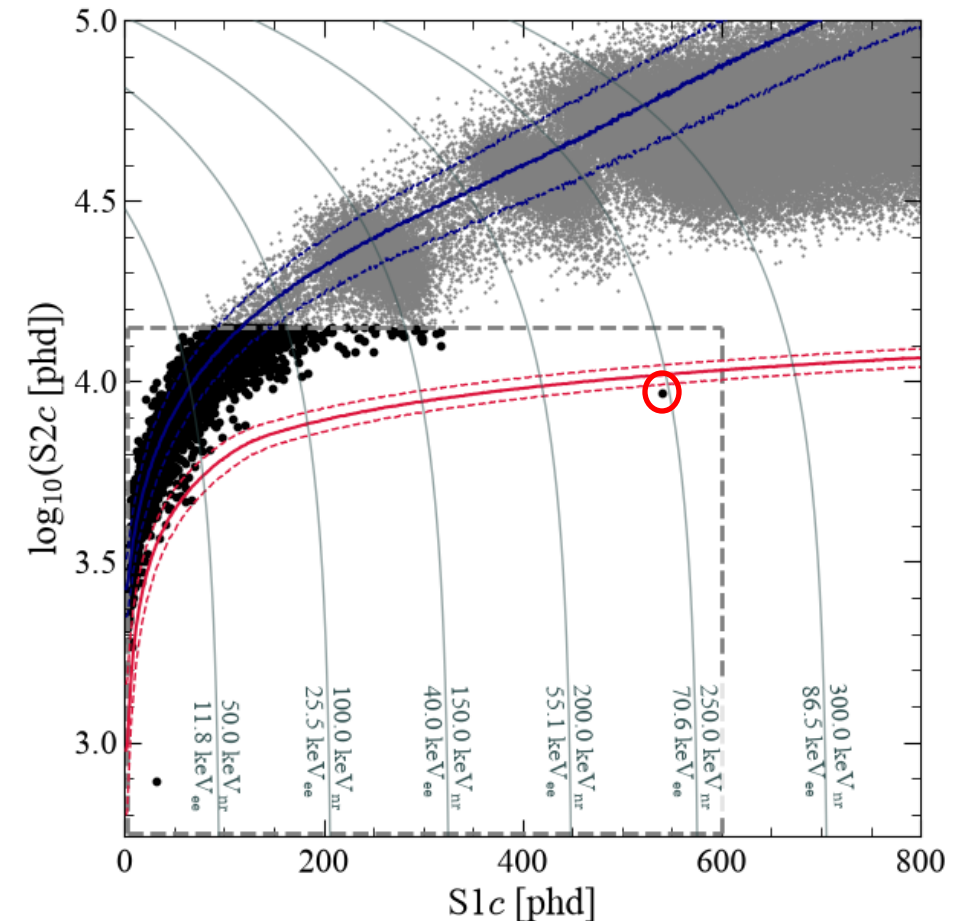
ONE EVENT OF NOTE OBSERVED... LZ230616

LZ230616: 16 June 2023, 21:22:39 UTC

- $S1c = 540.1$ phd, $S2c = 10^{3.98}$ phd
- $248 \pm 23_{\text{stat}} \pm 23_{\text{sys}}$ keV
compatible with nuclear recoil interaction
- 26.4 cm from cathode, 26.9 cm from TPC wall
- S1 & S2 waveforms broadly compatible with (x,y,z)



Contours: ER (10-90%), NR (10-90%)



SOME CONCEIVABLE BACKGROUND TOPOLOGIES

1. NR background

- Neutrinos: no scattering coherence; no soft scatters
- Neutrons: >8 MeV required; no soft scatters; no veto tags

2. Accidental background

- Low accidental rates expected for such large signals

3. S1 enhancement

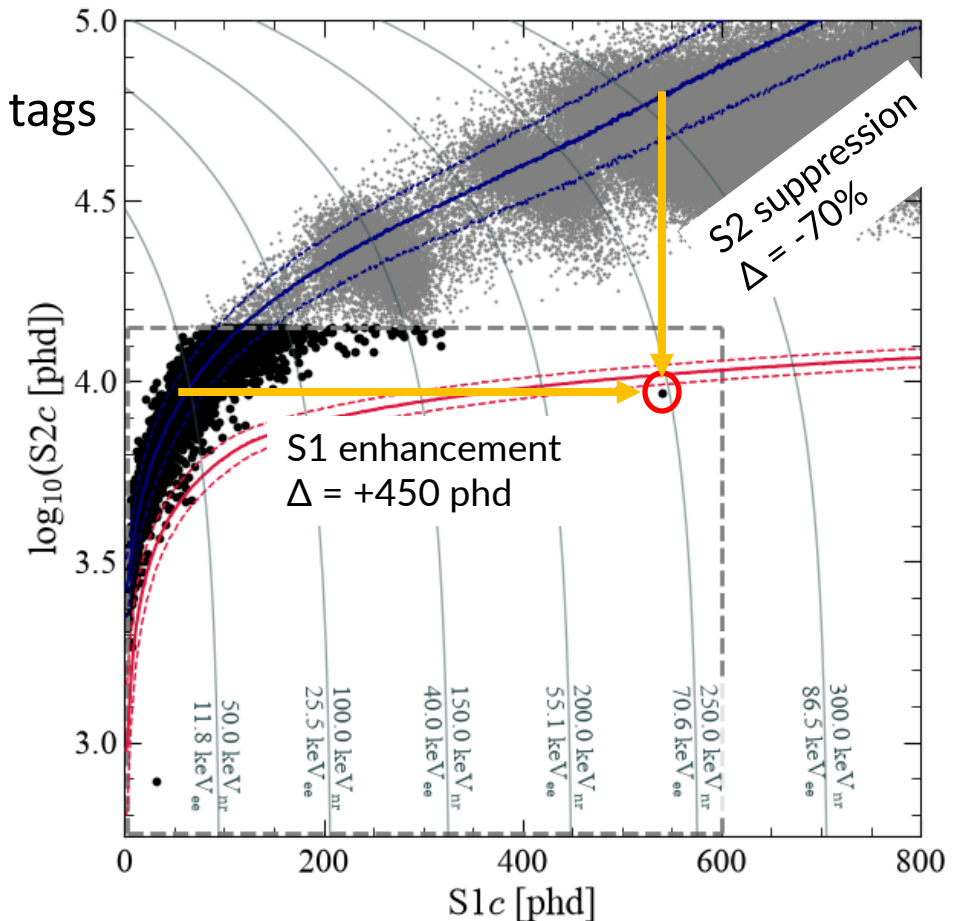
Double scatter, with charge lost from one site (MSSI)

- Conceivable, but hard to reconcile rates & topologies

4. S2 suppression

Single scatter with incomplete charge collection, e.g. blockage at gate-grid cell or liquid surface, or some other form of S2 gain “sagging”

- We find no evidence for such suppression



BACKGROUND TOPOLOGIES: MSSl

Locations causing MSSl events

- Reverse Field Region (below the cathode)
- Near the TPC walls (field fringing near the field-cage)

Dominant sources

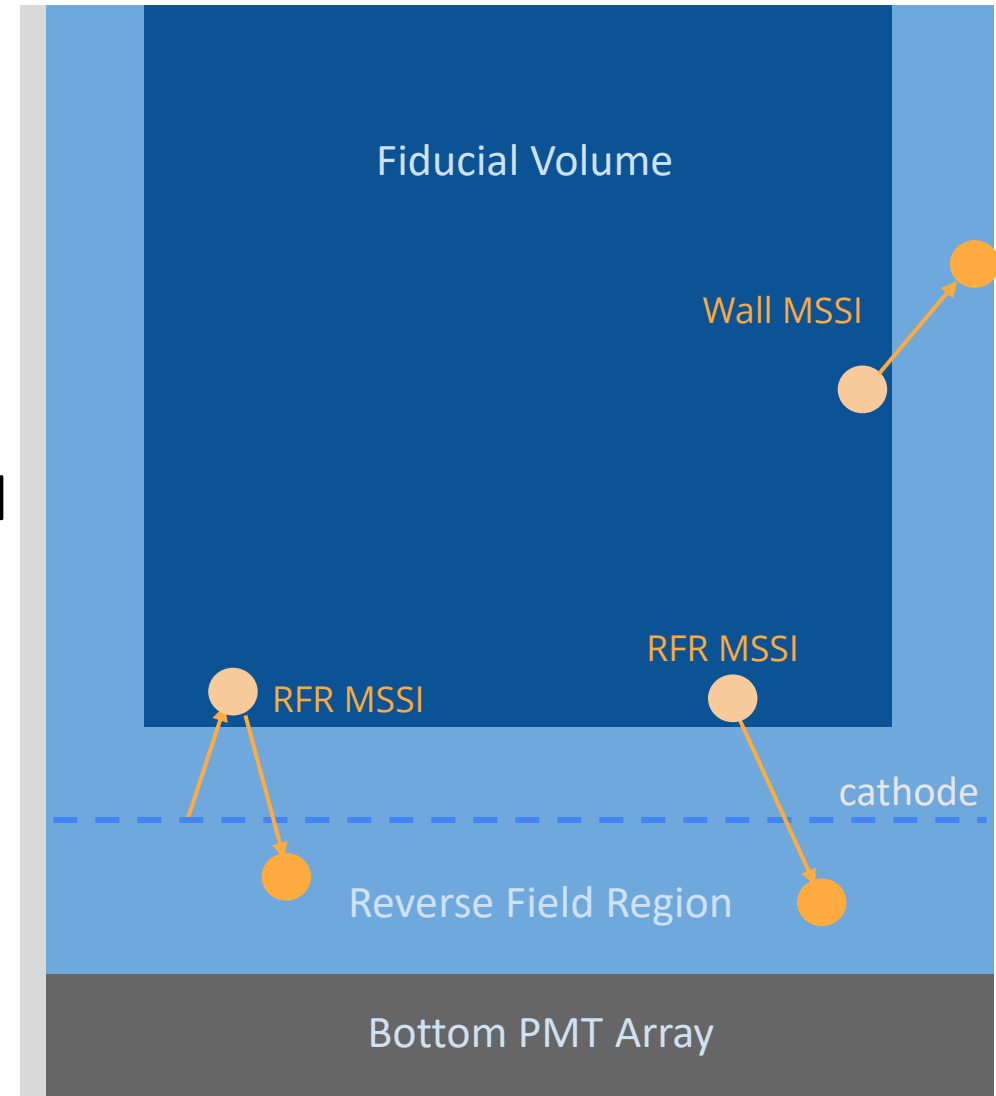
- γ -rays from detector components
- $^{214}\text{Pb} \rightarrow ^{214}\text{Bi} + e^- + \nu_e + \gamma$ [mostly 352 keV, up to 839 keV]

For an MSSl explanation, the γ -ray must do unlikely things

- Travel $\gtrsim 25$ cm (FV cut aggressively removes these)
- Scatter in a (potentially small) charge-dead region
- Evade the vetoes ($94 \pm 2\%$ prompt tagging efficiency)

