



NASA Icing Research Update 2024

Presentation for the
2024 AIAA Aviation Conference
August 1, 2024 | Las Vegas, NV, USA

Presenter

Dr. Peter M. Struk

Chief, Icing Branch

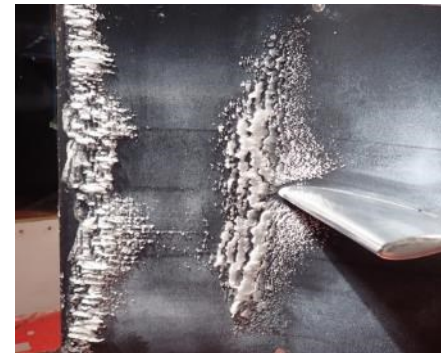
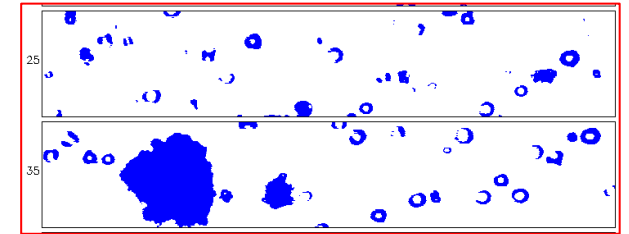
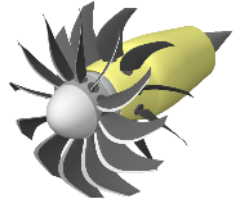
NASA Glenn Research Center

Cleveland, Ohio, USA



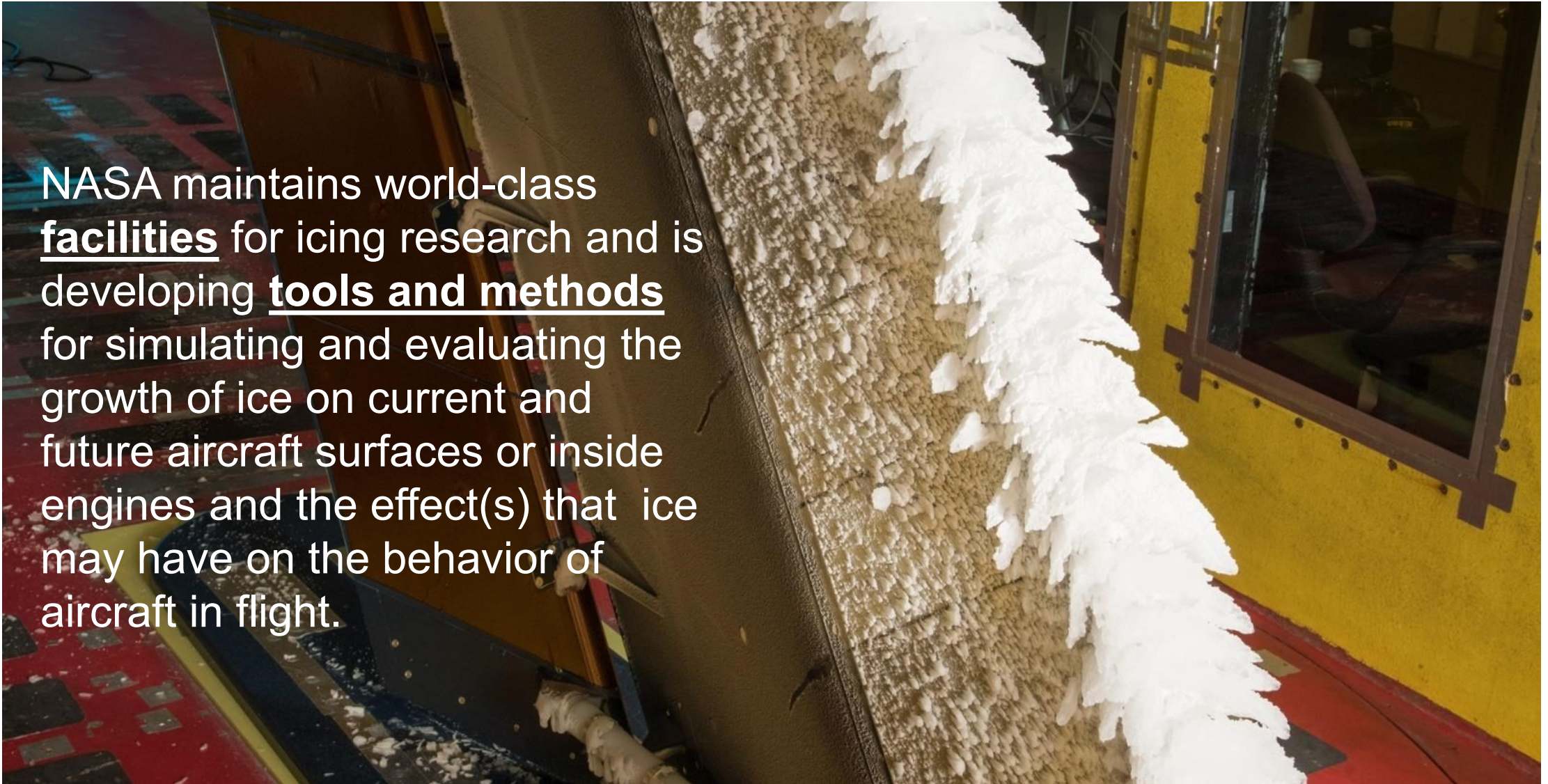
Outline

- NASA's Icing Mission
- Capability Portfolio:
 - Test Facilities, Laboratories, and Computational Tools
- What we are working on
- Ways NASA collaborates!



