Influence of f number variation on the properties of laser produced plasmas

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Experimental setup and results

The nhelix [1] system was used in experiments to test the f number influence on laser created plasma. The f number (f/#) is defined as the ratio of a lens focal length to the diameter of its entrance pupil. It has received some attention for its role on the laser produced plasma, as key parameter for the resonance absorption process [2]. The resonance absorption enhances the light absorption in the plasma. Therefore, it is important to understand the plasma physics and its applications.

In experiments perfomed at GSI with the nhelix facility a direct relation between f/# and the highly charged ions emission was found. This result is in agreement with previous works [2]. Figure 1 shows the experimental setup. The laser is focused onto the target with a lens (13 cm focal length) placed inside the vacuum chamber. The targets were magnesium slabs of 1 mm thickness. The laser beam incidence angle was fixed in 45°with respect to the target surface. The plasma spatial characteristics were recorded with X-ray pinhole cameras.

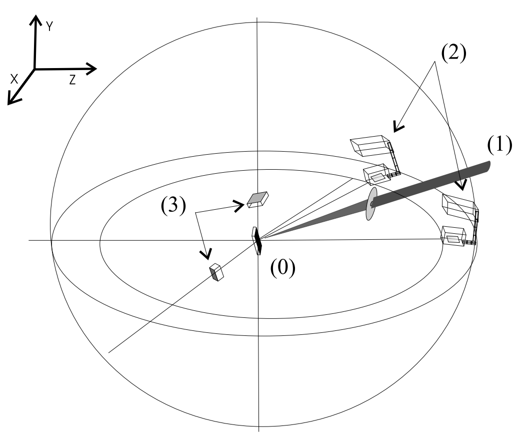

Figure 1: Experimental setup scheme: (0) Target, (1) Laser beam with last lens, (2) X-ray spectrometers and (3) Pinhole cameras.

The cameras were placed in perpendicular directions to probe the spatial characteristics in these two planes. Two X-ray spectrometers (FSSR [3]) were placed with angles of 0°(Fs1) and 90°(Fs2) with respect to the target surface. Their spectra were recorded using X-ray films. The spectral region between the He-β (7.85 Å) and He-γ (7.50 Å) magnesium lines was set up in the FSSR. The movement of the He-like ions is recorded on the FSSR in perpendicular to the wavelength axis. The comparison of the ion movement is then possible.

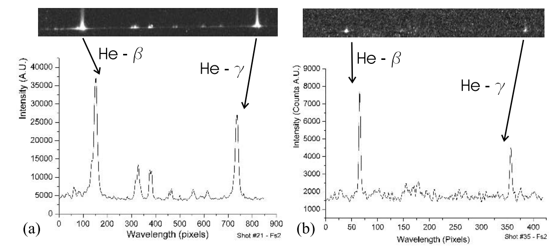

Figure 2: Fs2 spectra and their density traces for the two cases of f-number: (a) f/2.65 and (b) f/2.06

For the used lens a laser beam diameter variation from 49 mm to 63 mm implies that f/# goes from f/2.65 to f/2.06. These were the values used here. In fig. 2 the spectra and their total density trace are presented. The lines perpendicular to the wavelength axis show that with f/2.65 the plasma expansion is present. Such expansion does not appear with the smaller f/2.06. The ion emission measured with the peak value is five times higher with f/2.65 (37 000 counts) than with f/2.05 (7 700) in the He-β line. Similar results can be obtained with the He-γ line (right line in the figure 2).

Conclusions

The importance of f/# as key parameters in the laser plasma generation had been confirmed. With as litle change as 20% in f/# the ion peak emission has been increased 5 times. In order to use the nhelix as back iluminator the X-ray generated intensity must be maximized. As this works states, an increase in the f/# is very effective to obtain an incresaed X-ray flux. A non linear effect as the resonance absorption can explain the obtained results.

References

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