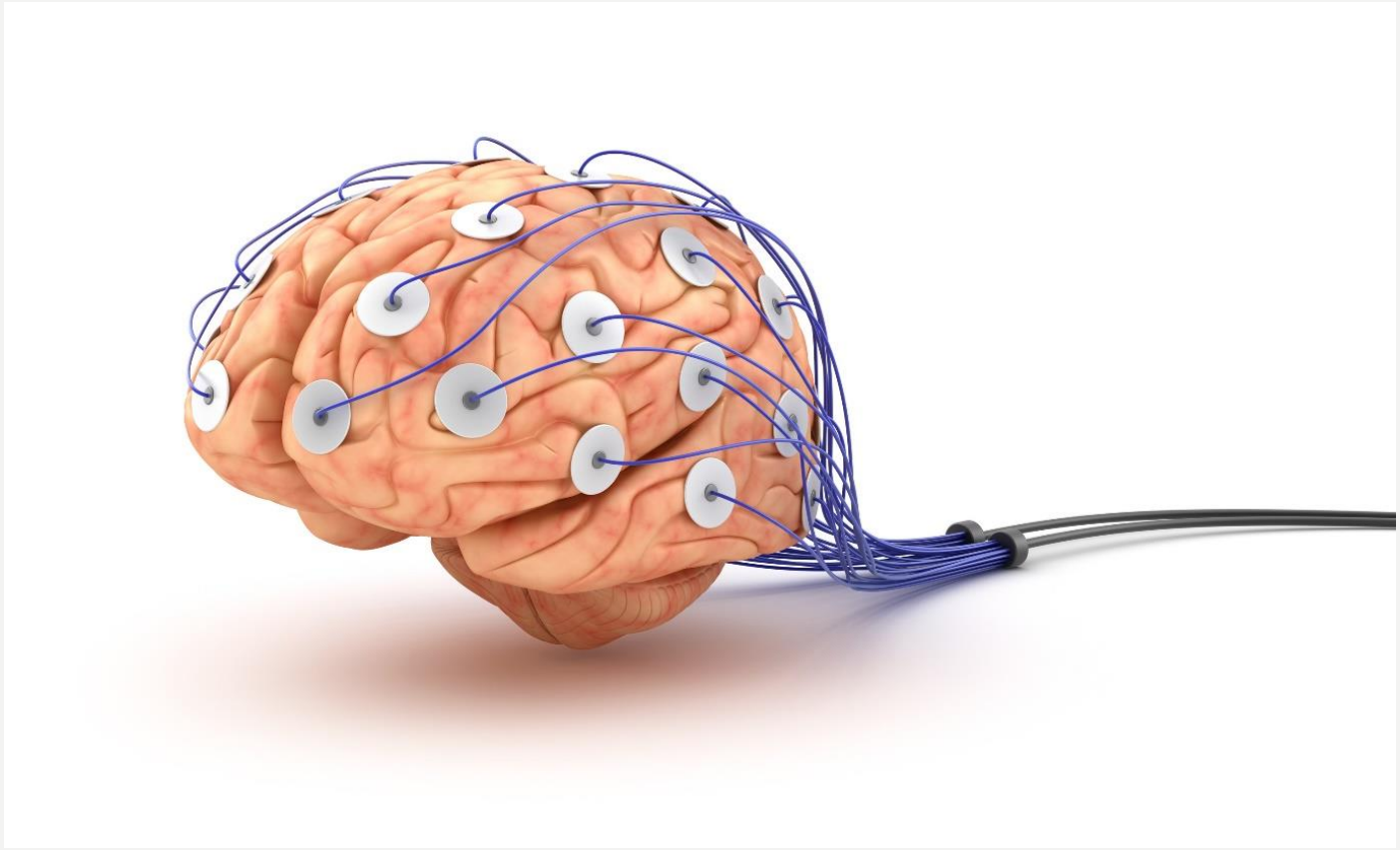
CLINICAL EEG: AN INTRODUCTION

DR. SHAHUL AMEEN MD

EEG IS…



The recording of electrical activity along the scalp produced by the firing of neurons within the brain.

IMMENSELY USEFUL IN ASSESSING-

- Seizures / pseudoseizures
  - Helps to classify seizures
  - Aids the decision on drug discontinuation
- Delirium
- Coma / dissociative stupor

THE LANGUAGE OF EEG

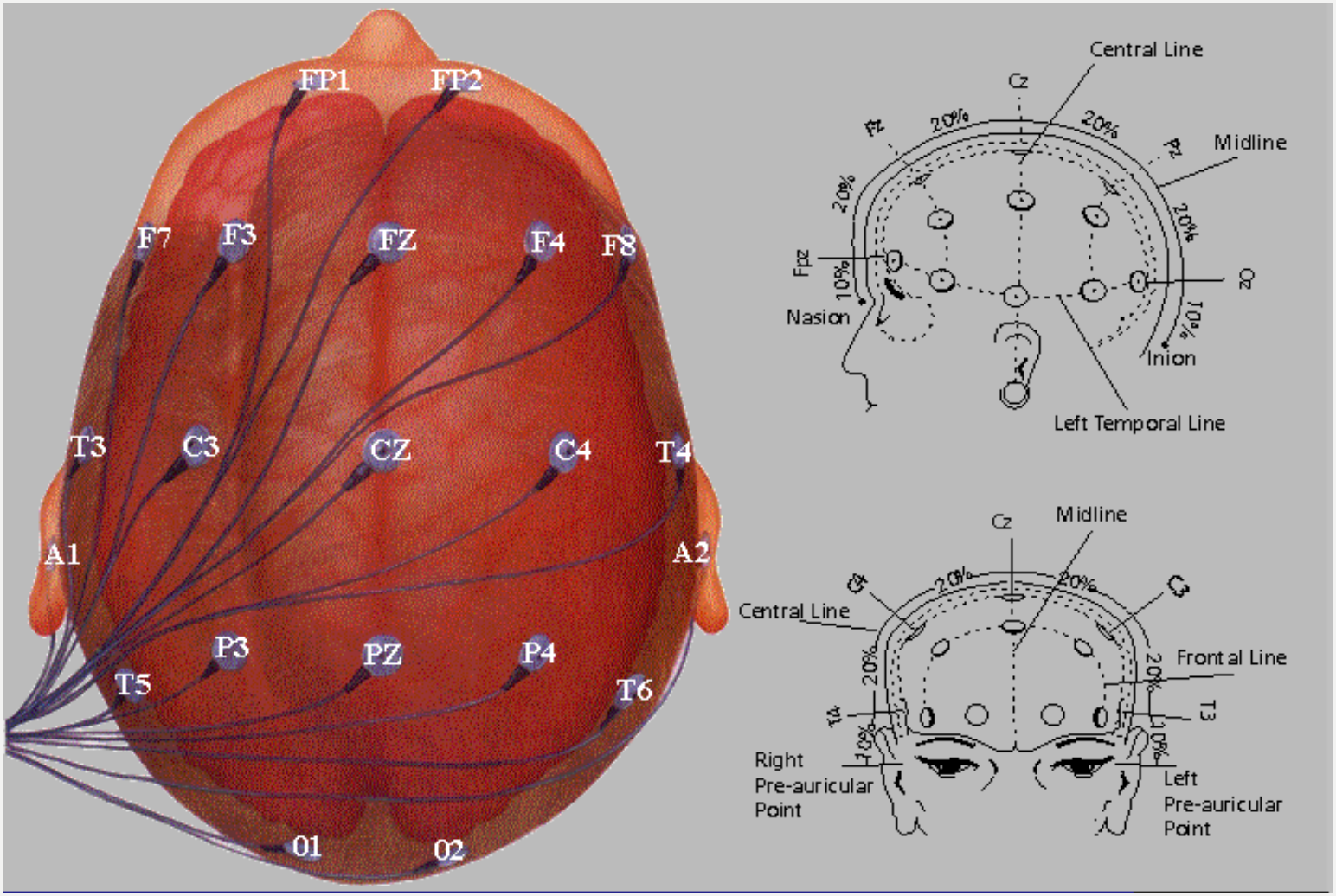
Electrode

Channel

Montage

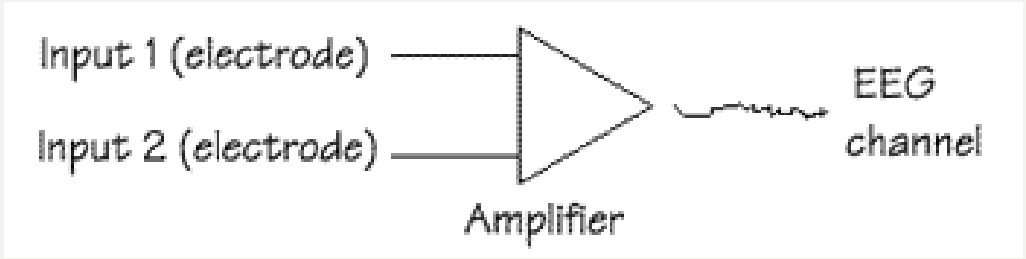
Sensitivity

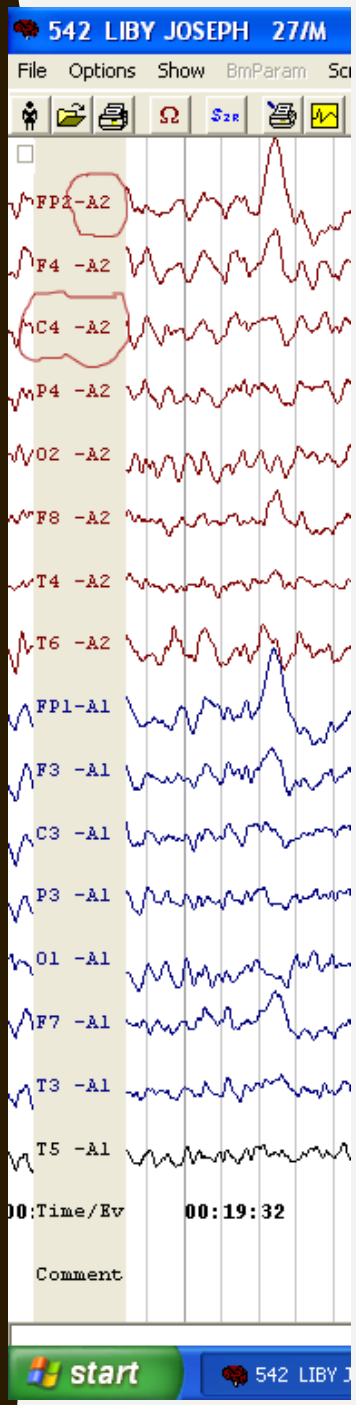
ELECTRODE POSITIONS IN ROUTINE EEG



CHANNELS

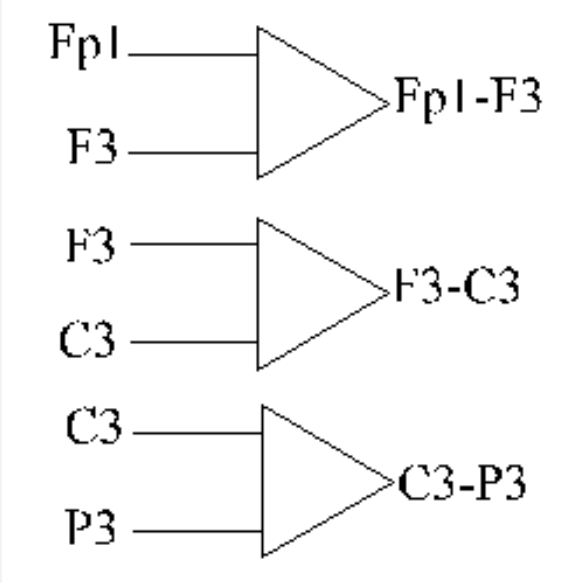

FP2-A2


Input 1 (electrode)
Input 2 (electrode)
Amplifier
EEG
channel

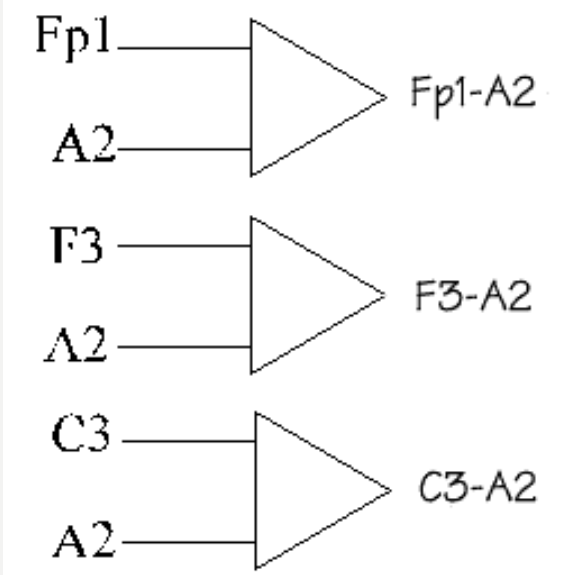


Montages

Bipolar

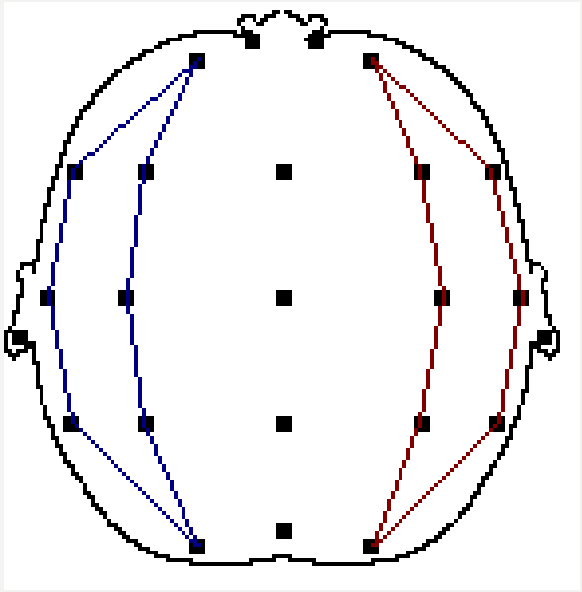


Monopolar

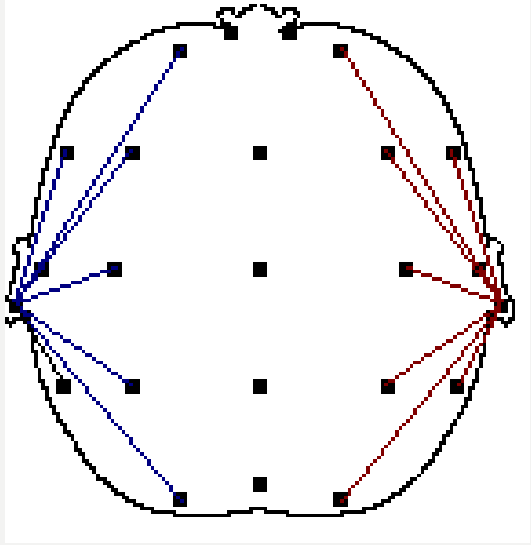


EXAMPLE OF A BIPOLAR MONTAGE

FP2- F4
FP1 - F3
F4 - C4
F3 - C3
C4 - P4
C3 - P3
P4 - O2
P3 - O1
FP2- F8
FP1 - F7
F8 - T4
F7 - T3
T4 - T6
T3 - T5
T6 - O2
T5 - O1

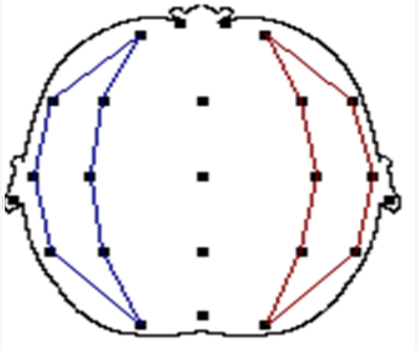


EXAMPLE OF A MONOPOLAR MONTAGE

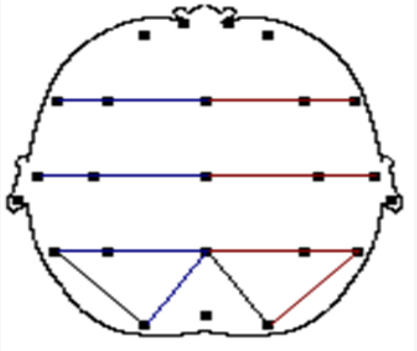


FP2- A2
F4 - A2
C4 - A2
P4 - A2
O2 - A2
F8 - A2
T4 - A2
T6 - A2
FP1 - A1
F3 - A1
C3 - A1
P3 - A1
O1 - A1
F7 - A1
T3 - A1
T5 - A1

