

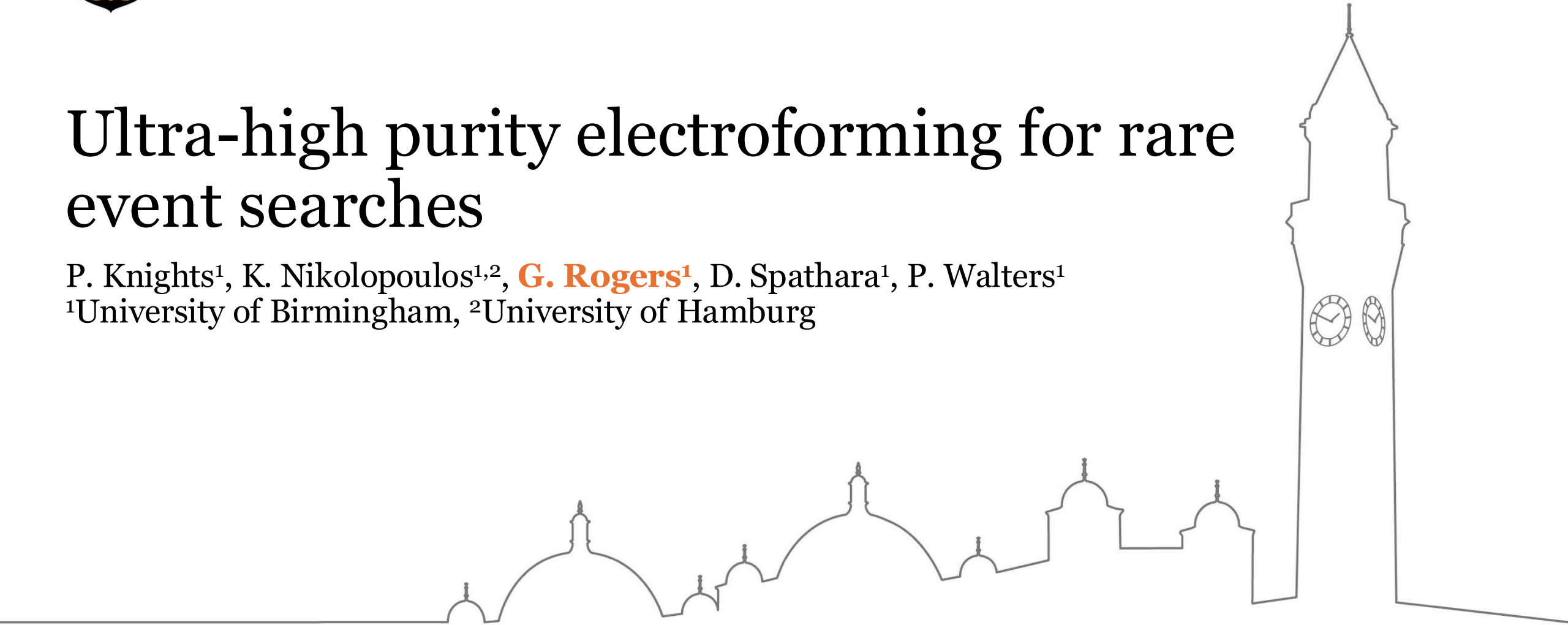


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Ultra-high purity electroforming for rare event searches

