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SAGA

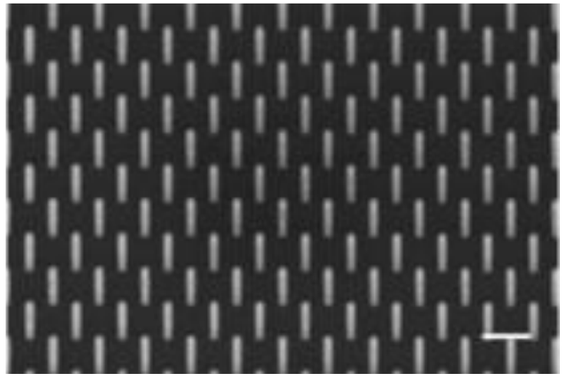
A Swedish initiative for a GISANS instrument at the ESS

SAGA (Surface Analysis using Grazing Angle neutron scattering)

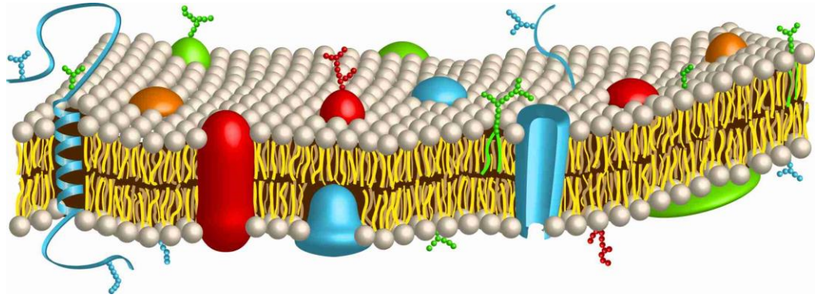
Max Wolff, Uppsala University: max.wolff@physics.uu.se
Tommy, Nylander, Lund University: tommy.nylander@chem.lu.se

Background

- Modern material science and technology today and even more so in the future rest on understanding interfacial behavior and structure.



- In life sciences and medicine, many, if not most, of the processes that control life, such as cell functions, occur at an interface.



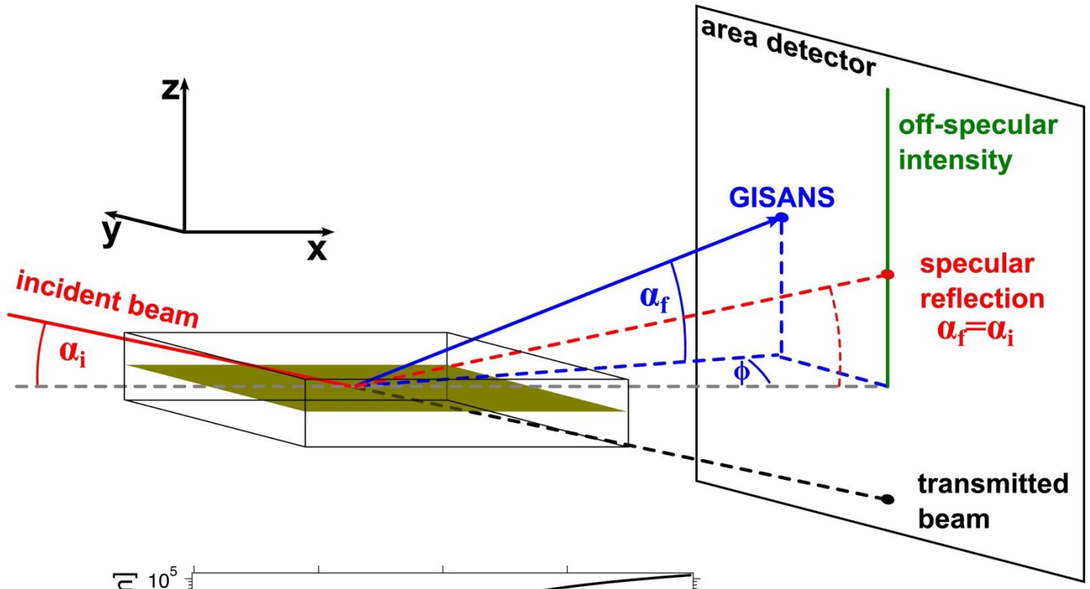
- Sweden has an internationally recognised competence in surface, colloid and interface sciences, new materials and biophysics studies.

