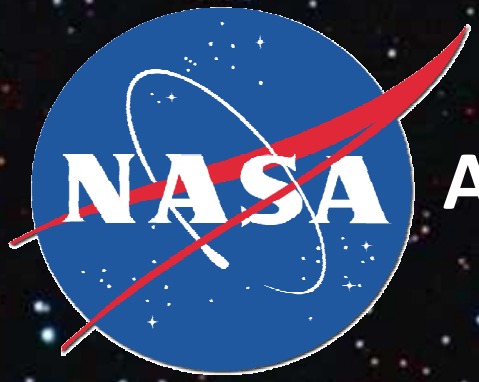


Aeronautics and Space Exploration Challenges

Dr. Damodar R. Ambur, Director
Ground Facilities and Testing Directorate

Presented at the University of Texas Arlington
August 27, 2010

Themes of the President's FY11 NASA Budget Request

- **Top-line increase of $6B over 5 years** -- National investment in NASA is $100B over 5 yrs
- **Increase for Science ($2.5B over 5 years)** -- Largely focused in Earth science
- **Reverse past decline and provide modest increase for Aeronautics (~15% or $75M/yr)**
- **Shift in approach for Human Exploration program. The goal remains the same.**
  - Additional $600M to complete 5 remaining Shuttle flights (3 as of today)
  - Extension of ISS to at least 2020
  - Commercial approach to LEO access ($6B over 5 years)
  - Modernization of the KSC launch complex ($2B over 5 years)
  - Flexible Path strategy to extend human presence beyond LEO
  - Restructure of Constellation Program; Modified Orion development continues
- **Significant focus on Technology Development to reposition NASA on the cutting-edge**
  - Central principle of new Human Exploration strategy
  - New DARPA-like Space Technology Program ($5B over 5 years)
- **Increased emphasis on partnerships and STEM education**
  - Other government agencies, academia, industry and international

NASA Aeronautics Research Mission Directorate

NASA has restructured its aeronautics programs, returning to long-term investment in cutting-edge fundamental research in traditional aeronautics disciplines. Three key principles guide this new focus:

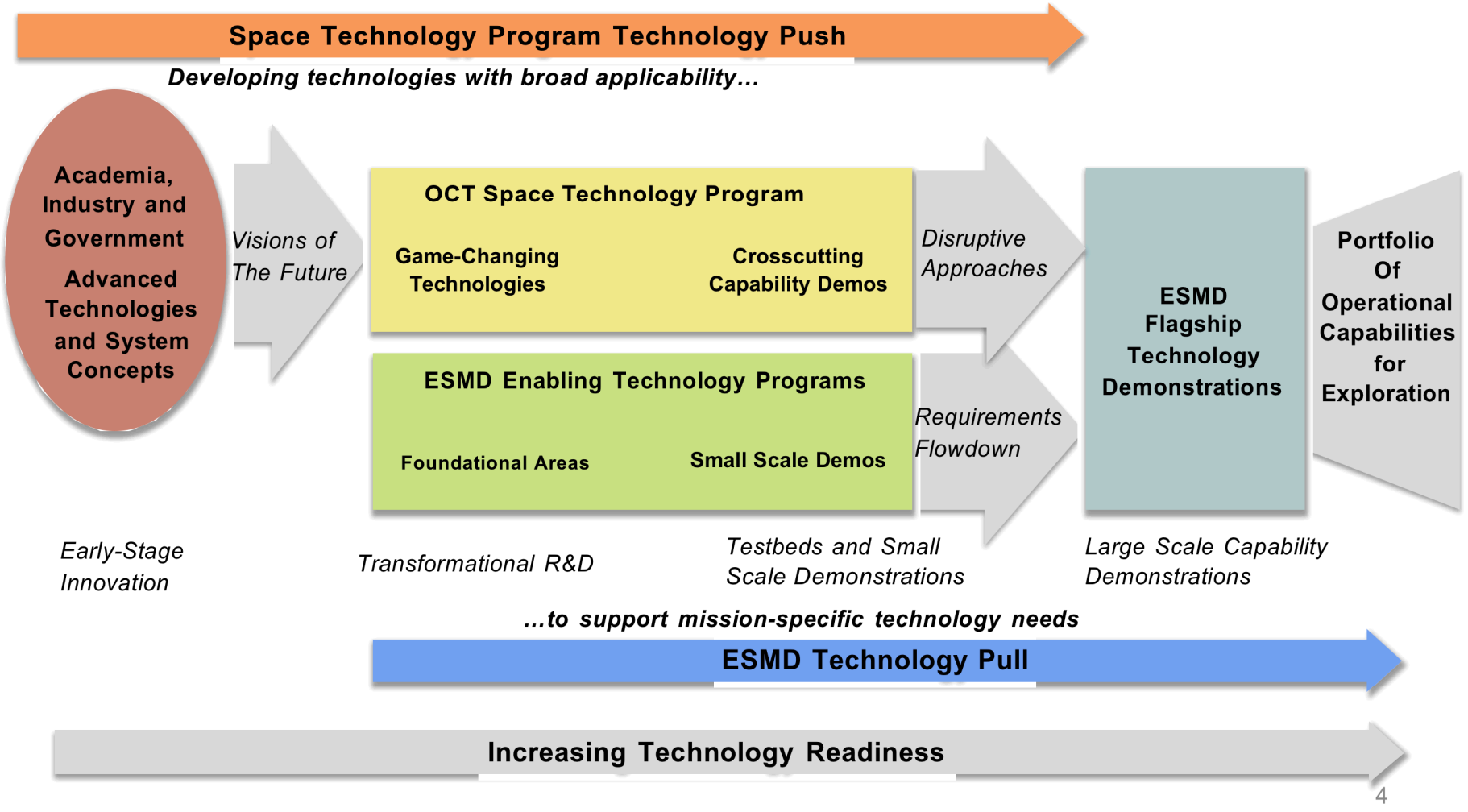
- **We will dedicate ourselves to the mastery and intellectual stewardship of the core competencies of aeronautics for the Nation in all flight regimes.**
- **We will focus our research in areas that are appropriate to NASA's unique capabilities.**
- **We will directly address the fundamental research needs of the Next Generation Air Transportation System (NextGen) in partnership with the member agencies of the Joint Planning and Development Office (JPDO).**

