

# A Method for Shaker Validation

*Today's Presenter: Joel Minderhoud*

*We will begin shortly!*



# A Method for Shaker Validation

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# Meet VR



Joel Minderhoud  
Research Scientist



# A Method for Shaker Validation

1. Need to Evaluate the Health of Shaker System
2. Use of System Check as a Method for Shaker Validation
3. Recommended Method for Shaker Validation
  - Sine Sweep
  - Total Harmonic Distortion Evaluation Tool

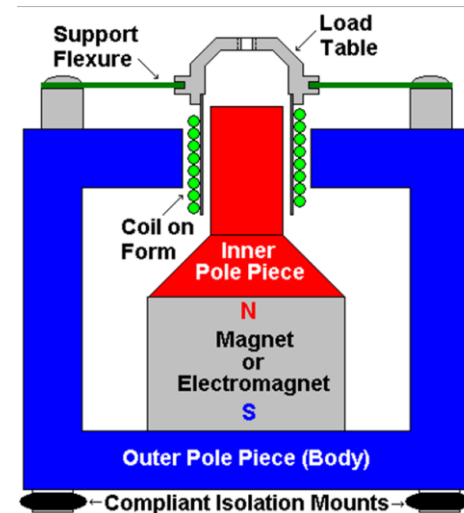
# Need for Shaker Validation

- Are your test results indicative of vibrations experienced by your product?



# Need for Shaker Validation

- Or is your shaker introducing vibrations into your test results?
  - Damaged Armature
  - Damaged Flexure/Roller bearings



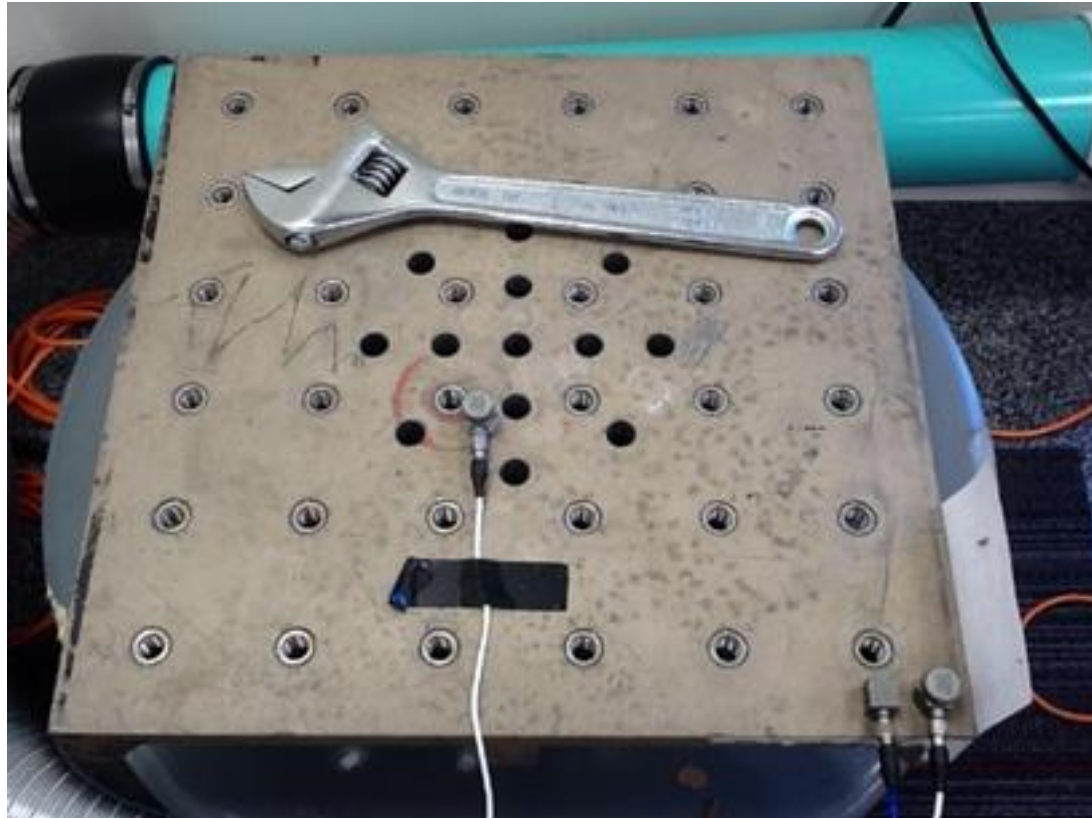
- When is the last time you checked if your shaker system was operating according to specifications?

# Need for Shaker Validation

- How often should I run a Shaker Validation Test?
  - Make it a routine task
  - Regularity of validation test should be test-facility driven – according to your needs and preferences
    - Monthly?
    - Quarterly?
- How similar should physical set-up be for Shaker Validation Test?
  - As identical as possible
    - **Bare shaker head!!**
    - Head expander only
    - Fixture only

# System Check and Sine Sweep Examples

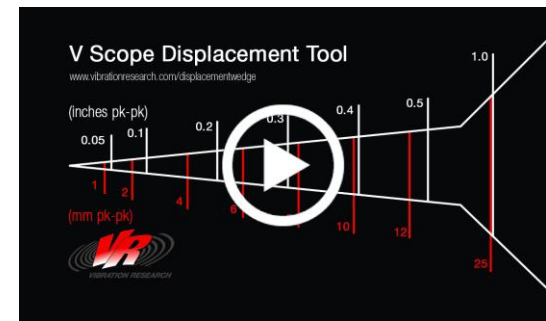
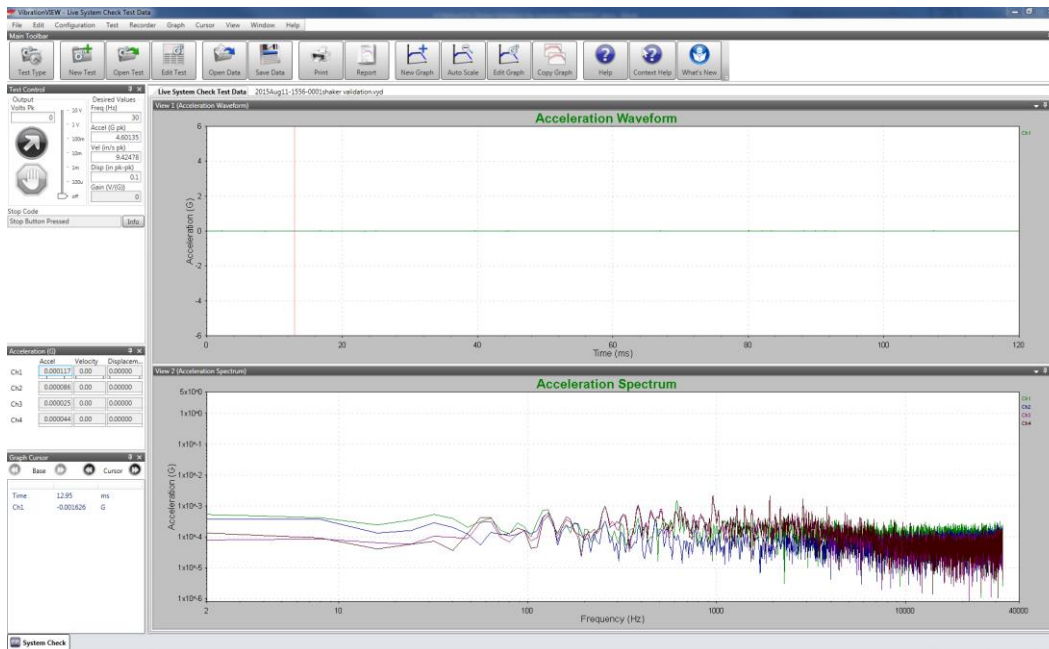
- Bare Table vs. Loose Wrench (Simulation Test)





