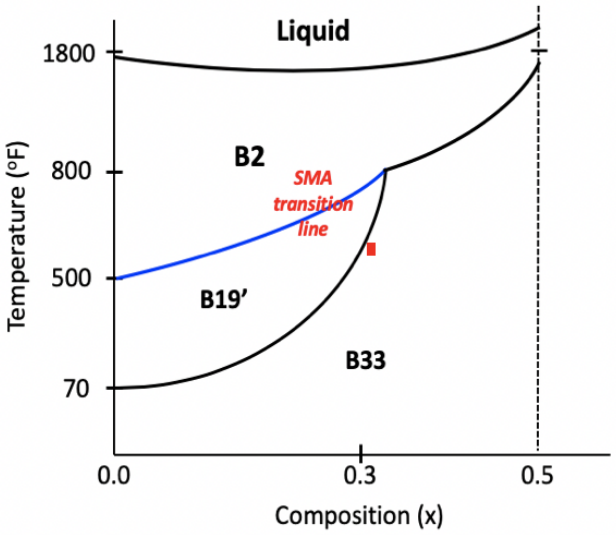
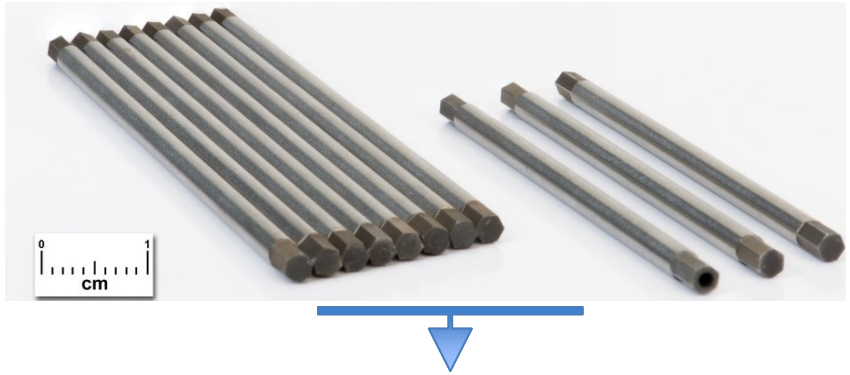
Shape Memory Alloy (SMA) Vortex Generators
2019 ecoDemonstrator flight test November 2019

- **Benefits**: Reducing aerodynamic drag during cruise, the longest segment of flight, improves fuel efficiency and lowers CO2 emissions.
- **How it works**: SMA technology enables vortex generators to change their configuration with temperature — deploying during takeoff/landing and retracting into the wing during cruise when the air is colder. Three SMA reconfigurable technology vortex generators (SMART-VGs) are being tested on the upper right wing, aft of the engine pylon on the Boeing 777 aircraft.

