 **Normal EEG:**
premature to 19 years of age



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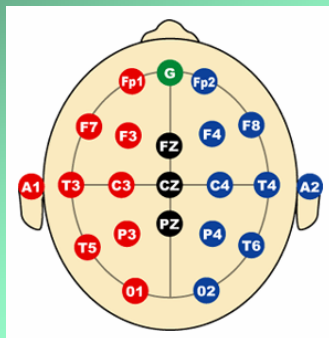
OUTLINE

- **Neonatal EEG**
 - electrode placement for neonates
 - basic ingredients of neonatal EEG
 - normal EEG in preterm to term neonates
- **Infant & childhood EEG**
 - normal EEG in infants
 - normal EEG in children

- The only clinical information required before EEG analysis is begun is **patient's age**.
- In the term newborn, age should be specified in days since delivery (chronological age)
- In preterm newborn, age should be corrected to the conceptional age (CA).

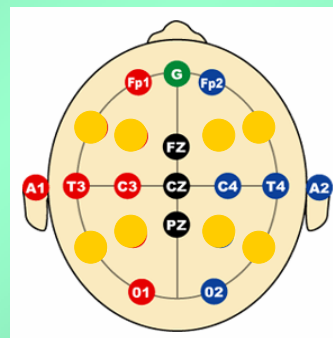


**Electrode placement:
infants and adults**



10-20 system

**Electrode placement:
neonates**



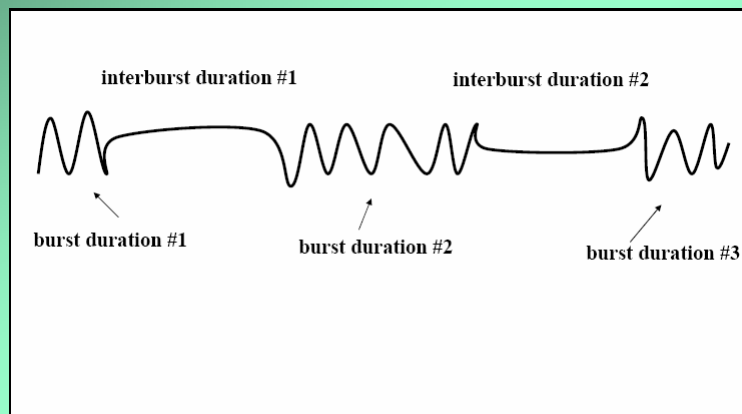
**10-20 system,
modified for neonates**

Neonatal EEG

- 1) Continuity & Discontinuity
- 2) Synchrony
- 3) Developmental landmarks
eg. delta brushes, frontal sharp transient etc.
- 4) Sleep-wake state
- 5) Reactivity to stimuli

In preterm, age should be corrected to “conceptional age (CA)”.

