

The amplitudeintegrated EEG in Neonatology



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1st Annual European  **NIHON KOHDEN** Meeting
Hurghada, Egypt

Monitoring - Changing times



Assessment of brain function

Electrophysiological

- Clinical (Sarnat or Thompson Score, etc.)
- Cerebral Function Monitoring (CFM)
- Imaging (MRI, Ultrasound, CT)
- Electrophysiological ^{with} (EEG)

amplitudeintegrated EEG (aEEG)

So why aEEG ?

aEEG vs. EEG

aEEG / CFM

Available immediatly

Long term monitoring

No details

pattern recognition

konv. EEG

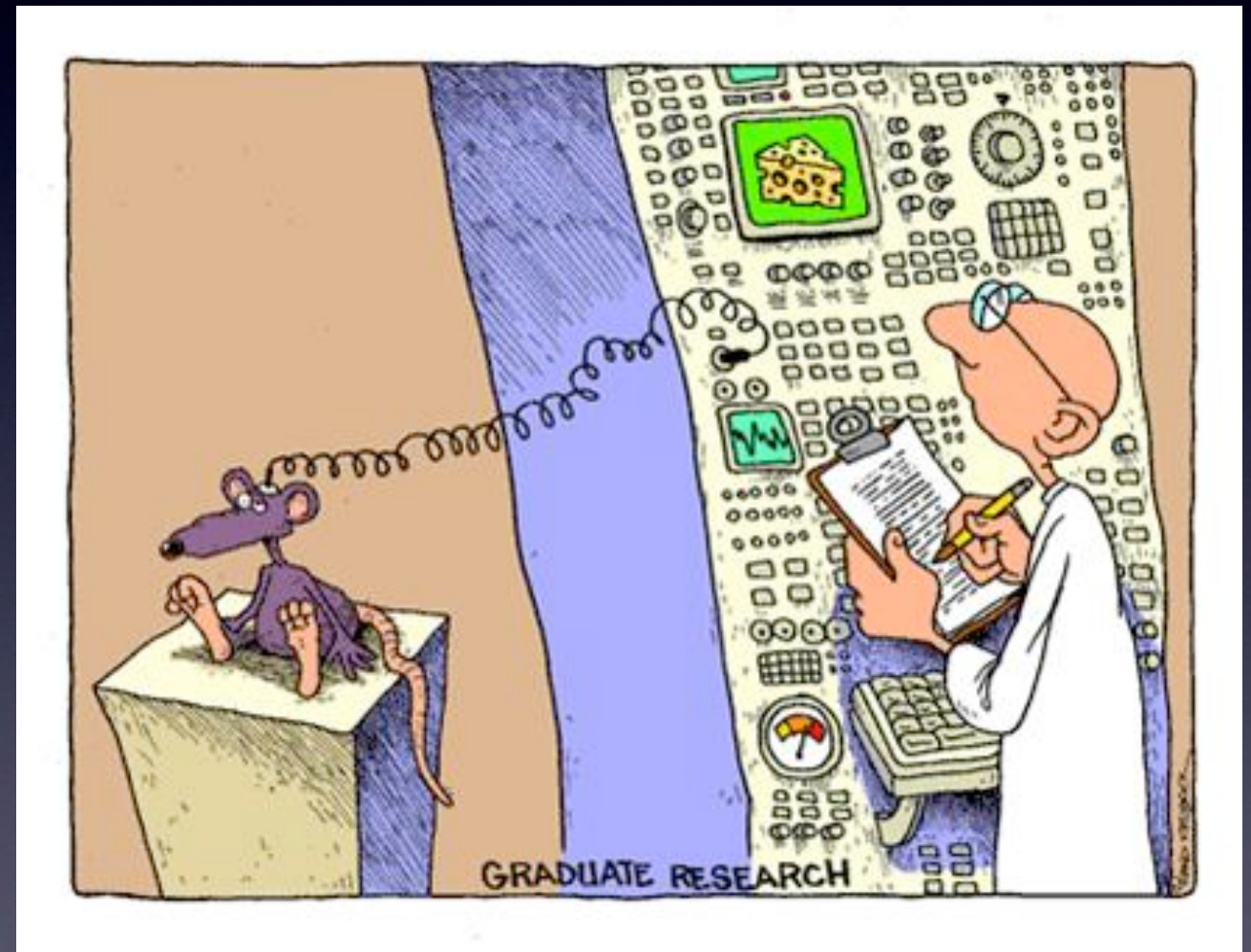
Not always available

Short term monitoring

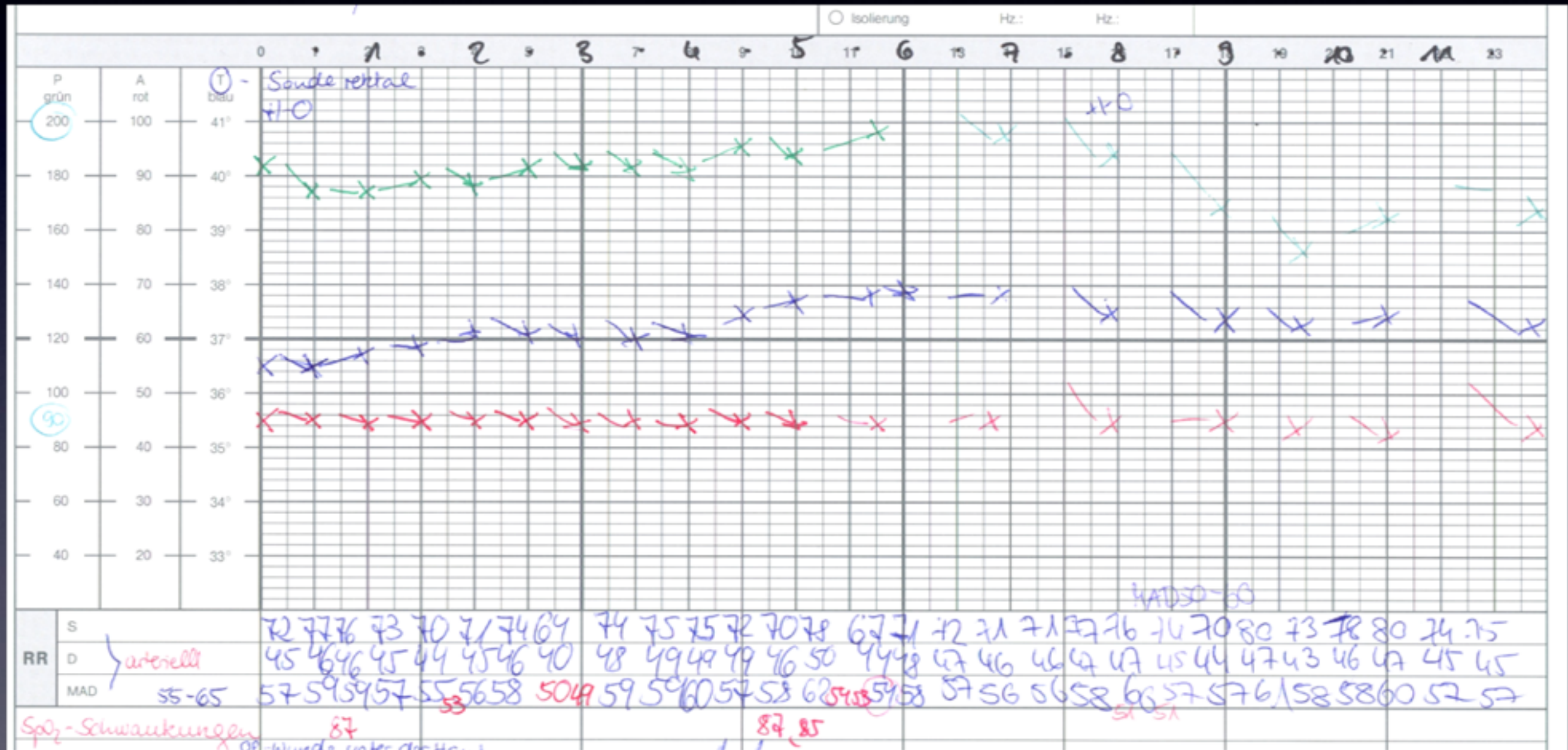
Many details

Difficult interpretation

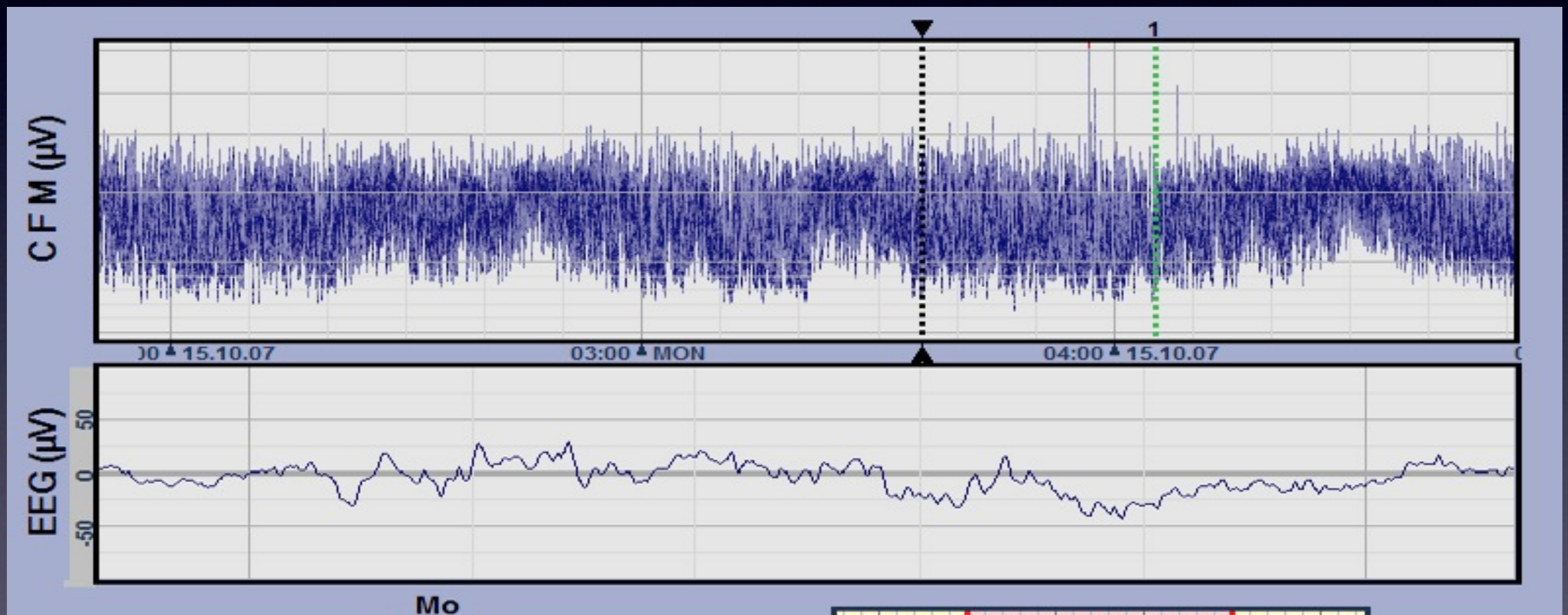
Key experiences



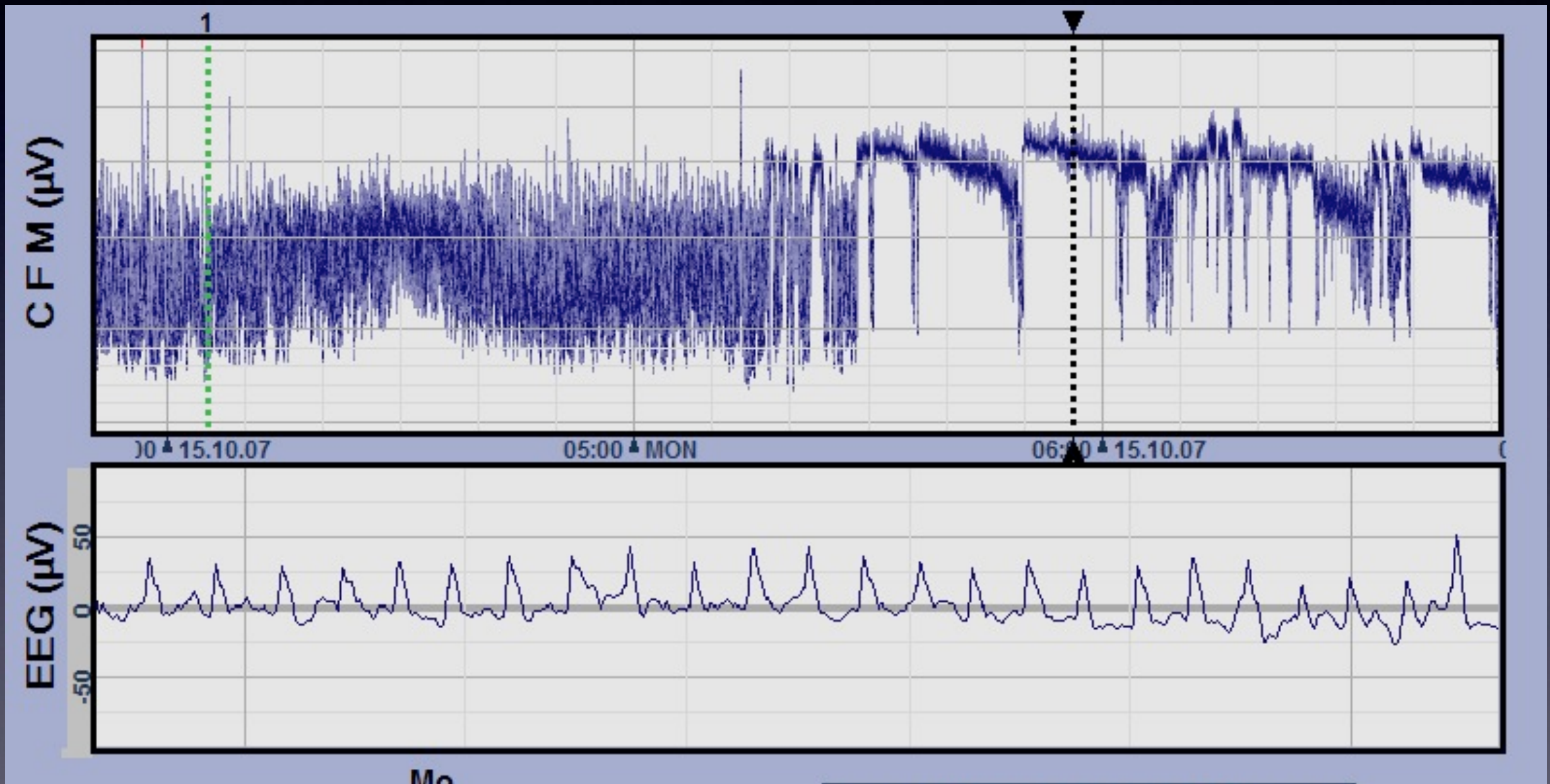
Key experiences



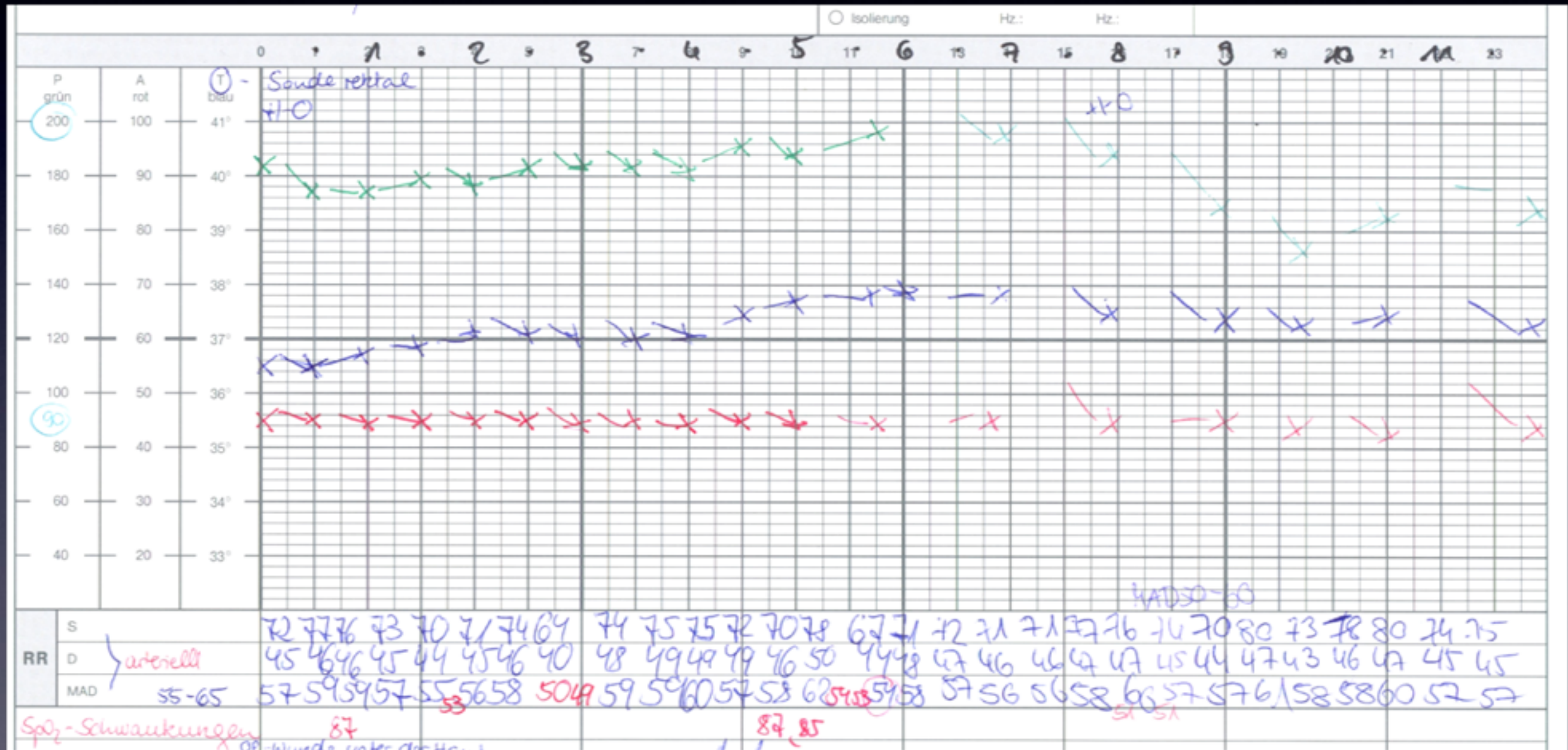
Key experiences



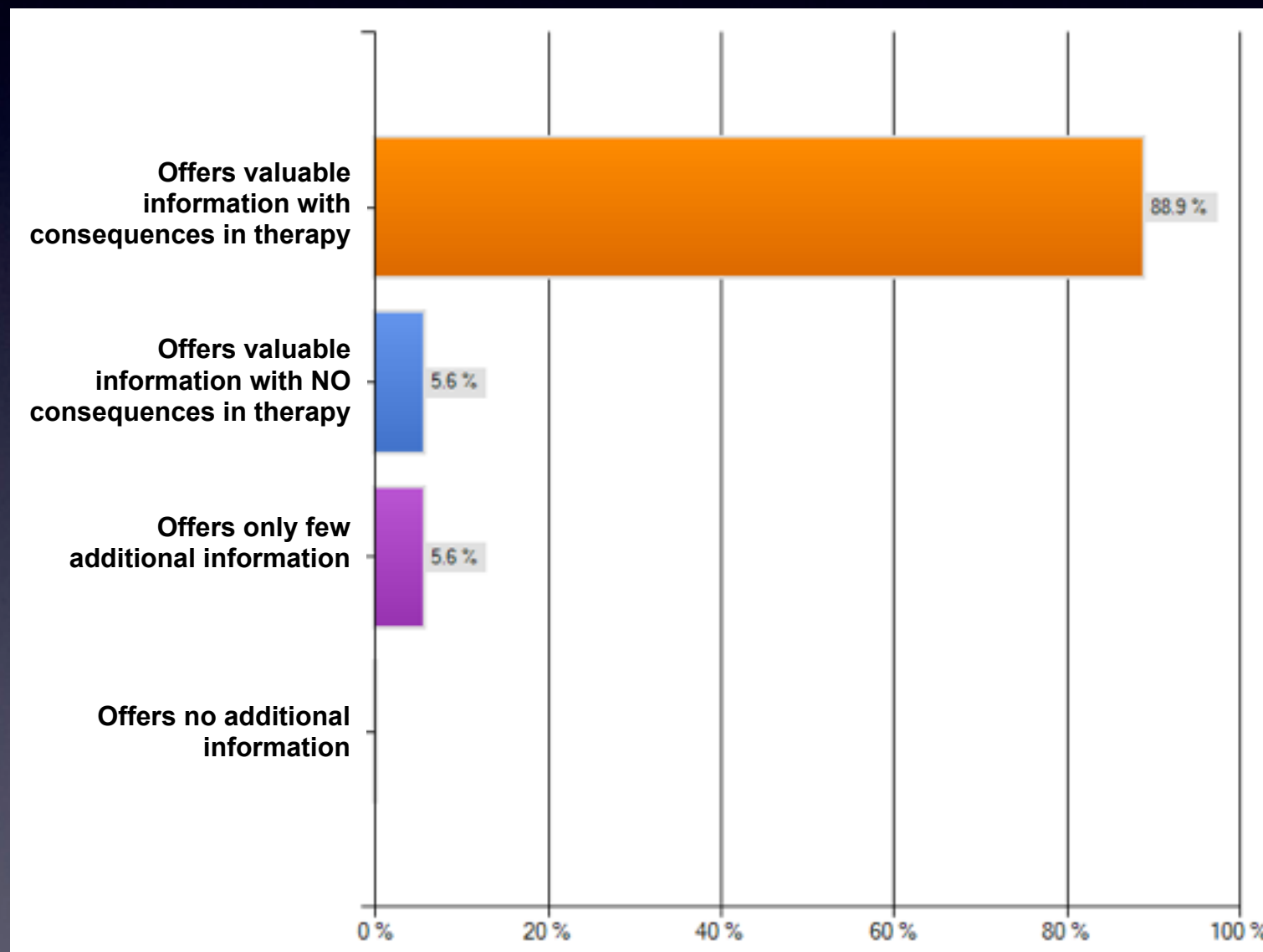
Key experiences