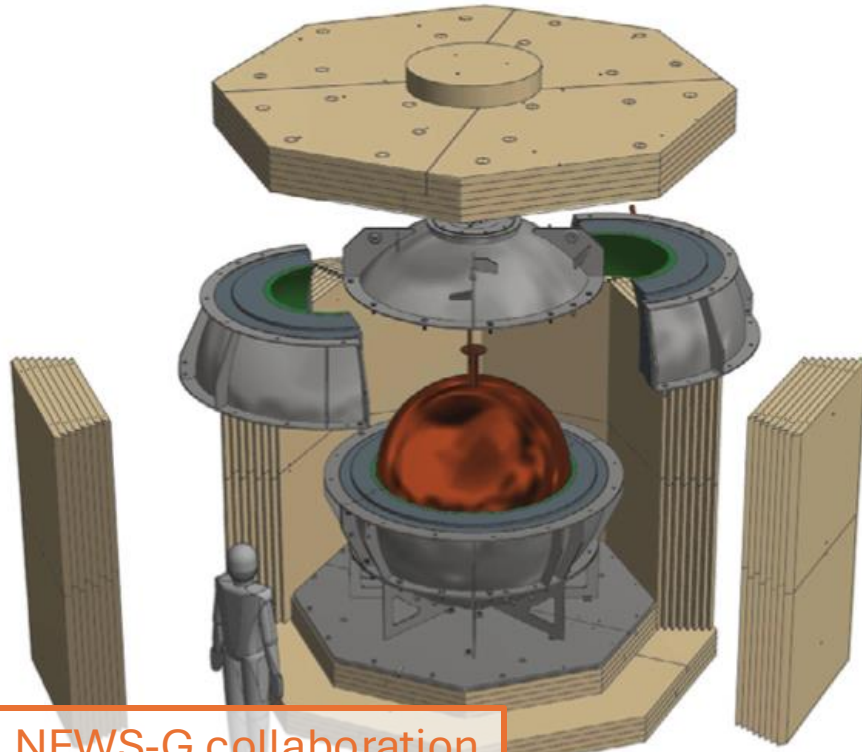
P. Knights¹, K. Nikolopoulos^{1,2}, **G. Rogers¹**, D. Spathara¹, P. Walters¹

¹University of Birmingham, ²University of Hamburg



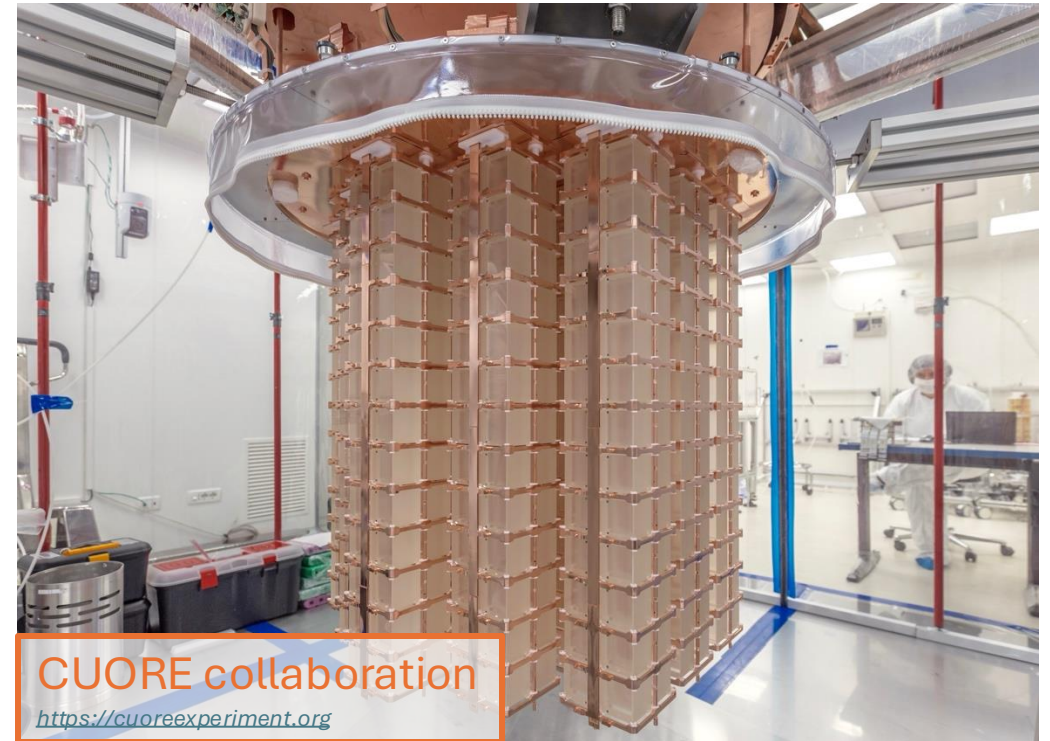
Copper as a detector material

- **Copper** is a common detector material for rare event searches
 - Commercially available at high-purity up to high-purity
 - Good mechanical and electrical properties
 - No long-lived radio-isotopes



