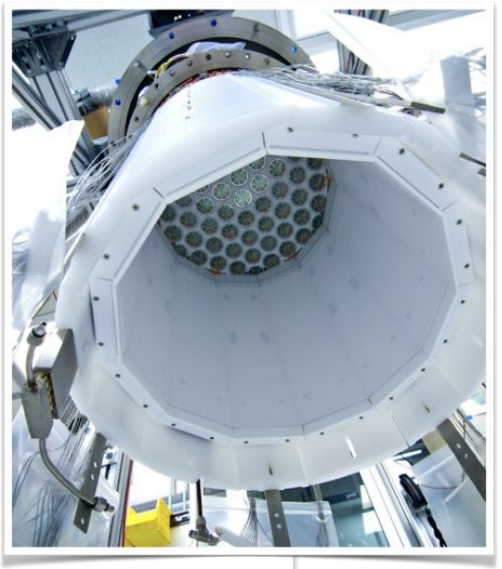
Recent results from LUX

Jornadas LIP 2018

A. Lindote, 17 February 2018

The LUX Detector

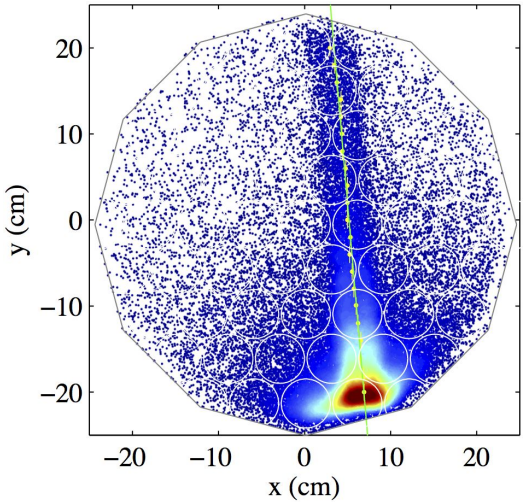
LUX internals: PTFE reflectors and top PMT array



- **World-leader in WIMP sensitivity (2013 - 2017)**
- 250 kg active Xe target
  - ~30× less than LZ
- Technology pioneer:
  - Titanium cryostat (ultra-low background)
  - Use of thermosyphons for cooldown
  - Chromatographic separation of Kr content down to ~4 ppt
  - Precise low-energy calibrations for Xe ER and NR response
    - Sources mixed in Xe (^{83m}Kr, CH_3T, ^{14}C)
    - Neutrons from DD generator

LIP responsibilities

- Hardware
  - LN System (F. Neves)
    - Fully automated system, hardware and software developed at LIP
  - Control System (V. Solovov)
    - ~500 channels (sensors, valves, HV, etc.), interface via mySQL (~2k accesses /s)
- Software and Analysis
  - Position reconstruction algorithm (C. Silva, V. Solovov)
    - Mercury, developed at LIP for ZEPLIN-III (JINST 13 P02001 2018)
  - Data processing (A. Lindote)
    - Development of the DP framework, processing of all the experiment data (>1 PB)
  - Many analysis contributions (WS analysis, wall model, etc.)
- Coordination Positions
  - Detector operations, on-site science operations, data processing
  - Analysis workgroup coordination (C. Silva is the current coordinator)



Reconstructed positions of neutron interactions from the DD generator

LUX Timeline

2008: LUX funded (DOE+NSF)

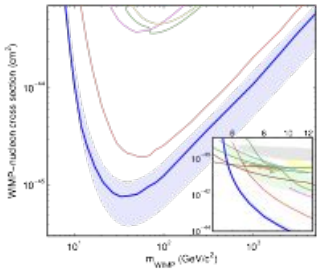
2006: LUX collab. formed

2012 (Jul): UG lab complete, LUX moves UG

2013 (Apr): First science run starts

100 live days

2013 (Nov): First results (3 months) reported

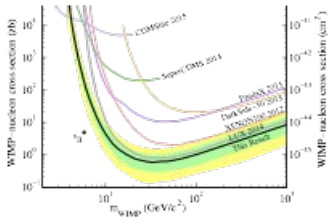


PRL, 112, 091303, 2014
(1575 citations)

2014 (Sep): 332-day run started!

