The amplitudeintegrated EEG in Neonatology

Karl Florian Schettler
Senior Physician Neonatology
Perinatal Care Center Landshut
Childrens Hospital St. Marien
Teaching affiliate of the
Ludwig-Maximilians-University of Munich

Contact: Karl.Florian@Schettler.eu

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Hurghada, Egypt

Monitoring - Changing times

Assessment of brain function

Electrophysiological

- Clinical (Sarnat or Thompson Score etc)
- Cerebral Function Monitoring (CFM)
- Imaging (MRI, Ultrasound, CT)

with

- Electrophysiological (EEG)

amplitudeintegrated EEG (aEEG)

So why aEEG ?

aEEG vs. EEG

aEEG / CFM

Available immediatly

Long term monitoring

No details

pattern recognition

konv. EEG

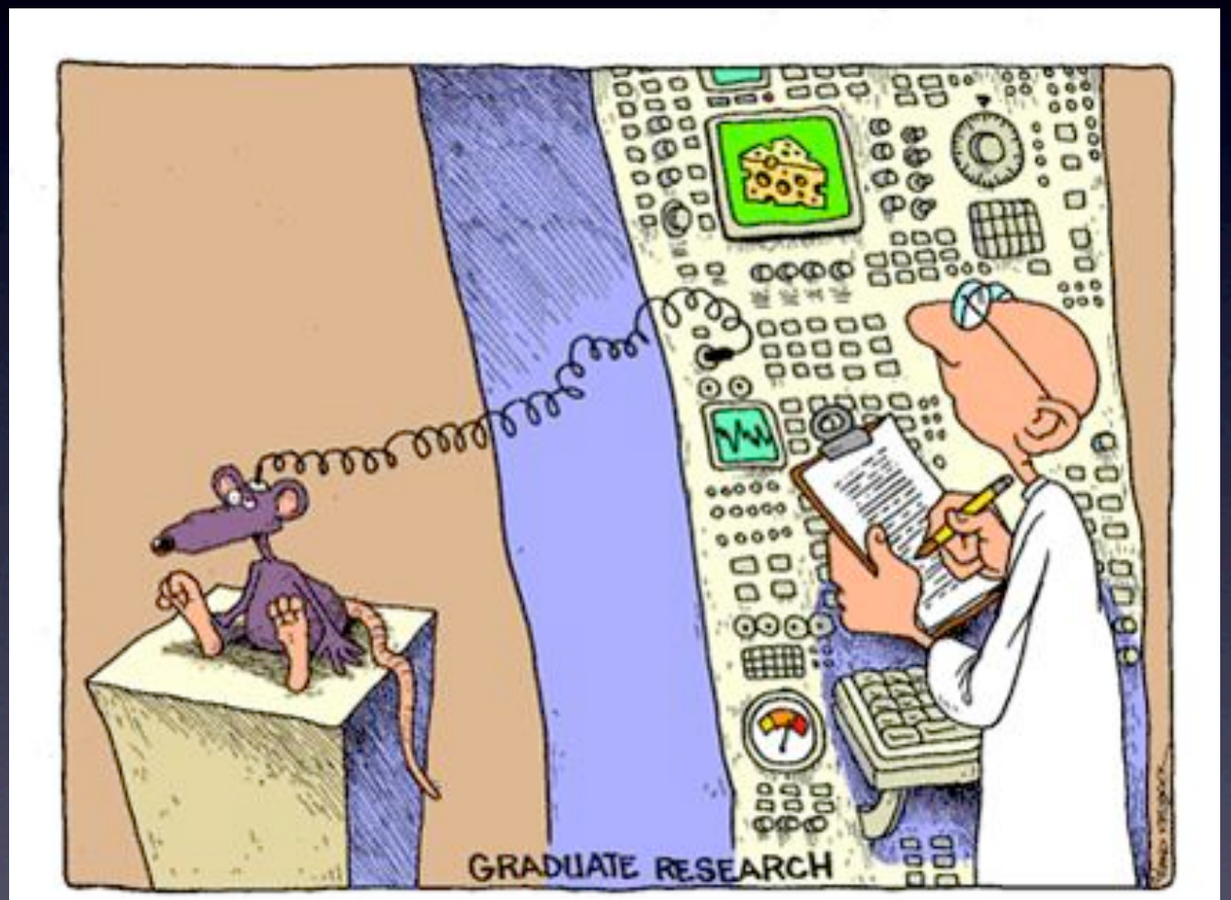
Not always available

Short term monitoring

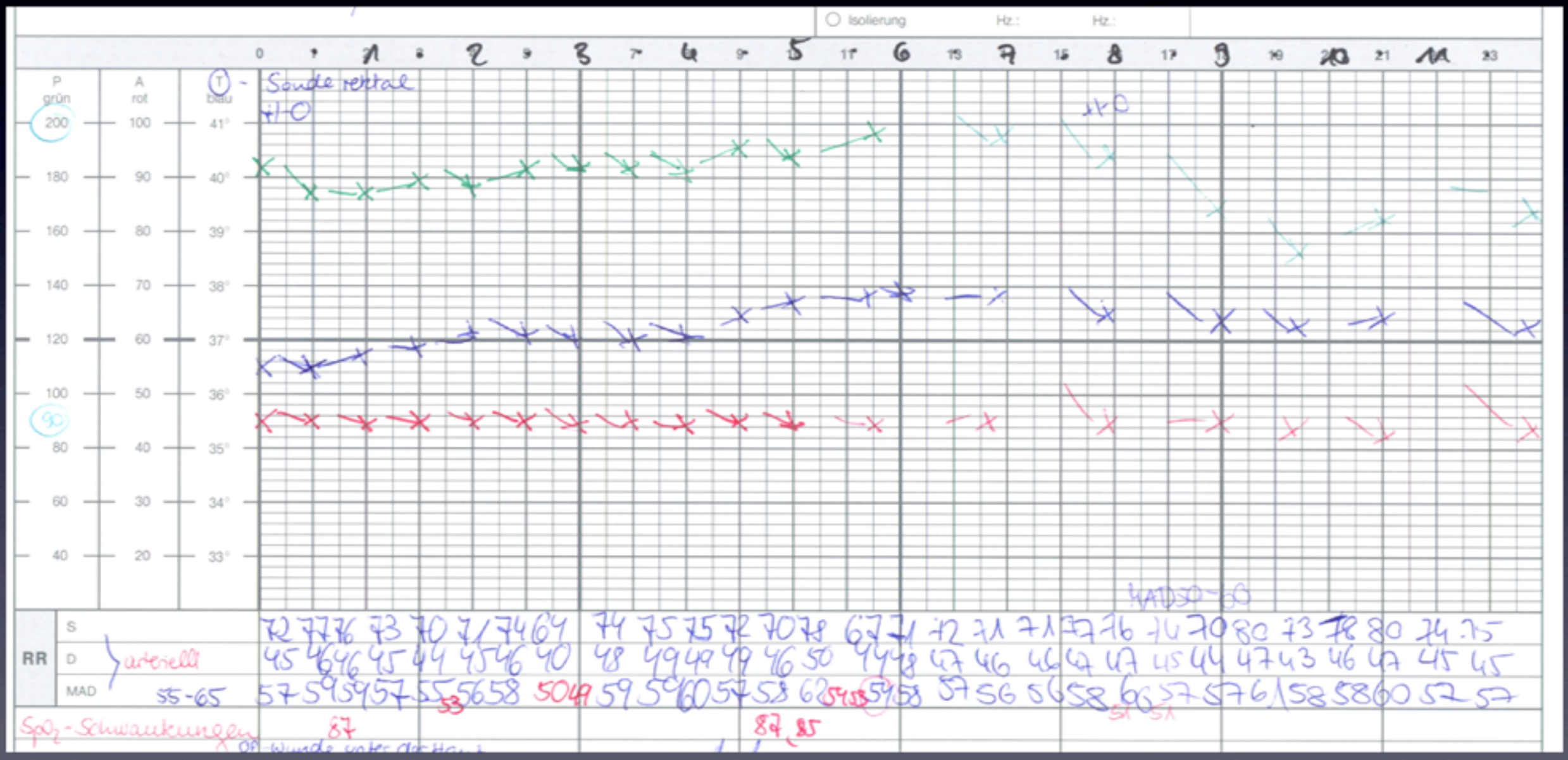
Many details

Difficult interpretation

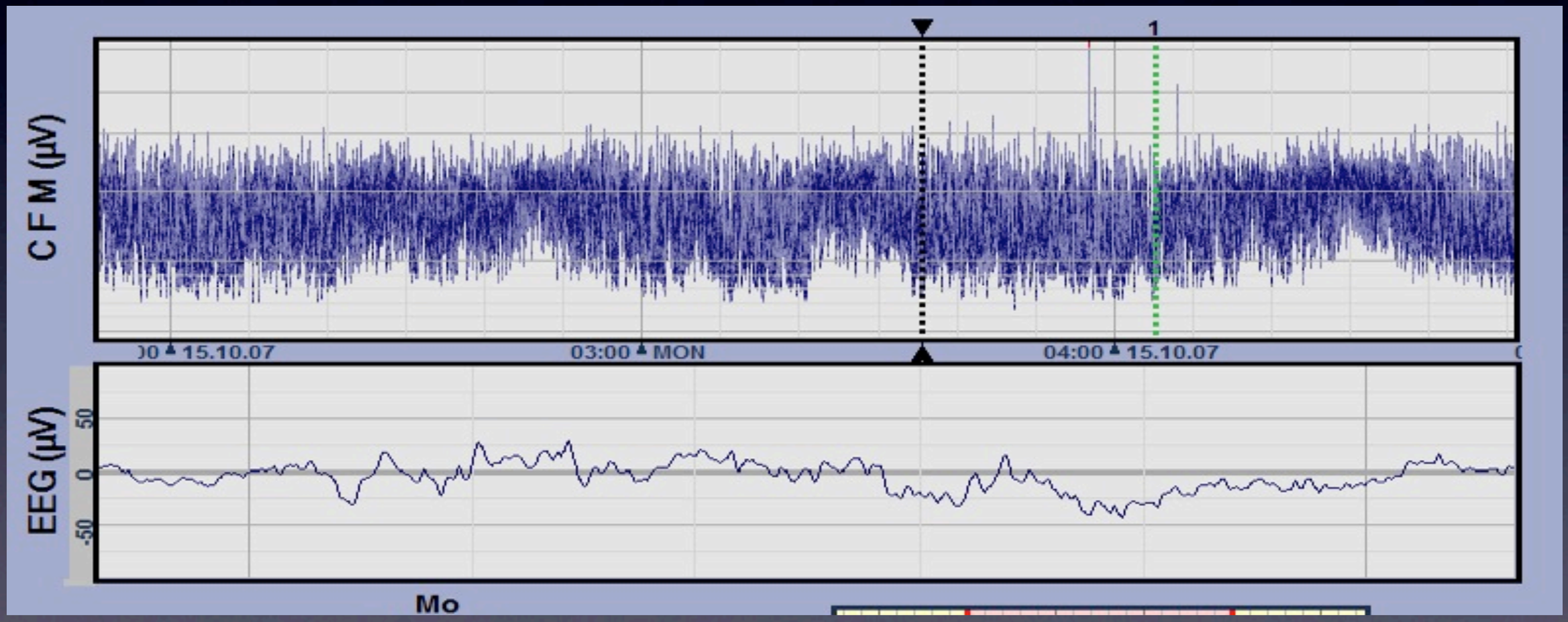
Key experiences



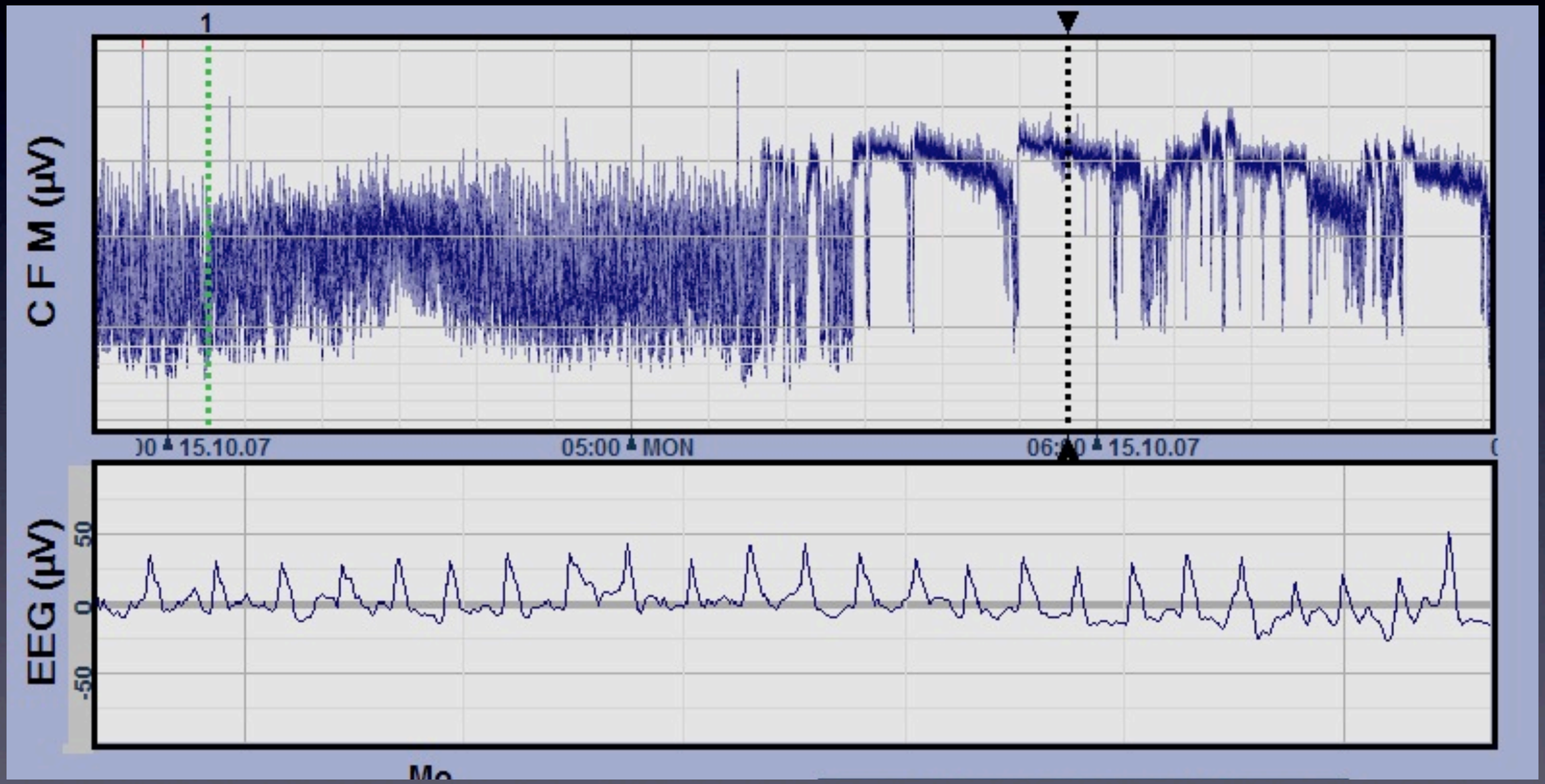
Key experiences



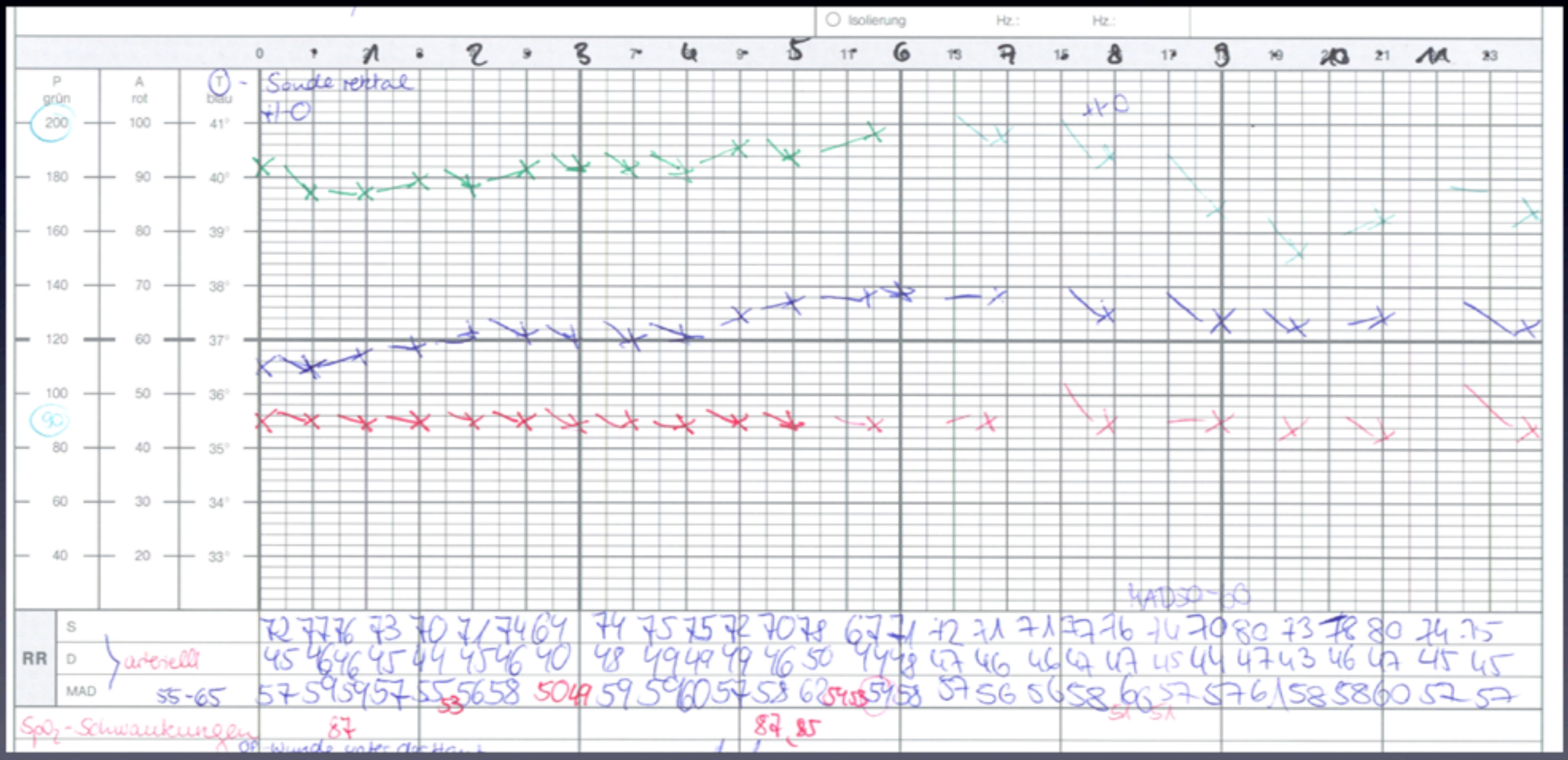
Key experiences



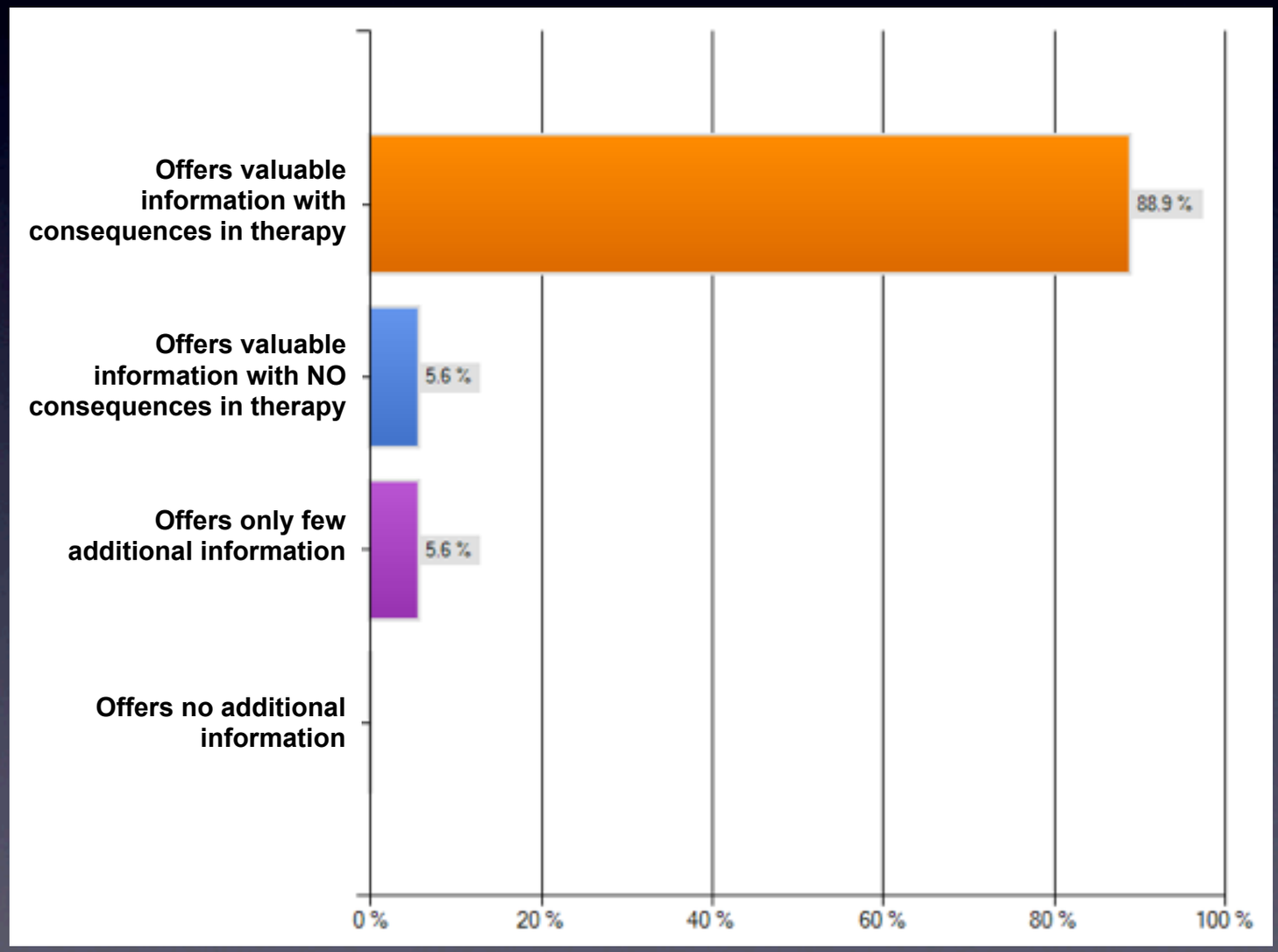
Key experiences



Key experiences



What is the general feeling about aEEG in your unit



Neonatologist landing at Neuroconference

Typical arguments against aEEG

About half of all cerebral seizures were not detected by non-EEG-experts

[Rennie JM et al. Arch Dis Child Fetal Neonatal Ed, 2004]

focal, low-amplitude or short episodes of neonatal seizures were unrecognized

[Toel et al. Pediatrics 109, 2002]

