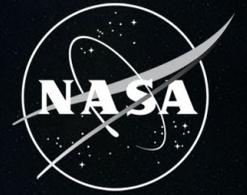


National Aeronautics and Space Administration



# ***NASA Langley Research Center:***

## ***Engineering Atmospheric Flight Systems From Concept to Flight***

Steve Sandford, Langley Engineering Director  
8<sup>th</sup> International Planetary Probe Workshop

Portsmouth, VA

June 2011

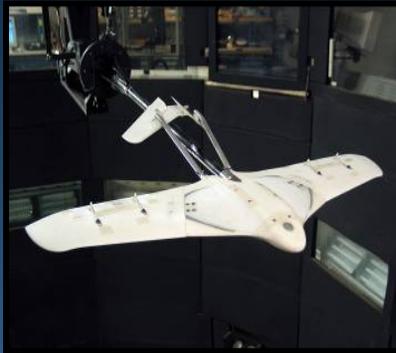
A photograph of a white sign with a red roof, set against a background of a dark sky with planets and a landscape with clouds. The sign features the NASA logo and the text "NATIONAL AERONAUTICS SPACE ADMINISTRATION" and "LANGLEY RESEARCH CENTER".

NATIONAL AERONAUTICS  
SPACE ADMINISTRATION  
LANGLEY RESEARCH CENTER

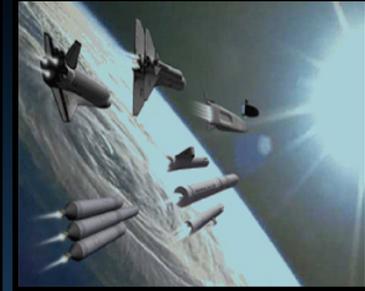
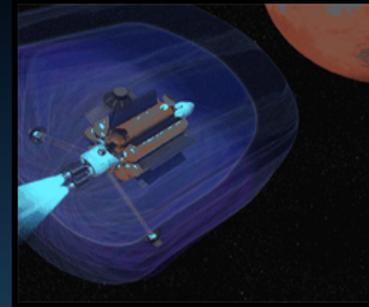
# NASA Langley Core Capabilities



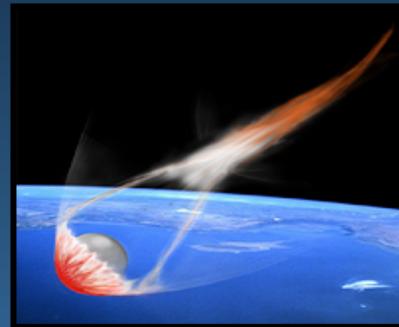
## Aerosciences R&D for Flight in All Atmospheres



