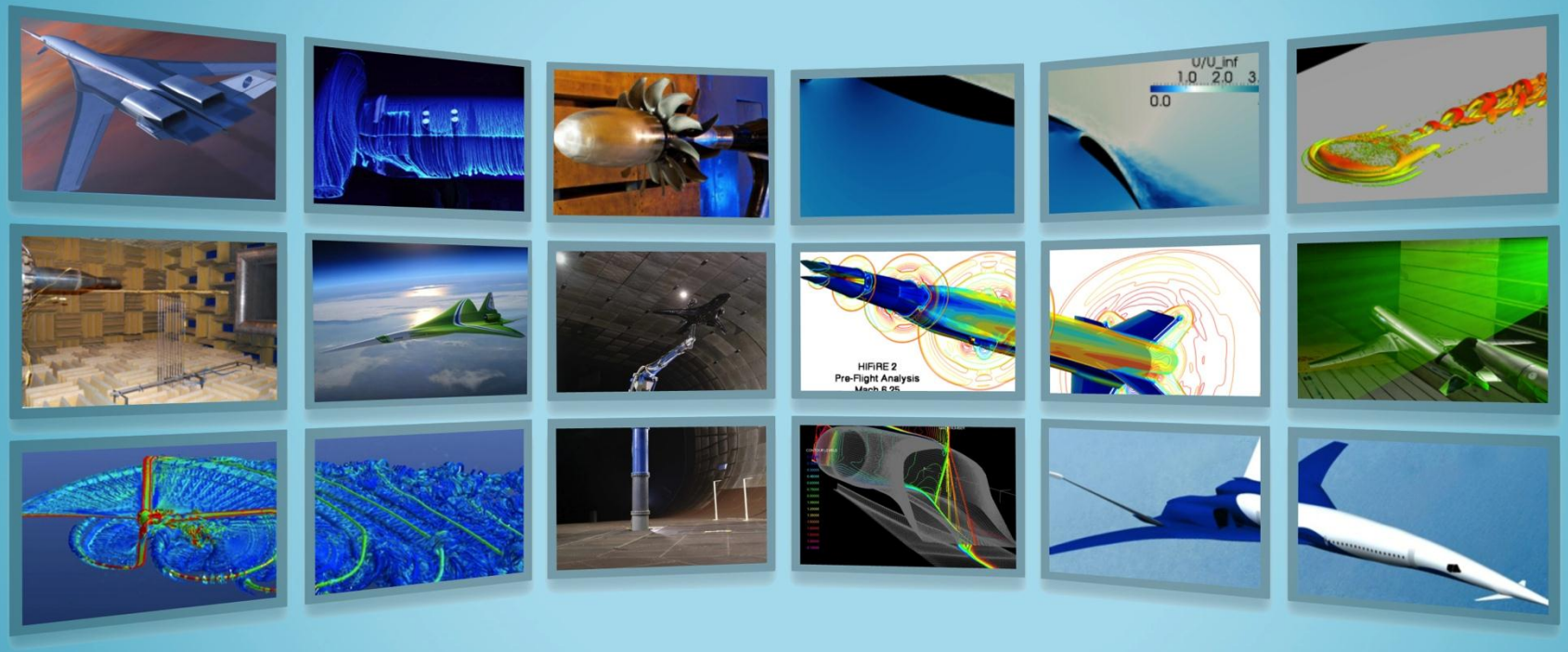
Aeronautics Research Overview

NASA Glenn Research Center



Dr. Marla E. Perez-Davis

February 25, 2013

NASA Aeronautics Programs



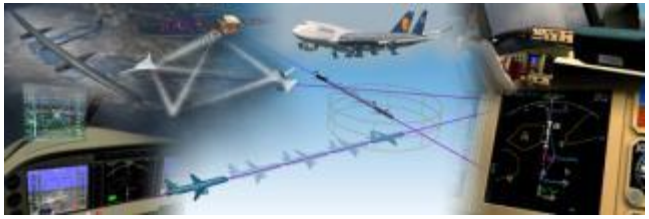

Fundamental Aeronautics Program

Conduct fundamental research that will generate innovative concepts, tools, technologies, and knowledge to enable revolutionary advances for air vehicles.

Integrated Systems Research Program

Conduct research at an integrated system-level on promising concepts and technologies and explore/assess/demonstrate the benefits in a relevant environment



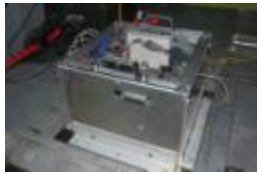


Airspace Systems Program

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.


