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

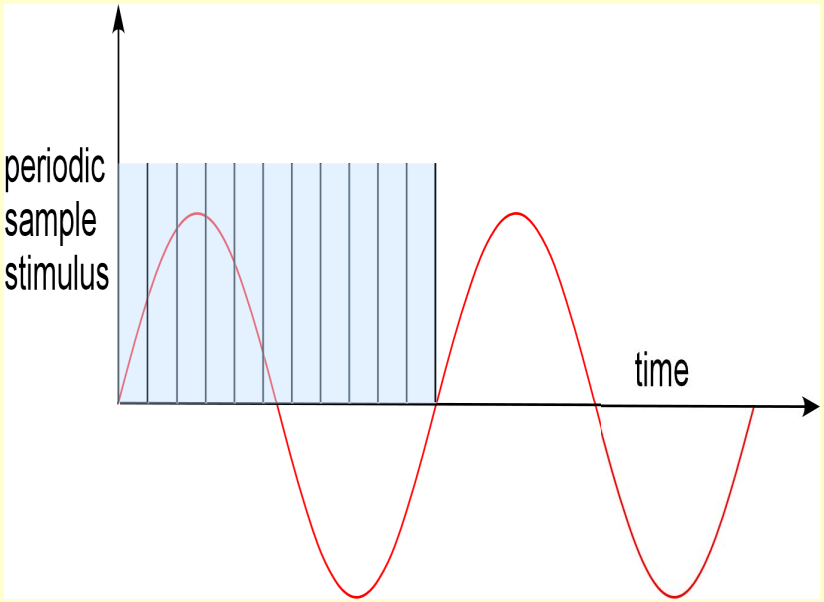
TISANE at the NCNR:

Current Status and Future Prospects

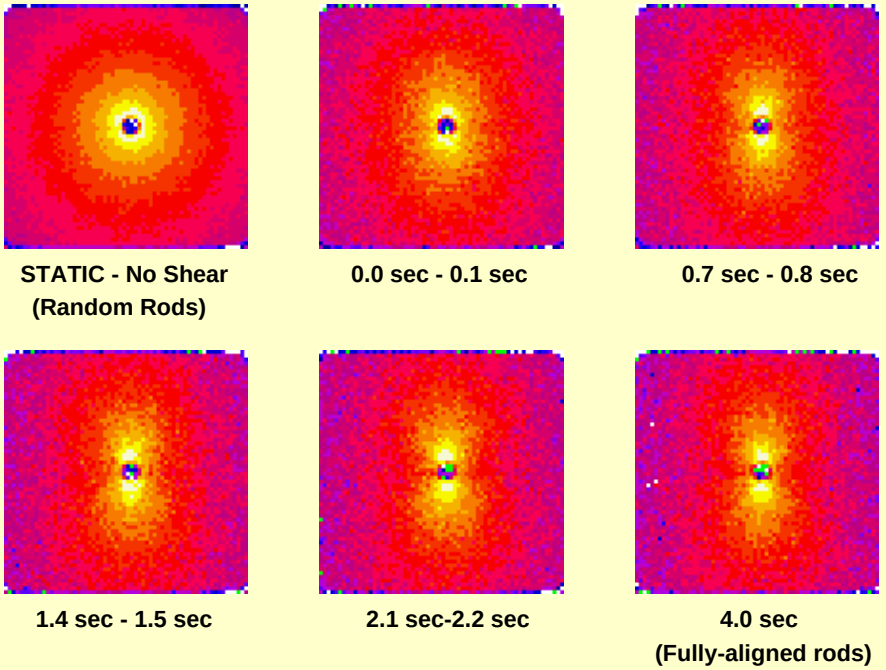
NIST National Institute of Standards and Technology

