Normal awake and sleep EEG

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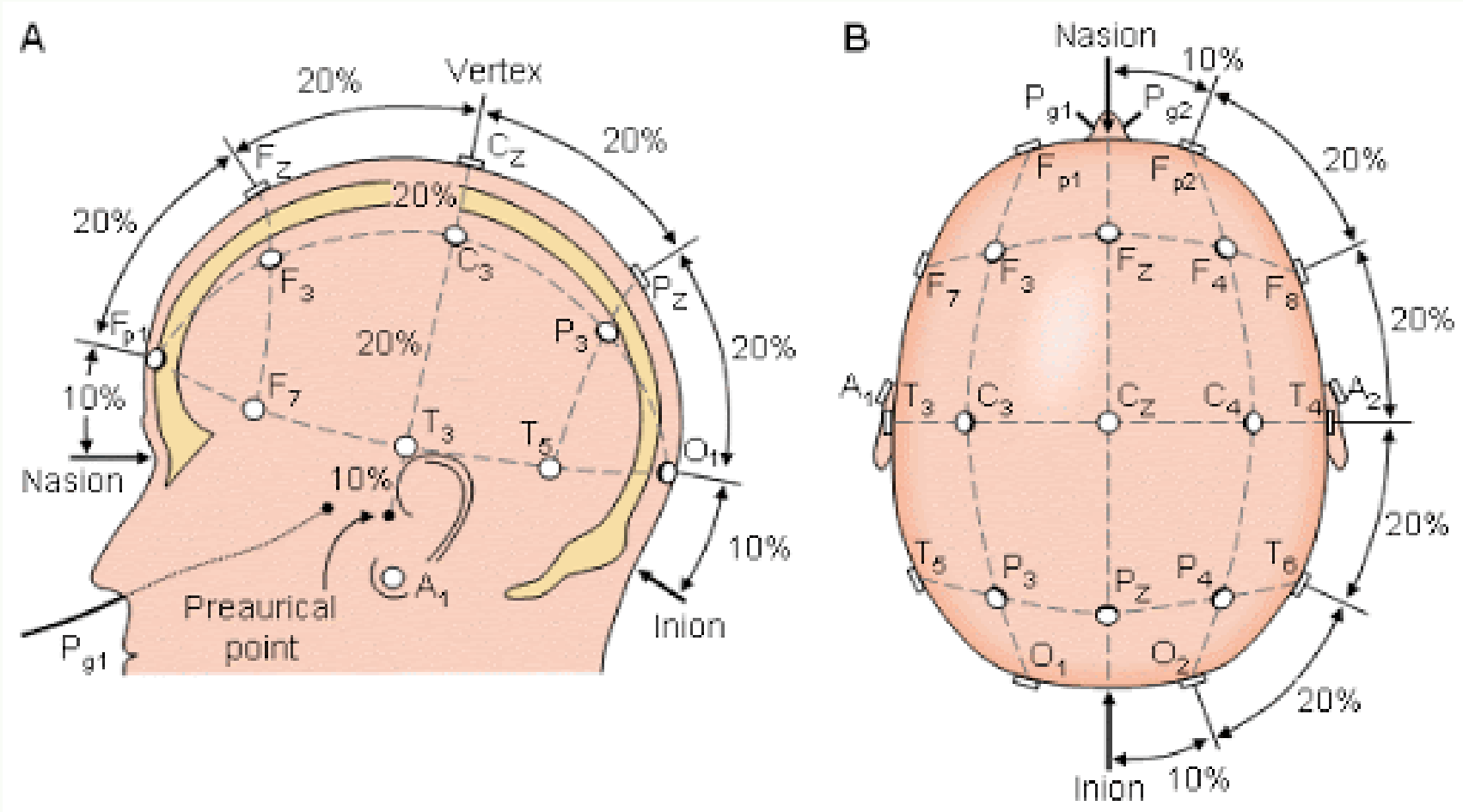
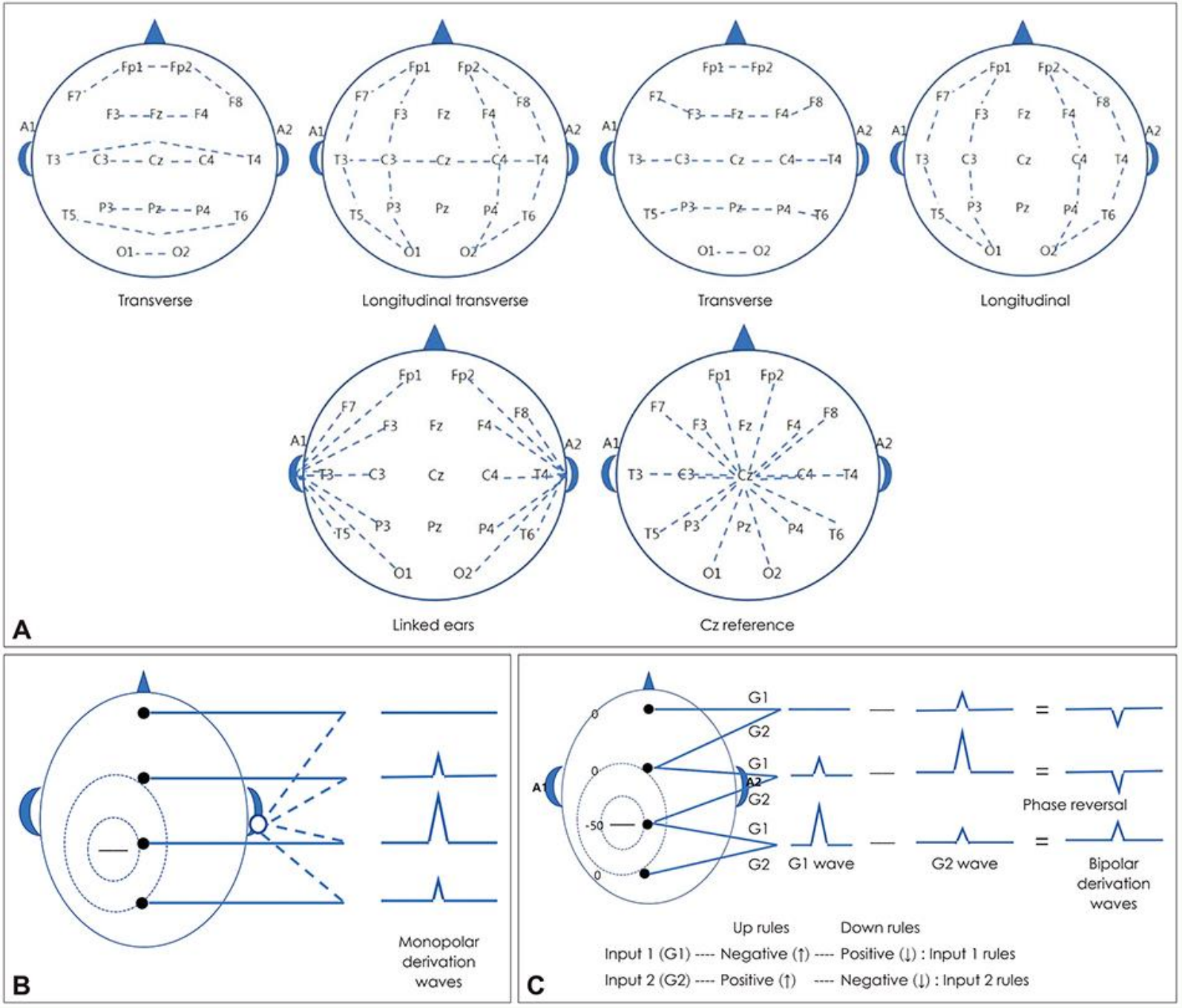
EEG : electroencephalogram

- Detect brain wave by scalp electrodes
- Summation of postsynaptic potentials (EPSP & IPSP) -> brain wave

Electrode placement

- International 10-20 system
  - Minimum 21 electrodes
  - Odd-numbered electrodes = left side of the head
  - Even-numbered electrodes = right side of the head
  - Specific letters designate the anatomical area : F = frontal, T = temporal, P = parietal, O = occipital, C = central


A
20%
Vertex
20%
20%
20%
20%
20%
20%
20%
10%
10%
10%
Nasion
Preaurical
point
Inion
F_{p1}
F_z
C_z
P_z
F_3
C_3
P_3
F_7
T_3
T_5
O_1
A_1
P_{g1}
B
Nasion
10%
P_{g1}
P_{g2}
20%
20%
F_{p1}
F_{p2}
F_7
F_3
F_z
F_4
F_8
A_1
T_3
C_3
C_z
C_4
T_4
A_2
T_5
P_3
P_z
P_4
T_6
O_1
O_2
20%
20%
Inion
10%



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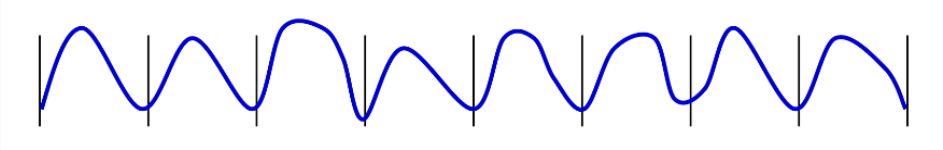
Basic EEG terminology

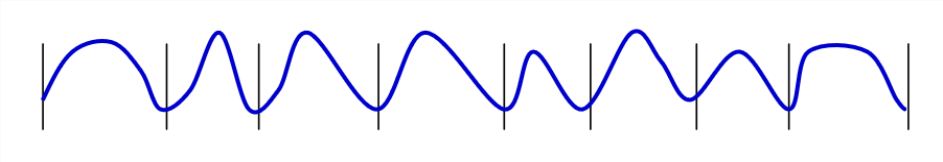
- Rhythm
- Amplitude
- Frequency
- Timing
- Wave form
- Distribution
- Persistence
- Reactivity

