

EEG Monitoring in ICU

EEG Pattern in Encephalopathy and Coma

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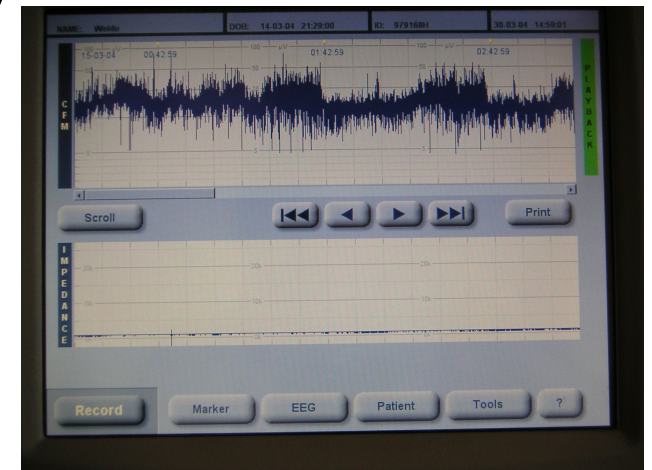
Faculty of Medicine Siriraj Hospital

Scope

1. Type of EEG monitoring in ICU
2. EEG pattern in encephalopathy / coma

EEG in ICU setting

- Continuous EEG (cEEG) monitoring
 - Using portable (real) EEG machine
- Amplitude-integrated EEG (aEEG) monitoring
 - Using aEEG machine
 - Cerebral Function Monitor (CFM)



cEEG

PROs

- ✓ Gold standard for seizure detection
- ✓ More leads
- ✓ Better sensitivity for focal, small seizure

CONs

- Require times for set up
- Need EEG technician
- Require neurologist to read
- More expensive

aEEG

PROs

- ✓ Easy set up
- ✓ Bedside interpretation by ICU staff

CONs

- ❖ May miss focal, small, brief seizure
- ❖ More artifact

cEEG monitoring: Benefit in ICU

- ✓ Seizure detection
- ✓ Severity of encephalopathy
- ✓ Possible etiologies ? (Some)
- ✓ Prognosis (etiology / EEG pattern)
- ✓ Response of treatment

Scope

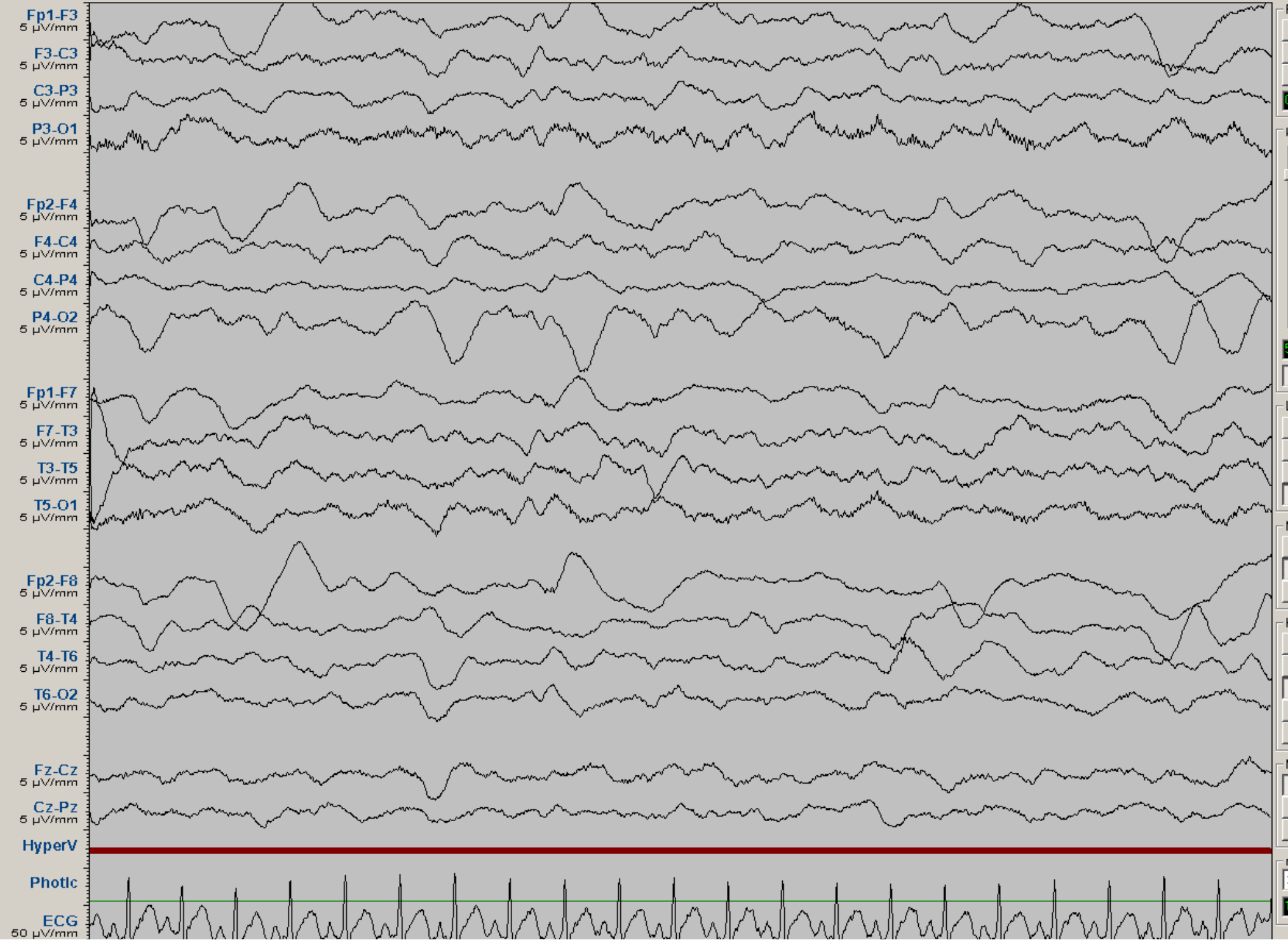
1. Type of EEG monitoring in ICU
2. EEG pattern in encephalopathy / coma
 - ❖ Severity of encephalopathy
 - Mild
 - Severe
 - ❖ Specific pattern