# System Check

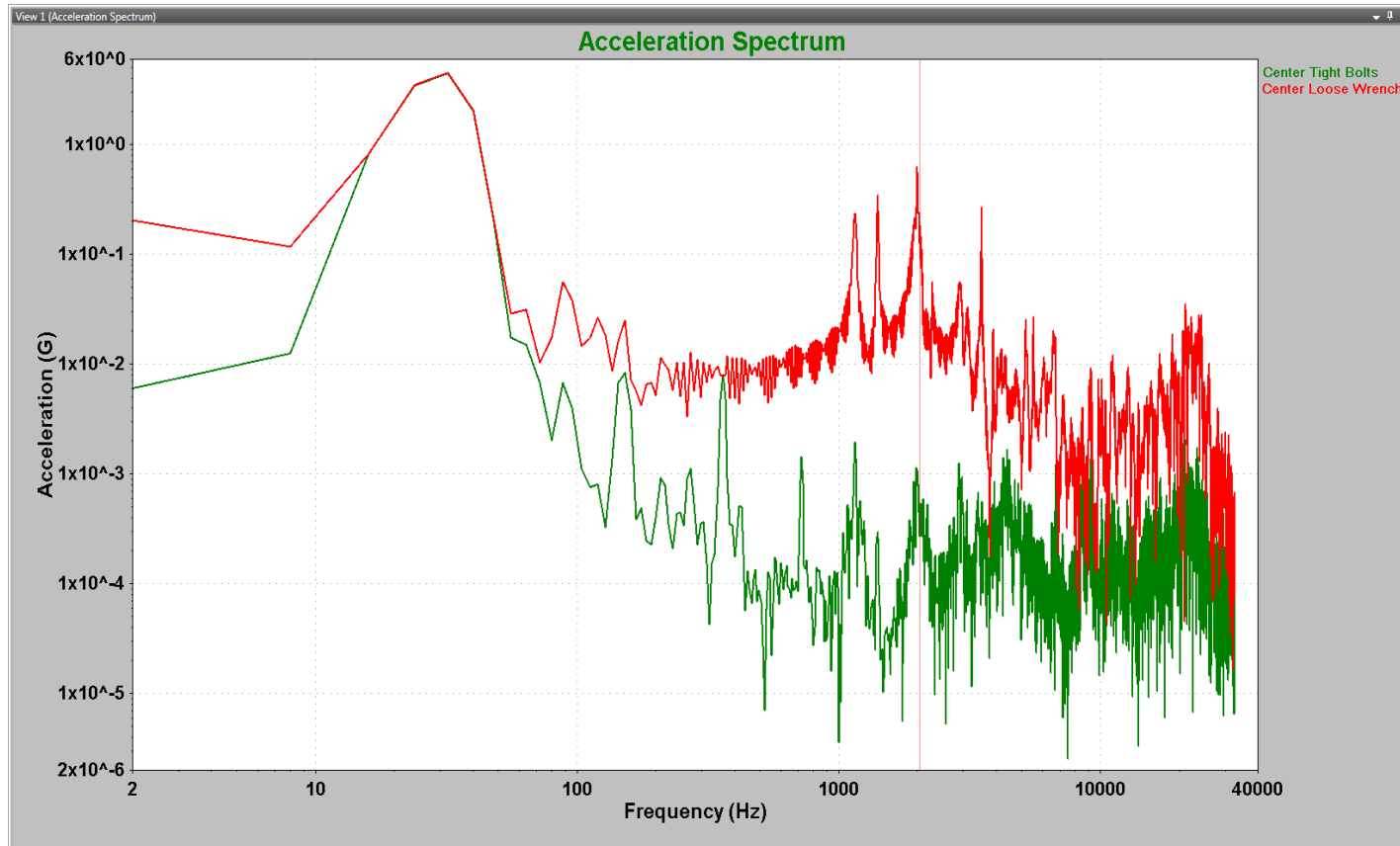
- Always begin tests with System Check
  - Check for properly attached accelerometers/cables
  - Make sure shaker performs as software requires
    - VR displacement wedge



<http://go.vibrationresearch.com/blog/displacement-wedge-what-is-it-how-to-use-it>

