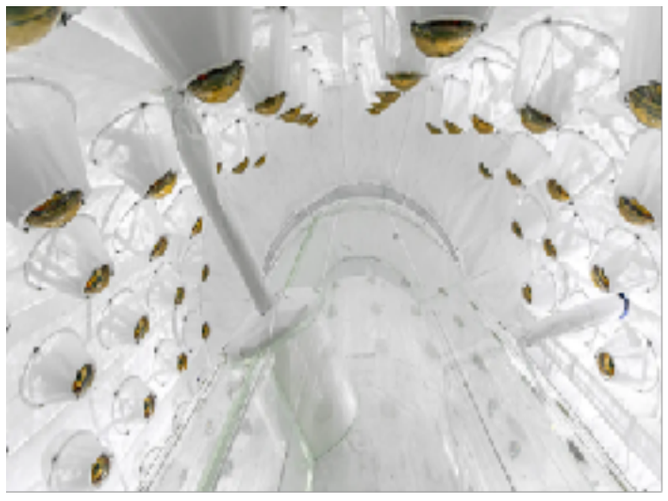
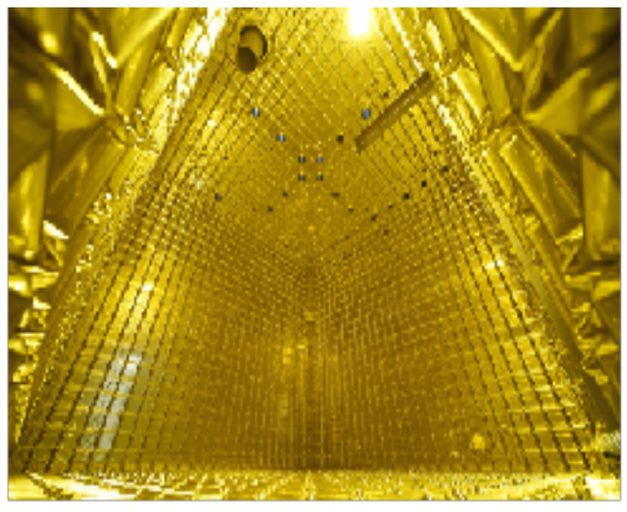
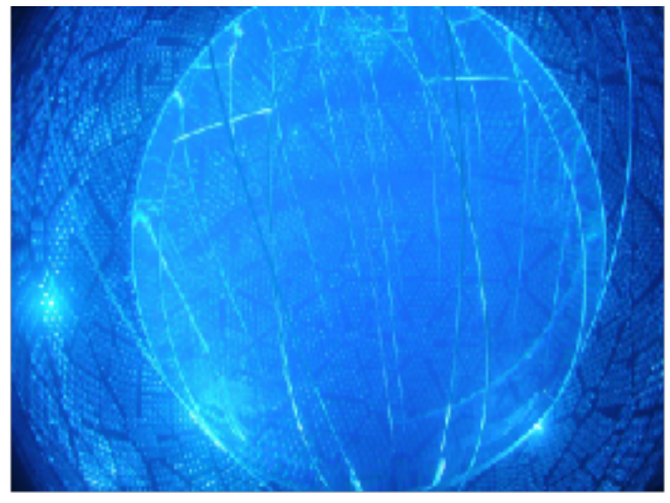





DRD2: The UK perspective

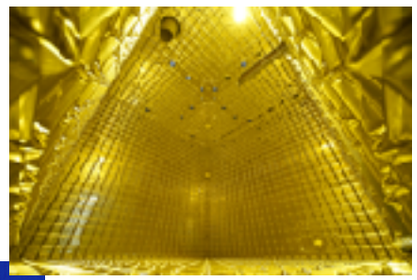
Roxanne Guenette
Jocelyn Monroe
Ruben Saakyan
Paul Scovell

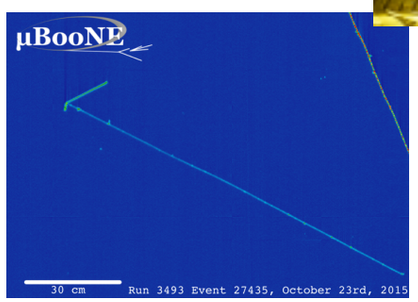
30 October 2023

The Science covered

Neutrinos

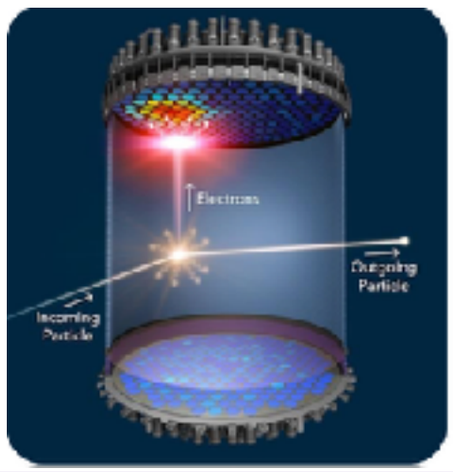
- Oscillation precision measurements (δ_{CP}, mass ordering, θ_{23} octant, sterile νs)
- Neutrino interactions (from CEvNS to DIS)
- Astro neutrinos