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

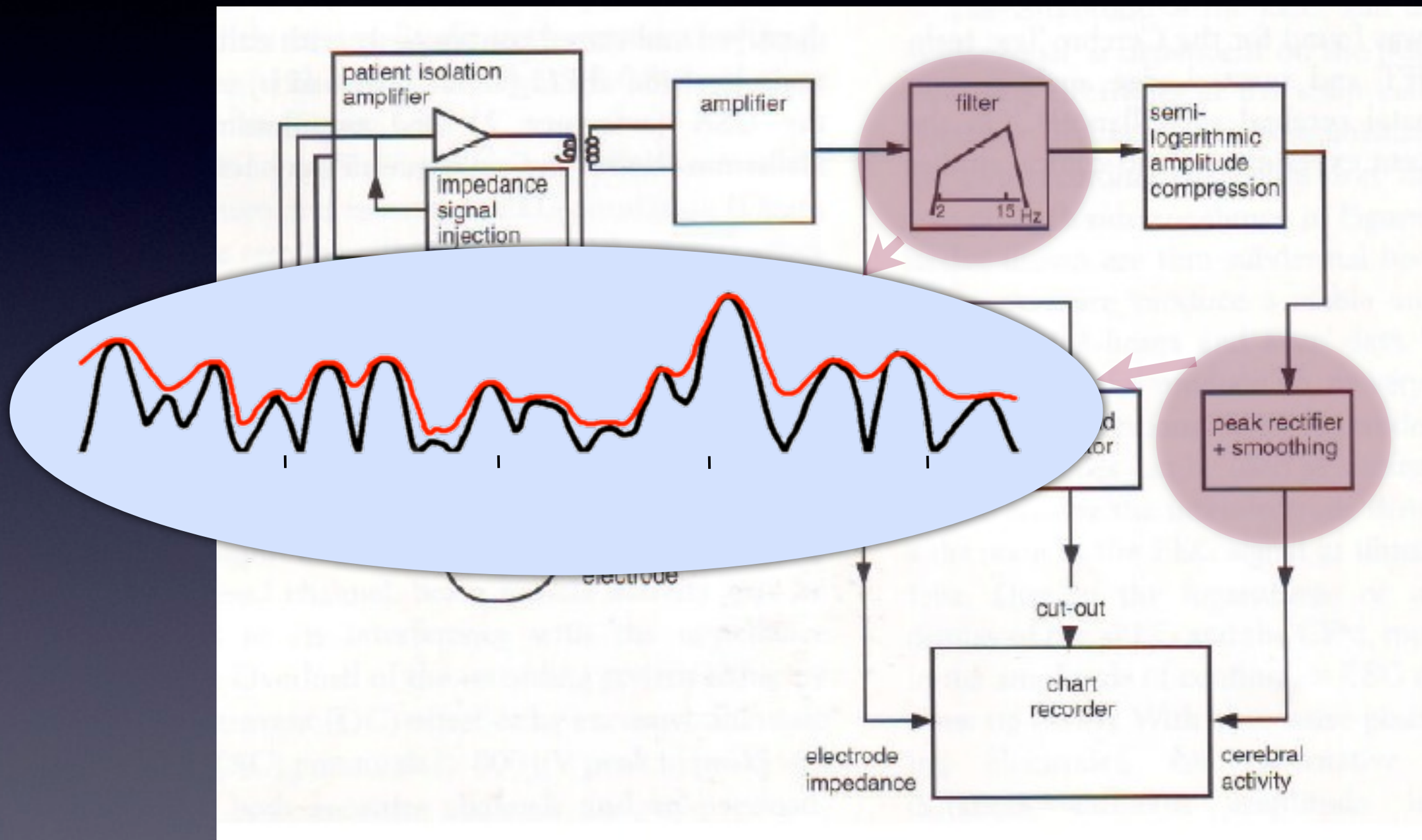
[Rosen. Clinics in Perinatology 2006; 33: 593-611]

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

A little history...

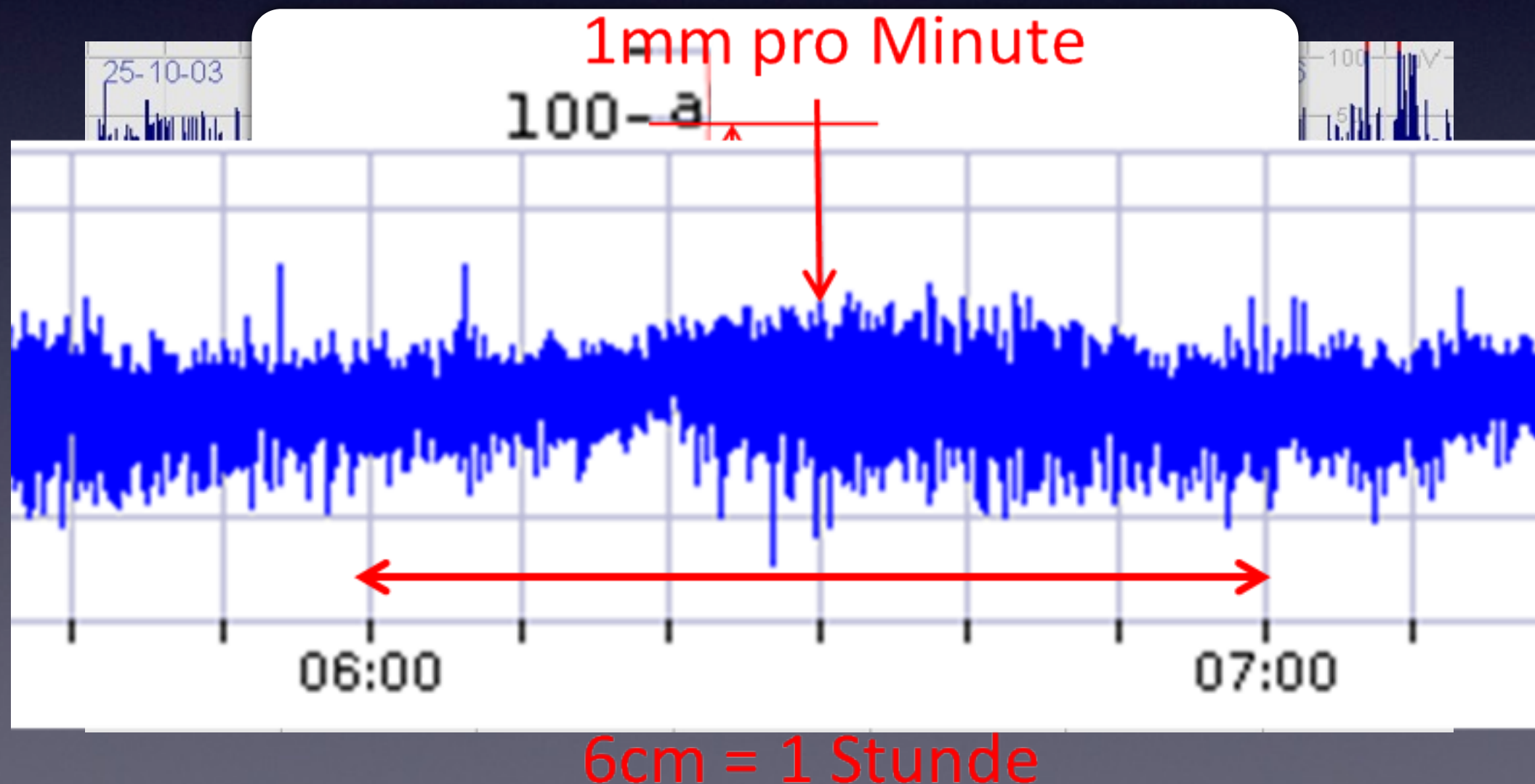
- ◆ developed in the 60s by Maynard and used by Prior in adults [Prior, Maynard. BMJ 1969; 4: 545-6]
- ◆ used in newborns by the end of 70s to beginning of the 80s [Viniker, Maynard, Scott. Clin. Electroencephalogr 1984; 15: 185-92]
- ◆ Renaissance since begin of 90s with digital display and including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

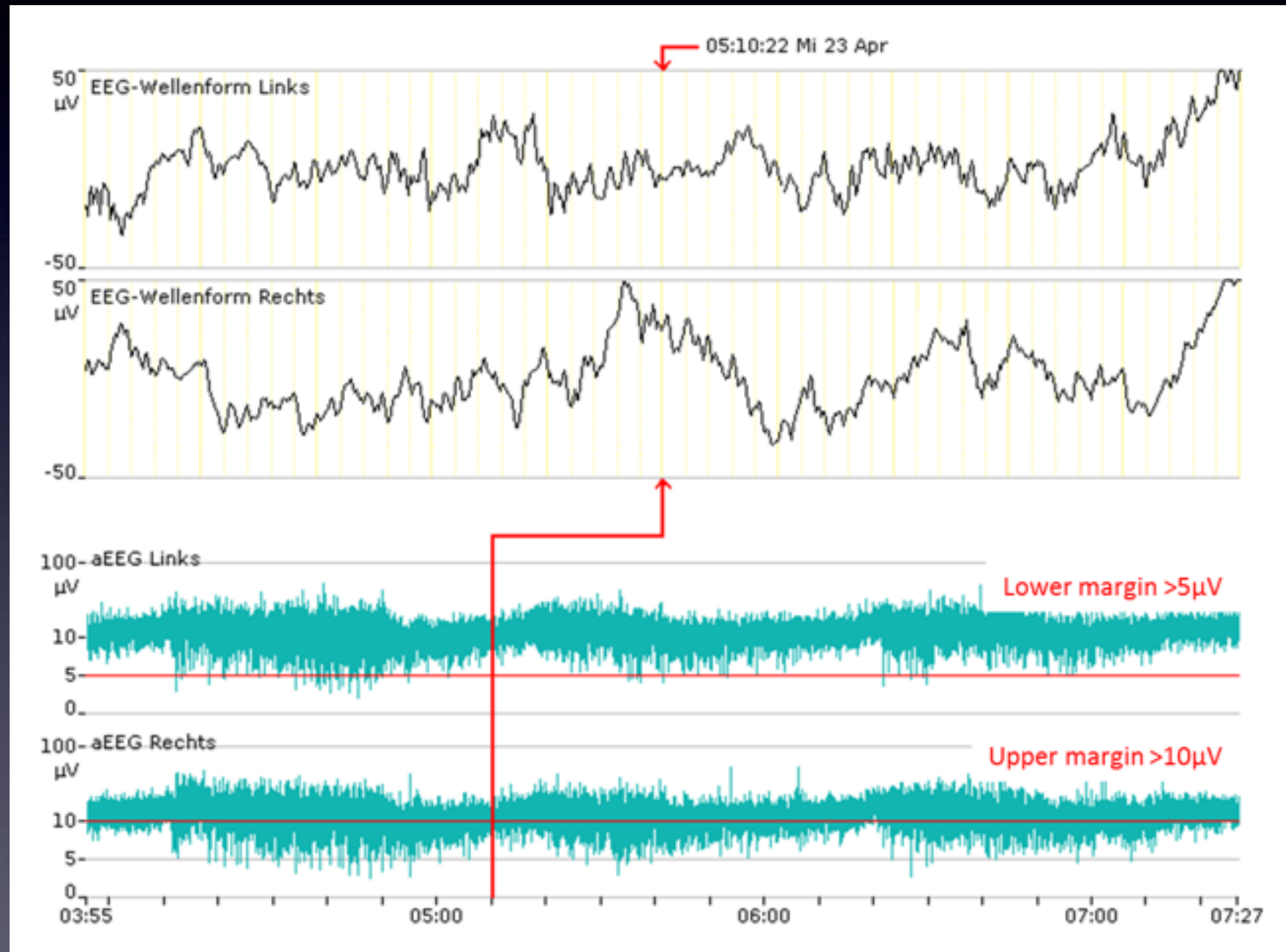
Sleep-Wake-Cycling

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	

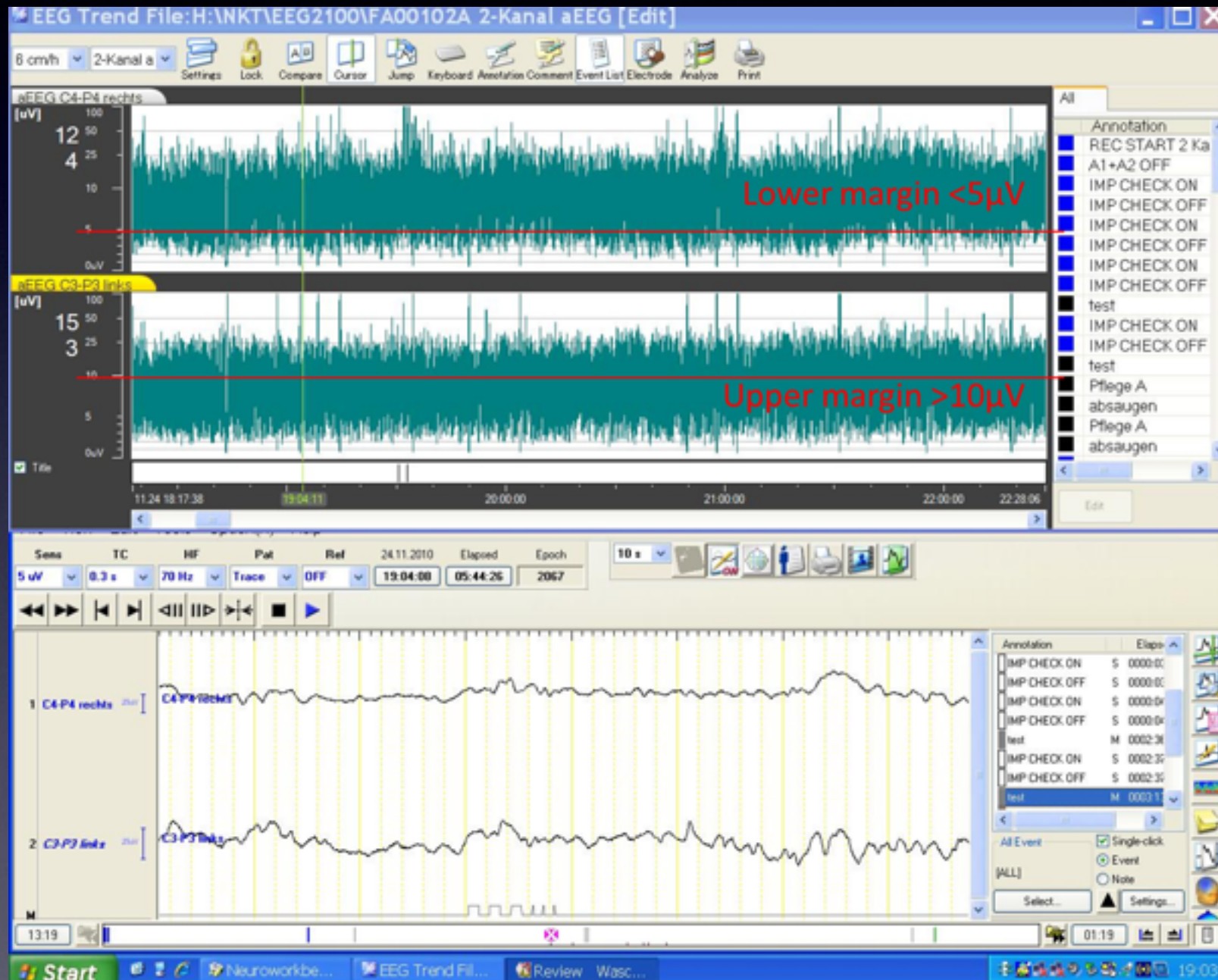
CNV, Continuous normal voltage, continuous pattern



**Maximum amplitude
10-25(-50) μV**

**Minimum amplitude
> 5 (7)-10 μV**

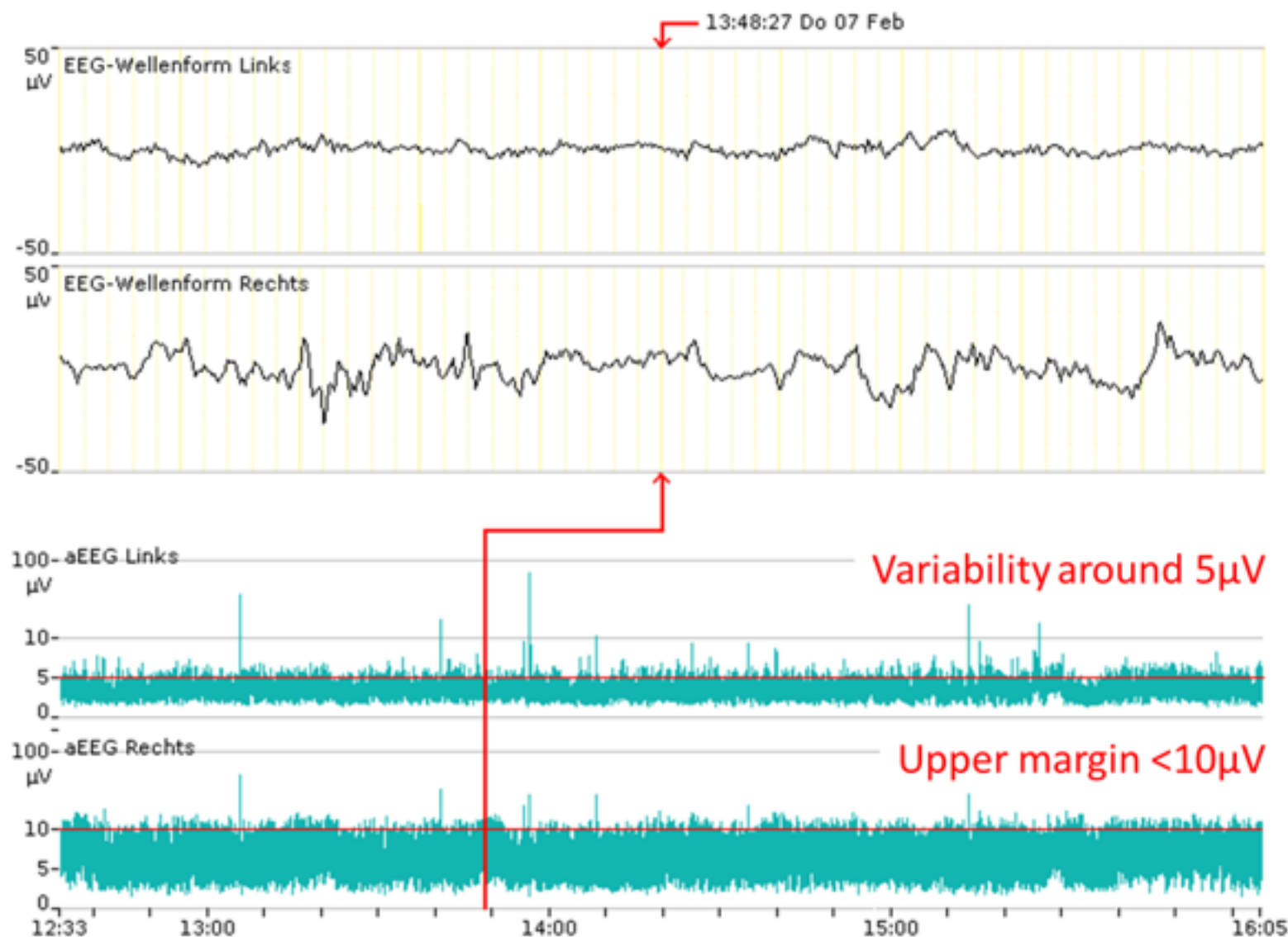
DC, Discontinuous voltage, discontinuous pattern



