exp4

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Computational Neuroscience Experiment 4

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MBA Tech. EXTC SEM 8

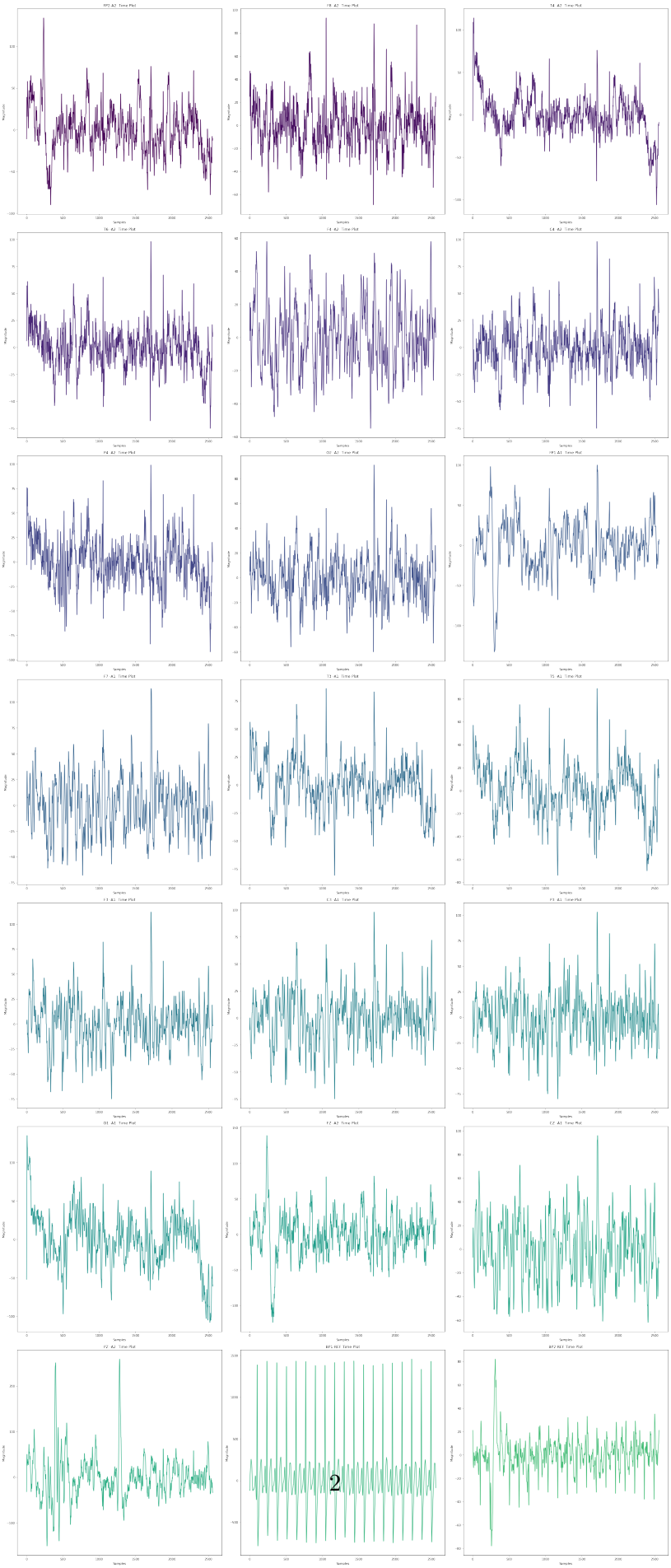
[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import warnings
warnings.filterwarnings('ignore')

columns = ['FP2-A2 ', 'F8 -A2 ', 'T4 -A2 ', 'T6 -A2 ', 'F4 -A2 ', 'C4 -A2 ',
       'P4 -A2 ', 'O2 -A2 ', 'FP1-A1 ', 'F7 -A1 ', 'T3 -A1 ', 'T5 -A1 ',
       'F3 -A1 ', 'C3 -A1 ', 'P3 -A1 ', 'O1 -A1 ', 'FZ -A2 ', 'CZ -A1 ',
       'PZ -A2 ', 'BP1-REF', 'BP2-REF']
```

Time Plots

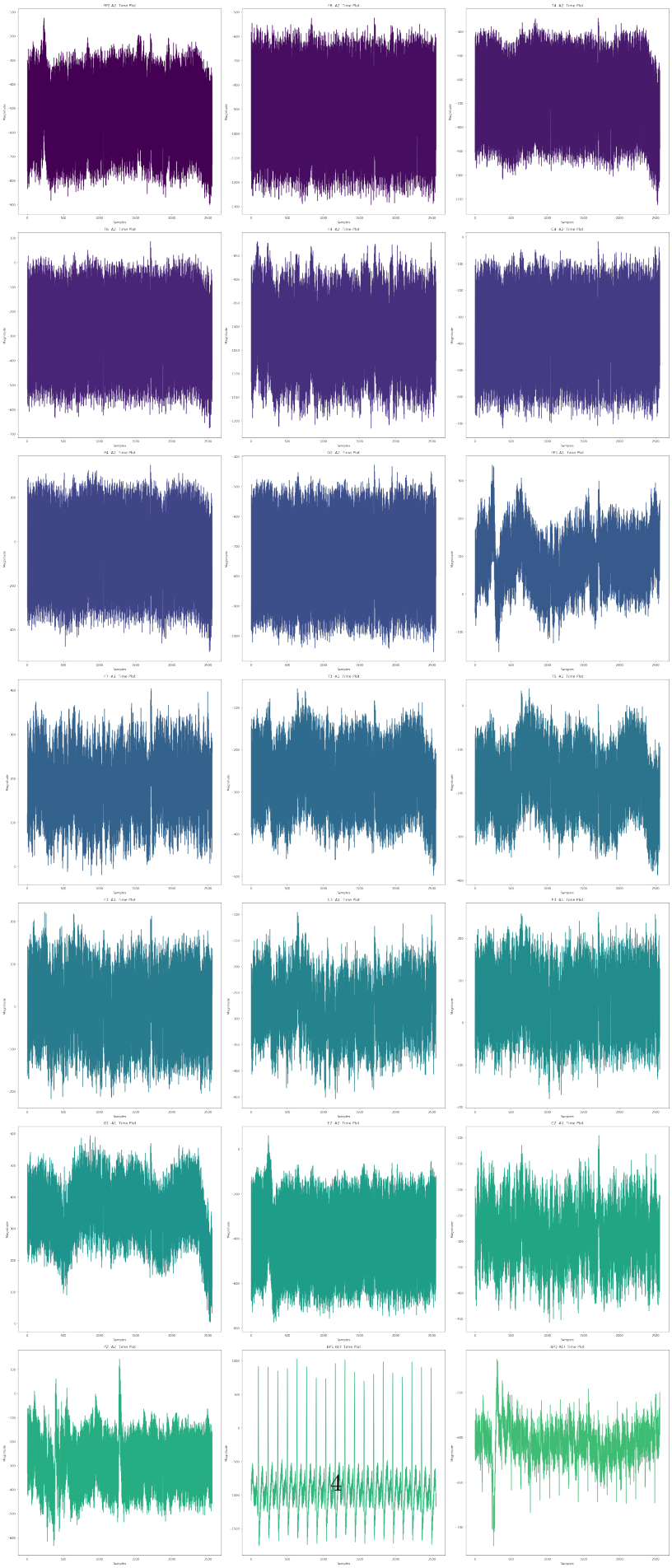
[ ]:
```
def time_charts(file):
    data = pd.read_csv(file)
    colormap = plt.cm.viridis
    colors = [colormap(i) for i in np.linspace(0, 1,30)]
    plt.figure(figsize=(30,70))
    for i in range(len(data.columns)):
        plt.subplot(7,3,i+1)
        data[columns[i]].plot(color=colors[i])
        plt.xlabel("Samples")
        plt.ylabel("Magnitude")
        plt.title(f"{columns[i]} Time Plot")
    plt.tight_layout()
    plt.show()
```

[ ]:
```
print("Time Plots for Filtered Data")
time_charts('5_filtered.csv')
print("Time Plots for Unfiltered Data")
time_charts('5_unfiltered.csv')
```

```
Time Plots for Filtered Data
```


FP2-A2 Time Plot
F8-A2 Time Plot
T4-A2 Time Plot
T6-A2 Time Plot
F4-A2 Time Plot
C4-A2 Time Plot
P4-A2 Time Plot
O2-A2 Time Plot
FP1-A1 Time Plot
F7-A1 Time Plot
