



Status of the LZ Experiment

Tomasz Biesiadzinski
For the LZ Collaboration
02/19/2018

LLWI 2018



LZ Collaboration

SLAC

38 Institutions
250 scientists, engineers, and technicians

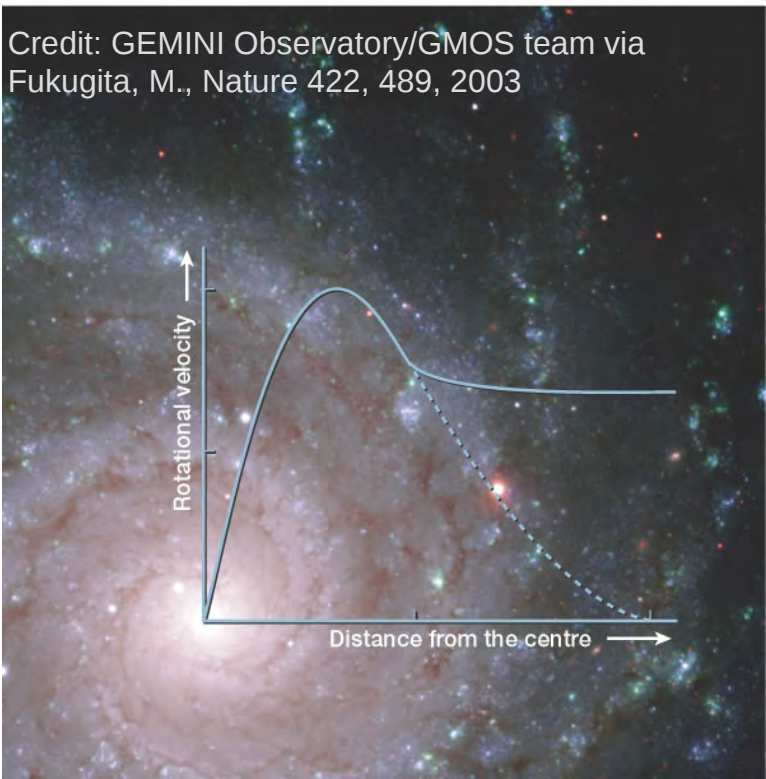


1. Center for Underground Physics (South Korea)
2. LIP Coimbra (Portugal)
3. MEPhI (Russia)
4. Imperial College London (UK)
5. Royal Holloway University of London (UK)
6. STFC Rutherford Appleton Lab (UK)
7. University College London (UK)
8. University of Bristol (UK)
9. University of Edinburgh (UK)
10. University of Liverpool (UK)
11. University of Oxford (UK)
12. University of Sheffield (UK)
13. Black Hill State University (US)
14. Brandeis University (US)
15. Brookhaven National Lab (US)
16. Brown University (US)
17. Fermi National Accelerator Lab (US)
18. Lawrence Berkeley National Lab (US)
19. Lawrence Livermore National Lab (US)

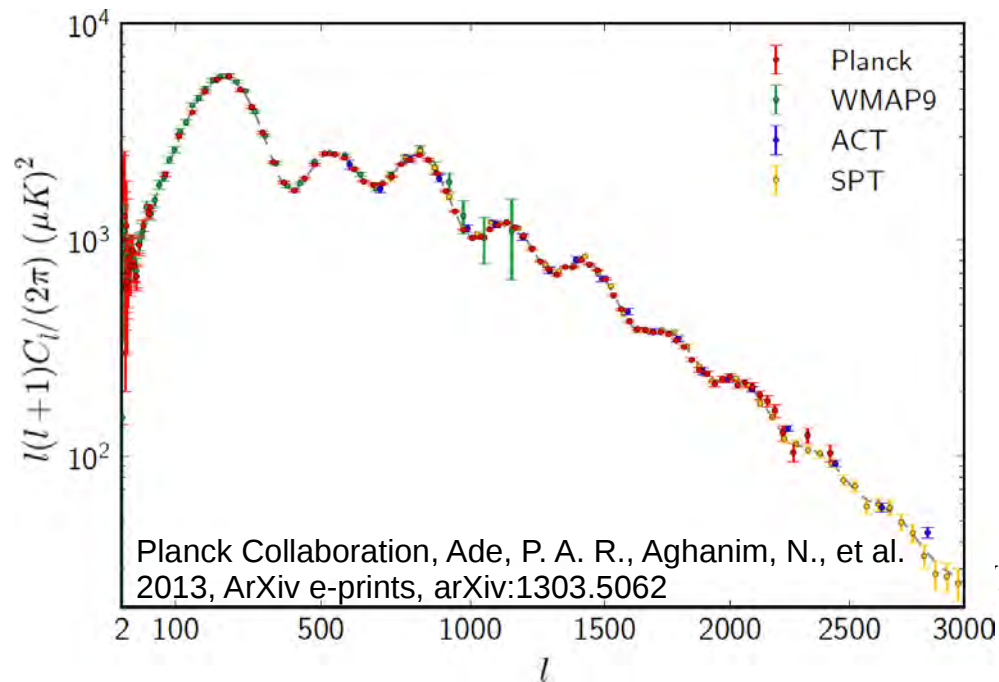
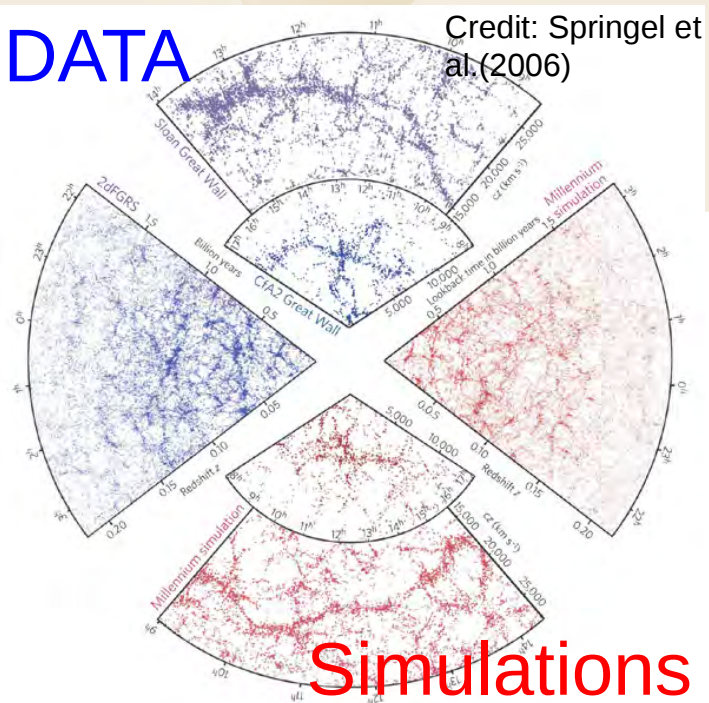
20. Northwestern University (US)
21. Pennsylvania State University (US)
22. SLAC National Accelerator Lab (US)
23. South Dakota School of Mines and Technology (US)
24. South Dakota Science and Technology Authority (US)
25. Texas A&M University (US)
26. University at Albany (US)
27. University of Alabama (US)
28. University of California, Berkeley (US)
29. University of California, Davis (US)
30. University of California, Santa Barbara (US)
31. University of Maryland (US)
32. University of Massachusetts (US)
33. University of Michigan (US)
34. University of Rochester (US)
35. University of South Dakota (US)
36. University of Wisconsin – Madison (US)
37. Washington University in St. Louis (US)
38. Yale University (US)



