EST 30th ANNIVERSARY ANNUAL MEETING

Quantitative EEG in Practice

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Talk Overview

- Basic Concept Review
- Applications
  - Seizure Trends
  - Guiding Treatment
  - Assessing Brain Functions
  - Prognostication
- Pitfalls in QEEG interpretations

The Clinical Need

Continuous EEG (cEEG) monitoring is essential for:

- Detecting Nonconvulsive Status Epilepticus (NCSE)
- Tracking delayed cerebral ischemia
- Real-time critical care forecasting

The Data Overflow

Raw EEG is read in 10-second epochs.

24 hours of cEEG = 8,640 pages of data.

Result: Delayed diagnosis, resource strain, and potential secondary neuronal injury while awaiting post-hoc expert review.

NotebookLM

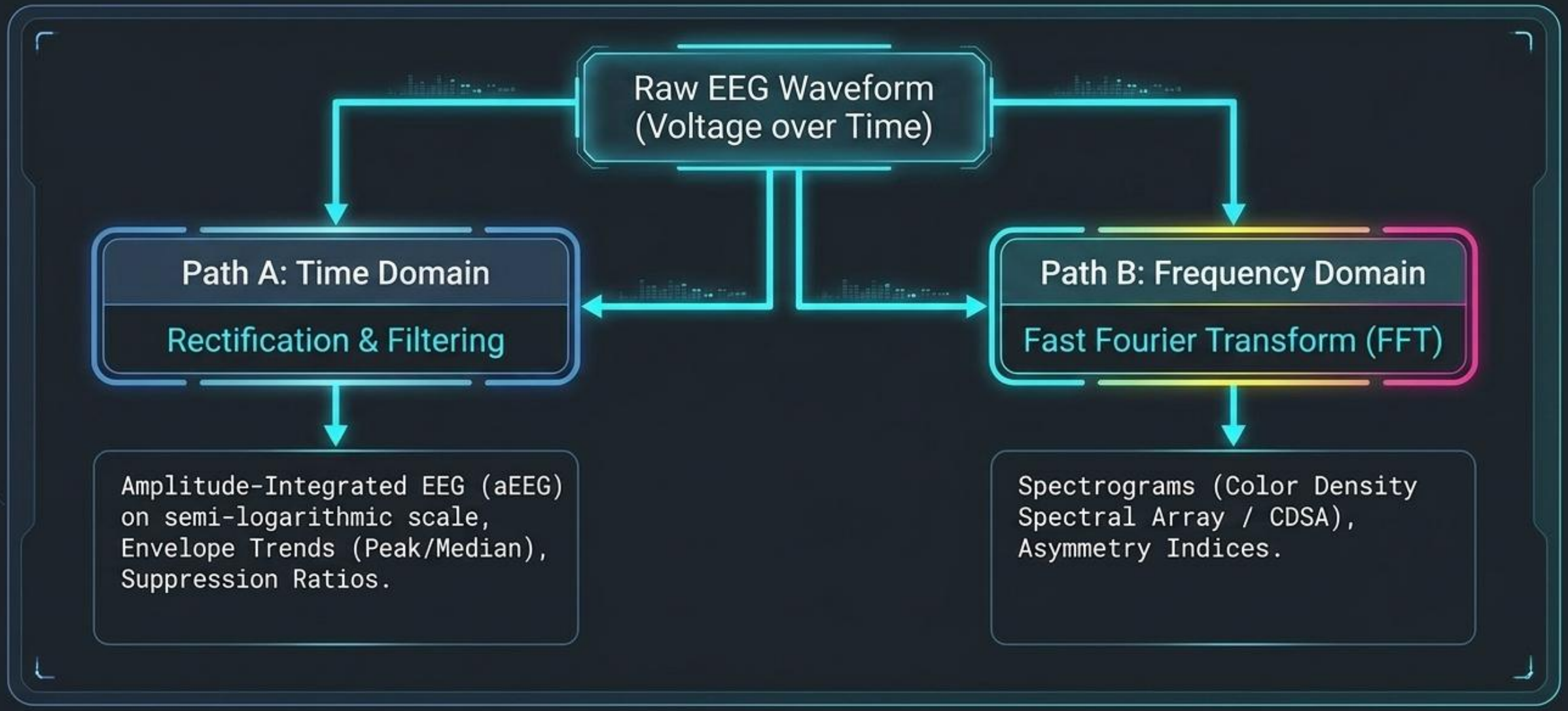
The Macroscope

qEEG does not replace traditional reading; it compresses time and transforms raw voltage into a topographical map.

It solves the data overflow by highlighting WHERE to look.

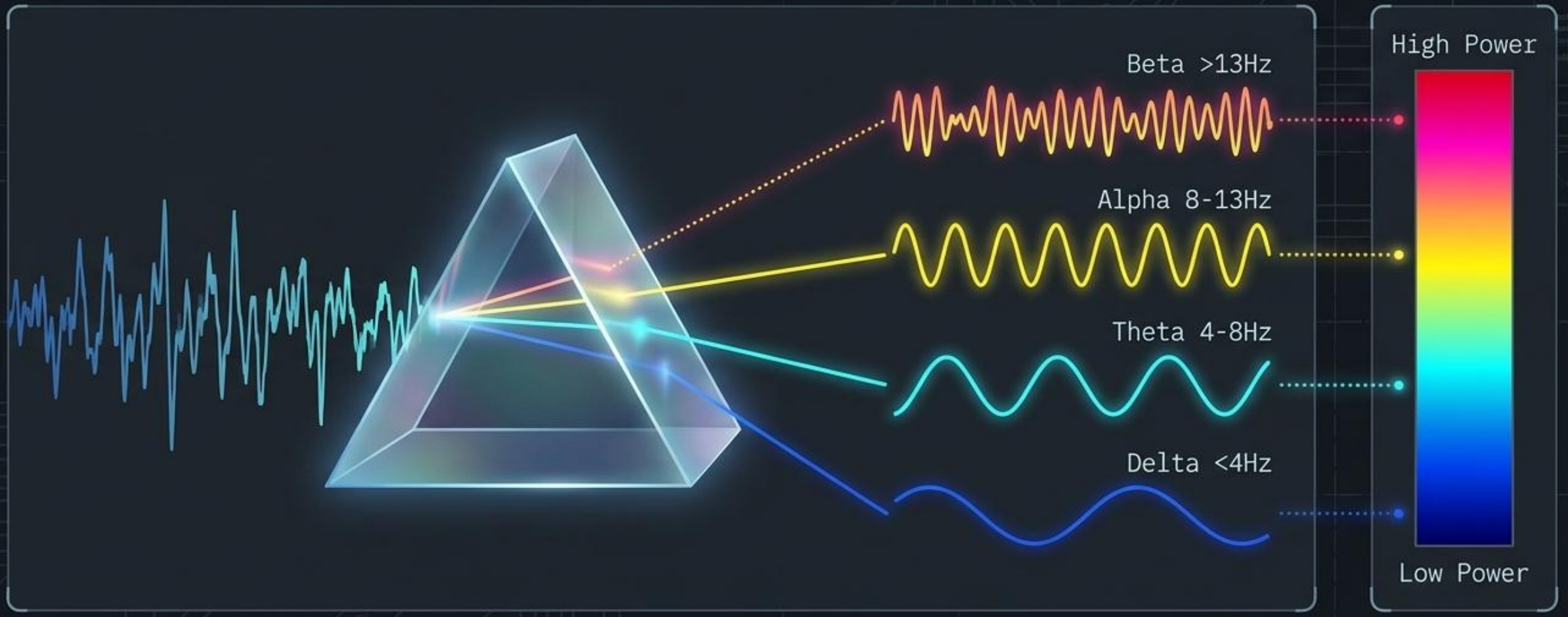
NotebookLM

The Transformation Matrix



NotebookLM

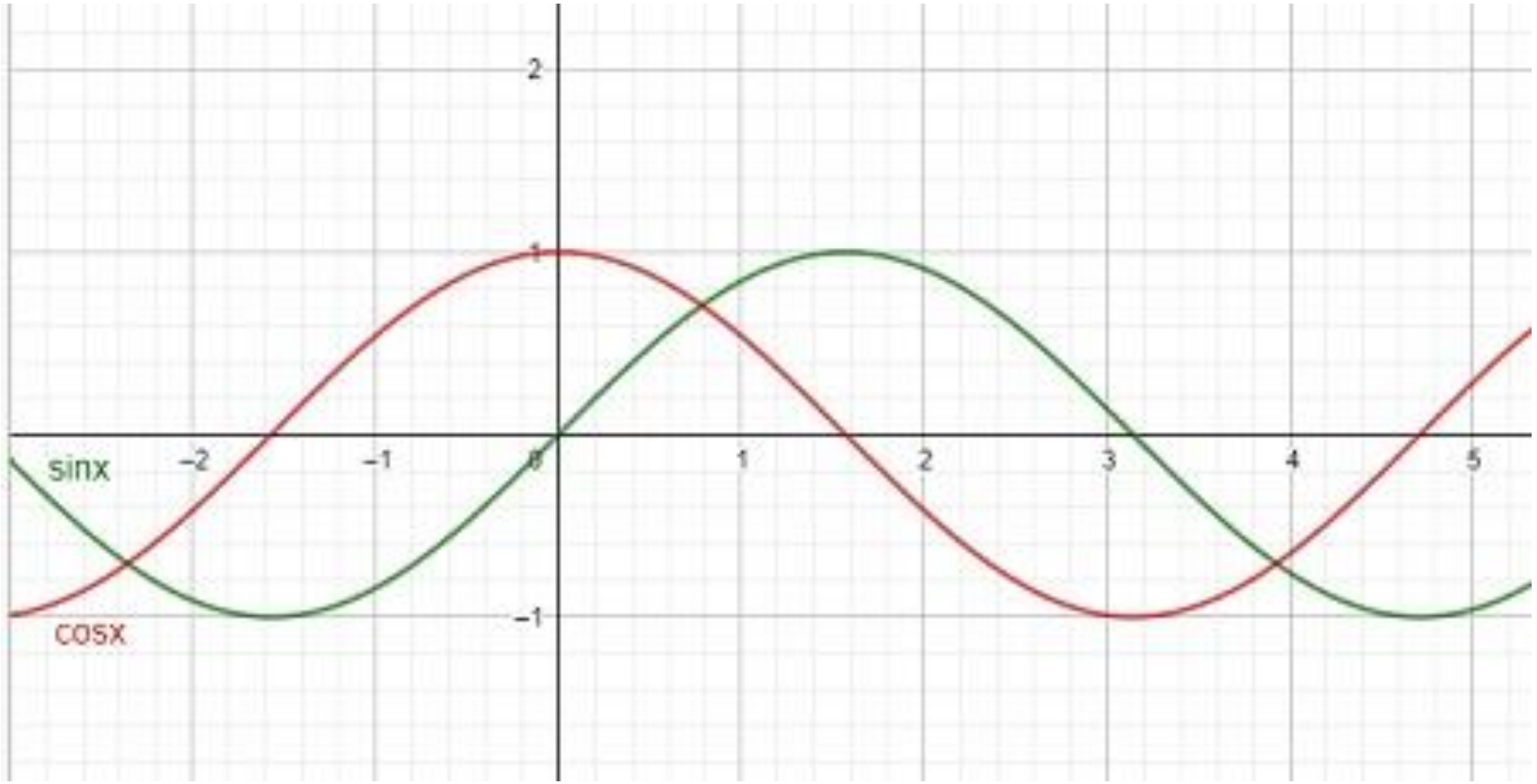
Deconstructing Frequency



The Fast Fourier Transform calculates frequency and amplitude, converting them into colored pixels on a topographical map.

NotebookLM

Oscillations: EEG background



Sinusoidal waves

https://study.com/academy/lesson/graphing-sin-cosine-transformations.html

Power = Square of the amplitude (A^2)

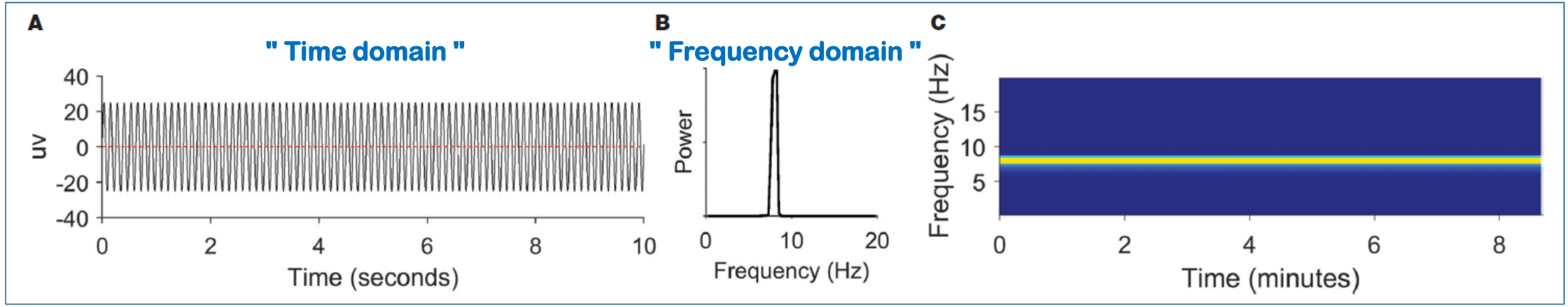


FIGURE 1.1 A. A sinusoidal wave at a single frequency. B. Power spectrum of the sinusoidal wave. C. Spectrogram of the same wave.

Power Spectrum **Spectrogram**

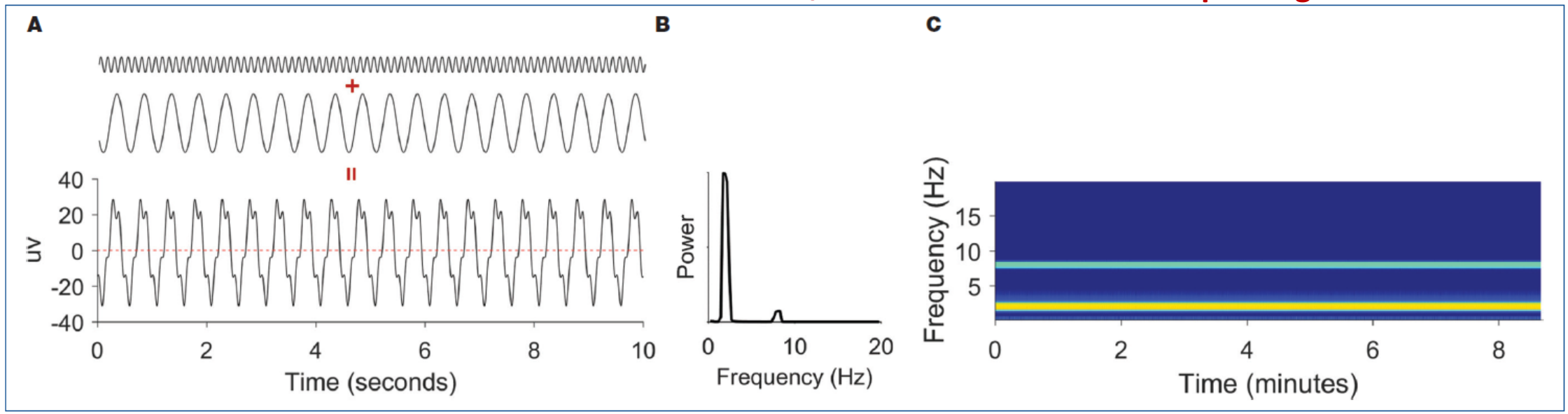


FIGURE 1.2 A. Two sinusoidal waves added together. B. Power spectrum of the two summed sinusoidal waves. C. Spectrogram of the two summed sinusoidal waves.

