

LUX-ZEPLIN (LZ)

status & outlook



Markus Horn

on behalf of the LZ collaboration

Outline

- Direct Dark Matter search with LZ
 - collaboration, detector principle, design
 - sensitivity projection
- LZ status updates
 - TPC assembly (Surface Lab at SURF)
 - Outer detector installation
 - Xenon circulation system
- Timeline and summary



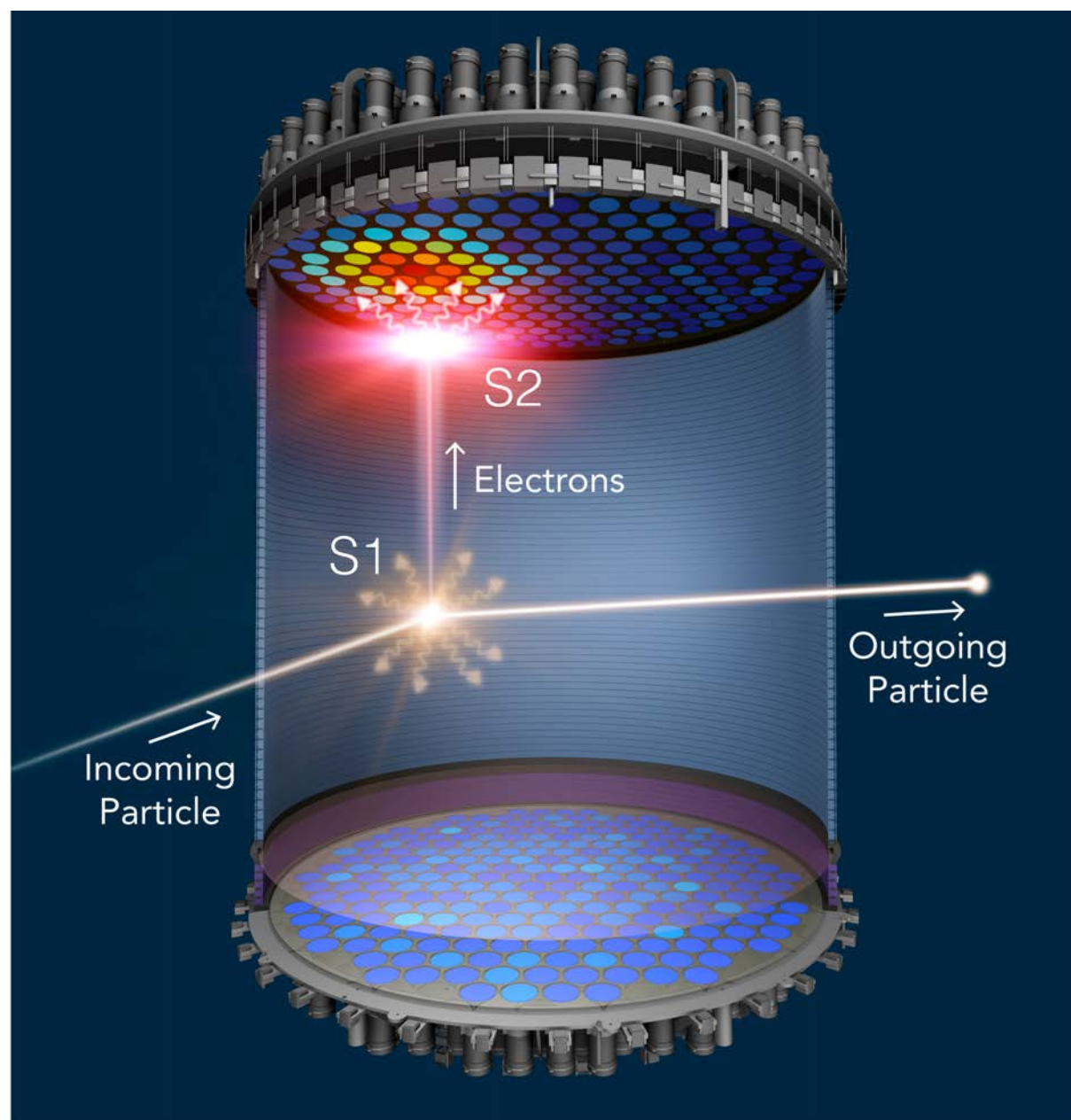
LUX - ZEPLIN (LZ)



- 37 institutions
- ~250 collaborators
- 5 countries, 3 continents
- ... and counting...

LZ - detector principle

- Two-phase liquid xenon time projection chamber
- Elastic scattering of WIMPs off target nuclei



scintillation (S1) and
ionisation (S2)

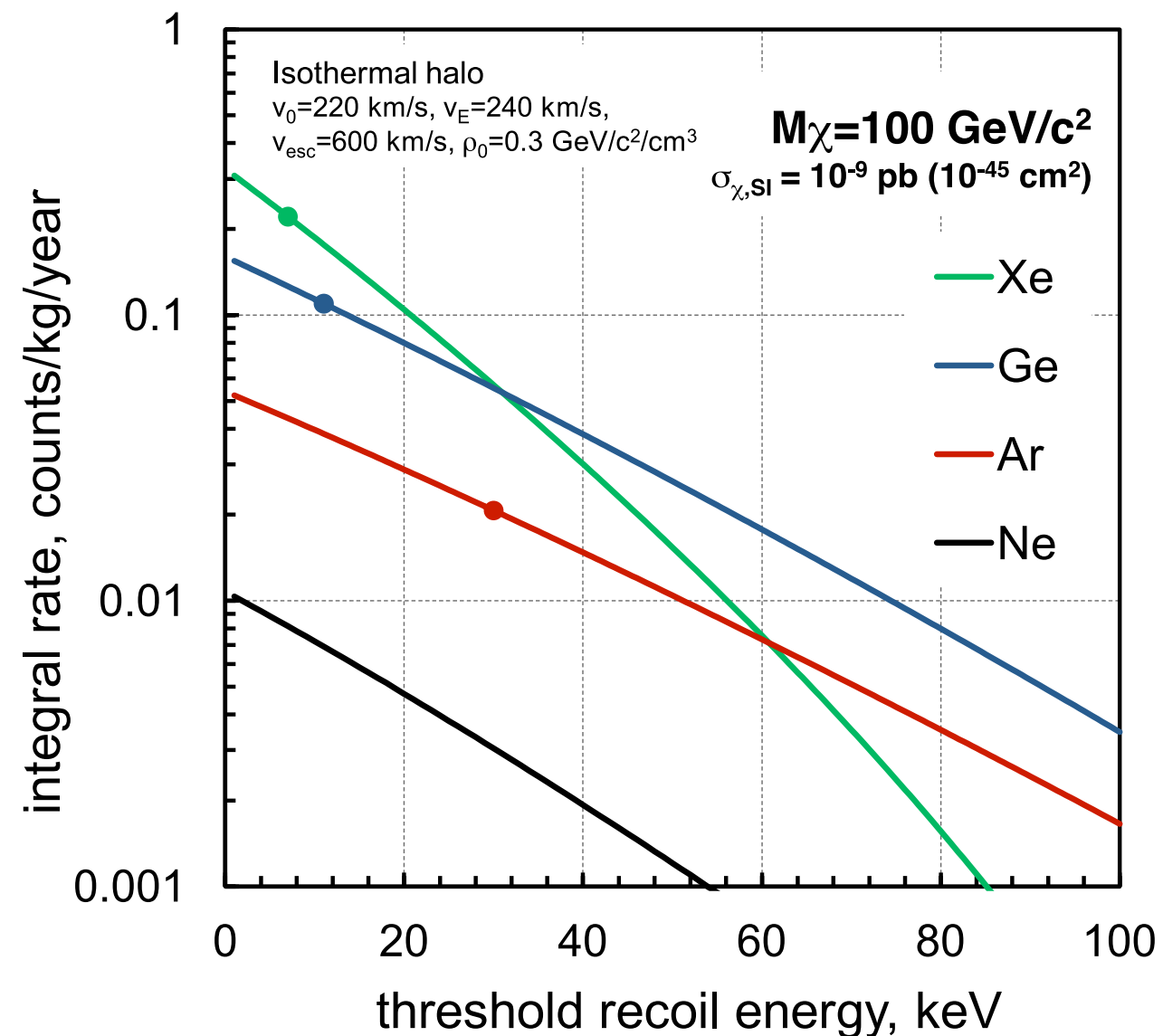
ratio of $S2/S1$ is different
for electron & nuclear
recoils $\Rightarrow$ particle ID

drift time and hit pattern
 $\Rightarrow$ 3D pos. recon.



