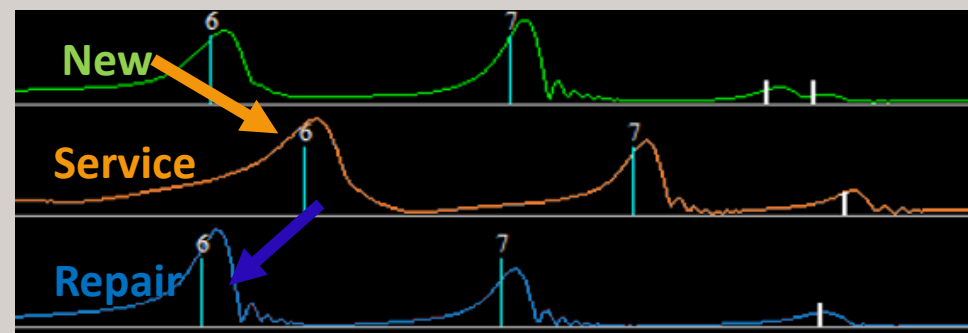




Process Compensated Resonance Testing (PCRT) Inspection of Aircraft Wheels: Expansion, Success, and Future

A4A September 2026

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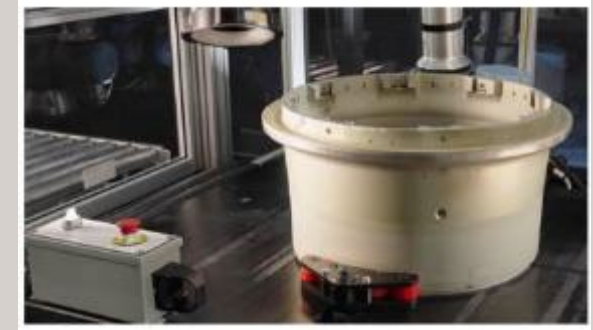
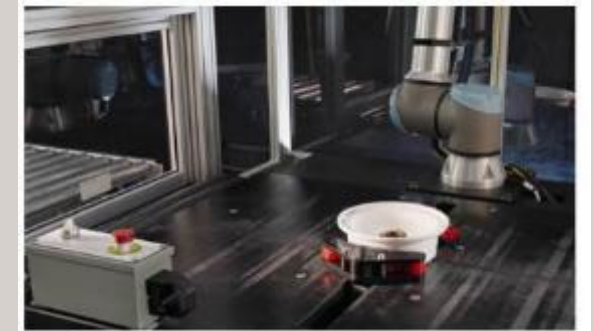
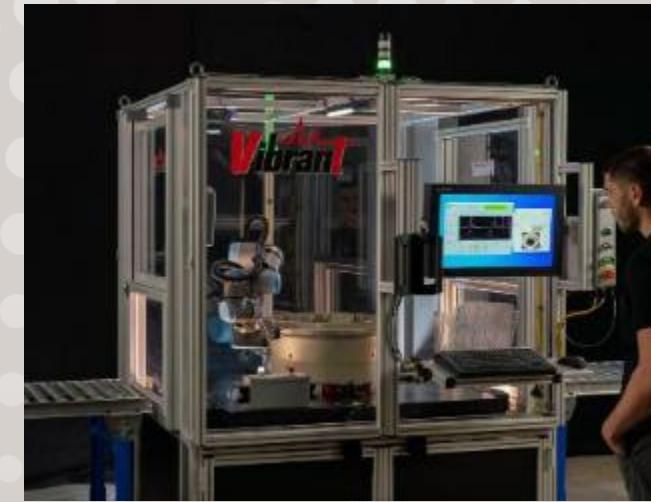
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PCRT Landing Systems: Fast NDT And Used In Industry

