

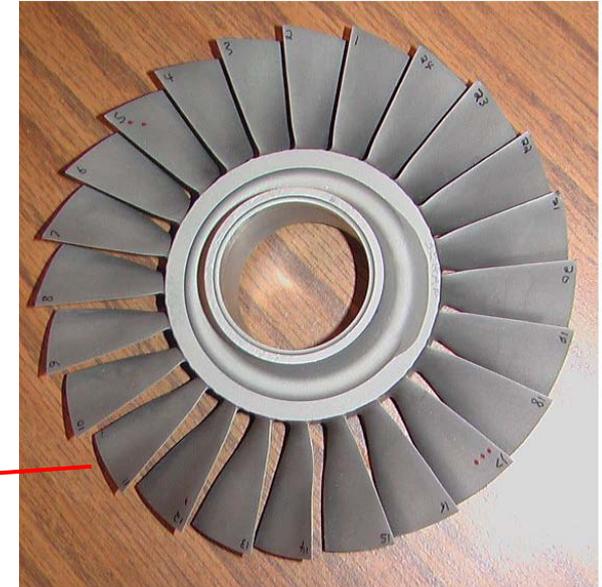
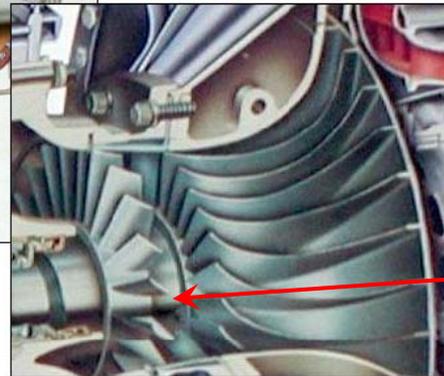
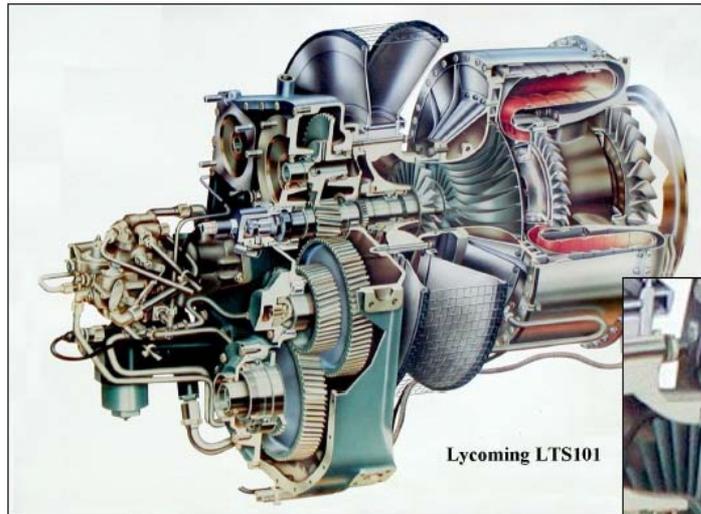
# **Preliminary Test Results for the Modified\* Philtec D63 Optical Probe for use as a High Speed Time of Arrival (TOA) Probe**

**John J Jagodnik**

**Project Engineer  
Mechanical Solutions, Inc.  
11 Apollo Drive  
Whippany, NJ 07981  
(973) 326-9920 x123  
jjj@mechsol.com**

