



TIMKEN

Condition Monitoring Methods for Wind Main Shaft and Gearbox Planetary Sections

Richard Brooks
PHM Conference 2013
Wind Energy Workshop

Stronger.

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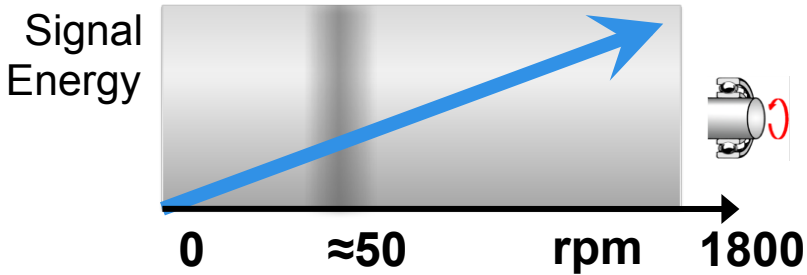
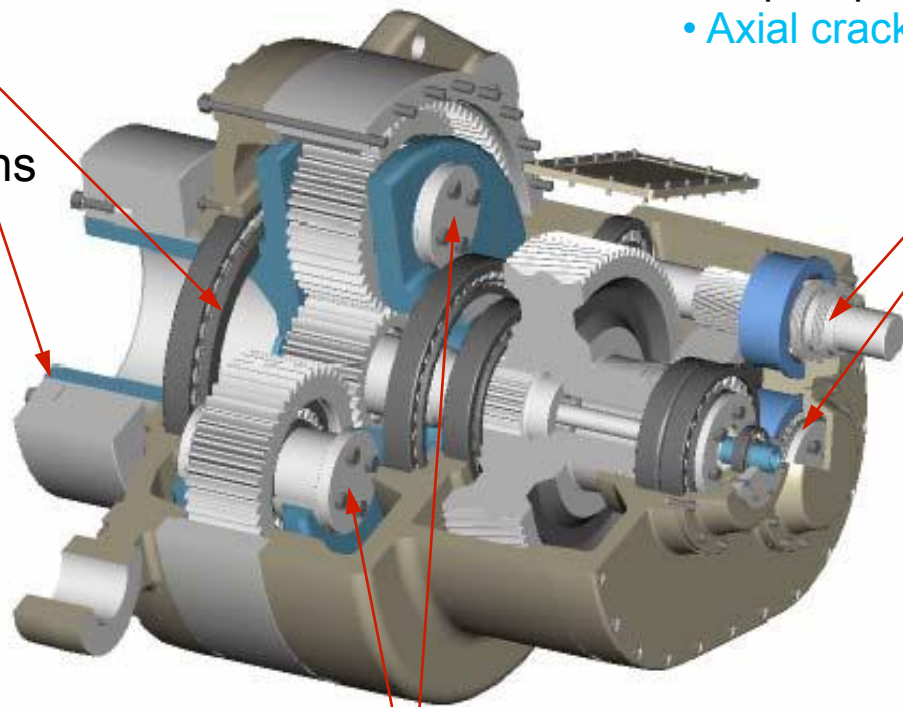
INHERENT CHALLENGES FOR WIND VIBRATION ANALYSIS

Main Shaft & Low Speed Positions:

- 5 to 20, 20 to 80 RPM
- Constant speed fluctuations
- Micropitting damage

Generator & High Speed shafts:

- 100 to 1800 RPM
- Rapid speed changes
- Axial cracks on Inners



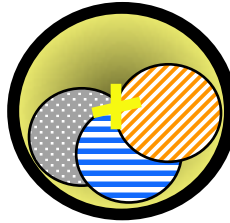
Planetary positions:

- 20 to 80 RPM
- Moving shafts
- Poor signal transmission path
- Debris & load damage



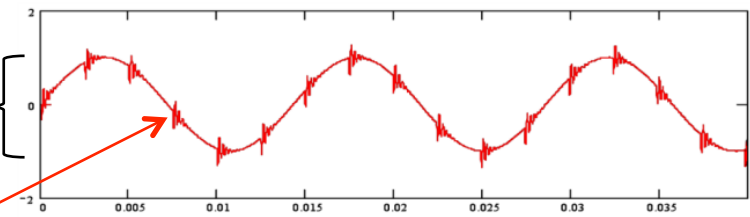
VIBRATION TECHNIQUES

Vibration - oscillating movement of a body about a reference position



“Movement”

