TALIF and CARS Diagnostics for Measuring Atomic and Molecular Hydrogen Densities in Divertor-relevant Plasmas

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One of the biggest challenges of a reliable fusion reactor is the handling of large heat and particle loads on the divertor wall. Key to reducing these loads is by plasma detachment, in which a large range of processes occur between the plasma and the neutral background [1,2]. Atomic and molecular processes largely determine the plasma dynamics, which is why these particles are often studied in divertor research [1,2]. However, measurements on electronic ground state densities for atoms and molecules are lacking for divertor-relevant plasmas. We will use active laser spectroscopy, using TALIF and CARS, to measure these densities.

To measure the atomic hydrogen ground state density, a TALIF setup has been developed to allow measurements in the linear plasma device UPP. UPP is able to create divertor-relevant plasma conditions ($n_e \approx 10^{20}$ m^{-3}, $T_e < 5$ eV). Nanosecond laser pulses in the 204-206 nm range are used to excite hydrogen from the ground state, and fluorescence was monitored with a gated ICCD camera. The first spatially-resolved measurements in UPP were performed and the results are shown in Figure 1. In the centre of the plasma column, closest to the target, the density is measured to be highest at $2.3 \cdot 10^{19}$ m^{-3}. Increasing the target distance seems to yield a hollow density profile, until reaching a constant value around $1 \cdot 10^{19}$ m^{-3} for larger distances.

A CARS setup is currently under construction to determine the rovibrational distribution of hydrogen molecules in the electronic ground state, and is expected to measure populations up to the second vibrational state. The plans for incorporating this setup in UPP will be discussed.

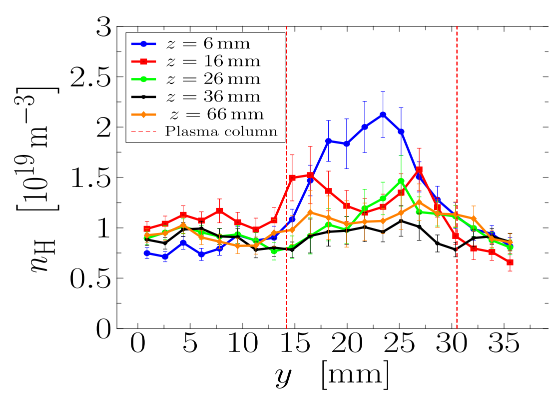

Fig. 1: spatially-resolved measured atomic ground state hydrogen densities, at varying radial positions *y* for a given distance to a tungsten target *z*.

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