South East Accelerometer Data Analysis

Show inputs

Importing Dependencies

- updated from 2020_11_05 notebook

Accelerometer Information and Placement Information

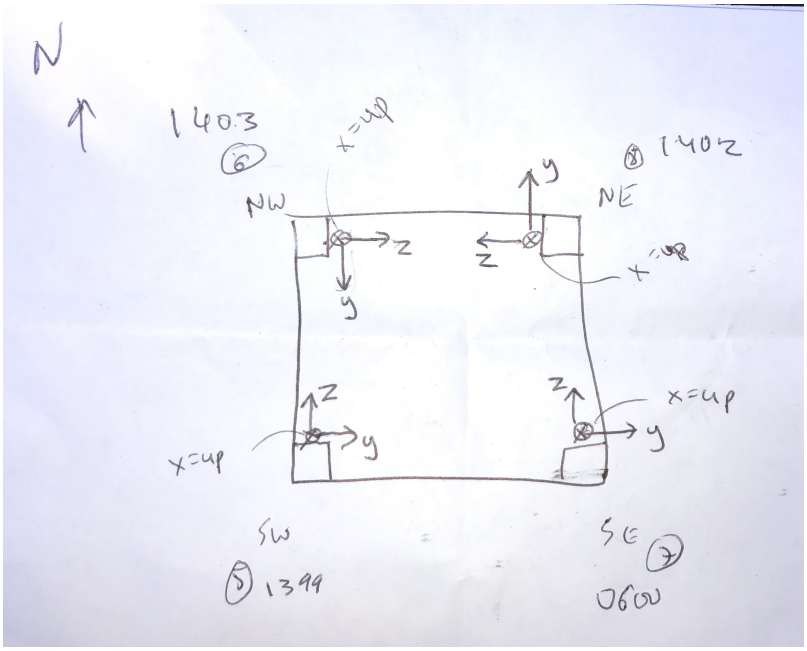
Out[3]:

Accelerometer 3 (South-East) | Accelerometer Number: 0600

- X : Pointing out of plane
- Y : Pointing right | SE direction
- Z : Pointing up | NE direction

Please refer to the image below for a visual representation

Out[4]:



Units Specification

- The acceleration is given as mG which **milli-G**, which is **1/1000 of a G**. G is Earth's gravity.
- Frequency is in **Hz**
- For the Power Spectral Frequency, the power is plotted as **10*log10(Pxx) for decibels**. The values of the power are given as **dB/Hz**

Uploading Full Acceleration Data and Normalization

Out[5]:

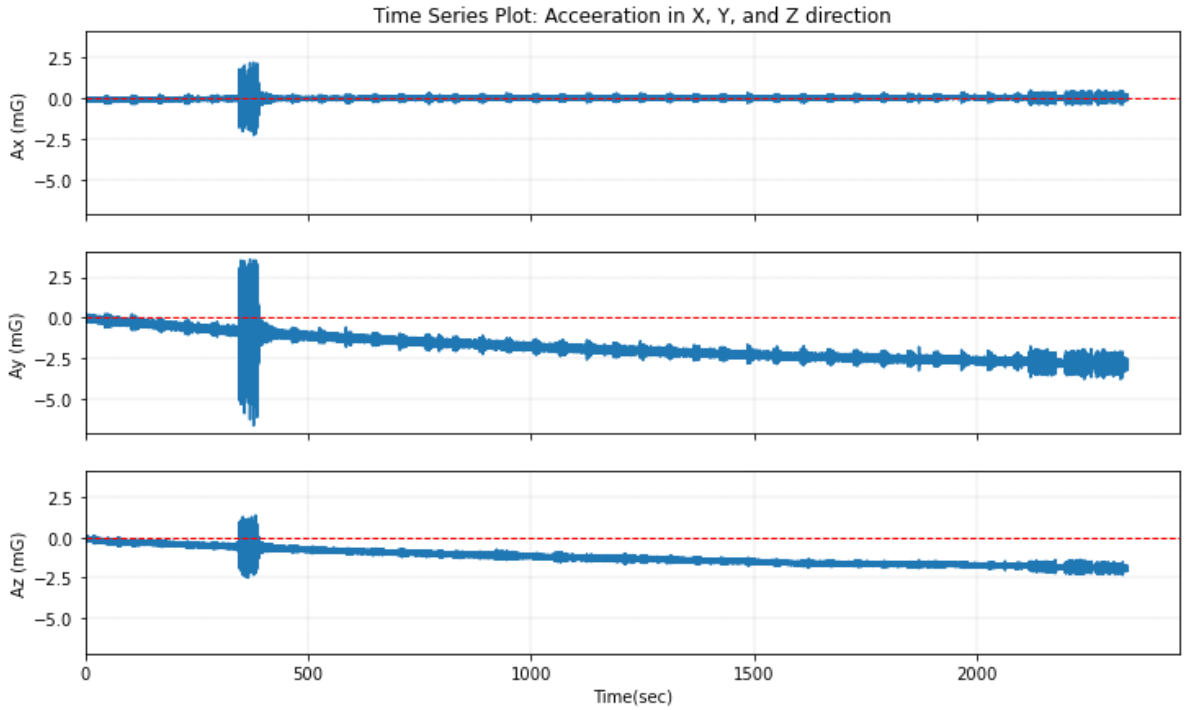
	Sample No.	time[sec]	Ax[mG]	Ay[mG]	Az[mG]	ATotal[mG]	Ts[deg.C]
0	1	0.000	1002.058327	34.240961	-7.385492	1002.670375	13.77832
1	2	0.002	1001.989484	34.129262	-7.378876	1002.597716	13.77832
2	3	0.004	1001.948416	34.144640	-7.425666	1002.557542	13.77832
3	4	0.006	1002.006233	34.231186	-7.462025	1002.618545	13.77832
4	5	0.008	1002.051771	34.339309	-7.501662	1002.668048	13.77832

The code below normalize the data by substracting each the values in Ax, Ay, and Az by corresponding ** first entry*

Out[6]:

Sample No.	time[sec]	Ax	Ay	Az	ATotal[mG]	Ts[deg.C]
1	0.000	0.000000	0.000000	0.000000	1002.670375	13.77832
2	0.002	-0.068843	-0.111699	0.006616	1002.597716	13.77832
3	0.004	-0.109911	-0.096321	-0.040174	1002.557542	13.77832
4	0.006	-0.052094	-0.009775	-0.076533	1002.618545	13.77832
5	0.008	-0.006556	0.098348	-0.116170	1002.668048	13.77832

Acceleration Plots in X, Y, and Z direction [Full Recording Length]

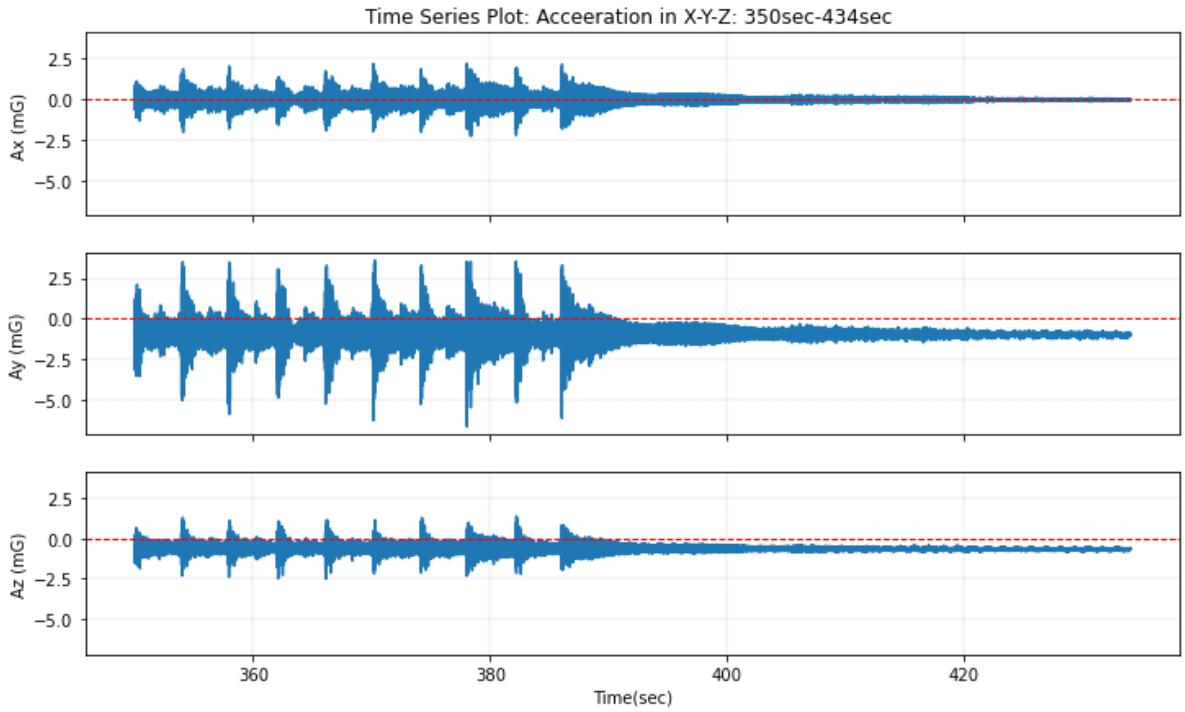


Acceleration Data in X, Y, and Z direction for [350 sec - 434 sec] Timeframe

Out[8]:

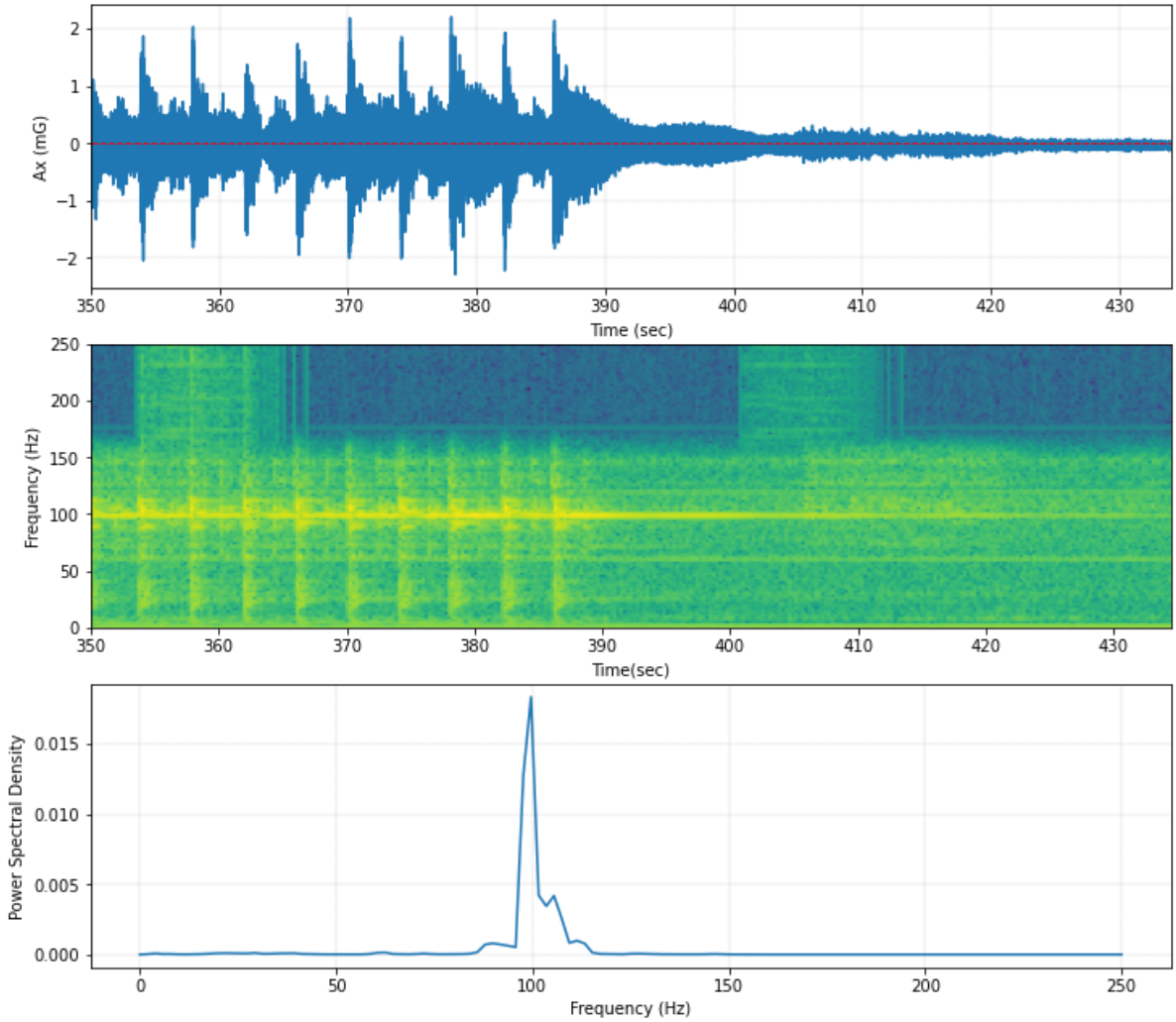
time[sec]	Ax	Ay	Az	ATotal[mG]	Ts[deg.C]	time[sec]
350.000	-0.622392	-2.047062	-0.534237	1001.984582	14.38867	350.000
350.002	0.043750	-0.687063	-0.517130	1002.694813	14.38867	350.002
350.004	0.483215	0.614405	-0.570357	1003.178815	14.38867	350.004
350.006	0.217855	-0.373661	-0.867069	1002.882169	14.38965	350.006
350.008	-0.377238	-2.541065	-0.962615	1002.217331	14.38965	350.008