Careful: continuous 'spikes' often missed, if raw-EEG is not looked at

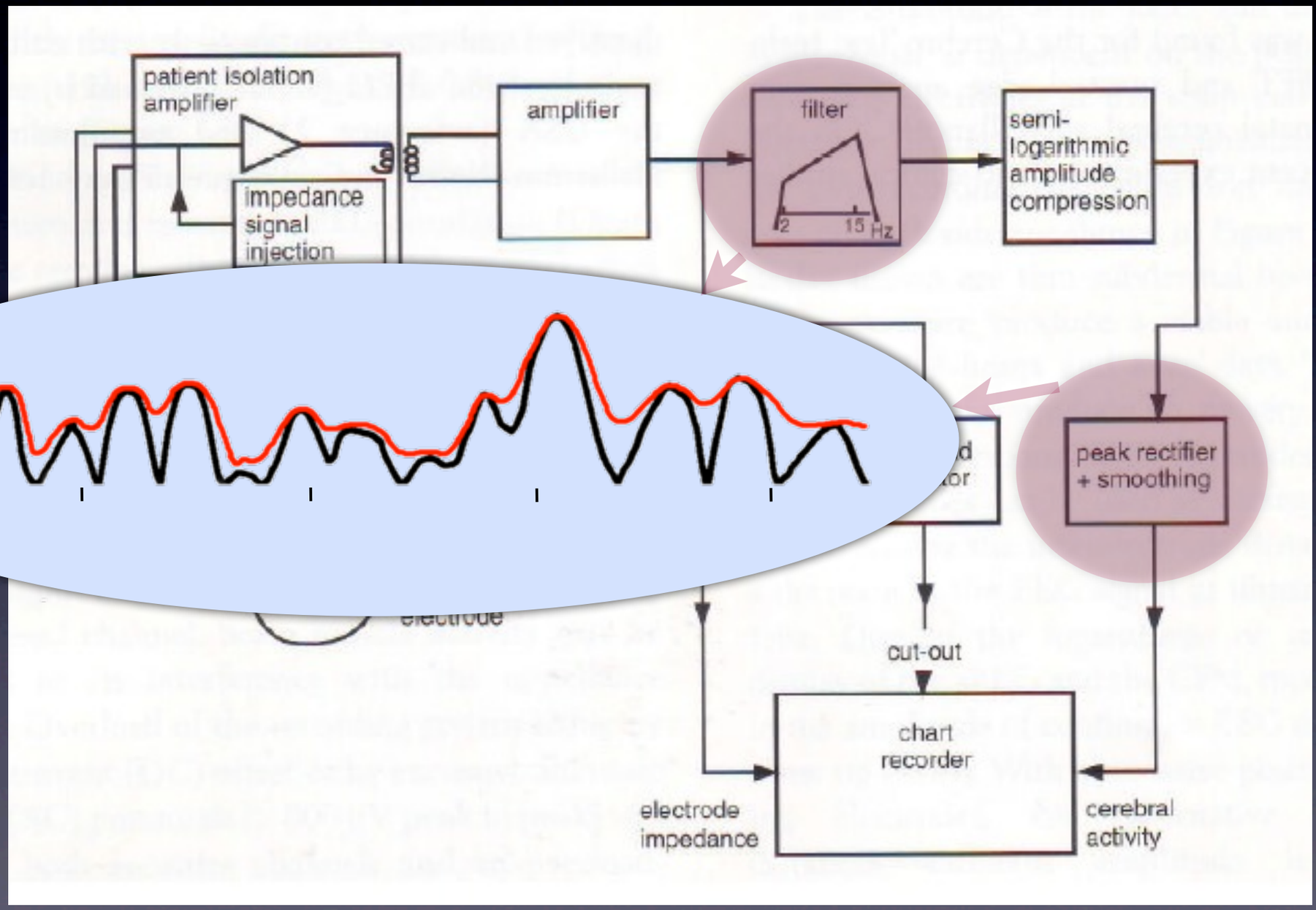
[Rosen. Clinics in Perinatology 2006; 33: 593-611]

No information about EEG-frequency and brain activity outside of electrodes region

A little history...

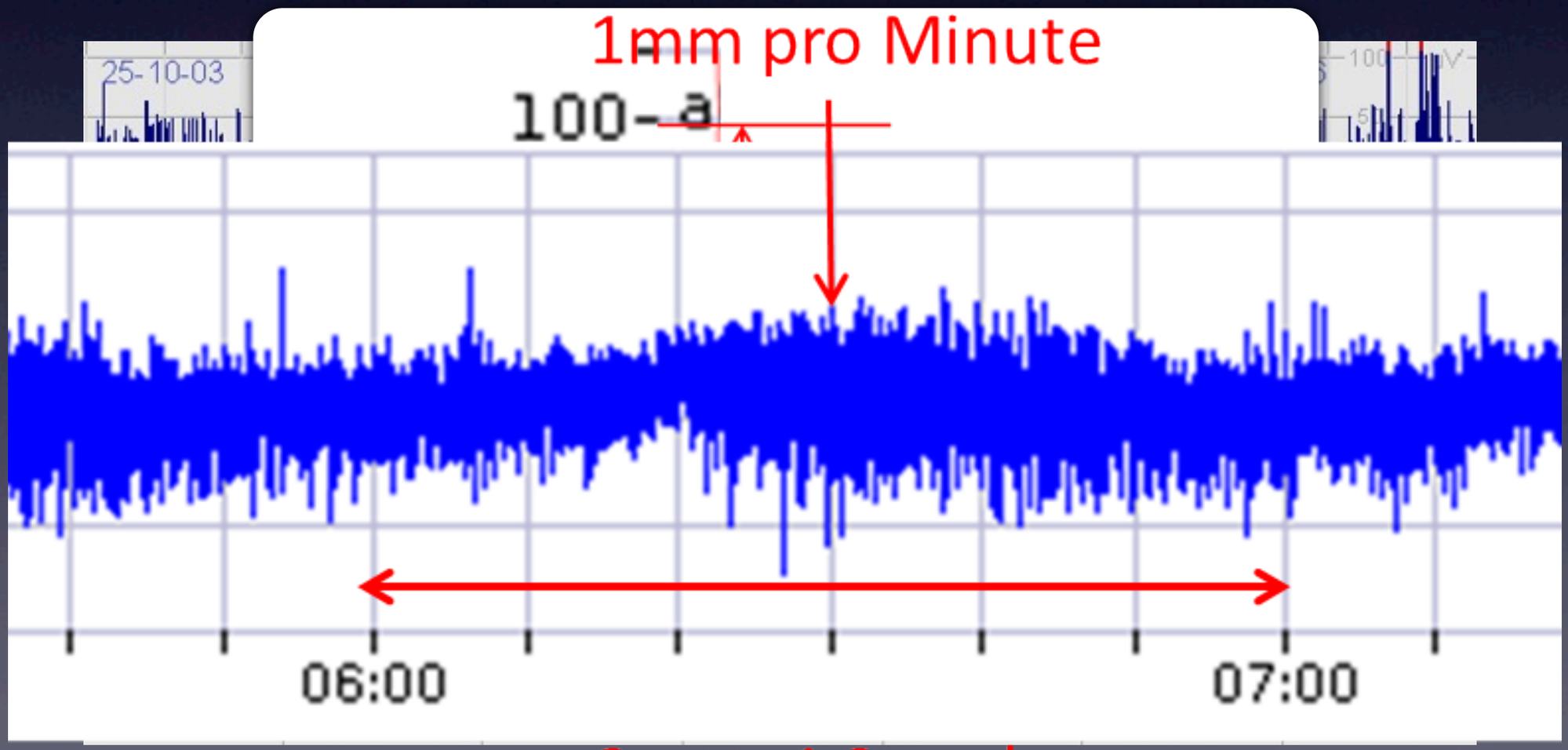
- developed in the 60s by Maynard and used by Prior in adults [Prior, Maynard. BMJ 1969; 4: 545-6]
- used in newborns by the end of 70s to beginning of the 80s [Viniker, Maynard, Scott. Clin. Electroencephalogr 1984; 15: 185-92]
- Renaissance since begin of 90s with digital display and including raw EEG and its use in the hypothermia studies like the cool-cap trial

Technical background



The recording

- reflects minimum and maximum amplitude of „raw“ EEG
- semilogarithmic: linear 0-10 µV, log. 10-100 µV
- time compressed 6cm per hour



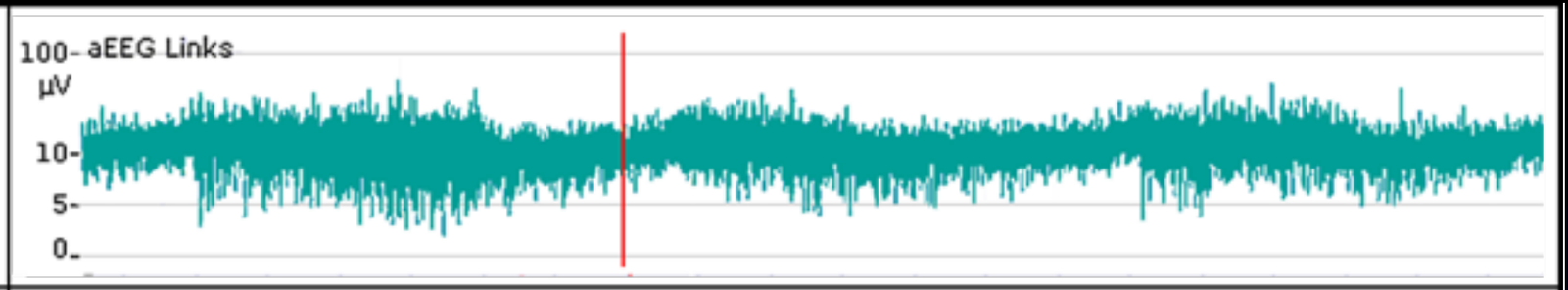
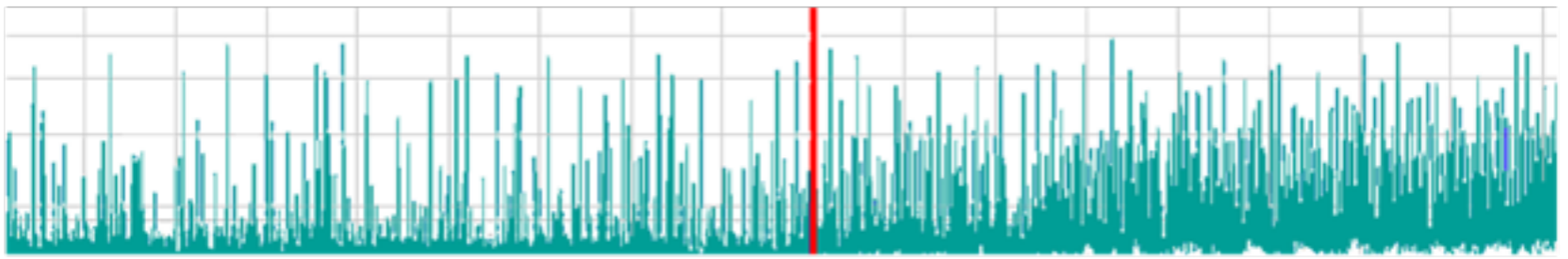
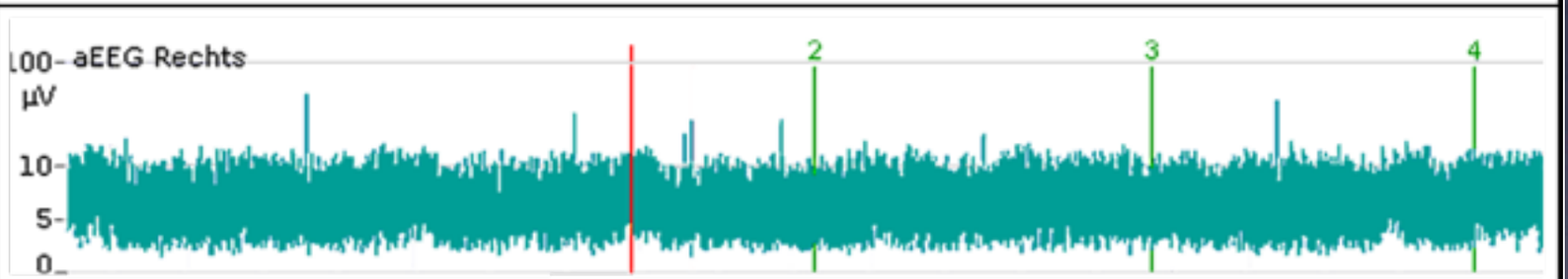
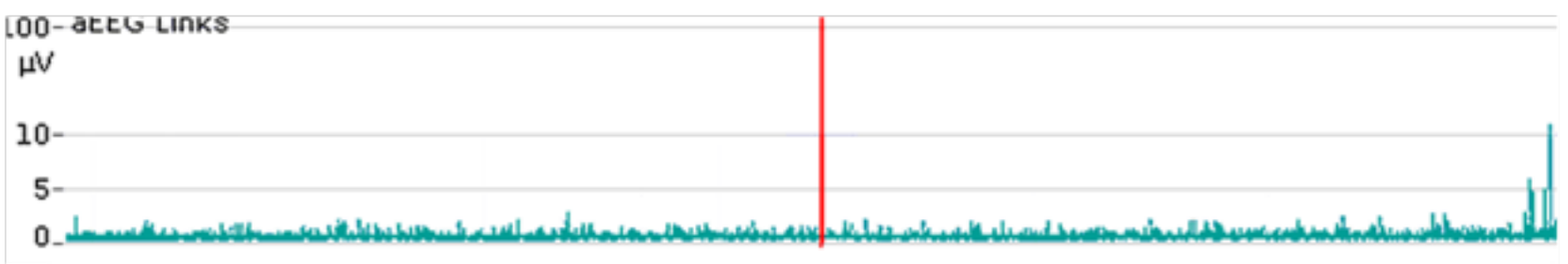
Assessment of an aEEG

Background activity

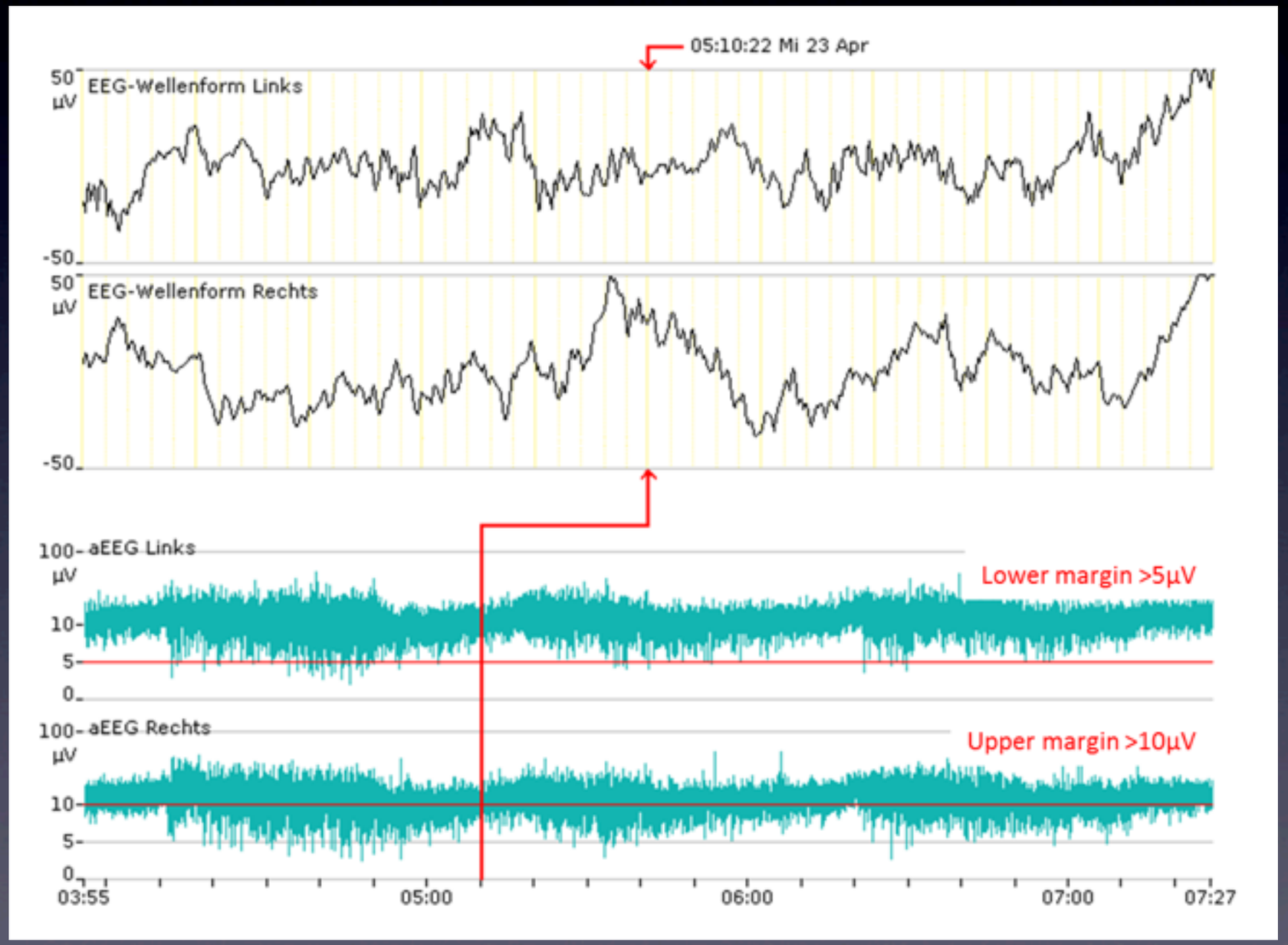
Sleep-Wake-Cycling

Seizure activity

Background activity (pattern recognition)

continuous normal voltage pattern, C Upper margin >10-25µV Lower margin >(5-)7-10µV	
discontinuous pattern, DC Upper margin >10-25µV Lower margin <5µV	
Burst suppression pattern, BS Lower margin 0-1(-2)µV Bursts >25µV BS- <100 bursts/hour BS+ >100 bursts/hour	
Low voltage, LV Lower margin at or <5µV Upper margin <10µV	
Inactive, flat trace, FT Upper and lower margin continuously <5µV	

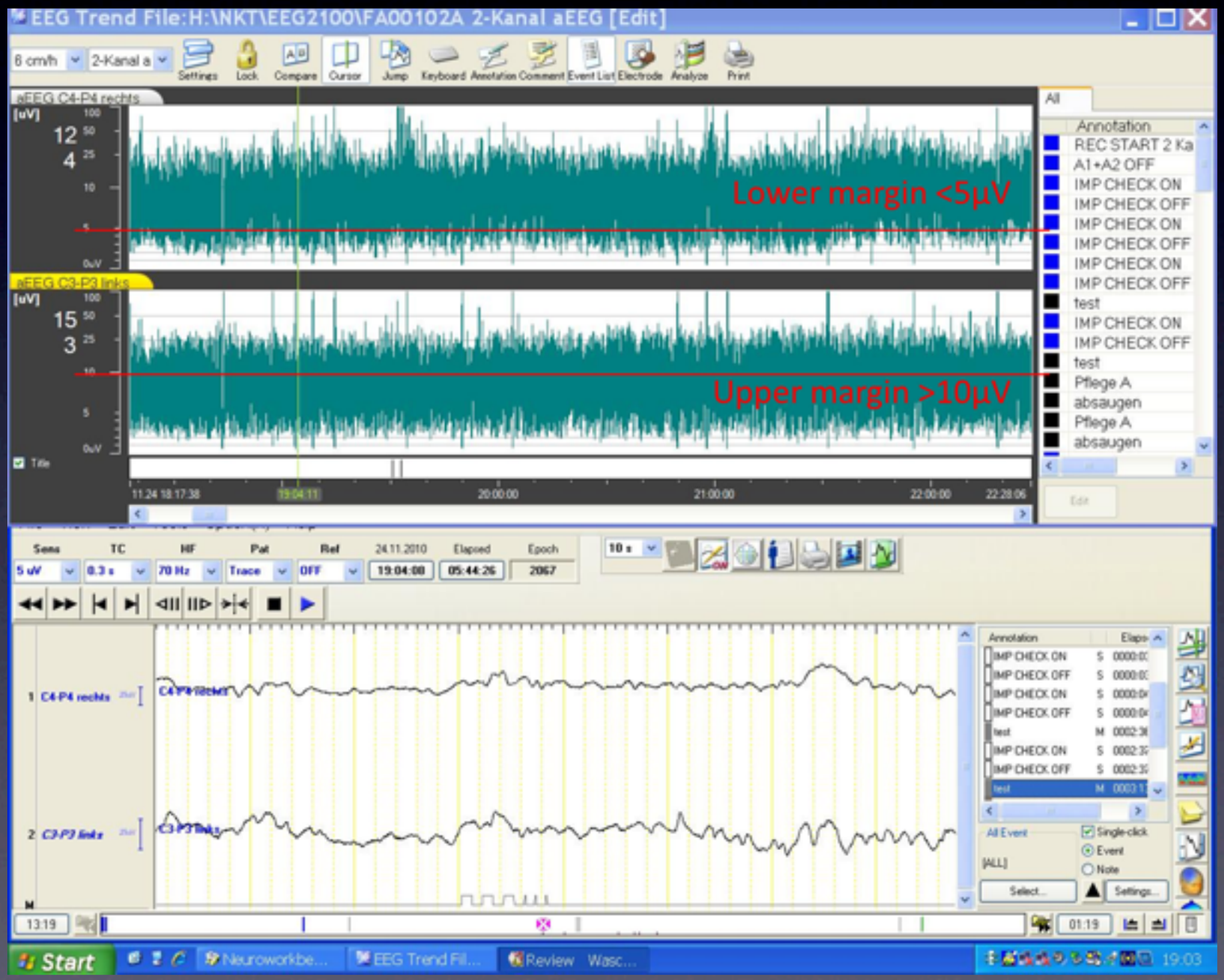
CNV, Continuous normal voltage, continuous pattern



