VIBRATION RESEARCH

What is the PSD?

THE INNOVATOR IN
SOUND & VIBRATION
TECHNOLOGY

CORE VALUES

COLLABORATION

CAPABLE & COMPETENT

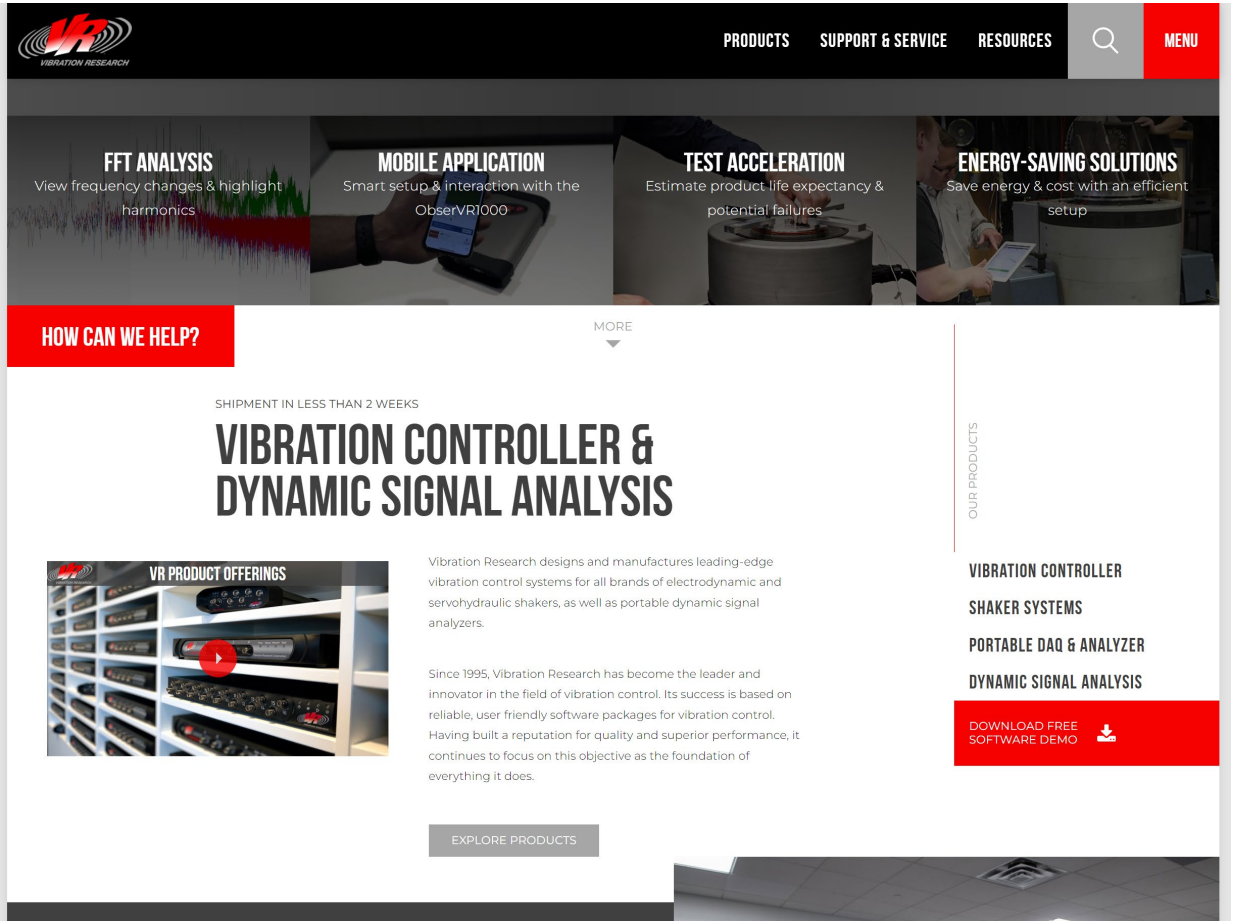
ACCOUNTABLE & RESPONSIBLE

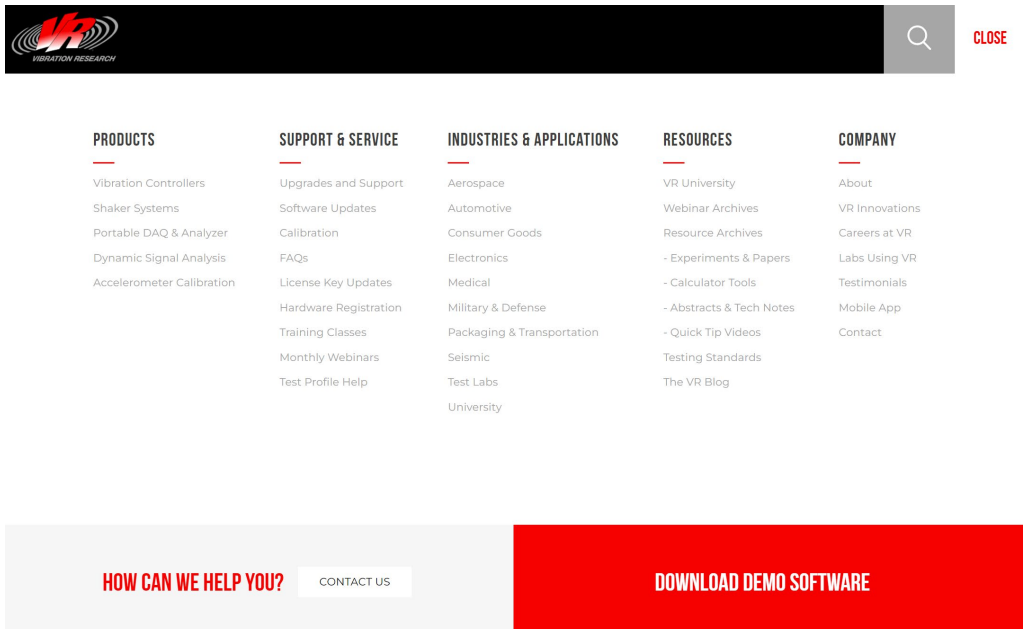
STRONG & DRIVEN WORK ETHIC

DO THE RIGHT THING

INNOVATION

DOWNLOAD DEMO SOFTWARE

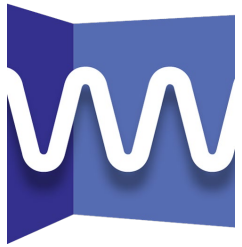


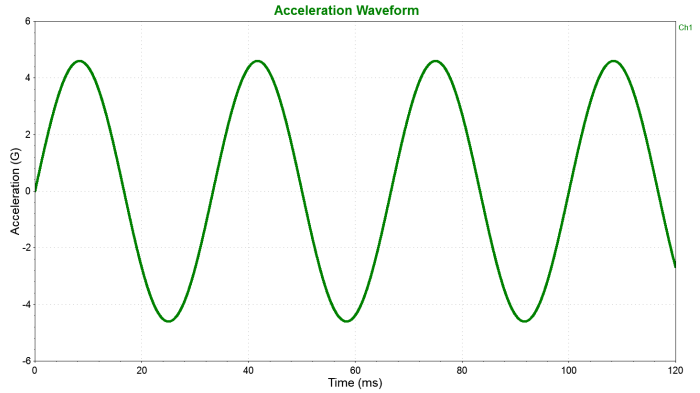


RANDOM VIBRATION

DEFINITION

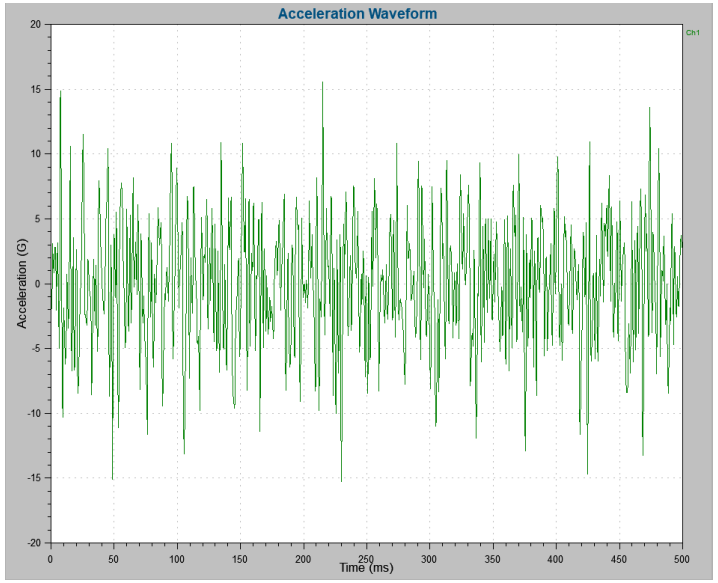
- Non-deterministic
  - Non-repetitive
- Stationary vs. Non-Stationary
- Linear vs. Non-Linear





