



# Boeing CLEAN II Program Update

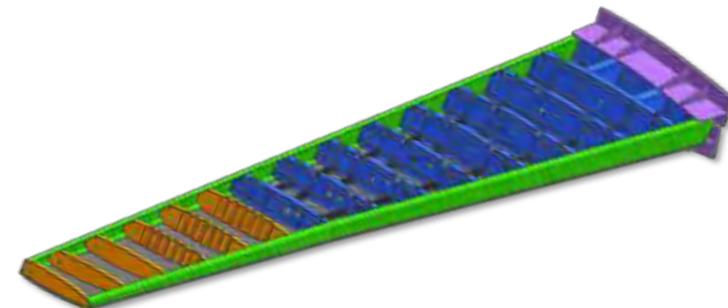
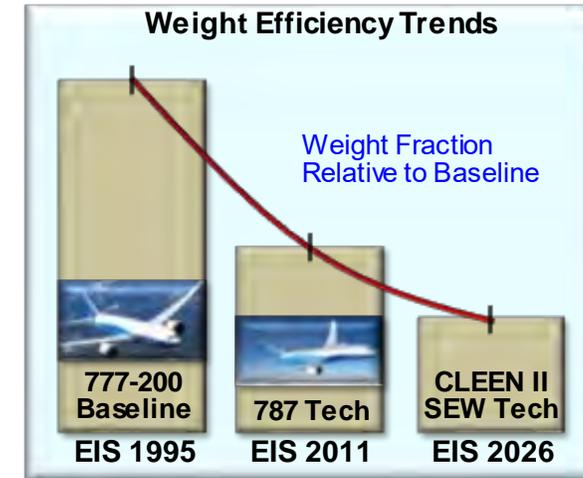
## *Structurally Efficient Wing (SEW)*

**Consortium Plenary Session**  
**Tim Tyahla**  
**May 13, 2020**

## CLEEN II

### Structurally Efficient Wing:

- Develop, build, and test a next-generation wing structure that demonstrates significant improvements in structural efficiency
- Show a continued weight reduction as compared to the 777-200 baseline
- Contribute to the FAA CLEEN II goal of reducing fuel burn, potentially reducing fuel consumption up to 3.5% through weight reduction of the wing.





