Magnetorelaxometry using Twinleaf's OMG

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We operate the commerically available "OMG (Optical Magnetic Gradiometer)" from Twinleaf with the aim of measuring the relaxation of previously aligned magnetic moments of magnetic nanoparticles (MNP). The OMG with a sampling rate of 1 kHz consists of two free induction decay (FID) magnetometers, forming a software-gradiometer with a baseline of 2.3 cm. The noise floor measured within a two-layer magnetically shielded room ($B_0 = 7\,\mu T$) and in a laboratory environment (Earth's field at 52 µT) is shown in Fig. 1. Within the shield, a magnetometer sensitivity of about $300\,fT/\sqrt{Hz}$ at 500 Hz was measured. The high power pulsed pumping of the OPM allows for low deadtime measurements after switching off mT fields, used for the alignment of MNP's magnetic moments. A low deadtime is desired to acquire early parts of the exponentially decaying magnetic field of the MNP. For the same reason the requirement of a high bandwidth (>10 kHz) arises, which can be achieved by FID and instantaneous-phase retrieval [1]. An unshielded 1 kHz and high bandwidth measurement is shown in Fig. 1.

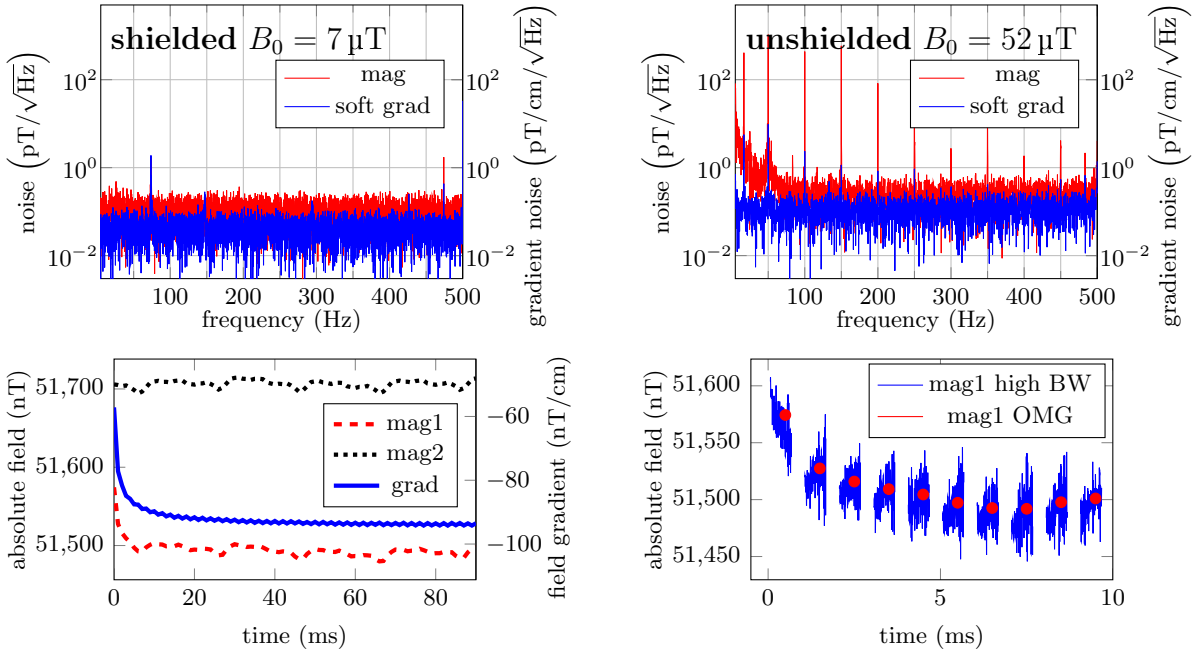

Figure 1. top: noise floor in shielded and unshielded environments. **bottom left:** relaxation signal of MNP, acquired by OMG electronics. **bottom right:** high bandwidth estimation of the magnetic field by analyzing the raw FID sidnal. The data was not averaged. The MNP's iron amount in this early measurement is several times higher than usually found in clinics.

As the first customers with an OMG, we will share our first shielded and unshielded experiences with the community. We will discuss dead time and high bandwidth measurements.

[1] N. Wilson, C. Perrella, R. Anderson, A. Luiten, P. Light, Wide-bandwidth atomic magnetometry via instantaneous-phase retrieval, Physical Review Research, **2**(1), 013213 (2020).