Maximum amplitude
10-25(-50) μV

Minimum amplitude
 $< 5 \mu V$

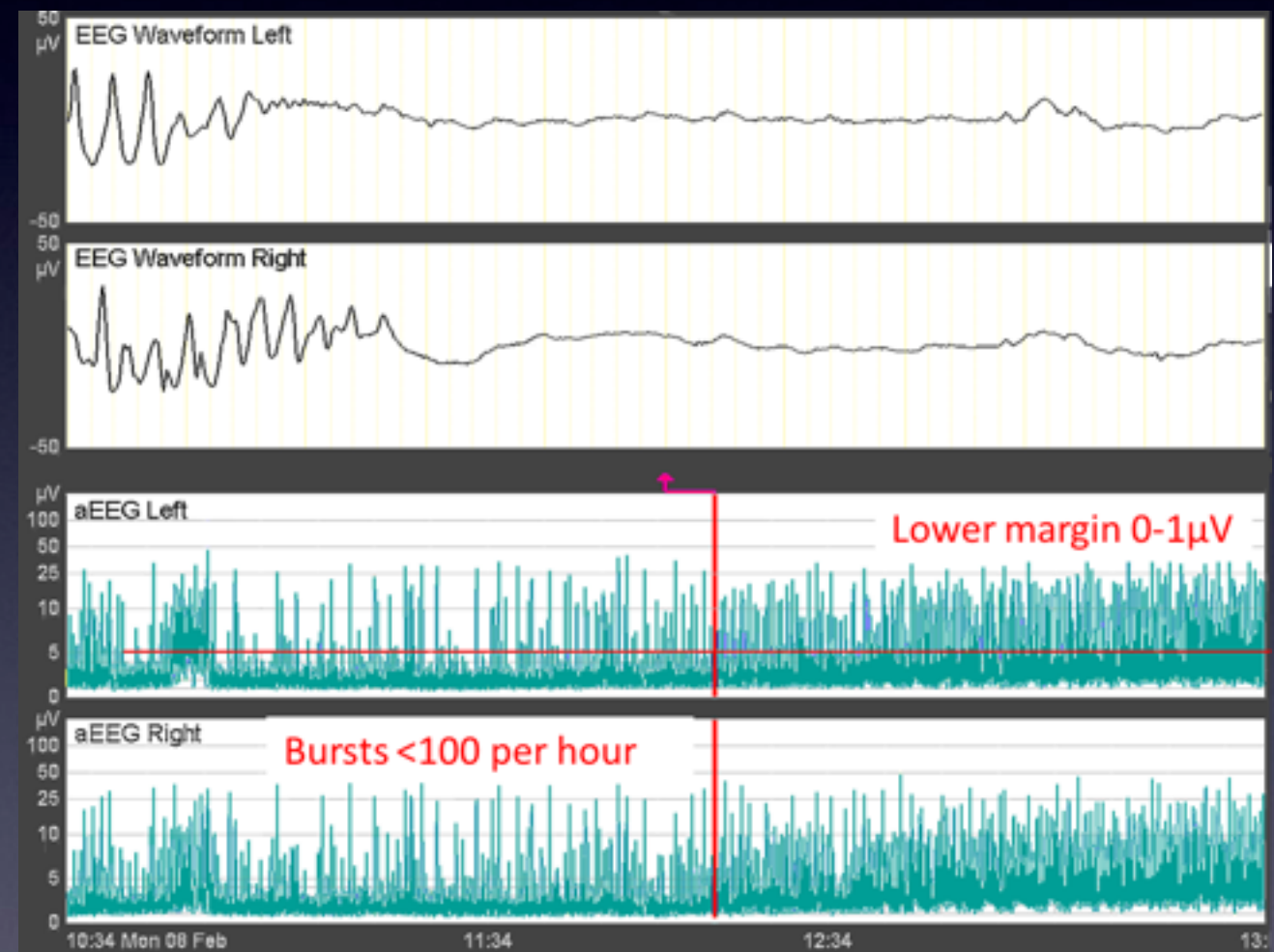
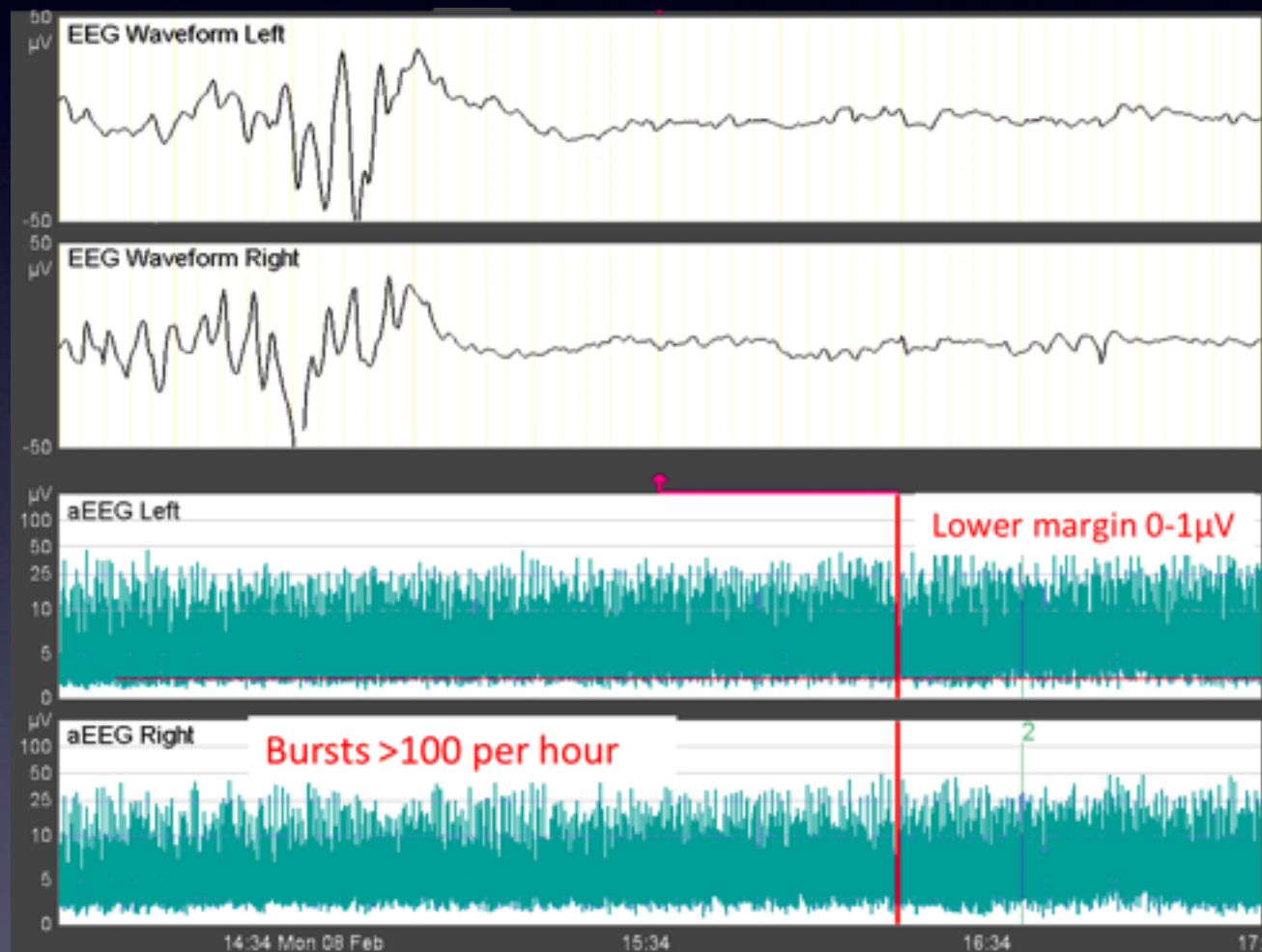
LV, Low voltage



**Maximum amplitude
< 10 μV**

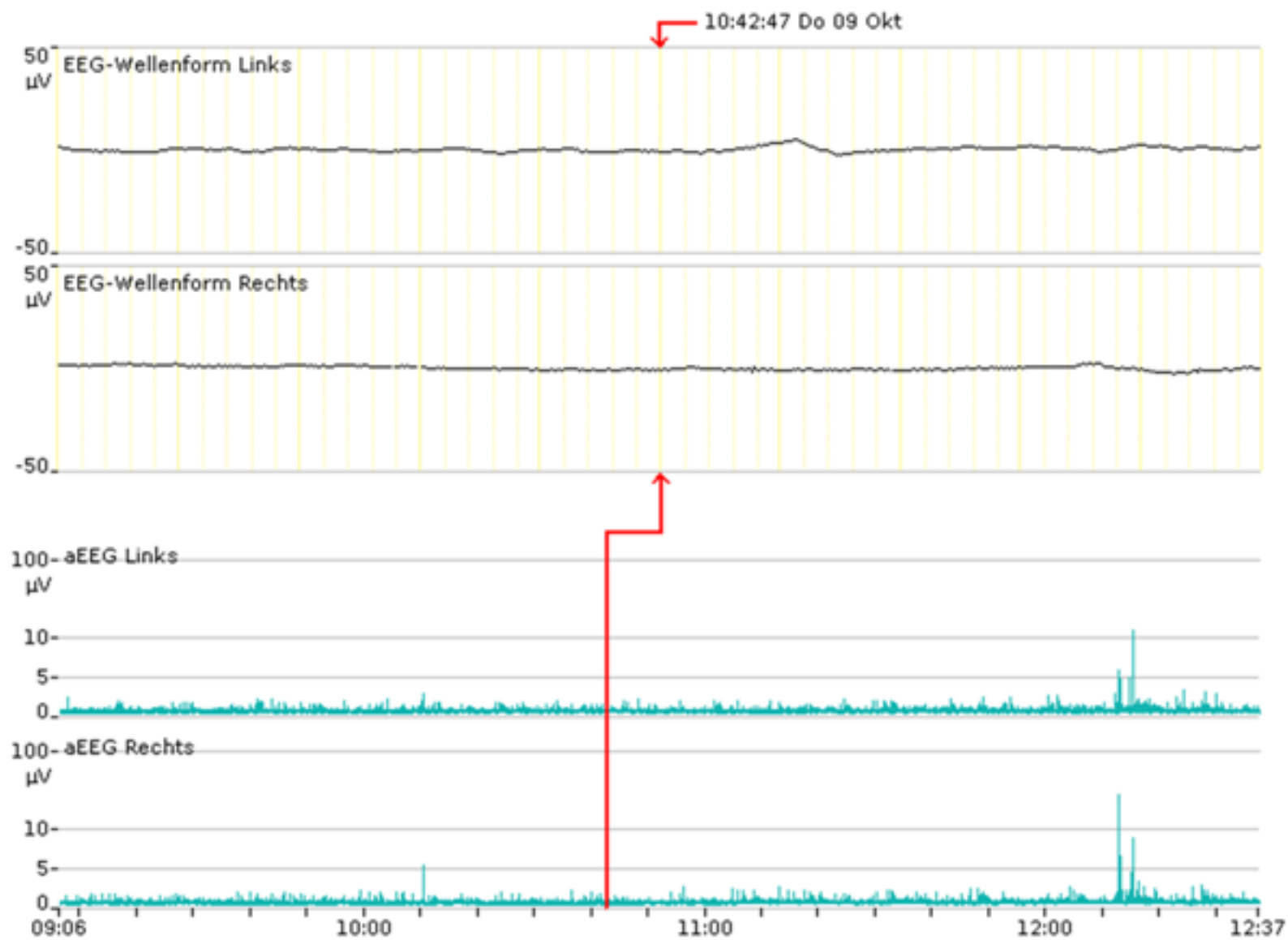
Variability around 5 μV

BS +/-, burst suppression pattern



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

FT, flat trace, inactive pattern

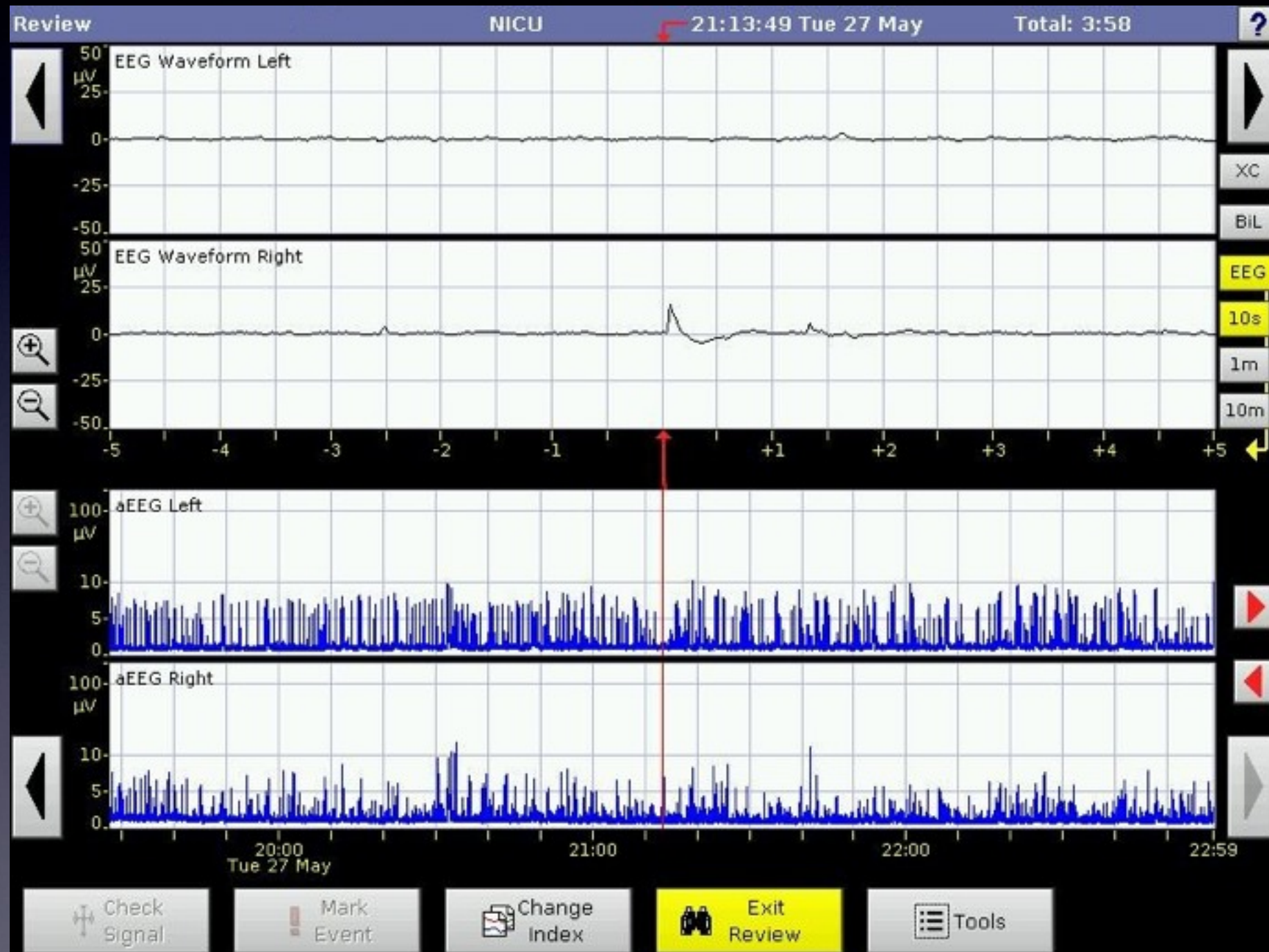


Pattern always $< 5 \mu V$ (isoelectric)

FT, flat trace, inactive pattern

Beware
of artefacts!

This is still FT



Background activity (pattern recognition)

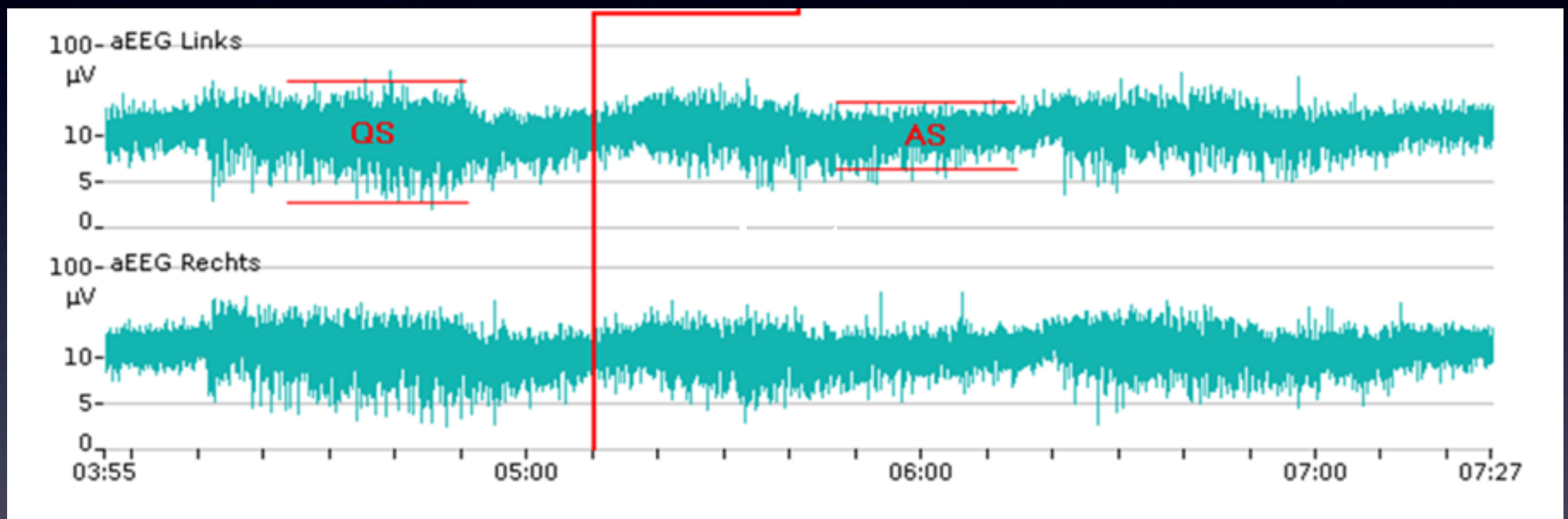
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Inactive, flat trace, FT Upper and lower margin continuously <5μV	

Assessment of an aEEG

Background activity 

SWC

Sleep-Wake-Cycling



Continuous activity with repeating sinusoidal periodic pattern
 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

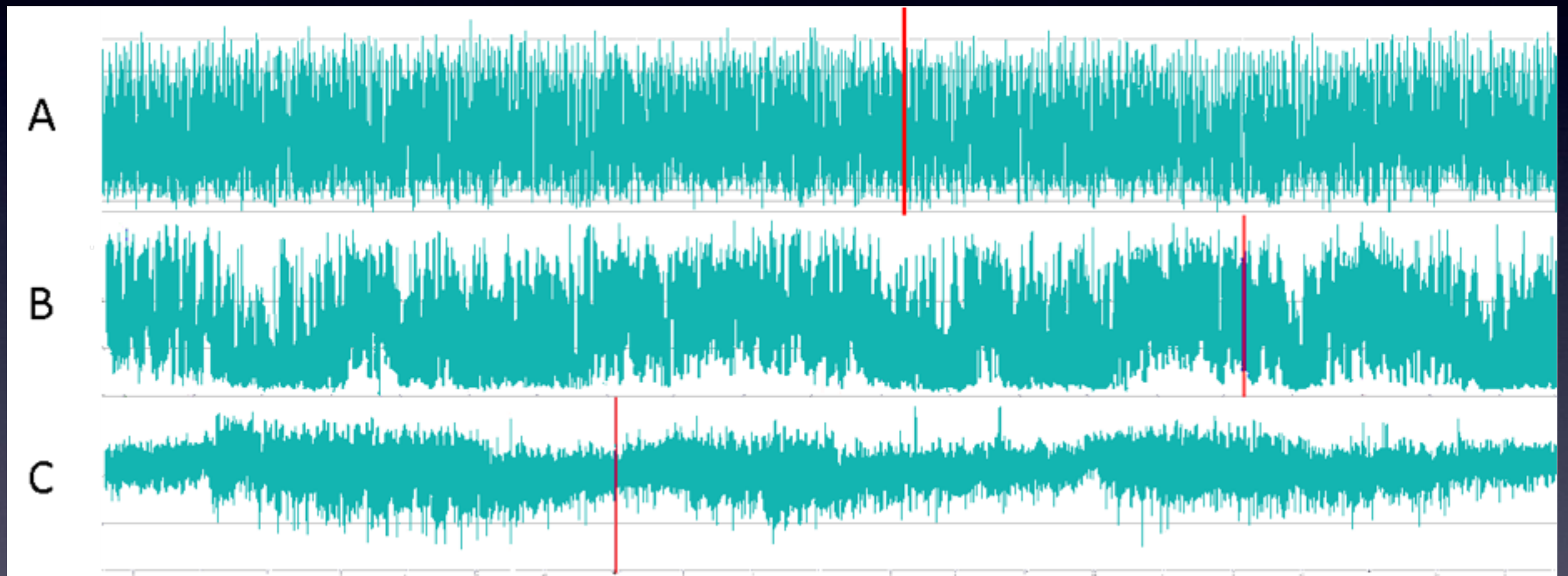
in part, but not fully developed cyclic variation of minimal amplitude
(in respect of the gestational age)

Developed/normal SWC

clearly identifiable sinusoid variations between discontinuous and continuous background activity with cycles longer than 20 minutes.