Credit: GEMINI Observatory/GMOS team via Fukugita, M., Nature 422, 489, 2003



Evidence For Dark Matter



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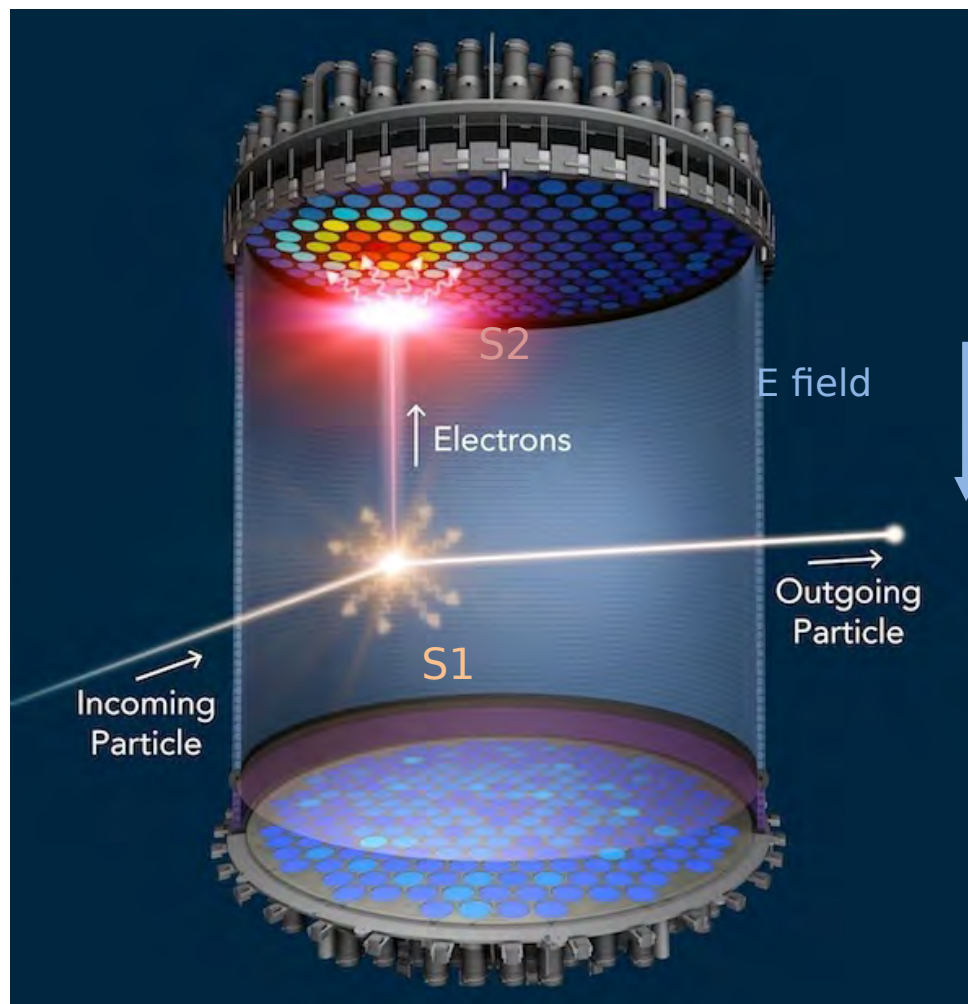