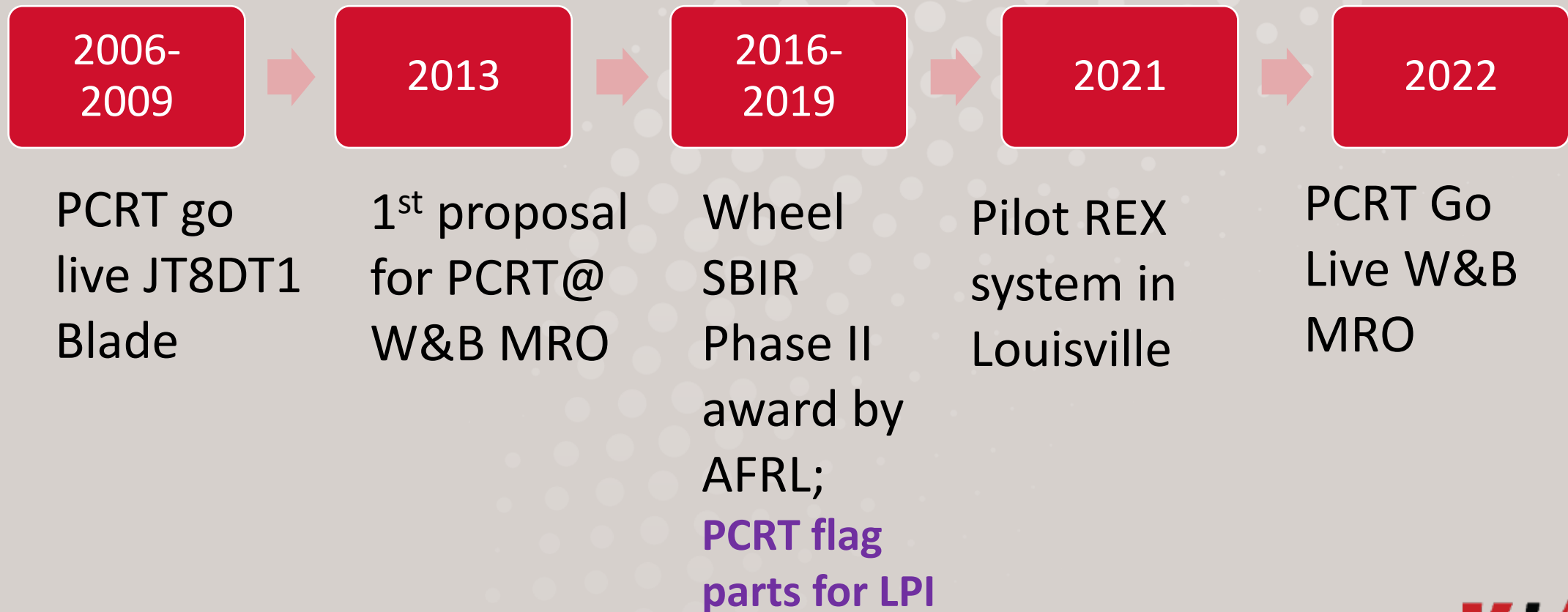


Resonance data collected and stored by Serial Number

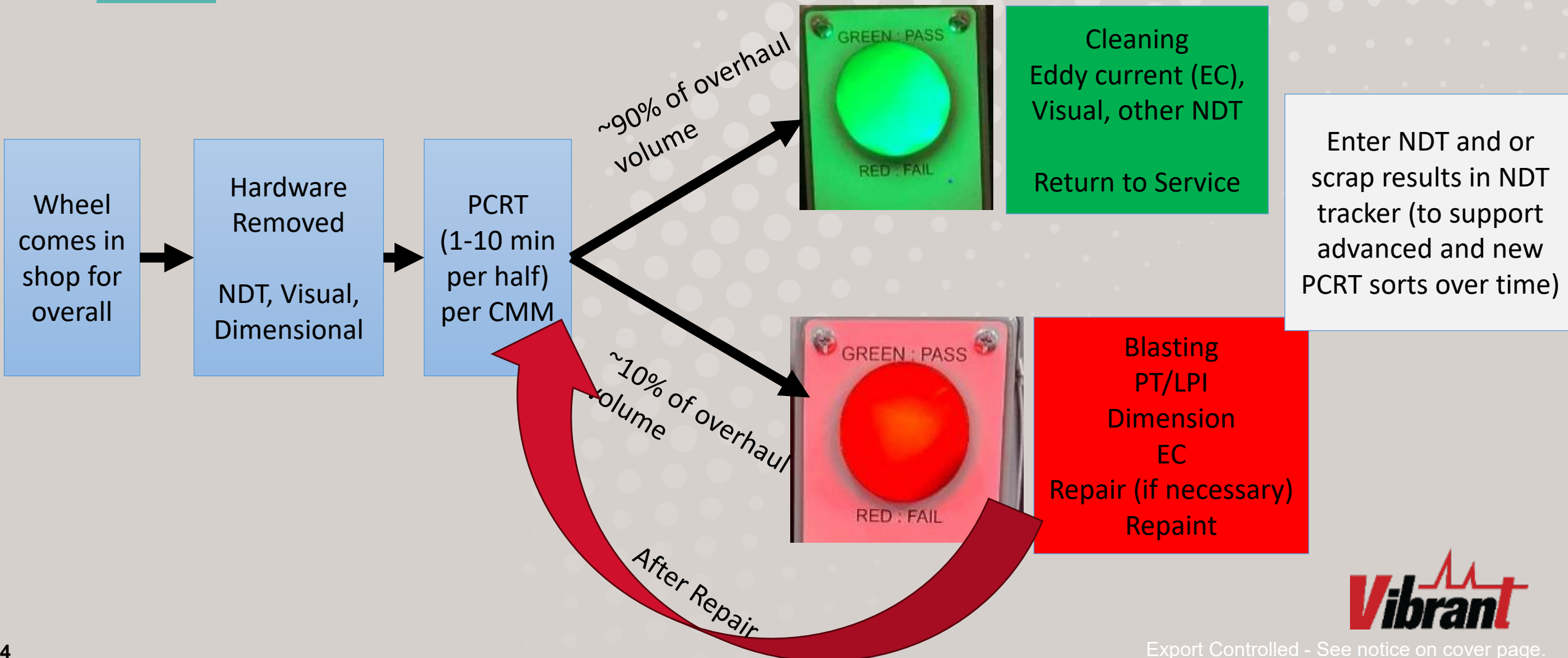


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The Long Path of New Technology



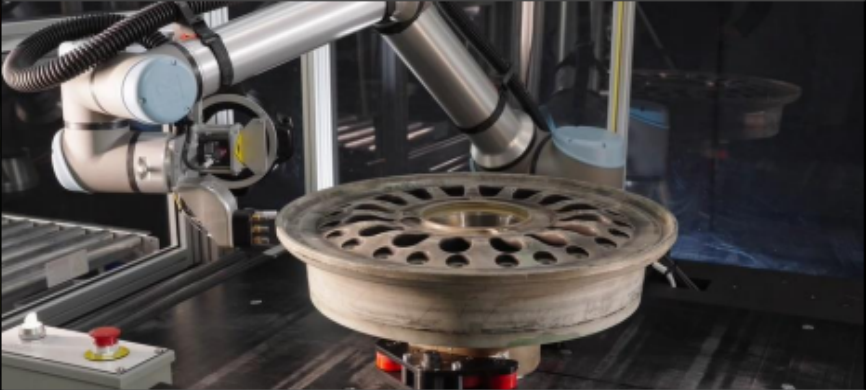
Example PCRT flow in MRO Shop



Airlines 4 America
Innovation Award
AFRL/RX, Collins, Vibrant,
DeltaTech Opps, Pratt & Whitney
Canada

Collins, Vibrant, USAF Innovation Award Presentation
<https://a4andtforum.com/wp-content/uploads/2022/10/291110-Novel-Resonance-Insp-of-Commercial-Aircraft-Wheels.pdf>



Goals	History with LPI	Current State with PCRT
		
Efficiency	Media blasting, inspecting, repainting 100% of wheels at majors for the 2-3% with findings	Paint removal and replacement goes from required at majors to on-condition
Sustainability	Media blasting, LPI, & painting generates significant amounts of waste material	No chemicals or waste produced (Reduced waste disposal by over 200,000 lbs)
EH&S	A lot of part handling during media blasting with potential for minor injuries	Minimized part handling
Quality	Subjective interpretation of LPI results	Objective results with quantified records that require no operator interpretation
Consistency	Turn around time for major inspection significantly longer than minor inspection	Turn around time for majors and minors are much more similar



Where is PCRT for landing systems now?