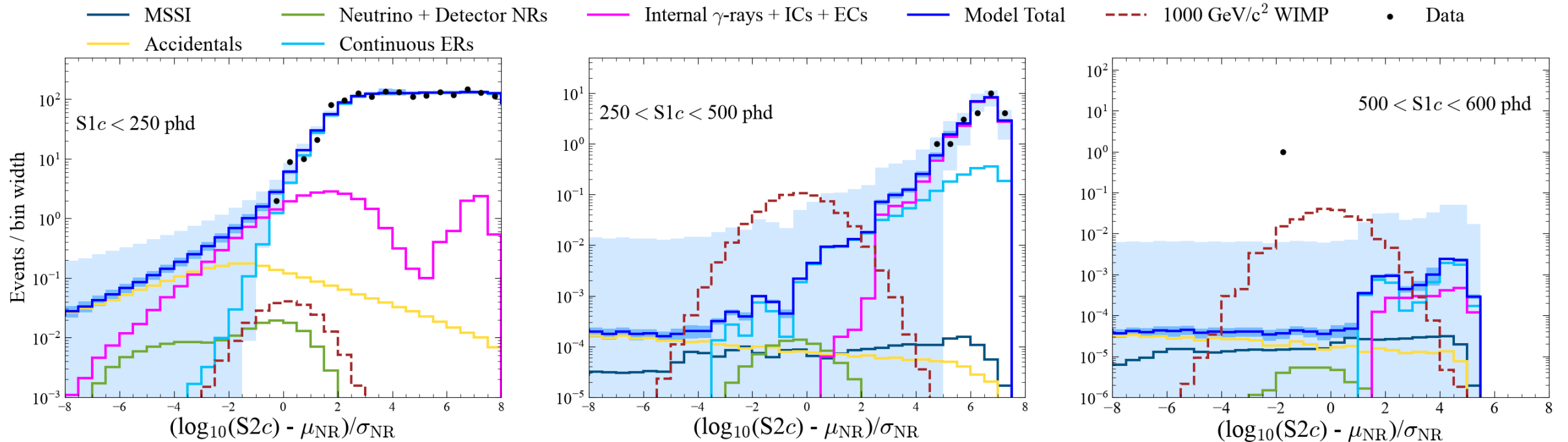
Expectation

- **0.005 ± 0.005** in science sample



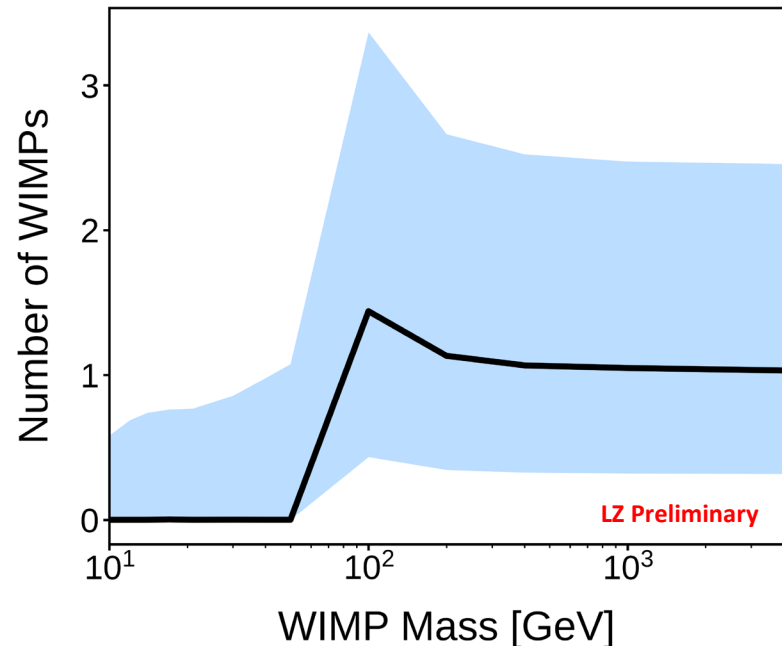
BACKGROUND FIT

- Projections of background model in science sample compared to NR band mean shown below
- Above $S1 > 250$ phd the background rate drops off significantly
- Integrated background count in $500 < S1c < 600$ region is $0.0106 \pm 0.0008_{\text{sys}}$



SCIENCE SAMPLE FIT

- The 3 data samples are fitted simultaneously
- Best fit # WIMPs is **1.0** for masses $> 100 \text{ GeV}/c^2$
- Similar result for any signal model with expected recoils at high energy



Source	Expected Events	Fit Result
Internal β decays	1341 ± 160	1340 ± 43
ν ER	140.6 ± 8.4	140.3 ± 8.4
^{136}Xe	110.0 ± 16.5	114.2 ± 16.1
CH_3T & ^{14}C	55.3 ± 3.1	55.2 ± 3.1
^{124}Xe	21.0 ± 6.3	22.6 ± 5.0
$^{83\text{m}}\text{Kr}$	17.1 ± 5.1	$17.0^{+3.5}_{-3.3}$
^{125}I	8.9 ± 2.7	9.8 ± 2.3
Detector ERs	8.5 ± 3.4	$9.4^{+1.7}_{-1.6}$
Accidental coins.	2.7 ± 0.6	2.6 ± 0.6
$^{127}\text{Xe} + ^{125}\text{Xe}$	1.5 ± 0.3	1.2 ± 0.3
Atmospheric ν	$(1.1 \pm 0.2) \times 10^{-1}$	$(1.1 \pm 0.2) \times 10^{-1}$
$^8\text{B} + \text{hep } \nu$	$(5.7 \pm 0.6) \times 10^{-2}$	$(5.7 \pm 0.6) \times 10^{-2}$
MSSI	$(4.9 \pm 4.9) \times 10^{-3}$	$(4.6^{+4.8}_{-4.6}) \times 10^{-3}$
Detector NRs	—	$[0, 0.118]$
$1000 \text{ GeV}/c^2$ WIMP	—	$1.0^{+1.4}_{-0.7}$
Total counts	—	1713 ± 39
Observed counts	—	1710

(Fits to other two ancillary data samples in backup slides)

RESULT: LIMIT ON LAGRANGIANS

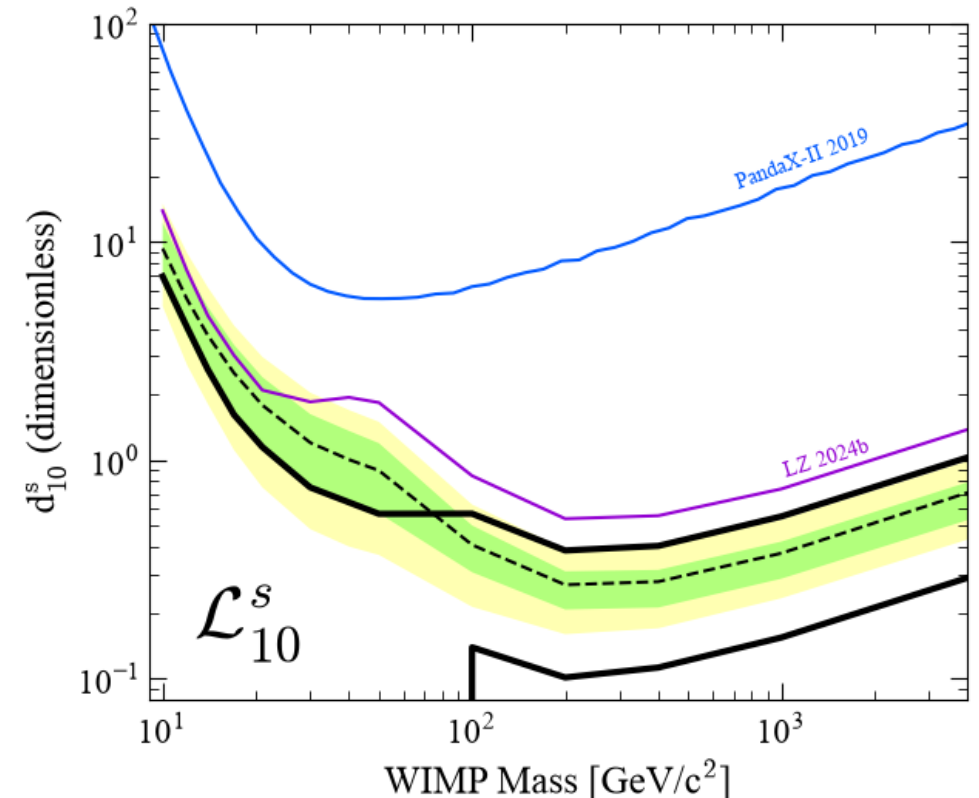
Confidence intervals on all models probed is available:
www.hepdata.net/record/182472

We set upper and lower 90% CL intervals on all models probed

- $\mathcal{L}_1 - \mathcal{L}_{20}$
- Inelastic $\mathcal{O}_1$ and $\mathcal{O}_4$ up to $\delta=350$ keV
- Isoscalar and isovector bases

This event suggests a relatively fast and heavy WIMP

- $v_{min} \sim 340$ km/s for 1 TeV WIMP to create 248 keV NR
 - $v_{rms} \sim 350$ km/s (SHM)
 - In June, $v_{max} = 810$ km/s in detector frame
-
- See more model ideas and interesting discussions in the [>100 citations](#) collected in the last 3 weeks!



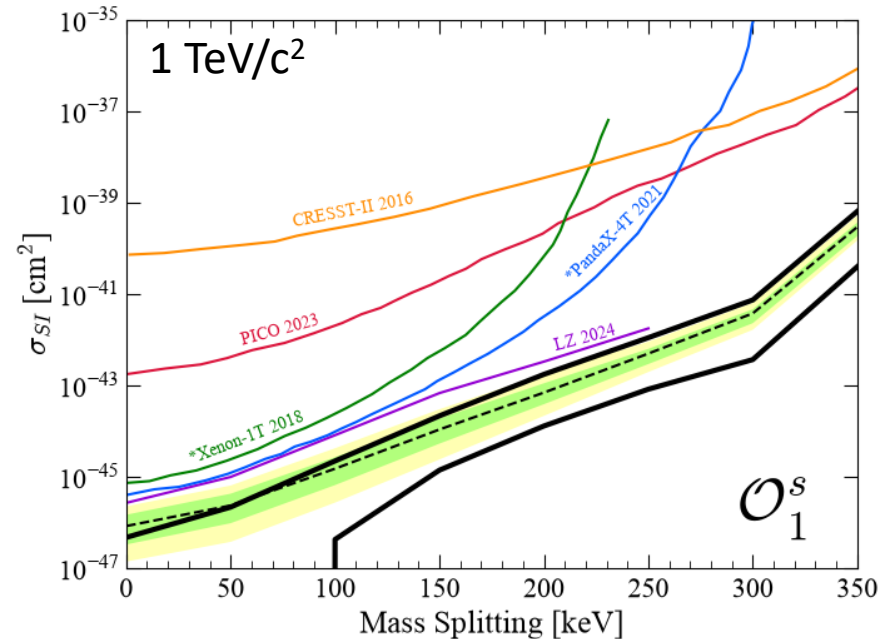
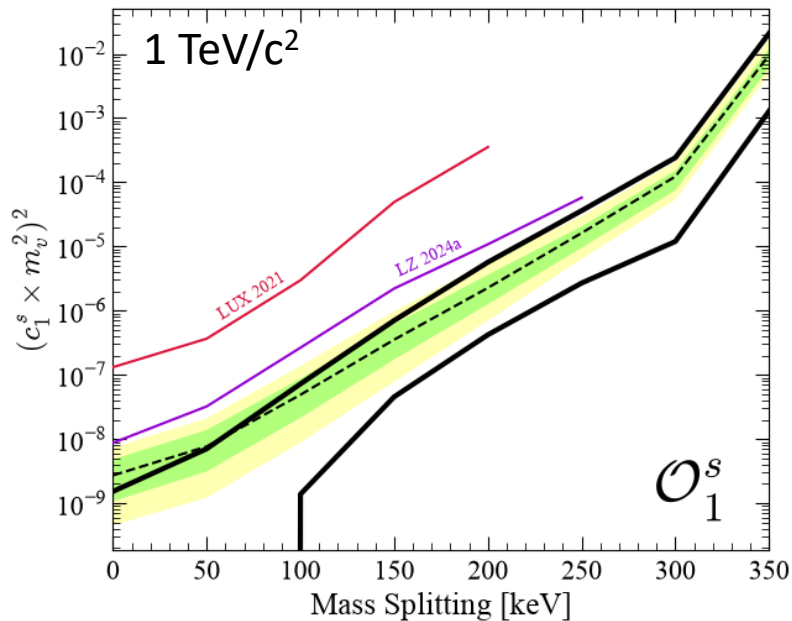
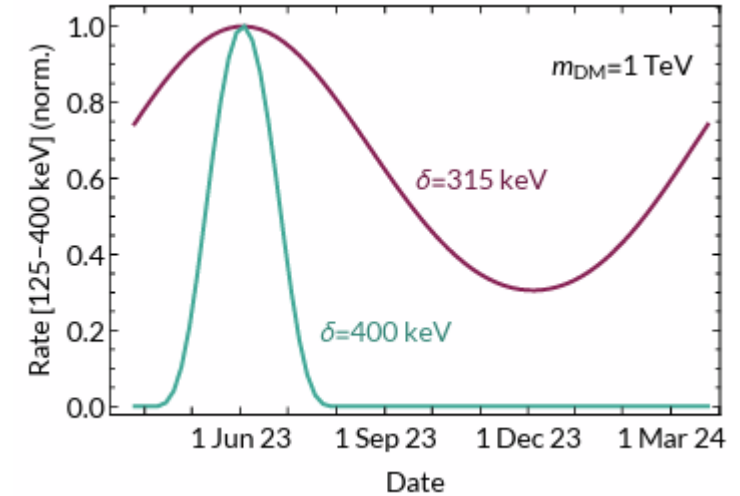
RESULT: LIMIT ON INELASTIC MODELS