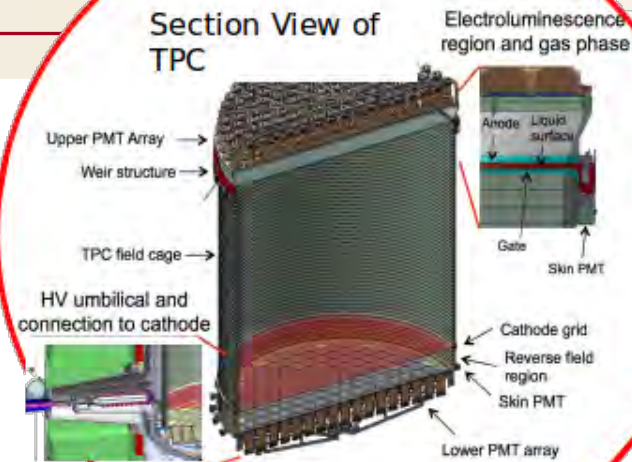
Time Projection Chamber

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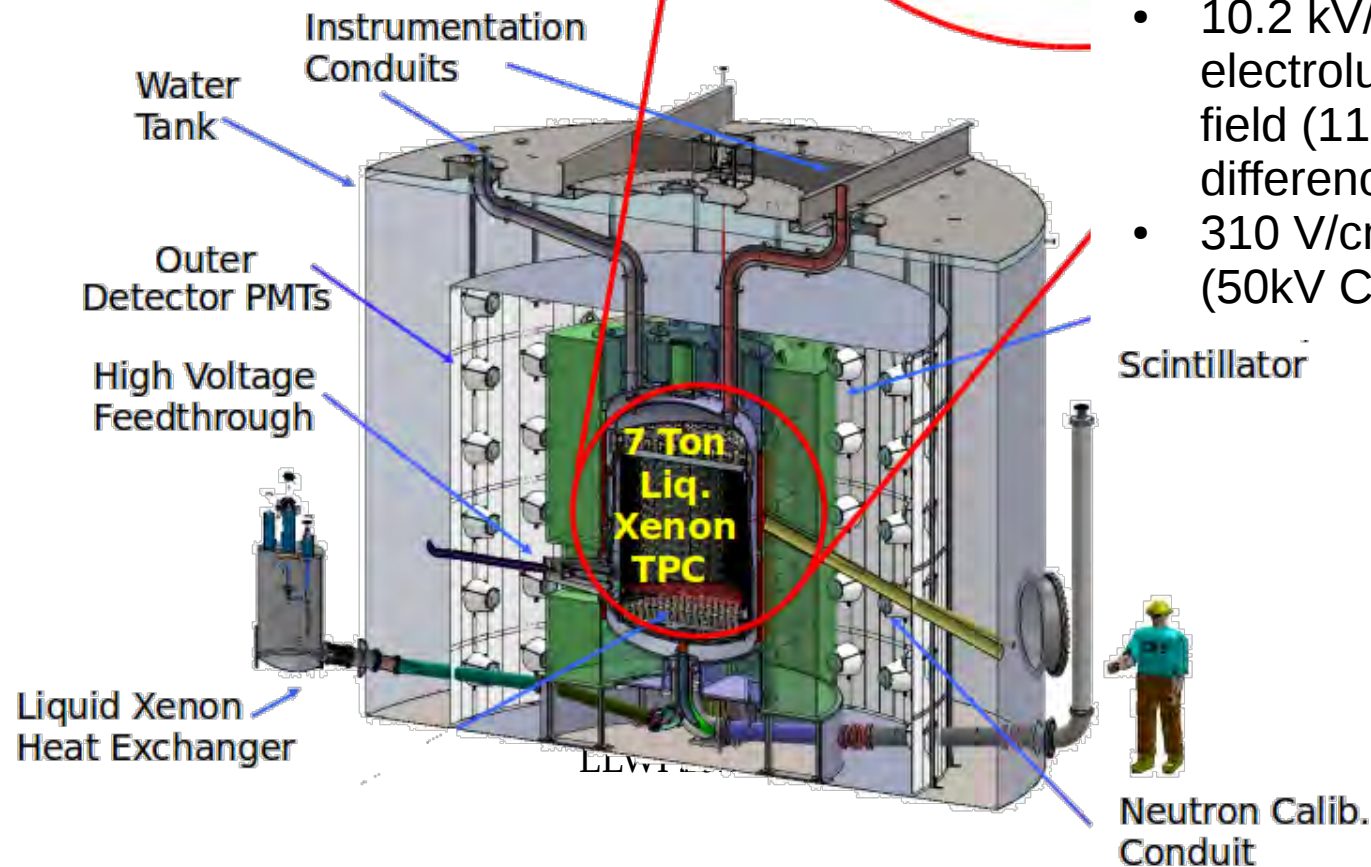
- LZ is a dual-phase time projection chamber (TPC)
- Particle collision \rightarrow light (S1) + charge
- Charge is extracted \rightarrow electroluminescence (S2)
- 3D position reconstruction
 - The S2 is localized in X-Y
 - Time difference between S1 and S2 gives depth
- Strengths of Xe TPCs
 - Self-shielding + position reconstruction \rightarrow Fiducialization
 - S2/S1 ratio \rightarrow BG discrimination



- 10 tonnes total, 7 tonnes active, 5.6 tonnes fiducial
- 1.5 m diameter, 1.5 m height
- 2-component veto system: LXe skin and outer detector
- Gas circulation/purification system @ 500 slpm
- Internal and external calibration, ER and NR
- 494 3" PMTs in TPC



- 10.2 kV/cm electroluminescence field (11.5kV difference)
- 310 V/cm drift field (50kV Cathode)





BG Controls

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- Screening of ALL materials
 - About 50% done
 - See <https://arxiv.org/abs/1702.02646> for example of the choice of Titanium
 - Includes radon assays
- On line radon removal system for most problematic components – warm cables
- Radon-reduced clean room for TPC assembly
- Exposure to dust tracked with witness plates
- Procedures and real-time quality controls