## CLEEN II SEW Technologies

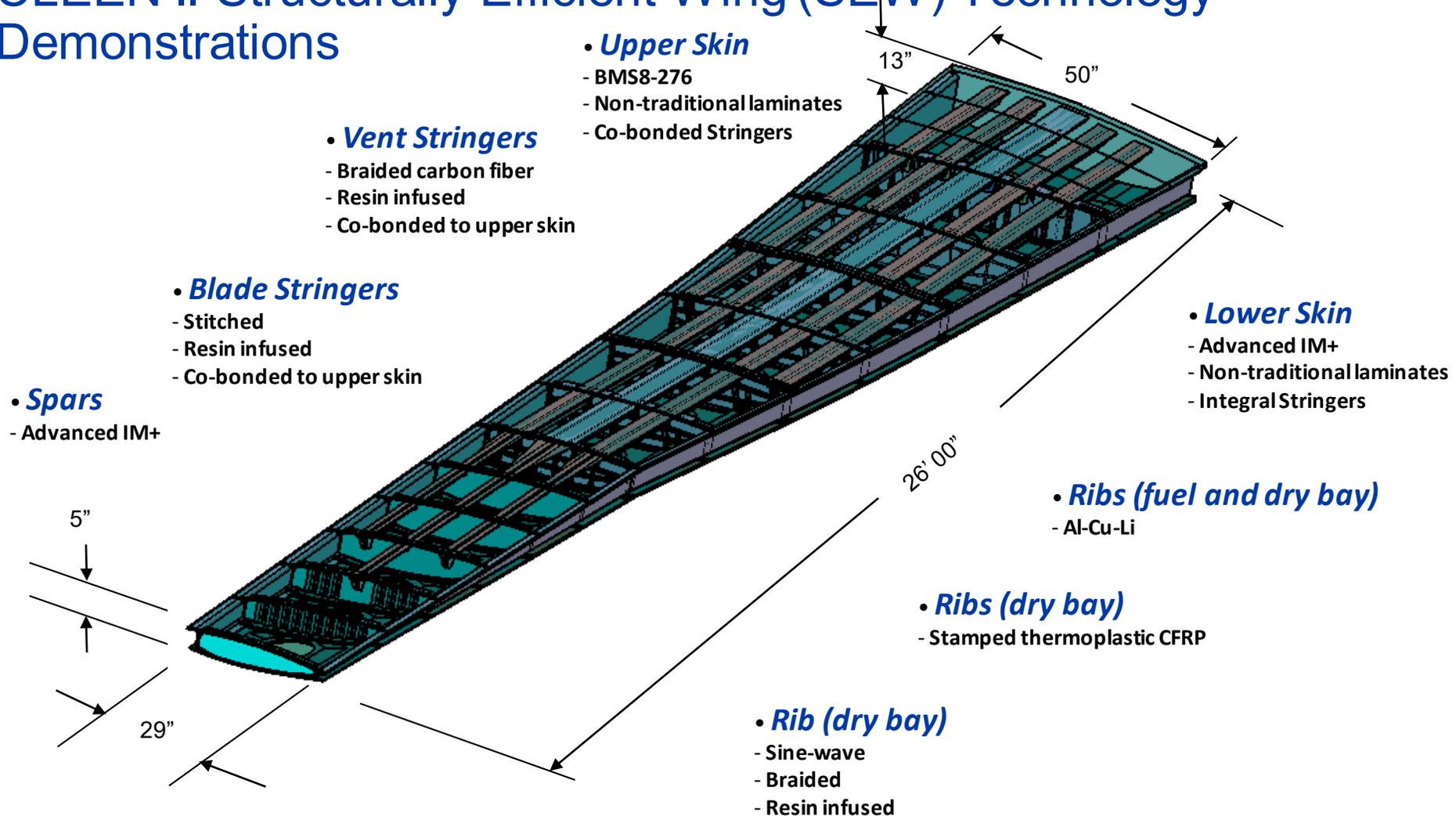
SEW CLEEN II Technology	Goal Impact	Benefits and Application
<ul style="list-style-type: none"><li>• Advancing manufacturing technologies</li><li>• Advanced prepreg composites</li><li>• Resin-infused stitched blade stringers</li><li>• Resin-infused hat stringers</li><li>• Advanced alloy metallic ribs</li><li>• Resin-infused sine wave rib</li><li>• Stamped thermoplastic ribs</li></ul>	Fuel burn reduction  CO <sub>2</sub> Production Avoidance	Lower weight, higher performance wing

All technologies contribute to the fuel consumption reduction goal by reducing structural weight and/or Drag

## SEW Major Achievements

- *Concept of Design Review (CoDR) completed early*
- *Preliminary Design Review (PDR) & Coupon Tests completed (TRL4)*
- *Building Block Tests Completed (TRL5)*
- *Detail Design Review (DDR) completed early*
- *Tooling, Part & Test Fixture Fab Completed*
- *Test Readiness Review (TRR) completed early*
- *Full Scale Test Series Completed (TRL 6)*

