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FILADELFIA
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ICU EEG Terminology

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Overview

- ACNS – terminology: the 2012 version
- Does this work? What is this good for?
  - IRA
  - Predicting seizures
- ACNS – terminology: new elements in the next version (2018?)
- How to use SCORE for reporting ICU-EEGs

INVITED REVIEW

American Clinical Neurophysiology Society's Standardized Critical Care EEG Terminology: 2012 version

L. J. Hirsch, S. M. LaRoche, N. Gaspard, E. Gerard, A. Svoronos, S. T. Herman, R. Mani, H. Arif, N. Jette, Y. Minazad, J. F. Kerrigan, P. Vespa, S. Hantus, J. Claassen, G. B. Young, E. So, P. W. Kaplan, M. R. Nuwer, N. B. Fountain, and F. W. Drislane

Objectives:

- Develop standardized terminology for scientific investigations
- Avoid "ictal", "interictal" and "epileptiform" for the equivocal patterns (e.g. the E in PLEDs)
- Allow multicenter studies/ comparison of results between centers

ACNS – 2012 terminology

- Rhythmic or periodic patterns
  - Main terms (1 & 2)
  - Modifiers
- Background EEG
- Quantification of sporadic epileptiform discharges
- Time epochs to be reported separately

Not included:

- Unequivocal seizure patterns
- Not intended for use in neonates

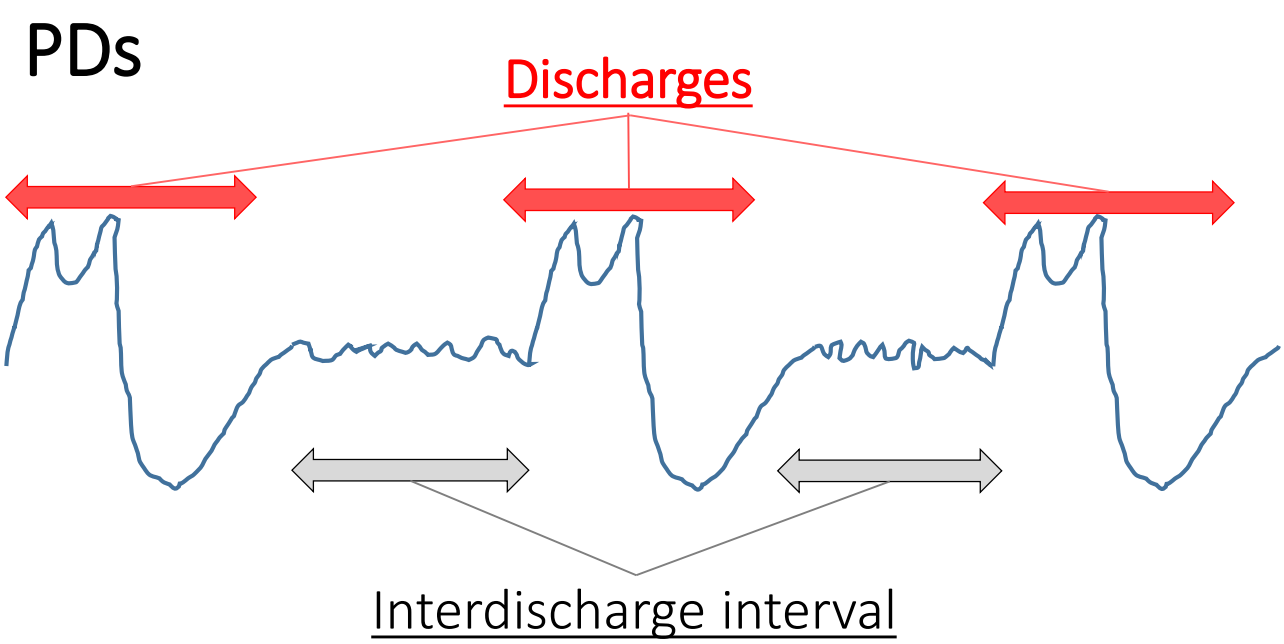
Rhythmic or Periodic Patterns

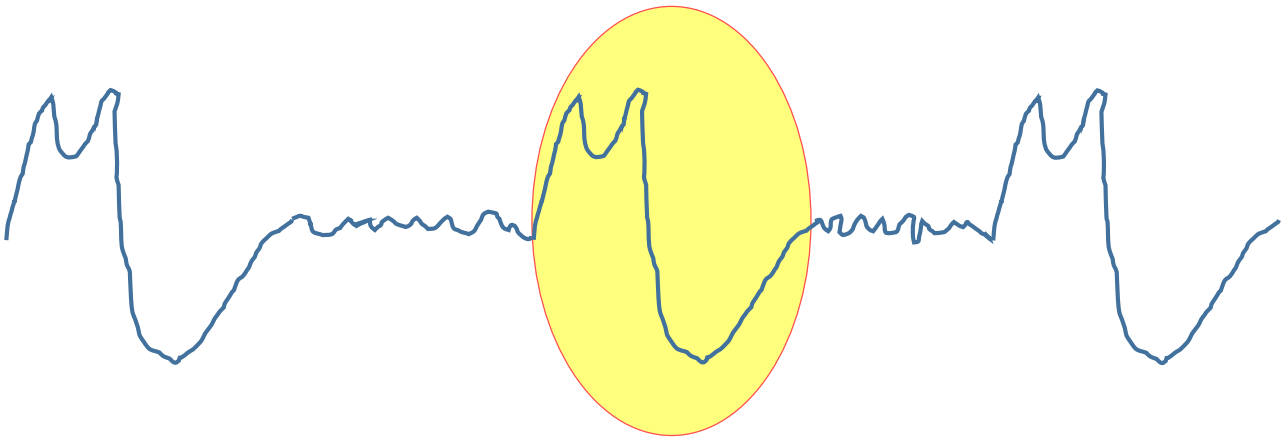
Main term 1

G	Generalized
L	Lateralized
BI	Bilateral Independent
Mf	Multifocal

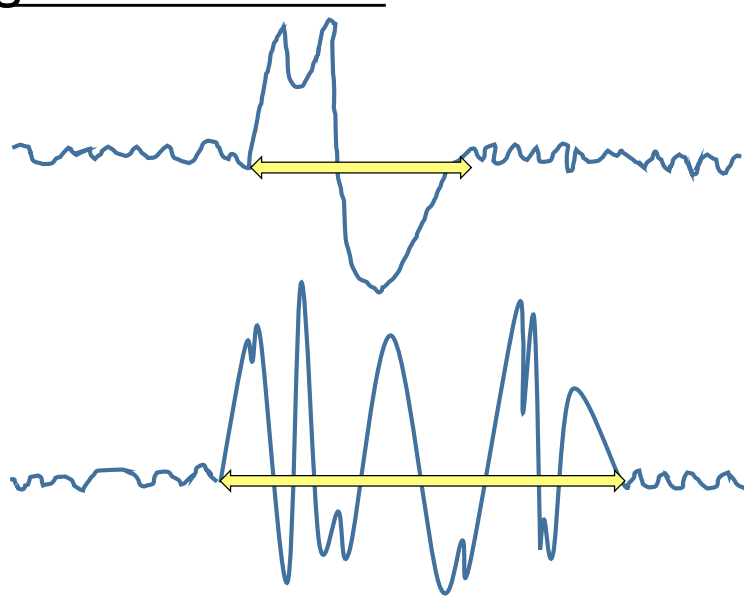
Main term #2

PDs	Periodic Discharges
RDA	Rhythmic Delta Activity
SW	(Poly)Spike-&-Wave/Sharp-and-Wave





Discharges versus Bursts



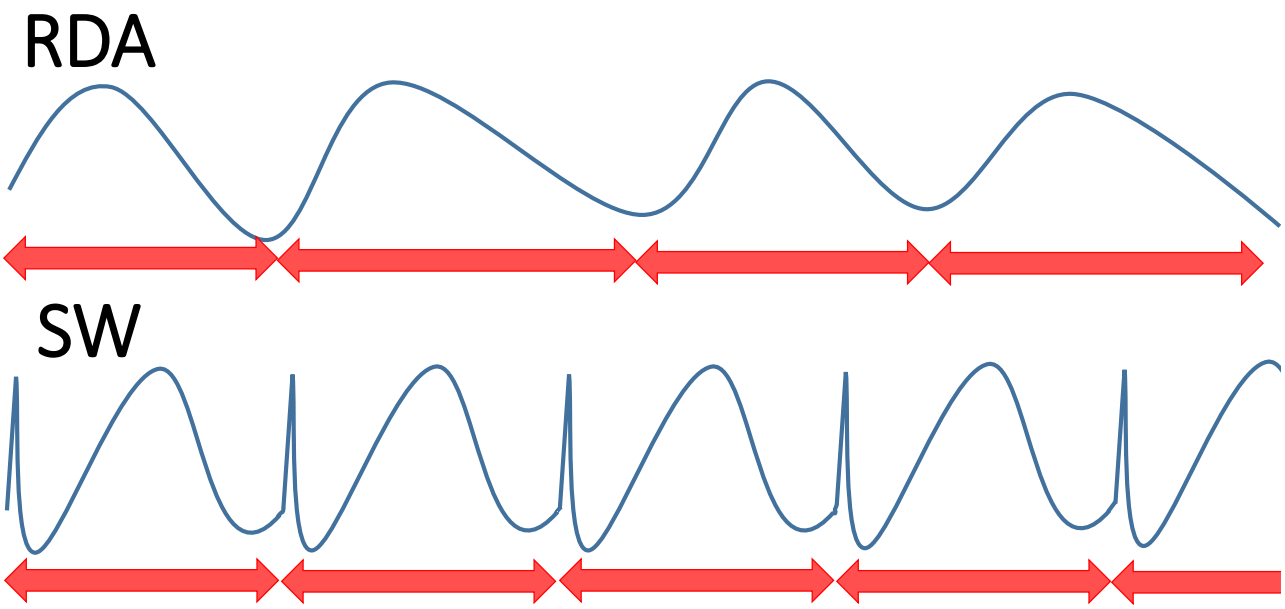
Discharges

- Any: shorter than 0.5 s
- Longer than 0.5 s and no more than 3 phases

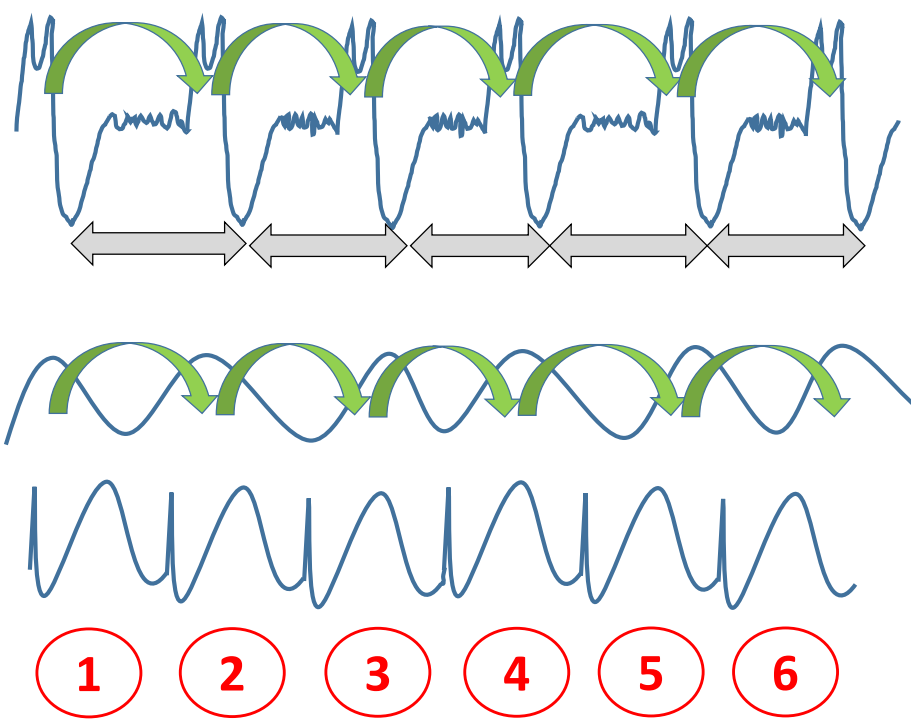
Bursts

- Longer than 0.5 s and more than 3 phases

No interval between consecutive waveforms / cycles



- PDs, RDA, SW:
  at least 6 cycles
- PDs: nearly regular intervals (varying by <50% ; in most cycles)
- Discharges / waves: relatively uniform morphology



