# Dynamics of Laterally and Orthogonally Colliding Laser Produced Plasmas

Khaled Al-Shboul, Ph. D.
Nuclear Engineering Department
Jordan University of Science & Technology
P.O. Box 3030, Irbid 22110, Jordan.

Tel.: Office + 962 2 7201000/ext. 22334
Fax: +962 2 7201074
e-mail: kfshboul@just.edu.jo
kalshbou@alumni.purdue.edu

The motivation behind this work emerges from a multitude of growing important applications of colliding plasmas. Colliding Laser Produced Plasmas (LPPs) showed a viable capability for simulating many scientific areas of great interest using laboratory-scale experiments such as the design of inertial confinement fusion (ICF) Hohlraum.[1, 2] Plasma collisions are expected in the fusion device chambers, and understanding the collision and subsequent interactions of the colliding plasmas is essential for using them for various applications. In this work, colliding LPPs are generated by splitting the laser beam into two sub-beams and then focus them onto flat or V-shaped targets. The dynamics of colliding laser-produced plasmas are investigated using fast photography and space resolved optical emission spectroscopy. The angular distribution of ions emanating from single and colliding plasmas was also examined by the aid of the Faraday cup detector. The seed plasmas were generated using 1064 nm, 6 ns Nd:YAG laser ablation of the target with varied geometries.

Plasma collisions lead to formation of what is kwon as the stagnation layer which is very complex as it had been shown that plasma stagnation can be preceded by a phase of interpenetration where the colliding plasma plumes initially pass through each other[3]. Many experiments have been performed on single LPP to obtain a comprehensive understanding of its evolution and underlying formation mechanisms, however, reports on colliding plasmas are still limited. With many simultaneous and complex processes involved, it is critical to use comprehensive diagnostic tools to investigate the seed plasmas and the interactions before and during the stagnation layer formation. Moreover, the plasma diagnostic tools are necessary as they provide a more complete picture of the physical nature of colliding plasmas and the mechanisms of stagnation which are extremely useful reference data for colliding plasma modeling efforts.[4-7]

In this work, a new experimental setup to investigate the properties and potential applications of colliding laser-produced plasmas is constructed. In this setup, the laser beam is split into two sub-beams that are focused on flat or 90° V-shaped targets as shown in figure 1. The optical system used to split the laser beam onto two separate foci on the target surface was similar to the one used previously.[8] The incoming laser beam from a nanosecond Nd:YAG laser system is split into two beams by a 0.86° wedge prism and focused on two points on the graphite target using a 2-inch Plano-convex lens with a focal length of 40 cm creating two 500 µm spots as shown in figure 2.

The results show that colliding plasmas can generate a stagnation layer accompanied by cluster production where a stagnation layer was observed at the interface of two, laterally or head-on, low temperature colliding laser-produced plasmas. Brighter emission with longer lifetime was found in the stagnation layer of the colliding plasmas compared to its seed plasma precursors. Besides, the ion temporal profiles collected by the Faraday cup show narrower kinetic energy profiles from the colliding region. Also, the major plasma parameters, viz., electron temperature, and density were estimated for single graphite plasma as well as for the stagnation zone from the spectral data.

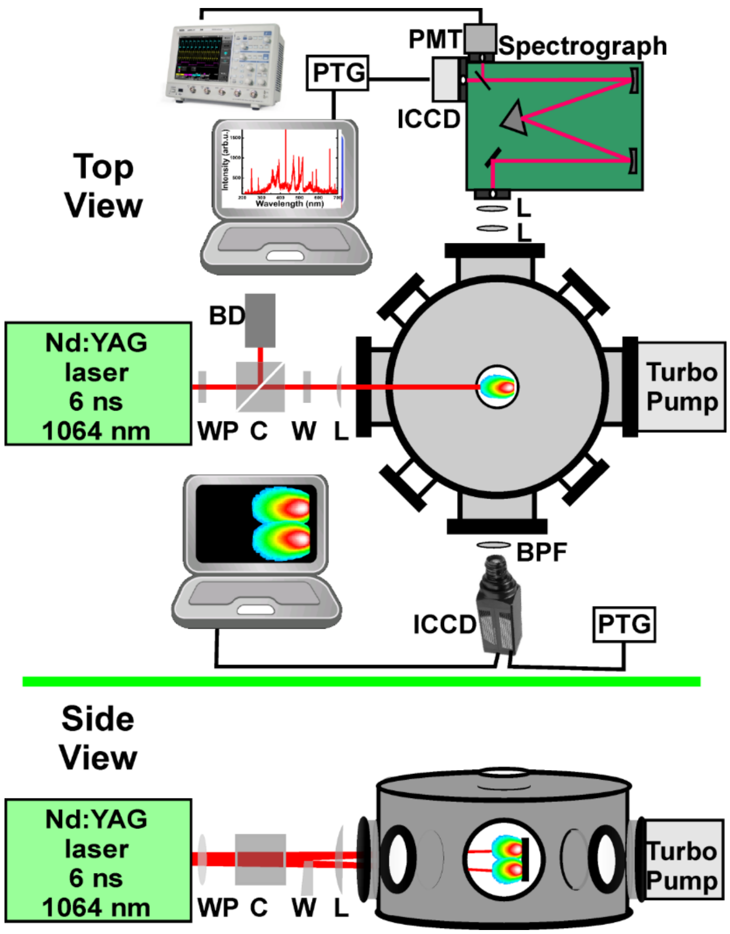


**Figure 1: The schematic of the experimental setup. (WP, wave plate; C, polarizing cube; BD, beam dump; W, wedge prism; L, lens; BPF, bandpass filter; PMT, photomultiplier tube detector; ICCD, intensified charged couple device detector; and PTG, programmable timing generator).**

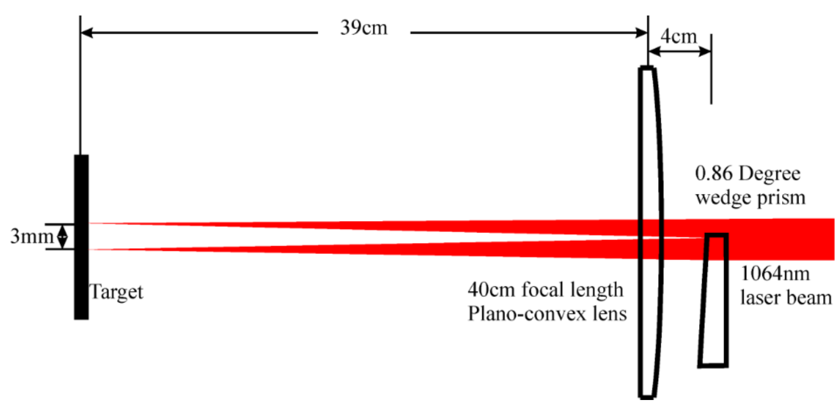


**Figure 2: Optical setup used to split the laser beam into two sub-beams with 500µm foci.**

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