Benchmark of COMSOL Vs. ROXIE Codes for the Calculation of a Particle Accelerator Quadrupole

I. Rodriguez[1], J.L. Munoz[1]

[1]ESS Bilbao, Bilbao, Spain

Abstract

The field quality requirements of most particle accelerator magnets are very tight (in the order of 10^-4 parts of the required field) and therefore very precise simulations are needed to accurately calculate these devices. CERN's ROXIE [1] code (Routine for the Optimization of magnet X-sections, Inverse field calculation and coil End design) is widely used as a reference code to calculate normal conducting and superconducting magnets for particle accelerator applications. ROXIE uses the full vector potential coupled to the BEM-FEM method to develop the magnetostatic calculations, so it does not require meshing neither the coil nor the air region of the model, thus increasing the solution precission with low computer memory requirements. However, COMSOL Magnetic Fields Interface uses the magnetic vector potential FEM and requires meshing both the coil and the air regions. The comparison of both codes in terms of precision, memory requirements and time of solution is presented in this paper. The parameterized model of a typical resistive quadrupole has been used for the comparison (see Figure 1 and Figure 2), both in 2D and 3D. ROXIE can use a maximum symmetry of 1/8th for the iron and COMSOL can use 1/16th symmetry for the whole model. The quadrupole iron is being used in the highly saturated zone of the BH curve and therefore its solution requires many nonlinear iterations. The precision of the solution is then calculated by applying the FFT to the magnetic field data on the reference radius circumference, as it is usually done for these kind of multipolar magnets.

Reference

[1] S. Russenschuck, "ROXIE - the routine for the optimization of magnet X-sections, inverse field computation and coil end design", 1st International Roxie Users Meeting and Workshop, CERN, Geneva, Switzerland, 16 - 18 Mar 1998, pp.1-6

Figures used in the abstract

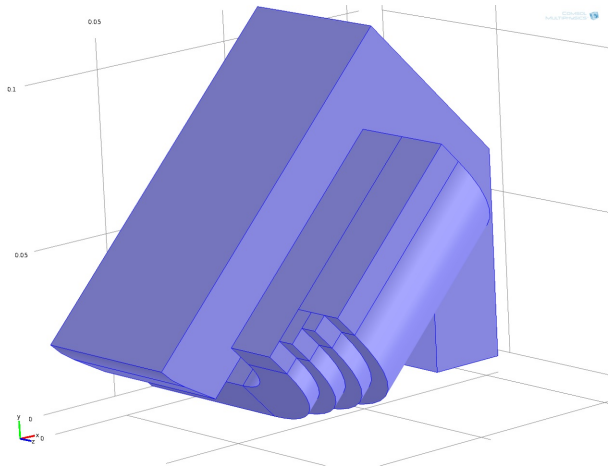

Figure 1: 3D model of the quadrupole in COMSOL (1/16th symmetry)

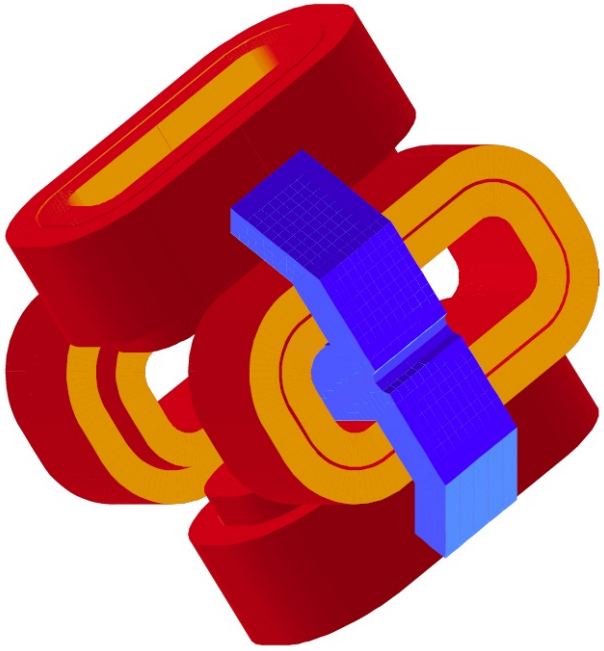

Figure 2: 3D model of the quadrupole in ROXIE (1/8th symmetry)