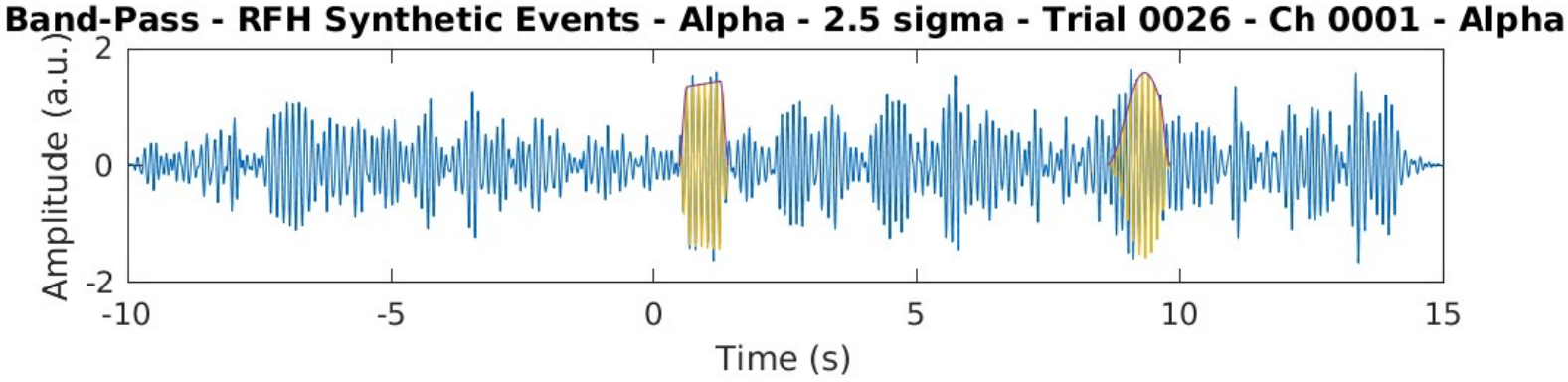
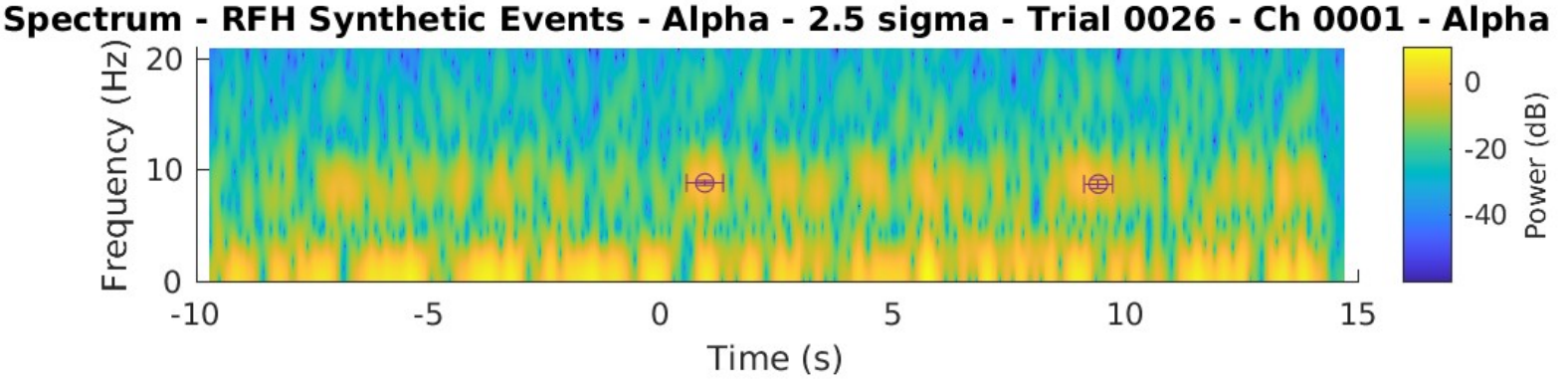
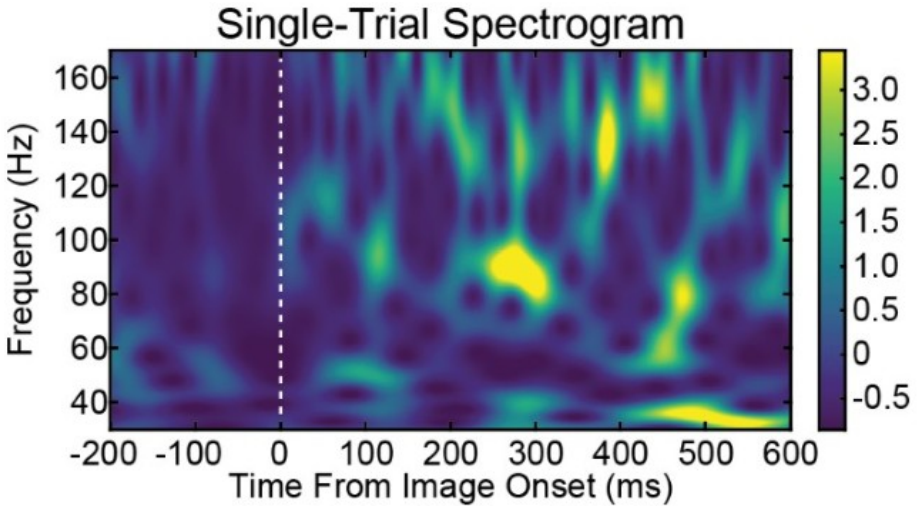
Characterizing LFP Oscillations

