Optimised Passive Magnetic Shielding System For CubeSat Applications

T. Smith[1], A. Davis[1], J. Eccleston Etxeberria[1], I. Maskery[1], N. Holmes[1], T. M. Fromhold[1]

[1]University of Nottingham

Abstract

The majority of emerging quantum technologies require strict control over their magnetic field environment for their successful operation, and many others for benchmarking (like quantum magnetometers). The best control over magnetic field environment can be achieved with the combination of intricate coil systems and high permeability magnetic shielding (known as hybrid magnetic shielding)[1]. The passive shielding component of such systems is often the heaviest. Lightweighting of passive shielding is therefore extremely desirable in handheld and space-based applications of quantum technologies. Presented in this talk is a method utilising COMSOL Multiphysics that allows the shape of passive shielding to be optimised to both improve its performance and reduce its weight.
In this talk, a previously designed hybrid magnetic shield for a satellite-based application is used as an example and improved upon. The placement of the shielding material is limited by the shape of the equipment inside of it and the exterior cubic box it is housed in. We optimise the shape of the passive shielding by using a simple quadratic deformation of the starting shield geometry and use COMSOL Multiphysics to evaluate how this affects shielding performance in terms of both Shielding Effectiveness (SE) and the shield's mass. The optimisation is shown to increase the SE by 24% in the central region and decrease the shield's mass by 30%.

Reference

[1] P. J. Hobson et al., "Benchtop Magnetic Shielding for Benchmarking Atomic Magnetometers," in IEEE Transactions on Instrumentation and Measurement, vol. 72, pp. 1-9), Art no. 6007309, (2023), doi: 10.1109/TIM.2023.3293540

Figures used in the abstract

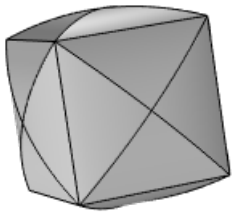

Figure 1 : Thumbnail: The quadratically deformed cube used as a passive magnetic shield.

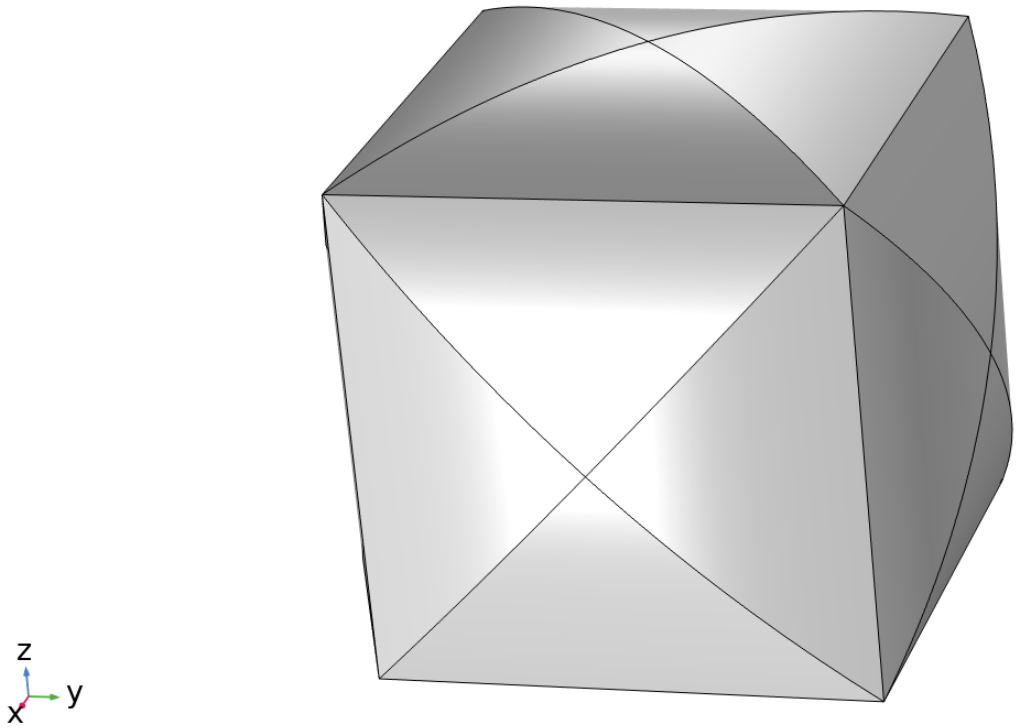

Figure 2 : Figure 1: A render of the deformed shield geometry. Created by quadratically deforming a cube.