Severity of encephalopathy

Mild

- Continuous slow
- Intermittent slow
- Slow background

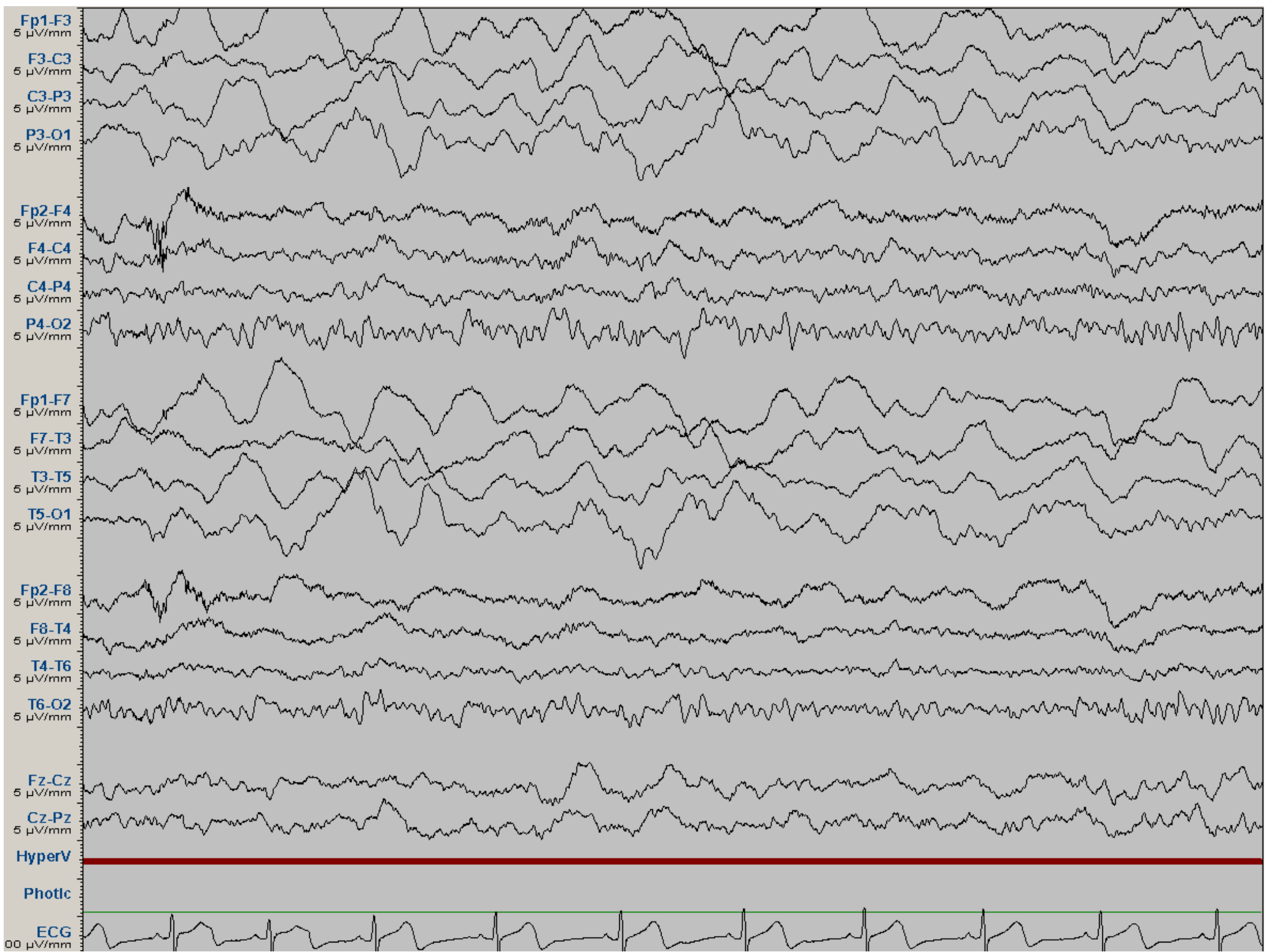
- ✓ Generalized
- ✓ Focal



Severity of encephalopathy

Mild

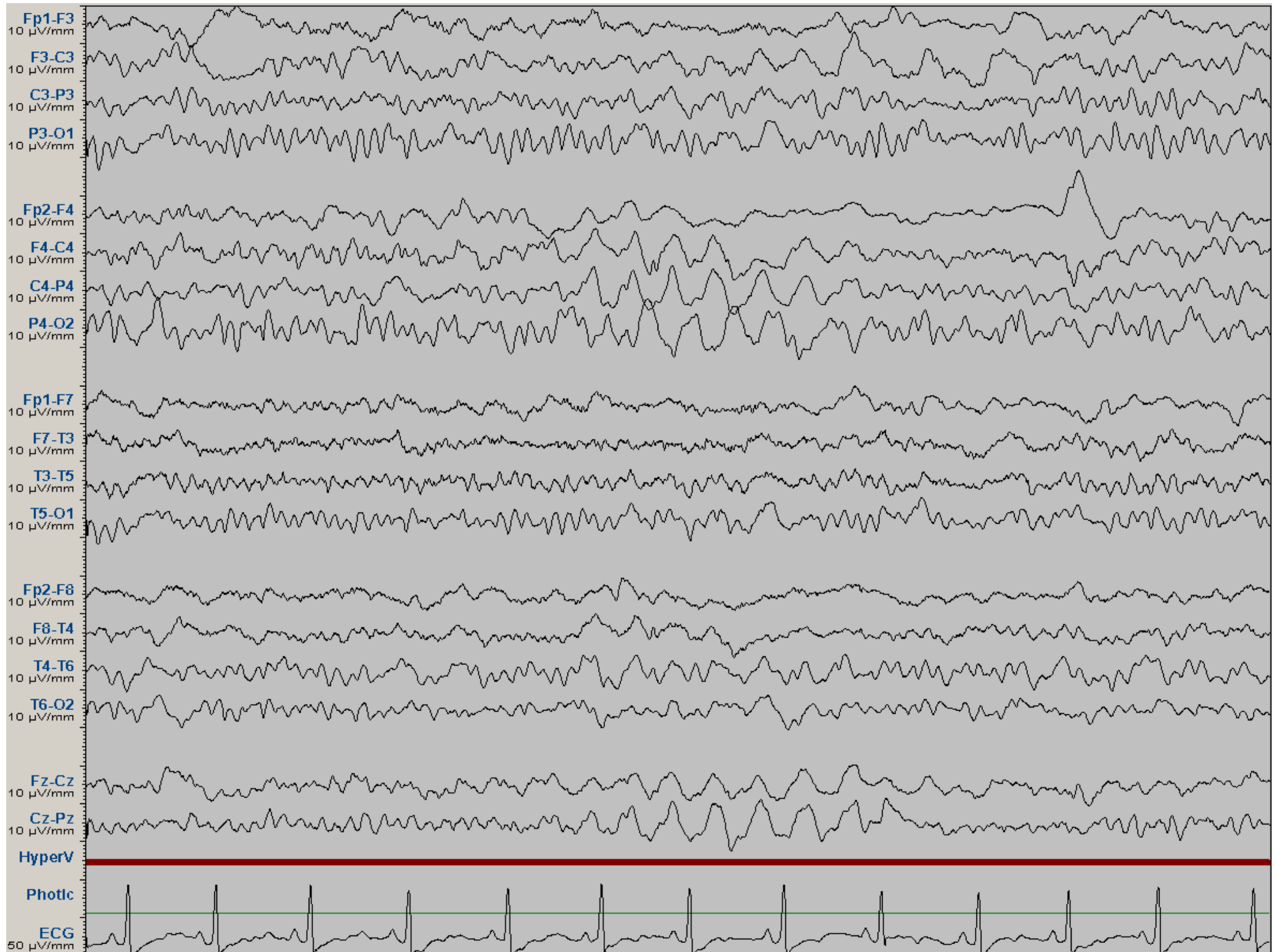
- Continuous slow
 - Intermittent slow
 - Slow background
-
- ✓ Generalized
 - ✓ Focal



Severity of encephalopathy

Mild

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- ✓ Generalized
 - ✓ Focal



Severity of encephalopathy

Mild

- Continuous slow
- Intermittent slow
- Slow background

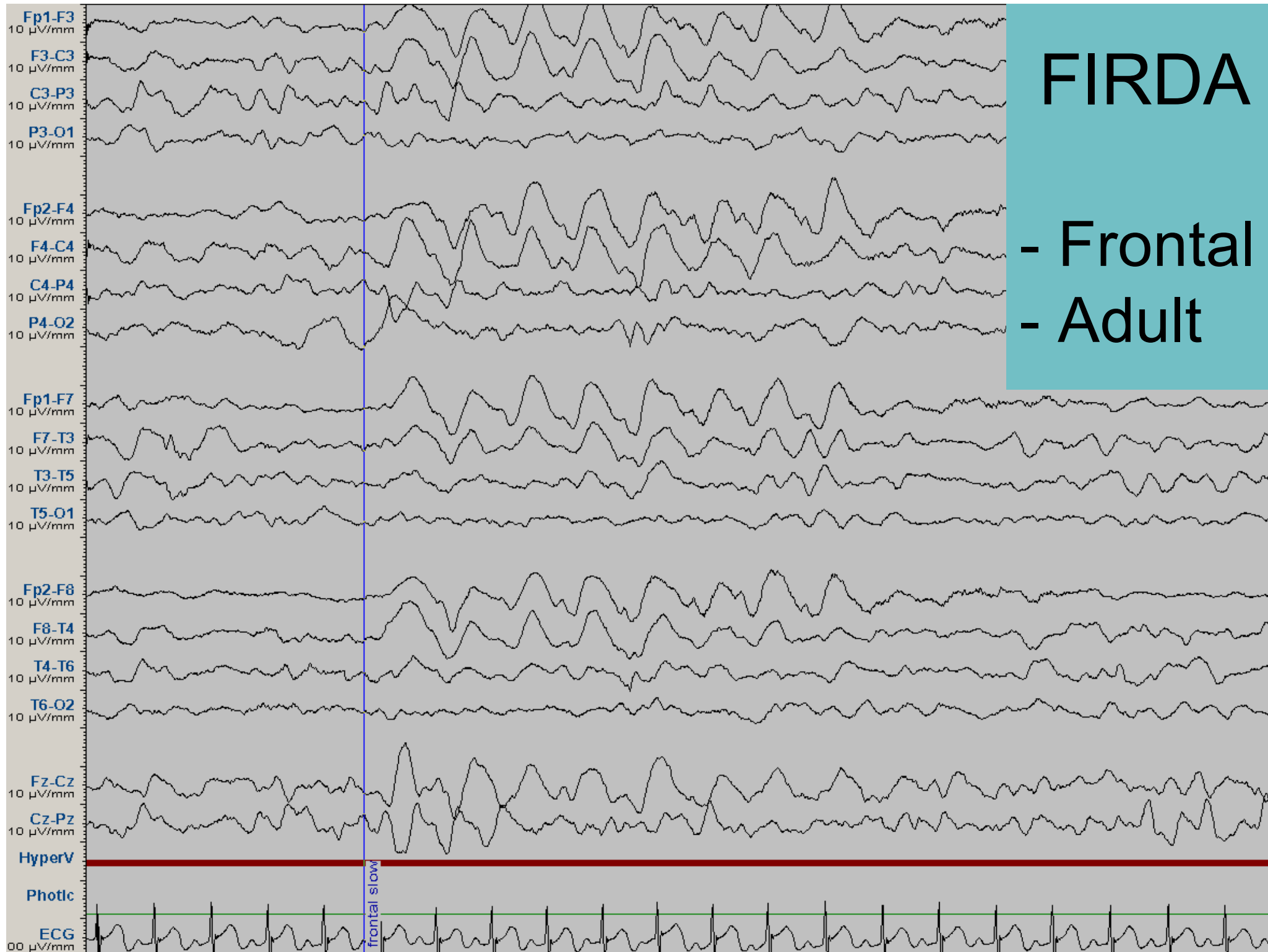
- ✓ Generalized & Rhythmic
- ✓ Focal

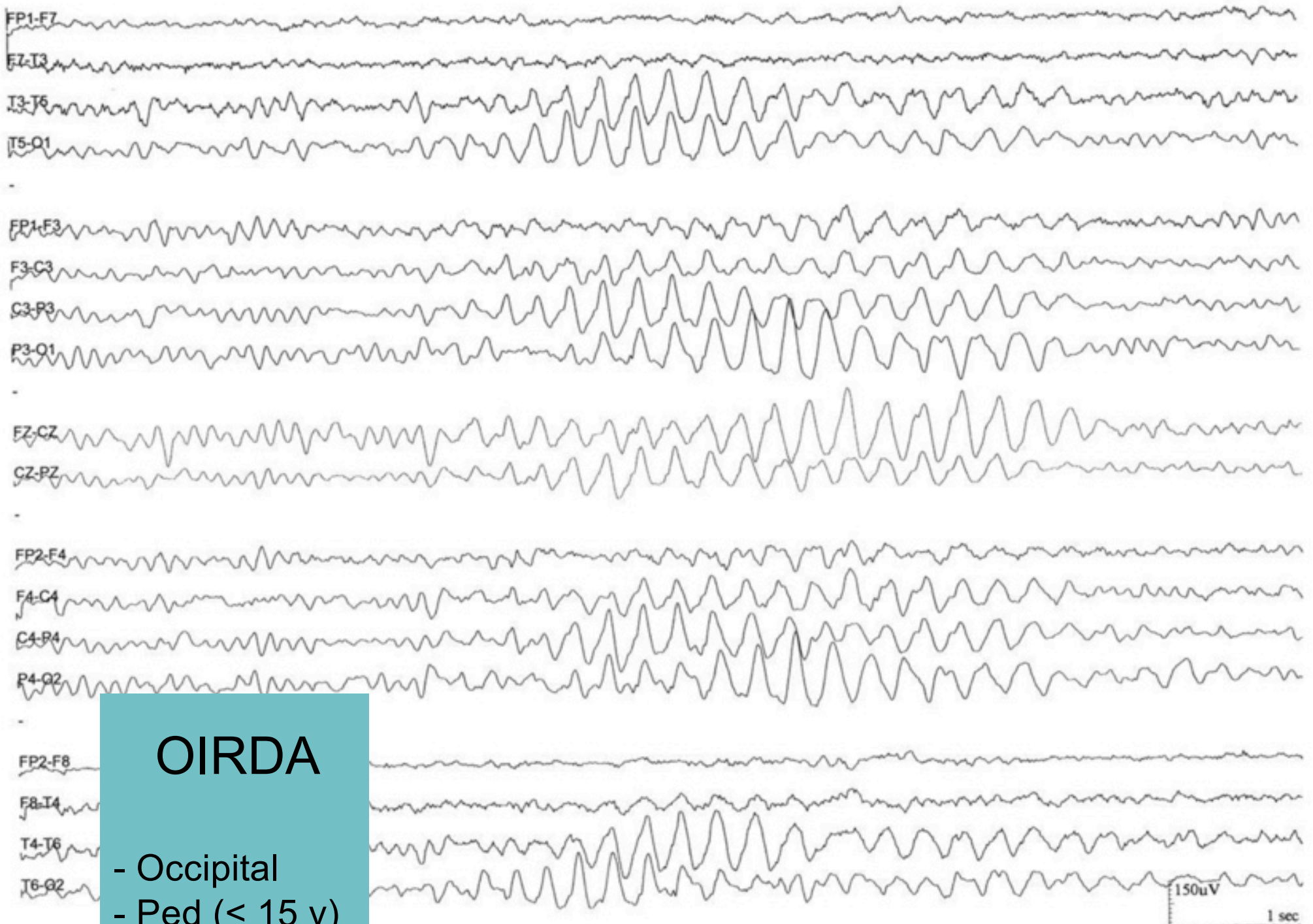
Intermittent rhythmic delta activity (IRDA)

