g.BSANALYZE

OFFLINE BIOSIGNAL ANALYSIS FOR MATLAB

g.BSanalyze is an interactive environment for multimodal biosignal data processing and analysis in the fields of clinical research and life sciences. g.BSanalyze has been on the market for more than ten years, and is used in more than 70 countries. It is the most comprehensive package available to analyze non-invasive and invasive brain-, heart- and muscle-functions and dysfunctions. The package won several international awards. The new version includes many new functions such as topographic plots, CCA, new filters, an importer for cortiQ files, updates for Result2D, and more!

PRODUCT HIGHLIGHTS

- Interactive and intuitive graphical user interface for EEG, ECoG, EOG, EMG, ECG, spikes, and physical data analyses and documentation under MATLAB as well as a stand-alone version
- Extensive tools for data processing in time, space, and frequency domains
- Powerful 2D and 3D visualization tools to rapidly generate publication ready figures
- Enhancement of power with g.tec's specialized EEG, aEEG, ECG, SPIKE, CLASSIFY and High-Resolution EEG toolboxes
- Flexibility to integrate other MATLAB toolboxes, as well as customers' specific algorithms
- Analyse data from g.Recorder, g.HIsys, MATLAB and C API and many other third-party recording devices
- The only package that supports all BCI principles such as P300, motor imagery, SSVEP/SSSEP, slow cortical potentials, acVEP
- Optimized for high-gamma activity analysis
- Discharge artefact removal algorithms for TMS experiments

TOOLBOXES OF G.BSANALYZE

g.BSanalyze consists of a base version for data import, visualization, transformation and pre-processing and has several dedicated toolboxes:

- EEG toolbox: specialized functions for pre-processing, analysis and parameter extraction for EEG data
- ECG toolbox: find QRS complexes and calculate heart rate variability parameters
- Classify toolbox: classify parameters with linear and non-linear methods including statistical analysis for zero class detection
- High-resolution EEG: map EEG activity on realistic head models
- CFM toolbox: calculate amplitude integrated EEG
- SPIKE toolbox: analyze spikes, multi-unit activity and positions to map physiological parameters

The package comes with many sample biosignal data-sets, including P300, SSVEP, motor imagery, CSP BCIs, Tilt-Table, EPs, multi-unit activity, CFM, and ERD/ERS.

MORE THAN 100 FUNCTIONS

g.BSanalyze's graphical user interface includes more than 100 state-of-the art functions for defining electrode montages, spatial or temporal filter designs, artifact treatment, quality control, spectral analysis, coherence, correlation, bandpower analysis, ERD/ERS analyses, EP analyses, visualization, data set classification, and other goals. It is the only package that supports all BCI principles: P300, SSVEP/SSSEP, cVEP, motor imagery and slow cortical potentials. You can load and save your preferred processing steps within a script program and automatically process your data in g.BSanalyze batch mode.

g.BSanalyze's processing capabilities allow you to extract relevant features from your multimodal data and define useful parameters for post-processing. Use these parameters directly with g.BSanalyze's classification tools to assign distinct classes to your data with linear and non-linear classifiers. The combination of the graphical user interface and the programming environment makes g.BSanalyze a truly unique package for biosignal analyses. The stand-alone version of g.BSanalyze can run without a MATLAB installation, but batch processing in the MATLAB command window is not possible.

Base Version Features

DATA VISUALIZATION

Data ruler, Undo (1-step, multi-step), Journal file, Full header access, High speed data scrolling (trial x channel/channel x trial), Assign and edit data attributes and markers, Epoching (free/multi trial/multi channel mode), Data scoring, Quick analyses of epochs, Assign comments, Attribute jumper, Data status monitor, Data player, Zoom, Data scaling (auto, amplifier, manual, type specific.)

DATA FILE I/O AND PRINTING

Import filter: recoveriX, mindBEAGLE, cortiQ, MATLAB, EDF, BKR, ASCII, RDF, CNT, TFM, MOBILAB, AXONA, MIT, Block import, Full support for third-party formats, Export ASCII, Assign class labels, Plot data, Printer options.

TRANSFORMATION

Cut trials-samples-channels, Sort data, Merge data sets, Arithmetic operations, Data triggering (on multiple triggers), Untrigger data.

PRE-PROCESSING

DC-correction, Smoothing/Rectifying, Data de-trending, Remove drift, Down- and up-sampling, Filter data (highpass, lowpass, bandpass, bandstop), Filter design with graphic support, Spatial filtering, Moving average, Baseline correction.

