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Numerical simulations of GAE stabilization in NSTX-U

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Simulations of confinement-limiting Alfvén eigenmodes in the sub-cyclotron frequency range show a robust physical stabilizing mechanism via modest off-axis beam injection, in agreement with experimental observations from National Spherical Torus Experiment (NSTX-U). Experimental results from NSTX-U have demonstrated that neutral beam injection from the new beam sources with large tangency radii deposit beam ions with large pitch, which can very effectively stabilize all unstable Global Alfven Eigenmodes (GAEs). Beam-driven GAEs have been linked to enhanced electron transport in NSTX, and the ability to control these modes will have significant implications for NSTX-U, ITER, and other fusion devices where super-Alfvénic fast ions might be present. Nonlinear simulations using the HYM code have been performed to study the excitation and stabilization of GAEs in the NSTX-U right before and shortly after the additional off-axis beam injection. The simulations reproduce experimental finding, namely it is shown that off-axis neutral beam injection reliably and strongly suppresses all unstable GAEs. Before additional beam injection, the simulations show unstable counter-rotating GAEs with toroidal mode numbers and frequencies that match the experimentally observed modes. Additional of-axis beam injection has been modelled by adding beam ions with large pitch, and varying density. The complete stabilization occurs at less than 10% of the total beam ion inventory.

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Author: Dr BELOVA, Elena (PPPL)

Co-authors: Dr FREDRICKSON, Eric (PPPL); Dr CROCKER, Neal (University of California Los Angeles)

Presenter: Dr BELOVA, Elena (PPPL)

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