Optimized Spectroscopic Measurement of High Energy, Narrow Energy-Spread Electron Beams from a Laser Wakefield Accelerator*

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A continuing goal of laser wakefield acceleration (LWFA) research is to decrease the spread in energy of the electron beams that these accelerators can produce while simultaneously increasing the maximum central energy of these beams. High-energy mono-energetic beams are a requirement for most applications of LWFA including using accelerated beams as light sources, or as a probe for fast-evolving fields. These beams present a particular challenge to accurately measure in the laboratory due to the standard dipole electron spectrometer's decrease in energy resolution as particle energies increase.

In this work, it is demonstrated through PIC simulations of various LWFA injection mechanisms that high-energy (in excess of 1 GeV) electron beams with low energy spread (a few percent) are produced using modern laser parameters and feasible experimental setups. These beams are then computationally measured using a simulated magnetic spectrometer. It is shown that a genetic algorithm approach may be applied to the configuration of the spectrometer's magnets and phosphorus screens to optimize energy resolutions in the energy range we are interested in. As LWFA beam energies continue to climb, further optimization of spectrometer techniques will be increasingly important.

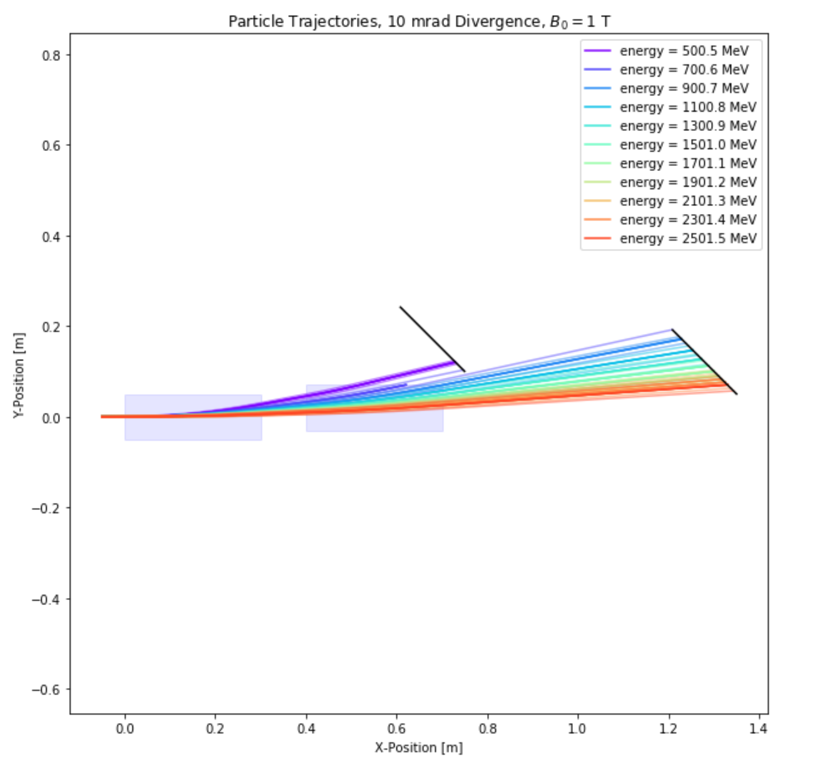

Figure 1 – A general setup of the magnetic spectrometer simulation using an analytic block-dipole magnetic field regions of dimensions of length 0.3 m, width 0.1 m, height 3 cm, and central field strength of 1 T, as well as particle trajectories of various energies on axis and 10 mrad divergence on the y-axis landing on two catching screens. Energy resolution of this setup as measured by deflection by the magnetic system on the catching screens.

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