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P3.150 Design and Instrumentation of a Divertor Manipulator at Wendelstein 7-X

Wednesday, 19 September 2018 11:00 (2 hours)

Steady-state and long pulse exposure of plasma-facing materials in reactor-relevant conditions are an integral step towards the qualification of next-step materials with respect to erosion, fuel retention and morphology changes in view of reactor applications.
W7-X will allow plasma operation of up to 30 minutes in its second operation phase (OP2) and thus provides an ideal framework for the qualification of materials in magnetically confined plasma conditions. A divertor manipulator system (DIMS) for W7-X with high heat load capability will follow the functionalities and design of the limiter lock system at TEXTOR[1] and DIM-II[2] at AUG, allowing dedicated tests of materials without necessary breaking of the vacuum for tile extraction.

Positioned as an extension of one the five lower horizontal divertor target plates, the manipulator head interacts with the scrape-off layer. Exposing material samples and components aims at study and qualification as well as determination of local plasma properties like electron temperature, density, flows etc. Furthermore, in-situ observation of the manipulator by adoption of the endoscope system equipped with multiple cameras and spectrometers provides surface information for intra- and inter-plasma phases. Complementary, a laser-based diagnostic system is proposed to study in-situ material composition and fuel retention.

Design and capabilities of the midplane manipulator drive train and control system[3] are developed further to accommodate the larger probe head size (35cm poloidally, 7cm toroidally) and weight(>25kg) foreseen here. The exposure duration of an intermediate, uncooled, probe-head design will be assessed by FEM simulations for different stroke depths and magnetic configurations. The sample holder design must allow rapid probe exchanges on a user-facility-type, while providing enough cooling abilities for the steady-state operation. Furthermore, the implementation of probes, other embedded diagnostics and a gas injection system will be detailed.

[1] B.Schweer,et al.,Fusion Sci. Technol.,47(2005)138-145

[2] A.Herrmann,et al.,Fusion Eng. Design,98-99(2015)1496-1499

[3] D.Nicolai,et al.,Fusion Eng. Design,123(2017)960-964

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