2022-2026: Wheel Testing Expansion, Success

>145,000 wheel halves (August 2026)

- Multiple MRO, OEM, and airlines
- Configured for >100 PN's
 - Main and nose wheel halves
 - A320, A330, A340, A321, A350
 - 747, 737, 787, 757, 777, 767
 - Military platforms and ER Jets

REX Wheel Systems Testing Locations

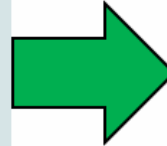


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A Risk Mitigation Approach to PCRT Implementation and Refinement;

Defect history review

- Review defect history for each component
- Highlight most typical/critical defects that must be accounted for
- Which NDT method is detecting these today?
- Is that the most sustainable and robust way?



PCRT Sort development

- Train the system on 100+ parts
- Correlate resonance spectra to legacy NDT results for all training parts to develop **Outlier Screening Sorts**
- Validate sort against parts with known defects to develop **Targeted Defect Sorts** as needed



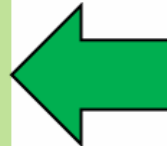
PCRT Sort monitoring / refinement

- Perform all legacy NDT on all PCRT outliers
- Review all PCRT passes and failures
- Vibrant and MRO Responsible Level III recommend Technique Sheet modifications
- Engineering / MRO review of proposed changes



PCRT Technique Sheet creation and release

- Release PCRT Technique Sheets with artificially conservative boundaries & supplemental inspections
- Release supporting aftermarket service documents
- Full spectra stored by S/N for every PCRT inspection to support future **Part to Itself Sorts**

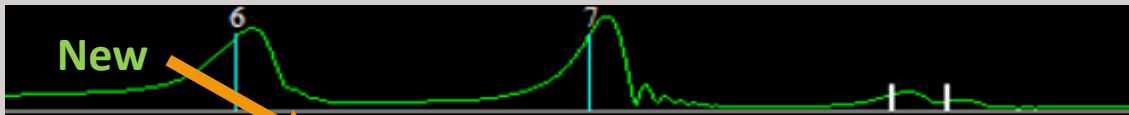


A conservative, step-wise approach to PCRT implementation

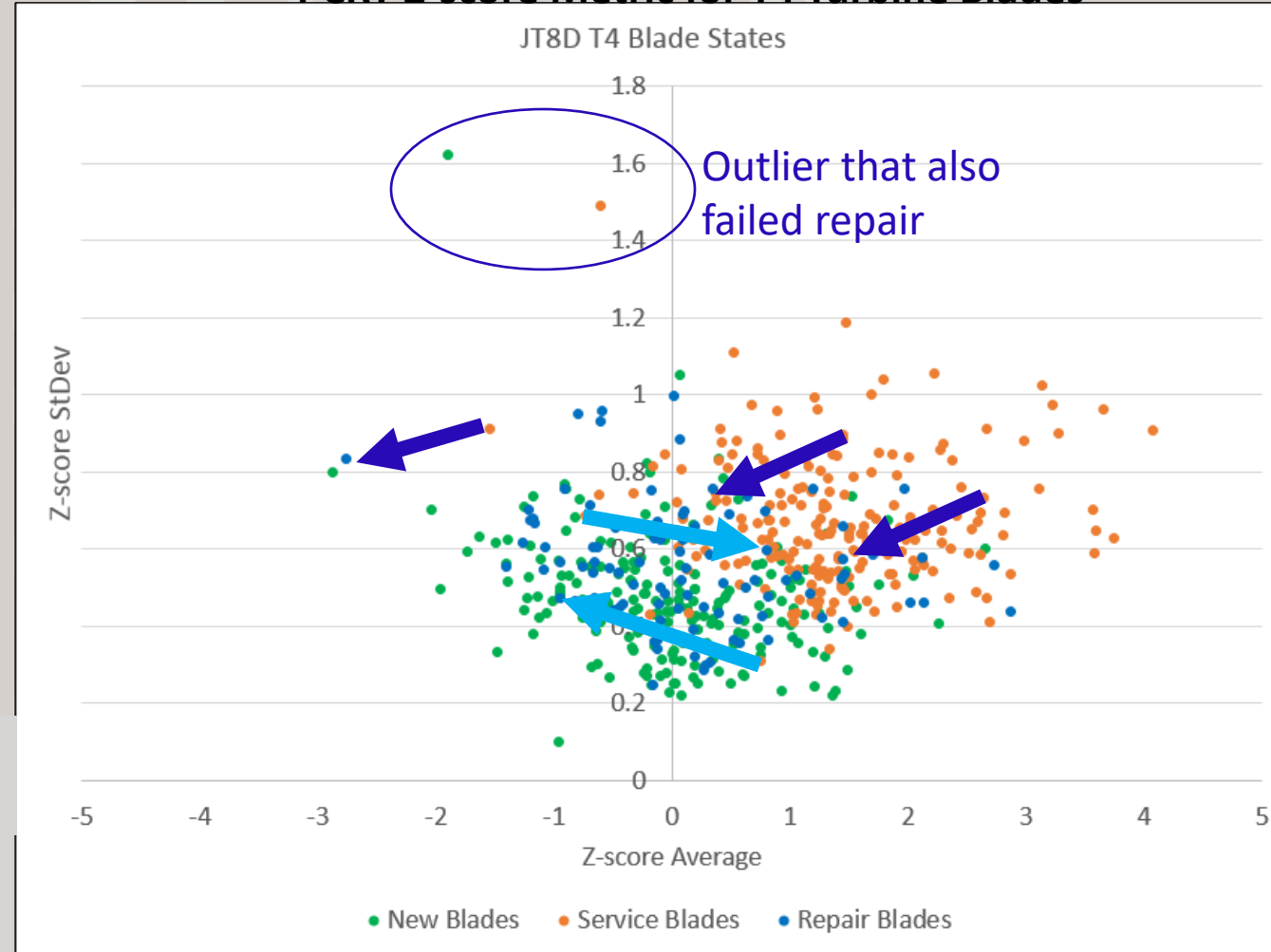
PCRT Method: Part-to-Itself (PTI) ASTM E3213