Rhythm

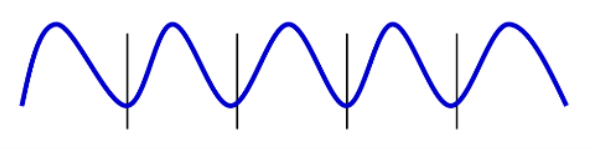
- **Rhythmic :** EEG activity composed of recurring waves of equal duration



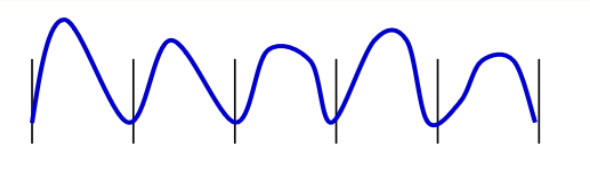
- **Arrhythmic :** EEC activity composed of recurring waves of unequal duration



- **Regular :** in addition to consistent duration, individual waves have fairly consistent shape

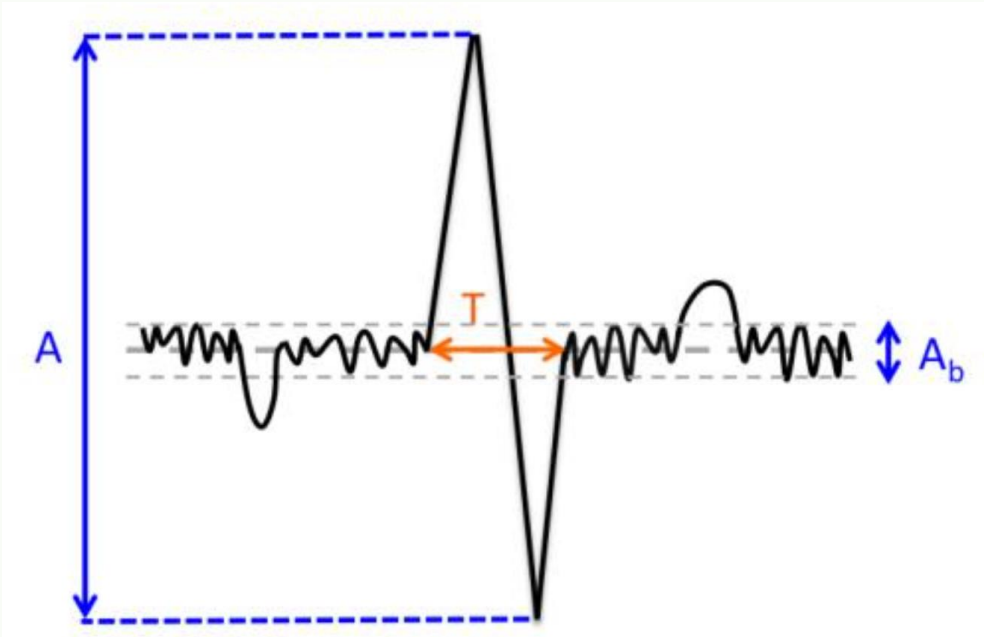


- **Irregular :** waves are not uniform



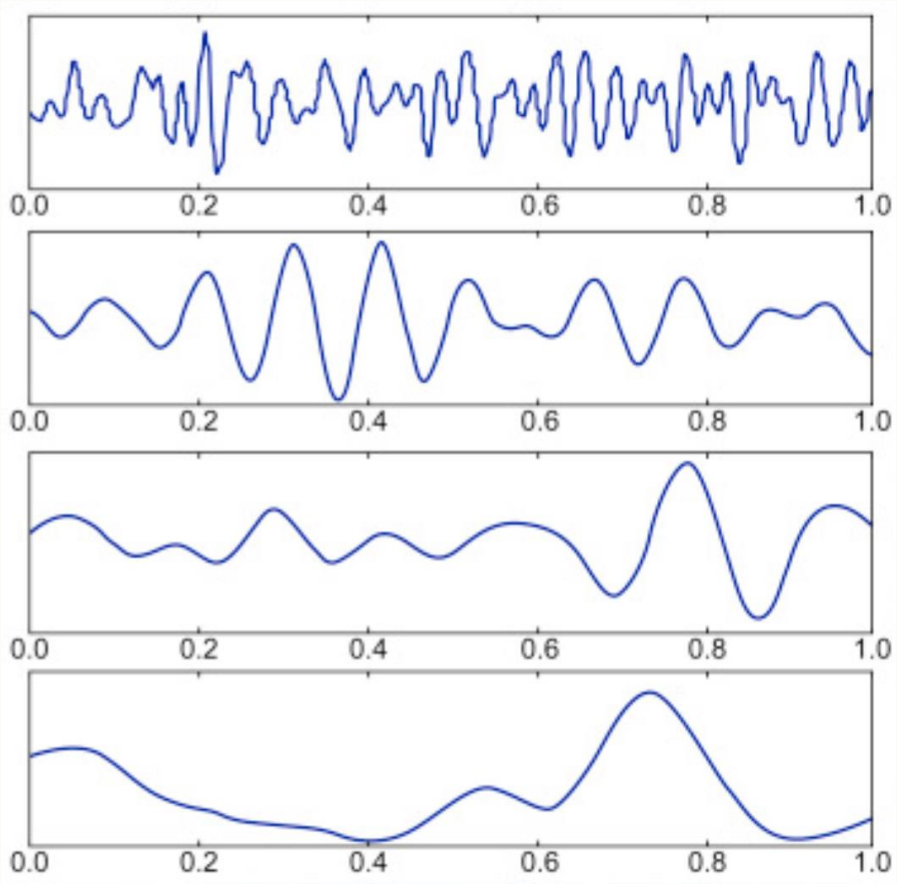
Amplitude

- Low amplitude < 20 µV
- Moderate amplitude 20-50 µV
- High amplitude > 50 µV
- How high on EEG depend upon sensitivity used e.g. 7.5 µV per 1 mm.



Frequency

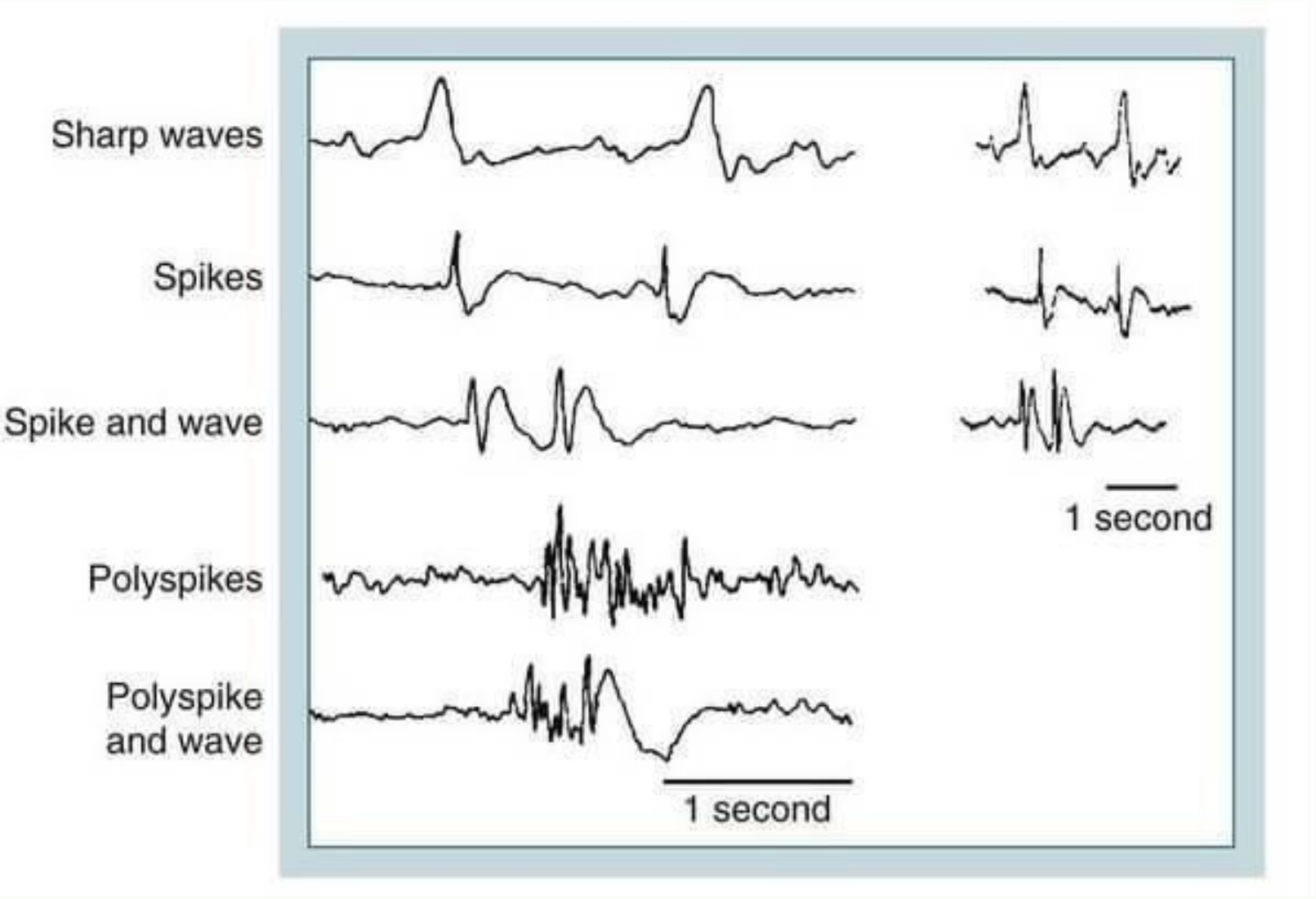
- Beta activity >13 Hz
- Alpha activity 8-13 Hz
- Theta activity 4-7 Hz
- Delta activity < 4 Hz



