

Advanced Topics in SANS

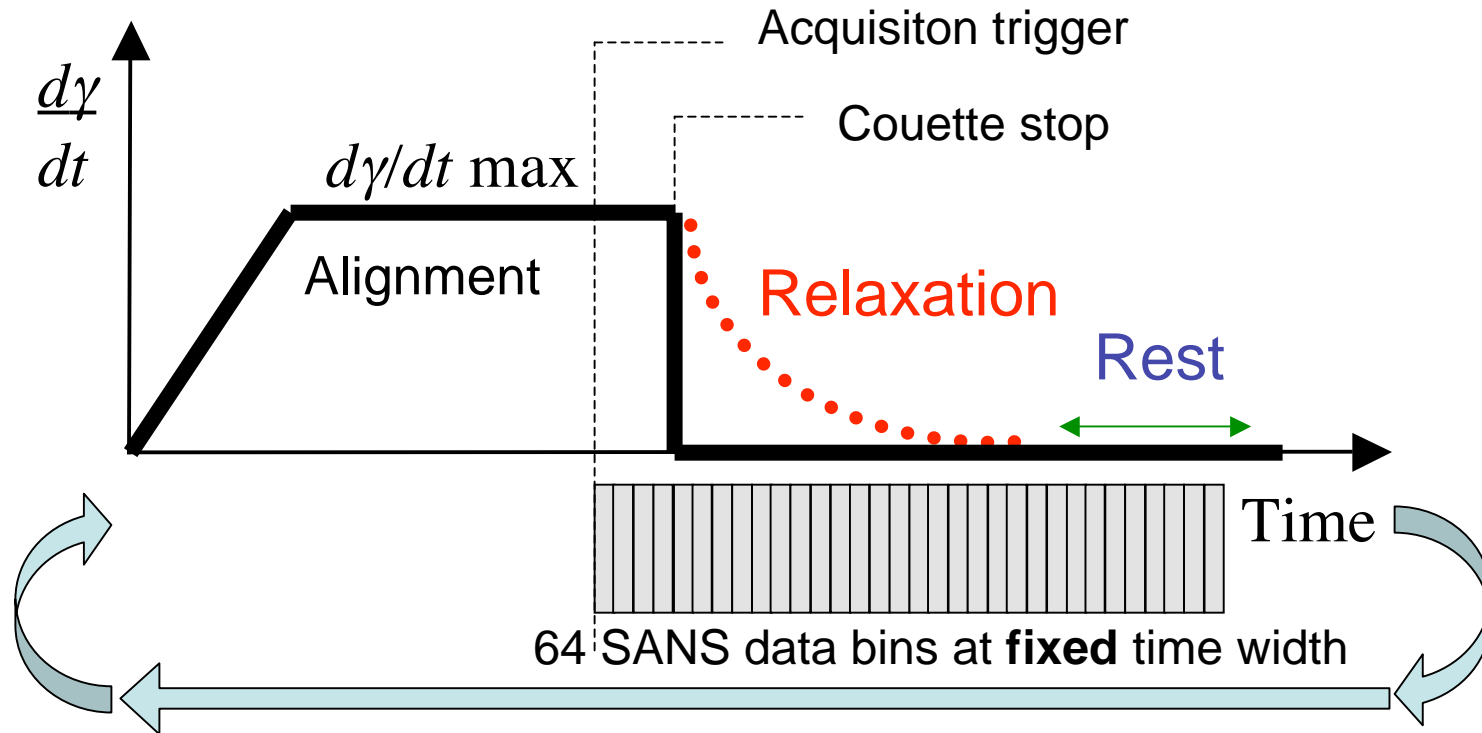
Andrew Jackson

29 June 2006

Time resolved SANS

- What time scale? - If kinetics are on the minute scale and scattering is strong - can do.
- If time scale is shorter or scattering is weak - time slicing required

