

Configuration Aerodynamics Branch

Configuration Aerodynamics Branch

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Sally Viken, Assistant Branch Head

March 20, 2014

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D327A Richard D. White, Asst. Hd.

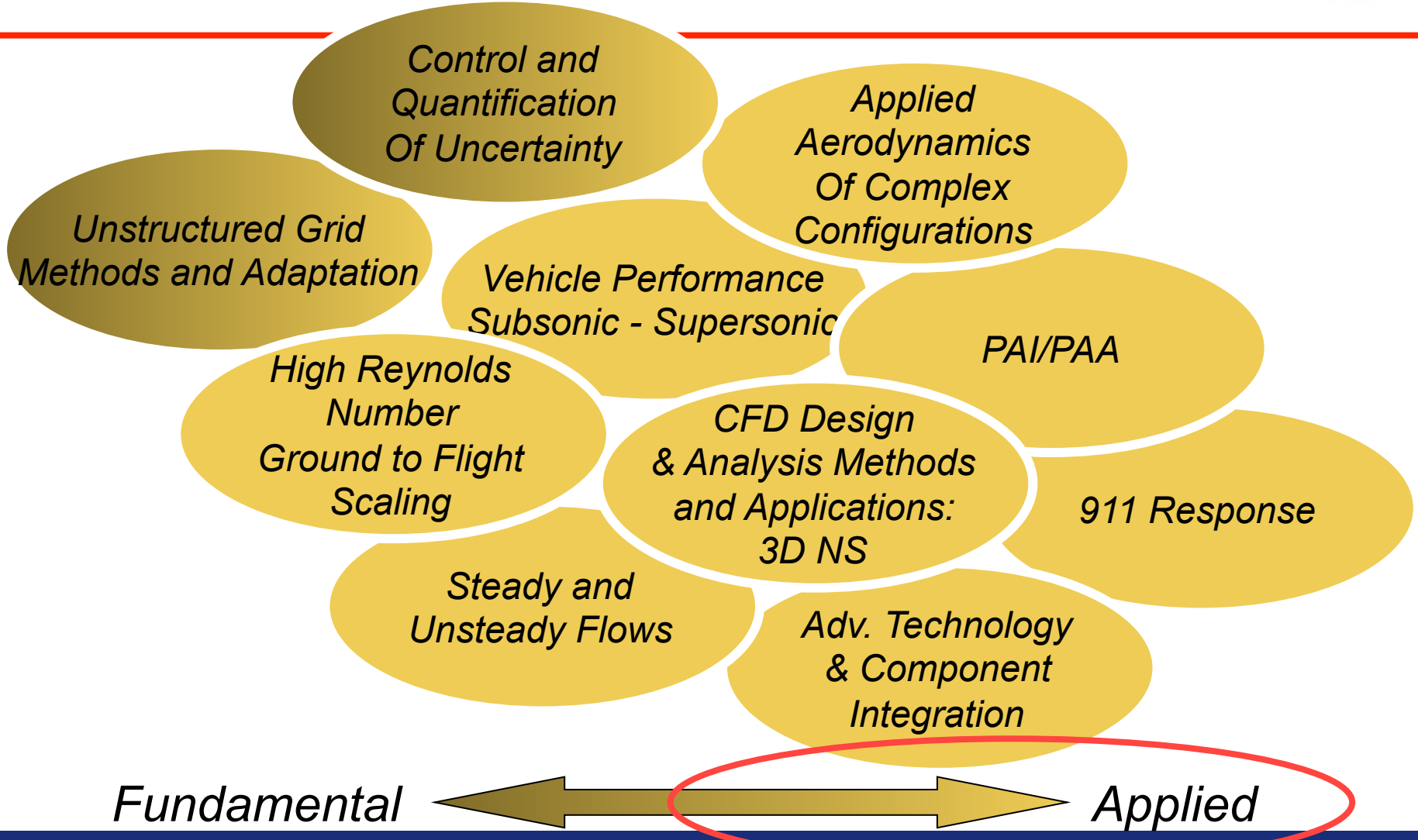
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D329 Structures Testing Branch
Lisa E. Jones, Head
D329A George F. Palko, Asst. Hd.

D330 Technologies Application Branch
Pete Jacobs, Acting Branch Head
Shawn R. Britton, Met. & Calibration Prog. Std Practice Eng.

