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Boulby Underground
Laboratory

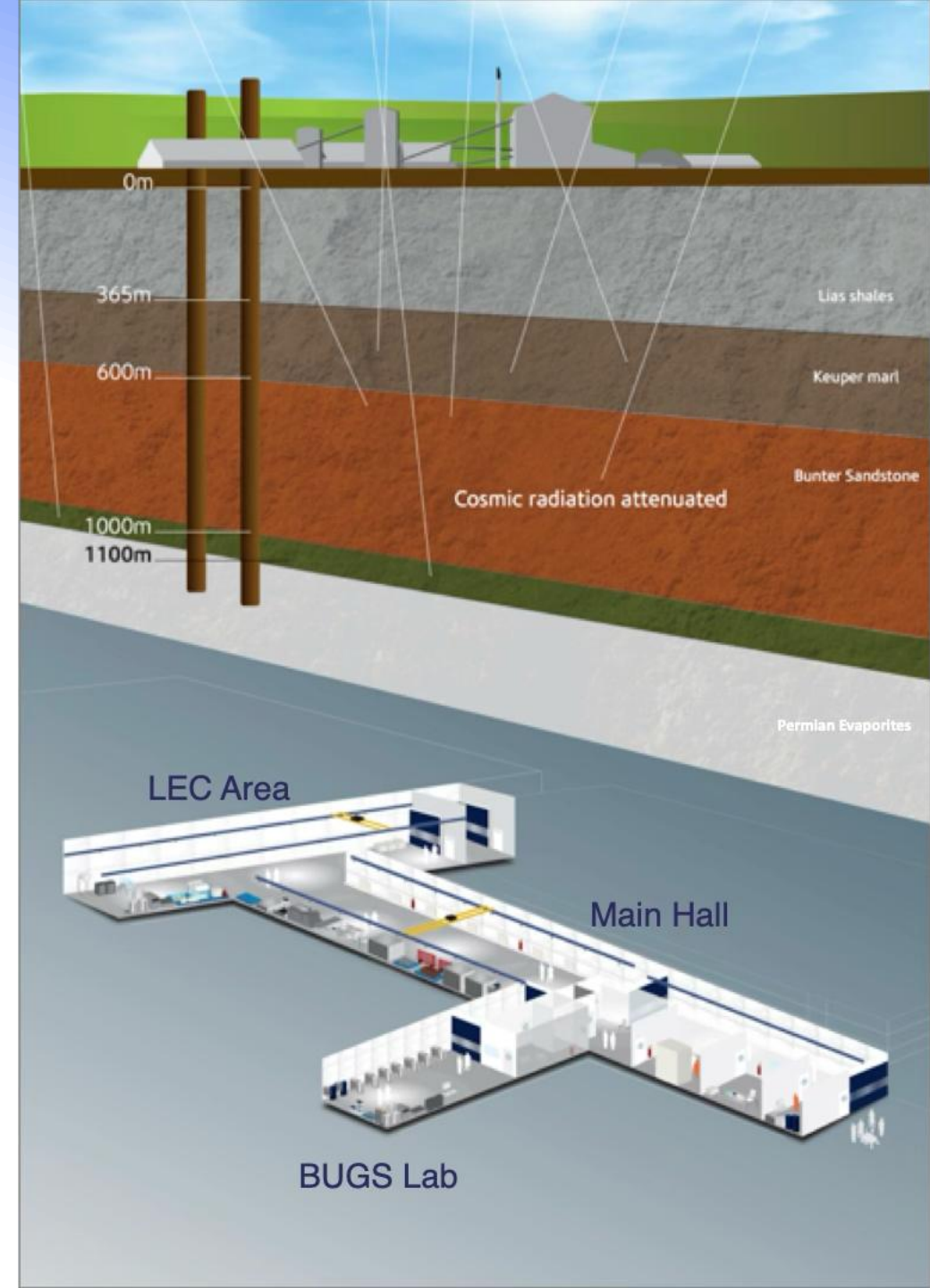
Materials Screening at Boulby Underground Laboratory



Alice Hamer
IOP APP/HEPP Conference
08/04/2026

Boulby Underground Laboratory

- The UK's deep underground science facility – 1.1km underground
- Main lab is class 10k cleanroom
- BUGS lab is class 1k cleanroom



Germanium gamma spectroscopy



Surface alpha counting



BUGS: Boulby UnderGround Screening



Radon emanation measurements



Inductively Coupled Plasma Mass Spectrometry

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Photo:
Beth
Green

Germanium detectors

- Gamma spectroscopy using high purity germanium crystals.
- Gammas deposit energy in the germanium crystal, producing charge carriers.
- The resulting energy spectrum has distinct peaks corresponding to different gamma emitters.