NSF CHRNS NIST

Conventional time-slicing SANS experiments



Shear Alignment of rod-like micelles

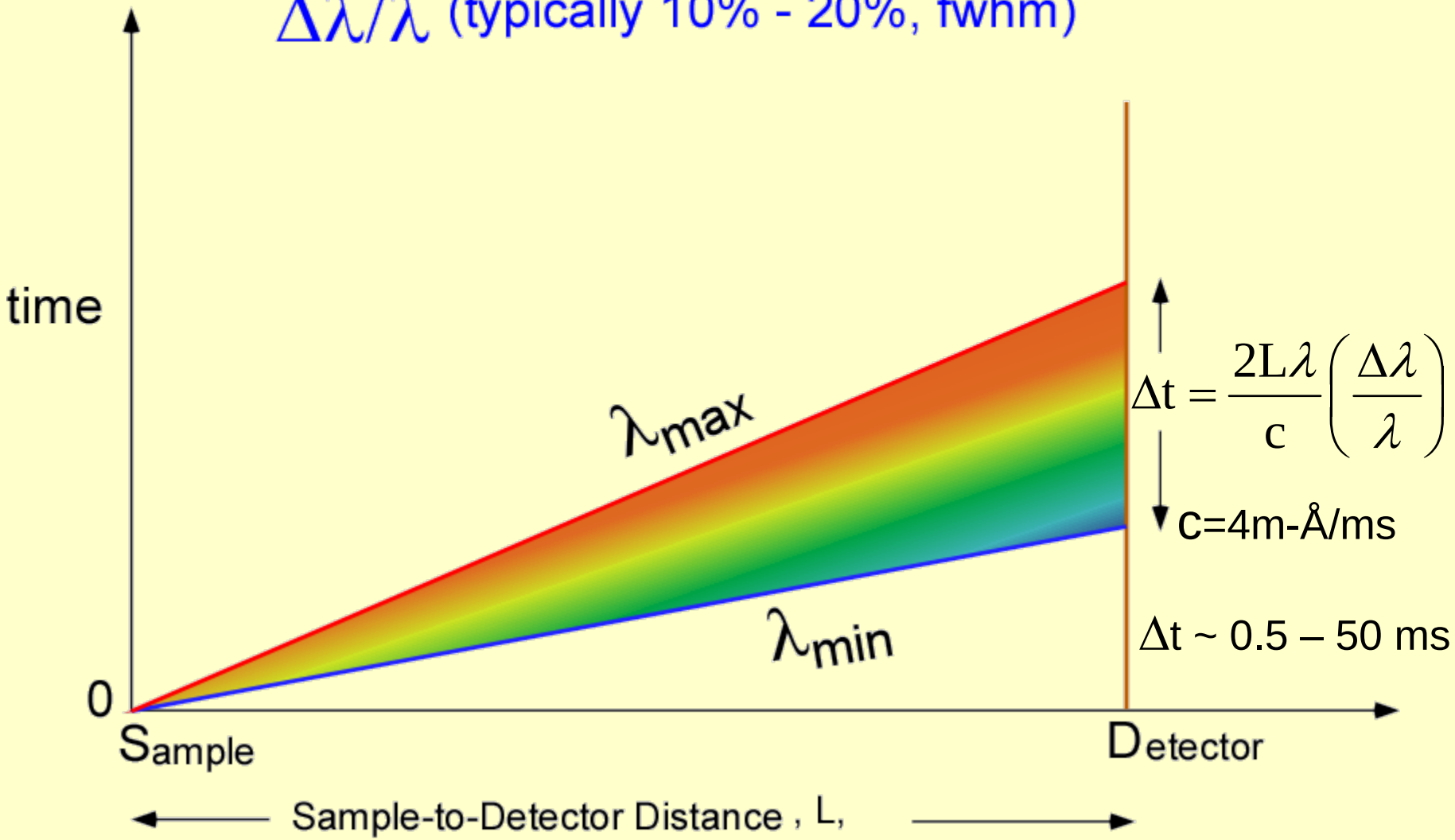


STATIC - No Shear (Random Rods) | **0.0 sec - 0.1 sec** | **0.7 sec - 0.8 sec**

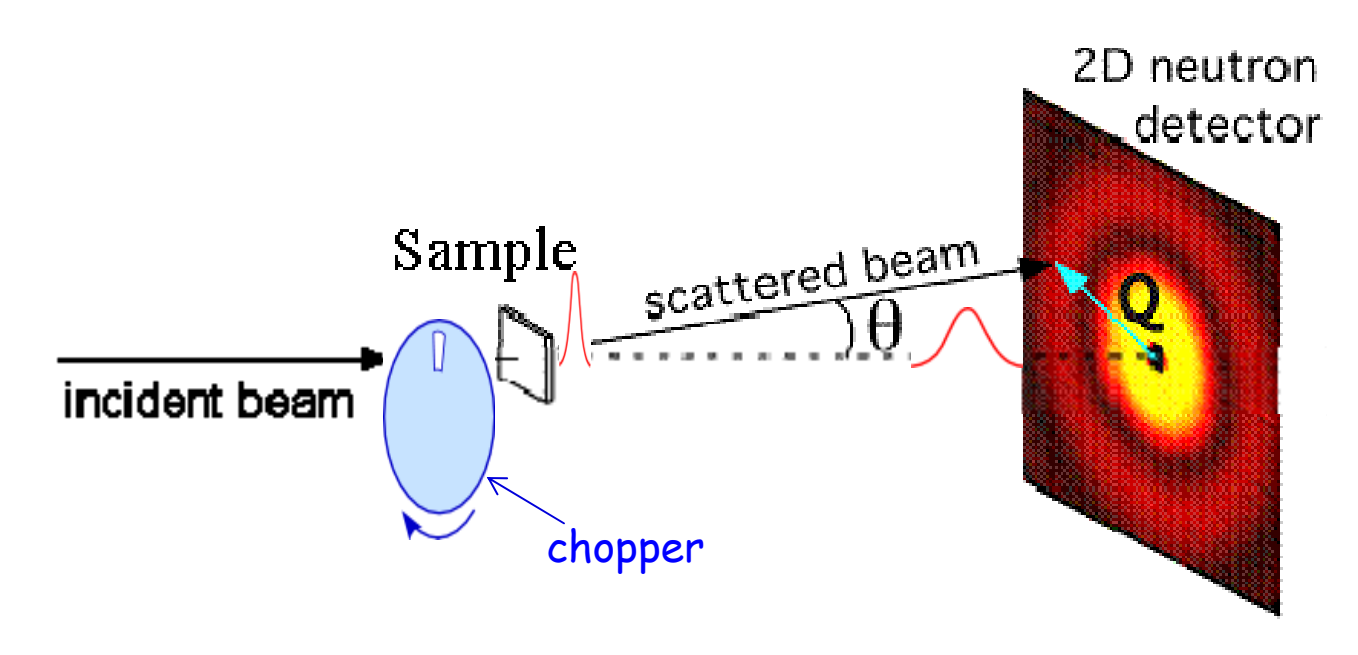
1.4 sec - 1.5 sec | **2.1 sec-2.2 sec** | **4.0 sec (Fully-aligned rods)**

Time resolution of 'conventional' time-slicing experiments is limited by the wavelength spread

$\Delta\lambda/\lambda$ (typically 10% - 20%, fwhm)



