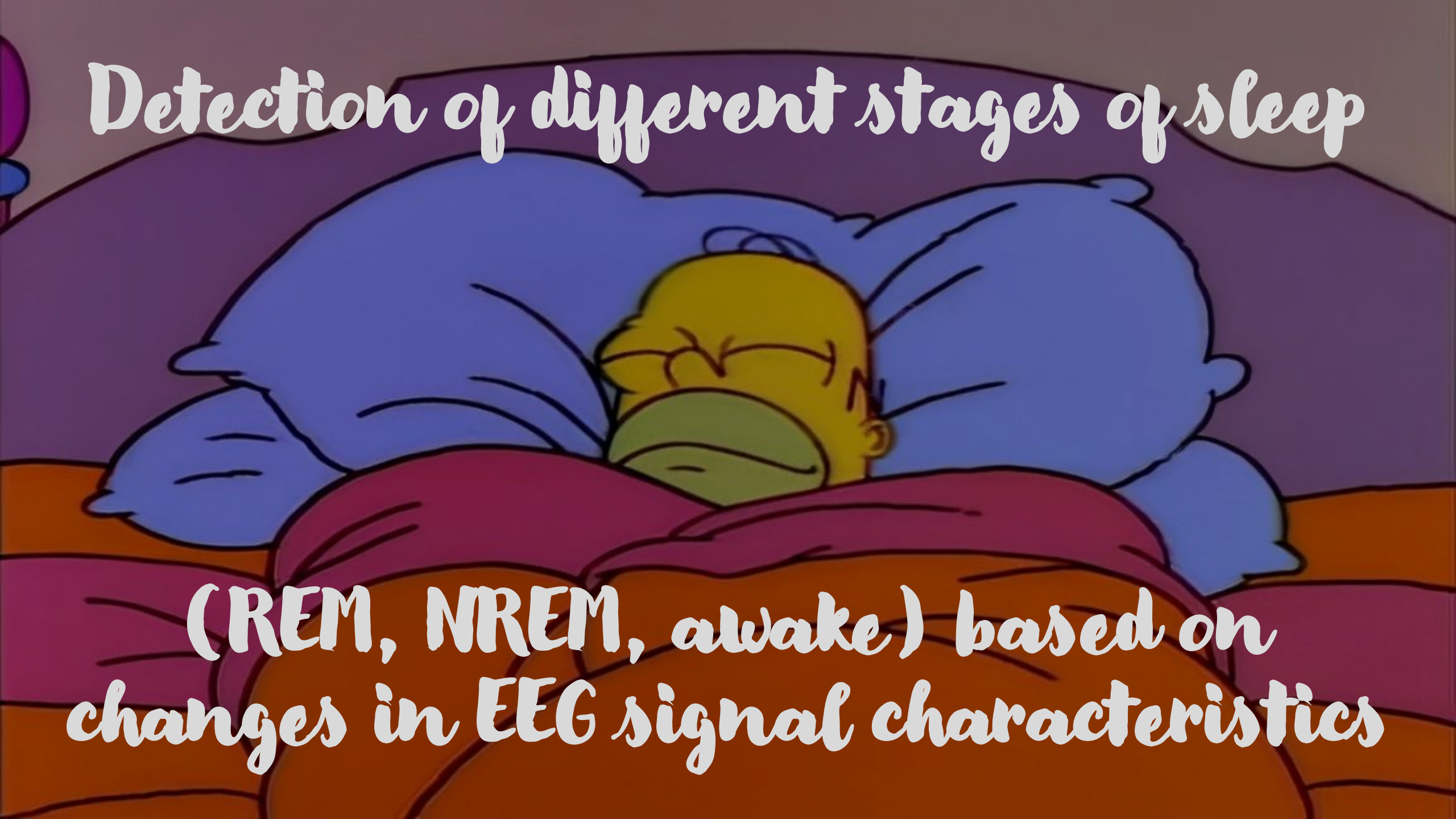
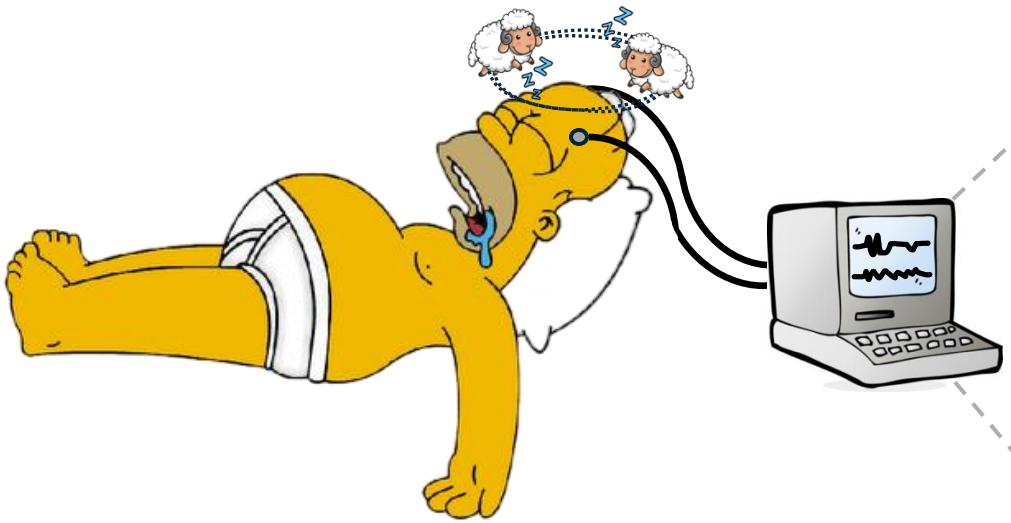