Maximum amplitude
10-25(-50) µV

Minimum amplitude
> 5 (7)-10 µV

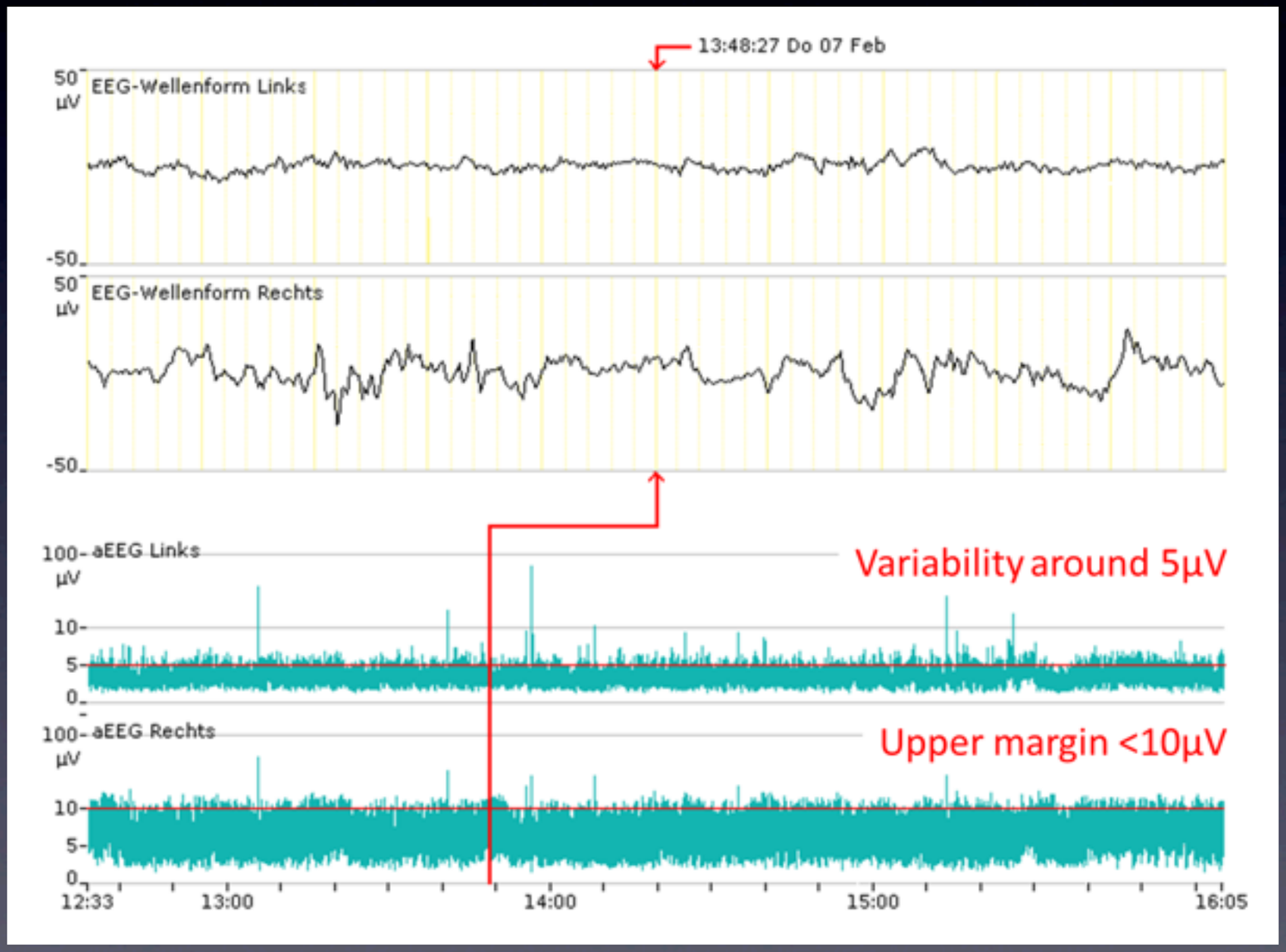
DC, Discontinuous voltage, discontinuous pattern



Maximum amplitude
10-25(-50) µV

Minimum amplitude
< 5 µV

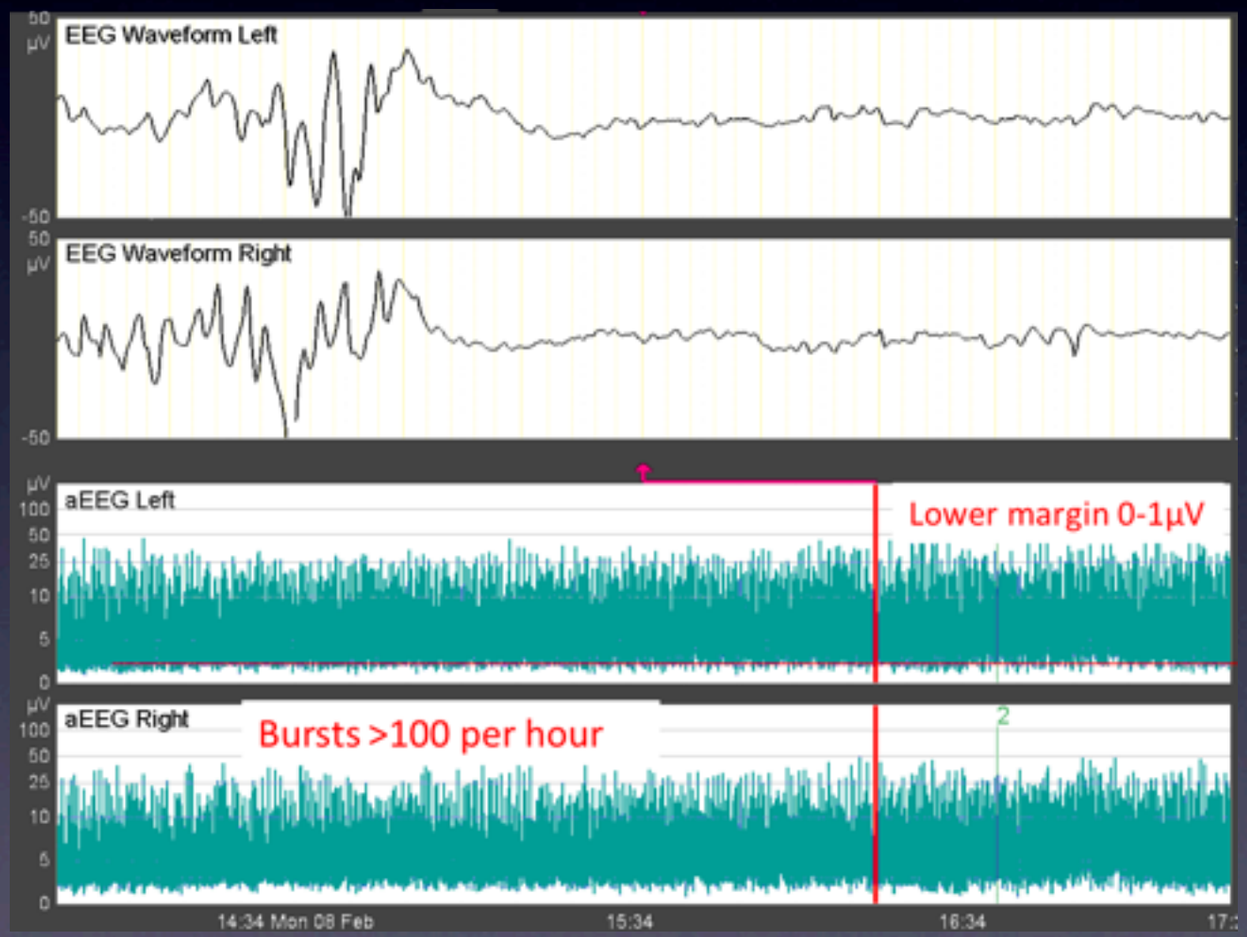
LV, Low voltage

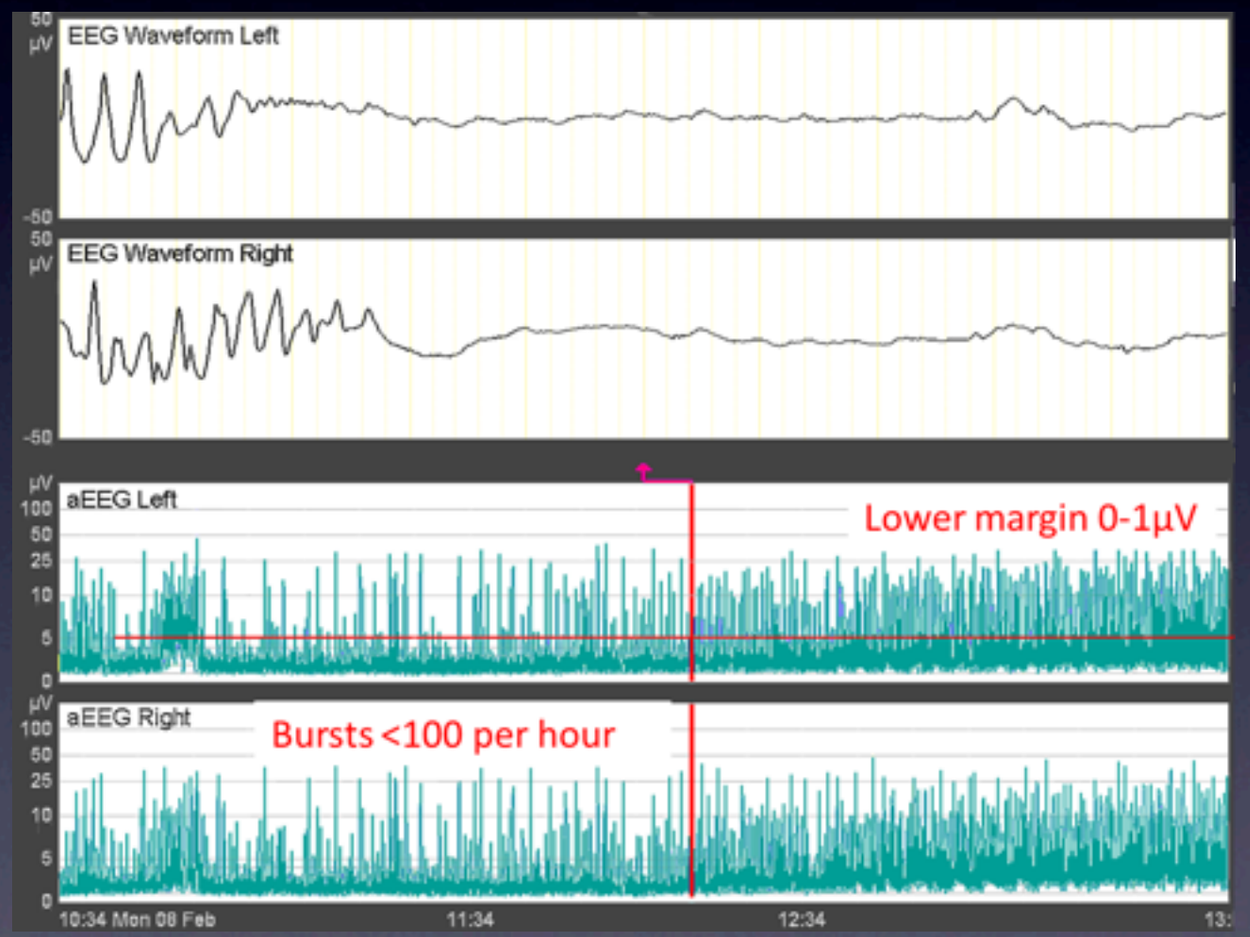


Maximum amplitude
< 10 µV

Variability around 5 µV

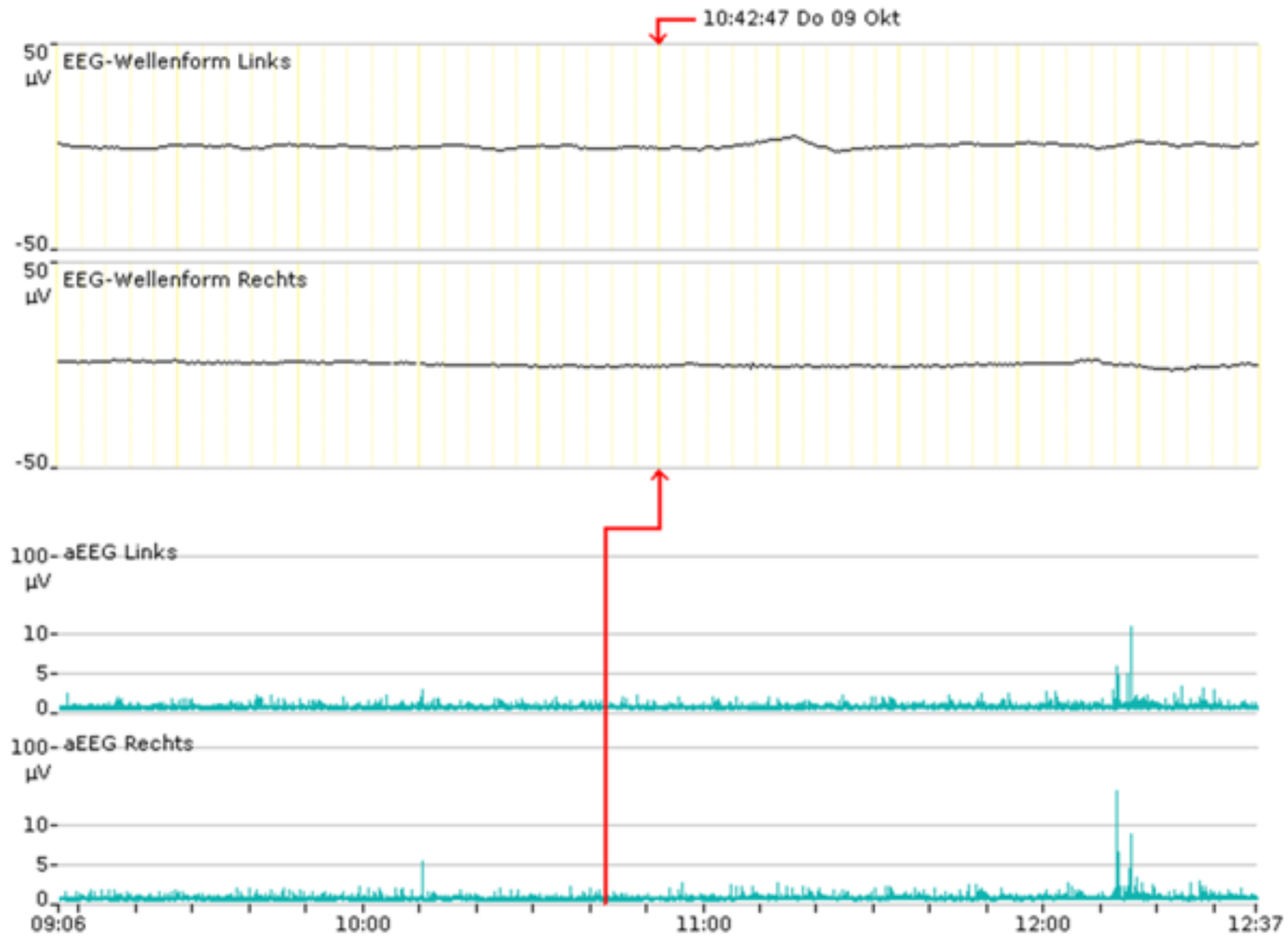
BS +/-, burst suppression pattern





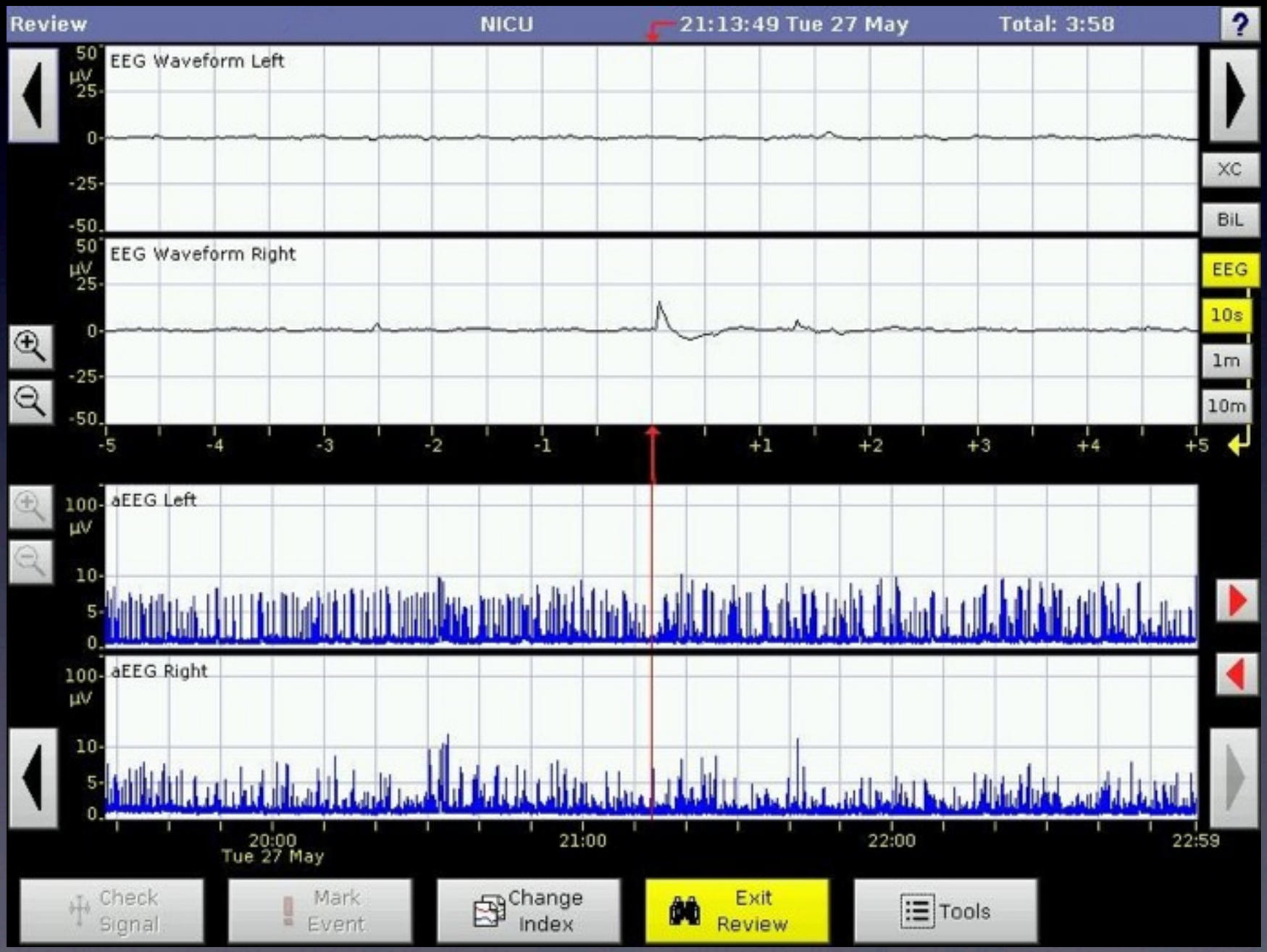
BS+ >100 Bursts / h or BS- <100 Bursts / h
Inter Burst Intervall (IBI)

FT, flat trace, inactive pattern



Pattern always < 5 µV (isoelectric)

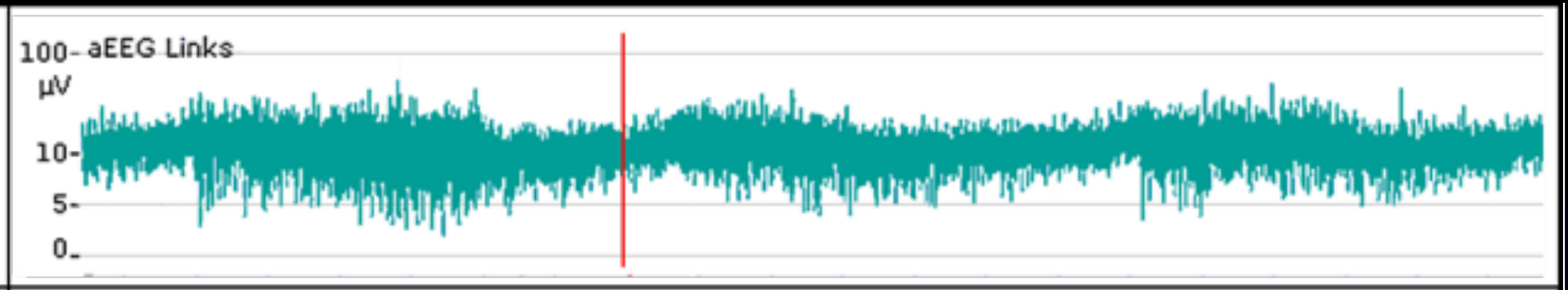
FT, flat trace, inactive pattern



Beware
of artefacts!

This is still FT

Background activity (pattern recognition)

continuous normal voltage pattern, C Upper margin >10-25µV Lower margin >(5-)7-10µV	
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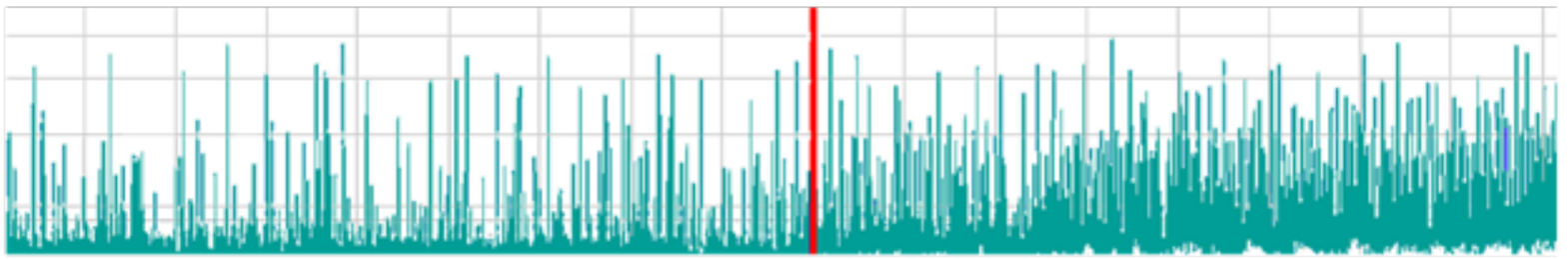
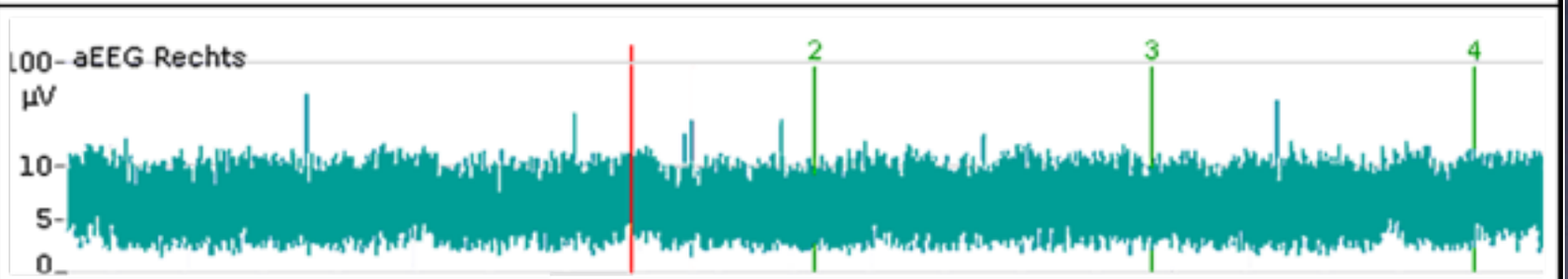
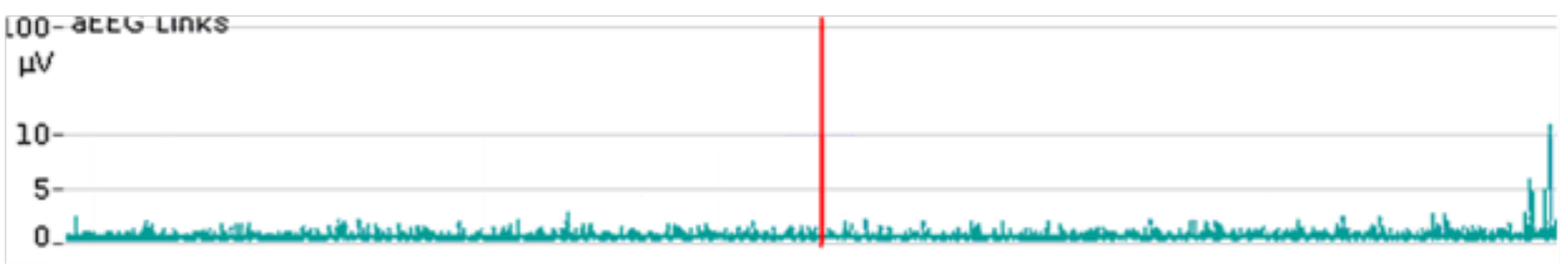
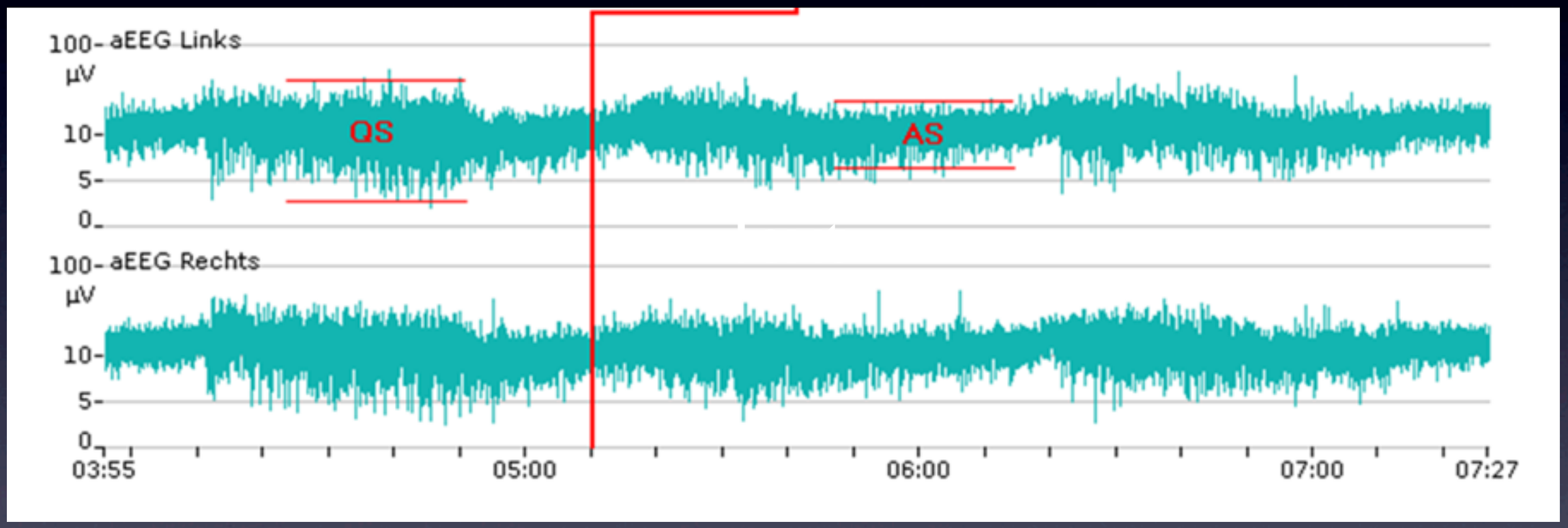
Burst suppression pattern, BS Lower margin 0-1(-2)µV Bursts >25µV BS- <100 bursts/hour BS+ >100 bursts/hour	
Low voltage, LV Lower margin at or <5µV Upper margin <10µV	
Inactive, flat trace, FT Upper and lower margin continuously <5µV	