- Bursts & runs of high-voltage, bisynchronous, well-formed slow waves relatively fixed frequency (2.5 Hz)
- May be asymmetrical, lateralized, or unilateral
- Not epileptiform or predictive of epilepsy but most likely diffuse encephalopathy
- DDx: Eye blinks, hyperventilation effect, and hypnagogic hypersynchrony

FIRDA

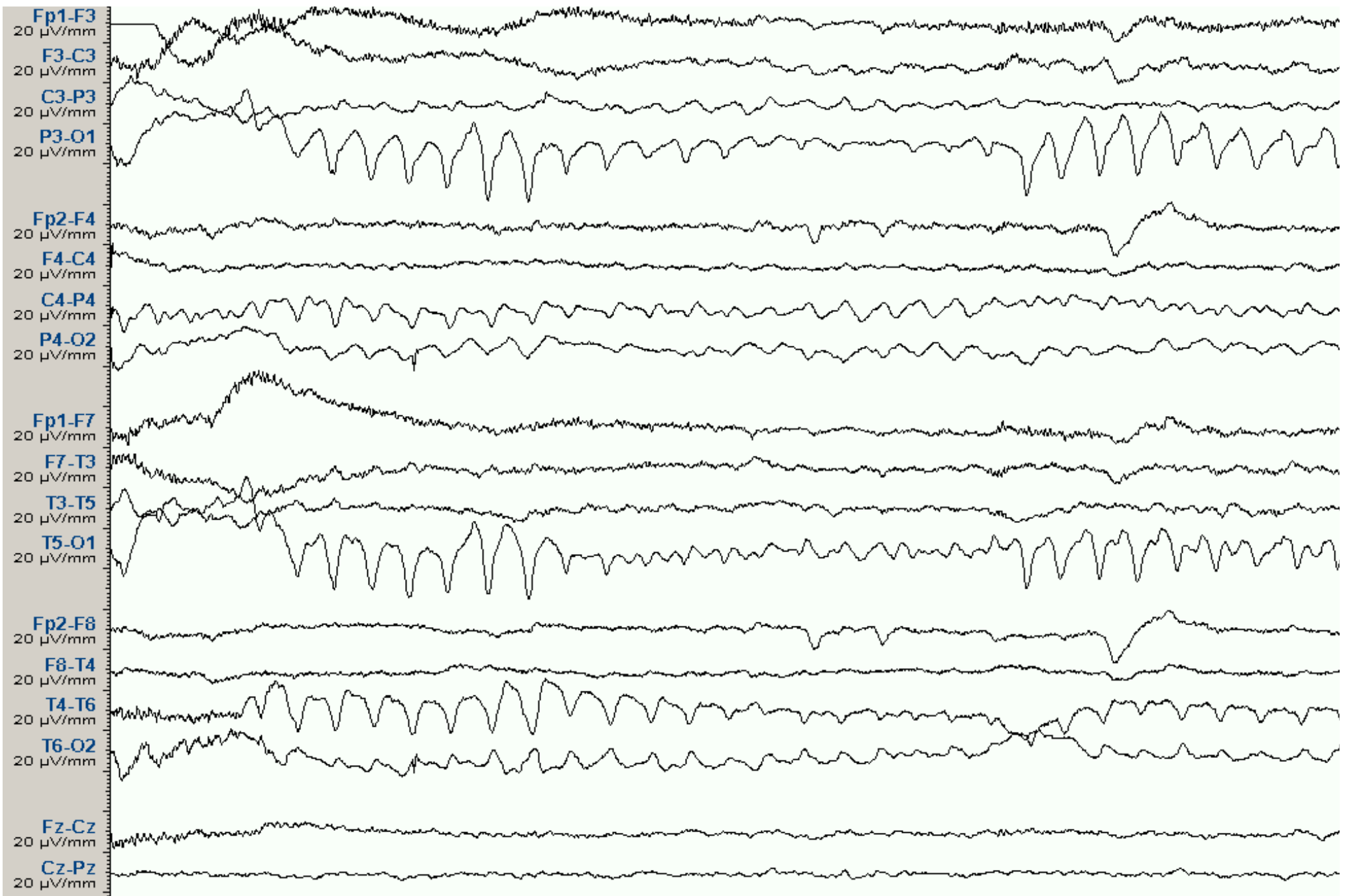
- Frontal
- Adult



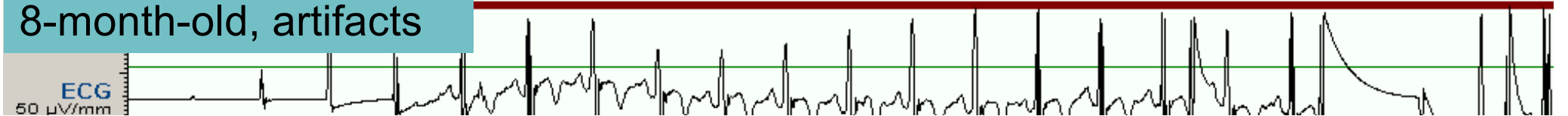


OIRDA

- Occipital
- Ped (< 15 y)
- Absence 1/3



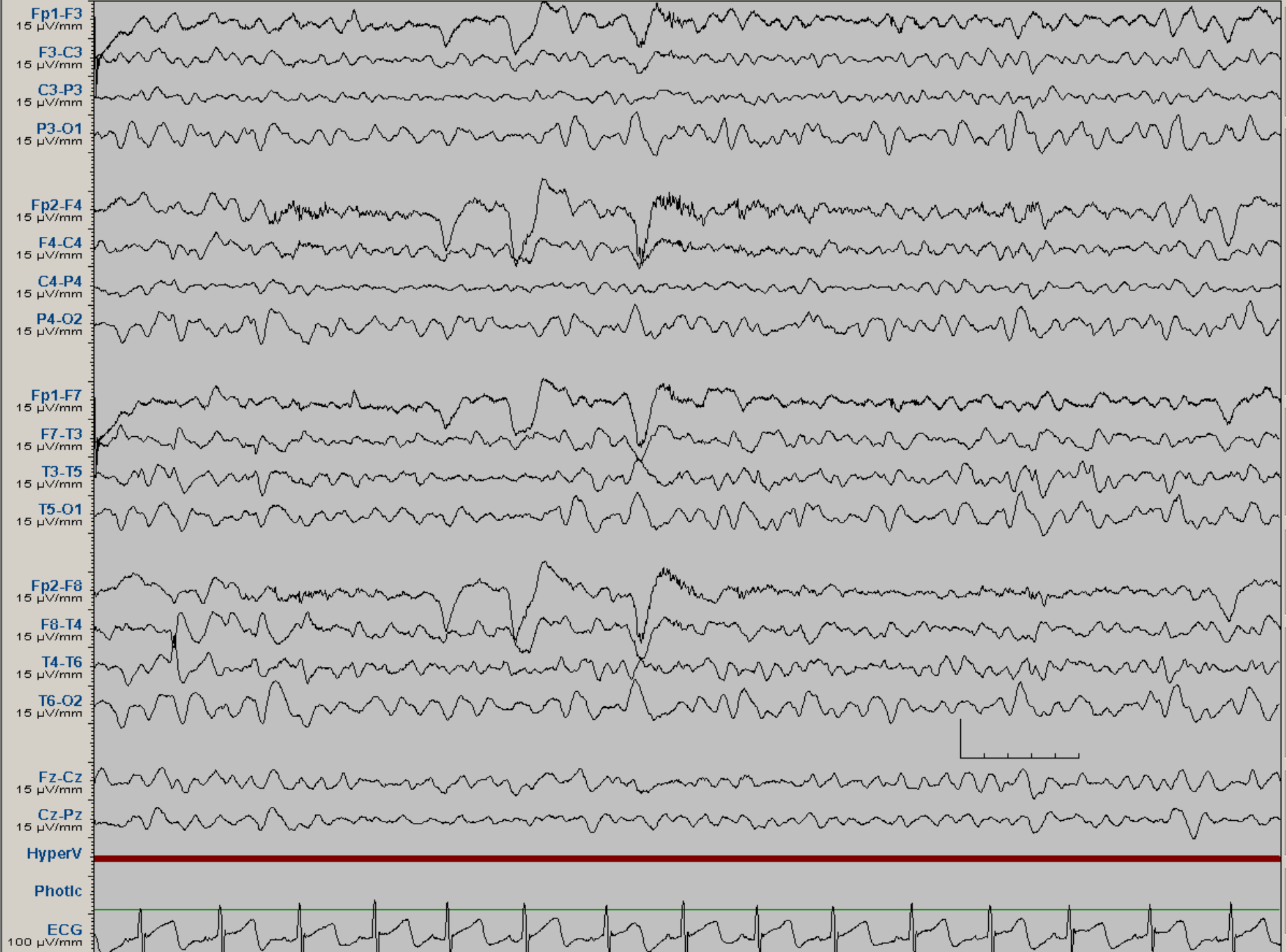
8-month-old, artifacts



Severity of encephalopathy

Mild

- Continuous slow
 - Intermittent slow
 - **Slow background**
-
- ✓ **Generalized**
 - ✓ Focal



