

QPSF Technology Diffusion Project
Progress Report

**Application of Finite Element Modelling Techniques to Analyse
Stresses in MRI magnets**

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Major Achievements

This project is in collaboration with Magnetica Ltd to develop new and high performance MRI (magnetic resonance imaging) magnets. In the past five months, a computer program has been developed for stress analysis of magnets using ANSYS Parametric Design Language and the C language, and more than 30 cases of thermal and mechanical stress analysis have been completed for magnets of varying field strengths. The analysis simulated the processes of cooling down from room temperature (300K) to working temperature (4K) and charging up to the full current, with different levels of analysis from preliminary/macro to detail/micro scales performed. Frictional contacts between coils and coil formers and orthotropic material properties in the coils are considered. The analysis outputs include deformations, stresses and strains as well as strain energies in coils and formers. Figures 1-3 show meshes, the deformed shape, stress distributions and strain energy distributions of a magnet subject to Lorentz's forces, in which due to symmetry, only a quarter of the magnet was modelled.

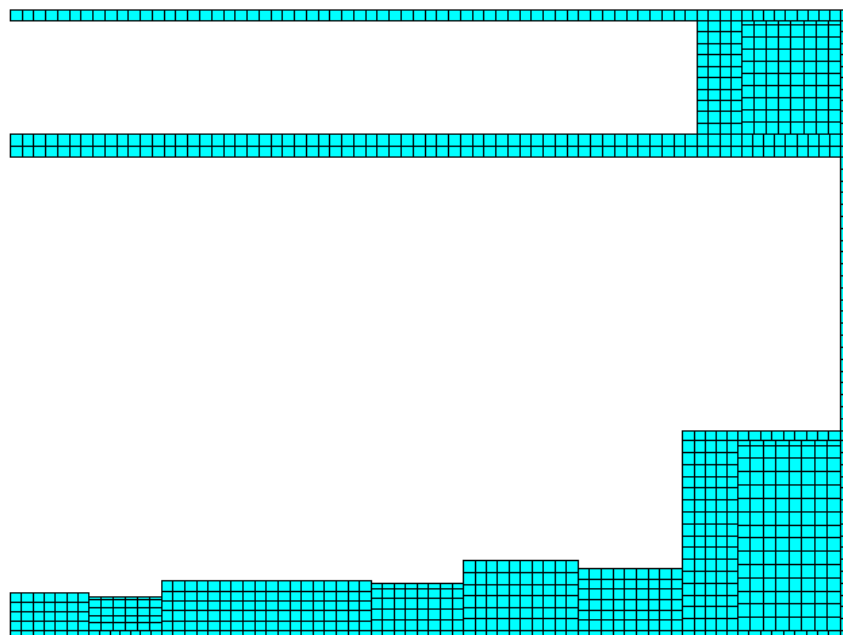


Figure 1. Meshes of the Magnet

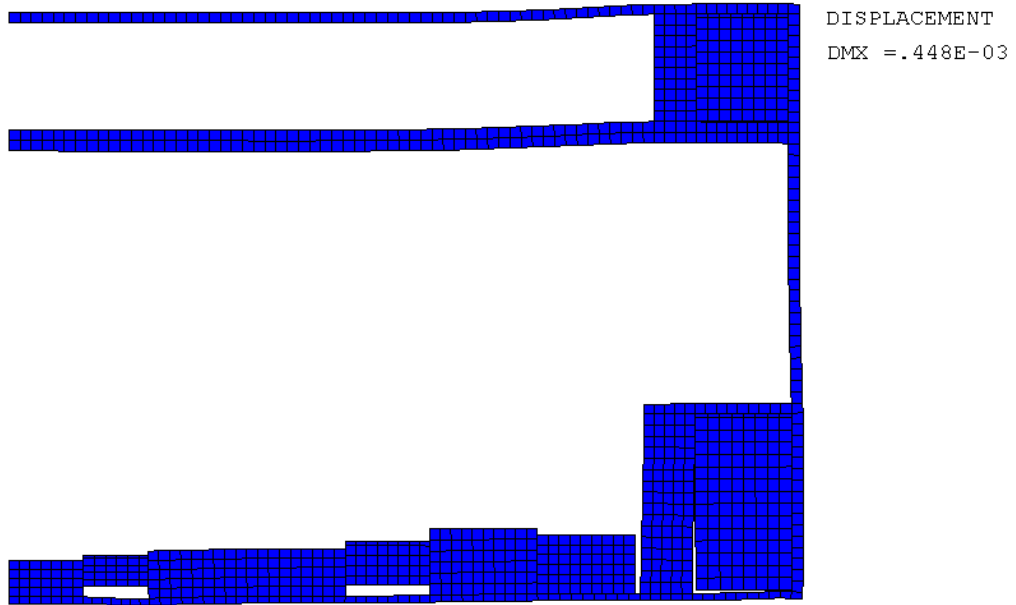


Figure 2. Deformation of the Magnet

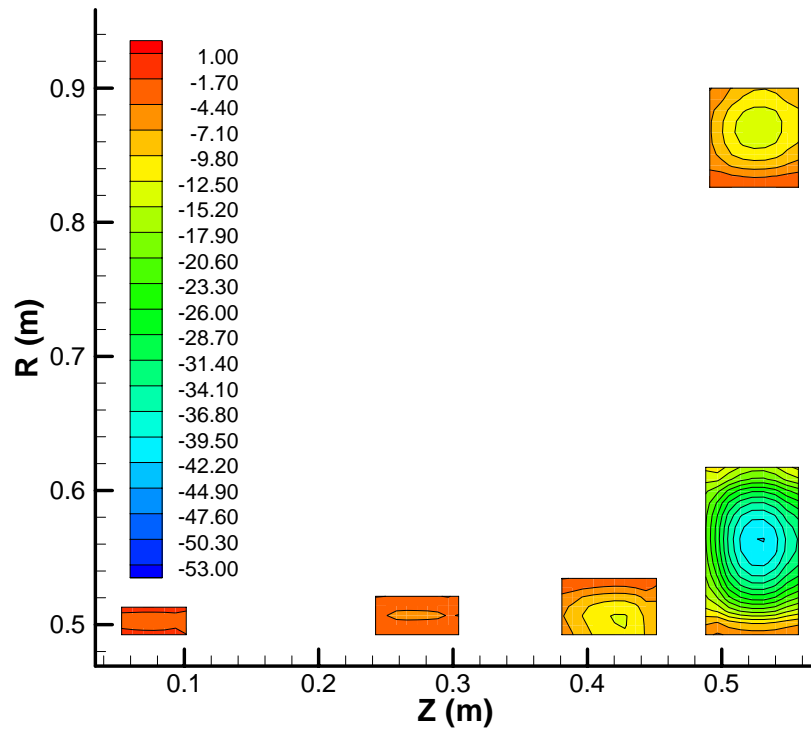


Figure 3. Radial Stress Distributions in Coils

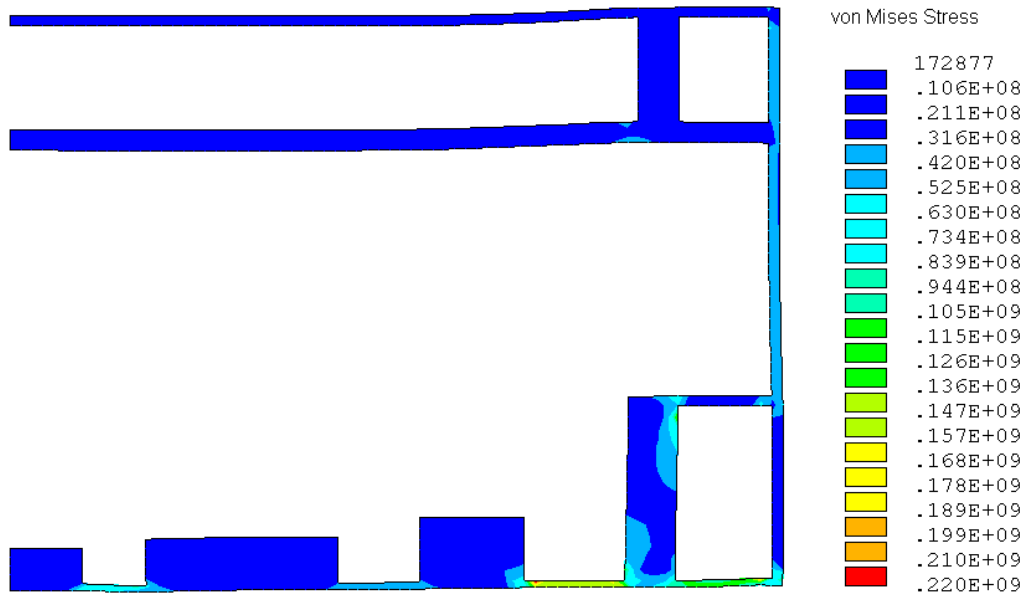


