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Measurement of fast electrons inside the dielectric material via observation of its Cherenkov radiation

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Direct measurement of extremely high energy density electrons created in ultra-intense laser plasma interactions is crucial issue for Fast Ignition. Cherenkov radiation is studied to obtain the energy distribution of electrons because the emission angle depends on the electron energy. However in the previous studies [F. Brandl et al. Europhys. Lett. 61, 632 (2003), M. Manclossi et al. Phys. Rev. Lett. 96, 125002 (2006)], the experimental configurations using a planer target raised issues of spatially overlapping among the light from the different energy electrons as well as the other emissions such as transition radiation. We developed a novel prism shaped target in which Cherenkov light emitted from different energy electrons are spatially separated, realizing an absolute measurement of the energy spectrum by counting the light intensities in each observed position. In the experiment we observed a clear expected horseshoe pattern indicating a portion of Cherenkov ring image. In addition, we found that many parts of electrons are considered to propagate along laser axis from the blur of the outer edge of the pattern. The calibrated energy spectrum agrees extremely well with a PIC calculation qualitatively. A large discrepancy between the magnetic electron spectrometer and the Cherenkov results infers the strength of the electrostatic sheath potential at the rear boundary which also well agrees with the calculation.