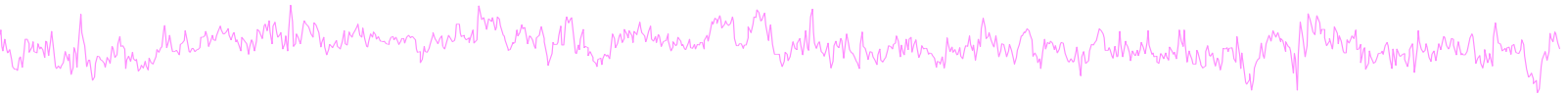
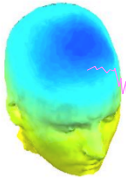


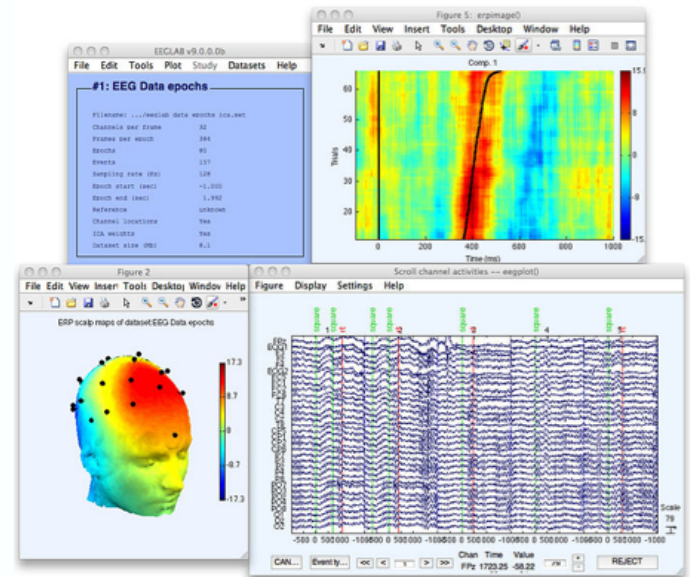
EEGLAB overview



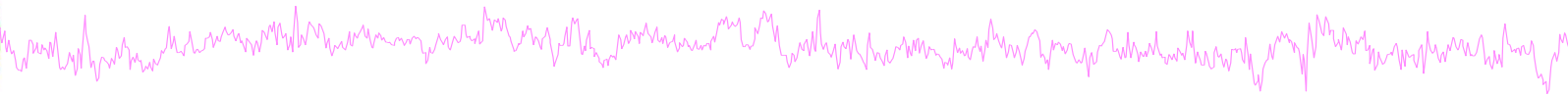
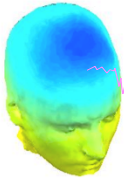
- Collection of about 600 functions (70 000 lines of code)
- About 100 000 download over the past 10 years
- About 6 500 users on the discussion list and 10 500 on the diffusion list
- NIH funding since 2003

<http://sccn.ucsd.edu/eeglab>

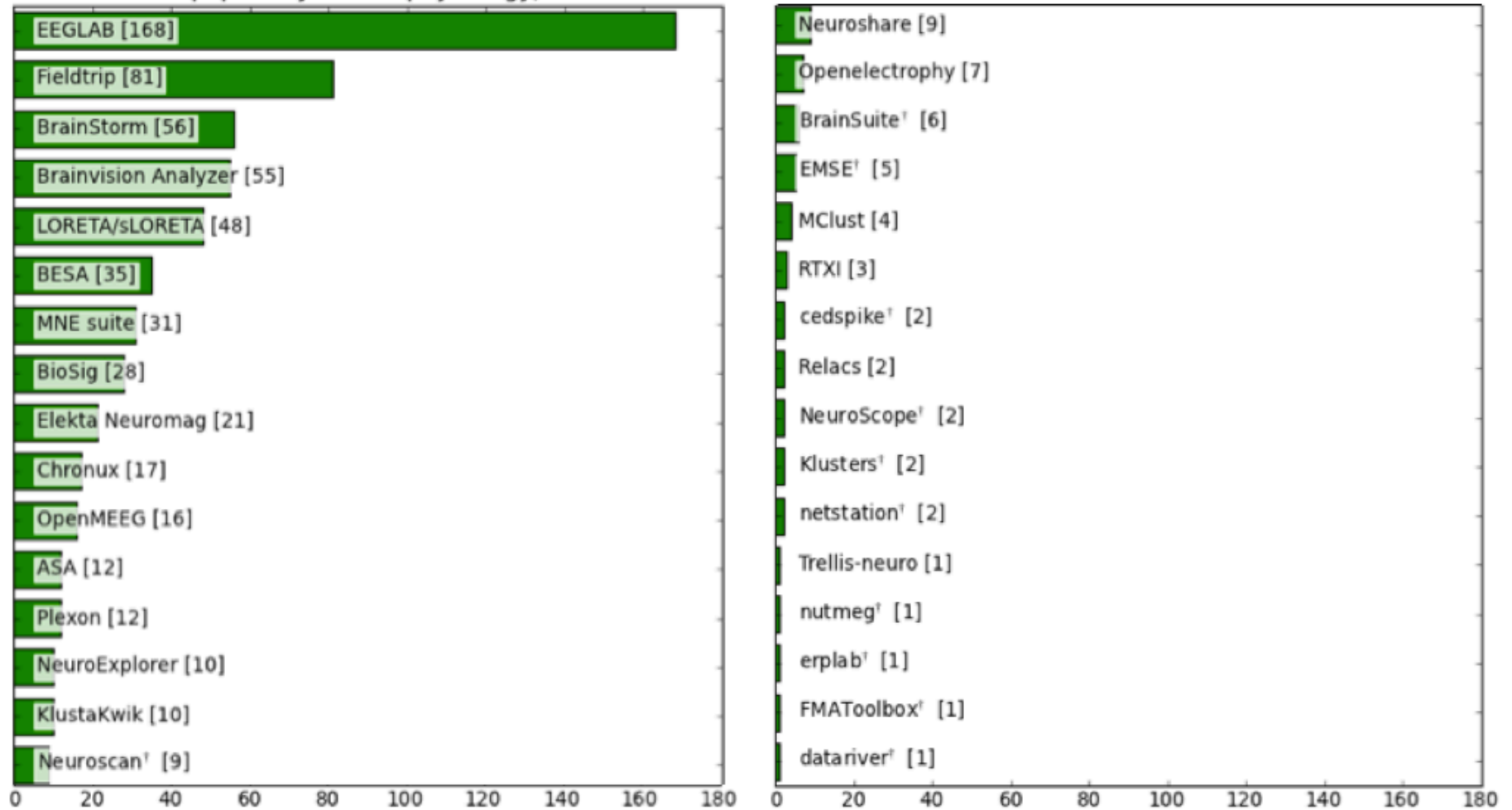
<http://sccn.ucsd.edu/wiki/eeglab>



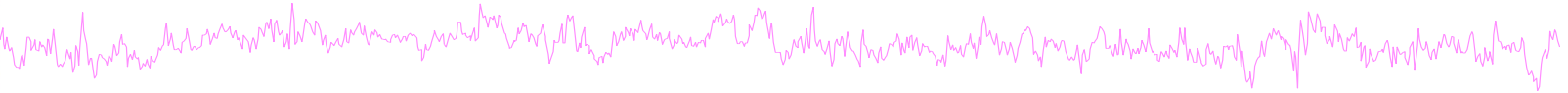
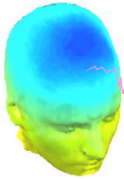
Hanke & Helcencko, 2011, Frontier in Neuroinformatics



Software popularity: Electrophysiology, MEG/EEG



EEGLAB standard processing pipeline



Single subject

1. Import binary data, events and channel location
2. Edit, Re-reference, Resample, High pass filter data
3. Reject artifacts in continuous data by visual inspection
4. Extract epochs from data & reject artifactual epochs
5. Visualize data measures
6. Perform ICA decomposition
 - Perform source localization of components
 - Analyze components contribution to ERP
 - Analyze components contribution to spectrum

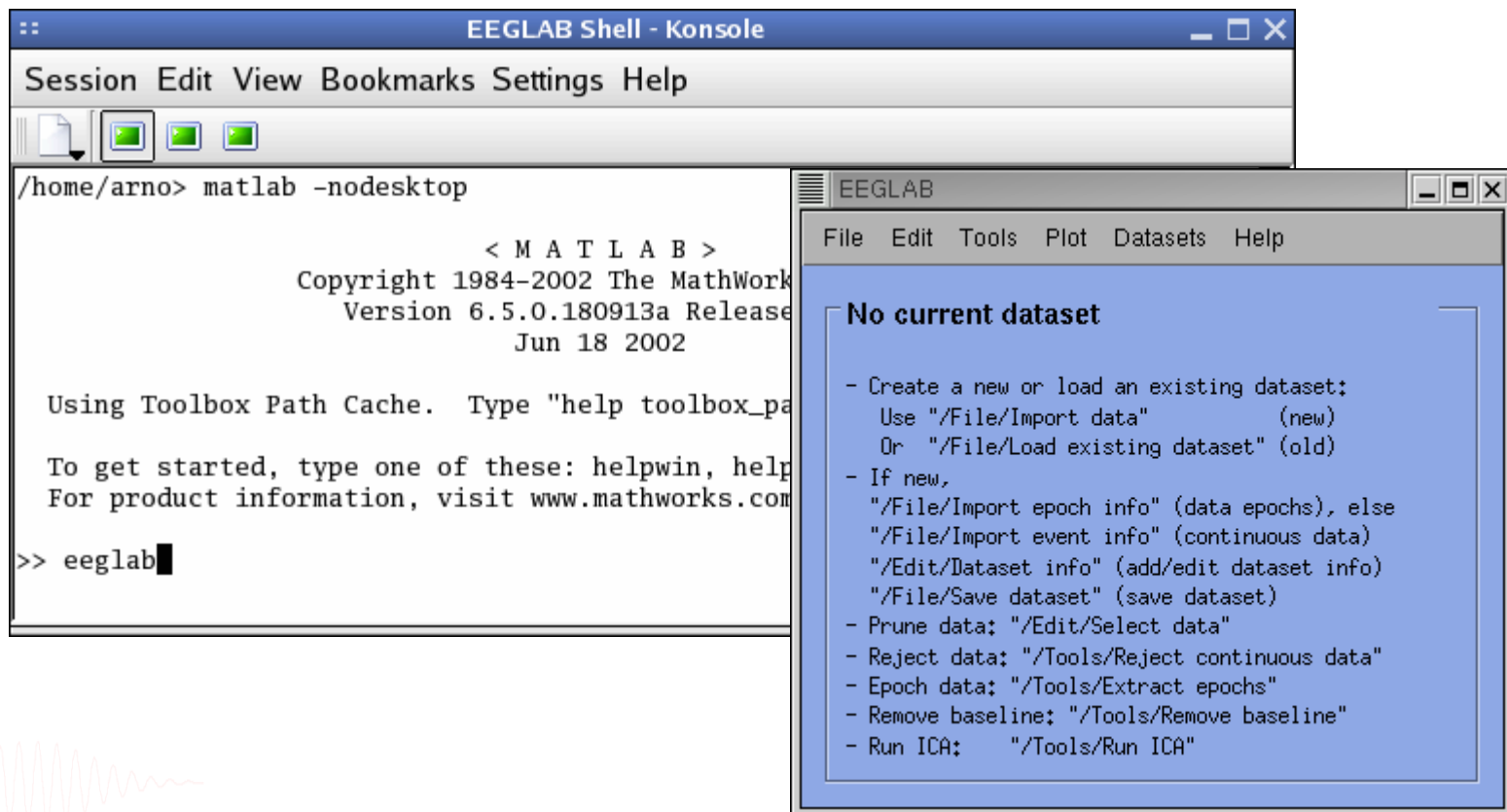
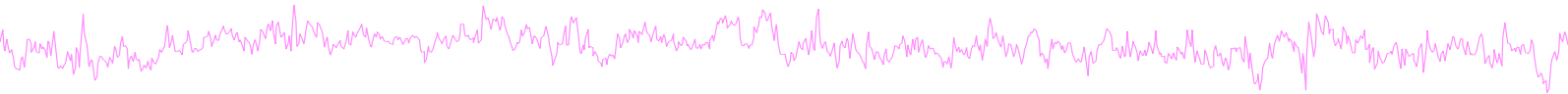
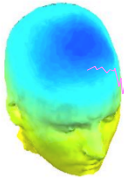
Multi-subjects

1. Build study and STUDY design
2. Pre-compute measures
3. Cluster components
4. Analyze clusters

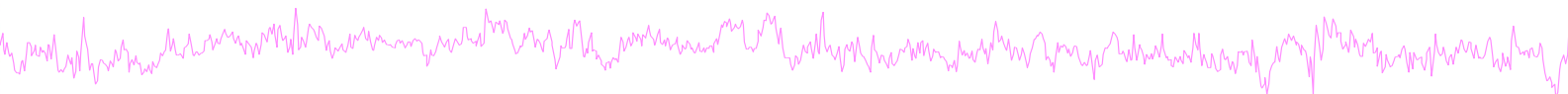
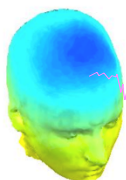


