The LUX Dark Matter Experiment

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On behalf of the LUX colaboration

Particle Physics and Cosmology
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LUX Collaboration

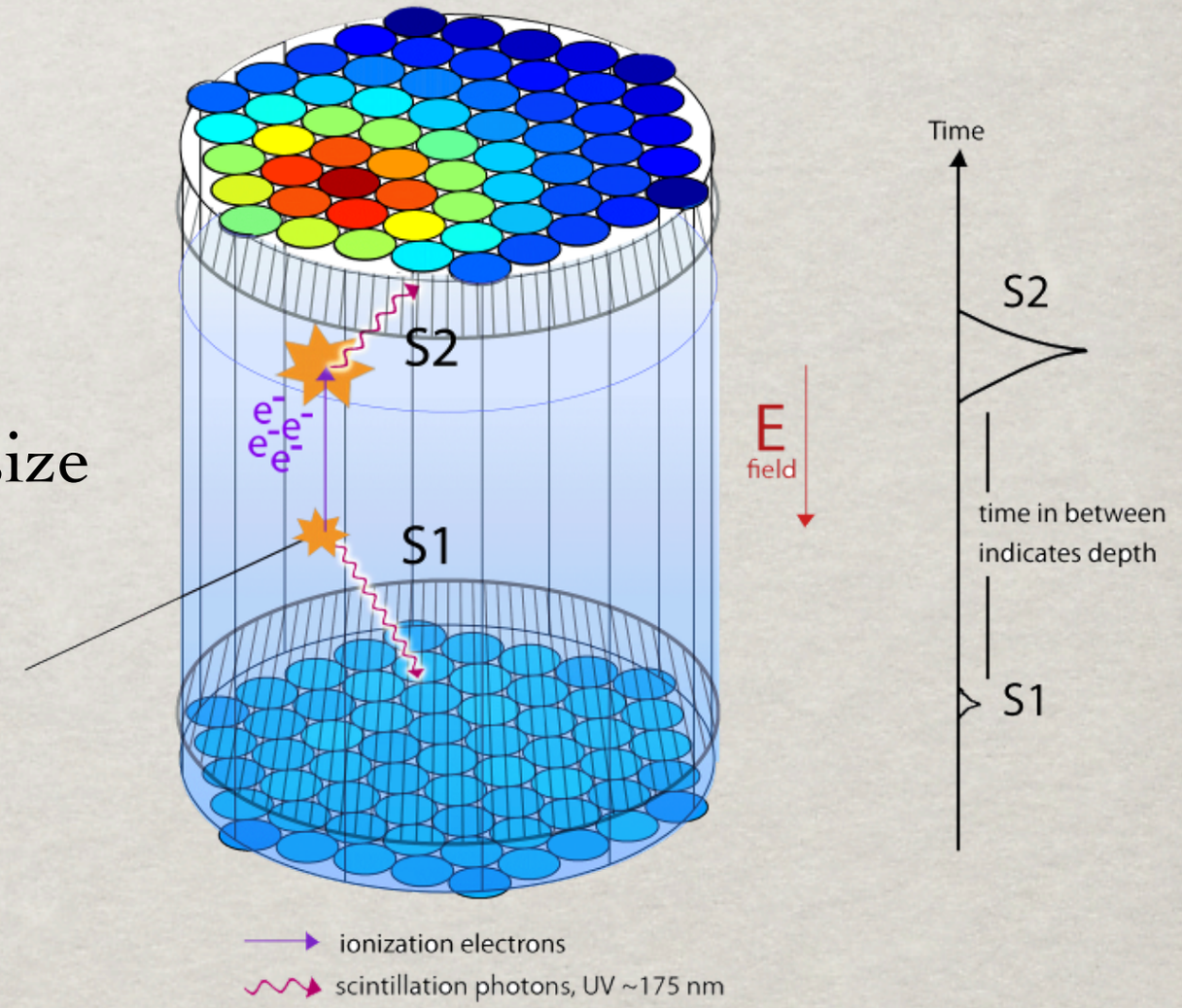
Brown
Case
Harvard
Maryland
LLNL
LIP Coimbra
Rochester
South Dakota
SDSMT
Texas A&M
UC Berkeley/LBNL
UC Davis
UC Santa Barbara
Yale

