EE 385V - Brain Computer Interaction
Homework 1 Report

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1 How does the dataset look like?

1.1 What do these dimensions mean?

The signal is the recorded EEG signal at a sampling frequency of 250-Hz, and the triggers represent recording interval.

2 Triggers

2.1 What do the triggers mean in our case?

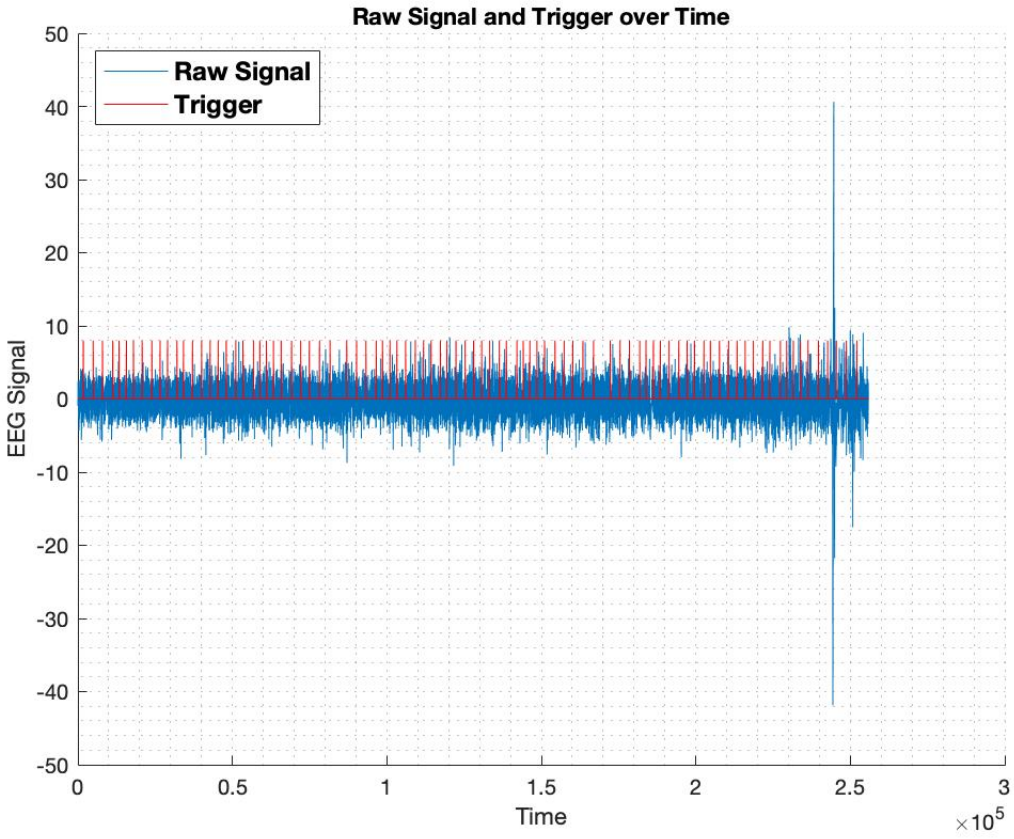
In our case, the triggers are starting points of the trials.

2.2 Can we deduce the number of trials? How?

Yes, by computing the length of the array 'trigger'. In our case, the length is 90, so there are 90 triggers.