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.



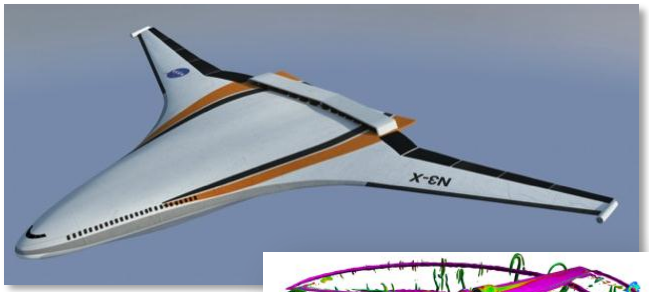


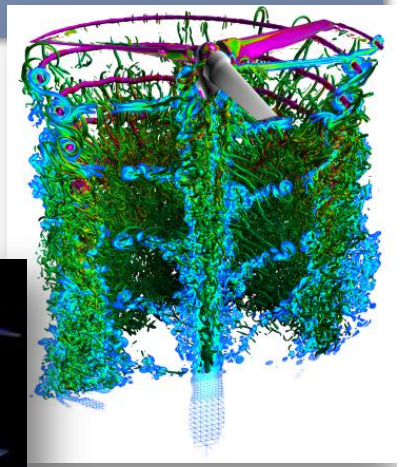
Aeronautics Test Program

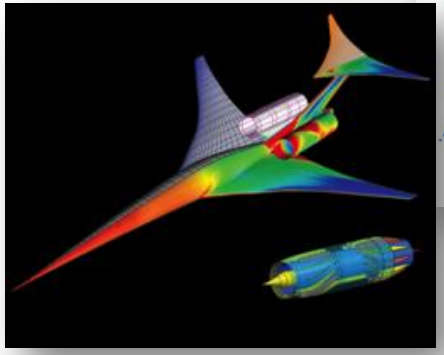
Preserve and promote the testing capabilities of one of the United States' largest, most versatile and comprehensive set of flight and ground-based research facilities.


Fundamental Aeronautics Program!

Conduct fundamental research that will generate innovative concepts, tools, technologies and knowledge to enable revolutionary advances for a wide range of air vehicles.







Fixed Wing (FW)

Explore and develop technologies and concepts for improved energy efficiency and environmental compatibility of fixed wing, subsonic transports.!

Rotary Wing (RW)

Develop and validate tools, technologies and concepts to overcome key barriers for rotary wing vehicles.!

High Speed (HS)

Tool and technology development and validation to address challenges in high speed flight.!

Aeronautical Sciences (AS)

Enable fast, efficient design & analysis of advanced aviation systems by developing physics-based tools and methods for cross-cutting technologies.

The NASA Fixed Wing Project

Explore and Develop Technologies and Concepts for Improved Energy Efficiency and Environmental Compatibility for Sustained Growth of Commercial Aviation

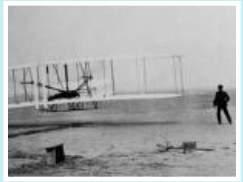
Vision

- Early stage exploration and initial development of game-changing technology and concepts for fixed wing vehicles and propulsion systems.

Scope

- Subsonic commercial transport vehicle (passengers, cargo, dual-use military)
- Technologies and concepts for addressing the challenges of aviation
- Development of tools as enablers for technologies and concepts, not as independent products

Evolution of Subsonic Transports



1903 1930s 1950s 2000s

Fixed Wing Project Research Themes

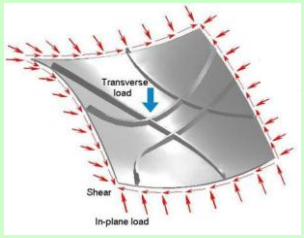
based on Goal-Driven Advanced Concept Studies

Goals	*Noise*	*Emissions (LTO)*	*Emissions (cruise)*	*Energy Consumption*
Metrics (N+3)	*Stage 4 – 71 dB cum*	*CAEP6 – 80%*	*2005 best – 80%*	*2005 best – 60%*

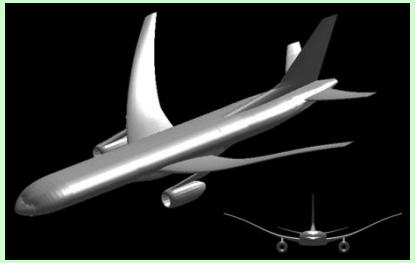
Goal-Driven Advanced Concepts
(N+3)