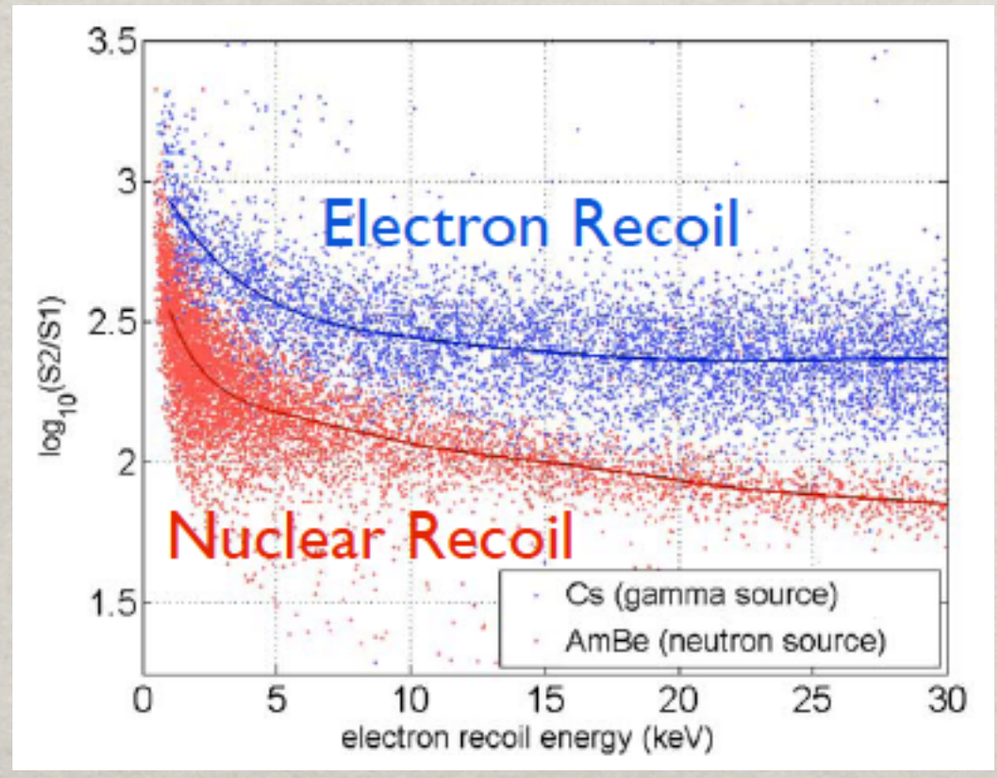
March 2011, Sanford Lab

Experimental Design

Double phase LXe TPC

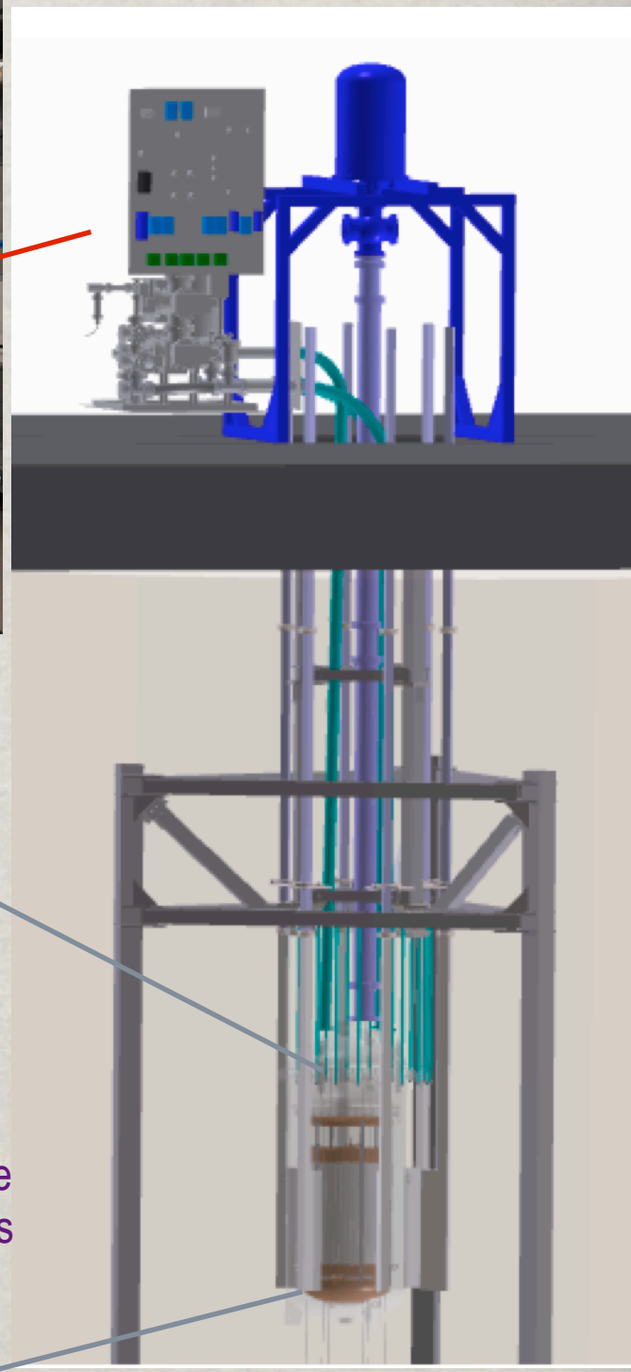
- Sensitive to single electrons and single photons
- Charge/light: nuclear recoils vs electron recoils
- Excellent 3D imaging
- Readily scalable up to multi-ton size