Advanced analysis using scripting and EEGLAB command line functions

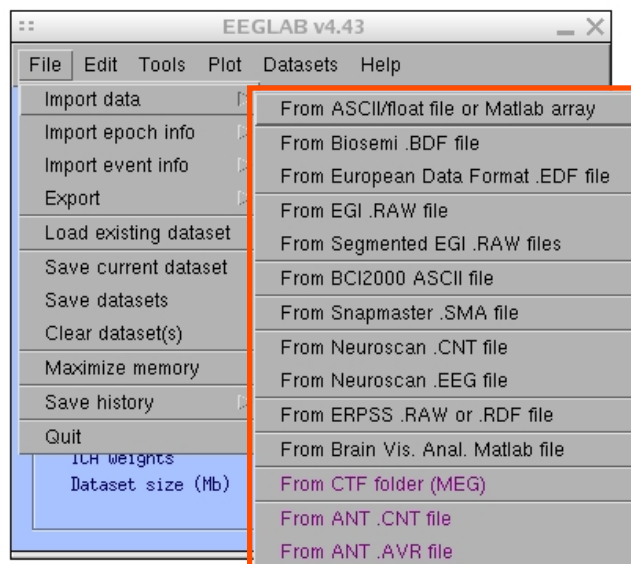
The EEGLAB Matlab software



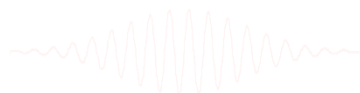
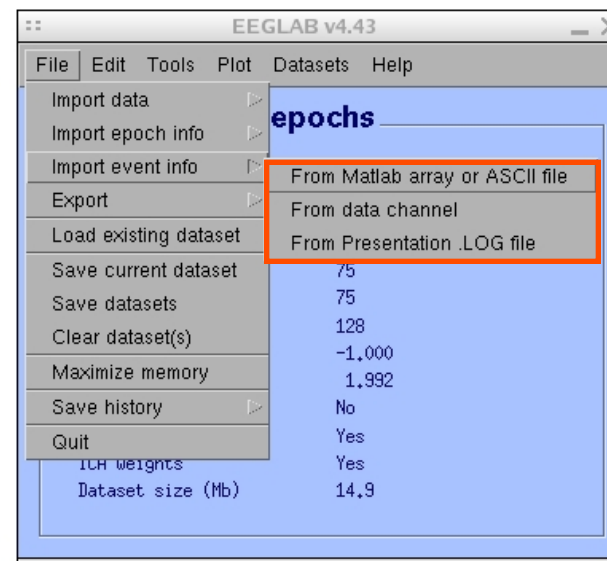
1. Importing data



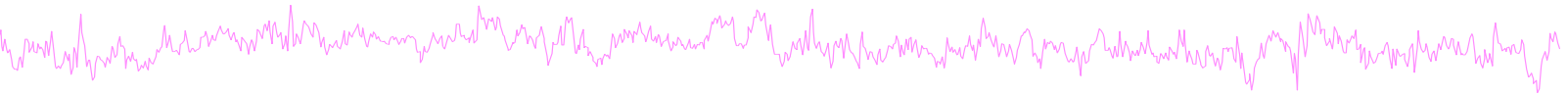
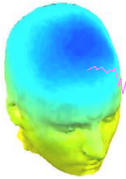
Import/load data



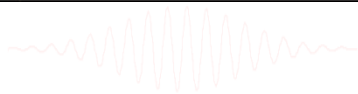
Import events



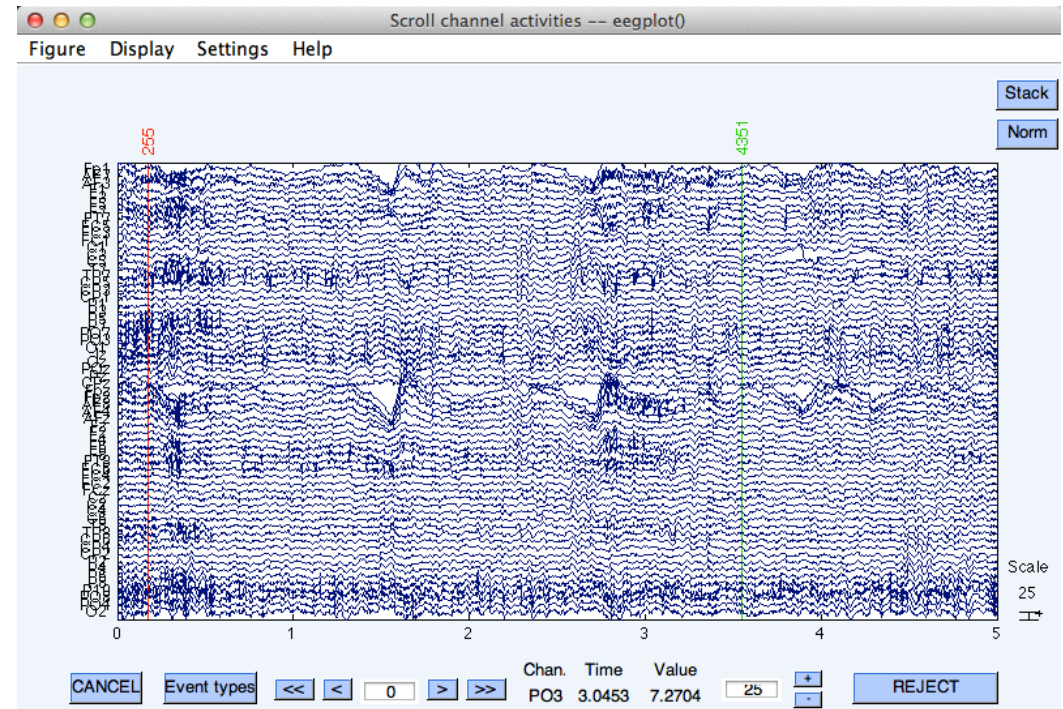
1. Importing data



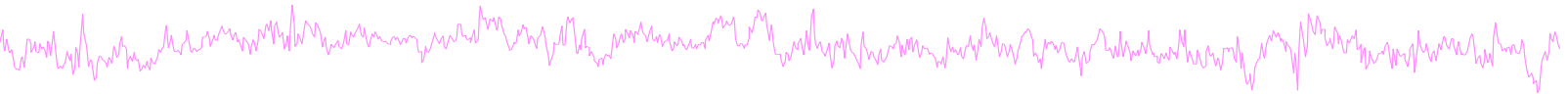
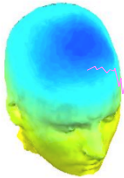
Data info



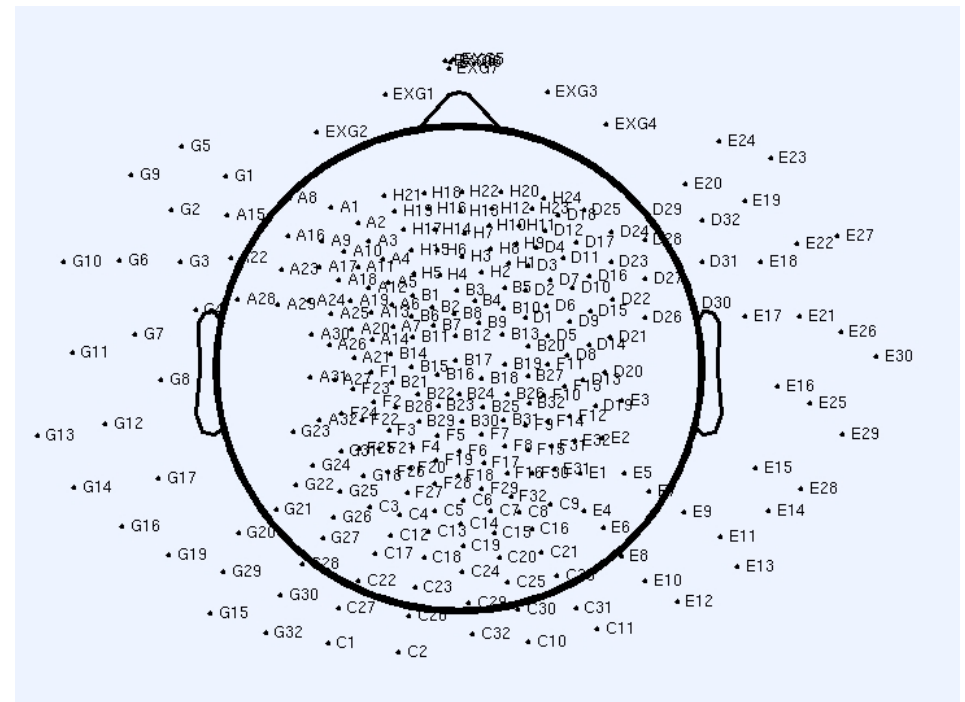
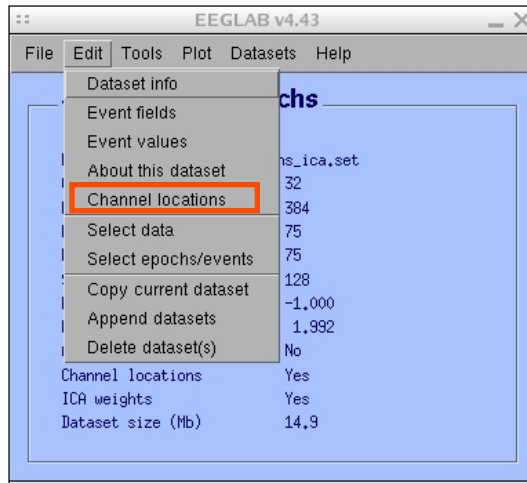
Scrolling data



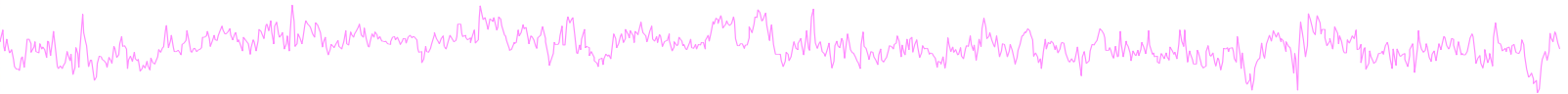
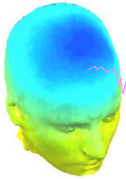
1. Importing channel location



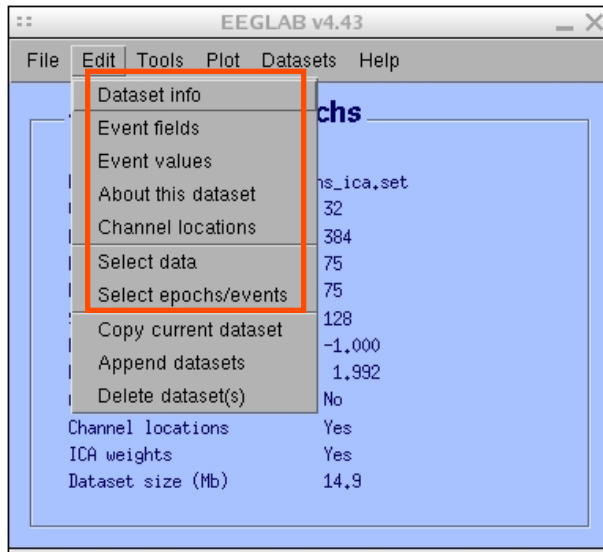
Import channel location



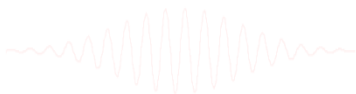
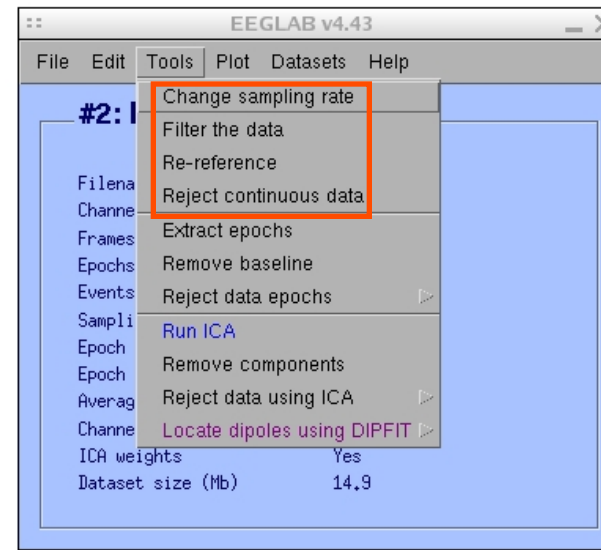
2. Edit, Re-reference, Resample, High pass filter data



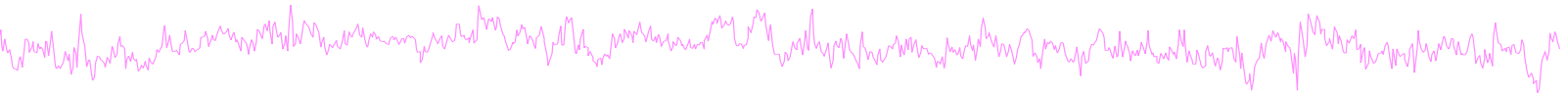
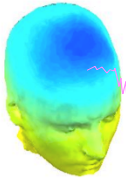
Edit/select data



