Synthetic Cable for the Assessment of Marine Power Impact (SCAMPI)

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Introduction

In this work, the design and testing of SCAMPI (Synthetic Cable for the Assessment of Marine Power Impact) is presented. SCAMPI is a device designed to reproduce magnetic field magnitudes and magnetic field vector orientations typical for high voltage submarine cables. It has been designed to be used for marine biology experiments concerning the impacts of submarine cables on marine life; thus, other aspects of the device (acoustic, thermal, EMF) have also been tested to ensure that no additional stresses are imposed by the experimental setup. The existing literature lacks in addressing the impact of the induced electric fields on animals. The proposed experimental setup includes this aspect and creates a more realistic distribution of the magnetic fields than most previously adopted approaches.

Design

SCAMPI consists of 31 turns of a 25 mm^2 cross-section cable contained in a mechanical enclosure. It is design to carry a maximum current of 130 A.

Figure 1: A picture of SCAMPI.

To evaluate the magnetic and electric fields from the device, 2D and 3D models of varying complexity were constructed. The 2D model gives a relatively accurate estimate of the magnetic field. However, it does not include the edges of the device and their influence on the field which means that the magnetic field computed using the 2D model is larger in comparison to the 3D model (Fig.6). Fig. 1 shows the 2D model which represents the middle slice of the device and Fig. 2 shows the 3D model geometry which includes individual conductors.

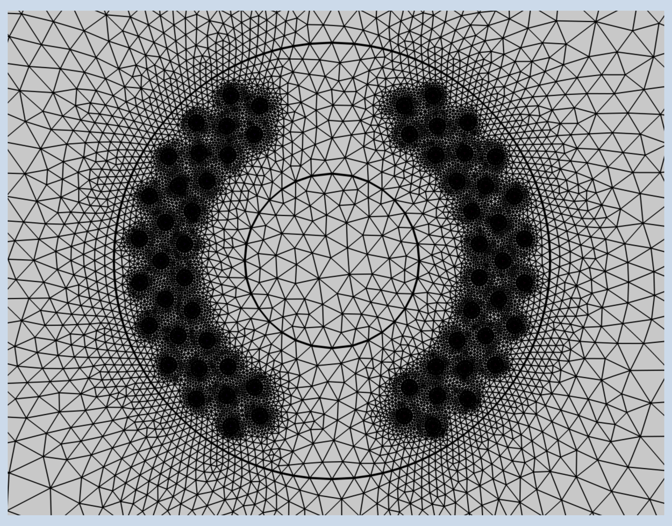

Figure 2: A 2D model of the device which represents a middle slice of the device.

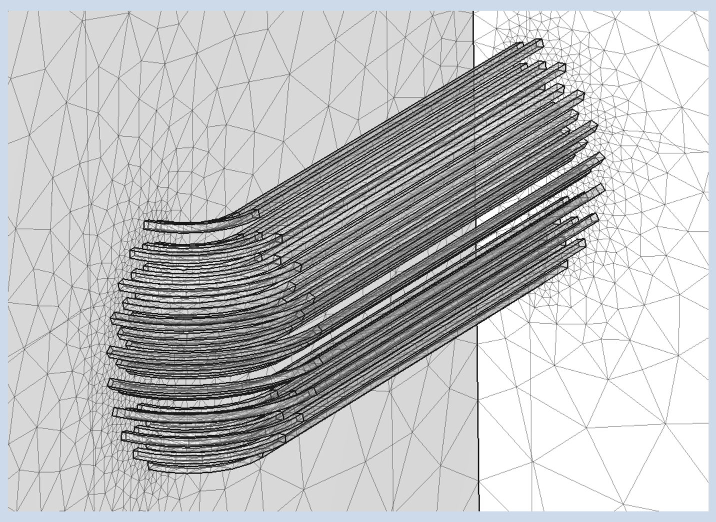

Figure 3: 3D model geometry and mesh. The model was reduced to a quadrant to reduce the computational cost.

The magnetic flux density norm produced by the device is presented in Figs. 4 and 5.