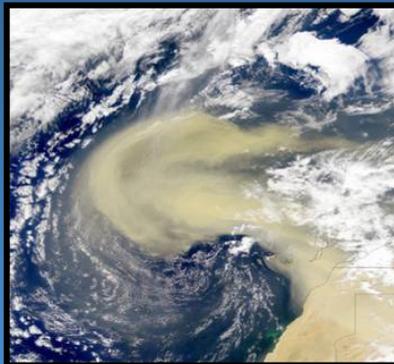
## Aerospace Systems Analysis



## Entry, Descent & Landing



## Characterization of all Atmospheres (Lasers & LIDAR)



## Aerospace Structural & Material Concepts



# From Ideas to Operational Deployment



Academia

NASA Centers

Industry

Fundamental  
Research

TECHNOLOGY DEVELOPMENT

Validation and  
Infusion

Operations

Concepts

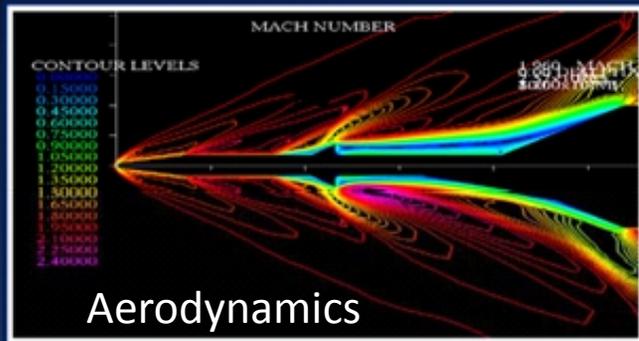
Technology Maturation

Flight Systems  
Development

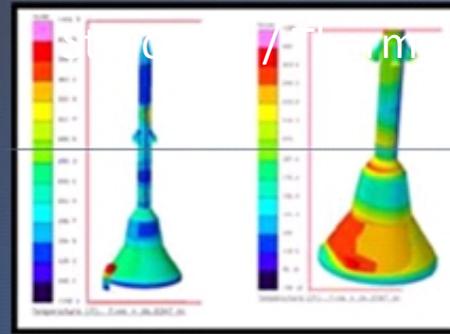


Increasing Cost and Complexity

# Langley Integrates Deep Multidisciplinary Expertise To Move From Concept to Flight



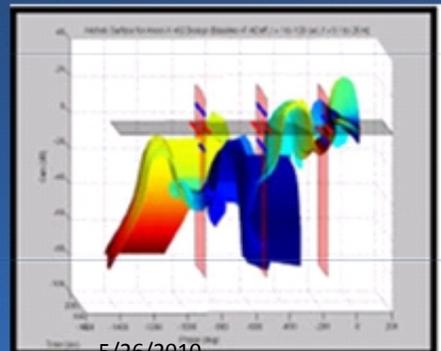
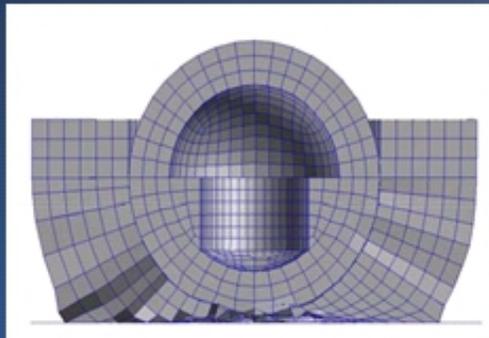
Aerodynamics



Acoustics



Structures & Materials



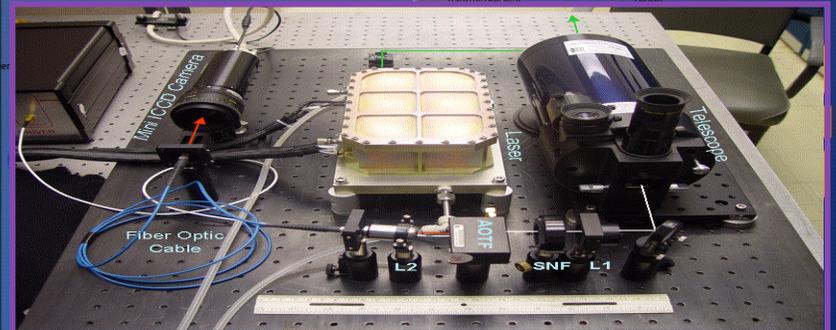
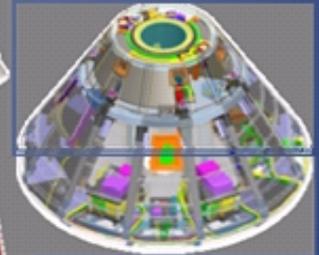
GN&C