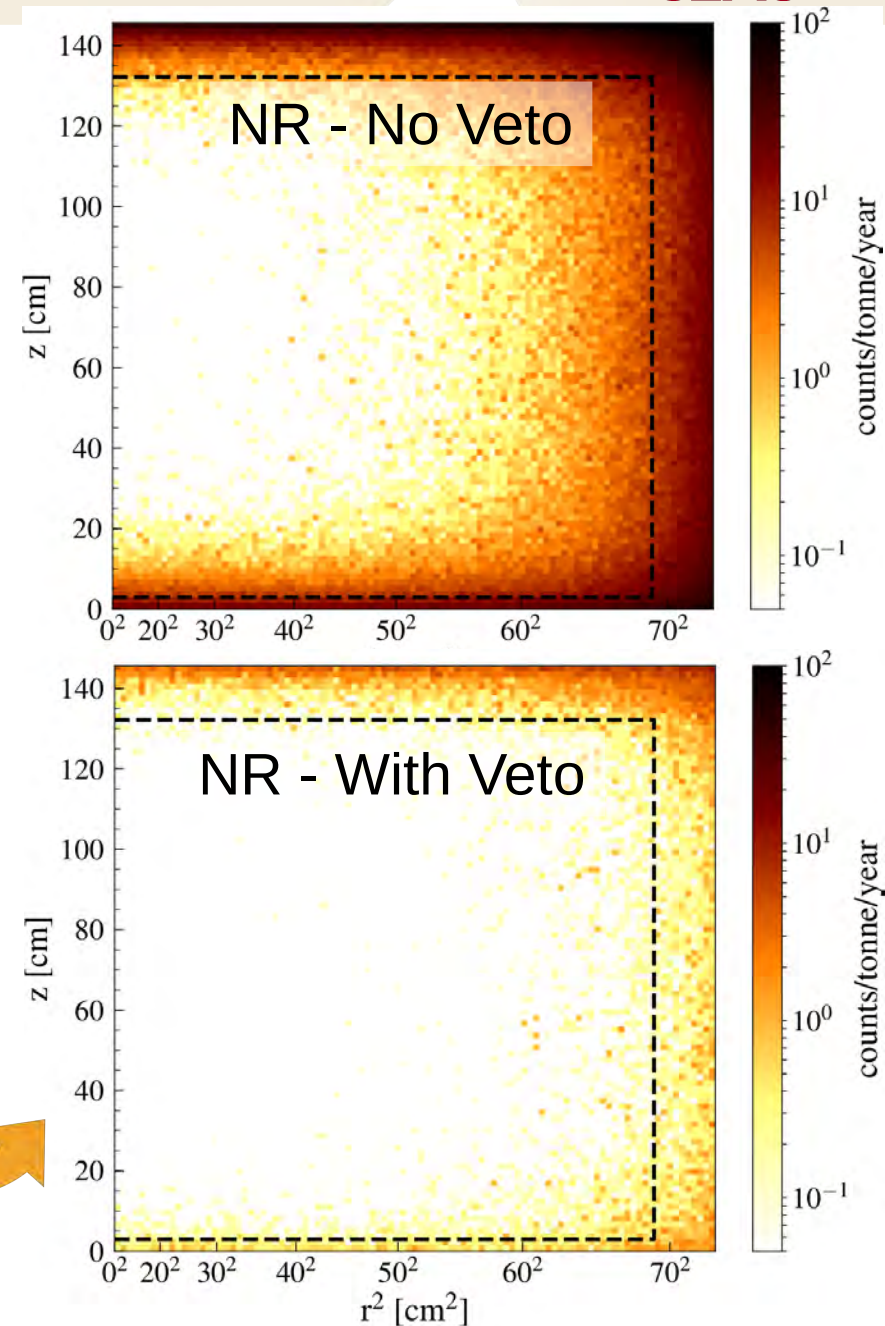
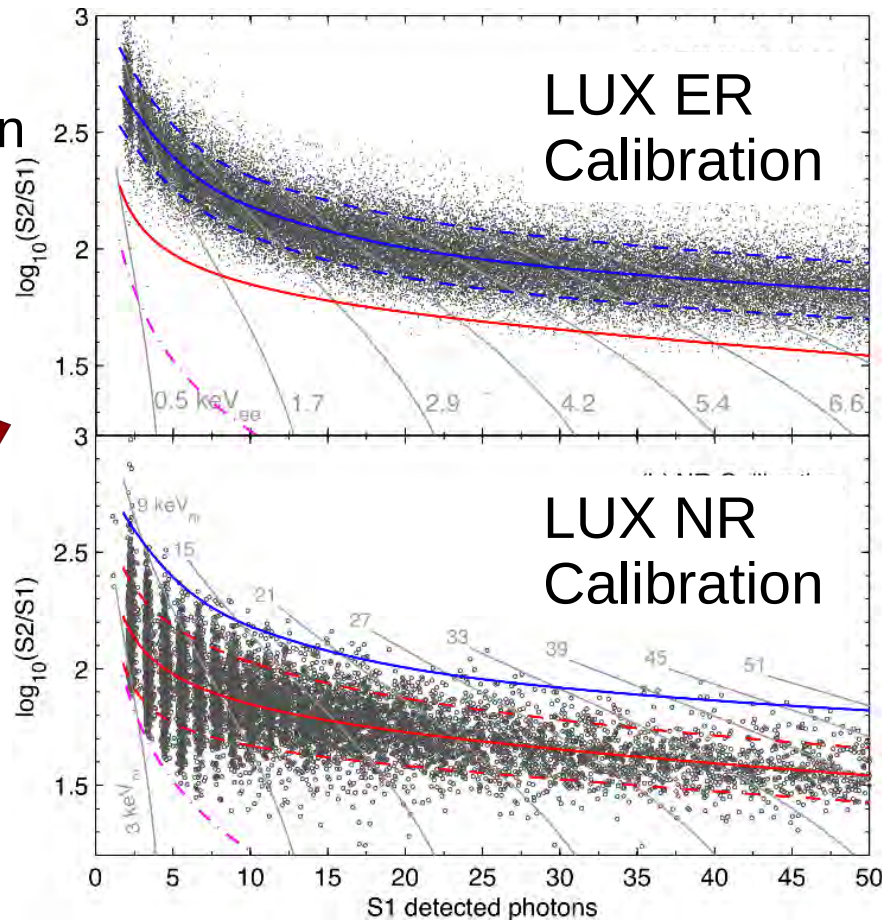




Discrimination and Fiducialization

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ER-NR
discrimination
thanks to S1
& S2



Xe skin and outer detector veto further
reduce backgrounds (simulation shown)