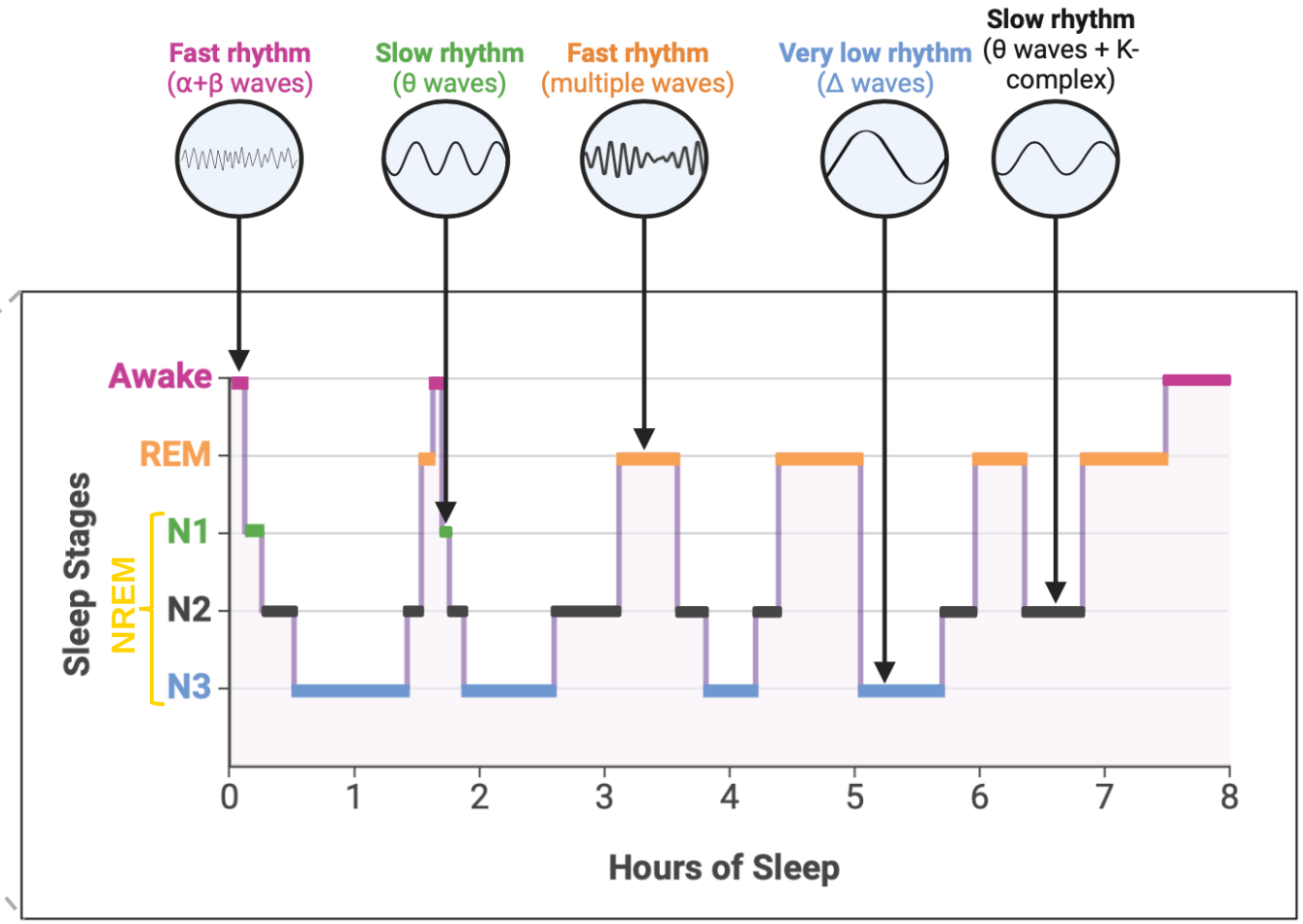
Detection of different stages of sleep



