Computational Assessment of the D8 Series N+3 Subsonic Transport Configuration

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Background

- D8 series aircraft configuration offers large potential efficiency benefit
- Computational assessment to address configuration challenges
  - Unconventional design traits: “double-bubble” fuselage, boundary layer ingestion
  - Potential challenges: engine response to distortion, tail configuration aerodynamics

Goals of Computations

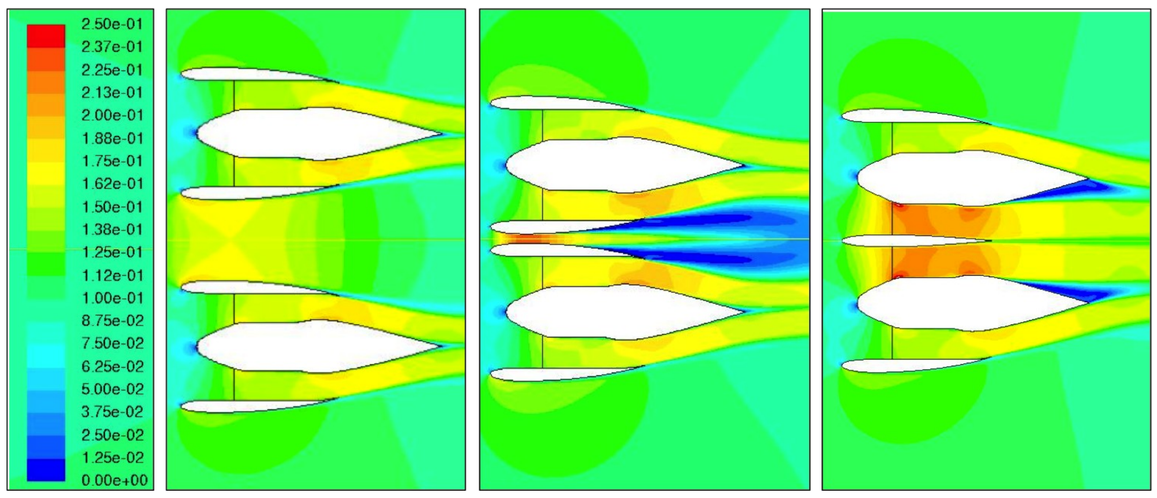
- Complement experimental assessment of D8 series configuration performance
- CDF-based design of fan and airframe-propulsion system integrated geometries for experimental tests
- Provide evaluation of full-scale, full-speed D8 aircraft

Computational Fluid Dynamics studies of internal and external flows, including flow around engines with simplified actuator-disk approach, flow through fan and nacelle with body-force methodology, flow around powered aircraft model and full-size aircraft.

Two-Engine Integrated Propulsion System

- Parametric study of engine integration using high fidelity simulations
- Simplified 2D study
  - Merged double-engine configuration yields highest thrust performance
  - Flow separation for small separation distances
- 3D simulations under way to determine engine integration for D8 aircraft
  - Design aft fuselage shape for optimal flow diffusion

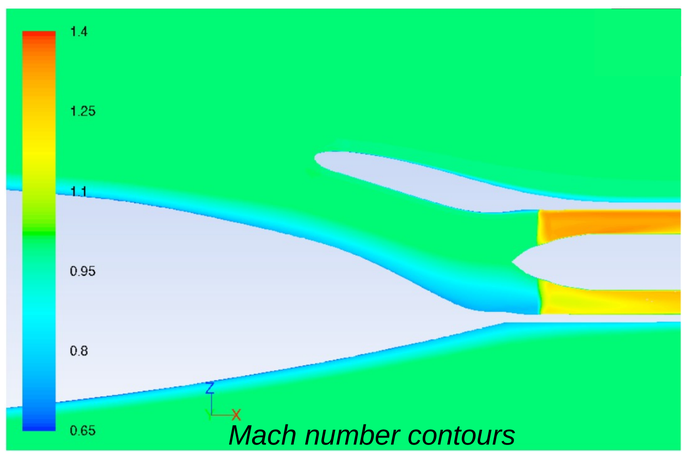
Mach number contours for different separation distances: 2D study