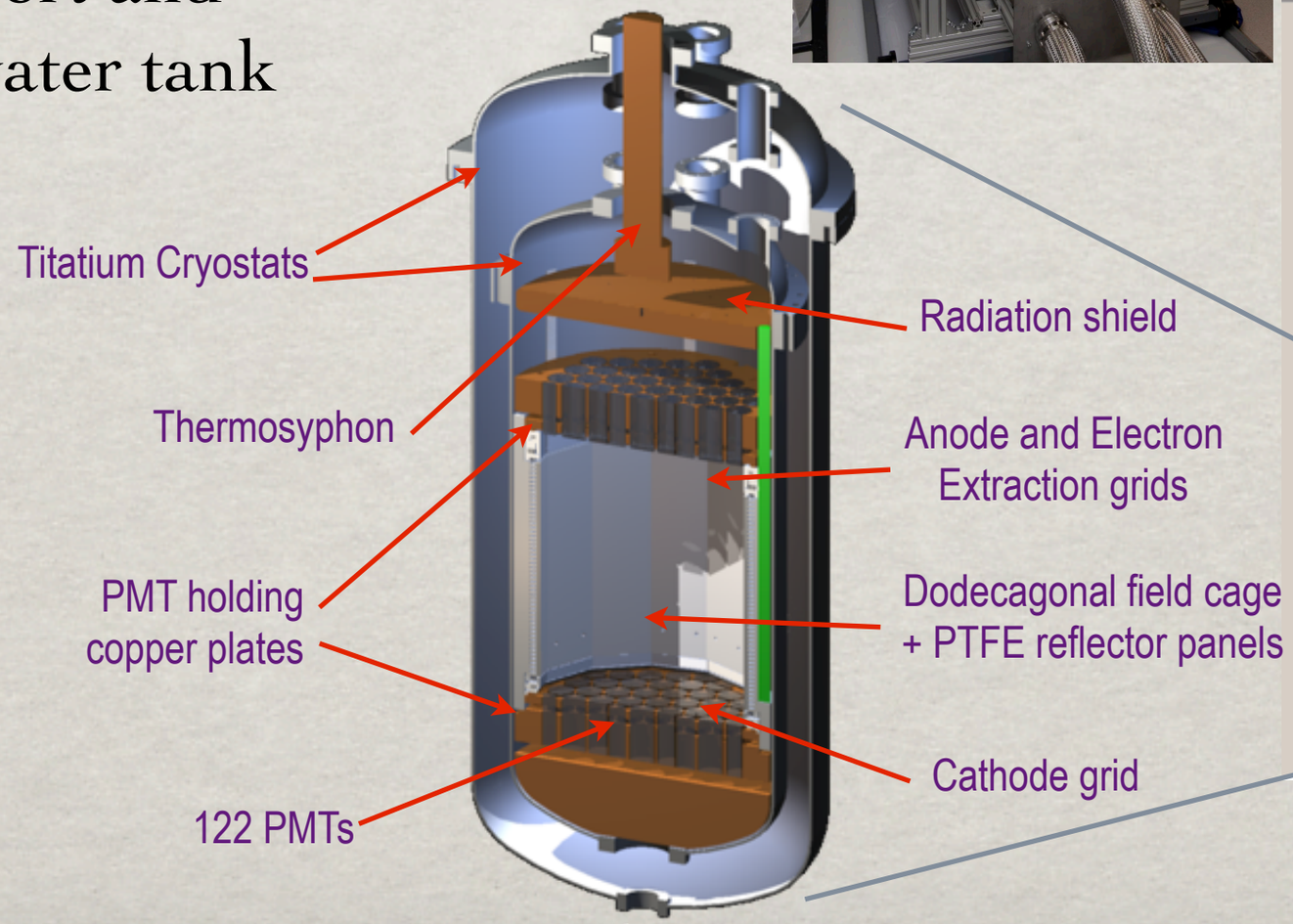




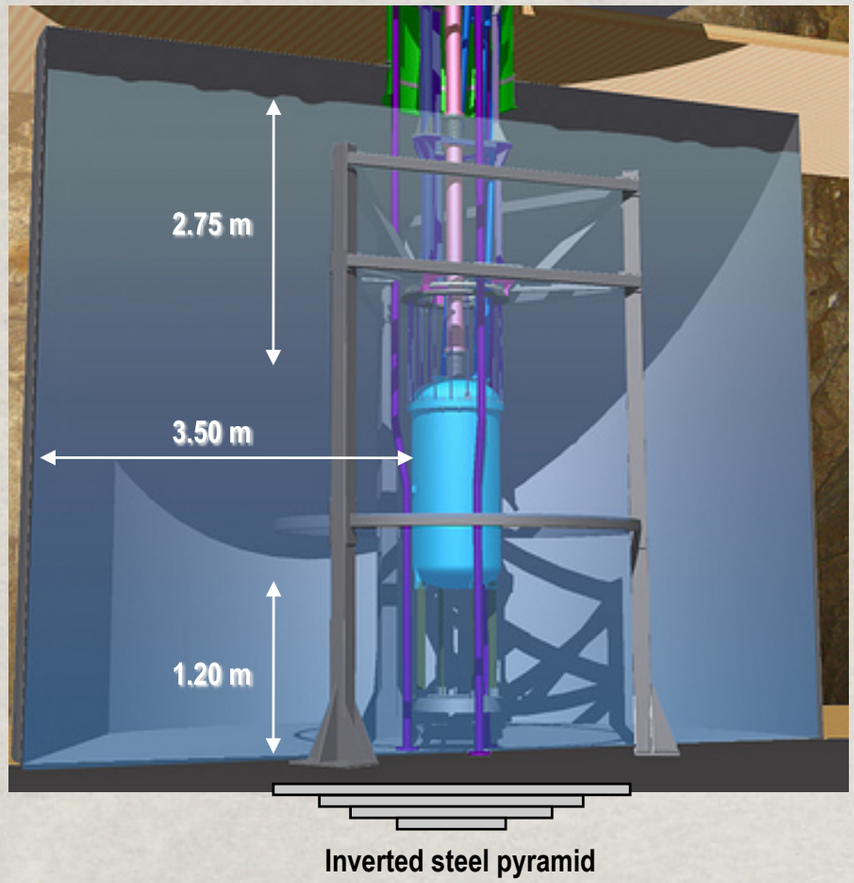
LUX Experimental Design

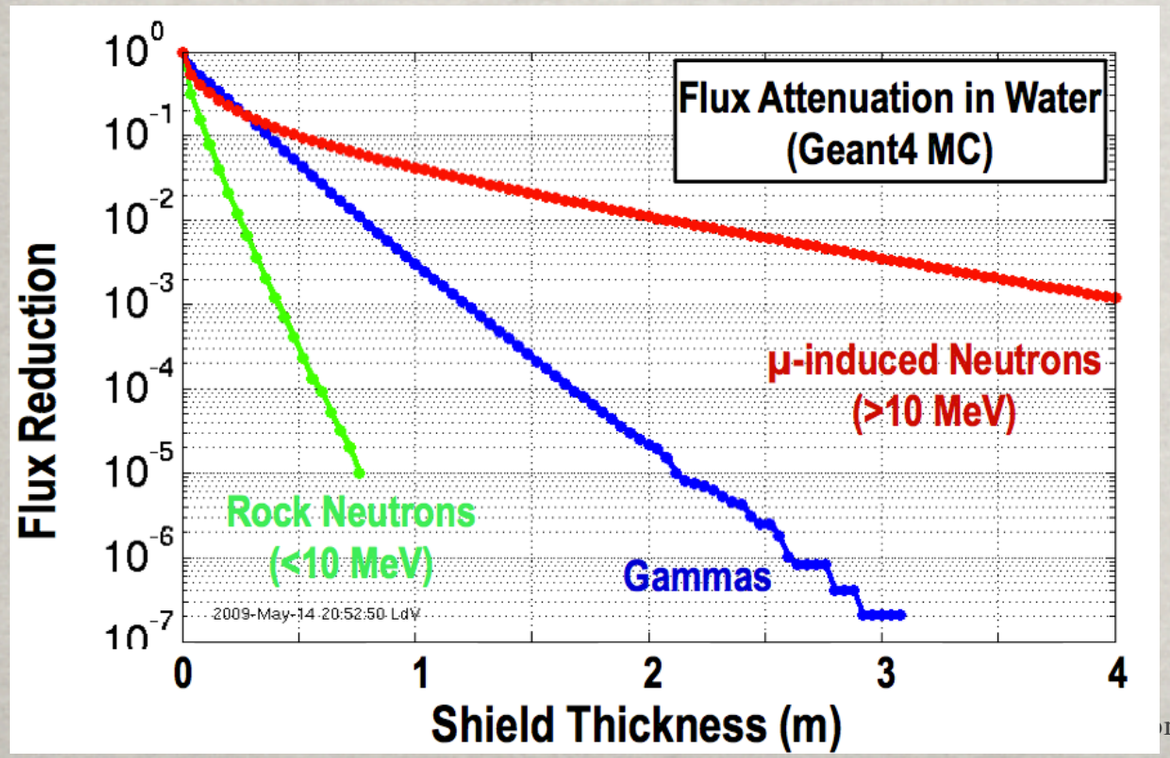
- 300 kg of Xenon
- Maximum drift length 50 cm
- Titanium cryostat material
  - No measured contamination at < ~0.2 mBq/kg limit
- Detector transport and installation in water tank





