MEA Analysis Toolbox

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Task

- Task: Detect peaks, seizure-like bursts & characterize them. Provide GUI.
- Contraints:
  - many channels
  - high sampling rate
  - high heterogeneity (slices)
- Existing toolboxes are
  - proprietary or vendor specific
  - quality-wise insufficient

What's there

So far...

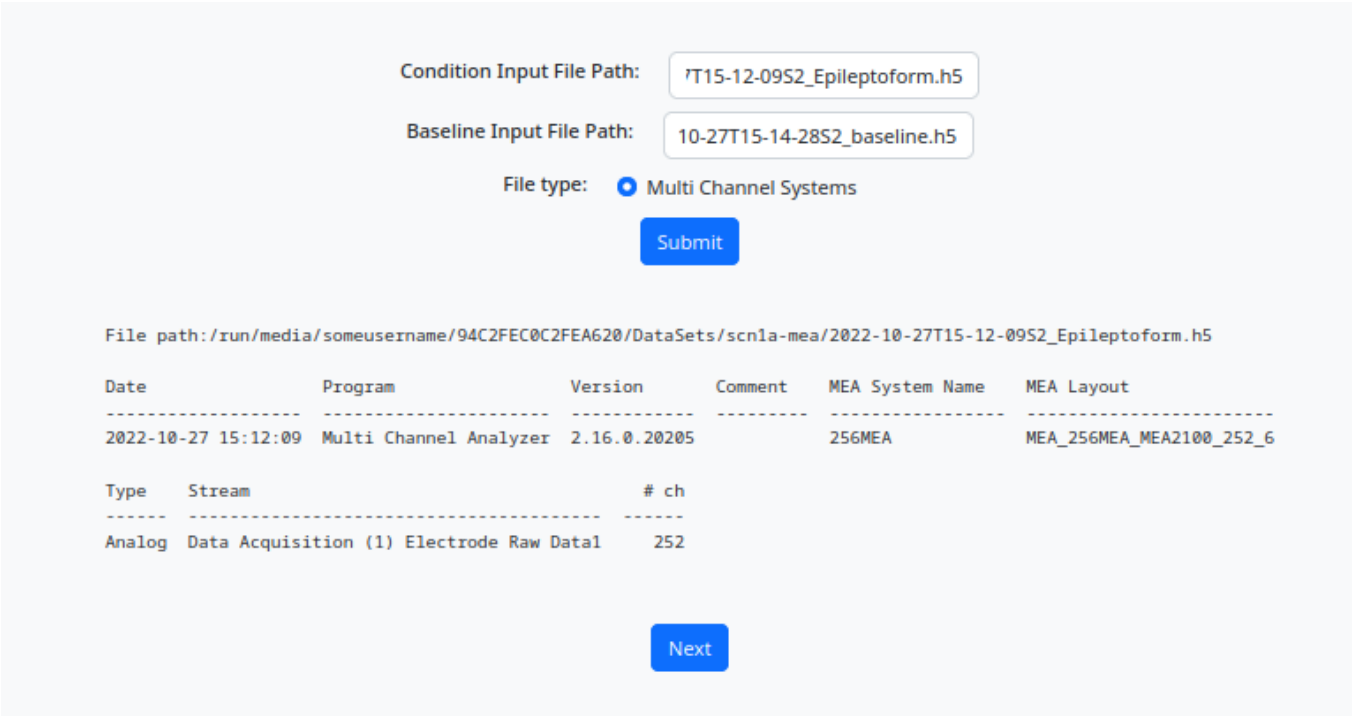
What is there so far

- was developed in $\approx$ 10 weeks,
- without recording a single slice myself,
- without analyzing more than 1-2 samples myself,
- without having extensive knowledge about the setup.

$\Rightarrow$ that's exactly what will follow in the next 6 months.