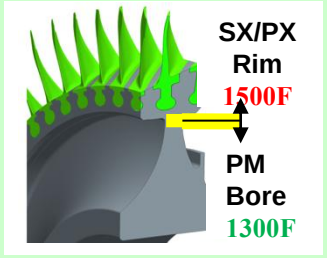


Lighter-weight Lower Drag Fuselage

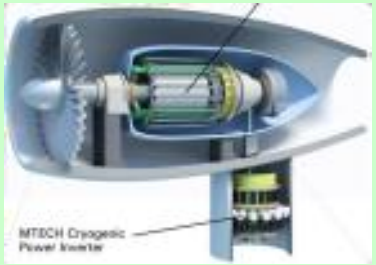


Higher Aspect Ratio Optimal Wing

Quieter Low-Speed Performance

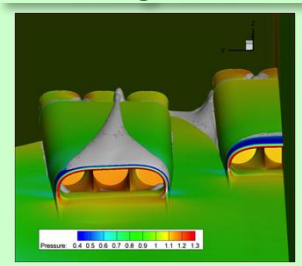


Cleaner, Compact Higher BPR Propulsion

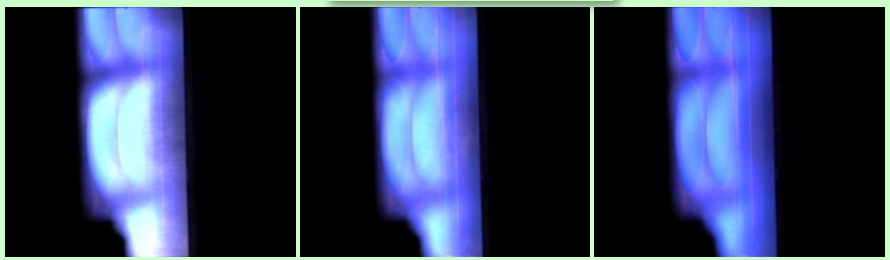


Hybrid Gas-Electric Propulsion

Unconventional Propulsion Airframe Integration



Alternative Fuel Emissions

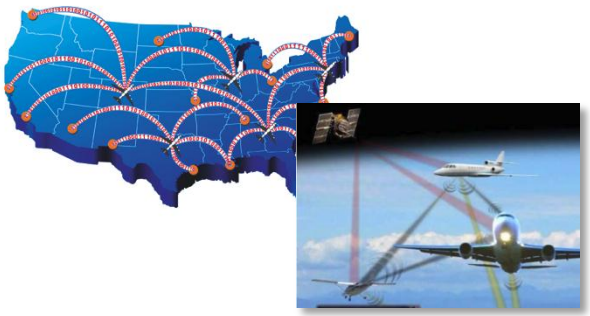


Systems Analysis and Integration

Research Themes

Aviation Safety Program

Program Goal: Proactively identify, develop, and mature tools, methods and technologies for improving overall aircraft safety of new and legacy vehicles operating in NextGen



Three Objectives

- *"Assure system-wide safety"*
  - Provide knowledge, concepts and methods to proactively manage increasing complexity in the design and operation of vehicles and the air transportation systems

- *"Maintain and improve vehicle safety in key areas"*
  - Identify risks and provide knowledge needed to avoid, detect, mitigate, and recover from hazardous flight conditions, and to maintain vehicle airworthiness and health

- *"Deal with the presence of atmospheric risks"*
  - Investigate sources of risk and provide technology needed to help ensure safe flight in and around atmospheric hazards

AEST Project's Technical Challenges

- **<u>Engine Icing: Characterization and Simulation Capability</u>:** Develop knowledge bases, analysis methods, and simulation tools needed to address the problem of engine icing; in particular, ice-crystal icing

- **<u>Airframe Icing Simulation and Engineering Tool Capability</u>:** Develop and demonstrate capability to simulate and model airframe ice accretion and related aerodynamic performance degradation for current and future aircraft configurations in an expanded icing environment that includes freezing drizzle/rain

- **<u>Atmospheric Hazard Sensing & Mitigation Technology Capability</u>:** Improve and expand remote sensing and mitigation [lightning composites] of hazardous atmospheric environments and phenomena