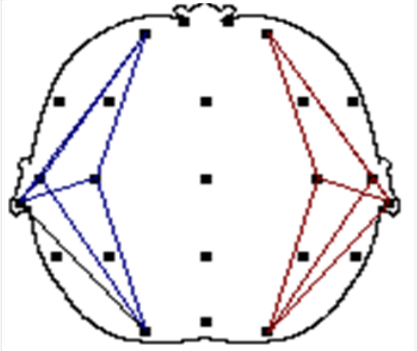
EXAMPLES OF MONTAGES



Double banana

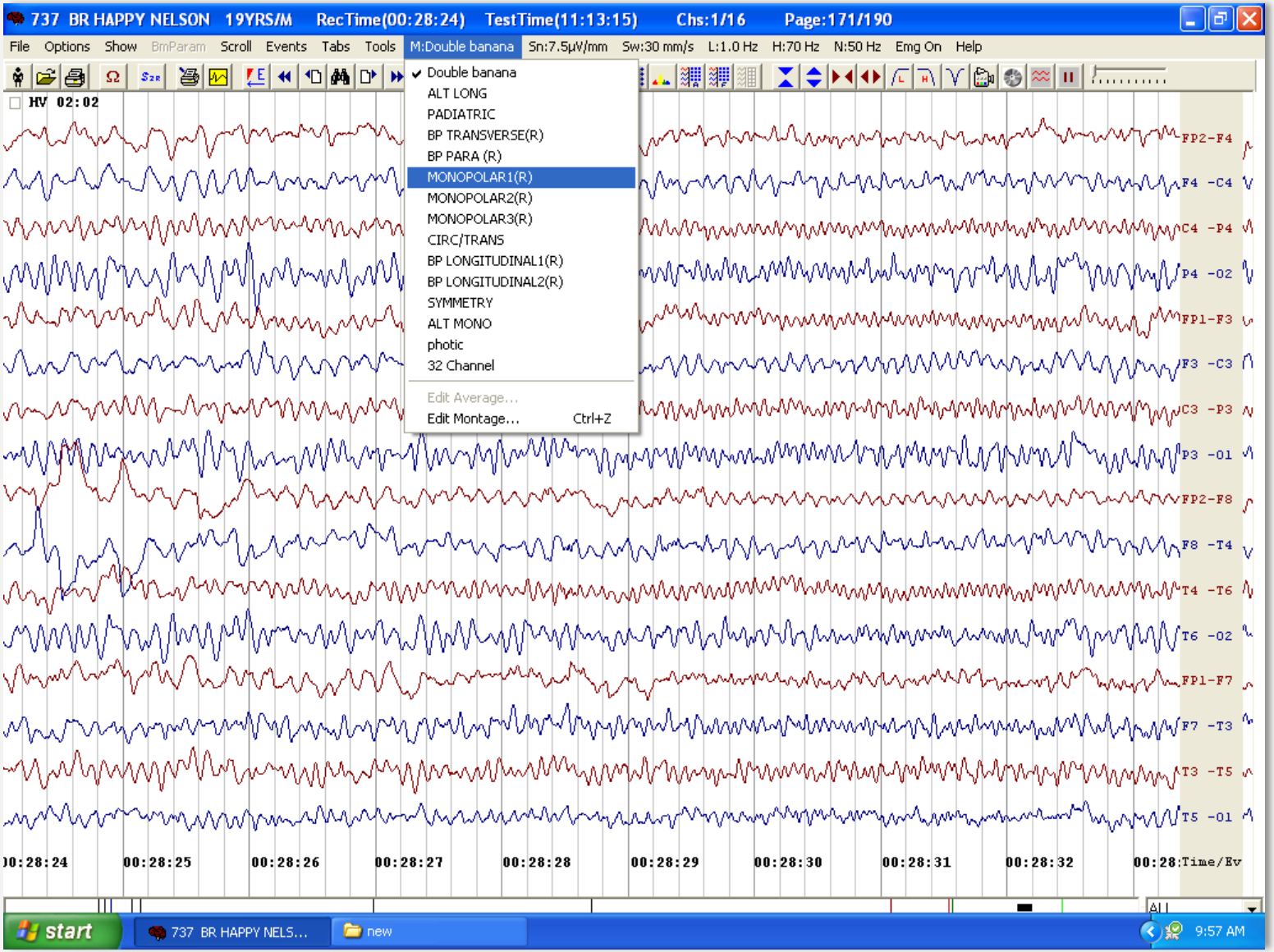


Transverse

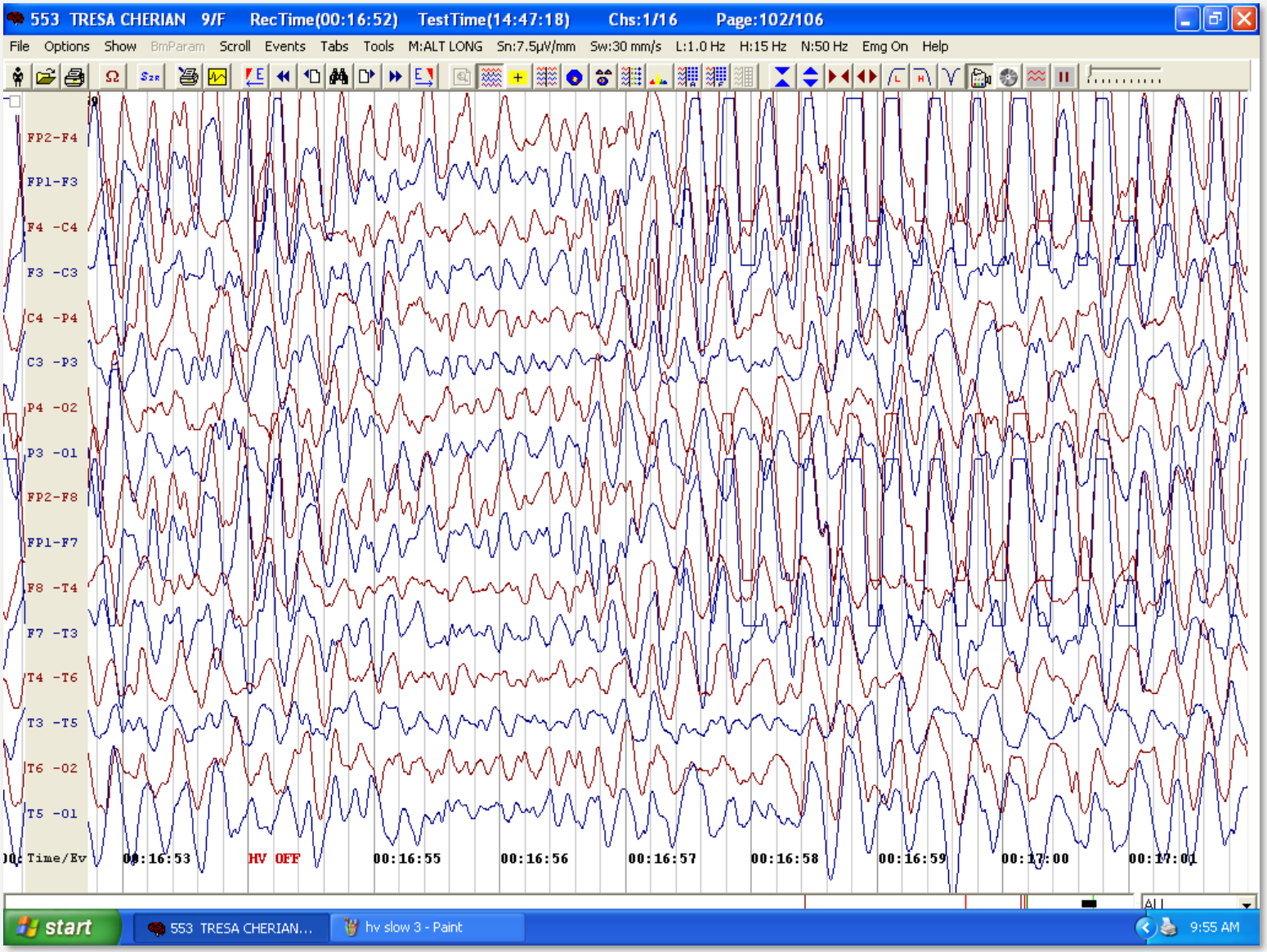


Pediatric

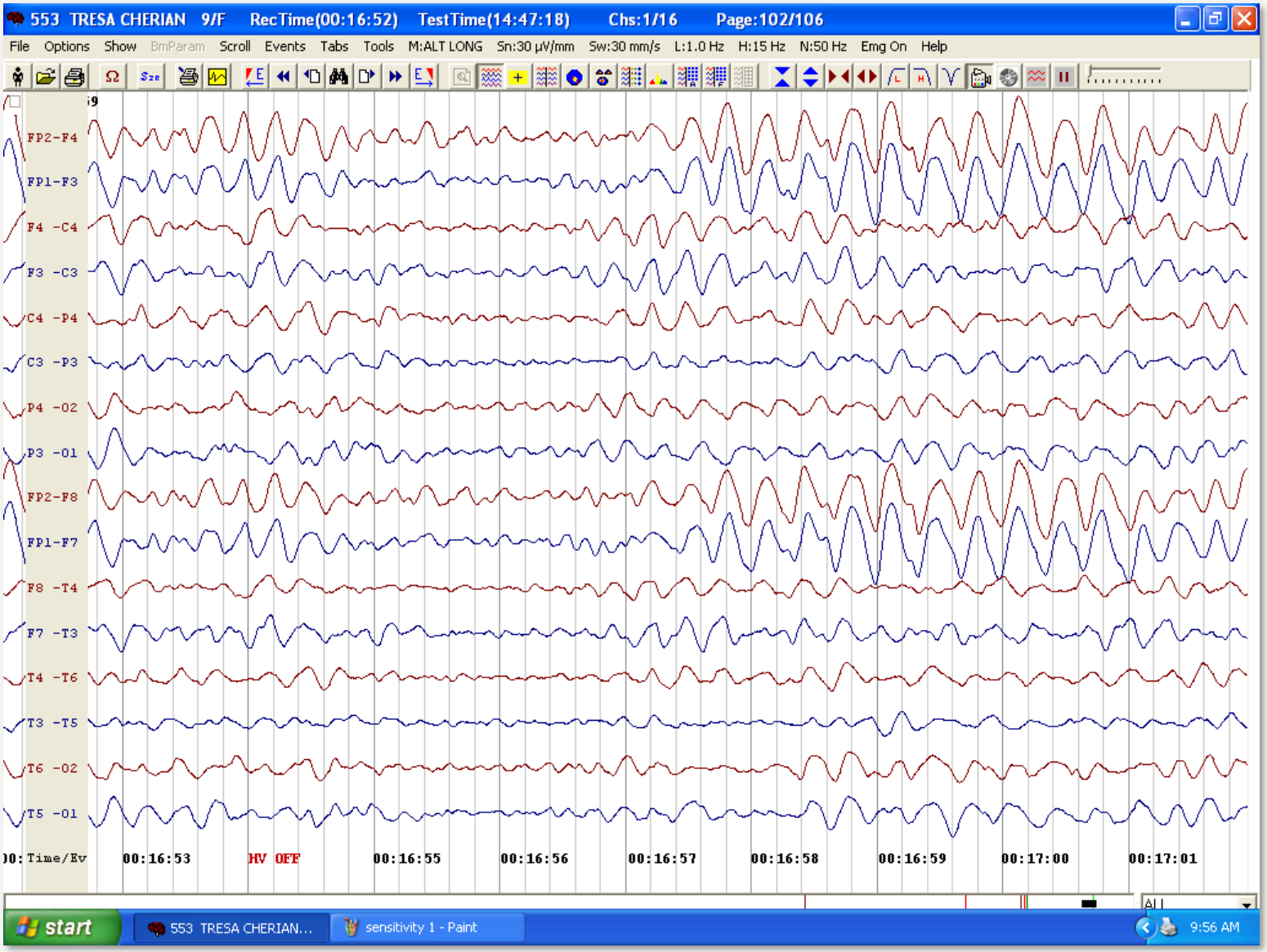
CHANGING MONTAGE



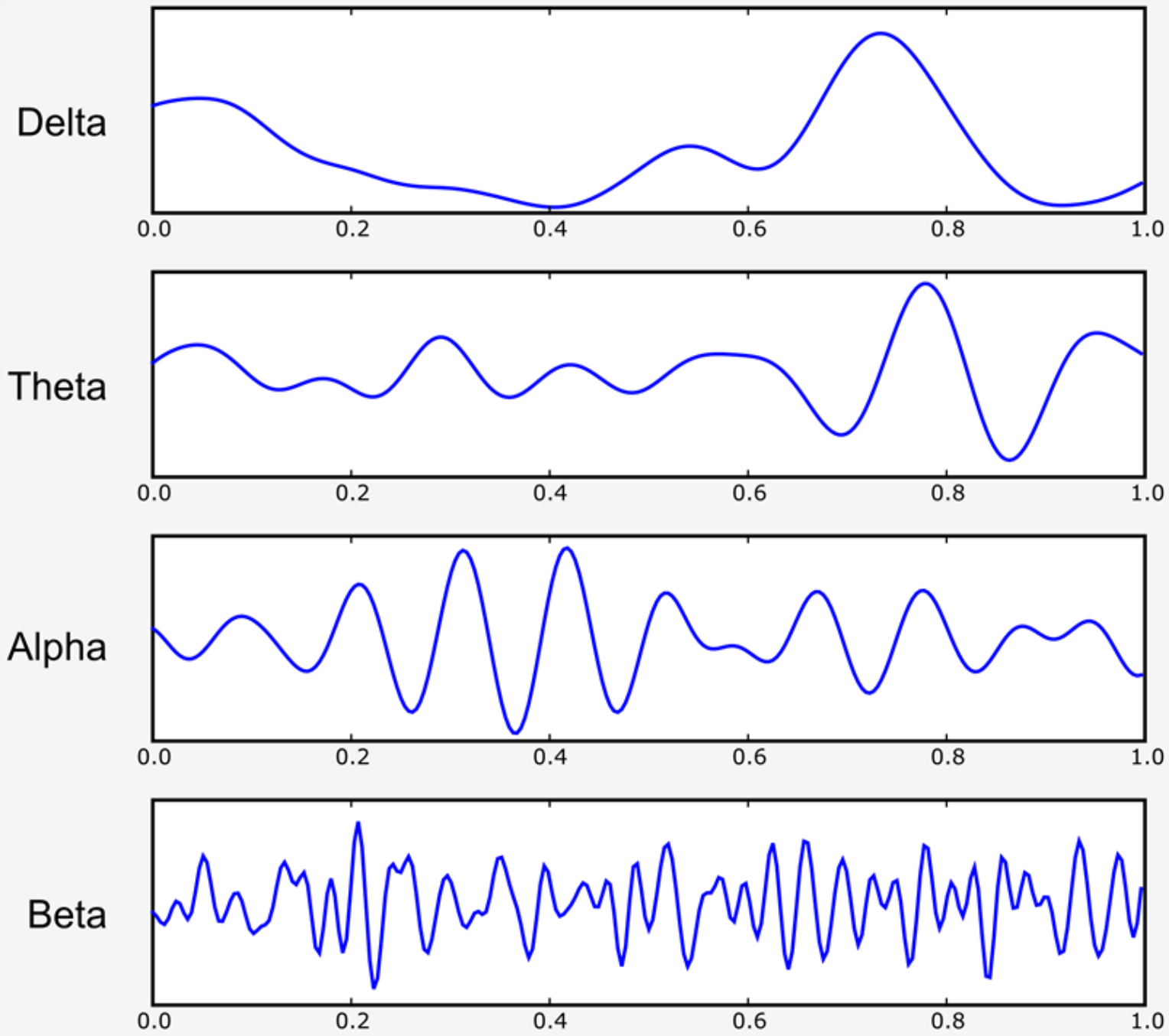
SENSITIVITY



SENSITIVITY



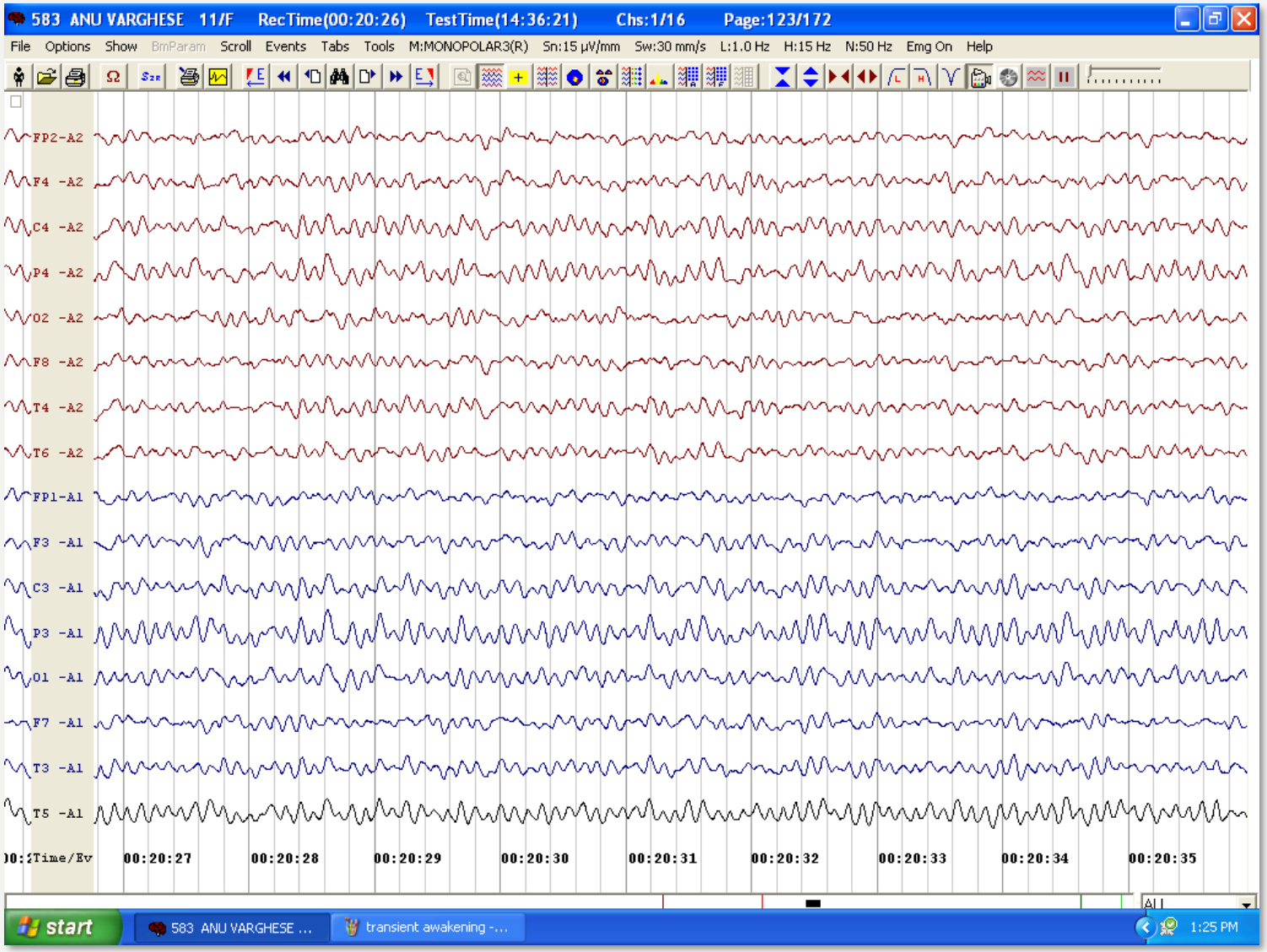
NORMAL EEG


Delta
0.0
0.2
0.4
0.6
0.8
1.0
Theta
0.0
0.2
0.4
0.6
0.8
1.0
Alpha
0.0
0.2
0.4
0.6
0.8
1.0
Beta
0.0
0.2
0.4
0.6
0.8
1.0

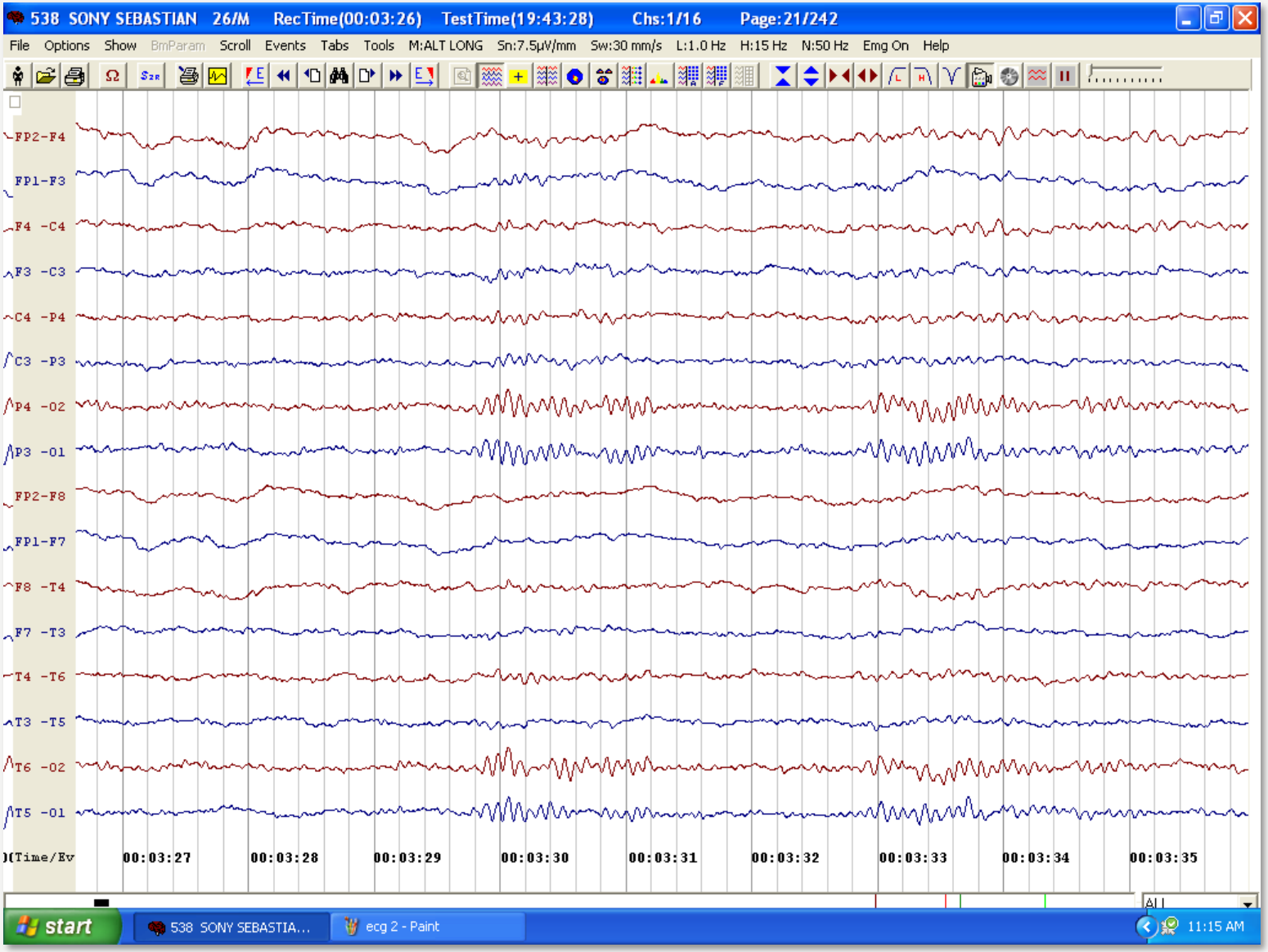
ALPHA WAVES

Frequency	• 8-13 Hz
Location	• Occipital, parietal
Seen in	• Alert restfulness

ALPHA WAVES (9 HZ)



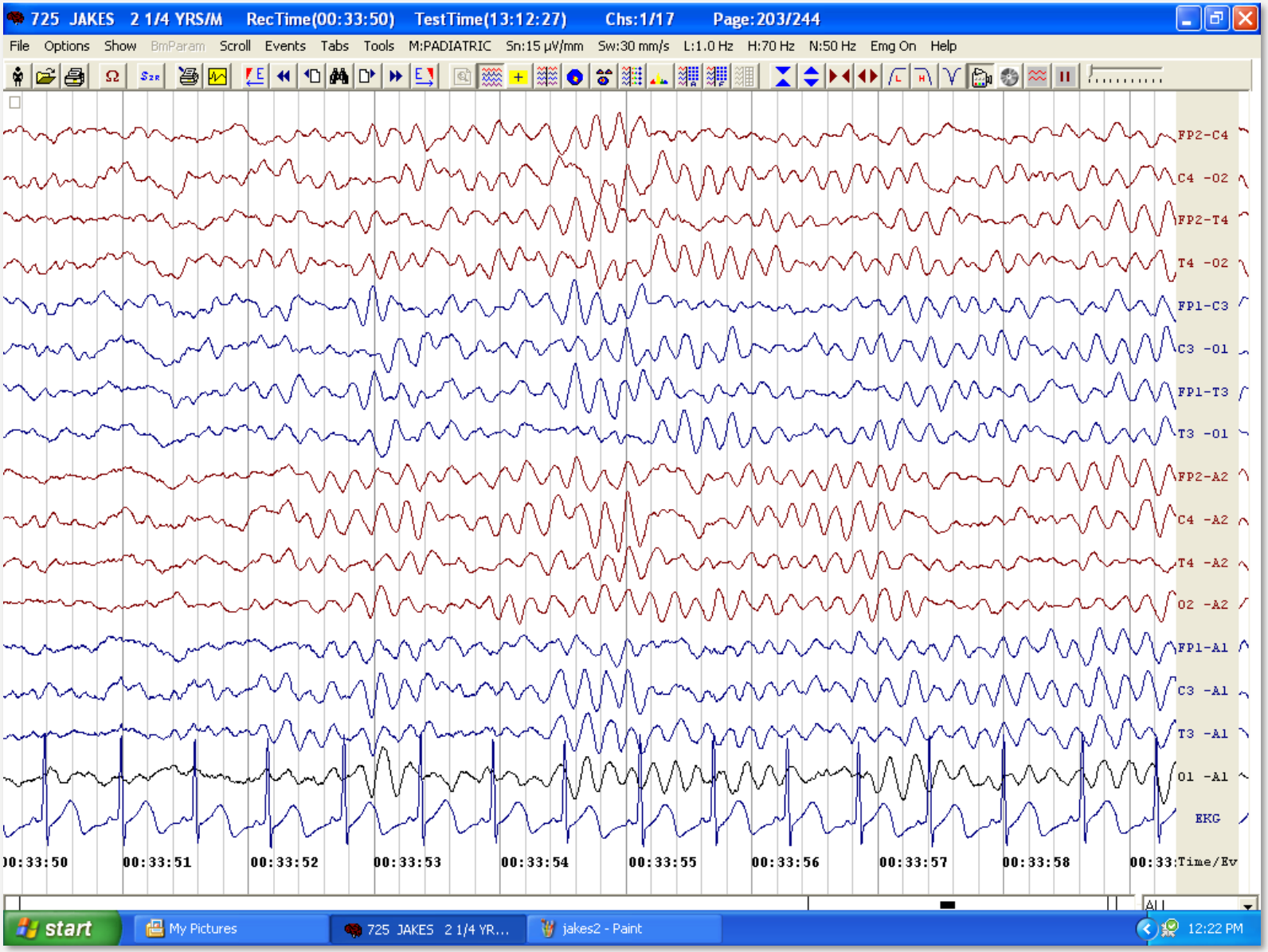
ALPHA WAVES (11.5 HZ)