SWC

Sleep-Wake-Cycling



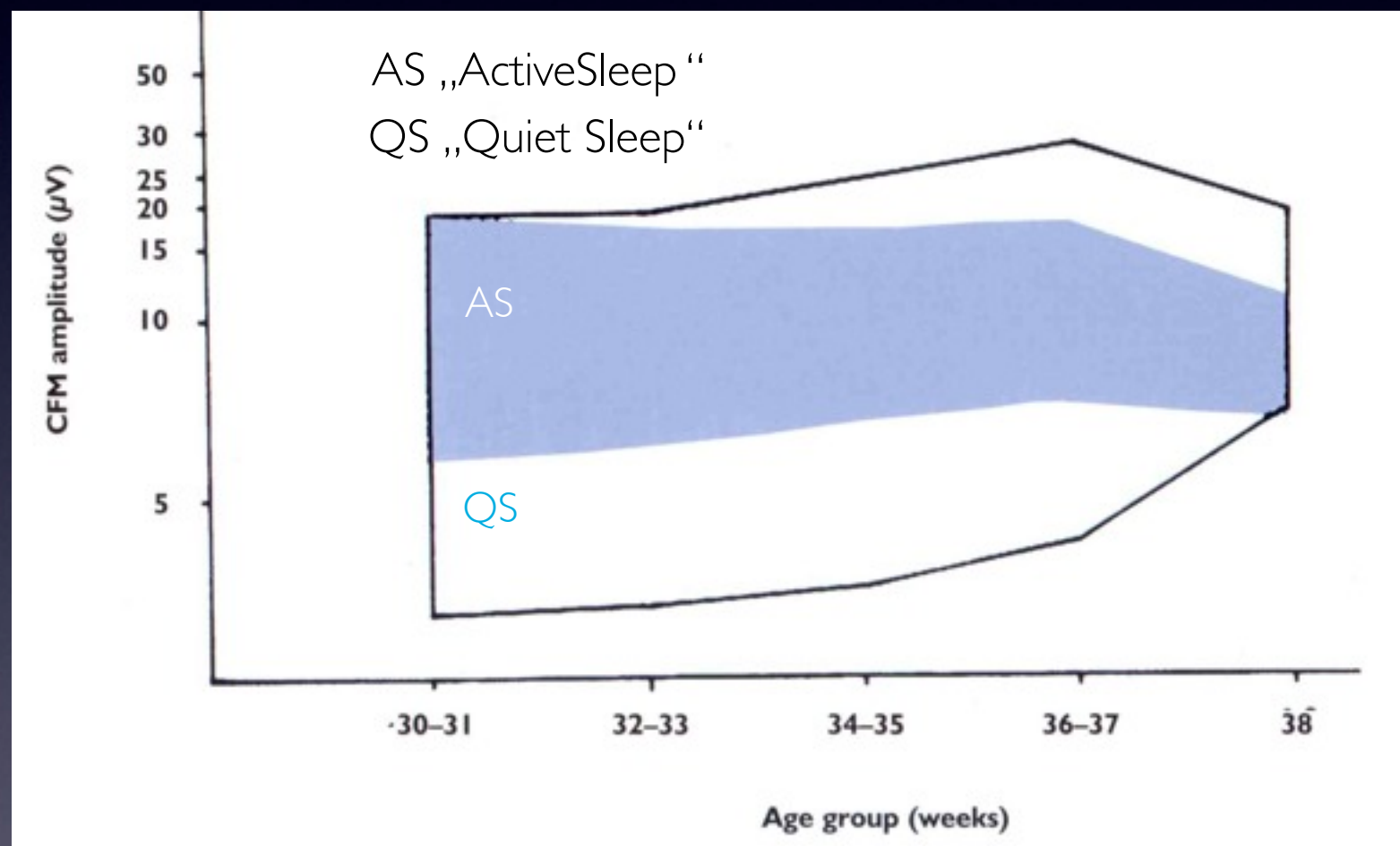
A: No SWC

B: immature or incomplete SWC (suboptimal variant)

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

SWC

Sleep-Wake-Cycling



Dependant on gestational age

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

Immature SWC from 25-26 weeks

from 29-30 weeks fully developed

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

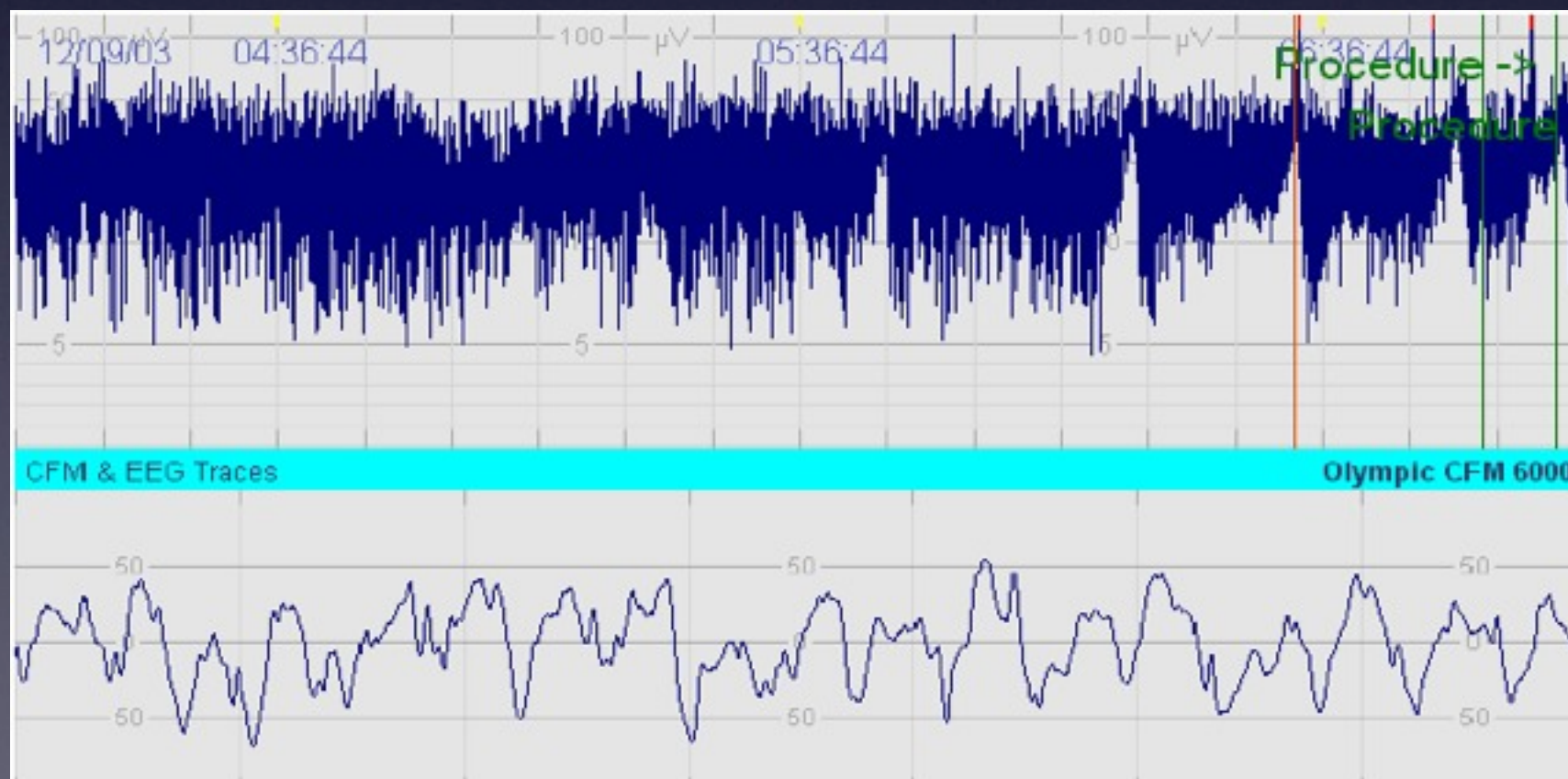
Assessment of an aEEG

Background activity ☒

Sleep-Wake-Cycling ☒

Seizure activity

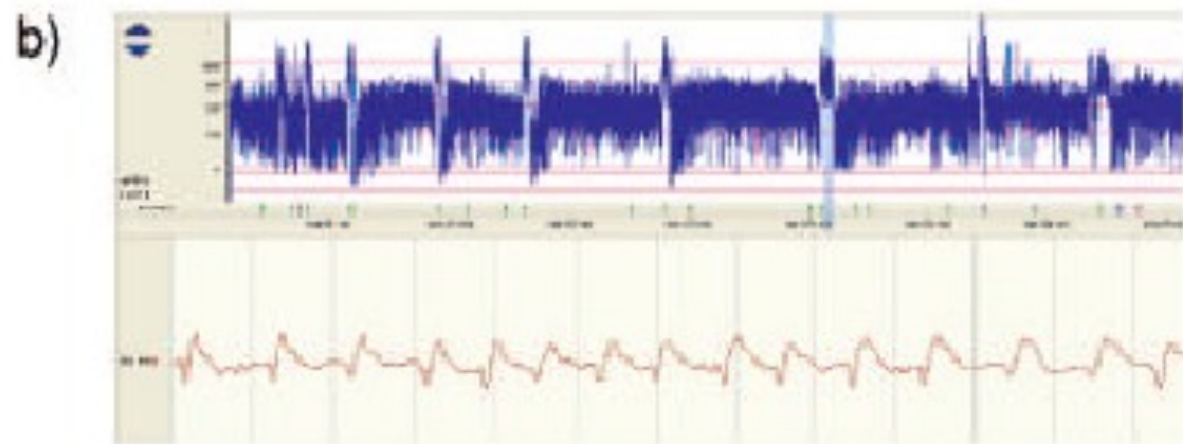
- Sudden change of background activity with higher amplitude.
- Often strong increase of upper and lower band, sometimes also only the lower band.
- Often followed by transient postictal depression of the amplitude. Must be longer than 10 seconds.



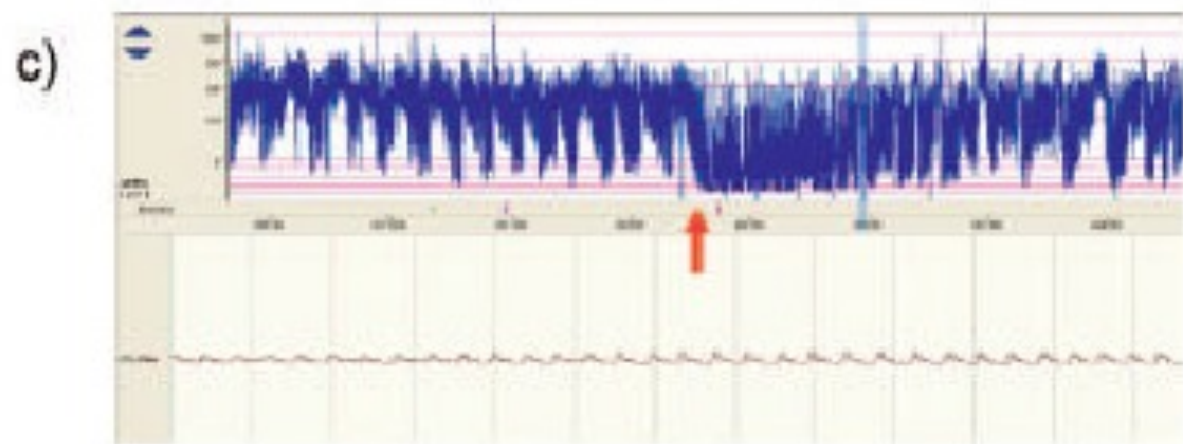
Seizure activity



a.) single seizures (SS)

