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RESEDA: Resonance spin echo spectrometer

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Abstract: RESEDA (**re**sonance **s**pin **e**cho for **d**iverse **a**pplications), a high-resolution resonance spin-echo spectrometer, operated by the Technische Universität München, is installed at the cold neutron guide NL5-S in the Neutron Guide Hall West. The instrument gives access to a large time and scattering vector range for quasi-elastic measurements.

1 Introduction

RESEDA (see Figure 1 and 2) supports **l**ongitudinal **n**eutron **r**esonance **s**pin **e**cho (LNRSE, time range from 0.001 to 20 ns for λ = 8 Å) and **m**odulation of **i**nt**e**nsity with **z**ero-**e**ffort (MIEZE, time range from 0.001 to 20 ns for λ = 8 Å) experiments. At RESEDA, the analysis of S(Q,τ) provides characteristic parameters, e.g. relaxation time and amplitude of the dynamic processes in the sample investigated. The determination of S(Q,τ) is feasible for different Q-values and/ or different temperatures and pressures.

NRSE experiments require non-depolarising sample environment conditions. For MIEZE experiments (and in contrast to NRSE) the spin manipulation and analysis is realised solely before the sample. Therefore, the MIEZE method enables high-resolution study of depolarising samples, under magnetic field and/ or within depolarising sample environments. However, as a consequence of the polarisation analysis before the sample, MIEZE experiments are limited to a smaller Q-range than NRSE measurements.

Next to ^{3}He detectors, a 2D CASCADE detector with an active area of 20 cm x 20 cm characterised by a spatial resolution of 2.6 mm^2 and a time dynamics of the order of a few MHz is available (Häußler et al., 2011; Schmidt et al., 2010).

Hence, RESEDA is in addition suited to (polarised) **s**mall **a**ngle **n**eutron **s**cattering (SANS) applications.

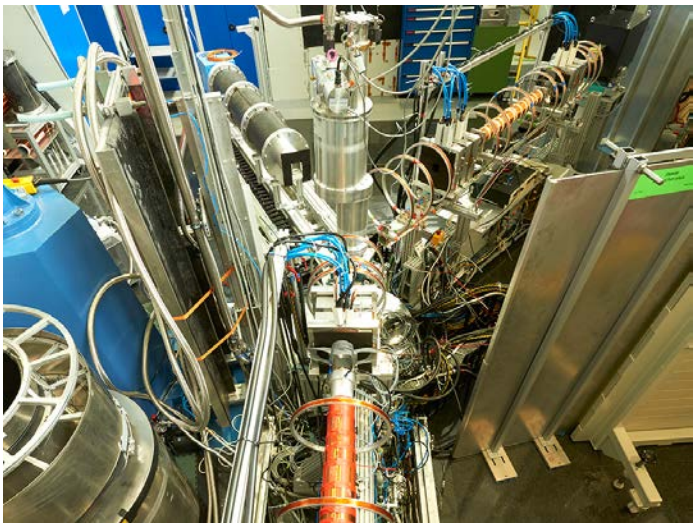

Figure 1: Instrument RESEDA (Copyright by W. Schürmann, TUM).

2 Typical Applications

- Quasi-elastic measurements:
  e.g. to determine the dynamics of water in porous media, polymer melts, diffusion processes in ionic liquids as well as magnetic fluctuations in single crystals, powder samples and thin films
- (Polarised) Small Angle Neutron Scattering (SANS):
  e.g. to investigate the diffraction pattern of magnetic structures and vortex lattices to choose suited reflections for a line-width determination
- Spherical polarisation analysis

3 Sample Environment

At RESEDA the whole sample environment of the MLZ is applicable. Depolarising conditions are limited to MIEZE experiments.

- Available temperature range: 50 mK (dilution insert, see below) up to more than 1300 K (high temperature furnace, non-depolarising)
- Maximal pressure: 7 GPa
- Maximal magnetic field: 7.5 T

Available cryostats:

- Closed cycle cryostat: (3 K $<$ T $<$ 300 K)
- ^{3}He insert: (450 mK $<$ T $<$ 300 K)
- Dilution insert: (50 mK $<$ T $<$ 6 K)

4 Technical Data

4.1 Primary beam

- Neutron guide: NL5-S
- Guide cross section: 29 x 34 mm^2
- Wavelength selection: Velocity selector (max. 28000 rpm)
- Wavelength range: λ = 3 – 12 Å
- Wavelength bandwidth at sample position: $\Delta\lambda/\lambda$ = 9 – 20 %
- Polariser: V-cavity (length: 2 m, coating: m = 3)

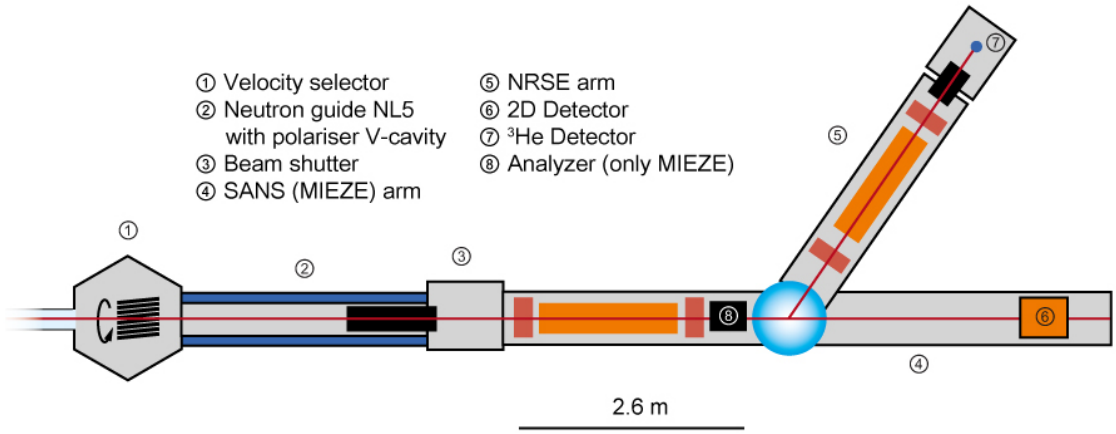

Figure 2: Schematic drawing of RESEDA.

4.2 Spectrometer

- Optional polariser before sample: V-cavity (length: 30 cm, coating: m = 4)
- Length of the spectrometer arms: 2.6 m
- Two secondary spectrometer arms: SANS (MIEZE) arm and LNRSE arm
- For polarisation analysis available: V-cavity, Bender
- Detectors: ^{3}He counter or 2D detector (CASCADE)

4.3 Characteristic parameters

- Flux at sample position: $\varphi \geq 10^6$ n cm^{-2} s^{-1} (at λ = 5.3 Å)
- Frequency range of RF coils: 35 kHz – 1.7 MHz
- Maximum scattering angle: $2\theta = 93°$
- Maximum scattering vector: Q = 2.5 Å^{-1} (at λ = 3 Å)
- Spin echo time range: τ = 0.001 – 20 ns for λ = 8 Å
- Energy resolution: 0.03 µeV – 0.1 meV

References

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