

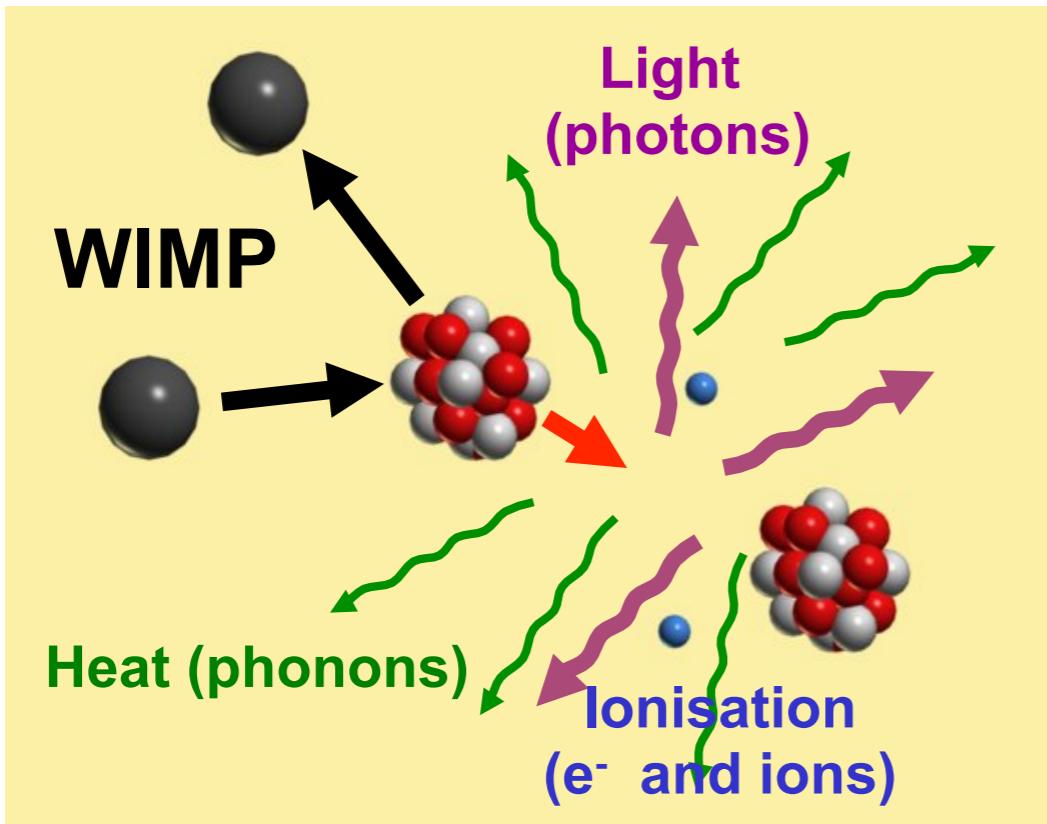
LUX experiment: an overview



Alexandre Lindote (LUX Collaboration)

Jornadas LIP 2012

Direct WIMP Search



Problems

- Very low event rate (10^{-5} to 10^{-2} ev/kg/day)
vs high background from μ , γ and n
- Low energy nuclear recoils (< 100 keV)

Solutions:

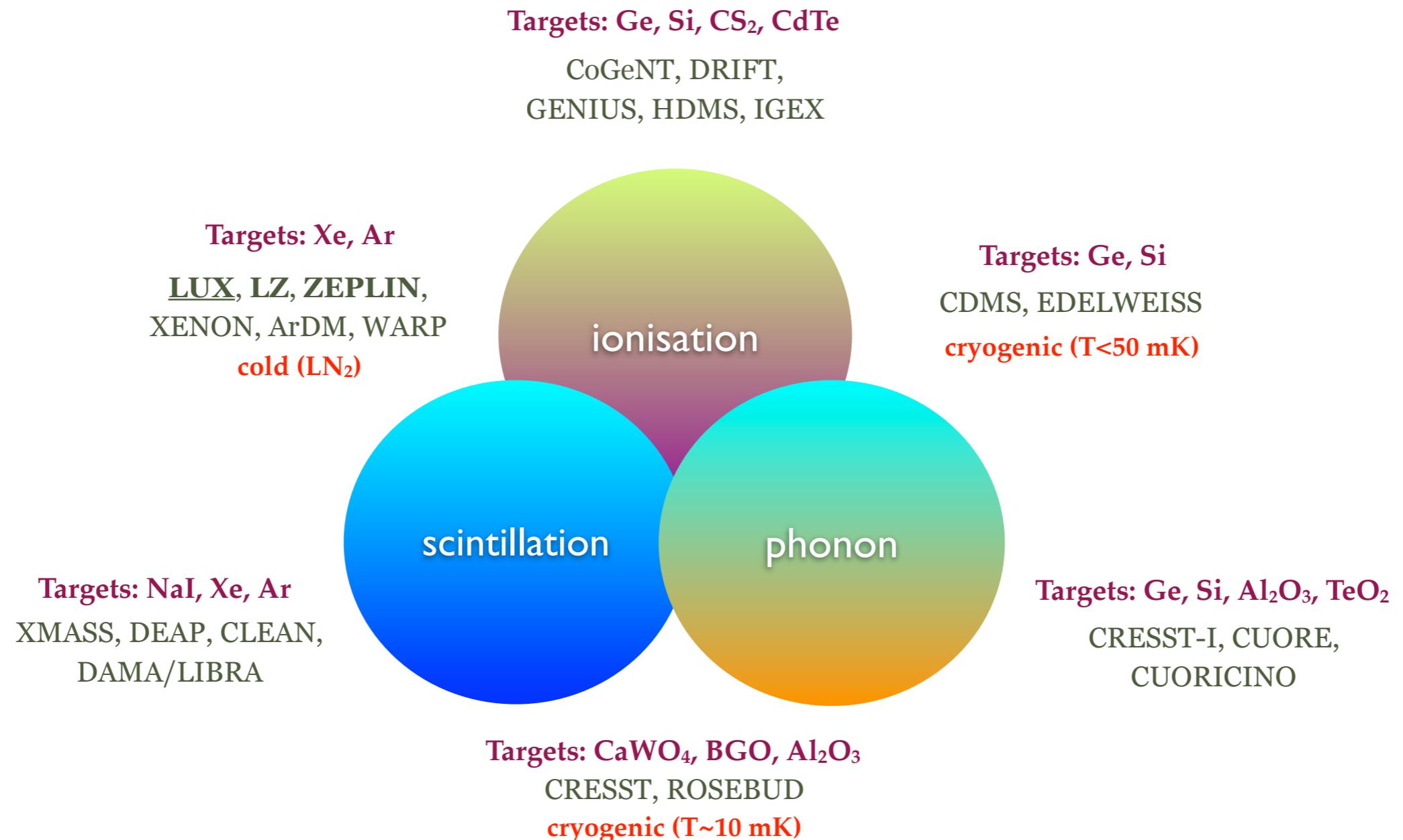
Reduce background

- Low-background materials
 - Radiopure
 - Not easily activated
- Go deep underground
- Passive shielding
- Active shielding (veto)