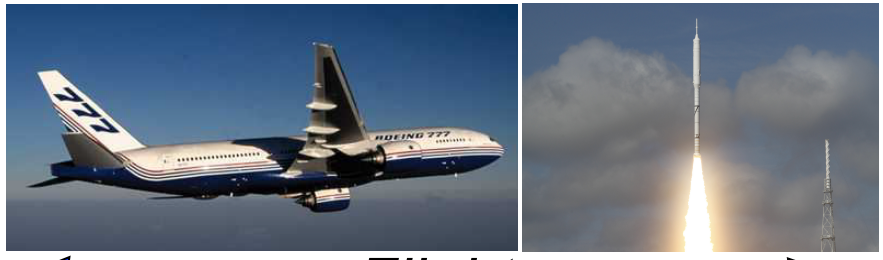
D331 Revolutionary Aviation Technologies Branch
Scott D. Holland, Head

Configuration Aerodynamics Branch



Configuration Aerodynamics Branch

Flight Prediction Tools and Technology

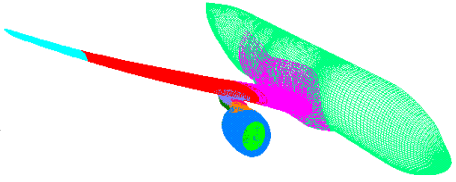


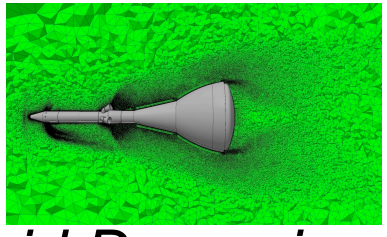
Flight





Wind Tunnel





Computational Fluid Dynamics

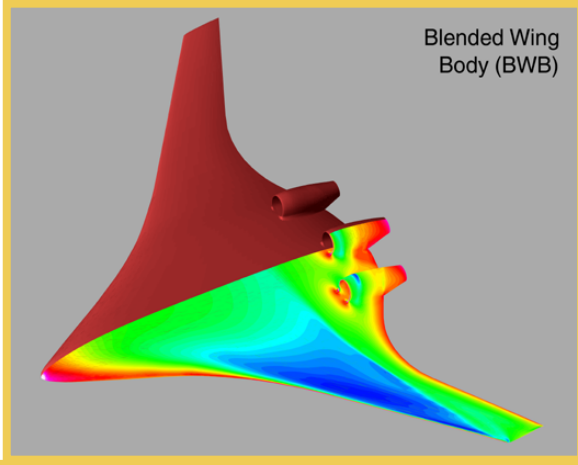
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TOOLS

Computational Methods

OVERFLOW	*TetrUSS (VGRID, USM3D) **
*PAB3D **	*CDISC (Design Driver) **
*JET3D **	*CFL3D, MSES, VSAERO, CART3D*

*(*Developers resident within CAB)*



Experimental Facilities Typically Utilized in Applied Aero Research

- *National Transonic Facility*
- *Unitary Plan Wind Tunnel*
- *14x22 Low Speed Tunnel*
- *Transonic Dynamics Tunnel*
- *Jet Exit Test Facility*
- *ARC 11', AEDC 16T, ETW*
- *Boeing Polysonic*



National Transonic Facility

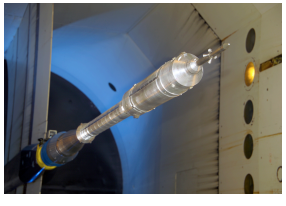
Configuration Aerodynamics Branch

Exploration/Space/Science Mission Directorates Supported

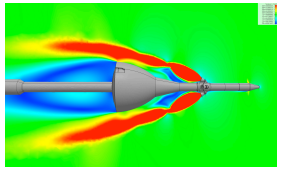
Exploration Systems Mission Directorate

Constellation Program

- *SE&I*
- *Ares I Project*
- *Ares I-X Project*
- *Ares V*
- *Orion Project*

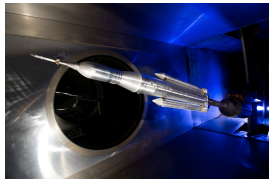






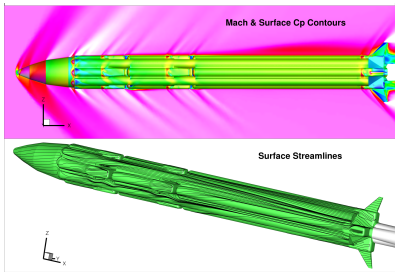
Human Exploration and Operations Mission Directorate

- *Heavy Lift (Space Launch System) Program*
- *Multi-Purpose Crew Vehicle Program*



Space Technology Mission Directorate

Soldier-Warfighter Operationally Responsive Deployer for Space (SWORDS)