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Backgrounds

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5.6 Tonne fiducial mass, 1000 live-days, ~1.5 - 6.5keV, single scatters and veto

Background Source	ERs	NRs
Detector Components	9	0.07
Dispersed Radionuclides — Rn, Kr, Ar	816	—
Laboratory and Cosmogenics	5	0.06
Surface Contamination and Dust	40	0.39
Physics Backgrounds — 2β decay, neutrinos* * Not Including ^8B and hep	322	0.51

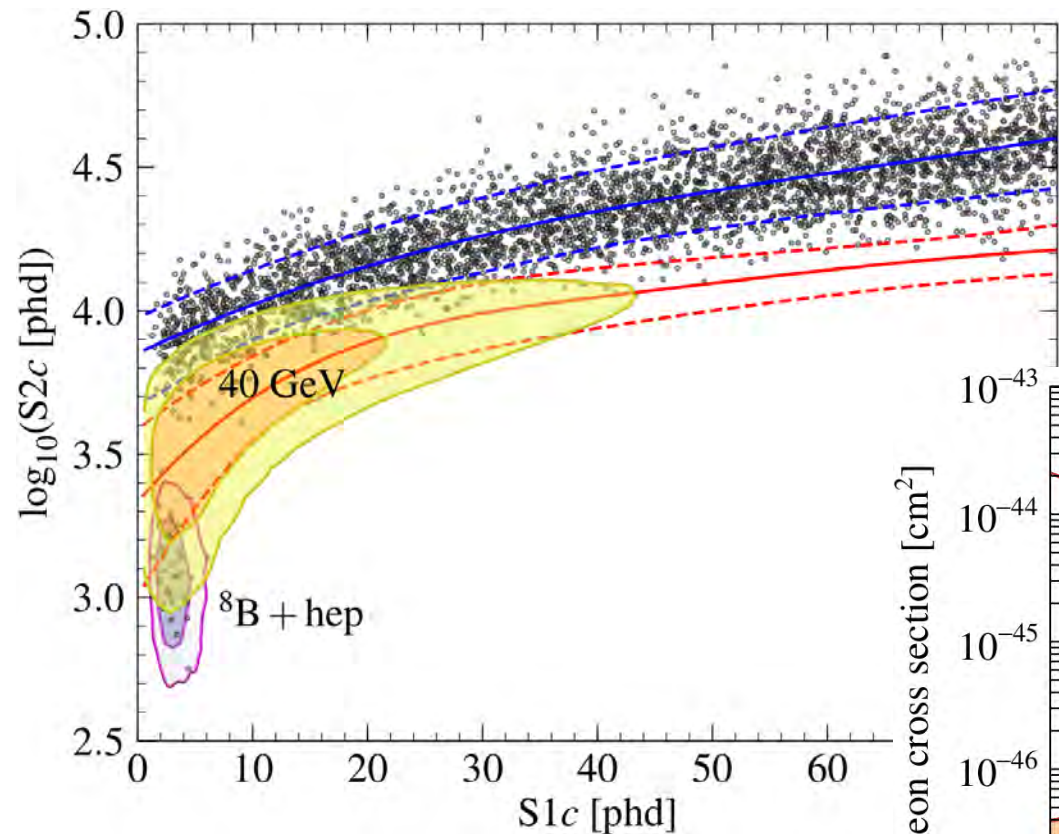
Total (after 99.5% discrimination and 50% NR efficiency)

