Design of Precision Magnetic Fields for Fundamental Neutron Symmetries

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Abstract

The traditionally magnetic design process involves guessing at a reasonable conductor geometry, using finite element analysis (FEA) software to calculate the resulting fields, and modifying the configuration iteratively to reach an acceptable solution. Taking the opposite approach, we developed an method of calculating the conductor geometry as a function of desired magnetic field. This method is based on the magnetic scalar potential, which satisfies the Laplace equation, and field is specified as boundary conditions. The conductor windings follow equipotential contours of the solution on the boundary. We use LiveLink™ for MATLAB® functionality to extract these contours, convert them back as COMSOL Multiphysics® coil geometry, and simulate the resulting magnetic fields for verification. This design and validation procedure is demonstrated on a precision electromagnetic coil being developed for an experiment to measure the electric dipole moment of the neutron to a precision of 1e-28 cm.

Figures used in the abstract

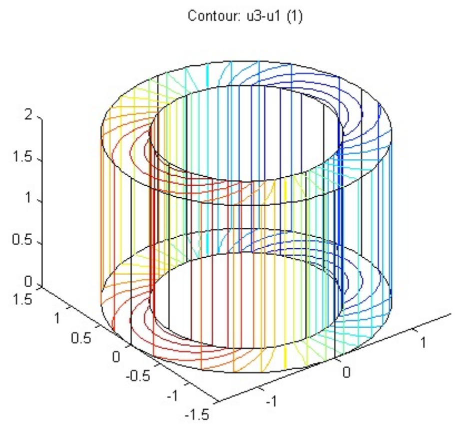

Figure 1: The equipotential contours, i.e. conductor windings, of a coil generated using COMSOL.

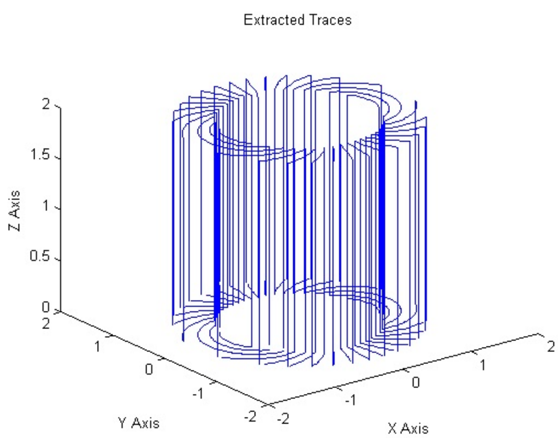

Figure 2: The extracted conductor windings of the coil using LiveLink™ for MATLAB®.