Scott Feister

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EDUCATION

Doctorate of Philosophy, Physics
The Ohio State University, Columbus, Ohio — May 2016
Concentration: High Energy Density Physics

Masters of Science, Physics
The Ohio State University, Columbus, Ohio — December 2012
Concentration: High Energy Density Physics

Bachelor of Science, Physics
University of Notre Dame, Notre Dame, Indiana — May 2009
Concentration: Physics
Minor: French

EXPERIENCE

Postdoctoral Scholar — August 2016 - present
Department of Astronomy & Astrophysics, University of Chicago, Chicago, IL

- Computationally studied the physics of particle diffusion within turbulent, magnetized plasmas at the Flash Center for Computational Science
- Researched laboratory astrophysics in large scientific collaborations with University of Oxford, Massachusetts Institute of Technology, and Lawrence Livermore National Laboratory
- Designed and interpreted scientific experiments at the world's most energetic laser facilities (The National Ignition Facility, Livermore, CA and Omega Laser Facility, Rochester, NY)
- Contributed to the submission and oral defense of a multi-institution federal research proposal
- Programmed and executed massively-parallel magnetohydrodynamic simulations of laser-driven magnetic turbulence (FLASH code) using high performance computing resources, exhausting millions of CPU-hours at Argonne National Laboratory's 10-petaflop Mira supercomputer
- Mentored undergraduate sophomore in magnetized plasmas physics; mentored second-year graduate student in simulation design and analysis

Research Scientist — May 2014 - August 2016
Air Force Research Laboratory / Innovative Scientific Solutions, Inc., Dayton, OH

- Experimentally studied efficient electron and ion acceleration by high-intensity lasers (10^{18} W/cm^2) at kHz repetition rate
- Invented data acquisition system, involving new electronic plasma diagnostics and synchronization of eleven independent experimental measurements of single laser-plasma interactions at >10 Hz. The result was creation and analysis of gigabytes of data per minute, and real-time laboratory feedback of electron acceleration
- Developed 3D hydrodynamic FLASH simulations of laser pre-pulse as initial conditions for PIC code, matching experimental inputs and outputs for a laser-plasma interaction with complex dynamics
- Collaborated with the University of Notre Dame Nuclear Physics group to calibrate a Lanex-based electron spectrometer ranging from 300 keV to 6 MeV
- Independently wrote our group's monthly and quarterly scientific reports for funding reviews

- Disseminated scientific research through journal publications, conference attendance and presentations
- Mentored first-year through fourth-year graduate students in experimental techniques and the physics of high-intensity laser-plasma interactions
- Mentored undergraduate freshman in experimental laboratory work (including laser safety), mentored undergraduate senior in computational electron scattering analysis

Graduate Research Assistant August 2010 - May 2014
Department of Physics, The Ohio State University, Columbus, OH

- Extensively planned and built sections of the 15 J, 400 TW 1/min Scarlet laser, as well as associated laboratory diagnostics
- Laid out and implemented the chirped-pulse laser compressor and experimental target chamber at six-inch beam diameter and high vacuum, starting from completely empty rooms
- Diagnosed, maintained, and aligned the entire laser system, beginning with the laser oscillator, continuing through chirp, pulse cleaning and amplification stages, and ending at the target with micron precision
- Designed and built Scarlet's on-shot laser diagnostics table, including energy, spectrum, wavefront, focal spot, and contrast diagnostics
- Conducted research on ion acceleration and warm dense matter at ultra-high intensities (10^{21} W/cm^2)
- Delivered frequent summary presentations to the research group, and wrote scientific text for grant applications and reviews
- Disseminated laser development and scientific research through journal publications, conference attendance and presentations
- Mentored two undergraduate physics juniors/seniors in experimental laboratory work, mentored three computer science undergraduates in experimental data analysis

Graduate Teaching Assistant August 2010 - May 2011, Aug. 2012 - Dec. 2012
Department of Physics, The Ohio State University, Columbus, OH

- Instructed university undergraduates in introductory Classical Mechanics, Electromagnetism, and Modern Physics
- Independently led recitations with thirty students per class, independently ran weekly hands-on laboratories
- Responsible for office hours, grading, and grade submission

