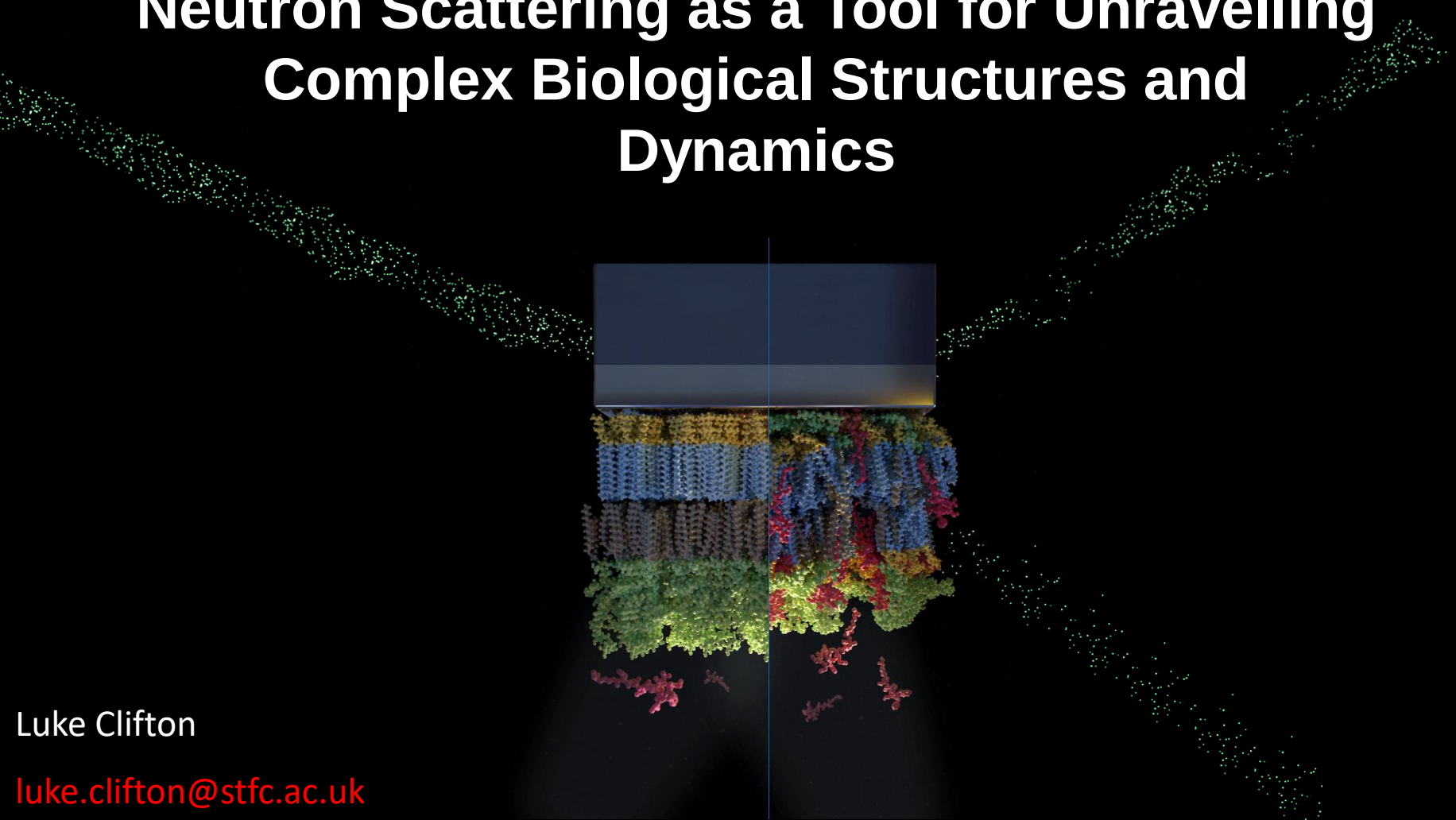
ISIS Pulsed Neutron and Muon Source:

Neutron Scattering as a Tool for Unravelling Complex Biological Structures and Dynamics



