DPP16-2016-001192

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

Results from the first operation phase of W7-X[1]

THOMAS SUNN PEDERSEN[2], Max Planck Institute for Plasma Physics

This talk will give a review of stellarator physics and the mission of Wendelstein 7-X (W7-X) [1], and will summarize the most important results obtained during its first operation phase, OP1.1 [2], which was completed in March 2016. The HELIAS [3] reactor vision and open issues in stellarator research will also be discussed. The stellarator concept dates back to the 1950s [4]. It has several intrinsic advantages, including being free of current-driven disruptions, and not needing current drive. However, the stellarator has been lagging behind the tokamak with respect to energy confinement. Recent advances in plasma theory and computational power have led to renewed interest in stellarators since they allow a complex but effective optimization of the confinement properties, one that should allow for tokamak-like confinement times. W7-X is the largest and most optimized stellarator in the world, and aims to show that the earlier weaknesses of the stellarator concept have been addressed successfully by optimization, and that the intrinsic advantages of the concept persist, also at plasma parameters approaching those of a future fusion power plant. It is built for steady-state operation, featuring 70 superconducting coils, and a confinement volume of about 30 m^3. During OP1.1, it was operated at full field (B=2.5 T on axis), with ECRH power up to 4.3 MW (later to be extended to 10 MW). Plasma operation was performed with helium and hydrogen, with deuterium planned for later phases. More than 2,000 discharges were created during the 10 operation weeks of OP1.1. Core $T_e \approx 8$ keV and $T_i \approx 2$ keV were reached in discharge with densities in the low to mid 10^{19} range, and confinement times were on the order of 100-150 ms, within expectation.

[1] H.-S. Bosch *et al.*, Nucl. Fusion **53** (2013) 126001

[2] Pedersen, T. S. *et al.* Plans for the first plasma operation of Wendelstein 7-X. Nucl. Fusion **55**, 126001 (2015).

[3] J. Nuhrenberg and R. Zille, Stable stellarators with medium β and aspect ratio, Phys. Lett. **114A**, 129-132 (1986) [4] L. Spitzer, Phys. Fluids **1**, 253-264 (1958).

[1]This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the European Unions Horizon 2020 research and innovation programme under grant agreement number 633053.

[2]On behalf of the W7-X team