NEWS-G collaboration

<https://www.snolab.ca/experiment/news-g/>

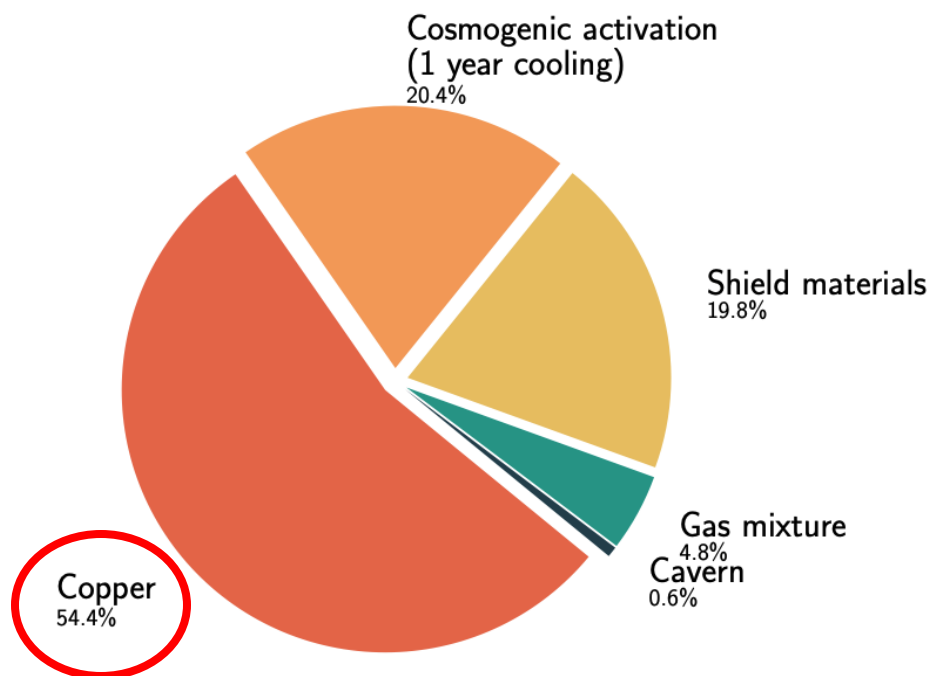


CUORE collaboration

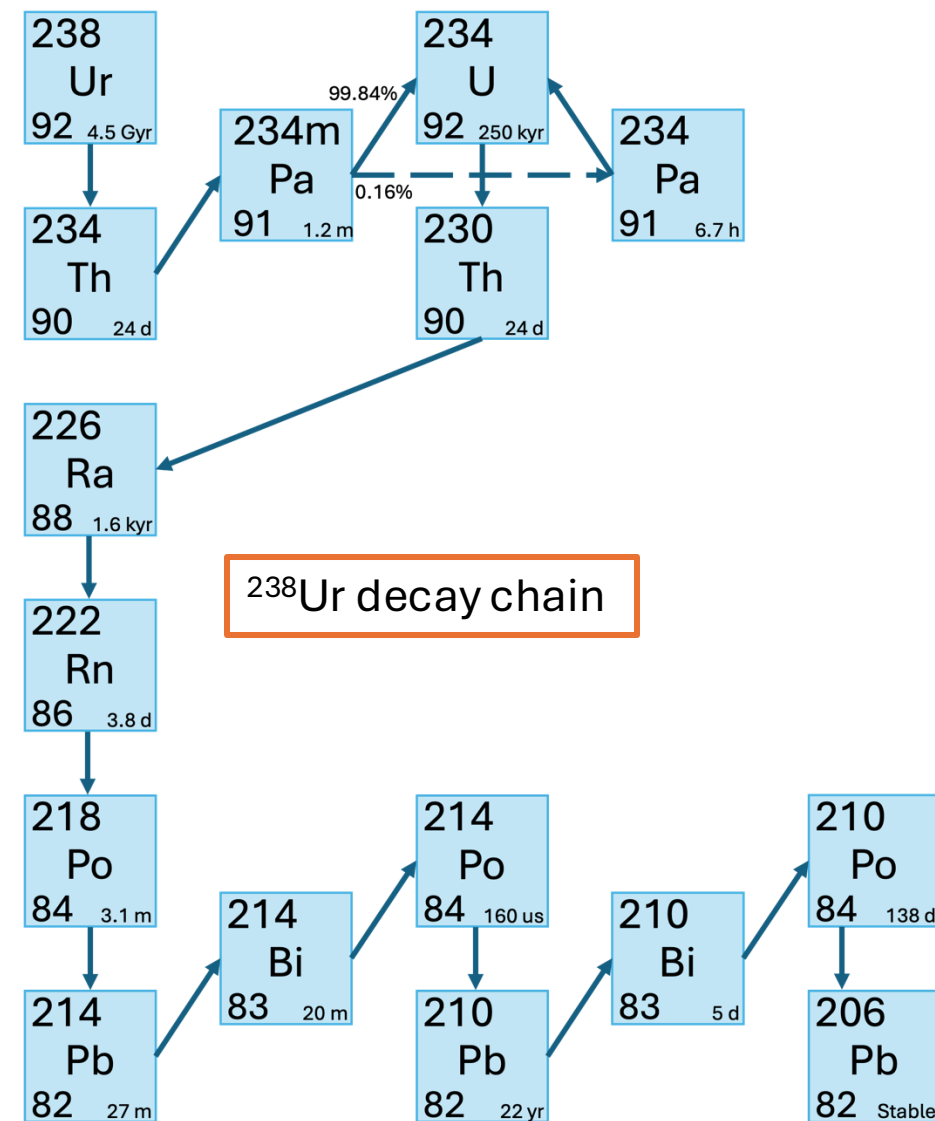
<https://cuoreexperiment.org>

Copper background

- Copper can still represent an important background
- Commercial copper contaminated - ^{238}U and ^{232}Th decay chains:
 - Natural ore contamination
 - Cosmogenic activation
 - Implanted during manufacture



Simulated backgrounds for NEWSG's current detector