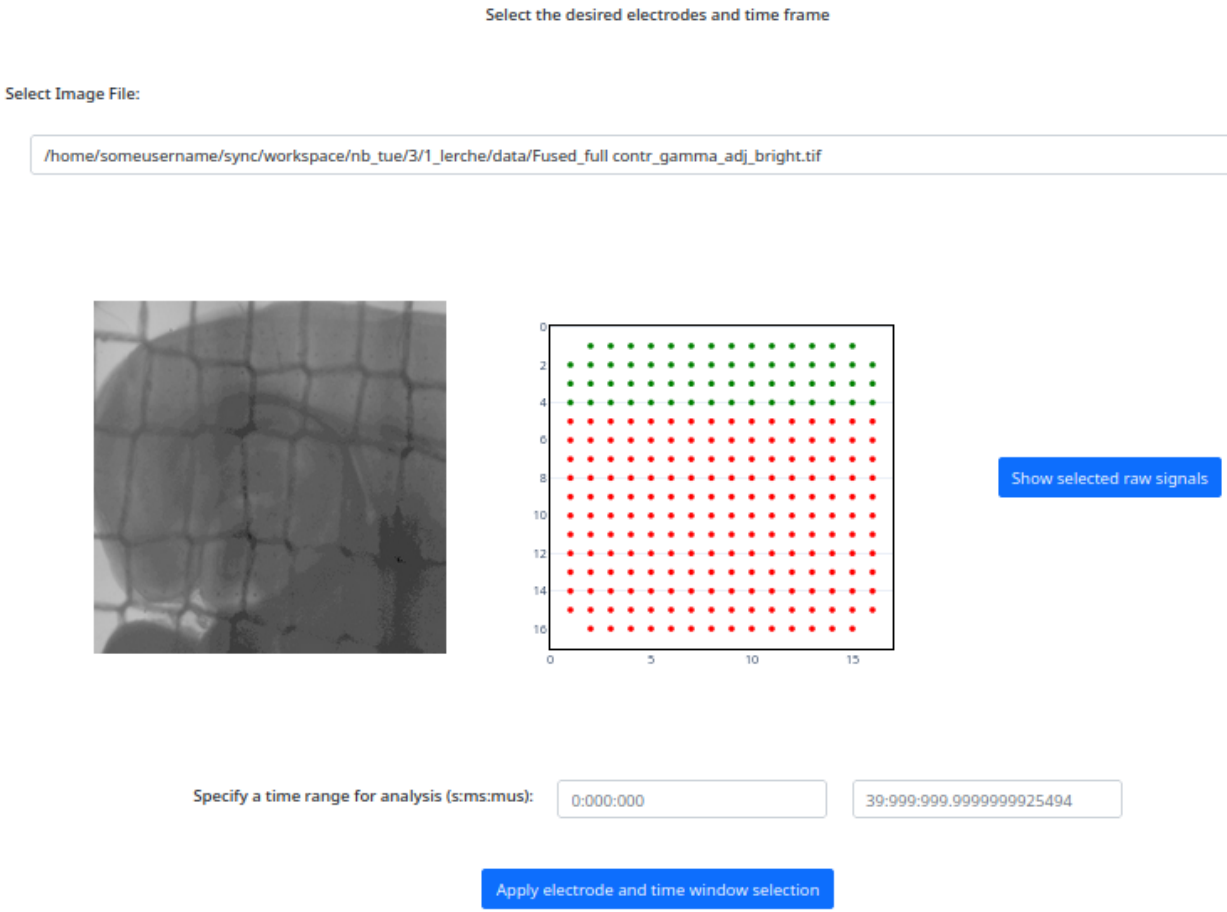
MEA Analysis Toolbox I

Semi-automated data analysis pipeline with UI.
Currently supports MultiChannel Systems 256 electrode MEA



