



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

Towards laboratory-produced relativistic electron-positron pair-plasmas

H. Chen, S. C. Wilks, D. D. Meyerhofer, P. Beiersdorfer, R. Cauble, F. Dollar, K. Falk, A. Hazi, C. D. Murphy, J. Park, J. Seely, C. I. Szabo, R. Shepherd, R. Tommasini, K. Zulick

September 2, 2010

14th International Workshop on Radiative Properties of Hot Dense Matter
Marbella, Spain
October 4, 2010 through October 8, 2010

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

Abstract for 14th International Workshop on Radiative Properties of Hot Dense Matter
Marbella, Spain, October 4 – 8, 2010

Towards laboratory-produced relativistic electron-positron pair-plasmas

Hui Chen¹, S. C. Wilks¹, D. D Meyerhofer², P. Beiersdorfer¹, R. Cauble¹, F. Dollar³,
K. Falk⁴, A. Hazi¹, C. D. Murphy⁴, J. Park¹, J. Seely⁵, C. I. Szabo⁵, R. Shepherd¹, R.
Tommasini¹, K. Zolick³

1. Lawrence Livermore National Laboratory, Livermore, CA 94551, USA

2. LLE, University of Rochester, Rochester, NY 14623, USA

3. University of Michigan, Ann Arbor, MI 48109, USA

4. University of Oxford, Oxford, UK

5. Naval Research Laboratory, Washington, DC 20375, USA

Relativistic pair-plasmas and jets are believed to exist in many astrophysical objects and are often invoked to explain energetic phenomena related to Gamma Ray Bursts and Black Holes. On earth, positrons from radioactive isotopes or accelerators are used extensively at low energies (sub-MeV) in areas related to surface science positron emission tomography and basic antimatter science. Experimental platforms capable of producing the high-temperature pair-plasma and high-flux jets required to simulate astrophysical positron conditions have so far been absent. In the last few years, we performed extensive experiments generating positrons with intense lasers [1, 2] where we found that relativistic electron and positron jets are produced by irradiating a solid gold target with an intense picosecond laser pulse. The positron temperatures in directions parallel and transverse to the beam both exceeded 0.5 MeV, and the density of electrons and positrons in these jets are of order 10^{16} cm^{-3} and 10^{13} cm^{-3} , respectively. With the advent of high-energy ultra-short laser pulses, we expect that a charge-neutral, relativistic pair-plasma is achievable, a novel regime of laboratory-produced hot dense matter. This talk will present some details of the laser-produced pair-plasma experiments.

*This work performed under the auspices of the U.S. DOE by LLNL under Contract DE-AC52-07NA27344 and was funded by LDRD #10-ERD-044.

[1] Chen, Hui, et al., *Phy. Rev. Lett.* **102**, 105001 (2009)

[2] Chen, Hui, et al., *Phy. Rev. Lett.* **105**, 015003 (2010)