# CLEEN II Structurally Efficient Wing (SEW) Technology Demonstrations



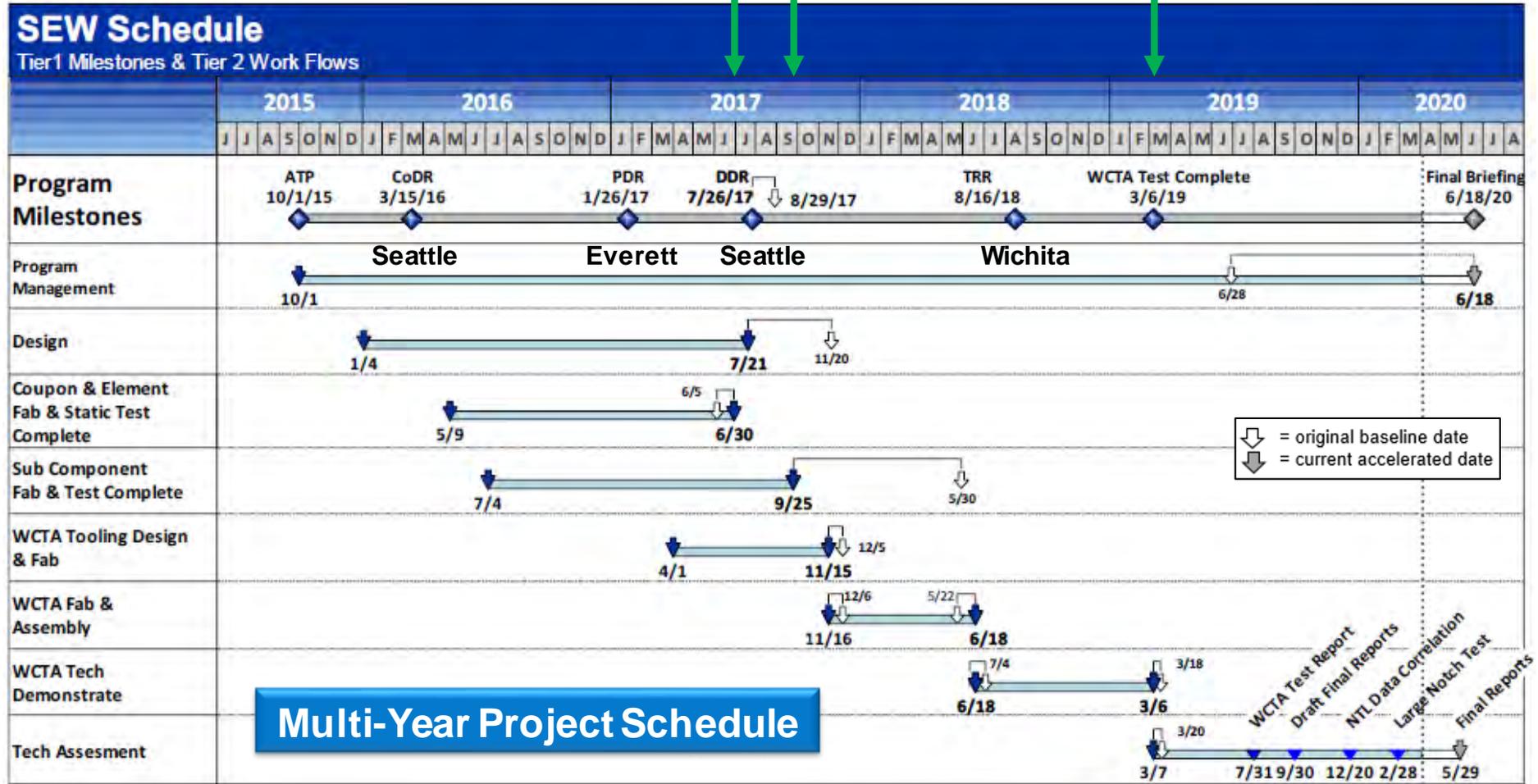
Reduce Weight up to 28% as Compared to the 777-200



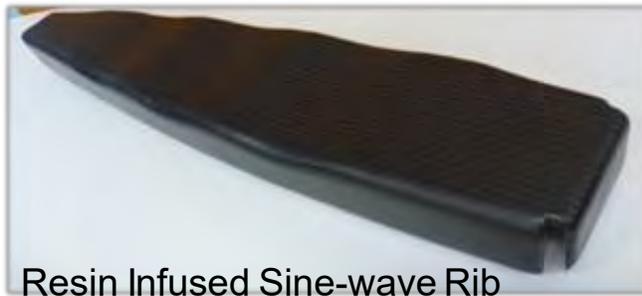
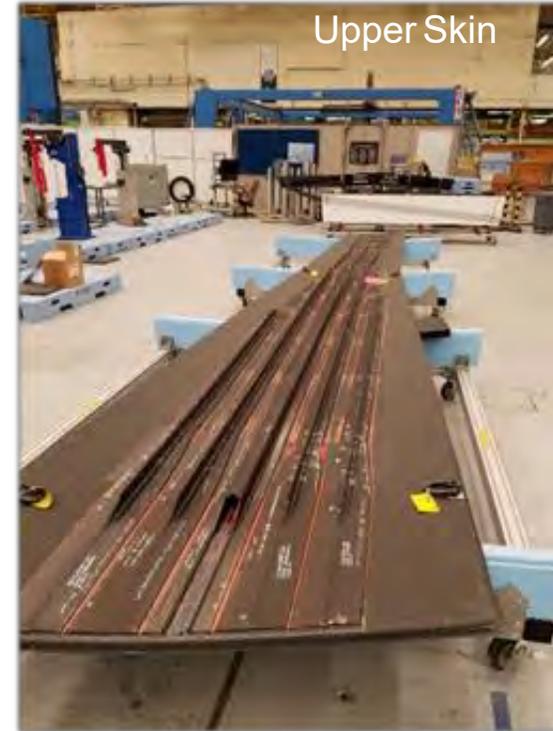
# CLEEN II Boeing SEW – Accelerated Schedule

