



TISANE – more than just herbal tea!

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S. Mühlbauer, 15.06.2015

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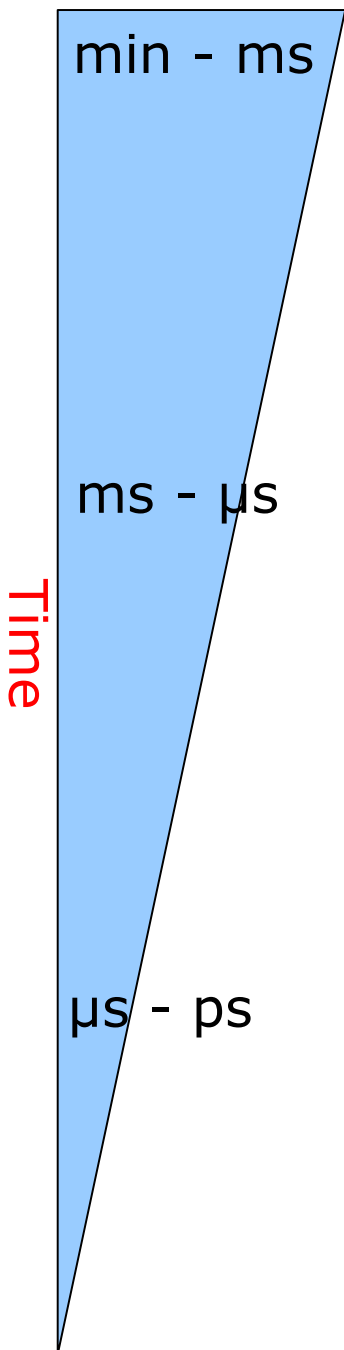
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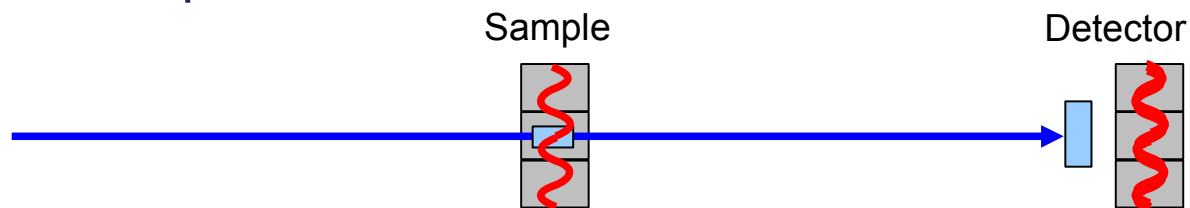
IFW Dresden