THETA WAVES

Frequency	• 5-7 Hz
Seen in	• Sleep, children

THETA WAVES (5 HZ) IN A SLEEPING CHILD



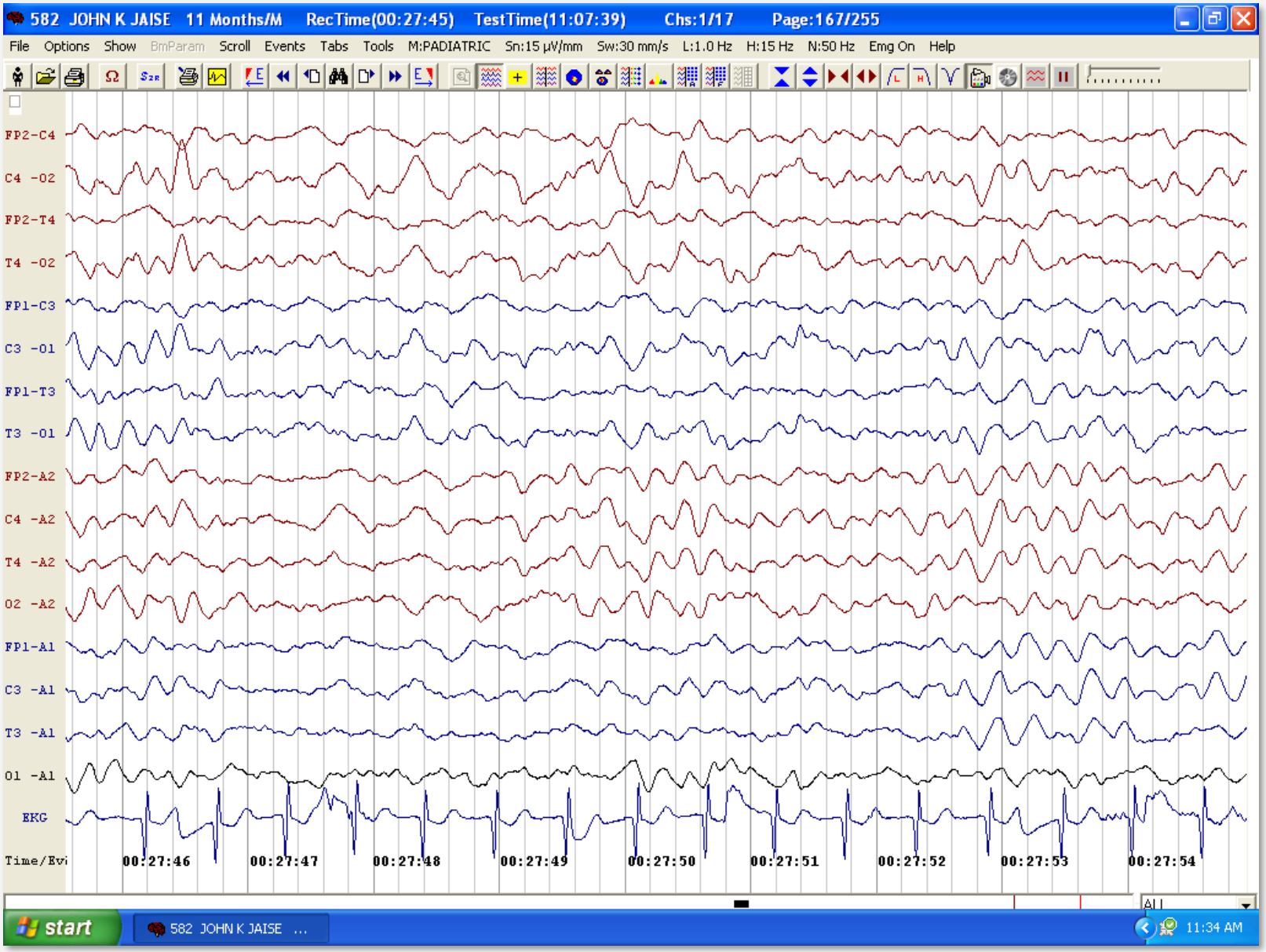
DELTA WAVES

Frequency
- ≤4 Hz

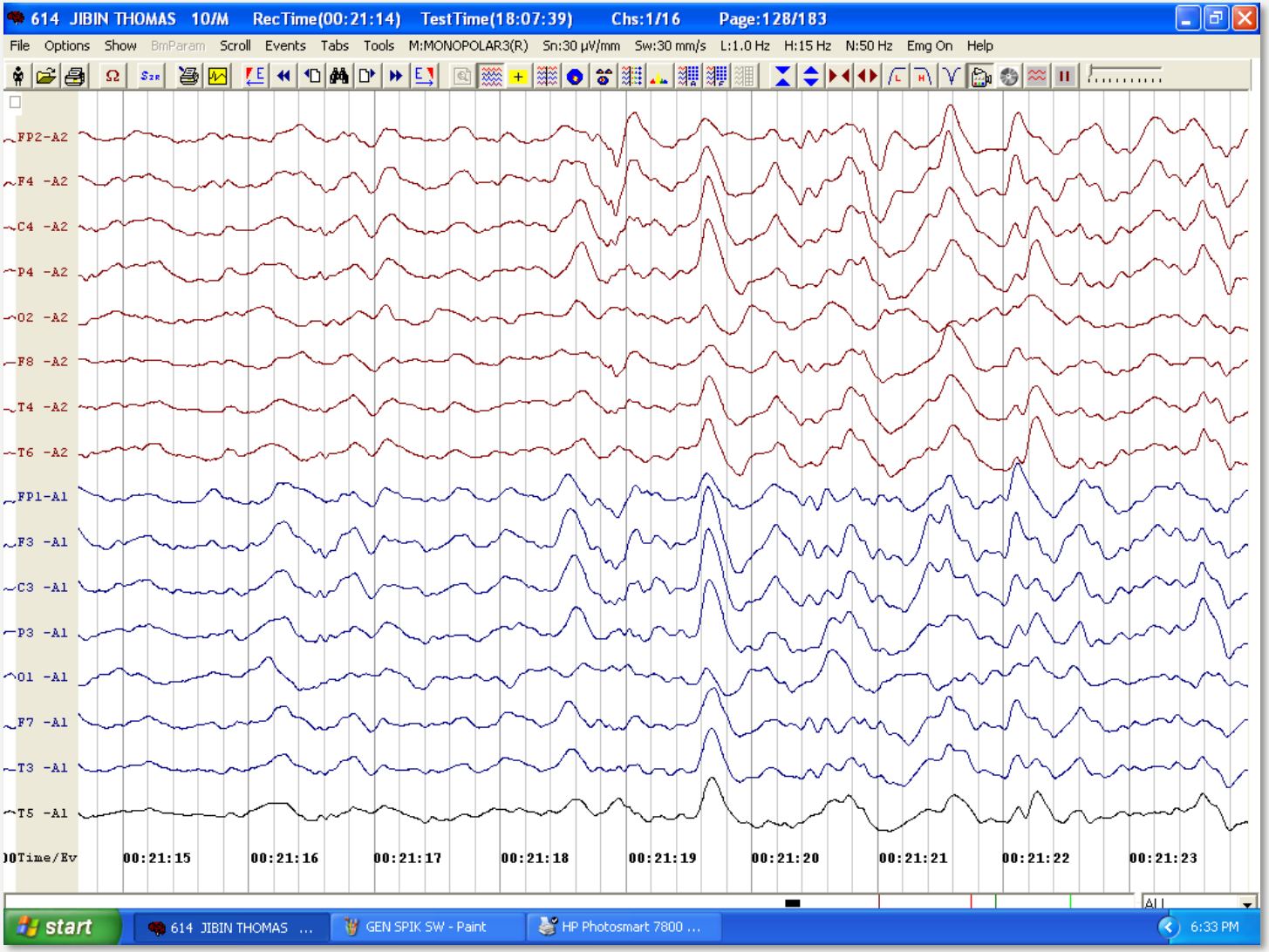
Seen in
- Slow wave sleep, awake infants

Presence in awake adults indicate brain damage.

DELTA WAVES IN A SLEEPING INFANT



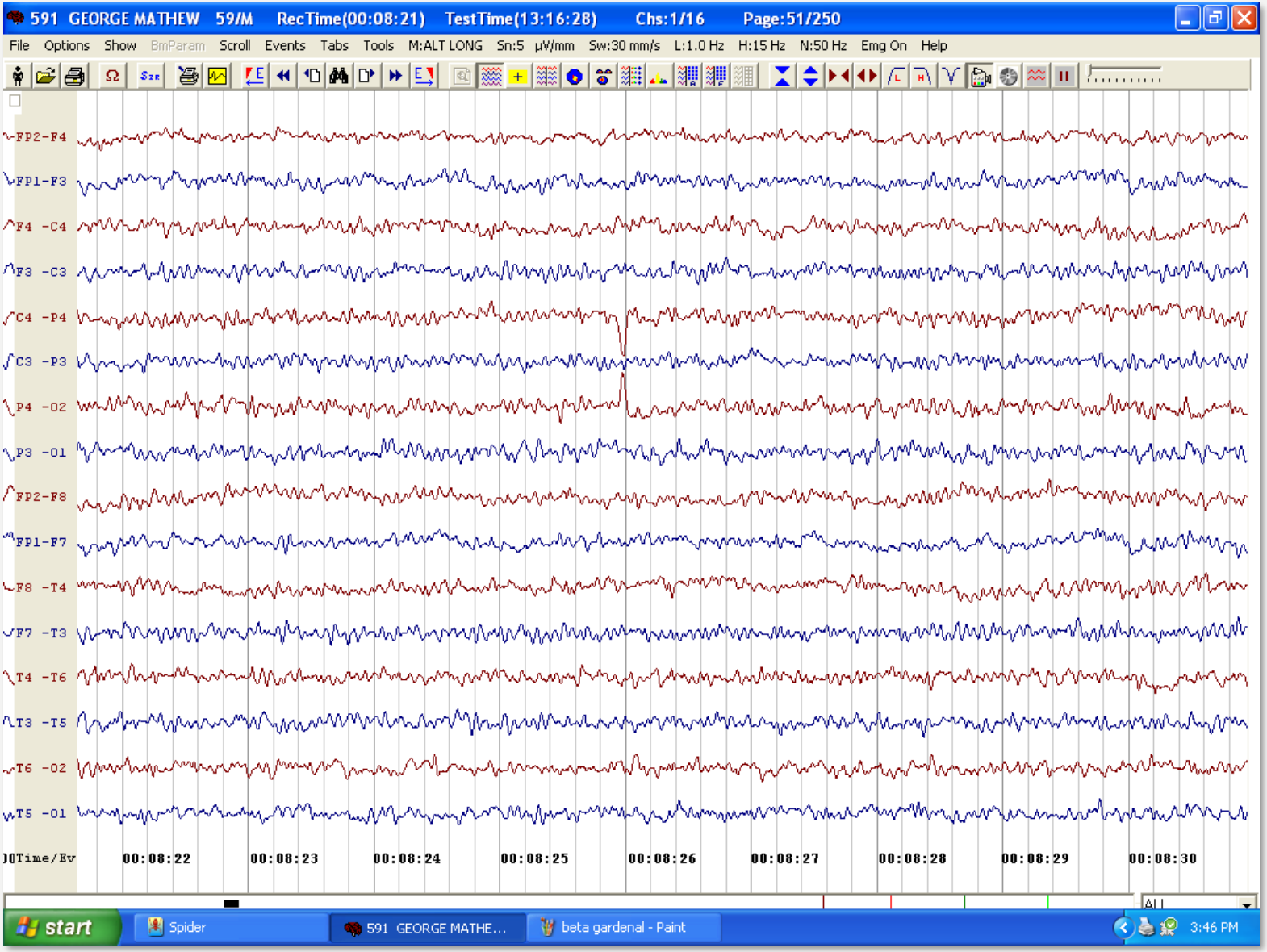
HIGH AMPLITUDE DELTA WAVES IN A SLEEPING CHILD



BETA WAVES

Frequency	• 14-30 Hz
Induced by	• Benzodiazepines and barbiturates

BETA WAVES BY PHENOBARBITONE (15 HZ)

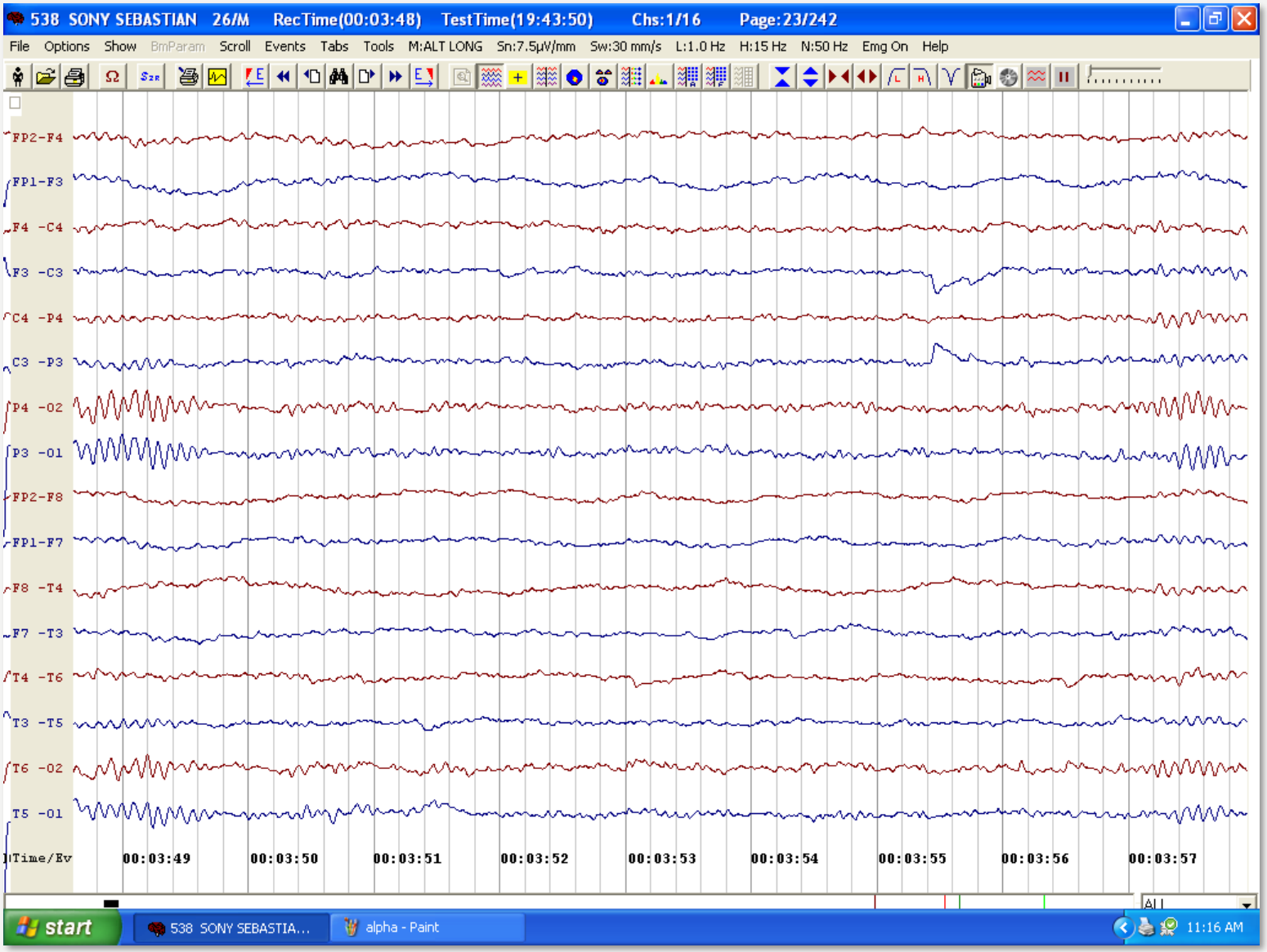


SLEEP

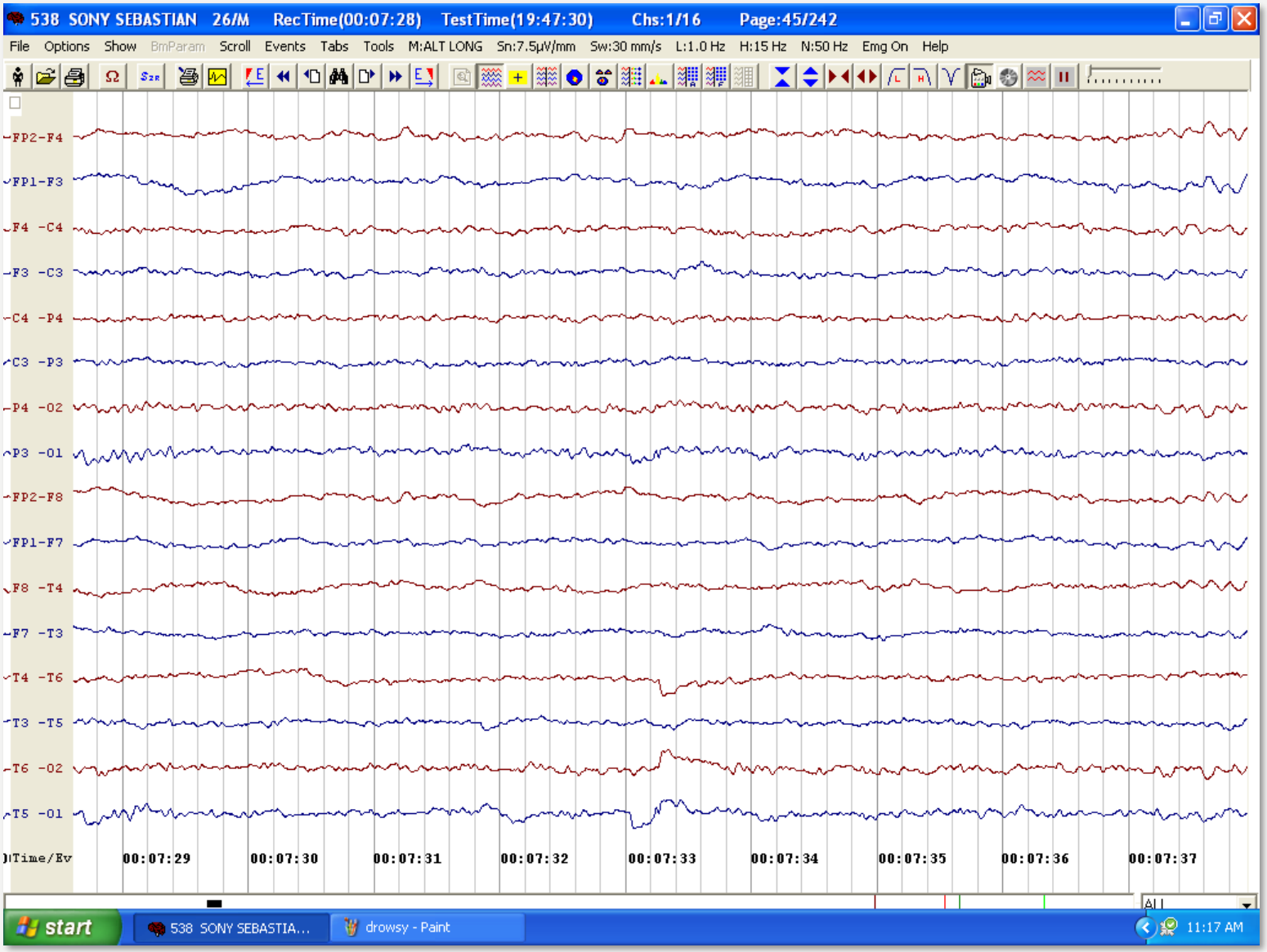
STAGE 1 SLEEP (N1)

- Decrease in amplitude of waking alpha rhythm

STAGE 1 SLEEP – SLIDE 1



STAGE 1 SLEEP – SLIDE 2

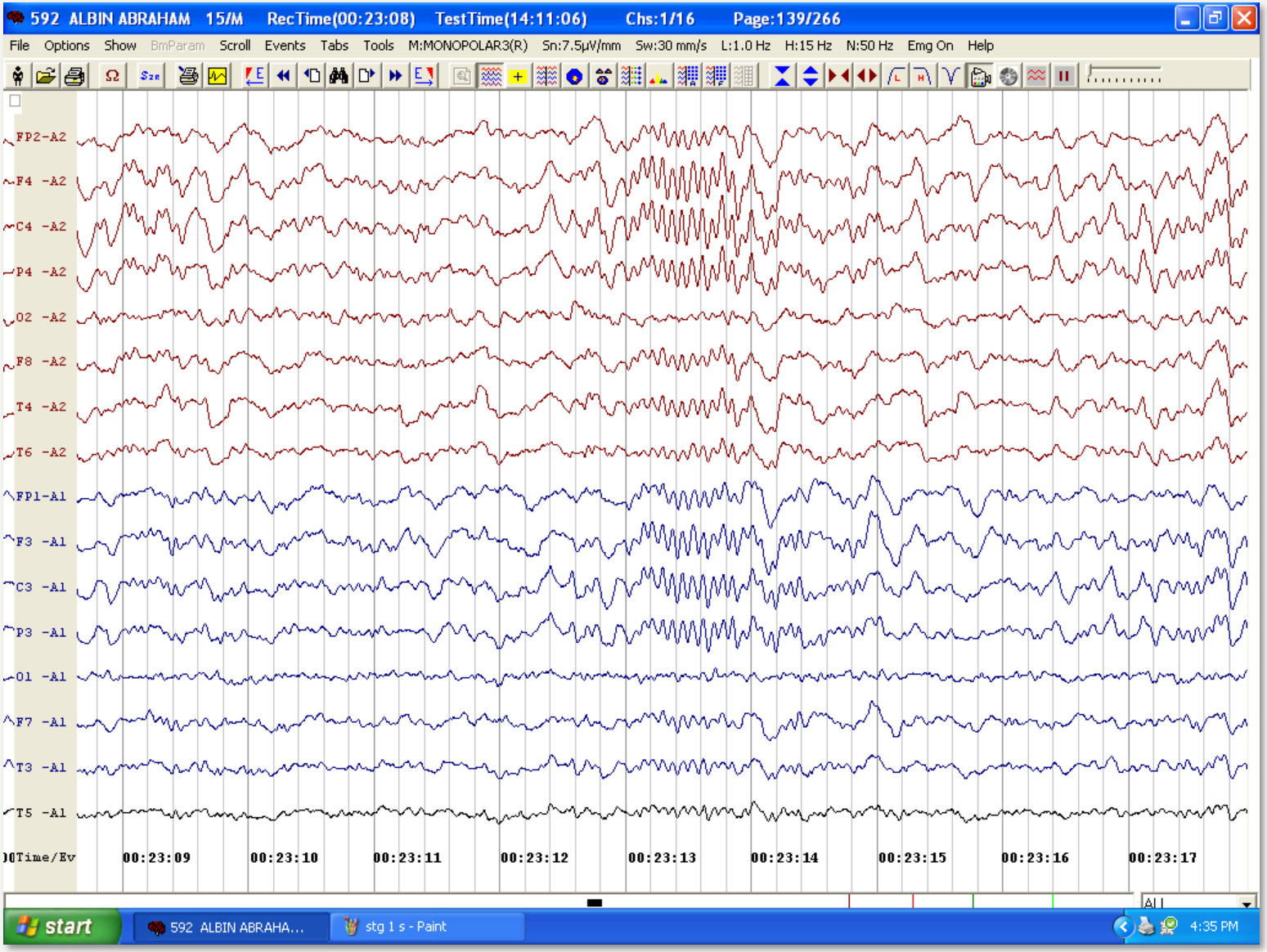


STAGE 2 SLEEP (N2)

