EEG in children

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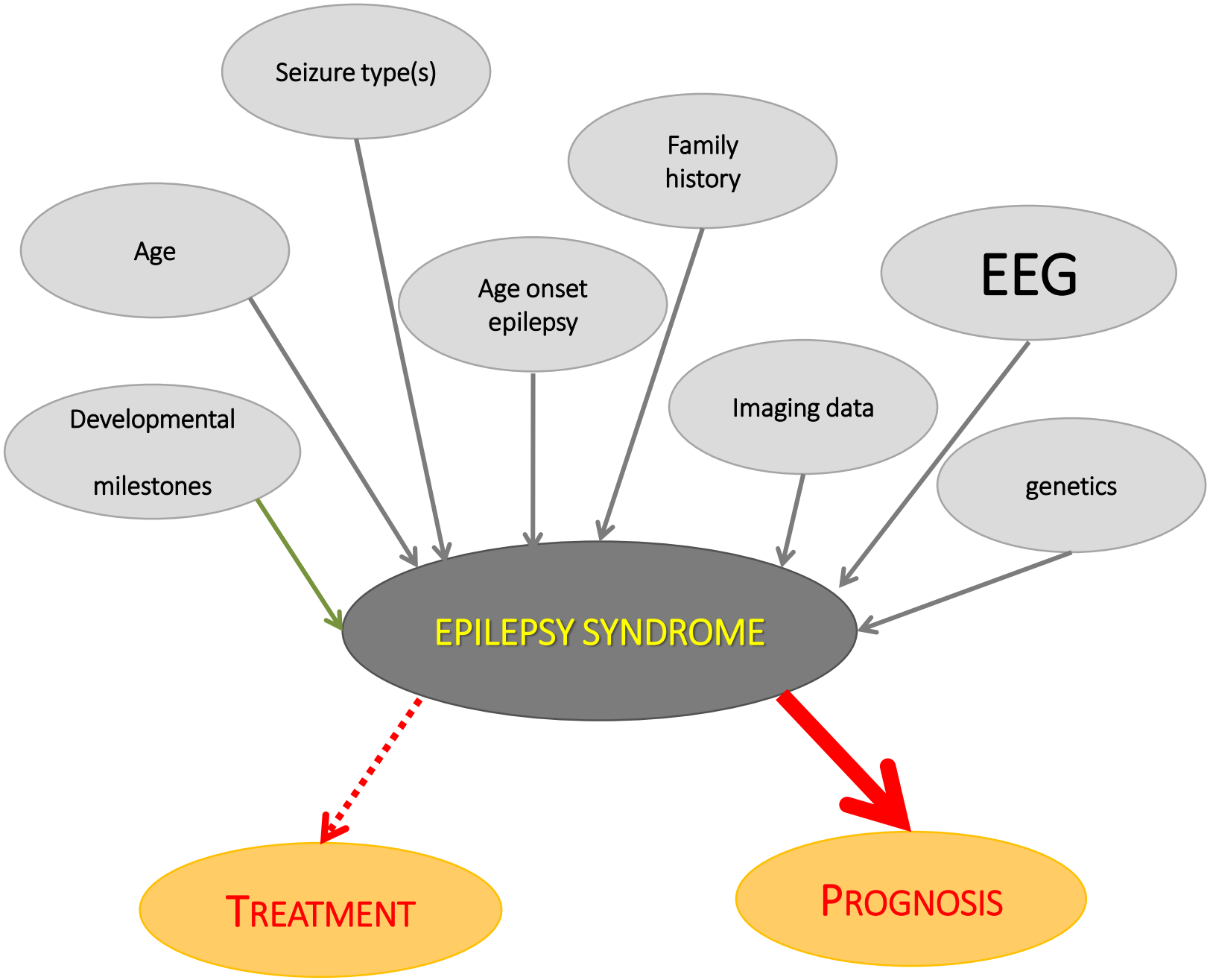

Seizure type(s)
Family history
Age
Age onset epilepsy
EEG
Developmental milestones
Imaging data
genetics
EPILEPSY SYNDROME
TREATMENT
PROGNOSIS

Not all EEGs are equal

- Standard EEG (20 minutes to 1 hour)
- Standard EEG plus sleep stage 1-2
- Sleep deprivation EEG
- Long-term EEG (24 h)
- Presurgical long term monitoring

- video registration
- At least 24 electrodes

- No sedation (if needed melatonine?)

- **Interictal versus ictal EEG**

Ictal EEG

remains golden standard to confirm epilepsy diagnosis

- Rare in short standard EEGs

Interictal EEGs

- Likelihood to find epileptic abnormalities increases in sleep
- Generalized epilepsies : interictal sometimes normal
- Focal spikes also possible in generalized epilepsies
- Background activity and number of spikes : related to cognitive problems

Event is captured during EEG	Seizure	No seizure
Ictal tracé	**Epilepsy diagnosis confirmed**	**Subclinical seizure**
Normal EEG during event	**Is it a seizure?**	

Event is not captured during EEG	History of a Seizure	No seizure
Interictal epileptic abnormalities	Epilepsy diagnosis Confirmed (???)	Normal ?
Normal EEG	Can be epilepsy	

1. EEG is not necessary for the diagnosis of epilepsy

   but it is very helpful

   - to classify the epilepsy
   - to assess the severity of the epilepsy (risk factor)
   - to differentiate epilepsy from
     non-epileptic paroxysmal events

2. It is not necessary to always repeat EEG during follow up.

But it should be repeated

1. When doubt about the diagnosis remains
2. When new seizure types occur
3. When new neurological problems arise

3. EEG should not be normal before tapering
of the anti-epileptic medication is considered

But EEG study after 2 years of seizure freedom is helpful to evaluate the risk of recurrence

4. EEG has no ***routine*** place in the diagnosis of

- Head trauma
- Learning problems
- ADHD

  (EEG should not be done before start stimulants)
- Autism

3-5 % of “normal” children have epileptic EEG abnormalities

What is the role of EEG abnormalities in other neurodevelopmental disorders ?

- autism
- ADHD

Frequency of Epileptiform Discharges in the Sleep-Deprived Electroencephalogram in Children Evaluated for Attention-Deficit Disorders

John J. Millichap, Cynthia V. Stack and J. Gordon Millichap

J Child Neurol 2011 26: 6 originally published online 17 August 2010

Frequency of Abnormal Electroencelphalograms (EEGs) in Attention-Deficit Disorder Clinic Patients Who Slept Compared With Those Who Stayed Awake

EEG	Normal n (%)	Abnormal n (%)	Total n
Sleep	408 (72.0)	159 (28.0)[a]	567
Awake	53 (93.0)	4 (7.0)[a]	57
Total	481	163	624

[a] Fisher exact test, $P = .0002$.

26 %

EEG : Autism versus ADHD

Relation between EEG abnormalities and clinical entities.

	PDD					AD/HD		
	Autistic disorder	Asperger disorder	PDD-NOS	PDD with AD/HD[a]	Total	Combined type	Inattention type	Total
Number	15	32	17	51	64	17	5	22
Background abnormalities	5 (33%)	7 (22%)	2 (12%)	12 (24%)	14 (22%)	2 (12%)	0	2 (9%)
Paroxysmal discharges	8 (53%)	19 (59%)	6 (35%)	26 (51%)	33 (52%)	9 (53%)	0	9 (41%)
Diffuse	4 (27%)	11 (34%)	5 (29%)	15 (29%)	20 (31%)	4 (24%)	0	4 (18%)
Foci at Fp–F	3 (20%)	10 (31%)	3 (18%)	15 (29%)	16 (25%)	3 (18%)	0	3 (14%)
C–T	3 (20%)	9 (28%)	2 (12%)	12 (24%)	14 (22%)	8 (47%)	0	8 (36%)
P–O	2 (13%)	5 (16%)	3 (18%)	7 (14%)	10 (16%)	5 (29%)	0	5 (23%)
RS	1 (7%)	1 (3%)	1 (6%)	2 (4%)	3 (5%)	0	0	0
Laterality Rt	3 (20%)	7 (22%)	3 (18%)	10 (20%)	13 (20%)	3 (18%)	0	3 (14%)
Lt	1 (7%)	1 (3%)	2 (12%)	4 (8%)	4 (6%)	3 (18%)	0	3 (14%)

PDD, pervasive developmental disorder; AD/HD, attention-deficit/hyperactivity disorder; PDD-NOS, pervasive developmental disorder not otherwise specified; Fp–F, frontopolar–frontal region; C–T, central–temporal region; P–O, parietal–occipital region; RS, rolandic spikes; Rt, right side dominant; Lt, left side dominant.

[a] Cases of PDD fulfilled the diagnostic criteria for AD/HD.

Autism : 52 %

ADHD : 41 %

More centro temporal spikes

Kawatani et al, Brain and Development, 2012

5. EEG studies are not necessary in simple febrile seizures

But EEG is helpful in complex febrile seizures

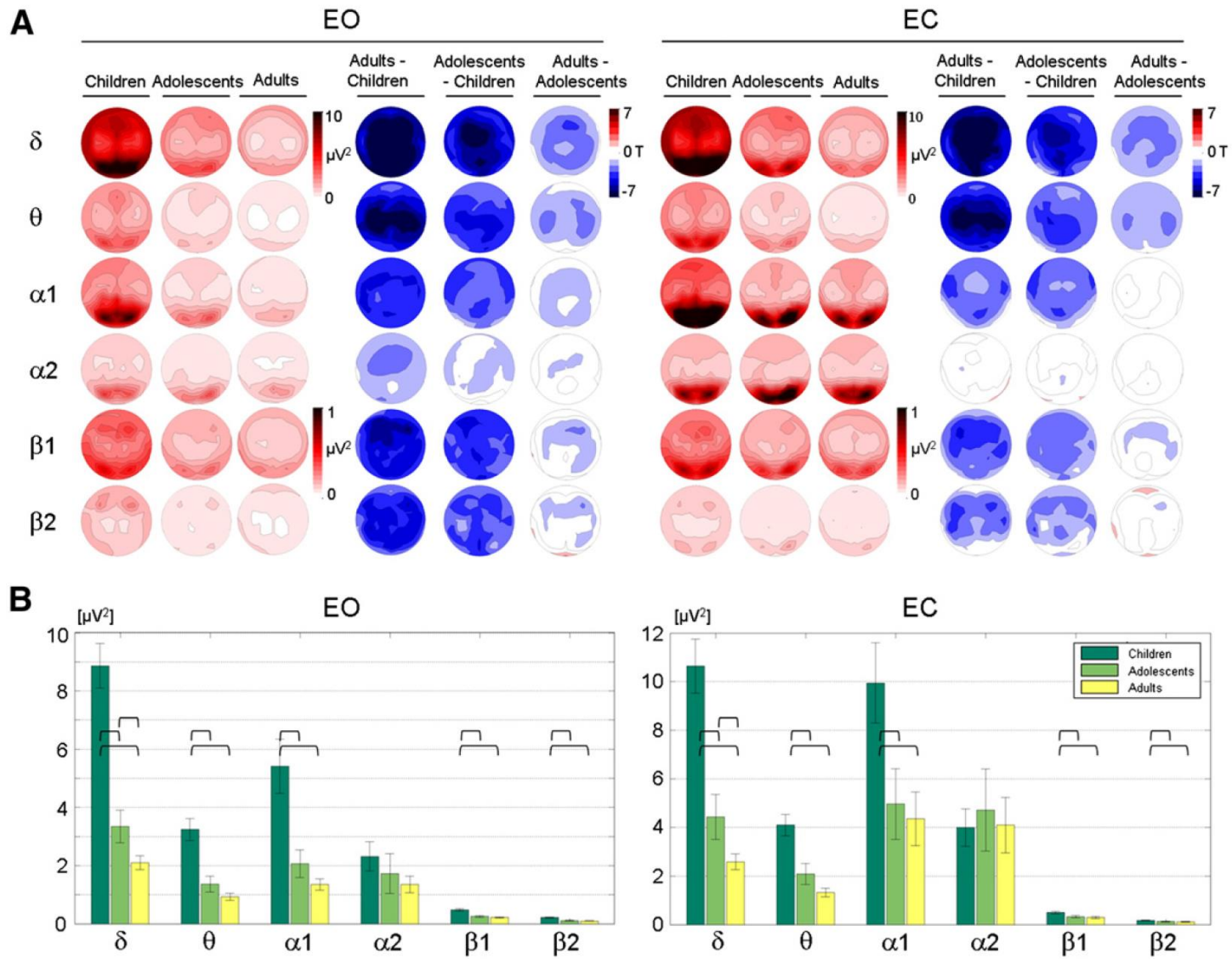
(= epilepsy)

EEG in childhood : developmental issues

- Dominant rhythm moves from central to occipital
- posterior-anterior gradient develops early on
- Dominant rhythm at 6 years should be >= 8 Hz
- Slow activity (theta) physiological , but symmetric

- Stage 1 and 2 sleep : most epileptogenic
- Sleep spindles asymmetric, and longer duration up to 6 months

