

# Future plans for the Boulby Underground Laboratory

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PPD R&D SHOWCASE 31/08/22



# INTRODUCTION

- ▶ Boulby is well known to people on this call
- ▶ Not time to give details but a good overview can be found at <https://www.boulby.stfc.ac.uk/Pages/home.aspx>
- ▶ Riding the crest of a wave of interest in developing the facility further
- ▶ Large scale is important but so is medium/small scale
- ▶ BUGS is our most prized possession at the moment
  - ▶ Keeping this developing



# LARGE SCALE PLANS

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- ▶ Between 2019 and 2021 we undertook a preliminary study to determine the feasibility of hosting a large scale next gen experiment at Boulby
- ▶ Studied locations at 1100 m and 1400 m
- ▶ Surface and underground infrastructure
- ▶ Power, temperature, personnel, cryogenics, geotechnical
- ▶ Preliminary design undertaken by AMCO leveraged knowledge gained from AIT-NEO studies
- ▶ Shows it is feasible at both depths for £150-£200 million
- ▶ Around 30 FTE required to operate the facility

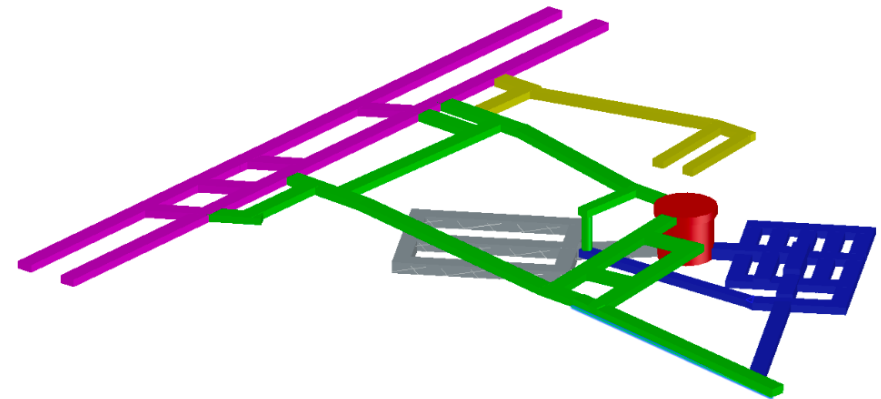
## FINAL REPORT

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**FEASIBILITY STUDY  
FOR DEVELOPING THE BOULBY UNDERGROUND LABORATORY  
INTO A FACILITY FOR FUTURE MAJOR  
INTERNATIONAL PROJECTS**

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Supported by the STFC Opportunities Call 2019





# LARGE SCALE PLANS

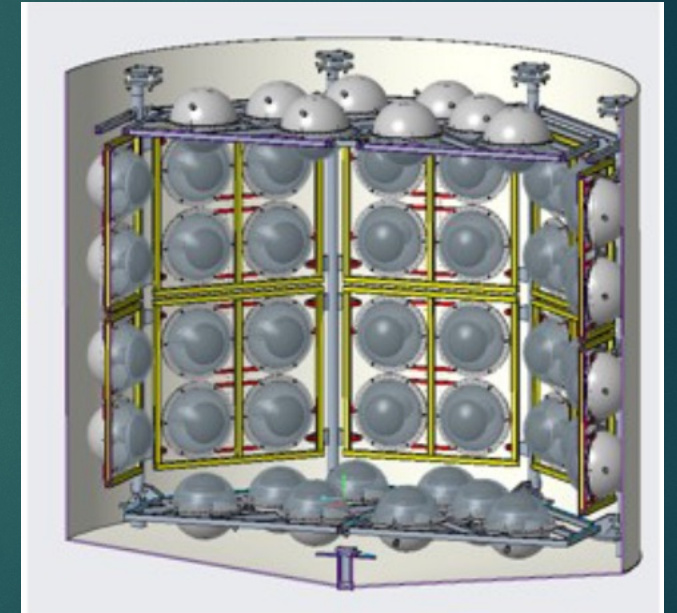
- ▶ Successful bid to infrastructure fund to bring the conceptual designs at 1100 m and 1400 m up to final and preliminary design levels, respectively
- ▶ Develop business case for BEIS
- ▶ Engage with the community to find their wants and needs and to put forward the case for Boulby as a site for future experiments
- ▶ Team currently being build but currently consists of members from STFC Programs, PPD, Boulby, BID



# BUTTON

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- ▶ Project to wrap up FIC funding initially for the AIT-NEO programme
- ▶ Includes UK AIT-NEO partners plus several US colleagues
- ▶ Developing a smaller (~30 tonne) scale neutrino technology testbed
- ▶ Boulby (Toth) are leading the development of the site for this
- ▶ AIT-NEO is not quite what we had originally hoped but STFC have learnt a great deal about how to build a large scale facility in the Boulby salt.



