

Test Devices Inc.



Performance Characterization
and Life Testing of Turbo-
machinery Blades & Dampers by



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Dynamic Spin™ Testing

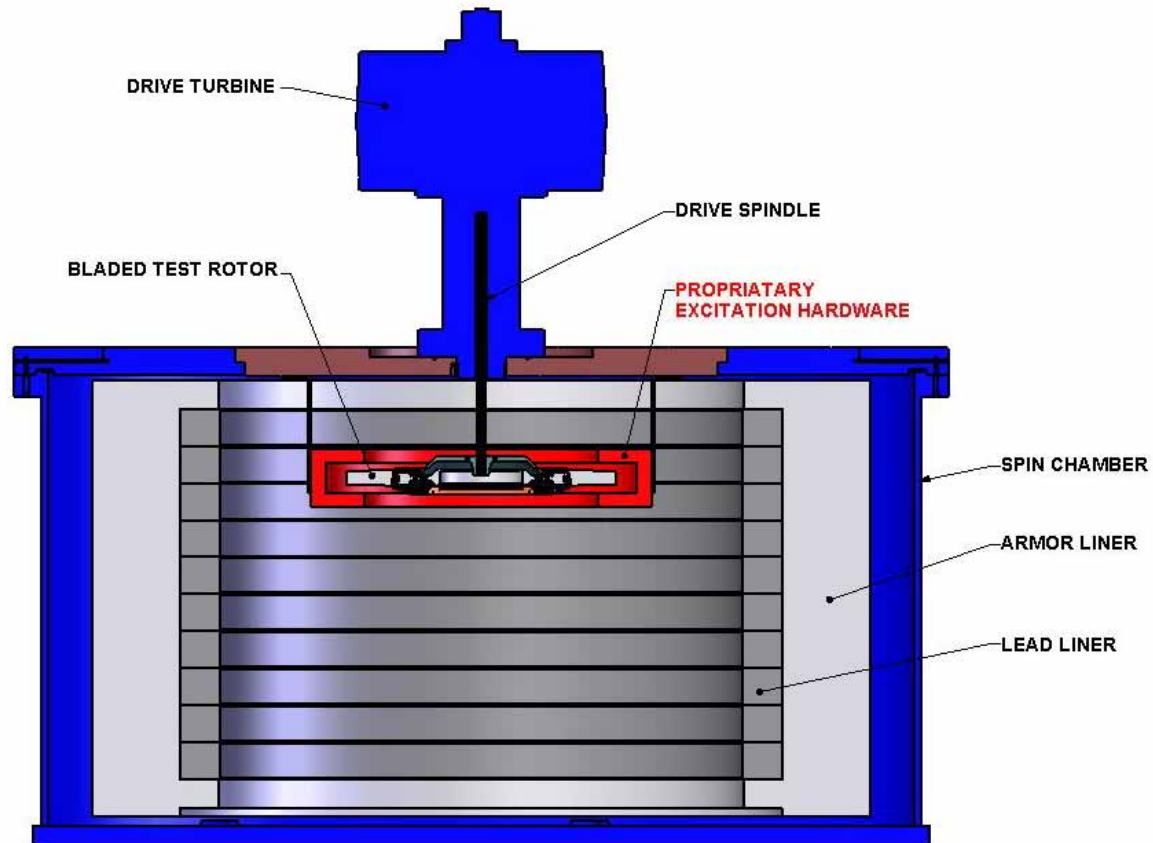
Defined:

**Excitation of blade resonant vibrations
in fully assembled jet engine stages
during rotational testing at operational
speeds.**



Dynamic Spin™ Testing

Defined:



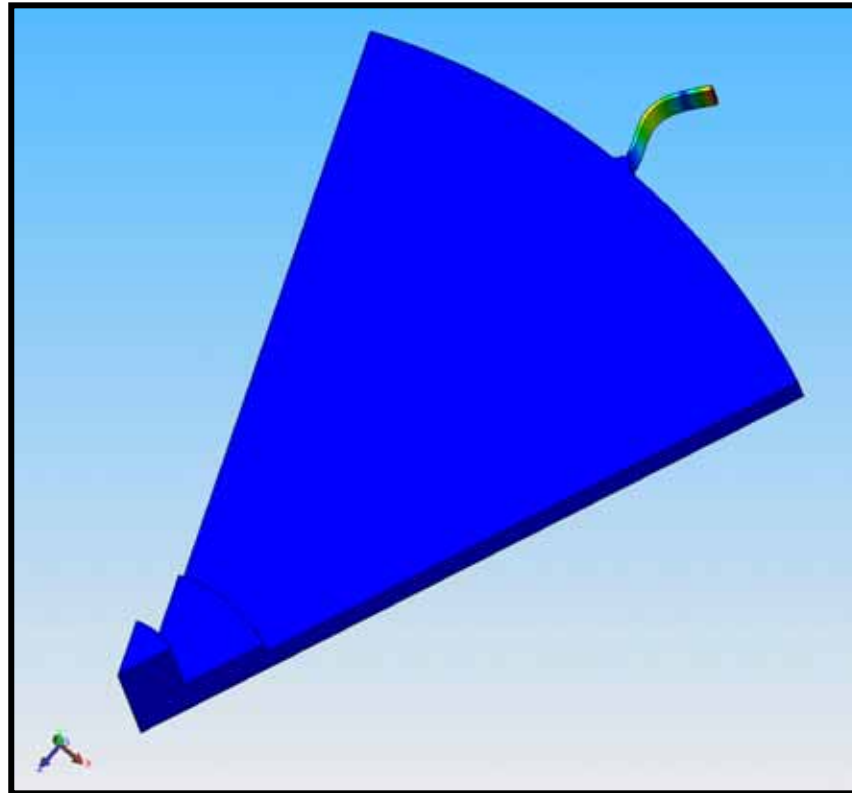
Layout of Dynamic Spin Rig setup

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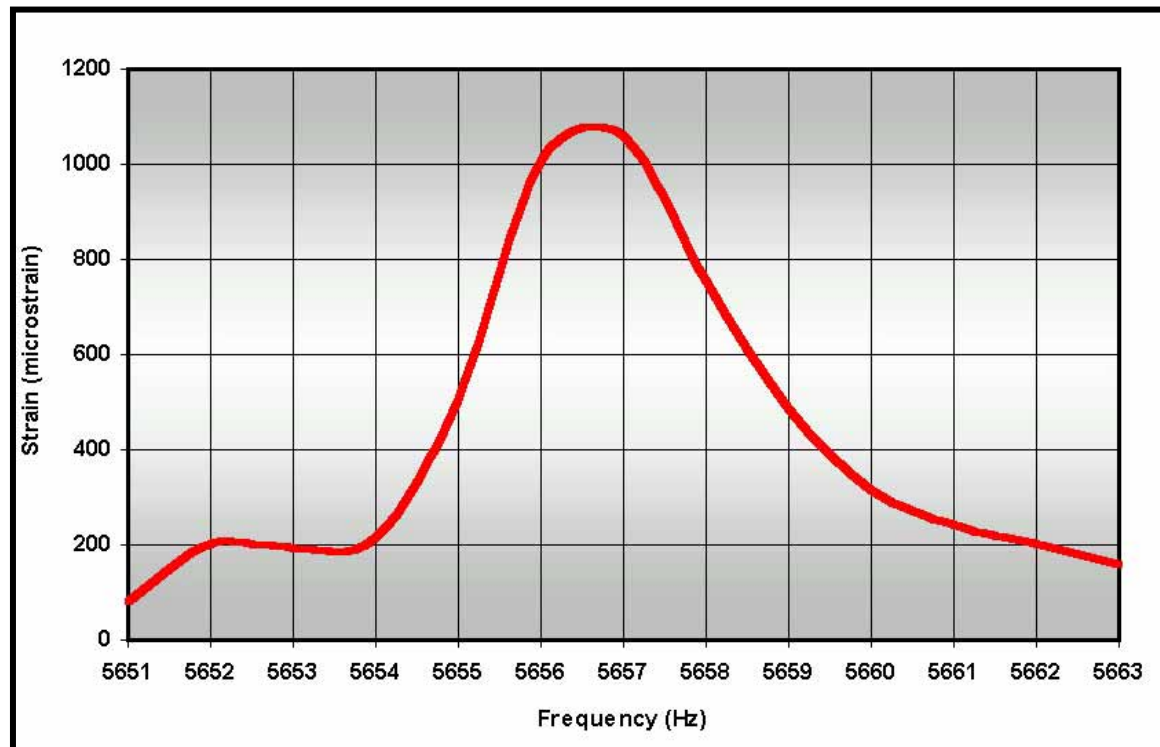
Defined:



