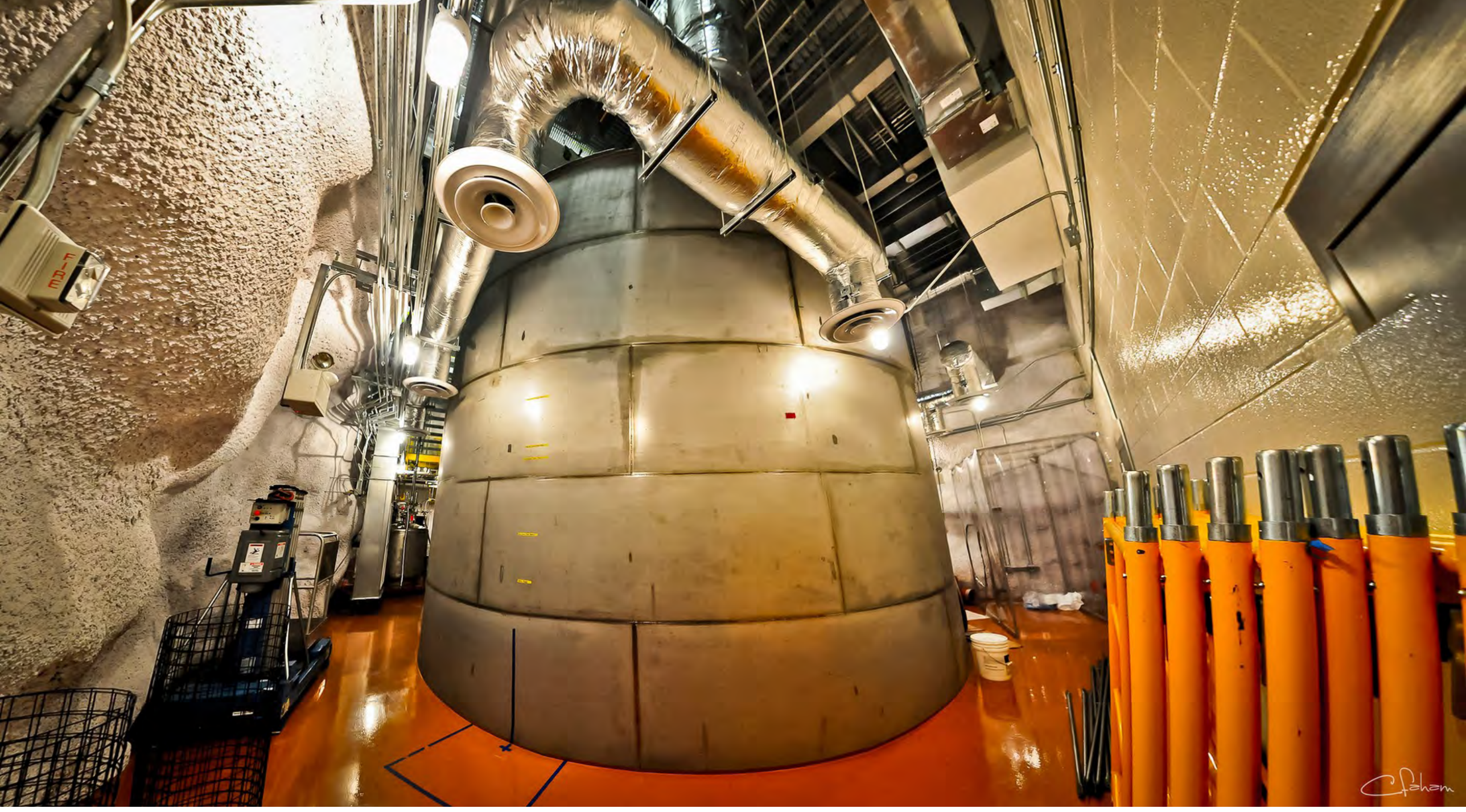


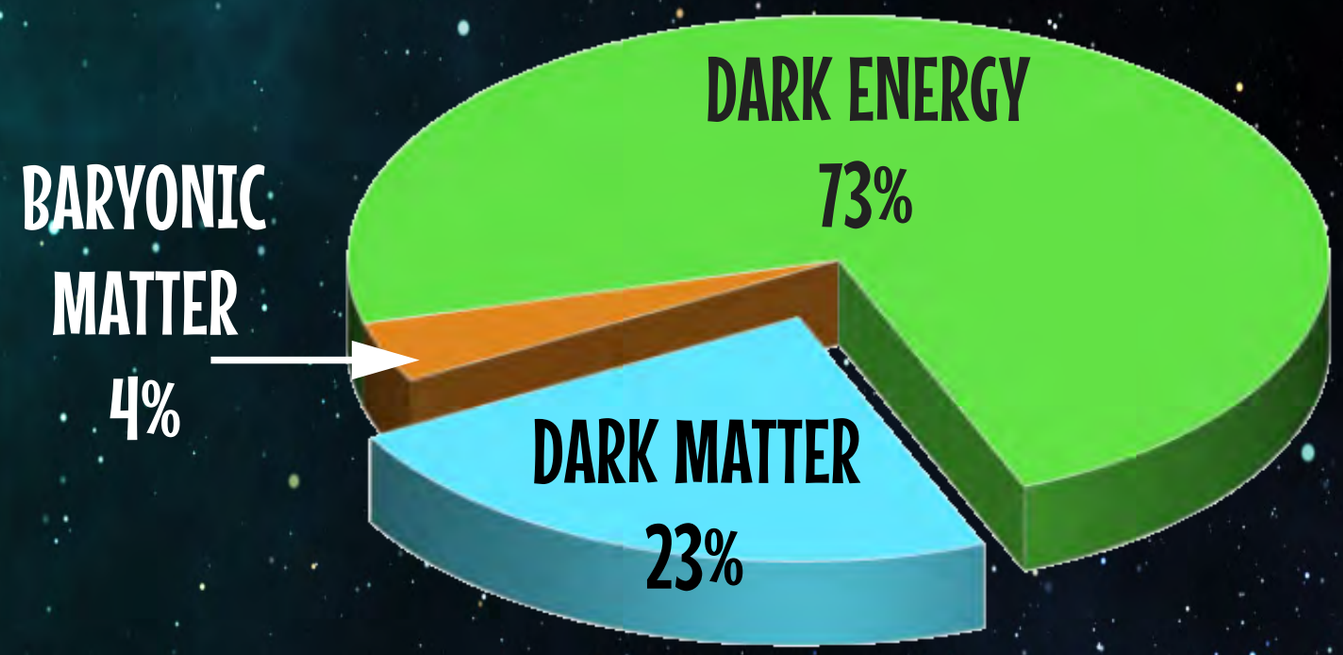
LZ : DARK MATTER EXPERIMENT

NISHAT PARVEEN

ON BEHALF OF LZ COLLABORATION

ADVISOR: PROF. CECILIA LEVY

COMPONENTS OF OUR UNIVERSE



DARK MATTER: one of the GREATEST UNSOLVED MYSTERIES of the UNIVERSE!!!

