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Magnetic field turbulence in laboratory laser plasma experiments

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We address one of the most important problems of high energy density science namely, the transport of relativistic, mega-ampere, femtosecond electron pulses through dense matter. Crucial to this transport are several instabilities driven by the electron pulse. We will focus specifically on instabilities related to giant magnetic field generation and present results on solid density plasmas excited by ultrahigh intensity (10^{19} W/sq.cm), 25 femtosecond, 800 nm laser pulses. Using pump-probe spatio-temporal polarimetry, we map out the time and space evolution of the magnetic field *simultaneously* - the former on femtosecond timescales and the latter on micrometer length scales -and demonstrate the turbulent evolution of the magnetic field captured by its power spectrum[1,2]. The power spectra provide clear evidence for the recently proposed finite beam mechanism[3] indicating the origin of the field at macroscopic (electron beam size) length scales. We show that the much investigated Weibel instability occurring at the skin depth, enters the picture at later times contrary to the established understanding. By monitoring the evolution of the magnetic field at the front and rear surfaces of an appropriate target, we capture the linear and nonlinear stages of evolution in the *same* experiment, thereby enabling a complete study of the process[4].

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