We set upper and lower 90% CL intervals on all models probed

- Inelastic $\mathcal{O}_1$ and $\mathcal{O}_4$ up to $\delta=350$ keV
- These can be recast into cross-sections
- Note: these models imply significant annual modulation!

$$(c_1^s \times m_v^2)^2 = \sigma_{SI}^N \frac{\pi \cdot m_v^4}{(\frac{\hbar c}{\text{GeV}})^2 \mu_N^2}$$

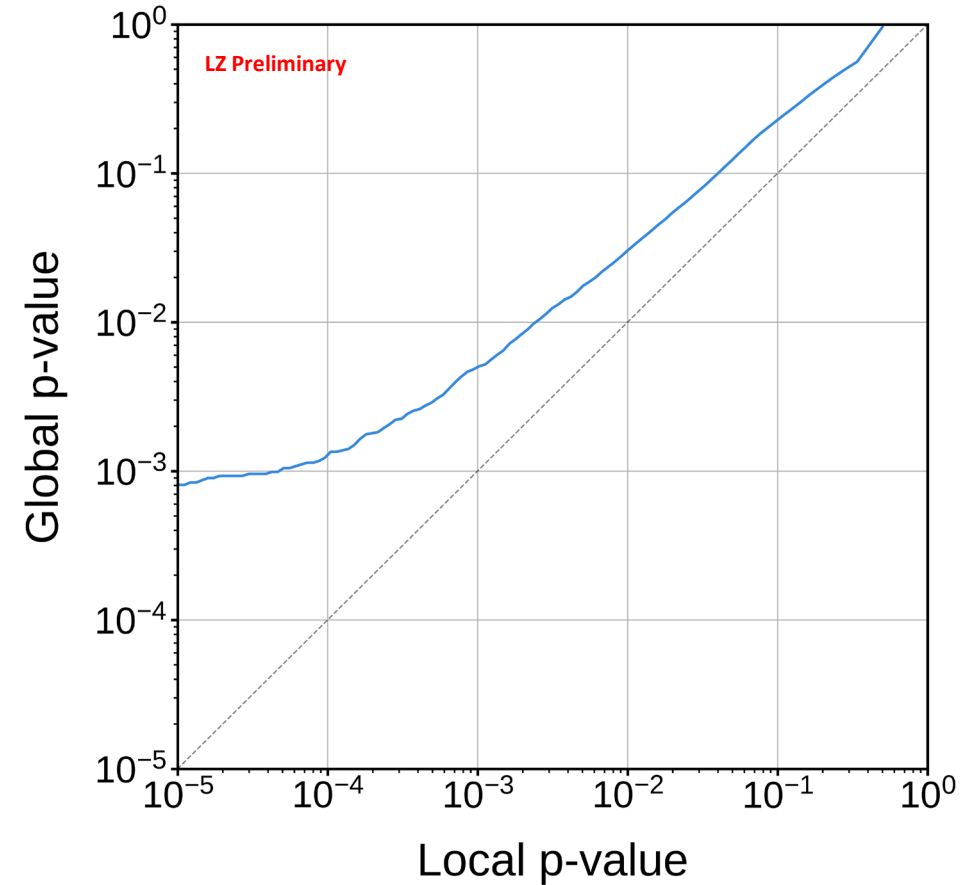
[McCabe 2609.04181](#)



RESULT: STATISTICAL SIGNIFICANCE

Look Elsewhere Effect: 616 models tested

- **3.4- σ local** significance
- **2.6- σ global** significance
- Multiple models have >3 local significance
- Local significance for all models provided in the data release:
www.hepdata.net/record/182472



LZ COLLABORATION



- Black Hills State University
- Brookhaven National Laboratory
- Brown University
- Center for Underground Physics
- Edinburgh University
- Fermi National Accelerator Lab.
- Imperial College London
- King's College London
- Lawrence Berkeley National Lab.
- Lawrence Livermore National Lab.
- LIP Coimbra
- Northwestern University
- Pennsylvania State University
- Royal Holloway University of London
- SLAC National Accelerator Lab.
- South Dakota School of Mines & Tech|
- South Dakota Science & Technology Authority
- STFC Rutherford Appleton Lab.
- Texas A&M University
- University of Albany, SUNY
- University of Alabama
- University of Bristol
- University College London
- University of California Berkeley
- University of California Davis
- University of California Los Angeles
- University of California Santa Barbara
- University of Liverpool
- University of Maryland
- University of Massachusetts, Amherst
- University of Michigan
- University of Oxford
- University of Rochester
- University of Sheffield
- University of Sydney
- University of Texas at Austin
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XLZD: RARE EVENT OBSERVATORY BASED ON THE NOBLE LIQUID XENON

LZ HENR
([2609.02823](#))

“Who ordered this?”



Dark Matter

WIMPs
 $\tilde{b}$ -GeV
Inelastic
Axion-like particles
Planck mass
Dark photons



Science White Paper (2023)

OPEN ACCESS

IOP Publishing

J. Phys. G: Nucl. Part. Phys. 50 (2023) 013001 (115pp)

Journal of Physics G: Nuclear and Particle Physics

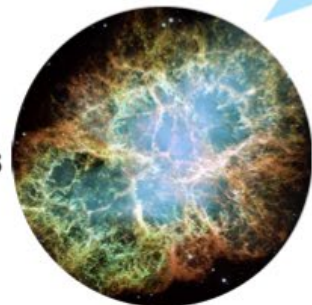
<https://doi.org/10.1088/1361-6471/ac941a>

Topical Review

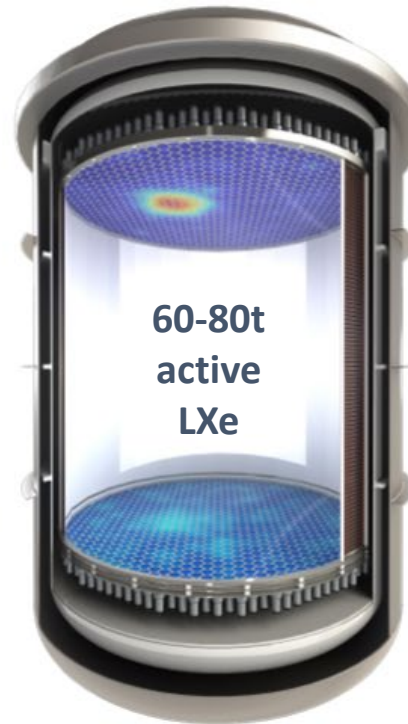
A next-generation liquid xenon
observatory for dark matter and neutrino
physics

Supernovae

Early alert
Supernova neutrinos
Multi-messenger
astrophysics



XLZD Design Book
(2024)



Neutrino nature

Neutrinoless double
beta decay
Neutrino magnetic
moment
Double electron
capture



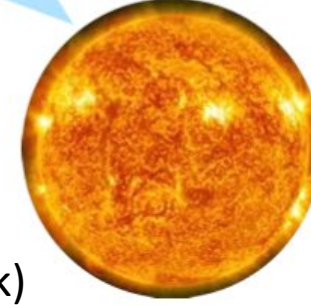
XLZD ONBB sensitivity ([2410.19016](#))

LZ ONBB decay search ([TevPA 2026](#))

B-8 via CEvNS by LZ ([2608.29450](#)),
XENONnT ([2604.06002](#)) & PandaX-4T)

Sun

pp neutrinos
Solar metallicity
 ^7Be , ^8B , hep



(see Tianyu Zhu's talk)

pp solar neutrino detection by XENONnT ([2608.29450](#))

XLZD: RARE EVENT OBSERVATORY BASED ON THE NOBLE LIQUID XENON

Underground observatory for rare particle interactions and rare nuclear decays, aiming to make paradigm-shifting discoveries related to the composition of the universe:

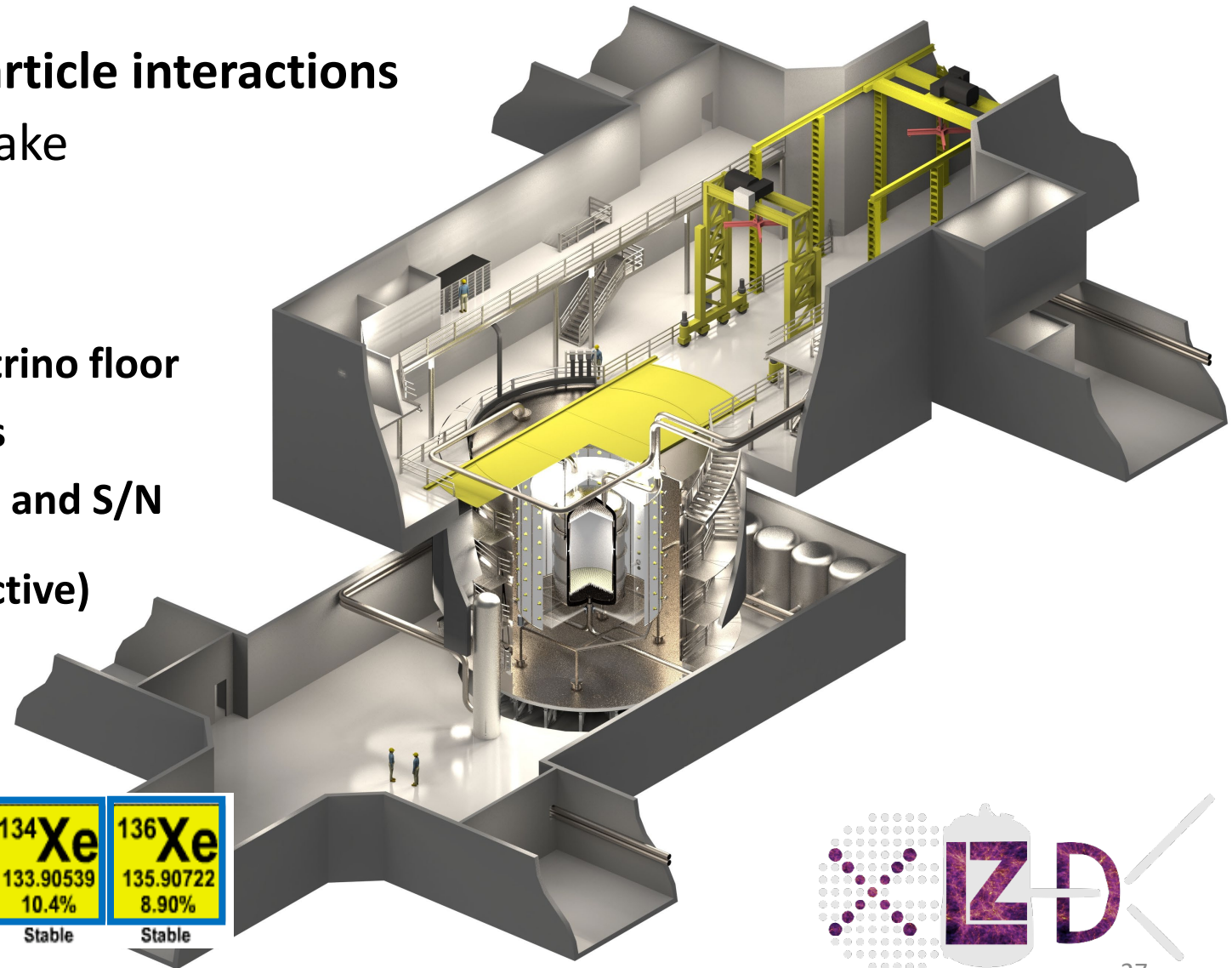
- Chasing **dark matter** scattering to the neutrino floor
- Probing $0\nu\beta\beta$ decay in ^{136}Xe to $\sim 10^{28}$ years
- Studying **astrophysical neutrinos** from Sun and S/N

Dual-phase xenon TPC with 60-80 tonnes (active)

- 10-fold scale-up from LZ and XENON-nT
- Rich portfolio of isotopes in $^{\text{nat}}\text{Xe}$

^{124}Xe	^{126}Xe	^{128}Xe	^{129}Xe	^{131}Xe	^{130}Xe	^{132}Xe	^{134}Xe	^{136}Xe
123.90589	125.90426	127.90353	128.9047	130.905083	129.90350	131.90415	133.90539	135.90722
0.10%	0.09%	1.91%	26.4%	21.2%	4.1%	26.9%	10.4%	8.90%
Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable	Stable

Henrique Araújo



XENON + LUX-ZEPLIN + DARWIN

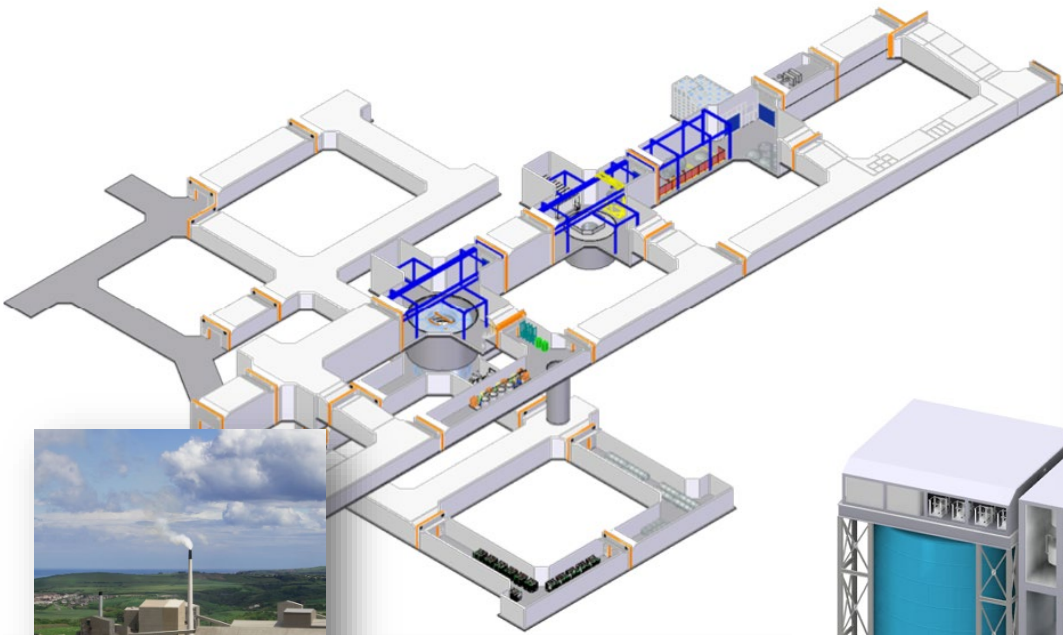
- Consortium of X+LZ+D collaborations formed in 2021; unified scientific collaboration formalised in 2024
- Many new institutes have joined since, notably from Canada – and more continue to join
- Approaching 500 scientists and engineers in 87 institutes in 17 countries



*XLZD Collaboration Meeting,
Zurich, Summer 2026*

HOST LABORATORY

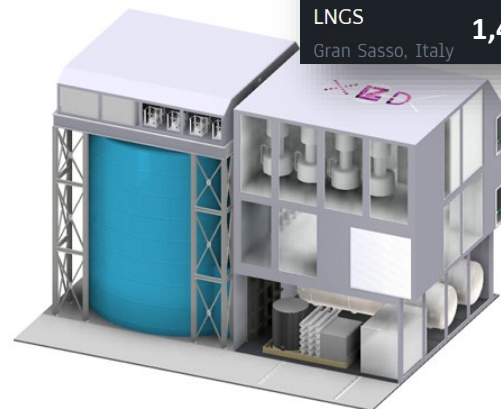
- Five underground laboratories expressed interest in hosting
- Four shortlisted after extensive assessment process:
Boulby (UK), LNGS (IT), SNOLAB (CA), SURF (US)
- Site selection will be mostly out of the hands of physicists:
we can deliver our science at all these four sites



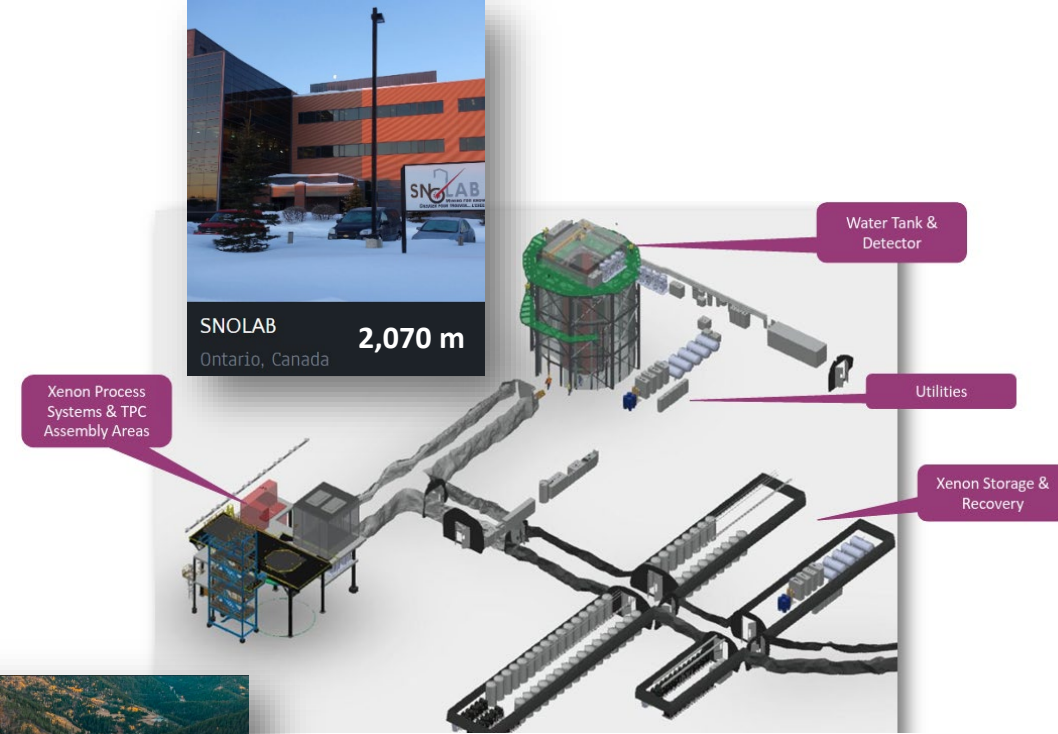
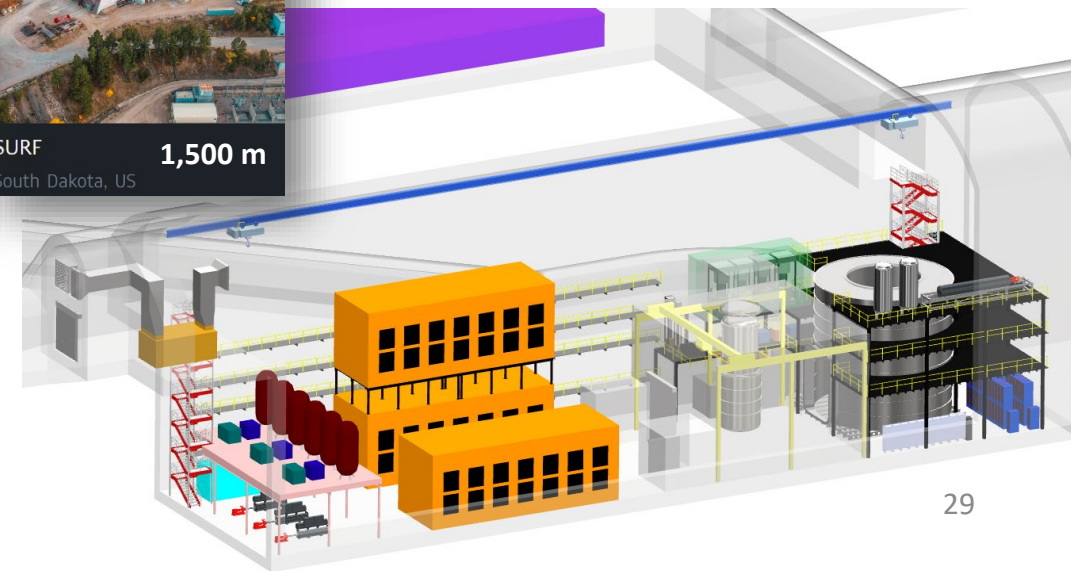
Boulby
North Yorkshire, UK
1,100 m



LNGS
Gran Sasso, Italy
1,400 m



SURF
South Dakota, US
1,500 m



SNOLAB
Ontario, Canada
2,070 m

EXPERIMENTAL STRATEGY

Reference Configuration [\[2410.17137\]](#) XLZD Design Book]