Getting into the Time Domain



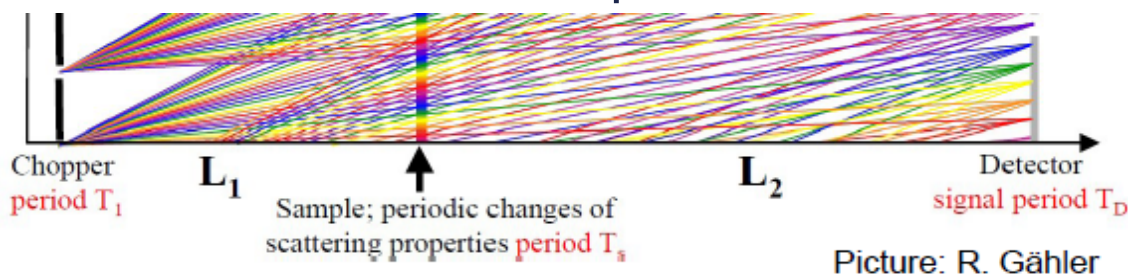
Stroboscopic SANS

SANS + stroboscopic excitation of the sample



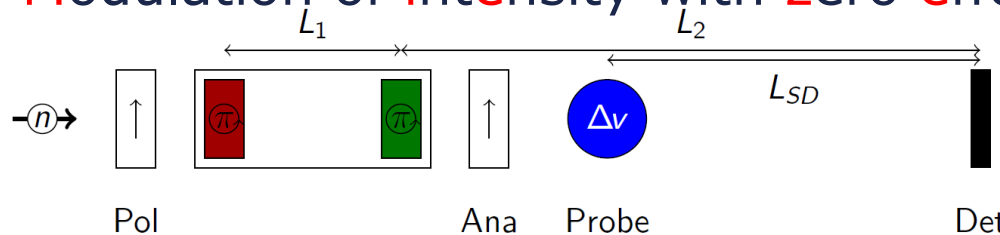
TISANE

SANS + chopper + stroboscopic excitation of the sample



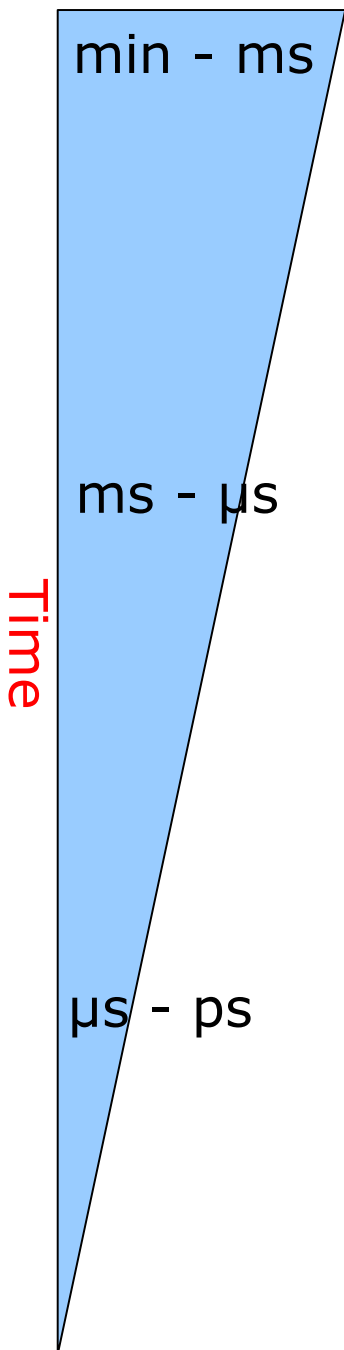
MIEZE

Spin echo technique:
Modulation of intensity with zero effort



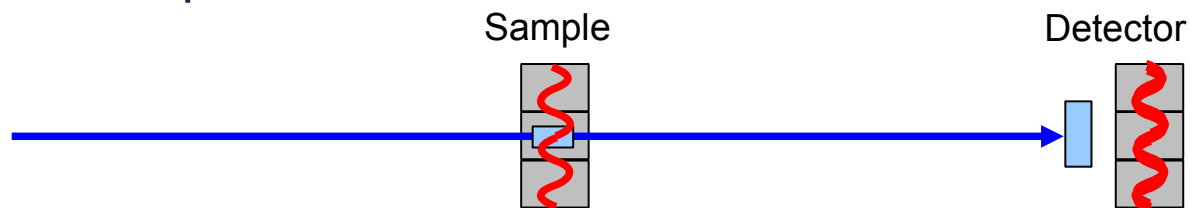
External control parameter

Intrinsic dynamic behaviour $S(q, \tau)$



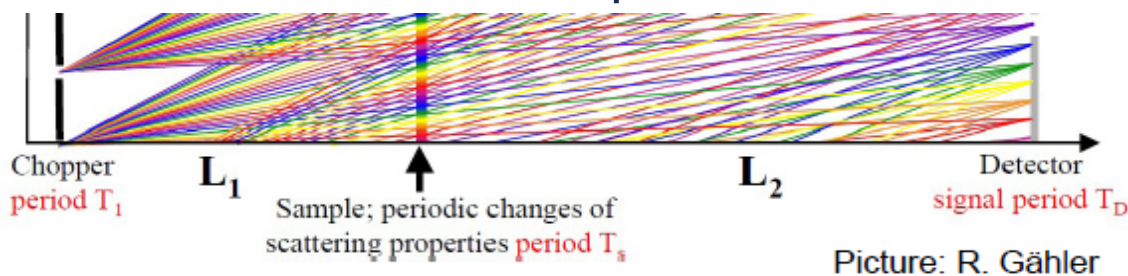
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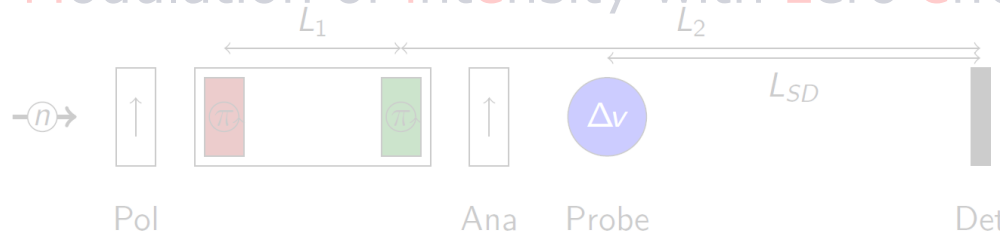
TISANE