Second to sub-second kinetics

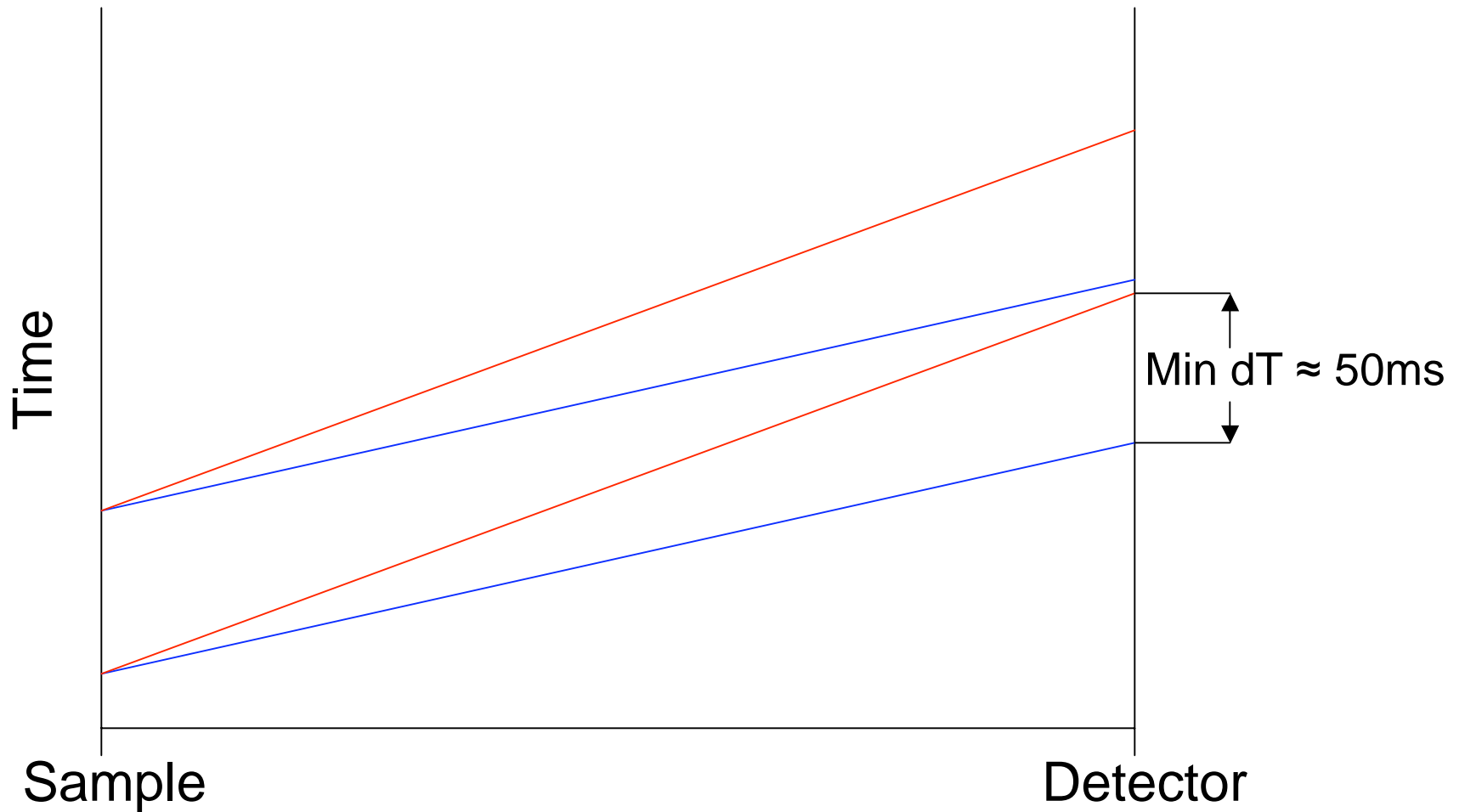


Relies on reversibility of response to stimulus
Limited by wavelength band due to range of time of flight

"Relaxation of a shear-induced lamellar phase measured with time resolved small angle neutron scattering",
L. Porcar, W.A. Hamilton, P.D. Butler and G.G. Warr, *Physica B: Condens. Matter.* 350 E963 (2004).