- Many more artifacts and normal variants
- Epileptic activity comparable to adults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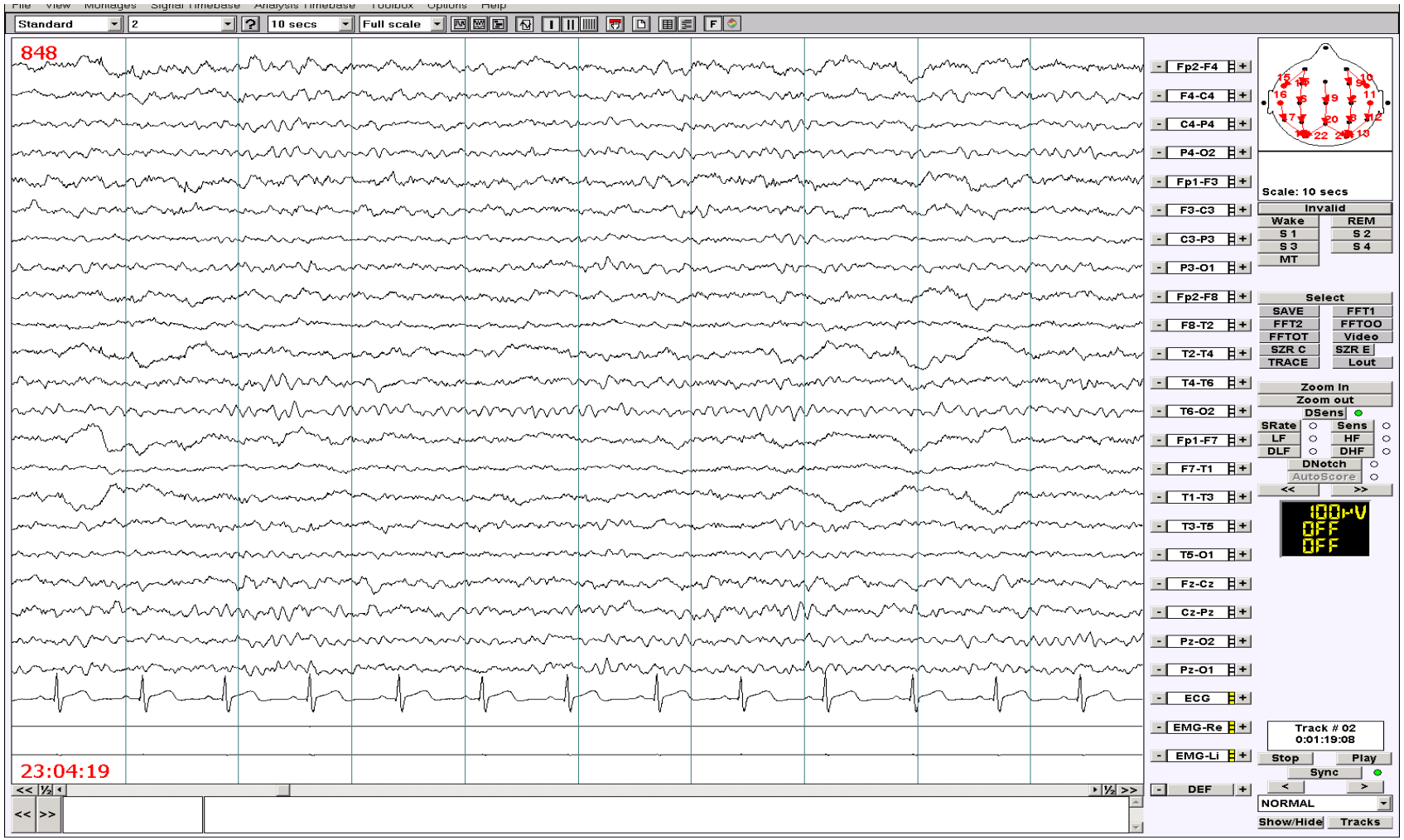
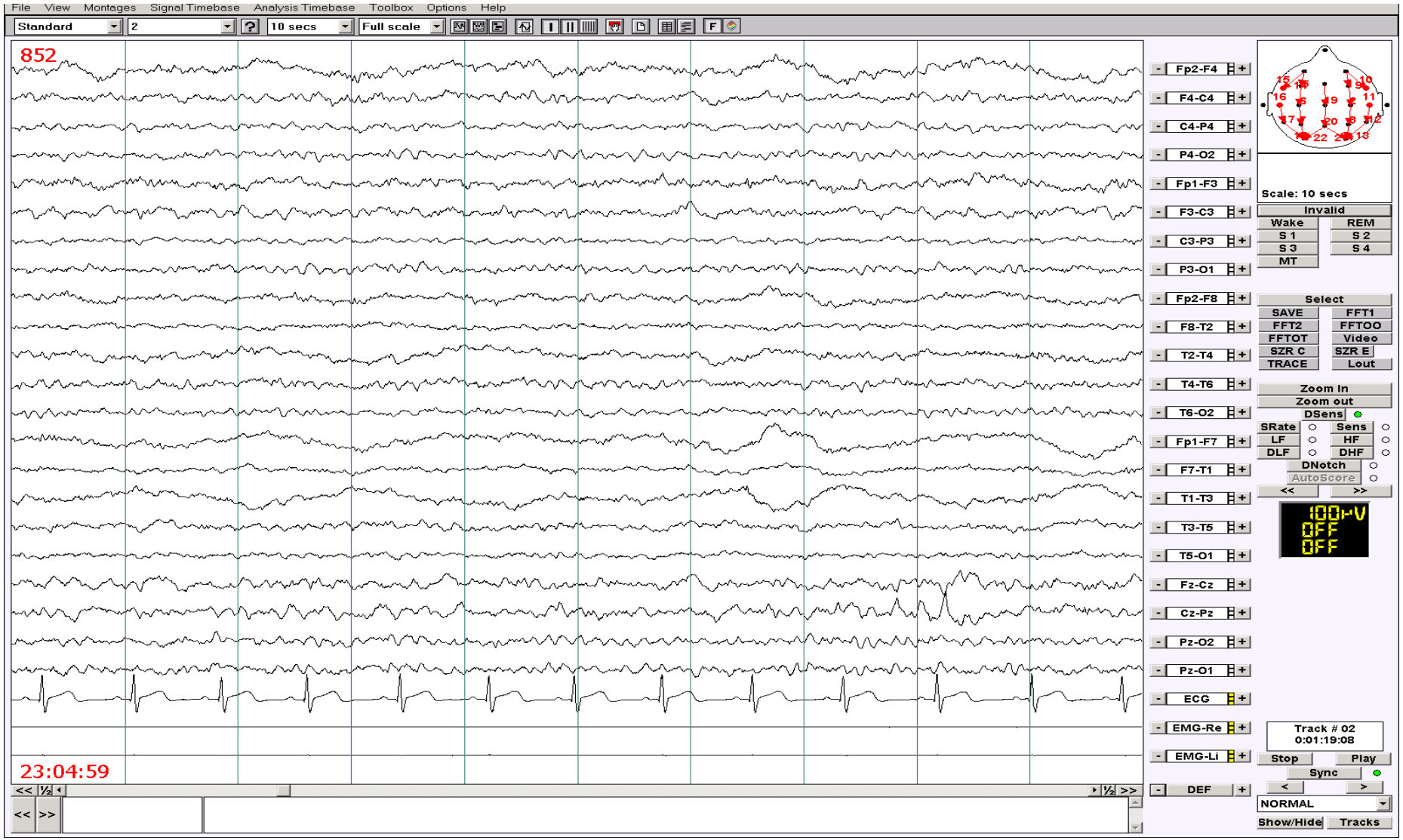
Always include ECG

Ventricular extrasystoles

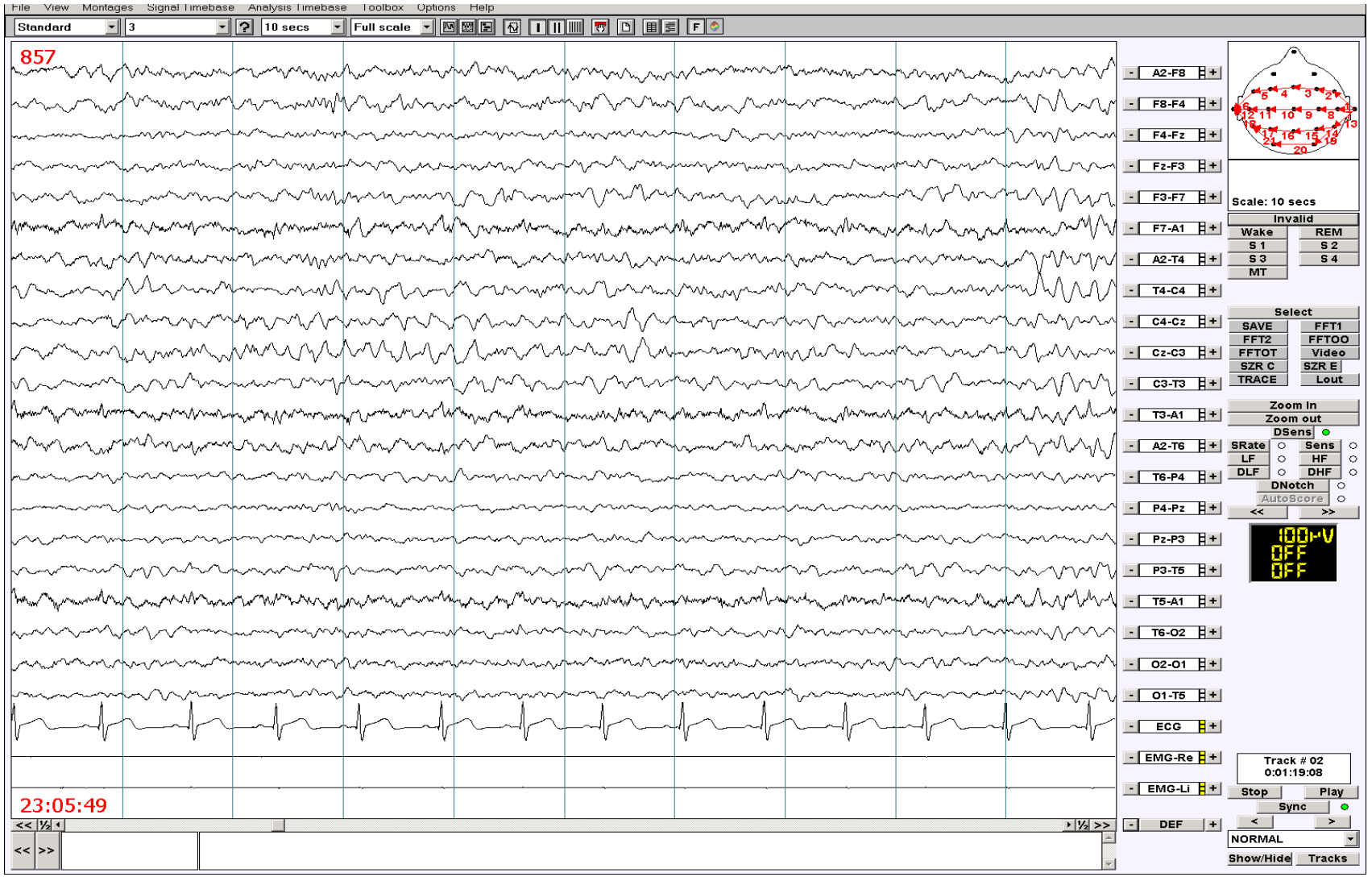
Drowsiness: waxing and waning of occipital alpha



