aEEG & the Olympic Brainz Monitor
Florida FN3 Meeting
Nemours Children's Hospital
August 4, 2018

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Objectives

Upon completion of this program, the clinician will be able to:

- Describe aEEG trace nomenclature and qualifications as they pertain to term babies and premature babies at various gestational ages
- Describe aEEG trending components including filtering, compression, rectification
- Assess aEEG trace patterns and apply trace qualifications for areas of suspicion/suspected seizures
- Describe aEEG electrode options, including preparation and placement
- Hands-on practice with aEEG electrodes
- Q & A

What is aEEG?

- aEEG is:
  - 1, 2, or 3 channel bedside brain *monitor*
  - Basic neurologic function trending tool
  - Long-term monitoring capability
  - Used to measure global electro-cortical activity or specific site brain activity
  - Developed by Neonatologists, for Neonatologists
  - Complimentary tool to *quickly* obtain information regarding the baby's neurological status

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Monitoring Tools in the NICU

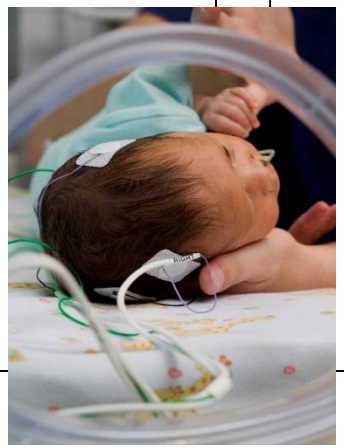
What Do We Want to Know When We Monitor the Brain with aEEG?

- **What is the neurological status of the patient?**
  - Is there cerebral injury?
  - What is the severity of the injury?
  - What changes are occurring over time?
    - Is there improvement or worsening of the neurological status
  - What is the impact of NICU treatments to the patient's brain function?
- **Is the patient having seizures?**
  - What is causing the seizures?
  - Are the seizures occurring more frequently, or for longer/shorter duration?
  - Are the seizures responding to medical therapy?
    - Is there electromechanical disassociation after medication?

Who Should Be Monitored? | Clinical Applications

- **Infants that have experienced a sentinel event during delivery and are at risk for hypoxic ischemic encephalopathy (HIE):**
  - Low Apgar
  - Low pH
  - Required resuscitation or artificial ventilation at birth
  - Poor tone/poor reflexes
- **Infants receiving hypothermia treatment for HIE**
- **Infants with definite or questionable seizures (clinical or subclinical):**
- **Infants with unexplained neurological symptoms (i.e. severe apnea)**

*Thoresen M, Hellstrom-Westas L, Liu X, de Vries L. "Effect of Hypothermia on Amplitude-Integrated Electroencephalogram in Infants With Asphyxia". *Pediatrics* published online June 21, 2010; DOI: 10.1542/peds.2009-2938



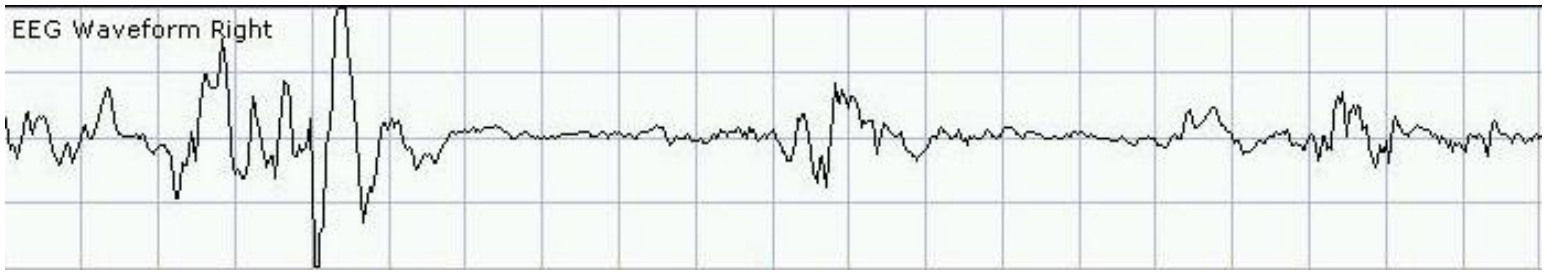
- **Infants who are at higher risk for cerebral complications due to circulatory instability**
  - Sepsis
  - Hypoxia
  - Persistent pulmonary hypertension
  - Meconium aspiration
  - Cardiac malformations
  - Diaphragmatic hernia
- **Additional clinical applications**
  - Muscle relaxed/neuromuscular blockade
  - Grade 3 or 4 IVH
  - ELBW infants
  - Inborn errors of metabolism (e.g. urea cycle disorders, hypoglycemia, hypocalcemia)
  - Neonatal abstinence syndrome (e.g. alcohol/opiate withdrawal)
  - Post surgical
  - Post cardiac arrest
  - Infants requiring ECMO or surgery for CHD

NeoReviews Vol 7 No. 2
February 2006
Hellstrom-Westas, Rosen, deVries, Greisen

Breakdown - How Does aEEG Work?

- **aEEG (“a”=amplitude integrated / EEG = electroencephalography):**
  - One, two, or three channels of EEG that go through a number of modifications:
    - special filtering
    - rectification
    - compression
    - very slow, trend display
  - aEEG is a process of taking a raw EEG, modifying it, and producing a trending pattern that allows clinicians to measure and view the microvoltage of the brain over time

Background Information - Channel

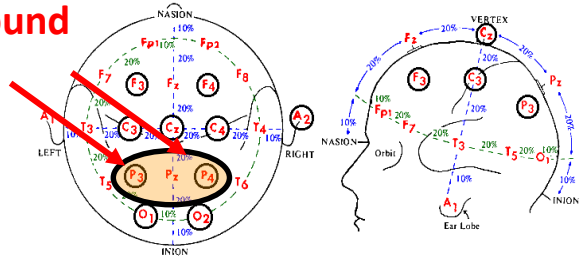


- Two electrodes are needed to create a single channel
- EEG waves reflect electrical voltage differences between these two electrodes sites
  - Measured in microvolts (µV)

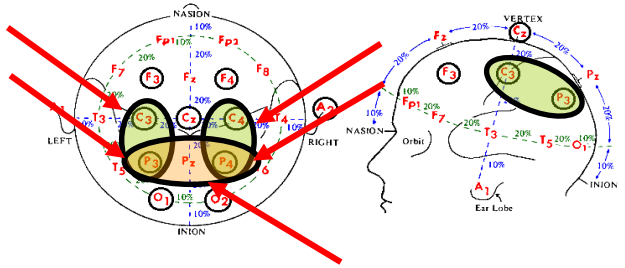
aEEG Channels & the 10-20 System

- The Olympic Brainz Monitor may be used to monitor and record aEEG patterns through either:

  - **Cross-Cerebral (default mode)**
    - **3 electrodes - 2 active & 1 hydrogel ground**
    - 1 aEEG channel (P3/P4)
    - 1 EEG channel (P3/P4)

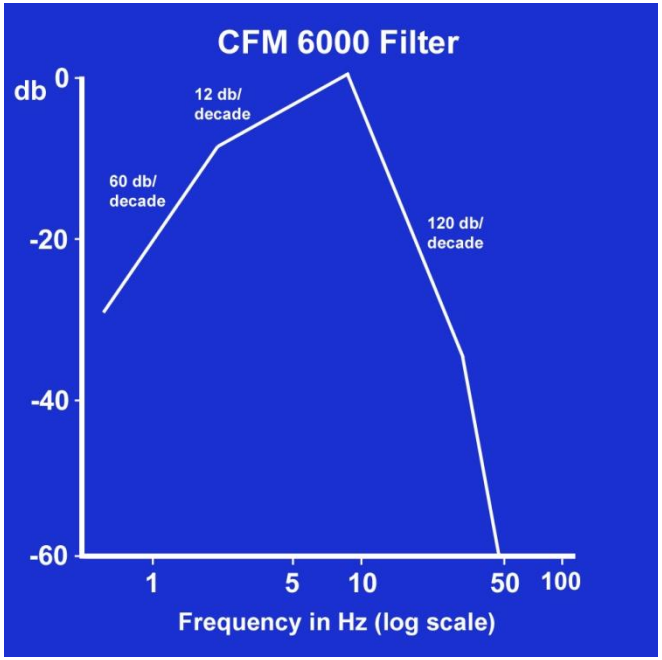


  - **Bilateral**
    - **5 electrodes – 4 active & 1 hydrogel ground**
    - 3 aEEG channels (C3/P3, C4/P4, P3/P4)
    - 3 EEG channels (C3/P3, C4/P4, P3/P4)