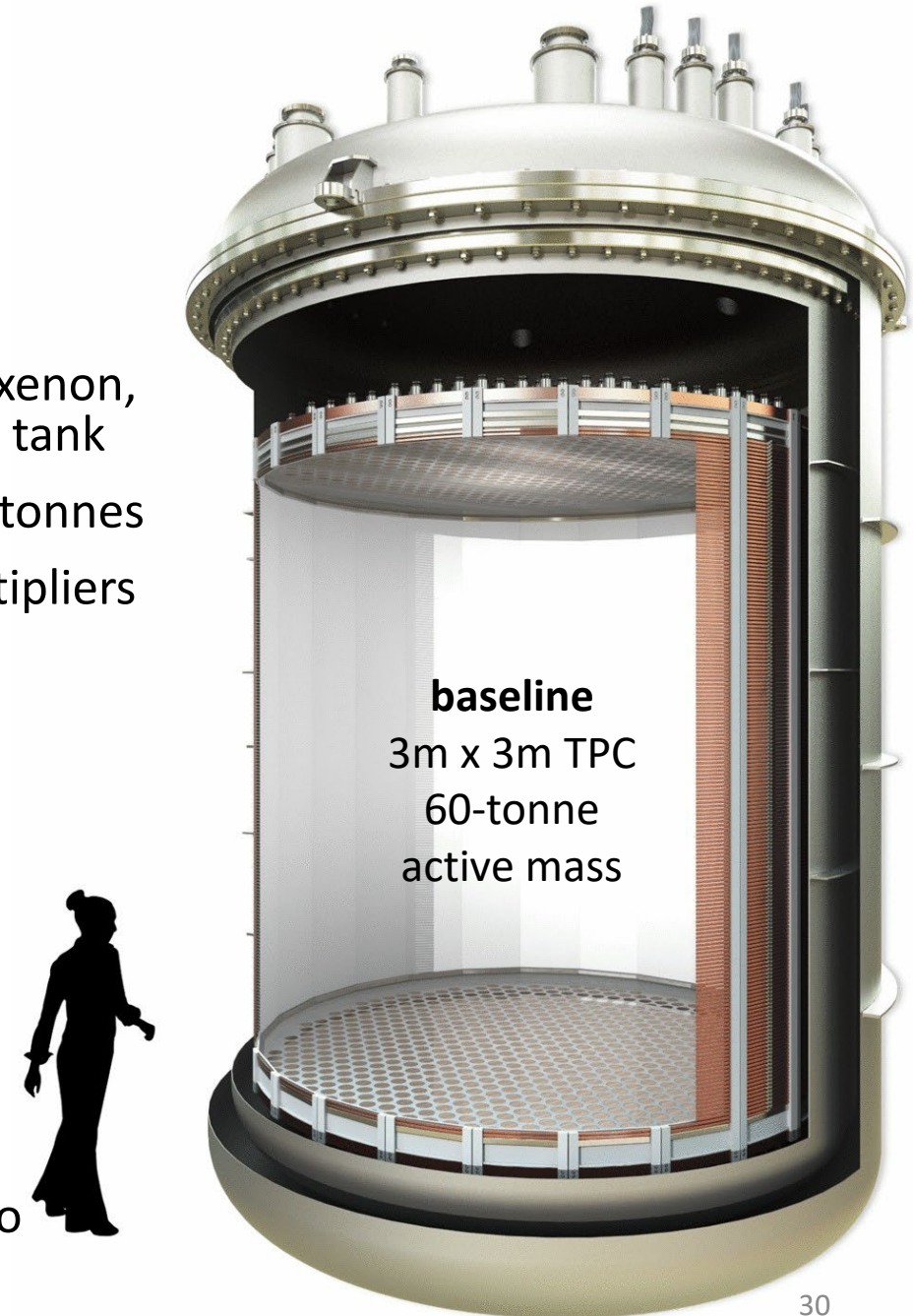
- Dual-phase xenon TPC with 60 tonnes of “active” mass of natural xenon, surrounded by a Skin Detector and an Outer Detector, 12 m water tank
- Fixed TPC diameter at 3 m, nominal height 3 m for 1x1 ratio at 60 tonnes
- Photosensors: 2- and 3-inch ultra-low-background VUV photomultipliers

Full-Scope Configuration

- 80-tonne TPC (3m $\rightarrow$ 4m height) to meet DM and $0\nu\beta\beta$ goals
- **Infrastructure designed to manage risks and opportunities**

We understand this technology

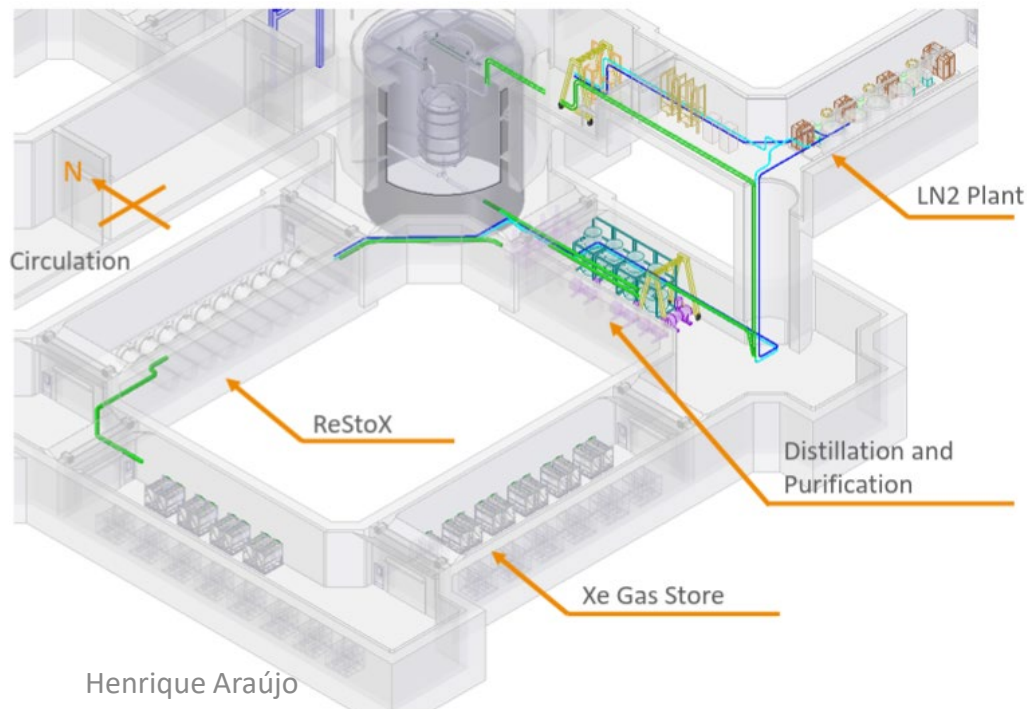
- Many DM searches delivered over the last 20 years
- $0\nu\beta\beta$ decay searches now emerging from two-phase $^{\text{nat}}\text{Xe}$ TPCs too



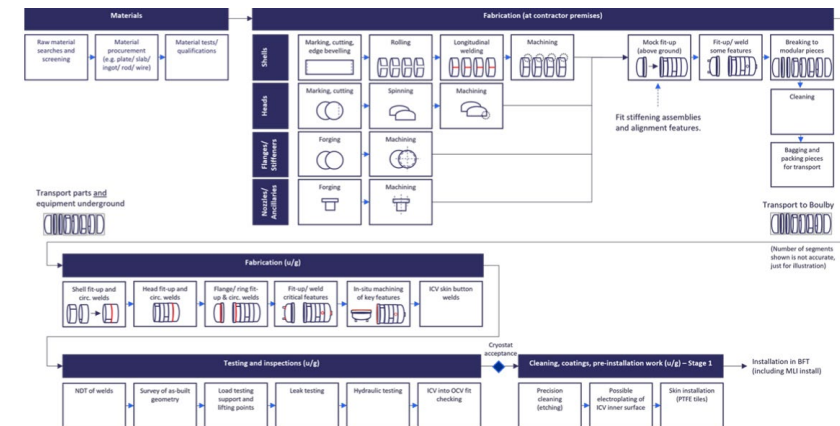
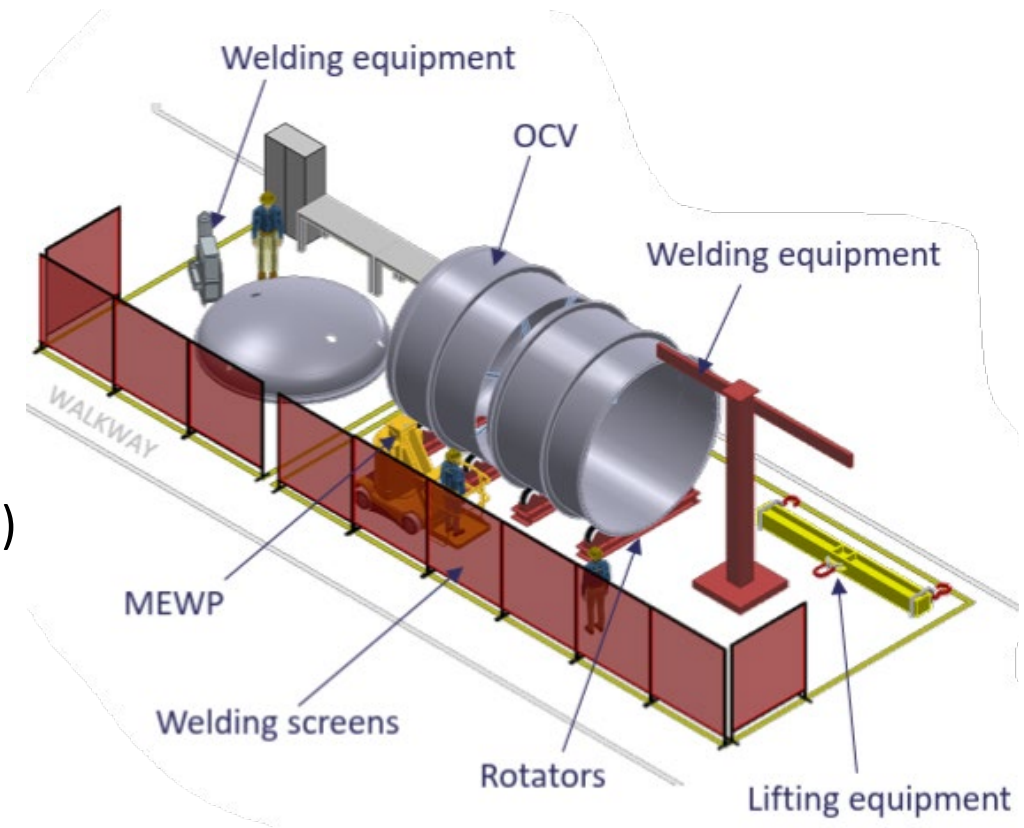
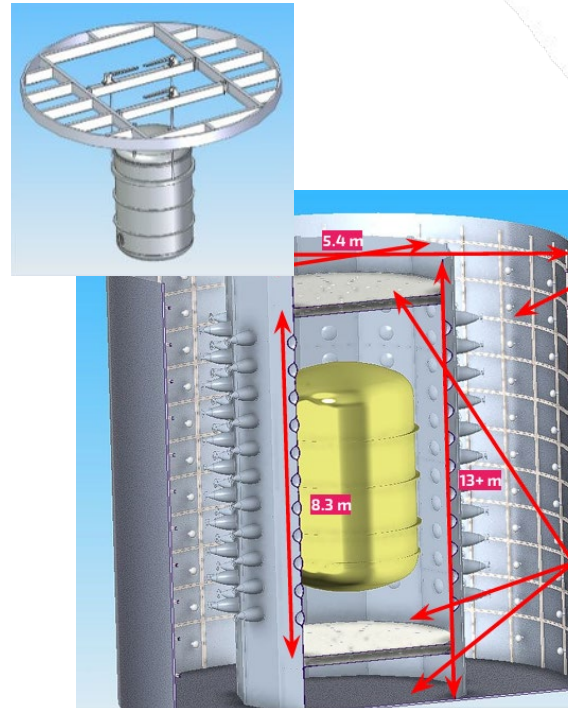
DEVELOPMENT WORK