LUX + ZEPLIN =LZ

ZEPLIN

DRIFT

EDELWEISS

KIMS

CDMS
CoGENT

XMASS

LUX
LZ

DEAP - 3600 & MiniCLEAN
PICASSO
COUPP
SuperCDMS

DAMA/LIBRA
DarkSide
XENON1T
XENONnT

PandaX
CDEX

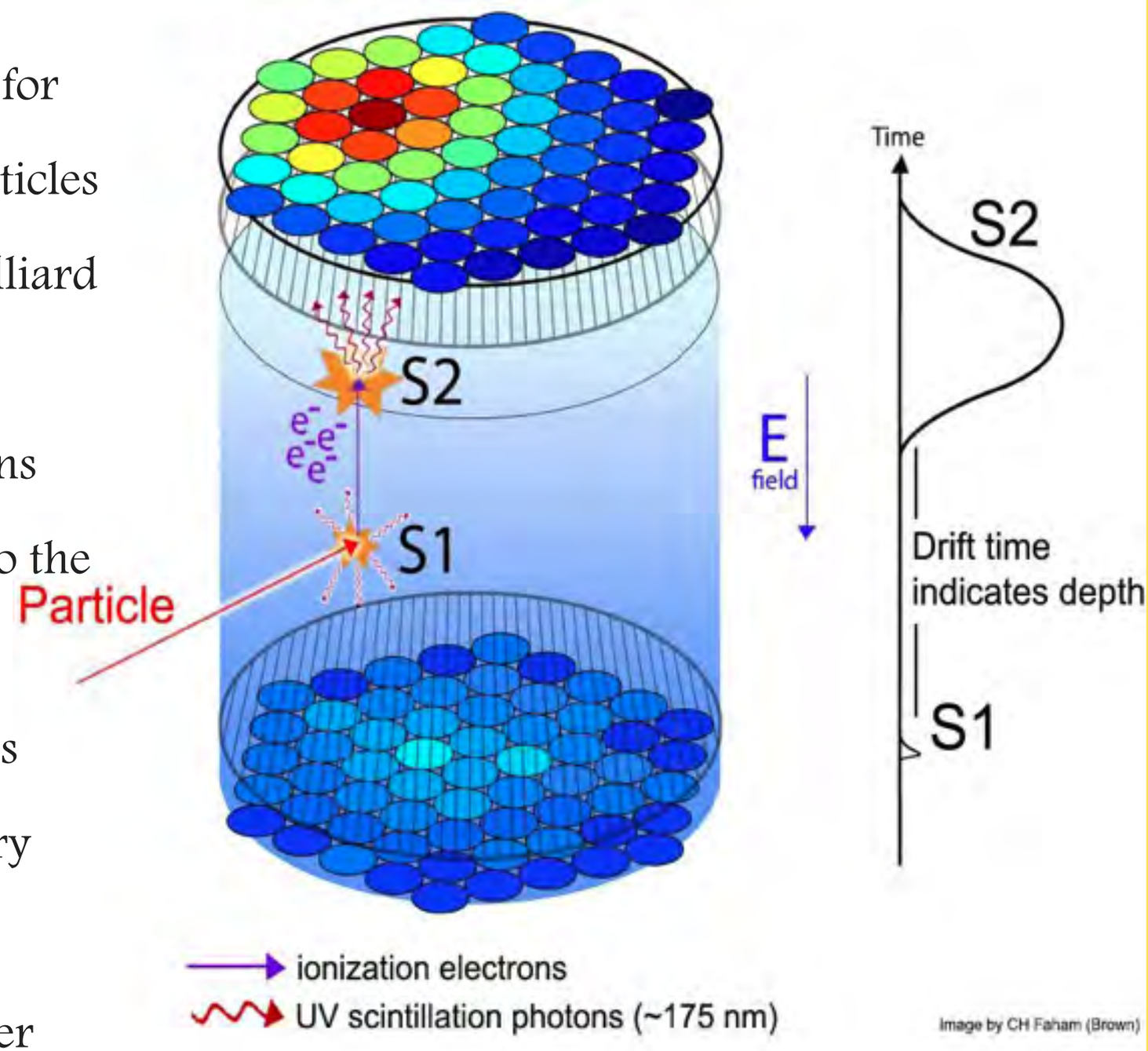
UNDERGROUND DARK MATTER EXPERIMENTS

Located 4,850 ft underground in Sanford Underground Research Facility (SURF), Lead, South Dakota

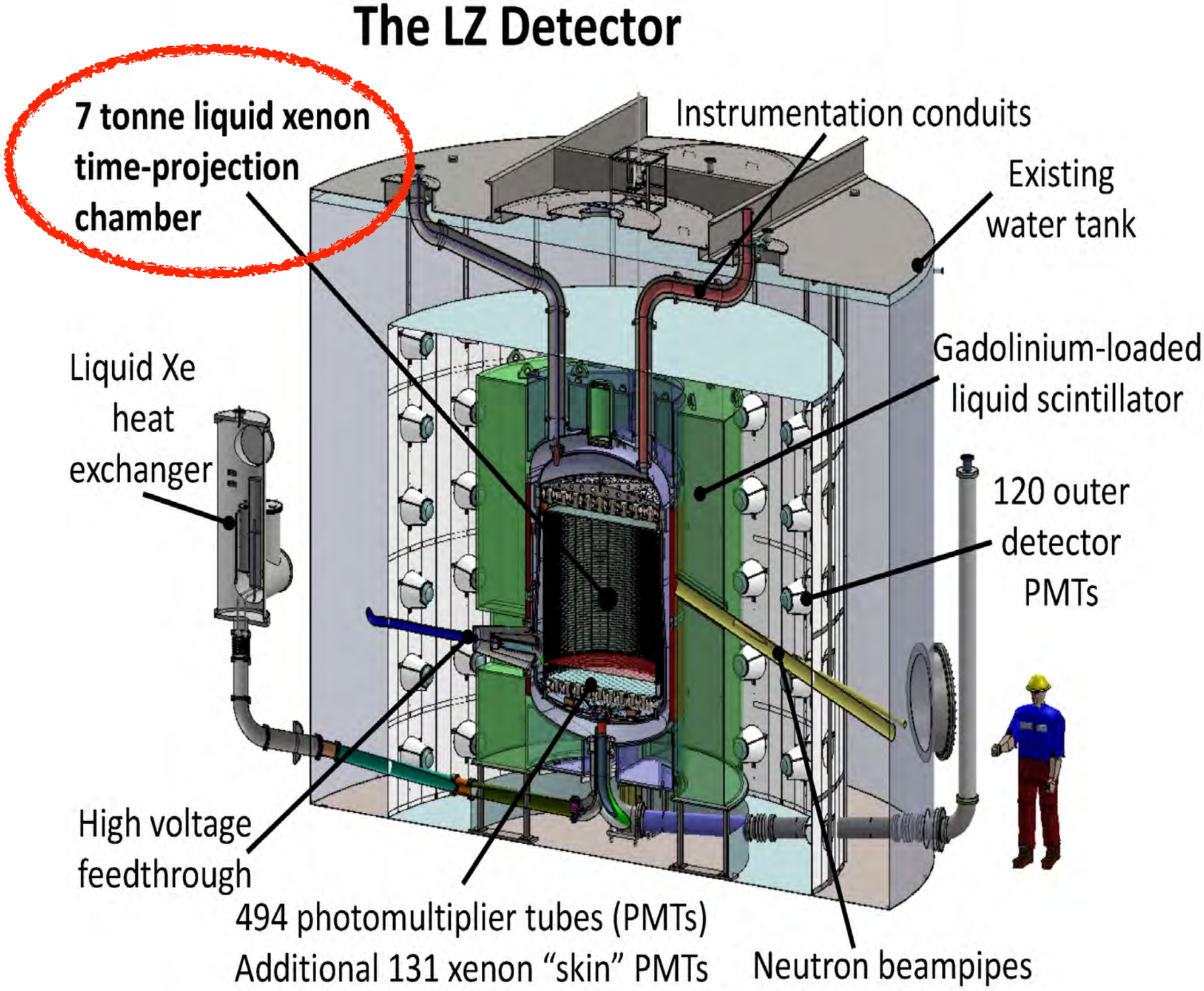
LZ Collaboration meeting at Rutherford Appleton Laboratory, UK (6 - 10 January 2020)