Main term-1

- **G** (Generalized) → bilateral, bisynchronous and symmetric pattern
  - Frontally predominant /occipitally predominant / midline predominant
- **L** (Lateralized) → unilateral and bilateral synchronous but asymmetric (focal, regional and hemispheric patterns)
  - Specify: unilateral vs bilateral asymmetric
  - Specify: lobe(s) most involved or hemispheric
- **BI** (Bilateral Independent) → 2 independent (asynchronous) lateralized patterns, one in each hemisphere
- **MF** (Multifocal) → at least three independent lateralized patterns, at least one in each hemisphere)
  - Specify: symmetric vs. asymmetric
  - Specify: lobe(s) most involved or hemispheric

Modifiers

1. Prevalence
2. Duration
3. Frequency
4. Number of phases
5. Sharpness
6. Amplitude
7. Polarity
8. Stimulus-Induced
9. Evolving or fluctuating
10. ”Plus” features

Modifiers

- **Wave-morphology:**
  - **Plus**
  - **Sharpness**
  - **Number of phases**
  - **Amplitude**
  - **Polarity**
- **Time-related features:**
  - **Evolving or fluctuating**
  - **Prevalence**
  - **Duration**
  - **Frequency**
- **Modulation:**
  - **Stimulus Induced**

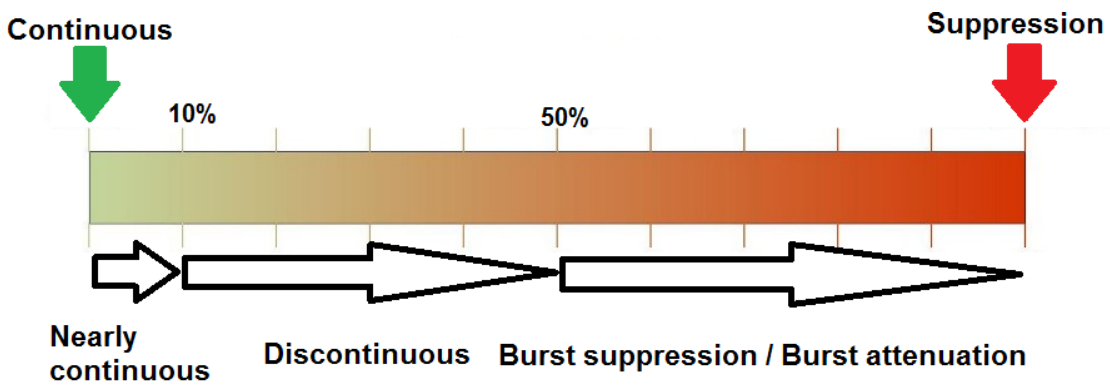
Background EEG

- **Symmetry:**
  - Symmetric
  - Mild asymmetry (consistently; <50% amplitude or 0.5 - 1 Hz in frequency)
  - Marked asymmetry (consistently; >50% amplitude or >1 Hz in frequency).
- **Breach effect** (note present/ absent / unclear)
- **Posterior dominant rhythm:**
  - Absent
  - Specify frequency (to the nearest 0.5 Hz)
- **Predominant background EEG frequency:**
  - Delta, Theta, and/or >Alpha.
- **Anterior-posterior (AP) gradient** (Present, absent or reverse)
- **Variability** (Yes / No / Unknown/unclear/not applicable)
- **Reactivity** (Yes / No / Unknown/unclear/not applicable)
- **Voltage** (Normal / Low: <20 µV / Suppressed: <10 µV).
- **Continuity**

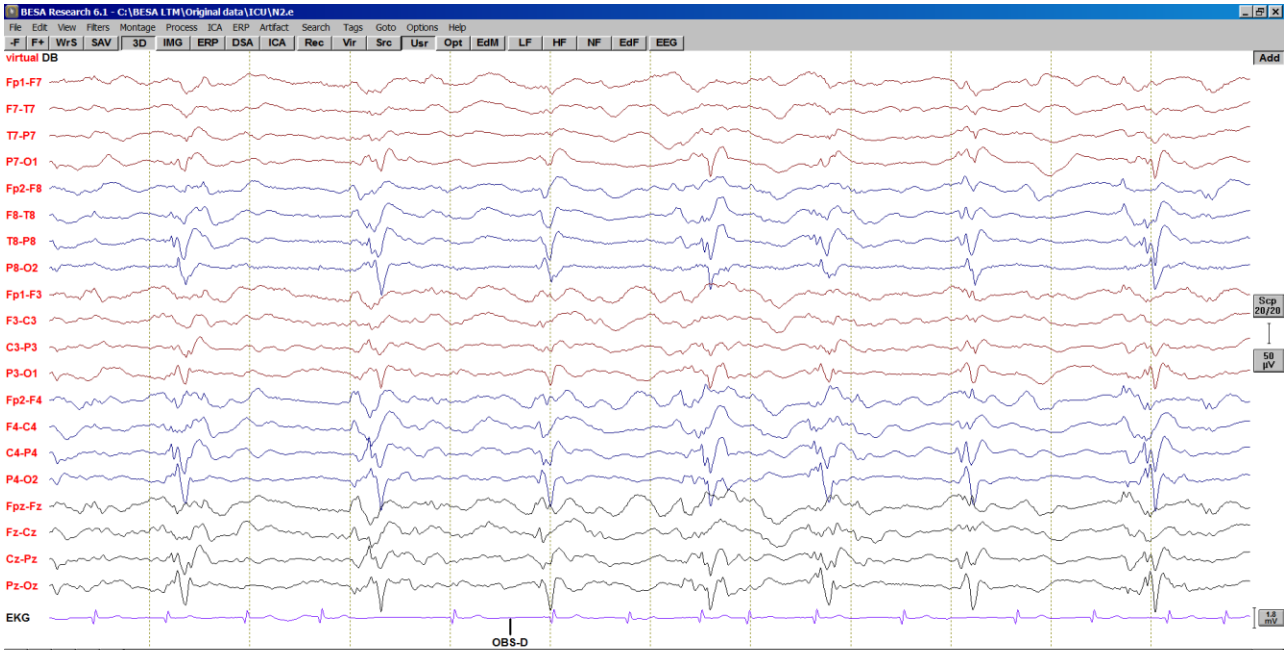
Background EEG: Continuity

*What is **not** continuous:*

- Suppression: <10 µV
- Attenuation: ≥ 10 µV but but <50% of the background voltage



Sharp LPDs + FR



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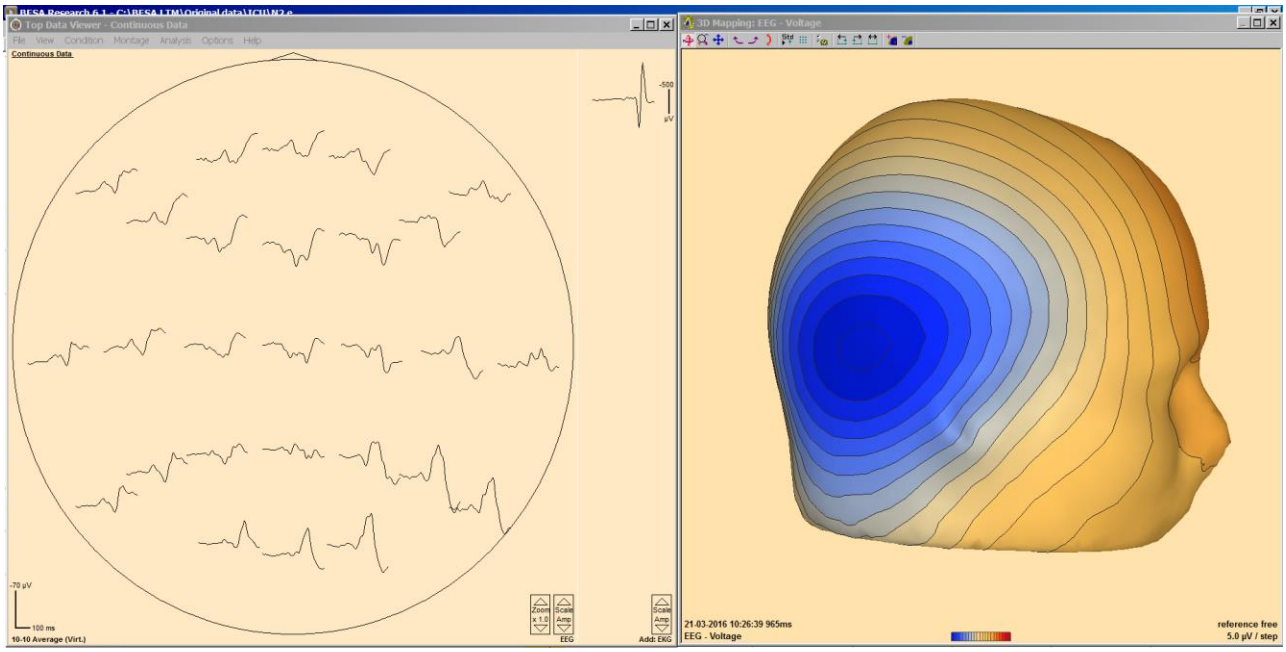

