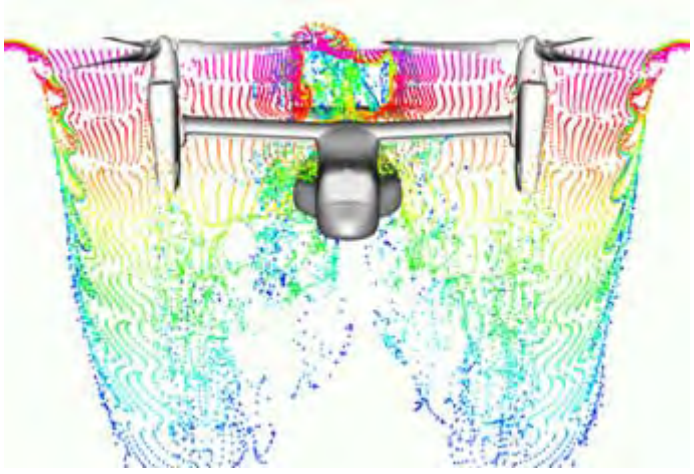
Welcome and Program Highlights

Fundamental Aeronautics 2007 Annual Meeting

Hilton New Orleans Riverside

New Orleans, LA

October 30, 2007



Fundamental Aeronautics 2007 Annual Meeting

- 3-day meeting to communicate details of work pursued by the FA program
- Plenary session during the morning of the first day
- 4 parallel technical sessions including:
  - SFW: Noise, emissions, airframe and propulsion performance
  - SRW: Structures & Materials, Aeromechanics, Propulsion, Flight Dynamics & Control, Acoustics
  - Sup: Cruise efficiency, lightweight durable airframes and engines, sonic boom and airport noise
  - Hyp: Aerothermodynamics, GN&C, Entry Descent & Landing, Propulsion, Exp Cap, Materials & Structures, MDO
- One student paper session (Tue afternoon)
- 2 Plenary talks: Aircraft Environmental Policy (C. Burleson, FAA) and History of Hypersonics (R. Hallion, Smithsonian Institution)
- Feedback sessions
- For more information visit: http://www.aeronautics.nasa.gov

NASA's Aeronautics Program

Dr. Lisa J. Porter
Associate Administrator for Aeronautics

October 30, 2007

ARMD Mission and Principles

The Overarching Mission of NASA's Aeronautics Research Mission Directorate (ARMD):

- To advance U.S. technological leadership in aeronautics in partnership with industry, academia, and other government agencies that conduct aeronautics-related research.
- ARMD supports the Agency's goal of developing a balanced overall program of science, exploration, and aeronautics, and ARMD's research plans also directly support the National Aeronautics R&D Policy and accompanying Executive Order 13419.

The Three Core Principles of ARMD:

- 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).

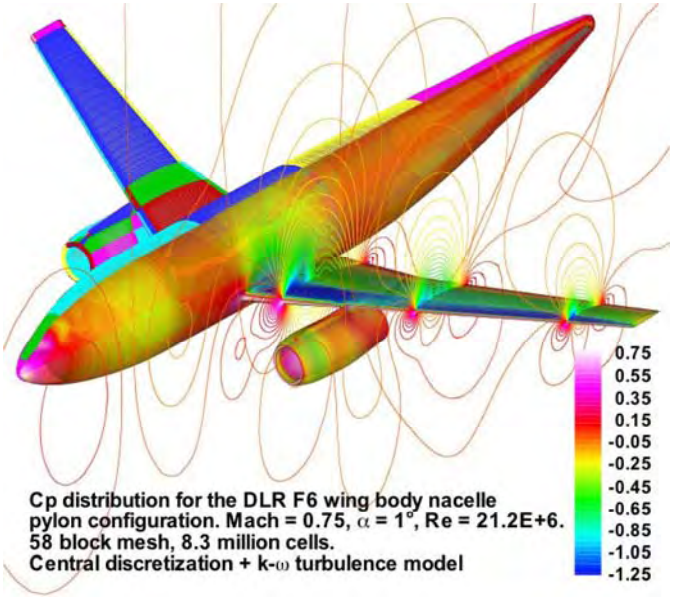
Aeronautics Programs

Fundamental Aeronautics Program

- Subsonic Fixed Wing
- Subsonic Rotary Wing
- Supersonics
- Hypersonics

Aviation Safety Program

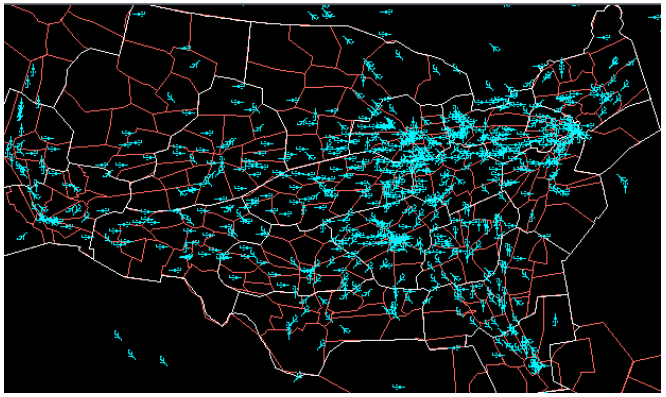
- Integrated Vehicle Health Management
- Integrated Resilient Aircraft Control
- Integrated Intelligent Flight Deck
- Aircraft Aging & Durability



Cp distribution for the DLR F6 wing body nacelle pylon configuration. Mach = 0.75, α = 1°, Re = 21.2E+6. 58 block mesh, 8.3 million cells. Central discretization + k-ω turbulence model

Airspace Systems Program

- NGATS Air Traffic Management: Airspace
- NGATS Air Traffic Management: Airportal



Aeronautics Test Program

- Ensure the strategic availability and accessibility of a critical suite of aeronautics test facilities that are deemed necessary to meet aeronautics, agency, and national needs.

Aviation Safety Program

- Cutting-edge research that will produce tools, methods, concepts, and technologies to improve the intrinsic safety attributes of current and future aircraft.
- Overcome safety barriers that could otherwise constrain the full realization of NextGen.
  - Safety challenges include increased air traffic density, increased reliance on automation, increased diversity of vehicles, and increased complexity in the system.
  - We also need to transition from a diagnostic to a prognostic approach to identifying system-wide safety issues.

Research Thrusts

Integrated Vehicle Health Management

Integrated Intelligent Flight Deck

Aircraft Aging & Durability

Integrated Resilient Aircraft Control

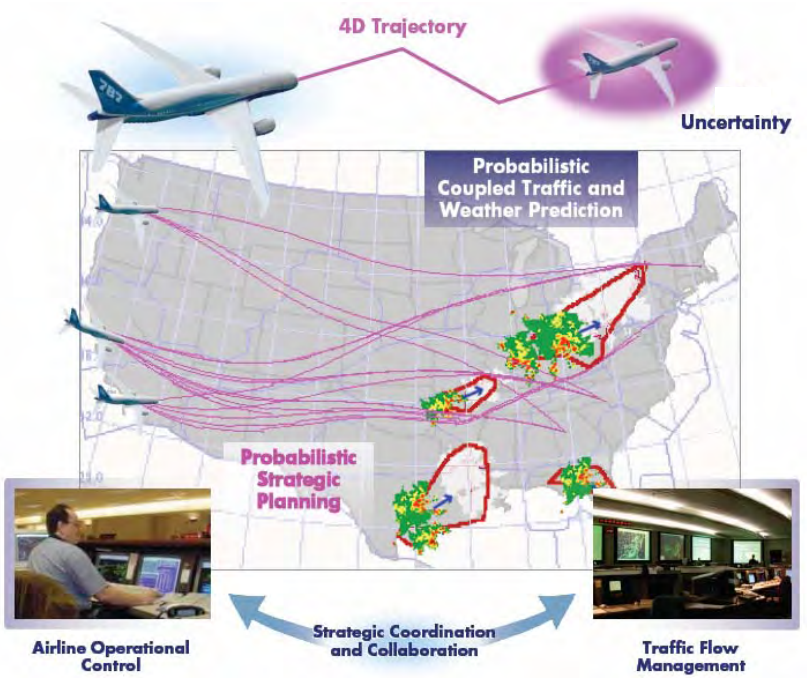
Airspace Systems Program

Program Objective

Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.

