Experimental determination of plasma parameters in the presheath region of the Magnum-PSI linear plasma generator

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Near the surface of plasma-facing components, in the region of ion acceleration called the presheath, the incoming plasma flow can interact with neutrals reflected from the wall. This interaction can be particularly strong under conditions of high density and low temperature, like those in the ITER divertor plasma. Such plasma-neutral interaction can potentially influence the plasma fluxes, and therewith the particle and heat loads on the wall. Models of the Scrape-Off-Layer and plasma sheath can be used to predict divertor loads, but need to be experimentally verified in ITER-relevant conditions. Such conditions are provided by the Magnum-PSI linear plasma generator, along with good diagnostic access.

In this report, the first Coherent Thomson Scattering (CTS) measurements in Magnum-PSI are presented, under typical operating conditions: a magnetic field of 1.2 T, and a discharge current of 175A at 7 slm Hydrogen gas flow. The observed CTS spectra are used to determine the plasma flow velocity and ion temperature.

As expected in a highly collisional plasma, the ion and electron temperatures ($T_i$, $T_e$) were found to coincide in the region several cm from the wall. However, close to the wall, $T_e$ has been found to drop [1], whereas $T_i$ showed a slight increase. The latter could be caused by energetic neutral heating, the former is thought to be an effect of plasma momentum loss. The parallel plasma velocity was found to be $5.0 \pm 0.5$ km/s, corresponding to a Mach number of $0.24 \pm 0.03$. The combination of coherent and incoherent TS yields the first direct, local measurements of particle and momentum fluxes in Magnum-PSI. Using these data, we can improve the estimations of particle and heat loads under ITER-relevant plasma-conditions.