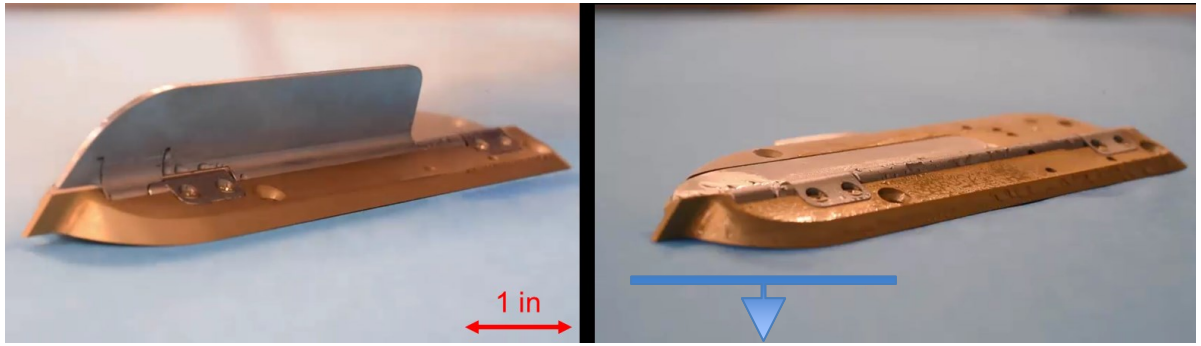


Computational tools used to help select material composition

Low-temperature SMA tubes/rods



VG deployed and retracted



VGs instrumented and ready for flight

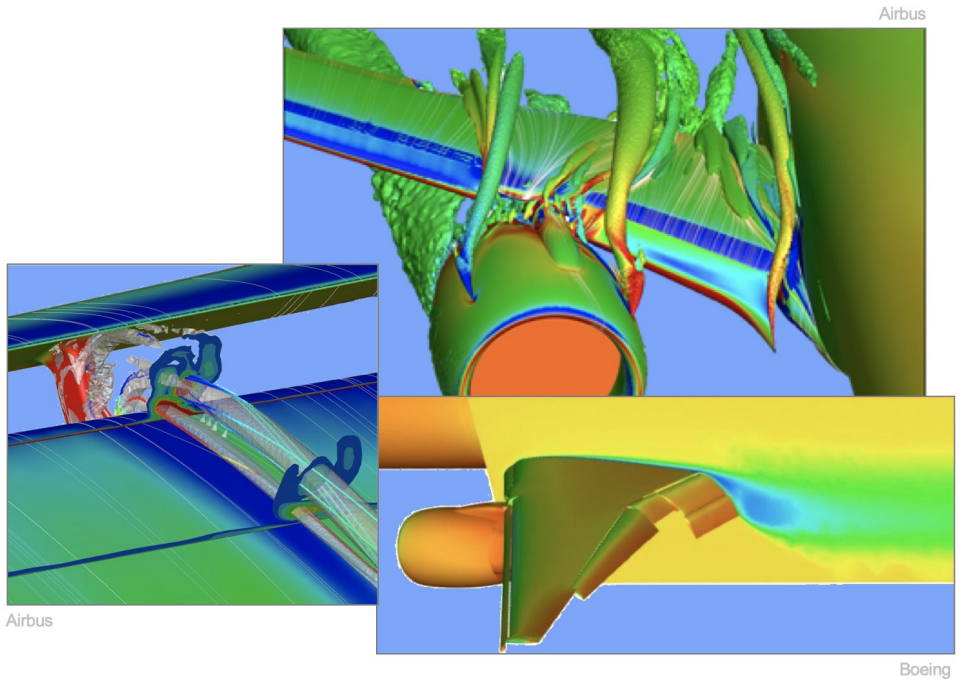
Efficient Eddy-Resolving Methods for CL*max* Prediction

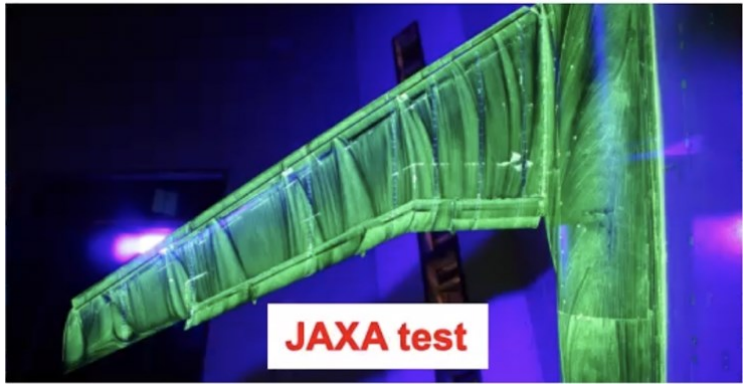
BCA Engineering | **Flight Sciences**

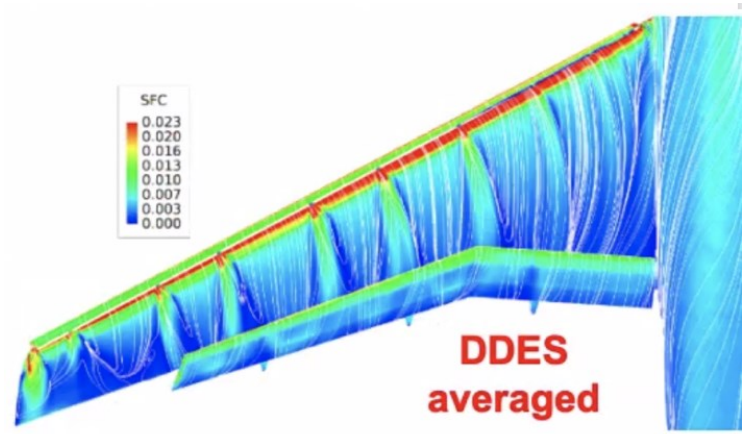
High Lift Flow Modeling is Complex and Challenging