ARMD Programs

+ Fundamental Aeronautics Program
+ Airspace Systems Program
+ Aviation Safety Program
+ Aeronautics Test Program
+ Integrated Systems Research Program

NASA's Integrated Technology Programs

- A portfolio of technology investments which will enable new approaches to NASA's current mission set and allow the Agency to pursue entirely new missions of exploration and discovery.



The New Path for Human Space Exploration

- **The renewed emphasis on technology in the President's FY11 budget request balances the long-standing NASA core competencies of R&T, spaceflight hardware development, and mission operations.**
- **Funding is provided for critical enabling human exploration including:**
  - Technology development and demonstrations to reduce cost and prove required capabilities for future human exploration
  - Research & development of heavy-lift and propulsion engines and other key developments
  - Exploration precursor robotic missions to multiple destinations to cost-effectively scout human exploration targets and identify hazards and resources for future human exploration
  - Increased investment in Human Research utilizing ISS to prepare for long journeys beyond Earth
  - Expanded efforts to develop U.S. commercial human spaceflight capabilities, making space travel more accessible and affordable
- **Technology investment strategy: Needed capabilities are identified, multiple competing approaches to provide that capability are funded, and the most viable of these are demonstrated in flight so that exploration architectures can then reliably depend upon them.**
- **The FY2011 budget will continue the development of the an Orion-derived vehicle that will serve as an emergency return vehicle from ISS, and will be part of the technological foundation for advanced spacecraft to be used in future deep space missions.**