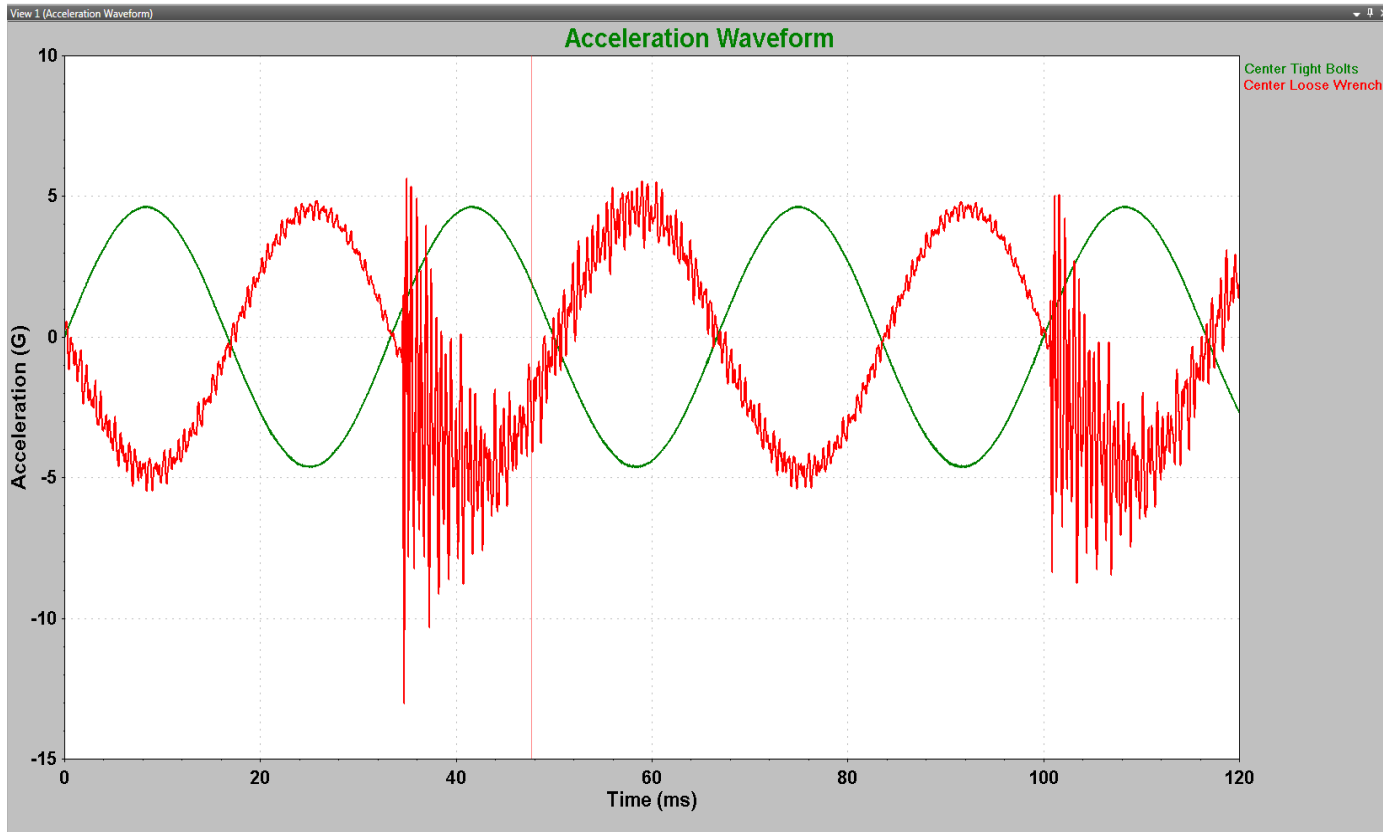
# System Check

- Helpful to evaluate the “health” of shaker system
  - Acceleration Spectrum



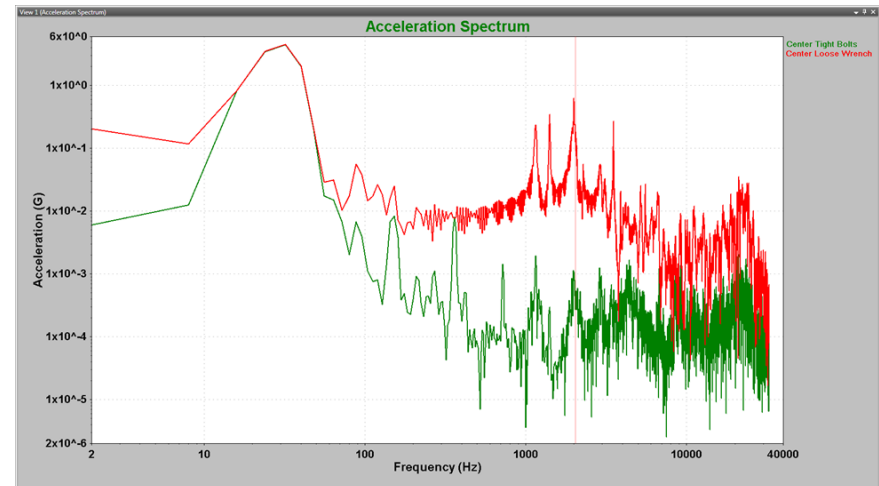
# System Check

- Helpful to evaluate the “health” of shaker system
  - Acceleration Waveform



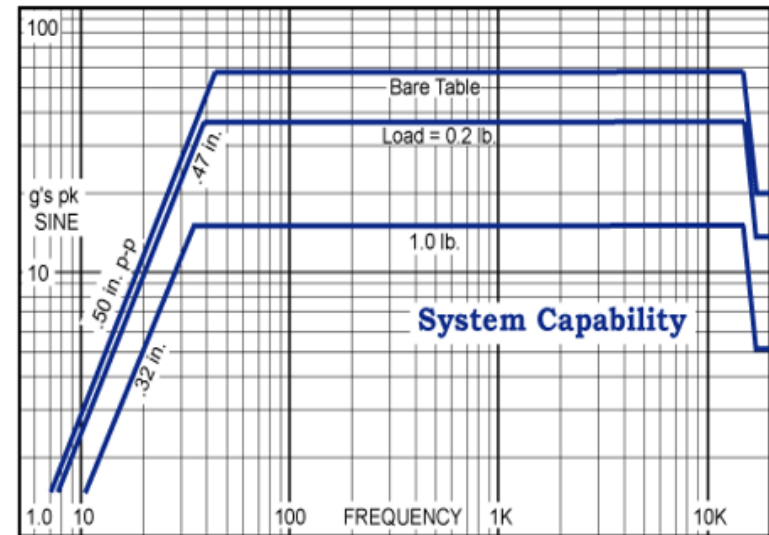
# System Check

- Has Limitations
  - Only a snap-shot at a *specific* frequency
  - Does not employ tracking filters so the data at frequencies outside of setting is not as accurate as with sine sweep.



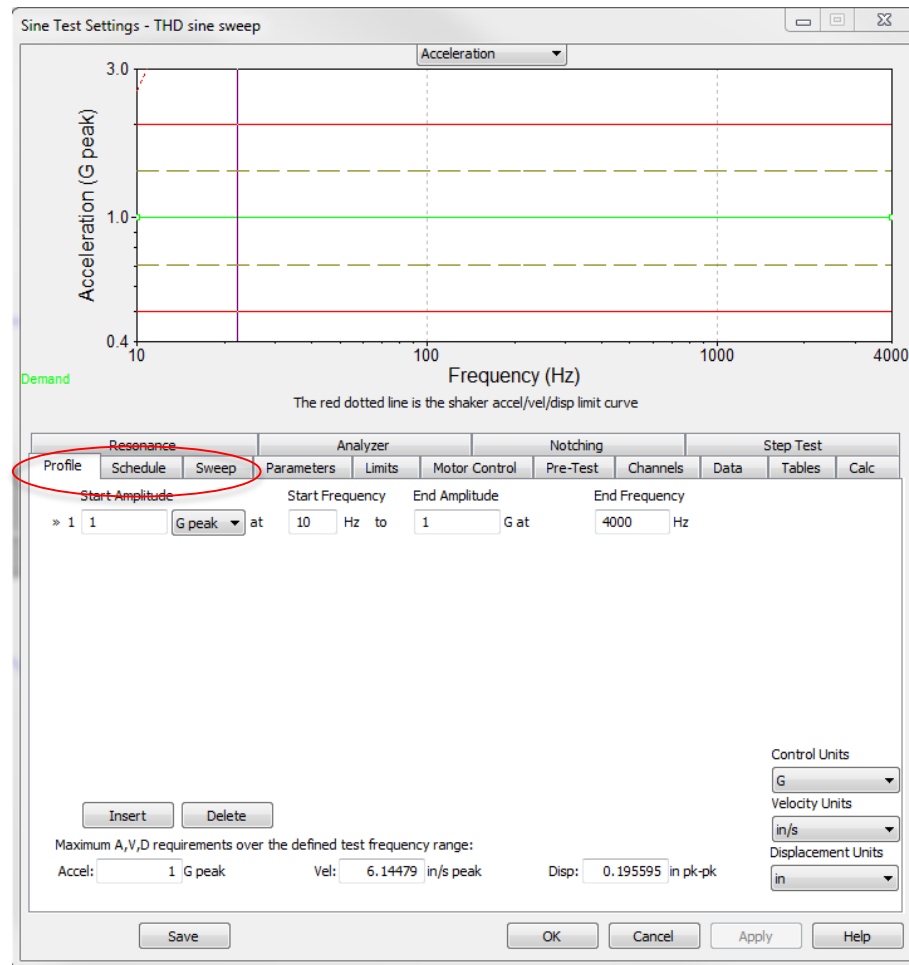
# Recommended Method: Sine Sweep

- Rationale:
  - Relate to shaker manufacturer specs
  - Obtain data about shaker across large frequency spectrum
  - Many ways to evaluate data
    - Particularly Total Harmonic Distortion (THD)



