Beitrag ID: **8** Typ: **Contributed talk**

Modeling Screening Currents in a Reduced Magnetic Vector Potential Formulation with Higher-Order Magnetic Moments

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Superconducting coils in accelerator magnets consist of several cables composed of multiple superconducting wires. This makes a finite element (FE) simulation discretizing all individual wires computationally very demanding. Reduced magnetic vector potential formulations avoid the explicit discretization of those wires at the cost of calculating a Biot-Savart integral in the computational domain. In the standard approach [1], the Biot-Savart integral has to be evaluated in the whole computational domain, which can still be quite computationally expensive, especially for a 3D field simulation. Moreover, screening currents in the superconducting wires induced by transient magnetic fields are usually modeled by adding artificial wires into the geometry, which further increase the computational cost of this approach.

We present an alternative reduced magnetic vector potential formulation [2], which requires the evaluation of the Biot-Savart integral only on an interface of the computational domain, leading to a huge improvement in computational efficiency compared to the standard approach. Furthermore, we introduce the magnetic dipole moment into the formulation in order to take screening currents into account without adding artificial wires into the geometry. The method is implemented in the open-source FE solver GetDP and employed for the magnetic field simulation of superconducting magnets in 2D and 3D.

[1] O. Bíró, K. Preis, W. Renhart, K. R. Richter, and G. Vrisk, "Performance of different vector potential formulations in solving multiply connected 3-D eddy current problems," in IEEE Transactions on Magnetics, vol. 26, no. 2, pp. 438–441, March 1990.
[2] L. A. M. D'Angelo et al., "Efficient Reduced Magnetic Vector Potential Formulation for the Magnetic Field Simulation of Accelerator Magnets," in IEEE Transactions on Magnetics, vol. 60, no. 3, pp. 1–8, March 2024.

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