

Publications and Conference Presentations

Publications

- P. J. Adrian, J. Frenje, B. Aguirre, B. Bachmann, A. Birkel, M. Gatu Johnson, N. V. Kabadi, B. Lahmann, C. K. Li, O. M. Mannion, W. Martin, Z. L. Mohamed, S. P. Regan, H. G. Rinderknecht, B. Scheiner, M. J. Schmitt, F. H. Séguin, R. C. Shah, H. Sio, C. Sorce, G. D. Sutcliffe, and R. D. Petrasso, “An X-Ray Penumbra Imager for Measurements of Electron–Temperature Profiles in Inertial Confinement Fusion Implosions at OMEGA,” *Rev. Sci. Instrum.* **92**, 043548 (2021).
- C. D. Arrowsmith, N. Shukla, N. Charitonidis, R. Boni, H. Chen, T. Davenne, A. Dyson, D. H. Froula, J. T. Gudmundsson, B. T. Huffman, Y. Kadi, B. Reville, S. Richardson, S. Sarkar, J. L. Shaw, L. O. Silva, P. Simon, R. M. G. M Trines, R. Bingham, and G. Gregori, “Generating Ultradense Pair Beams Using 400 GeV/c Protons,” *Phys. Rev. Res.* **3**, 023103 (2021).
- S. Brygoo, P. Loubeyre, M. Millot, J. R. Rygg, P. M. Celliers, J. H. Eggert, R. Jeanloz, and G. W. Collins, “Evidence of Hydrogen–Helium Immiscibility at Jupiter-Interior Conditions,” *Nature* **593**, 517 (2021).
- C. Dorrer, M. Spilatro, S. Herman, T. Borger, and E. M. Hill, “Broadband Sum-Frequency Generation of Spectrally Incoherent Pulses,” *Opt. Express* **29**, 16,135 (2021).
- D. H. Edgell, A. M. Hansen, J. Katz, D. Turnbull, and D. H. Froula, “Unabsorbed Light Beamlets for Diagnosing Coronal Density Profiles and Absorption Nonuniformity in Direct-Drive Implosions on OMEGA,” *Rev. Sci. Instrum.* **92**, 043525 (2021).
- C. Goyon, M. R. Edwards, T. Chapman, L. Divol, N. Lemos, G. J. Williams, D. A. Mariscal, D. Turnbull, A. M. Hansen, and P. Michel, “Slow and Fast Light in Plasma Using Optical Wave Mixing,” *Phys. Rev. Lett.* **126**, 205001 (2021).
- D. Haberberger, A. Davies, J. L. Shaw, R. K. Follett, J. P. Palastro, and D. H. Froula, “Hot Raman Amplification,” *Phys. Plasmas* **28**, 062311 (2021).
- S. K. Han, R. F. Smith, D. Kim, J. K. Wicks, J. R. Rygg, A. Lazicki, J. H. Eggert, and T. S. Duffy, “Polymorphism of Gold Under Laser-Based Ramp Compression to 690 GPa,” *Phys. Rev. B* **103**, 184109 (2021).
- K. P. Hilleke, T. Ogitsu, S. Zhang, and E. Zurek, “Structural Motifs and Bonding in Two Families of Boron Structures Predicted at Megabar Pressures,” *Phys. Rev. Mater.* **5**, 053605 (2021).
- V. V. Ivanov, A. V. Maximov, R. Betti, L. S. Leal, J. D. Moody, K. J. Swanson, and N. A. Huerta, “Generation of Strong Magnetic Fields for Magnetized Plasma Experiments at the 1-MA Pulsed Power Machine,” *Matter Radiat. Extremes* **6**, 046901 (2021).
- T. M. Johnson, A. Birkel, H. E. Ramirez, G. D. Sutcliffe, P. J. Adrian, V. Yu. Glebov, H. Sio, M. Gatu Johnson, J. A. Frenje, R. D. Petrasso, and C. K. Li, “Yield Degradation Due to Laser Drive Asymmetry in D³He Backlit Proton Radiography Experiments at OMEGA,” *Rev. Sci. Instrum.* **92**, 043551 (2021).
- R. G. Kraus, F. Coppari, D. E. Fratanduono, R. F. Smith, A. Lazicki, C. Wehrenberg, J. H. Eggert, J. R. Rygg, and G. W. Collins, “Melting of Tantalum at Multimegabar Pressures on the Nanosecond Timescale,” *Phys. Rev. Lett.* **126**, 255701 (2021).
- A. Kryjevski, T. Luu, and V. Karasiev, “Electronic Structure of Semiconductor Nanoparticles from Stochastic Evaluation of Imaginary-Time Path Integral,” *Phys. Rev. Res.* **3**, 023173 (2021).
- O. L. Landen, J. D. Lindl, S. W. Haan, D. T. Casey, P. M. Celliers, D. N. Fittinghoff, N. Gharibyan, V. N. Goncharov, G. P. Grim, E. P. Hartouni, O. A. Hurricane, B. J. MacGowan, S. A. MacLaren, K. D. Meaney, M. Millot, J. L. Milovich, P. K. Patel, H. S. Robey, P. T. Springer, P. L. Volegov, and M. J. Edwards, “Fuel Convergence Sensitivity in Indirect Drive Implosions,” *Phys. Plasmas* **28**, 042705 (2021).
- O. M. Mannion, I. V. Igumenshchev, K. S. Anderson, R. Betti, E. M. Campbell, D. Cao, C. J. Forrest, M. Gatu Johnson, V. Yu. Glebov, V. N. Goncharov, V. Gopalaswamy, S. T. Ivancic, D. W.

