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The New OPCPA Laser at Lund High Power Laser Facility and LWFA Applications

The 31 year successful story of the old Terawatt laser at Lund University finally came to an end last year, when the laser was retired to make way for the new laser system. Manufactured by the Lithuanian company “Light Conversion”, the new laser offers a 9 fs, 800 nm, CEP stable beam. The laser is split into 2 arms capable of delivering 250 mJ pulses at 10 Hz and 50 mJ pulses at 100 Hz. My poster will focus on the upgraded 10 Hz beamline, which is used to perform LWFA experiments. The stretched pulse from the laser room is compressed using an array of 16 broadband chirped mirrors which add a positive group delay dispersion of 800 fs^2, allowing the laser to reach its Fourier-limited pulse duration of 9 fs. The beam’s wavefront aberrations are corrected with a deformable mirror and the beam is telescoped down to allow it to be steered with 4” optics. The pulse is transferred to an interaction chamber, where it is focused with an off-axis parabola into the exhaust of a supersonic gas jet. The tail of the pulse has sufficient intensity to ionize the gas (usually a mixture of helium and nitrogen in a 99:1 ratio), so that the center of the pulse meets the gas in its plasma phase. The extremely high intensity of the order of 10^{19} W/cm^2 in the focus pushes the electrons of the plasma out of its path, whereas the heavier ions are relatively unaffected. This creates a plasma channel comprised of a series of bubbles where electrons have been ejected out of. If electrons are somehow injected into these bubbles, they can be accelerated to relativistic velocities thanks to the extremely high field gradients of the order of several hundreds of GV/m which are supported by the plasma, reaching energies in the order of hundreds of MeV across just few mm. Future plans of the beamline include combining LWFA with attosecond pulses which are generated in the other 100 Hz beamline.

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