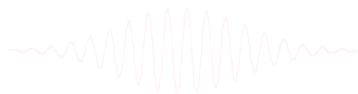
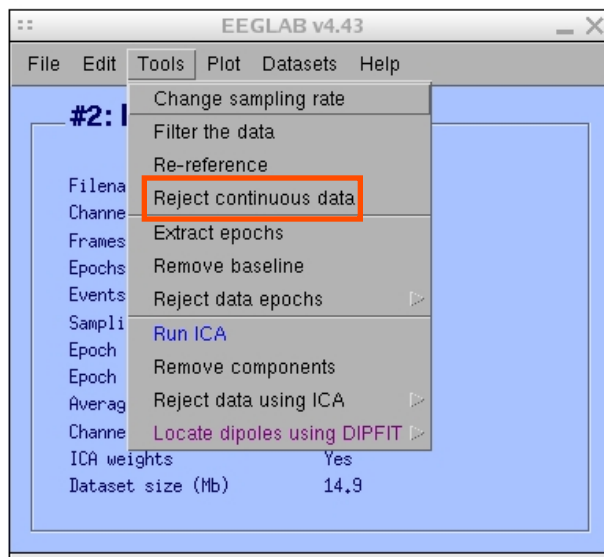
Preprocessing data



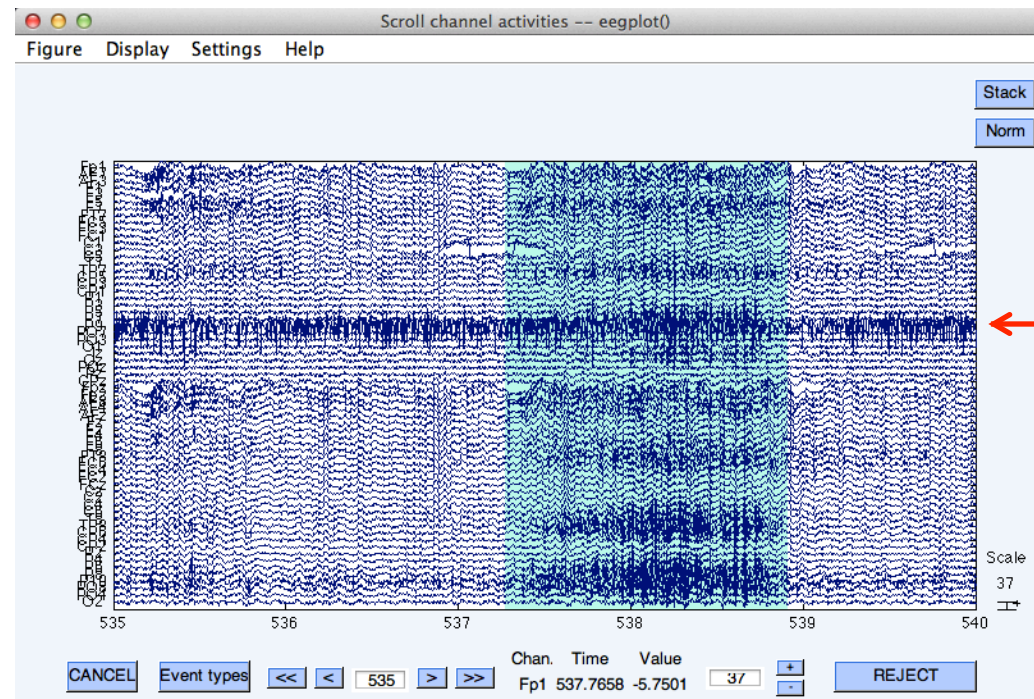
3. Reject artifacts in continuous data by visual inspection



Data info



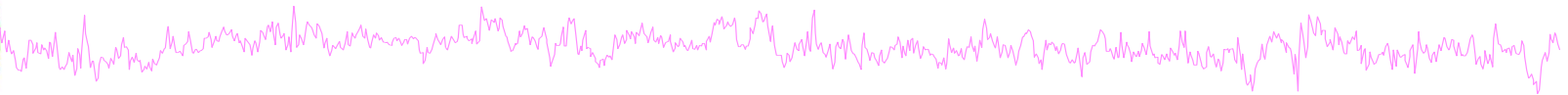
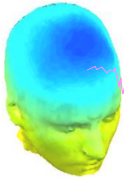
Reject portions of continuous data



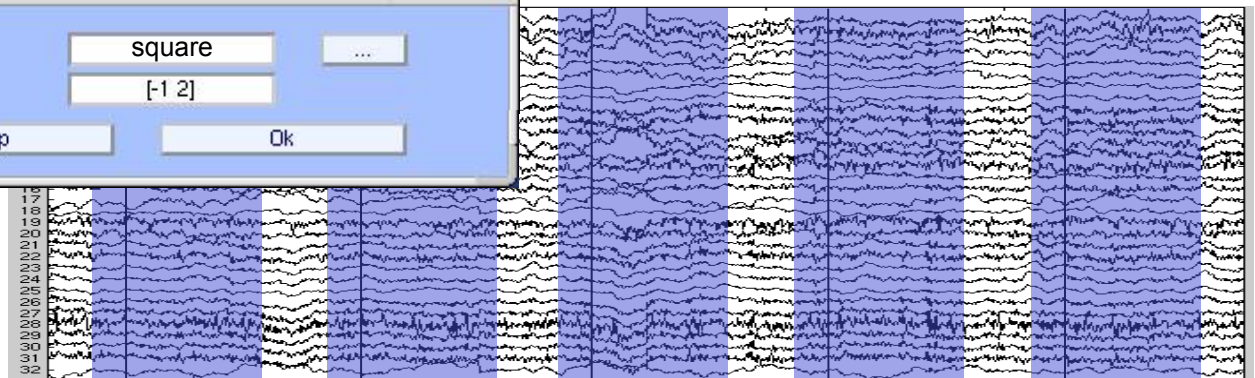
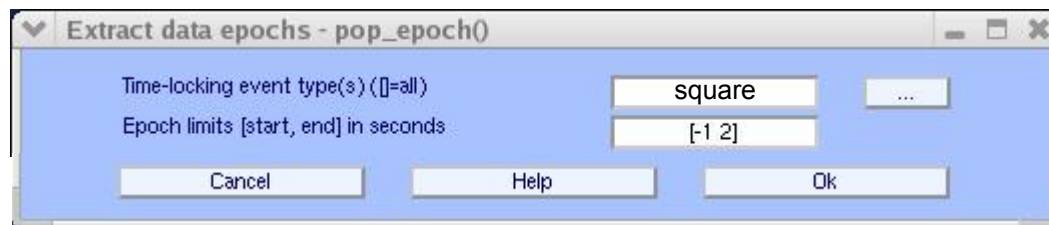
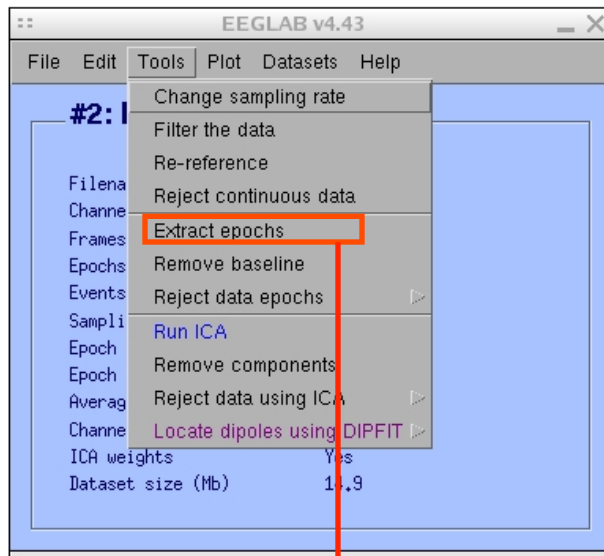
Bad channel

Bad portion of data

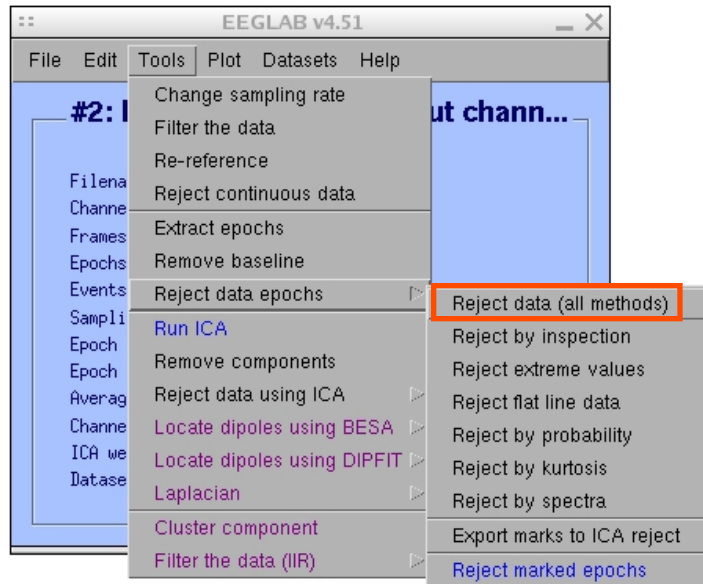
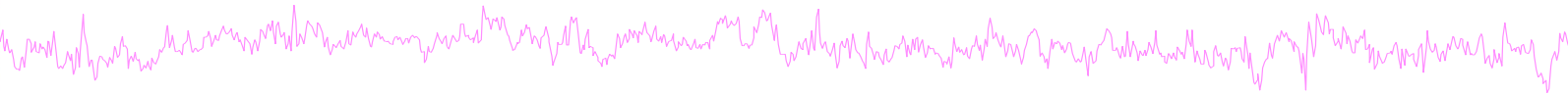
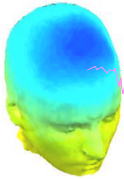
4. Extract epochs from data & reject artifactual epochs



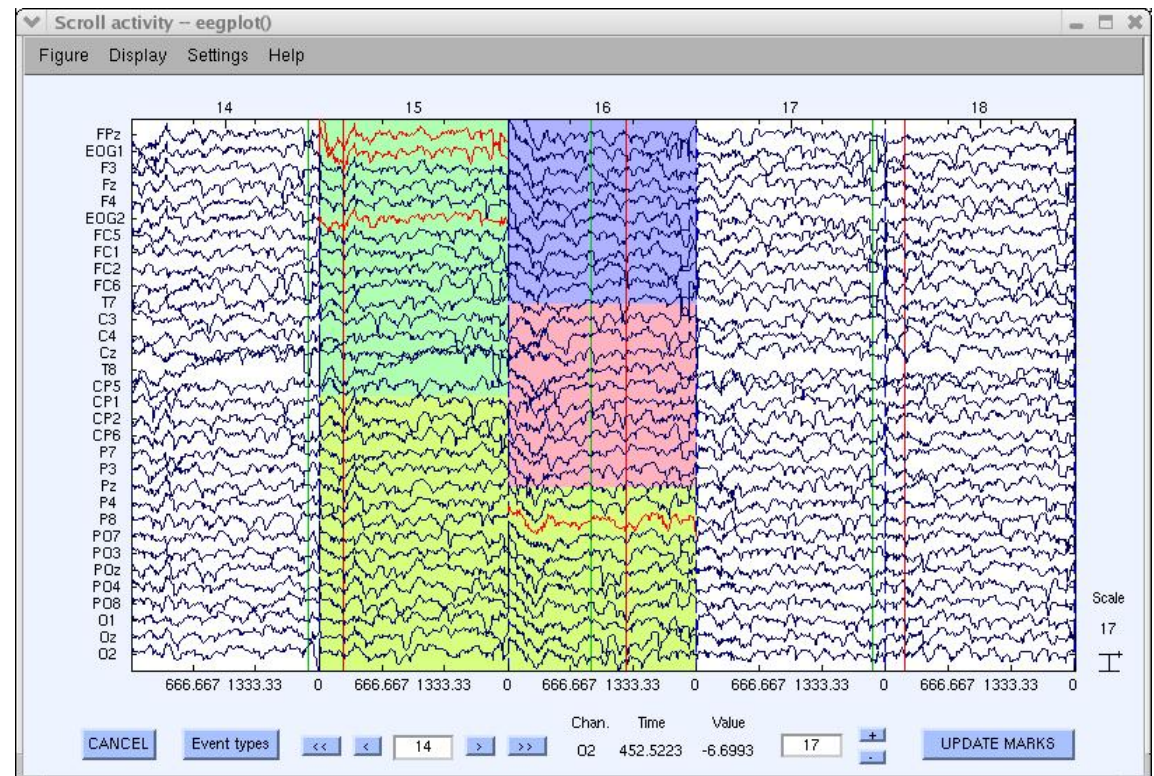
Preprocessing data



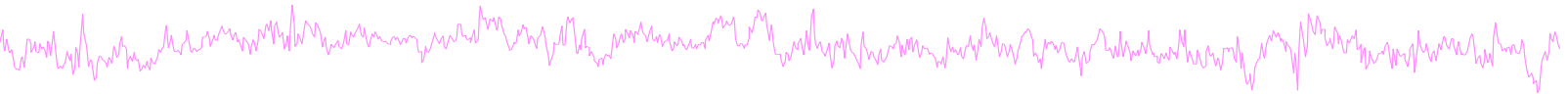
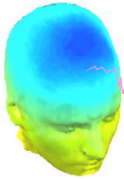
4. Extract epochs from data & reject artifactual epochs