Jacobs-Perkins, A. Kalb, J. P. Knauer, J. Kwiatkowski, A. Lees, F. J. Marshall, M. Michalko, Z. L. Mohamed, D. Patel, H. G. Rinderknecht, R. C. Shah, C. Stoeckl, W. Theobald, K. M. Woo, and S. P. Regan, “Mitigation of Mode-One Asymmetry in Laser-Direct-Drive Inertial Confinement Fusion Implosions,” *Phys. Plasmas* **28**, 042701 (2021) (invited).

A. L. Milder, J. Katz, R. Boni, J. P. Palastro, M. Sherlock, W. Rozmus, and D. H. Froula, “Measurements of Non-Maxwellian Electron Distribution Functions and Their Effect on Laser Heating,” *Phys. Rev. Lett.* **127**, 015001 (2021).

Z. L. Mohamed, O. M. Mannion, J. P. Knauer, C. J. Forrest, V. Yu. Glebov, C. Stoeckl, and M. H. Romanofsky, “Application of an Energy-Dependent Instrument Response Function to Analysis of nTOF Data from Cryogenic DT Experiments,” *Rev. Sci. Instrum.* **92**, 043546 (2021).

D. B. Schaeffer, W. Fox, M. J. Rosenberg, H.-S. Park, G. Fiksel, and D. Kalantar, “Measurements of Electron Temperature in High-Energy-Density Plasmas Using Gated X-Ray Pinhole Imaging,” *Rev. Sci. Instrum.* **92**, 043524 (2021).

J. L. Shaw, M. A. Romo-Gonzalez, N. Lemos, P. M. King, G. Bruhaug, K. G. Miller, C. Dorrer, B. Kruschwitz, L. Waxer, G. J. Williams, M. V. Ambat, M. M. McKie, M. D. Sinclair, W. B. Mori, C. Joshi, H. Chen, J. P. Palastro, F. Albert, and D. H. Froula, “Microcoulomb ($0.7 \pm 0.4/0.2 \mu\text{C}$) Laser Plasma Accelerator on OMEGA EP,” *Sci. Rep.* **11**, 7498 (2021).

G. Sutcliffe, P. Adrian, J. Pearcy, T. Johnson, N. Kabadi, S. Haque, C. Parker, B. Lahmann, J. Frenje, M. Gatu-Johnson,

H. Sio, F. Séguin, B. Pollock, J. Moody, V. Glebov, R. Janezic, M. Koch, R. Petrasso, and C. Li, “A New Tri-Particle Backlighter for High-Energy-Density Plasmas,” *Rev. Sci. Instrum.* **92**, 063524 (2021) (invited).

