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JET disruption mitigation and avoidance in support of DT operation and ITER

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JET is starting a multi-campaign effort that will lead in 2020 to the first experiments in D-T mixtures since 1997. While intense experimentation is going on in order to prepare the operational scenarios and physics bases for DT operation, an important part of the JET programme is devoted to disruption avoidance, minimizing the possible damage to the machine during DT campaigns, as well as to disruption mitigation studies with the Shattered Pellet Injector (SPI) in support of ITER.
The effectiveness of SPI in radiating disruptions thermal load on plasma facing components has been modelled for the first time using the 3D non-linear MHD code JOREK, and the predictions will be possibly validated on first JET SPI data and compared with results obtained with massive gas injection (MGI). A particular effort has been devoted to the optimization of bolometry and SXR tomographic inversion techniques in order to identify toroidal and poloidal radiation asymmetries that had been found with single MGI mitigation. The Electro Magnetic load on the JET vacuum vessel has been modelled using 3D MHD codes, yielding to a reduction of 30-40% in vessel forces in case of MGI mitigated disruptions, with good agreement with JET experimental data.
Special focus has been put on runaway electrons (RE) physics, mitigation and Real Time (RT) control in support of ITER Disruption Mitigation System (DMS) design. Several diagnostic upgrades have been carried out in order to diagnose the RE beam energy and position, gamma ray tomography and hard X-ray detectors, while a bespoke RT detection algorithm has been developed to control the RE beam position and current. The diagnostic effort has been coupled with numerical assessment of RE formation condition and modelling of gas penetration from MGI.
The effectiveness of MGI in mitigating runaway electrons beams has been tested on JET, showing that background plasma density plays a key role. The results will be compared with initial JET experiments of RE mitigation by SPI injection, which will exploit the above diagnostic and control upgrades.
A large effort has been devoted to the improvement of JET DMS trigger signals, in order to optimize the use of disruption mitigation and increase the anticipation of the trigger with respect to the disruption. Different disruption predictors have been developed based on the RT signals of mode lock and internal inductance, with attention on the portability of the predictors to larger device, in order to decrease risks for ITER. Machine learning methods have been applied to the problem of disruption avoidance, with the use of Generative Topographic Mapping on RT indicators derived from internal plasma profile peaking and high bandwidth magnetic signals. Disruption anticipation times of more than one second can be achieved on a regular basis. The mentioned method could also provide a basic classification of disruption types, with the aim of programming the response of the JET RT systems. A new RT alarm triggering system has been designed and deployed, in order to rationalize the triggering of different disruption mitigation or avoidance alarms and to increase flexibility in configuring the response to different alarms.
The campaigns in 2018/19 will provide the final test of disruption mitigation and avoidance techniques to be used during 2020 JET DT campaigns, while giving a unique chance of consolidating the physics basis of the ITER DMS system.