Subplots for [Ax, Ay, Az] for Timeframe [350 sec - 434 sec]

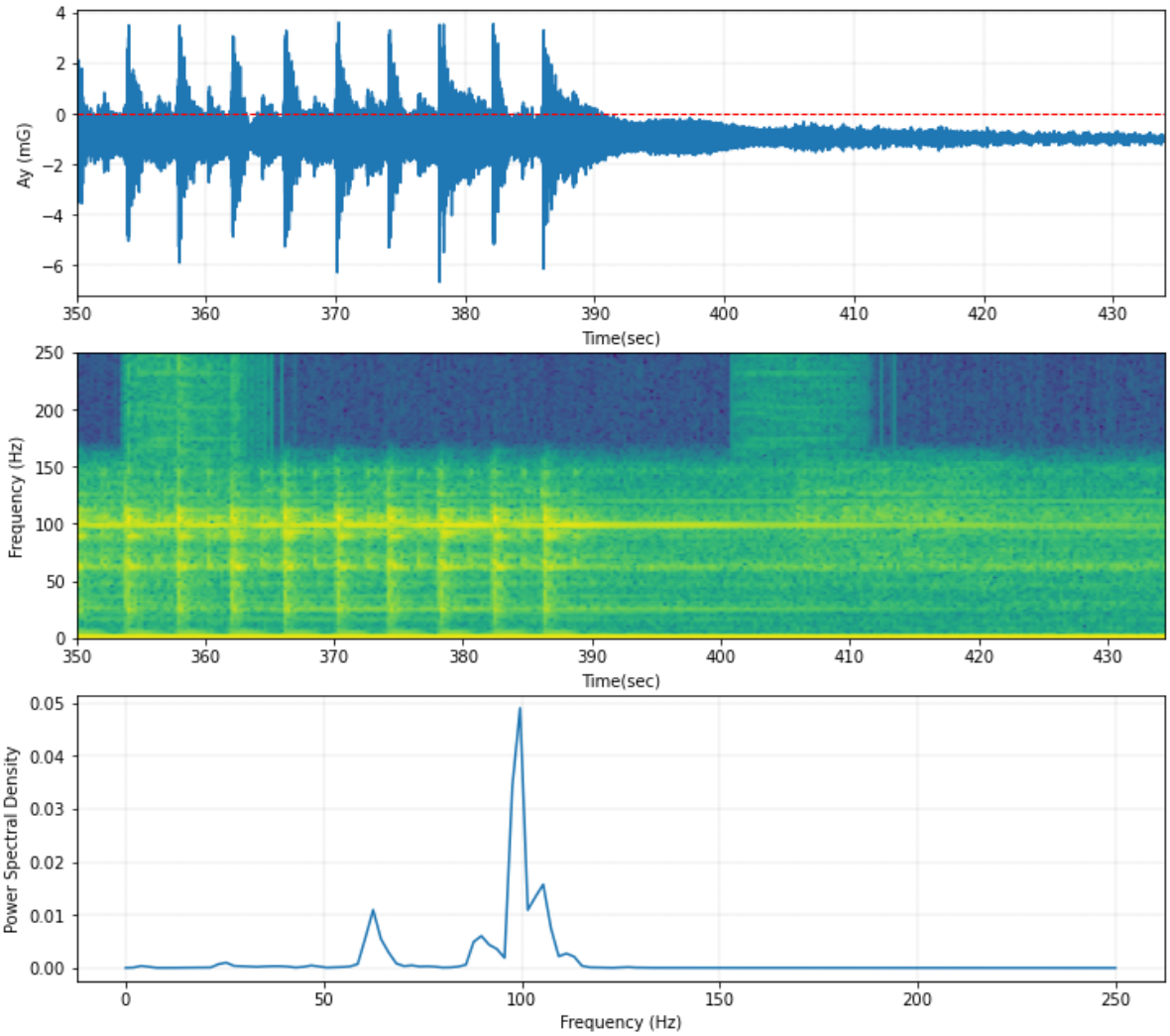


<Figure size 432x288 with 0 Axes>

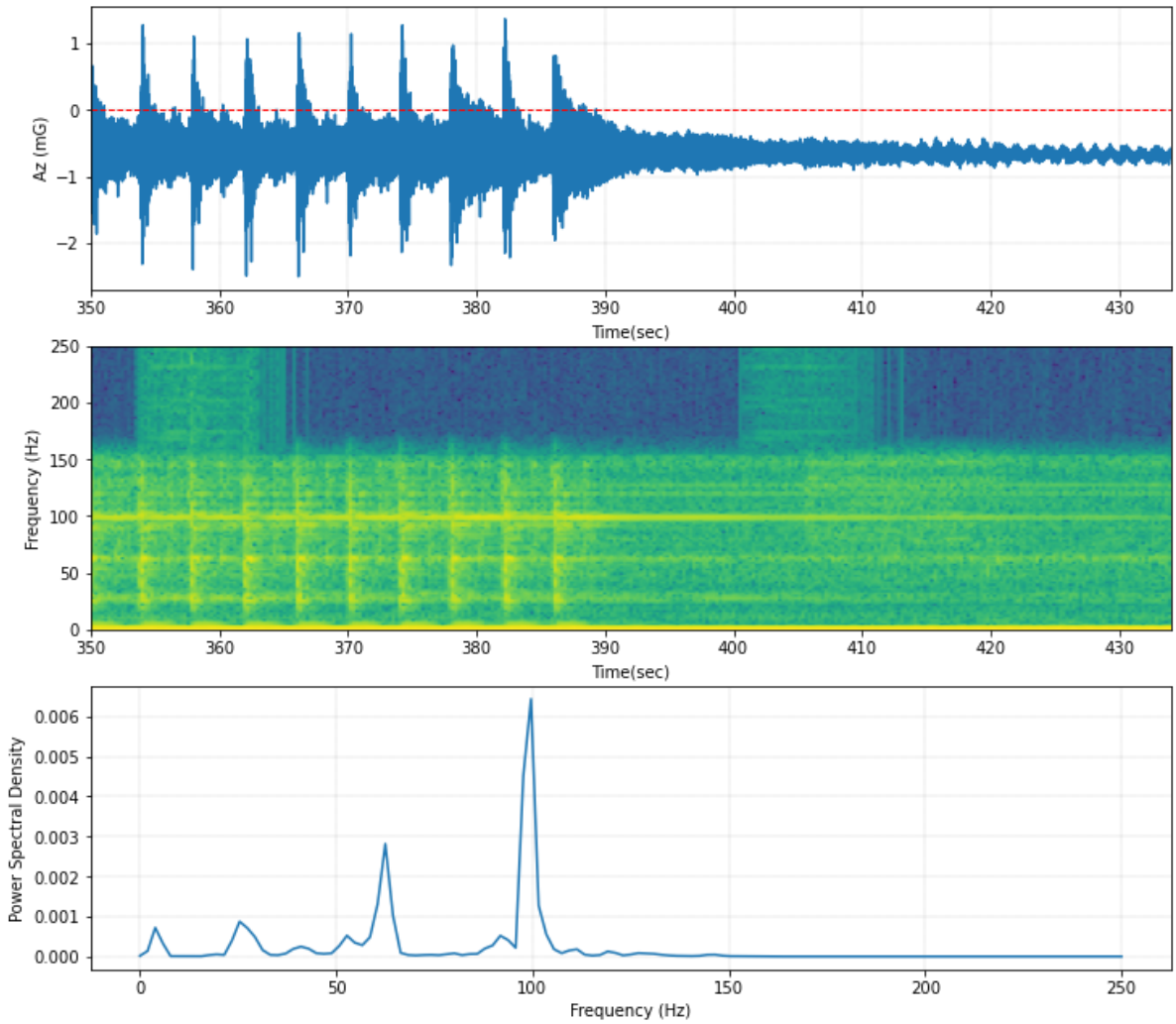
Ax [Acc vs Time | Spectrogram | Power vs Frequency]



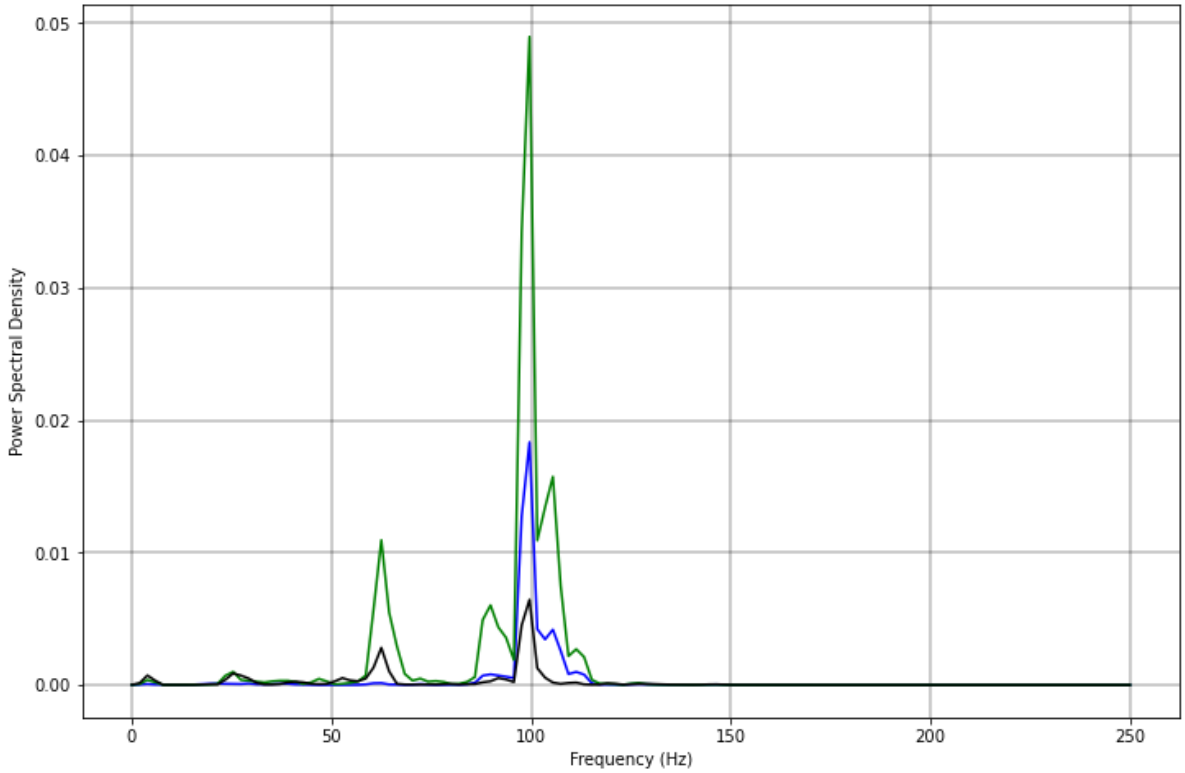
Ay [Acceleration vs Time | Spectrogram | Power vs Frequency]