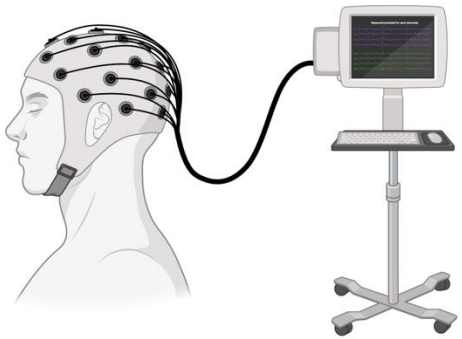
(REM, NREM, awake) based on changes in EEG signal characteristics

What happens when we sleep?

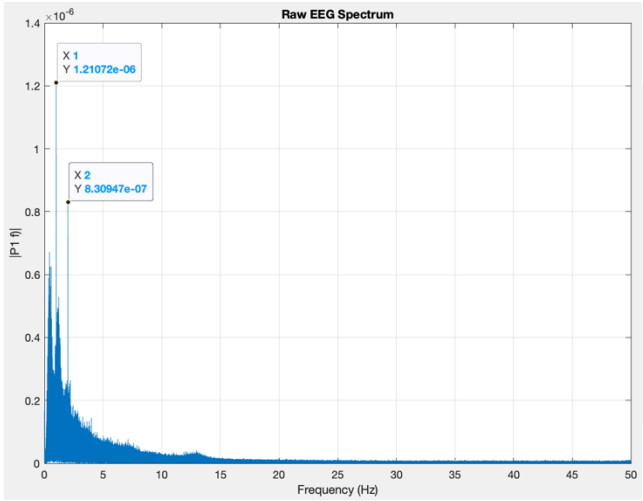




- Data acquisition -

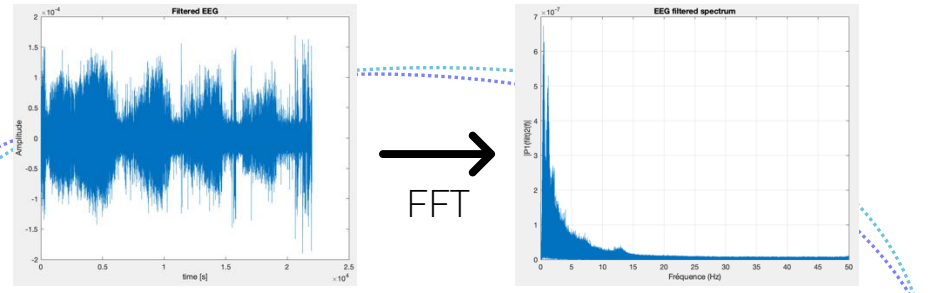


1 night

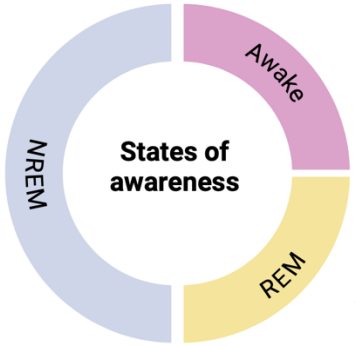


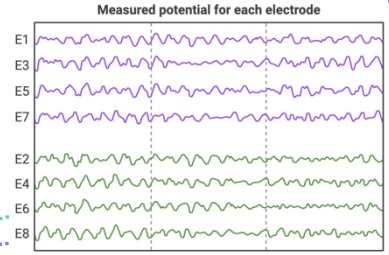
- Pre-processing -

- Filtering (Notch + Bandpass)
- Segmentation in epochs
- Compressed Spectral Array