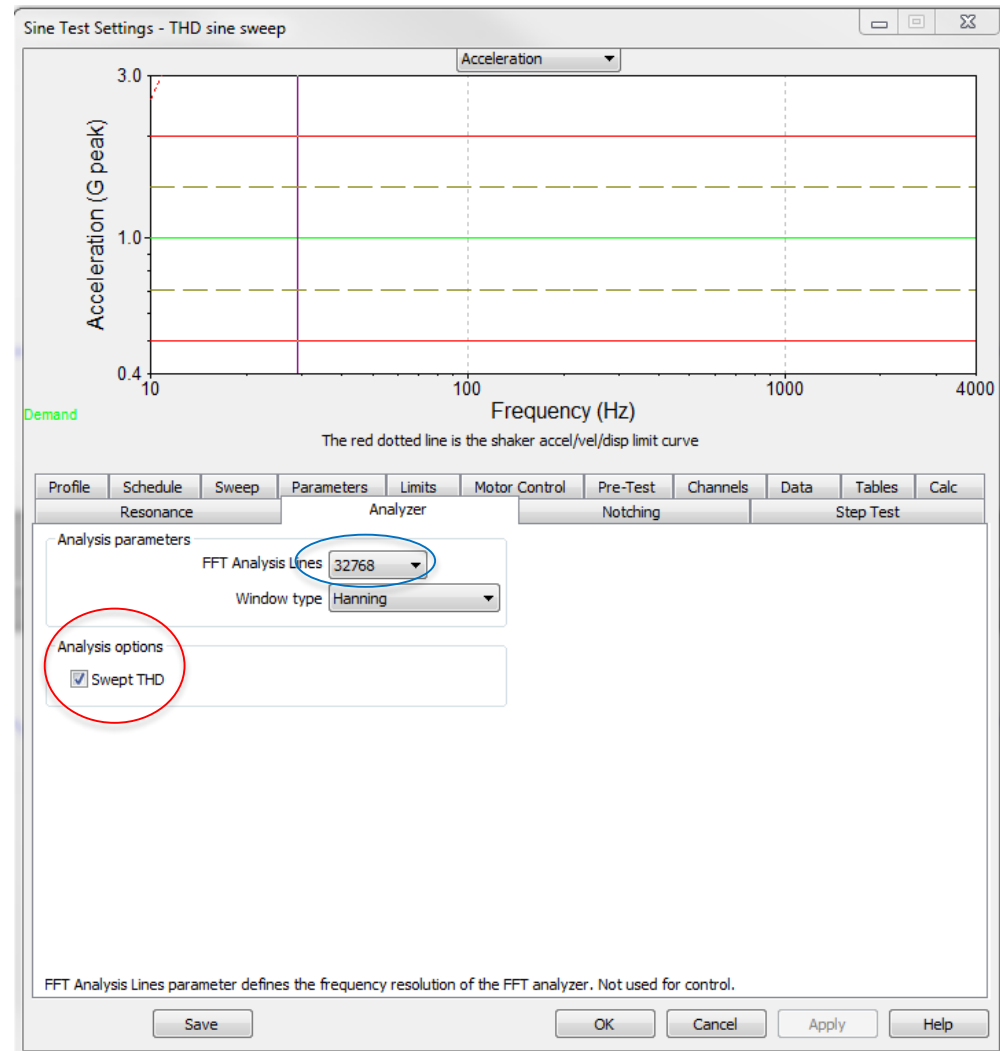
# Recommended Method: Sine Sweep

- Traditional Sine Sweep Test Set-up
  - Profile
  - Schedule
  - Sweep



# Recommended Method: Sine Sweep

- Evaluate with ANALYZER
  - Activate “SWEPT THD” (Total Harmonic Distortion)
  - Use large number of lines
  - Not affected by tracking filters



# Total Harmonic Distortion

- THD Definition

- Comparison of all harmonic content in a signal to the fundamental

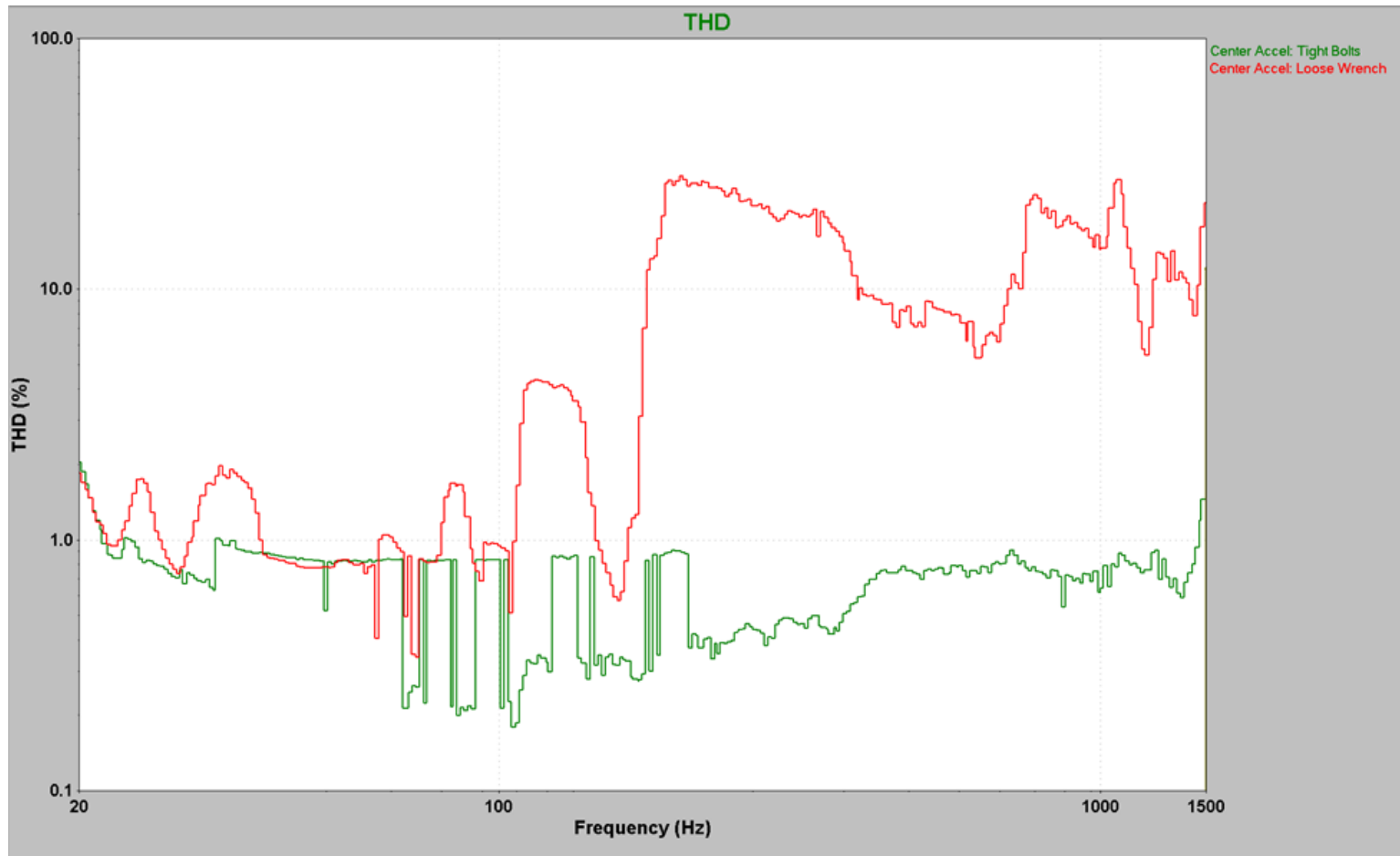
- $$\% THD = \left( \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \dots + V_n^2}}{V_1} \right) \times 100$$