Electrodeposition

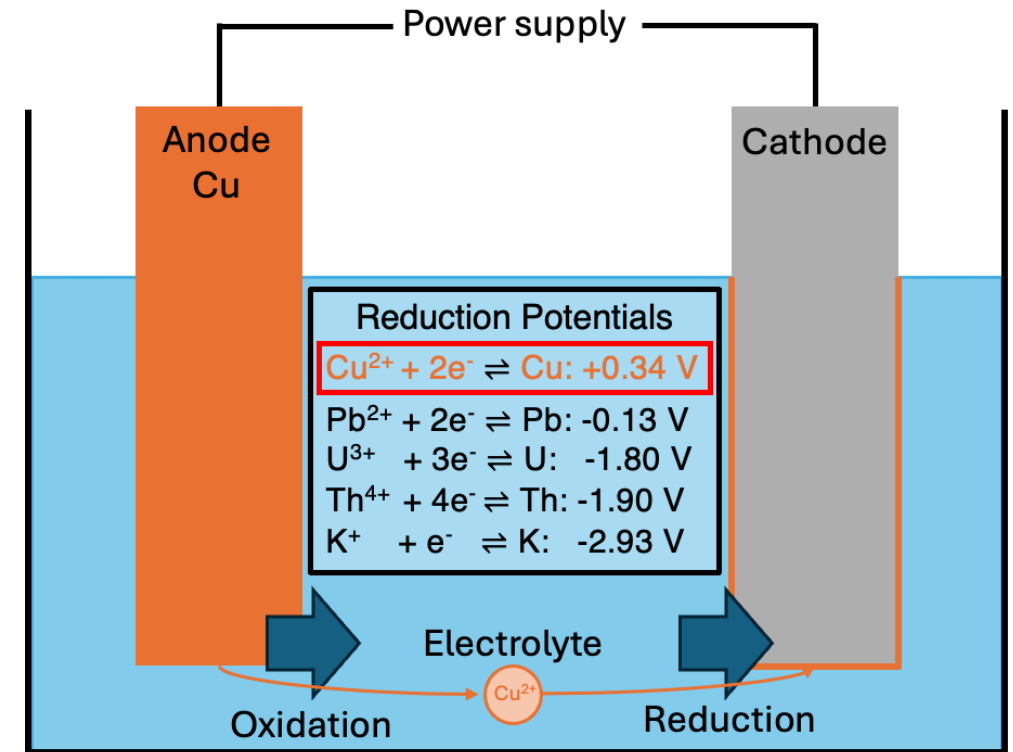
- Deposit Cu^{2+} ions onto a cathode by applying a voltage
- Copper has a higher reduction potential than contaminants -> more easily reduced onto the cathode

Electroplating

- Cu plated onto existing structure (i.e. cryostat) acting as an ultra-pure shield

Electroforming

- Cu plated onto a mould (called mandrel)
- Remove the mandrel leaving a pure copper structure