3 Raw Signals

3.1 Plot the raw signal. On top, plot when the triggers appear.

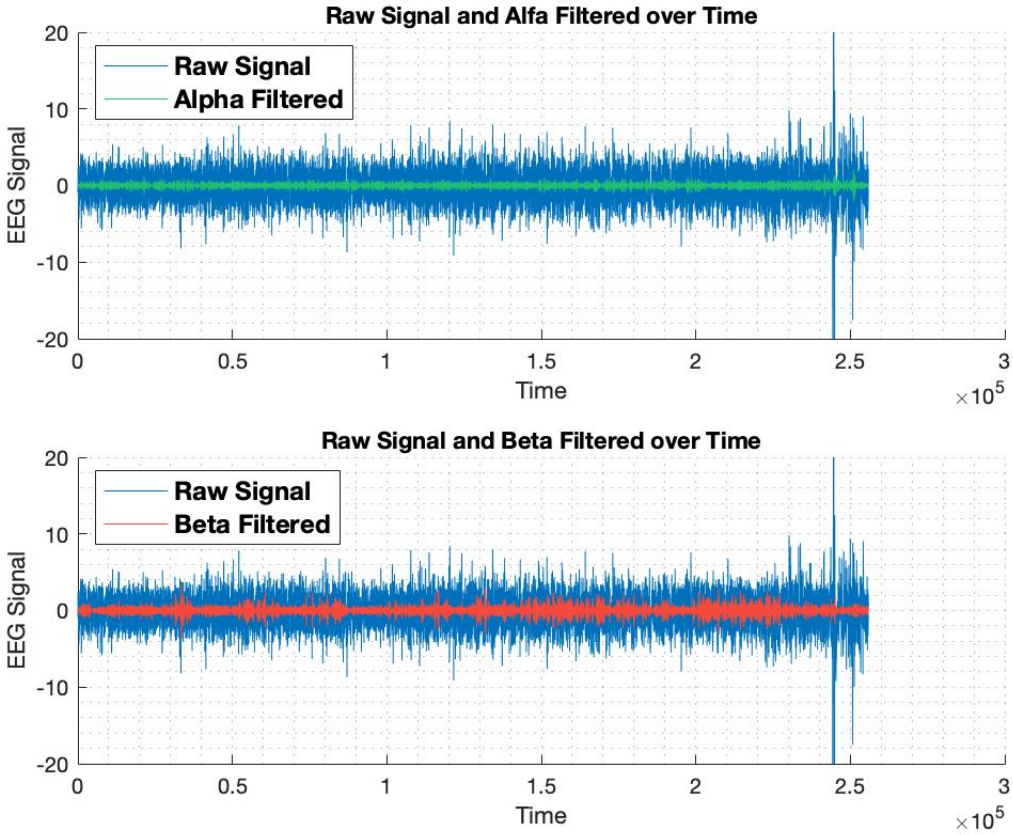


4 Filtering

4.1 Why filtering data?

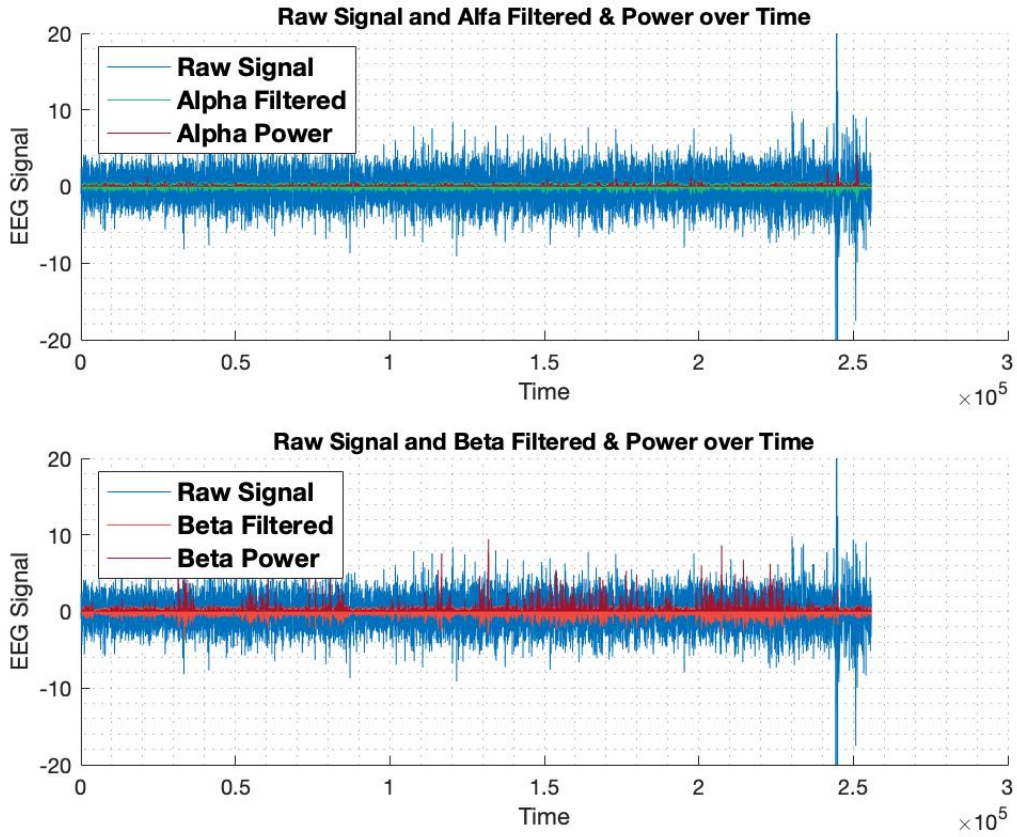
We filter data to mitigate noise and to remove artifacts so that we can observe the relevant behaviors in our signal.

