§41. Hot Electron Spectra in Plain, Cone and Integrated Targets for FIREX-I Using Electron Spectrometer

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The LFEX laser irradiates plain targets to measure the spot size and tuning diagnostics. We can compare the difference of the pre-formed plasma shape in varied materials. T_{eff} defined from the slope of the electron spectrum strongly depends on the scale length of the pre-formed plasma, which is mainly produced by the pre-pulse and/or the pedestal of the LFEX laser. All T_{eff} data dependence on LFEX laser intensity in this experimental series FI01 is shown.

Generally T_{eff} becomes low when the target Z is large. The pre-formed plasma of high-Z does not expand easily because the target mass number A($\propto$Z) is large. However T_{eff} in a copper target is much higher than T_{eff} in an Al one. One possibility is that the pre-formed plasma contains water on the copper surface. We compare T_{eff} in a cone irradiated by the LFEX laser with T_{eff} in a plate. T_{eff} in the cone is obviously higher than T_{eff} in the plate. Several reasons can be considered. The pre-formed plasma in the cone converges to the cone axis which is the path of the LFEX laser. The effective pass length of the laser in the pre-formed plasma becomes longer due to the geometrical effect of the expansion of the pre-formed plasma in the cone. According to the simulation, the oblique injection of the laser makes the higher T_{eff}.

In the integrated experiments, the DLC-cone is used instead of the Au-cone in order to prevent a huge X-ray and γn-neutron noise, and to decrease a hot electron loss in the cone. However the pre-formed plasma grows quickly because the DLC-cone consists of low-Z material. Au-coating on inner side of the DLC-cone has been performed in order to reduce the expansion of the pre-formed plasma. The DLC-cone has also the merit in that the interaction between laser and cone can be observed. In the integrated experiments, four different type targets of the standard Au-cone shell, DLC-cone shell, open hole-cone shell and open hole-shell have been tested. In the previous experimental series FG02, the dependence between T_{eff} and the imploding timing (deviation between the imploding time and the LFEX laser injection time) has been plotted. Maximum T_{eff} could be observed near the implosion time (=imploding timing 0). The residual ω component from the imploding 2 ω laser (GXII) may have irradiated the inner wall of the cone. In FI01, T_{eff} can be reduced by elimination of the residual ω component using a mechanical shutter. However T_{eff} seems to be still higher around the implosion time. The reason is that the lower component of the hot electrons is dissipated in the imploded core. This phenomenon is remarkable in the DLC-cone shell rather than in the Au-cone shell because the lower component of the hot electrons is already lost in the Au-cone itself. Therefore T_{eff} becomes higher.

In FI01, we can suppress the pre-formed plasma scale length within 30 μm (estimated from Phukov scaling) by elimination of the pre-pulse. T_{eff} can be reduced to be 5 MeV in a DLC-cone shell and 6 MeV in an Au-cone shell. The electron flux in the DLC-cone is almost the same as that in the Au-cone. T_{eff} in an integrated target seems to be determined by the cone shape because T_{eff} in integrated target is almost the same as in the cone only.

In integrated experiments, DD neutrons are measured by MANDALA. The neutron yield in the Au-cone shell is higher than that in the DLC-cone shell. The neutron yield has a strong positive dependence on the imploding laser power. The large imploding laser power produces the high imploding density core. At the beginning, we expected that the lower component of the hot electrons can give their energies to the core in the DLC-cone. However those facts mean that the imploding core in FI01 couples better with the higher energy electrons than we expected. The neutron source region is localized around the core center. The lower component of the hot electrons may heat only the surrounding region of the core but cannot produce neutrons because the electron to ion energy transfer is small due to the low plasma density in the surrounding region.

In integrated experiments, 9 beams out of GXII 12 beams are used for implosion. The external magnetic field (B_{ext}) can be induced by the residual 3 beams of the laser. The laser irradiates the parallel plates with a one turn coil in front of the cone. The magnetic field of several hundred Tesla can be easily obtained in the one turn coil. The magnetic field compression by implosion can be expected if the magnetic field is created in a shell before implosion. Therefore the hot electrons which are trapped on the magnetic line can be expected to be guided toward the imploded core. In integrated experiments, the hot electron spectra with and without B_{ext} are shown. T_{eff} and the hot electron flux as a function of the LFEX laser intensity are shown, respectively. The hot electron flux remarkably increases when B_{ext} is applied although T_{eff} becomes slightly low as shown in Fig. 1. The increase of the flux in ESM cannot be explained by the hot electrons convergence due to the magnetic field. The hot electrons convergence due to the magnetic field occurs only around a narrow region (<1 mm) around the core. The magnetic field is open at the position far from the core. The hot electrons diverge with the original divergence angle and are measured at the ESM position (1 m from the core). Therefore almost the same flux should be observed by the ESM. The increase of flux may be explained by the change of the pre-plasma shape in the magnetic field application. The neutron yield does not change clearly even if B_{ext} is applied. The reason may be that the pre-formed plasma shape has been changed by B_{ext}.

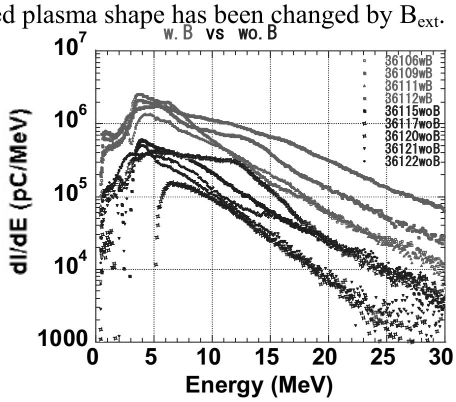

Fig. 1.