Luke Clifton

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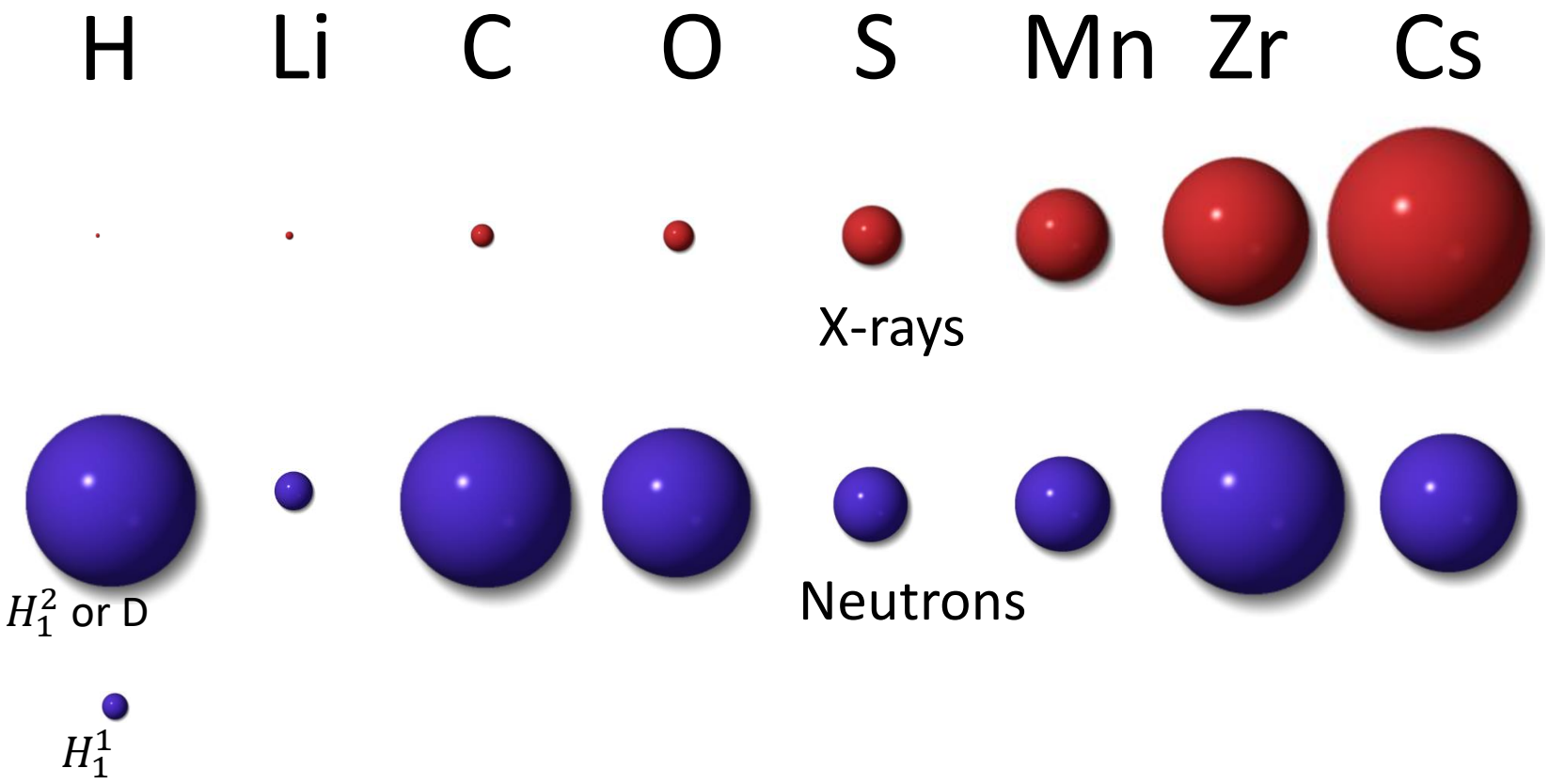
Rutherford Appleton Laboratory
Diamond
X-Rays
ISIS
Neutrons
Muons

Cold Neutrons – a tailor-made probe

- Neutron wavelength in the Ångstrom regime (ISIS TS2 NR ~1 Å - ~16 Å).
- H / D contrast
- Magnetic Moment
- Highly penetrating
- Non Destructive

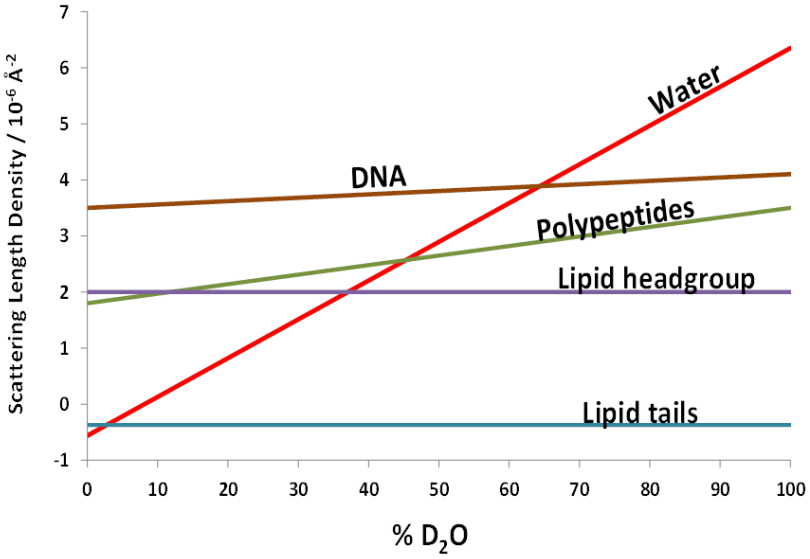
https://www.archaeology.wiki/blog/2012/11/05/neutron-imaging-and-neutron-methods-in-archaeology-and-cultural-heritage-research/

