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Engineering Challenges in W7-X and preparations for the second operation phase

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In 2015 the optimized stellarator Wendelstein 7-X stellarator started with operation. The main objective of W7-X is the demonstration of the integrated reactor potential of the optimized stellarator line. An important element of this mission is the achievement of high heating-power and high confinement in steady-state operation. The approach to this mission is following three steps. First plasmas were produced in a limiter configuration (OP 1.1), then a test divertor unit is being installed (TDU) for the next campaign, OP 1.2, before the full steady state capability will be achieved implementing active cooling of all in-vessel components and a steady state high heat flux divertor.

In 2014/15, after the closure of the outer vessel, the commissioning of the W7-X device started. After the evacuation of the cryostat vessel and the plasma vessel, and checks of the mechanical stability of the vessels, the leak-search and cleaning of the 2000 m cryo-piping was started. In spring 2015 the magnetic coil set together with the support system was cooled down to 4 K. In the next step, the superconducting magnet system was loaded with currents for the first time. After integral commissioning of the magnet system, magnetic flux surfaces were confirmed using an electron beam.

In December 2015, the first helium plasma was generated using ECRH, in February 2016 the working gas was switched to hydrogen. The first operation phase (OP 1.1) was successfully finished in March 2016. At the end of OP 1.1 the discharge duration was close to 6 seconds, the limit for the heating energy was increased to 4 MJ and electron temperatures of ~ 10 keV were achieved. Due to the low densities in the range of 10^{19} cm⁻³ and the pure electron heating by ECRH, the ion temperatures reached only 2 keV.

At present, W7-X is undergoing the next completion phase, including the installation of the test divertor unit, the installation of the carbon tiles on the inner plasma vessel wall, an upgrade of existing diagnostics and the installation of new diagnostics.

This talk will discuss the engineering challenges in the preparation of OP 1.1, the first results from OP 1.1 and the further completion of W7-X and the preparation of OP 1.2.

Eligible for student paper award?

No

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