WORKING PRINCIPLE

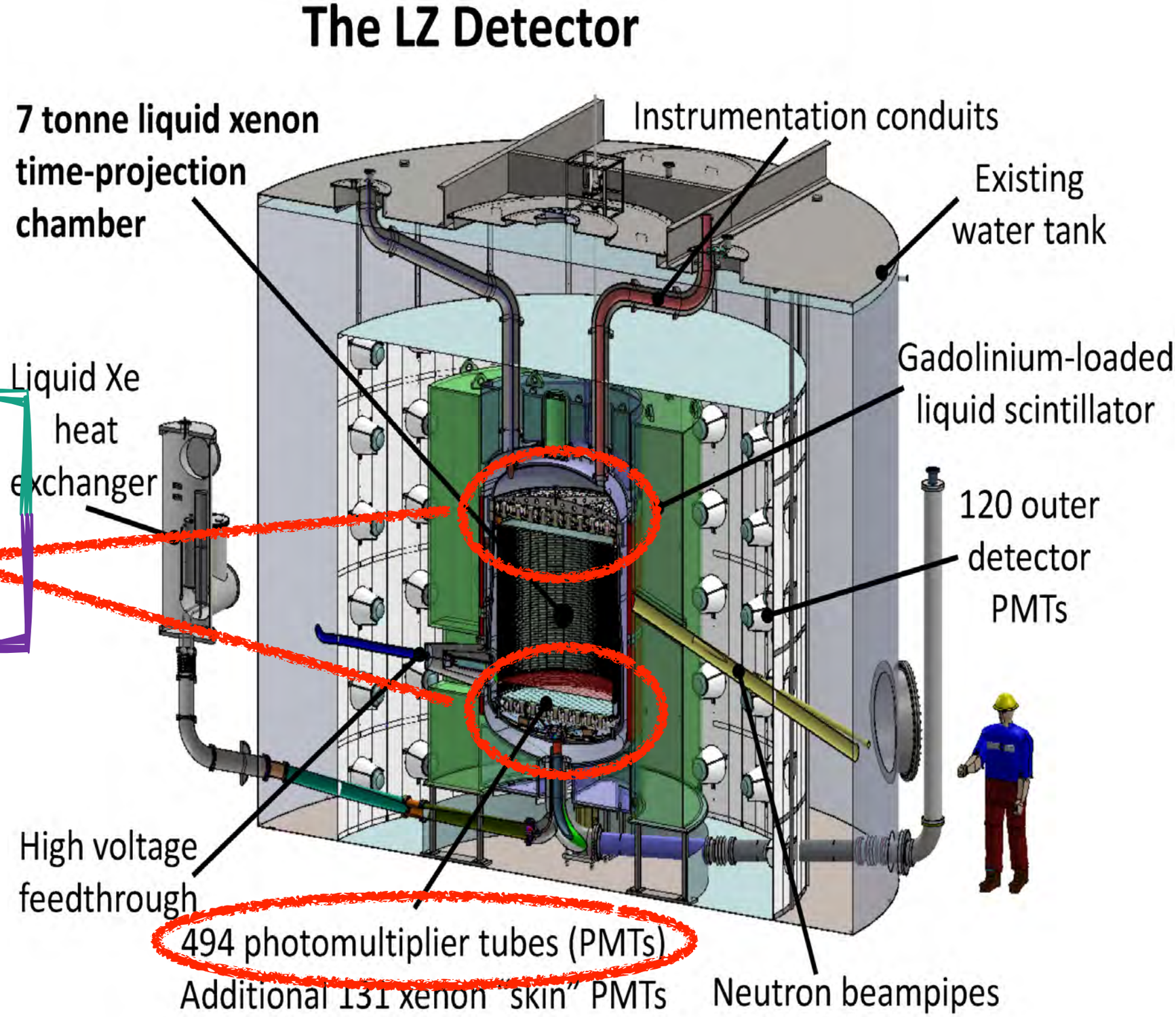
- Uses 7 tons of liquid Xenon as target for collisions with dark matter (DM) particles
- DM particles scatter target nuclei (billiard ball collision) producing scintillation photons 'S1' signal and recoil electrons
- Ionization electrons are accelerated to the liquid surface by the electric field
- Ionization electron excites and ionizes gaseous Xe atoms creating a secondary scintillation signal 'S2' signal
- Signals are detected by Photomultiplier tubes (PMTs)



