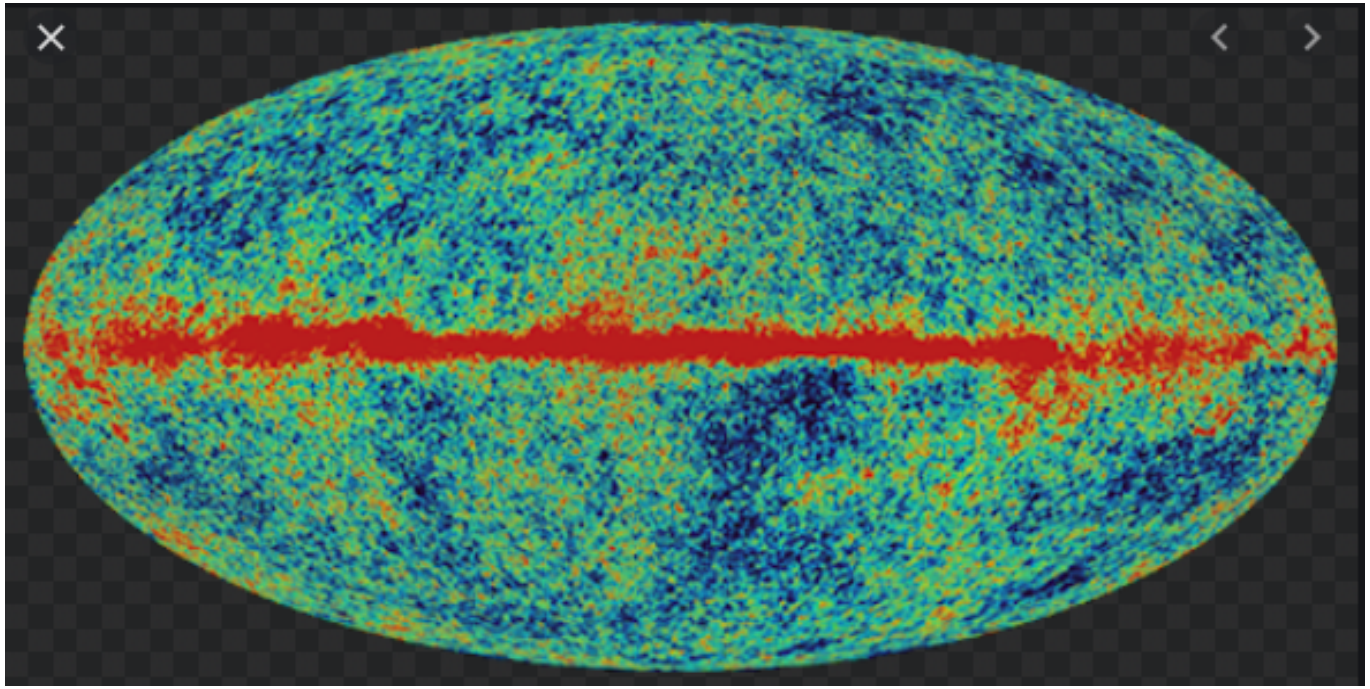
Direct Detection Dark Matter: Lux-Zeplin

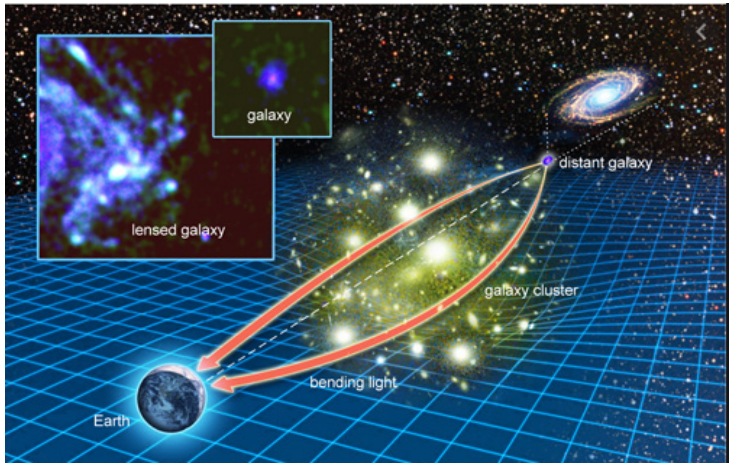
Cold Radon Emanation Facility: next generation dark matter