6.48



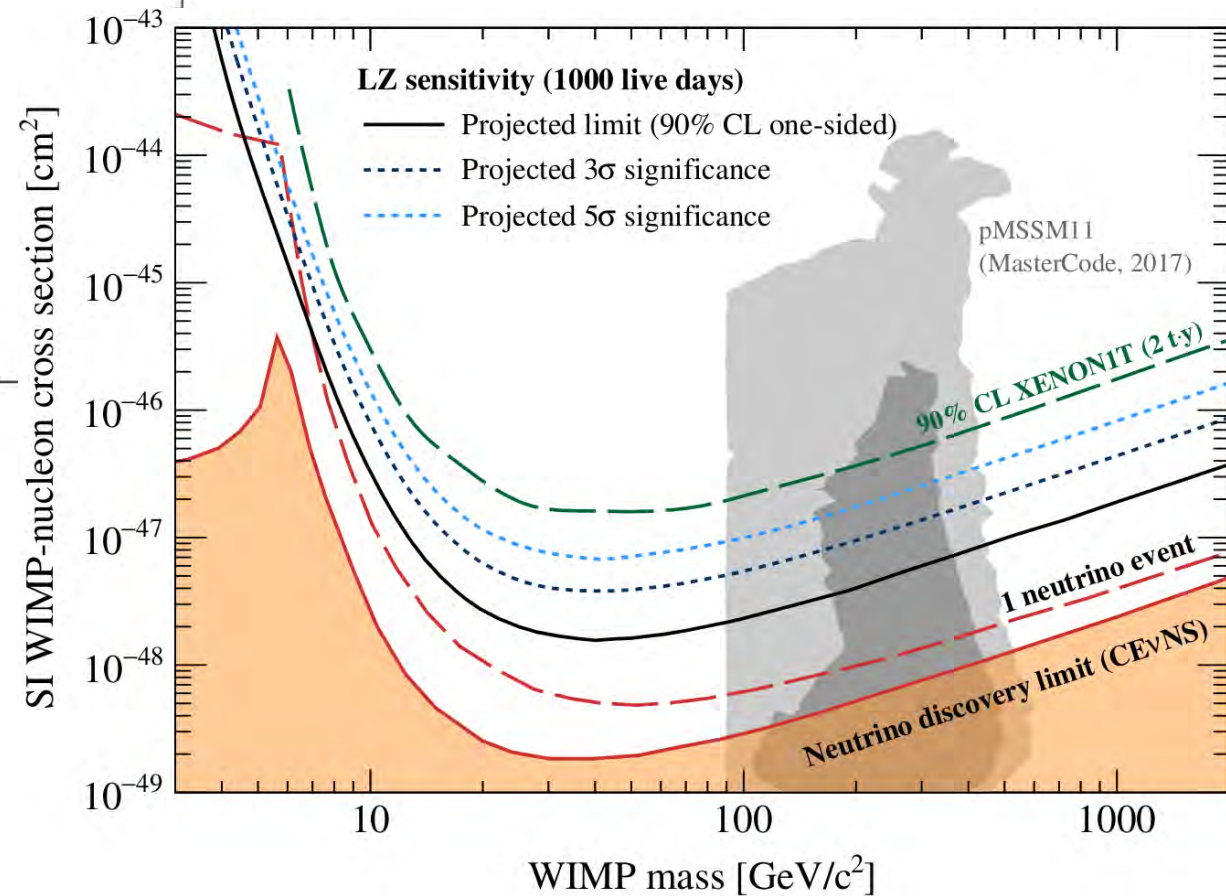
Sensitivity

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- Simulation of a 1000 day LZ run

- Projected detection and exclusion curves for LZ



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Progress

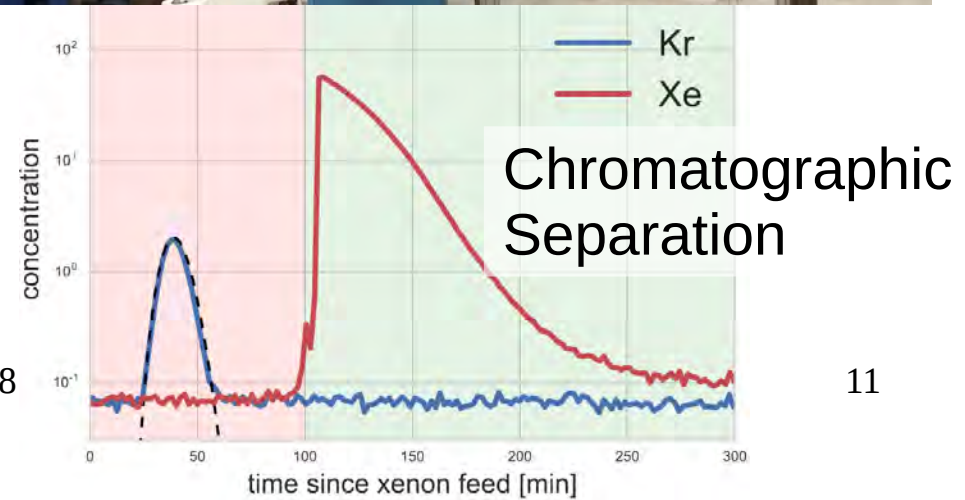


Xenon Procurement and Purification



- 6.5 tonnes of Xe at SLAC
 - 4 tonnes to go
- Xenon purification via charcoal chromatography
 - <https://arxiv.org/abs/1605.03844>

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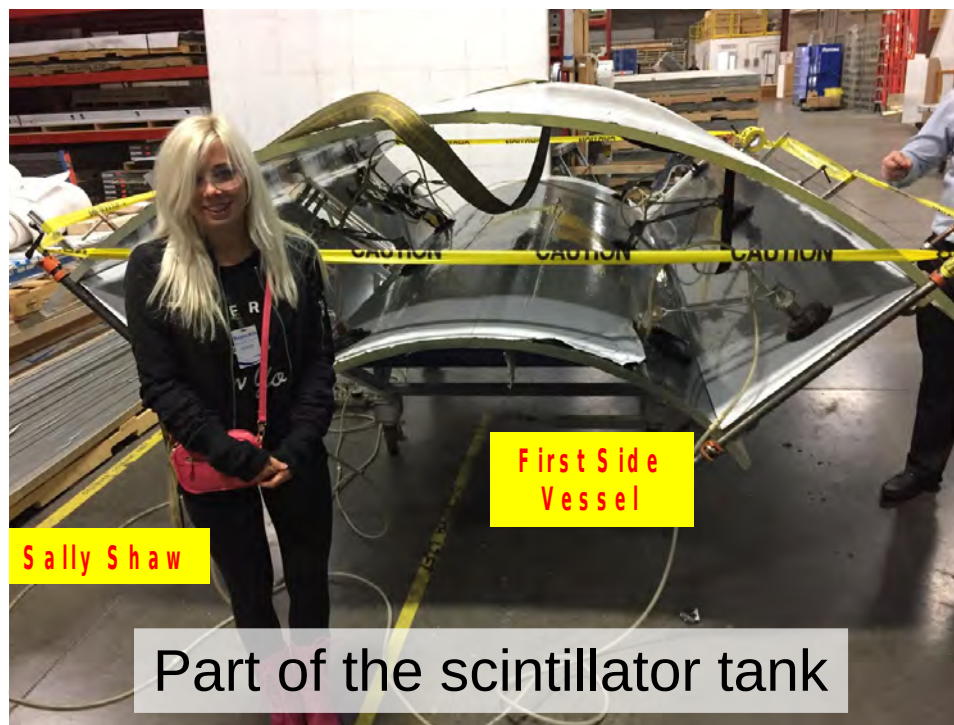
Xe & OD Vessels

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Inner Vessel

- Inner and outer vessels are finished, delivery soon
- Outer detector scintillator tanks finished this month



Sally Shaw

First Side Vessel

Part of the scintillator tank



Xe Gas and Liquid Handling

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System test @ SLAC

- Circulation tests at ~70SLPM at SLAC
- LZ circulation system installed and tested underground at the end of 2018
 - Using a dummy cryostat