Design work ongoing across all subsystems

- Focus on performance to meet requirements & goals, cleanliness & radioactivity, underground manufacture, detector serviceability, laboratory integration (all host options)
- 13 work packages, plus working groups & task forces



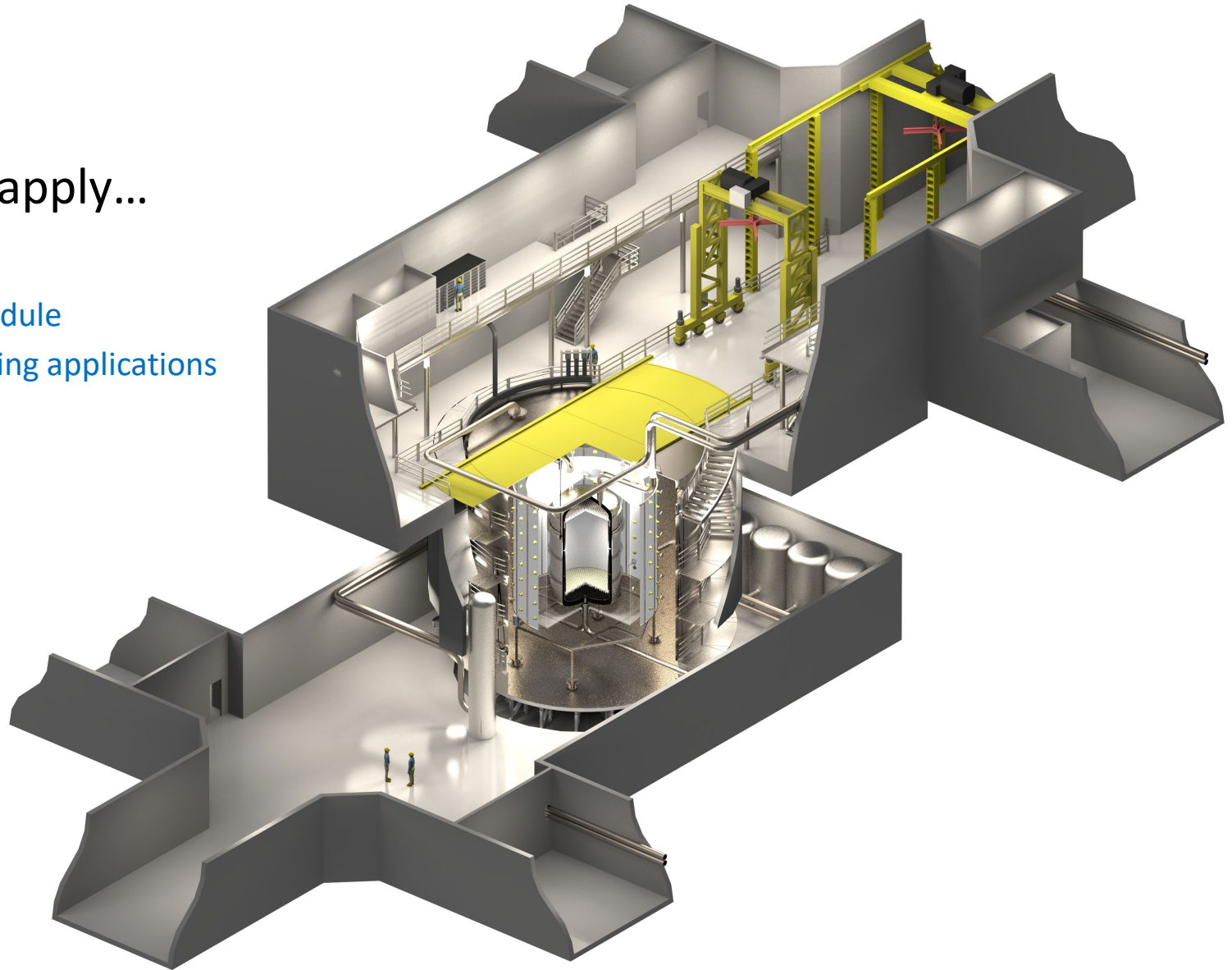
Henrique Araújo



TIMELINE

“Credible” timeline, usual caveats apply...

- **Conceptual Design 2026/27**
 - Technical design, management, cost & schedule
 - CD Report & Review to support major funding applications
- Site selection 2027-28
- Preliminary Design 2028/29
 - Defines draft project baseline
- Start of Construction 2029/30
- **Start of Operations 2035**
- Operations 15 years, nominally



CONCLUSION

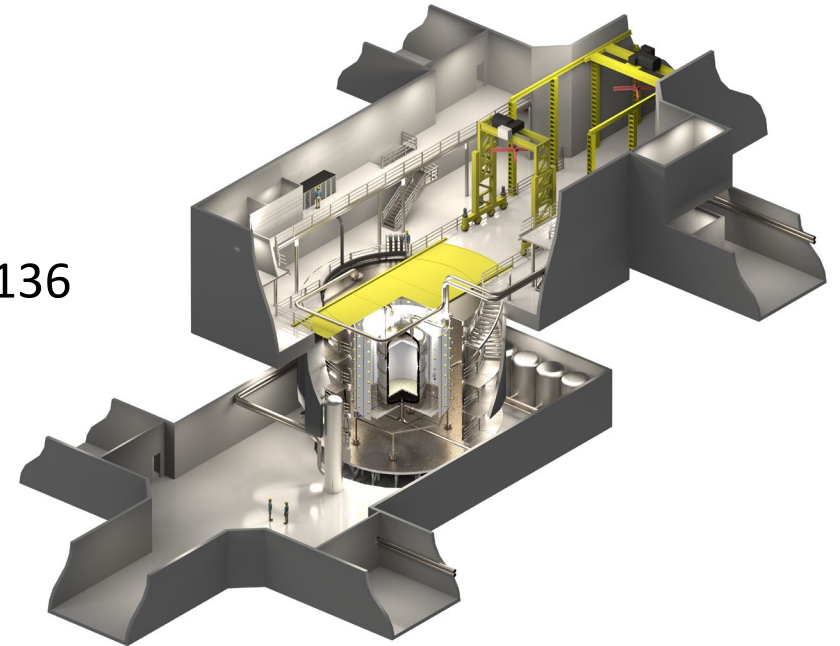


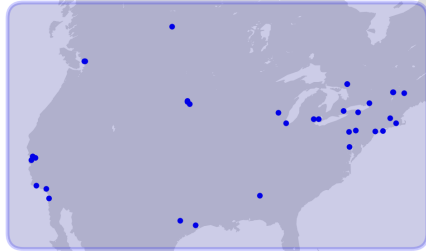
Dual-phase xenon experiments such as LUX-ZEPLIN (LZ) have made tremendous sensitivity improvements over the last two decades

- They are now probing – and finding – very rare events
- LZ observation is consistent with credible dark matter models
- But we need more events to be sure...

XLZD is the next-generation rare event observatory for dark matter and neutrino physics

- The top-level scientific aims are DM scattering and $0\nu\beta\beta$ decay in Xe-136
- XLZD is substantially derisked by the two largest DM experiments operating in real-(under)world conditions
- This will be the definitive experiment for the next decade
- **Join us if you want to contribute!**





Black Hills State University
Brookhaven National Laboratory
Brown University
Bucknell University
Columbia University
Laurentian University
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
McGill University
McMaster University
Pennsylvania State University
Queen's University
Rice University
SLAC National Accelerator Laboratory
SNOLAB
Sanford Underground Research Facility
South Dakota School of Mines
TRIUMF
The University of Chicago
University of Alabama
University of Alberta
University of British Columbia
University of California, Berkeley
University of California, Los Angeles
University of California, San Diego
University of California, Santa Barbara
University of Maryland
University of Massachusetts
University of Michigan
University of Rochester
University of Texas, Austin
University of Windsor
University of Wisconsin
Université de Montreal
Université de Sherbrooke



Heidelberg University
INAF Osservatorio Astrofisico Torino
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Karlsruhe Institute of Technology
King's College London
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LPNHE
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University of Barcelona
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University of Bristol
University of Coimbra
University of Edinburgh
University of Ferrara
University of Freiburg
University of L'Aquila
University of Liverpool
University of Münster
University of Naples "Federico II"
University of Oxford
University of Sheffield
University of Sussex
University of Zurich
Vinca Institute of Nuclear Sciences
Weizmann Institute



Institute for Basic Science
Institute of Science Tokyo
Kobe University
Nagoya University
The Chinese University of Hong Kong, Shenzhen
The University of Tokyo
Tsinghua University
Westlake University



The University of Melbourne
The University of Sydney

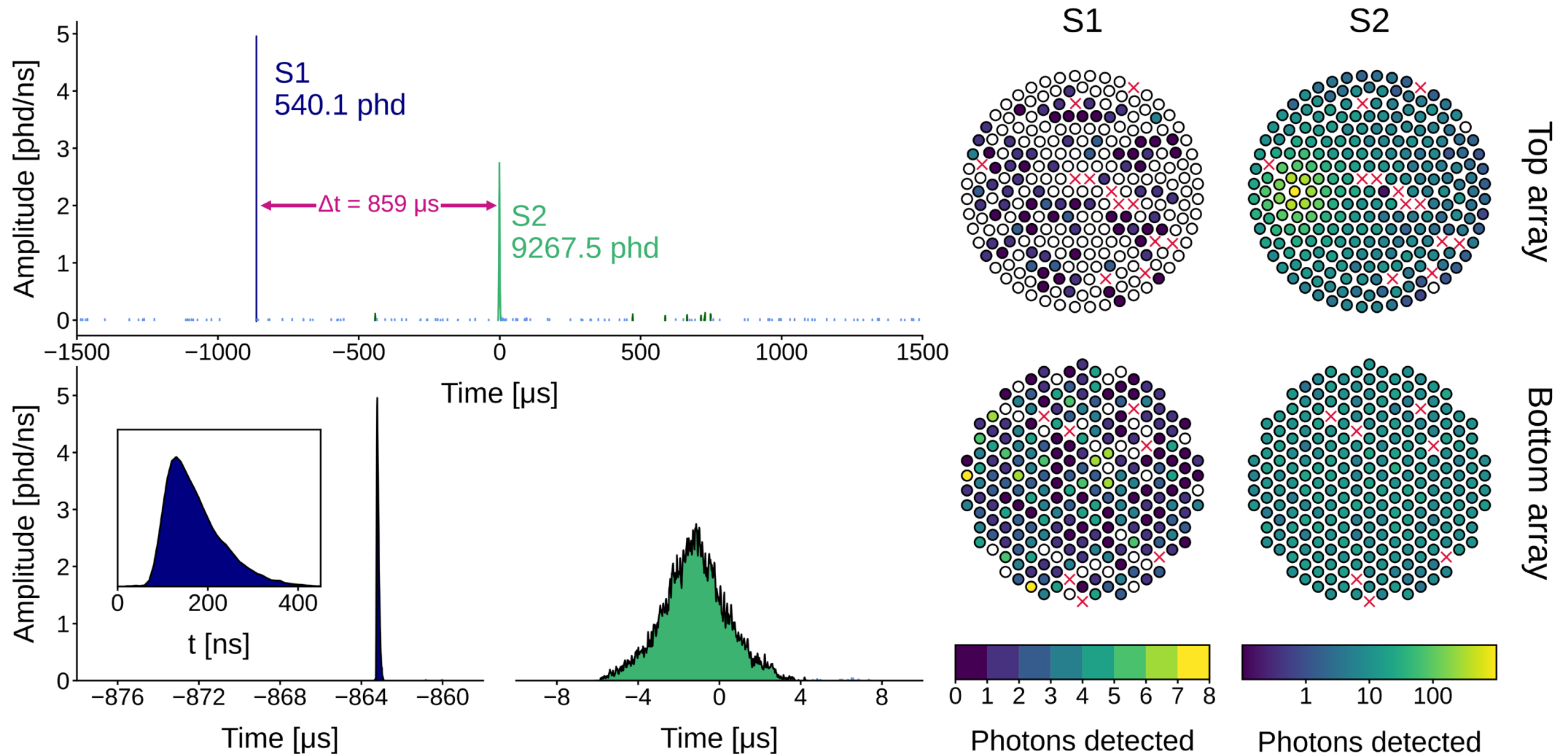
XLZD COLLABORATION

THANK YOU – AND KEEP YOUR EYES PEELED FOR MORE!