TOOLS

Stimulus/response detector, Reaction time analysis, Single trial analysis, Trigger finder.
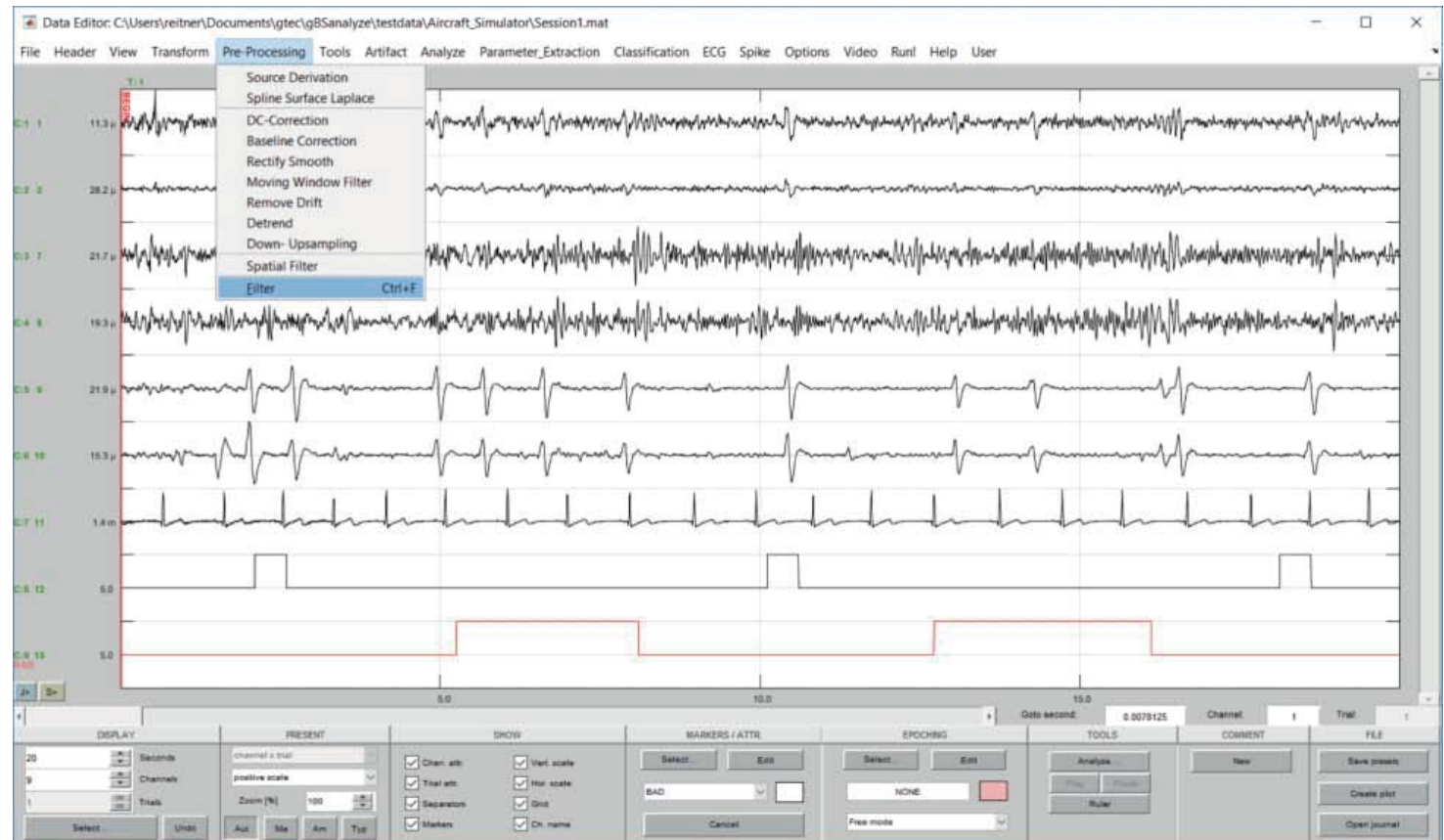
The Data Editor shows the biosignal time series and allows you to scroll through the data. The menu gives access to the analysis functions and every single step is reported in the MATLAB command window.

ARTIFACT TREATMENT

Overflows, Zerolines, Eventfinder with automatic attribute/marker assignment, Artifact removal with ICA/spatial filters, Automatic artifact epoch detection.

BATCH MODE

Automatic generation of journal files, Batch mode processing for multiple data sets, Automated Batch Starter.

ANALYZE

Independent Component Analysis (ICA), Principal Component Analysis (PCA).

General Analyze Features

ANALYZE FUNCTIONS

Data quality (histogram, distribution and statistic measures), Average across trials (EP analysis, baseline correction, SNR, graph comparison, ...), power spectrum analysis and significance test of differences, Wavelet analysis.

PARAMETER EXTRACTION

Adaptive autoregressive (AAR) parameters, Signal variance, Bandpower, Exponential window, Cross correlation and CC-based template matching, Minimum energy.

RESULT VISUALIZATION

2D plots of analysis results, Layout editor, Copy and measure, Background image, ASCII export, Clone plots, Topography, Header editor.

PRE-PROCESSING

Source derivation.