Measurements of Discontinuity



Definitions of Behavioral State

Normal

Awake = eyes open

Asleep = eyes closed

Active sleep = REM

Quiet sleep = NREM

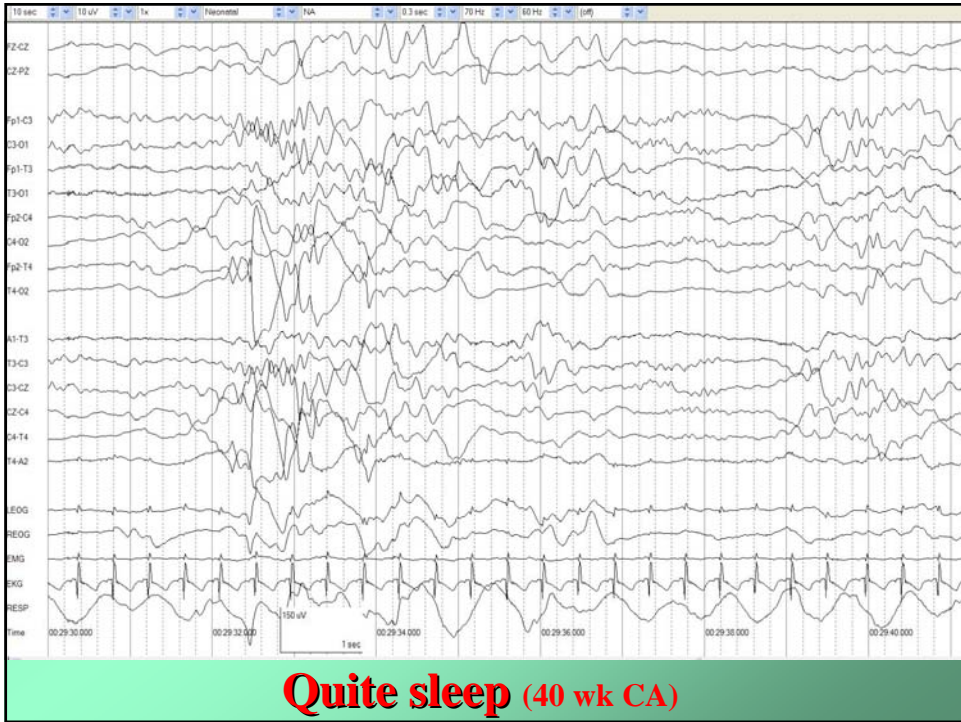
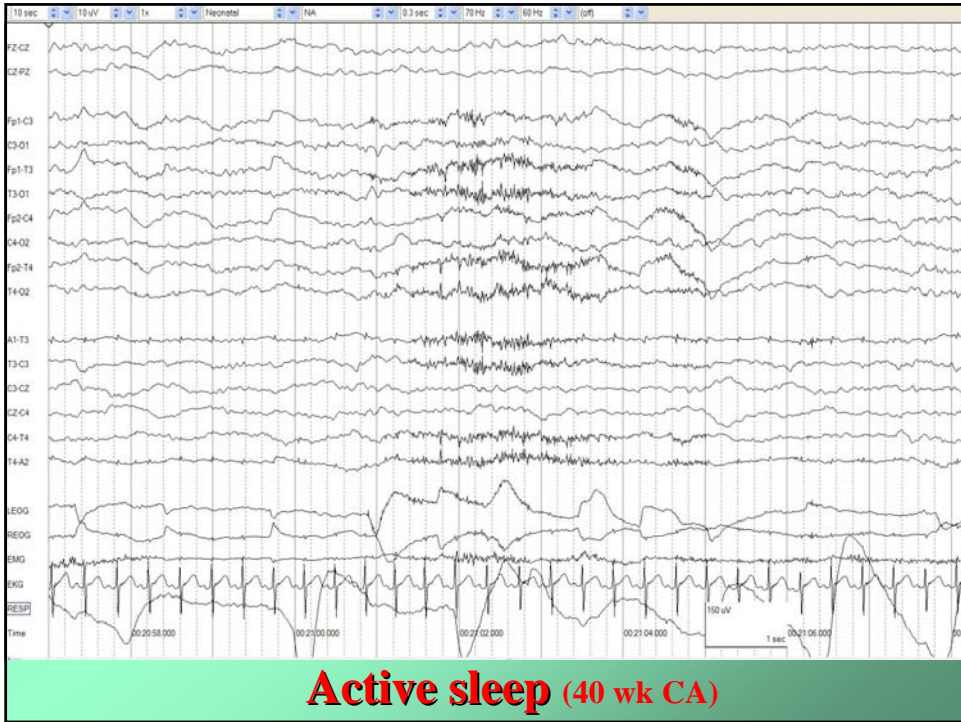
Abnormal

Lethargy/Coma = abnormal, eye closed

Undetermined = eyes fused or baby paralyzed

Physiologic measurement of Awake/Sleep state

Physiological Measure	Awake	Active sleep	Quite sleep
EMG (chin)	phasic & tonic	phasic	tonic
Respiration	irregular	irregular	regular
Eye movements	random or pursuits	REM	absent
Body movements	facial, limbs & body	sucking & irregular limb movement	none