**Technology Risk Reduction**

TRL 3/4    TRL 5    TRL 6



# SEW WCTA Assembly Preparation

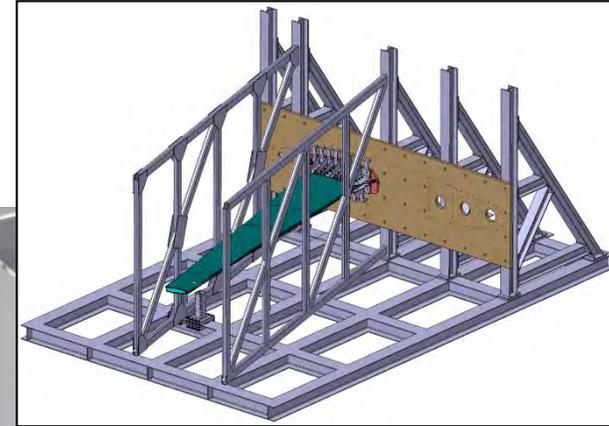




# SEW Wing Component Test Article Test

Fore / Aft Framework Constructed

Load Pads Applied





# SEW Wing Component Test Article Test

Successful 177% Design Limit Load Test – February 14, 2019

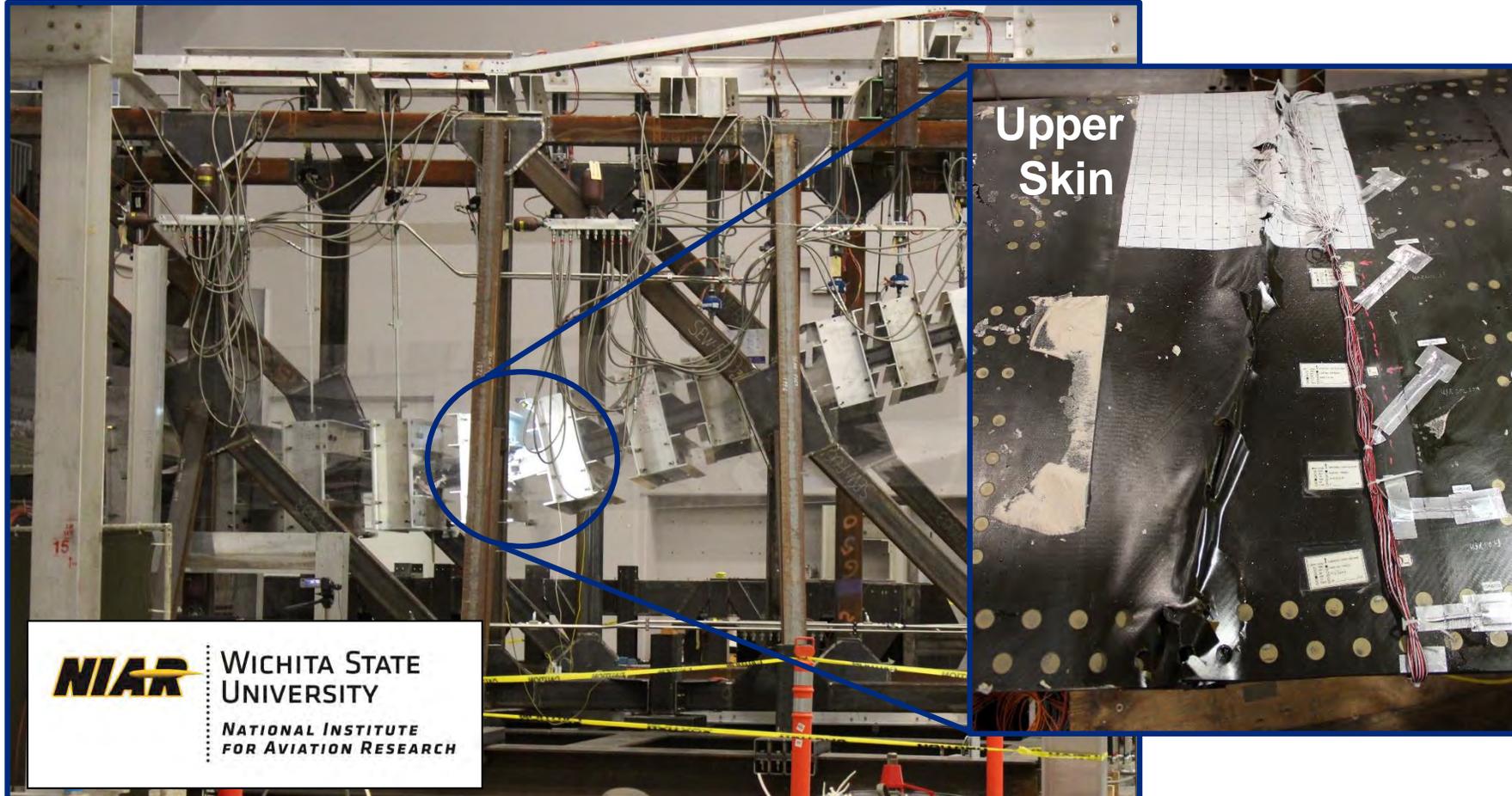


# WCTA Residual Strength Test – Notch Configuration

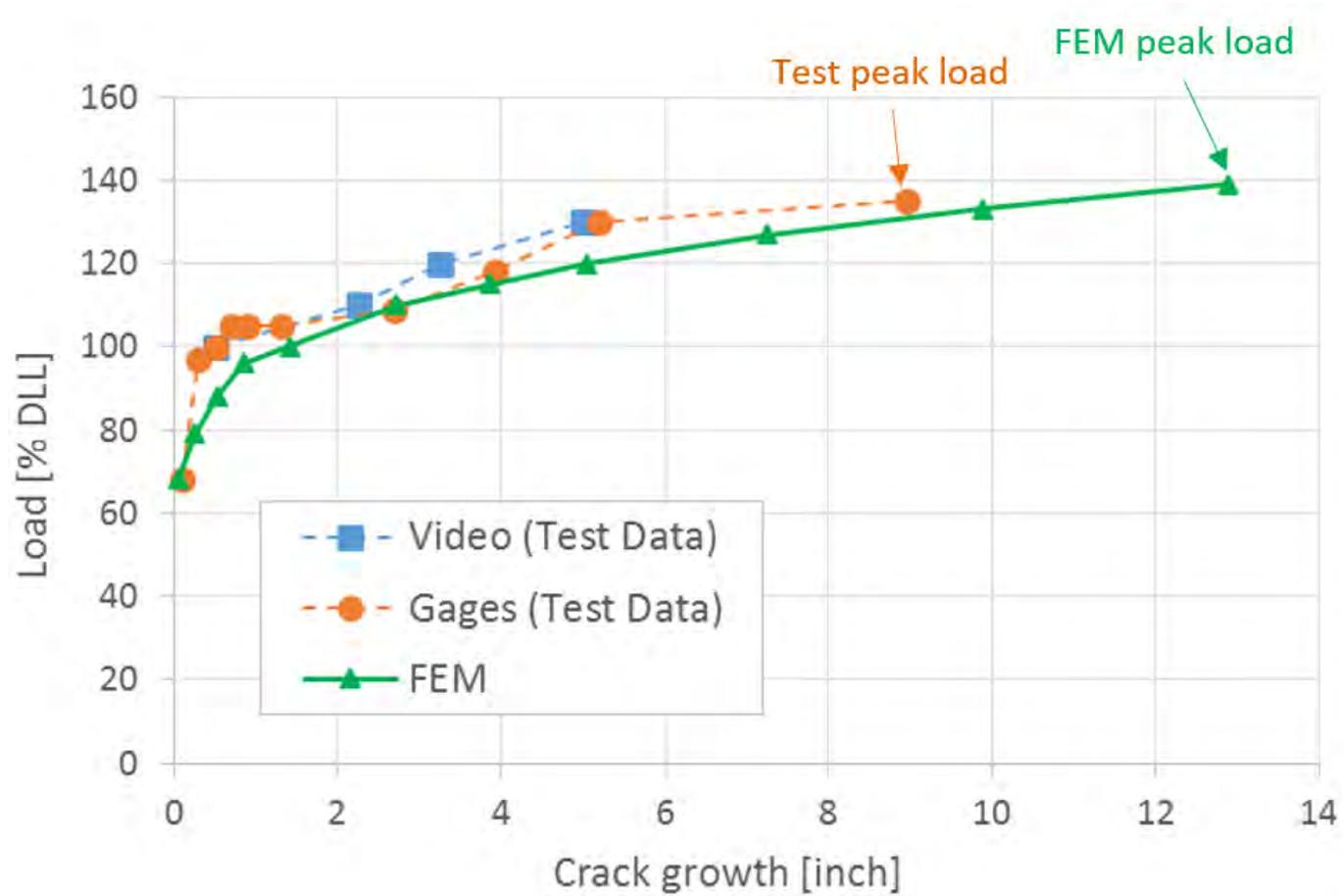
Front View



# SEW WCTA Residual Strength Test

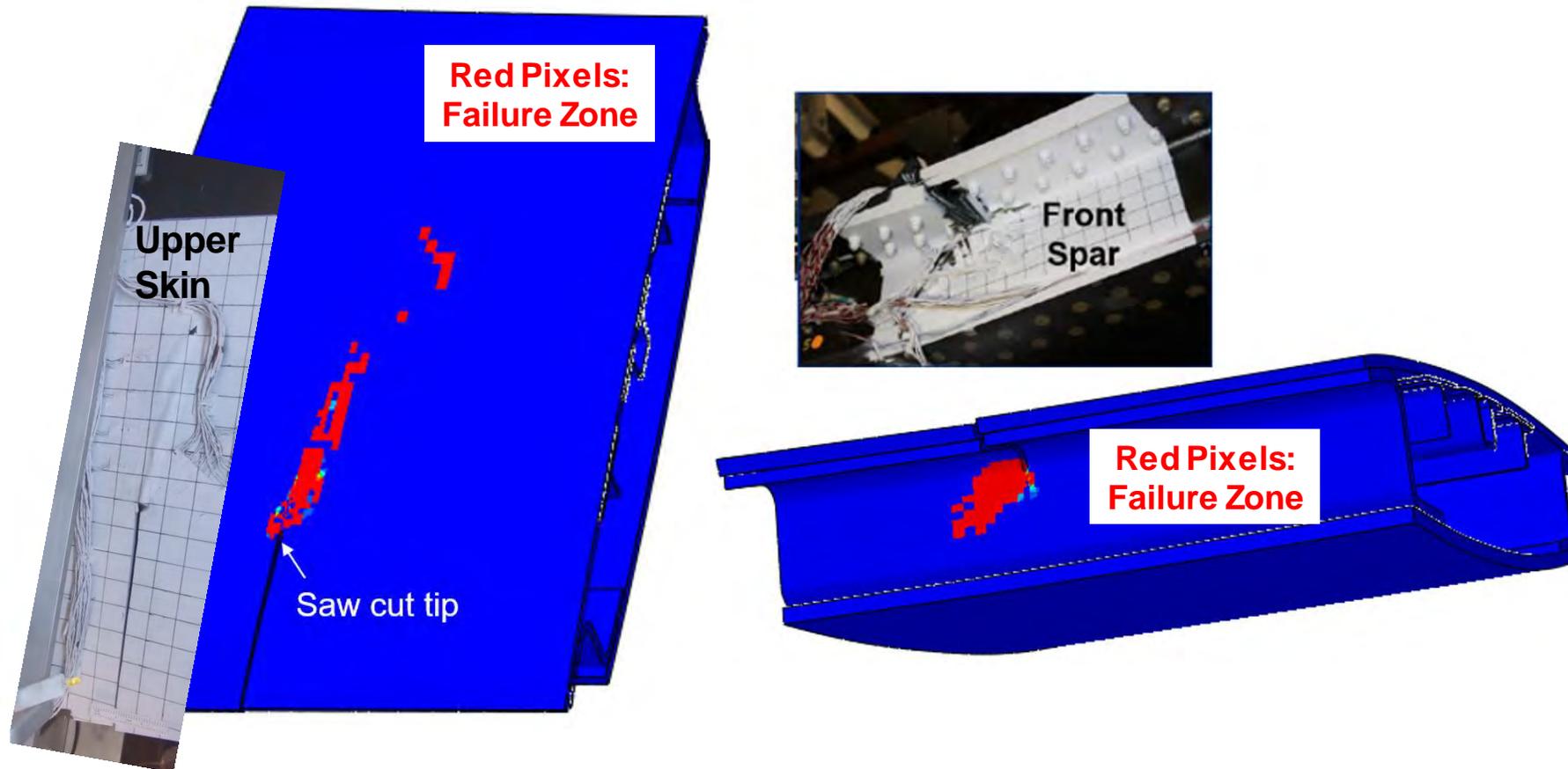


# Residual Strength Test Analysis



Excellent Correlation of Test Data and Analysis

# Residual Strength Model Behavior



Excellent Correlation of Model Behavior