4/16/2009

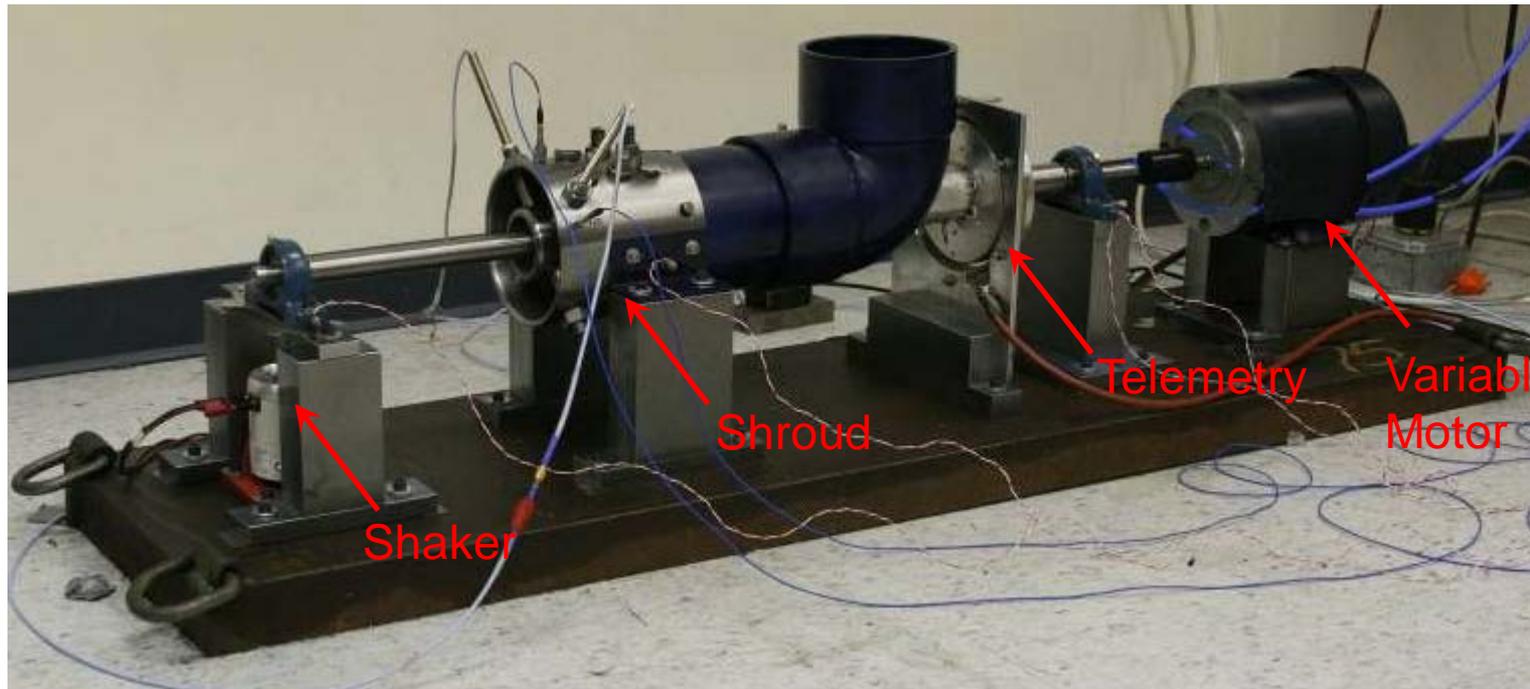
# MSI's Compressor Test Rig



**Honeywell LTS101 Turboshaft Engine.**

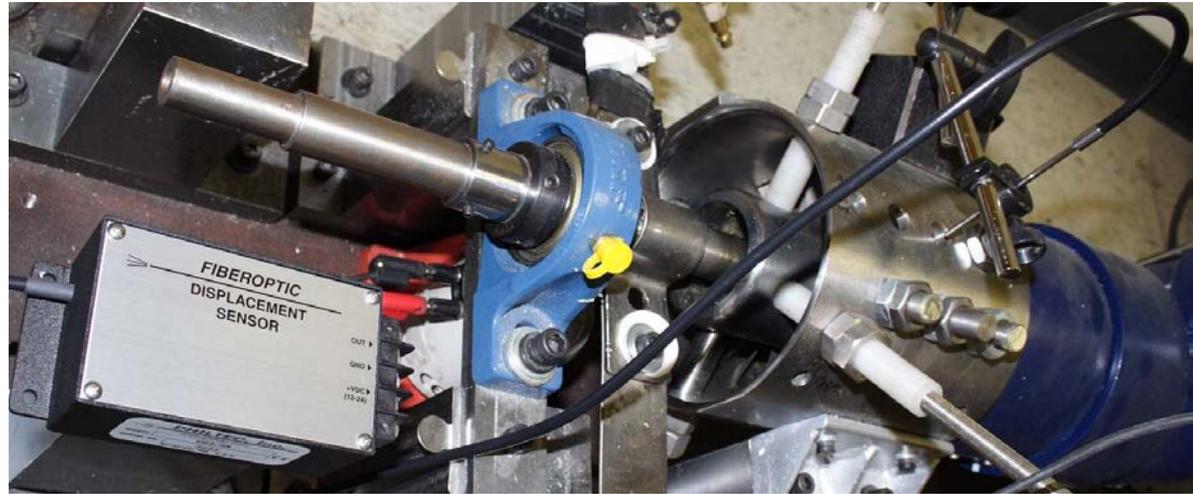
- MSI tested the 2 MHz bandwidth D63 optical probe on our in house high speed compressor test rig.
- The compressor test rig uses a small axial blisk from a 2 stage LTS101 Turboshaft Engine.