DISSERTATION SUMMARY

Title: Efficient acceleration of electrons by an intense laser and its reflection
Advisor: Dr. Richard R. Freeman

Here I present an experimental, theoretical, and computational exploration of an extremely efficient scheme for laser-based acceleration of electrons. A series of experiments were performed at the Air Force Research Laboratory in Dayton, OH, to show that a high-repetition-rate short-pulse laser (3 mJ, 40 fs, 1 kHz) normally incident on a continuous water stream can accelerate electrons in the back-reflection spray with >1% laser-to-electron efficiency for electrons >120 keV, and with >MeV electron energies present in large number. Characterization of the accelerated electrons was followed by explorations of appropriate focal conditions, pre-plasma conditions, and laser-intensity parameters. These experiments show clear signatures of plasma instabilities, with substantial $\frac{3}{2}\omega$ and $\omega/2$ optical harmonics detected concurrently with efficient electron acceleration. Particle-in-cell (PIC) simulations of high-intensity laser interactions are able to reproduce the electron energies and acceleration efficiencies, as well as plasma instabilities. Analysis of the simulations suggest that electrons are accelerated by a standing wave established between incident and reflected light,

coupled with direct laser acceleration by reflected light. Using hydrodynamic simulations of the laser pre-pulse interaction as initial conditions for PIC simulations of the main-pulse interaction clarifies mechanisms by which experimental manipulation of pre-pulse has effectively determined electron-acceleration efficiency in the laboratory.

SKILLS

Experimental plasma diagnostics development

- Designed and built unique high-acquisition rate diagnostics: 60 Hz Lanex-based electron cameras, 100 Hz electron spectrometer, femtosecond-gated interferometric probe of plasma expansion (300 time steps characterized in 5 minutes), 30 Hz neutron time-of-flight spectrometer, 10 Hz multi-leaf Faraday cup. All were computer-interfaced with real-time analysis.
- Implemented standard and/or modified versions of plasma diagnostics: single-hit gamma spectrometer, X-ray diffraction diagnostics (HOPG, K-alpha imager, XUV imager), bremsstrahlung cannon, magnetic ion spectrometer, Thomson parabola ion spectrometer, magnetic electron spectrometer, plasma self-emission optical spectrometer
- Knowledgeable of and have built plasma diagnostics with each of these detectors: image plates, CR-39, radiochromic film, Lanex, liquid scintillators, photomultiplier tubes, Faraday cups, photodiodes, cooled X-ray CCDs, linear CCDs

Simulation of lasers, particles and plasma

- Performed plasma fluid simulations (FLASH code), 2D/3D Particle-in-cell (LSP code) simulations, and liquid-gas fluid simulations (OpenFOAM)
- Accessed high performance computing resources at Argonne National Laboratory (10-petaflops Mira Supercomputer) and the Ohio Supercomputer Center for FLASH and LSP simulations
- Utilized the Monte Carlo software MCNP and *Geant4* to evaluate electron and x-ray propagation in complex material arrangements
- Computed 3D magnetic fields and charged particle deflection within yoked magnet using *Radia* in Mathematica
- Modeled wavefront aberrations and optical alignment techniques during laser design in FRED optical modeling software

High-intensity laser systems engineering

- Technically competent in the state of the art of high energy, short-pulse laser systems
- Re-designed and calibrated an in-house scanning third-order cross-correlator to measure laser temporal properties; designed and built single-shot and scanning second-order autocorrelators
- Built a plasma-mirror based diagnostic for nanosecond contrast measurement
- Using the above laser diagnostics, tracked a major laser contrast issue to the beginning of the laser chain; designed a simple measurement technique to iteratively correct the issue, enhancing ion acceleration from thin targets
- Implemented wavefront sensing and adaptive optics to correct laser aberrations
- Diagnosed and repaired circuit boards of two high voltage Pockels cell drivers
- Performed routine maintenance and alignment of two 25 J Nd:YAG pump laser systems and multiple Ti:Sapph chirped-pulse-amplification systems