T3-A1 Time Plot
T5-A1 Time Plot
F3-A1 Time Plot
C3-A1 Time Plot
P3-A1 Time Plot
O1-A1 Time Plot
FZ-A2 Time Plot
CZ-A1 Time Plot
FZ-A2 Time Plot
RF1-REF Time Plot
RF2-REF Time Plot
Magnitude
Samples

Time Plots for Unfiltered Data


FP2-A2 Time Plot
F8-A2 Time Plot
T4-A2 Time Plot
T6-A2 Time Plot
F4-A2 Time Plot
C4-A2 Time Plot
P4-A2 Time Plot
O2-A2 Time Plot
FP1-A1 Time Plot
F7-A1 Time Plot
T3-A1 Time Plot
T5-A1 Time Plot
F3-A1 Time Plot
C3-A1 Time Plot
P3-A1 Time Plot
O1-A1 Time Plot
FZ-A2 Time Plot
CZ-A1 Time Plot
PZ-A2 Time Plot
EMG-REF Time Plot
EMG-A1 Time Plot
Samples
Magnitude

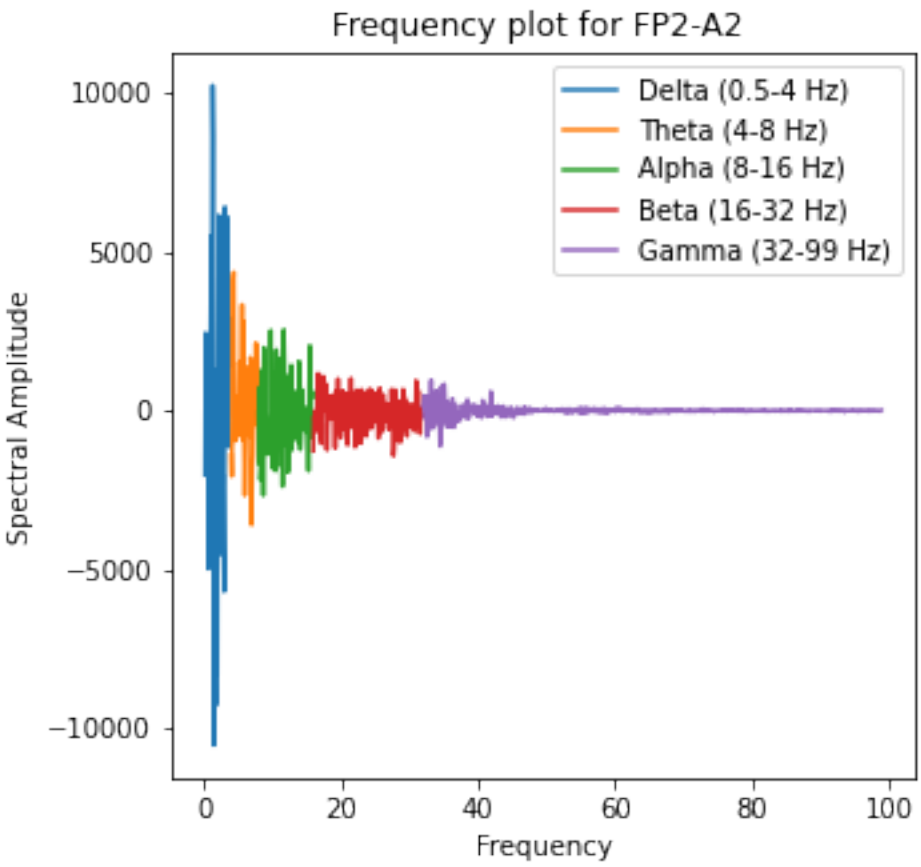
Frequency Plots

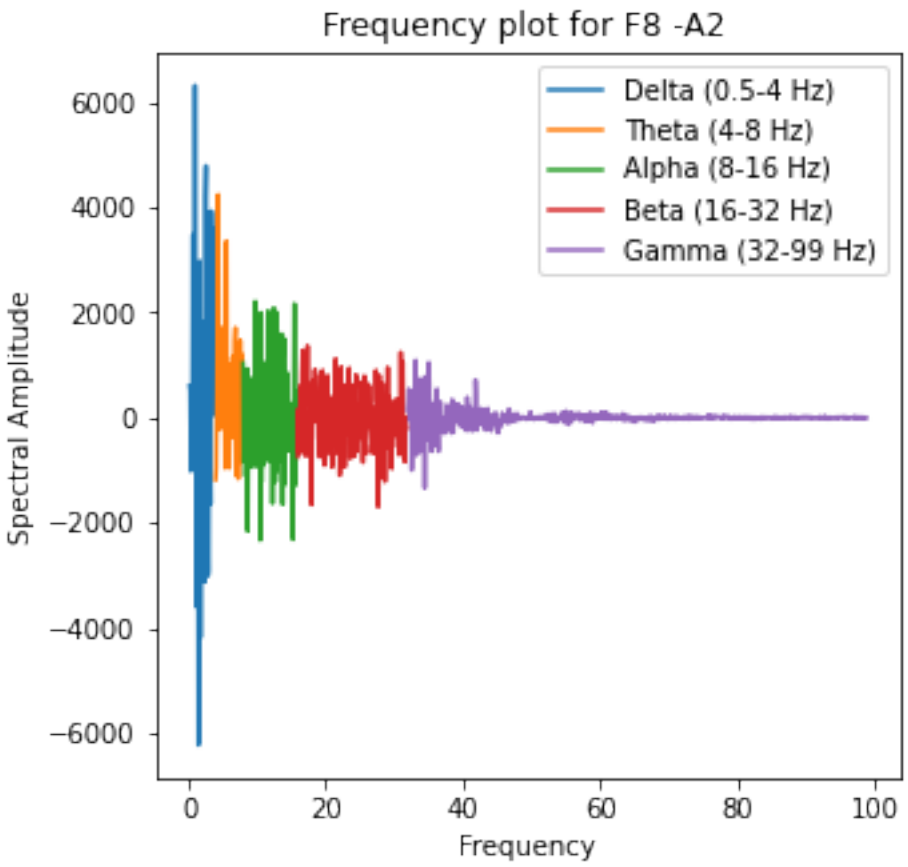
[ ]:
```
def fft(arr):
  arr = np.asarray(arr, dtype=float)
  n = np.arange(arr.shape[0])
  k = n.reshape((arr.shape[0], 1))
  M = np.exp(-2j * np.pi * k * n / arr.shape[0])
  return np.dot(M, arr)
```

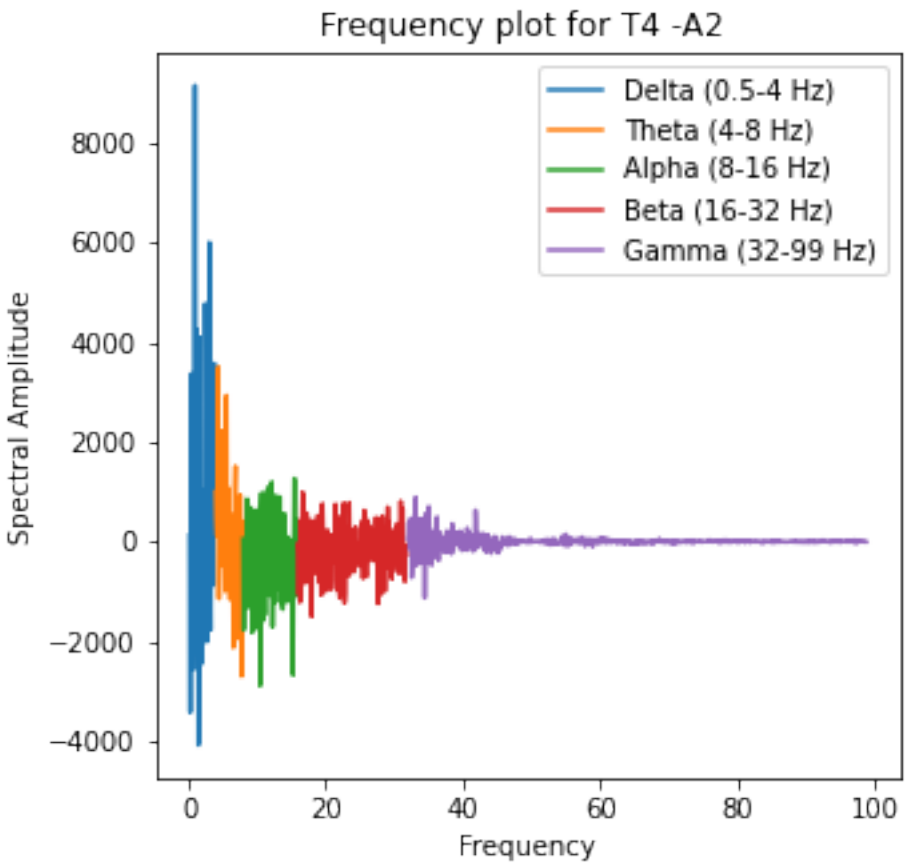
[ ]:
```
def freq_chart(file):
  df = pd.read_csv(file, index_col = False, header = None)
  df = df.iloc[2: , :]
  df.dropna()
  channels = [0,4,8,16,32,99]
  channel_names = ['Delta (0.5-4 Hz)','Theta (4-8 Hz)','Alpha (8-16 Hz)','Beta␣
 ↪(16-32 Hz)','Gamma (32-99 Hz)']

  N = 2560
  T = 1/256
  xf = np.linspace(0, 1/(2*T), N//2)
  yf = df.apply(fft)

  for i in range(len(df.columns)):
    plt.figure(figsize=(5,5))
    for j in range(len(channels)-1):
      intervals = np.where(np.where(np.logical_and(xf>channels[j],␣