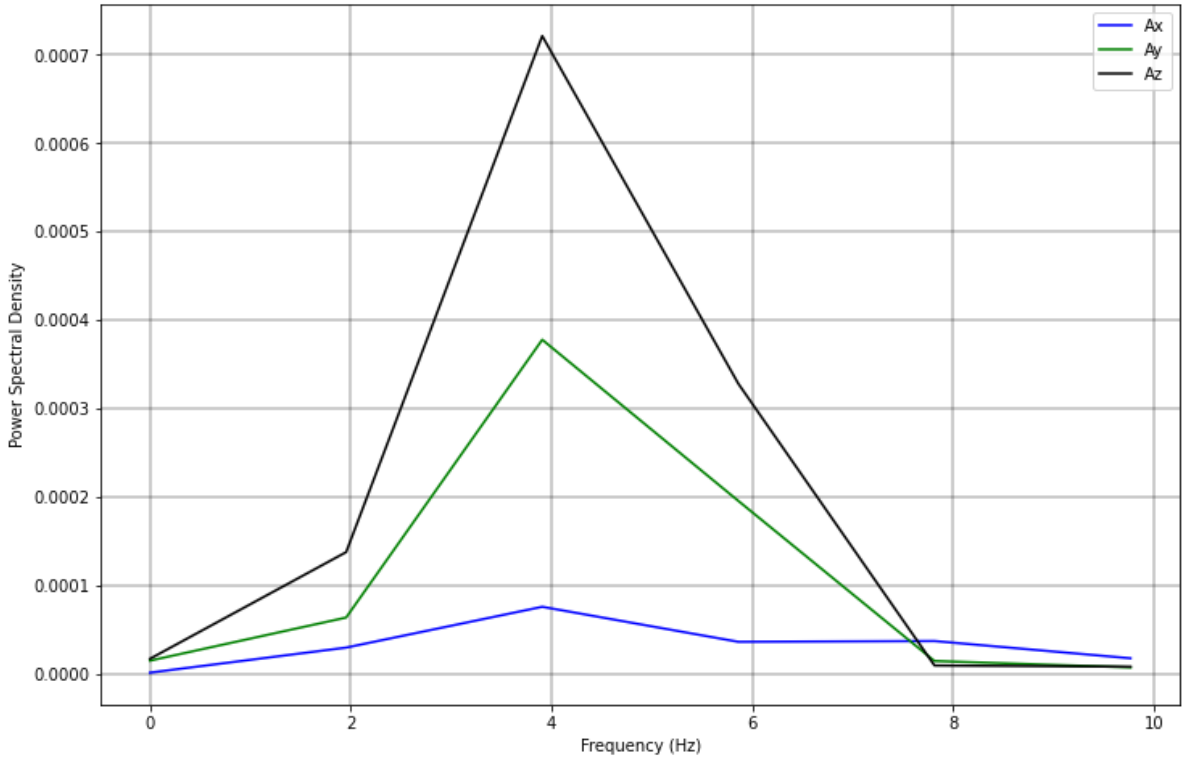


Az [Acceleration vs Time | Spectrogram | Power vs Frequency]



Power Spectral Density Ax-Ay-Az plotted together


0.05
0.04
0.03
0.02
0.01
0.00
Power Spectral Density
0
50
100
150
200
250
Frequency (Hz)

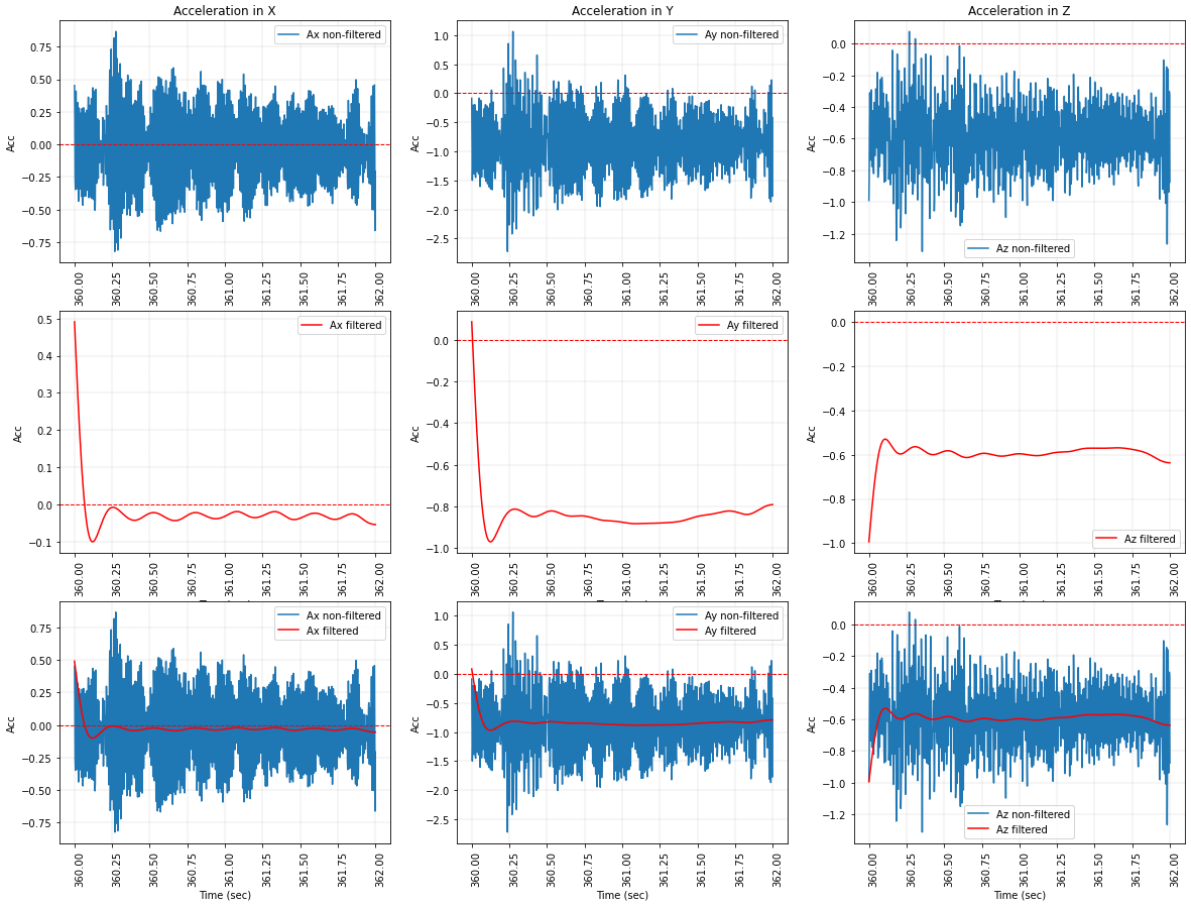


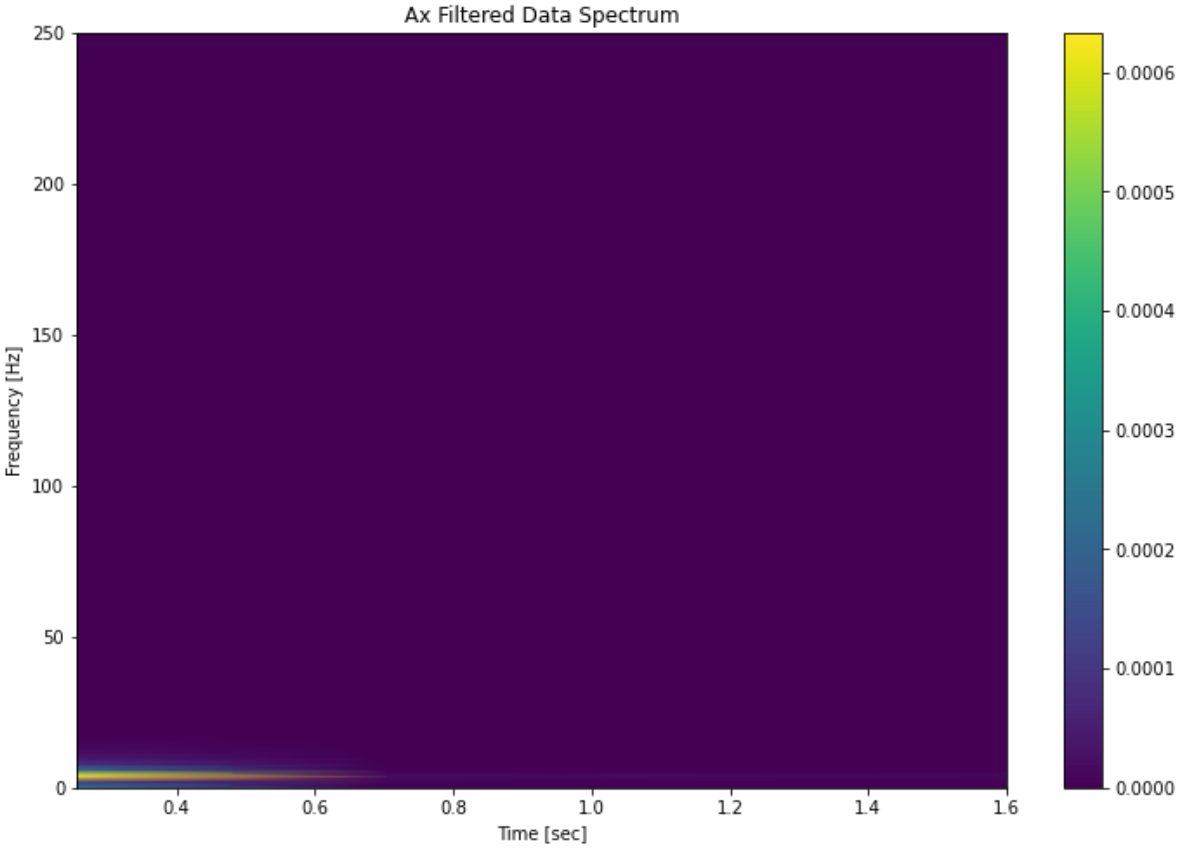
Subplots [Ax, Ay, Az] for Time Frame [360 sec - 362 sec]

