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Preparing ITER Tungsten Divertor Operation in Tore Supra: Physics Basis for the WEST Project

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Power exhaust is one of the main challenges for next step fusion devices. The WEST project (Tungsten (W) Environment in Steady State Tokamak) is targeted at paving the way for the ITER divertor procurement and operation. It consists of implementing a divertor configuration and installing an ITER like actively cooled tungsten divertor in Tore Supra, taking full benefit of its unique long pulse capability. This paper describes the physics studies developed to prepare the scientific exploitation of WEST.

WEST provides an integrated platform for testing the ITER divertor components under combined heat and particle loads in a tokamak environment and allows extending plasma scenarios over relevant plasma wall equilibrium timescale (˜minutes).

Three classes of plasma scenario are foreseen. A standard scenario at medium power (12 MW) will be the workhorse for testing the ITER like PFCs and demonstrating integrated H mode long pulse operation. For the study of plasma wall interactions at high particle fluence, a scenario up to 1000 s is foreseen. Finally, a high power scenario at 15 MW will be developed for 30 s high performance discharges. Ongoing work includes integrated modelling of the three classes of plasma scenario, studies for RF heating, assessment of power loads and particle fluence on the WEST divertor, and estimate of the tungsten plasma contamination.

For the 3 scenarios foreseen, ITER relevant heat fluxes (in the range 10-20 MW/m2) are expected on the WEST ITER like divertor. From preliminary estimates, reaching ITER relevant fluence (˜1027 D/m2) for plasma wall interaction studies would require a few days of operation.

The RF heating will ensure dominant electron heating. The penetration of LH heating is seen to be challenging for high pedestal plasma density. The ICRH frequency can be tuned, and is optimized to provide central heating. In scenarios with significant LH current drive, a reversed q profile is obtained, likely accompanied by an Internal Transport Barrier. Results from COREDIV indicate tungsten core concentrations similar to those obtained for ASDEX Upgrade simulations.

The above simulations are consolidated by experimental results : a WEST like configuration has been performed in ASDEX Upgrade, showing that high power H mode operation is possible in a full tungsten environment with the shallow divertor geometry foreseen for WEST.

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