

Laser Ablation Characterization in Laboratori Nazionali di Legnaro

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INTRODUCTION

To fully understand a Laser Ion Source (LIS) behavior is mandatory to familiarize and to deeply analyze laser ablation processes onto target materials. This the aim of the new laser setup implemented in Laboratori Nazionali di Legnaro, where studies on laser ablation are just beginning. A Q-switched Nd:YAG is used to ablate target placed in front of an ions collector into an high vacuum chamber. Thank to this simple configuration inspired by [1] it will be possible to test the system configuration, the signal and data collecting procedure in order to move a secure first step into this new line of research for our group. This work will synthetize the firsts experiments and results with this simple configuration and a it will show possible future steps for the experimental setup and measurements.

EXPERIMENTAL SETUP

The experiment involves several systems and can be resembled in figure 1, where a laser beam is focalized onto a target inside a vacuum chamber and a collector, placed in front of the target, collects the ion signal from the expanding plasma plume.

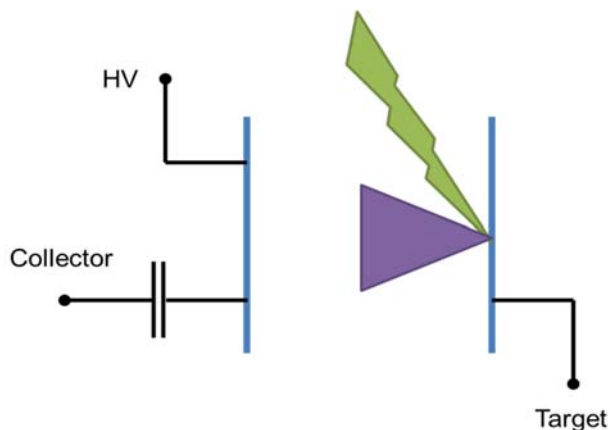


Figure 1. Simplified experimental setup

Laser and focalization system

The used laser is a Quantel YG980 Q-switched Nd:YAG laser system, operating at its fundamental wavelength (1064 nm), capable to delivery up to 2 J energy 10 ns pulses at maximum rep rate of 10 Hz. Laser beam, entering in the vacuum chamber with an angle between 20 and 45 degrees, is focalized onto target by a 20 cm lens.

Vacuum Target Chamber

The vacuum chamber (figure 2) was entirely designed and assembled in LNL. The high vacuum is ensured by a diffusive oil pump (Edwards DIFFSTAK 63/150) capable of 135 liter/sec.

The final vacuum value measured after 2 hours pumping is $7 \cdot 10^{-6}$ mbar.

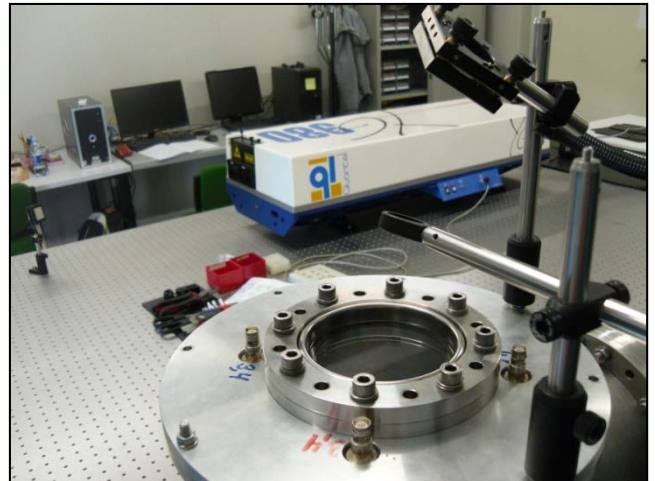


Figure 2. View of vacuum chamber

Inside the chamber is placed the target-collector system. Target is made of a Copper plate, electrically isolated by a plastic support. It can be rotated to expose different area to each shot of the laser beam and it can be electrically polarized positive or negative respect to the collector and the chamber by an external high voltage power supply.