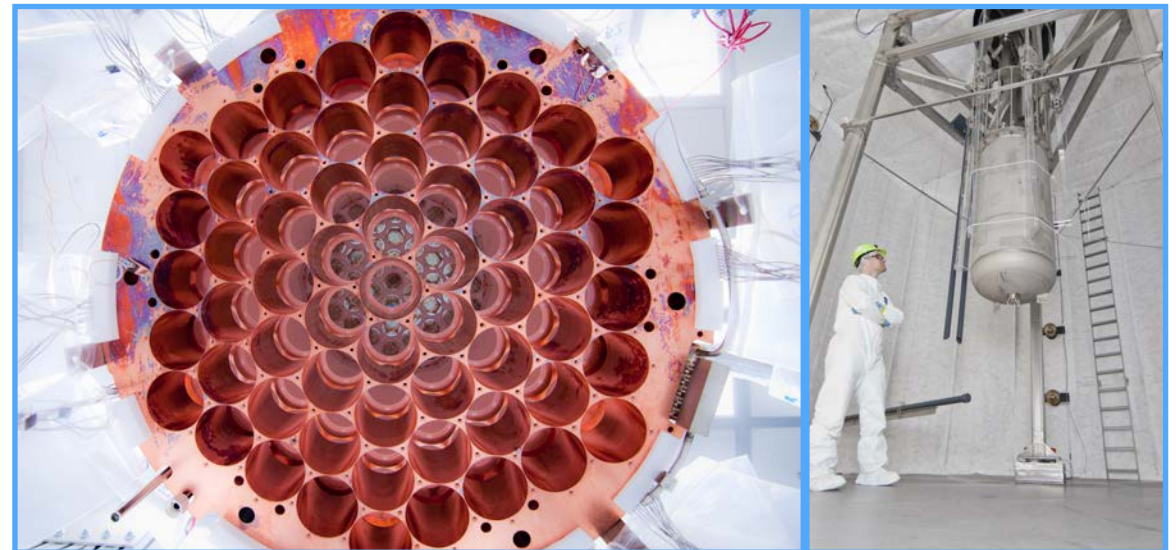
Xenon

- High density (2.9 g/cm³)
- High atomic mass (A=131 g/mol)
- Spin-dependent sensitive isotopes
- Large light output and fast response
- Long electron drift lengths (~1 m)
- Excellent ionization threshold
- No long-lived radioactive Xe isotopes
- Self-shielding (using 3D pos. recons.)
- Scalable to multi-ton size



Predecessors: ZEPLIN and LUX

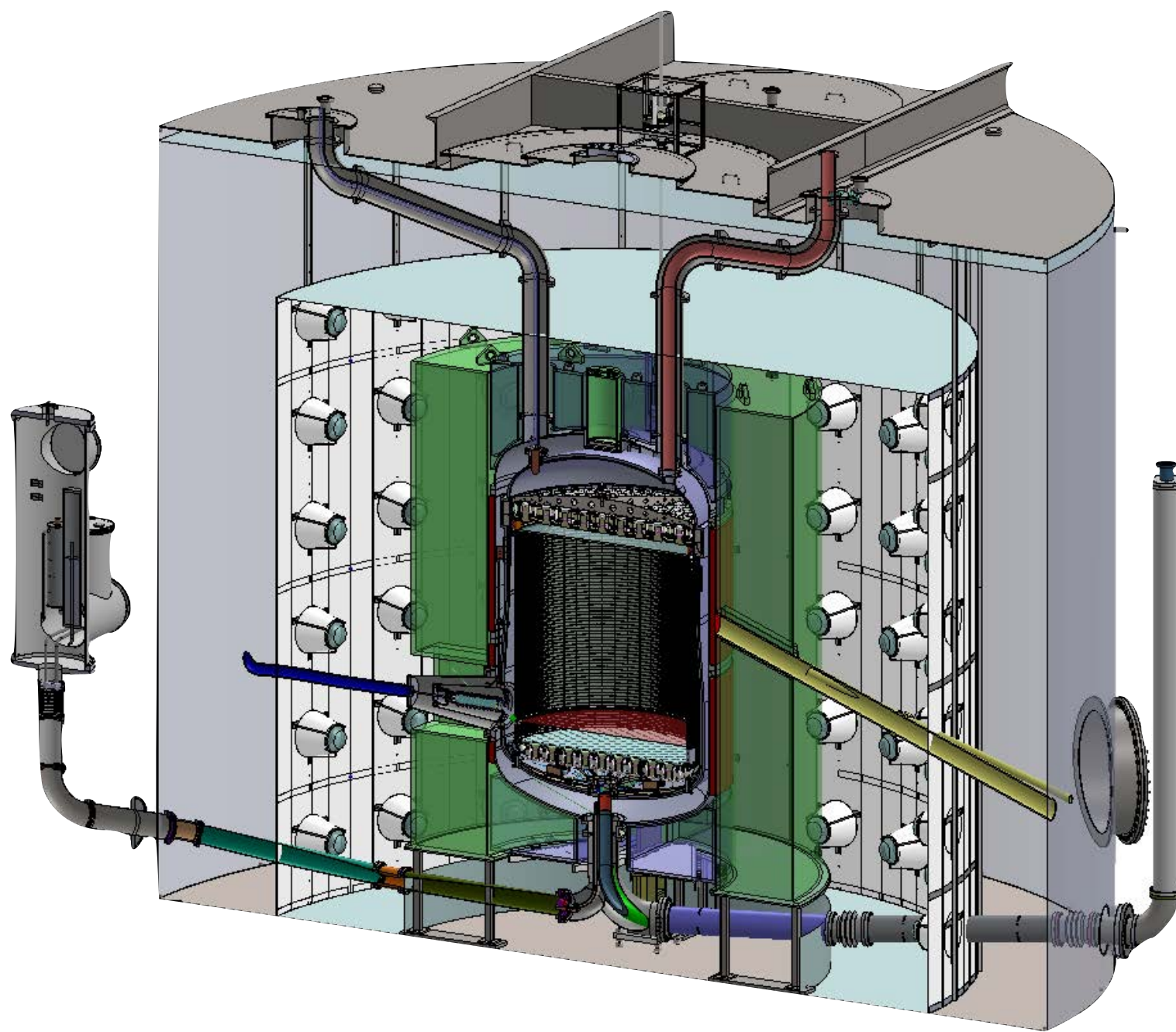
- ZEPLIN - 12 kg Xenon, high field, 319 days, veto, etc.
@Boulby, UK



- LUX - 370 kg Xenon, world-leading, water tank veto, etc.
@Sanford Lab, SD - USA