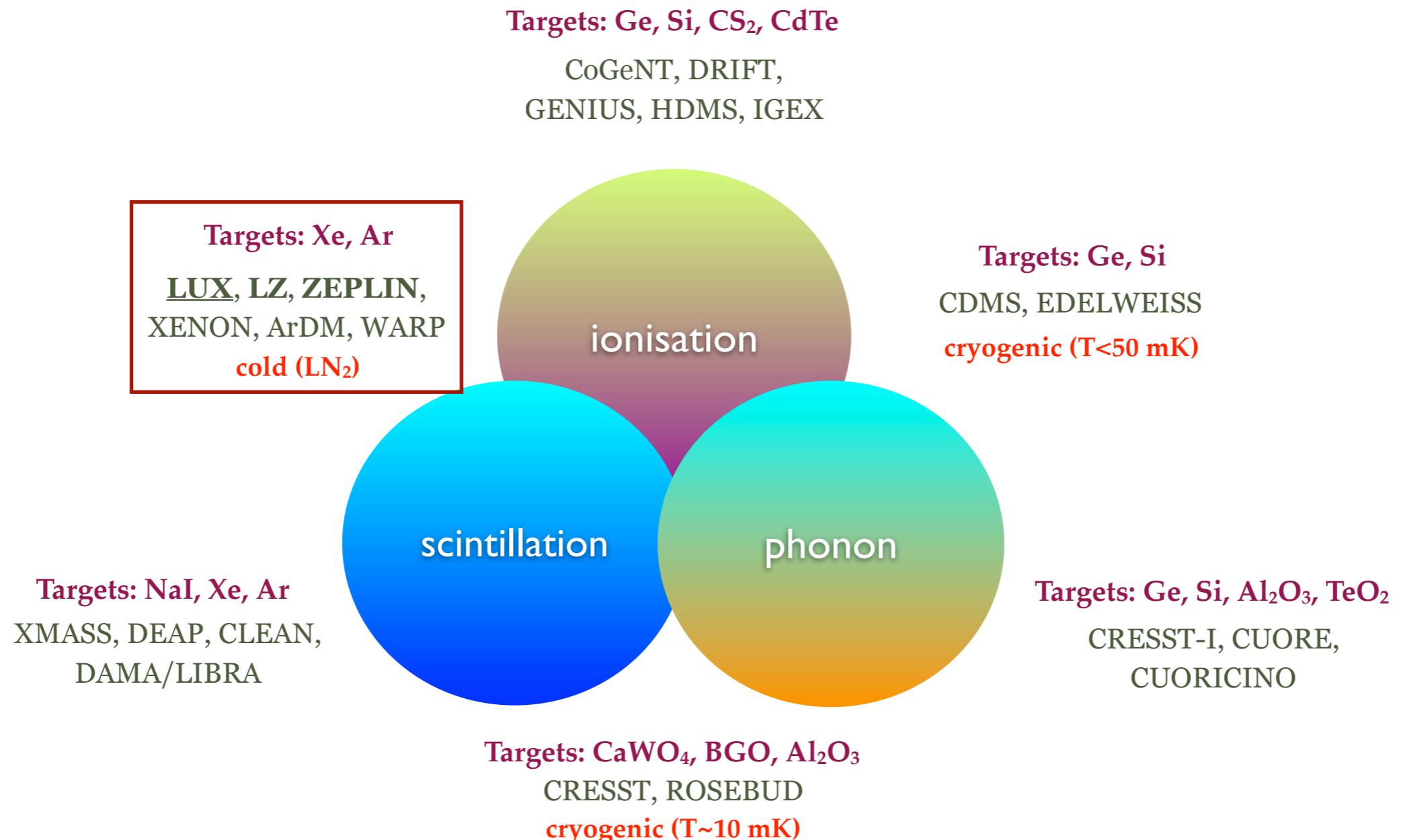
Reject background

- Discriminate between electron and nuclear recoils

Direct WIMP Search Technologies



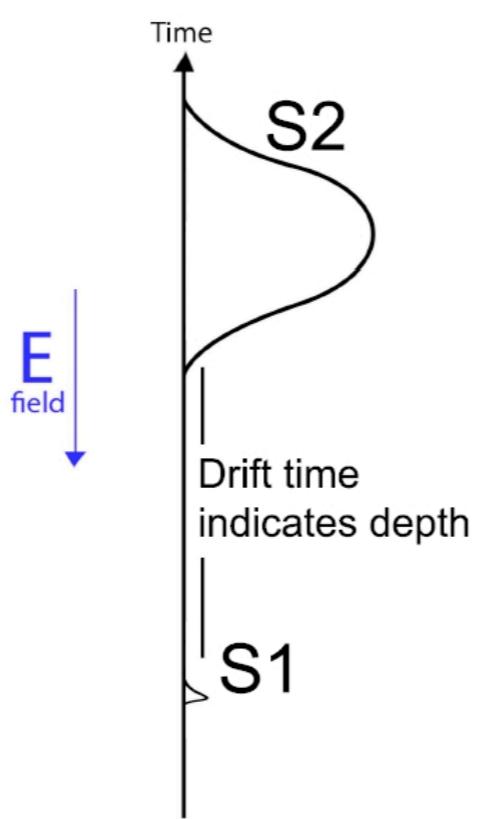
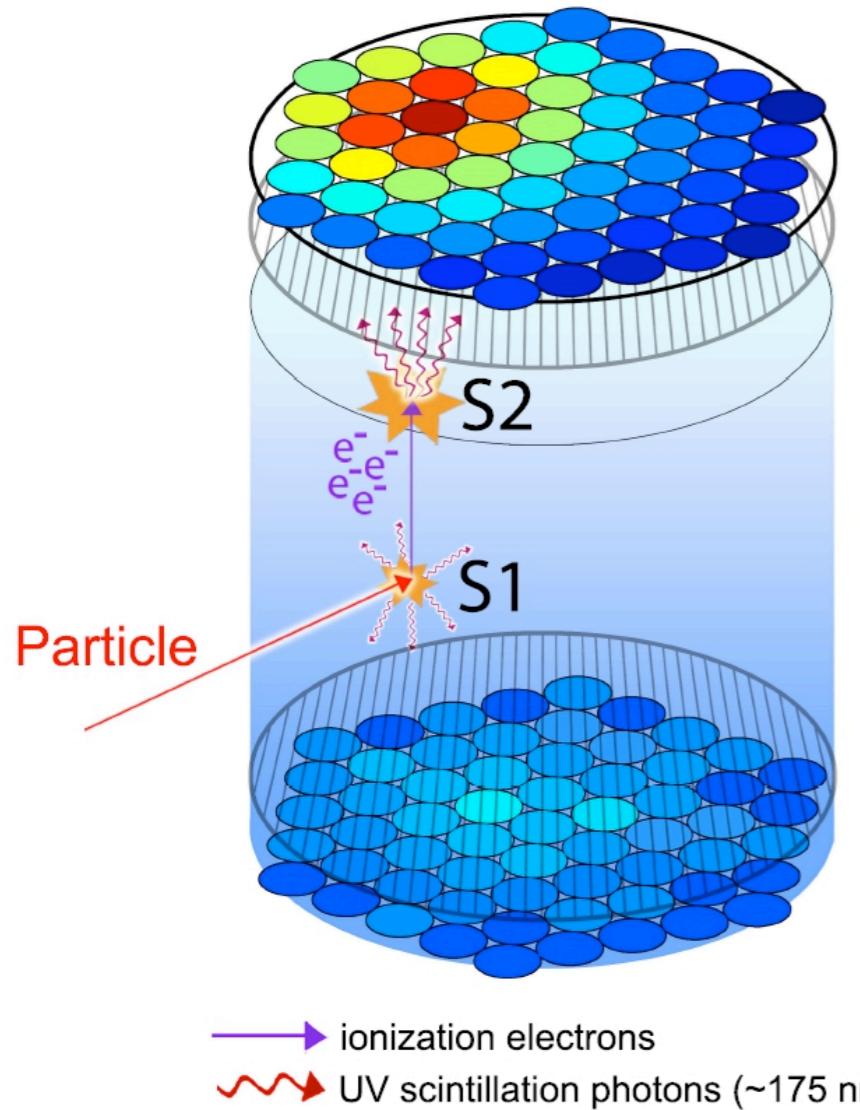
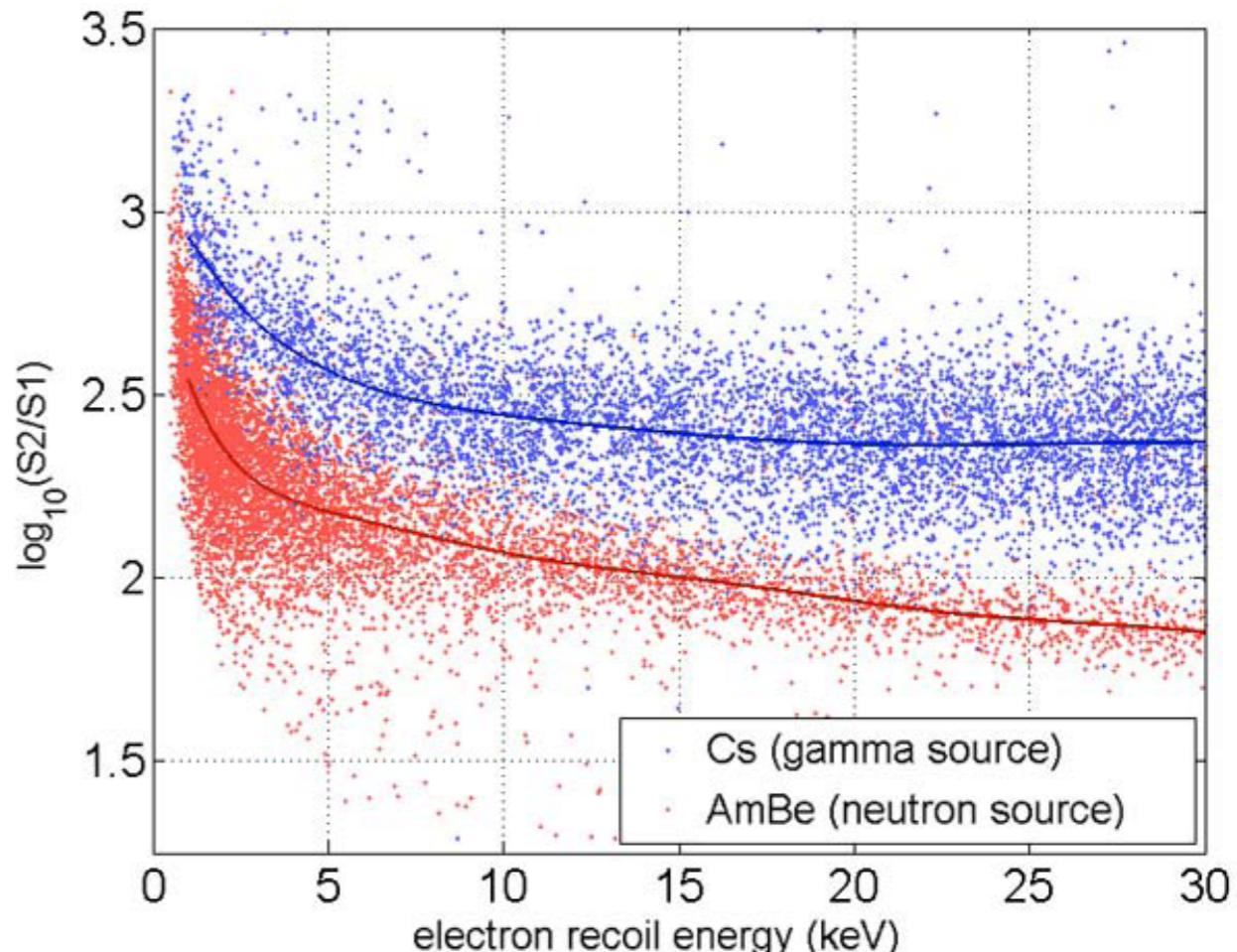
Direct WIMP Search Technologies



LUX is a 2-phase Xenon TPC

Discrimination Power

- WIMPs and neutrons interact with nuclei **short, dense tracks**
- γ s and e^- interact with atomic electrons **longer, less dense tracks**
- **S2/S1 used for discrimination (>99.5%)**