NASA's Mission in Icing

NASA maintains world-class facilities for icing research and is developing tools and methods for simulating and evaluating the growth of ice on current and future aircraft surfaces or inside engines and the effect(s) that ice may have on the behavior of aircraft in flight.

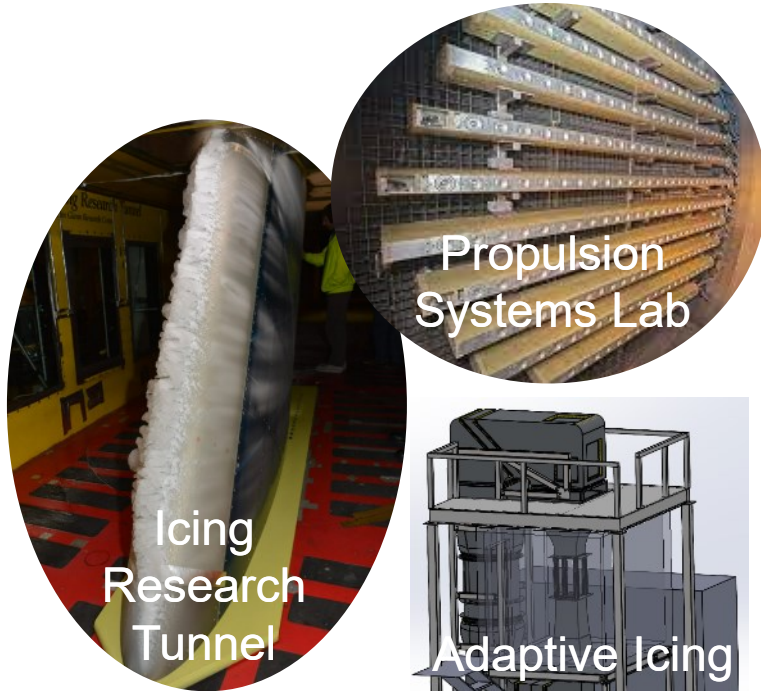




NASA's Portfolio of Icing Capabilities

<https://www1.grc.nasa.gov/aeronautics/icing/>

Facilities



Revolutionary Icing Materials Evaluation Laboratory for Adhesion Mitigation Projects

Our Staff



Laboratories



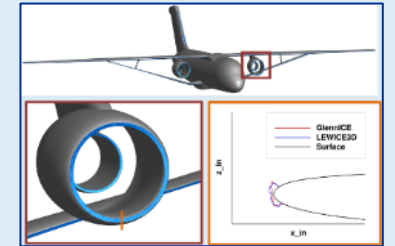
Simulation Tools

Ice accretion software

LEWICE

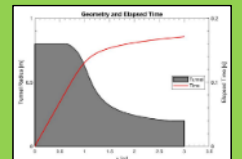
LEWICE 3D

GlennICE



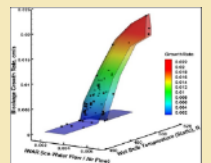
Facility Simulation

TADICE



Engine Icing Risk

COMDES-MELT





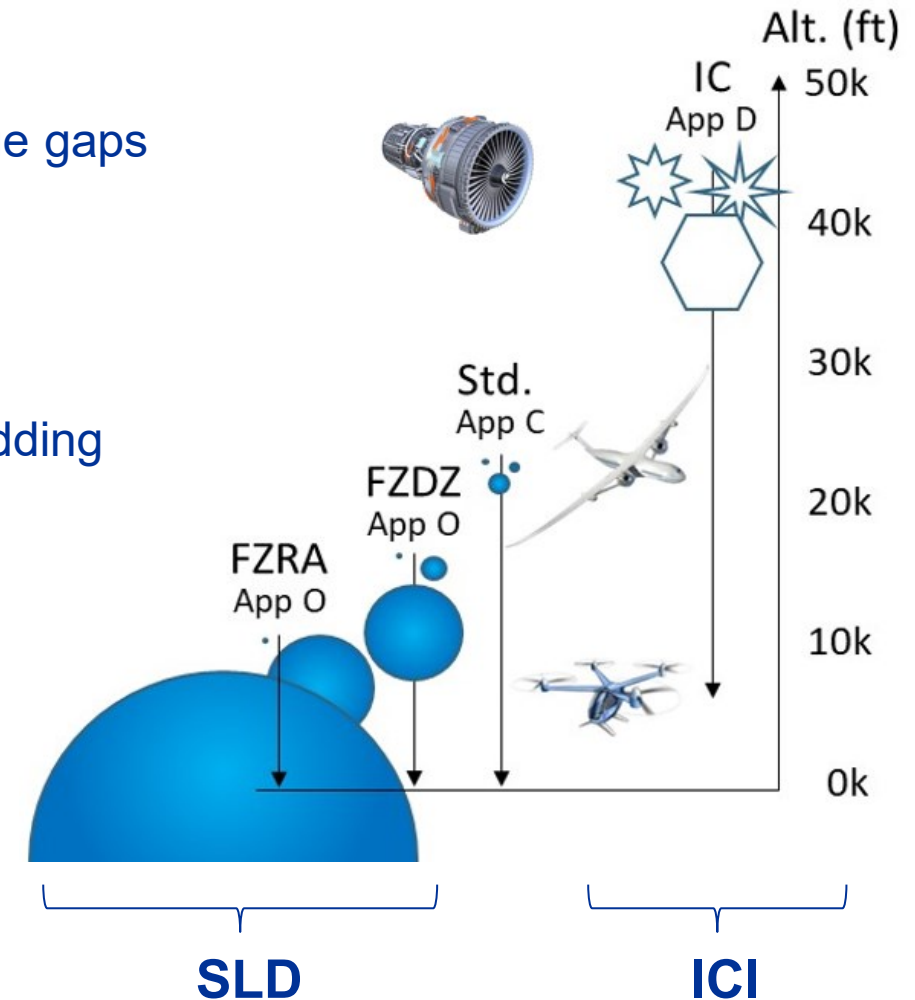
Icing Analysis of Alternatives Study Outcomes (2020-2021)