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MIEZE

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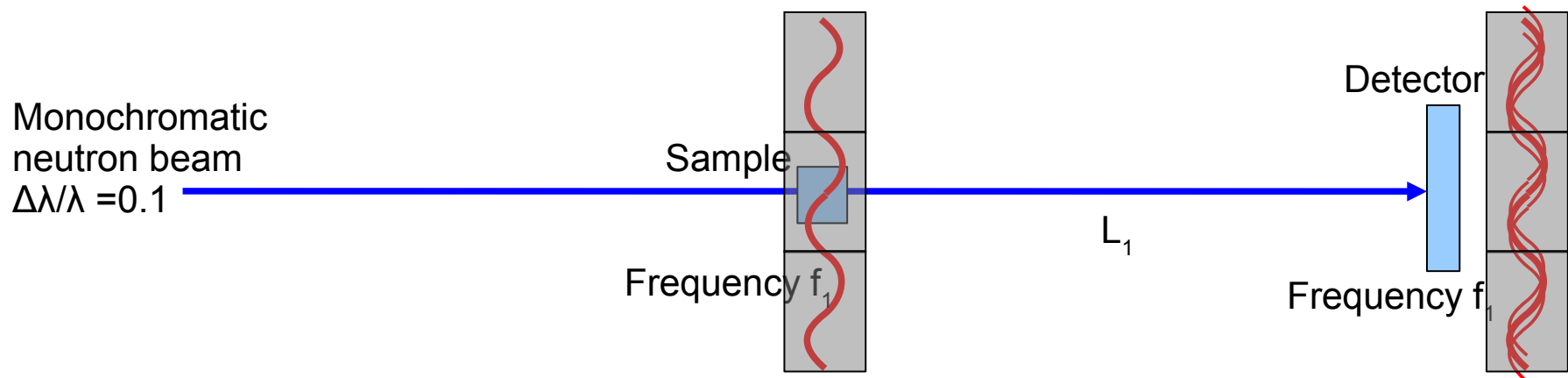


External control parameter

Intrinsic dynamic behaviour $S(q, \tau)$

- ➔ Cyclic perturbation of the sample with external control parameter (T, H, P, etc), min to ms.
- ➔ Time resolved detector.
- ➔ Coherent summation of many cycles.
- ➔ Time resolution: Smearing due to wavelength spread over flight path \approx ms.

$$t_{\text{TOF}}[\text{ms}] = \lambda[\text{nm}] \times L_2[\text{m}] \times 2.52778$$