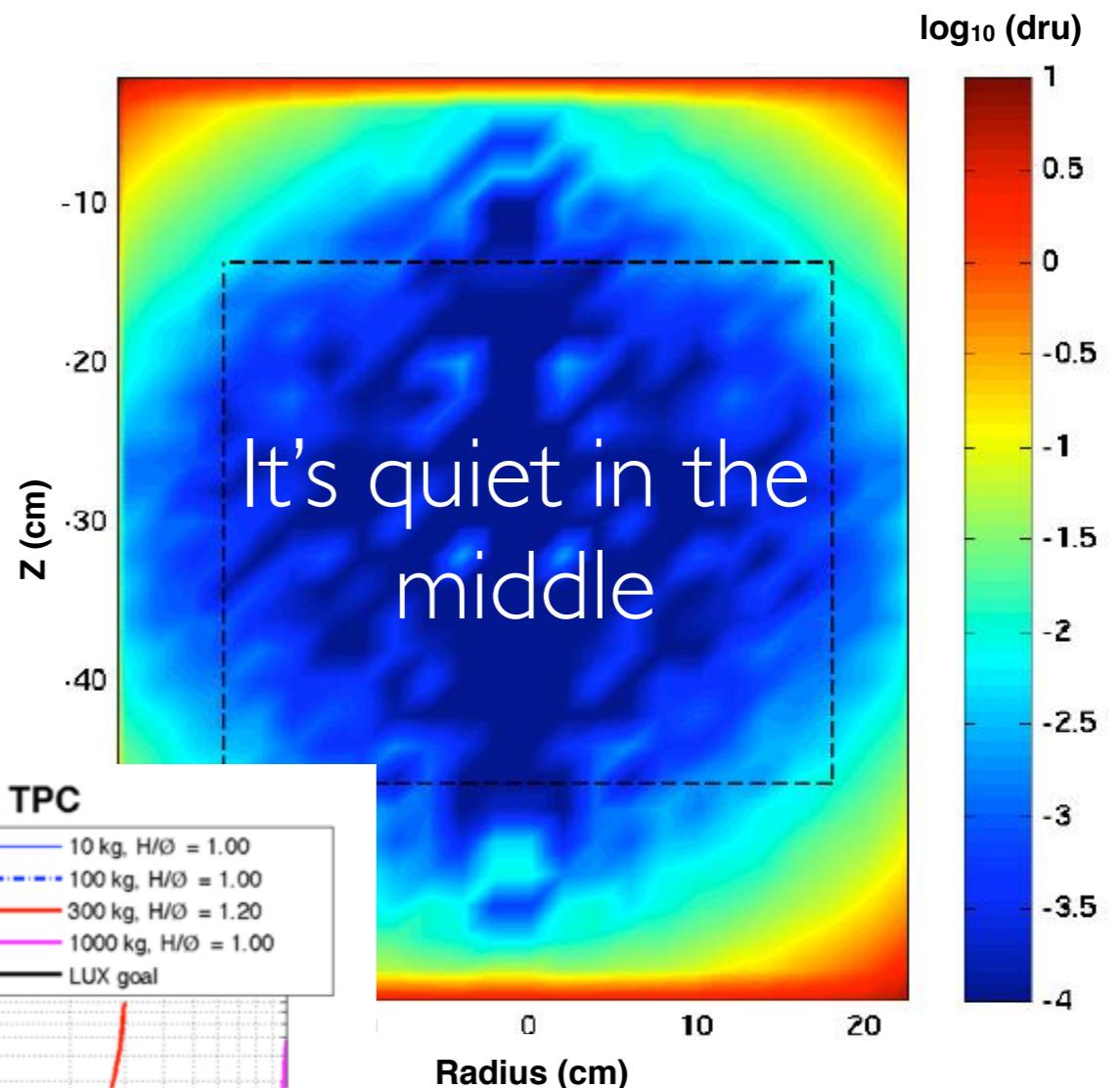
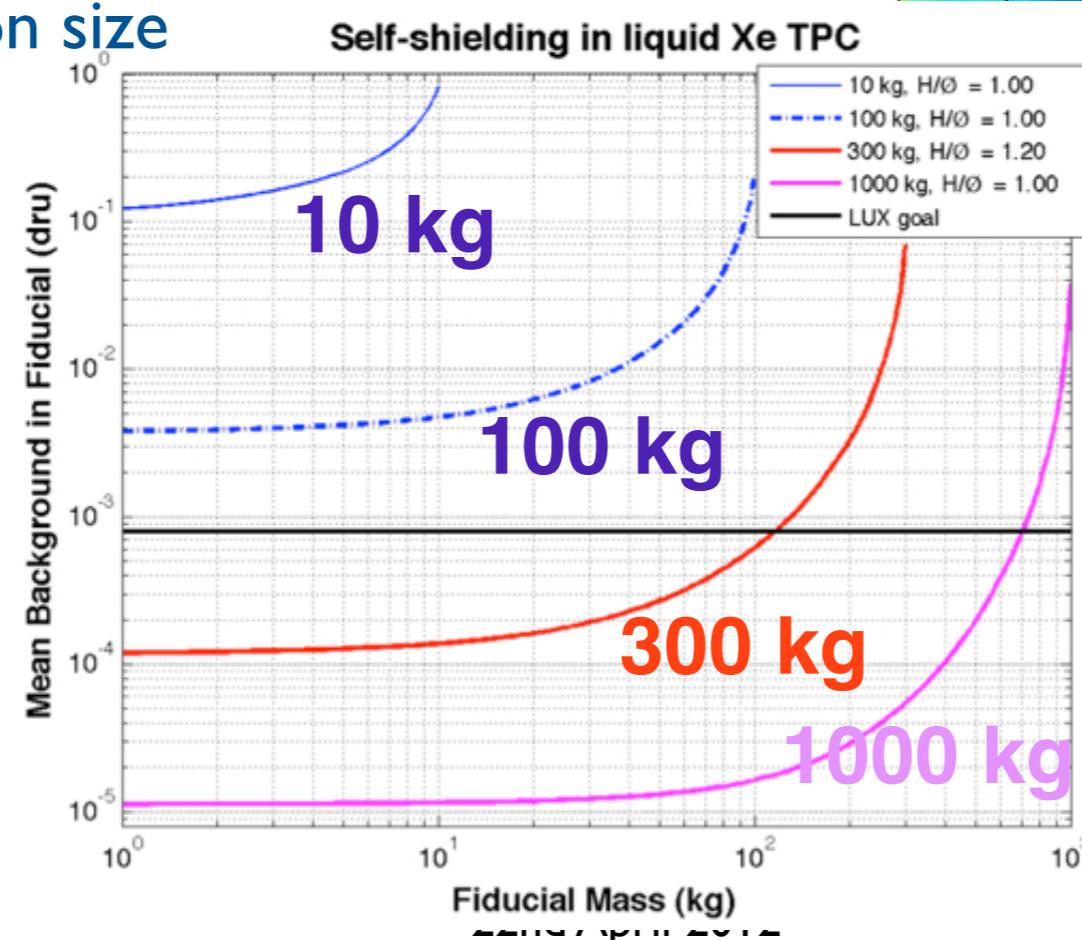


3D Position Reconstruction

- Z from time difference between S1 and S2
- XY reconstructed from S2 light distribution
(see Vladimir's talk)

