Photonics and Ultrafast Laser Science

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Master Thesis

Application of ultrafast laser-driven plasma generation

The plasma group is a newly established part of the PULS group. The goal of our subgroup is to use the laser sources available/developed by the PULS group for applications in the field of laser-driven plasma generation. Laser-driven plasma has found numerous application cases, ranging from THz generation to lightning-guiding [1], [2]. The broad range of available laser systems at PULS offers us the unique opportunity to study the plasma generation process and its applications using driving lasers with different wavelengths, from NIR to MIR, and repetition rates, Hz to MHz [3]. The goal of our current scientific work is a holistic approach to constructing a high-power, broadband THz source with which we endeavor to perform spectroscopic measurements in water to better understand its properties as a "universal" solvent.

You will be part of the plasma sub-team for the duration of your project. Your main tasks consist of the following parts:

- Assisting with currently running experimental campaigns using a high-power ultrafast laser system (500 W). Focus on laser-plasma interaction, laser filamentation application, or THz generation/detection for water spectroscopy.
- Constructing small-scale experiments/diagnostic setups for larger projects.
- Evaluation of experimental data.

Successful completion of the project will give you skills besides a degree:

- Opto-mechanical design.
- Knowledge of ultrafast laser pulse generation compression and characterization.
- Experience with high-power ultrafast laser systems.
- Knowledge of non-linear optics and its application.
- Programming in Python

If you are interested in this topic, don't hesitate to get in touch with Dr. Malte Schröder for further discussion via

email: Malte.Schroeder-w9x@ruhr-uni-bochum.de

[1] D. K. Kesim, C. Millon, and C. J. Saraceno, 'Two-color plasma THz transients at 400 kHz repetition rate', presented at the European Conference for Lasers and Electro-Optics (CLEO Europe), Munich, Germany, p. Talk CC-3.6, pg. 77 (2021).

[2] A. Houard *et al.*, 'Laser-guided lightning', *Nat. Photonics*, pp. 1–5, Jan. 2023, doi: 10.1038/s41566-022-01139-z.

[3] R. Löscher *et al.*, 'High-power sub-picosecond filamentation at 1.03 μm with high repetition rates between 10 and 100 kHz', *APL Photonics*, vol. 8, no. 11, p. 111303, Nov. 2023, doi: 10.1063/5.0175100.