Traditional Vibration Analysis



“Ringing”

A damaged bearing generates two distinct signals:
“Movement” & “Ringing”

Common Resonator methods

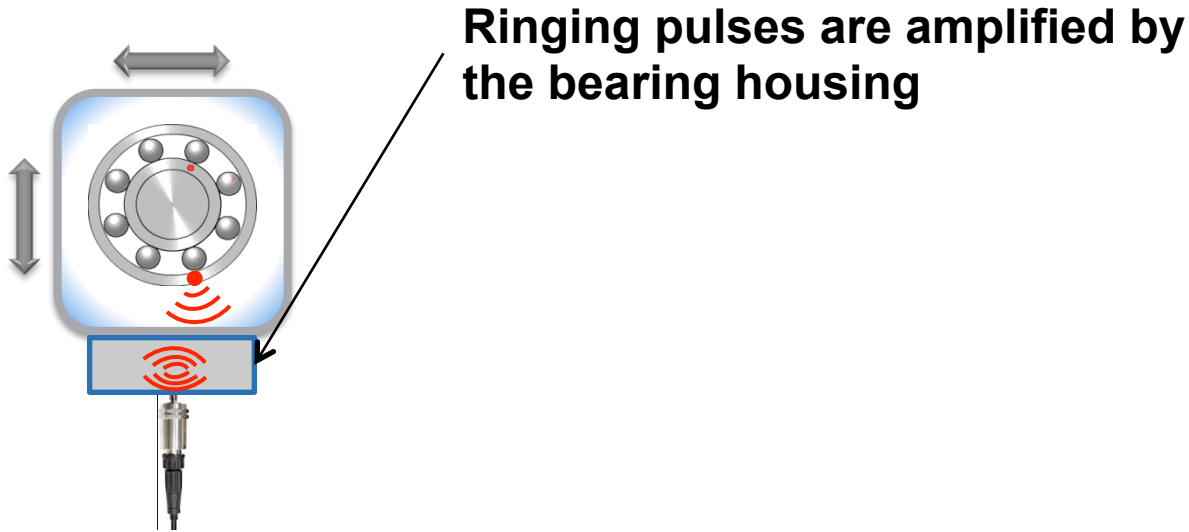
- Vibration Enveloping
- Peak Vue
- Spike Energy
- Stress Wave
- Shock Pulse

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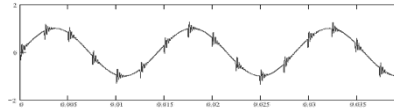
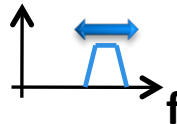


Housing Resonator methods

- *Vibration Enveloping*
- *Peak Vue*
- *Spike Energy*
- *Others*



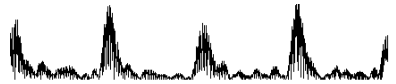
Band Pass



Rectify

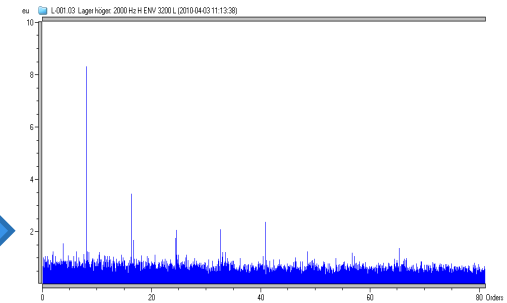


Demodulate



Envelope

FFT

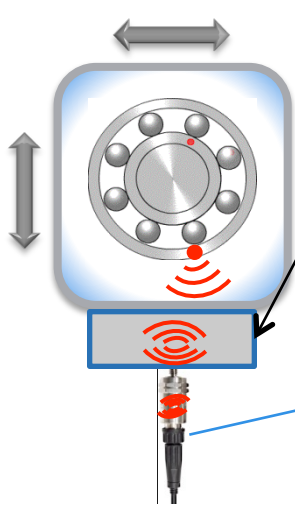


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Sensor Resonator methods

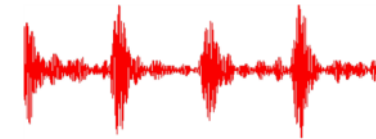
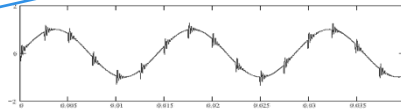
- Shock Pulse
- Stress Wave
- Others