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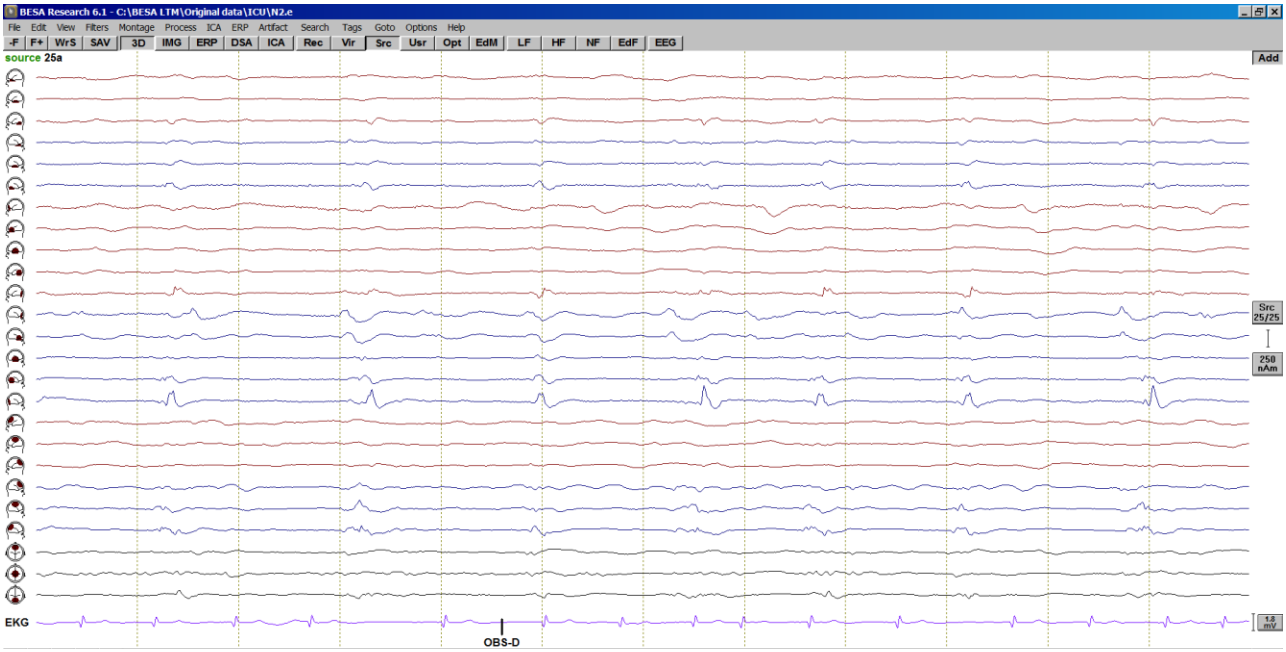
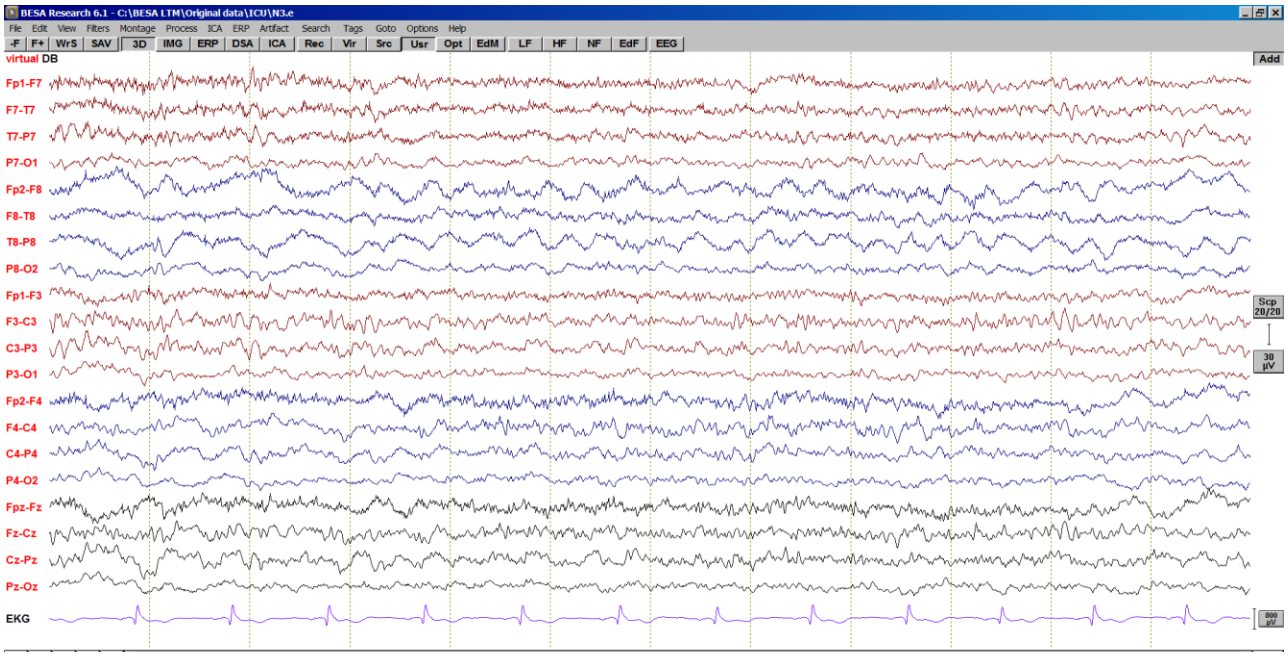


LRDA + S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T8-P8
P8-O2
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F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
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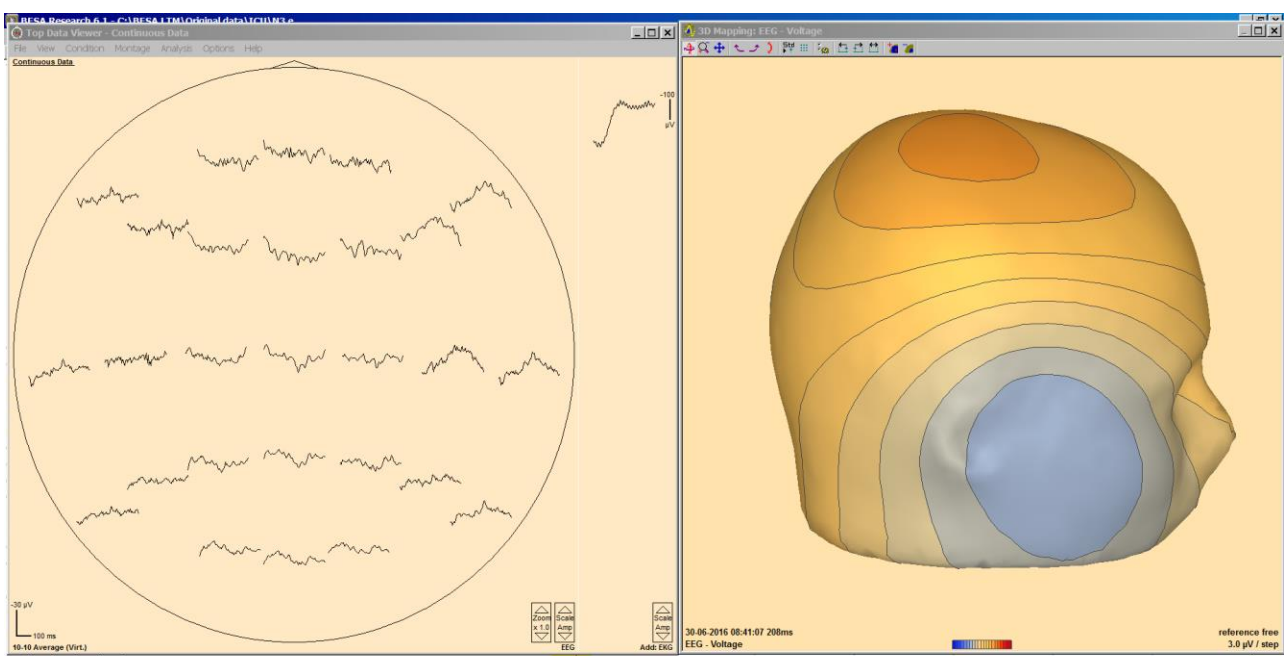
Pz-Oz
EKG
Scp 20/20
30 µV

LRDA + S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EEG - Voltage
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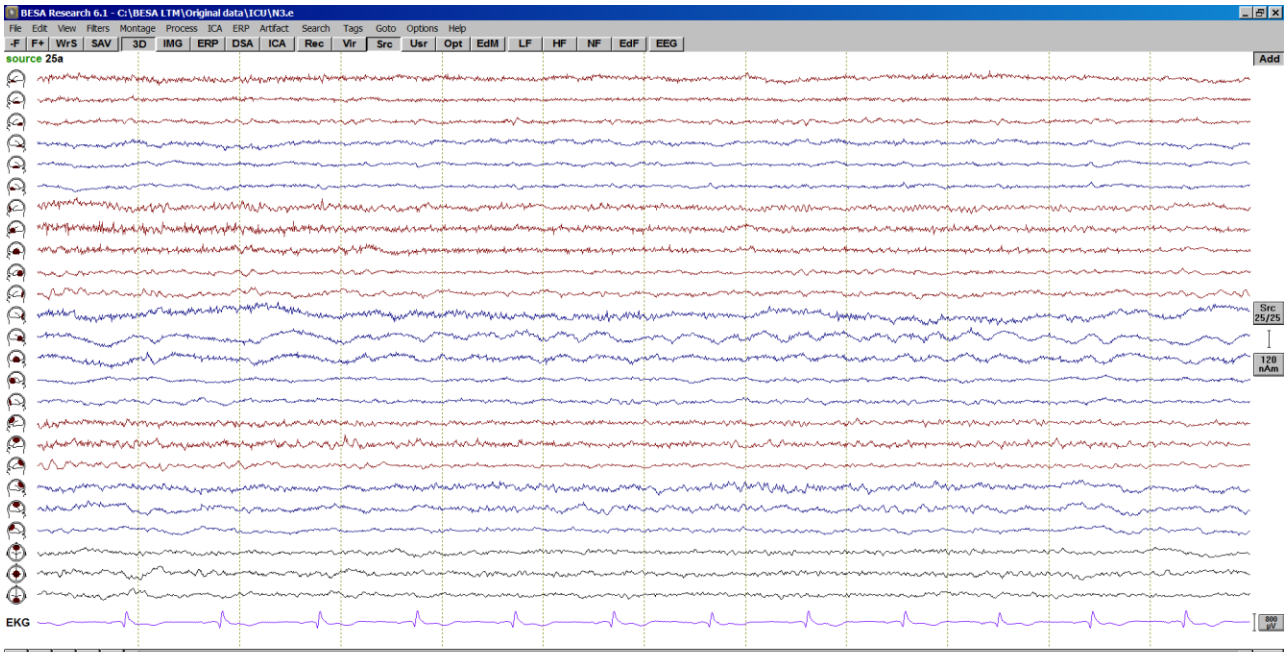
3.0 µV / step

LRDA + S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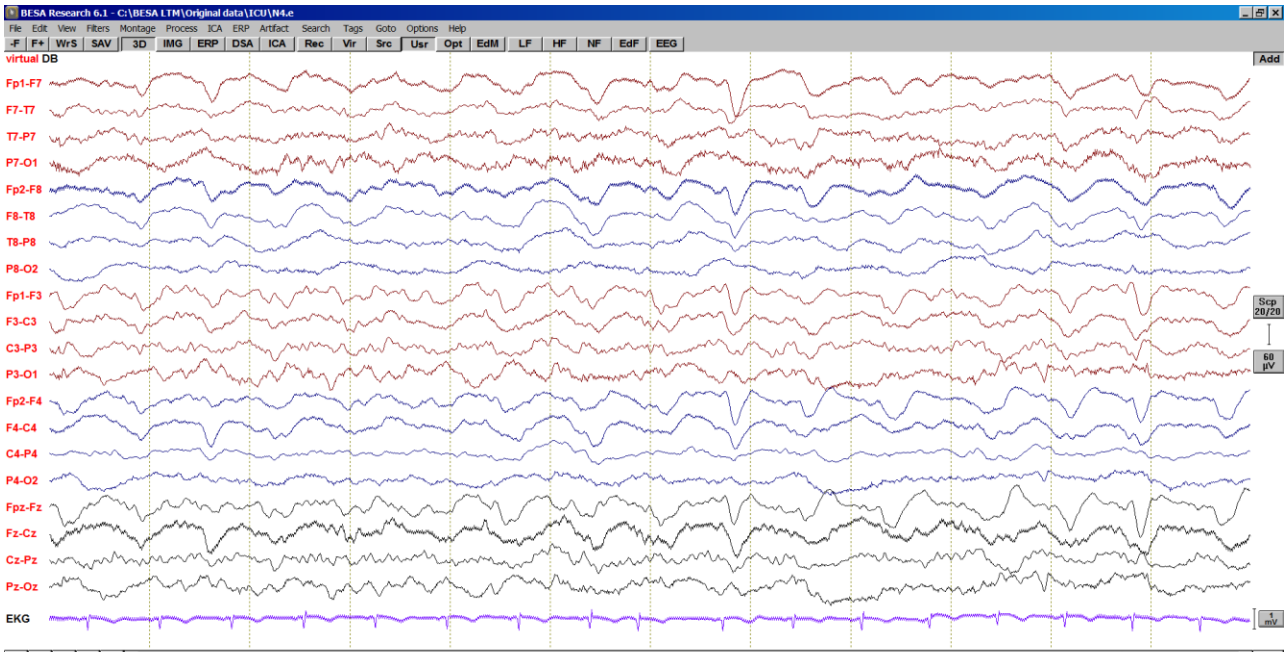
120 nAm
EKG
800 µV

