Impurity seeding and divertor fueling effects on the plasma surface interaction of Wendelstein 7-X

V. R. Winters[1], T. Barbui[1], S. Brezinsek[2], F. Effenberg[1], K. Hammond[3], J. Harris[4], M. Jakubowski[3], R. König[3], P. Kornejew[3], T. Kremeyer[1], M. Krychowiak[3], L. Rudischhauser[3], O. Schmitz[1], E. Wang[2], G. Wurden[5] and the W7-X team

[1] *University of Wisconsin-Madison, Madison WI 53706 USA*

[2] *Forschungszentrum Jülich GmbH, IEK-4, D-52425 Jülich, Germany*

[3] *Max-Planck-Institut für Plasmaphysik, D-17491 Greifswald, Germany*

[4] *Oak Ridge National Laboratory, Oak Ridge, TN 37830 USA*

[5] *Los Alamos National Laboratory, Los Alamos, NM 87545 USA*

The method and efficiency of plasma fueling at Wendelstein 7-X (W7-X) is shown to have a direct impact on the level of carbon erosion during the first experimental phase with the carbon-covered Test Divertor Unit (OP1.2a). Two approaches to manipulate the plasma fueling were taken: (a) cooling the scrape-off layer (SOL) via the seeding of radiative impurities (Ne, N_2) in order to make it more transparent for fueling H neutrals or (b) fueling the plasma through a gas valve located directly in the island divertor. A set of ORNL Filterscopes [1] was used to directly characterize the C erosion from these changes in fueling by observing the C-III line (465.0nm, 2nm FWHM) in the divertor where both seeding impurities and hydrogen were introduced. Combination of these spectroscopic data with plasma parameter data from the Langmuir probes located in that divertor, data from the thermal helium beam diagnostic [2], and temperatures inferred from H line ratios, allow the extraction of C particle fluxes using S/XB coefficients. With direct fueling into the island at the divertor target, a decrease of the C erosion yield from the divertor surface was measured. This most likely is due to ionization cooling from the fueling gas, which directly can affect the PMI through reduced physical sputtering rates. This is promising as the localized fueling seems to reduce C erosion at the same time. The seeded impurities have, depending on the species chosen, a more complex interaction with the PMI, which is being investigated. Depending on the actual ion temperatures, physical sputtering can be increased due to the higher mass and/or charge state of seeding ions and a change to chemical erosion is likely for species like N_2.

Acknowledgements: This work was funded in part by U.S. DoE grant DE-SC0014210.

References

[1] Colchin, R J et al, Rev. Sci. Instrum. **74** (2003)

[2] Barbui, T et al, Rev. Sci. Instrum. **87** (2016)