Propulsion Systems Laboratory's (PSL) Inaugural Engine Ice Crystal Tests

PSL Configured with the Honeywell ALF502 Engine Known to Ice

PSL Control Room

- On February 11, 2013 NASA demonstrated a one of a kind high altitude, ice crystal, full-scale engine test facility to study and gain a physics-based understanding of the engine ice crystal icing phenomenon- an aviation safety concern.
- The Honeywell ALF502 engine being tested has had documented ice crystal icing related field events (i.e. engine rollback). The test plan is focused within a small window around these documented field events.
- NASA and Honeywell researchers and engineers were able to replicate engine anomalies at atmospheric conditions experienced in flight demonstrating a unique PSL capability.
- Major goals of the engine testing is to duplicate the field event in PSL-3 (i.e. demonstrate capability), establish test methods and techniques that enables the effective and efficient study of engine icing in new and existing commercial engines, and develop validation data sets required to enable the creation of a system of computer codes that can be specifically applied to assess engine icing susceptibility as well as engine performance and operability effects.
- The PSL Icing effort is sponsored by the Aviation Safety Program, Aeronautical Test Program partnering with Honeywell Engines. Honeywell Engines provided the engine test article and support staff required to perform these facility development.

Integrated Systems Research Program Overview

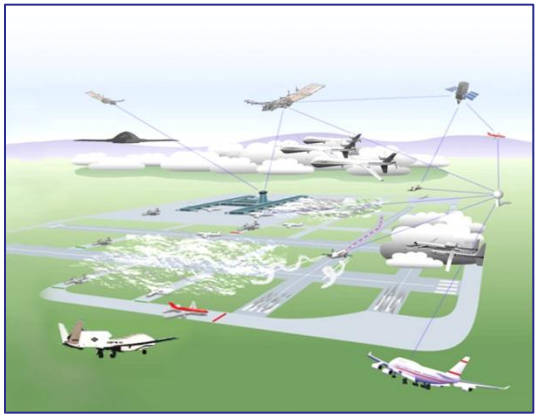
Program Goal:
Pursue innovative solutions to high priority aeronautical needs and accelerate implementation by the aviation community through integrated system level research on promising concepts and technologies, demonstrated in a relevant environment.

Environmentally Responsible Aviation (ERA) Project

Mature technologies and study vehicle concepts that together can simultaneously meet the NASA Subsonic Transport System Level Metrics for noise, emissions and fuel burn in the N+2 timeframe.

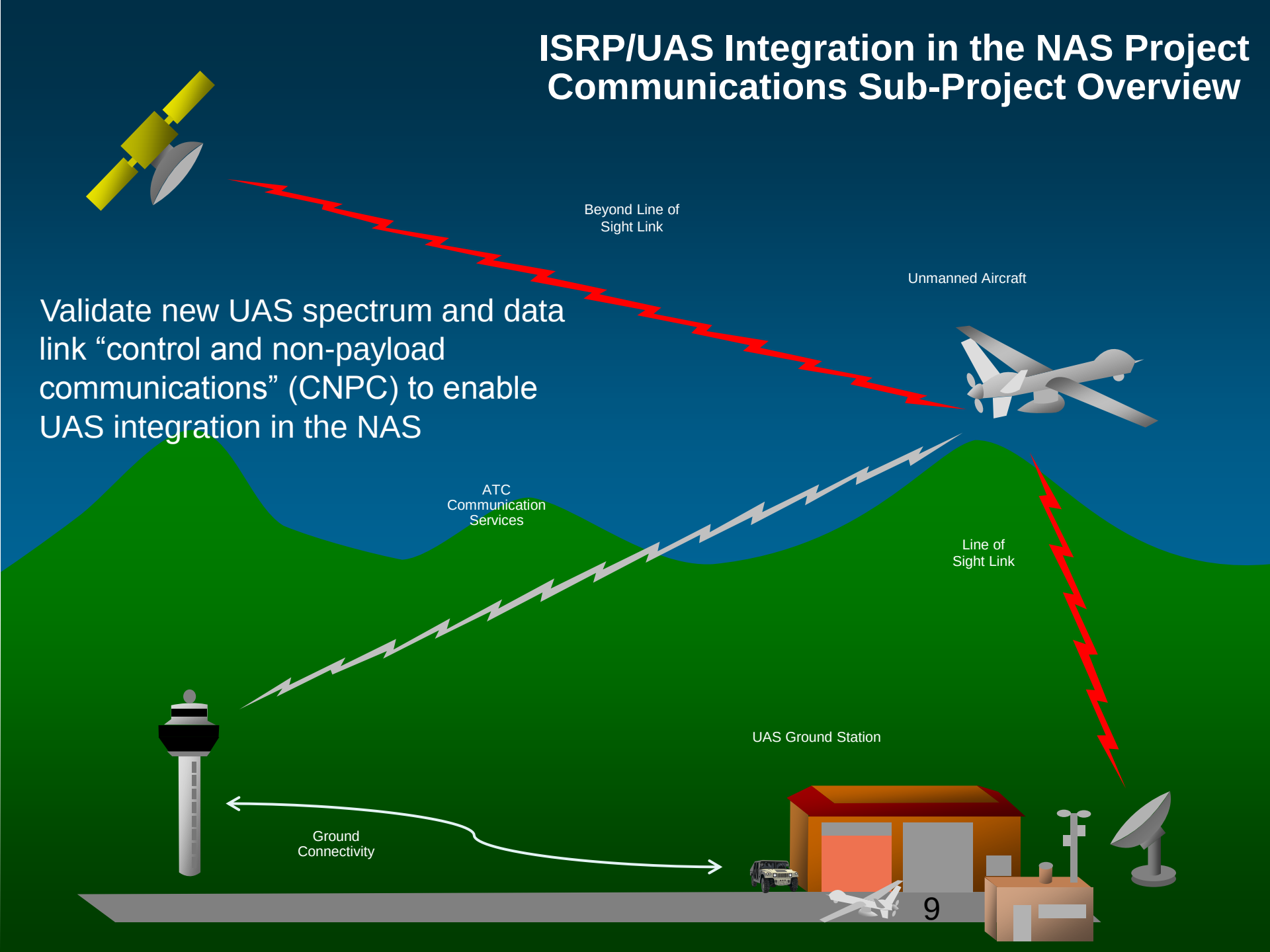
Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project

