Shielded rooms for OPM based MEG and MCG

T.H. Sander[1], A. Jodko-Wladzinska[1,2] , S. Hartwig[1], A. Schnabel[1], J. Voigt[1], L. Trahms[1], and T. Middelmann[1]

[1] Physikalisch-Technische Bundesanstalt, Germany
[2] Warsaw University of Technology, Warsaw

Biomagnetic methods as MEG or MCG can gain a lot from the flexibility of miniaturized optically pumped magnetometers (OPM). High-sensitivity OPMs rely on close to zero internal field. This can be achieved by adequate shielding against external magnetic fields providing low residual fields and residual field gradients, respectively. Current commercial zero-field OPMs tolerate static fields up to 200 nT as internal field compensating coils reduce the 200 nT to the physically required static fields of less than 5 nT, which then allow to record dynamic field changes of the same size. Here we demonstrate results of MEG and MCG measurements performed in two different magnetically shielded rooms (MSRs).

In two-layer MSRs such as, e.g. [1], with active external shielding and after degaussing static fields < 50 nT and dynamic field amplitudes < 2 nT can be achieved. This is sufficient for multichannel MEG with a stationary subject. Mounting the sensors in a wearable 3D-printed structure the array geometry is fixed to the subject's head and the subject is seated at rest. The remaining difference in static field across the array, i.e. the internal gradient of the room in the range of a few nT/cm, is compensated individually by each sensor.

For subjects moving as in exercise MCG a static and dynamic shielding as realized by an 8-layer MSR [2,3] allows almost unlimited experimental protocols. The static fields below 1 nT and small gradients with correspondingly small dynamic field amplitudes do not require compensation of individual sensors.

The results show the potential of OPMs to complement existing SQUID arrays if a two-layer room can be upgraded to have active shielding. Measurements involving subjects movements are still restricted to multilayer rooms or require advanced compensation coils as in [4].

[1] https://ww.vacuumschmelze.com/fileadmin/Medienbiliothek_2010/Downloads/HT/MSR_2018.pdf
[2] Bork J, Hahlbohm H-D, Klein R, Schnabel A (2001) The 8-layered magnetically shielded room of the ptb: design and construction. In Nenonen, Ilmoniemi, and Katila, eds, Proc. BIOMAG 2000, pages 970- 973. Helsinki University of Technology
[3] https://www.ptb.de/cms/en/ptb/institutes-at-ptb/geraetezentrum-8-2/technical-equipment.html
[4] Boto E, et al. (2018) Moving magnetoencephalography towards real-world applications with a wearable system, Nature 555: 657661