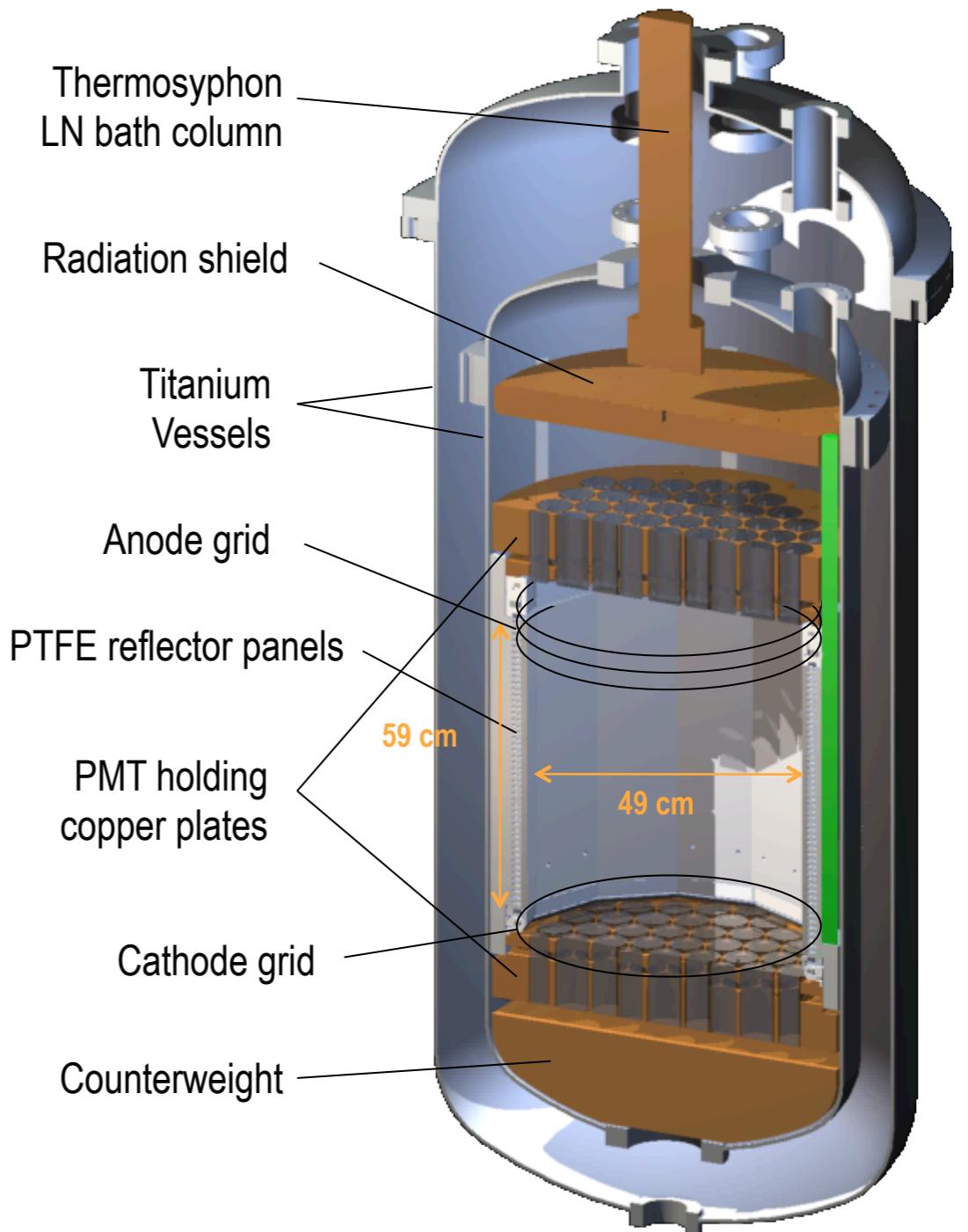
Xenon Technology

- High atomic number ($A=131$ g/mol)
- Relatively high density ($\rho=2.9$ g/cm 3)
- Large light output (~ 70 ph/keV @ 0 field)
- Sensitive to single ionisation electrons
- Nuclear recoil threshold ~ 1 keV (S2)
- No intrinsic backgrounds
- Self-shielding (using position recons.)
- Scalable to multi-ton size

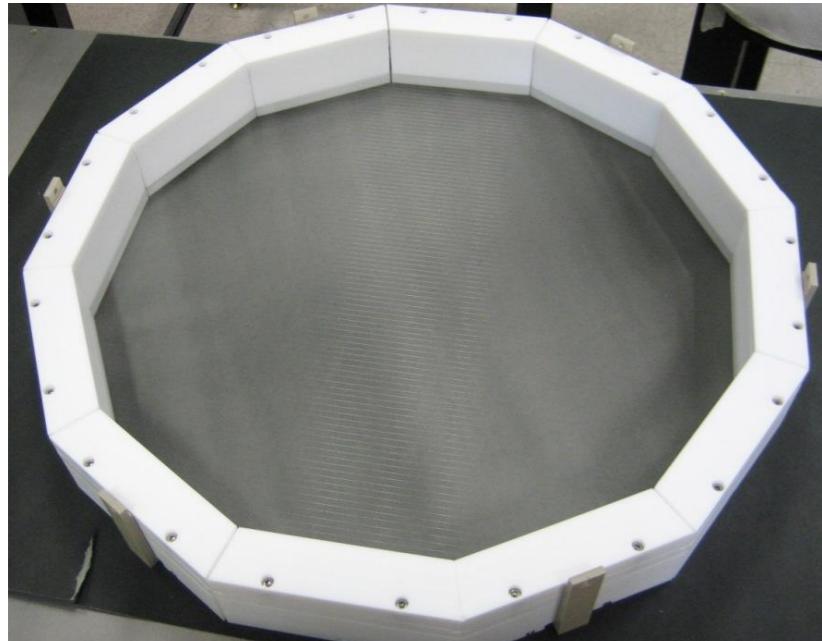


LUX Overview

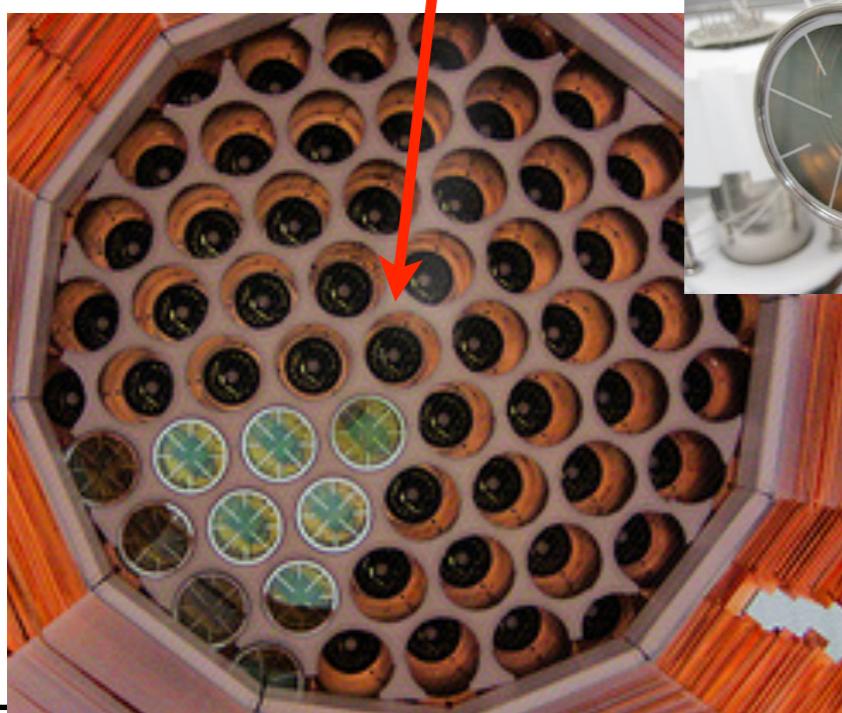
- Ultra-low background, 350 kg liquid xenon TPC
- Titanium cryostats ($<0.2 \text{ mBq/kg}$)
- 2 PMT arrays with a total of 122 tubes
- Maximum drift length: 50 cm
- Active region defined by PTFE slabs
- Installed inside 300 T water tank
- Already tested on the surface (Nov 2011 - Feb '12)
(see results on Francisco's talk)



