Project Title: Nanosecond Fast-Framing Imaging of Pulsed Plasmas for Advanced Propulsion Experiments

Project Reference Code: Cassibry-UAH

Name of Project Leader: Jason Cassibry

Host Facility: University of Alabama in Huntsville

Internship Location: Charger Advanced Power and Propulsion Laboratory, 238 Business Park, Madison, AL 35758

Host Facility Location: 301 Sparkman Drive, Huntsville, AL 35899

Project Description (roughly 300 words):
Pulsed-power plasma experiments evolve on extremely short timescales, requiring diagnostics capable of resolving plasma formation, compression, and instability development over tens of nanoseconds. This project will modernize and characterize a legacy nanosecond-gated fast-framing camera and integrate it as an optical diagnostic for the Charger Advanced Propulsion and Power Laboratory's 60-kJ "Sparky" pulsed-power facility. The student will develop a modern computer interface for camera control and image acquisition, characterize camera timing and exposure behavior, and develop the triggering and synchronization system necessary to coordinate imaging with the Sparky current pulse and other experimental diagnostics. Bench testing will be used to establish timing accuracy, repeatability, spatial resolution, and appropriate optical configurations before deployment on pulsed-plasma experiments. Following commissioning, the camera will be used to investigate the formation and evolution of transient plasma structures produced by Sparky. Nanosecond-scale images will be correlated with electrical diagnostics such as current and voltage measurements to examine plasma geometry, compression, symmetry, and the development of instabilities during the pulse. Experiments may include Z-pinch and related pulsed-plasma configurations relevant to advanced propulsion and fusion-energy research. The project will provide the student with hands-on experience in plasma physics, pulsed power, high-speed diagnostics, experimental design, instrumentation, data acquisition, and scientific analysis. The completed system will also establish a reusable fast-imaging diagnostic for future plasma research at UAH.

Disciplines:
Primary: Mechanical Engineering / Aerospace Engineering
Also appropriate: Electrical Engineering, Physics, Optical Engineering, Computer Engineering

Importance:
Fast-framing imaging is an important diagnostic technique for pulsed-power and plasma experiments because many important plasma phenomena occur on nanosecond-to-microsecond timescales and cannot be resolved using conventional imaging systems. These diagnostics are used in fusion-energy, high-energy-density physics, electric propulsion, and pulsed-power research worldwide to study plasma formation, compression, symmetry, and instabilities. Nationally, pulsed-power and high-speed plasma diagnostics support research in fusion energy, advanced propulsion, materials science, and national-security applications at universities, national laboratories, and government research centers. Locally, these capabilities are particularly relevant to the Huntsville research community because of its

concentration of aerospace, propulsion, defense, and space-technology organizations. The project will expand experimental plasma-diagnostic capability at UAH while training an undergraduate student in instrumentation, pulsed power, data acquisition, and plasma physics. The resulting diagnostic will be used with UAH's 60-kJ Sparky pulsed-power facility and will remain available for future student research in fusion and advanced propulsion.

Requirements:

- Preferred Major
  - Mechanical and/or Aerospace Engineering.
- Class work
  - 1st semester physics, introductory programming (like UAH EGR 101), and introductory circuits course is recommended.
- Programming knowledge
  - Python and Matlab.
- Software knowledge
  - N/A.
- Other

Biography (roughly 100-150 words):

Dr. Jason Cassibry is a Professor of Mechanical and Aerospace Engineering at The University of Alabama in Huntsville and Director of the Charger Advanced Propulsion and Power (CAPP) Laboratory. His research focuses on fusion energy, advanced space propulsion, pulsed-power systems, plasma physics, and computational modeling. His current research includes magneto-inertial fusion, plasma-jet-driven fusion, magnetic confinement concepts, high-voltage pulsed-power experiments, and plasma diagnostics. He has extensive experience mentoring undergraduate and graduate students in experimental and computational research and has led research efforts supported by government and industry. His work emphasizes hands-on student involvement in challenging, multidisciplinary engineering and plasma-physics problems.

Is U.S. citizenship required to participate in this project? No.

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Name(s) of Mentor(s) and contact information:

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Internship Coordinator/ HR manager:

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