On the nature of electromagnetic pulse emission generated by short-pulse lasers and the possible mitigation methods

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One of the side effects of high-intensity laser-target interactions under conditions typical for laser-induced proton acceleration is an undesirable strong emission of electromagnetic pulses (EMP) in the MHz to multi-GHz frequency range, as was recently reviewed in [1]. The physical origin of these signals is clear, they are related to the creation and propagation of hot electron bunches, but a reliable quantitative predictive approach is still missing. In our contribution we report on a numerical study of EMP generation, performed with the use of a numerical package allowing for electromagnetic signal computation in the presence of conducting elements in parallel with particle-in-cell modeling of charged particle propagation. To model EMP we make some educated assumptions on the characteristics of fast electrons escaping from the laser target and we use this as an input for the commercial Computer Simulation Technology Studio Suite package. We then compute electromagnetic fields in the vicinity of the target and the target holder under conditions corresponding to a real life experiment performed at the 10 TW fs laser in IPPLM. We also perform simulations for arrangements aimed at mitigation of EMP emission, such as the ”birdhouse" target concept [2]. Simulations show that EMP generated off metal foils contains substantial contribution from frequencies higher than 6 GHz, which is a bandwidth of probes and oscilloscopes used in many EMP studies. Finally, we confront numerical results with measurements performed at the IPPLM facility. Our studies show the importance of making EMP measurements in correlation with the laser-accelerated proton energies [3]. Our results should be useful in guiding EMP measurements and EMP mitigation attempts at high-power high-intensity laser facilities.

References

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