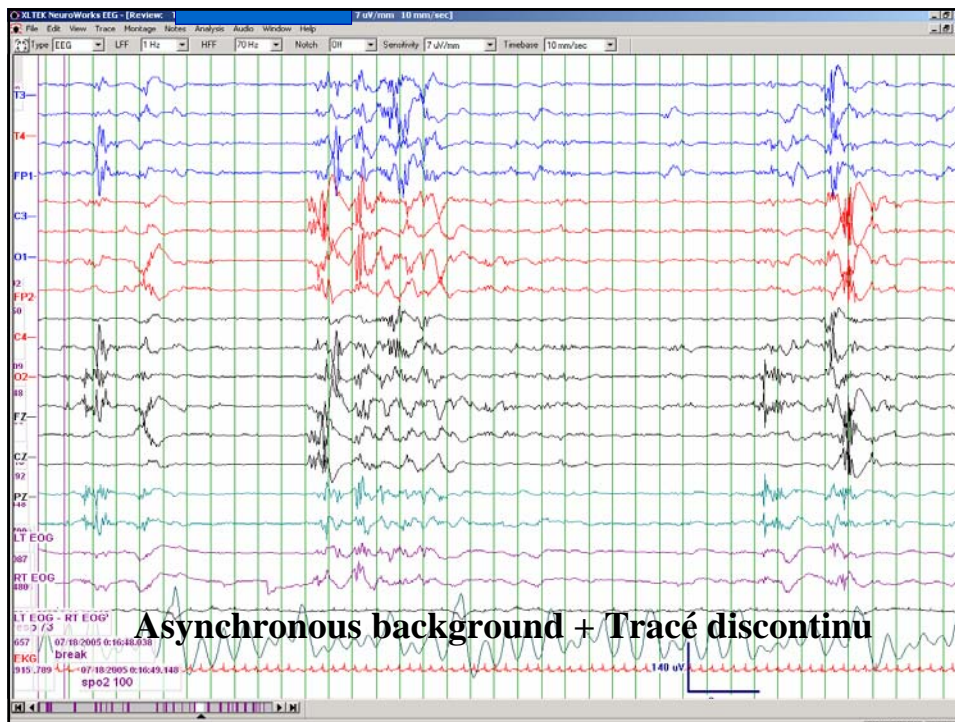
Neonatal EEG

< 29 wk CA

1. Tracé discontinu
2. Asynchronous background activity
3. Delta brushes & Monorhythmic occipital delta
4. EEG appears the same while awake or sleep
5. No change in EEG with stimulation

< 29 wk CA

- Tracé discontinu
 - discontinuous pattern
 - interburst interval (IBI) amplitude < 25 μ V
 - maximal IBI 30-35 seconds
 - present during all states

