LA-UR-19-21839
Approved for public release; distribution is unlimited.

Title: Simulating High Intensity Laser-Plasma Interactions Including Models of Quantum Radiation

Author(s): Yin, Lin
Luedtke, Scott Vernon
Stark, David James
Bird, Robert Francis
Nystrom, William David
Albright, Brian James
Hegelich, Bjorn Manuel

Intended for: Report
Web

Issued: 2019-03-01

Disclaimer:
Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Simulating High Intensity Laser-Plasma Interactions Including Models of Quantum Radiation

PI: L. Yin[1], Co-PI: S. V. Luedtke[1,2], Co-Inv.: D. J. Stark[1], R. F. Bird[1], W. D. Nystrom[1], B. J. Albright[1], and B. M. Hegelich[2]

[1]Los Alamos National Laboratory, Los Alamos, New Mexico, 87545
[2]University of Texas, Austin, Texas, 78712

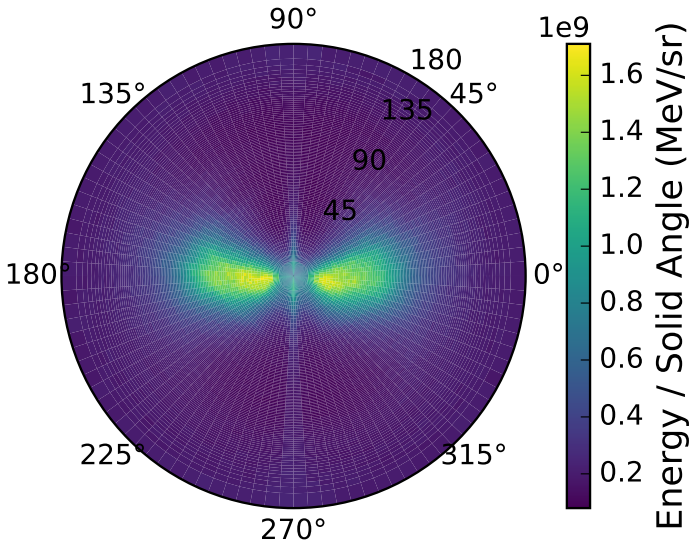
Project Highlights
February 26, 2019

Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

High-energy photons emitted into two jets

- Simulations of certain experimental configurations using QED models show photons are directed into narrow 'jets'
- Jets are split along laser polarization
- No wavelength-scale structure in target needed