Consistent Set of Exploration Capability Investments

	1969 Post-Apollo Space Program (NASA STG)	1986 Pioneering the Space Frontier (Fogleman)	1987 America's Future in Space (Ride)	1988 Beyond Earth's Boundaries (NASA)	1989 90 Day Study (NASA)	1990 Future of U.S. Space Program (Augustine)	1991 America at the Threshold, SEI (Stafford)	1997 Human Exploration of Mars DRM (NASA)	2004 Vision for Space Exploration (President's Commission on U.S.
Advanced/Closed Loop Life Support		X	X	X	X	X	X	X	X
Advanced Power Generation & Storage (in-space and surface, Solar and nuclear)	X	X	X	X	X	X	X	X	X
Advanced In-Space Propulsion (chemical, solar electric, nuclear thermal, nuclear electric)	X	X	X	X	X	X	X	X	X
In-Space Cryo/Propellant Transfer and Storage		X	X	X	X		X	X	X
Heavy Lift Launch Vehicle			X	X	X	X	X	X	X
Autonomous/Expert Systems		X	X			X		X	X
Robotics (tele-robotic & autonomous operation)		X	X		X	X	X	X	X
EDL (includes aerocapture, aerobraking, aeroentry)		X	X	X	X	X	X	X	X
Human Health and Performance (Radiation, gravity, psychological effects and mitigation, medical technologies)	X	X	X		X	X	X	X	X
Autonomous Rendezvous and Docking				X	X		X		X
In-Situ Resource Utilization (Lunar, NEO, and Mars based)		X	X	X	X	X	X	X	X
Lightweight Structures and Materials		X					X	X	X
Advanced In-Space Engine					X	X	X		X
Advanced EVA Systems		X		X	X	X	X	X	X
Communication Technology	X				X	X	X		X
Reliable Efficient Low Cost Advanced Access to Space	X		X						
Reusable In-Space Transfer	X	X	X		X	X			
Surface Rovers				X			X	X	