GRDA + S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T7-P7
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P8-O2
Fp1-F3
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C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
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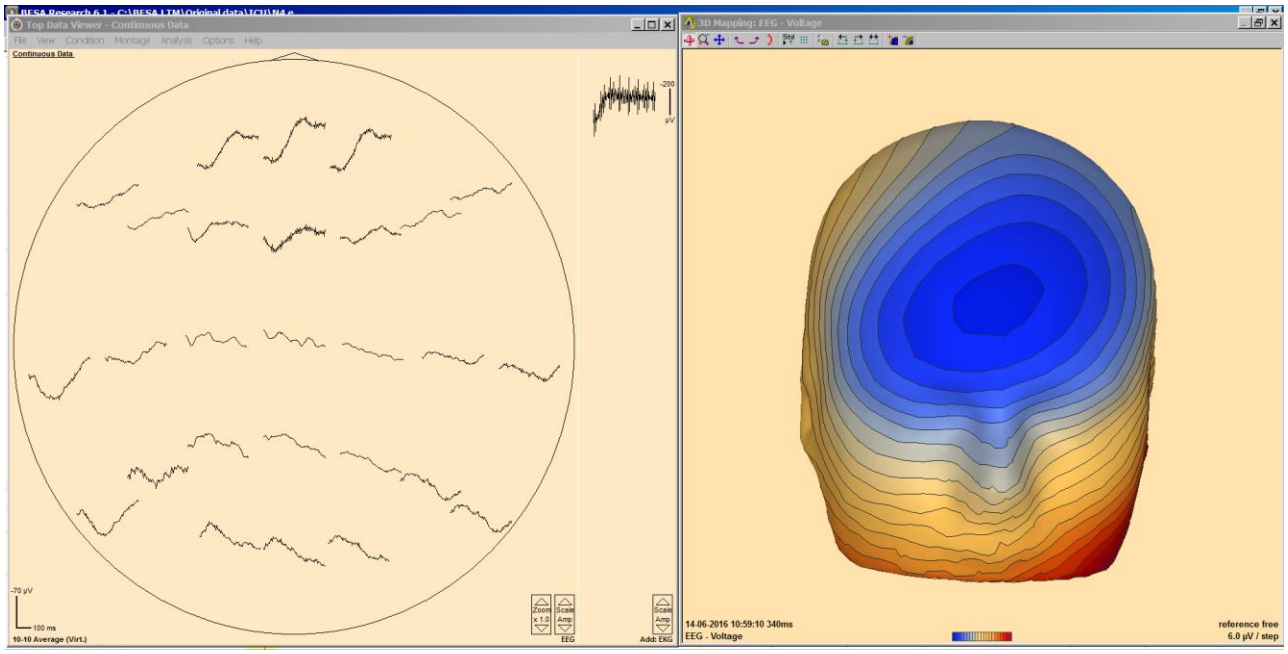
Fz-Cz
Cz-Pz
Pz-Oz
Scp 20/20
60 µV
EKG
1 mV

GRDA + S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Continuous Data
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µV
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x 1.0
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EEG
Add: EKG
3D Mapping: EEG - Voltage
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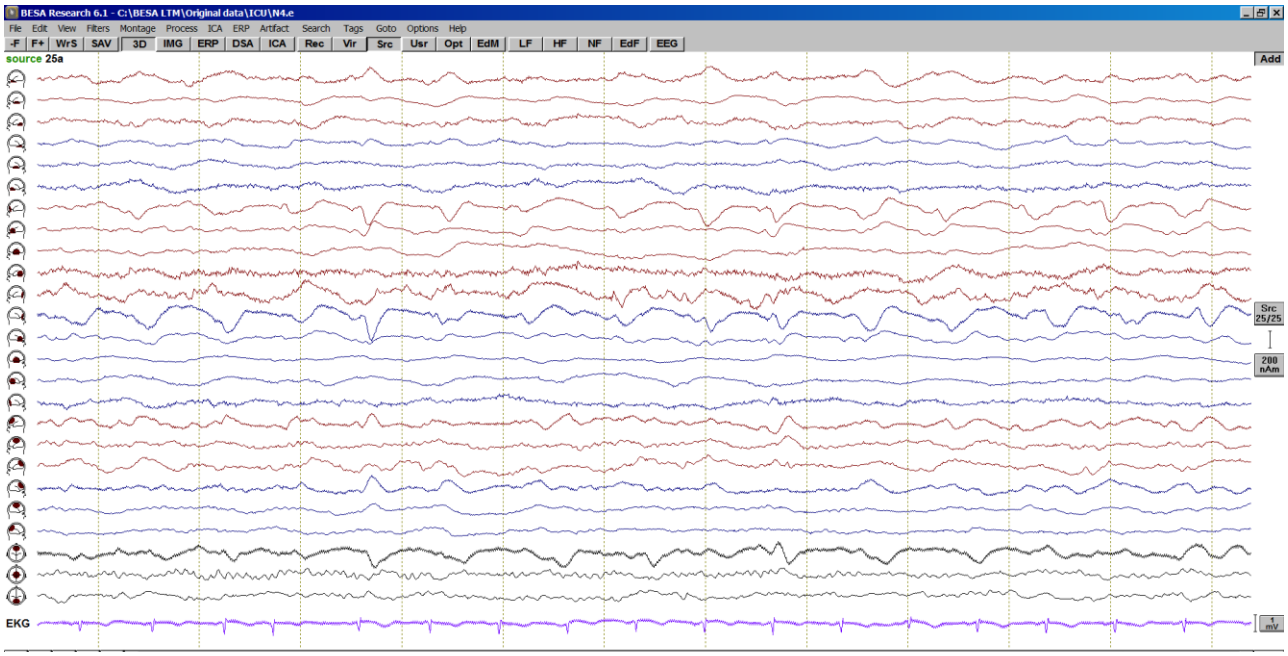
EEG - Voltage
reference free
6.0 µV / step

GRDA + S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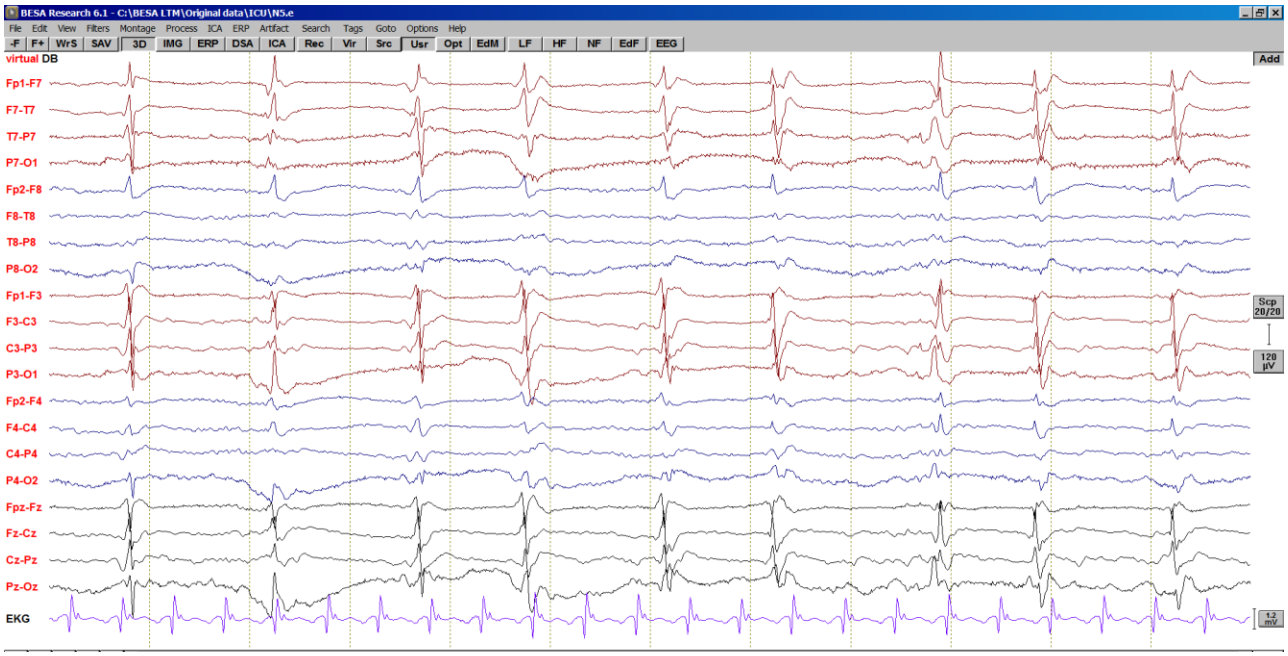
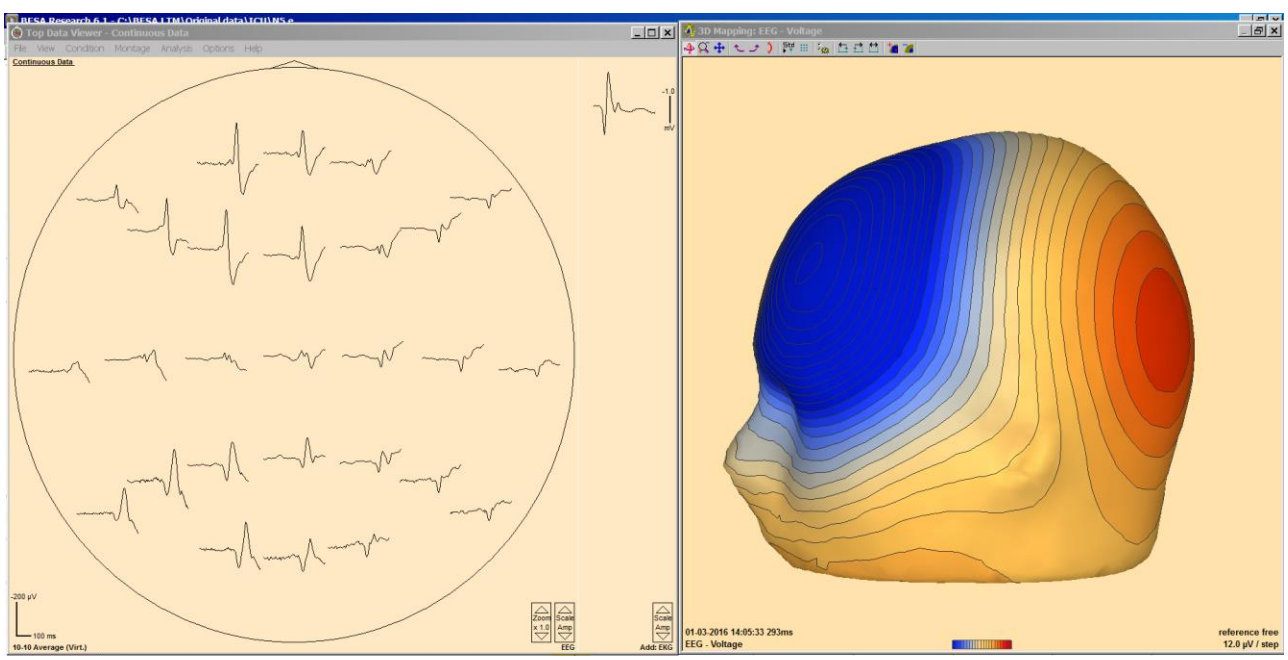
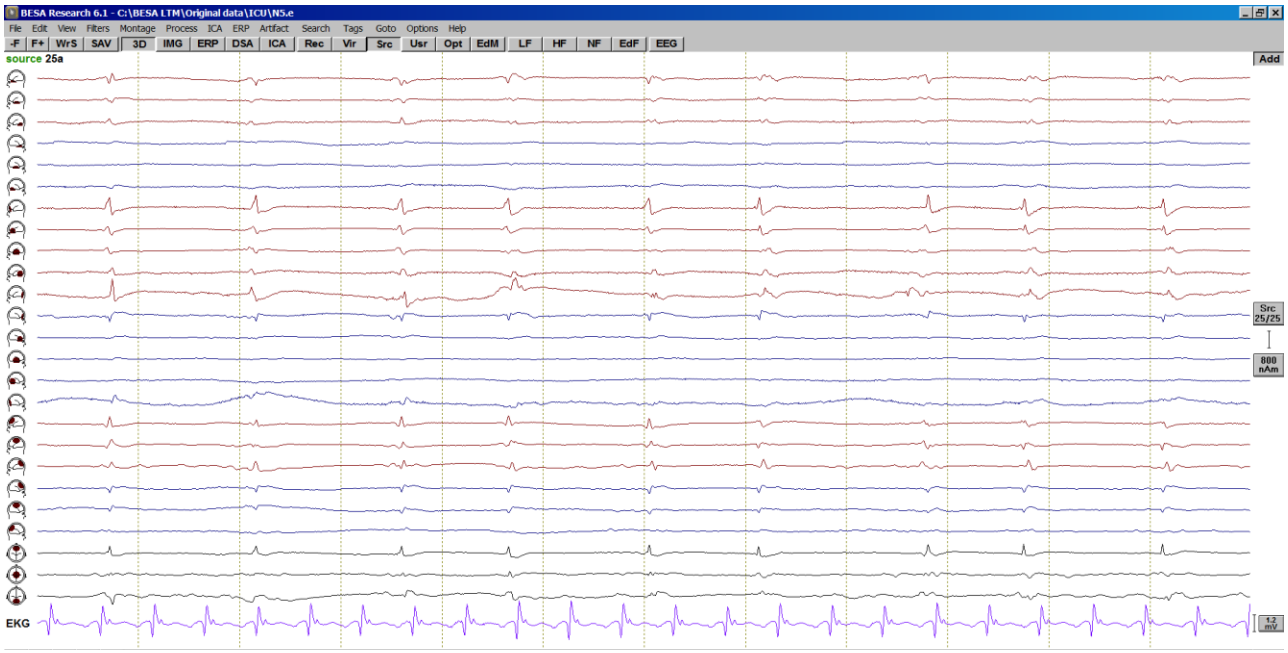
Spiky LPDs