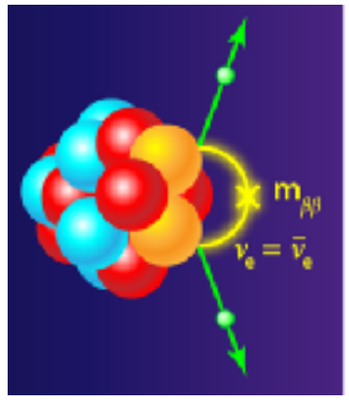
Dark Matter

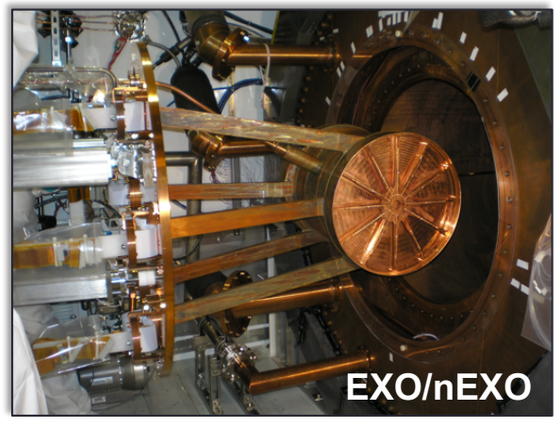
- Direct detection (WIMPs, …)



0νββ

- Search for Majorana neutrinos





The Physics Needs (high level overview)

Neutrinos

- **Push Energy thresholds down** to ~1MeV to enhance oscillation physics, supernovae νs study, to enable solar νs …
- **Unambiguous readout**
- **Scalability**

Dark Matter

- **Push Energy thresholds down** to 1 meV/10 eV/1 keV to enable low mass DM/1 GeV DM/ WIMPs.
- **Reduce background rates**
- **Scalability**

0νββ

- **Improve Energy Resolution** to sub-% FWHM
- **Reduce background rates**
- **Scalability**

Future targeted *projects* (UK)

Liquid Nobles (Argon/Xenon)

- Dark Matter (Xe): XLZD
  (Few R&D needs from inputs)
- Dark Matter (Ar): Argo
- Neutrinos: DUNE LAr 3rd/4th modules
- Future Kilotonne-scale Xenon detectors:
  https://indico.slac.stanford.edu/event/8015