PPD – UCL

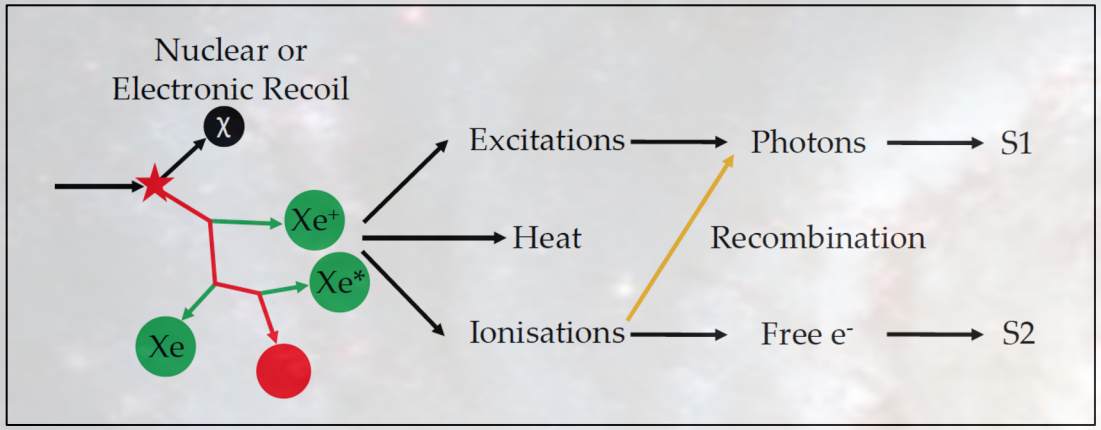
(Maurits van der Grinten/Chamkaur Ghag)

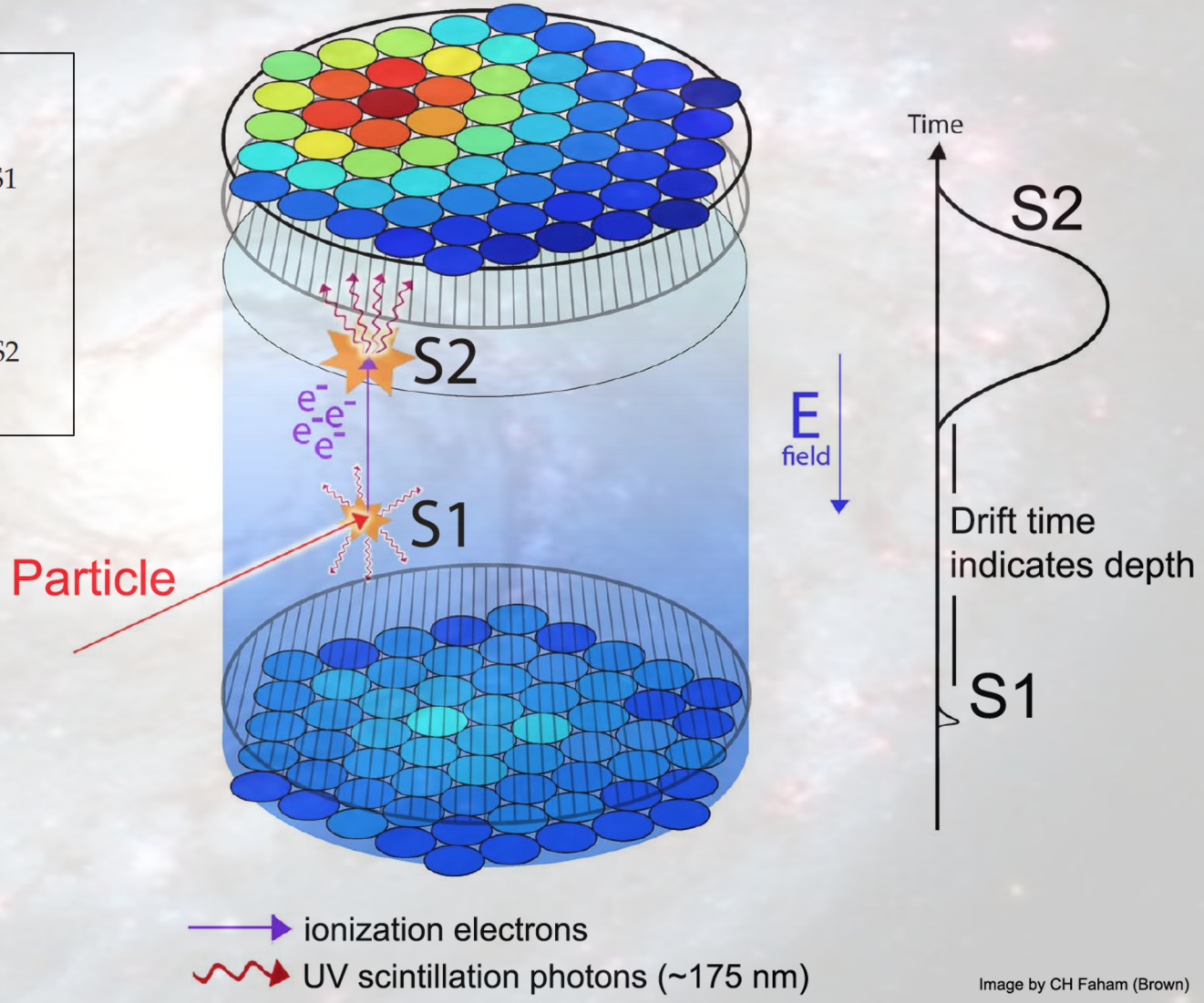
Dark Matter:
Some of the most existential questions, what is our Universe made of?





