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Transient analysis of fast ramping normal-conducting muon-collider magnets

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The efficient production and capture of muons as well as their immediate acceleration towards high particle energies are severe engineering challenges on the path towards the first 10TeV synchrotron-based muon-collider, envisioned by the European MuCol program. The required ramp rates of up to 4.5kT/s within the rapid-cycling-synchrotron can reliably be provided by normal-conducting magnets in combination with a periodically switched capacitor-based powering system.

The numerical analysis of this subsystem necessitates transient simulation schemes considering both circuit and magnet, whereby the latter is discretized as finite-element (FE) model. The calculations are especially demanding due to highly non-linear circuit elements such as switches and diodes as well as the non-linear and hysteretic behavior of the ferromagnetic laminated iron core.

This contribution presents a pragmatic modeling approach for the transient and nonlinear analysis of bending magnets powered by current pulses of few ms. An implementation within a conventional 2D/3D FE framework led to novel insights in magnet and power supply design.

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