MONTAGE CREATOR

Edit topography/electrode positions according to the international 10-20 system or free electrode system, Specify source derivations (BIP/CAR/LAR/LAP,...), Edit geometry data.
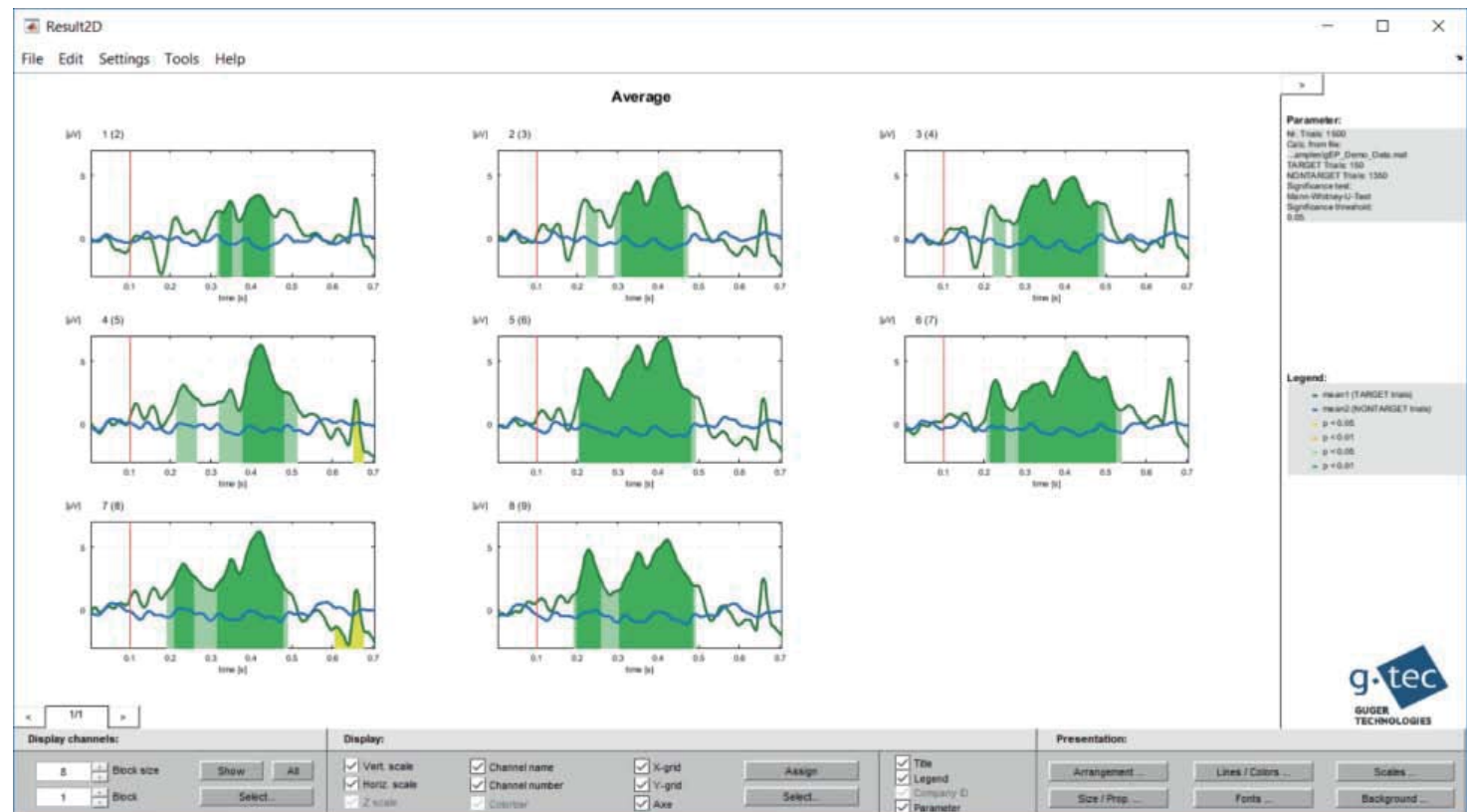
The g.Result2D result viewer shows the ERPs from 8 channels. Each channel shows the ERPs elicited by the target stimuli in green, and ERPs to non-target stimuli in blue. Sections with statistically different differences between these two lines are shaded in green. The result viewer can also topographically arrange the results.

