IOP Institute of Physics | RSC Advancing the Chemical Sciences

Neutron Scattering Group & Particle Accelerators and Beams Group

Science & Technology Facilities Council ISIS Neutron and Muon Source

NSG

www.iop.org/conferences

Organised by the IOP Neutron Scattering Group and Particle Accelerators & Beams Group Co-sponsored by STFC ISIS Pulsed Neutron and Muon Facility

The Future and Next Generation Capabilities of Accelerator-driven Neutron and Muon Sources

Event information

The future and next generation capabilities of accelerator driven neutron and muon sources is a one day event aimed at bringing two important aspects of neutron and muon facilities together – Accelerators and Users. This will highlight future possibilities for upgrades at the STFC Rutherford Appleton Laboratory and Showcase current and future opportunities in neutron and muon science. The aim is to generate user support to build the science case for the next iteration of neutron and muon facilities.

Speakers:

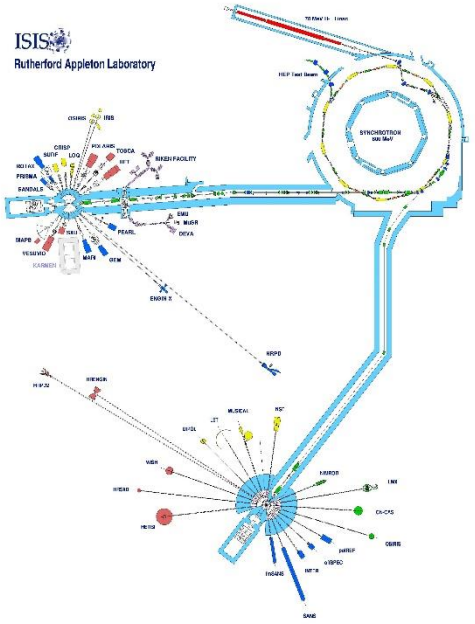
Jeff Penfold, David Barlow, Rob Dalgliesh, Sarah Youngs, Lucy Clark, Steve Hull, Zoë Bowden, Ciprian Plostinar, Mike Plum, Philip King, Alain Menelle, John Thomason

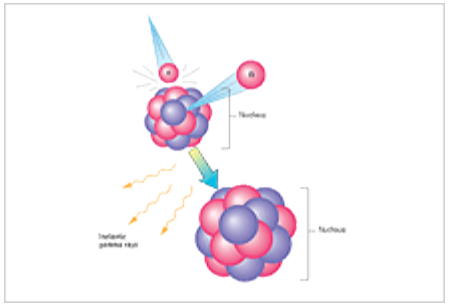
14th August 2018

STFC Rutherford Appleton Laboratory, Chilton, Didcot OX11 0QZ

Future Science at ISIS

Jeff Penfold

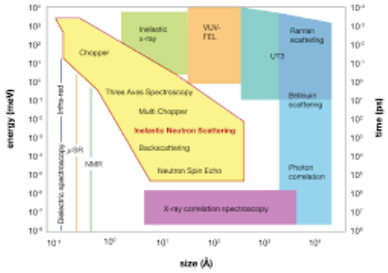


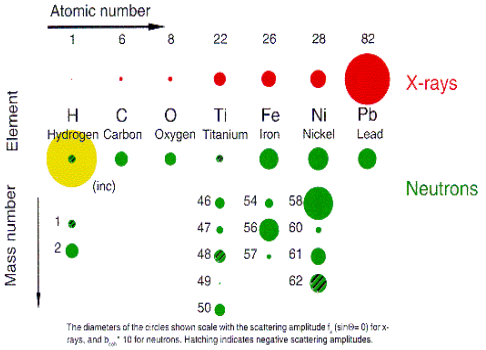


- **Focus on advantages of neutron scattering**
- **Exploit features of pulsed sources**
- **Recognise importance of complementarity**