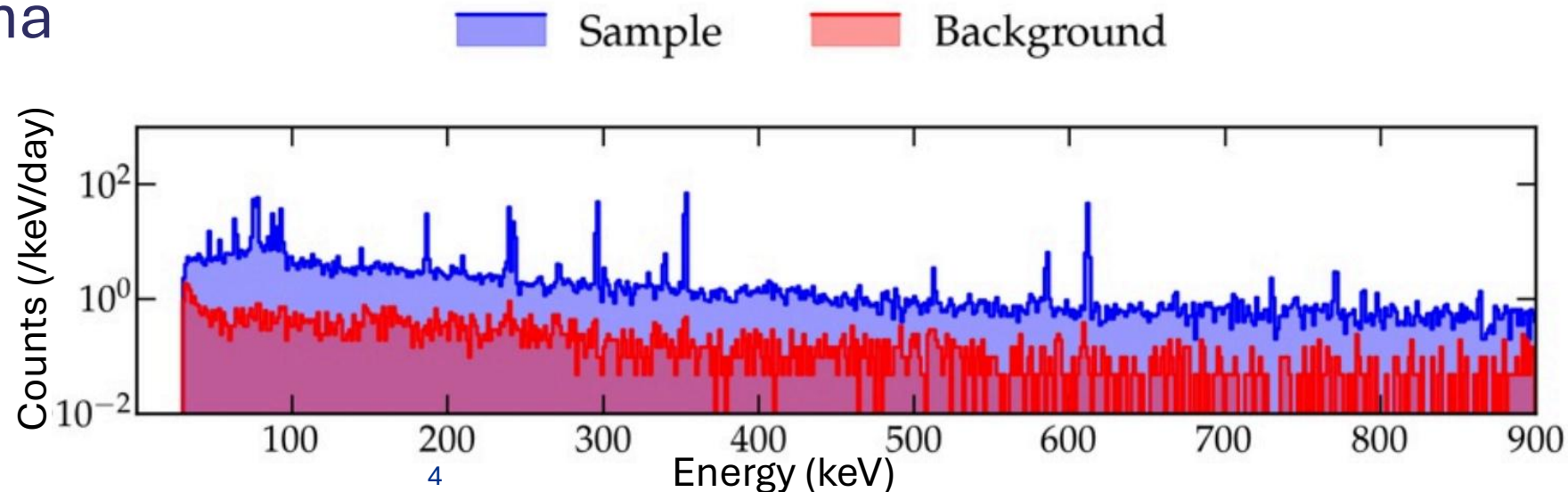
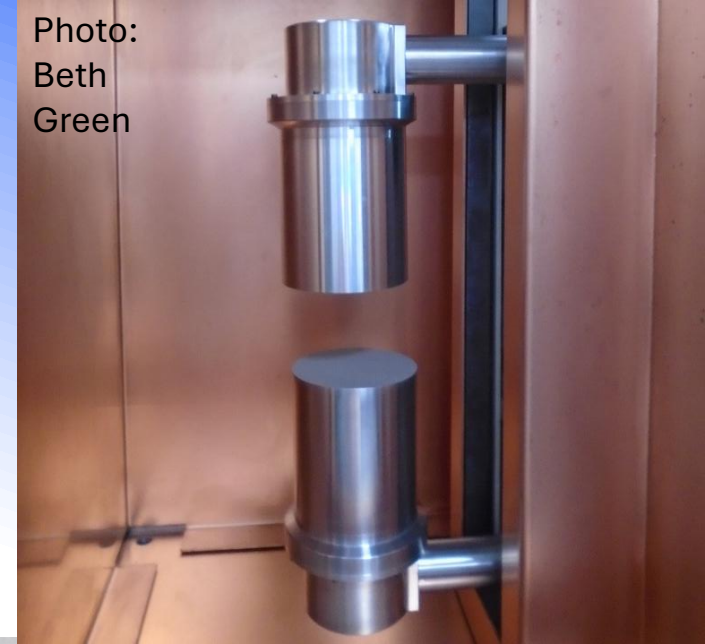


Photo:
Beth
Green

Germanium detectors

- 6 individual detectors (some with world leading sensitivities), each in their own copper-lined lead castle.
- Plus a new twin system.
- All castles are purged at 3L/min with radon-reduced nitrogen gas.