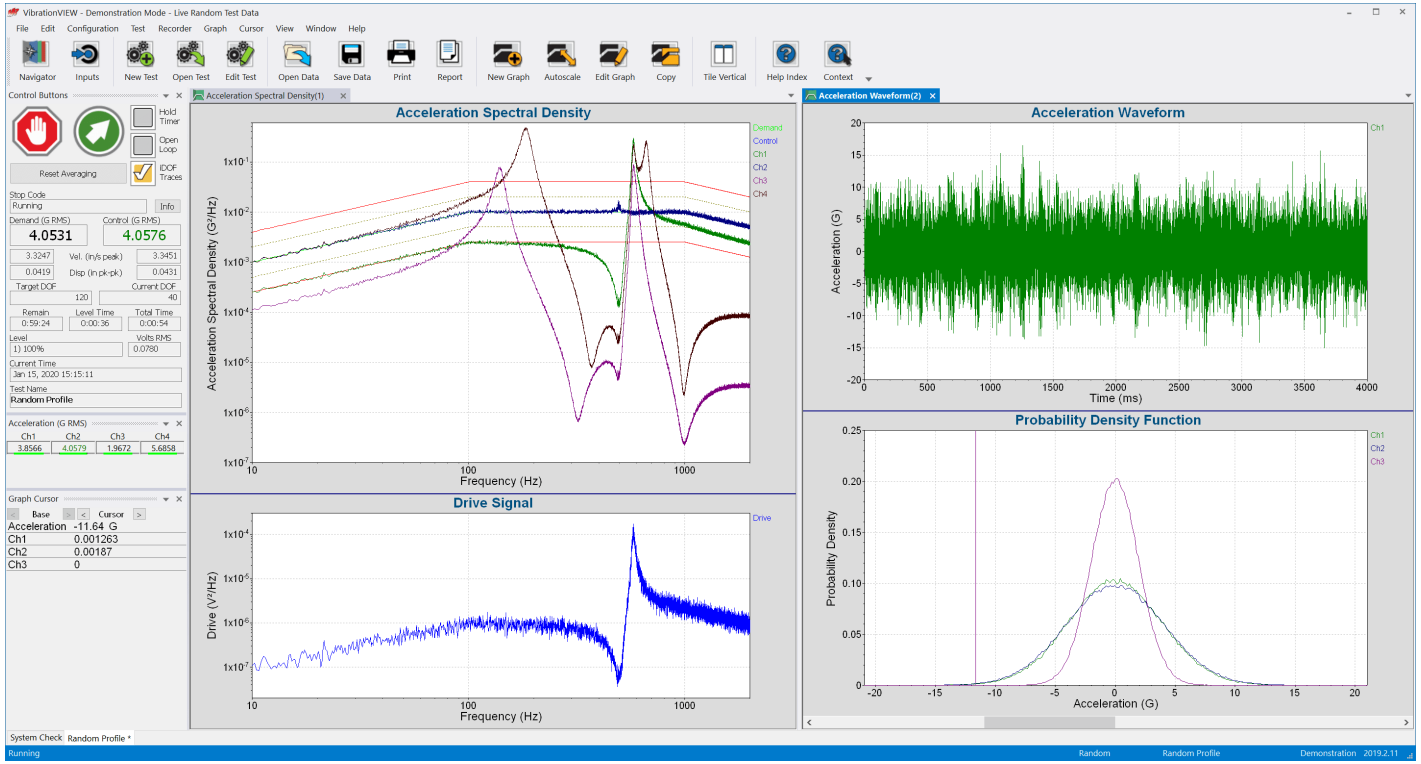
APPLICATIONS

- Most widely used test type
  - “Real World” Vibration
  - Automotive (Road Vibration)
  - Airplane wing in flight
- Product Validation



KEY TERMS OF THE PSD

- GRMS
- Fast Fourier Transform (FFT)
- Windowing
- Frequency Resolution
- Averaging
- G^2/Hz
- $(m/s^2)^2/Hz$



POWER SPECTRAL DENSITY

Power

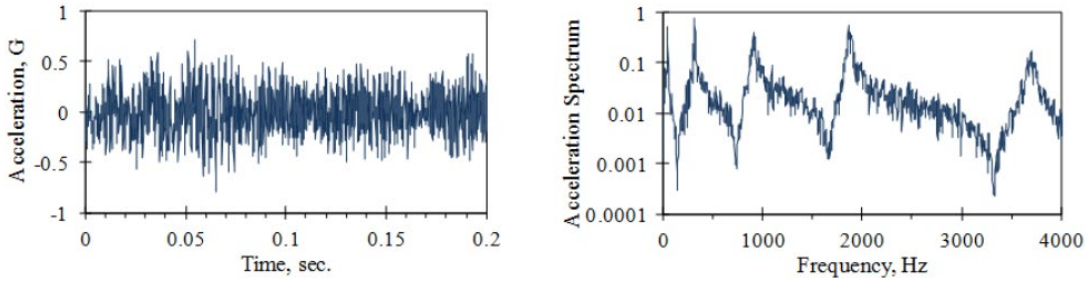
- Magnitude of the PSD
- Mean square value of the signal

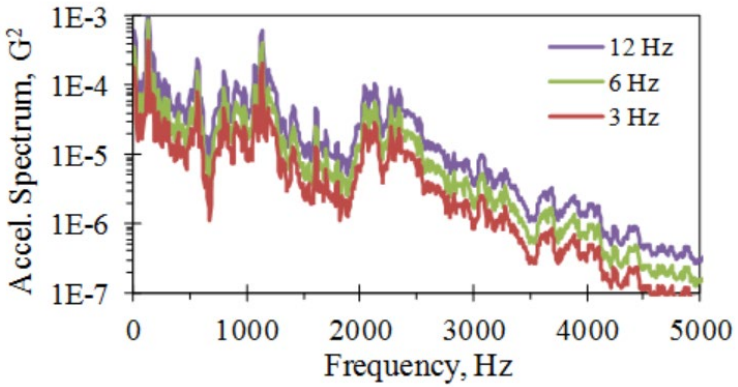
Spectral

- The PSD is a function of frequency
- Representative of signal distribution over a spectrum of frequencies

Density

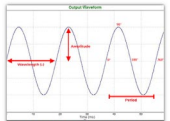
- Magnitude is normalized to a single hertz bandwidth





