

DRD2: Liquid Detectors

Roxanne Guenette



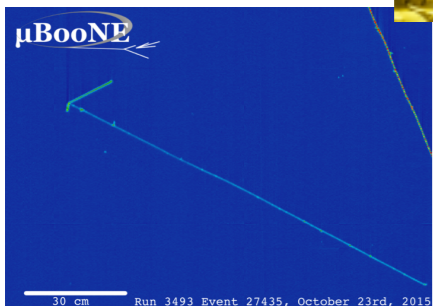
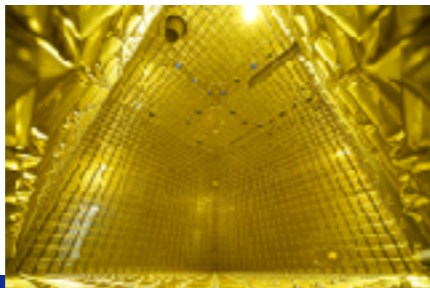
The University of Manchester

7 November 2023

The Science covered

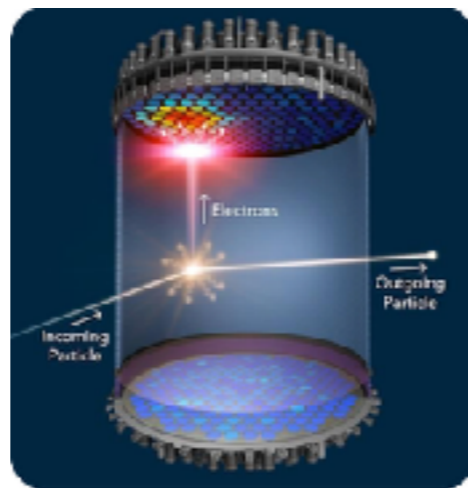
Neutrinos

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



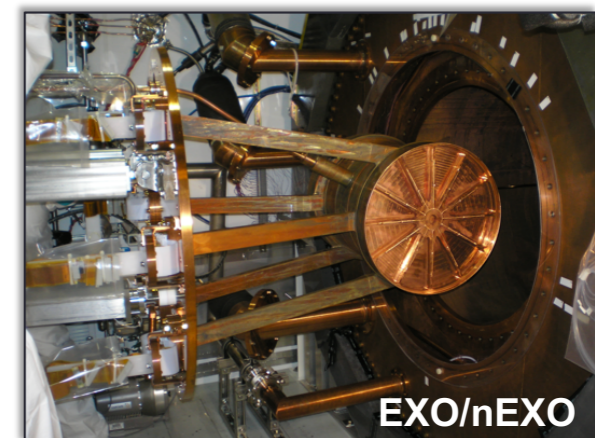
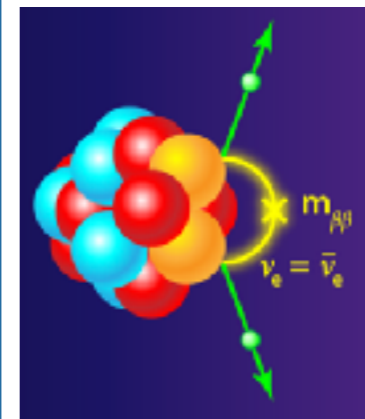
Dark Matter

- Direct detection (WIMPs, ...)



$0\nu\beta\beta$

- Search for Majorana neutrinos



The Physics Needs (high level overview)

Neutrinos

- **Push Energy thresholds down** to ~ 1 MeV to enhance oscillation physics, supernovae ν s study, to enable solar ν s ...
- **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**

$0\nu\beta\beta$

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

Future targeted *projects*

Liquid Nobles (Argon/Xenon)

