

Boulby Underground Laboratory

Boulby Underground Laboratory

Status update and future plans

Paul Scovell - 09/07/2024

- Boulby Mine is located in the north-east of England
- About 25 minutes northwest of Whitby



Boulby Underground Laboratory



Credit: Google Maps

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- Boulby Mine is located in the north-east of England
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Boulby Underground Laboratory



Credit: Google Maps



Boulby Underground Laboratory

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Credit: Google Maps

- Commercial Polyhalite and Salt mine
- Shafts sunk in 1968 with full production from 1976
- Main tunnels mined through salt remains of Zechstein sea
 - Potash (previously mined) sits above
 - Polyhalite sits below



Boulby Underground Laboratory



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https://en.wikipedia.org/wiki/Zechstein

The Boulby Underground Laboratory







Boulby Underground Laboratory

Pics: S. Paling





The current facility





The current facility



The current facility

- Boulby has hosted studies in the Dark Matter search for over two decades including NAIAD, DRIFT & ZEPLIN experiments
- Boulby currently hosts CYGNUS directional DM programme, NEWS-G/ Dark-Sphere R&D experiments
- The BUGS lab provides ultra low background material screening for worldwide experiments e.g. LUX-ZEPLIN
- Boulby also hosts the BUTTON neutrino technology demonstrator



Science and Technology Facilities Council

Boulby Underground Laboratory See J. Tranter Poster Also I. Manthos talk for more info



Multidisciplinary Science

Applied low background particle physics, Earth and Environmental science, Astrobiology & Planetary Exploration Technology Development.

Astrobiology and planetary exploration technology development



Astrobiology & Planetary Exploration



Sampling life in Boulby

Brine

MINAR:



Minina & extraplanetary

exploration instrumentation development









Boulby and Instrumentation for Earth and Space Exploration



MINAR: MINe Analogue Research



Looking to the future



Boulby Feasibility Study

Boulby-FS (2020-21) Overview:

- Community-led study of motivation and practicalities of creating a major new deep underground science facility in UK
- Infrastructure specifications for potential projects (Dark Matter, Neutrinos & more).
- Conceptual designs for excavations and outfitting laboratories in 1.1km (Salt) and 1.4km (Polyhalite) layers
- Staffing and surface facility needs.
- Detailed costs and schedules.

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	TINAL HEFORT
	FEASIBILITY STUDY
FOR DE	VELOPING THE BOULBY UNDERGROUND LABORATOR
	INTO A FACILITY FOR FUTURE MAJOR
	INTERNATIONAL PROJECTS
	Supported by the STFC Opportunities Call 2019
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	listen v1.0

Continued Expansion

- STFC committed to the future expansion of the Boulby Underground Laboratory
- Singled out in STFC delivery plan as a key strategic long-term ambition



 Complete the design study for a greatly expanded underground science facility in the North East, with the potential to host a major international science infrastructure, such as a next generation dark matter experiment (with £2.8 million from the Infrastructure Fund).



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See: https://stfc.ukri.org/files/delivery-plan-2019/

Boulby Development Project (BDP)

UKRI Preliminary Infrastructure Funding £2.84M, 3 year project (2022/3-2024/5).

The principal aim of the project has two components:

- To build a world-class underground laboratory in the North East region, suitable of hosting the most advanced, low background particle physics and multi-disciplinary underground science experiments
- To host a state-of-the-art, international, dark matter experiment in the new laboratory facility



Current Facility

- Looking to host a world leading medium scale dark matter detector in current facility at Boulby
- £10 million fund recently announced
 - Over 5 years
 - To deliver a world leading DM result
- Closed 30th May
 - A number of experiments have applied
- Part of a wider demonstration of STFC commitment to expanding DM programme in UK