Flight Dynamics



Mechanical Design



Electro-optics

# Recent Langley Exploration Developments



MISSE



Landing System Drop Tests



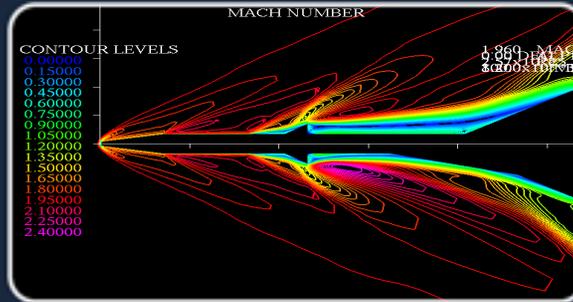
Lunar Architecture & Concepts



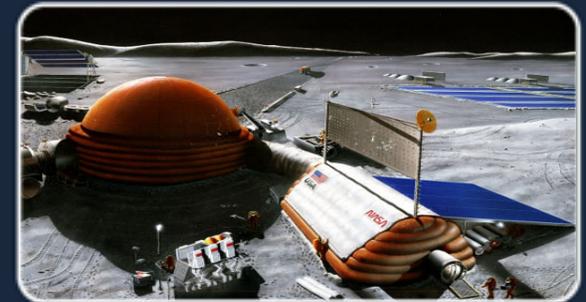
Flight Test Articles



Ares I Aero Characterization



Habitat Structures & Materials



Launch Abort System



Entry, Descent & Landing Systems



Mars Architecture



# Recent Langley Aviation Projects



Hypersonics



Integrated Vehicle Health Management

Supersonics



Integrated Intelligent Flight Deck

Subsonic Fixed-Wing



Aircraft Aging and Durability

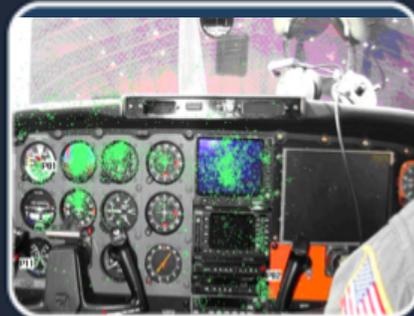
Rotary-Wing



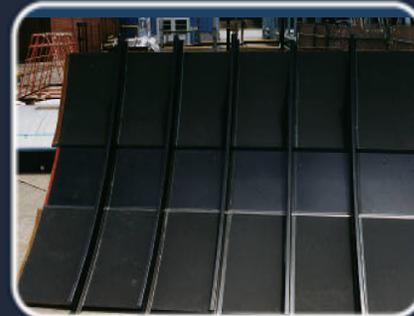
Integrated Resilient Aircraft Control



Environmentally Responsible Aviation



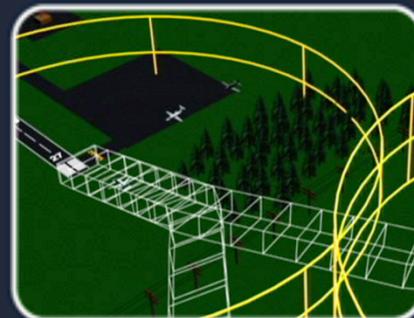
Systems Analysis, Integration and Evaluation



Concepts and Technology Development



Test Facilities



# Complex Atmospheric Flight Vehicle Development

ARES 1-X



MLAS



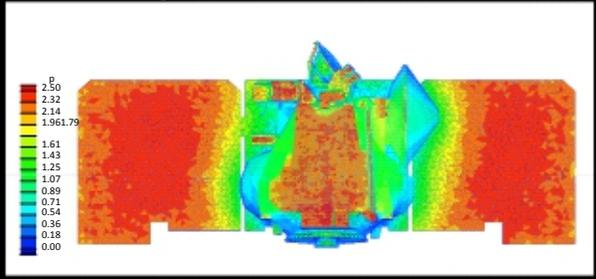
IRVE



Orion LAS



# Langley Leverages the Synergy Between Experience, Predictive Methods, and Test Facilities



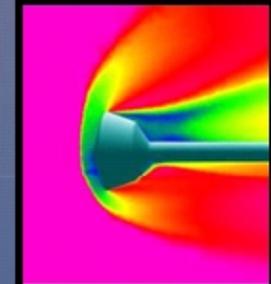
Transitional Rarefied DSMC, Odyssey, MRO, MER, MSL



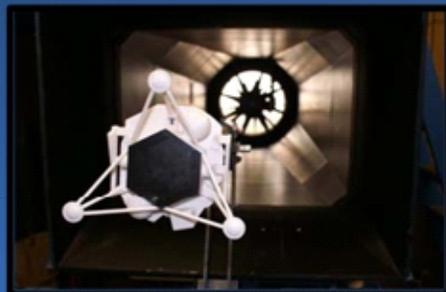
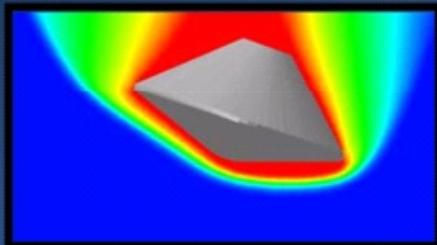
Parachute Aero Testing, MER



Supersonic Wind Tunnel Testing & CFD, MSL



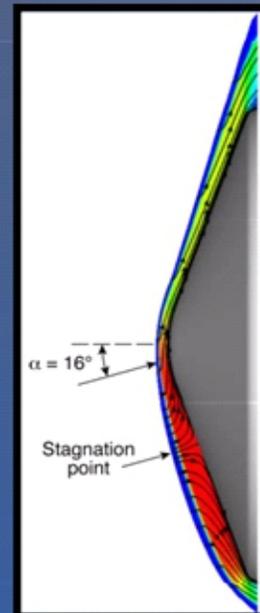
MSL CFD: Laminar vs. Turbulent Heat Rates



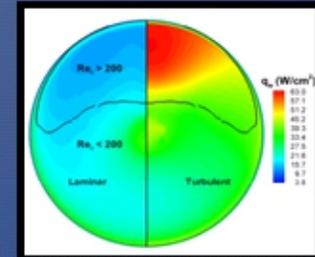
Terminal Descent, Phoenix



Supersonic Decelerator Technology Wind Tunnel Testing



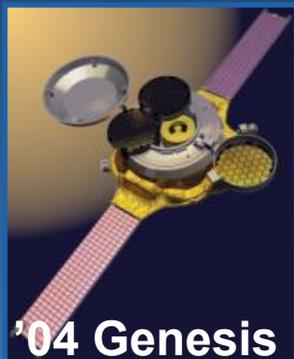
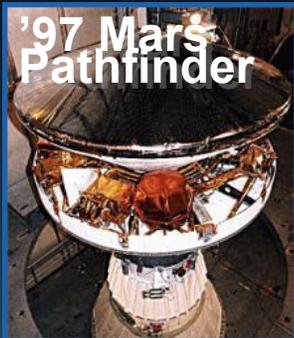
Hypersonic Mars Flight CFD, MSL



