RQ14-8

AFRL CALL FOR RESEARCH

1. Research Title: *Characterization of Supersonic Flows Using Laser-Based Diagnostics*

2. Individual Sponsor:

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3. Academic Area/Field and Education Level: Engineering Physics, Applied Physics, Mechanical Engineering, Aerospace Engineering (MS and/or Ph.D. level)

4. Objectives: Apply advanced laser diagnostic tools to investigate critical aspects of the supersonic combustion ramjet (scramjet) engine, including fuel injection and mixing, combustion initiation and flame holding/propagation, and shock/boundary-layer interactions.

5. Description: Currently an inadequate science basis limits the development of the scramjet engine. This will continue to be a limiting factor as engineers try to design complex flowpaths such as turbine-based combine cycle engines. The need for better understanding of fundamental problems—such as fuel injection and mixing and flame holding and propagation—therefore shapes this thesis research program. The DAGSI masters or PhD student and faculty member will utilize the Aerospace Systems Directorate's (AFRL/RQ) wind-tunnel and laser diagnostic assets (described below) to study these critical phenomena. Topics could include the following:

a. Study of injection and mixing of gaseous jets from simple injectors into a supersonic flow, to provide a database for advanced computational model development (e.g., large eddy simulation, LES). Work to date has included injection characterization using Raman scattering and laser-induced fluorescence of an injectant into a Mach-2 flow.
b. Study of injection of a condensing, supercritical fuel jet into quiescent environments and high-speed flows. Work to date has included measurement of droplet sizes within the condensing jet using small-angle X-ray scattering (SAXS, at Argonne National Laboratories).
c. Study of fundamentals of flame holding and propagation in a supersonic flow. Work to date has included the application of laser-induced florescence of the OH radical, to mark the flamefront location, within a cavity flame holder, and particle image velocimetry.

Facilities at WPAFB include a variety of wind-tunnels (including direct-connect scramjet tunnels) and a variety of optical and laser components (including Q-switched Nd:YAG lasers, dye lasers, spectrometers, and specialized digital cameras). Optical measurement techniques such as planar laser-induced fluorescence (PLIF), Raman and Rayleigh scattering, and particle image velocimetry (PIV) are routinely performed. An area for future diagnostic development and application that might be explored within the thesis research is *high-repetition-rate imaging diagnostics* (e.g., for PLIF).

6. Research Classification/Restrictions: No restrictions anticipated.

7. Interest in Summer USAFA Cadet: No

8. Eligible Research Institutions: [X] Universities (DAGSI) [X] AFIT [ ] USAFA