"Fast Relaxation of a Hexagonal Poiseuille Shear-induced Near-Surface Phase in a Threadlike Micellar Solution",
W.A. Hamilton, P.D. Butler, L.J. Magid, Z. Han and T.M. Slaweki, *Physical Review E (Rapid Communications)* **60**, 1146 (1999)

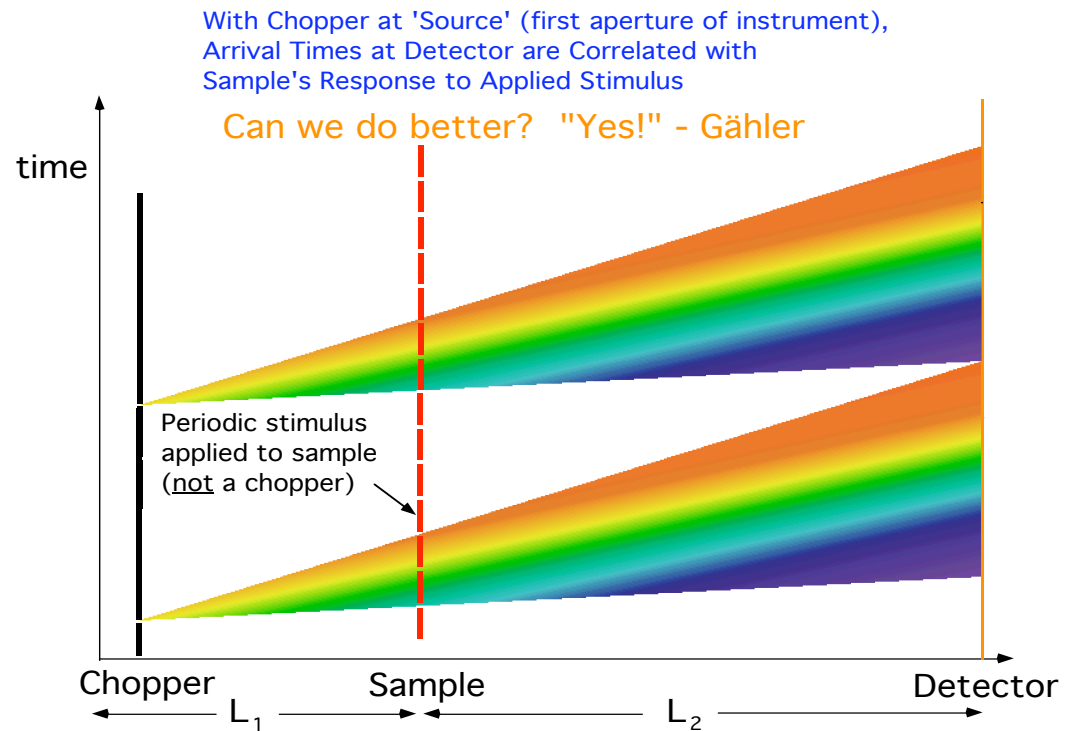
Minimum timescale limited by wavelength band due to range of time of flight



Sub-millisecond timescales?

TISANE (R Gähler, ILL)

- Chopper at source
- Sample stimulus rate and chopper synchronized
- Neutrons that arrive at the same time were scattered at the same time in the sample response curve
- Can get $50\mu\text{s}$ - 100ms time resolution.