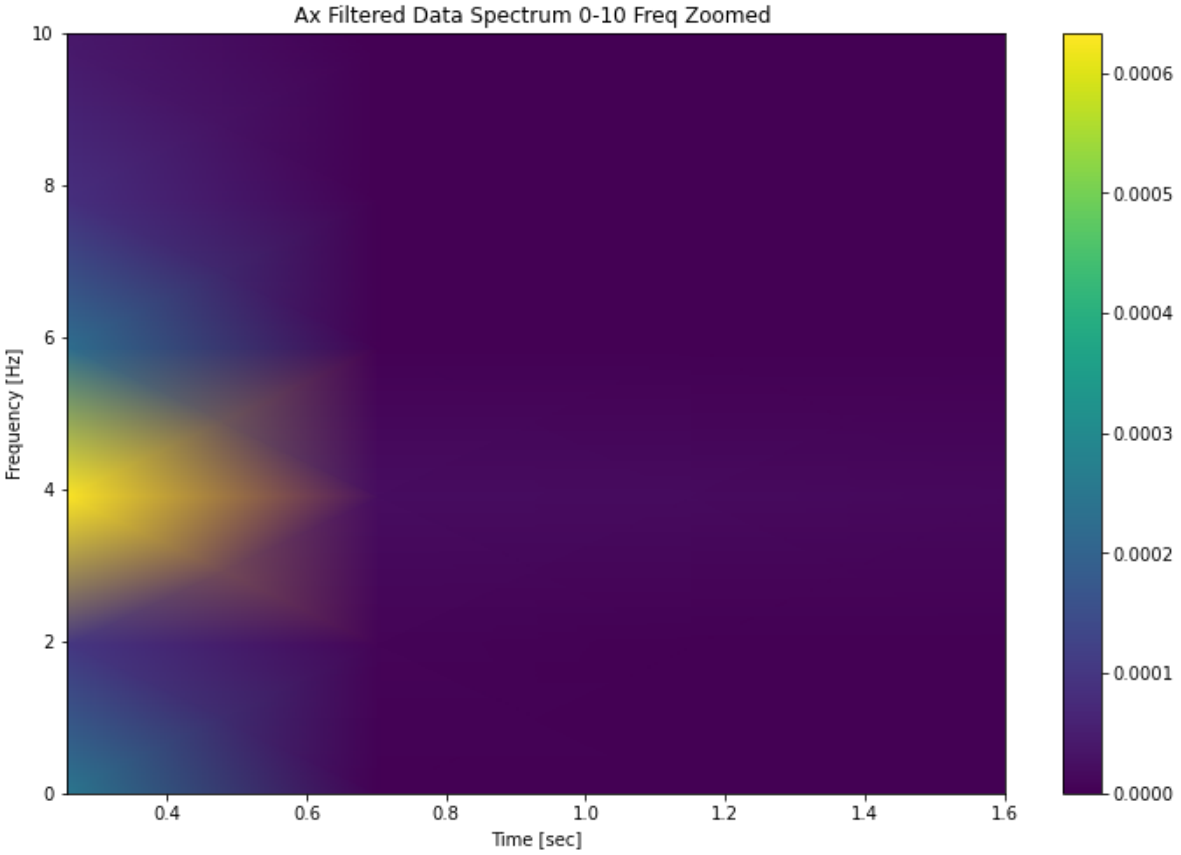
Out[16]:

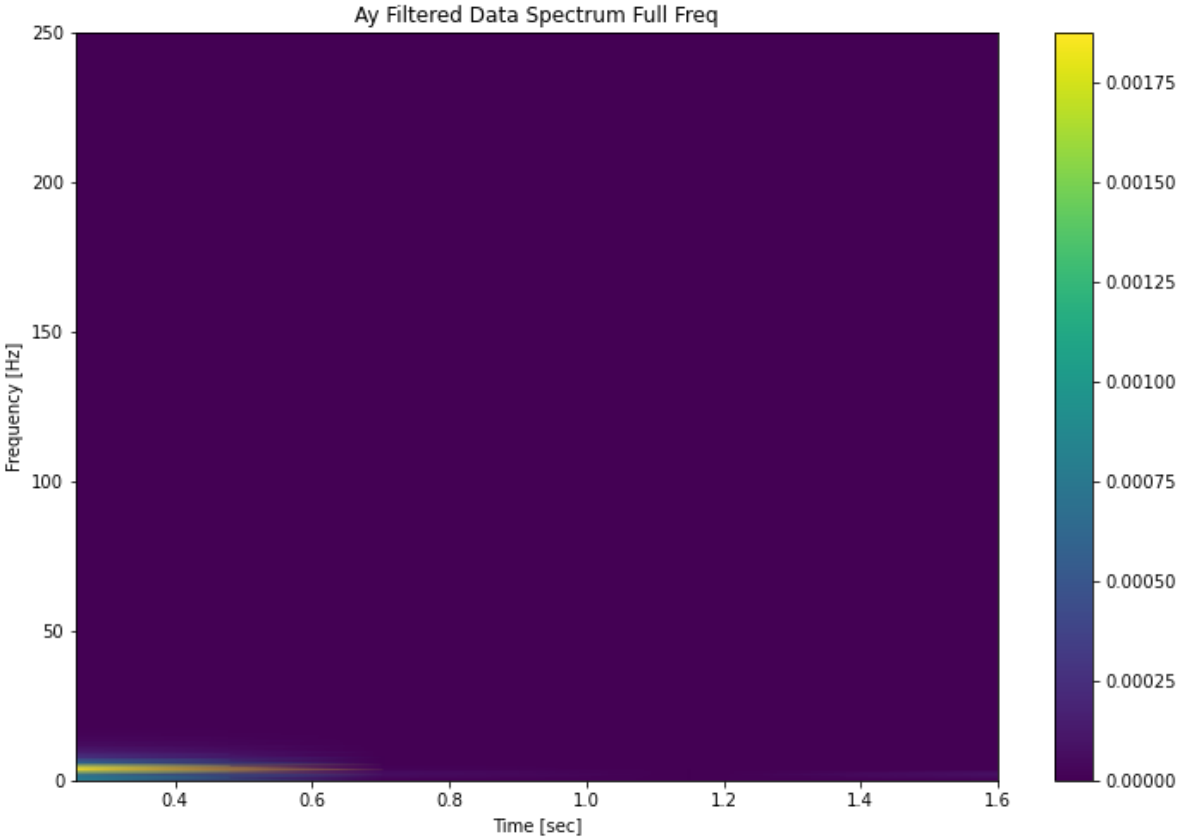
	Ax	Ay	Az	ATotal[mG]	Ts[deg.C]	time[sec]
time[sec]						
360.000	0.452340	-0.087619	-0.988663	1003.127217	14.39063	360.000
360.002	0.208140	-0.755846	-0.853360	1002.859512	14.39063	360.002
360.004	-0.260114	-1.496971	-0.502289	1002.364228	14.39063	360.004
360.006	-0.347197	-1.276970	-0.310183	1002.282912	14.38965	360.006
360.008	0.077903	-0.494301	-0.475884	1002.735091	14.38965	360.008

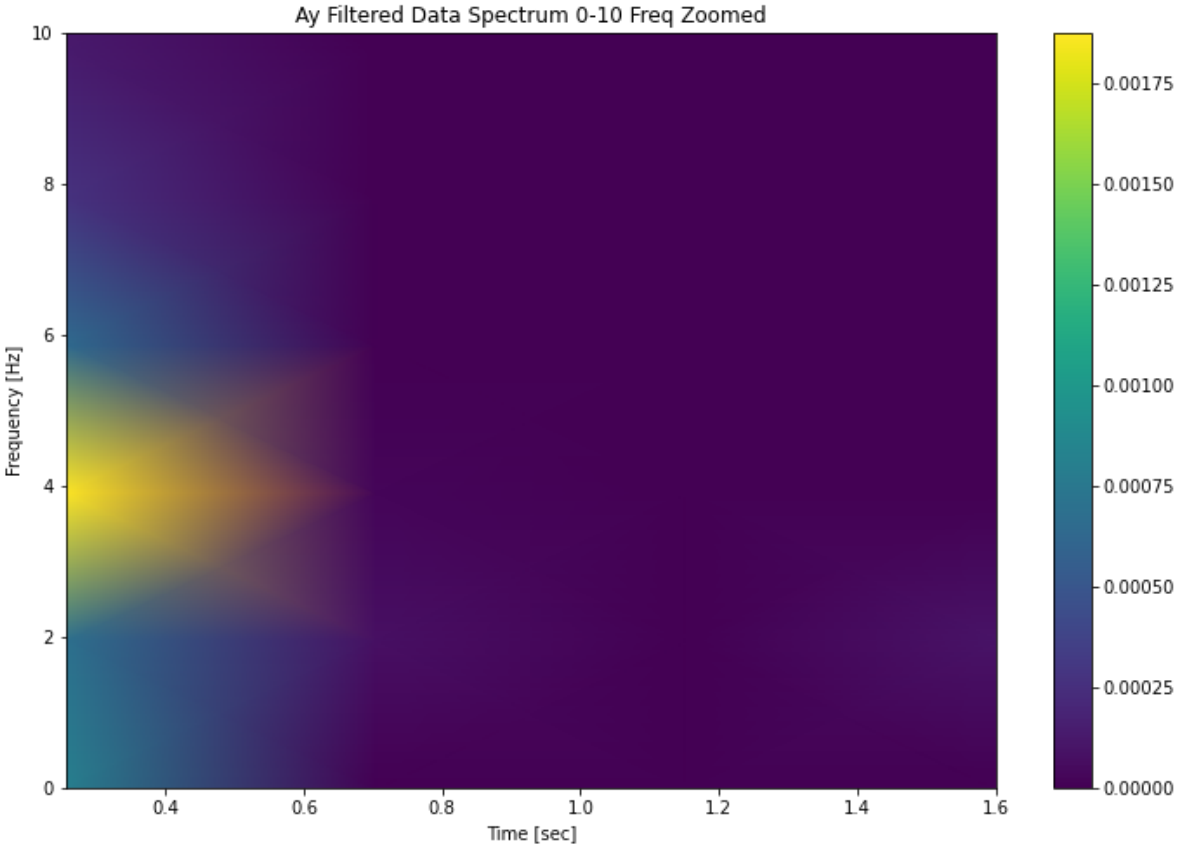
Comment: The plot below also show the LowPass filter at **4 Hz**

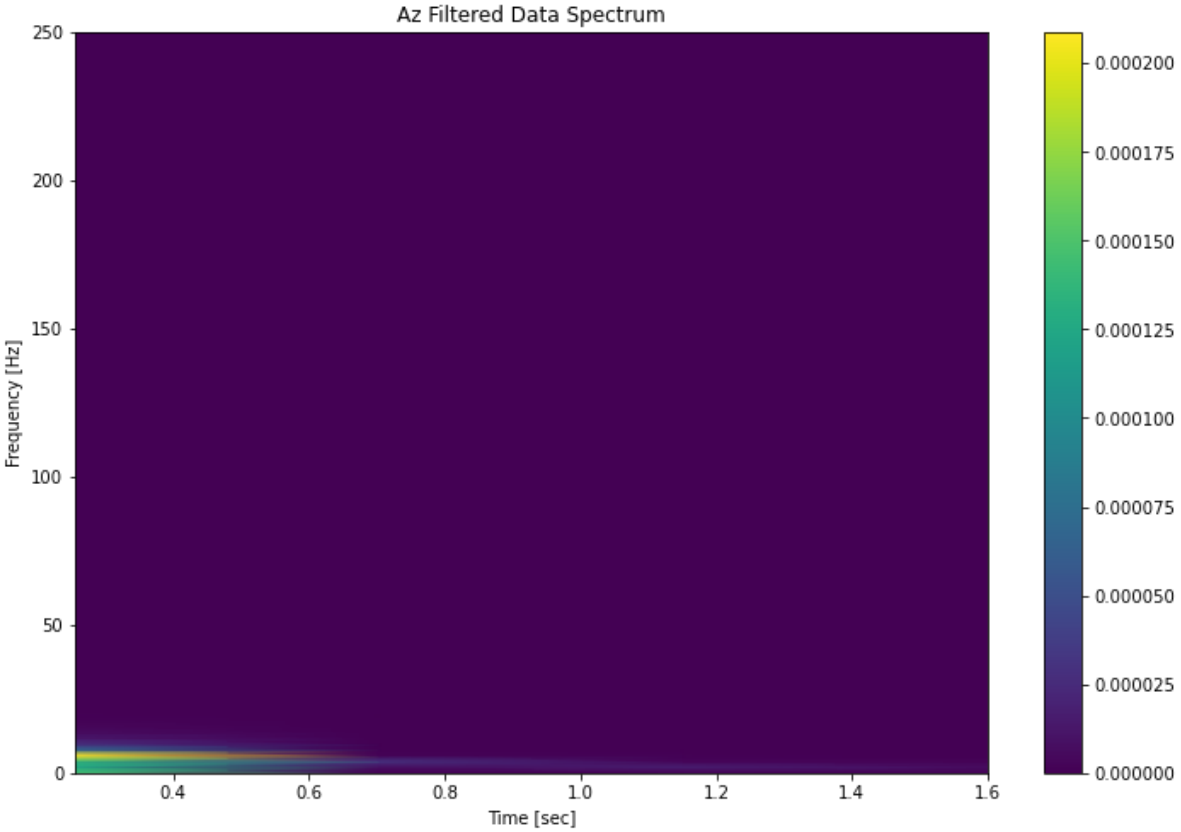

Acceleration in X
Acceleration in Y
Acceleration in Z
Ax non-filtered
Ay non-filtered
Az non-filtered
Ax filtered
Ay filtered
Az filtered
Acc
Time (sec)

