



# Epileptiform Abnormalities

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# Interictal Epileptiform Discharges (IED)

“ Distinctive waveforms or complexes resembling those recorded in a proportion of human subjects suffering from epileptic disorders and in animals rendered experimentally ”

# IED



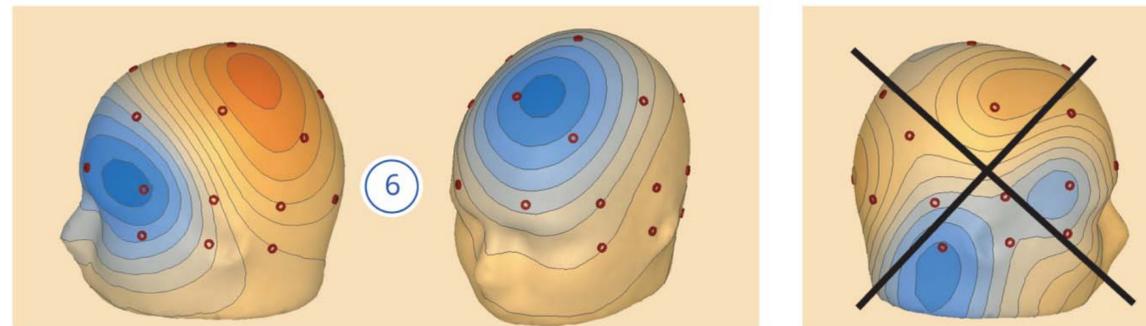
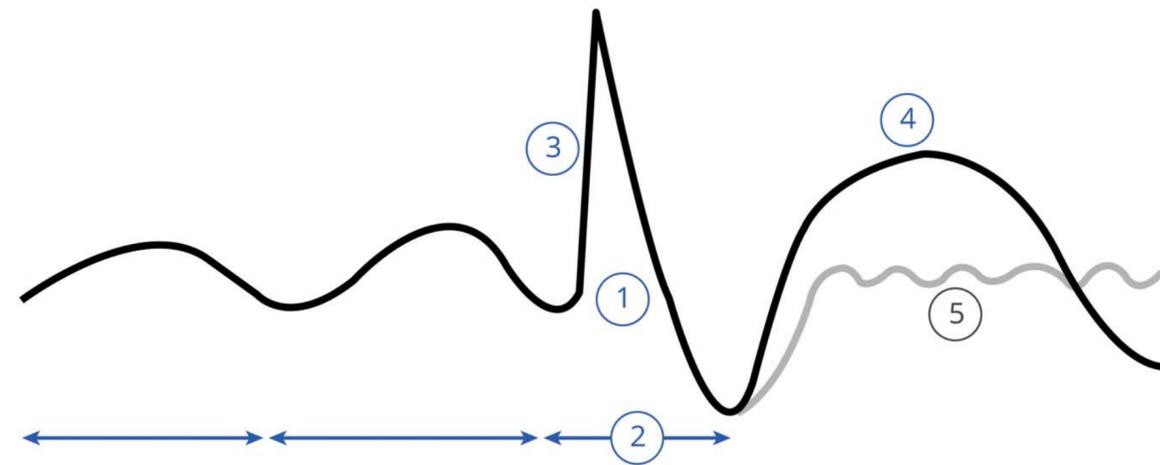
# Seizure

◆ EEG abnormalities that are associated with predisposition to experience or developing epileptic seizures

◆\*\* Predisposition : indicated that the association between epileptiform abnormalities and seizure is not absolute

- Taken together with the clinical history and other diagnostic test results
- Frequency of IED are not necessarily associated with a severity of epilepsy
- IEDs may help classify the epilepsy or epilepsy syndrome or localised epileptogenic zone

# Interictal Epileptiform Discharges



International Federation of Clinical Neurophysiology (IFCN)

Epileptiform patterns have to fulfill at least 4 of the following 6 criteria

- 01 Di- or tri-phasic waves with sharp or spiky morphology (i.e. pointed peak).
- 02 Different wave-duration than the ongoing background activity, either shorter or longer.
- 03 Asymmetry of the waveform: a sharply rising ascending phase and a more slowly decaying descending phase, or vice versa.
- 04 The transient is followed by an associated slow after-wave.
- 05 The background activity surrounding epileptiform discharges is disrupted by the presence of the epileptiform discharges.
- 06 Distribution of the negative and positive potentials on the scalp suggests a source of the signal in the brain, corresponding to a radial, oblique or tangential orientation of the source (see dipole).

# Focal

# Generalized

CATEGORIES

Spikes

Sharp waves

PLEDs

TIRDA

3-Hz Spike-and-wave

Atypical Spike-and-slow-wave

Slow spike-and-wave discharges

Generalized repetitive fast discharge  
(GFRD)

01

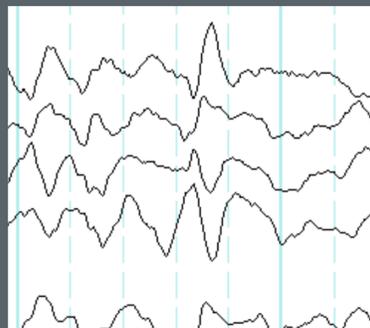
# Focal IED

# Focal IED

## Sharp waves

70 - 200 MILLISECONDS

- \* Amplitude varies
- \* Does not apply distinctive physiological events such as Vx, lambda waves and POSTs



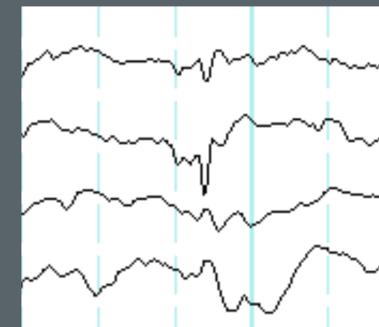
- \* A transient, clearly distinguished from background

- \* Surface negative, maybe followed by slow wave = spike-and-slow-wave complex

## Spike-waves

20-70 MILLISECONDS

- \* Amplitude varies but typically > 50 mV



# Focal spikes/Sharp waves : Location

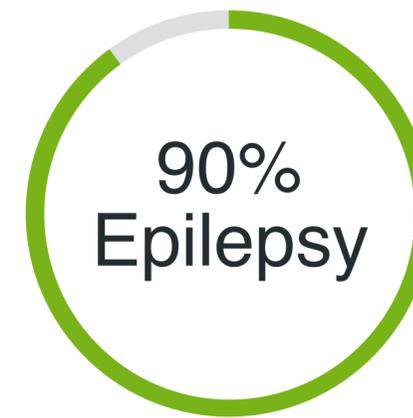
- ✱ Common Location

- ✱ Temporal > frontal > centrottemporal > parietal > occipital > midline central and/or paracentral

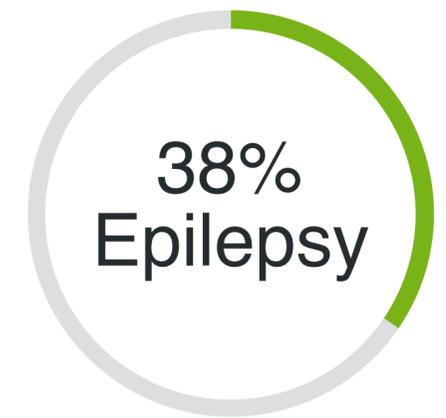
- ✱ The association with epilepsy is higher for temporal spikes/sharp waves than rolandic or occipital spikes/sharp waves