NASA priority needs

- 3D icing simulation capability for vehicle assessment
 - Assess **Transonic Truss Brace Wing** icing impacts & knowledge gaps
- Low ice adhesion material development
- Build icing assessment capability for AAM vehicles
- Engine Icing:
 - Continue ice crystal icing (ICI); shift some focus to fan icing / shedding
 - Supporting the assessment of engine ICI certification envelope

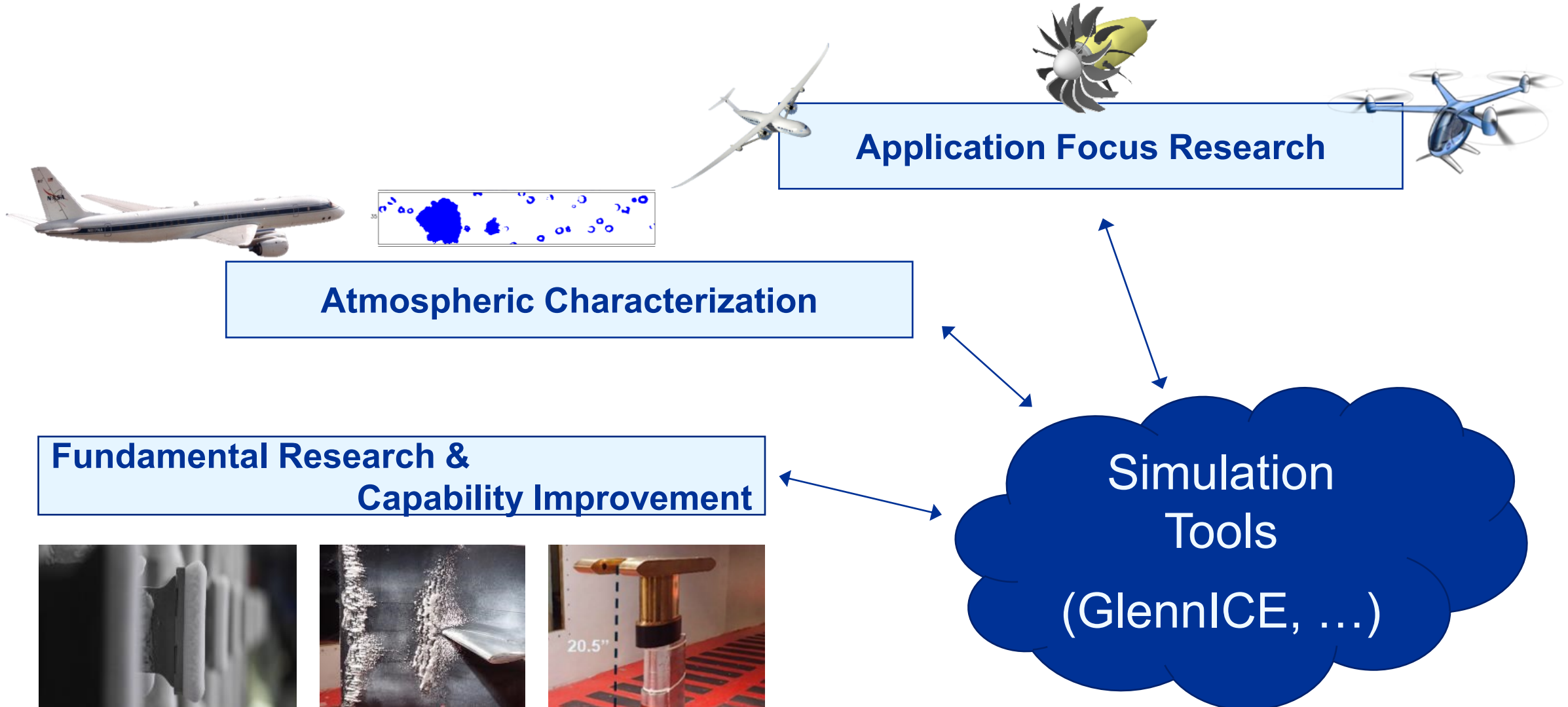
Community enduring needs

- Continue foundational icing physics studies in the public to improve current capabilities
 - Especially in newer areas such as SLD and ICI





What we're currently working on...





