Abstract for an Invited Paper
for the DPP07 Meeting of
The American Physical Society

MHD simulations of disruption mitigation on DIII-D and Alcator C-Mod[1]

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The three potential threats posed by disruptions—halo currents, heat fluxes and runaway electrons—scale unfavorably from present tokamaks to ITER. Disruption mitigation experiments on several tokamaks have shown massive gas injection (MGI) to be an effective means of reducing poloidal halo current and heat flux. However, both theory and measurements support the conclusion the penetration of the neutral jet is weak. Thus the core thermal quench relies on MHD, both to mix impurities into the core, and to conduct heat to the impurity-dense edge. NIMROD simulations of C-Mod have shown that enhanced transport alone—due to large 1/1 and 2/1 modes triggered by edge cooling—can quench the core plasma [1]. These simulations show similarity to C-Mod temperature measurements [2], and the role of the 1/1 and 2/1 modes is supported by observations in DIII-D [3]. However, to determine the relative importance of thermal transport versus impurity mixing simulations that include both mechanisms are needed. An extension of the NIMROD code has been developed which includes both accurate atomic physics from the 0D KPRAD code and separate continuity equations for each species. C-Mod simulations for both helium and argon impurities are compared with earlier simulations and experimental data to assess the extent of impurity mixing and evaluate MGI as a mitigation technique for ITER. DIII-D simulations are carried out with different radial neutral fueling profiles to understand the thermal quench when impurity injection is more uniform, or centrally peaked, as would be the case for designer pellets or liquid jets.

[1] V.A. Izzo, Nucl. Fusion **46** (2006) 541.
[2] R.S. Granetz, et al., Nucl. Fusion **46** (2006) 1001.
[3] E.M. Hollmann, et al., Nucl. Fusion **45** (2005) 1046.

[1]Supported by US DOE under DE-FG03-95ER54309; In collaboration with D.G. Whyte, P.B. Parks, E.M. Hollmann, R.S. Granetz.