# Langley Delivers for Planetary Missions: Past, Present & Future



## Missions



### Technology Advancement, Systems Analysis, Concept Development Through Flight Operations

**Aero / Aeroheating**

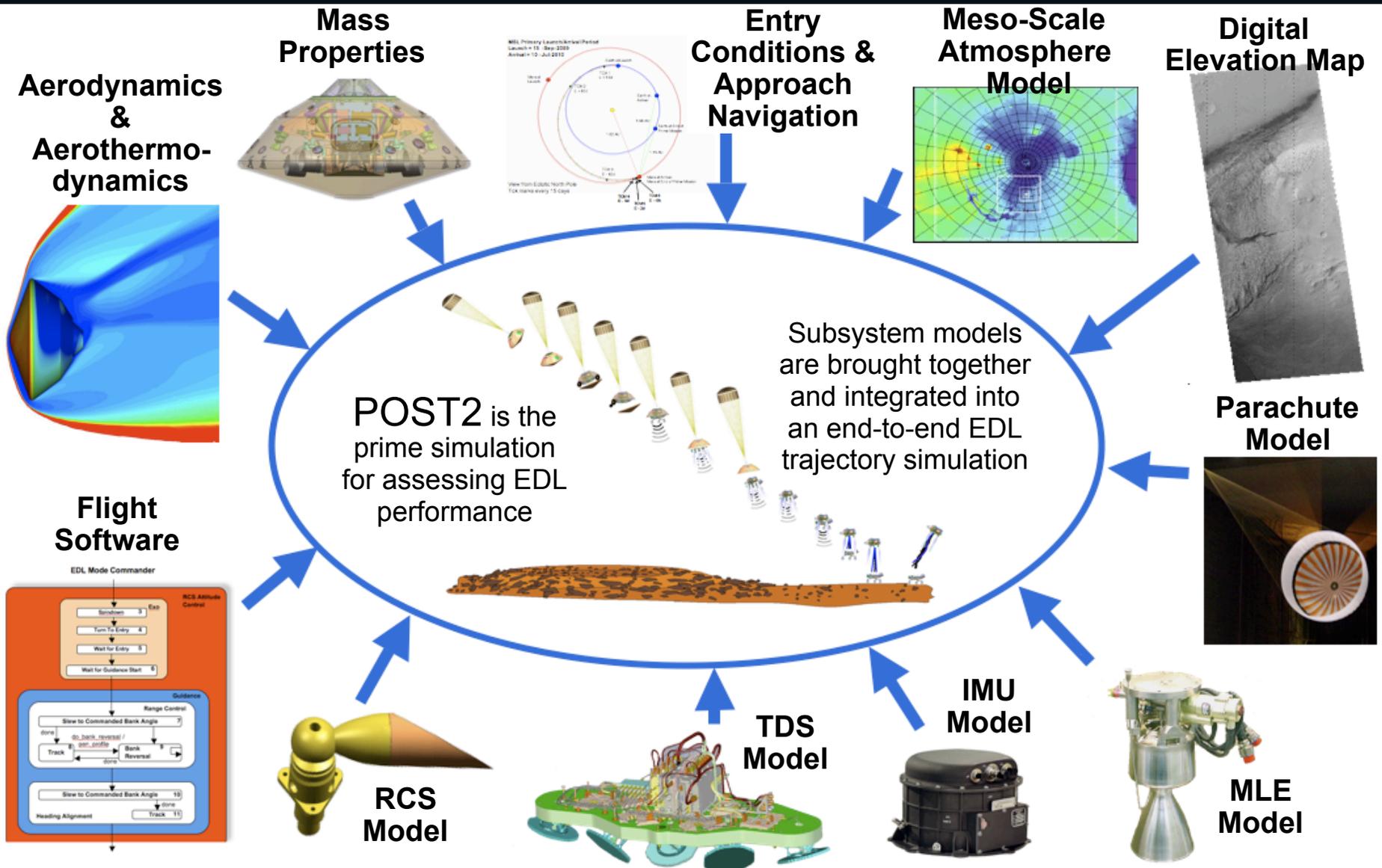