 ↪xf<channels[j+1]),1,0)==1)[0][[0,-1]]
      if channels[j]==0:
        plt.plot(xf[intervals[0]:intervals[1]], yf.iloc[intervals[0]:
 ↪intervals[1],i])
      else:
        plt.plot(xf[intervals[0]-1:intervals[1]], yf.iloc[intervals[0]-1:
 ↪intervals[1],i])
    plt.title(f'Frequency plot for {columns[i]}')
    plt.xlabel('Frequency')
    plt.ylabel('Spectral Amplitude')
    plt.legend(labels = channel_names)
    plt.show()
```

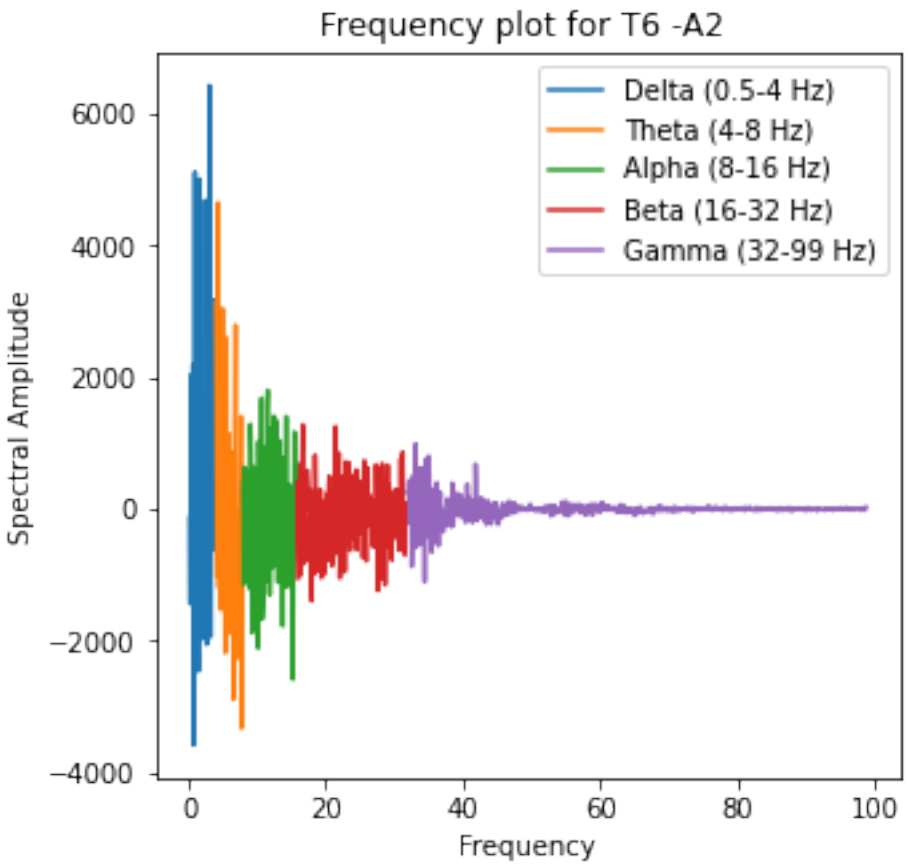
[ ]:
```
print("Frequency Plots for Filtered Data")
freq_chart('5_filtered.csv')
print("Frequency Plots for Unfiltered Data")
freq_chart('5_unfiltered.csv')
```

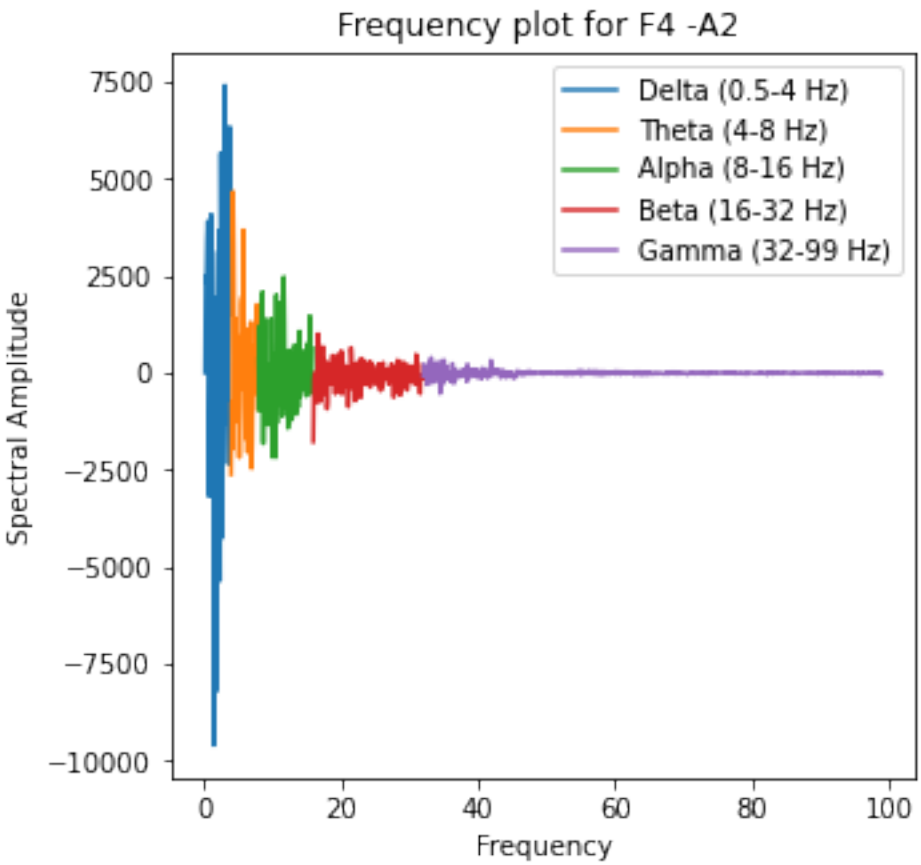
```
Frequency Plots for Filtered Data
```

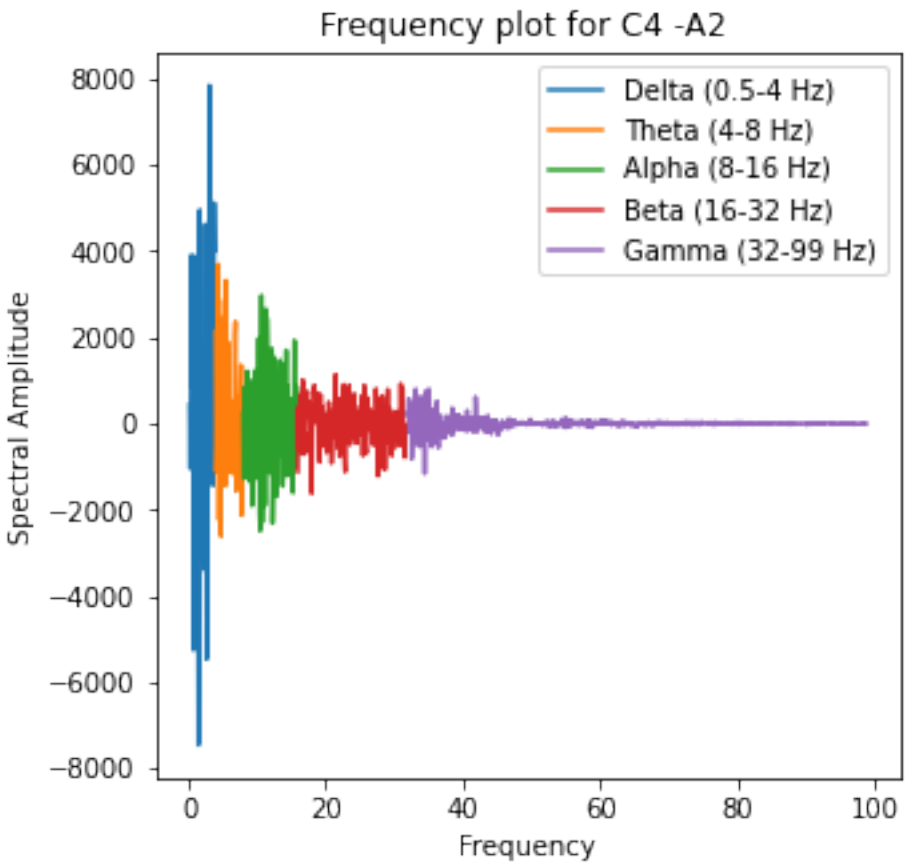

Frequency plot for FP2-A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
5000
0
−5000
−10000
0
20
40
60
80
100
Frequency

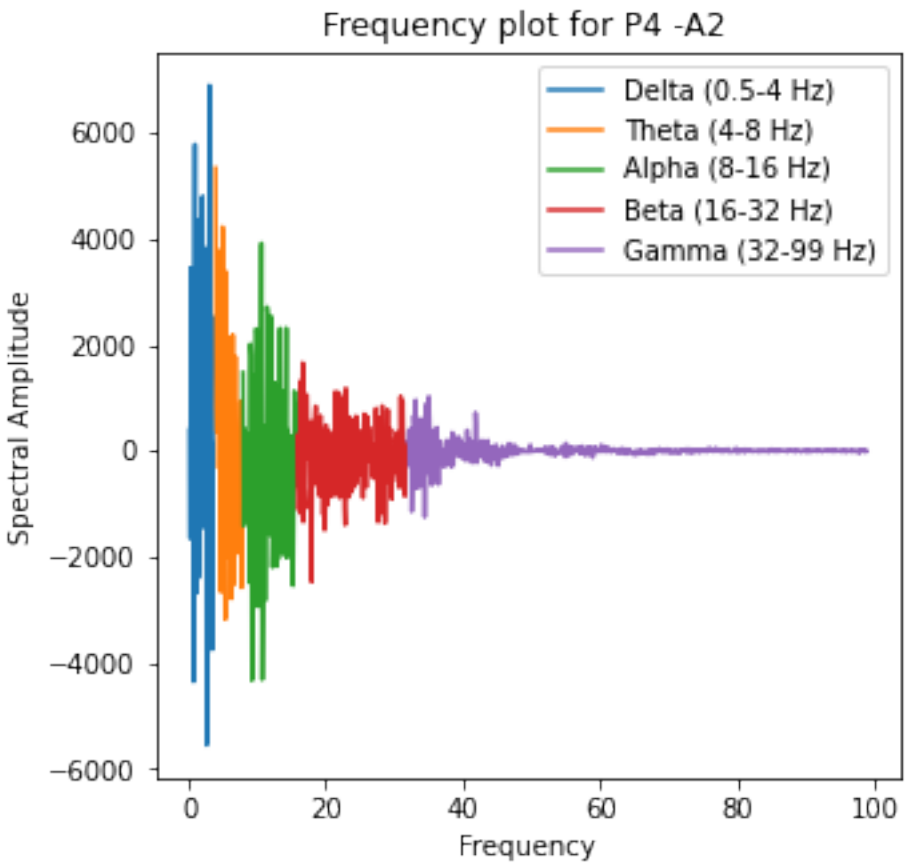

Frequency plot for F8 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
6000
4000
2000
0
−2000
−4000
−6000
0
20
40
60
80
100
Frequency

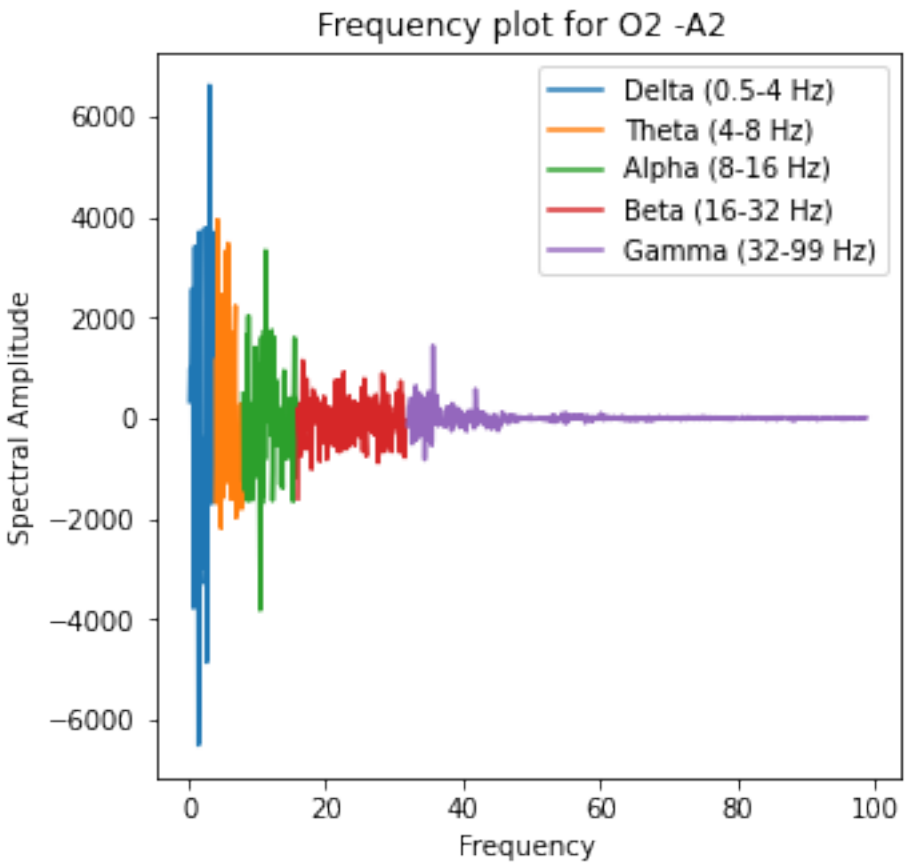

Frequency plot for T4 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
8000
6000
4000
2000
0
−2000
−4000
0
20
40
60
80
100
Frequency

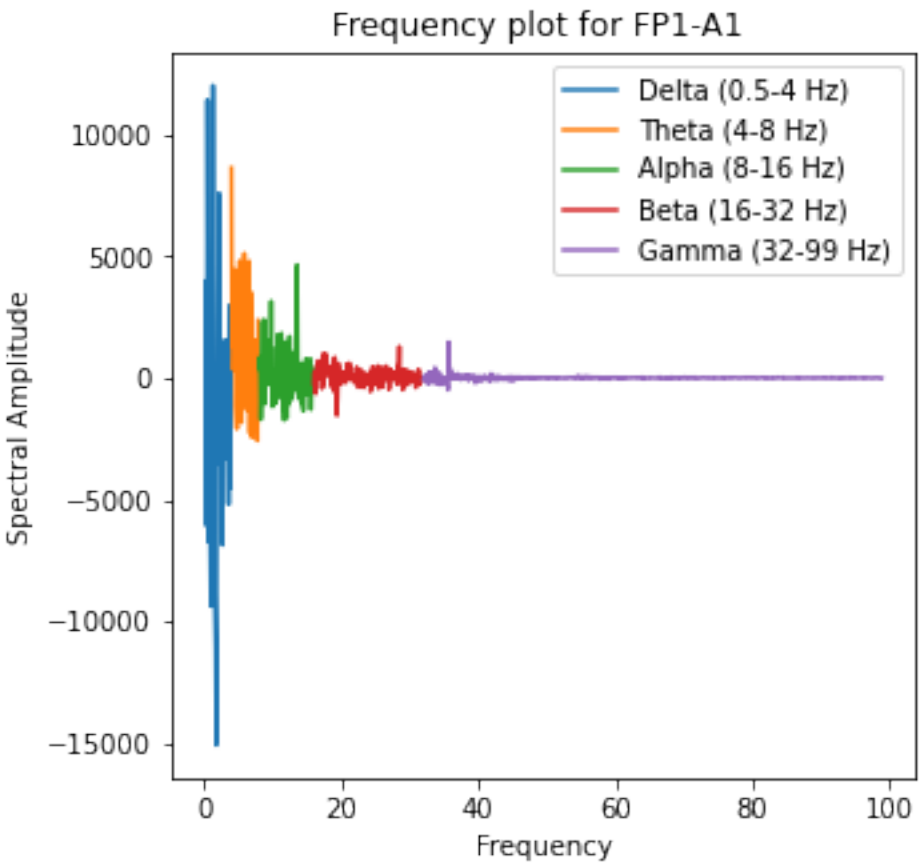

Frequency plot for T6 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
6000
4000
2000
0
−2000
−4000
0
20
40
60
80
100
Frequency