Ringing pulses are amplified by a tuned resonator in the sensor



Resonator (Brass bar)

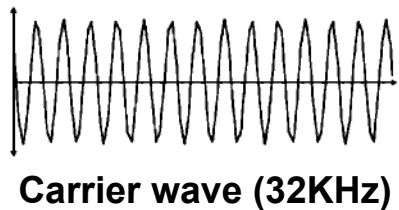
Piezo crystal



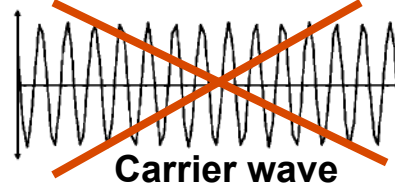
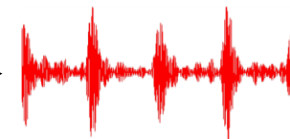
Enveloping

Rectifier

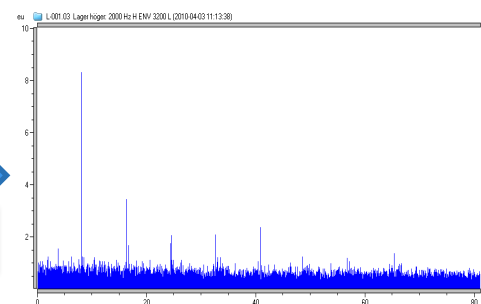
Demodulation



+



FFT



Resonator Method Comparison

Sensor

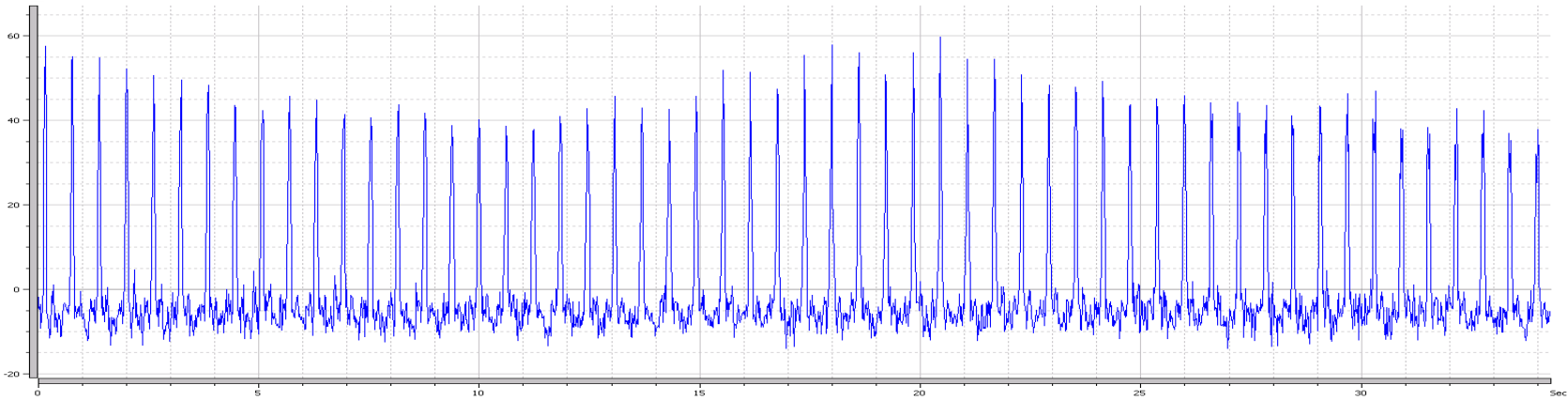
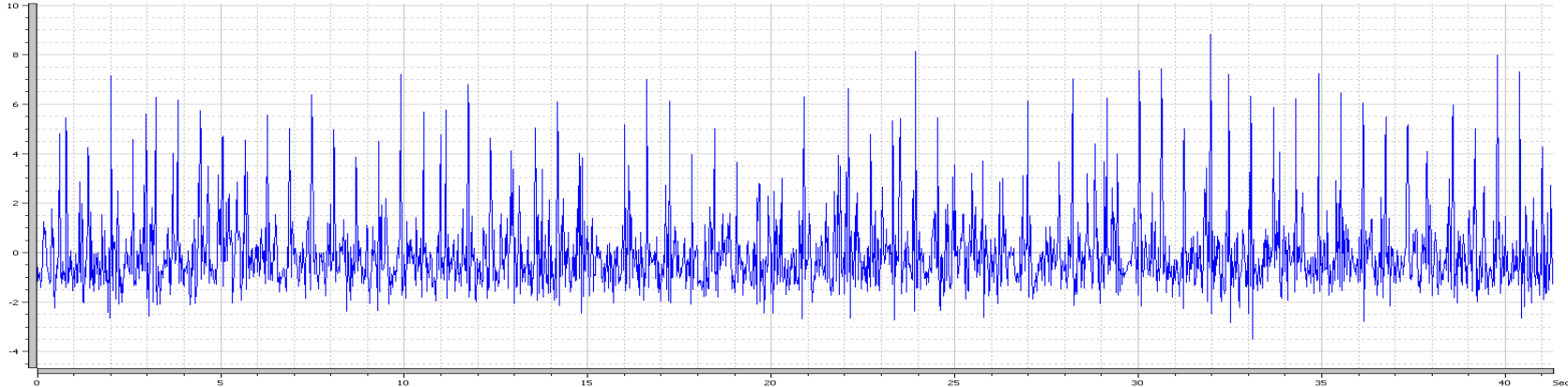
- Enhanced sensitivity to shocks
- Measurements repeatable with different sensors and locations
- Requires separate sensor for conventional vibration readings
- Mounting method more critical. Must use epoxy or hard mount

Housing

- Standard sensitivity to shocks
- Measurements vary with different sensors and locations
- Same sensor used for both Resonator and conventional readings
- Mounting less critical. Can use a magnet

