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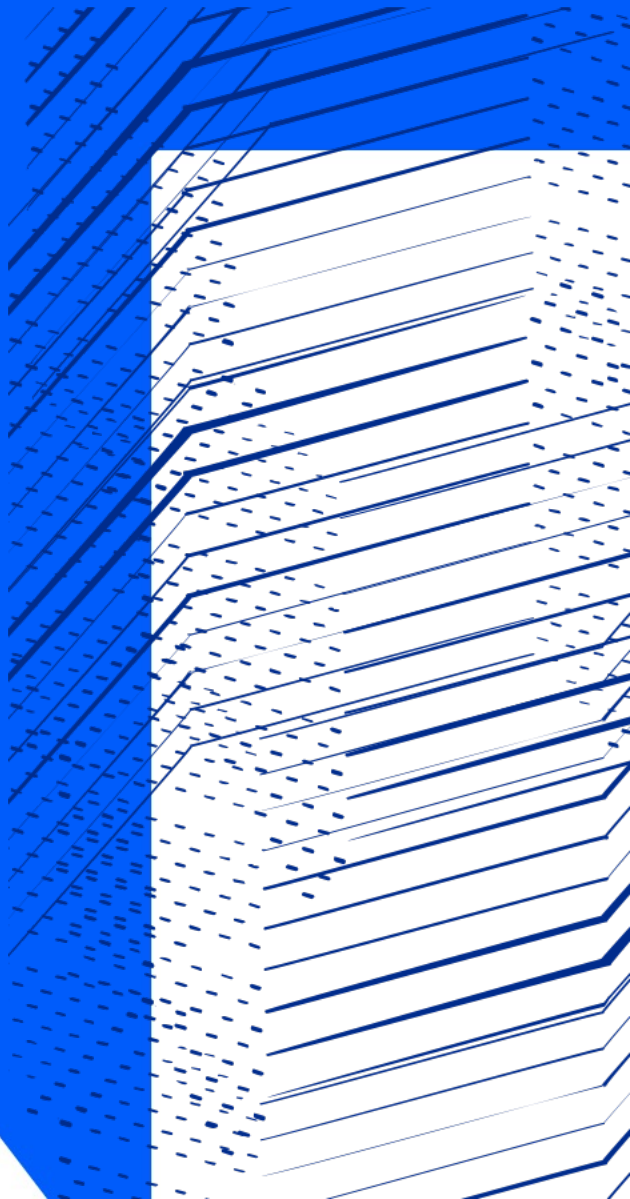
Challenges for Experiments at Boulby

Paul Scovell – 26/2/2021



Agenda

1 The Boulby experience

- What is it like to work at Boulby
- Logistics
- Environment

2 Challenges for the facility to overcome

- Environmental challenges
- H&S challenges
- Logistical challenges

3 Challenges for the experiments to overcome

- Detector design challenges
- Detector deployment challenges
- Detector operation challenges

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The Boulby experience

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The Boulby experience

What to expect

- Even among underground laboratories, Boulby is unique
- Experience at SURF, SNOLAB, LNGS, etc may be similar
- However, each location has its own challenges
- Darlington Railway Station: 1hr by car/taxi
- Darlington – London: 3hr
- Darlington – MAN: 2hr20

- Ample accommodation in Whitby
  - Out of peak summer periods
- Also accommodation in Saltburn/Middlesbrough in extremis

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The Boulby experience

Getting Underground

- Upon arriving on site you must be inducted at the gatehouse
- Face fit tests for FFP2 masks are mandatory
  - Particularly for when going to polyhalite district
- Getting down

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The Boulby experience

General Environment

- Standard roadways driven through salt – 8m x 4m (w x h)
  - Roadways of 10 m x 10 m are easily feasible (plus bigger bespoke!)
- General atmosphere is quite dusty
  - Well below any action levels
  - Well above cleanroom standard!
- Temperature of rock is in the 30s at the 1100 m level
  - Ventilation brings ambient temperature down to mid 20s
  - This is true close to the shaft but it is much warmer as you get further away – and deeper.
- Temperature of rock at 1400 m more like mid 40s