INSTRUMENT OVERVIEW

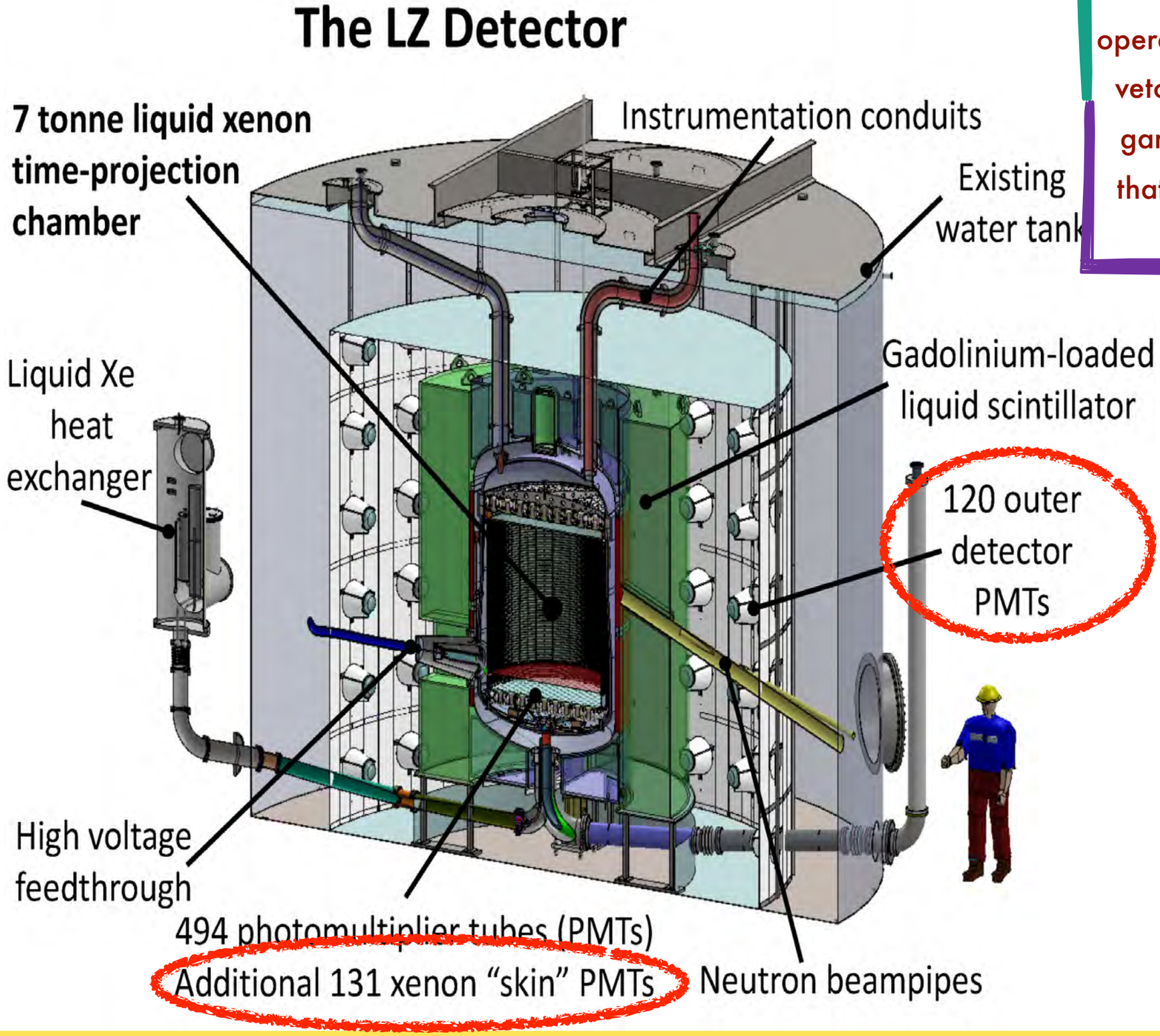


INSTRUMENT OVERVIEW



TOP & BOTTOM ARRAY OF PMTs

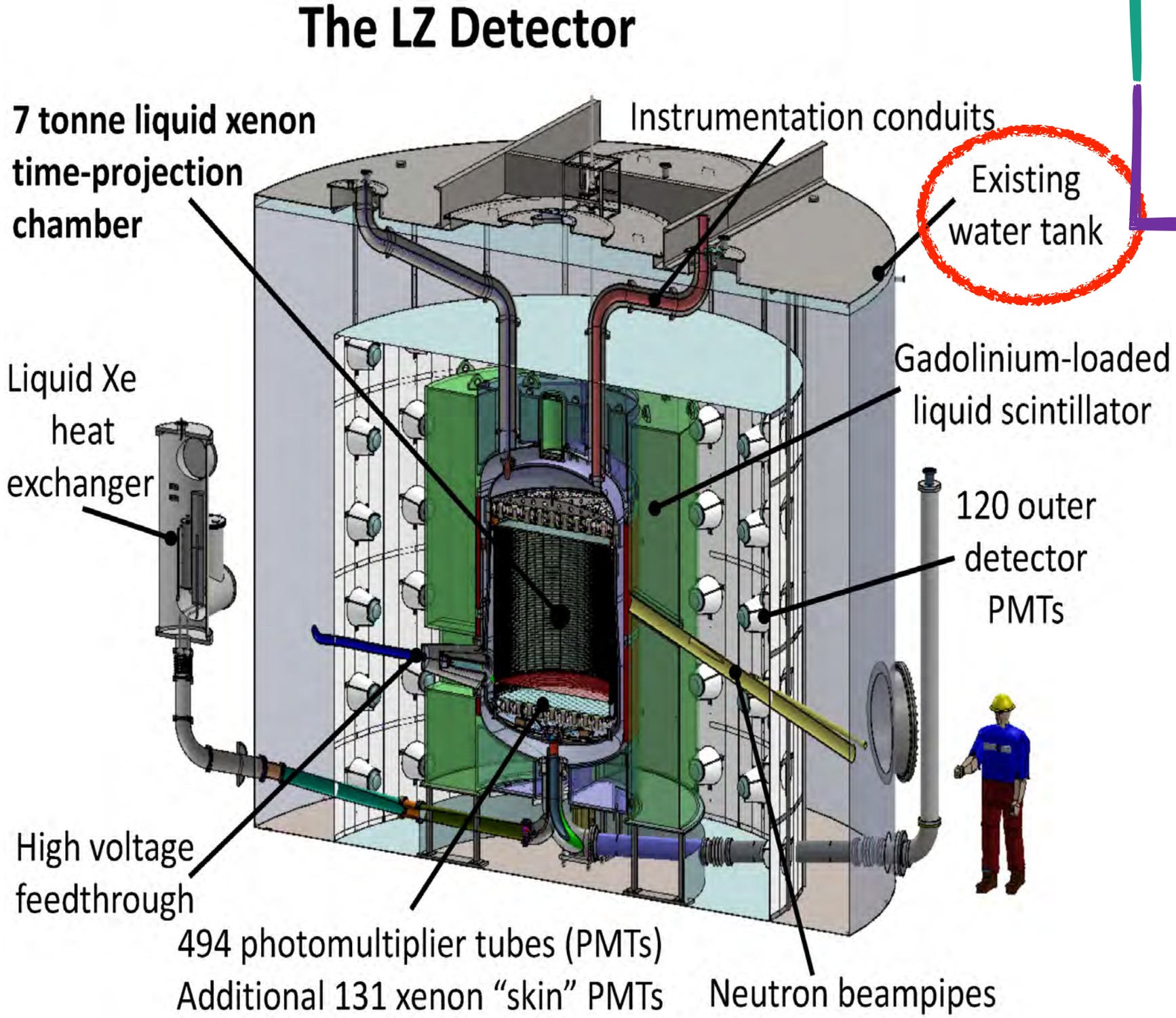
INSTRUMENT OVERVIEW



Skin & Outer Detector – operates as an integrated veto system – rejecting gammas and neutrons that mimic DM particle signals

INSTRUMENT OVERVIEW

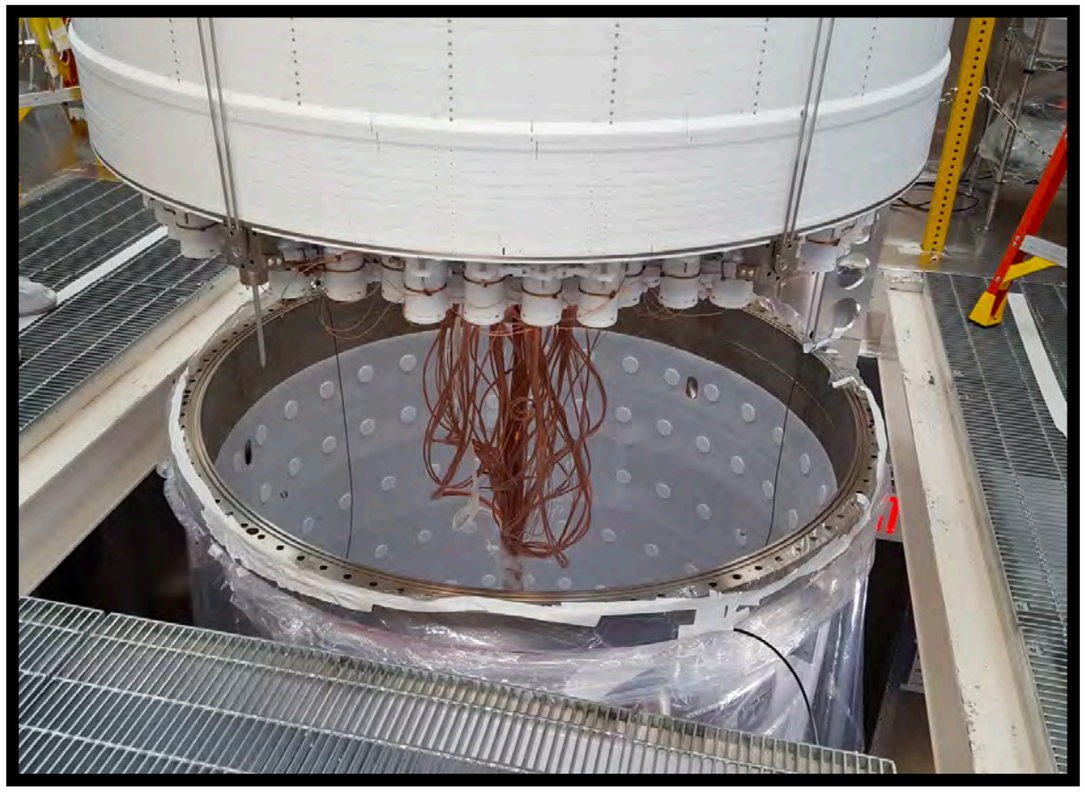
TO MITIGATE COSMOGENIC BACKGROUNDS



TIME PROJECTION CHAMBER

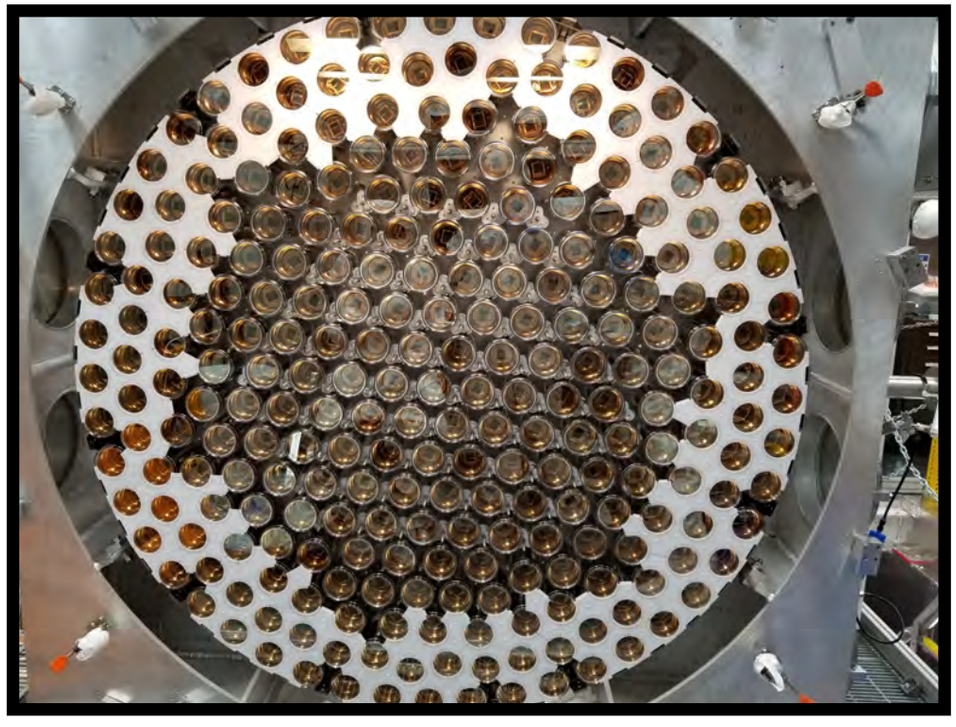
- Core of the LZ experiment ~ TPC is 150 cm tall and 150 cm wide, containing 7 tonnes of ultra-pure cryogenic liquid Xe.

