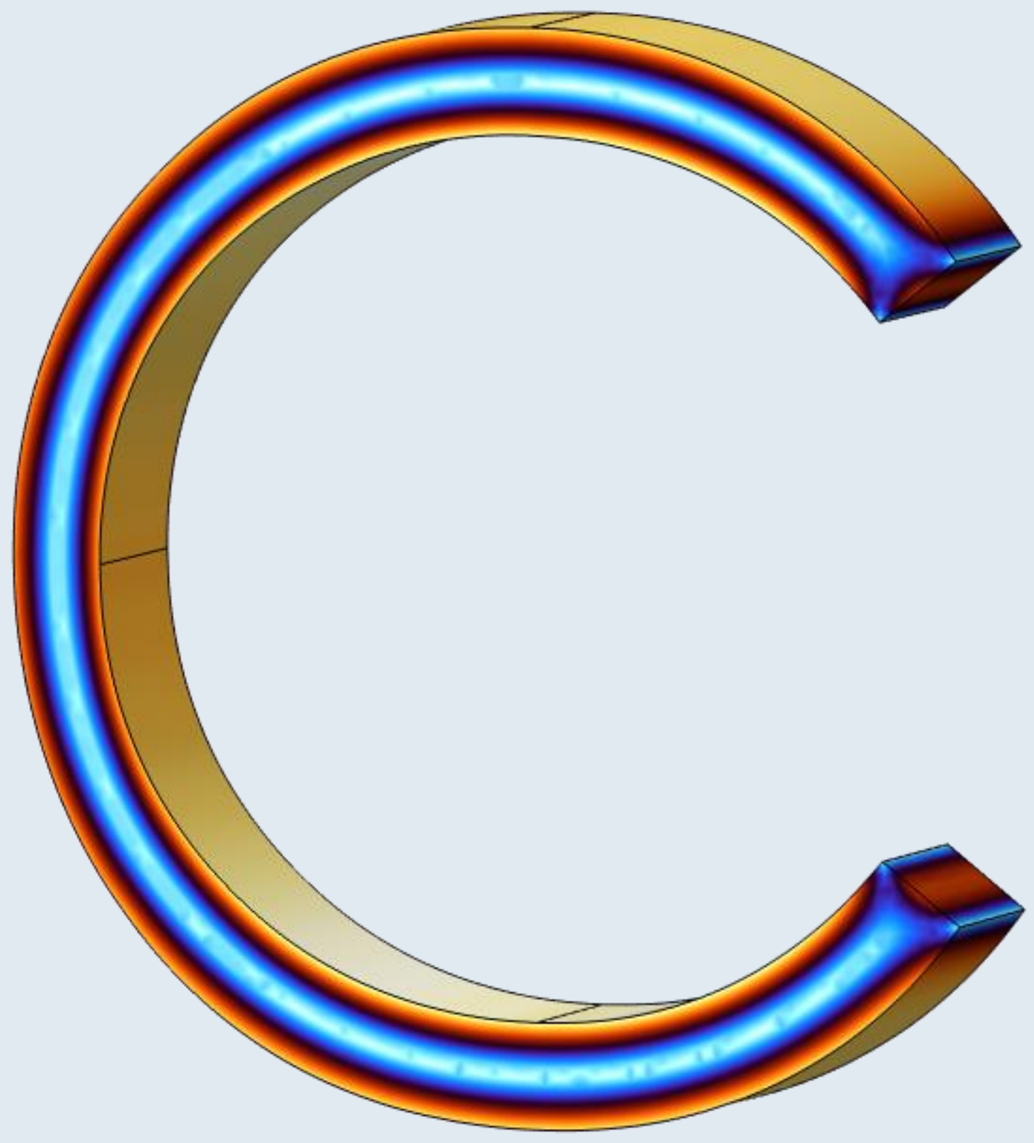


Analysis of a Magnetic Induction Tomography system

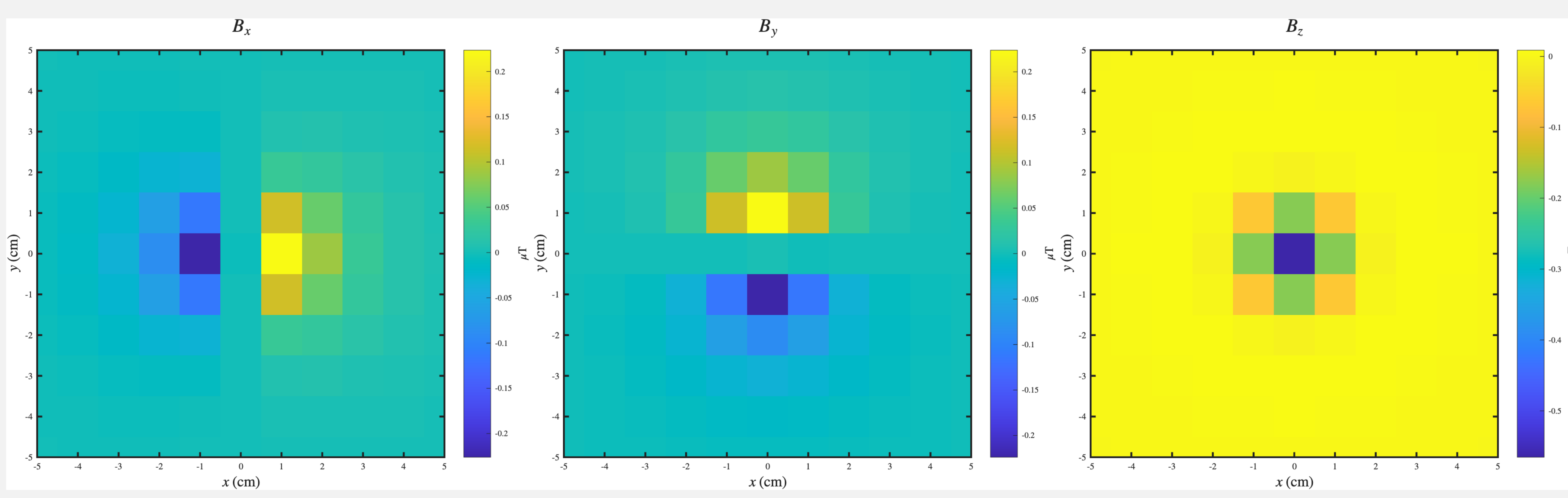
A COMSOL simulation of MIT paving the way towards the imaging of low conductivity objects with potential applications in medicine, industry, and geophysical surveying.

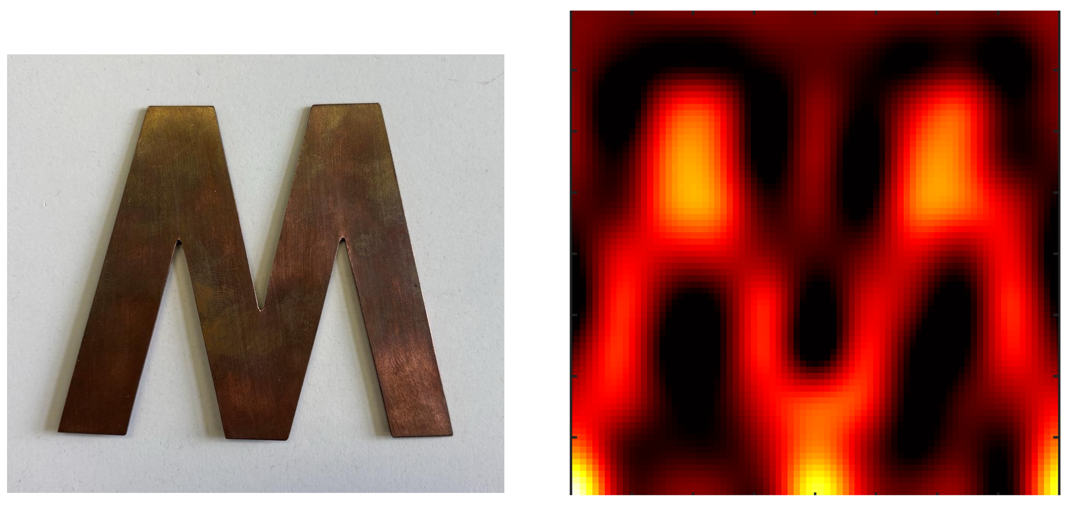
J. Eccleston Etxeberria[1], T. Smith[1], A. Ray[1], N. Peralulalan[1], A. Davis[1], C. Morley[1], A. Taylor[1], T. M. Fromhold[1], N. Holmes[2, 3]

1. School of Physics and Astronomy, University of Nottingham, University Park, Nottingham, NG7 2RD, UK.
2. Sir Peter Mansfield Imaging Centre, School of Physics and Astronomy, University of Nottingham, University Park, Nottingham, NG7 2RD.
3. Cerca Magnetics Ltd, Unit 7 \& 8, Office Village, Castle Bridge Rd, Kirtley Dr, Nottingham NG7 1LD.