Will be installed on a SANS beamline at NCNR

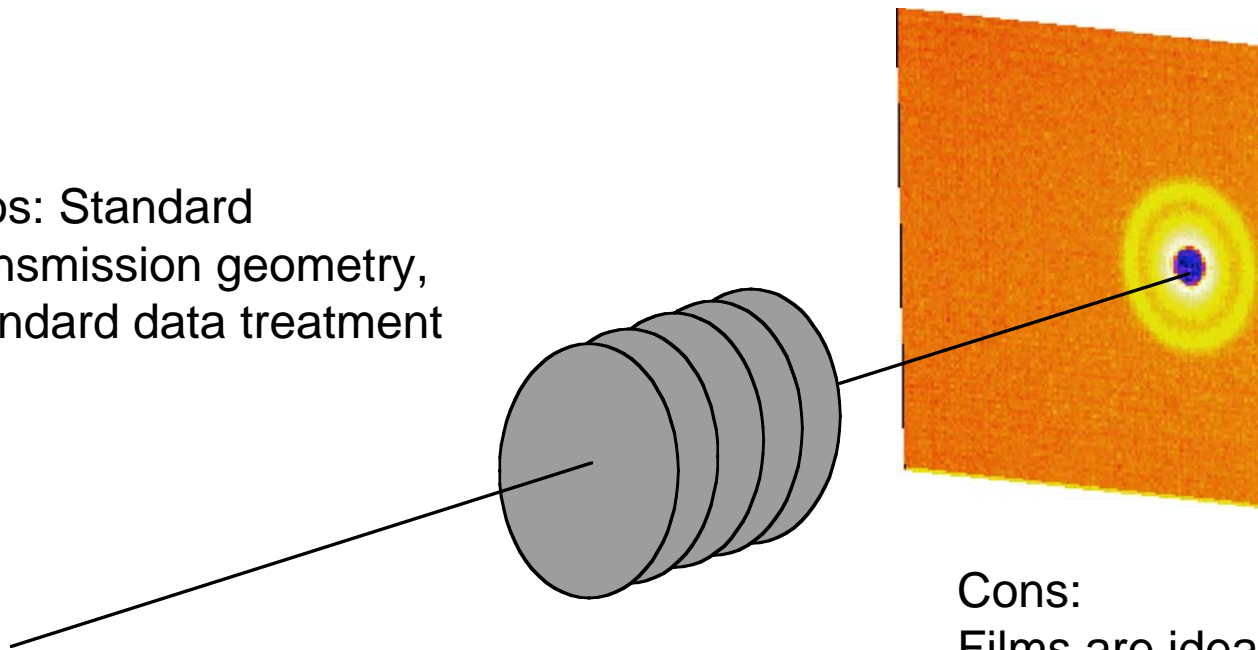
In Plane Structure at Surfaces

- SANS provides information about bulk structure in-plane (to several mm depth)
- Reflectometry provides information about structure perpendicular to interface (to a few hundred nm depth)

Can we get information about in-plane structure close to surfaces?

Stack of wafers coated with thin film...

Pros: Standard transmission geometry, standard data treatment



Cons:
Films are ideally several microns - not really looking at near surface region