Mechanical engineering and vacuum systems

- Designed the tip/tilt mount and vacuum chamber for a six-inch aperture deformable mirror in SolidWorks CAD software
- Built and modified parts for laboratory experiments using mill, saws, and lathe in machine shop

- Worked with high vacuum systems, including daily vacuum venting and turbo pumping, cleaning of parts in sonic baths, and maintenance of large roughing pumps

Computational laboratory analysis and acquisitions

- Exceptionally skilled in interfacing laser and plasma diagnostics with computer control and performing advanced real-time and post-analysis
- Programmed acquisition and analysis of large, multi-instrument datasets (thousands of interferometric images, optical spectra, etc.)
- Extensive automation of data acquisition at Scarlet and AFRL, including low-level driver development for triggered oscilloscopes, optical spectrometers, gamma spectrometers, cameras, deformable mirror, and in-vacuum target alignment motors
- Wrote genetic algorithm for optimizing laser focal spot using a deformable mirror and in-plane focal image. Implemented modified versions which optimized for gamma flash, nonlinear harmonics generation, and electron production
- Implemented real-time interferometric analysis of pre-plasma formation (a computationally expensive analysis) by adapting high-performance C++ libraries from an open-source project into LabVIEW
- Programming languages of choice: LabVIEW, Python, MATLAB, C++. Competent in or can quickly pick up other languages

LANGUAGES

English, native. Taught English as a second language professionally.
French, business fluent. Lived and worked in a non-English speaking region of France throughout the academic year 2009-2010. Studied a university semester in 2007 in Angers, France.

COMMUNITY

Member, Physics Graduate Student Council, Ohio State 2010 - 2012
Represented my physics graduate cohort by meeting with administrators, led town hall style meetings, organized on-campus visits of prospective graduate students

Outreach Teacher, Scientific Thinkers 2012
Engaged elementary students at Columbus schools with hands-on scientific activities

Member, American Physical Society (APS) 2010-present
Participated in national APS Division of Plasma Physics meetings and Women in Plasma Physics discussions

Member, High Energy Density Science Association 2014-present
Advocated for federal funding of university programs in High Energy Density Science

PUBLICATIONS

P. L. Poole, C. Willis, R. W. Daskalova, K. George, **Scott Feister**, S. Jiang, J. Snyder, J. Marketon, D. W. Schumacher, K. Akli, L. van Woerkom, R. R. Freeman, and E. A. Chowdhury. "Experimental capabilities of 0.4 PW, 1 shot/min Scarlet laser facility for high energy density science." Appl. Opt., **55** 4613-4719 (2016).

Gregory K. Ngirmang, Chris Orban, **Scott Feister**, John T. Morrison, Kyle D. Frische, Enam A. Chowdhury, W.M. Roquemore. "Three dimensional particle-in-cell simulations of electron beams created via reflection of intense laser light from a water target." Phys. Plasmas, **23** 043111 (2016).

J. T. Morrison, E. A. Chowdhury, K. D. Frische, **Scott Feister**, V. M. Ovchinnikov, J. A. Nees, C. Orban, R. R. Freeman and W. M. Roquemore "Backward-propagating MeV electrons from 10^{18} W/cm^2 laser interactions with water" Phys. Plasmas, **22** 043101 (2015).

C. Orban, J. T. Morrison, E. A. Chowdhury, J. A. Nees, K. Frische, **Scott Feister** and W. M. Roquemore. "Backward-propagating MeV electrons in ultra-intense laser interactions: Standing wave acceleration and coupling to the reflected laser pulse" Phys. Plasmas, **22** 023110 (2015).

Scott Feister, J. A. Nees, J. T. Morrison, K. D. Frische, C. Orban, E. A. Chowdhury, and W. M. Roquemore "A Novel Femtosecond-Gated, High-Resolution, Frequency-Shifted Shearing Interferometry Technique for Probing Pre-Plasma Expansion in Ultra-Intense Laser Experiments" Rev. Sci. Instrum., **85** 11D602 (2014).

P. L. Poole, C. D. Andereck, D. W. Schumacher, R. L. Daskalova, **Scott Feister**, K. M. George, C. Willis, K. U. Akli and E. A. Chowdhury "Liquid crystal films as on-demand, variable thickness (50 - 5000nm) targets for intense lasers" Phys. Plasmas, **21** 063109 (2014).