- Computing flow around high lift wings is complicated due to **multiple, interfering, and unsteady flow features**, such as turbulent boundary layers, vortices, and wakes
- **Geometric complexity** drives mesh resolution, which creates demanding computing requirements
- **Adequate mesh resolution** is needed for robust propagation of flow features
- **Accurate physical modeling** (e.g. turbulence) is required to make high-lift flow modeling tractable

Modeling improvements are required to close gaps between the virtual and real worlds





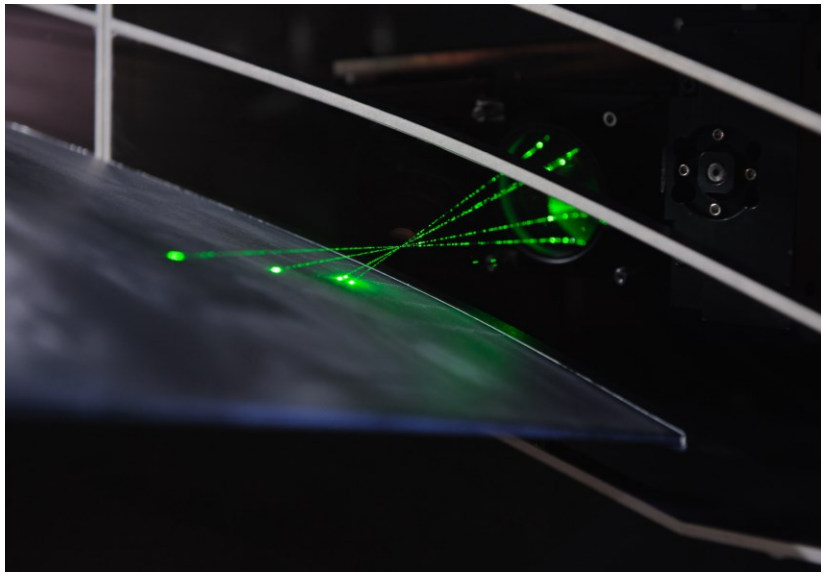


Identify opportunities for near-term impact of analytical tools to reduce certification time and cost

Validation Experiments for Computational Tool Validation

QWSS

NASA Juncture Flow Experiment in LaRC 14'x22' wind tunnel



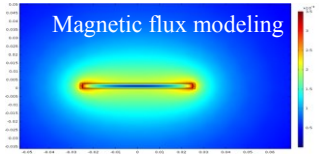
On-board Laser-Doppler Velocimetry (LDV)

wall rake

A CFD Validation Experiment should include the measurement of all information, including boundary conditions, geometry information, and quantification of experimental uncertainties, necessary for a thorough and unambiguous comparison to CFD predictions.

Enabling Fundamental Technologies for Electrified Aircraft Propulsion (EAP)

High Voltage Power Cabling



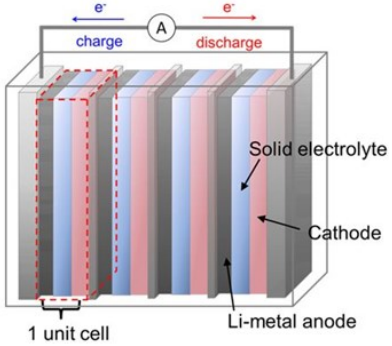
Goal - large reduction of weight & concurrent increase in power for high voltage power distribution.
Why do more?- SOA high voltage cabling is large & heavy. Planes are limited to 250V. Industry is actively pursuing 500 V operation. 1-2 MW needed for urban air mobility; 30 MW is required for regional jet service. Thermal management issues.

New Energy Storage

Goals

- Solid state architectures
- Safer
- New chemistries
- Higher energy densities
- Lighter weight

Why do more?- aero has unique requirements – higher cycle life, lighter weight, safety.



Advanced Multi-Functional Materials & Manufacturing

Goals - Light weight components & actuation

- Stream line processing & manufacturing
- Efficient interface design
- Near net shape actuator design by additive manufacturing

Why do more?- replace heavy components and hydraulics.

Soft Magnetic Materials

Goal - improved efficiency
Soft magnetics are in all electric motors, inductors & components, actuators, EMI shielding, electronics, sensors, etc. *Why do more?*- otherwise component size, weight & temperature increase with higher voltages.

Inductor made with NASA GRC Ribbon for Eaton.