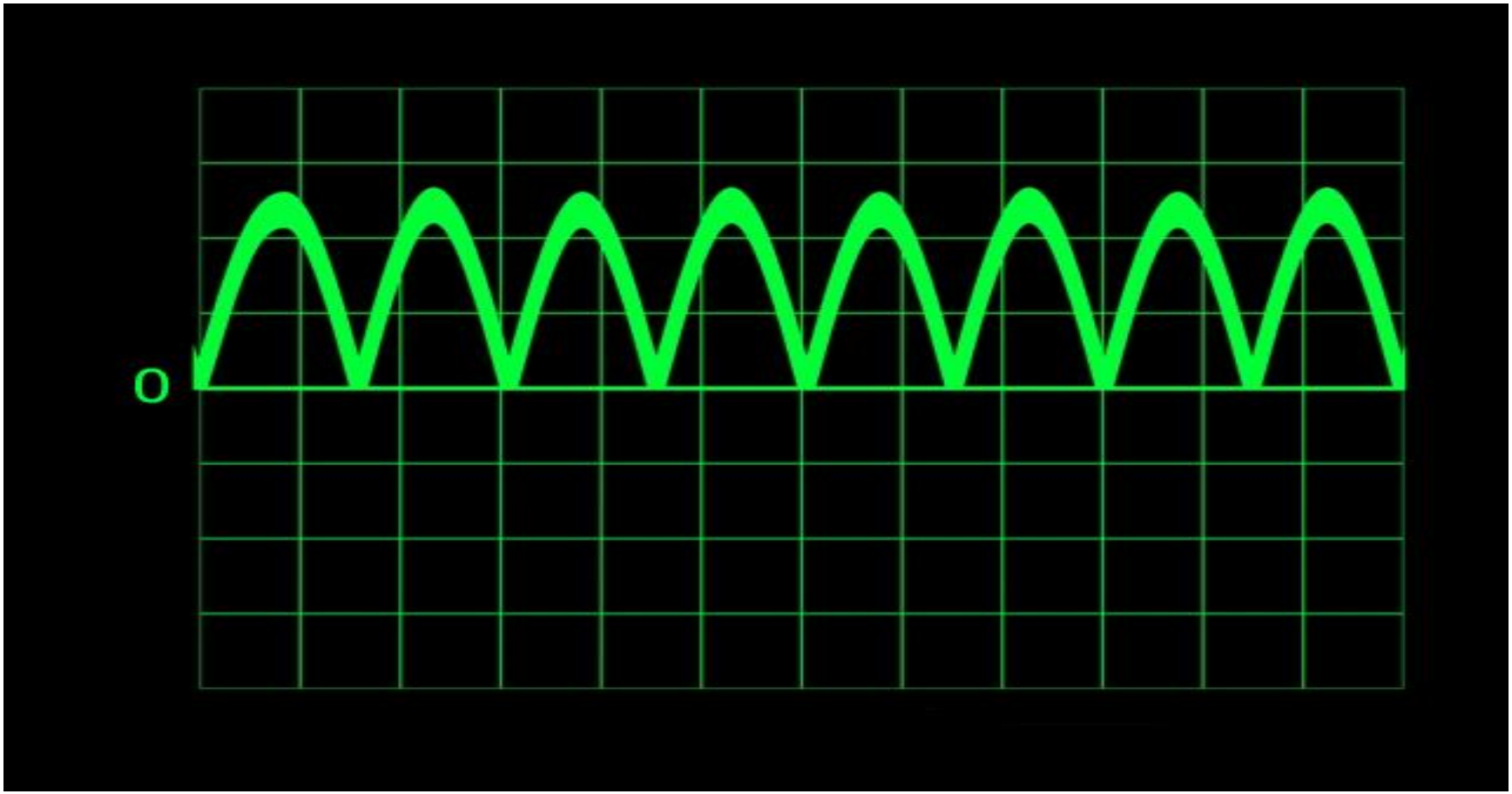


Filtering

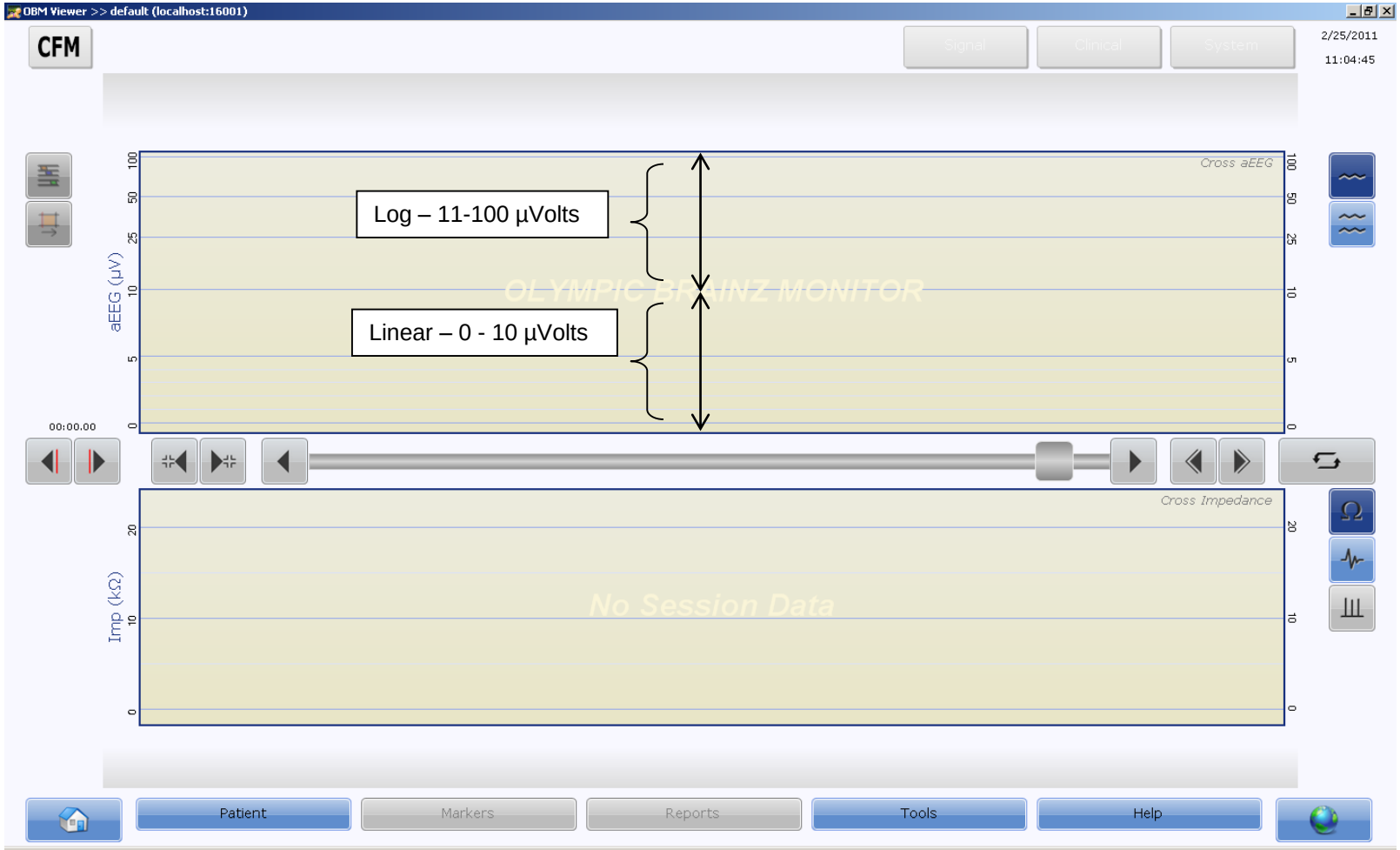
- The EEG signal is filtered 2–15 Hz
- Specially shaped filter
- Reduces muscle and other artifacts



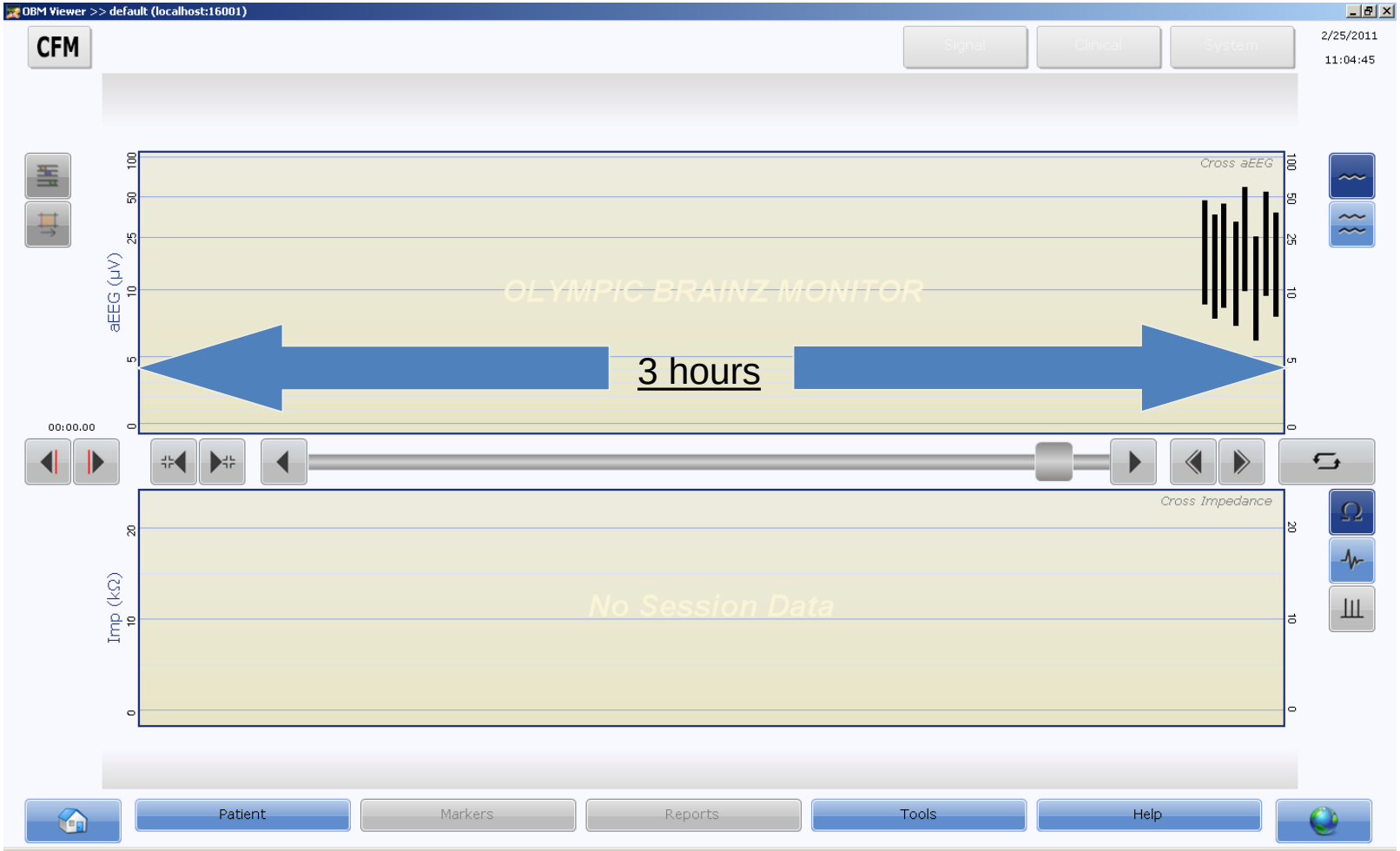
Rectification



Compression



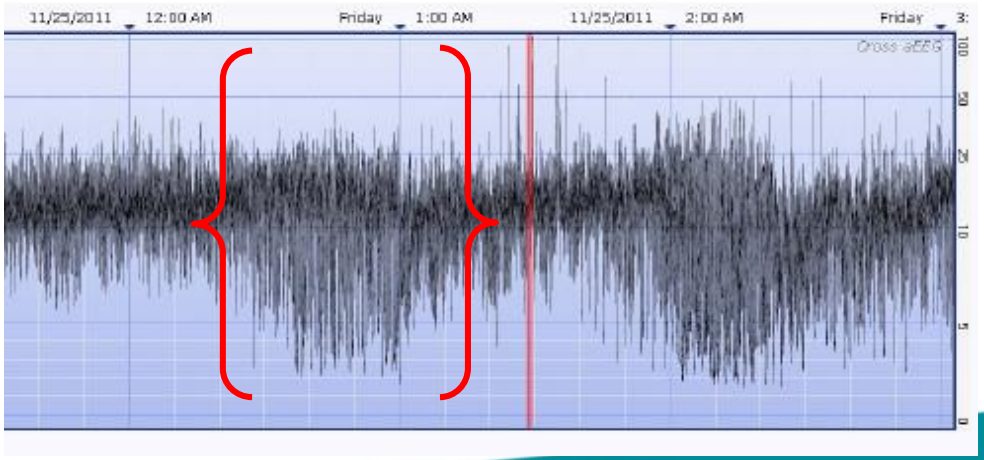
Very Slow, Trend Display



Background Information - Margins

Background Information – Sleep Wake Cycling (SWC)

- **SWC characterized by:**
  - Smooth sinusoidal variations, mostly in the lower margin
  - Broader bandwidth represents discontinuous background activity during quiet sleep
  - More narrow bandwidth corresponds to more continuous activity during wakefulness and active sleep
  - Quiet Sleep Cycle duration ≥ 20 minutes
    - Total SWC ~60-90 minutes



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aEEG Classification Framework

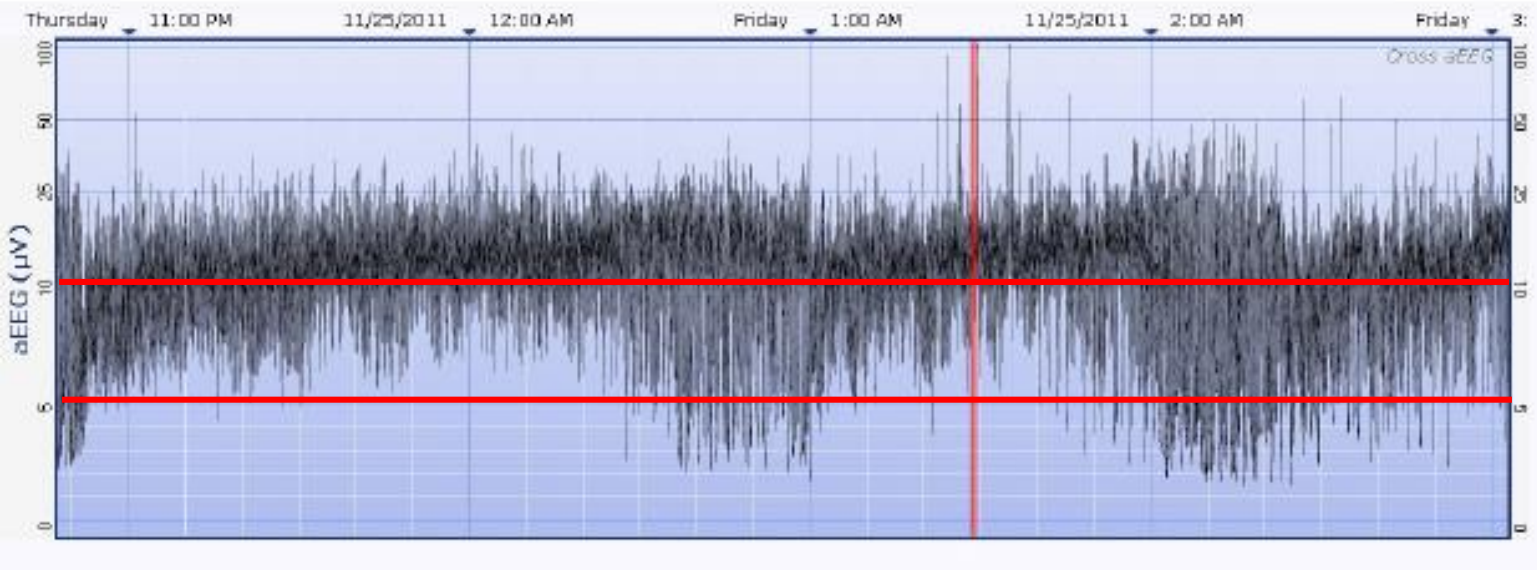
Feb 2006 – NeoReviews – Hellstrom Westas

