Guided Electromagnetic Discharge Pulses Driven by Short Intense Laser Pulses

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We present a new set of data on the controlled generation of strong electromagnetic fields from laser-plasma interactions, in particular those streaming along a guiding structure within a solid density target.

The transient electromagnetic fields are driven by ultra-intense sub-ps laser pulses of several tens of Joule at intensities above 10^{19} W/cm^2. We review previous work on the matter and unify two fields of research that, until recently, have been investigated separately: discharge pulses and longer time-scale return currents. We present new details of discharge pulses with 10s of ps FWHM and kA amplitudes. Experimental data are compared to a novel model [1] able to describe the dispersion relation of electromagnetic discharge pulses.

The results are relevant for many applications in science and technology, e.g. the controlled generation of THz radiation [2, 3]. Successive return currents of similar amplitude but longer pulse duration can be used as a quasi-static source of electromagnetic fields in high power laser experiments [4], a key technology for the phase-space modulation in laser-driven accelerators and laboratory astrophysics studies relying on magnetised plasma. Our description of the dynamics of pulsed currents will enable the development of new platforms.

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[4] T. Pisarczyk et al., PPCF 64 115012 (2022), doi:10.1088/1361-6587/ac95c4