AFRL RESEARCH TOPIC CALL FOR FY13

1. **Research Title: Sensor Development for Hypersonic Vehicles**
2. **Individual Sponsor:** Dr. Saba Mudaliar, AFRL/RYHE
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3. **Academic Area/Field and Education Level:** Electrical Engineering, Physics, Mechanical or Aerospace Engineering / Hypersonic phenomenology, waves through turbulent flows, windows and radomes, nonintrusive diagnostics (M.S. or Ph.D. level)
4. **Objectives:** Develop theoretical and experimental tools to assess the impact of environment on sensors aboard hypersonic vehicles
5. **Description:** The primary goal is to develop theoretical and experimental tools to assess the impact of the environment on sensors aboard hypersonic vehicles. A secondary goal is to develop techniques to mitigate the adverse effects on sensors caused by the hypersonic environment. Hypersonic flights lead to high temperature flows, ionized flow fields, and cumulative heating of air-frames. Consequently the performance of all on-board sensor systems such as GPS, telemetry, communication, command and control, radar, ladar, and electro-optical sensors are all adversely affected to varying degrees by the hypersonic environment. Some of the issues encountered are: signal attenuation, communication blackout, signal distortion due to turbulent flow, radiation from heated optical windows, and emission from hot flows. Communication blackout although old is still a problem and is encountered when the signal frequency is well below the plasma frequency. A successful technique to work around or eliminate the plasma sheath would alleviate some of the problems. Even in the case when the RF signal is above the plasma frequency the hot flow field may be a dispersive, inhomogeneous, fluctuating, and lossy medium. This poses challenges to wideband RF system using conformal arrays. Moreover the signal transmitted from the vehicle may be sufficiently intense to initiate nonlinear processes in the flow field. The rapid maneuvers and high velocity place limitations on the integration time of the processing algorithms of the receivers. Although optical sensors are not affected by the ionized flow in the same way as the RF sensors they have their own share of issues. The hot window can radiate at infrared frequencies and the hot flow fields can emit and absorb at optical frequencies thereby seriously affecting the optical and EO/IR sensors on board. Of particular interest is to assess the impact of environment on spectral measurements and imaging. Beam pointing error and wave front distortions are also of concern. An adaptive sensor system which uses a diagnostic tool to sense and adaptively match to the environment will be desirable. Research opportunities exist in the analyses and mitigation of the above-mentioned issues confronted by sensors aboard hypersonic platforms.
6. **Research Classification/Restrictions:** Basic research in this area is unclassified.
7. **Eligible Research Institutions:** Place an X in all that apply.

   [X] Universities (DAGSI) ☐ AFIT (only) [X] USAFA
8. **Interest in Summer USAFA Cadet (Avg Cost for USAF Cadet for 33 days was $5000):**

   Interested in sponsoring a USAF Cadet in summer of 2013 contingent on funding availability