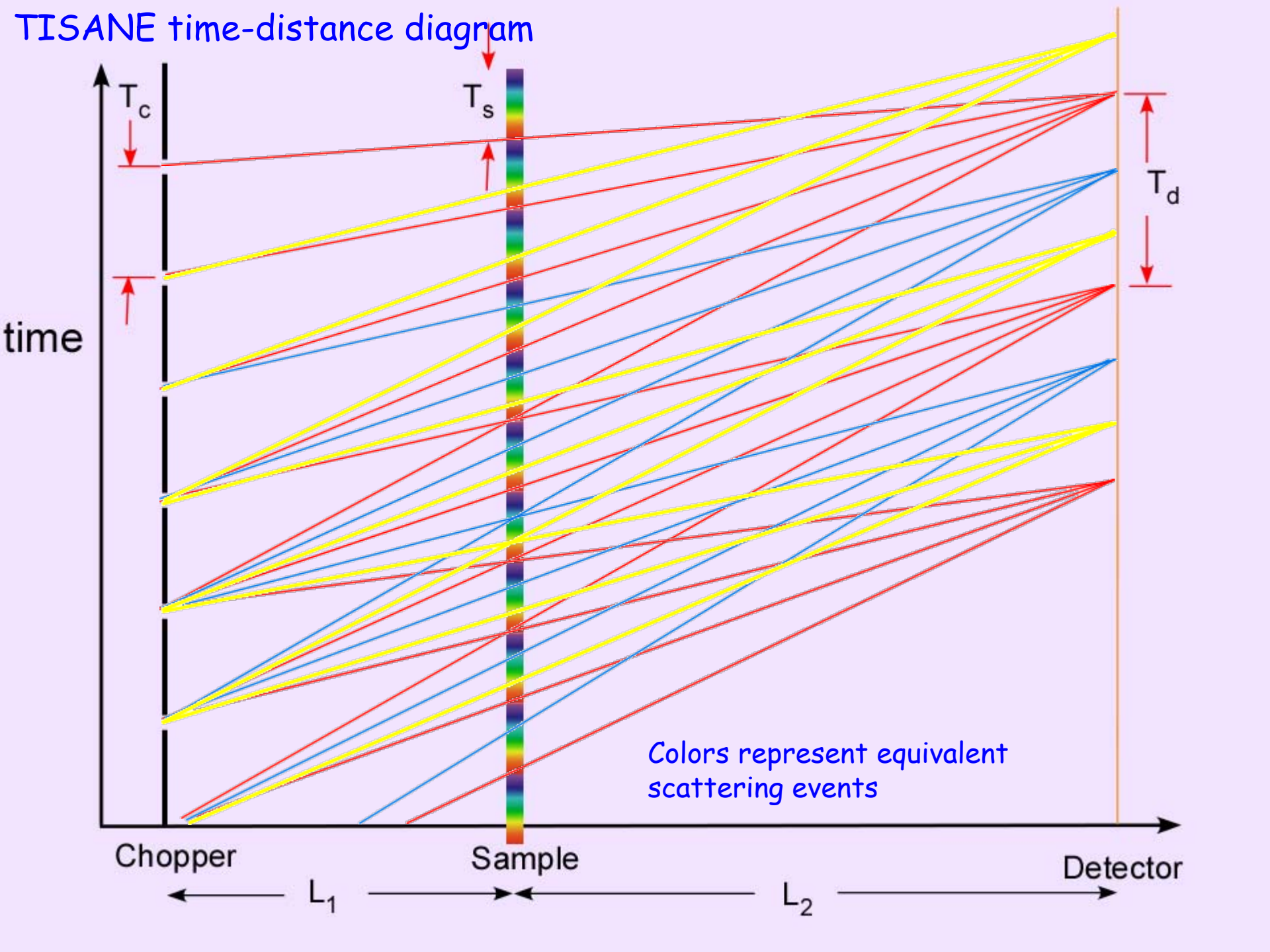
Conventional TOF SANS



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

Inefficient because chopper is closed most of the time

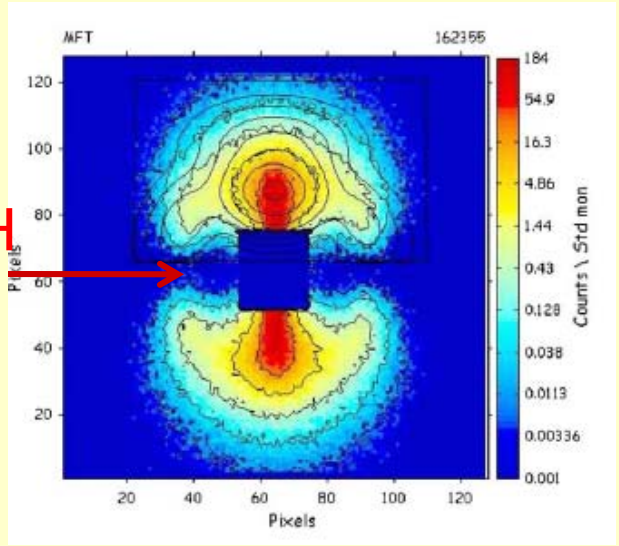
Can we do better? "Yes" - Gähler


TISANE time-distance diagram
T_c
T_s
T_d
time
Colors represent equivalent scattering events
Chopper
Sample
Detector
L_1
L_2