Capitalizing on NASA's unique capabilities, the project will utilize integrated system level tests in a relevant environment to eliminate or reduce critical technical barriers of integrating Unmanned Aircraft Systems into the National Airspace System



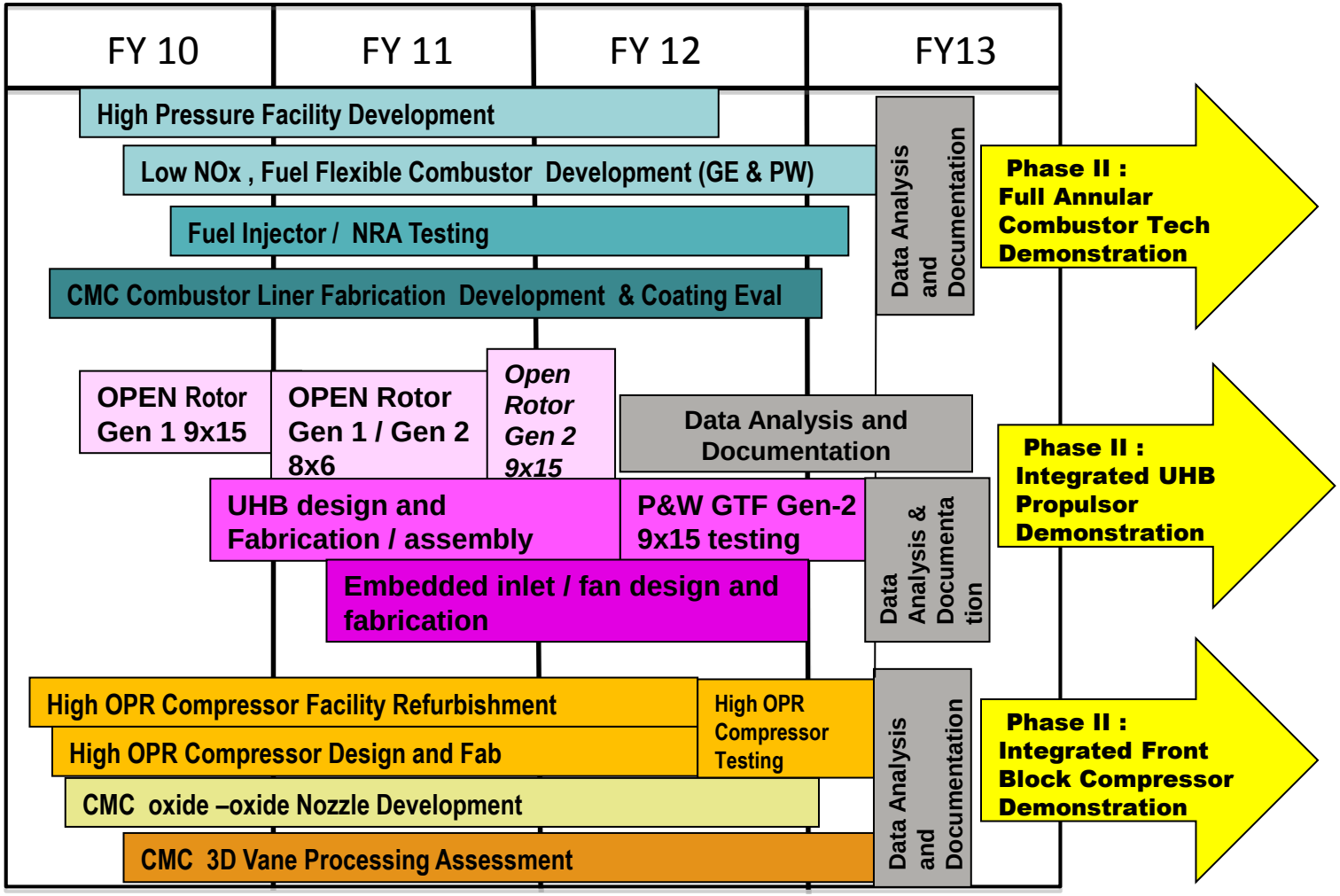
By focusing on technologies that have already proven their merit at the fundamental research level, this program helps transition them more quickly to the aviation community, as well as inform future fundamental research needs

