

Pulsed intrinsic gradiometer operating in Earth's field

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We monitor the free precession decay of ^{87}Rb alkali atoms in two vapor cells to form an all-optical gradiometer with 3 cm baseline that operates in Earth's field. A train of high intensity short σ_+ pump pulses ($< 1 \mu\text{s}$) initializes ^{87}Rb atoms with polarization near unity, giving spin-exchange relaxation suppression needed for long acquisition times at high ^{87}Rb densities. We obtain a sensitivity at $50 \mu\text{T}$ of about $10 \text{ fT}/\text{cm}\sqrt{\text{Hz}}$ in a frequency range of 1-150 Hz.

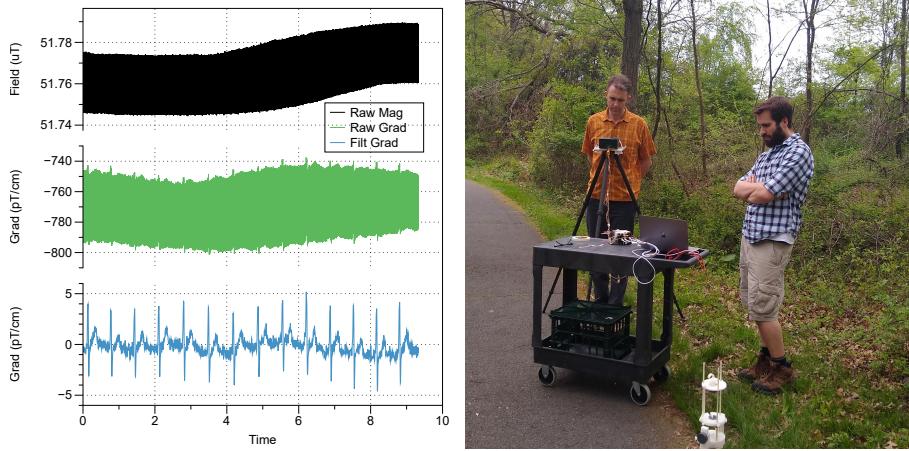


Fig. 1 (Left) Proof-of-concept magnetocardiogram using Twinleaf's pulsed intrinsic gradiometer (PIG) in Earth's ambient environment. The top plot is a single cell magnetometer signal, the middle plot is the gradiometer signal, and the lower plot is the gradiometer signal with 60 Hz notch and roll-off filter applied. (Right) The gradiometer and control electronics can be ran off a laptop battery.

We discuss several research involving this work, including unshielded biomagnetic measurements (see Fig. 1). We also discuss the continued development of a frequency counter capable of measuring sub-10 $\text{fT}/\text{cm}\sqrt{\text{Hz}}$ with our gradiometer.