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Facilities Council
Welcome

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An Introduction to Boulby Underground Laboratory

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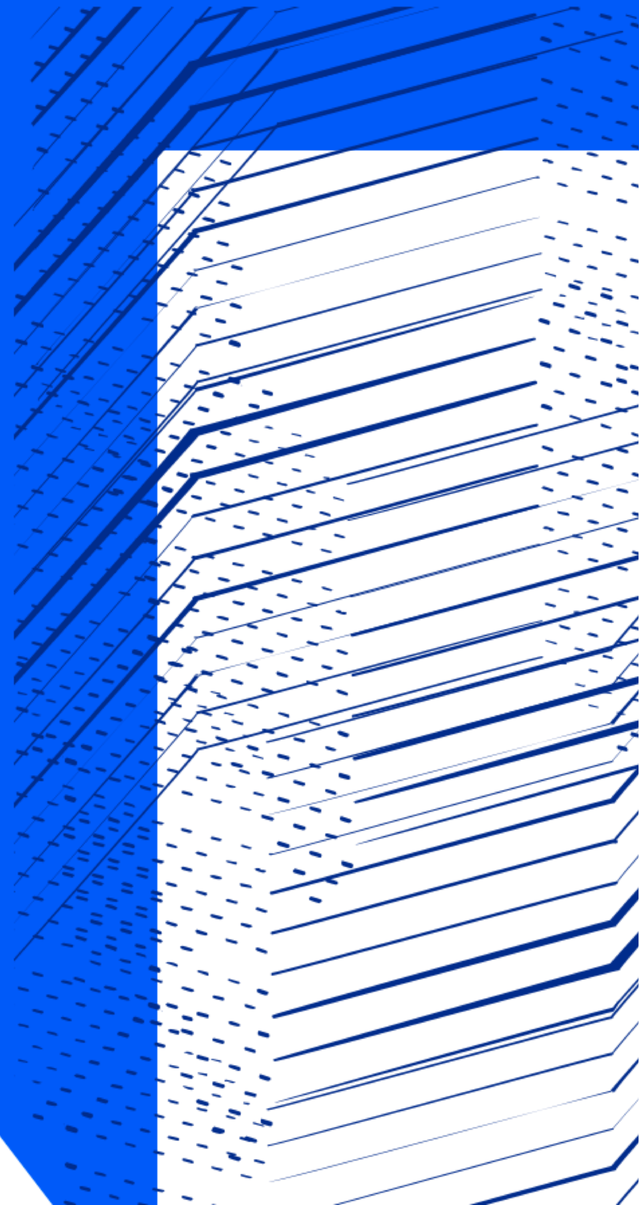
AAP, York, September 2023



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The Laboratory

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Boulby Underground Laboratory

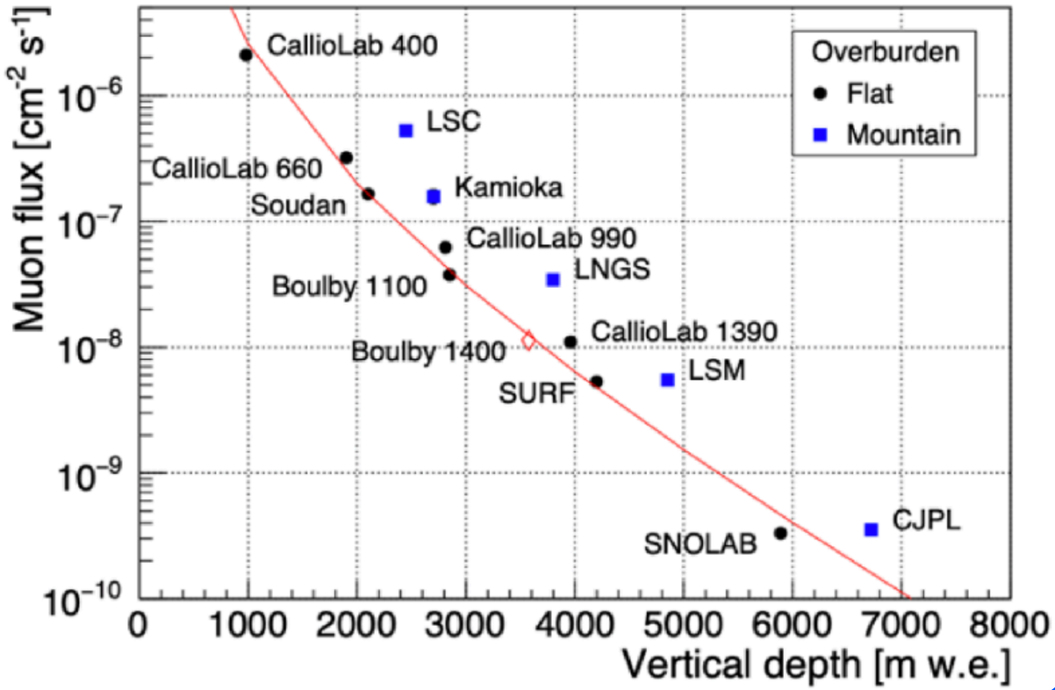
The UK's deep underground science facility