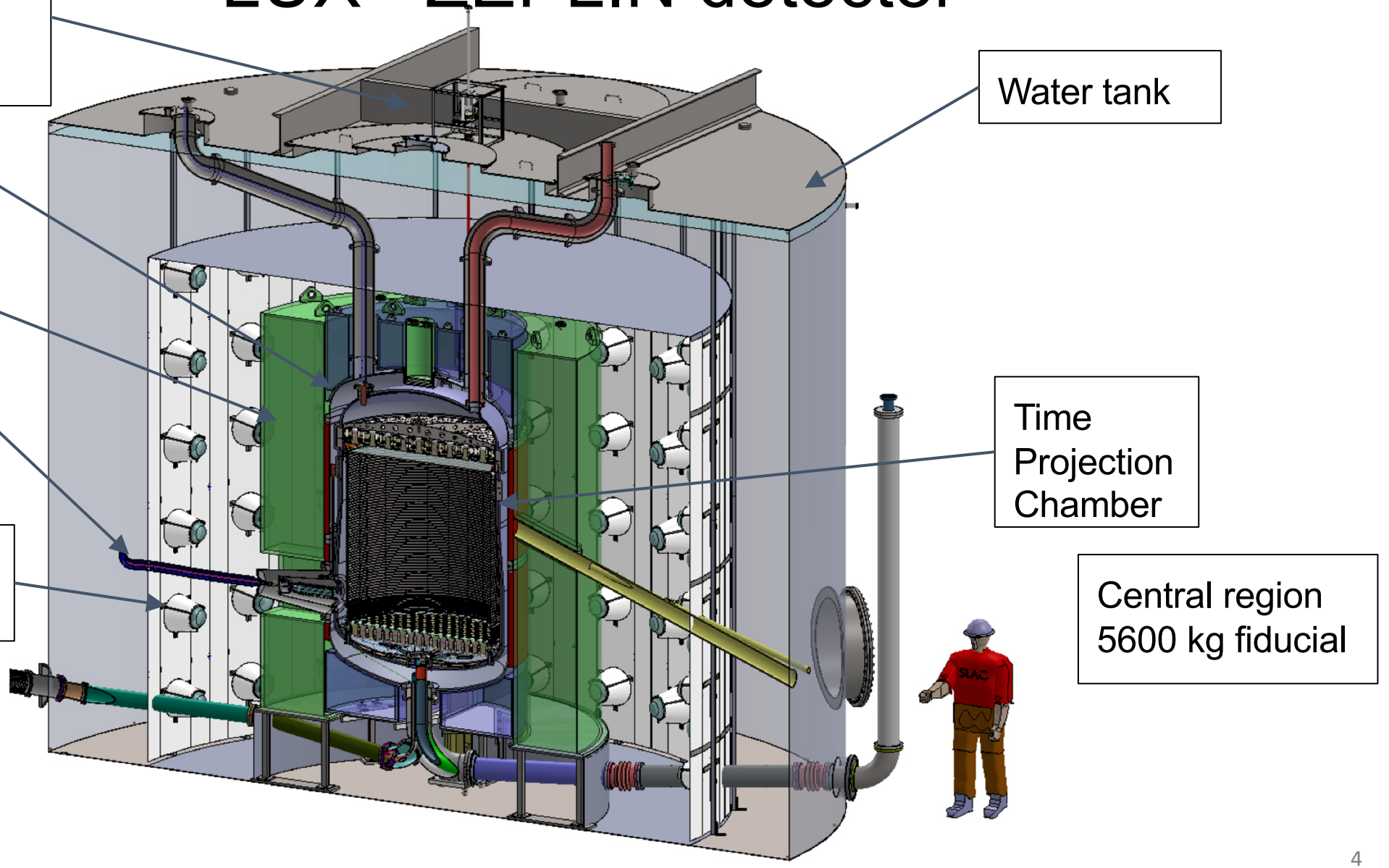
Dark Matter Direct Detection





- Single photon and electron sensitivity
- Z position from S1-S2 timing
- X-Y position from S2 signal pattern
