

Inference of Tungsten and High-Z Impurity Transport in W7-X Turbulence-dominated and Turbulence-reduced Discharges using X-ray Crystal Spectroscopy

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Abstract

A new InSb (1, 1, 1) crystal installed in the High-Resolution X-ray Imaging Spectrometer (HR-XIS) [1, 2] has enabled temporally and spatially resolved tungsten (W) spectral observations for impurity transport investigations in the Wendelstein 7-X (W7-X) stellarator for the first time. Specifically, the 5.6893 Å W⁴⁶⁺ line can now be observed in W7-X and is predicted to be the brightest W emission between 1 – 7.5 Å for $2.1 \lesssim T_e \lesssim 10$ keV according to collisional-radiative modeling of W atomic data calculations using the ColRadPy code [3]. W⁴⁶⁺ is populated over a wide temperature range which can be exploited for transport investigations and impurity density profiles using the imaging capabilities of the HR-XIS diagnostic for radial localization with ~ 3 cm spatial resolution. The 5.6893 Å W⁴⁶⁺ line and He-like resonance lines were measured using HR-XIS during experiments carried out during previous experimental campaigns in W7-X. The impurity transport experiments consisted of Laser Blow-Off injections of various high-Z materials such as W, Fe, and Ti in both the standard case, where turbulence dominates, and turbulence-reduced scenarios. The impurity transport times during turbulence-reduced scenarios have previously been observed to be an order of magnitude greater than in the standard case [4]. An optimization wrapper built around the Aurora 1.5D impurity transport code has been developed to infer impurity transport coefficients for W and other high-Z elements.

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References

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