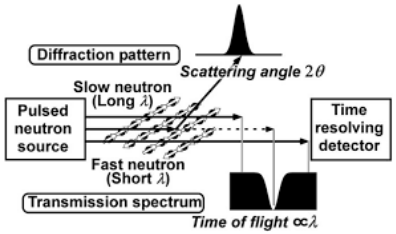
Neutron Scattering

- **Isotopic labelling / substitution (D/H and others)**
- **Nuclear interaction: not dependent upon atomic number**
- **Spin: magnetic interaction**
- **Momentum and energy transfer range: structure and dynamics of condensed matter**
- **Penetration**
- **Non-destructive**

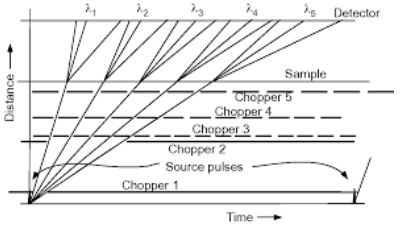




Pulsed Neutron Sources / Novel Instrumentation



- **White beam TOF: broad bandwidth**
- **Broad spectral range**
- **Time structure**



ISIS Second Target Station

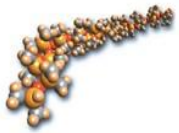
Science Case

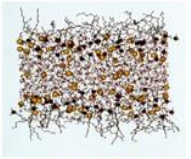
To exploit a new generation of neutron production target and Instrumentation

Through more efficient generation of cold neutrons, broad bandwidth and high resolution (low power, low rep rate, and efficient target –moderator assembly) .

Providing unique and unrivalled potential for structural and dynamical studies using cold neutron and high resolution spectroscopy

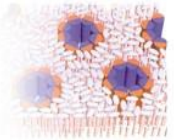
To focus on interdisciplinary studies in Soft Condensed Matter, Bio-molecular Sciences and Advanced Materials





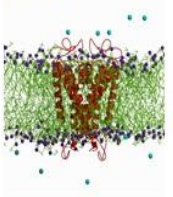
Soft Condensed Matter

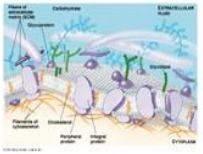
Surfaces, interfaces and bulk properties of complex fluids (polymers, surfactants, colloids)



Bio-molecular Sciences

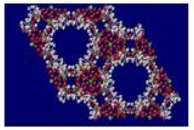
Pharmaceuticals, drug delivery, membrane-protein interactions, biocompatibility, biofunctionality, food technology





Advanced Materials

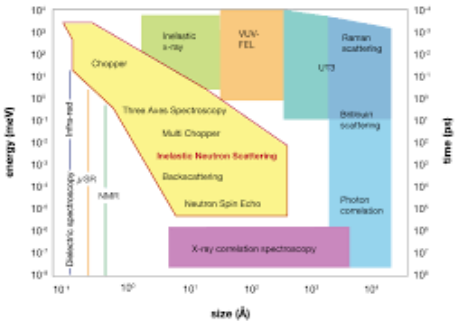
Crystalline, magnetic, disordered, engineering materials, Complex organic/inorganic assemblies, clathrates, intercalates, zeolites, nano-structured materials, high temperature superconductors, GMR, spin valves, magnetic thin films and Multilayers, glasses, complex fluids, porous media



Close alignment with Technology Foresight programme

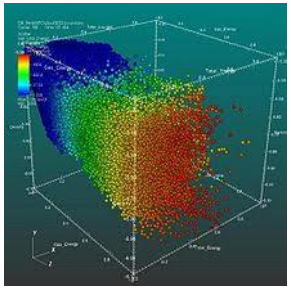
Some broad directions

- *Broader scattering approach: extending further length and time scales*
- *Greater use of complementary techniques (in-situ)*
- *Combining atomistic with nanoscale /mesoscale*
- *Greater combined intrinsic use of statics / dynamics*
- *Complexity*
- *Impact*