LZ Design

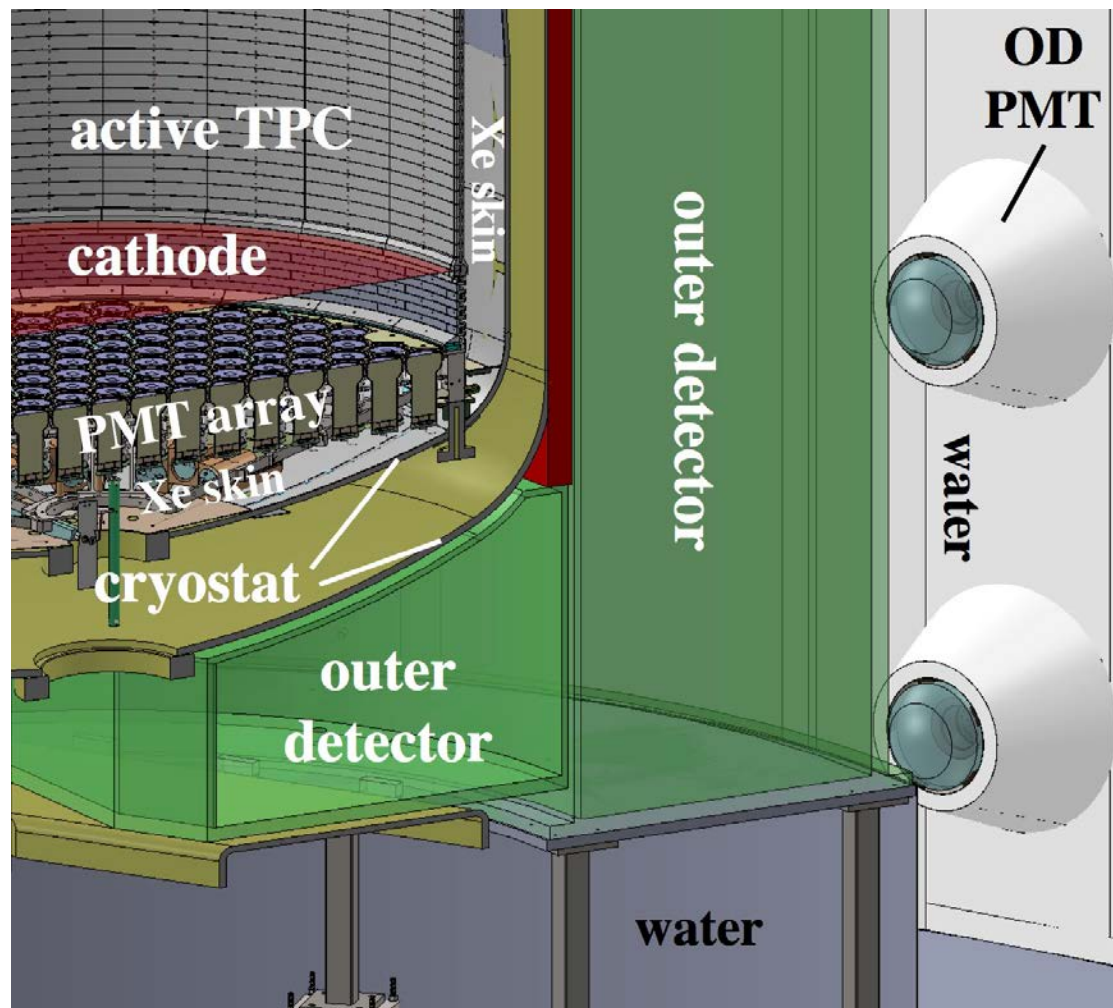


- 10 t liquid Xenon
(7 t active, 5.6 t fid.Vol.)
- 494 3" PMTs
- 50 kV cathode
- Xenon skin detector
(131 1" & 2" PMTs)
- liquid scintillator outer
detector (120 8" PMTs)
- high purity water shield
- 4850L Sanford Lab

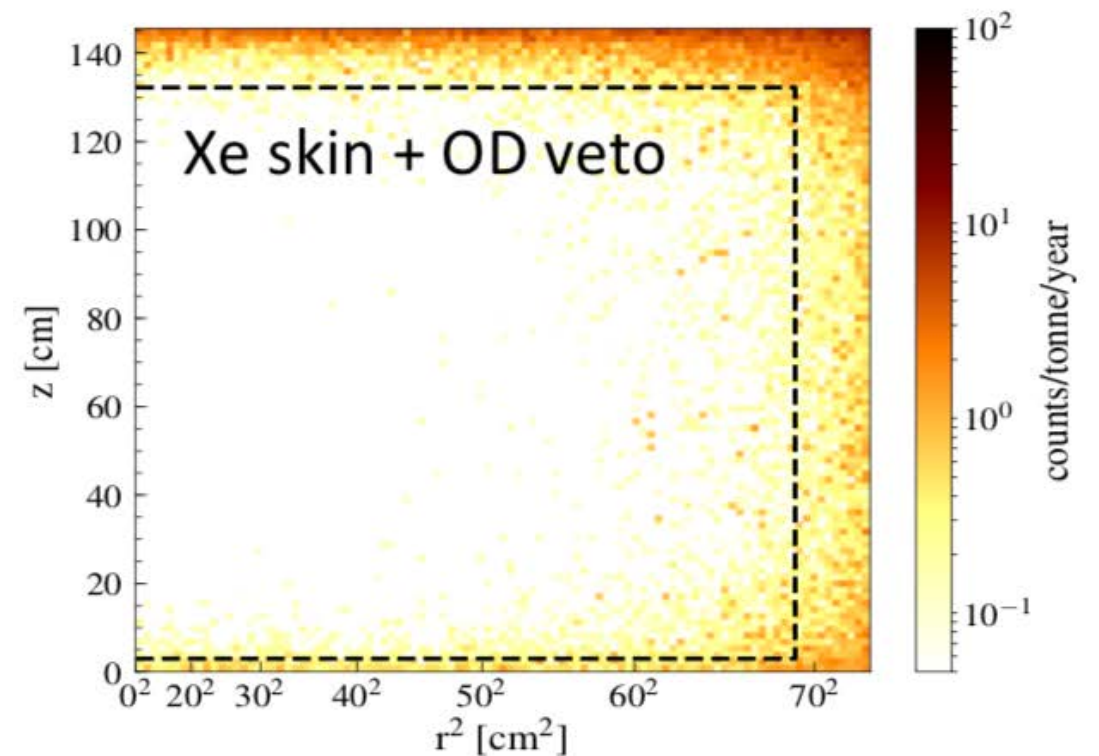
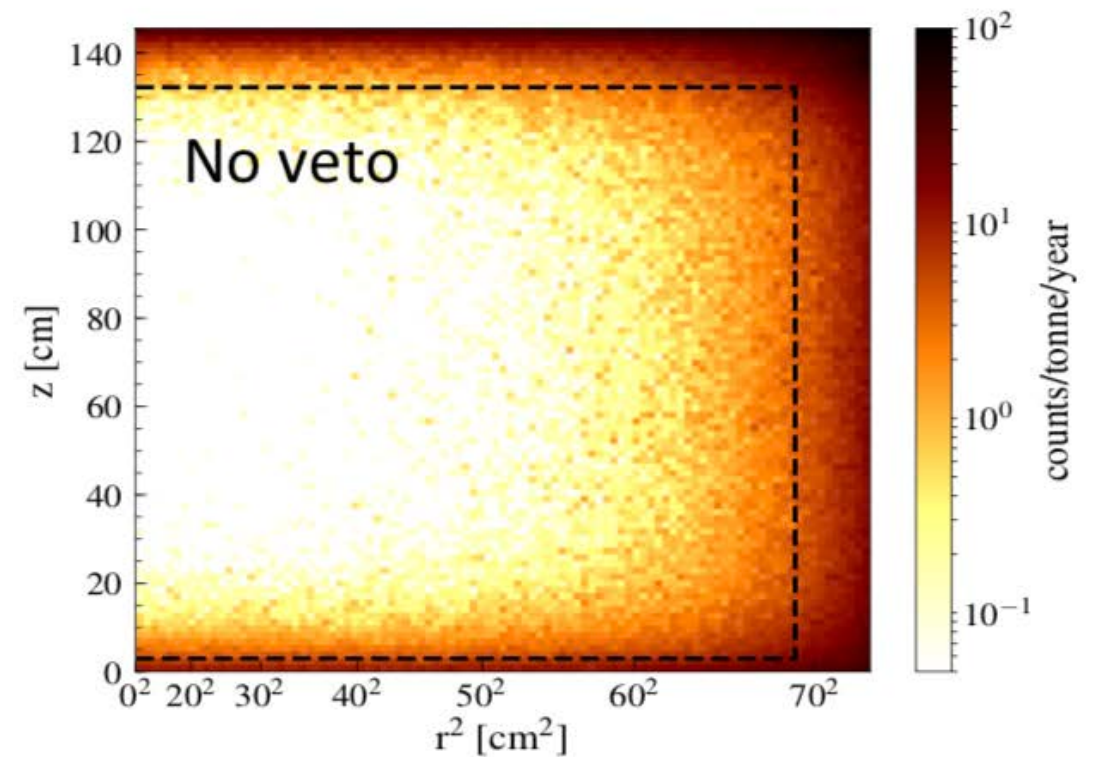
Technical Design Report, arXiv:1703.09144