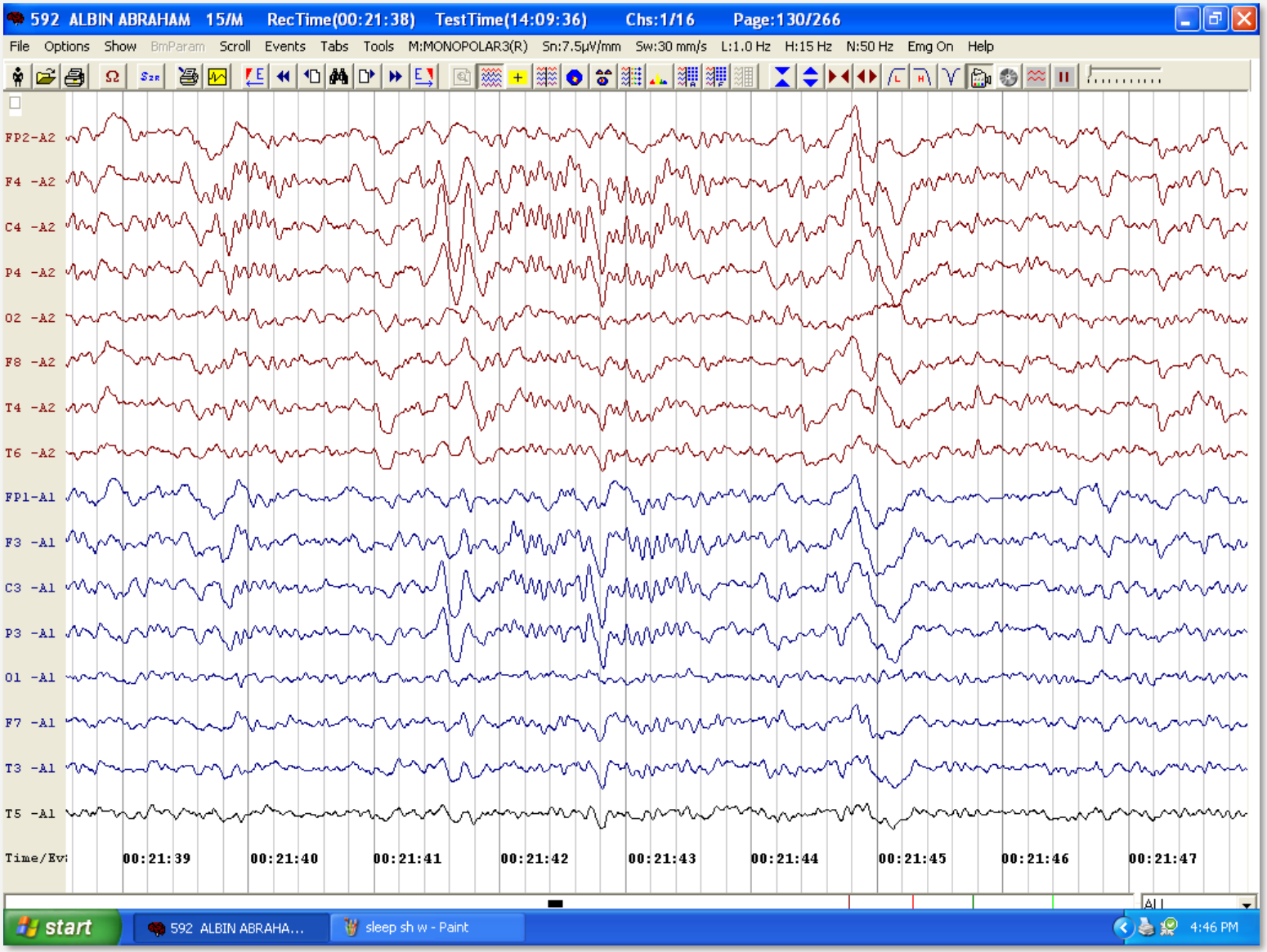
Sleep spindles

K-complexes

SLEEP SPINDLES



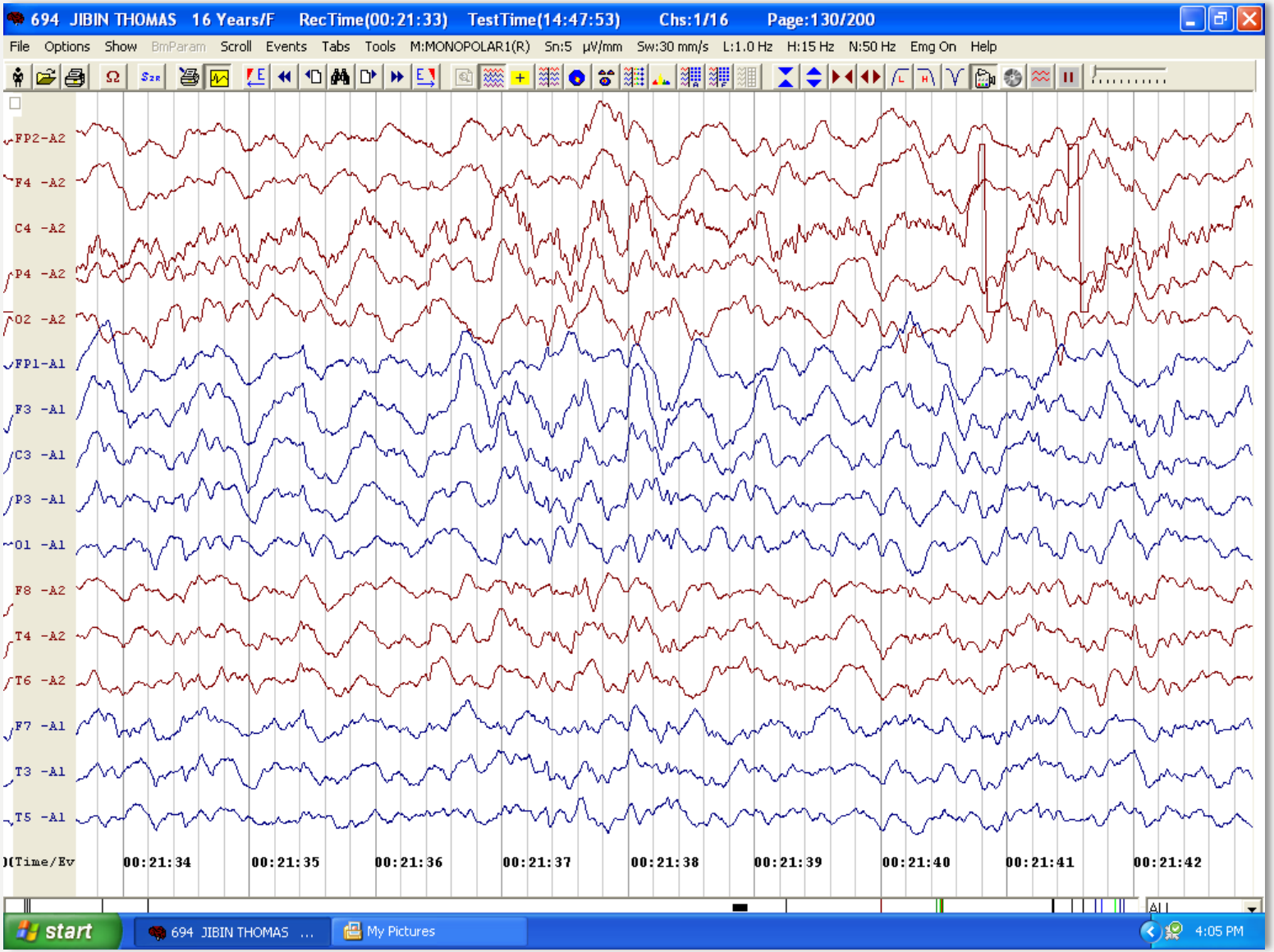
K COMPLEXES


592 ALBIN ABRAHAM 15/M RecTime(00:21:38) TestTime(14:09:36) Chs:1/16 Page:130/266
File Options Show BmParam Scroll Events Tabs Tools M:MONOPOLAR3(R) Sn:7.5µV/mm Sw:30 mm/s L:1.0 Hz H:15 Hz N:50 Hz Emg On Help
FP2-A2
F4 -A2
C4 -A2
P4 -A2
O2 -A2
F8 -A2
T4 -A2
T6 -A2
FP1-A1
F3 -A1
C3 -A1
P3 -A1
O1 -A1
F7 -A1
T3 -A1
T5 -A1
Time/Ev
00:21:39
00:21:40
00:21:41
00:21:42
00:21:43
00:21:44
00:21:45
00:21:46
00:21:47
start
592 ALBIN ABRAHA...
sleep sh w - Paint
4:46 PM

SLOW WAVE SLEEP (N3)

- Delta waves (0.5–2 Hz) occupy more than 20% of the background.

SLOW WAVE SLEEP (N3)