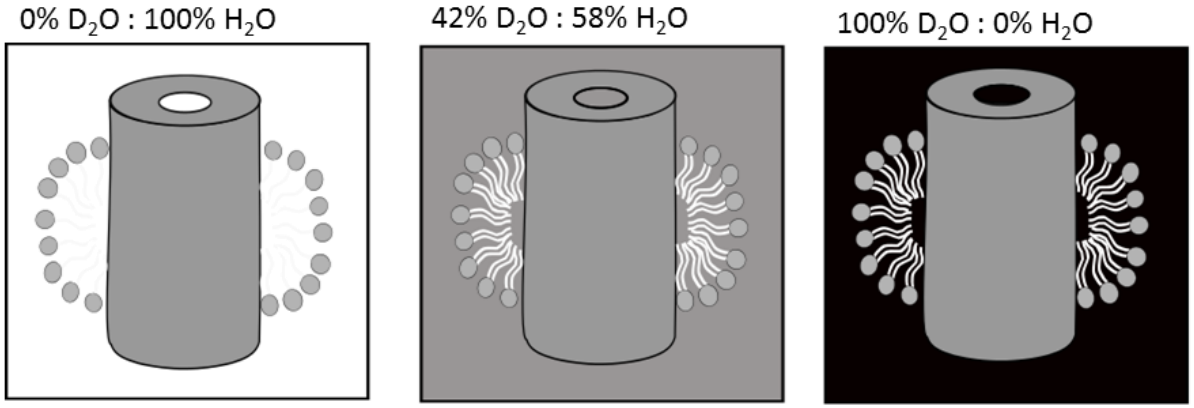
Neutrons interact with **the nucleus**
X-rays interact with **the electrons**



Isotopic Contrast Variation allows for Individual Components to be Identified amongst Complex Biological Samples

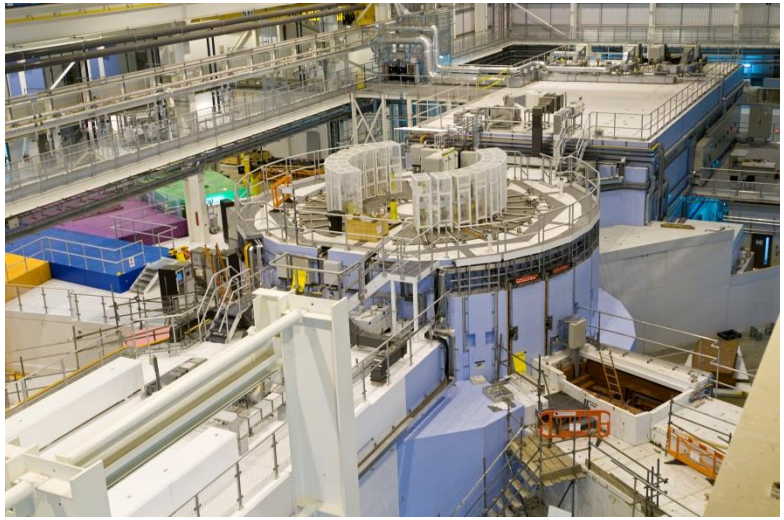
Element	Scattering Length (b)/ 10^{-5} Å
Hydrogen (99.98% protium)	-3.74
Deuterium	6.671
Carbon	6.646
Nitrogen	9.36
Oxygen	5.803
Sulphur	2.847
Phosphorus	5.13