Modeled disk sector demonstrating the 2nd bending mode in the attached blade

Dynamic Spin™ Testing Capabilities

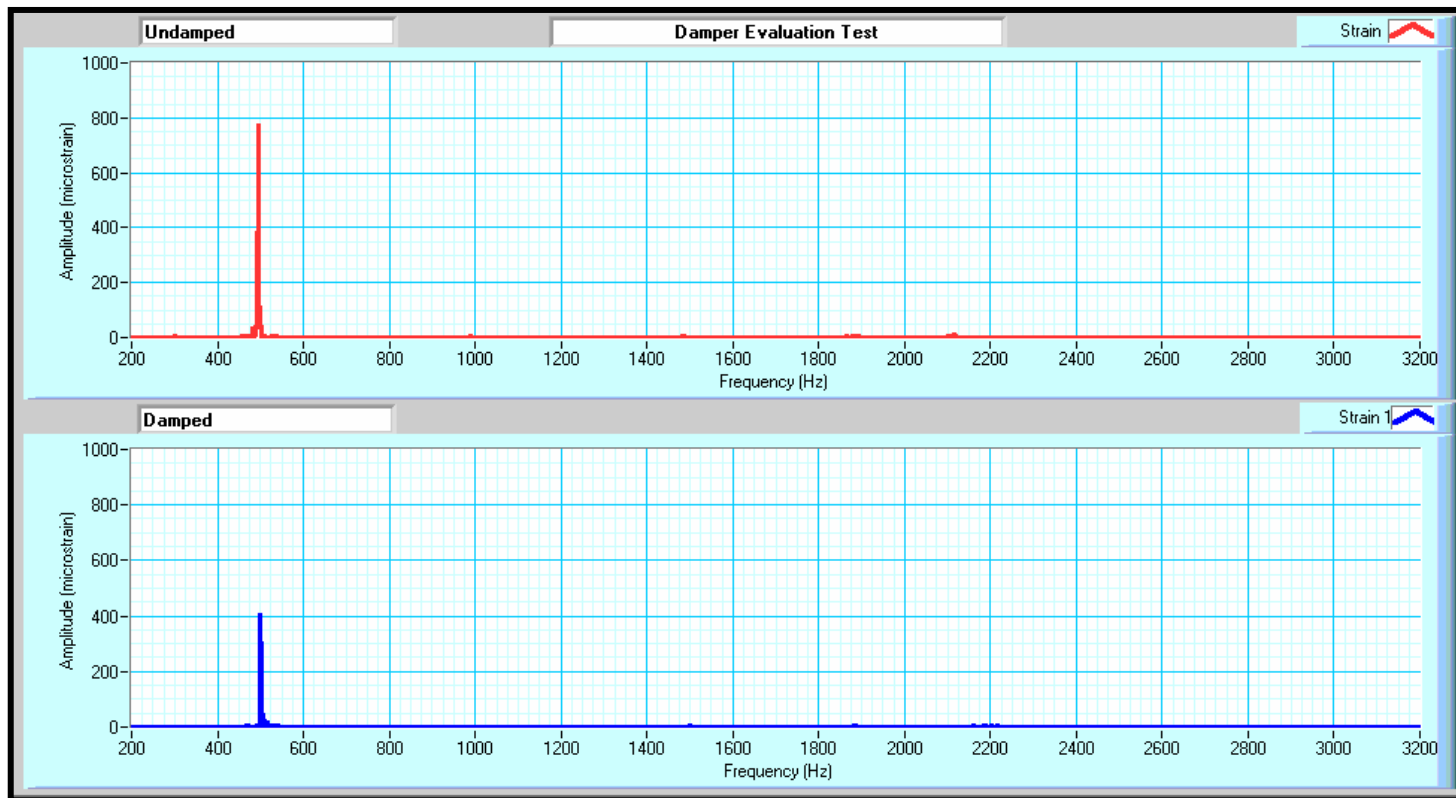
1. Characterization of blade resonant vibration



