Observation of Main-Chamber Heat Loads During Disruptions in DIII-D*

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One of the most potentially harmful characteristics of tokamak disruptions is the rapid deposition of the initial plasma thermal energy into plasma-facing components. In diverted tokamaks, the thermal energy is traditionally believed to flow into the divertor as a result of core confinement loss due to tearing mode island overlap, followed by fast parallel heat conduction along the scrape-off layer into the divertor. In contrast, comparison of XUV radiometry, soft x-ray tomography, main-chamber filterscope signals, divertor thermography, and main-chamber Langmuir probe signals show that disruptions in the DIII-D tokamak produce quite significant main-chamber heat loads. Typically, the main chamber heat load comes largely in the form of impurity radiation: the initial divertor heat load causes a sudden release of deuterium and carbon, and the resulting carbon ions mix rapidly into the main plasma, apparently by large-scale MHD mixing. The total radiated power fraction is found to average around 40%, *i.e.* roughly half the thermal energy is conducted into the divertor and roughly half is radiated away into both the divertor and the main chamber walls. Less often, in about 20% of DIII-D disruptions, the initial contact actually occurs in the main chamber, resulting in a main-chamber energy deposition which can exceed 90% of the initial plasma thermal energy. This main-chamber contact appears to result from the rapid (often <1 ms) growth of a global [dominantly (1,1)] kink to a sufficiently large amplitude where the plasma strikes the main wall. This mode can arise without the slow magnetic precursor and mode locking typically associated with tearing mode growth prior to disruptions and might therefore pose a significant challenge for the timely application of disruption mitigation techniques. Also, the presence of large conducted and radiated heat loads on the main wall could be an important issue to consider during wall material selection for future tokamaks.

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