Development of a High Intensity Laser Source of MeV Electrons Based on Ponderomotive Acceleration of Electrons

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During high powered, short pulse laser interactions with gas targets, electrons are ionized and interact directly with the laser beam. At very high focused intensities of 10^{18} W cm^{-2} and higher, the electrons are accelerated to relativistic velocities during each half cycle of acceleration in the focused electric field of the laser. The outward gradient in field intensity, or ponderomotive pressure, accelerates the electrons outwards from the focal volume with energies of the order of the oscillatory energy in the laser field. At very dilute pressures, where collective plasma effects are not important, the exit angle of the electrons is related to the electron energy, with higher energy electrons ejected closer to the forward direction. This phenomenon can be used to generate a relatively sparse relativistic electron source with the ability to control the output energy by selection of angle. Such a source can be useful in many different areas such as calibration of relativistic electron detectors for space missions and by analysing the electron energy spectrum can be used to characterize the peak focal spot intensities which existed in the interaction region. The latter measurement is very important for many ultra-high power (petawatt class) laser facilities around the world.

The generation of such electrons is being studied using the new 15 TW laser facility at the University of Alberta. A multichannel detector based on an array of scintillator-silicon-photomultiplier (SSPM) detectors is being developed to carry out these measurements. The array consists of a 4 x 4 grid of SSPM detectors which can each capture the energy of the electrons at individual grid points with single electron detection capability. In addition, a tunable pulsed electromagnet electron spectrometer is being developed for use in measuring the electron energy distribution at different emission angles.

Experimental results will be presented and compared to expected electron energies based on ponderomotive scattering theory.