Phased Development Strategy

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Phase I

Build the Foundation

Commercial Sector, Robotic Precursors, and Game Changing Technology Developments

Phase II

Systems Development

Design and Development of Heavy Lift and In-Space Capabilities

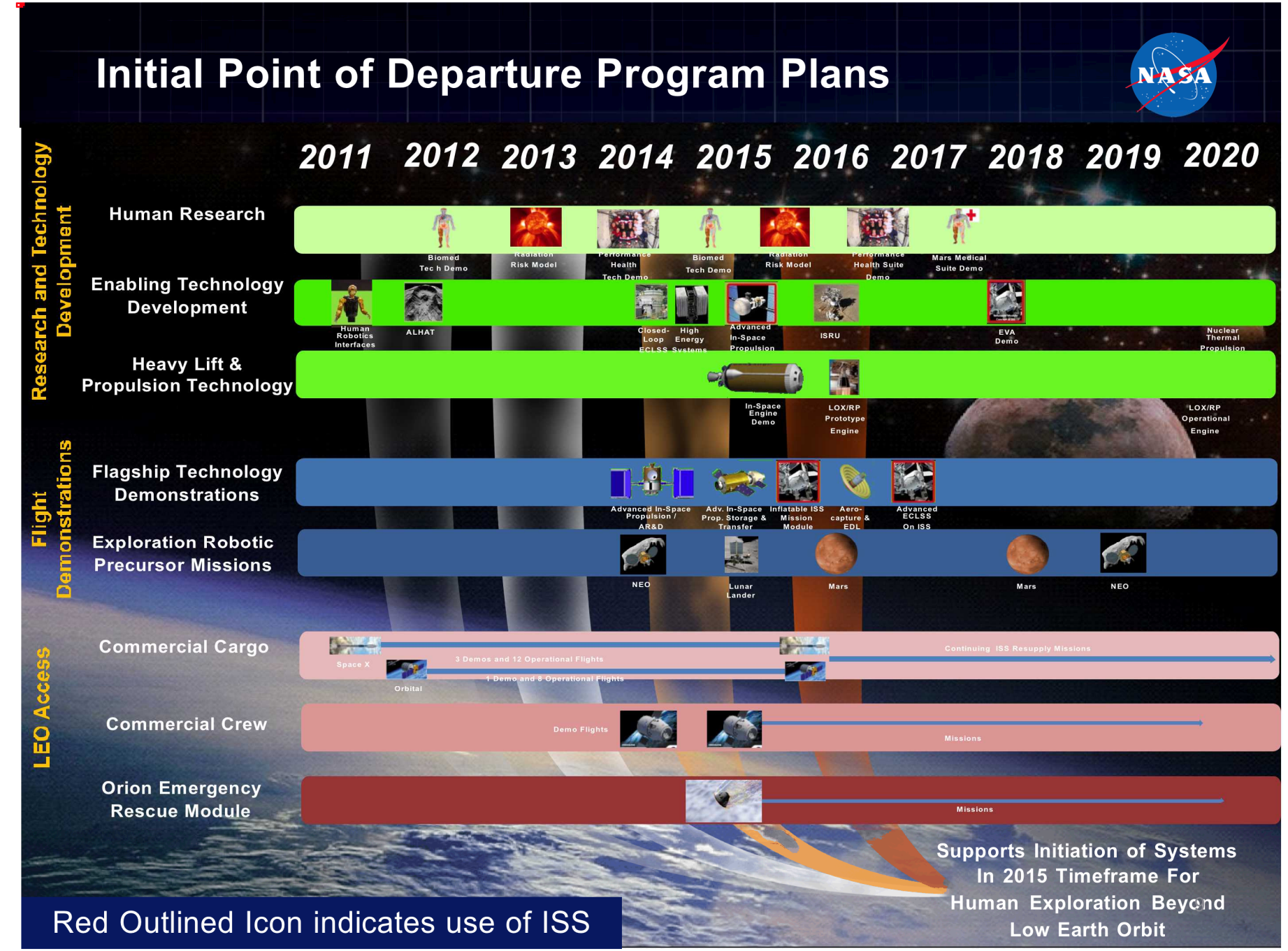
Phase III

Sustainable Exploration of the Solar System



Human Exploration Missions to Solar System Destinations

Initial Point of Departure Program Plans



Divisions & Programs

1) **Early-Stage Innovation**: Creative ideas regarding future NASA systems and/or solutions to national needs.
   - NIAC2
   - Space Technology Research Grants (includes Fellowship program)
   - SBIR/STTR
   - Centennial Challenges
   - Center Innovation Fund

2) **Game Changing Technology**: Prove feasibility of novel, early-stage idea that has potential to revolutionize a future NASA mission and/or fulfill national need.
   - Game Changing Development
   - Small Satellite Subsystem Technology

3) **Crosscutting Capability Demonstration:** Maturation to flight readiness of cross-cutting capabilities that advance multiple future space missions, including flight test projects where in-space demonstration is needed before the capability can transition to direct mission application.
   - Technology Demonstrations Missions
   - Edison Small Satellite Demonstration Missions
   - Flight Opportunities

Potential Grand Challenges

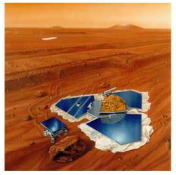

Make space access economical


Provide economical energy on demand


Develop routine satellite servicing


Forecast natural disasters

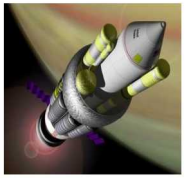

Manage climate change


Provide participatory exploration


Improve spacecraft safety and reliability


Provide carbon-neutral mobility


Protect astronaut health

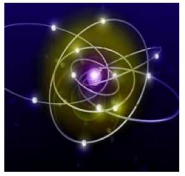

Engineer faster space vehicles


Unleash machine intelligence


Utilize space resources to explore


Prevent orbital debris

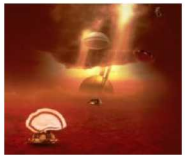

Secure the planet from space threats


Understand physics governing the universe


Establish conditions for permanent humans in space


Develop personalized STEM learning


Engineer the tools of scientific discovery


Discover life beyond earth

NASA Langley Research Center

The Langley Research Center (LaRC) pioneers the future in space exploration, scientific discovery, and aeronautics through research and development of technology, scientific instruments and investigations, and exploration systems.



