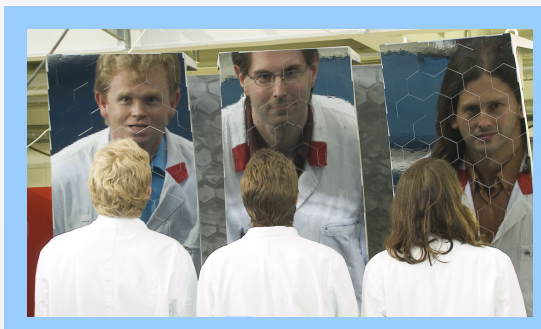
SPHERES
the High-Flux Neutron Backscattering Spectrometer of the Jülich Centre for Neutron Science



On the photo:
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The team at large:
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Proposals for experiments are welcome

To measure on SPHERES, contact an instrument scientist …

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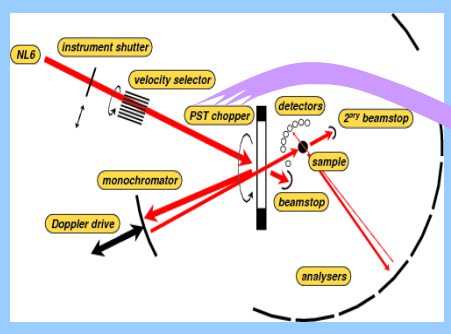
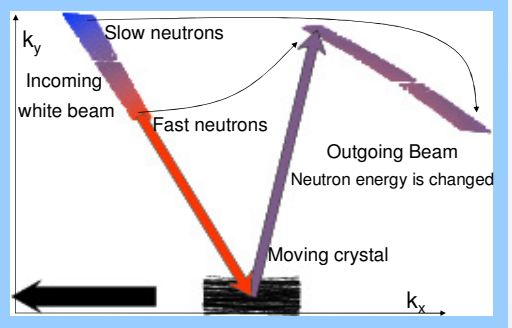
… and submit a proposal

to JCNS:
https://fzj.frm2.tum.de/
NMI3 funding available for European users

or to FRM-II:
https://user.frm2.tum.de/

A third-generation instrument





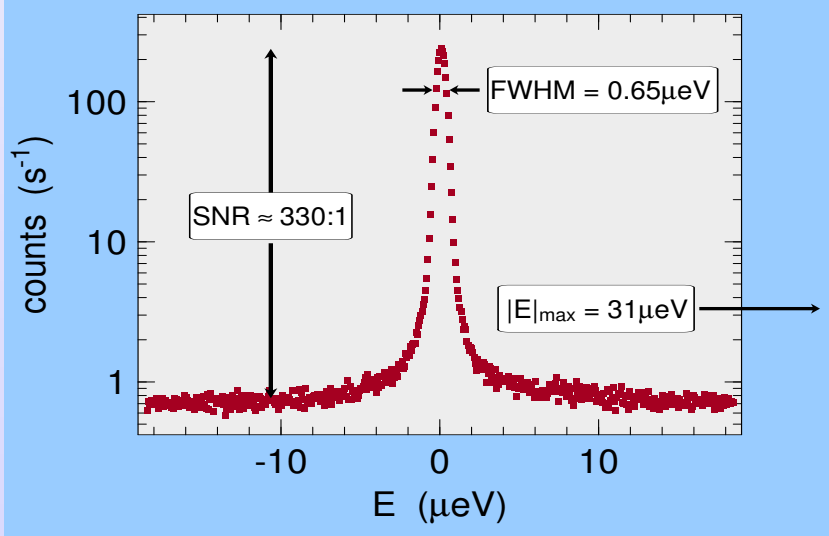
Backscattering spectrometer working principle

- High energy resolution by Bragg reflection near 180°
- Energy scans by Doppler shift in oscillating monochromator
- Deflector needed to build the instrument outside the neutron guide
- Chopper needed for selection of neutron paths

Phase-space transform chopper (PST)

- Combines functions of deflector and chopper
- Pyrolite graphite crystals with high mosaicity enhance accepted wavelength band
- Moving the crystals with 100 m/s (in future: 300 m/s) transforms „white“ to „wide“ [1]
- High flux even at highest energy transfers

Resolution function
(raw data without background subtraction)



Intensity

- At the end of neutron guide: 8 ·10^9 n/s
- At the sample: 7 ·10^5 n/s
- Count rate for a 10% scatterer: 200 n/s/detector
- 10 large-angle detectors
- 5 small-angle detectors (in comissioning)

