

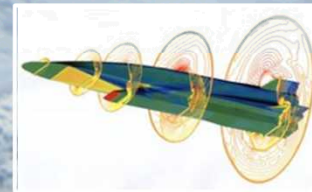
HTP

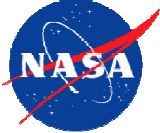


Hypersonic Technology Project

NASA Hypersonics Overview

AIAA Hypersonics Conference
September 2018





Hypersonics is a Broad Mission Area

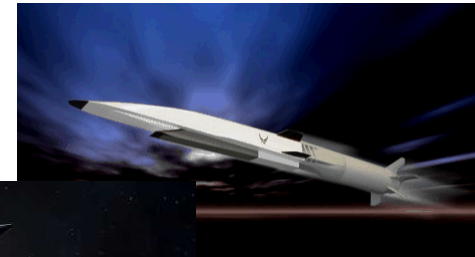


HYPERSONICS

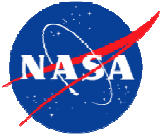
**Blunt Body
Re-entry**

**Unpowered
Atmospheric Flight**

**Powered / Sustained
Atmospheric Flight**



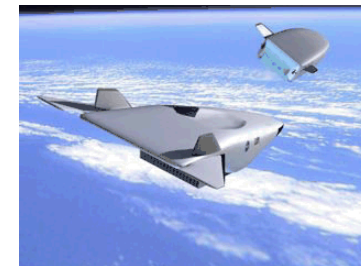
*Multiple NASA Missions require
Mastery of Hypersonic Flight*