Timing

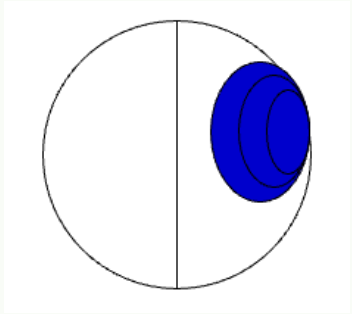
- The temporal relationship of the activity in different regions
- Activity occur in two regions simultaneously = synchronous or bilateral synchronous
- Activity occur at the different time in two or more region = asynchronous

Wave form

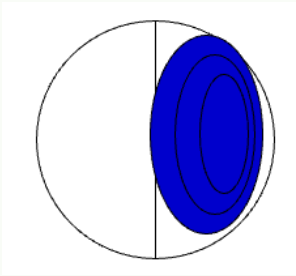

Sharp waves
Spikes
Spike and wave
Polyspikes
Polyspike and wave
1 second
1 second

Distribution

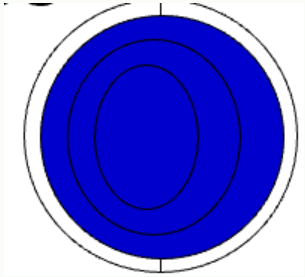
- The degree of involvement of the activity
- Regional = one region



- Lateralized = one hemisphere

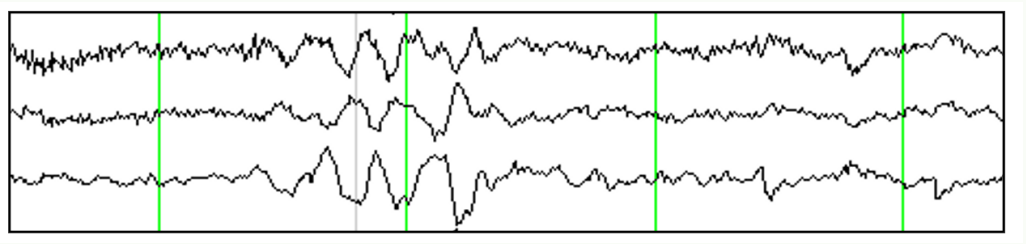


- Generalized = both hemisphere

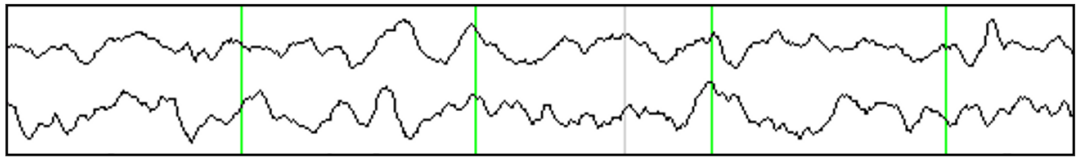


Persistence

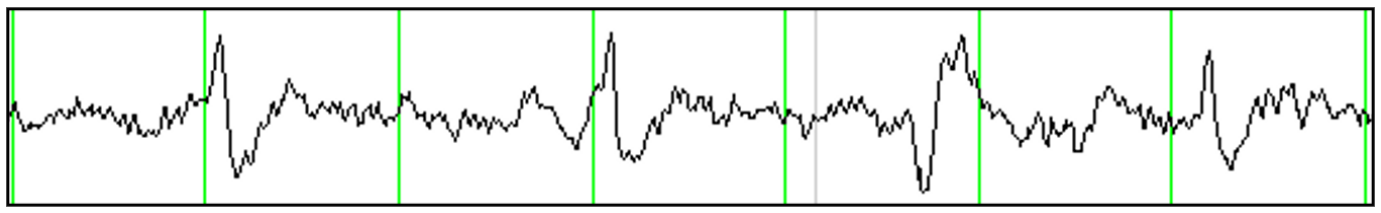
- The continuity of the activity
- Intermittent



