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MHD modeling of dispersive shell-pellet injection as an alternative disruption-mitigation technique[1]

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Simulations of dispersive shell-pellet (DSP) injection with the 3D MHD code NIMROD show outer flux surfaces maintained as core thermal energy is radiated, followed by loss of edge confinement during the second stage of a two-stage current redistribution, producing a current spike and a rapid loss of runaway electron (RE) test-particles. The DSP technique has been demonstrated on DIII-D [1], and is designed to produce high impurity assimilation, giving high radiated-energy fraction without the massive high-Z material injection—required for shattered pellet injection, currently planned for the ITER disruption mitigation system—that can exacerbate RE production. In the simulations, an ablated carbon shell quantity similar to DIII-D experiments leaves flux surfaces intact until the payload delivery. Dilution cooling by added carbon shell electrons drops the core temperature by >1keV, but without any significant loss of stored thermal energy by radiation or conduction. After payload delivery, the region of magnetic stochasticity expands from the core outward, and the edge remains warmer than the core. The end of the thermal quench (TQ) is characterized by large amplitude MHD fluctuations simultaneous with an increase in total plasma current ("I_p spike"), and a fast loss of remaining RE test-particles. This late time MHD and I_p spike is associated with the loss of a negative current layer formed due to "flux trapping" in the first stage of current redistribution, as described by Wesson [2]. The technique may therefore have advantages for RE deconfinement. Results of DIII-D modeling will be considered in light of ITER DMS requirements. [1] E.M. Hollmann, et al, PRL 122, 065001 (2019). [2] J.A. Wesson, D.J. Ward, M.N. Rosenbluth, *Nucl. Fusion* **30,** 1011 (1990).

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