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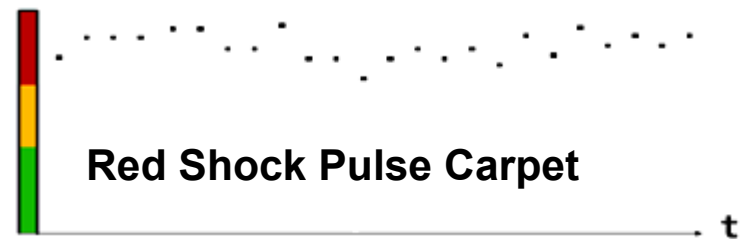
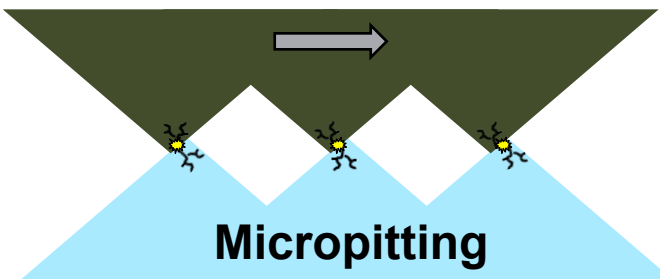
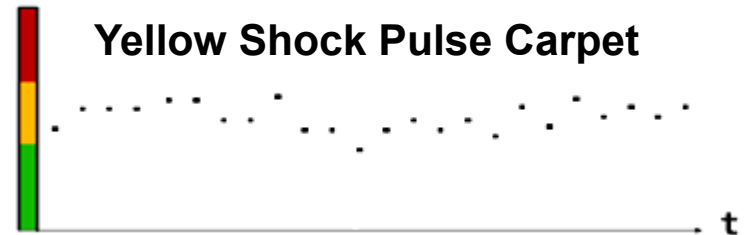
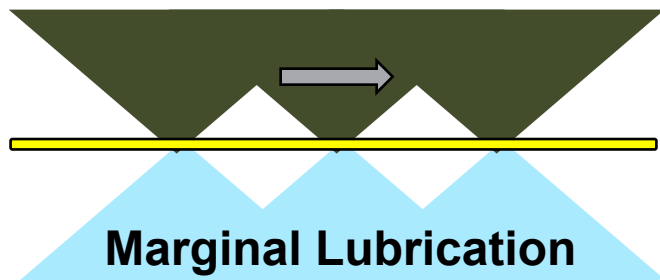
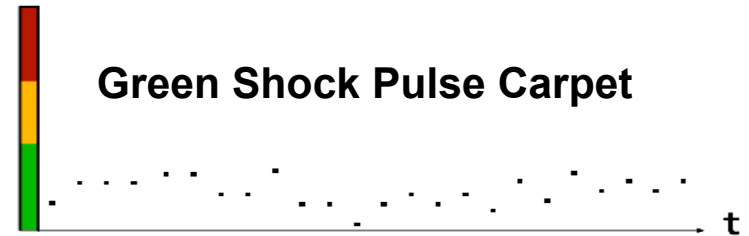
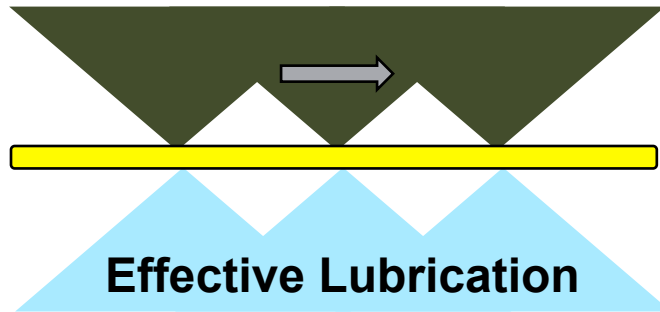
POST PROCESSING ALGORITHMS



Shock Pulse "Symptom Enhancer"