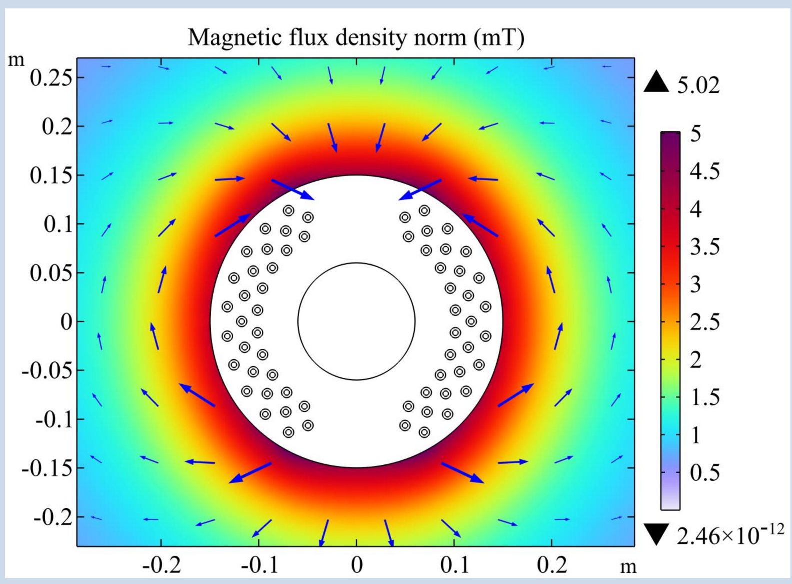

Figure 4: Magnetic fields and magnetic field vector orientation computed using the 2D model for a load of 85 A.

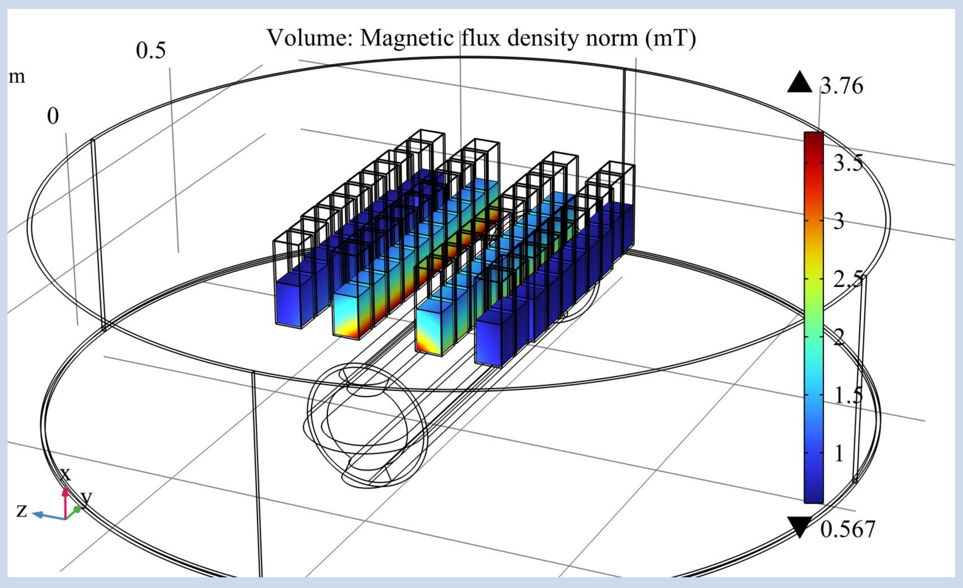

Figure 5: An example arrangement of the experiment and the magnetic field produced in individual cores computed using the 3D model.

