Contribution ID: **206** Type: **Oral**

Design and Analysis Progress of US ITER Integrated Diagnostic Upper Port 14

Tuesday 6 June 2017 11:00 (20 minutes)

ITER is the world's largest fusion device currently under construction in the South of France with over 50 diagnostic systems to be installed inside the port plugs (PPs), the interspace or the port cell region of various diagnostic ports. The Diagnostic First Wall (DFW) and Diagnostic Shielding Modules (DSM) are designed to protect front-end diagnostics from plasma neutron and radiation while providing apertures for diagnostic viewing access to the plasma. Four tenant diagnostic systems will be integrated into the upper port plug 14. The upper visible/IR wide angle viewing system (Vis-IR/Upper Cameras), or WAV system, is installed to provide visible and IR viewing of the inner vessel for machine component protection during plasma operations. The disruption mitigation system (DMS) is installed to mitigate the negative effects of plasma events due to sudden loss of plasma current or control by rapid injection of cryogenic pellets to mitigate the dissipation of the plasma thermal energy, the control of the plasma current quench, and the suppression of the generation of Runaway electrons. The Glow Discharge Cleaning (GDC) system is installed for reducing impurity and provides control of hydrogenic fuel out-gassing from plasma-facing components. The Plasma Position Reflectometry (PPR), for real time determination of the wall-plasma distance, is the ex-vessel tenant installed in the U14 Interspace region.

The PP engineering design and multi-physics analysis has been performed following ITER upper port integration requirements including weight, neutron shielding (100 uSv/hr total dose limit), cooling layout, allowable deflections and structural integrity validation under single and combined load cases. Various DSM design configurations have been analyzed and resultant component integration and mass distribution is optimized to limit its impact to the DFW (IO scope) and in-port diagnostics, to mitigate significant impact from the undesirable VDE (Vertical Displacement Event) inertial loads. The DSM design maintains EM load distribution similar to that from a generic box-like shielding structure, still provides needed stiffness for the protection of on-board diagnostics and structural integrity. To moderate impact from inertial loads due to the Vacuum Vessel (VV) movements during asymmetric plasma VDEs, the rigid lock-in DSM interface was implemented into the U14 port integration analysis models for design validation. Structural integrity of U14 assembly is largely driven by the electromagnetic loads induced on the metallic structural components during plasma VDEs. The in-port diagnostics and the mounting supports, on the other hand, are largely driven by the steady-state thermal loads from volumetric nuclear heating, and the dynamic response of components attached to the DSM-PPS assembly under the VDE inertial loads due to the vessel movements. Progress on the U14 integrated design and analysis is reported. The tenant interface load transfer is also presented in details for in-port system attached to the DSMs as part of the design and analysis tasks for ITER PP engineering.

Eligible for student paper award?

No

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Session Classification: T.OA1: Diagnostics and Instrumentation I

Track Classification: Diagnostics and instrumentation