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Long-baseline Single-layer 2nd-order High-T_c SQUID Gradiometer

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We have designed and fabricated 2nd-order high T_c SQUID gradiometers with a 30 mm long baseline. We used the same design rule as in our previous study on short baseline gradiometers. Three linearly aligned 10 mm × 10 mm pickup loops were coupled directly to a dc SQUID to measure $\partial^2 B/\partial x^2$. The devices had an overall size of 70.2 mm × 10.6 mm and were patterned from the single layer of $YBa_2Cu_3O_7$ films on sapphire substrates by argon ion milling with a photoresist mask. The junctions of the SQUID were formed by focused ion beam. Balancing of the device was achieved by optimizing the inductance of the center loop. Sensitivity of the gradiometer was estimated to be 1.8×10^{-10} T/m^2/Hz$^{1/2}$, which is equivalent to a field noise of 160 fT/Hz$^{1/2}$, for an intrinsic SQUID flux noise of 10^{-5} ϕ_0/Hz$^{1/2}$. For a typical heart pulse of 50 pT at the chest surface, the expected signal size of the gradiometer in the transverse mode with the baseline perpendicular to the frontal plane was about 10 pT, which is 2 orders of magnitude larger than the sensitivity. Details of noise properties, balancing procedures, and measurements of cardiomagnetic signals will be discussed.

keywords : SQUID, second-order gradiometer, magnetocardiography