Contribution ID: **100** Type: **Poster**

Measurements of impurity flows and line-radiation in the W7-X scrape-off layer

Monday, 7 November 2022 15:10 (20 minutes)

Characterizing the scrape-off layer (SOL) transport of Wendelstein 7-X (W7-X) is essential to assess the efficiency of its unique exhaust concept, the island divertor configuration. Insights into the SOL dynamics in attached and detached conditions can be gained by the measurement of particle flows. Investigations of impurity flow velocities and line-radiation have been carried out with the Coherence Imaging Spectroscopy (CIS) diagnostic, featuring 2D spatially resolved measurements that led to the first detection of the 3D counter-streaming flow pattern of the W7-X SOL [1]. The impurity monitored by CIS is C2+, selected via the C-III transition line at 465 nm (2s3p3P°⟶2s3s3S). Its line-emission intensity, integrated over the entire camera view, is observed to be linearly proportional to the total plasma radiated power (Prad) in both attached and detached plasmas for non-seeded conditions. This linear relationship, together with a multi-machine scaling for Prad [2], is exploited to link the C-III intensity to the line-averaged density, demonstrating experimentally that the plasma density can be used as an actuator for the carbon line-radiation. The related C2+ velocity exhibits a strong dependence on the SOL density, while the SOL input power has no direct influence on the velocity magnitude. In attached plasmas, both the velocity and the SOL density increase with increasing line-averaged density. The tendency reverses during detachment, in which both quantities decrease by at least a factor of 2 [3,4]. The sharp drop in velocity, together with a rise in line-emission intensity, is reliably correlated to the achievement of the detached state and can be used as one of its signatures [3]. Another distinctive feature of the measured C-III radiation during the transition to detachment is the appearance of localized emission areas around the X-point regions of the island chain, as predicted by EMC3-Eirene [5]. In the measurement domain, the impurity flow velocity appears to be well-coupled with the main ion one, thus implying the dominant role of impurity-main ion friction in the parallel impurity transport dynamics [6]. Using the C2+ impurity flow as a proxy for the bulk plasma one, the CIS results are interpreted with the help of EMC3-Eirene simulations, but their major trends are already explainable with a simple 1D fluid model, based on the continuity equation and the SOL power balance. At the same time, EMC3-Eirene modelling is not able to entirely capture the measured tendencies in the CIS flow velocities, due to the incompleteness of the physical model currently used in the code. A key missing physics aspect is the E×B drift, which is shown to substantially influence the measured flows, especially in the location of their stagnation regions [7].

References

[1] V. Perseo et al., Nuclear Fusion, vol.59, 2019.
[2] G.F. Matthews et al., Journal of Nuclear Materials, 241-243, 1997.
[3] V. Perseo et al., Nuclear Fusion, vol.61, 2021.
[4] F. Reimold et al., 28th IAEA FEC 2020, IAEA-CN-286-1296, 2021.
[5] Y. Feng et al., Nuclear Fusion, vol.61, 2021.
[6] Y. Feng et al., Nuclear Fusion, vol.49, 2009.
[7] D.M. Kriete et al., in preparation, 2022.

Speaker's Affiliation

Max Planck Institute for Plasma Physics

Member State or IGO

Germany

Primary author: Dr PERSEO, Valeria (Max-Planck-Institute für Plasmaphysik)

Co-authors: WINTERS, Victoria (Max Planck Institute for Plasma Physics); Dr KRIETE, David Matt (Auburn University); REIMOLD, Felix; FENG, Yuhe (Max-Planck-Institute for Plasma Physics); Dr FORD, Oliver Patrick (Max Planck Institute for Plasma Physics); KOENIG, Ralf (Max-Planck-Institut for Plasma Physics); BOZHENKOV, Sergey (Max-Planck-Institut für Plasmaphysik, Greifswald, Germany); Dr GRADIC, Dorothea (Max Planck Institute for Plasma Physics); JAKUBOWSKI, Marcin (Max-Planck-Institut für Plasmaphysik); Dr KREMEYER, Thierry (Max Planck Institute for Plasma Physics); Dr KRYCHOWIAK, Maciej (Max Planck Institute for Plasma Physics); Dr GAO, Yu (Max Planck Institute for Plasma Physics); Dr SCHLISIO, Georg (Max Planck Institute for Plasma Physics); ZHANG, Daihong; PEDERSEN, Thomas Sunn (Max Planck Institute for Plasma Physics)

Presenter: Dr PERSEO, Valeria (Max-Planck-Institute für Plasmaphysik)

Session Classification: Poster Session I (DEMOs & Next Step Facilities)

Track Classification: Divertors for DEMO and Next-Step Facilities