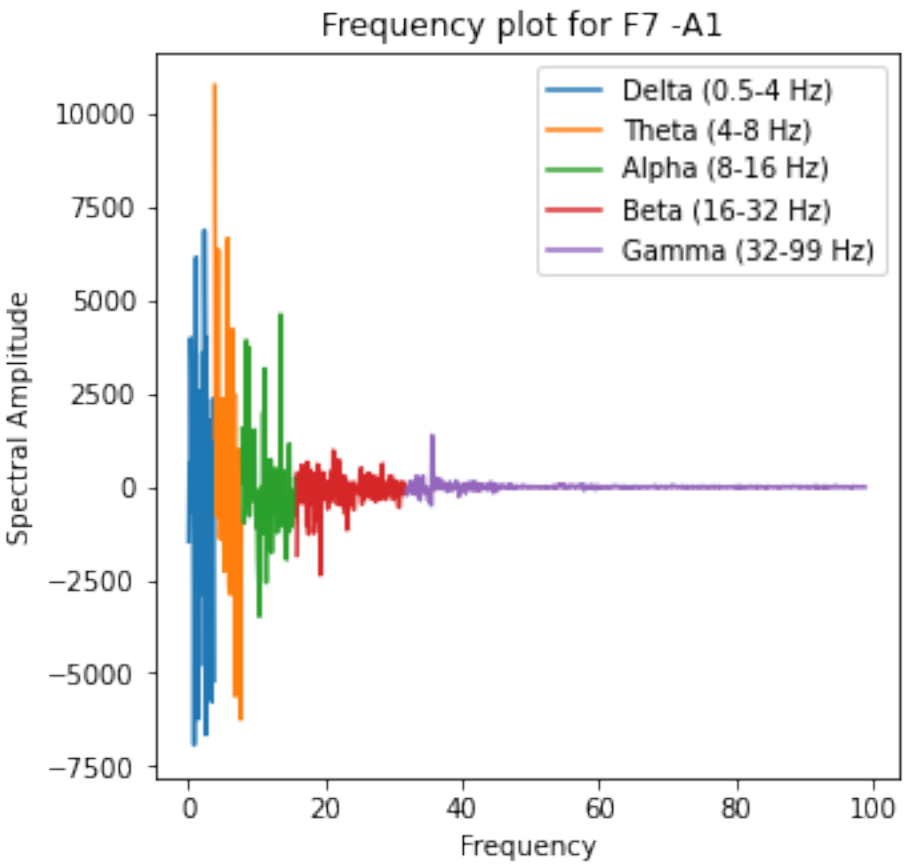

Frequency plot for F4 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
Frequency
7500
5000
2500
0
−2500
−5000
−7500
−10000
0
20
40
60
80
100

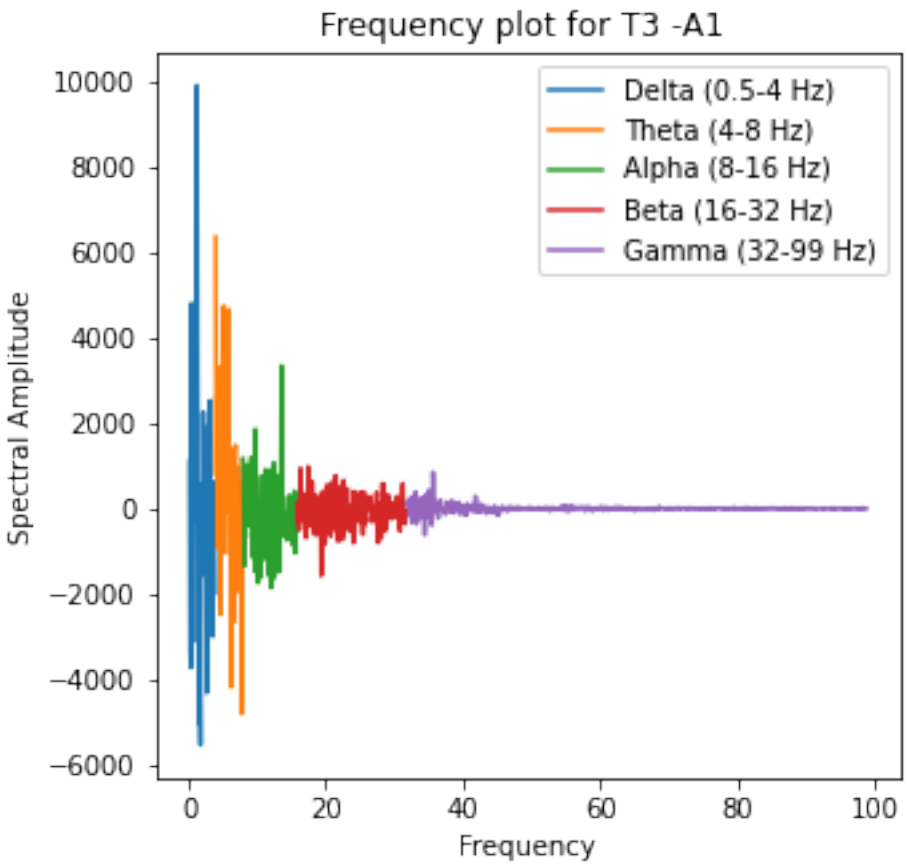

Frequency plot for C4 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
8000
6000
4000
2000
0
−2000
−4000
−6000
−8000
0
20
40
60
80
100
Frequency

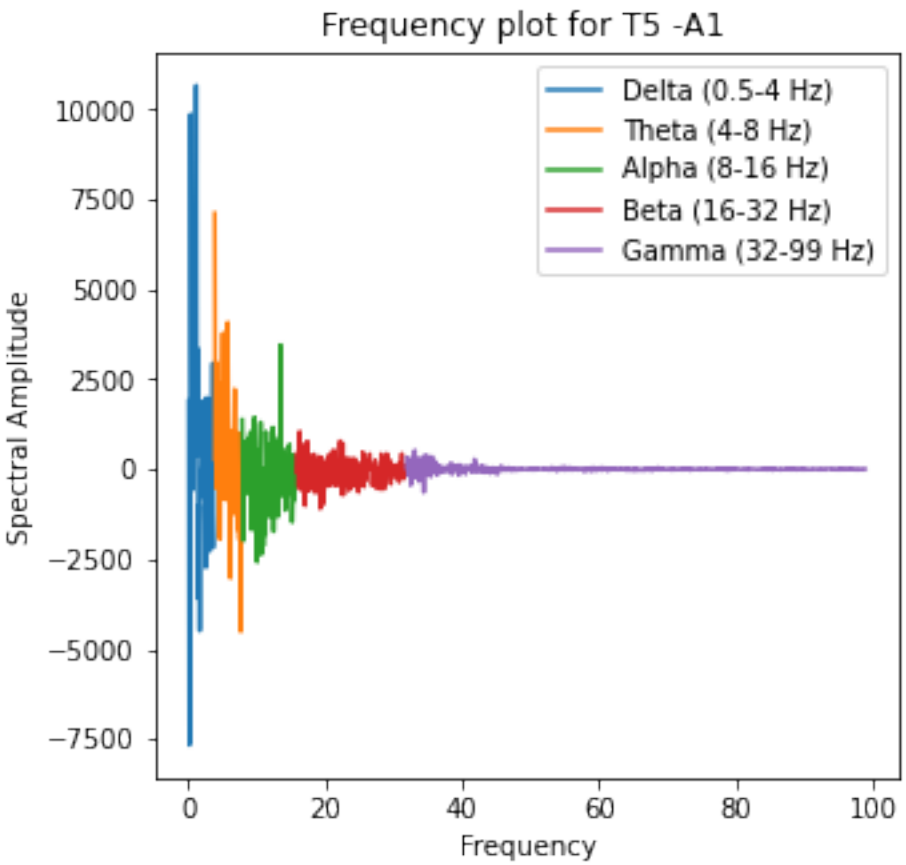

Frequency plot for P4 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
6000
4000
2000
0
−2000
−4000
−6000
0
20
40
60
80
100
Frequency

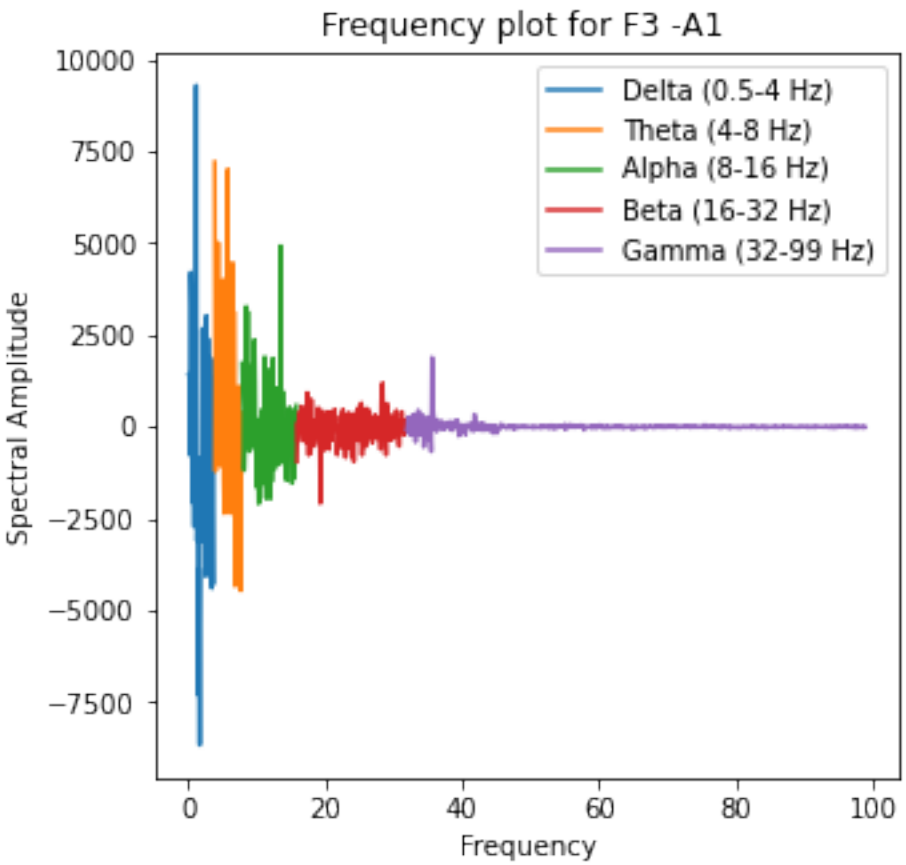

Frequency plot for O2 -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
6000
4000
2000
0
−2000
−4000
−6000
0
20
40
60
80
100
Frequency

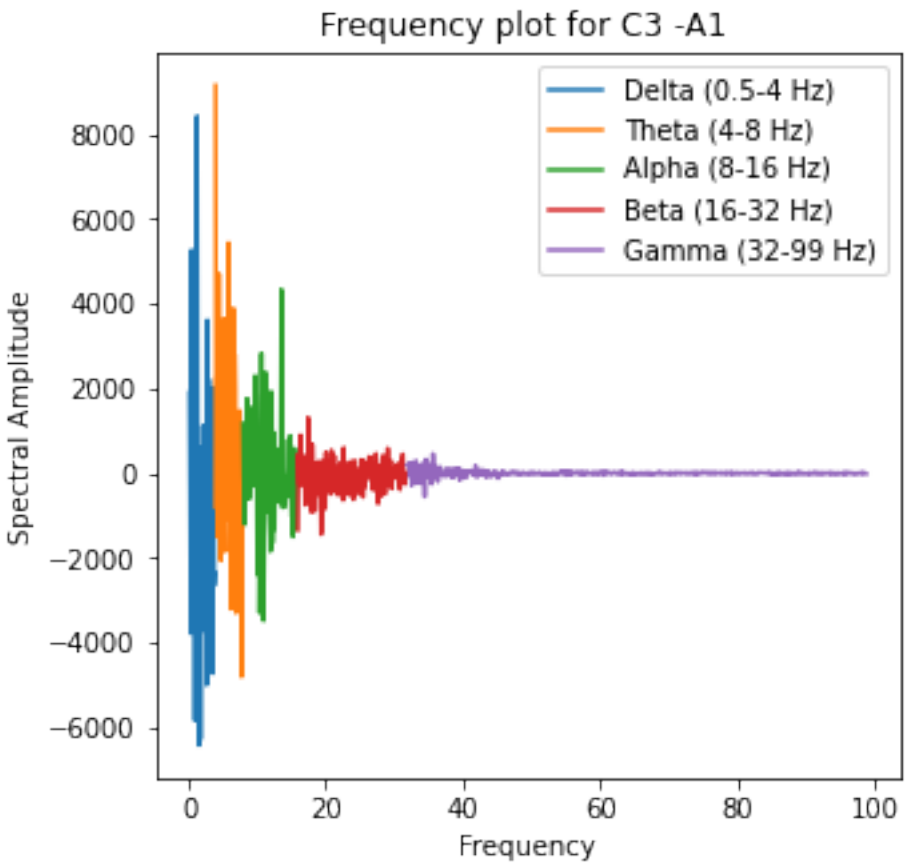

Frequency plot for FP1-A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
5000
0
−5000
−10000
−15000
0
20
40
60
80
100
Frequency

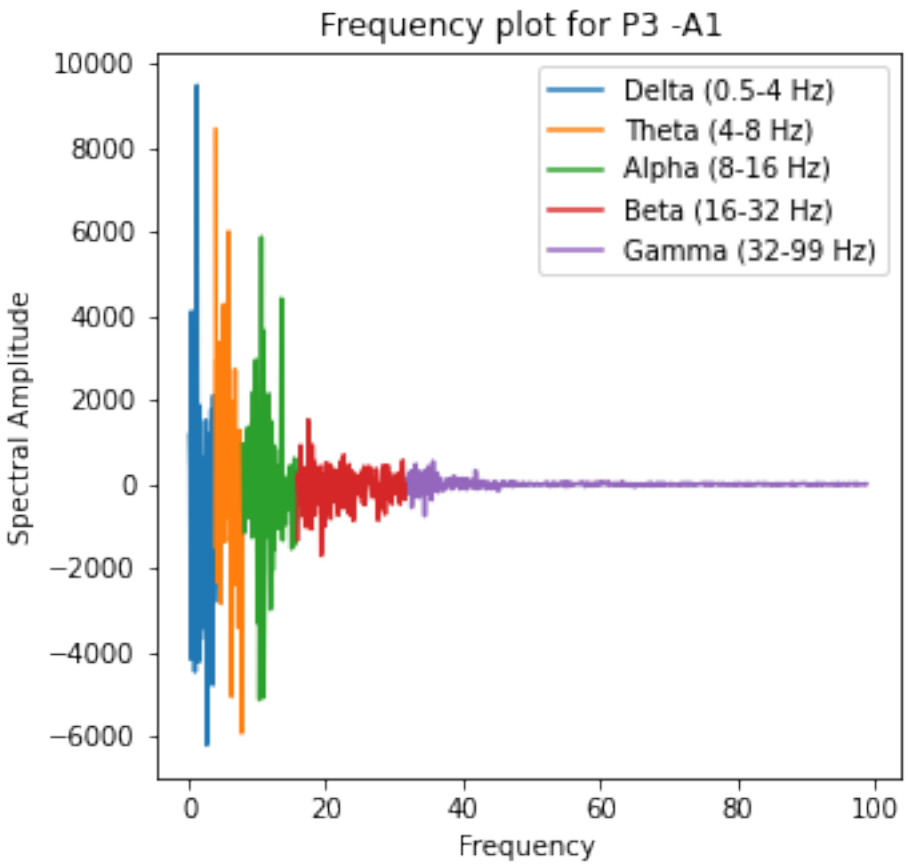

Frequency plot for F7 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
7500
5000
2500
0
−2500
−5000
−7500
0
20
40
60
80
100
Frequency

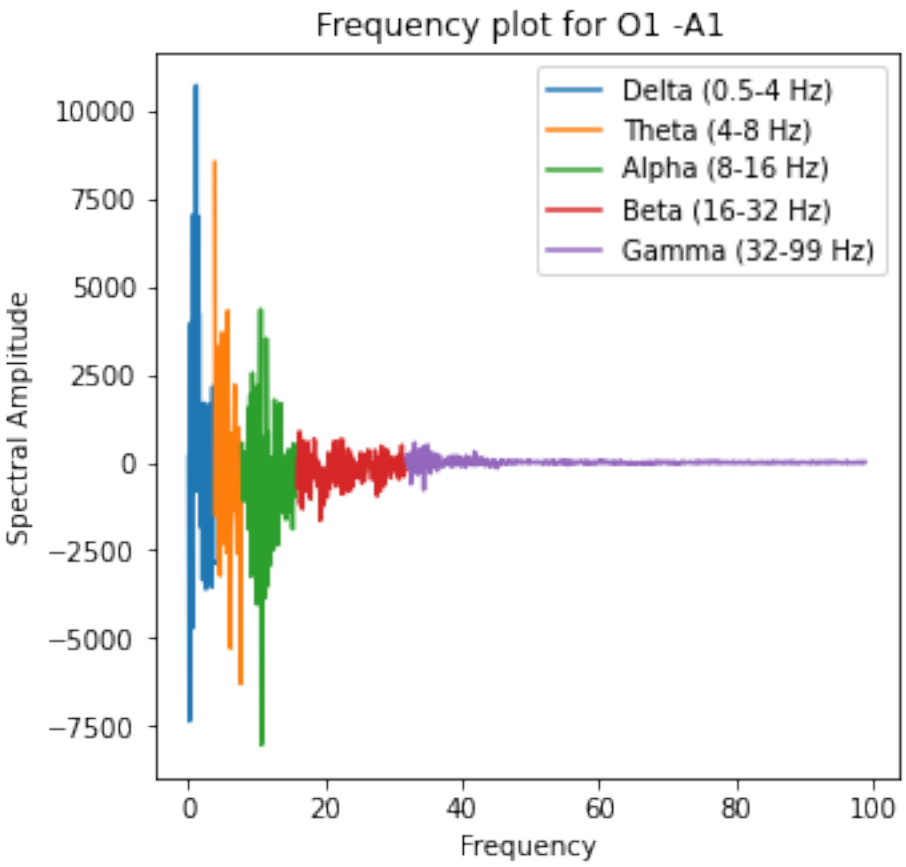

Frequency plot for T3 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
8000
6000
4000
2000
0
−2000
−4000
−6000
0
20
40
60
80
100
Frequency

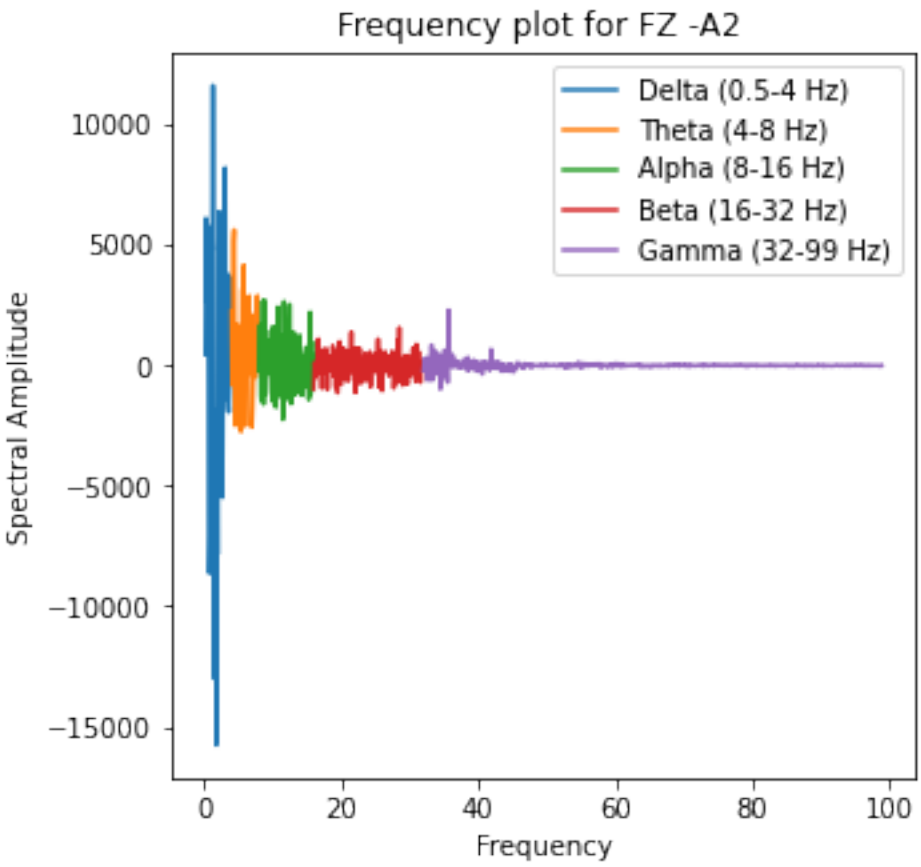

Frequency plot for T5 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
7500
5000
2500
0
−2500
−5000
−7500
0
20
40
60
80
100