LZ Design - skin and OD

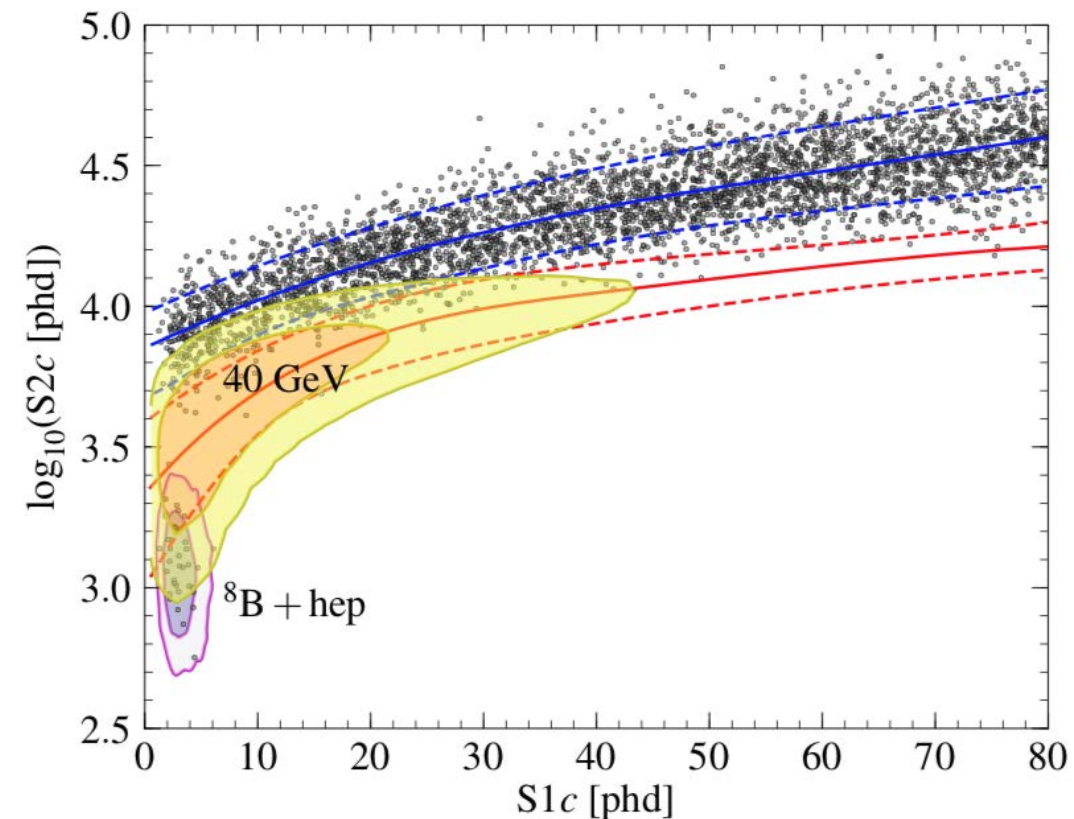
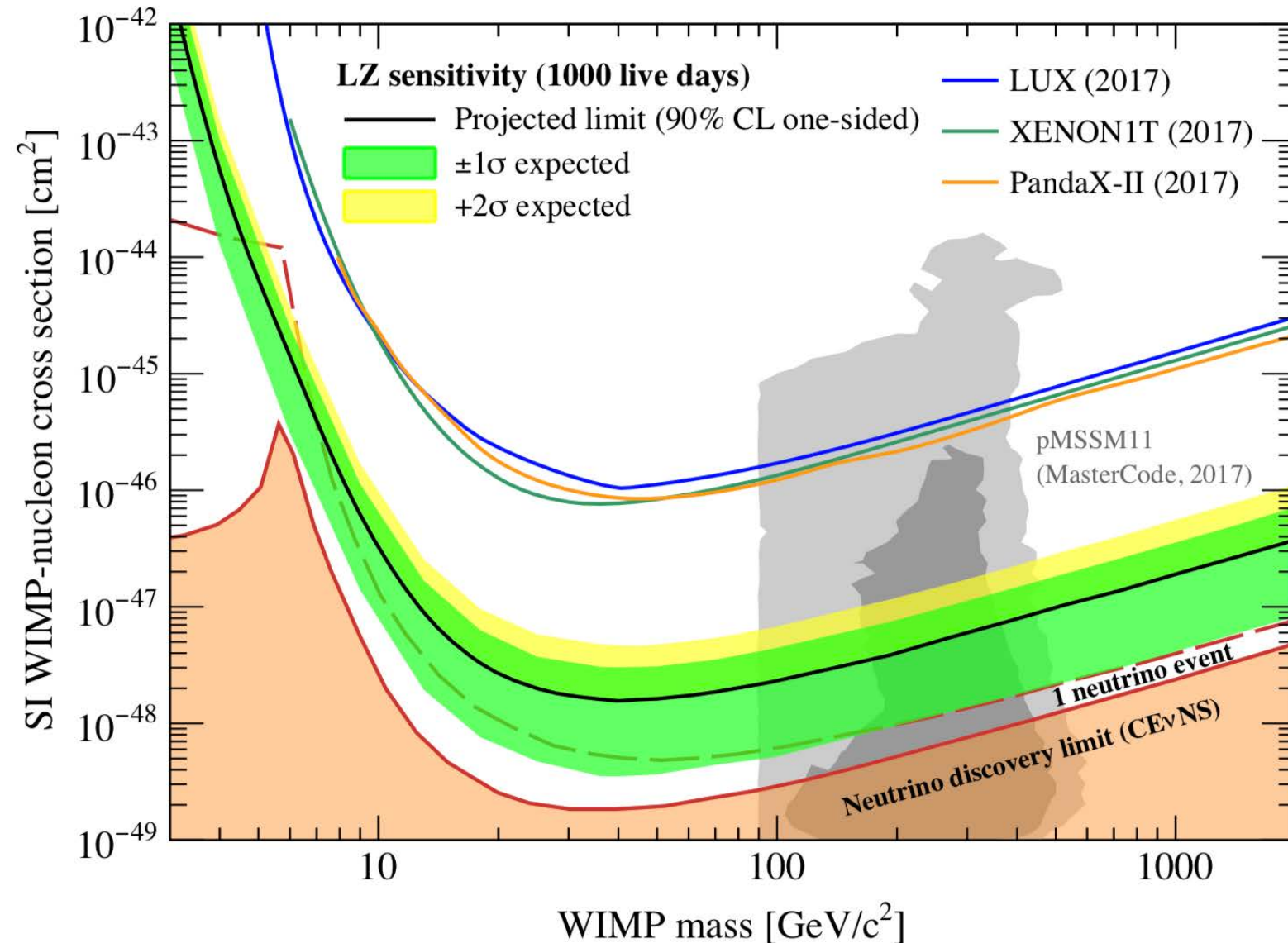


- Instrumented xenon skin - gamma-ray tagging
- Gd-LS - thermalize and capture neutrons



Sensitivity projection

- Spin-independent WIMP sensitivity projection (1000d)



