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Electron and Ion Spectra on Integrated Targets in FIREX
各種ターゲットにおける電子・イオンスペクトル

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A newly developed electron/ion spectrometer (ESM), which is available to measure the accurate electron and ion spectra down to low energy ranges, has been installed. The hot electrons are trapped by the self-magnetic field and the potential. The potential can be estimated from the ion energy. The potential in Diamond-like-Carbon (DLC) is higher than that in Au because the base electrons in DLC are less than in Au.

1. Introduction

A traditional fast ignition is performed to heat an imploded core which is created by an imploding laser by hot electrons, which is created through a guiding cone by a heating laser.1) The hot electrons can be propagated to the core since it is connected to the cone by the exploding plasma. Therefore the huge hot electron current can be compensated by a return current in the plasma. We have been making efforts to achieve the low effective temperature (T_{eff}) and high flux of hot electrons because the stopping range of the hot electron is much larger than the areal density of a core.

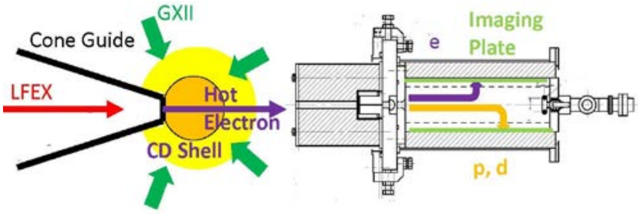

Fig. 1 The experimental setup and Electron/Ion Spectrometer.

2. Plain target

We install a newly developed electron/ion spectrometer (ESM), which is available to measure the accurate electron and ion spectra down to low energy ranges, as shown in Fig. 1(a), in order to investigate the electron behaviors.2) According to the results in experiment and simulation, 40-90% of the laser energy which irradiates the cone tip is converted from laser to hot electrons. The result is verified by the reflected laser measurement. The reflection seems to be decreased in the material of higher Z of the material. The reflection decreases at

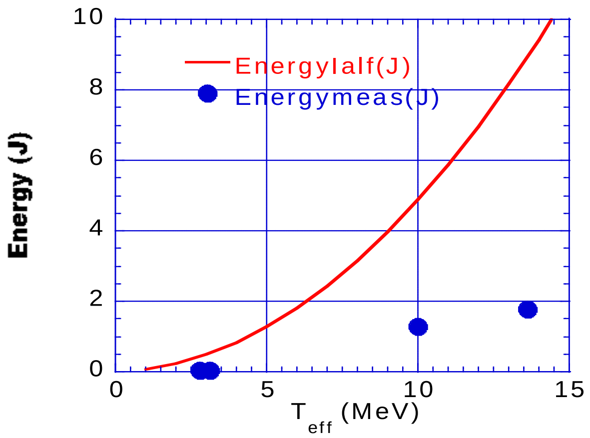

Fig. 2 Measured total electron energy vs T_{eff}
Au-plain data are compared with AL curve. The discrepancy comes from the potential.

the higher laser intensity because the laser absorption increases at the long scale length of pre-formed plasma. However, part of the electrons which are up to the Alfven limit (AL) and beyond the magnetic field trap can go out from the target. The hot electrons of only several percent of the total laser energy can be observed by ESM. Therefore, residual hot electrons are temporarily trapped around the target by a self-magnetic field and the potential. The electron energy fluxes in different T_{eff} can be obtained when Au plain targets are used, as shown in Fig. 2.3) The electron energy fluxes in Au are less than those determined by the AL. The reason is due to the target potential.