- ✱ Occipital IEDs can be seen in migraine

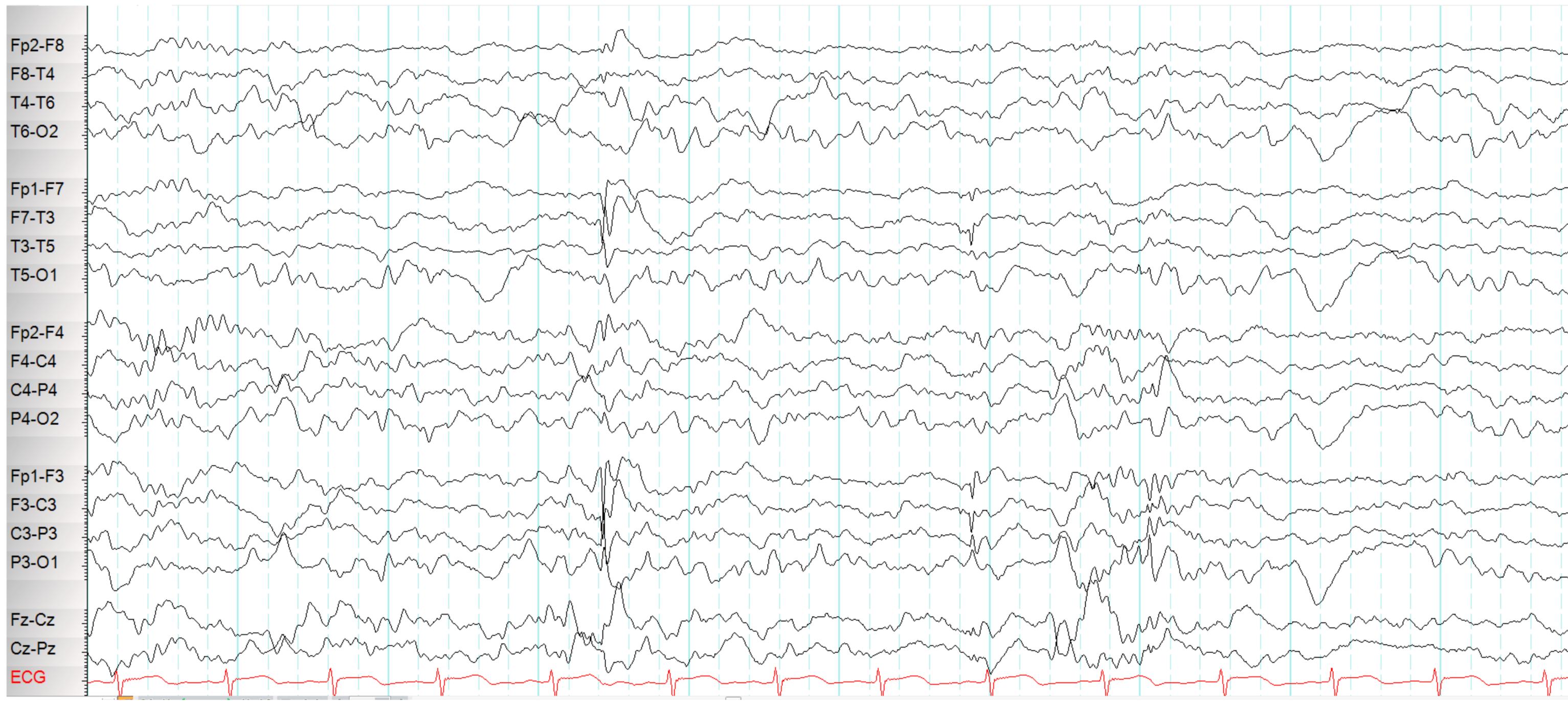
- ✱ Occipital “ Needle spikes” are seen in the EEG of children with congenital blindness, without seizure