Science Mission Directorate

Mars Exploration Program



Configuration Aerodynamics Branch

Aeronautics Research Mission Directorate Supported

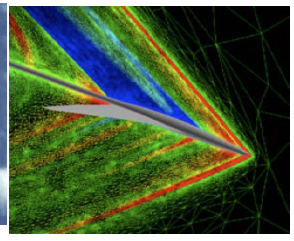
Aeronautics Test Program

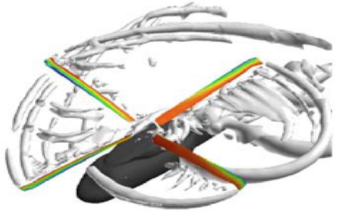


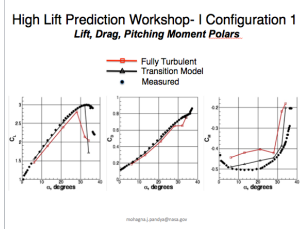
Fundamental Aeronautics Program

- *Fixed Wing Project*
- *High Speed Project*
- *Rotary Wing Project*
- *Aeronautical Sciences Project*



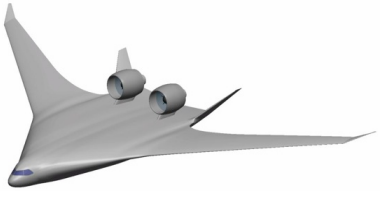






Integrated Systems Research Program

Environmentally Responsible Aircraft

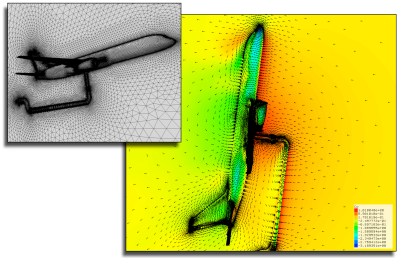




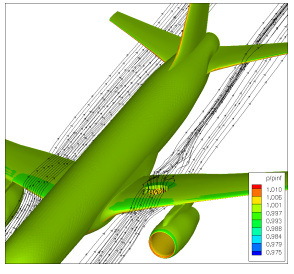
Aviation Safety Program

Vehicle Systems Safety Technologies

Deep Stall Flight Condition



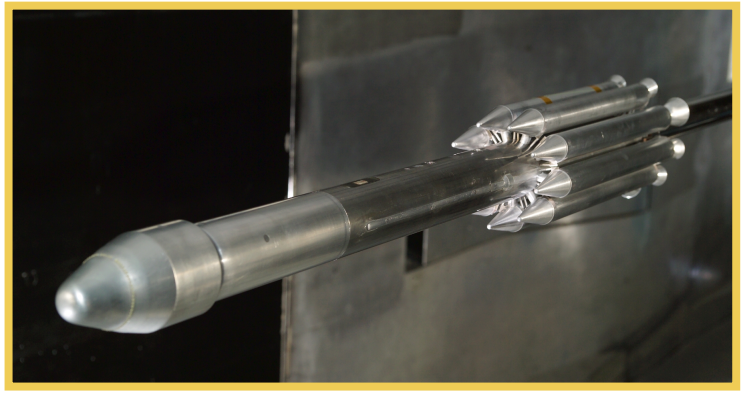
Hole in Wing Flight Condition

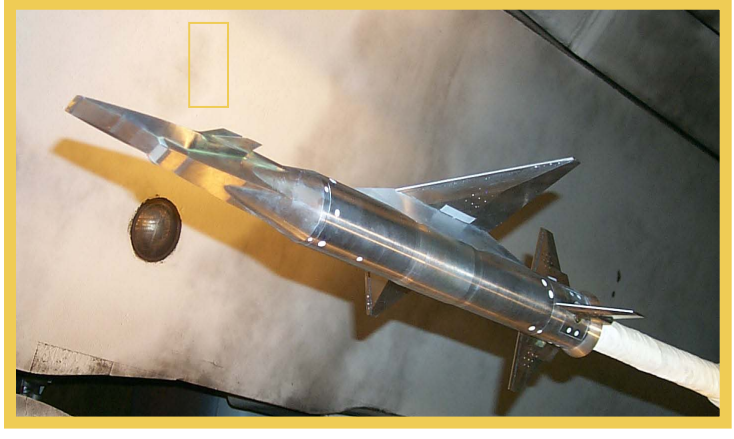


Configuration Aerodynamics Branch

DoD/Other Customer Support & 911s

- *Vehicle/component design and analysis*
- *Performance assessment and improvement*
- *911 Problem solving*
- *Physical understanding via EFD & CFD*
- *Support of DoD: F-111, F-14, F-15, F-16, F-18, B-1, B-2, F-22, Missiles, C-17, ABL, F-117, etc.*
- *Support of NASA programs: X-43A, Shuttle return to flight, Delta II Heavy launch vehicle, CLV, CEV*