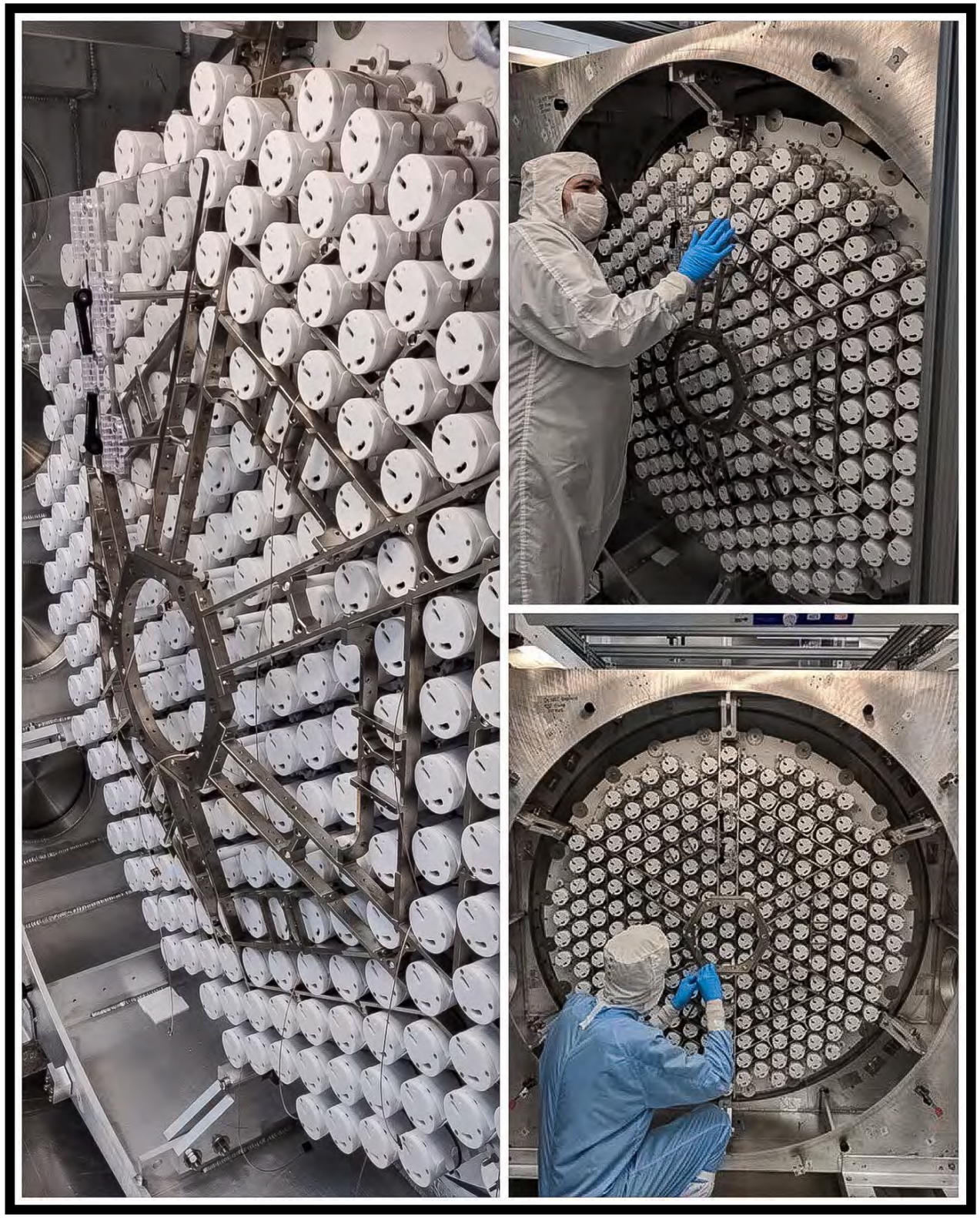
- Highly reflective PTFE panels ~ efficient measurement of the initial S1 scintillation signal.

