Electron–Positron Pair Jet: On 29 May 2013, an LLNL/LLE team performed a Laboratory Basic Science (LBS) experiment on the OMEGA EP Laser System designed to collimate positron jets produced in high-intensity laser interactions with high-*Z* targets. The ultimate goal is to confine the particles to make a relativistic charge neutral electron–positron pair plasma.[1] If successfully confined, an electron–positron plasma would offer a novel system enabling a detailed study of some of the most-exotic and energetic systems in the universe.

Previous LBS experiments by this team have shown that quasi-monoenergetic relativistic positron jets are formed during high-intensity interactions with thick gold targets.[2] The beam divergence was 30° (Ref. 3). The current experiments were designed to collimate the positron jet with an external magnetic lens. Using the new magneto-inertial fusion electrical discharge system (MIFEDS),[4] strong collimation of both positrons and electrons were observed. This results in a near pencil beam with an equivalent beam-divergence angle of 5°. The charge imbalance was reduced from ~100 (no collimation) to ~2.5 (with collimation)—a significant step toward making a charge neutral electron–positron pair plasma in the laboratory.

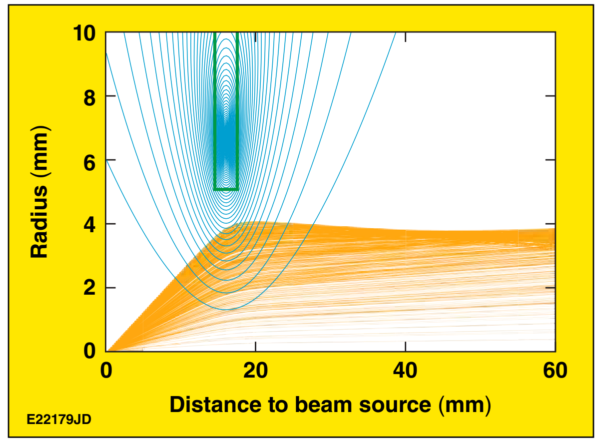

Figure 1. Simulation of the B fields (blue) from the MIFEDS coil (green box), and their effect on the positron jets (golden) for positron energy of 13 MeV and a coil diameter of 16 mm.

The experiments were performed using the OMEGA EP short-pulse beams with ~1 kJ at 10 ps. The targets were 1-mm-thick gold. A jet of positrons and electrons was emitted from the rear side of the target. MIFEDS coils produced a peak magnetic field of about 7 T (Fig. 1) between the target and the detector. The collimated beams were measured with a magnetic electron–positron spectrometer. Without the external magnetic field, the peak densities are about 10^{13} and 10^{15} cm^{-3} for positrons and electrons, respectively.[5] With the external B-field applied, a factor of ~40 increase in the peak positron and electron signal was observed (Fig. 2).

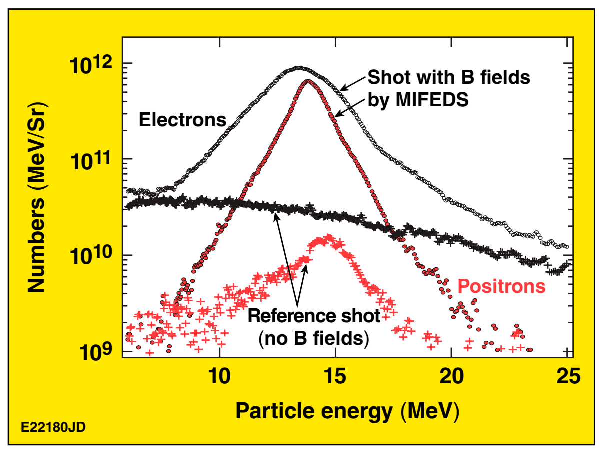

Figure 2. Comparison of experimental data from shots with B fields (circles) and without B fields (crosses). Substantial beam collimation was observed for both electrons and positrons at about 14 MeV for this MIFEDS configuration.

The next step is to confine the particles to make a pair plasma.[5]

Omega Facility Operations Summary: During May 2013, the Omega Facility conducted 205 target shots with an average experimental effectiveness of 98.8% (143 target shots on OMEGA with experimental effectiveness of 99.7% and 62 on OMEGA EP with an experimental effectiveness of 96.8%). The ICF program accounted for 52 shots for experiments conducted by LLE and LLNL teams and teams from LANL, LLNL, and LLE carried out 84 target shots for HED program experiments. Four teams led by Princeton, University of Michigan, and the University of California at San Diego conducted 44 target shots under the NLUF program and scientists from LLNL and LLE carried out 25 target target shots under the LBS program.

1. J. F. Myatt *et al.*, Bull. Am. Phys. Soc. **52**, 66 (2007); 2. H. Chen *et al.*, Phys. Rev. Lett. **102**, 105001 (2009).
3. H. Chen *et al.*, Phys. Rev. Lett. **105**, 015003 (2010); 4. O. V. Gotchev *et al.*, Rev. Sci. Instrum. **80**, 043504 (2009).
5. H. Chen *et al.*, High Energy Density Phys. **7**, 225 (2011).