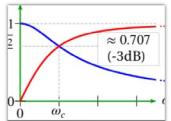
VIBRATION RESEARCH UNIVERSITY

VIBRATION TESTING THEORY

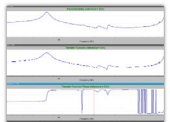

INTRODUCTION TO VIBRATION SIGNALS
Oct. 12, 2021


TEST DEVELOPMENT WITH RECORDED DATA
Feb. 23, 2021


SHOCK TESTING
Apr. 15, 2020



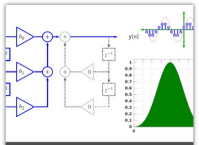
SAMPLING & RECONSTRUCTION
Jul. 3, 2019


MATHEMATICS FOR UNDERSTANDING WAVEFORM RELATIONSHIPS
Mar. 18, 2019


SINE TESTING
Mar. 5, 2018

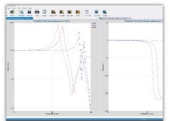

RANDOM TESTING
Mar. 5, 2018

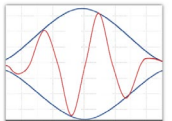
OBSERVIEW

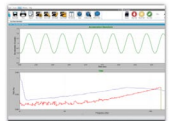

FUNDAMENTALS OF SIGNAL PROCESSING
Jun. 2, 2021


GETTING STARTED WITH OBSERVIEW
Mar. 31, 2021

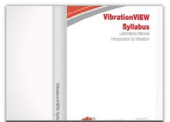
VIBRATIONVIEW


VIBRATIONVIEW ANALYZER SOFTWARE PACKAGE
Jan. 2, 2019


WINDOW FUNCTIONS FOR SIGNAL PROCESSING
Nov. 8, 2018

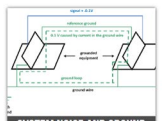

SYSTEM CHECK
Mar. 29, 2018


GETTING STARTED WITH VIBRATIONVIEW
Mar. 29, 2018

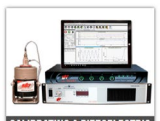


VIBRATIONVIEW SYLLABUS
Mar. 29, 2018

TESTING SYSTEM HARDWARE


SYSTEM NOISE AND GROUND LOOPS
Feb. 12, 2020


PRESERVING VR HARDWARE ACCURACY
Jun. 20, 2019


CALIBRATING A PIEZOELECTRIC ACCELEROMETER IN VIBRATIONVIEW
Dec. 28, 2018


MULTI-SHAKER CONTROL
Mar. 29, 2018


PREVENTATIVE MAINTENANCE
Mar. 29, 2018

MY ENROLLED COURSES


GETTING STARTED WITH VIBRATIONVIEW
STATUS: ENROLLED
ENROLLED: JANUARY 28, 2022


SAMPLING & RECONSTRUCTION
STATUS: ENROLLED
ENROLLED: APRIL 3, 2020


SINE TESTING
STATUS: ENROLLED
ENROLLED: AUGUST 28, 2018


SYSTEM NOISE AND GROUND LOOPS
STATUS: ENROLLED
ENROLLED: APRIL 29, 2020


VIBRATIONVIEW ANALYZER SOFTWARE PACKAGE
STATUS: ENROLLED
ENROLLED: OCTOBER 26, 2020

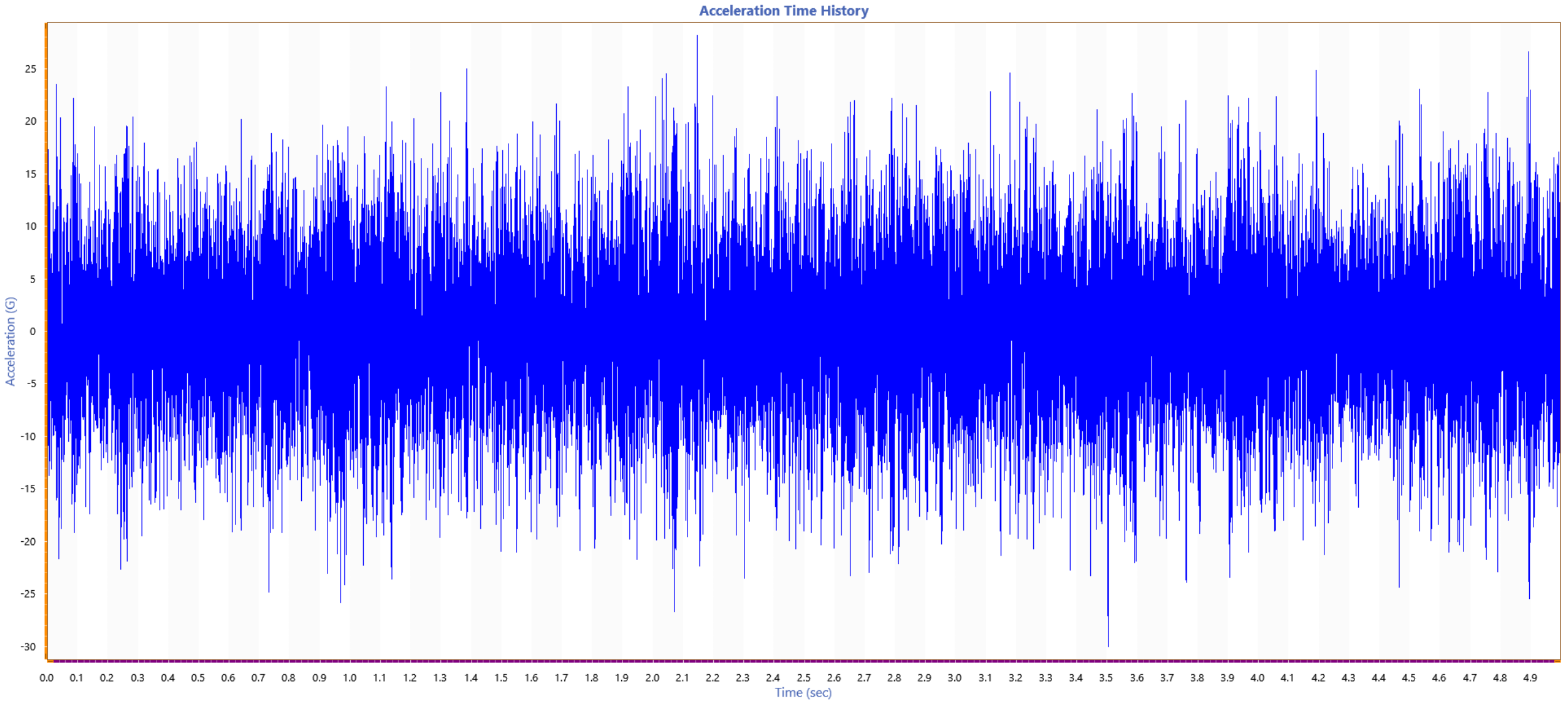
MY CERTIFICATES

DOWNLOAD CERTIFICATE - ALL

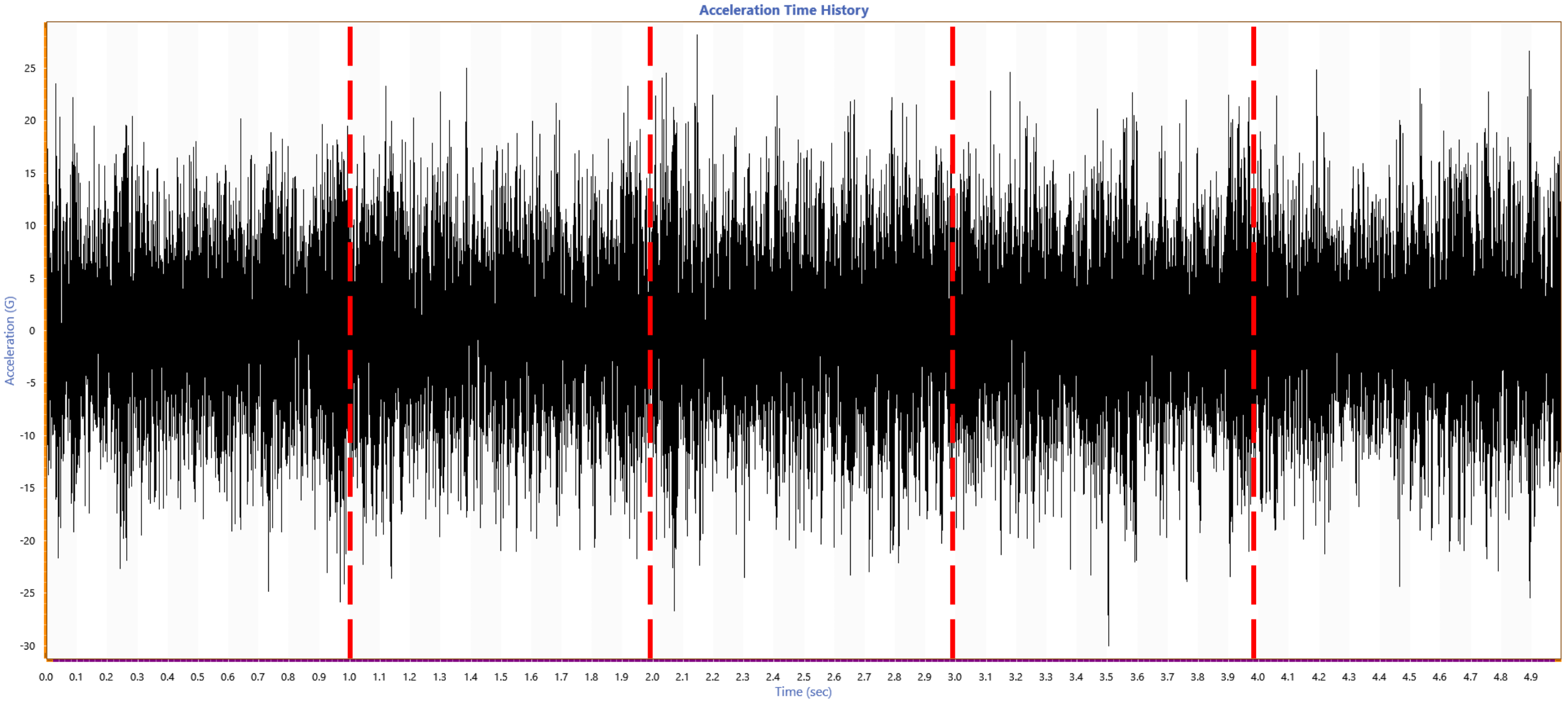
GENERATING THE PSD

- Gaussian Time-Domain Input Data
- Time-Domain data is partitioned into frames
- Each frame of time domain data is transformed into the frequency domain using the Fast Fourier Transform (FFT)
- Complex Frequency-domain data is converted to power by taking the squared-magnitude of each frequency point
- Squared-magnitudes (power values) of each frame are averaged together
    - Overlapping, windowing, normalizing