- $V_1$  is the fundamental's voltage signal (eg: V @ 60 Hz)
- $V_2, V_3$  are the next harmonics (eg: V @ 120 Hz, 180 Hz)

- The larger amount of harmonic content in a signal, the larger the % THD value will be
  - Indicative of noise or undesired vibration in signal



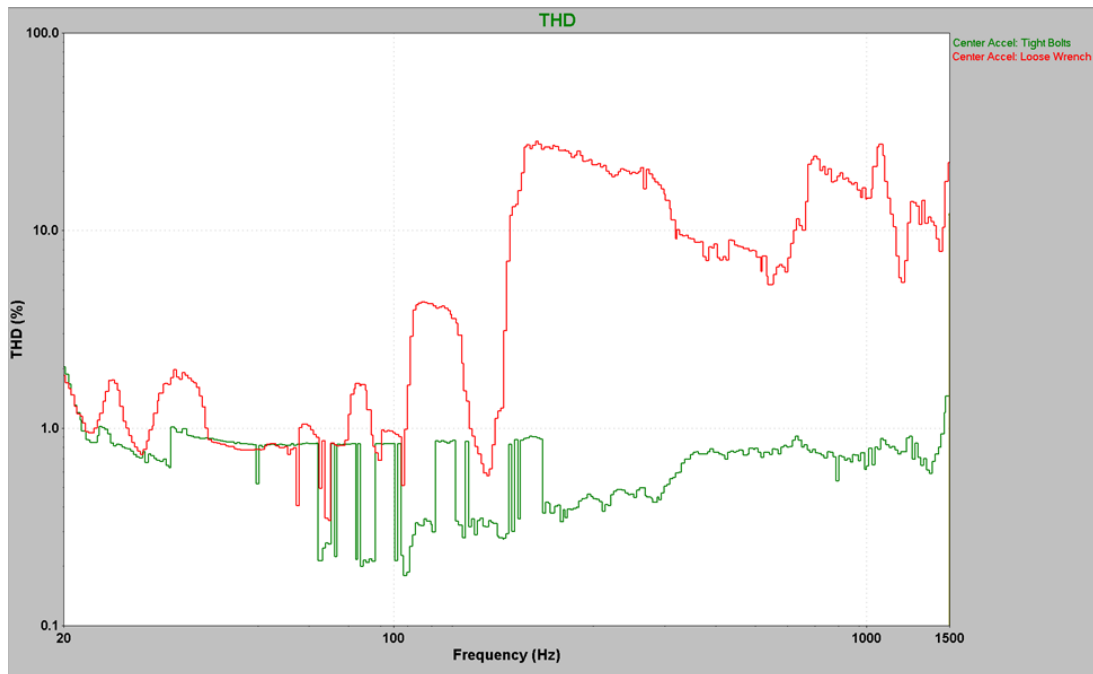
# THD Sample Results



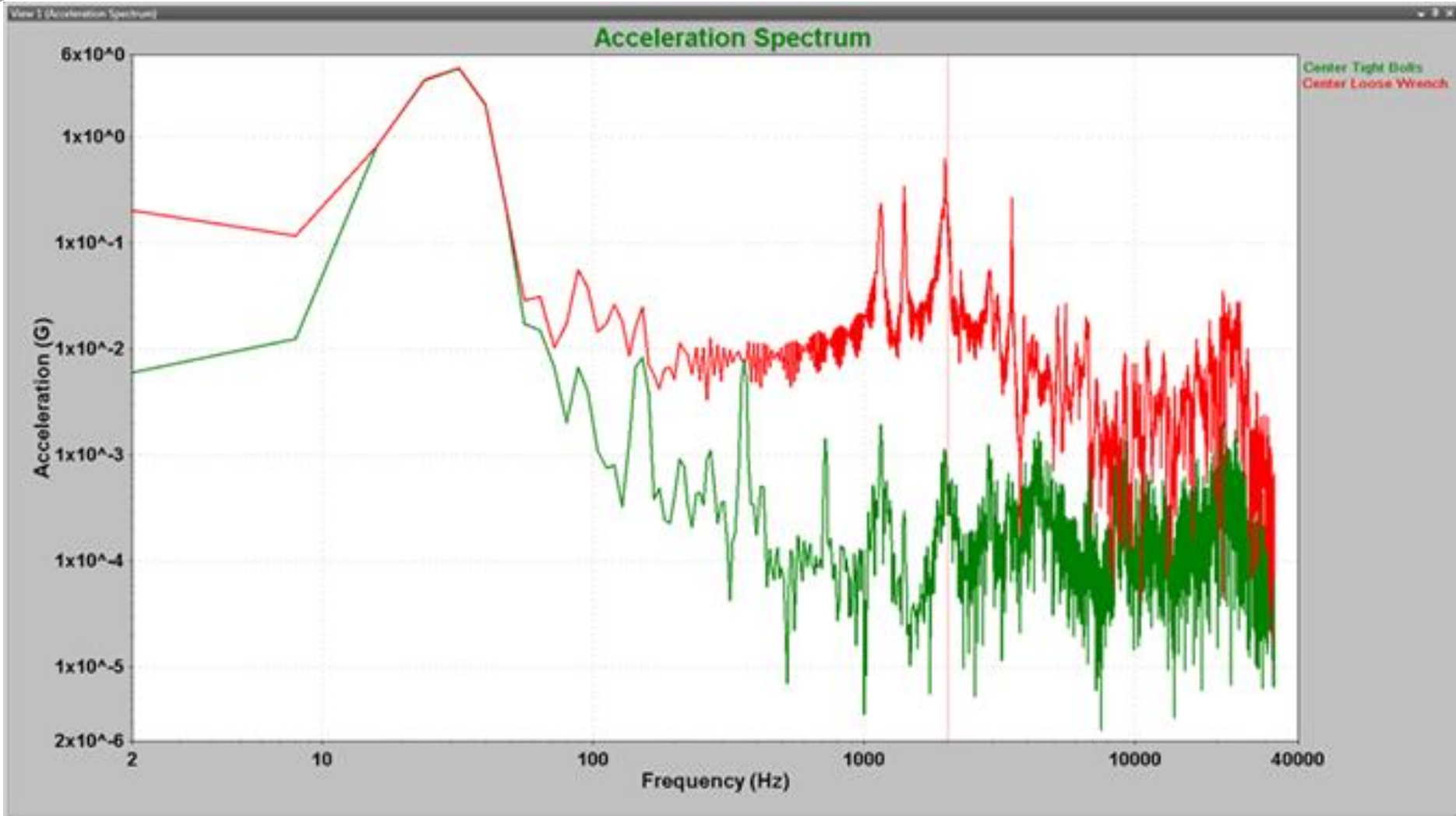
# THD Sample Results

## THD Tolerance?

- Rule of Thumb
  - Less than 10% THD
- Test-facility needs to determine acceptable variance

