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All-Optical Electron Injector

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Conventional electron acceleration at a place like SLAC needs miles to boost particles up to 50 GeV energies by feeding them microwaves in a succession of special cavities. In recent years physicists have been developing alternative acceleration concepts that might someday do the job in a much smaller space. Their near-term goal is to produce a first stage accelerator that outputs electron beams with lower energy but with properties that are more suitable for x-ray sources, such as those based on Compton scattering or the proposed linear synchrotrons at SLAC and DESY.

In the plasma wakefield approach, for example, a terawatt laser beam bites into a plasma-filled cell, setting up fast waves in the plasma. If timed just right, electrons in the plasma can surf the plasma waves to high speeds, as high as 100 MeV in the space of only a millimeter. One problem with this concept is the mismatch between the electron source (sometimes an external photocathode, sometimes a haphazard and uncontrolled cloud of electrons from the plasma itself) and the incoming laser pulse.

At the APS plasma meeting, Donald Umstadter of the University of Michigan (Paper BO1.1) has reported a new means of generating electrons in a controllable way, namely the use of a pair of crossed laser beams which position, heat, and synchronize the insertion of electrons into the plasma wave. This dramatically increased the number of energetic electrons as compared with use of only one of their laser beams. Besides potential applications to particle physics and x-ray lasers, high gradient acceleration schemes are also expected to benefit the production of medical radioisotopes and the ignition of thermonuclear fusion reactions.
