§26. The Results of the Electron Spectrometer on FF01 Experimental Series of the FIREX-I Project

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The electron spectro-meter (ESM) is tested to measure energetic electrons from the aluminum plain target with 10 mm thickness irradiated by LFEX laser (maximum energy 10 kJ, the wave length of 1.05 mm, 4 beamlets) with the pulse duration of 4 ps. The analyzer is installed on the Gekko XII Target chamber I at 20.9 degrees against the laser injection direction where is at the rear side of the target. This shot has been done by compression of one beam let LFEX laser. The maximum electron energy of 3 MeV can be observed when the LFEX laser is collimated up to 75 x 110 mm and the laser intensity of 3.5 x 10^{17} W/cm^2. The electron spectrometer only detects the escaped electrons over 0.5 MeV into and the amount of the electrons observed are strongly limited by the high electrostatic potential formation by the electrons.

LFEX laser irradiates the CD shells (deuterium polystyrene) with Au cone imploded by the Gekko XII laser. CD-shells specification is 500 mm diameter and 7 mm thickness with gold cone of 30-60 degrees. Mainly 9 laser beams of Gekko XII with 200–400 J/beam are used to compress the CD-shell. The injection timing of LFEX laser is adjusted so as to irradiate the imploded core of CD-shell using the optical delay system between LFEX and Gekko XII. The imploding time is determined by the shell specification and Gekko XII laser intensity. Until now the laser timing does not match each other accurately, we are finding the best timing for heating in the combination of the shell and laser energy.

Figure 1 show the typical energy spectra in three different cases of irradiated CD-Au shells. The real signal can be obtained by the subtracting the x-ray noise because much X-ray still remains on IP in spite of thick metal shielding. In the figure, the uniform spatial distribution is assumed. The spectra in the effective heating cases are different from that in ineffective heating case.

Figure 2(a) shows the LFEX laser energy dependence of the electron flux. The electron flux on Au target is larger than on Al target because there are more electrons in Au. The electron flux in the simple Au-cone is compared with that in CD-shell with Au cone. In CD-shell with Au cone, the LFEX laser should be injected at the final phase of the shell implosion ideally. However the implosion duration and the life-time of the imploded core are nano-seconds and several tens pico-seconds, respectively, which are larger than the LFEX laser pulse duration. Therefore the shell implosion process is independent on the energetic electron production mechanism by LFEX laser if the Au cone is not destroyed during the implosion. The electron flux in the Au cone should be equal to that in the CD-shell with Au cone. However the flux in CD-shell is obviously larger than that in Au cone. Two reasons are considerable. One is that the Au cone may be broken during implosion. Another possibility is that the ablation plasma makes short circuit so as to prevent the virtual cathode production. Figure 2(b) shows the injection timing dependence of the electron flux. At 200 ps in advance of the imploding, the Au cone is expected to remain without destroy. However the electron flux on CD-shell with Au cone is ten times larger than that on the simple Au cone. This means that the electron flux is enhanced by the ablation plasma.

In the electron measurement using ESM, we can find whether the heating is successful or not by the spectrum shape rather than the electron flux. At the successful heating, the low energy part in the spectrum is disappeared due to the electron absorption in the imploded core. For example, the intensity of the non-effective heating decreases at 2.3 MeV. However the intensity of the effective heating decreases at 3 MeV as shown in Fig.1. The spectra in the effective heating is the non-Maxwellian distribution because the electron may be absorbed by the imploded core. We find the spectrum has strong angular dependence from another detector, which is positioned just in front of the LFEX laser direction.

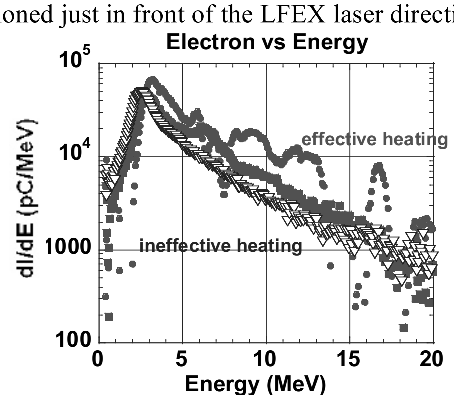

Figure 1. Typical energy spectra in effective and non-effective heating cases.

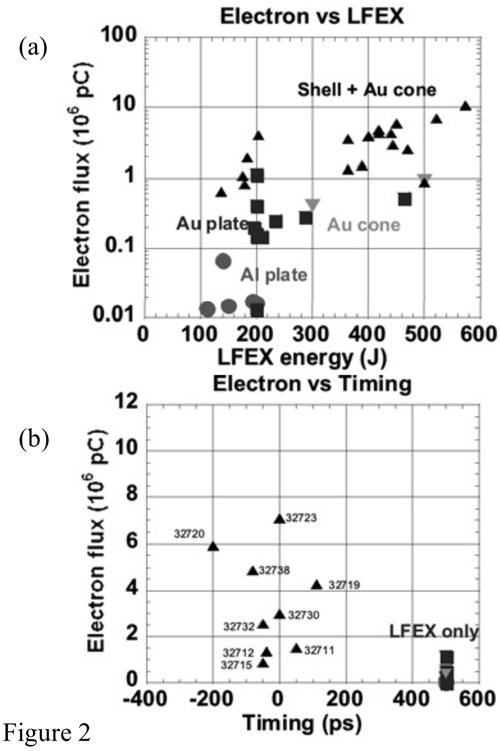

Figure 2
(a) LFEX energy dependence of the electron fluxes for four different targets..
(b) Electron intensity dependence of the timing between