- Continuous

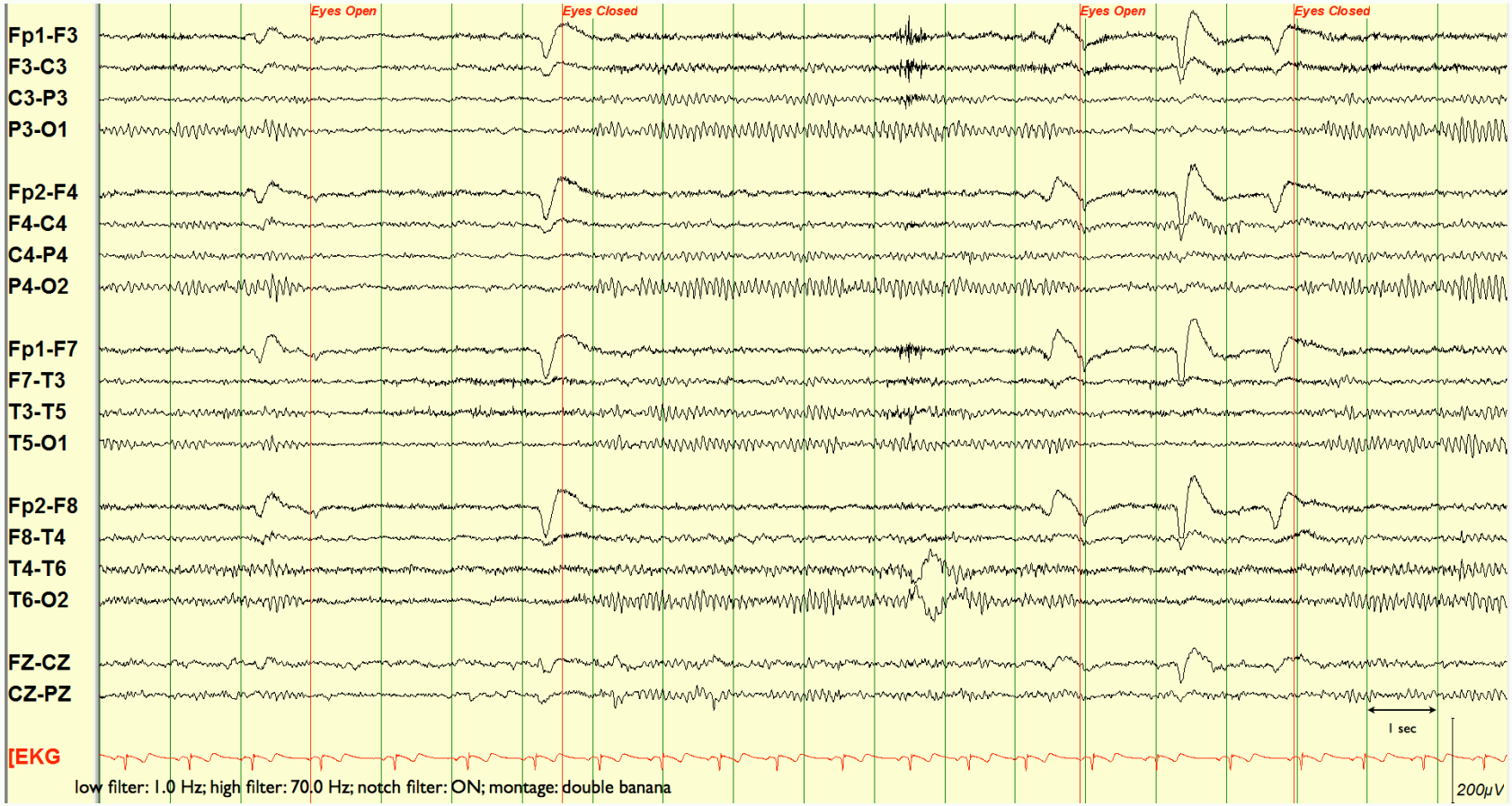


- Periodic



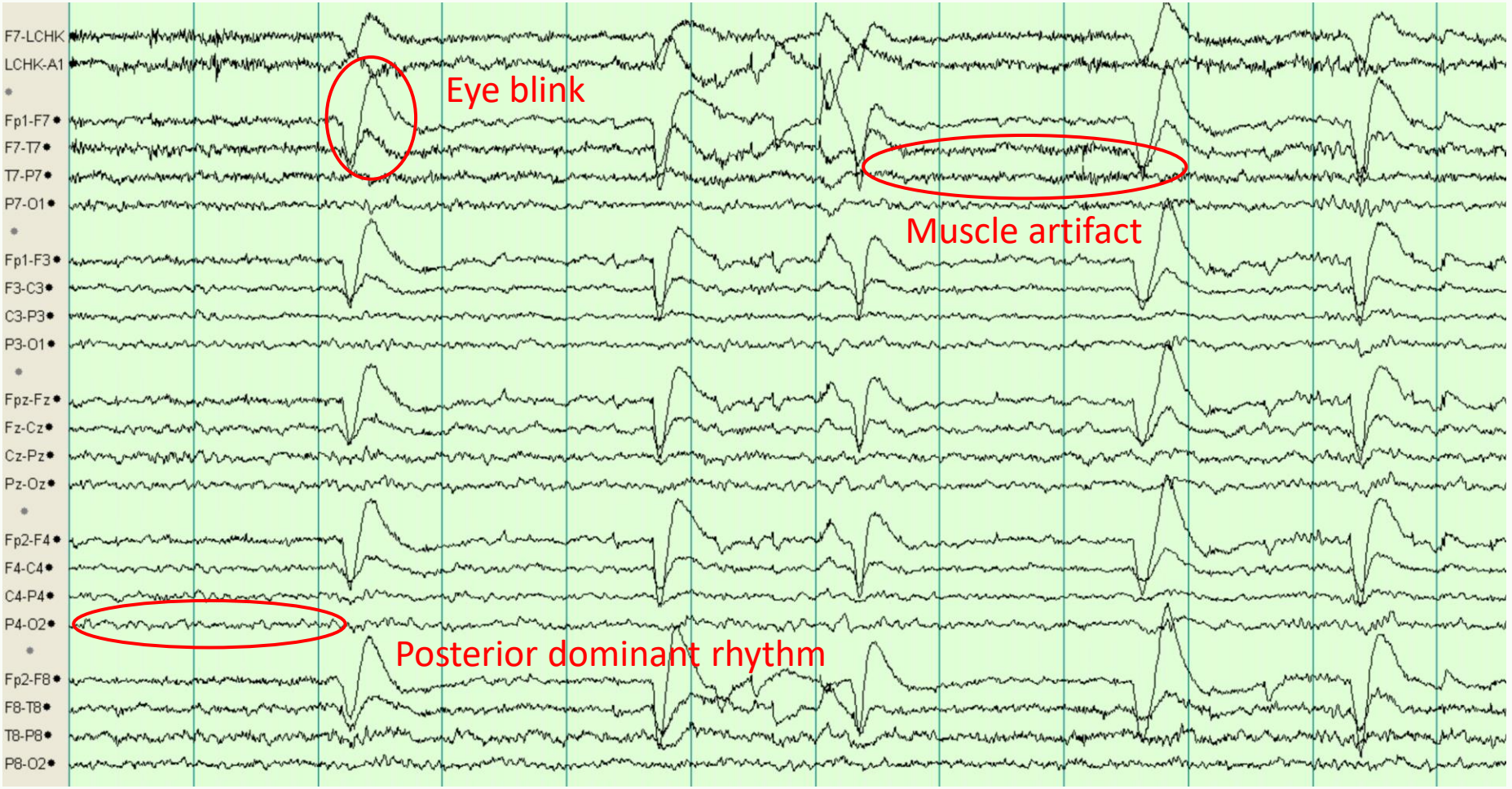
Reactivity

- The change of the activity in response to activations e.g. PDR reactive to eyes opening.



https://eegatlas-online.com/index.php/en/alphabetical-index/posterior-dominant-rhythm-guest

Normal awake EEG



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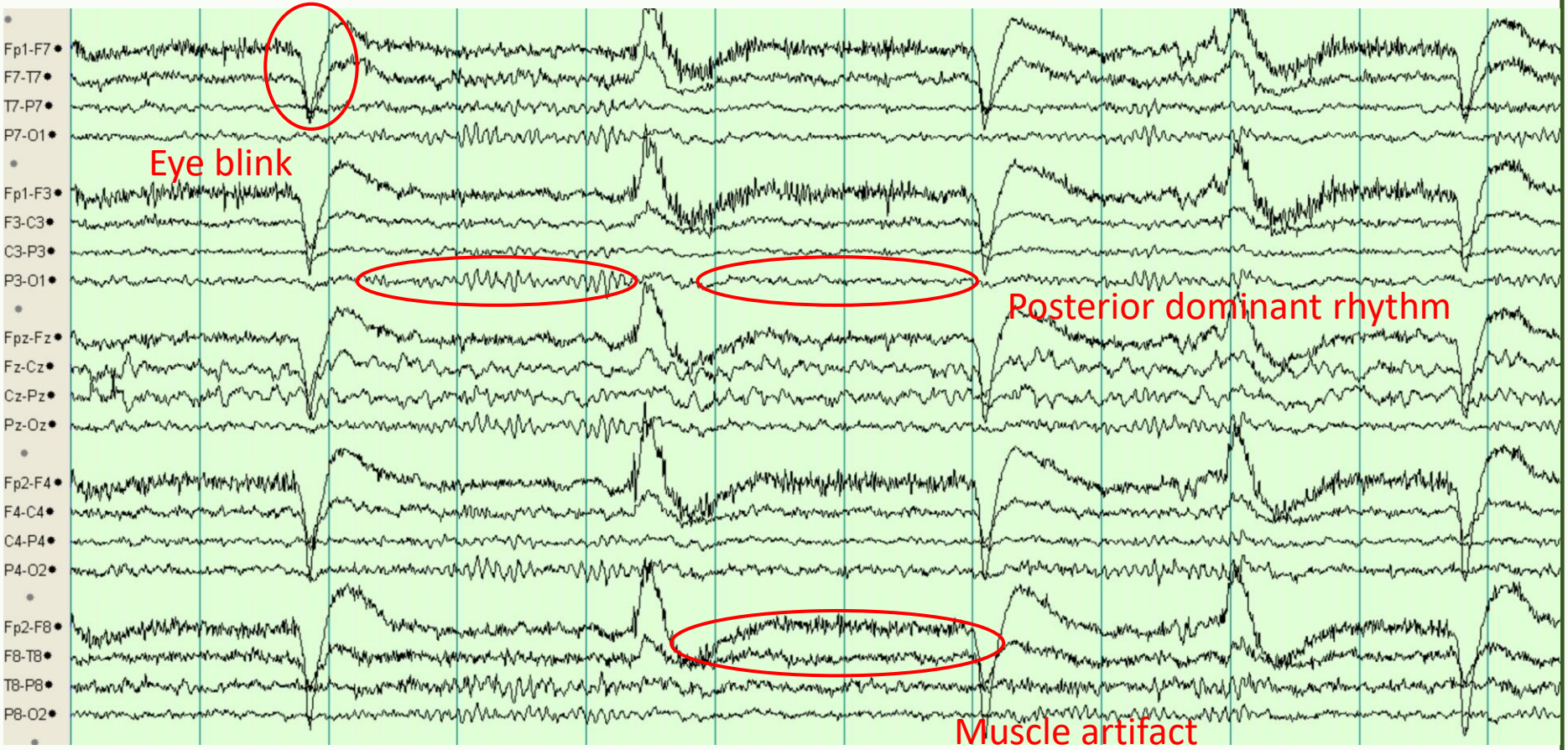


https://eegatlas-online.com/index.php/en/normal/awake

Posterior dominant rhythm (PDR)

- Frequency 8-13Hz in adult. 3-4 Hz in newborn, upto 8 Hz by 8 years
- Voltage: depends on age, higher voltage in children
- Waveform: regular, waxing and waning in amplitude in adult
- Occurrence : continuous during awake
- Location: occipital regions, symmetric
- Reactivity: reduced with eye opening.

Posterior dominant rhythm (PDR)

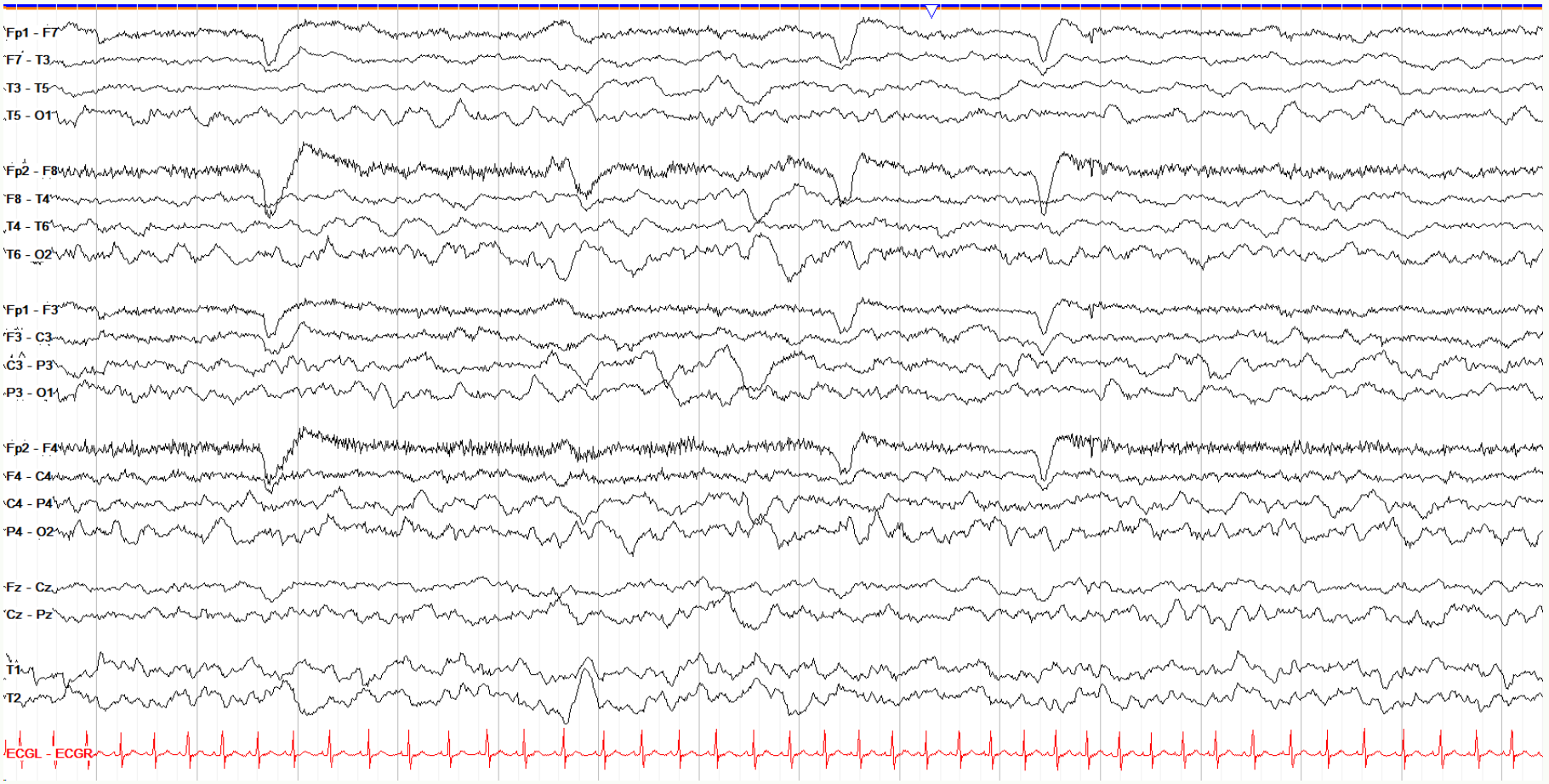
- Age dependence
- Term newborn : Chronological age
- Pre-term newborn : conceptional age