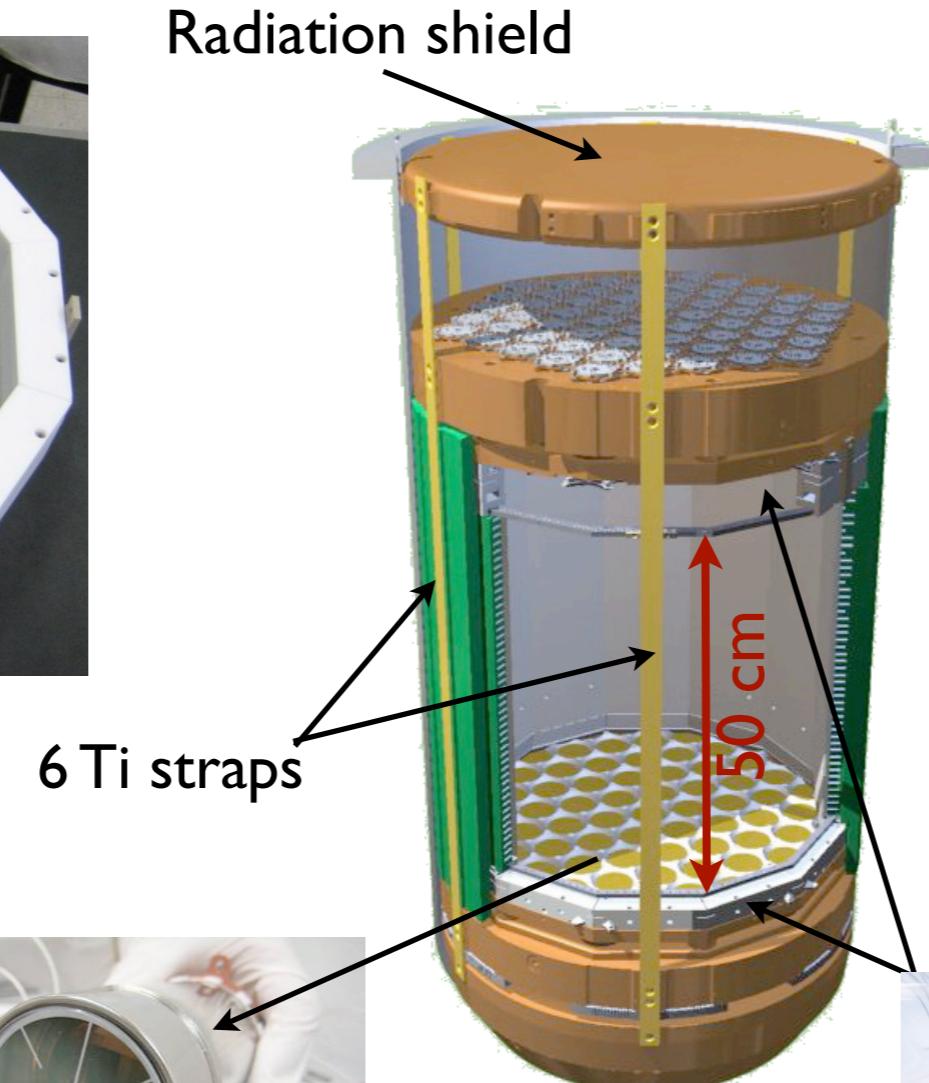
Detector Internals



HV Grids



PTFE "trifoils"