The Next Revolution in Powered Flight



Hypersonic Powered Atmospheric Flight



Weapons

**Sustained
Atmospheric Cruise**

**Space
Access**

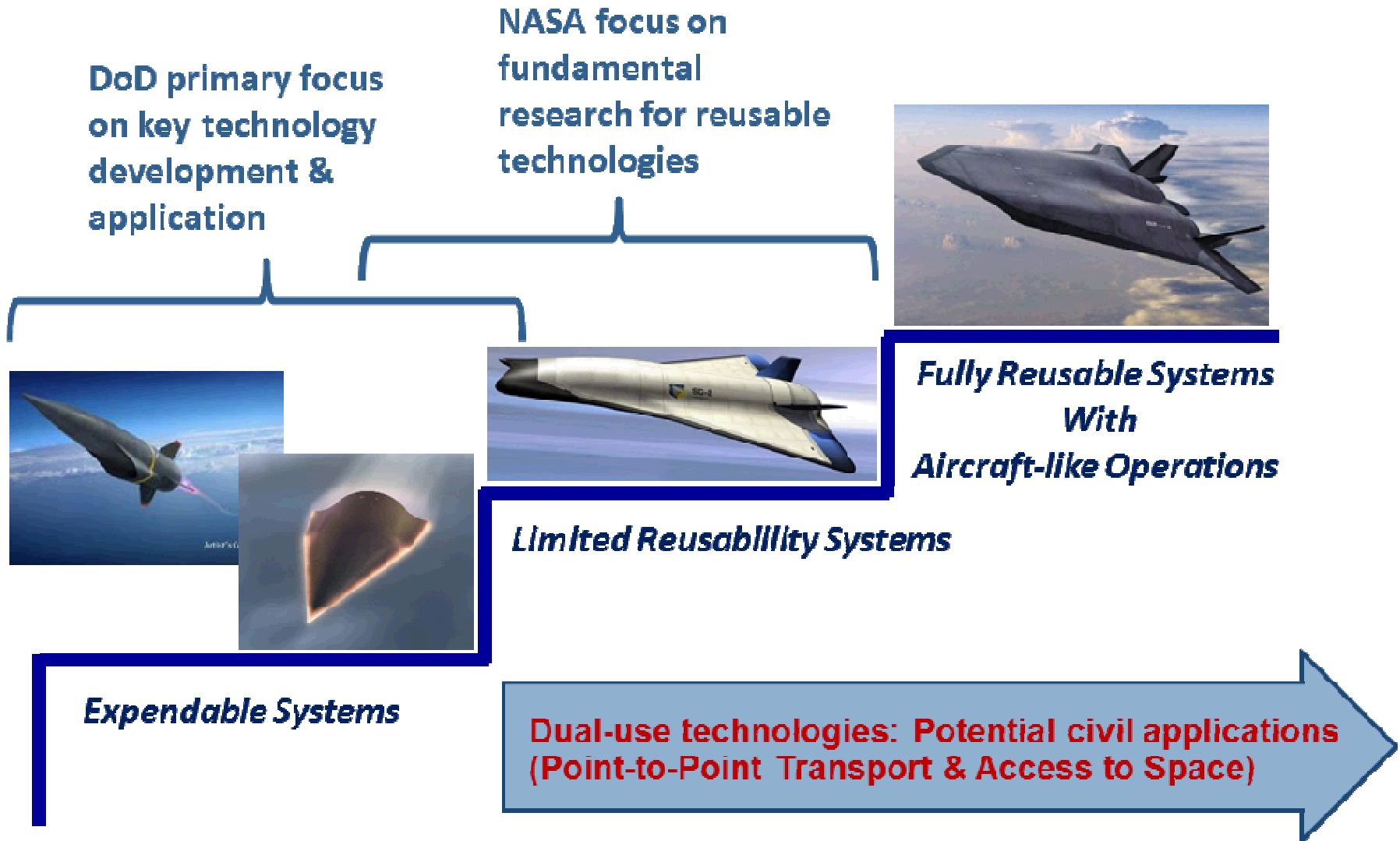


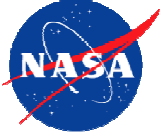
**Commercial
Point to Point**

**Military reusable
applications**



Civilian Applications





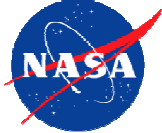
Enable Routine, Reusable, Airbreathing Hypersonic Flight

Approach

- Conduct fundamental research to enable a broad spectrum of hypersonic systems and missions by advancing the core capabilities and critical technologies underpinning the mastery of hypersonic flight and bringing them to bear on National Programs

Scope

- Fundamental research spanning technology readiness and system complexity levels
- Critical technologies enabling re-usable hypersonic systems
- System-level research, design, analysis, validation
- Engage, invigorate and train the next generation of engineers



HTP Research Topics



RT-1: System Level Design, Analysis, Validation

- Tool Development
- Uncertainty Quantification

RT-2: Propulsion Technologies

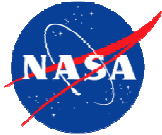
- Mode Transition
- Enhanced Mixing and Injection

RT-3: Vehicle Technologies

- Boundary Layer Transition
- Shock-Shock and Shock-Boundary Layer Interactions

RT-4: High Temperature, Durable Materials

- C-C Hot Structures
- Ceramic Matrix Composite Heat Exchanger



NASA/DoD Partnering



Department of Defense

- Focus on operational mission (especially in near-term)
- In-house expertise aligned with mission need
- Enhancing test capabilities
- Significant investment (especially in demonstrators)

Develop new military capability

Share valuable data with NASA enables DOD Mission

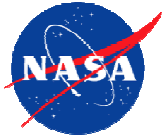
Provide subject matter experts and key facilities

Developing future workforce

NASA

- Focus on fundamental research (long term emphasis with near term impact)
- Fully utilizes data from demos to advance/validate fundamental capabilities
- Performs independent studies to assess Technology Readiness for advanced civil & military applications
- Maintains unique facilities & skills with unique expertise to benefit broad aerospace community

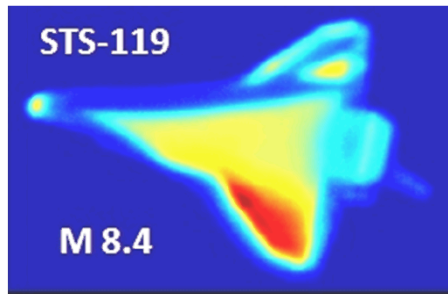
Fundamental research base for country & future missions