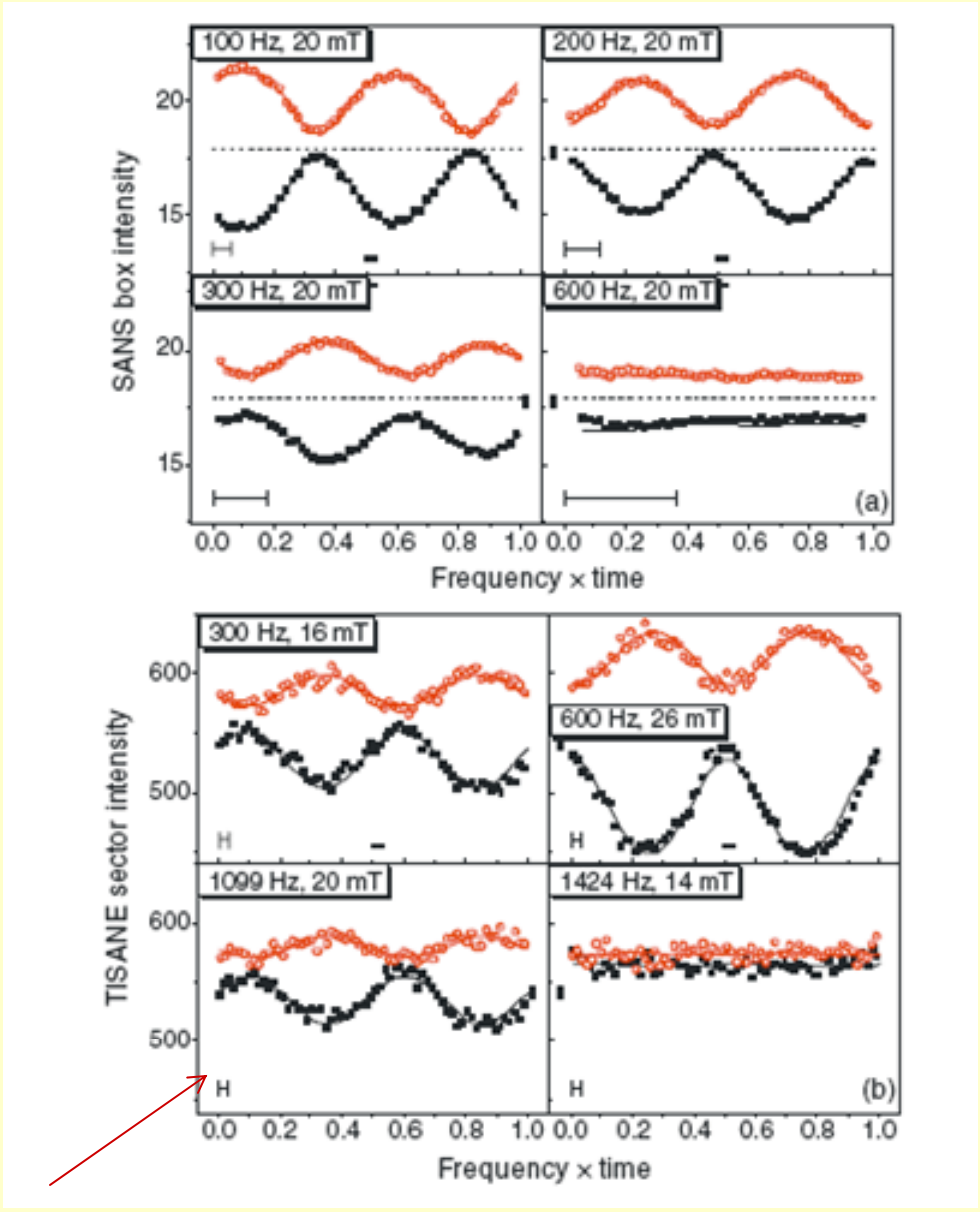
TISANE Example:

Field-Induced Ordering in Magnetic Colloids

A. Wiedenmann, et al. PRL, 057202 (2006)



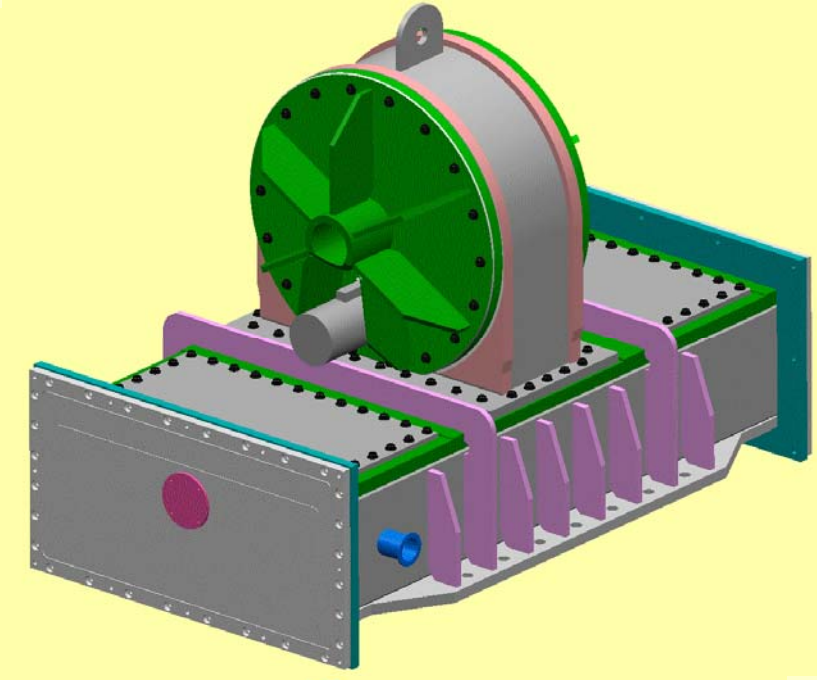
SANS from 6 vol % Co ferrofluid in a static magnetic field of 20 mT



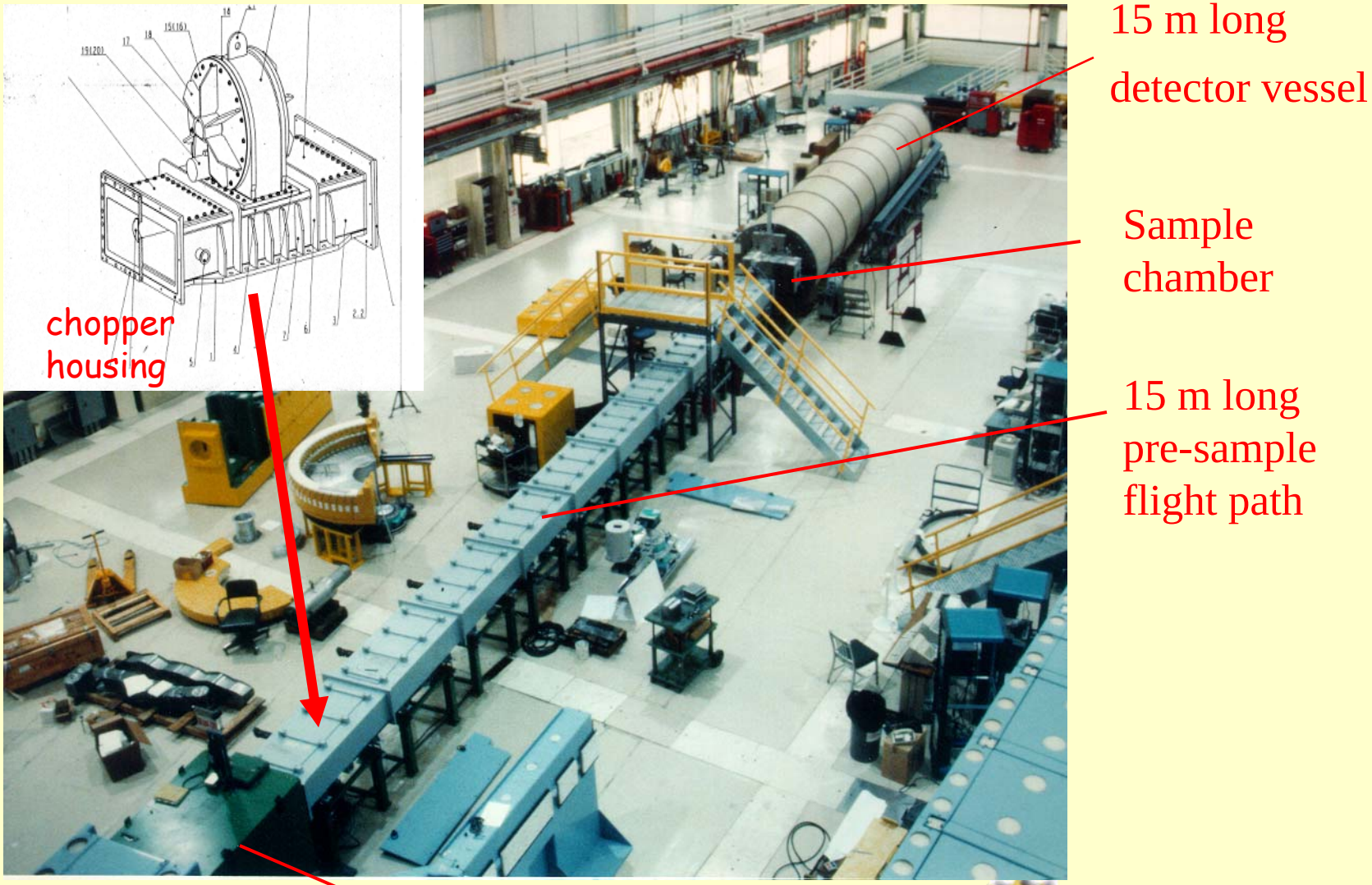
Scattering (at main peak) parallel (black dots)and perpendicular (red dots) to oscillatory magnetic field measured in time-slicing (top half) and TISANE modes (bottom half).

