

# Pratt & Whitney – FAA CLEEN III Consortium

Industry Day / Public Session

November 2023



**GO BEYOND**

CLEEN III: Fan Module Technologies Development &  
TALON® X+ Combustor Module Enhancements  
**693KA9-21-T-00005**

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# Pratt & Whitney – Sustainability Strategy

HOW WE ARE DEVELOPING SUSTAINABLE AVIATION SOLUTIONS



GO BEYOND



## Smarter Technology

Best-in-class GTF Engine Family

Hybrid-electric propulsion

Hydrogen and advanced architectures



## Cleaner Fuel

100% SAF compatible fleet

Shaping industry specifications

Expanding SAF availability



## Greener Business

Continual environmental footprint reduction

Proactive materials of concern management

Modernized manufacturing, Asheville, NC



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# Pratt & Whitney – GTF Engines

SUSTAINABILITY STARTS WITH THE GEAR



GO BEYOND



## Quietest, Greenest & Cleanest



Geared for Sustainability



Geared for Business



Geared for the Future



## Fast Facts



**20%**

Fuel and CO<sub>2</sub> savings possible per trip with GTF-powered aircraft.



**1.2B**

Gallons of fuel saved, equivalent to nearly 5 billion liters.



**25%**

Fuel and CO<sub>2</sub> savings possible per seat with GTF-powered aircraft.



**12M**

Metric tons of CO<sub>2</sub> emissions avoided.



**75%**

Smaller noise footprint, for happier passengers and communities.



**100%**

Certified for operation on 50% SAF. Successfully tested on 100%.



**23M**

Hours of experience, with 860 million passengers carried.



**1,600**

Aircraft with 60+ operators. 10,000+ engines ordered by 90+ customers.

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# P&W Engine Technologies for Sustainability

IMPROVING THERMAL ENGINE FUEL EFFICIENCY TO REDUCE EMISSIONS



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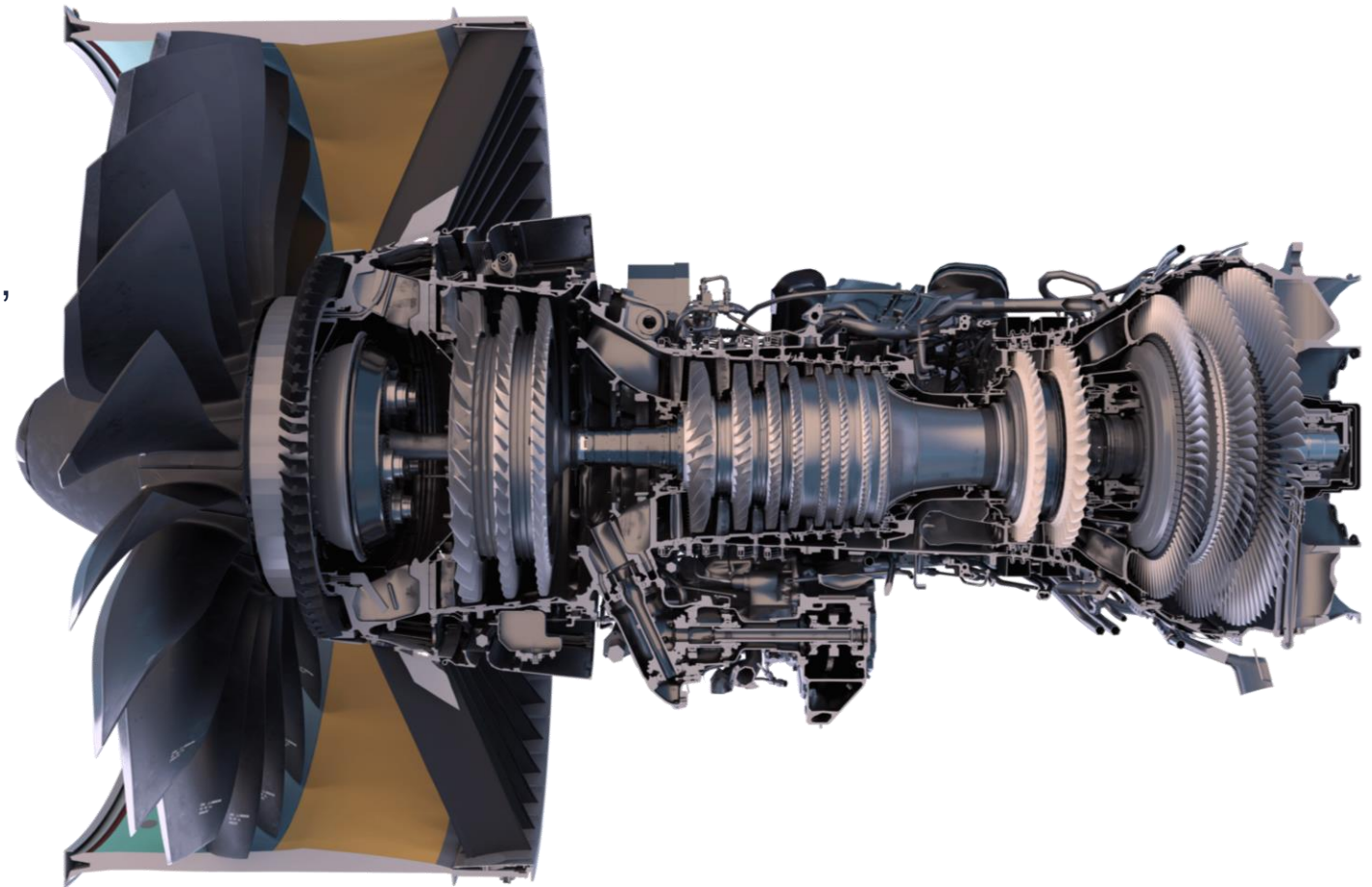