Data analysis / visualisation

New approach needed
Incorporation of modelling
Improved visualisation
Multiple data sets



Impact

Greater alignment / involvement with Industry
Establish strategic long term relationships
Bottom-up
Build on ICRD

Some contemporary issues

- Antibiotics

- Energy / batteries

- OLED's, photovoltaics

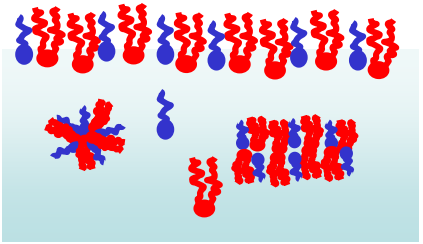
- Plastic waste / recycling
- Climate change
- Environmental impact

- Plant Science

Sustainability Approach: P and G; Sustainable Living Programme: Unilever

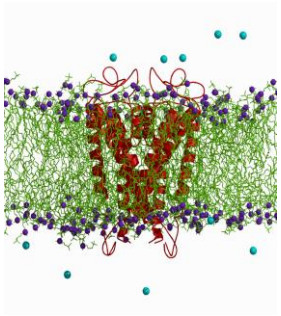
- *Biosustaintable / biodegradable products*
- *Reduced water usage (in manufacture and use)*
- *Energy reduction: efficient processing, operating at lower temps*
- *Reduced payloads: efficient products, concentrated formulations*

On-going from TS-2 Science Case



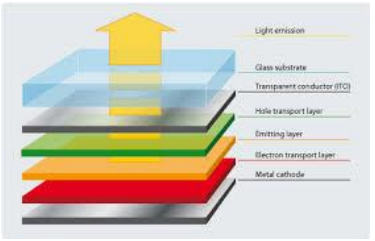
Soft Matter

Multi-component systems at technologically relevant interfaces
Processing soft solids



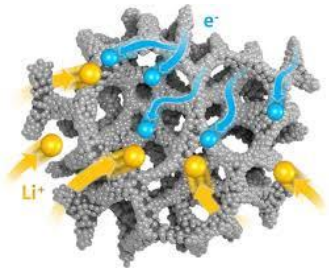
Biomolecular systems

Membranes: towards realistic models
Pharmaceuticals
Food technology

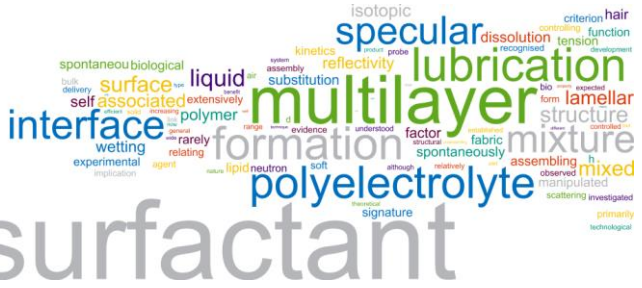


Advanced Materials

Composites / complex materials, Engineering materials,
nano-structured materials, Novel processing routes,
Magnetic thin films and thin film devices