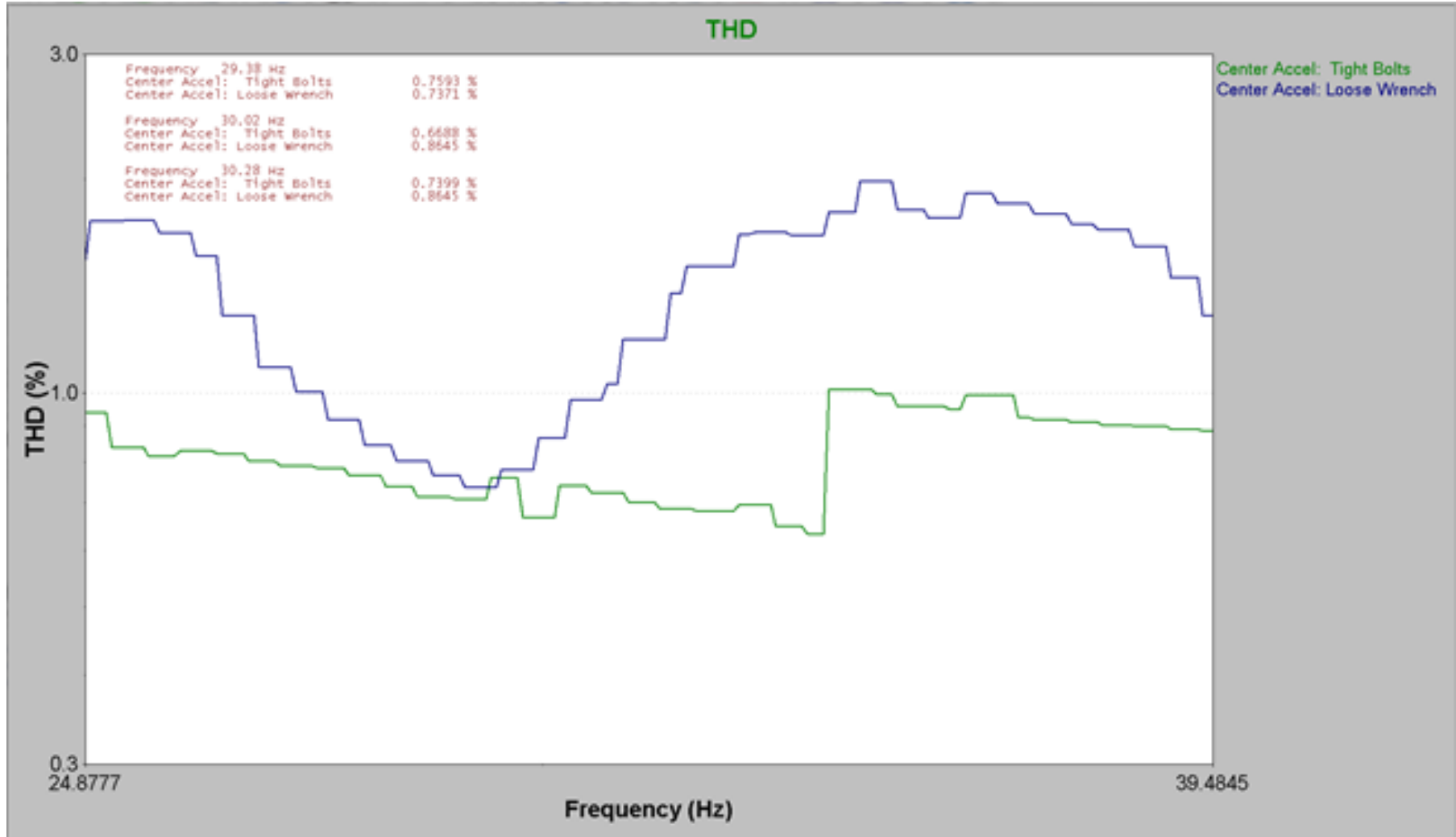


# System Check Sample Results

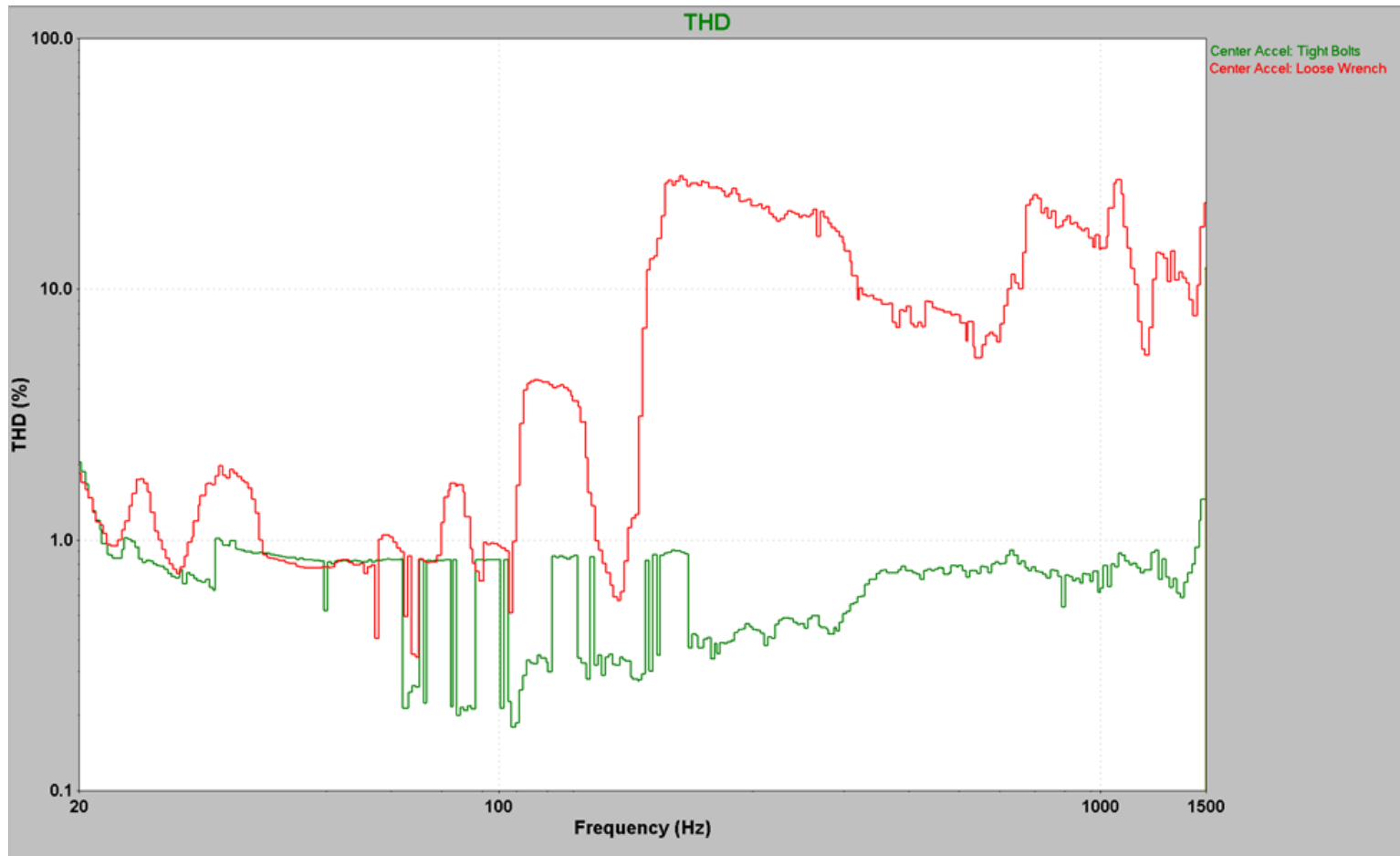


# THD Sample Results

Zoomed at 30 Hz (in order to