Pattern Definition (Hellstrom-Westas & Toet)	*Lower Margin (in µV)*	*Upper Margin (in µV)*
Continuous Normal Voltage	> 5	>10
Discontinuous Normal Voltage	<5	>10
Burst Suppression	<5	>10 due to high voltage bursts
Continuous Low Voltage	<5	<10
Isoelectric/Flat	< 5	<5

aEEG and TERM Babies

Continuous Normal Voltage

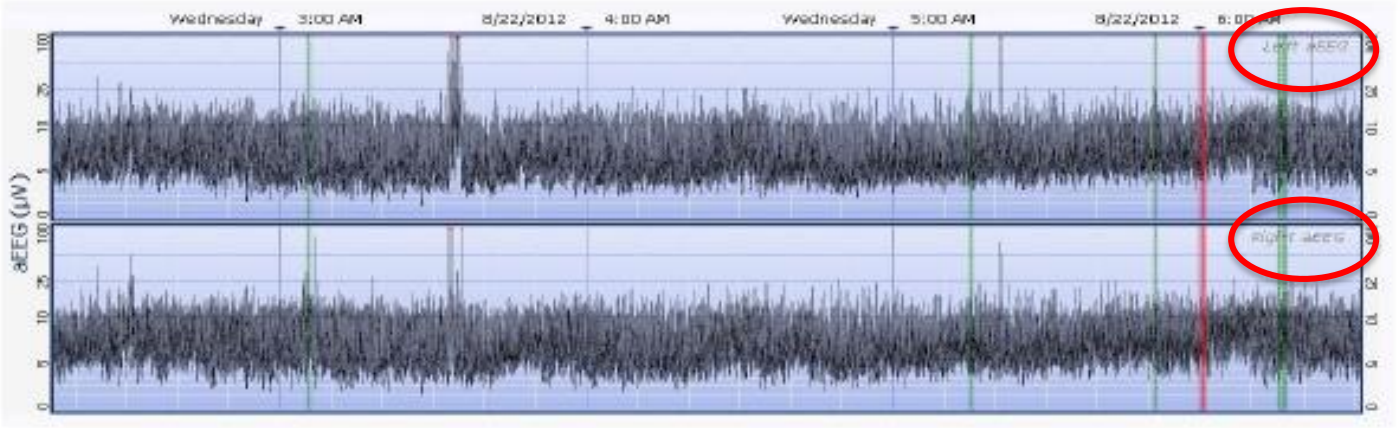
- Sleep/Wake Cycling
- Upper Margin > 10 µVolts
- Lower Margin > 5 µVolts
- Limited Bandwidth Variability (between upper and lower margin)
  - ~5-10 µVolts

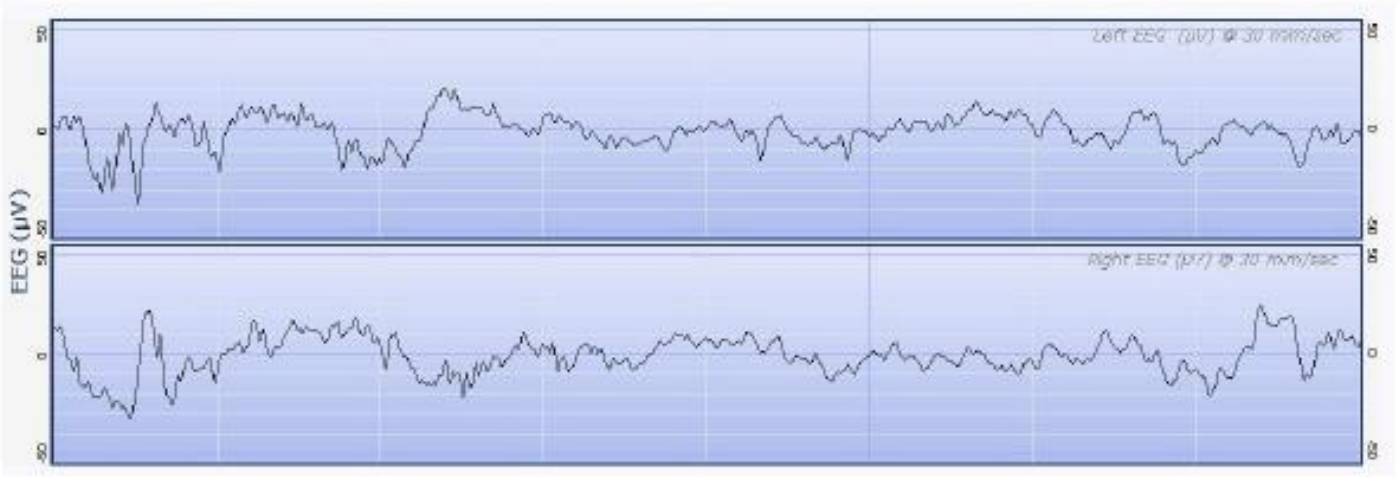


Discontinuous Normal Voltage

- No Sleep/Wake
- Upper Margin > 10 µVolts
- Lower Margin < 5 µVolts
- Increased Bandwidth Variability
  - ~30 – 40 µVolts

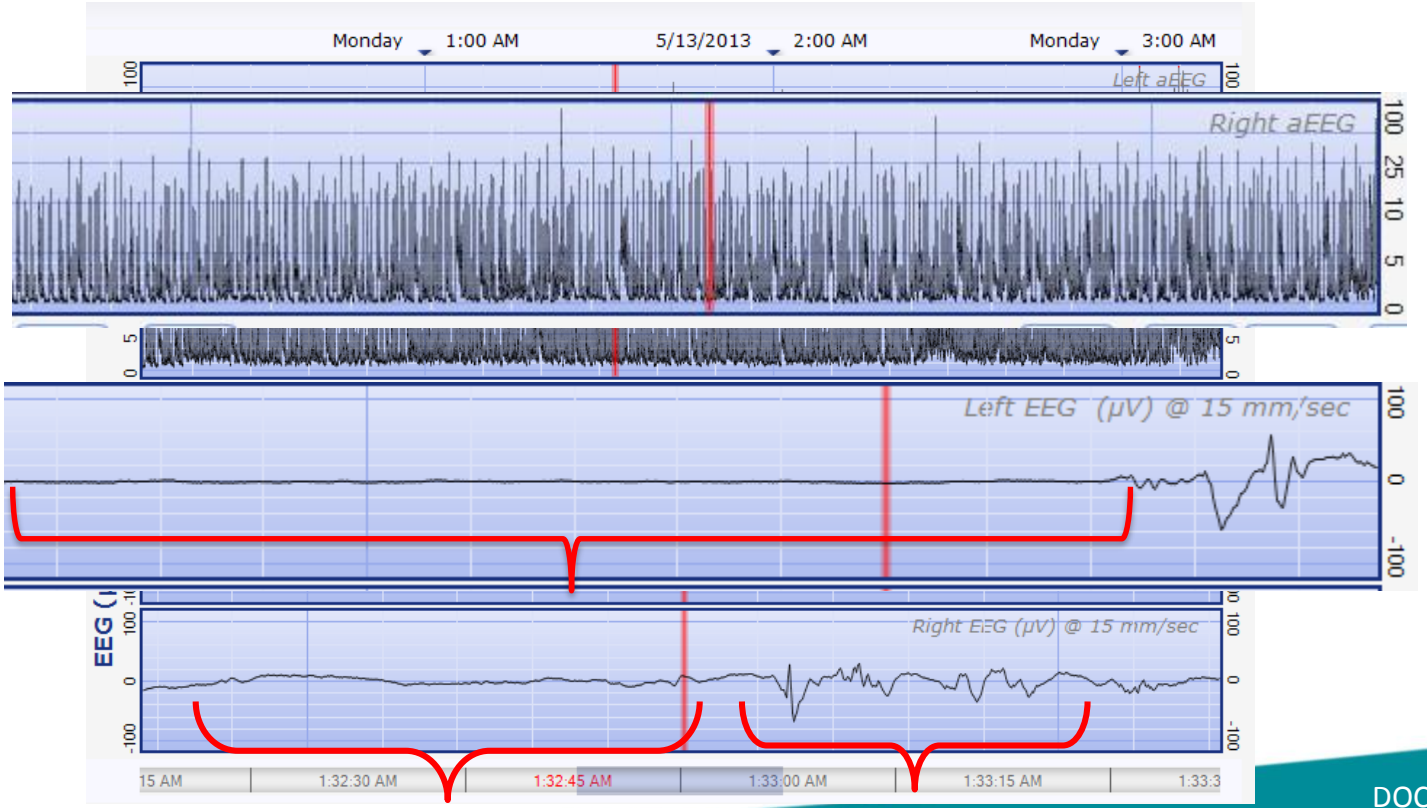
Discontinuous Normal Voltage





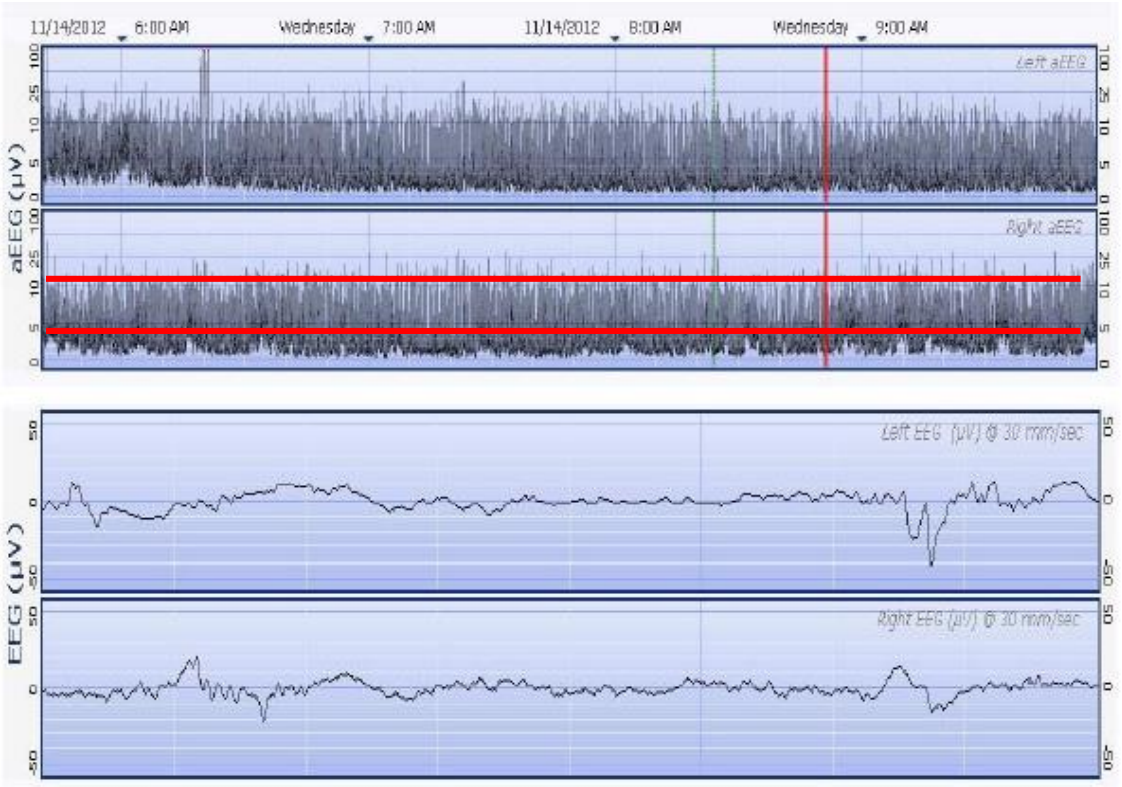
Burst Suppression

- No Sleep Wake Cycling
- Upper margin >10µV (due to high voltage bursts)
- Lower margin <5µV
- Limited variability of lower margin