Water Tank



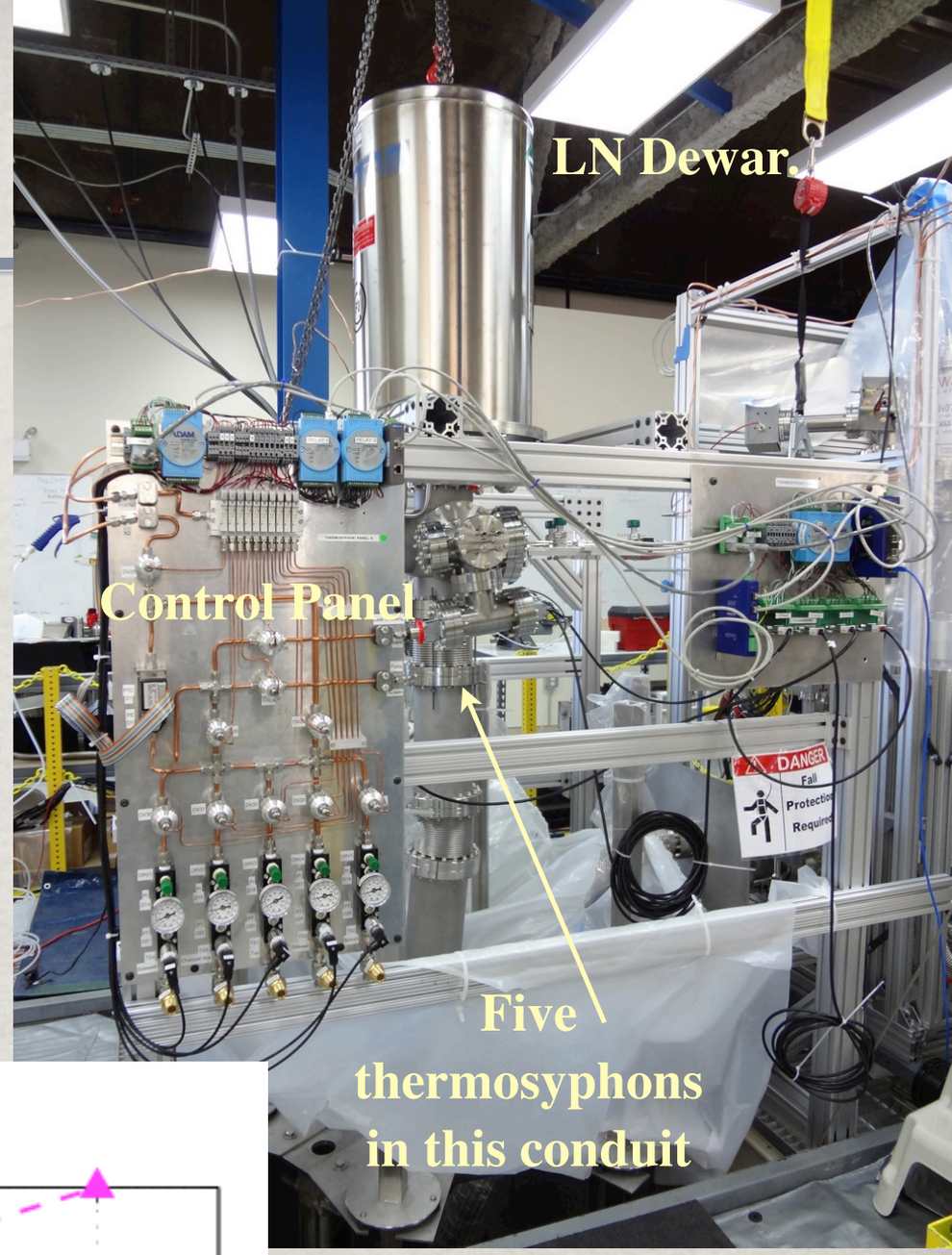


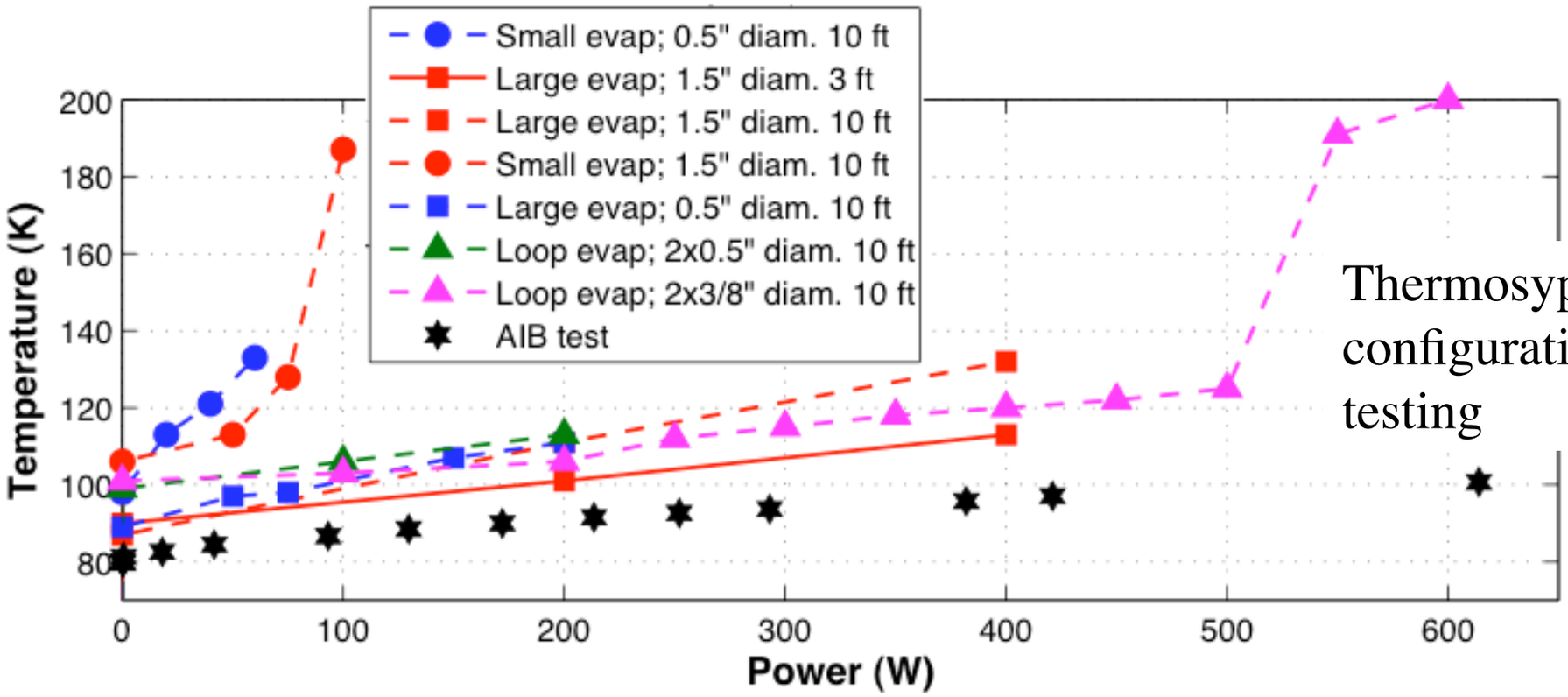
- Large water shield
  - Tank: d=8m, h=6m; **300 tonnes of water**
- 20 ton steel inverted pyramid below detector, to increase shielding
- Used as Cherenkov muon veto
  - 20 PMTs (Hamamatsu R7081, 10" diameter)
- Background reduction
  - Gamma events: ~10^{-9}
  - High-E neutrons (>10 MeV): ~10^{-3}

LUX: all external backgrounds sub-dominant

Cryogenics: Thermosyphon

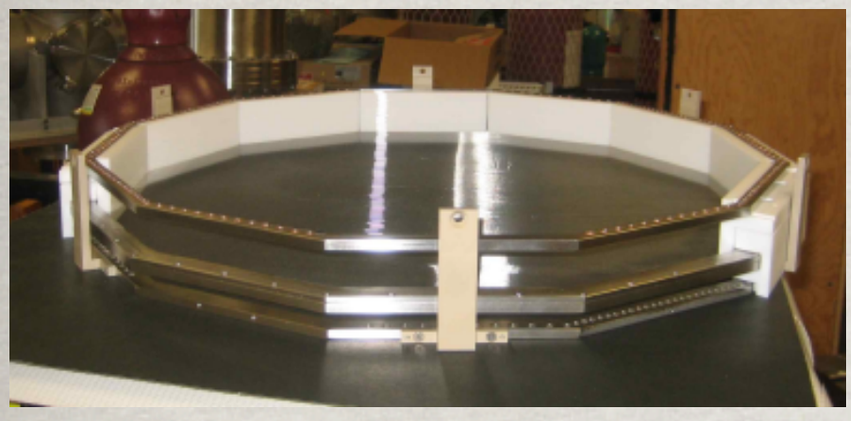
- Demonstrated ~800 kg for LUX 1.0
- Uniquely suitable for very large scale
  - Extremely high capacity: equivalent to a ~1 m Ø Cu bar
  - Remote deployment of multiple cold heads
  - Tunable to low power for fine control
- Intrinsically safe
  - Simple, no moving parts
  - Insensitive to loss of power