Assessment of an aEEG

Background activity ☑

SWC
Sleep-Wake-Cycling



Continuous activity with repeating sinusoidal periodic pattern
mainly in the minimal amplitude

Bursts with continuous activity (active sleep "AS") change periods
of lower more discontinuous amplitude

(like tracé alternant EEG, „quiet sleep" QS) and back.

Periods normally at least one hour, part of quite sleep usually 20-30 min.

SWC
Sleep-Wake-Cycling

No SWC

no cyclic variation of background activity

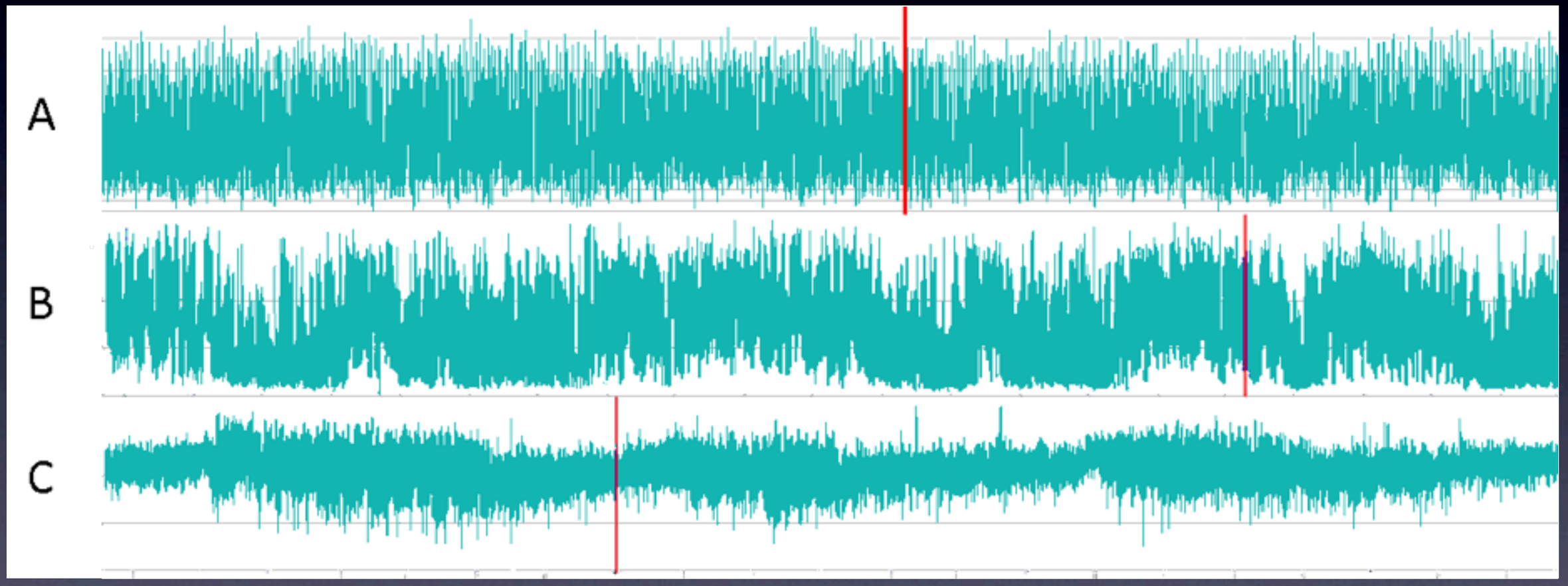
Immature/Incomplete SWC

in part, but not fully developed cyclic variation of minimal amplitude
(in respect of the gestational age)

Developed/normal SWC

clearly identifiable sinosoid variations between discontinuous and continuous background activity wit cycles longer than 20 minutes.

SWC
Sleep-Wake-Cycling

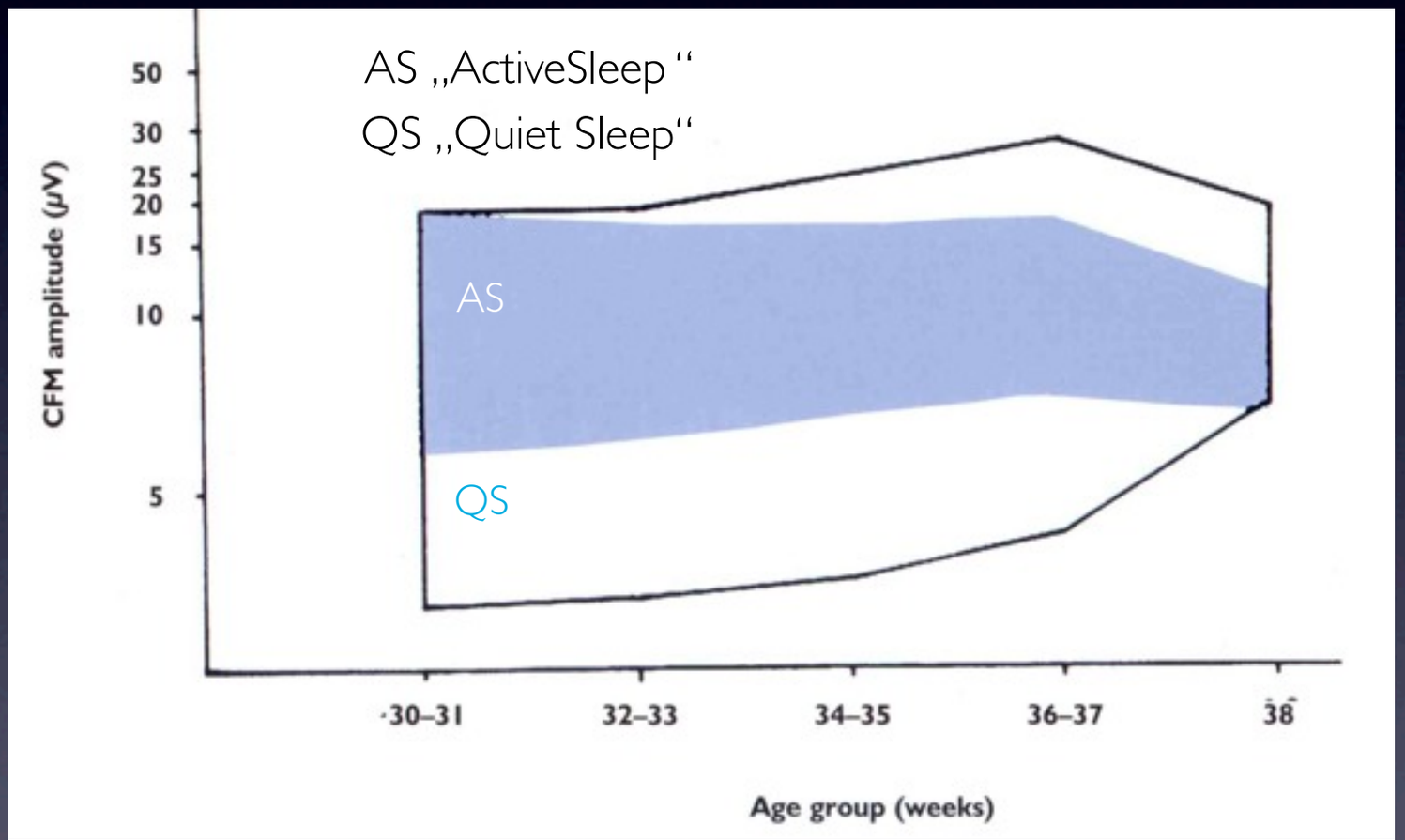


A: No SWC

B: immature or incomplete SWC (suboptimal variant)

C: normal SWC (Lasts > 20 Min. / cycle)

SWC
Sleep-Wake-Cycling



[from Thornberg und Thiringer 1990.
Aus: Hellstrom-Westas, de Vries,
Rosen. Atlas of aEEG in the Newborn]

Dependant on gestational age

In quiet sleep (QS) linear corrrelation between height of lower amplitude and maturity

Immature SWC from 25-26 weeks

from 29-30 weeks fully developed

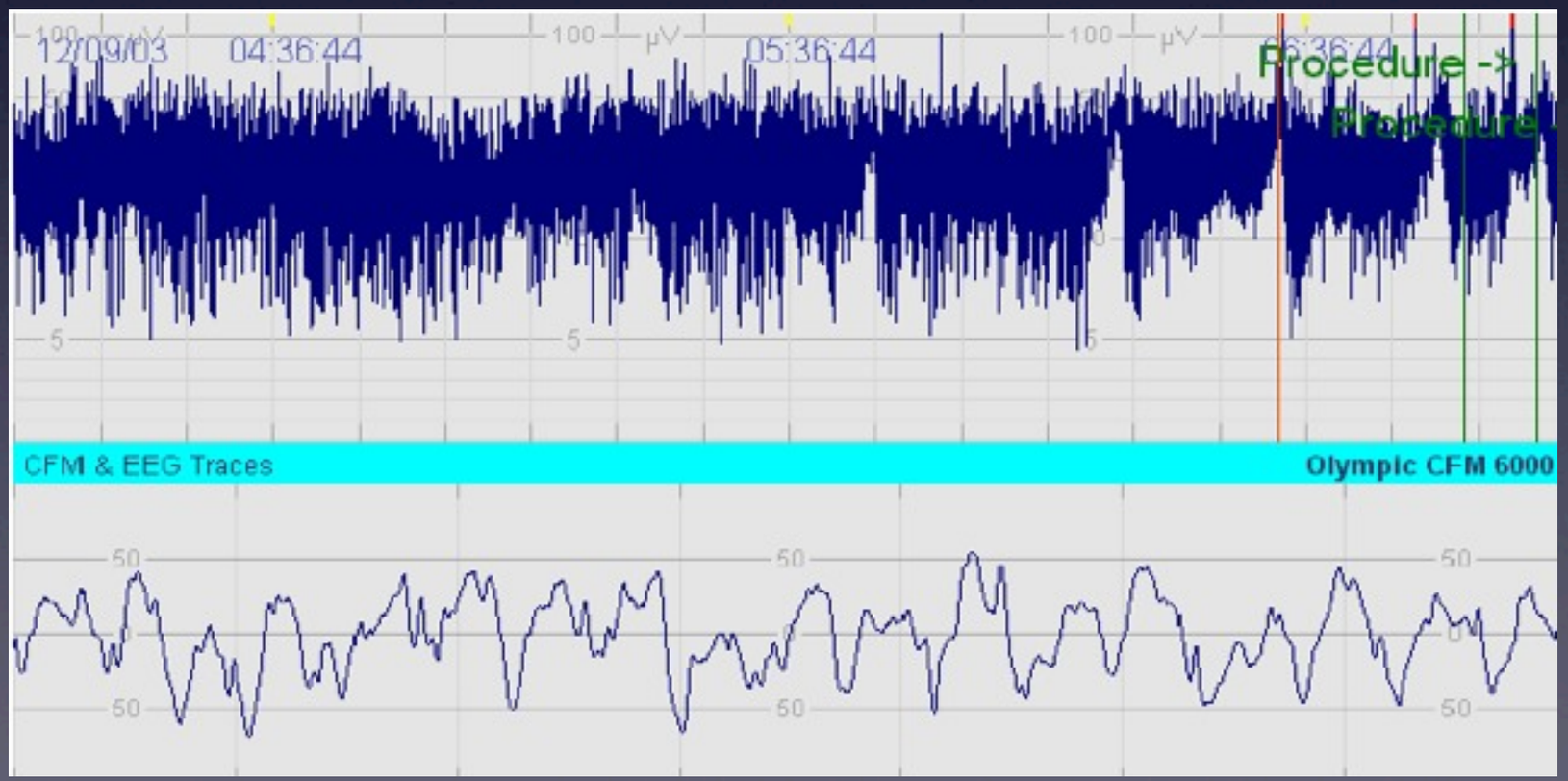
Assessment of an aEEG

Background activity ☑

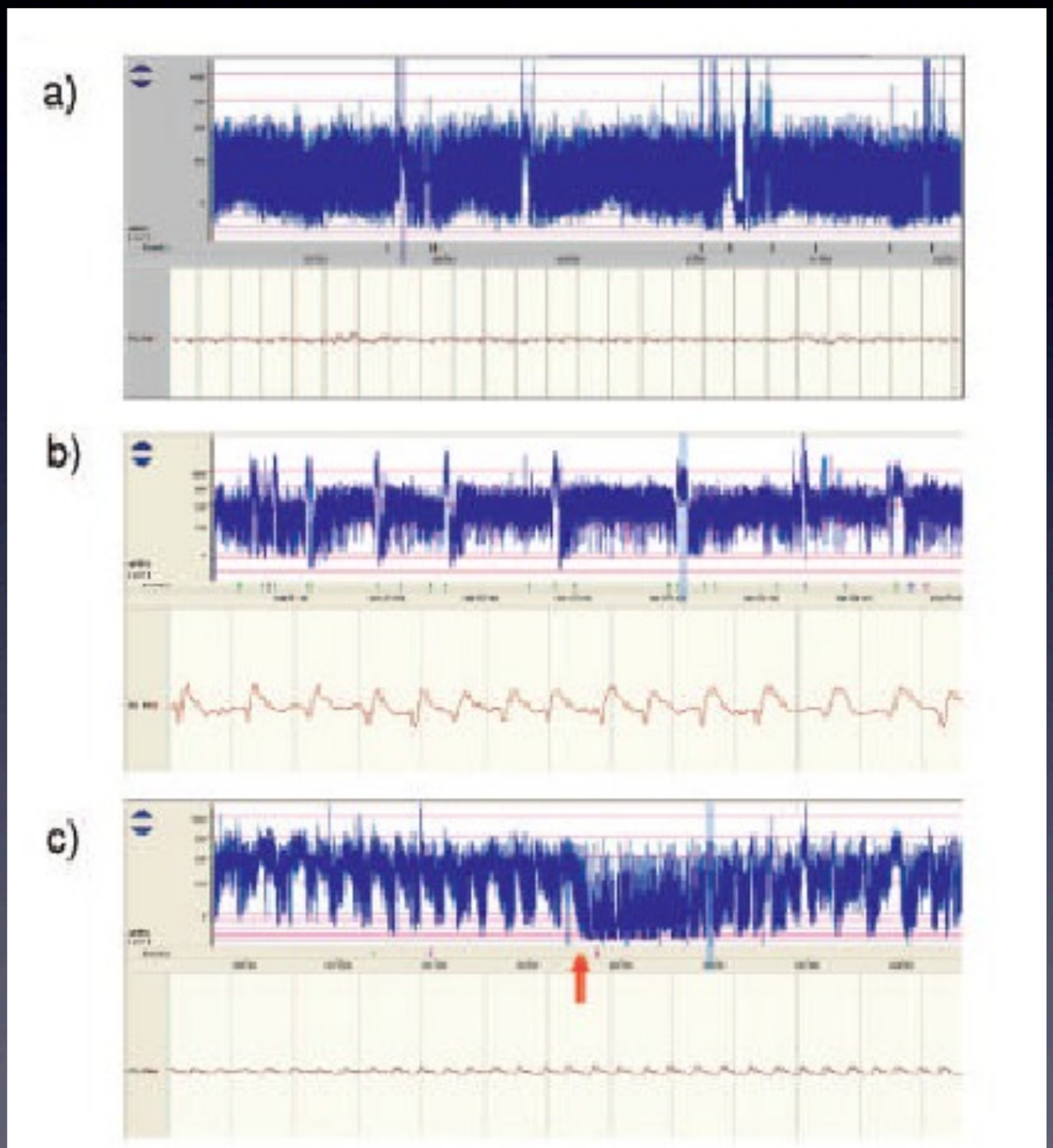
Sleep-Wake-Cycling ☑

Seizure activity

- Sudden change of background activity with higher amplitude.
- Often strong increase of upper and lower band, sometimes also only the lower band.
- Often followed by transient postictal depression of the amplitude. Must be longer than 10 seconds.



Seizure activity

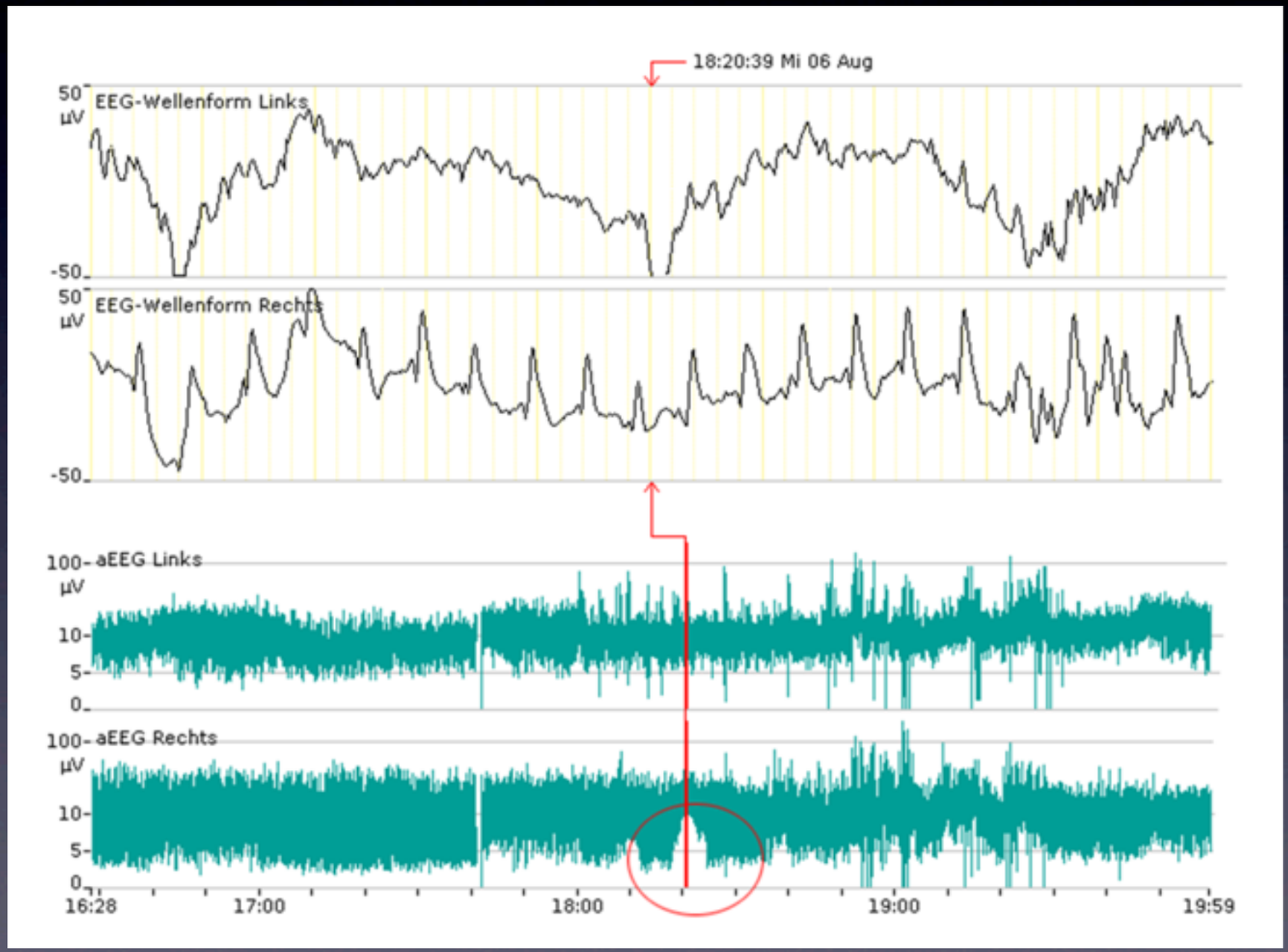


a.) single seizures (SS)

