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Optimization of the Driver Energy Deposition in Plasma Wakefield Acceleration Simulations by Varying Transverse Offset of Sextupole Magnets

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Plasma Wakefield Acceleration (PWFA) is a method of accelerating charged particles using a plasma. It has the potential to produce exceptionally large accelerating gradients on the order of 10's of GeV/m. The FACET-II test facility accelerates pairs of 10 GeV electron bunches to study the PWFA process—a drive bunch to produce a wake in the plasma in a lithium-ion oven, and a witness bunch to be accelerated by PWFA. By using arrangements of sextupole magnets, it is possible to alter the chromaticity and other energy-dependent properties of the beams prior to their entry into the plasma. The purpose of this study was to determine how the transverse offsets of the sextupole magnets could be optimized to increase the amount of energy deposited into the plasma by the drive bunch as this energy deposition is critical to maximising the efficiency of PWFA. To achieve this, a simulation of the FACET-II beamline was performed with sextupole offsets as adjustable parameters in a Bayesian Optimization procedure. The results demonstrate the value of using beam simulations as guides to improve the PWFA process, thereby reducing the need to perform costly experiments at the FACET-II facility.

Footnotes

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