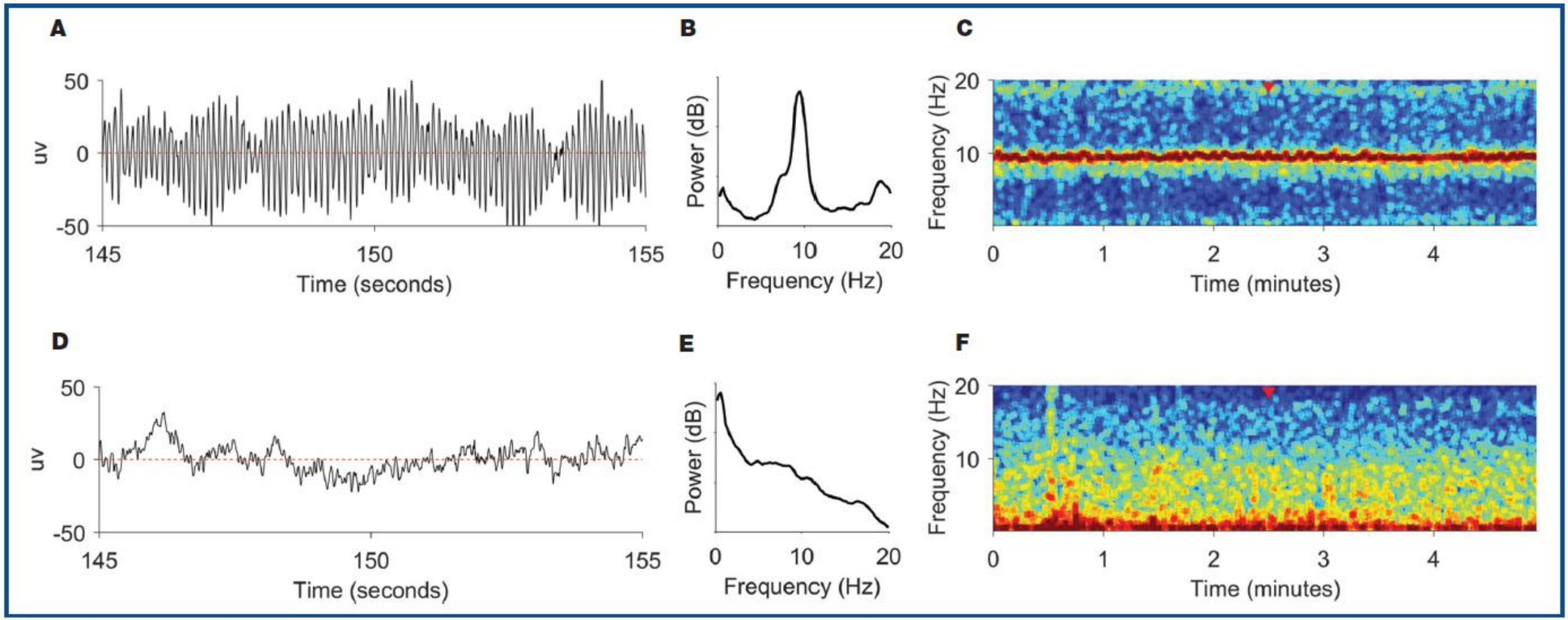


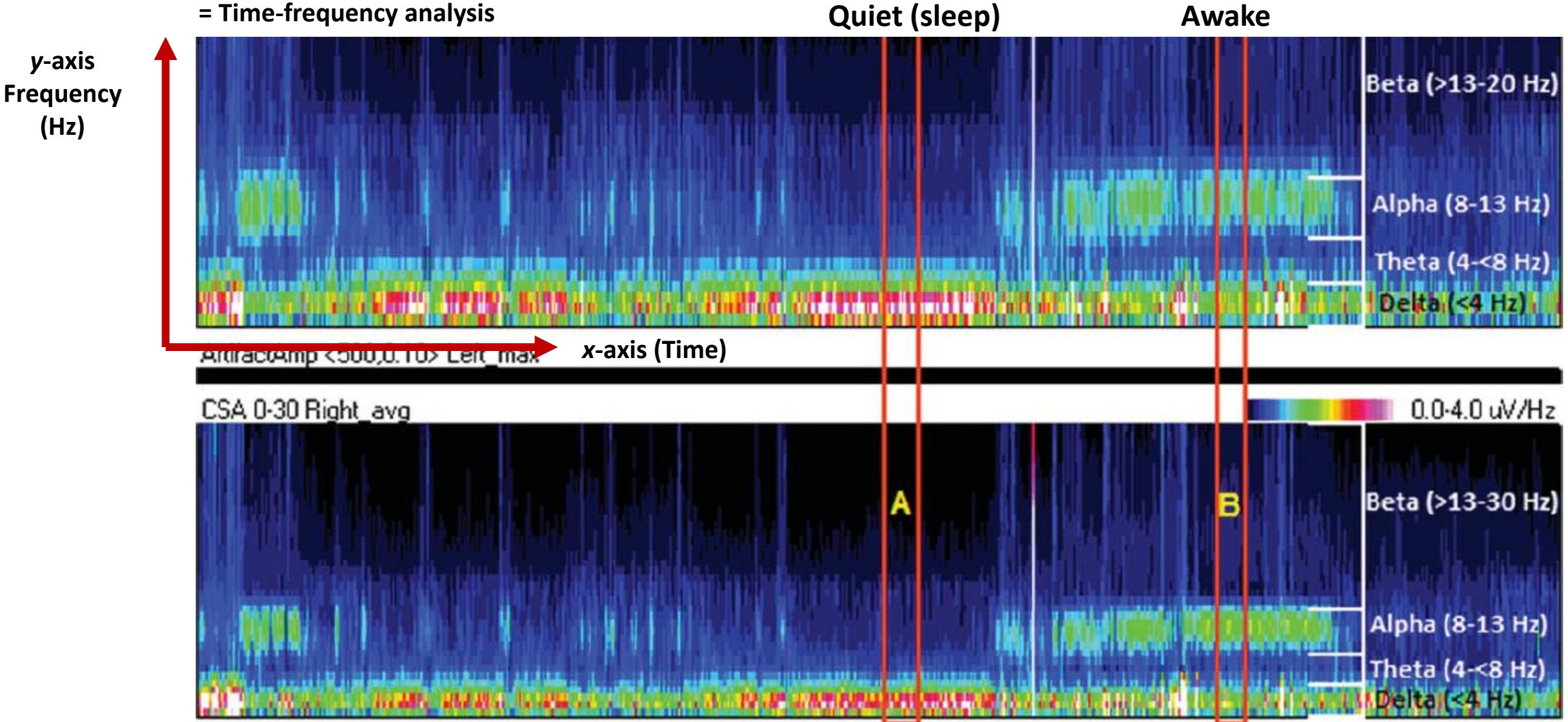
FIGURE 1.3 **A.** A 10-second EEG sample of the posterior dominant rhythm (PDR) in the alpha frequency range. **B.** Power spectrum (log (decibel) scale) of the PDR sample in (A) as a plot of log-power (in decibels) versus frequency. **C.** A 5-minute spectrogram (frequency versus time plot). The time point where the 10-second PDR sample in (A) comes from is indicated by the inverted red triangle at the center-top of the spectrogram. **D.** A 10-second sample of a "slow EEG", decomposable into a broad mixture of regular EEG waves. **E.** Power spectrum of the EEG sample in (D). **F.** A 5-minute spectrogram. The 10-second EEG sample in (D) comes from the time point indicated by the inverted red triangle at the center-top of the spectrogram.

Color spectral array (CSA)

Compressed spectral array (CSA)

= the Fast Fourier Transform (FFT)
= density spectral array
= compressed density spectral array (CDSA)
= power spectrogram
= Time-frequency analysis

Stage changes and alpha rhythm



Evolving patterns: Long EEG events (Seizures)

Simulated seizure

Real seizure with an evolving mixture of frequencies and amplitudes

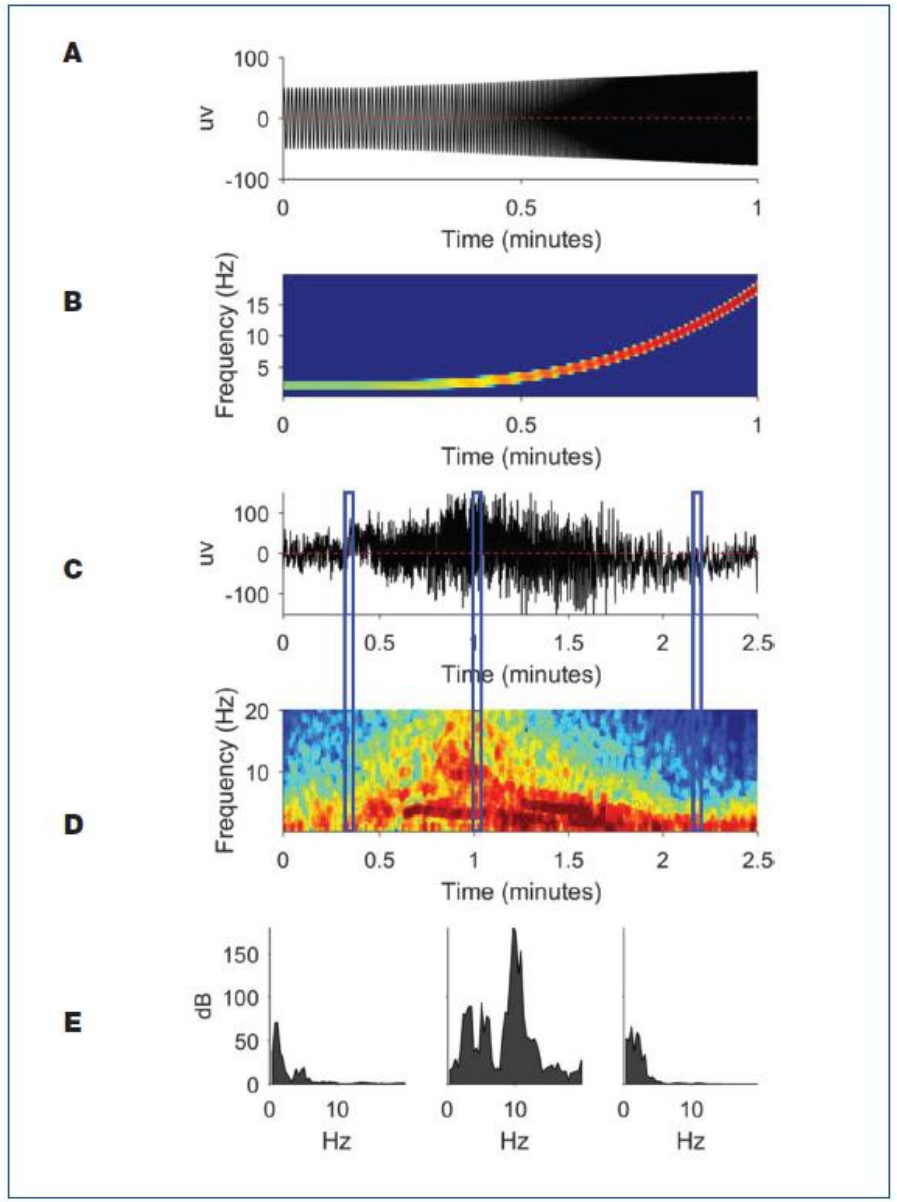
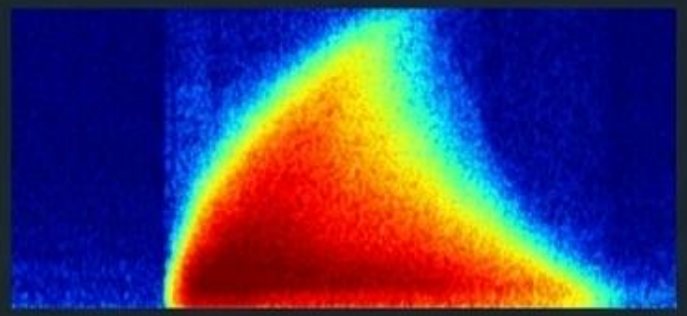
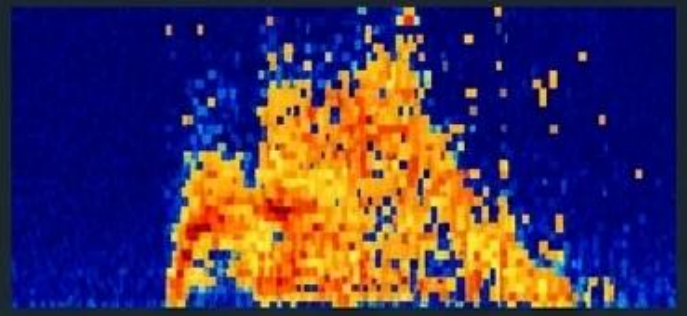


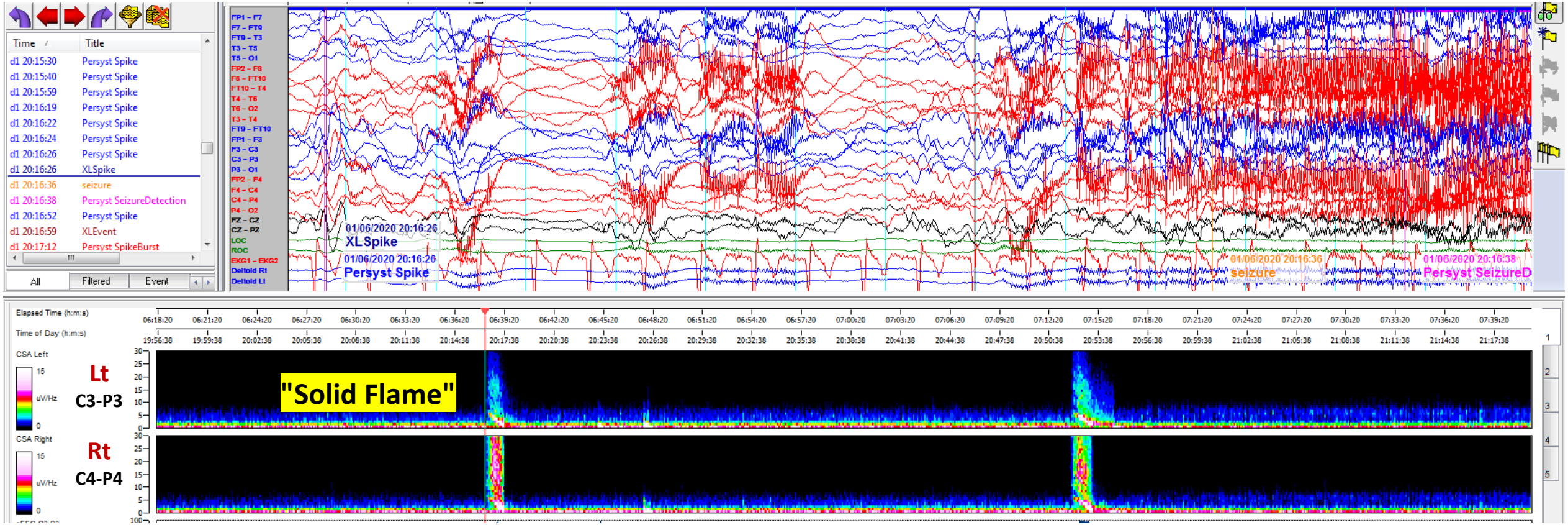
FIGURE 1.7 A. A simulated seizure at a single frequency increasing in frequency and amplitude over time. B. Time-aligned spectrogram of the simulated seizure in (A). C. A real seizure with an evolving mixture of frequencies and amplitudes. D. Time-aligned spectrogram of the seizure in (C). E. Power spectra from samples within each of the vertical blue rectangles from (C) and (D).

The Spectrogram Field Guide: Ictal Events

Visual Signature	Standardized Term	Clinical Translation
	Solid Flame	Highly correlated with electrographic seizures. Abrupt increase in power across frequencies.
	Choppy / Irregular Flame	Often state changes, movement, or alternating patterns. Less likely a true seizure, but requires review.

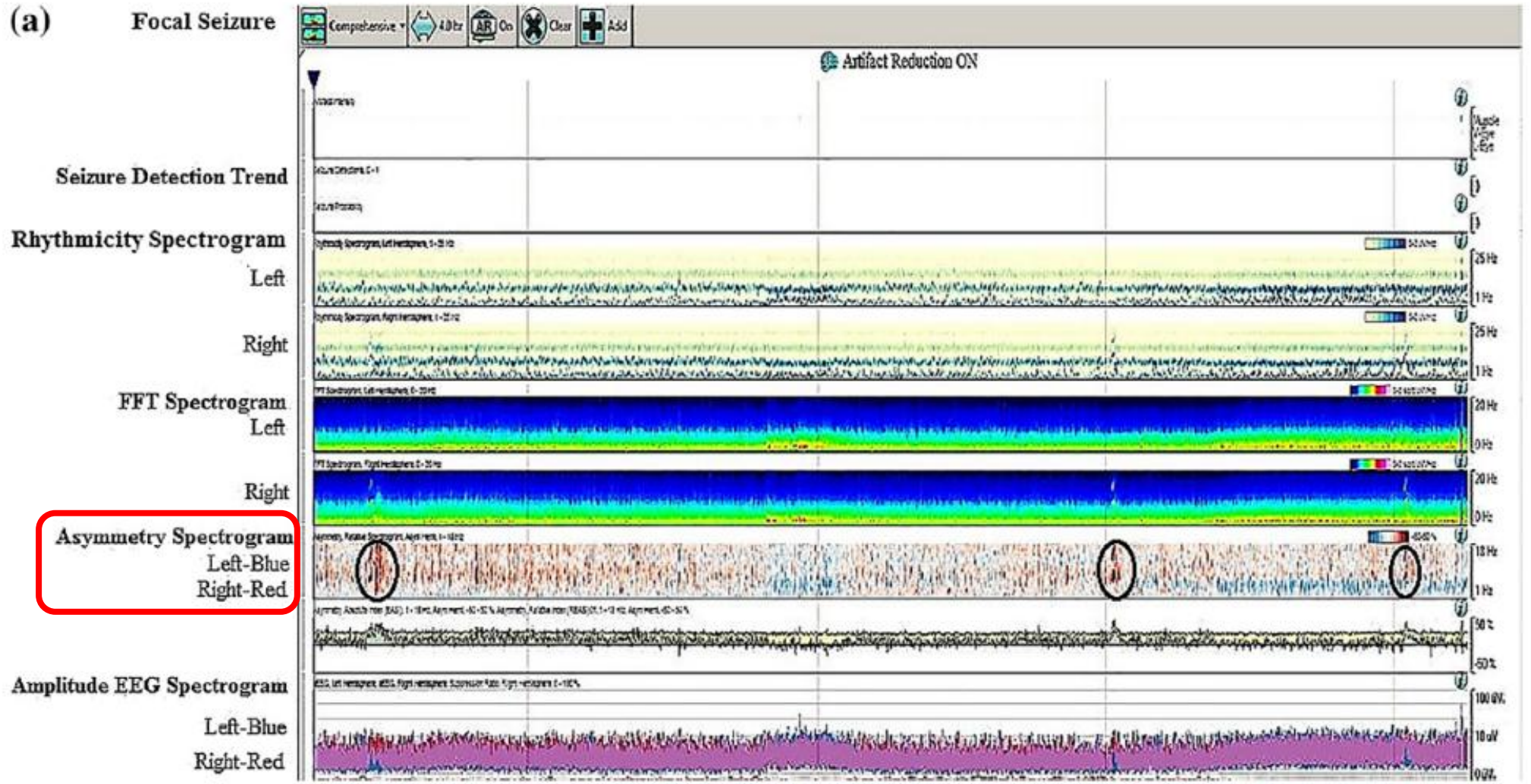
NotebookLM

Three episodes of seizure lasting for 2 minutes
- Clinical - **Generalized Clonic Seizure**



"Focal seizure"