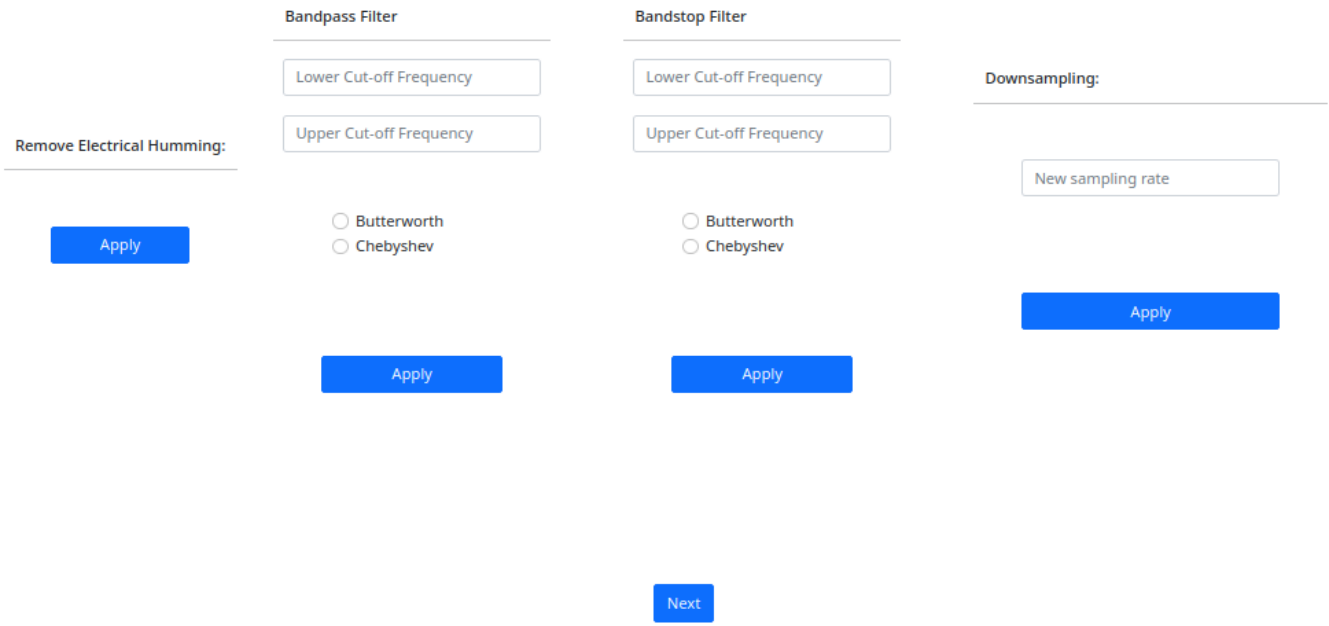
MEA Analysis Toolbox II

Graphical selection of electrodes and time window



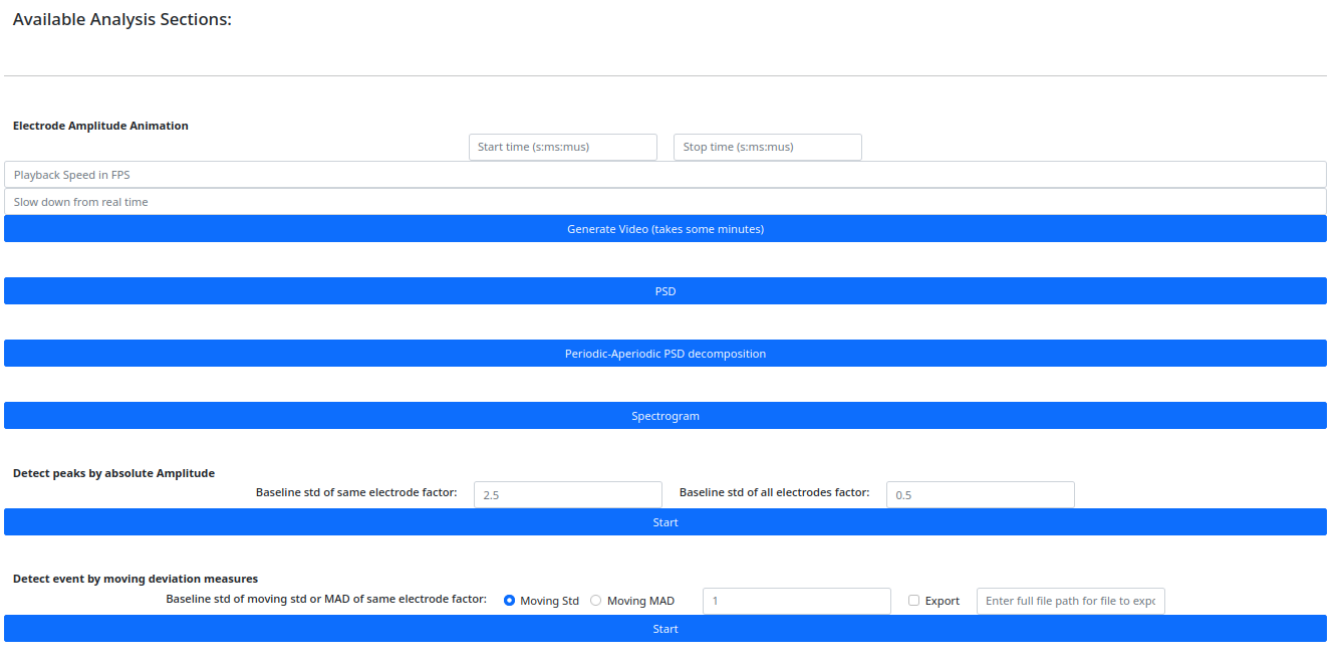
MEA Analysis Toolbox III