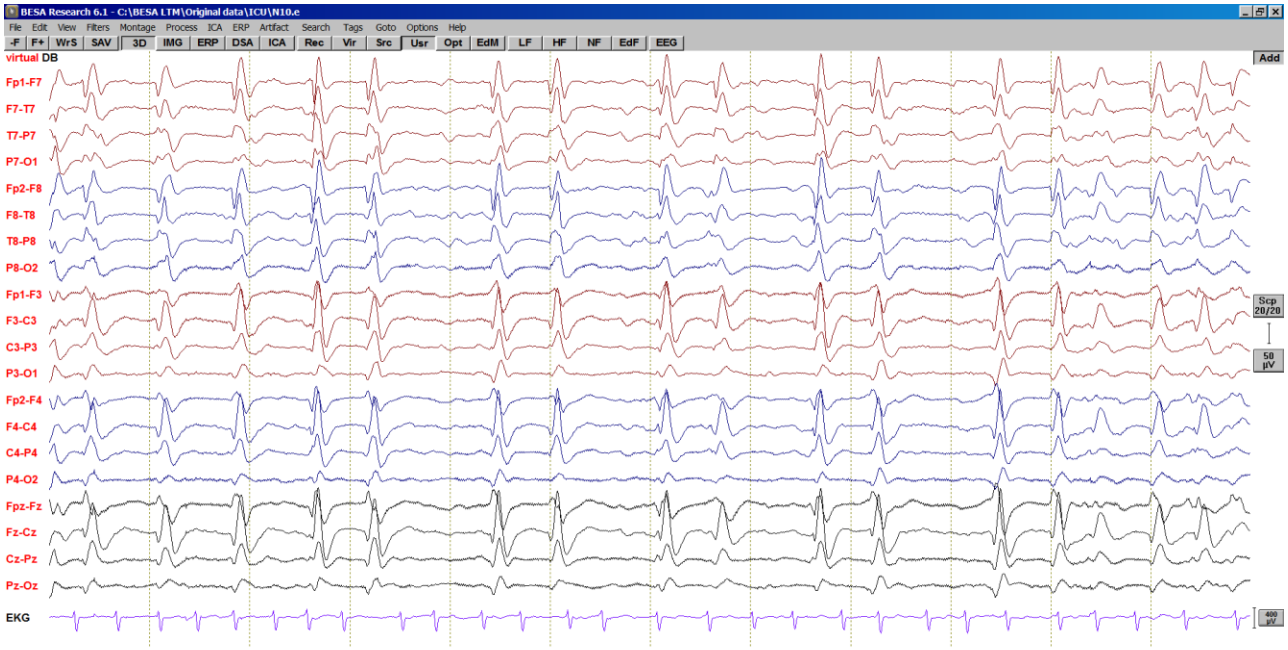
Spiky LPDs



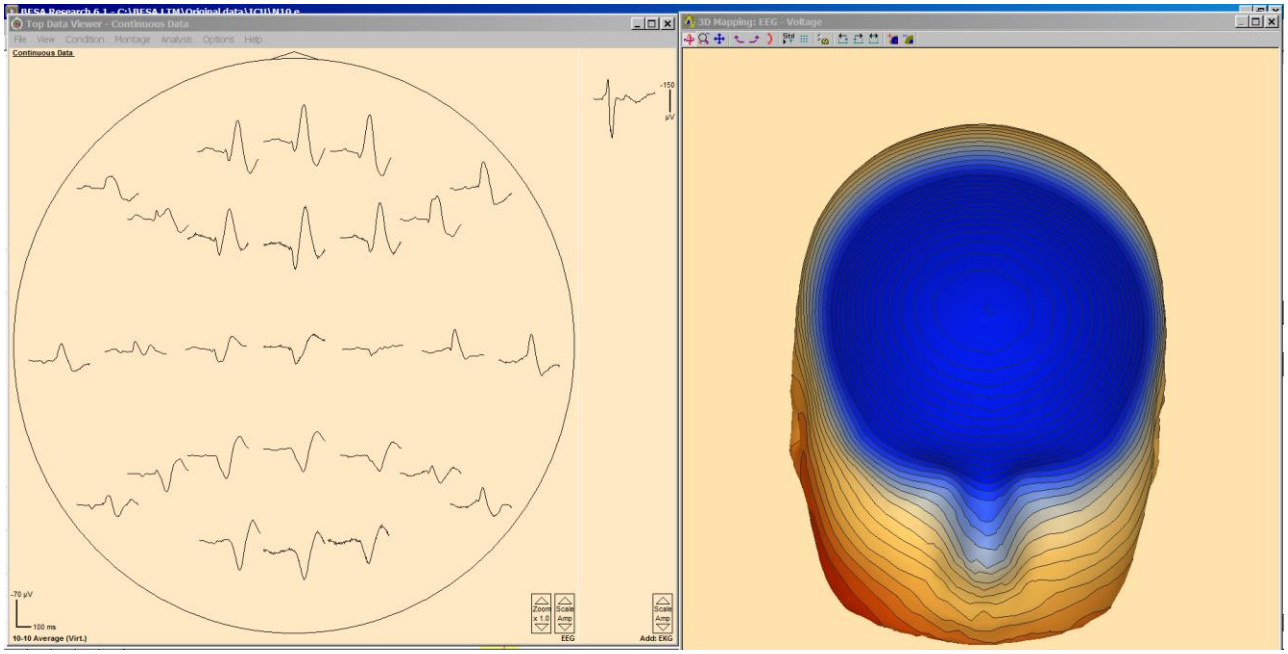
Spiky LPDs



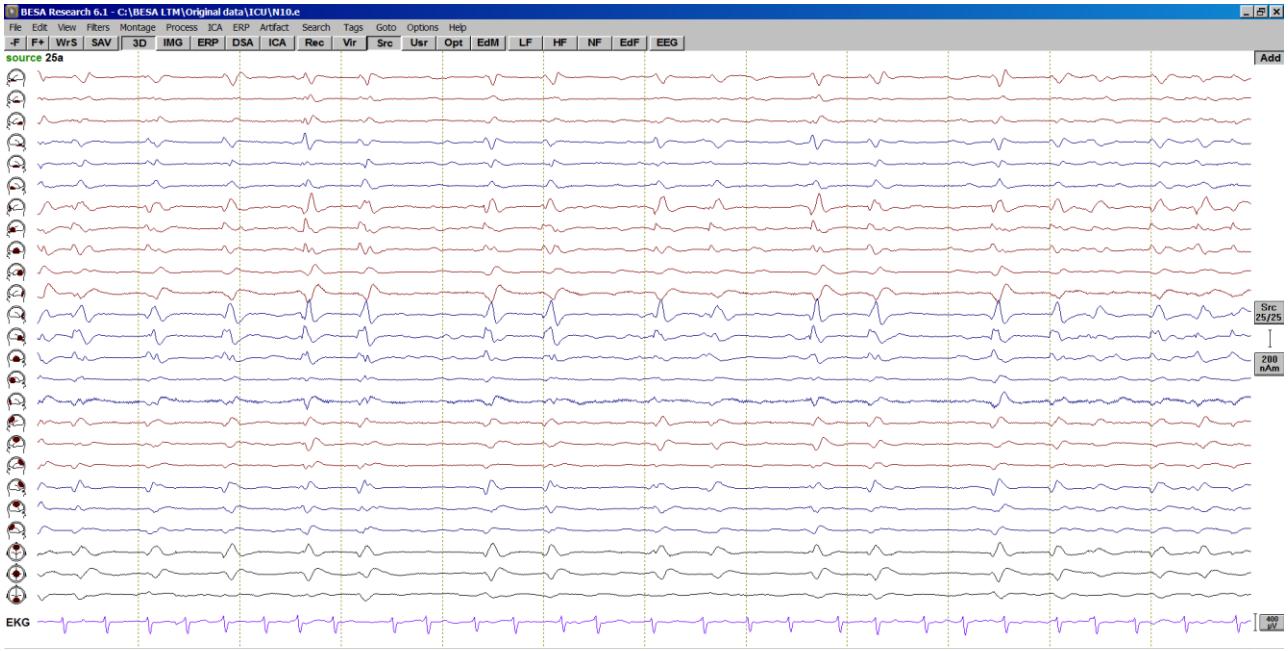
Sharp GPDs



Sharp GPDs



Sharp GPDs



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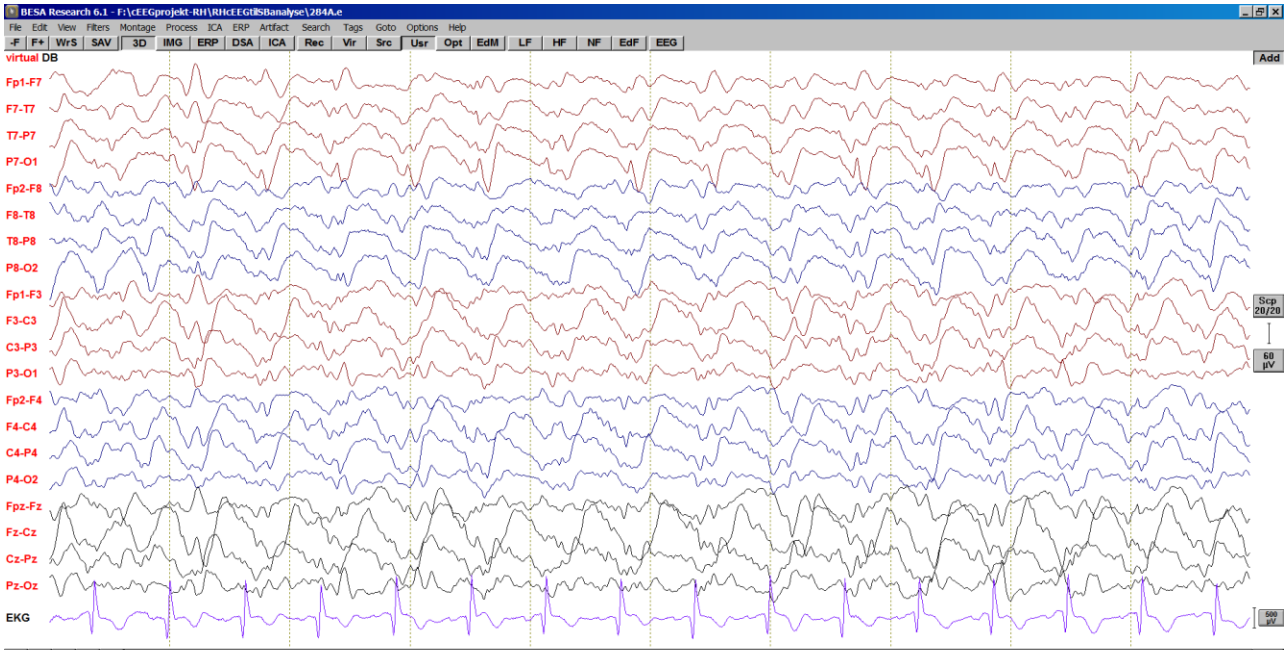
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Fp1-F3
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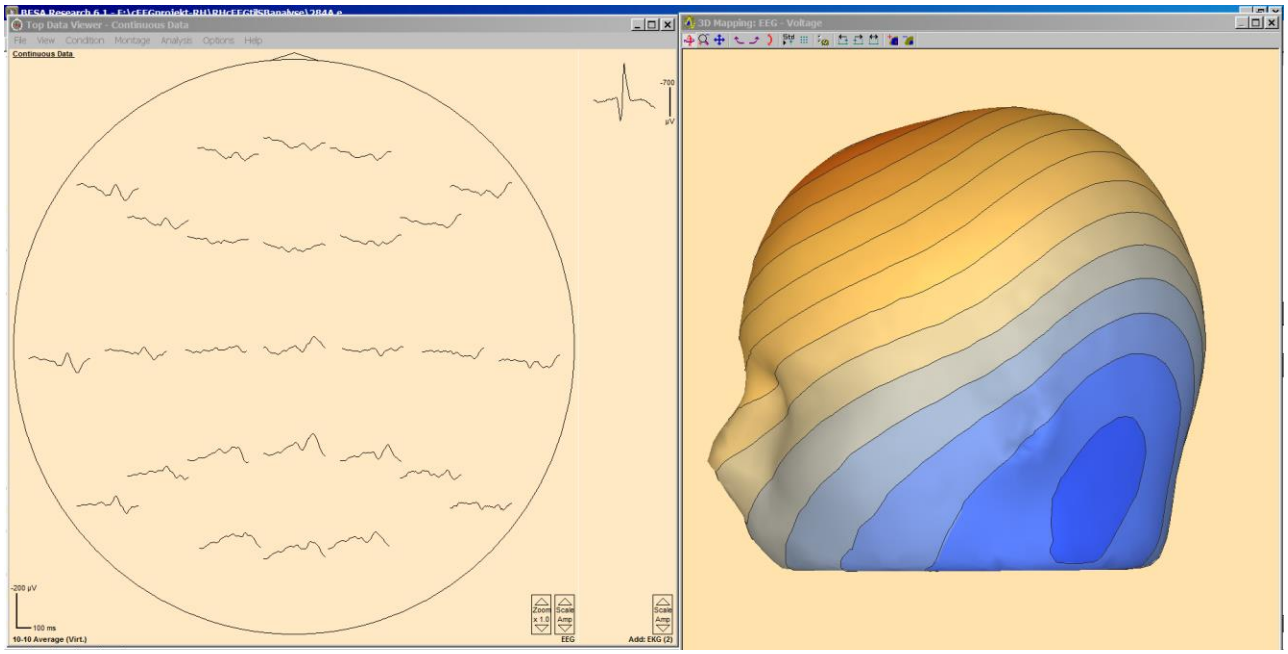
F4-C4
C4-P4