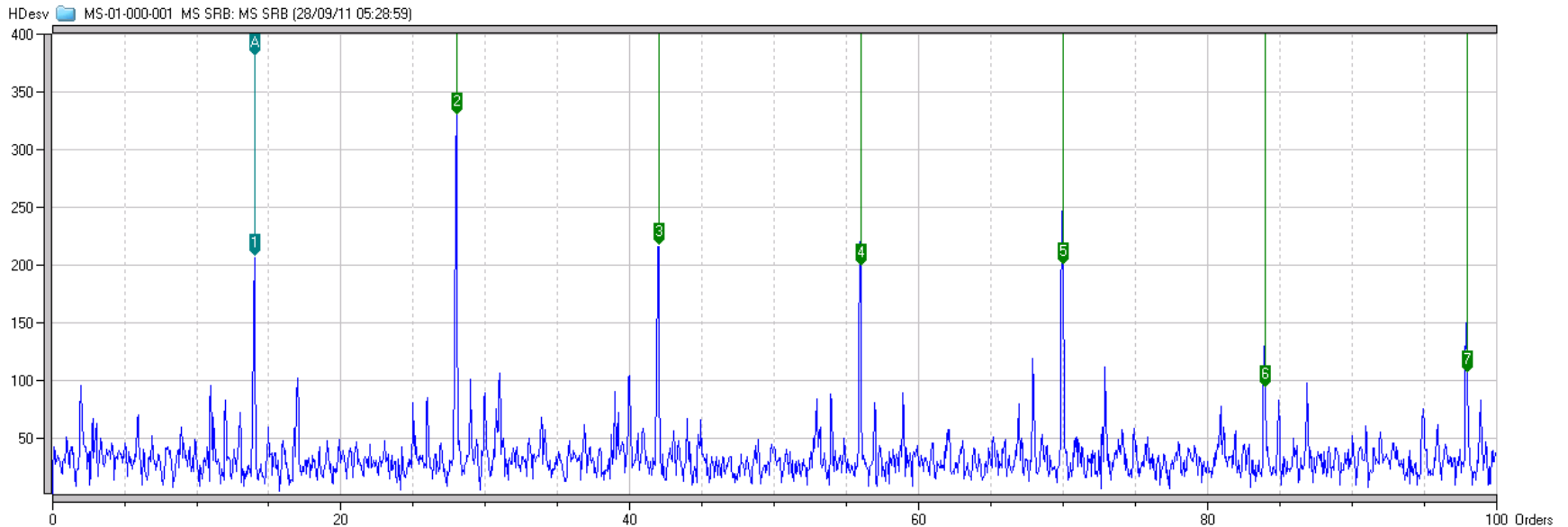


SHOCK PULSE FOR ASSESSING LUBE FILM EFFECTIVENESS AND MICROPITTING