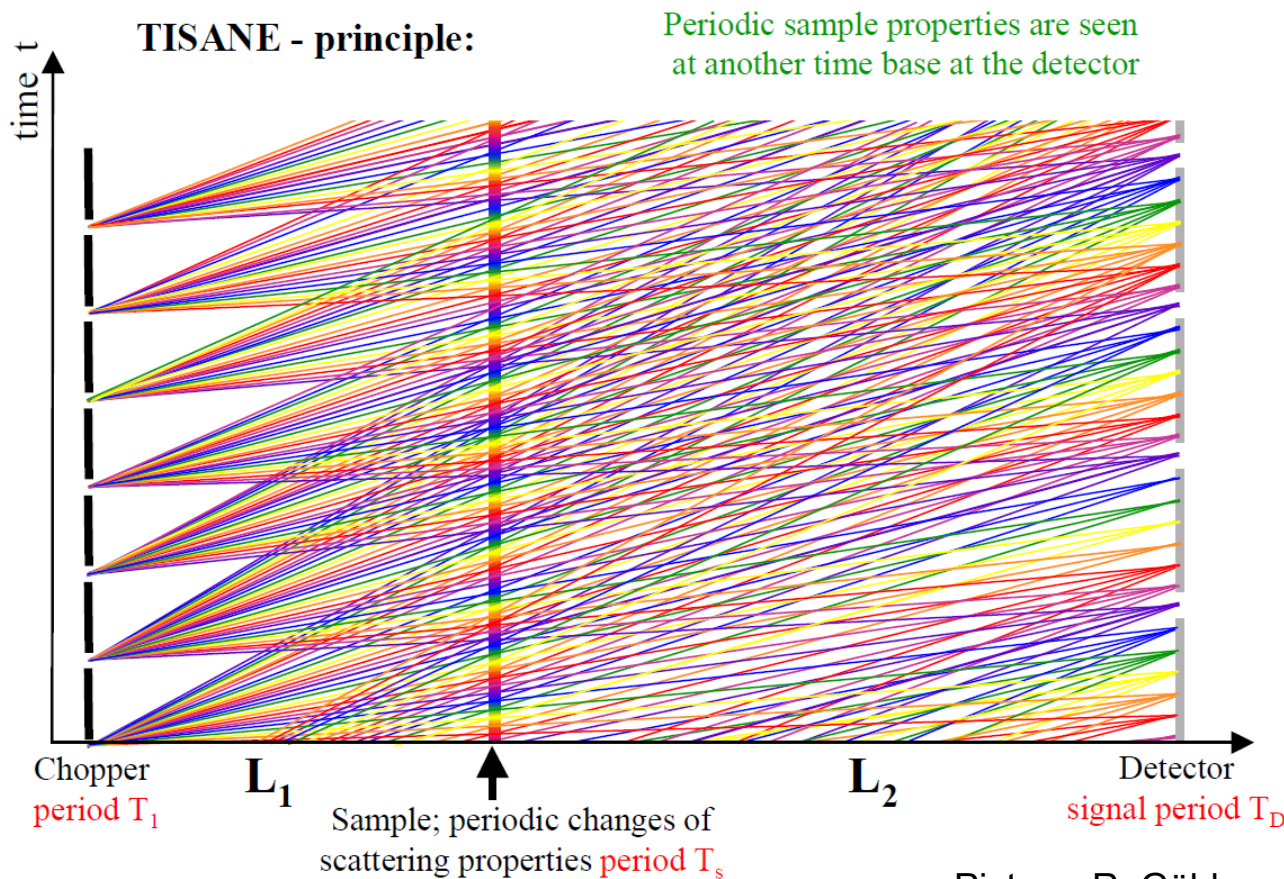
TISANE: Time Involved Small Angle Neutron Experiments

“Standard” SANS setup + chopper.

Theorem of intersecting lines:

$$\frac{L_2}{L_1} = \frac{T_D}{T_1} \quad \frac{T_D}{T_s} = \frac{L_1 + L_2}{L_1}$$

Accessible timescale: μ s.



Picture: R. Gähler

TISANE @ SANS-1

Setup of the shielding:
05/2014

Comissioning: 10/2015

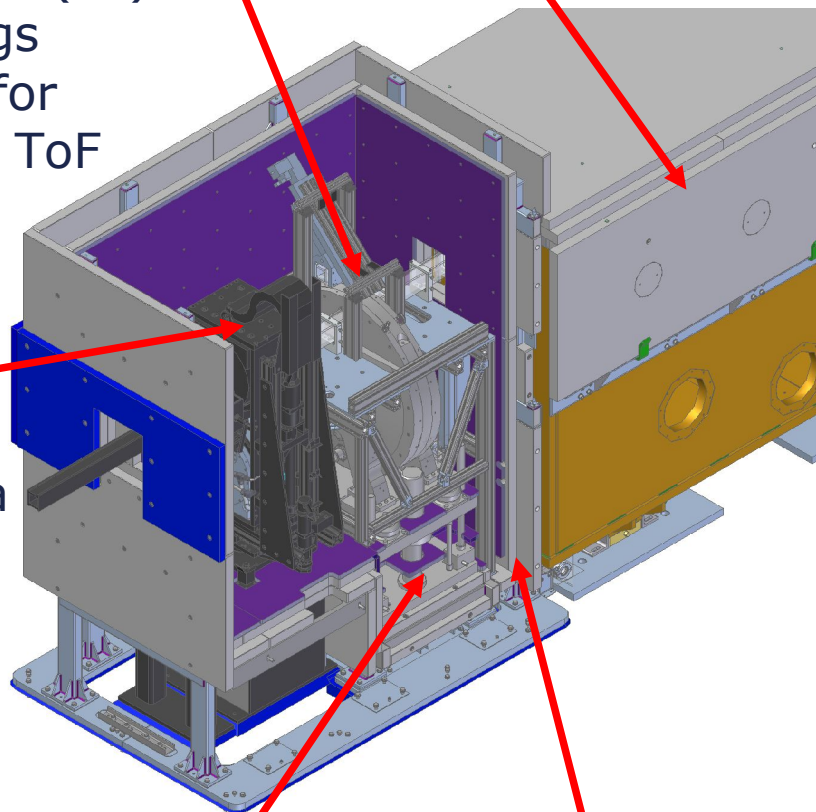
Astrium counter rotating
double chopper:

- 20.000 rpm
- 14 equal windows (9°)
- Magnetic bearings
- Master chopper for later upgrade on ToF

Velocity
selectors

NL 4a

Collimation
tracks



Huber-Table

Lifts the TISANE-Chopper
into the beam position

New common shielding for
both selectors and chopper



Strongly correlated electrons/ Magnetism

Vortex/Skyrmion matter:

Pinning /depinning for transport currents

Melting transitions

Magnetism:

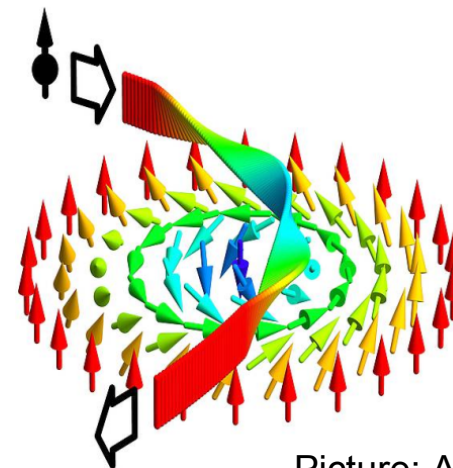
Switching of multilayer systems (GISANS)

Dynamics of magnetic domains

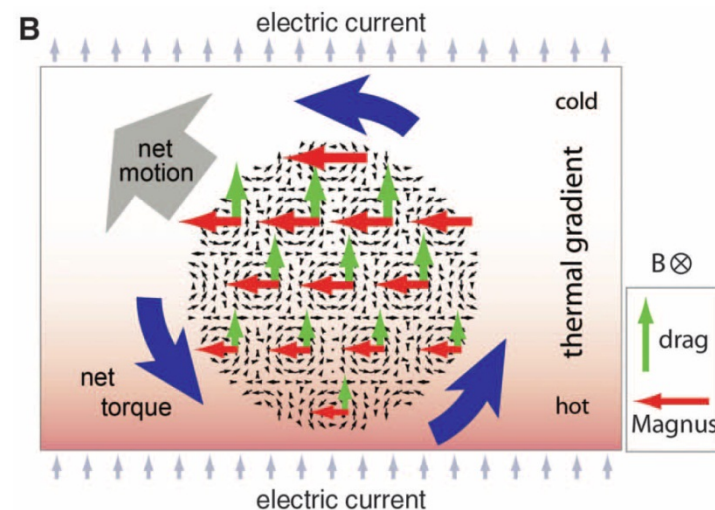
Relaxation of frustrated magnetic structures

Switching of multiferroic systems

Ferrofluids



Picture: A. Rosch



Soft Matter / Materials Science

Life science

Dynamics of biological reactions

Light as fast trigger?

Organic solar cells

Polymer folding/mixing (Shear cell
provided by T. Unruh, FAU)

Material science

Switching of multiferroic systems
(ultrasound excitation)