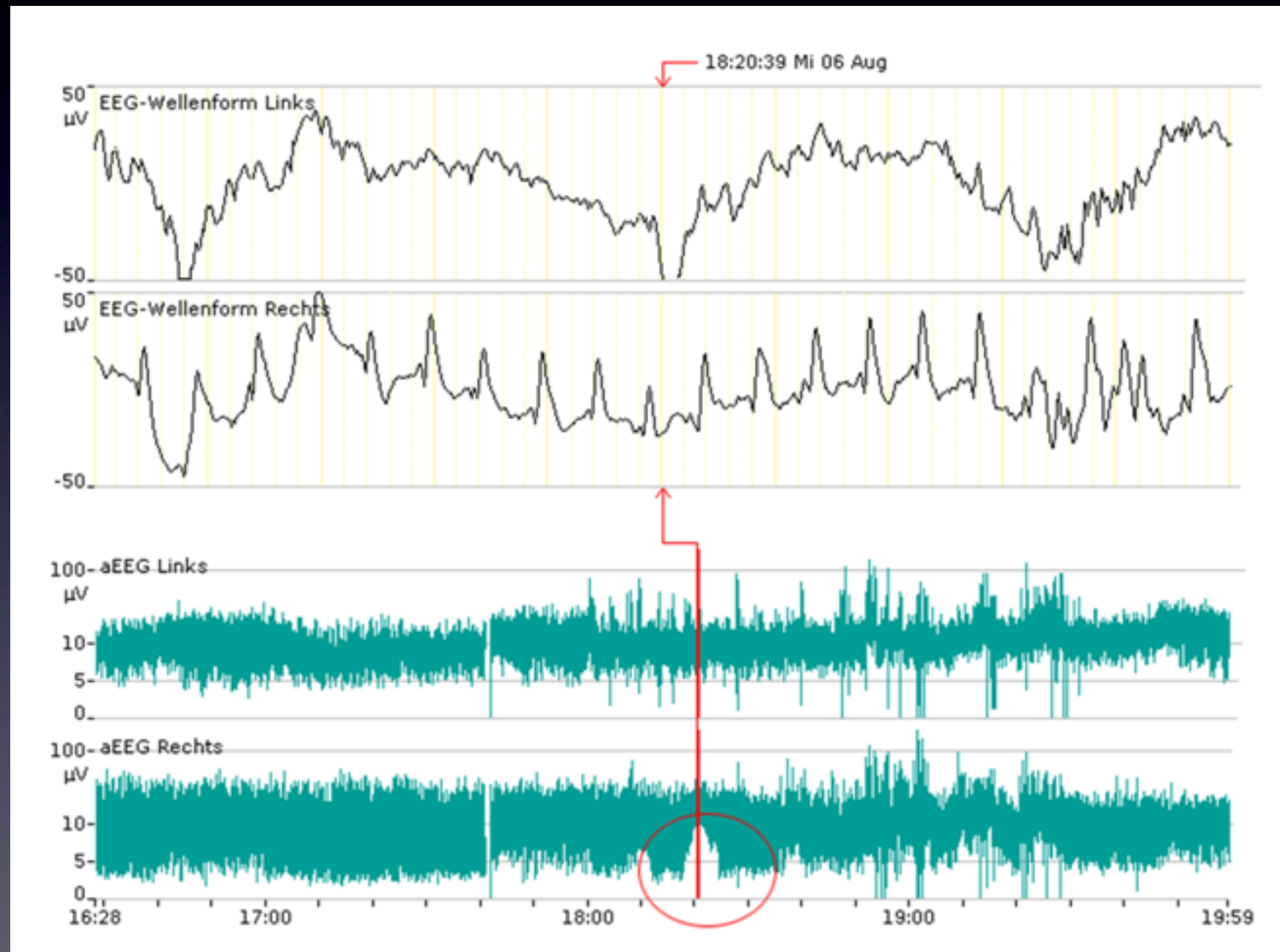


b.) repetitive seizures (RS) within 30 minutes

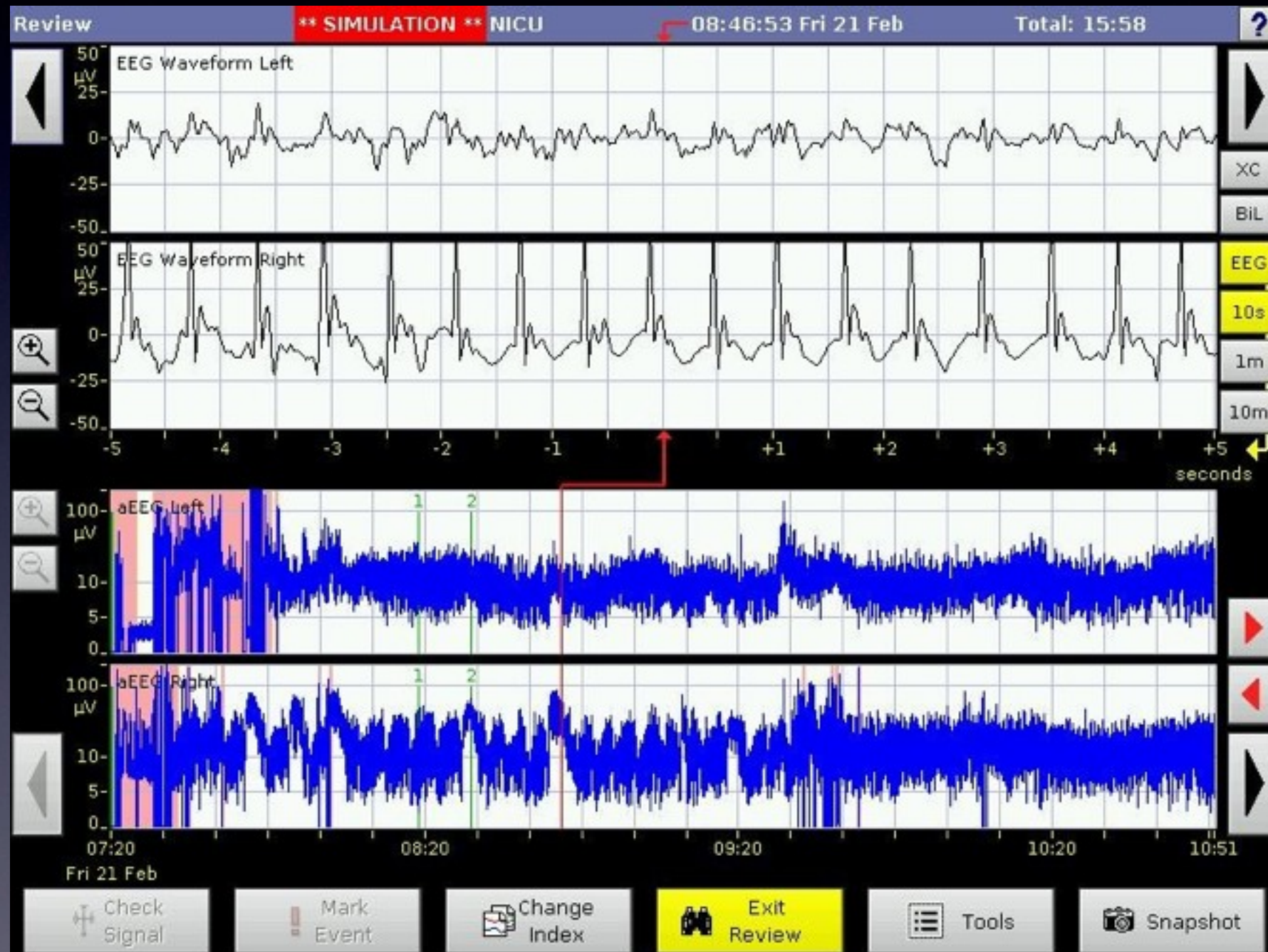


c.) Status epilepticus (SE, 'sawtooth pattern')
seizure activity > 30 minutes

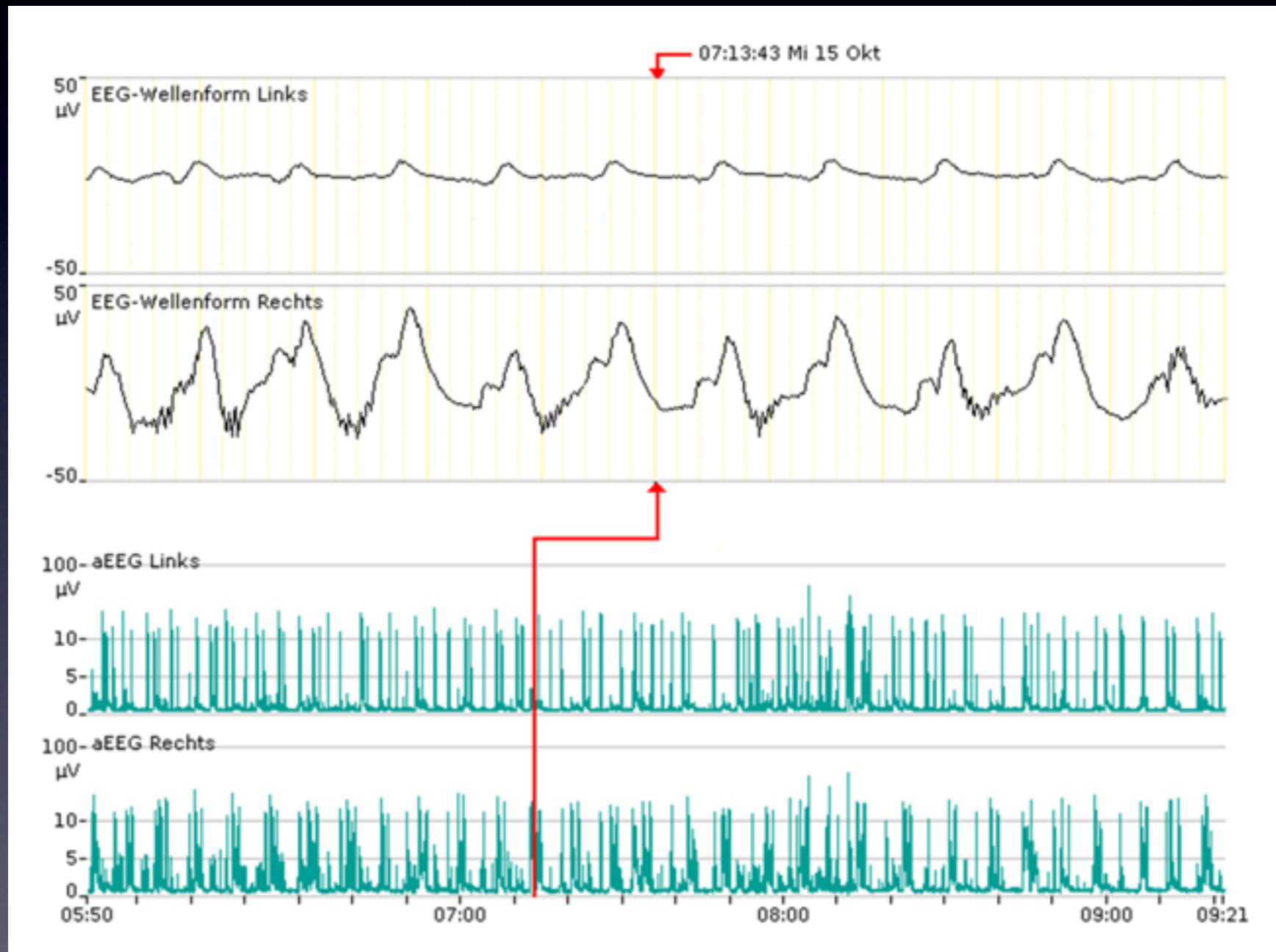
Single Seizure



Repeated Seizure



Status epilepticus



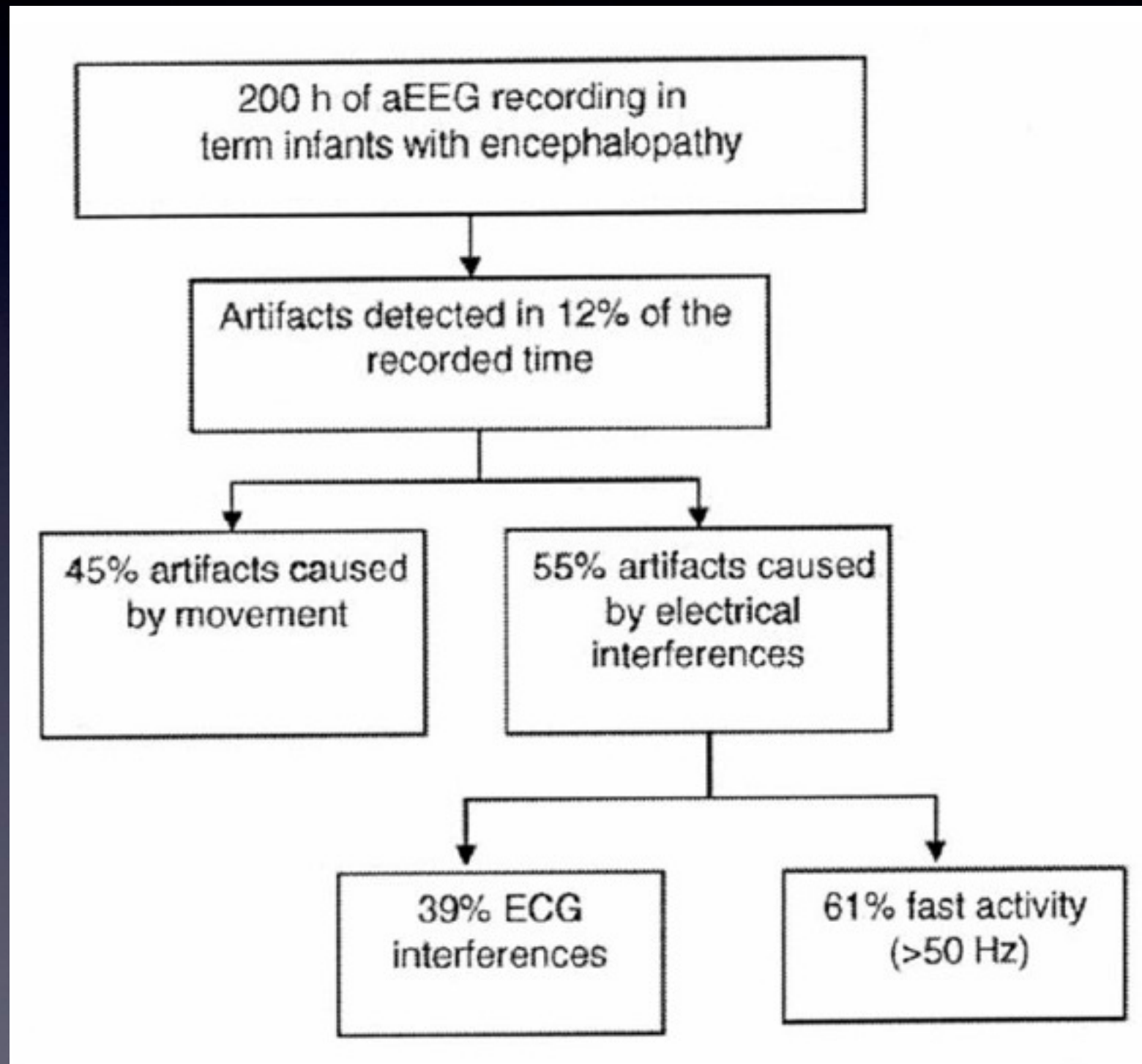
Assessment of an aEEG

Background activity ☒

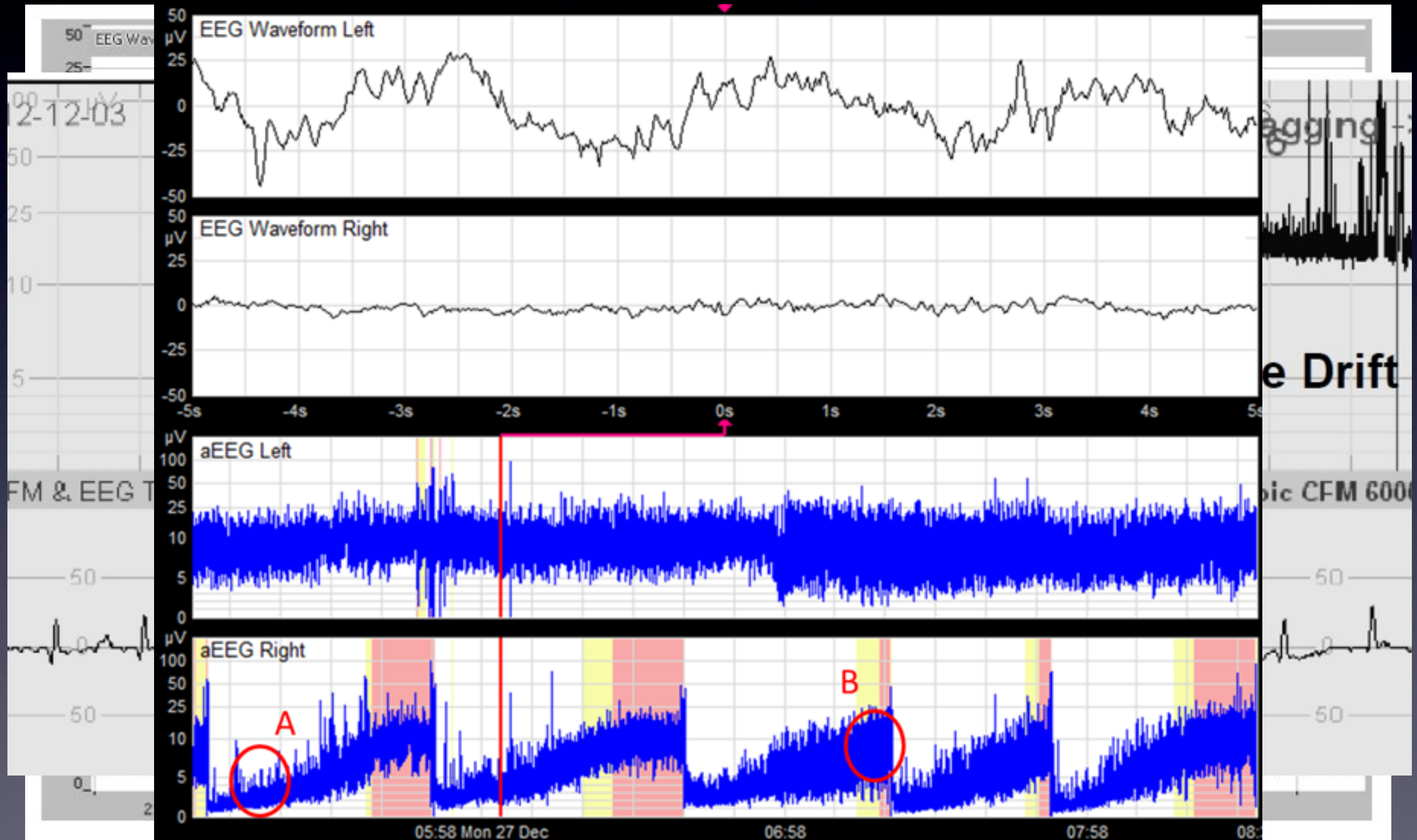
Sleep-Wake-Cycling ☒

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)

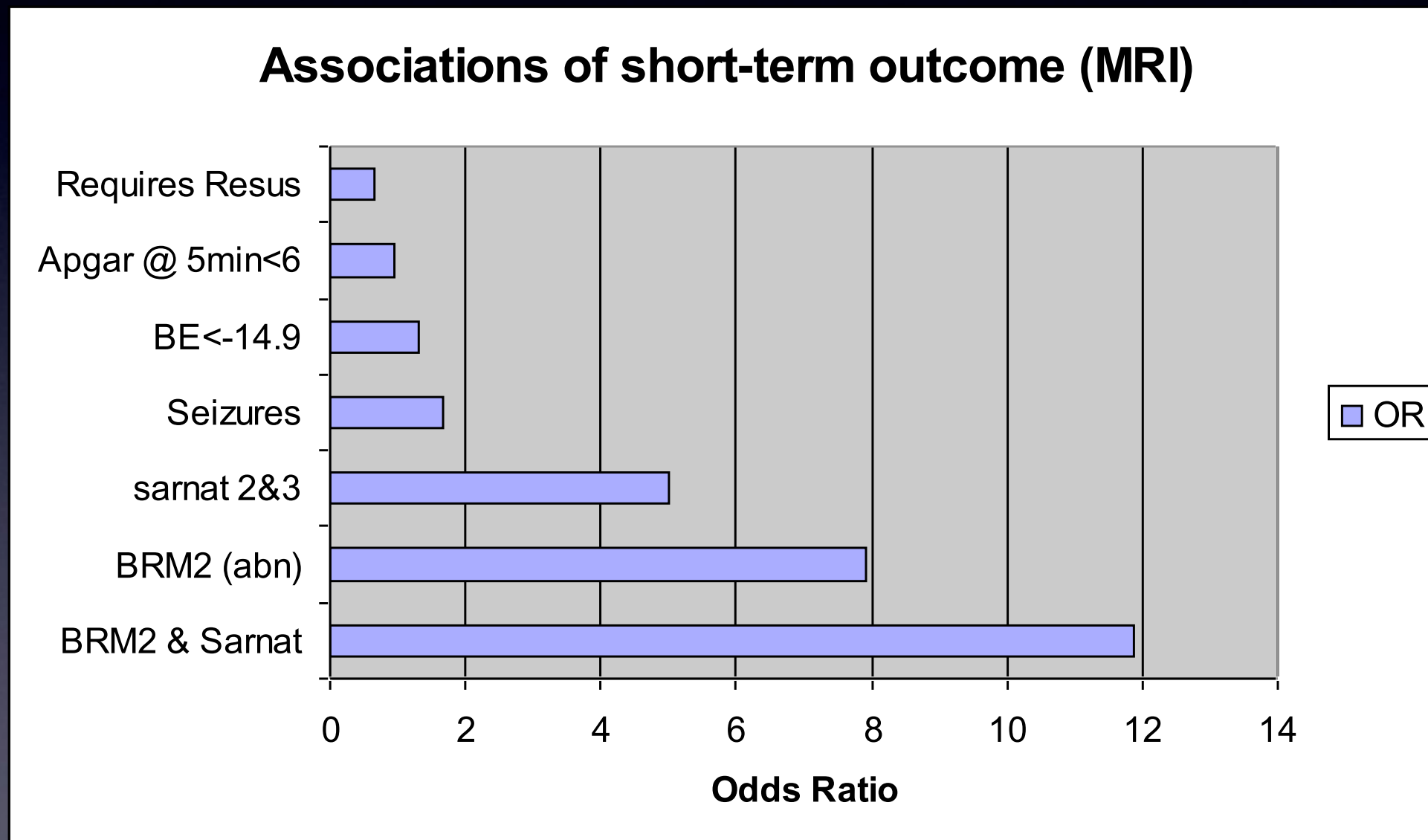
Monitoring of PHVD

postoperative, especially after cardiac surgery (together with NIRS)

Sleep-Wake-Cycling (somnology, minimal handling)

Examples for use of aEEG

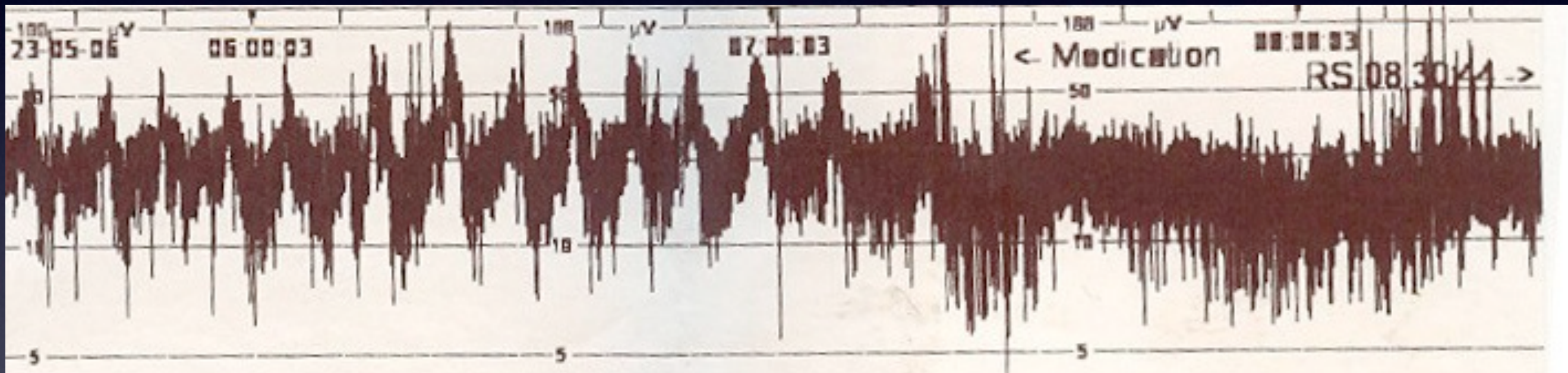
Prediction after Asphyxia



Lavery et al, 2006, abstract-PSANZ

Examples for use of aEEG

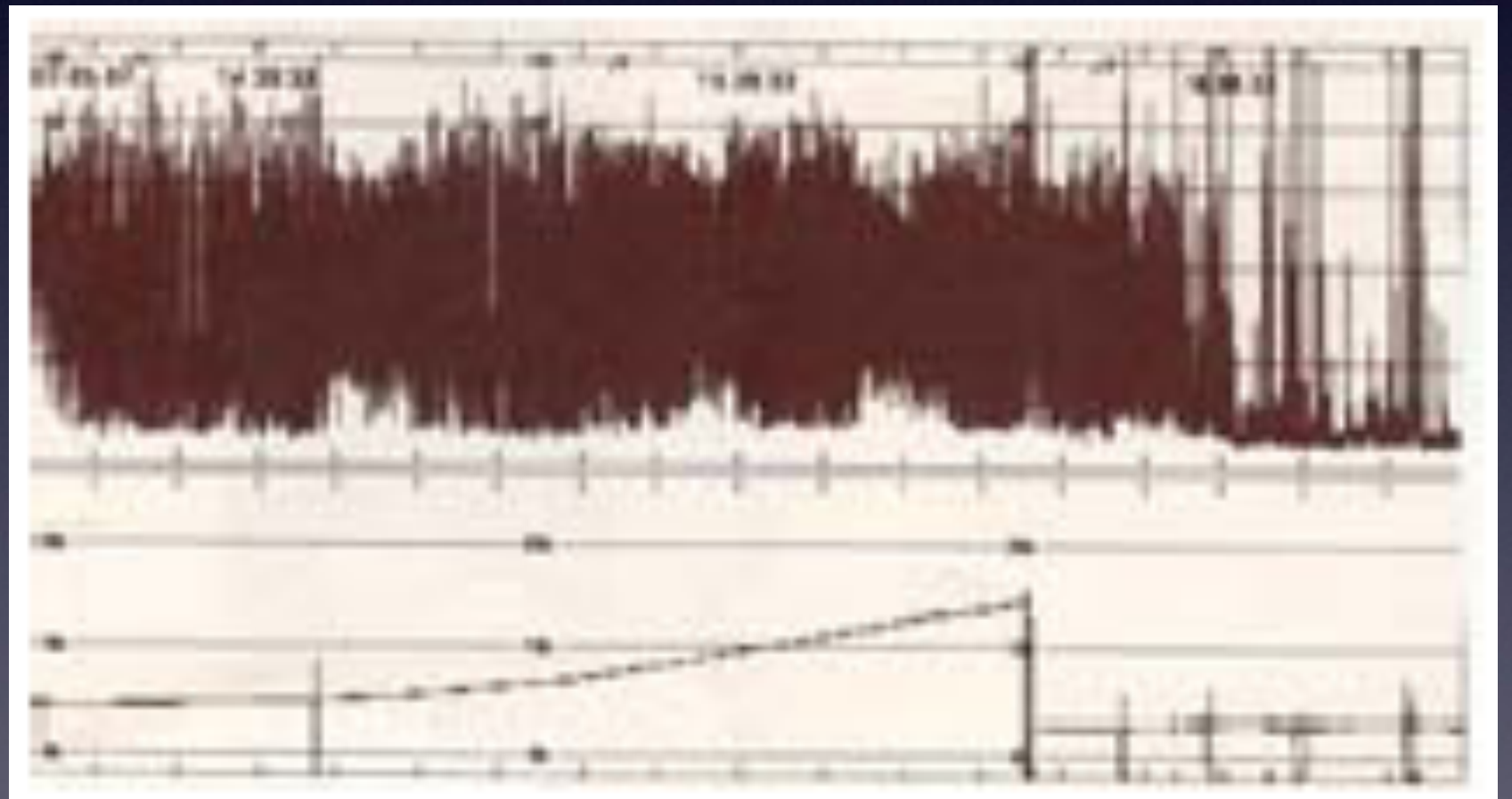
Detection of seizures and
monitoring effect of medication



