ANALYSIS OF PLASMA CHANNEL FORMATION IN THE MM-SCALE PLASMA

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For realizing fusion reactions via fast ignition, the effective conversion of Petawatt laser power into fast electrons is required to heat a high-density fuel core to an ignition temperature. We use a scheme making use of relativistic laser self-focusing to cut through the surrounding corona plasma to deliver the ignition energy to the core. During the laser propagation in the underdense plasma, the laser loses its energy through laser-plasma interactions. The pre-formed low-density plasma channel may be a good choice to reduce the energy loss. In our previous experiment at OmegaEP facility at the Laboratory for Laser Energetics, the University of Rochester, we observed the plasma channel formation with angular filter refractometry (AFR) technique [1]. Figure 1 shows the experimental setup. Channeling beam is injected into the plasma created by 1-kJ UV beams, and a 4ω probe beam passed cut through the plasma with AFR. AFR diagnostic produces ring-like pattern of refracted probe beam, each of which corresponds to plasma density. Figure 2 shows the AFR images. The plasma channel penetrates to $5 \times 10^{20}$ cm$^{-3}$ (0.5$n_c$), and filamentary structure is observed from the front of the channel toward the forward direction.

In order to analyze this result, we have performed ray trace calculations and have compared these results with 2D PIC simulation. We study the effect of the plasma channel profile on the AFR image by changing the channel parameters in ray trace calculations. Figure 3 shows the laser E-field obtained in 2D PIC simulation, indicating the strong split of laser beam. This structure could correspond to the filamented structure observed in AFR image (FIG.2). We discuss the details of the analysis.