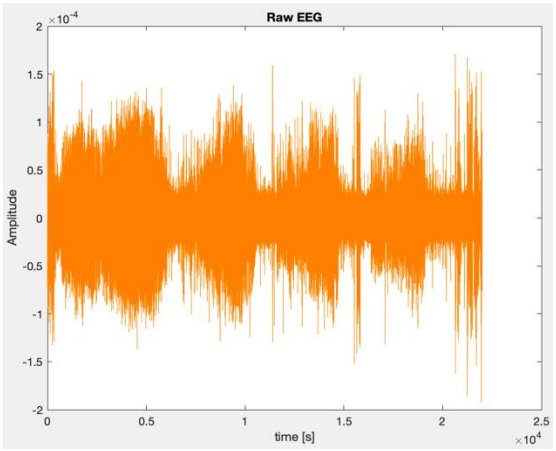
- Processing -



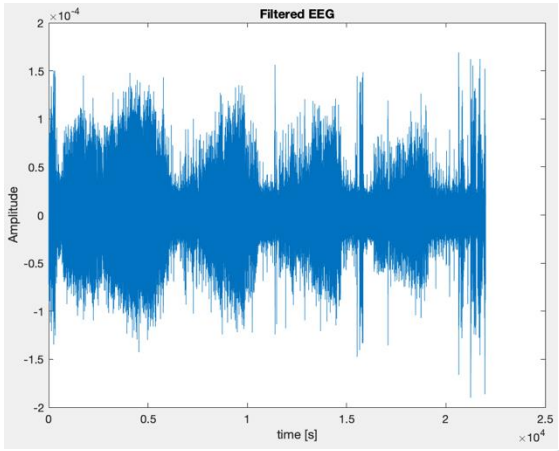


Wave percentage calculation

Results of the pre-processing

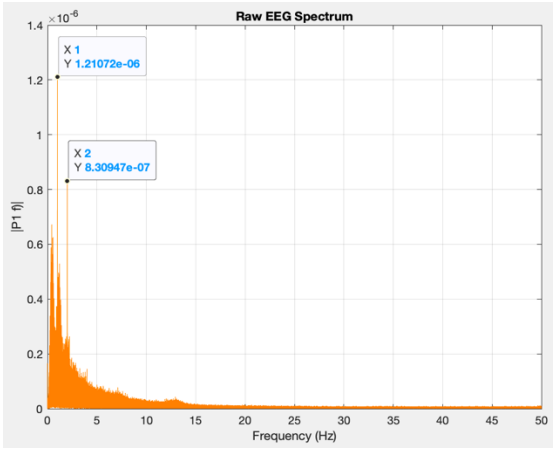


Filtering (Notch)

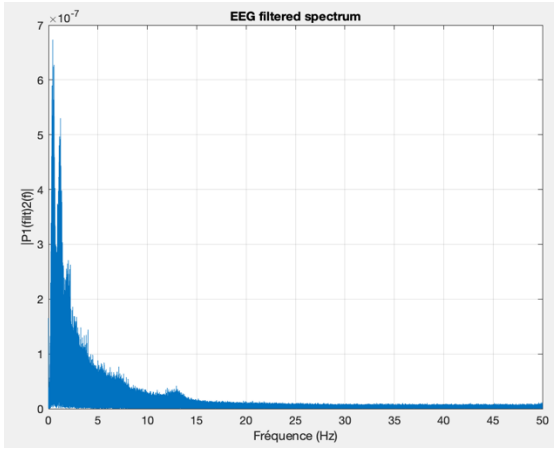


TIME DOMAIN

FFT



FFT



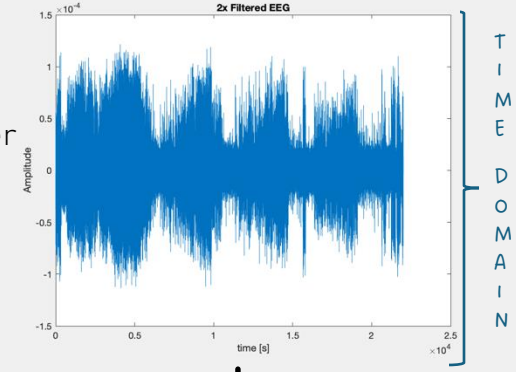
FREQUENCY DOMAIN

>>> Removing of the 1 & 2 Hz frequencies

Removing of EEG artefacts

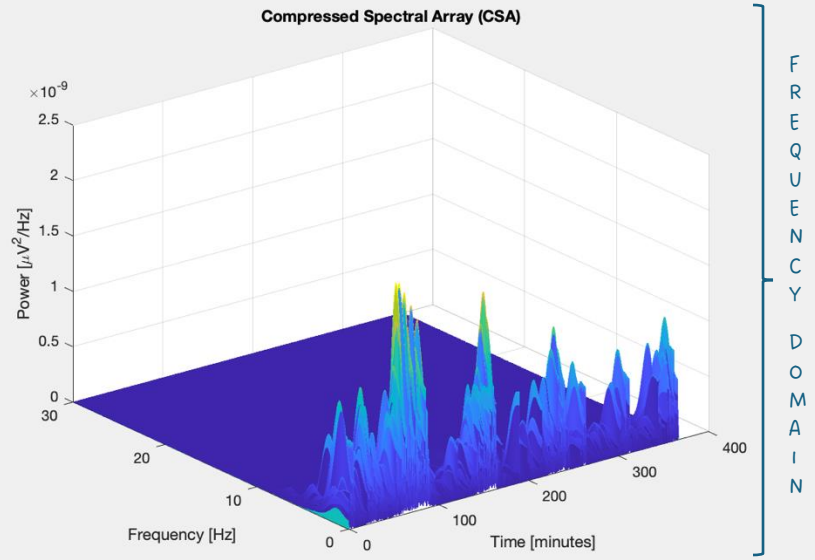
Isolation of the content of interest (band-pass filter) + CSA