P4-O2
Fpz-Fz
Fz-Cz
Cz-Pz
Pz-Oz
EKG
Scp 20/20
60 µV
500 µV

LSW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Continuous Data
-700 µV
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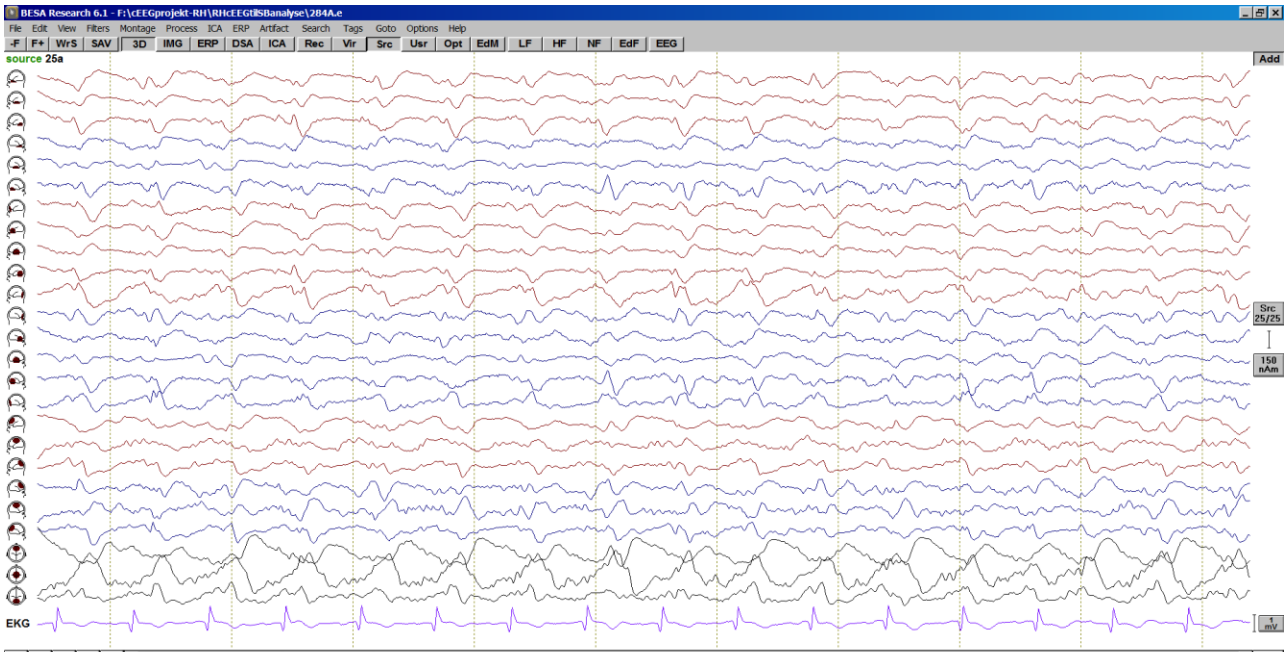
100 ms
10-10 Average (Virt.)
Zoom x 1.0
Scale Amp
EEG
Add: EKG (2)
3D Mapping: EEG - Voltage

LSW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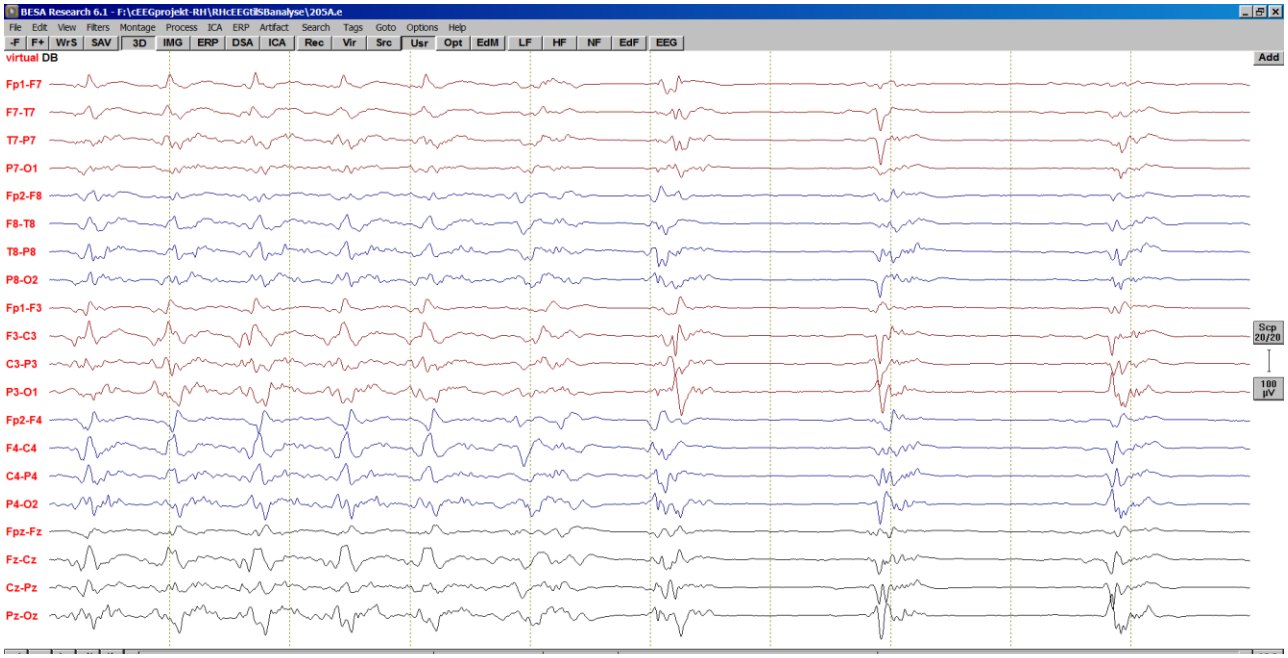
Src 25/25
150 nAm
EKG
1 mV