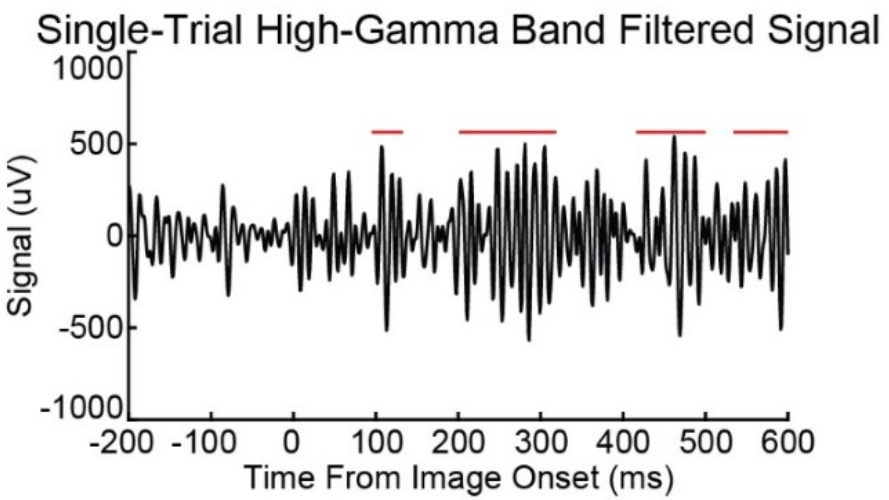




Presented by Christopher Thomas.

LFP has Transient Oscillations





Figures: Koenig 2024

- Brief narrow-band power excursions.
- Many different bands.
- May co-occur (e.g. gamma bursts modulated by theta).