# MSI's Compressor Test Rig



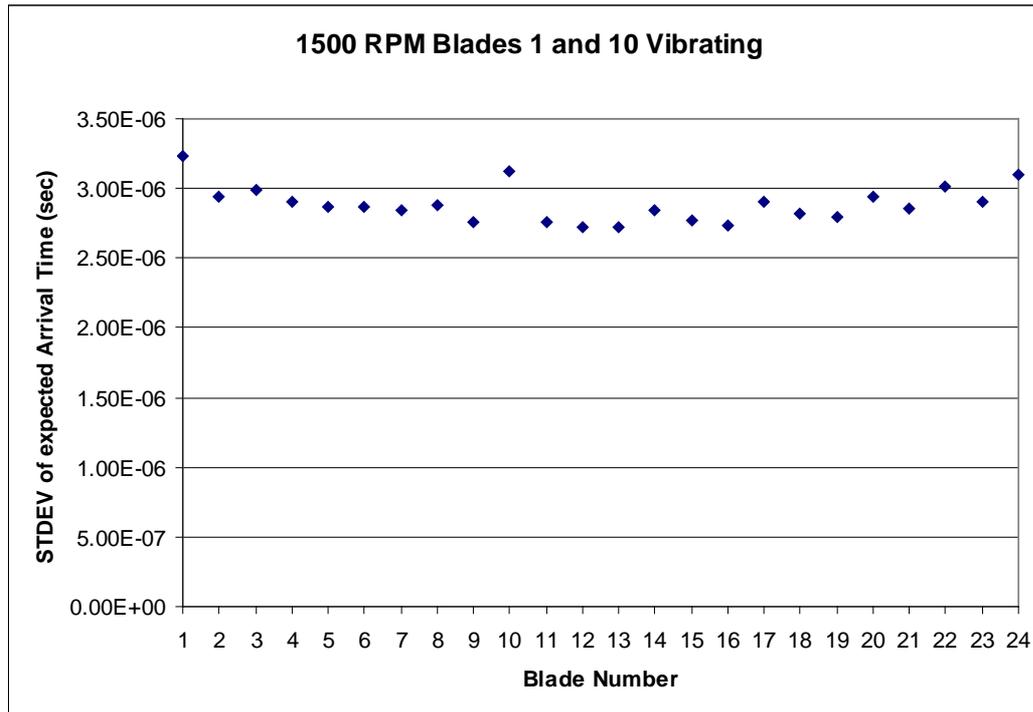
- MSI's compressor test rig includes:
  - A shaker to excite blade modes
  - Instrumented shroud
  - Telemetry to simultaneously monitor strain on 2 blades
  - A variable speed electric motor