Frequency

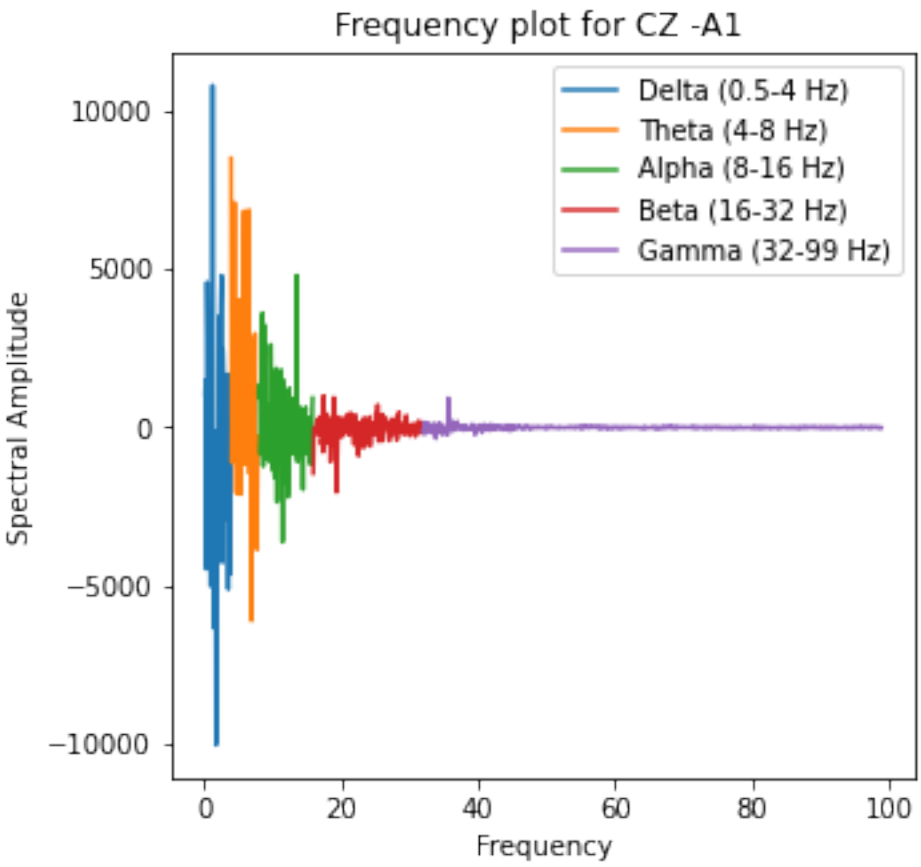

Frequency plot for F3 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
Frequency
10000
7500
5000
2500
0
−2500
−5000
−7500
0
20
40
60
80
100

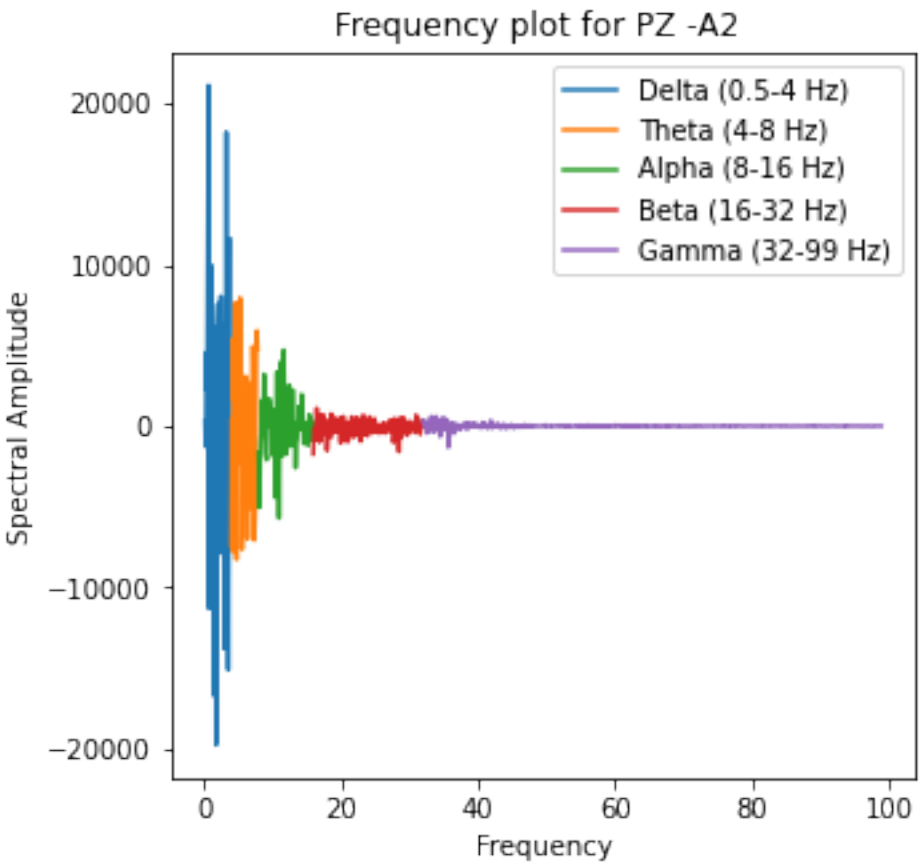

Frequency plot for C3 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
8000
6000
4000
2000
0
−2000
−4000
−6000
0
20
40
60
80
100
Frequency

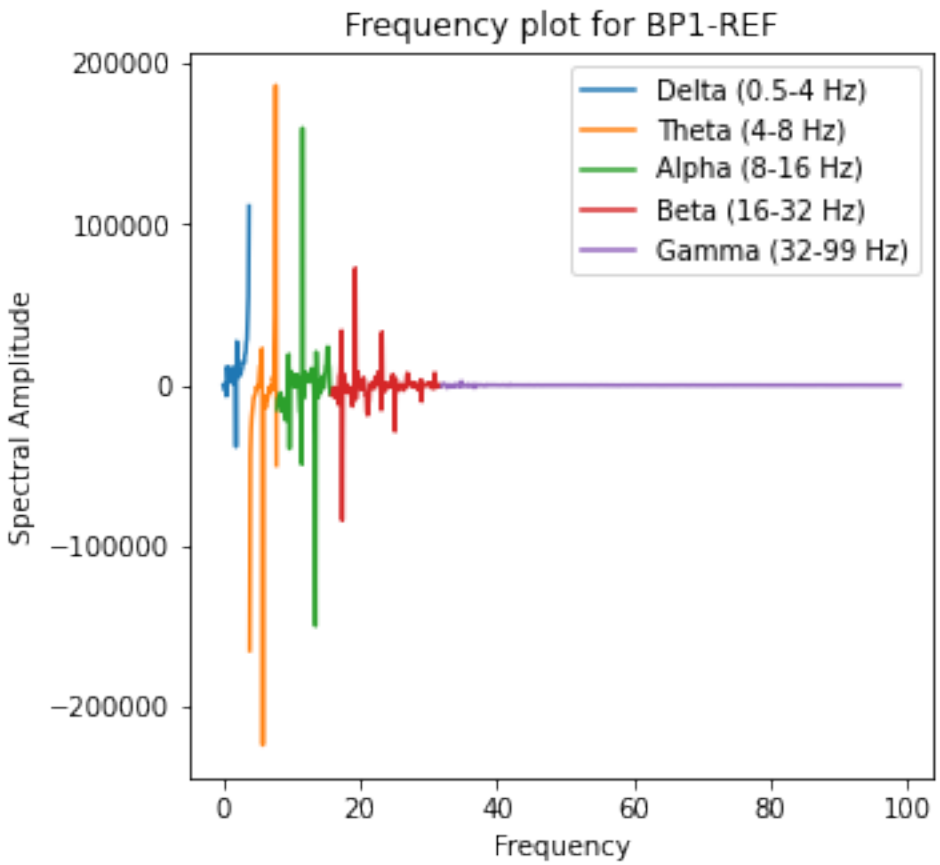

Frequency plot for P3 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
8000
6000
4000
2000
0
−2000
−4000
−6000
0
20
40
60
80
100
Frequency

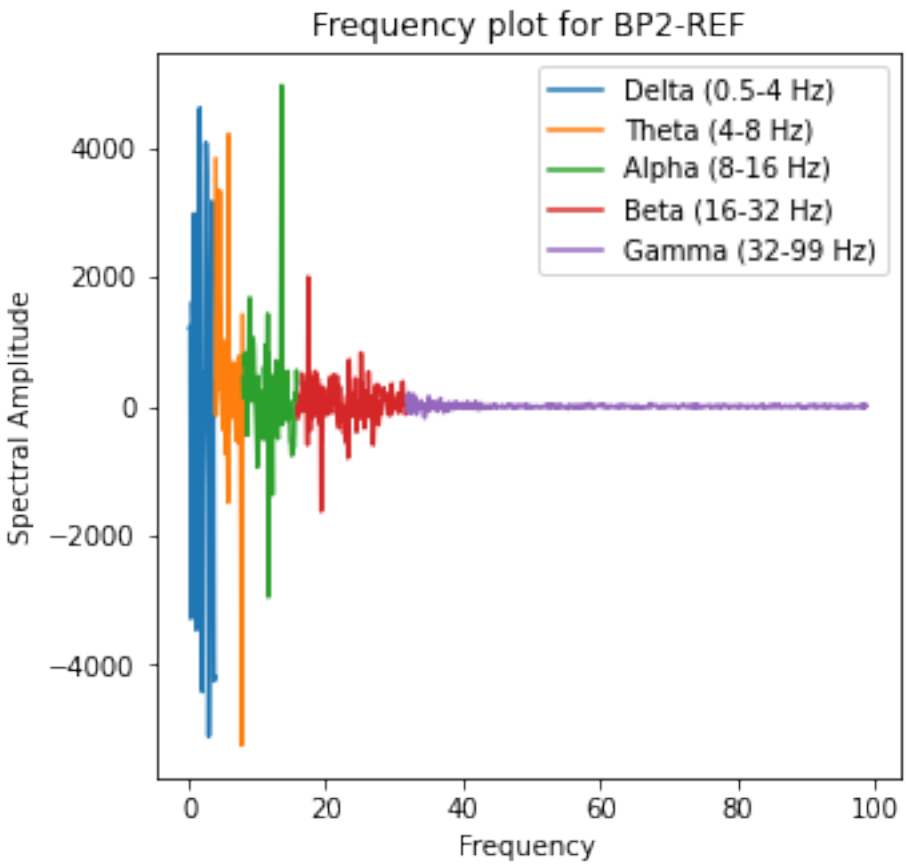

Frequency plot for O1 -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
7500
5000
2500
0
−2500
−5000
−7500
0
20
40
60
80
100
Frequency


Frequency plot for FZ -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
5000
0
−5000
−10000
−15000
0
20
40
60
80
100
Frequency

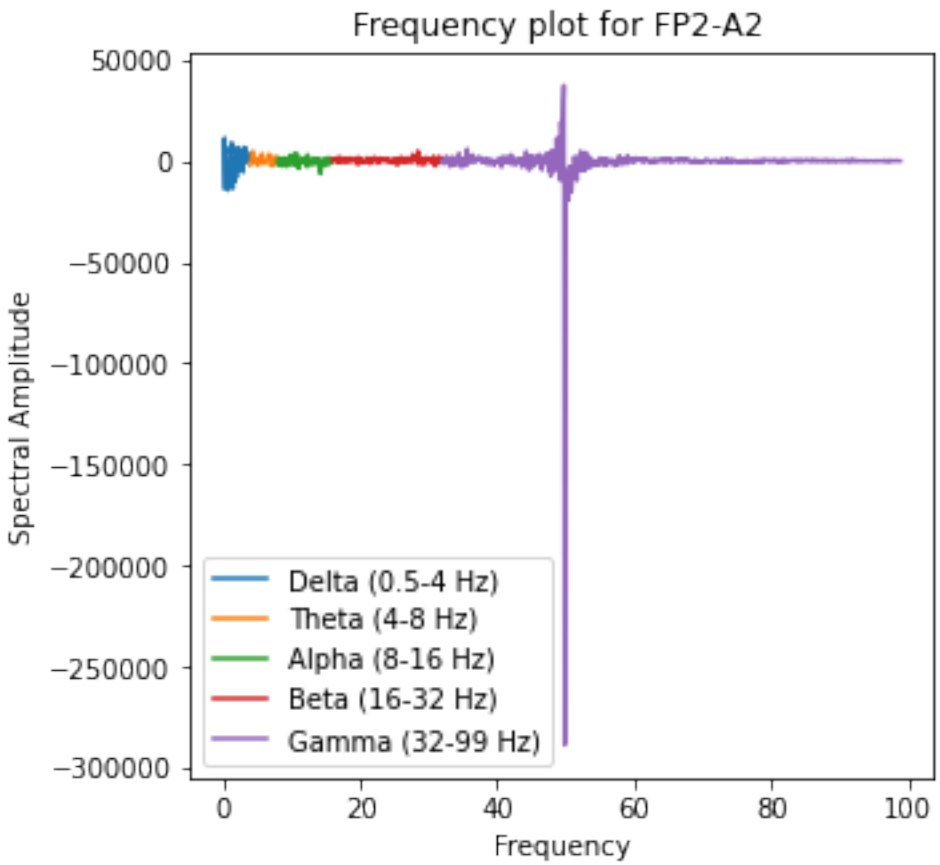

Frequency plot for CZ -A1
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
10000
5000
0
−5000
−10000
0
20
40
60
80
100
Frequency

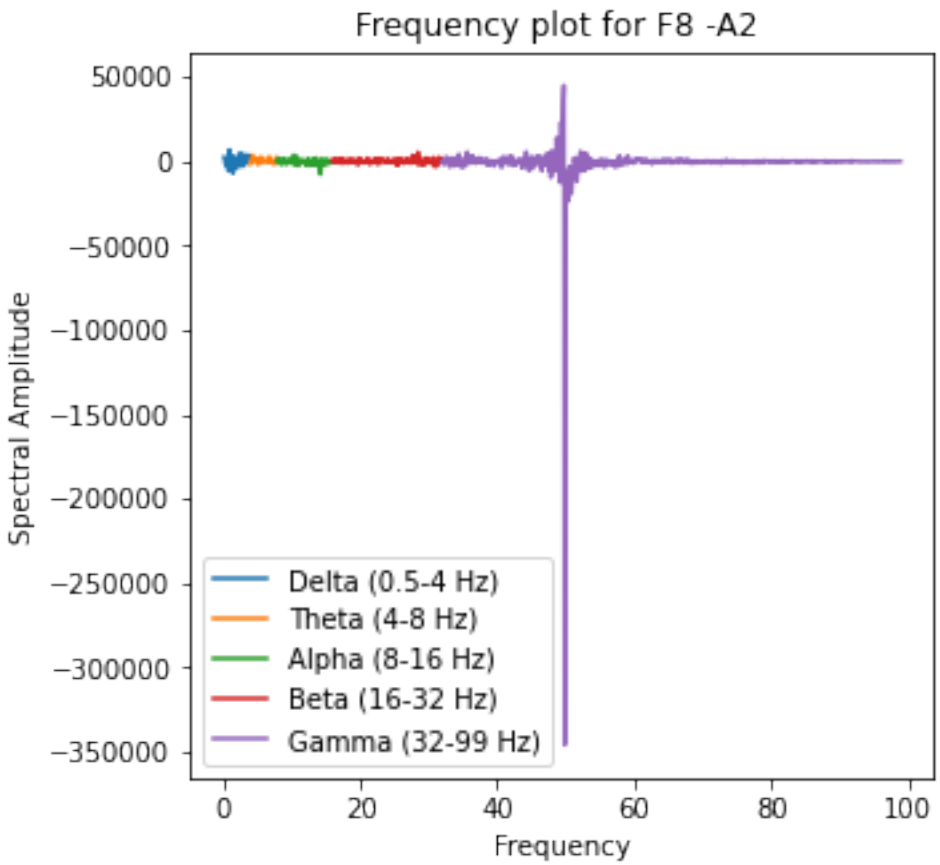

Frequency plot for PZ -A2
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
20000
10000
0
−10000
−20000
0
20
40
60
80
100
Frequency

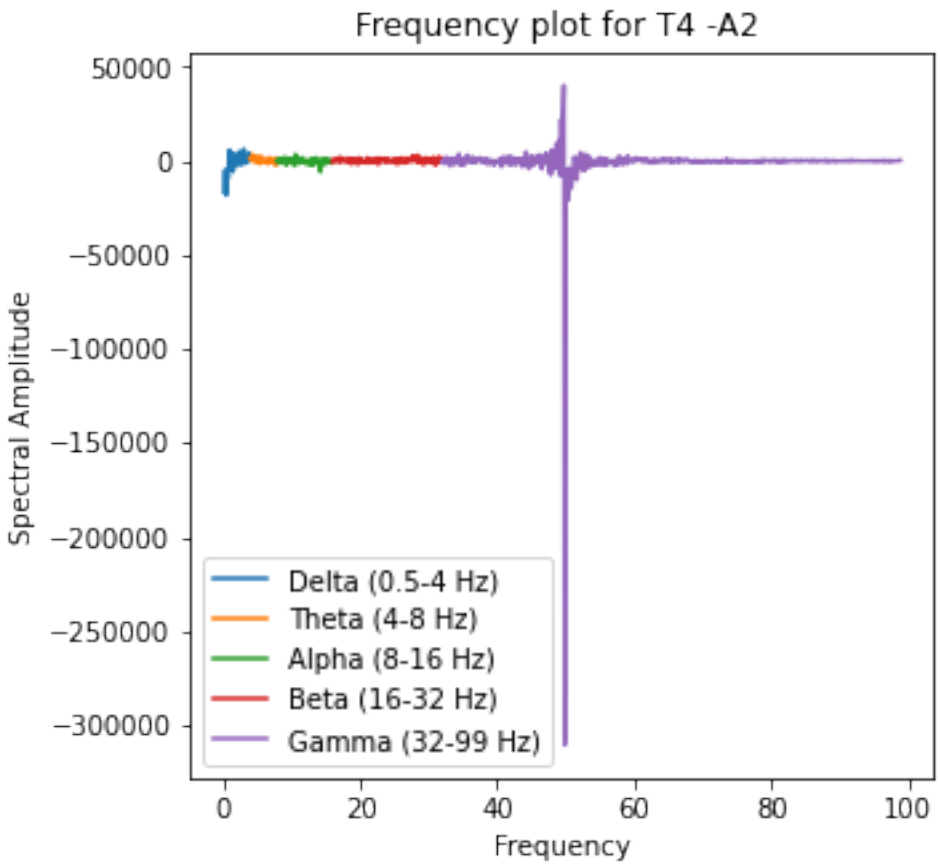

Frequency plot for BP1-REF
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
200000
100000
0
−100000
−200000
0
20
40
60
80
100
Frequency