LFP Bursts are Informative

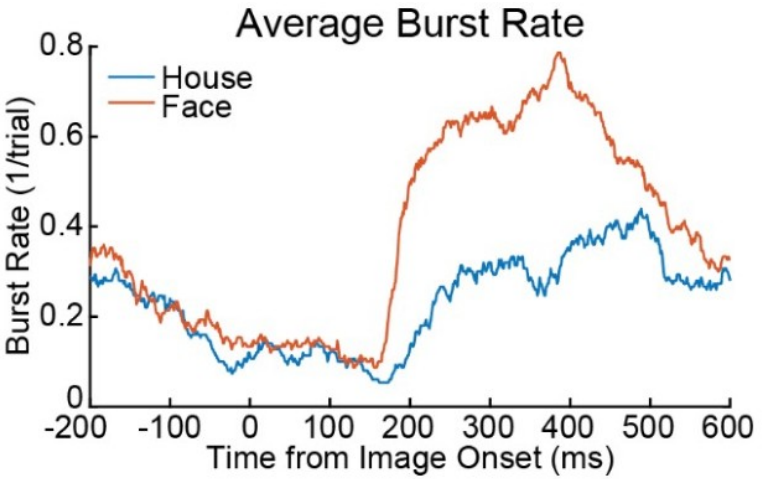


Figure: Koenig 2024

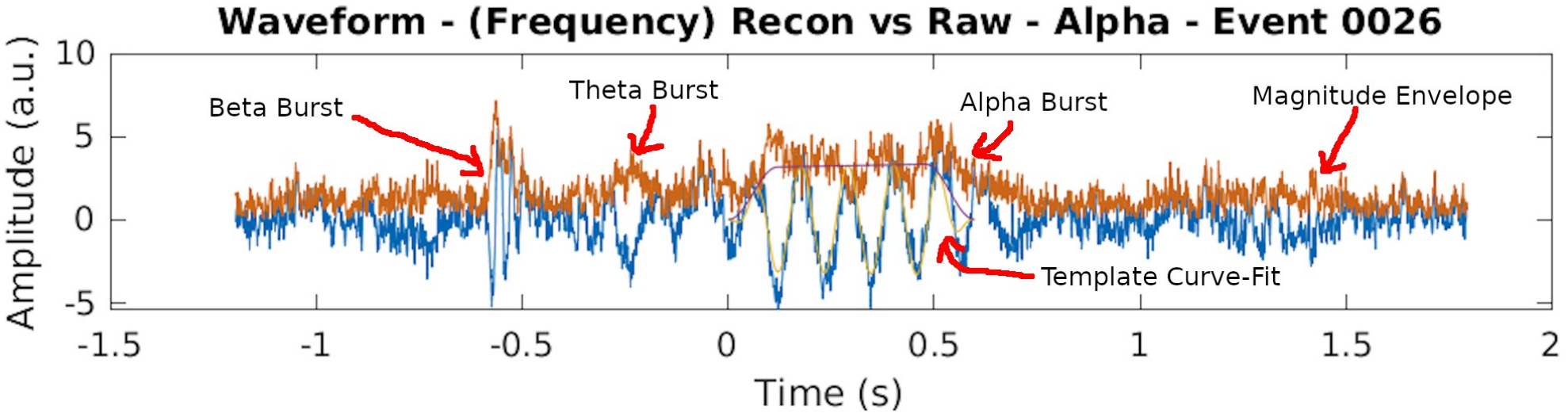
- Rate of burst occurrence correlates with experiment conditions.
- Synchronization between different sites may also be relevant ("communication through coherence" hypothesis).

➔ Motivated to identify and characterize oscillatory bursts.

“wlBurst” Library Detects and Characterizes Bursts

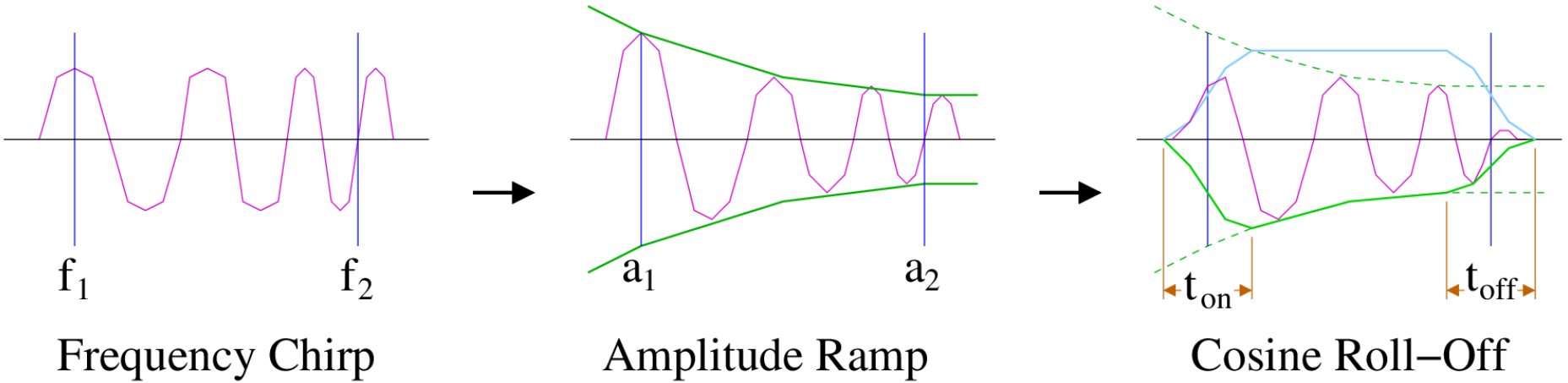
```
% This gets the raw event lists, including poor fits.

thisdetect = wlFT_doFindEventsInTrials( ...
  ftdata, bandlist, segconfig, paramconfig, ...
  bandtuning, want_tattle_progress );

% Drop events where the curve fit failed.
% This usually means it detected two bursts as one event.

thisdetect = wlFT_calcEventErrors( thisdetect, errorfunc, errorfield );
thisdetect = wlAux_pruneMatrix( thisdetect, prunepassfunc );

% Get burst rates.

[ rate_avg, rate_dev, rate_sem ] = wlStats_getMatrixBurstRates( ...
  thisdetect, time_bins_single, bootstrap_count );
```