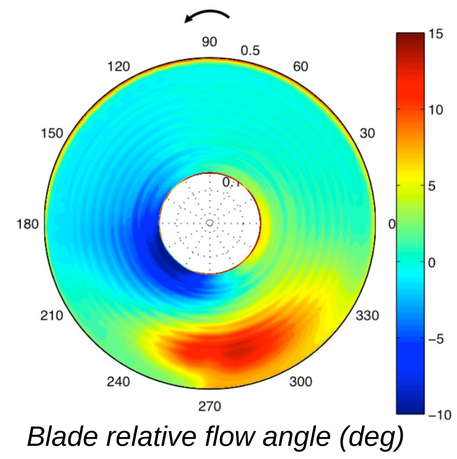
Body-Force Description of Fan Operation in Distortion

- Replace rotating geometry with distributed source field
  - Source terms determined from range of calculations on bladed geometry
  - Captures distortion transfer, “smears out” blade-to-blade effects
- Well-suited for use as design tool for distortion-tolerant fan
  - Fast computations: steady flow on medium-sized grid
  - Used for N+2 boundary layer ingesting (BLI) propulsor analysis

N+2 BLI propulsor over hybrid wing-body configuration



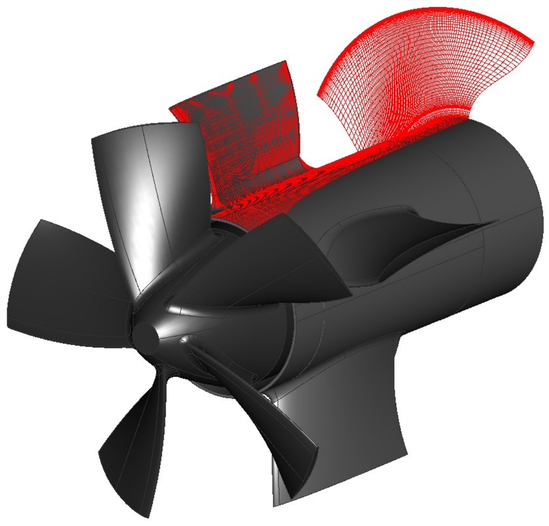
Mach number contours

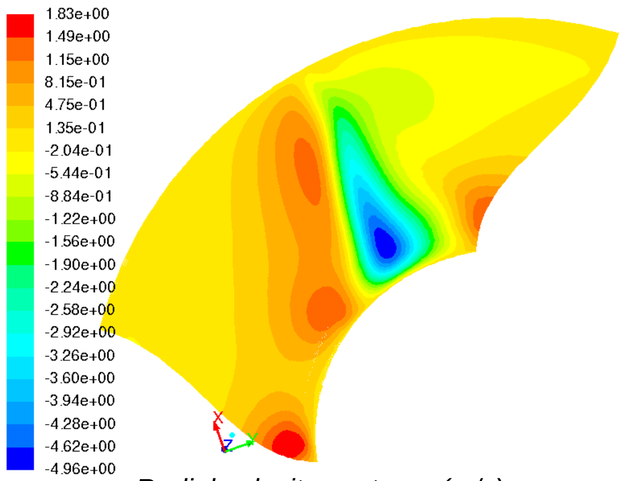


Blade relative flow angle (deg)

Fan Simulations

- Analysis of flow through commercial off-the-shelf large RC airplane engine for 1:11 scale D8 experiments
- In-house design of distortion-tolerant fan for 1:4 scale D8 experiments