NGATS ATM: Airspace Project: Address demand/capacity imbalance problem in the most safe, equitable, and efficient manner, including the functional allocation of automation and humans to achieve substantial increases in airspace capacity.

NGATS ATM: Airportal Project: Address factors leading to an airportal where operators achieve maximum efficiency in the use of gates, taxiways, runways, and approach airspace while balancing requirements such as safety and environment.



- Both projects will conduct system-level design and analysis.
- Substantial leveraging of research across the two projects will occur.
- Results of the two projects will be integrated to ensure gate-to-gate solutions that are aligned with NextGen needs.

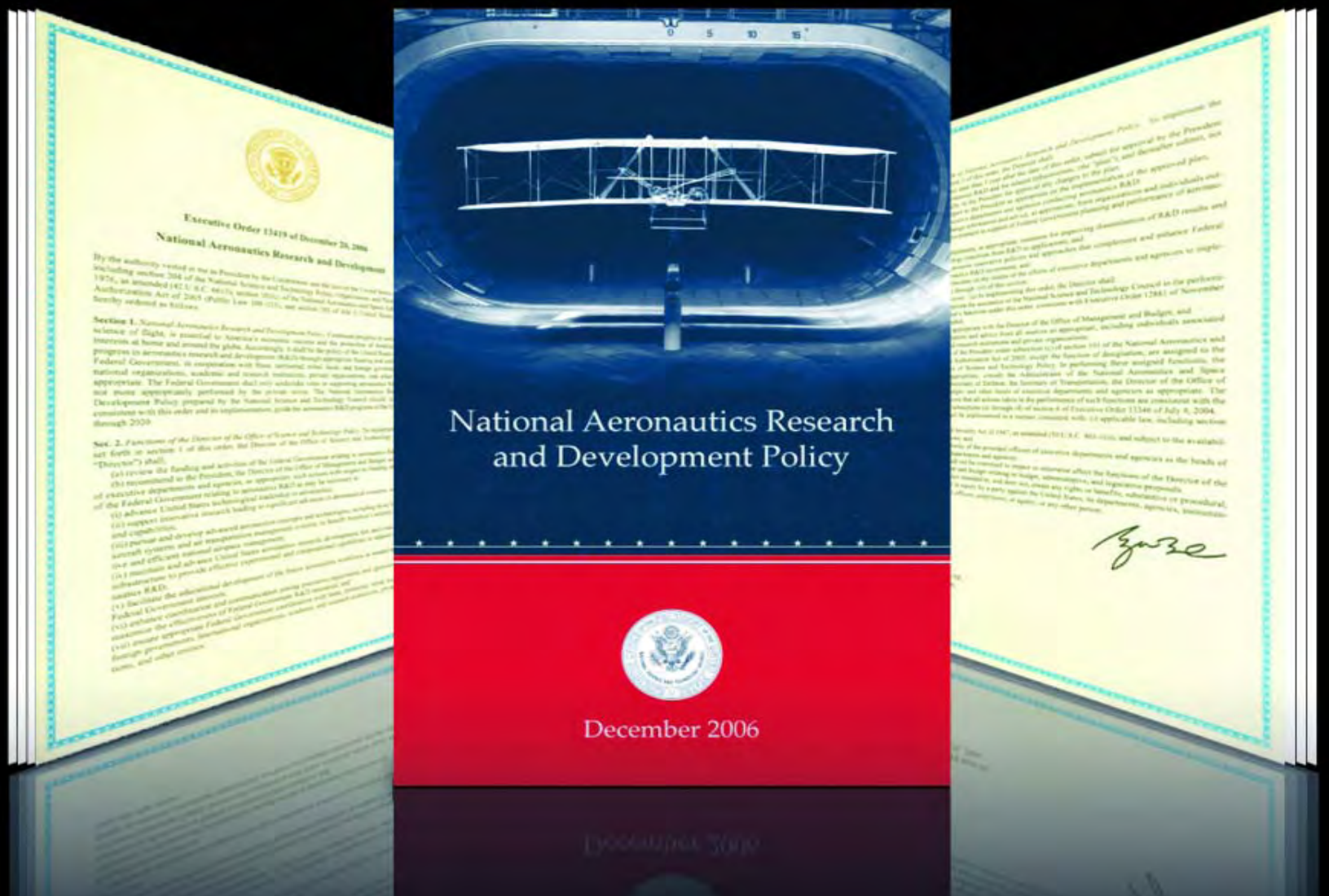
Aeronautics Test Program

- Ensure the strategic availability and accessibility of a critical suite of aeronautics test facilities that are deemed necessary to meet aeronautics, agency, and national needs.
- Includes 11 major ground test facilities at ARC, LaRC, and GRC, and Flight Operations and Test Infrastructure at DFRC.
- Operate facilities in most effective and efficient manner possible.
- Ensure intelligent investment in, and divestment of, facilities in line with strategic goals.
- Provide consistent cost accounting practices, pricing policies, and performance measurements.

- Pursue development of innovative test methods.
- Create a renewed partnership with DOD to improve coordination and cooperation.

ARC Unitary Wind Tunnel

F-15B Test-bed Aircraft With Supersonic Quiet Spike



Feedback on current draft due by Nov 7th

Executive Order, Policy, Draft, and Goals & Objectives all available on the web

For more information visit: http://www.ostp.gov/nstc/aeroplans

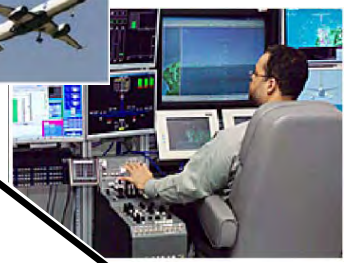
Aeronautics Programs

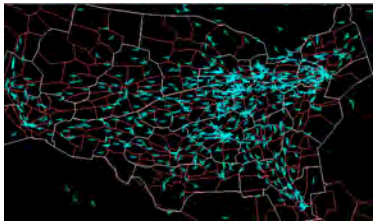
Fundamental Aeronautics Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to enable revolutionary changes for vehicles that fly in all speed regimes.

Aviation Safety Program

Conduct cutting-edge research that will produce innovative concepts, tools, and technologies to improve the intrinsic safety attributes of current and future aircraft.





