6 - 17 Reseach Status of Laser Ion Sources at IMP

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In 2016, the research and development of laser ion sources were mainly contributed to promote the performance of the ion source, such as to prolong the pulse duration of the ion beam, to realize the repetition rate operation mode of the ion source. In addition, the production of highly charged metallic ion beams from an ECR ion source with laser ablation plasma injection was also investigated preliminarily.

The confinement of laser produced plasma with a solenoid was studied. For this purpose, a 1.5 m-long solenoid was installed on the expansion stage of the laser ion source. As shown in Fig. 1, the current intensity and pulse duration of the ion beams were inceased with the magnetic field, while the charge state distribution kept nearly constant. The measurement of the transverse profile of the ion beam showed that the divergence of the plasma was compressed. This research will help to enhance the injection efficiency of the laser ion source.

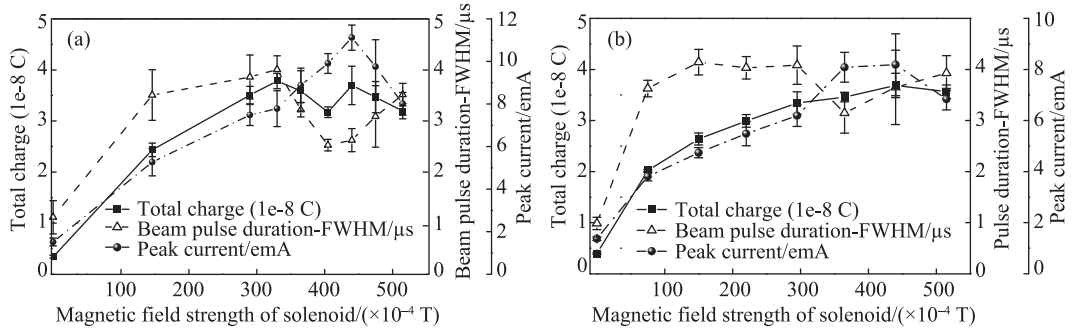

Fig. 1 The evolution of the total charge quantity, pulse duration, and peak current with the magnetic field of the solenoid for carbon (a) and aluminum (b) ion beams.

A new control system was designed for the laser ion source, which integrated the control of the target movement, laser trigger, data acquisition and storage, and made these actions happen in sequence both in single mode and in repetitive mode. With this control system, the laser ion source can be operated with the repetition rate up to 1 Hz.

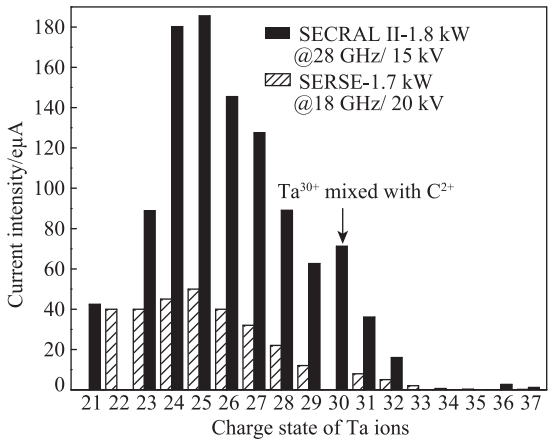

Fig. 2 Charge state distribution of Ta ion beams produced by SECRAL II and SERSE with laser ablation plasma injection.

Except for the laser ion source itself, the feasibility of using laser ablation plasma as the feed method for ECR ion sources with refractory metallic materials was also investigated. For this application of laser produced plasma, the persistency of the target for over 10^4 laser shots is necessary. During the off-line experiment, over 3×10^4 laser shots at the same position were realized for a tantalum target, which yielded 10^{15} particles per pulse on an average. The on-line experiment was carried out on the SECRAL II ion source. The tantalum target was fixed in the center of the negatively biased disk. The laser beam was focused by a lens with a focal length of 5 m, and transported through a K9 window at the end of the staight-through port of the analyzing magnet, the holes of the electrodes. Finally the loosely focused laser beam struck the target and produced plasma. With this scheme, the highly charged tantalum ion beams was produced by SECRAL II. The charge state distribution is shown in Fig. 2, accompanied with the result of the similar experiment carried out at the SERSE ion source[1].

Reference

[1] S. Gammino, L. Torrisi, G. Ciavola, et al., J. Appl. Phys., 96(2004)2961.