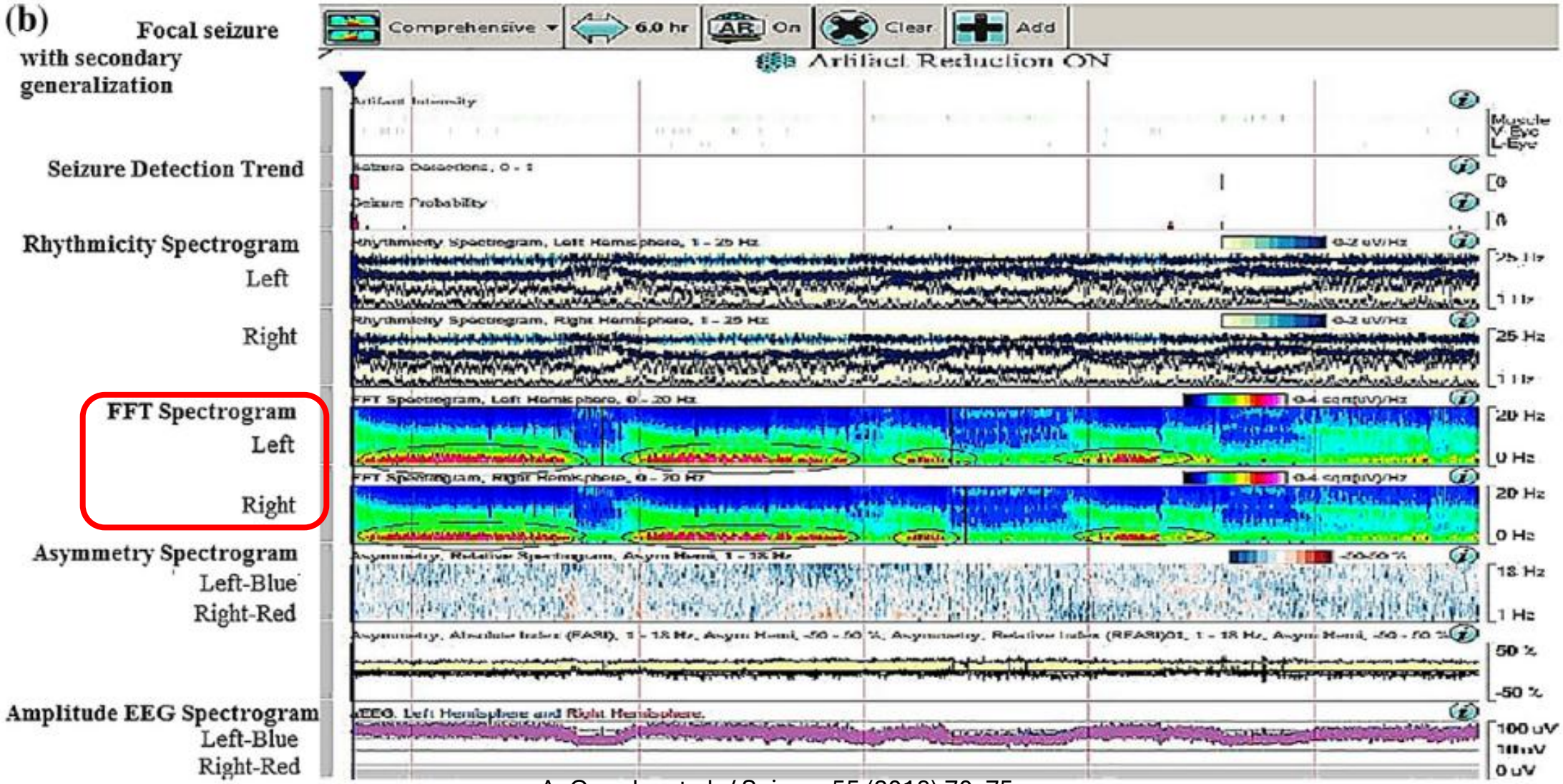
(Persyst® version 12 QEEG spectrograms)



A. Goenka et al. / Seizure 55 (2018) 70–75

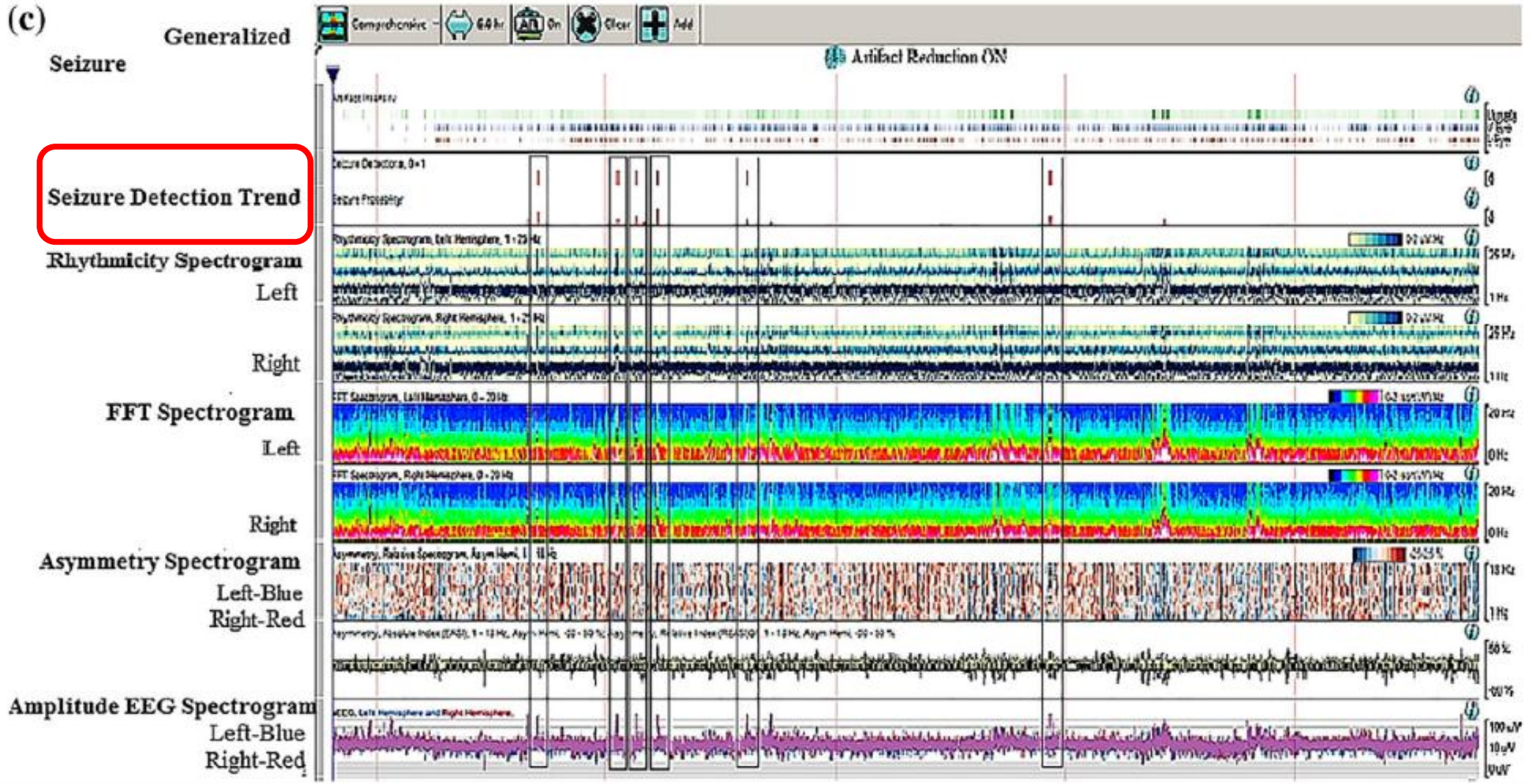
"Focal seizure with secondary generalization"

(Persyst® version 12 QEEG spectrograms)



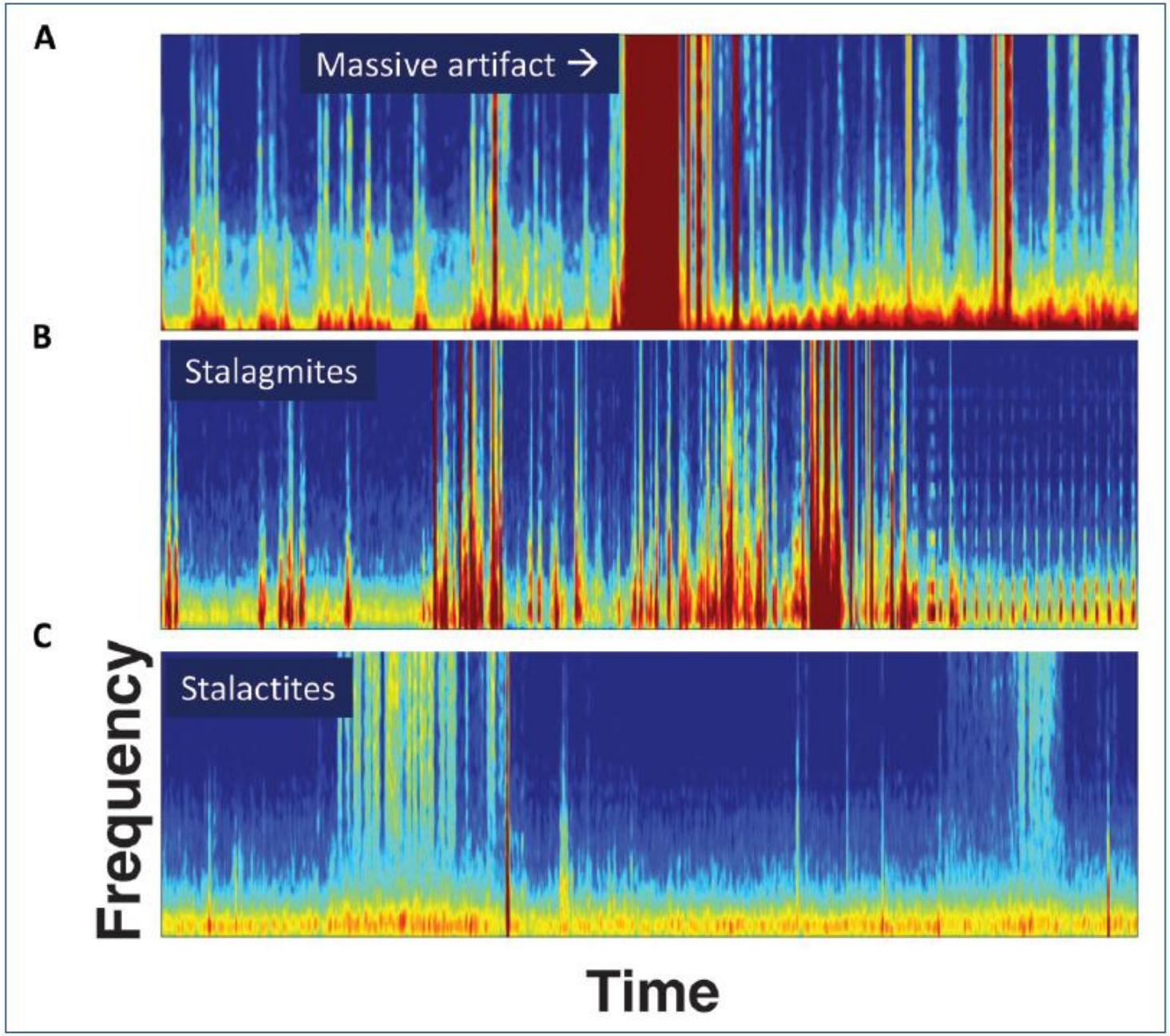
A. Goenka et al. / Seizure 55 (2018) 70–75

"Generalized seizures"
(Persyst® version 12 QEEG spectrograms)



A. Goenka et al. / Seizure 55 (2018) 70–75

stalagmite vs. stalactite

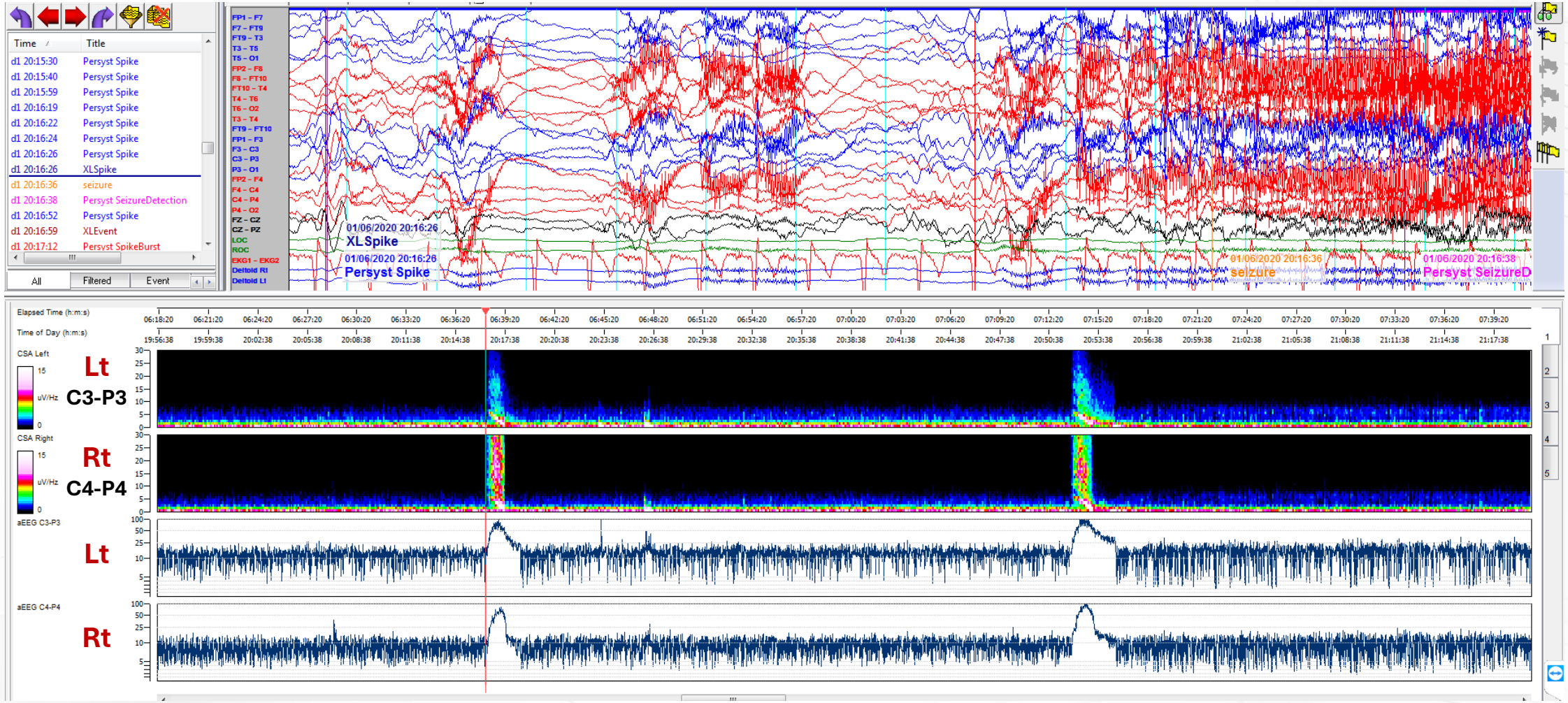


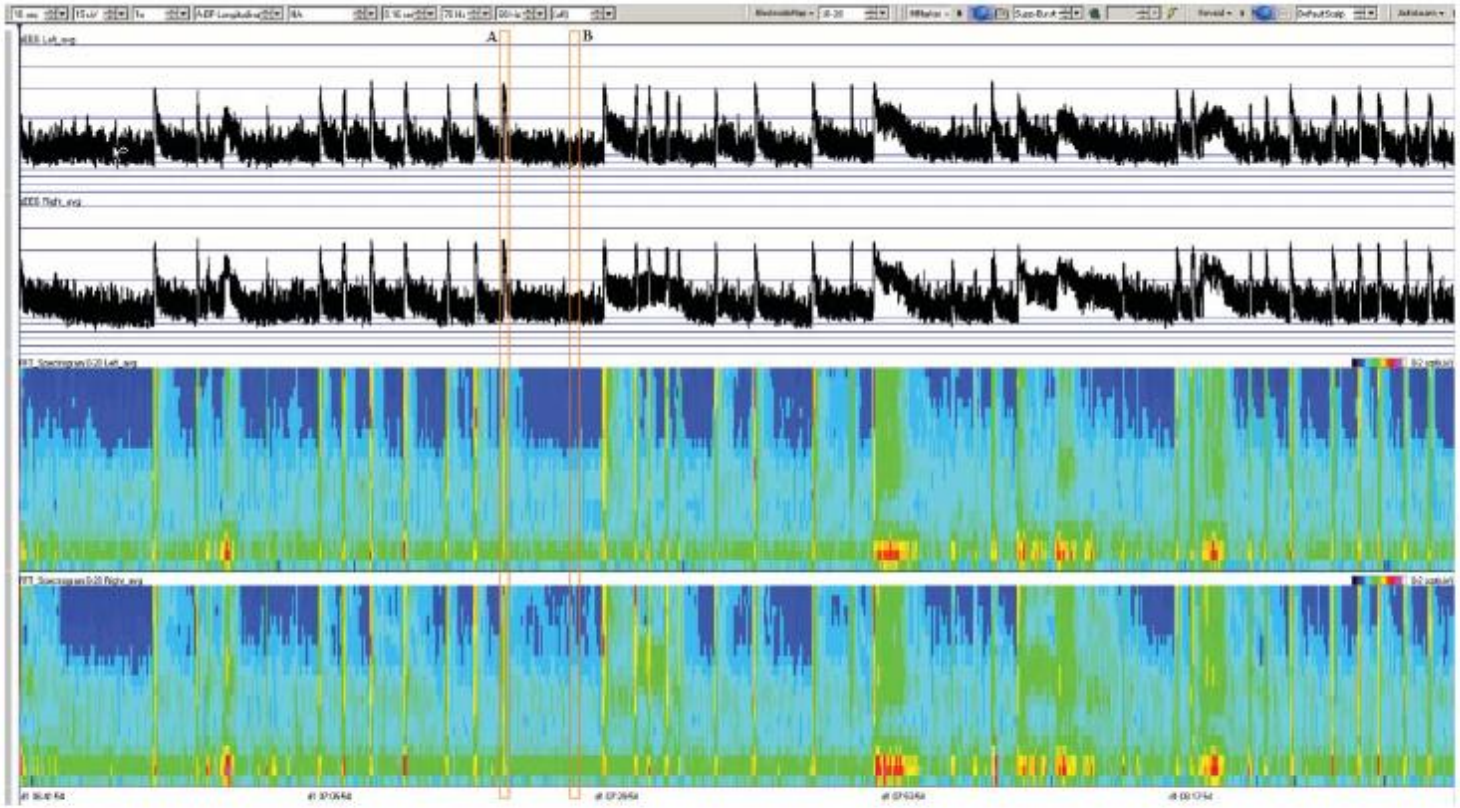
Prominent motion or electrical artifact

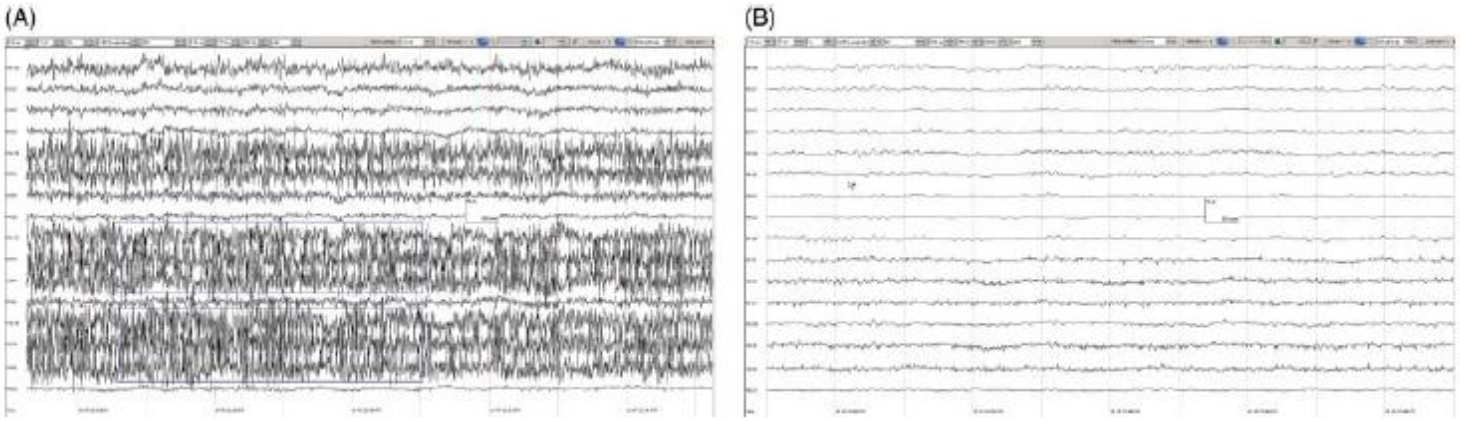
Motion artifact

Myogenic artifact

Three episodes of seizure lasting for 2 minutes - Clinical - **Generalized Clonic Seizure**