Airspace Systems Program

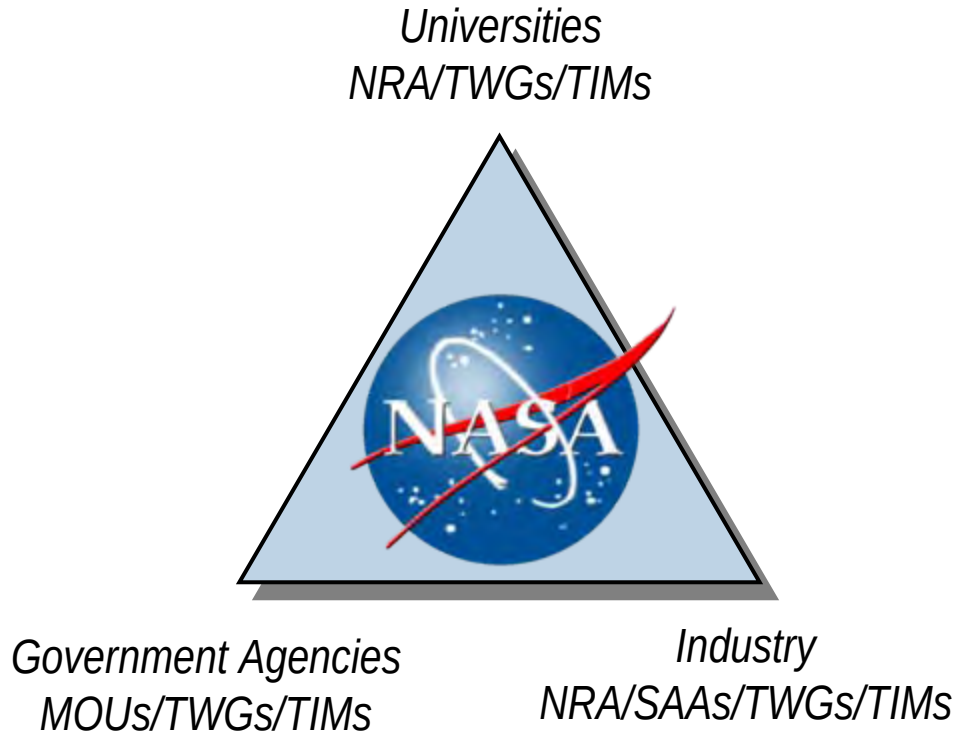
Directly address the fundamental ATM research needs for NextGen by developing revolutionary concepts, capabilities, and technologies that will enable significant increases in the capacity, efficiency and flexibility of the NAS.

Integration of Advanced Concepts and Vehicles into NextGen

- Goal of the Study: to research the issues associated with deploying new or advanced air vehicles within NextGen in order to:
  - Understand how advanced vehicles will operate within NextGen
  - Understand the tradeoffs involved for both vehicles and the ATM system, including safety considerations, system performance, environmental constraints, and other relevant issues
  - Indicate the most productive areas for future ATM, vehicle, and safety research
- NRA status:
  - Pre-proposal Conference held Aug 9, attended by over 120 people from 90 different organizations
  - Draft NRA released late August; Comments received from the community.
  - Final NRA released two weeks ago
  - Proposals due 11/28/2007

Partnering Philosophy

- Enhance the state of Aeronautics for the Nation
- Help foster a collaborative research environment in which ideas and knowledge are exchanged across all communities
- Maximize the return on investment to the taxpayer (our main stakeholder)
- Every element of our portfolio targets innovative, pre-competitive research that will advance our Nation's aeronautical expertise
- In accordance with NASA's Space Act (as amended) and the National Aeronautics R&D Policy, we will provide for the widest practical and appropriate dissemination of our research results (consistent with national security and foreign policy)



How to Find Out More About ARMD

Information about NASA's Aeronautics Research:

www.aeronautics.nasa.gov

- Overview of each Program
- Detailed Project plans with Schedule and Milestones
- NASA Research Announcement (NRA) information
    - Current solicitations
    - Award recipients
- ARMD Technical Seminars
- MOUs with other OGAs
- The National Aeronautics R&D Policy and NASA's Report to Congress in response to the Policy
- Educational information (design competitions, scholarships)
- Pictures and Videos of the X-48B
- Etc

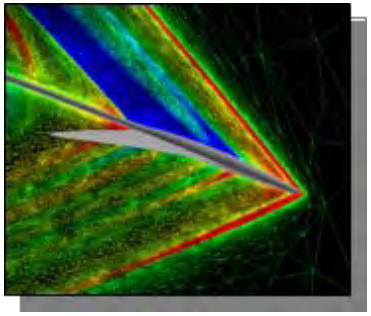
The ~~New~~ Fundamental Aeronautics Program

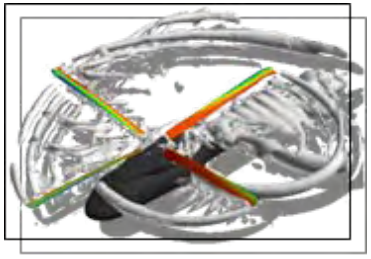
"Not-So-New"

- Fundamental Aeronautics has transformed from a *demonstration-based* program to one focused on *fundamental technology*
- Emphasis on *core-capability* in *discipline and multidiscipline technology* critical to sustaining the advancement of aeronautics
- Addressing main concerns of modern air transportation:
  - Public concerns over *noise and emissions*
  - Increasing costs associated with *high fuel consumption*
  - Lack of progress towards *faster means of transportation*
- Aeronautics and space technology are closely related: *Fundamental Aeronautics contributes to NASA's broader Vision for Space Exploration*
- Emphasis on advanced *multidisciplinary analysis and design* capability to
  - Guide our research and technology investments
  - Realize integrated technology advances in future aircraft and spacecraft

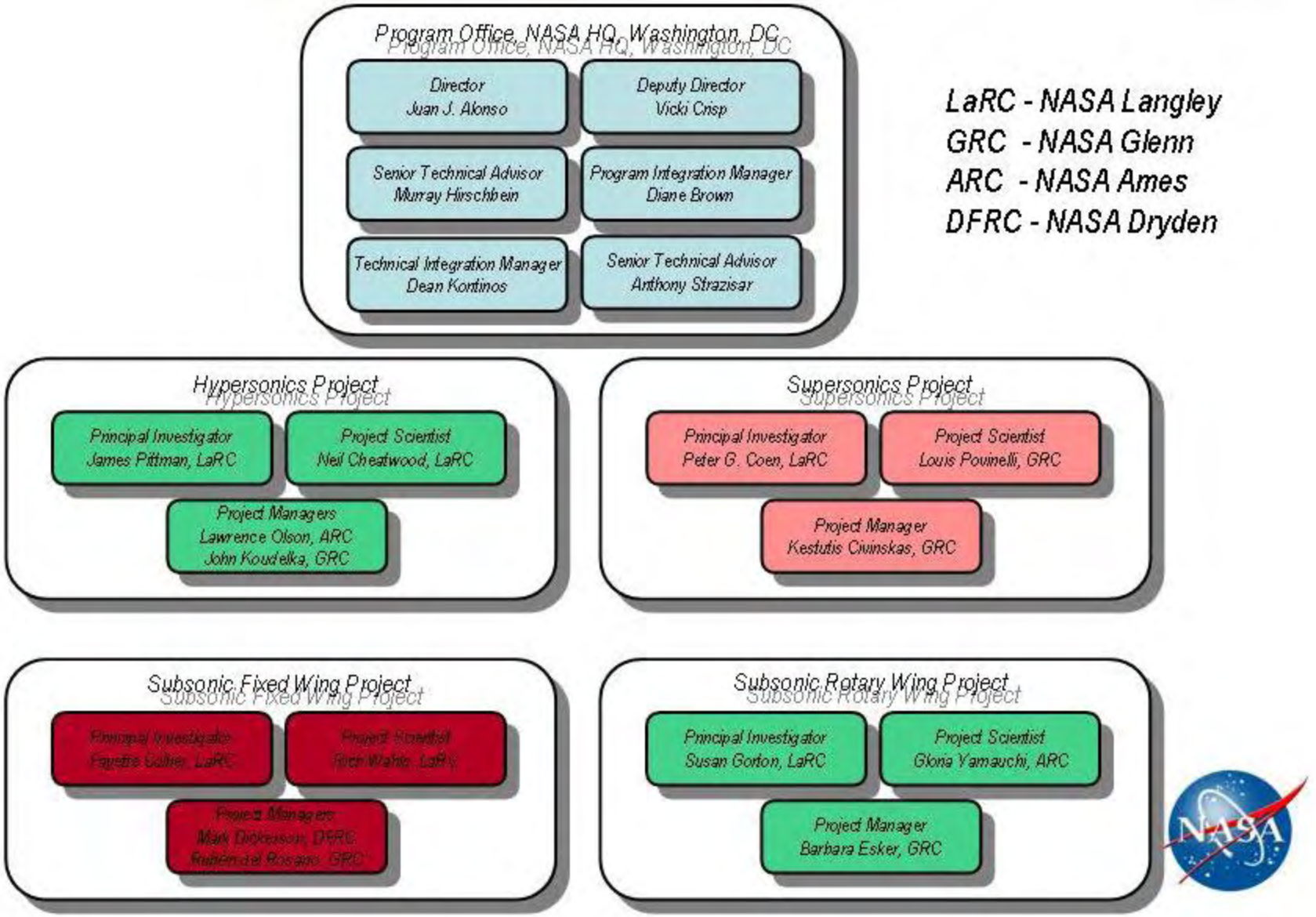
Fundamental Aeronautics Program: Mission Statements