Thermosyphon configuration testing

LUX Detector Internals

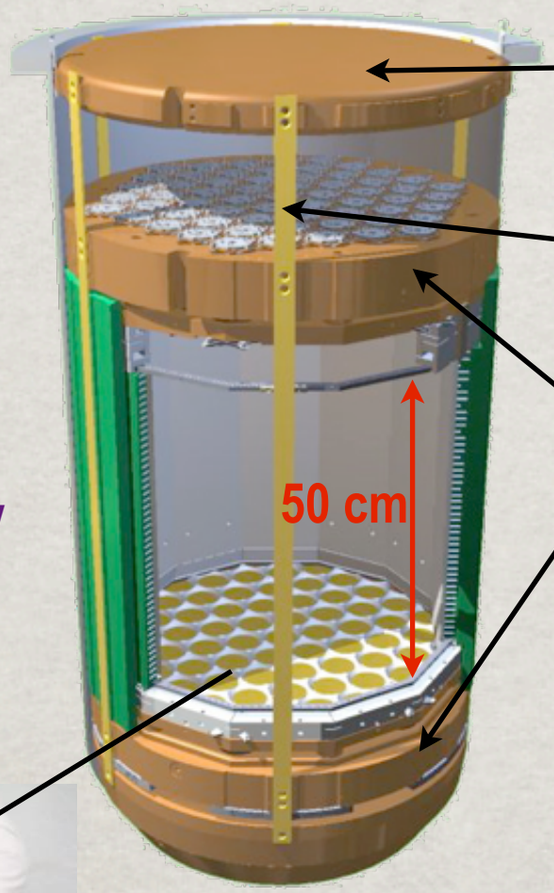


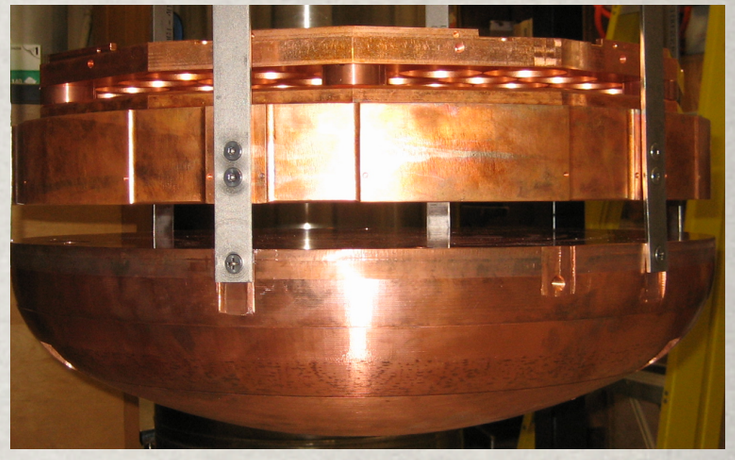
HV Grids

- 99% open area
- tested in real HV condition

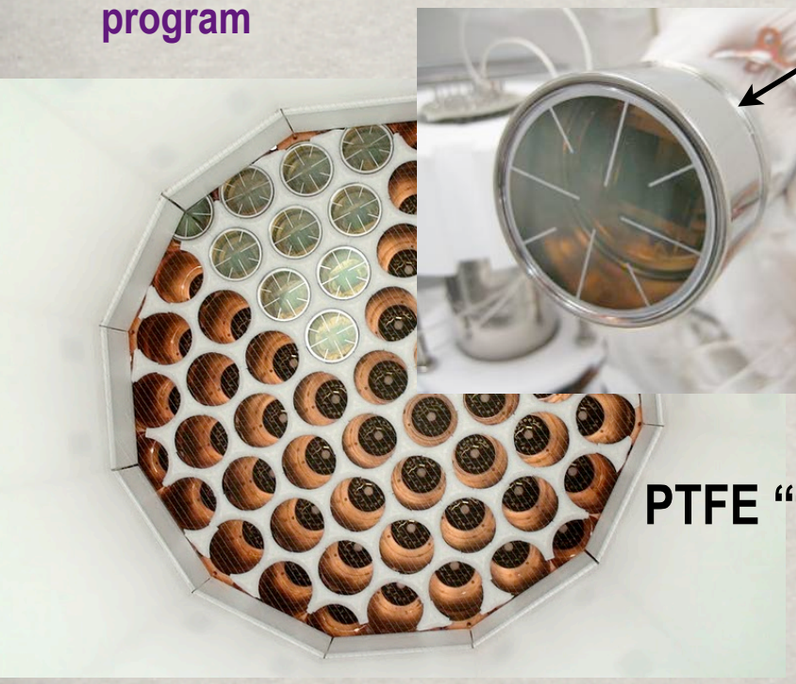
122 2" PMT R8778

- 175 nm, QE > ~30%
- U/Th ~9/3 mBq/PMT
- All tested in LUX 0.1 program





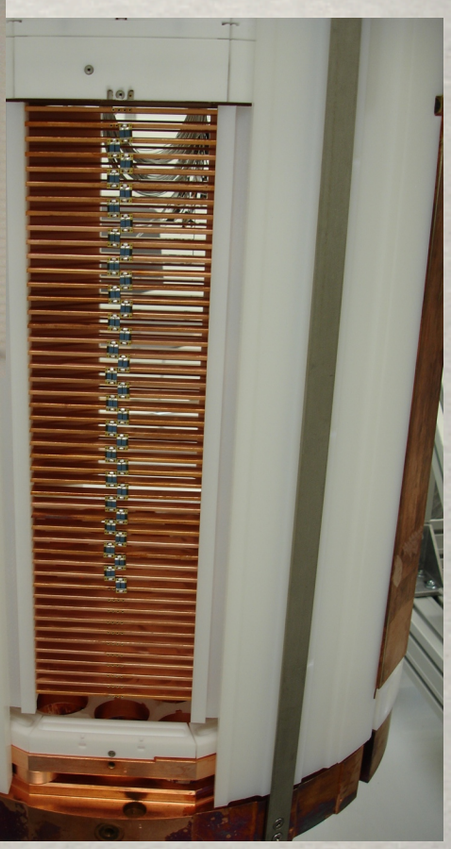
Bottom copper structure



PTFE “trifoils”