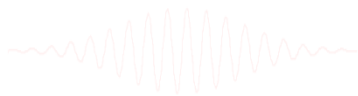
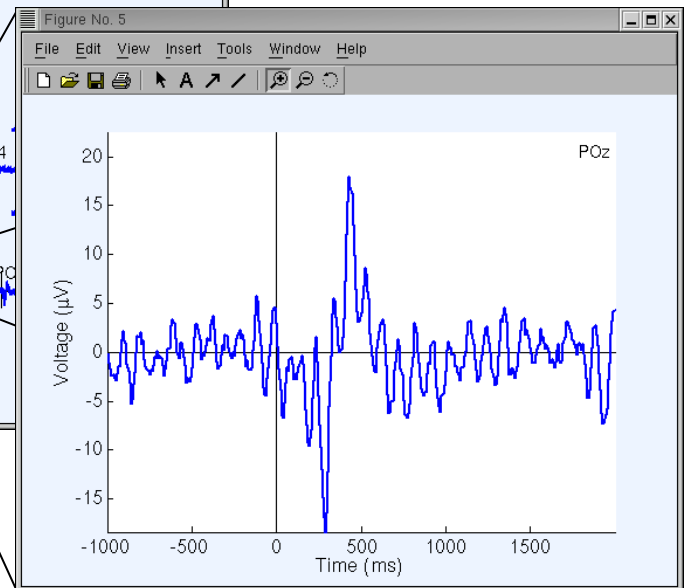
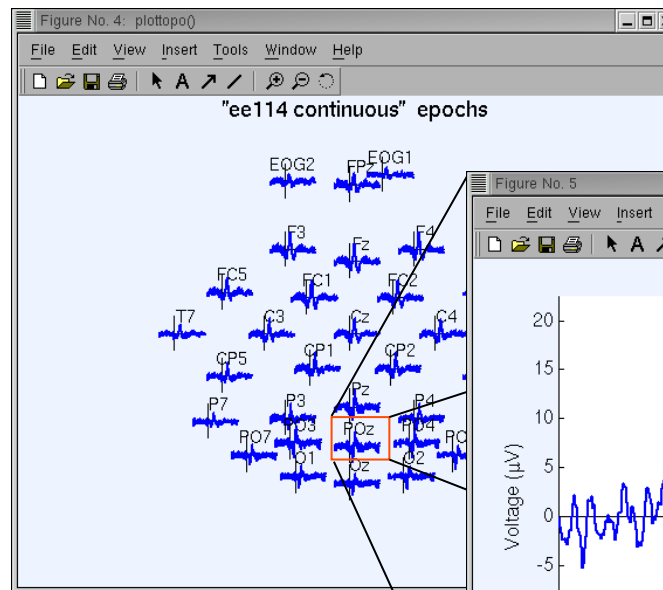
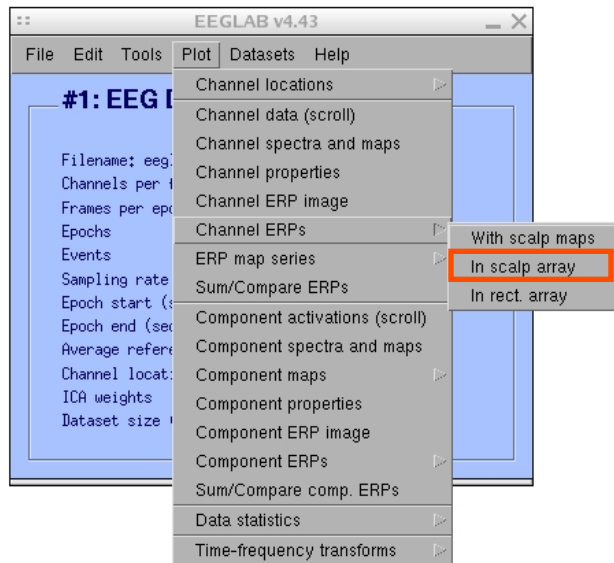
Different color = different rejection methods



5. Visualize data measures

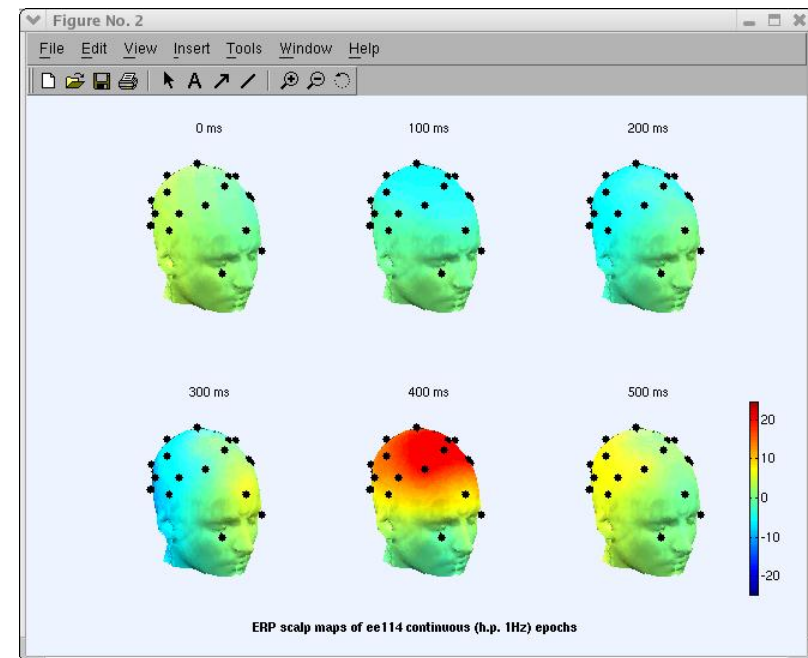
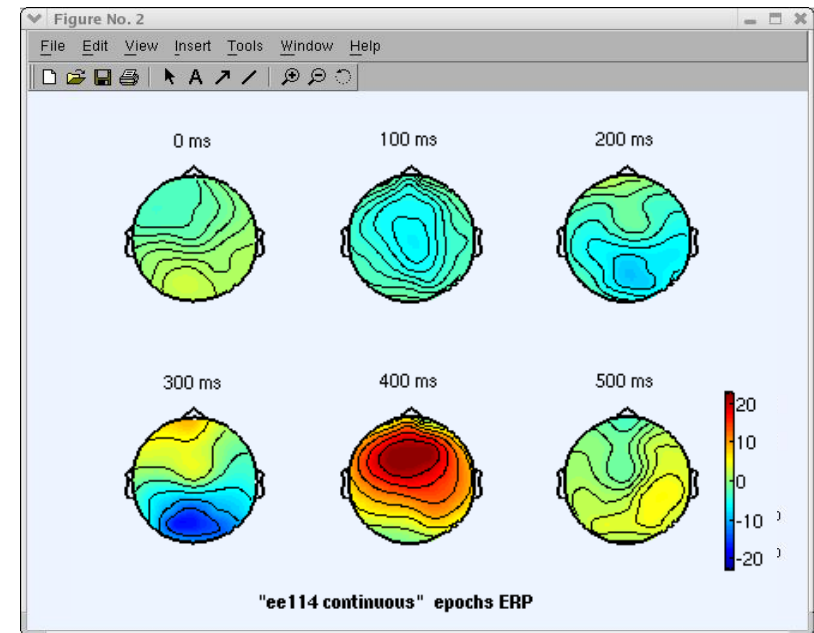
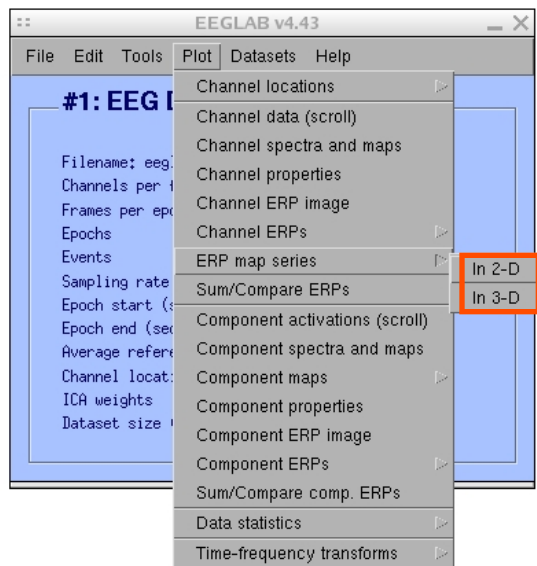


Plot ERP

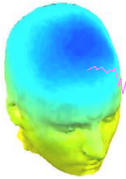


5. Visualize data measures

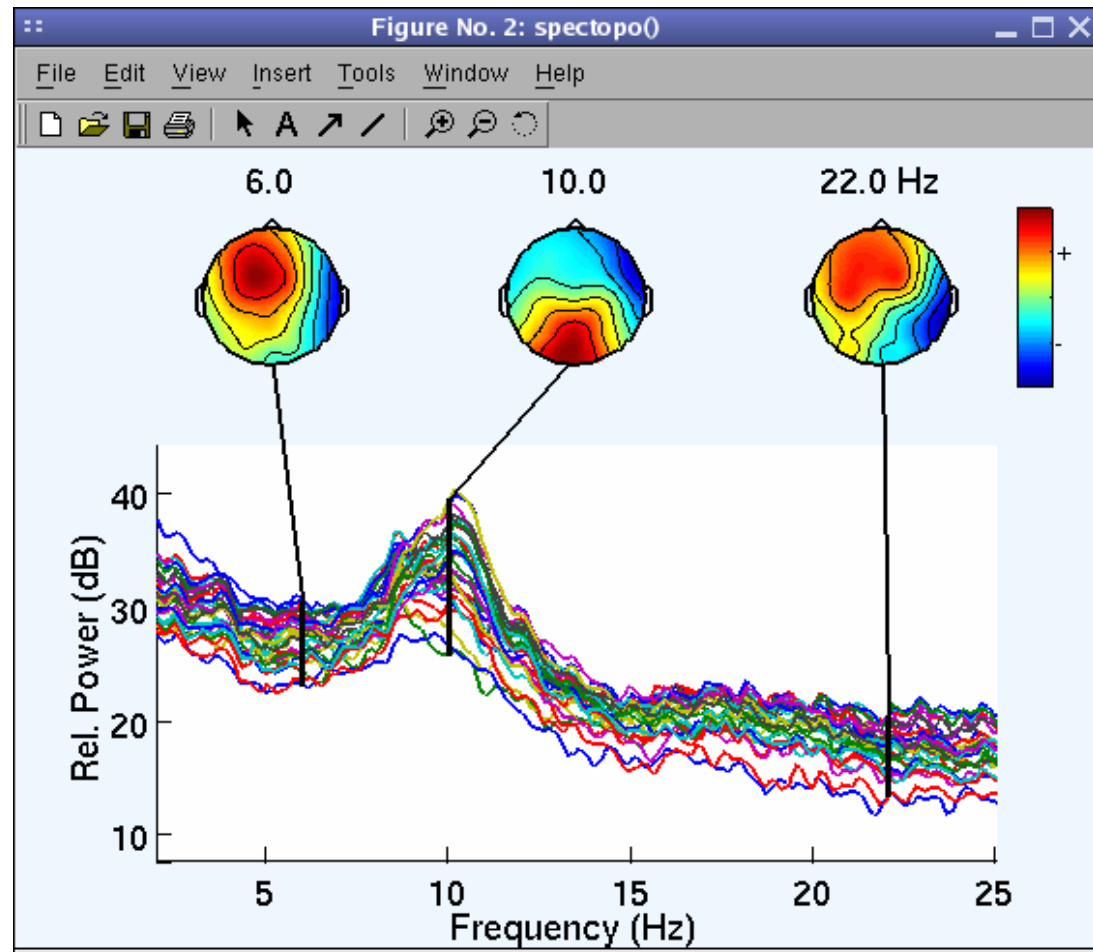
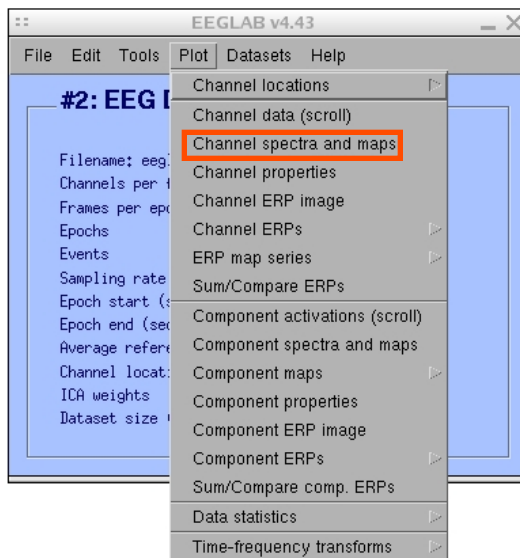
Plot ERP
map series



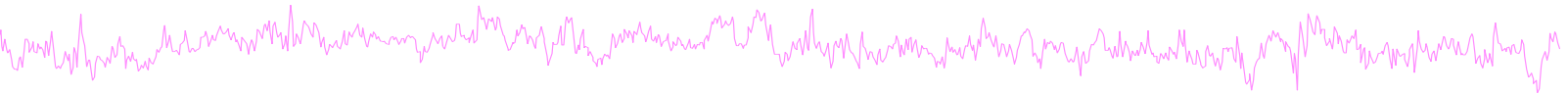
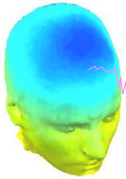
5. Visualize data measures



