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Cross-diagnostic calibration of the density measurements in TOMAS

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The TOMAS device is a TOroidally MAgnetized System (TOMAS), which is operated by LPP-ERM/KMS at the FZ-Jülich. It is a facility designed to study plasma production, wall conditioning and plasma – surface interactions [1]. A magnetron with a frequency f_{EC} = 2.45 GHz is used as microwave source for Electron Cyclotron Resonance Heating (ECRH) of the plasma and can inject 0.7-6.0 kW of power. The device is equipped with various plasma diagnostics [2]. The Langmuir probe system consists of two movable quadruple Langmuir probes (QLPs) to measure the plasma density, temperature and potential. The optical diagnostics include upgraded high resolution color video cameras, a photo-detector, optical emission spectroscopy and a microwave interferometer. Particle diagnostics include a time-of-flight neutral particle analyzer, a retarding field energy analyzer, a residual gas analyzer (quadrupole mass spectrometer) and vacuum gauges.

The horizontal QLP density measurements are calibrated using the O-wave cutoff density, which can be identified in the temperature evolution and the reflected power measurements. The vertical probe is then relatively calibrated. The density measurements of the QLPs are consequently combined with the light emission captured by the video imaging system to obtain a 2D profile of the electron density. The obtained data is correlated with the data from the spectrometer and the interferometer. These combined measurements are used to characterize helium, hydrogen and deuterium plasmas for different values of the gas pressure and injected power, different polarization of the injected waves and several values of the magnetic field.

References

[1[A. Goriaev et al., “The upgraded TOMAS device : a toroidal plasma facility for wall conditioning, plasma production, and plasma–surface interaction studies,” REVIEW OF SCIENTIFIC INSTRUMENTS, vol. 92, no. 2, 2021.
[2] Y. Kovtun et al., ‘Overview of TOMAS plasma diagnostics’, Journal of Instrumentation, vol. 18, no. 2, 2023.

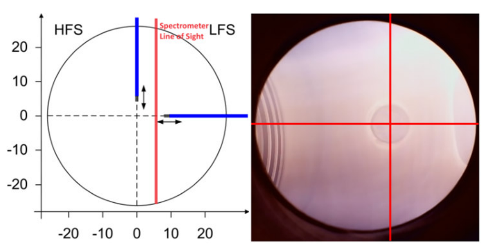

Figure 1: The position of the QLP and the spectrometer with respect to the vessel (left) and with respect to the field of view of the camera system (right).

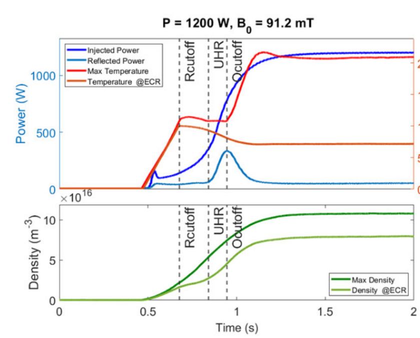

Figure 2: Calibration of the horizontal QLP measurements with the O Cutoff

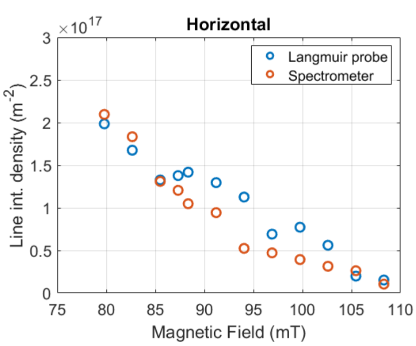

Figure 3: Comparison of QLP and spectrometer line integrated density measurements

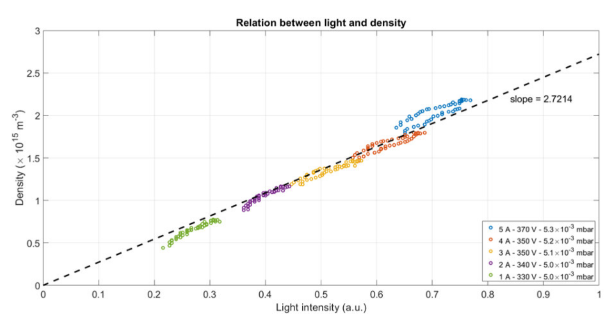

Figure 4: Relation between the QLP density measurements and the light intensity observed by the