Dodecagonal field cage
+ PTFE reflector panels

48 copper field rings

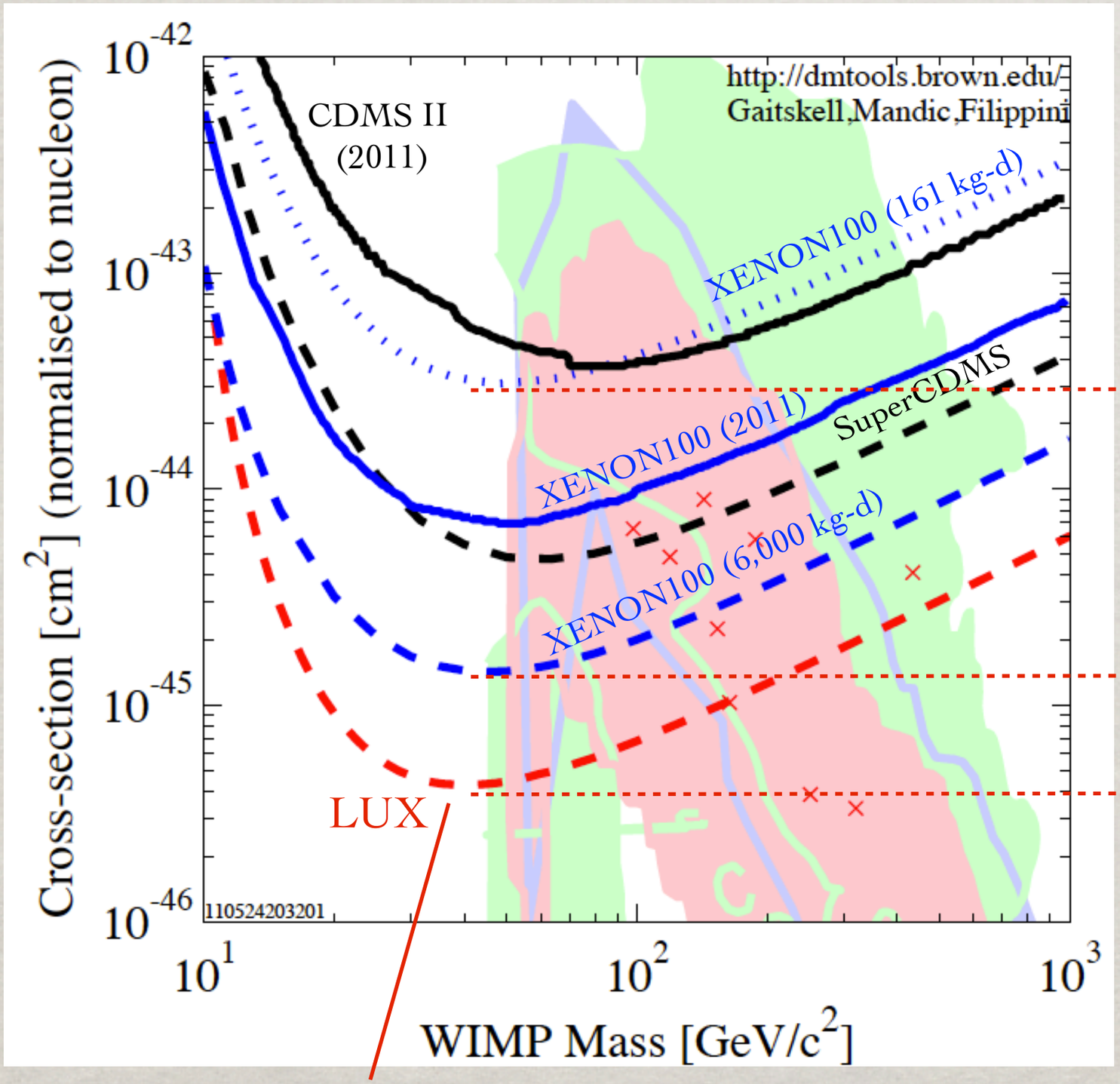


Assembled at Sanford lab in 2010

Backgrounds

- Goal: < 1NR event / 100kg / 300 days (50% accept.)
- Expected ER background ~260 μdru
  - PMT contribution dominant / external sources (10^{-4})
  - ^{85}Kr < 5 ppt (~10% of LUX ER background budget)
  - 300 kg = full advantage of Xe self-shielding
- Expected NR background < 500 $ndru_r$
  - Neutrons mostly from (alpha,n) on PMTs
  - Subdominant to gammas after ~99.5% ER discrimination
- Strength of LUX is in the extremely low ER and single NR background in the fiducial volume
  - 2 days ➔ < 1 ER event
  - 60 days ➔ <<1NR, ~16 ER before discrim. 99.5%
    - Equivalent to 150 days XENON100, zero background
  - 300 days ➔ 0.06 NR, 80 ER before discrim. 99.5%

LUX WIMP Sensitivity



LUX ~2 days

LUX ~60 days

LUX ~300 days

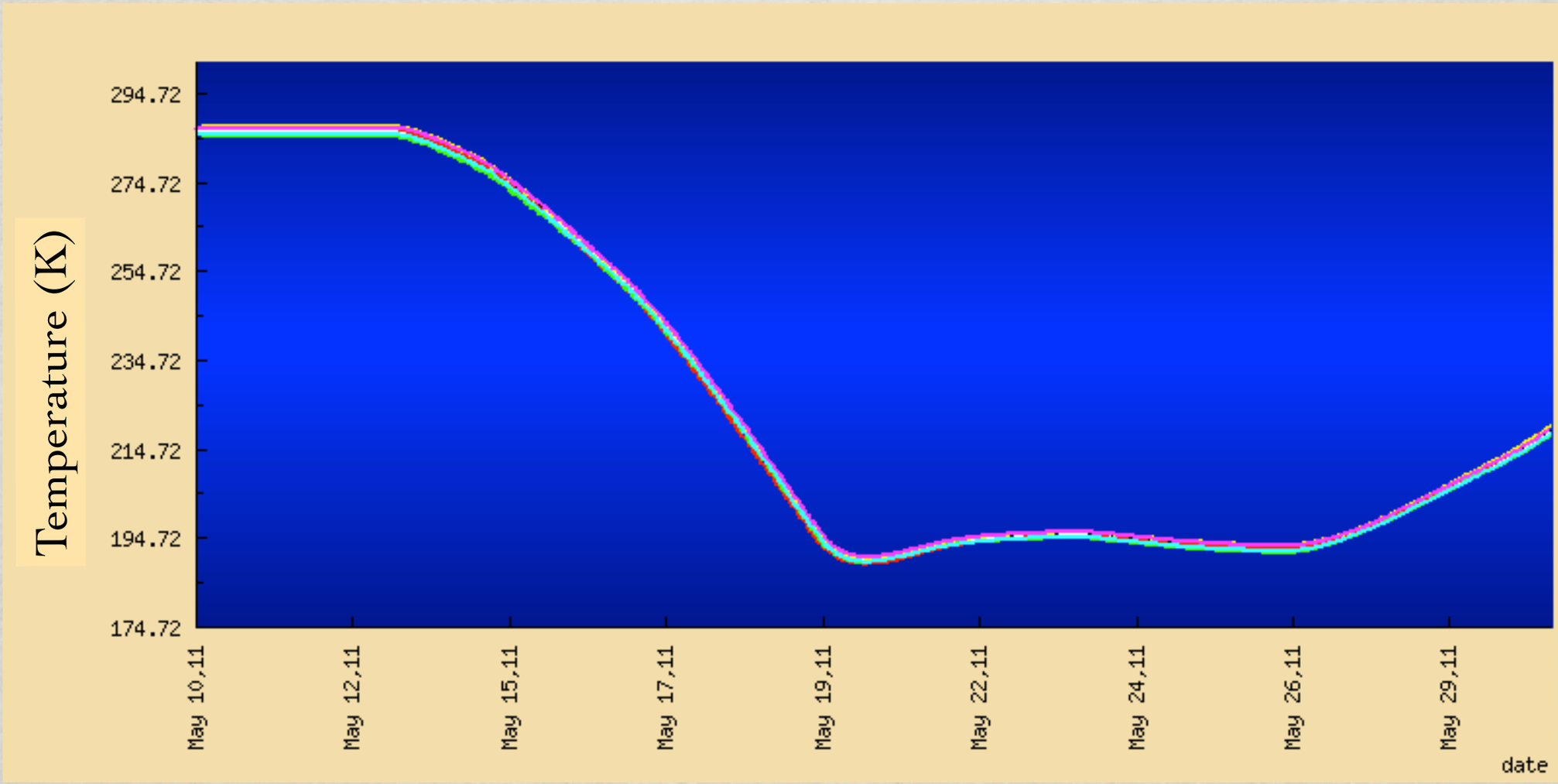
3.9 WIMPs at 7×10^{-46} cm^2 (100 GeV) in 1 year

Surface Operations at Sanford Lab

- Surface Infrastructure 100% complete
- Experiment in final stages of integration
- Duplicate of underground layout
- Right now: First cooldown at Surface Lab
- Near future: Davis Cavern (4850L)
  Underground deployment in 2012