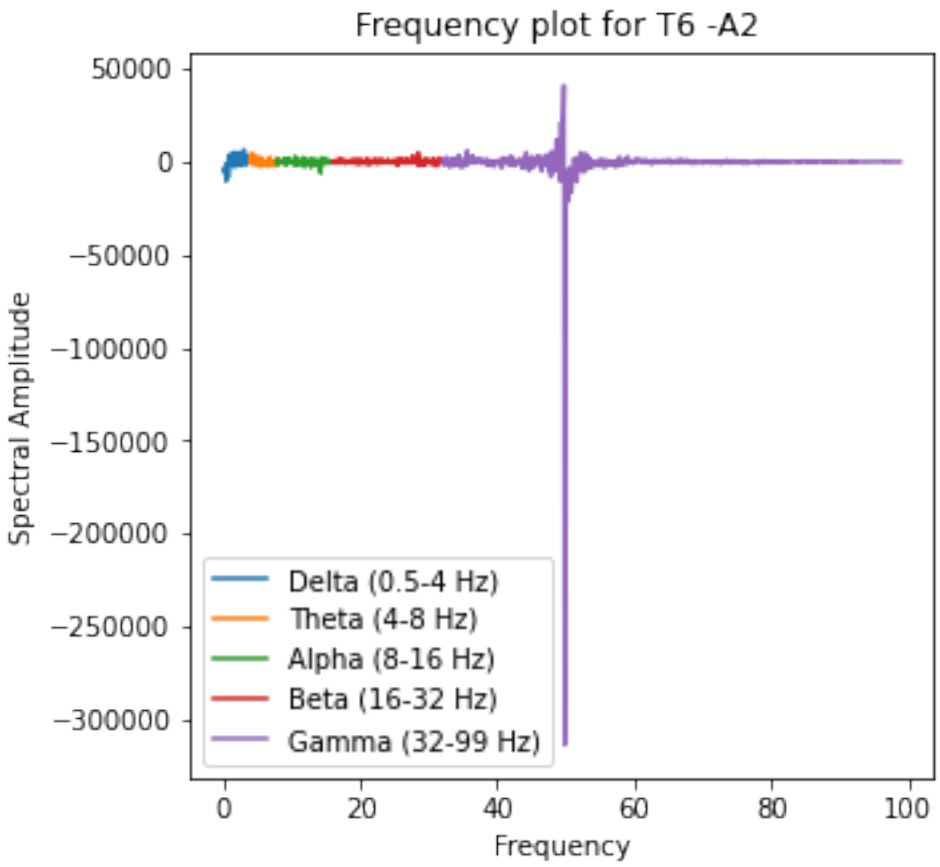


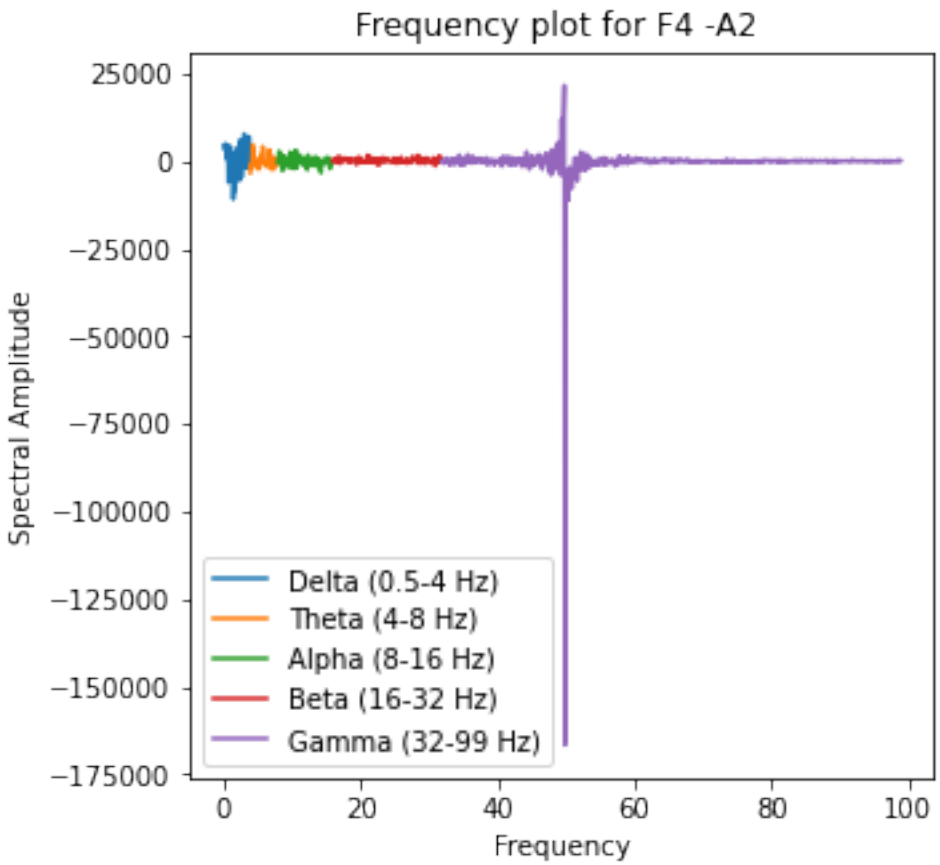
Frequency Plots for Unfiltered Data

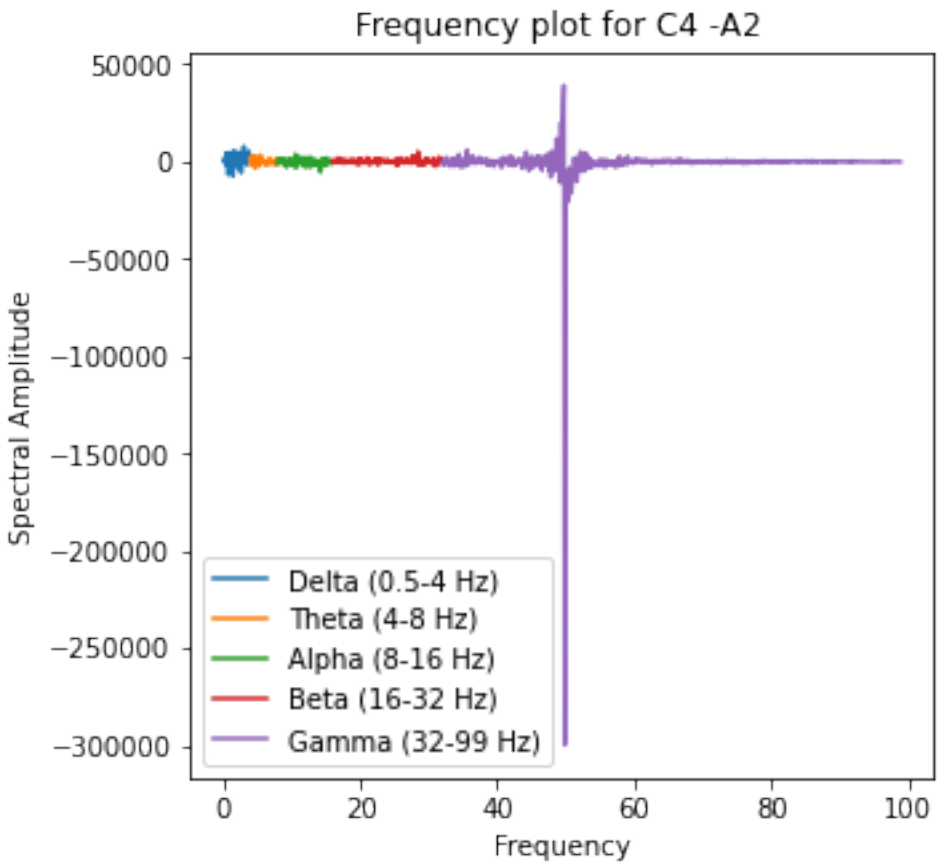

Frequency plot for FP2-A2
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
Spectral Amplitude
0
20
40
60
80
100
Frequency
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

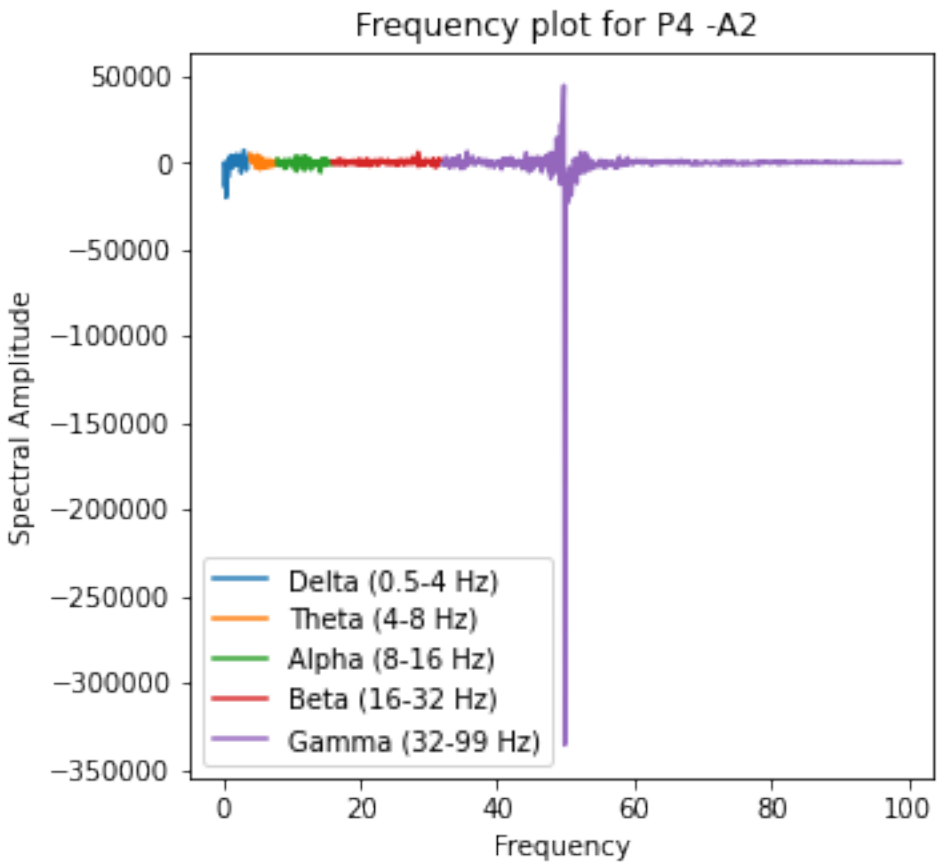

Frequency plot for F8 -A2
Spectral Amplitude
Frequency
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
−350000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

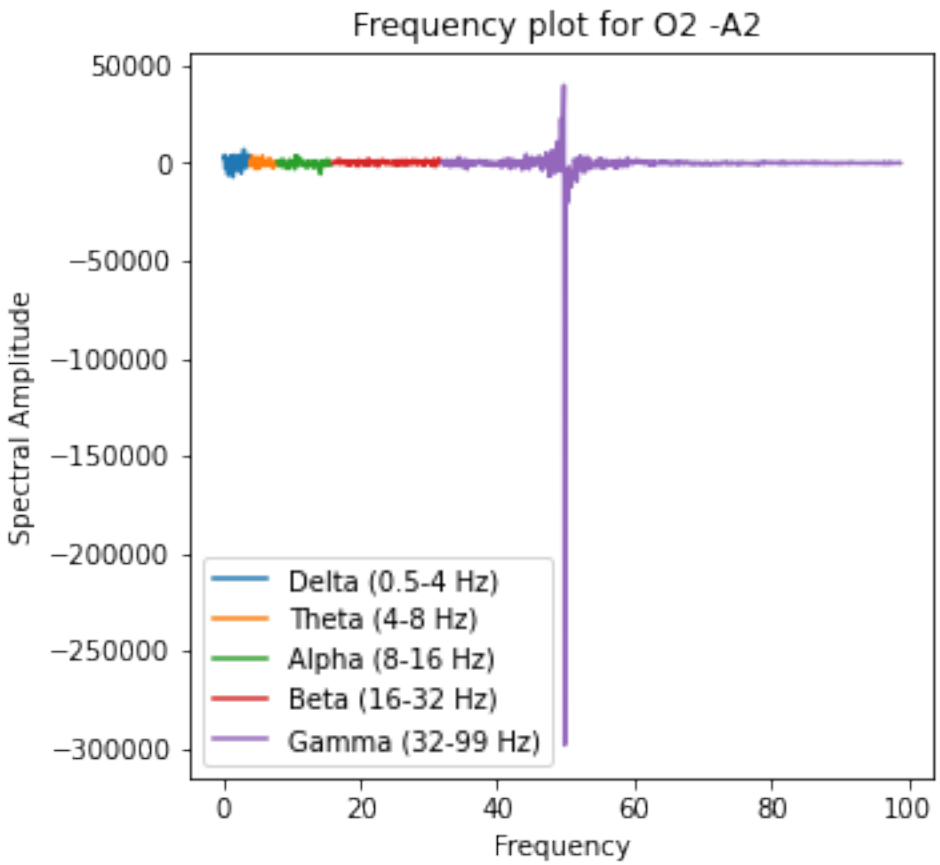

Frequency plot for T4 -A2
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
Spectral Amplitude
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
0
20
40
60
80
100
Frequency

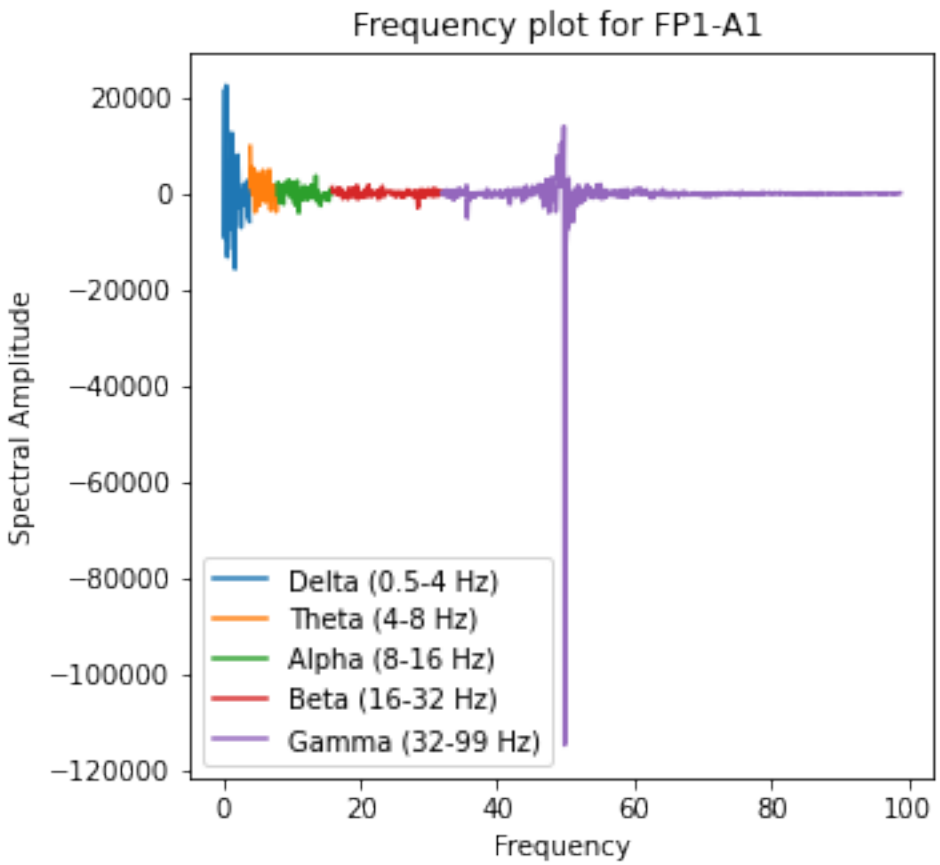

Frequency plot for T6 -A2
Spectral Amplitude
Frequency
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

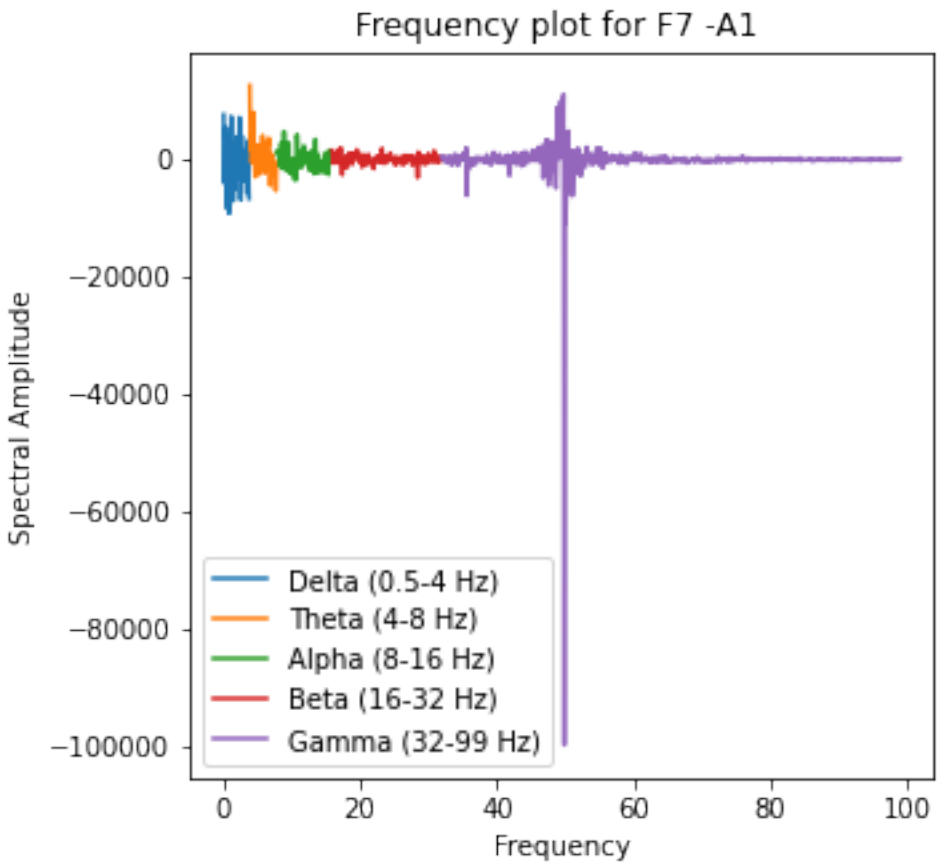

Frequency plot for F4 -A2
Spectral Amplitude
Frequency
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
−175000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

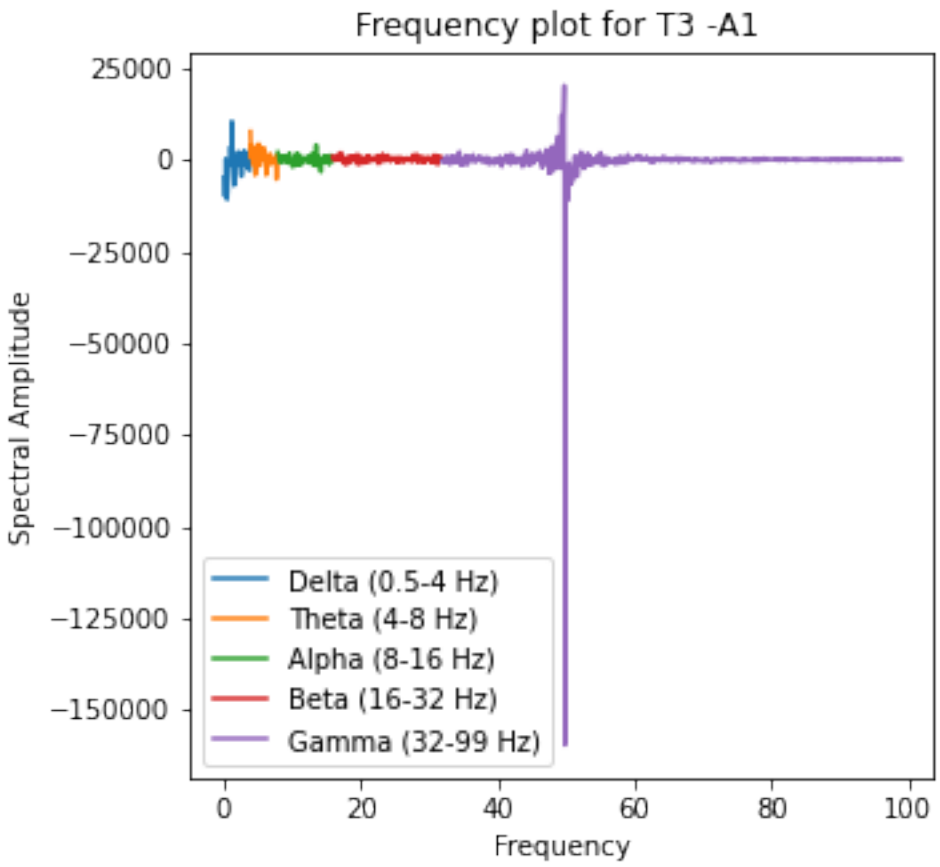

Frequency plot for C4 -A2
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
Spectral Amplitude
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
0
20
40
60
80
100
Frequency

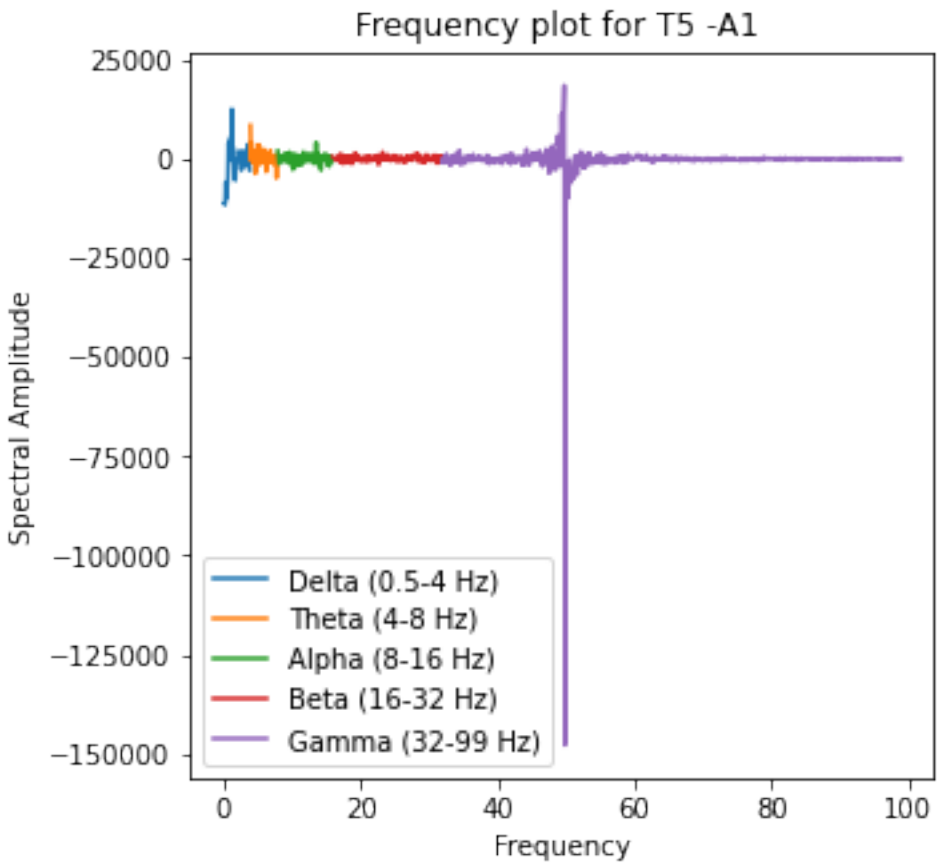

Frequency plot for P4 -A2
Spectral Amplitude
Frequency