4.2 Filter signal in alpha and beta bands (9-11 Hz and 18-22 Hz, respectively). Then plot the two filtered signals on top of the raw signal.



5 Power and Moving Average

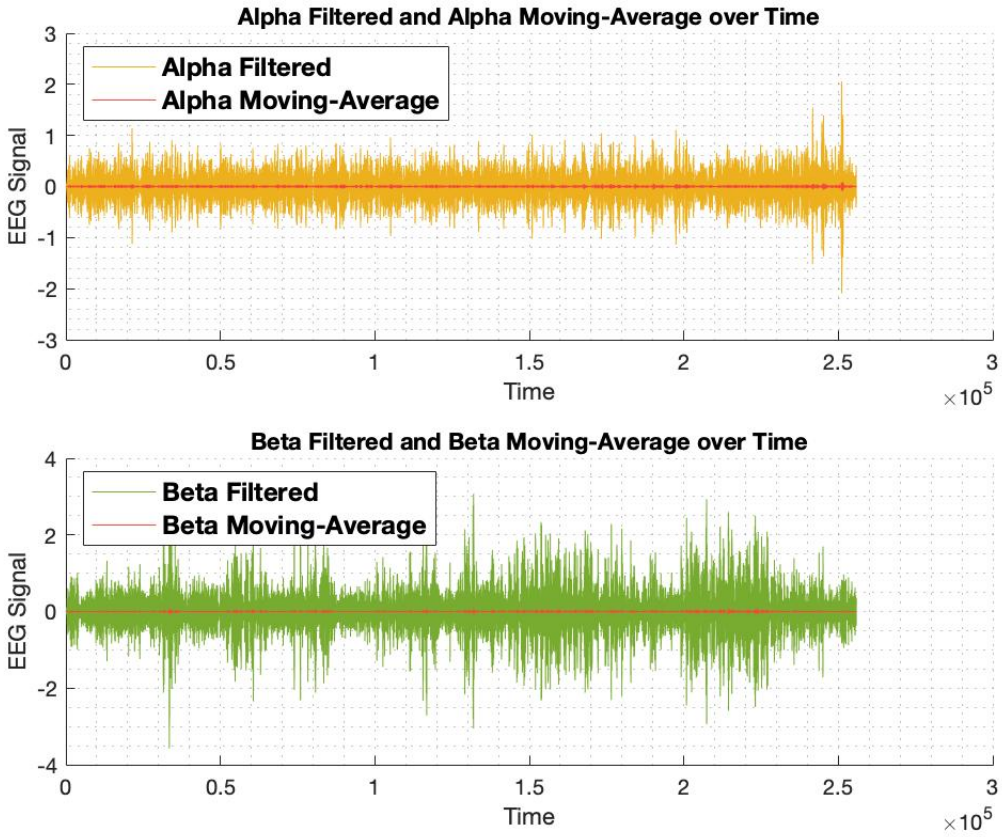
5.1 Compute the power of the signal, then plot it on top of the previous signals.



5.2 What is the moving average? Why apply it?

It attenuates the effect of outliers on the rest of the data and it suppresses high frequency noise.