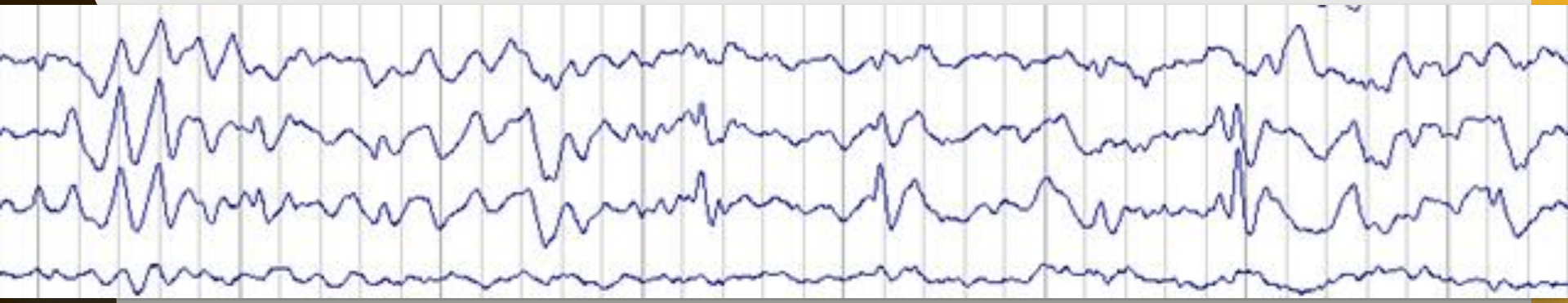
INTERICTAL EPILEPTIFORM DISCHARGES: GENERALIZED

Spikes

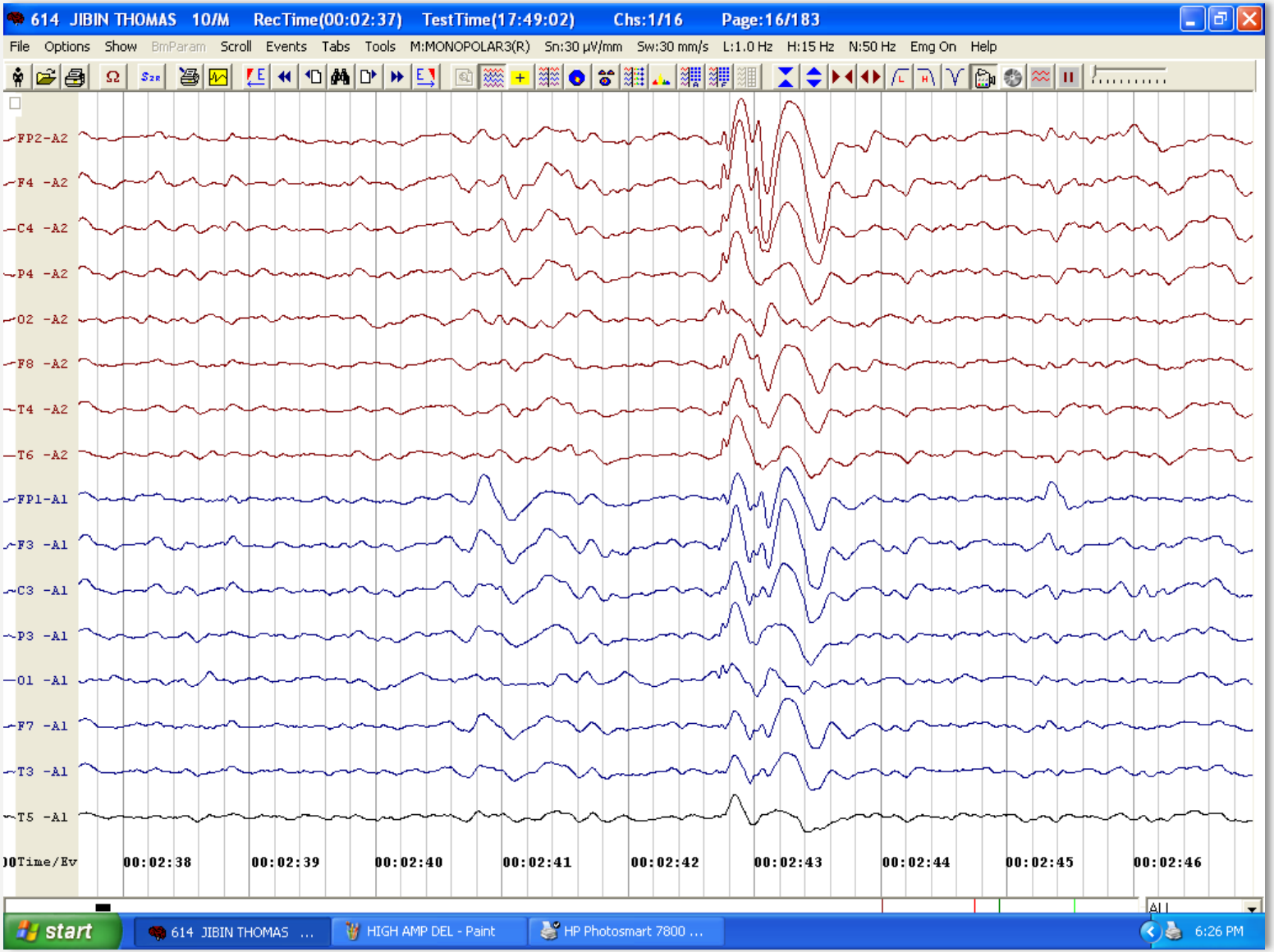
- <70 msec in duration

Sharp waves

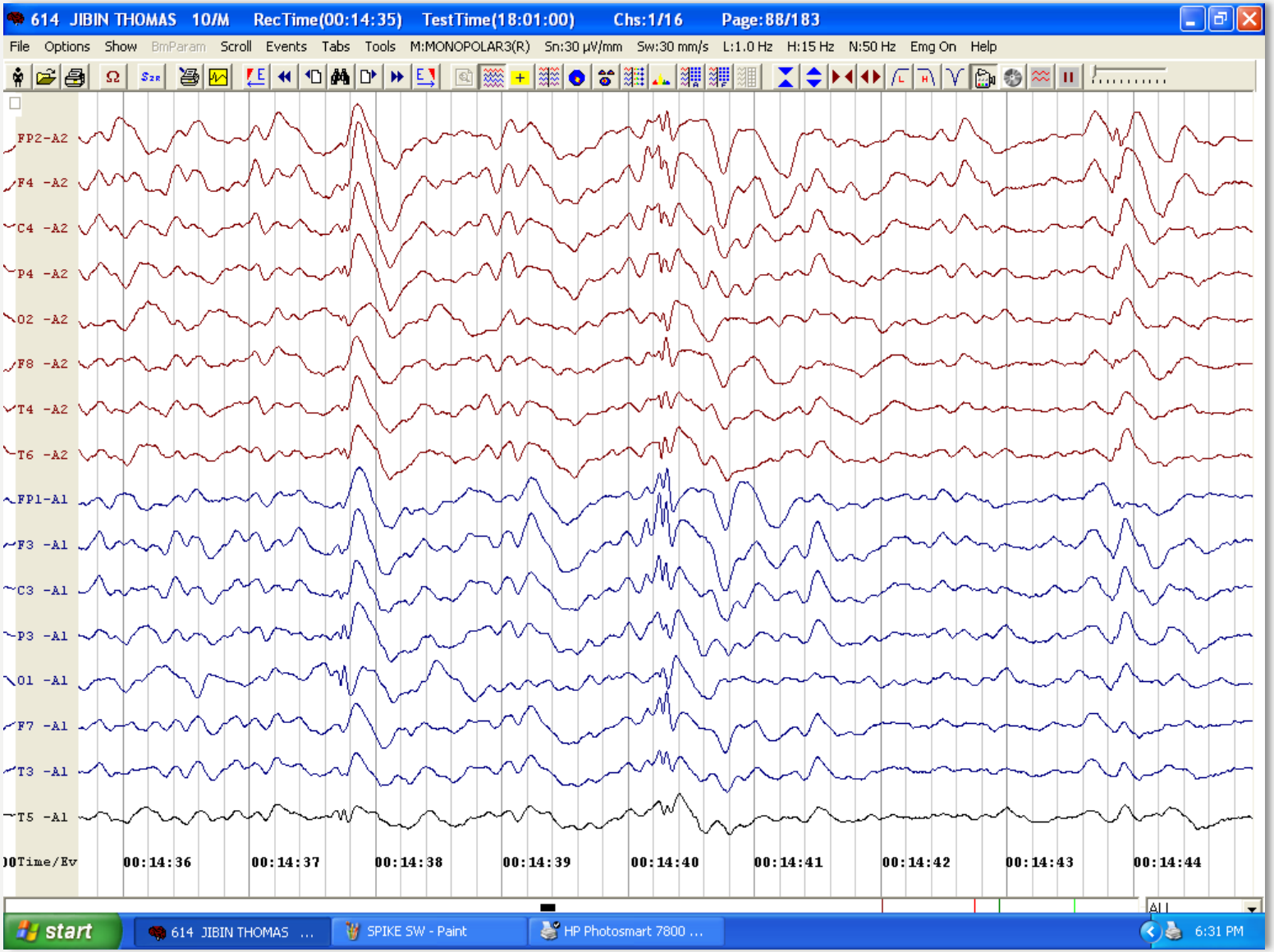
- 70-200 msec in duration



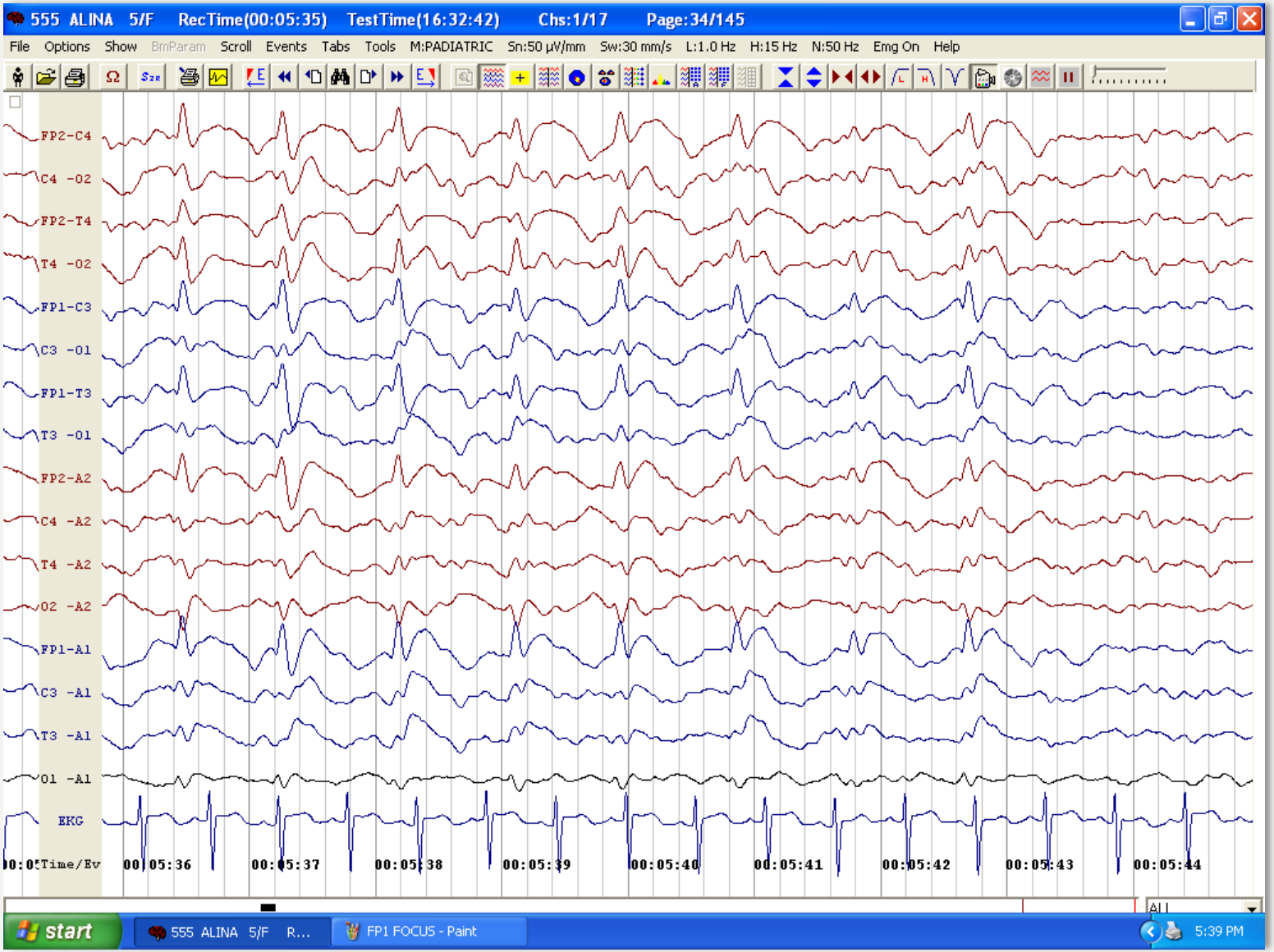
GENERALIZED SPIKE-AND-WAVE DISCHARGES IN SLEEP



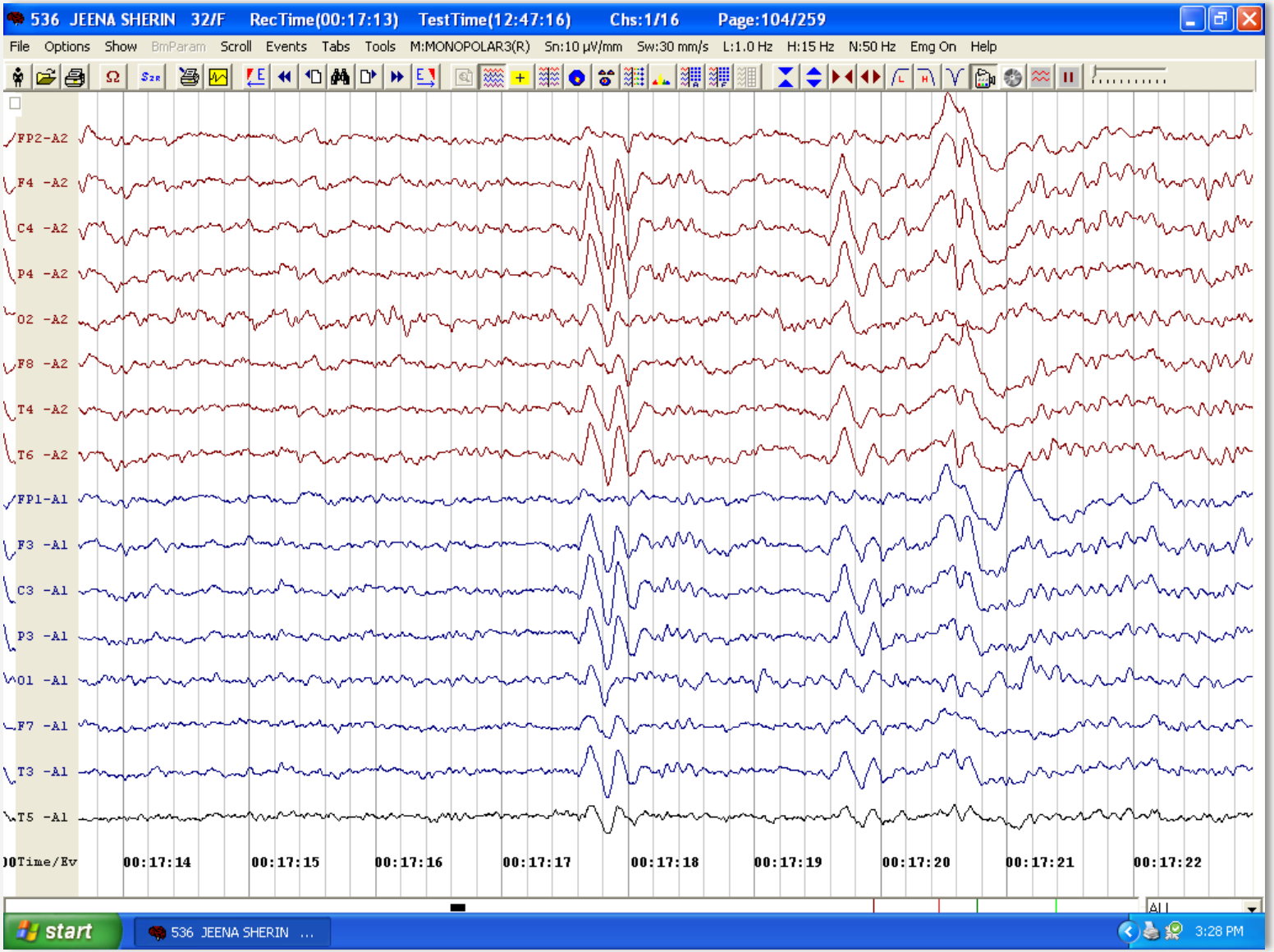
GENERALIZED POLYSPIKE-SLOW WAVE DISCHARGES IN SLEEP



GENERALIZED SHARP AND SLOW WAVE COMPLEXES



GENERALIZED SHARP WAVES



GENERALIZED IEDS AND PSYCHIATRY

- Forced normalization
- Clozapine can produce epileptiform abnormalities
- In ADHD, IEDs might increase the risk for seizures with Methyl Phenidate.

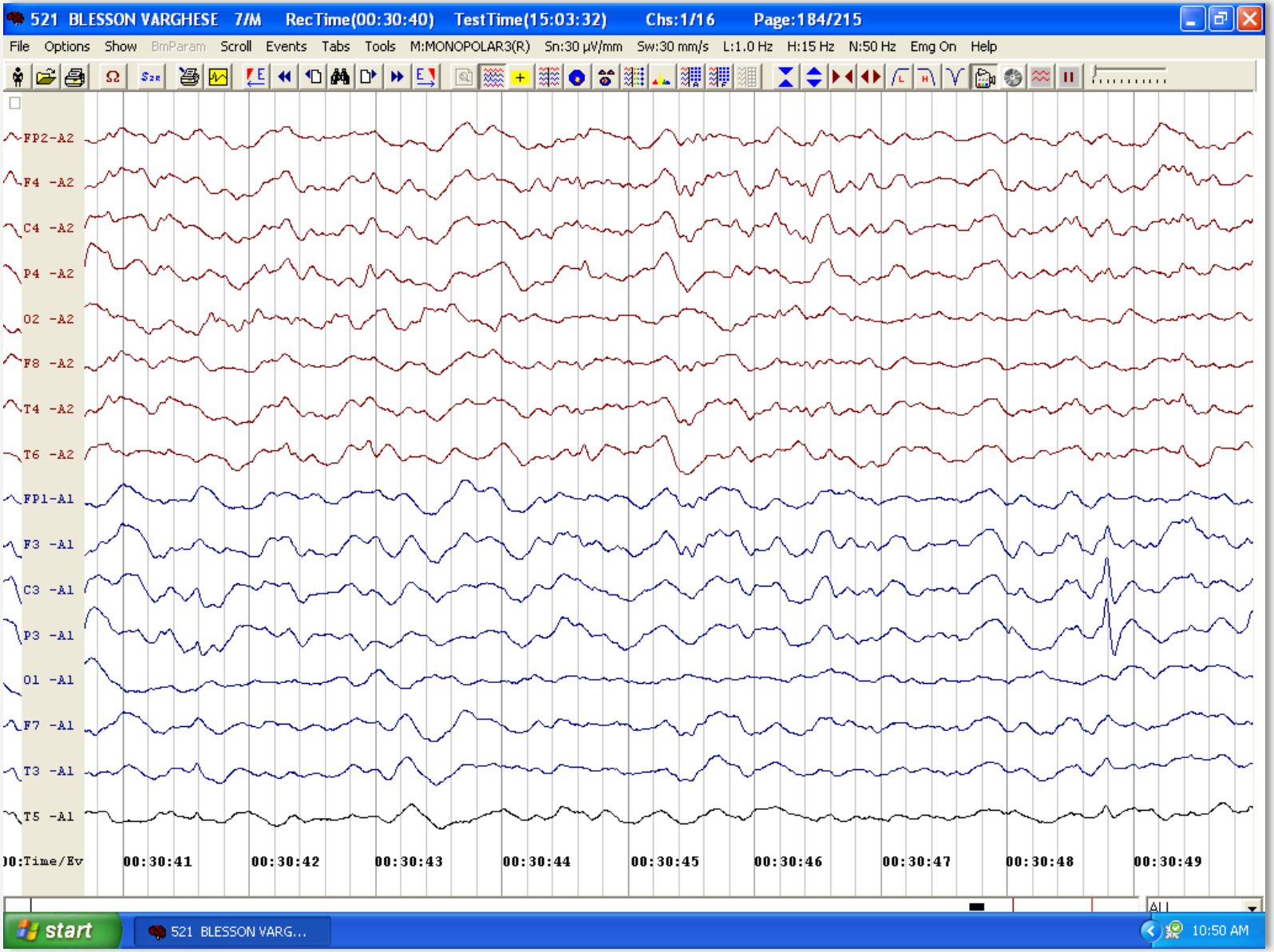
Hughes JR. (1996) A review of the usefulness of the standard EEG in psychiatry. Clin Electroencephalogr, 27(1), 35-39.

INTERICTAL EPILEPTIFORM DISCHARGES: FOCAL

LOCALIZATION TECHNIQUES: MONOPOLAR MONTAGES

- Note the electrode which records the highest amplitude of the abnormal pattern.

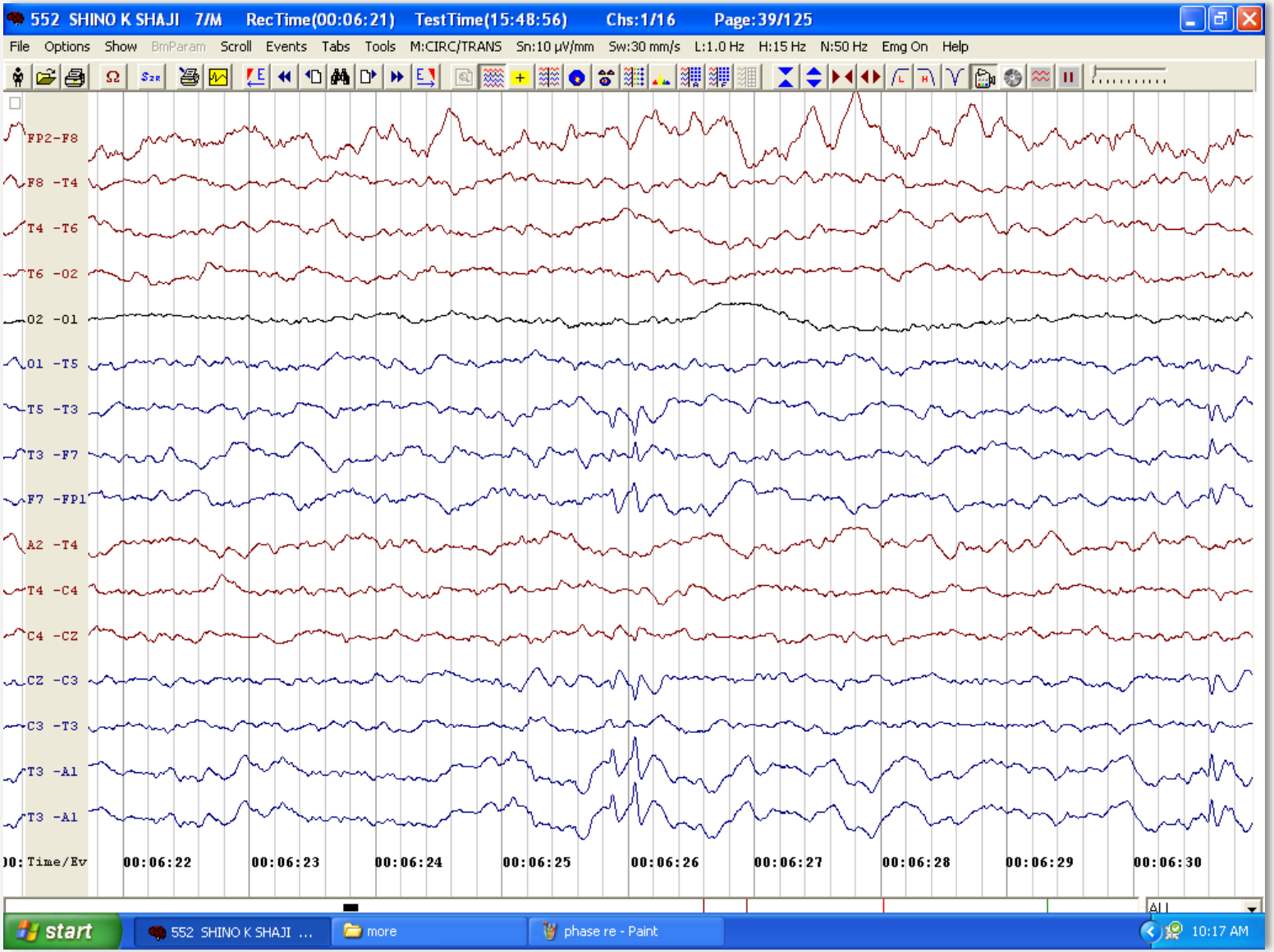
LOCALIZATION IN A MONOPOLAR MONTAGE



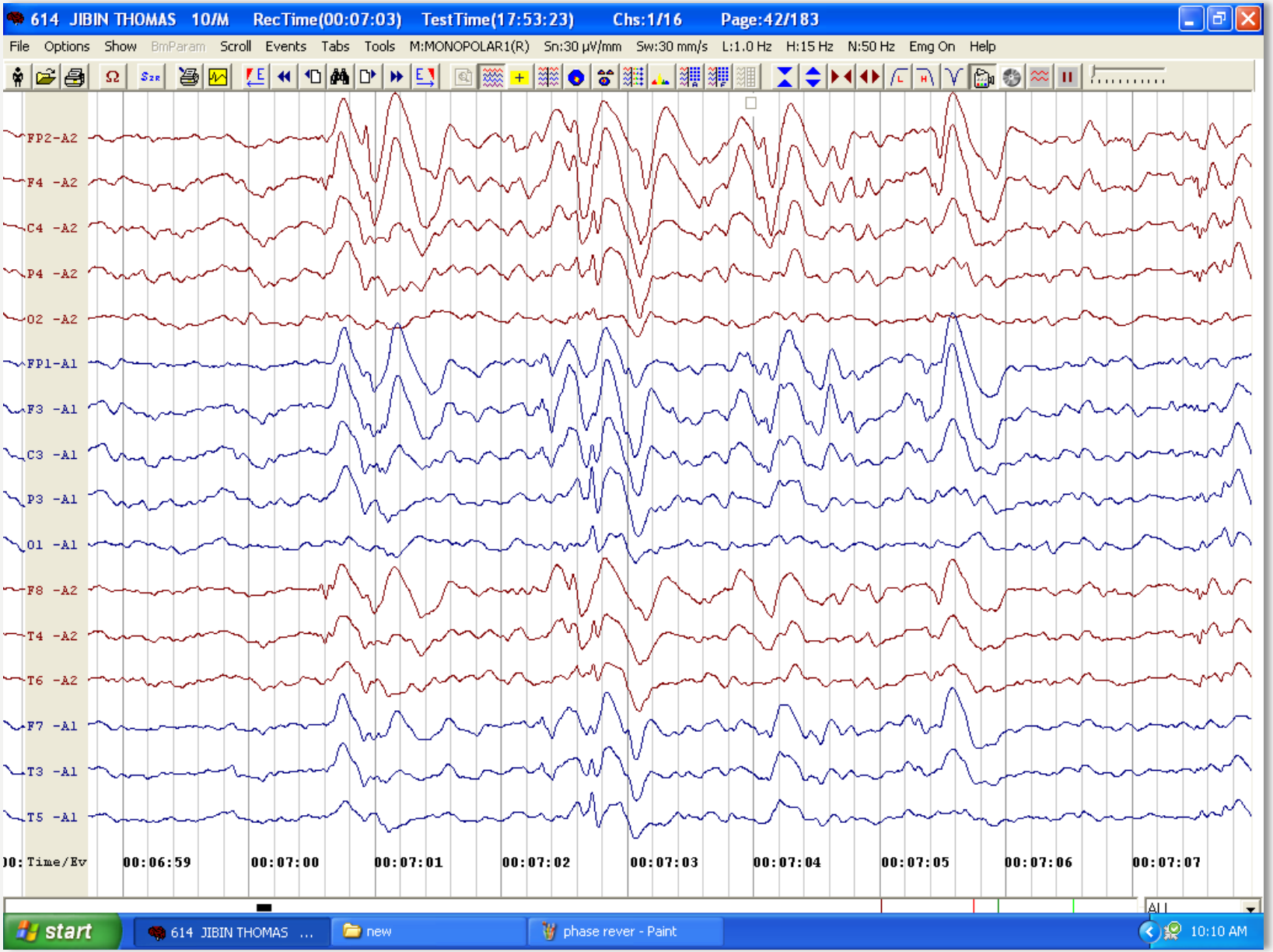
LOCALIZATION TECHNIQUES: BIPOLAR MONTAGES

- Look for two adjacent channels with opposite phases (**phase reversal**).
- The electrode common to those channels gives the localization of the abnormality.

