Observation of Self-Mitigation of a Density-Limit Disruption in DIII–D*

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Fast radiated power measurements taken during the thermal quench of a density limit disruption in the DIII-D tokamak demonstrate that the dominant energy loss channel is main chamber radiation. This contrasts with the standard picture of the thermal quench of disruptions, where energy is lost along open field lines into the divertor. Spectroscopy and power balance estimates indicate that the observed radiation results from a sudden increase in both deuterium and carbon released from the main chamber walls, with carbon being the most important for radiated power loss. This release of neutrals from the walls self-mitigates the disruption, leading to a very low divertor heat load (about ten times smaller than the main chamber heat load). The impurities and the associated cold front are observed to mix into the plasma core at a rate about 100 times larger than standard (H-mode) particle diffusion rates, suggesting that some form of MHD-driven transport must occur during the thermal quench. Comparison with other types of disruptions in DIII-D suggests that main chamber neutral release may play an important role in the thermal quench of many disruptions. These results could have positive implications for the severity of divertor heat loading during disruptions in future high density tokamaks.

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