GlennICE

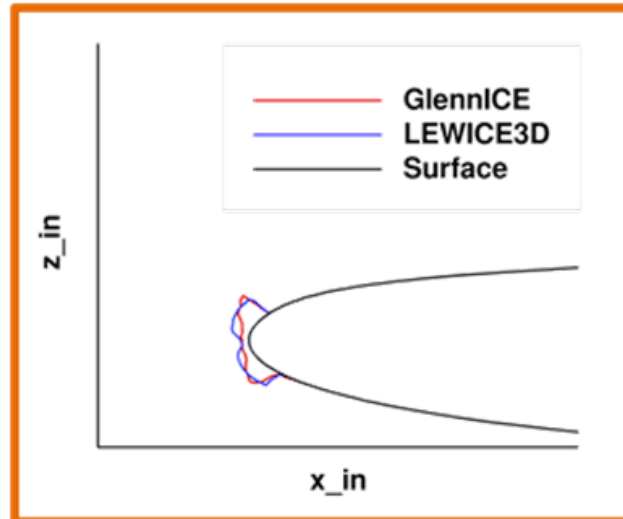
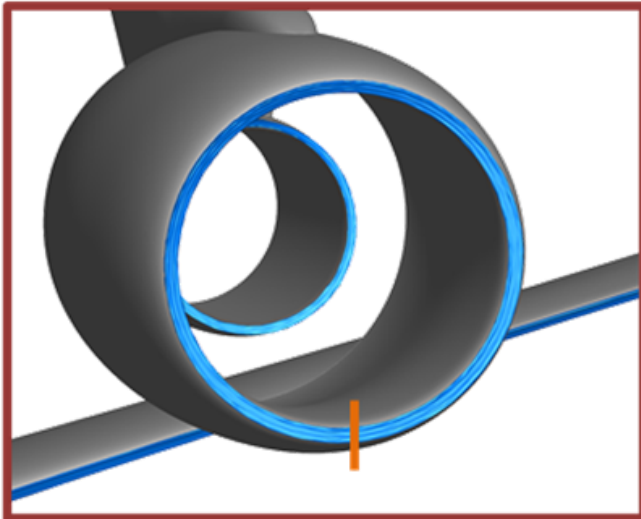
- Fully 3D icing simulation and particle tracking tool
- CFD post processor
- Lagrangian droplet tracking with adaptive refinement
- Predicts water impingement & resulting ice growth on arbitrary aircraft surfaces
- Fully parallelized trajectory scheme built for HPCs

GlennICE [1]

External Icing

Rotational Icing

Ice Crystal Icing



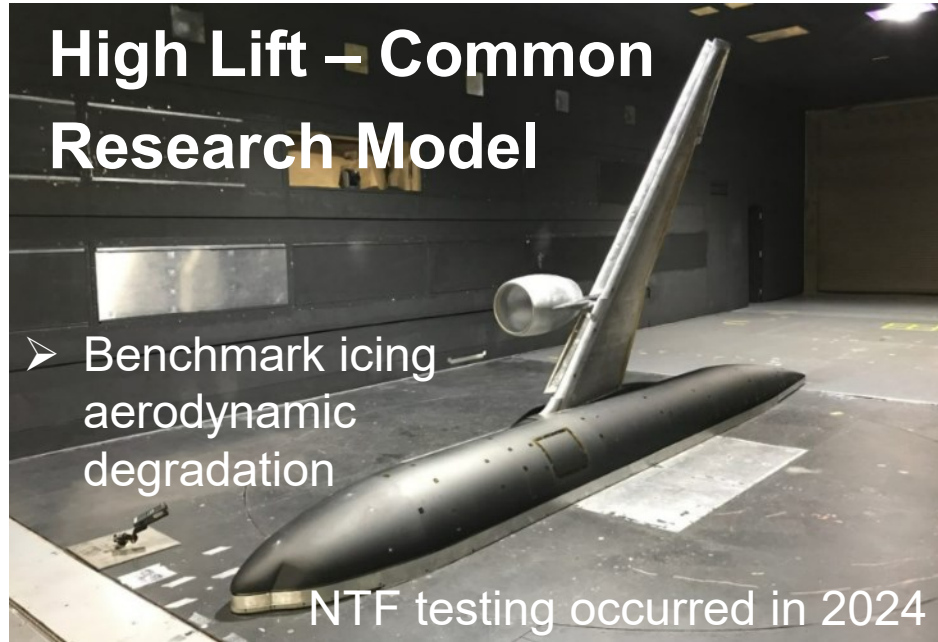
As of 2018, **GlennICE** is the foundational code through which NASA will develop and evaluate physical models associated with ice accretion

Ongoing Application Focused Research

High Lift – Common Research Model

- Benchmark icing aerodynamic degradation

NTF testing occurred in 2024



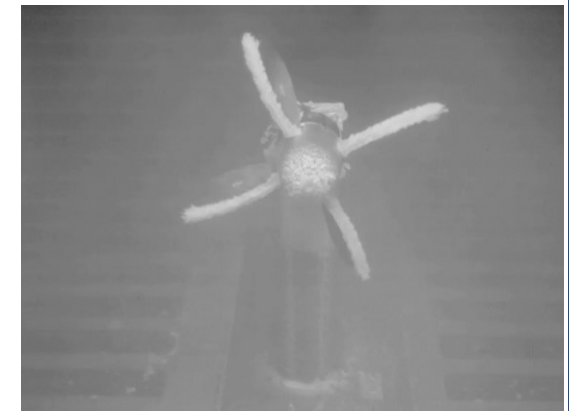
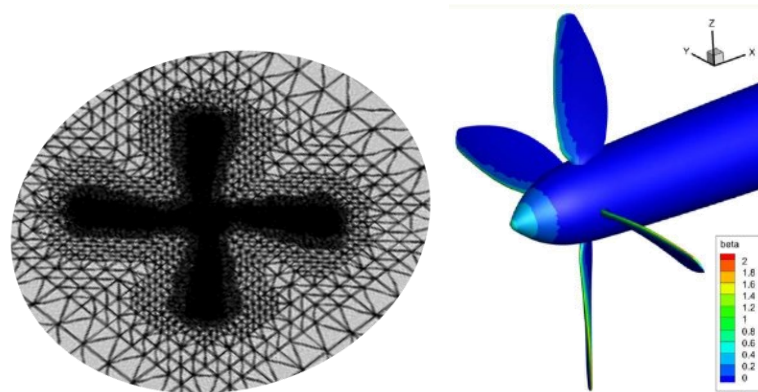
Transonic Truss Braced Wing