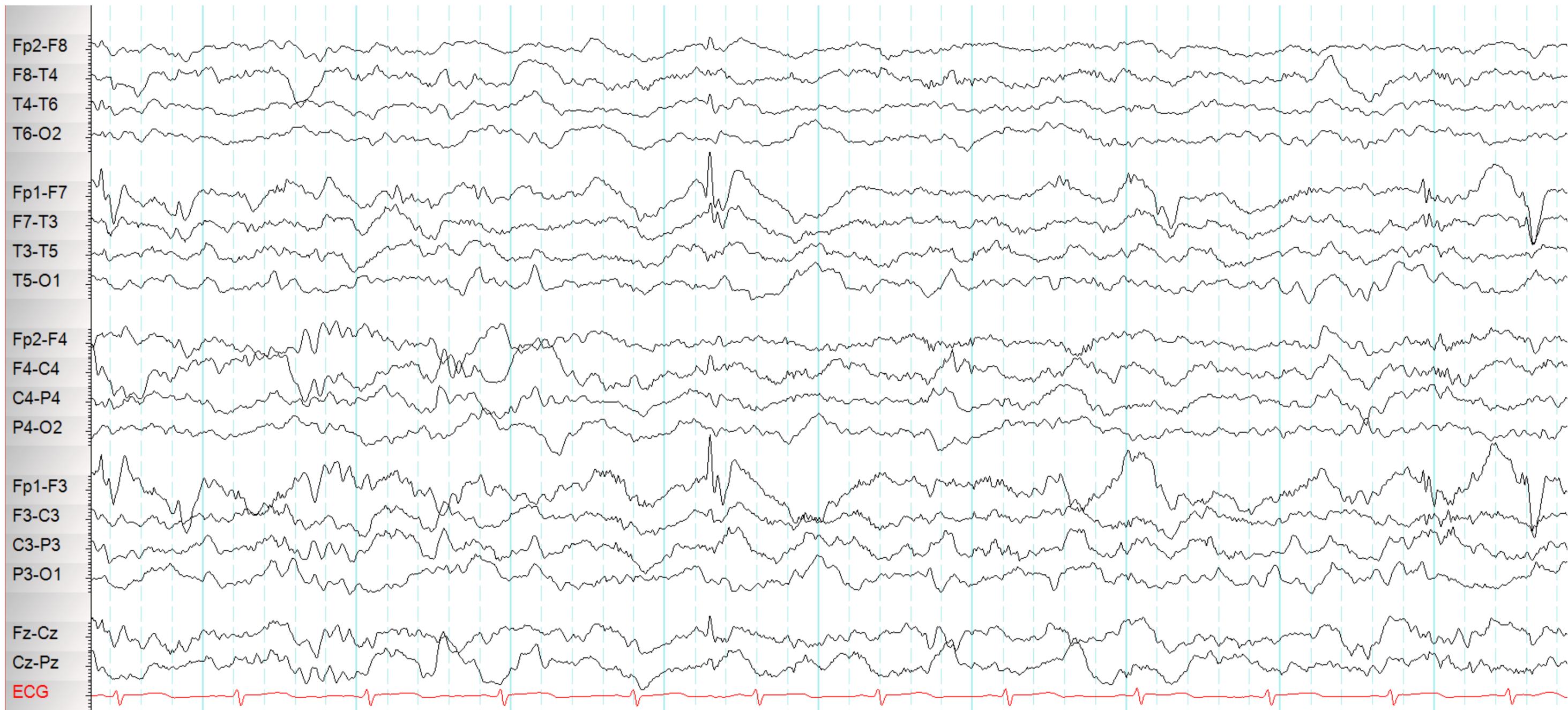


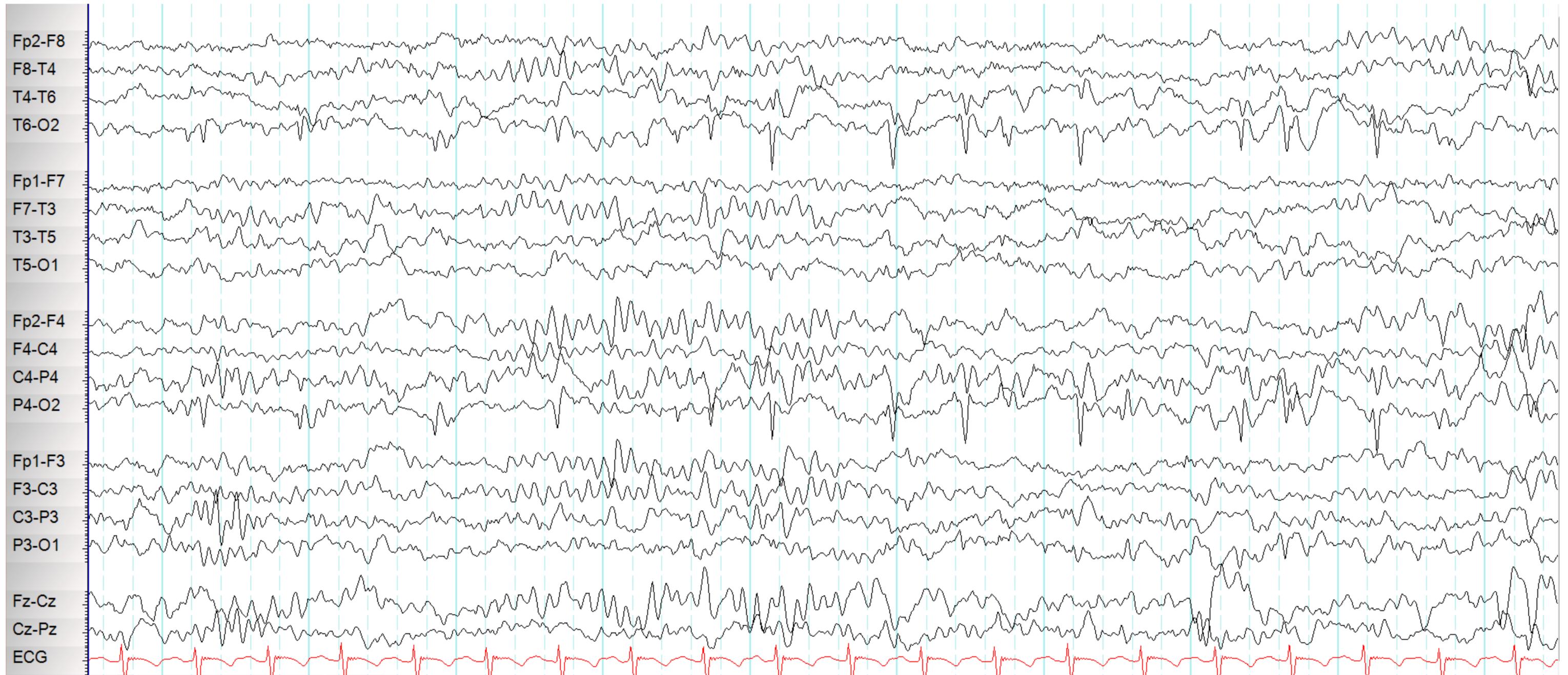
ANTERIOR TEMPORAL

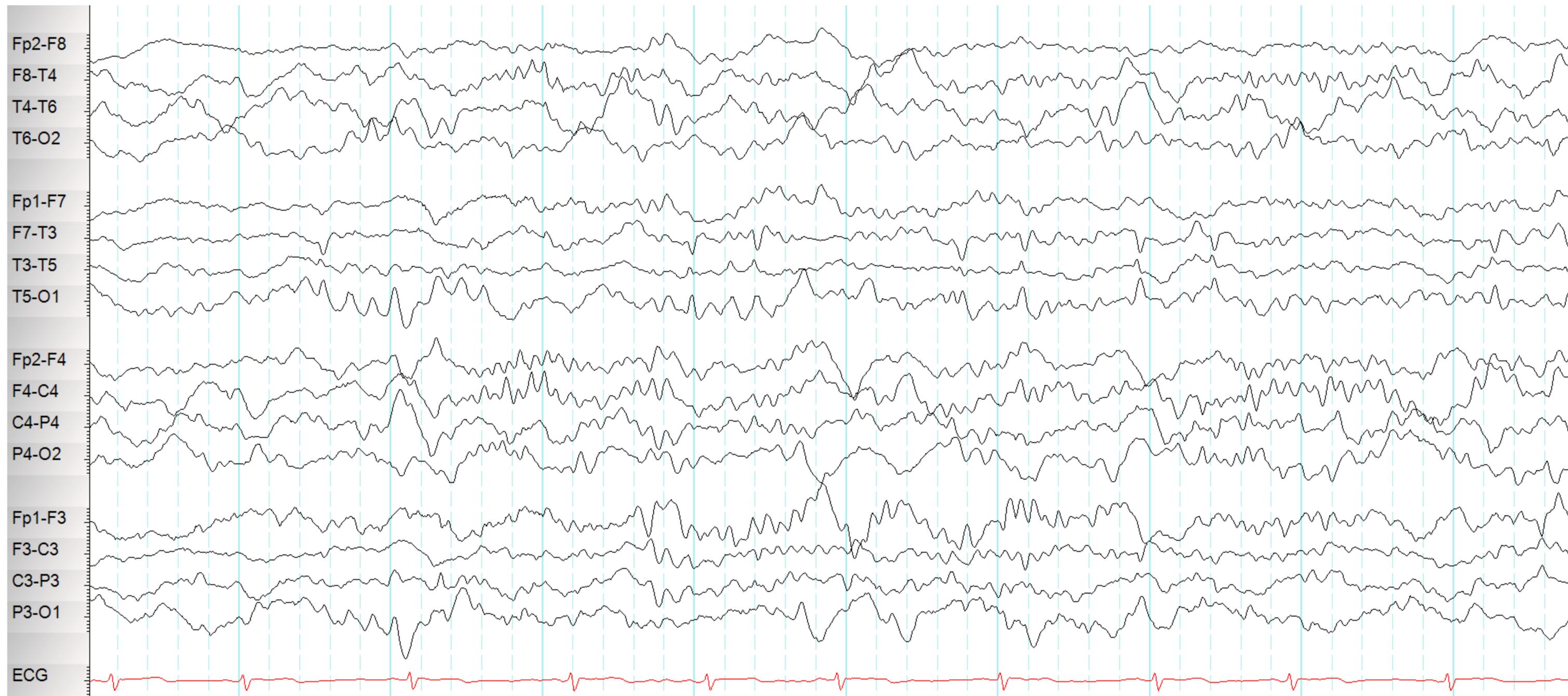


ROLANDIC



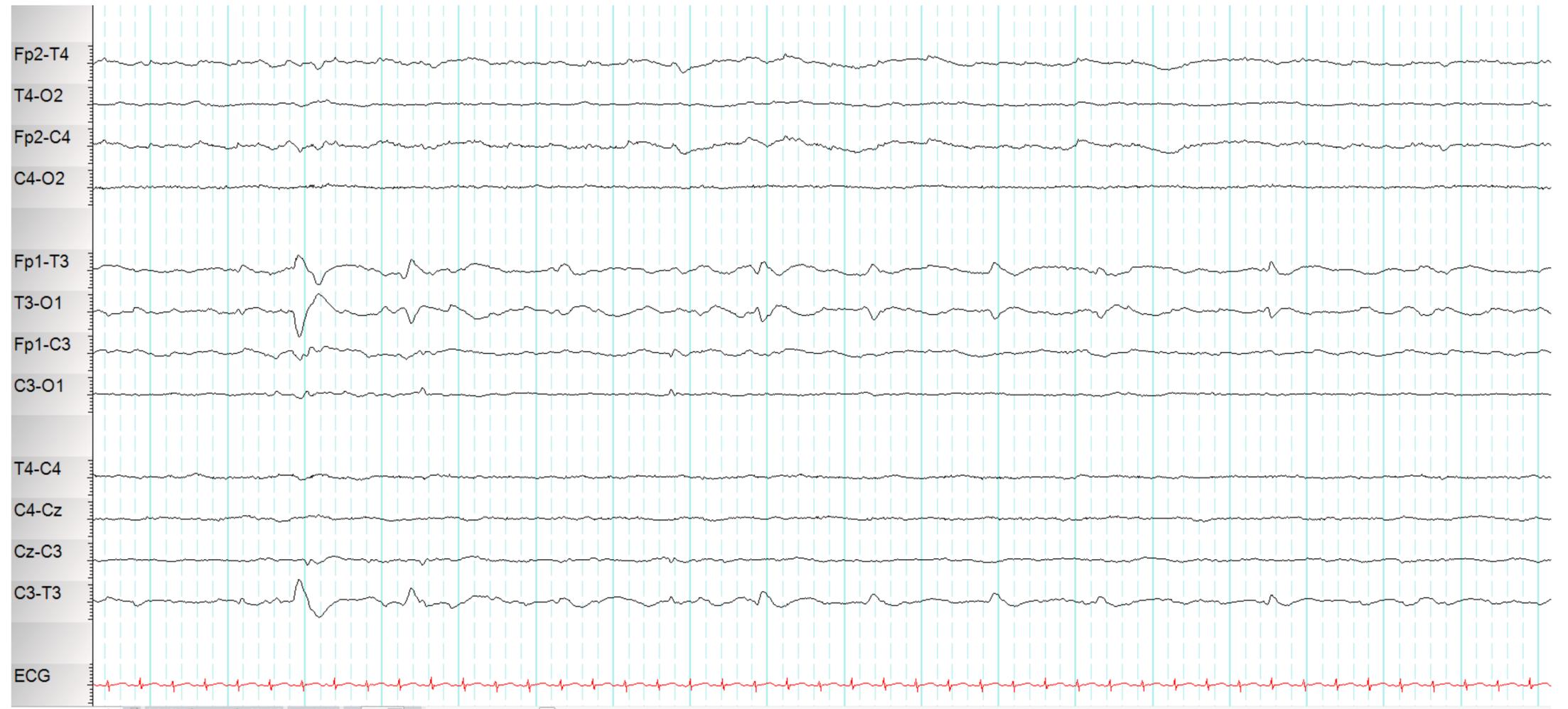






# Focal spikes/Sharp waves

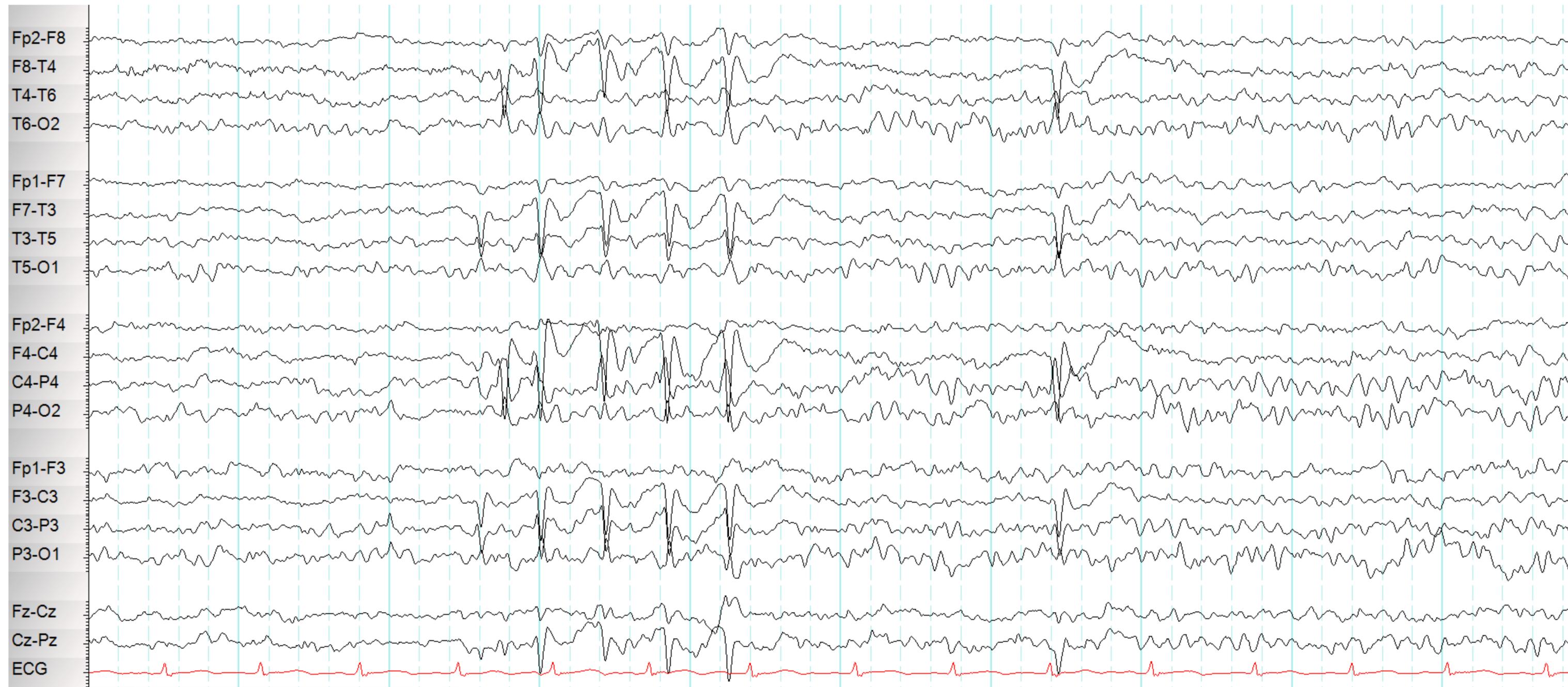
- ✱ Positive spikes/sharp waves are not common in adults
- ✱ Site of craniotomy
- ✱ Infants with intraventricular haemorrhage or white matter injury



# Focal spikes/Sharp waves

- \* Typical morphology, distribution and activation factors in benign, age-related syndrome
  - \* Benign epilepsy of childhood with centrotemporal spikes or benign rolandic epilepsy
  - \* Benign childhood epilepsy with occipital paroxysms
  - \* Early-onset Childhood Seizures with Occipital Spikes (Panayiotopolous syndrome)