Photic

On

Pause

Keep

Off

$\mu\text{V}/\text{mm}$

-1

-1000

15 $\mu\text{V}/\text{mm}$

Keep

LoPass, Hz

Off

70

30

15

Notch, Hz

Off

50

60

HiPass, Hz

Off

0.5

1

3

10

Noise, dB

Off

-3 dB

-6 dB

mm/sec

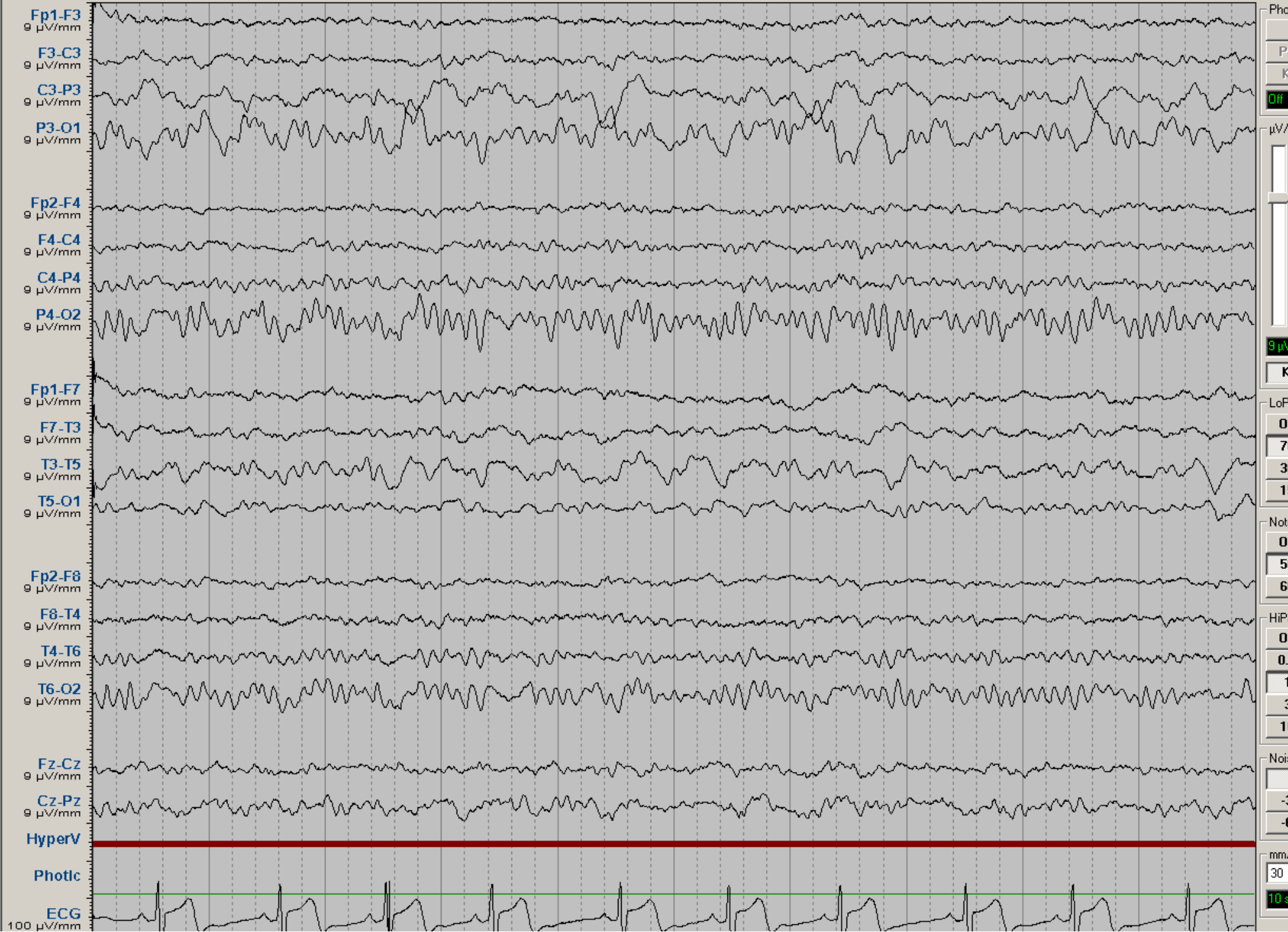
30

10 sec/p

Severity of encephalopathy

Mild

- Continuous slow
 - Intermittent slow
 - **Slow background**
-
- ✓ Generalized
 - ✓ **Focal**



Scope

1. Type of EEG monitoring in ICU
2. EEG pattern in encephalopathy / coma
 - ❖ **Severity of encephalopathy**
 - Mild
 - **Severe**
 - ❖ Specific pattern

Severity of encephalopathy

Severe

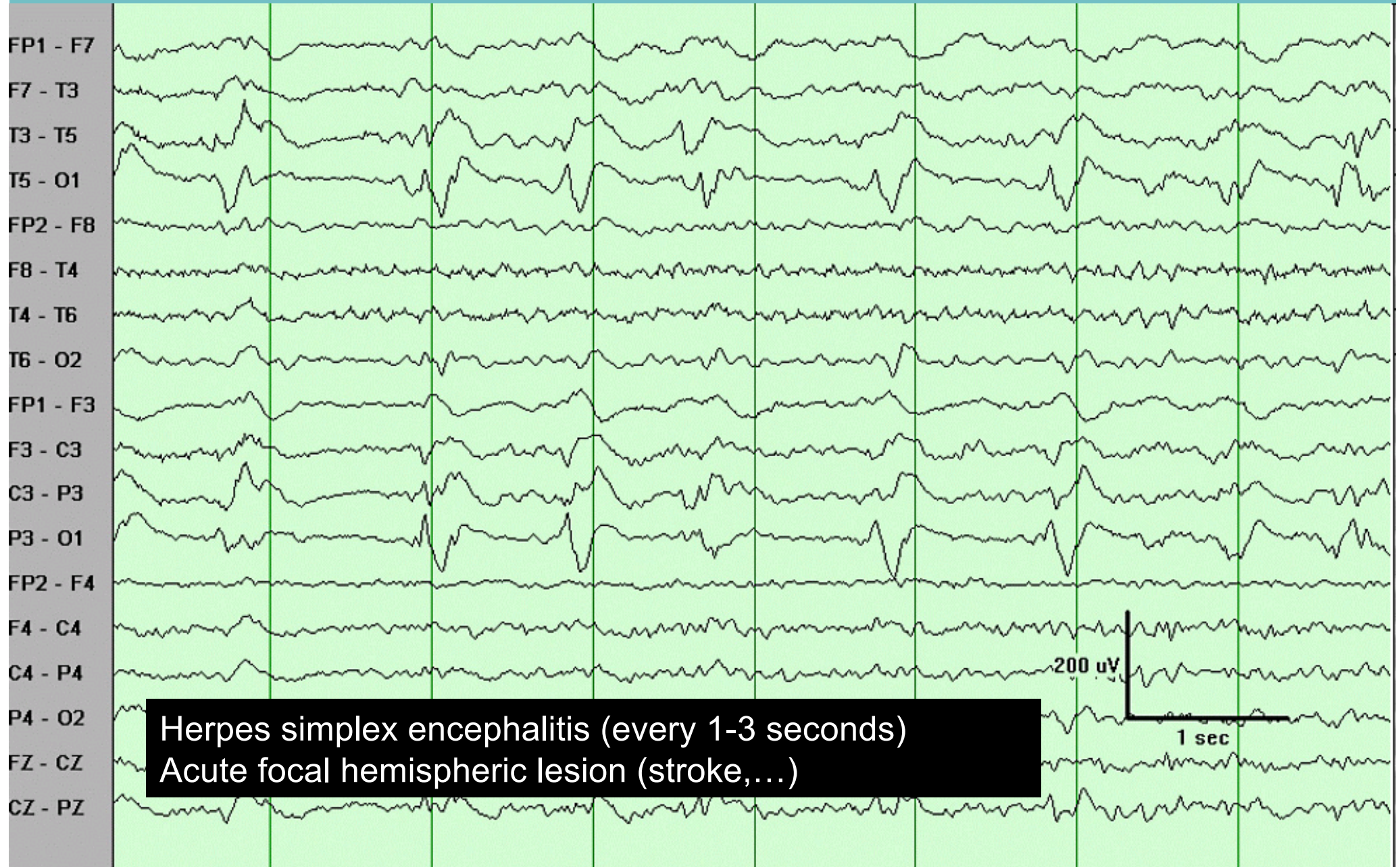
- Periodic pattern
- Burst-suppression pattern
- Background suppression
- Electrocerebral inactivity

Periodic pattern

- Regular interval
- Multiphasic, complex epileptiform morphology
- PLEDs: One hemisphere
- GPEDs: bilaterally synchronous
- Bi-PLEDs: bilateral but asynchronous

PLEDs

Periodic lateralizing epileptiform discharges



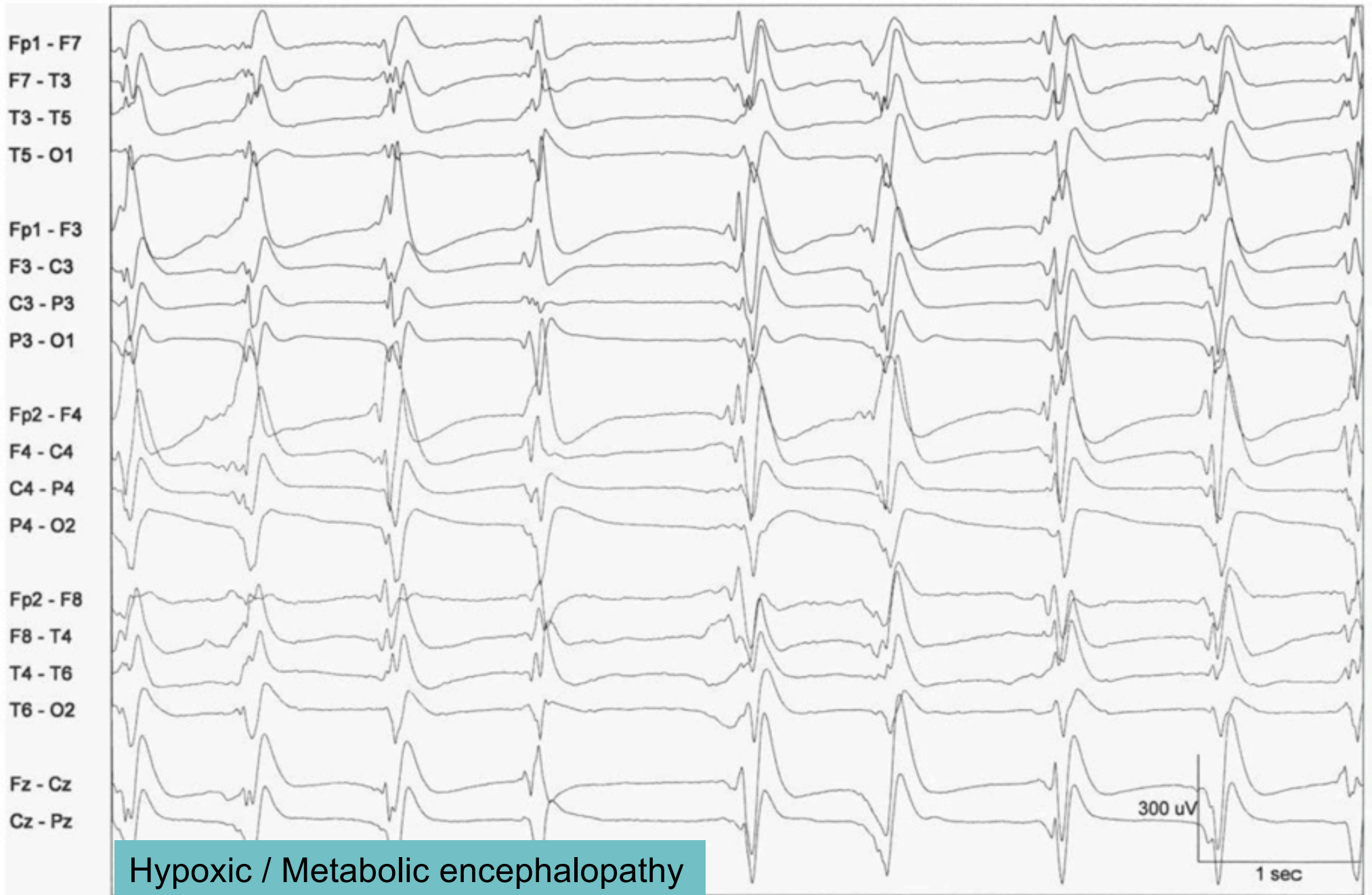
Periodic pattern

- Regular interval
- Multiphasic, complex epileptiform morphology
- PLEDs: One hemisphere
- **GPEDs**: bilaterally synchronous
- Bi-PLEDs: bilateral but asynchronous

