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Spectroscopic determination of electron density and species distribution

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For particle acceleration in plasmas one of the key issues for stable and reproducible beams is control over and knowledge of the background plasma parameters. Sophisticated electron injection and laser beam transport mechanisms require not only specific plasma parameters but also e.g. a longitudinal and transverse density profile. In addition the species distribution and ionisation- and dissociation-dynamics can have significant impact on the generated beams. Currently established methods, like interferometry or gas density diagnostics using scattering processes, only allow for analysis of gas targets operated at densities well above 10^17 cm-3 and can only dress the electron density distribution.
Plasma spectroscopy allows to decode with nanosecond temporal resolution the before mentioned plasma properties which are embedded in the radiation emerging the plasma. Exemplarily spatially and temporally resolved electron density profile inside a capillary discharge waveguide are presented. Results show that the technique can easily resolve electron densities in the low 10^17 cm-3 regime and will, even with the current setup, allow to resolve densities in the 10^16 cm-3 regime and possibly lower, which are important e.g. for upcoming experiments at PW class lasers systems.

Primary author: Dr SCHAPER, Lucas (University Hamburg / DESY)

Co-authors: Mr SCHWINKENDORF, Jan-Patrick (Deutsches Elektronen-Synchrotron); Dr OSTERHOFF, Jens (Deutsches Elektronen-Synchrotron DESY); Mr GOLDBERG, Lars (DESY); Mr KLEINWAECHTER, Tobias (DESY)

Presenter: Dr SCHAPER, Lucas (University Hamburg / DESY)

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