ECG Toolbox Features

ECG SPECIFIC ANALYZE FUNCTIONS

Coherence, Event-related coherence, Event-related ECG changes.
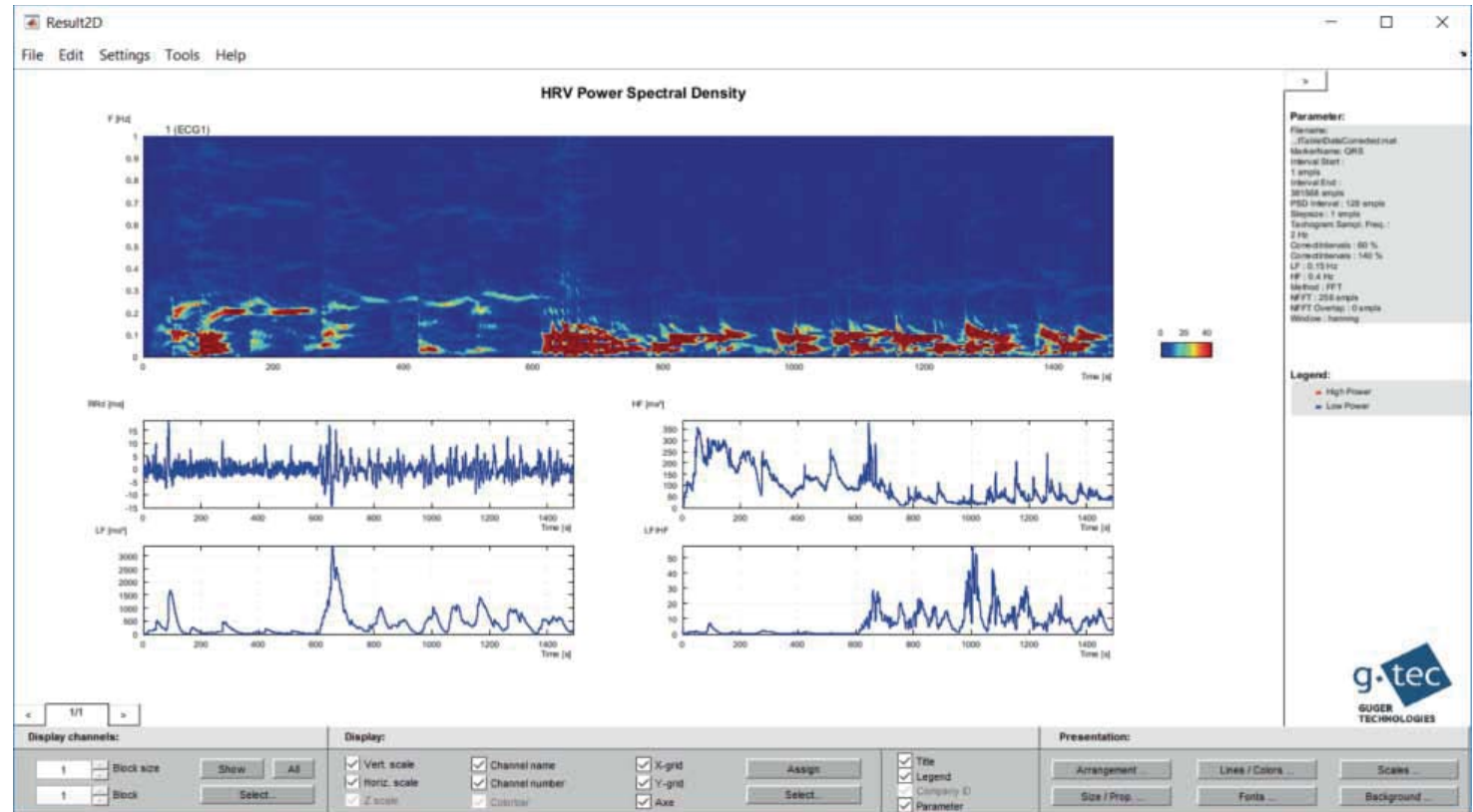
QRS/R-PEAK DETECTOR

Automatic R-peak detection and marker assignment.

PARAMETER EXTRACTION

Tachogram

HEART RATE/HEART RATE VARIABILITY

HR/HRV time domain parameters, Geometric measures, RR difference measures, Segmented measures, Poincaré plots, HR/HRV frequency domain parameters, Power measures, Normalized measures, HRV time-frequency maps.

g.Result2D shows the heart-rate variability analysis (HRV) in frequency domain of a tilt table experiment. The analysis shows the reactions of the low frequency and high frequency HRV parameters.

EEG Toolbox Features

ARTIFACT TREATMENT

TMS artifact removal.

EEG SPECIFIC ANALYSIS FUNCTIONS

Coherence, Event-related coherence, ERD/ERS analysis with significance test, ERD/ERS time-frequency maps with bootstrap test for significance, ERD/ERS time-frequency maps with complex demodulation, ERD/ERS time-frequency maps with wavelets, ERD/ERS time-frequency maps with Hilbert transformation, Common spatial patterns (CSP), Mean frequency, Phase-locking value, Averaging function with statistical comparison of different classes, EP calculation (ASSR, MMN, BAEP, P300, N400, ...).