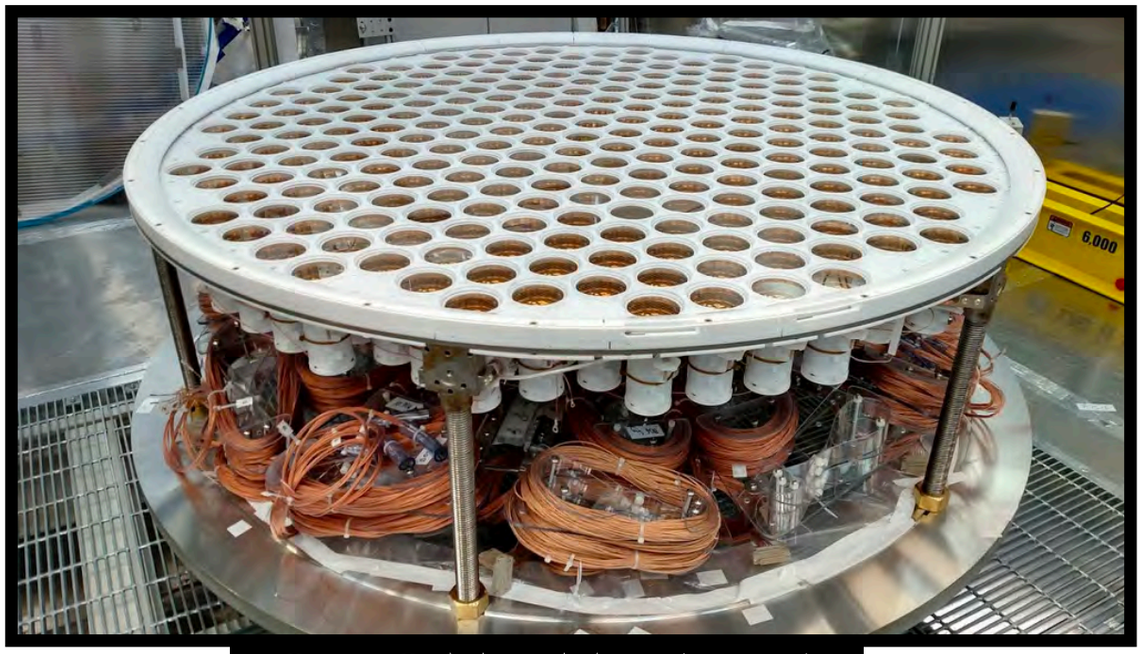


ASSEMBLED TPC

PMTs



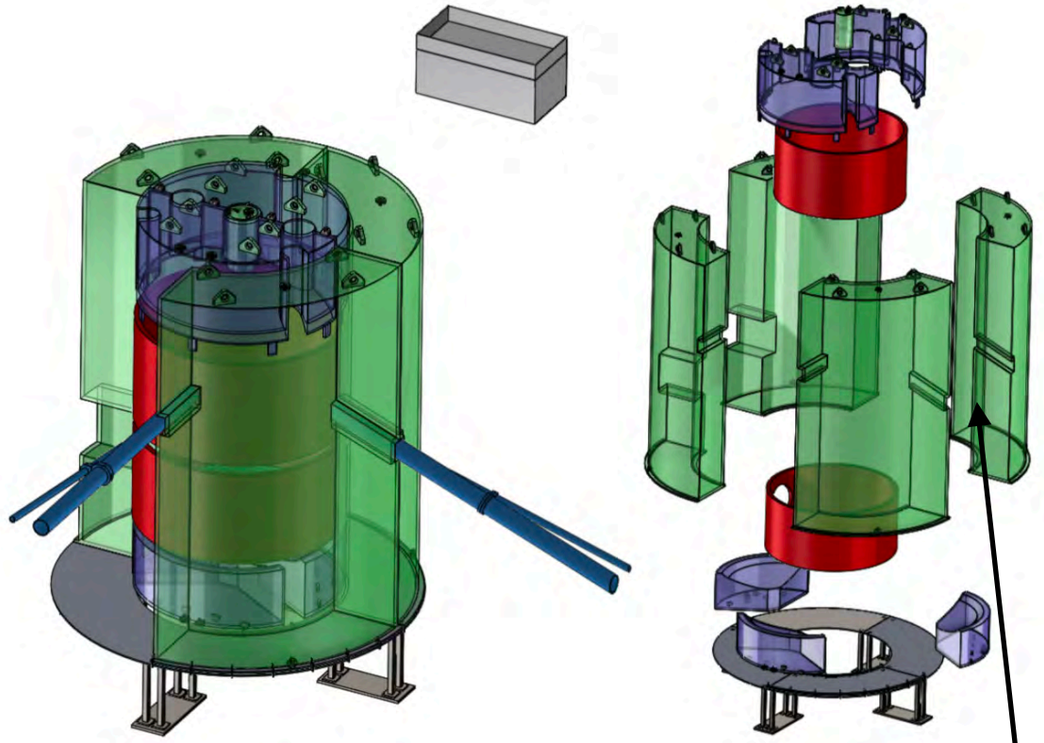




BOTTOM PMT ARRAY

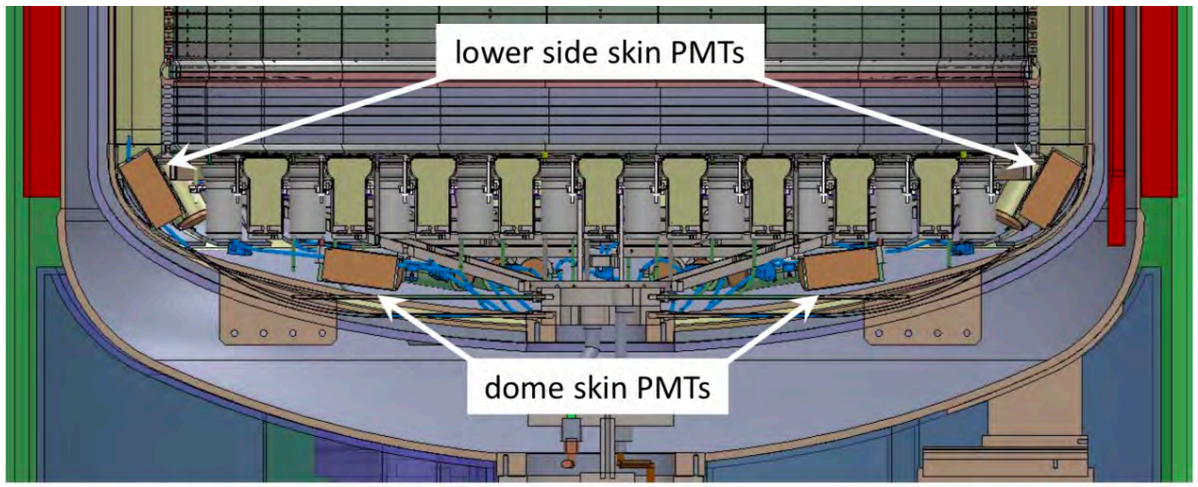
SKIN & OUTER DETECTOR

DOME SKIN PMT



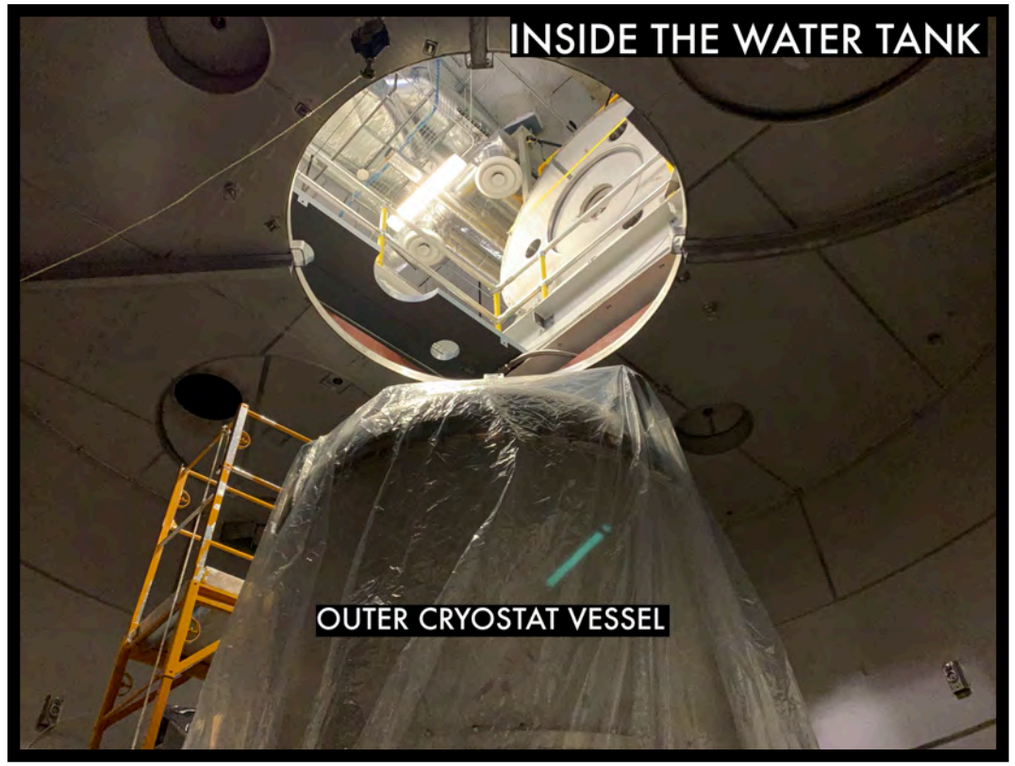
OUTER DETECTOR

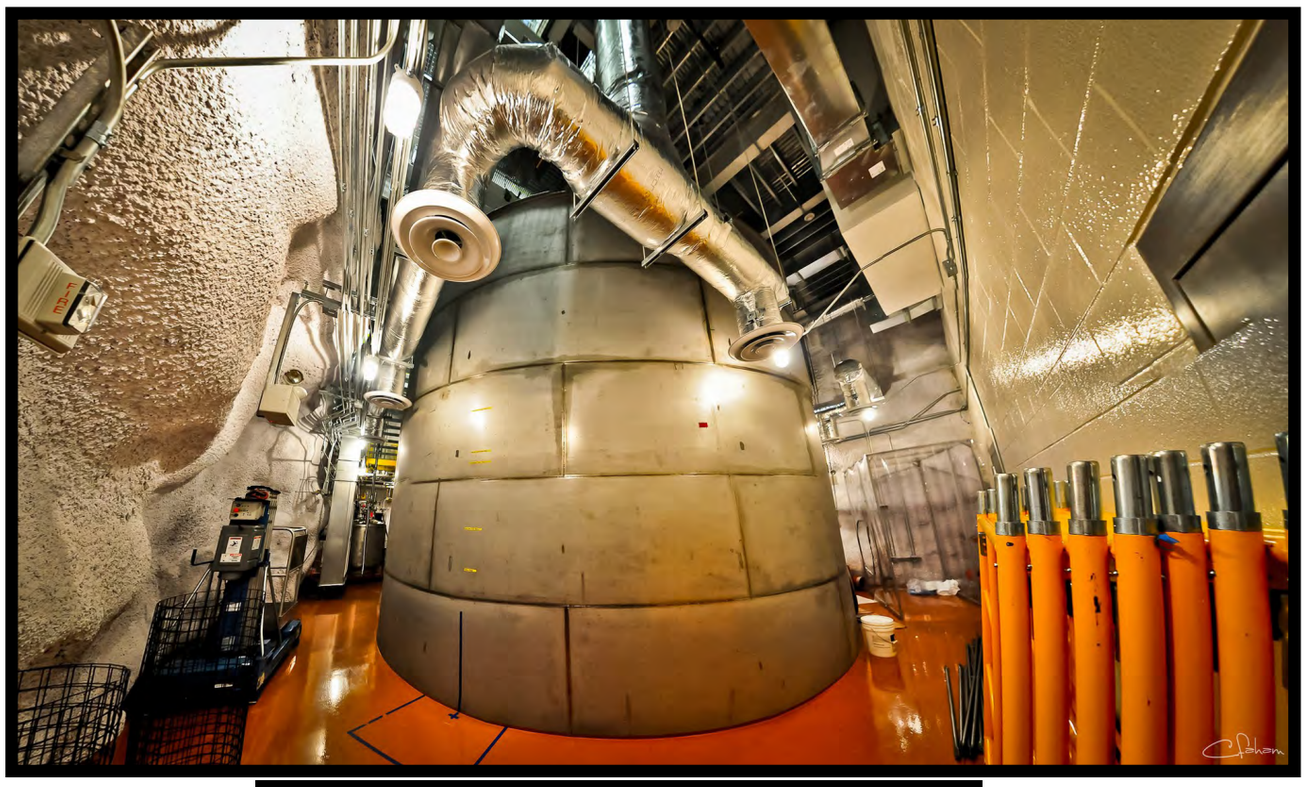
Acrylic vessel containing liquid scintillator



Liquid scintillator is doped with 0.1% Gd (Gd-LS) and held in large acrylic vessels

