Bio-magnetism with optically pumped magnetometers

AIM: High sensitivity optically pumped magnetometers (OPMs) for bio-magnetic measurements

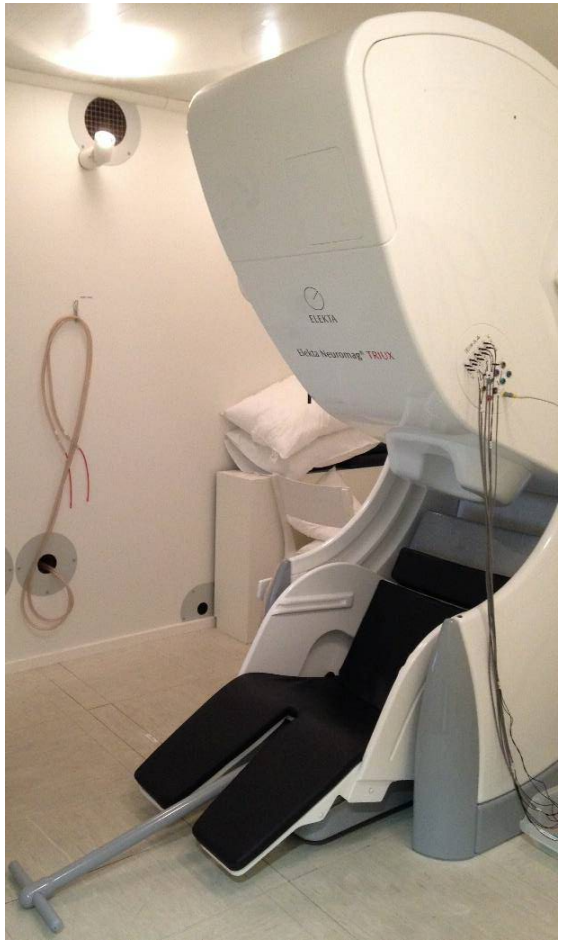
Enabling technology :

- Anodically bonded alkali vapour cells (Collaboration University of Strathclyde)
- VCSEL lasers for low power and compact package integration
- Magnetically shielded room

Principles and goals:

- Thermal atoms operation in spin-exchange relaxation free (SERF) regime.[3]
- Magnetic field sensitivity of ~ 10 fT/√Hz
- Perform magnetoencephalography (MEG) [4] and magnetospinography (MSG) on healthy subjects

Performance Parameters	OPM	SQUID
Distance Scalp-Sensor	4mm	2-4 cm
Sensor arrangement	Flexible	Fixed
Reference channel locations	Flexible	Inside Dewar
Sensor temperature	Heating > 60 °C	Cyrogenic cooling
Sensitivity	1-100 $fT/Hz^{1/2}$	3 $fT/Hz^{1/2}$
Bandwidth	DC - 1 kHz	DC - 10 kHz
Number of sensors	~20 currently	300 commercially
Large array status	Yet to be fully demonstrated	Well characterised

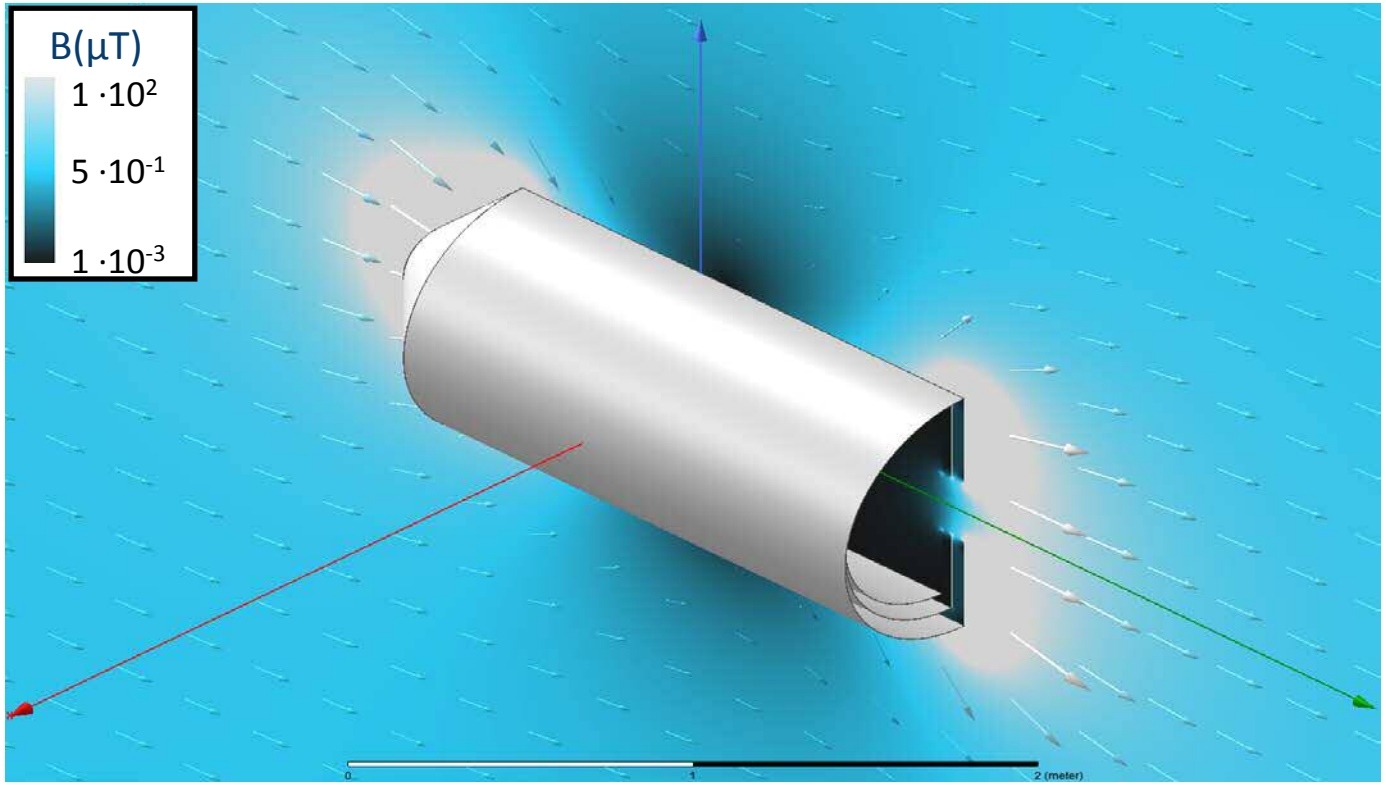


Vacuumschmelze Magnetically shielded room and Elekta MEG system

[1] Kominis et al. Nature, **422**, 596, (2003)
[2] Boto et al. NeuroImage, **149**, 404 (2017)

Magnetic Shields
Electromagnetic Engineering

- Developing low-cost magnetic shielding capabilities in conjunction with Magnetic Shielding Ltd
- Adapting active magnetic shielding to develop clinical solutions capable of providing higher comfort levels for patients
- Monitoring of the central nervous system should allow the study of a range of progressive degenerative disease.



Sumiya et al., Scientific Reports, 7, 2192 (2017)