CONFIGURATION AERODYNAMICS BRANCH RESEARCH HIGHLIGHTS

CAB Research Highlights

Sonic Boom Exploratory Testing

Objective

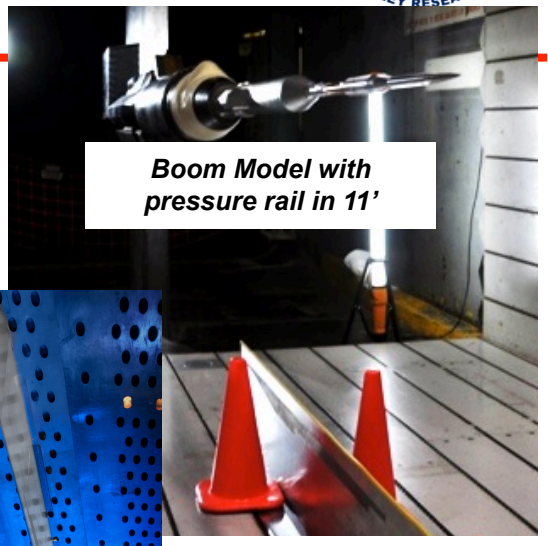
- *Obtain sonic boom data in ARC 9x7, ARC 11' and GRC 8x6 wind tunnels to determine options for future N+2 System Validation testing*

Accomplishment

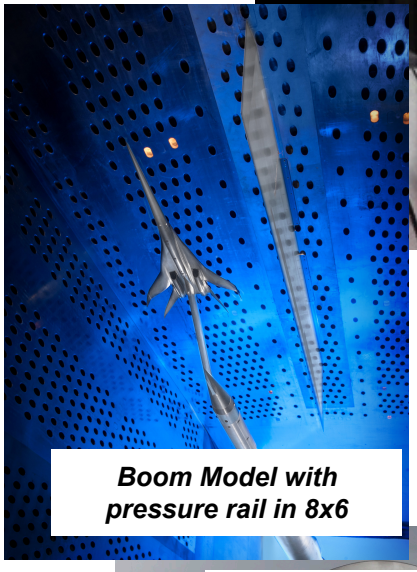
- *Validated capabilities of NASA facilities for sonic boom testing*
- *Identified approaches to significantly reducing uncertainty in sonic boom pressure measurement*
- *Maximized productivity for pressure rail testing*

Conclusions

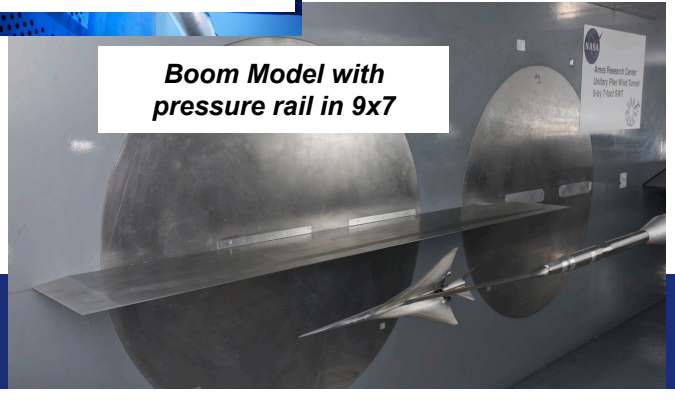
- *ARC 11'*
  - *Data can be obtained with spatial averaging technique*
  - *Model dynamics for larger models was a limiting factor*
- *GRC 8x6*
  - *Data can be obtained with spatial averaging; more experience desired*
  - *Wide Mach range makes facility attractive for tests in which sonic boom measurements are not the only objective*
- *ARC 9x7*
  - *Data can be obtained with spatial averaging*
  - *Experience established for boom testing within the Mach range of the facility*
- *Partners: ARD Wind Tunnel Division, GRC Facilities, Boeing, Lockheed Martin*



Boom Model with pressure rail in 11'



Boom Model with pressure rail in 8x6



Boom Model with pressure rail in 9x7

CAB Research Highlights

Plume Impingement Test Panel Experiment at the Marshall Space Flight Center Solid Rocket Test Motor (SRTM) Facility

An RD/NESC team piggy-backed on a solid rocket motor test firing on March 14, 2012, at MSFC with a Plume Impingement Test Panel (PITP) equipped with close to 200 aero and aero-thermal instruments, with the goal of characterizing hot plume aero-thermal environments as a risk mitigation activity for MLAS, and as a benchmark database for CFD validation of jet effects. This data set is unique and is being made available to anyone (NASA, DoD, commercial partners). The experimental data is being used in a CFD code validation effort to better understand what codes perform better in this type of harsh and highly unsteady environment.