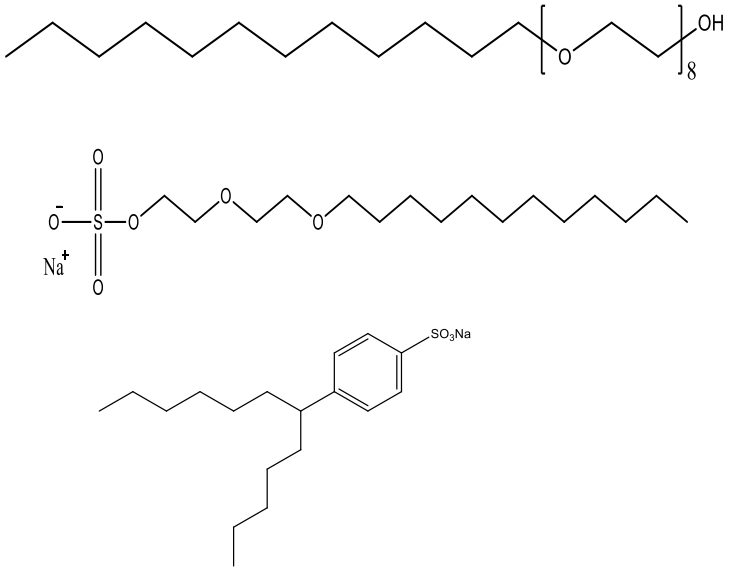


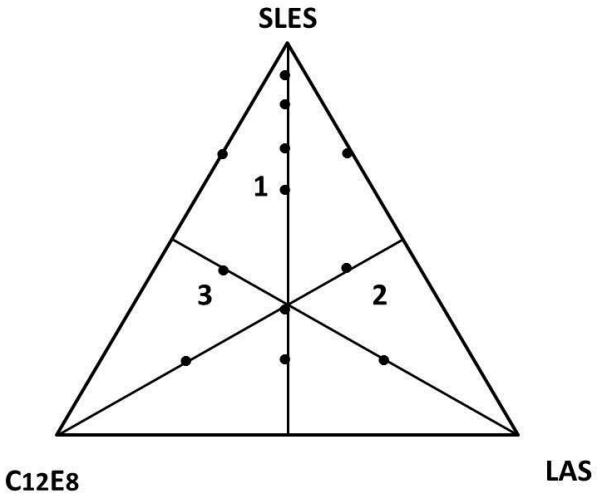
Example of Complexity



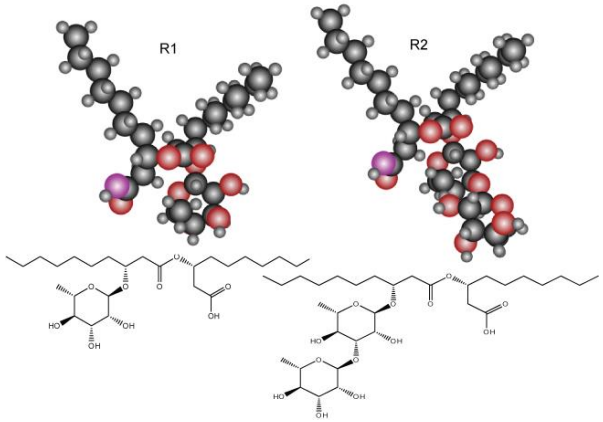
Adsorption of multi-component surfactant mixtures at the air-water interface