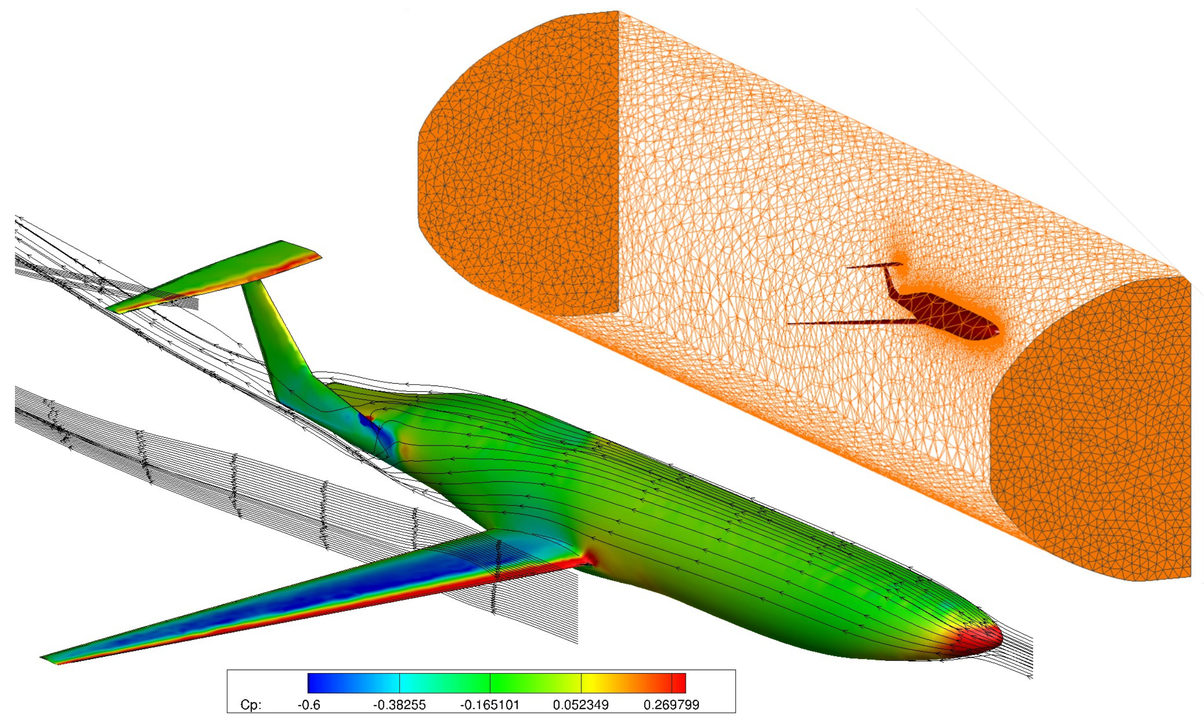




Radial velocity contours (m/s)

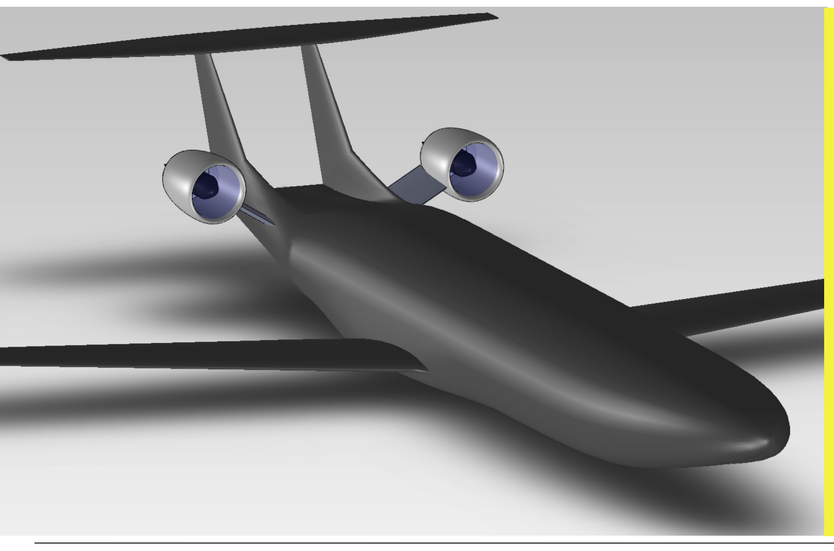
Simulations of Unpowered Airframe in Wind Tunnel

