P 6: Atmospheric Plasmas and their Applications II

Time: Tuesday 11:00–12:30 Location: ZHG006

Invited Talk P 6.1 Tue 11:00 ZHG006

Spatially and temporally resolved electric fields in an RF-APPJ measured by E-FISH — •Inna Orel[1], Nikita Lepikhin[1], Zoltan Donko[2], Dirk Luggenhölscher[1], and Uwe Czarnetzki[1] — [1]Ruhr University Bochum, Institute for Plasma and Atomic Physics, Bochum, Germany — [2]Institute for Solid State Physics and Optics HUN REN Wigner Research Centre for Physics, Budapest, Hungary

Spatially and temporally resolved electric fields in a self-sustained radio frequency atmospheric plasma jet (RF-APPJ) in a helium:nitrogen mixture are measured by electric field induced second harmonic generation (E-FISH). It is shown that the electric field in the bulk of the RF-APPJ is unexpectedly high, having an amplitude of about 1.6 kV/cm, and that it exhibits a phase shift of approximately -0.2π relative to the voltage waveform [1]. The electron density in the bulk is estimated from the measured phase shift between the electric field and the applied voltage by using an equivalent RC-circuit model for the discharge. Comparison of the measured electric field with the results of ab initio Particle-in-Cell/Monte Carlo collisions (PIC/MCC) simulations reveals excellent agreement. Special attention is paid to the calibration of the E-FISH measurement which includes removal of polarity sensitive artifacts.

The work is supported by the DFG funded SFB1316 Project "Transient atmospheric plasmas - from plasmas to liquids to solids".

[1] I Orel et al 2025, submitted to Plasma Sources Sci. Technol.

P 6.2 Tue 11:30 ZHG006

Applied machine learning for electron density measurements of an atmospheric plasma torch — •Christos Vagkidis, Alf Köhn-Seemann, Stefan Merli, Mirko Ramisch, Andreas Schulz, and Günter Tovar — IGVP, University of Stuttgart, Germany

Atmospheric plasma torches are considered a promising approach for the decomposition of waste gases. In order to enhance their performance, it is crucial to accurately measure the plasma properties. One of the most important properties of the plasma is the electron density.

In this work, a deep neural network is used to predict the electron density distribution of an atmospheric plasma torch. The neural network is trained on data obtained from 3D simulations, carried out with the COMSOL Multiphysics software. In the simulation domain, a microwave beam is propagating through the plasma and the beam power is monitored after the interaction with the plasma. A 1D cut of this power, calculated perpendicularly to the direction of propagation, is used as training data for the neural network.

Experimental data are obtained through a similar set-up. A network analyzer is used to measure the microwave beam power. By moving the detecting antenna of the network analyzer perpendicularly to the plasma torch the beam power is measured. The beam power profile is then fed into the neural network, which in turn estimates the electron density of the torch with very good accuracy.

P 6.3 Tue 11:45 ZHG006

The role of metastable atoms on the dissociation of CO_2 in the COST Reference Microplasma Jet — •Alexander Schicke, Amira Nouira, Sebastian Burhenn, Marc Böke, and Judith Golda — Plasma Interface Physics, Ruhr-Universität Bochum, 44801 Bochum, Germany

The dissociation of CO_2 has become a growing topic in recent years. There are many applications, including decarbonising the atmosphere and producing carbon for chemicals and fuels. When adding CO_2 to an rf plasma, the dissociation can nearly double using argon instead of helium as a feed gas, because of the lower excitation and ionisation energies. Consequently, the assumption was made that the dissociation of CO_2 is dominated by electron impact dissociation and dissociation via Penning collisions with metastable atoms.

Therefore, to quantify which part the metastable atoms play in the COST Reference Microplasma Jet, the respective densities of helium and argon metastable atoms were measured while changing the ratio of He/Ar in the feed gas. The metastable atom densities were measured via tunable diode laser absorption spectroscopy (TDLAS), which allows the simultaneous measurement of both densities with high spatial resolution. With this 2D maps of the discharge channel can be created, which gives us in-depth information on the dissociation of CO_2.

This work is funded by the projects A3 and B2 of the CRC 1316.

P 6.4 Tue 12:00 ZHG006

Open-source tools for interactive preselection and analysis of large image datasets — •Philipp Mattern[1], Richard Krieg[2], Hans Höft[1], Torsten Gerling[1], and Markus M. Becker[1] — [1]Leibniz Institute for Plasma Science and Technology (INP), Greifswald, Germany — [2]University of Greifswald, Greifswald, Germany

To gain a holistic understanding of complex phenomena in plasma processes, it is often necessary to combine several high-resolution diagnostics and extensive parameter variations. This results in large data sets that are difficult to access using conventional methods and analysis tools. This contribution introduces two open-source tools developed at INP Greifswald for efficient data handling and image analysis: WOLKE and BLITZ. BLITZ enables rapid loading, visualization, and statistical evaluation of large image collections—handling more than 20,000 images (exceeding 20 GB) in under a minute—without requiring specialized hardware. Its matrix-based approach allows swift calculation of key parameters even for massive datasets. WOLKE provides a web-oriented layout and filtering framework for interactively preselecting image data based on user-defined criteria (e.g., mean, entropy, sharpness, operation parameter combinations, timestamps, EXIF information or any pre-calculated value). Filtered subsets identified in WOLKE can be seamlessly examined and further analyzed within BLITZ. This combination creates a highly adaptable workflow for data exploration, evaluation, and presentation, effectively responding to evolving research demands in plasma physics and beyond.

P 6.5 Tue 12:15 ZHG006

Laser Optical Loop for highly repetitive laser measurements by a single laser pulse — •Nikita Lepikhin, Dirk Luggenhölscher, and Uwe Czarnetzki — Institute for Plasma and Atomic Physics, Ruhr University Bochum, D-44780 Bochum, Germany

A Laser Optical Loop (LOL) approach is proposed to achieve high repetition rates of laser pulses by using each single laser shot several times. As a result, measurement speed of laser based experimental techniques can be accelerated significantly, e.g. Electric Field Induced Second Harmonic generation (E-FISH), Two-Photon Absorption Laser Induced Fluorescence (TALIF), Thomson scattering, etc. Several optical schemes are proposed to form the optical loop and to trap the laser emission. The feasibility of the suggested method is demonstrated using the example of the E-FISH technique.

Acknowledgements: The work is supported by the DFG funded SFB1316 Project "Transient atmospheric plasmas - from plasmas to liquids to solids".