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Characterization of Initial Target Conditions in High Intensity Laser Solids Interaction Experiments

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Terawatt and Petawatt class high power laser systems have pre-pulses that can significantly affect the interaction physics. For example, in cone-guided high-intensity laser experiments the preformed plasma could cause filamentation and beam refraction [1]. Pre-pulses arrive picoseconds to nanoseconds before the main laser pulse can significantly increase the initial scale length and electron temperature of solid targets. It is important to know the initial target conditions to both correctly interpret the experimental data and to provide realistic initial conditions for theoretical calculations.
Pre-pulses that arrive in a nanosecond time scale prior to the main pulse can be measured using fast photodiodes [2-4]. Pre-pulses that arrive in picosecond time scale prior to the main pulse can in principle be characterized using a third order correlator [5]. However, on-shot pre-pulse diagnostic systems are often not readily available for users in many high-power laser facilities. Even if pre-pulse diagnostic systems are available they do not provide direct information about the degree of target disruption. Here, we present a technique for providing information about the degree of target disruption due to pre-pulses. We use a small portion of the laser beam as a probe beam to measure the change of target optical properties induced by the laser pre-pulse. An example using 30nm thin gold film targets will be presented here. The technique with sub-picosecond resolution allows us to detect pre-pulse heating down to 1/5 of the damage threshold energy density.

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[3] S. Le Pape et al., Opt. Lett. 34, 2997 (2009)

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Primary author: CHEN, Zhijiang (SLAC National Accelarator Laboratory)

Co-authors: CURRY, Chandra (University of Alberta); Dr HERING, Philippe (SLAC National Accelerator Laboratory); Dr GLENZER, Siegfrieed (SLAC National Accelerator Laboratory); TSUI, Ying (University of Alberta)

Presenters: TSUI, Ying (University of Alberta); CHEN, Zhijiang (SLAC National Accelarator Laboratory)

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