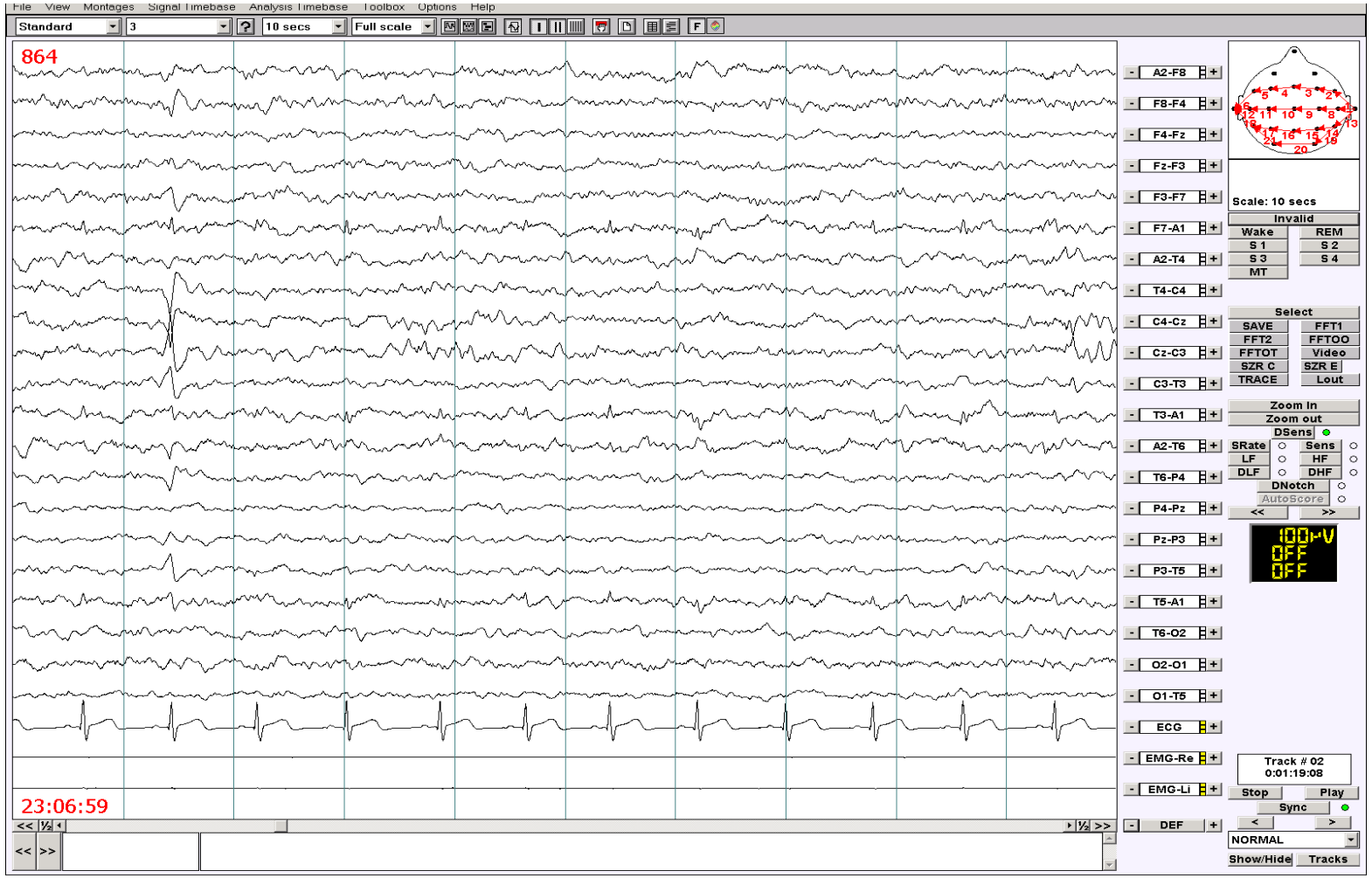
Drowsiness: posterior alpha is gone



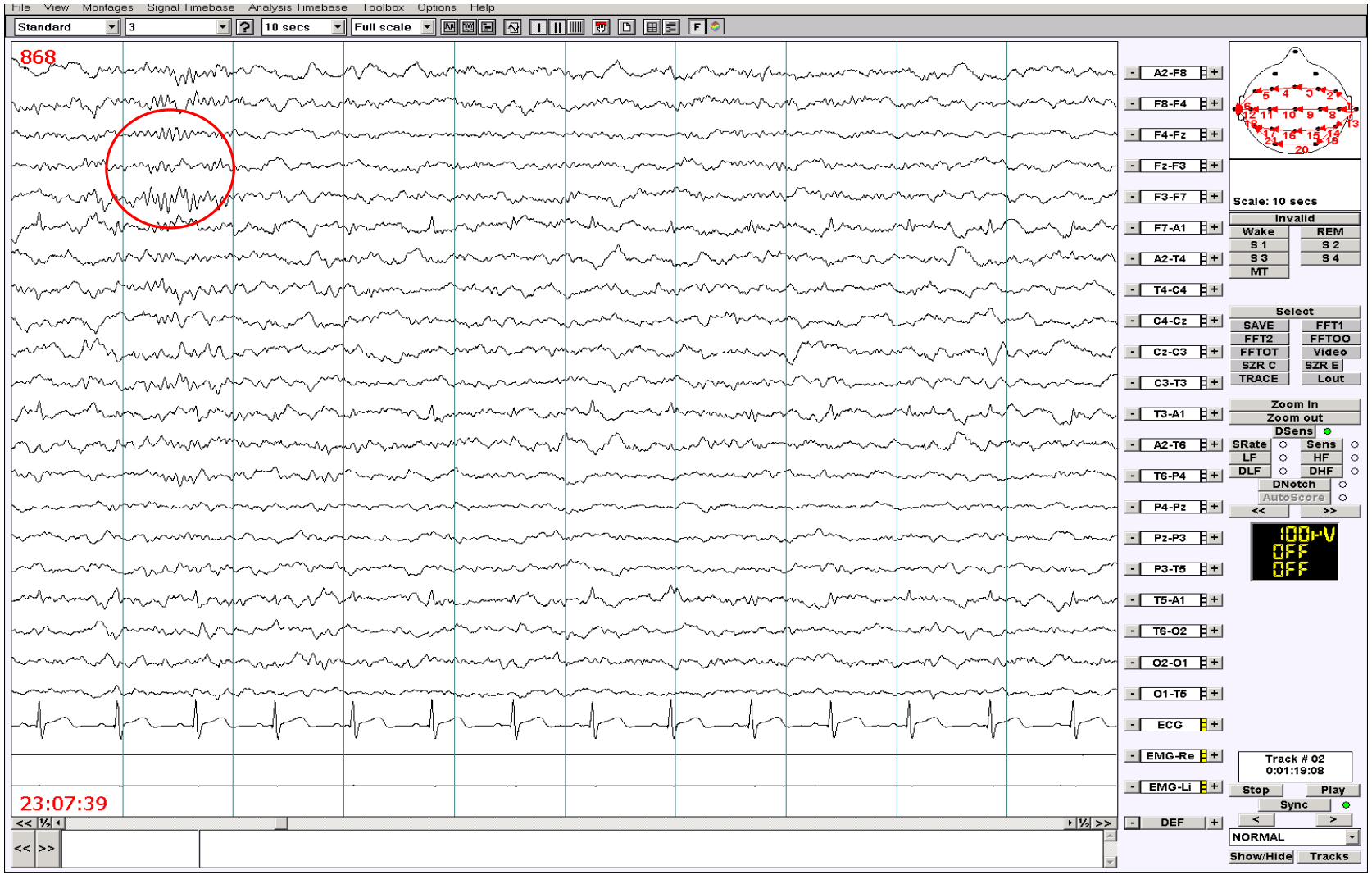
Sleep: Stage1 non - REM



Sleep: Stage 2 non-REM sleep : vertex sharp waves

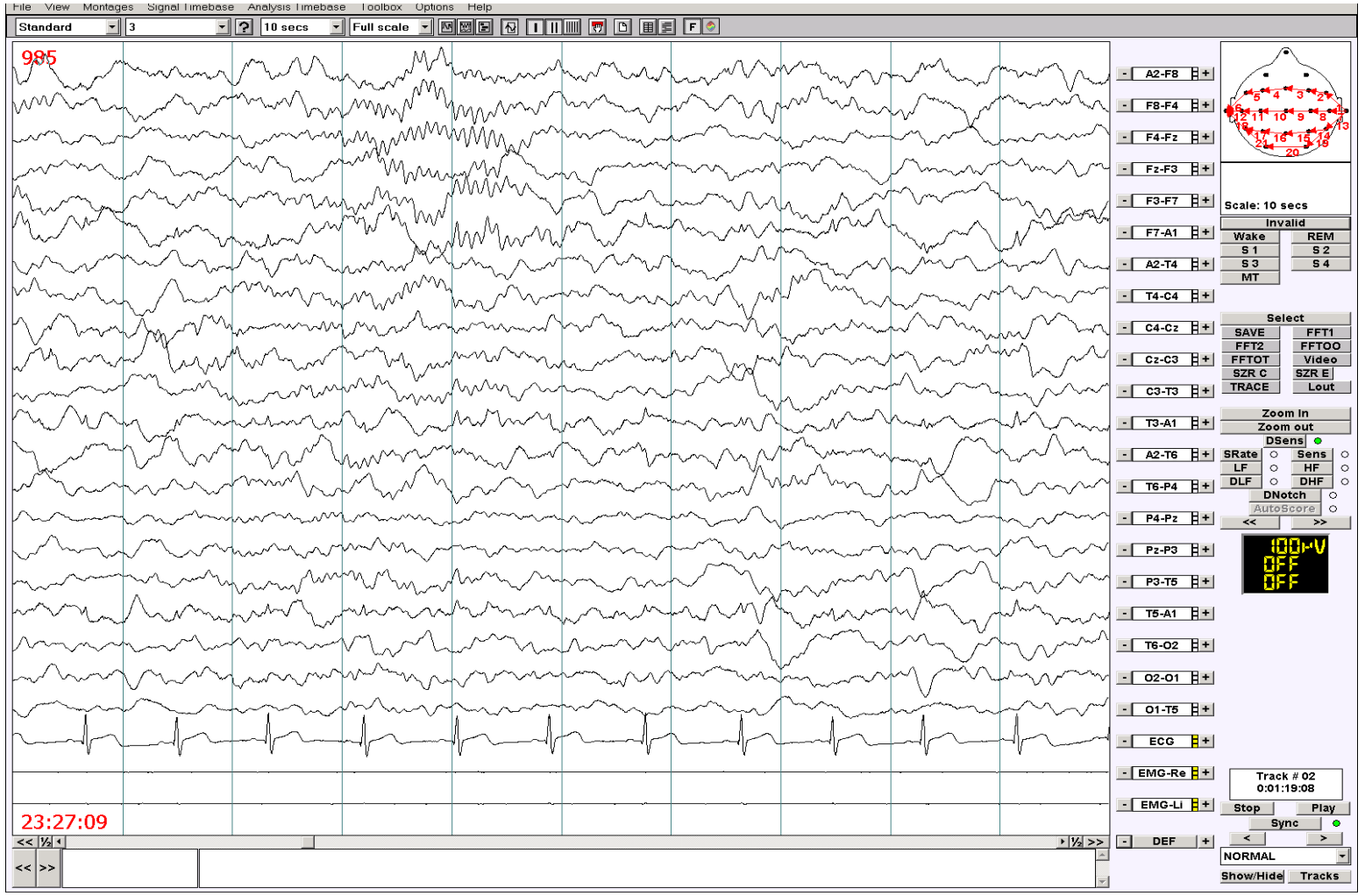


Sleep: Stage 2 non-REM sleep spindles

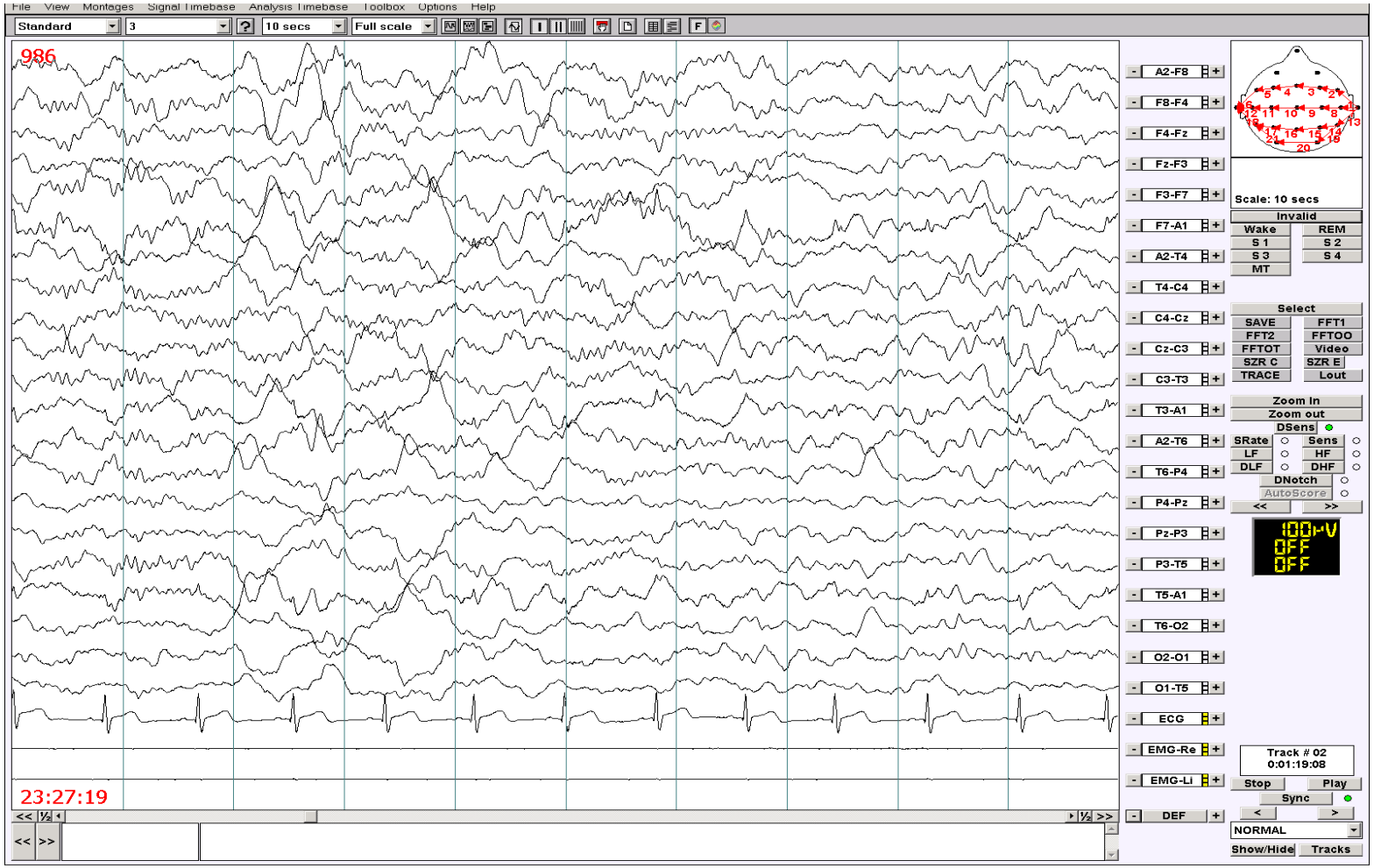


Sleep: Stage 2 non-REM sleep: K complexes

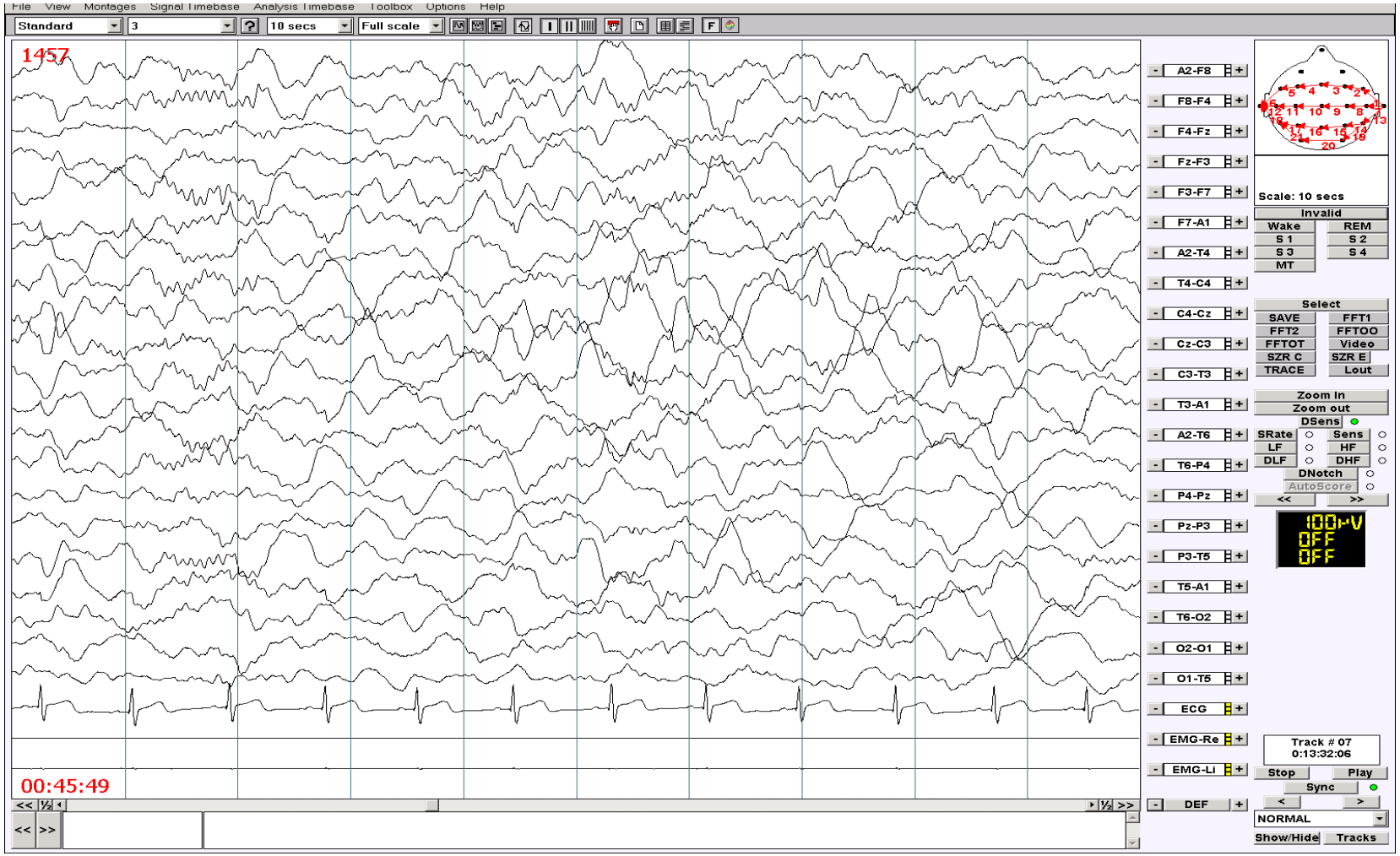
Sleep Stage 3 non-REM sleep : delta activity (20-50%)



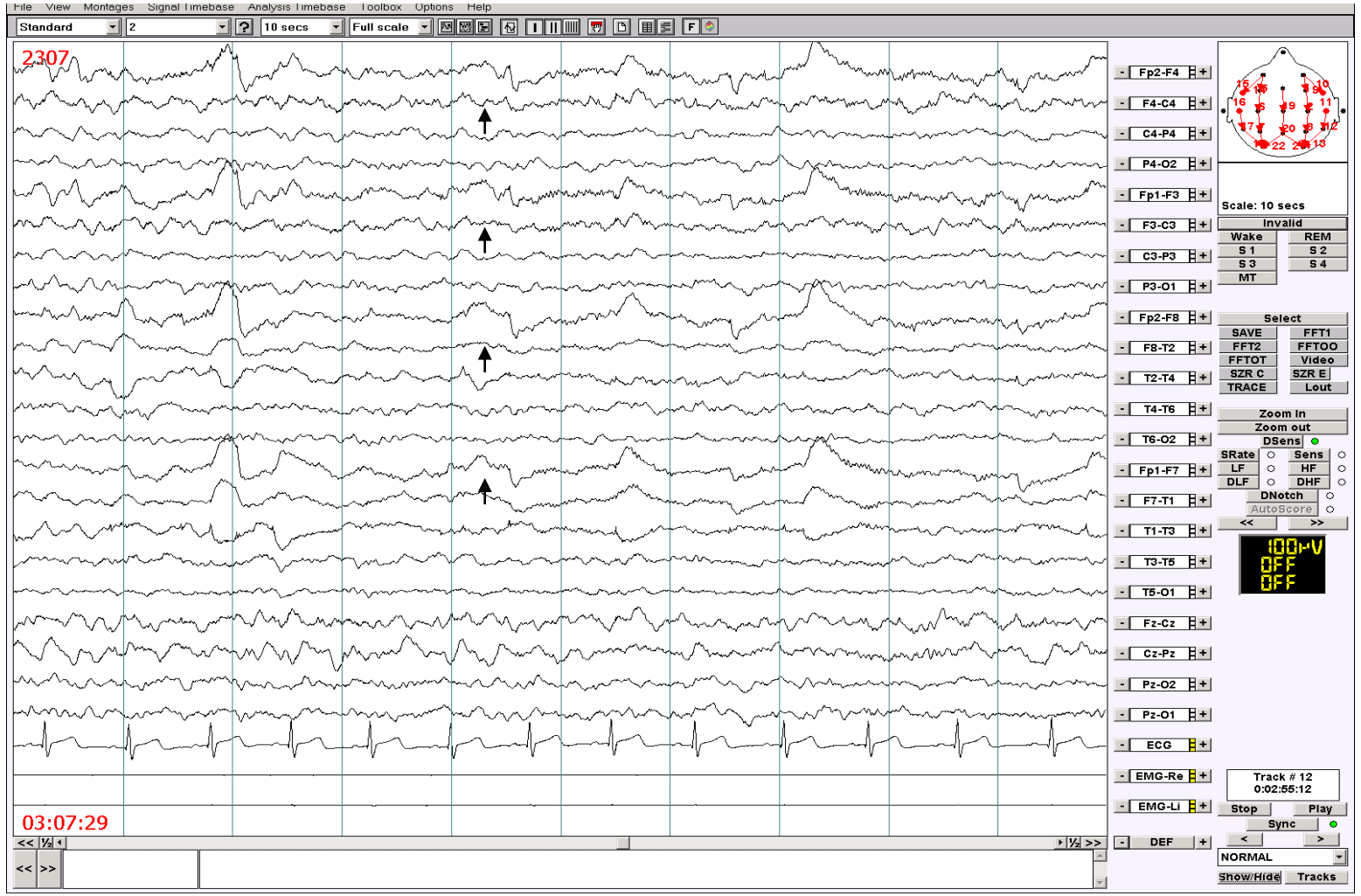
Sleep: Stage 3 non-REM sleep: delta activity (20-50%)