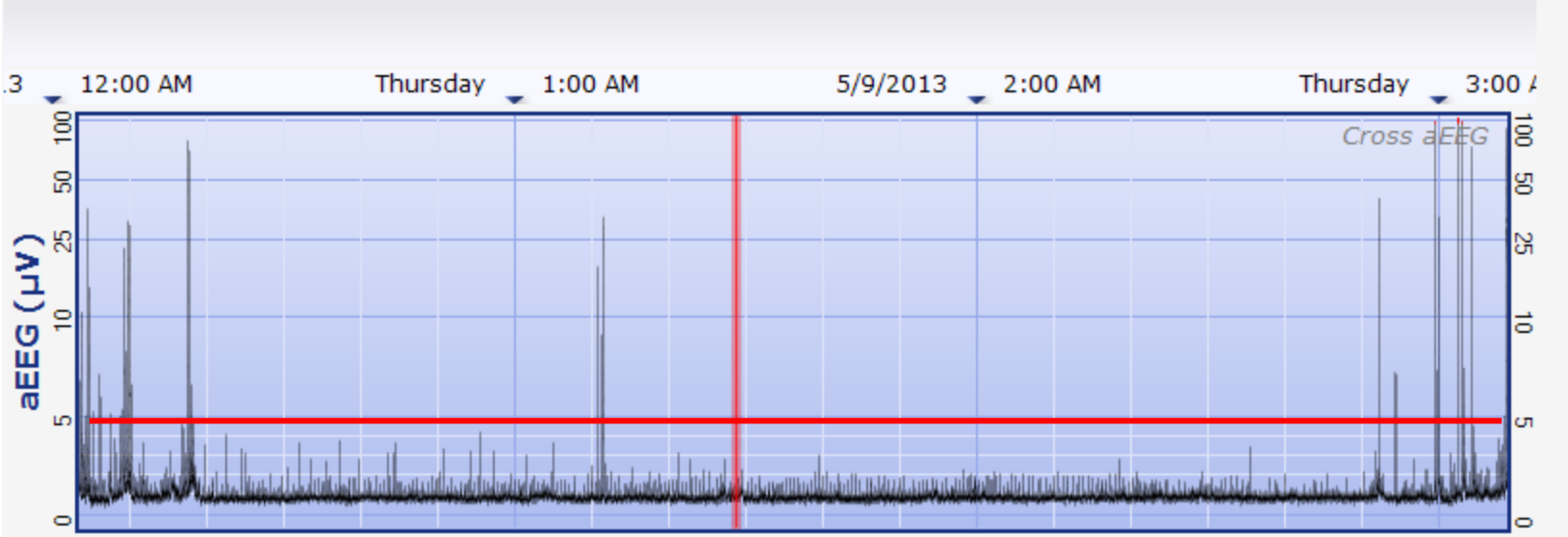
Continuous Low Voltage

- No Sleep/Wake Cycling
- Upper margin <10uV
- Lower margin <5uV

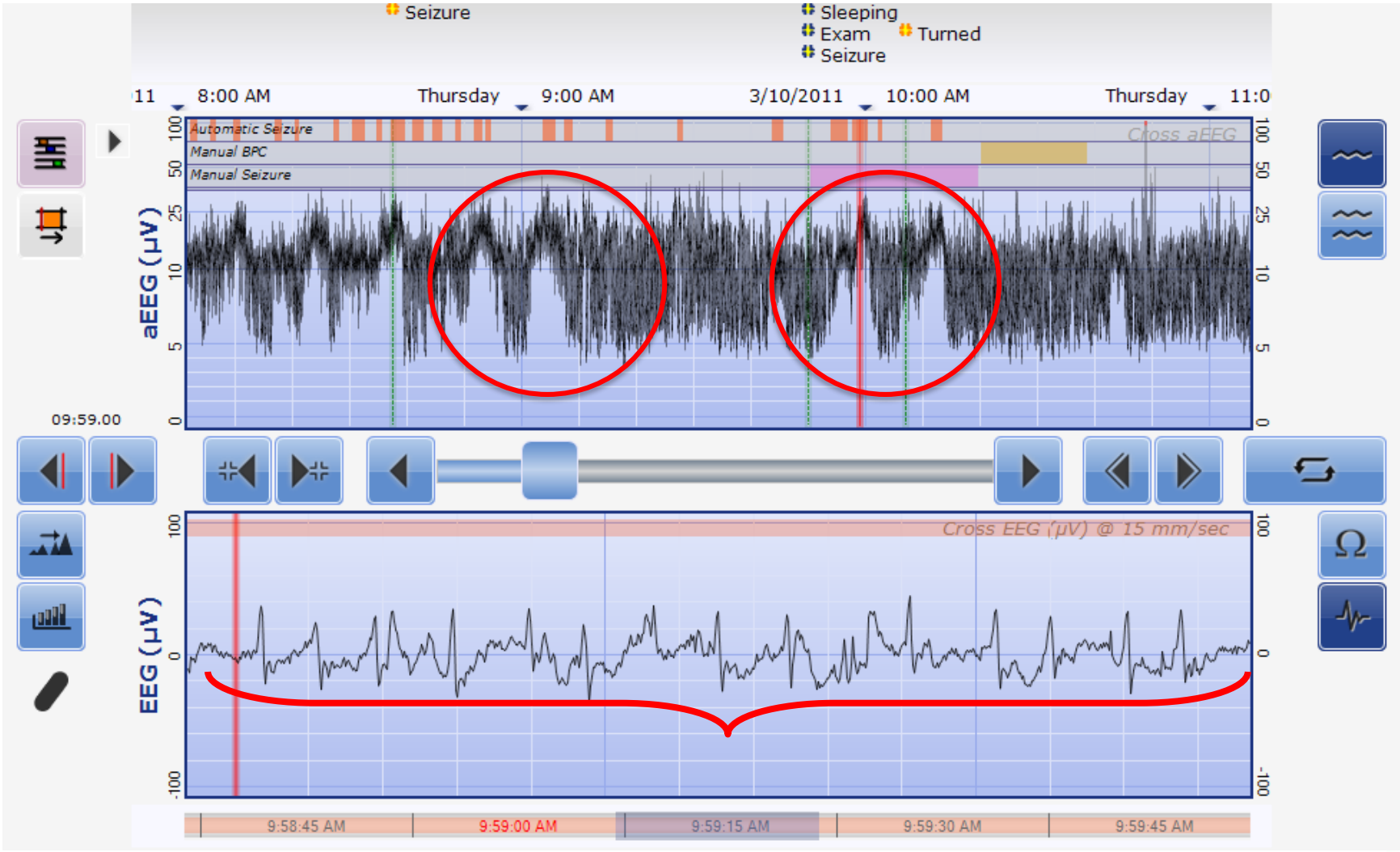


Isoelectric or Flat

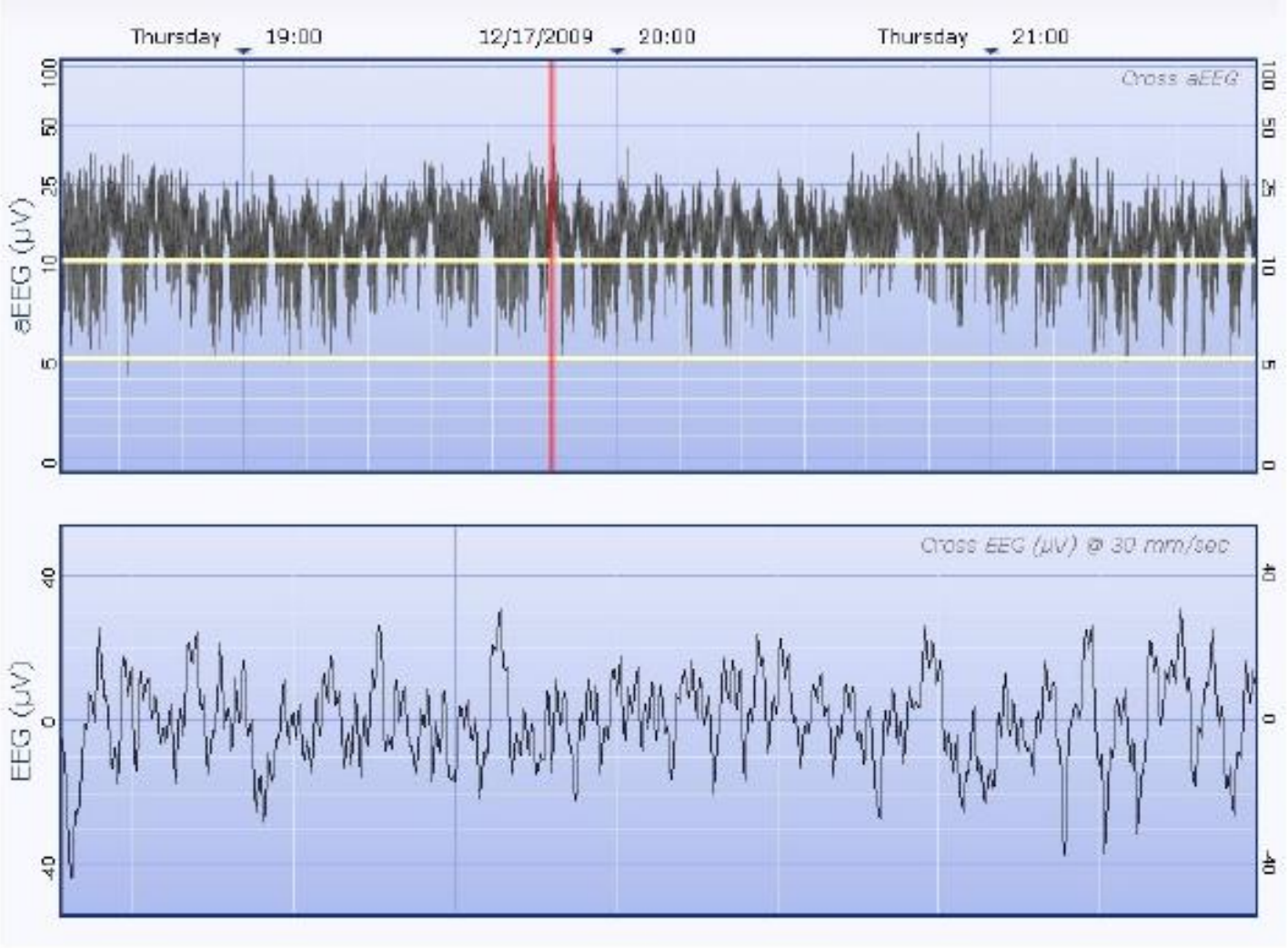
- No Sleep/Wake
- Upper Margin < 5 µVolts
- Greatly reduced bandwidth variability
  - ~1 µVolt



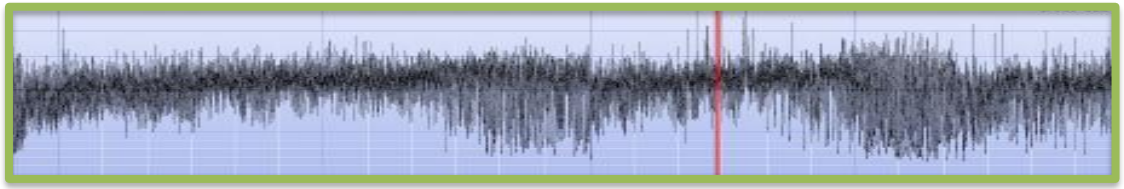
Seizure EEG


Seizure
Sleeping
Exam
Turned
Seizure
11
8:00 AM
Thursday
9:00 AM
3/10/2011
10:00 AM
Thursday
11:0
Automatic Seizure
Manual BPC
Manual Seizure
Cross aEEG
aEEG (µV)
100
50
25
10
5
0
09:59.00
Cross EEG (µV) @ 15 mm/sec
EEG (µV)
100
0
-100
9:58:45 AM
9:59:00 AM
9:59:15 AM
9:59:30 AM
9:59:45 AM