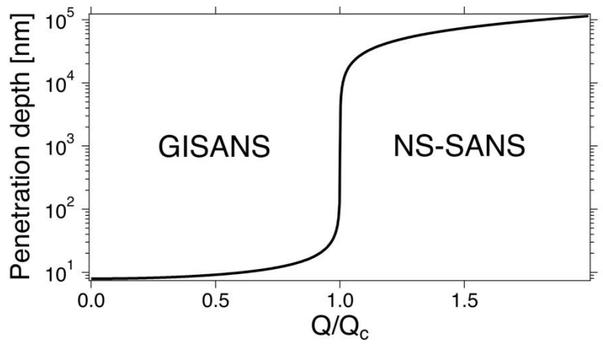
Super ADAM-the CRG Reflectometer at ILL

The only Swedish operated Neutron Instrument that is in operation today:

- A versatile angle dispersive high-resolution reflectometer with capability of polarisation analysis.
- Financed by the Swedish Research Council
- 50% of beamtime dedicated to Swedish users
- Applications from magnetic materials, thin films, material science to soft matter and life science
- Pioneering Magnetic Reference layer technology
- Development of off-specular reflectometry and near surface scattering techniques
- Testbench and pool of competence for SAGA

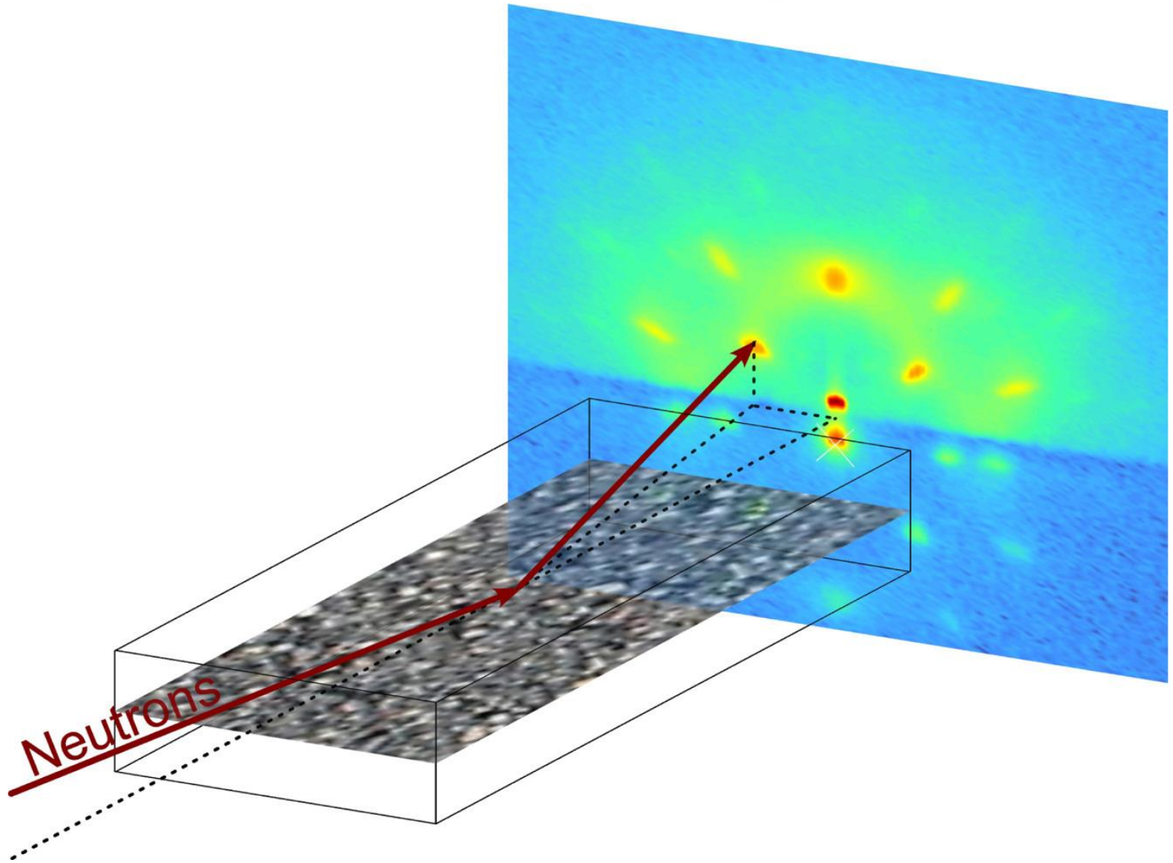
What is GISANS (Grazing Incidence Small Angle Neutron Scattering)?