The Huntsville Times

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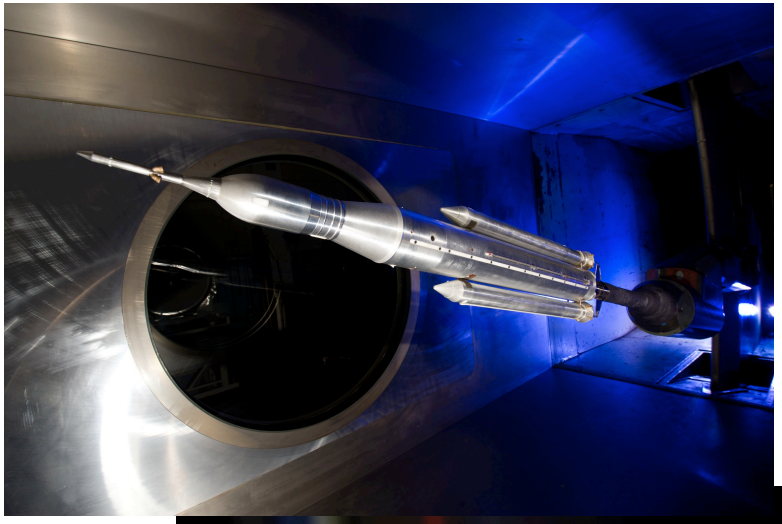
We break news online Thursday, March 15, 2012

TEST FIRING GETS THUMBS UP

CAB Research Highlights

SLS Ascent Aerodynamics Wind Tunnel Testing at the Boeing Polysonic Wind Tunnel (PSWT)

The SLS aerodynamics team from Langley completed in October 2012 a 0.8%-scale wind tunnel test of all major SLS configurations at the Boeing PSWT facility. The successful test covered the entire ascent aerodynamic conditions, from Mach 0.5 to Mach 5.0, and will result in the main ascent aerodynamic database.



NESC Wind Tunnel Testing of Alternate Spacecraft on SLS

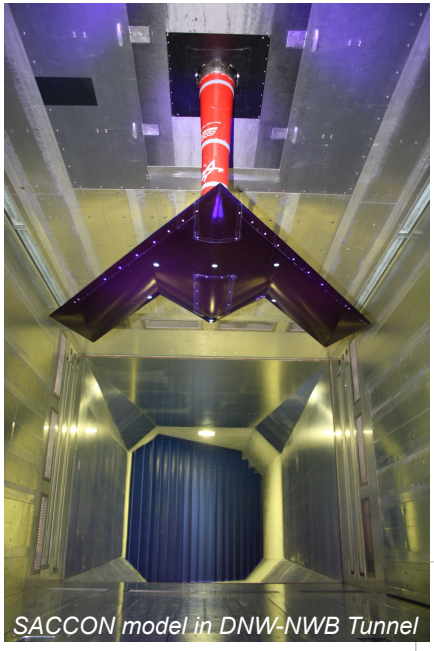
Commercial Crew providers have proposed a number of spacecraft shapes to service the International Space Station (ISS). These shapes range from a winged spacecraft similar in concept to the former Space Shuttle Orbiter to capsules and lifting bodies. A team of aerodynamicists from Langley has completed testing of five generic shapes, representative of proposed spacecraft concepts, on the SLS to determine their aerodynamic performance during launch. These tests will provide preliminary aerodynamic data should alternate spacecraft be proposed for operation using the SLS. Two tests were conducted to complete this task: the first test was conducted at the LaRC Unitary Plan Wind Tunnel (UPWT), covering the supersonic Mach range (M = 1.6 - 4.5), and the second test was conducted at the Boeing Polysonic Wind Tunnel (PSWT) facility to cover the subsonic/transonic Mach range (M = 0.5 - 1.6). Both tests were successful and data analysis is ongoing.