PARAMETER EXTRACTION

Hjorth parameters, Barlow parameters, Running fractal dimension, Temporal and spatial complexity, Minimum energy for SSVEP- and SSSEP-based BCI, P300 BCI accuracy.
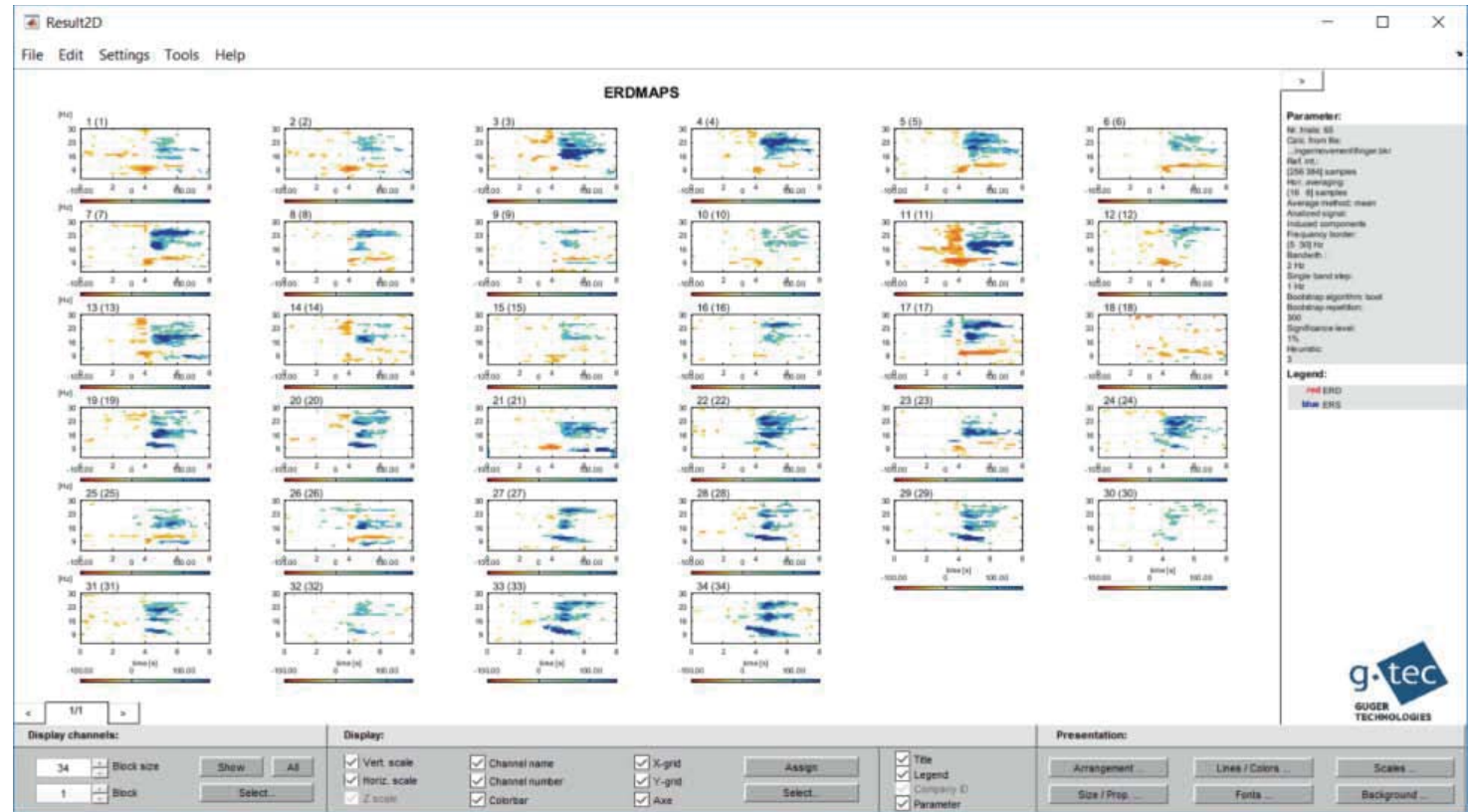
g.Result2D show the ERD/ERS analysis of a finger tapping task. The EEG was recorded with 32 channels. Red colors show an ERD in the alpha frequency range and blue colors show an ERS in the beta regions. The ERS is also called beta rebound and occurs after the finger movement.

Classify Toolbox Features

TOOLS

Generate feature matrix, Generate time segment feature matrix, Test classifier, Apply classifier, Store classifiers for online application (biofeedback, BCI, ...)

