



## NASA SBIR 2011 Phase I Solicitation

### A2.02 Combustion for Aerospace Vehicles

Lead Center: GRC

Participating Center(s): LaRC

Combustion research is critical for the development of future aerospace vehicles. Vehicles for subsonic and supersonic flight regimes will be required to emit extremely low amounts of gaseous and particulate emissions to satisfy increasingly stringent emissions regulations. Hypersonic vehicles require combustion systems capable of sustaining stable and efficient combustion in very high speed flow fields where fuel/air mixing must be accomplished very rapidly and residence times for combustion are extremely limited; a major challenge is developing scaling laws that will allow the size of scramjet engines to be increased by a factor of 10, i.e., to mass flow rates of 100 lbm/sec. Fundamental combustion research coupled with associated physics based model development of combustion processes will provide the foundation for technology development critical for aerospace vehicles. Combustion for aerospace vehicles typically involves multi-phase, multi-component fuel, turbulent, unsteady, 3D, reacting flows where much of the physics of the processes are not completely understood. CFD codes used for combustion do not currently have the predictive capability that is typically found for non reacting flows. Practical aerospace combustion concepts typically require very rapid mixing of the fuel and air with a minimum pressure loss to achieve complete combustion in the smallest volume. Reducing emissions may require combustor operation where combustion instability can be an issue and active control may be required. Areas of specific interest where research is solicited includes:

- Development of laser-based diagnostics and novel experimental techniques for measurements in reacting flows.
- Two-phase flow simulation models and validation data under supercritical conditions.
- Development of ultra-sensitive instruments for measuring gas turbine black carbon emissions at temperatures and pressures characteristic of commercial aircraft cruise altitudes.
- High frequency actuators (bandwidth ~1000 Hz) that can be used to modulate fuel flow at multiple fuel injection locations (with individual Flow Numbers of 3 to 5) with minimal fuel pressure drop for active combustion control.
- Combustion instability modeling and validation.
- Novel combustion simulation methodologies.

- 
- Concepts that will allow the scaling of scramjet engines burning hydrogen and/or hydrocarbon fuels.

The following areas are of particular interest:

- The effect that size has on mixing, injection, and thermal loading losses.
- The effect of size on mixing and flame propagation.
- The effect of size on injection strategies.
- The scaling of ignition devices, flameholders, and mixing devices.
- The effect that the size and thickness of the incoming boundary layer has on ignition devices and flameholders.
- Whether there is a ratio between the size of inviscid stirring structures and turbulent structures that is optimal for rapid mixing.