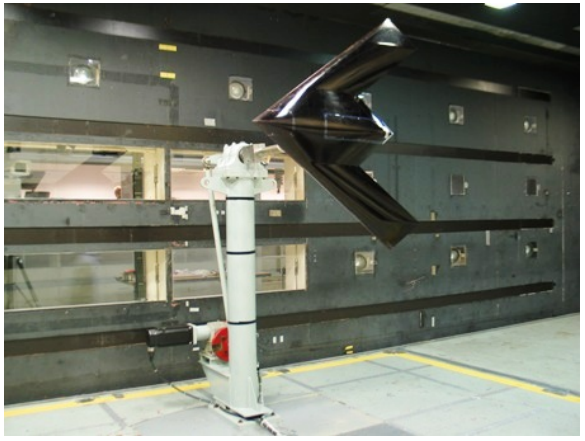
CAB Research Highlights

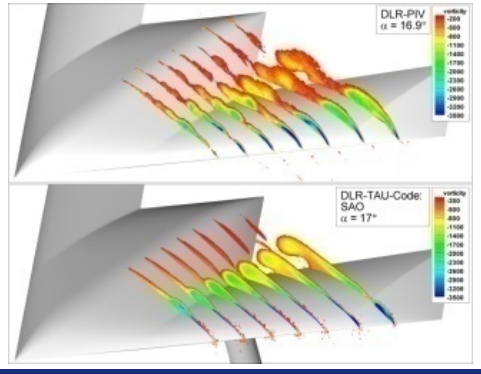
2012 NATO RTO Scientific Achievement Award

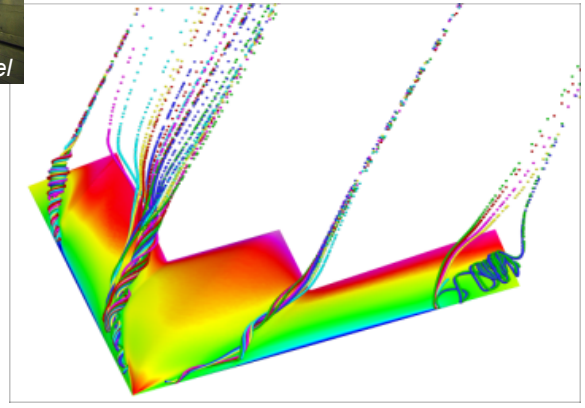
Dr. Neal Frink (Configuration Aerodynamics Branch) and Mr. Dan Vicroy (Flight Dynamics Branch) received the NATO Research Technology Organization (RTO) Scientific Achievement Award, the highest research group award within NATO, for their contributions between 2007 and 2010 to the highly successful AVT-161 task group titled "Assessment of Reliable Stability & Control Prediction Methods for NATO Air and Sea Vehicles".



SACCON model in DNW-NWB Tunnel







CAB Research Highlights

High-Reynolds-Number Circulation Control Research in the NTF with the FAST-MAC Model

OBJECTIVES

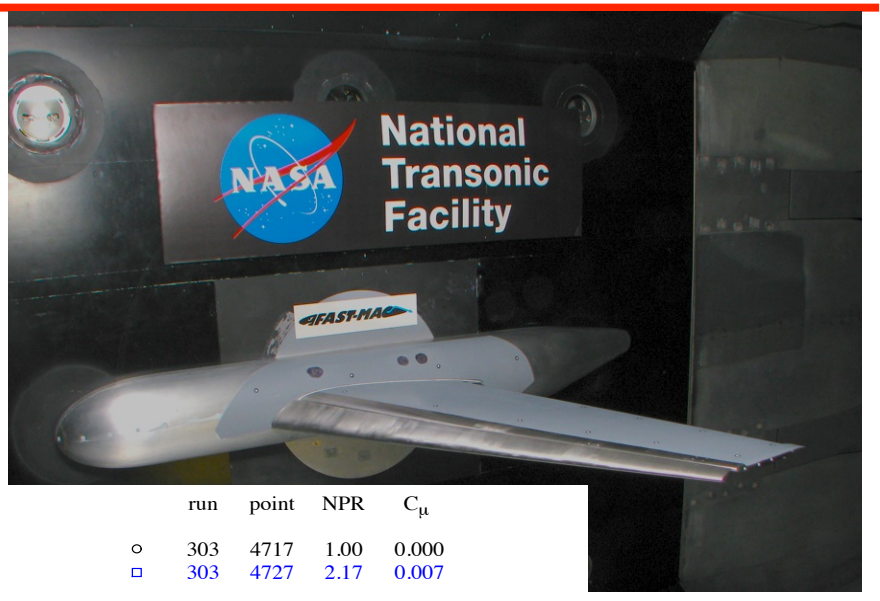
- Evaluate a simplified high-lift system comprised of a blown short-chord hinged flap, and a leading edge slat (Mach = 0.20)
- Explore the drag reduction potential of the blown flap in the stowed cruise position, at transonic speeds (Mach = 0.70 – 0.88)
- Develop a public dataset for evaluating CFD simulation and design codes at flight Reynolds numbers