- ER/NR discrimination by charge to light ratio (S2/S1)

LUX - ZEPLIN detector



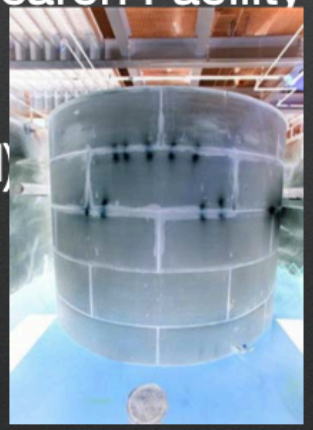
Davis Cavern 1480 m

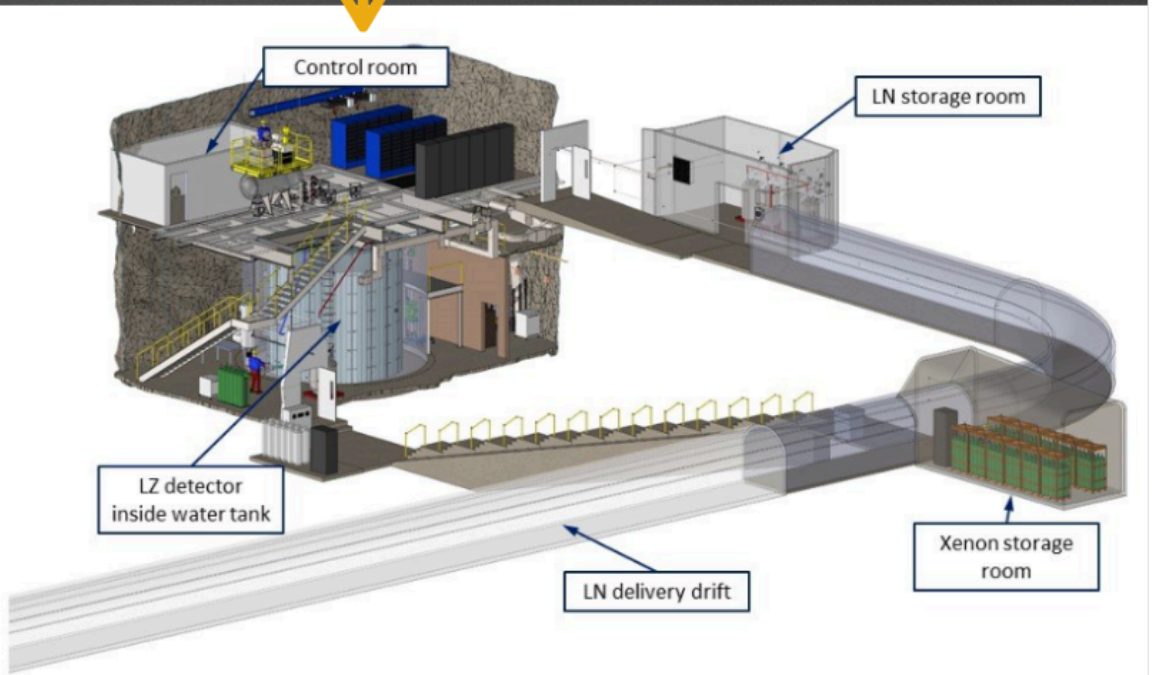
(4200 m water equivalent)