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

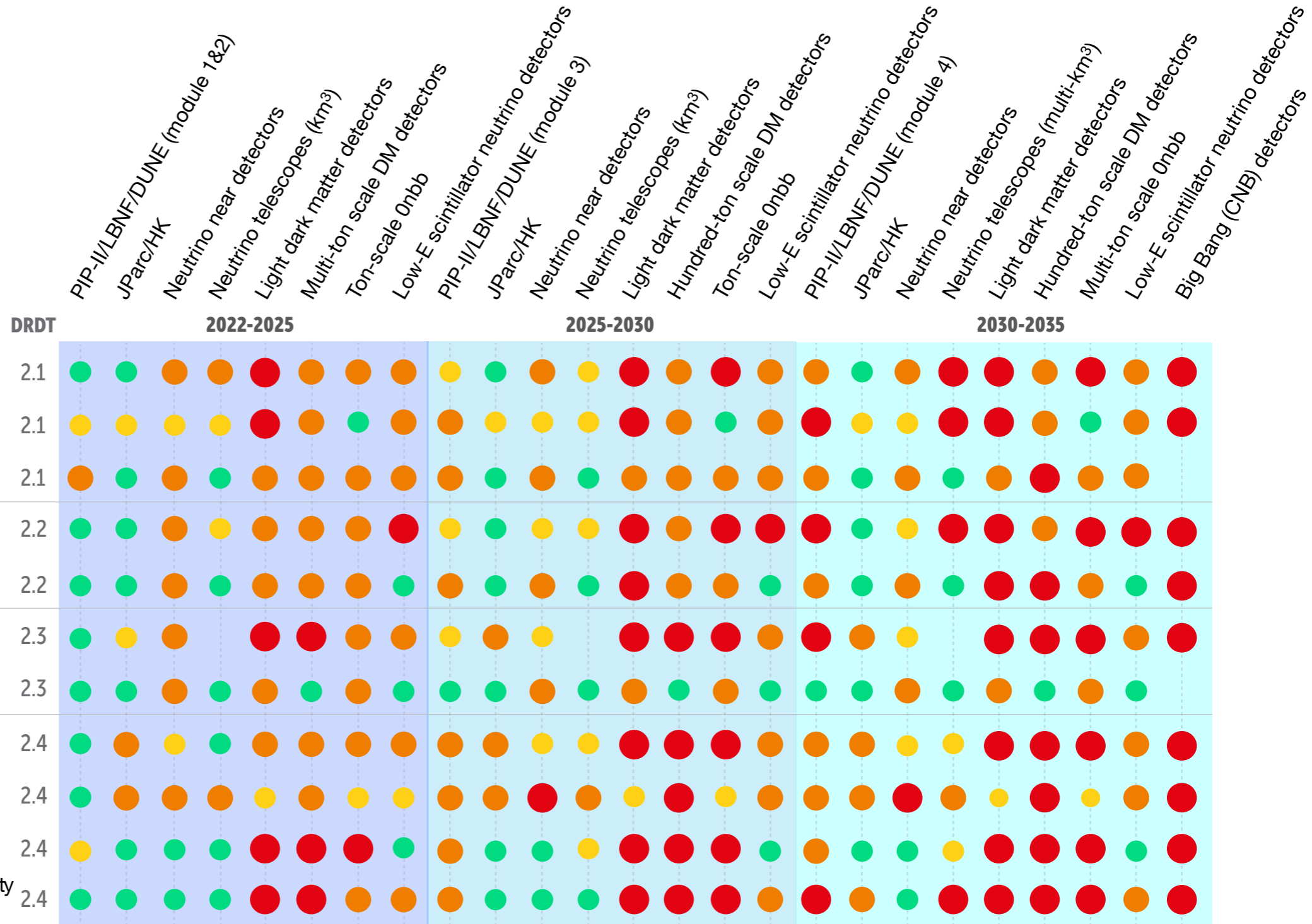
Liquid Scintillator

- THEIA (WbLS),
- LS $0\nu\beta\beta$: SNO+ high
Te doping
- Opaque LS: LiquidO

Water Cherenkov

- HyperK
(Few R&D needs from inputs)

ECFA Roadmap (2021)