- **1.1 km deep** (2,805 mwe) within a working polyhalite and salt mine
- Operated by the UK's Science, Technology & Facilities Council (**STFC**) in partnership with the mine operators **ICL UK**.

Boulby Underground Laboratory

The UK's deep underground science facility

- 1 of 5 labs in Europe, <15 worldwide.
- Supports work of over 15 collaborative projects, 40 institutions and 170 scientists and students.
- Operations, H&S and science managed by 17 onsite staff with additional support from Rutherford Appleton Laboratory (RAL).
- Additional, wide-ranging support granted by the mine operators, ICL-UK.



Low radon (3 Bq/m3)
Factor 10^6 reduction muon flux
Low background rock salt tunnels

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Boulby Underground Laboratory

The UK’s deep underground science facility

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Boulby Underground Laboratory

The UK's deep underground science facility

Laboratory Facilities:

- >4,000m^3 clean lab space, 3,000m^3 outside space
- Class 1,000 and 10,000 clean rooms
- 10T + 5T xy gantry cranes
- LN2 and N2 generation systems
- Surface support and storage buildings
- Air conditioning and high speed internet

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The Science Programme

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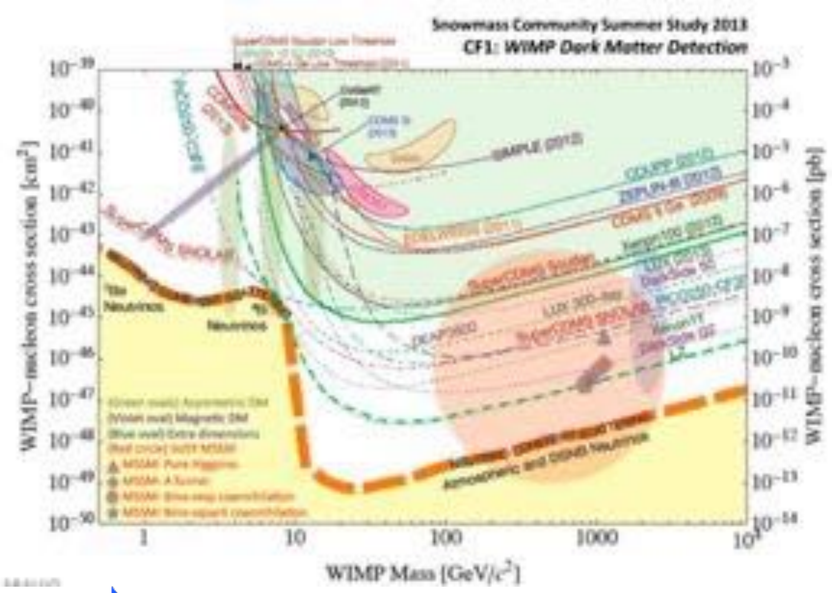
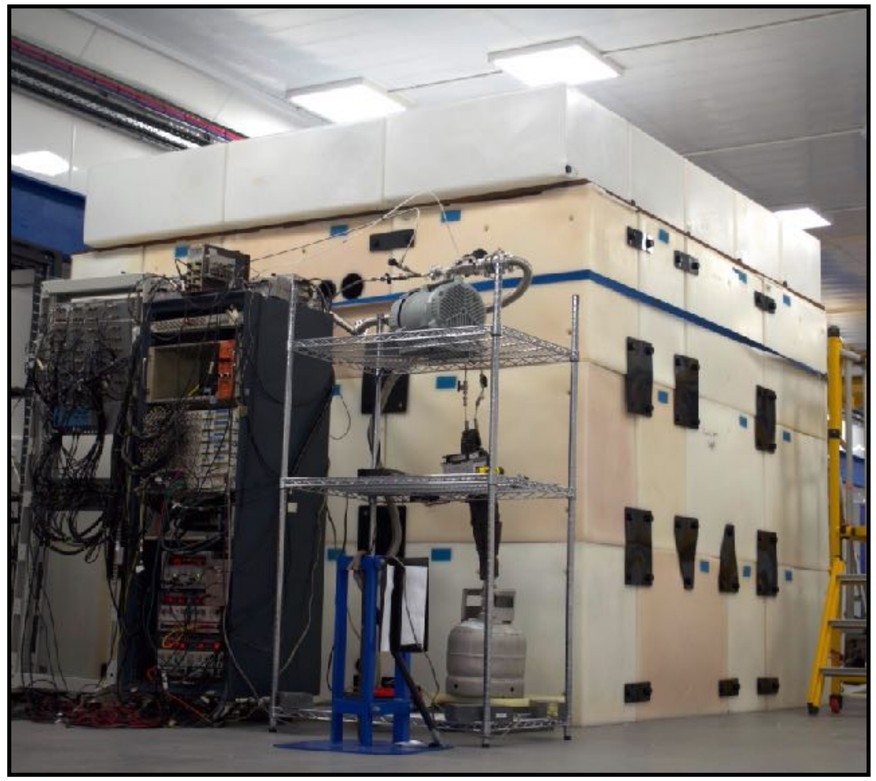
Particle Physics & Low Background Science

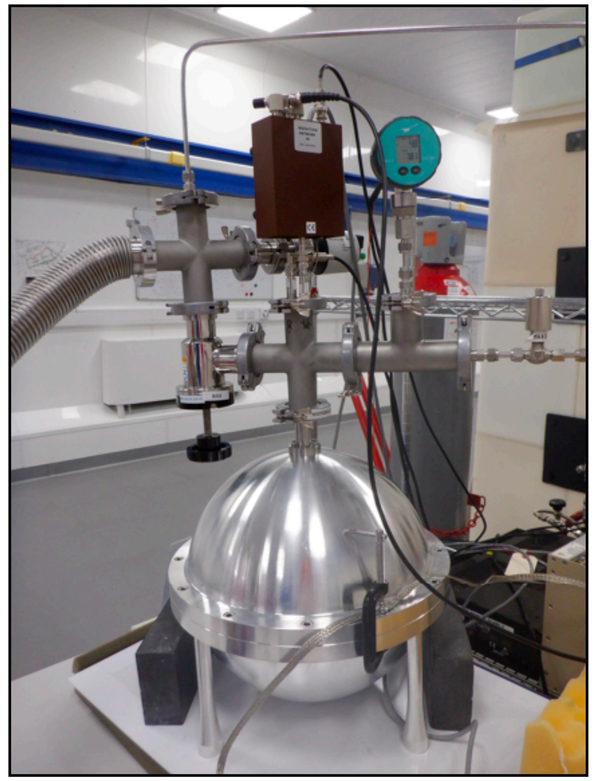
The Search for Dark Matter

Boulby Has hosted **Dark Matter search** studies for over two decades, including; **NAIAD**, **DM-Ice**, **DRIFT** & **ZEPLIN** programmes.





CYGNUS Detector



NEWS-G Detector

Boulby now hosts the CYGNUS directional DM programme, NEWS-G/Dark Sphere R&D and provides material screening for other studies including **LUX-ZEPLIN** (**LZ**).

