

# Data Exchange Standards for Clinical Neurophysiology

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# Purpose of Standardized Format

- Formatting and transmission of digitized waveforms to facilitate portable exchange between dissimilar computer systems
- Associated identifying and other annotative textual data incorporated into the data stream
- Complete context for clinical diagnosis as well as basic and clinical research purposes

# Clinical Neurophysiology Data

- Electroencephalograms (EEG)
- Magnetoencephalograms (MEG)
- Polysomnograms (PSG)
- Multiple sleep latency tests (MSLT)
- Evoked potentials (EP)
- Evoked magnetic fields (EMF)
- Event-related potentials (ERP)
- Electromyograms (EMG)
- Nerve conduction studies (NCS)

# Common “Reader” Program

- RV – EEG Review
- DV – Digital Video Review
- PAT – Reads patient demographics
- OLEV – Online event detection
- DTEV – Outputs detection events to OEM database
- RSEV – Reads recording system events
- RSMNT – Reads recording system montages

Alpha-Trace digitalEEG	RV, PAT, OLEV, RESV	*.alp
AstroMed Twin	RV,PAT	Logfile.qqq
Bio-logic BrainAtlas	RV, PAT	*.dat
Bio-logic CEEGraph V1	RV, PAT, RSEV	E*.dat
Bio-logic CEEGraph IV, V, VI,and XL	RV, DV, PAT, OLEV, RSEV, RSMNT	*.eeg
BIOMECC (via Persyst Layout)	RV, PAT, OLEV, RSEV, RSMNT	*.lay
BioSemi BDF	RV, PAT	.bdf
BrainLab	RV, DV, PAT	*.sig
Cadwell Spectrum32	RV	*.00?
Cadwell EasySystem	RV, PAT, OLEV, DTEV, RSEV, RSMNT	*.log,*eas
Cadwell EasyWindows	RV, PAT, OLEV, DTEV, RSEV, RSMNT	*.eas
Cleveland Medical Devices Crystal-EEG	RV, PAT, OLEV, RSEV, RSMNT	*.crl
Compumedics Limited	RV, DV, PAT, OLEV, DTEV, RSEV, RSMNT	*.raw
DigiTrace	RV, PAT	*.w18,*r27,*w27
EBNeuro GaINT	RV, PAT, OLEV, RSEV	*.gnt
European Data Format 90	RV, PAT	*.edf
Excel Tech Ltd.	RV, DV, PAT, OLEV, RSEV, RSMNT	*.erd
Grass-Telefactor AS40/Comet	RV	.dat
Grass-Telefactor CTE	RV	.dat
Grass-Telefactor EDF	RV, PAT	*.edf

Grass-Telefactor TUFF	RV,PAT	*.ref
Grass-Telefactor Twin	RV,PAT	Logfile.qqq
Lexicor	RV, PAT, OLEV, RSEV, RSMNT	*.dat
Lifelines/Trackit/EDF	RV, PAT, RSEV	*.edf
Micromed	RV, PAT, RSEV	*.trc
NEC Synafit	RV, PAT	*.dat
Nervus	RV, PAT, RSEV, RSMNT	*.e
Network Concepts Uniquant	RV, PAT, OLEV, RSEV, RSMNT	*.sif
NeuroScan	RV	*.cnt
Neuro Data NDF	RV, PAT	*.eeg
NeuroKard BrainLab	RV, DV, PAT	.dat
Nicolet AllianceWorks	RV, PAT, RSEV	data
Nicolet Alliance NT	RV, DV, PAT, OLEV,RSEV, RSMNT	*.eeg
Nicolet BEAM	RV	d*.
Nicolet BMSI 3.0+	RV	*.eeg
Nicolet Bravo	RV, DV, PAT, OLEV,RSEV, RSMNT	*.eeg
Nicolet Endeavor 3.x	RV, DV, PAT, OLEV,RSEV, RSMNT	*.xew
Nicolet NicoletOne cEEG	RV, DV, PAT, OLEV,RSEV, RSMNT	*.one
Nicolet NicoletOne nEEG/LTM/Monitor	RV, DV, PAT, OLEV,RSEV, RSMNT	*.e