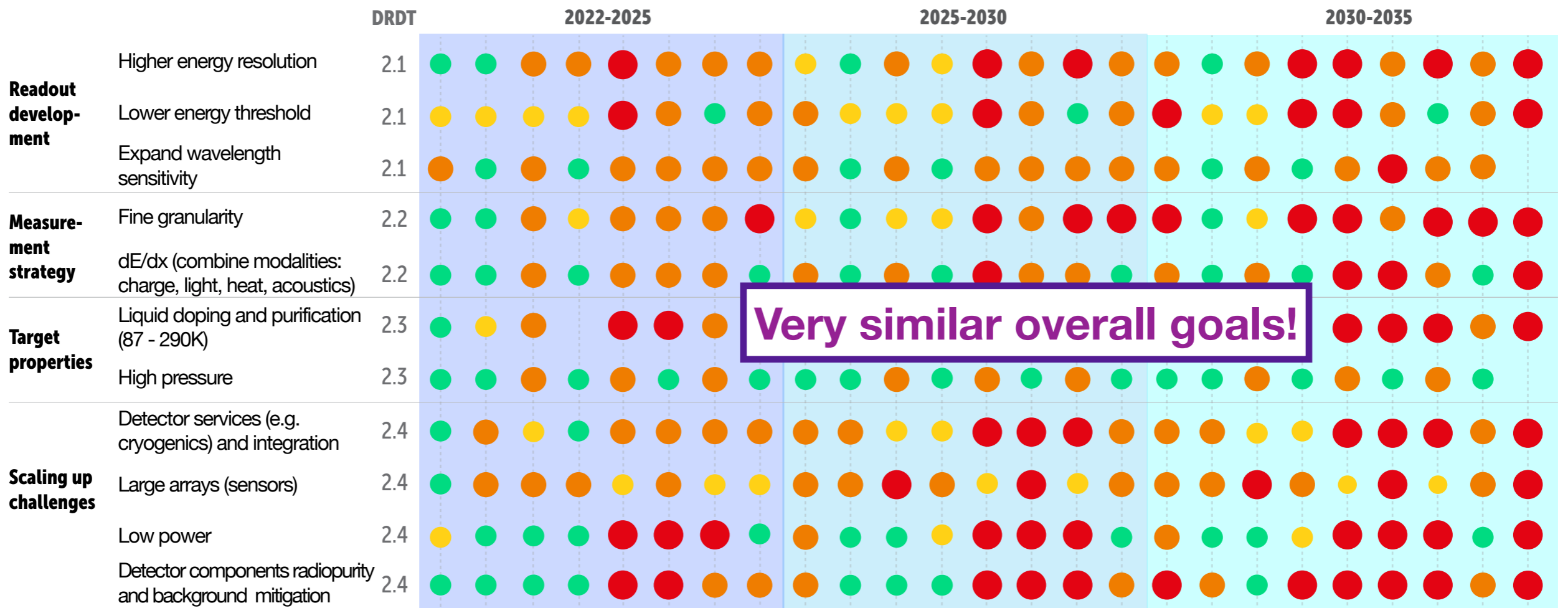


● Must happen or main physics goals cannot be met
 ● Important to meet several physics goals
 ● Desirable to enhance physics reach
 ● R&D needs being met

ECFA Roadmap (2021)

