Integrated optically pumped magnetometer system for measurements within Earth's magnetic field.

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We present a portable optically pumped magnetometer instrument for ultra-sensitive measurements within the Earth's magnetic field [1]. At the heart of the sensor head is a MEMS-based two-compartment Cs vapor cell operated in the light-shift dispersed Mz mode [2]. The sensor system includes a compact, battery-driven electronics unit designed for in-field use. We will review the working principles of the device and detail on the realization of both, sensor head and electronics. We show shielded and unshielded measurements within a static magnetic field amplitude of 50 uT demonstrating a noise level of the sensor system down to 100 fT/rtHz and a sensor bandwidth of several 100 Hz. Careful analysis of noise sources reveals dominating technical limitations with straightforward strategies for further improvements towards the sensors' fundamental noise limit of 12 fT/rtHz. We compare the sensor system's performance to a commercial SQUID system within a measurement environment typical for geomagnetic observatory practice and geomagnetic prospection.

[1] G. Oelsner et al., Integrated optically pumped magnetometer for measurements within Earth's magnetic field, arXiv:2008.01570 (2020).
[2] V. Schultze et al., An optically pumped magnetometer working in the light-shift dispersed Mz mode, Sensors 17, 561 (2017).