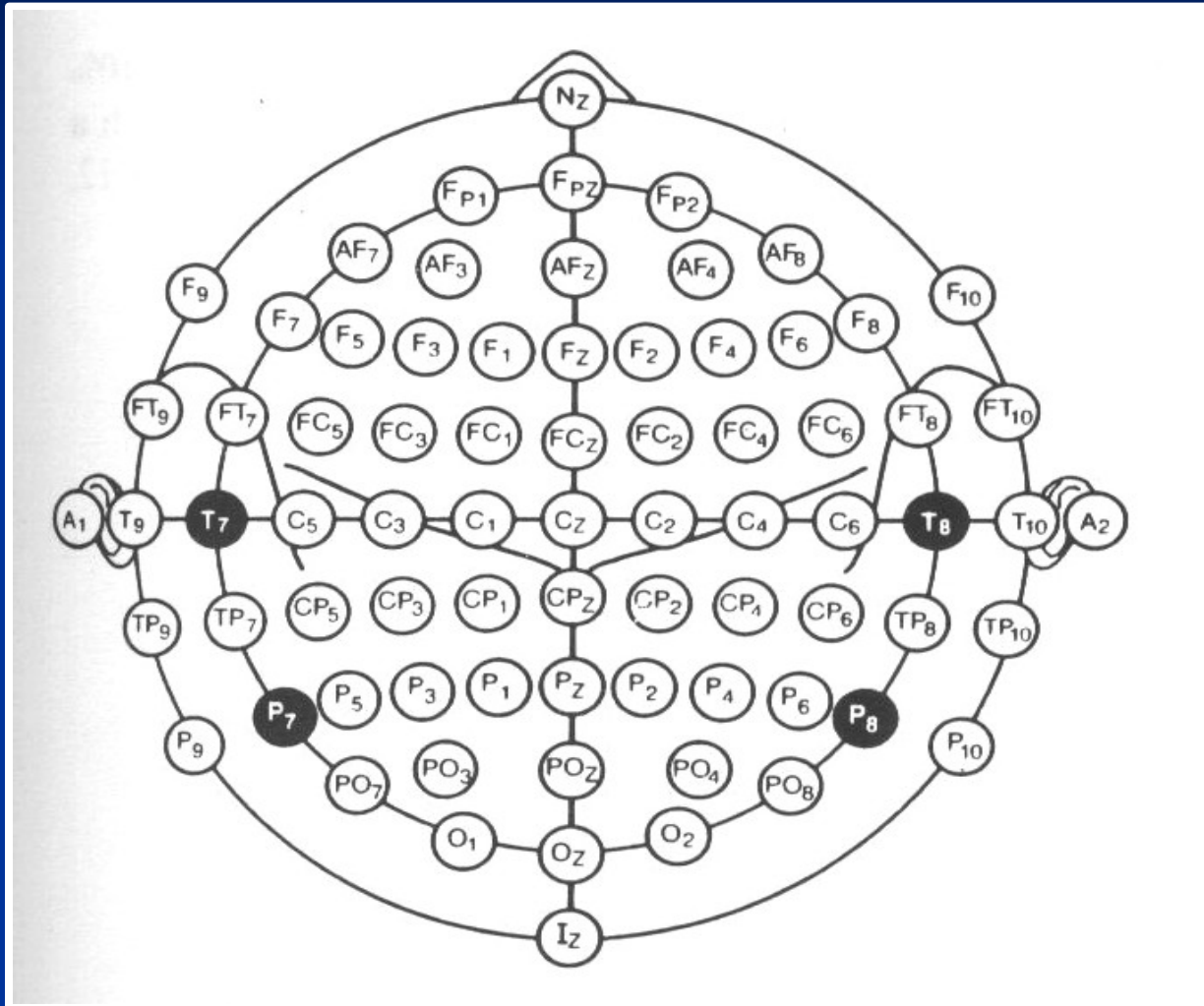
Nicolet Satellite	RV, PAT, RSEV	*.dat
Nicolet Satellite ES	RV, PAT, RSEV	*.ebm
Nicolet Voyager	RV, PAT, OLEV, RSEV, RSMNT	data
NihonKohden 1100/2100/9100	RV, DV, PAT, OLEV, DTEV, RSEV, RSMNT	*.pnt
Oxford 9200	RV	*.*
Oxford/Teca/Medelec DG32	RV, PAT, RSEV, RSMNT	*.mod
Oxford/Teca/Medelec Valor (Nervus)	RV, PAT, RSEV, RSMNT	*.e
Oxford/Teca/Medelec Profile	RV, PAT, RSEV	*.eeg
QSI 9X00	RV, PAT	*.ano
Neuroscan	RV, PAT	*.cnt
Rembrandt EDF format export	RV	*.edf
Stellate Monitor/Rhythm	RV, PAT	*.eeg
Telefactor CTE64	RV	*.dat
Telediagnostic (via Persyst Layout)	RV, PAT, OLEV, RSEV, RSMNT	*.lay
Vanguard	RV, PAT	b*
WalterGraphtek/Dantek PLEEG	RV, PAT, OLEV	*.wg1
XLTech/Excel Tech	RV, DV, PAT, OLEV, RSEV, RSMNT	*.erd