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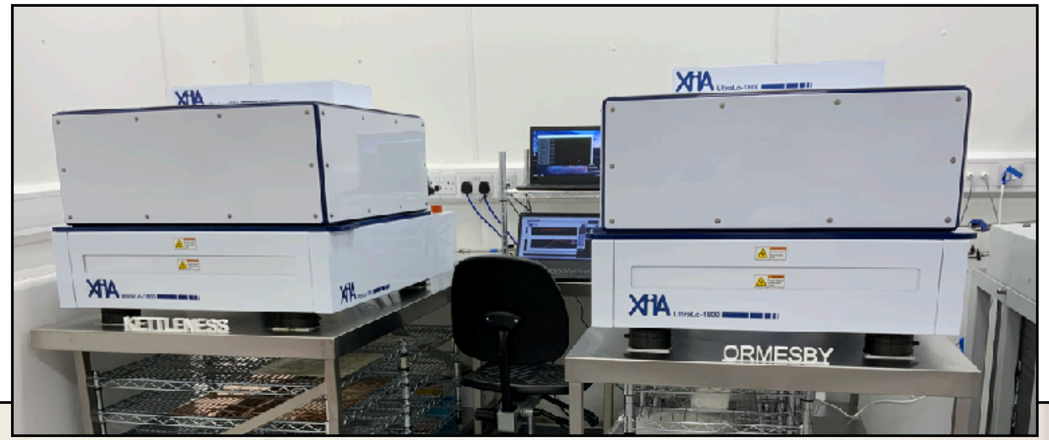
Particle Physics & Low Background Science

Boulby UnderGround Screening (BUGS)

World-class material screening for current and future ULB experiments. Towards ppt sensitivity for G3 DM.



- **8x ULB Germanium Detectors**
- **2x XIA Surface Alpha Counters**
- **Radon Emanation System**
- **ICPMS (surface)***

