

A Software Toolset for Rapid Analysis of EEG Seizure and Video Data

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Introduction

- Because large variations in EEG waveforms are found between animals due to such parameters as screw placement, brain morphology and animal size a majority of researchers still rely on human visual analysis of EEG data for accurate interpretation of seizure events.
- Analysis of long EEG datasets is very resource intensive, creating a hindrance to large-scale projects.
- To help streamline data analysis, we have developed a software toolset for rapid analysis of EEG-based data.
- The software includes detailed power spectrum analysis with adjustable Hanning and Hamming windows along with customizable power band selection for all channels. Once power spectra have been calculated for a specific dataset, colorized heat maps and power frequency plots are available for visual analysis.
- Rapid identification of seizures within large datasets is accomplished based on parameters such as seizure length, specific frequency, root mean squared (RMS) power and line length.
- Identified seizure events can further be classified using embedded video and rated using standard Racine's Scale parameters. After identification has been completed, aggregated seizure events are analyzed according to number, severity, frequency, and circadian distribution over user-defined periods and adjustable for light/dark cycles.

Video Recording

- Video can be recorded at varying resolutions (320 x 240, 640 x 480), adjustable frame rates and from different angles to meet the needs of any experiment including chronic experiments lasting weeks (Figure 1).
- Video frame to data point accuracy is less than 100 ms.
- Individual seizure events can be isolated and exported with video recording as .avi video clips for use in presentations and papers.

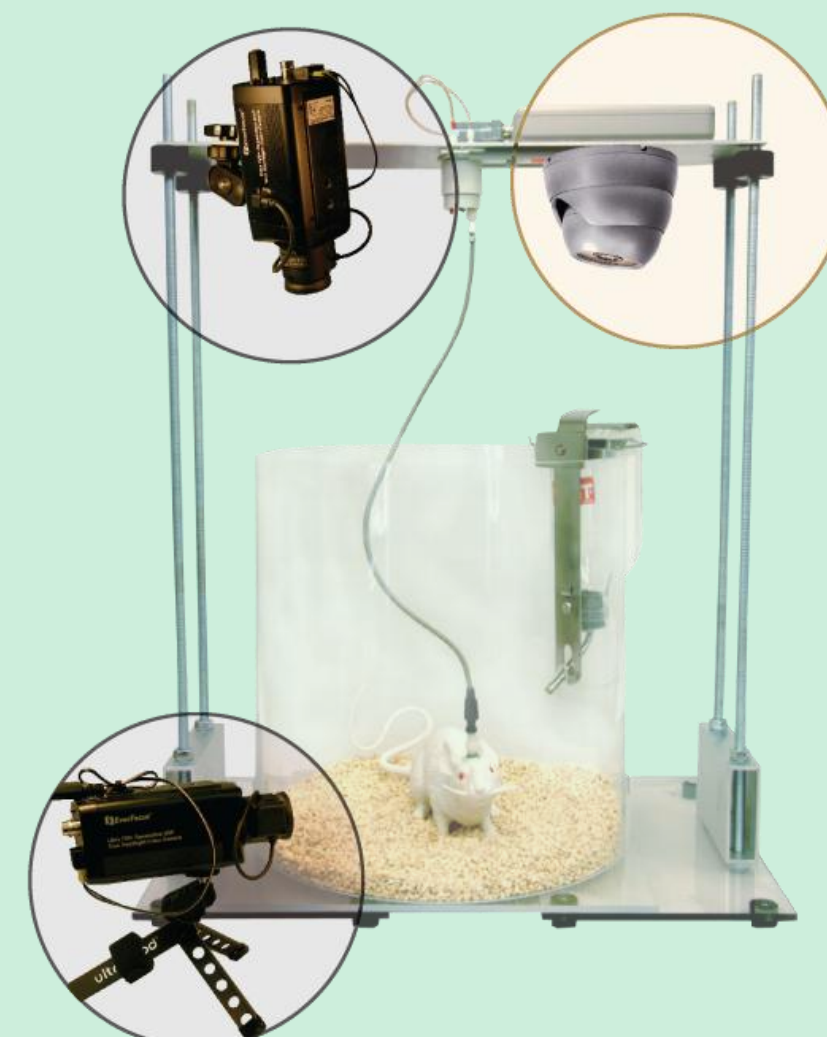


Figure 1: Video camera setup.

