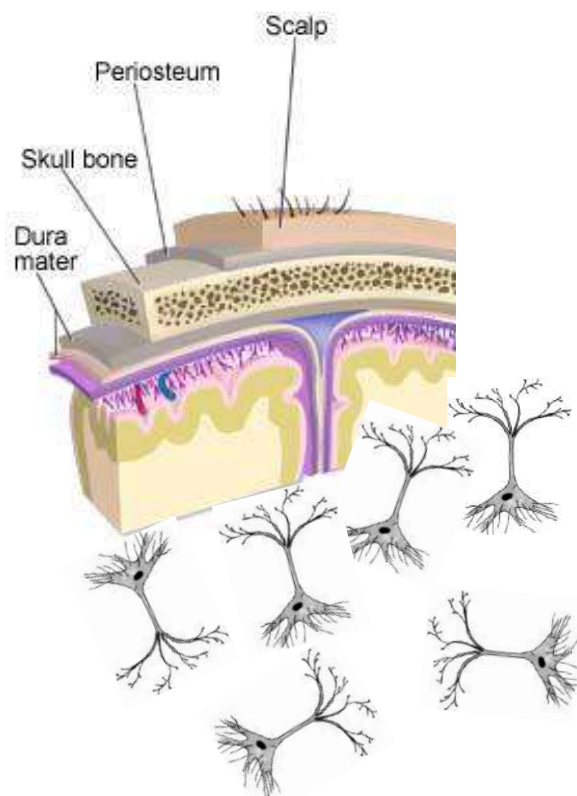


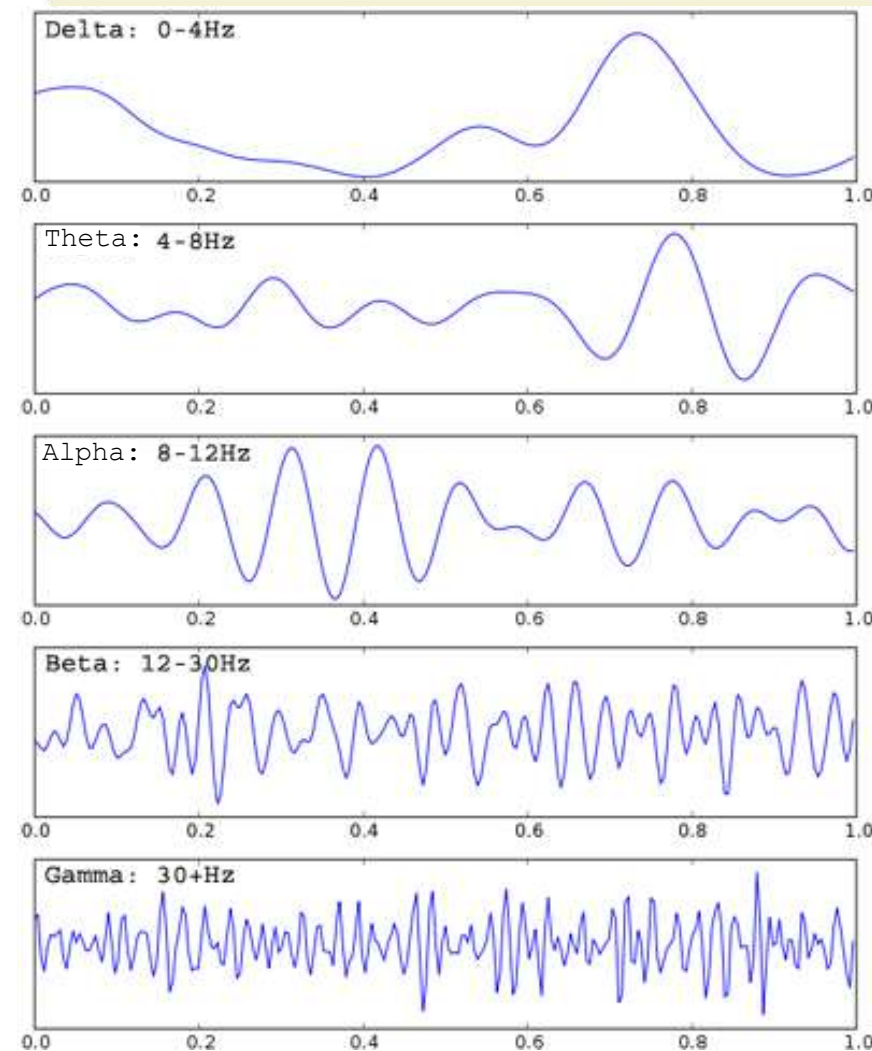
Clean. Mobile. Fast.

Practical, High-Fidelity
Dry Electrode EEG





Electrodes



Pros

- High temporal resolution (ms)
- Can be inexpensive
- Ambulatory

Limitations to mainstream adoption:

- Requires skin abrasion & conductive gel or fluids
- Sensitive to motion and electrical artifacts
- Needs time-synchronized context information
- Advanced signal analysis
- Not Practical: Not portable and not ambulatory



Skin Abrasion

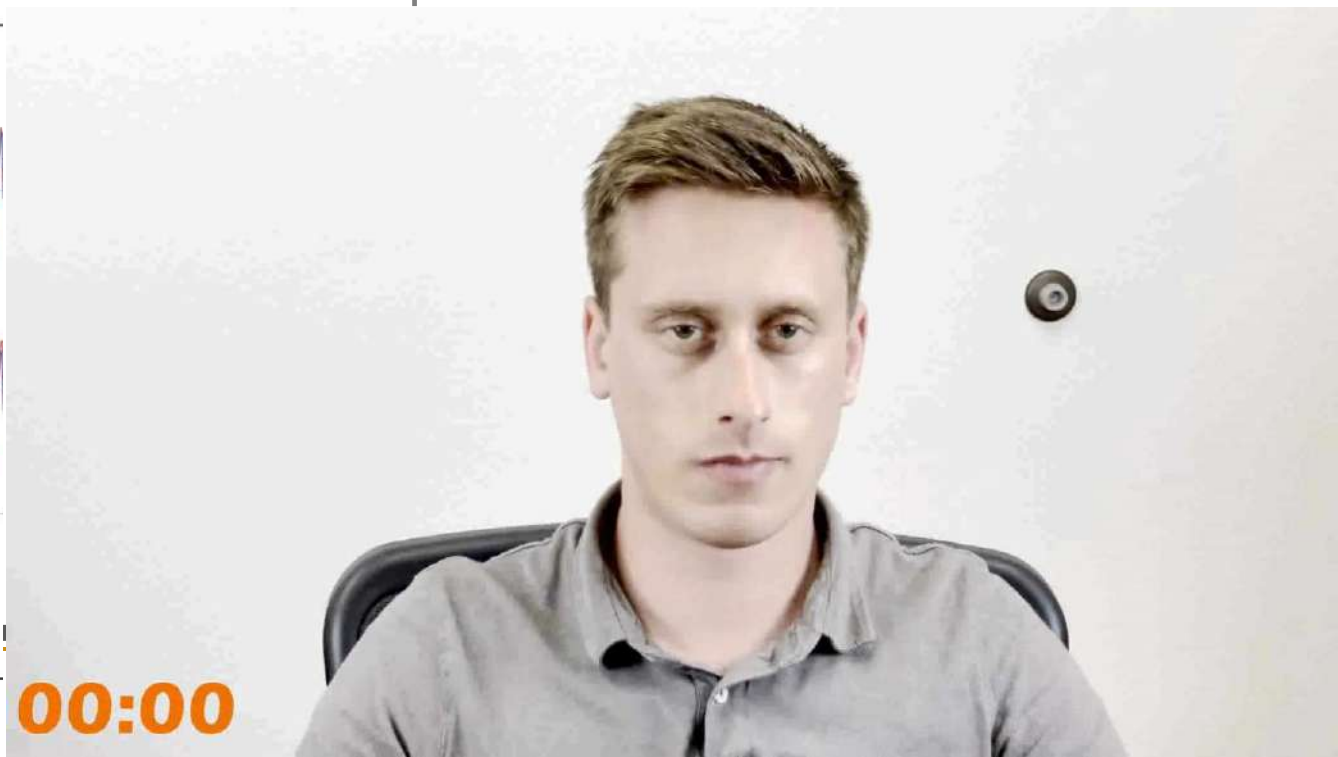


Wired Systems

Taking EEG to the Real World

- **No skin abrasion**
- **No gels nor liquids**
- **High signal quality**
- **Low artifact**
- **Easy and Fast to put on**
- **Comfortable for long time**
- **Ambulatory**

- ▶ Ultra-High Impedance Active Dry Sensor
- ▶ Through-hair Dry Electrodes
- ▶ Common Mode Follower
- ▶ Electrical & Mechanical Design and Shielding
- ▶ Headset Design
- ▶ Headset Design
- ▶ Wireless data acquisition



DSI-Streamer v.1.08.60

Data Source: Record Montage Advanced ERP TCP IP

Source: Headset COM8 Power Off Add Port Streaming

Headset Type: DSI-24 SN: 112

Trigger Source: Wireless Wired

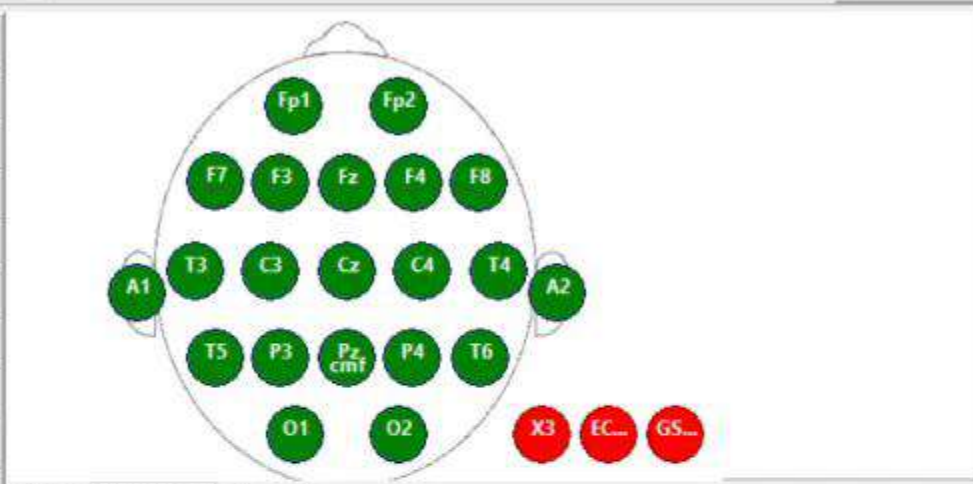
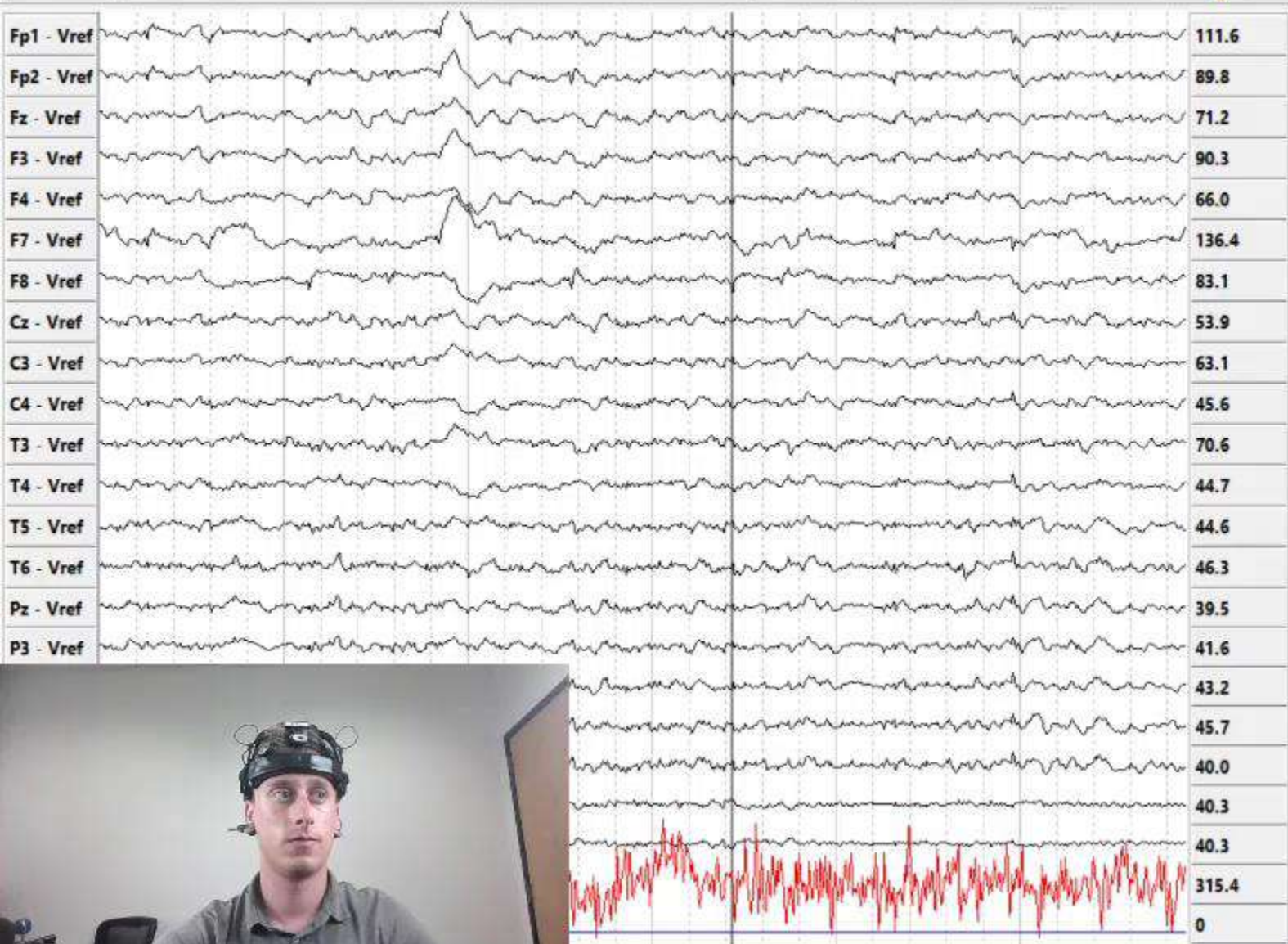
Timing: Plot Length 6 sec