Simulated dataset for
40 GeV/c^2 WIMP

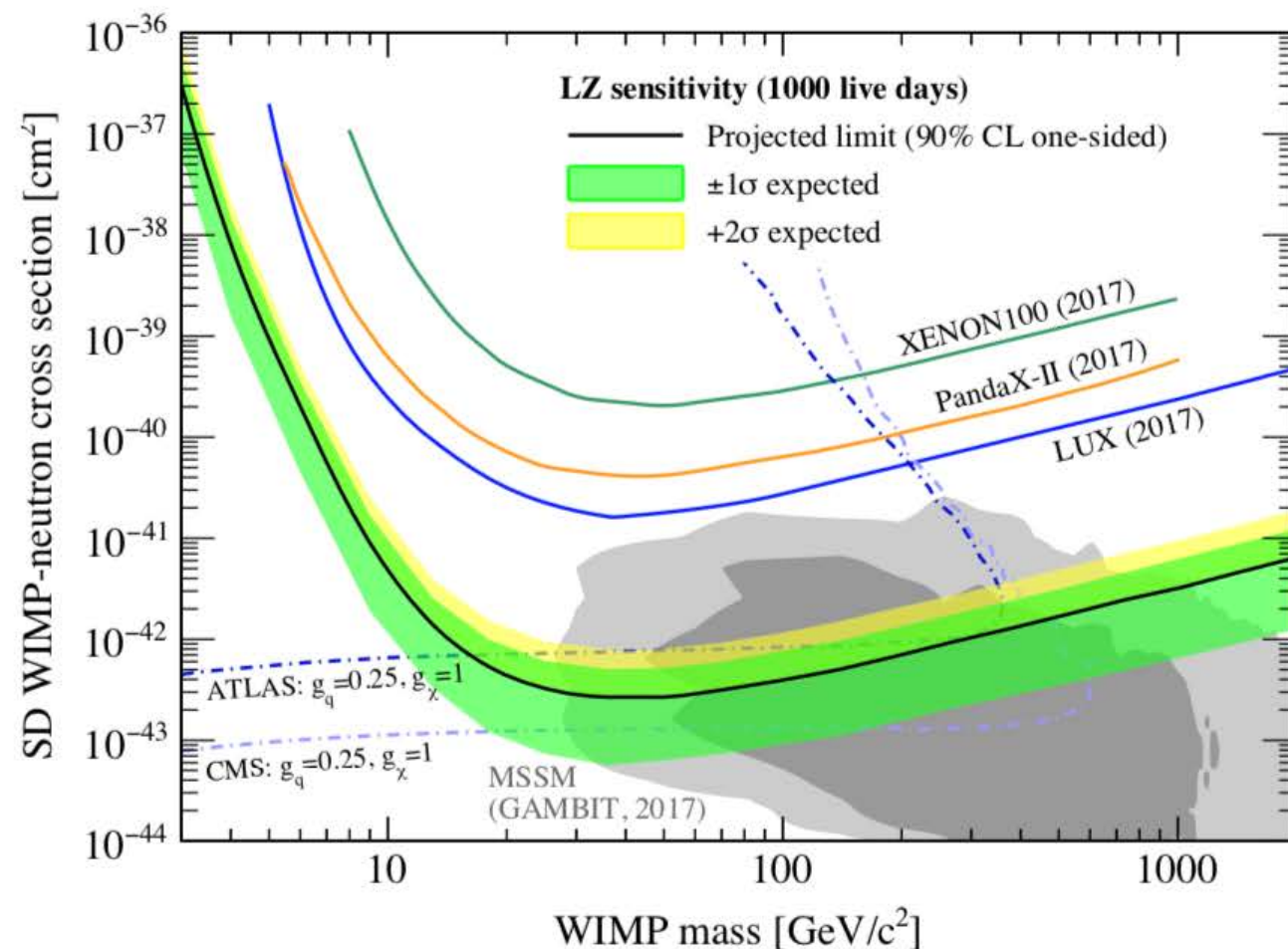
LZ projected WIMP sensitivity, arXiv:1802.06039



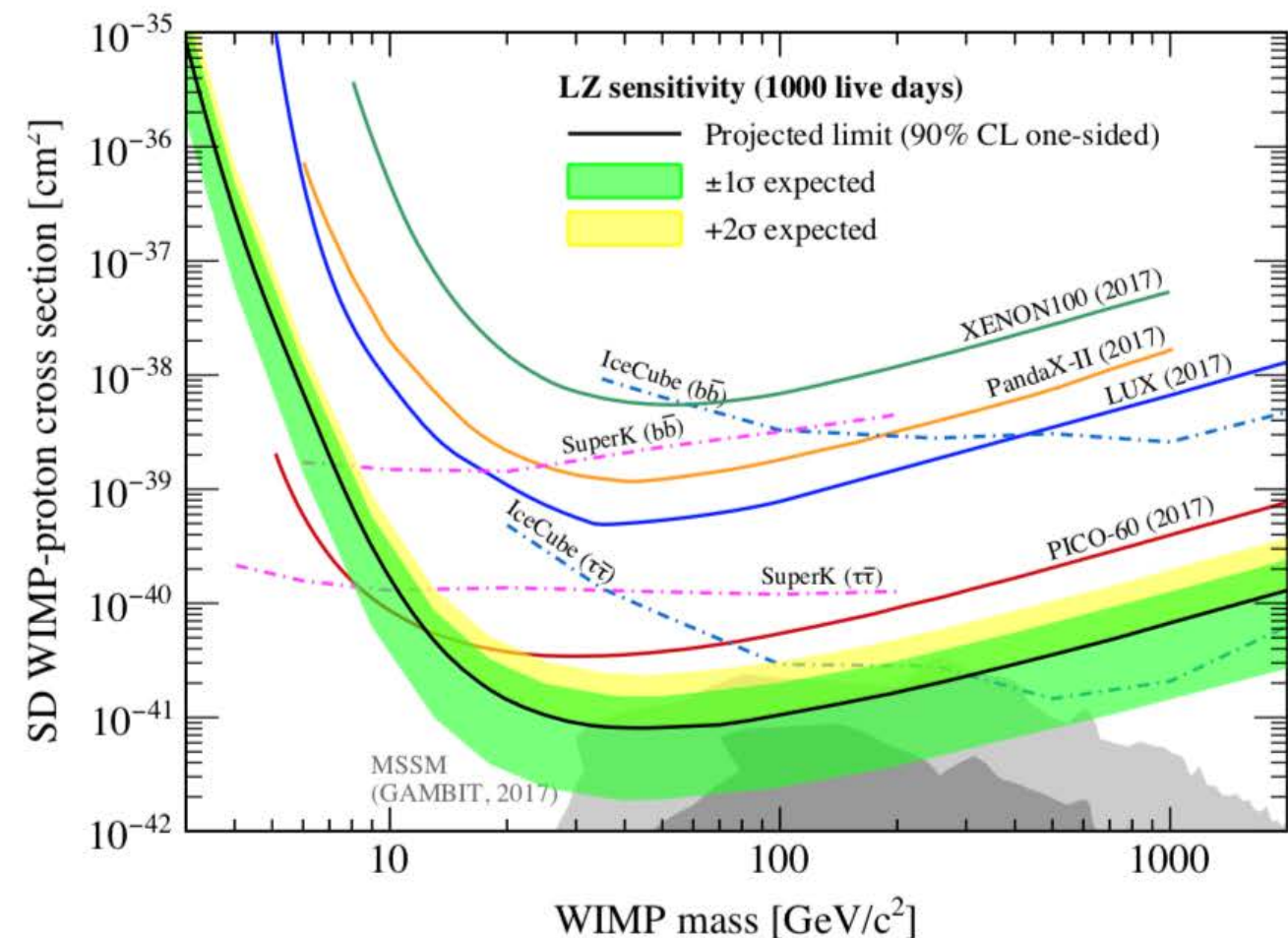
Sensitivity projection

- Spin-dependent WIMP sensitivity projection (1000d)