Use PCRT measurements before and after operations

- Quantify consistency
- Track accumulation of damage in parts over time
- Track operation, repair, recovery (quality) of the parts



PCRT Z-score Metric for T4 Turbine Blades



PTI Target Defects; Spoke Cracks IN USE

PTI sort developed targeting Spoke cracks in 737

- When wheel scanned, system automatically looks for previous scan and compares multiple peaks
- PCRT sort flags that have 'unacceptable' pattern changes
- Confirmed flagged over 25 cracked wheels in the field and counting!





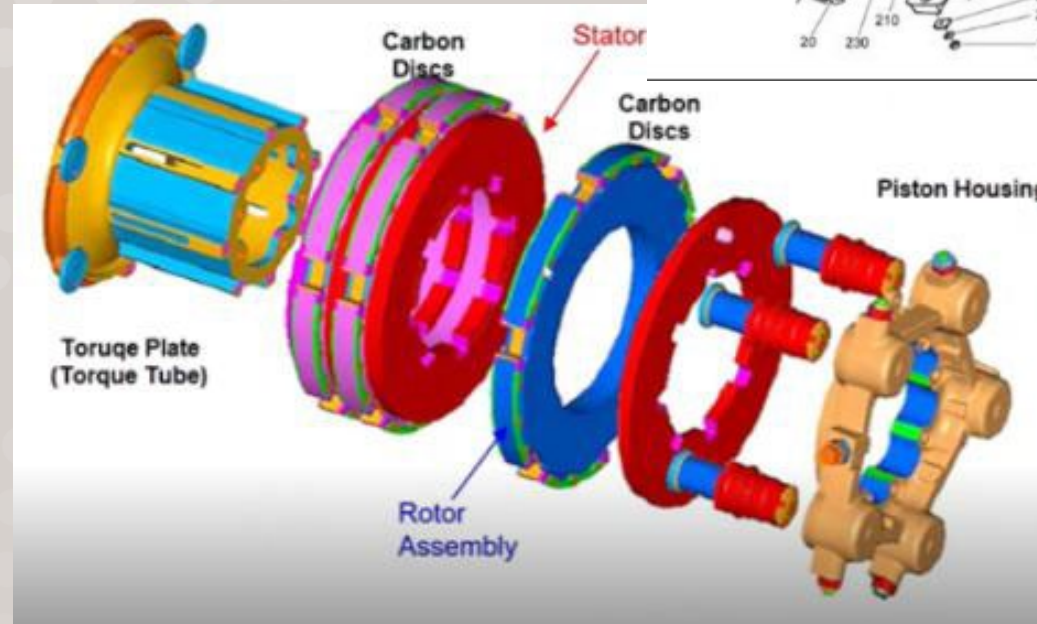
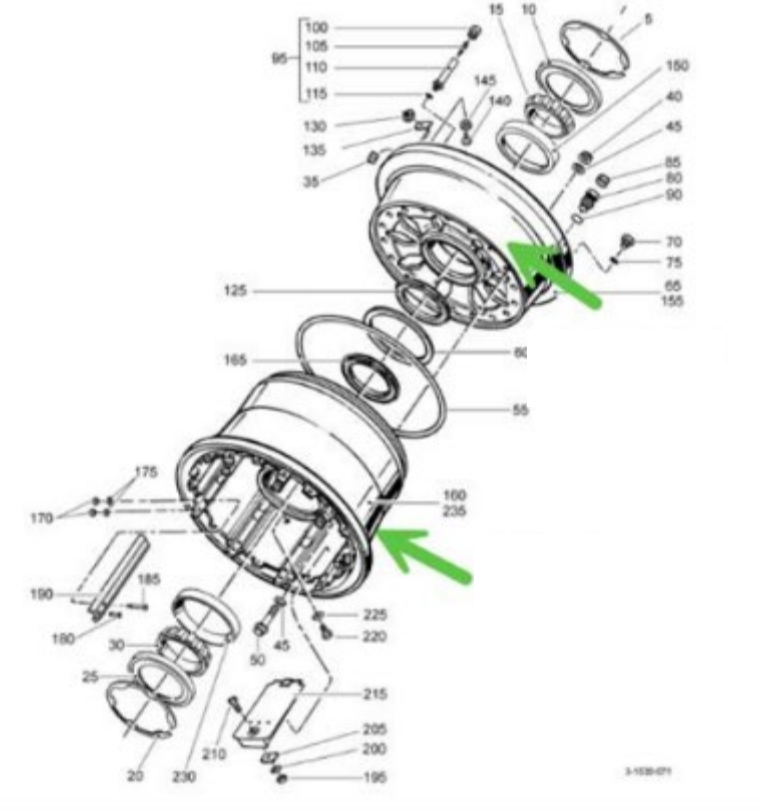
Future PCRT on Landing Systems



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PCRT Uses on Multiple Landing Systems Components

- PCRT can be used for most aircraft wheel and brake system components. Piloted programs for:
 - Torque plates
 - Piston housings
 - Brake discs
 - Additional components: Bolts, torque bars, heat shields, bearings, axle, etc.



Future: More REX Systems

- 17 systems deployed
- Additional systems in production now for early 2027 deployment
- Planning production for 2027/2028 at multiple airlines, MRO's, and US military applications around the world
- Safran Landing Systems Tech Pubs office is preparing to release SPM and CMM's including PCRT
 - Conservative and deliberate approach to contain any potential risk to wheel supply chain
 - Boeing 737, 767, 777 1st, other Boeing and Airbus CMM's to follow

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Upgrades to Fixture

- User, software, hardware upgrades
- Accommodate other geometries
 - Larger wheels
 - Torque Plates
 - Piston Housings
 - Non landing gear parts
 - Many others!



**Keyence Vision
System Integration**

**Investigating Oxygen
Canisters on REX**



**Fielded
Adaptor
used for
Torque Plate
Testing**



Future:

Advance coatings on wheels longer

- Factory coatings give BEST protection against corrosion
 - New coatings also in development
- IF must take coating off at first overhaul
 - Lose that BEST protection
 - Takes a longer time to remove!

How can we keep coatings on longer?