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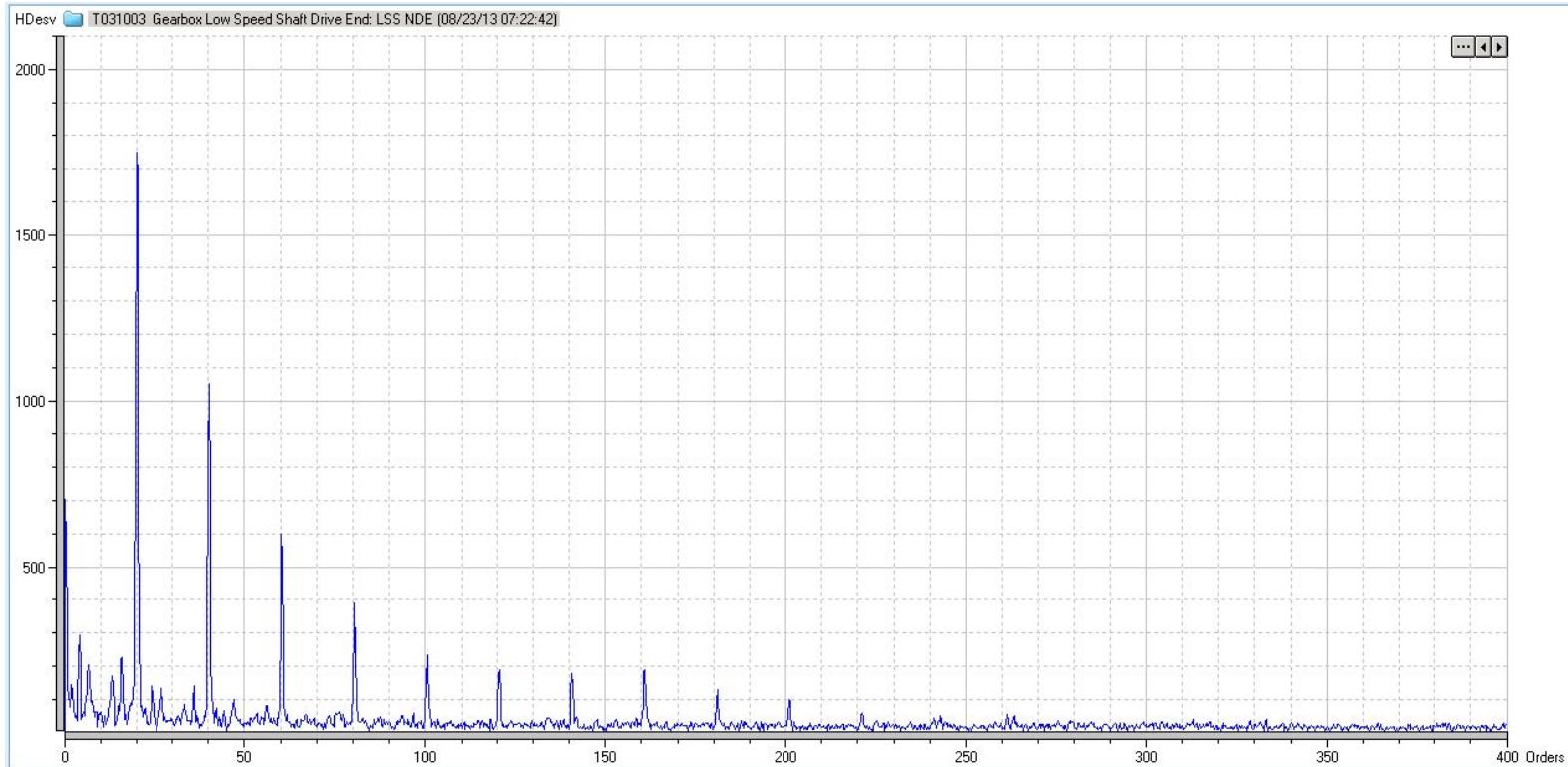
SHOCK PULSE DATA MAIN SHAFT 240/600 BEARING MICROPITTING & SPALLING



