Contribution ID: **352** Type: **Poster**

Characterization of the W7-X Scrape-Off Layer using the Multi-Purpose Manipulator

Friday, October 26, 2018 2:00 PM (20 minutes)

Wendelstein 7-X (W7-X) recently concluded its first operation phase (OP1.2a) featuring an island divertor. In this concept, the heat and particle exhaust to the divertors is governed by intrinsic three-dimensional magnetic islands at the plasma edge. In order to establish high performance plasmas with safe divertor operation, a comprehensive understanding of the island divertor physics is required, for which in turn thorough studies of the plasma properties and dynamics within the islands are essential.
The Multi-Purpose Manipulator (MPM), a carrier system for probe heads mounted at the outboard mid-plane of W7-X, is a key diagnostic for the characterization the W7-X Scrape-Off Layer. Being a multi-user platform, it served various scientific aspects during OP1.2a, including different electric and magnetic probes, plasma-surface interaction studies, hydrogen fuelling and impurity injection.
Characterization of the SOL by the MPM mostly relies on the use of reciprocating electric probes which can perform radial fast plunges through a magnetic island up the last closed flux surface. The fundamental quantities inferred from probe measurements (e.g. radial profiles of density, electron temperature, plasma flows, electric fields and potentials) already allow to infer conclusions on the magnitude and spatial distribution of parallel heat and particle transport to the divertor. Employing, in addition, spatially distributed arrays of probes, we obtained insight into the dynamics and propagation of turbulent fluctuations and the associated (perpendicular) fluctuation-induced transport.
Typical fundamental plasma parameters that have been obtained using the MPM are electron temperatures up to 100 eV and densities up to 1·1019 m-3 with a strong dependence on operation (e.g. heating power) and core plasma parameters (e.g. density). Furthermore, the complex magnetic field topology in the large configuration space of W7-X is found to play an important role for the edge plasma profiles. Hence, cross-checks with other SOL diagnostics are used for both validation of results as well as identification of local effects (e.g. due to the island structure).

Country or International Organization

Germany

Paper Number

EX/P8-18

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Session Classification: P8 Posters