*currently being commissioned

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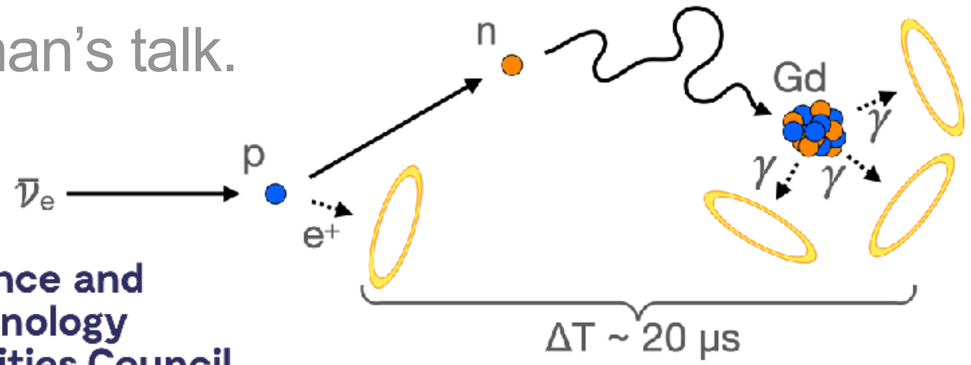
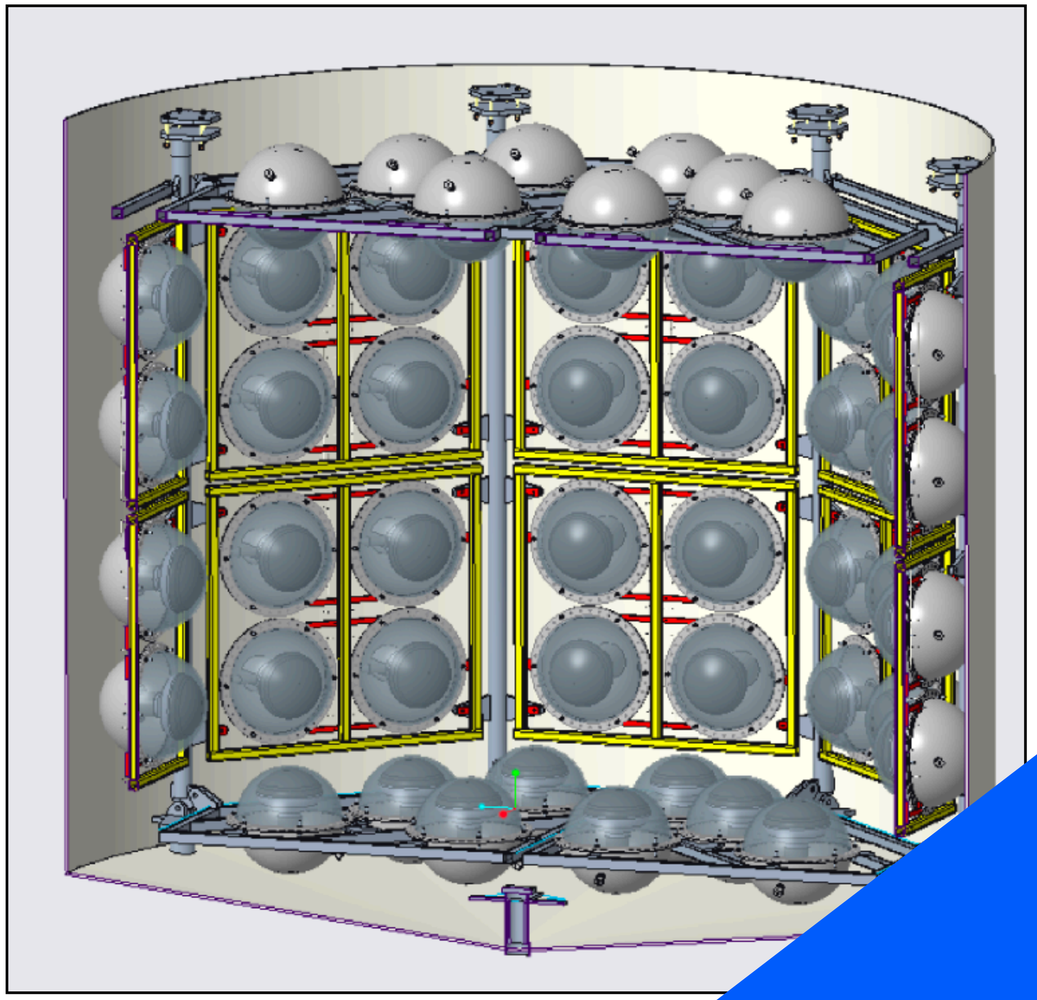
Particle Physics & Low Background Science

Boulby Underground Testbed Towards Observing Neutrinos (BUTTON)

- 30 Tonne Cherenkov detector, ~100 PMTs
- Versatile system to allow for existing and novel fill mediums; pure water, gadiated water or WbLS.
- Testbed for optical detection R&D, deploying low radioactivity glass PMTs, LAPPDs and SiPMs (FRANCIS tile) detectors.
- See J. Coleman's talk.





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Earth and Environmental Science

Climate Change Studies and Applied Particle Physics for Environment

Muography for Tsunami Early Warning Systems

- 10x dual coincidence muon paddle array
- 100m coverage, deployed under the coast, monitoring tidal height

(Left) Boulby deployment, (below) Tokyo Bay deployment

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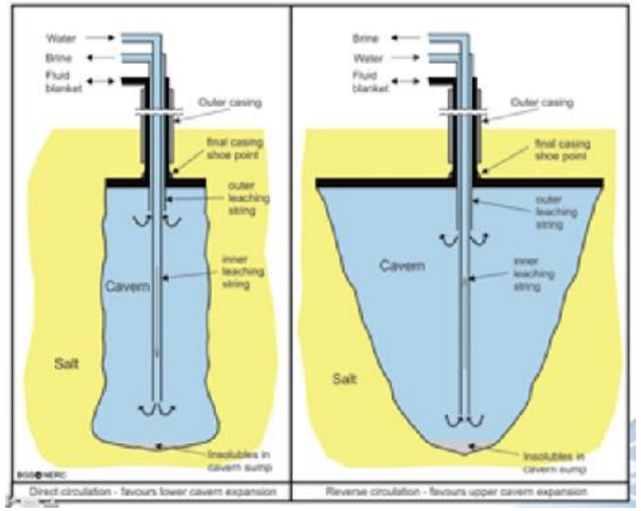
Renewable Energy StOrage in UndeRground CavErns (RESOURCE)

Mid-scale rock engineering tests of gas containment in salt cavities for renewable energy storage.



