Optically pumped magnetometer for biomedical applications

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We have developed a highly sensitive optically pumped magnetometer (OPM) based on cesium atomic vapor. The magnetometer is operated at room temperature and is well suited for biomedical applications. Using that magnetometer, we have performed proof-of-principle experiments where we have detected nerve impulses in a frog sciatic nerve [1] and the heartbeat of an isolated guinea-pig heart [2]. OPMs could potentially also be used to non-invasively image the electrical conductivity of biological tissue using a technique called magnetic induction tomography. This is a challenging task due to the low conductivity $\sigma \lesssim 1 \text{ S/m}$ of biological tissue. As a step towards imaging biological tissue, we have detected small containers with a few mL of salt-water with conductivity ranging from 4–24 S/m (see Figure 1). For those measurements, we employed a noise-canceling differential technique which increased the signal-to-noise ratio by more than three orders of magnitude. Our work [3] opens up new avenues for using OPMs to image low-conductivity biological tissue including the human heart which would enable non-invasive diagnostics of heart diseases [4].

Figure 1. Detection of a salt-water with varying conductivity.