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SANS-1: Small angle neutron scattering

Heinz Maier-Leibnitz Zentrum
Helmholtz-Zentrum Geesthacht, German Engineering Materials Science Centre
Technische Universität München

Instrument Scientists:
- André Heinemann, German Engineering Materials Science Centre (GEMS) at Heinz Maier-Leibnitz Zentrum (MLZ), Helmholtz-Zentrum Geesthacht GmbH, Garching, Germany, phone: +49(0) 89 289 14534, email: andre.heinemann@hzg.de
- Sebastian Mühlbauer, Heinz Maier-Leibnitz Zentrum (MLZ), Technische Universität München, Garching, Germany, phone: +49(0) 89 289 10784, email: sebastian.muehlbauer@frm2.tum.de

Abstract: The new small angle scattering instrument SANS-1, jointly operated by the Technische Universität München and GEMS, Helmholtz-Zentrum Geesthacht, has completed commissioning and is in regular user service (Gilles et al., 2006). SANS-1 is located at the end of neutron guide NL4a in the Neutron Guide Hall West.

1 Introduction

SANS-1 is a standard pinhole SANS instrument with both 20 m collimation distance and 20 m sample detector distance, respectively. SANS-1 has been optimised by Monte-Carlo simulations to fit the restrictions in both available space and optimal usage of the provided neutron beam (Gilles et al., 2007). A vertical S-shaped neutron guide with extreme suppression of fast background neutrons is optimised for complementary wavelength packages, followed by the selector tower with two selectors for high and low resolution, respectively. Adjacent to the selector tower, a collimation system with four parallel horizontal tracks provides vast flexibility: The first track is occupied by a neutron guide system, the second track carries the collimation system with additional background apertures on track three. One track remains empty for various future applications such as focussing lenses or a longitudinal spin echo option. Two Fe/Si transmission polarisers have been optimised to cover the whole wavelength band from 4.5 – 30 Å.

The acentric mounting of the detector tube with around 2.4 m inner diameter allows to use a primary detector of 1 x 1 m^2 with lateral movement of more than 0.5 m, significantly expanding the accessible Q-range to around $Q_{max} \approx 1$ $Å^{-1}$. The primary detector is made up of an array of 128 position sensitive

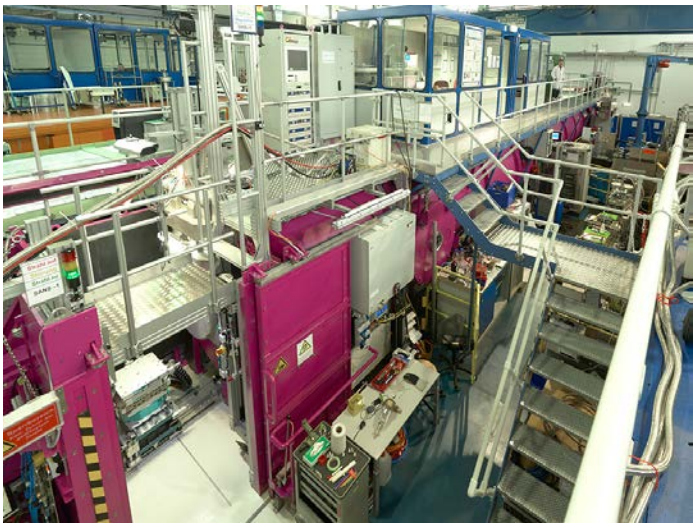

Figure 1: Instrument SANS-1 (Copyright by W. Schürmann, TUM).

tubes to provide 8 mm x 8 mm spatial resolution. A second high resolution (3 mm) detector, installed downstream of the primary detector is foreseen for 2016.

A TISANE chopper disk set-up will be available in 2015 which allows to perform kinetic neutron scattering experiments in the μs regime and simultaneously sets the stage for a later upgrade to a complete time-of-flight option for SANS-1.

2 Typical Applications

The instrument SANS-1 is dedicated to study the structure of materials on length scales of 10 to 3000 Å. With its polarised beam option, the flexible sample goniometer, the wide non-magnetic sample space and the specialised set of sample environment, SANS-1 is particularly adapted for the needs of materials research and magnetism. The precise sample goniometer carries various loads up to 750 kg and fulfills the rising demand on diffraction experiments at low scattering angles, for instance for studies of superconducting vortex lattices and other large magnetically ordered systems.