Preprocessing: electrical humming, bandpass, bandstop, downsampling



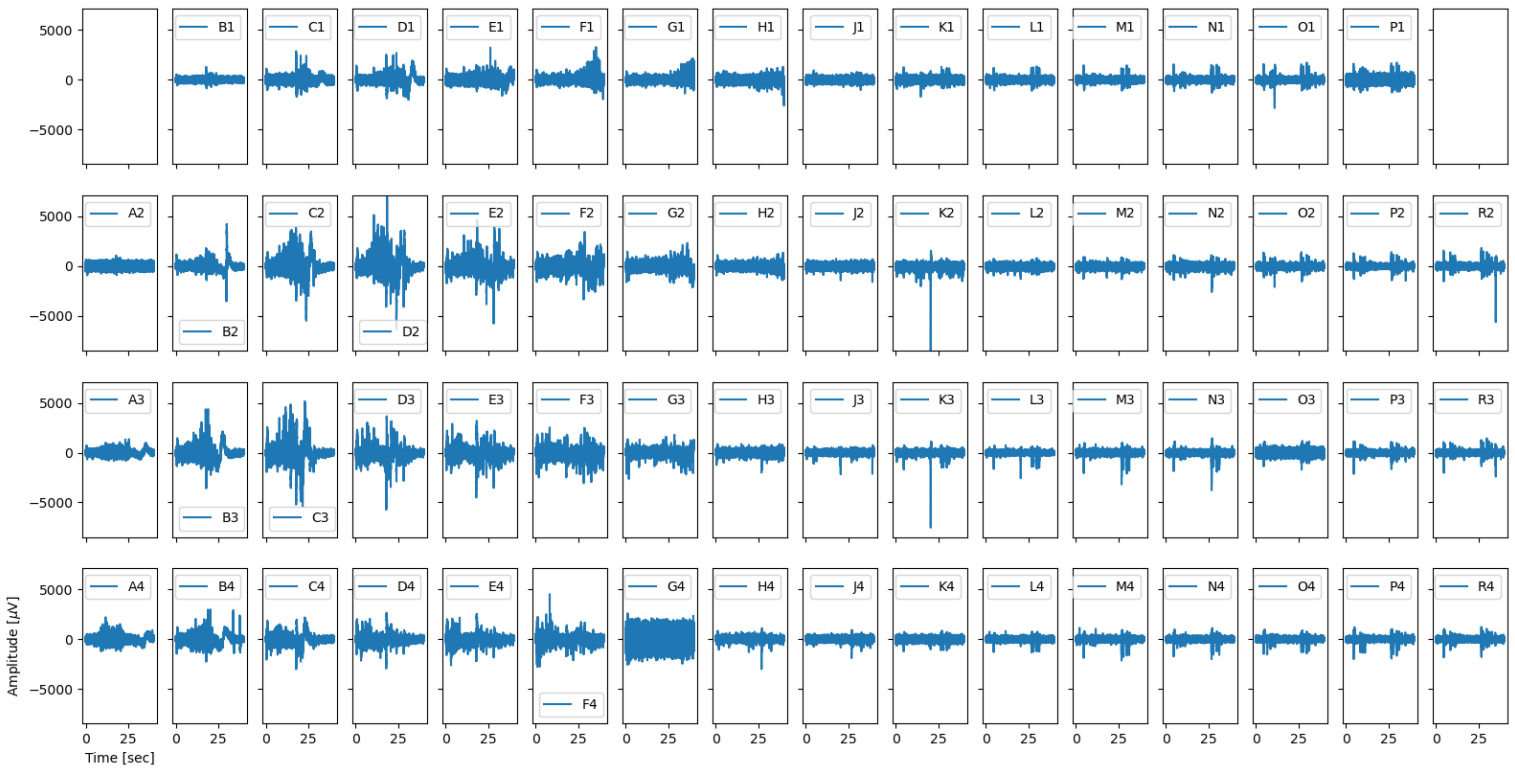
MEA Analysis Toolbox IV

Exploration & Analysis:

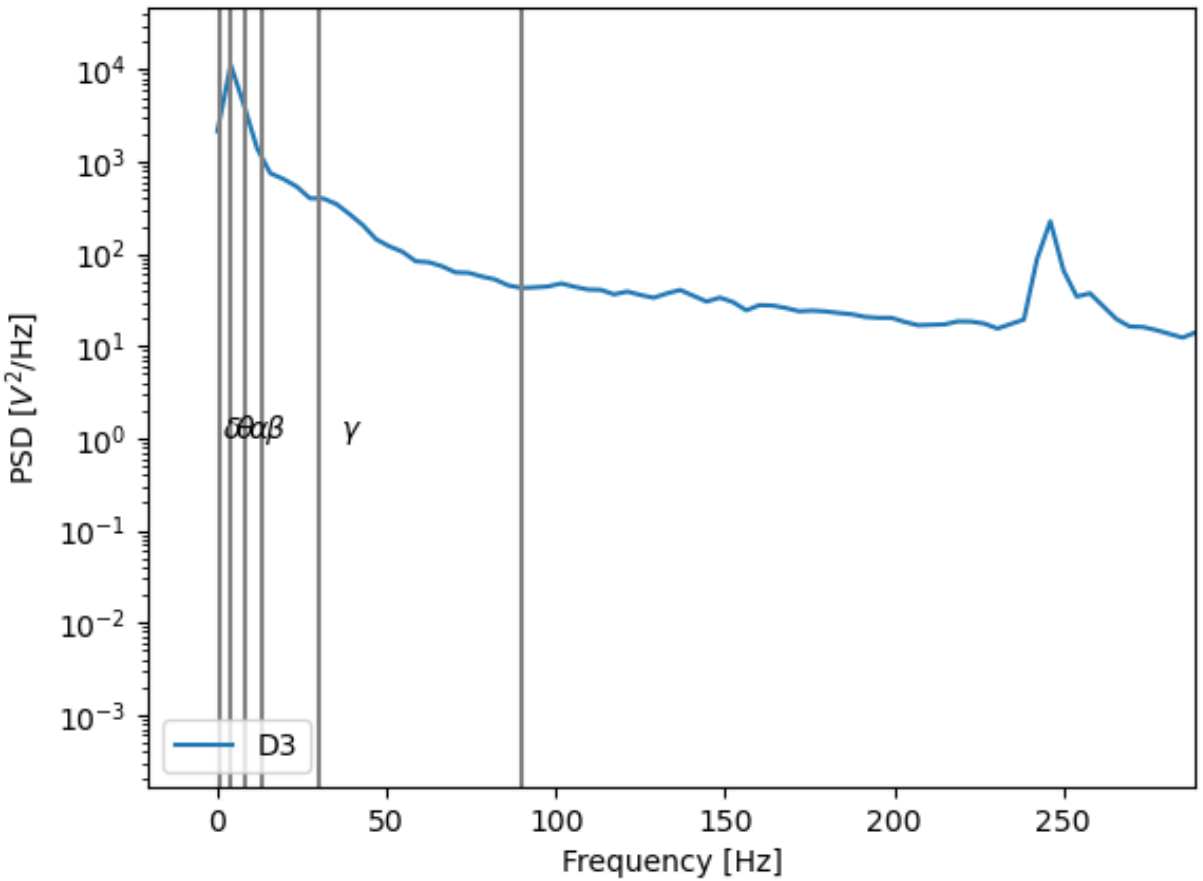


MEA Analysis Toolbox V

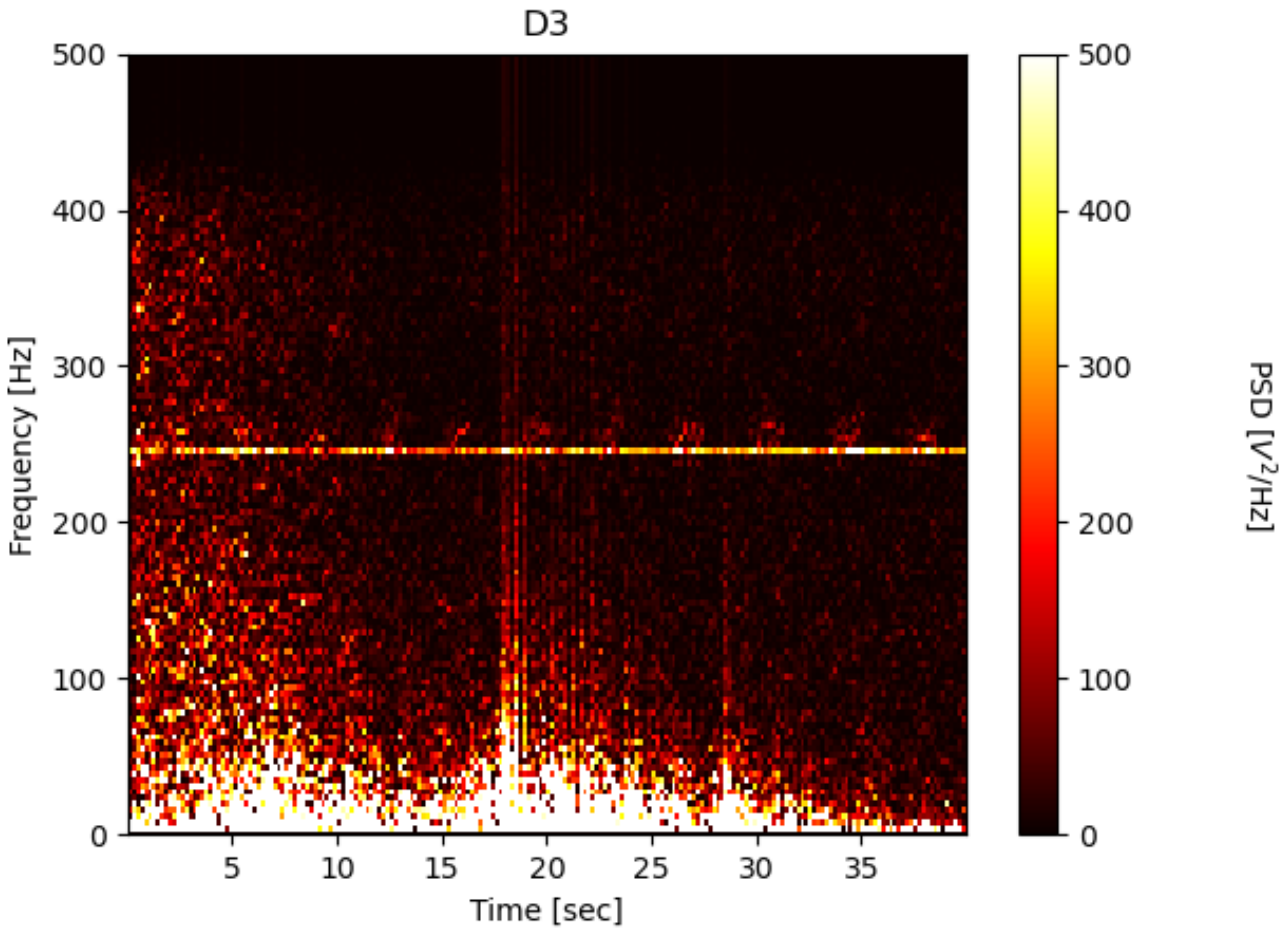
Exploration: raw signals, absolute amplitude animation, PSD, spectrogram