- Instrumented Xe ‘skin’ to veto gamma rays
- Outer detector to veto neutrons





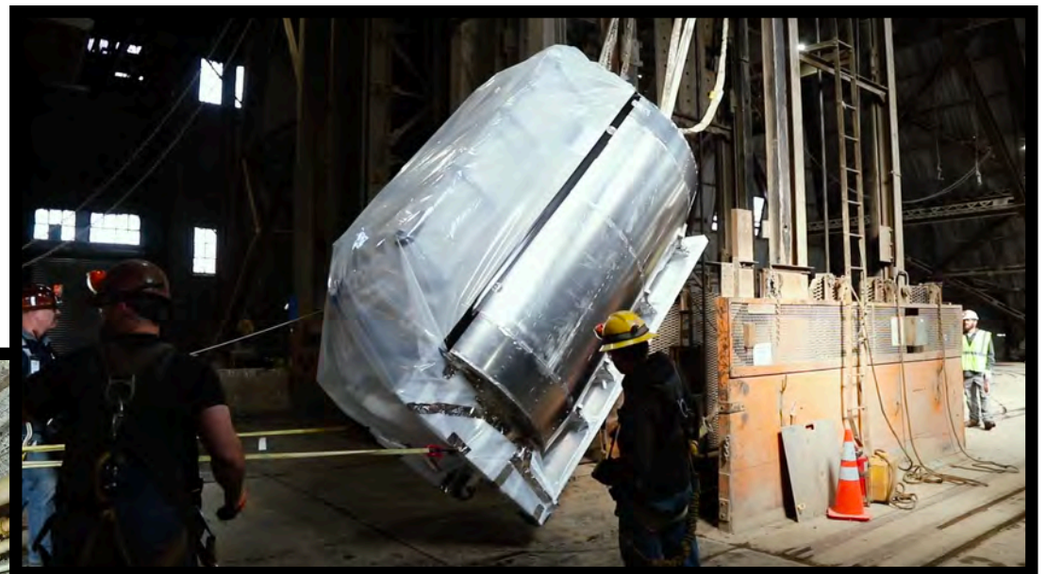
A fish-eye view of the water tank

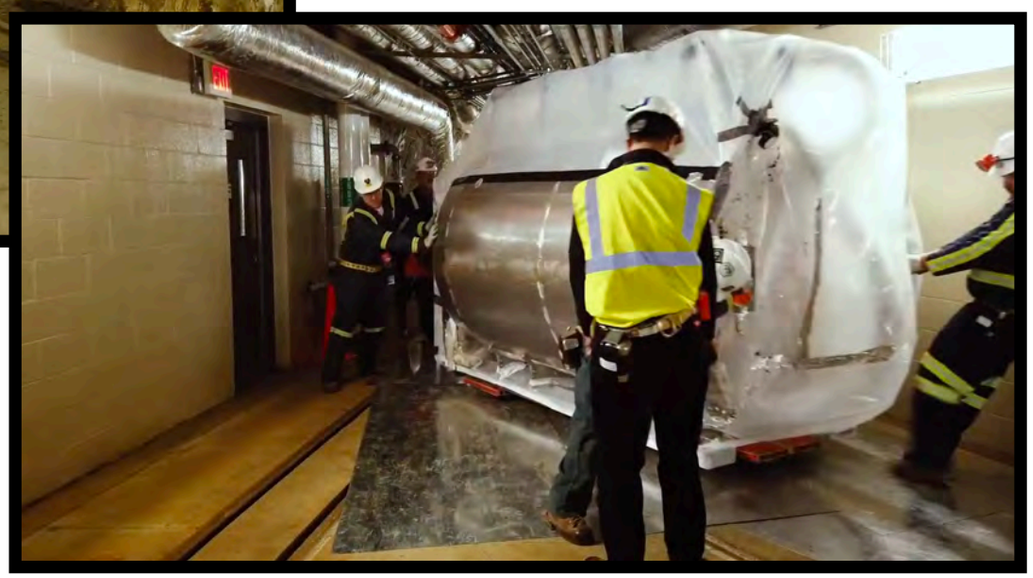
Height: 5.92 m
Diameter: 7.62 m

Dark Matter Experiment's Central Component Takes a Deep Dive – Nearly a Mile Underground

LUX-ZEPLIN experiment's time projection chamber is successfully moved to its research cavern

News Release • **October 29, 2019**





BACKGROUNDS

External Sources

Cosmogenic & Radiation from experiment cavern

Mitigation:

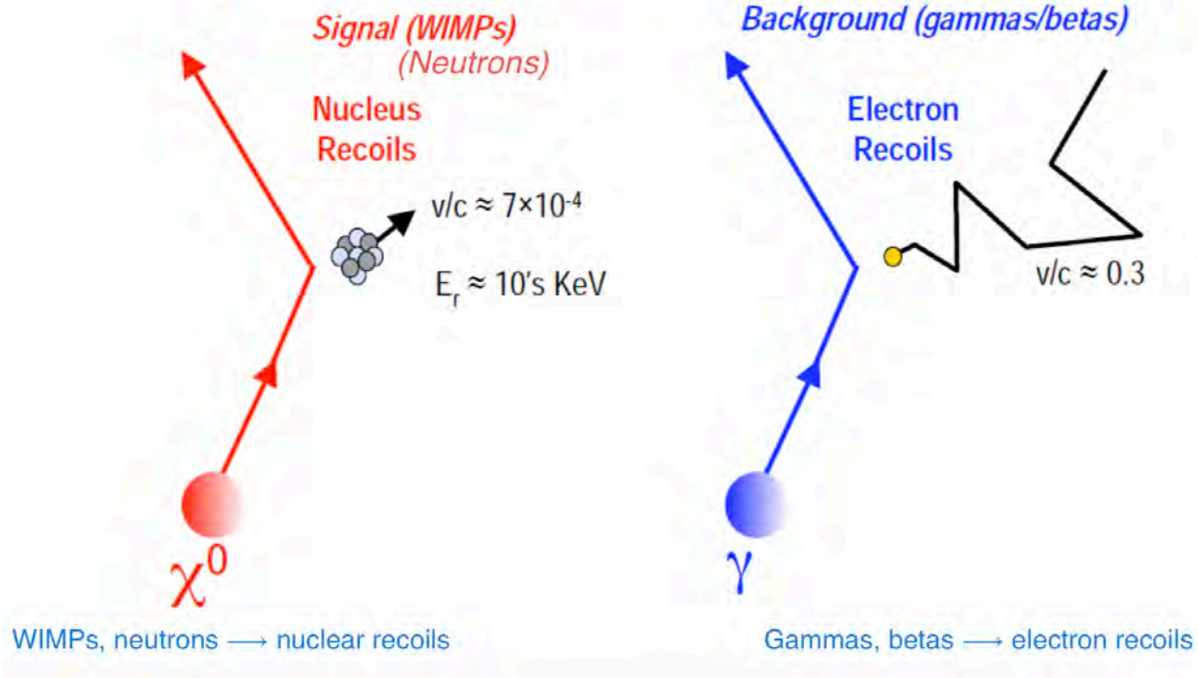
- Will operate underground at SURF in Lead, SD
- Measure rock backgrounds: ArXiv:1904.02112
- Instrumented Xe skin region
- Gd-LS outer detector
- High purity water shield

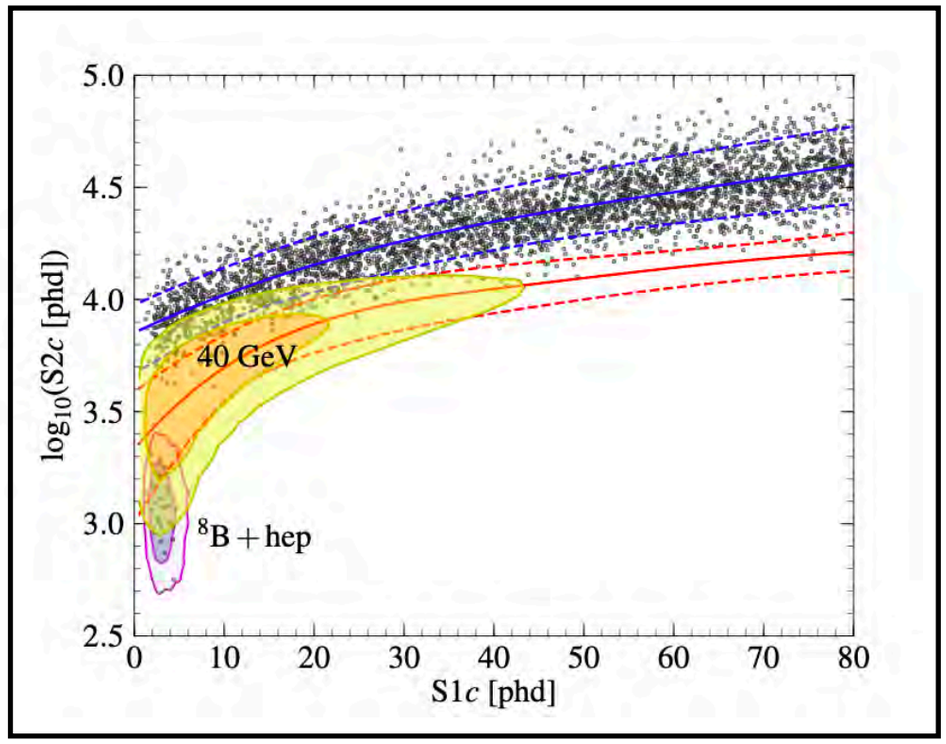
Internal Sources

- Radioactive materials in detector components
- Emanation of Radon from detector components
- Rn daughters & dust on surfaces
- Xenon contaminants- Kr, Ar, Rn