PDR

Frequency in Children

3-4 months:	4 Hz
12 months:	5-6 Hz
2 years:	7 Hz
3 years:	8 Hz
9 years:	9 Hz
15 years:	10 Hz

4 Hz x 6 months
6 Hz x 4 years
8 Hz x 8 years


Fp1 - F7
F7 - T3
T3 - T5
T5 - O1
Fp2 - F8
F8 - T4
T4 - T6
T6 - O2
Fp1 - F3
F3 - C3
C3 - P3
P3 - O1
Fp2 - F4
F4 - C4
C4 - P4
P4 - O2
Fz - Cz
Cz - Pz
T1
T2
ECGL - ECGR

Neurophysiologie Clinique/Clinical Neurophysiology (2013) 43, 35—65

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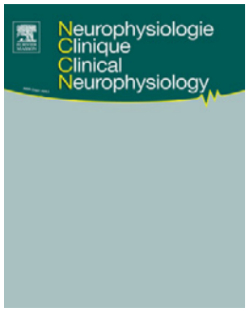

REVIEW/MISE AU POINT

Normal EEG in childhood: From neonates to adolescents

L'EEG normal chez l'enfant : du nouveau-né à l'adolescent

M. Eisermann [a,b,*], A. Kaminska [a,b], M.-L. Moutard [c], C. Soufflet [a,b], P. Plouin [a,b]

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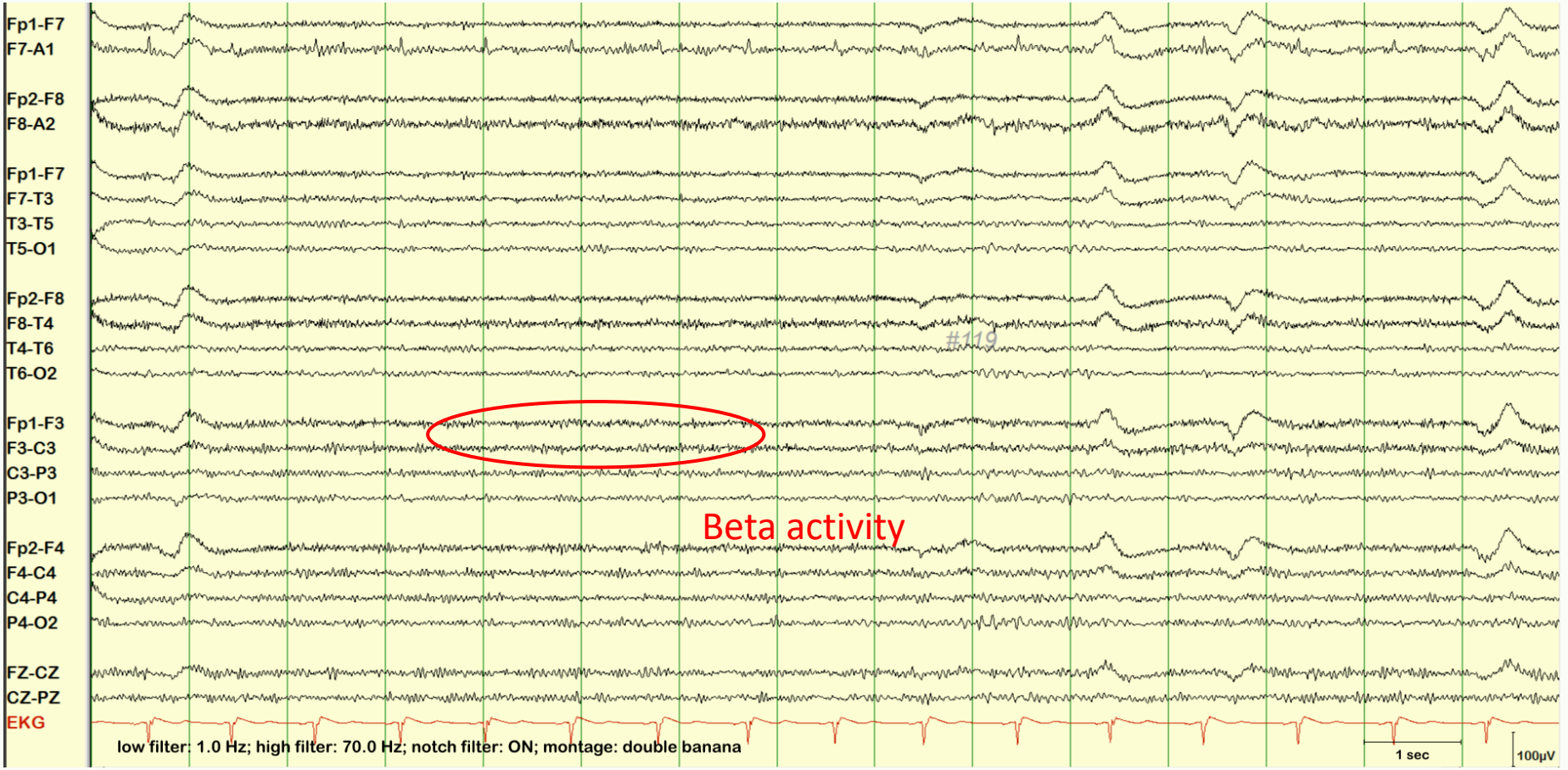
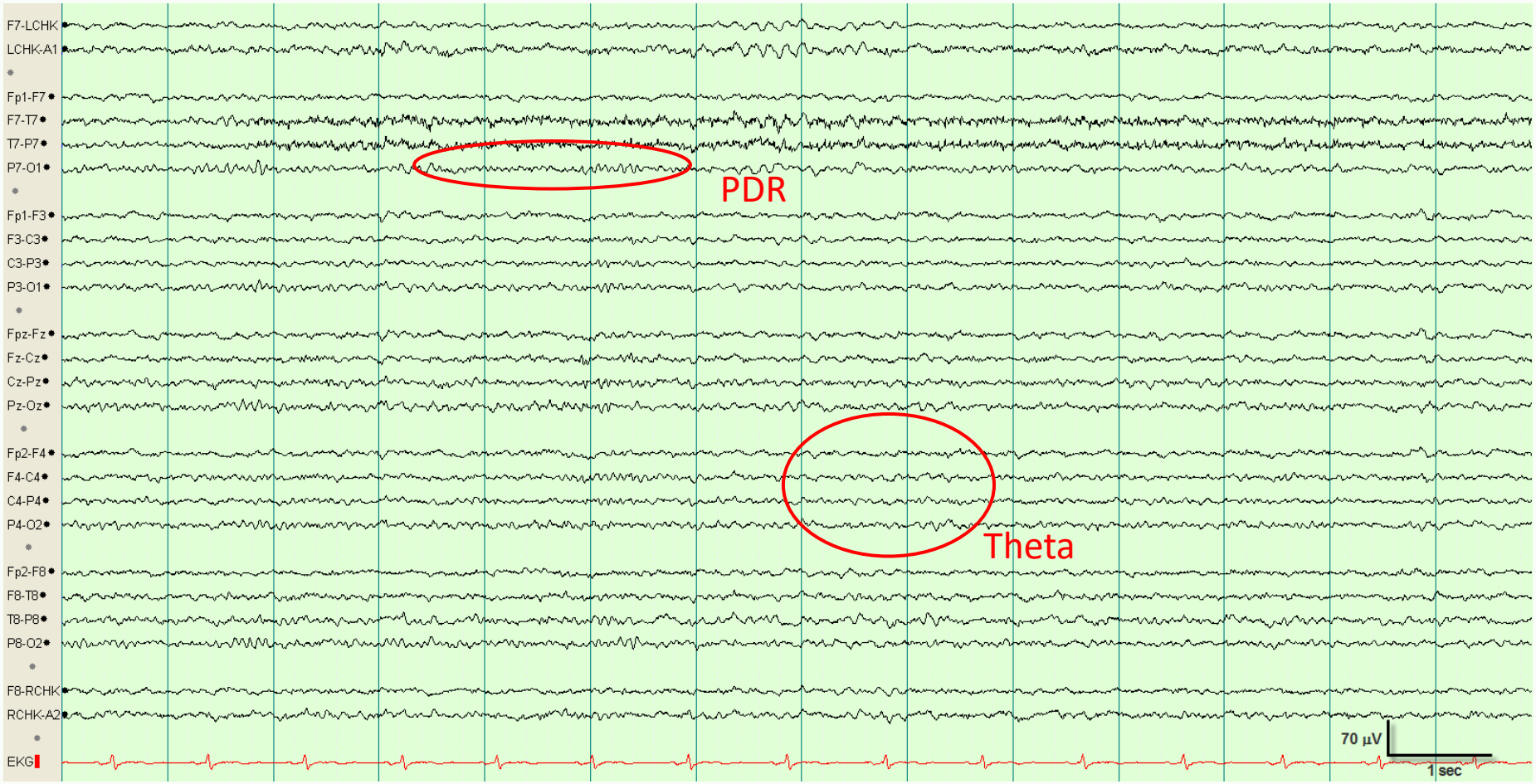