Continued expansion

- Staged approach
- Stage 1 will be in current salt strata
 - Excavation beginning early
 - Designed for construction of experiment for stage 2 and for long term multi-disciplinary laboratory
- Stage 2 will be deeper in polyhalite
 - Excavation beginning later
 - Large experimental excavation targeting next gen low-background particle physics



Conceptual Design

Stage 2





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Final design of both will differ

Conceptual Design

Stage 2

Stage 1 Stage 1: Clean manufacturing and multi-science lab in salt (1.1km) - 2028 Stage 2: Full depth science lab in Polyhalite (1.3km) ~2030+



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Final design of both will differ









S1 excavation: A south



S1 excavation : junction of drift with B north-south looking east)



2030-2040+

Boulby Science Activities Now and Potential Future

	Current Projects	Status
& Low Background	CYGNUS - DM R&D	E/P
	News-G - DM R&D	А
	BUGS: Ge, XIA, <u>RnEm</u> - Material Screening	А
	RECON - Nuclear Security R&D	А
	BUTTON – Nuclear security R&D	А
Environmental	Muon <u>Tomog</u> – CCS & undersea <u>Geoimaging</u> R&D	А
	RESOURCE – Energy store R&D	А
	Seismology/AION R&D	А
Planetary Exploration	BISAL – Biology/Astrobiology	А
	MINAR – Planetary Exploration Tech development	A
	Misc. Other. SELLR, C14, BIO-SPHERE	A/I
	Outreach/ Education - Misc events, progs, Remote3	А

Particle Physics

Earth &

Astrobiology &

Status: A = Active, P = Paused, E = End, I = Interest confirmed

2023-2030

Medium Term (Current Lab + mods)	Status
BUGS: Ge, XIA, <u>RnEm</u> , ICPMS - Material Screening	А
BUTTON-30 – Nuclear security R&D	А
RECON+ - Nuclear Security R&D	A/I
DarkSPHERE, SOLAIRE, ULT, Quantum Technologies – DM Search	I
DATUM – Neutrino Tech R&D	I
<u>SoLAr</u> – Neutrino R&D	I
AION-100 & 1000 R&D	I
Seismology Array – <u>Geosurvey</u> R&D	I
RESOURCE+ – Energy store R&D	A/I
Muon <u>Tomog</u> – CCS & undersea <u>Geoimaging</u> R&D	A/I
BISAL+ – Biology/Astrobiology	A/I
MINAR+ – Planetary Exploration Tech development	A/I
Misc. Other. Quantum Computing Tech R&D?	-
Outreach/ Education: General Public, Schools +	А

Long Term (Current lab plus major new lab)

Particle Physics and Low Background Science: Dark Matter: Major Next Gen Experiments:

- Xenon (XLZD) •
- Argon (SOLAIRE+) Gas (DarkSPHERE+)
- ULT technologies for DM
- Quantum Technologies for DM Neutrinos:
- **Target projects** for a major new **UK underground** facility / campus

- BUTTON-100+
- DATUM (LEGEND Support),
- SoLAR +....

Mat screening & LB Techniques: A world's best facility:

- Ge, XIA, RnEm, ICPMS, Cleanlines & Engineering R&D Misc Other:
- AION-100 / AION-1000
- Nuclear Security Gamma spec
- Quantum Computing Technology R&D?

Earth & Environmental Science:

- Sustainable Energy R&D
- Seismology Observatory
- Geological Repositories R&D
- Misc geology / Geophysics R&D

Astrobiology & Planetary Exploration:

- Extremophile R&D
- Astrobiology / life beyond Earth R&D
- Human habitation R&D
- Planetary exploration technology development
- Robotics and AI
- Mining and industry application development.

Outreach and Education:

• A National Centre for Science and technology outreach and education.

Conclusion

- There has been a rich history of scientific research at the Boulby Underground Laboratory
- This continues across many disciplines
- STFC committed to the future development of Boulby
- Excavation activity towards future facility has begun





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Thankyou

boulby.stfc.ac.uk



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