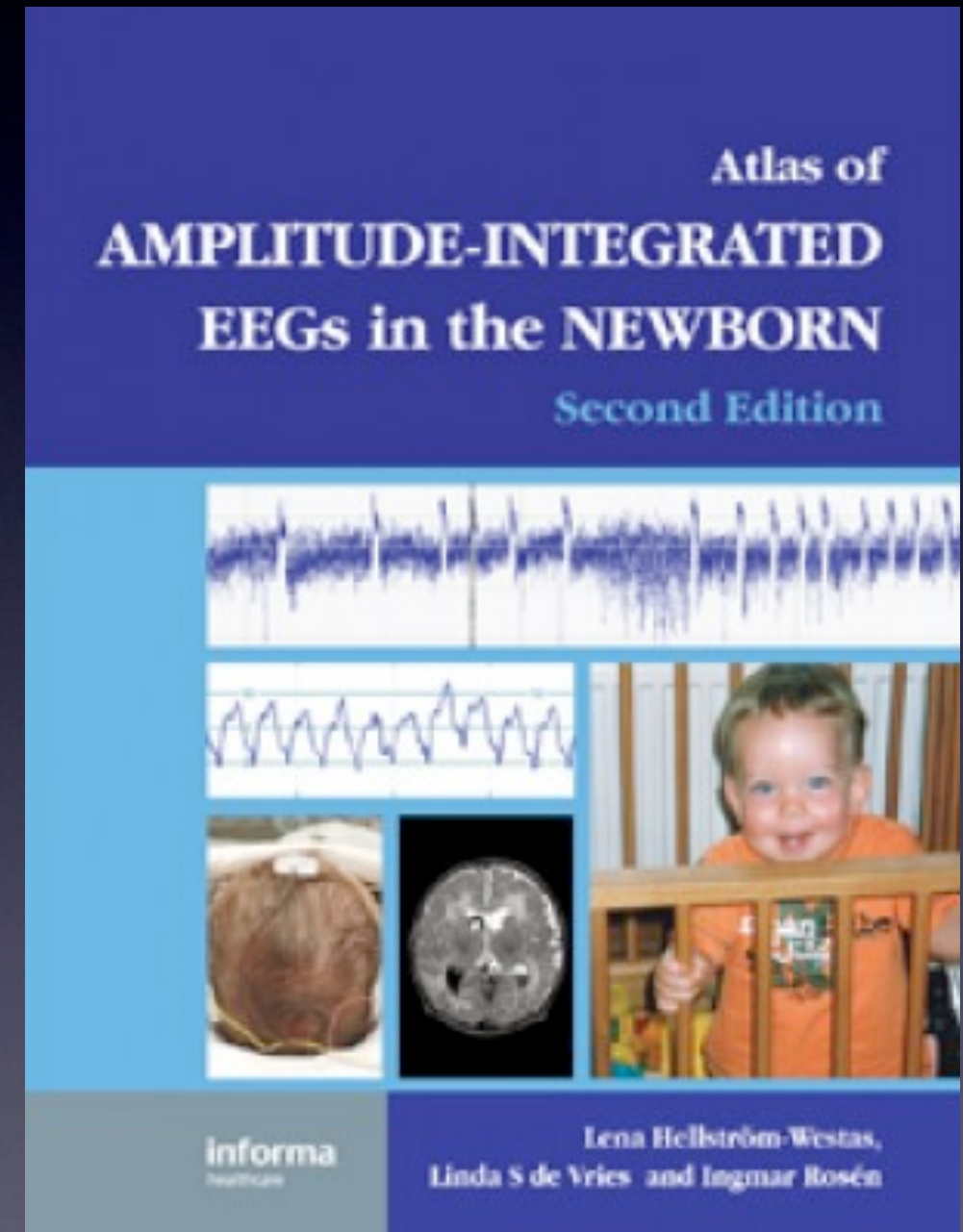
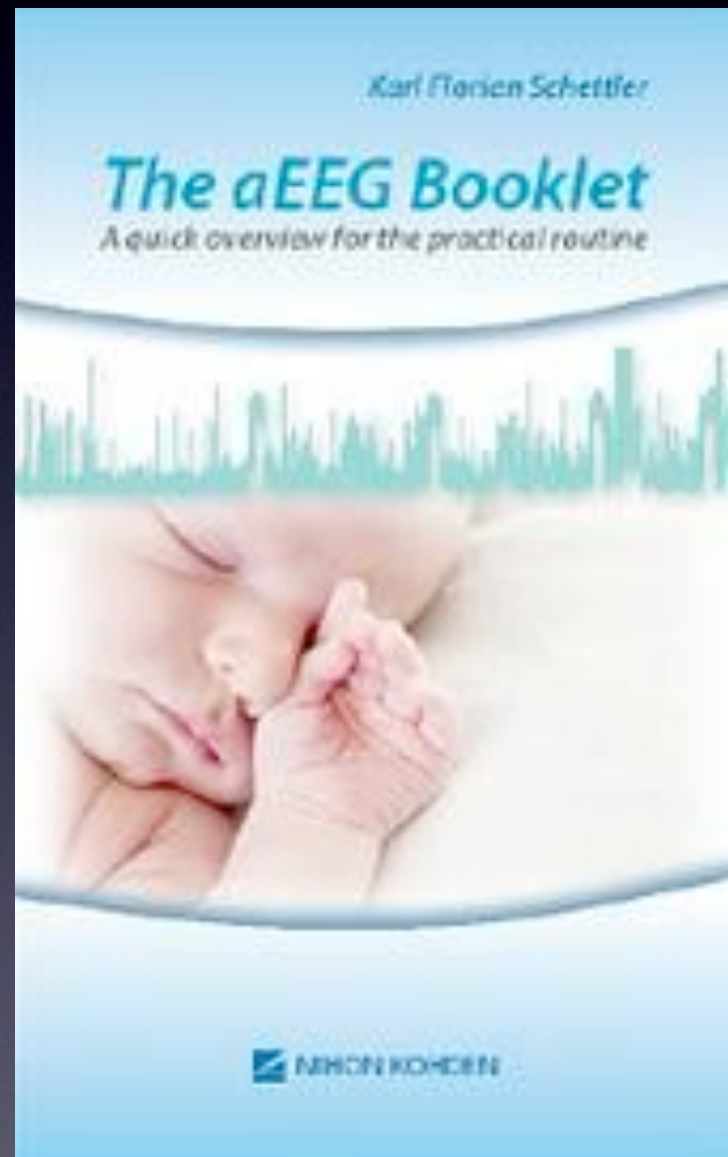
Examples for use of aEEG

Monitoring of neurological high risk patients
e.g. PHVD posthemorrhagic ventricular dilation

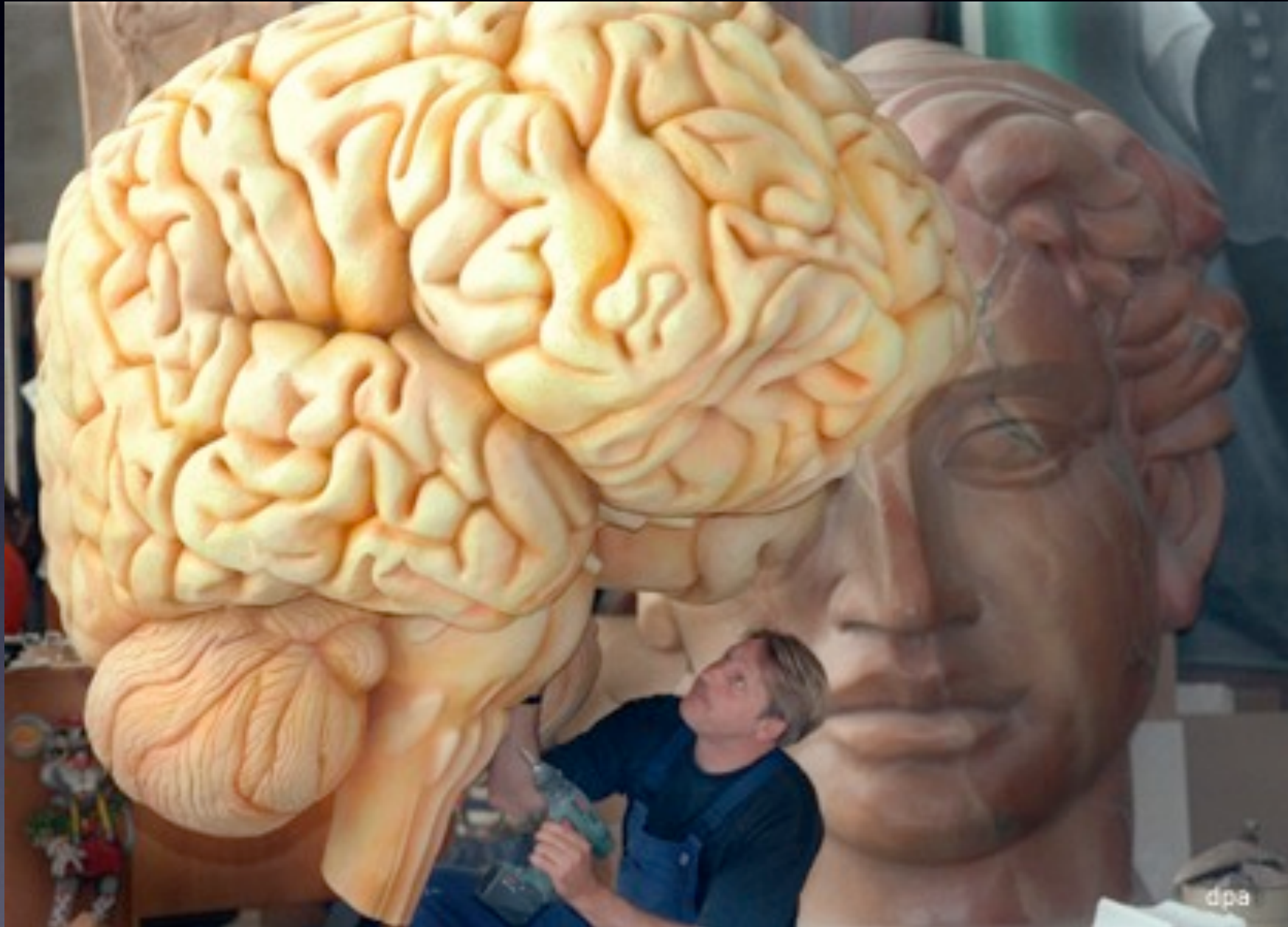
Real-time detection of pressure decompensation



Get a good overview...



Features to be aware of

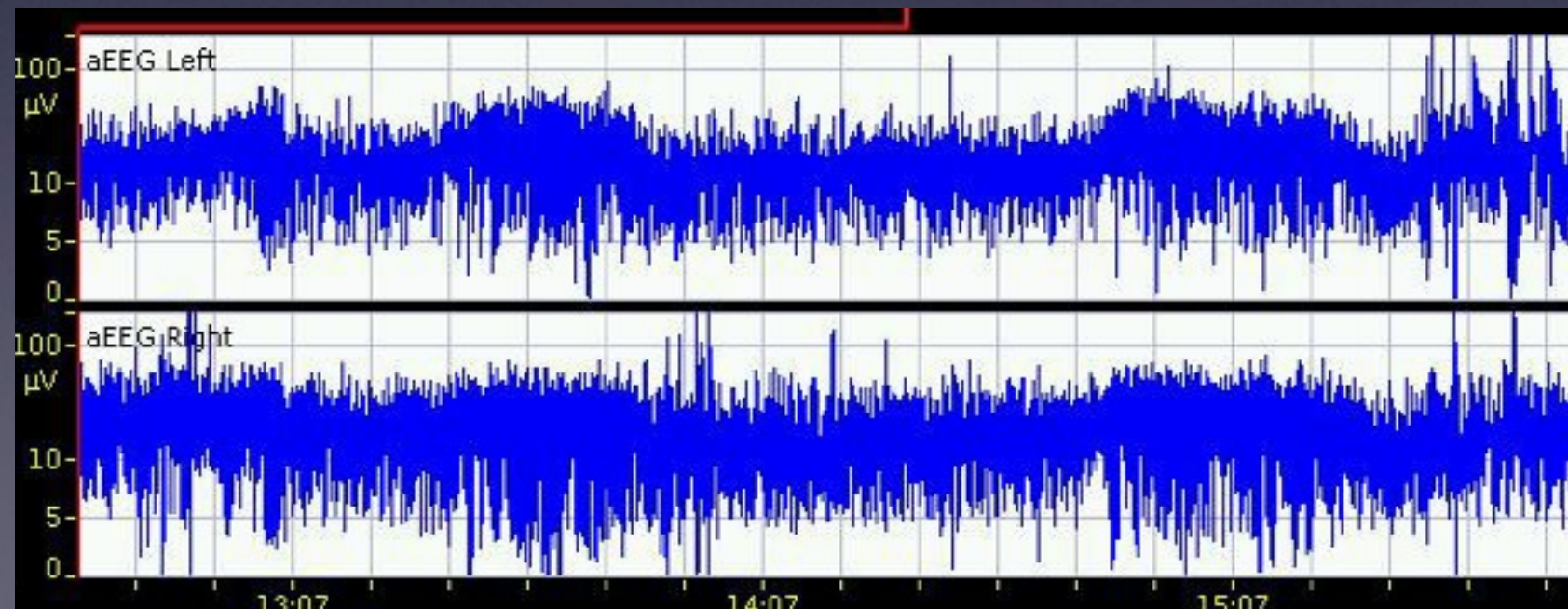
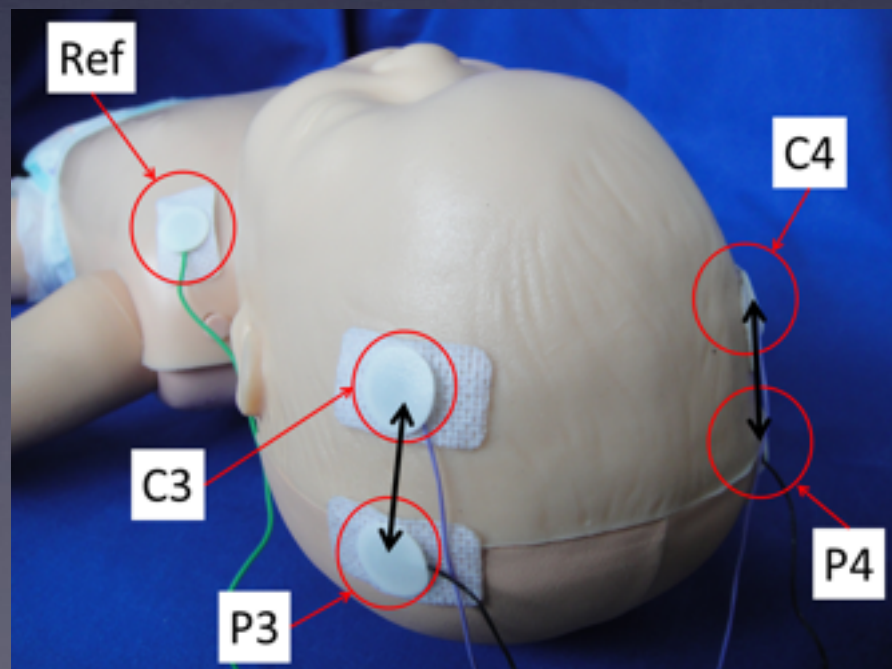
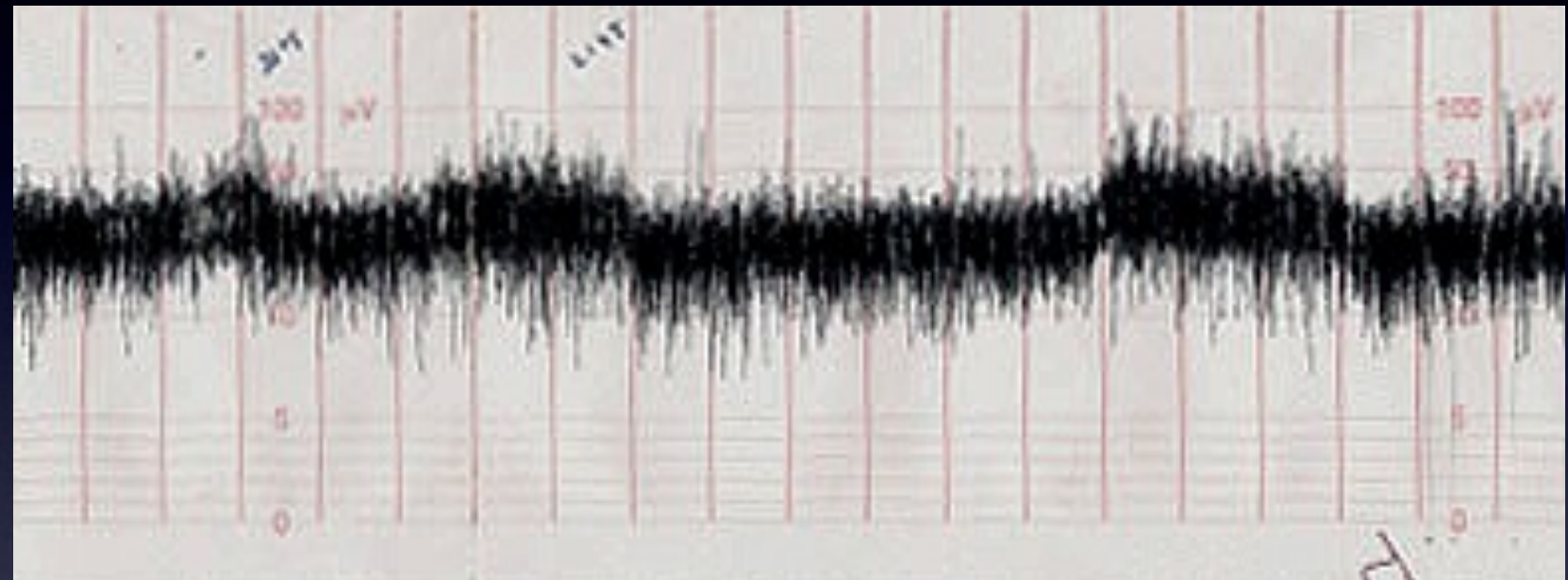
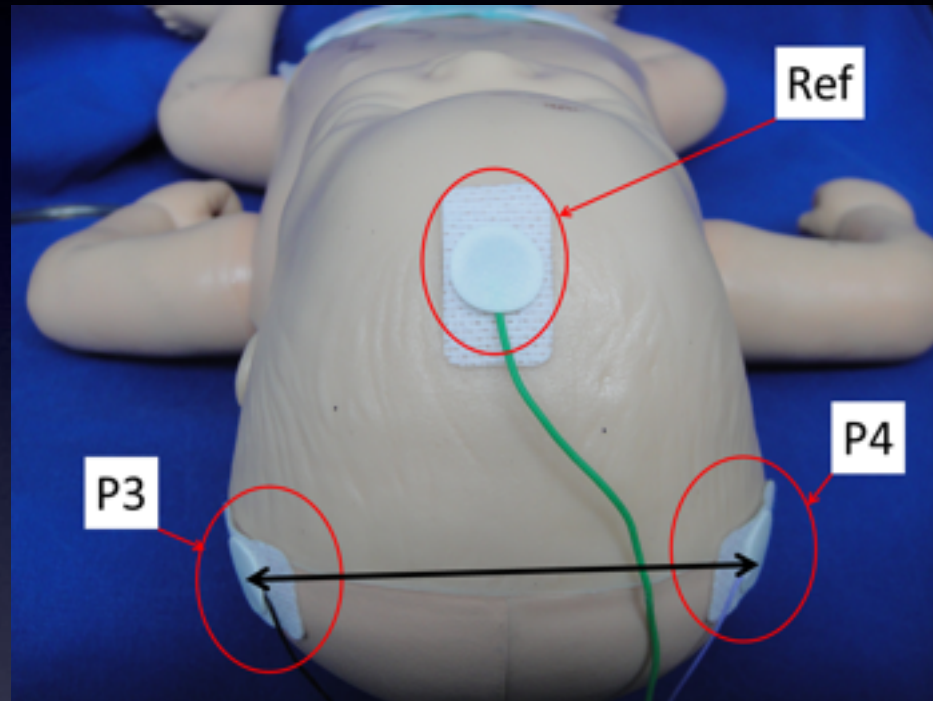