GPED

Generalized periodic epileptiform discharges

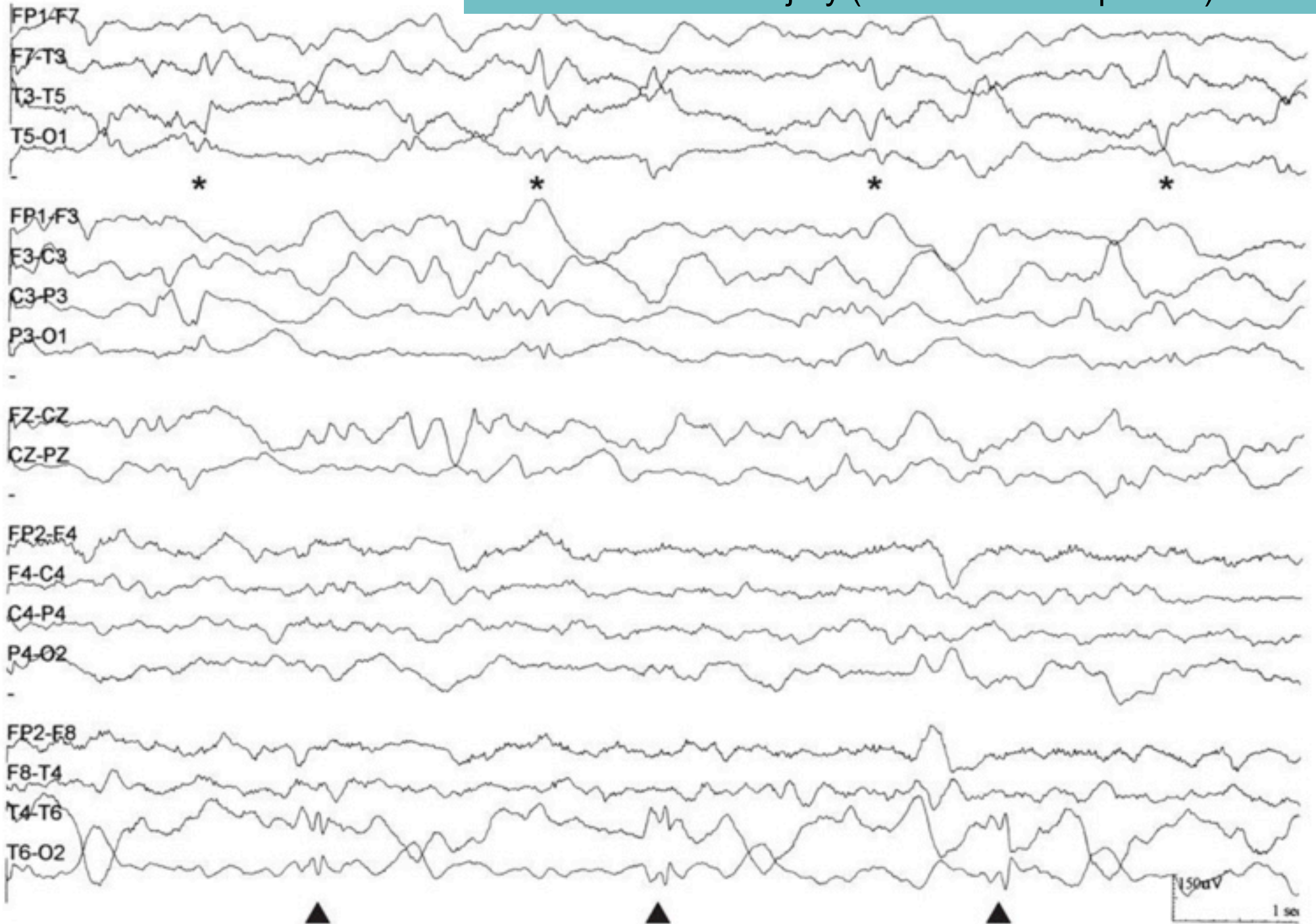
- Generalized, synchronous, periodic, or near-periodic complexes
- Hypoxic / metabolic encephalopathy
- If frequency greater than 2.5 Hz
→ concerning for seizure



Periodic pattern

- Regular interval
- Multiphasic, complex epileptiform morphology
- PLEDs: One hemisphere
- GPEDs: bilaterally synchronous
- **Bi-PLEDs**: bilateral but asynchronous (independent)

Multifocal cerebral injury (HIE / HSV encephalitis)



Severity of encephalopathy

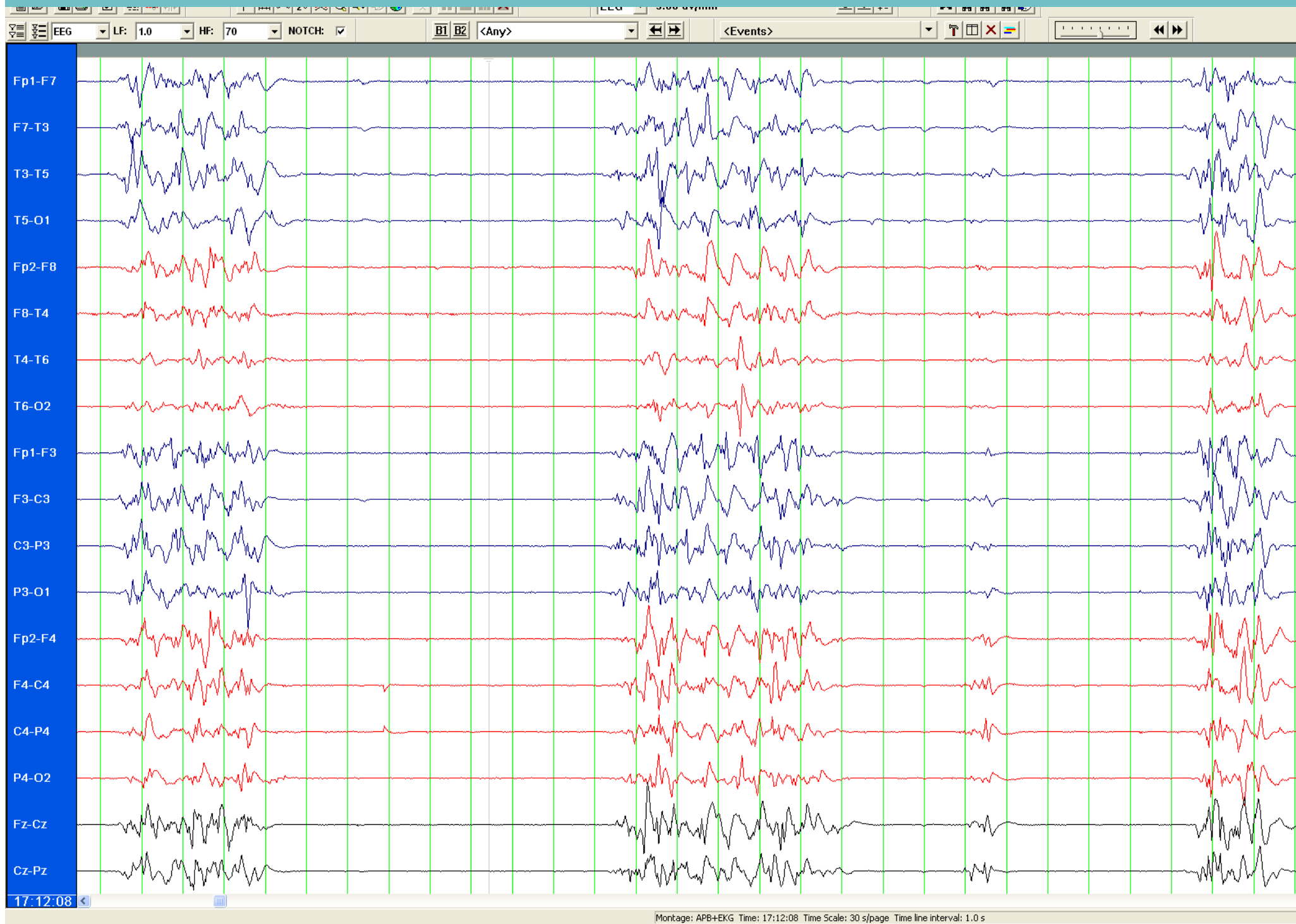
Severe

- Periodic pattern
- **Burst-suppression pattern**
- Background suppression
- Electrocerebral inactivity

Burst-suppression pattern

- Periodic
- Burst of mixed sharp and slow waves, 1-3 sec.
- Suppression, < 10-25 μ v, 5-10 sec.