One of LZ circulation compressors





HV Testing

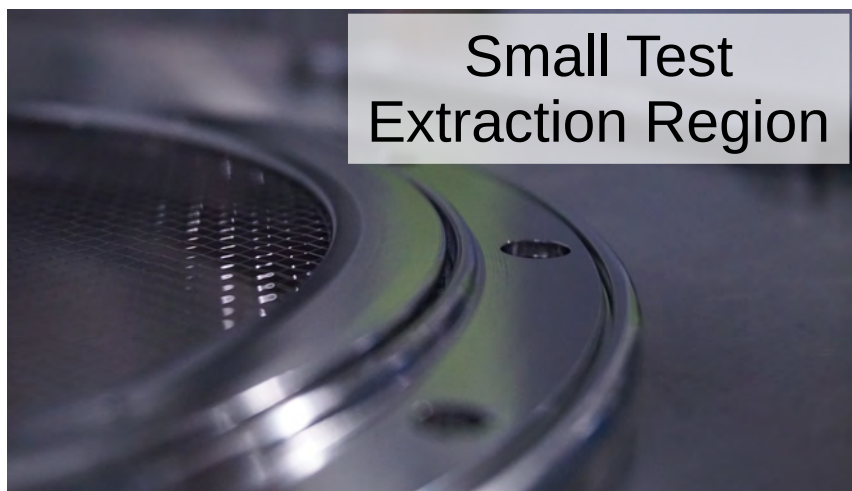
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- Cathode cable tested to 120kV
 - Cathode feedthrough testing in LAr to same voltage
- Small versions of grids (and individual wires) tested in gas and liquid Xe
- Full scale testing coming



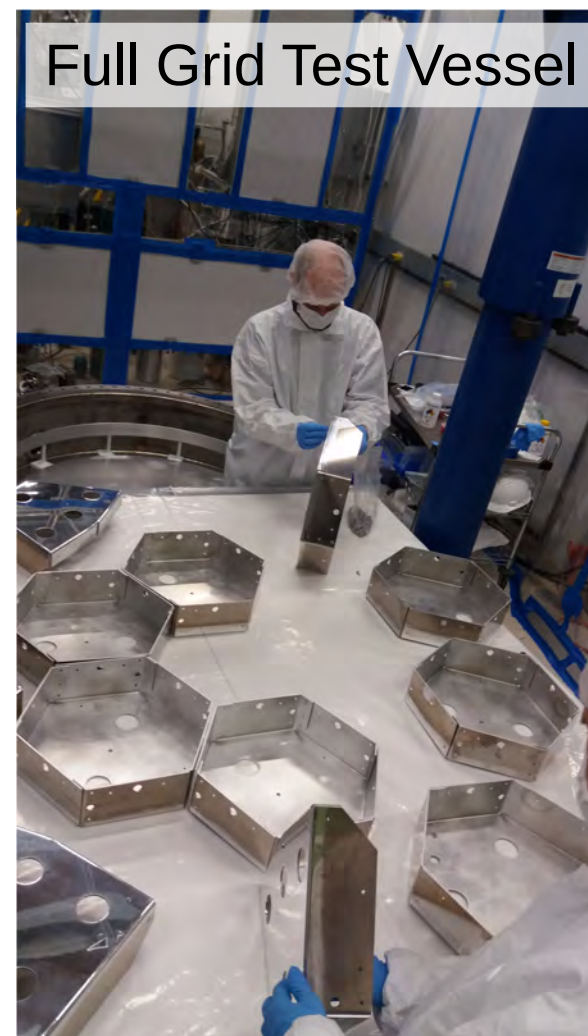
Cathode HV Test Structure

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Small Test Extraction Region

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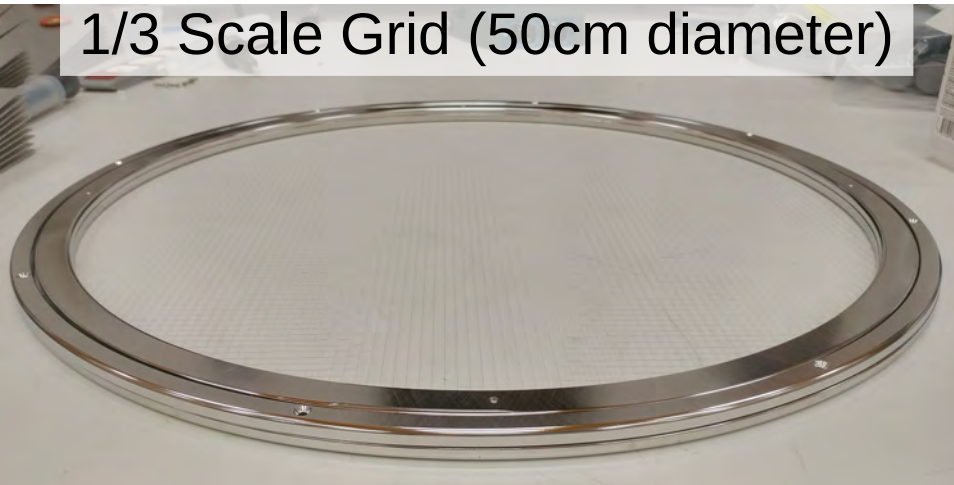
Full Grid Test Vessel