Artifact mimicking seizures on aEEG

No seizure
"Intermittent muscle artifact"

Tips

- **QEEG should never been interpreted without reviewing portions of the original waveforms**
- **Multiple QEEG trends are complimentary**

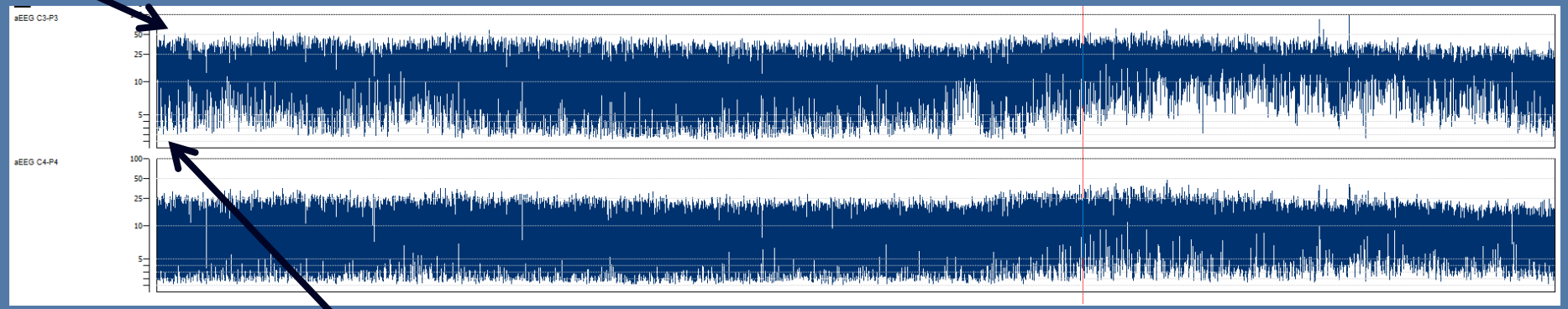
Amplitude-integrated EEG (aEEG)

AMPLITUDE INTEGRATED EEG (aEEG)

How to read?

MAXIMUM AMPLITUDE

Highest band at a time



Y axis

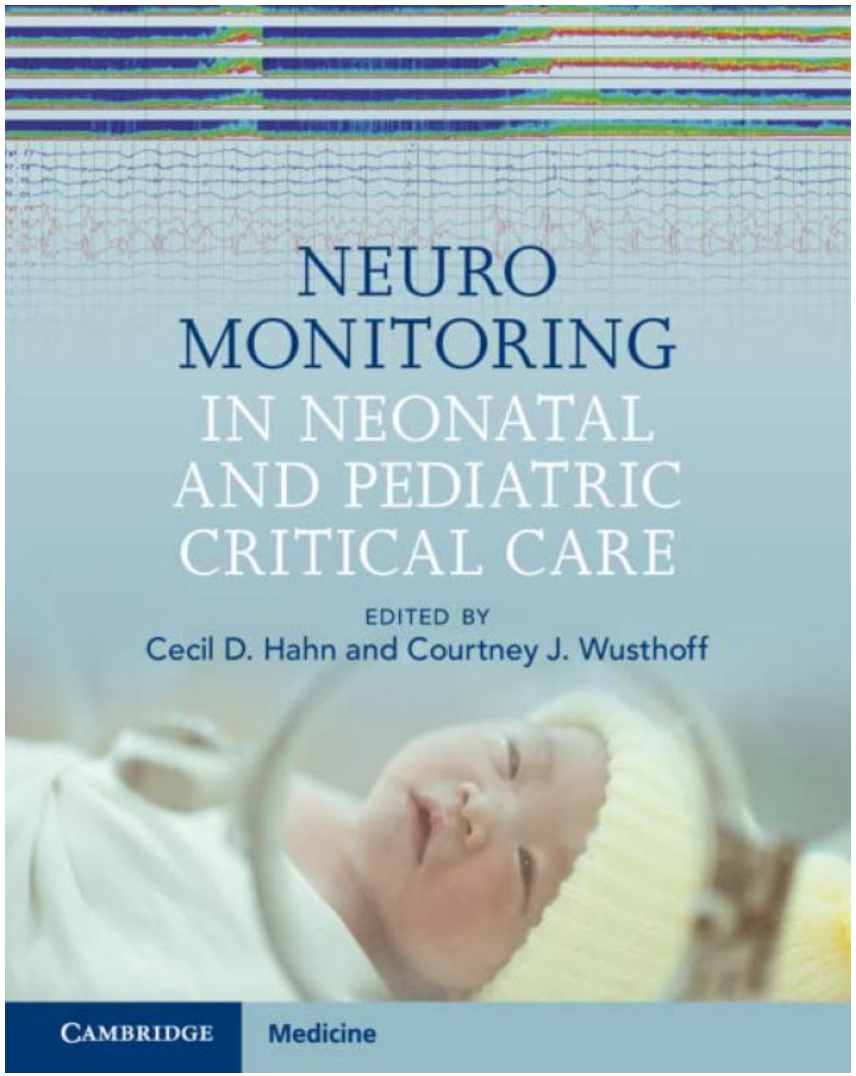
Degree of amplitude (μV)

X axis

Time(msec)

MINIMUM AMPLITUDE

Lowest band at a time



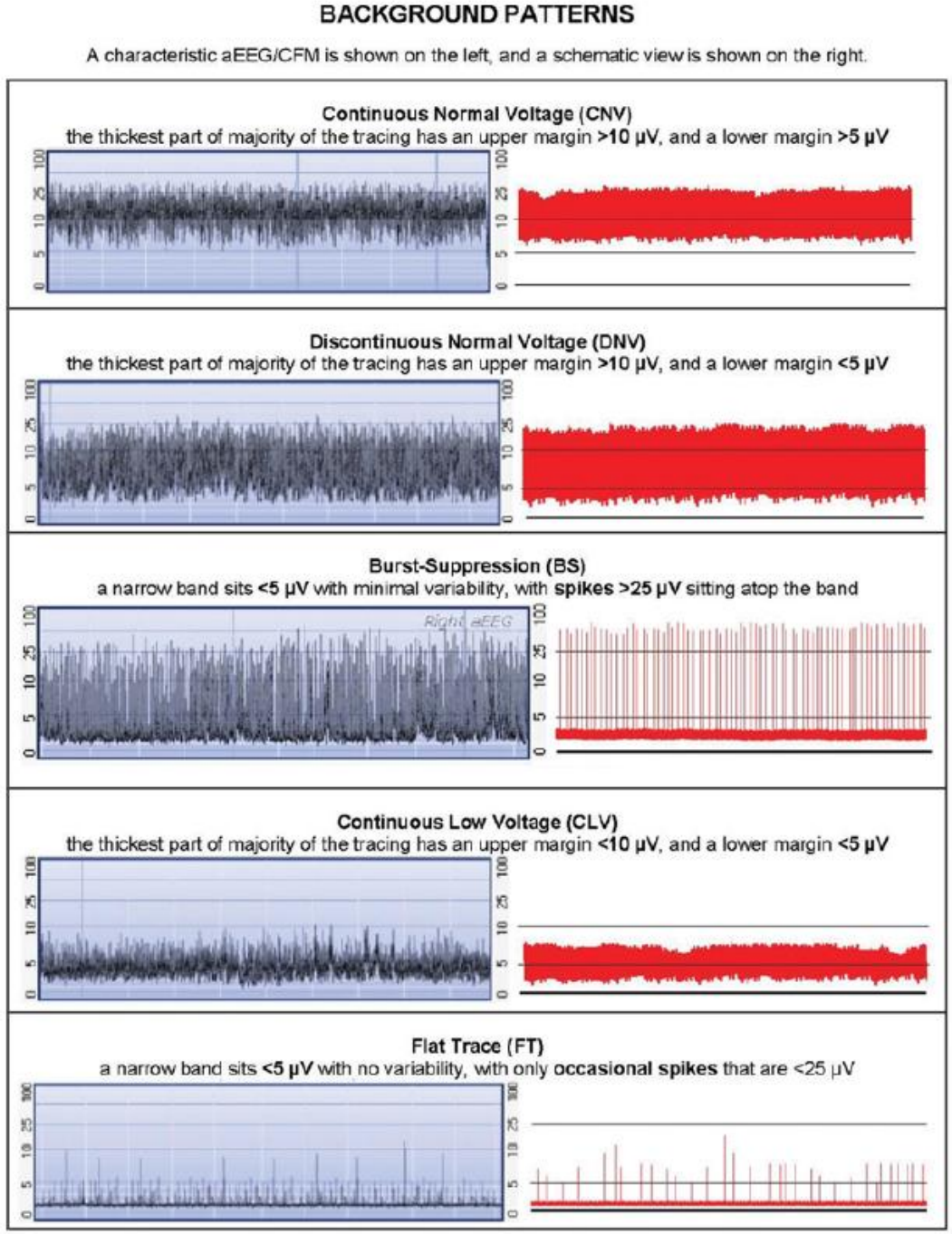
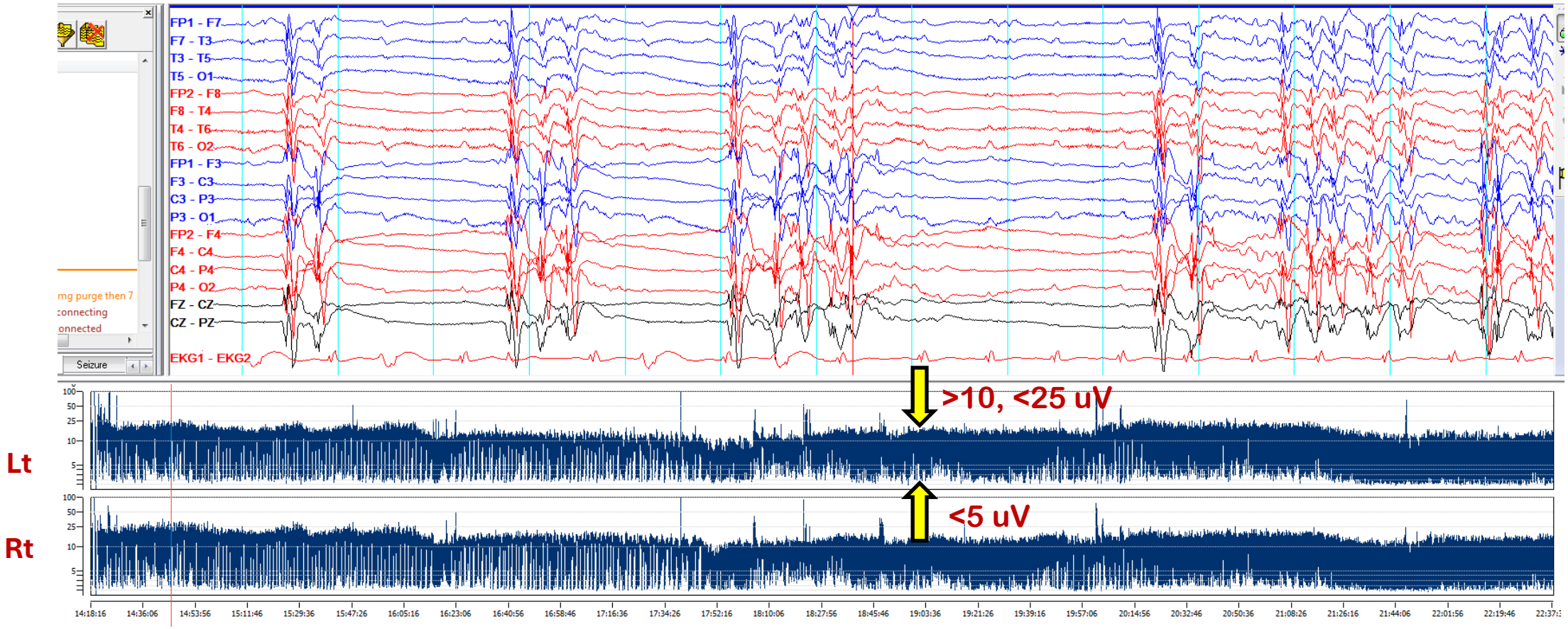


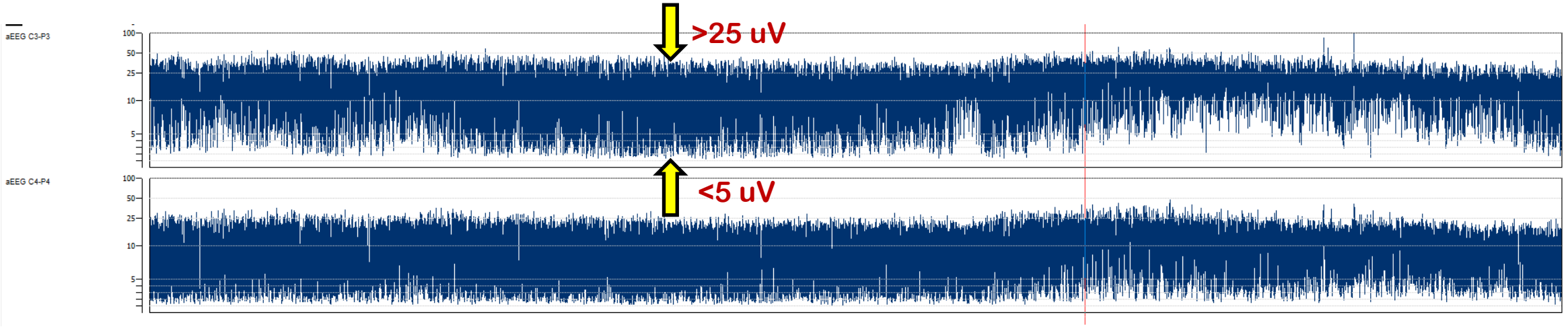
Figure 4.3 Classification of aEEG background patterns. Courtesy of the Hospital for Sick Children.