(1) Ternary mixture $C_{12}E_8$ / LAS / SLES

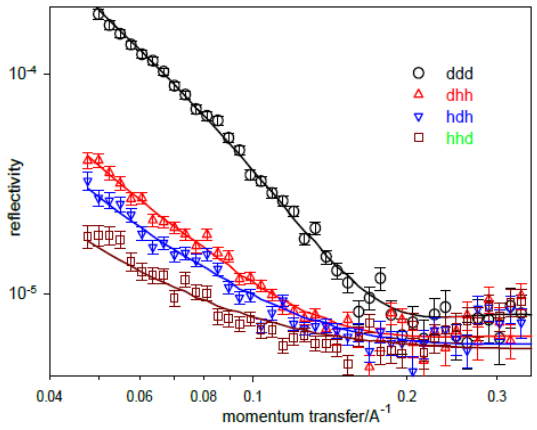


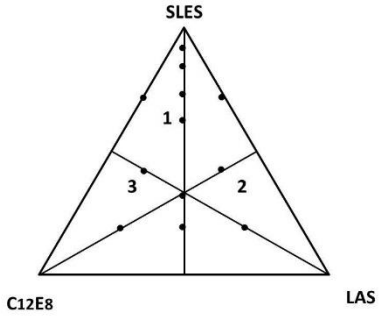


(2) Quinary Mixture R1/R2 / C12E8/LAS/SLES

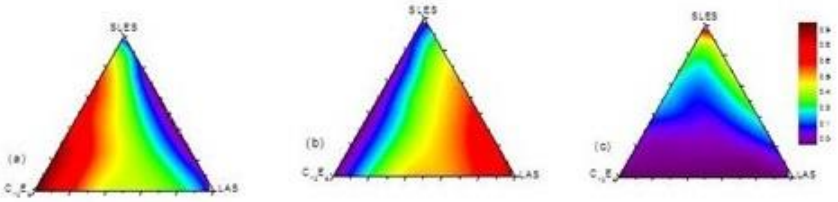


(1) Ternary mixture $C_{12}E_8$ / LAS / SLES

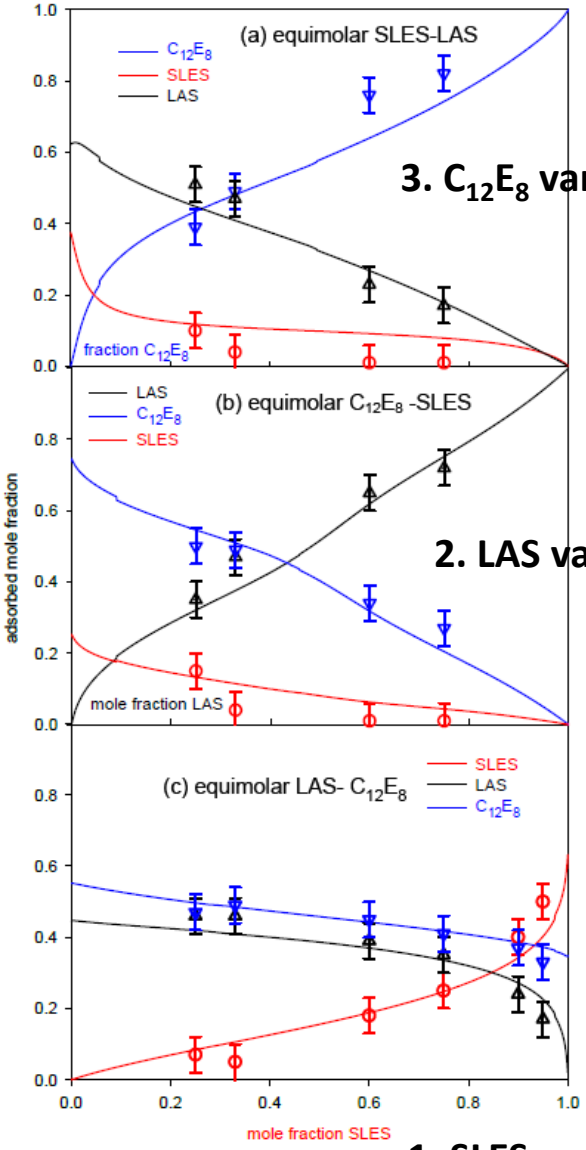




2 mM 0.125/0.125/0.75
$C_{12}E_8$ / LAS / SLES



$$G_e = x_1 x_2 \beta_{12} + x_1 x_2 (x_1 - x_2) C_{12}$$