- Assess icing impacts
- IRT tests scheduled in 2024 / 2025



AAM Icing

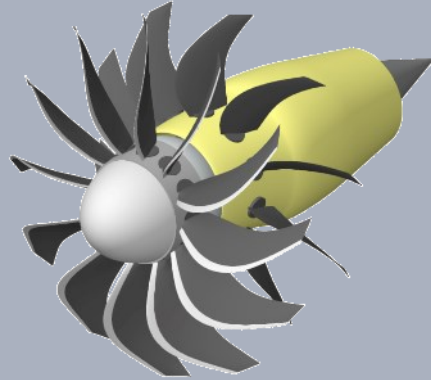
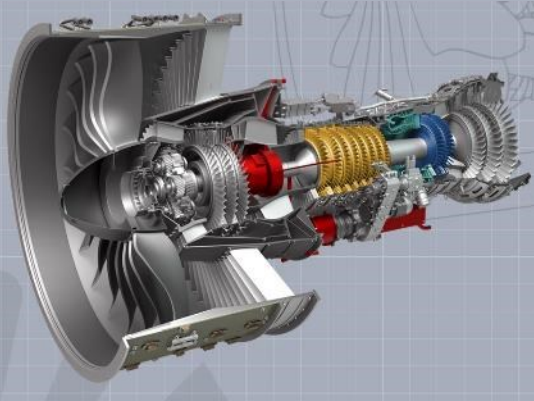
- Build icing assessment capability
- Add rotational icing to GlennICE
- IRT tests occurred in 2023/2024





New Application Focus Research

Efficient Quiet integrated Propulsor (EQuIP)



Icing Work Areas:

- Fan Icing
 - 3D rotational icing simulation
 - Ice shedding simulation
 - Requirements for engine fan icing test rig
- Ice Crystal Icing (ICI)
 - Simulation tools
 - IC capability development for IRT / AIT

New Tech Challenge (FY24-FY28)

Overall EQuIP Goals

Predict, model, and assess...next-gen propulsors
...while reducing risk* for use on...aircraft in 2030s

* Icing work in EQuIP seeks to reduce risk by raising TRL of engine icing simulation tools



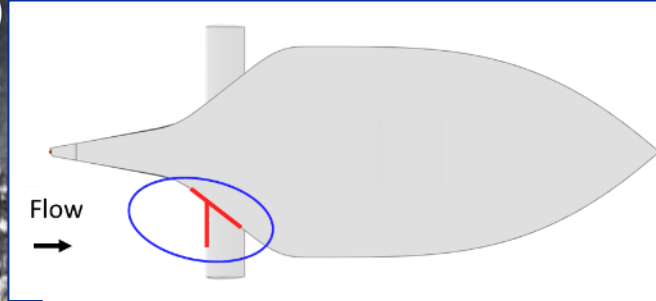
Atmospheric Characterization



- High Ice Water Content Flight Research
 - Characterize ice crystal cloud properties
- Participated in 5 campaigns; 3 with NASA DC-8
 - Most recently in 2022 in high-aerosols

Ongoing Fundamental Research

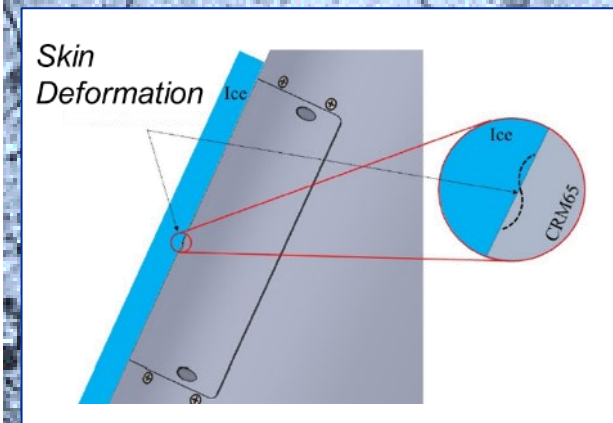
Simulated Inter-compressor Duct Research Model (SIDRM)



Generate data for ice crystal (IC) icing
IC accretion using a heated surfaces

Ice Adhesion Characterization

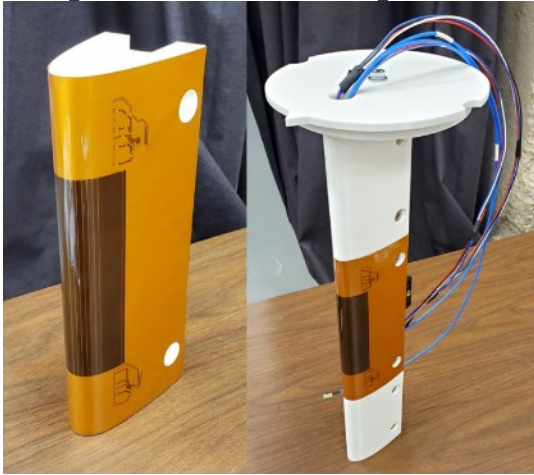
Understand impact ice properties
Examining measurement techniques
Deformed Skin Adhesion Test (DSAT)
Evaluating icephobic coatings