Custom Plot Generation

- The seizure analysis tools provide a method of viewing and comparing various frequency band and line length data as well as the raw EEG signal on a single time plot. Various filters and scaling can be applied to the waveforms to help visualize the data (Figure 2).

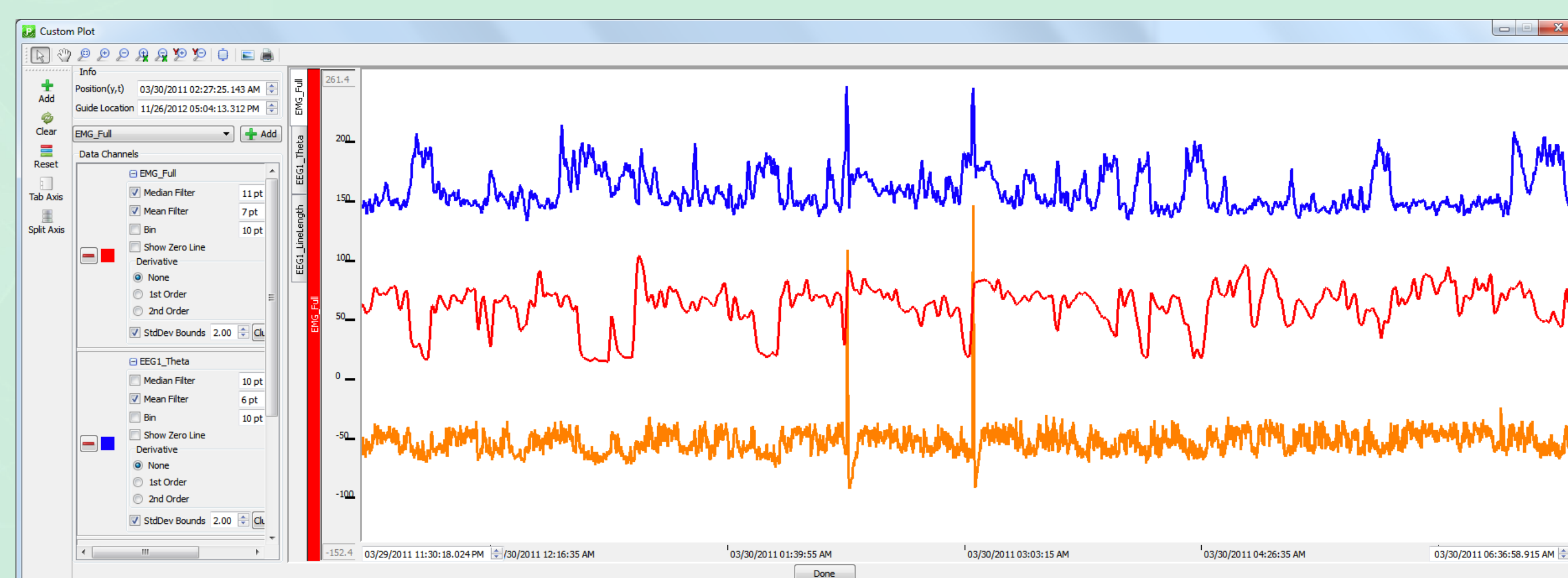


Figure 2: Custom plot displays - line length (orange), EEG theta (blue), and EMG RMS power (red). Seizure events are easily identified as spikes.

