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The Software and Hardware Architecture of the Real-Time Protection of In-Vessel Components in JET-ILW

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The JET ITER-like wall (JET-ILW) combines plasma-facing components (PFC) made of bulk beryllium for main chamber limiter tiles and of bulk tungsten as well as tungsten coated CFC tiles for divertor tiles. The risk of damaging the metallic PFCs caused by beryllium melting or cracking of tungsten owing to thermal fatigue required a new reliable active protection system. To address this issue, a real time protection system comprising newly installed imaging diagnostics, real time algorithms for hot spot detection and alarm handling strategy has been integrated into the JET protection system.
This contribution describes the design, implementation, and operation of the near infrared (NIR) imaging diagnostic system of the JET-ILW plasma experiment and its integration into the existing JET protection architecture. The imaging system comprises four wide-angle views, four tangential divertor views, and two top views of the divertor. Regions of interest (ROI) on the selected PFCs of different materials are analysed in real time and the maximum temperature measured in each ROI is sent to a real time algorithm called vessel thermal map (VTM) to determine the likely cause of the overheating and to request an appropriate response from the plasma control system. Post-pulse data visualization and advance analysis of all types of imaging data is provided by the new software framework JUVIL (JET Users Video Imaging Library). The hot spots formation at the re-ionization zones due to impact of the re-ionised neutrals as well as due to RF-induced fast ion losses is recognized as a big threat due to quick surface temperature rise. Because it could trigger the protection system to stop a pulse, it is important to identify the mechanisms and conditions responsible for the formation of such hot spots. To address this issue a new software tool Hotspot Editor has been developed. Future development of the JET real time first wall protection is focused on the D-T campaign and the ITER relevant conditions which will cause failure of camera electronics within the Torus hall. To provide the reliable wall protection, two more sensitive logarithmic NIR camera systems equipped with new optical relays to take images and cameras outside of the biological shield have been installed on JET-ILW and calibrated with in-vessel calibration light source.

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