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Compact high-resolution multi-GeV electron spectrometer for PW-laser-driven plasma accelerators

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We report the design and performance of a compact magnetic spectrometer tailored to unique characteristics of quasi-monoenergetic, multi-GeV electron bunches from petawatt-laser-driven wakefield accelerators: mrad-level shot-to-shot pointing fluctuations, co-generation of betatron X-rays and of background electrons with a broad energy spectrum. The spectrometer replaces the first screen of a standard two-screen spectrometer with an array of thin, precisely-located, high-Z wires distributed throughout, and perpendicular to, the magnet's dispersion plane. The thin, sharply-bounded shadows that they cast on betatron X-ray and electron signals enable determination of > 10 GeV electron energies and launch angles with few-% precision using a ~ 1 T dipole magnetic field of ~ 10 cm dimensions. Perturbations to the electron signals caused by hybrid acceleration mechanisms or inserted foils are also shown to be resolvable.

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