**Flight Mechanics**

**Aerocapture  
Systems Analysis**

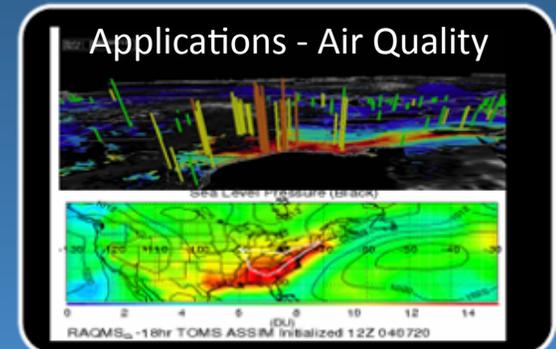
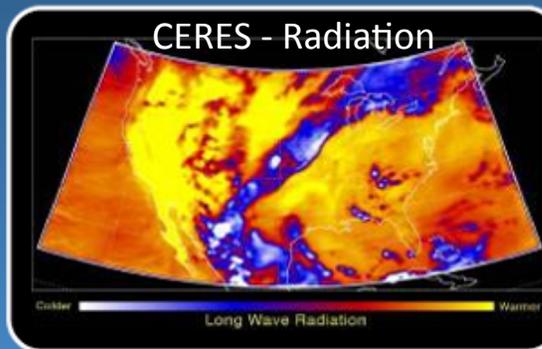
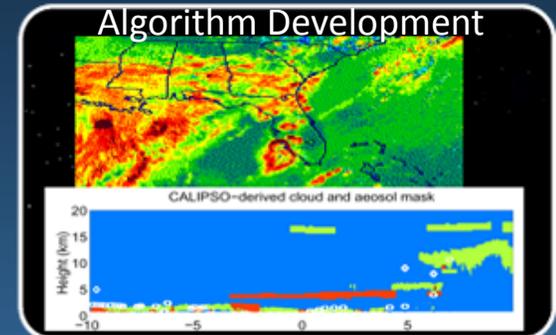
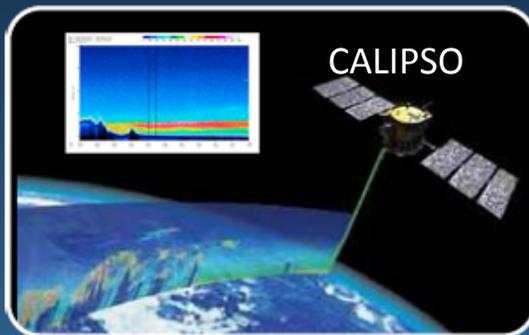
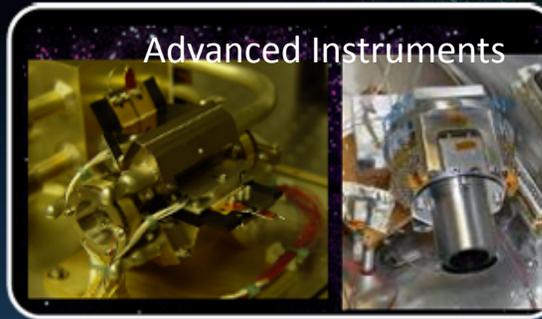
**Autonomous  
Aerobraking**