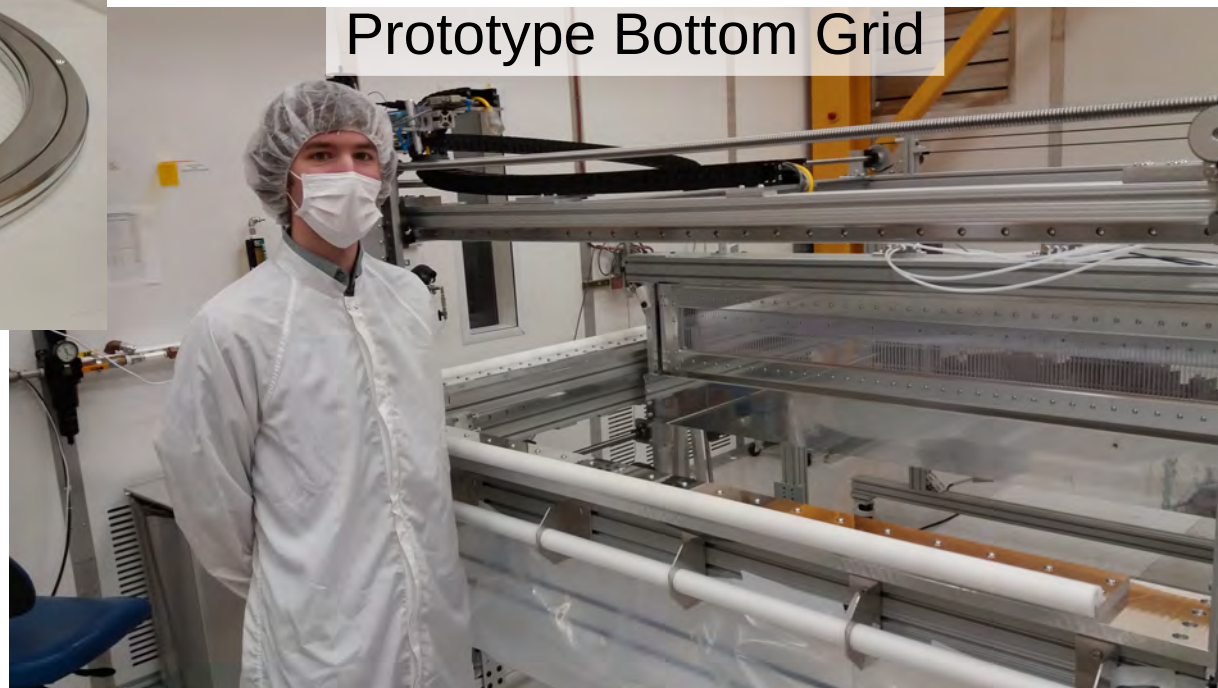
HV: Full Scale Grids

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1/3 Scale Grid (50cm diameter)



Prototype Bottom Grid



- 50cm test grid woven and glued to test methods
- First full scale grid in production now



PMT & DAQ

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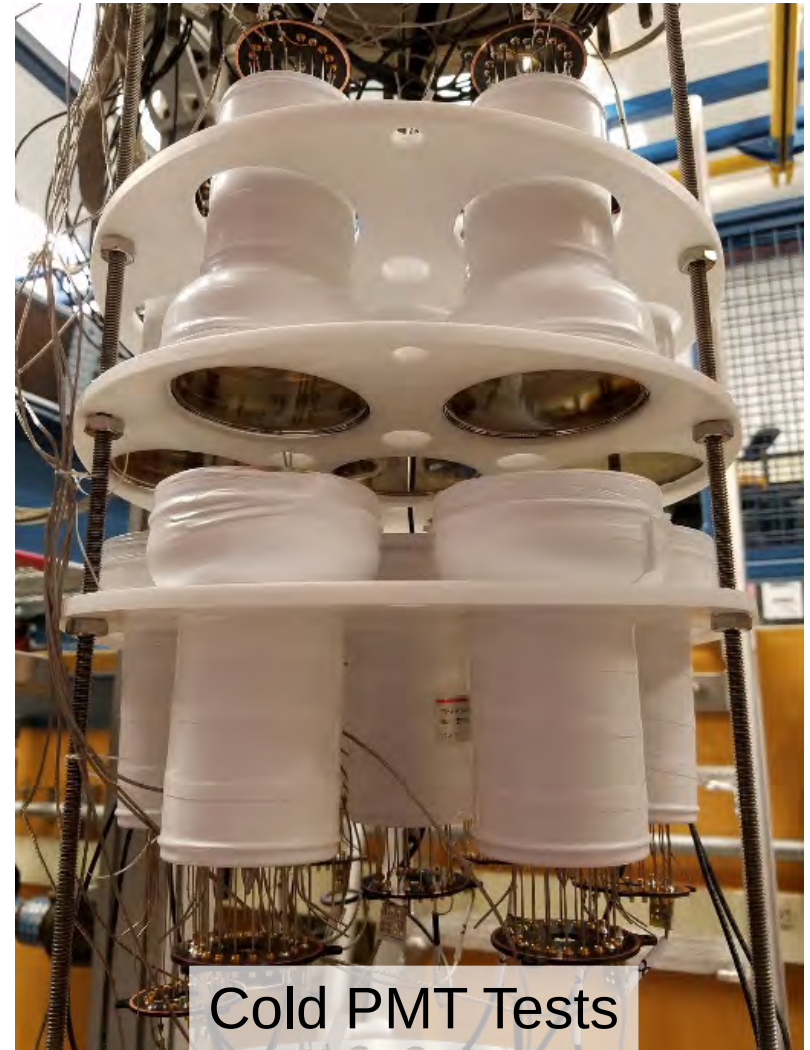
Titanium PMT Array Under Construction



- All 3" PMTs in hand
- All cold tested
- DAQ chain test constructed
- Measured response to Xe scintillation light
 - <https://arxiv.org/abs/1801.01597>

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Schedule

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- CD1 Review – March 2015
- CD2 Review – April 2016
- CD3 Review – February 2017 - construction can start in earnest
- Cryostat fabrication just completed
- PMT array assembly begins in March
- Xenon handling installation and commissioning starts Fall 2018
- TPC installation Spring-Summer 2019
- Cooldown starts Winter 2019-2020
- First physics data – Spring 2020



Conclusions

- WIMP dark matter remains an attractive dark matter candidate
- LZ will exclude a large fraction of the available parameter space and has the potential to discover WIMPs even if previous experiments fail to see them
- Massive screening and R&D program has made LZ possible
- Construction is under way!
- Details in the technical design report
<https://arxiv.org/abs/1703.09144>
- ... and the sensitivity paper:
<https://arxiv.org/abs/1802.06039>

Thank You