- *Hypersonics*
  - Fundamental research in all disciplines to **enable very-high speed flight** (for launch vehicles) and **re-entry into planetary atmospheres**
  - High-temperature materials, thermal protection systems, advanced propulsion, aero-thermodynamics, multi-disciplinary analysis and design, GNC, advanced experimental capabilities
- *Supersonics*
  - **Eliminate environmental and performance barriers** that prevent **practical supersonic vehicles** (cruise efficiency, noise and emissions, vehicle integration and control)
  - Supersonic deceleration technology for **Entry, Descent, and Landing** into Mars
- *Subsonic Fixed Wing (SFW)*
  - Develop revolutionary technologies and aircraft concepts with highly **improved performance** while satisfying **strict noise and emission constraints**
  - Focus on **enabling technologies**: acoustics predictions, propulsion / combustion, system integration, high-lift concepts, lightweight and strong materials, GNC
- *Subsonic Rotary Wing (SRW)*
  - Improve **competitiveness of rotary wing vehicles** (vs fixed wing) while maintaining their unique benefits
  - Key **advances** in multiple areas through **innovation** in materials, aeromechanics, flow control, propulsion





Fundamental Aeronautics Program: Organizational Chart

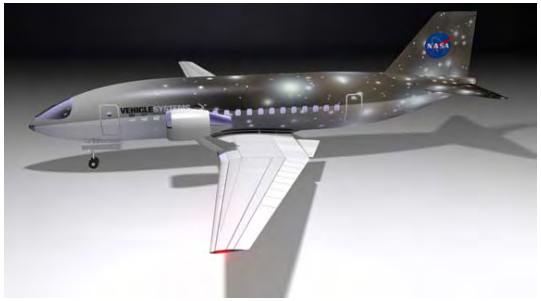


SFW System Level Metrics

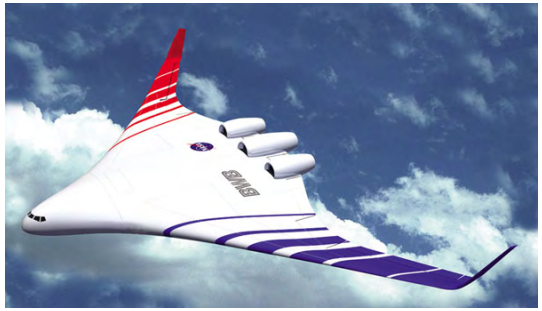
.... technology for dramatically improving noise, emissions, & performance

CORNERS OF THE TRADE SPACE	N+1 Generation Conventional Tube w/Wing (2012-2015)	N+2 Generation Unconventional Hybrid Wing Body (2018-2020)
Noise (cum below Stage 3)	- 42 dB	- 52 dB
LTO NOx Emissions (below CAEP 2)	-70%	-80%
Performance: Aircraft Fuel Burn (relative to B737/CFM56)	-33%	-50%***
Performance: Field Length (relative to B737/CFM56)	-33%	-50%