Sanford Underground Research Facility

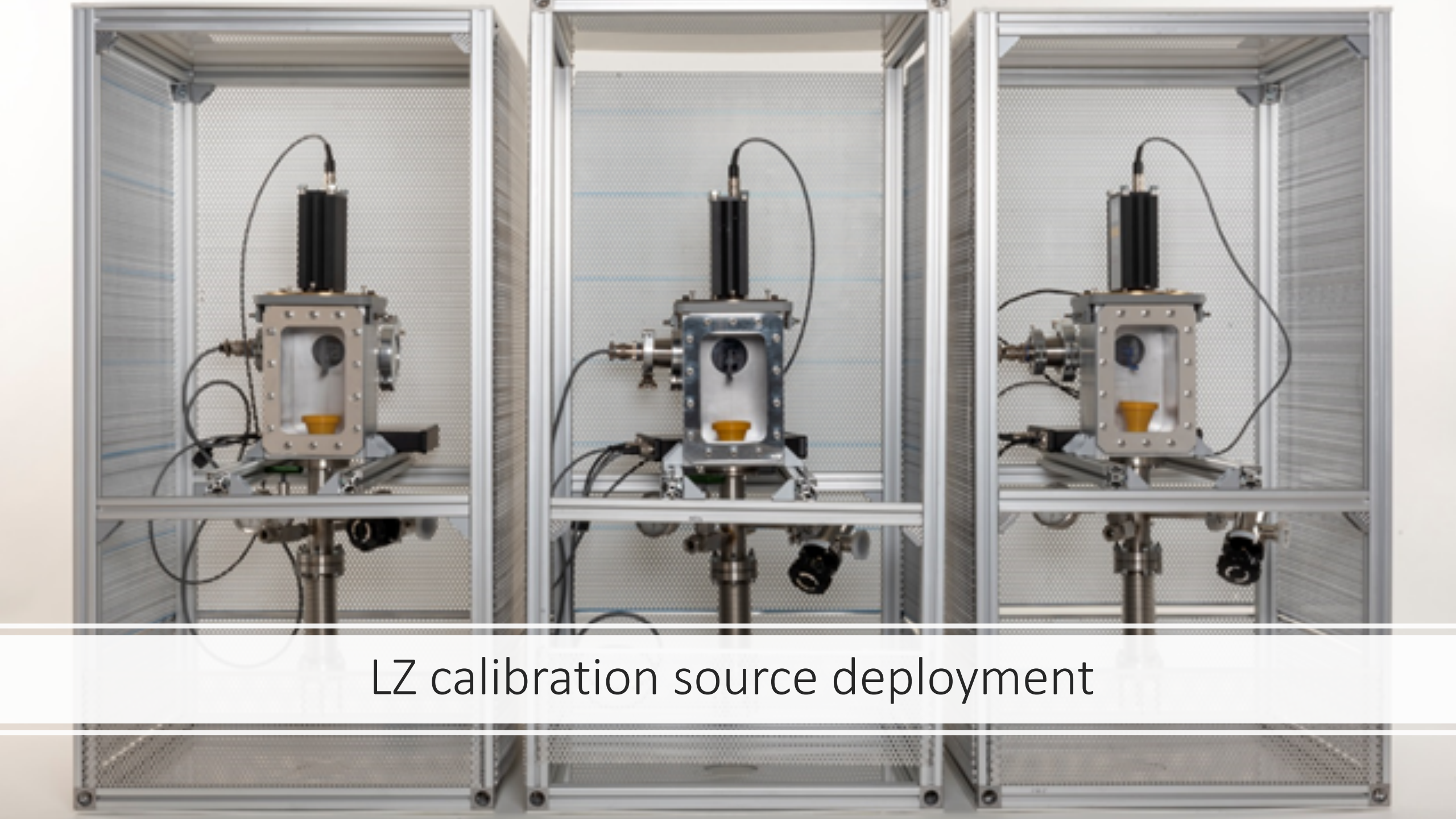
Homestake Gold mine

Lead, SD (near Deadwood)





LZ Ti cryostat manufacturing at Loterios



LZ calibration source deployment

Radon: spoiling all the fun, or not?

