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Long pulse operation in a tungsten environment: achievements and work plan for WEST

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The WEST tokamak has recently fully completed the installation of its ITER-like actively cooled divertor, and it is now ready to pursue integrated investigations for the qualification of the ITER divertor components (named PFU for Plasma Facing Units) as well as for operating high performance plasmas in a full tungsten environment. A comprehensive diagnostic survey tracks the evolution of the PFUs, and a post-mortem work plan characterizes the material transformation after exposure [Martin2021,Richou2021], including on-purpose local melting, erosion/redeposition and emissivity evolution [Gaspar2020]. Real-time protection via Infrared cameras is a topic of intense research due to the complexity of disentangling direct and reflected signals [Talatizi2021], and converting them into real temperatures with the large spatial and temporal variation of the tungsten emissivity. The scenario development activity in this environment is twofold. First, it aims at obtaining the intense heat fluxes, both stationary and transient, that are required to study the ageing of the ITER PFUs. In this aspect, noticeable achievements are the realization of discharges with a divertor heat flux reaching 5 MW/m2 for less than 5 MW of injected power, up to 100 MW/m2 on specifically designed tungsten blocs for melting experiments [Corre2021], and the discovery of an Optical Hot Spots issue due to PFU inter-spacing [Diez2020,Gunn2021]. The second aspect of scenario development aims at investigating integrated high performance plasma scenarios compatible with the stress on the tungsten walls (ageing issue) and the tungsten contamination (transport issue). In this respect, long pulse discharges (up to 55s so far) demonstrated a good particle and heat exhaust capability [Loarer2020], and transitions to H-mode confinement regime were maintained for up to 4s, close to the threshold power [Vermare2021]. The limitation foreseen for longer pulses relies on MHD limits, and for H-mode scenarios, it will be necessary to gain margins by reducing the radiated power enhanced after the pedestal formation, or increasing the injected power. For these two aspects and several others, the installation of a 3 MW ECRH system at the end of 2023 will open the operational space and help addressing essential issues for the development of integrated scenario for a fusion reactor using tungsten plasma facing components.

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