Filters: HP Filter 1.0 Hz LP Filter 50.0 Hz

Battery: 0% 38%

Scale: Auto 100

Buttons: Stop Pause A_Reset Diagnostic



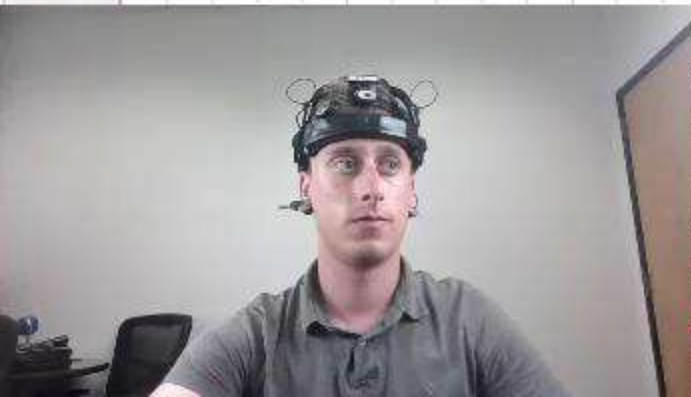
Guide Numericals Advanced

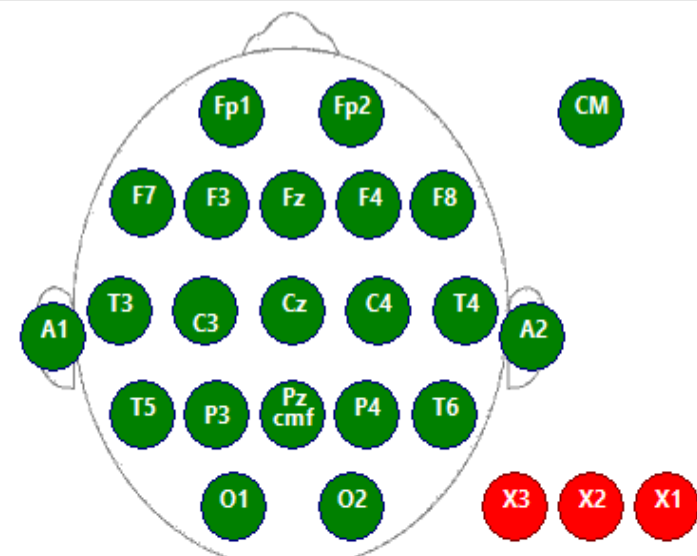
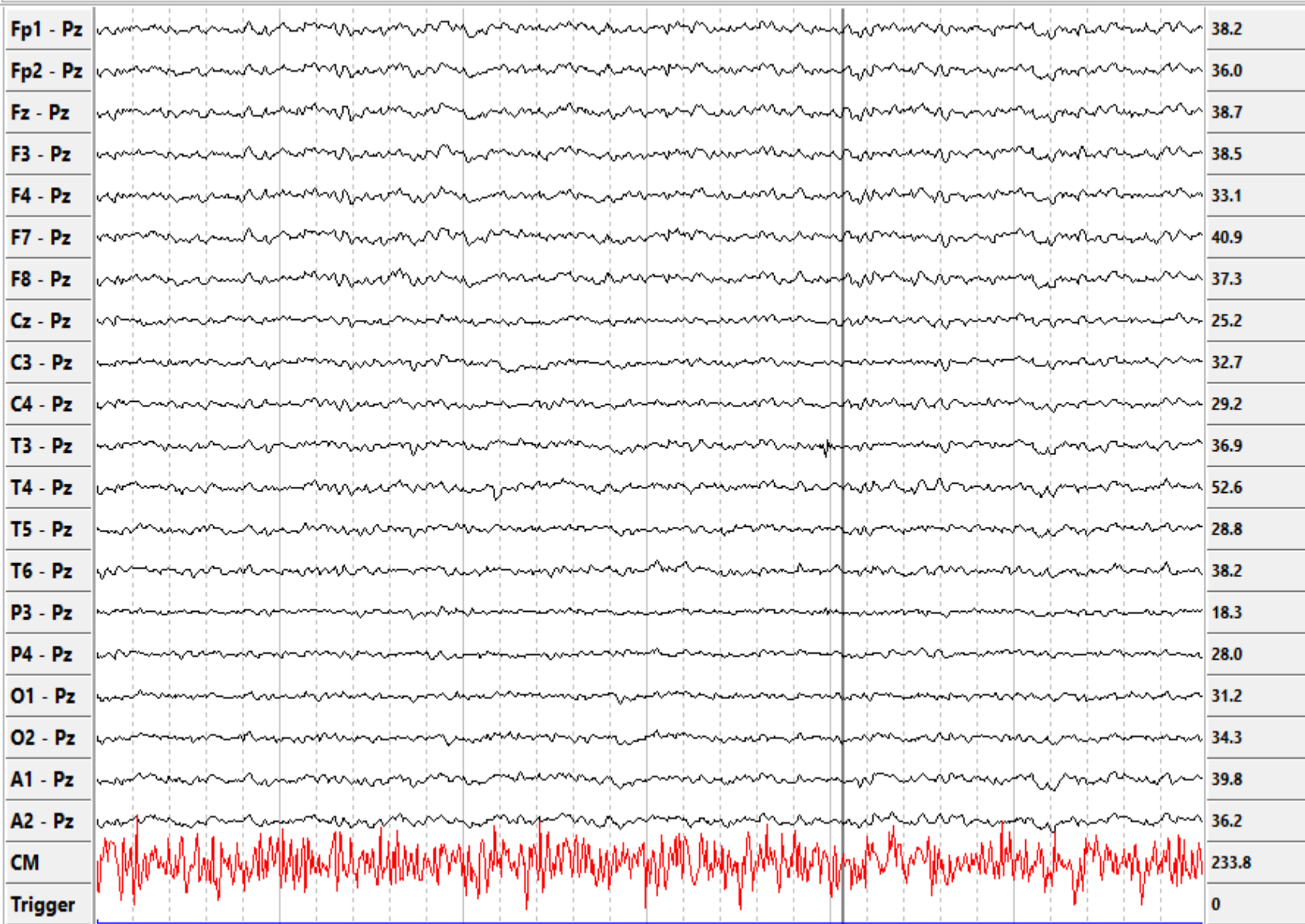
Impedance ON Record Impedance Hold A_Reset

	Z(M)	N(uV)	BL(uV)		Z(M)	N(uV)	BL(uV)
A1	0.10	12.8	75.0	Fz	0.19	9.5	-17.6
A2	0.11	14.5	-62.4	GSR2	0.00	0.2	-13.8
C3	0.35	5.8	142.6	O1	0.47	5.2	-17.4
C4	0.34	6.7	69.4	O2	0.39	5.2	-114.6
Cz	0.33	4.4	32.5	P3	0.32	3.0	2.9
ECG2	0.00	0.2	-13.2	P4	0.31	3.3	-66.3
F3	0.20	8.6	57.1	Pz	0.40		
F4	0.18	8.3	-160.7	T3	0.33	10.2	-69.8
F7	0.18	14.0	211.3	T4	0.26	9.6	56.2
F8	0.21	12.0	113.4	T5	0.40	5.6	97.2
Fp1	0.11	10.9	222.7	T6	0.13	6.4	-33.7
Fp2	0.11	11.4	212.7	X3	0.00	0.2	-8.6

