Efficient energy coupling between heating laser and a fusion fuel is required for the fast-ignition laser fusion. Heating laser is converted to relativistic electrons by laser-plasma interactions, heating laser energy is carried by the electrons, and the electrons deposit their energy in the fusion fuel. It was found in previous experiments that the electron beam diverges during transport with an angle of 100 deg. Active control is required to reduce the divergence angle of the relativistic beams. One candidate scheme is to apply an external magnetic field parallel to the beam propagation direction in the fuel. When the magnetic flux density exceeds 2 kT, relativistic electrons are trapped by the magnetic field lines and lateral transport of the electrons is strongly suppressed.

We use a laser-driven capacitor-coil target to generate the magnetic field instead of the conventional magnetic field generation scheme. Figure 1 shows a schematic of the magnetic flux density measurement with Faraday effect. The horizontally polarized second harmonics of a Q-switched Nd:YAG laser (wavelength $\lambda = 0.532 \mu m$) were used as the probe. Fused silica was used as a Faraday medium in this experiment, whose Verdet constant is $298 \times 10^2 \text{ deg.}/\text{T m}$ for $0.532 \mu m$ probe light. Probe light transmitted through the fused silica cylinder was divided into horizontally and vertically polarized components by a Wollaston prism and the divided probe light was imaged on a visible streak camera. The rotation angle can be determined from the intensity ratio $I_H / (I_H + I_V)$ between the horizontal ($I_H$) and vertical ($I_V$) components.

We measured the magnetic flux densities by varying the intensity and wavelength of the drive laser and the thickness of the fused silica cylinder to obtain a scaling law of the flux density against laser intensity and wavelength. Figure 2 summarizes the maximum magnetic field obtained.

The flux density generated with a laser-driven capacitor-coil target is high enough that it can be applied to the collimation of the relativistic electrons. Furthermore, the initially diverged magnetic field line may reduce the electron reflectivity at the magnetic waist generated around the fuel core. This magnetic field will be implemented in an integrated fast-ignition experiment.