# Langley Integrates the MSL Atmospheric Flight System Simulation



# Langley Science Mission Contributions





# Flight Instruments & Systems



LDEF



MEEP



CERES



PASDE  
ON STS



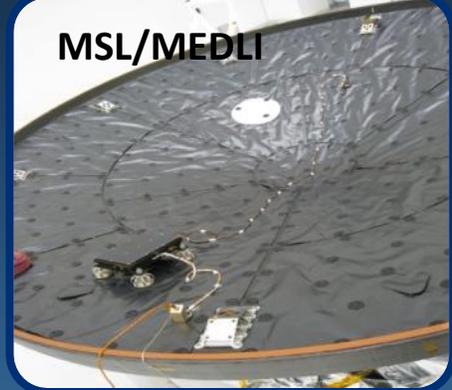
ACCESS



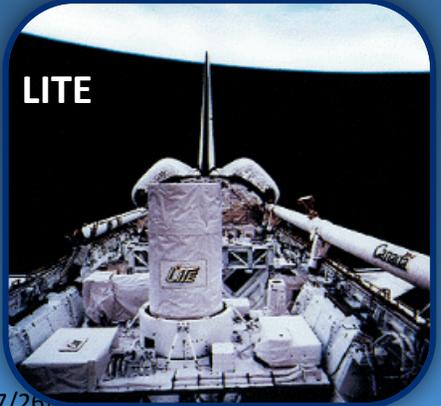
STORM



SAGE III



MSL/MEDLI



LITE



MISSE



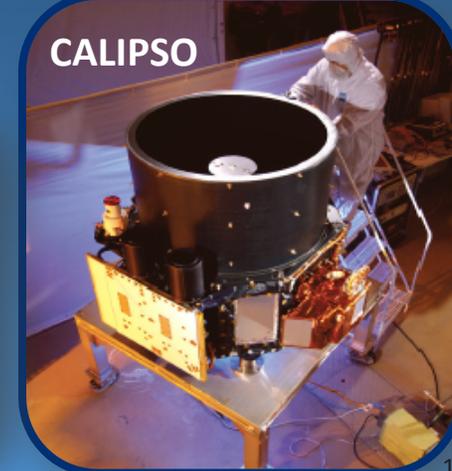
X-43



IR Camera



CETA

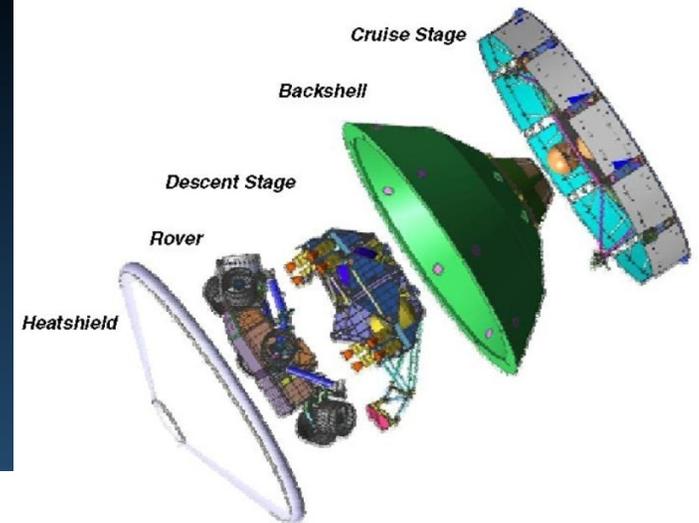


CALIPSO

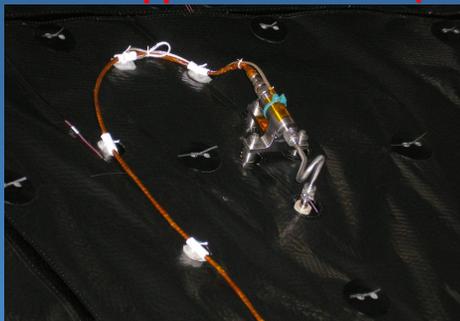
# MSL Entry Descent and Landing Instrumentation (MEDLI)



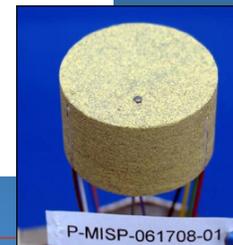
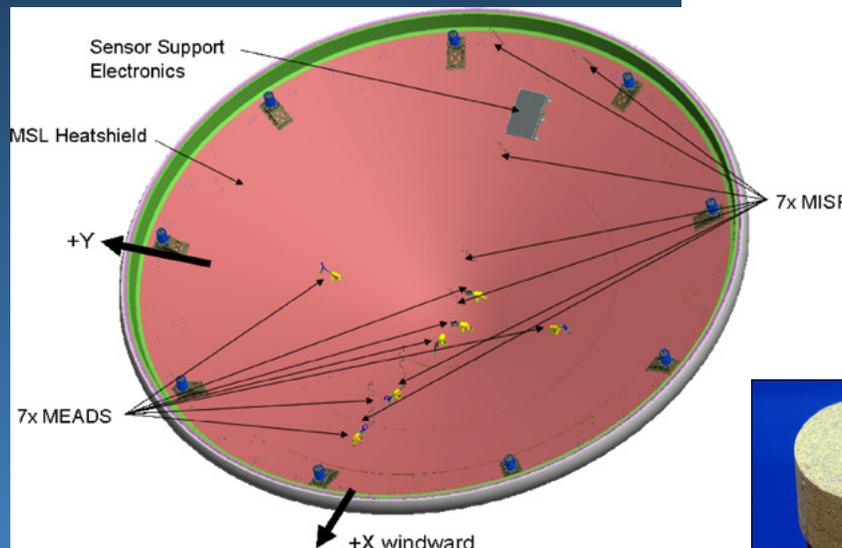
- MEDLI consists of 7 MEADS pressure ports, 7 MISP integrated sensor plugs, and support electronics.
- Will gather higher resolution entry and descent landing than all previous mission combined to help design future Mars missions:
  - Aerothermal, aerodynamic, and thermal protection system (TPS) performance
  - Atmospheric density and winds



Sensor Support Electronics (SSE)



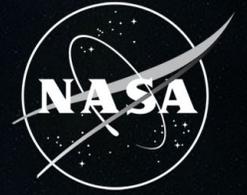
Mars Entry Atmospheric Data System (MEADS)



MEDLI Instrumented Sensor Plug (MISP)

A LaRC, ARC, JPL and Lockheed partnership, funded by ESMD, ARMD, and hosted on an SMD mission.