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
−350000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

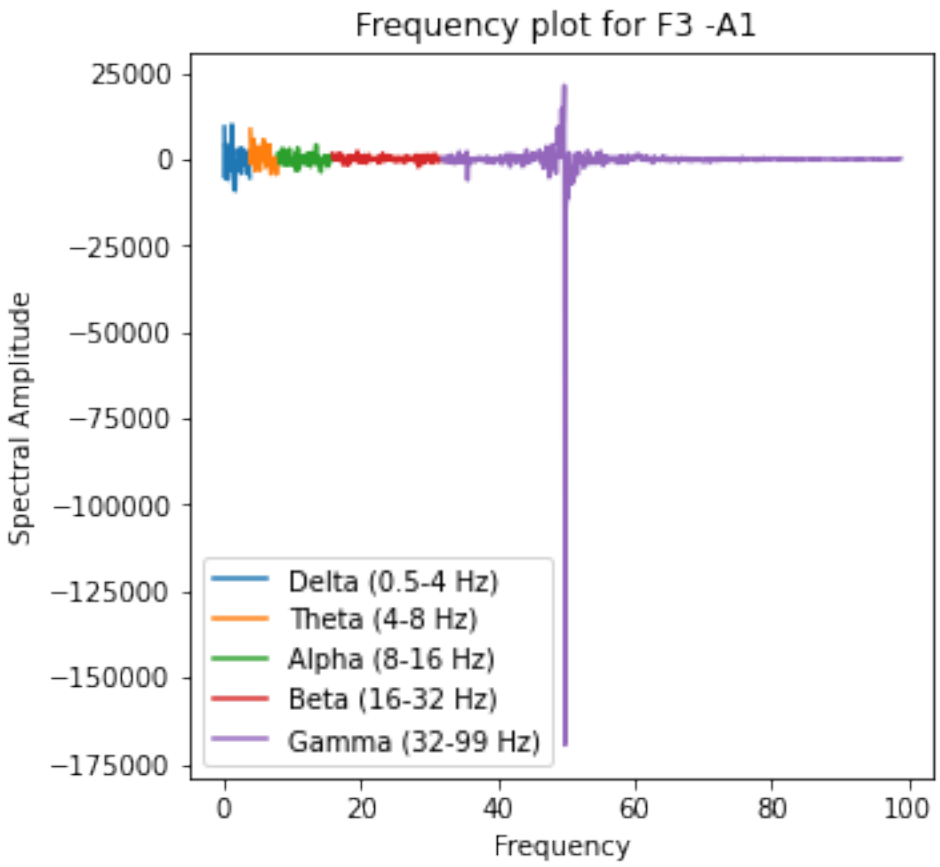

Frequency plot for O2 -A2
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
Spectral Amplitude
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
0
20
40
60
80
100
Frequency

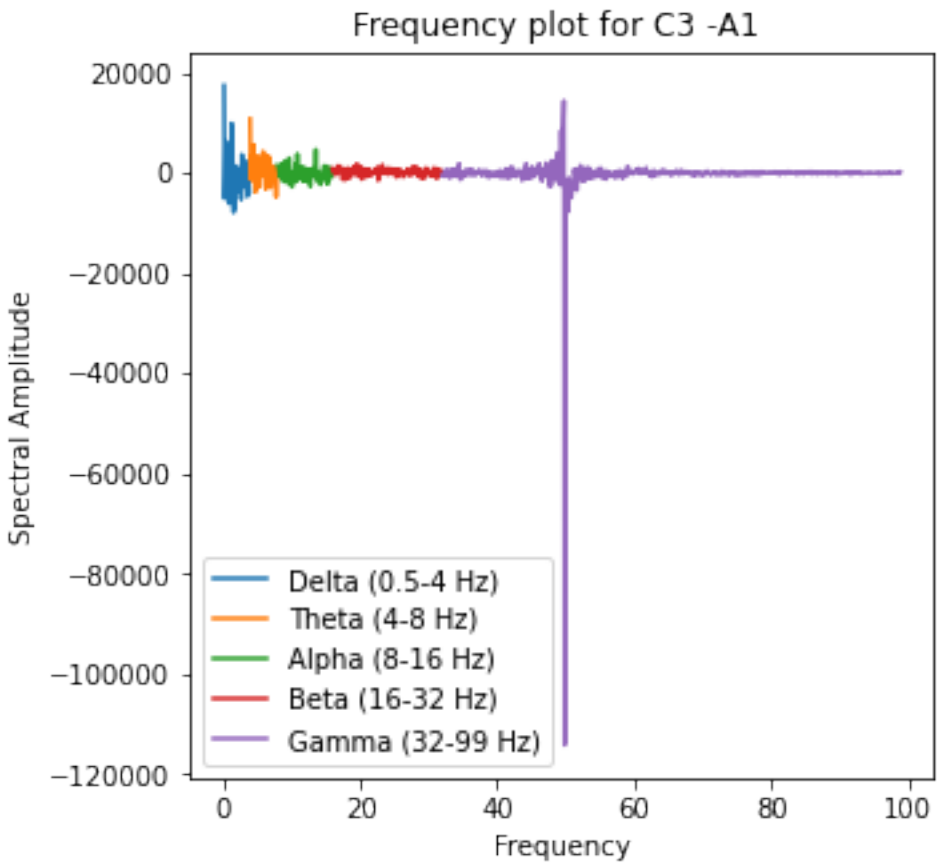

Frequency plot for FP1-A1
Spectral Amplitude
Frequency
20000
0
−20000
−40000
−60000
−80000
−100000
−120000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

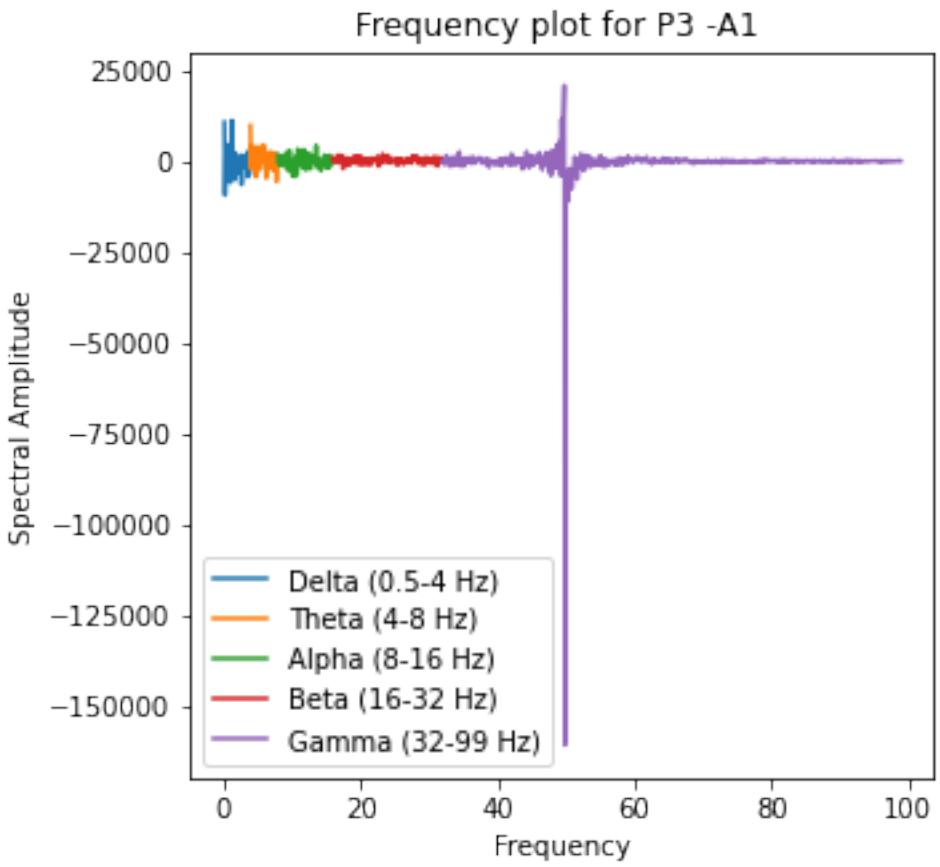

Frequency plot for F7 -A1
Spectral Amplitude
0
−20000
−40000
−60000
−80000
−100000
0
20
40
60
80
100
Frequency
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

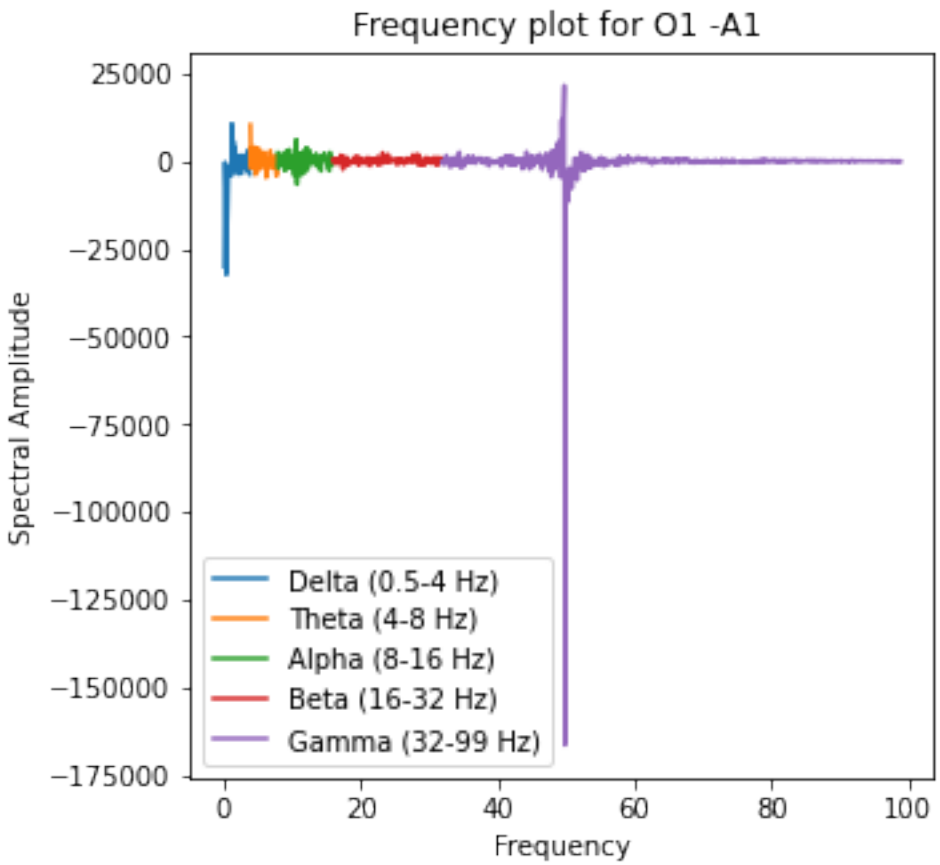

Frequency plot for T3 -A1
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
Spectral Amplitude
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
0
20
40
60
80
100
Frequency

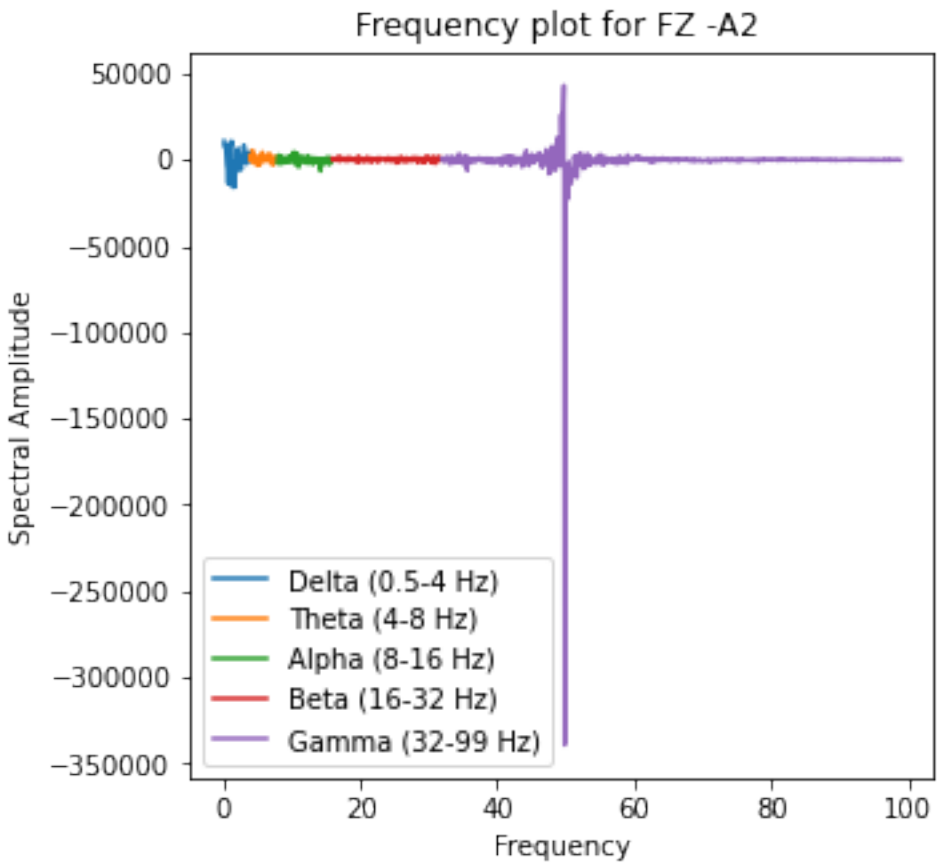

Frequency plot for T5 -A1
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
Spectral Amplitude
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
0
20
40
60
80
100
Frequency

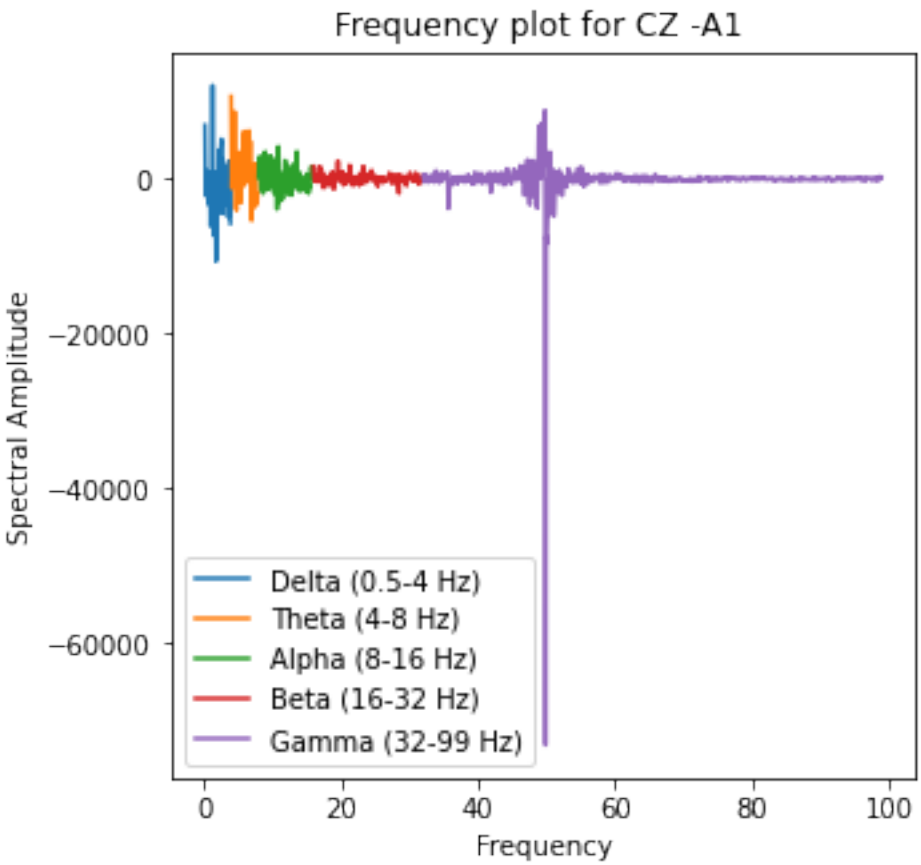

Frequency plot for F3 -A1
Spectral Amplitude
Frequency
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
−175000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

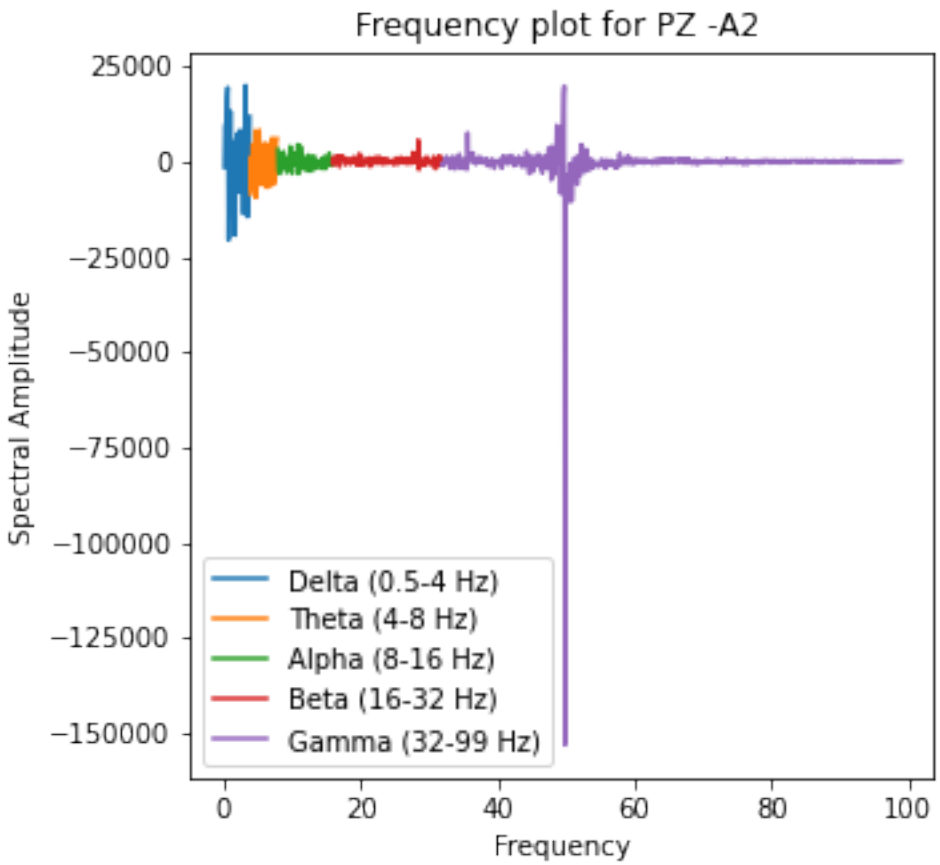

