

RESEDA: Resonance spin echo spectrometer

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Abstract: RESEDA (**r**esonance **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 longitudinal neutron resonance spin echo (LNRSE, time range from 0.001 to 20 ns for $\lambda = 8 \text{ \AA}$) and modulation of intensity with zero-effort (MIEZE, time range from 0.001 to 20 ns for $\lambda = 8 \text{ \AA}$) experiments. At RESEDA, the analysis of $S(Q, \tau)$ provides characteristic parameters, e.g. relaxation time and amplitude of the dynamic processes in the sample investigated. The determination of $S(Q, \tau)$ 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 ^3He 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) small angle neutron scattering (SANS) applications.

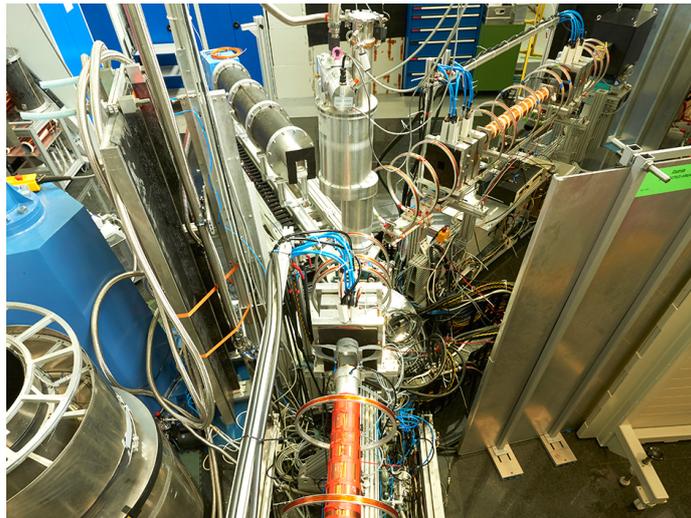


Figure 1: Instrument RESEDA (Copyright by W. Schürmann, TUM).

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

4 Technical Data

4.1 Primary beam

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

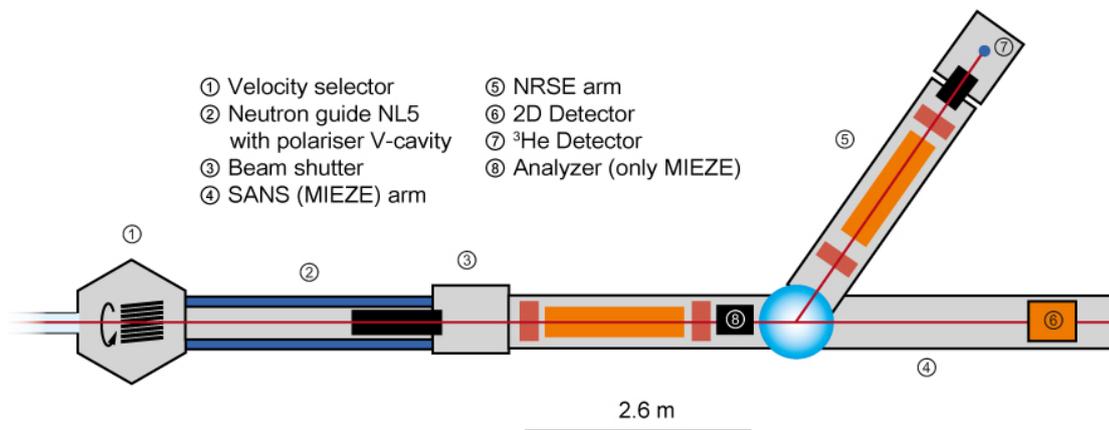


Figure 2: Schematic drawing of RESEDA.

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: ³He counter or 2D detector (CASCADE)

4.3 Characteristic parameters

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

References

- Häußler, W., Böni, P., Klein, M., Schmidt, C. J., Schmidt, U., Groitl, F., & Kindervater, J. (2011). Detection of high frequency intensity oscillations at RESEDA using the CASCADE detector. *Review of Scientific Instruments*, 82(4), 045101. <http://dx.doi.org/10.1063/1.3571300>
- Schmidt, C. J., Groitl, F., Klein, M., Schmidt, U., & Häußler, W. (2010). CASCADE with NRSE: Fast Intensity Modulation Techniques used in Quasielastic Neutron Scattering. *Journal of Physics: Conference Series*, 251(1), 012067. <http://dx.doi.org/10.1088/1742-6596/251/1/012067>