Seizure and Video Synchronization

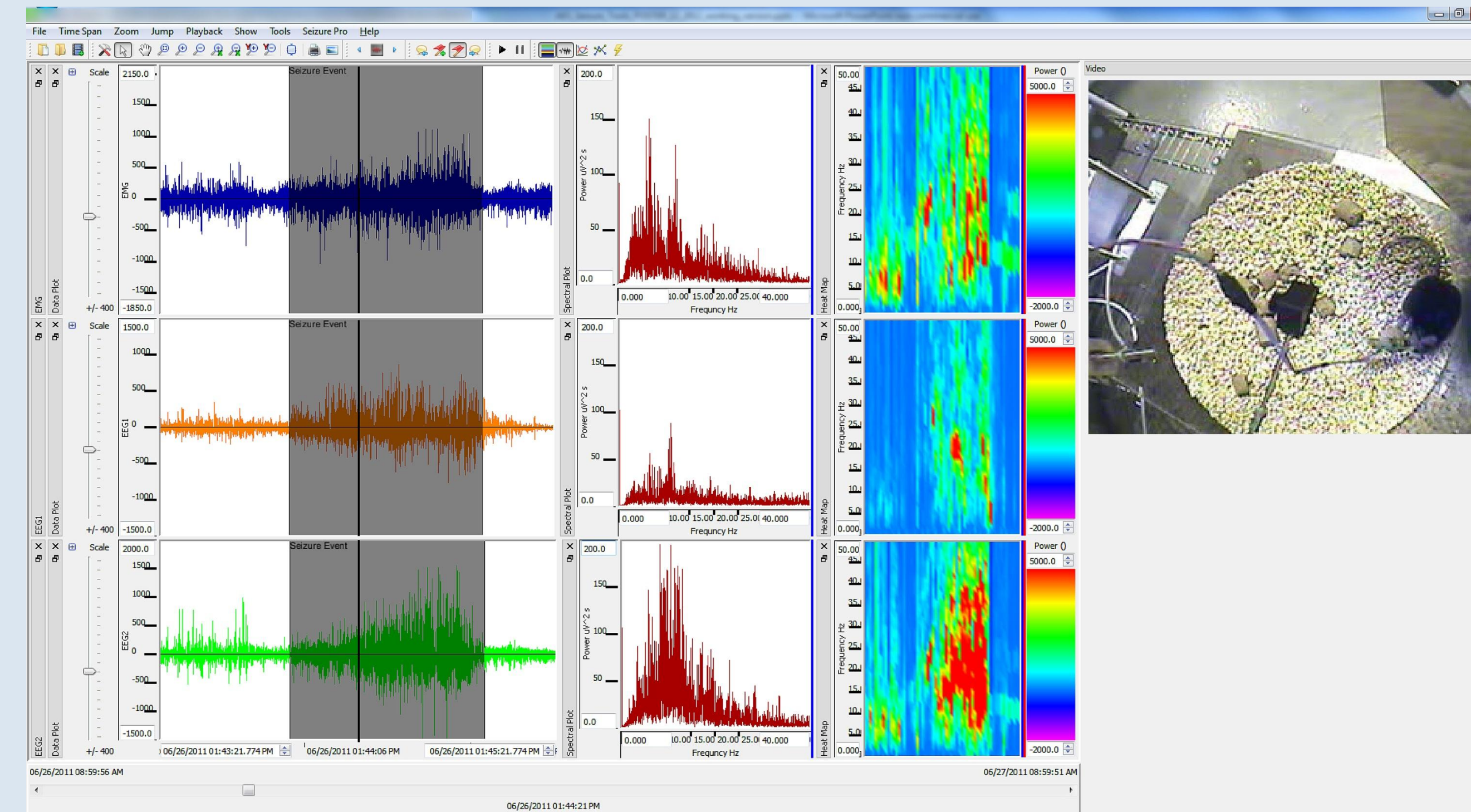


Figure 3: Seizure recording with integrated, synchronized video playback

- The seizure analysis software displays the data, annotations, and a synchronization line for video (Figure 4).
- Frequency data can also be displayed and is updated in real time based on the data signal
- A heat map of the data spectrum plot displays time and frequency of seizure activity in red for rapid identification of a seizure event.