## Efficiency

- Higher bypass ratio with less drag
- Lower fan pressure ratio
- Smaller cores with improved aerodynamics, sealing and manufacturing
- Higher temperature with CMCs and advanced castings
- Advanced architectures with electrification and improved cycles

## Fuel

- Sustainable Aviation Fuel from new feedstocks and electricity (PtL)



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# Pratt & Whitney's CLEEN III Technologies



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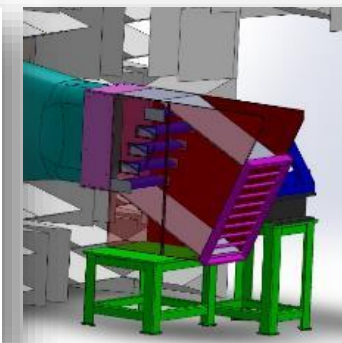
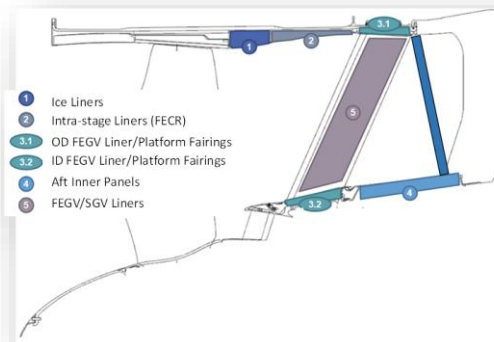


Program  
Technology Development



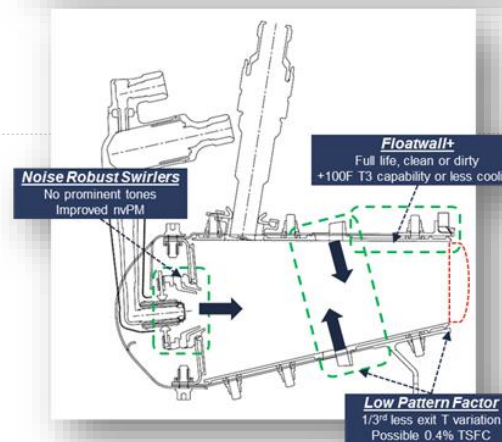
## Fan Technologies

Additively Manufactured Acoustic Liners  
Low-Loss Intra-Stage Liners  
Low-Count / Low-Noise Guide Vanes