Electrodeposition

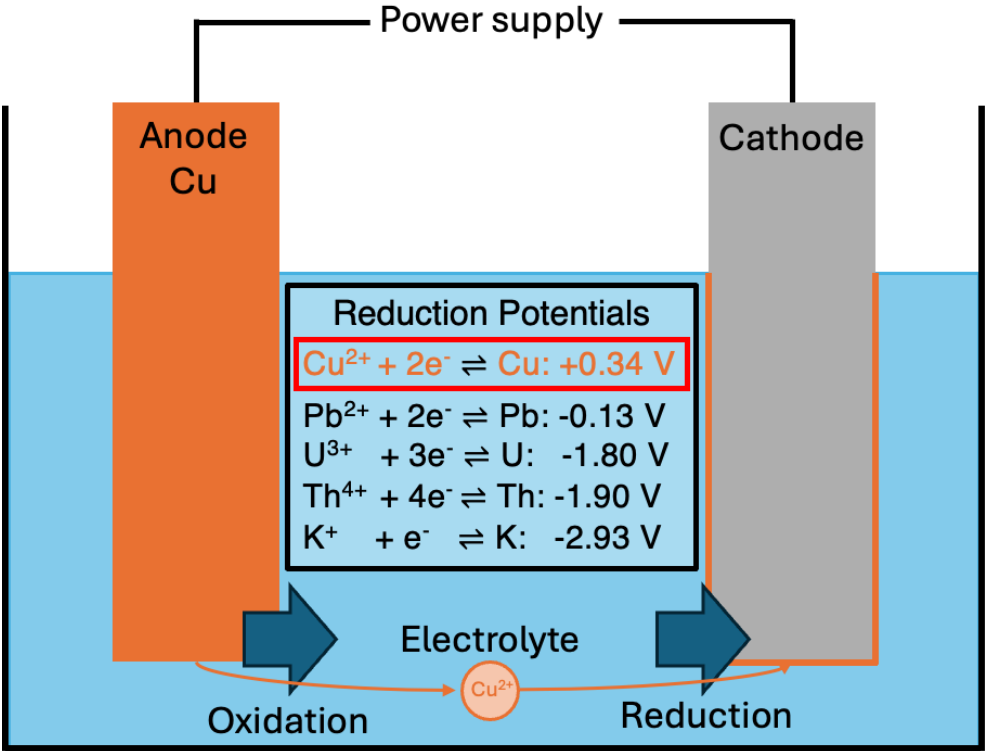
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Electroplating

Electroforming

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Sample of copper	^{232}Th [uBq/kg]	^{238}Ur [uBq/kg]
Commercial C10100	8.7 ± 1.6	27.9 ± 1.9
NEWS-G plated NIMA 988 (2021) 164844	<0.24	<0.11
Majorana demonstrator electroformed NIMA 828 (2016) 22-36	<0.119	<0.099



Majorana demonstrator
Electroformed Cu
[OSTI \(2012\) 1039850](#)



NEWS-G electroplated Cu
[NIMA 988 \(2021\) 164844](#)



