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2D MODELLING AND ASSESSMENT OF DIVERTOR PERFORMANCE FOR ITER

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An operating point for ITER divertor operation in a highly radiating, partially attached mode has been found in [1, 2]. Acceptable power loads and helium pumping efficiency are achieved when radiation from both intrinsic and seeded impurities (neon), occurring primarily in the divertor, is taken into account. An initial study of the operating window has been presented in [3, 4]. All these studies rely on computational models which simulate the transport and particle-wall interactions in the edge plasma in realistic, two-dimensional geometry. These models are being continuously updated and validated against the experimental data which are becoming available.

The B2-Eirene code results are being compared with experimental measurements from the main divertor experiments (JET, JT-60U, DIII-D, C-mod and ASDEX-Upgrade) in L-mode and H-mode regimes with the same modeling assumptions. Initial results indicate that the code is able to reproduce broadly experimental features seen in the experiments such as the achievement of divertor detachment at the measured upstream densities, divertor neutral pressures and levels of radiated power. The comparison of these results and implications for ITER modeling are discussed in the paper.

The present paper describes the results of studies of the ITER operating window to date. These include the effect of reduction of the radial transport and variation of the divertor length, as well as variation of the upstream density and the impurity level. The reference operating point described in [2, 3] was obtained for $\chi_\perp$ = 1 m^2/s and a midplane density at the separatrix $n_s = 3.6\ 10^{19}\ m^{-3}$, resulting in peak power loads of 6 to 8 MW/m^2. Values of $\chi_\perp$ lower by a factor of 2 result in power loads on the target above 10 MW/m^2, which is not acceptable from the point of view of divertor design. Reduction of n_s leads to a similar increase of the power load. In order to widen the divertor operational window for H-mode conditions, in particular for simultaneous low radial transport and low edge density, the power entering the SOL is varied. This simulates additional seeding with an impurity which radiates at the edge and leads to acceptable power loads.

Studies of the start-up phase (limiter operation) are also presented. A model has been implemented in UEDGE to insert a limiter-like surface near the separatrix which intercepts most of the heat flux and therefore simulates the limiter start-up.

Various issues affecting the divertor design (presence of "wings", shape of the "dome", erosion of plasma-facing components, etc.) are assessed using the 2D models. It is found that the presence of "wings" along the divertor channels in the private-flux region would not be expected to have a large influence on the divertor parameters because only a small fraction of the parallel momentum (less than 10%) is transferred to them by the neutrals. As concerns the "dome", it is found that much longer dome would impede the transition to the partially attached state and therefore results in higher heat loads, whereas removal of the dome would degrade helium pumping. The results including recommendations for the design are reported in the paper.

References

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