Scott Feister, Drake R. Austin, John T. Morrison, Kyle D. Frische, Chris Orban, Gregory Ngirmang, Abraham Handler, Jay A. LaVerne, Enam A. Chowdhury, R.R. Freeman, and W.M. Roquemore. "Relativistic electron acceleration by mJ-class kHz lasers normally incident on liquid targets." arXiv:1508.07374 **(under review)**

Scott Feister, John T. Morrison, Kyle D. Frische, Drake R. Austin, Chris Orban, Gregory Ngirmang, Enam A. Chowdhury, and W. M. Roquemore. "Acquisition and analysis for high-repetition-rate HEDP (10 Hz to 1 kHz)" **(in prep.)**

Scott Feister, Chris Orban, Gregory Ngirmang, Joseph Smith, Mark Schillaci, John T. Morrison, Kyle D. Frische, Enam A. Chowdhury, and W. M. Roquemore. "Escape of laser-accelerated MeV electrons through an extended low-density pre-plasma" **(in prep.)**

Drake R. Austin, **Scott Feister**, John T. Morrison, Kyle D. Frische, Chris Orban, Jay A. LaVerne, R. R. Freeman, Enam A. Chowdhury, and W. M. Roquemore. "A compact, optics-free, high-acquisition rate Lanex electron spectrometer" **(in prep.)**

UPCOMING PRESENTATIONS

Omega Laser Facility Users Group Workshop, 26 - 28 April 2017, Rochester, NY. (Poster)

2017 Stewardship Science Academic Programs Symposium, 12 - 13 April 2017, Naperville, IL. (Poster)

PRESENTATIONS

National Ignition Facility and Jupiter Laser Facility User Group Meeting, 5 - 8 February 2017, Livermore, CA. "FLASH Simulations of Magnetic Turbulence Experiments at NIF" (Poster), Scott Feister, Petros Tzeferacos, Jena Meinecke, Farhat Beg, Tony Bell, Roger Blandford, Archie Bott, Frederico Fiuza, Dustin Froula, Michel Koenig, Chikang Li, Francesco Miniati, Richard Petrasso, Brian Reville, Steven Ross, Dongsu

Ryu, Dmitri Ryutov, Subir Sarkar, Alexander Schekochihin, Qian Xia, Hye-Sook Park, Don Lamb, and Gianluca Gregori. Presented by Scott Feister. **Awarded "Best Postdoctoral Researcher Poster"**.

Department of Astronomy and Astrophysics Chalk Talk Series, 17 January 2017, Chicago, IL. "Laser laboratory astrophysics: Diffusion and acceleration of charged particles in turbulent magnetized plasma" (Oral), Scott Feister. Presented by Scott Feister.

58th Annual Meeting of the American Physical Society (APS) Division of Plasma Physics, 31 October - 4 November 2016, San Jose, CA. "Escape of laser-accelerated MeV electrons through an extended low-density pre-plasma" (Oral), S. Feister, C. Orban, J.T. Morrison, G.K. Ngirmang, J. Smith, K.D. Frische, A.C. Peterson, A.J. Klim, E.A. Chowdhury, R.R. Freeman, and W.M. Roquemore. Presented by Scott Feister.

58th Annual Meeting of the American Physical Society (APS) Division of Plasma Physics, 31 October - 4 November 2016, San Jose, CA. "kHz Ion Acceleration Under Variable Background Pressure" (Oral), J.T. Morrison, S. Feister, K.D. Frische, D.R. Austin, G.K. Ngirmang, A.C. Peterson, J. Smith, A. Klim, C. Orban, E.A. Chowdhury, and W.M. Roquemore. Presented by John Morrison.

58th Annual Meeting of the American Physical Society (APS) Division of Plasma Physics, 31 October - 4 November 2016, San Jose, CA. "Wavelength and Intensity Dependence of the Standing Wave Mechanism in the Near-IR Regime in Producing High Energy Backwards Electron Beams" (Oral), G.K. Ngirmang, C. Orban, S. Feister, J.T. Morrison, E.A. Chowdhury, and W.M. Roquemore. Presented by Gregory Ngirmang.