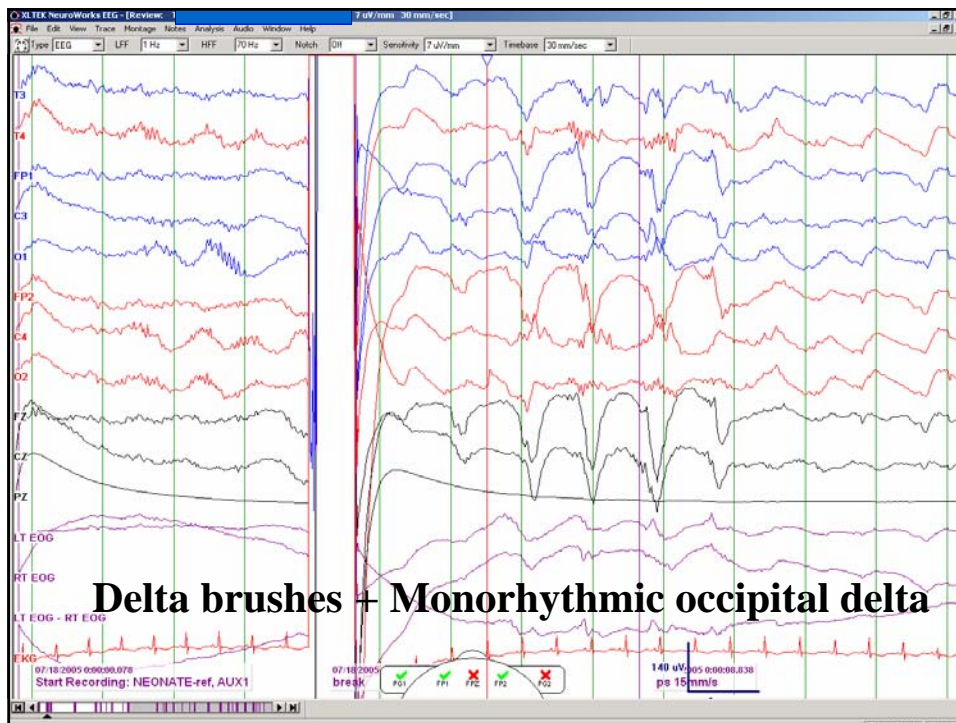


< 29 wk CA

- Delta brushes
 - moderate to high amplitude 0.3-1.5 Hz delta waves with superimposed burst of fast activity (8-12 Hz, and 18-22 Hz)
 - 1st appear at 26 wk CA and located over central region; prominent from 29-38 wk CA, extend to temporal & occipital distribution
 - disappear at 44 wk CA

< 29 wk CA

- Monorhythmic occipital delta activity
 - monomorphic, high amplitude delta waves, usually bisynchronous and symmetric, over occipital areas
 - 1st appear at 23 - 24 wk CA; prominent from 31 - 33wk CA
 - disappear at 35 wk CA



