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Measurement and control of the group velocity of an axiparabola for dephasingless acceleration of electron

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To circumvent dephasing in plasma-based electron accelerator, a new concept of acceleration using a reflective optic generating Bessel-like beams called axiparabolas was recently proposed [1]. This method could increase the energy of the accelerated electrons by several orders of magnitude (up to 50 GeV on PW installation). In this scheme, the velocity of the laser pulse in the plasma is controlled independently from the intensity distribution along the focal line using spatio-temporal couplings (STC) [2]. Here, we demonstrate the production of superluminal laser pulses by measuring the group velocity along the focal line of an axiparabola using an interferometry technique [3], as well as its control by introducing a known amount of spatio-temporal couplings using chromatic doublets. The results obtained are in accordance with a theoretical model that was developped. They pave the way for further work on higher-order STCs allowing for the experimental realization of the dephasingless acceleration scheme.

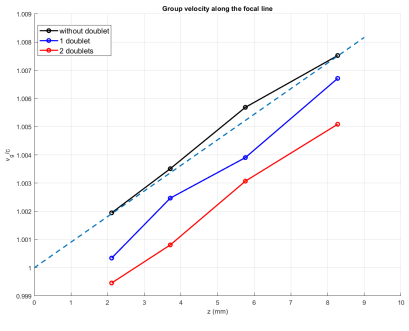

Figure 1: Measured group velocity along the focal line with or without added STC. The dashed line represents the theoretical group velocity without STC.

References

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