Distance between plates can be varied from 2 to 5 cm. Signals are collected by electrical connection of the plates directly to the oscilloscope (Tektronix TDS 3034C) channels with 50 Ohm terminations. A 3D section of the chamber is showed in figure 3.

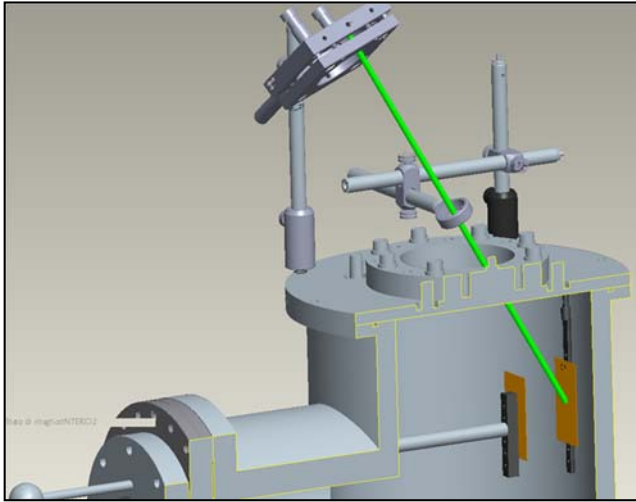


Figure 3. Section view of the chamber and target.

Data collection

In order to collect data from the system an automatic procedure was implemented using MATLAB® as command interpreter between the PC and the oscilloscope. Data of interest, such as laser pulse duration and plates voltages are automatically recorded and plotted in the PC monitor for immediate evaluation.

RESULTS

We measured several parameters to evaluate laser ablation processes and ions generation. Distance between target and collector plate was fixed to 4,5 cm, polarization voltage between plates and laser pulse energy were variable parameters.

Figure 4 shows an example of data collected representing different voltage signals on the collector plate varying its voltage from -40V to +80 V respect to the target plate.

Signal starts from negative values, due to electrons attracted by the positive +40 V polarization, to positive voltages due to ions attracted by negative polarization.

Results are consistent with the existing literature confirming that the apparatus is ready to a more intense measurement campaign. Furthermore these processes could be used to a first evaluation of the produced state of charge for ions extracted from the plasma.

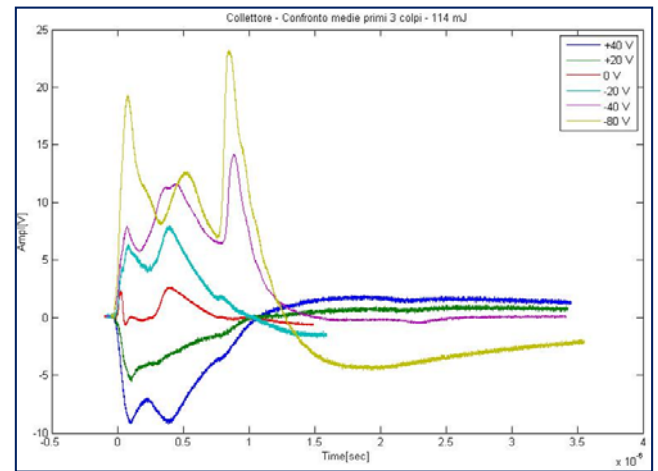


Figure 4. Collector plate signals at different voltages.

The high speed of the material, ions and neutral, expelled by the laser ablation process combined to the reduced distance between the target and the collector, does not allow an easy analysis of the charges expelled. Furthermore the absence of some kind of suppressor system on the collector side, allows generation of secondary emission electron even from the neutrals atoms impinging the plate.

Experiments of ions generation by laser plasma were performed in LNL. An easy setup composed by a target-collector system was assembled to start studies on plasma characterization and observed results are consistent with the existing literature. Future developments, involving the assembly of an home made Time of Flight mass spectrometer, are planned to better characterize these processes of ions formation in term of state of charges distributions and efficiency of the generation process.

[1] T. Yoshitake; Journal of Material Science **35** (2000) 1469-1474.