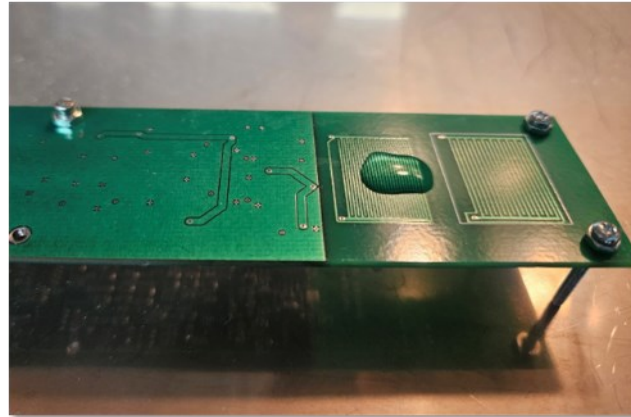
1 mm

Ongoing Capability Improvement

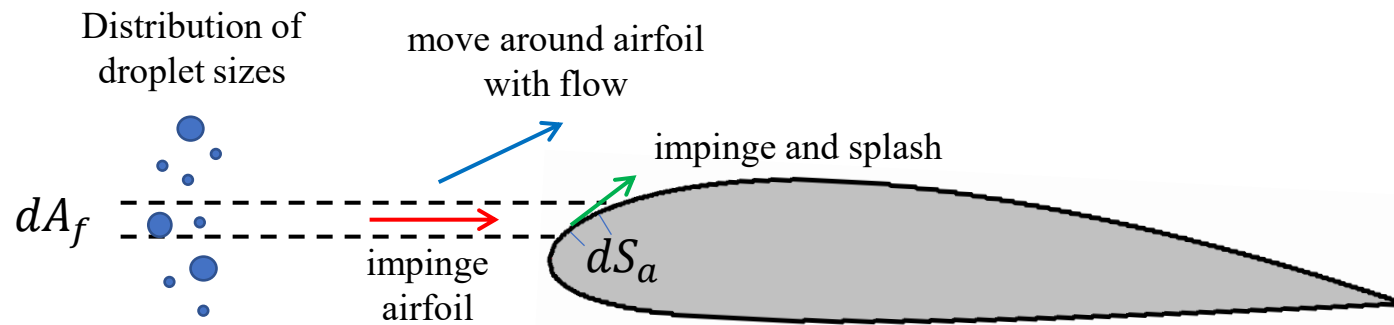
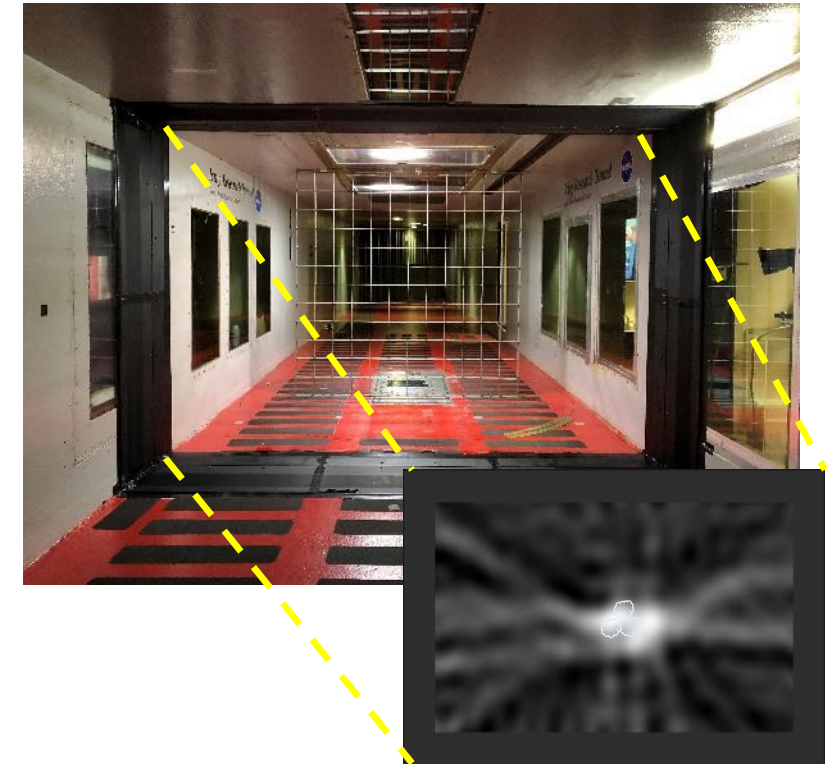
Microwave-based collection efficiency measurement with Baylor University