58th Annual Meeting of the American Physical Society (APS) Division of Plasma Physics, 31 October - 4 November 2016, San Jose, CA. "Thin liquid sheet target capabilities for ultra-intense laser acceleration of ions at a kHz repetition rate" (Poster), A. Klim, J.T. Morrison, C. Orban, S. Feister, G.K. Ngirmang, J. Smith, K. Frische, A.C. Peterson, E.A. Chowdhury, R.R. Freeman, and W.M. Roquemore. Presented by Adam Klim.

7th Conference of the International Committee on Ultrahigh Intensity Lasers, 11 - 16 September 2016, Montebello, Québec, Canada. "Acceleration of particles by intense lasers, at 1 kHz" (Oral), J.T. Morrison, S. Feister, K. Frische, D.R. Austin, G.K. Ngirmang, C. Orban, E.A. Chowdhury, R.R. Freeman, W.M. Roquemore. Presented by John Morrison.

DoD High Performance Computing Internship Program Review, 13 July 2016, Dayton, OH. "Leveraging thousands of processors to understand wildly-intense and (near) speed-of-light electrons" (Oral), S. Feister. Presented by Scott Feister.

Omega Laser Facility Users Group Workshop, 27 - 29 April 2016, Rochester, NY. "Acquisition and analysis for high repetition rate HEDP (10 Hz to 1 kHz)" (Poster), S. Feister, J.T. Morrison, K. Frische, D.R. Austin, C. Orban, G.K. Ngirmang, E.A. Chowdhury, R.R. Freeman, and W.M. Roquemore. Presented by Scott Feister. **Awarded "Best Graduate Student Poster"**.

Edward F. Hayes Graduate Research Forum, 26 February 2016, Columbus, OH. "Relativistic acceleration of electrons with kHz-pulsed lasers" (Oral), S. Feister. Presented

by Scott Feister.

National Ignition Facility and Jupiter Laser Facility User Group Meeting, 31 January - 3 February 2016, Livermore, CA. "Acceleration of ions at 1 kHz to >MeV" (Poster), Scott Feister, J.T. Morrison, E.A. Chowdhury, K. Frische, C. Orban, R.R. Freeman, and W.M. Roquemore. Presented by Scott Feister.

International Conference on Extreme Light, 23 - 27 November 2015, Bucharest, Romania. "Precision liquid target development for kHz particle acceleration studies in The Air Force Research Laboratory, USA" (Oral), E.A. Chowdhury, J.T. Morrison, K. Frische, S. Feister, D.R. Austin, C. Orban, R. R. Freeman and W.M. Roquemore. Presented by Enam Chowdhury.

3rd High-Power Laser Workshop, 5 - 6 October 2015, Menlo Park, CA. "Relativistic electron spectra from normal incidence, kHz laser interactions" (Poster), Scott Feister, Drake R. Austin, John T. Morrison, Kyle D. Frische, Chris Orban, Gregory Ngirmang, Abraham Handler, Mark Schillaci, Enam A. Chowdhury, R.R. Freeman, and W.M. Roquemore. Presented by Scott Feister.

3rd High-Power Laser Workshop, 5 - 6 October 2015, Menlo Park, CA. "A compact, high-acquisition rate electron spectrometer" (Poster), Drake R. Austin, Scott Feister, John T. Morrison, Kyle D. Frische, Chris Orban, R. R. Freeman, Enam A. Chowdhury, and W. M. Roquemore. Presented by Drake Austin.

46th Annual Meeting of the APS Division of Atomic, Molecular and Optical Physics, 8 - 12 June 2015, Columbus, OH. "Backward-going MeV electrons and gamma rays from 10^{18} W/cm^2 laser interactions with water" (Oral), S. Feister, J. T. Morrison, K. D. Frische, C. Orban, V. M. Ovchinnikov, J. A. Nees, D. R. Austin, E. A. Chowdhury, R. R. Freeman, and W. M. Roquemore. Presented by Scott Feister.