# Primary Data

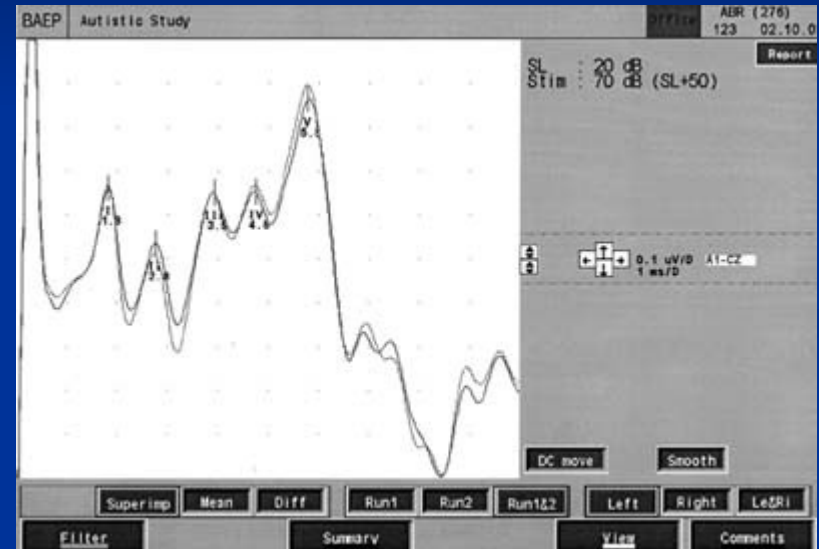
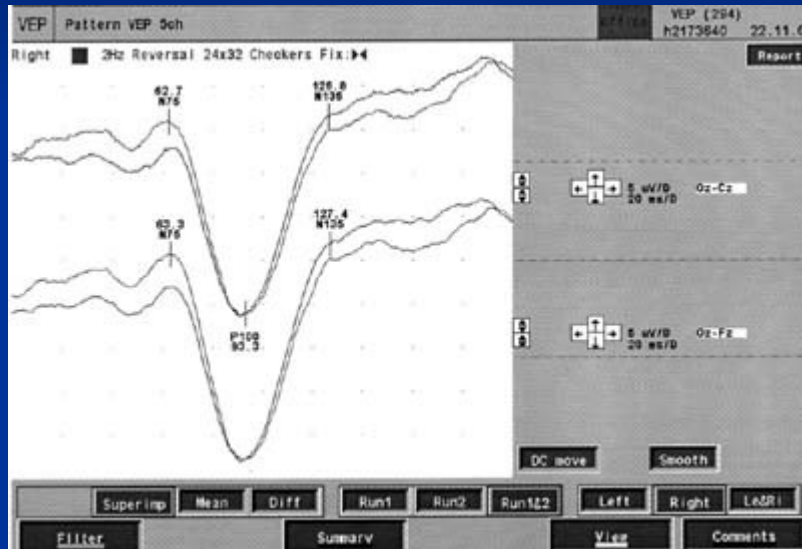
- Digitized waveforms for multiple channels
- Channel identifications, sensitivities, filter settings, and sampling frequency
- Averaging parameters for averaged data
- Date and time of day labels
- Electrode or transducer locations and attributes
- Measured distances
- Stimulation parameters (visual, auditory, electrical, or other)
- Calibration data
- Technical comments or annotations created before or during the study
- Medications administered
- Special procedures performed
- Instruments used