Zgnd= 0.16M; SNR= 2.77

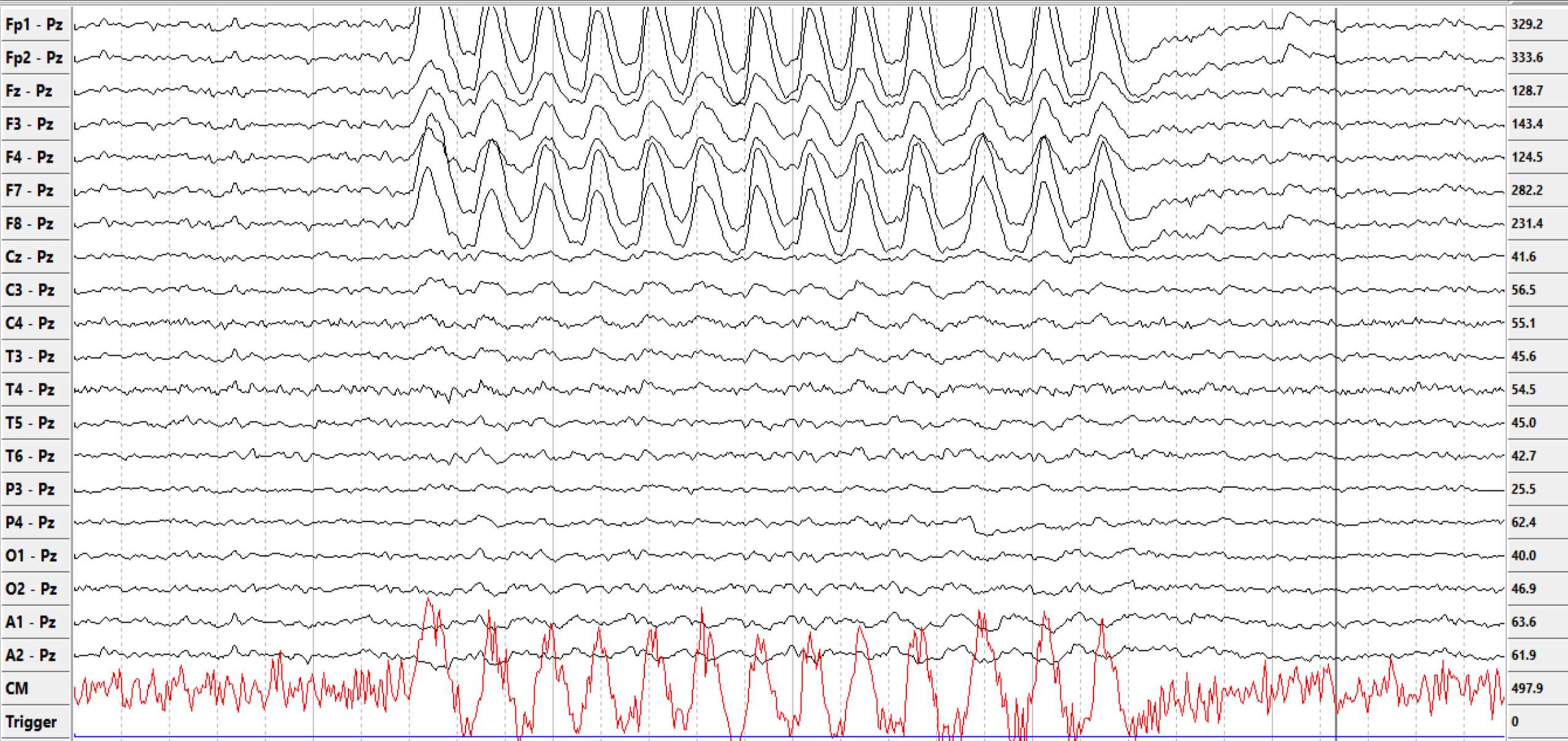
Run Time = 3051.48 s No Recording



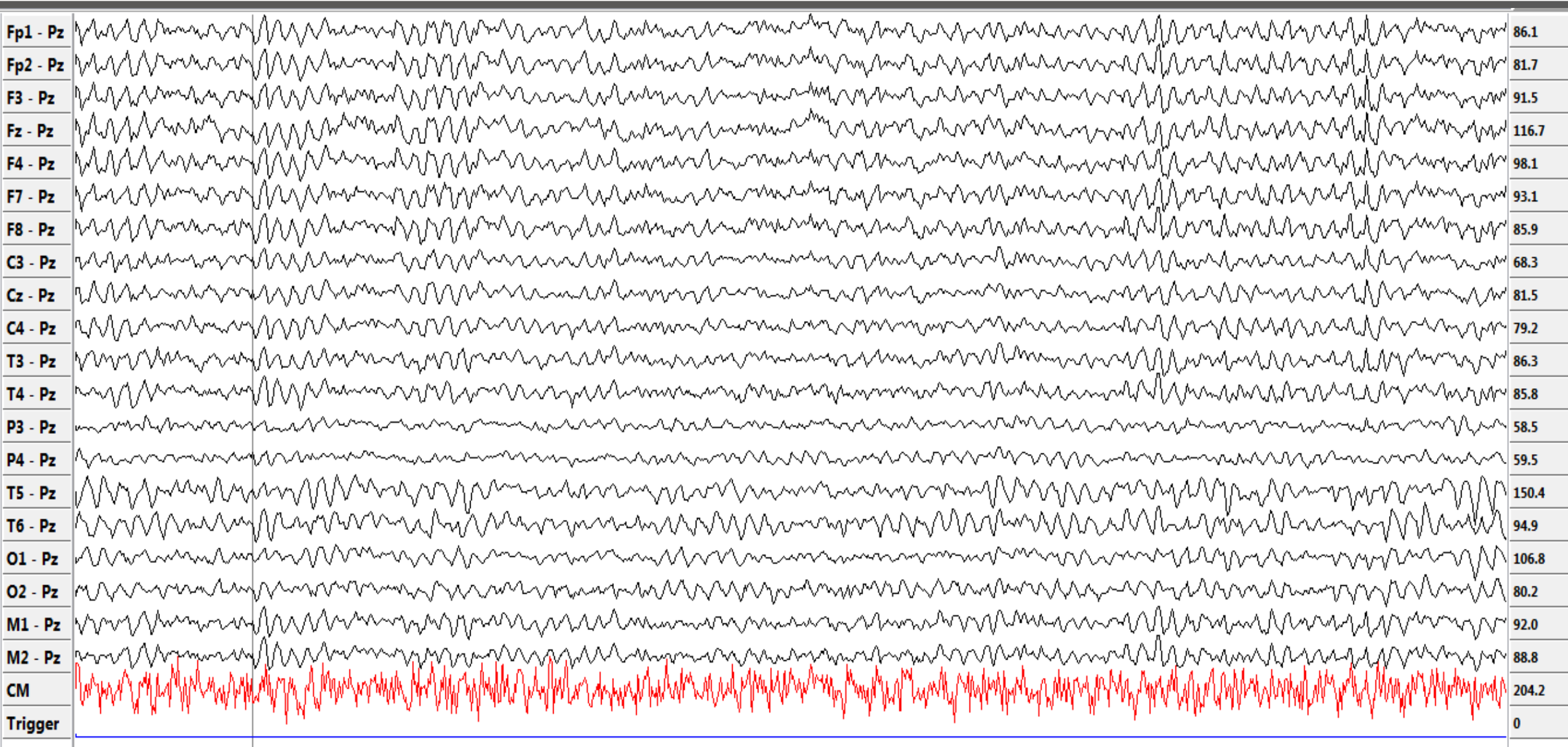


Guide	Numericals	Advanced
	Z(M)	BL(uV) N(uV)
P3	0.39	-224.7 3.8
C3	0.27	-254.3 7.8
F3	0.37	-237.3 9.4
Fz	0.78	-19.3 8.4
F4	0.37	-474.0 9.2
C4	0.19	-473.0 6.7
P4	0.33	-378.4 4.9
Cz	0.24	-118.9 5.6
CM	0.21	
A1	0.11	221.9 10.6
Fp1	0.10	352.4 9.0
Fp2	0.10	238.8 9.4
T3	0.37	131.3 9.9
T5	0.42	-162.2 7.0
O1	0.42	-254.8 6.4
O2	0.32	446.6 10.1
X3	0.00	-6.2 0.2
X2	0.00	-13.0 0.2
F7	0.13	173.8 10.5
F8	0.16	30.5 8.2
X1	0.00	-8.4 0.2
A2	0.11	224.6 9.1
T6	0.35	-383.2 7.8
T4	0.32	-200.7 7.7