Sleep Stage 4 non-REM sleep: domination of delta activity (>80%)

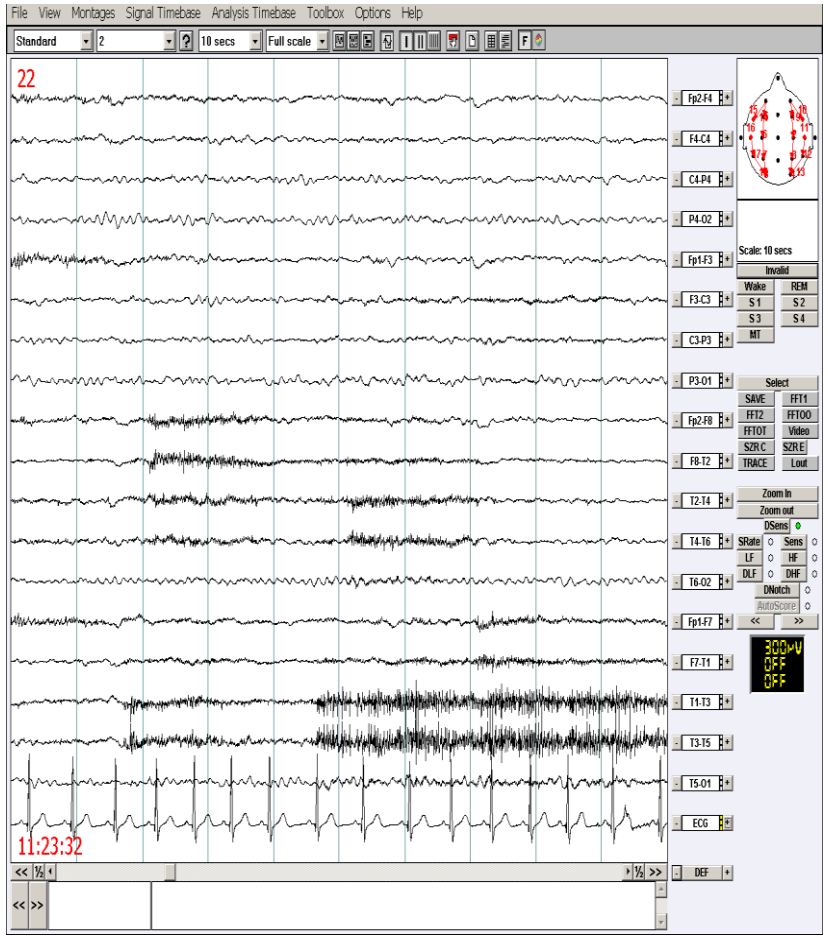


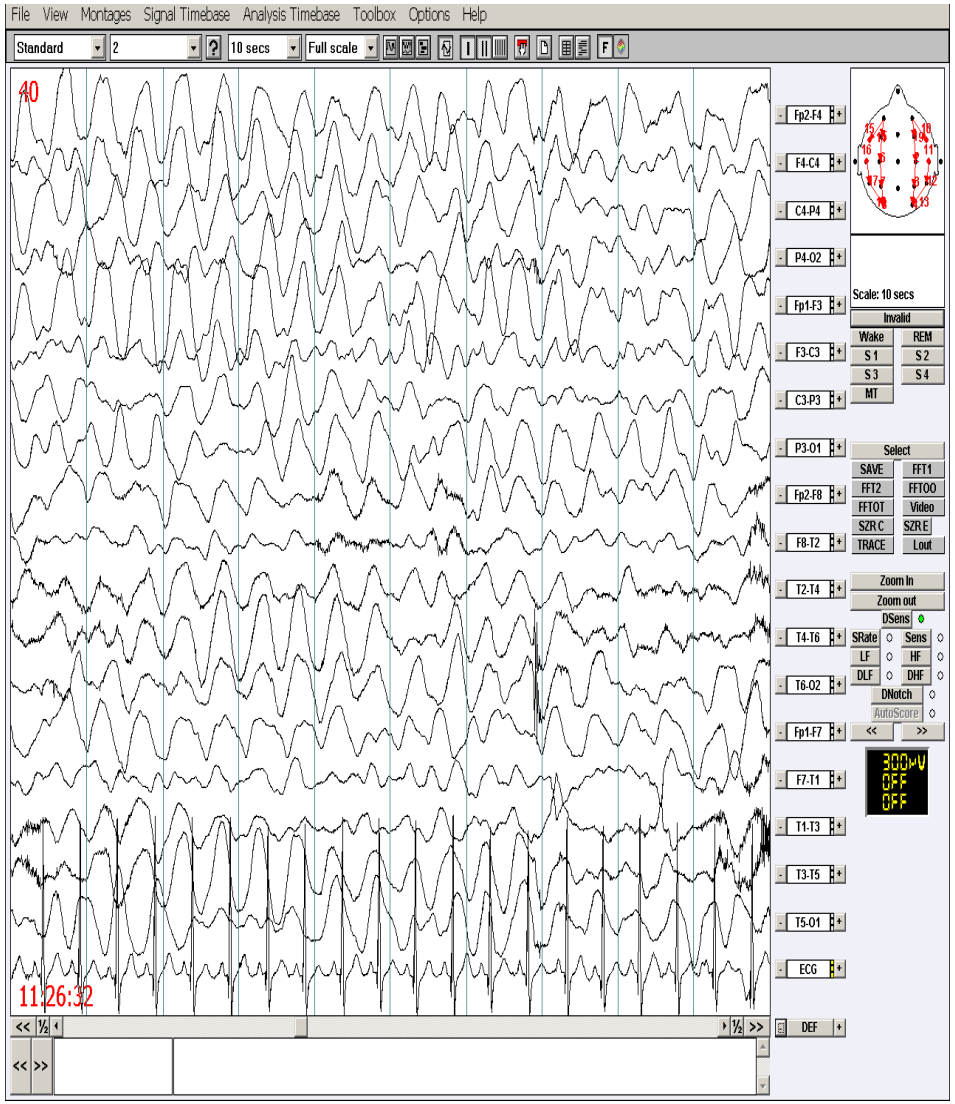
REM- (**R**apid **E**ye **M**ovements)



Provocation by Hyperventilation

Left: 5 y old child, normal background activity before HV is started. Right: after 2 minutes of HV
bilateral high voltage slowing delta



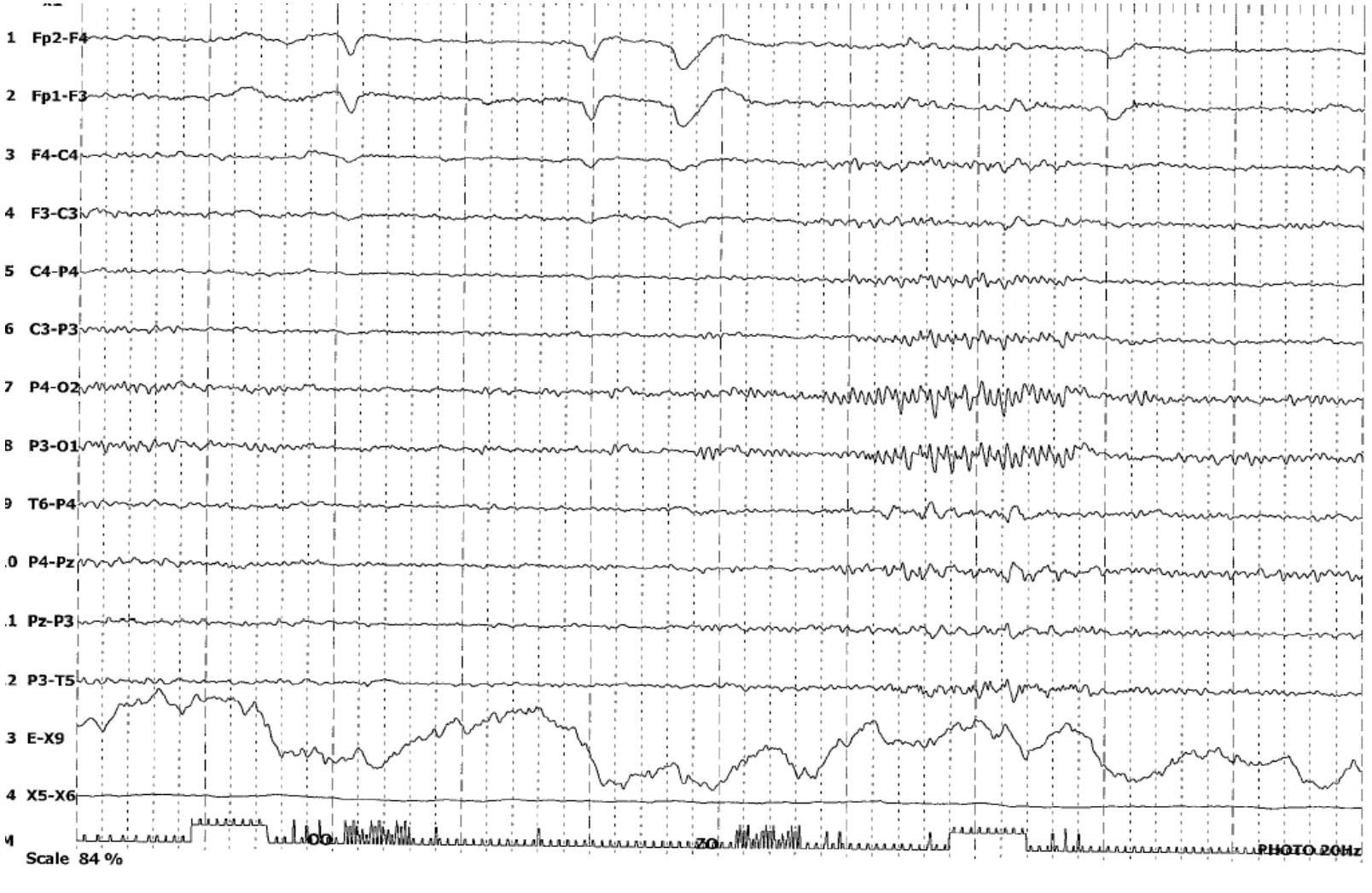


Intermittent photic stimulation : Photoparoxysmal Response

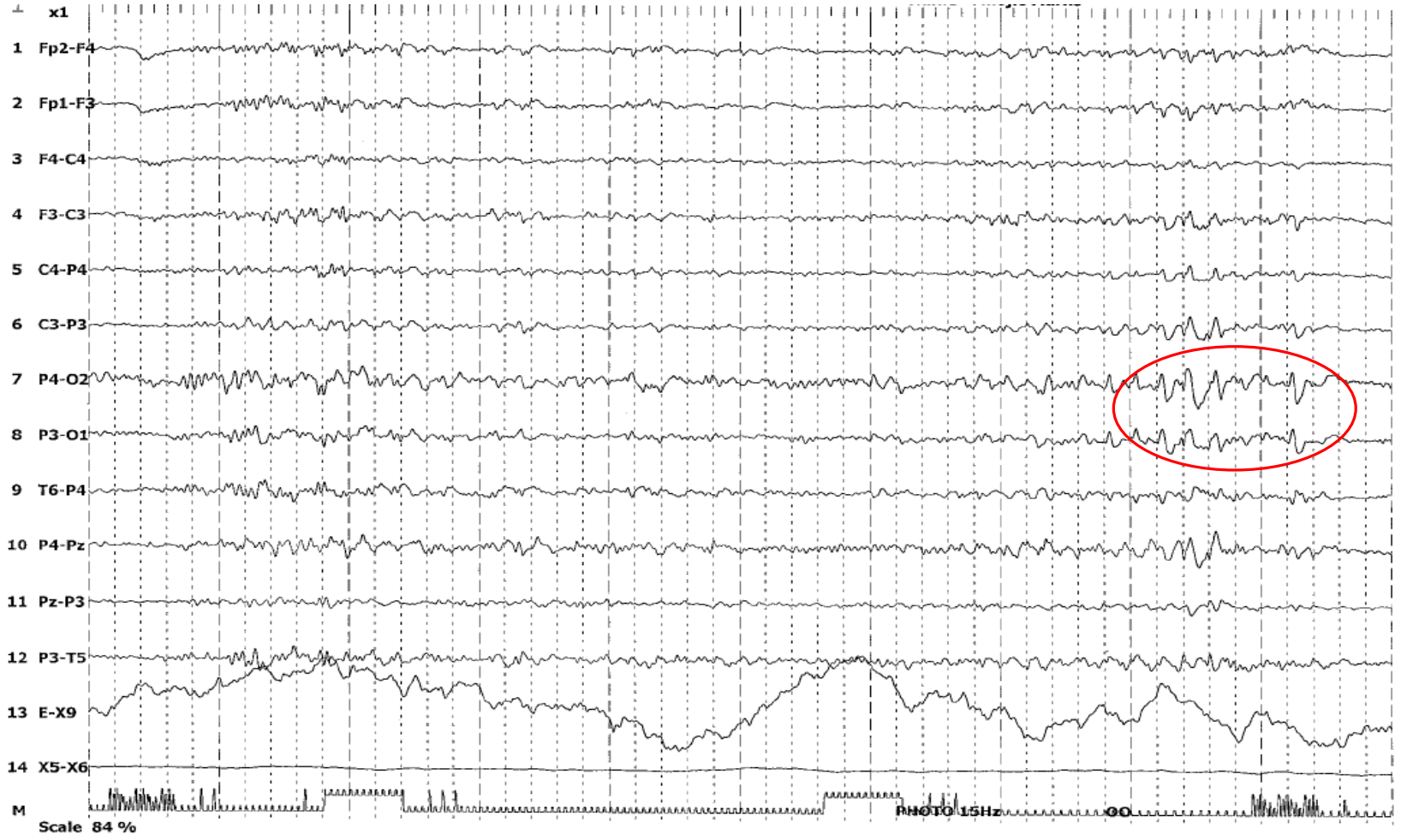
Classification of PPR (Waltz et al. 1992)

PPR type	Features
Type 1	Spikes/sharp waves in occipital areas, same frequency as stimulation frequency
Type 2	Parieto-occipital spikes with posterior localized biphasic slow waves
Type 3	Parieto-occipital spikes with posterior localized biphasic slow waves which spread to anterior regions
Type 4	Generalized spike-wave complexes PHOTOCONVULSIVE