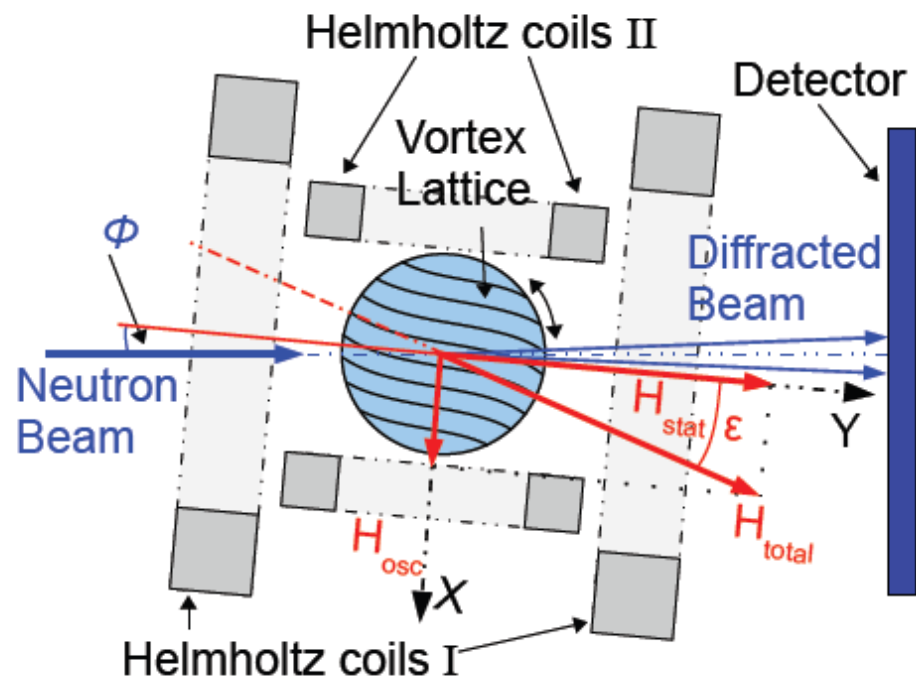
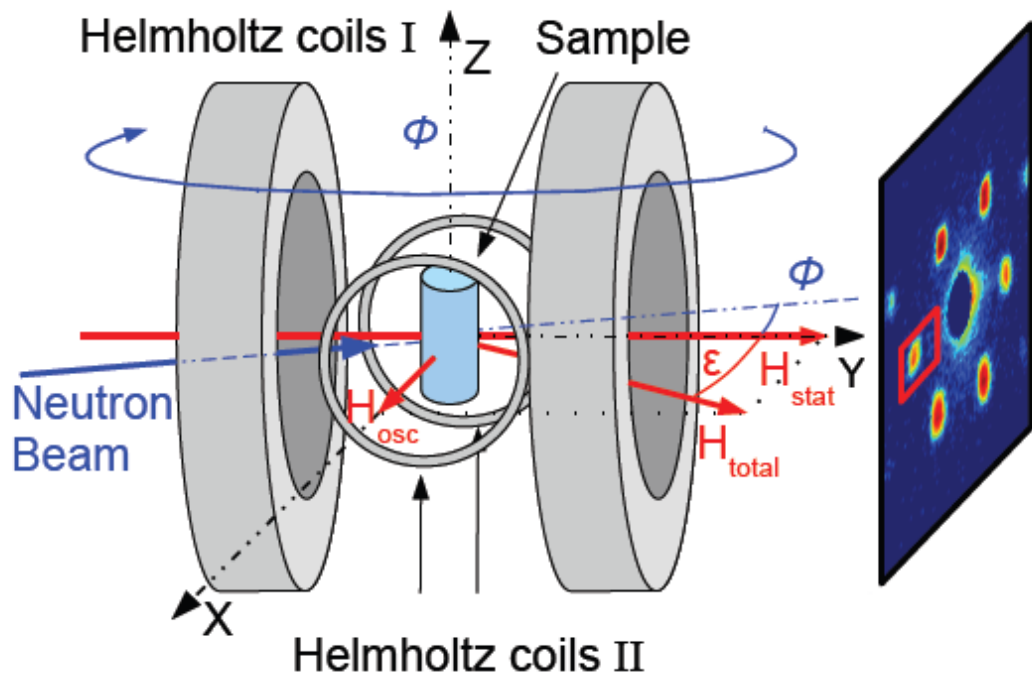
Light as fast trigger (SFB 677
"Function by Switching)

Stopped flow experiments

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Typical Experiment:

Driven Vortex Lattice Dynamics



static field
(H_{stat})
+
rectangular
pulses (H_{osc})



Two **equilibrium**
positions of VL.
Diffusion of the VL



Angular distribution of the
VL diffusion as function of
time, T and H .