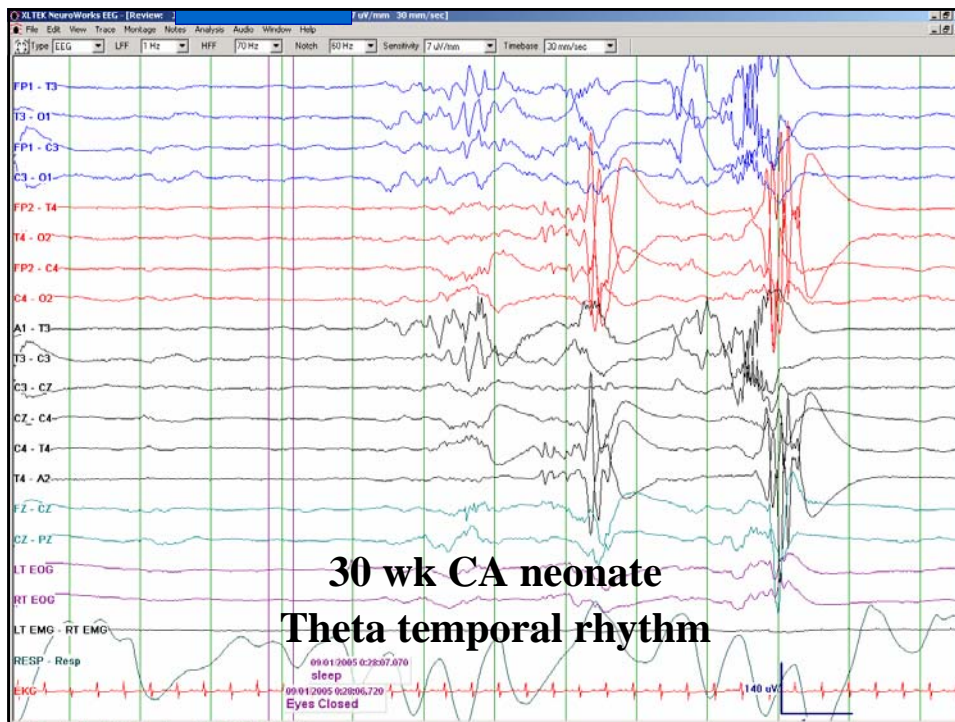
Neonatal EEG

29 - 31 wk CA

1. Delta brushes occur more frequent
2. Temporal theta rhythm
3. Minimal between active sleep (REM) & quiet sleep (NREM)

29 - 31 wk CA

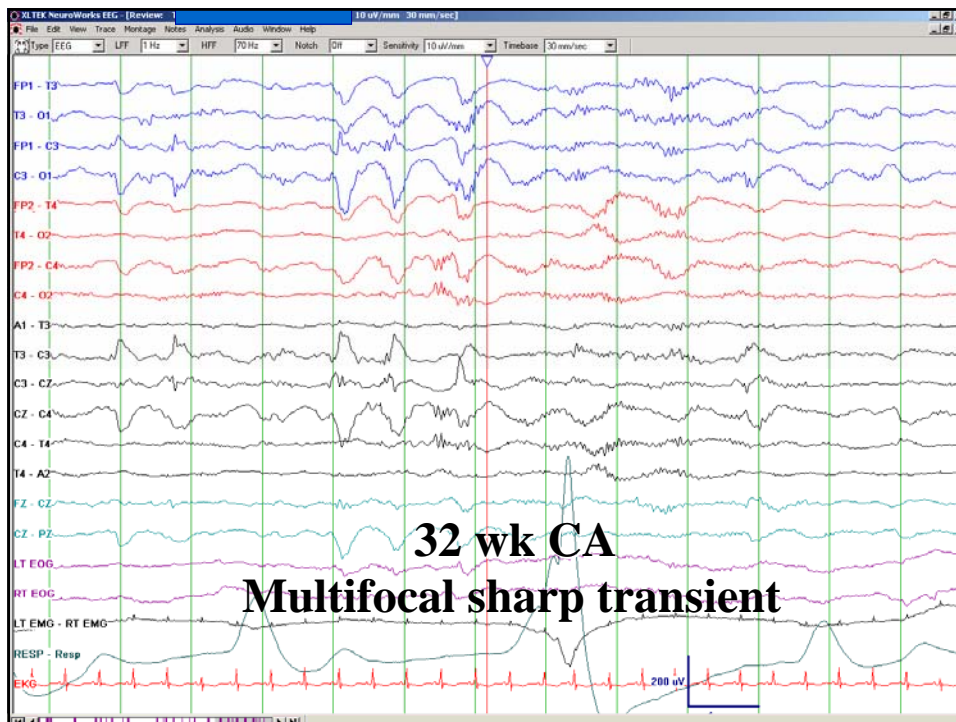
- Temporal theta rhythm
 - short run (<1sec) of rhythmic, theta frequency
 - useful to estimate CA
 - maximum response at 30 - 32 wk CA
 - disappear at 35 wk CA



Neonatal EEG

32-34 wk CA

1. Tracé discontinu
 - shorter duration: IBI 5-8 sec., max. 20 sec.
2. Some changes in EEG with stimulation
3. Appearance of EEG reactivity (voltage flattening)
4. Increase in the number of multifocal sharp transients