# MSI's Compressor Test Rig



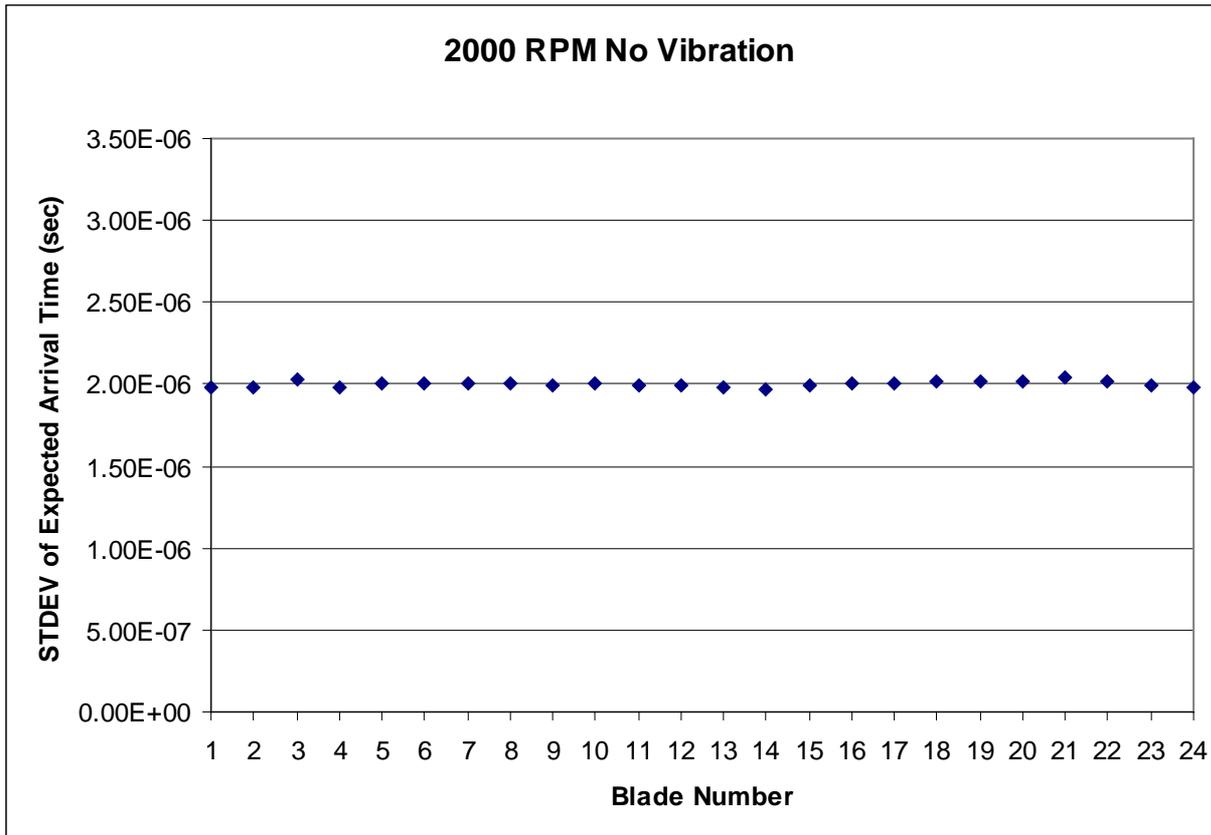
- The Philtec D63 Probe was attached to the shroud and pointed radially inward at the blade tips.
- The time of arrival (TOA) of each blade was recorded using an 80 MHz NI counter timer card.