National Aeronautics and Space Administration



# *Engineering Atmospheric Flight Systems from Concept to Flight*

A photograph of a white sign with a red roof, set against a backdrop of a cloudy sky and a dark landscape. The sign features the NASA logo and the text "NATIONAL AERONAUTICS SPACE ADMINISTRATION LANGLEY RESEARCH CENTER".

NATIONAL AERONAUTICS  
SPACE ADMINISTRATION  
LANGLEY RESEARCH CENTER

# Advanced Concepts for EDL Technologies



## Landing System Technologies and Concepts



Air Bags  
(Vented and  
Anti-bottoming  
Bags)



Deployed  
Crushable Energy  
Absorbers



Landing  
Gear and  
Legs



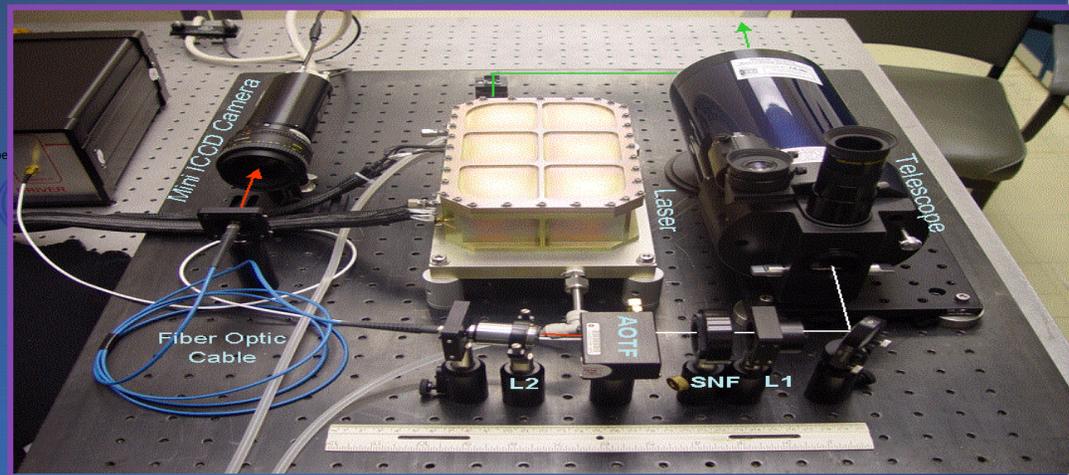
Propulsive  
Systems  
(Retro Rockets)



Hybrid  
Concepts



IRVE II



ALHAT Doppler Lidar System

5/26/2010

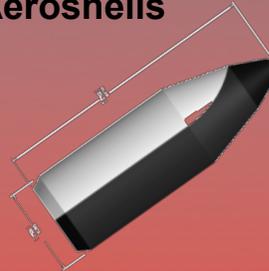
Langley Engineering Overview

# Decelerators and Landing System Technologies

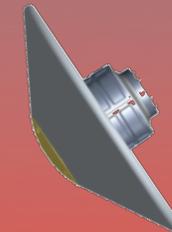
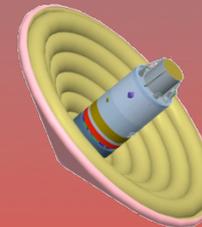


## Hypersonic

### Rigid mid L/D Aeroshells

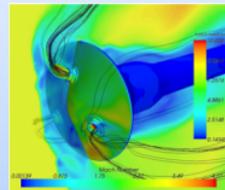


### Inflatable / Deployable Aeroshells

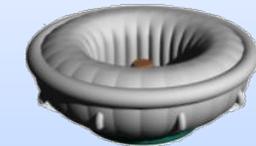


## Supersonic

### Supersonic Retro-propulsion



### Inflatable / Deployable Decelerators



## Subsonic / Terminal Descent

### Landing System Technologies and Concepts



**Air Bags**  
(Vented and Anti-bottoming Bags)



**Deployed Crushable Energy Absorbers**



**Landing Gear and Legs**



**Propulsive Systems (Retro Rockets)**



**Hybrid Concepts**

*IAD concepts are part of integrated EDL system architectures optimized for specific mission requirements.*

