Plasma conditioning and planned active sample-handling in the upcoming linear plasma device JULE-PSI

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Linear plasma devices are capable of generating steady-state dense plasma over long durations and are regularly used to study plasma-wall interactions on plasma-facing-materials (PFMs) [1]. The plasma exposures are combined with in-situ and ex-situ measurements for fuel retention, material erosion amongst other thermo-mechanical properties. The measured material data on PFMs is essential towards the design of fusion power plants and is is intrinsically linked to the operational scenarios of the reactor. As we progress towards D-T reactors and commercial power plants, there is a need for lifetime studies under reactor relevant conditions, including neutron damage. This involves exposing irradiated materials to plasma & high heat flux exposures in linear plasma devices.

JULE-PSI is an upcoming linear plasma device at Forschungszentrum Jülich, Germany and is designed to be operated in a hot cell environment [2]. This allows for the handling of radioactive samples and exposure of the irradiated PFMs to reactor conditions. At present, the plasma chamber along with the plasma-source and a plasma-dump is mounted on a test stand undergoing plasma commissioning with helium plasma. The aim of the plasma conditioning stage is to achieve stable plasma with a top hat profile, electron density of ~10^{17}-10^{19} m^{-3}, an electron temperature of 3-10 eV and an ion flux to the target of ~10^{21}-10^{23} $m^{-2}s^{-1}$. The plasma is characterized through a single tip Langmuir probe and a segmented dump with current measurement capabilities. Alongside the plasma chamber, a detailed design of a manipulator-based sample transport and handling system is being developed to remotely expose samples and ensure compatibility with the hot cell enclosure. This system should also allow suitable access to laser based diagnostics.

In this contribution, a status update on the device development alongside plans for irradiated sample handling and transport inside the hot cell will be presented. Furthermore, the measurements of plasma temperature and density through the Langmuir probe cross-checked with the segmented dump will be discussed. Lastly, an outlook for the operation and commissioning of the device will be shared.

[1] B. Unterberg et al 2011 Fusion Engg. And Design 86
[2] L. Scheibl et al 2015 Fusion Engg. And Design 98-99

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