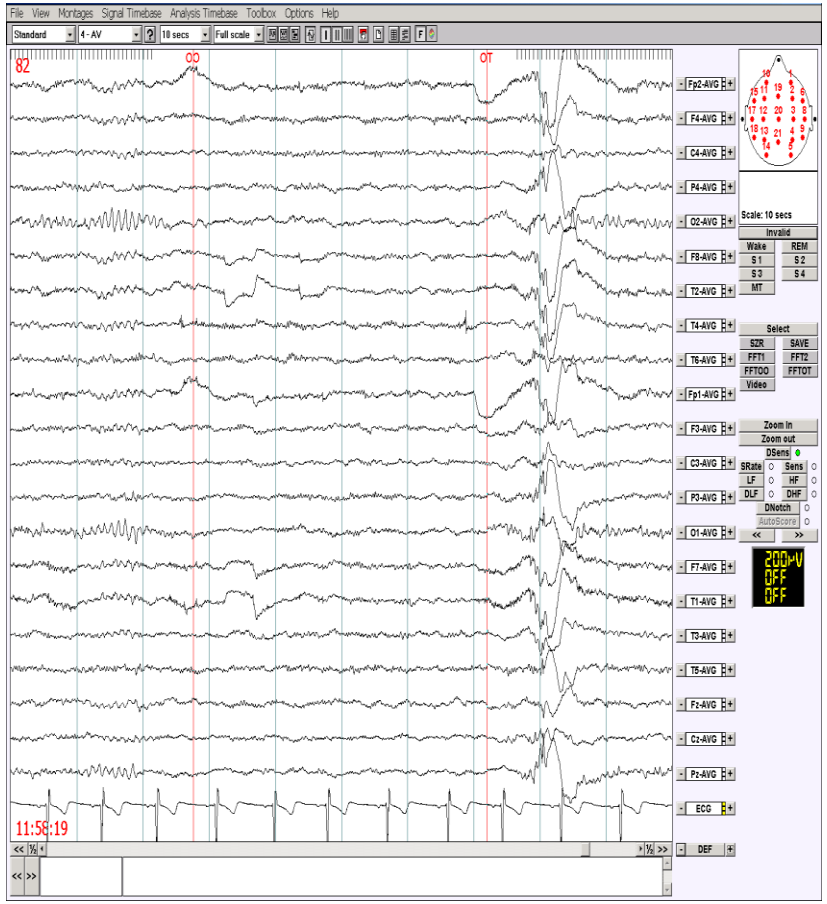
PPR Type 1 : spikes over occipital electrodes (‘driving’)

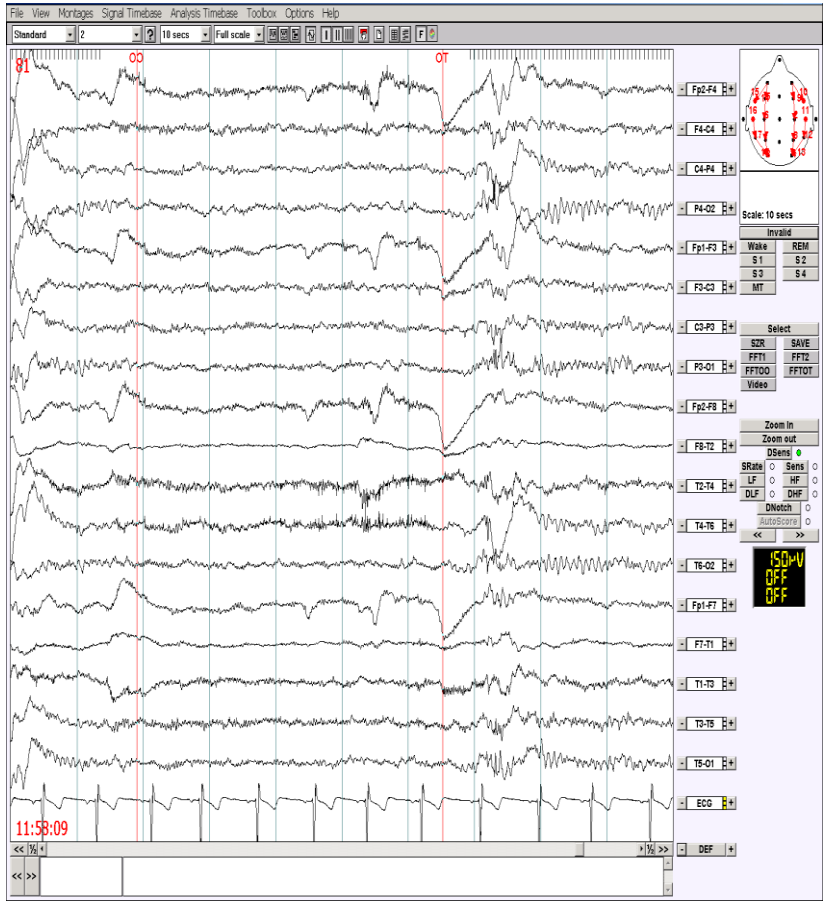


PPR Type 2: Parieto-occipital spikes

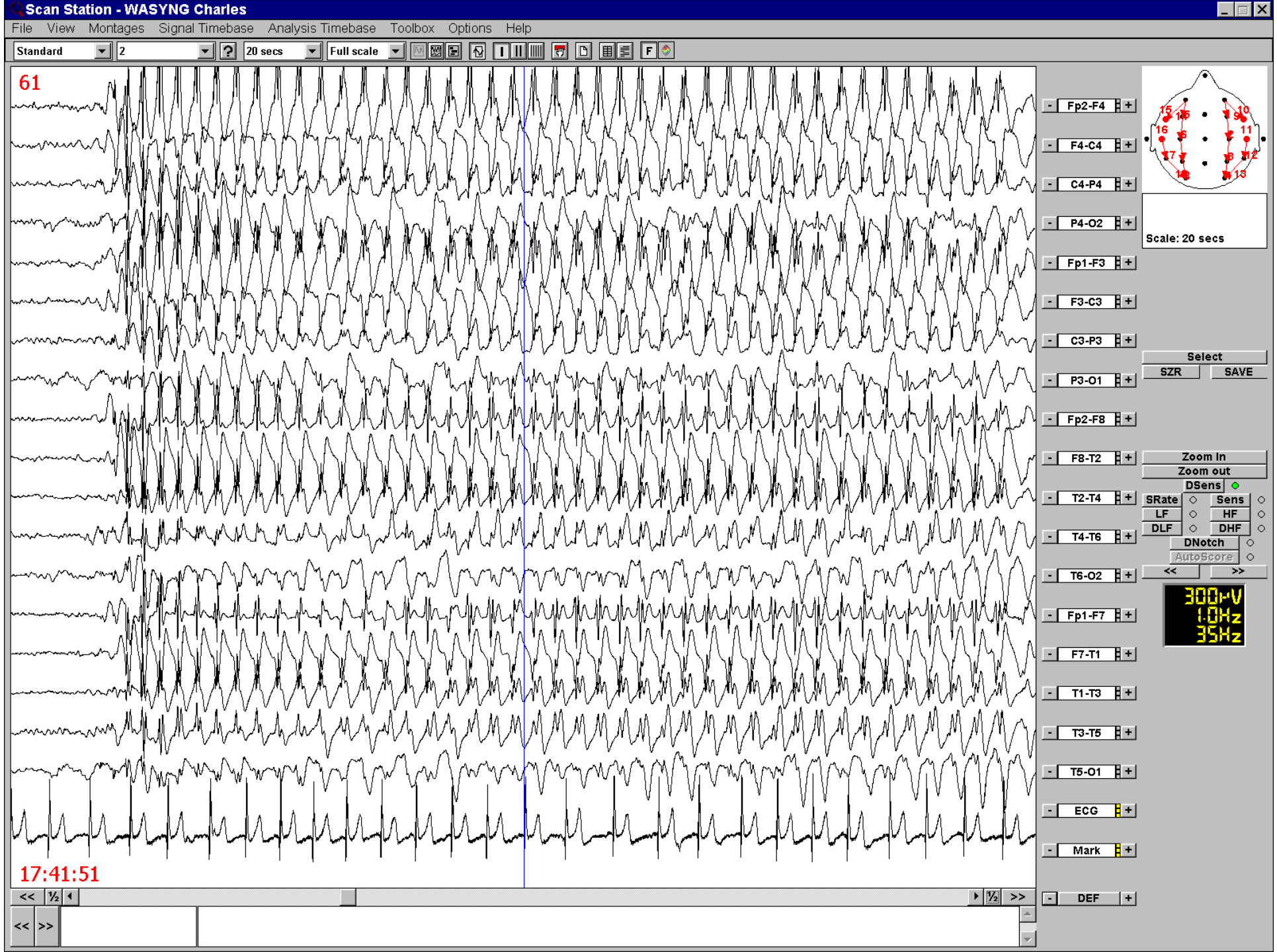


PPR Type 3: Parieto-occipital spikes which spread to anterior regions





PPR Type 4: Generalized spike-wave complexes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F4-C4
C4-P4
P4-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F8
F8-T2
T2-T4
T4-T6
T6-O2
Fp1-F7
F7-T1
T1-T3
T3-T5
T5-O1
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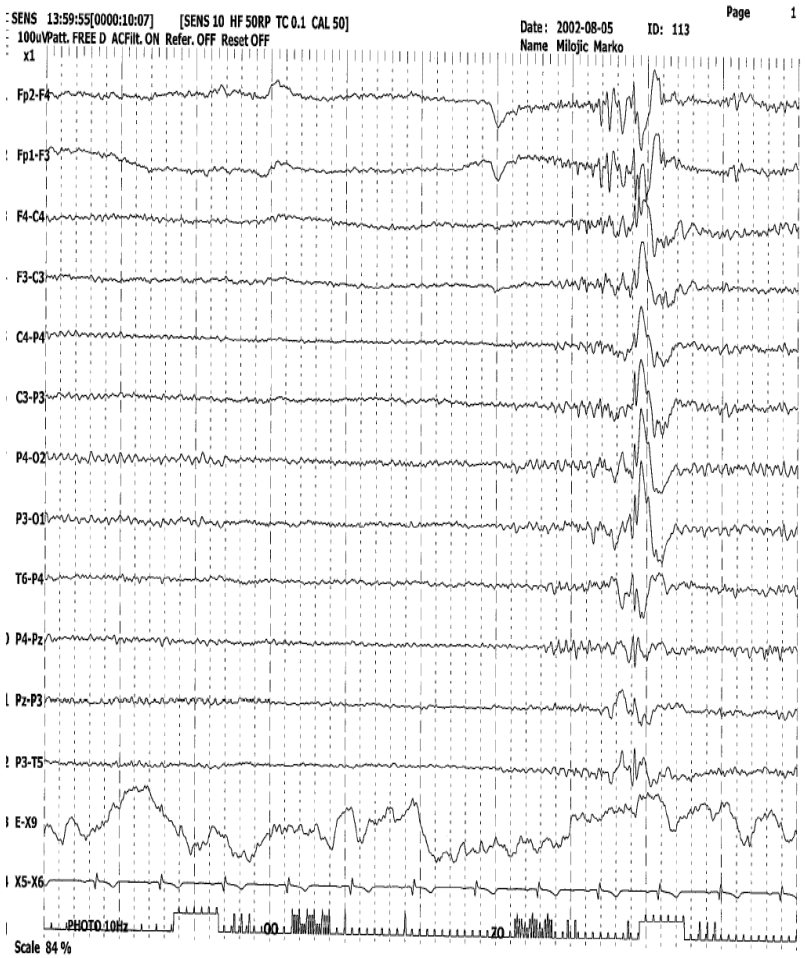
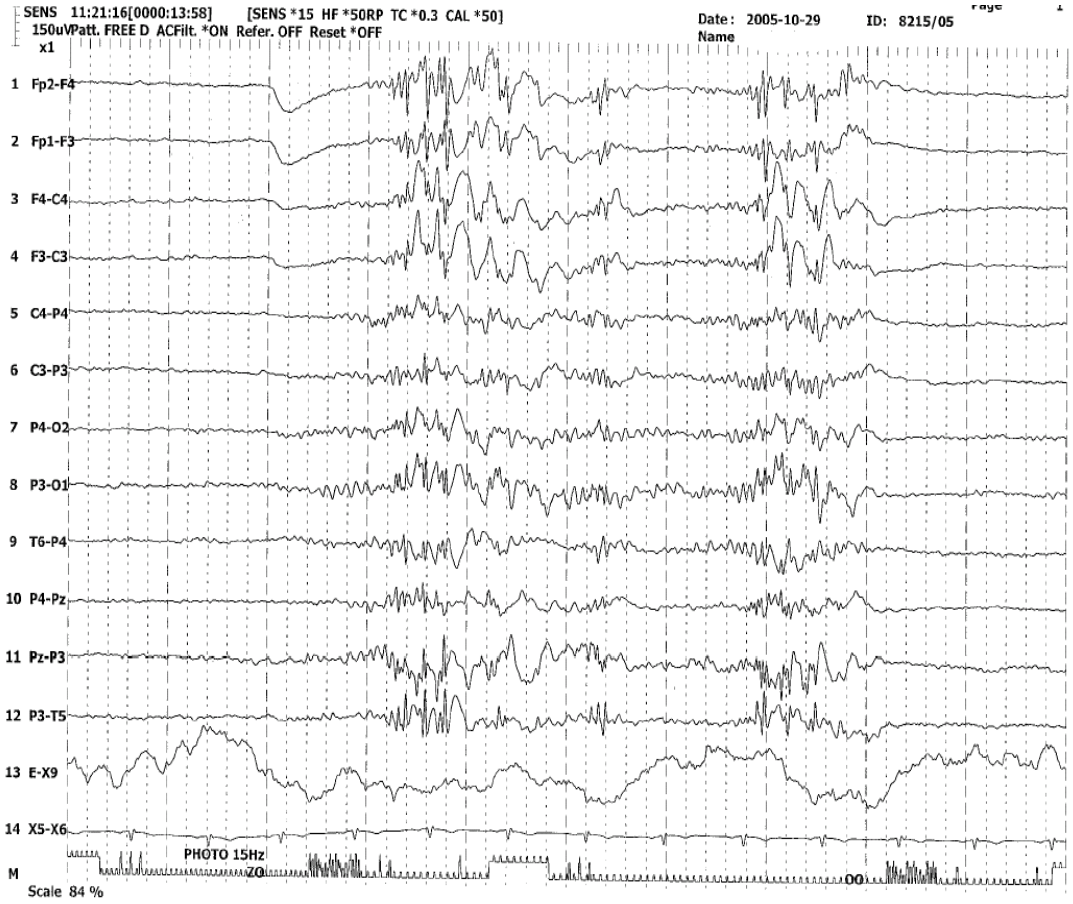
Childhood absence epilepsy (CAE) girl 7 y old. Ictal EEG pattern, bifrontal onset

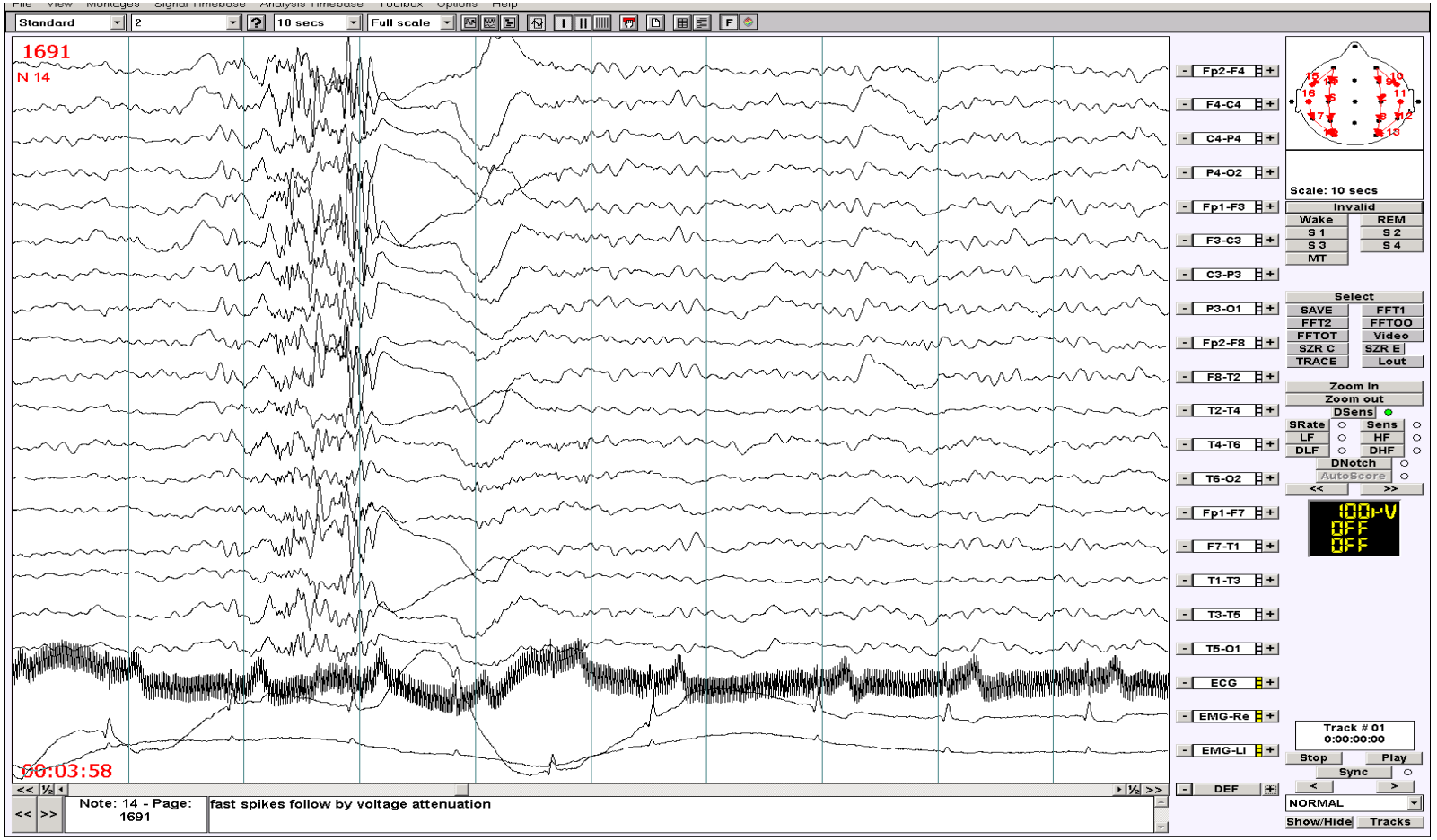
Juvenile absence epilepsy (JAE),
female, 13 y old. Generalized epileptiform discharge, 3.5 Hz spike and wave