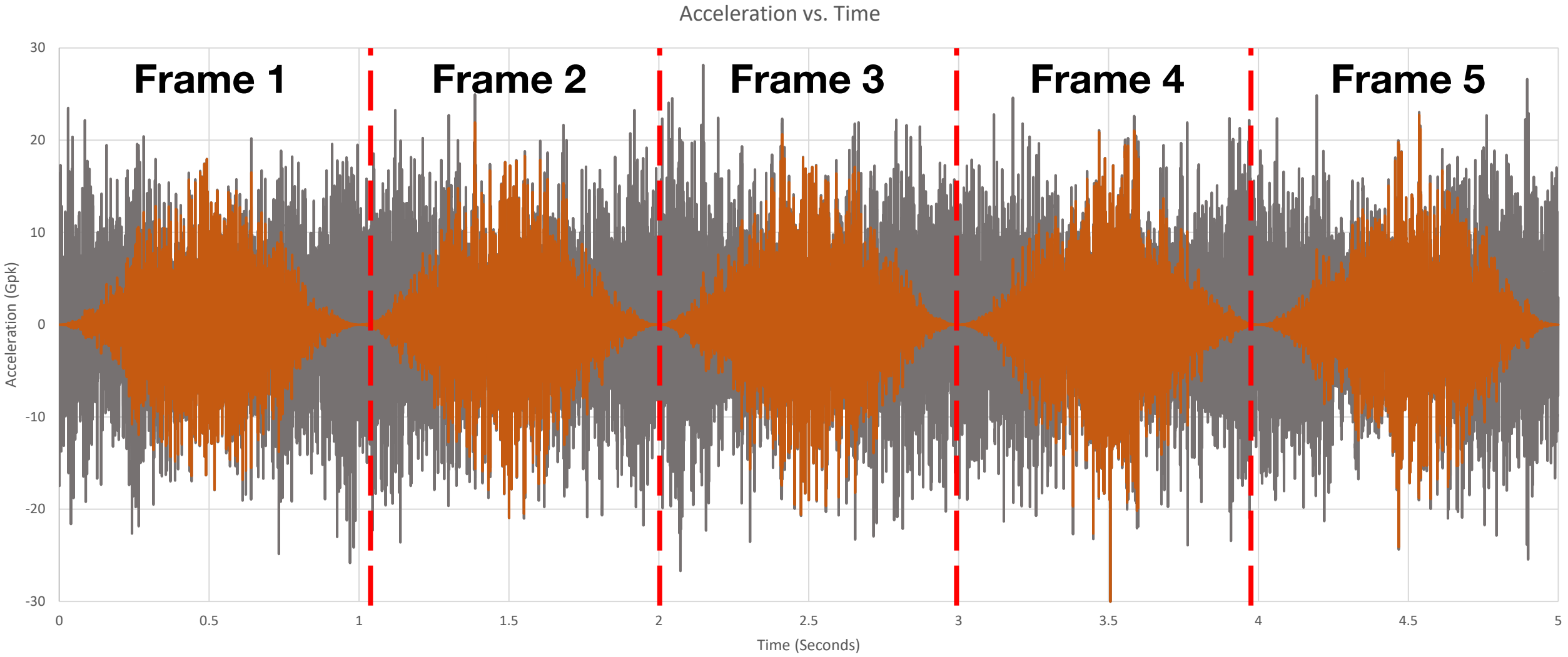
INPUT TIME DATA



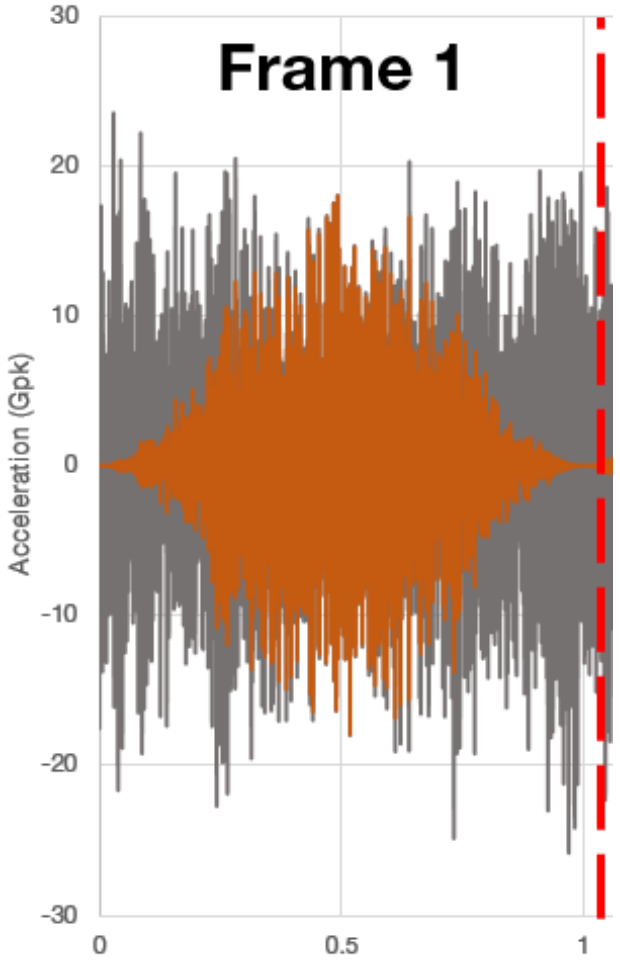
DIVIDE INTO FRAMES

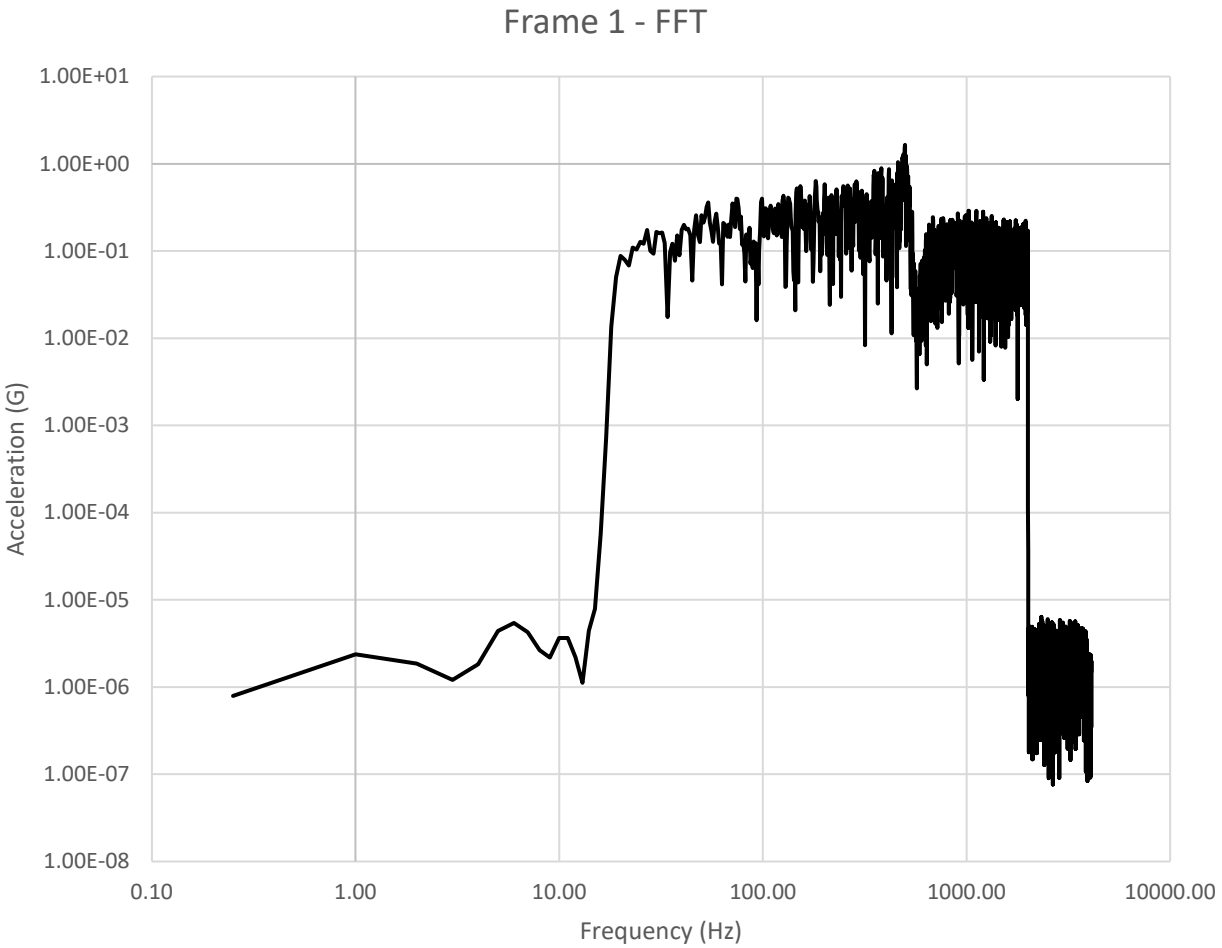


APPLY WINDOW FUNCTION TO EACH FRAME

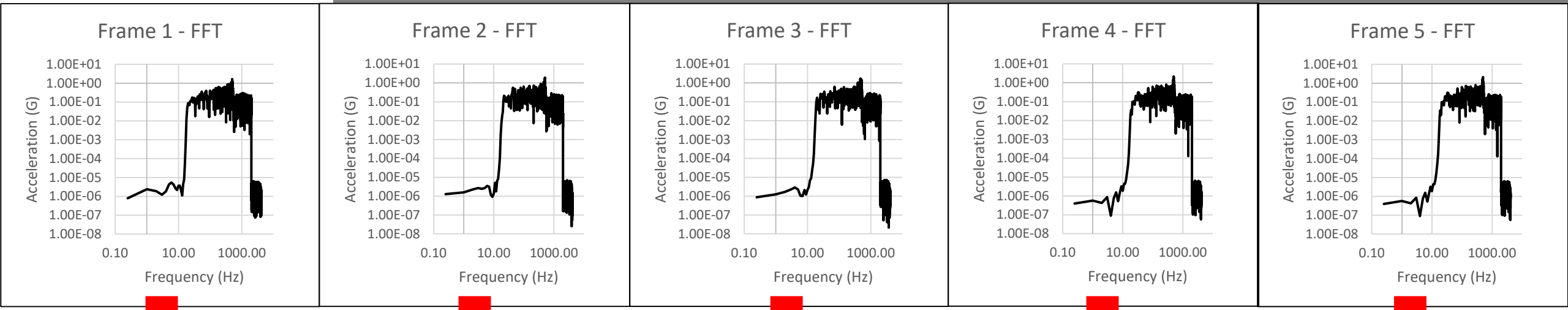