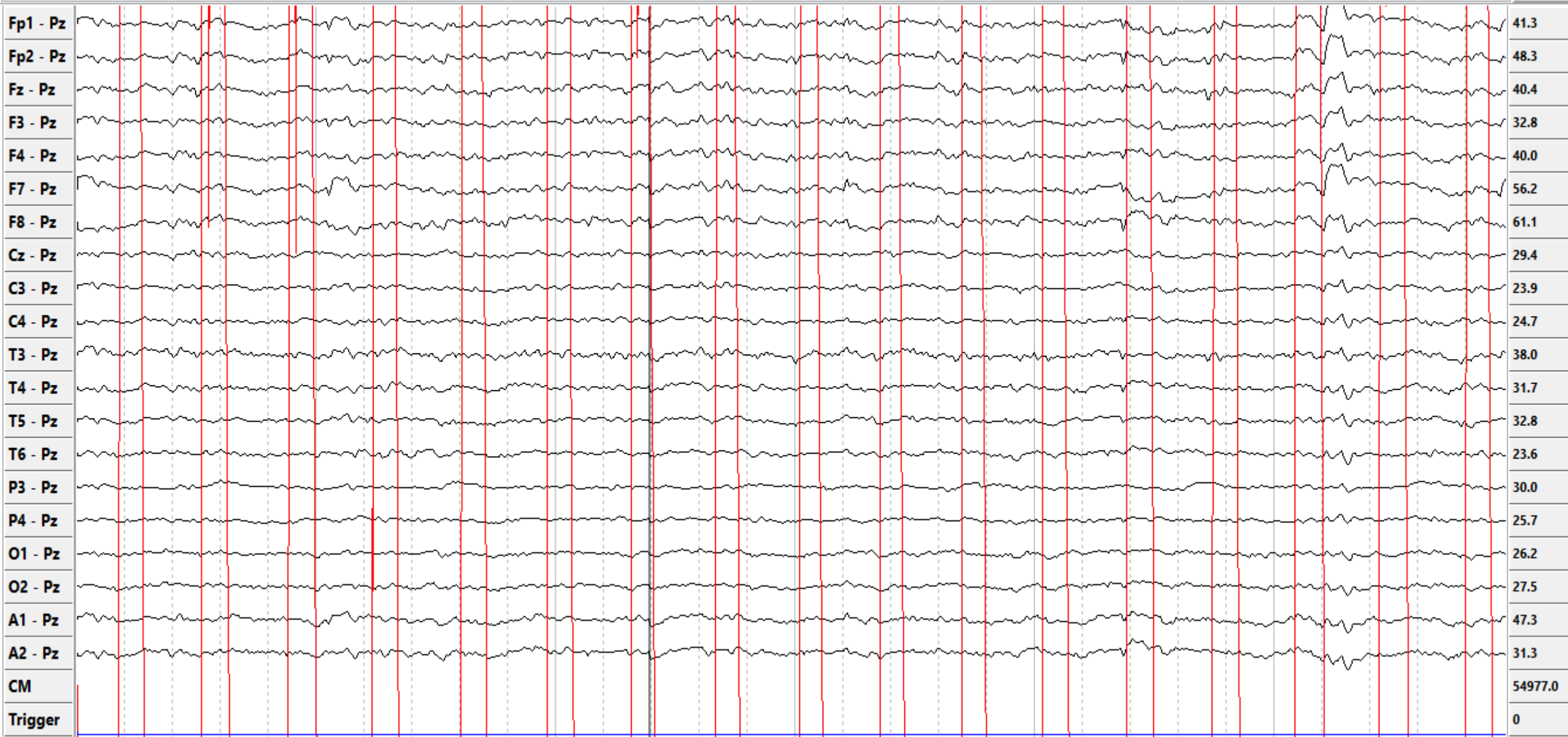
Z(CMF)= NA

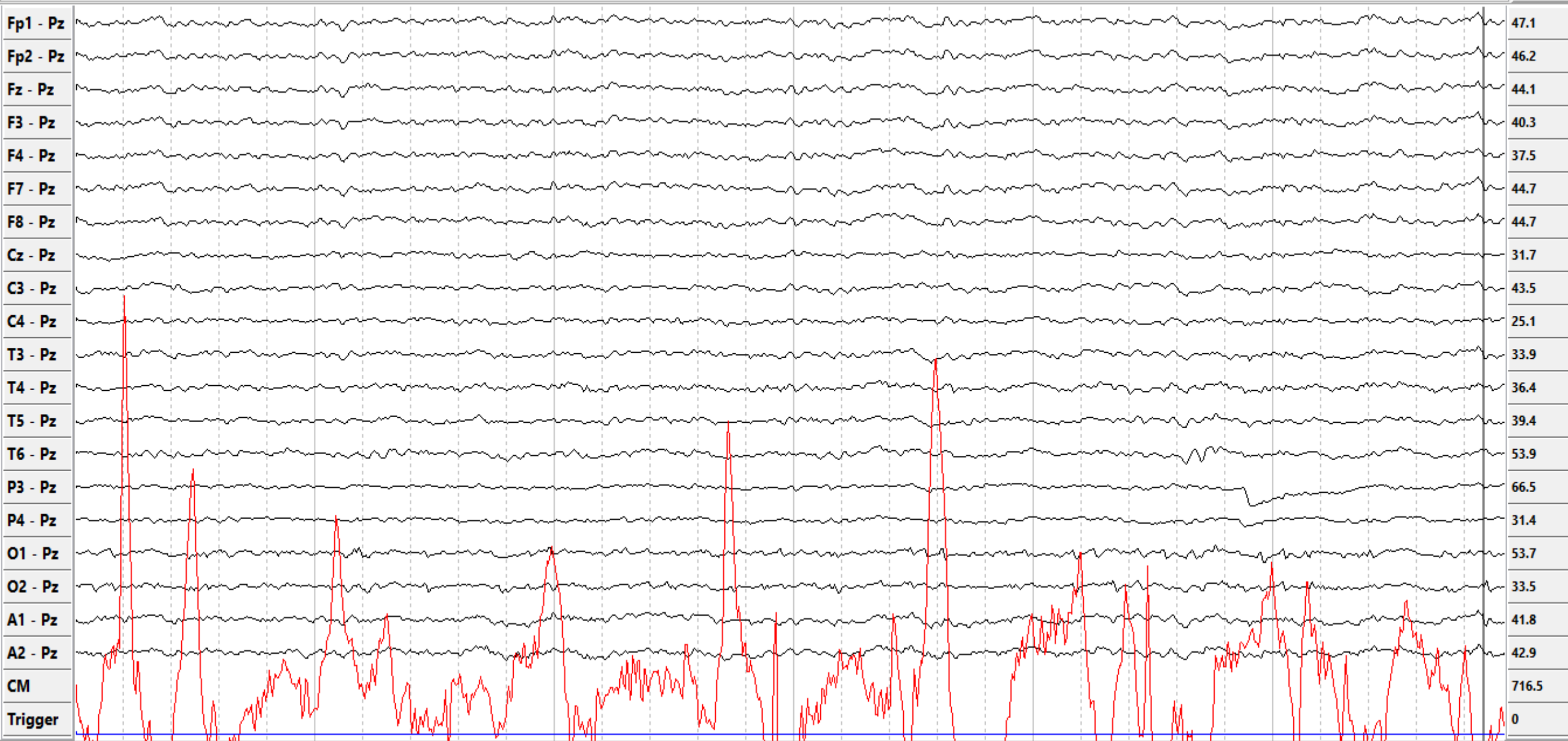


Signal Quality: Eyes Closed



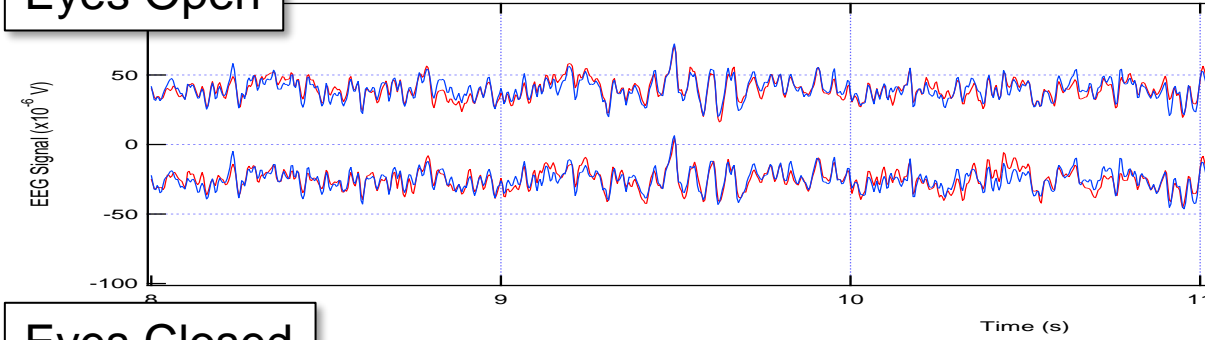
Signal Quality: Foot Tapping



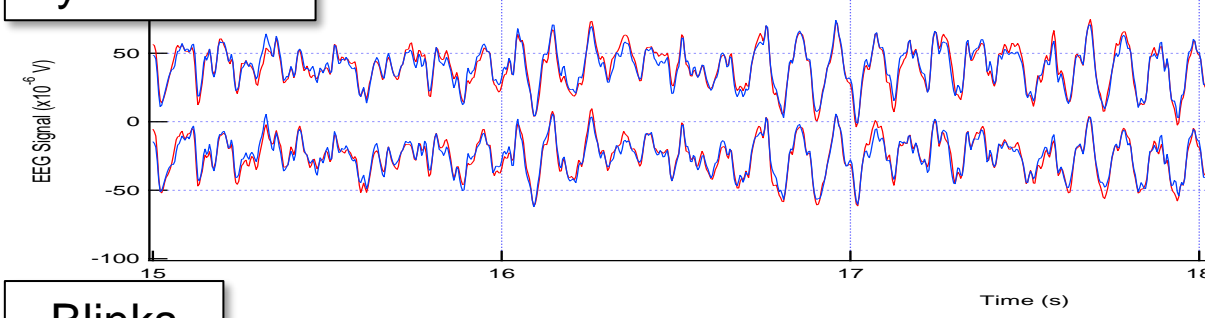


EEG Signal Comparison: QUASAR Dry Electrodes vs. Conventional Wet Electrodes

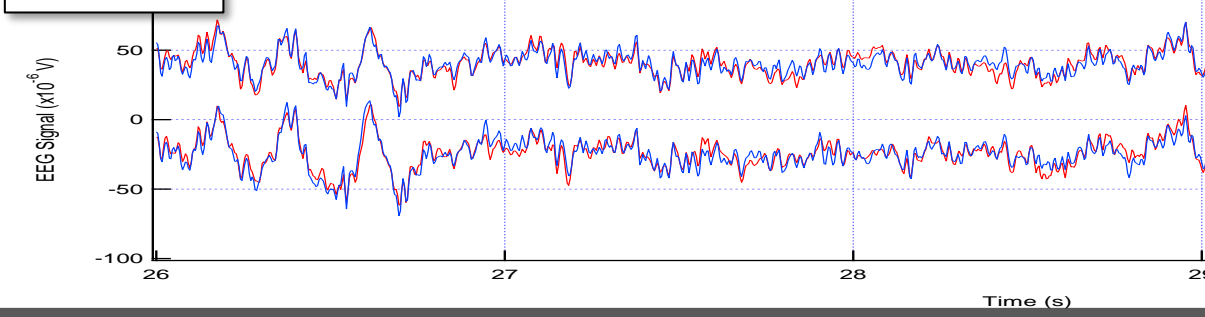
Eyes Open



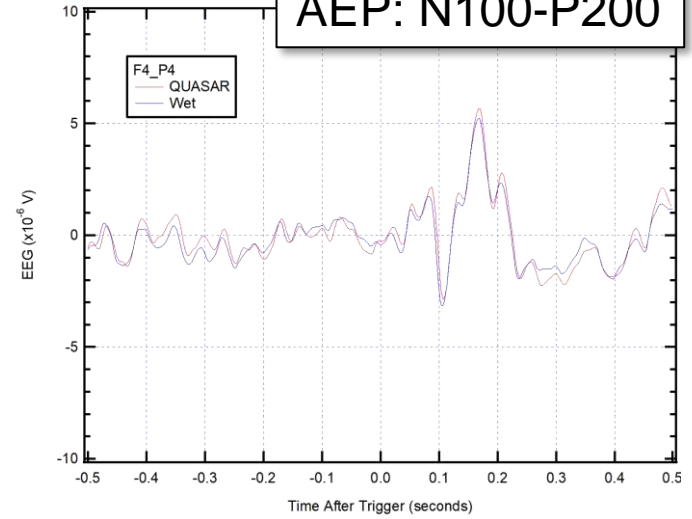
Eyes Closed



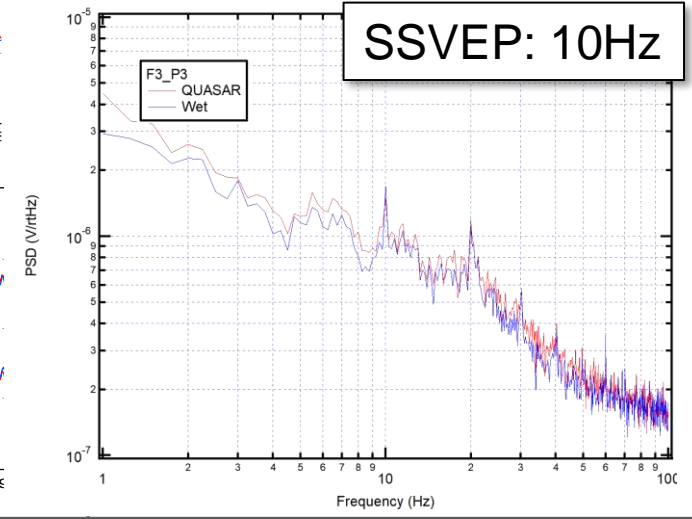
Blinks



AEP: N100-P200

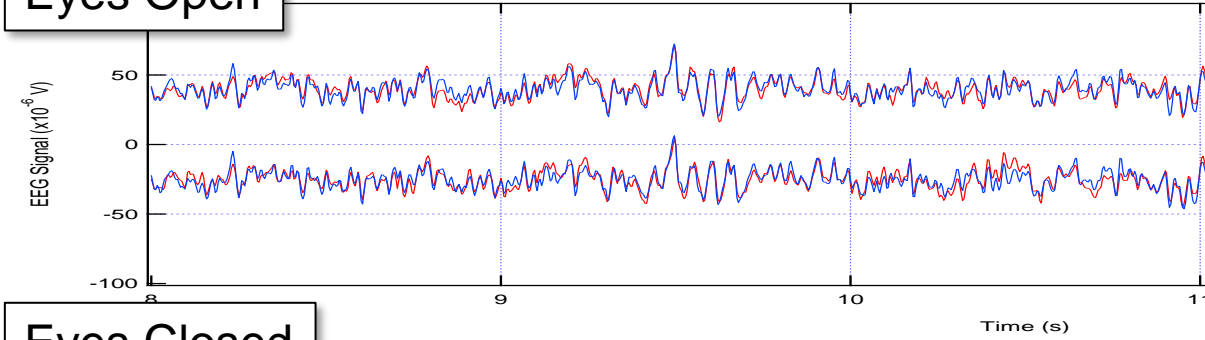


SSVEP: 10Hz

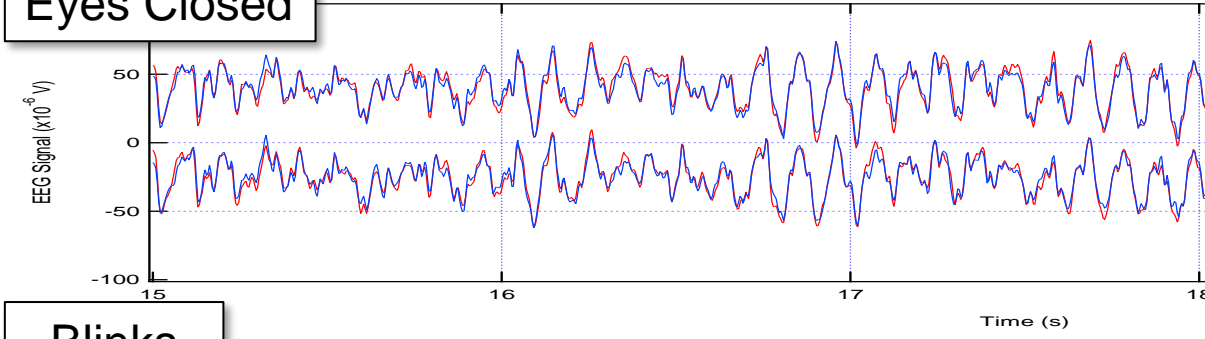


EEG Signal Comparison: QUASAR Dry Electrodes vs. Conventional Wet Electrodes

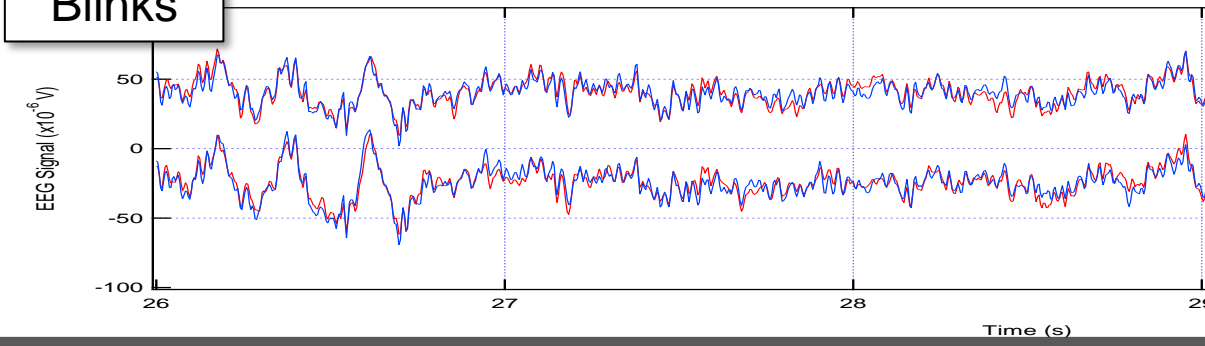
Eyes Open



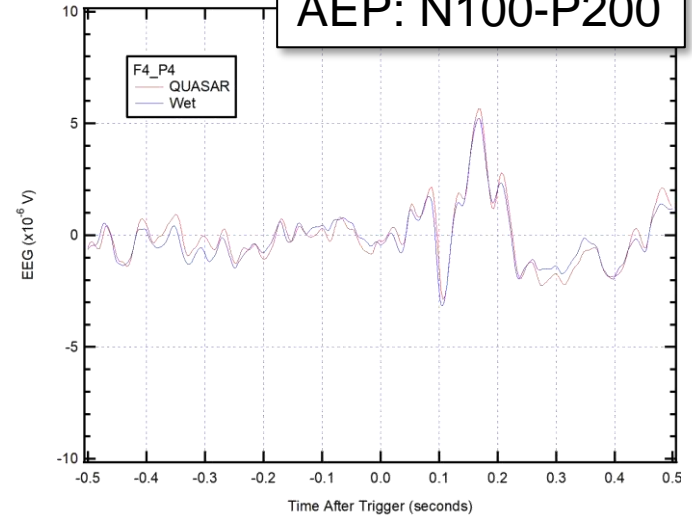
Eyes Closed



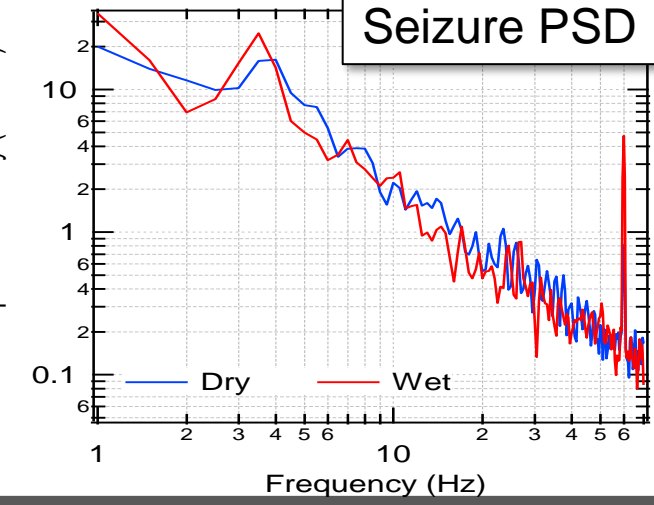
Blinks



AEP: N100-P200



Seizure PSD

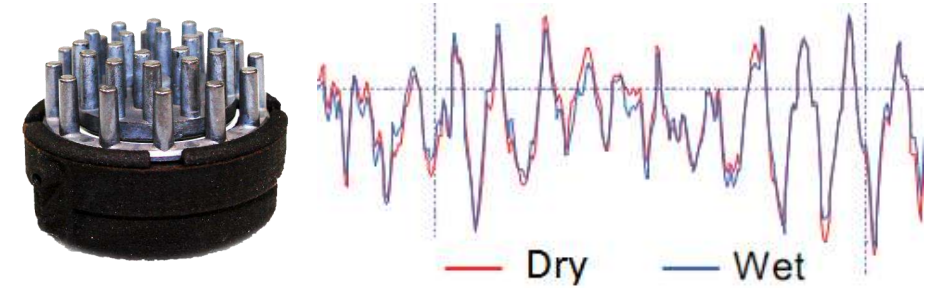


High Fidelity Sensors

- Through-hair dry electrodes
- High signal quality
- Artifact Resistant

Practical Headsets

- Rapid Set-up
- Comfortable for repeated long-term use
- Wireless and Ambulatory



Everyday



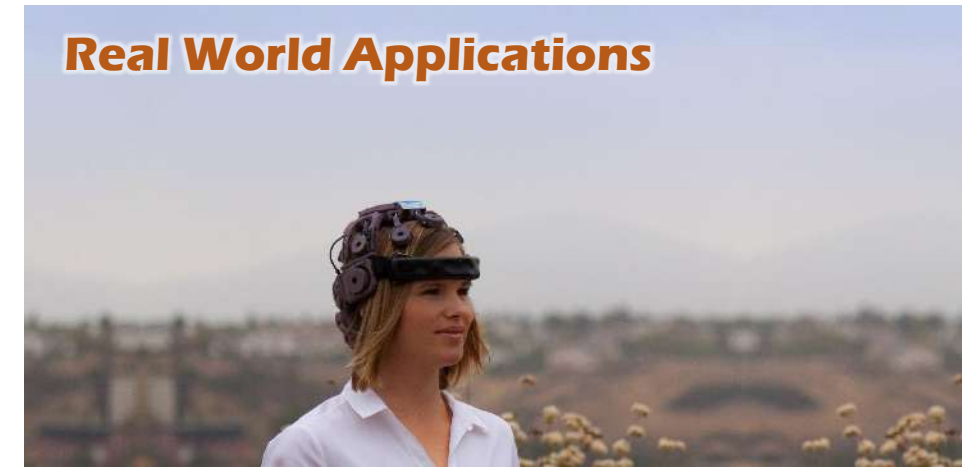
Sleep



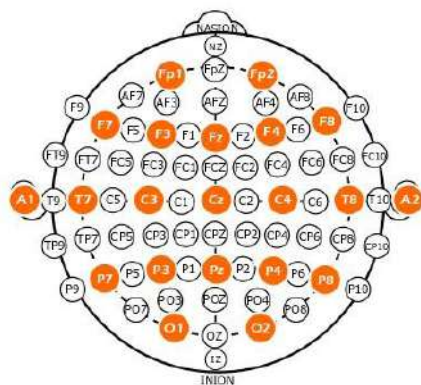
Virtual Reality



Real World Applications



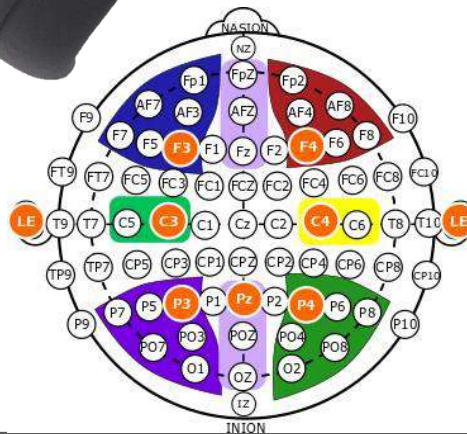
Product Portfolio