additional slides

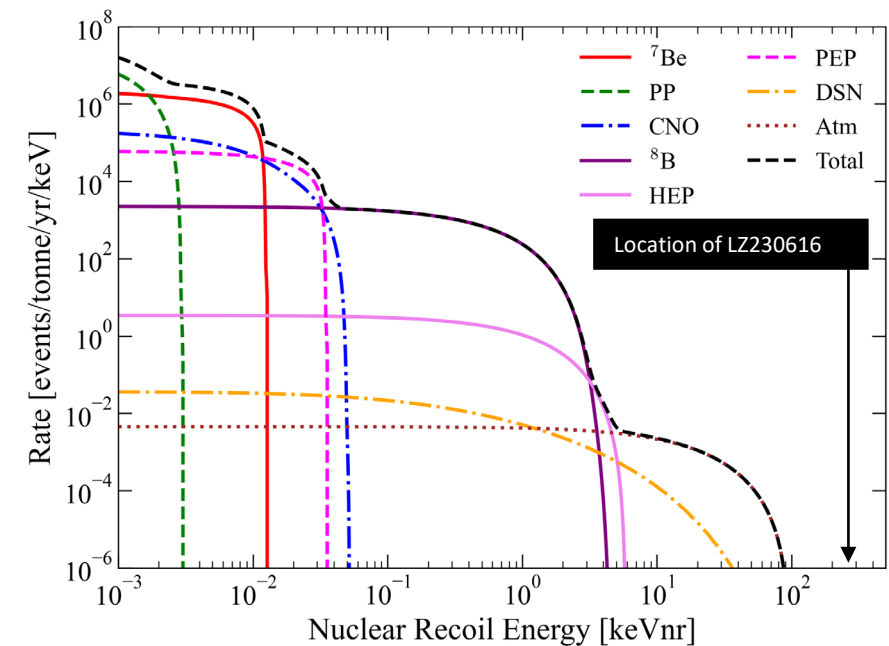
LZ230616: WAVEFORM-LEVEL EVENT INFORMATION



LZ230616: NEUTRINO BACKGROUNDS

- Coherent elastic neutrino-nucleus scattering (CEvNS) produces NR signals
- A large momentum transfer is required to produce LZ230616
- In this region, the CEvNS cross section is suppressed

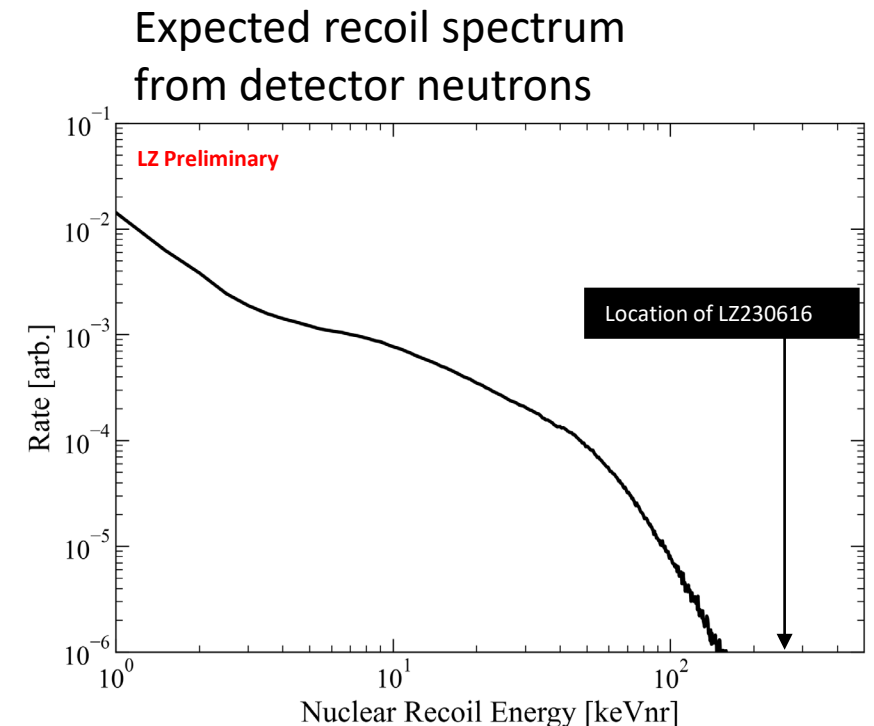
It is highly unlikely to observe a single high-energy neutrino scatter and no low energy scatters



LZ230616: NEUTRON BACKGROUNDS

- Only neutrons > 8 MeV can produce 250 keV elastic recoils
- Sources of neutrons
 - (α, n)
 - spontaneous fission
 - Muon-induced cascades
- Elastic scattering is forward peaked
- There is a high tagging efficiency for neutrons in OD+Skin
 - Detector component simulations: **$92 \pm 4\%$**

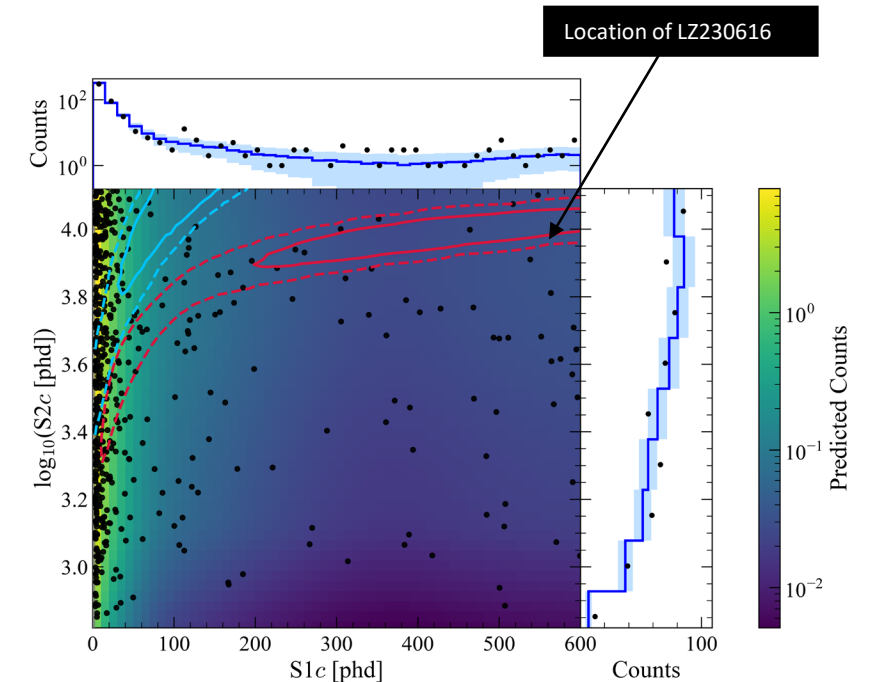
It is highly unlikely to see a single high energy neutron scatter and no low energy scatters, and also no tagged neutrons appeared in the veto samples



LZ230616: NEUTRON BACKGROUNDS

- Accidental coincidence of uncorrelated S1 and S2 pulses: [PhysRevD 108 012010](#)
- Accidentals model
 - Rate: measured from unphysical drift time single scatters; cut efficiencies determined using manufactured accidental events
 - Shape: created by combining isolated S1 and S2 waveforms and applying analysis cut efficiencies
- Expectation
 - 2.7 ± 0.6 (in whole S1-S2 space)
 - Analysis cuts have 99.5% rejection power

LZ230616 is in a low probability region for accidentals.



Contours: L10s 1000 GeV/c², ER backgrounds

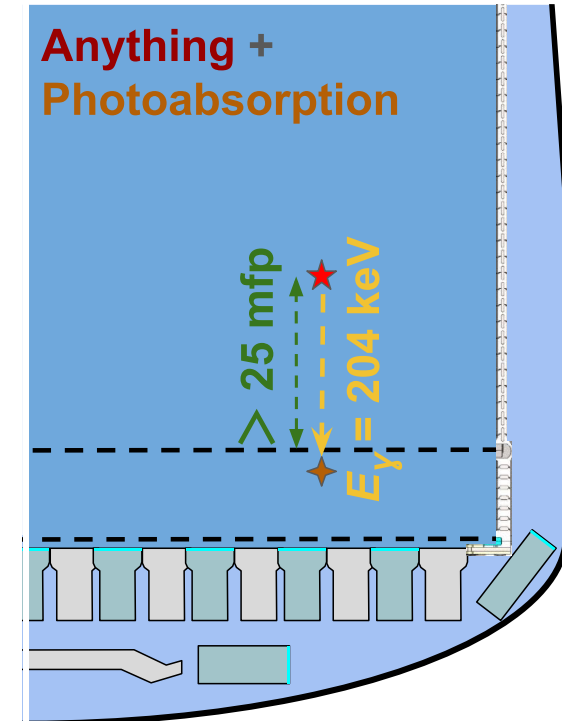
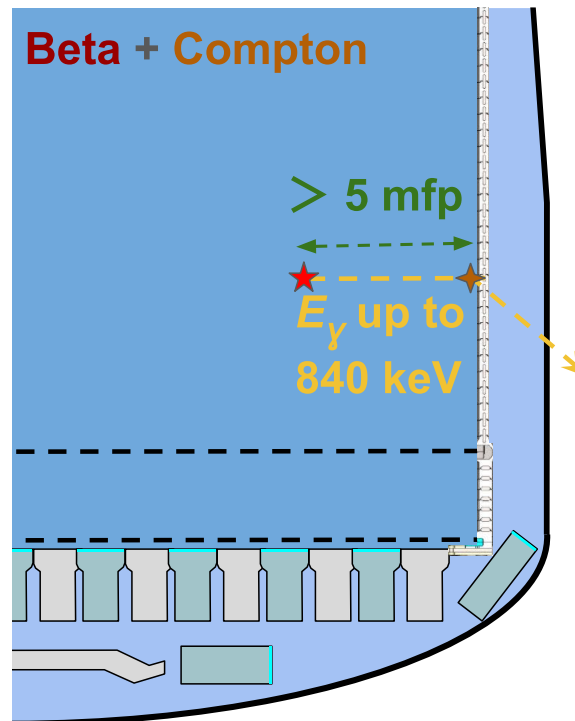
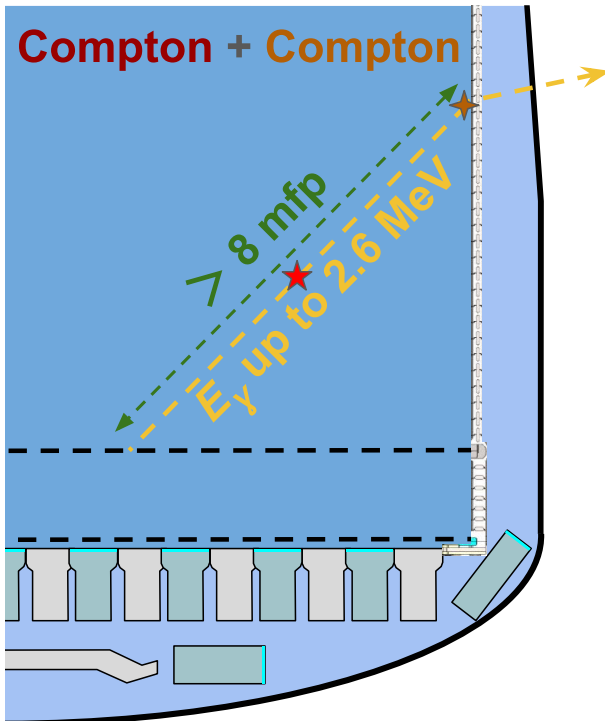
LZ230616: MSSl TOPOLOGIES

If this is an MSSl event

- The S2 pulse implies a 12 ± 2 keV scatter in the FV
- The extra ~ 450 phd from the S1 pulse must come from
 - 204 ± 40 keV in RFR or 78 ± 7 keV by wall

To be caused by MSSl, the γ -ray must:

1. Travel ~ 25 cm
 2. Scatter in a charge-dead region
 3. Evade the very efficient veto detectors
- Each of these scenarios is unlikely!