MEA Analysis Toolbox VI

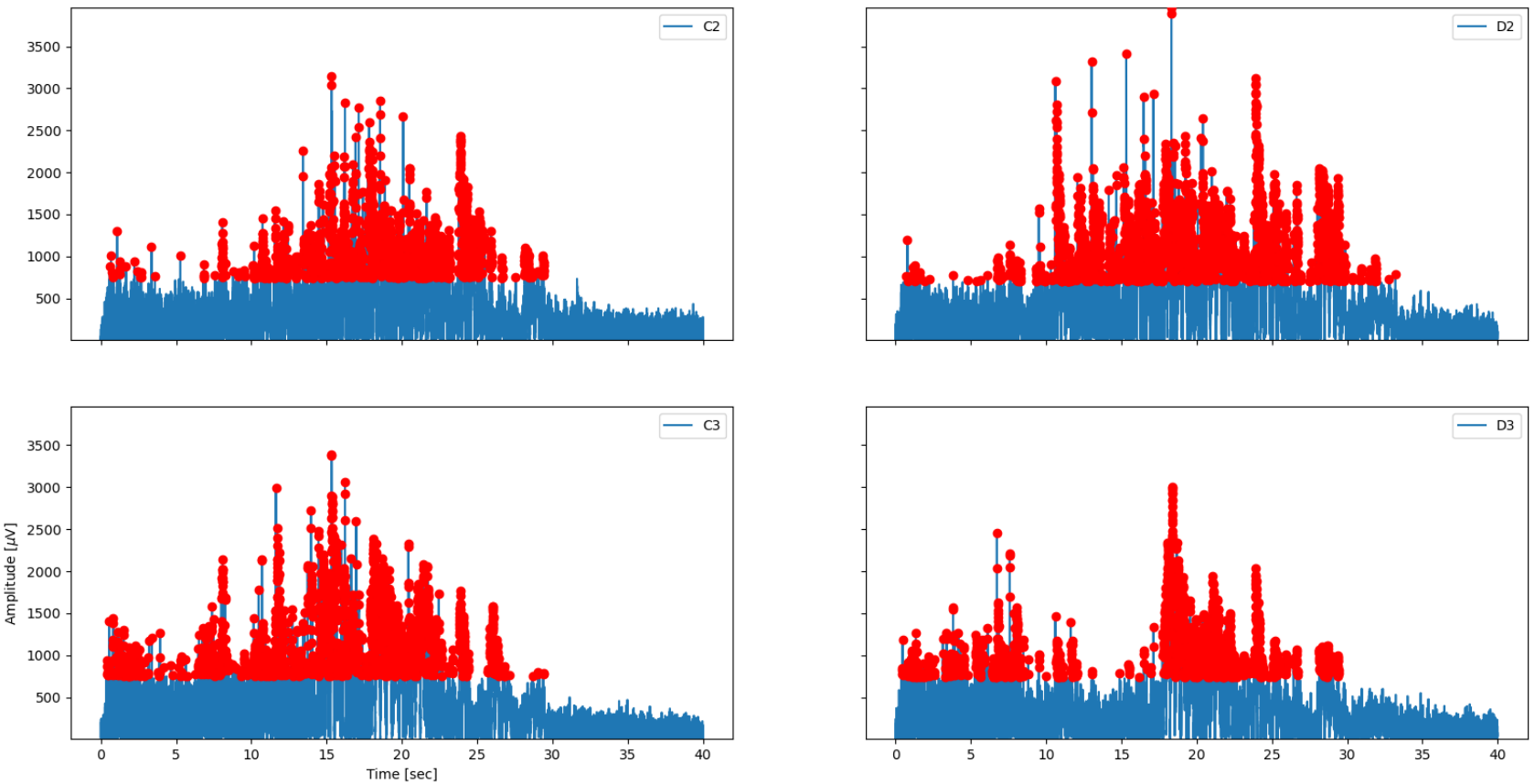


MEA Analysis Toolbox VII

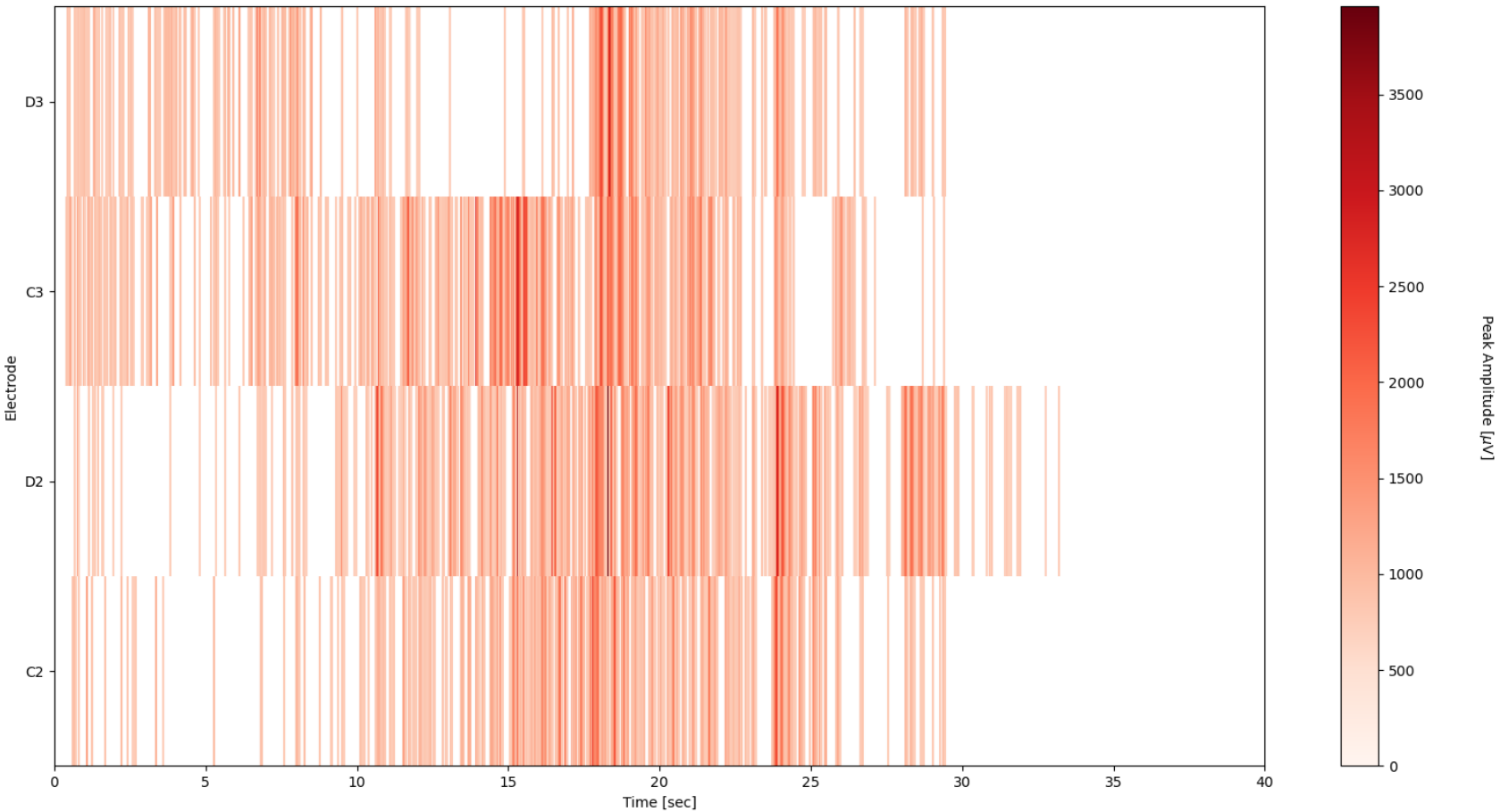


MEA Analysis Toolbox VIII