N+1 Conventional



N+2 Hybrid Wing/Body



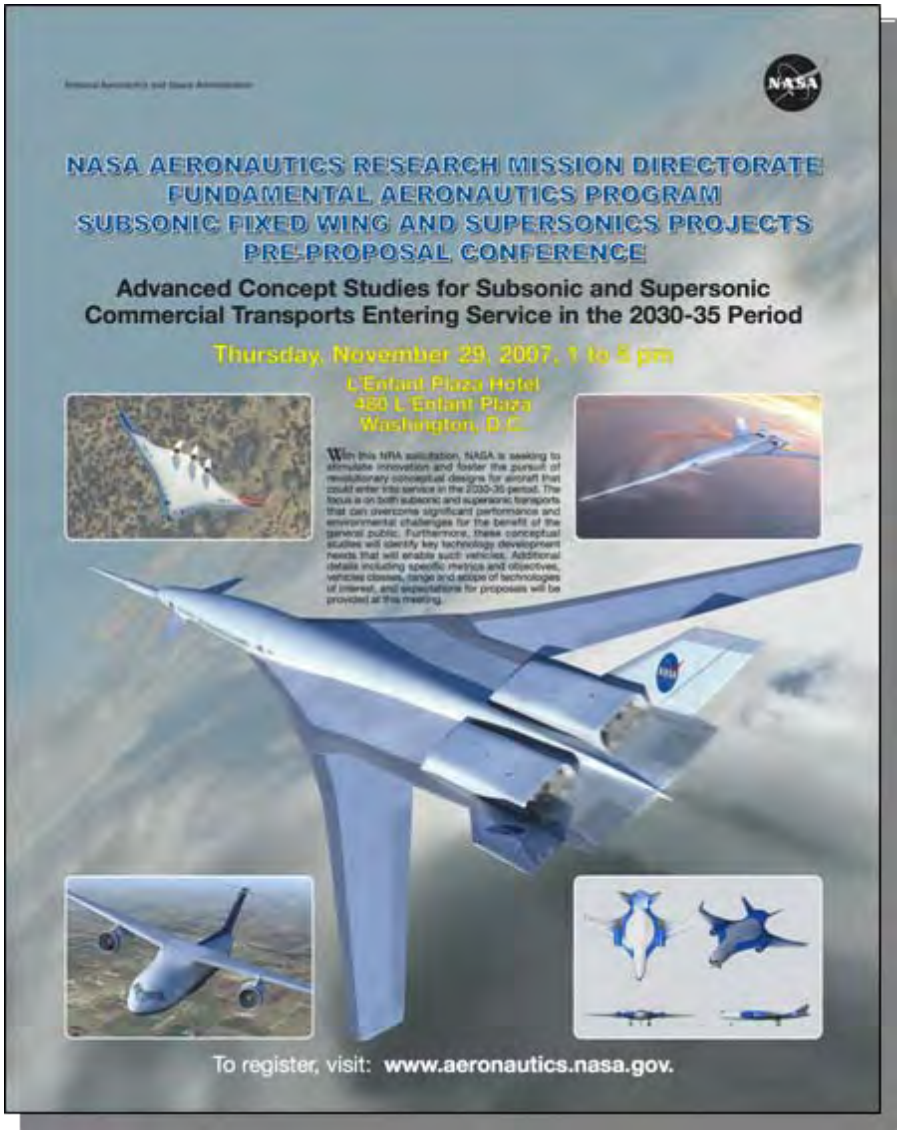
Supersonics System Level Metrics

CORNERS OF THE TRADE SPACE	N+1 Supersonic Business Jet Aircraft (2015)	N+2 Small Supersonic Airliner (2020)	N+3 Efficient Multi-Mach Aircraft (2030-2035)
Cruise Speed	Mach 1.6-1.8	Mach 1.6-1.8	Mach 2.0 Unrestricted Mach 1.6-2.0 Low Boom
Range (nmi)	4,000	4,000	6,000
Payload	6-20 pax	35-70 pax	100-200 pax
Sonic Boom	65-70 PLdB	65-70 PLdB	65-70 PLdb low boom fligh 75-80 PLdB unrestricted flight
Airport Noise (cum below Stage 3)	10 EPNdB	10-20 EPNdB	20-30 EPNdB
Cruise Emissions	?	?	?
Fuel Efficiency	Baseline	15% Improvement	25% Improvement

N+1 "Conventional"

N+2 Small Supersonic Airliner

NASA NRA Pre-Proposal Conference, Nov 29

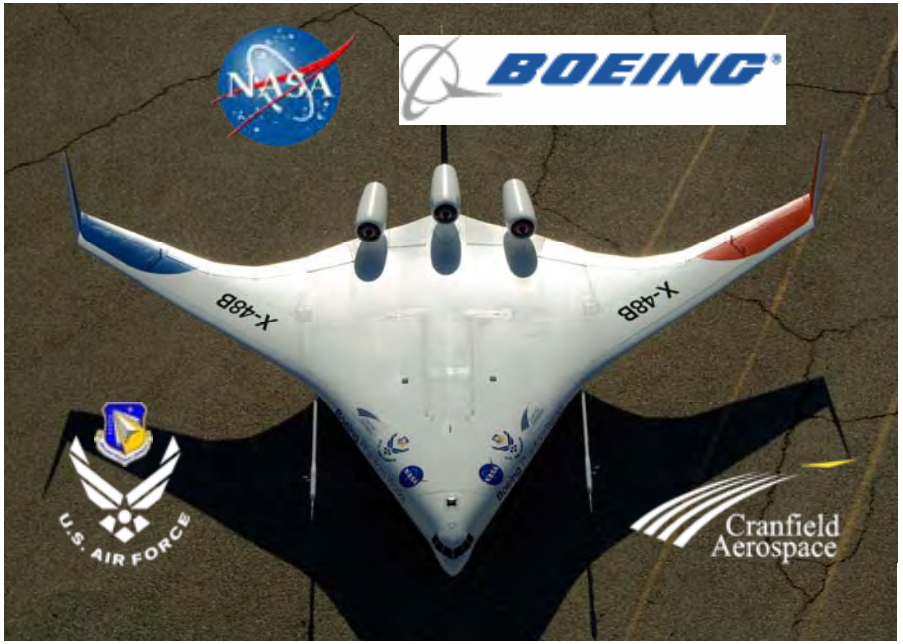


- *Advanced Concept Studies for Subsonic and Supersonic Commercial Transports Entering Service in the 2030-35 Period*
- November 29, 2007, 1-5 pm
- L'Enfant Plaza Hotel, Washington, DC
- Stimulate innovation and foster the pursuit of revolutionary conceptual designs for aircraft that could enter service in the 2030-35 time period. Overcome significant performance and environmental challenges for the benefit o the public.
- Phase I: 12-Months, Phase II: 18 Months to Two Years, with significant technology demonstration

Subsonic Fixed Wing: X-48B First Flight

First flight July 20, 2007
- X-48B
- 500 lb, 21 ft wing span
- 31 minute flight
- Low-speed flying/handling qualities experiment
- Potential future use for acoustics tests (ground and flight) and transonic experiments

6 Flights Completed

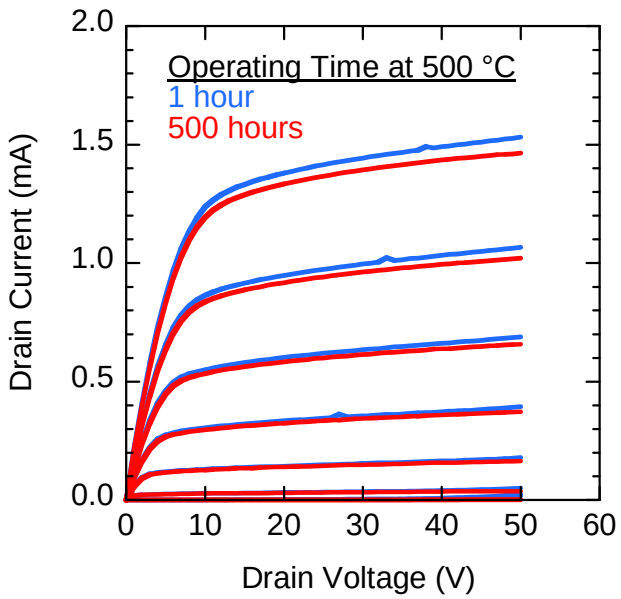


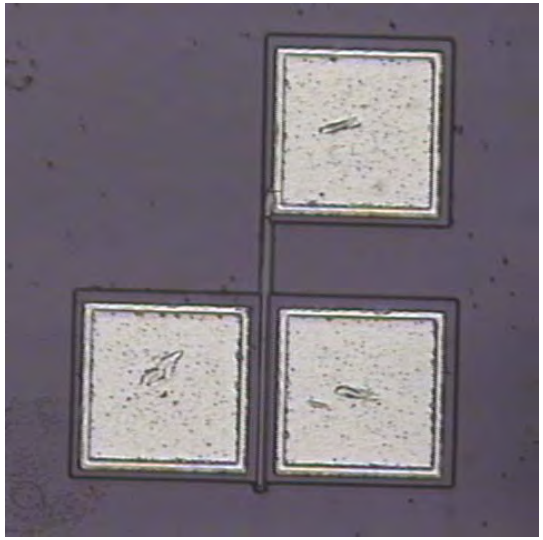
Subsonic Fixed Wing: Controls & Dynamics

High Temperature Silicon Carbide Junction Field Effect Transistor

New device demonstrated at 500 ^{O}C continuous operation for over 2,000 hours

- Far superior turn-off characteristics than previous device
  - Enables development of feasible high temperature logic devices
- Current-voltage characteristics are very good and stable after 500 hours
  - Enables development of feasible high temperature analog devices such as amplifiers and oscillators
- Effort is a leveraged investment between Distributed Engine Controls (Subsonic Fixed-Wing) and High Temperature Wireless (IVHM)