Germanium detectors

- Pipework for nitrogen purge has been upgraded.
- Planned upgrade to radon reduction system.
- Working with XLZD to improve shielding and further reduce backgrounds.
- See Beth's poster for more info!



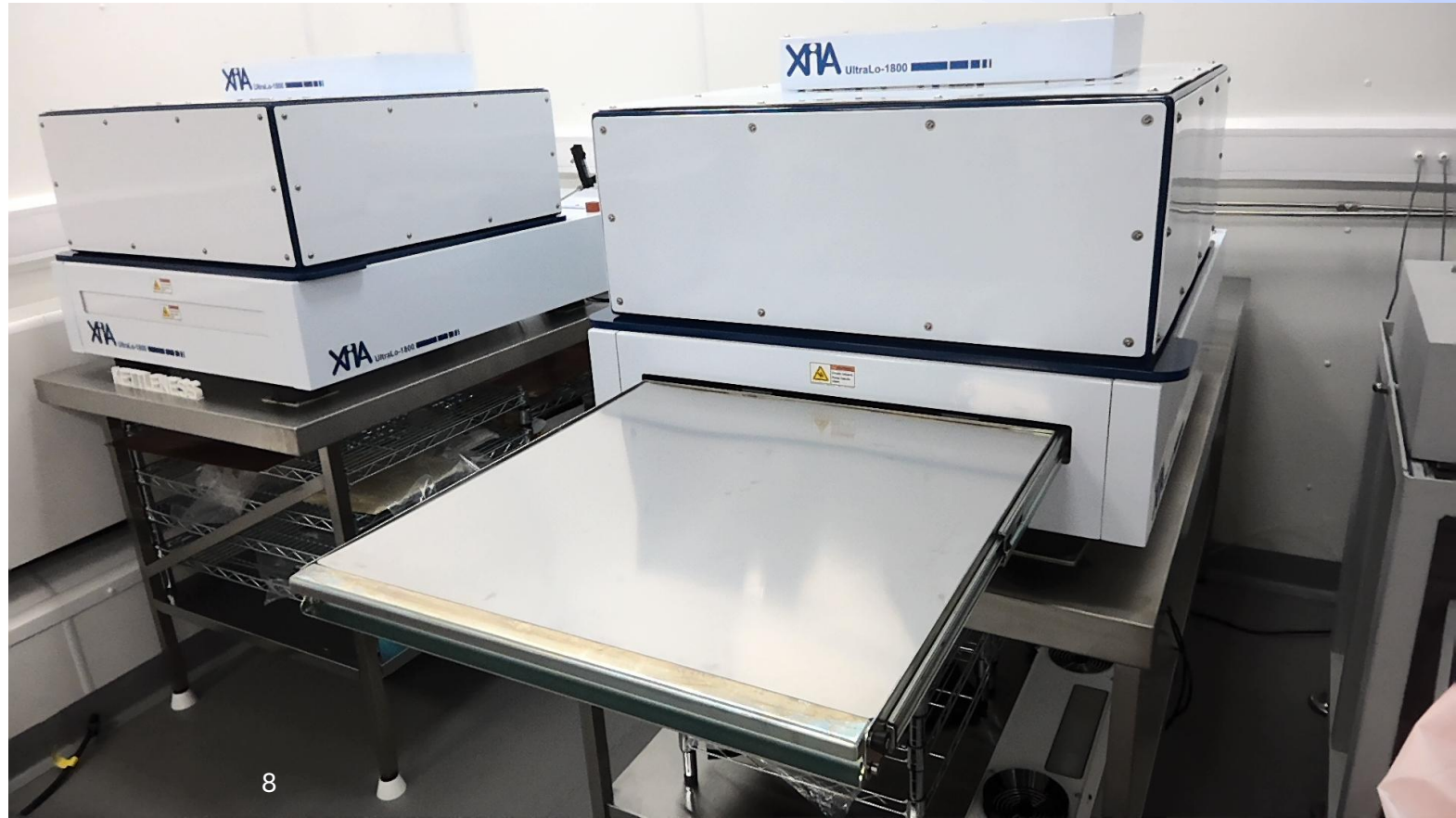
XIA

- Surface alpha counting using XIA UltraLo-1800 detectors