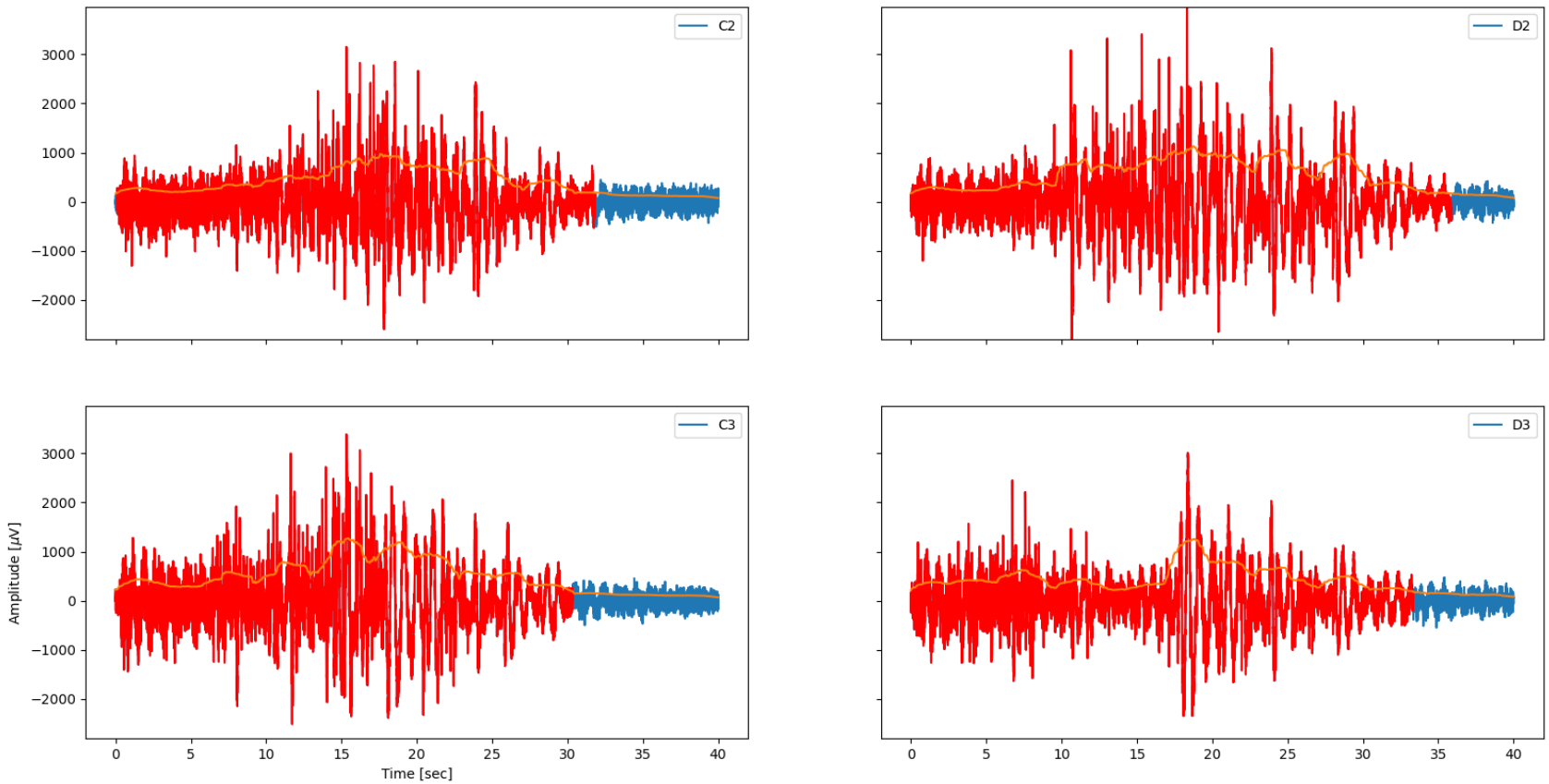
Analysis: Peak detection by threshold based STD per channel, burst detection based on moving STD or moving mean absolute deviation