- 21 EEG sensors + 3 channels for:
- EOG, EMG, ECG, GSR, respiration, skin temperature, 3D accelerometer, ...
- Adult and Child-sized Versions
- Wired, Wireless, or On-board Storage
- Wireless triggering for synchronization
- Acquisition Software, API, TCP/IP, LSL
- Raw data output as CSV or EDF
- Interfaced with 3rd Party applications
 - Eye-tracking / Motion capture
 - NeuroGuide / BrainSurfer
 - EEGLAB / ERPLAB /BCILAB
 - Mensia Neuro RT / OpenVibe / BCI2000
 - Various Presentation Packages
- Applications in research, neurofeedback, BCI, neuromarketing, neuroergonomics,...

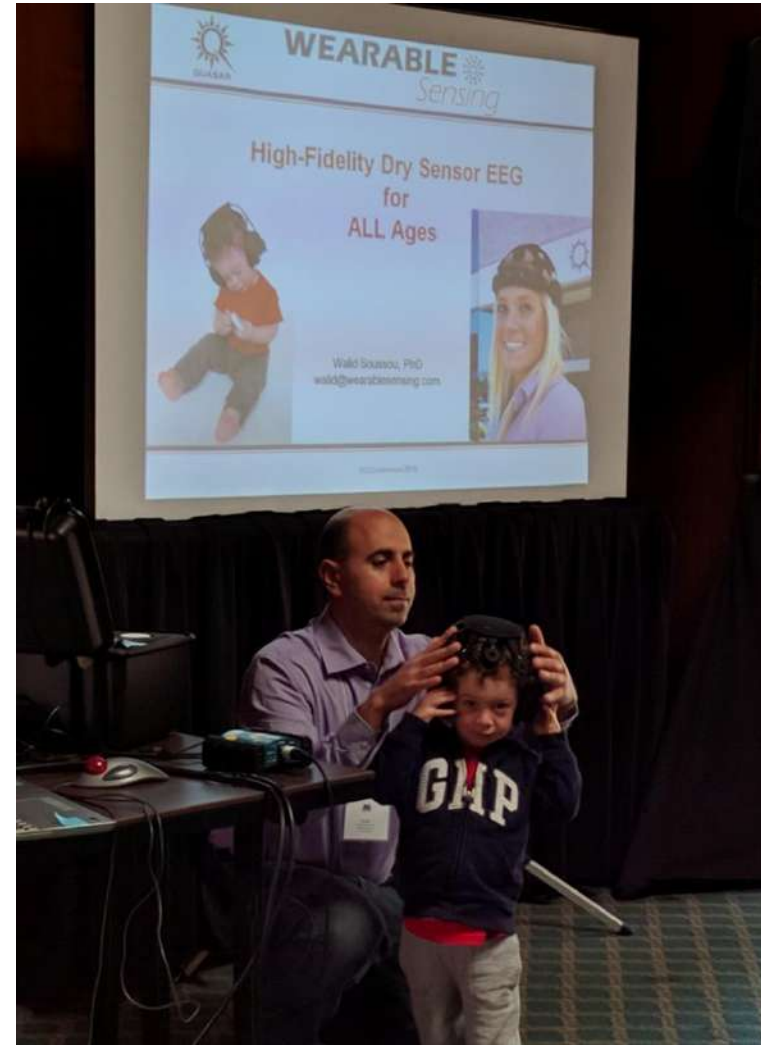
DSI-24 + VR Adapter : Setting Up





- Lightweight, ultra-fast donning
- 7 EEG sensors
- Factory customizable locations
- ECG option, 3D accelerometer, 600Hz
- Adult and Child-sized Versions
- Wired, Wireless, or On-board Storage
- Wireless triggering for synchronization
- Acquisition Software, API, TCP/IP, LSL
- Raw data output as CSV or EDF
- Interfaced with 3rd Party applications
 - Eye-tracking / Motion capture
 - EEGLAB / ERPLAB /BCILAB
 - Mensia Neuro RT / OpenVib / BCI2000
 - Various Presentation Packages
- Applications in research, neurofeedback, BCI, neuromarketing, neuroergonomics,...

Child-Sized Versions



DSI-7 + VR Adapter : Fast, Light and now with VR!