WIMP-neutron



WIMP-proton

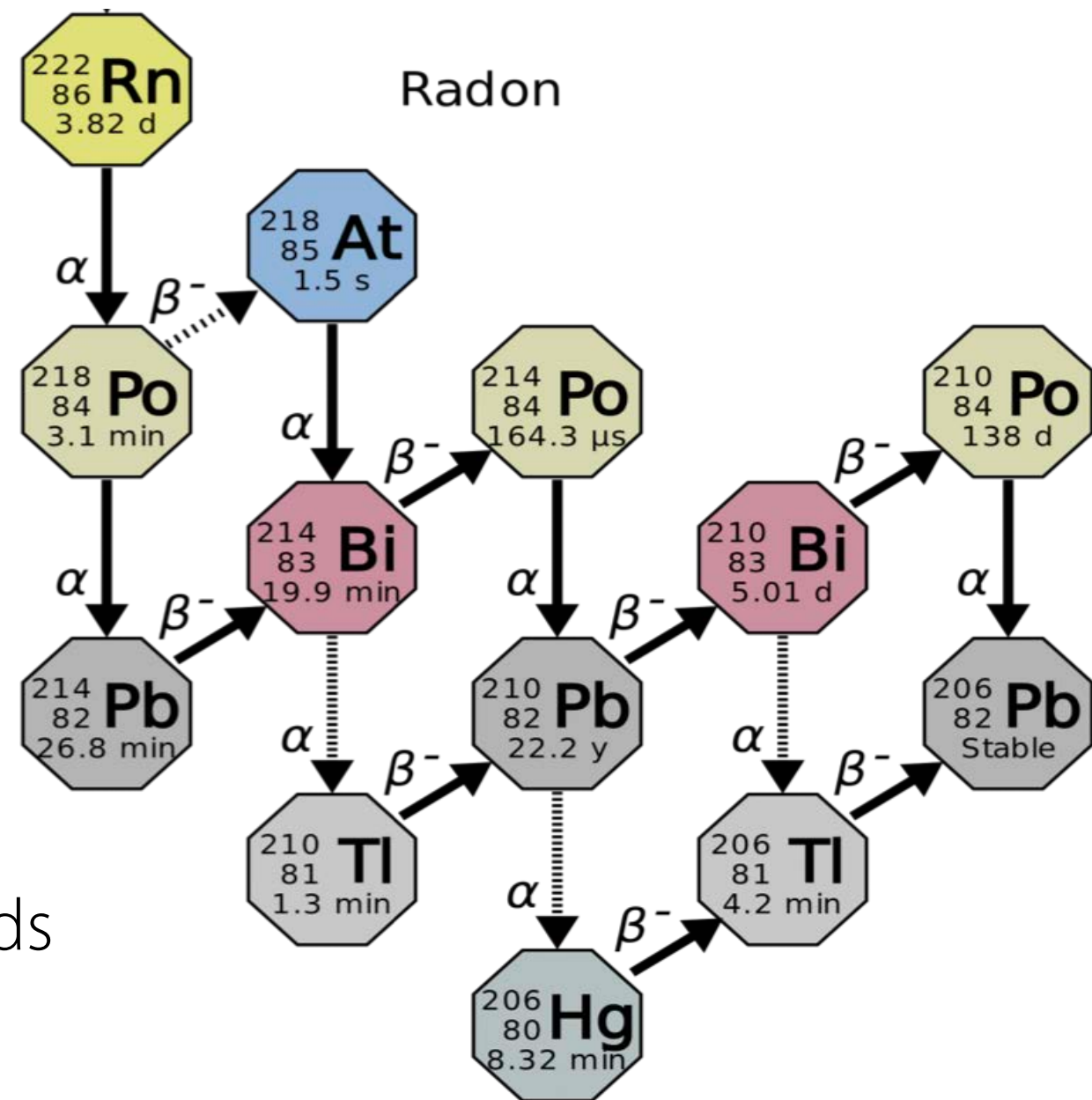


LZ projected WIMP sensitivity, arXiv:1802.06039



Background

- Detector materials
 - Radio-assay campaign
- Rn emanation
 - Rn emanation screening and assaying of assembled parts
- Rn plate-out and dust
 - Rn-reduced cleanroom assembly
 - dust-monitoring
- Xenon contaminants
 - 85Kr removal at SLAC
- Cosmogenics and external backgrounds
 - 4850L at SURF
 - instrumented Xe skin, Gd-LS OD, water shielding

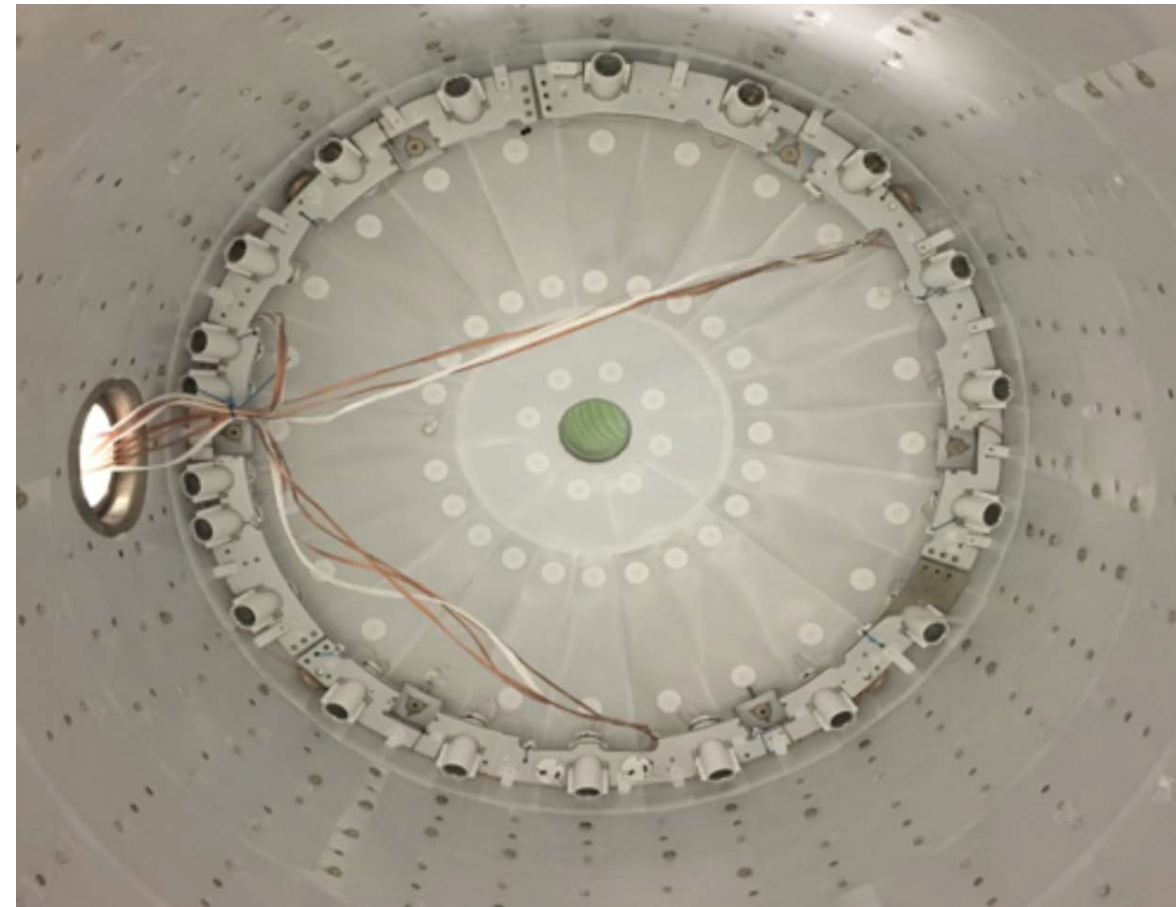


Calibrations

- Expand on successful LUX calibration program
- Spatial response and temporal variations - $^{83\text{m}}\text{Kr}$, $^{131\text{m}}\text{Xe}$
- Xenon skin and Gd-LS - ^{220}Rn , movable γ -sources
- Electron recoil - CH_3T , ^{14}C , (^{37}Ar)
- Nuclear recoil - mono-energetic DD, photo-neutron sources and other high & low energy neutron sources
- Optical calibration systems for PMTs and OD (LEDs)