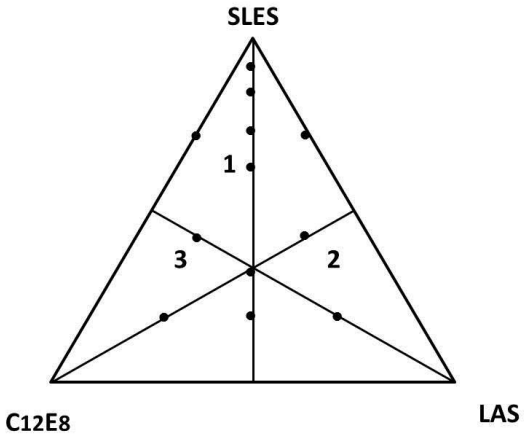


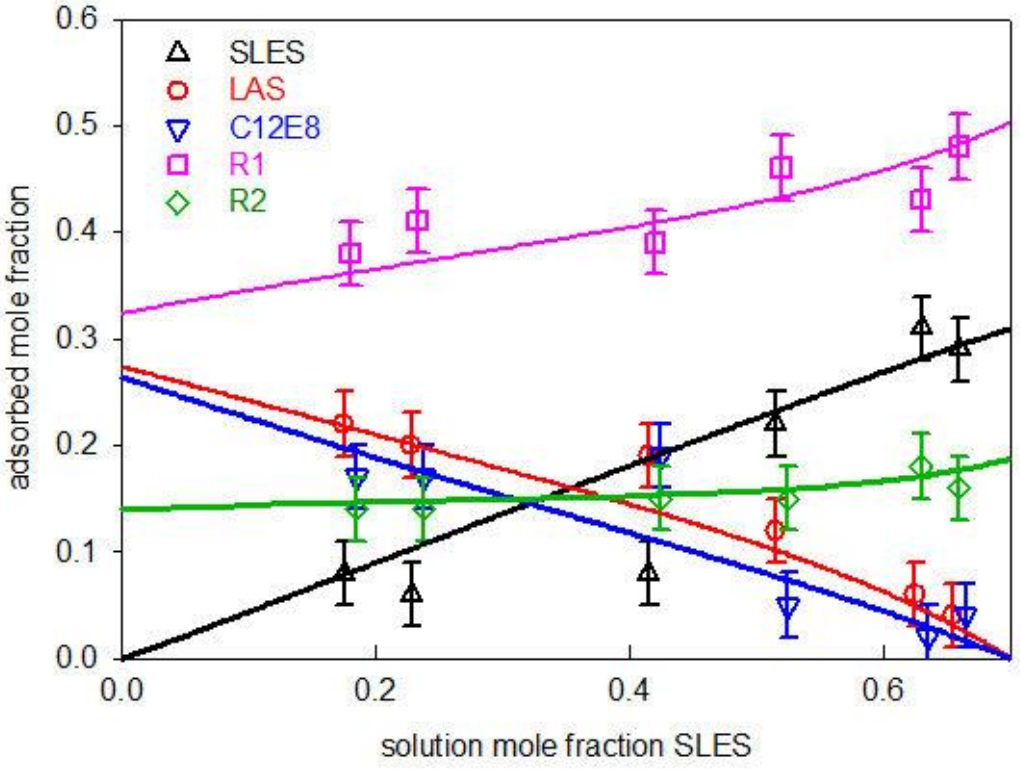
3. $C_{12}E_8$ varying

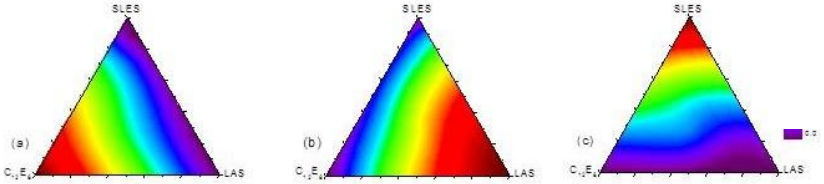
2. LAS varying

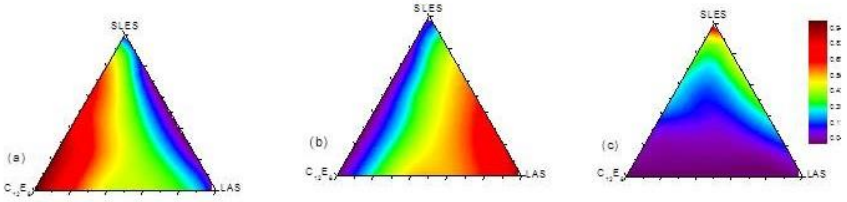
1. SLES varying

(2) Quinary Mixture R1/R2 / C12E8/LAS/SLES









Variation with SLES composition for
1:1 R1:R2 30 mol% (R1+R2)/
70 mole% ($C_{12}E_8$+LAS+SLES)