May need many wafers - background from substrate

GISANS

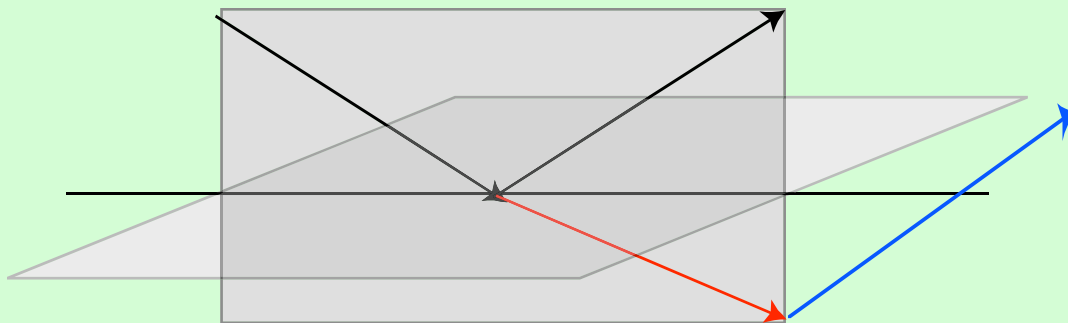
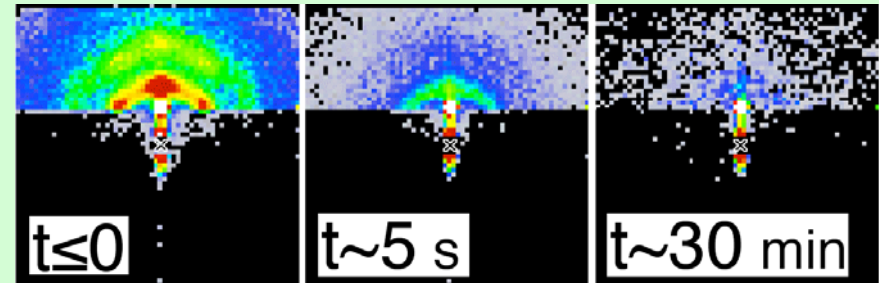
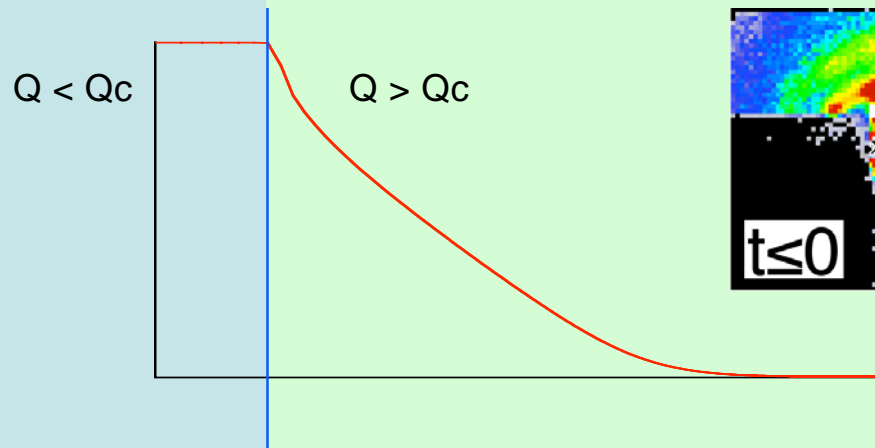
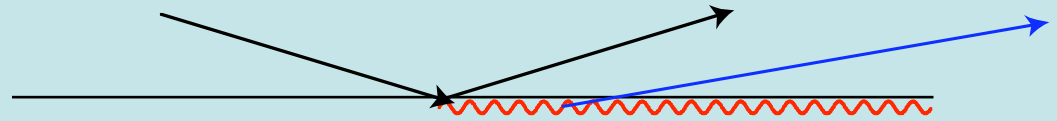
- Grazing Incidence SANS
- Incoming neutrons at angle to interface smaller than the critical angle.
- Evanescent wave scattering from interfacial region with thickness determined by the wavelength of the neutrons, contrast (difference in refractive index of the two media) and the angle.
- Intensity of wave decays exponentially
- Done very successfully with x-rays - neutron intensity means that scattering by the evanescent wave is very weak.

NSSANS

- Near-Surface SANS
- Incoming neutrons at angle greater than the critical angle
- Refracted wave scattered from region below the interface. Scattering volume largely determined by sample environment
- Is a significant cause of background in reflectometry experiments.
- Is the bulk of what is measured as Off-specular reflection.

GI-SANS

Scattering of evanescent wave
Gives in-plane structure of thin films e.g. lateral segregation in mixed surfactant monolayers



NS-SANS

Scattering of transmitted wave by underlying bulk sample
Gives in-plane structure of e.g. micelle layer below the surface

Division has physical origin but not related to practice
so..

In Reality...

GISANS = NSSANS = Off Specular NR

(with different Q accessibility - geometry and instrument dependent)