3. Simulation

The hot electron propagation in the Al target with pre-plasma of 1 μm has been studied by using computer simulation in order to investigate the

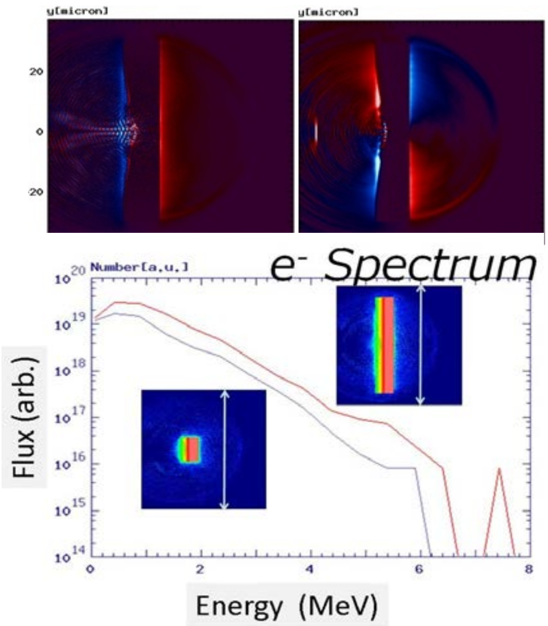

Fig. 3 Simulation in the plain targets
(upper) Electric and magnetic fields
(lower) Electron spectra in different size targets.

electron behaviors in the target. Many hot electrons run along the target front surface, and partially enter the target. When they reach the rear surface, many electrons run on the rear surface again. On the front surface, the return current is insufficient because the half space is a vacuum. Therefore, the strong magnetic field appears, the hot electrons are trapped by it, and the electric field is generated. The electrons are drifted along the surface by the ExB force. The magnetic field is generated due to the lack of the return current. Some of the electrons move to the vacuum and are detected by the ESM. We can obviously understand that electrons are trapped by the self-magnetic field by applying the external longitudinal magnetic field as show in Fig. 4. The observed electron flux in the ESM is remarkably increased when the magnetic field is applied because the AL is mitigated.

4. Integrated Targets

In the integrated experiment, the more complicated phenomena can be observed when different cone materials (DLC: Diamond-like Carbon, Au) are used. The electron flux in DLC is much less than that in Au, as shown in Fig. 2. The energetic ions are generated by the higher sheath potential in DLC than that in Au, as shown in Fig. 5. This indicates that the electron generation mechanism in DLC is different from that in Au. One reason may be due to the insufficient electron in the target. To confirm this, simulations in two

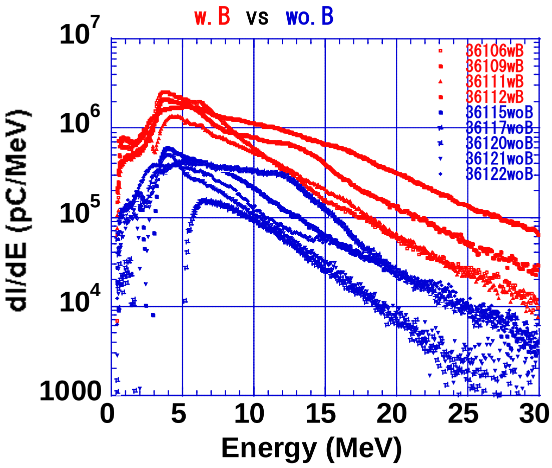

Fig. 4 Electron spectra with/without the external magnetic field

different size targets have been performed. Here we

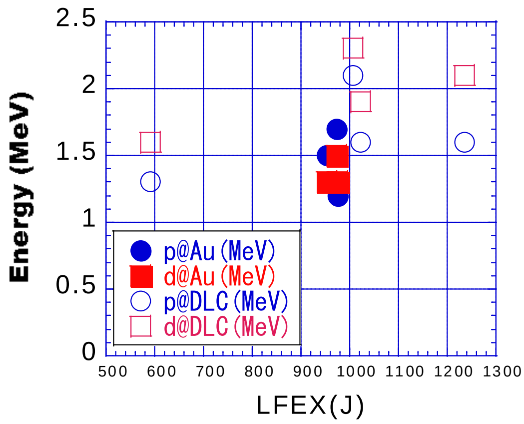

Fig. 5 Ion energy vs Laser energy.
Proton/deuteron energies accelerated by the sheath potential.

change the target size instead of the material species. In the short target, the electric field is generated due to the lack of the electrons in the target. Therefore, the electron flux is reduced as shown in Fig. 3. In the experiment, protons with higher energy in DLC are observed, as shown in Fig. 5. Those results are qualitatively agreed.

Acknowledgments

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