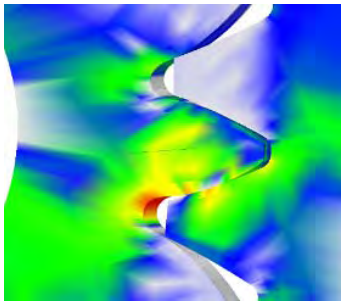
Magnified view of unpackaged device

Subsonic Rotary Wing Project

Solving Civil Utility Problems

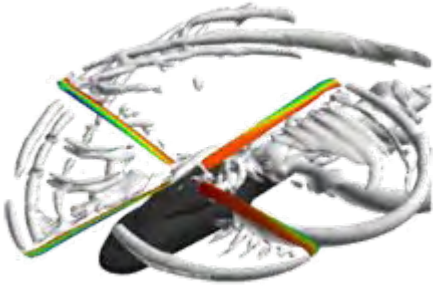
- Solving problems relevant to civil and military applications
- Close partnership with the Army
- Researchers working side-by-side on fundamental, difficult problems
- Sharing and leveraging experimental and computational expertise

Other partners include: Bell Helicopter, Sikorsky, HeloWerks, AF, DARPA

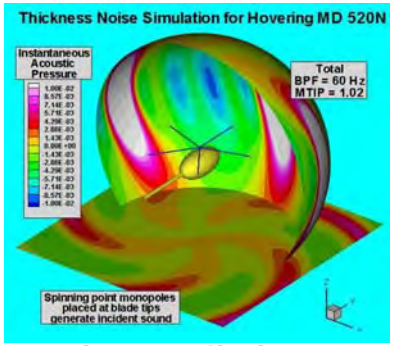


3-D Analysis of Spur / Helical Gears

14- by 22-Foot Subsonic Tunnel



First-Principles Modeling



Noise prediction

Research Areas:

Noise propagation and reduction	➡	Community acceptance
Increase speed and range	➡	Reduce airport congestion
Increase propulsion efficiency	➡	Reduce emissions
Increase payload	➡	Decrease cost, increase utility
Improve control systems	➡	Safe operations for advanced concepts

Subsonic Rotary Wing: Major Activities

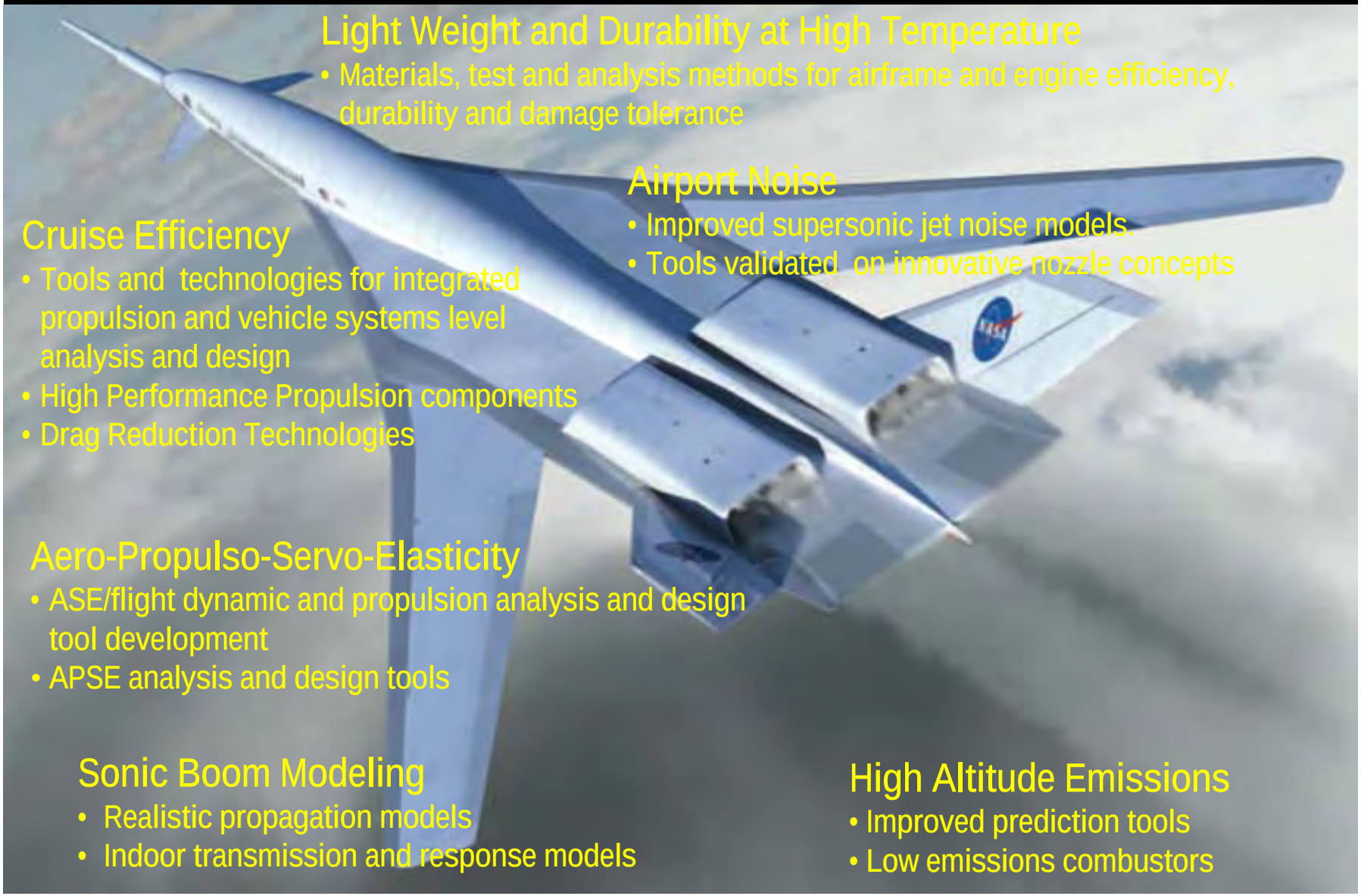
- Acoustic flight test at Eglin AFB in partnership with the Army and DARPA. Flight started Aug 13 (VR-71, MD-902, Mi-8)
- Preparations for Individual Blade Control (IBC) research underway. LRTA installed in NFAC for training. IBC testing currently scheduled for April 2008.
- Preparations for Small Scale Active Rotor (SSAR) demonstration testing in 7x10 underway. Test scheduled for fall 2007 (Joint with Army, Boeing).
- Completed acoustic flight test at Hollister, CA with Bell, UMD in June 2007
- CE18 upgrades complete. Final inspections being accomplished.
- Fly-by-wire flight control demonstration underway (joint with Army).
- Preparations for large-field of view PIV measurements in 14x22 with Army slowed-rotor JHL model

Aris/Bell 206, Hollister, CA

LRTA being lifted into the 40x80

Supersonics Project Technical Elements

Project Plans to Deliver Knowledge, Capabilities, and Technologies Addressing Supersonics Challenges



Light Weight and Durability at High Temperature

- Materials, test and analysis methods for airframe and engine efficiency, durability and damage tolerance

Airport Noise

- Improved supersonic jet noise models.
- Tools validated on innovative nozzle concepts

Cruise Efficiency

- Tools and technologies for integrated propulsion and vehicle systems level analysis and design
- High Performance Propulsion components
- Drag Reduction Technologies

Aero-Propulso-Servo-Elasticity

- ASE/flight dynamic and propulsion analysis and design tool development
- APSE analysis and design tools