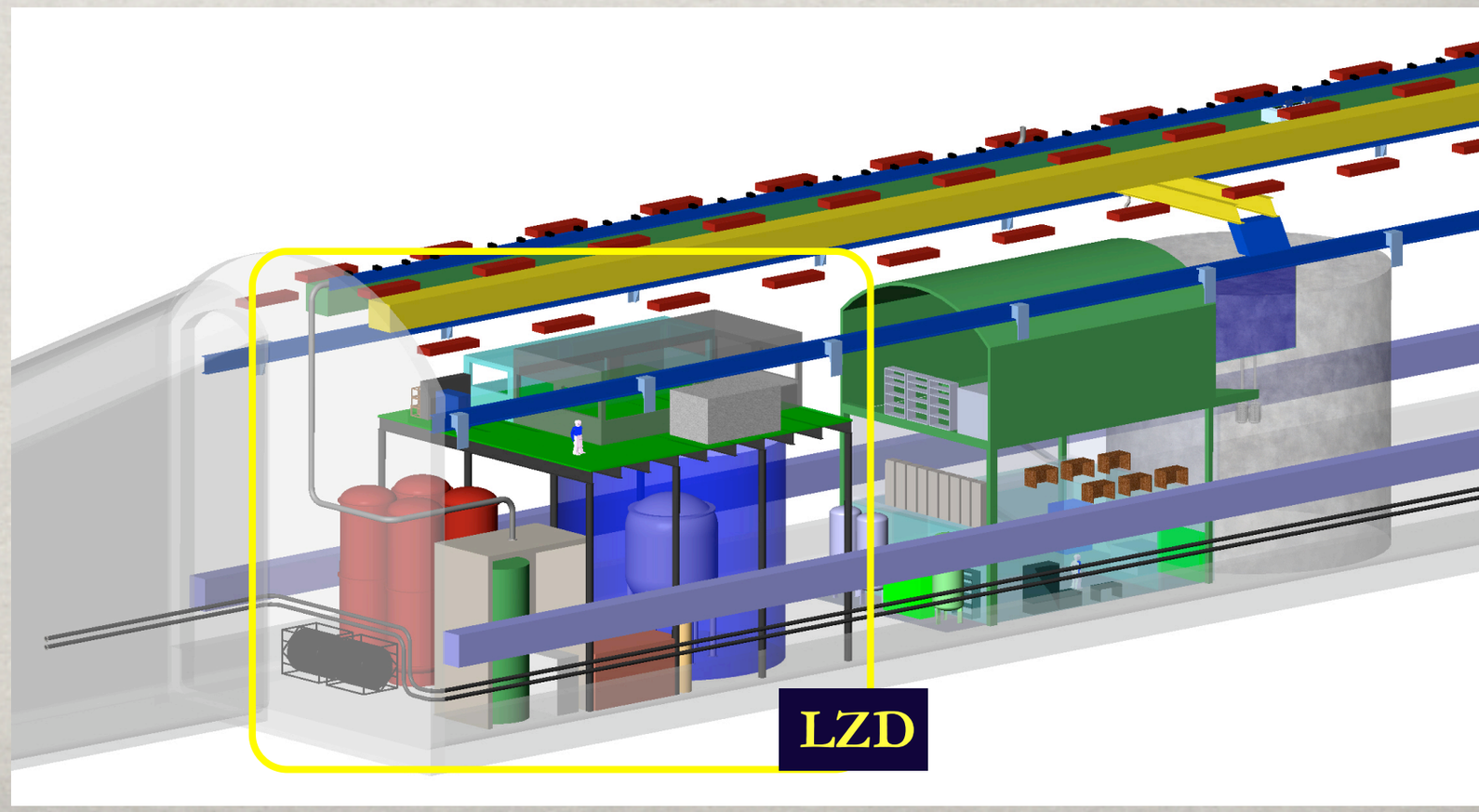
Surface Operations at Sanford Lab

First cooldown at Surface lab, May 2011



The LZ Collaboration

- LUX + ZEPLIN
  - Imperial College London, UK
  - Institute of Theoretical and Experimental Physics (ITEP), Russia
  - LIP-Coimbra, Portugal
  - STFC - Rutherford Appleton Laboratory, UK
  - University of Edinburgh, UK
  - Moscow State Engineering Physics Institute (MEPhI), Russia
  - STFC - Daresbury Laboratory, UK
- LZS
  - 1.5 ton, in Davis Cavern
- LZD
  - 20 ton LXe mass