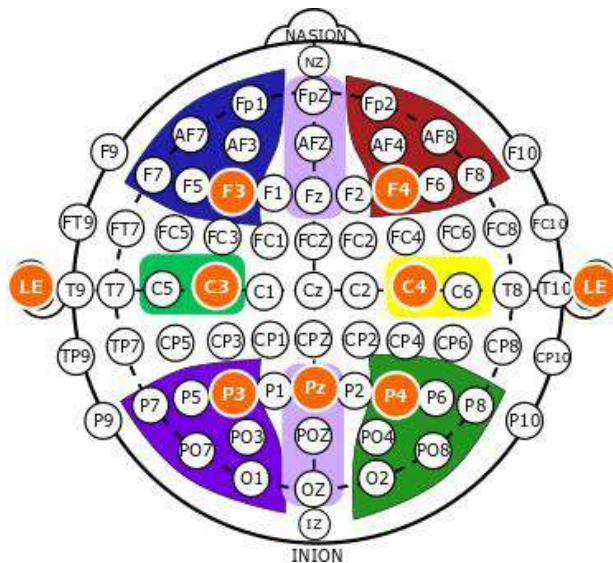


Features/Benefits:

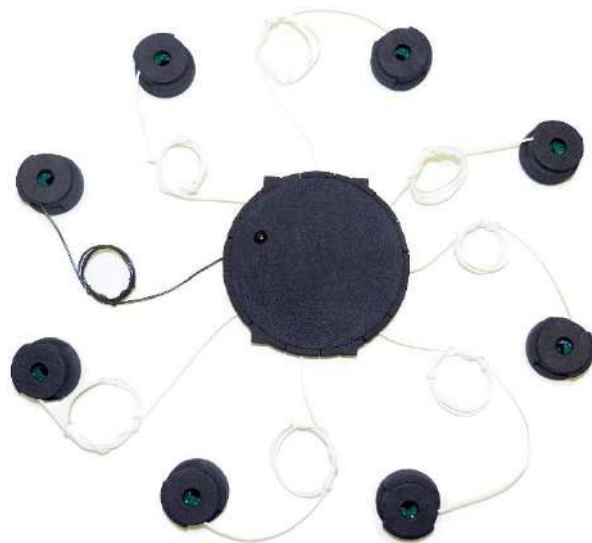
- Customizable locations
- Easiest Set-up
- Lighter Weight
- Stabilization Headband

Compatible with:

- HTC Vive
- HTC Vive Pro
- HTC Vive Pro Eye
- Oculus Rift (NOT Rift S)
- Oculus Quest
- MORE (check with us!)



DSI-7-FLEX

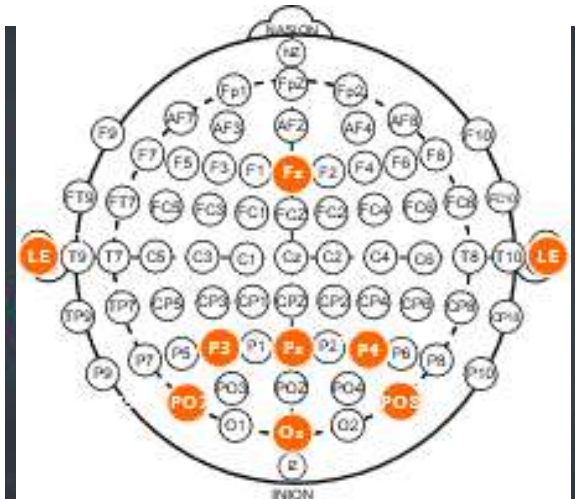


- 7 sensors on wires
- FLEXIBLE locations
- EEG, ECG, EMG, EOG
- Various Sensor Pods and sizes
- BraiNet mounting elastic harness
- 3D accelerometer
- SOON: CAPACITIVE SENSORS
- Wired, Wireless, or On-board Storage
- Wireless triggering for synchronization
- Acquisition Software, API, TCP/IP, LSL
- Raw data output as CSV or EDF
- Interfaced with 3rd Party applications
 - Eye-tracking / Motion capture
 - EEGLAB / ERPLAB /BCILAB
 - Mensia Neuro RT / OpenVib / BCI2000
 - Various Presentation Packages

Developed in Collaboration with



Same **DSI** Technology seamlessly integrated with HTC-Vive
Records EEG while subjects are in **V**irtual **R**eality
Optimized for **P300** ERP



Super simple use

- One adjustment wheel
- Embedded through-hair tool
- HTC-Vive replaceable with headstrap



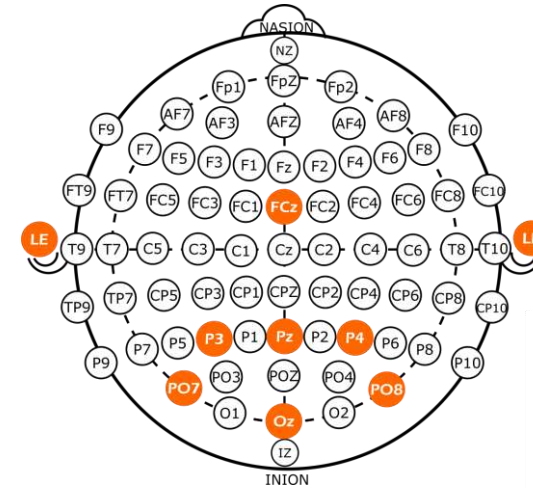
DSI-VR300 + DSI-VRVEP : Similar yet Different



DSI-VR300

Locations optimized for

- Visual Stimuli
- P300 Experiments
- Alertness
- Strong emotions and phobias
- Some sensory associations



Compatible with:

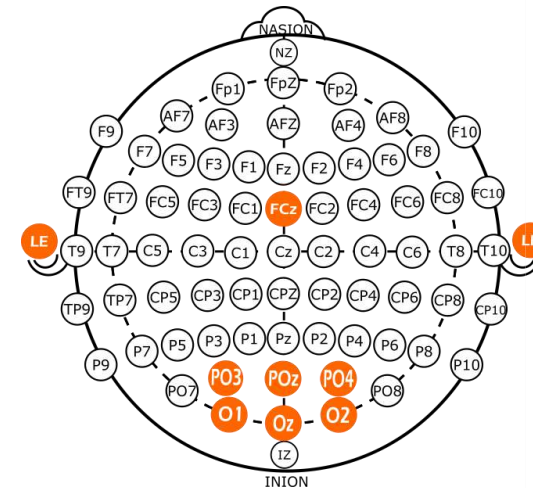
- HTC Vive
- HTC Vive Pro
- HTC Vive Pro Eye
- Oculus Rift (NOT Rift S)
- Oculus Quest 2



DSI-VRVEP

Locations optimized for

- Visual processing
- Visually Evoked Potentials
- Steady State VEP (SSVEP)



DSI-VR300 + DSI-VRVEP : Setting Up

- Same **DSI** Technology (*same signal quality and robustness to artifacts*)
- DSI headset integrated with VR Head-Mounted Display (HMD)
- VR headset replaceable with strap



DSI-VR300 + VR



Extracts features from

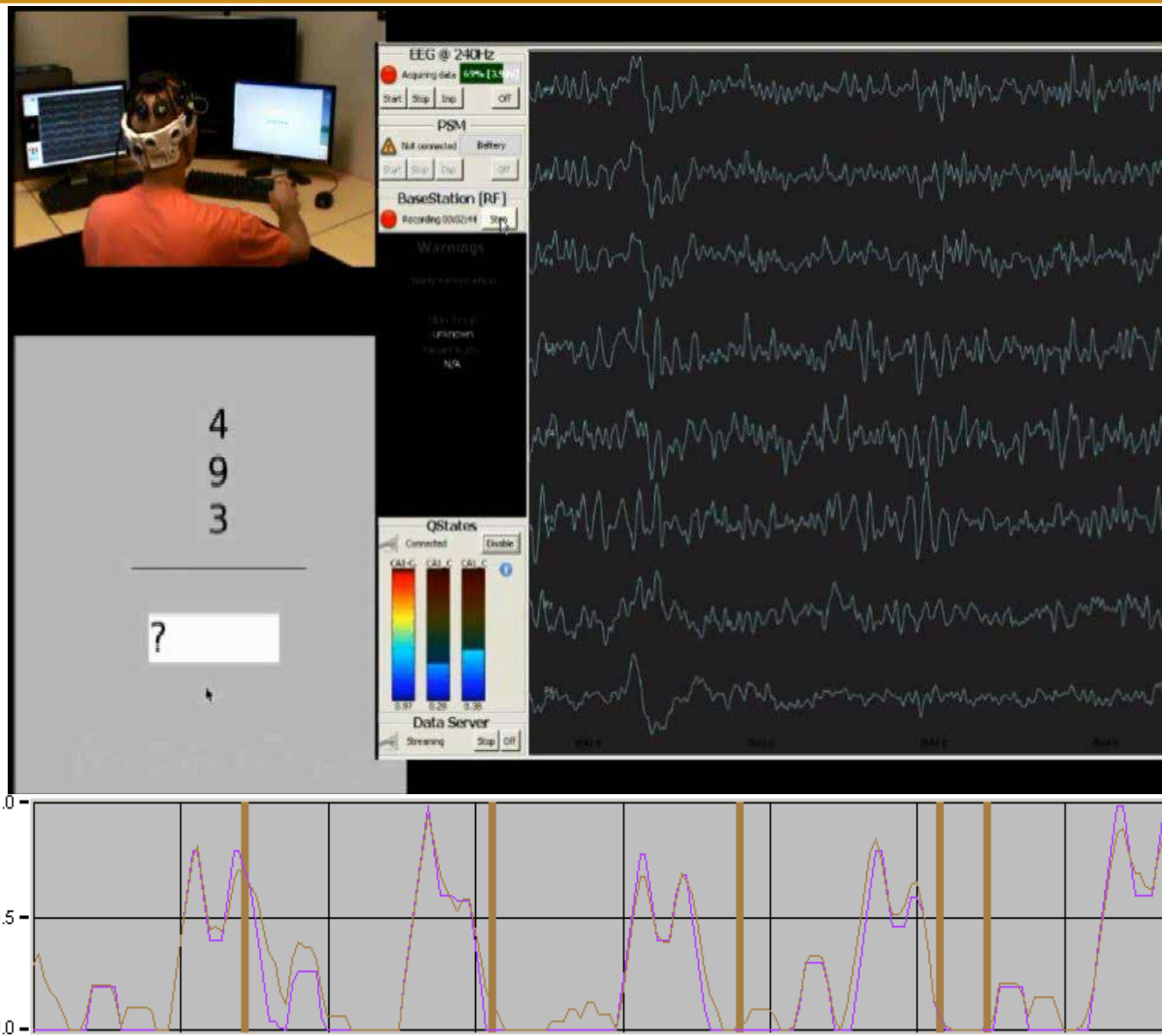
- ▶ EEG
- ▶ EMG, ECG, EOG
- ▶ GSR
- ▶ Skin Temperature
- ▶ Respiration
- ▶ fNIR

Machine Learning Algorithm

- ▶ Partial Least Squares (PLS) core
- ▶ Individualized & Normative Models
- ▶ Fast training
- ▶ Automated Artifact Elimination
- ▶ Real-time & Offline Analysis