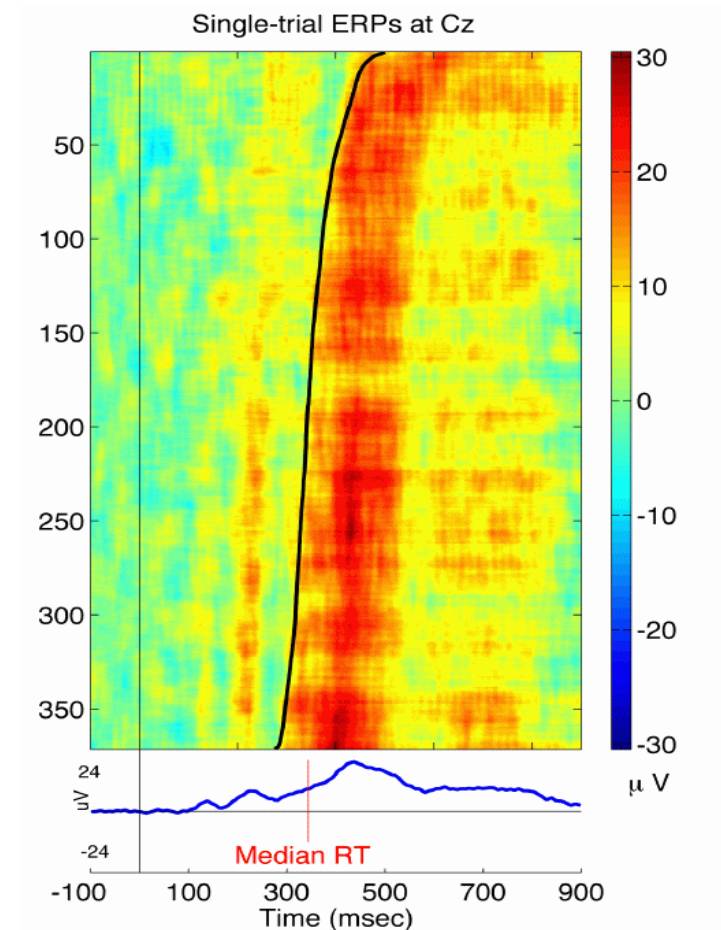
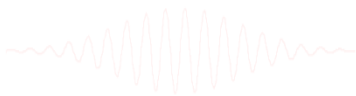
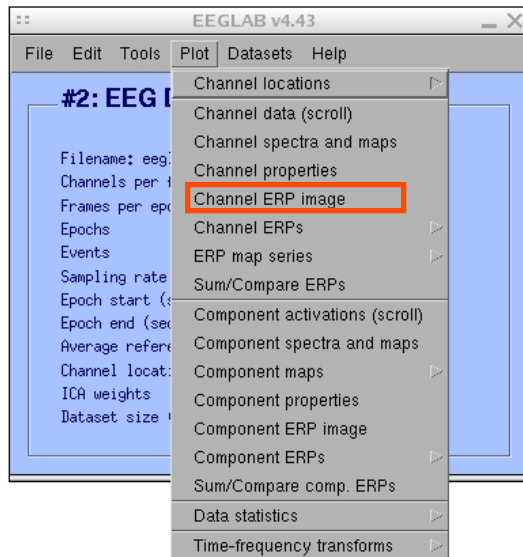
Plot data
spectrum and
maps



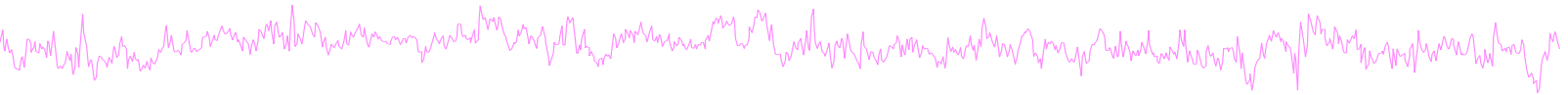
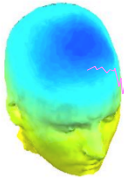
5. Visualize data measures



Plot channel ERPimage



EEGLAB standard processing pipeline



Single subject

1. Import binary data, events and channel location
2. Edit, Re-reference, Resample, High pass filter data
3. Reject artifacts in continuous data by visual inspection
4. Extract epochs from data & reject artifactual epochs
5. Visualize data measures
6. Perform ICA decomposition
 - Perform source localization of components
 - Analyze components contribution to ERP
 - Analyze components contribution to spectrum

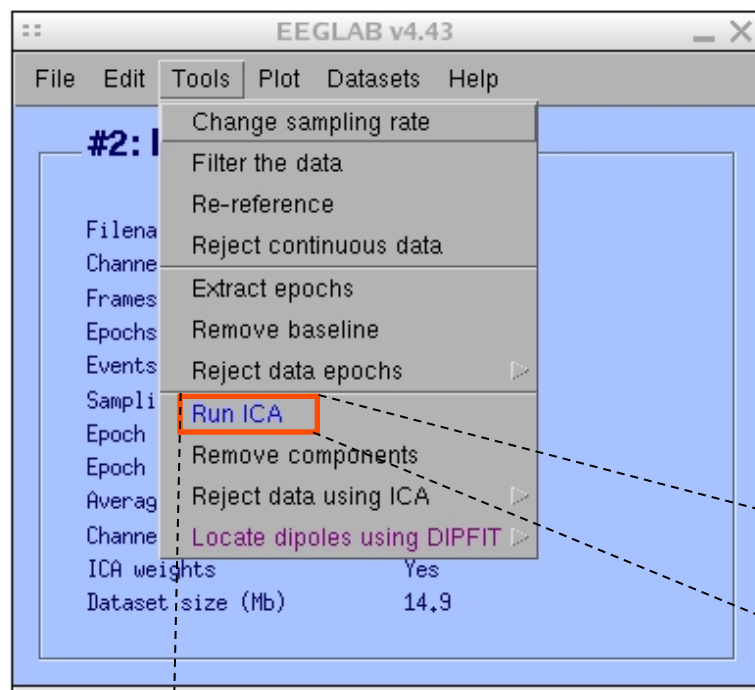
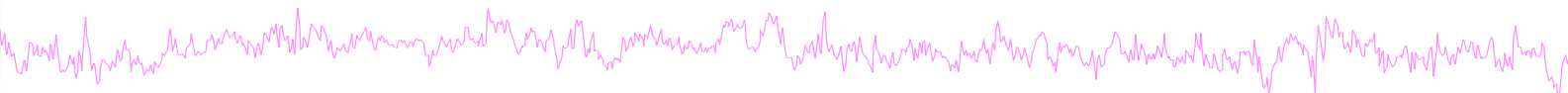
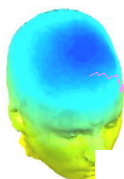
Multi-subjects

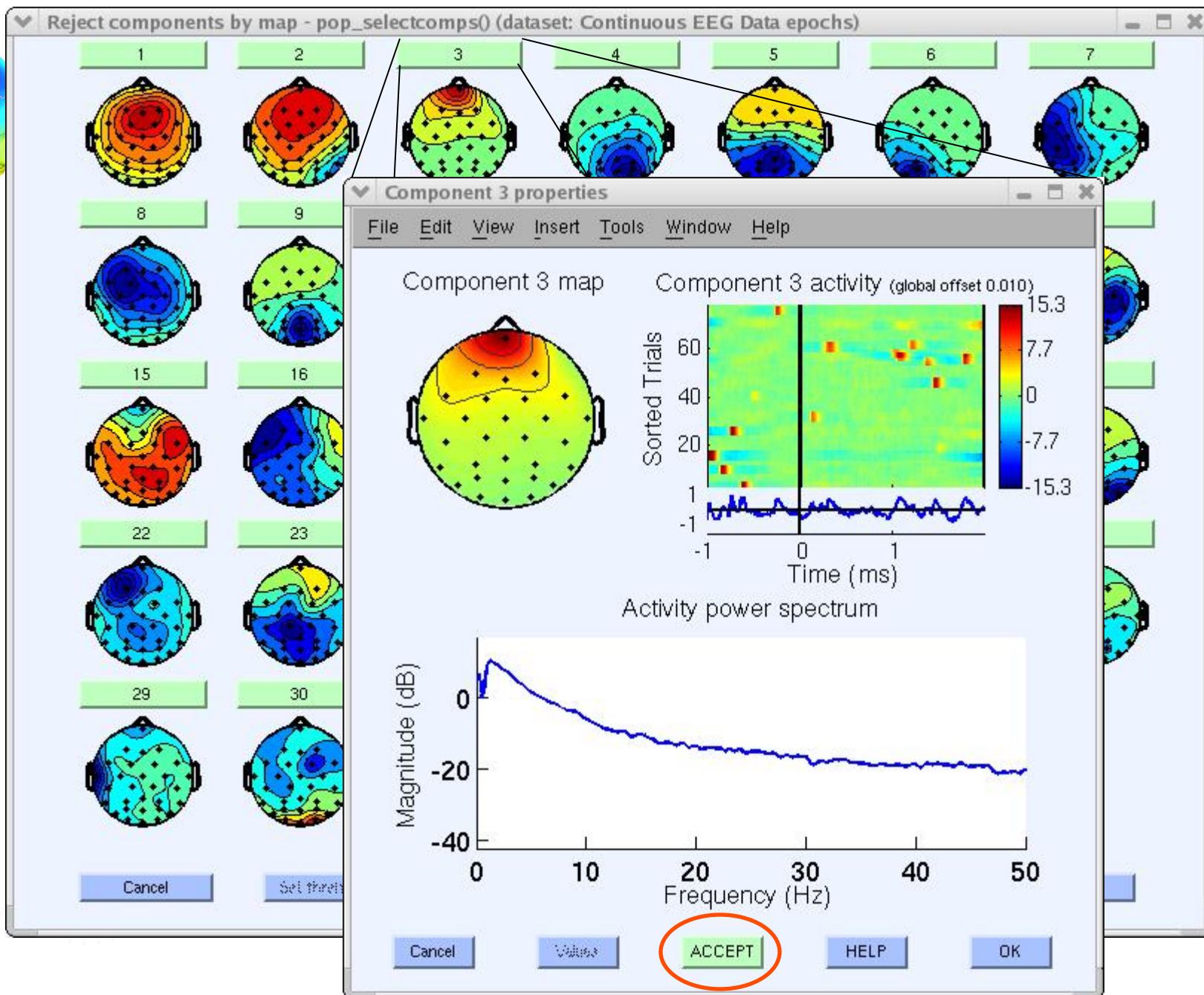
1. Build study
2. Pre-compute measures
3. Cluster components
4. Analyze clusters



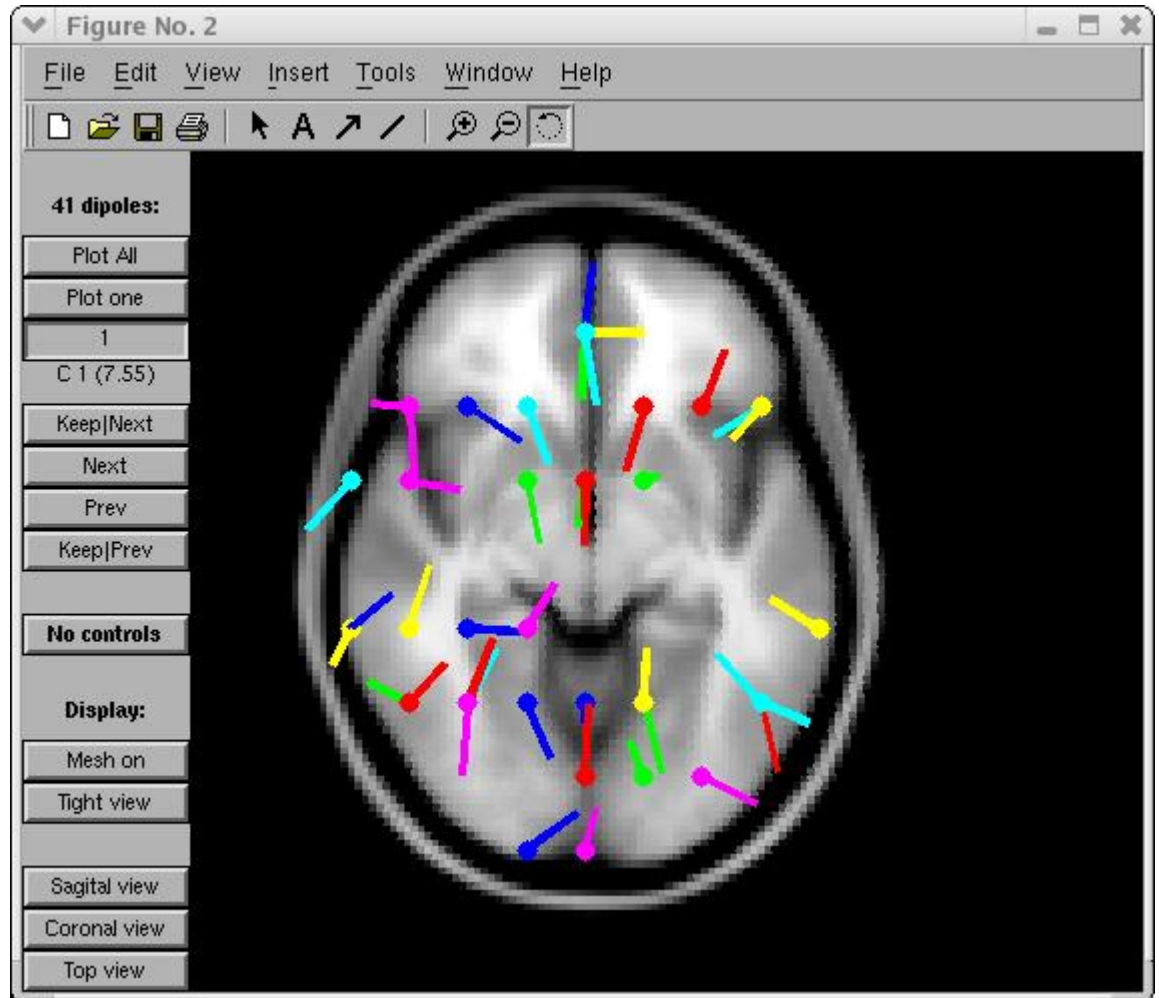
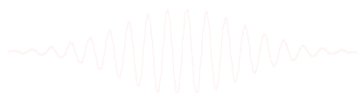
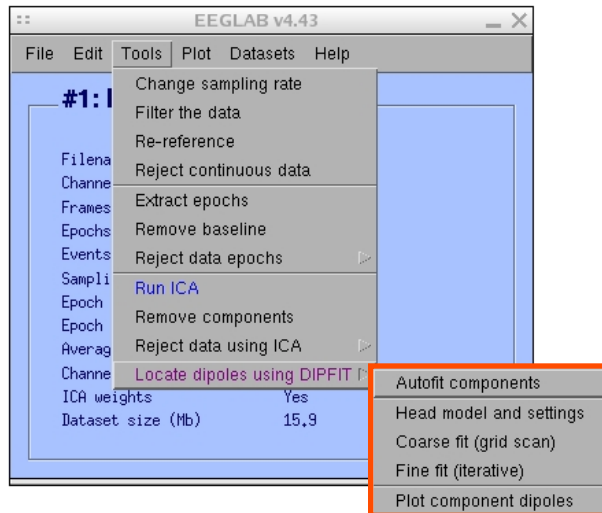
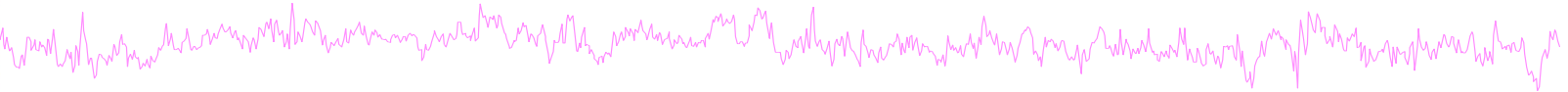
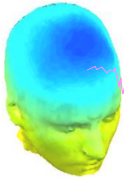
Advanced analysis using scripting and EEGLAB command line functions