CALCULATE FFT FOR EACH FRAME

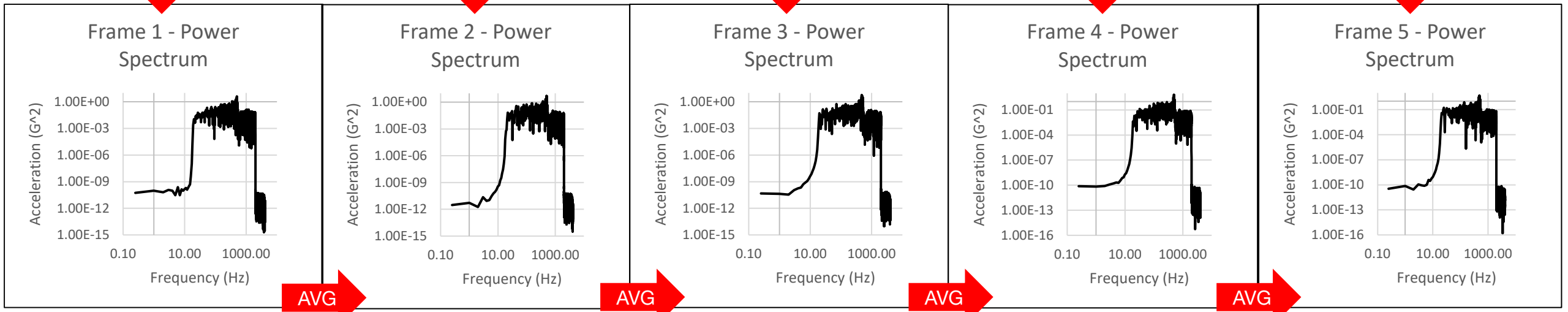




AVERAGE THE FFT

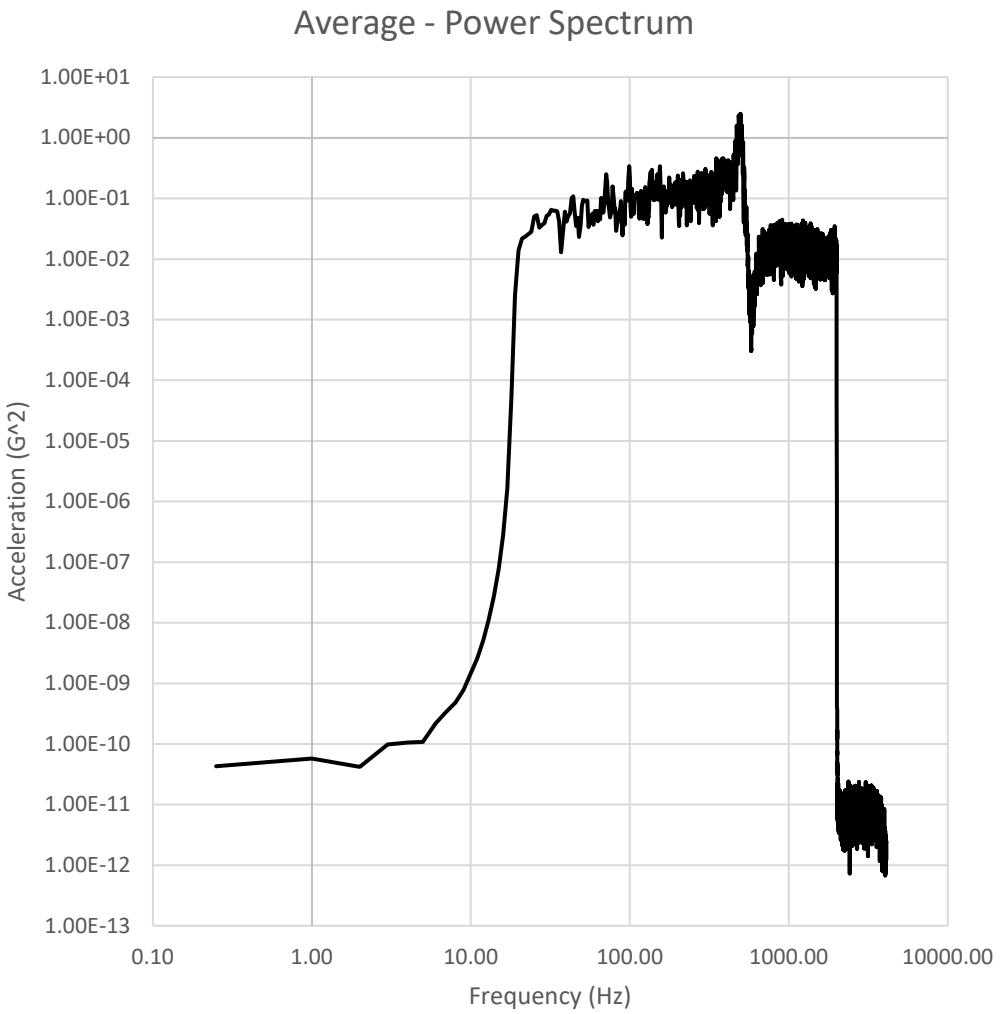


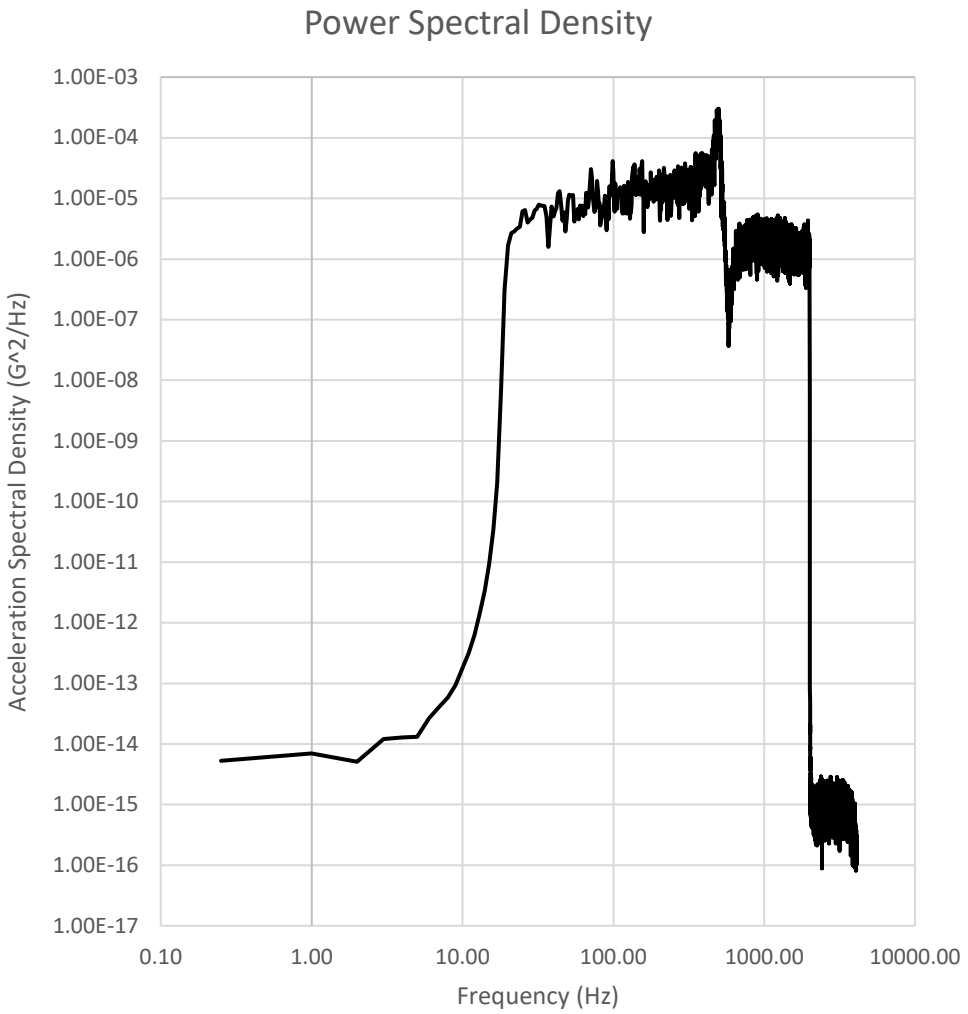
FFT^2



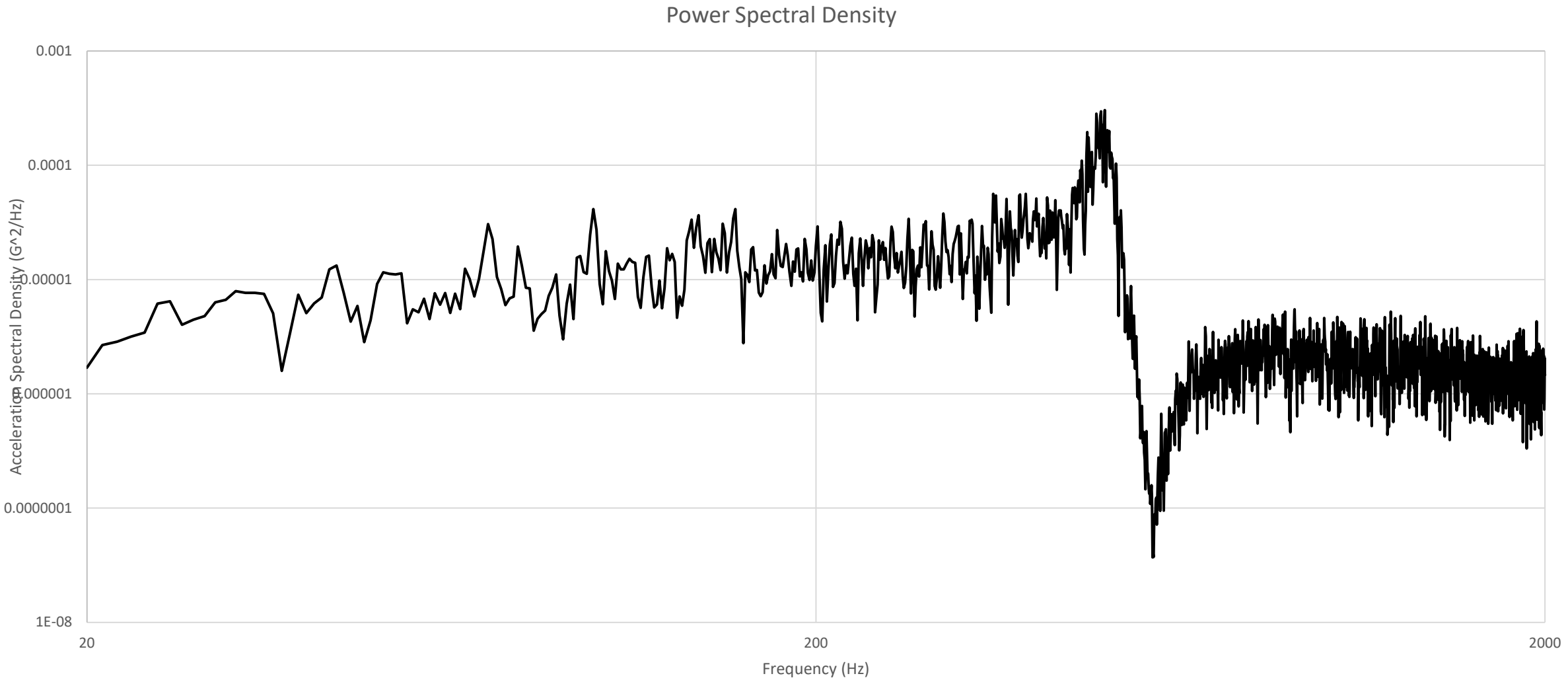
AVG