5.3 Compute and plot it for alpha and beta band.

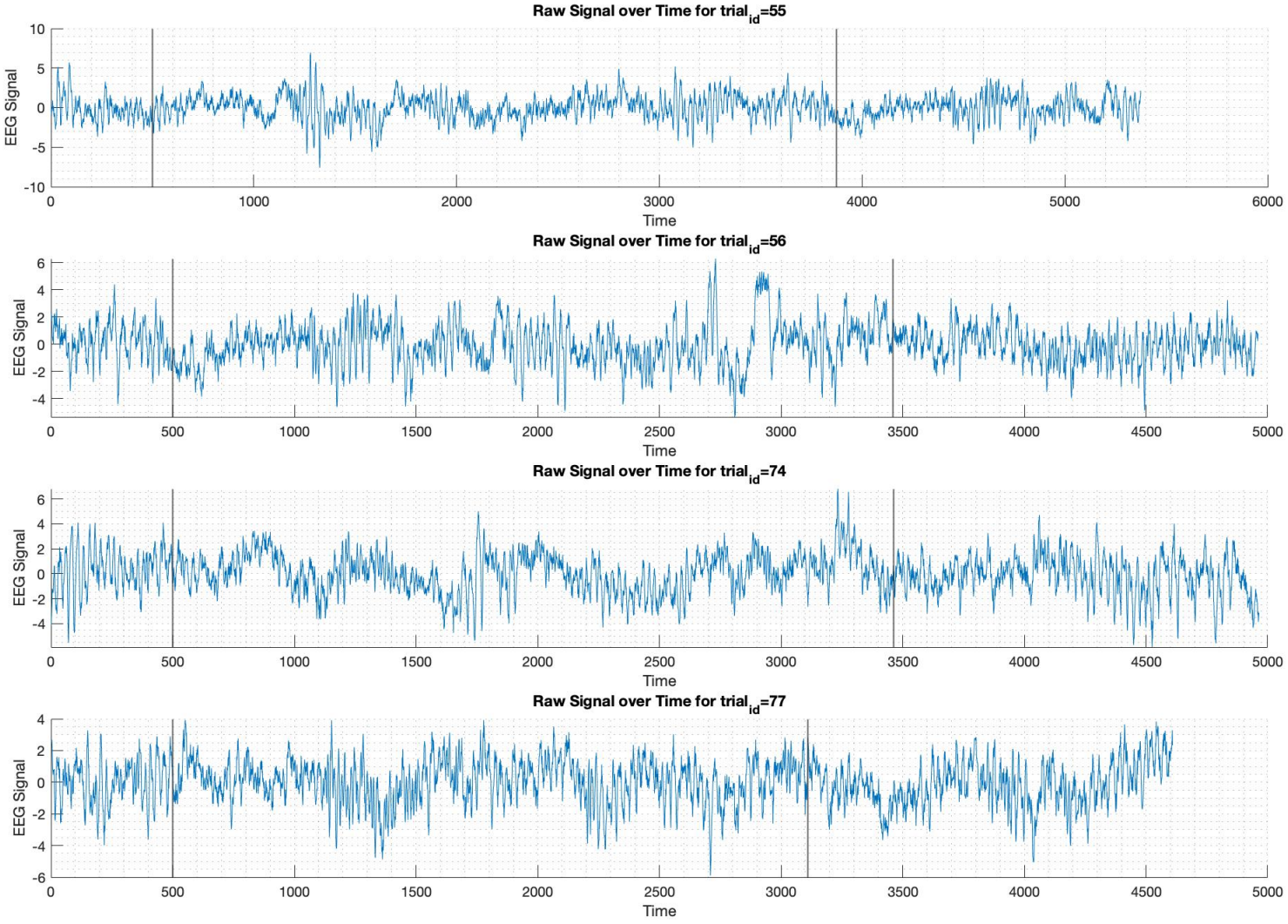


5.4 What happens by changing the window size?

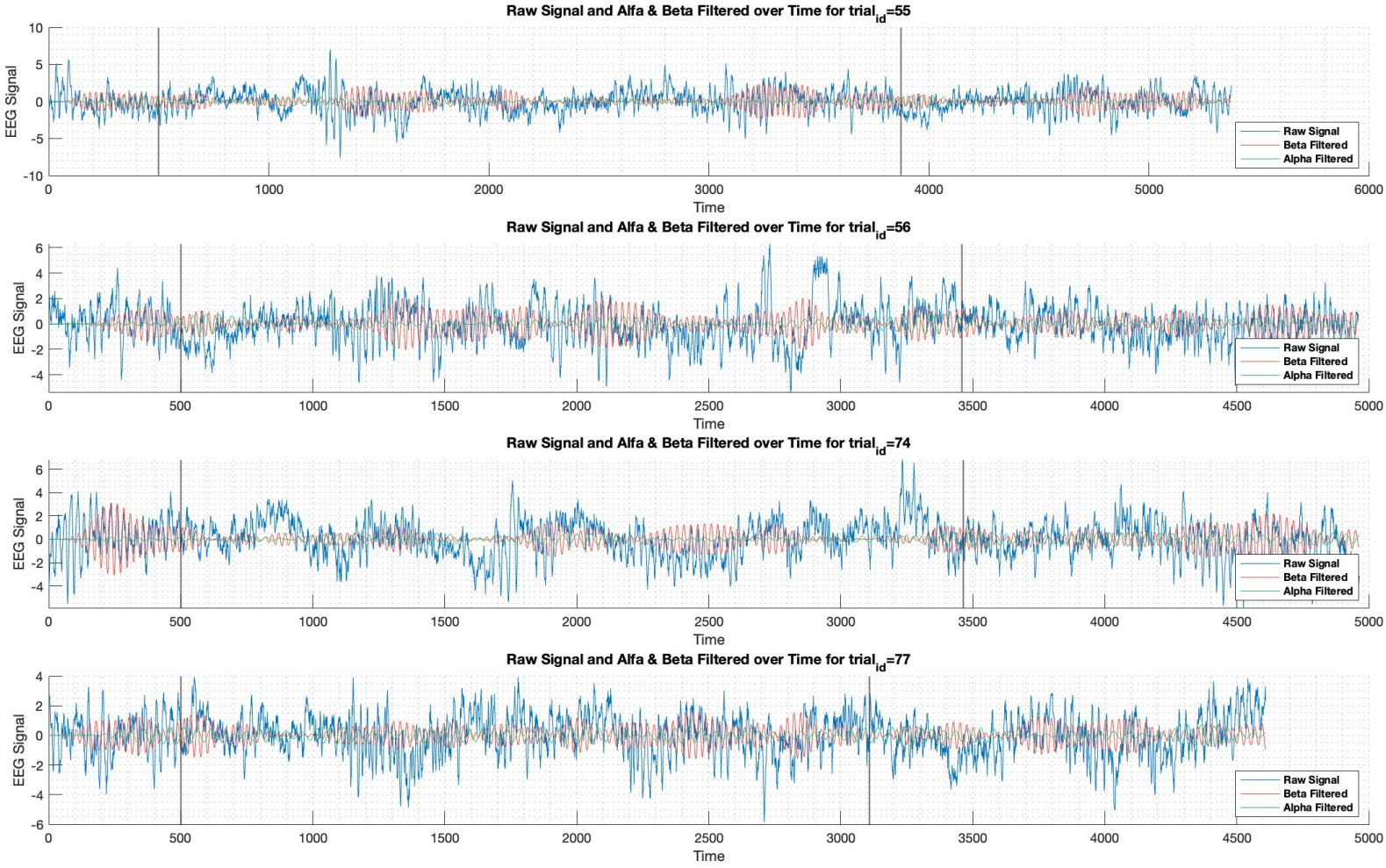
By increasing the window size, you increase the number of samples that are being averaged. And the more samples are being averaged, the less the value of a given recording has an effect on the overall trend.

