The Low-Background Screening and Measurement Facility at the Boulby Underground Laboratory in the UK

Xin Ran Liu (x.liu@ed.ac.uk)
School of Physics and Astronomy, The University of Edinburgh
on behalf of the Boulby Underground Laboratory

Abstract
Radio-purity requirements remain the main challenge facing current and future generations of neutrino and dark matter experiments e.g. SuperNEMO, SuperK/HyperK and LUX-ZEPLIN experiments. Along with material selection, screening data is critical for building the background model against which any signal is evaluated. As construction materials continuously improve in terms of radio-purity, their measurement is limited by current detection methods and detectors. To answer this critical demand a new world-class screening facility has been established at the newly completed 4000 m³ Boulby Underground Laboratory.

Boulby Underground Laboratory

Located on the N.E coast of England, the laboratory is situated in a working potash, polyalite and rock-salt mine. It is host to 9 projects involving 20 institutions on a wide range of topics from astro/particle physics to geophysics, life in extreme environments and technology development for planetary exploration.

Ultra-low Background Facility

- A class 1000 cleanroom with the lowest radon levels of any underground laboratory was established to support UK DM and neutrino communities.
- Currently 7 ultra-low background gamma-spectroscopy detectors, including 3 new S-ULB class detectors from Mirion (Canberra) and a new XIA UltraLo-1800 alpha counter.

Germanium Detectors

Coaxial Detectors
- Optimised for large samples (few 1000 cm³)
- Ey > 100 keV.

Broad Energy (BEGe) Detectors
- Optimised for low energy gammas with high resolution (~ 1000 cm³)
- Ey > 10 keV.

Well Type Detector
- Optimised for small samples with high detection efficiency (few cm³)
- Ey > 40 keV.

The Boulby Underground Germanium Suite (BUGS) aims to become one of the world’s most sensitive germanium detector facilities.

Roseberry (BEGe) has the potential to achieve world leading sensitivity in the HPGe assay of Pb210.

XIA UltraLo-1800

- The UltraLo is a ultra-low background surface alpha counter which employs electronic background suppression to achieve background rates of 0.0001 alphas/cm²/hr.
- Precise measurement of surface alphas will be critical to the next generation of dark matter detectors which will have significantly increased surface area due to their increase in size.

- Currently developing analysis software to tag surface radon emanation from samples and monitor radon emanation rate over time.

Future Outlook

- The ultra-low background facility plans to expand with additional S-ULB germanium detectors and the construction of radon emanation measurement capabilities with the aim to place Boulby as a center of excellence for both assay and cleanlinesses.
- Service current and future onsite experimental programmes.
- BUGS can also carry out science measurements, such as using Ge to measure ⁹²Zr double beta decay to 1st excited state [4].
- Screening for current and next generation neutrino experiments such Gd for SuperK, SuperNemo post demonstrator, Dune and the WATCHMAN experiment.

References