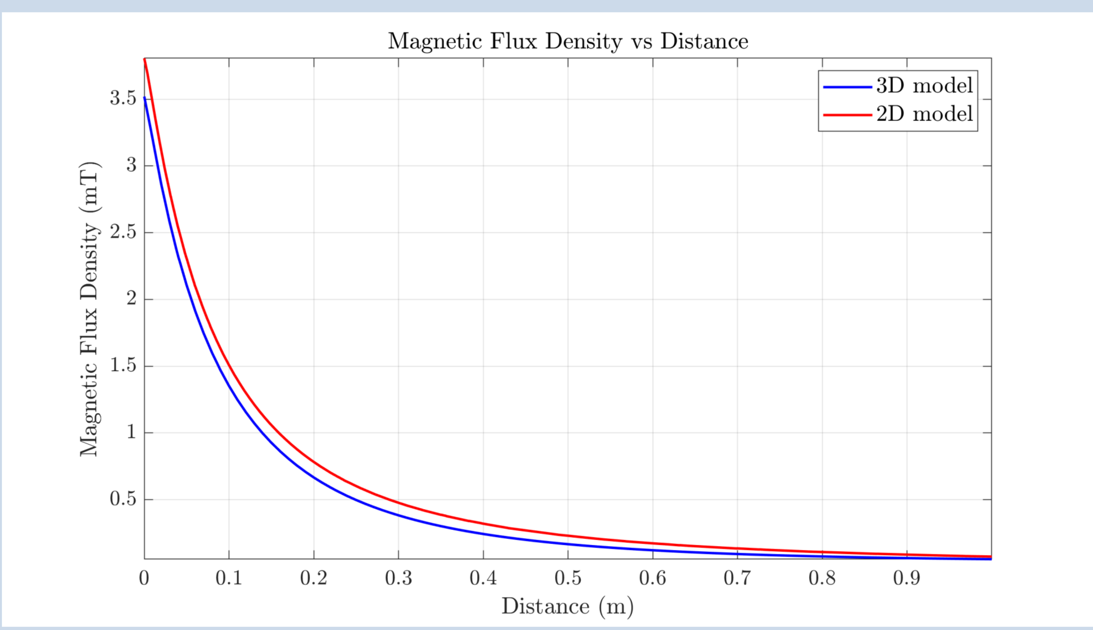

Figure 6: Comparison of the 2D and the 3D approaches to modelling of the magnetic field from the device.

Testing

For AC experiments, SCAMPI is supplied via a variac (variable transformer) and a CT (a current transformer. Acoustic and electromagnetic tests have been performed.