# BRE

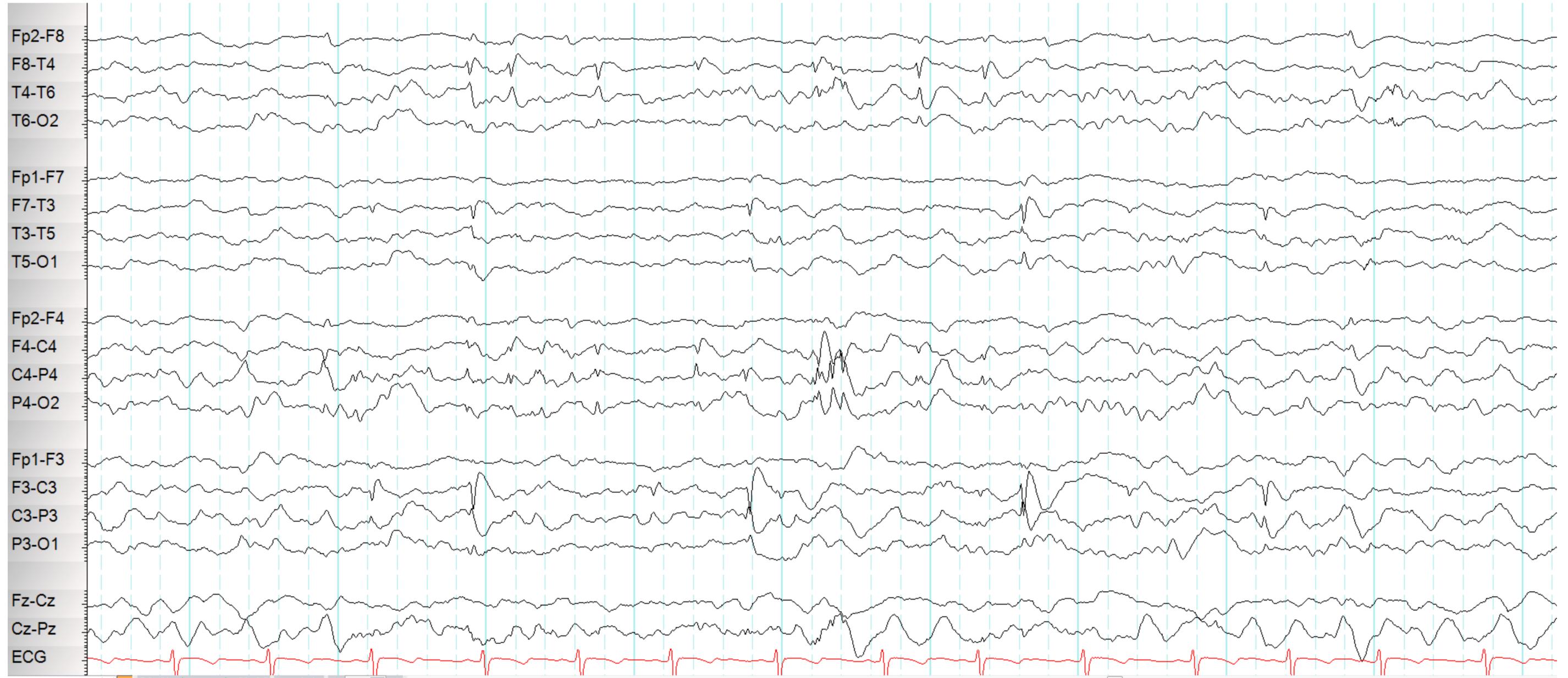




# Multifocal spikes/Sharp waves

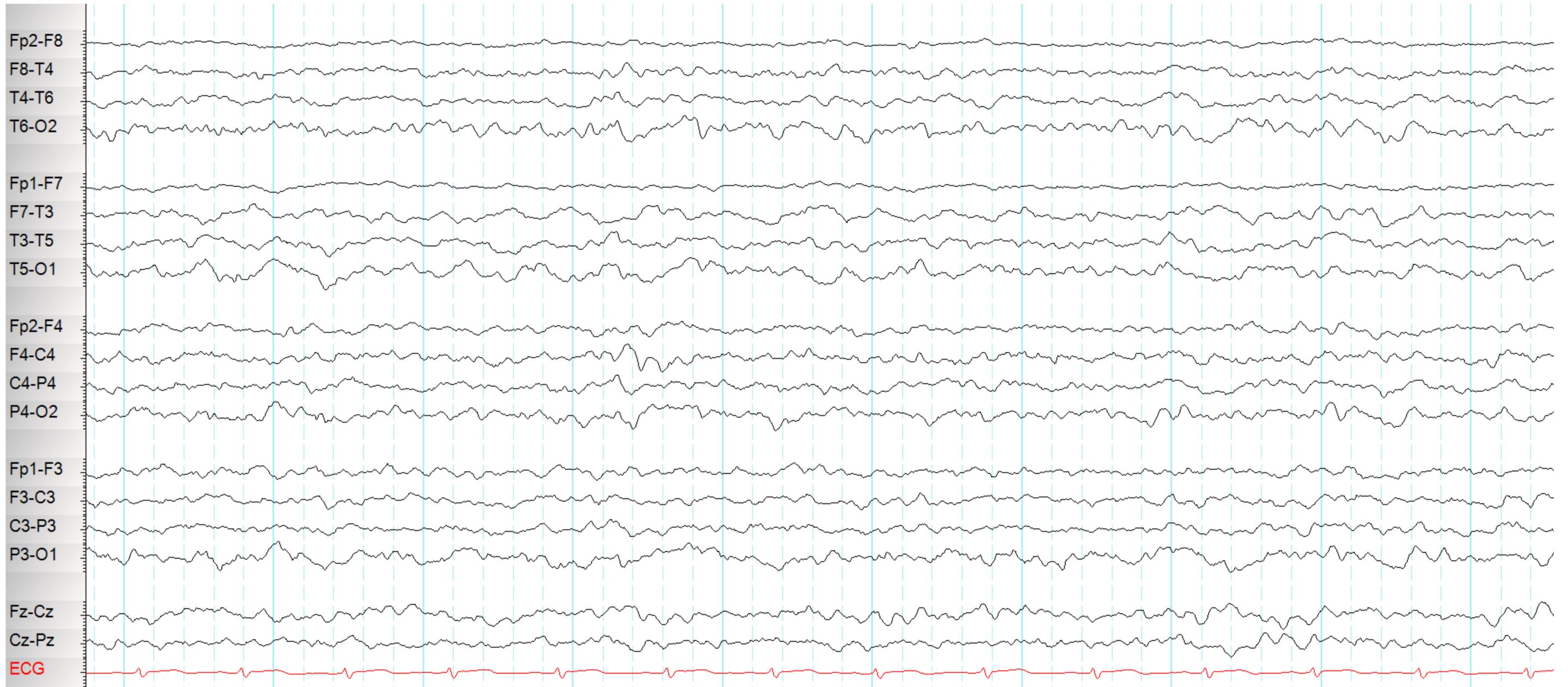
- ✱ Multiple independent foci of spikes or sharp waves involved both hemisphere
- ✱ Can be seen at any age, frequently in children aged 4 - 7 years
  - ✱ Nearly all of them have EEG background slowing
  - ✱ 94% of them have seizure
  - ✱ Generalized motor seizures are the most common (76%), 50% have daily seizure
  - ✱ Association with structural brain abnormalities or history of brain injury

# Multifocal spikes/Sharp waves



# Temporal Intermittent Rhythmic Delta Activity (TIRDA)

- \* Intermittent sinusoidal train of rhythmic delta waves from the temporal region, last several seconds, common frequency is 2 - 3 Hz
- \* Seen in awake and sleep, prominent in drowsiness
- \* Highly associated with temporal lobe seizures and/or underlying structural lesions (2/3 of patients)
- \* Temporal depth electrode recording during TIRDA showed active spiking activity in mesial temporal structures



# Periodic Lateralized Epileptiform Discharges (PLEDs)

- \* Epileptiform discharges or complexes that recur with regular periodicity in one hemisphere, usually every 0.3 - 0.4 seconds, monophasic or polyphasic spikes or sharp waves
- \* Focal, regional or diffusely affecting entire hemisphere, interval between PLEDs lengthens over days-weeks
- \* Highly associate with acute cerebral disorders, especially structural lesions such as stroke, trauma, herpes encephalitis, tumor and abscess
- \* Rare cause ; metabolic encephalopathy, CJD, migraine, and toxic encephalopathy (aminophylline or alcohol intoxication)

# Periodic Lateralized Epileptiform Discharges (PLEDs)

- \* 50% of patient will develop seizure
- \* **PLEDs-plus** carries a much higher association with clinical seizures and status epilepticus compared to **PLEDs-proper**
- \* **BIPLEDs** = bilaterally discharges, dependent or independent, seen in patients with severe hypoxic encephalopathy or bilateral hemisphere destructive lesions
- \* **Multifocal PLEDs** = at least 3 foci of periodic activity involve two hemisphere - etiologies; multifocal strokes, infection., etc.-90% of patients have seizure



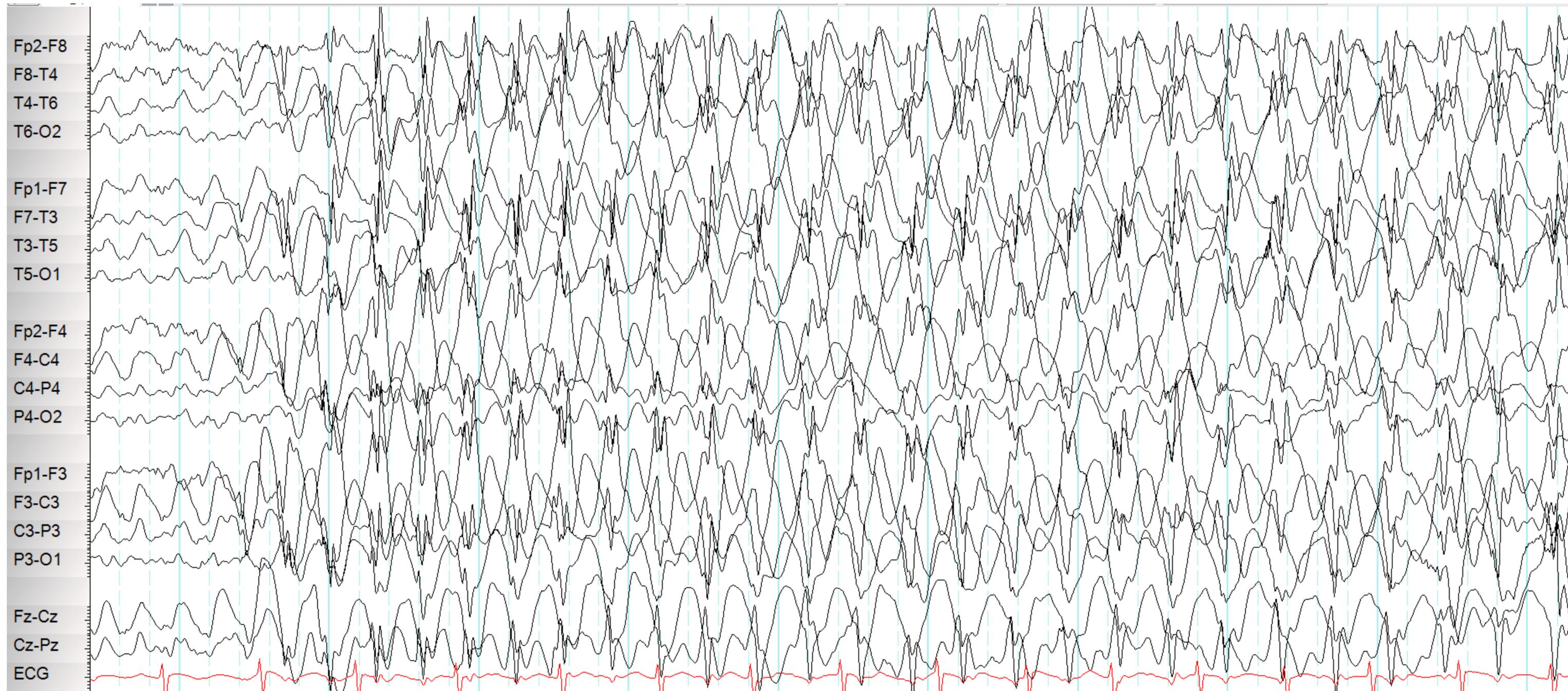
02

# Generalized IED

# 3 Hz Spike-and-Wave

- \* Bilateral spikes and after-coming slow waves -repeat rhythmically at a rate of three cycles per second
- \* Burst lasts 1-3 seconds, or longer when activated by hyperventilation or drowsiness
- \* Synchronous in timing and symmetry- difference between hemispheres can be detected, but no more than 20 milliseconds
- \* Amplitude prominent in midline frontal area
- \* Signature of absence epilepsy
- \* Must be aware of **Pseudo-absence events**

