

E4: The 2-Axis Diffractometer at BER II

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Abstract: The double-axis diffractometer E4 is operated by the Helmholtz-Zentrum Berlin. It is suited for magnetic structure determinations and parametric studies on single crystals in a wide range of external conditions. Pyrolytic graphite and germanium focusing monochromators offer two fixed neutron incident wavelengths of about $1.0 \cdot 10^6 \text{ ncm}^{-2} \text{ s}^{-1}$.

1 Introduction

The instrument is primarily suited for magnetic structure determination under various conditions, which includes magnetic fields up to 17 T, temperatures down to 30 mK and hydrostatic pressures up to 10 kbar. The application of uniaxial pressure and use of auxiliary methods (e.g. electrical resistivity, ac susceptibility, pyroelectric current measurements) is also possible. The most common application is to reveal spatial arrangement ordered spin structures to study magnetic and/or crystal structure phase transitions and construction of phase diagrams. Using the polarized neutrons option facilitates the separation of magnetic contributions from nuclear scattering. The measurement of flipping ratios allows registration of very weak magnetic scattering.

The monochromator shielding contains one beam channel at $2\Theta_M = 42.5^\circ$. This position corresponds to the incident wavelength of 0.24 nm for the vertical focusing PG(002) monochromator and 0.122 nm for the double-focusing Ge(311) monochromator. Both monochromators are operated remotely. Sapphire and PG filters offer an effective suppression of unwanted epithermal and $\lambda/2$ (for PG monochromator) neutrons. Before the monochromator position a radial collimator is placed.

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The secondary flight path is conical and primarily without collimators that can be placed (with flat monochromator) optionally. Motorized slits offer a possibility to reduce the background. The additional option of polarized neutrons uses a super mirror bender and a π -flipper. The instrument runs under the system CARESS; automatic control of temperature and magnetic field is provided. An Eulerian cradle can optionally be used to access the four dimensional Q - ω -space.

The instrument is equipped with a position sensitive $200 \times 200 \text{ mm}^2$ detector before which an oscillating collimator is placed. The detector is mounted assymmetrically so that it covers below the scattering plane about 4 degrees and above about 10 degrees. The coverage in 2θ amounts to about 14 degrees.

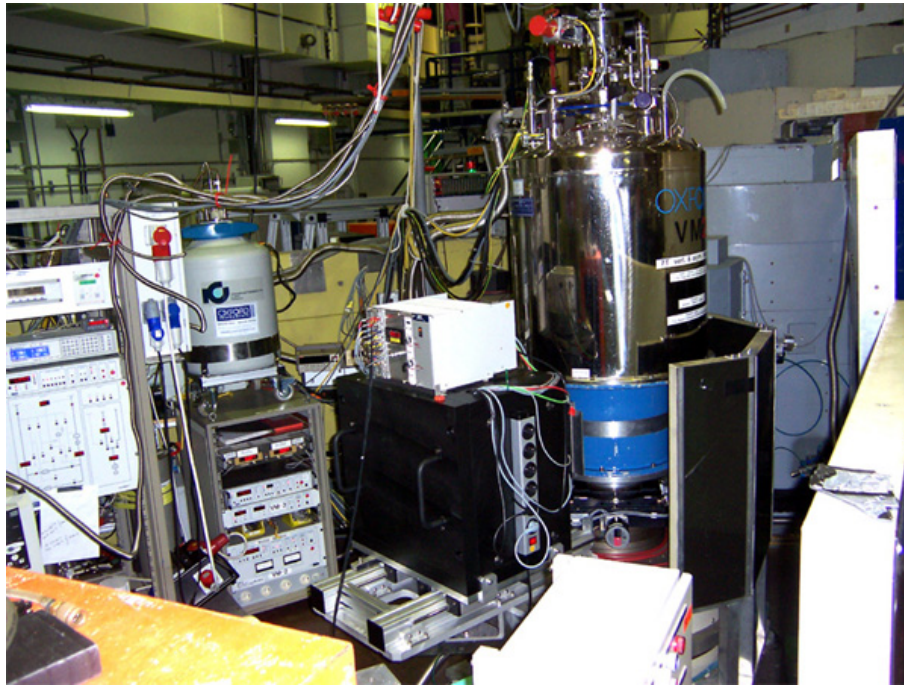


Figure 1: View of E4 with an extensive sample environment installed: the vertical cryomagnet and the dilution refrigerator.