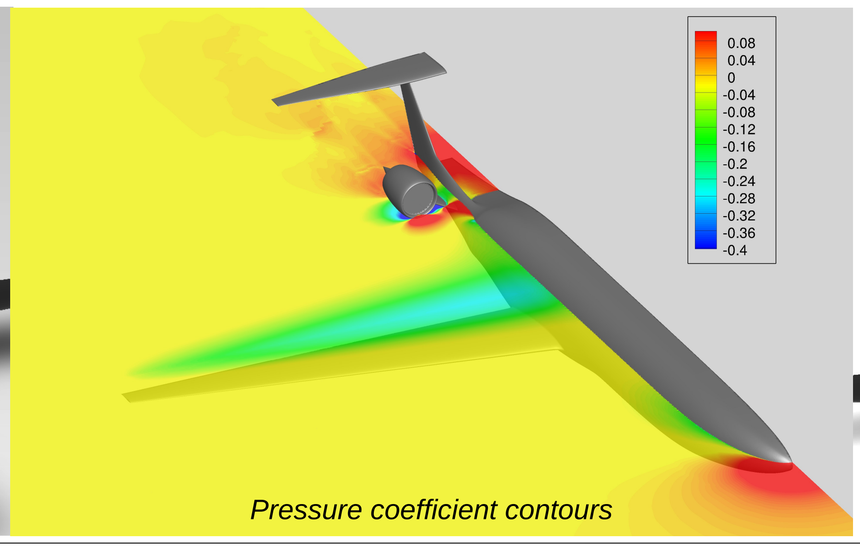
- Conditions of experimental test in MIT Wright Brothers Wind Tunnel



D8 Aft Section Design: Propulsion System Integration

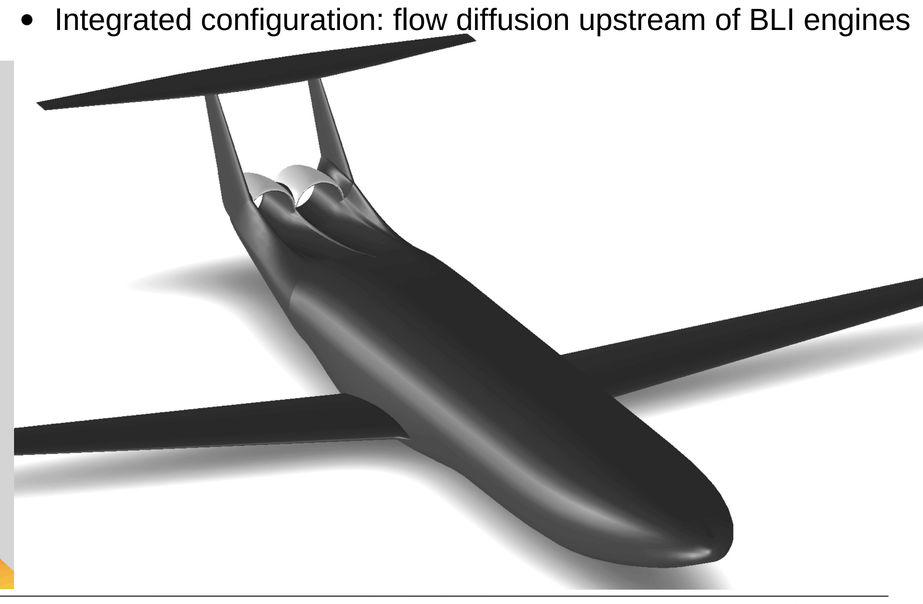
- Podded configuration: designed for minimal interference with fuselage-wing-empennage





Pressure coefficient contours

- Integrated configuration: flow diffusion upstream of BLI engines



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