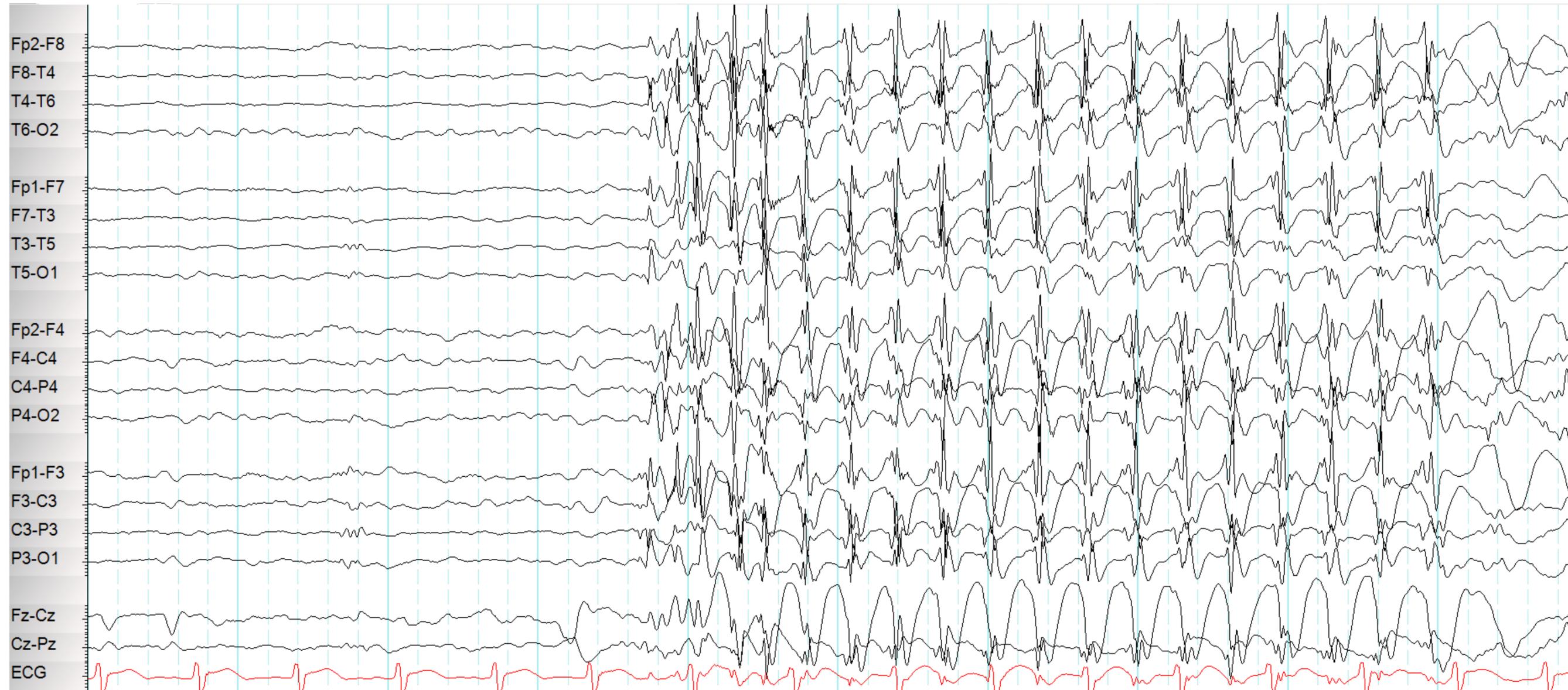
# 3 Hz Spike-and-Wave



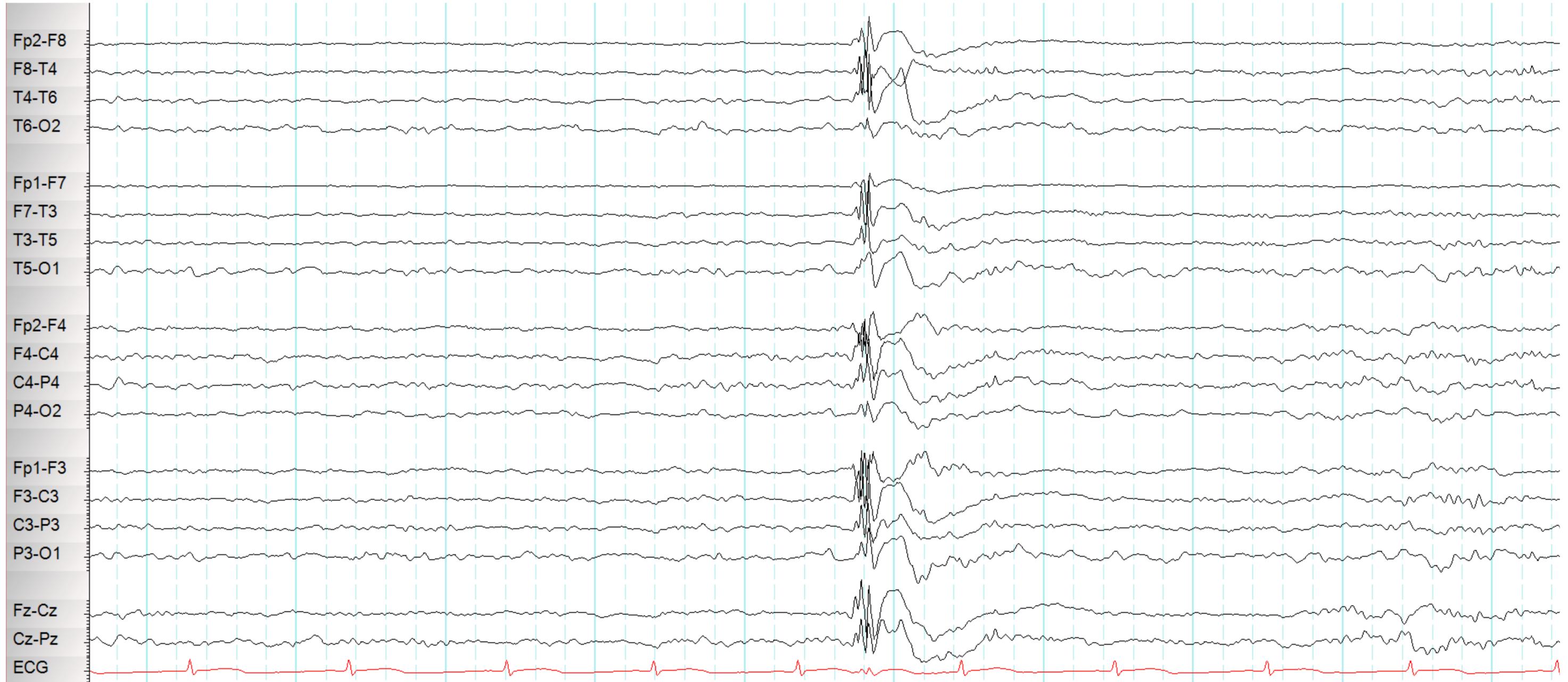
# Generalized Atypical Spike-and-Slow-Waves

