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P1.1005 Impurity transport studies using TESPEL in W7-X stellarator

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The tracer-encapsulated solid pellet (TESPEL), which can be considered as an impurity-embedded hollow pellet, was developed at NIFS, Japan to promote detailed impurity transport studies in magnetically-confined high-temperature plasmas [1]. Recently, a TESPEL injection system has been commissioned on the Wendelstein 7-X (W7-X) stellarator at IPPGreifswald, Germany through on a collaboration between NIFS, IPP and Ciemat [2]. This has been prompted by the need to identify W7-X operation scenarios that avoid the impurity accumulation predicted for high-density steady-state discharges of this optimized stellarator [3]. Since its plasma volume is similar to that of the Large Helical Device (LHD), similar sized TESPELs are used for W7-X and LHD: the outer diameter is about 700/900 µm. One advantage of TESPEL is that it produces a 3-dimensionally isolated extrinsic impurity source inside the magnetically confined plasma. Such a local deposition of the tracer impurity embedded in the TESPEL has been confirmed in W7-X plasmas by signals from filtered PMTs, which view the light emissions from the ablation cloud from its injection port. The temporal evolution of various emission lines from highly-ionized tracer impurities has been observed clearly by other diagnostics installed in the W7-X, e.g., HEXOS, PHA, XICS, HR-XIS [4]. In particular, HEXOS clearly observed a local maximum in the temporal behaviour of some spectral lines emitted by tracer impurity ions. This is primarily attributed to the processes of outward transport and recombination of the impurity ions that come from inside the plasma where the tracers are deposited. Thus, this result clearly emphasizes the usefulness of the TESPEL for precise (local) studies of impurity transport. The temporal evolution of the line emissions observed by these various diagnostics is also compared with 1-D modelling by the STRAHL code for estimating impurity transport coefficients. In the W7-X, a laser blow-off (LBO) system is also installed as a complementary impurity injection method [5]. Therefore, the impact of impurity source location (at the core by TESPEL and at the edge by LBO) on impurity transport can be uniquely investigated in the W7-X. In this contribution, initial assessments of results from the TESPEL injection experiments in the operational phase OP1.2b of W7-X will be reported and discussed.

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