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Betatron radiation diagnostic systems for a plasma wakefield-based linear collider

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Characterizing the beam-plasma interaction in the plasma wakefield accelerator, an essential ingredient for a potential linear collider or free-electron laser represents a significant challenge for experimental measurements. The typical dimensions involved in such diagnostic systems are below one micron, with attendant femtosecond time-resolution. Further, the plasma environment and the beam intensity generally prevent insertable, destructive diagnostics. The most robust window into this interaction is betatron radiation, which reveals beam properties such as size, emittance, matching, and development of instabilities. In this talk, we review the powerful new double-differential spectrometer under development at UCLA that is to be installed at FACET-II. We discuss the unique optics of this Compton-based spectrometer, which permits single shot measurements of incoming betatron gamma spectra ranging from 0.2 to 30 MeV. We describe significant progress in implementing machine learning techniques for reconstructing the beam-plasma interaction physics.

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