METHODS

Multi-class linear discriminant analysis, Minimum distance classifier, Backpropagation neural network, Receiver operator curves, Radial basis function, Distinction sensitive learning vector quantization (DSLVQ), DSLVQ for feature weighting, K-means clustering, Support vector machine, Change rate/majority voting, Zero-class, P300-accuracy, Plot classification result mapping.
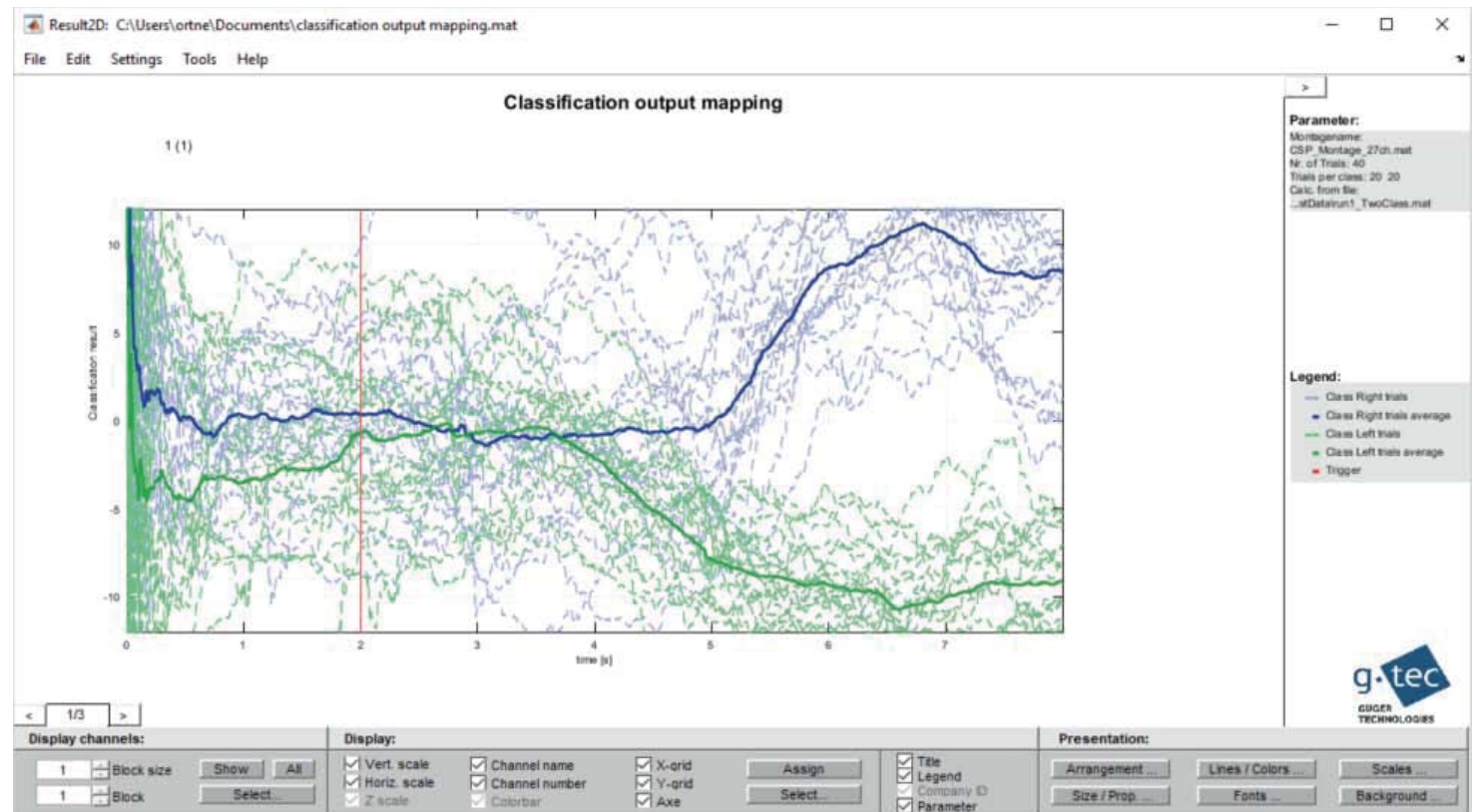
Result2D shows the result of a motor imagery BCI task. The subject imagined left hand and right hand movements (80 times each). The red line shows the onset of the imagination and the blue and green lines are the averages of the single movement imaginations. After 2 seconds, the two classes can be well separated and used as a BCI control signal.

CFM Toolbox Features

OFFLINE ANALYSIS OF NEONATE EEG

The CFM (aEEG) signal can be computed from selected data segments. The CFM traces are displayed in a viewer window for visual inspection.

AUTOMATIC CFM SEGMENTATION

CFM traces can be classified automatically. The following classes are assigned to data segments of a predefined length (e.g. 10 min): CVP (continuous voltage pattern), DLVP (discontinuous low voltage pattern), DHVP (discontinuous high voltage pattern), ISO (isoelectric pattern), BSP (burst suppression mode), BURST (bursts). Criteria for automatic segmentation can be adjusted/optimized for special applications or derivation techniques.
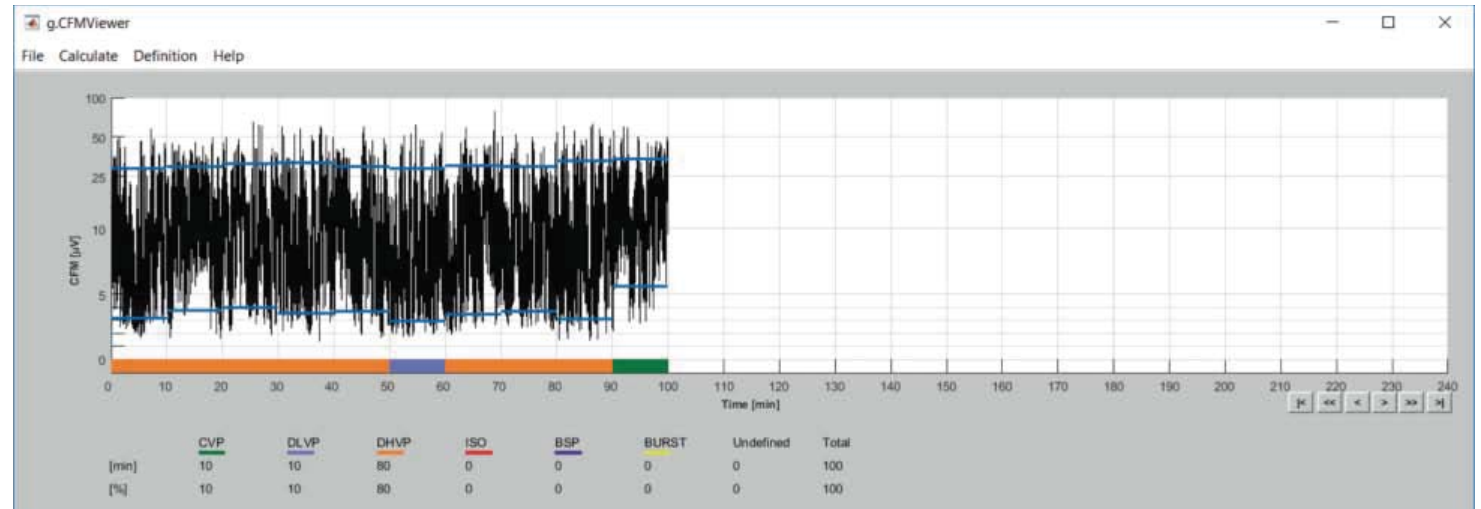
The g.CFMViewer shows the amplitude integrated EEG of a 100 minute recording of a neonate in the intensive care unit. The trace mostly shows a DHVP pattern and two segments of DLVP and CVP. The aEEG gives a time compressed view of the brain status of these patients.