compare with System Check)



# THD Sample Results



# A Method for Shaker Validation

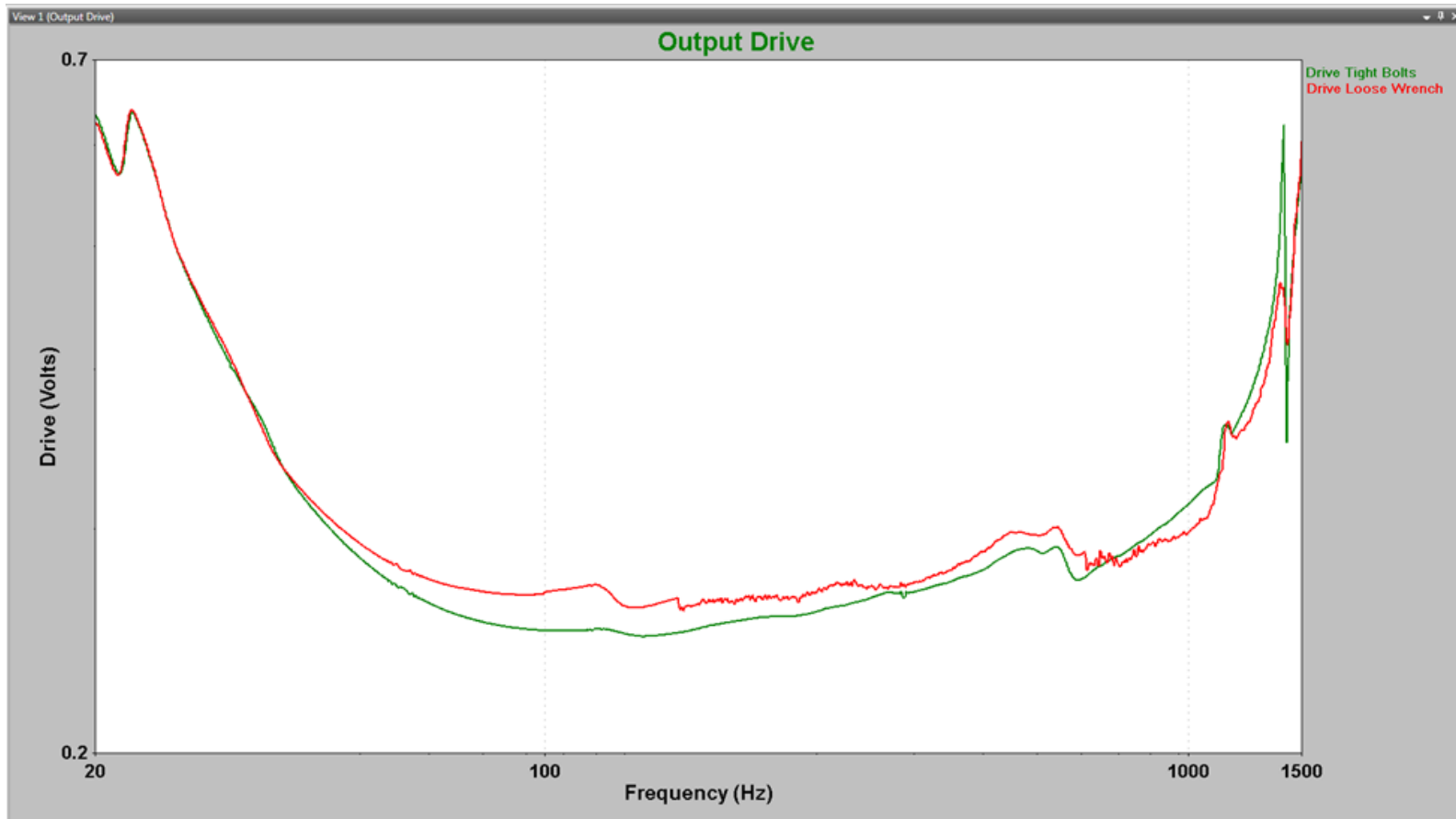
- **Other Analysis Options with Sine Sweep**