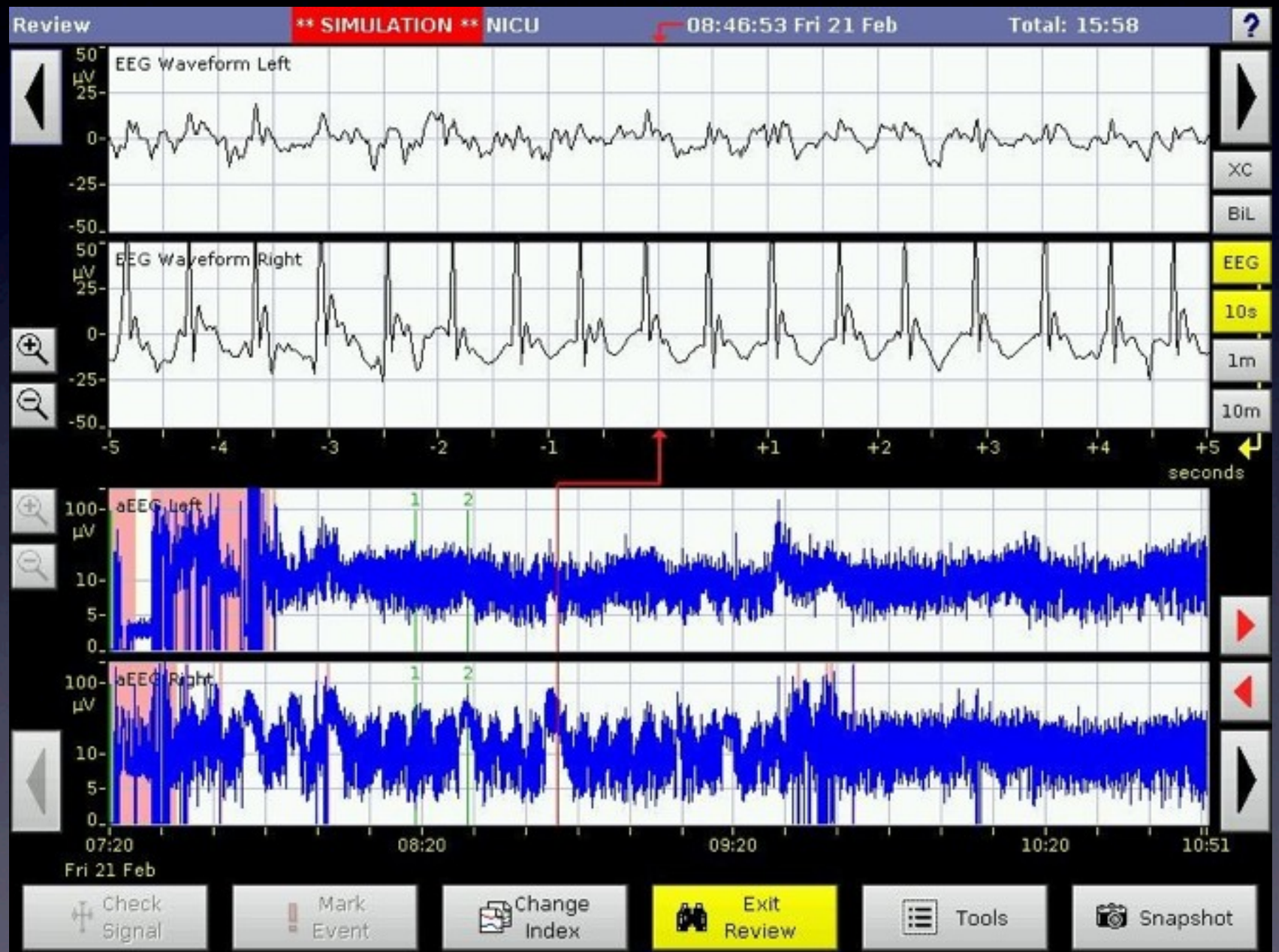
b.) repetitive seizures (RS) within 30 minutes

c.) Status epilepticus (SE, ‚sawtooth pattern') seizure activity > 30 minutes

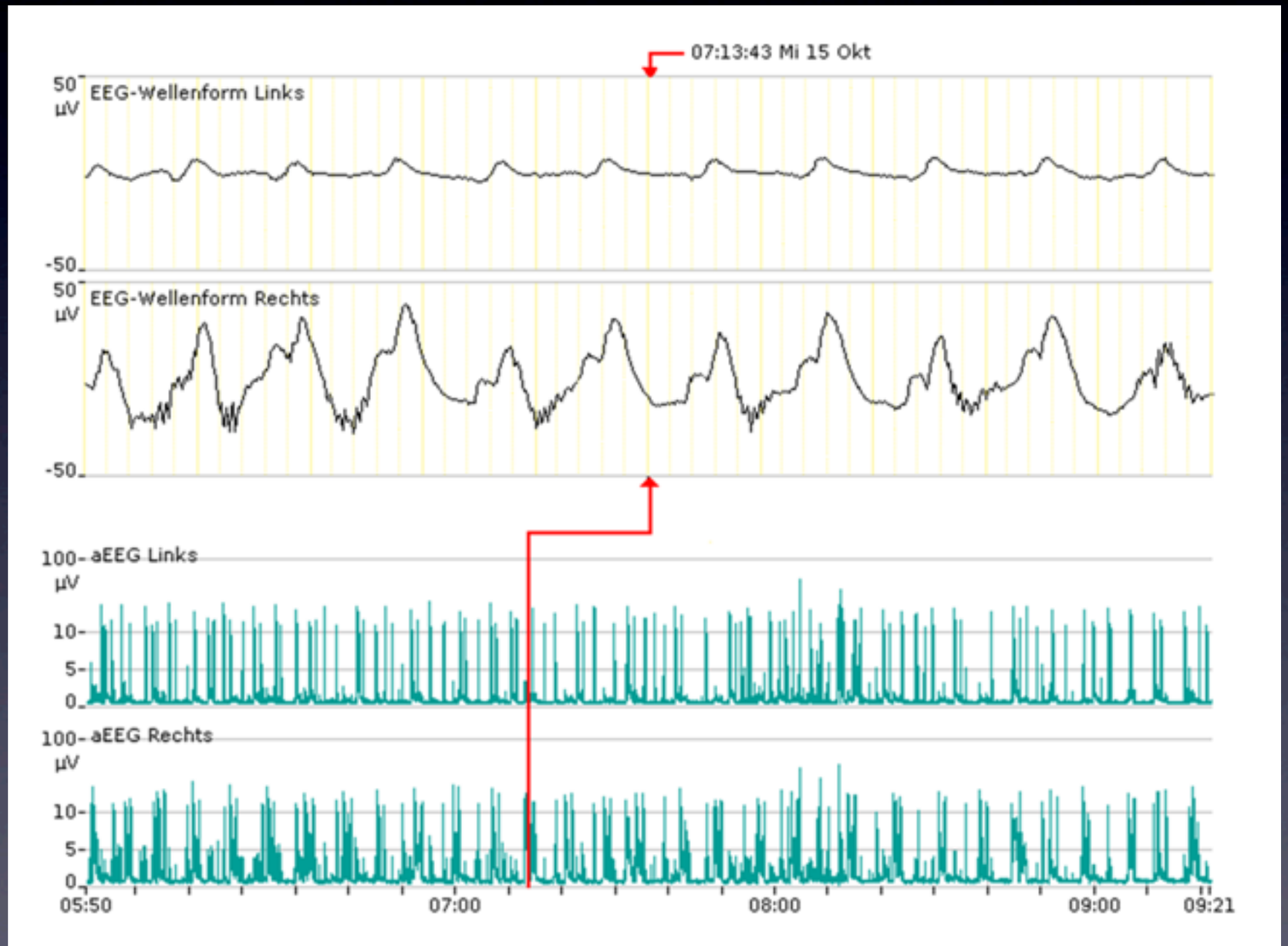
Single Seizure



Repeated Seizure



Status epilepticus



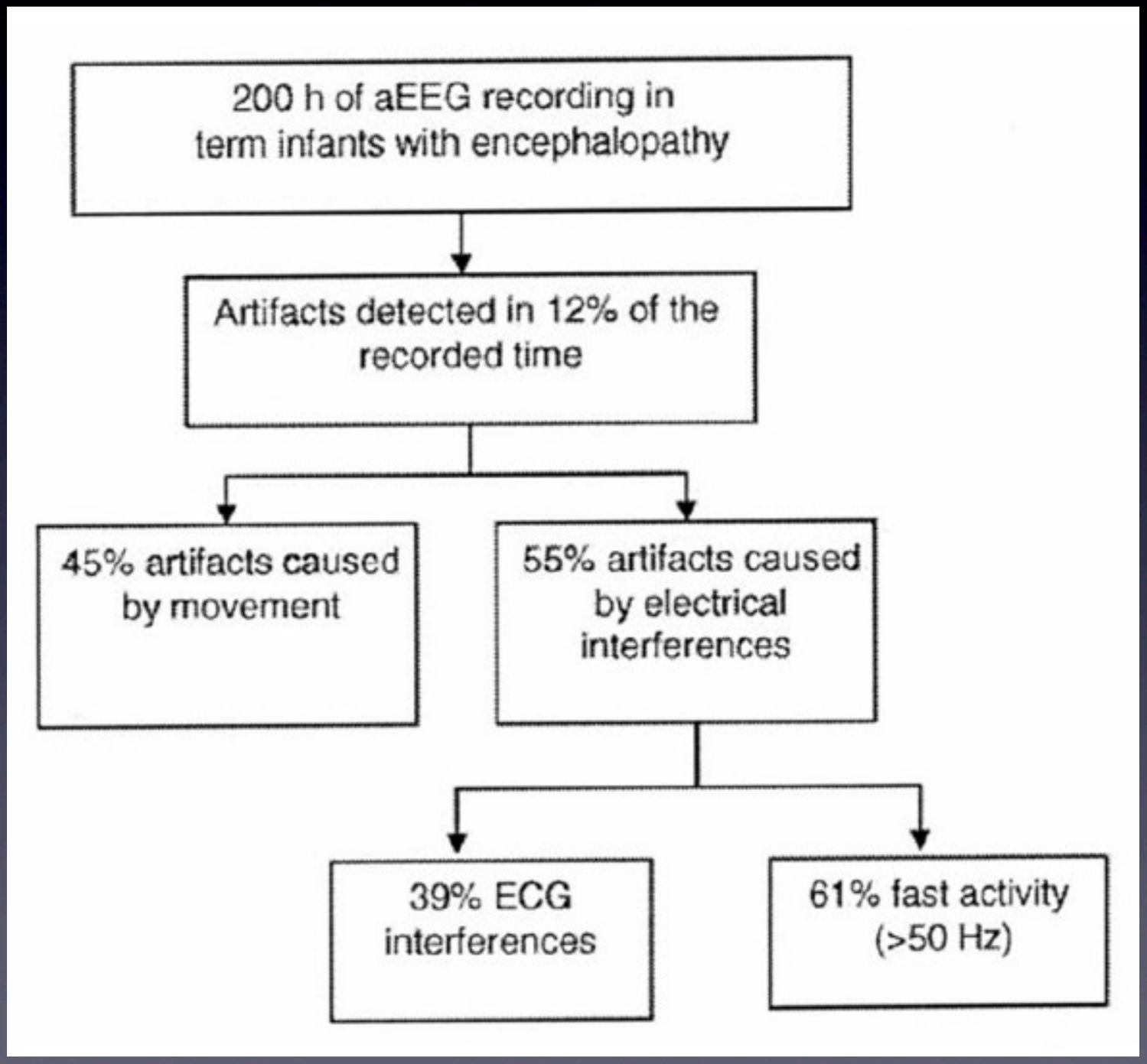
Assessment of an aEEG

Background activity ☑

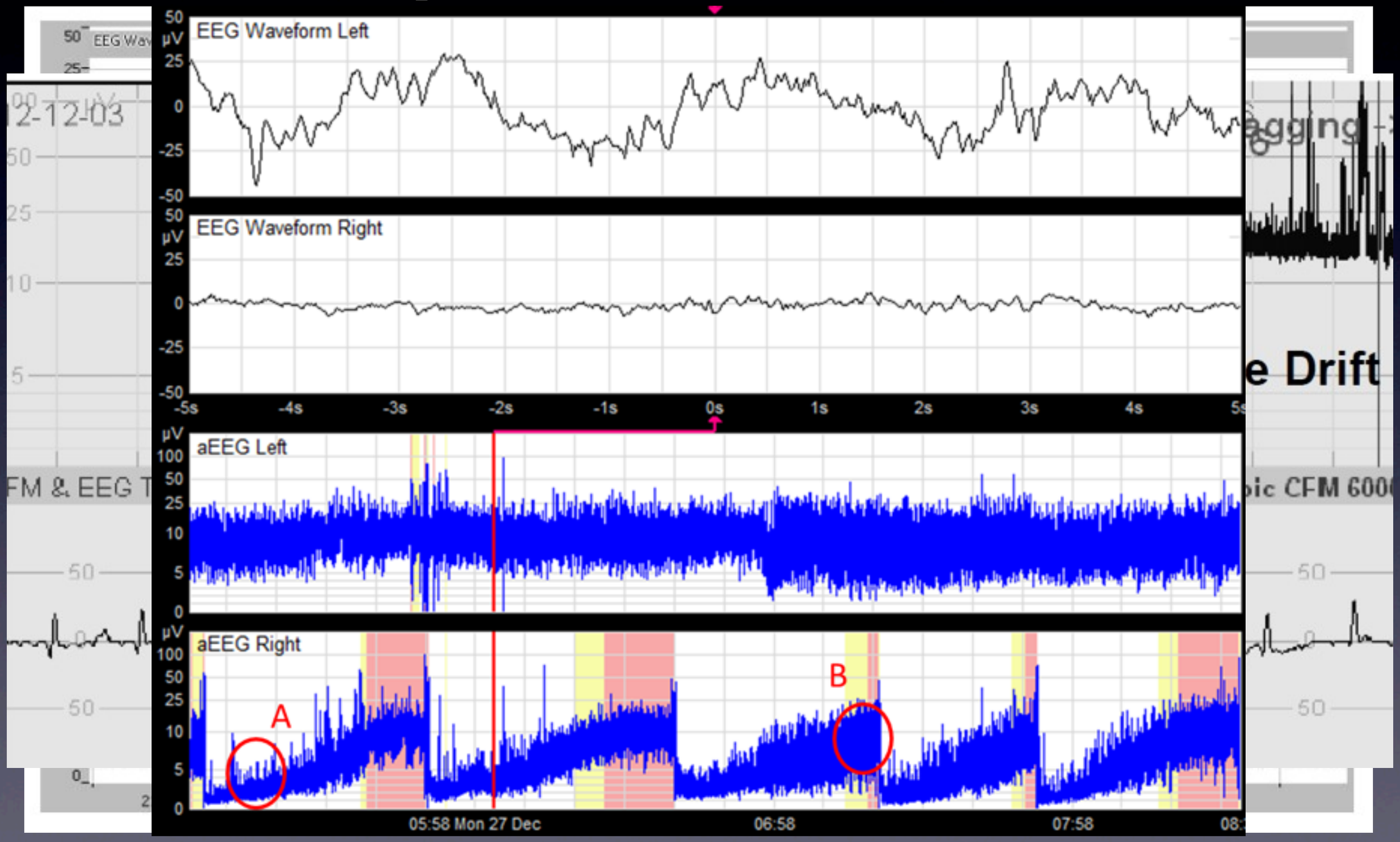
Sleep-Wake-Cycling ☑

Seizure activity ☑

Beware of artefacts



Examples for artefacts



Reasons for artefacts

Movement

Rhythmic padding

Muscle activity (EMG)

ECG

Respiratory artifact (e.g. HFO)

Edema and Hematoma

Change in impedance / lost electrodes

-> train early to look at raw eeg to be effective in detecting artifacts

Use of aEEG

Perinatal asphyxia / HIE

Monitoring for seizures or clarifying apneas

Monitoring of antiepileptic drugs / sedation / relaxation

Course of Encephalopathy, e.g. metabolic diseases, Meningoencephalitis etc.

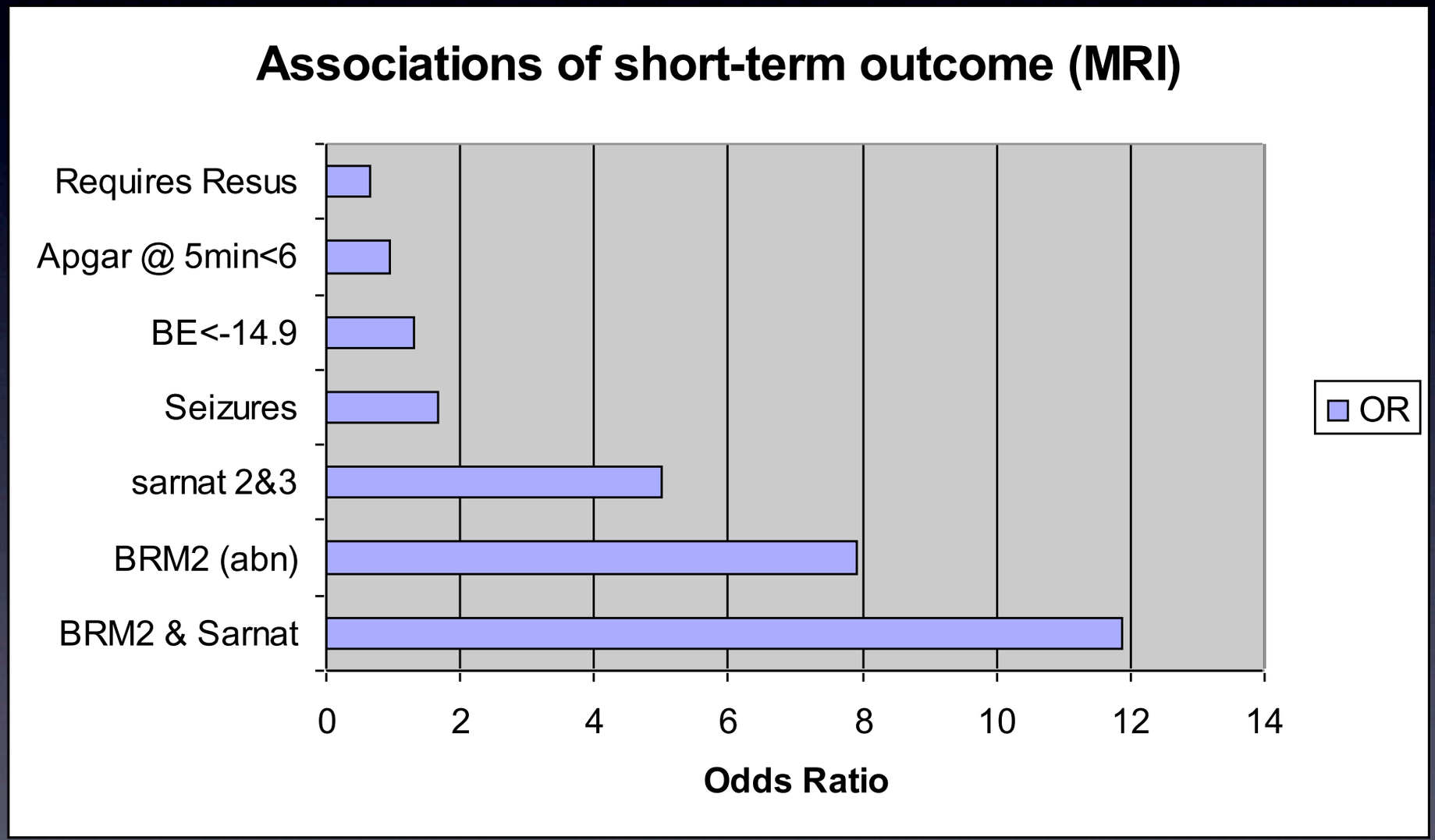
Monitoring of VLBW preterms (brain maturation, outcome prediction)

Monitoring of PHVD

postoperative, especially after cardiac surgery (together with NIRS)

Sleep-Wake-Cycling (somnology, minimal handling)

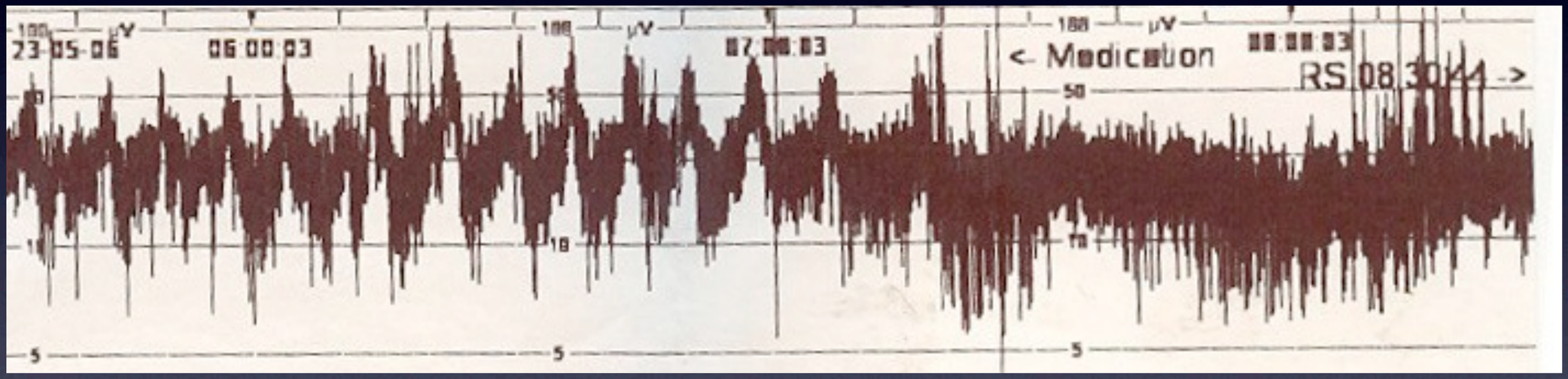
Examples for use of aEEG Prediction after Asphyxia