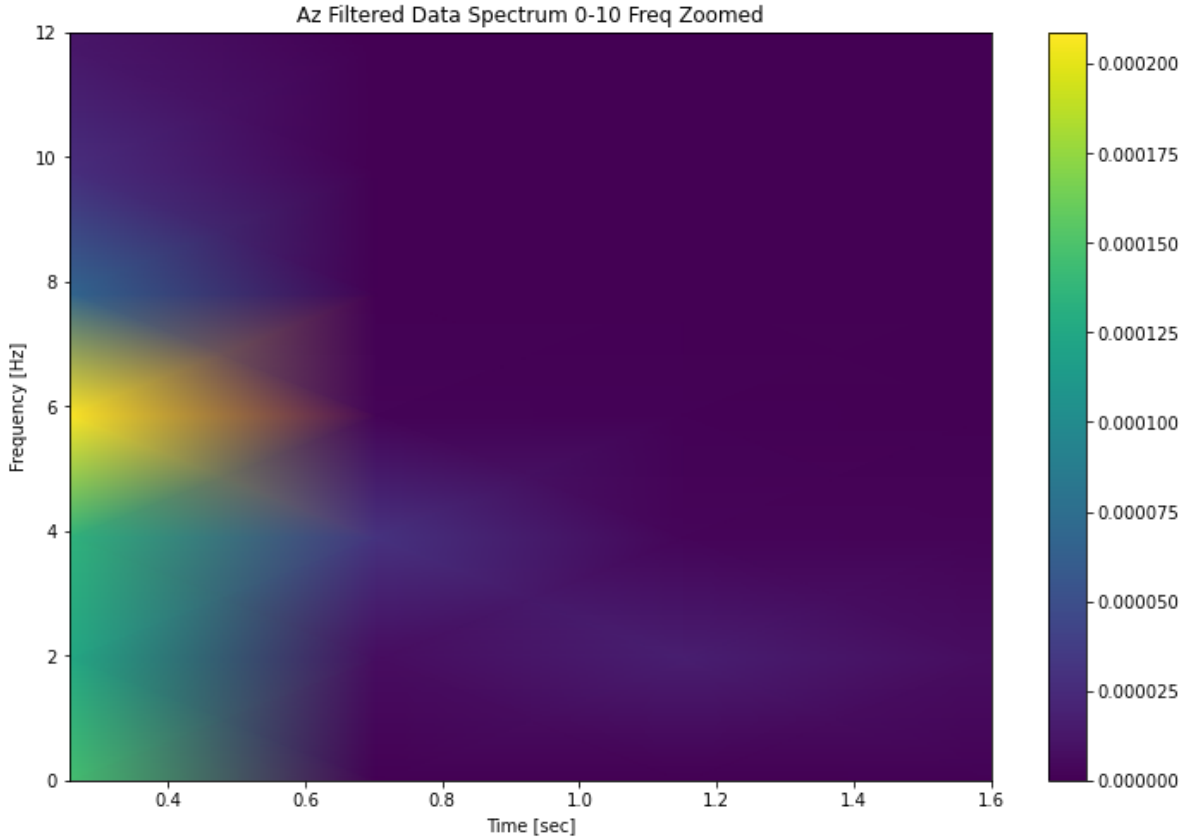

Ax Filtered Data Spectrum
250
200
150
100
50
0
Frequency [Hz]
0.4
0.6
0.8
1.0
1.2
1.4
1.6
Time [sec]
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000


Ax Filtered Data Spectrum 0-10 Freq Zoomed
Frequency [Hz]
Time [sec]
10
8
6
4
2
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000

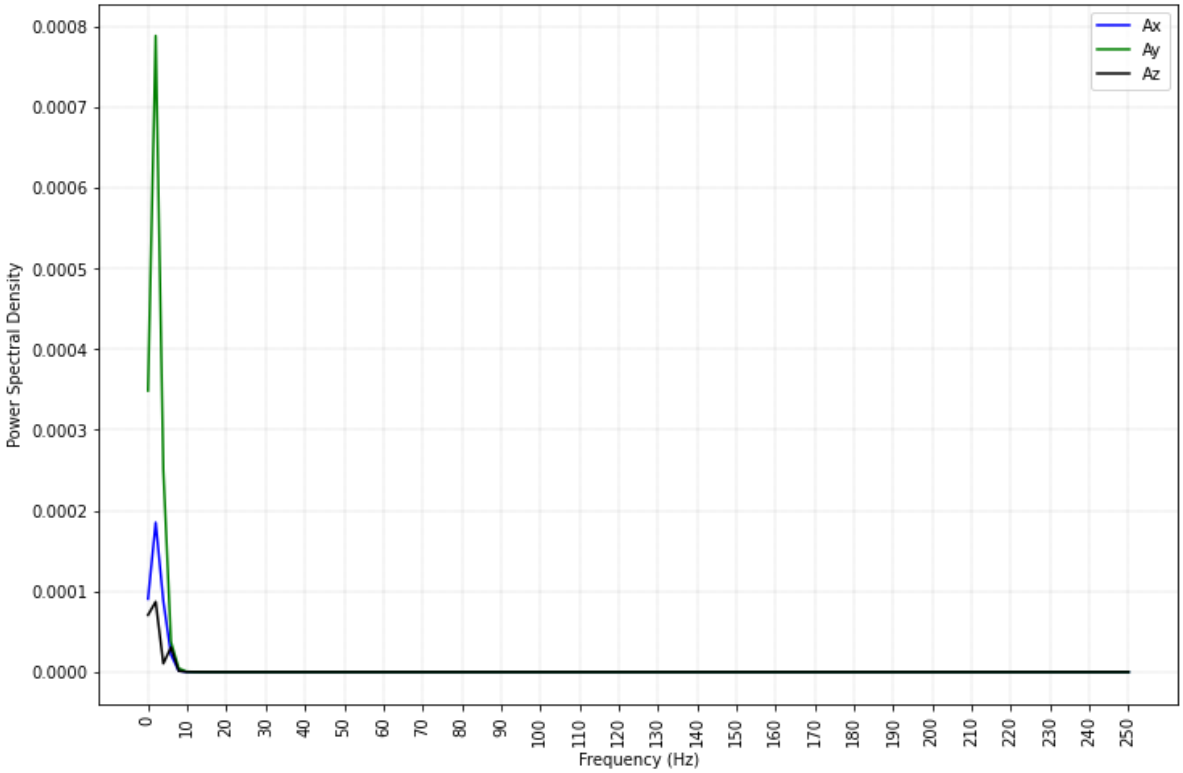

Ay Filtered Data Spectrum Full Freq
Frequency [Hz]
Time [sec]
250
200
150
100
50
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000

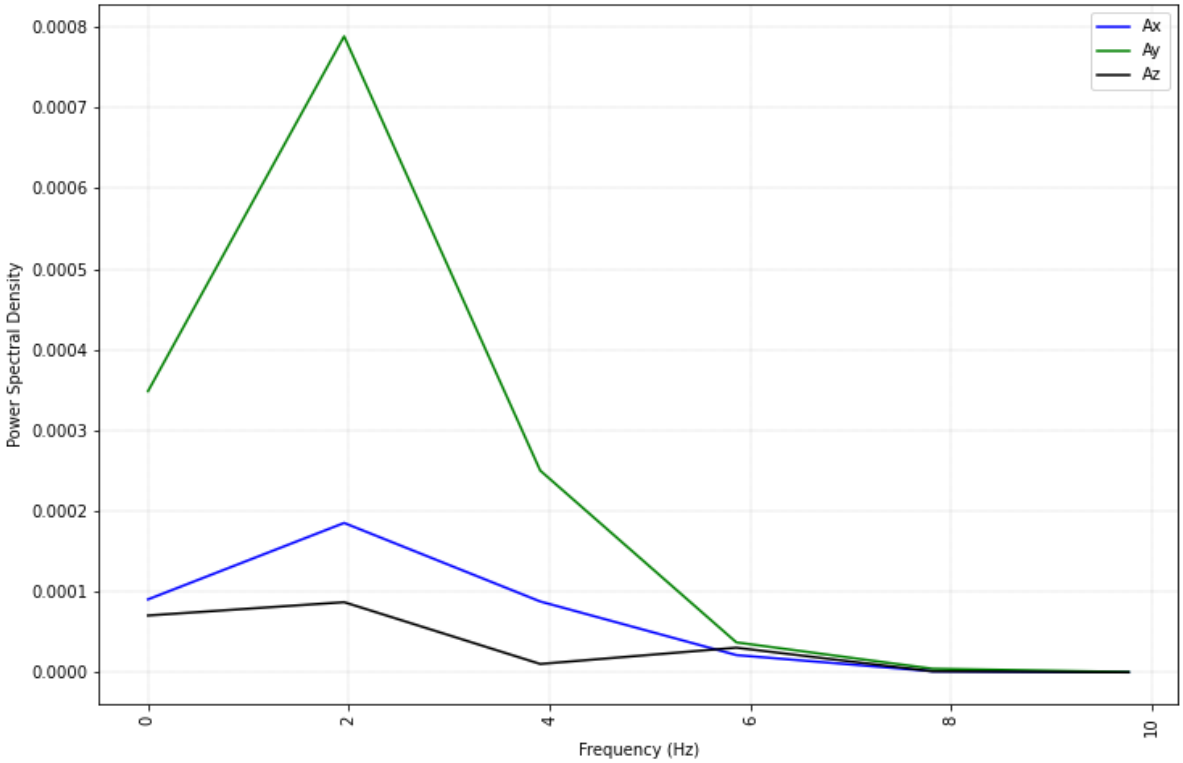

Ay Filtered Data Spectrum 0-10 Freq Zoomed
Frequency [Hz]
Time [sec]
0
2
4
6
8
10
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000


Az Filtered Data Spectrum
Frequency [Hz]
Time [sec]
250
200
150
100
50
0
0.4
0.6
0.8
1.0
1.2
1.4
1.6
0.000200
0.000175
0.000150
0.000125
0.000100
0.000075
0.000050
0.000025
0.000000



<Figure size 864x576 with 0 Axes>


Ax
Ay
Az
Power Spectral Density
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
Frequency (Hz)

