

RQ15-36

1. **Research Title:** *Design Approaches for Hypersonic Inlet and Isolator Operability*

2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Aerospace Engineering / Hypersonic Aerodynamics and Propulsion (MS or Ph.D. level)

4. **Objectives:** Design for improved operability of hypersonic inlets and isolators, using refined inlet starting criteria and prediction methods; or develop innovative flow management approaches to enable stable performance across a wide range of operating conditions.

5. **Description:** The Kantrowitz limit has traditionally been used in the design process to set the minimum area ratios that will ensure reliable starting of inlets that contain internal contraction regions. Empirical data show this limit to be conservative such that an inlet will start for an inlet area ratio between the Kantrowitz limit and the isentropic compression limit. For the proposed project, computational and/or experimental methods can be employed to refine the design criteria and also improve prediction methods for inlet starting.

Alternatively, innovative flow management approaches could be applied within the context of existing inlet design theory to enable stable system performance across a range of at least three Mach numbers and 20 degrees angle of attack (e.g.  $M=3-6$ ,  $\alpha=-5^{\circ}-15^{\circ}$ ). These approaches include, but are not limited to bleed and energy deposition. The device and technology should be compatible with conceptual system integration considerations including combustor operation limits, vehicle length and weight, reliability, and cost. Flow management approaches should consider fluid dynamics phenomena such as shock and boundary layer interactions. Development and validation of flow control approaches can be accomplished through numerical modeling and/or suitable physical testing.

6. **Research Classification/Restrictions:** Basic work on contraction theory is expected to be unrestricted; any work on flow management strategies for inlet/isolator control is expected to be ITAR restricted, and thus restricted to U.S. citizens.

7. **Interested in Summer USAFA Cadet:** No

8. **Eligible Research Institutions:**  Universities (DAGSI)  AFIT  USAFA