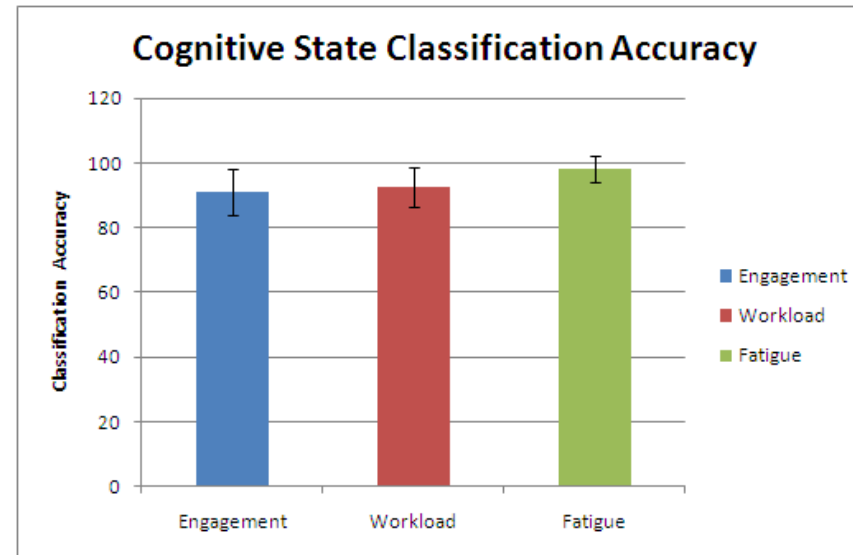
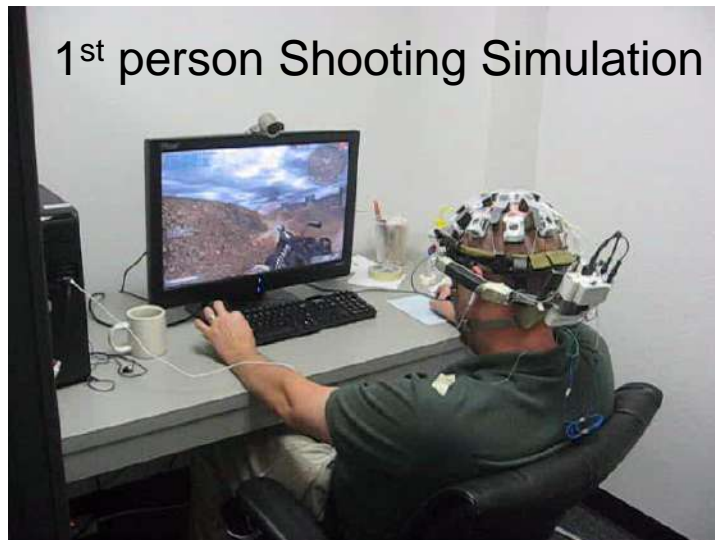
Validated

- ▶ >90% Accuracy Workload, Engagement, Fatigue

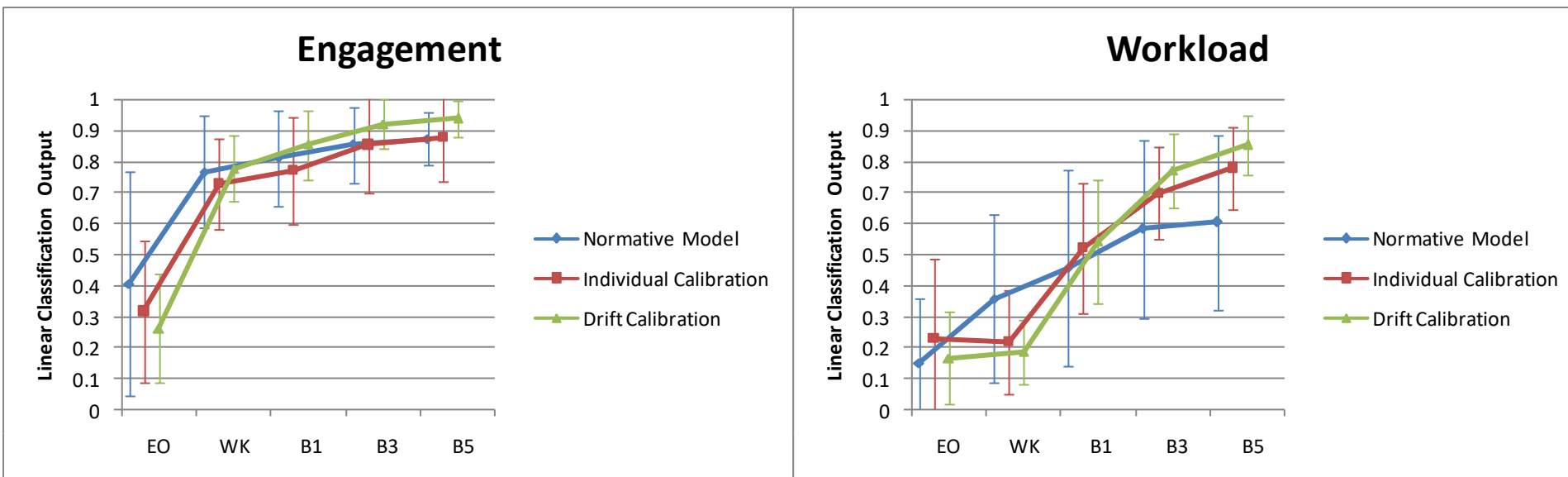


Cognitive State Monitoring

Cognitive Monitoring can be useful for training, fatigue monitoring, system evaluation, neuroergonomics, and workload management



QUASAR's Cognitive State Monitoring algorithm uses EEG features to classify Cognitive **Engagement**, **Workload**, and **Fatigue**, and yields **>90% accuracy**



Engagement Model Trained:
Eyes Open vs. (Walk+BF5)

Workload Model Trained:
Walk vs. BF5

Normative Model Trained on **all 18** subjects
Individual Model trained using **1** calibration session per subject
Drift Model trained using **2** calibration sessions per subject

Multimodal Sensing

Multi-Modal Physiological Sensors: The Suite



EEG



ECG



EMG



EOG



fNIRS



Motion Tracking



Eye Tracking



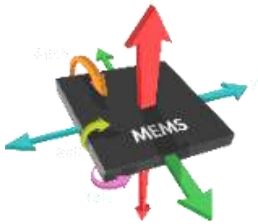
GSR



Respiration



Temperature



3D accelerometer

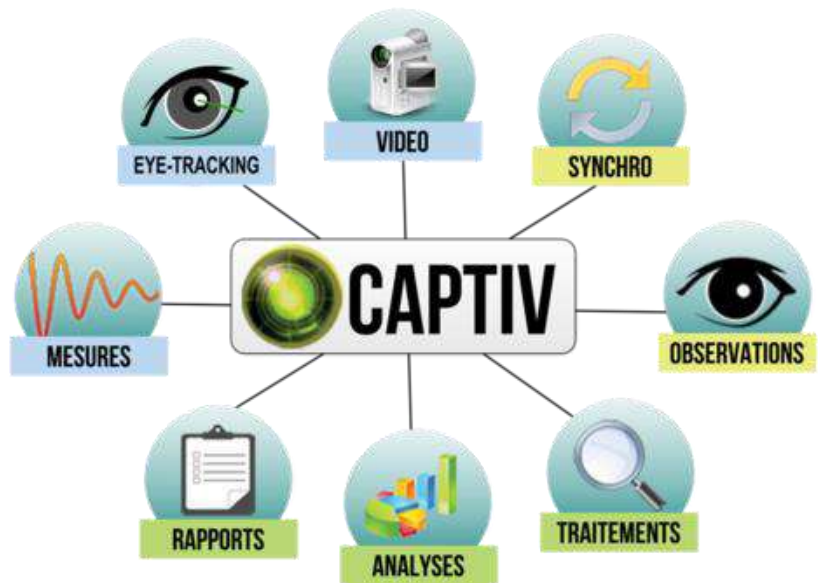


VR + EEG Applications

Interfacing EEG with VR

To integrate EEG signals with Unity or Unreal Engines

- Wearable Sensing's TCP/IP socket
- Wearable Sensing's c-based API
- Neurable SDK
- Lab-Streaming Layer (LSL) + Unity4LSL
- TEA-CAPTIV



Virtual Reality for Research and Beyond

VR Benefits

- Controlled simulation environment
- Rapid simulation development
- User immersion

VR Expansion Tools

- Eye Tracking in VR
- Haptic Body Suits
- Motion Tracking
- Diverse controllers

VR Applications

- Research
- Entertainment
- Neuromarketing
- Meditation
- Education
- And much much more



Neurofeedback in VR

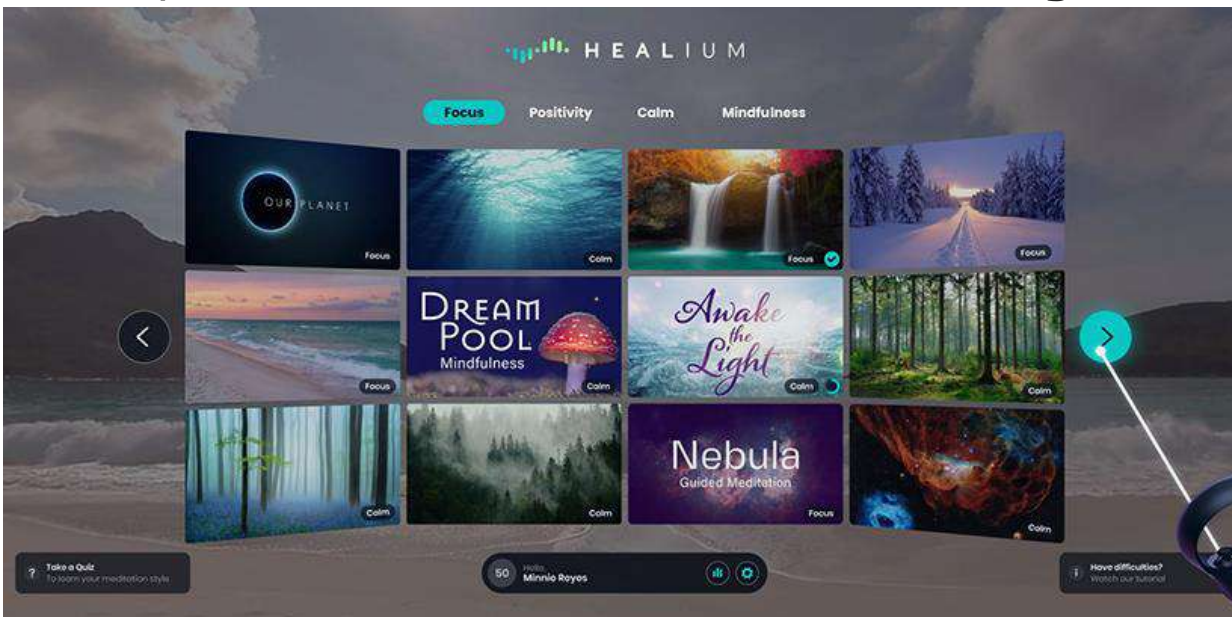
VR immersion can improve

- Patient Retention
- Immersion (for Fear or Pain)
- DSI now Interfaced with
 - Zukor Air*
 - Healum* (coming soon)
 - DreamMachine (coming soon)

*Requires BrainMaster's Avatar or ANI's Neuroguide



Zukor Air: 3D planes flying through rings



HEALIUM: 360° VR clips for meditation with fade feedback



DreamMachine: Immersive mindfulness training



Software Development Kit Demo



Multimodal + EEG Applications

Multi-Modal Physiological Sensors: ECG



Sensors

- Differential
- OR
- Referential

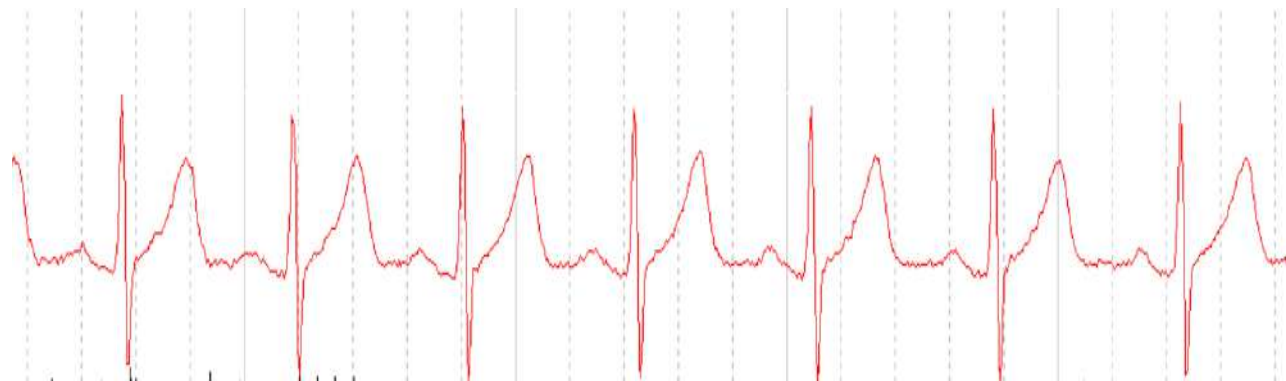
Electrodes

- Dry electrodes + harness
- OR

- Stick-on electrodes

Applications

- Heart Rate Variability
- Stress monitoring
- Fitness
- Medical research
- Biofeedback