Astrobiology & Planetary Exploration

Mars Analogue site, allowing astrobiology technique & instrumentation development.

MINAR
Mine Analogue Research

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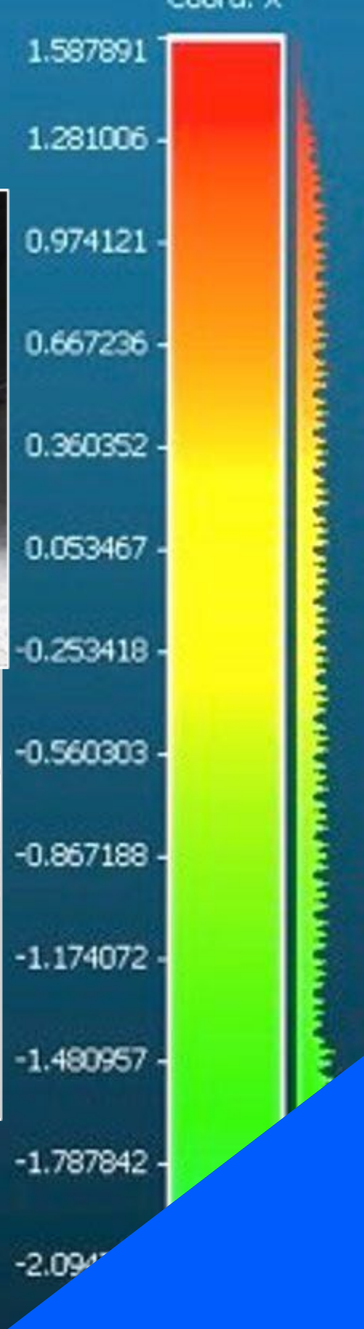
BISAL
Boulby International Subsurface Astrobiology Lab