Research Councils (RCUK) Grand Challenges

Research and Innovation

Cutting edge research, inter-disciplinary, global partnerships

Sustainable Development

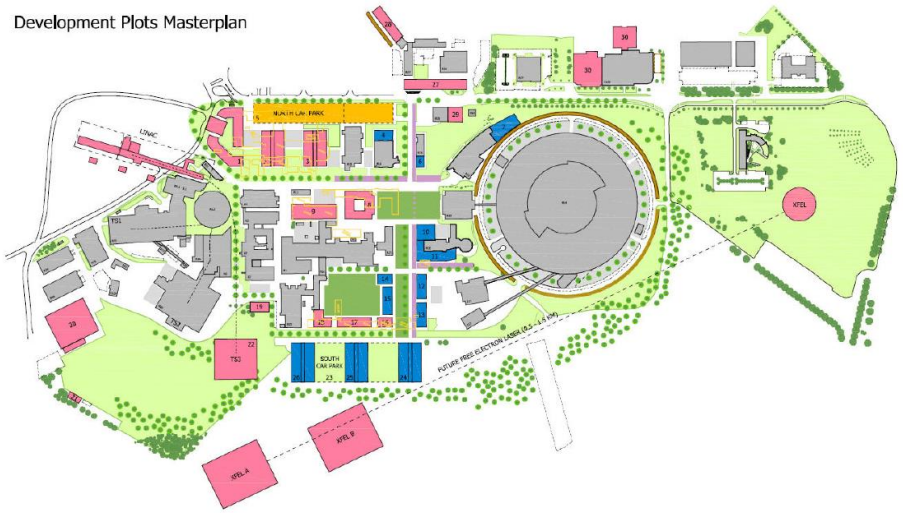
- **Secure resilient food supply**
- **Sustainable health and well being**
- **Clean air, water, santitation**
- **Affordable reliable sustainable energy**

Sustainable Economy

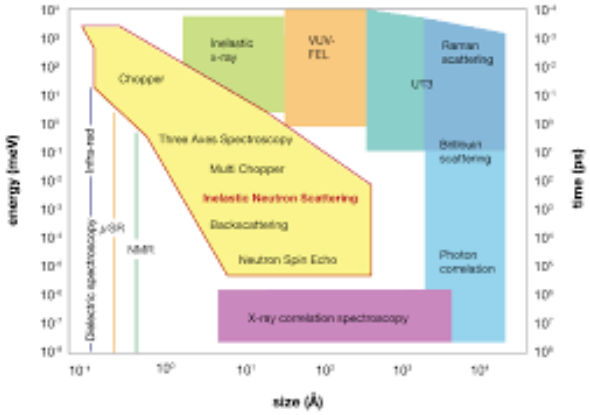
- **Consumption, production**
- **Environment**

- ***Cancer research, global health initiative***
- ***Industrial biotechnology, bioenergy***
- ***Digital economy: quantum computing***
- ***Energy supply***
- ***Antimicrobial resistance***
- ***Carbon capture***
- ***Security***
- ***Environmental change***
- ***Technology touching life: novel techniques and technologies***

Source / Instrumentation



- *High useable flux at sample*
- *Broad spectral range (source frequency, pulse structure)*
- *High resolution*
- *Novel instrumentation*
- *Accessible / ease of use*
- *Complementary techniques*
- *Advance sample environment / specialist sample preparation*



Summary

- *Due to advances in sources and instrumentation, opportunities to exploit neutron scattering have never been better*
- *Many contemporary issues need the greater in depth understanding that comes from neutron scattering in order to progress*
- *Greater need for advanced analytical tools*
- *In combination with other techniques neutron scattering can make a central contribution*