Chopper disks - ILL

Chopper housing and control system - FZ-Jülich



30-meter SANS Instrument - NG-3



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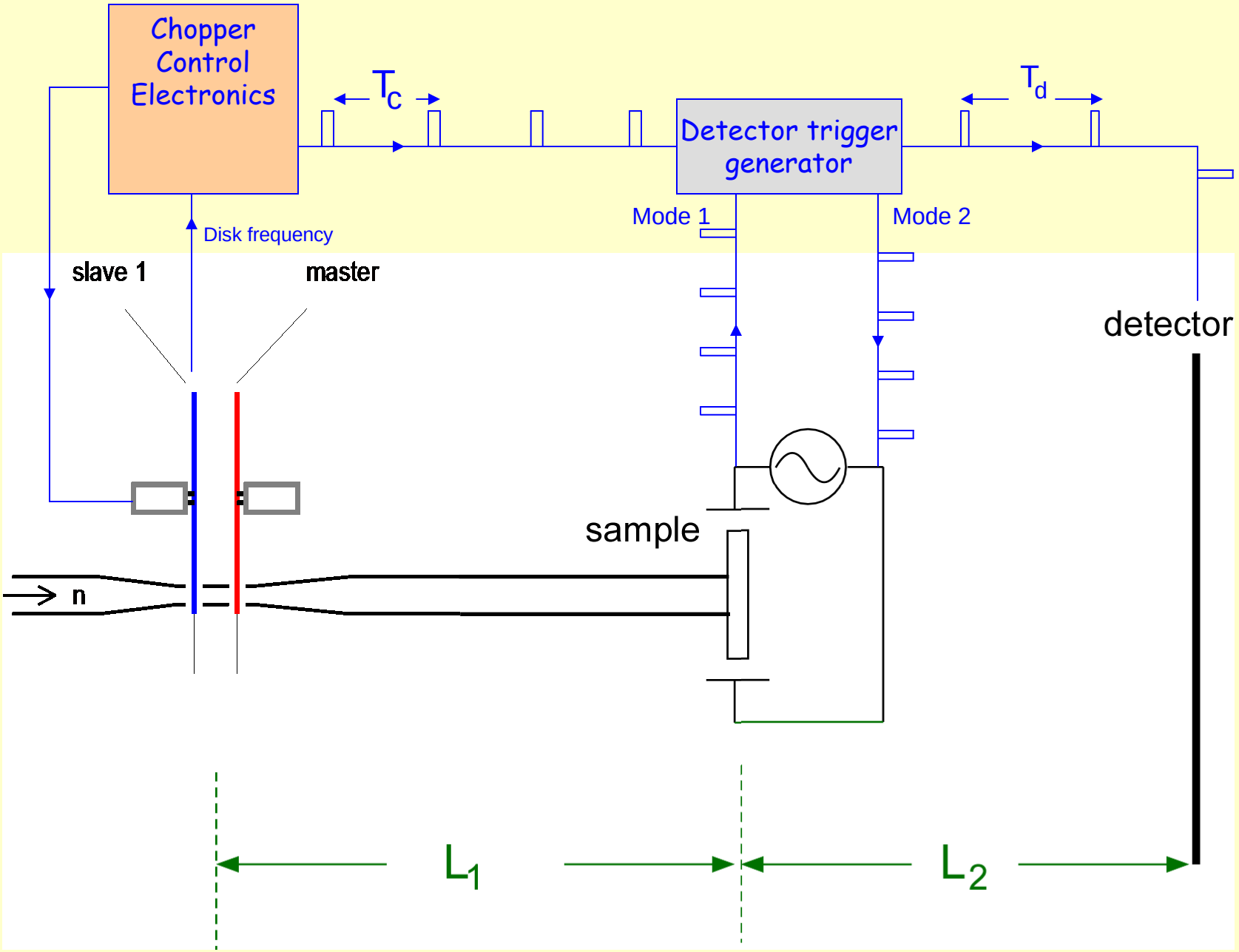