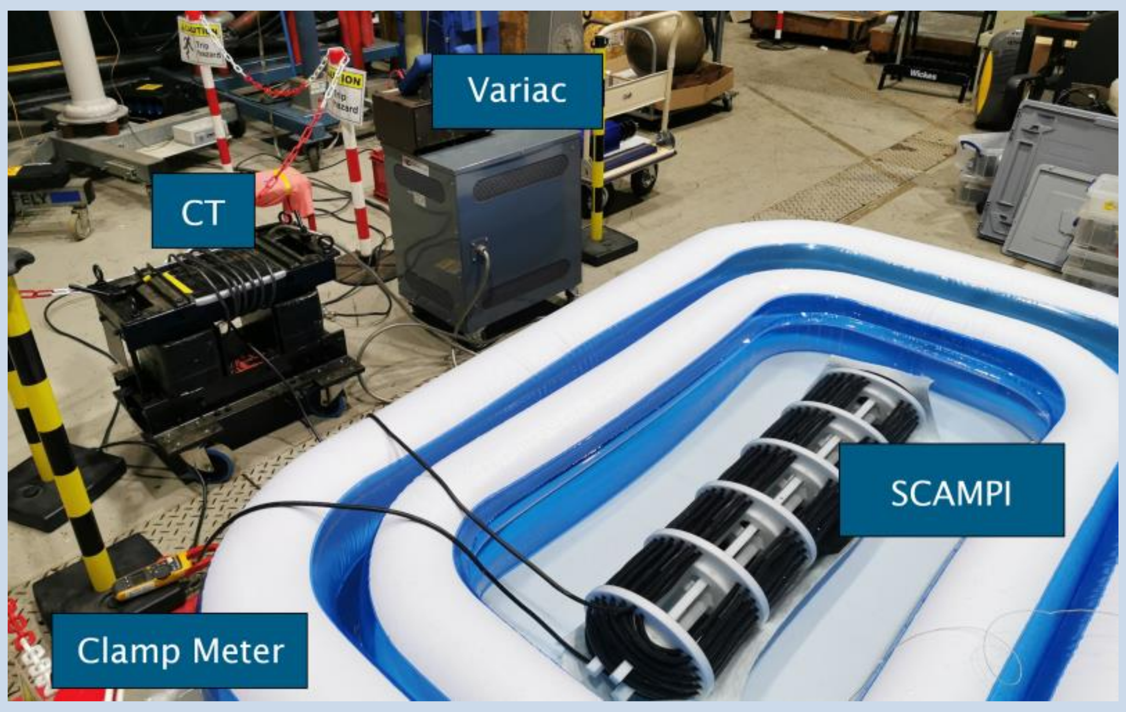

Figure 7: A picture of SCAMPI during AC testing.

EMFs produced by SCAMPI were measured and compared with the 3D model. The measurement and simulation agreed as shown in Fig. 8.

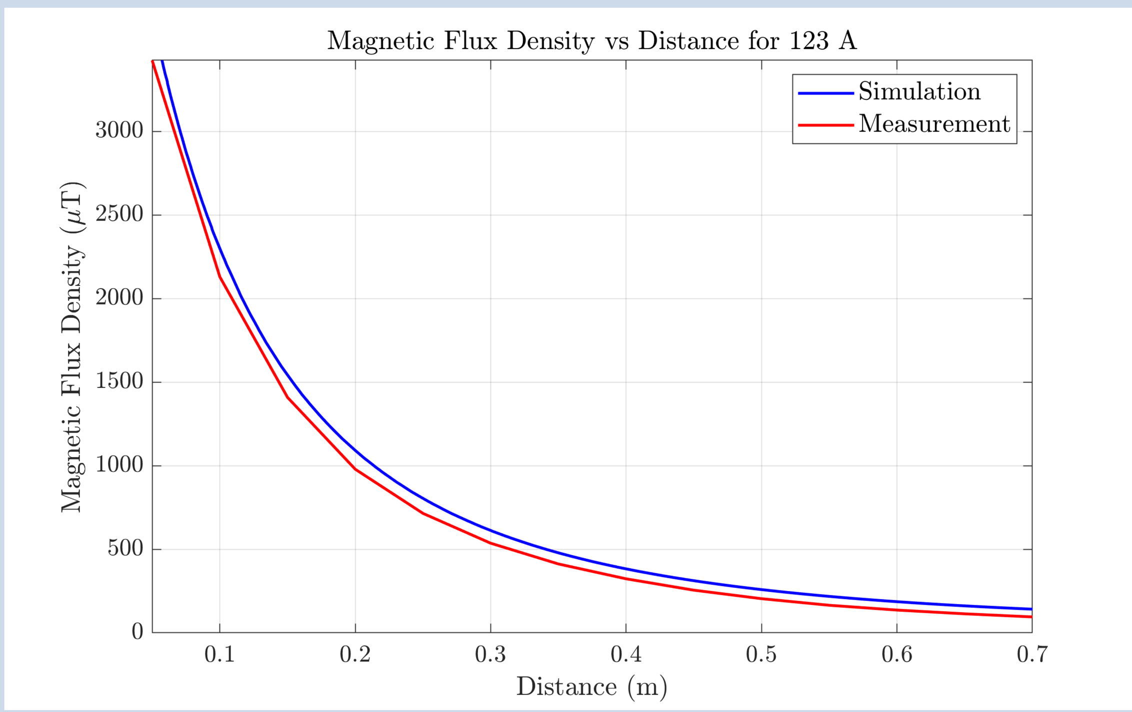

Figure 8: The comparison of the magnetic field calculated using the 3D model and the measurement for 123 A.

Acoustic testing has shown that there is additional noise present when SCAMPI is energised due to the frequency component of the current (Fig.10). No noise above ambient was recorded during the DC operation (Fig.9). Additional experiments will be performed to assess if the AC noise is an additional stressor.