Severe diffuse encephalopathy / Epileptic encephalopathy / Effect of SE treatment



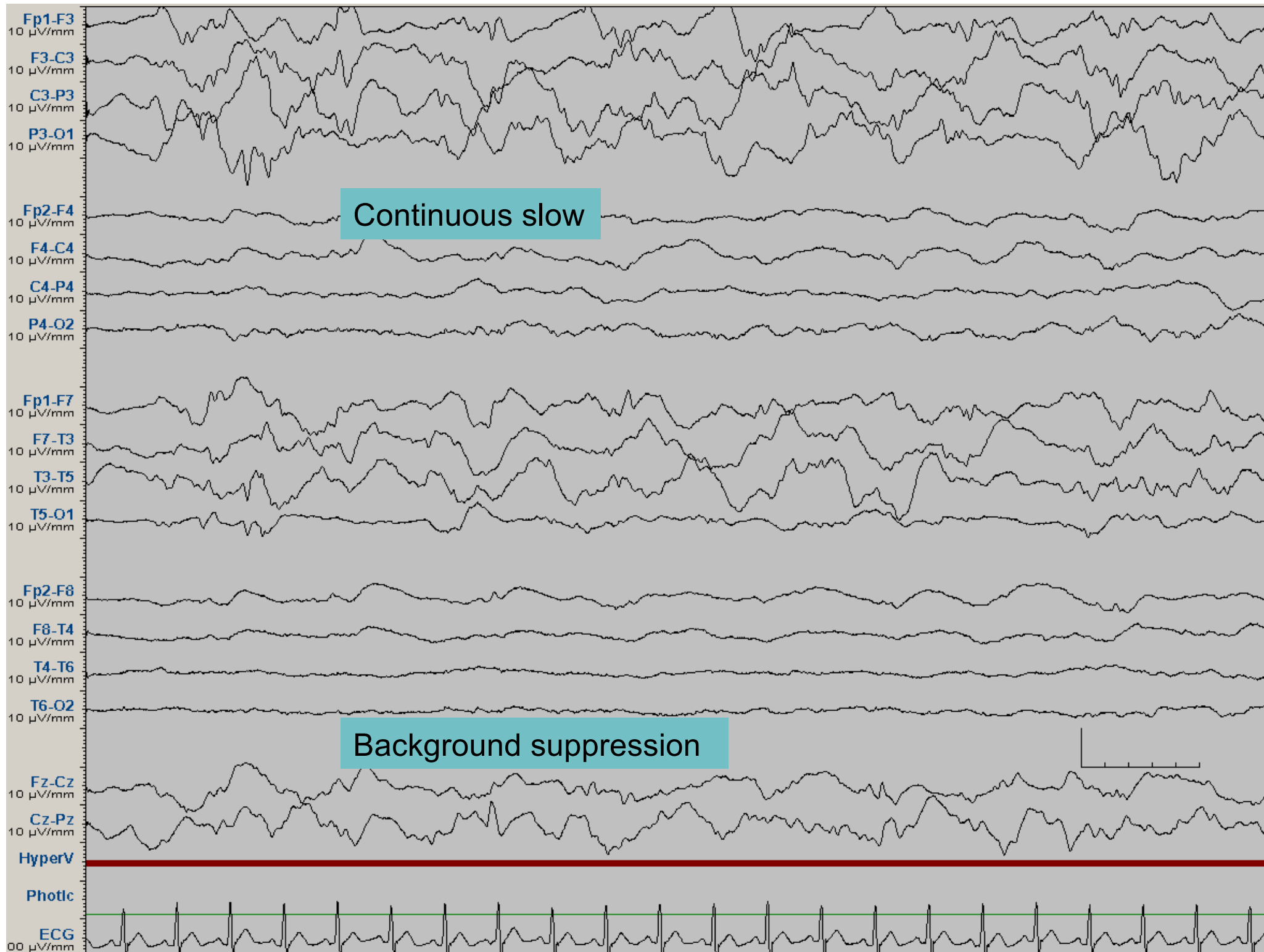
Severity of encephalopathy

Severe

- Periodic pattern
- Burst-suppression pattern
- **Background suppression**
- Electrocerebral inactivity

Background suppression

- Voltage < 10 uv
- Nearly flat
- No reactivity



Severity of encephalopathy

Severe

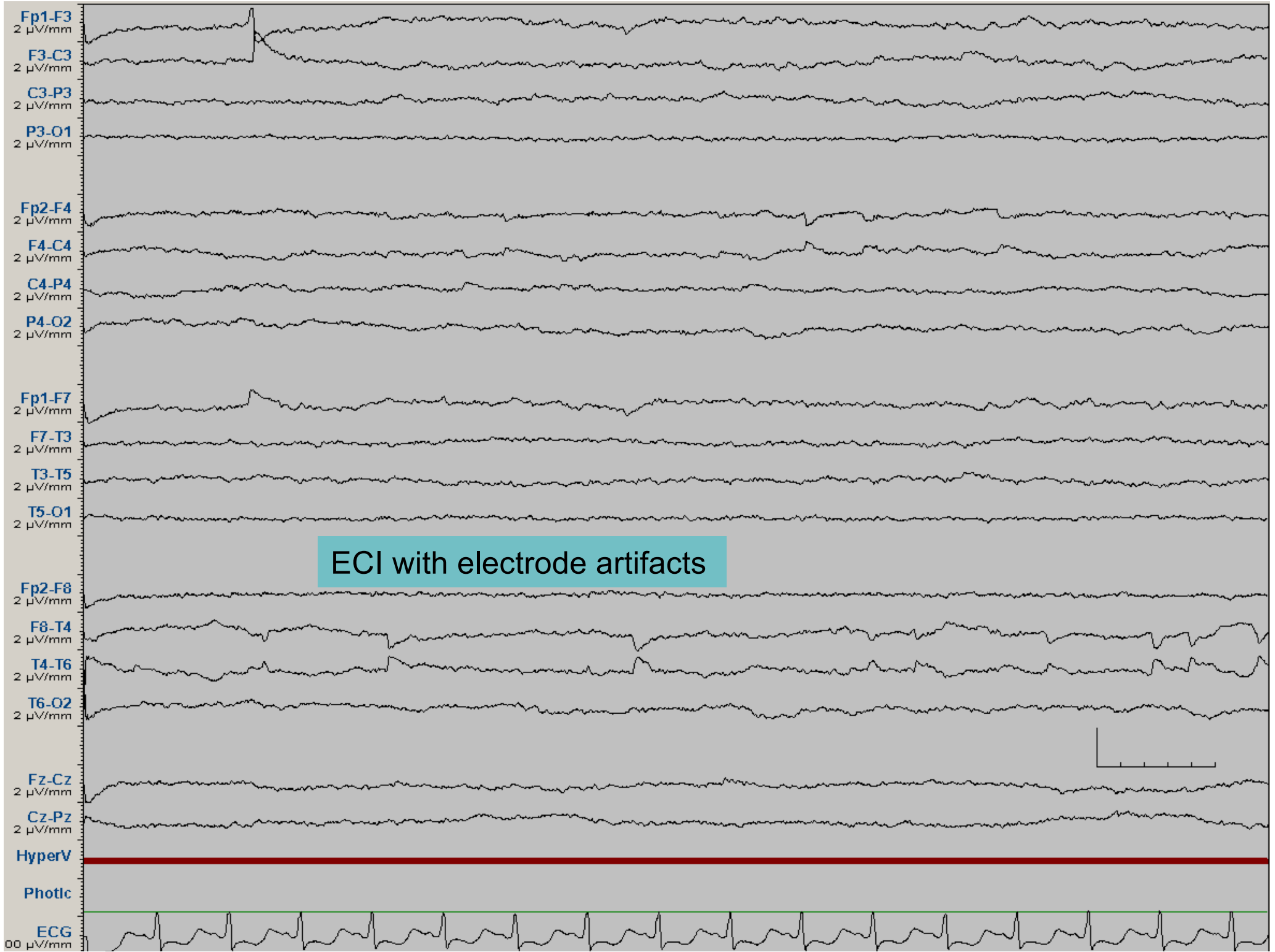
- Periodic pattern
- Burst-suppression pattern
- Background suppression
- **Electrocerebral inactivity**

Electrocerebral inactivity
(ECI)
Electrocerebral silence
(ECS)



Brain death

- A minimum of 8 scalp electrodes
- Impedances between 100 and 10,000 ohms
- Interelectrode distances of at least 10 cm
- Electrode test by touching each individually to obtain appropriately located artifact potential
- Sensitivity of at least 2 μV for 30 minutes of the recording
- High-frequency filter (HFF) not set below 30 Hz and low-frequency filter (LFF) not set above 1 Hz
- No EEG reactivity to tactile, auditory, or visual stimulation
- If ECI in doubt, EEG repeated after an interval (suggested 6 hr)



Scope

1. Type of EEG monitoring in ICU
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 - ❖ Severity of encephalopathy
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 - Severe
 - ❖ Specific pattern

Specific pattern in encephalopathy

- Triphasic wave
- SSPE
- CJD
- Alpha coma
- Beta coma
- Spindle coma

Specific pattern in encephalopathy

- Triphasic wave → metabolic encephalopathy

Bilateral synchronous

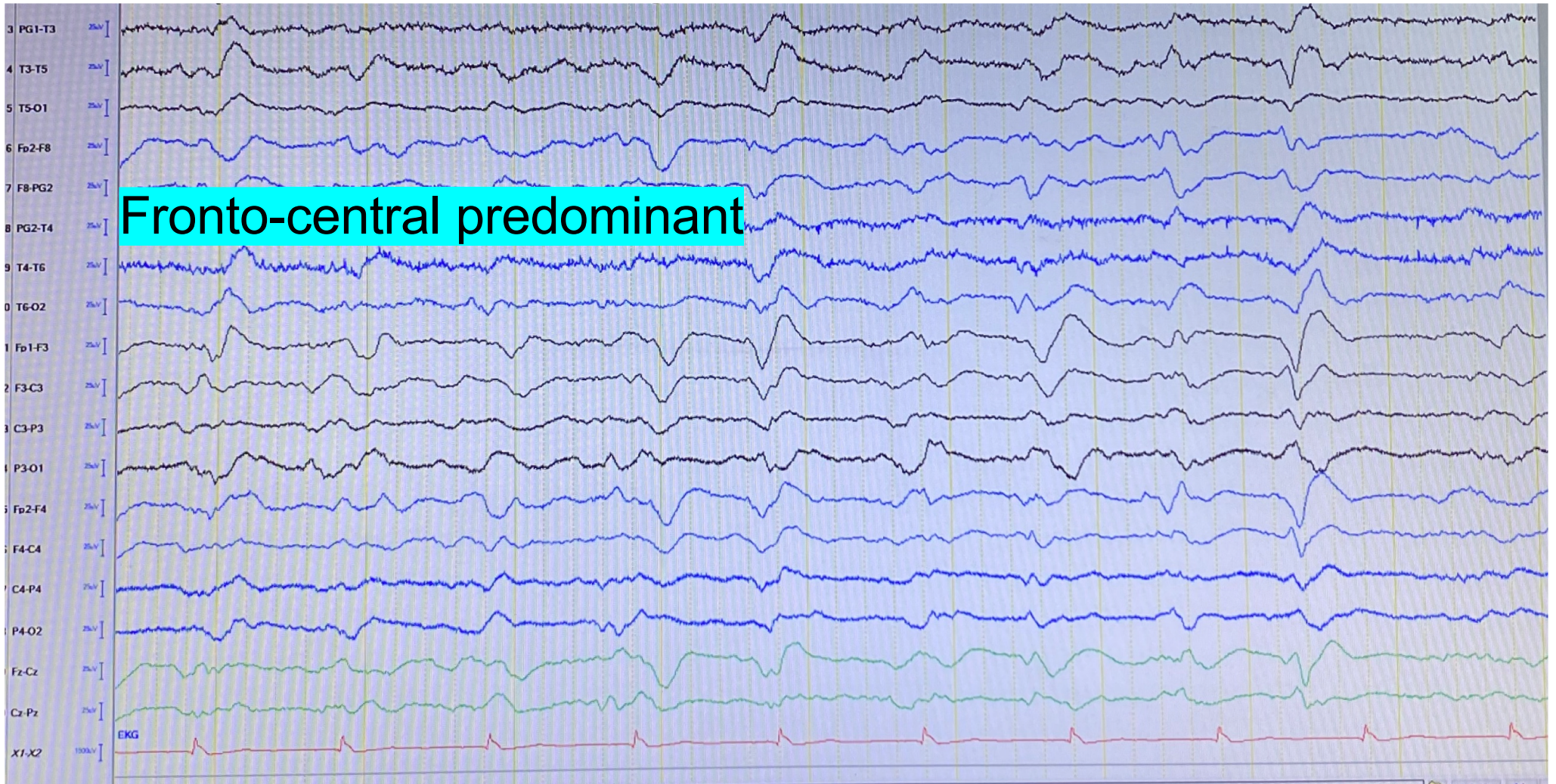


- SSPE
- CJD
- Alpha coma
- Beta coma
- Spindle coma

Triphasic waves (1-2 Hz, age > 20 y)