BIPDs+F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P7-O1
Fp2-F8
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P8-O2
Fp1-F3
F3-C3
C3-P3
P3-O1
Fp2-F4
F4-C4
C4-P4
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Fpz-Fz
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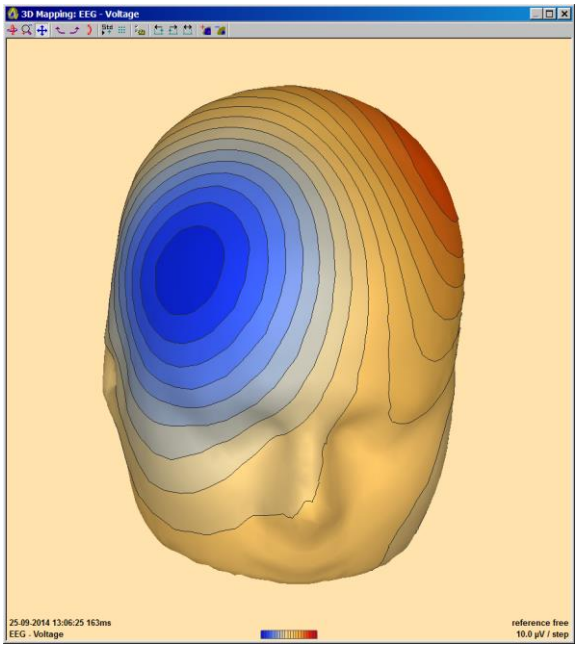
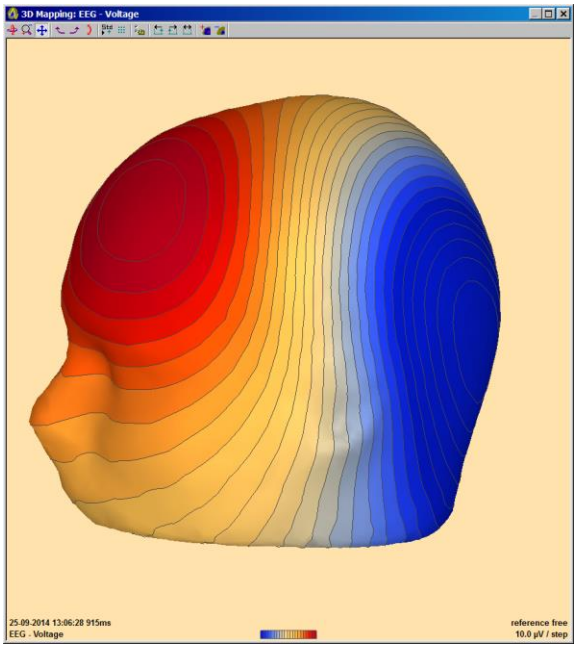
Cz-Pz
Pz-Oz
Scp 20/20
100 µV

BIPDs+F





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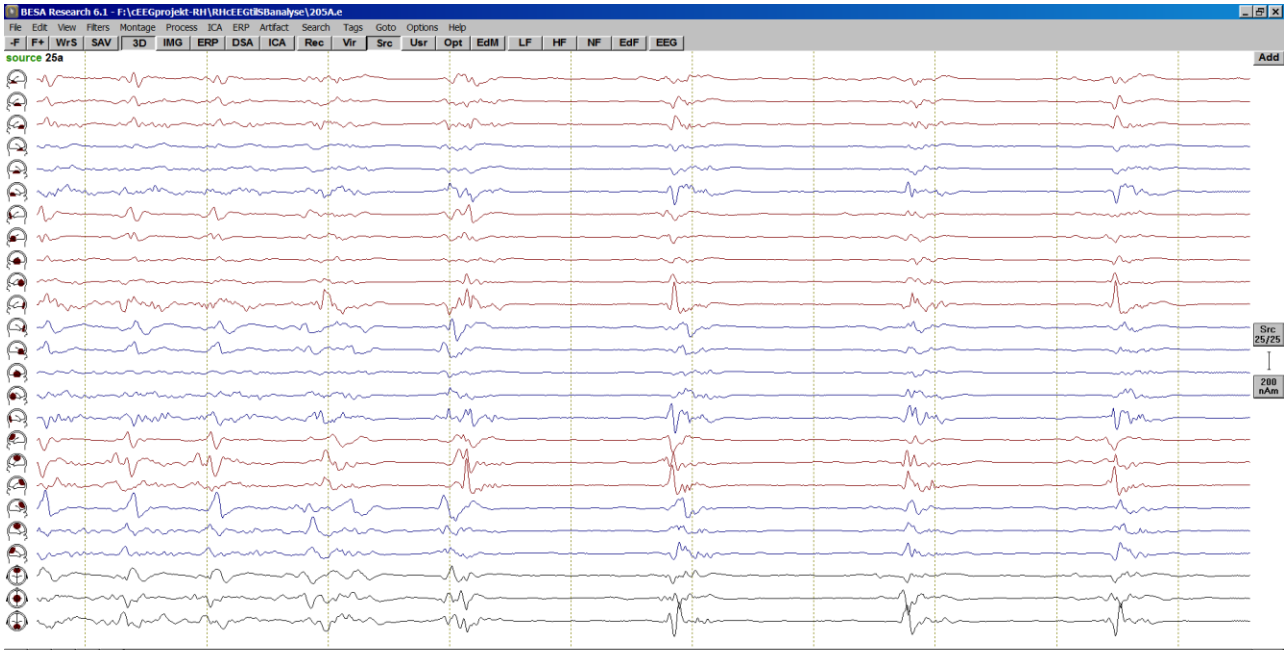

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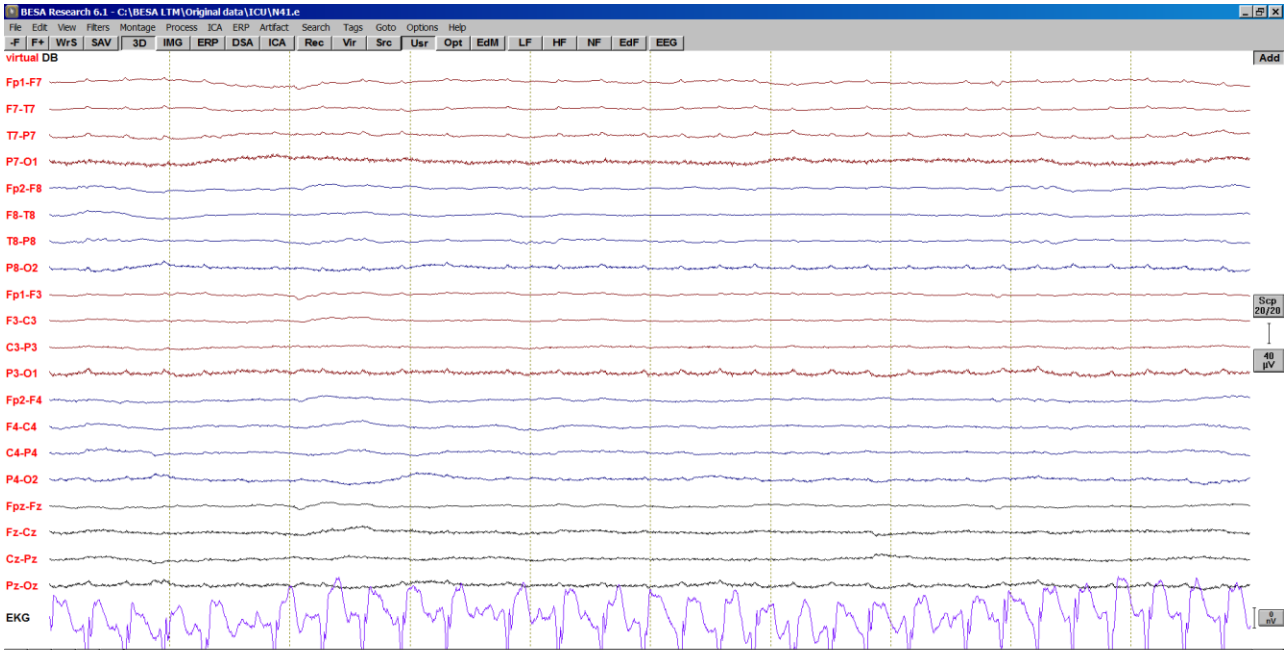

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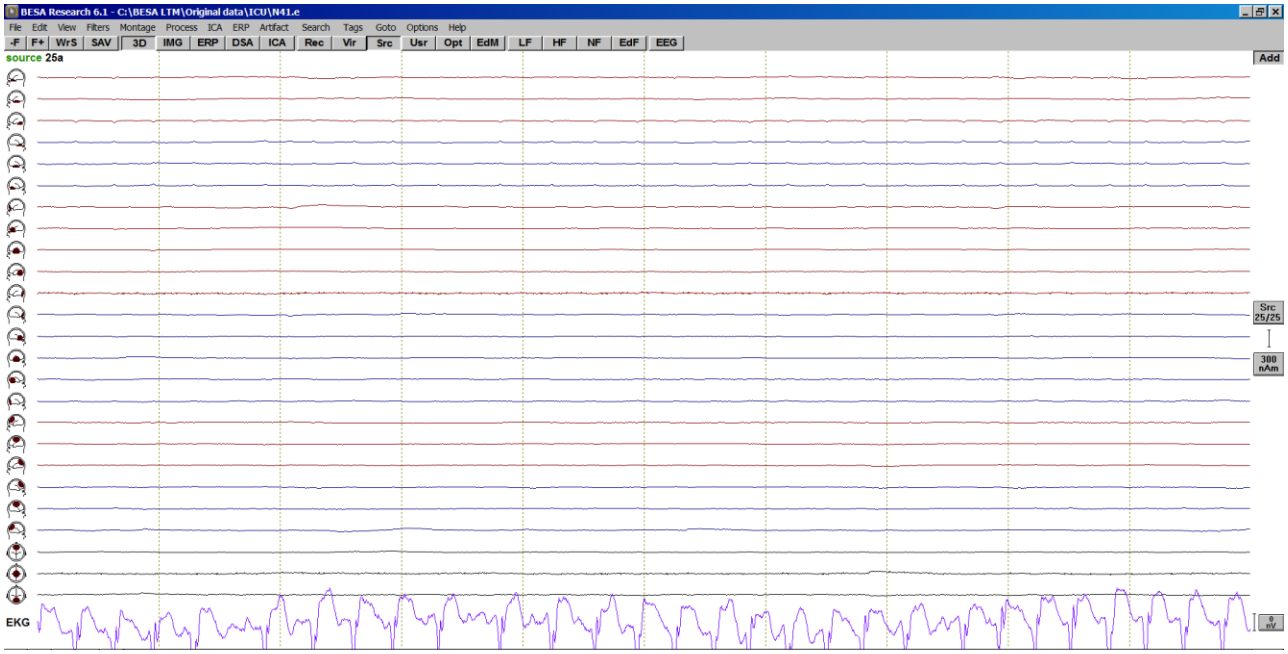