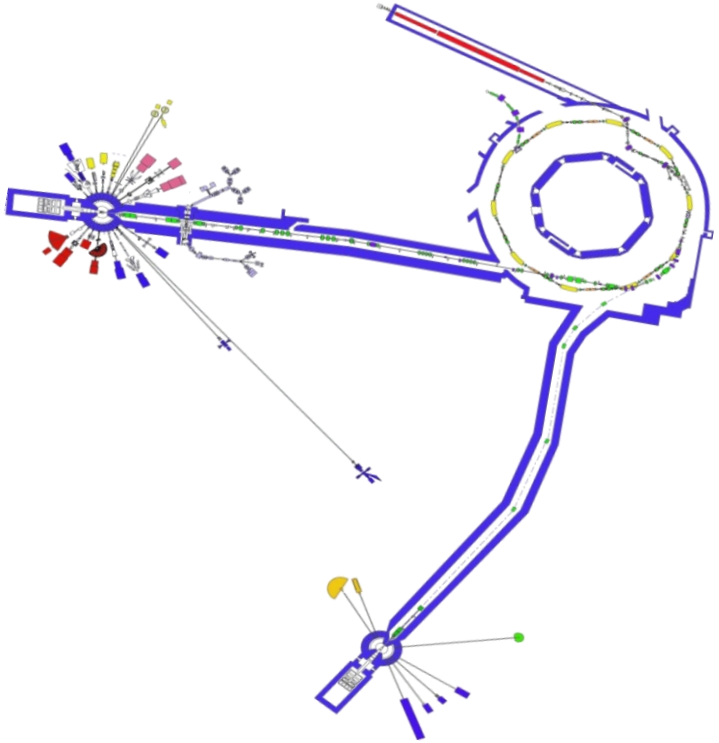


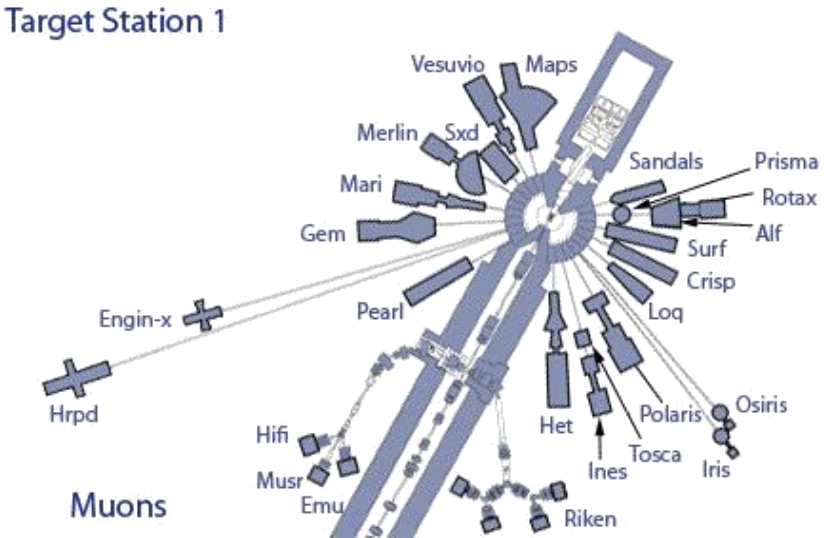


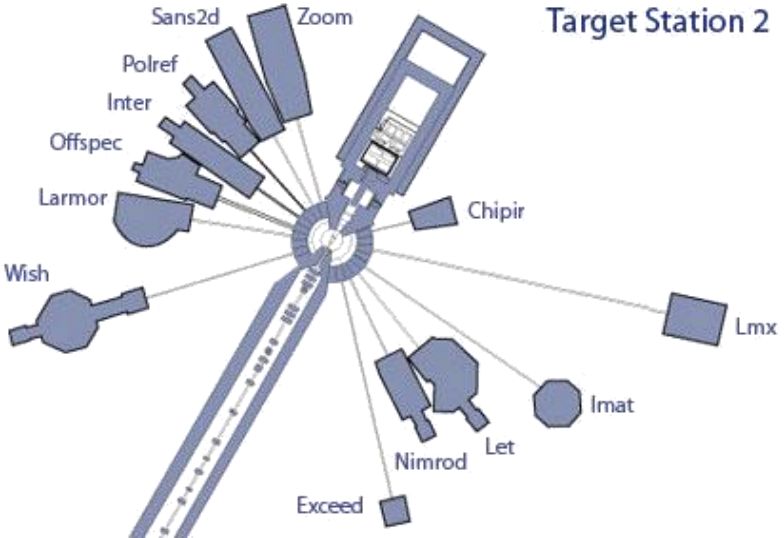
Lipid-Protein Interactions, 2019, Methods in Molecular Biology, 201-251