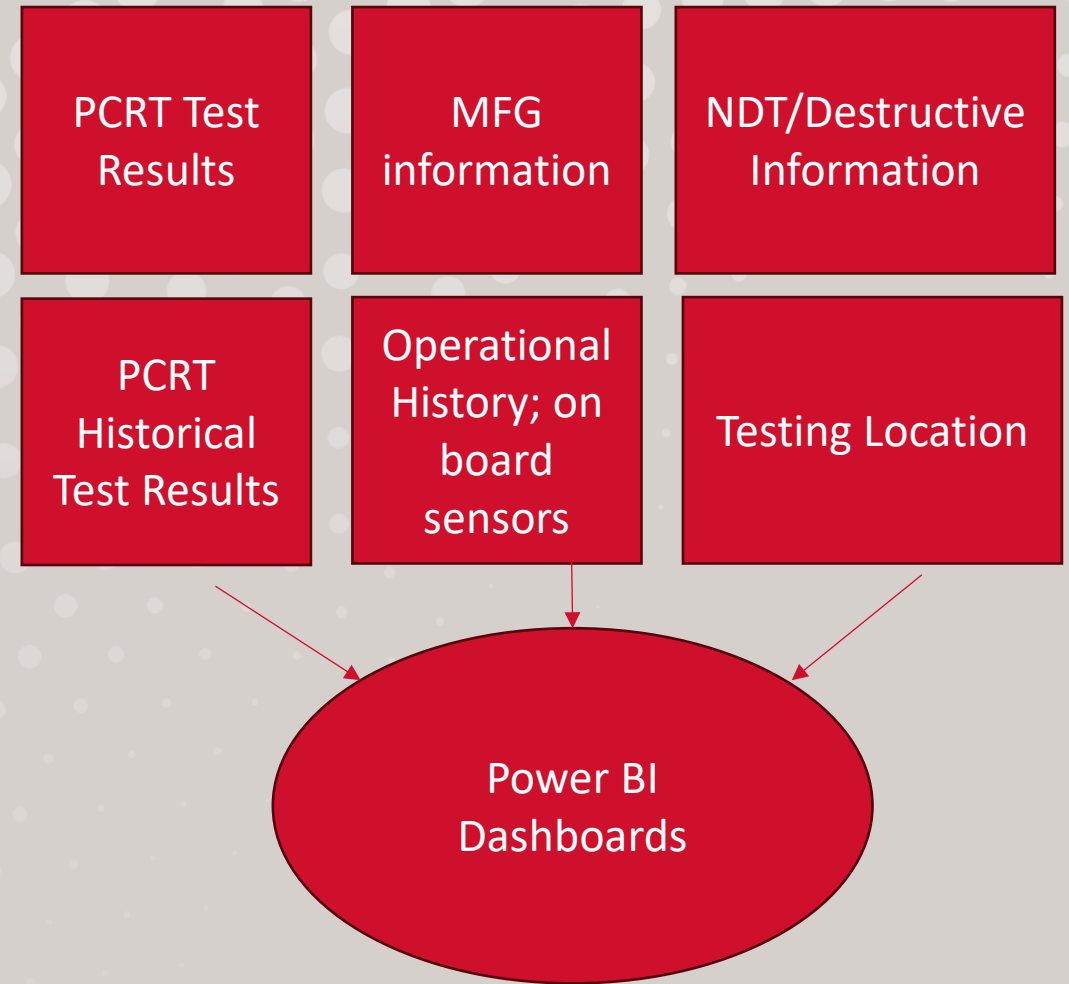
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Future: Integrate PCRT Birth Certificates



Future: Integrate PCRT in Big Data Lifecycle Maintenance

- Integrate as part of Life Extension
 - CBM, CBM+ Lifecycle
- Bring data together
 - What conditions yield best performance?
 - Digital twins
 - Uncover trends and correlations
 - Feed data to OE's



Life Extension of Parts= Cost Savings

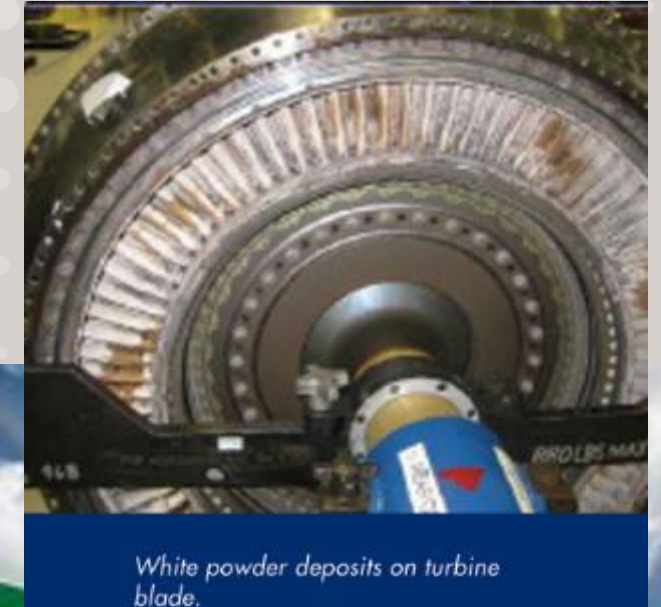
**PCRT Proven on
Turbine Blades
and Power
Generation
Blades**

