An example of a new approach for the development of Disruption Protection Tools for JET: the mode-lock disruption class.

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Studies based on a first-principles physics approach have produced a wider understanding of JET disruptions [1, 2]. The next step consists of exploring the implementation of a disruption protection system to integrate the physics knowledge on each type of disruption with the machine experience and the technical constraints posed by the actual real-time JET plasma protection and control systems.

The general purpose of this approach is to study what practical measurement techniques can be applied to anticipate the occurrence of a disruption, starting from the physical analysis of the different classes [3] and studying the features and the dynamics for each disruptive event. This paper focuses on the analysis of locked mode disruptions. Locked modes occur when there is no rotation between the MHD mode and the vessel wall, often as a result of plasma braking due to the interaction of a rotating MHD mode with either any error fields present or a resistive wall. In a locked mode disruption the perturbation amplitude causing the rotation braking grows as the plasma rotation decreases [1, 2].

On JET, protection against locked mode disruptions already exists and uses the mode amplitude as a threshold. The present algorithm suffers from an offset in the magnetic signal used to monitor the growth of the perturbation. This offset has a nonlinear dependence on the poloidal field circuit currents that are very difficult to compensate with sufficient reliability. Hence, to avoid the effect of spurious trips in this signal, the trigger level used to request the pulse termination is set to a high value. This procedure has the drawback of delaying the request to safely shut down the plasma even where, by monitoring the signal, the presence of a mode lock could have been predicted earlier.

This study analyses the locked mode algorithm to understand what can be done to minimise the effect of this offset, starting from its physical and engineering basis, to improve the current mode lock protection system. This paper presents different approaches used to tackle this problem, focusing on the discrete frequency spectrum of the locked mode signal calculated using the discrete Fourier transform, which presents the best performance. By analysing a database of 106 disrupted pulses it has been concluded that using this technique with the present protection system, the performance increases from 63% of pulses correctly predicted to 90%. Moreover this technique anticipates the alarm for 77% of the considered pulses. This method allows an improvement on performances, but using it on its own does not protect against all kinds of disruption and further studies are needed for others types of disruption.

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