- Uses gaseous argon as an ionisation medium between two electrodes to detect alpha particles emitted from the sample surface.



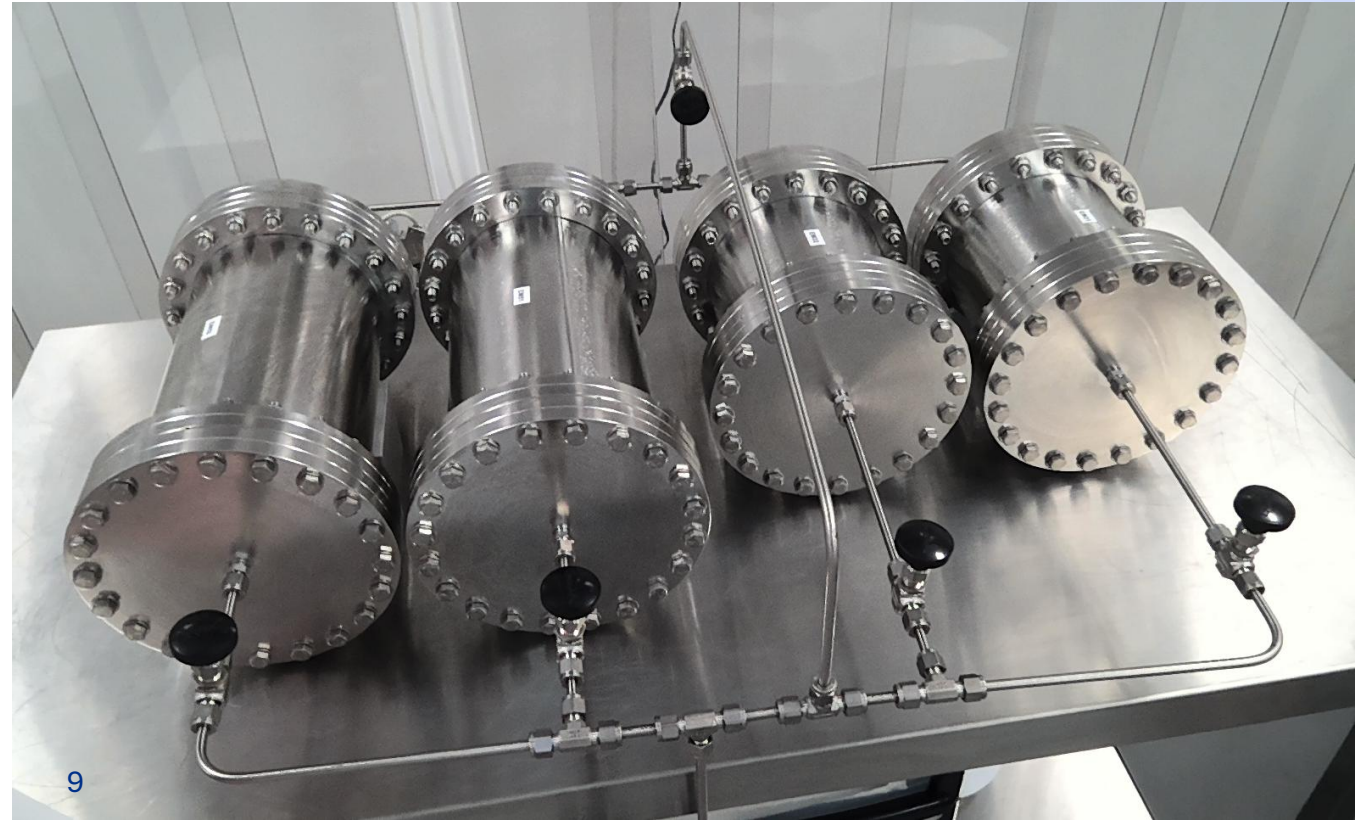
XIA

- The detector trays can accommodate samples up to 42x42 cm and 6.35 mm* thick. Works best with thin, flat samples.
- Recently had a lot of samples for XLZD.