CONVERT FFT TO POWER

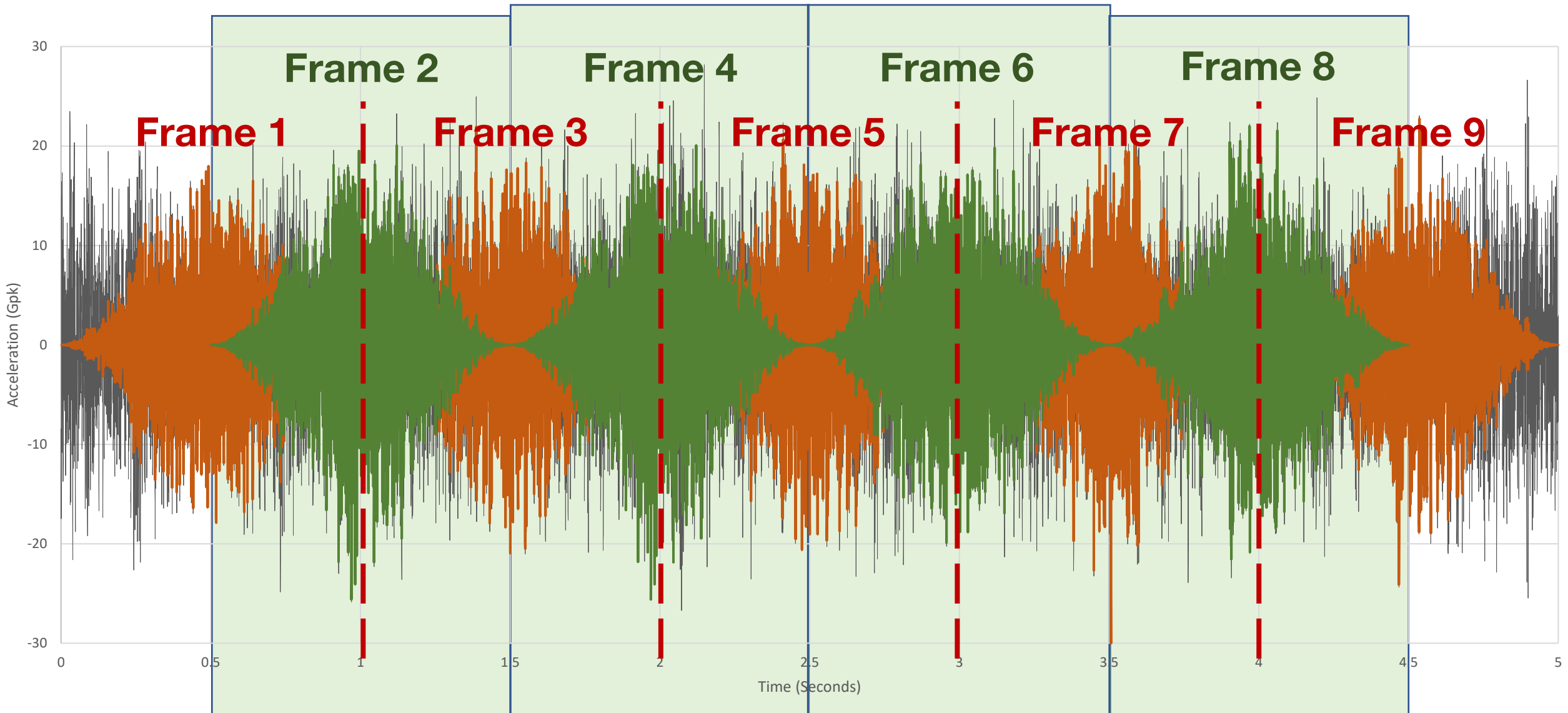




CREATE A PSD

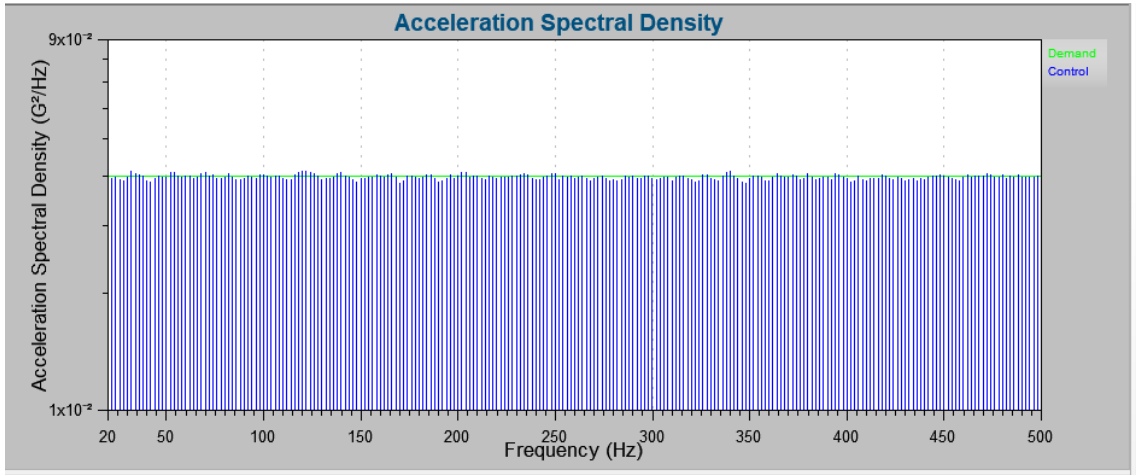

Power Spectral Density
0.001
0.0001
0.00001
0.000001
0.0000001
1E-08
Acceleration Spectral Density (G^2/Hz)
20
200
2000
Frequency (Hz)