Elastic energy for uniform tilt ($k=0$):

Tilt modulus

$$c_{44} = \frac{B \partial F}{\partial B} = \frac{B B_a}{\mu_0}$$

Viscosity

$$\eta = \frac{B^2}{\rho_{FF}} \approx \frac{B B_{c2}}{\rho_n}$$

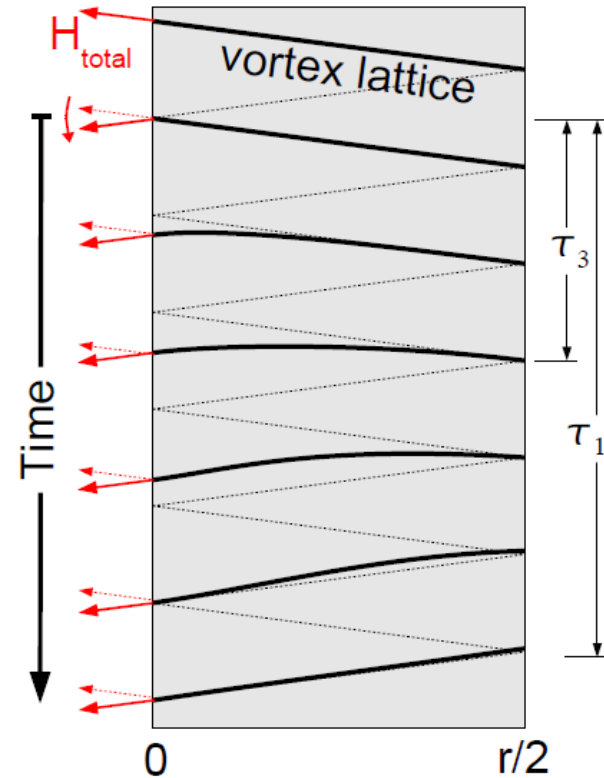
Diffusion process for uniform tilt and small changes of H.

$$D = \frac{c_{44}}{\eta}$$

Fourier solution of diffusion equation: Modes decay independently ($t \sim 1/n^2$).

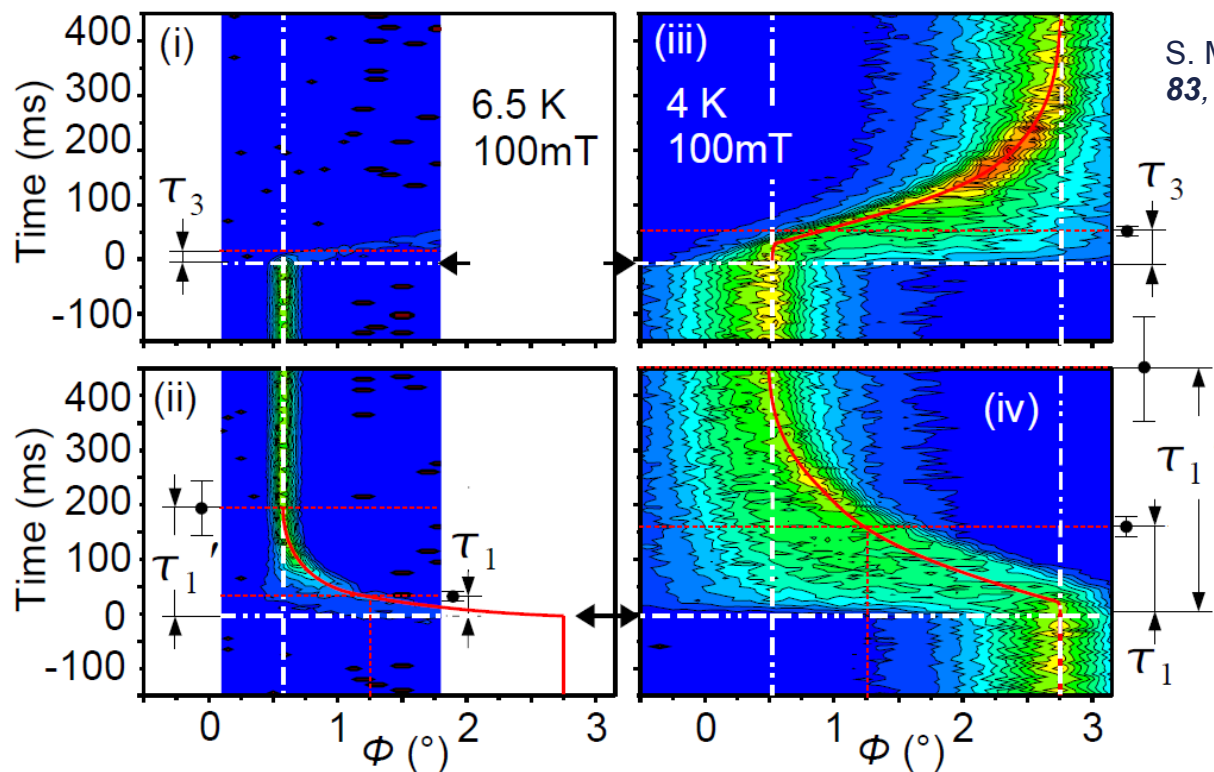
$$u(x, t) = \sum_{n=1}^{\infty} D_n \left(\cos \frac{n\pi x}{2r} \right) e^{-\frac{n^2 \pi^2 D t}{4r^2}}$$