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The Boulby experience

Getting to the laboratory

- The existing laboratory is in the central area of the mine – 800m from pit bottom
- There is very limited opportunity for expansion in this location
  - Large scale excavations v. close to main shaft are not feasible
  - Future of Boulby Underground Laboratory is outside central
- AIT lab will be about 2 km from pit bottom
- G3 @1100 m would be very close by
- G3 @1400 m would be approximately 10 km from pit bottom
- Majority of 10 km is a straight road with a speed limit of 20 mph
  - About 20-30 minutes

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The Boulby experience

Getting to the laboratory

- 1100 m location under land
- 1400 m location under sea

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Challenges for the facility to overcome

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Challenges for the facility to overcome

General points

- Cleanliness
- HVAC
- Storage of hazardous materials
- Underground material transport logistics
- Distance from pit bottom

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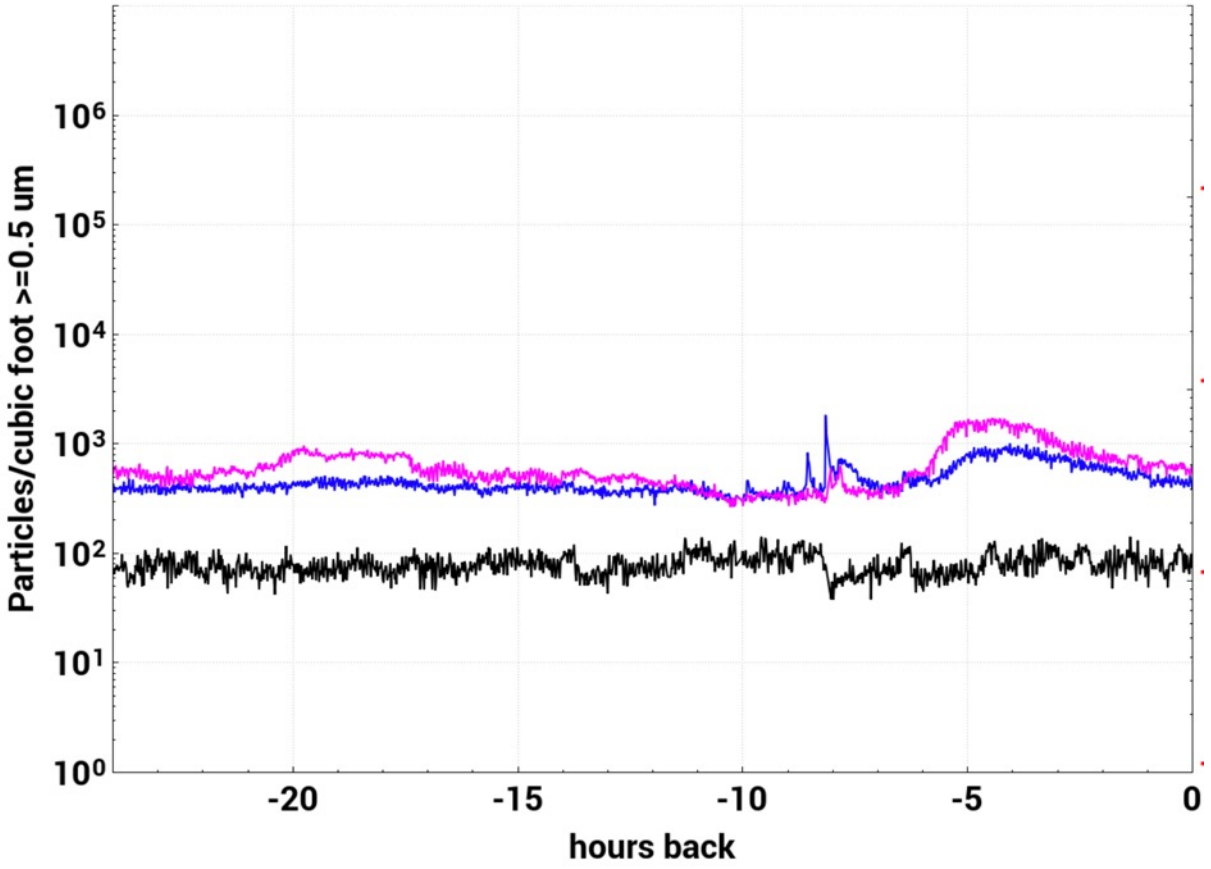
Challenges for the facility to overcome