Radon

- Radon originating from Uranium and Thorium chains
- Radon-222 has half-life of 3.82 days, once in Xenon it disperses throughout
- Background mimics WIMP signal

Temperature considerations

- Radon diffusion suppressed in some materials at cryogenic temperatures
- Radon recoiling out from surfaces not suppressed
- Limited data available on the overall temperature dependence of radon outgassing from materials
- Very limited data available distinguishing surface from bulk emission

Joint Cryogenic Radon Emanation Facility:

1. Conduct assays under cryogenic conditions
2. Scale up the chamber volume

This facility:

Sensitivity of < 50 μBq/sample envisaged

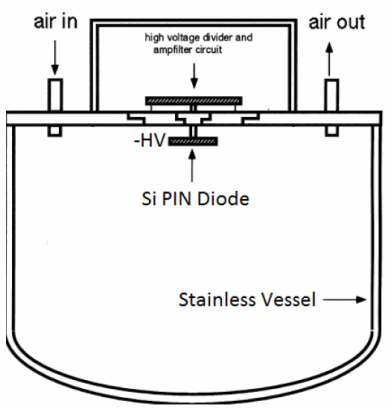
Cold Radon Emanation Facility

Facility consists of:

1. Large cryogenic vacuum vessel & cryostat
2. ISO Class 7/6 controlled environment
3. Large (~ 200l) test chamber
4. Radon concentration line
5. Radon detector
6. UCL & PPD operational running resources

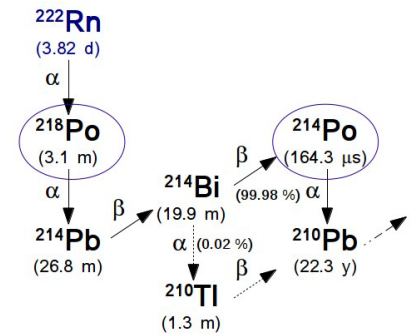
RnCL Operation principle

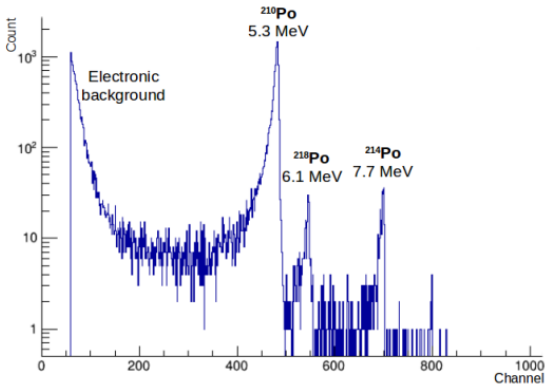
- Drive purified carrier gas through test chamber
- Trap radon in cold carbon traps
- Accumulate radon over a set period
- Warm up and release radon into detector
- Detect Rn decay



