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Multichannel on-scalp MEG based on high-Tc SQUID magnetometers

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Recent development of high-T_c SQUID magnetoencephalography (MEG) has shown the potential of the technique both as a possible replacement for the traditional low-T_c systems [1-5] and for increased information capacity from the close proximity to the brain [6]. SQUID magnetometers made from single layer high-T_c superconductors usually have an order of magnitude or more higher noise than their multilayer low-T_c counterparts. However, for MEG applications, the simpler cryogenic requirements make it possible to decrease the sensor-to-head distance from 20 mm to approximately 1 mm, retaining the signal-to-noise ratio. Furthermore, higher spatial resolution could be obtained and higher moments of the sources could be resolved from near-field measurements. Here, we report on benchmarking of high-T_c vs. low-T_c MEG and on the development of a multichannel high-T_c MEG system. The system is configured with a densely-packed set of seven 8.6 mm x 9.2 mm high-T_c SQUID magnetometers positioned in a slightly concave hexagonal pattern on a sapphire window connecting thermally to a liquid nitrogen bath. A method of direct feedback injection to the SQUID loops was chosen to minimize crosstalk between the sensors. To improve the field sensitivity, we have developed a new method to produce high-T_c flux transformers for flip-chip arrangements for the next generation MEG system. Finally, we are investigating the possibility to use high-T_c nano-wire based SQUIDs as magnetometers for MEG in future systems.

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