The ISIS Pulsed Neutron and Muon source



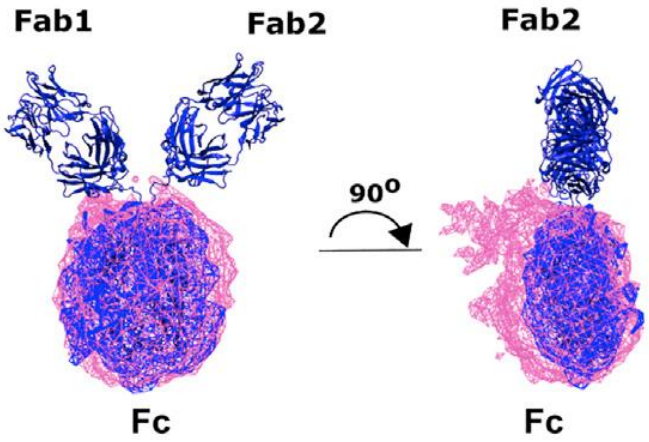






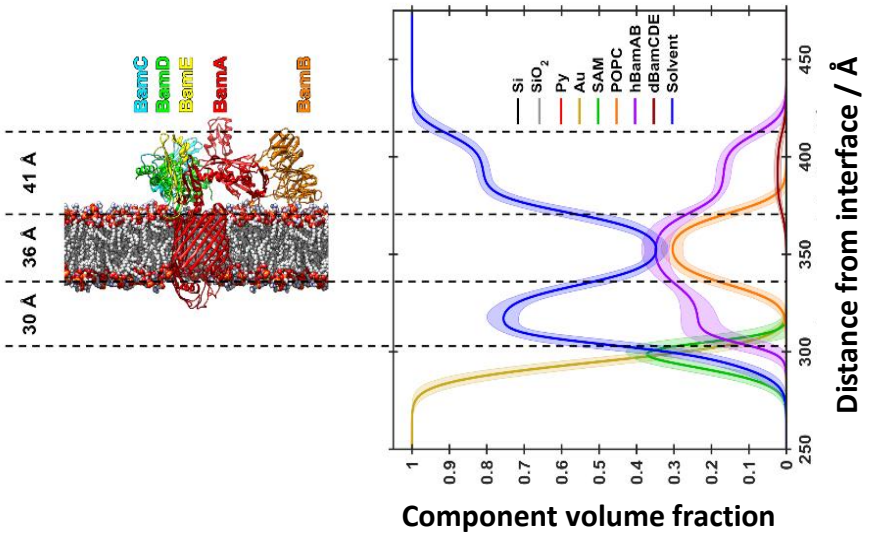
Biology at ISIS

Complex Biological Structures in Solution



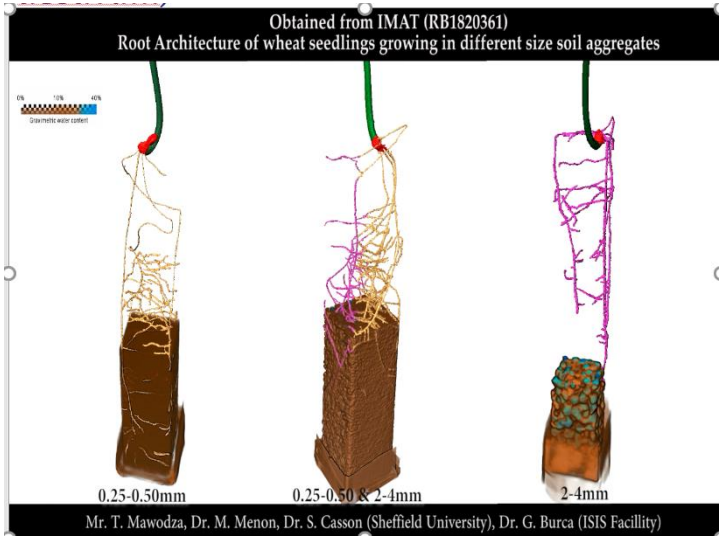
DOI: 10.1016/j.bpj.2021.02.038

Complex Biological Structures at Interfaces

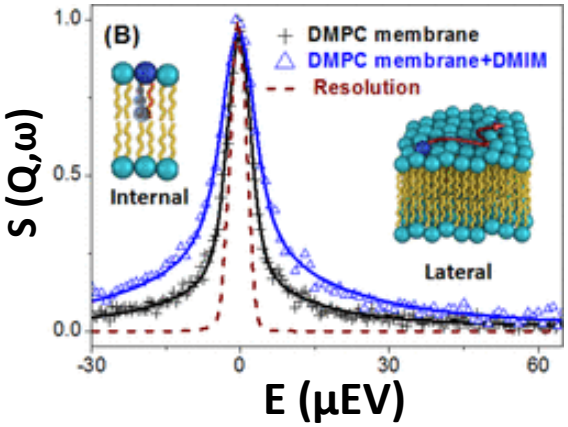


DOI:10.1016/j.bpj.2021.10.033

Buried Structures



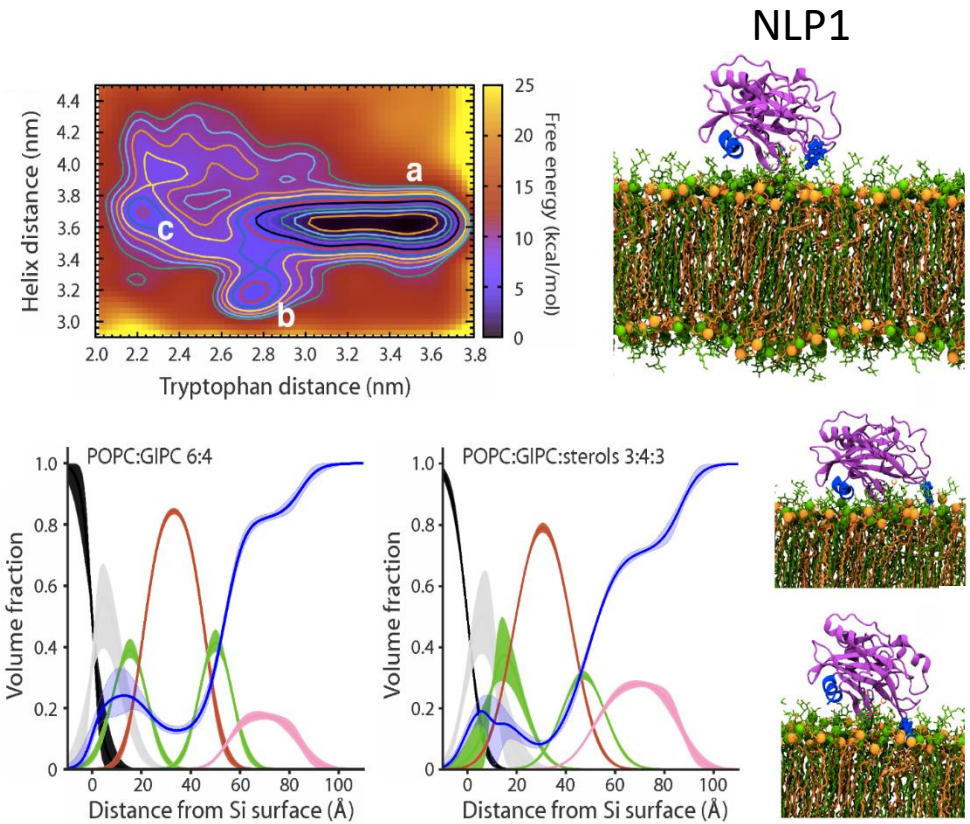