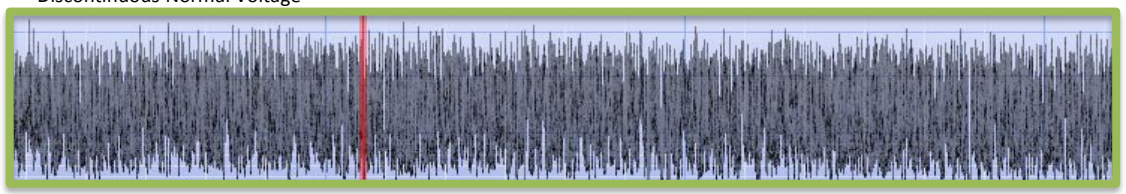
Status Epilepticus



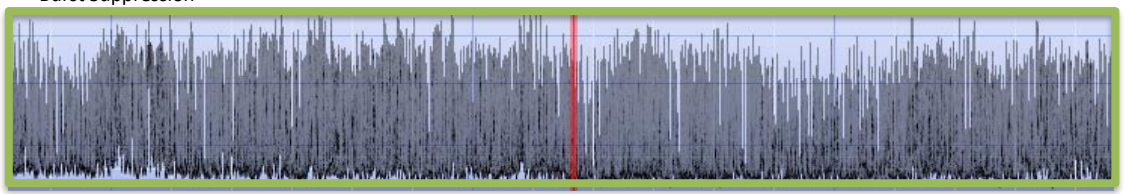
Continuous Normal Voltage



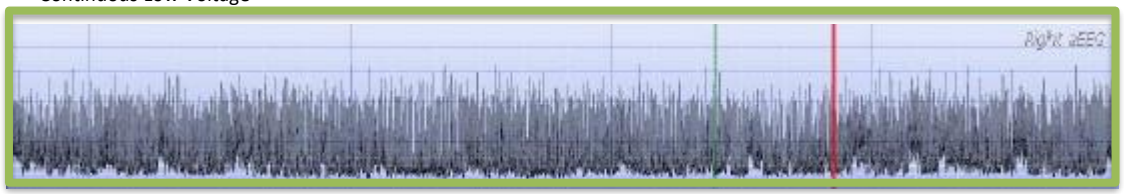
Discontinuous Normal Voltage



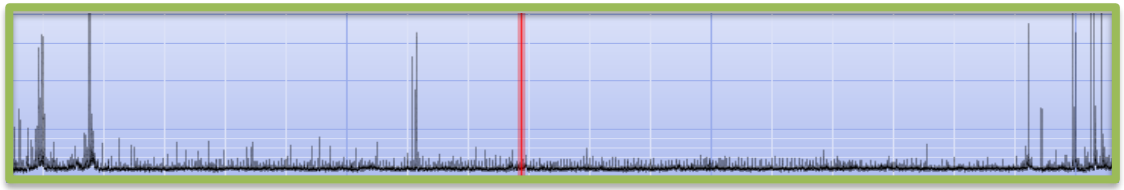
Burst Suppression



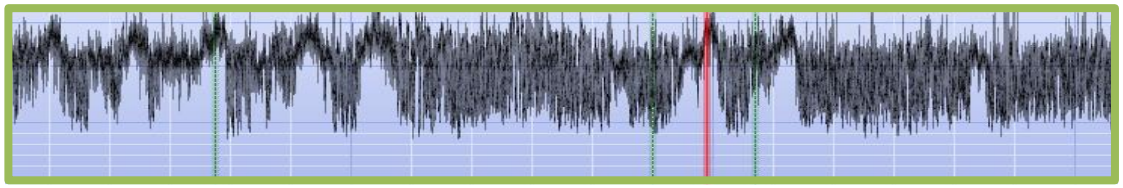
Continuous Low Voltage



Isoelectric



Seizures

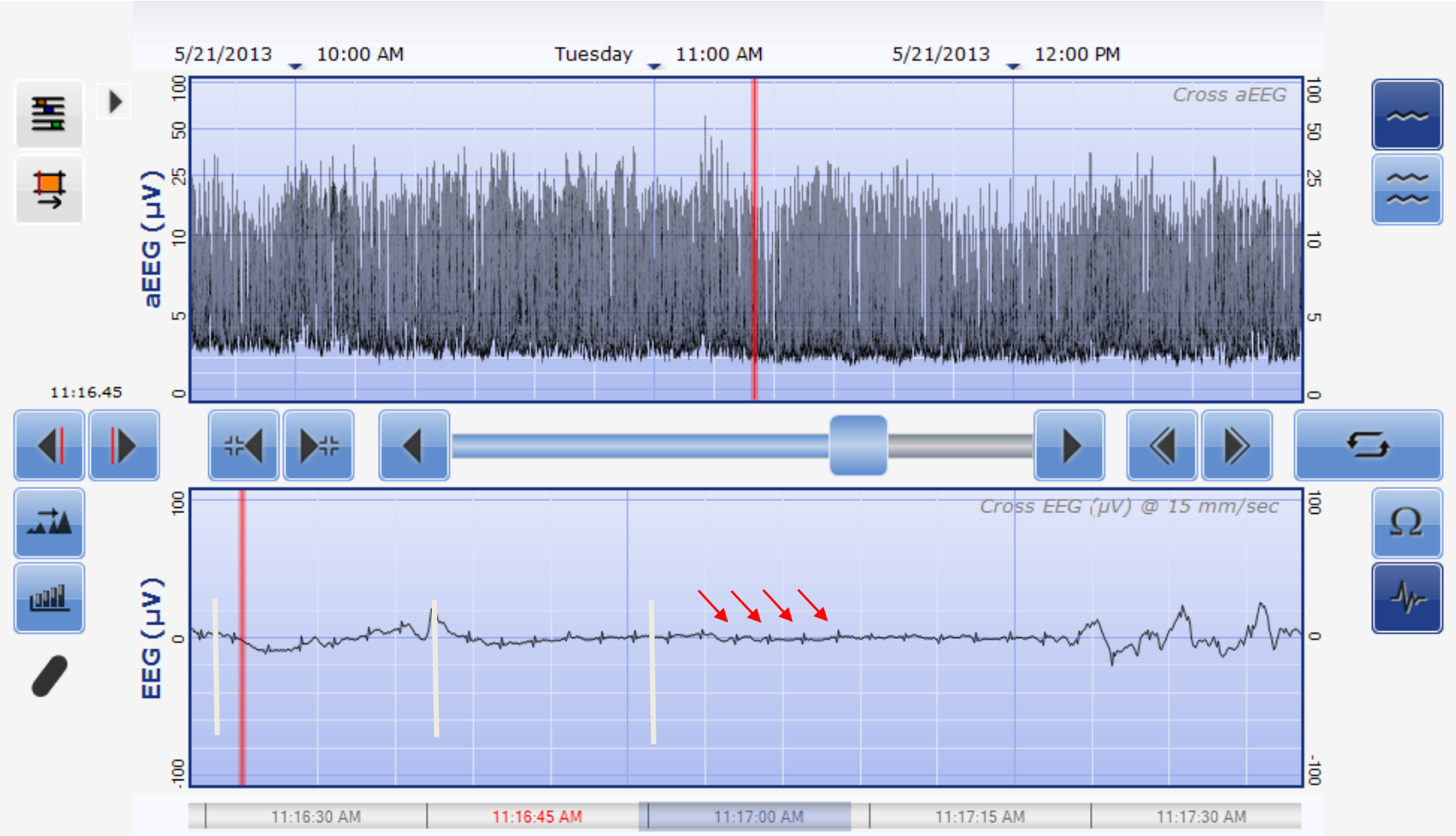


Impedance and Artifact

- **Impedance**
  - A measure of the quality of electrode contact
  - Anything that gets between the sensor (hydrogel or low impedance needles) and “impedes” or interferes with the devices ability to read the brain signal (hair, dry skin, vernix)

- **Artifact**
  - Any electrical activity other than the brain’s electrical activity (monitors, IV pumps, ventilators, etc.)
  - Live EEG signal is used as a point of reference to confirm suspected brain activity OR to distinguish artifact from the real signal

ECG Artifact



aEEG and Premature Babies

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Pre-Term Infants

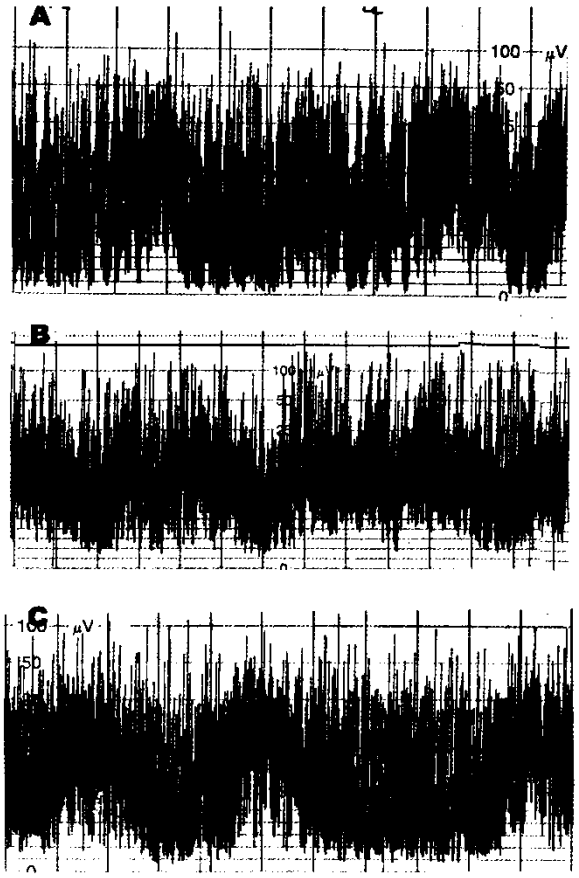
Gestational or Postconceptual Age (wk)	Dominating Background Pattern	SWC	Minimum Amplitude (mcV)	Maximum Amplitude (mcV)	Burst/h
24 through 25	DC	(+)	2 to 5	25 to 50 (to 100)	>100
26 through 27	DC	(+)	2 to 5	25 to 50 (to 100)	>100
28 through 29	DC/(C)	(+)/+	2 to 5	25 to 30	>100
30 through 31	C/(DC)	+	2 to 6	20 to 30	> 100
32 through 33	C/DC in QS	+	2 to 6	20 to 30	> 100
34 through 35	C/DC in QS	+	3 to 7	15 to 25	>100
36 through 37	C/DC in QS	+	4 to 8	17 to 35	> 100
38+	C/DC in QS	+	7 to 8	15 to 25	> 100

SWC: (+) = imminent/immature; SWC: + = developed; SWC: QS = quiet/deep sleep;
DC = discontinuous background pattern; (C) = continuous

NeoReviews. Vol 7 No. 2 February 2006
Hellstrom-Westas, Rosen, deVries, Greisen

Normal aEEG's at Various Gestational Ages

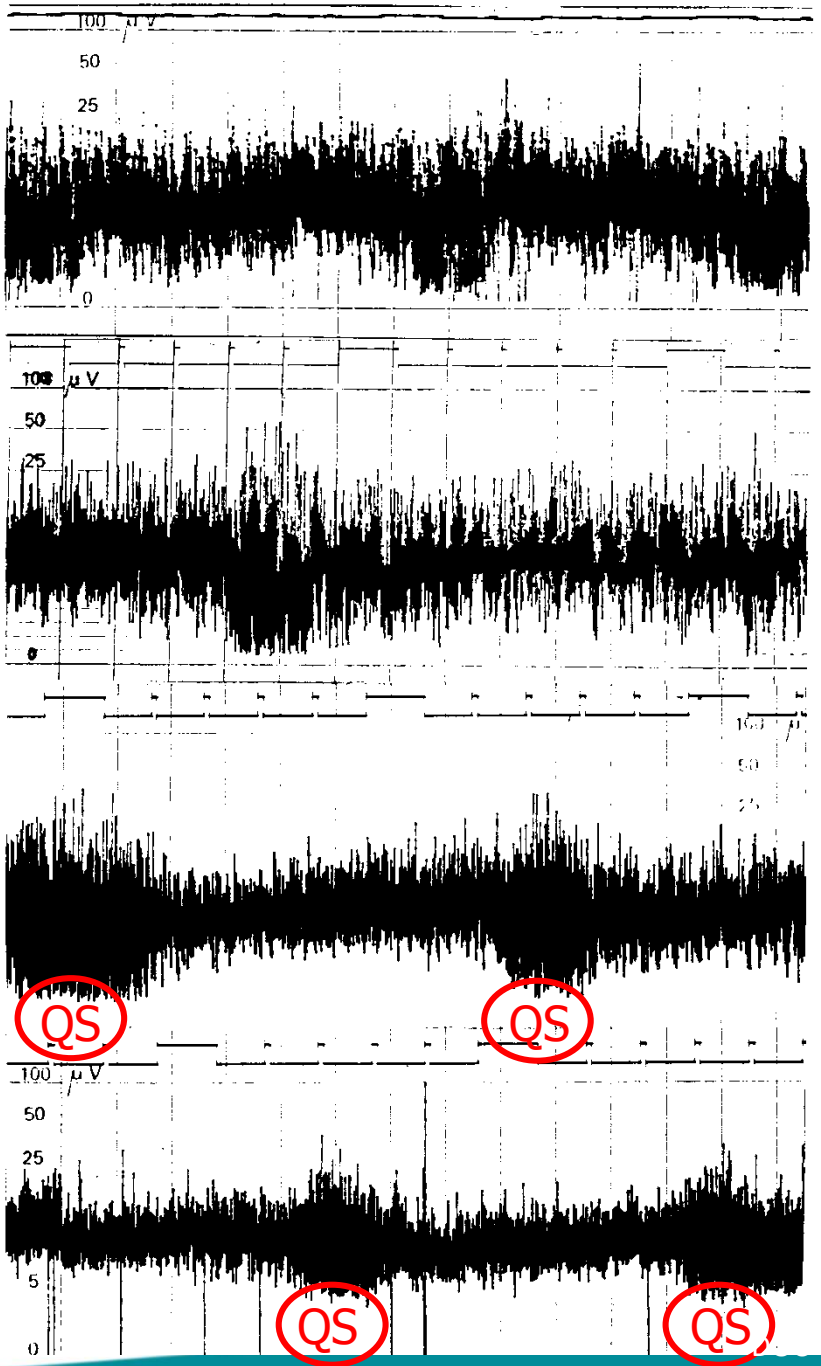
Thornberg & Thiringer 1990, Kuhle et al 1999)



