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Poloidal radiation asymmetries during disruption mitigation by massive gas injection on the DIII-D tokamak[1]

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Measurements of poloidal asymmetry in the radiated power during thermal quench (TQ) mitigation by massive gas injection (MGI) on DIII-D show poloidal peaking in the radiated heat flux at the wall generally consistent with 3D resistive MHD modeling, that indicates a large n=1 tearing mode causes these asymmetries. Radiation asymmetries are a concern to ITER because they can cause localized melting of the first wall even if globally the mitigation successfully radiates 100% of the plasma thermal energy. Toroidal radiation asymmetries have been well-studied, but until now the equally important poloidal asymmetries were not well constrained. Radiation emissivity profiles are reconstructed by tomographic inversion of AXUV photodiode arrays, from which the peaking measurements are derived. The poloidal peaking measurements are compared to NIMROD 3D resistive MHD simulations. Qualitatively, the measured and modeled peaking evolve similarly. In both cases, peaking during the TQ changes little with toroidal phase, consistent with predictions of n=1 MHD during the TQ producing the asymmetry. Quantitatively, the measured TQ peaking amplitudes are comparable to but consistently higher than the modeled values. This is a result of the measured radiation exhibiting high emissivity lobes at larger minor radius (and outside the separatrix) than the modeled cases, which may indicate incomplete treatment of the plasma-neutral interaction at the plasma edge in the model. This work, combined with previous measurement and modeling and toroidal radiation asymmetries, provides a basis for constraining localized mitigation radiation heat flux in ITER.

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