Cleanliness

- There is already precedent for providing a clean lab space underground at Boulby
- Older labs were not so great but current lab was build specifically to provide a clean environment
- ISO-7 and ISO-6 environments and below possible
- Techniques now well understood



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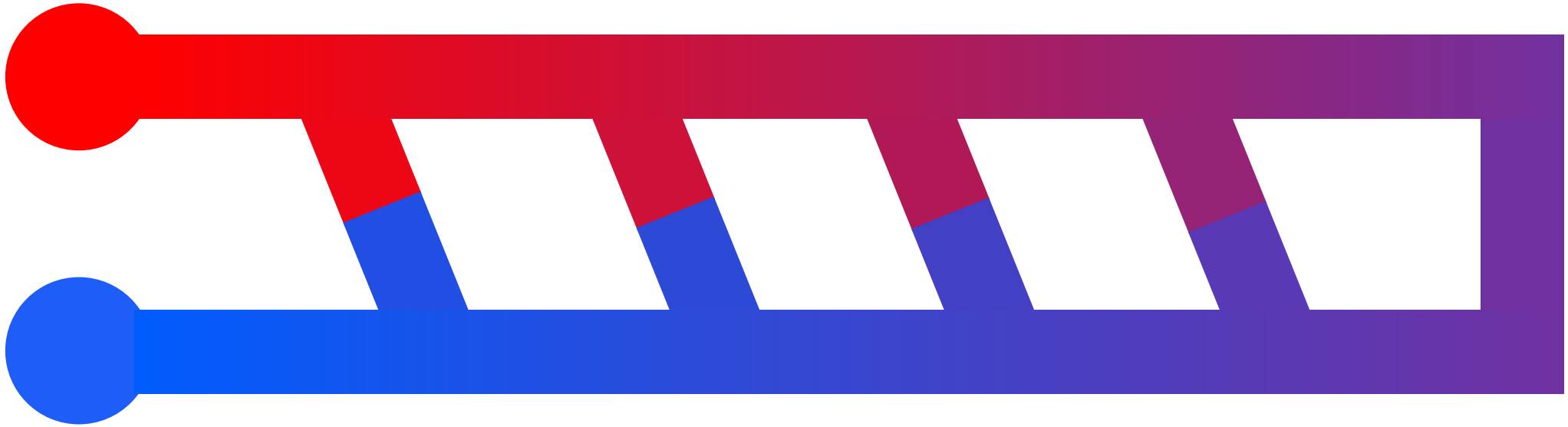
Challenges for the facility to overcome

HVAC: Air – One way in, one way out

Rock Shaft – Return Air

Both for V and AC



Man Shaft – Fresh Air

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Challenges for the facility to overcome

HVAC

- Heating not really and issue
- 30 m^3/s of air available at pit bottom
- Distributed round the mine
- Consolidation of mining in future means close to the full 30 will pass front door of lab
- This air can be borrowed to ventilate lab
  - Must go back for ventilation of any areas further “inbye”
- Any heat generated is dumped into a return airway

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Challenges for the facility to overcome

