Electromagnetic pulses generated from large laser infrastructures in China

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Electromagnetic Pulses (EMPs) can be generated from high-power laser interacting with sold targets, which are closely related to laser parameters and target factors. In this report, we will present EMP generation in various larger laser infrastructures in China including SG-III prototype, SG-III, SG-II, SG-II UP and XG-III facility. The EMP amplitude and spatiotemporal distribution inside and outside laser chambers are recorded and analyzed and the involved mechanisms are interpreted based on simulations.

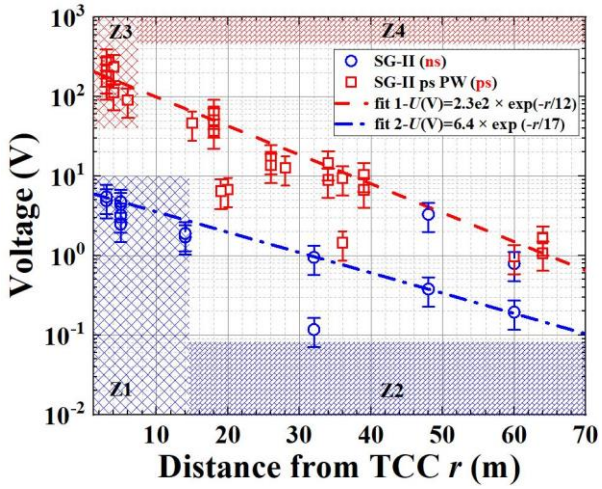

Figure 1 Evolution of the maximum amplitudes of the EMP signals with the distance from TCC at different laser modes in SG-II and SG-II UP laser facilities[1].

Variation of the maximum amplitudes of the EMP signals with the distance from TCC is presented in figure 2. The results indicate that EMP produced at SG-II series laser facility is strongly related to the laser modes and the distance from the target chamber center (TCC). Firstly, EMPs induced by SG-II ps PW laser are one order intense than that of SG-II laser with the same distance from TCC, which may be attributed to the higher laser intensity of the SG-II ps PW laser (0.8×10^{19} W/cm^2) compared with the SG-II laser (1.25×10^{15} W/cm^2). For SG-II or SG-II UP laser, The EMP amplitude outside the target chamber decreases exponentially with the distance from the target chamber center, which may attribute to the propagating loss of electromagnetic waves.

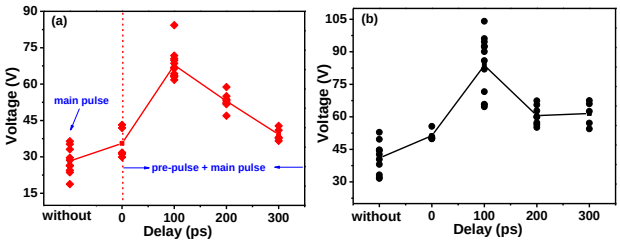

Figure 2 Variation of EMPs with the main laser delays tested by the loop antennas (a1 and a2) at varying positions: (a) before the target and (b) behind the target. The solid lines denote the average values at each delay case[2].

The maximum amplitudes of EMPs measured by the two loop antennas in the CLAPA target chamber under different delaying cases are demonstrated in Figure 2, where the solid line denotes the average value of EMPs at each delay case. The delay time is defined as the time interval between the end of the 200ps pre-ablation pule and the leading edge of the 30 fs main laser. It can be seen that with the increase of the delay, the intensities of EMPs firstly increase and then decrease. At 100 ps delay, the average value shows more than twice of the gain compared with the without pre-ablation case. The increased EMPs cause serious interference some electronic components. For example, at the delay time of 100 ps, several stepping motors in the chamber were shut down in the experiment. Note that the maximum intensities of EMPs measured at the back of target are about 1.5 times higher than those measured before the target for each corresponding test.

References

[1] Q.He , N.Kang , L.Ren, Ch.Tian, C.Wang, Z.Zhang, D.Liu, L.Yang, H. Liu ,M.Sun , B.Zhu , W.Zhou, T.Li, Plasma Sci. Technol. 23 (2021) 115202 (7pp).

[2] Y.Xia, D.Li, S.Zhang, M.Wu, T.Yang, Y. Geng, J.Zhu, X.Xu,C.Li, C.Wang, F.Wang, C.Lin, T.Li, X.Yan, Phys. Plasmas 27(2020) 032705.