332 live days

2015 (Dec.) 3-month run reanalysis posted

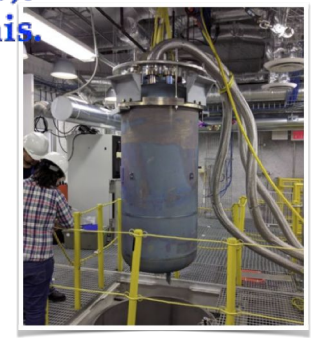


PRL, 116, 161301, 2016
(371 citations)

2016 (May): Run finished

2016 (July): 332 day results announced

2016 (Sep): Decommis. starts

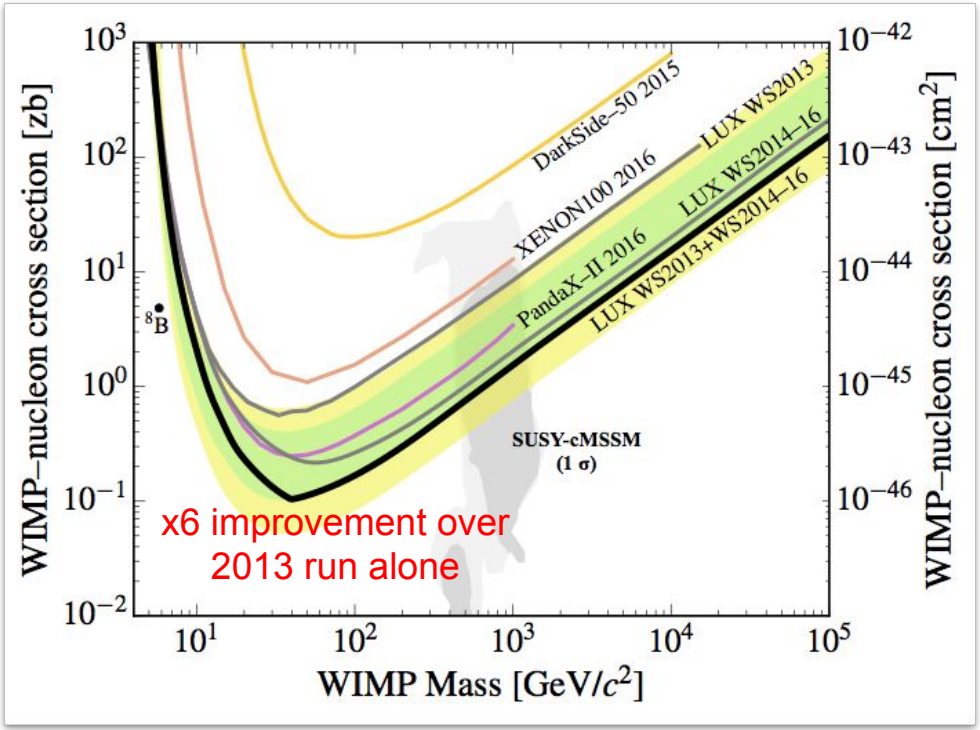


WIMP SI Sensitivity

In January 2017 LUX published the combined sensitivity of the two runs

PRL 118, 021303 2017
(535 citations)

Most cited particle physics paper of 2017!!!



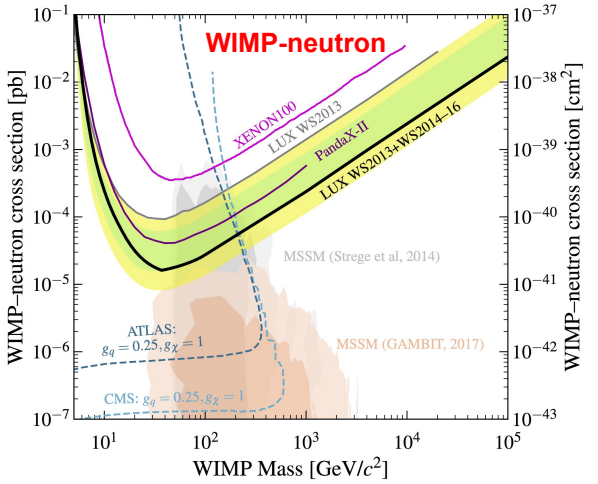
Still world-leading for low mass WIMPs (4 - 10 GeV)