6 Single Trial Plots

6.1 Plot some trials of raw signal



6.2 Plot the same trials filtered in alpha and beta bands



6.3 What can you infer from the different plots? Are there (dis)similarities between different bands?

Similarities:

- There is a synchronization before the trigger, then a desynchronization at the trigger, and then a rebound when the action is imagined.
- All of the beta filtered signals have larger amplitude than the alpha filtered signals.

Dissimilarities:

- They have different frequency content.
- They have different energy for this task.

6.4 Are there (dis)similarities between trials?

Similarities:

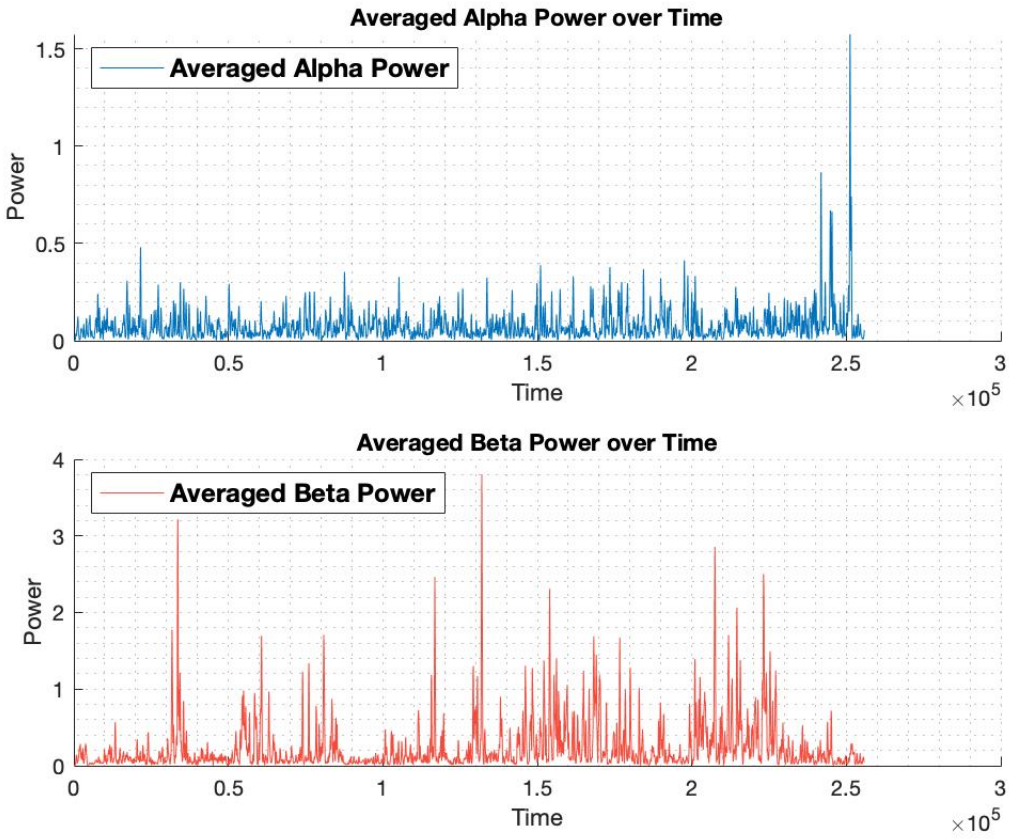
- There is a synchronization before the trigger, then a desynchronization at the trigger, and then a rebound when the action is imagined.

Dissimilarities:

- The triggers are not evenly spaced out.

7 Grand Average

7.1 Plot averaged signals of alpha and beta power.



7.2 What can we infer from these plots?

We can see that the averaged alpha signal power is greater than averaged beta signal power.

7.3 What are the differences between single trial and grand average signals?

They are both useful, but you can't create a final grand average in real time. So it is best to rely on the single trial and to use a grand average as the fingerprint to check against that single trial.

7.4 What is more useful for online real time BCI?

They are both useful, but you can't create a final grand average in real time. So it is best to rely on the single trial and to use a grand average as the fingerprint to check against that single trial.

7.5 What are the main difficulties when dealing with single trial analysis?

- Noise
- Artifacts
- The subject's focus and preparation
- More challenging filtering approach