HVAC

- Feasibility study will look at power needed to cool large excavation to comfortable temperature
  - Higher ambient temperature – more power
  - Current lab requires a modest 35 kW of power to cool to 20C – 4000 m^3
- Important to understand heat dumped into return roadway
- Facility will aim to provide:
  - Around 20C in general rooms
  - Lower in cleanroom areas

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Challenges for the facility to overcome

HVAC

- Ventilation is incredibly important
- Anything escaping the lab will go:
  - Inbye - passing working districts
  - Outbye - release into return airway leads to rock shaft pit bottom
- Facility may provide excavations for capture of dangerous materials (water, LS, noble gases, etc)
  - Mining of standard roadways for capture is simple
  - Water cannot be captured and stored in a salt sump!
- Facility can provide instrumentation for monitoring
- Ducting to rock shaft pit bottom can be installed to vent gases
- ODH calculations part of feasibility study for baseline design

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Challenges for the facility to overcome

Storage of hazardous materials

- Flammable and Combustible materials highly regulated underground
- Will need close collaboration with ICL and HSE
  - Fire suppression and confinement
- Storage of large gas volumes (in bottles) needs
  - Space – more gas bottles, more space
  - Monitoring – fixed monitoring and personnel monitoring
  - Ventilation – what happens if bottle pack ruptures?
- Storage of hazardous materials should be minimised where possible
  - Liaise with mine

Challenges for the facility to overcome

Material transport logistics

- Materials arriving on site need to be:
  - Stored
  - Processed
  - Sent underground
  - Transported to experimental site
- All at the same time as the mine are sending equipment down and product up
- Facility would handle these logistics with ICL/experimental teams

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Challenges for the facility to overcome

Distance from pit bottom

- Personnel need transport
  - Vehicles are common underground, facility would provide vehicles and drivers
  - One UG bus = up to 10 people
- Basic everyday material transport relatively simple

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Challenges for experiments to overcome

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Challenges for experiments to overcome

General points

- Vertical Access
  - Limited envelope for getting equipment underground
  - Underground machining and construction
- Recapture of detector gases/liquids
- Control of hazardous materials

Nick Catford – subbrit.org.uk

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Challenges for experiments to overcome

Vertical access

- Limited envelope for getting equipment underground
  - 1.8 m x 2.9 m
  - 3.4 m diagonal
  - Centre of gravity in line with centre of shaft
- Max length of items determined by route to experimental location
  - Probably not much more than 7-8 m

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Challenges for experiments to overcome

Vertical access

- Vertical access limitations may require underground machining
- Facility should provide clean areas and radon reduced air
- Some machining equipment is experiment specific so would likely be part of experimental cost
- Facility could provide ventilation for eg welding but experiments would need to develop strategies for disposal of cleaning chemicals
  - Obviously in partnership with facility team and ICL

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Challenges for experiments to overcome

Recapture of detector gases/liquids

- Excavation of standard tunnels is straightforward
- Recapture of gases could be as simple as allowing them to flood dedicated tunnels for later recapture
  - Is this reasonable for your experiment?
- For liquids, sumps could be created
  - How would we avoid dissolving salt
  - Could liquid be sacrificed and replaced – pump out of mine quickly
  - For polyhalite (1400m) dissolving of rock is not an issue

Challenges for experiments to overcome

Control of hazardous materials

- Facility can provide storage space for hazardous materials
- Experiments need to consider the movement of these materials within the facility
  - Radiation
  - Liquid scintillator
  - etc

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Conclusions

- There are clearly challenges to overcome
  - Same in any underground lab
- Some of these are universal for all experiments and will be provided by the facility
- Some of these are unique to specific experiments and would need to be considered by experimental teams in partnership with facility
- As things stand, shaft dimensions are the biggest limitation
- This cannot be changed so experimental teams will have to determine how to allow for this in design
- I believe all other limitations and challenges can be overcome
  - Have been in other labs and some already have at Boulby

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