# High Resolution EEG Toolbox Features

PRE-PROCESSING

High resolution spline Laplacian derivations for ERD/ERS, ERP, etc.

ANATOMICAL MODELING

Generation of realistic anatomical multi-layer models from segmented CT/MRI data, Fit electrode positions to models, Edit geometry data.

RESULT MAPPING

2D and 3D mapping of results for different model layers, Edit transparency and colors, Free rotation of models/maps, Generate time series.
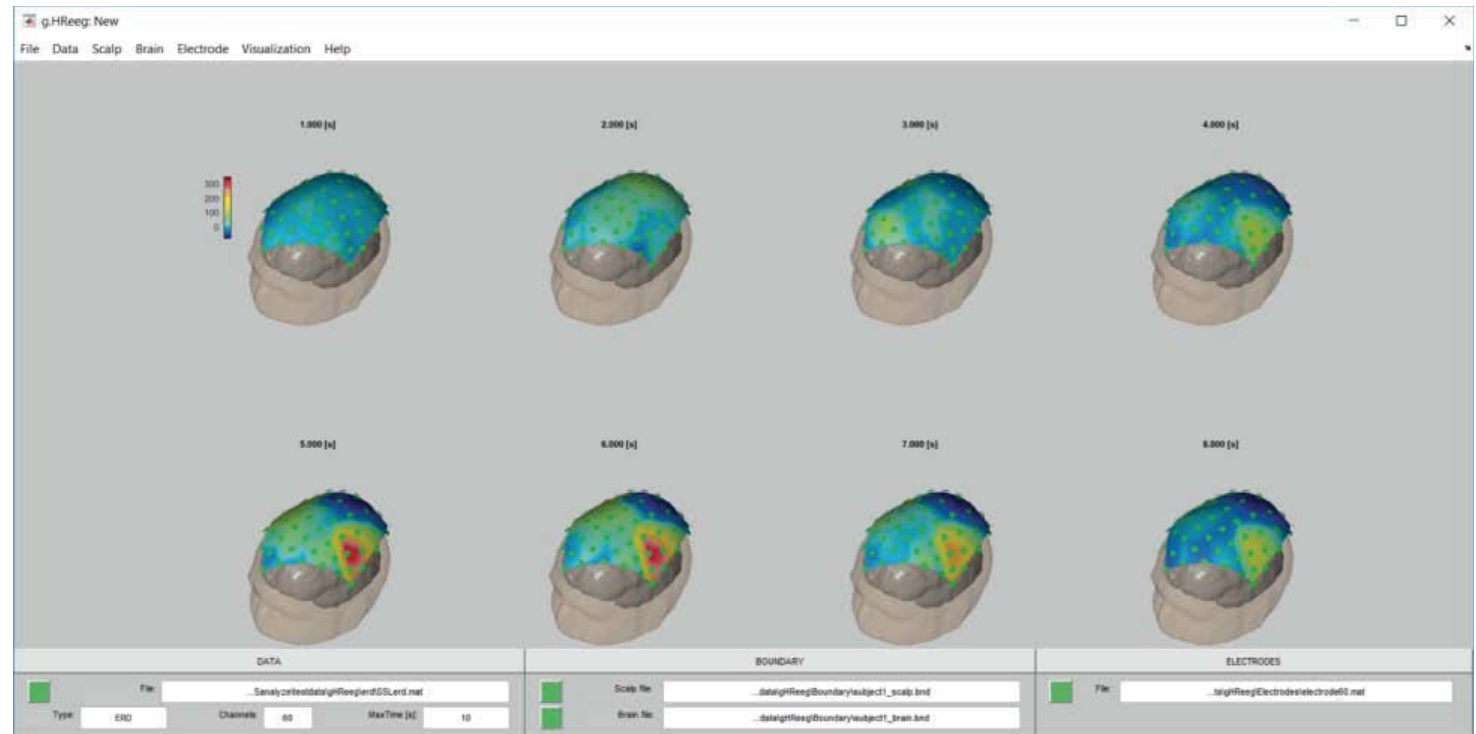
g.HReeg shows the time course of a right hand movement imagination that results in an ERD over the left sensorimotor area.

