# High-Density OPM-Array Simulations for Clinical Brain-Computer Interfaces (BCI)

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Optically-pumped magnetometers (OPM) were successfully introduced as a powerful neuroimaging tool, offering a number of advantages over super-conducting quantum interference devices (SQUID) or nitrogen vacancy centers (NVC) [1]. Besides working at room-temperature, OPMs can provide much higher spatial resolution comparable e.g. to invasive electrocorticography (ECoG). This makes OPMs not only very appealing for neurodiagnostics, e.g. to locate an epileptic focus, but also for noninvasive brain-computer interfaces (BCI), e.g. controlling robots or exoskeletons. It is unclear, however, which sensor geometry would be optimal for such high-density recordings across these different clinical BCI applications. Here, we simulated a single superficial source dipole with complex broadband brain noise activities to imitate brain activity in a motor-imagery task. The resulting projected magnetic field is then imaged by our simulated OPM sensor array with multiple different configurations.

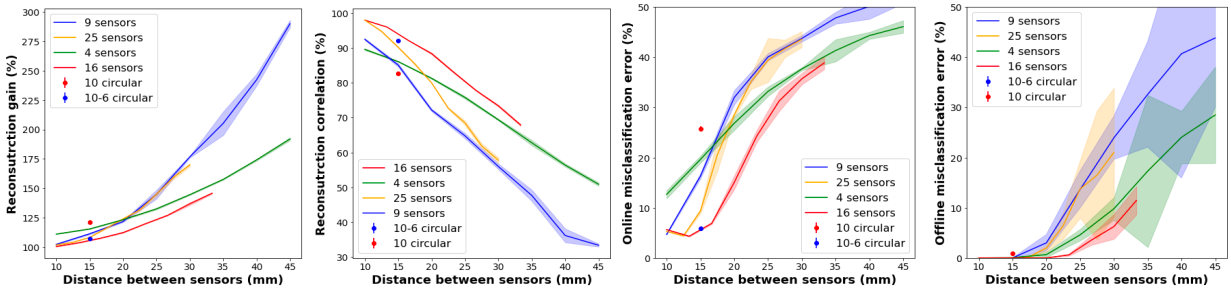


Figure 1: Four performance measures of six different sensor configuration simulations are shown. Four square grid sensors configurations (2x2, 3x3, 4x4, 5x5), and two circular configurations with a single and double concentric circle (6 inner- and 10 outer) were compared. All sensors were equally spaced.

We found that 16 sensors in a square grid configuration with 13 mm spacing between each sensor (40 $mm^2$ area) yields the best overall result. These findings have to be validated in empirical BCI studies, e.g. to decode whole-arm exoskeleton movements.

## References

[1] T.M. Tierney et al. “Optically pumped magnetometers: From quantum origins to multi-channel magnetoencephalography.” NeuroImage **199**: 598-608 (2019).