ISRP/UAS Integration in the NAS Project Communications Sub-Project Overview



Validate new UAS spectrum and data link “control and non-payload communications” (CNPC) to enable UAS integration in the NAS

ERA Propulsion Technology (PT) Overview



ERA Phase II (2013-2015) builds on Phase 1 (2010-2012) : leveraging Integrated Technology Development / Demonstration coupled with systems analysis and incorporation of Advanced Vehicle Concepts

Fundamental Aeronautics Program
Integrated Systems Research Program

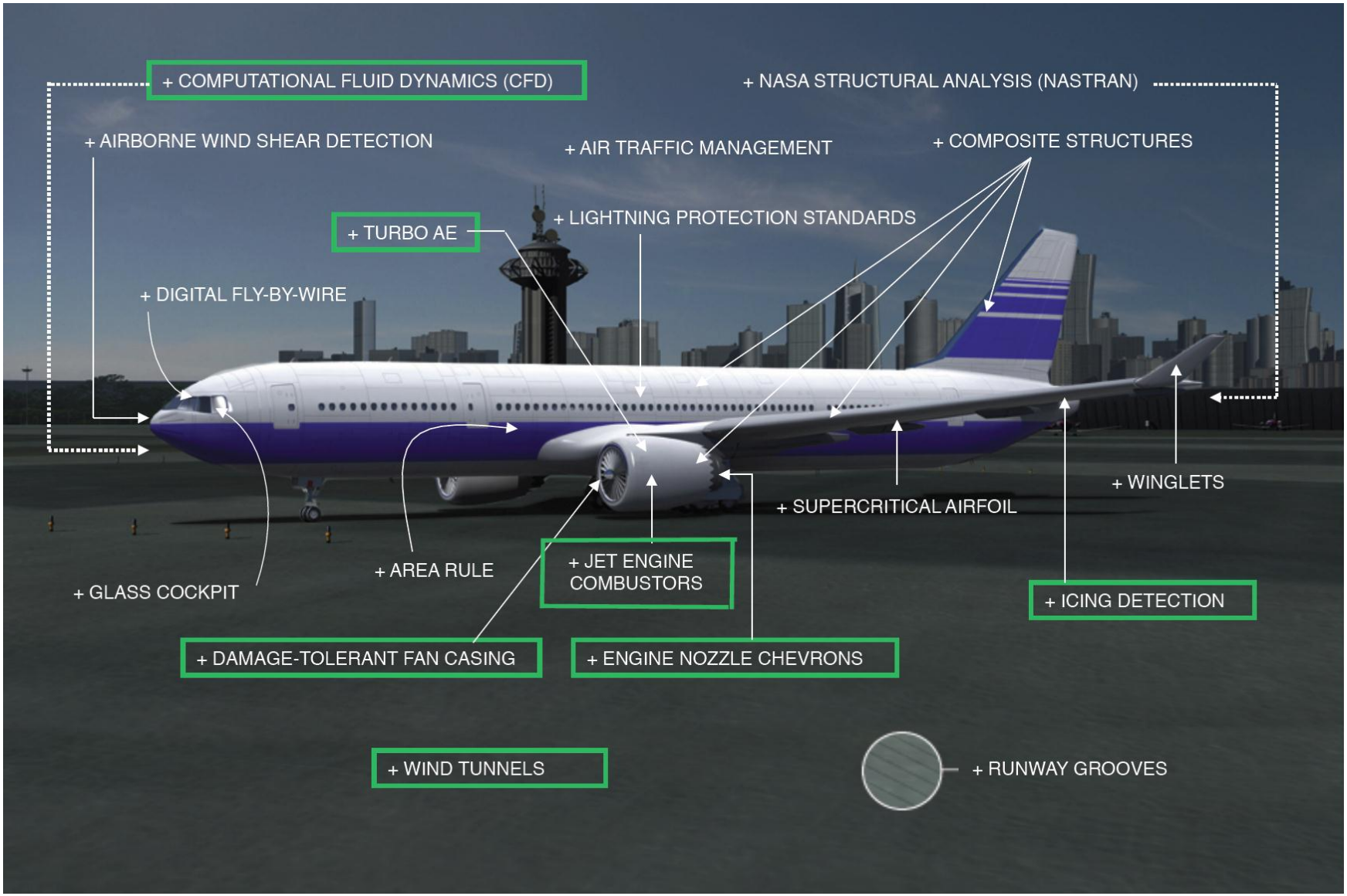
Fixed Wing Project

The Fixed Wing Project conducts research to improve prediction methods and technologies that will produce lower noise, lower emissions, and higher performing subsonic aircraft for the Next Generation Air Transportation System.

Environmentally Responsible Aircraft