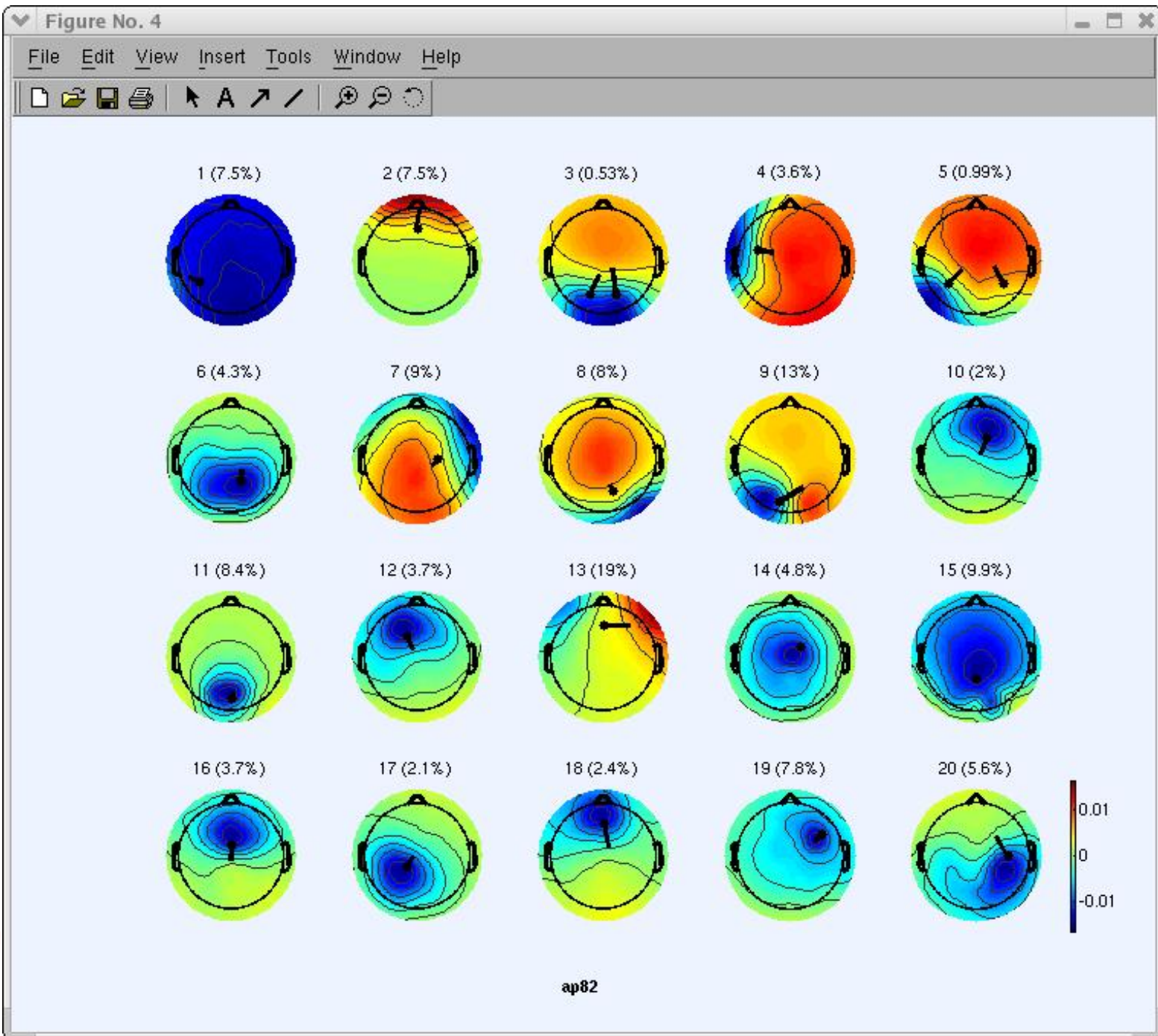
6. Perform ICA decomposition



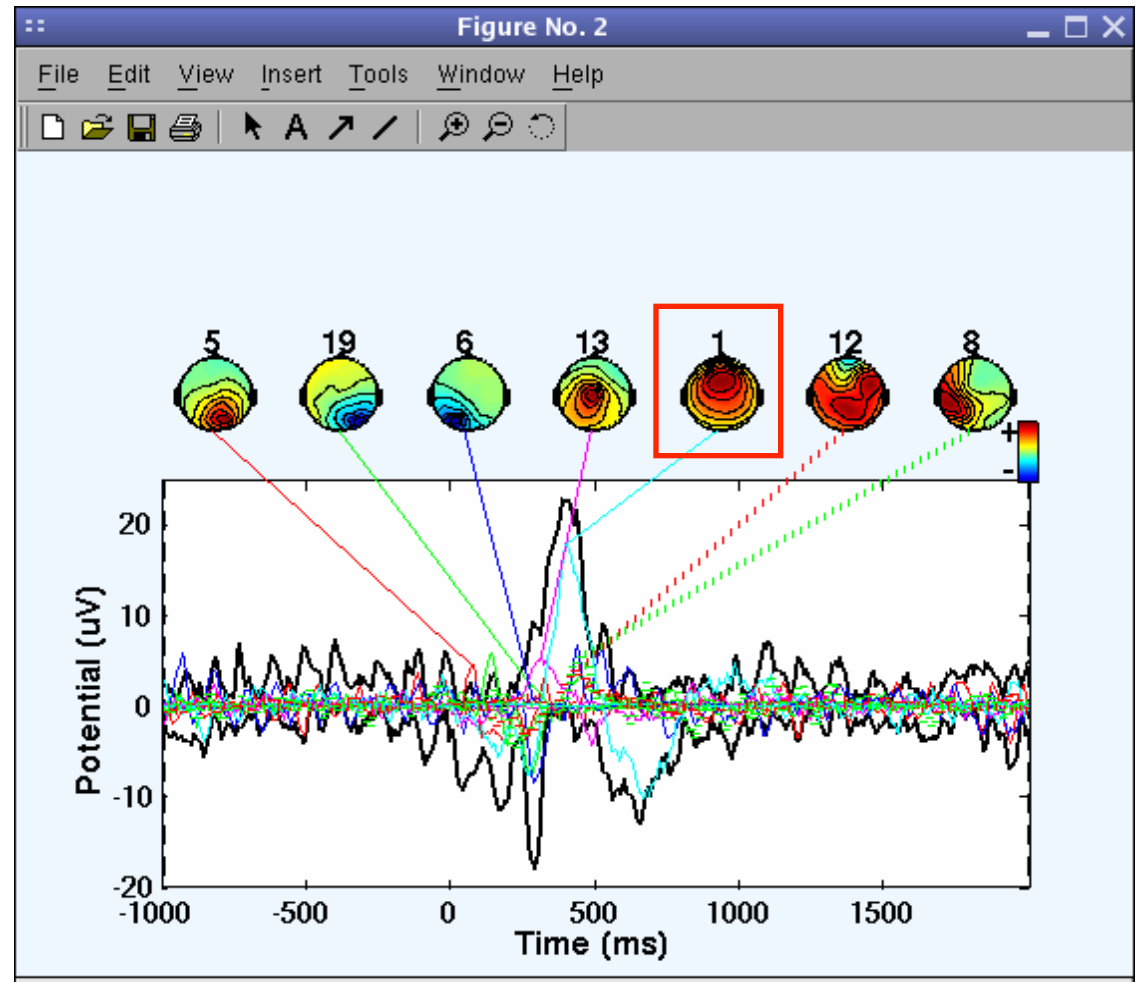
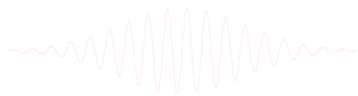
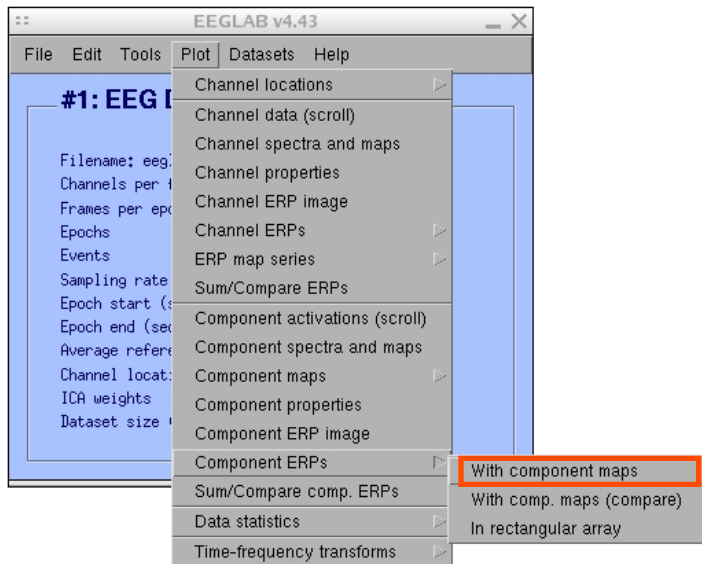
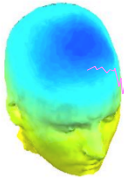