SIDEBAND SAMPLE FITS

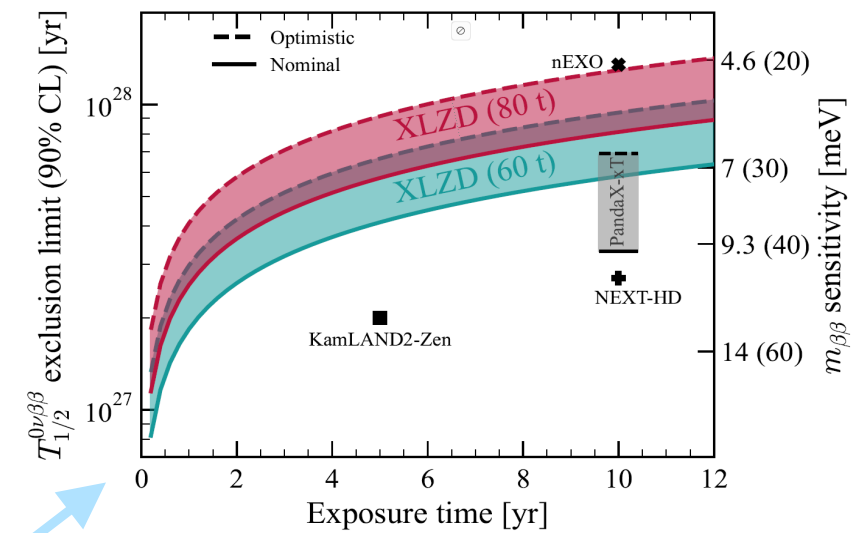
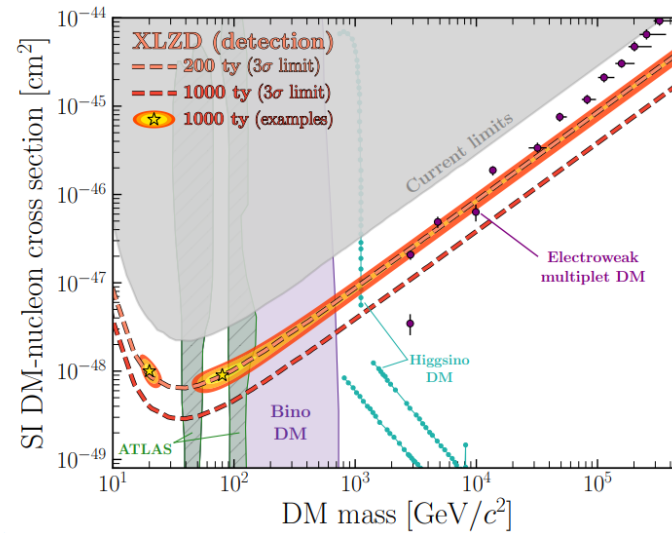
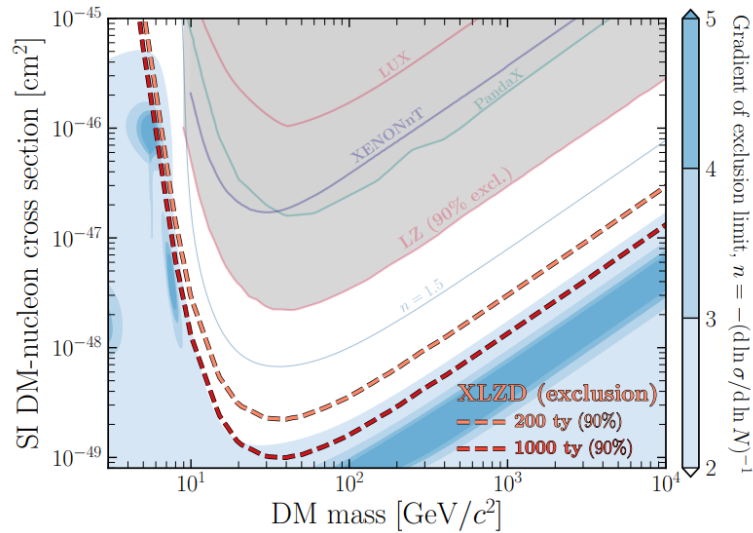
Delayed Sample

Source	Expected Events	Fit Result
Internal β decays	39.5 ± 4.7	39.4 ± 1.3
ν ER	4.1 ± 0.2	4.1 ± 0.2
^{136}Xe	3.2 ± 0.5	3.4 ± 0.5
CH_3T & ^{14}C	1.6 ± 0.1	1.6 ± 0.1
^{124}Xe	$(6.2 \pm 1.9) \times 10^{-1}$	$(6.6 \pm 1.5) \times 10^{-1}$
$^{83\text{m}}\text{Kr}$	$(5.0 \pm 1.5) \times 10^{-1}$	$(5.0 \pm 1.0) \times 10^{-1}$
^{125}I	$(2.6 \pm 0.8) \times 10^{-1}$	$(2.9 \pm 0.7) \times 10^{-1}$
Detector ERs	$(2.5 \pm 1.0) \times 10^{-1}$	$(2.8 \pm 0.5) \times 10^{-1}$
Accidental coincidences	$(8.0 \pm 1.9) \times 10^{-2}$	$(7.7 \pm 1.8) \times 10^{-2}$
$^{127}\text{Xe} + ^{125}\text{Xe}$	$(4.5 \pm 1.0) \times 10^{-2}$	$(3.4 \pm 0.9) \times 10^{-2}$
Atmospheric ν	$(3.3 \pm 0.7) \times 10^{-3}$	$(3.3 \pm 0.7) \times 10^{-3}$
$^8\text{B} + \text{hep}\nu$	$(1.7 \pm 0.2) \times 10^{-3}$	$(1.7 \pm 0.2) \times 10^{-3}$
MSSI	$(1.4 \pm 1.4) \times 10^{-4}$	$(1.3 \pm 1.0) \times 10^{-4}$
Detector NRs	–	$[0, 1.3]$
1000 GeV/c ² WIMP	–	$(3.1^{+4.2}_{-2.1}) \times 10^{-2}$
λ_{DN}	$(8.7 \pm 0.2) \times 10^{-1}$	$(8.7 \pm 0.1) \times 10^{-1}$
λ_{PN}	$(5.0 \pm 1.0) \times 10^{-2}$	$(5.0 \pm 0.7) \times 10^{-2}$
Total counts	–	50.4 ± 2.0
Observed counts	–	55

Prompt Sample

Source	Expected Events	Fit Result
Internal β decays	$(1.3 \pm 0.2) \times 10^{-1}$	$(1.33 \pm 0.04) \times 10^{-1}$
ν ER	$(1.41 \pm 0.08) \times 10^{-2}$	$(1.40 \pm 0.08) \times 10^{-2}$
^{136}Xe	$(1.1 \pm 0.2) \times 10^{-2}$	$(1.1 \pm 0.2) \times 10^{-2}$
CH_3T & ^{14}C	$(5.5 \pm 0.3) \times 10^{-3}$	$(5.5 \pm 0.3) \times 10^{-3}$
^{124}Xe	$(2.1 \pm 0.6) \times 10^{-3}$	$(2.3 \pm 0.5) \times 10^{-3}$
$^{83\text{m}}\text{Kr}$	$(1.7 \pm 0.5) \times 10^{-3}$	$(2.0^{+0.4}_{-0.3}) \times 10^{-3}$
^{125}I	$(8.9 \pm 2.7) \times 10^{-4}$	$(9.8 \pm 2.3) \times 10^{-4}$
Detector ERs	62.2 ± 24.9	$61.6^{+11.5}_{-10.5}$
Accidental coincidences	$(2.7 \pm 0.6) \times 10^{-4}$	$(2.6 \pm 0.6) \times 10^{-4}$
$^{127}\text{Xe} + ^{125}\text{Xe}$	11.2 ± 2.4	7.7 ± 2.1
Atmospheric ν	$(1.1 \pm 0.2) \times 10^{-5}$	$(1.1 \pm 0.2) \times 10^{-5}$
$^8\text{B} + \text{hep}\nu$	$(5.7 \pm 0.6) \times 10^{-6}$	$(5.7 \pm 0.6) \times 10^{-6}$
MSSI	$(7.7 \pm 7.7) \times 10^{-2}$	$(7.1^{+7.6}_{-7.1}) \times 10^{-2}$
Detector NRs	–	$[0, 0.07]$
1000 GeV/c ² WIMP	–	$(1.0^{+1.4}_{-0.7}) \times 10^{-4}$
λ_{DN}	$(8.7 \pm 0.2) \times 10^{-1}$	$(8.7 \pm 0.1) \times 10^{-1}$
λ_{PN}	$(5.0 \pm 1.0) \times 10^{-2}$	$(5.0 \pm 0.7) \times 10^{-2}$
λ_{PG}	$(8.8 \pm 0.2) \times 10^{-1}$	$(8.7 \pm 0.2) \times 10^{-1}$
λ_{MSSI}	$(0.94 \pm 0.2) \times 10^{-1}$	$(9.4 \pm 0.2) \times 10^{-1}$
Total counts	–	69.4 ± 11.7
Observed counts	–	66

XLZD SENSITIVITY FOR DARK MATTER AND 0NBB DECAY



[XLZD Design Book \(2025\)](#)

Dark Matter

- WIMPs
- Sub-GeV
- Inelastic
- Axion-like particles
- Planck mass
- Dark photons

Neutrino nature

- Neutrinoless double beta decay
- Neutrino magnetic moment
- Double electron capture

[XLZD \$0\nu\beta\beta\$ sensitivity \(2025\)](#)

LXe-TPC

Active mass: 60-80 tonnes, 10x LZ

Diameter: 3.0 m, 2x LZ

Supernovae

- Early alert
- Supernova neutrinos
- Multi-messenger astrophysics

Sun

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

[Science White Paper \(2023\)](#)

OPEN ACCESS
IOP Publishing

Journal of Physics G: Nuclear and Particle Physics

J. Phys. G: Nucl. Part. Phys. 50 (2023) 013001 (115pp)

<https://doi.org/10.1088/1361-6471/ac841a>

Topical Review

A next-generation liquid xenon observatory for dark matter and neutrino physics