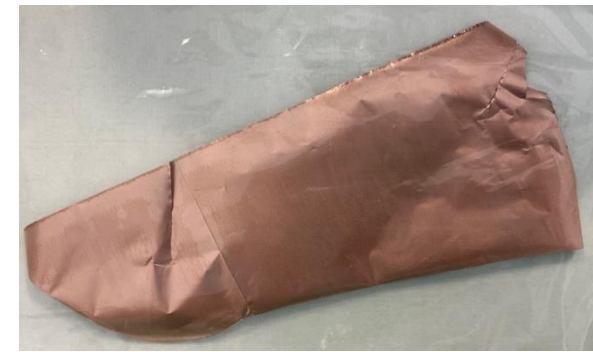
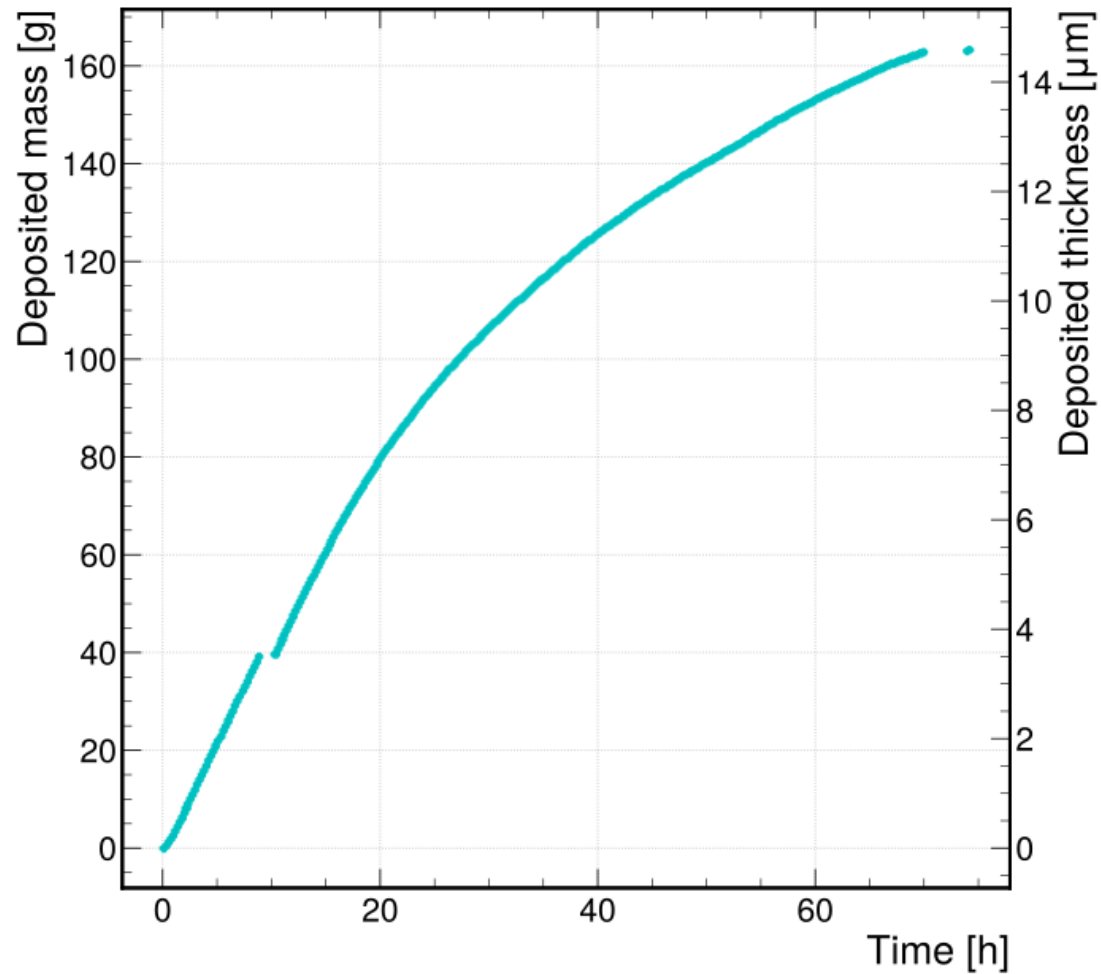
Electroforming facility at Boulby

- 1.1km underground at the UK's deep underground laboratory Boulby -> **reduce cosmogenic activation**
- Construction and cleaning **finished**
- Currently commissioning with cylindrical mandrels
- Immediate goal: electroform a $\varnothing 30\text{cm}$ SPC **DarkSPHERE-30**
- Ultimate goal: **DarkSPHERE** $\varnothing[\varnothing 3\text{m}]$



Commissioning

- Copper plated onto stainless steel cylinder
- Peeled copper off mandrel -> assay results pending



Physics Potential

- Fully electroformed SPCs will have world leading sensitivity to low-mass dark matter
- DarkSPHERE-30 will begin construction in the coming months
- Alloys being explored to improve the properties of electroformed copper – PureAlloys project