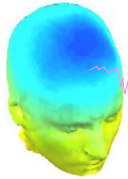
Localizing components



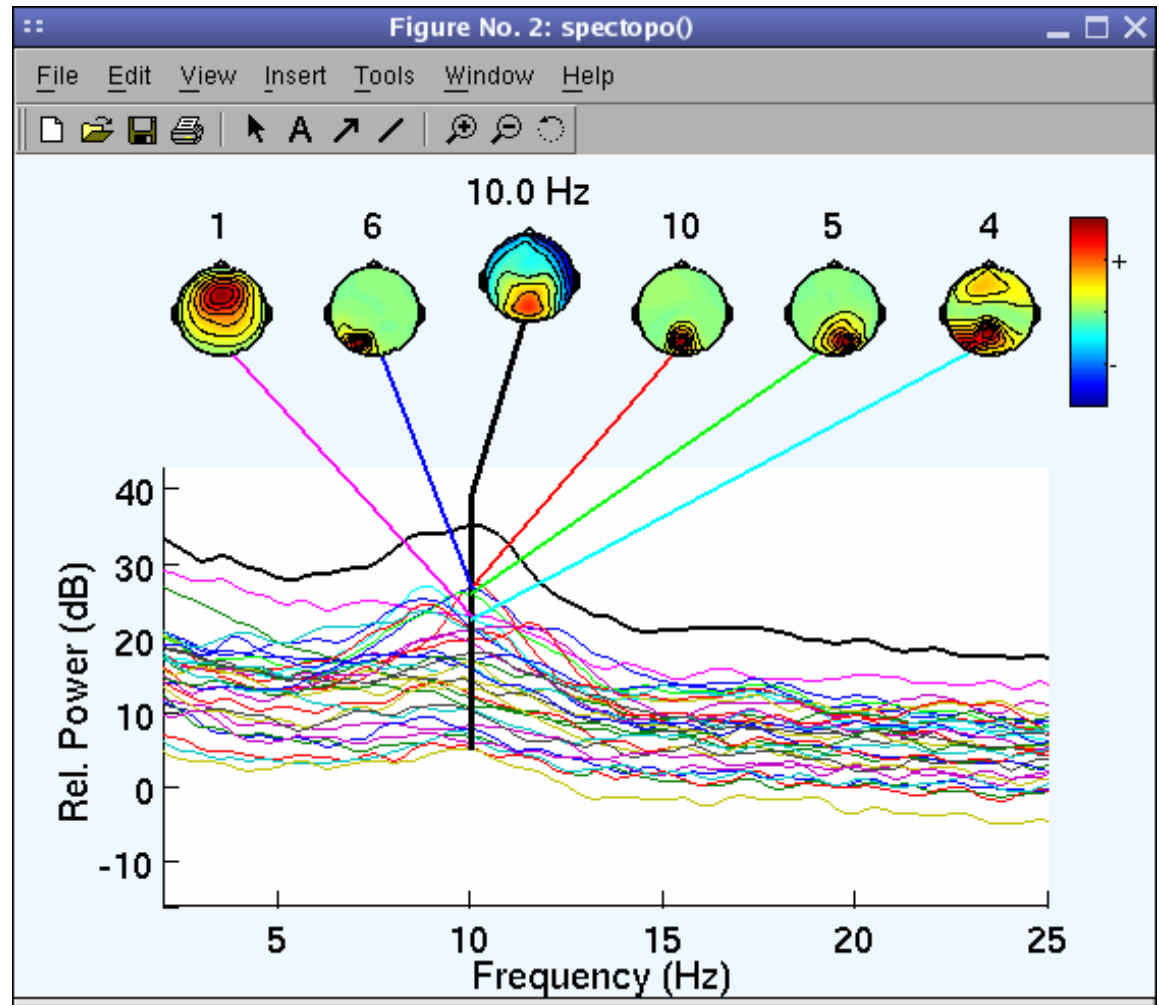
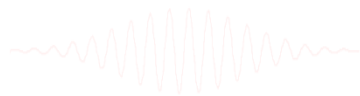
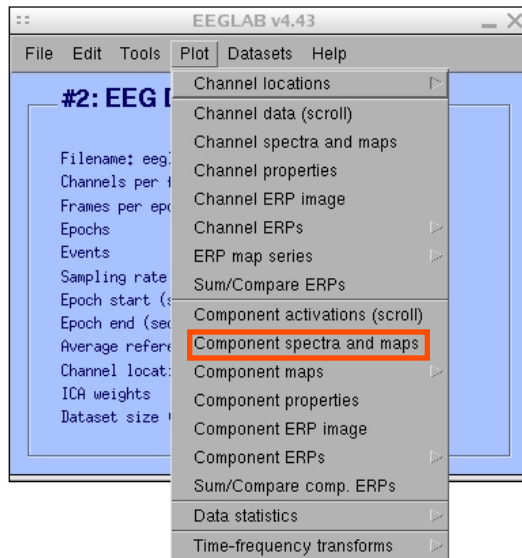
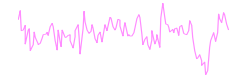


Component contribution to the ERP

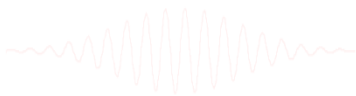
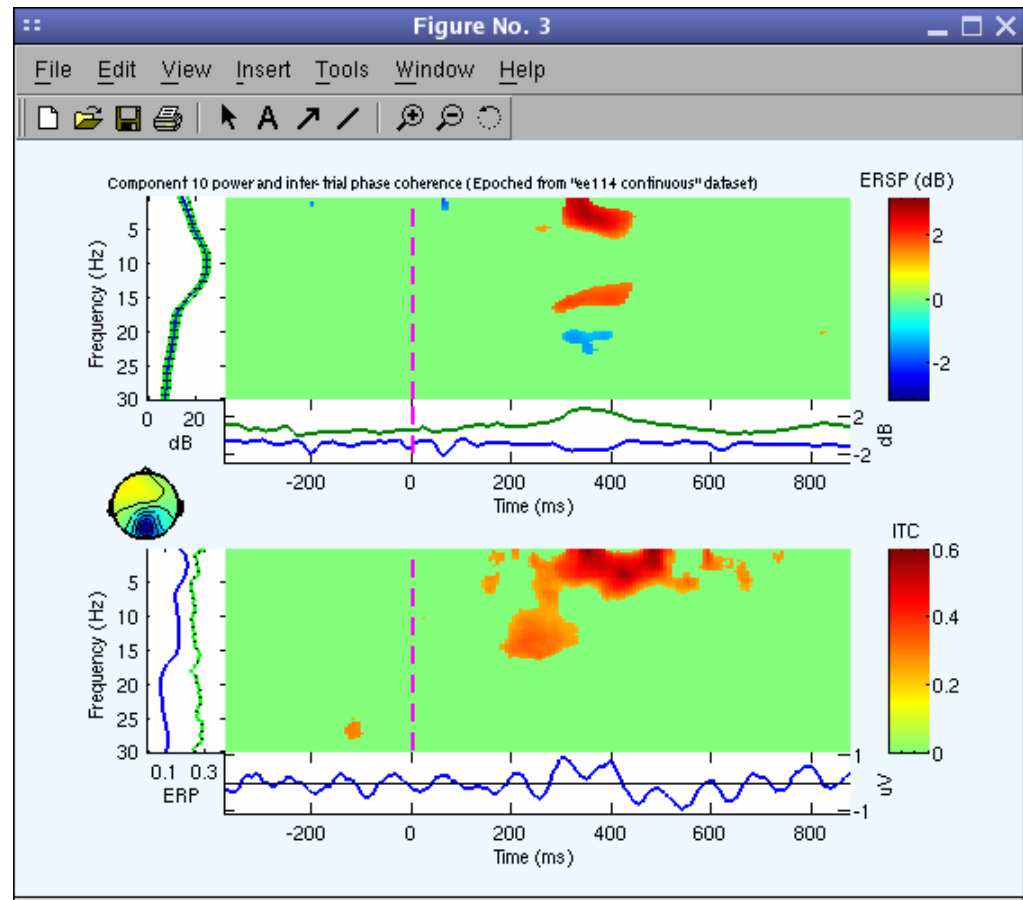
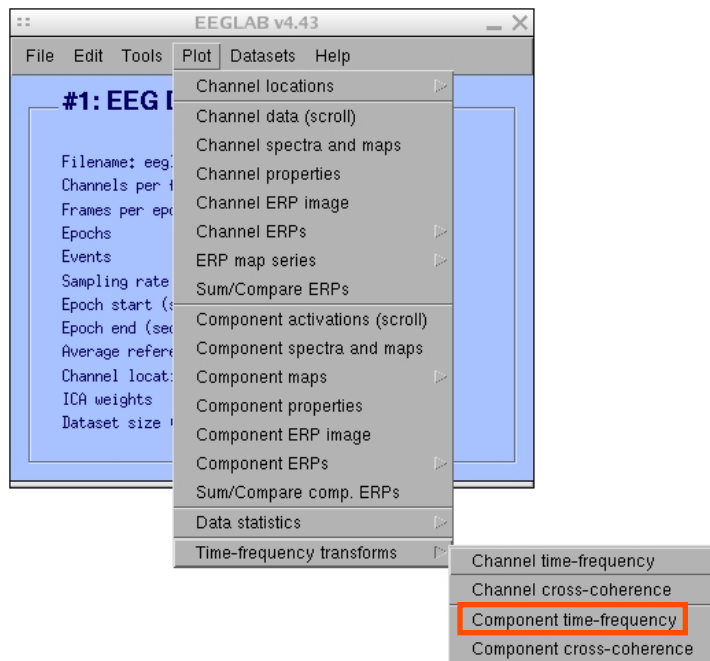
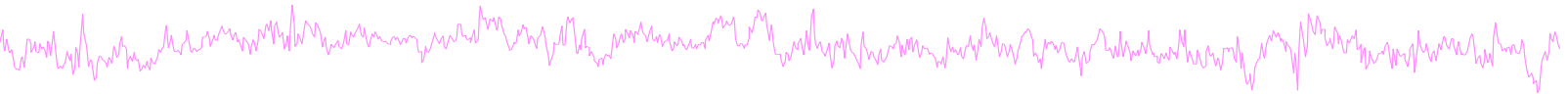
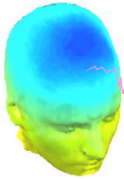




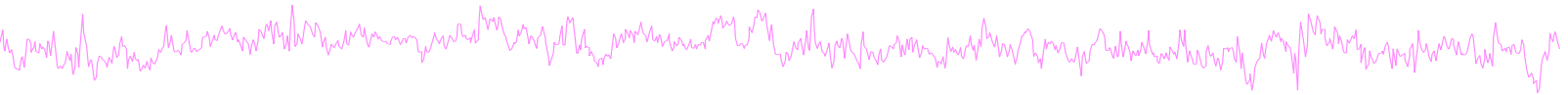
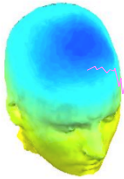
Component contribution to the EEG spectrum



Component time-frequency



EEGLAB standard processing pipeline



Single subject

1. Import binary data, events and channel location
2. Edit, Re-reference, Resample, High pass filter data
3. Reject artifacts in continuous data by visual inspection
4. Extract epochs from data & reject artifactual epochs
5. Visualize data measures
6. Perform ICA decomposition
 - Perform source localization of components
 - Analyze components contribution to ERP
 - Analyze components contribution to spectrum

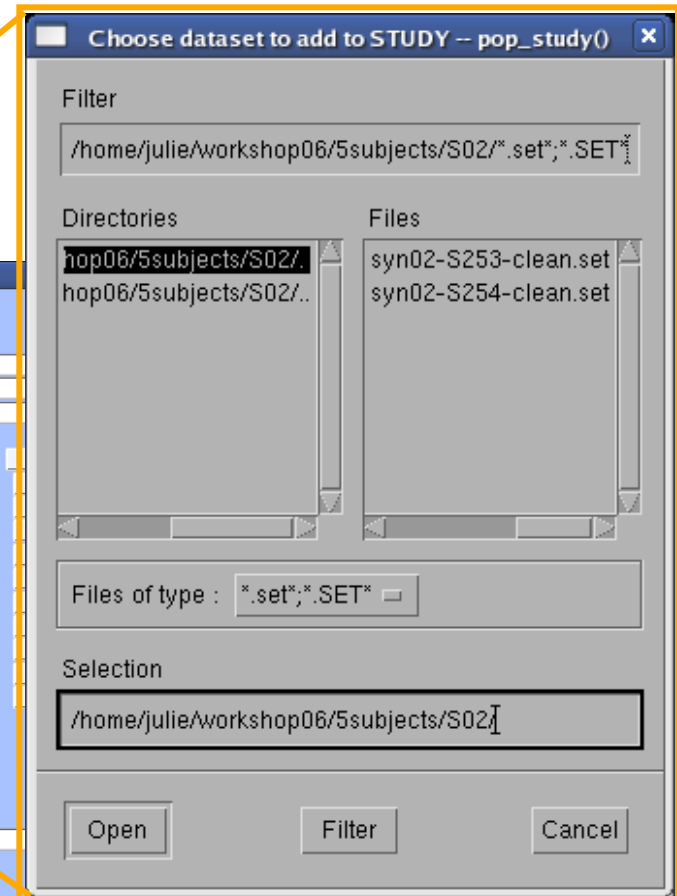
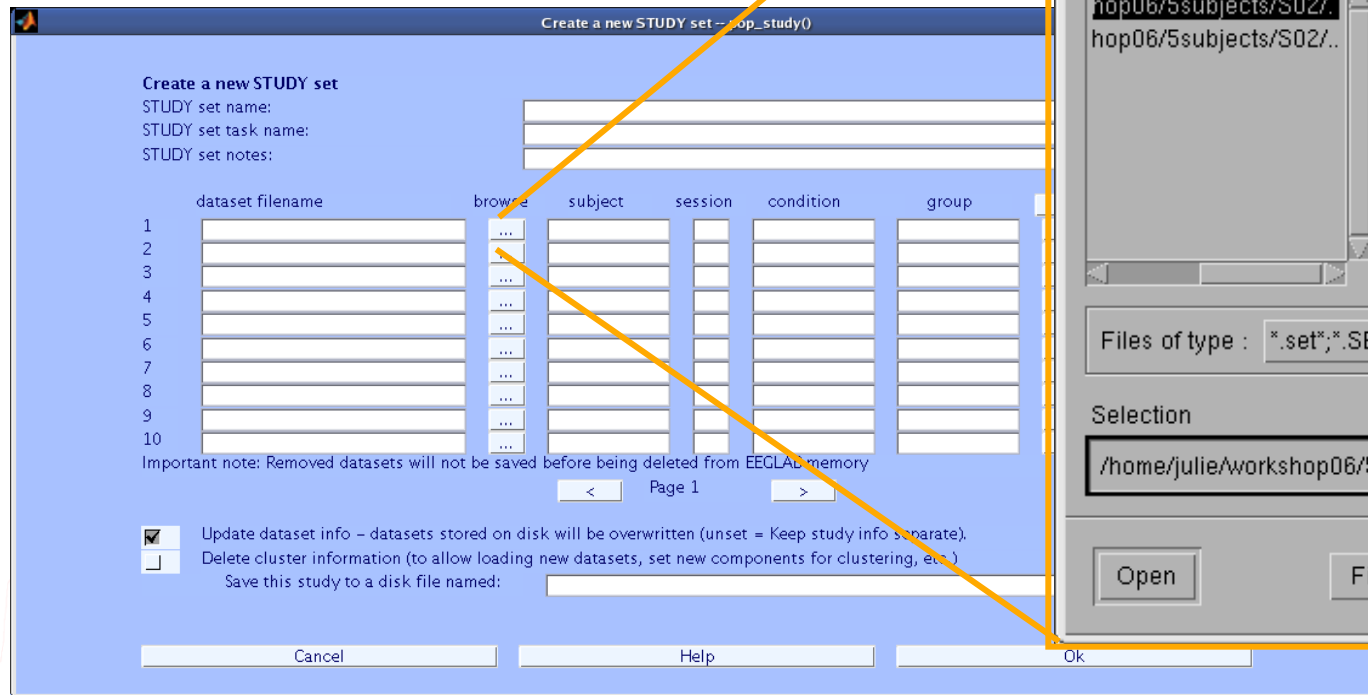
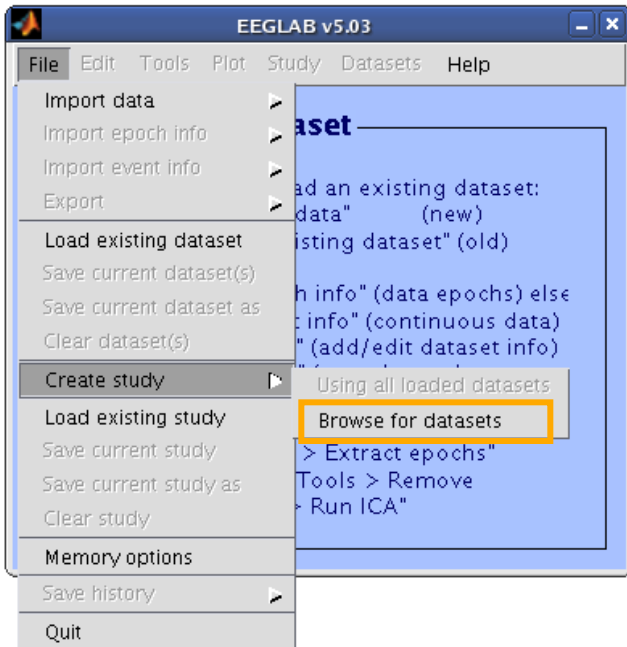
Multi-subjects