# Vibrating Blade Test Results



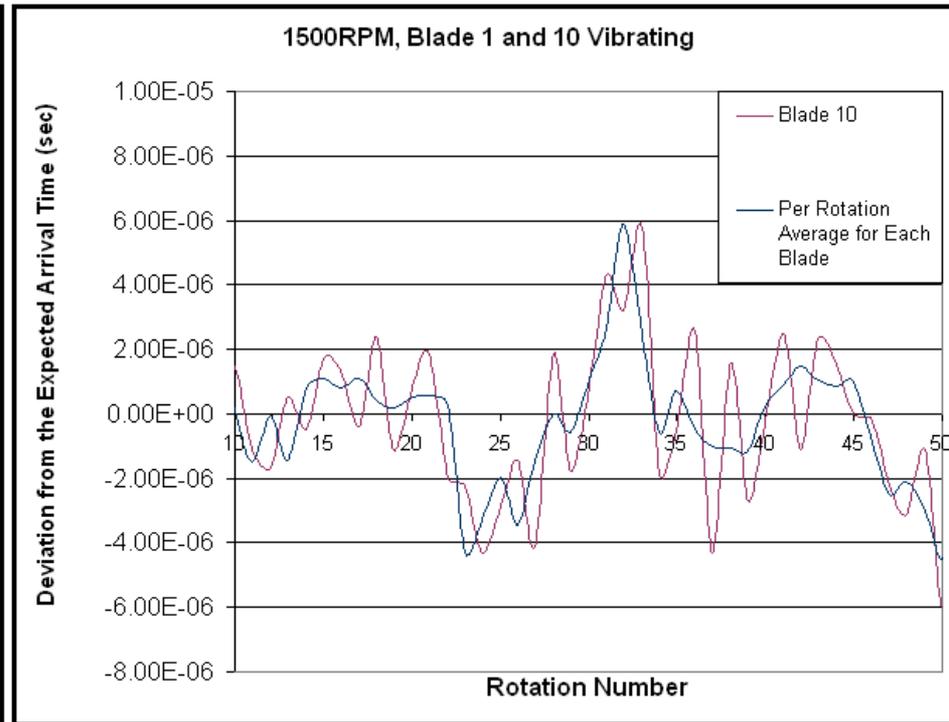
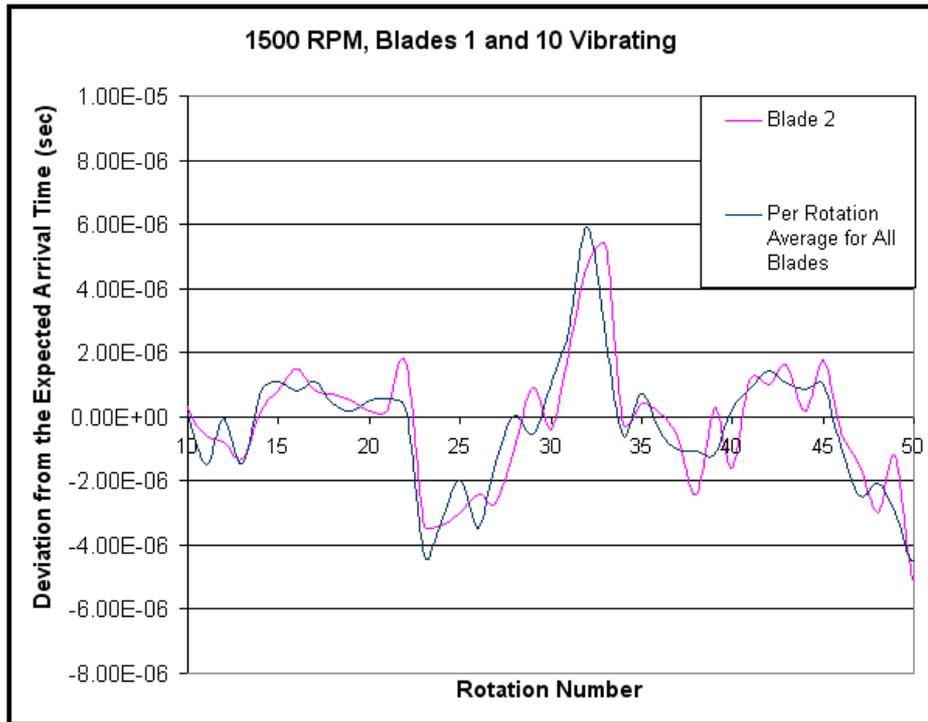
- While spinning at 1500 RPM, the shaker was activated at the first bending frequency of Blade 10.
- This resulted in higher non-synchronous vibration levels on Blade 10 (Blade 1 also demonstrated higher vibration levels).
- All other blades (which have higher first bending frequencies) vibrated at significantly lower levels.
- A larger standard deviation of the expected arrival time was observed for the vibrating blades.

# Non Vibrating Blade Test Results



- A test was then conducted spinning at 2000 RPM with no shaker excitation.
- This resulted in low vibration levels for each blade.
- No variations in the standard deviation of the expected arrival time were observed, indicating that no blades were significantly vibrating.

# Deviation from the Expected Arrival Time vs. Rotation Number



- The blade vibration can be detected directly from the deviation in expected arrival time curves for each blade.
- The graph on the left demonstrates that for rotations 10-50, Blade 2 (low vibration levels) has only small deviations from the 24 Blade average deviation (representative of average rotational speed fluctuation).
- The graph on the right demonstrates that for rotations 10-50, Blade 10 (high vibration levels) has large deviations from the 24 Blade average deviation.

# Future Work

- **MSI has ordered two D63 optical probes with modified amplifiers for higher slew rates.**
- **One probe will be used as a once per rev, monitoring a shaft keyway near the blades.**
- **The second probe will monitor blade time of arrival.**
- **The combined 2 probe method will be used to separate out arrival time variations caused by fluctuations in shaft rotational speed.**