Band-Pass filter → [0.5 – 30 Hz]



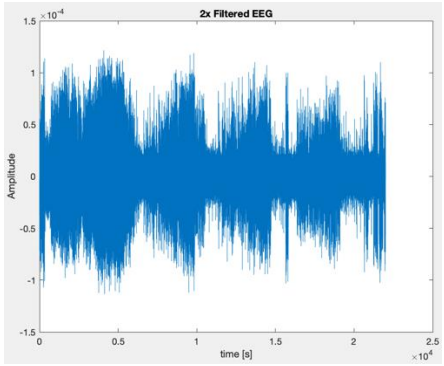
TIME DOMAIN

CSA



FREQUENCY DOMAIN

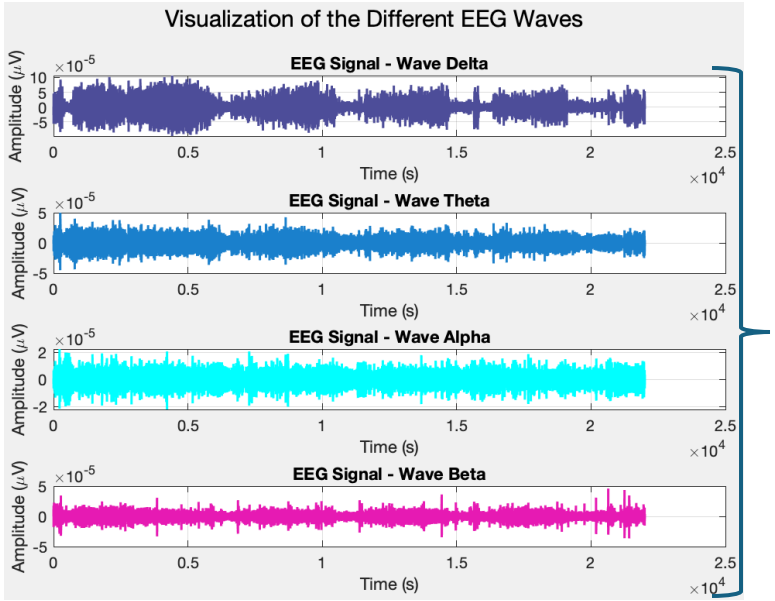
Isolation of the waves and detection of the sleep stages (processing)



+

Waves	Band (Hz)
Δ	1-4
θ	4-7
α	7-10
β	10-30

↓ Can be decomposed in :

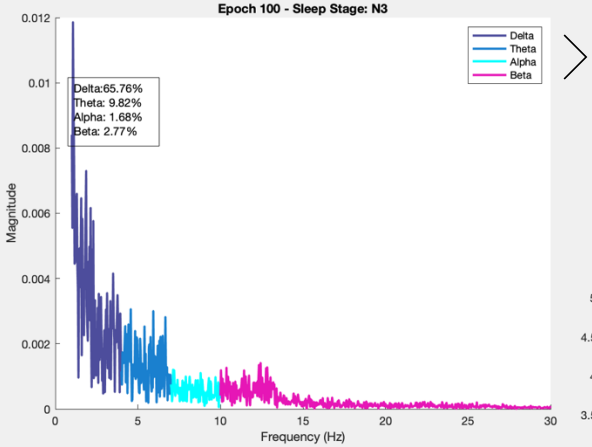


Highlighting of the cerebral waves

+ Threshold

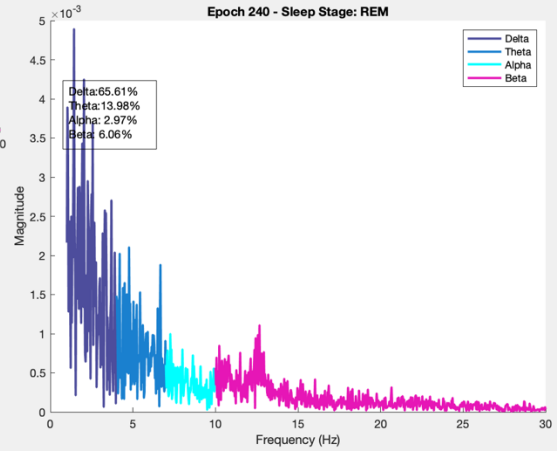
Determine

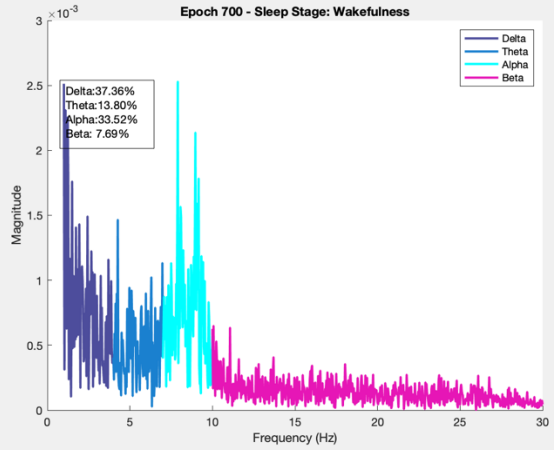
Determining of the type of sleep based on the proportion of waves