Sonic Boom Modeling

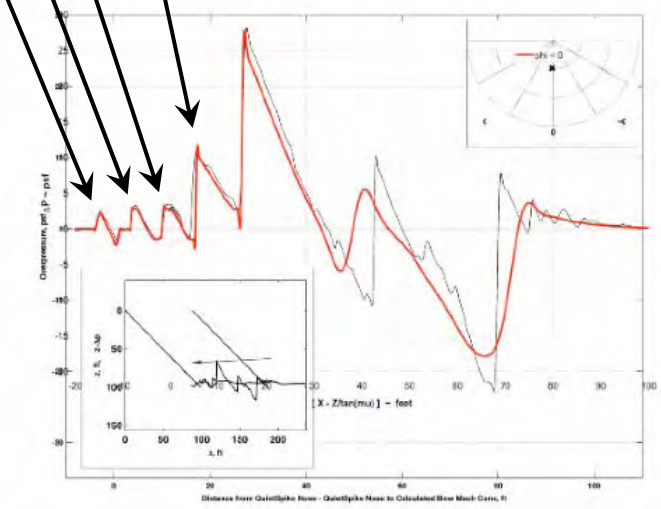
- Realistic propagation models
- Indoor transmission and response models

High Altitude Emissions

- Improved prediction tools
- Low emissions combustors

Supersonics:
Quiet Spike Flight Experiment

- Quiet Spike™: a Gulfstream Aerospace / NASA collaboration
  - Flight validation of non-coalescing shocklets produced from Quiet Spike configuration
- 32 successful flights, Mach 1.8, 45,000 ft, flight data for structural loads, dynamics, and shock strengths match predictions



Preliminary CFD comparison (red) with measured signature (black) at 95 ft. below the F-15, M = 1.4, 40,000 ft

- Open geometry and experimental data sets, available to entire community

- Results of flight experiments in the process of being published and disseminated
  - Fifteen joint publications (NASA/Gulfstream) in preparation or already submitted
  - Special AIAA Aerospace Sciences Meeting & Exhibit session for Quiet Spike (Jan 2008

- Substantive NASA/Gulfstream collaboration opens door to future efforts

Gulfstream
A GENERAL DYNAMICS COMPANY

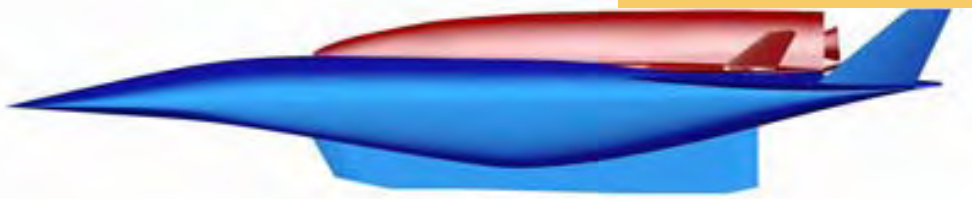
NASA

Hypersonics Project Focus

Highly Reliable Reusable Launch Systems

Materials & Structures
- Thermal Protection Systems
- Hot Structures
- High Temperature Seals

Integrated Systems
- Staging
- Thermal Management
- Power and Actuators
- Intelligent Controls

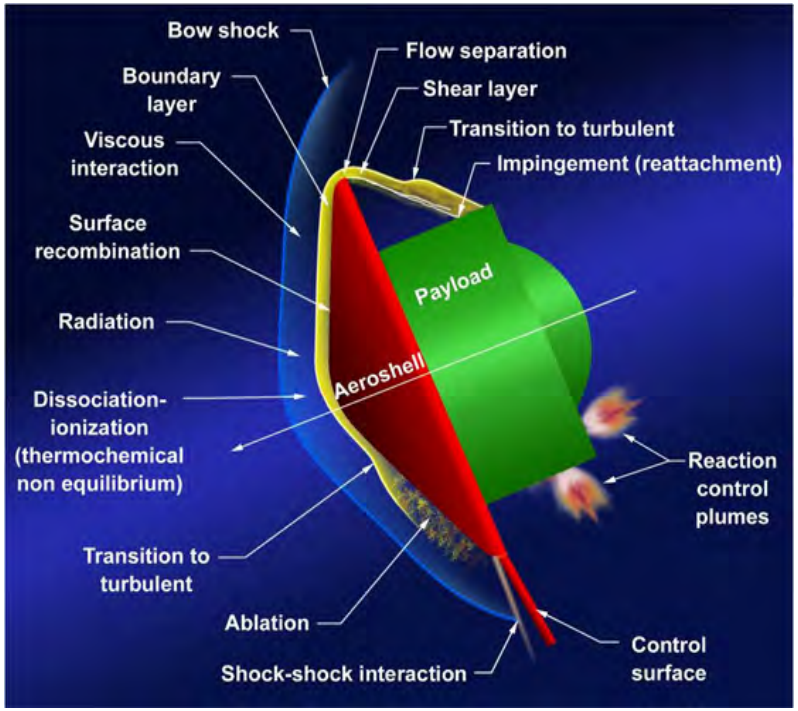


Airframe-Propulsion Integration
- Integrated Vehicle Performance
- Inlet Boundary Layer Ingestion
- Nozzle Performance

Propulsion
- High-Mach Turbojets
- Dual-Mode Scramjets
- Combined Cycle Engines

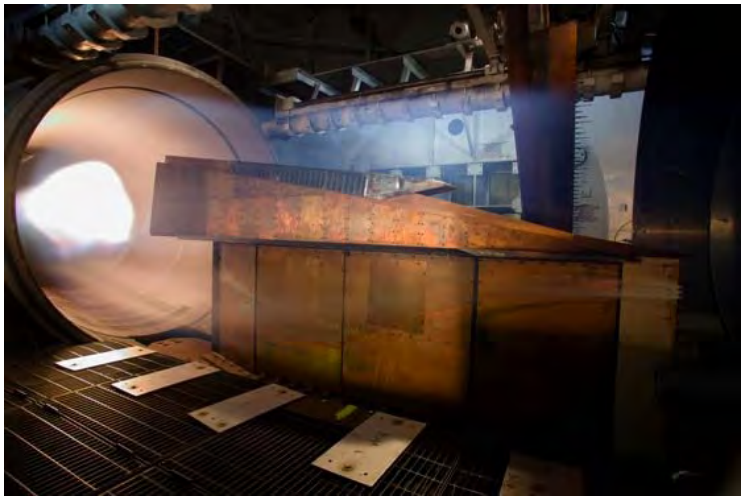
Similar technologies needed for both applications

High Mass Mars Entry Systems



Mission Statement: Conduct fundamental and multidisciplinary research to enable airbreathing access to space and entry into planetary atmospheres

Hypersonics:
X-51A Scramjet Engine Demonstrator



X-1 Engine Undergoes Testing in the 8ft Tunnel

NASA's Role:
- Full-scale propulsion testing in the NASA 8-Foot High Temperature Tunnel
- Sub-scale configuration testing in NASA wind tunnel
- Computational Fluid Dynamics (CFD) calculations
- Expertise in supersonic combustion and system integration