Bio-molecular Dynamics

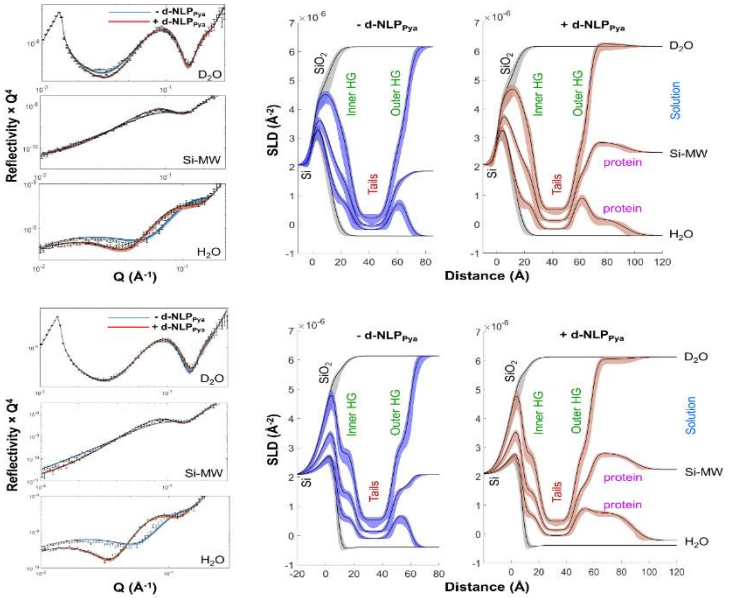


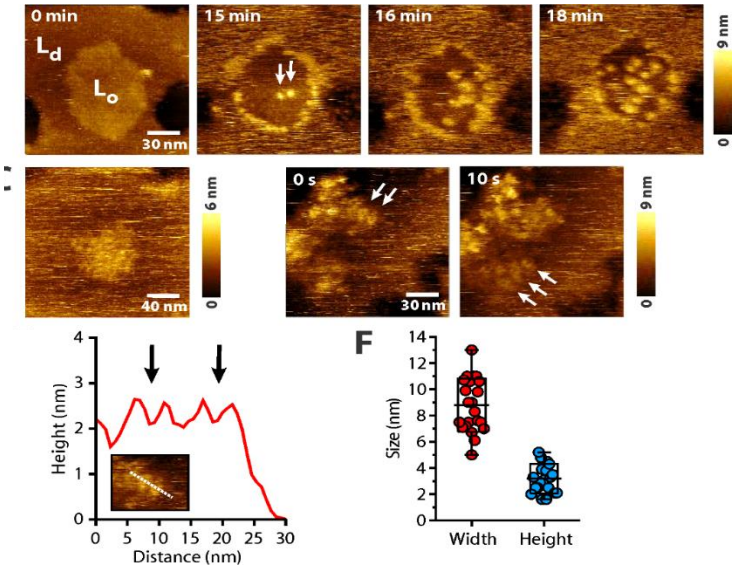
DOI:10.1021/acs.langmuir.0c02516

Understanding Crop Pathogens

PI: Gregor Anderluh, Nat. Chem. Institute, Ljubjana



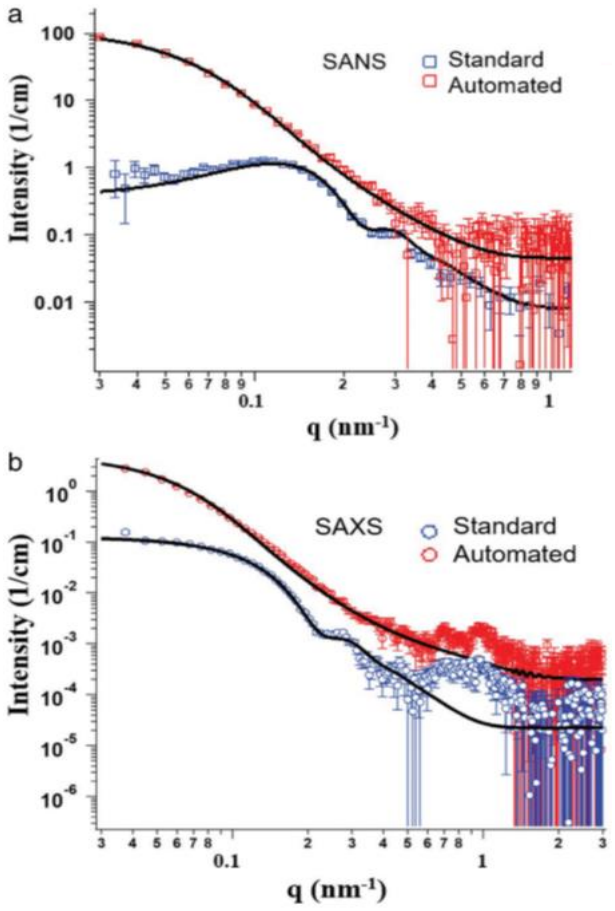


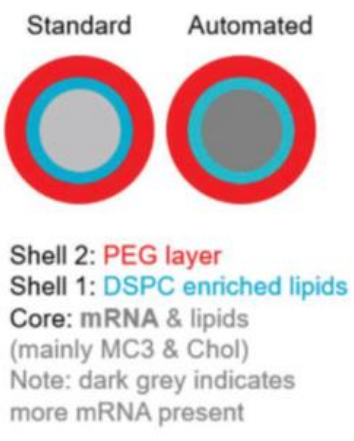


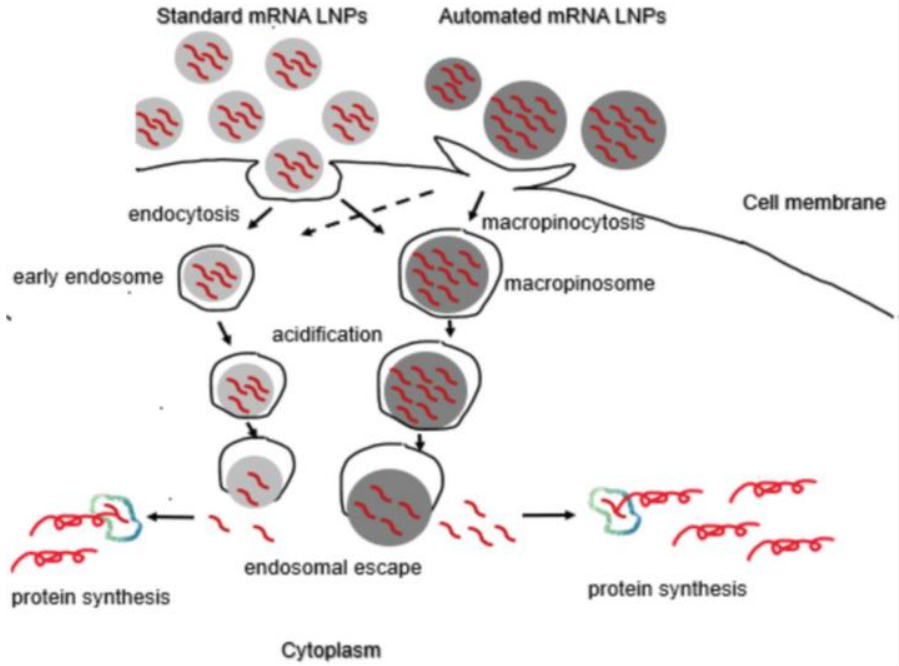
Pirc *et al*, Science advances, 2022, 8 (10), eabj9406

Lipid nanoparticle (LNP) for RNA delivery: formulation & structure challenges