Lavery et al,2006, abstract-PSANZ

Examples for use of aEEG

Detection of seizures and monitoring effect of medication

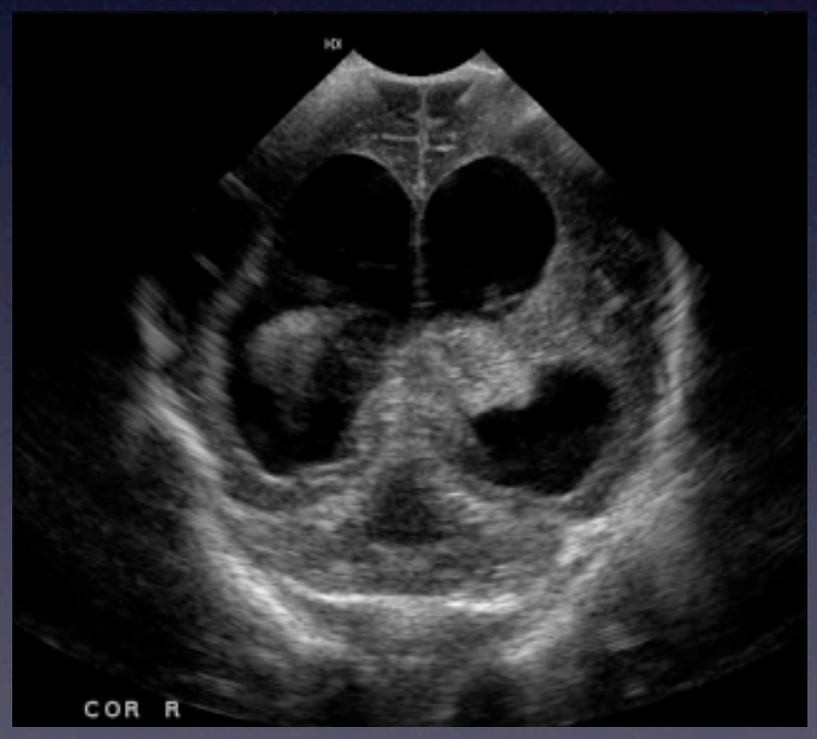


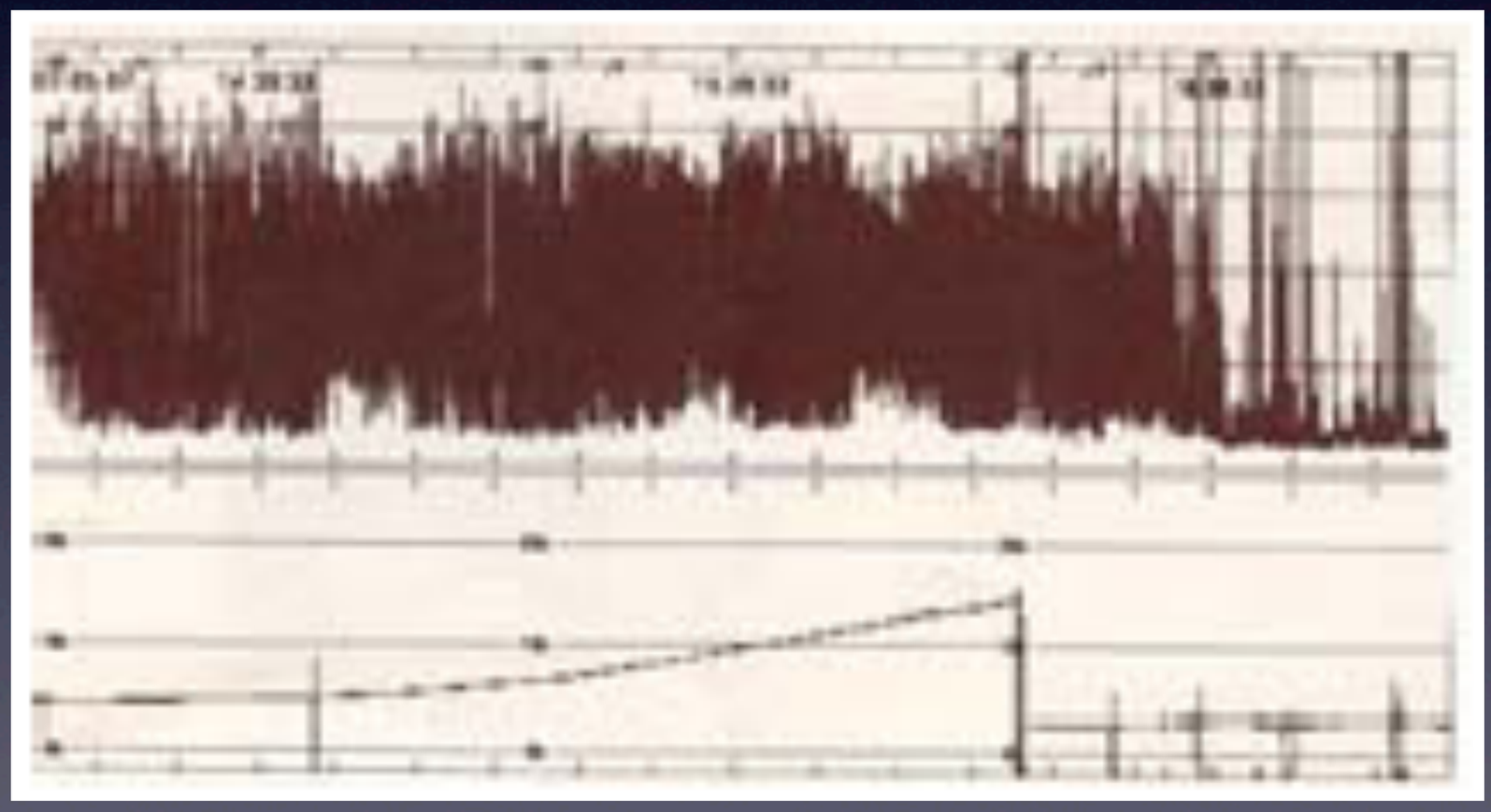
Examples for use of aEEG

Monitoring of neurological high risk patients

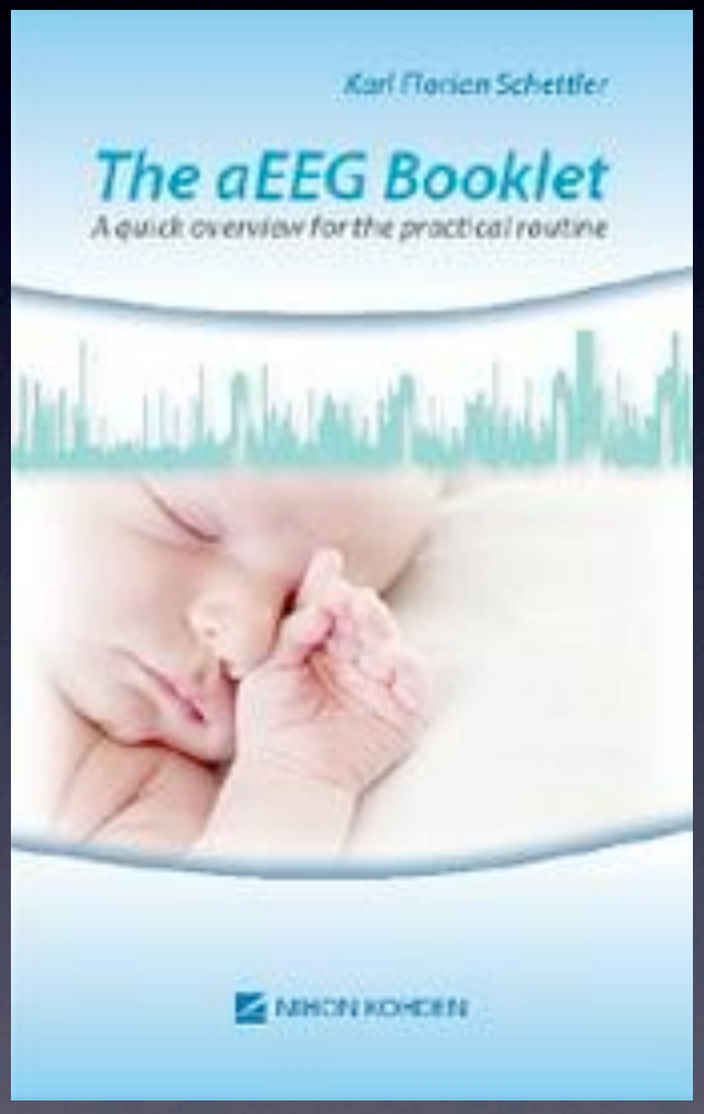
e.g. PHVD posthemorrhagic ventricular dilation

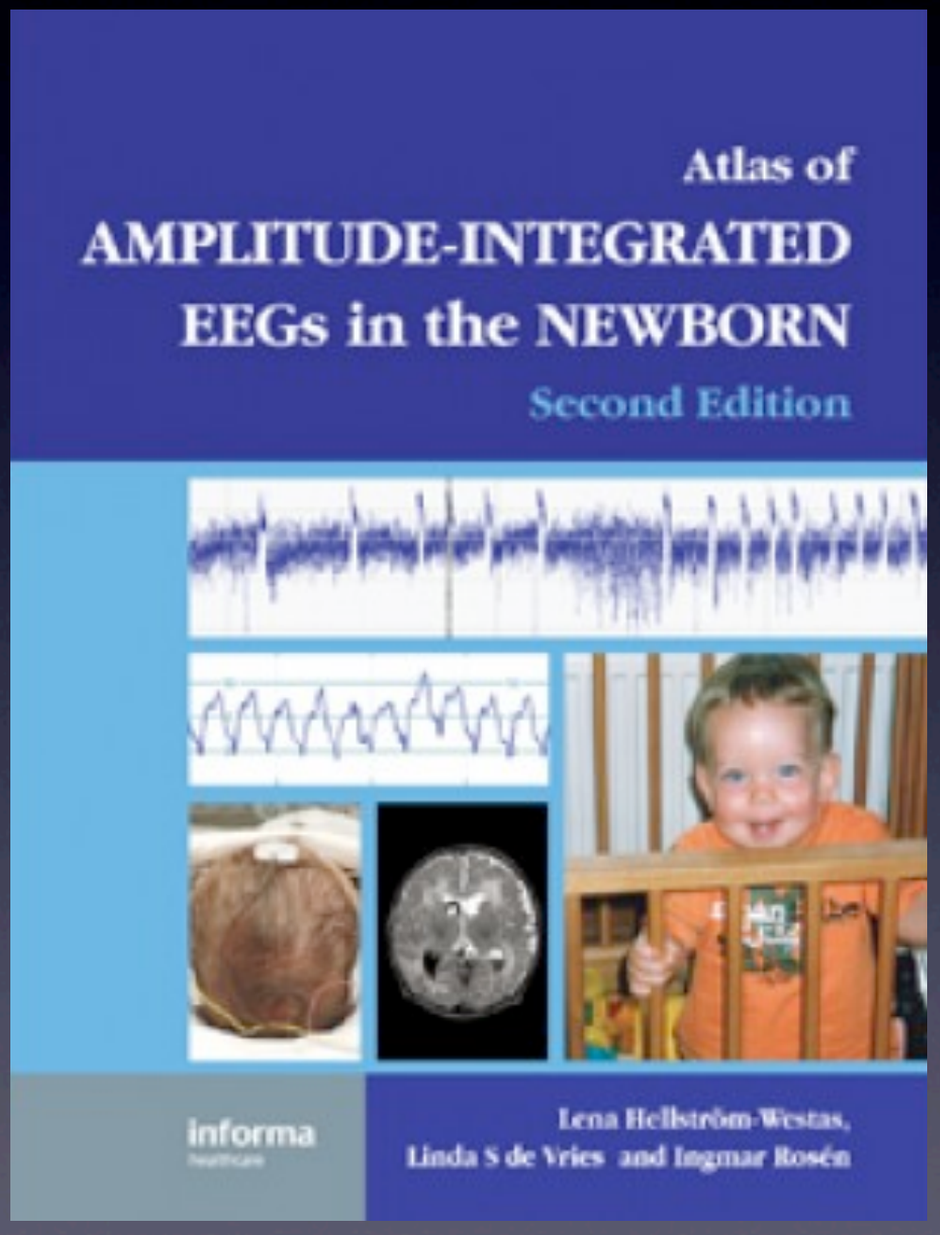
Real-time detection of pressure decompensation



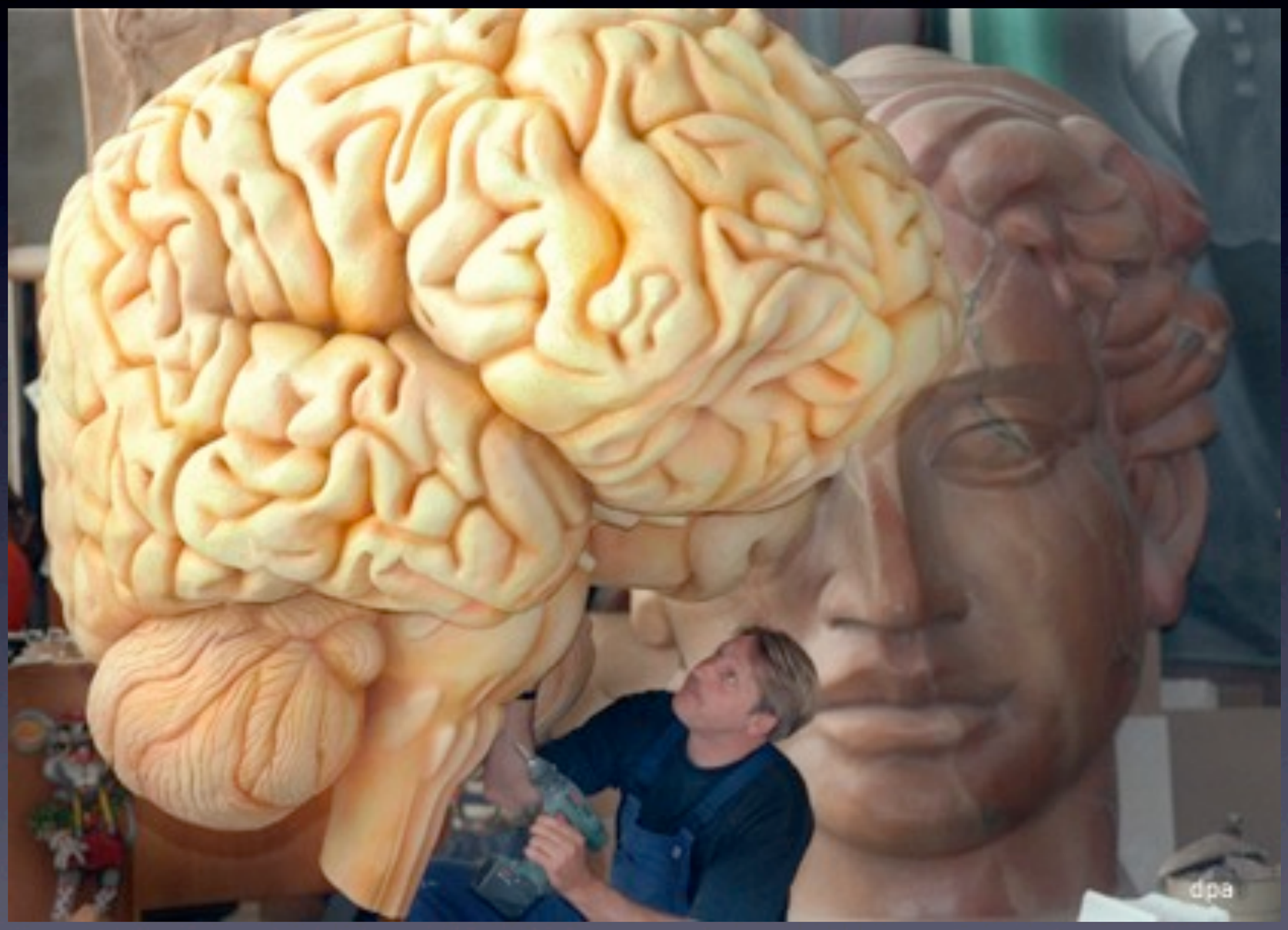


Get a good overview...





Features to be aware of

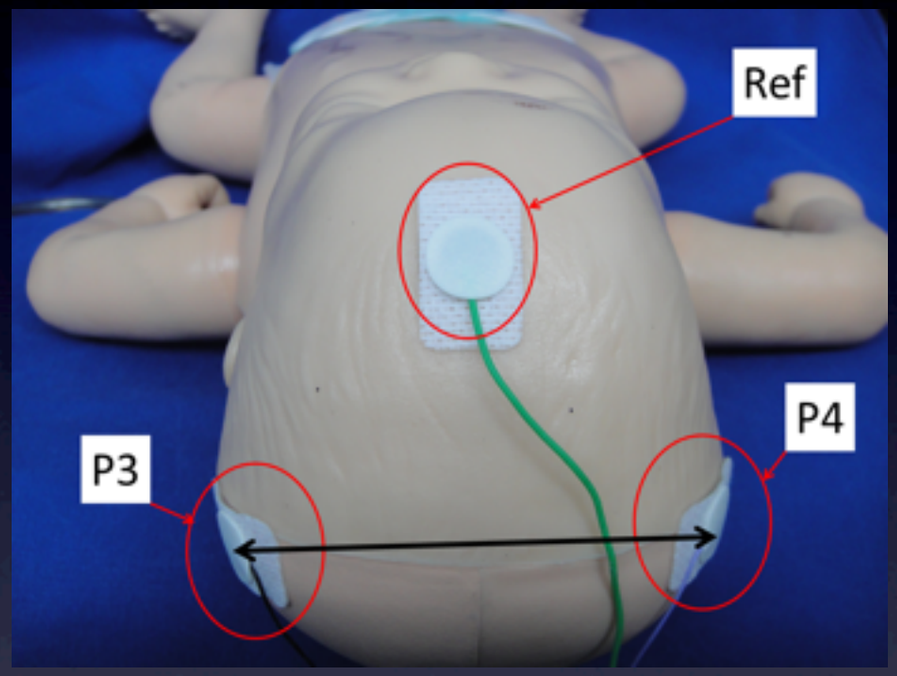


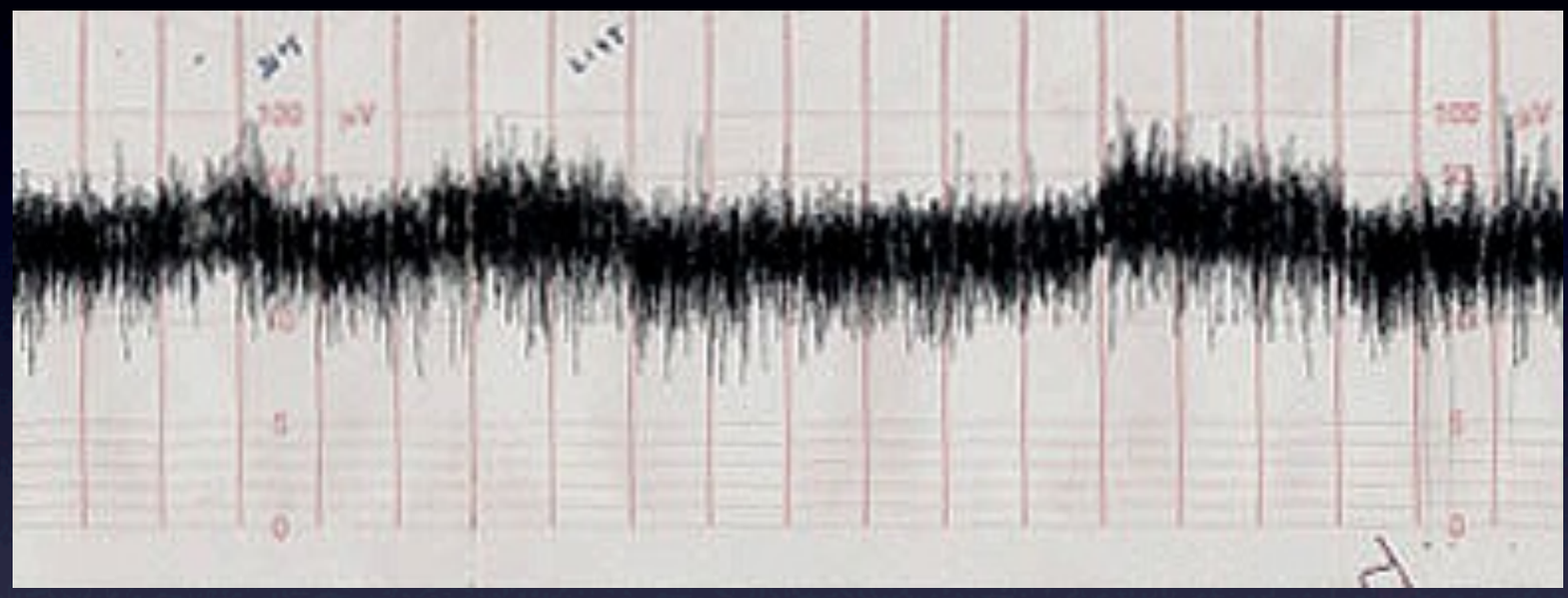
aEEG on the market

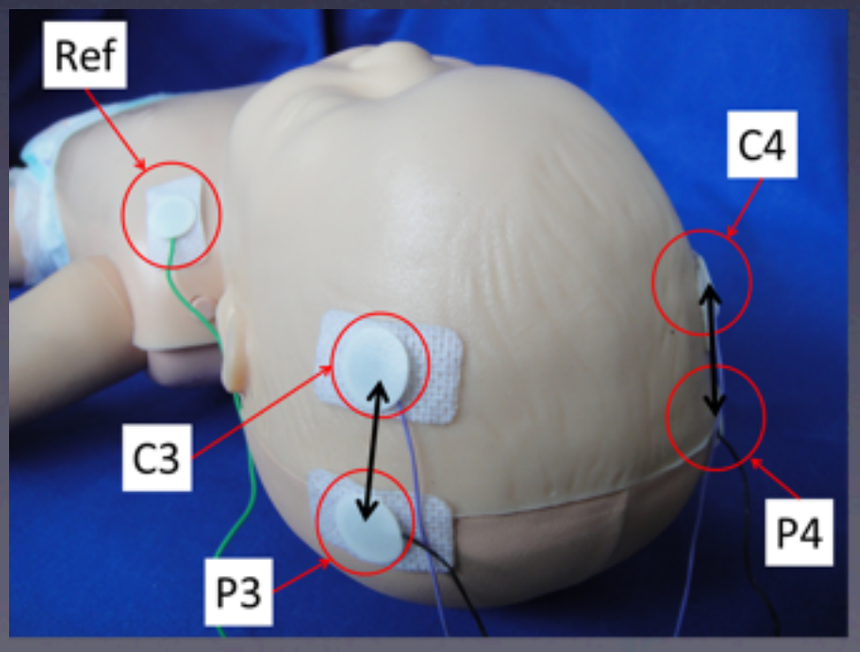
Key competitors

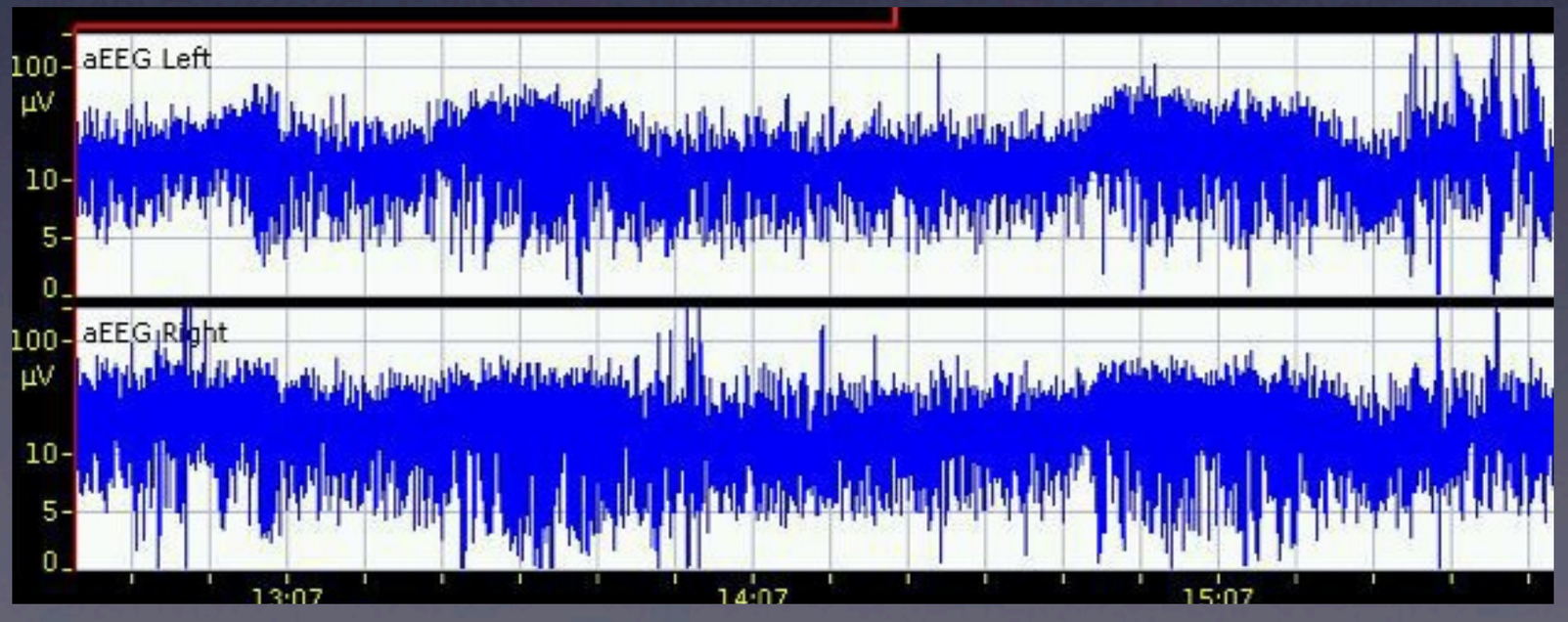
- CFM 6000
- Brainz / OBM
- Nicolet
- ....