Conventional EEG: Burst-suppression



aEEG: "Discontinupus Pattern"

aEEG: "Burst-Suppression Pattern"



Applications

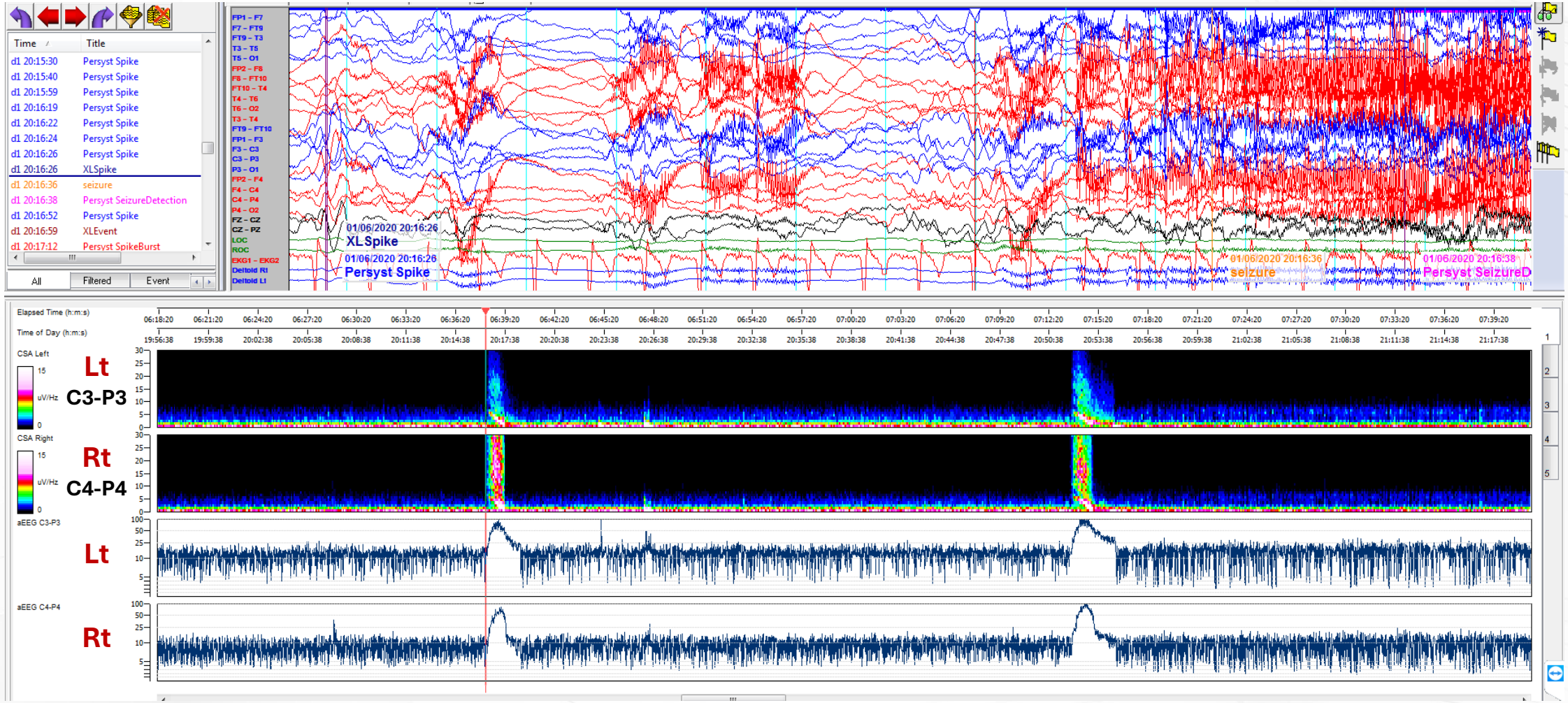
Seizure Trends

CSA and aEEG

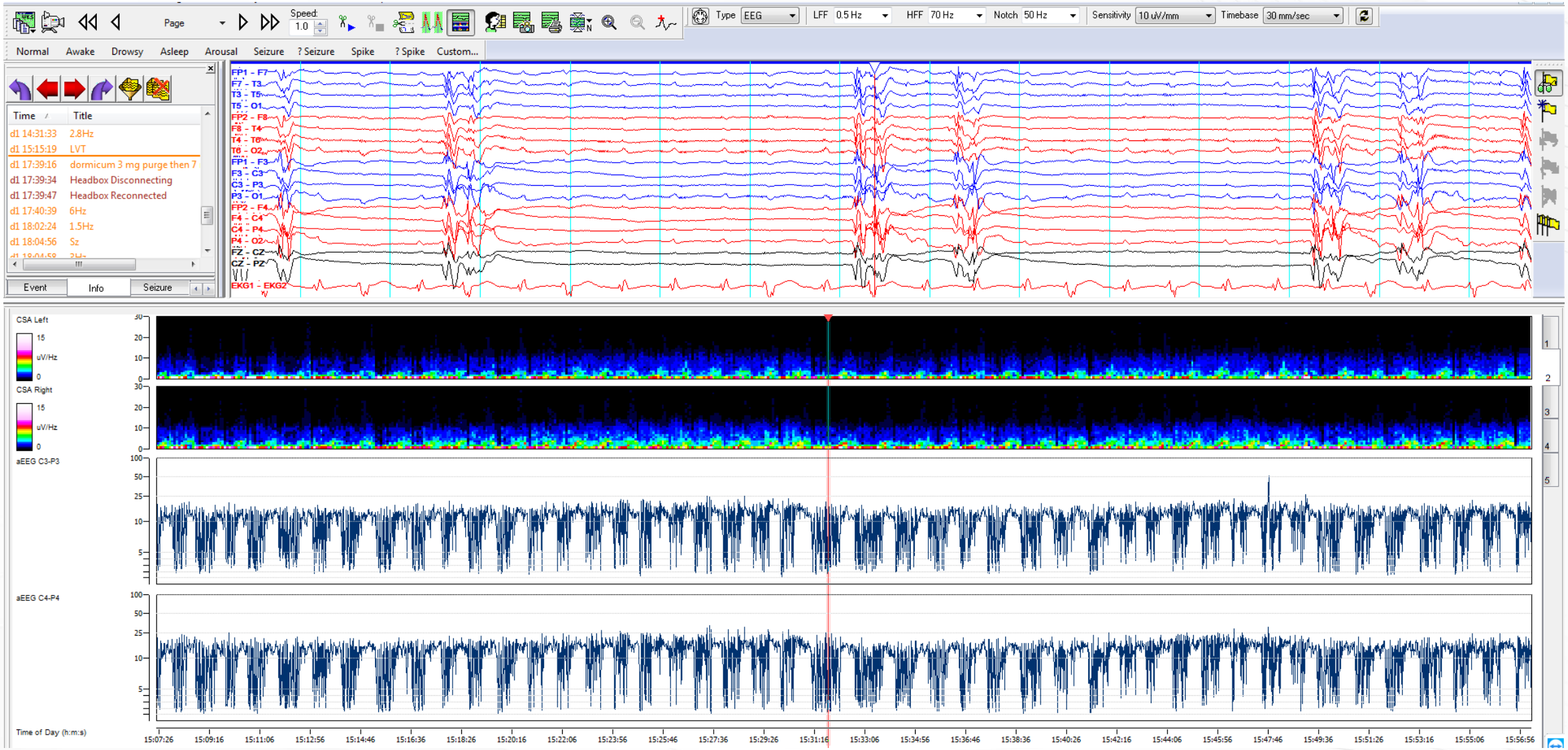
TREND ANALYSIS

NIHON KOHDEN

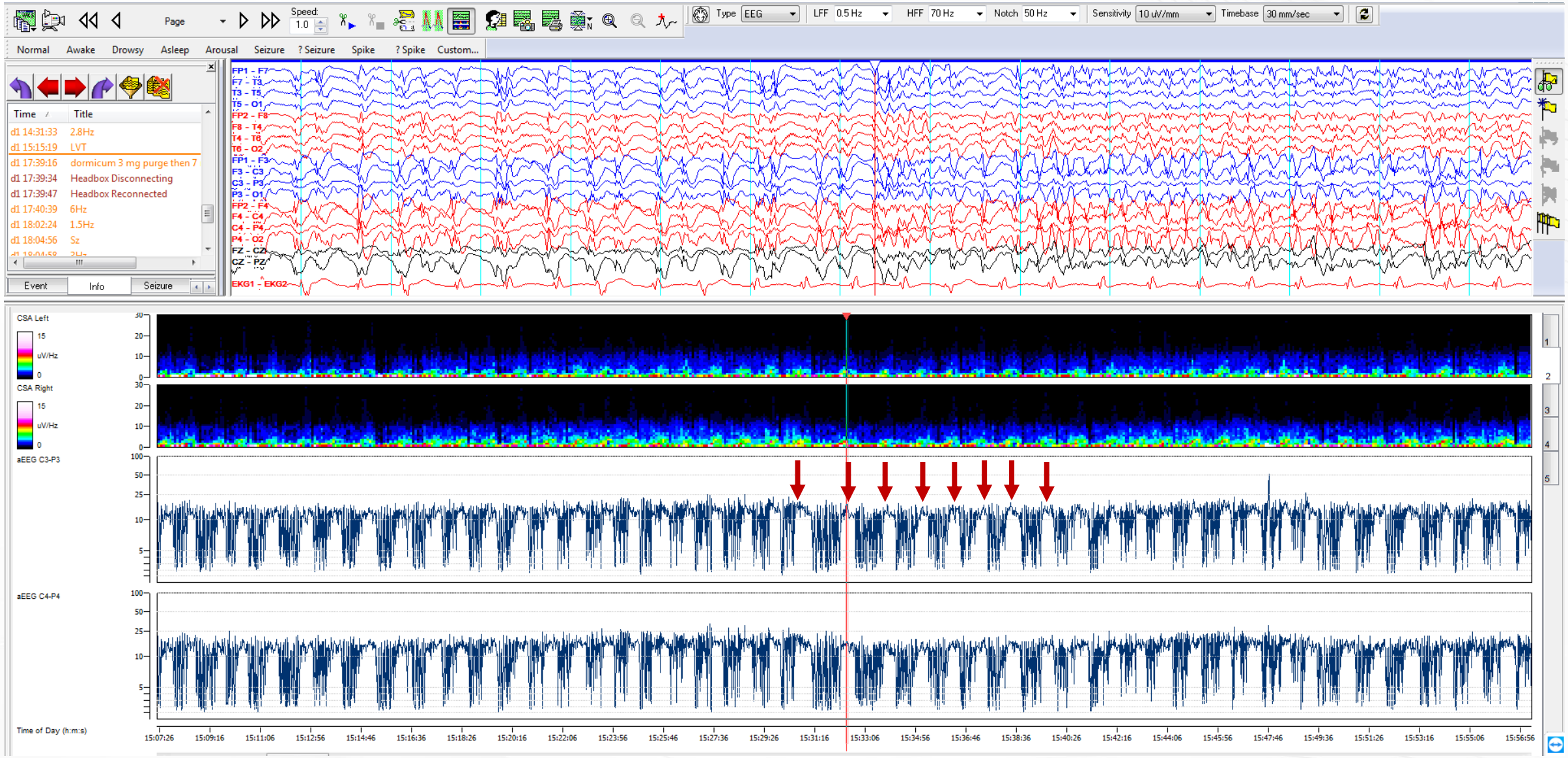
Three episodes of seizure lasting for 2 minutes - Clinical - **Generalized Clonic Seizure**



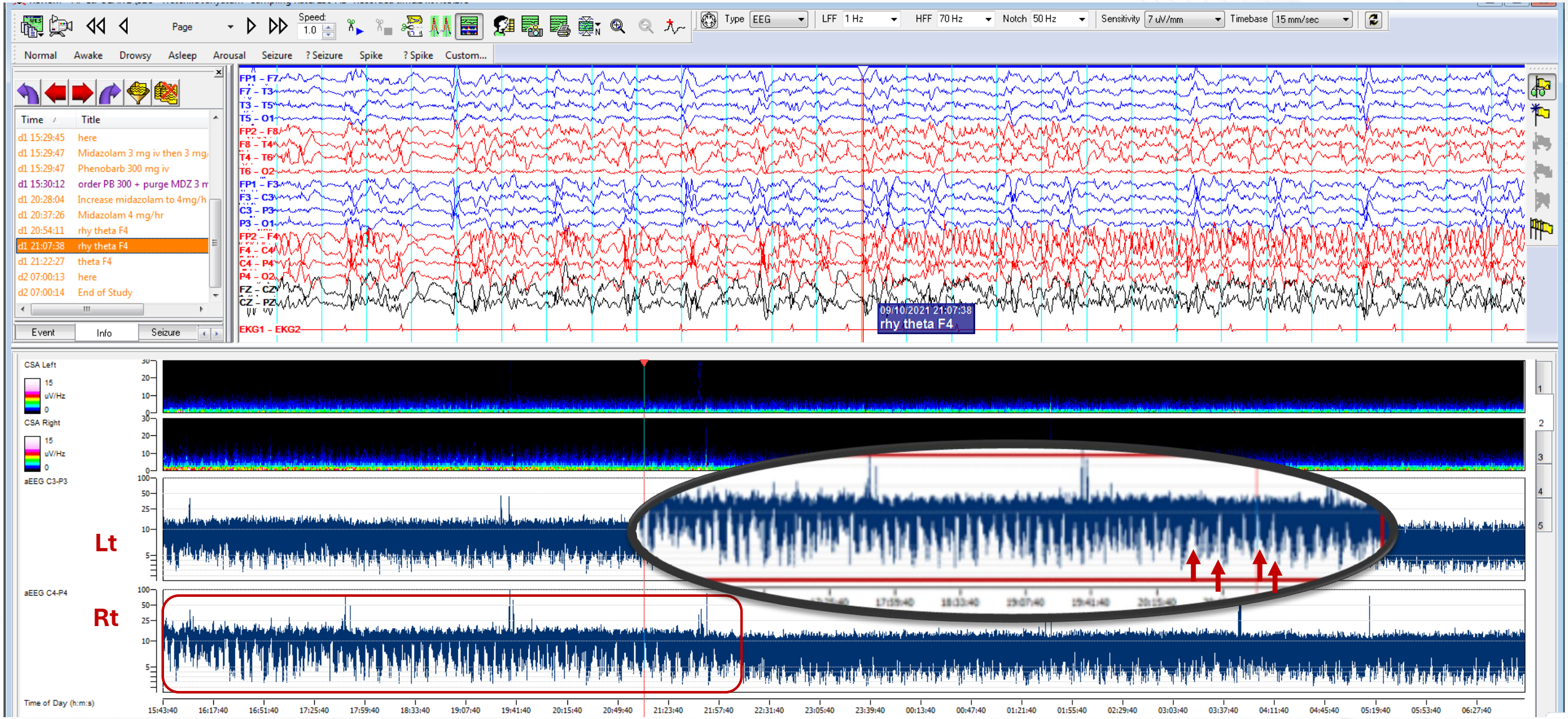
"Burst suppression"



"Seizure"


Page
Speed: 1.0
Type EEG
LFF 0.5 Hz
HFF 70 Hz
Notch 50 Hz
Sensitivity 10 uV/mm
Timebase 30 mm/sec
Normal
Awake
Drowsy
Asleep
Arousal
Seizure
? Seizure
Spike
? Spike
Custom...
Time
Title
d1 14:31:33 2.8Hz
d1 15:15:19 LVT
d1 17:39:16 dormicum 3 mg purge then 7
d1 17:39:34 Headbox Disconnecting
d1 17:39:47 Headbox Reconnected
d1 17:40:39 6Hz
d1 18:02:24 1.5Hz
d1 18:04:56 Sz
Event
Info
Seizure
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
EKG1 - EKG2
CSA Left
15
uV/Hz
0
CSA Right
aEEG C3-P3
aEEG C4-P4
Time of Day (h:m:s)
15:07:26
15:09:16
15:11:06
15:12:56
15:14:46
15:16:36
15:18:26
15:20:16
15:22:06
15:23:56
15:25:46
15:27:36
15:29:26
15:31:16
15:33:06
15:34:56
15:36:46
15:38:36
15:40:26
15:42:16
15:44:06
15:45:56
15:47:46
15:49:36
15:51:26
15:53:16
15:55:06
15:56:56

"Seizure, Right Hemisphere, F4"



Guiding Treatment (1)

