Sub-Millisecond Time-Resolved Small-Angle Neutron Scattering ("TISANE" - Gähler)

TISANE at the NCNR:
Current Status and Future Prospects

National Institute of Standards and Technology
Conventional time-slicing SANS experiments

Shear Alignment of rod-like micelles

- STATIC - No Shear (Random Rods)
- 0.0 sec - 0.1 sec
- 0.7 sec - 0.8 sec
- 1.4 sec - 1.5 sec
- 2.1 sec - 2.2 sec
- 4.0 sec (Fully-aligned rods)
Time resolution of 'conventional' time-slicing experiments is limited by the wavelength spread

\[ \frac{\Delta \lambda}{\lambda} \] (typically 10% - 20%, fwhm)

\[ \Delta t = \frac{2L\lambda}{c} \left( \frac{\Delta \lambda}{\lambda} \right) \]

\[ c = 4 \text{m}-\text{Å}/\text{ms} \]

\[ \Delta t \sim 0.5 \text{ – } 50 \text{ ms} \]
Conventional TOF SANS

Time resolution is limited by chopper opening time (burst time)

Inefficient because chopper is closed most of the time

Can we do better?  “Yes” - Gähler
TISANE time-distance diagram

Colors represent equivalent scattering events
TISANE Example:

Field-Induced Ordering in Magnetic Colloids


SANS from 6 vol % Co ferrofluid in a static magnetic field of 20 mT

Scattering (at main peak) parallel (black dots) and perpendicular (red dots) to oscillatory magnetic field measured in time-slicing (top half) and TISANE modes (bottom half).
Chopper disks - ILL

Chopper housing and control system - FZ-Jülich

Stefan Hintzen - FZ Jülich
30-meter SANS Instrument - NG-3

15 m long detector vessel
Sample chamber
15 m long pre-sample flight path
chopper housing
Velocity selector

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TISANE Measurement Range at NG-3 SANS

Sample modulation frequencies: ~ 10 Hz to 20 000 Hz

Sample modulation periods: 50 μsec to 150 ms
TISANE Implementation Checklist:

• chopper, sample and detector timing electronics testing ✓
• test ORDELA detector time-stamping electronics ✓
• data processing software for time-stamped data - in progress
• shielding - plan for temporary shielding given go-ahead
• install chopper when all offline testing is complete
• do test experiments
Summary

TISANE would provide access to phenomena occurring on time scales (50 μs to 150 ms) not currently probed by any other neutron scattering technique

- microstructural response of light sensitive materials, electro-rheological fluids, ferrofluids, liquid crystals, etc.
- structure in complex fluids induced by oscillatory shear
- biological processes, e.g. muscle contraction
- dynamics of flux lines in superconductors
- dynamics of magnetic domains