## Combustor Technologies

Noise Robust Swirler  
Low Pattern Factor Combustor  
Floatwall+

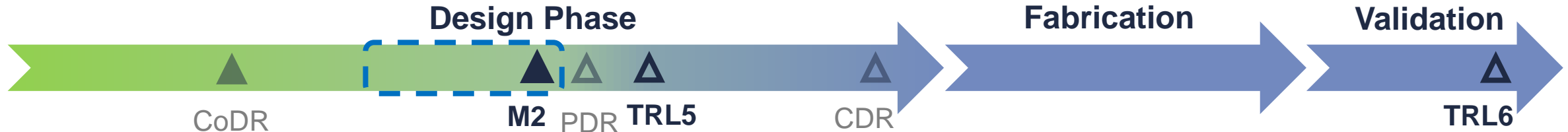


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# Fan Technology – Accomplishments



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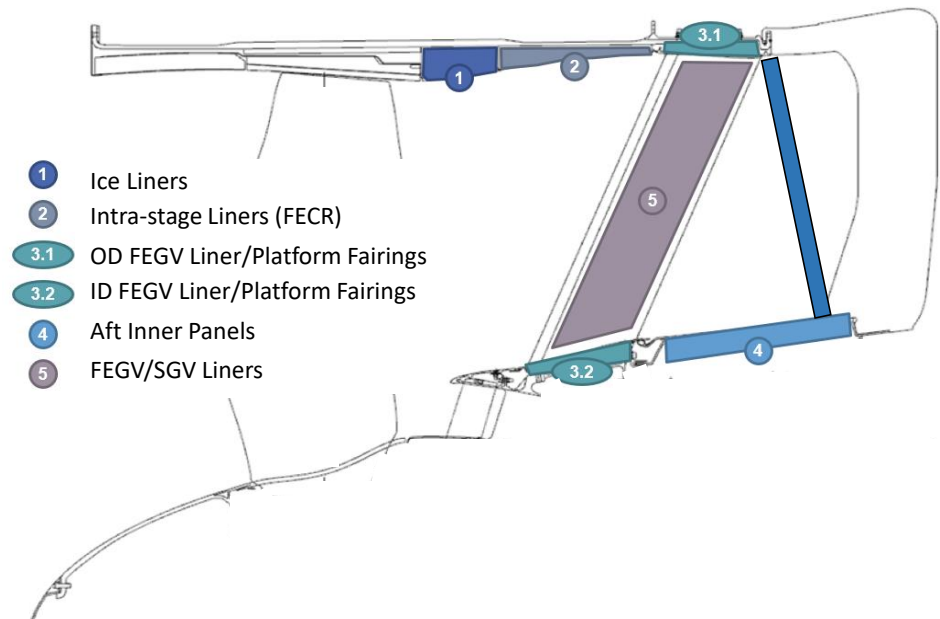


## Additively Manufactured (AM) Acoustic Liners

- ✓ Polymer AM fabrication trials for challenging acoustic part treatment
- ✓ Down-select of Polymer AM materials and manufacturing processes
- ✓ Drag and impedance testing of Polymer AM flat panels