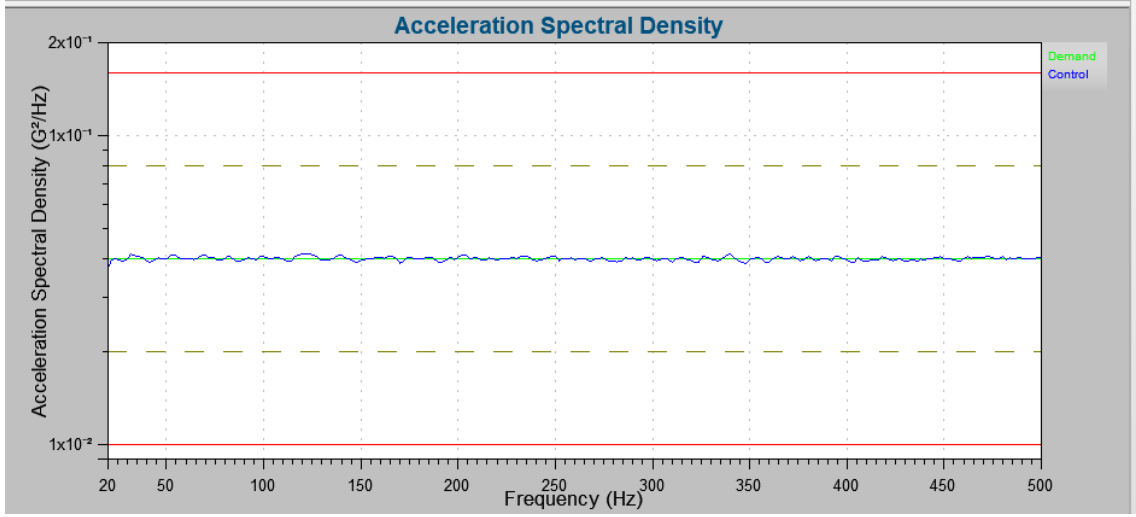
OVERLAPPING



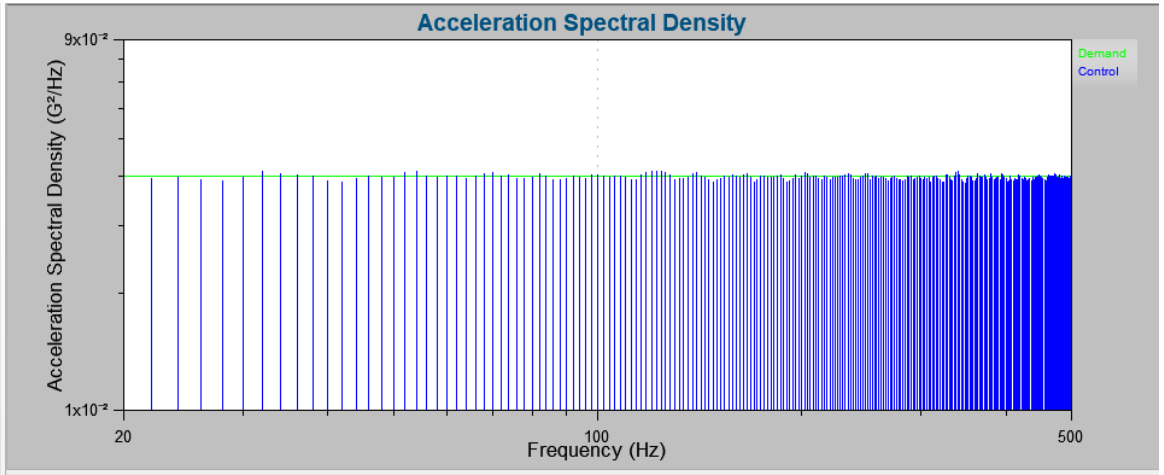
THE PSD

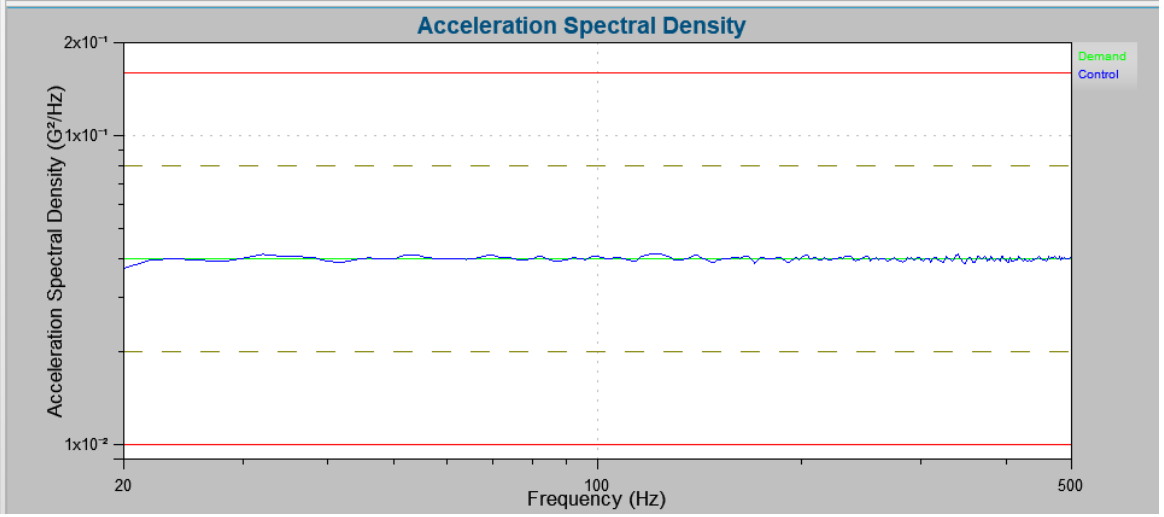
Linearly Spaced Lines of Resolution





Linearly Spaced Lines of Resolution (Log Graph)