Impedance based ice / water sensor

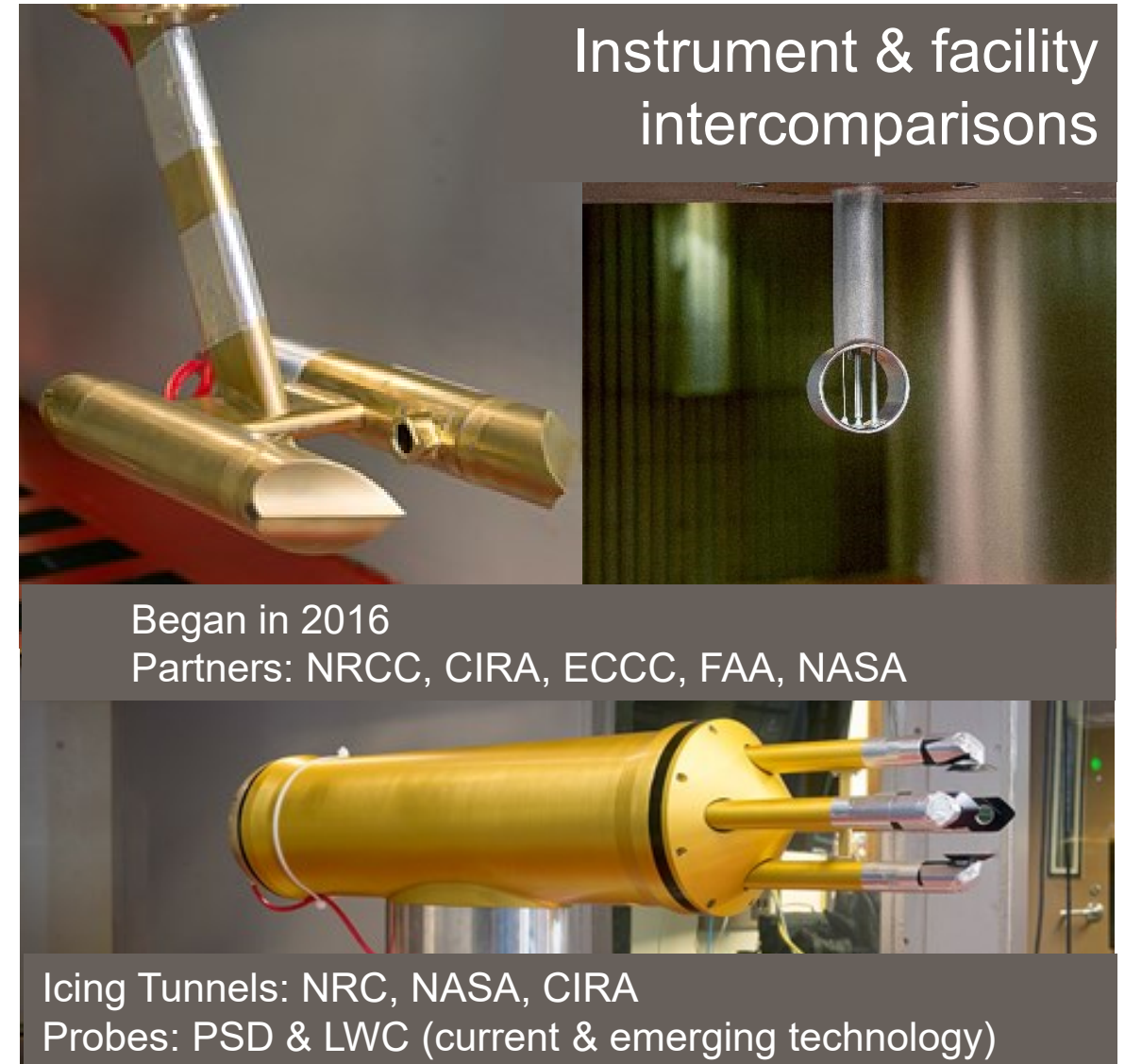
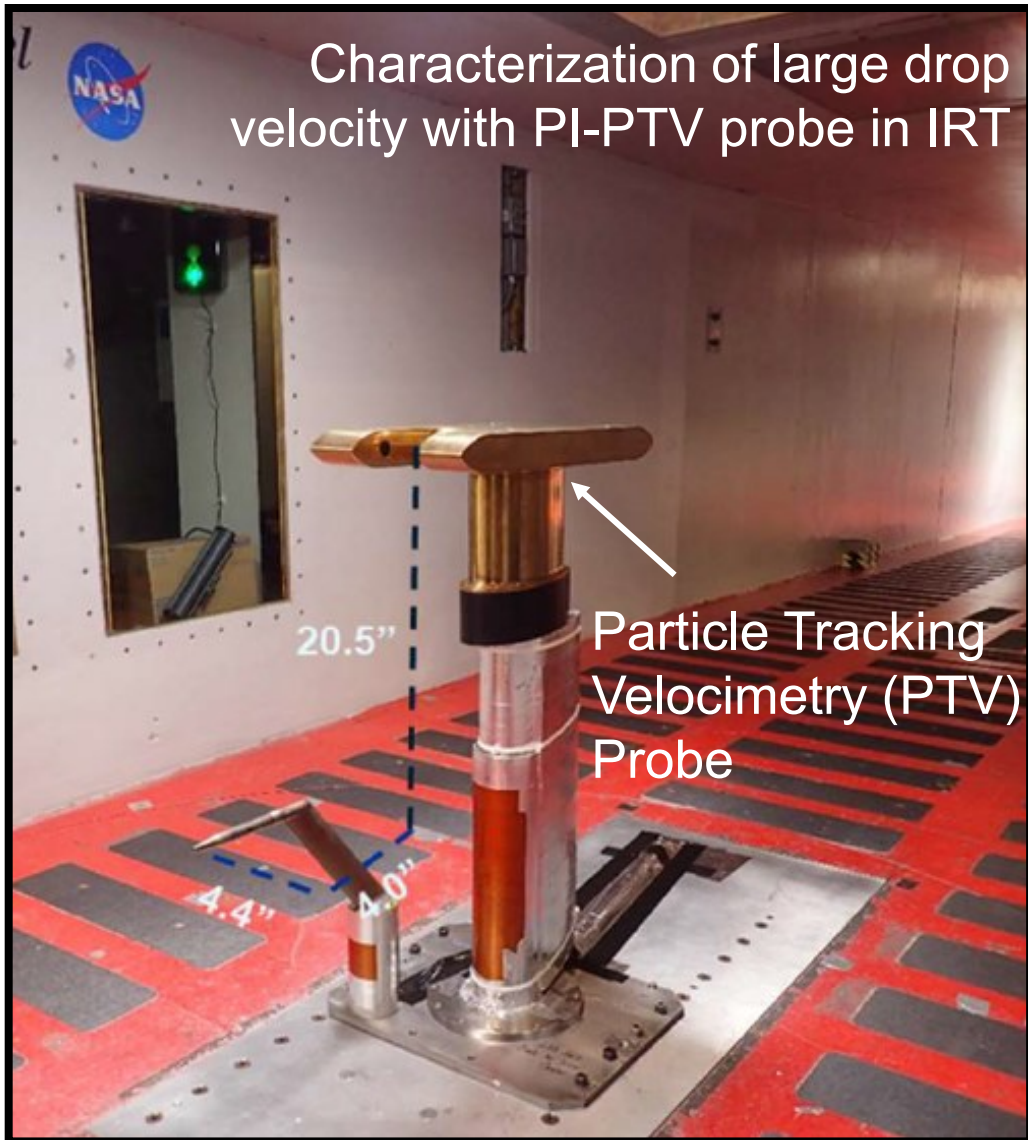