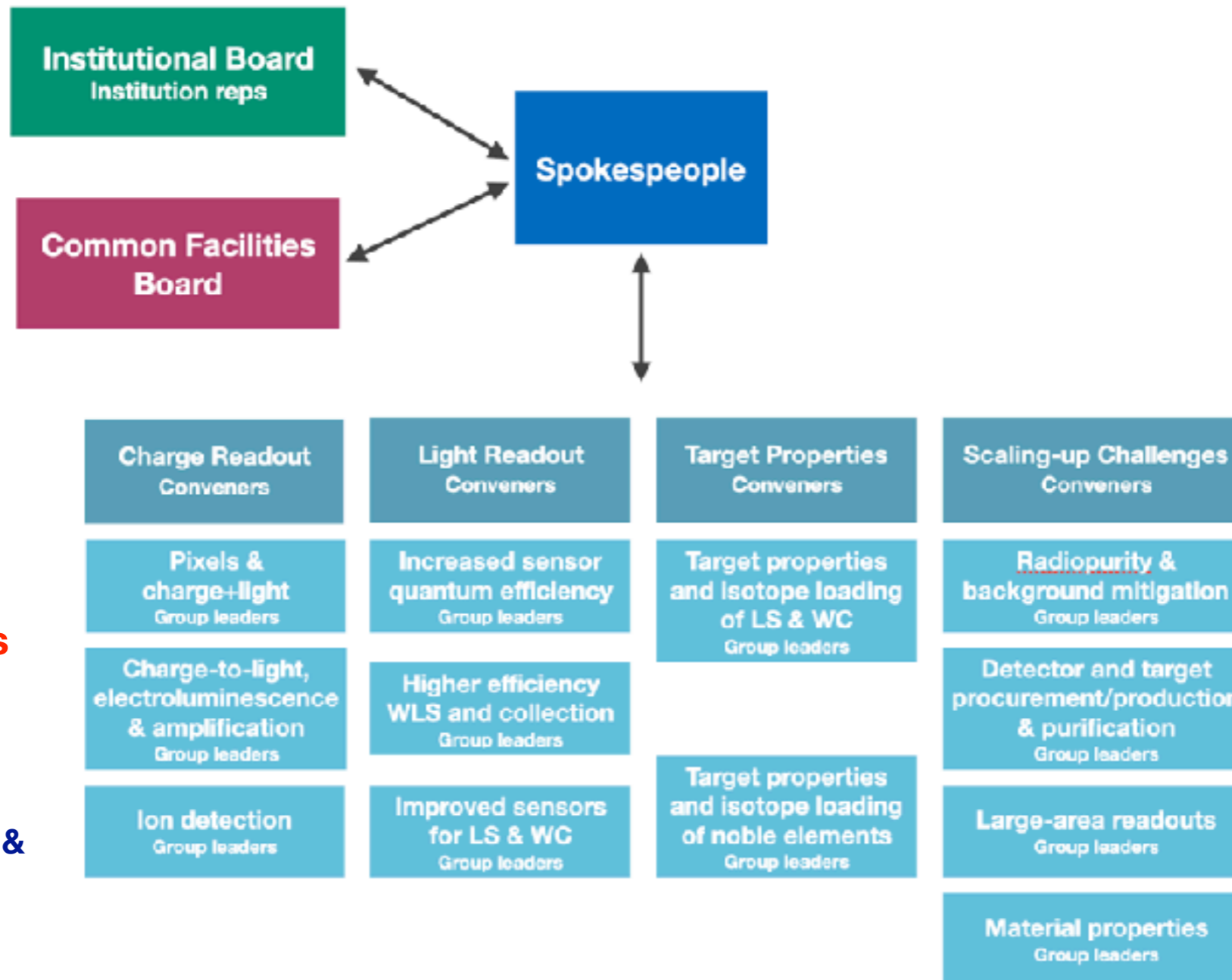
BRN Priority Research Directions

Nobles	PRD 4: Enhance and combine existing modalities to increase signal-to-noise and reconstruction fidelity
	PRD 5: Develop new modalities for signal detection
	PRD 6: Improve the understanding of detector microphysics and characterization
	PRD 25: Advance material purification and assay methods to increase sensitivity
	PRD 26: Addressing challenges in scaling technologies



● Must happen or main physics goals cannot be met
 ● Important to meet several physics goals
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 ● R&D needs being met