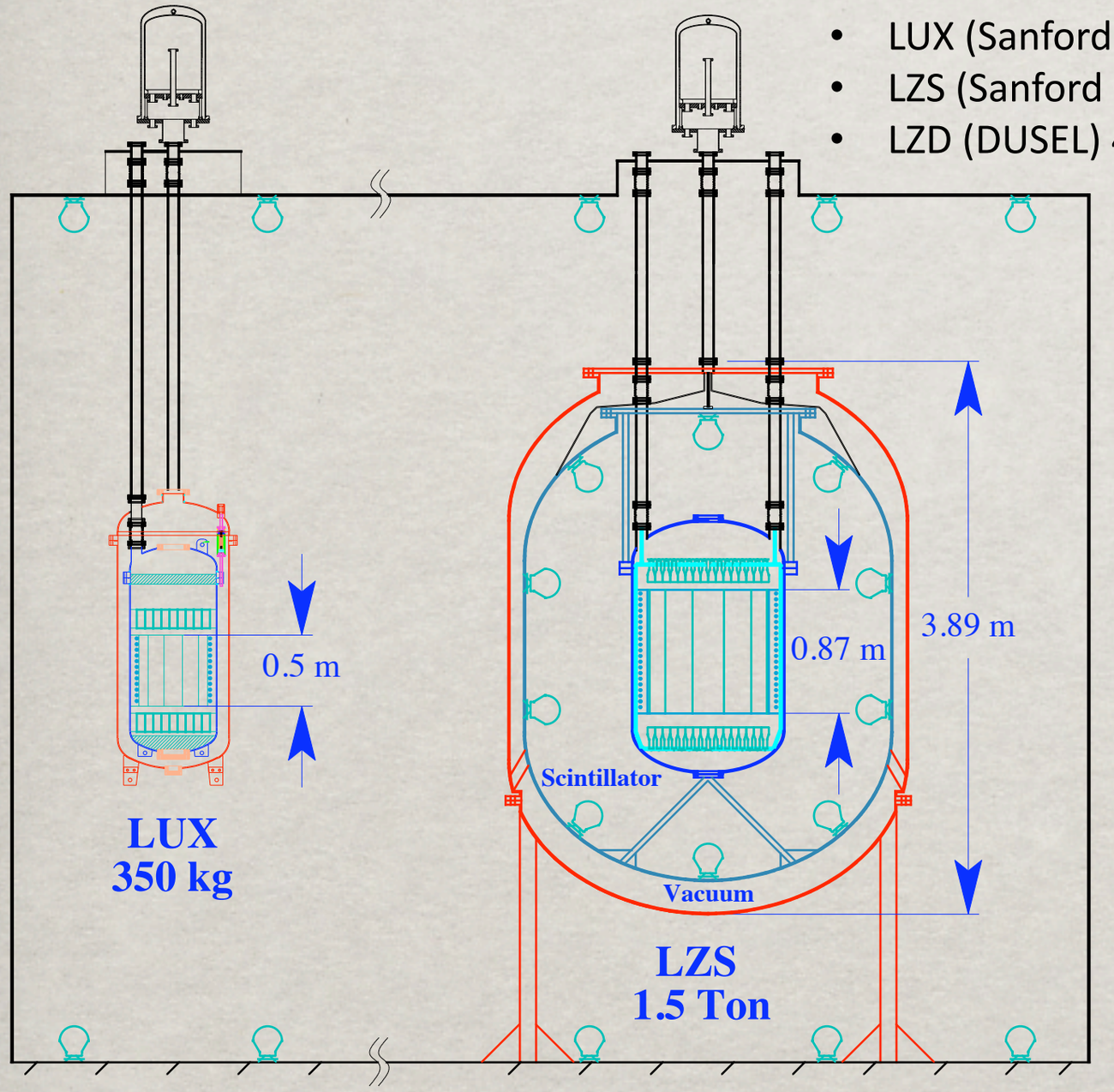


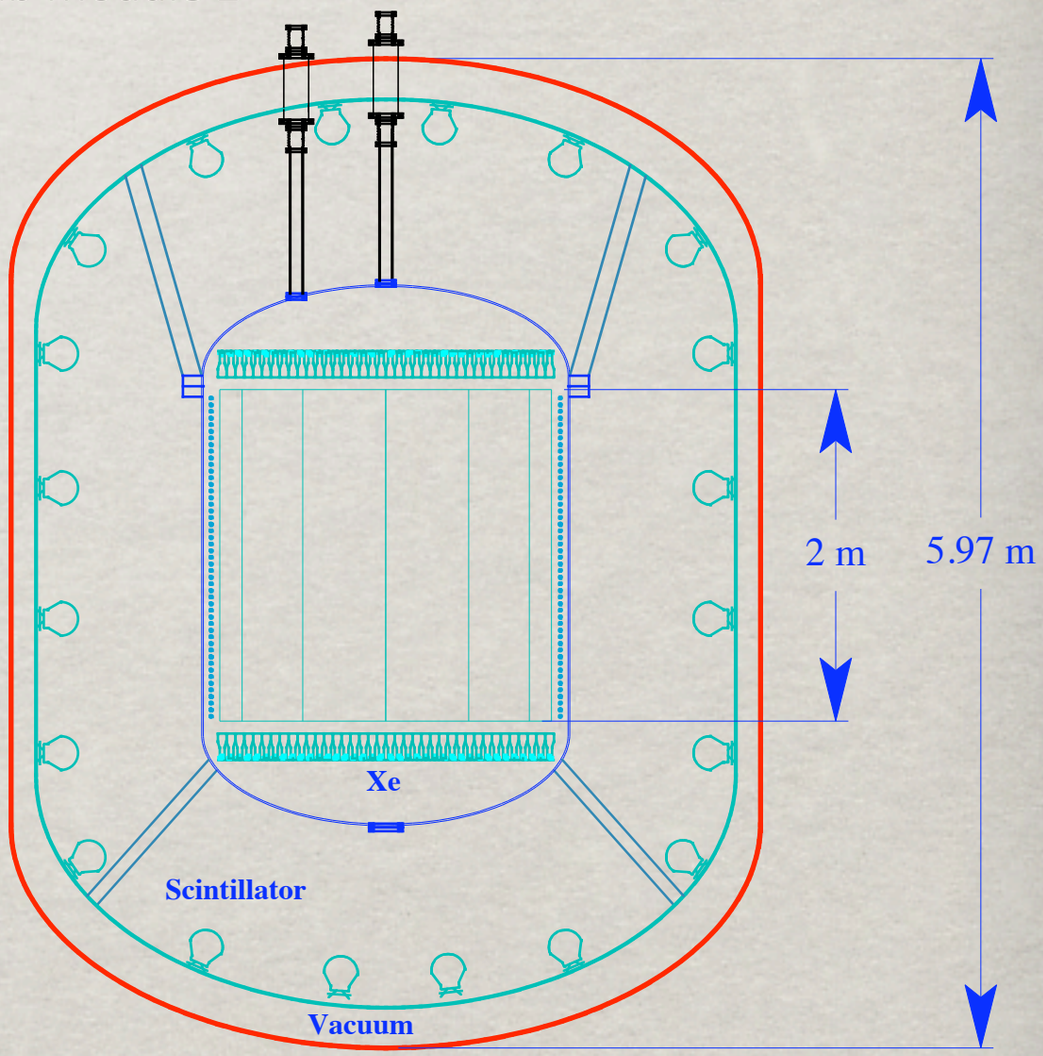
LUX → LZSanford → LZDusel

- LUX → LZD is factor 4 linear increase

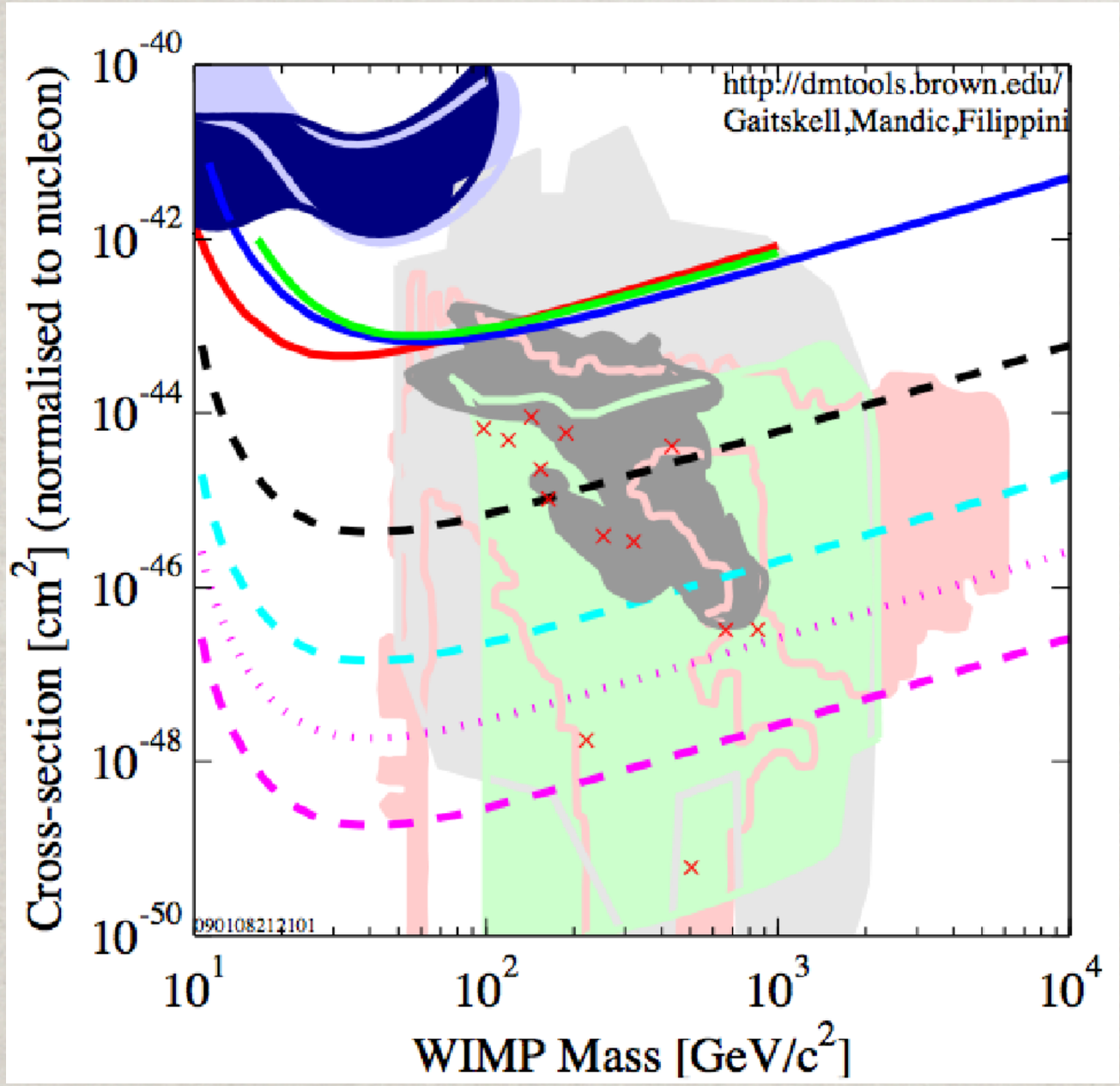
LZD: Xe 20 tonnes,
Ultimate Search?

- LUX (Sanford Lab) 4850 Davis Complex
- LZS (Sanford Lab) 4850 Davis Complex
- LZD (DUSEL) 4850 Lab Module 2





LZ Program WIMP Sensitivity



LUX (constr: 2009-2011, ops: 2011-2012)
100 kg x 300 days

LZ-S (constr: 2012-2013, ops: 2013-2014)
1,200 kg x 500 days

LZ-D (constr: 2014-2017, ops: 2017-2022)
17,000 kg x 1,000 days

Fiducial volumes selected to match < 1NR event in full exposure

Thank you!