Two-Threshold Detection



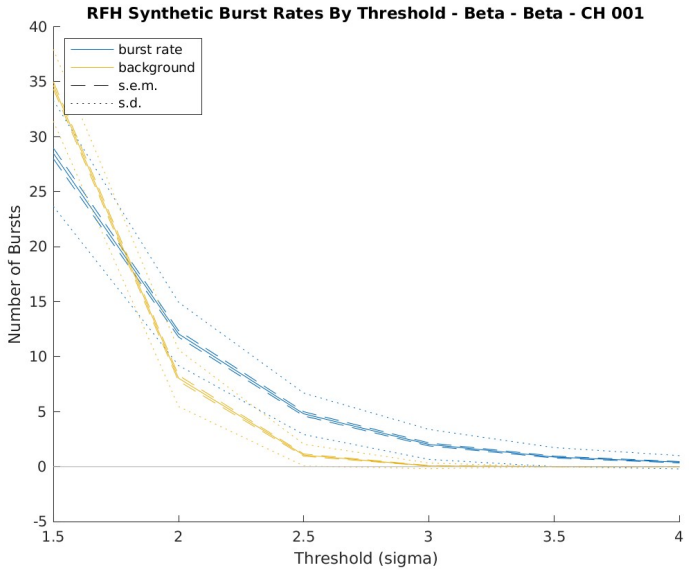
- A burst is present when the magnitude is above a “turn-on” threshold.
- A burst ends where magnitude falls below a “turn-off” threshold.

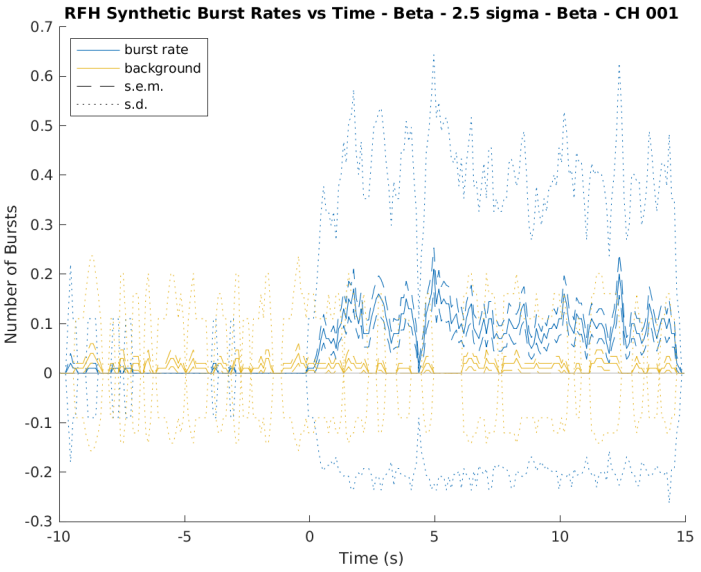
Characterization via Curve Fitting



- Oscillation waveform shape may be relevant (Cole 2019).
- Once burst events are identified, shape is extracted via curve fit.
- Intention is to cluster shape features. Not part of this demo.

Tuning Detection Threshold





- Plot burst rates vs time and vs detection threshold.
- Look for detection rate confidence interval outside background's CI.

About C.I.s and Background

- Burst rate confidence intervals can be estimated by “bootstrapping”:
  - Draw individual trials’ results from random trials to build a “resampled” distribution.
  - Do this many times to see how much the average rate varies.

- Background detection rate is estimated by building “phase surrogates”:
  - Phases of a trial’s frequency components are scrambled to smear out real features.
  - Only noise-generated features remain.