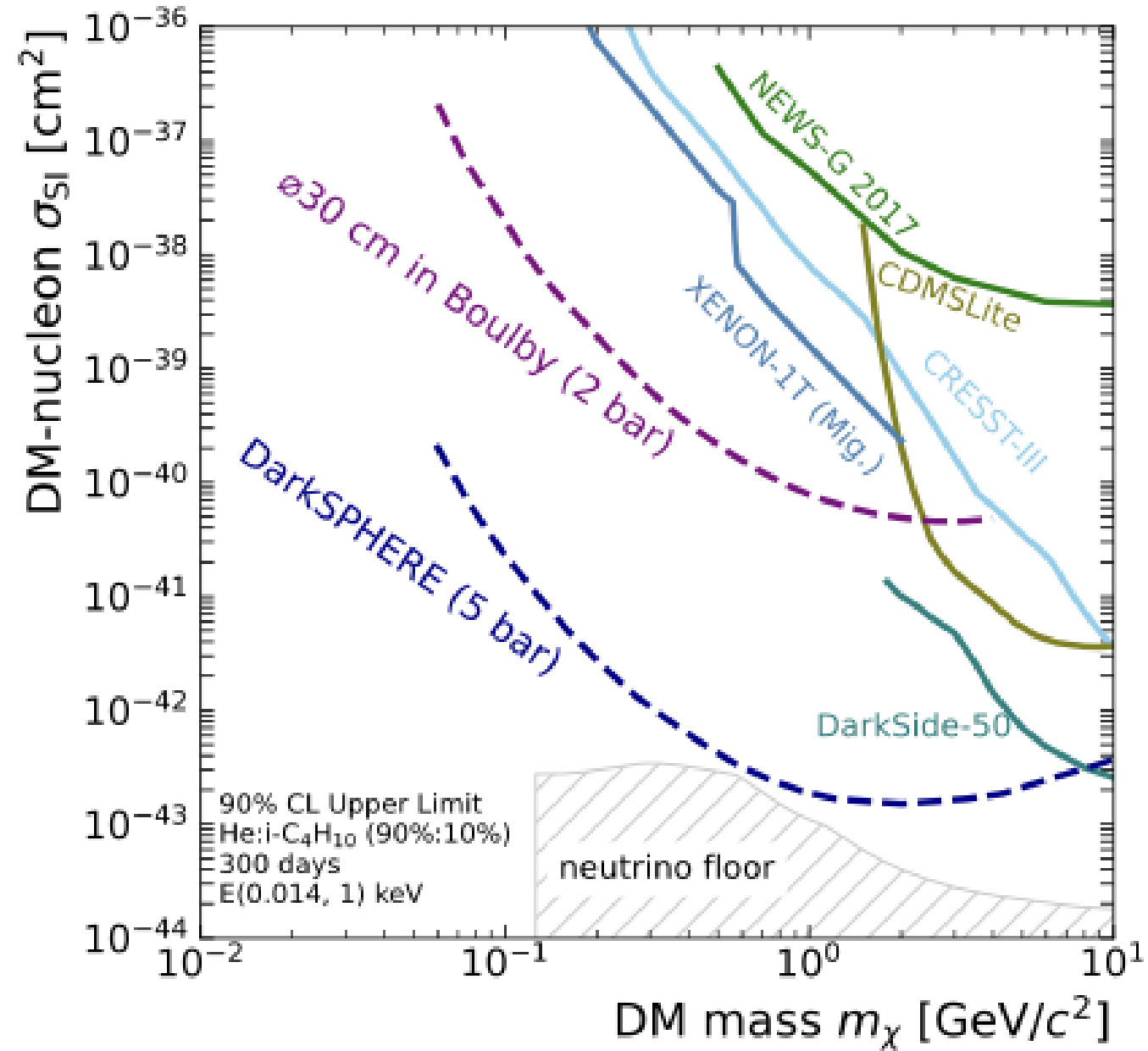
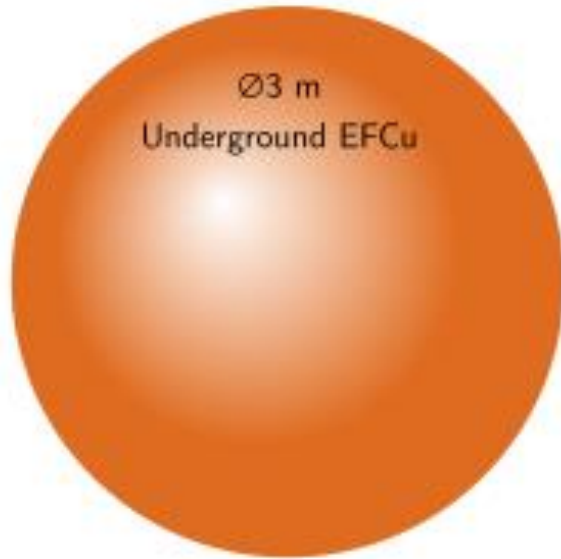
- [NIMA 1082 \(2026\) 170970](#)
- [arXiv.2507.00799](#)