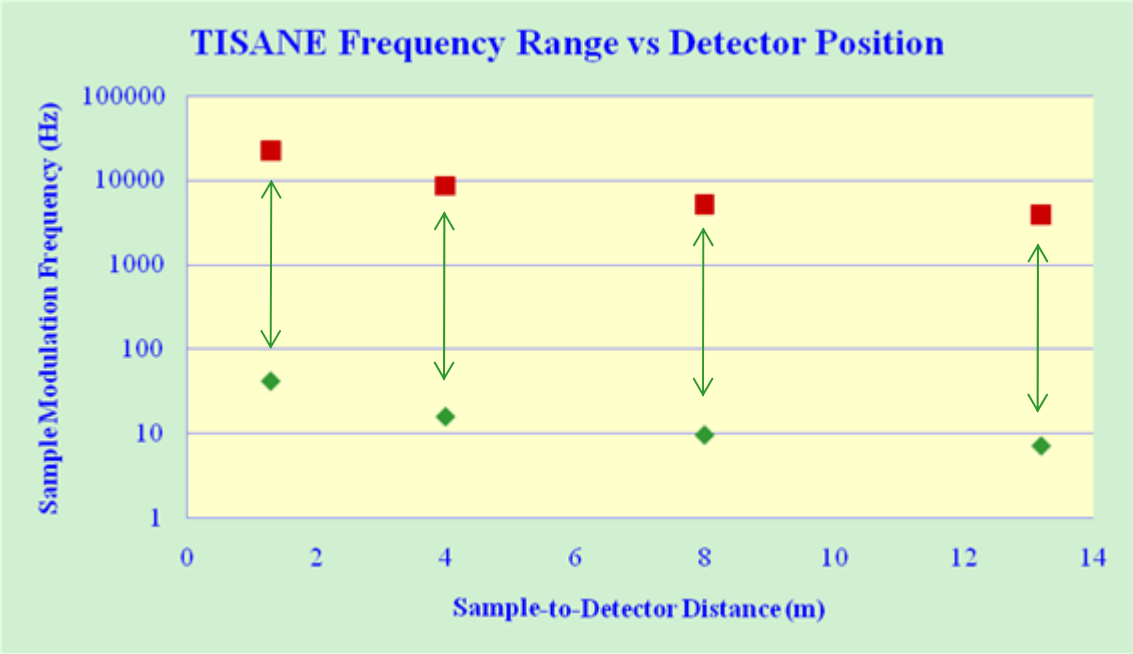

Chopper
Control
Electronics
T_c
Detector trigger
generator
T_d
Mode 1
Mode 2
Disk frequency
slave 1
master
detector
sample
n
L_1
L_2

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