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Monte-Carlo Simulations of the Creation of High Energy Gamma Rays and Electron/Positron Pairs and Experiments on the Texas Petawatt Laser ALEXANDER HENDERSON, EDISON LIANG, PABLO YEPES, Rice University, GILLISS DYER, NATHAN RILEY, KRISTINA SERRATTO, University of Texas at Austin — High intensity ($>10^{18}$ W/cm^2) lasers incident on high-Z, solid targets produce a large number of high-energy electrons, which in turn produce gamma-rays and electron-positron pairs. We have used GEANT4 Monte-Carlo simulation to characterize the production of these particles in and their passage through thick (>1 mm) Au and Pt targets. The general results of these simulations have been validated in experiments conducted from 2011 to 2013 on the Texas Petawatt Laser (TPW), and refinements have been made to the simulation to help design future experiments. In addition, this simulation was used in the design and calibration of spectrometers used in these experiments. In particular, we have designed and deployed a Forward Compton Electron Spectrometer (FCES) which is more compact and cheaper than previous spectrometers build on the same principle, with only a minor reduction in resolution and applicable range. We were able to characterize the angular distribution of the gamma-rays as a Gaussian cone with a Full-Width-at-Half-Maximum (FWHM) of 35 degrees. The laser -to-gamma-ray-energy yield was around 2%, The gamma-ray spectra fit a two-temperature model, with mean temperatures of 2.1 MeV at low energies (up to 5 MeV) and a mean temperature of 6 MeV at high energies (above 10 MeV). In the future, we hope to explore the astrophysical implication of these systems.

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