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WEST - LONG PULSE OPERATION IN A TOKAMAK

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Since 2016, the WEST tokamak has brilliantly demonstrated its capability to perform long plasma discharges in a fully metallic environment.
WEST, qualified as a long pulse machine, presents the specific features of a permanent magnetic field produced by 18 Superconducting Toroidal Field coils cooled at 1.8K thanks to its liquid helium cryogenic system, the entire plasma facing components including the tungsten ITER grade divertor actively cooled by a pressurized water loop. WEST offers a representative and complete environment for next step devices such as ITER, JT-60SA and DEMO.
The last two experimental campaigns in 2023 and 2024 are crowned by experimental results and performance continuously improved. The machine availability reached 80% for more than 8 months. The integrated plasma operation exceeded 5 hours for each campaign and energy handling capabilities was demonstrated with 80 GJ of cumulated energy injected with Lower Hybrid Current drive (LHCD) and Ion Cyclotron Resonance Heating (ICRH) systems. In addition, two records of plasma duration of 101s in 2023 and 364s in 2024 were obtained.
Operation of long pulse in a tokamak requires on one hand, machine availability achieved by maintenance and evolutions on sub-systems, technical management of unplanned interventions and operation coordination. On the other hand, the capability to ensure protection of Plasma Facing Components (PFC) during long steady state discharges is essential. The paper presents selected highlights about the strategy put in place on the WEST Tokamak.
A key point in improving the responsiveness of technical interventions has been the automatization of water leak detection through the evolution of the complex water network configuration. As this point is crucial for the future machines, advanced techniques are developed, such as infrared water leak detection and remote sniffing inside vacuum vessel.
Based on systematic electronic data logging and manual record of events, a complete technical performance study has been performed covering the two last campaigns. The analysis focus on tokamak reliability, operation starting time, pulse rate, pulse rating and actions to increase available time for experiments.
For PFC protection, a remarkable set of infrared diagnostics, covering 52% of the first wall of the vacuum vessel, provides a large thermal mapping, identifies thresholds and deliver an alarm to the plasma control system to tune the heating power in order to prevent over-heating and continue plasma discharge.
The upcoming campaign is now preparing with the implementation of the new ECRH heating system and the goal of a plasma duration of 1000s.

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