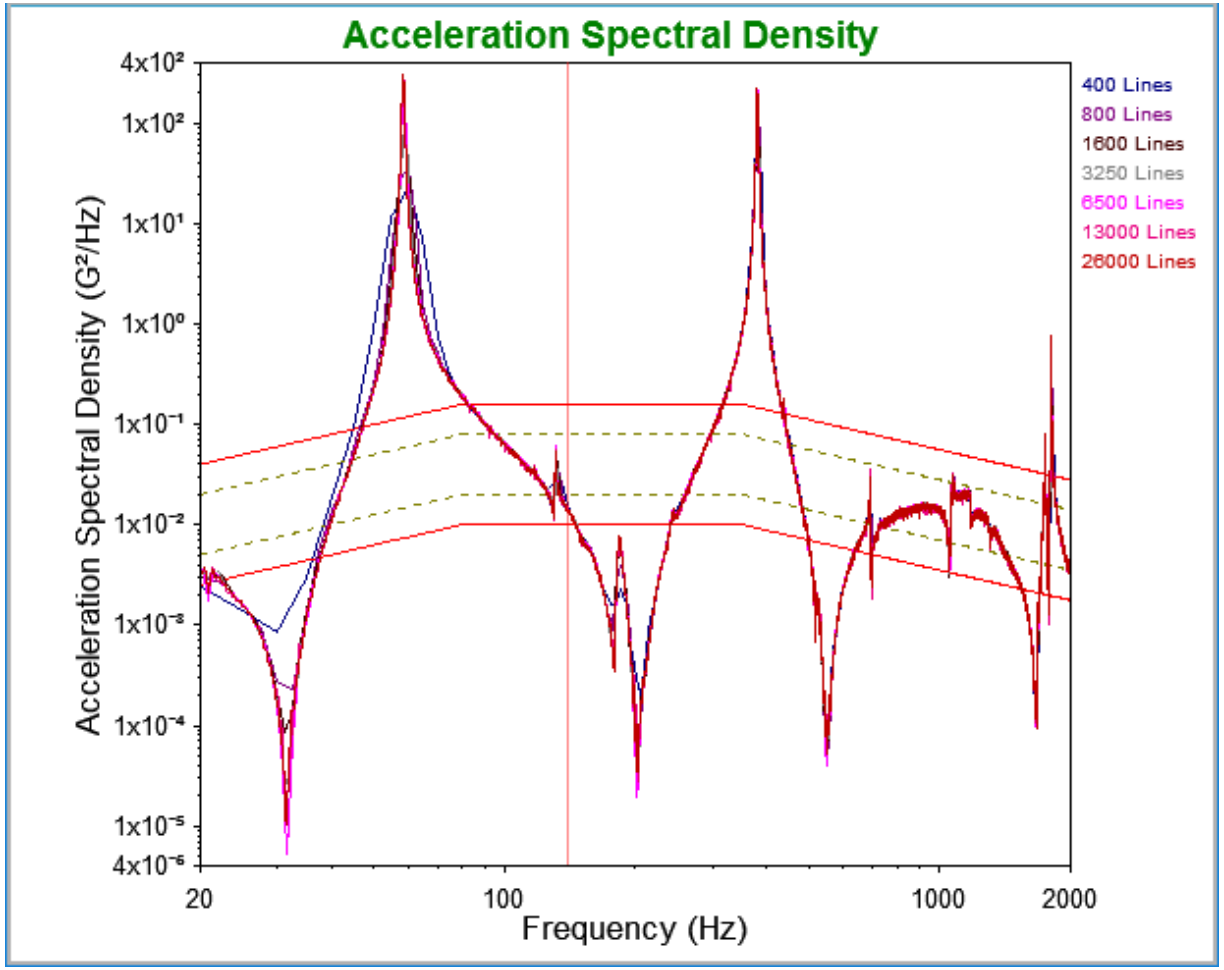




PSD COMPUTATION

FREQUENCY RESOLUTION

- Determines Bin Width of the PSD
  - Single point amplitude/bin
- High Lines = Small Bin Width
  - Higher resolution will create a single point amplitude that more closely represents the energy of that particular frequency range
- 3+ lines of resolution in a resonance to properly resolve the peak



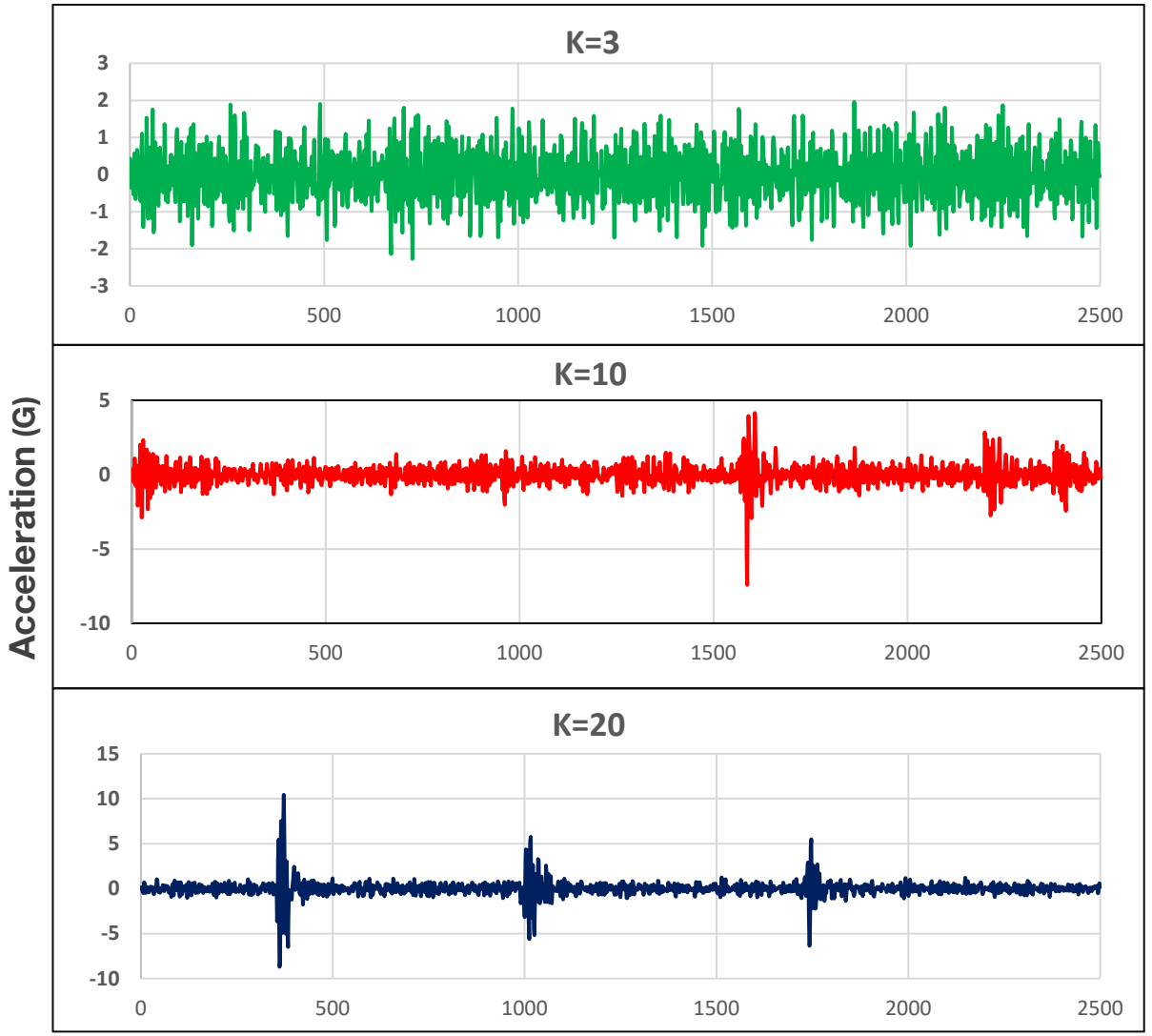
STATISTICS AND PROBABILITY

- Mean – 1st Statistical Moment, Arithmetic Average
  - For random vibration, the mean is often at or near 0
  - Mean Square
    - Measures the average strength or power of a signal
- Variance – 2nd Statistical Moment, “Hashiness of Signal”
  - As Degrees of Freedom (DOF) increases, variance decreases
  - Standard Deviation
    - Variability of a signal about its mean value
    - For random vibration, Root Mean Square (RMS) = Standard Deviation
- Skewness - 3rd Statistical Moment, More positive or negative
  - Measure of the asymmetrical spread of a signal about its mean value

STATISTICS AND PROBABILITY

KURTOSIS

- Normalized 4th central moment
- Characteristic of the waveform that describes the “peakiness”
- Probabilistic Distribution of peaks in random vibration
- Gaussian Distribution K=3
- For traditional vibration testing the kurtosis will equal 3
- FIELD DATA is often Non-Gaussian



VIBRATION RESEARCH

ANY QUESTIONS?

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