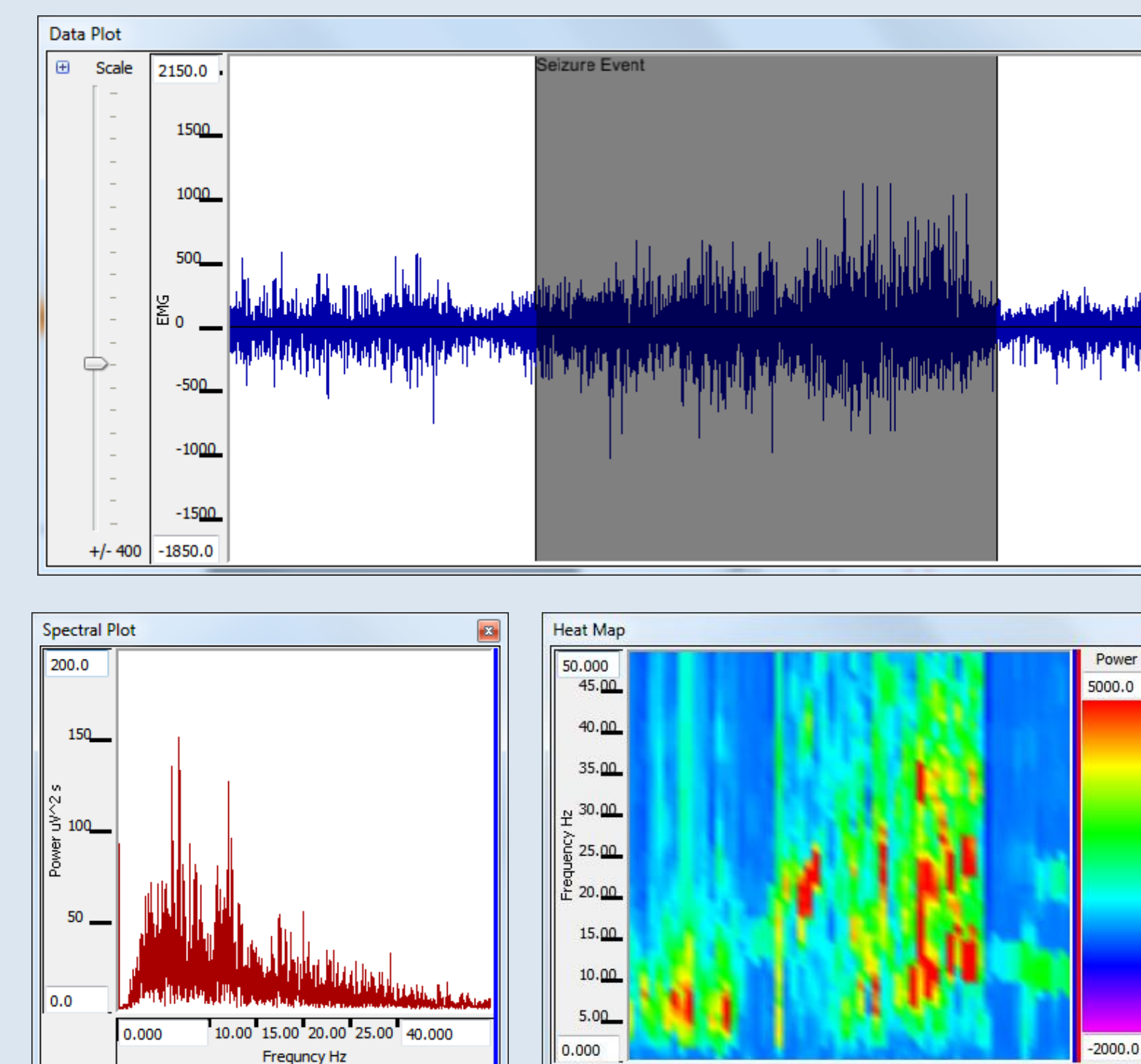


Figure 4: Raw EEG Data (top), Spectral Plot Data (bottom left), and Spectrum Heat Map Plot (bottom right).