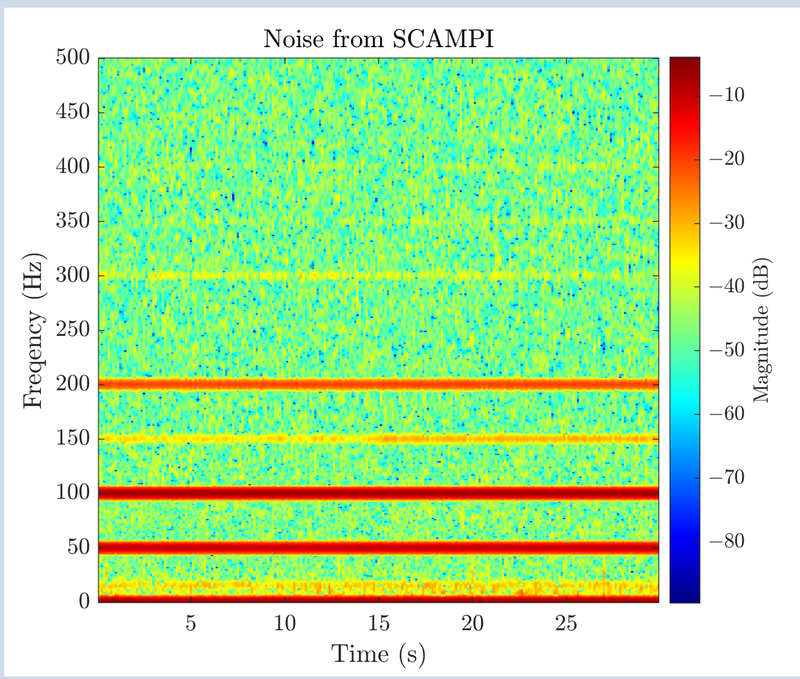

Figure 9: Acoustic noise from SCAMPI under AC.

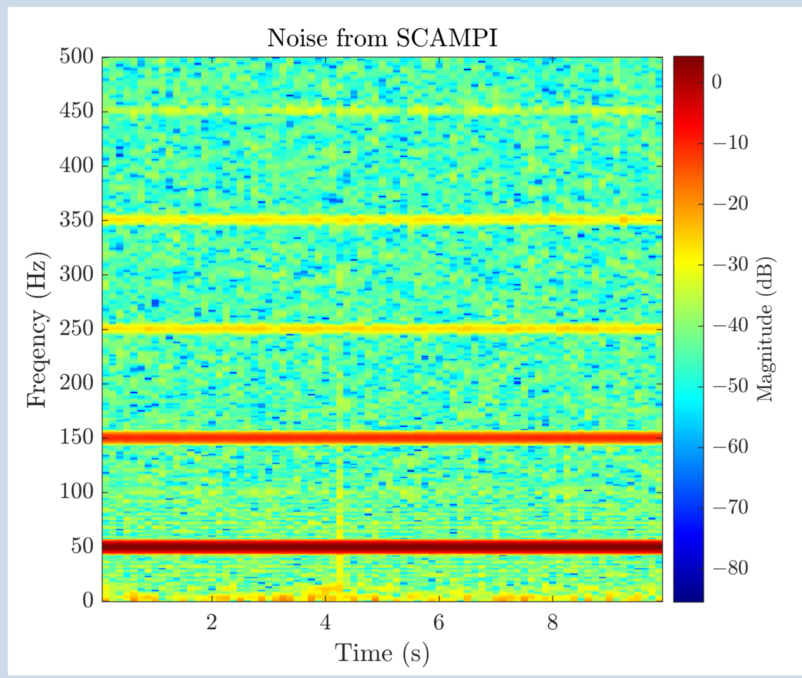

Figure 10: Acoustic noise from SCAMPI under DC (no noise above background electrical noise was detected).

Future work

- Thermal tests with a chiller used in the final experiment
- Acoustic tests to assess the level of stress due to the ambient noise
- Modification of the cores to include electric fields

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