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Measuring extreme magnetic fields

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The measurement of magnetic fields is fundamental to the study of many interactions including magnetic dynamos, instability growth, and magnetic reconnection. The magnetic fields can be measured through optical probing (polarimetry) or particle probing (charged particle deflectometry). Optical probing at common laser wavelengths is limited to measuring low density targets and requires x-rays to probe the fields on the surface of solid density targets. Protons and electrons have been successfully used to probe the magnetic fields of solid density targets; however, a limit exists for the maximum field strength that can be measured by a particle of a certain energy due to a breakdown of the standard analysis techniques. This is currently a limiting factor in the measurement of fields in relativistic laser-solid interactions, therefore new techniques will be required for measuring the much stronger fields expected from the next-generation of laser facilities. We propose the use of high energy $\mathcal{O}$(GeV) laser wakefield accelerated electron beams to measure the expected $\mathcal{O}$(0.1 MT) fields. The many additional considerations that must be made including energy spreading, beam divergence, and quantum electrodynamic (QED) effects to perform electron deflectometry in this regime will be presented. This work was supported by the NSF (1751462). The OSIRIS Consortium (UCLA and IST) provided access to the OSIRIS 4.0 framework (NSF ACI-1339893).