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Three-dimensional plasmoid-mediated reconnection and the effect of toroidal guide field in simulations of start-up Helicity Injection

FATIMA EBRAHIMI, Princeton Plasma Physics Laboratory and Princeton University — Physics of three-dimensional plasmoid-mediated magnetic reconnection during transient Coaxial Helicity Injection (CHI) plasma start-up is investigated using nonlinear MHD NIMROD simulations in a spherical tokamak. We numerically examine i) the role of three-dimensional magnetic fluctuations arising from neighboring outer edge n $\neq$ 0 current-sheet instabilities on the formation of plasmoid-mediated closed flux surfaces, and ii) the effect of toroidal guide field on the MHD stability during transient CHI. Consistent with NSTX experiments, we find that even in the presence of non-axisymmetric edge magnetic fluctuations, current-carrying axisymmetric (n=0) plasmoids are rapidly formed while twisted open field lines are being injected, and are merged to form a large current-carrying magnetic bubble for plasma startup in a tokamak. It is also found that the 3-D physics response is drastically different for simulations at higher toroidal field and complete stabilization of non-axisymmetic fluctuations were achieved at higher toroidal flux. MHD analysis for URANIA and QUEST ST's and optimization, at higher poloidal injection flux up to 1 Wb to achieve MA current startup will be explored. Supported by DOE grants DE-SC0010565, DE-AC02-09CH11466.

Fatima Ebrahimi
Princeton Plasma Physics Laboratory and Princeton University

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