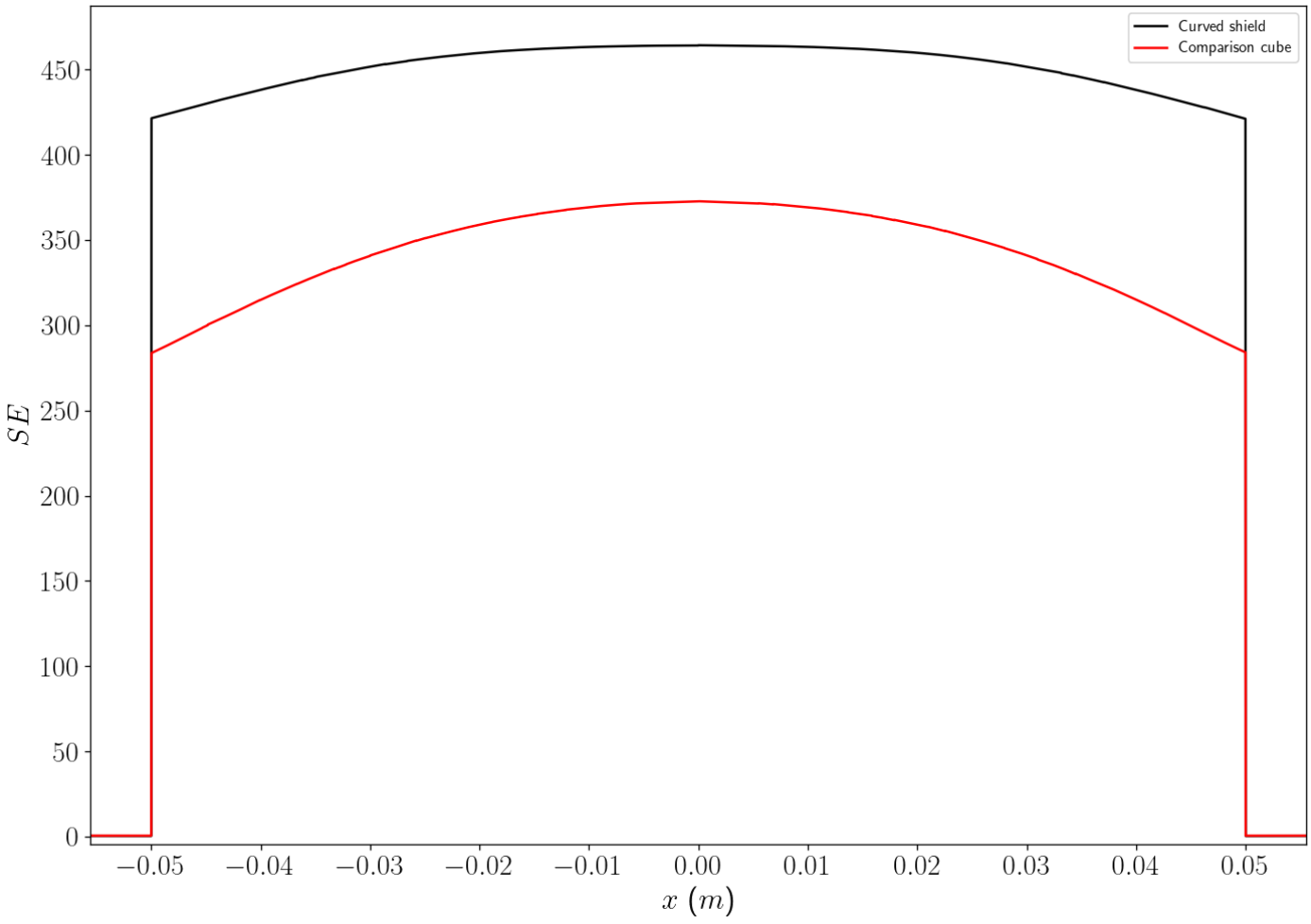

Figure 3 : Figure 2: A comparison of the Shielding Effectiveness (SE) along a central line inside the shield between the deformed shield and the cubic shield.