24 w

25 w

26 w



31 w

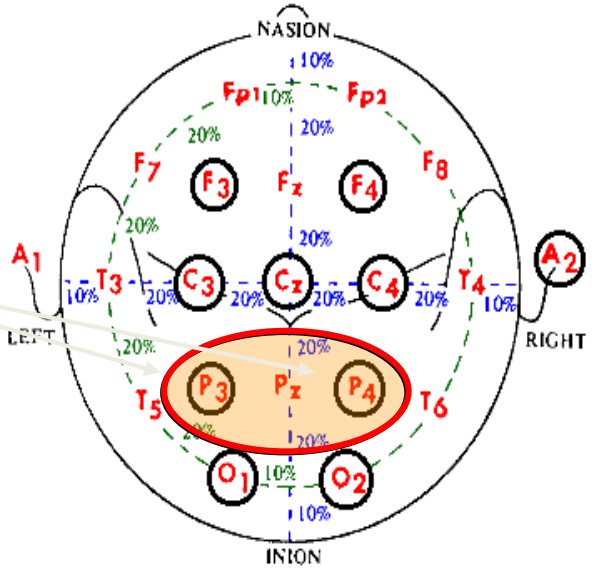
33 w

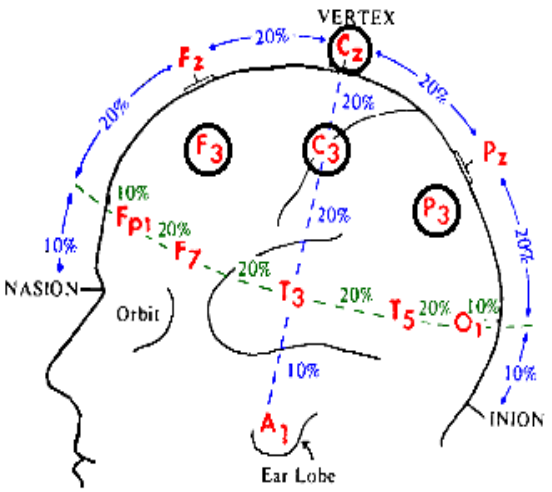
35 w

37 w

Olympic Brainz Monitor Electrode Placeme

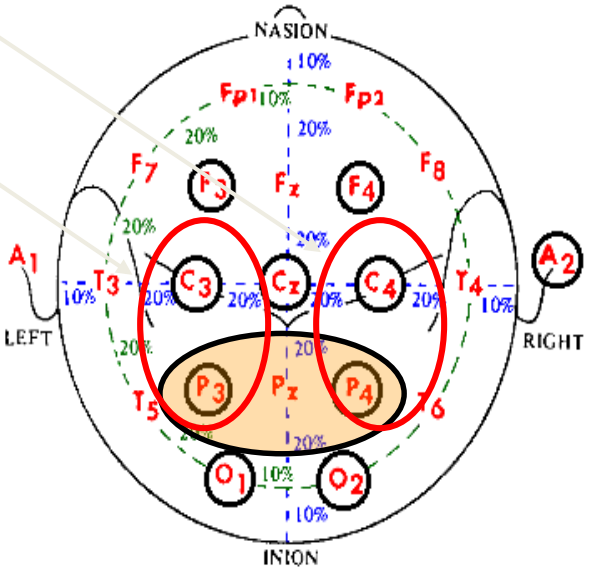
- 3 Electrodes
  - 2 Active
    - Hydrogel
    - Low impedance needles
  - 1 Reference/Ground
    - Hydrogel
- Lead Placement:
  - P3/P4 placement
  - Reference Ground
    - back or chest

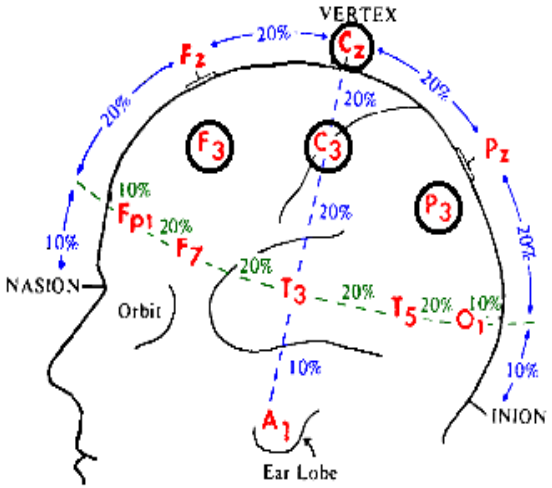




Olympic Brainz Monitor – Electrode Placeme

- 5 Electrodes
  - 4 Active
    - Hydrogel
    - Low impedance needles
  - 1 Reference/Ground
    - Hydrogel
- Lead Placement:
  - C3/P3 and C4/P4 placement
  - Reference Ground
    - back or chest





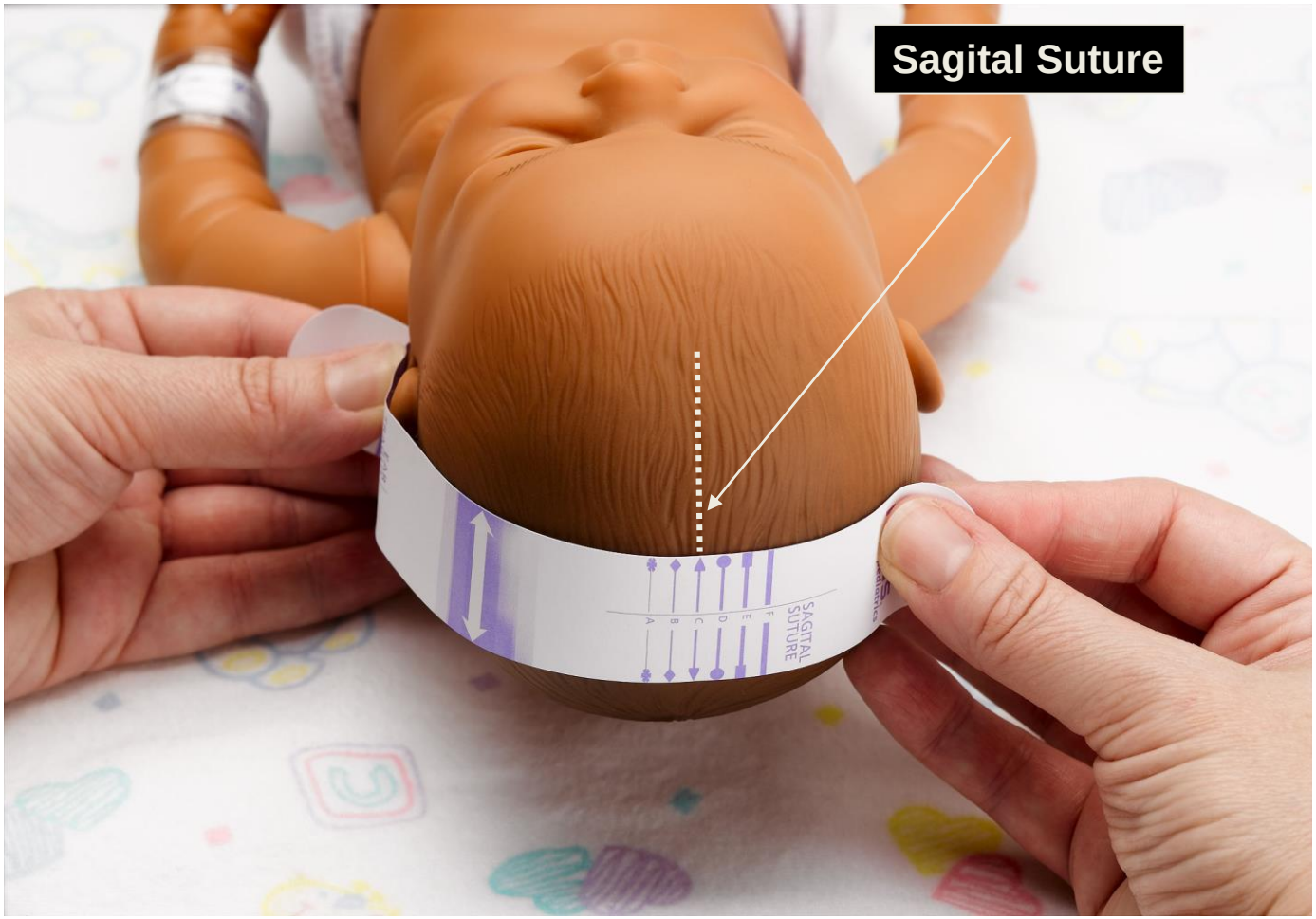
Olympic Brainz Monitor – Patient Preparation

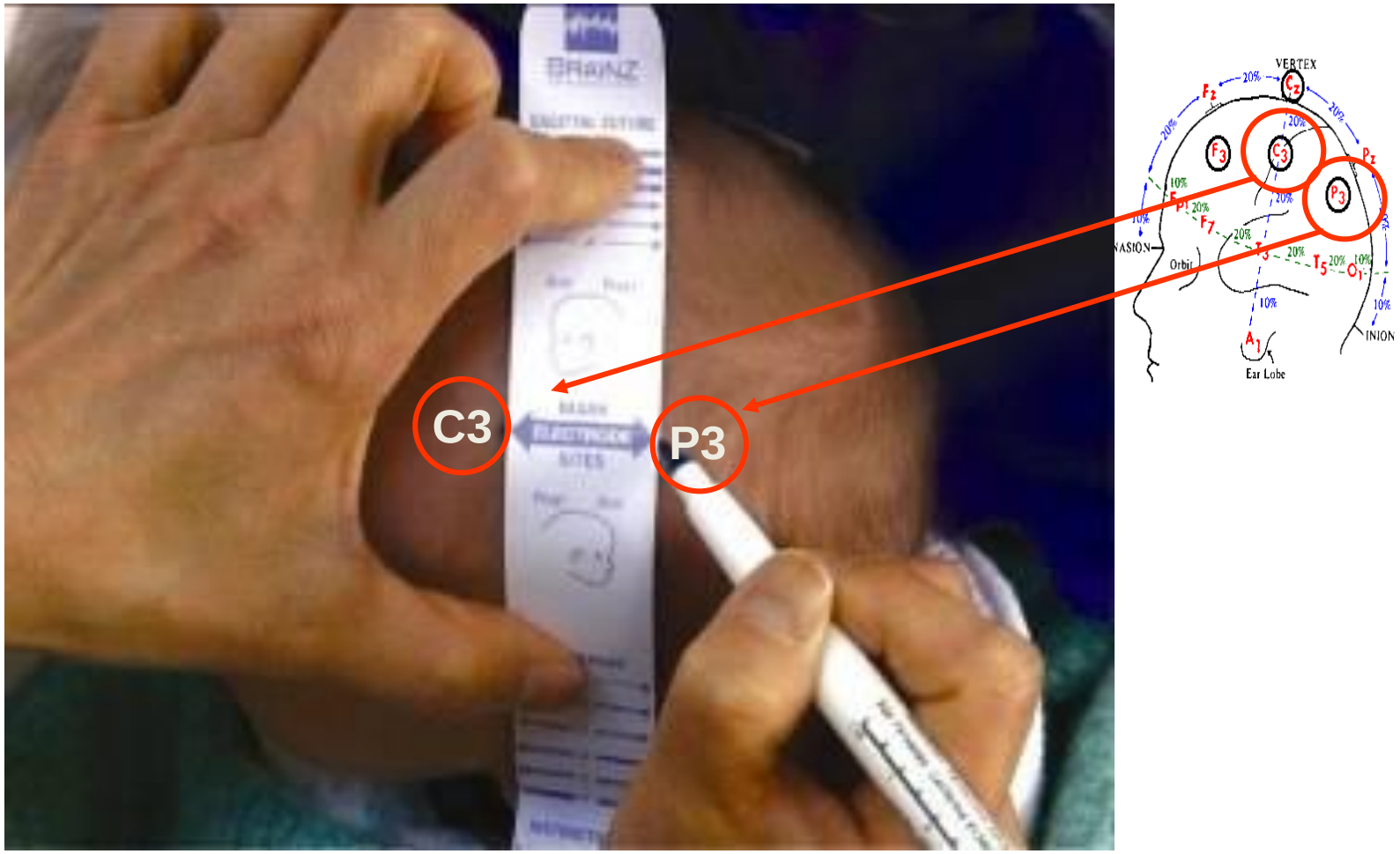
- The following steps describe the preparation and application of the 5 electrode configuration
- Omit the application of the anterior (most forward pair) of electrodes when the 3 electrode configuration is employed