NASA Core Hypersonic Competencies



**Hypersonic
Airbreathing
Propulsion**

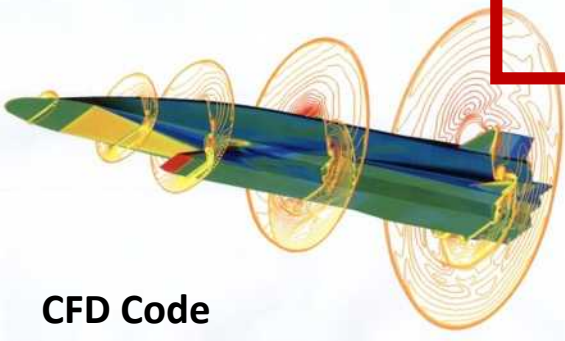


Aerosciences



**Vehicle Level
Conceptual
Design & Systems
Analysis**

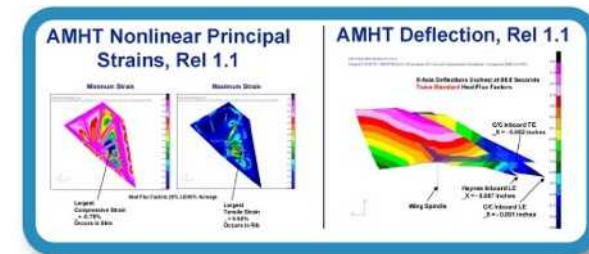
NASA has the knowledge to develop and apply our world class combination of computational expertise, experimental facilities and flight experience in propulsion, aerothermodynamics, materials, thermal structures, guidance & control and conceptual vehicle design to deliver mission success.



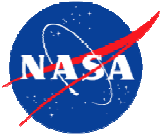
**CFD Code
Development / Application**



Ground Testing & Diagnostics



Structures & Materials



NASA Hypersonic Propulsion Test Facilities



8-Ft. High Temperature Tunnel (8-Ft. HTT)

Flight Mach Enthalpy: 3 - 7



10x10

Flight Mach: 2.0 - 3.5



Arc-Heated Scramjet Test Facility (AHSTF)

Flight Mach Enthalpy: 4.7- 8



Propulsion Systems Lab (PSL)

Flight Mach Enthalpy: 4.7- 6



1x1, Flight Mach: 1.5 - 6



Unitary Plan Wind Tunnel (UPWT)

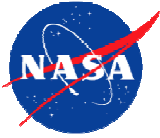
Flight Mach: 1.5 - 4.6



Direct-Connect Supersonic Combustion Test Facility (DCSCTF)

Flight Mach Enthalpy: 4.5 - 7





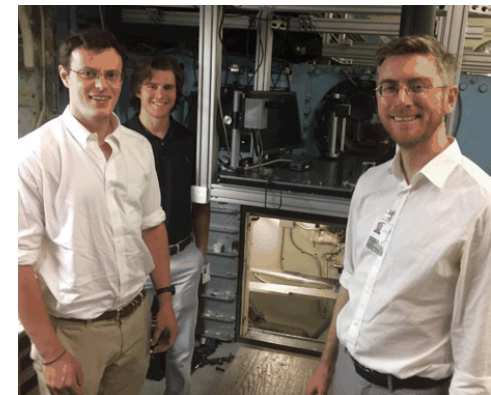
Academic Outreach



- Supported 47 student interns in FY17
- Supported over 20 student interns in FY18
- In FY18, granted 4 multi-year scholarships supporting graduate research to be conducted partly in NASA facilities with NASA researchers
 - Additional scholarships to be awarded in FY19
- Partnering with AFOSR, ONR, and universities to bring testing into NASA facilities



UTSI professor Dr. Phil Kreth, NASA researcher Dr. Brett Bathel, and graduate student Laura Lash in the LaRC 20-inch M6



(from left to right) Thomas Whalen, Cole Sousa and Dr. Laurence (UMD) at LaRC 20-Inch Mach 6 Tunnel.