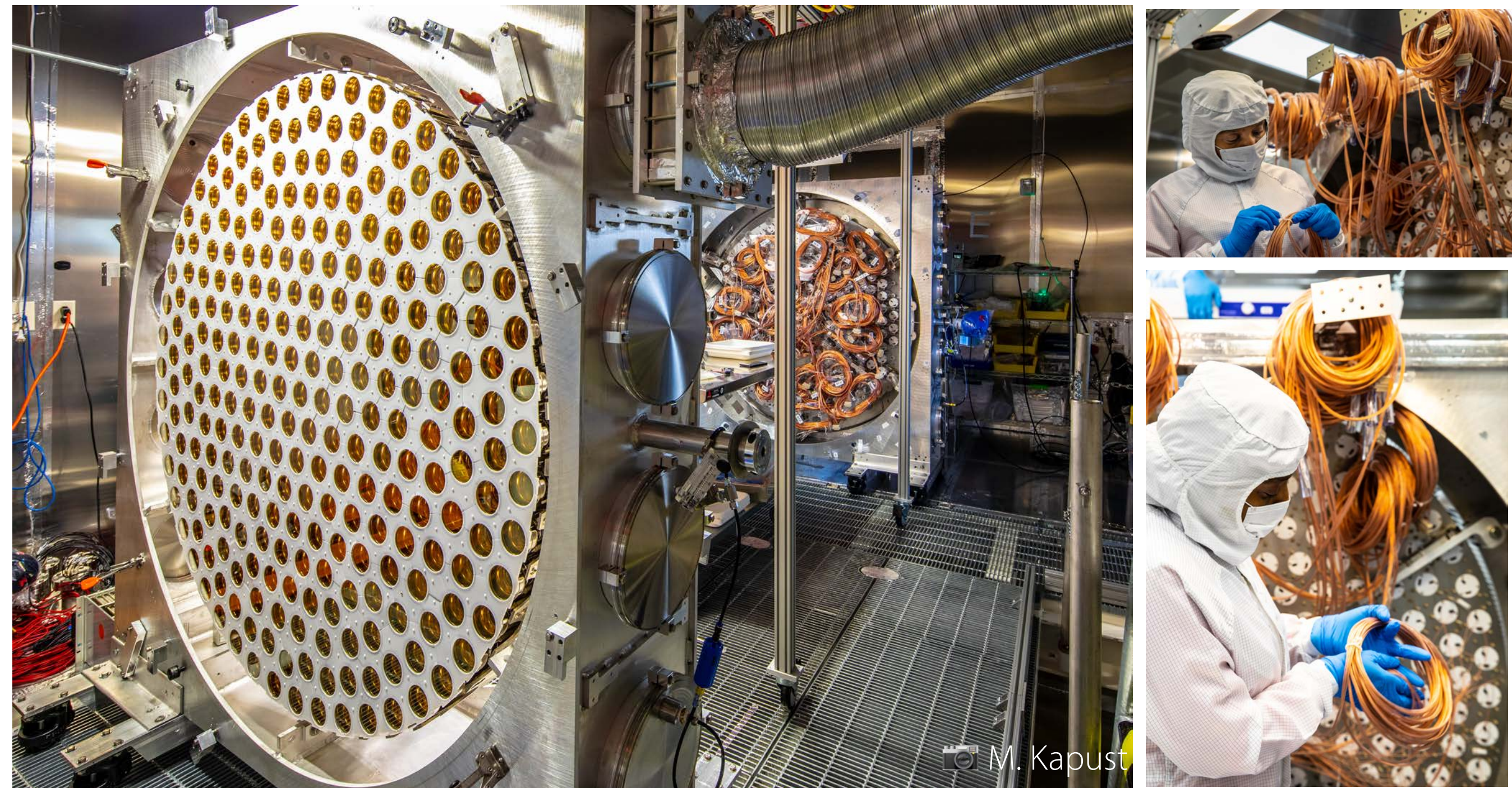
Status update - Titanium vessel



- Intensive program to identify low activity titanium material (arXiv: 1702.02646)
- Fabricated in Italy, at SURF May '18, vessel acceptance completed
- OCV in water tank at 4850L, ICV tiling (PTFE) complete, skin PMTs installed)



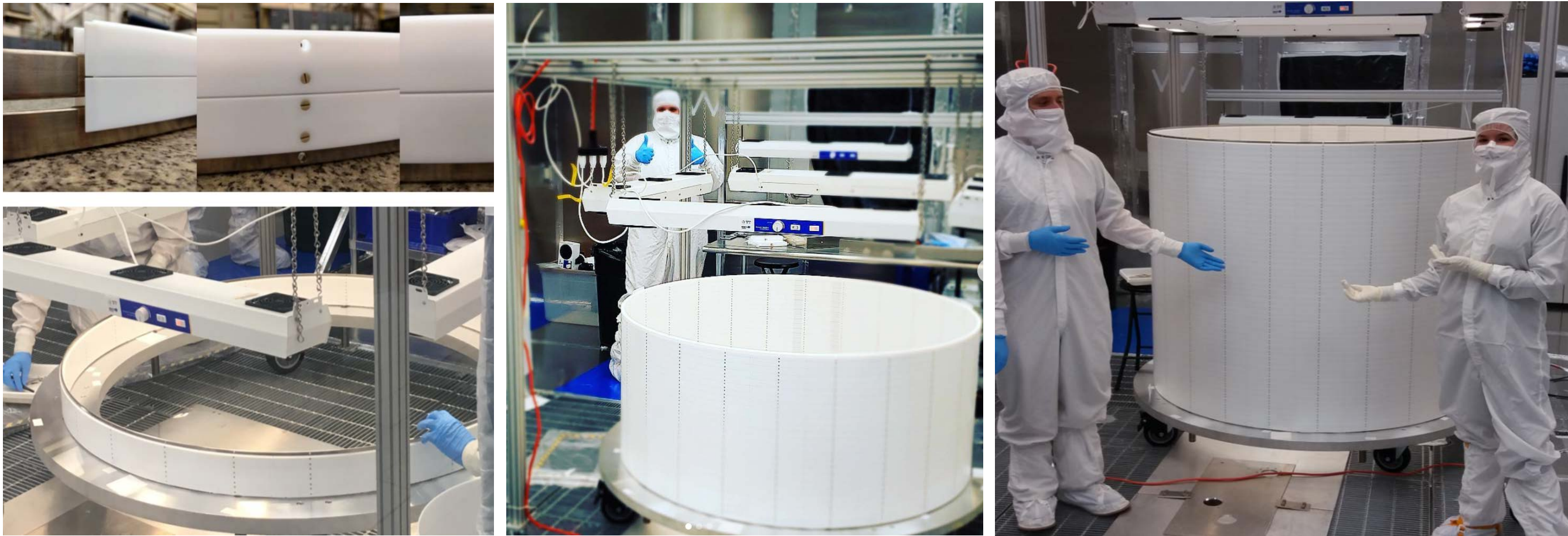
Status update - PMT arrays



- Top & Bottom array checkouts complete - June '19



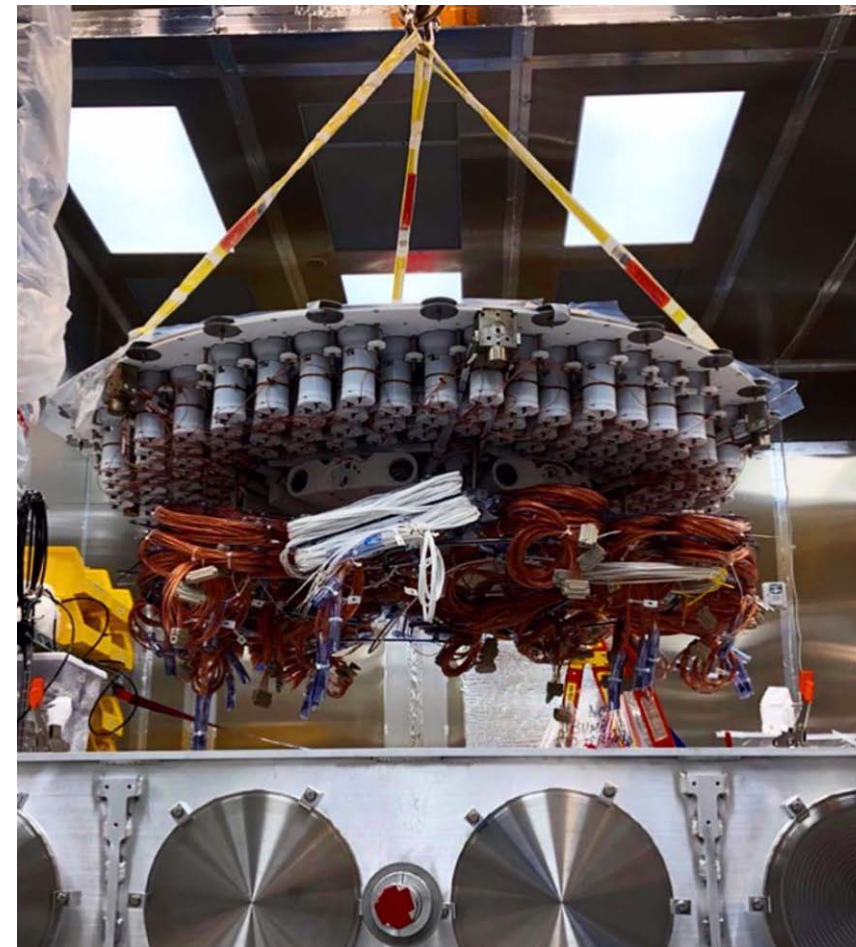
Status update - TPC



- titanium field-shaping rings encased within PTFE
- assembly of FFR completed Dec '18



Status update - HV grids



- (semi-)automated loom weaving SS wire grids at SLAC
- cathode & RFR grids at SURF May '19, anode scheduled June '19
- TPC assembly (from bottom PMT array up) started June '19 (This week !!!)



