Measurements of biomagnetic fields with optically pumped magnetometers in weakly shielded environments

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The aim of this work is the development of optically pumped magnetometers (OPM) which are suitable for the detection of biomagnetic fields with lower requirements on the shielding factor to suppress the ambient magnetic field than needed for well-established SQUID- and SERF-OPM- based setups. Our sensor is operated in the Light-Shift Dispersed Mz (LSD-Mz) regime [1] which enables a magnetic-field resolution on the order of tens of fT/√Hz even at Earth's magnetic-field strengths. It is based on a micro-fabricated Cs vapor cell assembly [2] filled with nitrogen buffer gas consisting of a cesium-reservoir compartment connected to two identical cavities with optical windows on both sides. The cell structure is electrically heated to about 100°C. Through each of the two cavities two circularly polarized laser beams with opposite helicity tuned near the Cs-D1 transition are guided for optical pumping of the Cs atoms and their readout. By this approach, on one hand, the LSD-Mz magnetometer signals from the two cavities 40mm apart allow for compensation schemes of magnetic field noise from distant sources relaxing the demands on magnetic shielding. On the other hand, the signal of interest resulting from a (biomagnetic) source close to one of the measurement volumes remains detectable.

In this contribution, we will show the sensor setup and parameter characterization. Measurements carried out on a phantom (Fig.1) inside a shielded room as well as results on the noise compensation in unshielded environments will be discussed.

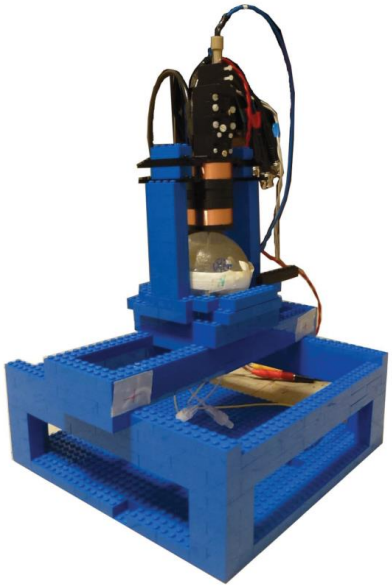

Figure 1. OPM measurements of a phantom. The sensor is mounted on top using LEGO bricks.

[1] V. Schultze, B. Schillig, R. IJsselsteijn, T. Scholtes, S.Woetzel, and R. Stolz, An Optically Pumped Magnetometer Working in the Light-Shift Dispersed Mz Mode, Sensors **17**, 561 (2017).

[2] S. Woetzel, V. Schultze, R. IJsselsteijn, T. Schulz, S. Anders, R. Stolz, and H.-G. Meyer, Microfabricated atomic vapor cell arrays for magnetic field measurements, Rev. Sci. Instr. **82**, 033111 (2011).