Many other graphs are available with Sine Sweep data

- Output Drive
- Transmissibility
- Phase

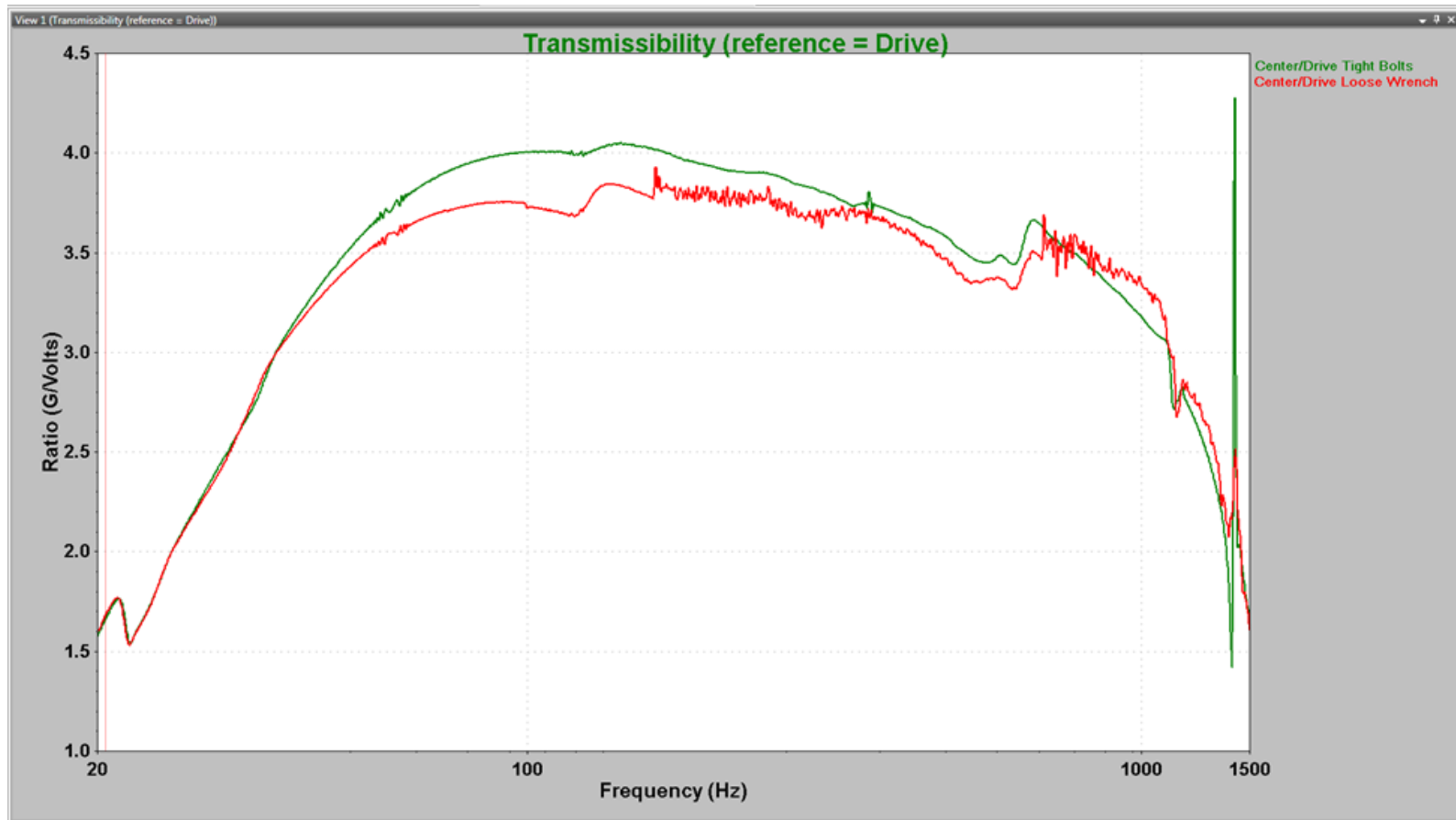
# A Method for Shaker Validation

- Output Drive



# A Method for Shaker Validation

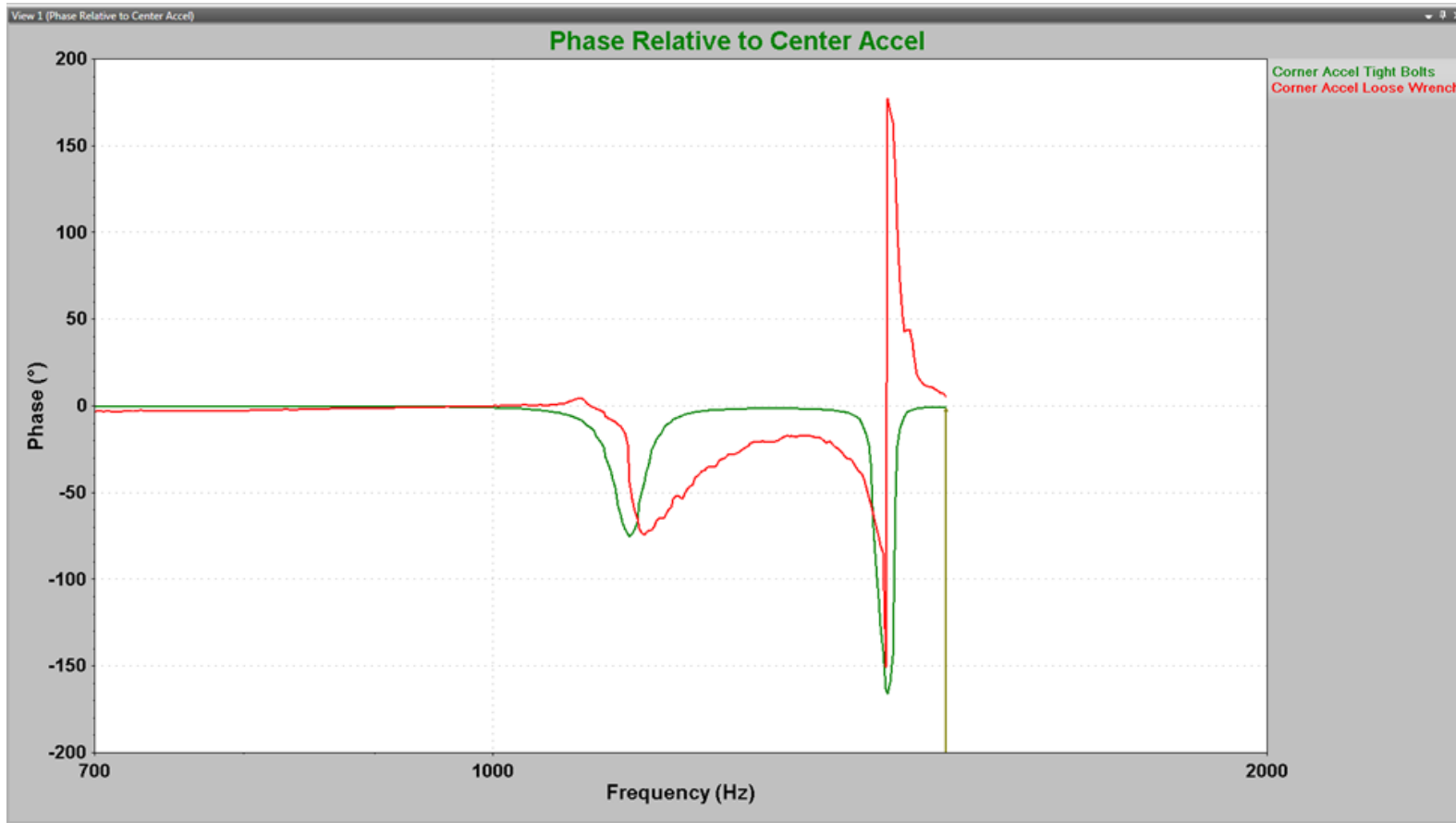
- Transmissibility





# A Method for Shaker Validation

- Phase



# THD vs. System Check

- System Check is a good starting point
  - Gives some indication of the “health” of shaker system
  - Limited by the fact that it is a single snap-shot in time of a specific frequency
- Sine Sweep with Total Harmonic Distortion is better
  - More accurate than System Check
    - Because Tracking Filters are employed
    - Because entire frequency spectrum is accurately analyzed
  - More accurate than Random
    - Not all frequencies simulataneously

# A Method for Shaker Validation

- **Benefits** of Sine Sweep Analyzed with THD
  1. Identifies possible issues across the **entire** frequency range of shaker system (using tracking filters)
  2. Many other graphs are available with Sine Sweep data
    - Output Drive
    - Transmissibility
    - Phase
  3. Total Harmonic Distortion is easy to use and interpret

# Thank You for Attending!

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