**Spectrum: Inner Race
Damage Frequencies
Prominent**

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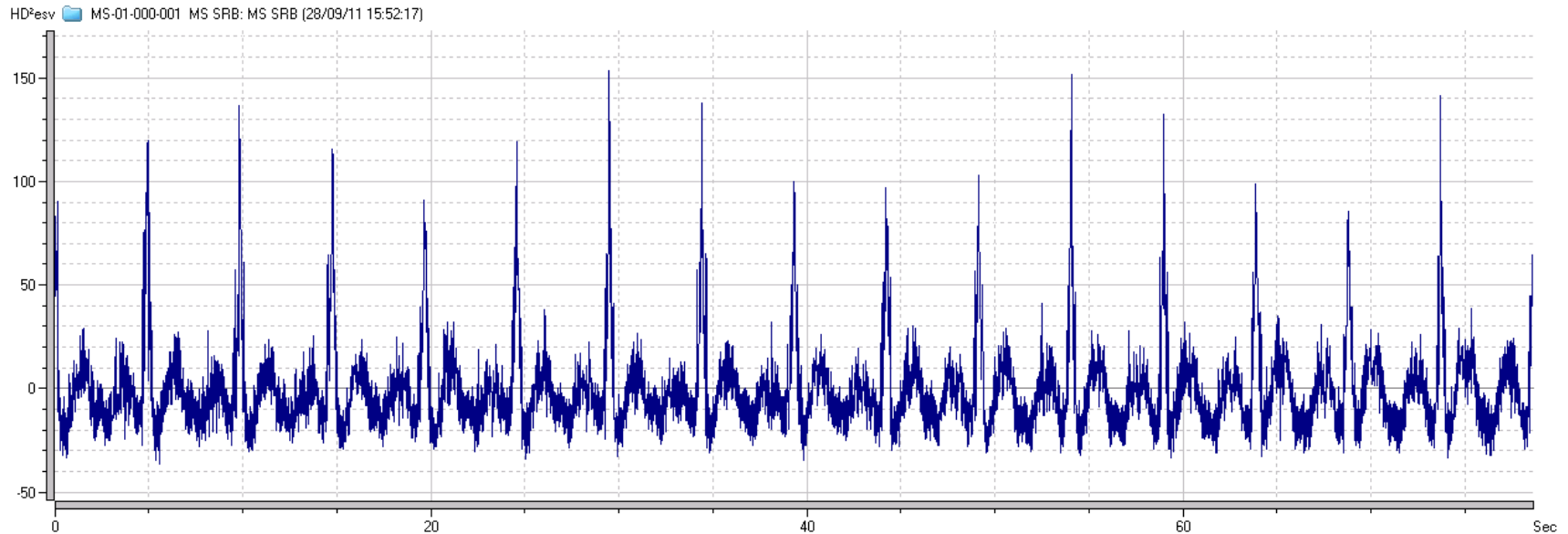
SHOCK PULSE DATA PLANET CARRIER NF2964 BEARING DEBRIS DAMAGE



**Spectrum: Roller Spin
Damage Frequencies
Prominent**

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SHOCK PULSE DATA MAIN SHAFT BEARING HUB IMPACT



**Waveform: Sharp 1X
impact from hub
cover damage**

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