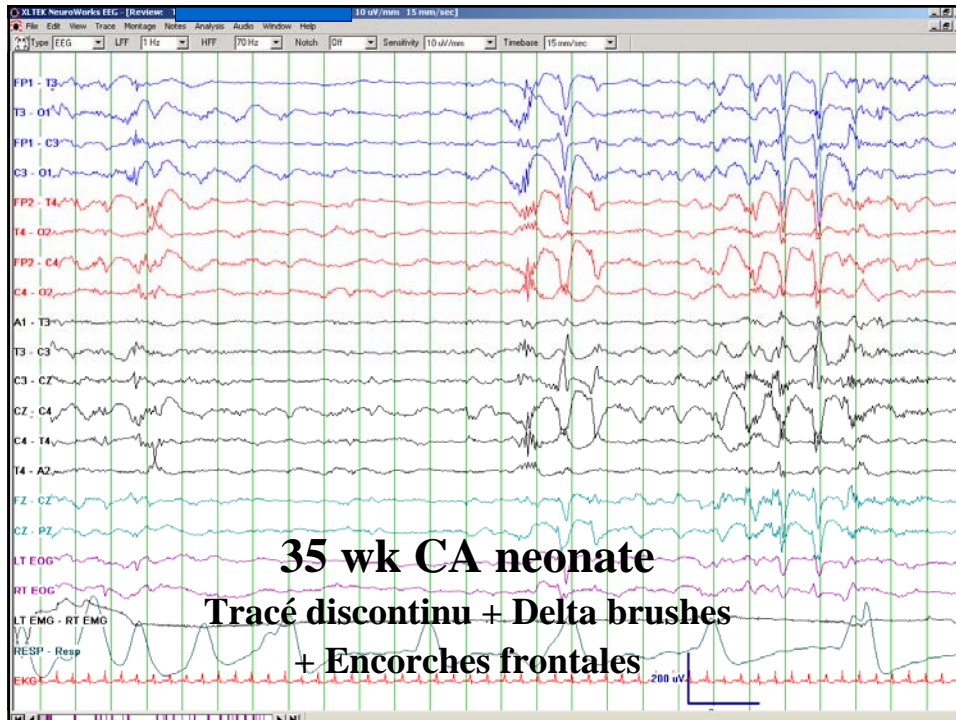
Neonatal EEG

34-37 wk CA

1. Tracé discontinu
 - well established between 34-36 wk.
 - IBI amplitude $> 25 \mu\text{V}$; duration 4-6 sec., max. 10 sec.
2. Continuity: low to moderate amplitude, mixed frequency, continuous in awake and active sleep
3. Encorches frontales (frontal sharp transients)
4. Anterior slow dysrhythmia
5. Definitely distinguishable awake and active sleep (appearance of tracé alternant)

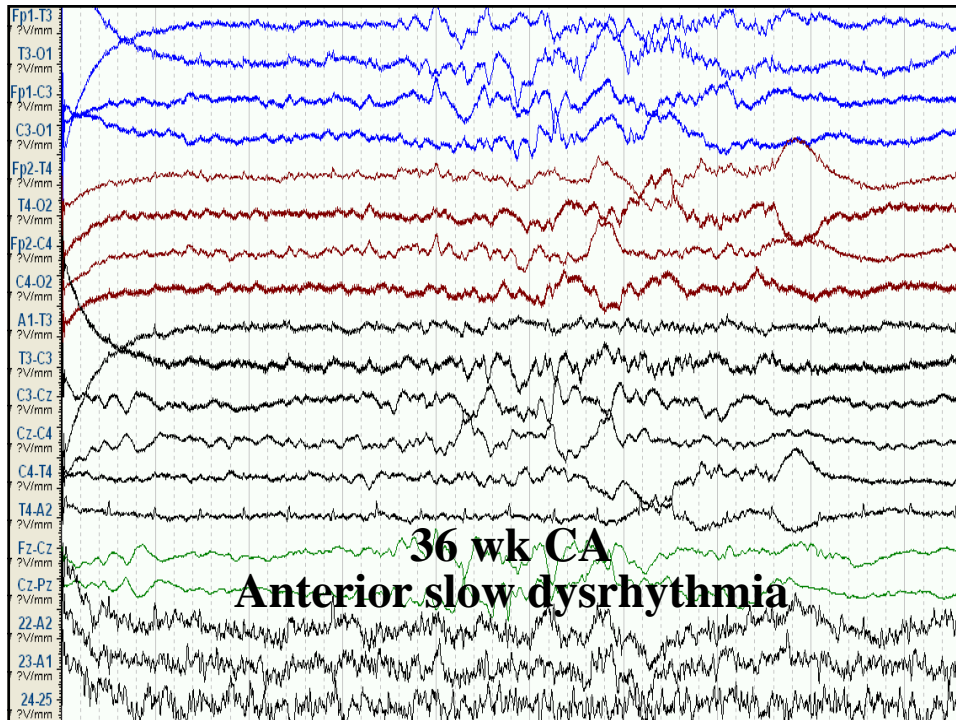
34 - 37 wk CA

- Encorches frontales (frontal sharp transients)
 - brief runs of medium amplitude biphasic, notched frontal activity
 - first phase of negative sharp wave followed by second phase of positive slow wave
 - appear at 33 - 34 wk CA, predominant at 35 wk CA
 - disappear at 46 wk CA