NREM

REM





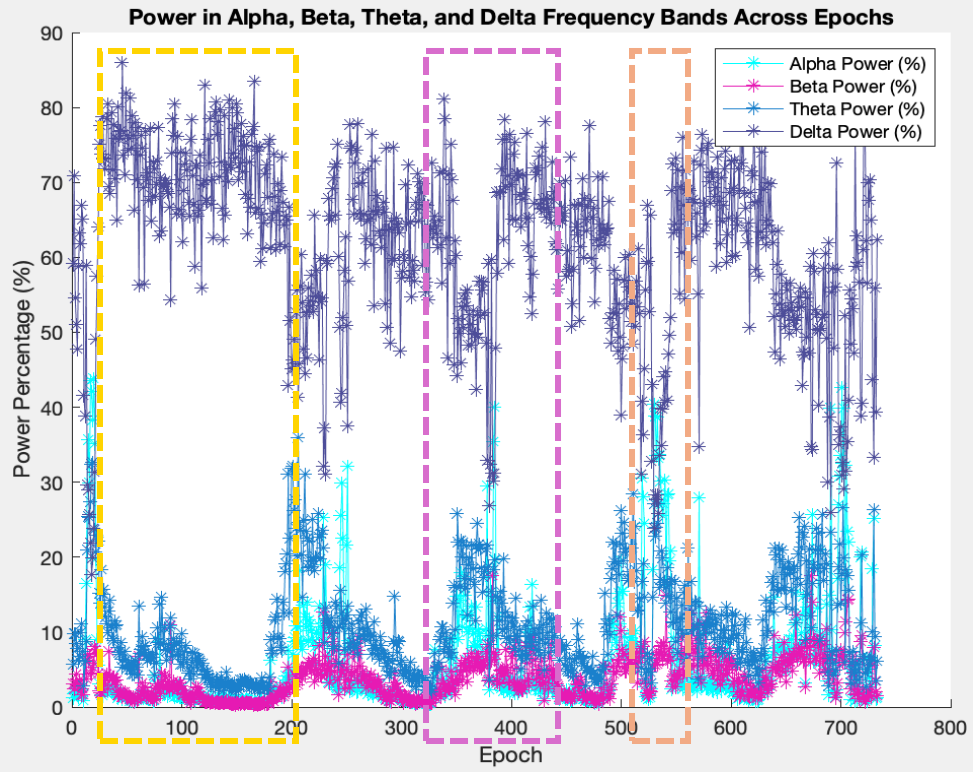
Awake

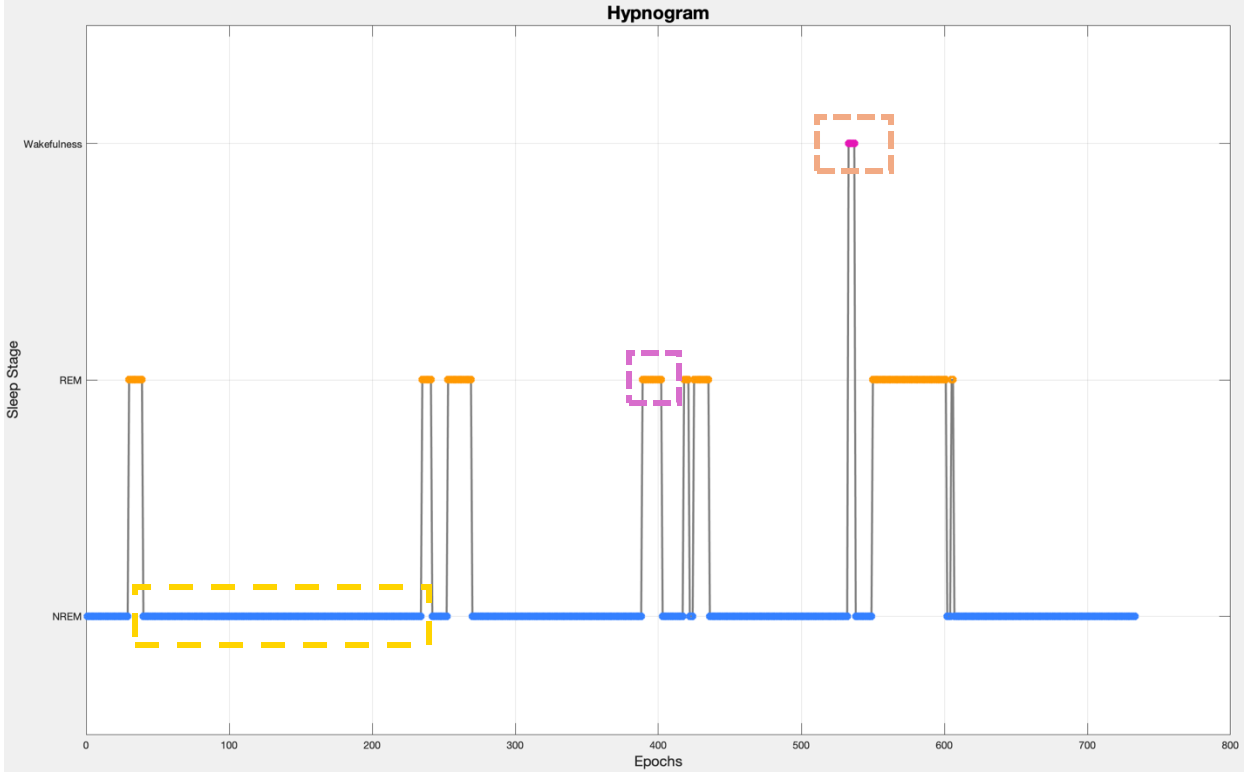
6 hours of sleep

↓

733 epochs of 30 s

Correlation between waves proportion and sleep stages





Highlighting of the link between brain waves and sleep stage

NREM → Light sleep : Δ+ and θ+ but α-

NREM → Deep sleep : Δ+++ but α,β-

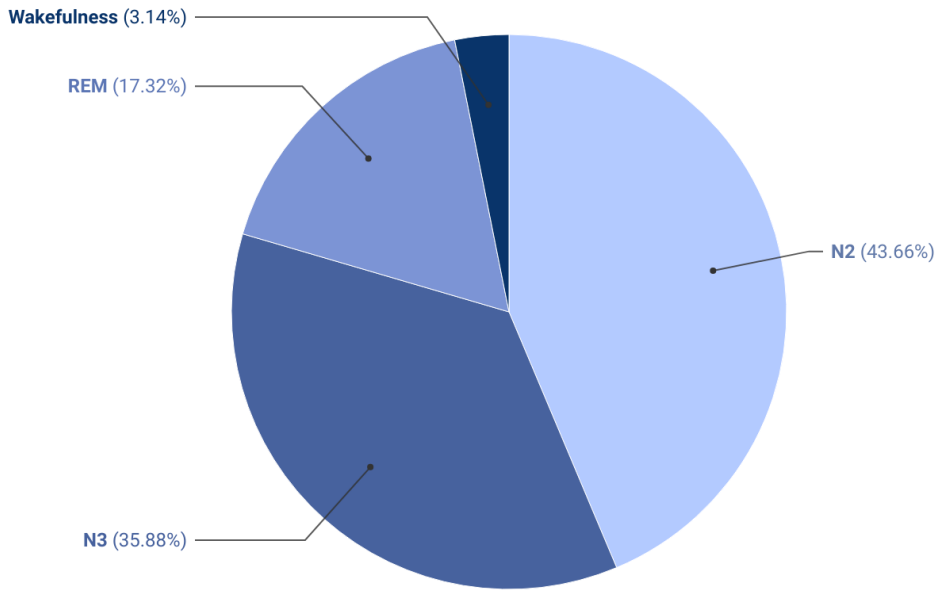
Wakefulness → α+++ and β+

REM → θ,β+ but Δ-

Reliability of results