## SEW Summary

**Boeings CLEEN II technologies represent some of our highest impact concepts with a clear path to certification and implementation.**

- SEW contributes to the FAA's CLEEN II goal of reducing fuel burn
- FAA & Industry benefit from continued CLEEN program investment and collaboration.
- The building-block test approach on SEW developed the selected technologies along the TRL scale, resulting in a TRL 6 demonstration with the completion of the Wing Component Test Article (WCTA) full scale test series

**WCTA Test Results Support the Transition of SEW Technologies to Commercial Transport and Military Applications**

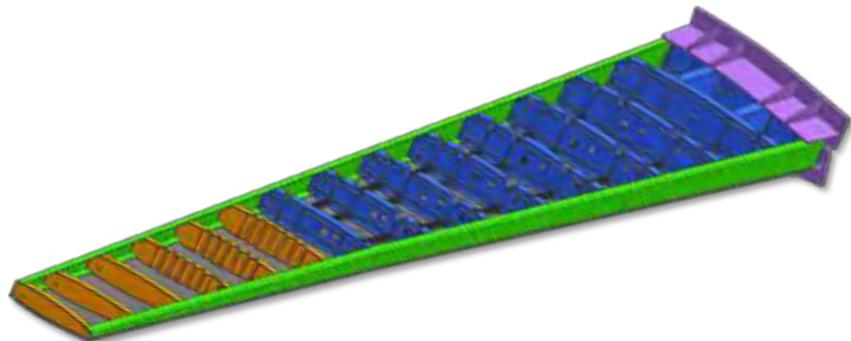


## Acronyms

<b>ATP</b>	<b>Authority to Proceed</b>
<b>CoDR</b>	<b>Concept Design Review</b>