Kardiovaskuläre Doppler Ultraschallgeräte

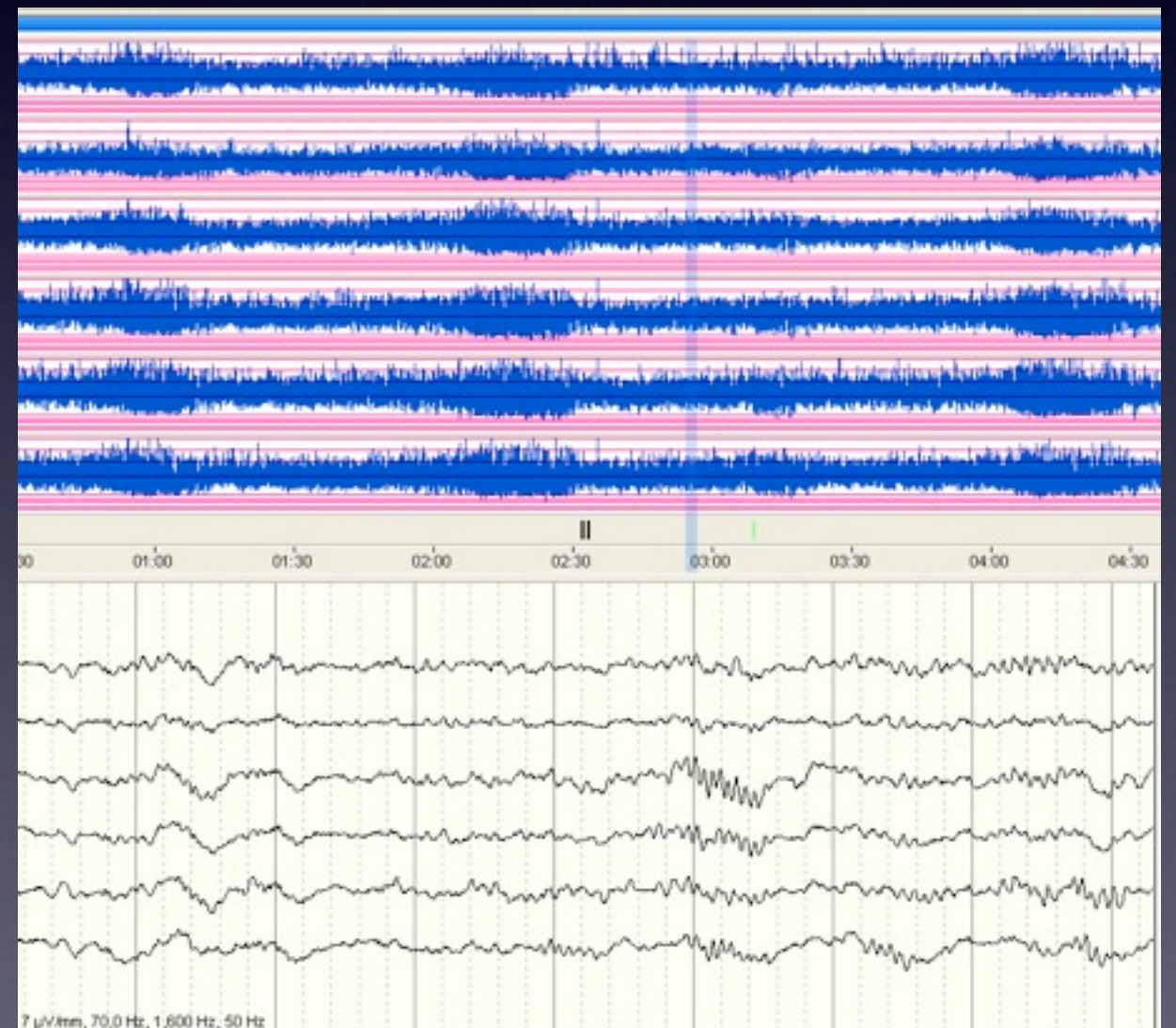
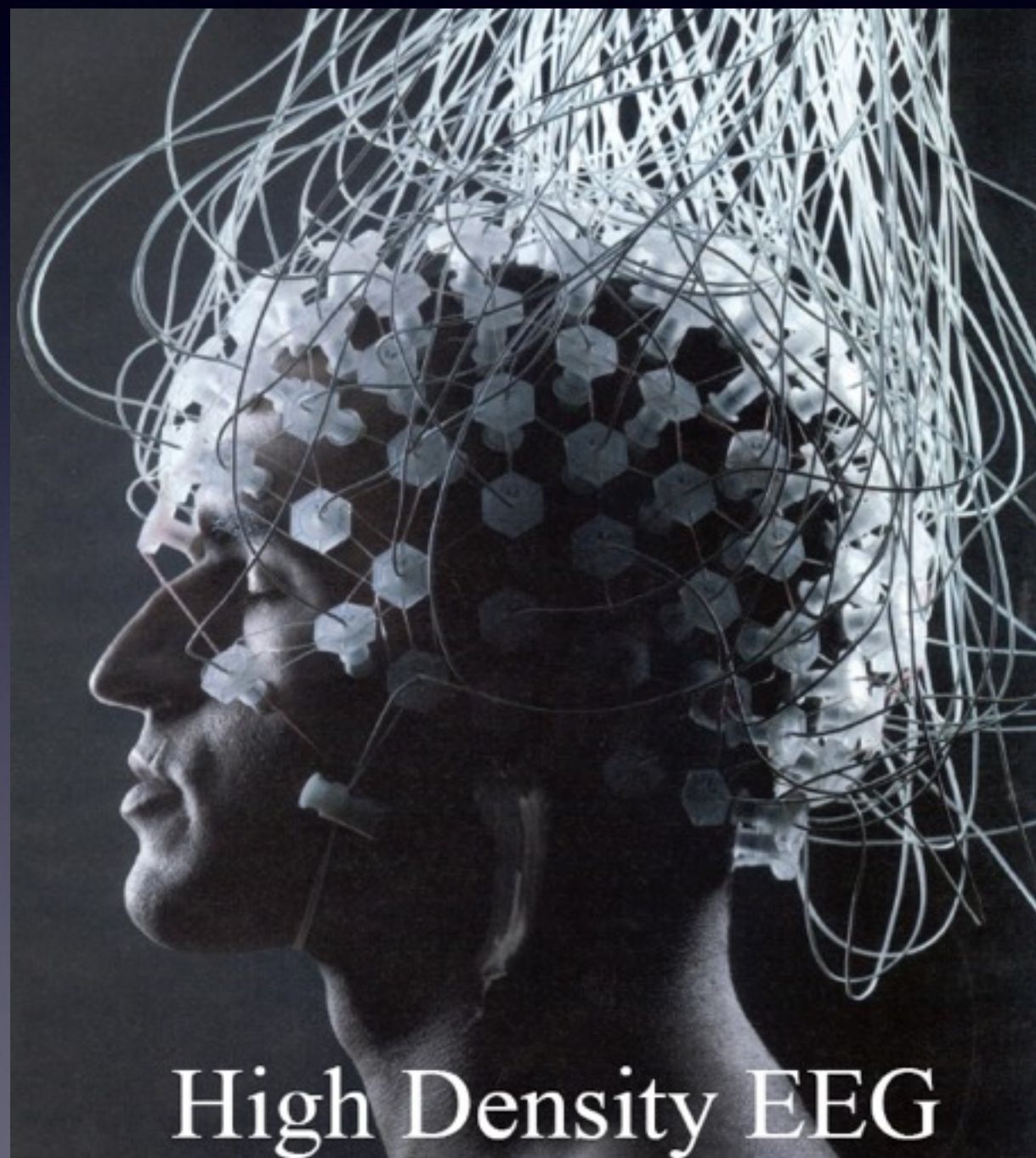
- CFM 6000
- Brainz / OBM
- Nicolet
-



1- or 2-channel

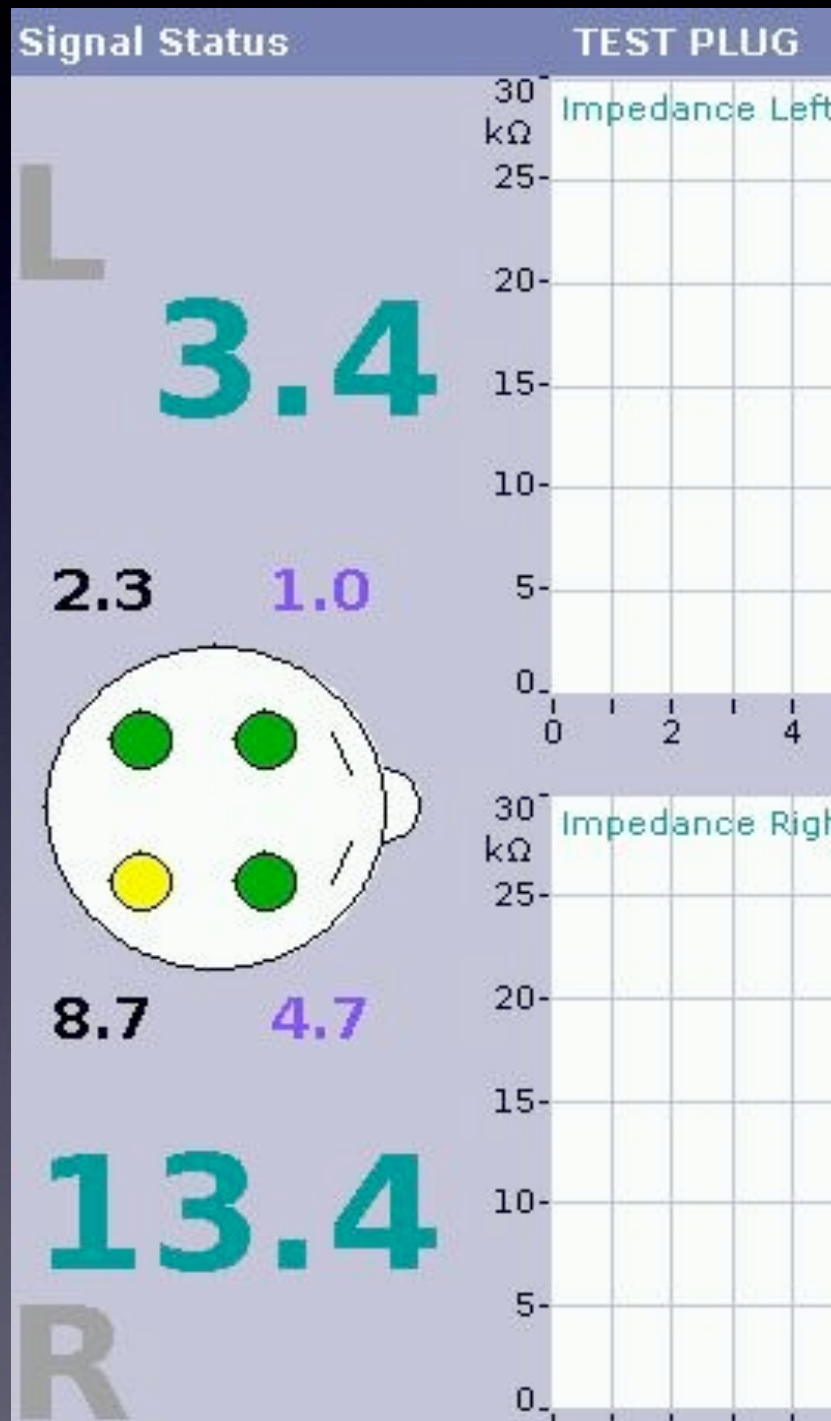


How many channels do you need ?