Detector operation

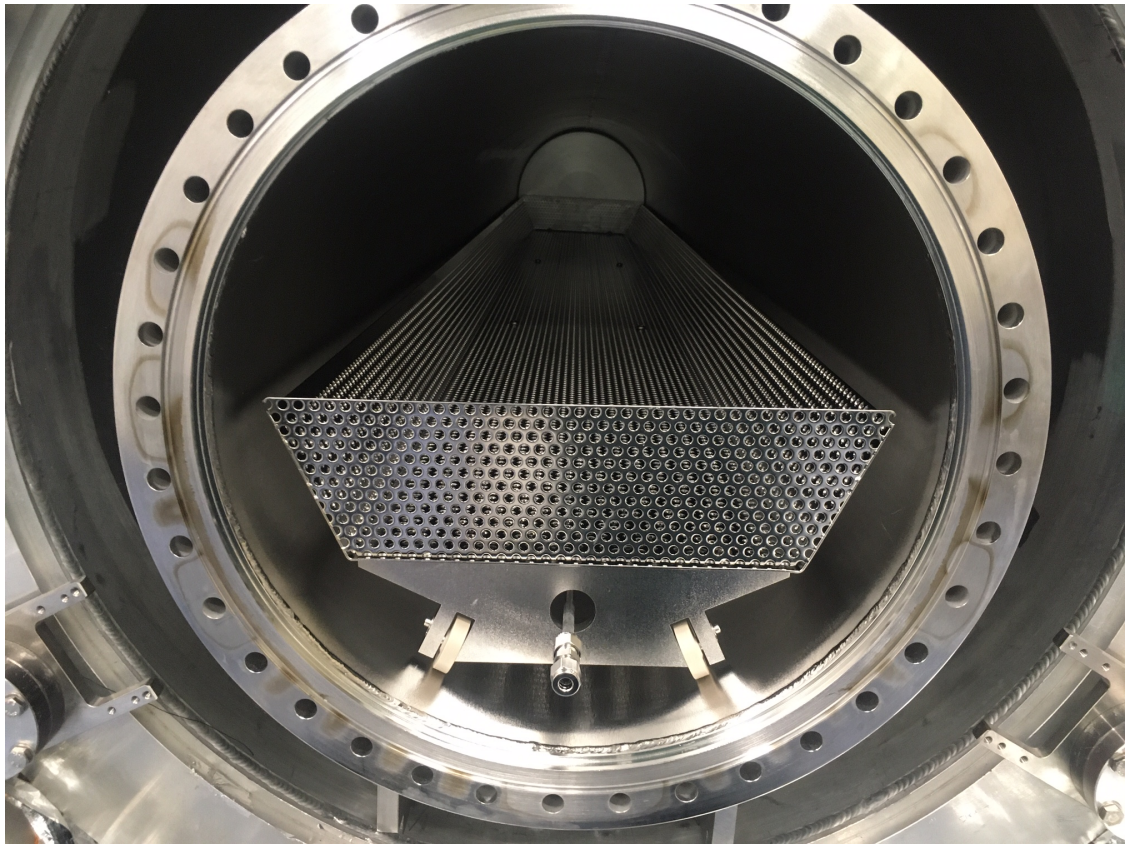
- ^{222}Rn directed into vessel
- Positive decay ions collected on pin diode
- Po alphas identified by energy deposited



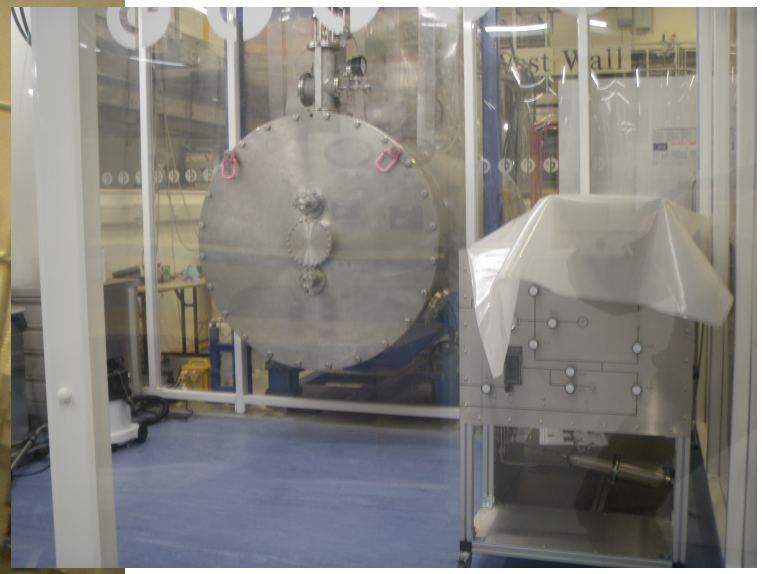


Science & Technology Facilities Council
Rutherford Appleton Laboratory

Radon vessel installation



Experimental Hall R5.2
Cold Radon Emanation Facility



Thesis work:

- Prepare for next generation (G3) dark matter experiment: background suppression and control
- Integrated in LZ experiment: start data taking later this year
- Experimental work shaping the Rn emanation facility & technologies as well as operational responsibilities. Pursue, and shape, experimental program on Rn emanation
- Understanding and development of background models

Summary:

- Join a PPD/UCL team with leading expertise in dark matter experiments, cryogenics, background studies
- Part of LZ which is entering its exploitation phase
- Pioneering a unique new facility and being able to drive its science
- Relevant for now and next generation experiments

at the heart of the most critical aspect of underground rare event searches