- Precipitates and segregation in alloys
- Chemical aggregation
- Defects in materials, surfactants, colloids
- Ferromagnetic correlations in magnetism
- Magnetic domains
- Polymers, proteins, biological membranes, viruses, ribosomes and macromolecules
- Superconducting vortex lattices
- Large magnetic structures such as helical magnets and skyrmion lattices

3 Sample Environment

- Standard sample changer with 22 positions
- Different types of high temperature furnaces up to 1900°C
- Deformation-rig with heating
- Set of magnets (5 T horizontal, parallel and perpendicular access, 7.5 T vertical)
- Sample changer with thermostat (-20 +200 °C), 11 positions
- Different cryostats with optional ^{3}He insert (460 mK base temp. with 5 T magnet, 50 mK with 7.5 T magnet)
- Polarisation analysis with ^{3}He cell

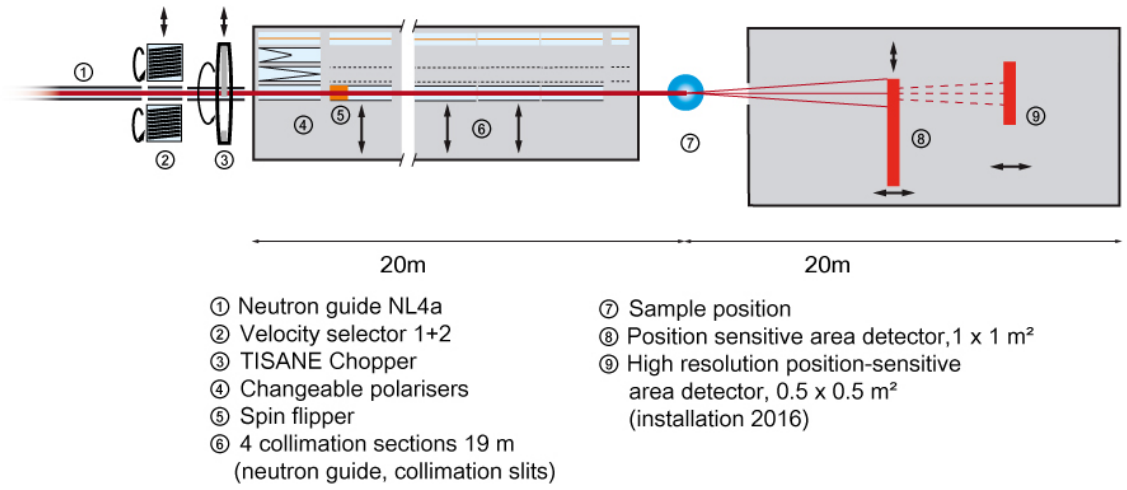

Figure 2: Schematic drawing of SANS-1.

4 Technical Data

4.1 Primary beam

- S-shaped neutron guide (NL 4a), 50 x 50 mm^2
- Mechanical velocity selectors with variable speed
  1) $\Delta\lambda/\lambda$ = 10 % medium resolution
  2) $\Delta\lambda/\lambda$ = 6 % high resolution
- Wavelength range: 4.5 Å – 30 Å
- TISANE chopper setup with µs time resolution

4.2 Polarisation

- Two V-shaped polarisers

4.3 Collimation system (source-to-sample distance)

- 1 m, 2 m, 4 m, 8 m, 12 m, 16 m to 20 m in steps via insertion of neutron guide sections

4.4 Sample size

- 0 – 50 mm diameter

4.5 Q-range

- 0.0005 $Å^{-1} < Q < 1$ $Å^{-1}$ with primary detector
- Q_{min}= 0.0001 $Å^{-1}$ with secondary high resolution detector

4.6 Detectors

- Primary detector: Array of 128 ^{3}He position sensitive tubes with an active area of 1000 x 1020 mm^2 and 8 mm resolution. Lateral detector movement up to 0.5 m, counting rate capability up 1 MHz.
- Secondary high resolution detector (3 mm) and an active area of 500 x 500 mm^2 to be installed 2016.

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