Investigating tomography for cloud uniformity in IRT



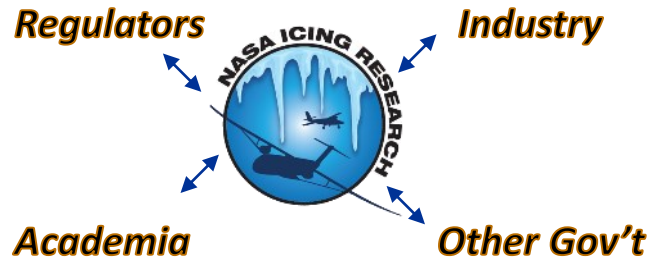
Prototype system accurately measuring 3 nozzles

Supercooled Large Drop (SLD) Research





NASA Collaborations in Icing



NASA Partnerships



SBIR • STTR



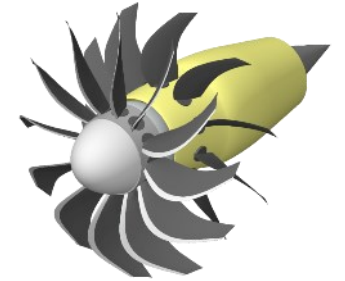
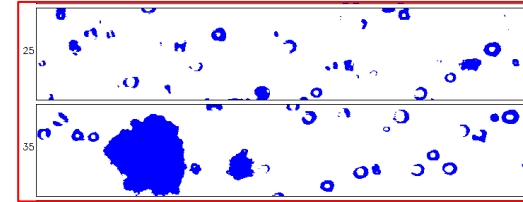
- NASA partners with domestic and international community
 - Regulators, Industry, Academia, Other Gov't Entities
- NASA Partnerships via Space Act Agreements (SAA)
 - Reimbursable / non-reimbursable
 - International Agreements
- Research Opportunities:
 - Small Business Innovation Research (SBIR)
 - NASA Research Announcements
 - University Leadership Initiative (ULI)
 - NASA Established Program to Stimulate Competitive Research (EPSCOR)
 - Student Internships / Academic Fellowships
 - Coming soon: Icing Community of Interest (FAA / NASA)



Summary

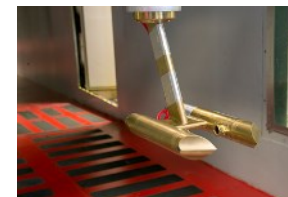
NASA:

Maintains world-class icing facilities
Develops tools and methods for icing simulation
Conducting research activities guided by recent study
Continually seeking collaboration opportunities



Icing Research Topics

1. Application Focus Research
2. Atmospheric Characterization
3. Fundamental Research / Capability Improvement





Thank You!



PROJECT ACKNOWLEDGEMENTS

Advanced Air Transport Technology
Revolutionary Vertical Lift Technology

Advanced Air Vehicles
Program

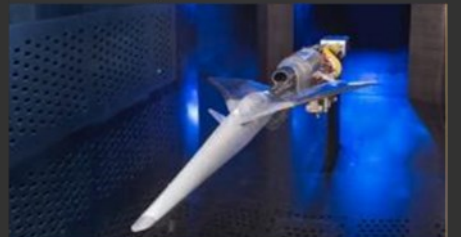


Transformative Aeronautics
Concepts Program



Transformational Tool & Technology
Convergent Aeronautical Solutions

Aerosciences Evaluation &
Test Capabilities Portfolio



Operations
Capability Improvement