## Low-Loss Intra-Stage Liners & Low-Count / Low-Noise Guide Vanes

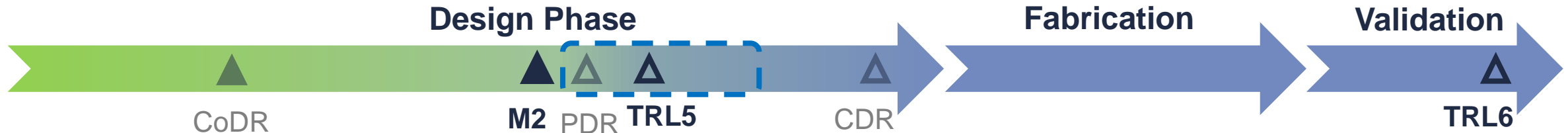
- ✓ Compact liner formulated and fabricated for cascade Guide Vane wind tunnel testing
- ✓ Preliminary Design Review (D2/M2)
- ✓ Optimized Machine Learning framework
- ✓ Identified aero performance architectures to compliment acoustic treatment objectives



# Fan Technology – Look Ahead

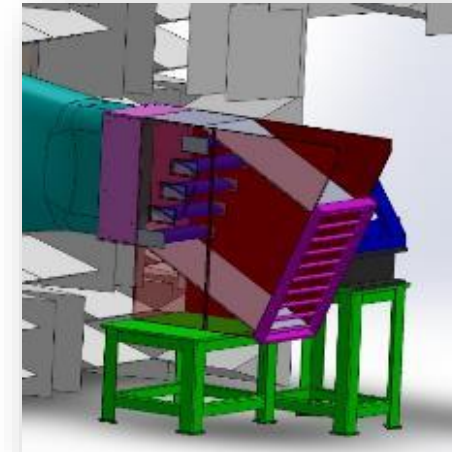


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## Fan Detail Design / Demo Engine

- Begin detail design for demo engine Fan Module
- Continue validation of Machine Learning w/ integration of favorable noise reduction predictions
- Incorporate new aero performance architectures complimenting acoustic treatment objectives
- Complete wind tunnel drag and impedance testing with the curved acoustic treatment panel on the guide vanes
- Advance manufacturing readiness (MRL) of the curved polymer AM panels
- Release long-lead material and hardware

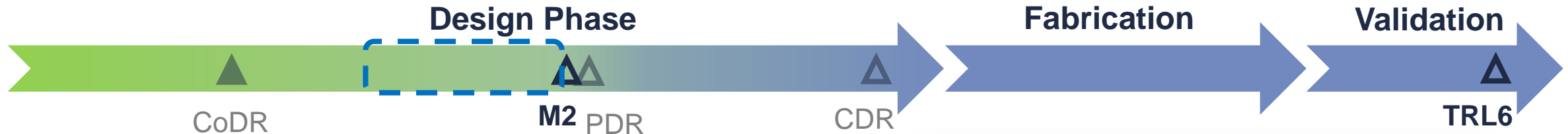


Cascade Guide Vane Wind Tunnel

# Combustor Technology – Accomplishments



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## Noise Robust Swirler (NRS)

- ✓ Complete spray tests of final round of swirler concepts
- ✓ Final round of SNR swirler testing

