Abstract—We report a retro-reflection probing design of an brain atomic magnetometer (AM) for magnetoencephalography (MEG), which has a wide measurement area over a human head. In comparison with a superconducting quantum interference device (SQUID)-based MEG system, the AM system has advantages of comparable or higher sensitivity, no need for liquid helium consumption and easy to implement multi-channel recording. Tangential field component recording with a retro-reflection probe scheme enables to localize the MEG source current dipoles.

I. INTRODUCTION

Previously, a high-density alkali-metal vapor atomic magnetometer (AM) based on semi-conductor laser optical pumping techniques has been reported to have a comparable sensitivity to a superconducting quantum interference device (SQUID) magnetometer even without cooling down in consumption of liquid helium [1]. With a multichannel AM system, we succeeded in measuring auditory evoked magnetoencephalographic (MEG) signals [2] and its signal-to-noise ratio is comparable to that of a SQUID-based MEG system [3, 4]. However, due to a small coverage of sensing area and the blind direction of probe beam, it was impossible to localize the source current dipole and a new design was required.

II. DESIGN

In neuroelectric source localization, it is essential to obtain a wide enough magnetic field distribution. Therefore, we design a new system using a rectangular pancake-shape cell. The size of the K-cell is 136x136x50 (mm), which is wide enough to localize a neuroelectric excitation on the neocortex. It is the largest rectangular AM cell ever made. Specifically, the probe beam is reflected back to the light source and measured so that the beam path may be doubled. With an alternative orthogonal pumping scheme, the probe beam measures the two orthogonal tangential components (TC) of the magnetic fields. The TC measurement, in which the probe beam is normal to the skull, circumvents loss of position information along the beam path and prevents clipping of extremes in a magnetic field pattern that happens in measuring the normal components with a system having a limited detection area. To get an even pumping profile through the cell and to eliminate the light shift caused by detuning, we utilize two laser sources for pumping which are symmetrically detuned from the optical resonance. In a preliminary test, the single-channel noise level of the newly built system is similar to that of the previous system in the AEF operation, ~20 fT/√Hz. With the recordings of this system, we will demonstrate that the localization of the current dipole source is possible.

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REFERENCES