Percentage of each stage of awareness in the EEG

NREM : 79,54%, REM : 17,32%, Awake : 3,14%

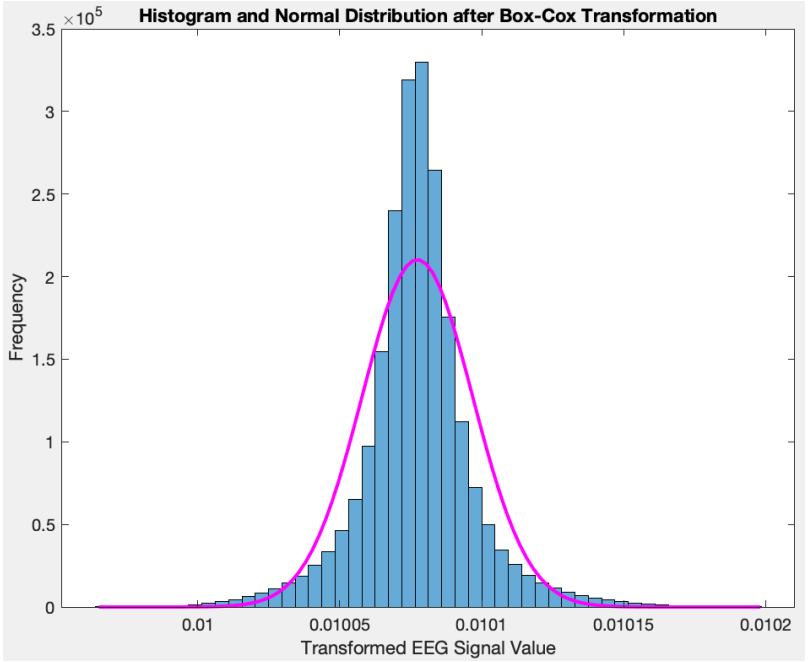


Created with Datawrapper

The results show:

- Δ waves predominate
- Majority of N2/ N3 stages

→ Majority of NREM sleep stage



→ Normal distribution ✓

Sleep stage	Duration (hours)
NREM	4,84
REM	1,06
Wakefulness	0,21 (≈12,5 min)

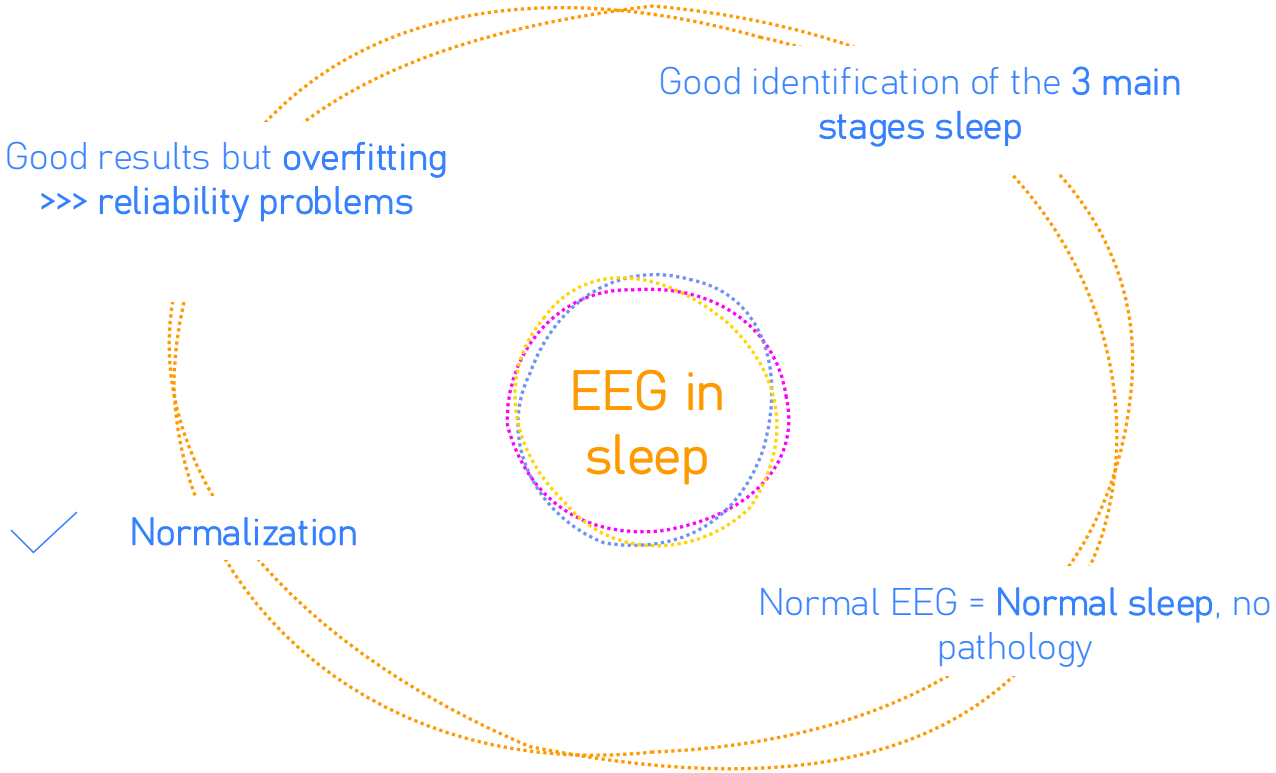
→ In line with the literature

BUT >>> Use of overfitting

↓

Reliability ?

The results showed that



References

[1] C-S. Huang, C-L. Lin & al. September 2014. *Knowledge-based identification of sleep stages based on two forehead electroencephalogram channels*. Frontiers in Neuroscience. Volume 8.

[2] W. Dement and N. Kleitman. June 1937. *Cyclic variations in EEG during sleep and their relation to eye movements, body motility and dreaming*. Electroencephalogr Clin Neurophysiol. Volume 9 : 673-90.