Comparison with benchmark

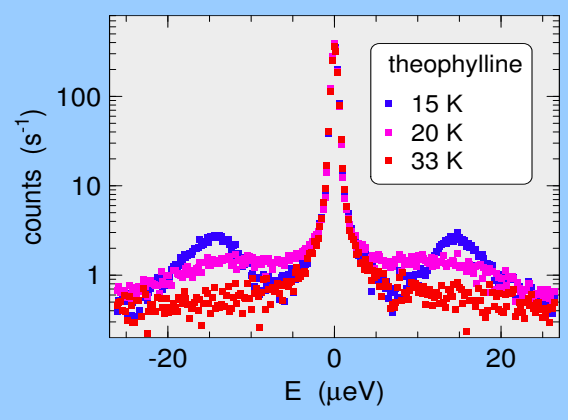
High-flux backscattering spectrometer (HFBS) at NIST [3]:
- Flux at end of guide: 6.5 ·10^9 n/s
- Flux at sample: 1.1 ·10^6 n/s
- Signal-to-noise ratio without sample environment: >400:1
- Resolution FWHM = 0.93 μeV

Future improvements

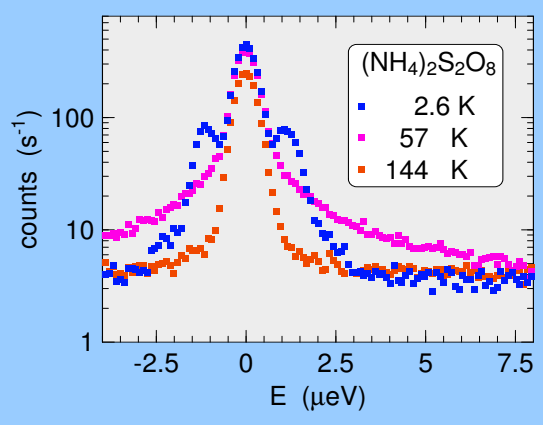
- Eliminate further background channels
- Argon filling of the secondary spectrometer
- New chopper with 300 m/s will augment PST effect by factor of 2

First experimental results

Quantum tunneling and rotational diffusion

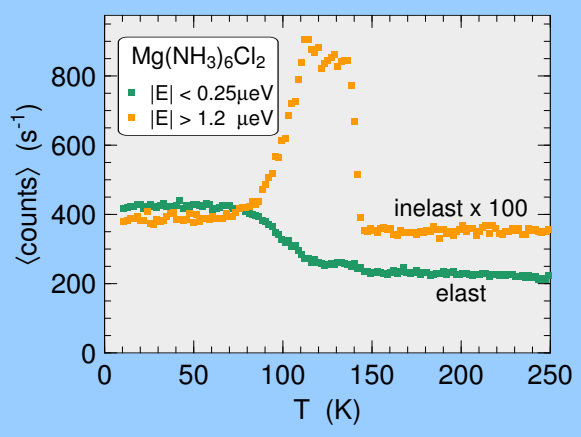


Prager, Pawlukojc, Wischnewski, Wuttke [5]



Prager, Grimm, Natkaniec, Nowak, Wuttke

Phase transition



Shi, Pardo, Jacobsen, Lefmann, Vegge, Wuttke

The instrument will be used to study:

- Nuclear spin excitations
- Molecular rotations, including quantum tunneling
- Diffusion
- Dynamics of liquid crystals, plastic crystals, orientational glasses
- Relaxation in viscous liquids
- Dynamics of polymers and biological systems

References

[1] J. Schelten, B. Alefeld, in: Proc. Workshop in Neutron Scattering Instrumentation for SNQ, Hrsg. R. Scherm, H. H. Stiller, Report Jül-1954 (1984)

[2] O. Kirstein, M. Prager, H. Grimm, D. Richter, J. Neutron Research, 8(2) 119-132 (1999)

[3] A. Meyer, R. M. Dimeo, P.M. Gehring, D. A. Neumann Rev. Sci. Instrum., 74 (5), 2759-2777 (2003)

[4] P. Rottländer, T. Kozielewski, M. Prager, D. Richter, Physica B350(1/3) e823 - e825 (2004)

[5] M. Prager, A. Pawlukojc, A. Wischnewski, J. Wuttke, J. Chem. Phys. (in press)