Time resolved evolution of the EEDF in a ns-pulsed atmospheric pressure plasma jet in Helium

C. Schregel[1], D. Luggenhoelscher[1], U. Czarnetzki[1]

[1]Institute for Plasma and Atomic Physics, Faculty for Physics and Astronomy,
Ruhr-University Bochum, Germany
Email: Uwe.Czarnetzki@ep5.rub.de

1.Introduction

In the investigation of plasmas of any kind, knowledge of the EEDF is fundamental. A convenient, non-invasive diagnostic tool to access this is Thomson scattering. However, the small signal due to the small scattering cross section and the presence of a strong Rayleigh peak make a complicated triple grating spectrometer (TGS) setup necessary.

In this work, a TGS has been used to acquire the time resolved evolution of the EEDF of a ns pulsed micro discharge closely resembling an atmospheric pressure jet. The results are complemented with electrical and emission measurements. This provides a detailedpicture of the physics of the discharge.

2. Experimental Setup

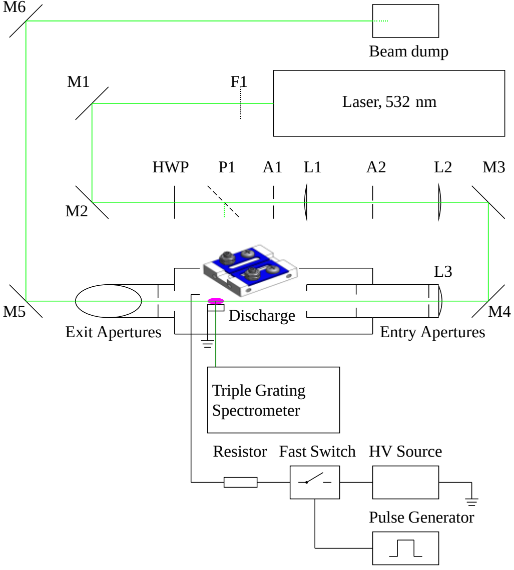

Fig. 1: *Experimental Setup.*

A very basic discharge configuration was chosen. Two molybdenum electrodes of 20mm x 1,5 mm face each other with a 0.95 mm gap in between (See Fig. 1). They are covered at top and bottom by thin glass plates. To ensure cooling for arcing prevention, Helium is blown in through a shower head set of holes in the lower glass plate. Due to the requirement of an unobstructed line through the discharge, no end cap exists, and outflow is at both ends.

To ignite the plasma, a pulsed voltage of 1-2 kV amplitude and 150 ns duration is applied with a repetition frequency of 5 kHz to one of the electrodes.

A Nd:YAG laser provides an8 ns laser pulse at 532 nm that focused into the discharge with a f=33 cm lens. The scattered light is collected with a solid angle of $\Delta\Omega/4\pi=0.027$and guided to the TGS. Detection is by a gated($\Delta t=20$ ns)iCCD camera.

3. Results

The velocity distribution in the plane parallel to the electrode surface is detected and under assumption of isotropy, the EEDF can be inferred. By changing the laser timing, the time evolution of the EEDF was acquired and electron density and average energy calculated.

With integration times of 10 min at a given phase of the discharge, a dynamic range for the EEDF of two to three orders of magnitude could be archived in the energy range from 0.5 eV to 12 eV. The EEDF shape shows a very dynamic behavior ranging from Maxwellian to non-Maxwellian. In particular heating by superelastic collisions in the afterglow phase becomes visible in the EEDFs. Good correlation with current, voltage and optical emission measurements are found (See Fig. 2).

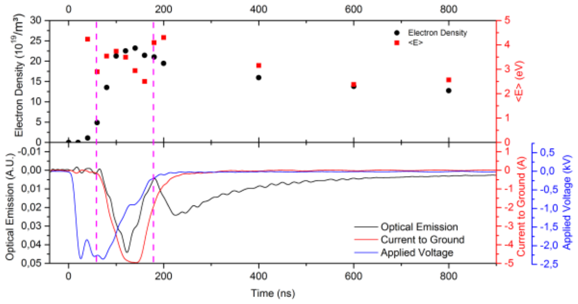

Fig. 2: n_e, *<E>, U, I and total optical emission.*

Acknowledgment:

This work was founded by the DFG Research Group FOR1123.