- \* Resemble 3-Hz spike-and-waves discharges, but variable rates and spike component is often polyphasic
- \* Amplitude and morphology vary within and between bursts
- \* Enhanced by drowsiness and non-REM sleep
  
- \* Clinical correlation with primary generalised epilepsy - benign myoclonic epilepsy of early childhood, juvenile myoclonic epilepsy (JME), juvenile absence epilepsy and photosensitive epilepsy

# Generalized Atypical Spike-and-Slow-Waves

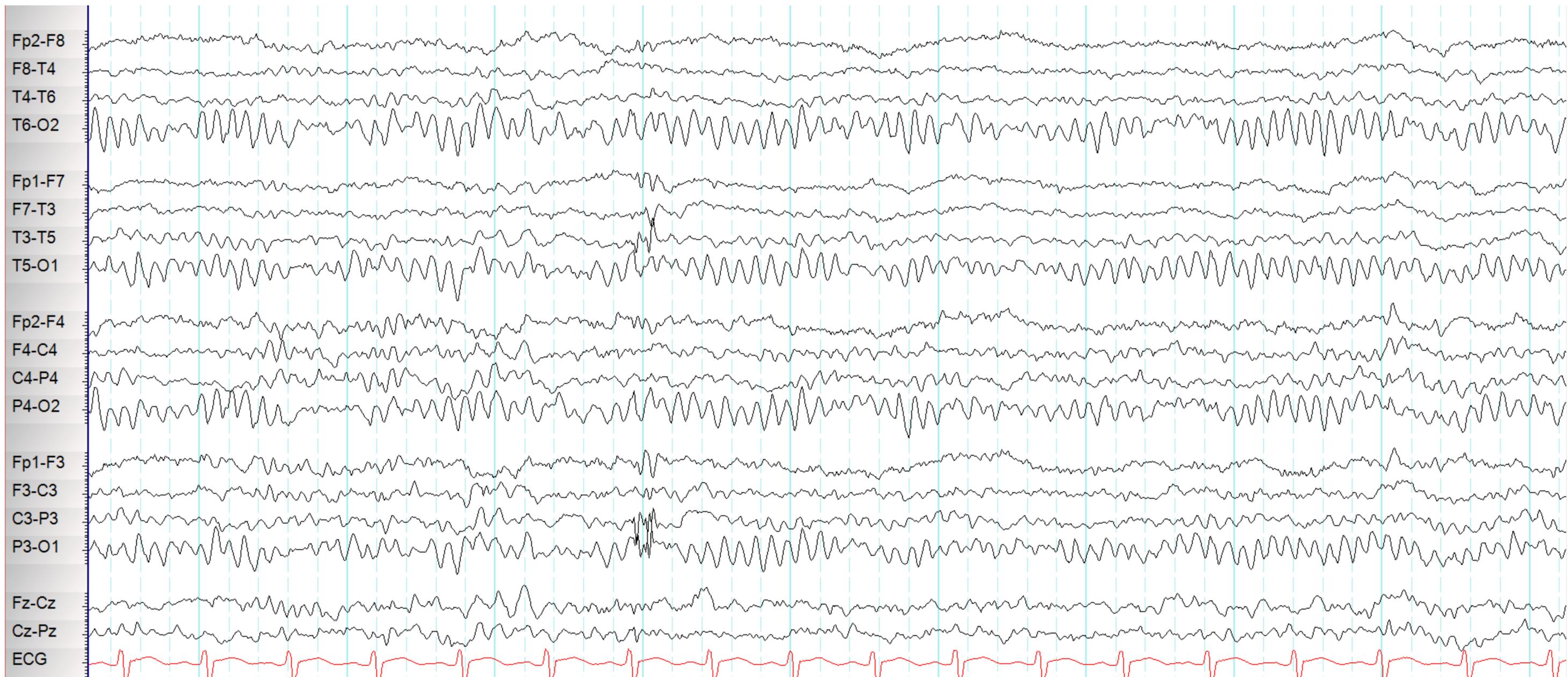


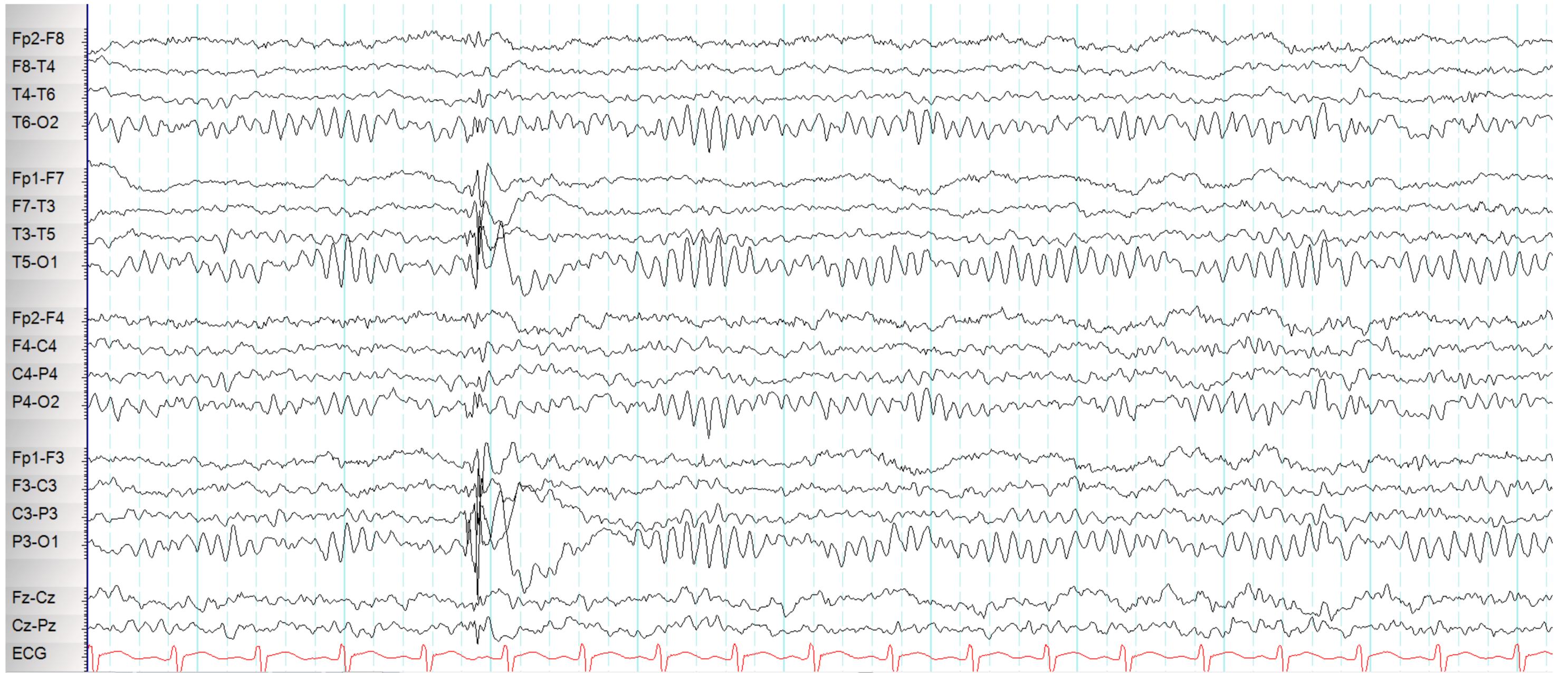
# Generalized polyspike-and-Slow-Waves



# Generalized Atypical Spike-and-Slow-Waves

- \* 3-Hz and atypical spike-and-slow-waves : focal spikes of low amplitude in the frontal and temporal areas during drowsiness