Omega Laser Facility Users Group Workshop, 22 - 24 April 2015, Rochester, NY. "Backward-Propagating MeV Electrons from 10^{18} W/cm^2 Laser Interactions with Water" (Poster), S. Feister, J. T. Morrison, E. A. Chowdhury, K. D. Frische, V. M. Ovchinnikov, J. A. Nees, C. Orban, R. R. Freeman, and W. M. Roquemore. Presented by Scott Feister.

Laser Plasma Targetry Workshop, 20 - 22 April 2015, Paris, France. "Precision liquid target development for kHz relativistic laser matter interaction studies in The Air Force Research Laboratory, USA" (Oral), E.A. Chowdhury, J.T. Morrison, K. Frische, S. Feister, D.R. Austin, J.A. Nees, C. Orban, and W.M. Roquemore. Presented by Enam Chowdhury.

National Ignition Facility and Jupiter Laser Facility User Group Meeting, 8 - 11 February 2015, Livermore, CA. "Backward-Propagating MeV Electrons from 10^{18} W/cm^2 Laser Interactions with Water" (Poster), S. Feister, J. T. Morrison, E. A. Chowdhury, K. D. Frische, V. M. Ovchinnikov, J. A. Nees, C. Orban, R. R. Freeman, and W. M. Roquemore. Presented by Scott Feister.

56th Annual Meeting of the American Physical Society (APS) Division of Plasma Physics, 27 - 31 October 2014, New Orleans, LA. "Experimental Generation of Backward-Propagating MeV Electrons in Ultra-Intense Laser Interactions" (Oral), S. Feister, J. T. Morrison, V. M. Ovchinnikov, K. D. Frische, J. A. Nees, C. Orban, E. A. Chowdhury, and W. M. Roquemore. Presented by Scott Feister.

DoD High Performance Computing Internship Program Review, 21 August 2014, Dayton, OH. "High Performance Computing for High Intensity Laser Laboratory Science" (Oral), S. Feister. Presented by Scott Feister.

The Ohio State University Poster Competition, 18 August 2014, Columbus, OH. "A Novel Femtosecond-Gated, High-Resolution, Frequency-Shifted Shearing Interferometry Technique for Probing Pre-Plasma Expansion in Ultra-Intense Laser Experiments" (Poster), S. Feister, J.A. Nees, J.T. Morrison, K. Frische, C. Orban, E.A. Chowdhury, and W.M. Roquemore. Presented by Scott Feister.

Topical Conference on High Temperature Plasma Diagnostics, 1 - 5 June 2014, Atlanta, GA. "A Novel Femtosecond-Gated, High-Resolution, Frequency-Shifted Shearing Interferometry Technique for Probing Pre-Plasma Expansion in Ultra-Intense Laser Experiments" (Poster), S. Feister, J.A. Nees, J.T. Morrison, K. Frische, C. Orban, E.A. Chowdhury, and W.M. Roquemore. Presented by Scott Feister.

Omega Laser Facility Users Group Workshop, 23 - 25 April 2014, Rochester, NY. "The Ohio State University 400 TW Scarlet Laser" (Poster), S. Feister, C. Willis, P. Poole, K. George, F. Aymond, S. Jiang, R. Daskalova, J. Marketon, E. Chowdhury, K. U. Akli, D. Schumacher, R. R. Freeman. Presented by Scott Feister.

Stewardship Science Academic Programs Symposium, 19 - 20 February 2014, North Bethesda, MD. "The Ohio State University 400 TW Scarlet Laser" (Poster), S. Feister, C. Willis, P. Poole, K. George, F. Aymond, S. Jiang, R. Daskalova, J. Marketon, E. Chowdhury, K. U. Akli, D. Schumacher, R. R. Freeman. Presented by Scott Feister.

National Ignition Facility and Jupiter Laser Facility User Group Meeting, 9 - 12 February 2014, Livermore, CA. "The Ohio State University 400 TW Scarlet Laser" (Poster), S. Feister, C. Willis, P. Poole, K. George, F. Aymond, S. Jiang, R. Daskalova, J. Marketon, E. Chowdhury, K. U. Akli, D. Schumacher, R. R. Freeman. Presented by Scott Feister.