1- or 2-channel

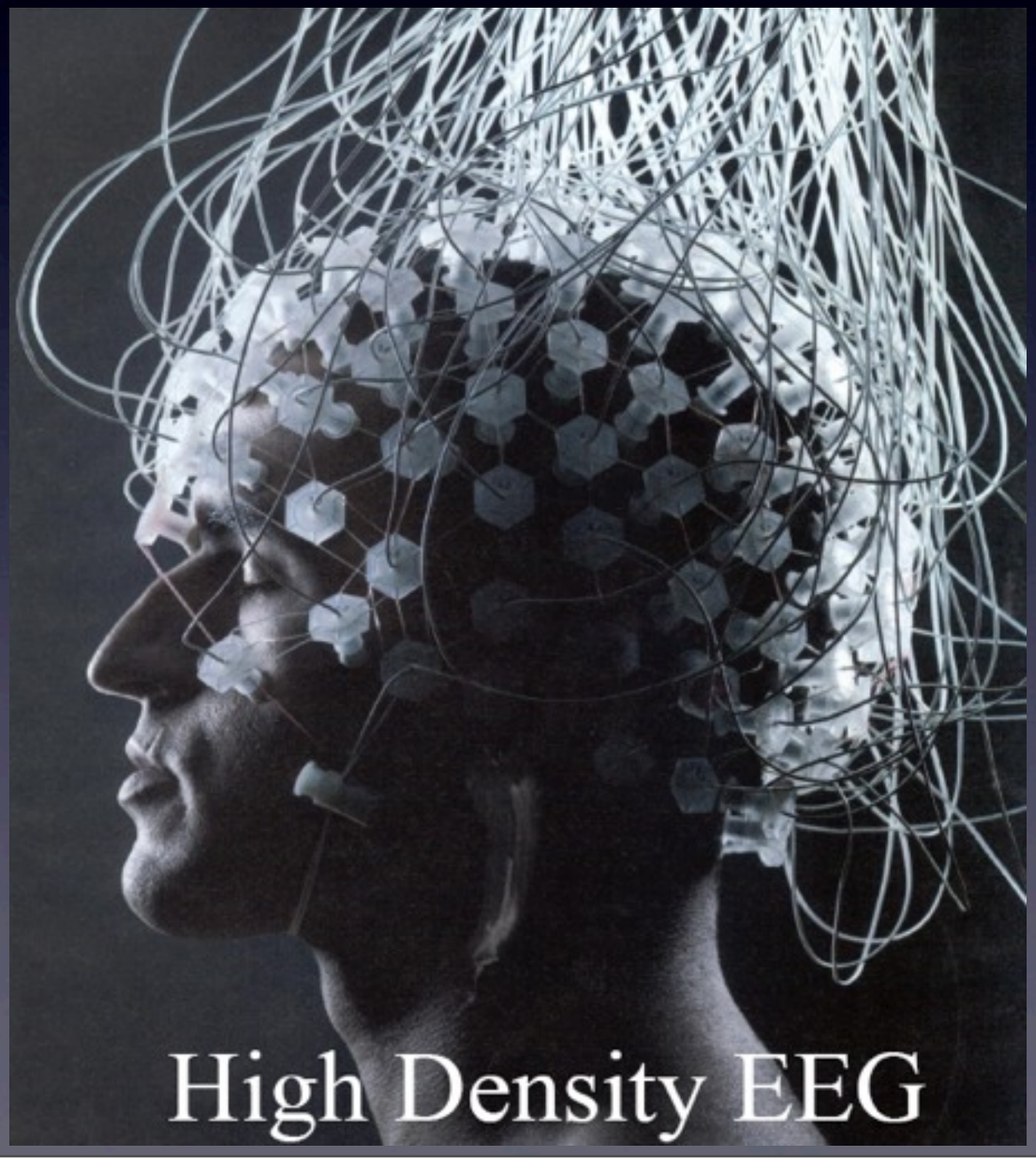


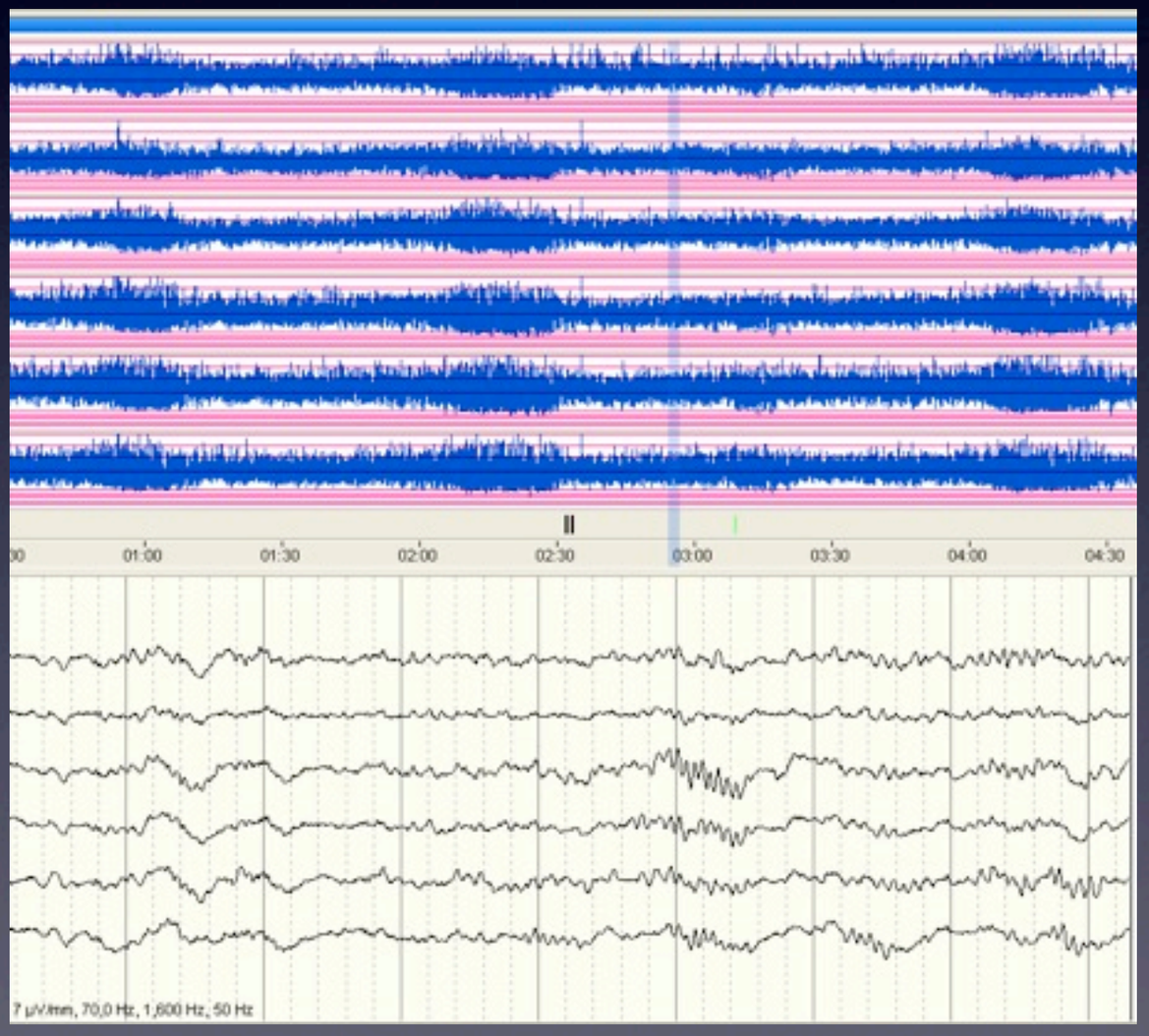






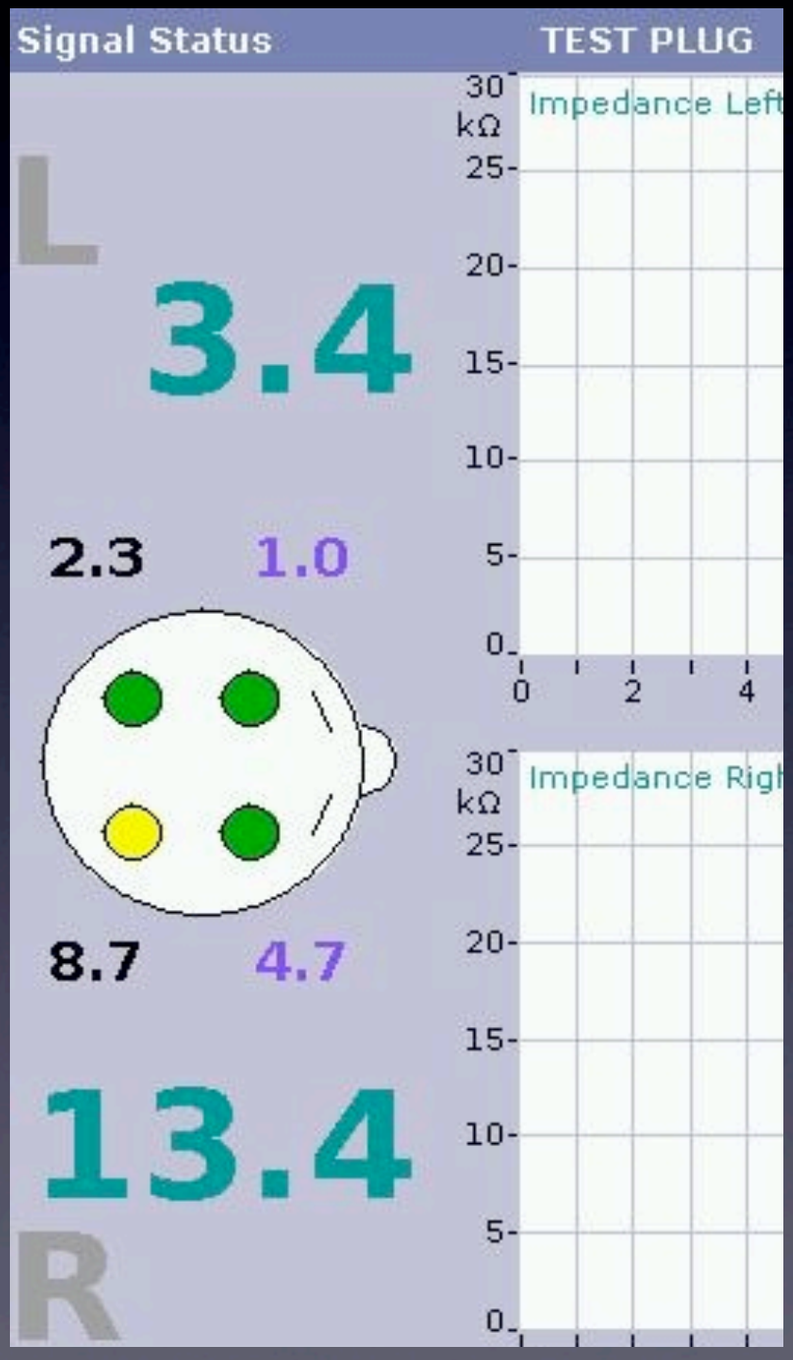
How many channels do you need ?



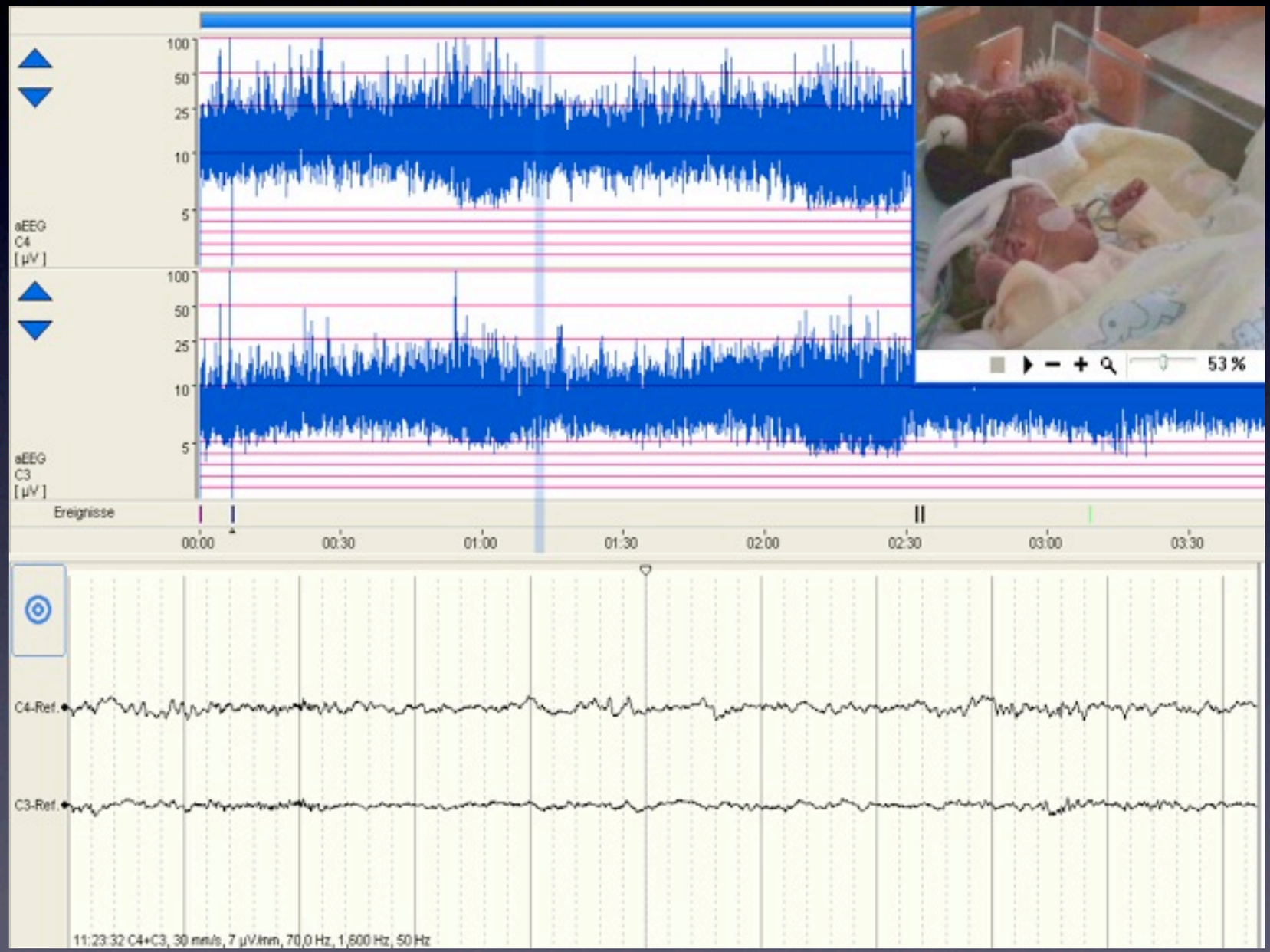


Impedance

measured continuously in „classic“ aEEG



Audio / Video


aEEG
C4
[µV]
100
50
25
10
5
aEEG
C3
[µV]
Ereignisse
00:00
00:30
01:00
01:30
02:00
02:30
03:00
03:30
53 %
C4-Ref.
C3-Ref.
11:23:32 C4+C3, 30 mm/s, 7 µV/mm, 70,0 Hz, 1,600 Hz, 50 Hz