Spike Toolbox Features

NEURONAL ACTIVITY PROCESSING

Firing rate of neural cells

PSTH – PERISTIMULUS TIME HISTOGRAM

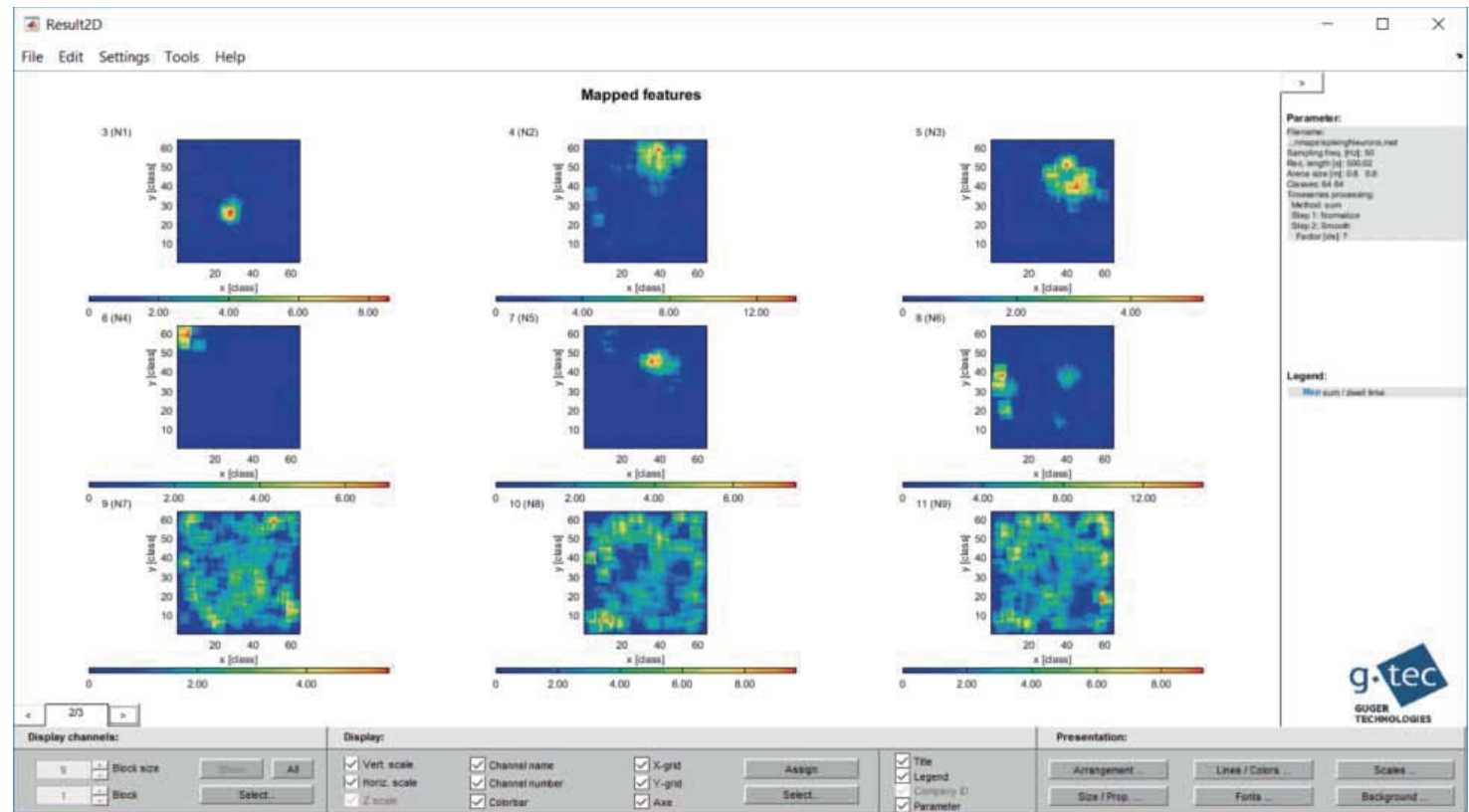Firing histogram to identify active regions

ANALYZE POSITION DATA

Movement trajectories, Visits per class,
Class probability, Dwell time

CALCULATE DIFFERENT MAP PARAMETERS

Firing fields, Skaggs index, Spatial coherence, Spatial selectivity, Mean non-zero-rate, Maximum activity, Minimum activity

CALCULATE SPEED

g.Result2D shows the firing fields of place cells of a foraging rat in a rectangular maze. Neurons N1-N6 show isolated and good place fields, while neurons N7-N9 are less specific. Neuron N2 decodes the area close to the border of the maze very well, while N4 decodes a corner of the maze.