# Langley's deep aeronautics and atmospheric expertise delivers complex flight systems on time

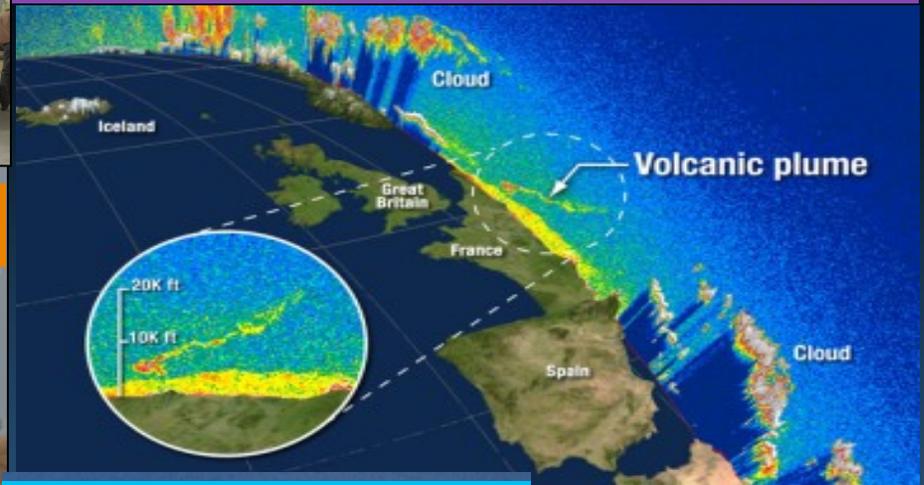


Ares 1-X



IRVE

CALIPSO



X-43A



Orion Pad Abort



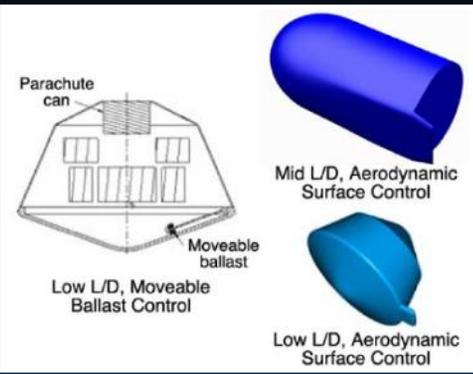
PHOENIX



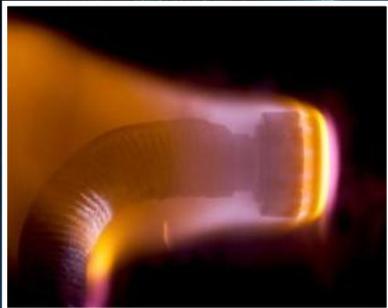
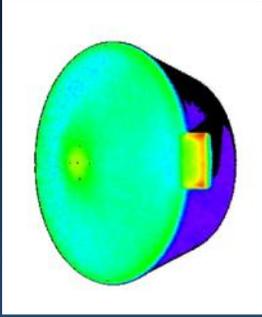
MLAS



# EDL System Technologies



**Aerothermodynamics:**  
Aerocapture, Earth return, EDL



**TPS:**

Aerocapture, Earth return, EDL



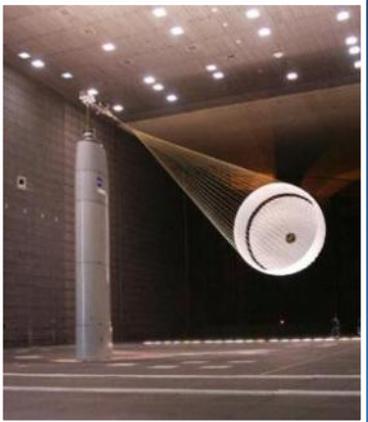
**Auto. Landing and Hazard**

**Avoidance Tech.**

EDL (safe landing)

**Angle of Attack Control:**  
Aerocapture, EDL (pinpoint)

**Inflatables:**  
Aerocapture, EDL (mass, pinpoint)

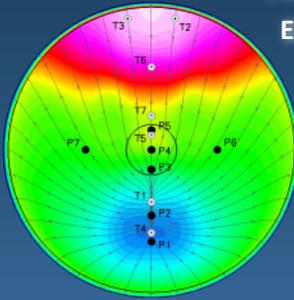


**High Mach Parachutes:**

EDL (mass, pinpoint)

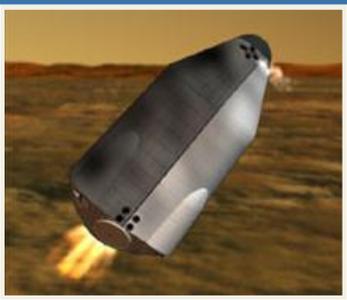
**Steerable Parachutes:**

EDL (pinpoint)



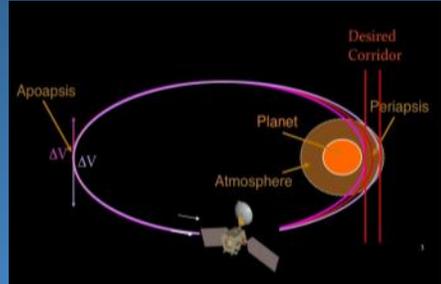
**Instrumentation:**

MEDLI, every entry vehicle



**Supersonic Retropropulsion:**

EDL (mass, pinpoint)



**Technology Demonstration:**

Autonomous Aerobraking