Detailed structure and mRNA loading of automated versus standard (microfluidics) LNPs (AstraZeneca, Cambridge): can only be resolved by a combination of neutron and X-ray scattering and lipid deuteration.

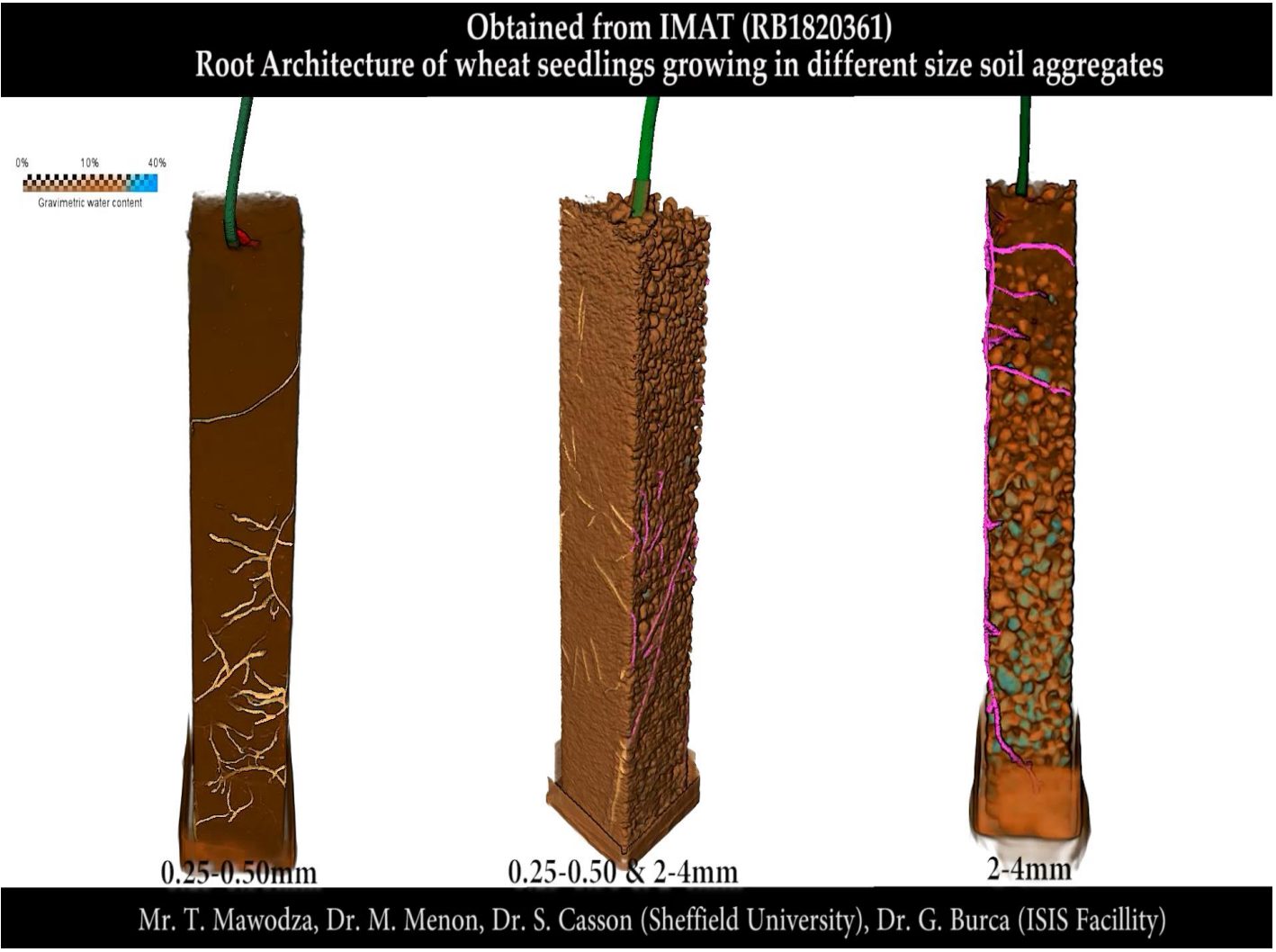




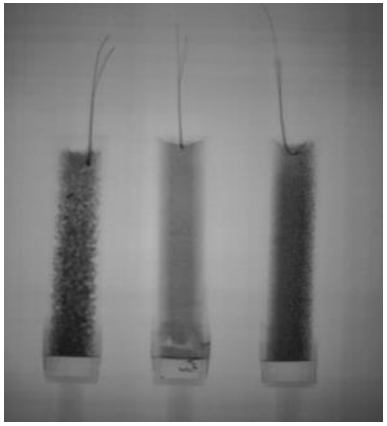


Cui *et al.*, Small, 2022, 18, 2105832

Assessing the effect of aggregate size on early root growth in wheat (*Triticum aestivum)*