Female 15y old with Juvenile myoclonic epilepsy (JME)
Generalized poly-spike waves (during IPS)



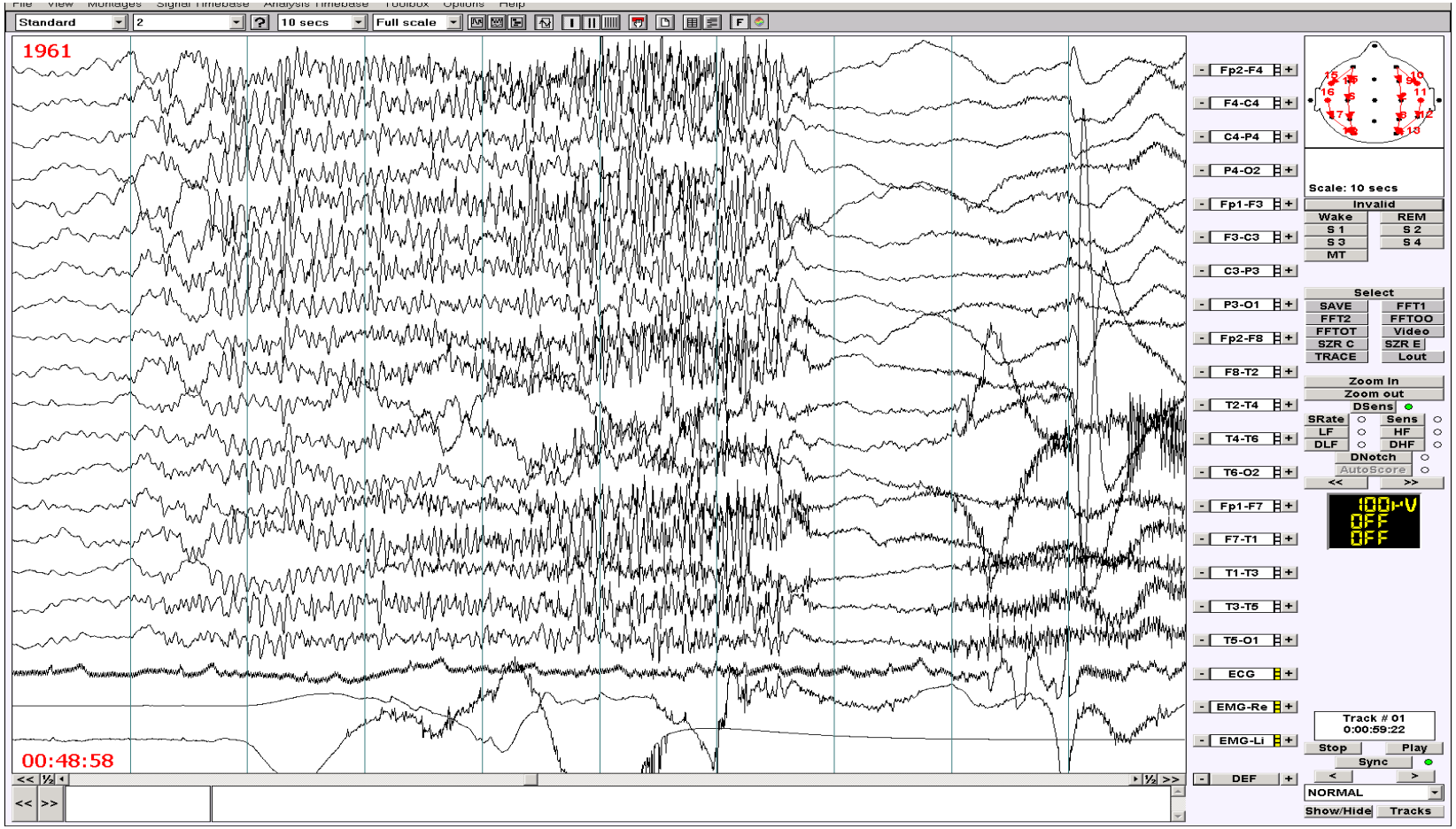


Boy 10 y old with Lennox Gastaut Syndrome.
Generalized paroxysms of spikes followed by short postparoxysmal attenuation

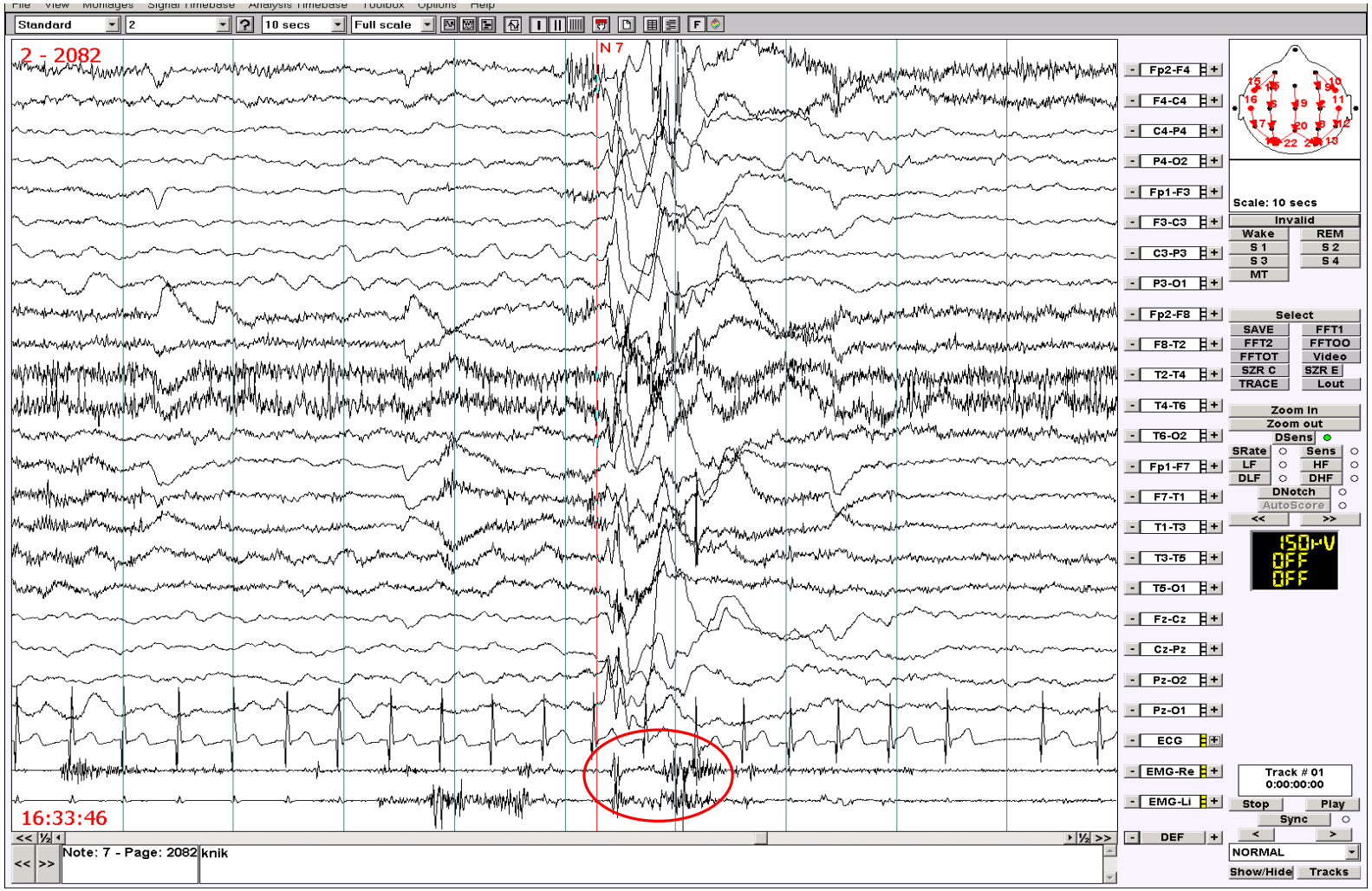


Male 24y old, frontal lobe epilepsy

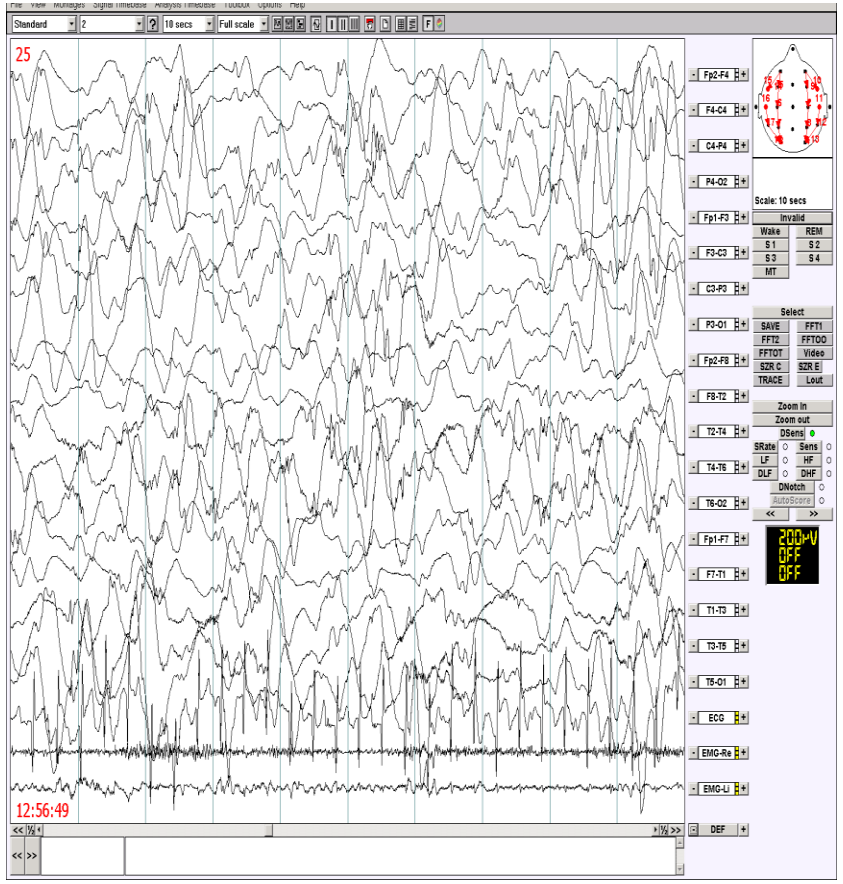
Ictal sleep EEG: tonic seizure : fast activity 10-14Hz, and postictal attenuation.