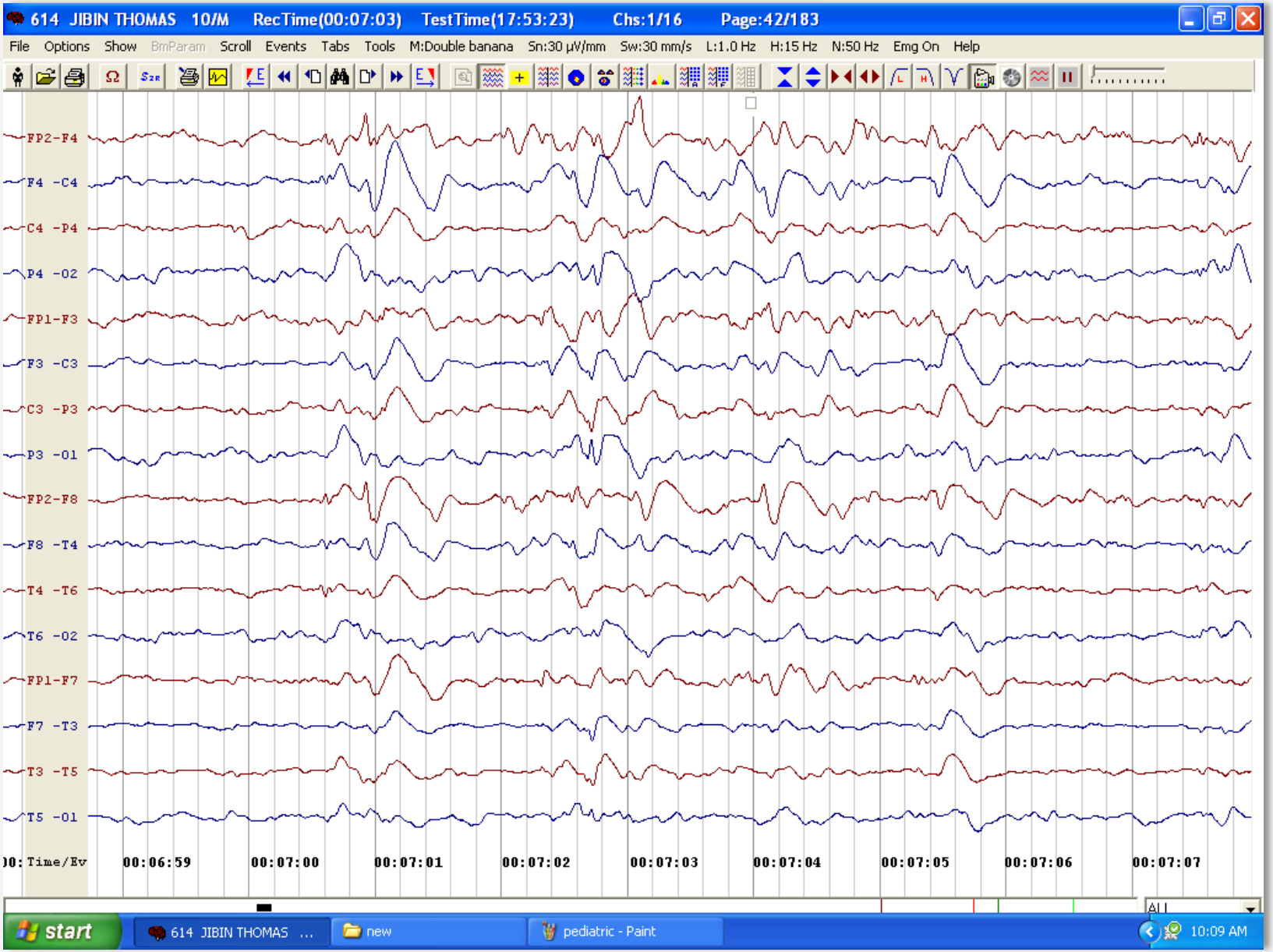
PHASE REVERSALS



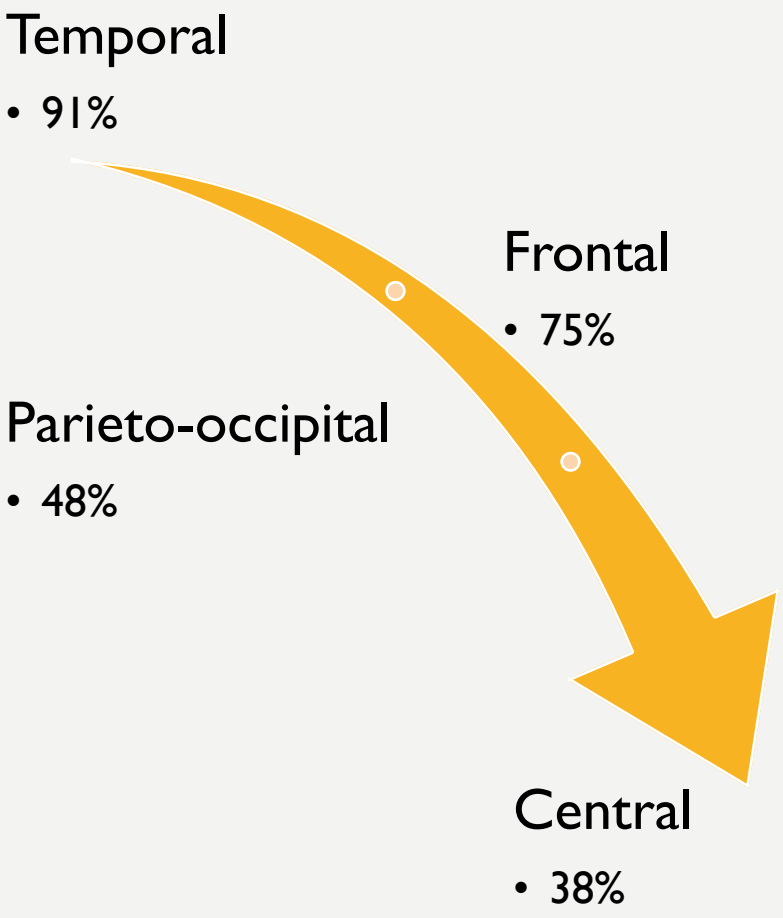
LOCALIZATION TO P3 IN MONOPOLAR MONTAGE



LOCALIZATION TO P3 IN BIPOLAR MONTAGE



LIKELIHOOD OF SEIZURES WITH FOCAL EPILEPTIFORM DISCHARGES



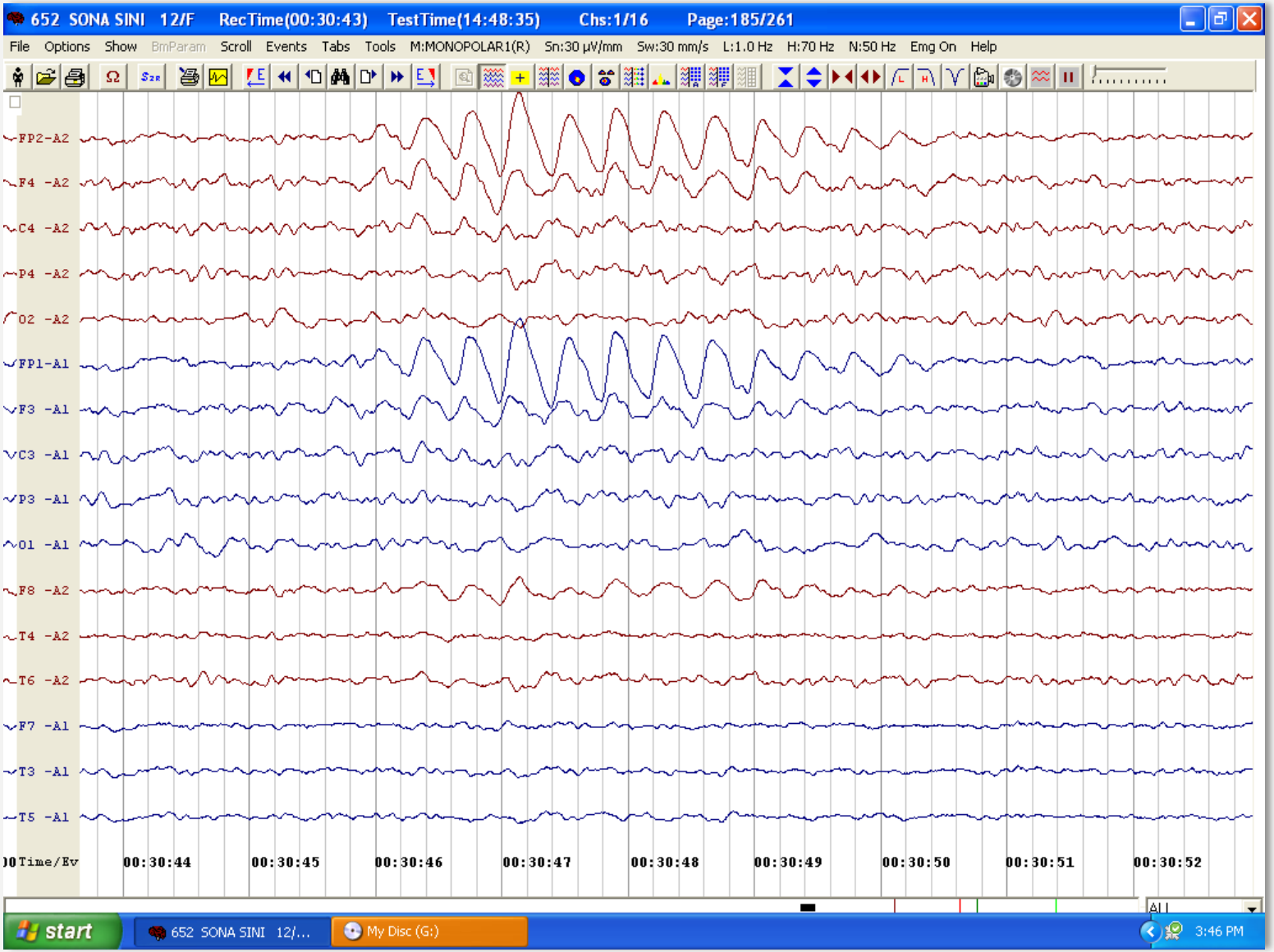
FOCAL IEDS & PSYCHIATRY

- Some evidence exists that argues for cognitive, behavioral, or emotional disturbances associated with paroxysmal discharges.
- Spikes can be found in psychiatric patients with no obvious seizure manifestations.
- Presence of episodic aberrant behavior (particularly explosive aggressiveness) in such cases may be empirically treated with a trial of anticonvulsants.

Boutros, N.N., Iacono, W.G., & Galderisi, S. (2009). Applied electrophysiology. In Sadock, B.J., Sadock, V.A., & Ruiz, P. (Eds.), Kaplan & Sadock's *Comprehensive textbook of psychiatry*, *V. 1*, Ninth Edition (pp. 211-248). Baltimore: Lippincott, Williams, & Wilkins.

SLOWING

FRONTAL DELTA WAVES



SLOWING & PSYCHIATRY

- Diffuse slowing can be present in drug toxicities, hypothyroidism, electrolyte imbalance, etc.
- Dissociative stupor will usually have a normal EEG that will show responsiveness to visual or auditory stimuli.
- After five sessions of ECT diffuse slow waves are often seen.

EEG AND DELIRIUM

- In hyperactive delirium, EEG is often helpful in indicating whether the cause is:
  - A diffuse encephalopathic process
  - Nonconvulsive status epilepticus
  - A focal brain lesion
- EEG is particularly useful in diagnosing hypoactive delirium

Boutros, N.N., Iacono, W.G., & Galderisi, S. (2009). Applied electrophysiology. In Sadock, B.J., Sadock, V.A., & Ruiz, P. (Eds.), Kaplan & Sadock's *Comprehensive textbook of psychiatry*, *V. 1*, Ninth Edition (pp. 211-248). Baltimore: Lippincott, Williams, & Wilkins.

EEG AND DELIRIUM…

- Patients with delirium shows slow activity, except in delirium tremens, which often is associated with a fast activity.
- If abnormal slow activity is found in a patient with DT, consideration should be given to a Wernicke encephalopathy or to a hepatic disorder.

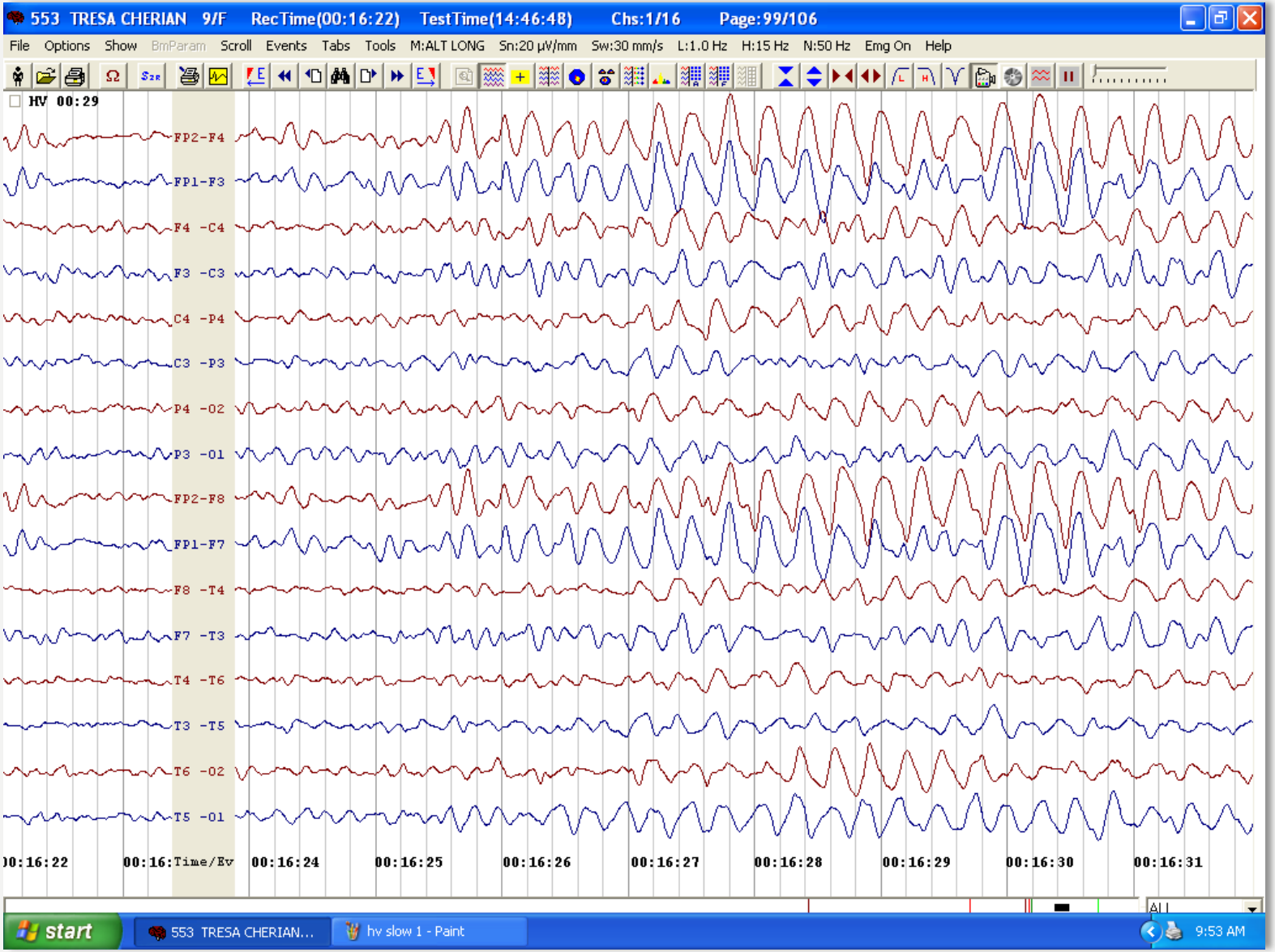
- Hughes JR. (1996) A review of the usefulness of the standard EEG in psychiatry. Clin Electroencephalogr, 27(1), 35-39.
- Kelley JT, Reilly EL: EEG, alcohol, and alcoholism, in EEG and Evoked Potentials in Psychiatry and Behavioral Neurology, edited by Hughes JR, Wilson WP. London, Butterworth, 1983, pp 55–77
- American Psychiatric Association Practice Guidelines for the Treatment of Delirium.

ACTIVATION PROCEDURES

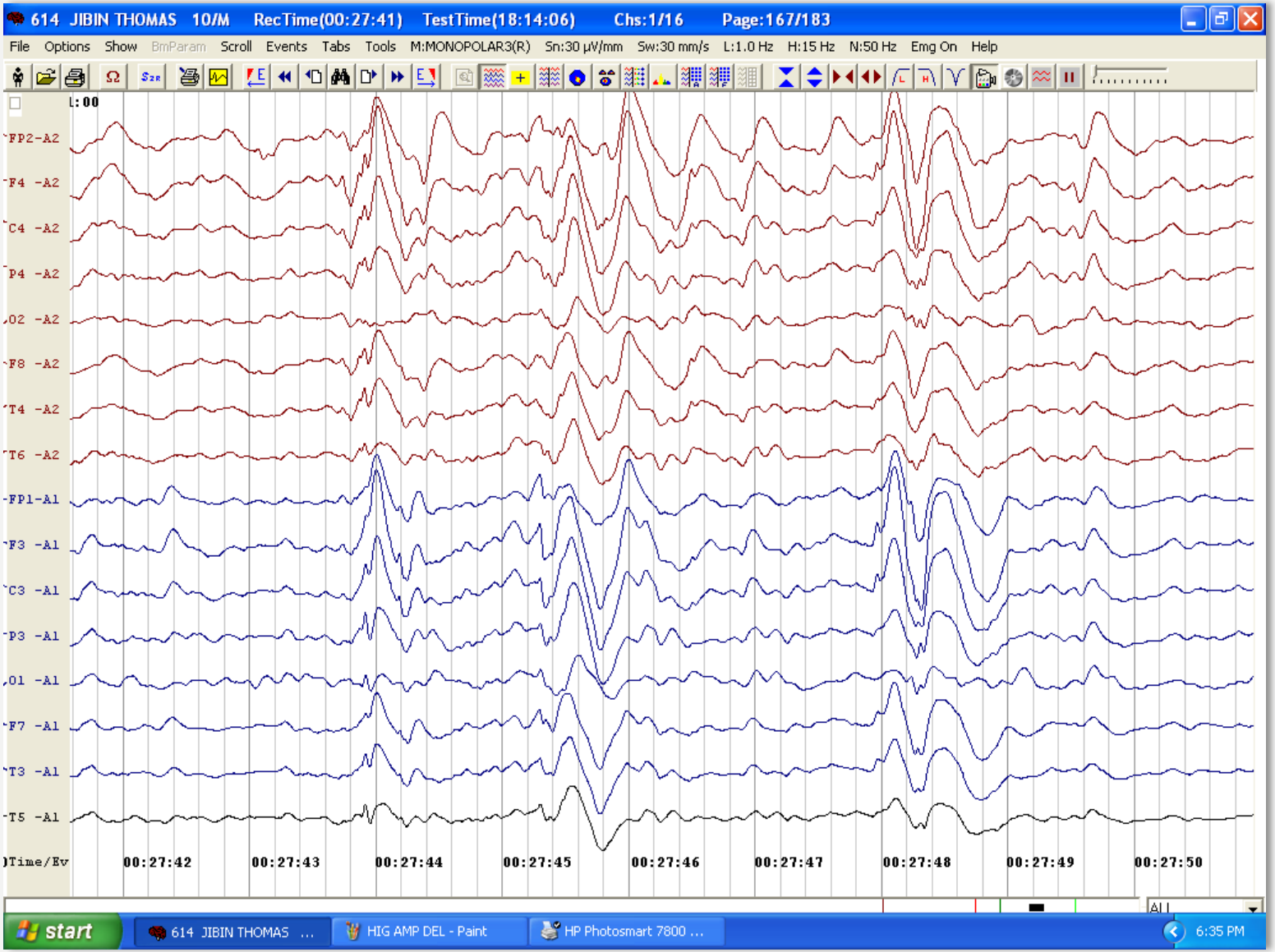
ACTIVATION PROCEDURES

- Sleep deprivation
  - Partial
  - Total
- Hyperventilation
- Photic stimulation

