Aerospace Research Center
Mo Samimy

Experimental Laboratories and Capabilities

• Aeronautical and Astronautical Research Laboratories
  – Gas Dynamics and Turbulence Laboratory
• Gas Turbine Laboratory
• Don Scott Airport (General Aviation Airport)
• Nonequilibrium Thermodynamics Laboratory
• Center for Electron Microscopy and Analysis
• ElectroScience Laboratory
• 2x2x4 ft subsonic tunnel with speed up to 100 m/s (aircraft takeoff and landing speed) – various optical diagnostics, time-resolved pressure

• Flow control in slowed rotor compound vehicle using NS-SBD actuators (ARO/ARL)

Phase-averaged swirling strength (Re = 5.10^5, \( \alpha = 15^\circ \), St_F = 0.2, St = 0.2)
• 2x2x4 ft subsonic tunnel with speed up to 100 m/s (aircraft takeoff and landing speed) – various optical diagnostics, time-resolved pressure

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Control effect on peak pressure
• 2x2x12 in. supersonic wind tunnel (up to Mach 5) – pressure/optical diagnostics
• Flow control for shock trapping in scramjet isolator (AFRL/ISSI)

Suppression of pressure within the cavity – frequency/time analysis: M=0.6, top (baseline); bottom (3-D forcing with f = 7550 Hz)
• 3x3x12 in. supersonic wind tunnel (up to Mach 5) – various optical diagnostics
• Flow control for shock/boundary layer interaction (AFOSR) using LAFPAs

Schematic of supersonic tunnel test section with shock generator and the location of plasma actuators
Aerospace Research Center (ARC)

Prof. Mo Samimy
Gas Dynamics and Turbulence Laboratory

- Jet facility with anechoic chamber for jet noise research (with forward flight effect) – near/far-field acoustics and optical measurements
- Jet control for noise mitigation with single jet and twin jets (AFOSR, ONR)
Research Overview:

- Understanding and control of unsteady, separated flows
  - Dynamic Stall
  - Bluff-body wakes
- Unique approach:
  - High-resolution optical diagnostics
  - Flow Control with Three-dimensional forcing
- Application focus: rotorcraft
- Goal: Efficient flight, low noise, higher performance
• Time-varying freestream effects on compressible dynamic stall (ARO YIP)
• Unsteady pressure measurement on rotor blades (Vertical Lift COE / NASA)

OSU 6”x22” Transonic Blowdown Wind Tunnel for Dynamic Stall Investigations

Particle-Image Velocimetry (PIV)
Pressure-Sensitive Paint (PSP)

Unsteady PSP on Rotor Blade in Forward Flight

PIV / PSP Setup at NASA Langley (ref: NASA)
Multidimensional Forcing Strategies for Bluff Body Wake Control (AFOSR) – target 3D instabilities in the wake

Wake profile resulting from spanwise forcing of 3D DBD Plasma Actuators

Phase-Averaged Vorticity from Hot Wire Data

Spatially-modulated forcing using 3D DBD plasma actuation (PIV results)

Larger and weaker vortex, offset from centerline

Smaller and stronger vortex, closer to centerline and phase delayed

Porter et al.
Blowdown Mach 2-5 Nonequilibrium Flow Wind Tunnel

Diagnostics: psec CARS (T, T_v), high frame rate NO PLIF, NO_2 MTV, Laser Differential Interferometry (LDI)

Plenum pressures from 0.25-1 atm
5-10 sec state run time
Ample optical access
High amplitude / bandwidth plasma flow actuators in supersonic section

Sustaining nonequilibrium flows:
N_2 vibrational energy loading by a ns pulse / DC discharge in nozzle plenum
Flow downstream of discharge: T_{rot} = 380-450 K / T_{vib} = 700-2000 K
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