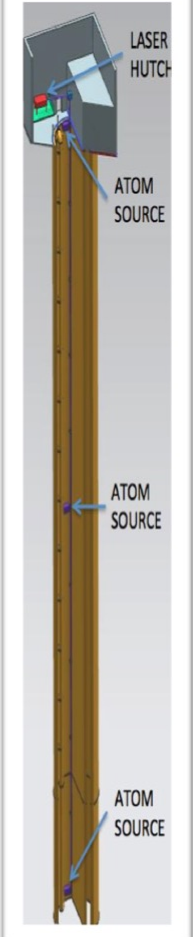


# AION

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- ▶ Pawel will discuss this in more detail in the future however
- ▶ AION-100 is a straight shootout between CERN and Boulby shaft-3 at the moment
- ▶ CERN does not have a 1.1km shaft, however...
- ▶ Currently embarking on seismic studies
- ▶ Funded through QTFP programme

*Aberdeen, Birmingham, Bristol, Brunel, Durham, Glasgow, Imperial College, Kings College London, University College London, Liverpool, Nottingham, Open University, Oxford, RAL, Sheffield, Strathclyde, Sussex, Swansea and NPL*



Taken from O. Buchmueller 2019 talk



# DETECTOR DEVELOPMENT LAB

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- ▶ Seeking funding through the UKRI infrastructure fund (preliminary activity)
- ▶ Developing tools for novel detector construction and characterisation
- ▶ Lead by UCL/Liverpool LEGEND collaborators (Saakyan, Waters, Agostini, Boston)
- ▶ Initially the UK contribution to LEGEND construction but would be used for development of detectors for PP and NP
- ▶ STFC link currently through Daresbury TD (and Boulby obvs)



# QUEST-DMC

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- ▶ Again looking for funding through UKRI infrastructure (preliminary activity)
- ▶ Equip a facility with cryogen-free nuclear demagnetisation cryostats
- ▶ Optimisation for radio-purity, vibration isolation, radiofrequency shielding and magnetic shielding
- ▶ Low mass dark matter (sub-GeV), and other fundamental questions
- ▶ University of Lancaster and Royal Holloway



*Taken from U. Lancaster website*



# NEWS-G/DARKSPHERE

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- ▶ Currently running a small prototype detector to develop AKINOS sensor
  - ▶ Will give thermal neutron background measurement for Boulby
  - ▶ Sensor will go in eventual NEWS-G
  - ▶ Building a small copper-electroforming system
- ▶ DARKSPHERE is the successor to NEWS-G
- ▶ You guessed it – looking for IF (preliminary activity) funding
  - ▶ Developing an upgraded facility for copper-electroforming
  - ▶ Developing shielding for larger spherical TPC system
  - ▶ A pilot run of a system built using electroformed copper



*NIMA 998 (2021) 164844*



- ▶ This one is all ours!
  - ▶ With help from UCL (Ghag), Edinburgh (Murphy, Liu) & Sheffield (Thiesse)
- ▶ Facility has provided material characterisation for a number of projects
  - ▶ LZ, Darkside, SK-EGADS, DUNE, QUEST-DMC, NEWS-G, etc
  - ▶ Also involved in GCRF project for monitoring lead in water (UK, Mexico, Argentina)
- ▶ BID helping to develop industrial partnerships
- ▶ Currently have HPGe systems, Surface alpha, RnEm all underground in one room
- ▶ However – with what is coming on the horizon, no time to rest...



# BUGS (no, more than 10 slides!)

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- ▶ Customers and samples for next gen projects will be many and plentiful
  - ▶ Developing relationships with other labs to coordinate global efforts
- ▶ R&D at Boulby involves:
  - ▶ Development of cross-calibration techniques
  - ▶ Development of software to improve surface alpha analysis (with U. Edinburgh)
  - ▶ Development of PSD techniques for BEGE and Well detectors (hopefully!)
  - ▶ Commissioning of a new coincidence Ge system (once we have a shield!)
  - ▶ Relocation of UCL ICP-MS system to Boulby surface facility after construction of new clean-room facility



# CONCLUSIONS

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- ▶ Potentially a very exciting future for the BUL
- ▶ Looking to expand in a way previously not possible
  - ▶ Huge increase in underground footprint and staffing levels
- ▶ Strong backing through STFC and UKRI
  - ▶ “Dark Matter’s coming home”???
- ▶ However, very important to support projects that could operate in the current facility