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3D Magneto-Hydrodynamic Modelling of an Overstressed Helical Magnetic Flux Compression Generator

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Lawrence Livermore National Laboratory (LLNL) is actively engaged in an experimental program using two-stage magnetic flux compression generators (MFCGs) as pulsed power sources for equation of state measurements. These MFCGs amplify a current pulse in two stages. The first stage uses a helical MFCG and the second stage uses a coaxial MFCG. In support of this program, LLNL recently conducted an overstress test of a megajoule class helical flux compression generator. This experiment was intended to push the generator into a regime where losses would become nonlinear. One of the goals of this experiment was to serve as a benchmark for the suite of computational tools used to predict the performance of these devices. This paper will focus on analysis of this experiment using the LLNL developed magneto-hydrodynamic (MHD) code ALE3D. Analysis of a helical MFCG with an MHD code is particularly challenging because the magnetic field is inherently three-dimensional and does not lend itself well to computational domain reductions using symmetry conditions. This means that large-scale simulations are required to analyse even the simplest helical generators. Regardless of these challenges, this paper will show that ALE3D is capable of predicting the overall behaviour of the generator as well as allowing one to see the source of the nonlinearity in gain. For this particular experiment, the analysis suggests that a significant portion of the loss in compression was due to excessive magnetic pressure on the armature and stator of the generator changing the phasing behaviour of the contact.

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