M. P. Valdivia, D. Stutman, C. Stoeckl, W. Theobald, G. W. Collins IV, V. Bouffetier, M. Vescovi, C. Mileham, I. A. Begishev, S. R. Klein, R. Melean, S. Muller, J. Zou, F. Veloso, A. Casner, F. N. Beg, and S. P. Regan, “Talbot-Lau X-Ray Deflectometer: Refraction-Based HEDP Imaging Diagnostic,” *Rev. Sci. Instrum.* **92**, 065110 (2021).

W. Y. Wang and R. S. Craxton, “Pentagonal Prism Spherical Hohlraums for OMEGA,” *Phys. Plasmas* **28**, 062703 (2021).

H. Wen, R. K. Follett, A. V. Maximov, D. H. Froula, F. S. Tsung, and J. P. Palastro, “Suppressing the Enhancement of Stimulated Raman Scattering in Inhomogeneous Plasmas by Tuning the Modulation Frequency of a Broadband Laser,” *Phys. Plasmas* **28**, 042109 (2021).

K. M. Woo and R. Betti, “Impact of Areal-Density Asymmetries on the Loss of Confinement and Ignition Threshold in Inertial Confinement Fusion Capsules,” *Phys. Plasmas* **28**, 054503 (2021).

S. Zhang, J. Li, C. M. Krauland, F. N. Beg, S. Muller, W. Theobald, J. Palastro, T. Filkins, D. Turnbull, D. Haberberger, C. Ren, R. Betti, C. Stoeckl, E. M. Campbell, J. Trela, D. Batani, R. H. H. Scott, and M. S. Wei, “Pump-Depletion Dynamics and Saturation of Stimulated Brillouin Scattering in Shock Ignition Relevant Experiments,” *Phys. Rev. E* **103**, 063208 (2021).

Forthcoming Publications

X. Bian, J. K. Shang, E. G. Blackman, G. W. Collins, and H. Aluie, “Scaling of Turbulent Viscosity and Resistivity: Extracting a Scale-Dependent Turbulent Magnetic Prandtl Number,” to be published in *Astrophysical Journal Letters*.

A. R. Christopherson, R. Betti, C. J. Forrest, J. Howard, W. Theobald, J. A. Delettrez, M. J. Rosenberg, A. A. Solodov, C. Stoeckl, D. Patel, V. Gopalaswamy, D. Cao, J. L. Peebles, D. H. Edgell, W. Seka, R. Epstein, M. S. Wei, M. Gatu Johnson, R. Simpson, S. P. Regan, and E. M. Campbell, “Direct Measurements of DT Fuel Preheat from Hot Electrons in Direct-Drive Inertial Confinement Fusion,” to be published in *Physical Review Letters*.

L. E. Hansen, D. E. Fratanduono, S. Zhang, D. G. Hicks, T. Suer, Z. K. Sprowal, M. F. Huff, X. Gong, B. J. Henderson, D. N. Polsin, M. Zaghoo, S. X. Hu, J. R. Rygg, and G. W. Collins, “Melting of Magnesium Oxide up to Two Terapascals Using Double-Shock Compression,” to be published in *Physical Review B*.

N. V. Kabadi, R. Simpson, P. J. Adrian, A. Bose, J. A. Frenje, M. Gatu Johnson, B. Lahmann, C. K. Li, C. E. Parker, F. H. Séguin, G. D. Sutcliffe, R. D. Petrasso, S. Atzeni, J. Eriksson, C. Forrest, S. Fess, V. Yu. Glebov, R. Janezic, O. M. Mannion, H. G. Rinderknecht, M. J. Rosenberg, C. Stoeckl, G. Kagan, M. Hoppe, R. Luo, M. Schoff, C. Shulberg, H. W. Sio,

J. Sanchez, L. Berzak Hopkins, D. Schlossberg, K. Hahn, and C. Yeaman, “Thermal Decoupling of Deuterium and Tritium During the Inertial Confinement Fusion Shock-Convergence Phase,” to be published in *Physical Review E*.