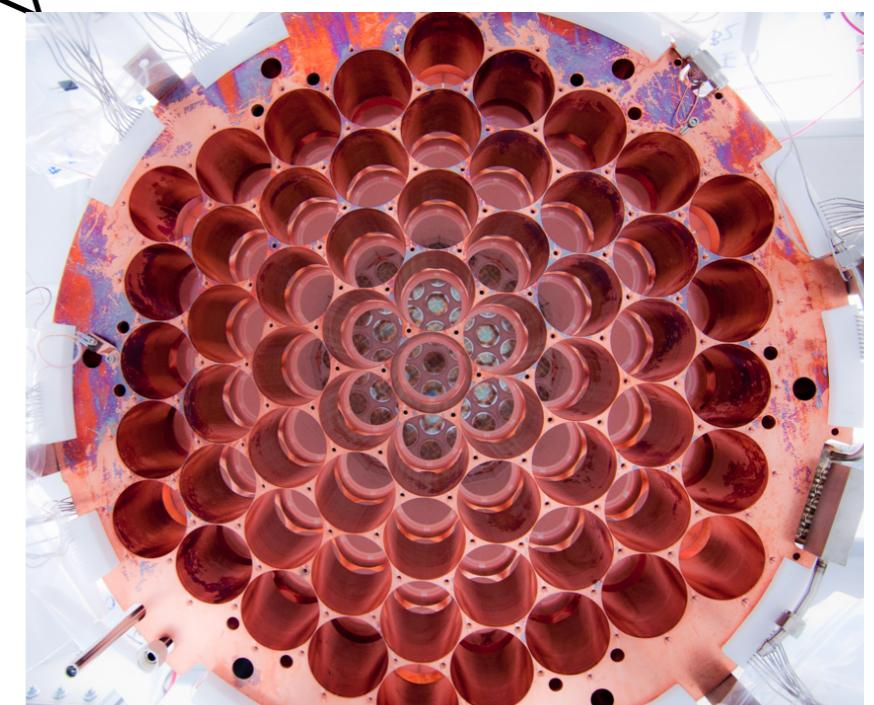


122 2" PMT R8778

- 175 nm, QE > ~30%
- U/Th ~9/3 mBq/PMT
- Dominant source of background



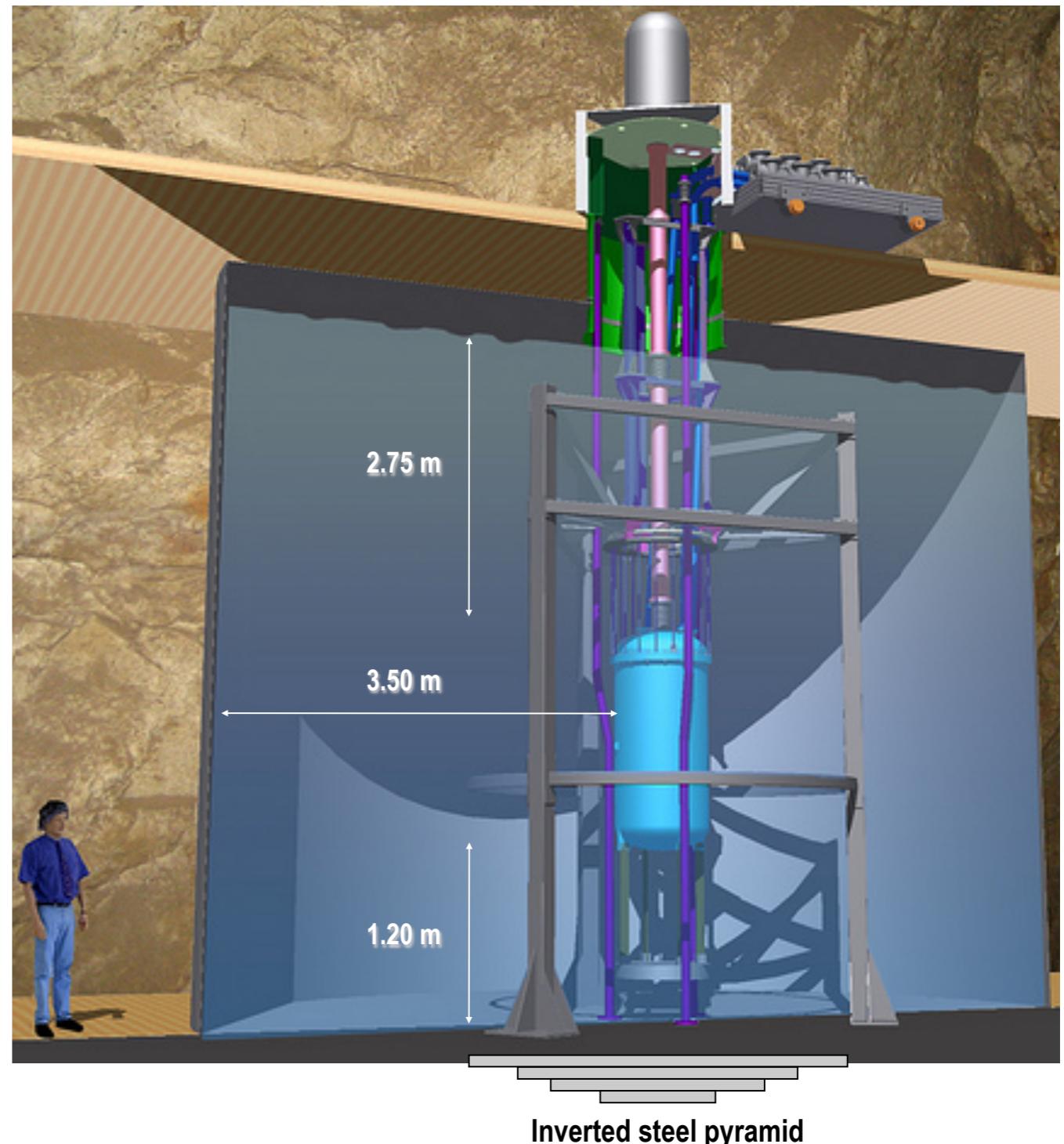
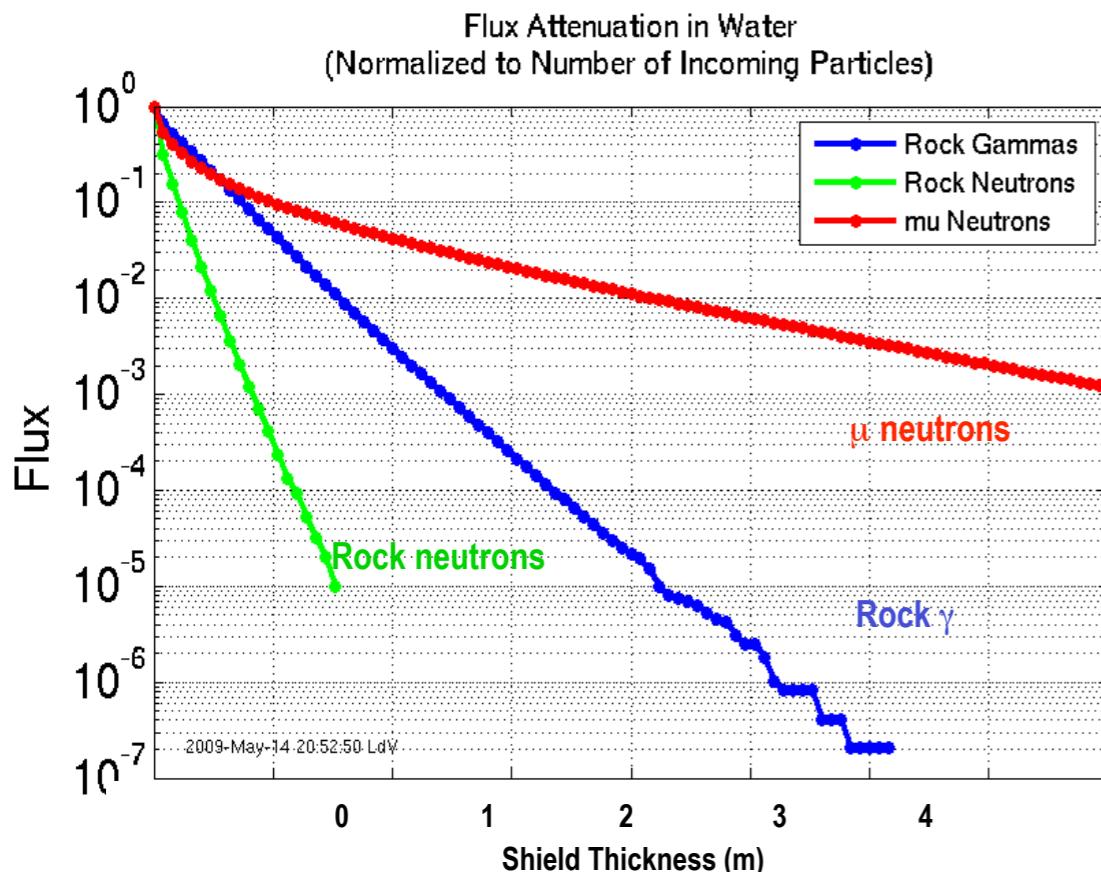
Dodecagonal field cage
+ PTFE reflector panels



Copper PMT holding plate

Water Tank

- Water Tank: $d = 8 \text{ m}$, $h = 6 \text{ m}$
 - 300 tonnes, 3.5 m thickness on the sides
- Cherenkov muon veto
 - 20 PMTs (10" diameter)
- Ultra-low background facility
 - Gamma event rate reduction: $\sim 10^{-9}$
 - High-E neutrons ($> 10 \text{ MeV}$): $\sim 10^{-3}$
- All external backgrounds subdominant



Davis Cavern @ Homestake

Former Home of the Homestake Solar Neutrino Experiment

- Located in an old gold mine (Lead, SD)
- 4850 ft deep (1.5 km, 4300 m w.e.)
- 10^7 reduction in muon flux
→ 4 muons/m²/day
- LIP proposes to measure UG muon flux