Radon Emanation

- Samples are placed in sealed chambers and left to emanate for 30 days, allowing radon to reach secular equilibrium.
- The gas from the chamber is then flushed through to the detector using radon-reduced nitrogen gas.



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Radon Emanation

- In the detector, positively charged radon daughters are attracted to the anode where a PIN diode detects their decays.
- Setting up an improved DAQ system which will allow us to use both detectors.
- Working on improving understanding of backgrounds.



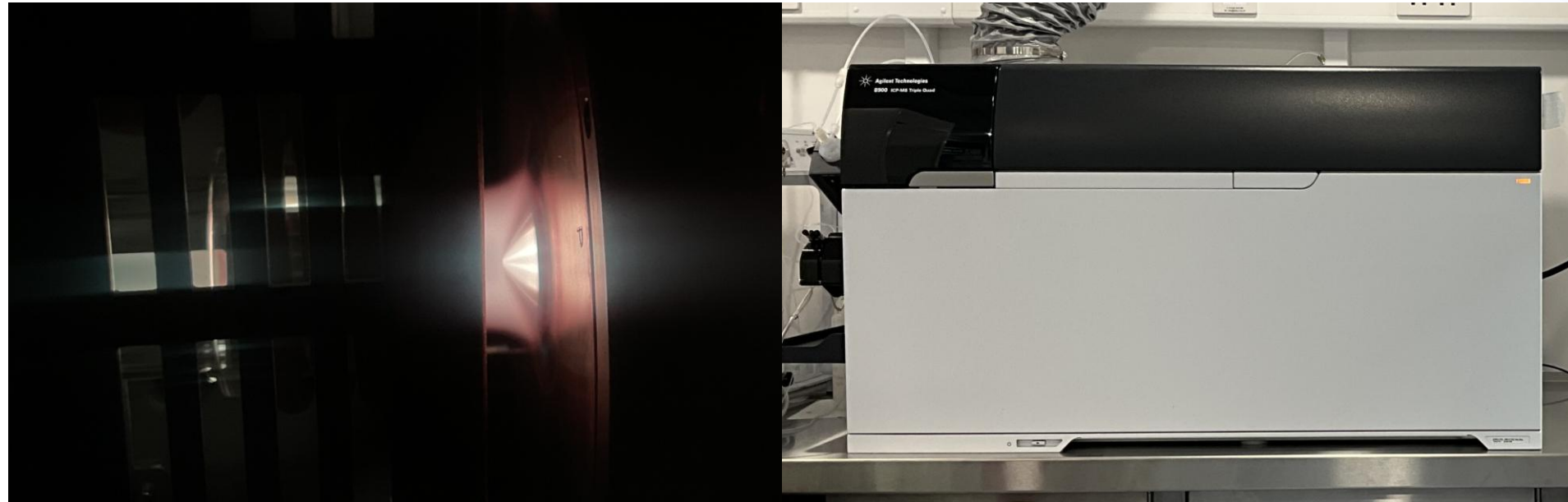
Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

- Destructive method which can determine the amount of a given element that is present in a sample.
- Small amounts of sample material are dissolved in acid.
- An Ar plasma is used to convert the liquid sample into ions.
- The ions then pass through the mass spectrometer which filters and detects the element of interest.



Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

- Currently able to screen metals and polymers for U-238 and Th-232 to sensitivities better than usually required (1-0.01 ppt).
- Planned improvements should push detection limits to 10 ppq.
- See Kayleigh's poster for more info!