B. J. MacGowan, O. J. Landen, D. T. Casey, C. V. Young, D. A. Callahan, E. P. Hartouni, R. Hatarik, M. Hohenberger, T. Ma, D. Mariscal, A. Moore, R. Nora, H. G. Rinderknecht, D. Schlossberg, and B. M. Van Wonterghem, “Trending Low Mode Asymmetries in NIF Capsule Drive Using a Simple View-factor Metric,” to be published in *High Energy Density Physics*.

J. L. Peebles, G. Fiksel, M. R. Edwards, J. von der Linden, L. Willingale, D. Mastrosimone, and H. Chen, “Magnetically

Collimated Relativistic Charge-Neutral Electron-Positron Beams from High-Power Lasers,” to be published in *Physics of Plasmas*.

A. Pineau, B. Chimier, S. X. Hu, and G. Duchateau, “Improved Modeling of the Solid-to-Plasma Transition of Polystyrene Ablator for Laser Direct-Drive Inertial Confinement Fusion Hydrocodes,” to be published in *Physical Review E*.

S. Rai, M. Hecht, M. Maltrud, and H. Aluie, “Scale of Oceanic Eddy-Killing by Wind from Global Satellite Observations,” to be published in *Science Advances*.

R. Sobolewski, “Optical Detectors and Sensors,” to be published in the *Handbook of Superconducting Materials*.

Conference Presentations

J. L. Peebles, J. R. Davies, D. H. Barnak, M. J. Bonino, G. Brent, T. Cracium, and R. Betti, “Laser-Drive Coils, How Well Do They Work?” presented at the HEDS Seminar, virtual, 1 April 2021.

E. M. Campbell, “LLE: Today and Tomorrow,” presented at the Institute of Optics Colloquium, virtual, 5 April 2021.

J. L. Shaw, G. Bruhaug, M. Freeman, F. Merrill, V. Geppert-Kleinrath, C. Wilde, and D. H. Froula, “Electron Radiography Based on Electron Beams from Self-Modulated Laser Wake-field Acceleration,” presented at LANSCE Futures Spring 2021 Workshop Series, virtual, 6 April 2021.

The following presentations were made at the 4th International Symposium on High Power Laser Science and Engineering, virtual, 11–16 April 2021:

J. Bromage, S.-W. Bahk, M. Bedzyk, I. A. Begishev, S. Bucht, C. Dorrer, C. Feng, C. Jeon, C. Mileham, R. G. Roides, K. Shaughnessy, M. J. Shoup III, M. Spilatro, B. Webb, D. Weiner, and J. D. Zuegel, “MTW-OPAL: A Technology Development Platform for Ultra-Intense OPCPA Systems.”

E. M. Campbell, “A Vision of the Future for High-Power Laser Research and Its Applications.”

E. M. Campbell, “Laser Fusion: Present Status and the Path to Fusion Energy,” presented at Cornell Energy Seminar, Cornell, NY, 15 April 2021.

S. P. Regan, “JASON Briefing,” presented at JASON, virtual, 15 April 2021.

A. K. Schwemlein, C. Stoeckl, W. T. Shmayda, C. J. Forrest, J. P. Knauer, S. P. Regan, and W. U. Schröder, “Generating a TNSA Tritium Beam on OMEGA,” presented at the APS April Meeting, virtual, 17–20 April 2021.

J. P. Palastro, D. H. Froula, M. Ambat, E. M. Campbell, R. K. Follett, P. Franke, V. N. Goncharov, D. Ramsey, J. L. Shaw, T. T. Simpson, D. Turnbull, K. Weichman, H. Wen, S. Jolly, F. Quéré, C. Benedetti, E. Esarey, C. Geddes, C. Schroeder, R. Bingham, S. Stoller, N. Vafaei-Najafabadi, G. Gregori, B. Malaca, A. Helm, J. Vieira, A. Di Piazza, A. Howard, A. Arefiev, T. M. Antonsen, Jr., and Z. Li, “Laser-Plasma Interactions Driven

by Spatiotemporally Structured Light Pulses,” presented at the Bothe Colloquium, virtual, 21 April 2021.