## Low Pattern Factor (LPF)

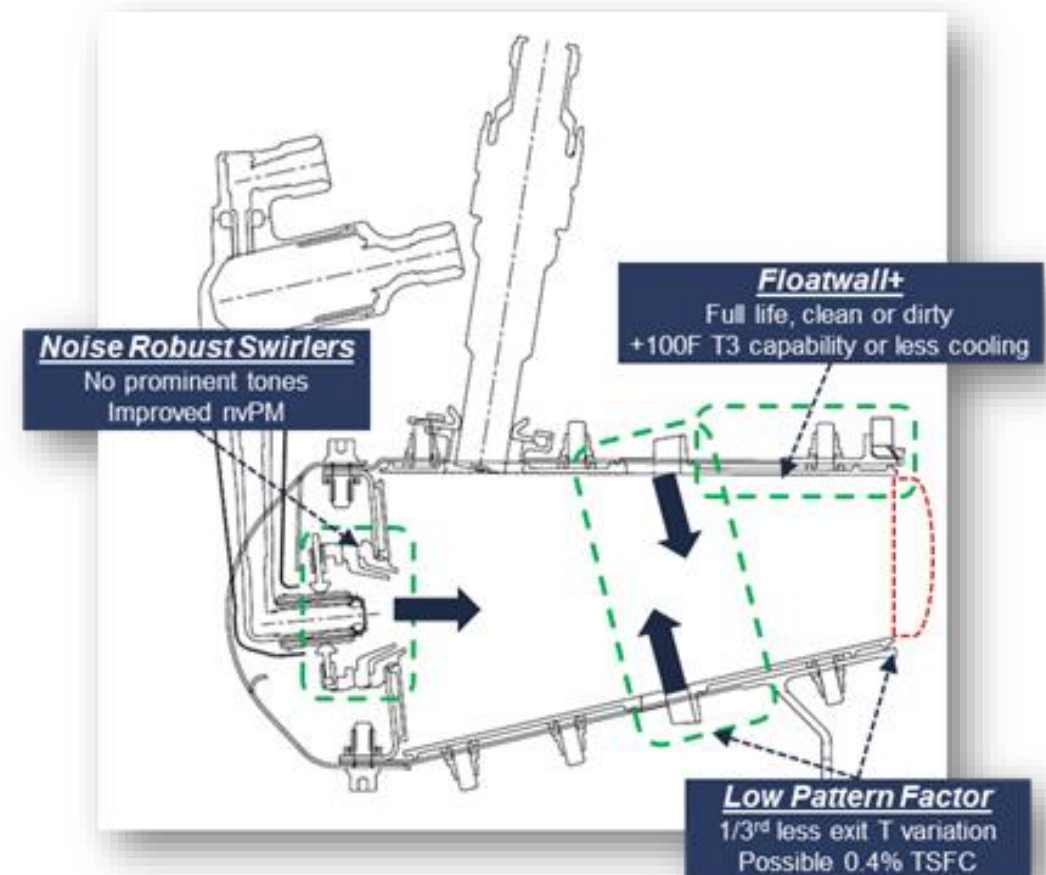
- ✓ Explored impact of additional features on pattern factor
- ✓ Transferred tools and approach to commercial engine program

## Floatwall+ (FW+)

- ✓ Completed final round of SNR panel testing
- ✓ Completed Multi-Sector Full Annular Rig pretest CFD

## Full Annular Rig / Demo Engine

- ✓ Finalized Integrated Full Annular Rig Build 1 configuration
- ✓ Initiated hardware procurement for 2024 combustor rig tests



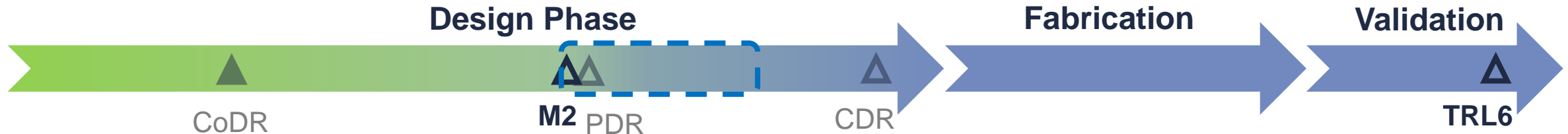
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# Combustor Technology – Look Ahead



GO BEYOND



## Noise Robust Swirler (NRS)

- Finalize demo engine swirler configuration

## Low Pattern Factor (LPF)

- Full Annular Rig combustor test to demonstrate reduced pattern factor

## Floatwall+ (FW+)

- Multi-Sector Full Annular Rig combustor test to measure improved metal temperatures

## Full Annular Rig / Demo Engine

- Begin detailed design for demo engine combustor configuration
- Finalize Integrated Full Annular Rig (FAR) Build 3 / Demo combustor configuration



Full Annular Rig (FAR)





GO BEYOND

# POWERING SUSTAINABLE AVIATION™

SMARTER.  
CLEANER.  
GREENER.