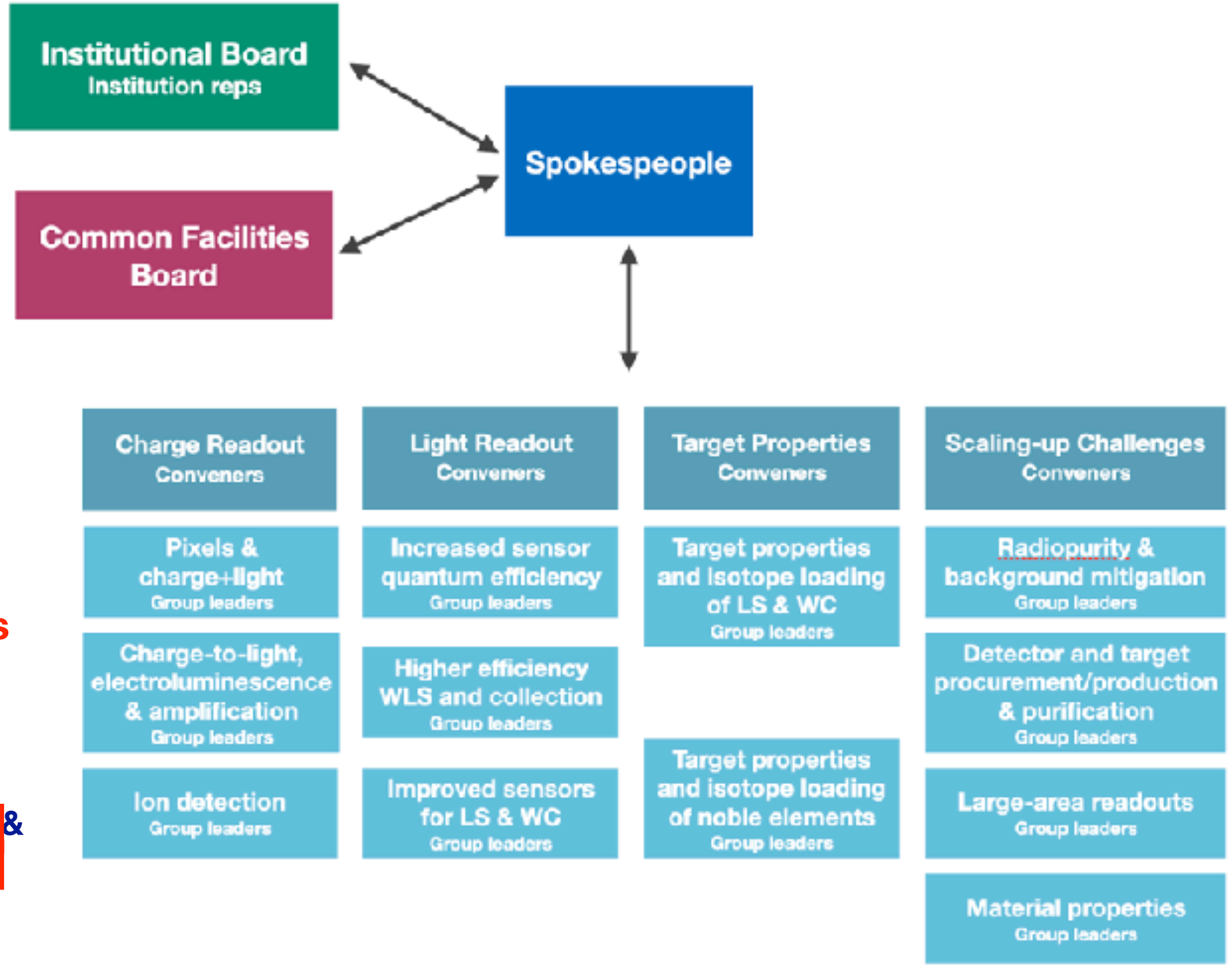
Liquid Scintillator

- LS $0\nu\beta\beta$: SNO+ high Te doping
- Opaque LS: LiquidO

Water Cherenkov

- HyperK
  (Few R&D needs from inputs)

DRD2 Collaboration



UK members

DRD2 Leaders:
Roxanne Guenette & Jocelyn Monroe

Charge Readout:
1.1 Jonathan Asaadi & Elena Gramellini
1.2 : Alexander Deisting & Kostas Mavrokoridis

Light readout:
2.1 Jocelyn Monroe & Fabrice Retiere
2.2 Marcin Kuzniak, Justo Martin-Albo, Clara Cuesta
2.3 Mathieu Bongrand & Tobias Lachenmaier

Target Properties:
3.2: Davide Franco , Marie-Cecile Piro, Andrea Zani, Andrzej Szelc
3.1: Hans Steiger, Micheal Wurm, Stefan Schoppmann

Scaling-up Challenges:
4.1 Roberto Santorelli & Jim Dobson
4.2 Walter Bonivento & Minfan Yeh
4.3 Ines Gil-Botella , Jose Crespo , Giuliana Fiorillo

DRD2: UK input

Charge readout

- Manchester
- Liverpool

Light readout

- Edinburgh
- Manchester
- Liverpool
- Open Uni.
- RAL/STFC
- RAL PPD
- Royal Holloway
- Royce Institute
- Sussex
- York

Target Properties

- Edinburgh
- Liverpool
- King's
- Oxford

Scale-up challenges

- Boulby (STFC)
- Edinburgh
- King's
- RAL PPD
- Sheffield
- UCL

DRD2: UK input -> A coherent picture?

Charge readout

- Manchester
- Liverpool

Charge+light and charge-to-light

Light readout

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Isotope loading in LS
Quantum dots in WC

Scale-up challenges

- Boulby (STFC)
- Edinburgh
- King's
- RAL PPD
- Sheffield
- UCL

VUV sensors development
Metasurfaces for light collection
Large area WLS
Improved fibers for light collection

All related to radiopurity and bkg reduction

DRD2: UK input -> A coherent picture?

Charge readout

- Manchester
- Liverpool

Charge+light and charge-to-light

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Target Properties

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- Oxford

Isotope loading in LS

Quantum dots in WC

Light propagation in nobles

Scale-up challenges

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- King's
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VUV sensors development

Metasurfaces for light collection

Large area WLS

Improved fibers for light collection

All related to radiopurity and bkg reduction

See Ruben's talk

All related to light!

UK Coherent picture

Case Study2 : Increased light detection in liquid detectors

Issue: Increased light detection and reduction of both energy thresholds and backgrounds would be transformative for future neutrino and dark matter experiments. This requires R&D efforts to develop new and improved solutions for light detection, hand-in-hand with improved background rejection techniques. A step change in technologies to measure and control trace radioactivity and particulate contamination is also essential.

Aim: We aim to increase, improve and combine the light signals recorded, underpinned by ultra-low background developments. A coherent R&D effort includes: development and characterisation of light sensors; increased collection and detection efficiency over a broad wavelength range; development of charge-to-light and charge+light readouts; and background reduction with improved material screening techniques and use of novel low-background materials.

UK DRD Activity: The UK community spans noble liquid detectors targeted at dark matter searches and neutrino physics, water Cherenkov detectors for neutrino physics and liquid scintillator detectors to search for neutrinoless double beta decay. The programme will benefit all these and builds on previous investments in world-class facilities at the Boulby underground laboratory, which will boost industrial engagement. Developing UK global leadership in light detection for liquid detectors and collaborating with international partners will improve the prospects for the UK hosting world-leading large-scale science projects.