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The following presentations were made at the Omega Laser Facility Users Group 2021 Workshop, virtual, 27–30 April 2021:

J. Bromage, S.-W. Bahk, M. Bedzyk, I. A. Begishev, S. Bucht, C. Dorrer, C. Feng, B. N. Hoffman, C. Jeon, C. Mileham, J. B. Oliver, R. G. Roides, E. M. Schiesser, K. Shaughnessy, M. J. Shoup III, M. Spilatro, B. Webb, D. Weiner, J. D. Zuegel, D. H. Froula, J. L. Shaw, P. M. Nilson, H. G. Rinderknecht, L. J. Waxer, J. C. Puth, and E. M. Hill, “Commissioned MTW-OPAL Laser and Proposed 2×25 PW EP-OPAL Laser.”

G. W. Collins, “Extreme Matters: Pressure to Explore New Worlds and Exotic Solids.”

E. C. Hansen, A. C. Reyes, M. B. P. Adams, J. Carroll-Nellenback, J. R. Davies, K. Weide, D. Q. Lamb, and P. Tzeferacos, “Implicit Anisotropic Magnetic Resistivity in the *FLASH* Code.”

P. V. Heuer, D. Stanczak, E. T. Everson, N. A. Murphy, and J. R. Davies, “Open Source High-Energy-Density–Physics Diagnostic Tools in PlasmaPy.”

T. R. Joshi, R. C. Shah, W. Theobald, I. V. Igumenshchev, D. Cao, and S. P. Regan, “Observations of the Modulations Associated with the 60-Beam Overlap in X-Ray Self-Emission Images of Directly Driven Implosions.”

Y. Lu, H. Li, K. Flippo, K. Kelso, A. Liao, S. Li, E. Liang, and P. Tzeferacos, “Monte Carlo Simulations for Proton Radiography in High-Energy-Density Plasma Experiments.”

S. F. B. Morse, “Omega Facility OLUG 2021 Update: Progress on Recommendations and Items of General Interest.”

S. P. Regan, “2020 Review of Inertial Confinement Fusion Approaches: The Research Path to Ignition.”

A. Reyes and P. Tzeferacos, “High-Order Implicit-Explicit ADER-RK Methods for Hyperbolic Systems with Stiff Source Terms in the *FLASH* Code.”

P. Tzeferacos, A. Reyes, E. C. Hansen, Y. Lu, D. Michta, M. P. A. Adams, C. J. Armstrong, K. Moczulski, and D. Q. Lamb,

“The *FLASH* Code for Computational High-Energy-Density Physics—Recent Additions and Improvements.”

M. S. Wei, “Omega Basic Science User Programs Update.”

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E. M. Campbell, “Laser Fusion: Present Status and the Path to Fusion Energy,” presented at Cornell University, virtual, 5 May 2021.

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P. Tzeferacos, “Extended MHD with *FLASH*: A Numerical Toolset for Magnetized Plasma Experiments,” presented at the Center for Matter Under Extreme Conditions Seminar, virtual, 5 May 2021.

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The following presentations were made at CLEO 2021, virtual, 9–14 May 2021:

S.-W. Bahk, I. A. Begishev, B. Webb, C. Jeon, R. G. Roides, C. Feng, M. Spilatro, R. Cuffney, C. Dorrer, C. Mileham, S. Bucht, and J. Bromage, “Effect of Pump Beam on the Amplified Signal Wavefront in DKDP Optical Parametric Amplification.”

J. Bromage, S.-W. Bahk, M. Bedzyk, I. A. Begishev, S. Bucht, C. Dorrer, C. Feng, B. N. Hoffman, C. Jeon, C. Mileham, J. B. Oliver, R. G. Roides, E. M. Schiesser, K. Shaughnessy, M. J. Shoup III, M. Spilatro, B. Webb, D. Weiner, and J. D. Zuegel, “MTW-OPAL: A Technology Development Platform for Ultra-Intense All-OPCPA Systems.”

C. Dorrer, I. A. Begishev, S.-W. Bahk, and J. Bromage, “Spatially Resolved Characterization of Partially Deuterated KDP Crystals for Parametric Amplification.”

C. Dorrer, M. Spilatro, T. Borger, S. Herman, and E. M. Hill, “Broadband Sum-Frequency Generation in a Novel Angularly Dispersed Noncollinear Geometry.”