Running the Demo

- Choose a data set.
- Choose a band and a default detection threshold.
- Run the script. Look at detected events and background vs threshold.
- Adjust the threshold and run it again.
- Look at how activity changes with time in your data.
- Optional: View individual events with “ft_databrowser” or by turning on debugging plots.

Datasets Provided

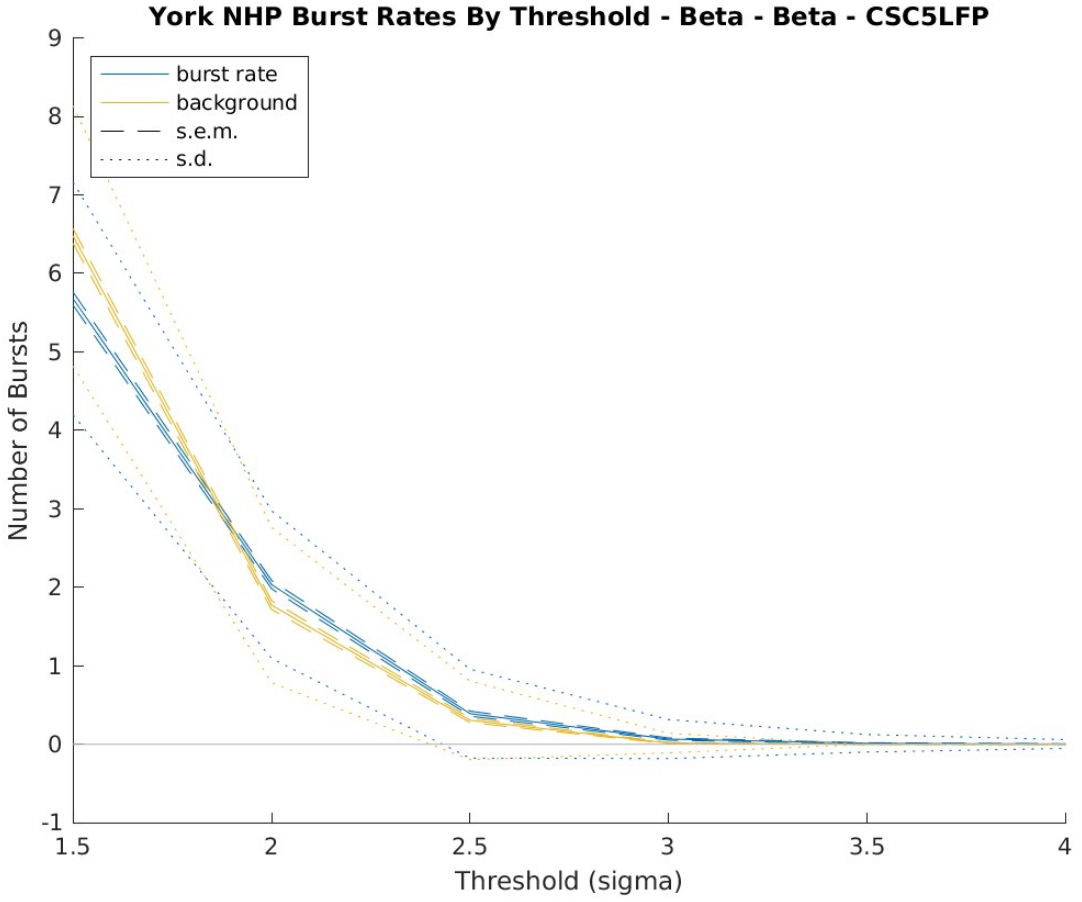
- Example datasets are in Field Trip format.
- Low-pass filtered and downsampled to 1 ksps.

- “wlBurst” set: Events in all bands, rates don’t vary with time.
- “RFH” set: Events in alpha band, rates increase at t=0.
- “NHP” set: Primate playing a puzzle game; alpha, beta, and gamma activity.