DarkSPHERE-30

Ø30 cm
Underground EFCu

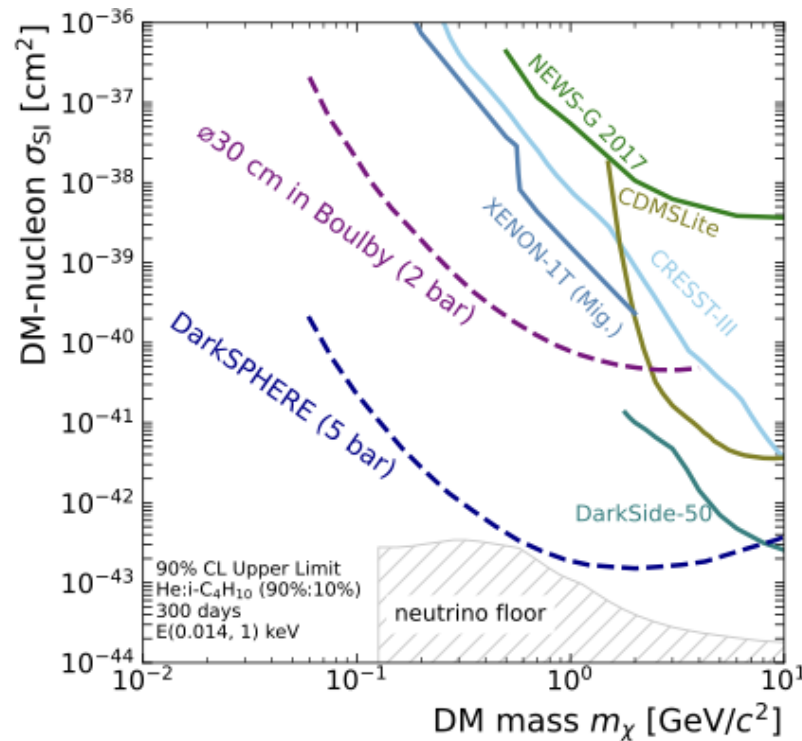
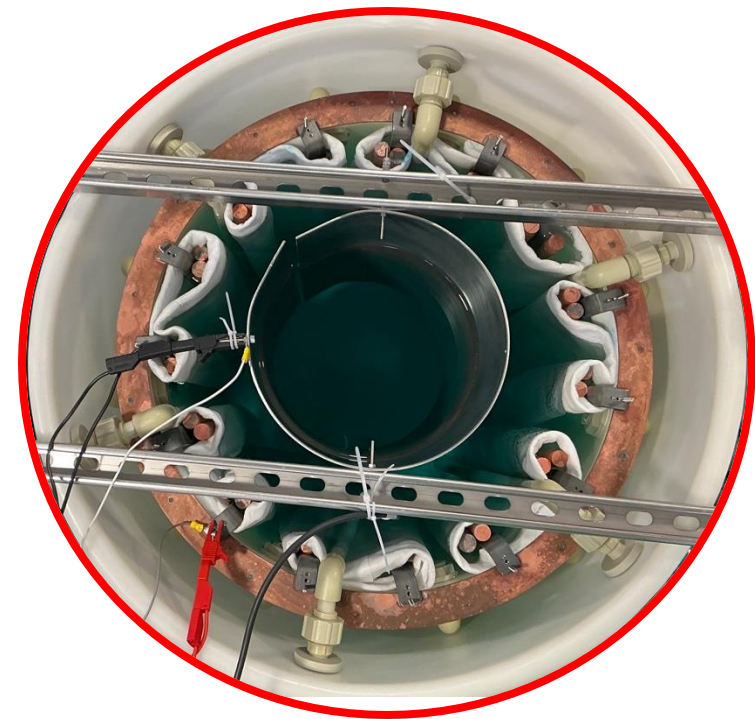
DarkSPHERE

Ø3 m
Underground EFCu



Summary

- Copper electroforming for radio-pure detectors
- Electroforming facility constructed at Boulby
- First copper plated onto stainless steel cylinder
- Electroforming a $\varnothing 30\text{cm}$ SPC in the coming months
- Many other experiments exploring the use of electroformed Cu



BACKUP SLIDES

Spherical proportional counter

- Proportional counter filled with gas
- Choice of gas -> **kinematic matching**
- Low capacitance -> **Single electron detection**
- Simple design -> **Radiopure construction**
- Optimised for light dark matter searches
- NewsG operate several SPCs – current detector is **Snoglobe** at Snolab

[JAS 2025 \(2025\) 548](#)