Multi-Modal Physiological Sensors: EMG



Sensors

- Differential

OR

- Referential

Electrodes

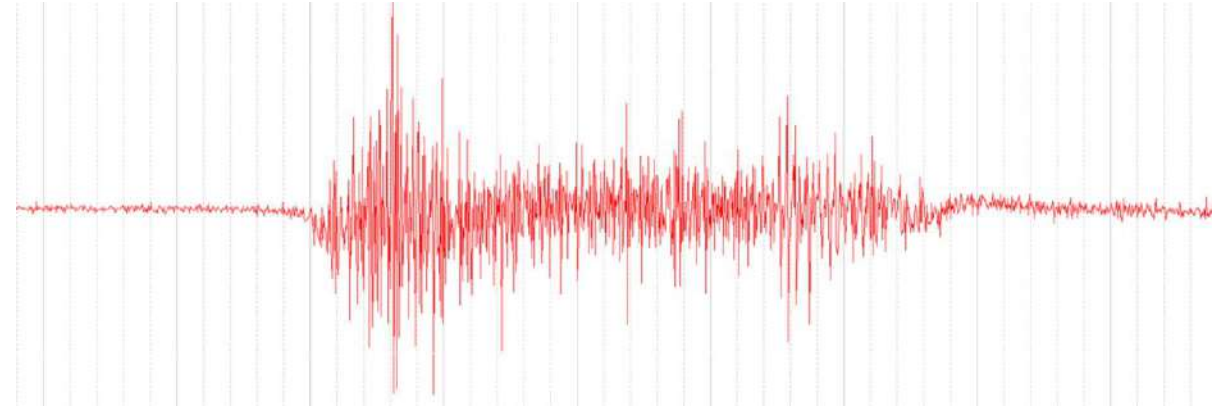
- Dry electrode + harnesses

OR

- Stick-on electrode

Applications

- Biomechanics
- Ergonomics
- Medical research
- Biofeedback



Multi-Modal Physiological Sensors: EOG



Sensors

- Differential
- OR
- Referential

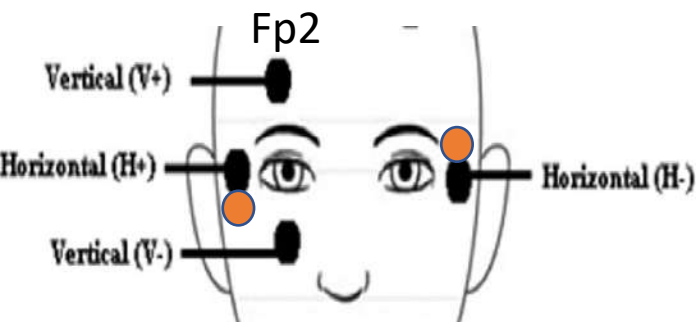
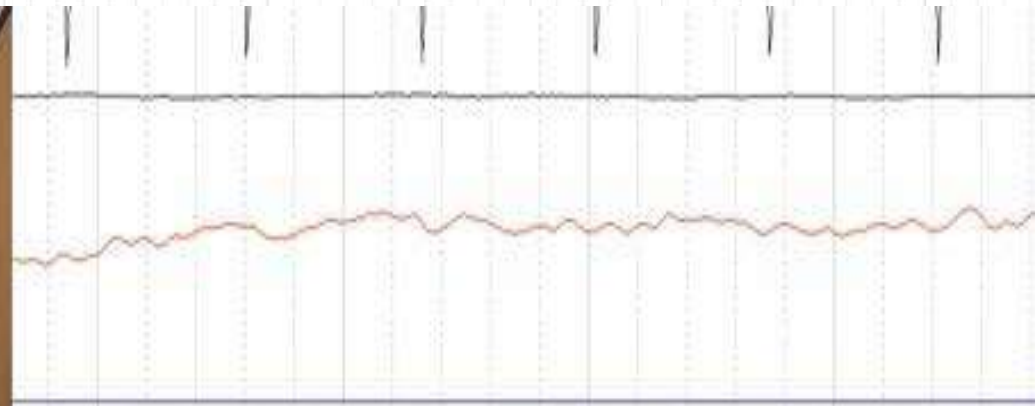
Electrodes

- Dry electrode + tape
- OR

- Stick-on electrode

Applications

- EOG artifact removal
- Eye-tracking
- Fatigue monitoring



Multi-Modal Physiological Sensors: GSR



Sensors

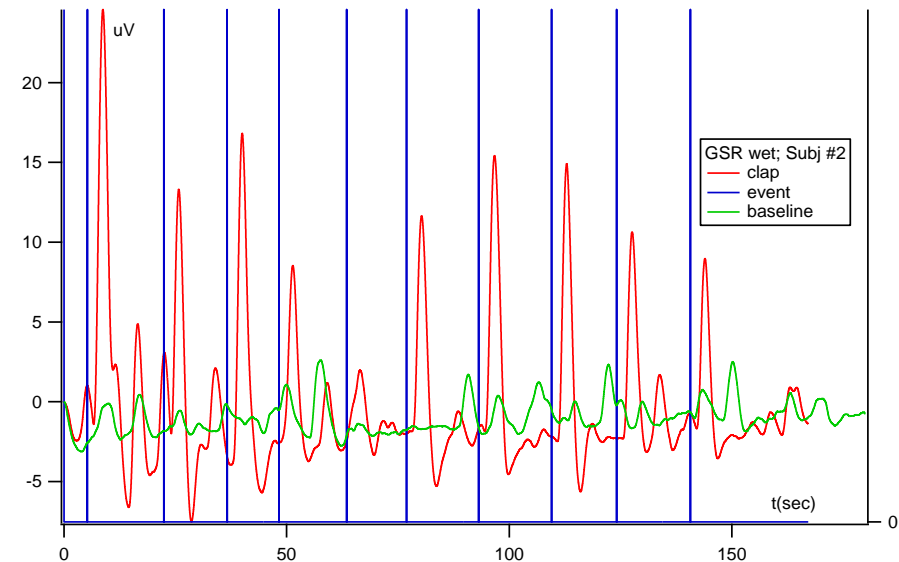
- Two sensors

Electrodes

- Dry electrode (wrist)

OR

- Finger electrode



Applications

- Stress monitoring
- Emotional arousal
- Lie detection



Multi-Modal Physiological Sensors: Respiration



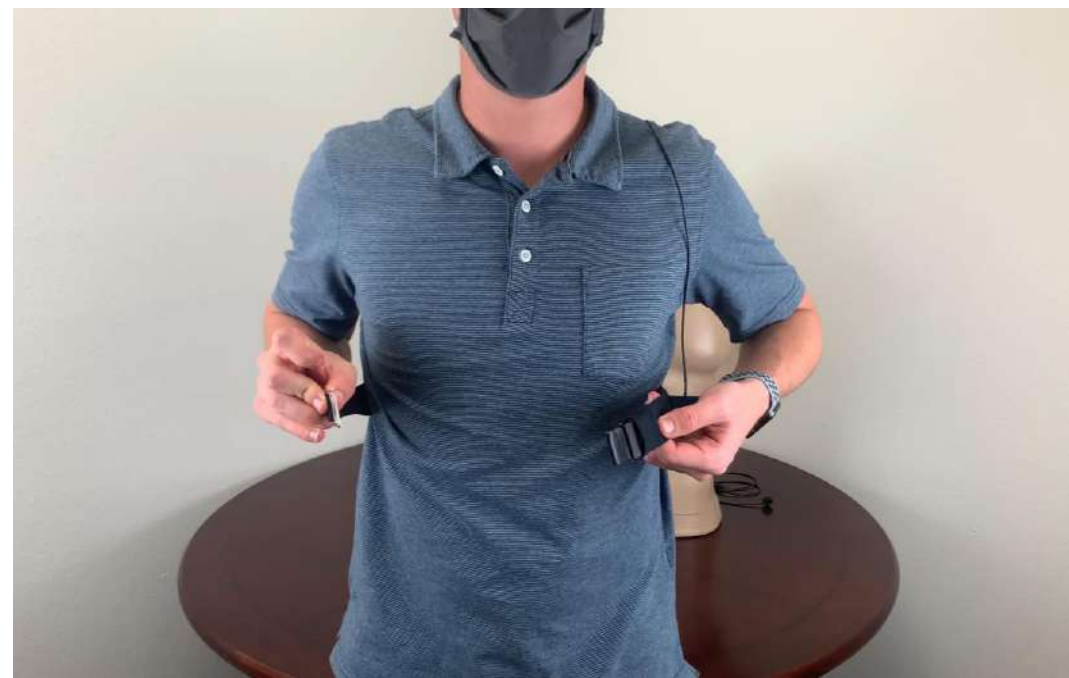
Sensors

- Stretch Sensor
- Elastic strap



Applications

- Stress monitoring
- Emotional arousal
- Fitness
- Medical
- Biofeedback



Multi-Modal Physiological Sensors: Temperature



Temperature

Sensors

- Thermistor Sensor

Output

- Fahrenheit

OR

- Celsius

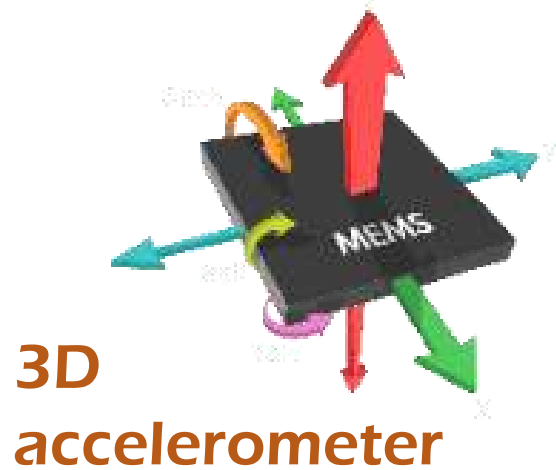


Applications

- Stress monitoring
- Emotional arousal
- Fitness
- Medical
- Biofeedback



Multi-Modal Physiological Sensors: 3D Accelerometer



Sensors

- MEMS Sensor in headsets

Output

- Ax in g
- Ay in g
- Az in g

Applications

- Movement tracking
- Activity decoding
- Artifact reduction
- Rehabilitation
- Biofeedback



Multi-Modal Physiological Sensors: EEG



DSI-24

DSI-7



DSI-7-Flex



DSI-4



DSI-VR300

DSI-VRVEP

DSI-Systems

- Dry Electrodes for EEG
- DSI-EEG+fNIR / DSI-24 have 3 auxiliary channels ready
- DSI-7/VR300/VRVEP can substitute up to 3 channels
- DSI-7-Flex can substitute any channel
- DSI-4 NONE

Electronics

- Synchronized Wireless Acquisition
- On-board storage for DSI-24 and DSI-7
- Power source
- **3D accelerometer On-Board**

► Cognitive Psychology

- What drives our behaviors?
- How do people interact

► Neuro-Ergonomics

- How easy-to-use is this UI?
- How is physical performance affected by cognitive states?

► Neuro-Marketing

- What is engaging our attention?

► Neuro-Rehabilitation

- Gait, dexterity, and attention post-injury and during rehabilitation

► Sports Science

- Biomechanics
- Cognitive load and focus monitoring
- Peak performance training

► Biomarkers

- Autism

► More...