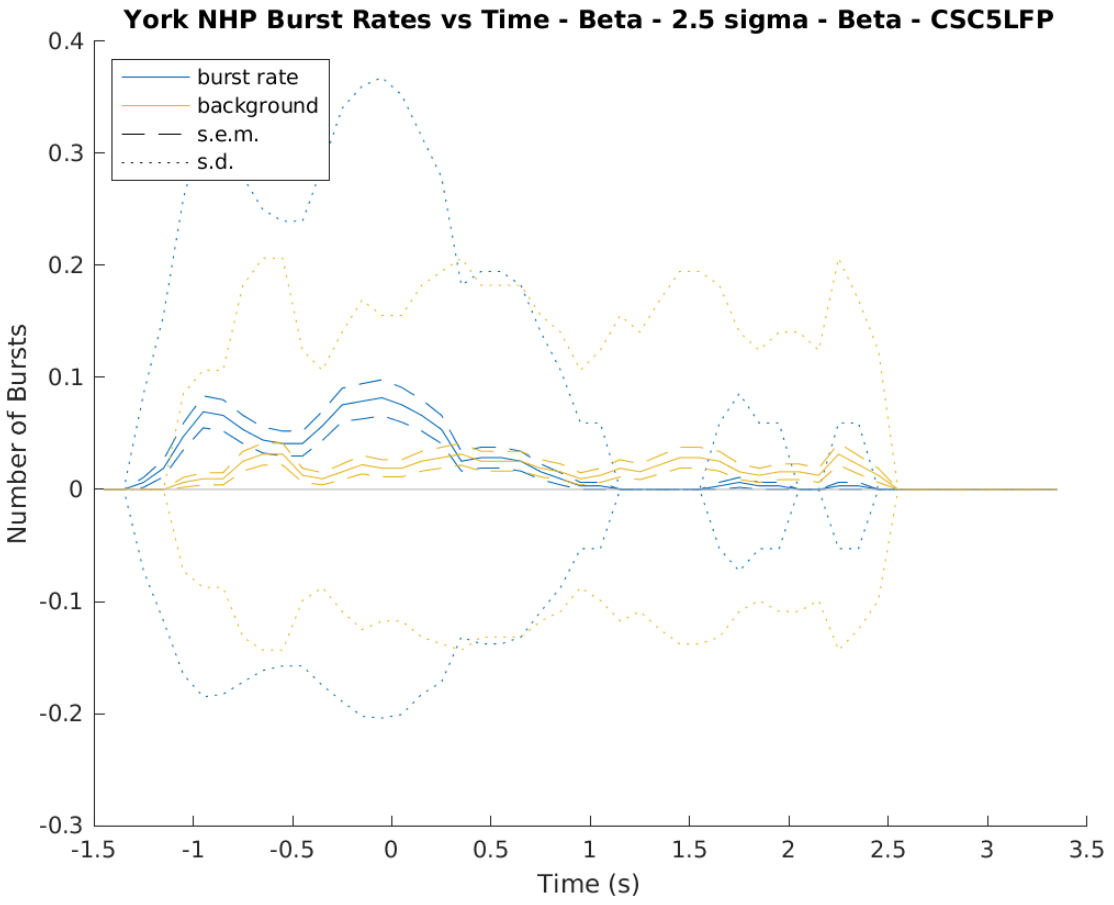
Try It!

- https://github.com/att-circ-contrl/wlBurst_v2_demo
- https://github.com/att-circ-contrl/wlBurst_v2
- “Demo” project has starter script and datasets.
  - NHP data.
  - Synthetic varying with band, synthetic varying with time.
- “wlBurst_v2” project has example code and user manual.

