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ITR/P1-28: Multi-machine Comparisons of Divertor Heat Flux Mitigation by Radiative Cooling

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Due to the absence of carbon as intrinsic low-Z radiator, and tight limits for the acceptable power load on the divertor target, ITER will rely on impurity seeding for radiative power dissipation. Partial detachment of the outer divertor needs to be achieved and integrated with an ELM mitigation technique. This contribution reports about cross-machine studies of impurity seeded scenarios initiated by the ITPA group for integrated operational scenarios (IOS-1.2).

In current devices, the plasma response to impurity seeding reveals a quite broad phenomenology. In Alcator C-Mod, energy confinement degrades when the power flux through the separatrix is reduced towards the L-H threshold power, PLH, under EDA H-mode conditions. In AUG, improvement of confinement is seen during nitrogen seeding at higher values of Psep/PLH, correlating with increasing Zeff due to N seeding. In JET, degradation of normalized confinement was usually obtained during seeding. Different responses of the pedestal on the increased impurity level is supposed to be the main origin of the observed behaviour. To allow the comparison of different experiments with regard to the heat flux reduction, an analytical scaling relation for the normalized divertor power load has been developed, based on the main plasma Zeff and the divertor neutral pressure. Higher divertor neutral pressures and higher heating powers in terms of P/R will be required to approach ITER divertor conditions in present day devices. No issues are foreseen for the combination of impurity seeding with ELM mitigation by pellet ELM pace-making. Regarding ELM mitigation by magnetic perturbations, the quite different responses of the plasma in AUG, DIII-D and JET do not allow a clear forecast for ITER. So far, no negative effects of magnetic perturbations on the radiative efficiency or core impurity penetration have been observed in DIII-D and AUG. On the technical side, possible sensors and combined control schemes for the facilitation of partial detachment in ITER will be discussed based on recent tokamak experience.

Country or International Organization of Primary Author

Germany

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ITPA IOS

Primary author: Mr KALLENBACH, Arne (Germany)

Co-authors: LOARTE, Alberto (ITER organization); HERRMANN, Albrecht (Max-Planck-Institut f. Plasmaphysik); SIEGLIN, Bernhard (Max-Planck-Institut f. Plasmaphysik); LIPSCHULTZ, Bruce (MIT); GIROUD, Carine (CCFE); REIMOLD, Felix (Max-Planck-Institut f. Plasmaphysik); MADDISON, Geoff (CCFE); HUGHES, Jerry

(MIT); Dr SCHWEINZER, Josef (Max-Planck-Institut f. Plasmaphysik); WISCHMEIER, Marco (Max-Planck-Institut f. Plasmaphysik); REINKE, Matthew (MIT); BERNERT, Matthias (Max-Planck-Institut f. Plasmaphysik); WOLFE, Stephen (MIT); EICH, Thomas (Max-Planck-Institut f. Plasmaphysik); PETRIE, Tom (General Atomics)

Presenter: Mr KALLENBACH, Arne (Germany)

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