Spin-echo Resolved Grazing Incidence Scattering

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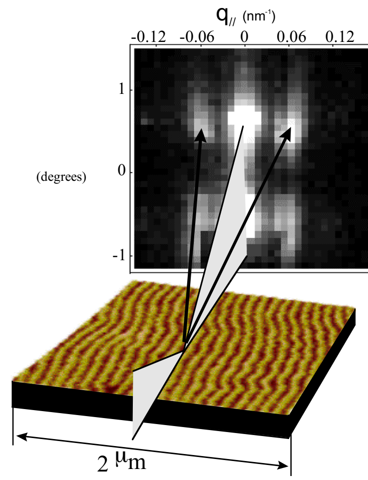
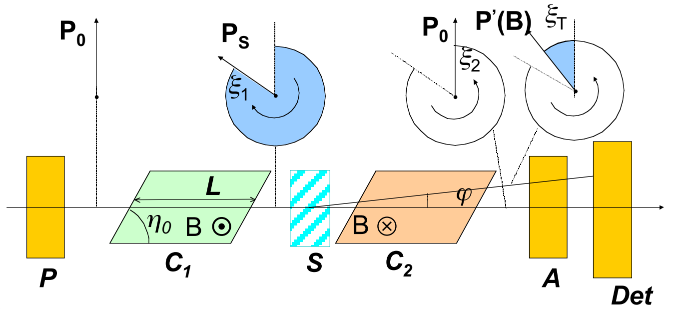
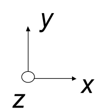
How it works?

SERGIS encodes by spin-echo the scattering of neutrons from a rough or corrugated surface on which they impinge at grazing incidence. This permits measurements with high resolution without collimation of the incident or scattered beam.
This method of analysis is unique to neutrons.

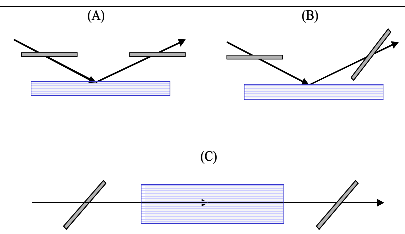


How spin-echo encodes the scattering angle φ (after M.Th. Rekveldt)



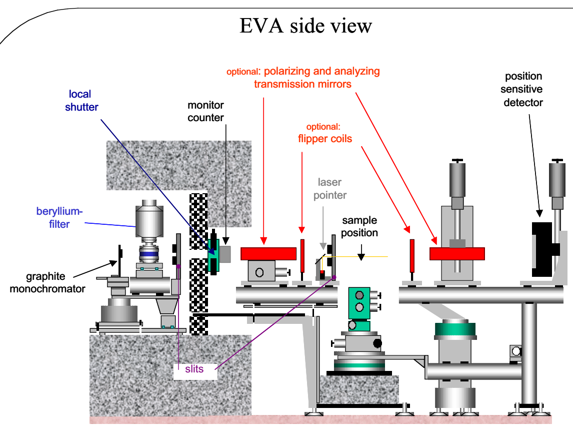


$$\xi_T = \xi_1 - \xi_2 = 2\pi\,[\gamma_n BL/v]\,\varphi \text{ ctan } \eta_0 = \delta\, q_y$$



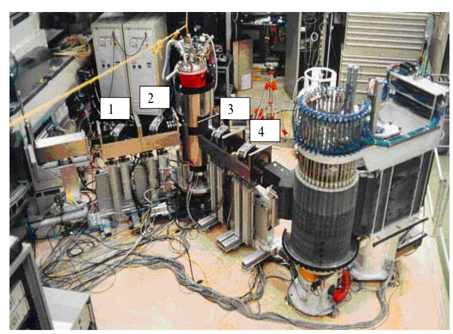
Alternative configurations of the precession field regions in SERGIS experiments. The blue shaded boxes represent reflecting samples, the arrows denote neutron trajectories and the gray shaded boxes are the spin precession regions. q_z is measured perpendicular to the reflecting sample, q_x is in the reflecting plane parallel to the sample and q_y is out of the reflecting plane.

(A) Geometry for obtaining good resolution in the q_x and for separating specular and diffuse scattering.
(B) Geometry for obtaining good resolution in the q_z direction.
(C) Geometry for obtaining good q_y resolution and probing lateral structure in thin films.



The EVA reflectometer at the Institut-Laue Langevin, in Grenoble, is being modified into a SERGIS instrument. Neutron resonance spin-echo coils are inserted between the polarizing mirror and the sample and between the sample and the analyzing mirror, after stretching the relative flight paths.

The FLEX spectrometer at HMI., showing the neutron resonance spin echo coils duplicated for insertion in EVA. Exposed are the rf coils (two before and two after the sample as indicated by numbers 1 through 4). The coils are tilted to the neutron path to encode the scattering angle.



We are experimenting with substituting the neutron resonance spin echo coils with thin magnetic films set up at an angle with the neutron beam. The number of spin precessions of the neutrons traversing the films depends sensitively on the angle of the neutron trajectory. This development might be incorporated in a design for SNS.

What can be learned with SERGIS?

Examples of the science enabled by SERGIS
- the working of artificial bio-membranes
- structure of de-wetted polymers and adhesive polymers
- lateral correlation of block copolymers
- structure of liquid crystals

Roadmap for the future

2003: Construction of a SERGIS line at ILL (spin echo on a single wavelength beam)
2004: Demonstration of the scientific opportunities of SERGIS
2005: Design of a SERGIS line at a pulsed beam

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