MRI/NMR Magnet Design

The most important thing we build is trust
Cobham Technical Services - Vector Fields Software has nearly 30 years’ experience in the development of advanced software for electromagnetic simulation. The scope of the Opera software suite has been driven by scientific and industry requirements to ensure its relevance to end-users. The software is fast, accurate, and provides a cost-effective engineering solution to real-world design problems. In addition to supplying leading-edge software, we passionately believe in providing users with the support they need to get the best from Opera. This includes training and help using Opera. We also employ experts in the principal engineering and scientific applications that Opera is used for so that we have a detailed understanding of user requirements and are able to provide in-depth application-specific assistance when this is required. We believe that many of our customers value the combination of high performance software and the attentive support offered by Cobham. As a result, customers include some of the largest and most advanced producers of electromagnetic devices and systems from many industries as well as prestigious research laboratories and academic institutions.

“Why is Opera particularly demanding?”

MRI/NMR application is particularly demanding because extremely high field precision is required in the imaging zone. Opera was developed from the outset with this requirement in mind, and as a result most of the leading MRI and NMR equipment manufacturers use Opera for designing superconducting magnets, for carrying out quench simulations, and for designing magnet shielding. The software has evolved over the years and today provides comprehensive multi-physics simulation that is capable of investigating thermal and stress in addition to electromagnetic waves.

“Can I automate the process?”

Opera has a very powerful scripting language which enables any frequently performed actions to be programmed into a macro file. Once the design process has been captured through an interactive session, the logged commands can be used to generate a first version of the macro, which can be subsequently extended and modified as requirements change. This also allows the creation of customized interfaces to Opera supporting parameterization, making use of the language’s tools for the user to define their own dialogs. The parameters can be used to define geometry, set up the analyses and run extensive post-processing.

“Is it needed for electromagnetic shielding?”

The formulation used in Opera-3d’s magnetostatic solver (previously known as TOSCA) allows the field from this type of perturbation problem to be computed very accurately. The field from unshielded solenoids can be calculated using the Biot-Savart expression to one part in 100 million. The shield and the reinforcing structure will make a small perturbation to the central field, usually in the order of one part in one thousand which is well within the accuracy of Opera.

“I need a solution provider, not a software vendor”

Cobham Technical Services - Vector Fields is a leading software system for numerical modelling of magnets. It captures expert knowledge, and provides a specialized design environment for rapid prototyping and operational setup.

“Can I design a superconducting solenoid MRI magnets and need to assess the small effect of the shielded room and the steel reinforcing on the magnet’s homogeneity?”

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Applications

- MRI/NMR Magnets
  - Main/DC coils
  - Gradient coils
- Superconducting Magnets
- EMC/EMI & Shielding
- Shimming
- Quench initiation, propagation and protection

Software Tools

- 2d & 3d modelling
- Solid modelling capability
- Coupled physics
- Parameterization
- Optimization
- Graphical circuit editor
- CAD import
- Simulink® integration
- Sumitomo HTS material library

Multiphysics Capabilities

- Electromagnetics (statics, steady state & transient)
  - Hysteresis
  - Eddy currents
  - Stray fields (EMC/EMI)
  - Losses
  - Forces
  - (De-)Magnetization
- Thermal (steady state & transient)
- Quench
- Mechanical (forces/loads can be generated from other physics, defined or imported)
  - Stresses & strains
  - Deformation
  - Thermal expansion
  - Magnetostriiction
  - Eigenfrequency
  - Linear elastic/small displacement

Customer Support

We provide support to Opera users from our offices in the UK and the USA, and through a worldwide network of local distributors. Our support engineers have an extensive knowledge of all types of magnets and are available to assist both existing and prospective customers with their design requirements. In addition, regular training courses are held, which provide “hands-on” training in the use of Opera for designing these types of systems. Whatever your application and wherever you are located, you can be sure of our interest and support.

The accuracy provided by finite element simulation is a vital part of the development process to design magnets, companies who use these techniques are able to differentiate themselves with optimal design performance, short development timescales, and cost-effective manufacture. Cobham has nearly 30 years’ experience working with foremost manufacturers to produce some of the most accurate and functionally advanced software for magnet design.

For more information about Opera and the numerical simulation of magnets, please refer to the relevant technical data sheets and application notes. They can be obtained from our website, magnet-design-software.com, which is dedicated to the finite element modelling of all types of magnets and is a repository for technical articles and information about magnet design. The website contains information, including a range of technical publications, videos and webinars, that is of general interest to engineers involved in MRI/NMR magnet design.

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