Seizure Analysis

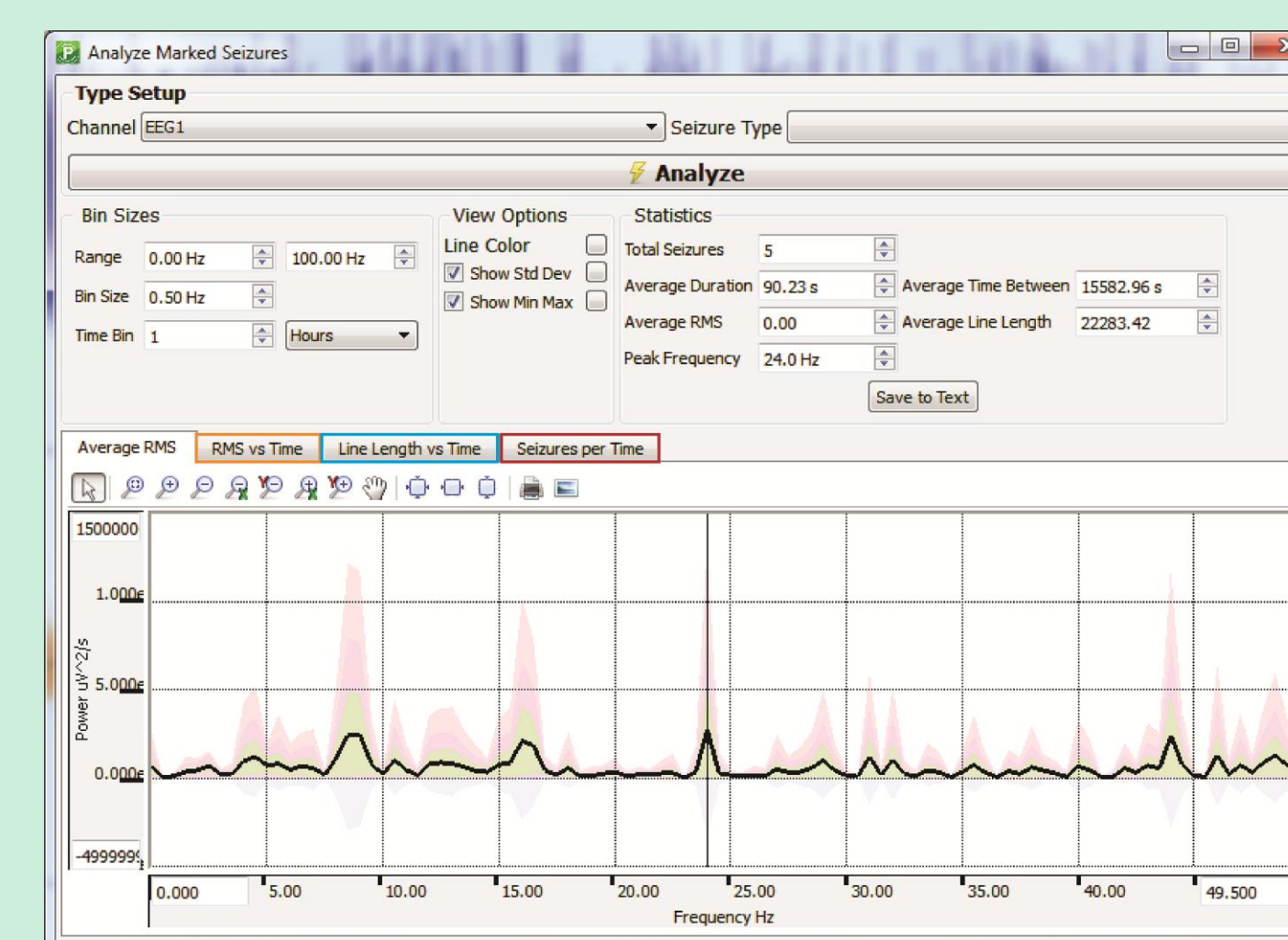


Figure 5: Aggregate seizure spectrum (top), RMS power vs time (orange), Line length vs time (blue), Number of seizures per unit time (red).

- The seizure analysis software calculates average duration, average time between events, average RMS power, and line length (Figure 5).
- The software constructs an aggregate spectrum plot of all marked seizures displaying the mean and variance.
- All calculations can be exported to ASCII text files for use with 3rd party analysis and statistical software.