https://eegatlas-online.com/index.php/en/normal/awake

Beta frequency

- Frequency > 13Hz (most common 18-25 Hz)
- Voltage : low voltage
- Occurrence: irregular but continuous during awake, maybe more prominent with drowsiness
- Location : fronto-central region, symmetrical



https://eegatlas-online.com/index.php/en/normal/awake

Theta frequency

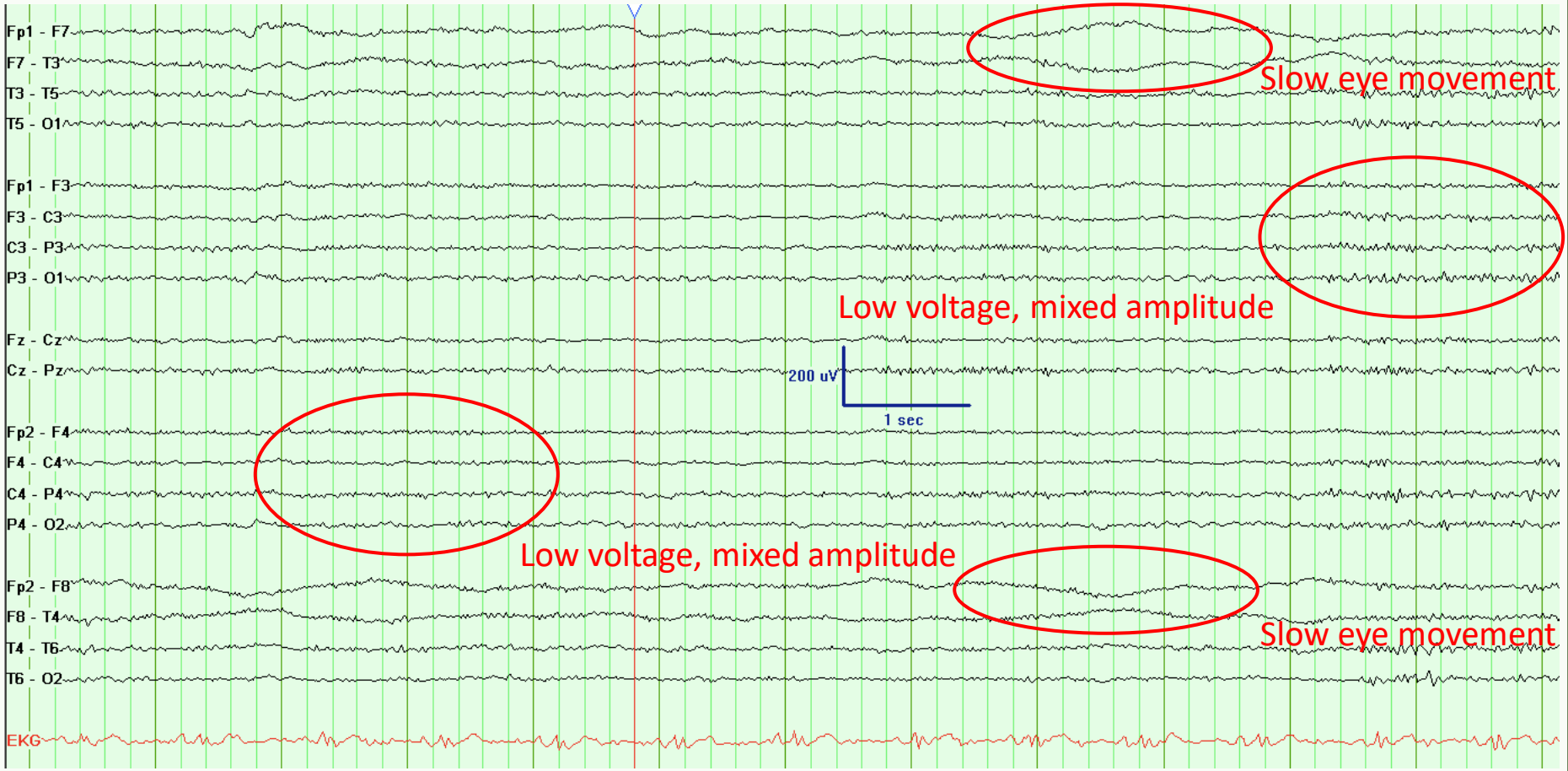
- Frequency 4-7Hz (most common 6-7Hz)
- Voltage : similar to alpha rhythm
- Occurrence: irregular, occur randomly intermized with other frequencies
- Location : frontal, fronto-central region, symmetric, enhance with drowsiness/light sleep

Normal sleep EEG

Sleep stage

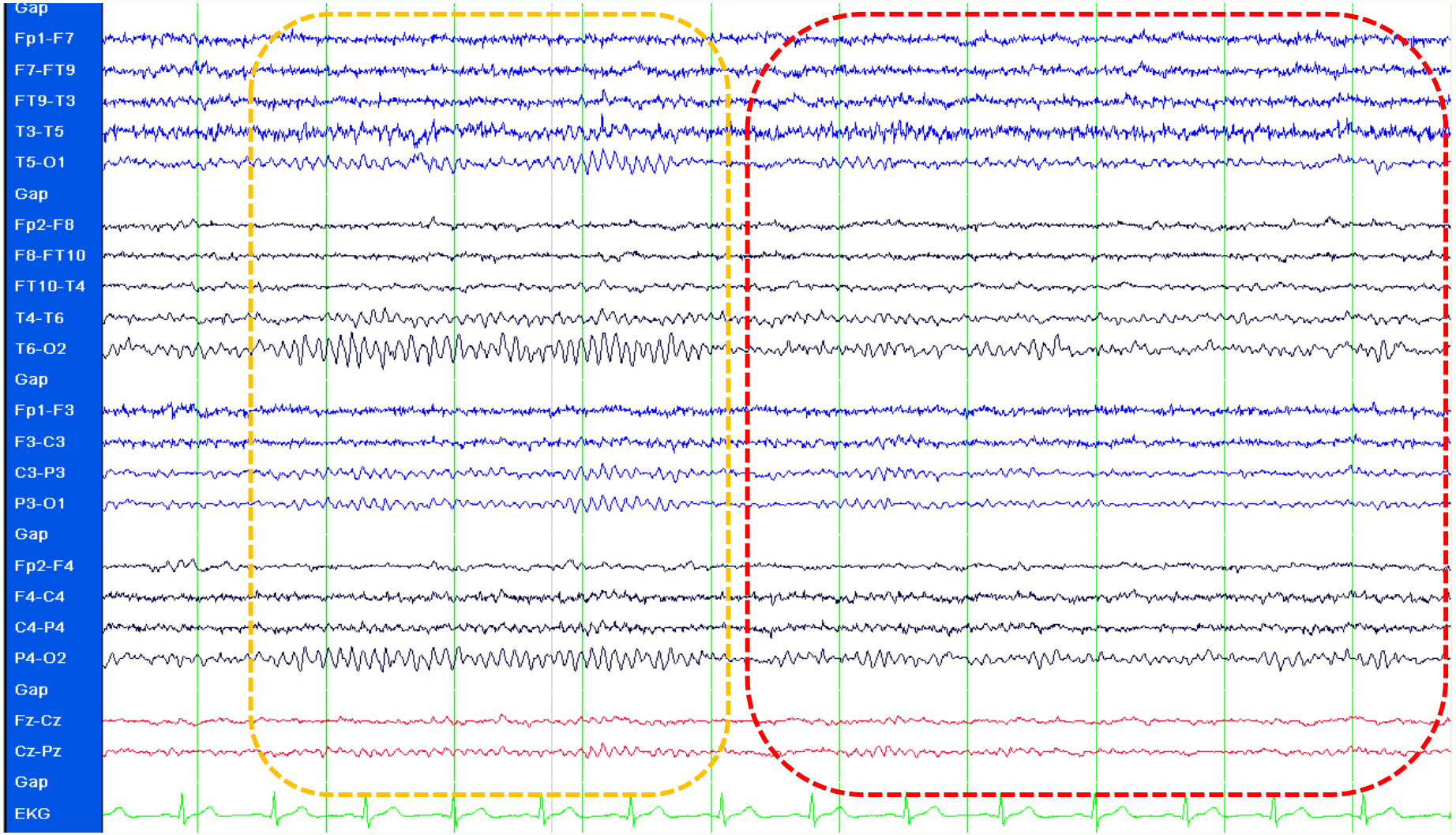
- Stage I (N1) : 5-10%
- Stage II (N2): 45-55%
- Stage III (slow wave sleep: N3) : 20-40%
- REM (rapid eyes movement) : 15-25%