Figure 4. von Mises Stress Distribution in the Former

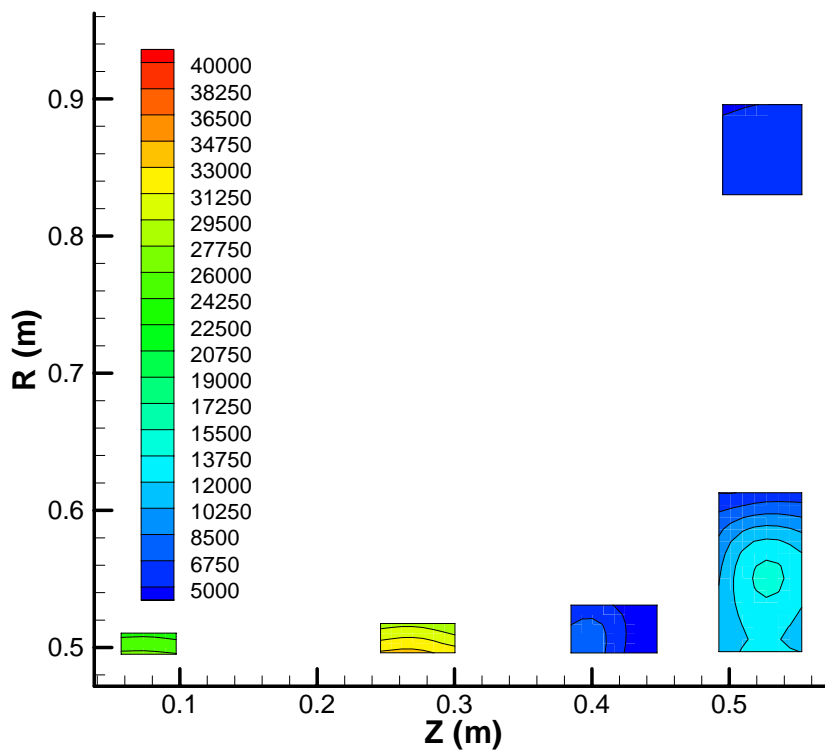


Figure 5. Strain Energy Density Distribution in the Coils

Progress against the AIMS

One of the major aims of the project is to apply finite element techniques to analyze stress distributions in MRI magnets subject to electromagnetic and thermal forces. This has been achieved, with more than 30 analysis cases completed from preliminary/macro to detail/micro scales.

Progress against the Milestones

- Analysis programs and models have been developed and stress analysis results have been obtained. Therefore tasks in milestone 1 have been completed.
- Based on the analysis results in milestone 1, design optimisation of magnets are now underway to improve product designs in both of cost effectiveness and performance.