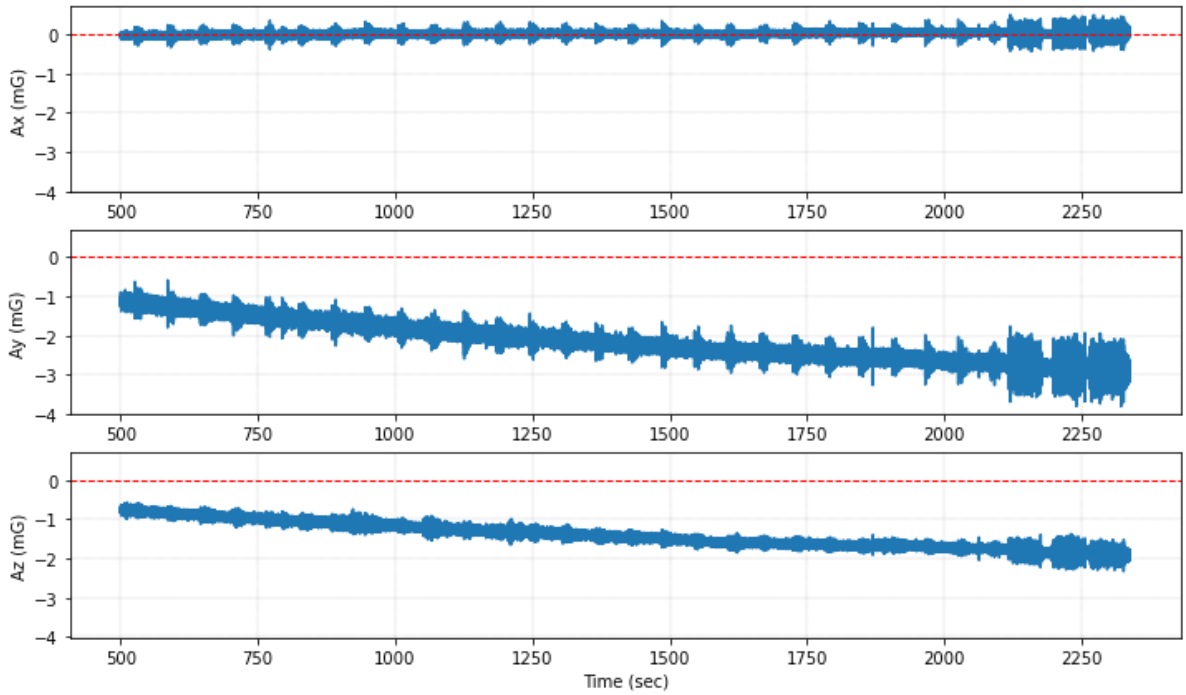


After Bell Ring Analysis

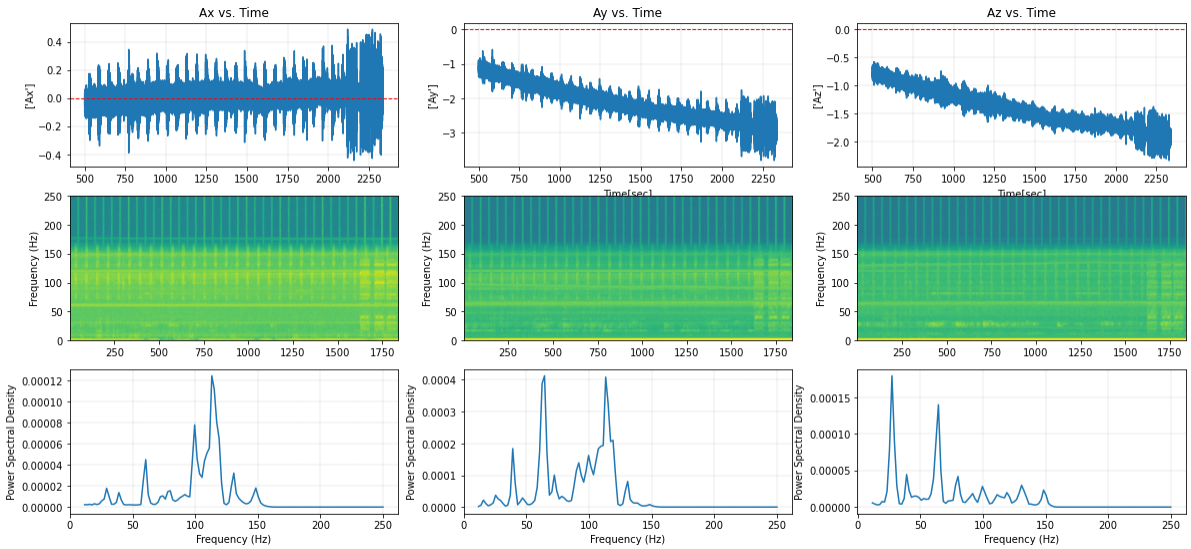
We explore the vibration of the structure when the bell stop rigging. The time span taken is between 750 second and 1250 sec. We consequently generate the follwing plots:

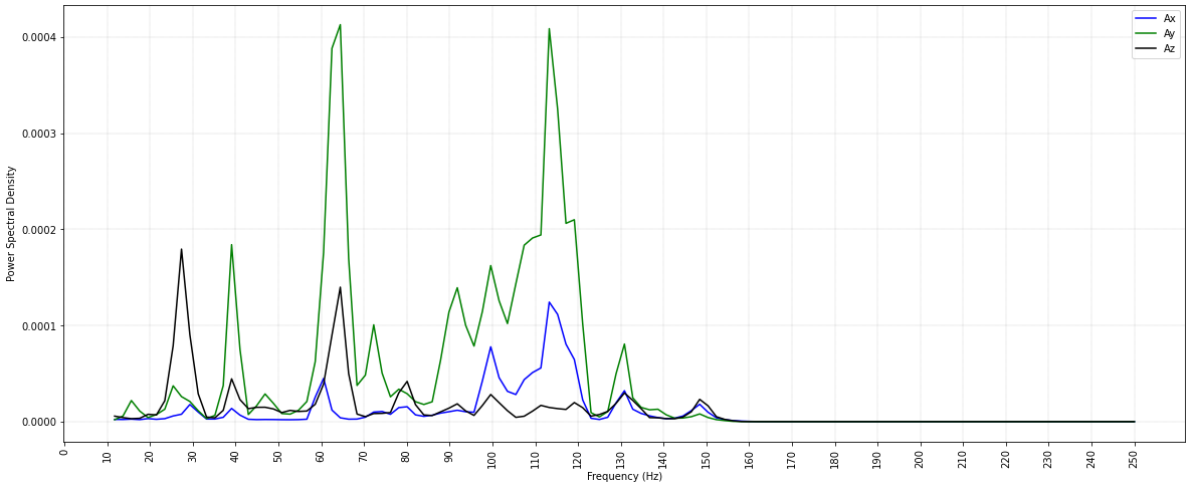
Out[28]:

time[sec]	Ax	Ay	Az	ATotal[mG]	Ts[deg.C]	time[sec]
500.000	-0.047445	-1.194537	-0.698746	1002.588265	14.54785	500.000
500.002	-0.012874	-1.074672	-0.695169	1002.626745	14.54785	500.002
500.004	0.007332	-0.980914	-0.734508	1002.650362	14.54785	500.004
500.006	-0.037968	-1.022518	-0.765860	1002.603964	14.54785	500.006
500.008	-0.087201	-1.146793	-0.788808	1002.550836	14.54785	500.008