Sleep stage N1

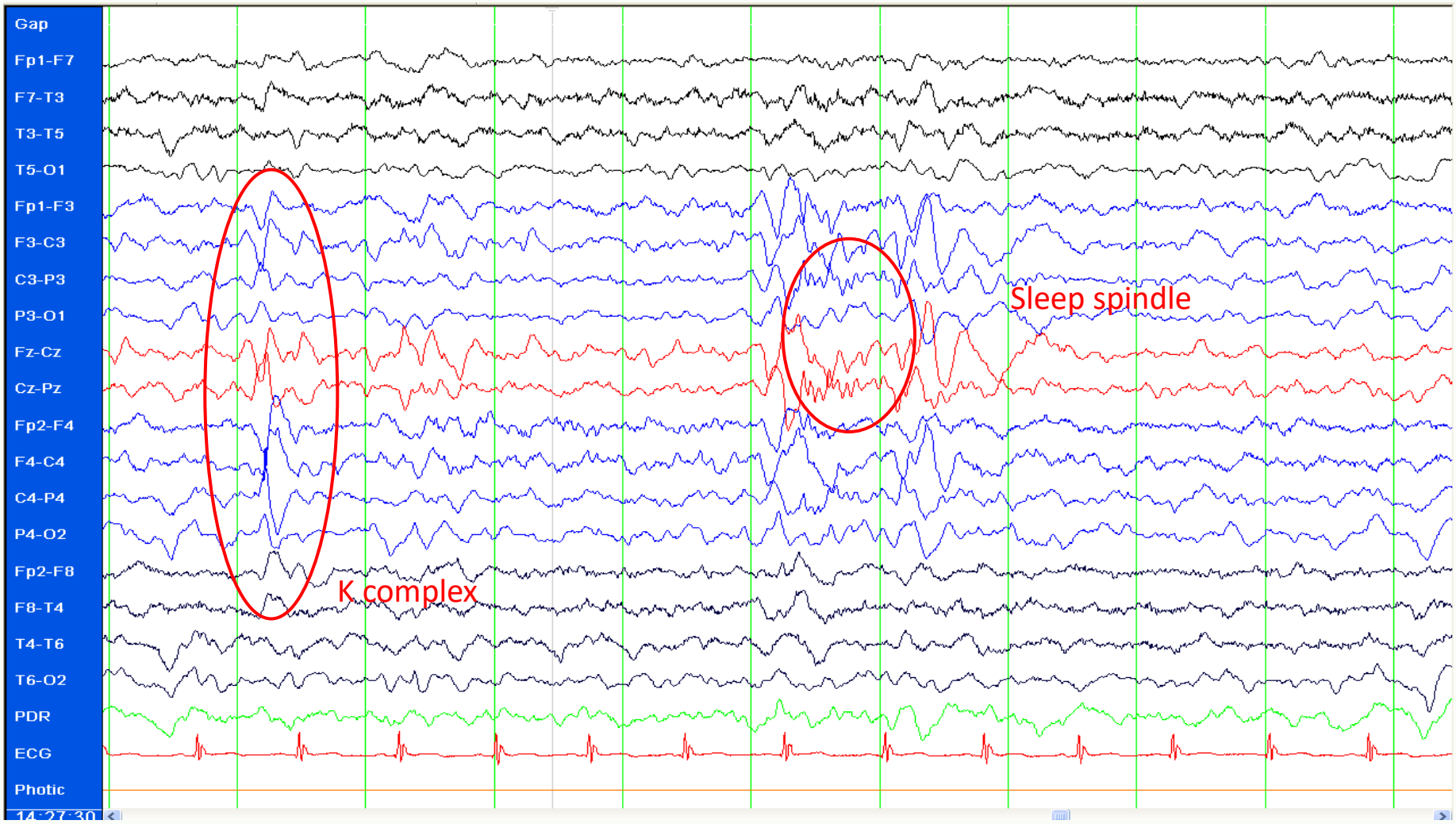


Sleep stage N1

- Slow eye movement (SEM)
- Low-amplitude, mixed frequency EEG activity (LAMF)
- Vertex sharp transient : sharply contoured waves with duration < 0.5 sec, maximal over the central region and distinguishable from the background activity. They are most often seen during transition stage N1 sleep but can occur in either stage N1 or N2 sleep. These waveforms typically first appear at 4-6 months post term.


Gap
Fp1-F7
F7-FT9
FT9-T3
T3-T5
T5-O1
Gap
Fp2-F8
F8-FT10
FT10-T4
T4-T6
T6-O2
Gap
Fp1-F3
F3-C3
C3-P3
P3-O1
Gap
Fp2-F4
F4-C4
C4-P4
P4-O2
Gap
Fz-Cz
Cz-Pz
Gap
EKG

Sleep stage N2

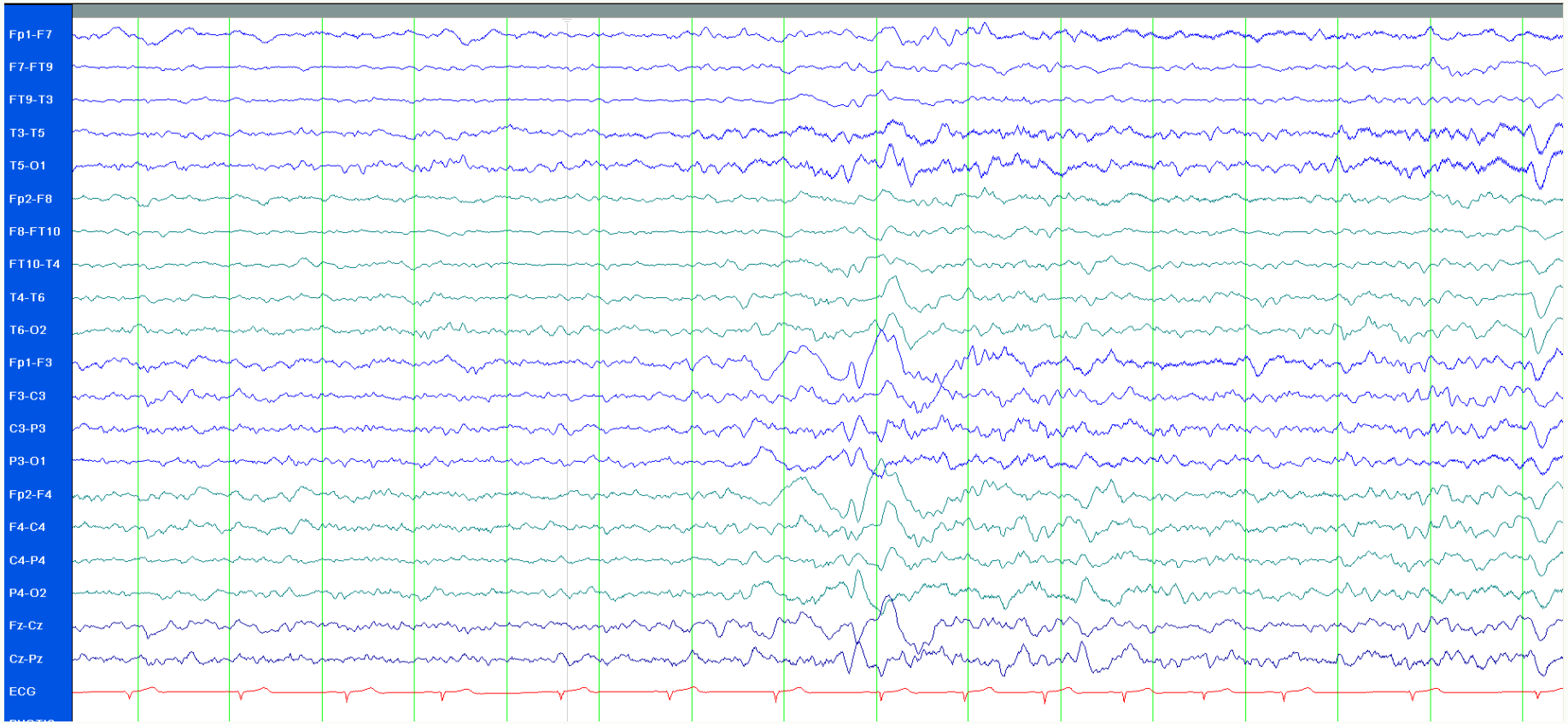


Sleep stage N2

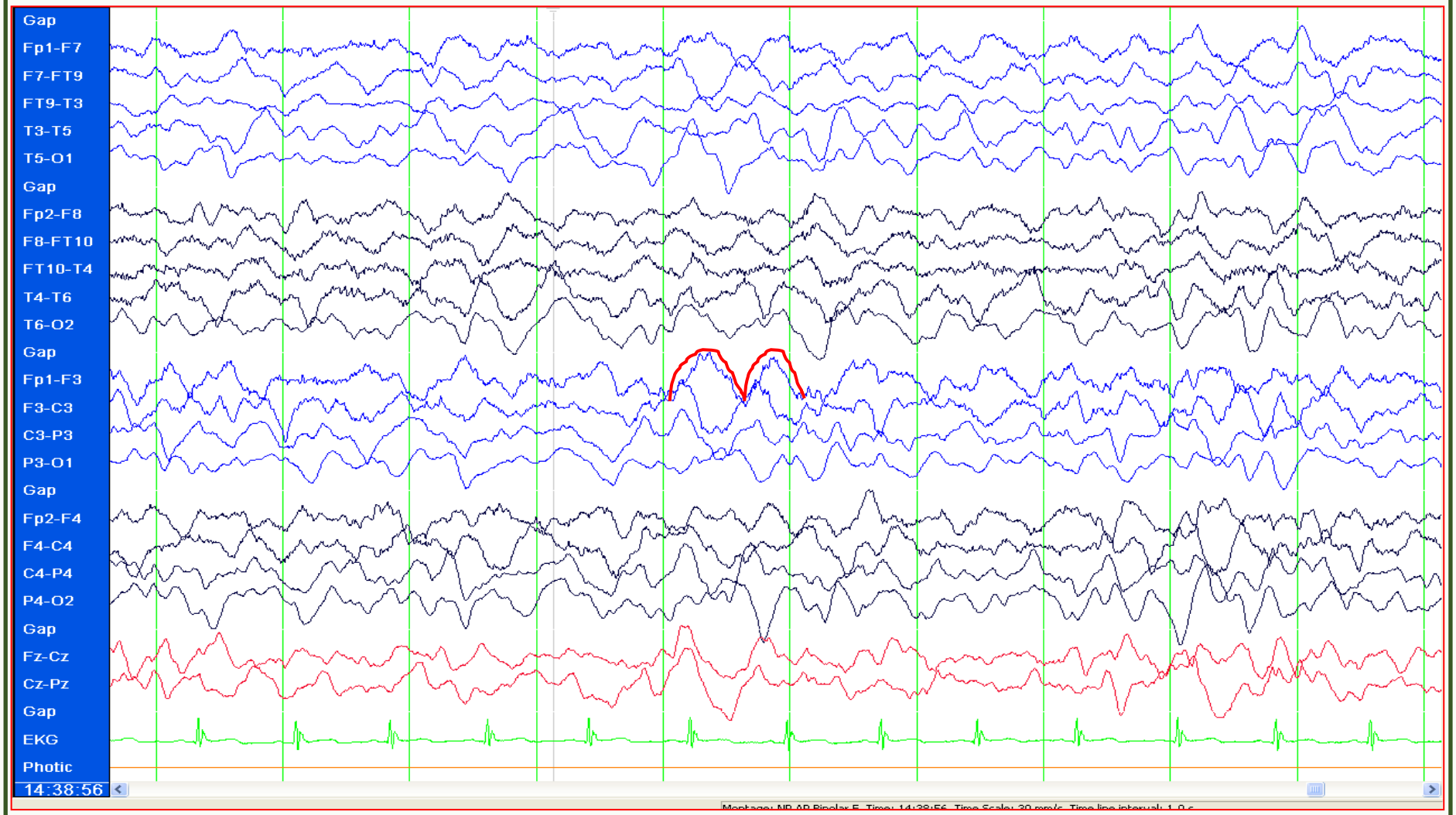
- K complex : a well-delineated, negative, sharp wave immediately followed by a positive component standing out from the background EEG, with total duration ≥ 0.5 sec, usually maximal in amplitude when recorded using frontal derivations.

