Femtosecond TALIF of atomic hydrogen in RAID

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Laser-induced fluorescence (LIF) techniques provide interesting ways to probe atomic hydrogen (H) and deuterium (D) in plasmas because they are non-invasive and they yield spatially localized measurements. These features make LIF very attractive in the field of fusion, in which investigation of neutral species is typically only done indirectly from optical emission spectroscopy measurements. Two-photon absorption LIF (TALIF), in particular, is considered a promising tool to measure H and/or D densities [1] because, among other advantages, it can be calibrated to provide absolute numbers.

In the context of high-power tokamak operations, however, typical discharges last only a few seconds. This makes it very challenging to use nanosecond or picosecond systems to determine H or D density during an experiment because the laser wavelength must be scanned across the two-photon resonance to reconstruct the full absorption line [2]. The use of femtosecond pulses constitutes an interesting alternative because their wide spectral width allows exciting the entire H and D populations with a single laser pulse, thereby allowing single laser pulse density measurements and opening the way to time-resolved H and D density measurements in fusion experiments.

We have developed a fs-TALIF system to investigate single laser-pulse determination of H densities [3] in the RAID linear device [4], where plasmas with densities $\sim 10^{18}$ m^{-3} are created and sustained with helicon antennas. This system builds upon the results recently obtained with a picosecond system [2] and explores the potential as well as possible limitations of fs-TALIF to diagnose fusion-relevant plasmas.

In this work, we present first experiments using fs-TALIF in a hydrogen plasma in RAID.

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