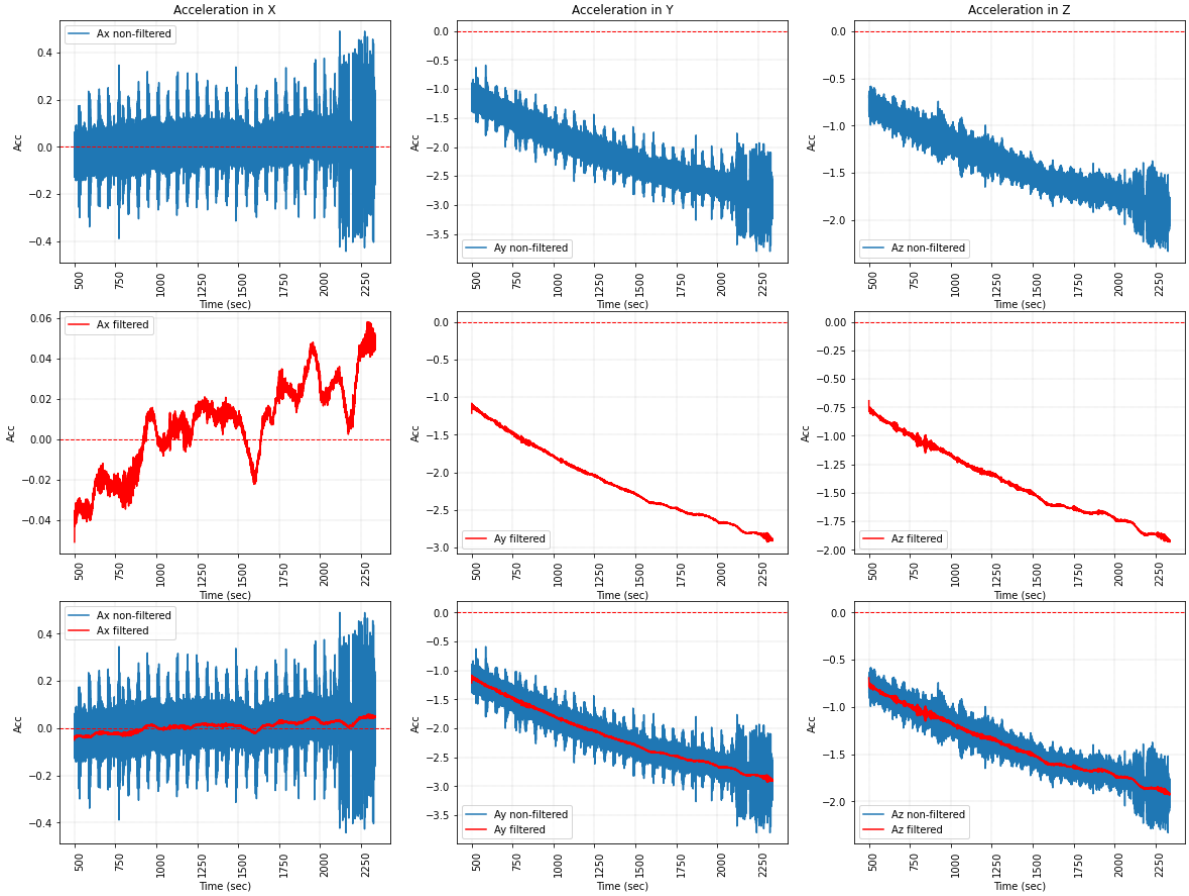


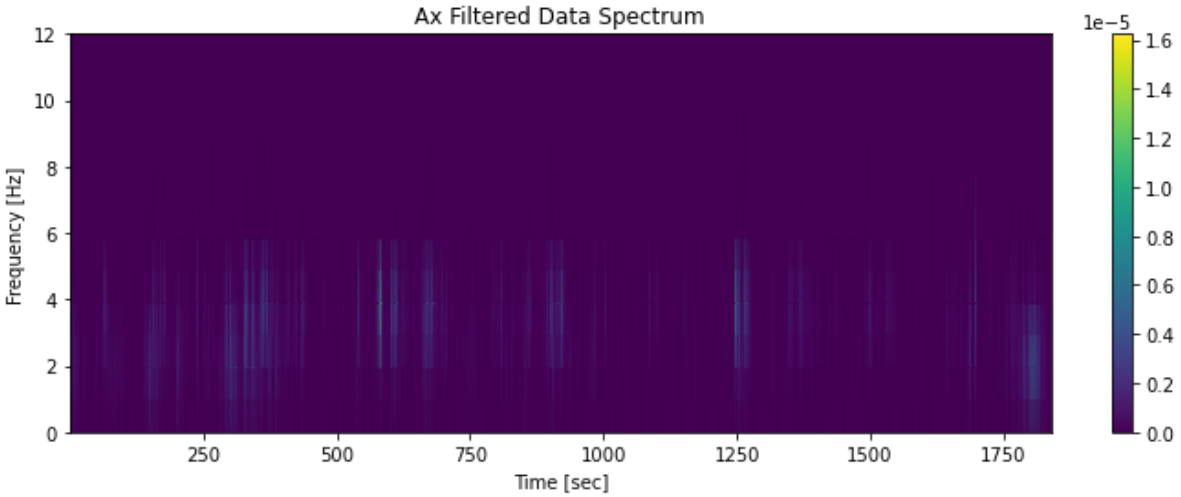
<Figure size 432x288 with 0 Axes>

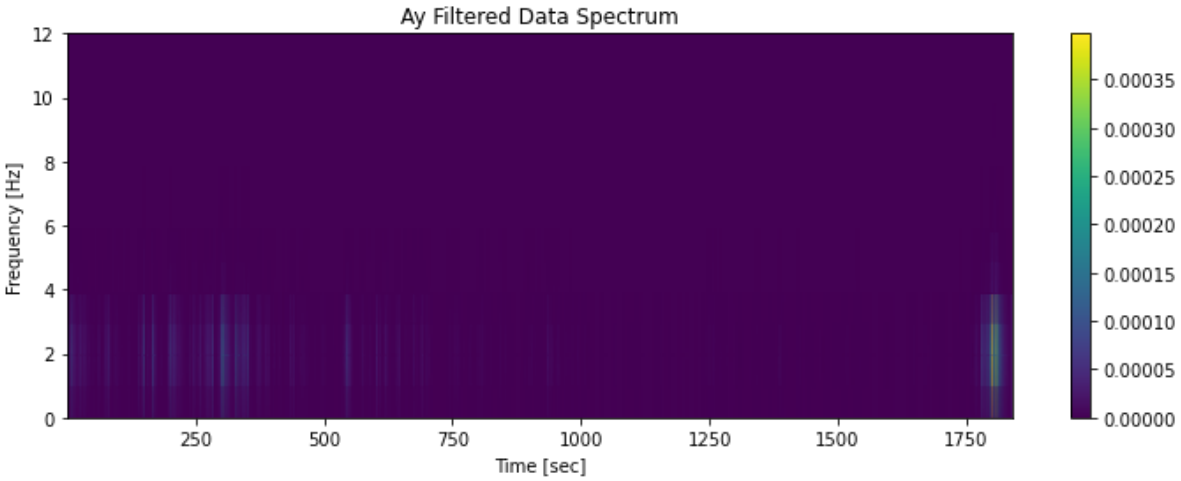


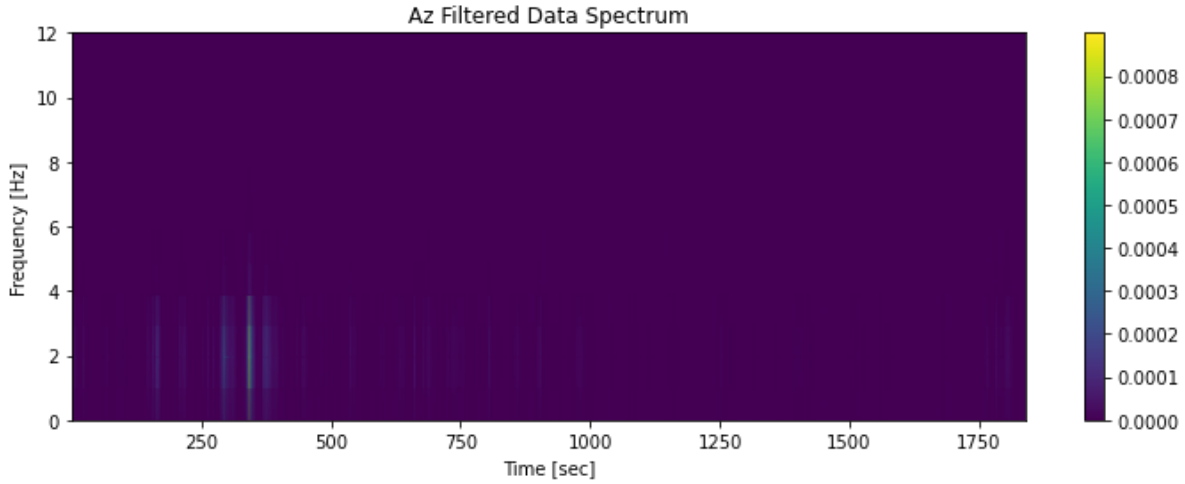


After Bell Ring Analysis -- Filtered




Ax Filtered Data Spectrum
Frequency [Hz]
Time [sec]
1e−5

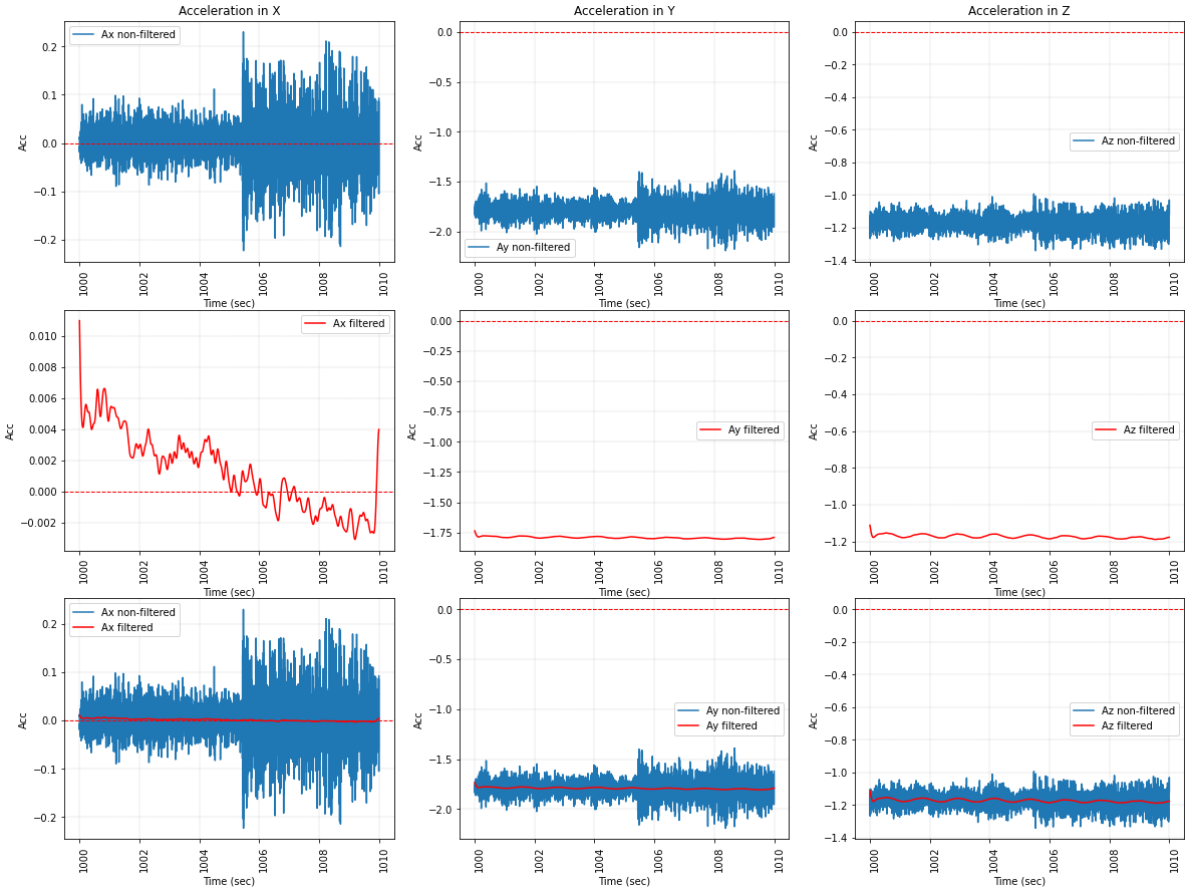

Ay Filtered Data Spectrum
Frequency [Hz]
Time [sec]



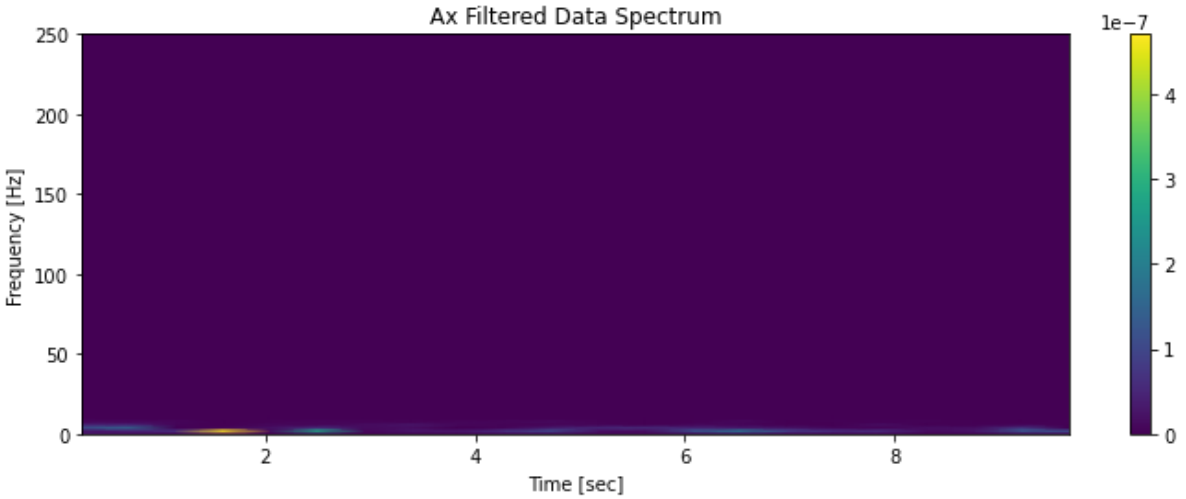
After ring - 10 sec - between 1000 sec to 1010 sec

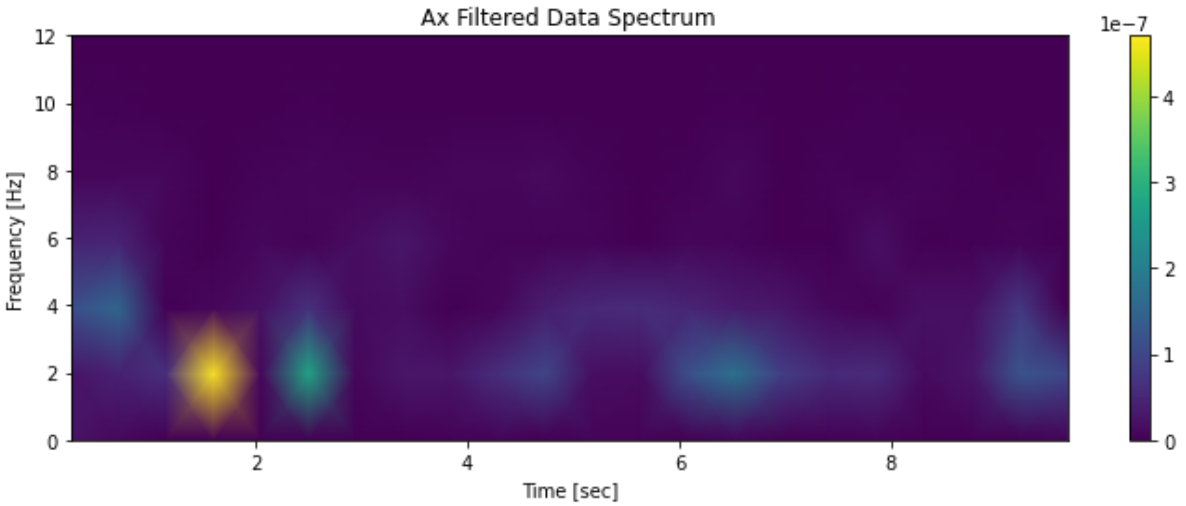
Out[37]:

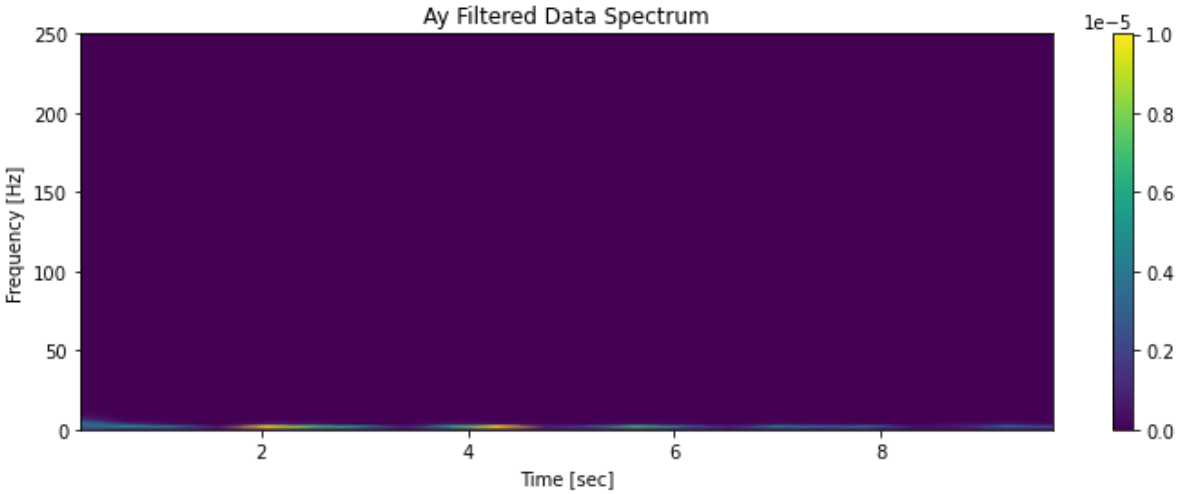
	Ax	Ay	Az	ATotal[mG]	Ts[deg.C]	time[sec]
time[sec]						
1000.000	0.008941	-1.731992	-1.129985	1002.630618	14.79688	1000.000
1000.002	0.012696	-1.792252	-1.154304	1002.632626	14.79688	1000.002
1000.004	-0.011742	-1.832366	-1.134575	1002.606736	14.79688	1000.004
1000.006	-0.018537	-1.819312	-1.178325	1002.600740	14.79688	1000.006
1000.008	-0.006377	-1.779020	-1.267612	1002.614963	14.79688	1000.008

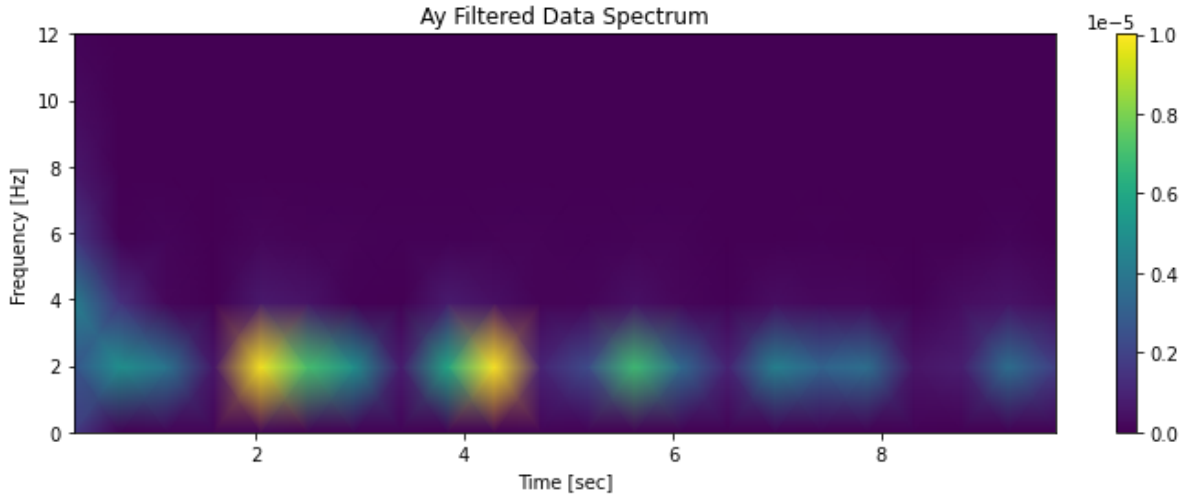

Acceleration in X
Acceleration in Y
Acceleration in Z
Ax non-filtered
Ay non-filtered
Az non-filtered
Ax filtered
Ay filtered
Az filtered
Acc
Time (sec)

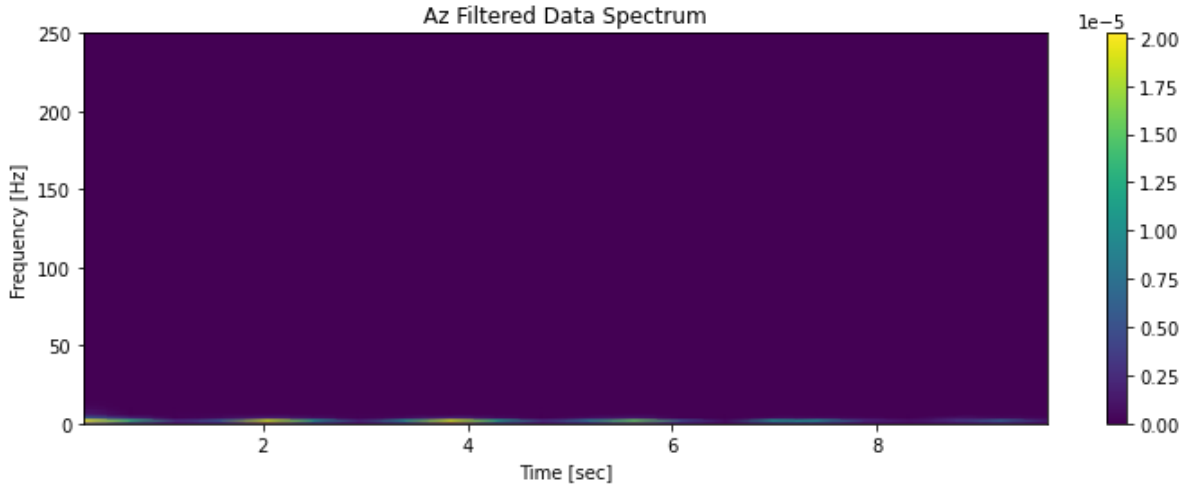
Ax non-filtered
Ax filtered
Ay non-filtered
Ay filtered
Az non-filtered
Az filtered
Acc
Time (sec)

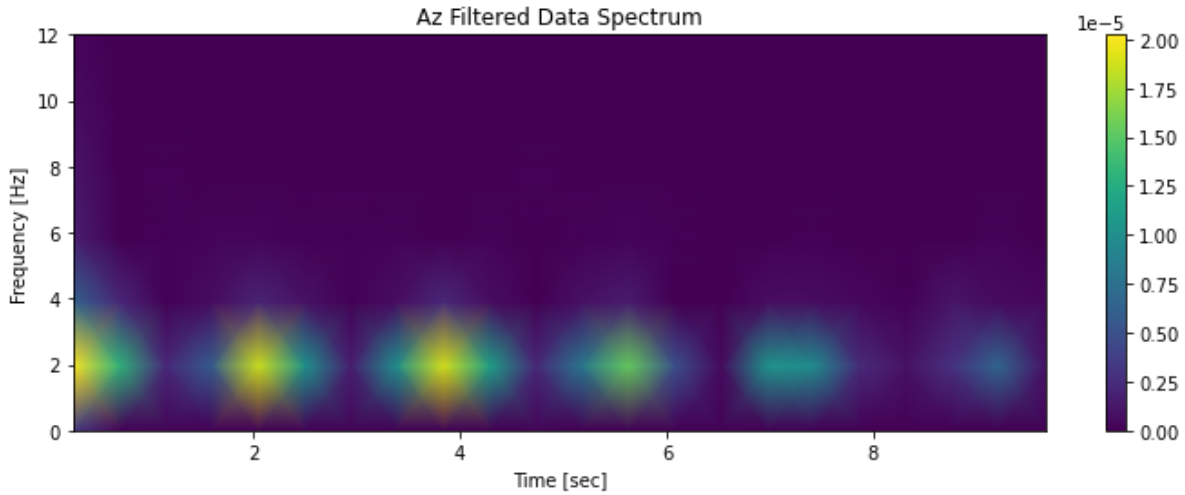

Ax Filtered Data Spectrum
Frequency [Hz]
Time [sec]
1e−7


Ax Filtered Data Spectrum
Frequency [Hz]
Time [sec]
1e−7


Ay Filtered Data Spectrum
Frequency [Hz]
Time [sec]
1e−5







Power Density Spectrum

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<Figure size 432x288 with 0 Axes>
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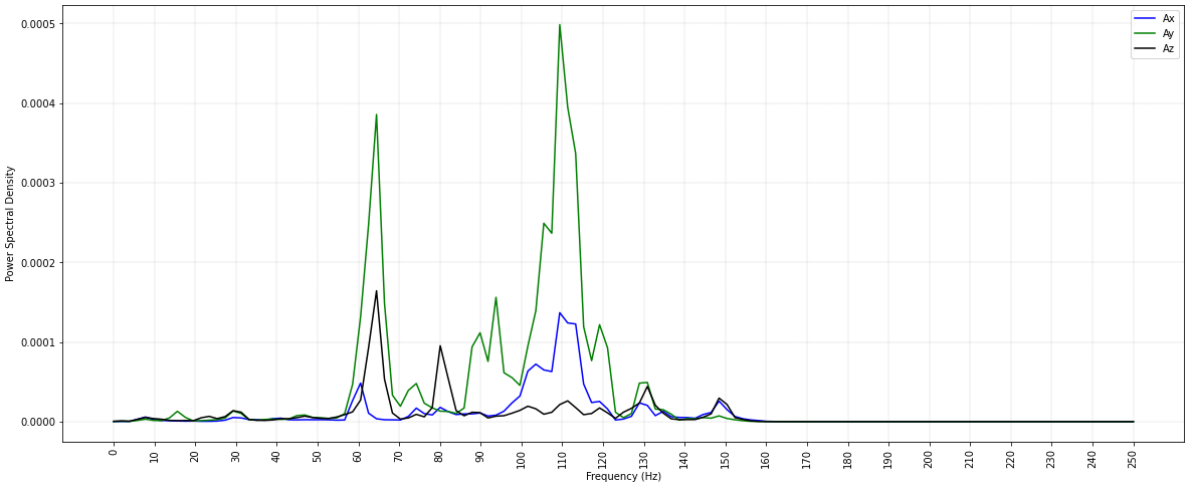
Ax
Ay
Az
Power Spectral Density
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
Frequency (Hz)