DRD2 Collaboration



 US 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

US participation

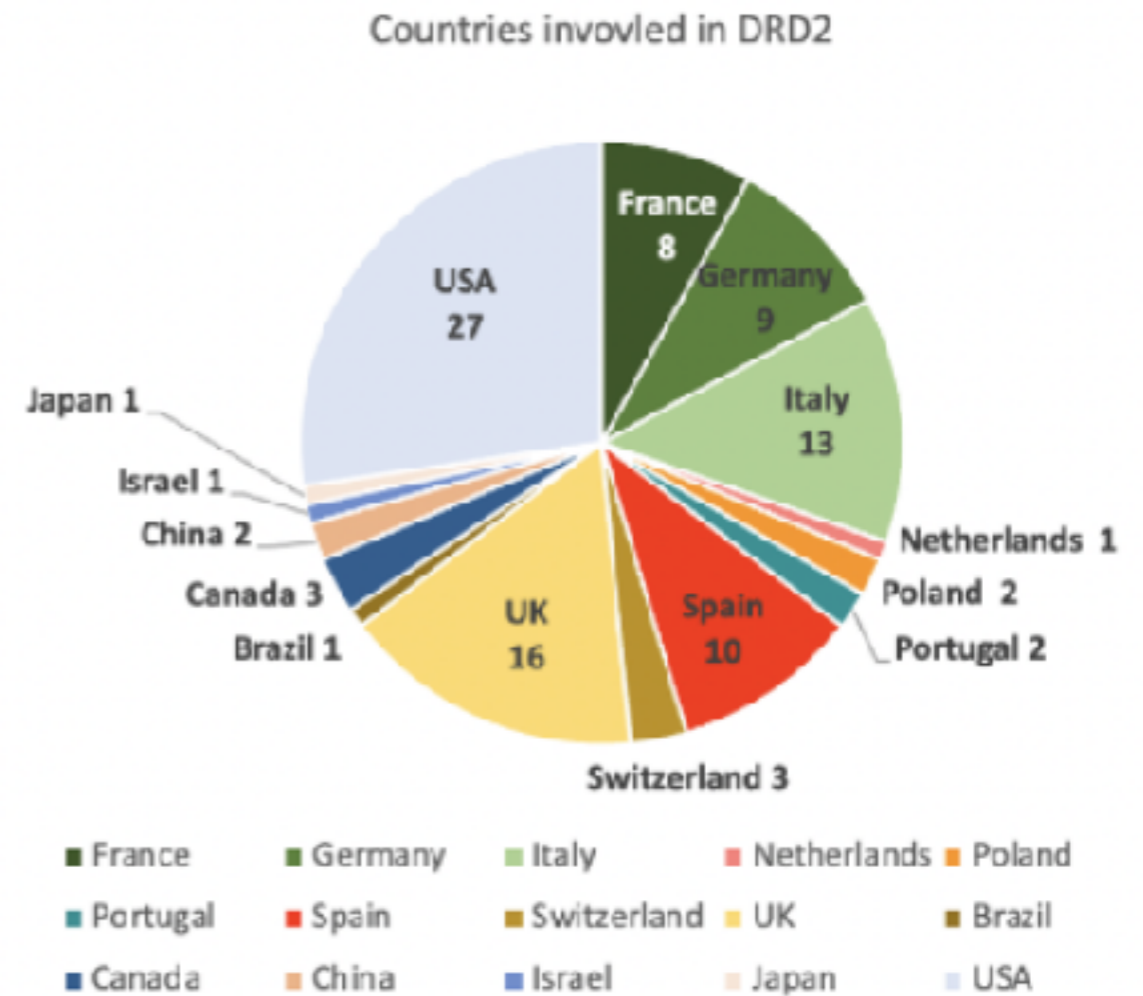
- Strong US participation in DRD2

✓ Charge Readout: 9 inst.

✓ Light Readout: 2 inst.

✓ Target Properties: 13 inst.

✓ Scale-up challenges: 3 inst.



DRD2 Proposal submitted

- Proposal was submitted in Summer 2023
- Link: <https://indico.cern.ch/event/1214404>
- Approval of DRD2 proposal expected end of 2023
- Spring 2024: Form DRD2 Collaboration

Proposal for a joint DRD2-RDC1 Collaboration

- Given the high involvement of US participants in DRD2
- Given the leadership positions held by US members across BRN, SNOWMASS, ECFA, resulting DRD2 proposal is well aligned with CPAD
- Idea would be to map out the RDC1 Working Groups identically to DRD2, and ensure leadership from both sides
- Idea would be to hold 1 “International Collaboration” meeting per year, alternating between US and Europe
- Goal is to ensure highest impact and intellectual exchange

Any thoughts?

- Reminder of Working Groups

Charge Readout Conveners	Light Readout Conveners	Target Properties Conveners	Scaling-up Challenges Conveners
Pixels & charge+light Group leaders	Increased sensor quantum efficiency Group leaders	Target properties and isotope loading of LS & WC Group leaders	<u>Radiopurity & background mitigation</u> Group leaders
Charge-to-light, electroluminescence & amplification Group leaders	Higher efficiency WLS and collection Group leaders		Detector and target procurement/production & purification Group leaders
Ion detection Group leaders Currently no rep	Improved sensors for LS & WC Group leaders In Photon detectors	Target properties and isotope loading of noble elements Group leaders	Large-area readouts Group leaders
			Material properties Group leaders Currently no rep