Mitigation:

- Radio-assay campaign
- Gamma-screening, ICPMS, NAA
- TPC assembly in Rn-reduced cleanroom
- Dust < 500 ng/cm^3 on all LXe wetted surfaces
- Rn-daughter plate-out on TPC walls < 0.5 mBq/m^2
- Charcoal chromatography at SLAC, California

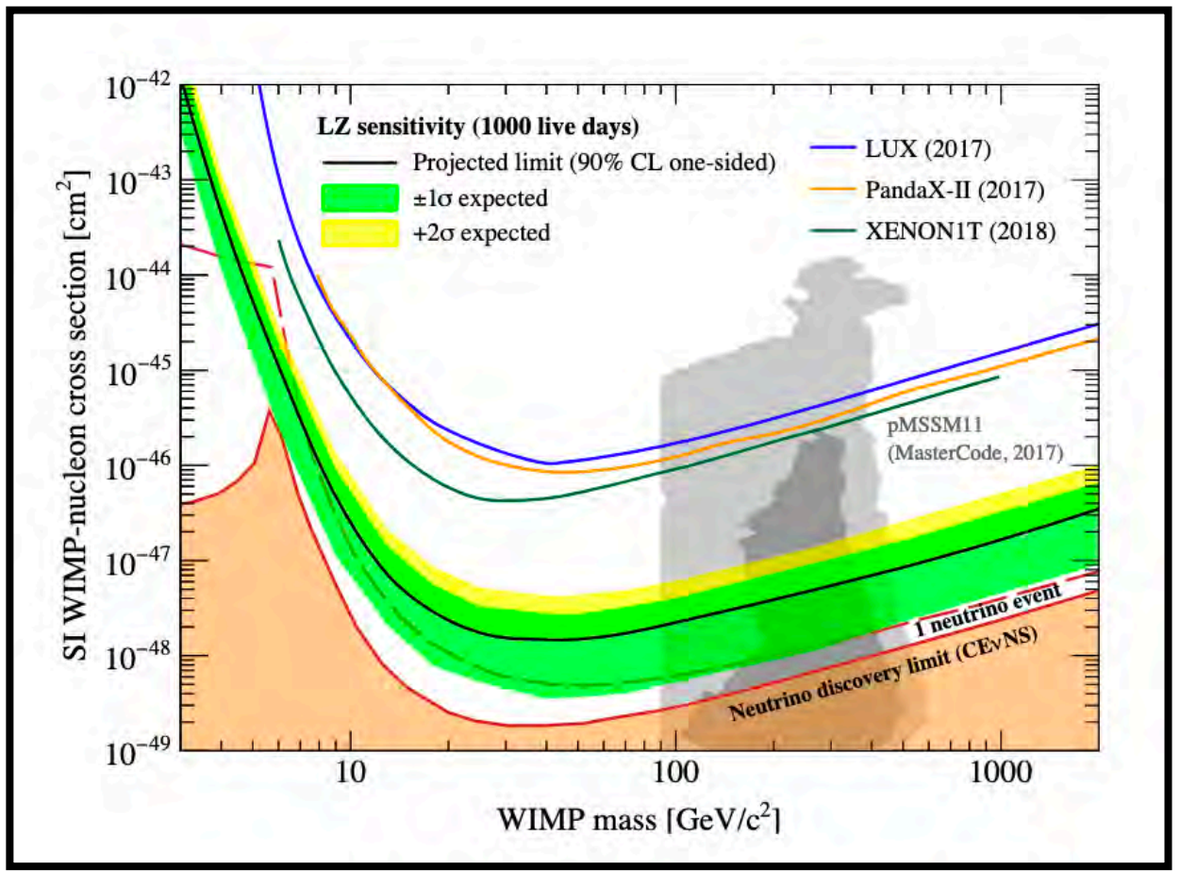




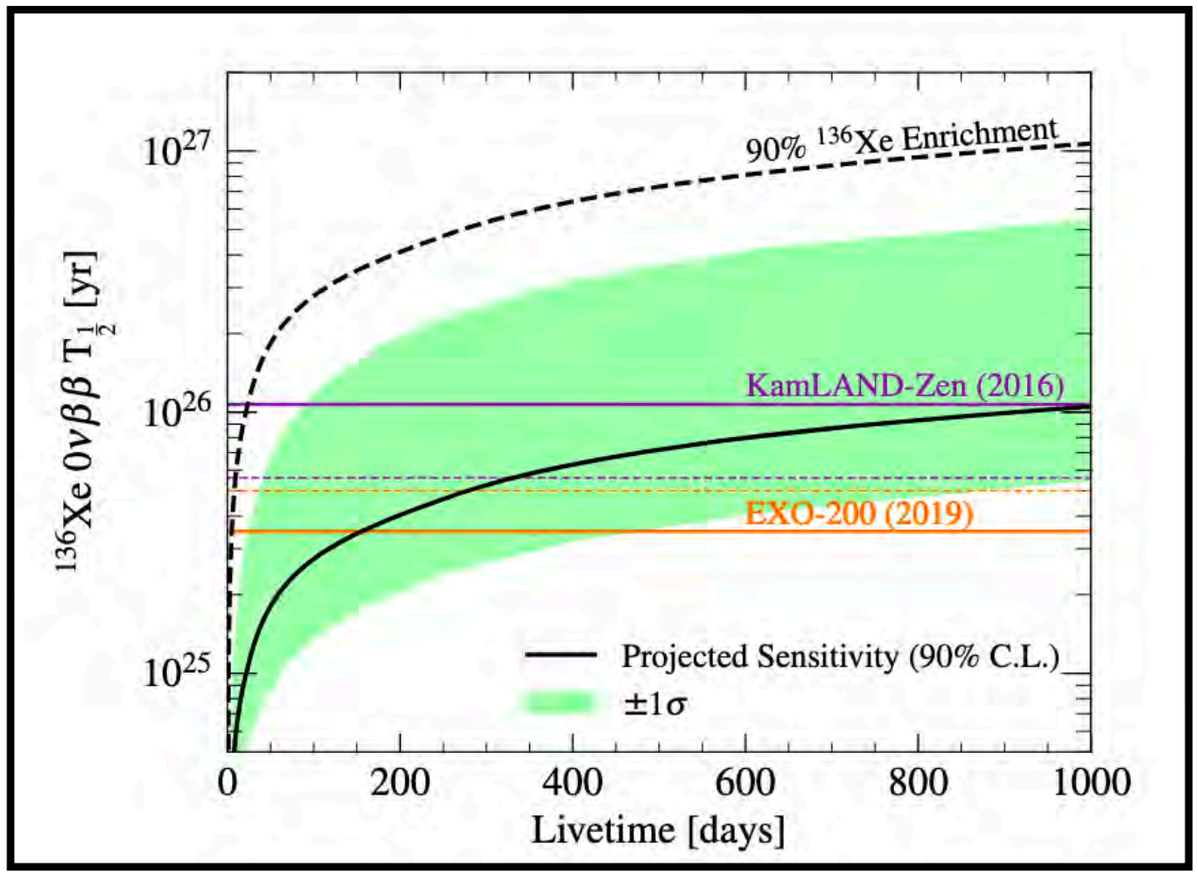
LZ simulation for a background-only 1000 liveday run and a 5.6 tonne fiducial mass

D.S. Akerib et al (LZ collaboration) 2019 arXiv:1802.06039

LZ projected sensitivity to SI WIMP-nucleon elastic scattering for 1000 live days and a 5.6 tonne fiducial mass



Physics sensitivity beyond WIMPs: LZ projected sensitivity to ^{136}Xe **0νββ** decay as a function of detector live time



A minimum sensitivity of 1.4×10^{-48} cm² is expected for 40 GeV/c² WIMPs

D.S. Akerib et al (LZ collaboration) 2019 arXiv:1802.06039

D.S. Akerib et al (LZ collaboration) 2019 arXiv:1912.04248

SUMMARY

Dark matter~ one of the greatest unsolved mysteries of the Universe

LZ ~ will be the most sensitive & the largest direct detection dark matter experiment!!!

LZ construction is nearly done and it will be entering its operations phase soon!!!

"I've either discovered dark matter, or I've left the lens cap on."

STAY TUNED . . .

THANK YOU!