The Integrated Systems Research Program (ISRP) focuses on maturing and integrating NextGen technologies into major vehicle/operational systems and subsystems that will address these national challenges.

Aeronautics Contributions

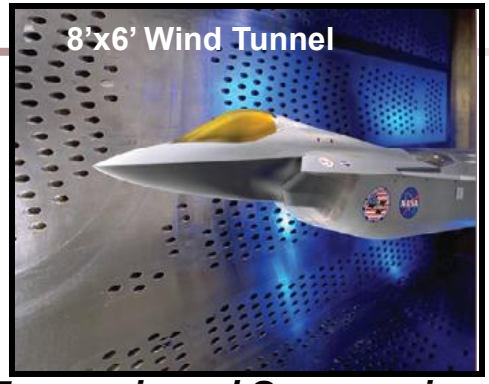


Back up Charts

NASA GRC Unique Aero Test Facilities

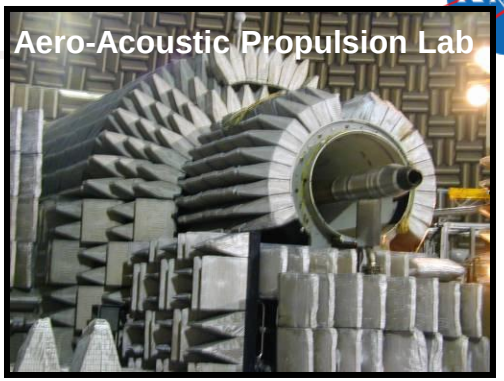
Subsonic Propulsion Wind Tunnels

- Noise suppression
- Inlet/Airframe integration
- STOVL hot gas ingestion



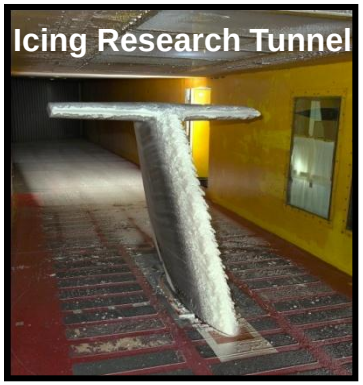
Transonic and Supersonic Propulsion Wind Tunnels

- Advanced propulsion concepts
- Inlet/Airframe Integration
- Internal/external aerodynamics



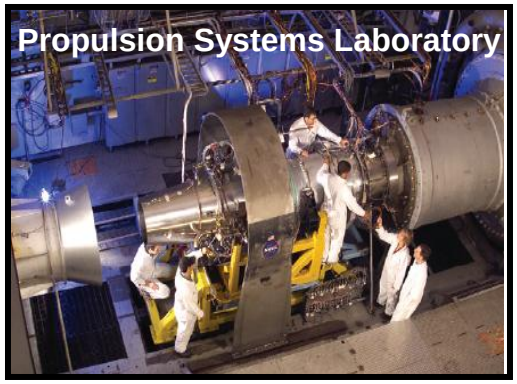
Engine Acoustic Research Facility

- Fan/nozzle acoustics research
- Simulate hot engine nozzles in flight
- Aerodynamic and Aeroacoustic measurements capabilities