Seizure Selection

- The seizure selection tool extracts features from an existing seizure and places the event and feature set into a database.
- The extracted features are then used to match patterns and identify similar seizures in other data sets (Figure 6).
- Features extracted include RMS power of a specific frequency band or line length.
- The features and the seizure waveform itself are stored in a database for future use in new analysis.

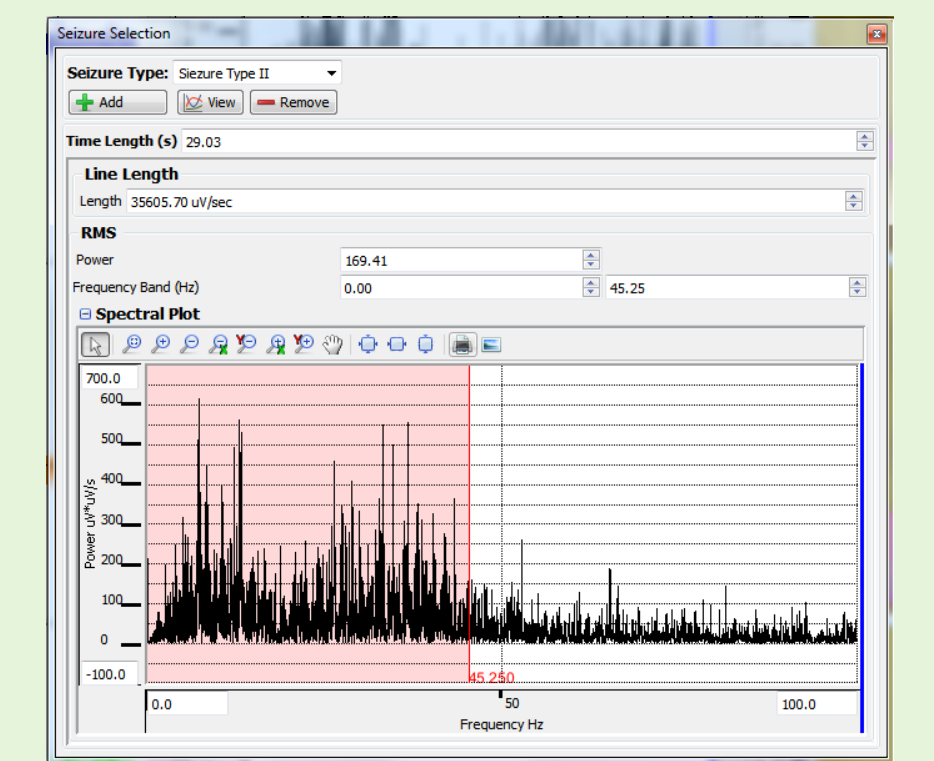
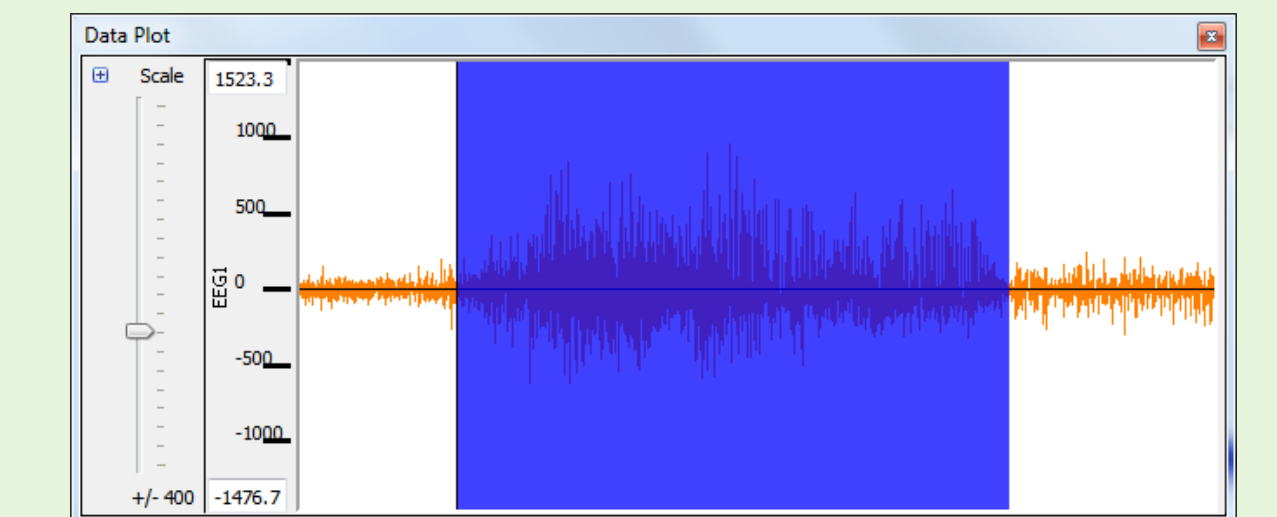