Triphasic wave (hepatic / renal / hypoxic encephalopathy)

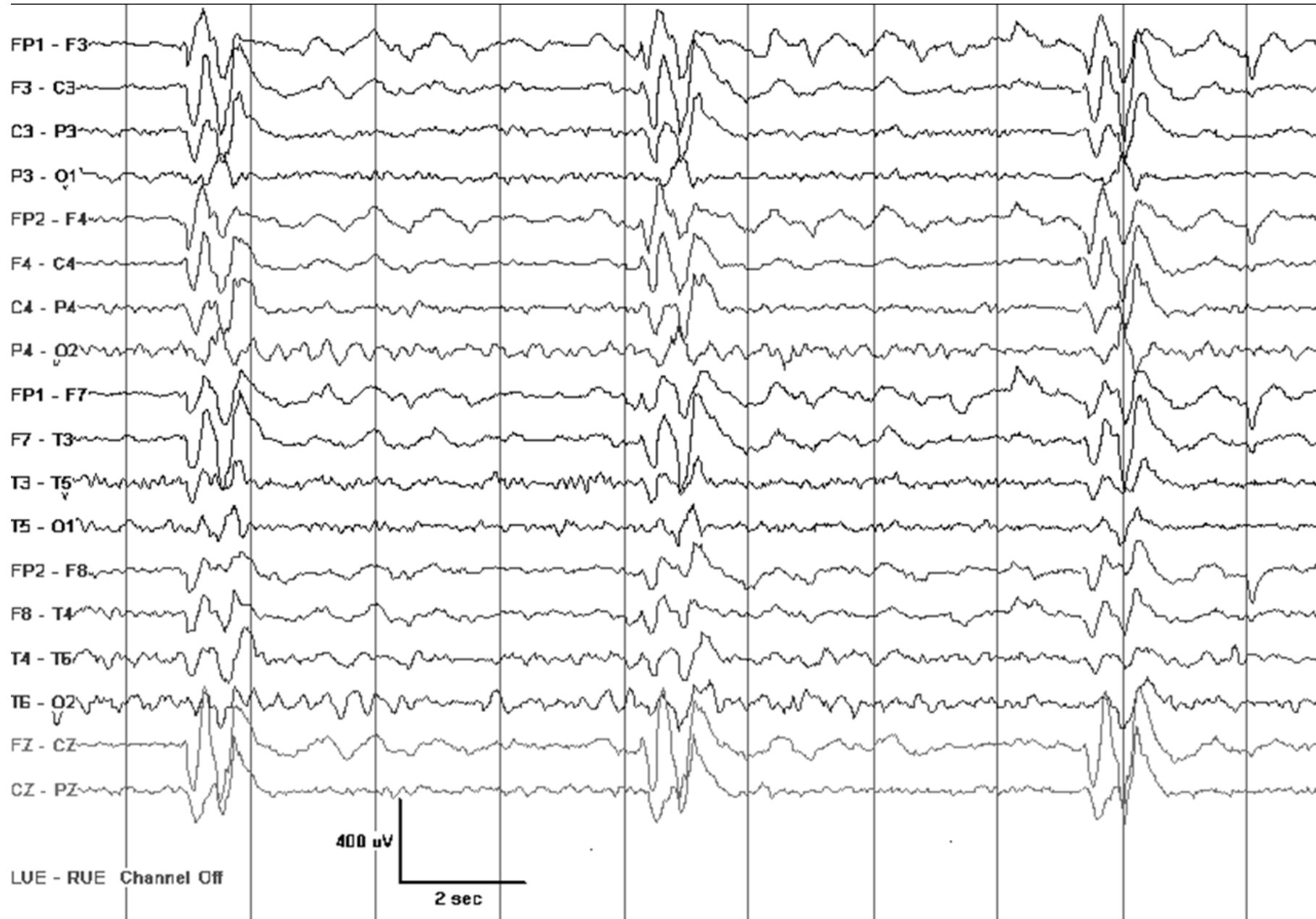


Specific pattern in encephalopathy

- Triphasic wave
- SSPE → every 4-10 seconds with myoclonic jerks
previous measles (3-10 years)
- CJD
- Alpha coma
- Beta coma
- Spindle coma