Status update - Outer Detector



- 4 side tanks at SURF inside water tank (top & bottom tanks expected June '19)
- Gd-LS production installation at BNL ongoing
- OD PMTs tests complete (Korea), mock ladder assembly tested March '19



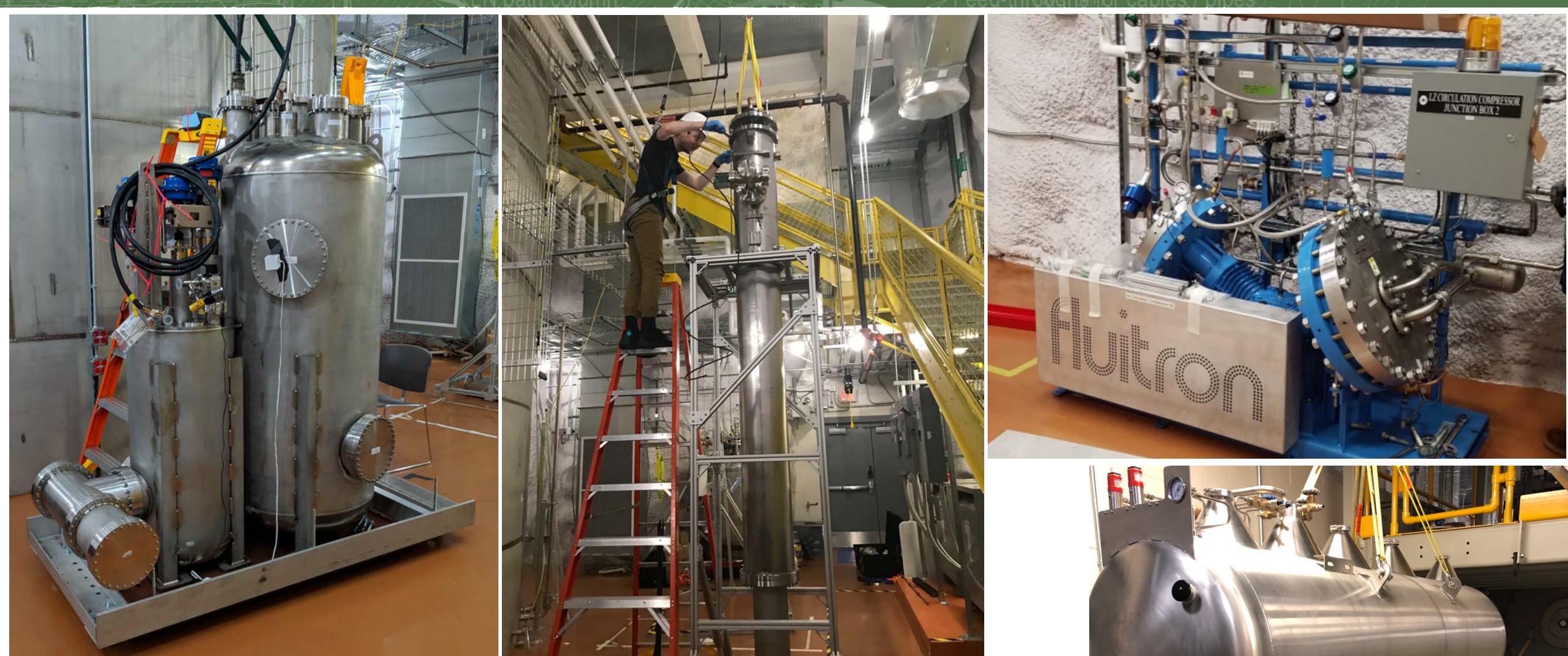
Status update - Xenon



- 7t Xenon in hand at SLAC
- Kr removal designed to 0.015 ppt starting July '19



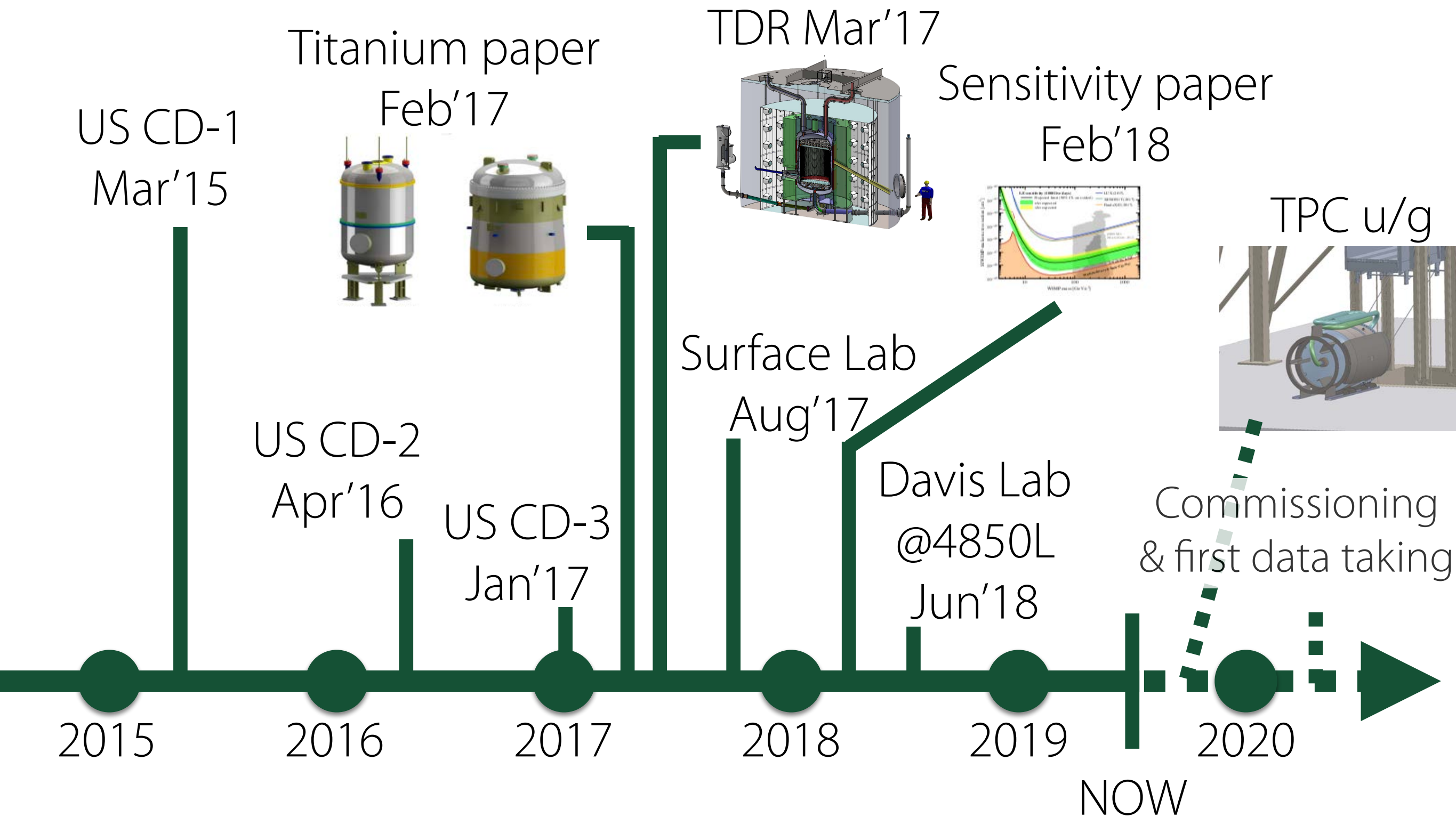
Status update - U/G Xenon system



- Xenon tower, Xenon circulation compressor and Xenon circulation test cryostat onsite
- Cryogenic system (cryo-cooler, LN storage, transfer lines) in place



Timeline



Timeline - Olivia-style

LUX disassembly
"We had good times"

First detector parts arrive onsite
Construction starts!

Ready for data!



Review process
US CD-1/2/3



2015

2016

2017

2018

2019

2020



END



THANK YOU