Largest Icing Tunnel in US

- Aircraft icing certification
- Ice protection systems development
- Icing prediction/code validation



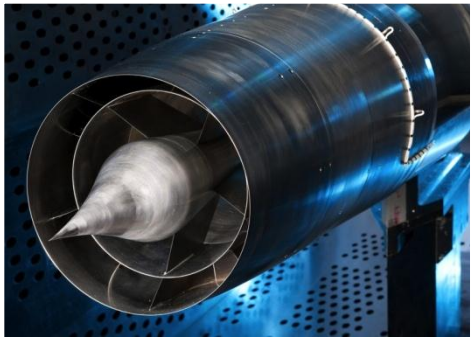
NASA’s only altitude full-scale engine facility

- Engine operability/performance
- High altitude, inlet distortion simulation
- Nozzle-engine integration/development

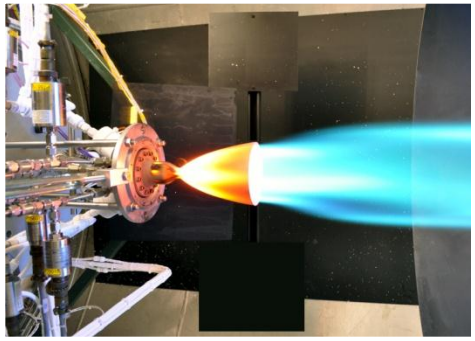
Over 50 Versatile Engine Component Facilities

- Combustor and Heat Transfer
- Compressor and Turbine
- Inlets and Nozzles

Glenn Core Competencies

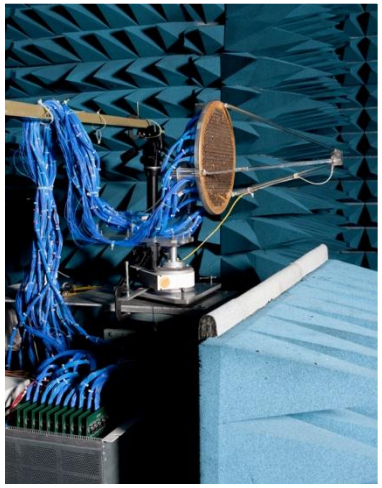


Air-Breathing Propulsion



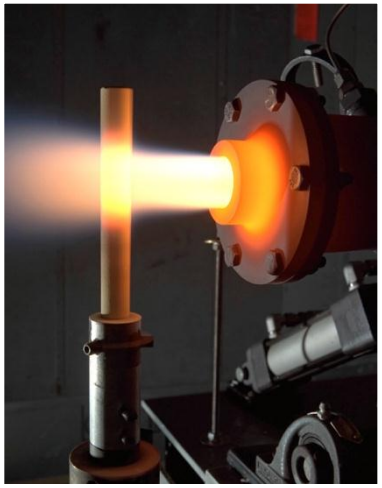
In-Space Propulsion and Cryogenic Fluids Management

Physical Sciences and Biomedical Technologies in Space



Communications Technology and Development

Power, Energy Storage and Conversion

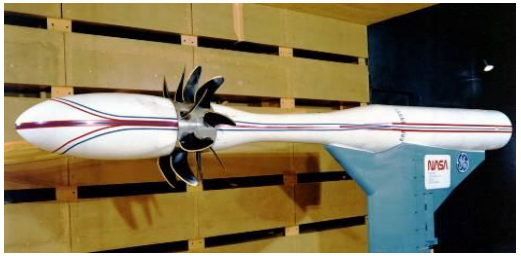


Materials and Structures for Extreme Environments

Reducing the Environmental Impact of Aviation

Advance Airframes

Open Rotor Propulsor



Geared Turbofan

Enabling technologies

- Novel architectures for increased lift over drag
- Lightweight structures
- Laminar flow to reduce drag
- Low NOx fuel flexible combustors
- Open rotors
- Ultra-high bypass turbofans
- Hybrid-Electric Propulsion
- Novel architectures for shielding airframe noise
- Distributed Propulsion

Environment Benefit/Goals

- **Fuel burn savings:**
  70% fuel burn reduction (ref B737/CFM56)
- **Emissions reduction:**
  75% less NOX (ref CAEP 6)
- **Noise reduction:**
  1/10 the nuisance noise around airports