# Plume dynamics of a laser produced plasma: Single and double pulse schemes

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**Synopsis** We present an investigation into the dynamics of a picosecond (ps) laser laser produced plasma (LPP) using an intensified CCD camera (ICCD). Single pulse and double pulse schemes are adopted to investigate the differences in the plume dynamics for application in high harmonic generation from highly charged ions.

Properties of LPP depend upon various factors like the laser parameters (fluence, pulse width, wavelength etc.) as well as material properties [1, 2, 3]. LPPs are highly transient in nature and therefore should be thoroughly characterized before devising it for various applications like nanoparticle production, high-order harmonic generation, attosecond pulse generation etc. Optical emission spectroscopy (OES), optical time of flight (OTOF), Langmuir probe, interferometry, etc are some of the commonly used diagnostic techniques [4]. Hydrodynamics of the plume can be revealed by using fast photography using a time-gated intensified CCD (ICCD); which would give time resolved information on the hydrodynamics of the expanding LPP plume [5]. A comparison of hydrodynamics of the plume generated by a single pulse (SP) and a double pulse (DP) schemes are investigated. Laser pulses of 800 $\mu$J energy, $\sim$ 60 ps pulse width and 800 nm operating at 1 kHz is used to generate plasma from a pure aluminium sample placed in nitrogen ambient at a pressure of 10 $^{-6}$ Torr. The pulse energy used in the single pulse scheme, i.e. the total energy 800 $\mu$J, is divided into two by using a combination of polarizing cube beam splitter and a half wave plate, generating two ps pulses of 400 $\mu$J delayed by $\sim$ 800 ps with each other is used for employing the DP scheme. The first pulse generates the plasma and the second pulse interacts with the plume leading to a different dynamics compared to the SP scheme. In the DP scheme, we have employed two approaches; irradiating the same point on the target surface (case 1) and irradiation at different points separated by $\sim$ 700 $\mu$m on the target surface leading to the generation of two plasmas side-by side (case 2). Adiabatic expansion of plasma with existence of fast and slow species is evident in all cases. While fast and slow species shows lower velocities for case 1, the velocities of fast component is found to be faster whereas the slow component remain at the same speed for case 2. The plume expansion is found to have considerable variation in case 2 due to the interaction of two plasmas, thus forming a collisional plasma such that the plume expansion is confined along the plume axis leading to a more cylindrical plasma plume with the fast species reaching to larger distances compared to the SP cases. In case 1, plasma plume is found to be more spherical mimicking a nanosecond plasma plume.

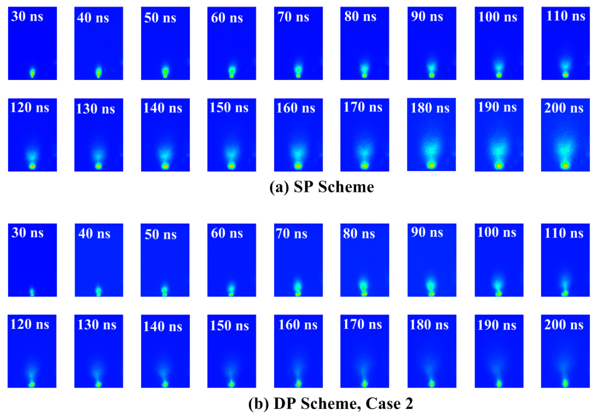


**Figure 1**. Plume dynamics for various delays staring from 30 ns after irradition until 200 ns with 10 % gate delay as gate width for (a). SP and (b). DP case 2

We will report the results of this investigation and the application of the LPP towards creating a new source for high harmonic generation of radiation.

## References

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