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ITR/2-2Ra & FTP/2-1Rb: Imaging Challenges for the ITER Plasma Facing Components Protection; Be Tile Power Handling and Main Wall Protection

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ITR/2-2Ra: Imaging Challenges for the ITER Plasma Facing Components Protection
The ITER actively cooled tokamak is the next-generation fusion device which will allow studying the burning plasma during hundreds of seconds. ITER plasma facing components (PFCs) real-time protection will be mandatory to minimize operational risks as critical heat flux leading to degradation of PFCs and eventually to water leak. Thanks to Tore Supra expertise in actively cooled tokamak and long pulse operation, urgent research and development actions are presented and discussed addressing the feasibility and the performances of the PFCs protection function foreseen in ITER using a network of wide angle visible and IR imaging systems (VIS/IR WAVS). Three major steps addressing PFCs protection have been reached. First, the contribution of reflected light that could disturb the measurement of surface temperature has been taken into account through an industrial physic-based Monte Carlo ray-tracing method. Secondly, an integrated software and hardware framework validated on existing fusion devices has been proposed. In addition, extended functionalities to analyze and understand in real-time the huge volume of images produced by the VIS/IR WAVS have also been developed. Finally prototypes of ITER first mirrors have been built and tested with successful first results. These results demonstrate that a more precise definition of the functional specifications of the entire imaging system can be obtained addressing both machine protection and plasma performance.

FTP/2-1Rb: Be Tile Power Handling and Main Wall Protection
In this paper we describe the design methodologies applied to JET's ITER-like Wall, many of which have been adopted by ITER, and the experimental evaluation of their effectiveness. Avoiding exposed edges over 40mm effective height and using rigorous methods to ensure true implementation good power handling, within the expected design values has been achieved. Compromises had to be made in the design of the upper dump plate, which has led to minor melting during vertical disruptions. This experience has direct relevance to the ITER plasma facing components (PFCs) where stringent criteria for exposure of edges at the castellation scale have not yet been set and penetration of field lines into areas in extreme off-normal configurations has to be considered. In addition, to prevent potential risks of melting due to tile misalignment, damage or design errors, an active protection system was put in place. The design requirements for the Be tiles includes good power handling for start-up limiter operation and the shielding of large of metallic components such as antennas and diagnostics from the high power fluxes due to high power input diverted ELMy H modes. In the design of the tiles surface, it is assumed an exponential decay of power density with radius, the scrape-off length values of 10mm for ohmic and L-mode plasmas and 5mm for H-mode plasmas; the scrape-off layer (SOL) surface is approximated by $2\pi R$ (where R is the SOL major radius). The limits on the surface temperature of the new Be tiles will constrain limiter operation and set the minimum gaps for diverted operation and require active protection to guard against melting. To test these limits and validate the assumptions of the design, experiments were performed with varying additional power and distance to the limiters in both L-mode and H-mode. Both shadowing and power handling depend on the field line angle as well as the plasma scrape-off length. Thus the power handling limitations will depend upon plasma scenario and is being explored experimentally. The impact on the overall performance caused by misalignments, damage and other possible non-conformances appears minimal. Real time active protection relying on near IR cameras has been used successfully for the protection of the main chamber and is close to being fully commissioned.

Country or International Organization of Primary Author

France

Primary authors: Dr FERREIRA NUNES, Isabel Maria (IPFN/IST); Mr TRAVERE, Jean-Marcel (France)

Presenter: Mr TRAVERE, Jean-Marcel (France)

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