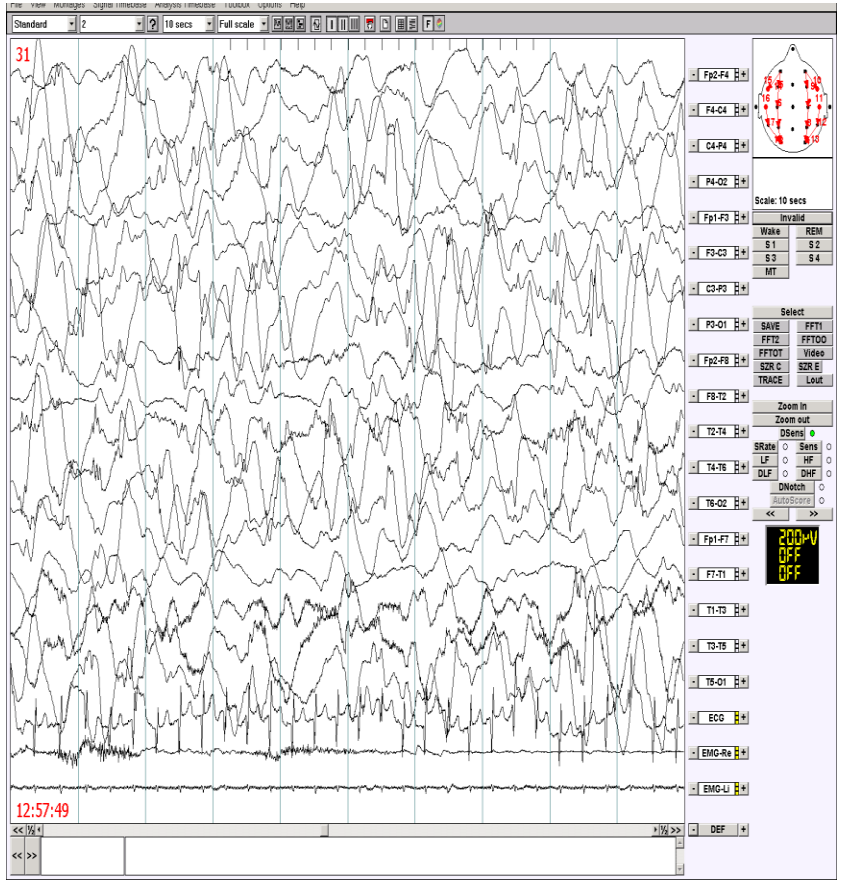


Boy, 2 ½ y old with Sturge Weber syndrome. Ictal tracé : Myoclonic seizure

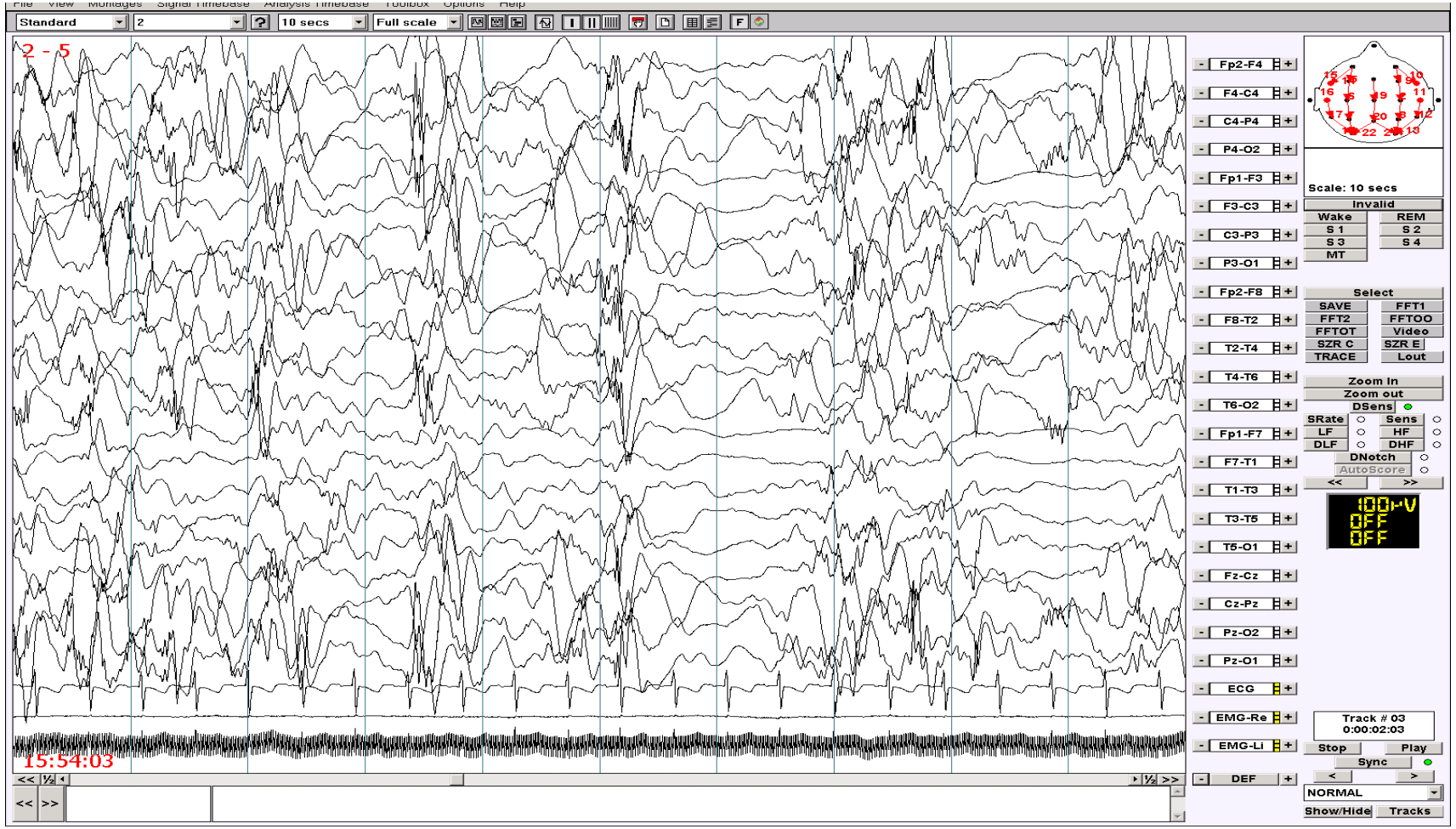


West syndrome in 7 months old baby:
hypsarrhythmia : high voltage irregular slow activity with multifocal spikes and sharp waves

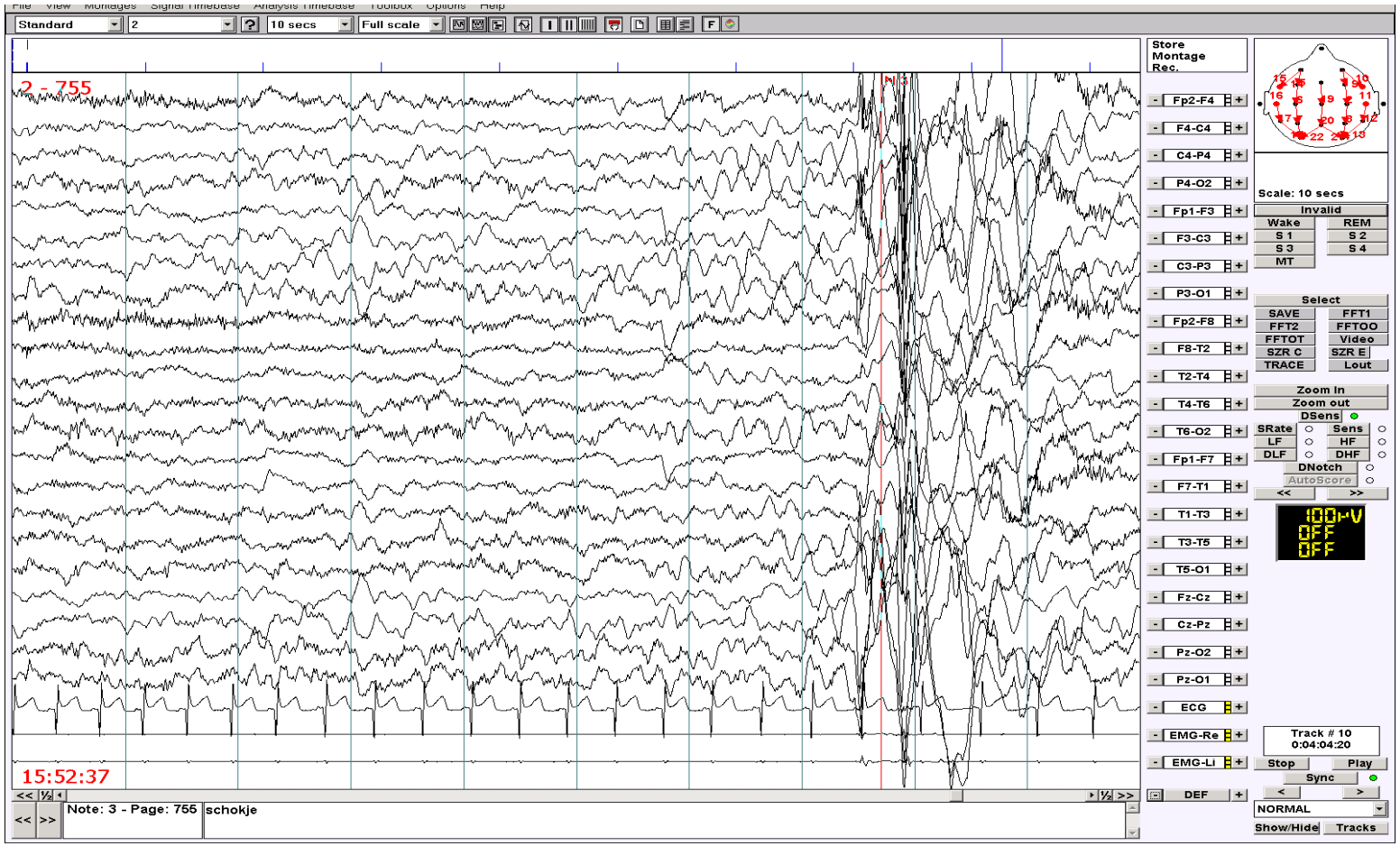




Interictal sleep EEG (2 ½ months old baby with flexion spasms)
disorganized background activity with very frequent generalized epileptiform discharges, and short suppression burst

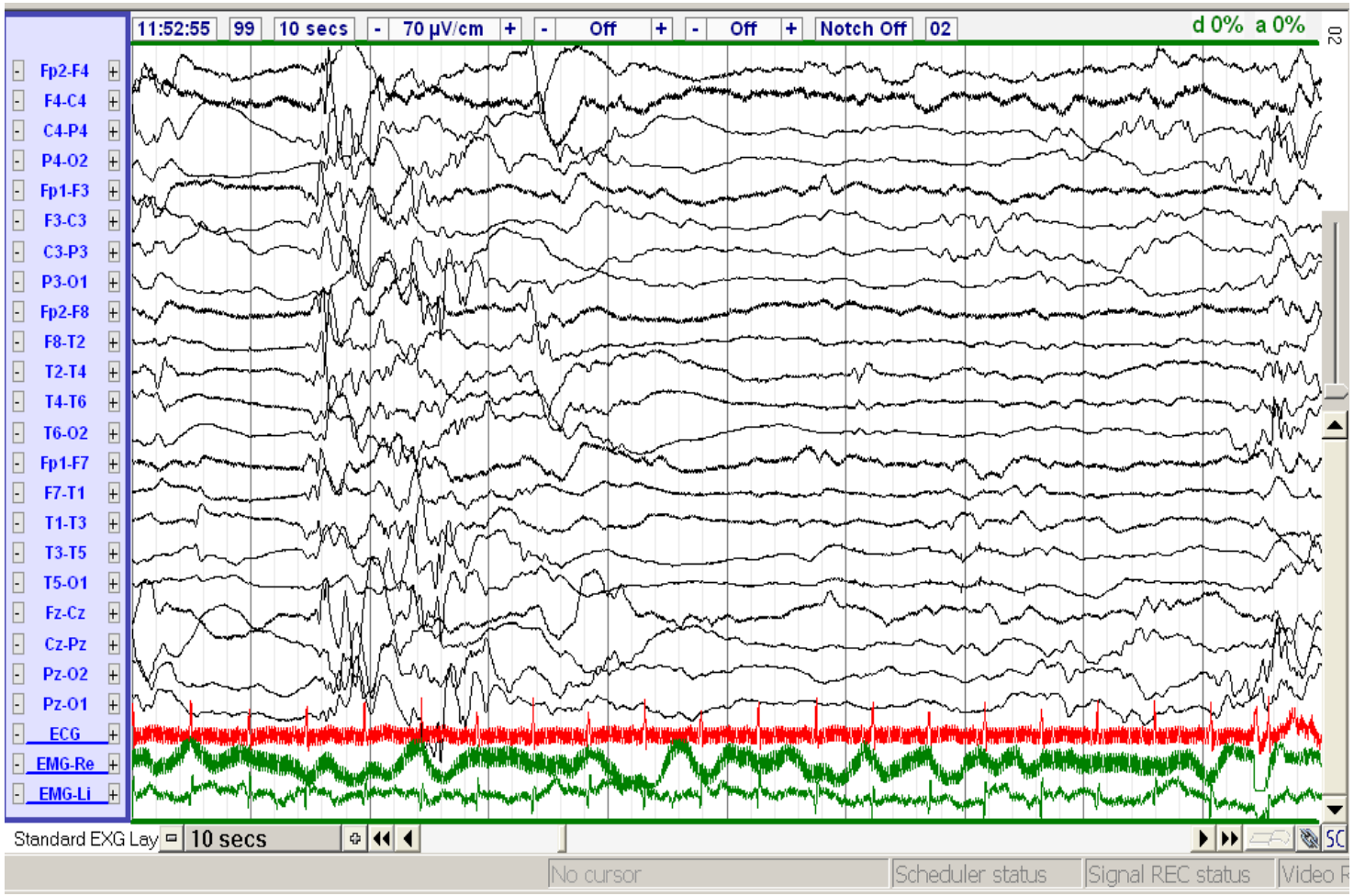


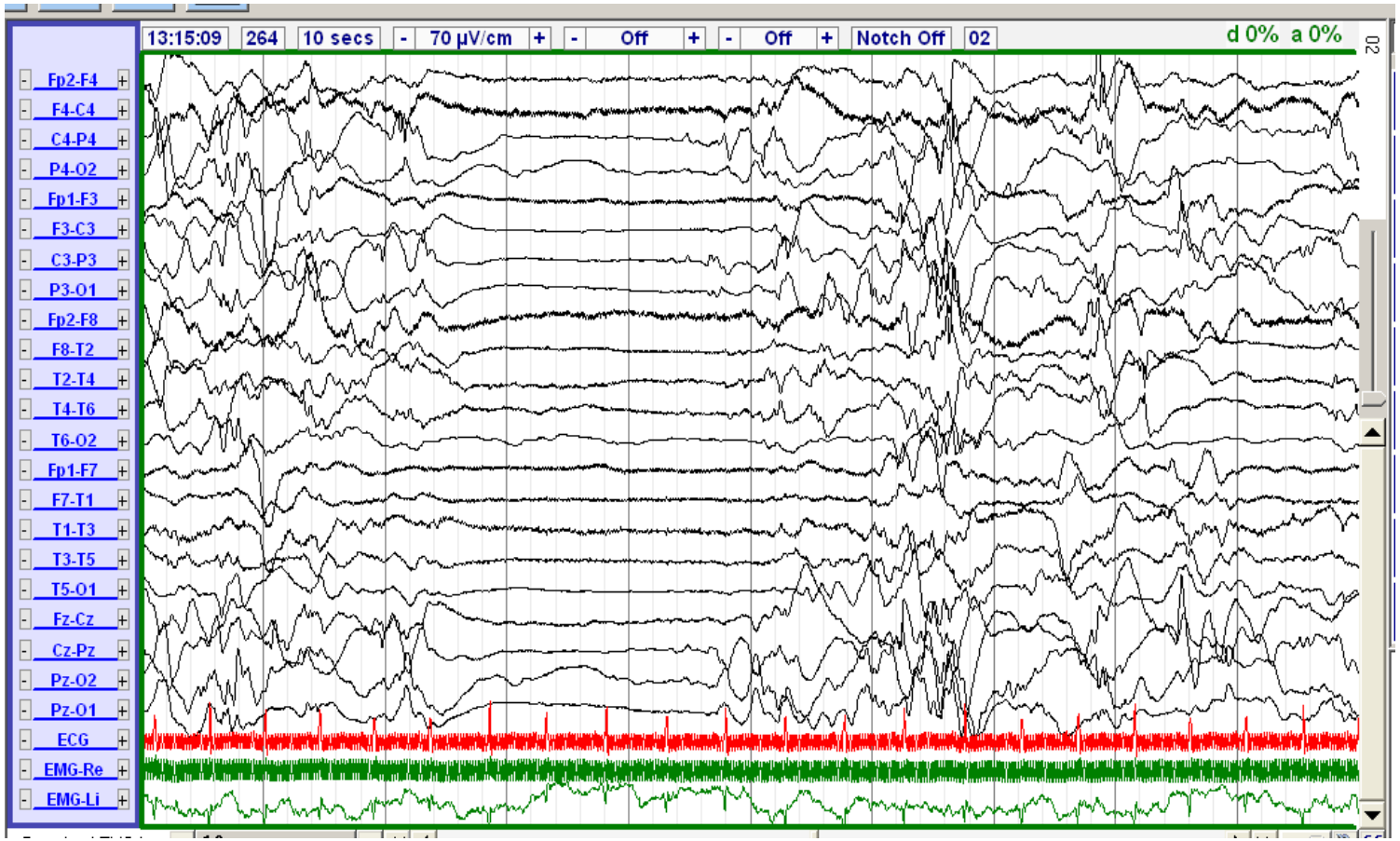
7 months baby with contolled extension spasms (West syndrome).
Generalized epileptic abnormalities



5 days old baby with Early Infantile Epileptic Encephalopathy with suppression burst .