- Sensors
  - Electrode Set
    - Hydrogel electrodes
    - Low impedance needle electrodes
    - Other – 1.5 mm compatible electrodes
- Positioning Aid
- Skin Marker
- Skin Prep
  - Hydrogel electrodes
    - NuPrep™, water, gauze, cotton swab, wrap hat (optional)
  - Low impedance needle electrodes
    - Antiseptic prep
    - Tape or other securing adhesive
- Comb – if excessive hair is present

Positioning Aid – Ear Tragus

Positioning Aid – Sagital Suture




BRAINZ
C3
P3
VERTEX
Orbit
Ear Lobe
INION

Positioning Aid

Ear
Tragus

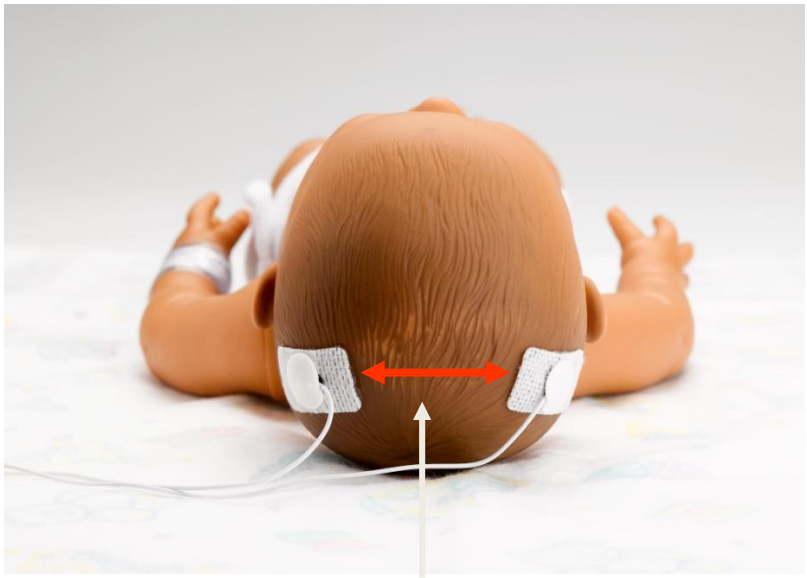
Sagital
Suture

Marking Electrode Sites

Part Hair and Prepare Skin

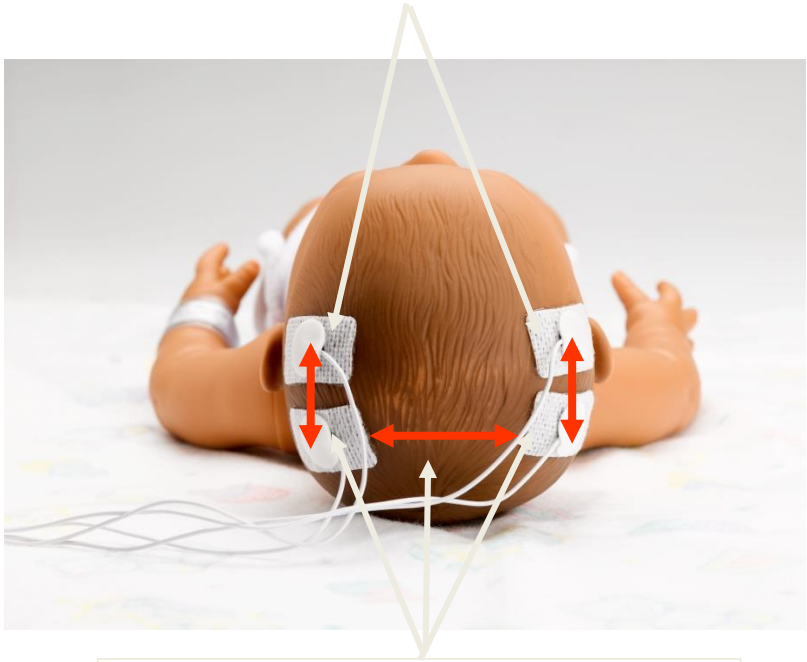
Apply Hydrogel Electrodes

Channels



Cross Cerebral or Bi-Parietal
1 Channel

Bi-Lateral – 2 Channels



Bi-Lateral and Cross Cerebral
3 Channels

- Hydrogel Electrodes
- Low Impedance Needle Electrodes
- Other

Which Type of Electrode is Appropriate?

- Considerations in Electrode Selection:
  - Anticipated length of monitoring
    - Short vs Long-Term
  - State of the baby
    - Acuity
    - Tolerance of handling
  - Physiologic considerations
    - Hair
    - Gestational age
    - Condition/fragility of skin
  - Special considerations:
    - IV's
    - Scalp injuries
    - CPAP
    - Phototherapy
    - NIRS

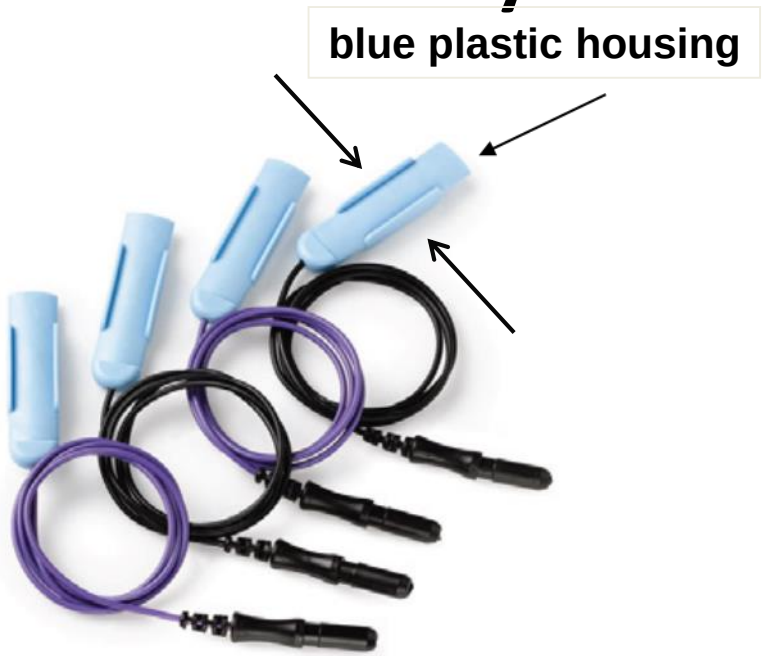
Skin Prep Suggestions – Hydrogel Electrodes

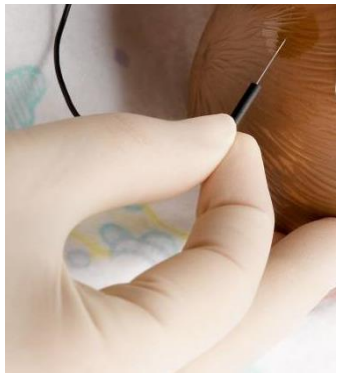
- Allow the hydrogel electrodes to warm by placing on the radiant warmer bed while prepping the skin
- It is recommended you prep and place one electrode at a time when possible
- Always apply the skin prep gel directly to the skin
- Never apply skin prep gel directly to an electrode
  - it can increase impedance
- Run a finger around the edges of the electrode for 20-30 seconds after placement to warm the electrode to the skin and ensure a secure seal
- Optional - Use a wrap hat as an additional measure to secure the electrodes

Low Impedance Needle – Preparation Supplies

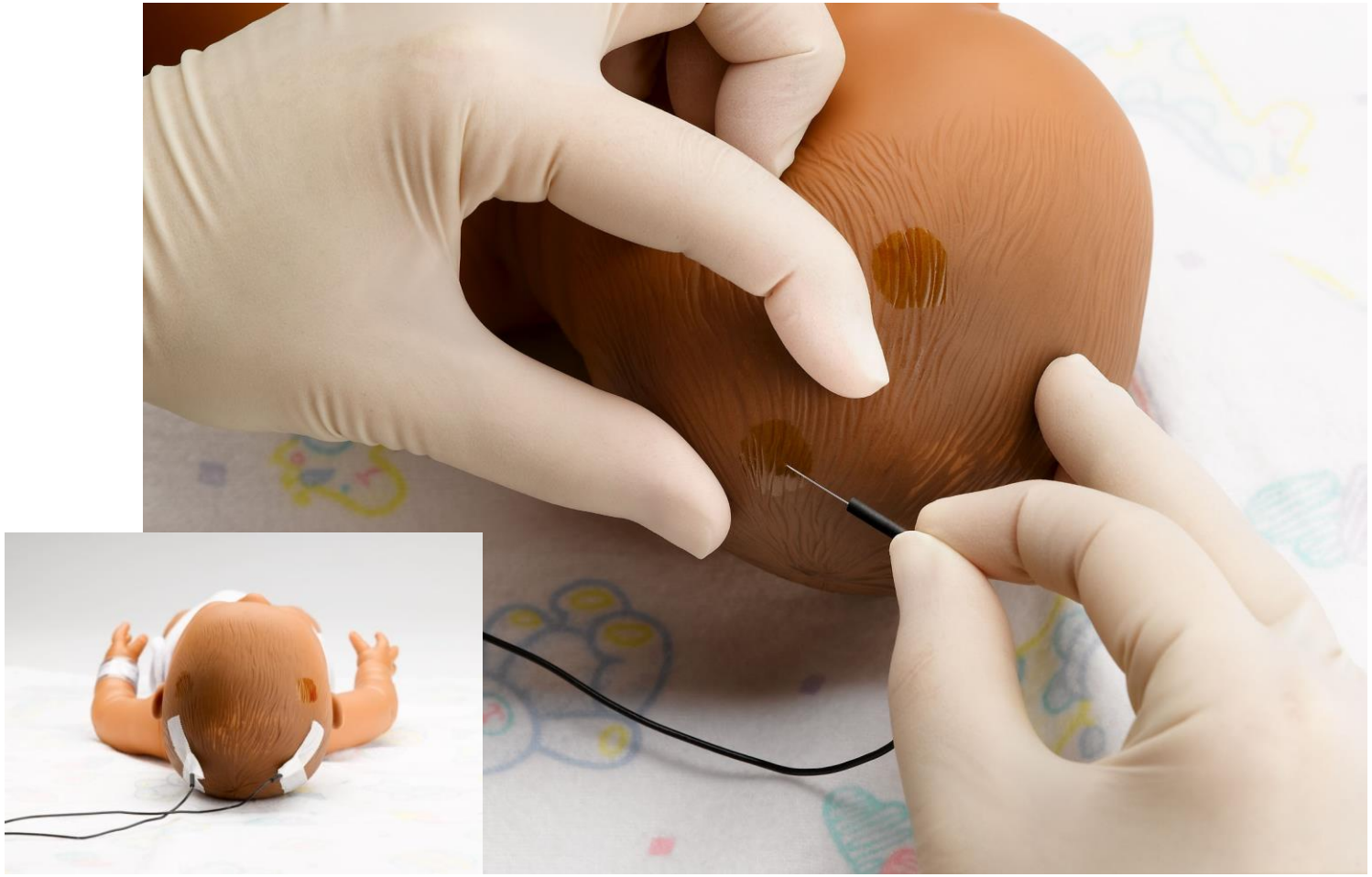
Low Impedance Needle Electrodes - Safety

- Note – the blue plastic housing of the low impedance needle electrode is also meant to be utilized to minimize the risk of needle stick when removing from the patient
  - To advance the low impedance needle from the hub:
    - Hold the blue plastic housing between your thumb and forefinger and press slightly.
    - Advance the lead wire from the bottom until the low impedance needle and black hub are exposed
    - Grasp the black hub and slide the blue plastic housing to the distal end of the lead wire
  - To remove the low impedance needle from the baby:
    - Hold the blue plastic housing and gently pull the lead wire back until the needle has completely retracted
    - Discard in sharps container