CSA and aEEG

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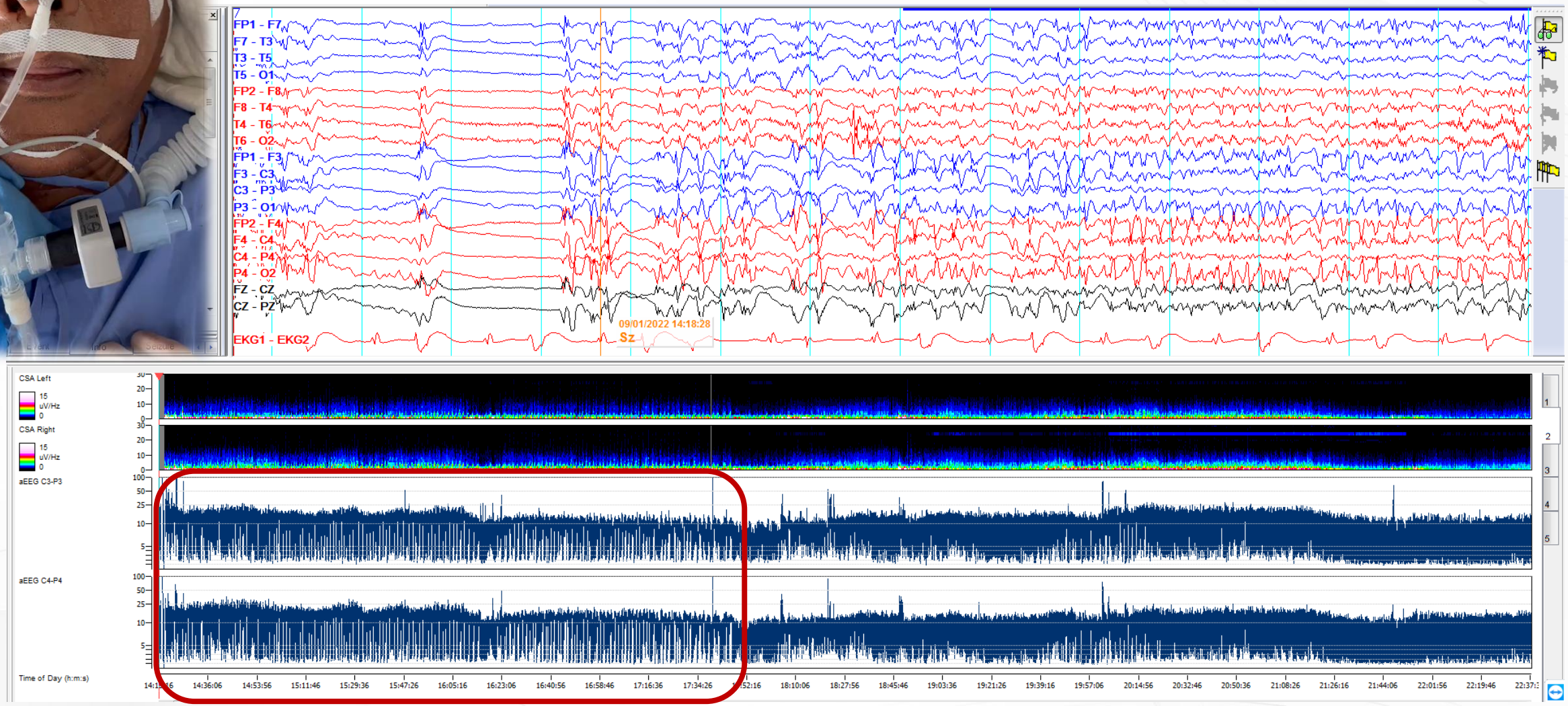
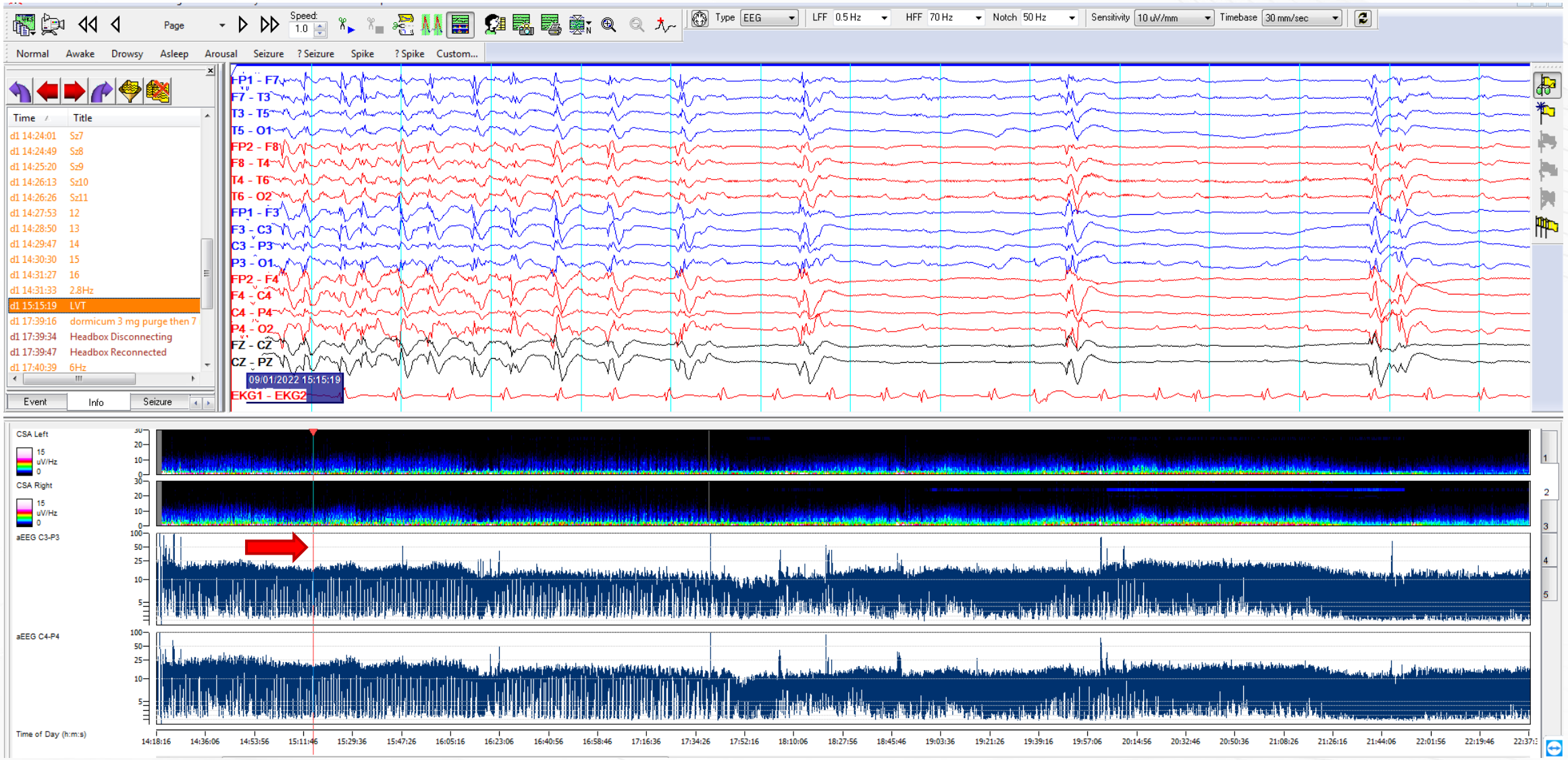
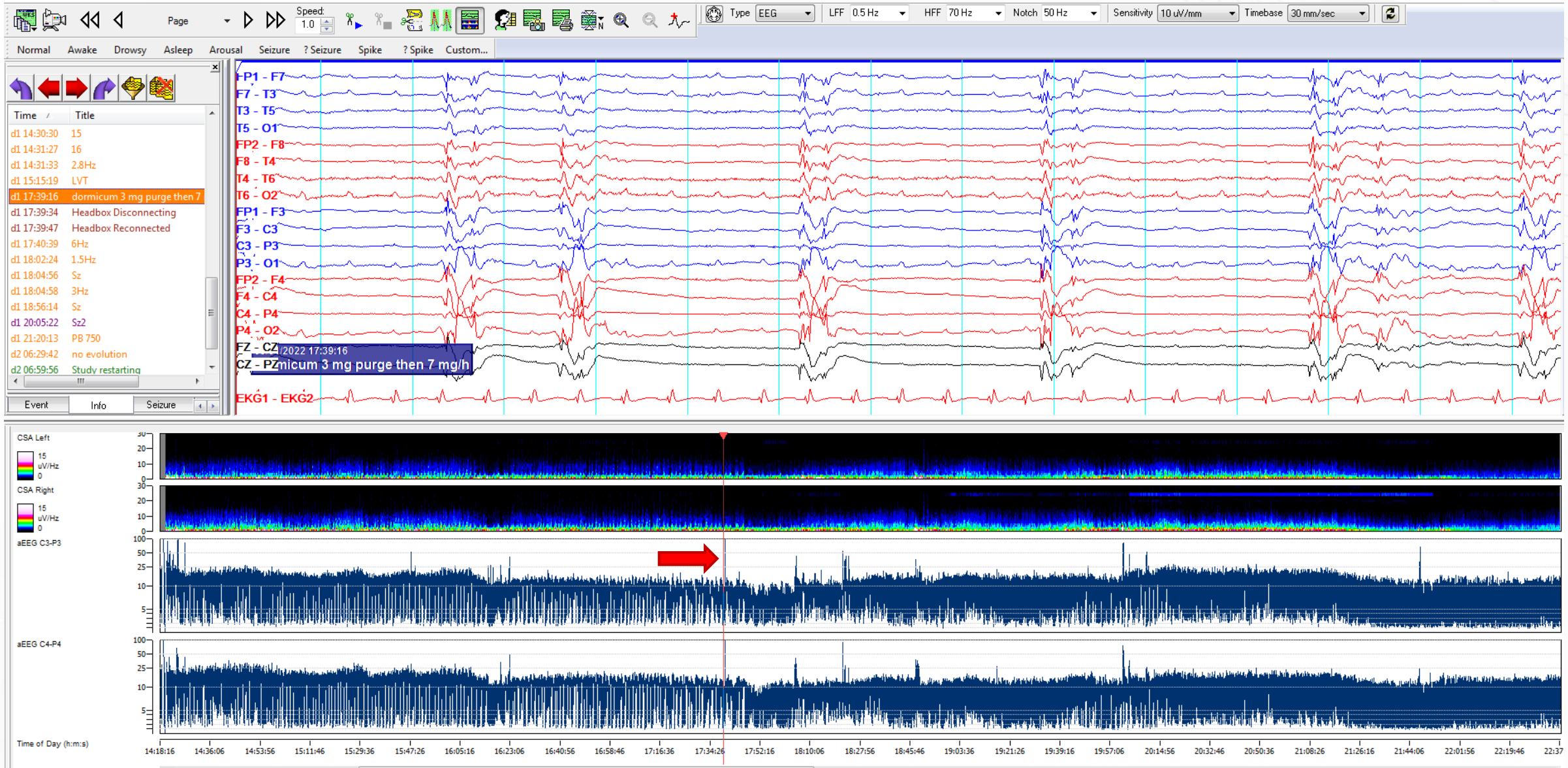
"Seizure, Rt paracentral" (left-face clonic seizure)



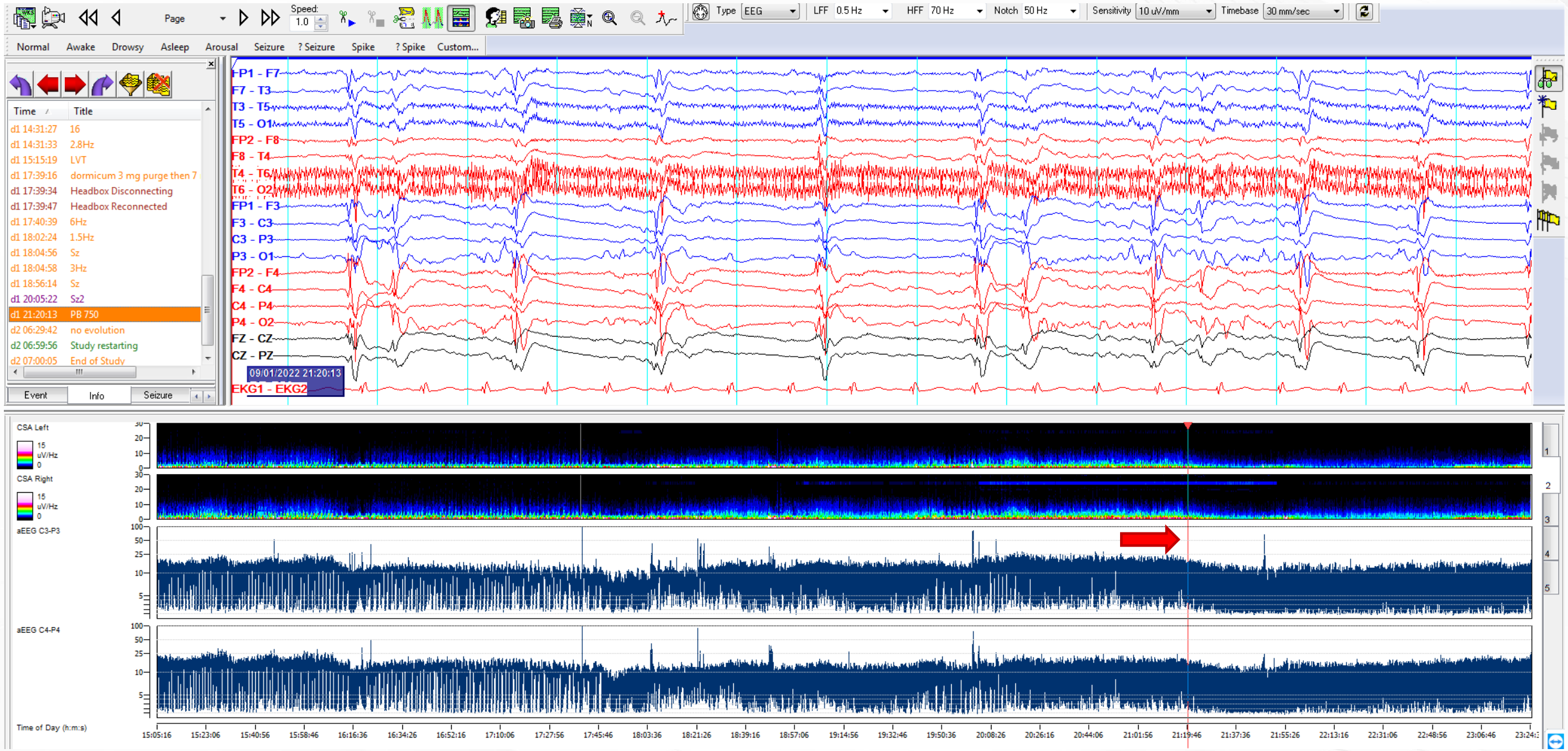
"LEV 1000 mg (no response)"



"MDZ 3 mg purge then increase from 6 to 7 mg/h (response to MDZ)"



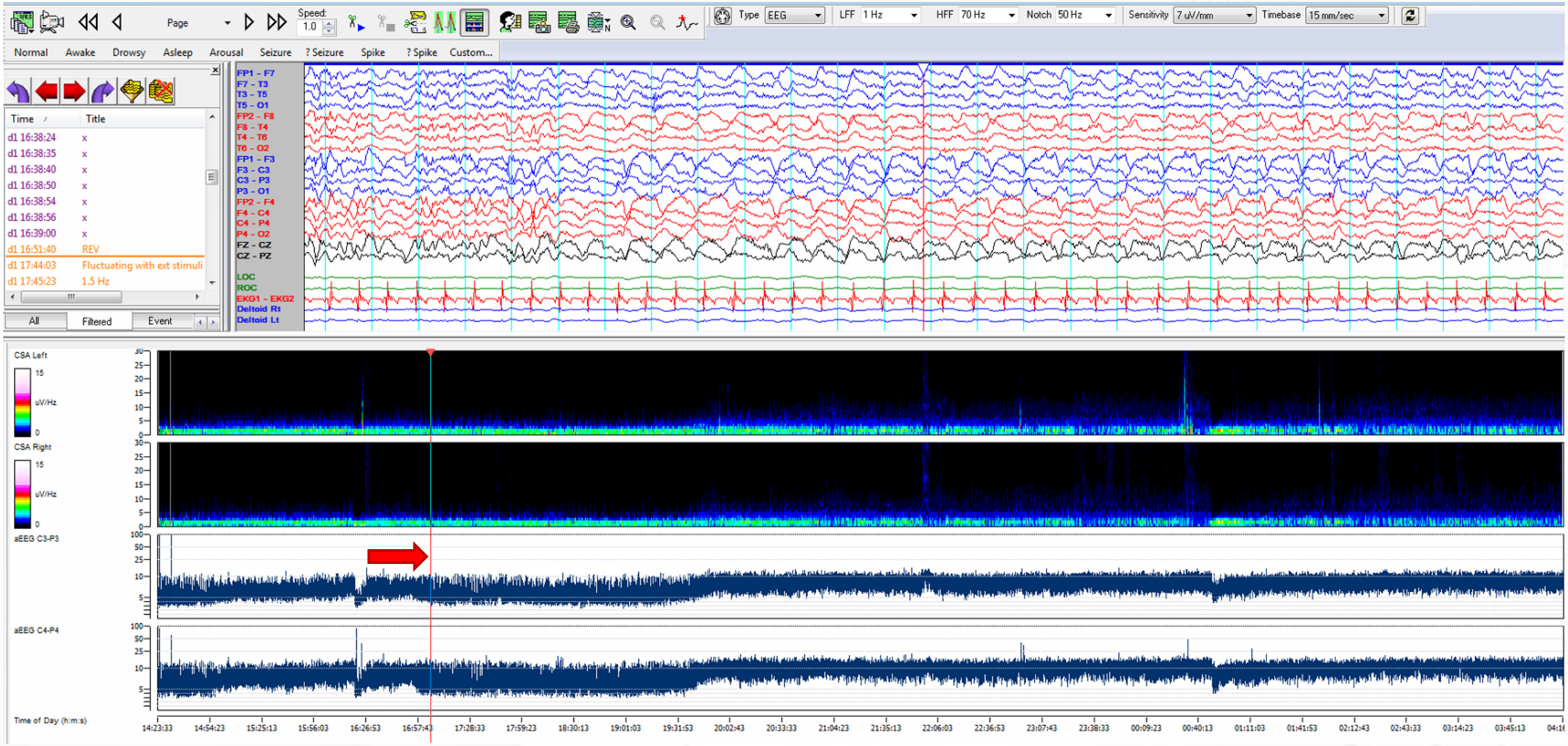
"PB 750 mg IV load (response to PB)"



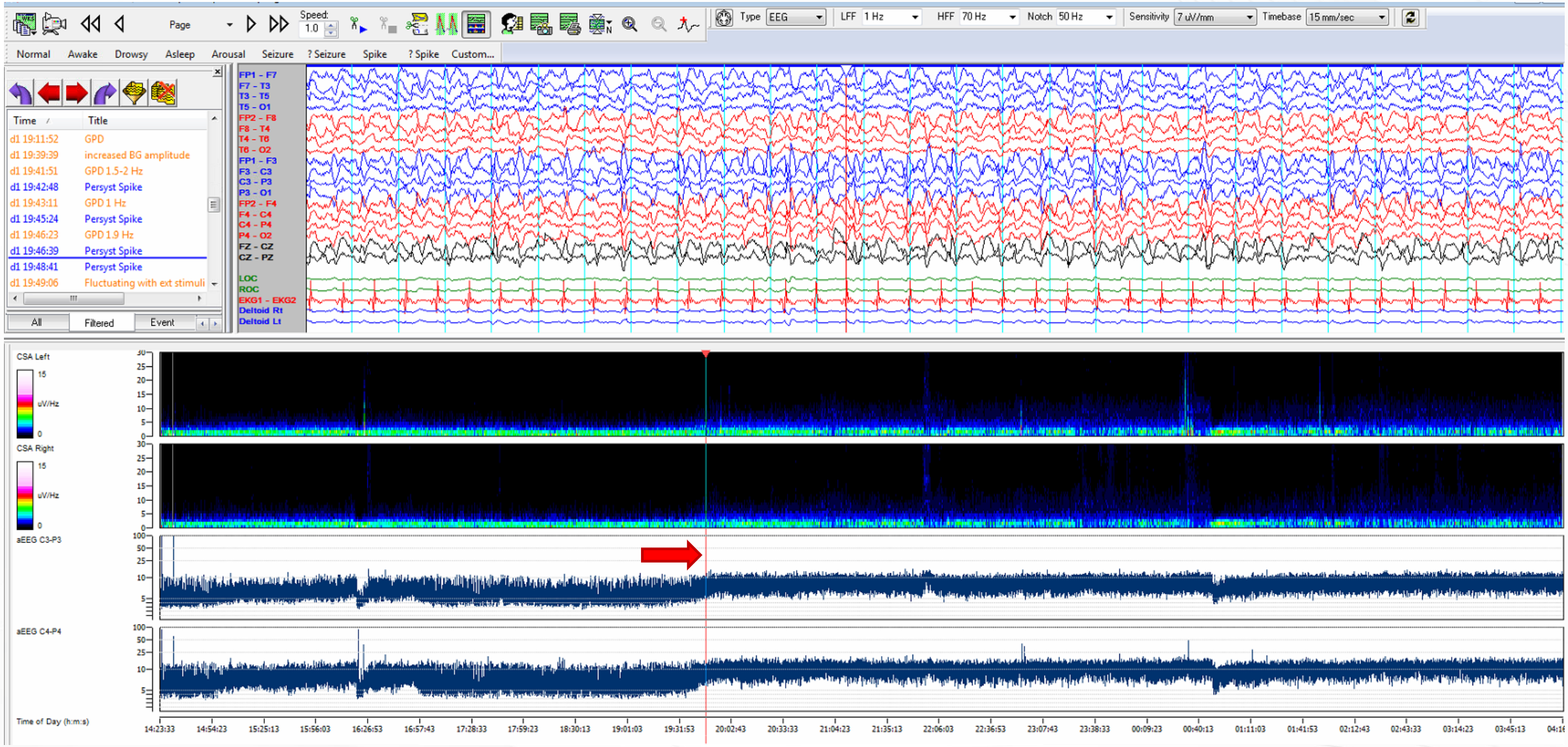
Guiding Treatment (2)