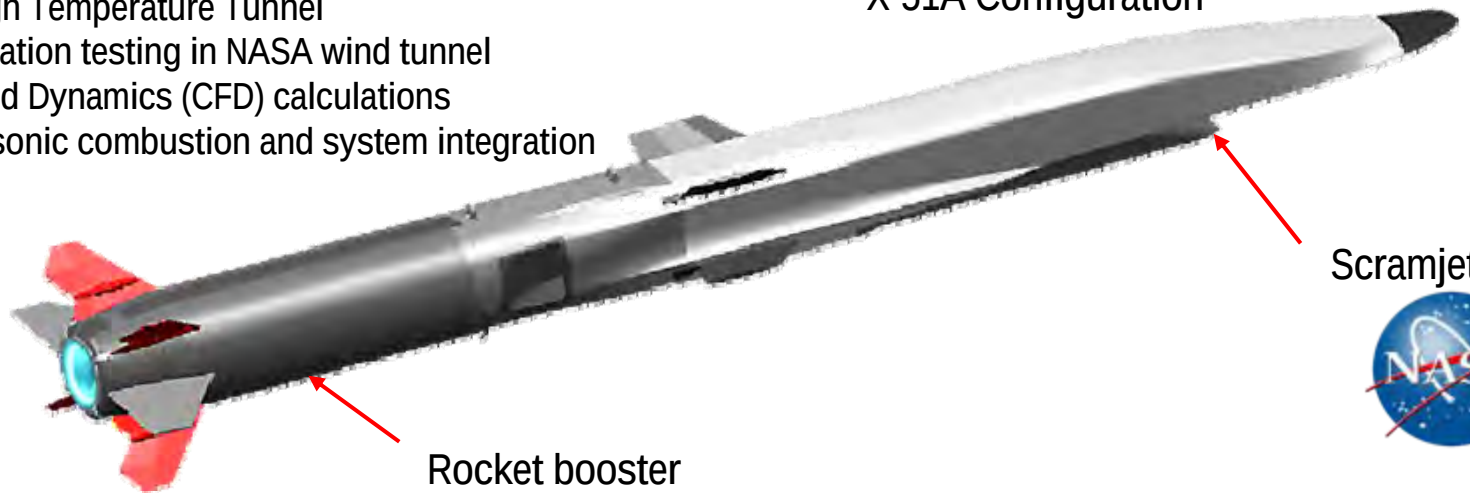
Program Overview

- Joint AFRL/DARPA/NASA flight demo
- Hydrocarbon-fueled and cooled scramjet
- Scramjet flight from Mach 4.5 to 6.5
- 5 minute-plus flight duration
- Four to eight flights (FY09 1st flight)

Major Accomplishment:

- Demonstrated hydrocarbon-fueled, self-cooling, complete envelope operation of scramjet engine for significant duration.

X-51A Configuration



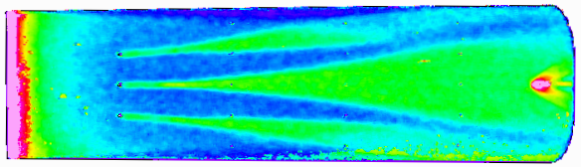
Hypersonic Boundary Layer Transition (HyBoLT) & Sub-Orbital Aerodynamics Re-Entry Experiments (SOAREX)

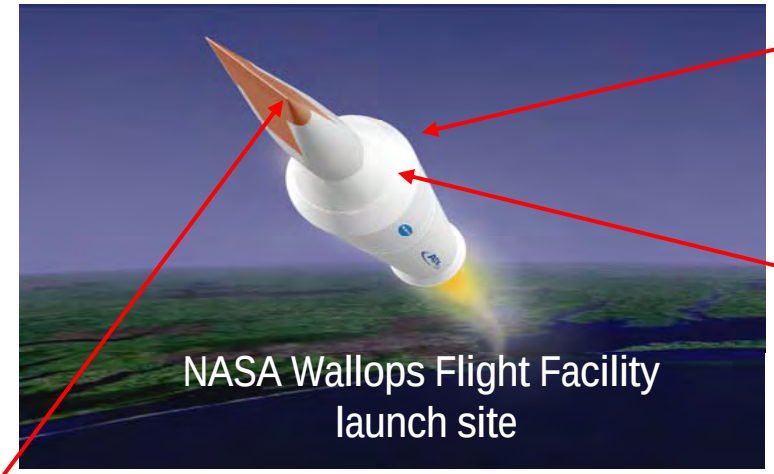
STS-114 gap-filler incident served as a potent reminder of the importance of pursuing mastery of the fundamentals of hypersonic flight.

Mission Objective: Obtain unique flight data for basic flow physics and Mars entry technology

Estimated launch date:
Spring 2008

Cost-sharing partners:
NASA
ATK

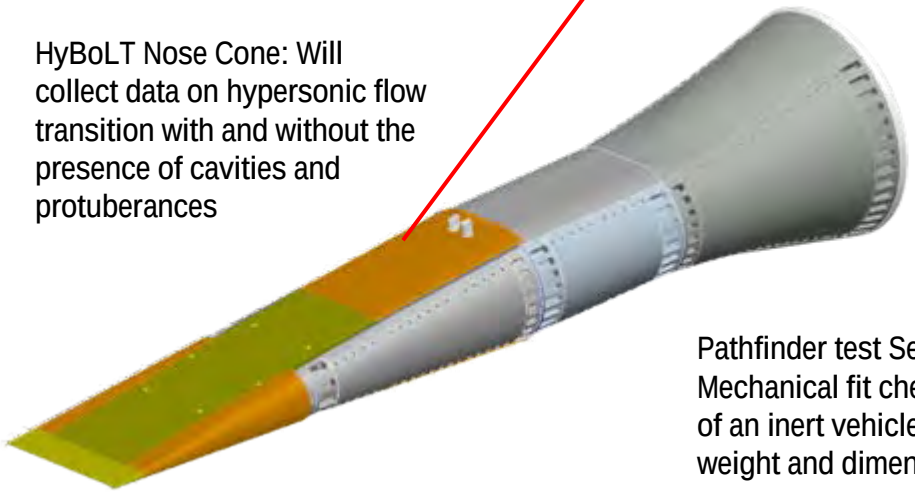




ATK Launch Vehicle (ALV X-1)

SOAREX will collect aerodynamic data on a re-entry shape during descent. Probe carried internally and ejected at 500 km altitude

HyBoLT Nose Cone: Will collect data on hypersonic flow transition with and without the presence of cavities and protuberances



Pathfinder test Sept 2006:
Mechanical fit check
of an inert vehicle with proper weight and dimensions

FA Cluster: RT Jones

- NASA's Fundamental Aeronautics Program faced with rapidly escalating demand for computational resources
- SGI Altix ICE blade architecture
  - 4096 cores (Xeon quad-core)
  - 4 TB total memory
  - 43 TF peak, 31.61 TF Linpack (would be 25 in current Top500)
  - Linux operating system
- Storage Environment
  - 240 TB on-line
  - Linked to 12 PB archive storage environment at NAS
- Operated and supported by NAS, exclusively for ARMD users

- Best of both worlds
  - Most ARMD/FA application codes run very efficiently on cluster systems
  - But ARMD/FA also retains access to and allocation on Columbia
- Offers from multiple vendors were evaluated before selection
  - Based on technology and price

FA Video


TomorrowsFlight_HDweb.mov
Today's Research...
Tomorrow's Flight
00:00:10

Agenda

Tuesday, October 30, 2007		
7:00 am-4:00 pm	**Registration**	**Chemin Royale**
7:00-8:00 am	**Continental Breakfast**	**Chemin Royale**
8:00-8:15 am	**Opening Remarks** *Dr. Lisa Porter, Associate Administrator, Aeronautics Research Mission Directorate*	**Grand Ballroom C**
8:15-8:30 am	Welcome and Program Highlights *Dr. Juan Alonso, Program Director*	
8:30-9:15 am	Subsonic Fixed Wing Project Overview *Dr. Fayette Collier, Principal Investigator*	
9:15-10:00 am	Subsonic Rotary Wing Project Overview *Ms. Susan Gorton, Principal Investigator*	
10:00-10:30 am	**Break**	
10:30-11:15 am	Supersonics Project Overview *Mr. Peter Coen, Principal Investigator*	
11:15 am-Noon	Hypersonics Project Overview *Dr. James Pittman, Principal Investigator*	
Noon-1:30 pm	**Lunch Break**	