Summary

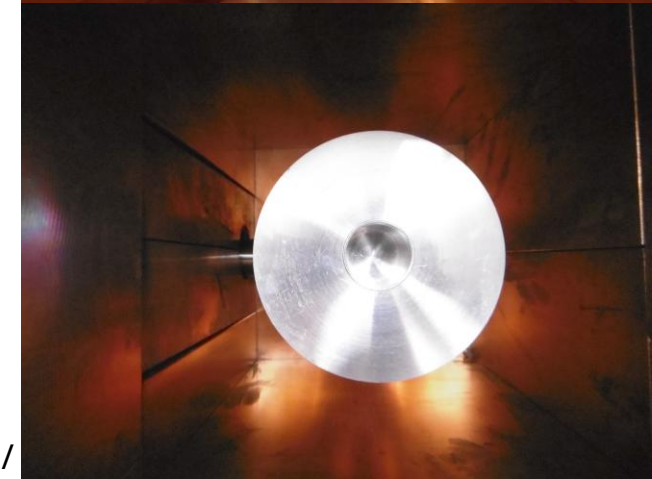
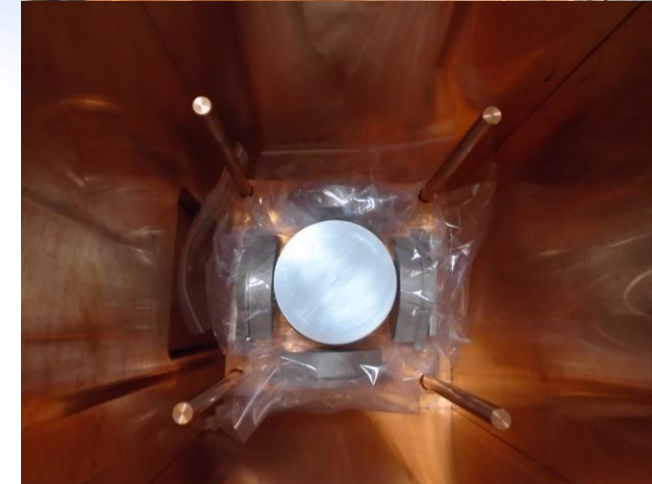
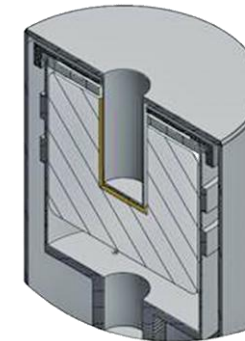
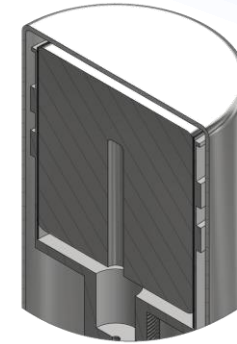
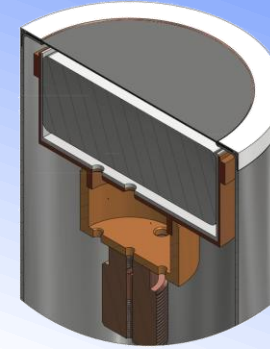
- Boulby has a wide array of assay facilities.
- 4 different technologies in close proximity, to reduce likelihood of contamination.
- Continuing to improve to reach even better sensitivities.

Backup slides

Germanium detectors

Variety of detectors with different uses:

- 2 BEGe detectors (Roseberry, Chaloner)
- 3 Coaxial detectors (Belmont, Lunehead, Merrybent)
- Well detector (Lumpsey)
- Twin detectors (Upleatham and Kirkleatham)



Germanium detectors

- Roseberry is world leading at low energies

Detector	Relative Efficiency or type	Count rate (/kg/day)				
		351 keV (²¹⁴ Pb)	609 keV (²¹⁴ Bi)	238 keV (²¹² Pb)	1461 keV (⁴⁰ K)	2615 keV (²⁰⁸ Tl)
Roseberry	BE6530	0.2(1)	0.15(7)	0.8(3)	0.8(2)	0.3(1)
Chaloner	BE5030	5(1)	4(1)	7(1)	8.4(14)	2.1(5)
Belmont	160%	0.2(1)	0.4(2)	0.13(8)	1.0(2)	0.3(1)
Merrybent	100%	2.5(3)	1.8(3)	0.3(1)	1.9(3)	0.8(2)
Lunehead	100%	5.6(5)	4.7(4)	8.3(5)	9.1(6)	2.0(3)
Lumpsey	SAGe-Well	1.1(7)	1.3(3)	1.1(7)	1.7(7)	0.2(2)