- Sleep spindle: a train of distinct sinusoidal waves with frequency 11-16Hz (most commonly 12-14Hz) with a duration ≥ 0.5 sec, usually maximal in amplitude in the central derivations.

Sleep stage N2



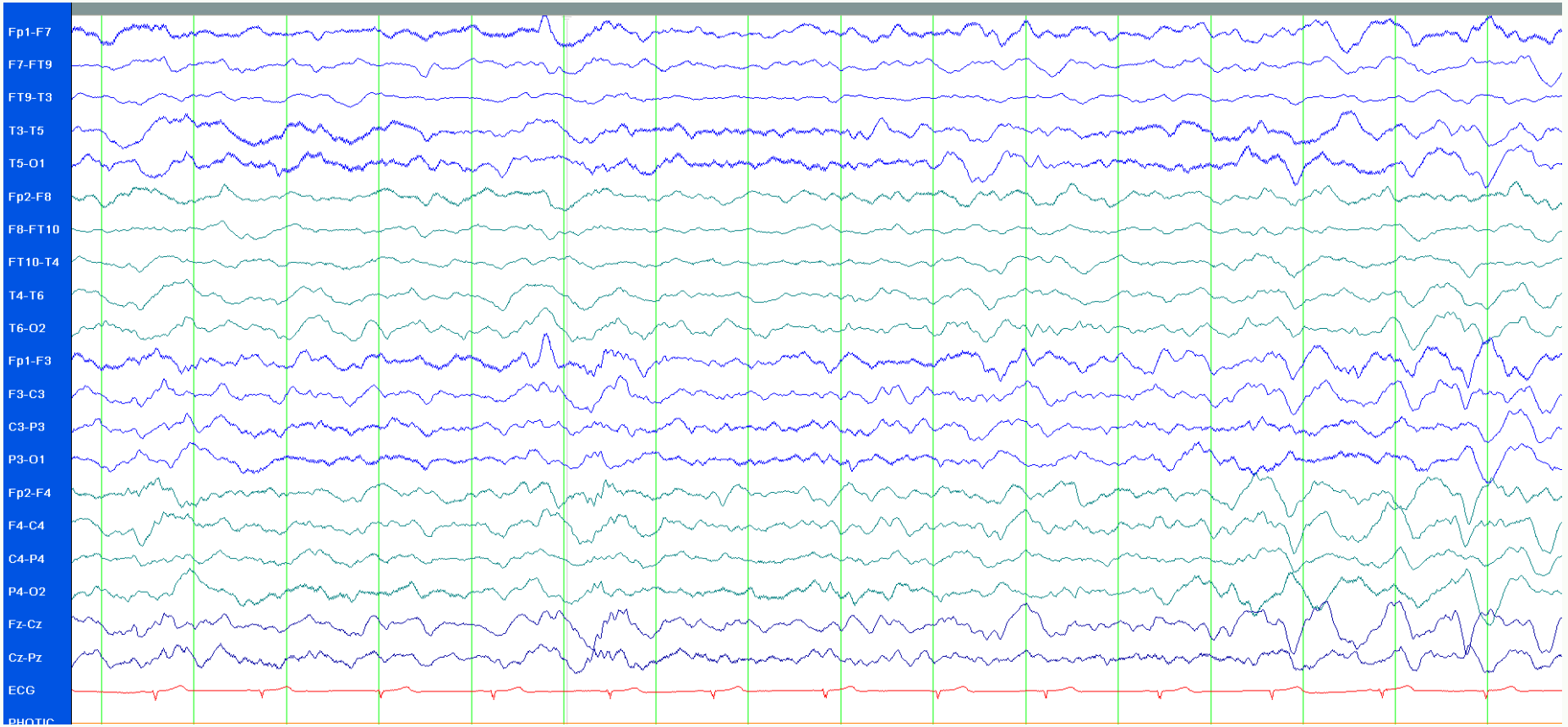
Sleep stage N3



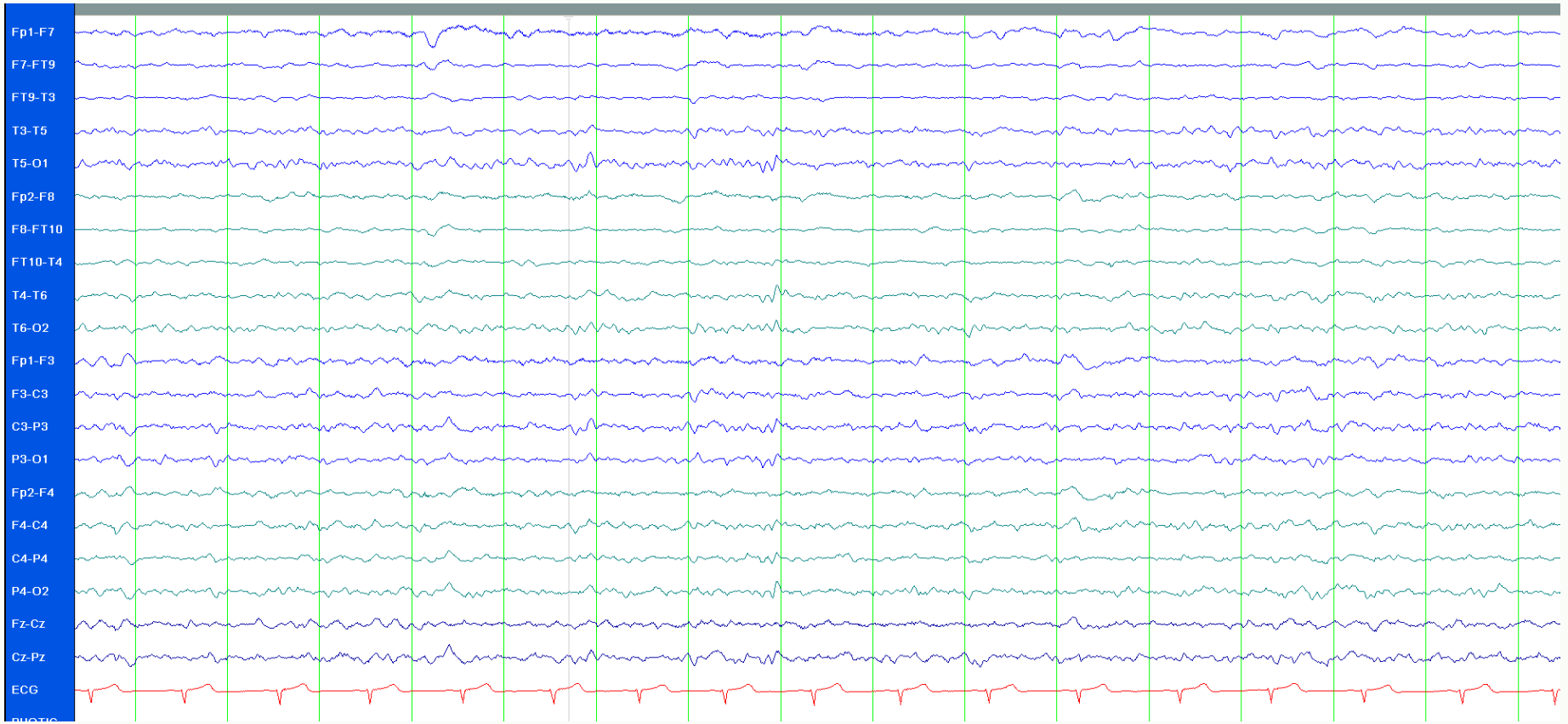
Sleep stage N3

- Slow wave activity : waves of frequency 0.5-2Hz and peak to peak amplitude > 75µV, ≥ 50 % of tracing

Sleep stage N3



Sleep stage REM



Sleep stage REM

- Rapid eye movement (REMs): conjugate, irregular, sharply peaked eye movements with an initial deflection usually lasting <500 msec.

- Sawtooth waves: An EEG pattern consisting of trains of sharply contoured or triangular, often serrated, 2-6Hz waves maximal in amplitude over the central head regions and often, but not always, preceding a burst of REM

- LAMF EEG activity


Thank You!