Measurement of blade amplification factors

Dynamic Spin™ Testing Capabilities

2. Performance evaluation of damper designs

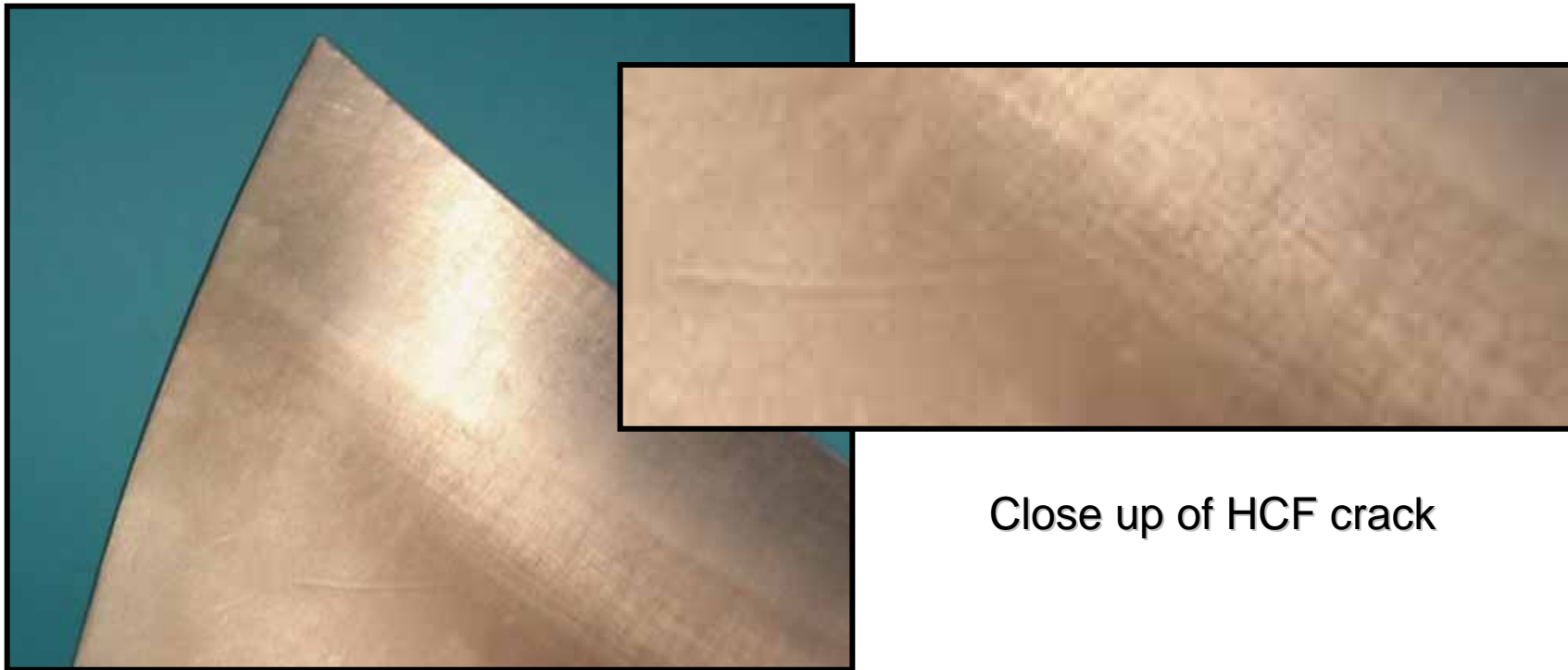


Comparison of damped vs. undamped

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Capabilities

3. High cycle fatigue testing of complete rotors



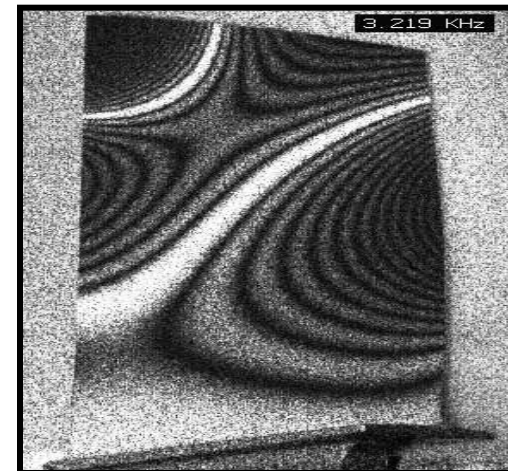
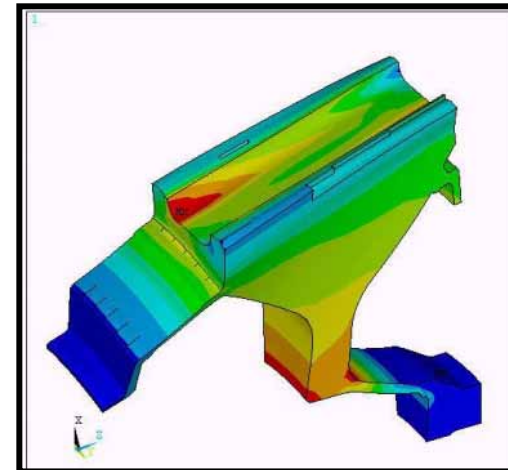
Close up of HCF crack

Blade crack occurred during continuous dwelling on resonance

Traditional Test Methods

- Finite Element Analysis
 - Difficult to accurately model boundary conditions or account for manufacturing variations.
 - There is no way to analyze the unexpected

- Vibrometry (“Bench Testing”)
 - Does not include centrifugal load
 - Rotors cannot be tested as complete assemblies.



Traditional Test Methods

Continued

- **Blow-down Rig**
 - Resonance crossings are transient and uncontrollable
 - No ability to evaluate fatigue life

- **Live Engine Testing**
 - Extremely expensive, costing an estimated \$100,000 per hour.
 - Risk of damage to other engine components due to blade failure.



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Dynamic Spin™ Testing

Advantages



1. Tests are run at engine operating speeds.
2. Blade, rotor, and damper hardware is tested as an assembly in “engine ready” condition.
3. Precise speed control allows for slow crossing and continuous dwelling “on resonance”.



Dynamic Spin™ Testing



Advantages - Continued

4. Multiple blade or damper designs can be tested simultaneously.
5. The cost is an order of magnitude less expensive than live engine testing.
6. Tests can be run at operational temperatures.



Conclusion



By including centrifugal stress and tailoring tests for specific rotor configurations, Dynamic Spin Testing provides a powerful new method for evaluating bladed turbine engine assemblies.