NASA Langley Research Center Organization

Agency Functions



NASA Engineering & Safety Center (C1)
Ralph R Roe Jr



Independent Program Assessment Office (AH)
James N Ortiz



Science Office for Mission Assessments (A1)
Raleigh B Perry Jr

Director's Office



Director (A)
Lesa B Roe



Deputy Director (A)
Stephen G Jurczyk



Assoc. Director (A)
Cynthia C Lee

Agency Programs



Exploration Technology Dev. Program Office (A4)
Frank Peri Jr



Earth System Science Pathfinder Program Office (A5)
Edward C Grigsby

Mission



Aeronautics Research (E1)
Vicki K Crisp



Science (E3)
Lelia B Vann



Exploration and Space Operations (E5)
David E Bowles



Flight Projects (E6)
Luat T Nguyen



Strategic Relationships (H1)
Richard R Antcliff



Ground Facilities and Testing (D5)
Damodar R Ambur



Research Services (D1)
Howard J Lewis Jr



Engineering (pending) (D2)
Stephen P Sandford



Systems Analysis and Concepts (E4)
Ajay Kumar



Research (pending) (D3)
Charles E Harris



Center Operations (D4)
George B Finelli

Mission Support



Safety & Mission Assurance (C2)
Grant M Watson



Systems Management (C4)
Preston I Carraway III



Office of Procurement (B1)
Virginia C Wycoff



Chief Counsel (B2)
Michael Nick Madrid



Equal Opportunity (B3)
Janet E Sellars



Human Capital Management (B4)
David Alan Ledoux



Chief Financial Officer (B6)
Kenneth J Winter



Chief Information Officer (B7)
Cathy H Mangum

GFTD Wind Tunnel Test Capabilities



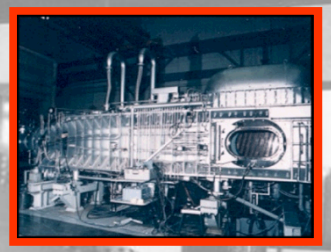
14- x 22-Ft Subsonic Tunnel
Subsonic, Alternate Uses



National Transonic Facility
High Reynolds Number Flow



LaRC Unitary Plan Wind Tunnel
Supersonic Speed Range



Aerothermodynamic Laboratory Complex
Exploration Workhorse

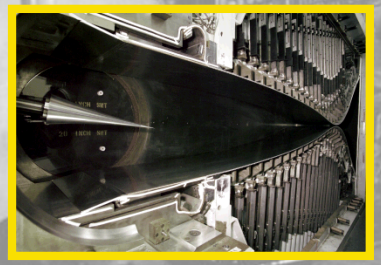
Subsonic **Transonic** **Supersonic** **Hypersonic**



20-Ft Vertical Spin Tunnel



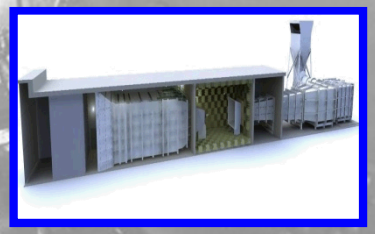
Transonic Dynamics Tunnel
Aeroelasticity & Flutter



20-In Supersonic Wind Tunnel



SCRAMJET Complex
Hypersonic Propulsion



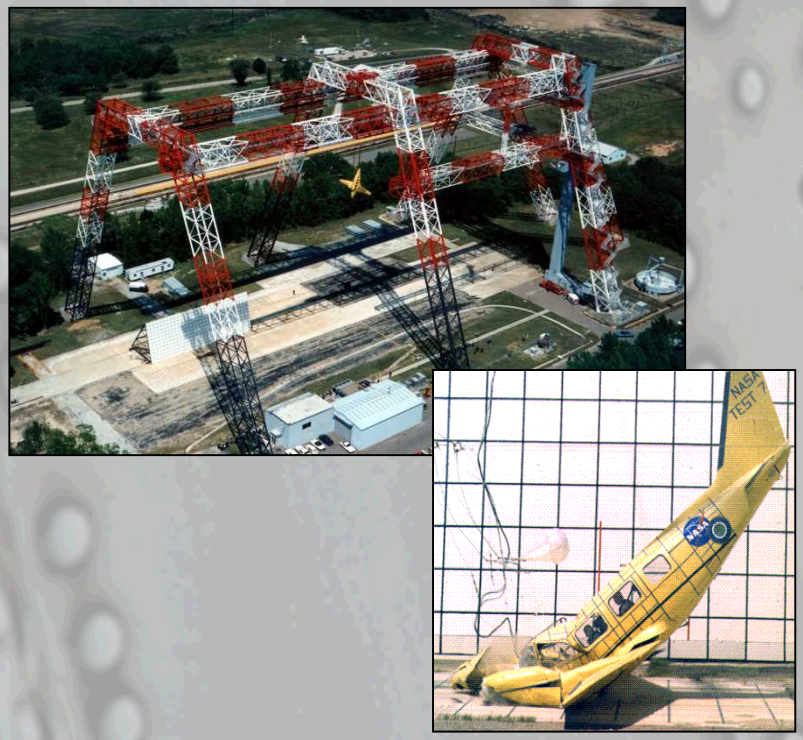
Low-Speed Aeroacoustic Wind Tunnel
Simulation of Jet Exhaust in Flight