CSA and aEEG

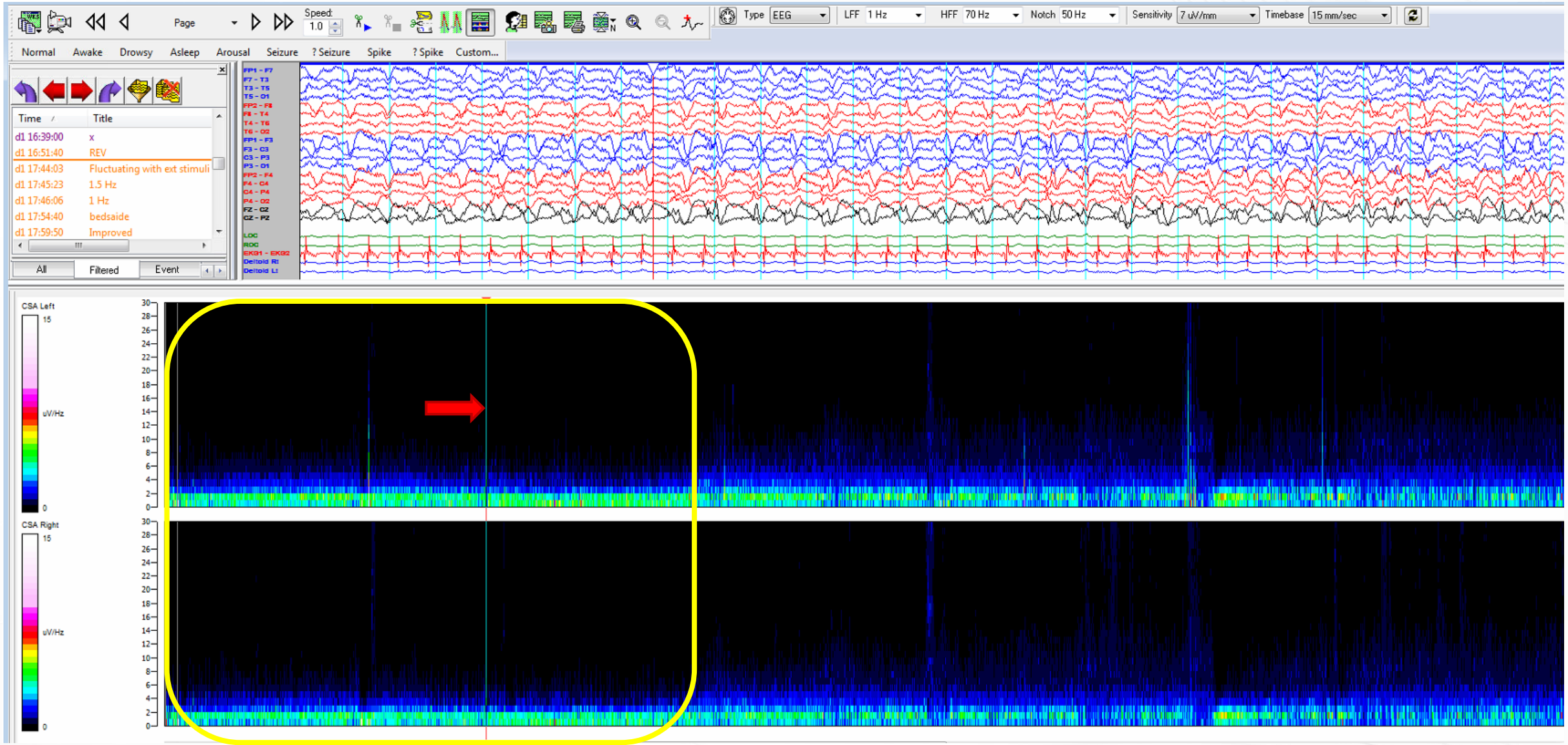
"Before IV ASM loading (at 18.00) GPDs and High Power Delta "



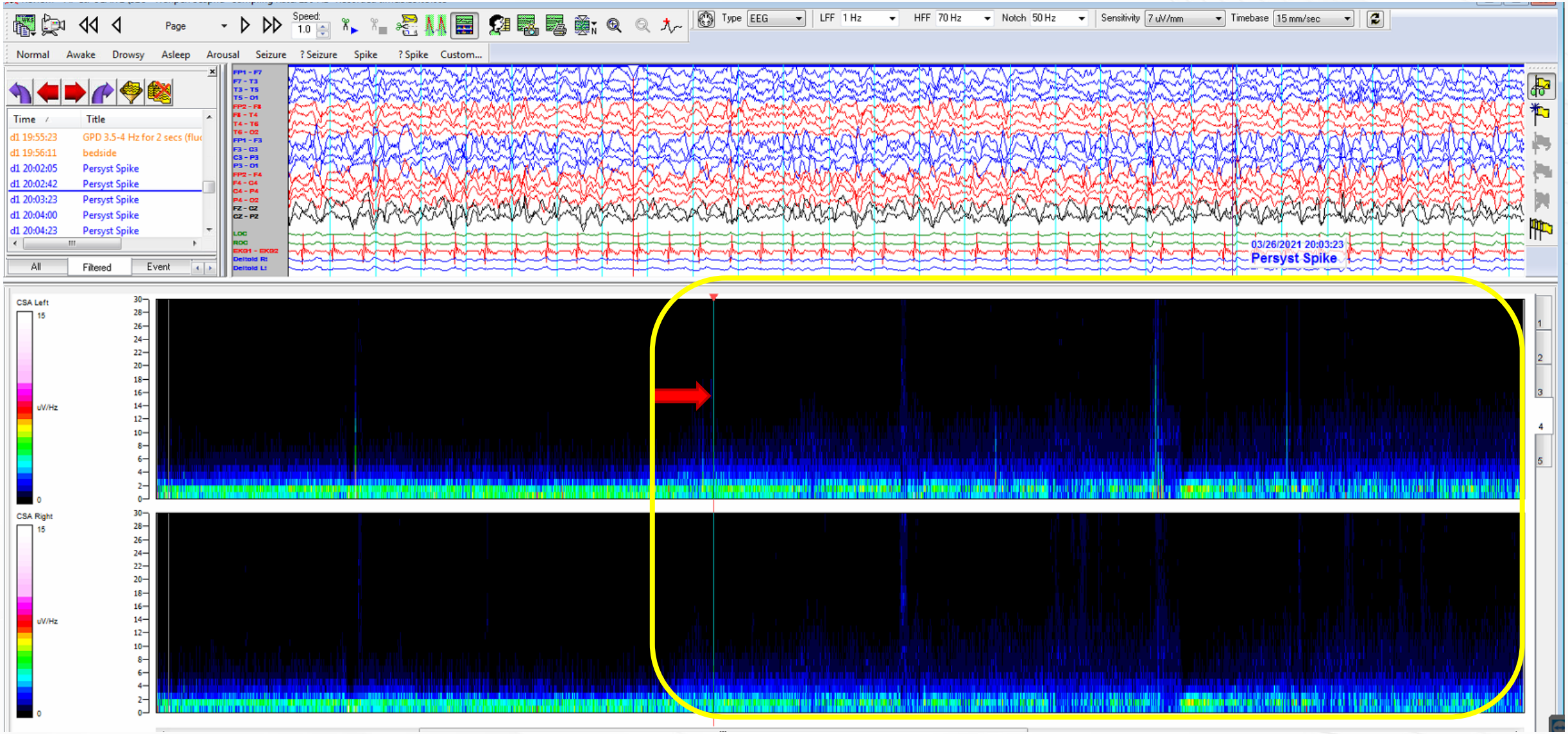
"19.00 (1 h after LEV 2000 mg loading)



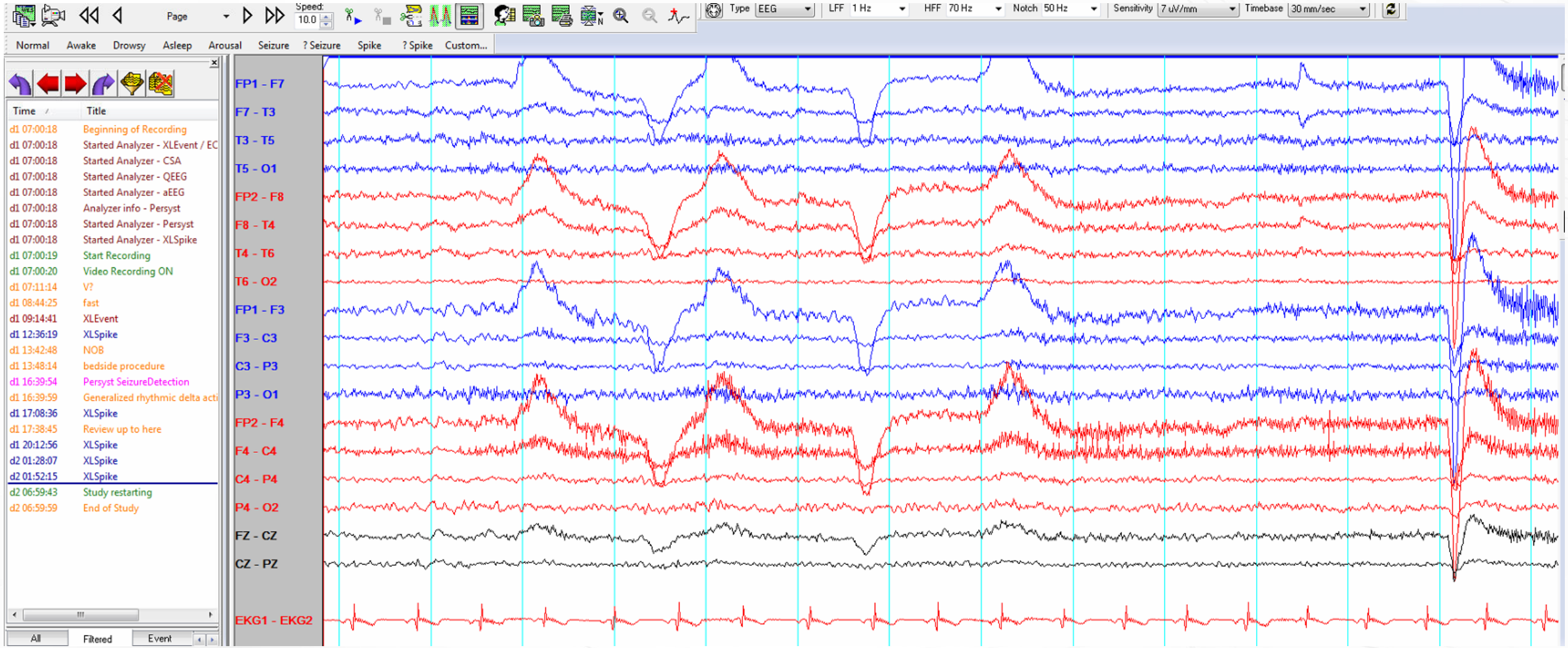
"Before LEV loading: BG mainly in delta band"



"After loading: Varied frequency bands up to alpha band"



"D2 after LEV: Significantly improved in BG"



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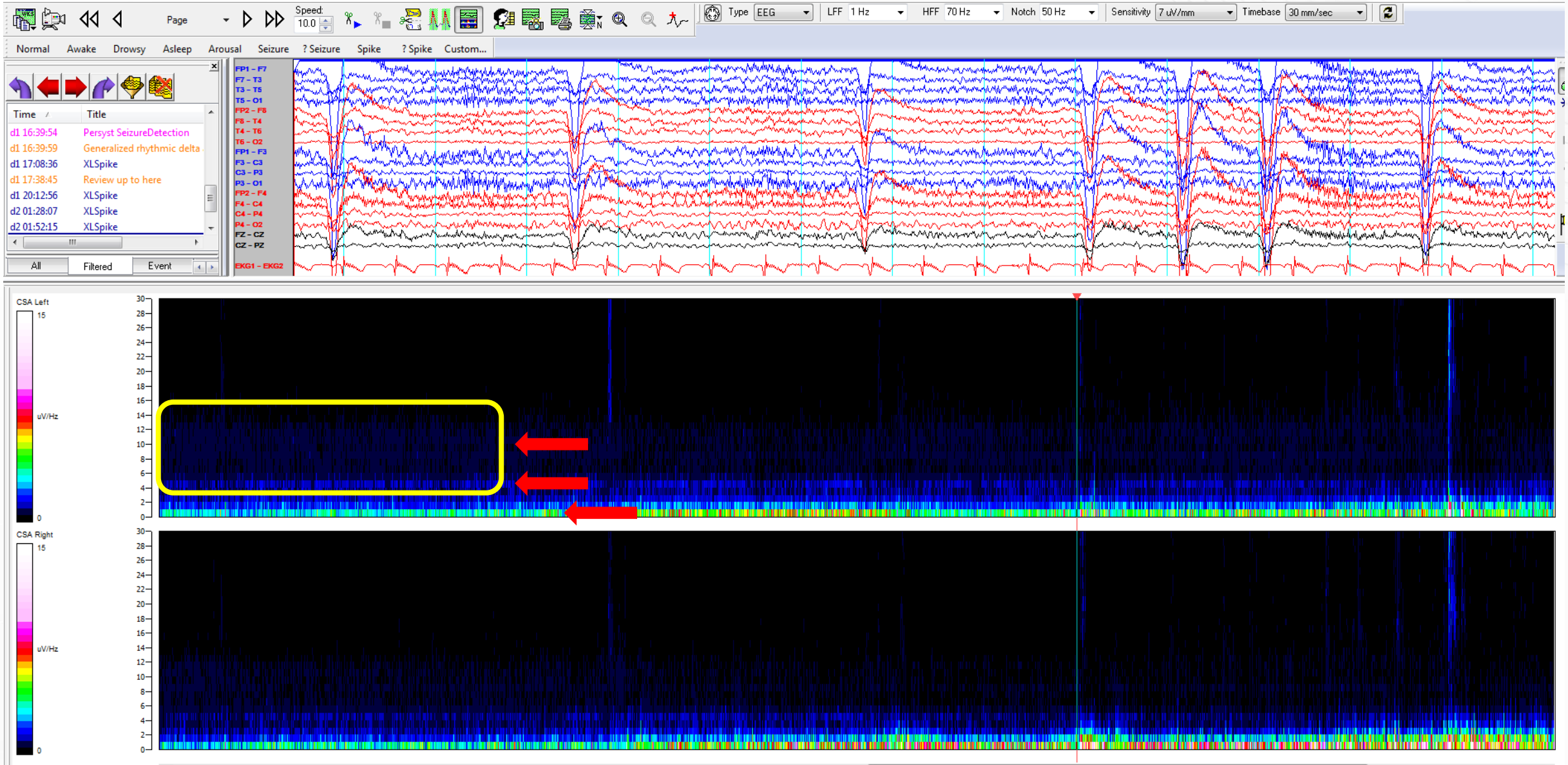
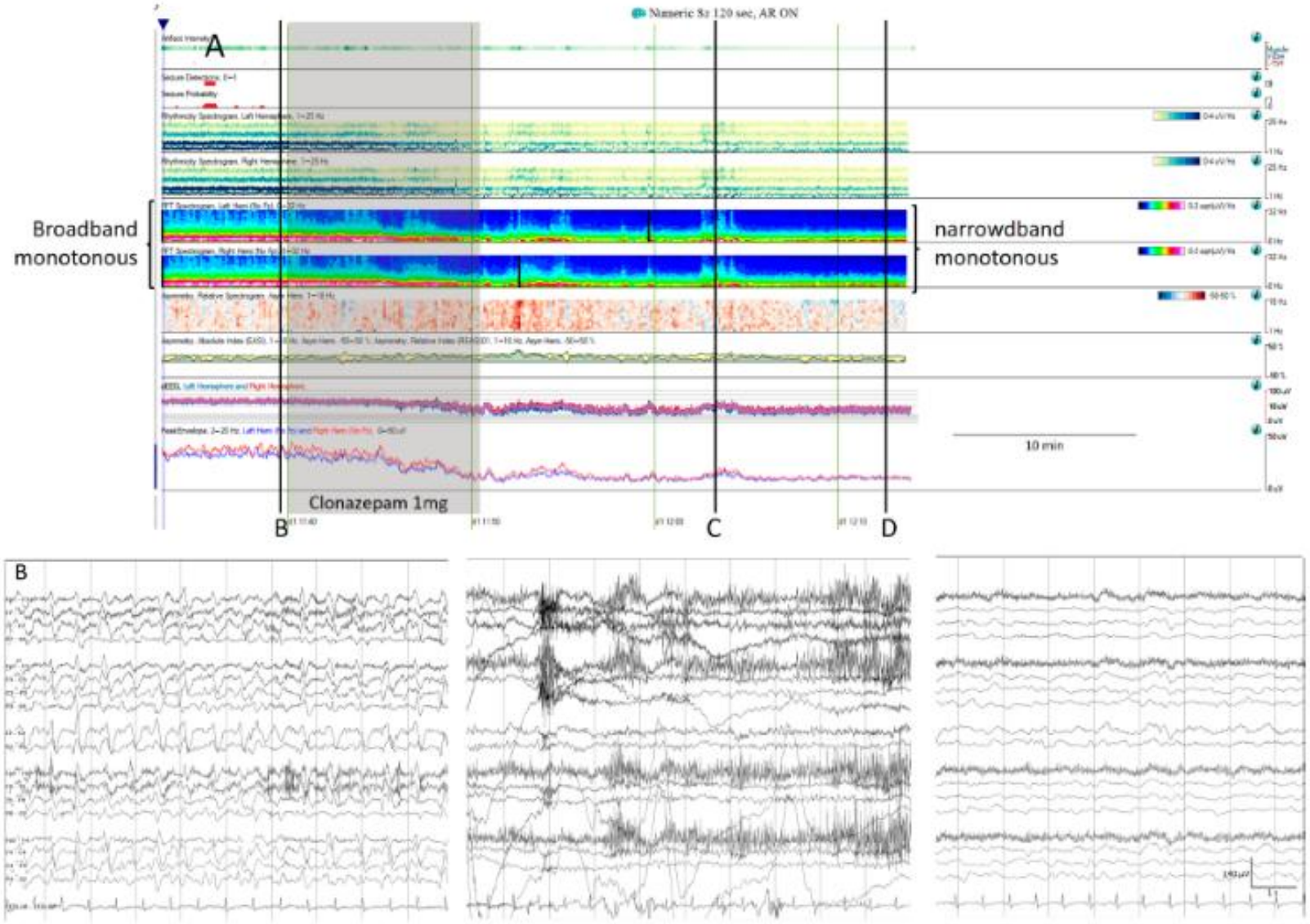
"Improved BG: persistence of alpha & theta bands, less power of delta band"