APPROACH

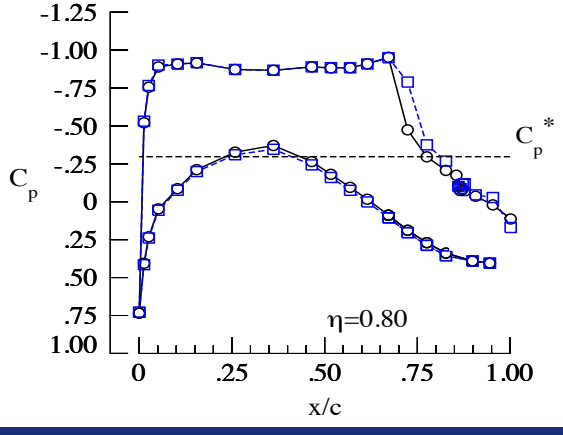
The new high-pressure air delivery station was used to supply four onboard model control valves, which allowed for independent control of the circulation control plenums. Force and moment data were obtained with the new NTF-117S balance, while surface pressure taps were used to measure the pressure distributions. A new high-speed digital data system was used in the semi-span support mechanism to control the model valves, and obtain unsteady pressure data. Cryogenic Pressure Sensitive Paint (PSP) data were also obtained in the transonic testing phase.

PRELIMINARY RESULTS

The FAST-MAC model performed well during the test due to model design features, and to expert technical assistance from the NTF staff. The Circulation Control increased the low-speed maximum lift coefficient by 40%. At transonic speeds the Circulation Control was capable of altering the shockwave pattern on the upper wing surface and affecting flow separation. Application of the technique to the outboard portion of the wing demonstrated the feasibility of pneumatic based maneuver control. Previous difficulties with cryogenic PSP were successfully overcome. Post test data analysis is required to remove the thrust contribution and document the drag reduction potential.



	run	point	NPR	C_μ
○	303	4717	1.00	0.000
□	303	4727	2.17	0.007



CAB Research Highlights

Common Research Model (CRM)

Background

- Discussion of building an open, modern and relevant geometry occurred at an AIAA Technical Working Group Meeting in 2006
- Open subsonic transport aircraft geometry with contemporary transonic supercritical wing designed to help develop experimental databases for the purpose of validating specific applications of CFD
- CRM is part of an international, collaborative ongoing effort
- Completed two test in the NASA Langley National Transonic Facility and one in the NASA Ames 11-foot Wind Tunnel
- Have released both force & moment and pressure data from the first NTF test and Ames 11-ft data to the Drag Prediction Workshop
- Ability to be tested at numerous wind tunnels to help anchor the experimental measurements and corrections methods between facilities.
- Provided information to JAXA so they could build their own 89% (of our 2.7%) scale CRM
- Website set up where anyone world-wide can obtain any wind tunnel and CFD data that have been released
- Discussion is ongoing on possible use of the CRM data for next aeroelasticity workshop

Recent and Upcoming Tests

February 2014 – ETW Test in Germany

- Objective - to further understand and predict unsteady wake effects by using various methods: wing deformation measurements, pressure distributions on the wind and along the wind tunnel walls, and time resolved PI

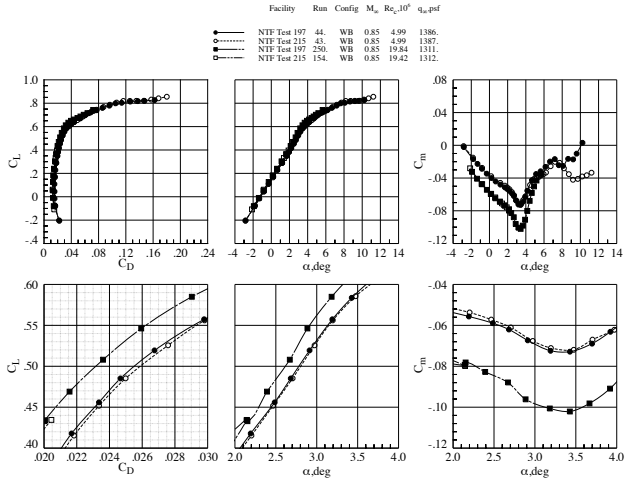
Summer 2014 - TsAGI T-128 Test in Russia

- Objective - to acquire data and compare them with existing wind tunnel data and CFD simulations; evaluate the effects of wall porosity on the CRM model

Reference Quantities

- *2.7% scale*
- *S_{ref} = 433.55 in^2*
- *MAC = 7.45 inches*
- *span = 62.47 inches*
- *AR = 9.0*
- *Designed for M_∞ = 0.85 and C_L = 0.5*