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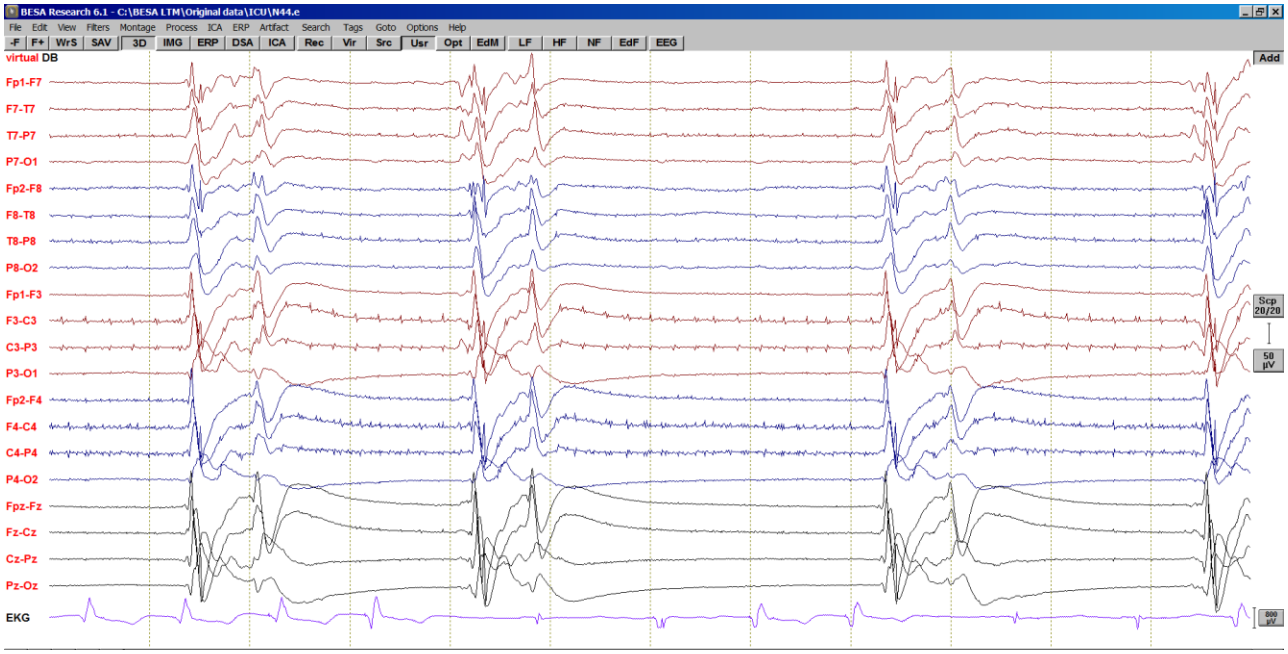

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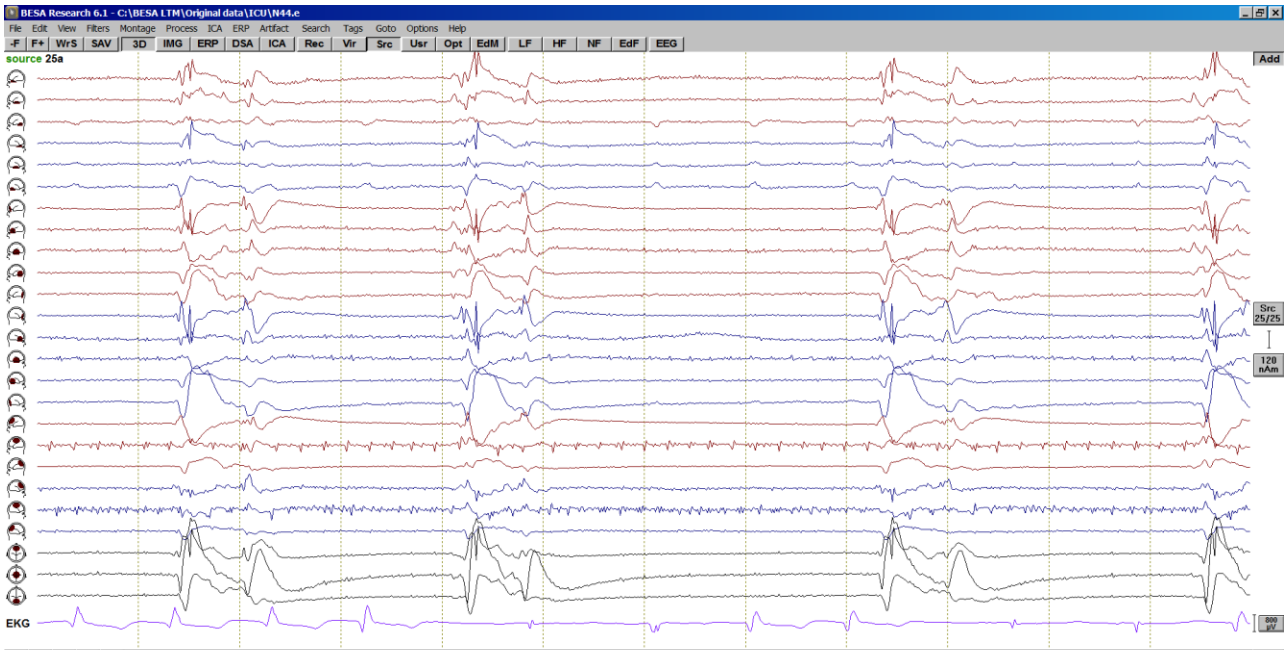

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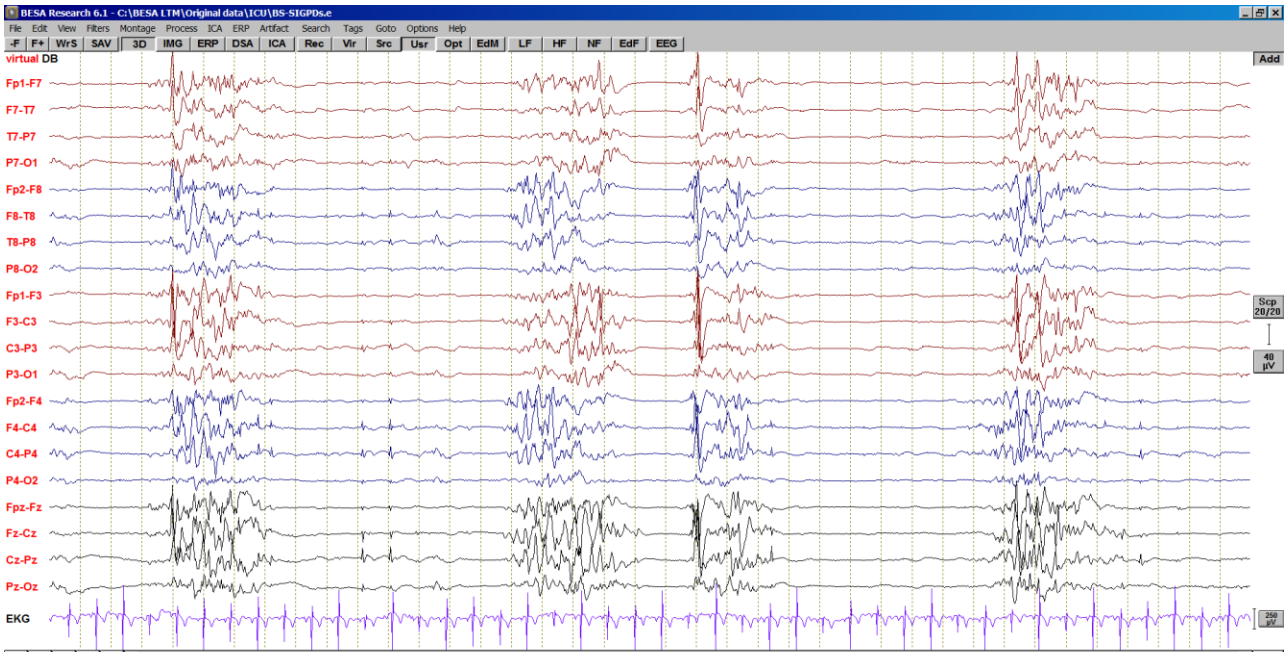

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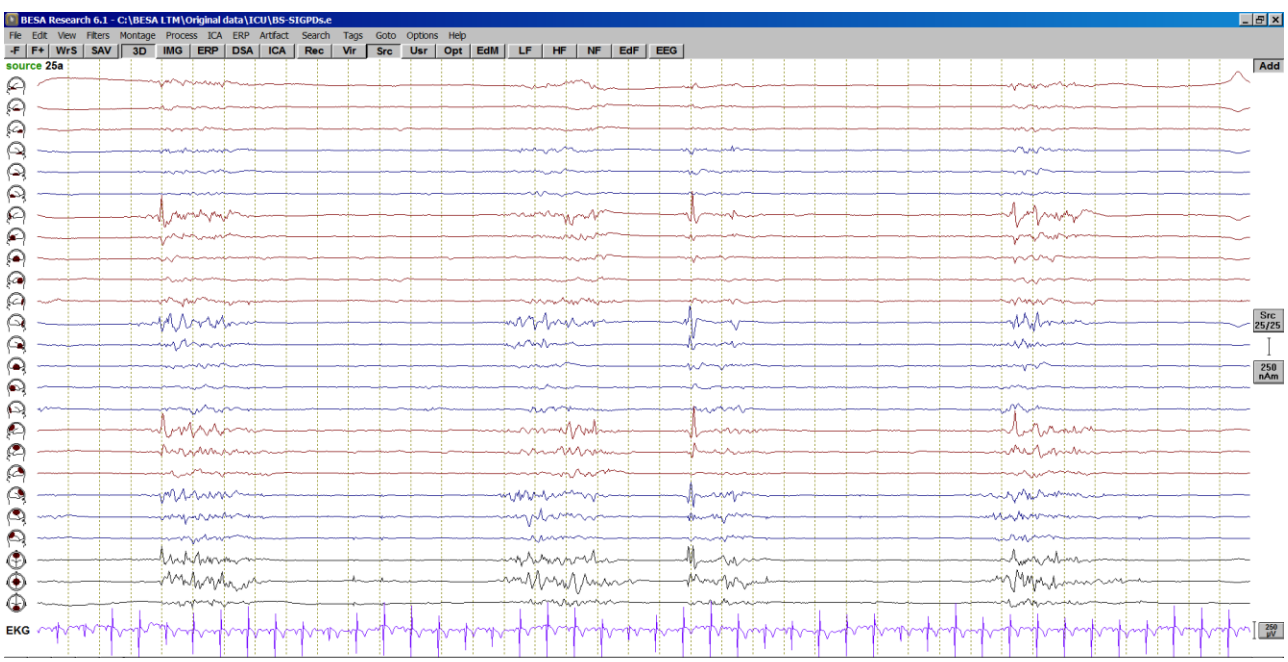

Does this work?

- **Almost perfect IRA:**
  - Main terms 1 & 2 (pattern location & type)
  - Modifiers: +S; sharpness; absolute amplitude; number of phases; frequency
- **Substantial IRA:**
  - Modifiers: +F; +R
- **Moderate IRA:**
  - Triphasic morphology
- **Fair IRA:**
  - Evolution (however: samples were too short for proper assessment of this)

49 raters; 37 EEGs; 11 features assessed
Gaspard et al., Epilepsia 2014

What is this good for? Predicting seizures?

- **LPDs:** the highest association with seizures
  - regardless of frequency
  - association was greater when the Plus modifier was present
- **LRDA & GPDs** were associated with seizures when:
  - Frequency ≥ 1.5 Hz, or
  - Plus modifier was present
- **Increased prevalence** of LPDs & GPDs = increased seizure-risk

- Not associated with seizures:
  - GRDA

CEEGs from 4772 critically ill patients
Rodriguez Ruiz et al, JAMA Neurol 2017

What is this good for?

Prognostication of post-cardiac arrest coma

At 24 h after ROSC:

- **Poor outcome:**
  - Low-voltage EEG
  - Burst-suppression
- **Good outcome:**
  - Normal background voltage ≥ 20 µV without epileptiform discharges at any time

Prospective study, 100 consecutive pts.
Sivaraju et al., Intensive Care Med. 2015