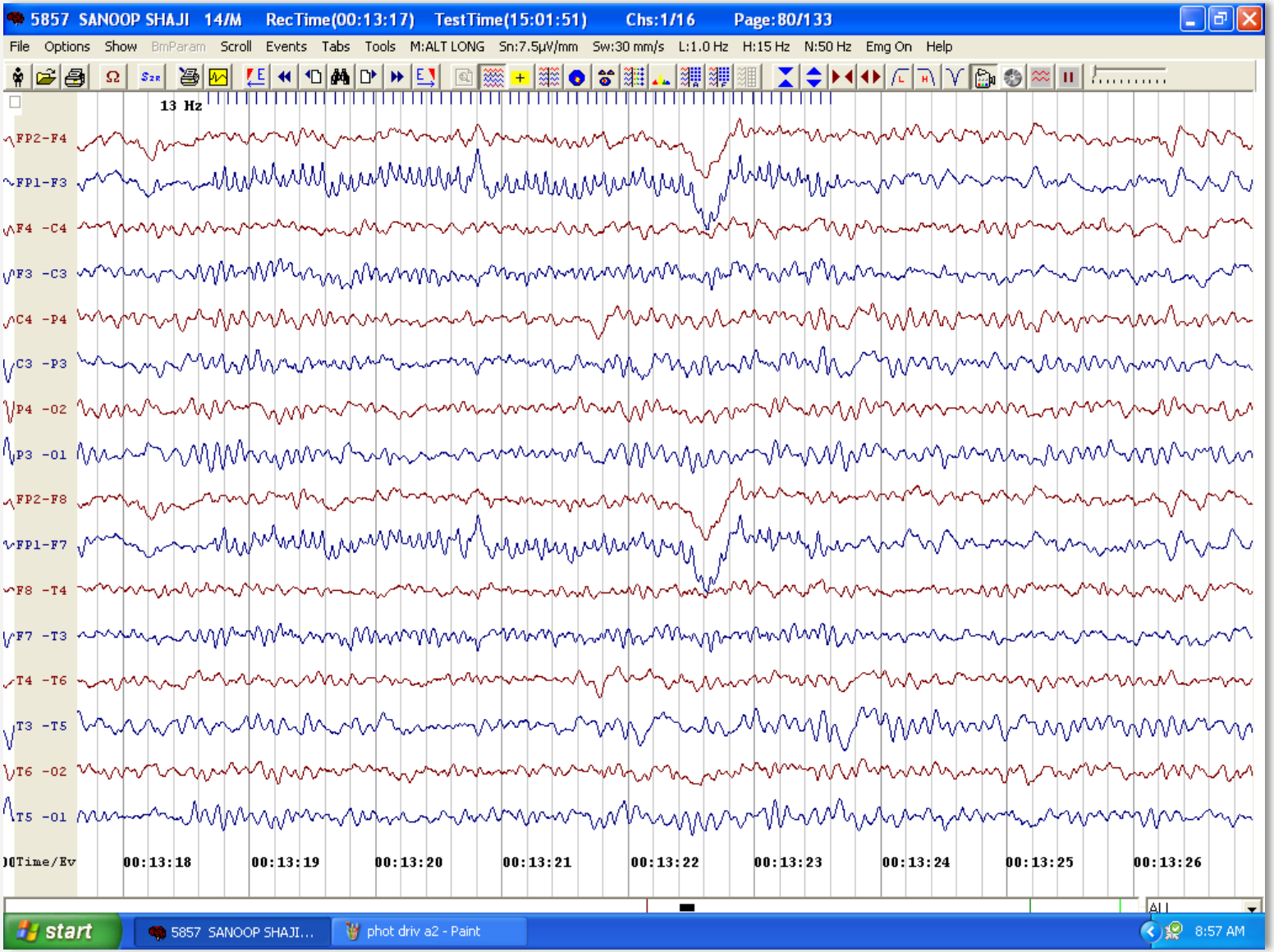
NORMAL, SYMMETRICAL SLOWING DURING HYPERVENTILATION



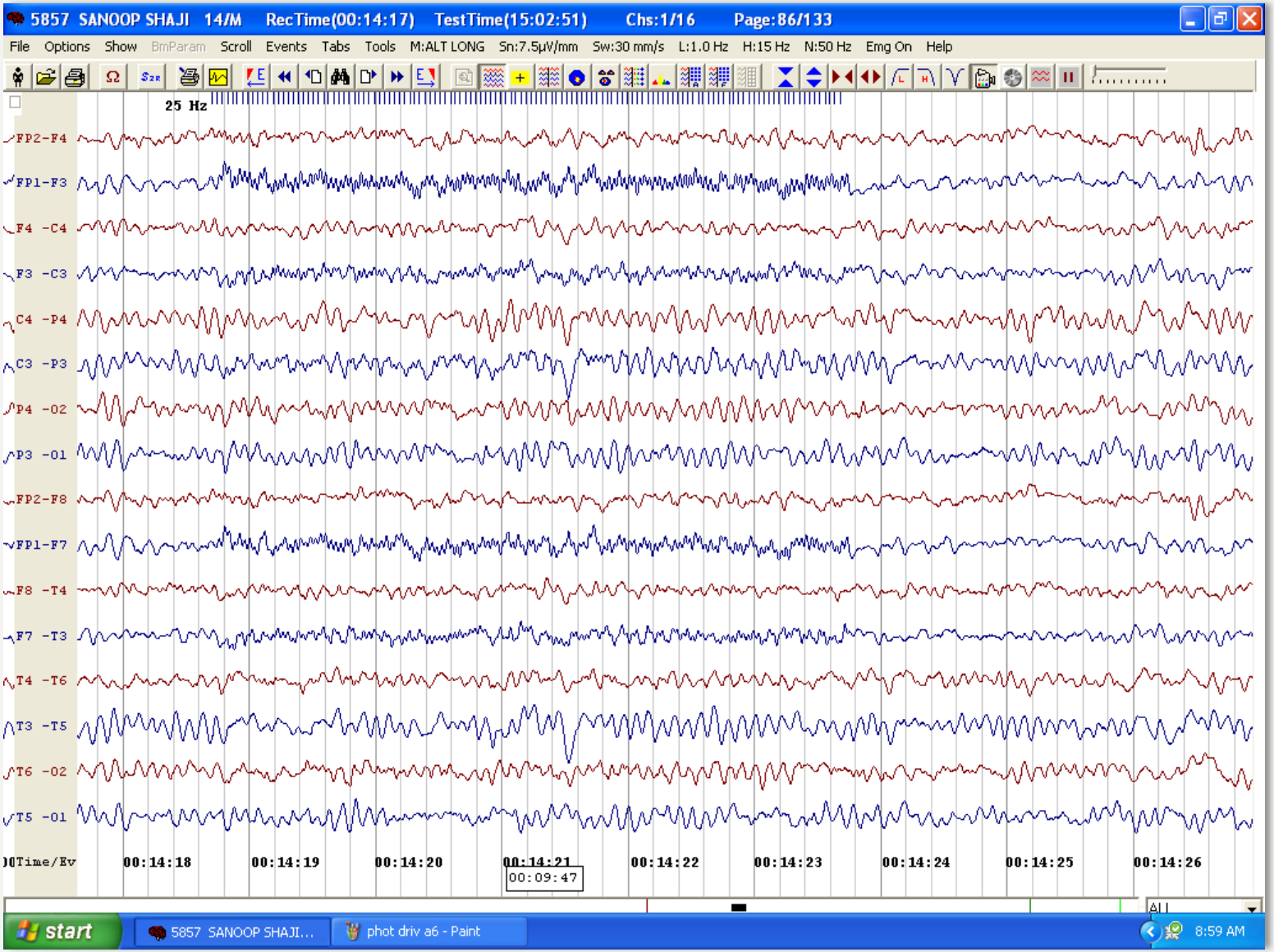
GENERALIZED SPIKE-AND-WAVE DISCHARGES DURING HYPERVENTILATION



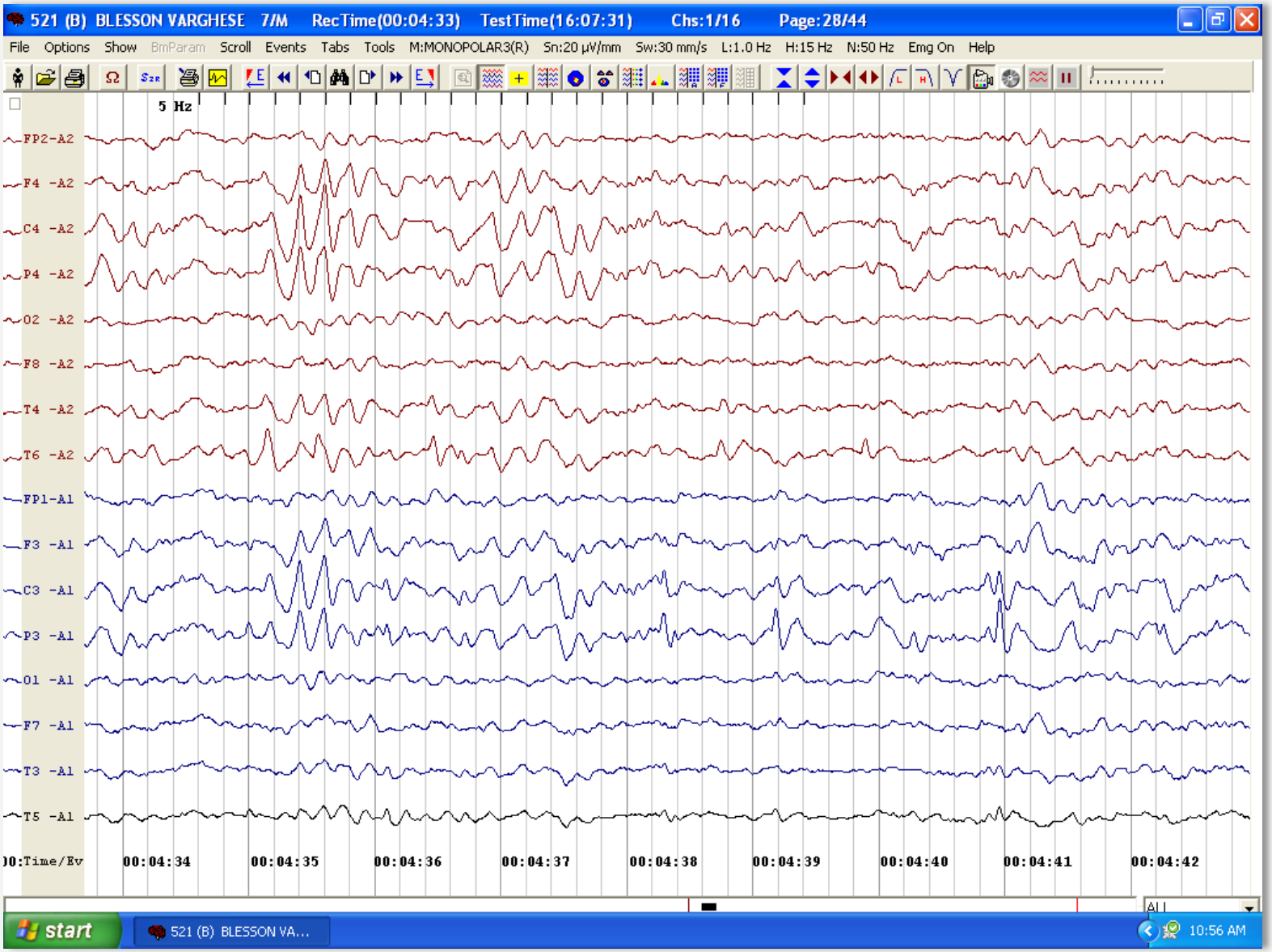
PHOTIC DRIVING



PHOTIC DRIVING



SHARP WAVES, SPIKE-AND-WAVE DISCHARGES, AND SHARP AND SLOW WAVE COMPLEXES DURING PHOTIC STIMULATION

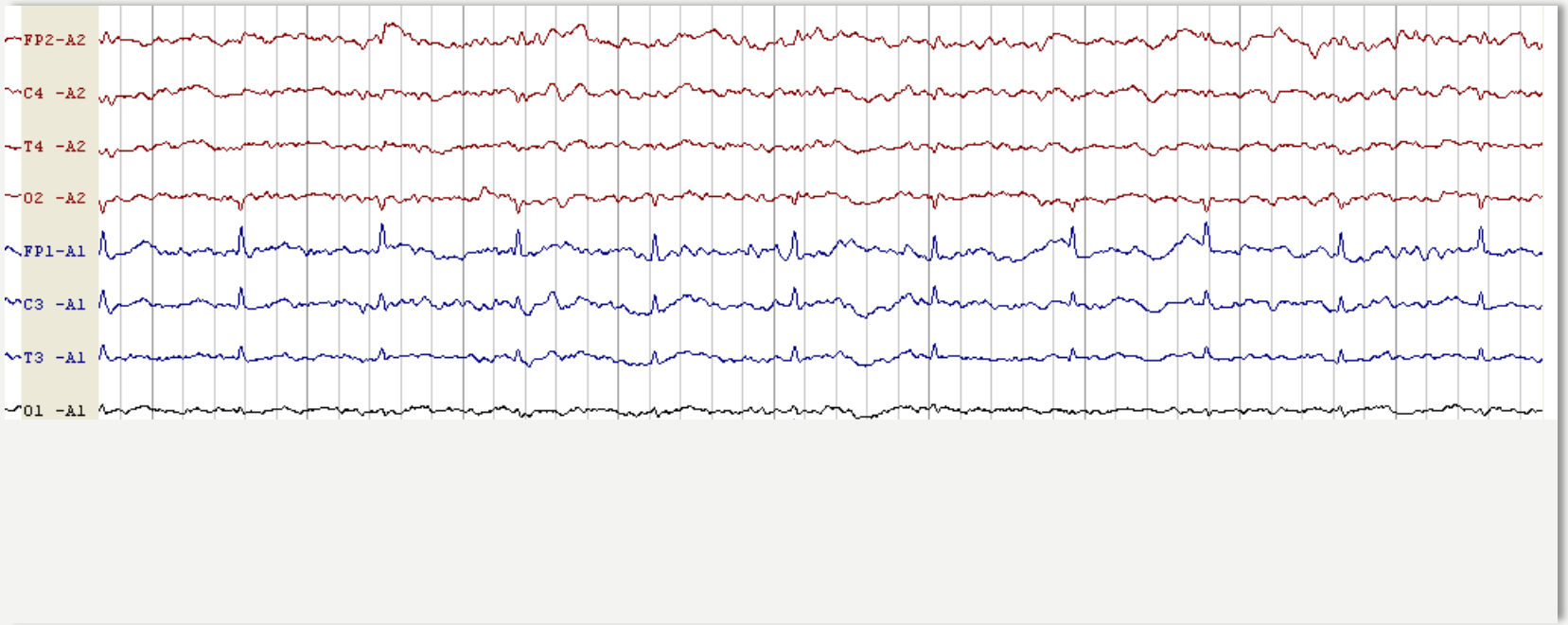


YIELD-ENHANCING TECHNIQUES

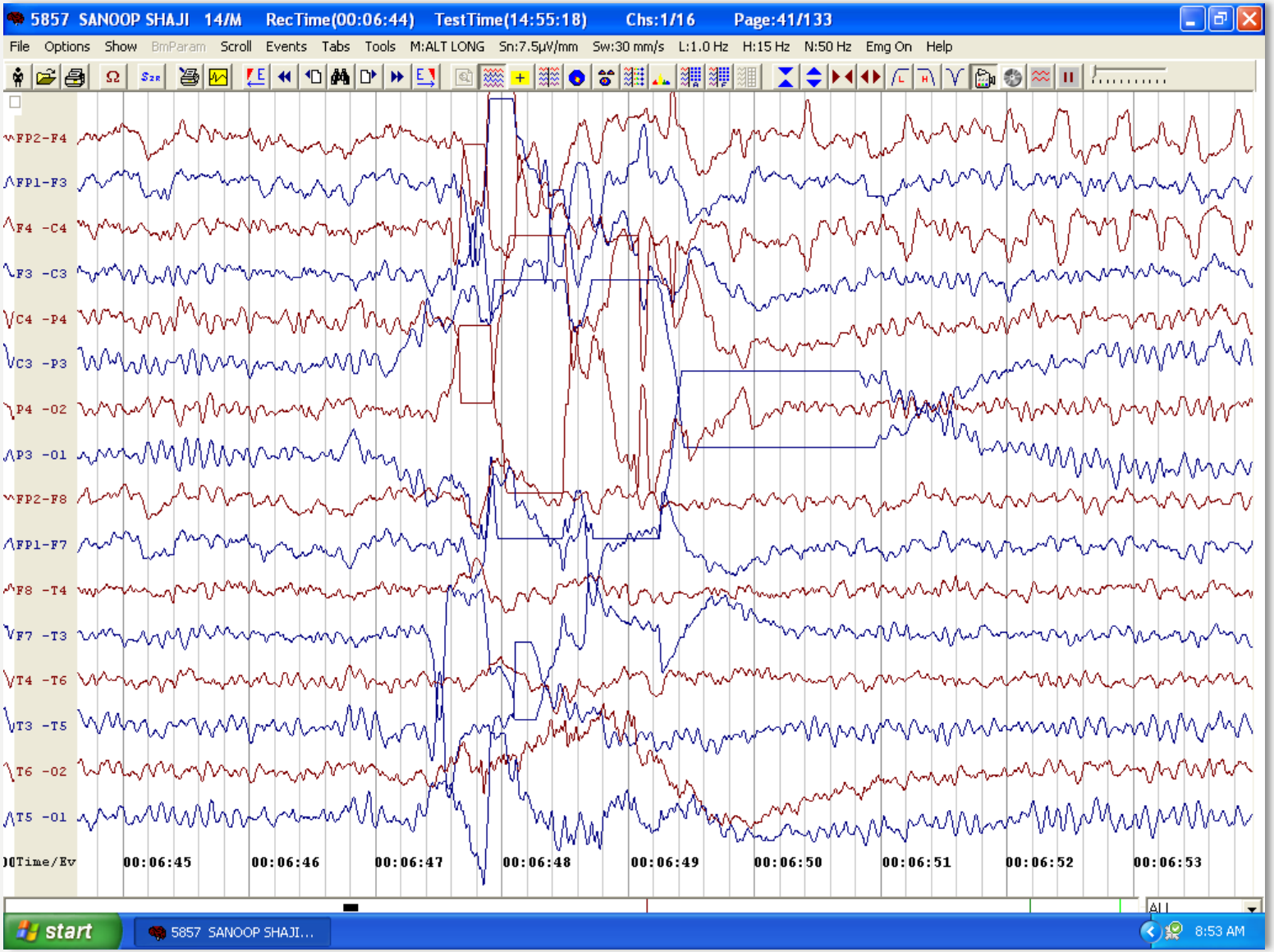
- Minimization of confounding variables (e.g., medications)
  - Anticonvulsants may be withdrawn prior to EEG studies in patients suspected of having pseudoseizures.
- A patient should not fast before an EEG because hypoglycemia can influence a tracing.