34 - 37 wk CA

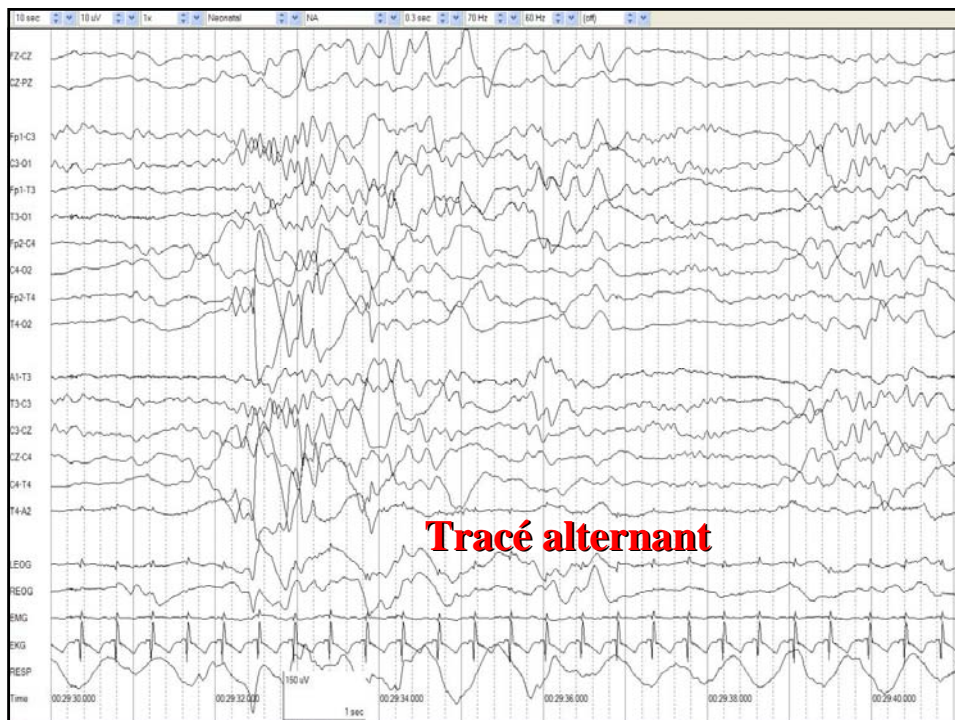
- Anterior slow dysrhythmia
 - short runs of bilaterally symmetrical, synchronous, monomorphic or rhythmic 2-4 Hz over anterior head regions
 - present during all states but frequently occur before QS
 - appear at 33 - 34 wk CA
 - disappear at 44 wk CA



Neonatal EEG

37 - 40 wk CA

1. Completely continuous during awake and sleep
2. Consistent reaction of EEG background
3. Four main EEG patterns are seen:
 1. low voltage irregular pattern
 2. mixed pattern (mixed voltage, mixed frequency)
 3. high voltage slow pattern, or continuous slow wave (CSW) during quiet sleep
 4. tracé alternant during quiet sleep



Summary of Preterm EEG

- 1) Continuity & Discontinuity
- 2) Synchrony
- 3) **Developmental landmarks** eg. delta brushes, enchoche frontales etc.
- 4) Sleep-wake state
- 5) Reactivity to stimuli

In preterm, corrected age is necessary for EEG interpretation

Normal Discontinuity

- Acceptably maximal IBI of each conceptional age
- Tracé discontinu (CA ~30-35 wk)
- Tracé alternant (CA ~36-44 wk)
- With maturation:
 - Discontinuity relates to quiet sleep*
 - Continuity dominates active sleep and wakefulness*

Longest acceptable single IBI duration values for conceptional age

Conceptional age	Maximal IBI
< 30 wk	30-35 sec.
31-33 wk	20 sec.
34-36 wk	10 sec.
37-40 wk	6 sec.

Forms of Abnormal Discontinuity

- Excessively prolonged IBI values for CA
- Excessively discontinuous in quiet sleep
 - IBIs abnormally long or low voltage
- Burst suppression

Developmental landmarks of neonatal EEG

- Rhythmic occipital/temporal “theta delta” activity
- Rhythmic occipital/temporal “Delta brushes” activity

Preterm neonates

- Anterior Dysrhythmia
- Enchocres Frontales

Approaching Term neonates

With Maturation...

From Slow Delta and Theta to faster “Delta brushes”

Overview of concepts: Developmental progression of continuity

CA (wk)		Awake & Active sleep	Quiet sleep
< 29	A		
30	B		
32	C		
36	D		
40	E		
44	F		
46	G		