Introduction

Magnetic Induction Tomography (MIT) consists of mapping the conductivity of an object by inducing eddy current through a primary magnetic field and measuring the secondary field produced by the eddy currents. The goal is to be able to perform MIT for objects of low conductivity (e.g. human tissue and saline (Ref. 1)) using Optically Pumped Magnetometers (OPMs). This poster outlines initial progress towards such a system.





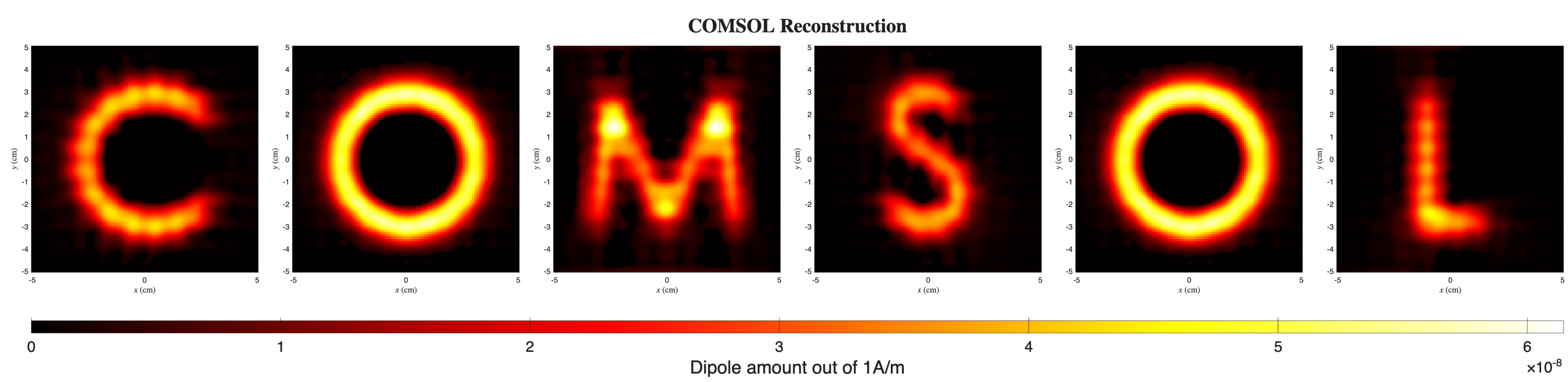
Left figure shows a copper M and right figure shows MNE reconstruction of the secondary field due to it. The measurement plane was an 8 cm by 8 cm square grid with points spaced 8 mm apart and a forward model based on 1 mm pixels. Frequency and primary field used were 900 Hz and 1.8 μT, respectively.

Methodology

The imaging algorithm used is based on **Minimum Norm Estimation (MNE)** (Ref. 2). The system is approximated through a simple magnetic dipole model described by $d = Ls$, where d is the measured secondary field at every point on the measurement plane, L is the sensitivity matrix of the system, and s is the dipole source distribution in the volume of interest (the "universe"). The L matrix elements encode the effect that a dipole anywhere in the universe has on every point in the measurement plane.

Inverting $d = Ls$ is most often an ill-posed problem. However, through simplifying assumptions and using a regularisation value α, we may approximate s by $s = L^T(LL^T + \alpha\mathbb{I})^{-1}d$.

Results



Reconstruction of copper 'COMSOL', each letter 1 cm thick. The measurement plane for (a)-(c) was a 10 cm by 10 cm square grid 1 cm from the object of interest with points spaced 1 cm apart and a forward model based on 1 mm pixels. Frequency and primary field used were 50 Hz and 150 \(\mu\)T respectively. In the case of (c), this was repeated for each letter.

REFERENCES

1. Kasper Jensen et al. "Detection of low-conductivity objects using eddy current measurements with an optical magnetometer". In: Phys. Rev. Res. 1 (3 Nov. 2019), p.033087.
2. Olaf Hauk. "Keep it simple: a case for using classical minimum norm estimation in the analysis of EEG and MEG data". In: NeuroImage 21.4 (2004), pp. 1612–1621. ISSN: 1053-8119.

University of Nottingham UK | CHINA | MALAYSIA

AWE NUCLEAR SECURITY TECHNOLOGIES