

# Smoothing effect of plasma density with pulsed magnetic field on beam emittance for laser ion source

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A laser ion source is one of the candidates of the ion source for heavy ion inertial fusion, which can supply a large current ion beam. On the other hand, a pulsed ion beam is obtained because a pulsed laser is used to generate plasma. The density modulation of the plasma during the pulse changes the meniscus of the surface of extracting an ion beam. Therefore, it changes the envelope of the beam during the pulse, which leads increase of the ion beam emittance [1]. In order to suppress the increase of the emittance, it is necessary to reduce the density modulation of the plasma density before extraction of the beam and the emittance variation in a pulse. In order to control the emittance variation, a pulsed magnetic field was applied to the plasma to smooth the temporal variation of the density. In this study, the influence of the smoothing of the plasma density on the emittance of the extracted ion beam was investigated.

We used an Nd: YAG laser with a pulse width of 6 ns and energy of 350 mJ to generate ablation plasma of the target Fe. The position of the lens was set so that the intensity of the laser is approximately  $10^9$  W/cm<sup>2</sup> on the target. The plasma is transported 3 m after passing through the pulse solenoid and the ion beam is extracted. After that, the grid lens was used to focus the beam on the emittance measuring device which consists of a pepper-pot, a micro-channel plate, and a phosphor. A pulsed magnetic field generated with a pulse solenoid was applied to smooth the beam current waveform.

Emittance images were obtained every 20  $\mu$ s with respect to the whole beam current waveform, and the difference of the emittance variation between with and without the magnetic field was investigated. The results showed that the changes in the emittance image are smaller by applying the magnetic field compared to that without the magnetic field. It indicates that the emittance in a beam pulse is improved by smoothing the change of plasma density in the pulse. From these results, it was found that not only increase of the beam current but also lowering the emittance of the beam can be attained by smoothing the plasma density by applying the pulsed magnetic field.

## References

[1] M. Okamura *et al.*, Nucl. Instr. Meth. Phys. Res. A **733**, 97 (2014)