

Pulse characterisation technique for multi-pulse laser plasma wakefield accelerators

martedì 19 settembre 2023 16:25 (20 minuti)

Multi-pulse laser plasma wakefield accelerators (MP-LWFA) provide an alternative way towards compact and kilohertz (kHz) operation of Gigavolts (GeV) electron acceleration for advanced light sources and future particle accelerators. The aim of this research is to understand whether or not spectral and temporal structures of picosecond (ps) long multi-pulses can be characterised with the latest ultrafast pulse measurement techniques. A single shot frequency resolved optical gating (FROG) device was developed to measure various pulse structures generated by temporal interference of two chirped pulses. Our research demonstrates that multi-pulse trains with 11 pulses and 194-fs pulse spacing could be retrieved by the temporal tychographic iterative engine (PIE) phase retrieval algorithm. The systematic error of the retrieved phase could be as low as 4 per cent accompanied by a standard deviation of 15 per cent. Our experimental results indicate that the structured pulses adopted in MP-LWFA can be characterised and the FROG technique can assist the development of advanced high power laser pulse shaping techniques for multi-GeV electron acceleration in tens of centimeter-long plasma channels.

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Classifica Sessioni: WG2: Laser technology (WP6 - Task2)

Classificazione della track: WG2: Laser technology