GPDs (IIC), therapeutic trial with IV CZP 1 mg



Heras M et al, Brain Sci. 2024, 14, 939

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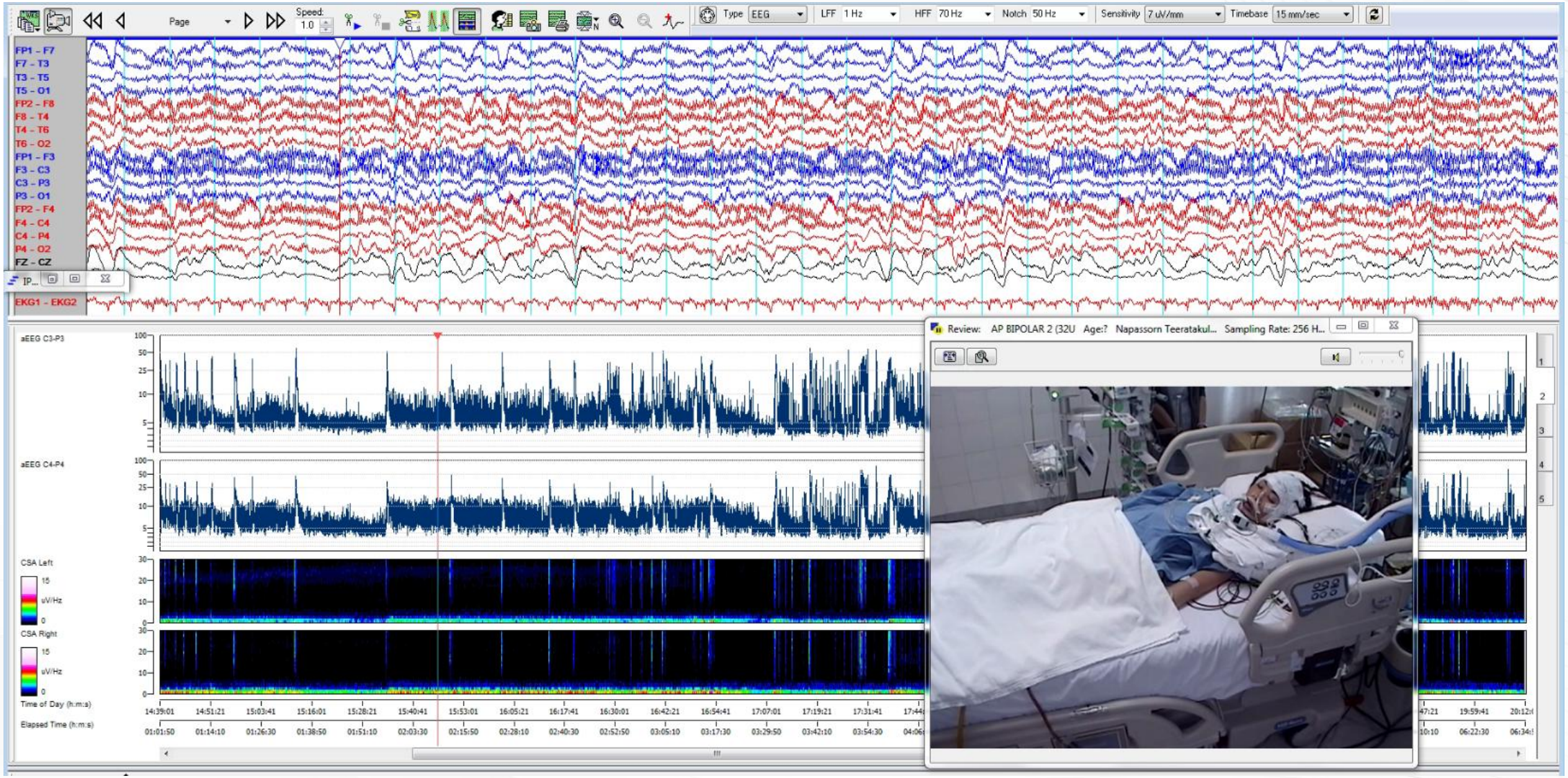
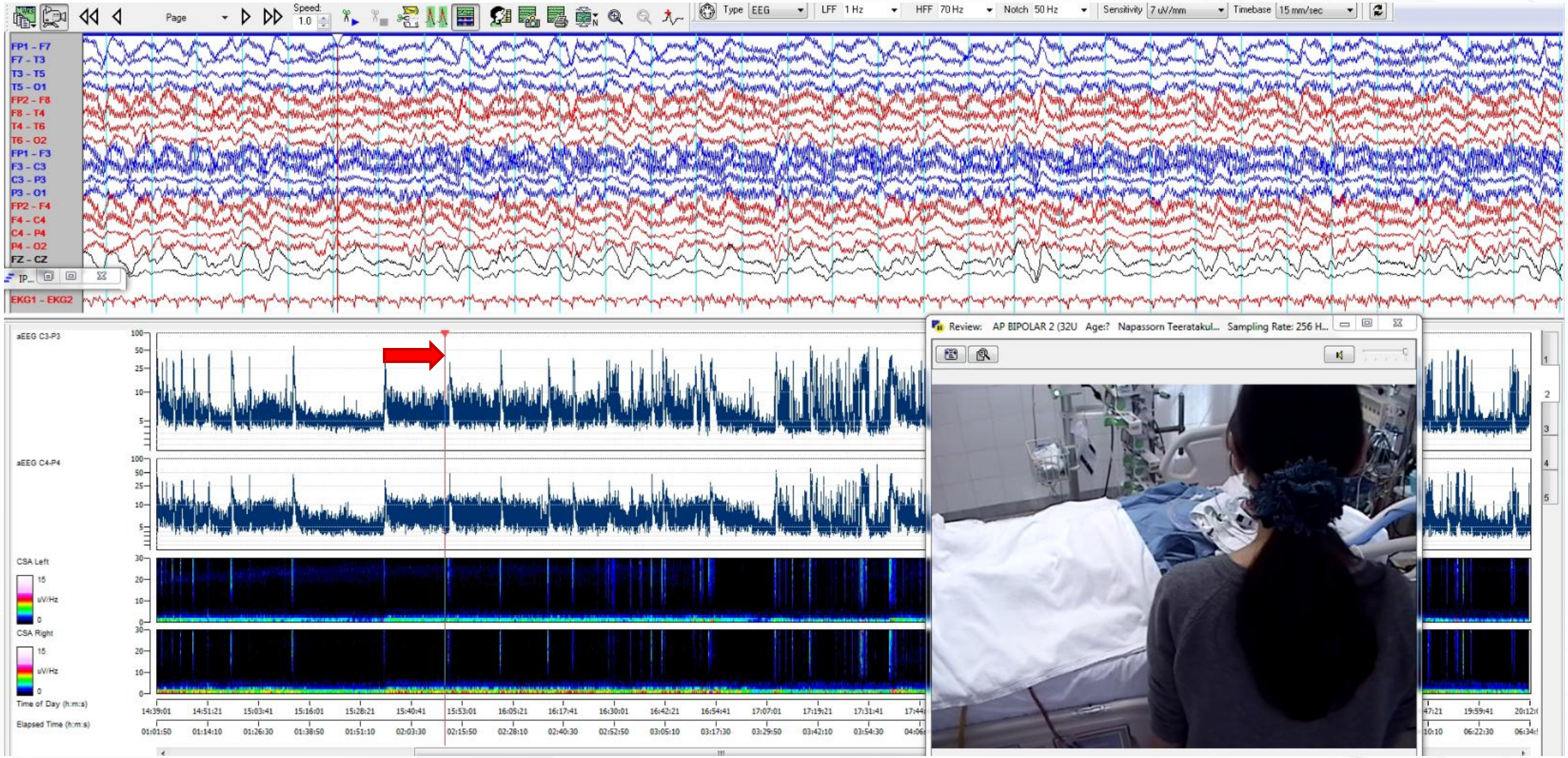
Pitfalls in QEEG interpretations

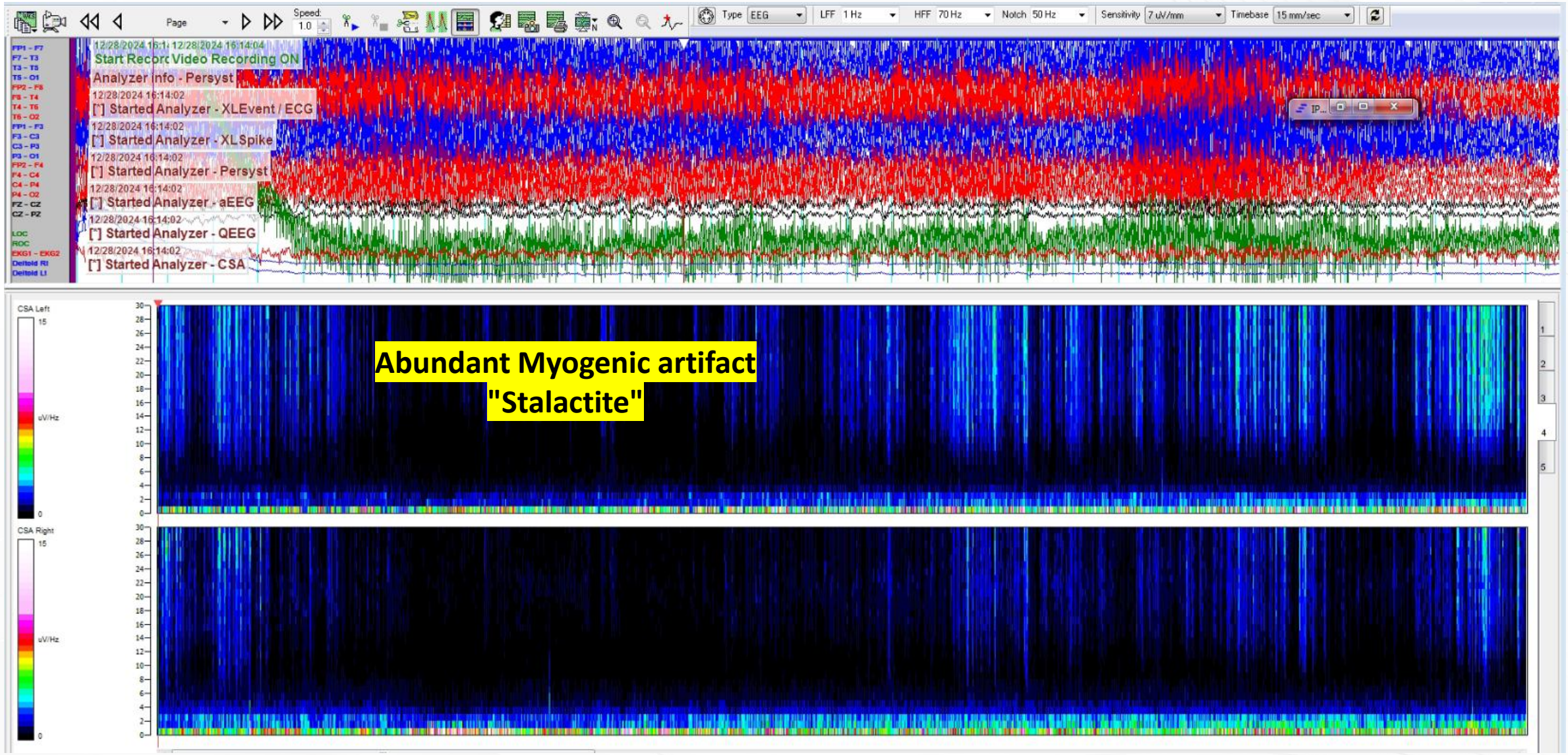
CSA and aEEG


Page
Speed: 1.0
Type EEG
LFF 1 Hz
HFF 70 Hz
Notch 50 Hz
Sensitivity 7 uV/mm
Timebase 15 mm/sec
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
EKG1 - EKG2
aEEG C3-P3
aEEG C4-P4
CSA Left
CSA Right
uV/Hz
Time of Day (h:m:s)
Elapsed Time (h:m:s)
Review: AP BIPOLAR 2 (32U Age:? Napassorn Teeratakul... Sampling Rate: 256 H...

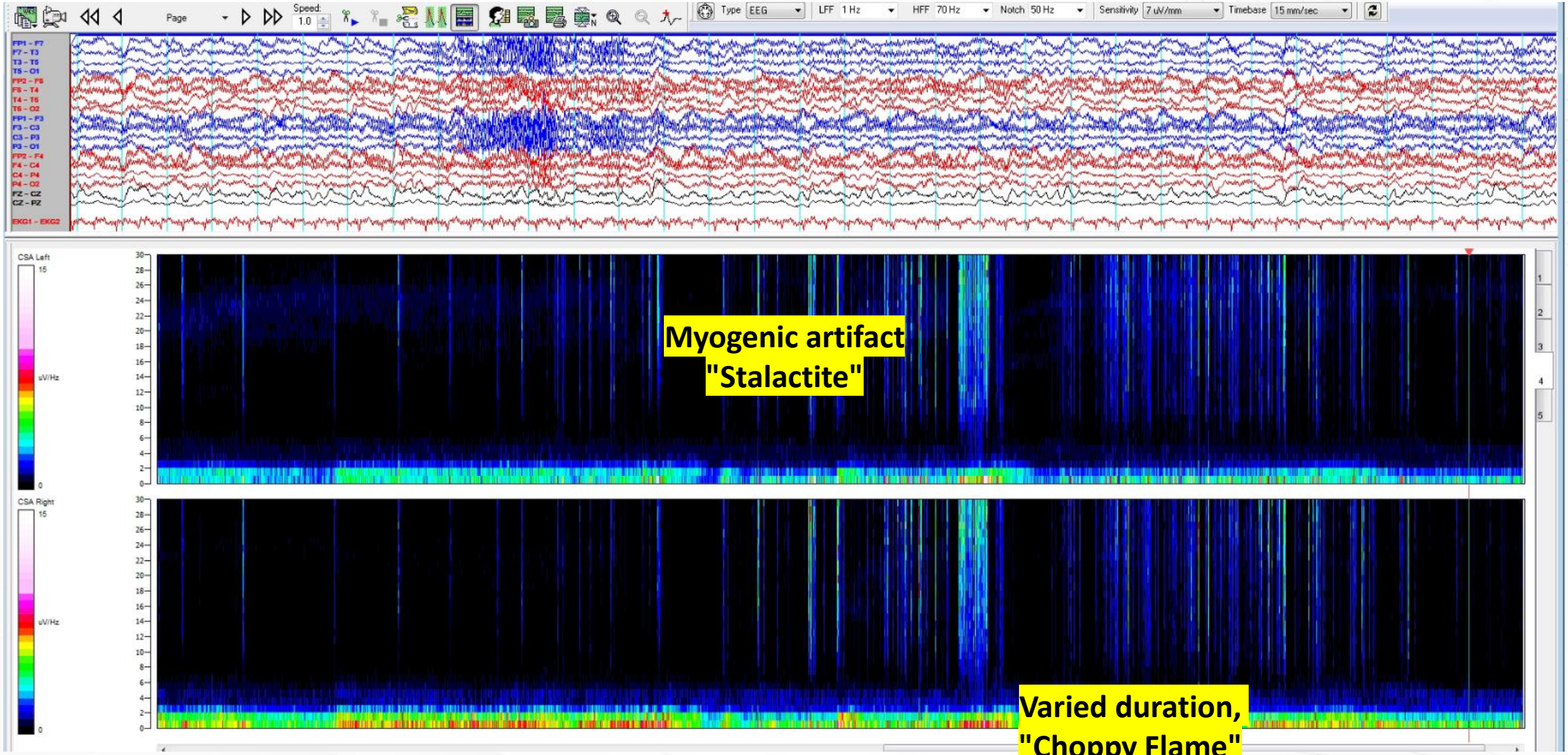
Nurse at bedside



"16.00 – 04.00"


Type EEG
LFF 1 Hz
HFF 70 Hz
Notch 50 Hz
Sensitivity 7 uV/mm
Timebase 15 mm/sec
Start Recor Video Recording ON
Analyzer info - Persyst
[*] Started Analyzer - XLEvent / ECG
[*] Started Analyzer - XLSpike
[*] Started Analyzer - Persyst
[*] Started Analyzer - aEEG
[*] Started Analyzer - QEEG
[*] Started Analyzer - CSA
CSA Left
CSA Right
uV/Hz
Abundant Myogenic artifact
"Stalactite"

"13.30-20.30"


Myogenic artifact
"Stalactite"
Varied duration,
"Choppy Flame"
CSA Left
CSA Right
uV/Hz

The Golden Rule

The Macroscope (qEEG)

An early alarm system.

It tells you WHERE to look.

qEEG should never be interpreted without reviewing the raw EEG waveforms.

The Microscope (Raw EEG)

The diagnostic verdict.

It tells you WHAT you are looking at.

NotebookLM