National Assets needed to meet the needs of the NASA, DoD and Industry



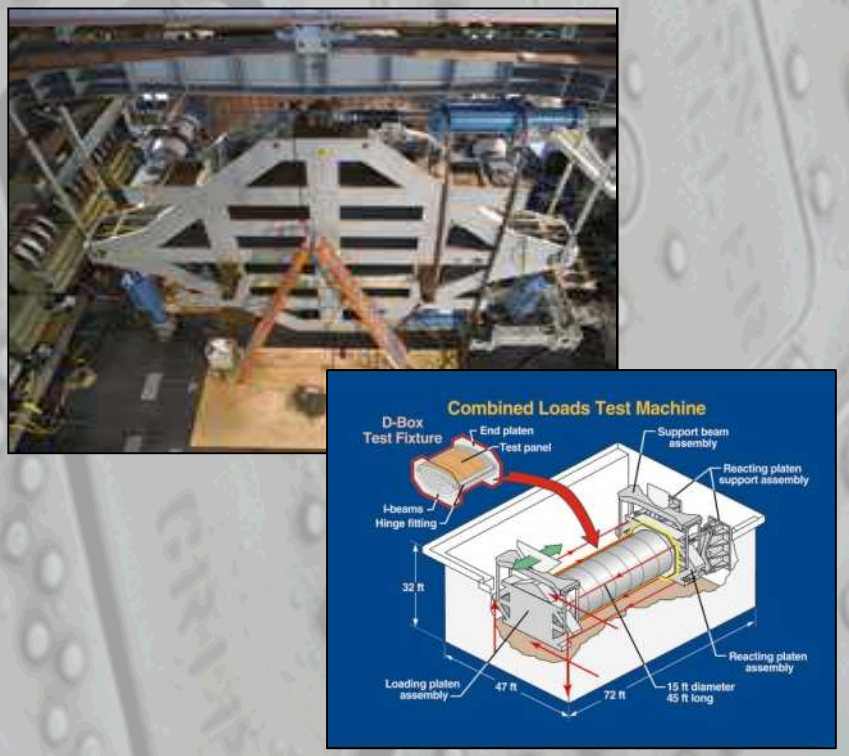
8-Ft High Temperature Tunnel
Large-scale Hypersonics & Propulsion

GFTD Structural Test Capabilities



Landing and Impact Research Facility (LandIR)

All aspects of research and development concerning structural impact dynamics



Combined Loads Test System (CoLTS)

Combined axial, shear, internal pressure, and thermal loading on full-scale curved panels and structures