Diffusion from the surface



τ_1 : Fundamental relaxation
($n=1$)

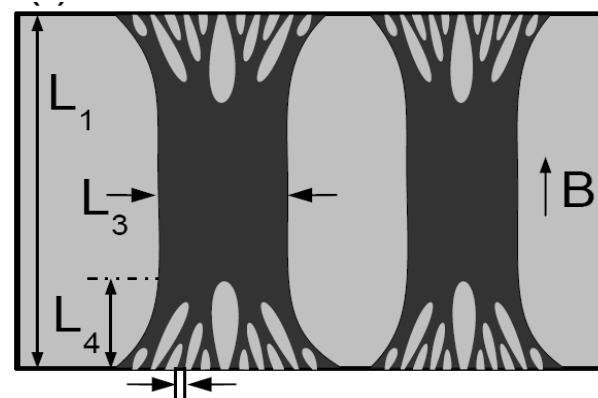
τ_3 : Distortion crosses sample, uniform bending ($n=3$)



S. Mühlbauer et al. *Phys. Rev. B*
83, 184502 (2011)

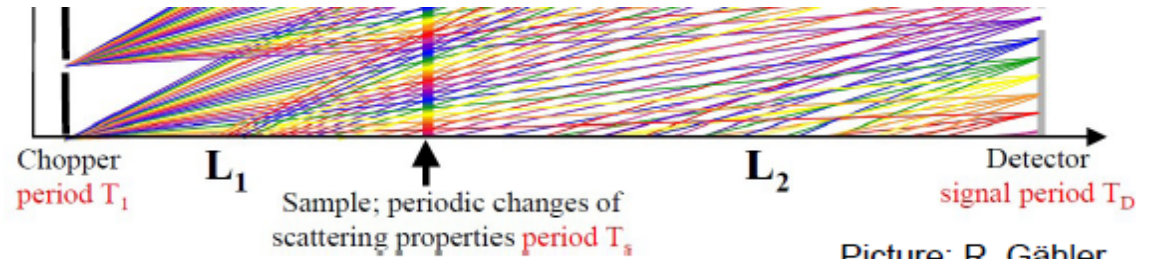
Morphology of VL strongly influences its relaxation.

- High T and H: Fast reaction of a stiff VL.
- Low T and H: Decomposition into Shubnikov domains.
- Surface of the sample: Landau branching

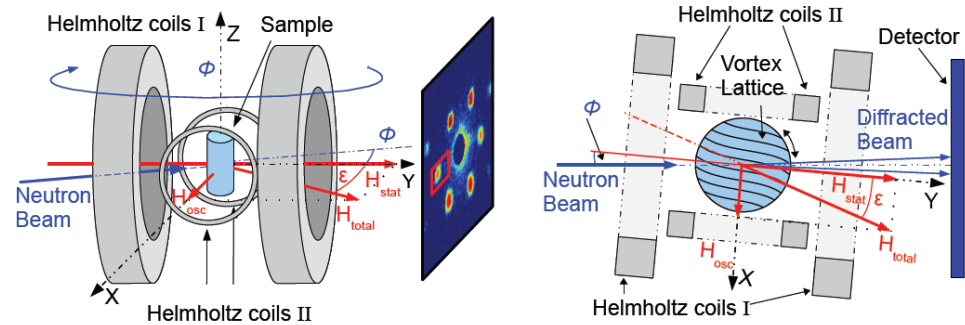


Kinetic neutron scattering & TISANE:

➔ Microsecond resolution



➔ Driven dynamics



➔ Careful choice of control parameter



Thank You!