

Services

– Magnetic shielding

Contact person: Dr. Allard Schnabel

Within this core facility centre we offer measurement time in three magnetically shielded rooms (MSRs) at PTB campus Berlin Charlottenburg:

- BMSR-2 (magnetic shielding factor 10^7 at $f > 0.01$ Hz) equipped with 304 SQUID vector-magnetometer system
- Zuse-MSR (magnetic shielding factor 100 at $f > 0.01$ Hz) equipped with Ultra-sensitive single-channel SQUID system for ULF NMR
- Acoustic-MSR (magnetic shielding factor 100 at $f > 0.01$ Hz) equipped with 128-channel SQUID MEG whole head system (Eagle Technologies, Japan)

These MSRs are walkable large size rooms with a special door for quick access. They offer versatile environments for various applications. Each external user will be supported by PTB experts for preparation and realization of the measurements.

– Magnetic sensors and sensor characterization

Contact person: Dr. Rainer Körber

Due to the extremely high magnetic shielding factor of 10^7 at $f > 0.01$ Hz and the special door for quick access the BMSR-2 provides ideal conditions for developing and testing new types of magnetic field sensors. The shielded environment provides several straight $\text{Ø}50$ mm feedthroughs for cables. The permanently installed 304 SQUID vector magnetometer can be used as a reference detector. Signals can be recorded at up to 24 bit resolution using custom made data acquisition units. Each external user will be supported by PTB experts for preparation and realization of the measurements.

– Manufacturing non-magnetic setups and material characterization

Contact person: Dr. Jens Voigt

A sensitive magnetic measurement requires negligible flux density interference by residual magnetism of the support structures and experimental setup. Therefore, we perform a thorough characterization of the magnetic properties of each individual component of the setup. For the construction of non-magnetic measurement setups, PTB has established a specialized workshop dedicated to the processing and the machining of non-magnetic plastics, including a 3D printing device. Within this core facility centre we offer consulting and characterization regarding the measurement setup.

– Biosignal acquisition and processing

Contact person: Dr. Tilmann Sander-Thömmes

Within this core facility centre we offer biosignal acquisition and processing for multichannel recording with our 128-channel whole head MEG or 304-channel SQUID device. In-house expertise enables the rapid conversion between different data. Often the combination of MEG with medical imaging data is required. For this, a clinical 3T MRI scanner is available on the PTB campus (note: the scanner is not part of the core facility centre). An example involving multi-

modal signal acquisition is the study of Parkinson's patients undergoing deep brain stimulator treatment. In addition to PTB support, the external user need is on ethics for the measurement and a medical attendant for the patient or volunteer.

– **Nuclear spin precession of polarized noble gases**

Contact person: Dr. Lutz Trahms

Precision measurements of nuclear spin precession at ultra-low magnetic fields may reveal the presence of minute interactions of the spin system with their environment which go beyond the physics of the standard model, such as e.g. the interaction with

- a hypothetical cosmic background field that may violate Lorentz invariance
- axions or axion-like particles that are considered candidates for dark matter
- externally applied electric fields due to the presence of a nuclear electric moment that violates CP symmetry.

Within this core facility centre we offer technology that is needed for such experiments, i.e. in particular, optical polarization of ^3He and ^{129}Xe nuclei in the gaseous phase, generation of homogeneous and stable ultra-low fields in the shielded environment of BMSR-2 that facilitate life times $>100\text{h}$ (^3He) of coherent spin and data acquisition systems that enable the observation of nuclear precession via SQUIDs over several days. Each external user will be supported by PTB experts for preparation and realization of the measurements. Additional materials i.e. noble gases have to be purchased.

– **Characterization of magnetic nanoparticles**

Contact person: Dr. Frank Wiekhorst

The application of magnetic nanoparticles (MNP) opens novel pathways in cancer therapy and non-invasive diagnostics. In addition, MNP may enable new therapy concepts, e.g. by heating areas (tumors) through interaction of MNP with external magnetic fields. The development of such diagnostic and therapeutic approaches requires detailed knowledge of the physical properties of MNP, which can be obtained by advanced magnetic measurement techniques. By basic characterization measurements a variety of MNP parameters can be acquired, such as saturation magnetization, magnetic moment distribution, hydrodynamic and core diameter distribution, effective anisotropy, dynamic susceptibility. Additionally, considering especially their biomedical in-vivo application, further parameters of MNP have to be examined, in particular changes of magnetic properties due to interaction with the physiological environment, aggregation behavior in physiological media, binding capacity to biomolecules and blood half life and clearance. Within this core facility centre we offer metrological infrastructure listed in attachment 2c with dedicated measurement protocols to accomplish all these tasks. Each external user will be supported by PTB experts for preparation and realization of the measurements.

– **Ultra-low-field NMR/MRI**

Contact person: Dr. Rainer Körber

Nuclear magnetic resonance at field strengths below the earth magnetic field has a long history. Recently, the use of SQUIDs for detecting low frequency signals has evoked renewed interest in ULF NMR. Within this core facility centre we offer an ULF NMR measurement setup with a frequency resolution of a few millihertz. The minute residual field and field gradients in the BMSR-2 enable NMR e.g. at ^1H Larmor frequencies down to 4 Hz. Each external user will be supported by PTB experts for preparation and realization of the measurements.