- GISANS, has a unique ability to reveal the structure of (hidden) surfaces in complex multi-component nanostructures.
- Neutron are sensitive to nuclear isotopes and magnetic structures - complementary surface probe to synchrotron X-ray studies (GISAXS/GIWAXS).
- Reflectivity reveals the depth profile of interfaces.

What is GISANS good for?

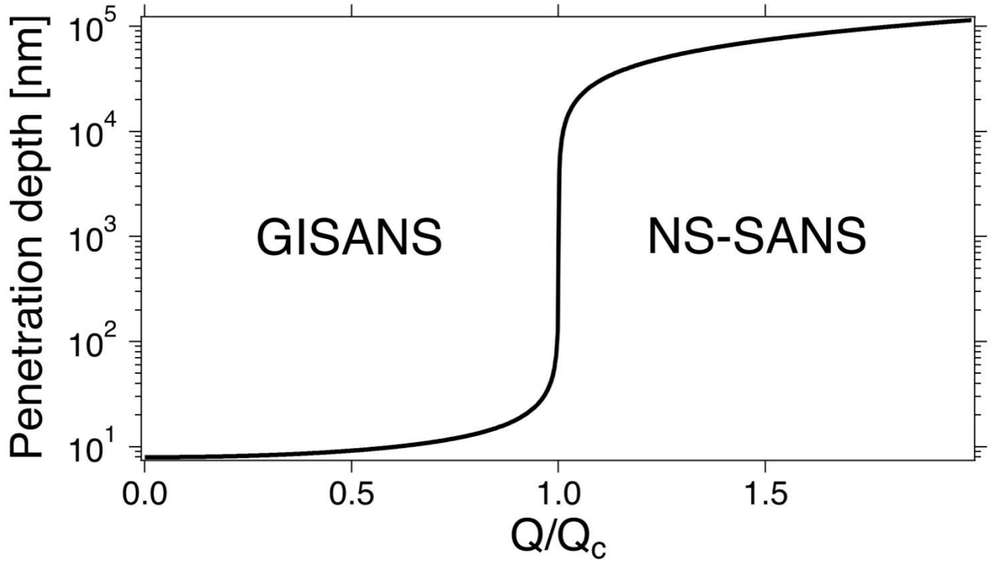


Sebastian Köhler, et al.: Recent progress in grazing incidence small-angle neutron scattering,
Advances in Colloid and Interface Science, 349, (2026) 103757, doi.org/10.1016/j.cis.2025.103757.