C. Feng, C. Dorrer, C. Jeon, R. Roides, B. Webb, and J. Bromage, “Analysis of Pump-to-Signal Noise Transfer in Multi-Stage Optical Parametric Chirped-Pulse Amplification.”

The following presentations were made at the ARPA-E Summit, virtual, 24–27 May 2021:

J. R. Davies, C. J. Forrest, V. Yu. Glebov, J. P. Knauer, and H. McClow, “The LLE Diagnostic Resource Team for Innovative Fusion Concepts.”

P. Tzeferacos, R. Betti, J. R. Davies, F. Garcia-Rubio, E. C. Hansen, D. Michta, C. Ren, A. C. Reyes, W. Scullin, A. B. Sefkow, J. G. Shaw, H. Wen, and K. M. Woo, “A Simulation Source for Innovative Fusion Concepts in the BETHE Program.”

P. Tzeferacos, A. Reyes, E. C. Hansen, Y. Lu, D. Michta, M. P. A. Adams, C. J. Armstrong, K. Moczulski, and D. Q. Lamb, “FLASH: A Simulation Code for HEDP and Innovative Fusion Concepts.”

H. G. Rinderknecht, M. S. Wei, G. Bruhaug, K. Weichmann, J. P. Palastro, J. D. Zuegel, A. Arefiev, T. Wang, T. Toncian, A. Laso Garcia, D. Doria, K. Spohr, H. J. Quevedo, T. Ditmire, J. Williams, A. Haid, and D. Stutman, “Relativistically Transparent Magnetic Filaments as a Gamma-Ray Source for All-Optical Nuclear Photonics,” presented at Nuclear Photonics 2021, virtual, 7–9 June 2021.

W. T. Shmayda, “Fundamentals of Tritium Handling,” presented at TRANSAT Second Tritium School, virtual, 14–16 June 2021.

P. Heuer, “Charged-Particle Radiography with PlasmaPy,” presented at the Summer Undergraduate Laboratory Internship Summer School, virtual, 14–25 June 2021.

E. M. Campbell, “Laboratory for Laser Energetics (LLE): Supporting OES Strategic Goals,” presented at the OES Executive Meeting, virtual, 15–16 June 2021.

J. Bromage, S.-W. Bahk, M. Bedzyk, I. A. Begishev, S. Bucht, C. Dorrer, C. Feng, B. N. Hoffman, C. Jeon, C. Mileham, J. B. Oliver, R. G. Roides, E. M. Schiesser, K. Shaughnessy, M. J. Shoup III, M. Spilatro, B. Webb, D. Weiner, and J. D. Zuegel, “MTW-OPAL—A Technology Development Platform for Ultra-Intense OPCPA Systems,” presented at EQEC, virtual, 20–24 June 2021.

The following presentations were made at the 47th European Physical Society Conference on Plasma Physics, virtual, 21–25 June 2021:

P. Franke, J. P. Palastro, D. Turnbull, D. Ramsey, T. T. Simpson, J. L. Shaw, M. V. Ambat, J. Katz, I. A. Begishev, R. Boni, J. Bromage, K. Daub, J. B. Oliver, C. Dorrer, D. H. Froula, S. Jolly, F. Quéré, C. Benedetti, E. Esarey, C. Geddes, C. Schroeder, R. Bingham, S. Stoller, N. Vafaei-Najafabadi, G. Gregori, B. Malaca, A. Helm, J. Vieira, A. Di Piazza, A. Howard, A. Arefiev, T. M. Antonsen, Jr., and Z. Li, “Spatiotemporal Control of Laser Pulses for Broadband Extreme Ultraviolet Generation.”

A. M. Hansen, K. L. Nguyen, D. Turnbull, R. K. Follett, R. Huff, J. Katz, D. Mastro Simone, A. L. Milder, J. P. Palastro, D. H. Froula, B. Albright, and L. Yin, “Cross-Beam Energy Transfer Saturation.”

E. M. Campbell, “Laboratory for Laser Energetics (LLE): Today and Tomorrow,” presented at the Pulsed-Power Sciences Center, virtual, 23 June 2021.

P. Heuer, “Charged-Particle Radiography with PlasmaPy,” presented at Plasma Hack Week, virtual, 28 June–2 July 2021.