SSPE

Subacute sclerosing panencephalitis

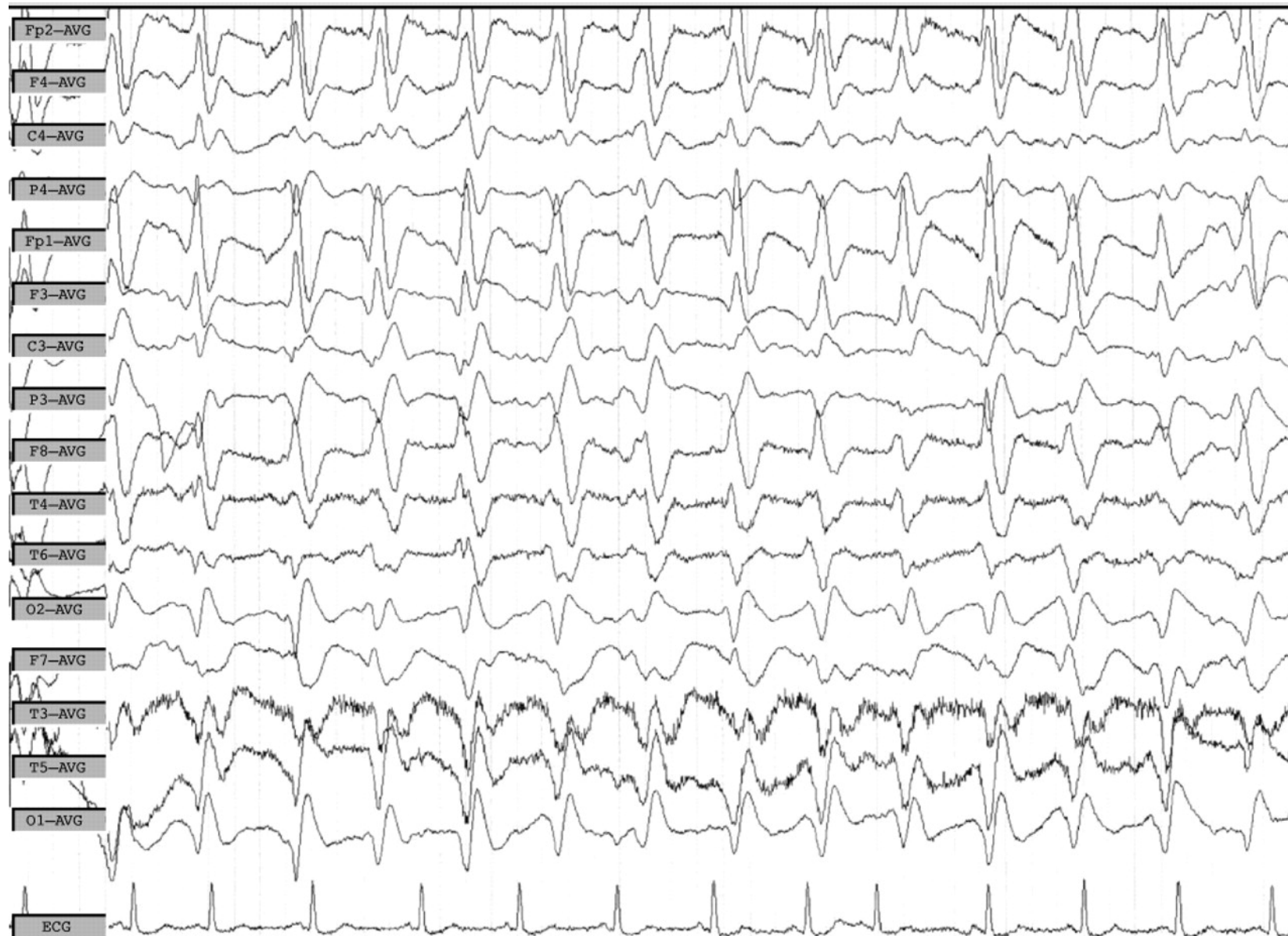


Specific pattern in encephalopathy

- Triphasic wave
- SSPE
- CJD → sharp wave complex every 1 second

- Alpha coma
- Beta coma
- Spindle coma

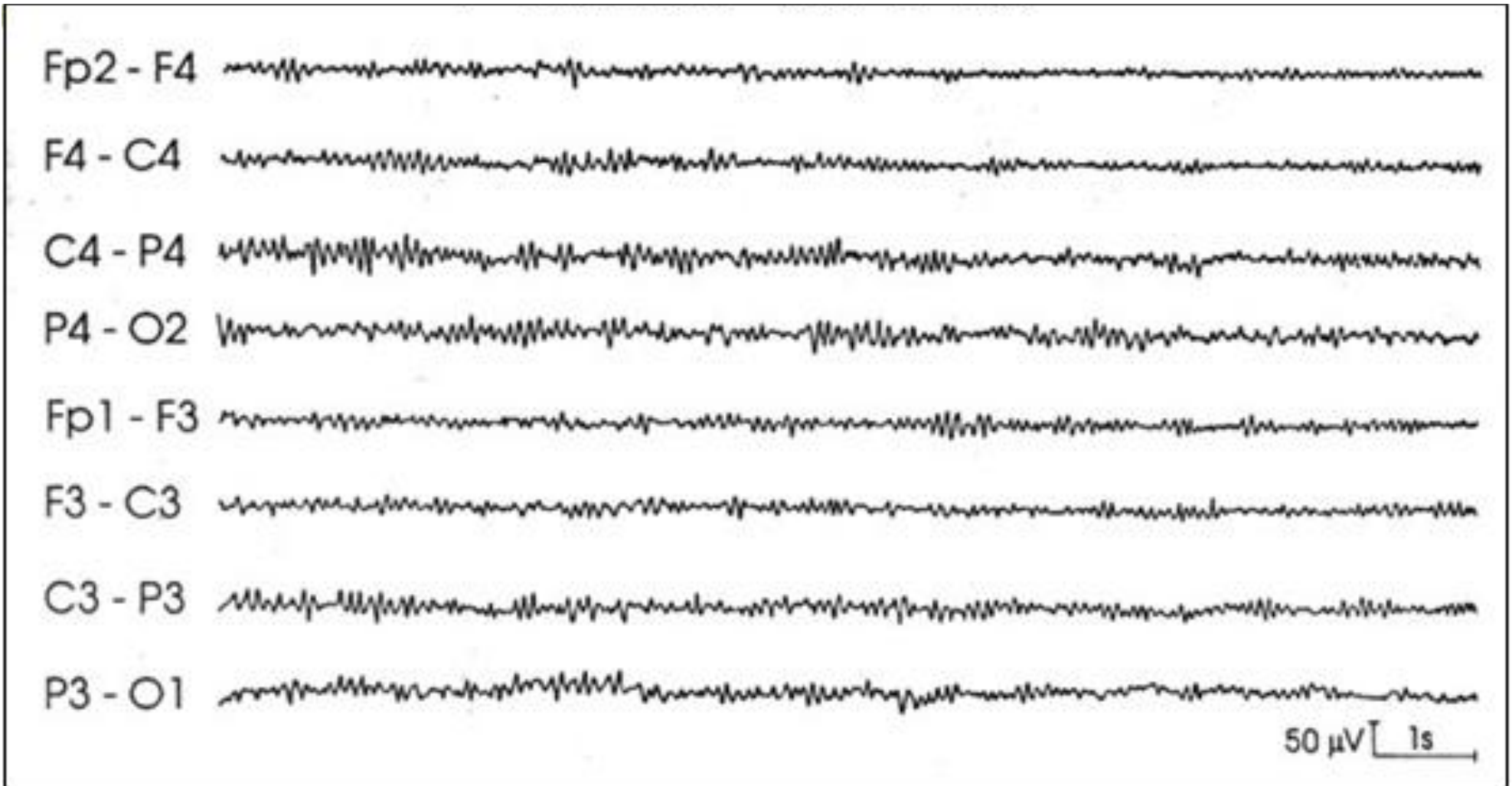
Creutzfeldt-Jacob disease (CJD)



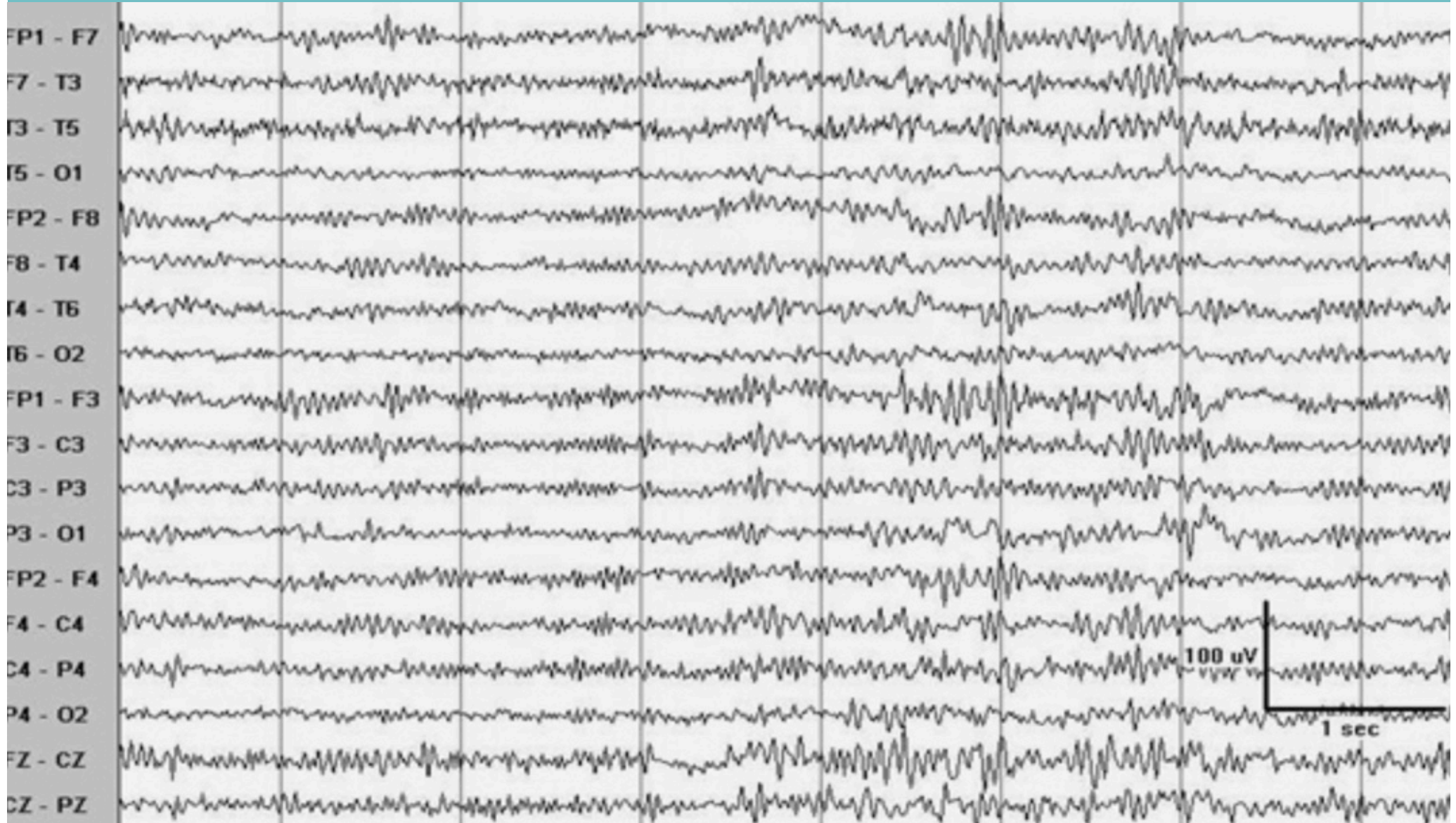
Specific pattern in encephalopathy

- Triphasic wave
- SSPE
- CJD
- Alpha coma → Very severe diffuse encephalopathy
- Beta coma → diffuse encephalopathy
- Spindle coma → diffuse encephalopathy

Alpha coma (hypoxia / post arrest / brainstem)



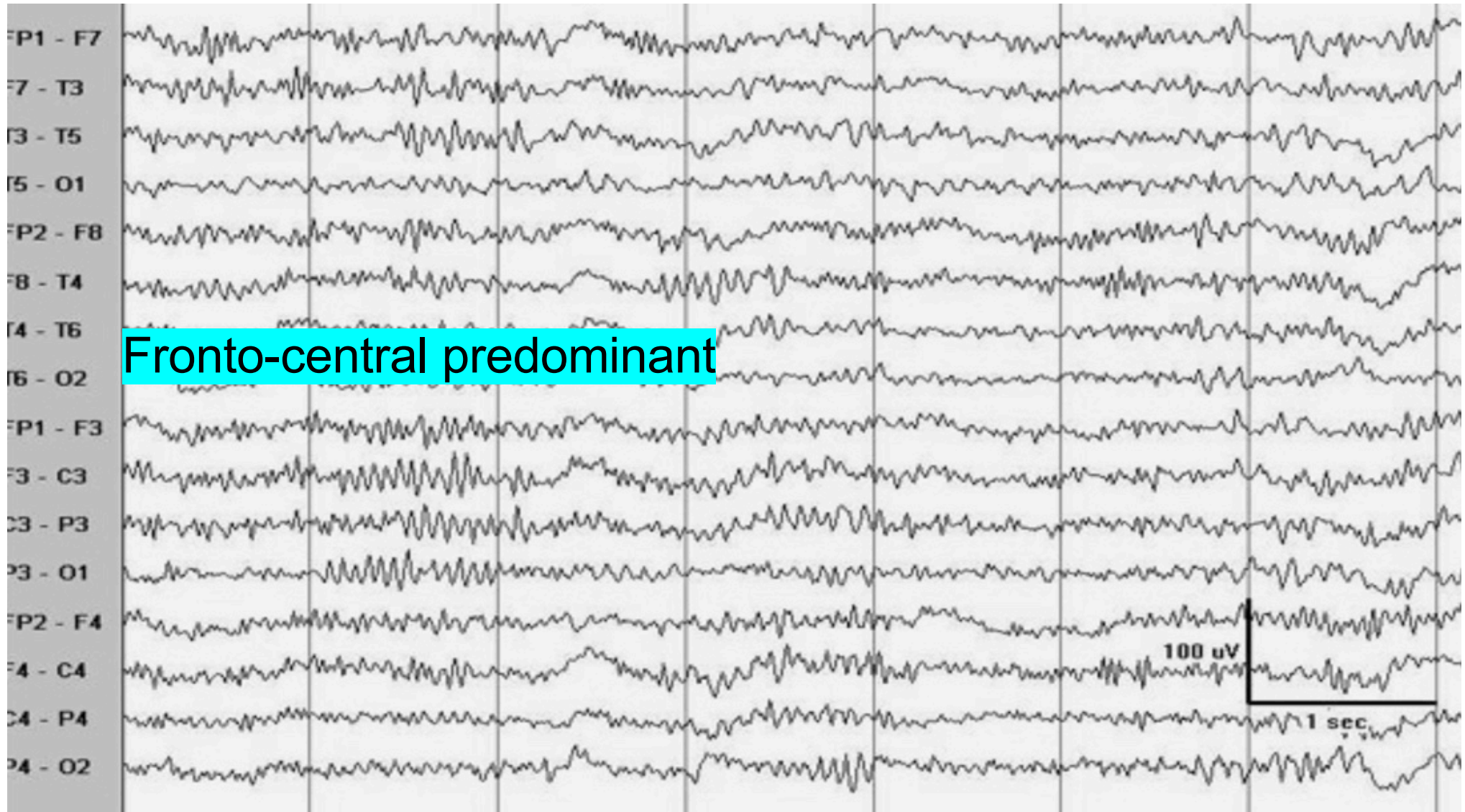
Beta coma (18-25 Hz)



Barbiturate, Benzodiazepine, Chloral hydrate

Spindle coma

(metabolic / infectious / hypoxic encephalopathy)



Summary

- cEEG is better for small / focal abnormality
- Delineate some etiologies: SSPE
- Poor prognosis (from EEG pattern)
 - Severe pattern: BS, BG suppression, ECI
 - Triphasic waves
 - Alpha coma
 - Continuous (polymorphic) slow, generalized
- Better prognosis (from EEG pattern)
 - ❖ Mild pattern: slow BG, intermittent slow
 - ❖ Spindle coma
 - ❖ Beta coma

Next

How about Status Epilepticus ?