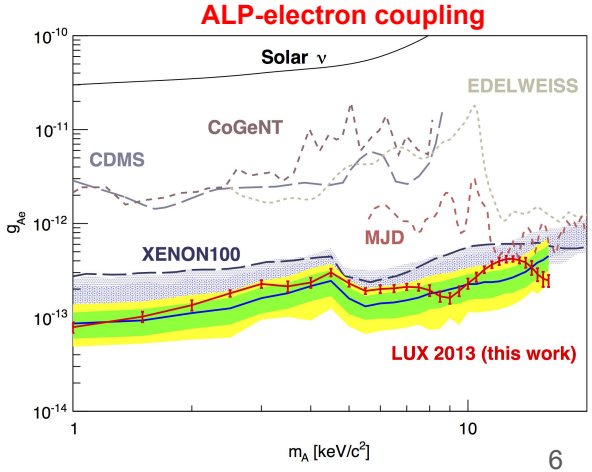
LUX was the most sensitive WIMP detector for 4 years (Oct. 2013 - Oct. 2017)

Other Physics Studies

LUX has a large amount of data which can be used for other analyses:

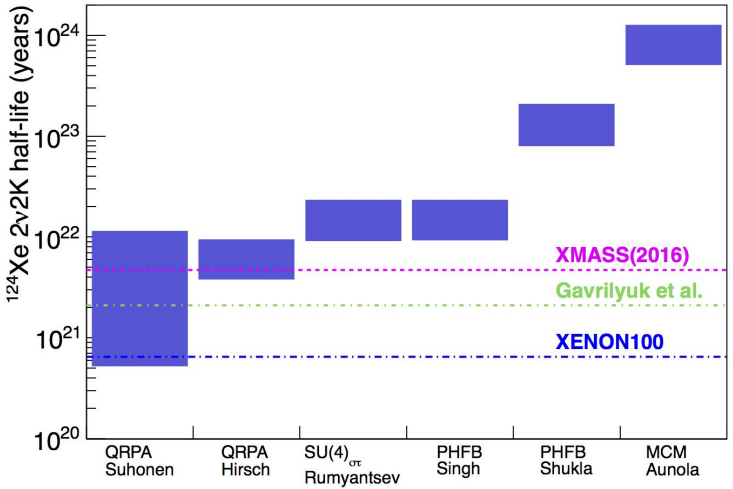
- Spin-dependent WIMP interactions (PRL 118, 251302 2017)
- Xenon physics
  - Low energy ER and NR calibrations (PRD 93, 072009 2016, arXiv:1608.053
  - Recombination and energy resolution (PRD 95, 012008 2017)
- Other Dark Matter candidates
  - Axions and ALPs (PRL 118, 261301 2017)
  - Mirror DM, light WIMPs, LIPs
- Neutrino studies (e.g magnetic moment)
- Rare decays in xenon isotopes
  - Neutrinoless double beta decay in ^{136}Xe and ^{134}Xe
  - Double beta decay in ^{134}Xe
  - Double electron capture in ^{124}Xe





Double electron capture in ^{124}Xe

- $^{124}Xe + 2e^- \rightarrow {}^{124}Te + 2\nu_e$ (allowed in the SM)
- Neutrinoless mode: lepton number violation, Majorana nature of the neutrino
- Studying the normal decay:
  - Tests nuclear models
  - Improves estimate of 0ν half-life
- In ^{124}Xe: 76.7% of the times the 2 captured electrons are from the K-shell
  - De-excitation X-rays and Auger e$^-$s: ~64 keV
- Half-life estimate:
  - 10^{20}–10^{24} yr (from different nuclear models)
- In LUX:
  - 10^{21}–10^{22} yr sensitivity achievable



Summary

- LUX had 4 extremely productive years, and is still producing new physics results
  - World leading WIMP search experiment until late 2017
  - Made significant improvements in the calibration of xenon detectors
- Various additional analyses are on-going, to explore the full physics potential of the data
  - WIMP annual modulation, inelastic DM, EFT, etc.
- Accumulated expertise used in the design of LZ
- The LIP team was deeply involved in all areas of the experiment
  - Made crucial contributions in hardware, software, data analysis and team coordination

LUX on display at the SURF visitors center

The LUX Collaboration

20 institutions in the US, Portugal and the UK

~100 scientists