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Transient finite-element simulations of fast-ramping muon-collider magnets

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Conceptual studies for a muon collider identify fast-ramping magnets as a major design challenge. Rise rates of more than 1 T/ms are attainable with normal-conducting magnets, incorporating iron yokes to make sure that stored magnetic energies and inductances stay below reasonable thresholds. Moreover, for energy efficiency, the magnets need to exchange energy with capacitors, such that the electric grid only needs to compensate for the losses. The design of such magnet systems is based on two- and three-dimensional finite element models of the magnets coupled to circuit models of the power-electronics equipment. The occurring phenomena necessitate nonlinear and transient simulation schemes. This contribution presents the analysis of a two-dimensional, nonlinear and time transient analysis of a bending magnet, energized by a symmetrical current pulse of a few ms.The magnet yoke is represented by a homogenized material refraining from the spatial discretization of the individual laminates, but nevertheless representing the true eddy-current and hysteresis losses.

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