Photon Energy Deposition
$E_\gamma > 1$ MeV

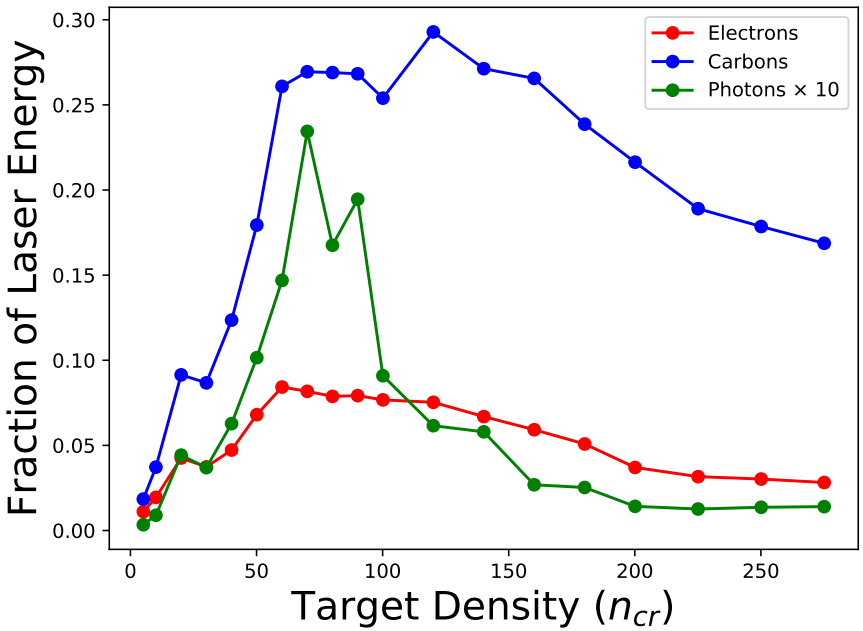


Simulation parameters: $60 n_{cr}$, 10 µm carbon target, $T_e = 10$ keV, $T_i = 10$ eV, $I_0 = 3.02 \times 10^{23}$ W/cm^2, FWHM = 150 fs, F/1.0, S-polarized, 60 electrons and 20 ions per cell, 10 nm cell size

Plasma dynamics producing photons depend highly on target density

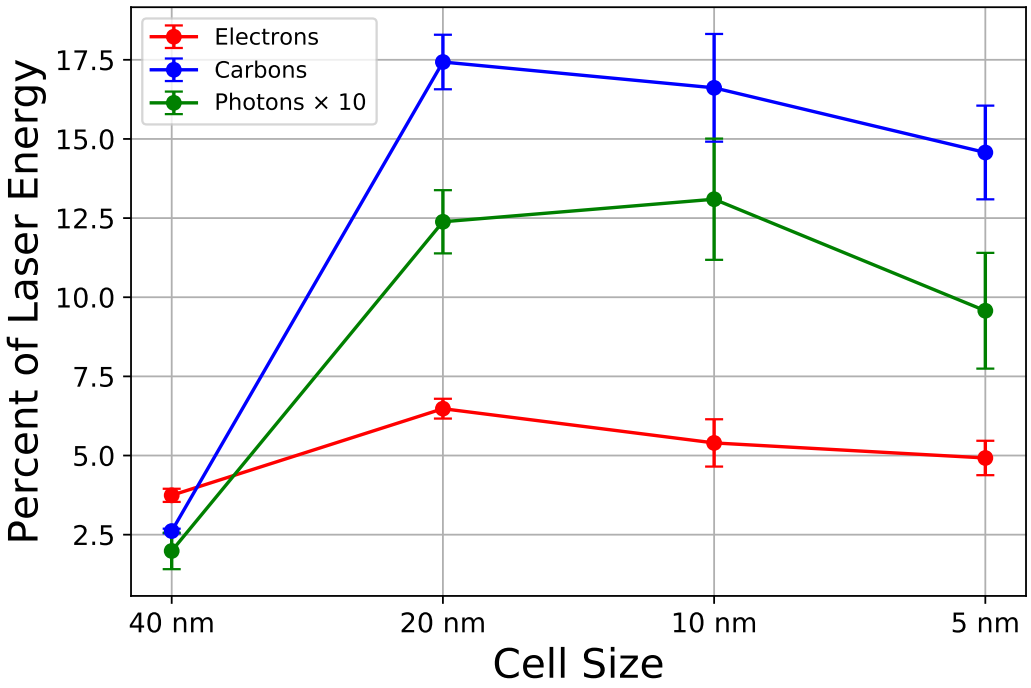
- If the density is too low, the pulse blows through the target early
- If the density is too high, no channel forms
- Channeling is significant for 50–100n_{cr}
- Experiments in this density range (i.e., carbon foam targets) should have observable of QED photons

Laser energy transfered to particles



Simulation parameters: 10 µm carbon target, $T_e = 10$ keV, $T_i = 10$ eV, $I_0 = 3.02 \times 10^{23}$ W/cm^2, FWHM = 150 fs, F/1.0, S-polarized, 60 electrons and 20 ions per cell, 10 nm cell size

Stochastic phenomena at higher resolution



Skin depth $l_s = 21.74$ nm
$\lambda_D = 3.04$ nm
Error bars are standard deviation from 5 simulations differing in random seed only.

- At low resolution, results are reproducible, but not converged
- At high resolution, there is variation in laser absorption and plasma dynamics
- Stochasticity is likely a result of the physics modeled, not computational errors