Frequency plot for C3 -A1
Spectral Amplitude
Frequency
20000
0
−20000
−40000
−60000
−80000
−100000
−120000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

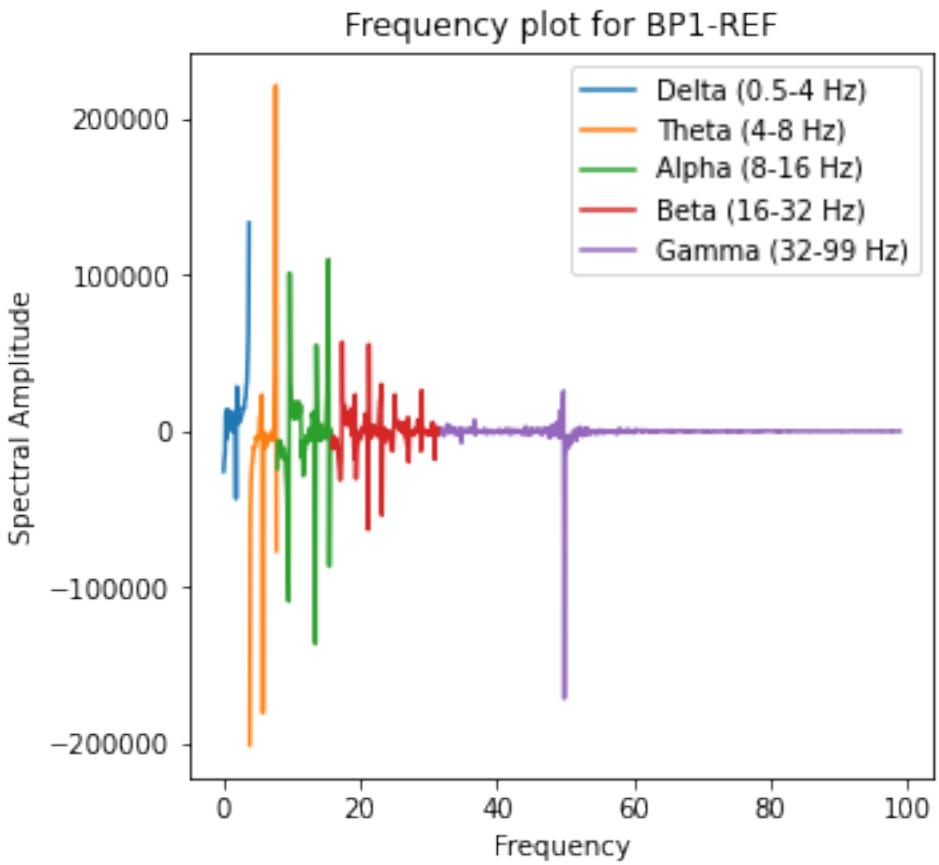

Frequency plot for P3 -A1
Spectral Amplitude
Frequency
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)

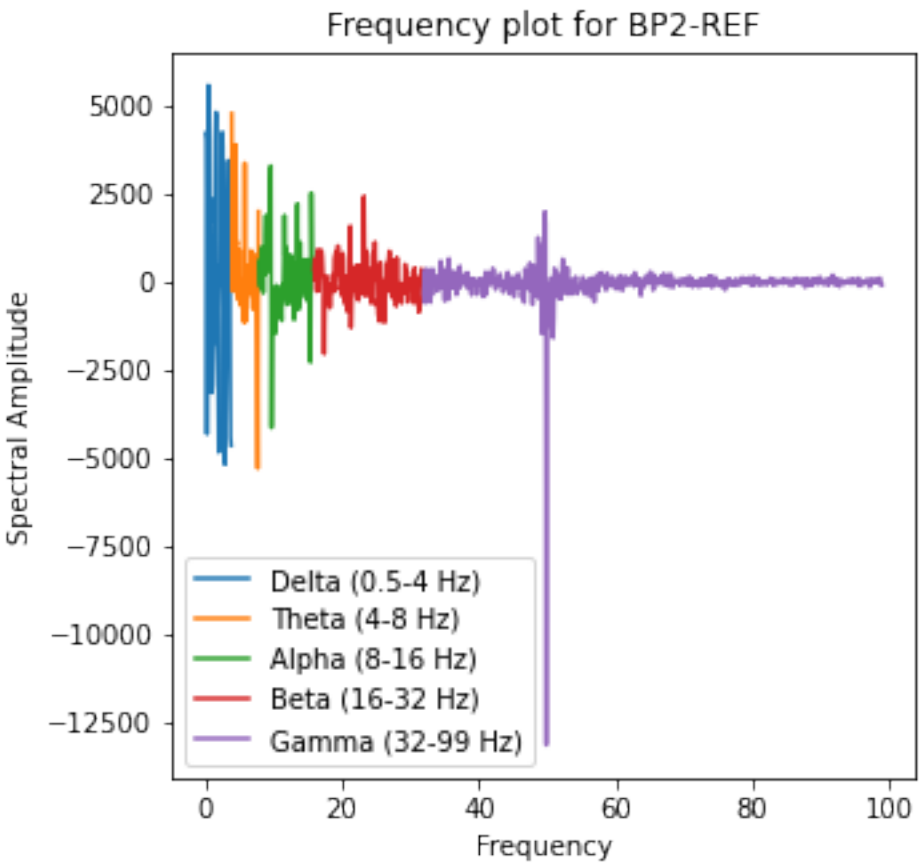

Frequency plot for O1 -A1
Spectral Amplitude
Frequency
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
−175000
0
20
40
60
80
100
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)


Frequency plot for FZ -A2
50000
0
−50000
−100000
−150000
−200000
−250000
−300000
−350000
Spectral Amplitude
0
20
40
60
80
100
Frequency
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)


Frequency plot for CZ -A1
Spectral Amplitude
0
−20000
−40000
−60000
0
20
40
60
80
100
Frequency
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)


Frequency plot for PZ -A2
25000
0
−25000
−50000
−75000
−100000
−125000
−150000
Spectral Amplitude
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
0
20
40
60
80
100
Frequency


Frequency plot for BP1-REF
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)
Spectral Amplitude
200000
100000
0
−100000
−200000
0
20
40
60
80
100
Frequency


Frequency plot for BP2-REF
Spectral Amplitude
5000
2500
0
−2500
−5000
−7500
−10000
−12500
0
20
40
60
80
100
Frequency
Delta (0.5-4 Hz)
Theta (4-8 Hz)
Alpha (8-16 Hz)
Beta (16-32 Hz)
Gamma (32-99 Hz)