Recent Technical Accomplishments

Subsonic and Transonic

NTF

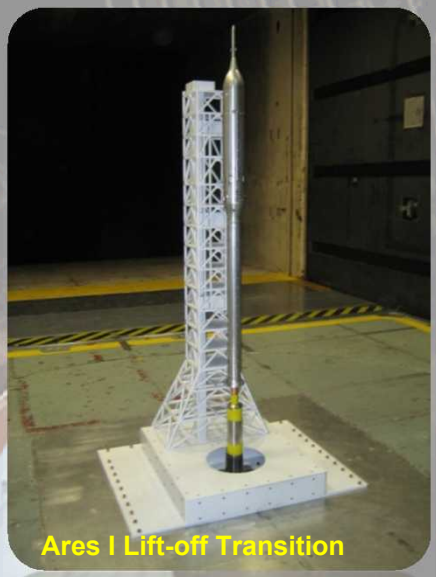


Natural Laminar Flow Wing


UCAV Forced Oscillation

14 x 22


Silorsky H-53 Inlet Distortion Test


Ares I Lift-off Transition



Orion Launch Abort Vehicle


Boeing CESTOL


AEI Joined Wing

TDT


Ares I-X Ground Winds Loads

Recent Technical Accomplishments

Supersonic and Hypersonic

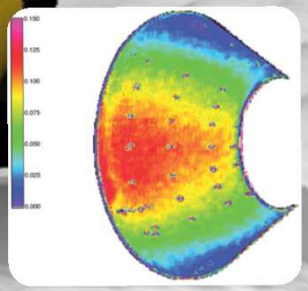


Ares I Performance Test

31” M10



Orion Aeroheating Test

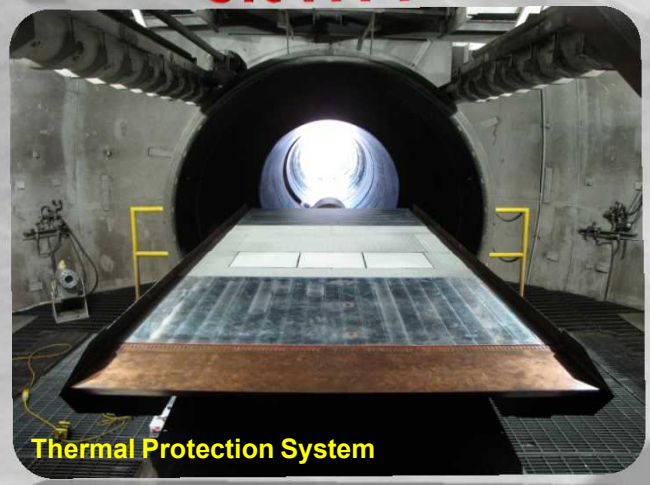


UPWT



Sonic Boom Wedge and Conical Probe Validation

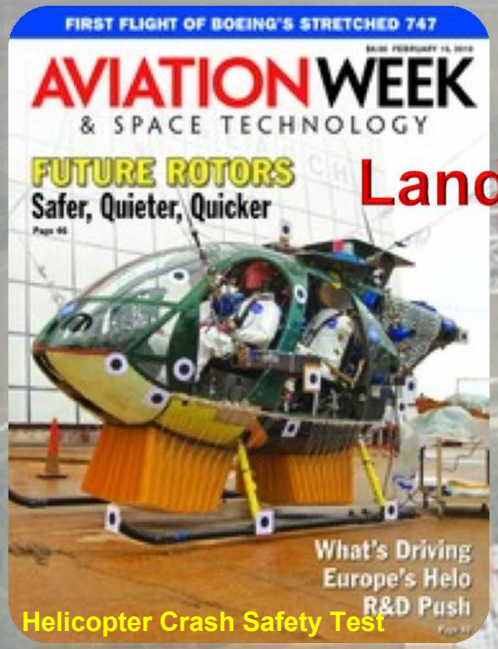
8ft HTT



Thermal Protection System

Recent Technical Accomplishments

Structures



LandIR

Helicopter Crash Safety Test



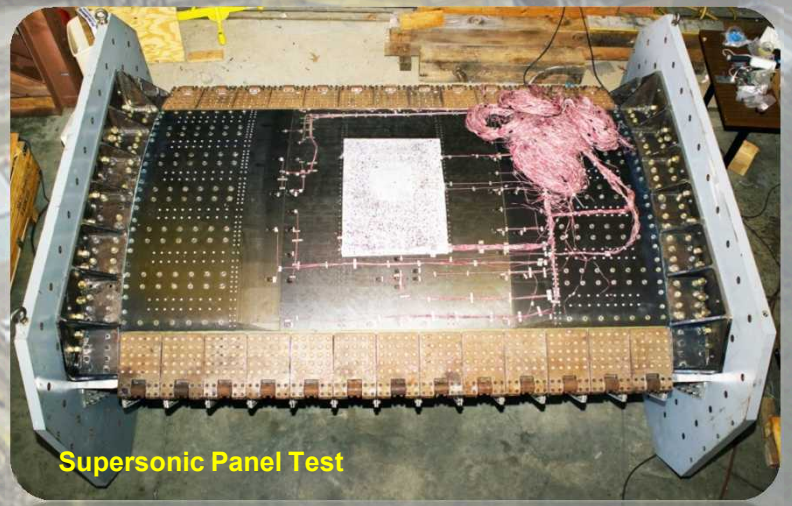
Composite Crew Module

MTTF



Skid Test

CoLTS



Supersonic Panel Test

Summary

- **NASA is investing in technology development to rebalance R&T competencies, systems development, and mission operations**
- **In space exploration, the grand challenges must be addressed through innovative high-risk and high-payoff technology development efforts to accomplish our mission goals**
- **A competitive process is planned to be used for technology development to harness the best ideas across the nation for early change innovation, game changing technologies, and cross-cutting capability demonstrations**
- **Langley Research Center's core competencies in systems analysis, aerosciences, structures and materials, entry descent and landing, and sensors and instrumentation are valuable to the aeronautics, space exploration, and science missions.**