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Thermal Quench and its diagnostics at JET

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Disruptions are an inherent property of tokamak plasmas, which cannot be completely eliminated. The consequences of disruptions are especially dangerous for large machines like ITER and even more so for DEMO. Thermal Quench (TQ) is the initial phase of disruption followed by plasma Current Quench (CQ). Essential diagnostics for the TQ are magnetics (dB/dt), Electron Cyclotron Emission (ECE) and soft X-rays. Of course, the signals must be recorded with high time resolution of more than 100 kHz. Some magnetics signal (e.g. Ip, Locked and rotating MHD amplitude, etc.) can be recorded at moderate time resolution in the range of (5-10) kHz. TQ is characterized by a sharp drop in plasma thermal energy (and hence electron temperature) and MHD bursts. The MHD disruption phase continues from the beginning of the TQ to the end of the distinctive plasma current spike. The TQ duration can vary from several hundred microseconds to milliseconds, and the MHD phase can vary within a few milliseconds. The dynamics of the TQ and the entire MHD phase can shed light on the nature of the MHD instabilities underlying these events. The widespread explanation of a TQ is associated with a Neoclassical Tearing Mode (NTM) or Resistive Wall Tearing Mode (RWTM), which drives islands on separate resonant surfaces nq = m and ultimately leads to global internal reconnections. However, the remarkably fast TQ of order of ~ 100 μs suggests that the Wall Touching Kink Mode (WTKM) can be another (or additional) underlying the initial phase of disruption. The WTKM mode is a free boundary kink mode which is the strongest and fastest kind of MHD instability in tokamaks.

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