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Core and edge modeling of JT-60SA H-mode highly radiative scenarios

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In the first phase of exploitation, JT-60SA will be equipped with an inertially cooled divertor. Therefore, heat loads of 10 $\mathrm{MW/m^2}$ will be sustainable by the targets for only few seconds [1]. As a consequence, for this phase, in order to maximize the duration of discharges, it is crucial to design operational scenarios with a high radiated fraction in the plasma edge region, while keeping acceptable core performances.

In this framework, with the aim of determining the physical parameters needed to operate the machine with heat loads significantly lower than 10 $\mathrm{MW/m^2}$, unseeded and neon seeded deuterium H-mode scenarios have been investigated. Core and edge simulations have been carried out using respectively the code METIS [2] and SOLEDGE3X-EIRENE [3].

In first analysis, the edge parameter space of unseeded scenarios has been studied. Simulations at intermediate edge power of 15 MW point out that, without seeded impurities, the heat loads at the targets are higher than 10 $\mathrm{MW/m^2}$ in attached cases and upstream electron densities above $4.2 \cdot 10^{19}\ \mathrm{m^{-3}}$ are required to achieve a detached regime. This result points toward the need for impurities injection during the first period of exploitation of the machine.

Therefore, neon seeded simulations have been carried out, performing a seeding rate scan and an injected power scan, while keeping the upstream electron density at the separatrix at $3.0 \cdot 10^{19}\ \mathrm{m^{-3}}$. When injecting neon, at 15 MW of power injected in the edge plasma, the inner target is easily detached, with low heat loads. However, at the outer target, detachment is not fully achieved and the heat fluxes are not lowered below 10 $\mathrm{MW/m^2}$, even when the power losses in the edge plasma are equal to the 50% of the power crossing the separatrix. Therefore, the tokamak will probably need to be operated in deep detached regime for both targets in its first phase of exploitation for discharges longer than a few seconds.

In the framework of core-edge integrated modeling, using METIS, the power radiated in the core has been computed for the most interesting cases, in order to estimate the total power to be injected for achieving the simulated edge conditions.

References

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