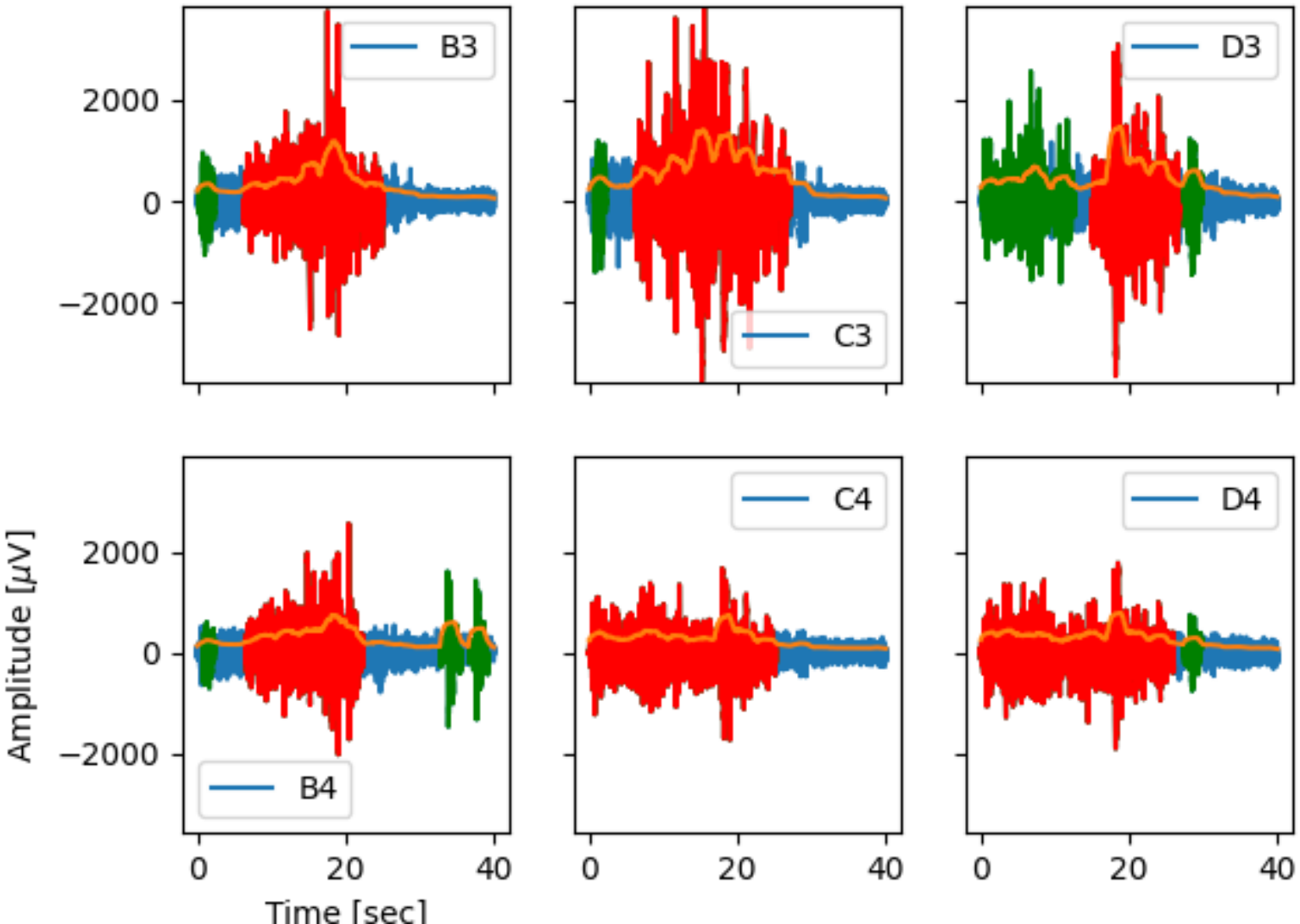
MEA Analysis Toolbox IX



MEA Analysis Toolbox X



MEA Analysis Toolbox XI



The next 6 months (and further)

Computing

- batch processing (multiple files/recordings)
- server deployment
- parallelization
- Qt-based GUI?

Setup

- HD/CMOS MEA support
- setup micrograph co-registration
- if 🖅: protocol & documentation for measurements

Preprocessing

- Bad channel detection based on SNR, impedances
- (re-) referencing
- between group alignment
- artifact removal using ICA
- epoching
- detrending

Visualization

- per band power animation
- between group comparisons
- spatial and temporal visualization of analysis

Analysis I

- Per electrode:
  - improve peak detection
  - improve burst detection
  - FOOOF: periodic & aperiodic component separation
  - waveform/event sorting, further features
  - waveform & spike analysis combined
  - spectral (and other kinds of) entropy/complexity meassures

Analysis II

- Between electrodes:
  - current source densities
  - transfer entropy/granger causality
  - coherence/“connectivity”
  - correlation
  - phase-amplitude coupling
  - spontaneous activity

Analysis III

- Within subject: coregistration with atlases
  $\Rightarrow$ structure-specific comparison
- Between subjects: aggregation to group
- Group analysis: t-tests, automated listing of significant p-values for the above

Famous last words

References I

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