Development of a Thomson scattering diagnostic for helicon plasma sources

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The resonant antenna ion device (RAID) [1] is a high power (up to 10kW) helicon source operated at the Swiss Plasma Center of Ecole Polytechnique Fédérale de Lausanne. A resonant birdcage antenna generates and sustains helicon plasmas to investigate applications for negative ion sources for fusion [2] as well as for the helicon plasma cell for the AWAKE (Advanced WAKefield Experiment) project [3]. Here, we report on the implementation of a Thomson Scattering (TS) diagnostic based on the second harmonic of a Nd:YAG laser, a high throughput spectrometer, and a PMT (photo multiplier tube) as detector. The non-invasive setup is characterized by a simple implementation, high flexibility, and high precision. An absolute density calibration is performed by Raman and Rayleigh scattering and the uncertainties are evaluated utilizing a Bayesian approach. Radial profiles of the electron density and temperature are obtained in argon in the so-called 'blue core' condition. Electron densities in the interval (2 – 12) x 10^{18} m^{-3} and temperatures up to 2.1 eV are measured. Additionally, the system provides the possibility to acquire the TS data phase-locked to the RAID radio-frequency (RF) power. Detailed measurements confirm that the electron velocity distribution function in RAID is Maxwellian and does not change significantly during the RF cycle. The TS setup can be used as a routine diagnostic on RAID. Furthermore, adaptation and migration of the system to the AWAKE helicon plasma cell in CERN is planned for the near future.

References

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