

Set-up of a laser ion source for beam neutralization experiments

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A laser ion source (LIS) is built to investigate space charge neutralization effects in the extraction gap. The reasons to use a LIS are its relative simplicity compared to other ion sources, the ability to produce large amounts of high charge states for a wide range of ion species and the ability to produce high current density in the extraction gap.

The experimental set-up contains two Faraday cups. The first one, at a distance of 24 cm behind the extraction gap, is movable, the second one is fixed at a distance of 70 cm. The experiment as described in Ref. [1] was extended by a gated CCD-camera as shown in Fig. 1. The CO₂-Laser pulse (10,6 μm, pulse duration FWHM: 1,3 μs) is focused on a

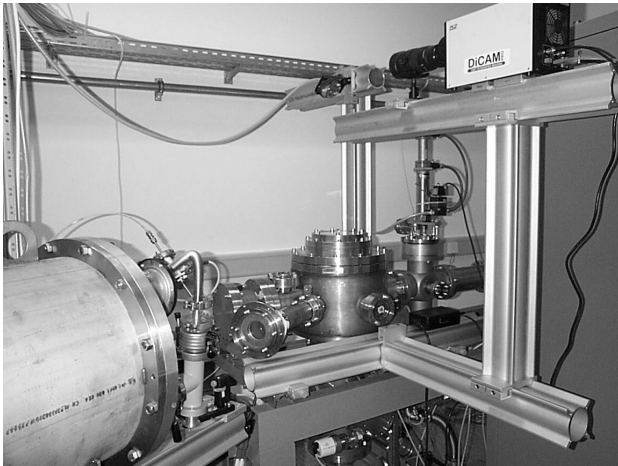


Fig. 1: Laser ion source with CCD-camera

carbon target. In a first step, Faraday cup measurements were done for a laser pulse energy of 800 mJ (Fig. 2), later the laser energy was increased to 1.6 J leading to a maximum ion current of 13 mA for 30 kV extraction voltage.

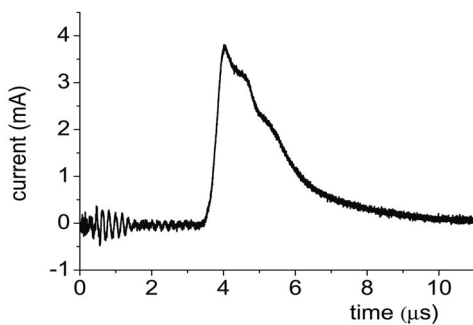


Fig. 2: Faraday cup signal for 15kV extraction voltage

However, the reproducibility of the measurement has to be improved. The extraction system is a simple diode setup which is currently optimized using IGUN [2]. The distance across the gap is 8 mm with an aperture diameter of

7 mm. Plasma production and expansion of the plasma cloud were simulated using a two-temperature 1D hydrodynamic code [3]. This code takes into account the radiative, dielectronic and three-body recombination as well as electron impact ionization. The calculations indicate a strong dependence of the charge state distribution and the ion current density on the laser pulse properties (Fig 3).

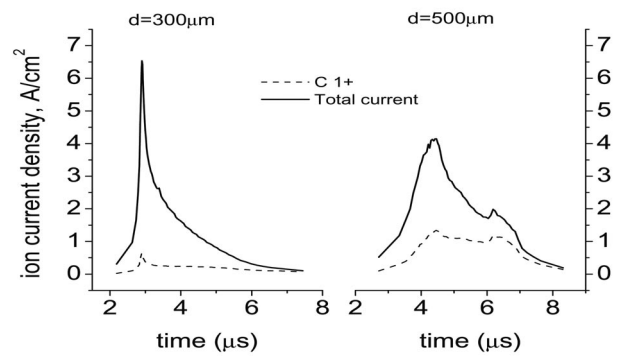


Fig. 3: Numerical results for the total ion current density and C¹⁺ fraction for two different focus diameters: left 300 μm and right 500 μm.

The plasma expansion was recorded with a gated CCD-camera. The expansion velocity of the plasma cloud is \cong 4 km/s and the mean direction is towards the laser pulse. After

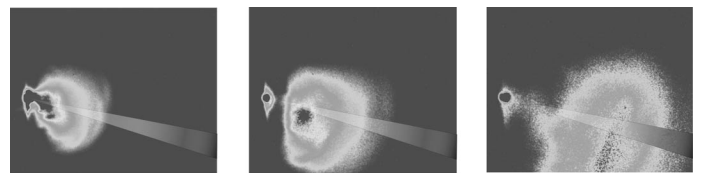


Fig. 4: Picture of plasma cloud at 3.7, 4.5 and 5.5 μs (the envelope of the laser pulse is overlaid in gray)

a few laser shots the surface of the target is damaged, therefore the expansion direction and appearance of the plasma cloud changes. To improve the reproducibility of the LIS the set-up will be changed in order to be able to move the target.

References

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- [2] R. Becker et, al. Rev. Sci. Instrum. **63** (1992)
- [3] I.V. Roudskoy, Las. Part. Beams **14**, 369-387 (1996)