Insert Subdermally

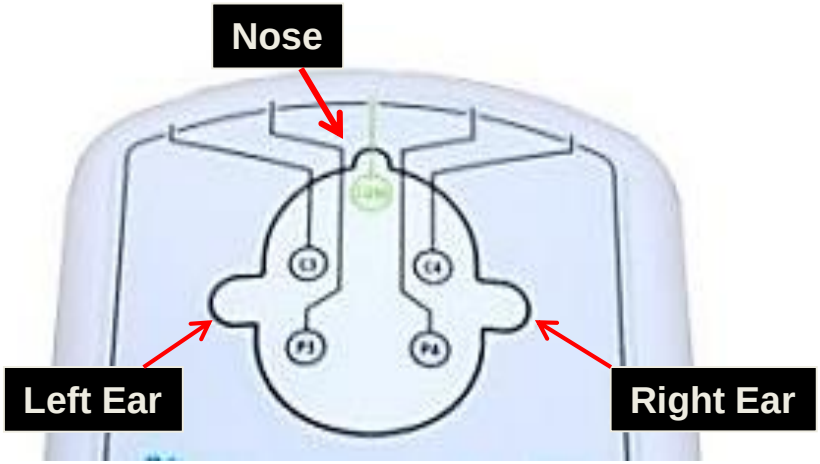


Olympic Brainz Monitor – Reference / Ground Hydrogel Electrode

- Select a site with minimal hair
  - Shoulder
  - Neck
  - Behind the ear
- Repeat previous steps to clean reference/ground electrode site
- Place electrode

Secure Electrodes

Connect Electrodes to DAB



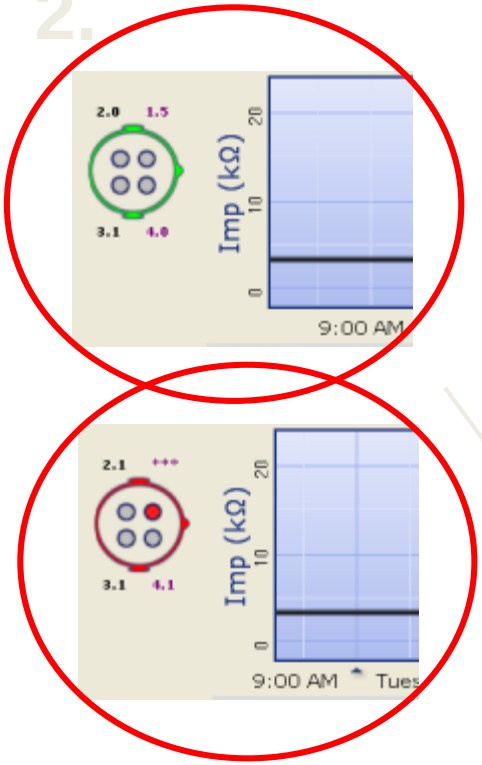
3 Electrode/Cross-Channel Configuration

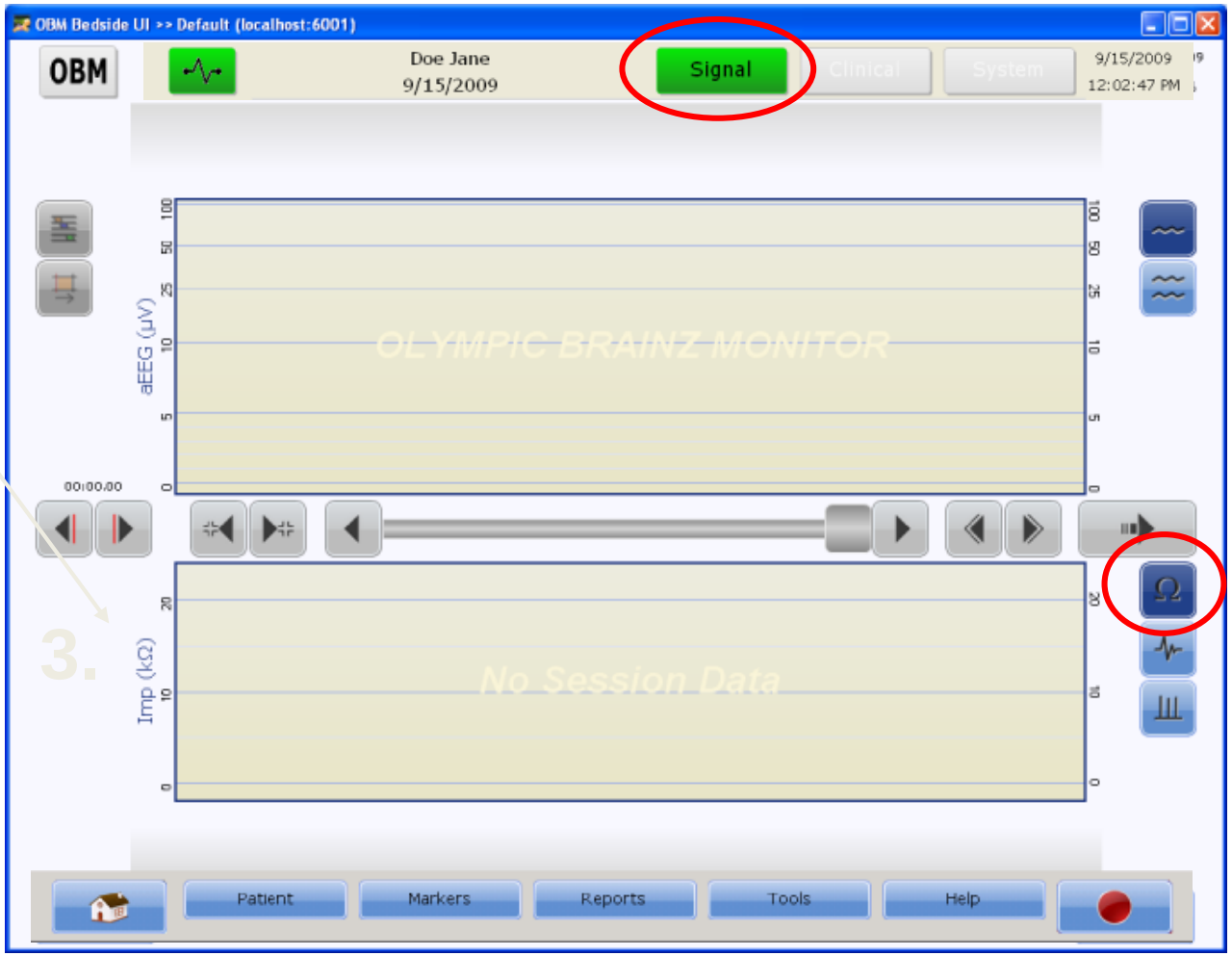
5 Electrode/Bi-Lateral Configuration

Check Signal Quality

1.

2.





3.

Troubleshooting – High Impedance Alert Hydrogel Electrodes

- Check the hydrogel sensor from the skin to the D.A.B.
  - Make sure all electrodes are properly connected to the D.A.B.
  - Make sure the D.A.B. is properly connected to the Olympic Brainz Monitor
  - If an electrode is lifting, attempt to rehydrate and reapply
    - To re-hydrate:
      - Slightly lift or remove electrode
      - Wet electrode surface with a drop of water

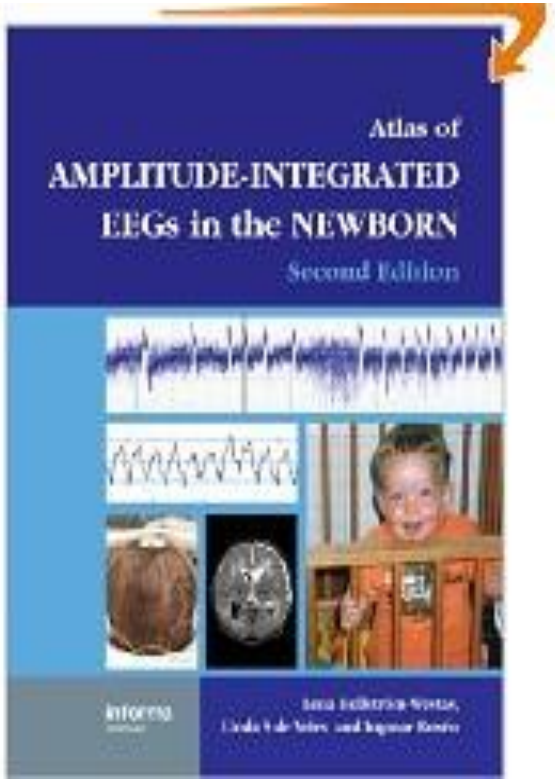
Troubleshooting – High Impedance Alert Low Impedance Needle Electrodes

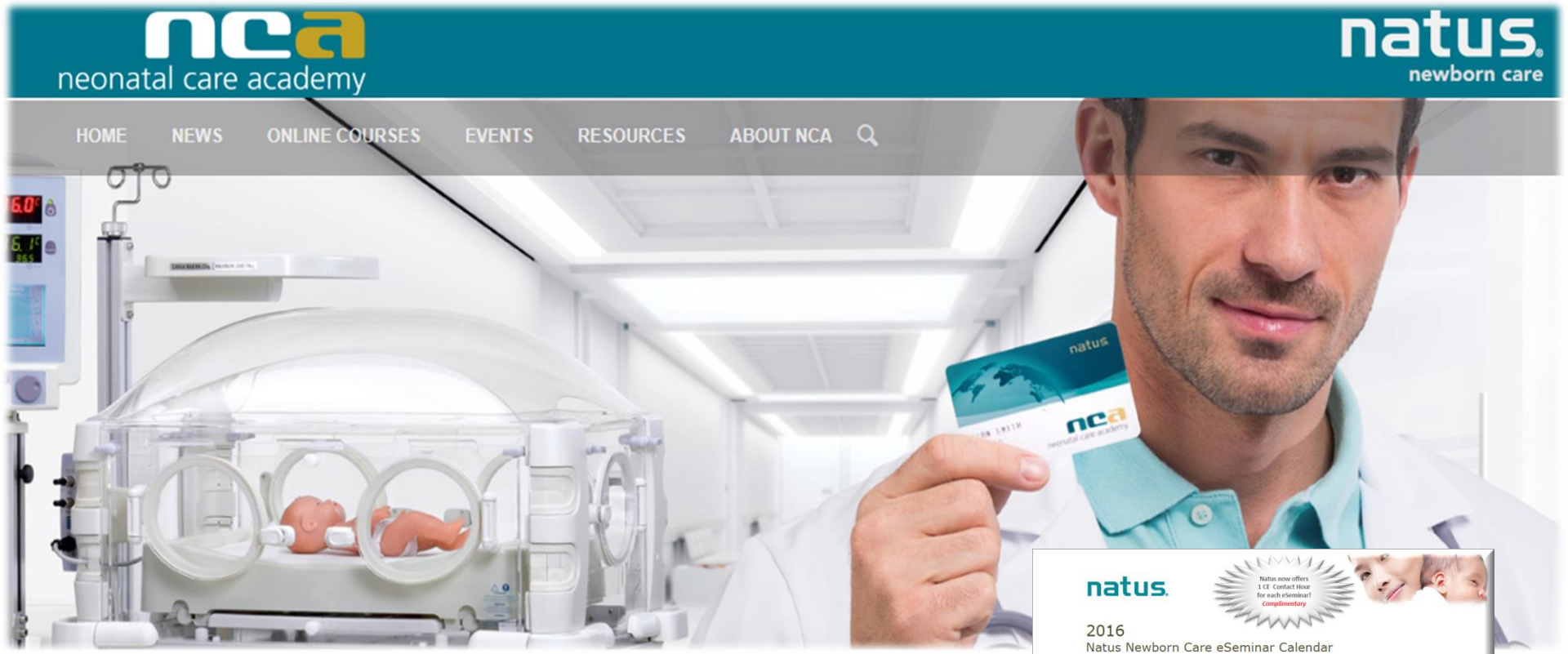
- Check the low impedance needle sensor from the skin to the D.A.B.
  - Make sure all electrodes are properly connected to the D.A.B.
  - Make sure the D.A.B. is properly connected to the Olympic Brainz Monitor
  - If an electrode is dislodged, obtain a new low impedance electrode, clean new site, insert, and secure with tape or other adhesive

aEEG Reference Literature

Reference:

- Atlas of Amplitude-Integrated EEGs in the Newborn: Second Edition (*Hellstrom-Westas, De Vries, Rosen; 2008)*





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Assessing Jaundice in the Newborn Infant
April 26, 2016
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MAY
Humidifying the Microenvironment
May 3, 2016
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Family Centered Care
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JULY
Optimizing the Thermal Environment – Creating a Comfort Zone
July 26, 2016
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Basics of aEEG
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OCTOBER
Creating a Healing Environment
October 4, 2016
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