PCRT data showed the 2nd stage FT-8 blades had consistent material properties and consistent mechanical behavior, with the exception of two outliers. Using that information in conjunction with an advanced repair process, the part life was extended and are continuing to operate without issue.

This one set of blades saved the customer
180,000€!

For the full story, please see the article below:

[PCRT Technology Aids Enel/Endesa in Turbine Blade Repair/Replace Decision \(epri.com\)](https://www.epri.com/Portals/0/PDF-files/PCRT-Technology-Aids-Enel-Endesa-in-Turbine-Blade-Repair-Replace-Decision.pdf)



PCRT Implementation and Integration: Team Effort



Alignment

- To add a new NDT or change process to use PCRT sort requires alignment with
 - OE and MRO
 - Level I's, Level II's, Level III
 - Quality Control
 - Maintenance
 - Customers
 - Update documentation (CMM's, etc.)
- For new geometries, creating new PCRT sort takes time
 - Collection of reference/damaged parts
 - PCRT Level III
 - ASTM guides for PCRT sort creation

PCRT and Vibrant CERTIFIED:

AS9100 Rev D and ISO 9001:2015 under certificate #10928.

FAA/EASA Repair Station VC3R947D

PCRT is FAA-approved for gas turbine engine blade inspection.

Resonant Ultrasound Spectroscopy (RUS) and PCRT application are described by ASTM Standard Guide E2001-18 & E3166 and ASTM Standard Practices E2534, E3081, & E3213.

ASNT approved NDT training program

Assorted customer documents: CMM, CRIM, NDT manuals, etc.



PCRT is a valuable addition to your NDT toolbox

- PCRT has been and will continue to aid multiple industry in NDT of highly critical components
 - Saving time, labor, chemicals, and adding sensitivity
 - High and low volume applications
 - Cradle to grave
 - Adds to NDT toolbox
- Happy to discuss the journey, the method, and you can benefit.



PCRT Applications	# Tested in 2025
Automotive	10 Million
Rotating (Turbine Blades, Power Generation Blades)	40,000
Landing Systems (Wheels/Brakes)	40,000
Other	5,000



Acknowledgements: 2022 A4A Award Team

NOVEL RESONANCE INSPECTION OF COMMERCIAL AIRCRAFT WHEELS

Airlines 4 America Innovation Award

AFRL/RX, Collins, Vibrant,
DeltaTech Opps, Pratt &
Whitney Canada

[Collins, Vibrant, USAF Innovation Award Presentation](https://a4andforum.com/wp-content/uploads/2022/10/291110-Novel-Resonance-Insp-of-Commercial-Aircraft-Wheels.pdf)

<https://a4andforum.com/wp-content/uploads/2022/10/291110-Novel-Resonance-Insp-of-Commercial-Aircraft-Wheels.pdf>



- Also want to thank all the Level III's, airlines, MRO and OEM, Power generation, and automotive customers who have utilized PCRT and aided in its development and deployment

AFRL Materials Directorate

Siamack Mazdiyazni (Retired)

Dr. Eric Lindgren

Collins

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Scott Whittle, Chief Structures Engineer

Brian Spencer, MRO Responsible Level III

Brian Skinner, Principal Customer Support Engineer

Steve Campbell, Operations Value Stream Engineering Manager

Delta TechOps

David Piotrowski, Senior Principle Engineer

Joe Benjamin, Principle Engineer Wheel & Brake

Roland Johnson, Wheel Shop Lead Technician

Vibrant Corp.

Leanne Jauriqui, VP of Technology

Julieanne Heffernan, Application Engineer

Mark Ortega, Manufacturing Engineering Manager

Robert Parker, Application Engineer

Pratt & Whitney Canada

David Craig, Senior Fellow & Manager NDT



Questions?