# Slow Spike-and-Waves (Sharp-and-Slow-Wave Complexes)

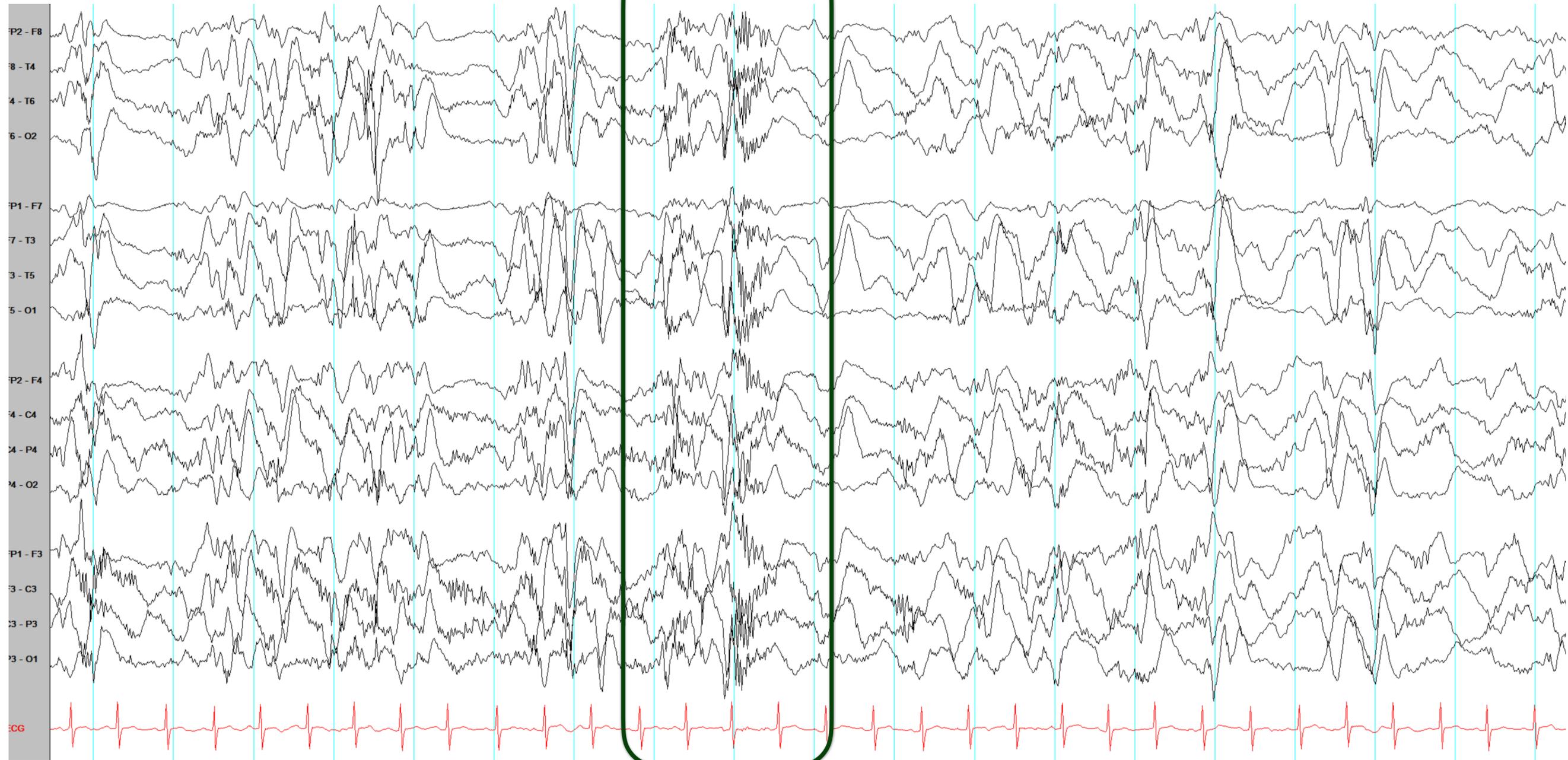
- \* Frequency around 1-2.5 Hz, mostly sharp waves - wide duration and blunt peaks
- \* Fluctuating asymmetry of amplitude is common
- \* Drowsiness or non-REM sleep may activated train -ESES?
- \* Enhanced by HV but not photic
- \* Seen in Lennox-Gastaut syndrome (LGS)

# Slow Spike-and-Waves



# Generalized Repetitive Fast Discharge (GRFD)

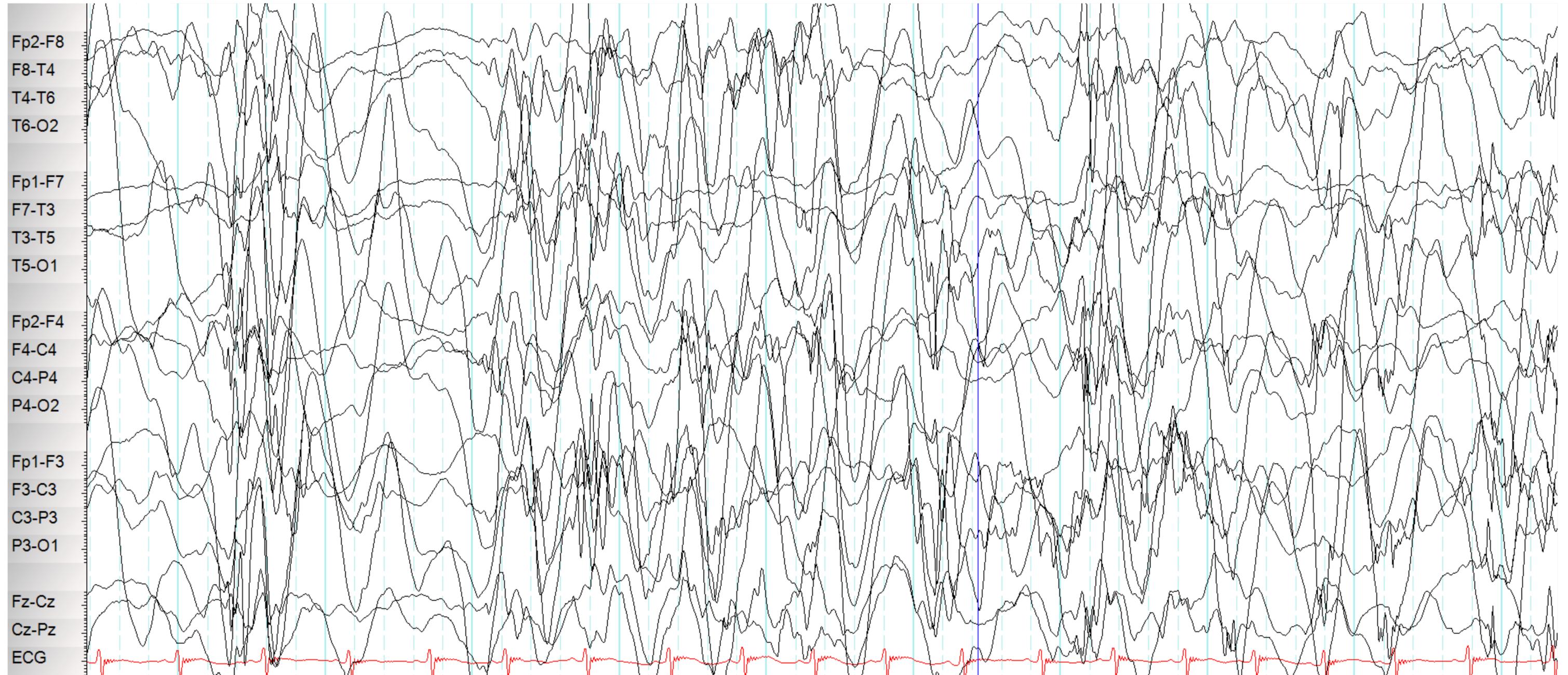
- \* Paroxysmal fast rhythm, generalised paroxysmal fast activity, or “runs of rapid spikes”
- \* Alpha or beta frequency range
- \* Generalized, low-to-medium amplitude, last less than 10 seconds
- \* Occur during sleep
- \* May be preceded or followed by generalised slow spike-and-wave discharge
- \* Considered an ictal rhythm- could be accompanied by tonic seizure
- \* Often associated with catastrophic epilepsy syndrome



# Hypsarrhythmia

- \* High-voltage background composed of disorganized slow theta and delta frequencies is seen in addition to nearly continuous multi-focal interictal epileptiform discharges

# Hypsarrhythmia



# Photo-epileptiform discharges

- \*IEDs elicited by intermittent photic stimulation
- \*Can be self-limited or self-sustaining
- \*Four categories
  - \*(1) Generalized (most common)
  - \*(2) Bilateral posterior dominant
  - \*(3) Bilateral occipital
  - \*(4) Focal unilateral (least common)
- \*77% of generalized photo-epileptiform discharges have seizure disorder, except bilateral occipital photo-epileptiform discharges are less commonly associated with epilepsy

