

Miniaturization of Medical Sensors for Magnetoencephalography

(Creating a new generation of MEG OPM sensors)

Context and objectives

Human brain attracts a lot of attention by being probably the most important organ defining our behavior, our thoughts, our personality and by still being probably the most unexplored of all of the human organs. There is already a progress in the study and treatment of such neurological disorders as epilepsy, Alzheimer's and Parkinson's diseases, sclerosis, migraine, autism, brain tumor... Still, the development of new techniques and methods for brain imaging are in a great demand. Magnetoencephalography is a functional neuroimaging technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain, using very sensitive magnetometers. For instance, such techniques are used as a clinical routine for the functional brain mapping and for the seizure focus resection – the most common type of epilepsy surgery.

Mag4Health develops a new generation of non-invasive magnetometers for MEG and an entire new MEG system to allow the imaging of the brain activity in real time with surgical precision. Thanks to the patented quantum technology working at room temperature, we are free from the cryogenic units, which are still the major obstacle for the adoption and commercialization of 'traditional' MEG systems (such systems can weight up to 10 tons and cost ~ 10M\$ for 10 years of work). The democratization of the MEG technique thanks to Mag4Health magnetometers would allow the emergence of new clinical applications, expansion of the technique in both clinics and research centers, its use for early diagnostics and even for emergency services.

Mag4Health is a young startup born at the CEA Grenoble. Today the team consists of 8 people working on the development, fabrication and commercialization of MEG systems for hospitals and medical research centers. The key component of our system is a magnetometric sensor, based on the optical pumping of ⁴He atoms. Our technology is already developed and the sensor design is mature enough to be industrialized. The current sensor model has entered the serial production stage and will be used in Mag4Health commercial MEG systems next years. However, even if the sensors show great performances today, its development would not stop, as we believe that our technology is still far from reaching the limit. Moreover, from the technical point of view it would be interesting to create a smaller/lighter/cheaper sensor without any deterioration of its performances.

The principle objective of the internship is to create a new model of MEG OPM sensor aiming the miniaturization of the sensor size (but not only!). The goal is ambitious and the project will touch all the aspects of the sensor development: starting from the physical principles of its operation, through the improving of the current optical and electronic schemes, new mechanical design, toward an industrially reasonable prototype. In your journey you will be supervised by our industrial research engineer and can count on the help of the entire team, however we expect a certain level of autonomy and creativity. The internship can (should) be considered as a pure R&D project which will start from preparing an experimental setup, performing a number of experiments and simulations and then, following the results, an adaptation (or a creation) of a new sensor design keeping in mind medical, industrial and commercial aspects (patient safety, sensor ergonomy, ease to use and to fabricate, cost, robustness, aesthetics, etc). The internship will allow you to test yourself in different aspects of R&D and

industrialization of medical devices, will give experience in optical and mechanical design, electronics, medical applications. The project is ambitious and we will not demand its accomplishment, but a progress toward the objective. An opportunity to continue within our team after your internship (as a PhD student) is possible and would be discussed.

Practical information

The internship will take place among the Mag4Health team, currently housed at the CEA Grenoble – ‘Presqu’île scientifique’, in less than 10 minutes by foot from Grenoble train station.

Desirable date to begin: 1st quarter of 2023

Candidature

The internship is proposed to M2 students (last year of M.S.) having a strong aptitude to experiments and engineering.

An experience in optical and mechanical design as well as a basic knowledge of the corresponding software (for ex, OSLO and SolidWorks) is desirable but not mandatory – otherwise you will learn it during the internship.

You should be fluent at least in English or French.

The candidature must include a CV and a motivation letter and to be send to the following contacts.

Contacts

The candidates are welcome to send their application to:

sm@mag4health.com – Dr. Sergey Mitryukovskiy, industrialization lead