# Modified 10-20 System

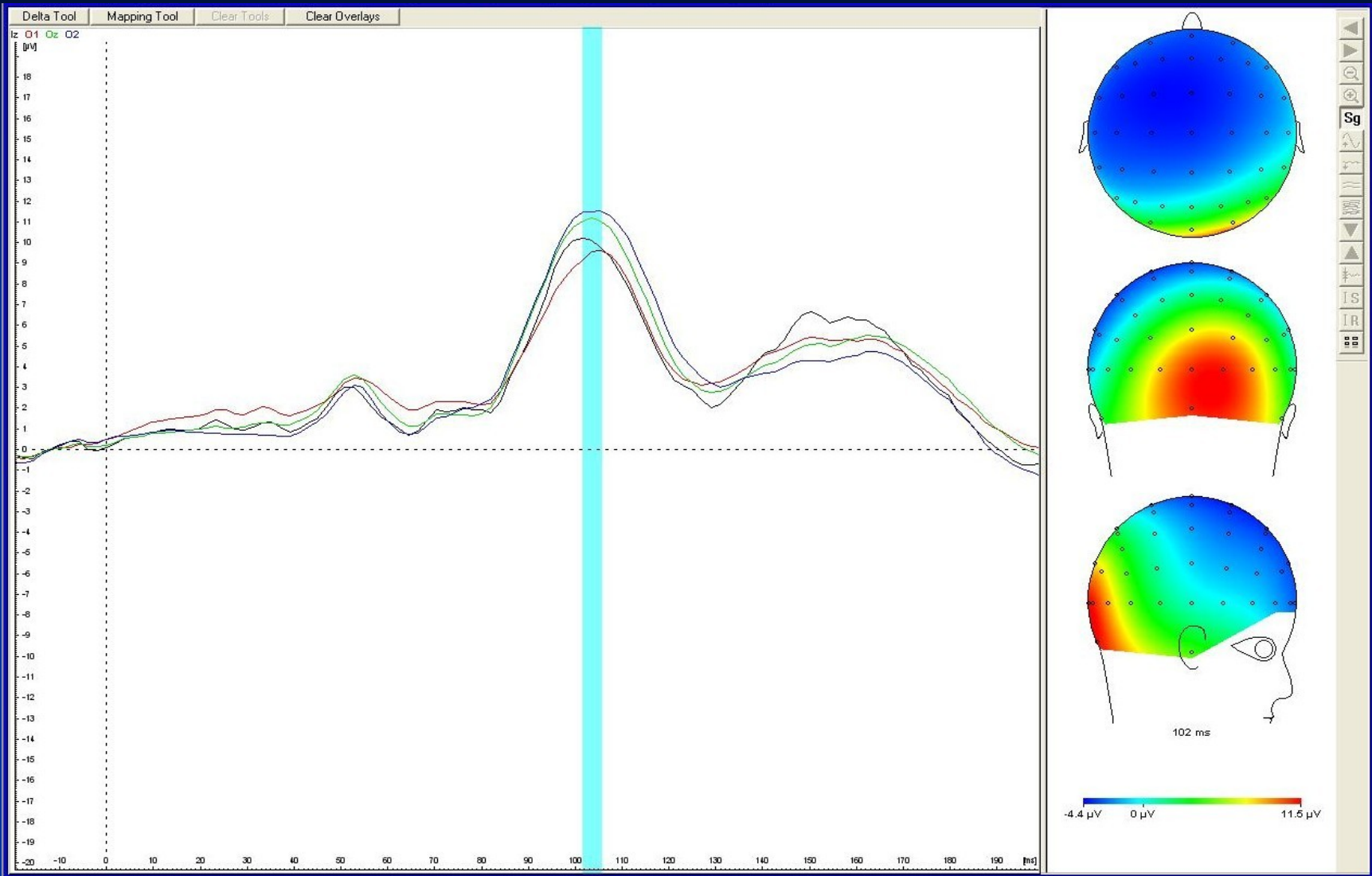


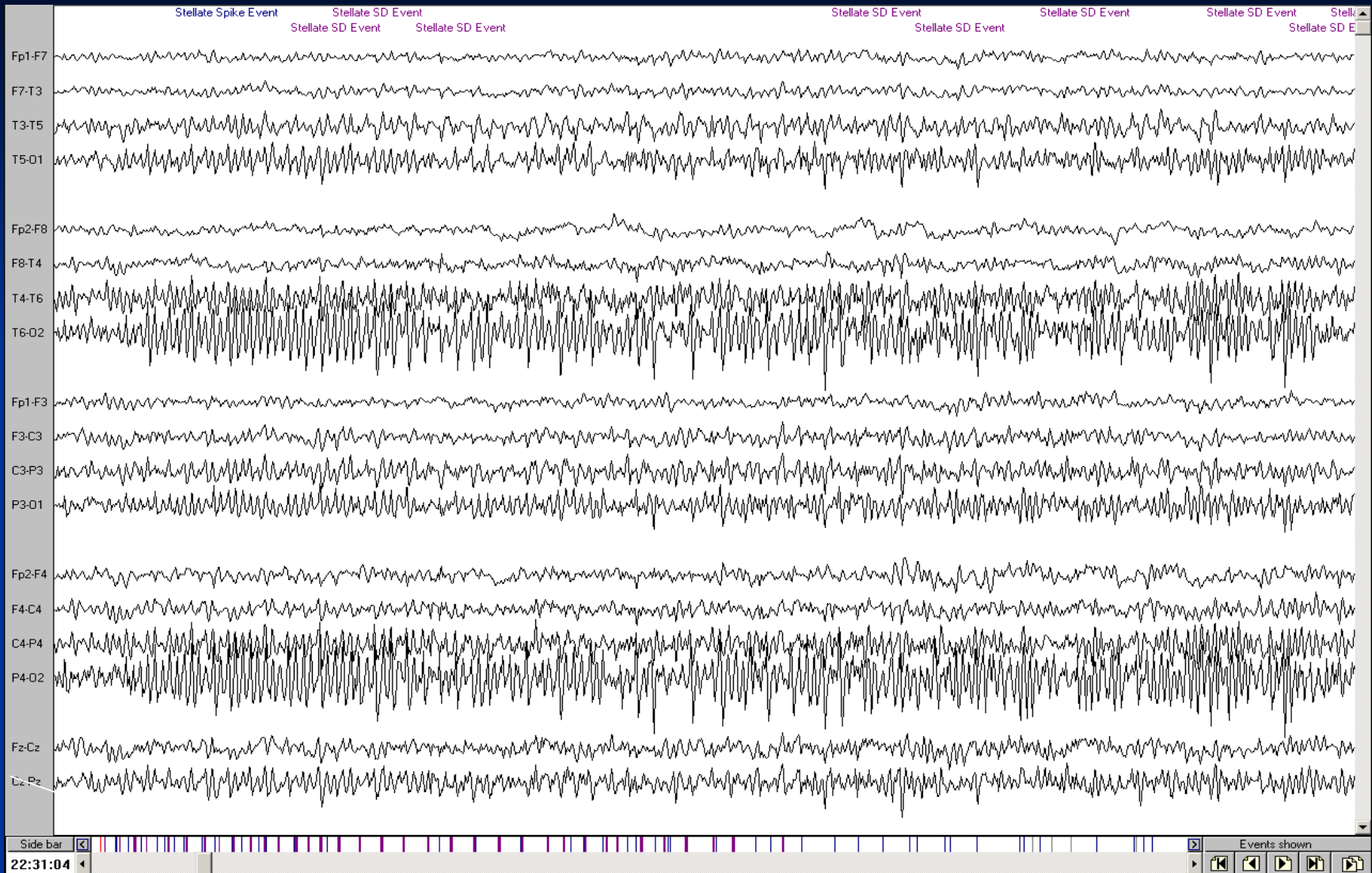
# Evoked Potentials



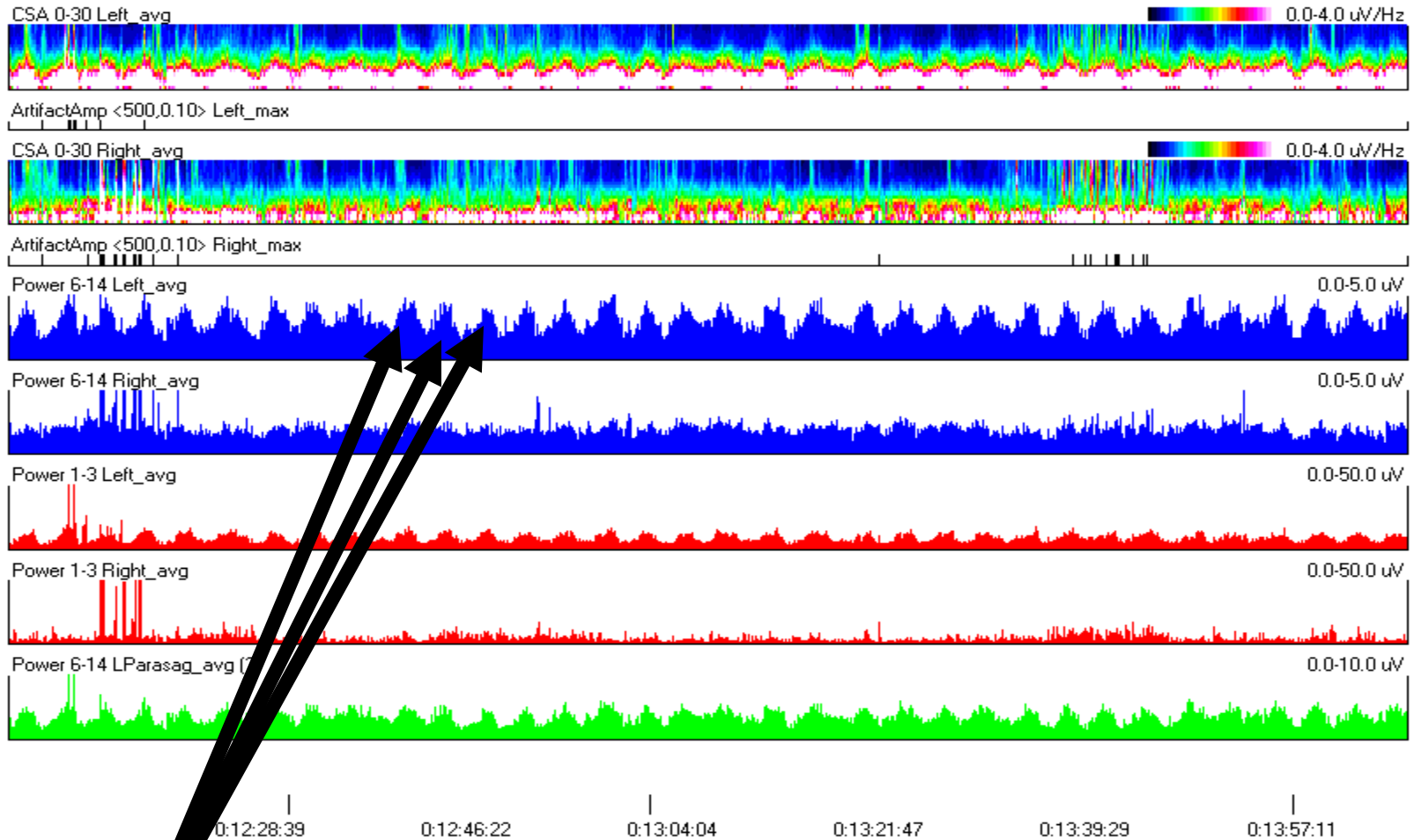
# Derived Data

- Measured feature or peak latencies, amplitudes, and other characteristics
- Either automatic algorithms or technician or physician scan
- Results of computer processing up the primary data (e.g. spectral analyses)
- Quantitative or qualitative results
- Comparison to normal ranges for laboratory
- Text reports, interpretations, diagnoses, and recommendations sent back to ordering physician





1 ap bp.mtg (off) (off) (off)  
Window=256 Overlapped=N Windows/Epoch=10 NEpochsPanel=1125 NEpochsCalc=3400 EpochDur=6.4 Smooth=3