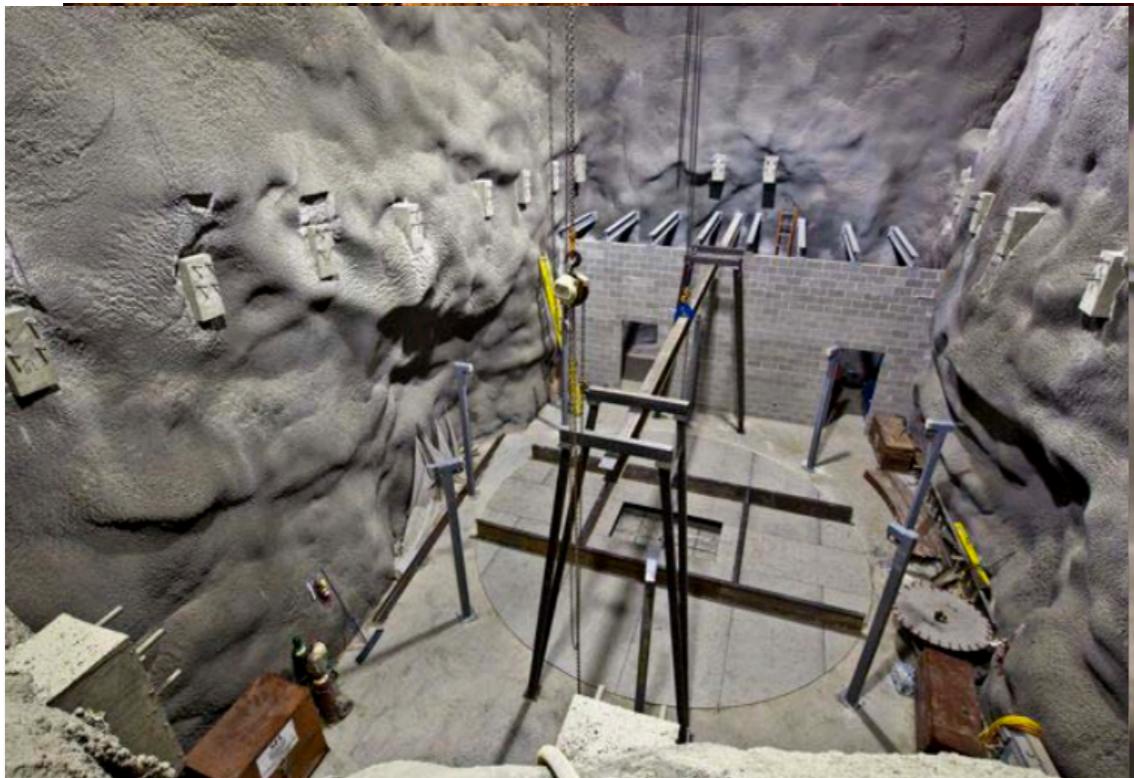
Davis Cavern



Davis Cavern

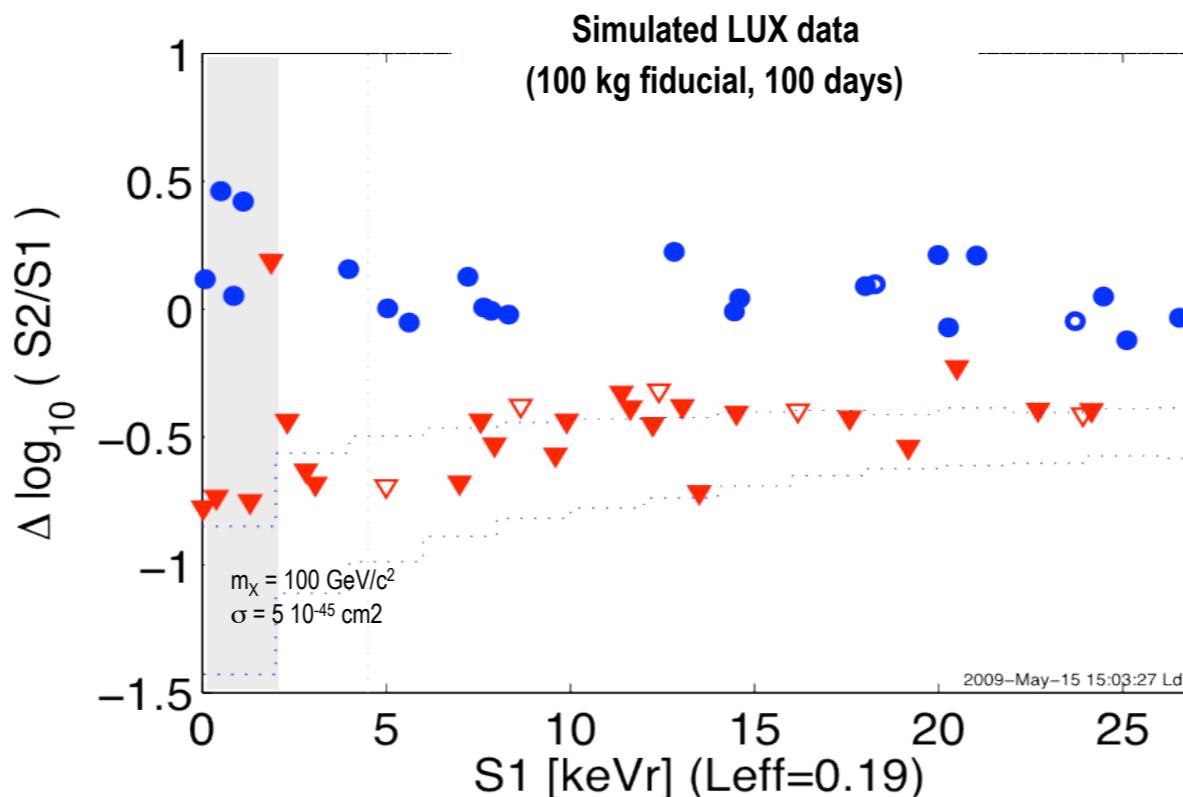


Davis Cavern



Backgrounds

- Goal: < 1 NR event / 300 days in 100 kg fiducial volume
- Expected ER background: $\sim 260 \mu\text{dru}$ (dru = ev/kg/day)
 - PMT contribution dominant (external backgrounds $\sim 10^{-4}$)
 - $^{85}\text{Kr} < 5 \text{ ppt}$ ($\sim 10\%$ of ER background budget)
- Expected NR background: $< 500 \text{ ndru}_r$
 - Neutrons mostly from (alpha,n) on PMTs
- Extremely low background in fiducial volume
 - 2 days $\rightarrow < 1$ ER event (before $> 99.5\%$ discrimination)
 - 60 days $\rightarrow \sim 16$ ER events
 - 300 days $\rightarrow 0.06$ NR, 80 ER events



WIMP Sensitivity

