Our group conducts cutting-edge research on hypersonic air breathing propulsion, supersonic aerodynamics, hypersonic ground and flight test techniques and diagnostic and measurement technique development. Major projects include the development of ground and flight test techniques for evaluating the design of scramjets, a cutting-edge technology that uses ram compressed air to reach speeds many times faster than that of sound.

“A conducting basic and applied research in advanced aerospace technologies.”
**Hypersonic Air Breathing Propulsion**
Given current industry trends, there is considerable interest in research to improve the safety, efficiency and cost associated with space access. Scramjets, and the promise of air breathing hypersonic propulsion, present the opportunity to attain such goals. A scramjet is an air breathing jet engine that maintains airflow at supersonic speeds during combustion. Whereas a ramjet or regular aircraft engine slows the air down to subsonic speeds before combustion, a scramjet keeps the airflow supersonic while the fuel is added and combustion takes place. By using oxygen in the atmosphere, the vehicle does not need to carry oxidizer, thus reducing the launch mass, and increasing the mass efficiency of the vehicle. Further, it is anticipated that scramjet-propelled vehicles can be flown in a fashion similar to take-off and landing of a regular plane. This is expected to lead to the safety, efficiency and cost gains mentioned above. Our lab is working to better understand how a scramjet works.

**Hypersonic Ground & Flight Test Techniques**
We are working to resolve ground testing issues related to the duration of the test flow and the effects of test medium on dual-mode scramjet engine performance. This program involves both ground and flight tests. Some of the ground test campaigns are performed in direct connect mode using the UVa Supersonic Combustion Facility (UVaSCF). The UVaSCF is an electrical resistance-heated supersonic wind tunnel that is capable of simulating up to Mach 5 and clean-air flow.

**Hy-V Program**
The Hy-V (pronounced “high five”) Program is being executed by a university, industry, and government team. The goal of the program is to obtain ground and flight data for the further advancement of scramjet technology. Particularly, the experiment will investigate the differences between free-flying scramjet data and ground tested wind tunnel data. The ground testing data will be accumulated from several wind tunnel facilities. The free-flying scramjet test will be a collaborative effort to launch a sounding rocket with a scramjet from NASA-Wallops Flight Facility located off the east coast of Virginia.

**Diagnostic & Measurement Technique Development**
We collaborate with NASA to develop novel diagnostic and measurement techniques related to hypersonic flows. A recent development involved the use of nitric-oxide planar laser-induced fluorescence (NO PLIF) to perform velocity measurements in hypersonic flows by generating multiple tagged lines which fluoresce as they convect downstream.

**Fluid Dynamics of Rotating Machinery**
The safe operating range of the pressure and the mass flow for a centrifugal compressor is limited by a dynamic flow instability known as surge. Surge occurs as the mass flow through the compressor is reduced to a critical point where the flow pattern becomes unstable. This critical point, called the surge point, separates the stable and the unstable operating region of the compressor in the compressor characteristic curve. We are working to develop a mathematical model for compression systems in order to better understand these dynamic systems.

**RECENT RESEARCH DEVELOPMENTS**
- Developed new ground test techniques to improve the capability of the Department of Defense and NASA to evaluate scramjet technology
- Developed new experimental scramjet database that is being used to validate advanced numerical models for the prediction of scramjet performance
- Discovered new techniques to enhance the flight testing of scramjet engines

**RECENT GRANTS**
- Office of the Secretary of Defense and Alliant Techsystems, Inc.- Propulsion Systems Performance Models; Resolving the Test Mediums Effects Issues
- NASA and UTRC – Test Media Effects on DMSJ Mode-Transition

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*Images and additional text not shown.*