Examples of area of research where GISANS has been applied:

- Polymer films
- Energy materials
- Coatings
- Surfactant self-assembly layers
- Biomembranes and lipid self-assembly
- Magnetic materials

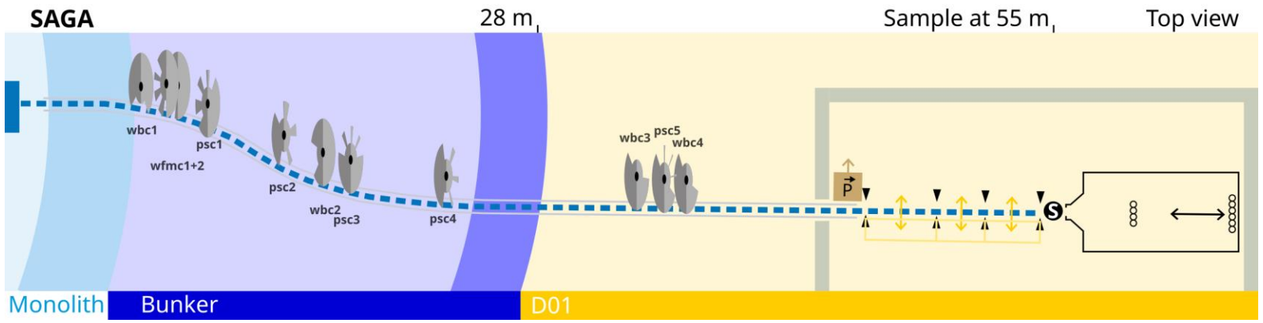
What are the needs for a good GISANS instrument



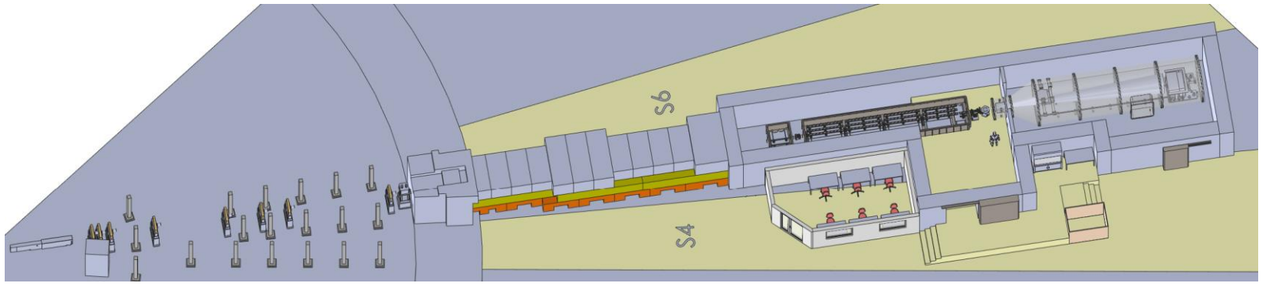
Low attenuation of neutron beams results in the need of high resolution for depth sensitivity

- Liquid interfaces can only be studied with horizontal sample geometry
- Data analysis with the distorted wave Born approximation foots on density profiles extracted from reflectivity
- Polarisation in analysis allows the study of quantum materials
- High resolution with respect to incident momentum
- Flexible sample environment

The Proposed SAGA GISANS Instrument for ESS



Topview



Engineering layout

- GISANS technique has so far suffered from fitting into existing SANS and Reflectometry instruments with a corresponding reduction in data quality and sample set-up.
- SAGA will maximise the potential of the ESS source to move the GISANS technique from the fringe to a mainstream instrument type.
- The potential for technology development together with HIBEAM includes:
  - Low scattering mirrors
  - Precision slits with low parasite scattering
  - Additive manufacturing of optical devices and sample environment components

The key features of SAGA:

- A 65m instrument to achieve a natural wavelength resolution of ~2-4%
- An optional wavelength frame multiplication (WFM) mode for 1% wavelength resolution for cases requiring good depth sensitivity.
- A natural downturn of 0.5° (around the critical angle for an air/D2O or air/silicon interface), for horizontal surfaces without additional optical elements for highest flux.
- Flexible collimation and detector distances of up to 10m to ensure the optimum balance between resolution and accessible Q-range
- Flexible collimation section with different optical components: supermirror for incident angle variation, k-focussing to optimise resolution and flux
- Space for polariser, analyser and a non-magnetic sample area.
- For reflectivity the narrow wavelength band makes measuring at 5-6 angles necessary to complete a reflectivity curve up to 0.3˚A^{-1}