The Future

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Future Projects

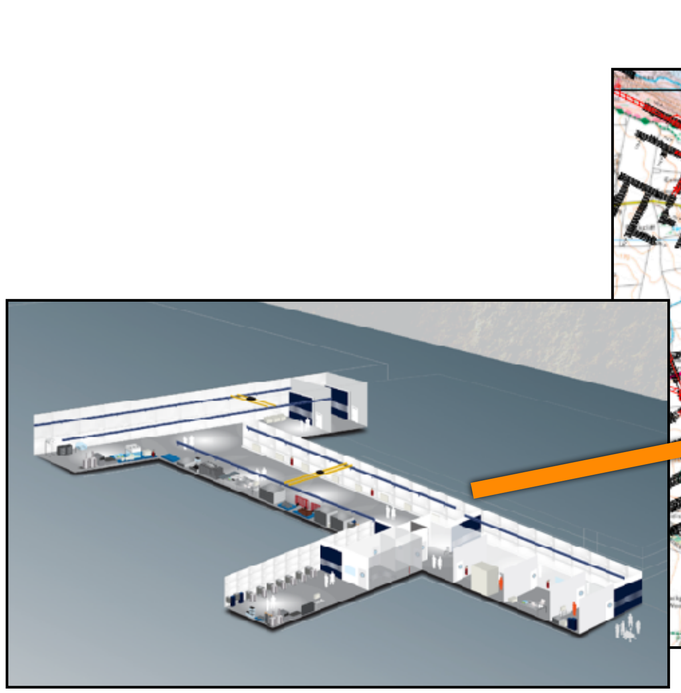
Plan to Continue Current Studies, PLUS…

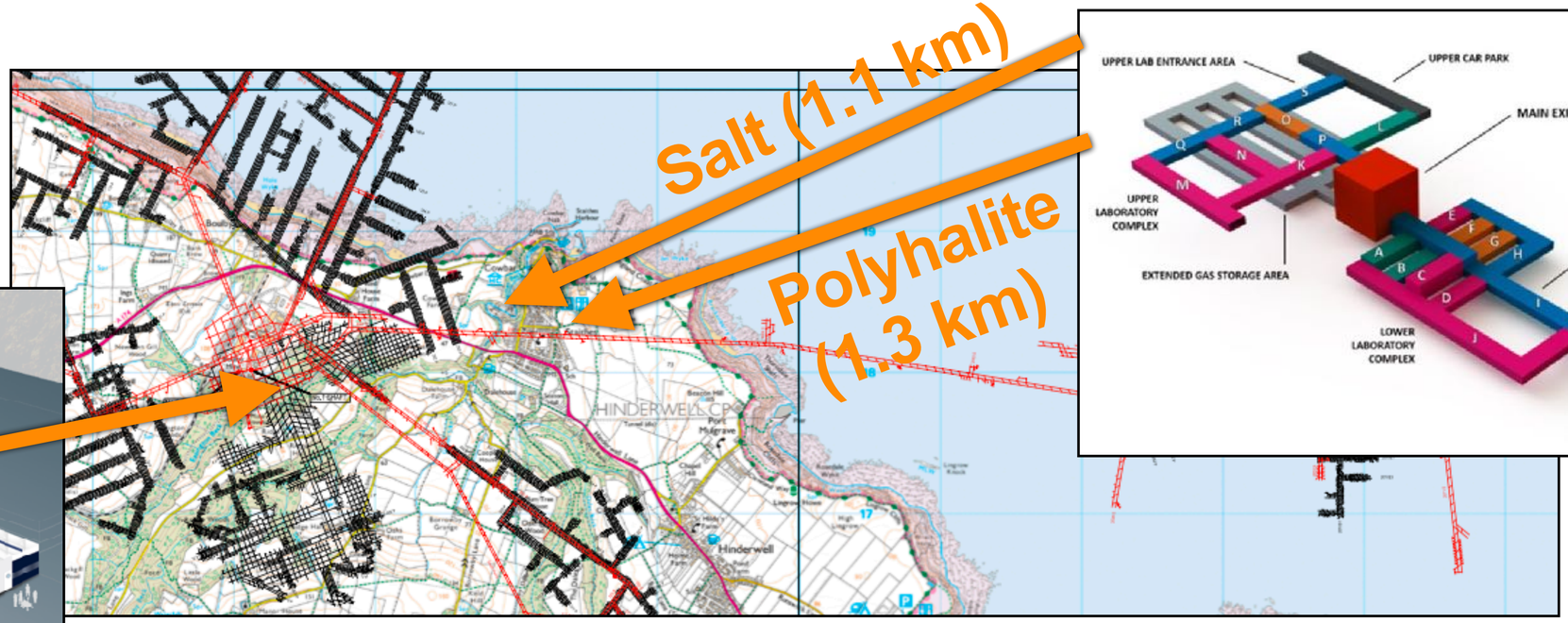
- **MINAR & Planetary exploration R&D**, expanded programme linking to mining, industry and **robotics**
- **RESOURCE+**: Advanced salt cavity test facility for renewable energy storage
- **BUGS+**: Expanding ultra low background material screening and environmental gamma spectroscopy
- **QCLB** (Quantum Computing): low background environments for quantum computing
- **DarkSPHERE**: world leading limit setting low mass dark matter detector
- **AION**: Atom Interferometry for dark matter / gravitational wave detection
- **BUTTON-100x?**: See J. Coleman's talk

Boulby Development Project

Next Generation Dark Matter and Neutrino Studies at Boulby

- Moving towards a new, **major** multidisciplinary underground laboratory in the UK.
- Results of feasibility study are: "**It is feasible at Boulby, well-motivated and timely.**"





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- **MAJOR** local & national investment, impact & visibility
- **HIGH** impact, world leading science
- **LARGE** multi-nation collaborations

Summary

1 The Laboratory

- UK’s centre for world class, deep underground science

2 The Science

- A growing and diverse multidisciplinary science programme

3 The Future

- Big plans on the horizon with opportunities for further collaboration and growth

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Thank you