**Diagnostic challenges for the JET DTE2 Campaign**

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In 2021 the Deuterium-Tritium (D-T) Experiment campaign 2 (DTE2) was conducted at the Joint European Torus (JET), achieving a new fusion energy world record and performing experiments to address key physics issues to inform ITER D-T operations. Availability of a comprehensive diagnostic set compatible with D-T plasmas was crucial to these achievements, with DTE2 benefitting from substantially increased diagnostic capabilities compared to the previous JET D-T campaign (DTE1) in 1997. DTE2 posed challenges for diagnostics not faced during operations with other fuel species, and a unique opportunity to evaluate solutions to these challenges. This talk will give an overview of the challenges faced by diagnostics for DTE2 and the work carried out to address them.

The principal diagnostic challenges faced for DTE2 included: DT-specific measurement requirements, particularly for fusion products and plasma composition; greatly increased deleterious radiation effects on components in the machine hall; reduced opportunities for maintenance, calibration & repair; effects of tritium ingress to vacuum-coupled diagnostics; and a greatly increased complexity of coordinating diagnostic requirements and operational resources with the experiment planning due to strict Tritium and 14 MeV neutron budgets. An extensive programme of preparation was undertaken prior to DTE2, including significant upgrades to neutron & gamma-ray spectroscopy and tomography systems; installation of two new long track (~40m) optical image relay systems to re-locate several camera diagnostics to a shielded area outside the machine hall; re-locating or shielding radiation-sensitive diagnostic components where practical; and development of data analysis tools and techniques to be able to meet the D-T specific requirements. New control room tools were implemented to help coordinate and confirm diagnostic setup and readiness for each D-T pulse.

During the experimental campaign, while many diagnostics operated with high availability and little or no performance degradation, a minority suffered degradation or failures, as anticipated when operating in the D-T environment. Radiation-induced transmission loss was observed in optical components, for example loss of ~40% in the unheated optical fibres used in the motional Stark effect diagnostic (although with relatively minor impact on the diagnostic operation). Malfunction of data acquisition electronics in the machine hall caused some ultraviolet spectroscopy and soft X-ray detection systems to become inoperable during the campaign, as expected. Ongoing work to quantify, and where possible mitigate, such effects will be discussed.

\*See the author list of ‘Overview of JET results for optimising ITER operation’ by J. Mailloux et al 2022 Nucl. Fusion 62 042026