ARTIFACTS

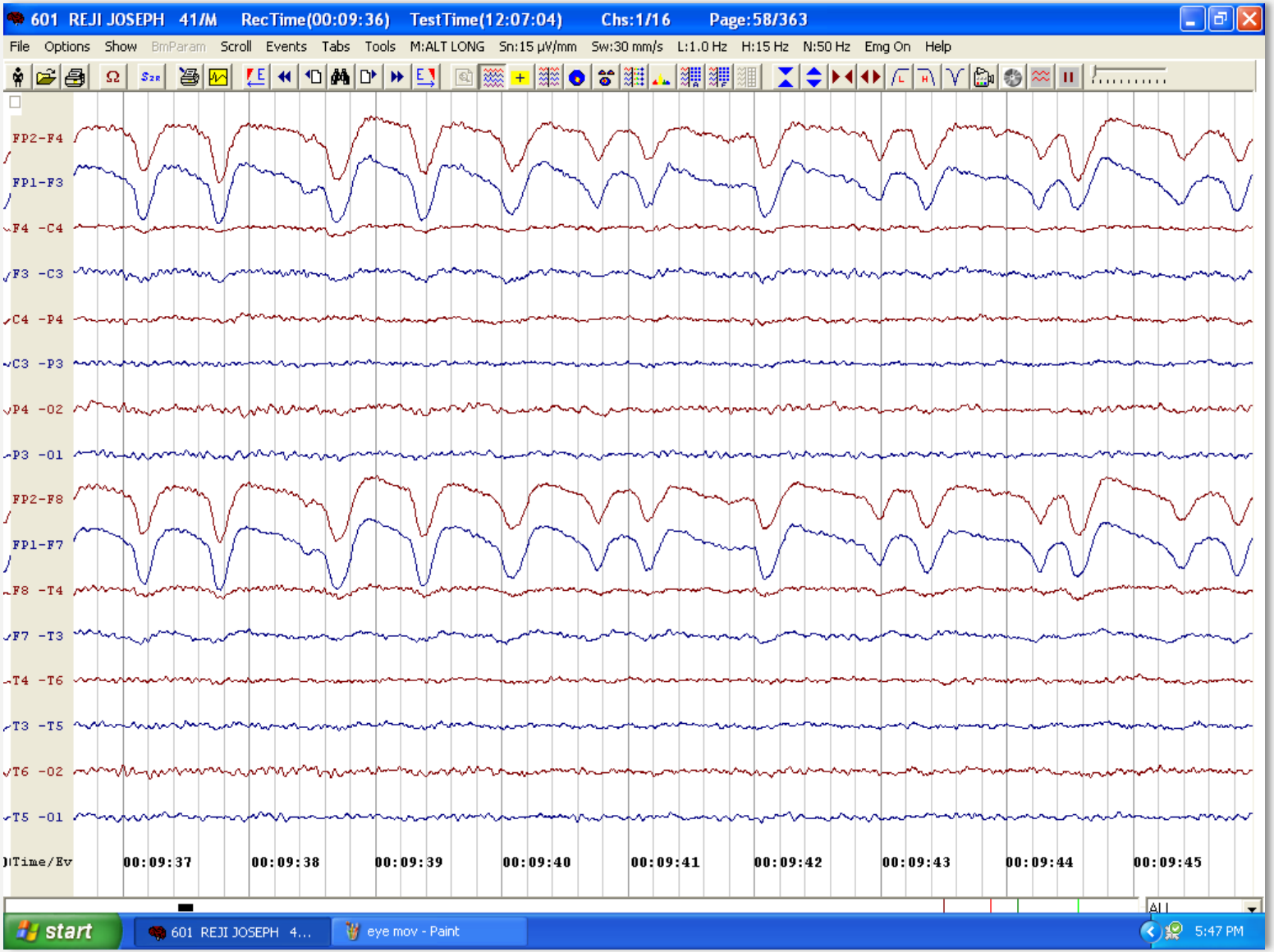
ECG ARTIFACTS



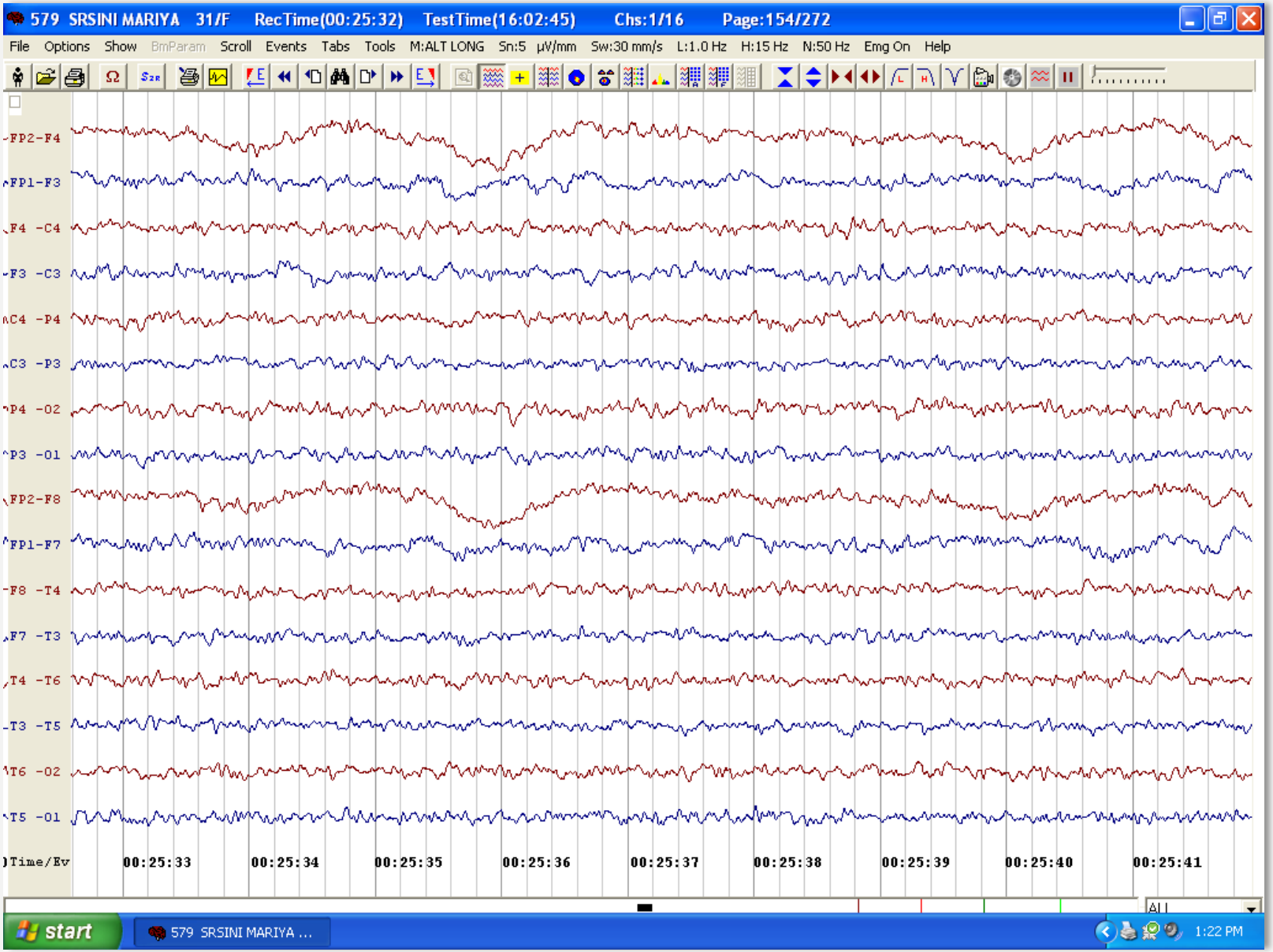
MOVEMENT ARTIFACT



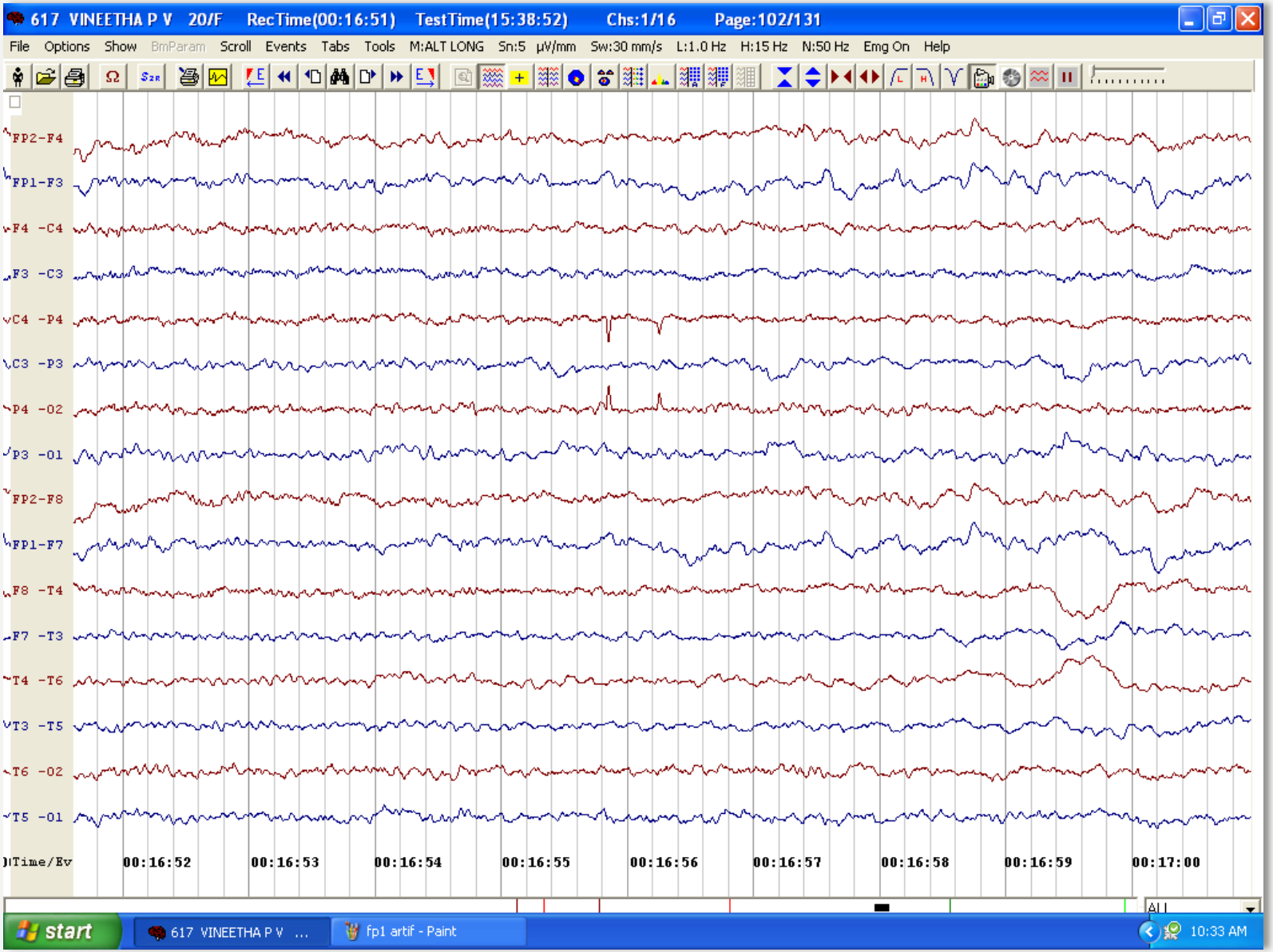
EYE MOVEMENT ARTIFACT



ELECTRODE MOVEMENT ARTIFACT IN FP2



SINGLE ELECTRODE ARTIFACT: P4

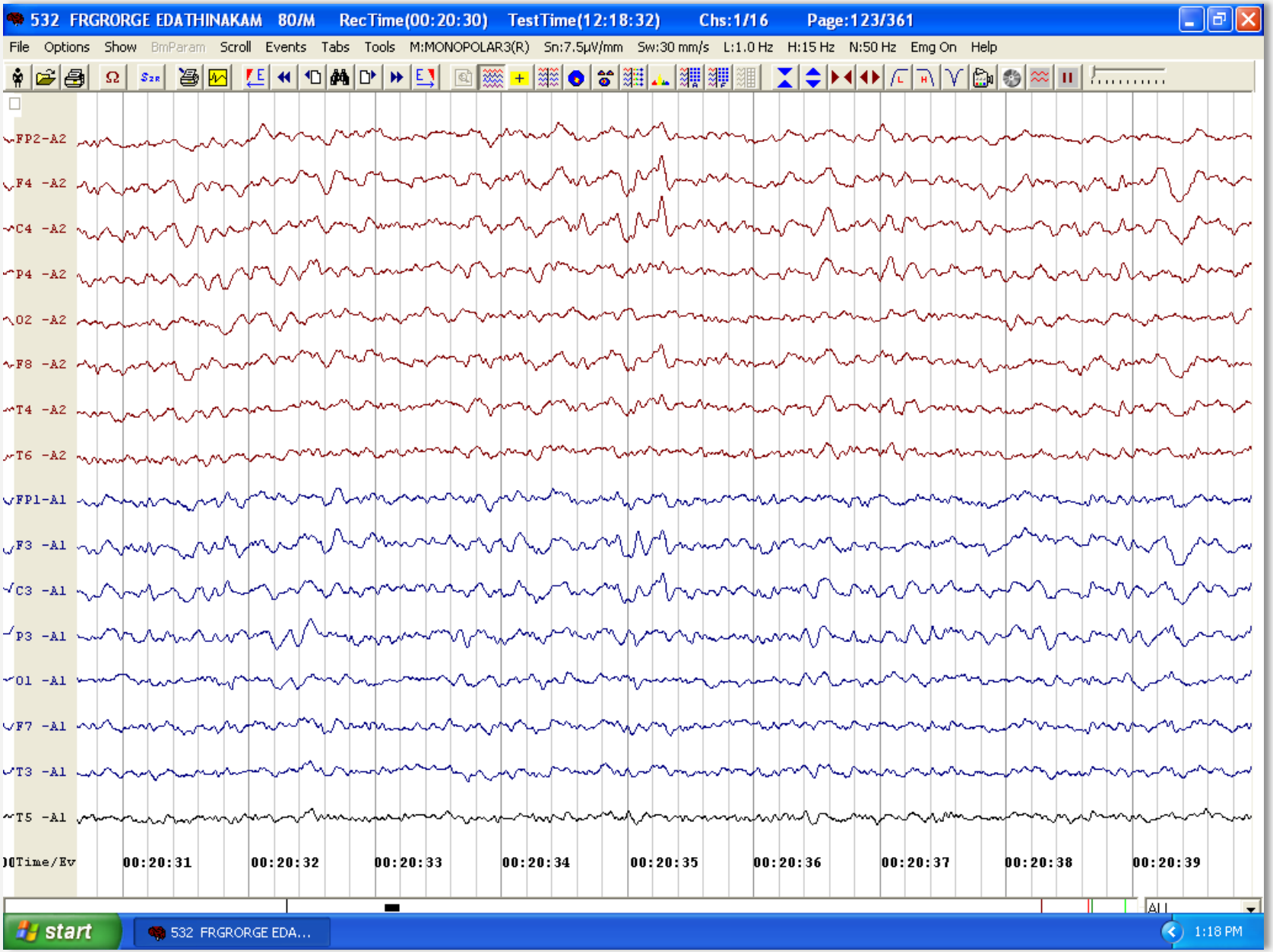


SOME TAKE HOME POINTS

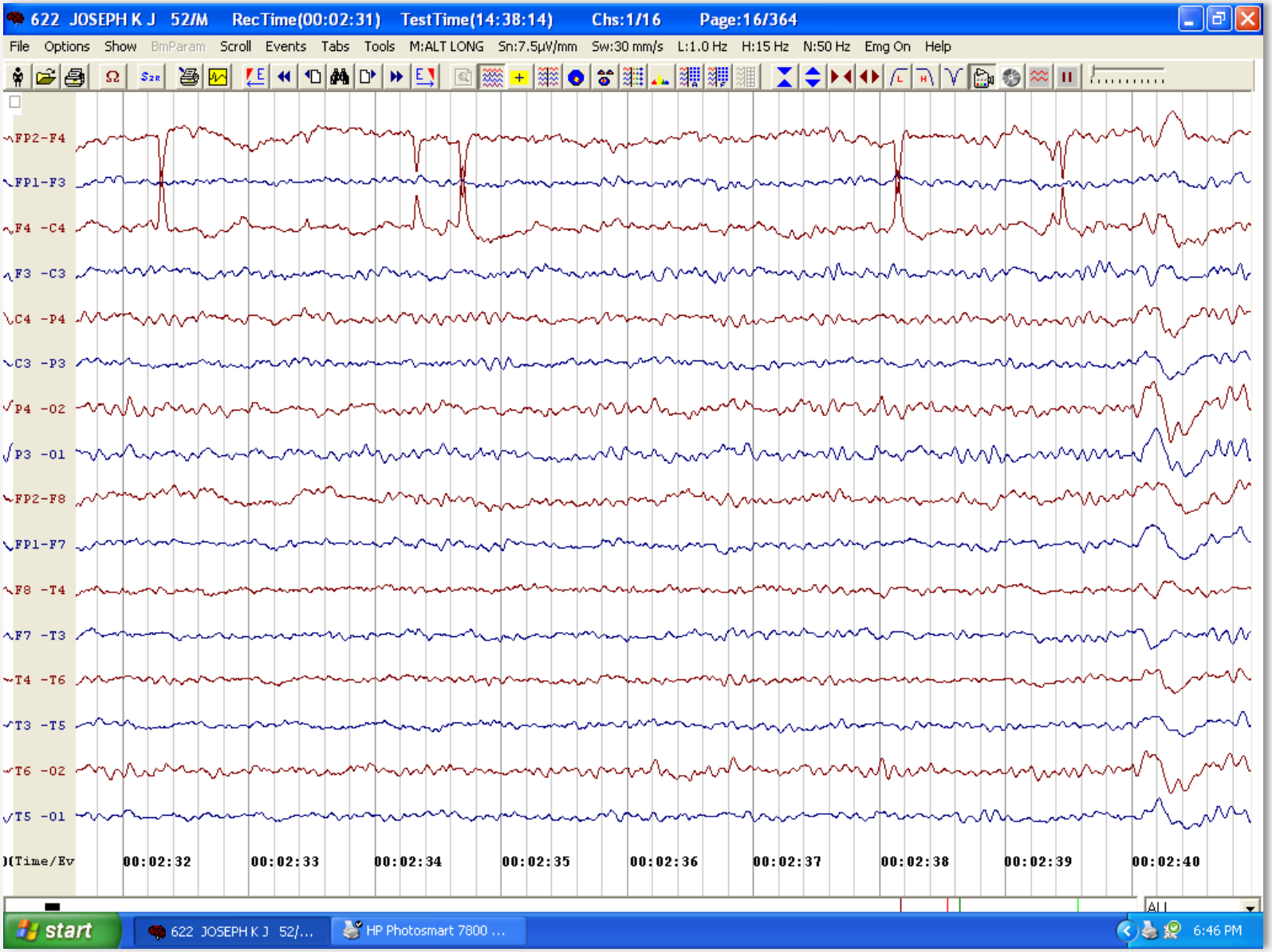
- A normal EEG never excludes any clinical condition.
- Perhaps 10-15% of normal subjects show some abnormality on EEG.
- As many as 64 - 68% of EEGs in psychiatric patients provide evidence of pathophysiology.
- The thoughtful integration of EEG data with material from clinical history and examination is fundamental to the EEG remaining a useful component in a psychiatric diagnostic armamentarium.


THANKS

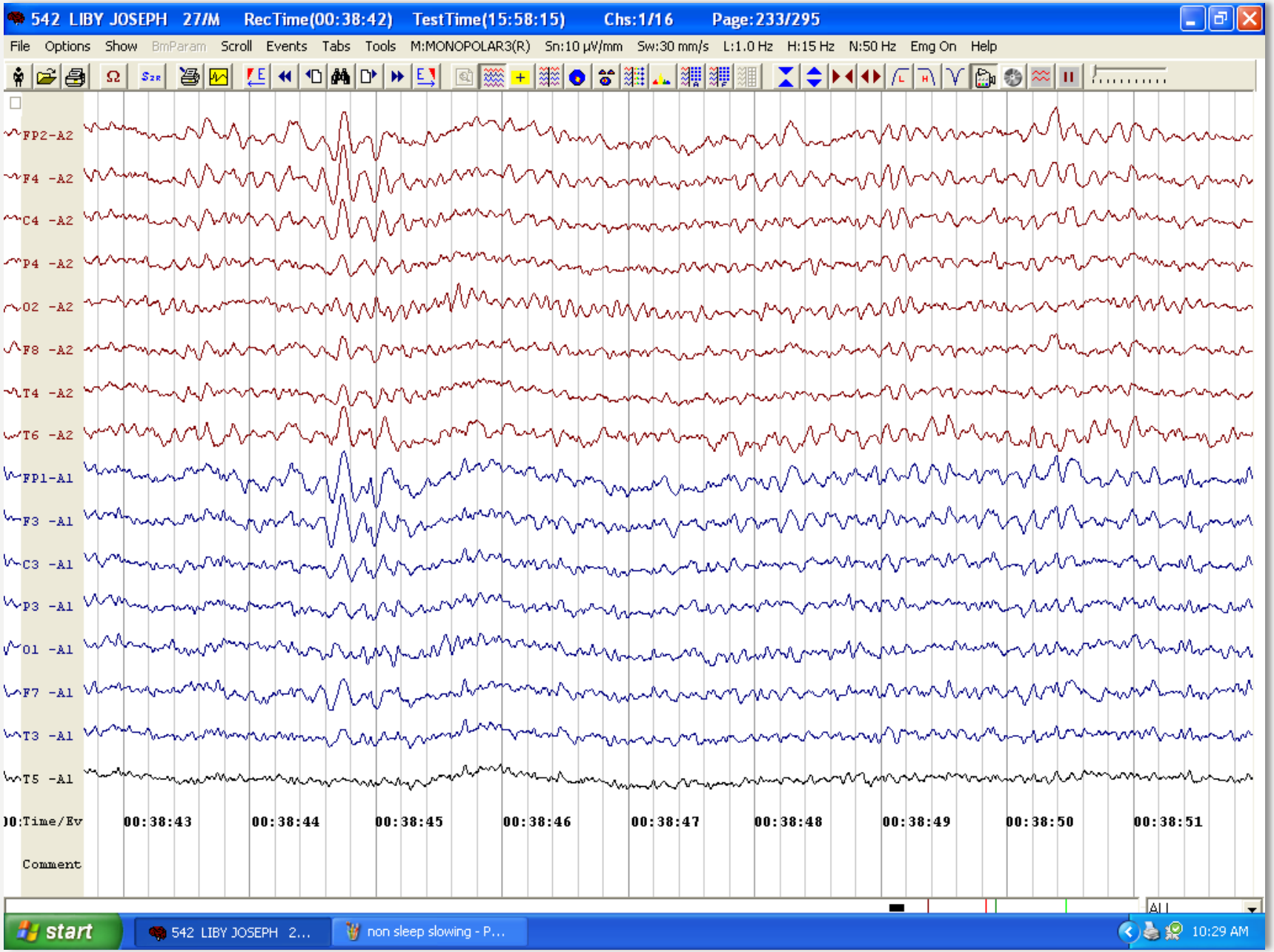
SPIKES IN RIGHT CENTRAL REGION



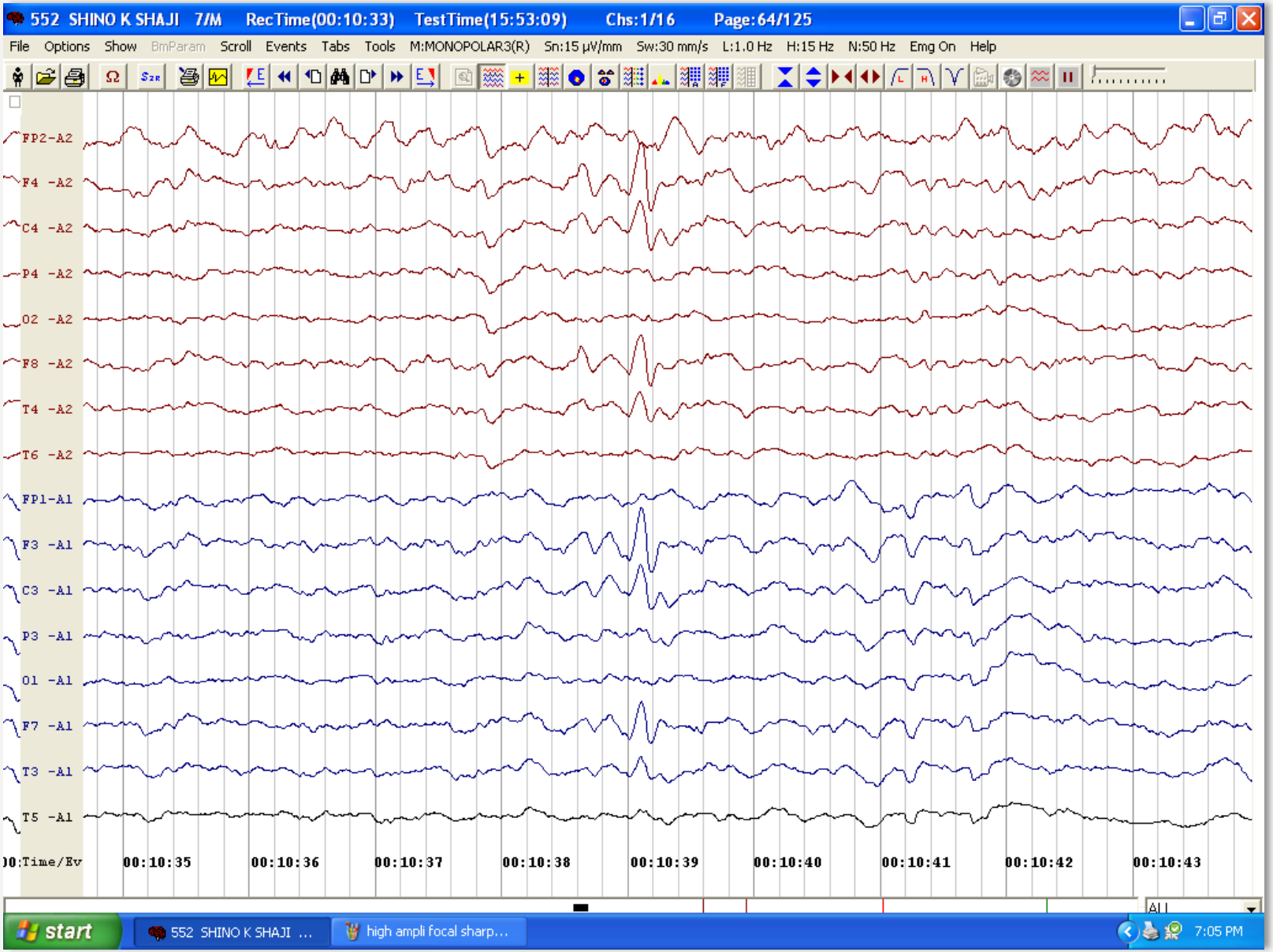
SINGLE ELECTRODE ARTIFACT: F4



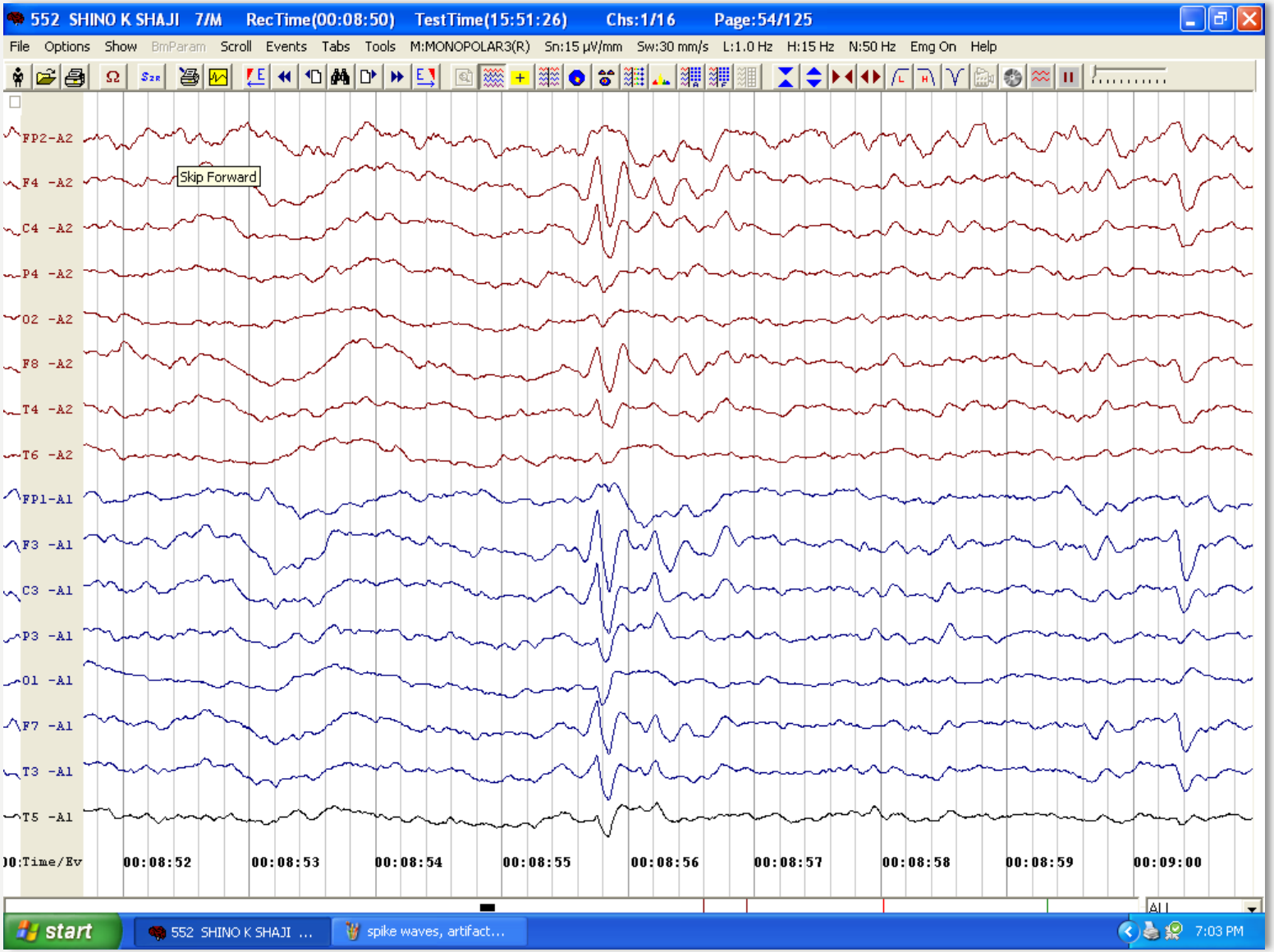
SHARP WAVES FROM RIGHT FRONTAL REGION



BIFRONTAL SHARP WAVES



SHARP AND SLOW WAVE COMPLEXES FROM LEFT FRONTAL REGION




THANKS