Figure 6: Seizure selected (in blue) and added to a pattern matching database. Frequency selection is shown in red.

Seizure Matching

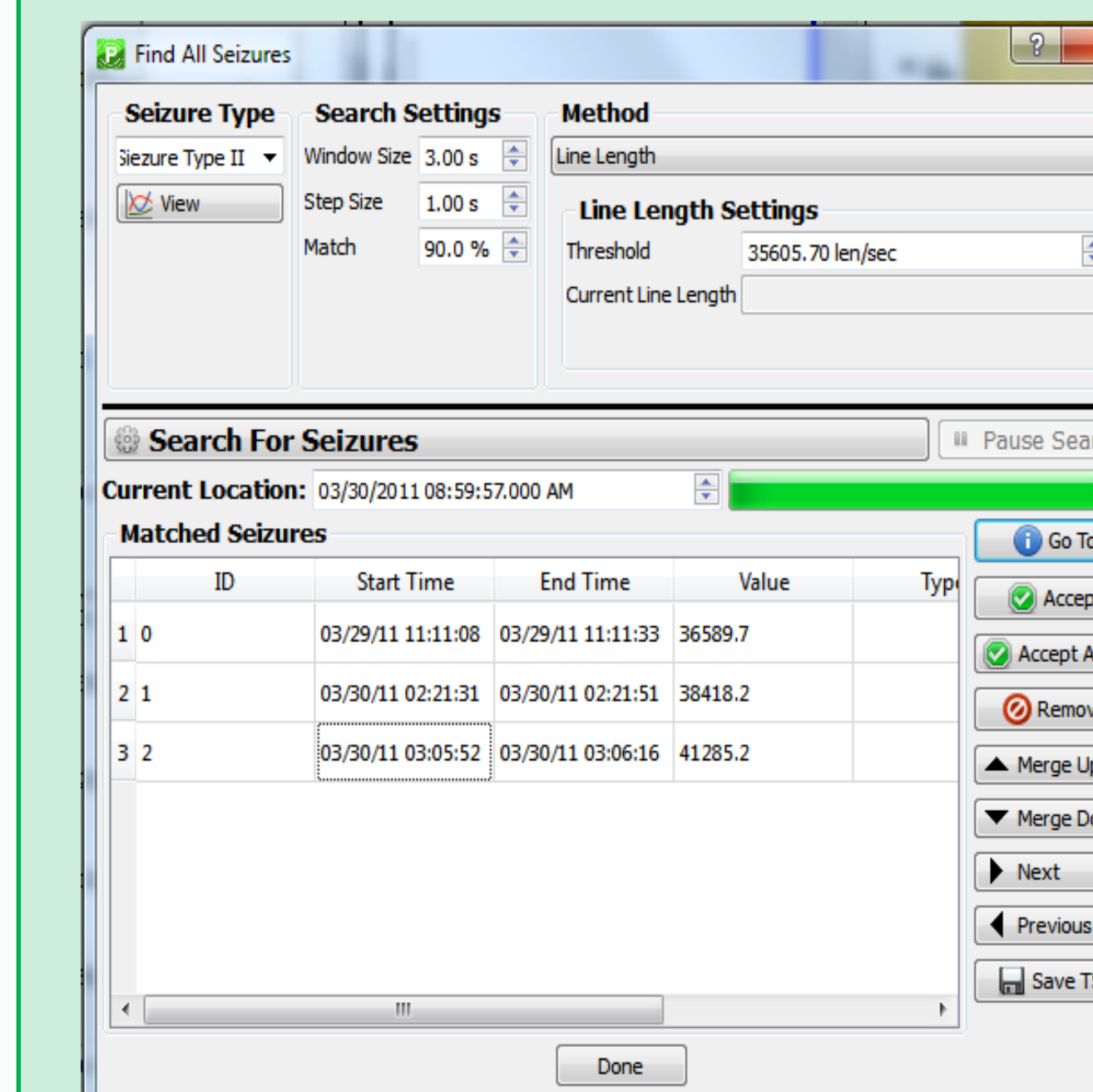
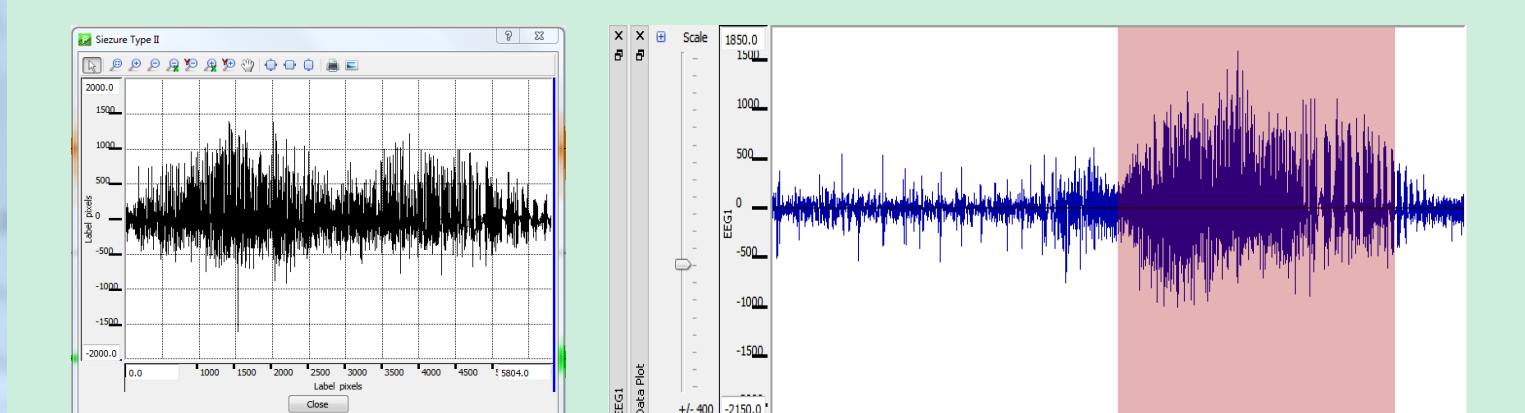


Figure 7: Pattern matching a seizure event. A list of matched events (left), a stored seizure event (middle), and a matched pattern in the EEG waveform (right).

- The seizure matching tool uses the seizure database to find similar seizure events and list them for human review (Figure 7).
- Pattern matching includes, but is not limited to, RMS power and line length.
- All the events can be accepted, rejected, or merged with nearby events to better classify seizures.



Testing

- Seizure detection was performed using RMS power and line length analysis separately on five individual mouse data files. All files were compared to an expert's analysis (Figure 8).

ACCURACY OF SEIZURE DETECTION

	# of Seizure Events Marked	Accuracy vs Expert Scorer	# of False Positives
Expert Scorer	21	N/A	N/A
RMS Power	23	100%	2
Line Length	21	100%	0

Figure 8: Seizure detection compared to manual scoring

Conclusions

- This software package provides comprehensive toolset for analysis and evaluation of EEG and EMG seizure events.
- Tools for automated seizure detection can be used for rapid identification of seizure events within large-scale datasets.
- Automated summary analysis tools provide researchers with rapid assessments of their data in both graphical and ASCII formatted outputs.