2 Typical applications

Typical applications include:

- Magnetic structure determination
- Study of magnetic and structural phase transitions
- Determination of magnetic phase diagrams
- Study of critical points as a function of magnetic field and temperature
- Measurement of correlation functions above the ordering temperature

3 Instrument layout

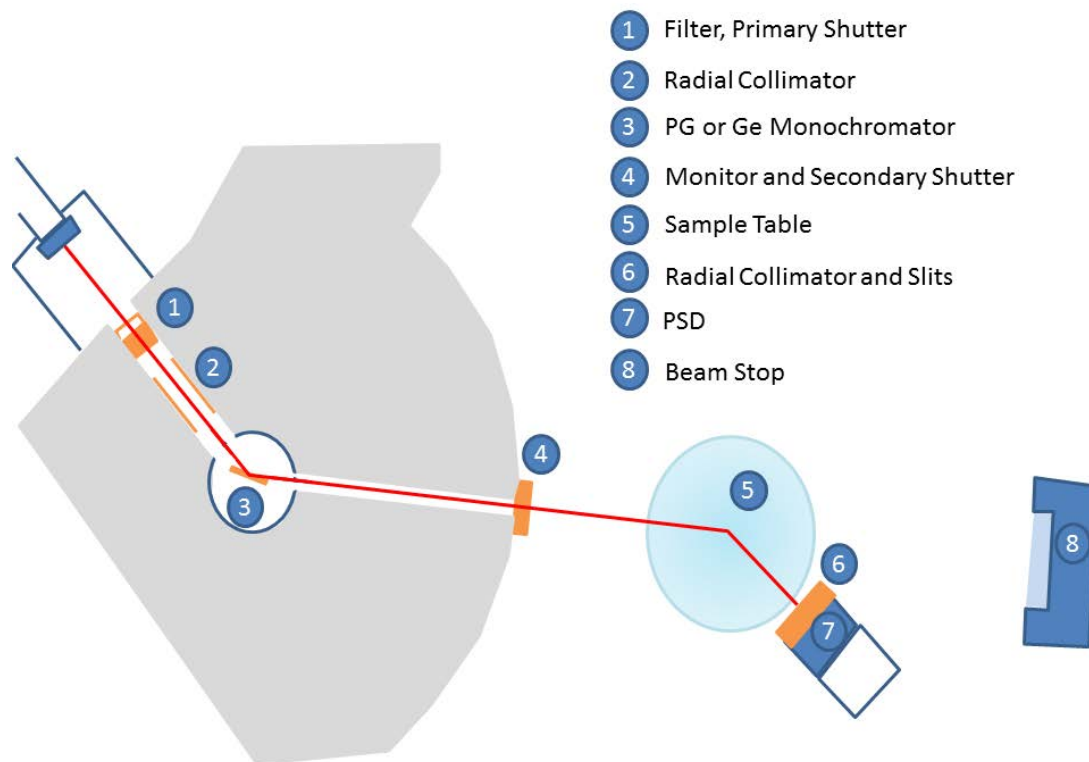


Figure 2: Schematic view of E4.

4 Technical Data

Beam tube	R 2
Collimation	automatic change of $\alpha_1 = 40^\circ$ radial, open geometrical divergence: 60° manual variation of α_2 (optional $10^\circ, 20^\circ, 40^\circ$) α_3 (oscillating radial)
Monochromator	PG (002) with variable vertical curvature Ge (113) double focusing
Take off angle of monochromator	$2\Theta_M = 42.5^\circ$
Wave length	$\lambda = 0.244$ nm (PG) or 0.122 nm (Ge)
Flux	$0.95 \cdot 10^6$ n/cm ² s (PG) $0.9 \cdot 10^6$ n/cm ² s (Ge) $0.3 \cdot 10^6$ n/cm ² s polarized (PG+bender)
Range of scattering angles	$0^\circ \leq 2\Theta \leq 120^\circ$ (with configurational restrictions related to sample environment)
Angle resolution	Depends on setting
Sample size	From 1 mm ³ for topic-focused studies
Detector	2D detector 200×200 mm ² (removable oscillating radial collimator in front), variable distance (700-950 mm)
Polarized neutrons	Yes (super mirror bender) Please contact the instrument scientist to discuss in advance
Instrument options	Polarization analysis (super mirror analysis)
Sample environment	<ul style="list-style-type: none"> • Horizontal magnetic field < 6 T • Vertical magnetic field < 17 T • Temperature range 0.03 - 600 K • Hydrostatic pressure 0 - 10 kbar • 4-circle mode
Software	CARESS, BEAN, set of supporting programs to deal with 2D data

Table 1: Technical parameters of E4.

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