Ohtahara syndrome

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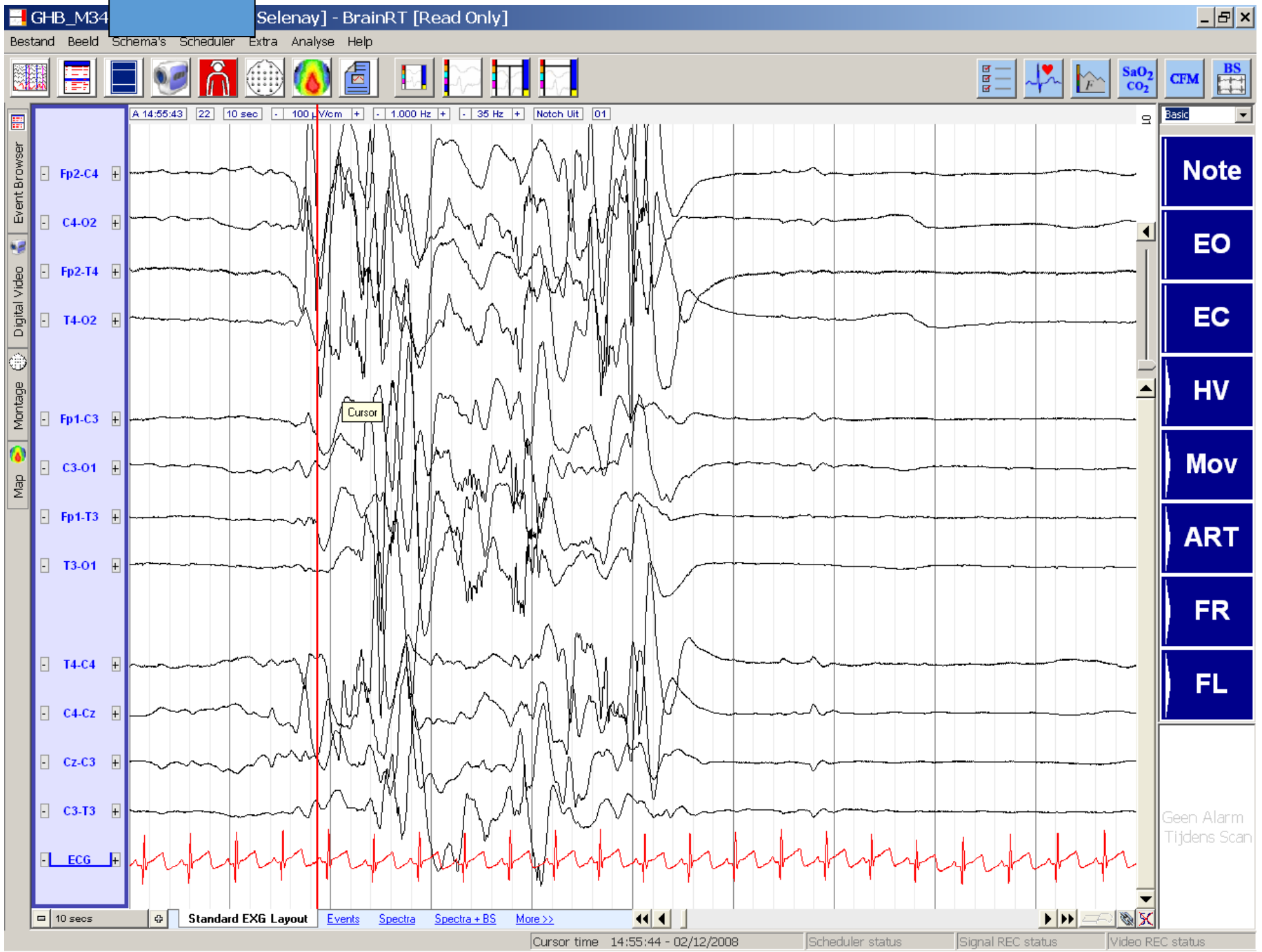
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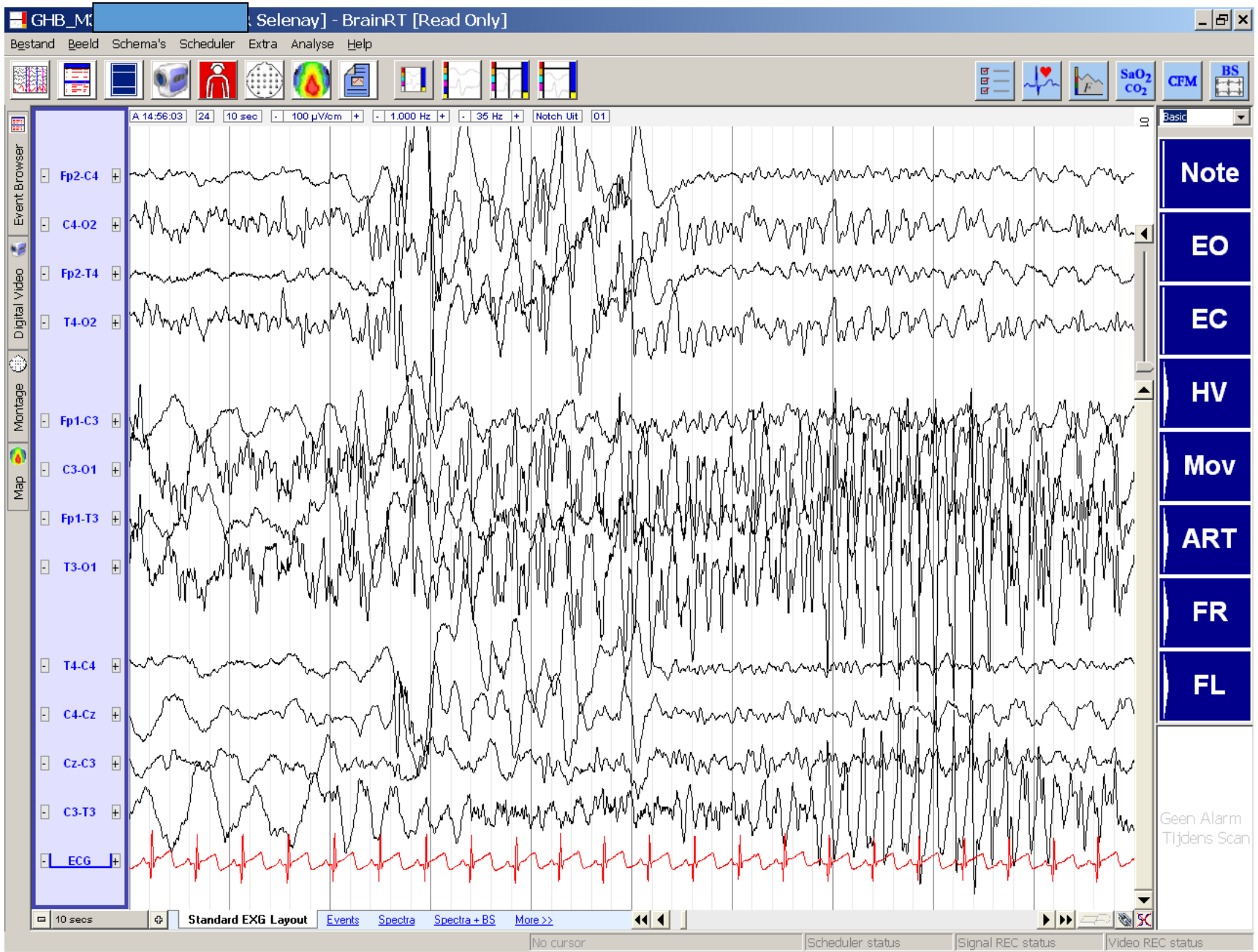
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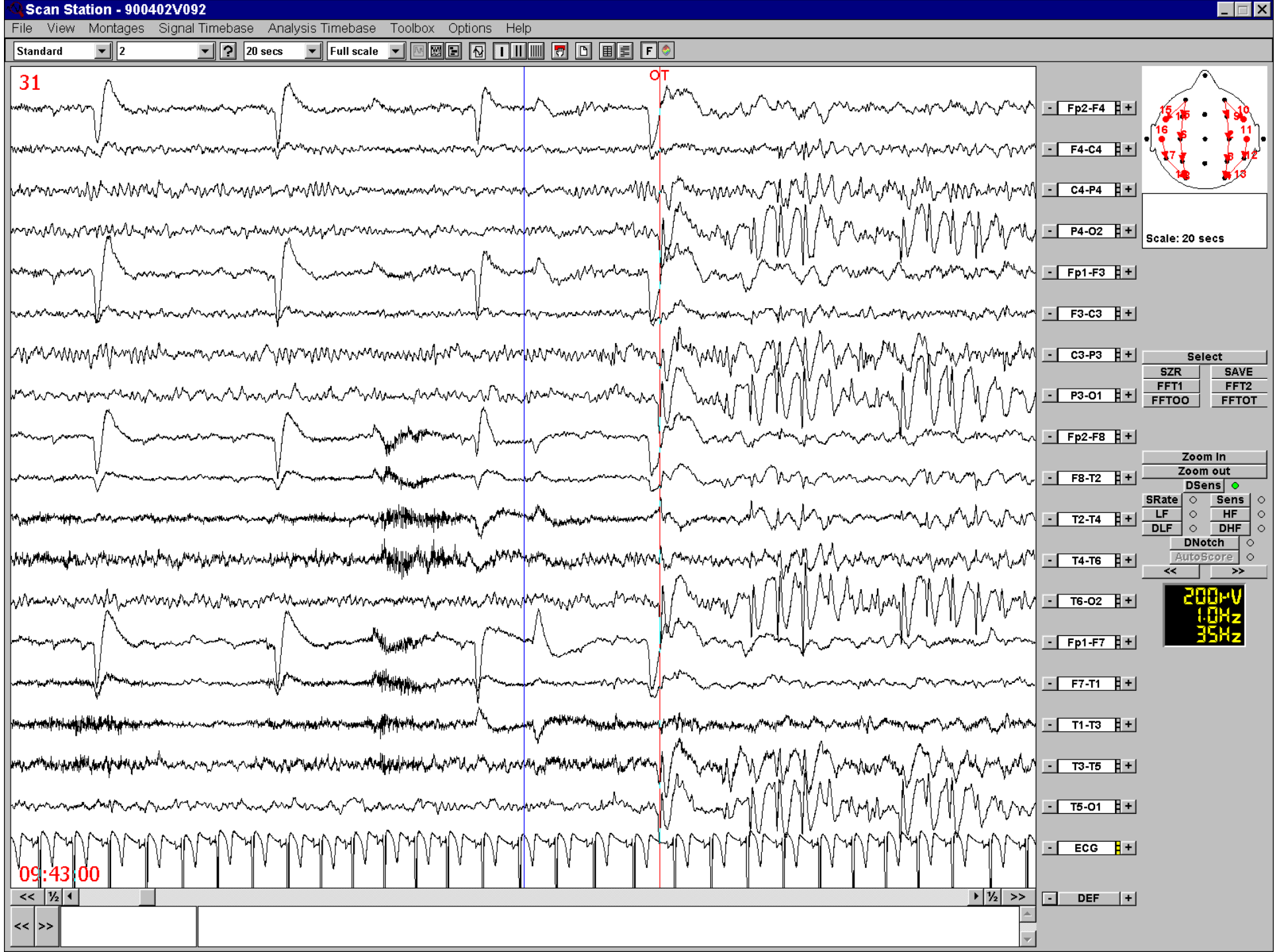
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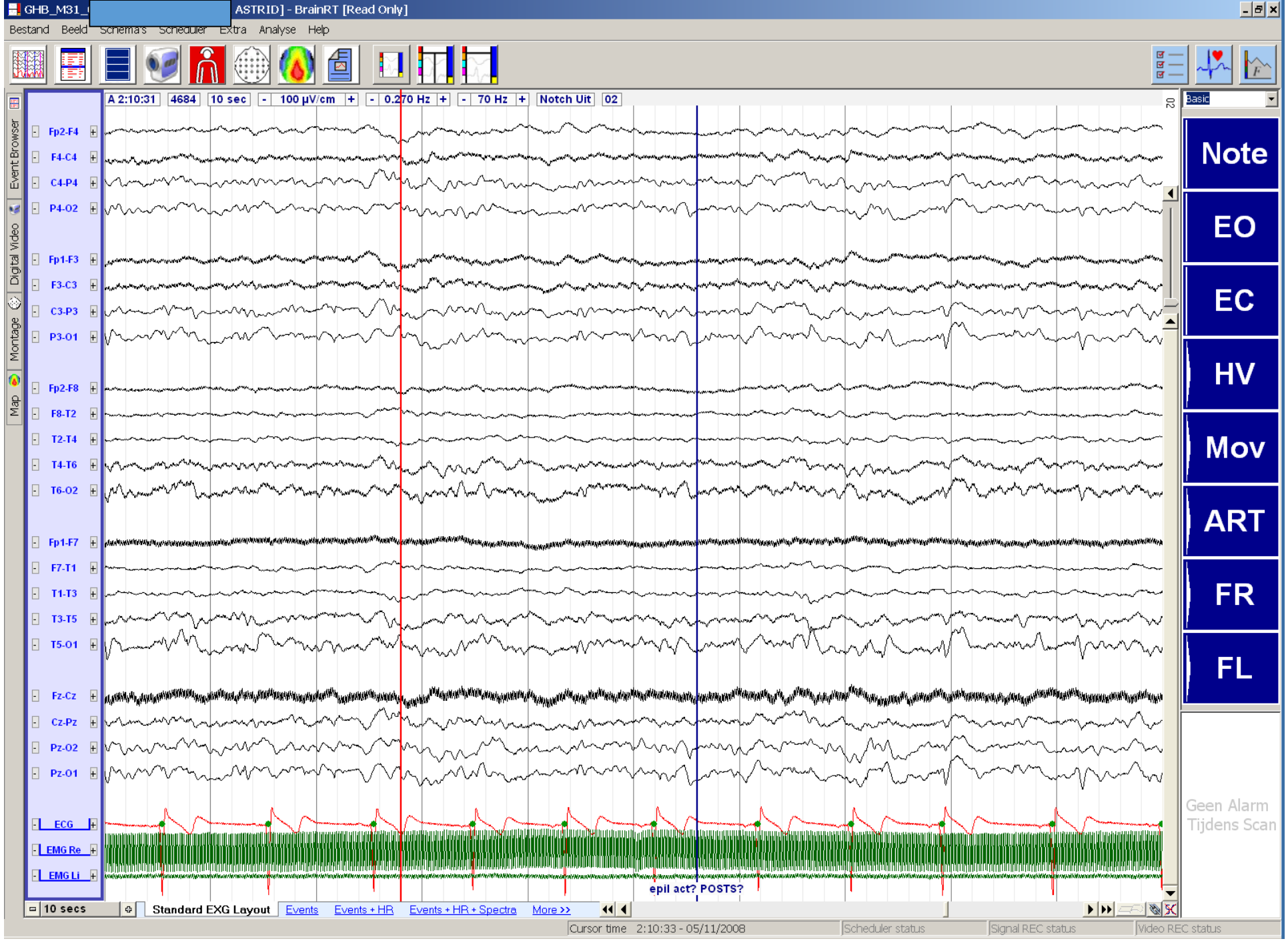
P3-O1
Fp2-F8
F8-T2
T2-T4
T4-T6
T6-O2
Fp1-F7
F7-T1
T1-T3
T3-T5
T5-O1
ECG
DEF
Scale: 20 secs
Select
SZR
SAVE
FFT1
FFT2
FFTOO
FFTOT
Zoom In
Zoom out
DSens
SRate
Sens
LF
HF
DLF
DHF
DNotch
AutoScore
<<
>>
200uV
1.0Hz
35Hz


GHB_M31_
ASTRID] - BrainRT [Read Only]
Bestand Beeld Schema's Scheduler Extra Analyse Help
A 2:10:31 4684 10 sec - 100 µV/cm + - 0.270 Hz + - 70 Hz + Notch Uit 02
Basic
Fp2-F4
F4-C4
C4-P4
P4-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F8
F8-T2
T2-T4
T4-T6
T6-O2
Fp1-F7
F7-T1
T1-T3
T3-T5
T5-O1
Fz-Cz
Cz-Pz
Pz-O2
Pz-O1
ECG
EMG Re
EMG Li
epil act? POSTS?
Note
EO
EC
HV
Mov
ART
FR
FL
Geen Alarm
Tijdens Scan
Event Browser
Digital Video
Montage
Map
10 secs
Standard EXG Layout
Events
Events + HR
Events + HR + Spectra
More >>
Cursor time 2:10:33 - 05/11/2008
Scheduler status
Signal REC status
Video REC status