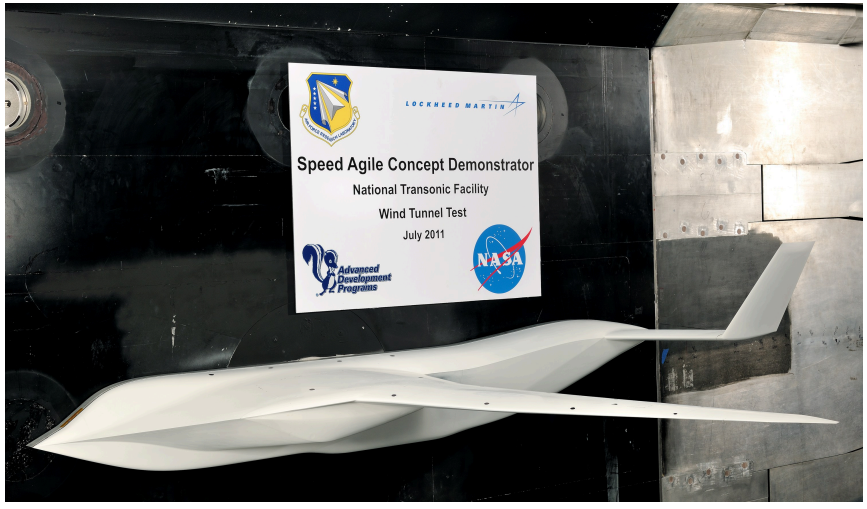
WB Configuration, M=0.85





CAB Research Highlights

High-Reynolds-Number Testing of the Lockheed Martin Speed Agile Concept Demonstrator (SACD) in the NTF





SUMMARY

Joint AFRL/NASA test of the Lockheed Martin SACD configuration to validate the transonic cruise performance at flight Reynolds numbers. Propulsion simulation and active flow control on the wing powered by the new high-pressure air station.

ONGOING ACTIVITY

Post-test pressure tare calibration to characterize bellows effects on force and moment data, including temperature effects. Pre-test calibration halted due to hardware limitations (Nov. 2011)

CAB Research Highlights

MIT D8 N+3 Configuration - Investigation in 14x22 Foot Subsonic Tunnel

Problem: Recent studies have shown the D8 configuration provides substantial performance benefit, a large part of which is attributed to boundary layer ingestion (BLI). These study results need to be experimentally evaluated.

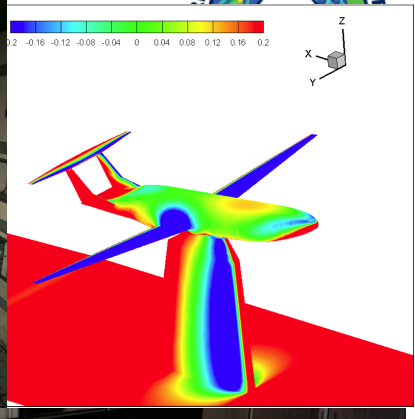
Objective: Experimentally assess the configuration drag benefits of BLI for the D8 configuration.

Approach: Obtain experimental data at simulated cruise conditions for the podded and integrated configurations and complement that dataset with computational analysis.

Results: Completed 4 weeks of testing on 9/16/13. Collected force & moment data, rake surveys of engine inlet and exit flows, surface pressures, and surface tuft visualization. Preliminary results indicate a 20-25 drag count reduction for the integrated configuration when compared with the podded configuration. This equates to an electrical power savings on the fans of roughly 5-8%.

Significance: Preliminary analysis of experimental results confirm the potential benefits of BLI for drag/fuel burn reduction.









CAB Research Highlights

ERA - 5.8-Percent Scale Hybrid Wing Body Configuration

A low-speed experimental investigation has been conducted on a 5.8-percent scale Hybrid Wing Body configuration in the NASA Langley 14- by 22-Foot Subsonic Tunnel. This Hybrid Wing Body (HWB) configuration was designed with specific intention to support the NASA Environmentally Responsible Aviation (ERA) Project goals of reduced noise, emissions, and fuel burn. This HWB configuration incorporates twin, podded nacelles mounted on the vehicle upper surface between twin vertical tails. Low-speed aerodynamic characteristics were assessed through the acquisition of force and moment, surface pressure, and flow visualization data. Longitudinal and lateral-directional characteristics were investigated on this multi-component model. The effects of a drooped leading edge, longitudinal flow-through nacelle location, vertical tail shape and position, elevon deflection, and rudder deflection have been studied.



