MAGNETIC AND THERMAL ENERGY FLOW DURING DISRUPTIONS IN DIII–D*

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A plasma disruption results in a rapid loss of stored plasma energy to various components of tokamak hardware in a few milliseconds. Disruptive energy quenches are a major concern for large devices such as ITER, where the plasma stored energy is expected to exceed 1 GJ and the thermal quench (TQ) time is estimated to be on the order of 1 ms. The plasma stored energy primarily consists of the plasma's thermal energy and the energy stored in the magnetic field generated by the plasma current. During disruptions some of the stored magnetic energy is inductively deposited into the conducting structure and some is converted to plasma particle energy in the core and in the scrape-off layer (SOL). Particle energy is either radiated or transported to plasma facing components (PFCs). Extremely large heat fluxes to PFCs from radiation and particle transport can result.

We report on experiments in DIII–D where disruptions are intentionally induced in neutral beam heated single-null diverted discharges. We measure the spatial distribution and temporal evolution of energy flows via the different pathways using bolometer tomography of a few millisecond time resolution, magnetic data taken at sub-millisecond intervals and a set of infrared video (IRTV) cameras which measure the spatial and temporal evolution of the heat flux to PFCs with 8 kHz resolution. Two toroidally separated cameras measure toroidal asymmetry. Bolometer and IRTV data are used to separate the divertor heat flux into radiation and particle components. The DIII–D Multipulse Thomson scattering diagnostic measures spatially resolved plasma temperatures and densities in the core and the SOL at up to 10 kHz sampling rate. The evolution of the stored magnetic energy through the TQ and current quench (CQ) phases and an overall energy balance through the TQ phase will be discussed for various types of disruptions: radiative collapse, high beta, etc. We find that for most disruptions we can account for the stored energy lost during the TQ phase to within roughly 20%. We observe that the disruption driven heat flux to the divertor floor shows significant radial broadening over pre-disruption levels, and in some cases it shifts from outer leg to inner leg dominated heat flux. In some cases, we observe substantial heat flux in the private region far from divertor separatrices. The details of the heat flux patterns with disruption type will be discussed.

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