Computerized analysis of 2 hours of EEG shows extremely frequent seizures (status epilepticus). Each “blue bump” indicates a 3 minute seizure. A large amount of EEG data can be reviewed quickly, and nurses and physicians who do not read EEG can easily interpret this study at the bedside

# Desired Features

- Nonproprietary
- International language support
- Header information compatible with HL7
- Support for unlimited number of channels
- Channel specific sampling rate, sensitivities, filter settings, etc.
- Standardized nomenclature for electrode positions
- Single / common reference (reformatting of data)
- Standardized nomenclature for common annotations
  - Provision for non-standard annotations

# Desired Features

- Binary format
  - Compatible with EDF
  - Fast retrieval and processing
- Time and date annotations for noncontiguous data
  - Ability to take subsets of data (“clips”)
  - Ability to concatenate data
- Provision for data encryption
- Ability to “strip” patient identifying information for research purposes
- Smallest possible file size, few other files
- Original uncompressed signal



# TS1 (Technical Standard 1)

- American Clinical Neurophysiology Society Medical Instrumentation Committee
  - [www.acns.org/guidelines.cfm](http://www.acns.org/guidelines.cfm)
- American Society for Testing and Materials (ASTM) Committee E-31 on Computerized Systems
  - Subcommittee E31.16 on Interchange of Electrophysiologic Waveforms and Signals
- Revised edition was published as ASTM E 1467-94

# TS1 (Technical Standard 1)

- Level 1: Waveforms only
  - Decoding of digital waveform data and labeling of channels
- Level 2: Waveforms or procedure annotations or both
  - Waveform data
  - Required data elements (e.g. patient identification)
  - Optional data elements, including site-specific data
- Level 3: Coded information
  - Associates standard alphanumeric codes with textual data elements (e.g. ICD-9 code)
  - Translated by receiving system into a defined text string by means of an internal table of diagnoses (code tables)
  - More structured and standardized medical record
  - Facilitate automated machine processing