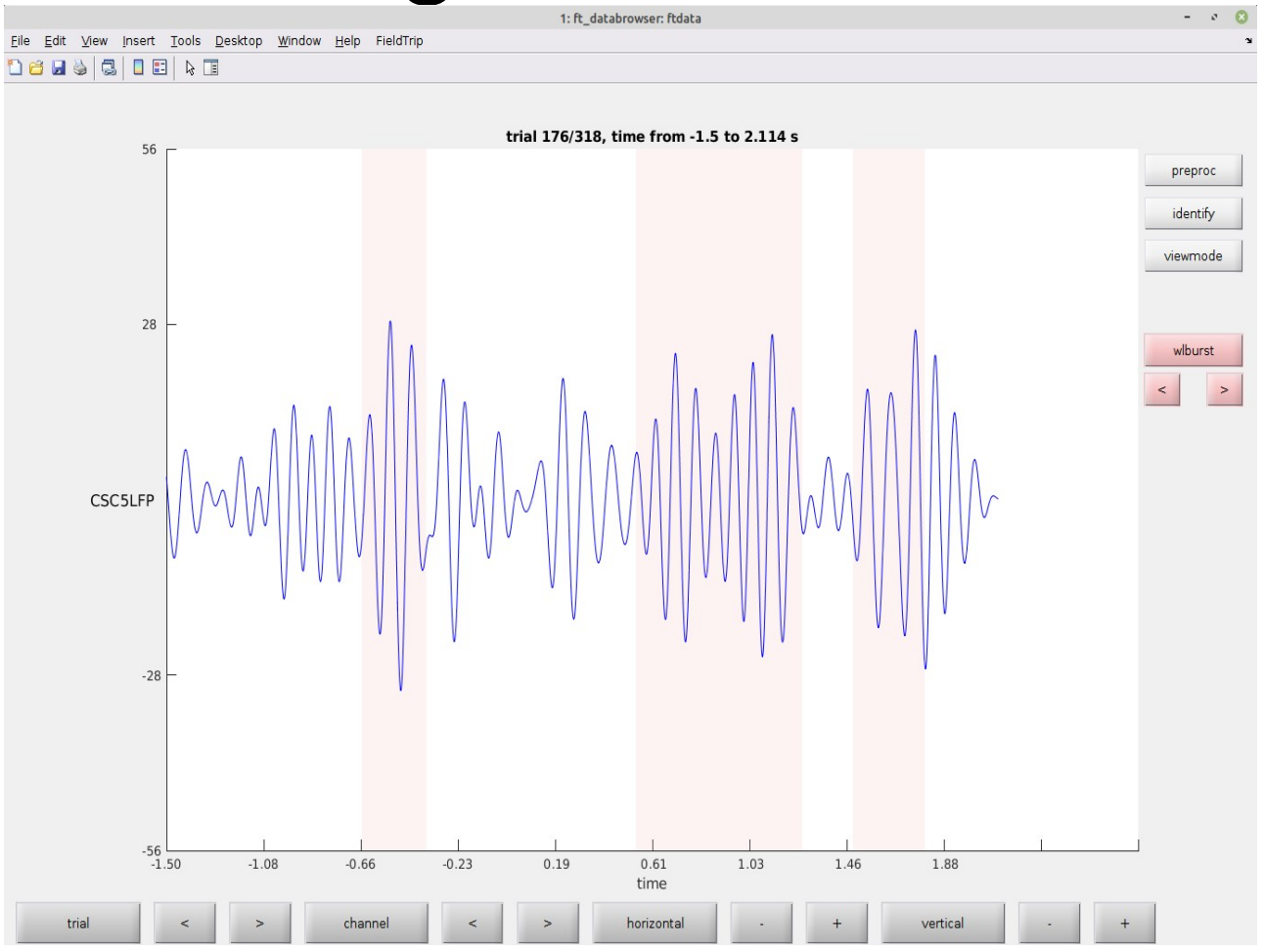
Bonus: NHP Rates vs Threshold



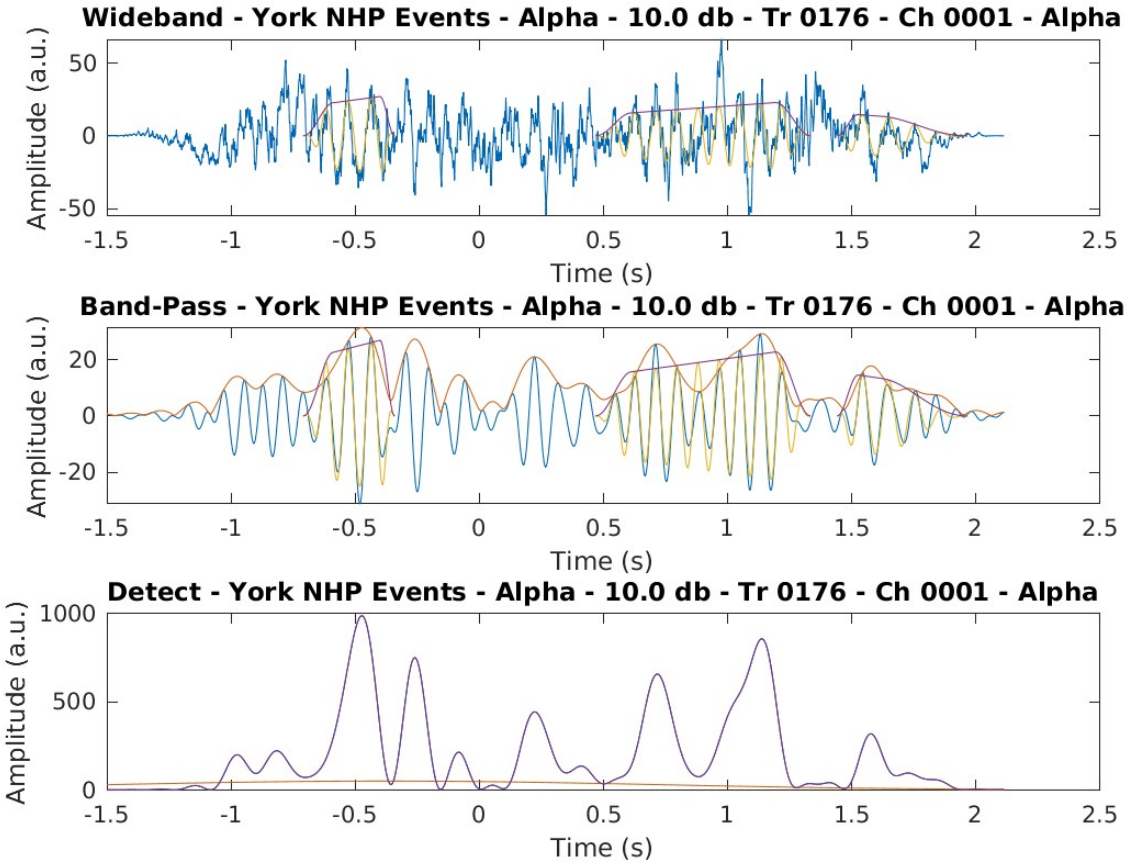
Bonus: NHP Rates vs Time



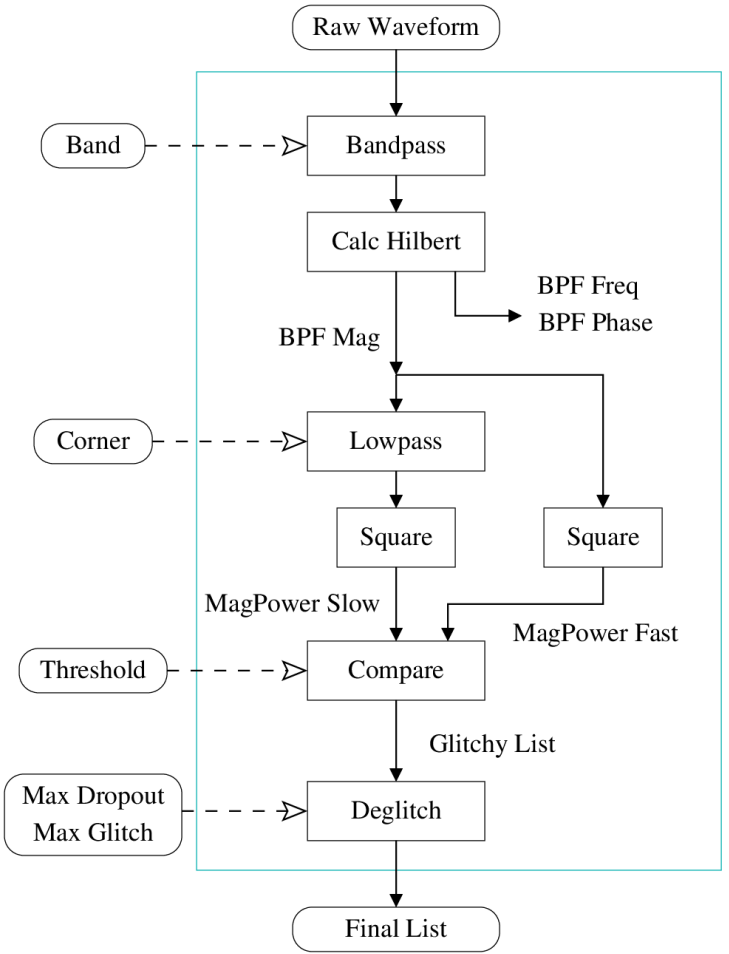
Bonus: Viewing Events with Field Trip



Bonus: Viewing Detection Thresholds



Bonus: Detection Details



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