Integrated data

DSA

FFT Power

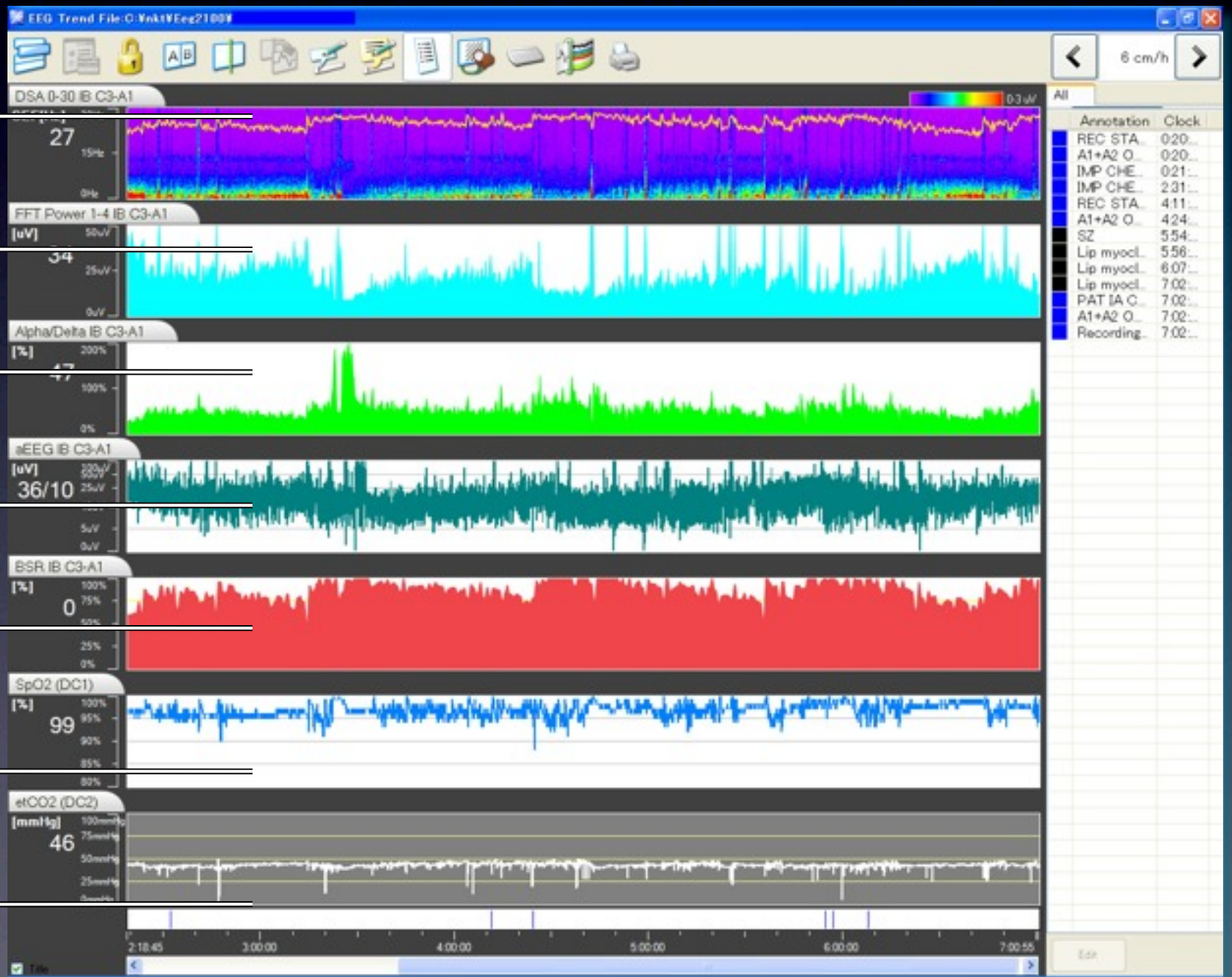
FFT Power Ratio

aEEG

BSR

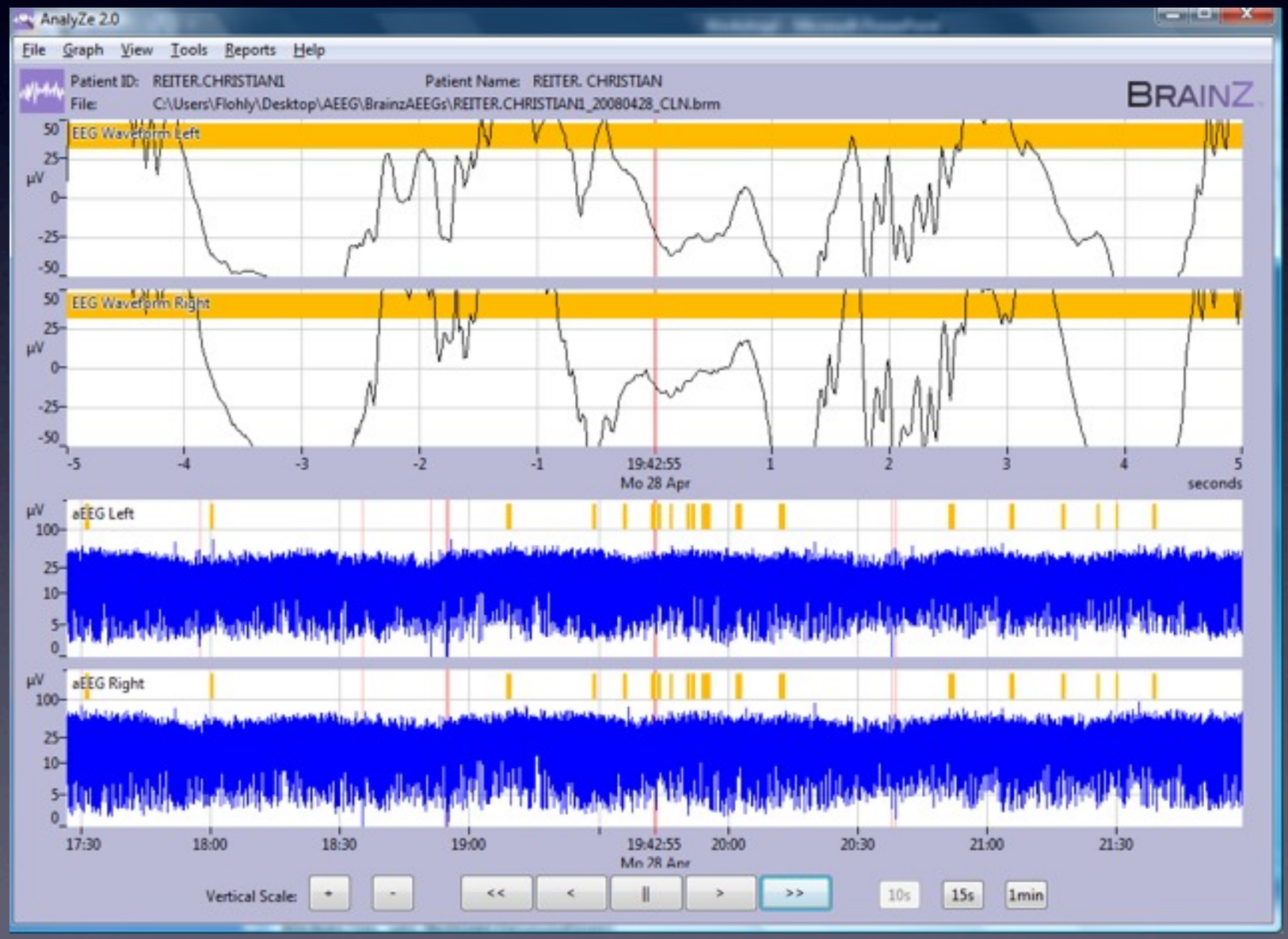
SpO_2

$EtCO_2$

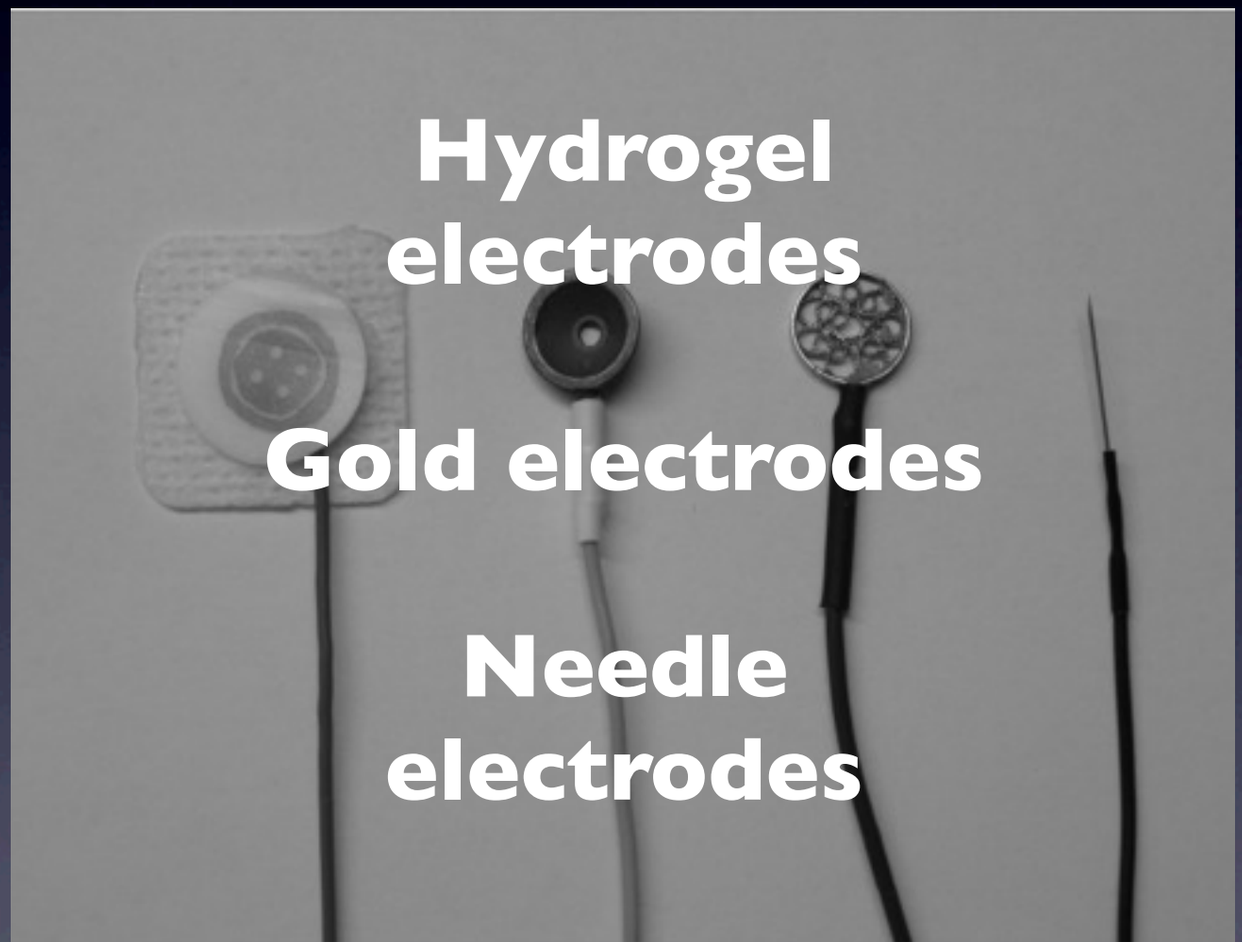


Automated seizure detection

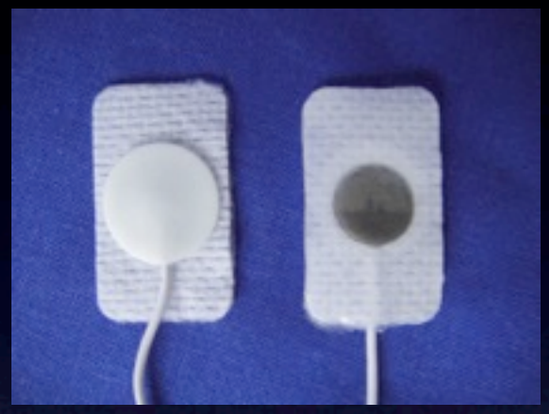
Algorithm by Navakatikyan, Sensitivity 83-95%, Specifity 48-77%



Electrodes



Hydrogel electrodes



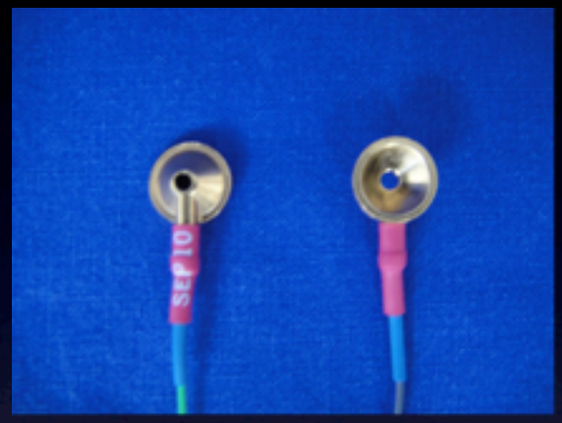
Advantages:

All-in-One concept
Better adhaesion at the beginning
Seems less invasive
No fear in Neonatologists to handle

Disadvantages:

Do not hold on very long
Not reusable
Often difficult to get good impedance / lead quality
Price

Gold electrodes



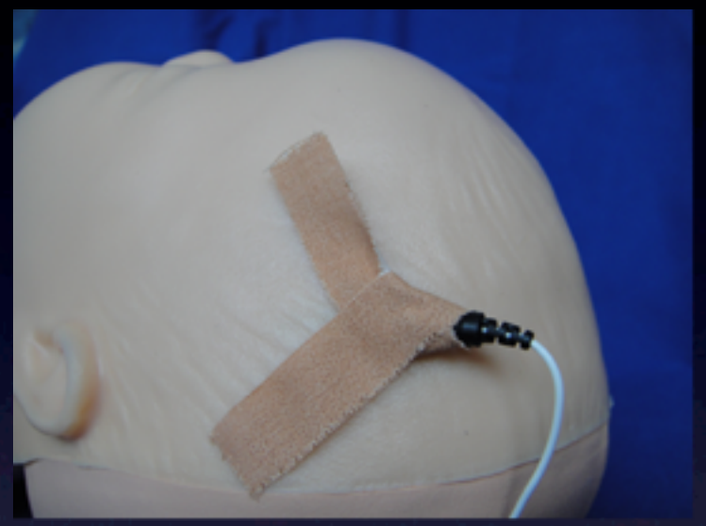
Advantages:

Reusable
Easy to refix
Seems less invasive
Often better Impedance / lead quality than hydrogel
Best and most often used by nurses in EEG labs

Disadvantages:

Expensive if thrown away
Placement/Fixation a little more difficult to learn

Needle electrodes



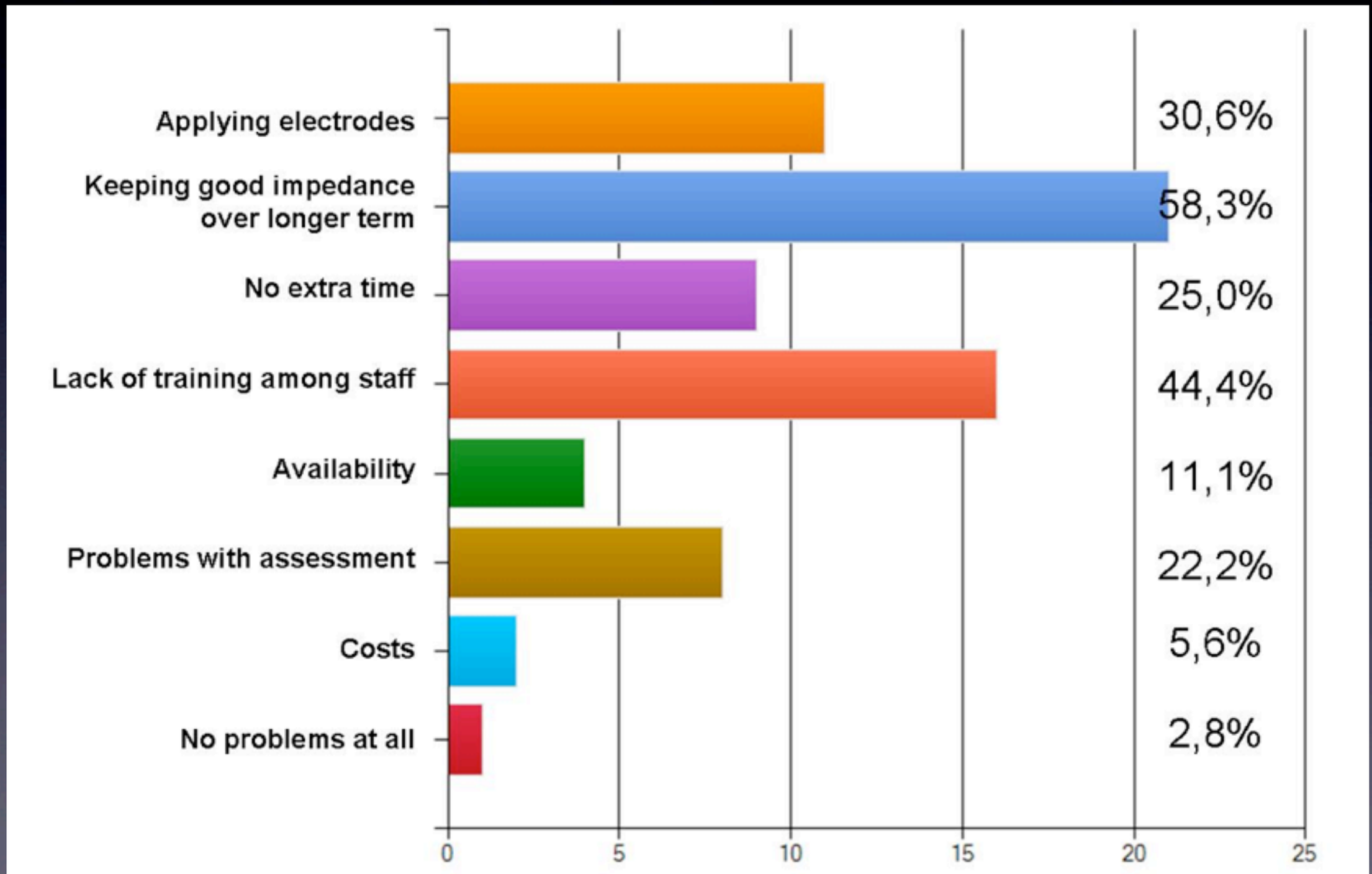
Advantages:

Fastest placement / fixation
Hair is no problem
Long recordings without refixing electrodes
Long term perfect Impedances / lead quality

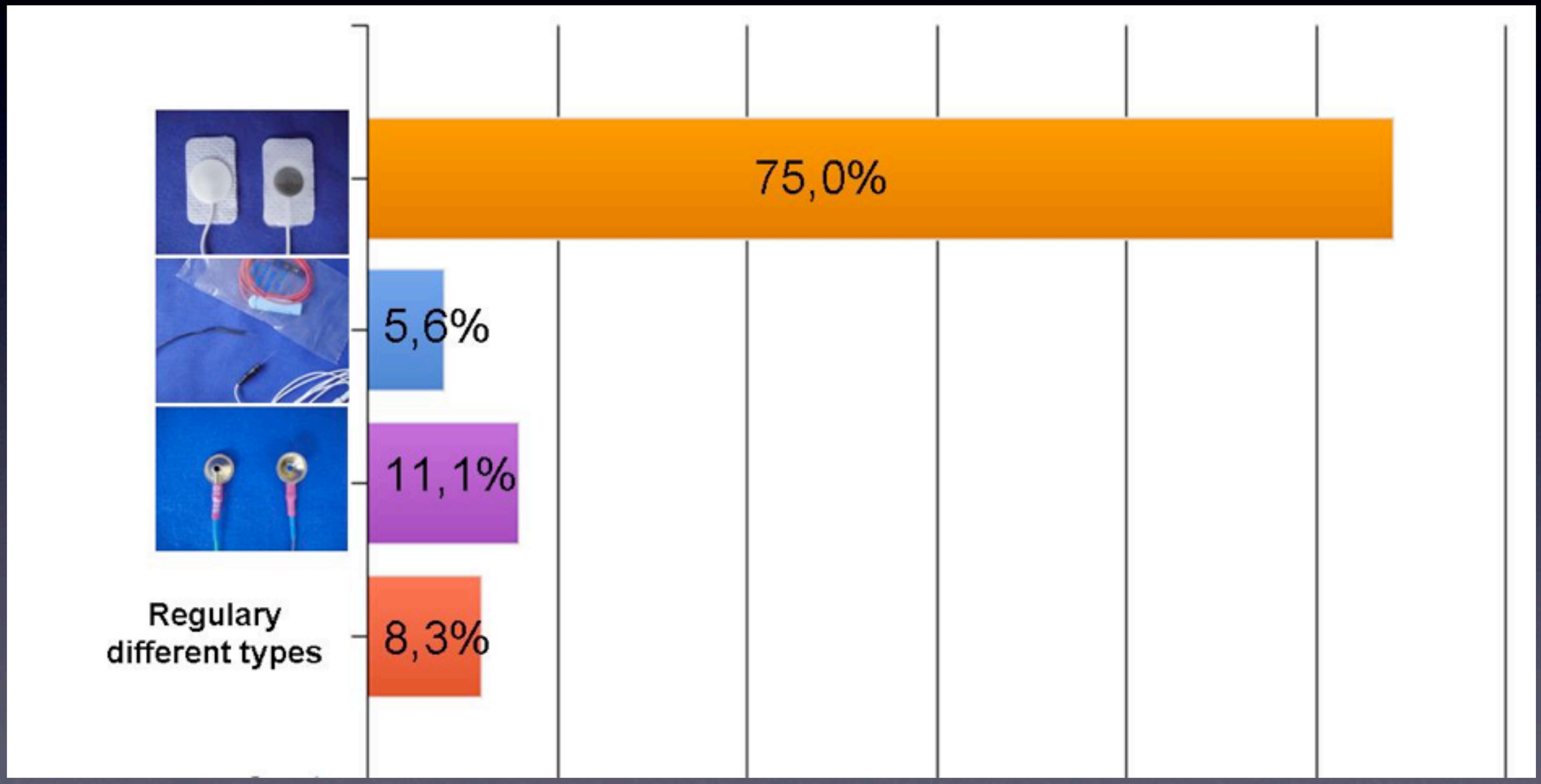
Disadvantages:

Expensive
Seems highly invasive
Potential risk of infection ?

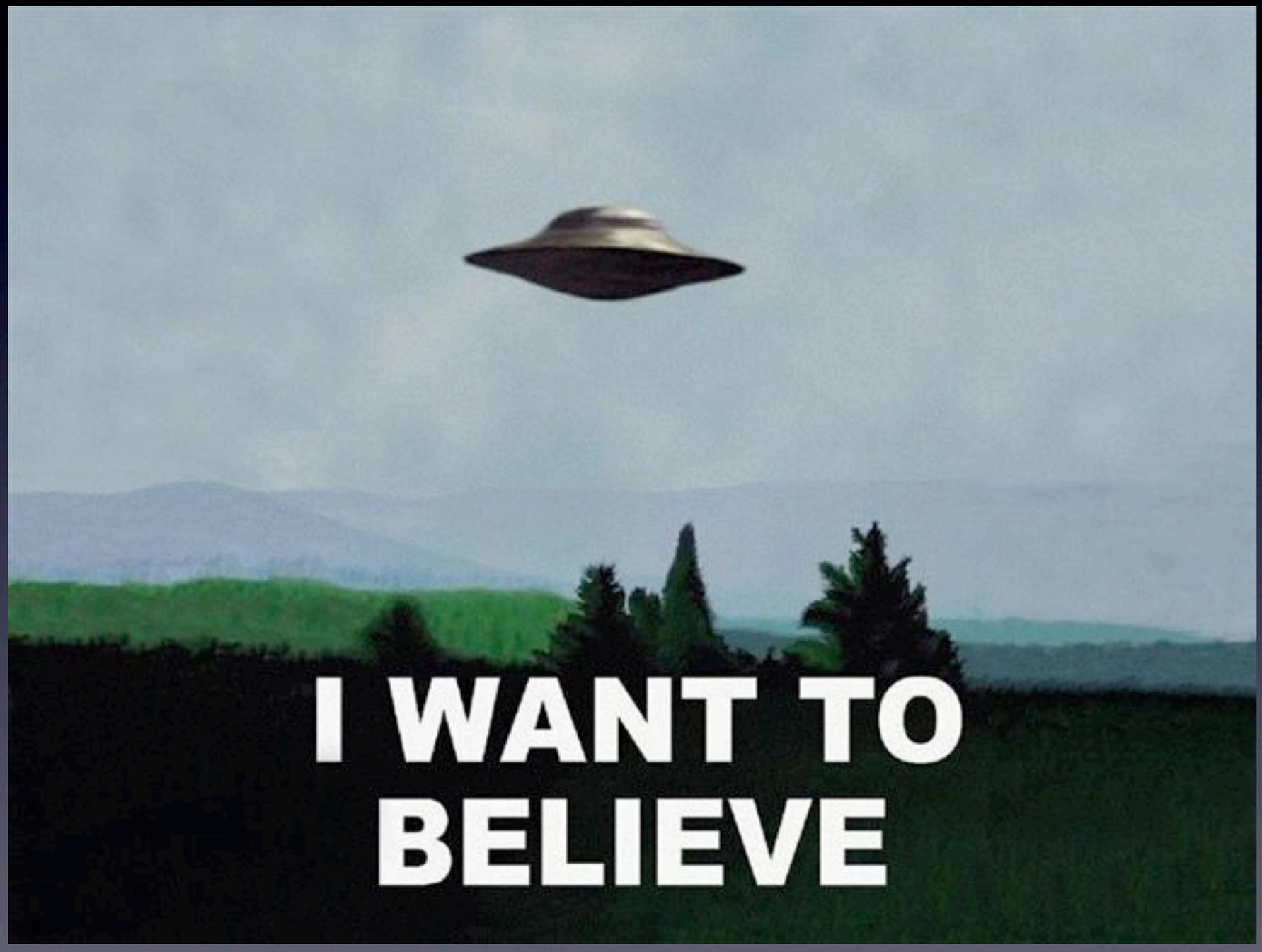
What keeps you away from using aEEG more often ?



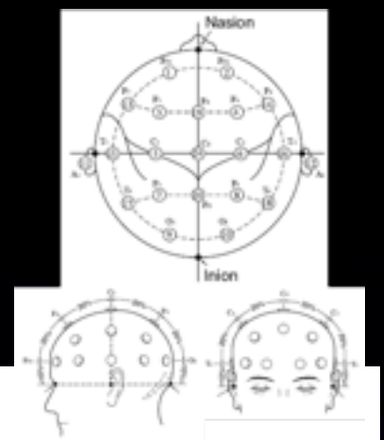
Which type of electrodes do you typically use ?

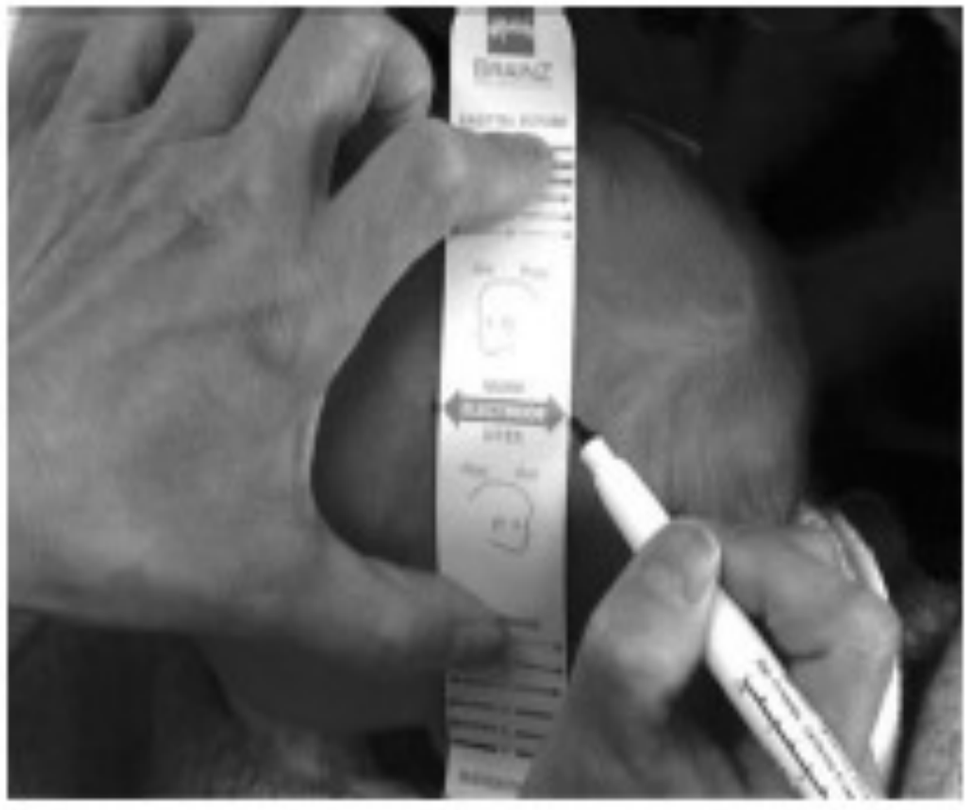


Connection between frequency of use and type of electrodes ??



Positioning





rter

C4

P4

P3

aEEG and CPAP

Let´s go „hands on“

For downloading this talk as pdf go to:

www.schettler.eu/downloads.html

If you are interested, need help with aEEG, questions etc. Contact me:
Karl.Florian@Schettler.eu

First announcement...

Munich International Conference

Improvement of neurodevelopmental outcome in Neonatology

July 6th, 2013

with Pre-Conference:

The amplitude-integrated EEG (aEEG) in Neonatology

on July 5th, 2013