- 2 contrasting soil aggregate sizes (Coarse[2-4mm] vs Fine[0.25-0.50mm])
- Wheat grown for 22 days at similar water potential
- 3D Root architectural differences analysed
- Results from Neutron imaging compared with 2D WinRhiozo ® scans



The University Of Sheffield.

Grantham Centre for Sustainable Futures

Conclusions

- Neutron scattering techniques are a powerful set of tools for examining complex biological structures and dynamics.

- Careful use of deuterium labelling of the sample/solution allows for the relative distributions of components within complexes to be resolved.

- The neutron beams are non-damaging and highly penetrating meaning processes within complex sample environments can be probed.

- If you have any systems you think would benefit from analysis by these techniques please fell free to contact us at the facility.

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Solution structures:
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Imaging:
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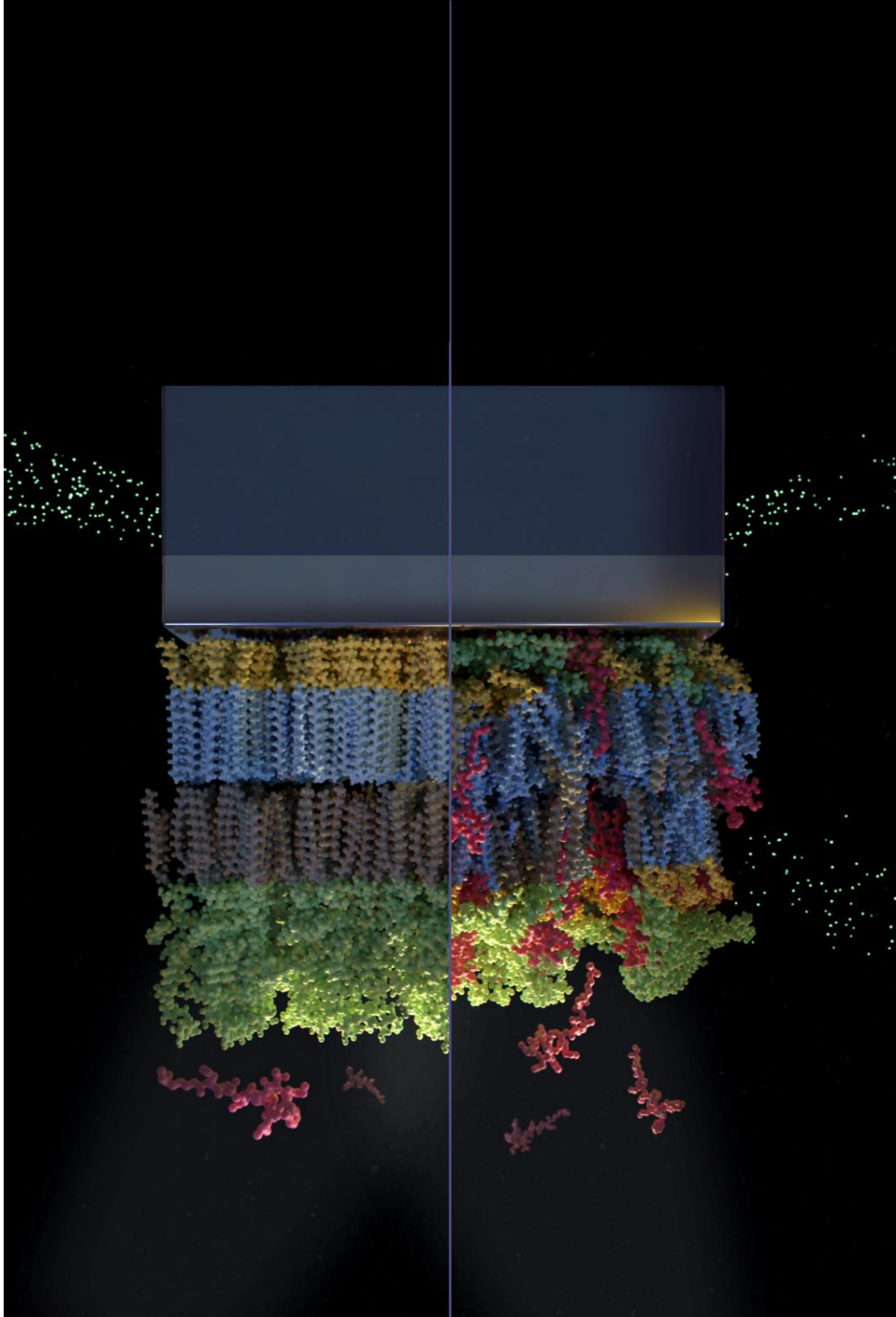

Thank you for listening