<b>DDR</b>	<b>Detailed Design Review</b>
<b>DLL</b>	<b>Design Limit Load</b>
<b>EIS</b>	<b>Entry into Service</b>
<b>FEM</b>	<b>Finite Element Model</b>
<b>NIAR</b>	<b>National Institute for Aviation Research</b>
<b>PDR</b>	<b>Preliminary Design Review</b>
<b>SEW</b>	<b>Structurally Efficient Wing</b>
<b>TRL</b>	<b>Technology Readiness Level</b>
<b>TRR</b>	<b>Test Readiness Review</b>
<b>WCTA</b>	<b>Wing Component Test Article</b>



## Structurally Efficient Wing (SEW)



**Objectives:** *Demonstrate a suite of material and structural technologies that will contribute to the FAA's CLEEN II goal of achieving fuel burn reductions by 2026.*

**Work Statement:** *Boeing's disciplined development and building-block test approach will mature structural wing technologies and will demonstrate via the Wing Component Test Article (WCTA).*

**Anticipated Benefits:** *Cumulative predicted impact over twenty years:*

- *Jet A fuel consumption savings of approximately 200 million tons*
- *CO2 production avoidance of approximately 660 million tons*

**Risks/Mitigation Plans:**

- *Risks Identified, mitigation plans in place*

**Accomplishments/ Milestones since Boeing initiated this technology/project:**

- ✓ *Oct 2015 ATP (completed)*
- ✓ *Mar 2016 CoDR (completed)*
- ✓ *Jan 2017 PDR (completed)*
- ✓ *Jul 2017 DDR (completed)*
- ✓ *Aug 2018 TRR (completed)*
- ✓ *Mar 2019 Full Scale Testing (completed)*
- ✓ *July 2019 Test Report*
- *May 2020 Final Report (Test Opportunity)*
- *June 2020 Final Briefing*