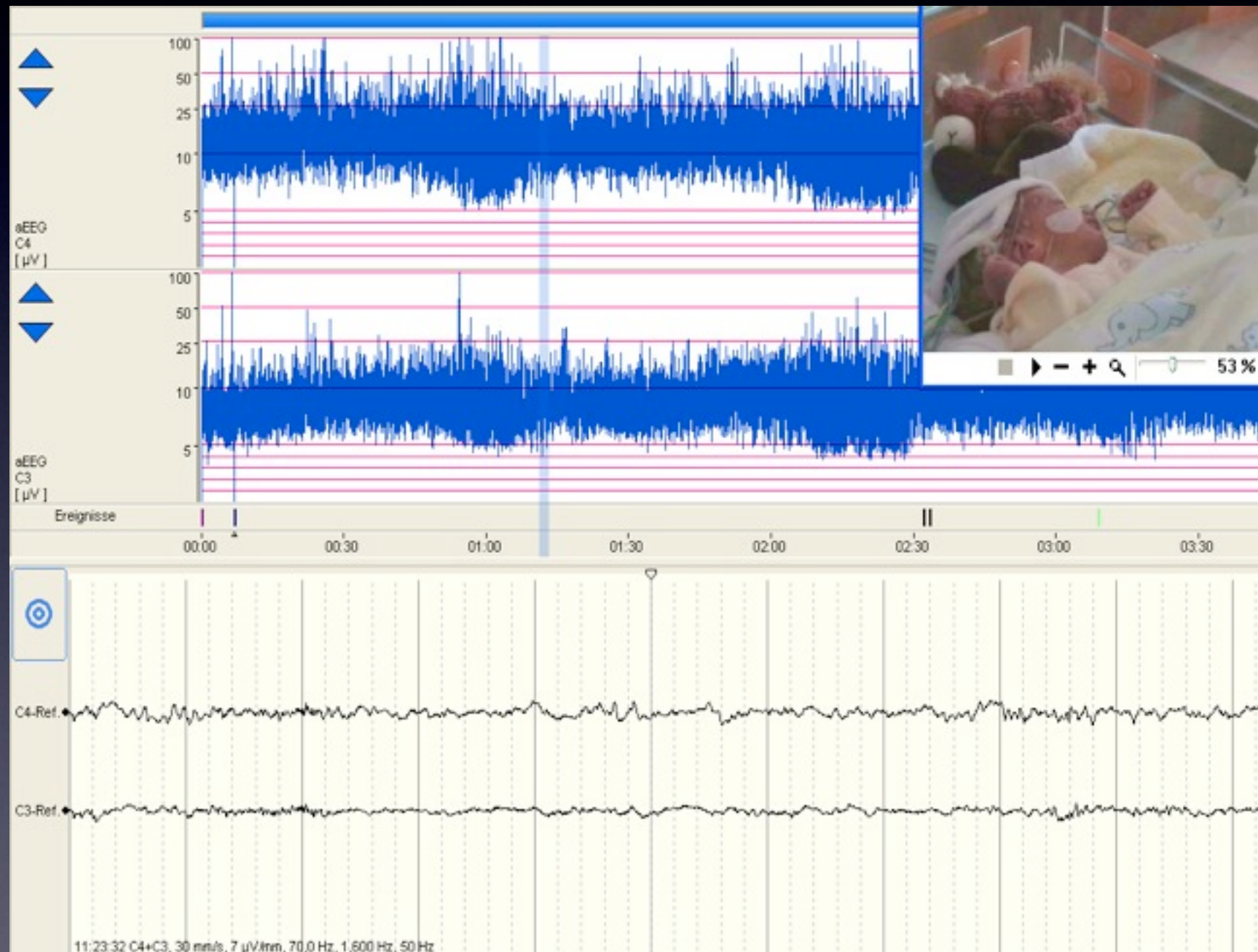


Impedance

measured continuously in „classic“ aEEG



Audio / Video



Integrated data

DSA

FFT Power

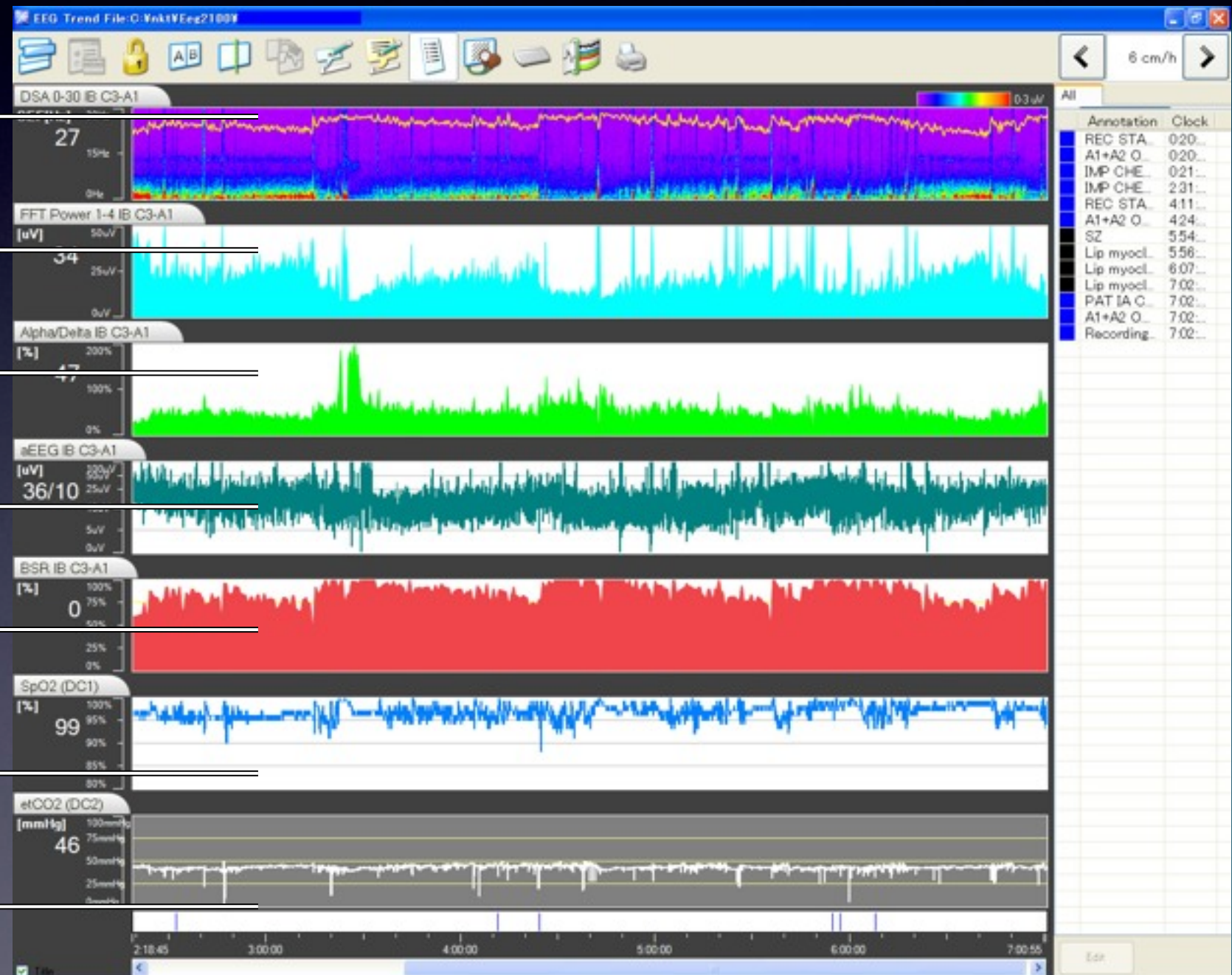
FFT Power Ratio

aEEG

BSR

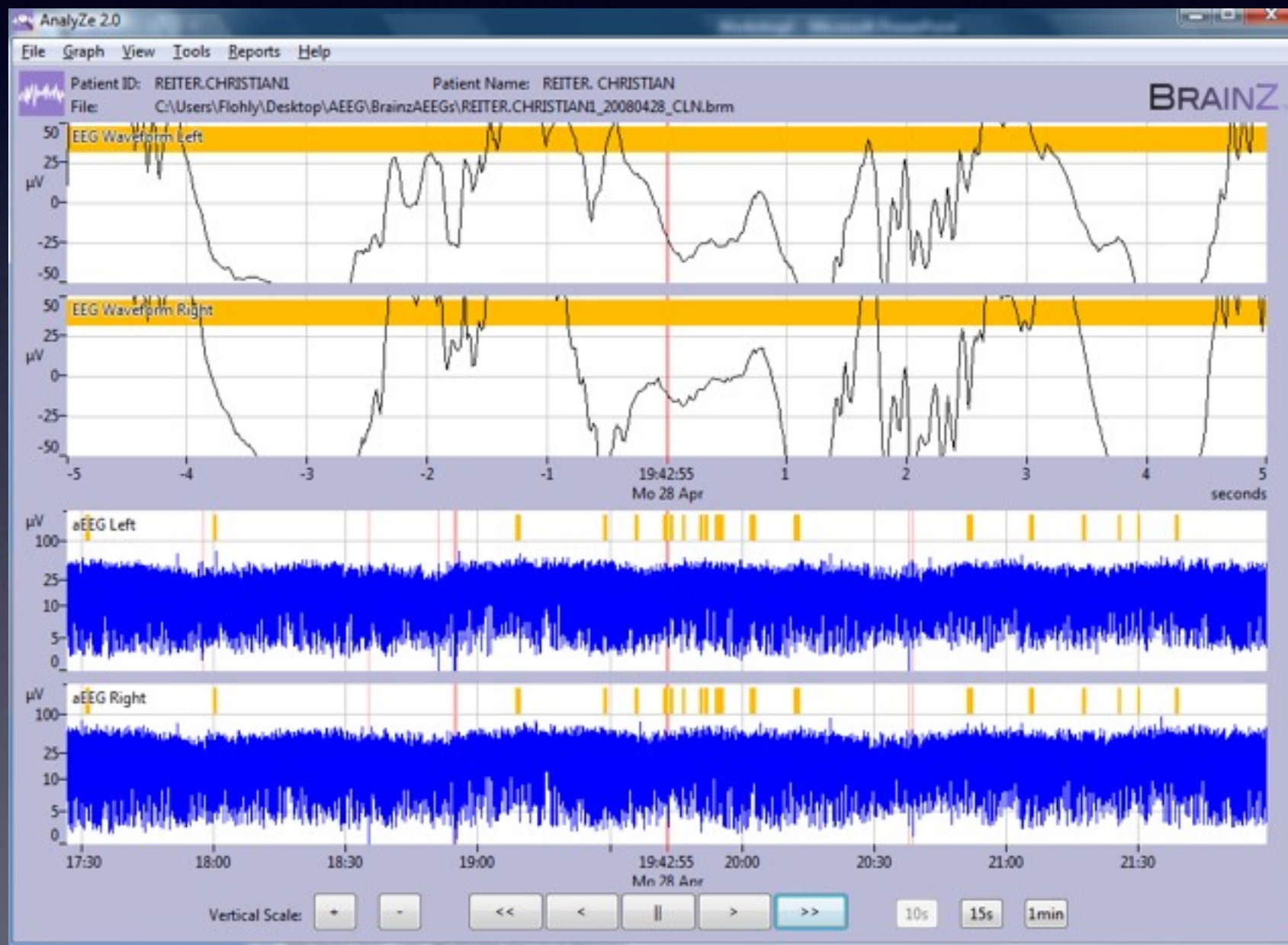
SpO₂

EtCO₂

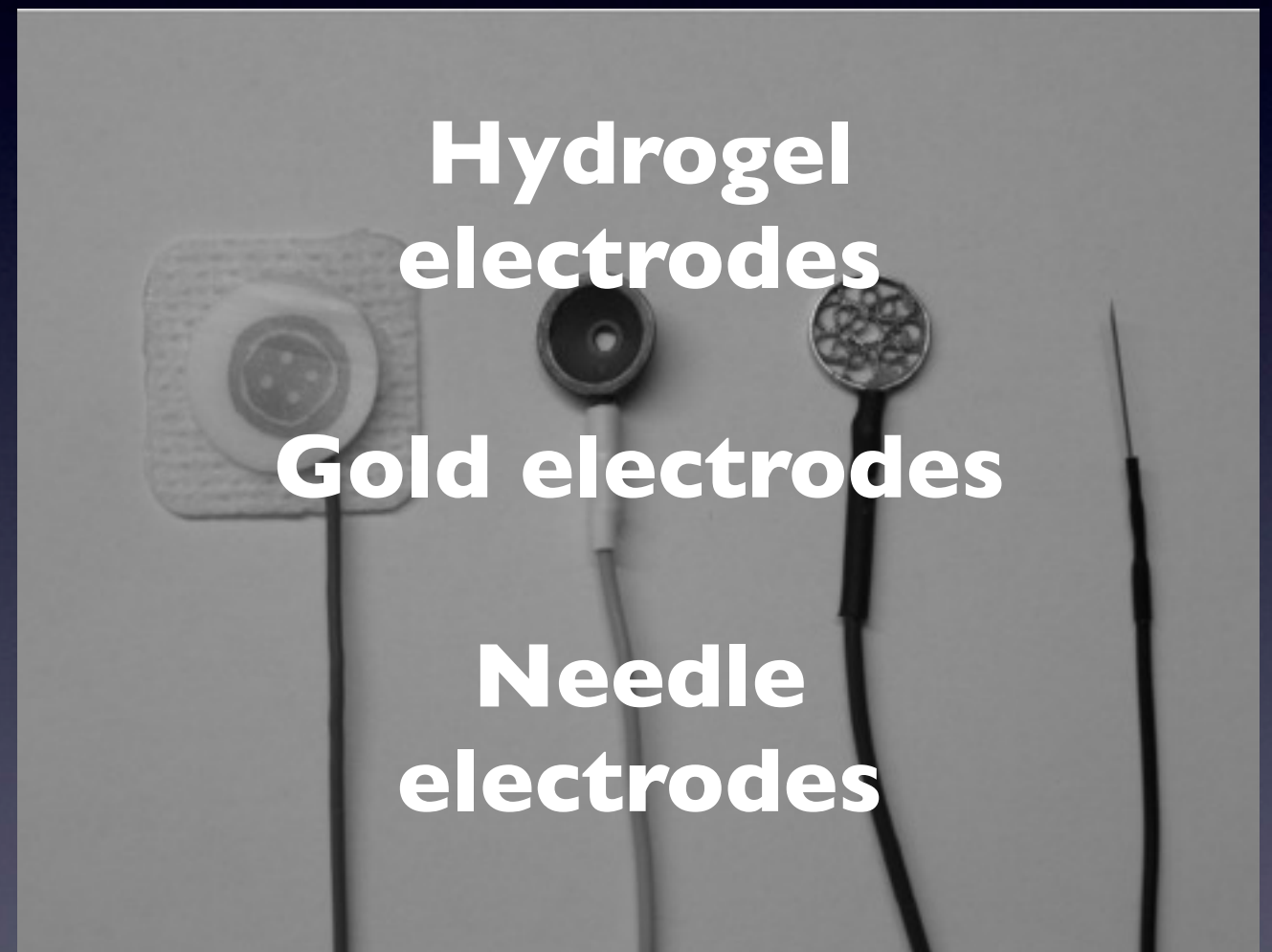


Automated seizure detection

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



Electrodes



**Hydrogel
electrodes**

Gold electrodes

**Needle
electrodes**

Hydrogel electrodes



Advantages:

- All-in-One concept**
- Better adhesion 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

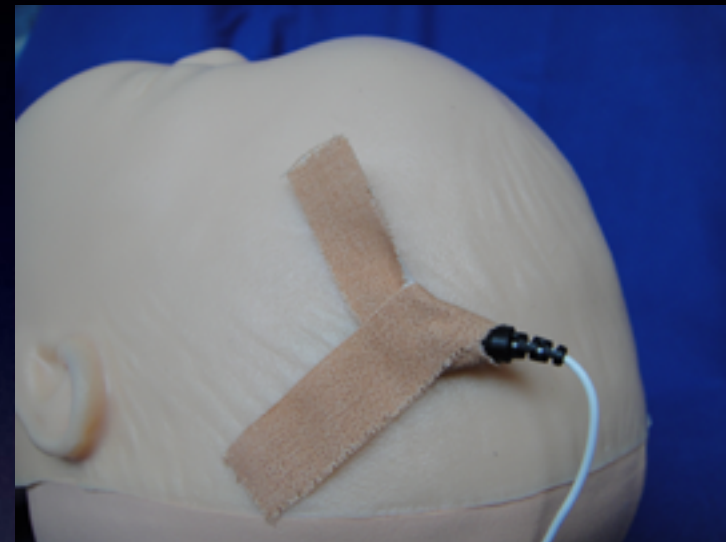
Best and most often used by nurses in EEG labs

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

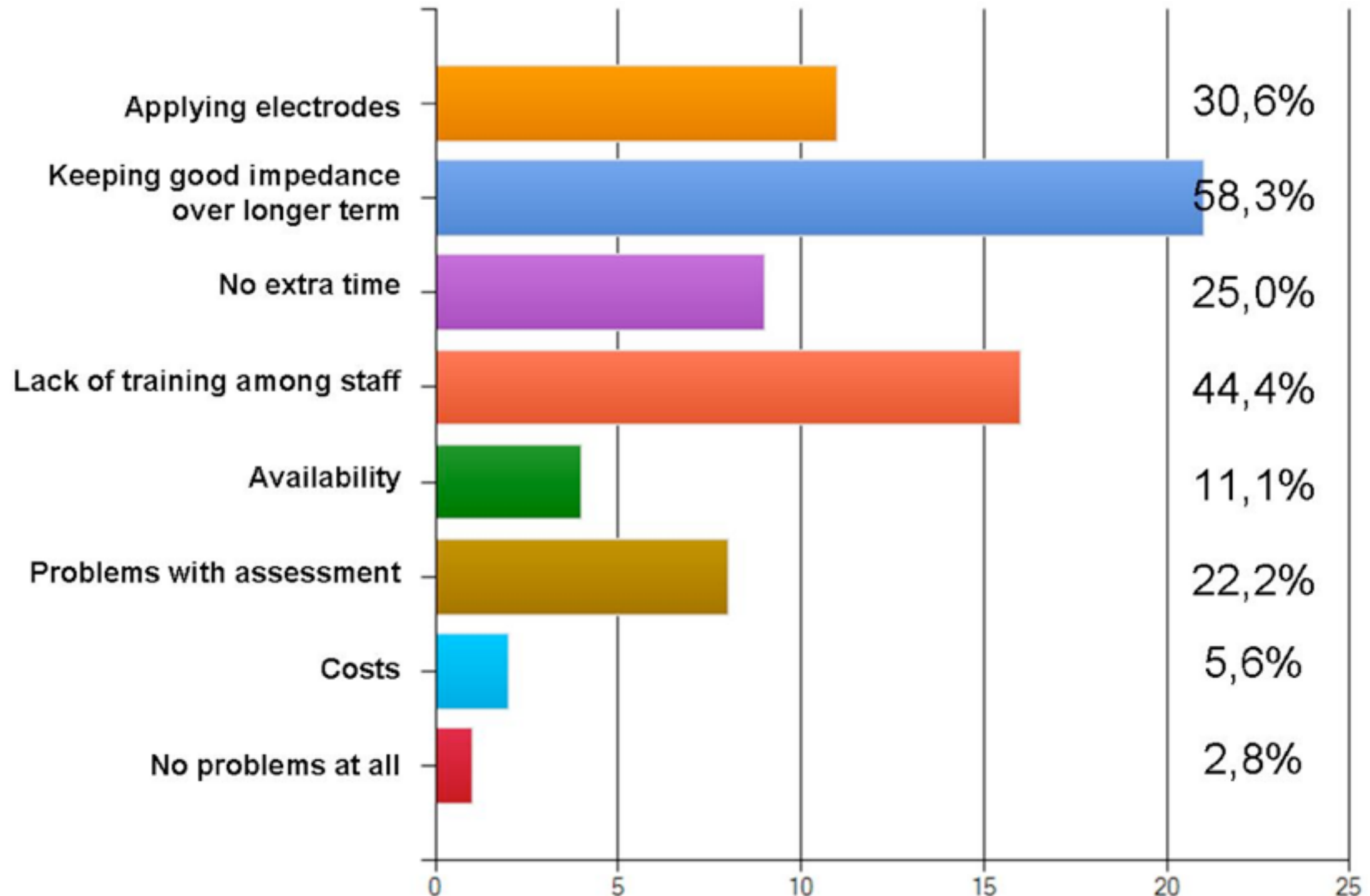
Disadvantages:

Expensive

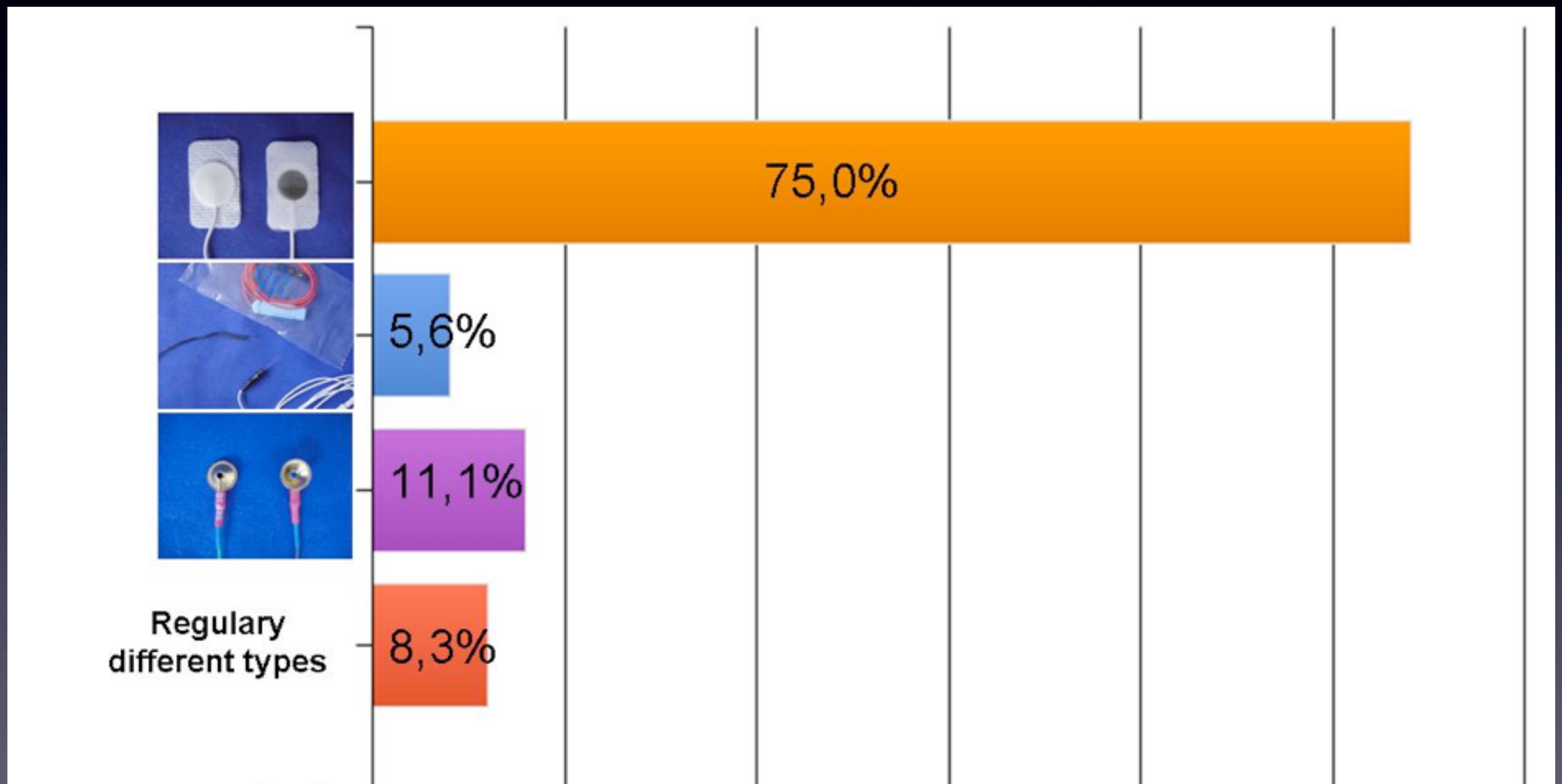
Seems highly invasive

Potential risk of infection ?

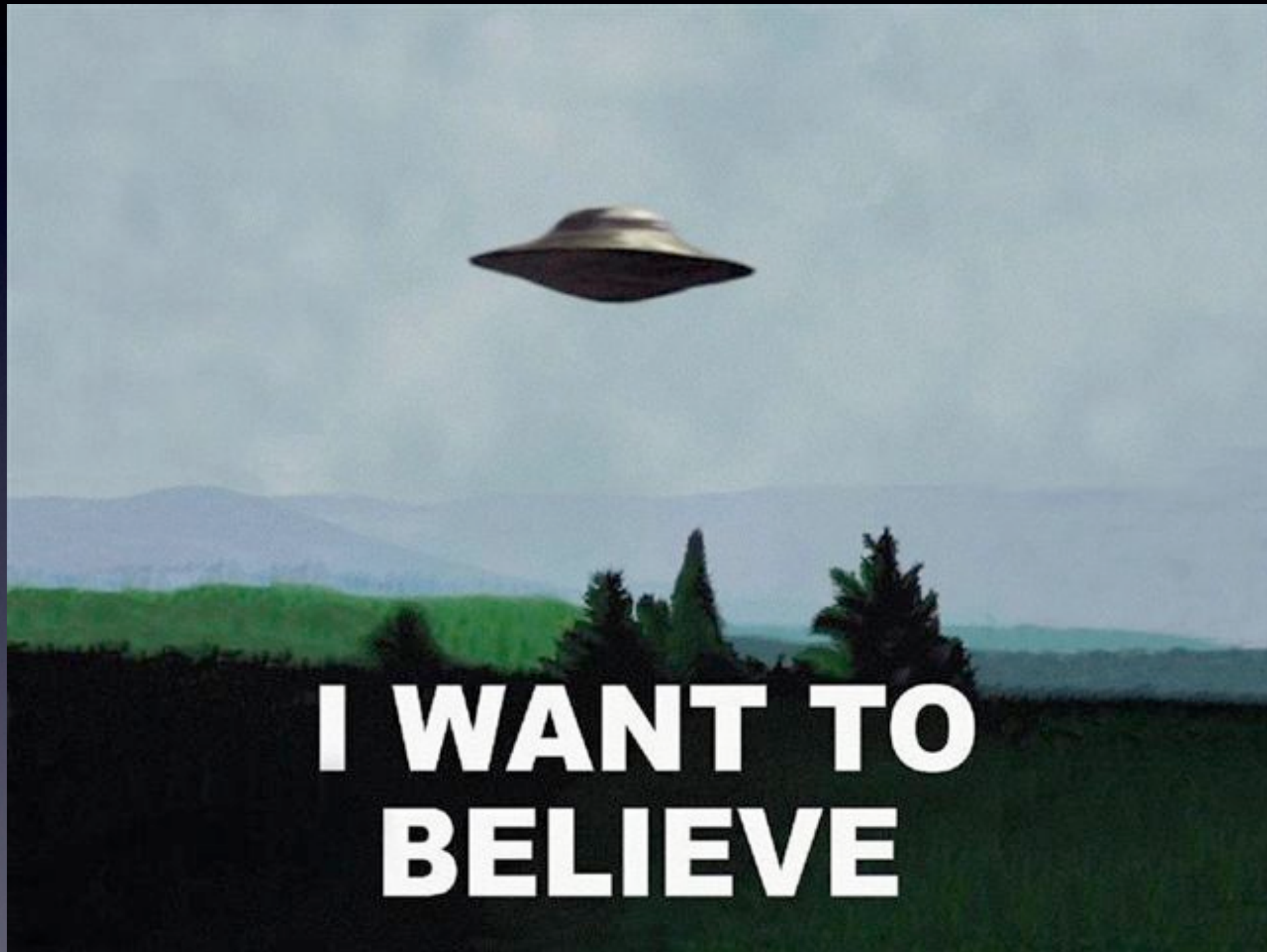
What keeps you away from using aEEG more often ?



Which type of electrodes do you typically use ?



Connection between frequency of use and type of electrodes ??





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

A Unique Learning Experience.

Basic Course fee: € 850 per person
The basic course fee includes all class lecture handouts, lecture materials on CD, Certificate of participation, DEGUM Certificate (German Society for Ultrasound in Medicine), CME* credits, lunch, snacks, and refreshments.

All-inclusive fee: €1,505 per person
This fee is fully inclusive of the basic Echo-course fee (all class lecture handouts, lecture materials on CD, Certificate of participation, DEGUM-Certificate by the German Society for Ultrasound in Medicine, CME* credits, lunch, snacks, and refreshments), 7 overnight stays at a four-stars Hotel from Monday July 8th, through Monday July 15th, 2013, all shuttle transfers and admission tickets to LaHo.

Special Programs fee: please inquire about our special programs we have available for your spouse or companion, who plans to come with you to Landshut but is not participating the courses and workshops.

*All participants will be eligible to collect 15 accredited CME points (Continuing Medical Education credits), certified by Bavarian State Chamber of Medicine.

Come join our Echo-course and be a part of the legendary "Landshuter Hochzeit" or "LaHo". The "Landshuter Wedding" is one of the largest historical pageants in Europe. More than 2,000 participants in medieval costumes bring a festival to life in all the splendor of the Late Middle Ages—the wedding between Hedwig, the Polish King's daughter, and Georg, the son of the Landshut Duke.

The tickets to the LaHo events, as well as hotel bookings, usually sell out rapidly. If you are interested in experiencing this spectacular event – which only takes place once every four years – early registrations of the all-inclusive fee is strongly recommended in order to secure your admission tickets and hotel reservations.

Save the date:
Tuesday 9th - Friday 12th, July 2013.

St. Mary Children's Hospital of Landshut, Germany is offering courses in Echocardiography, Sonography and Dopplerasonography in Neonatology and Pediatric Emergency Care.

Target Audience:
Pediatricians, neonatologists, pediatric internists, pediatric radiologists

Course Chairs & Faculty:
Rudolf Henrich, MD
Prof. Karl-Heinz Deng, MD
Johannes Hermann, MD
Florian Schettler, MD

Abbott

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**