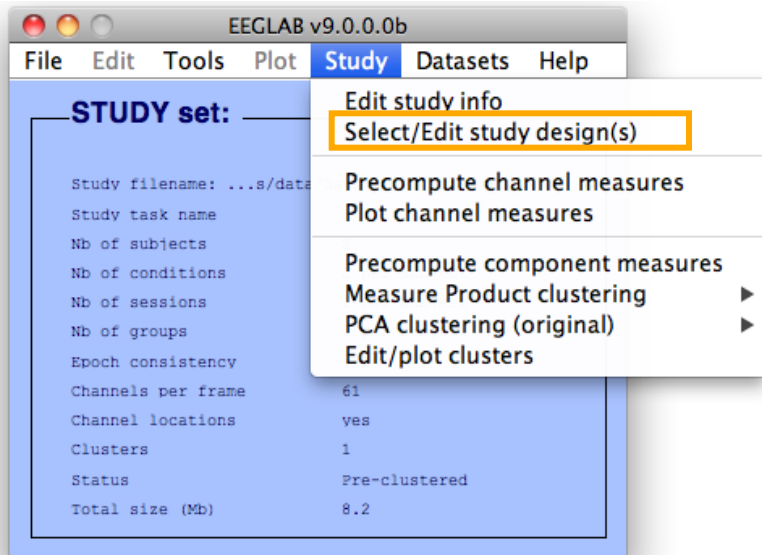
1. Build study and STUDY design
2. Pre-compute measures
3. Cluster components
4. Analyze clusters



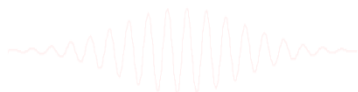
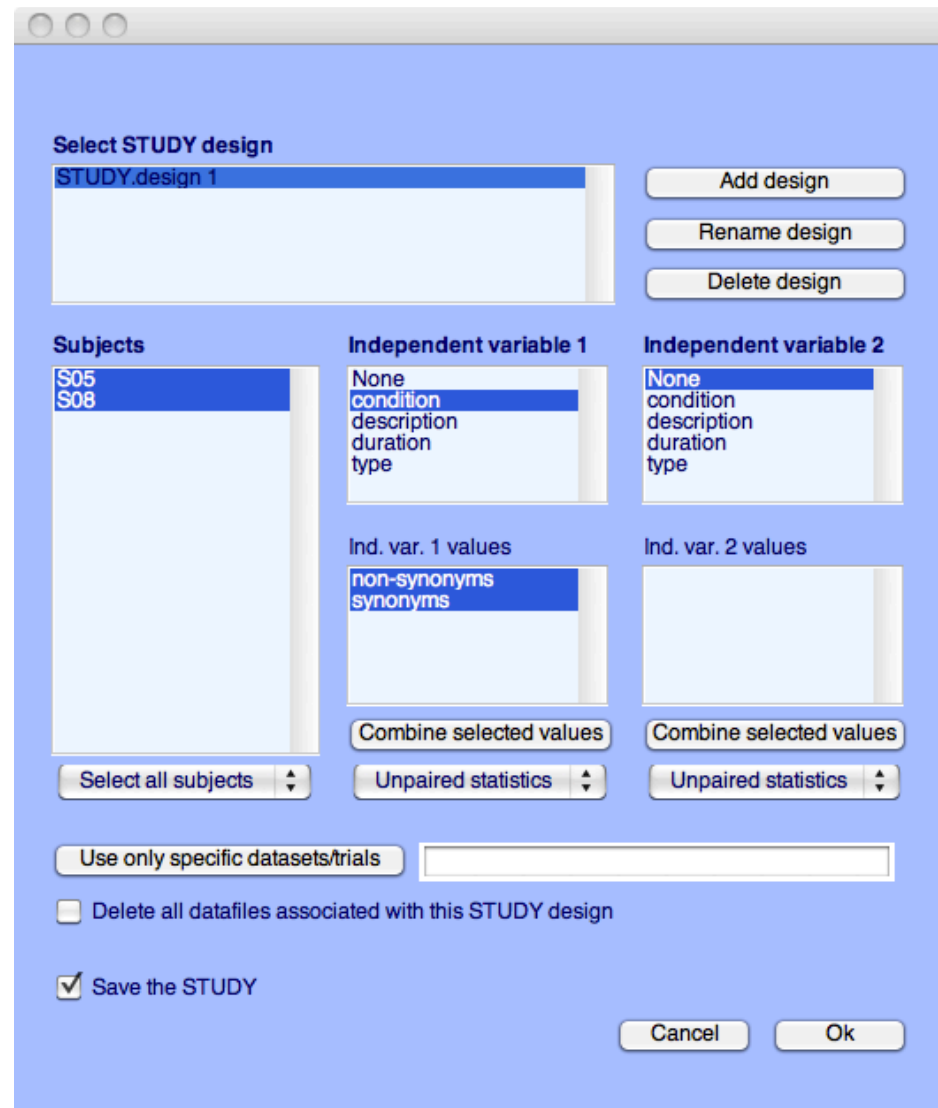
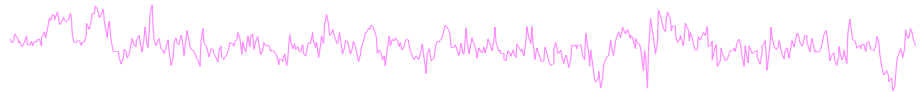
Advanced analysis using scripting and EEGLAB command line functions

1. Build a STUDY

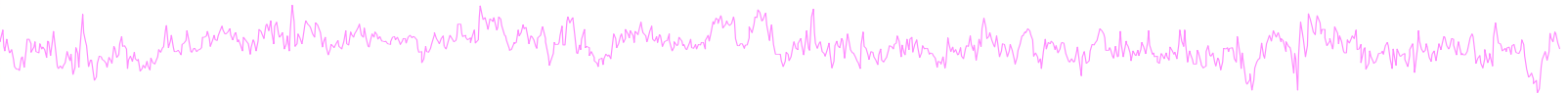
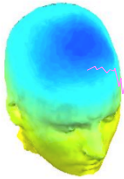




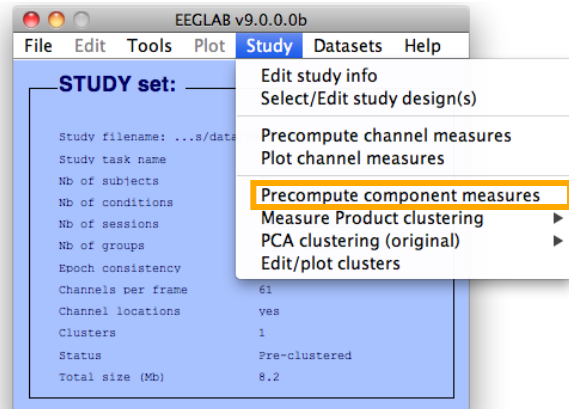
Edit STUDY design



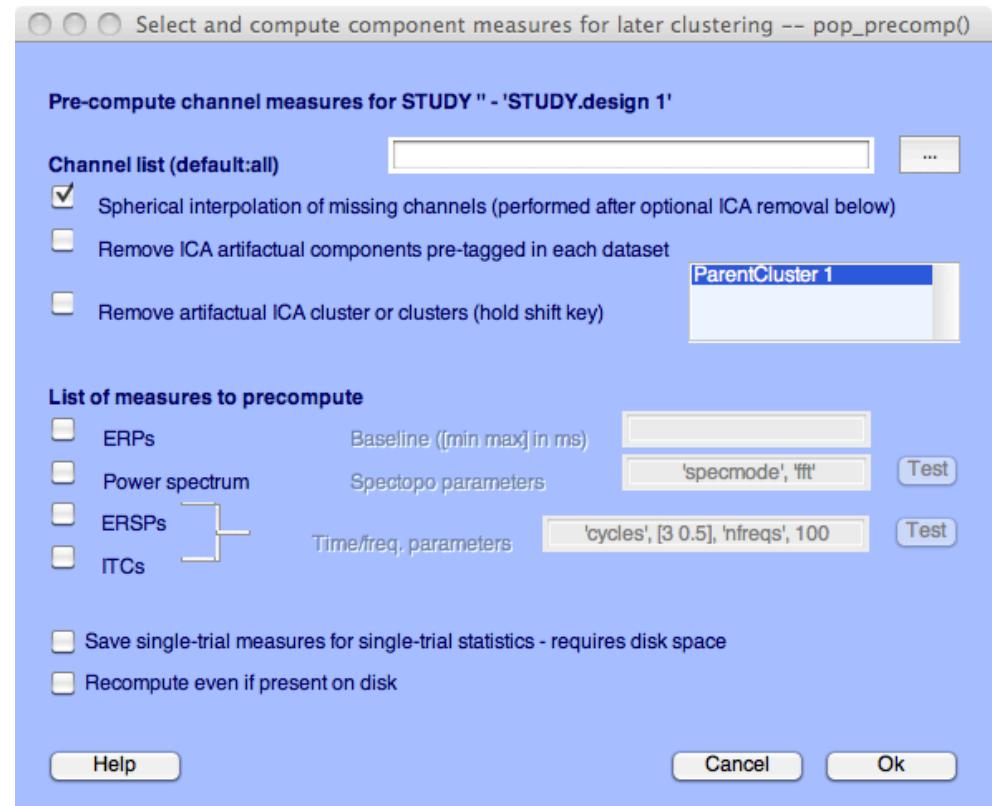
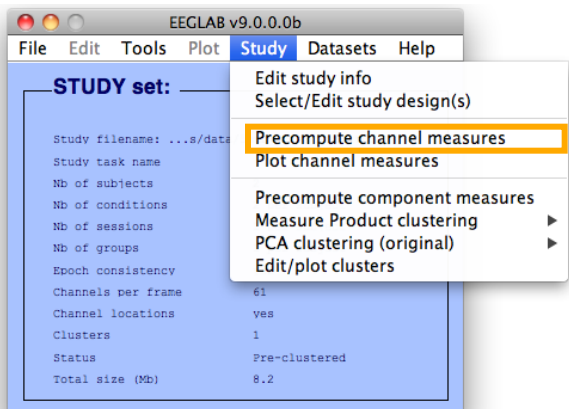
2. Pre-compute measures

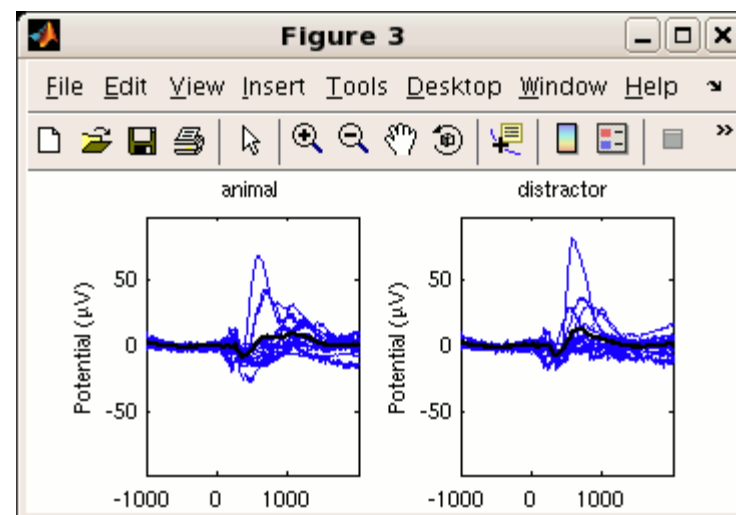
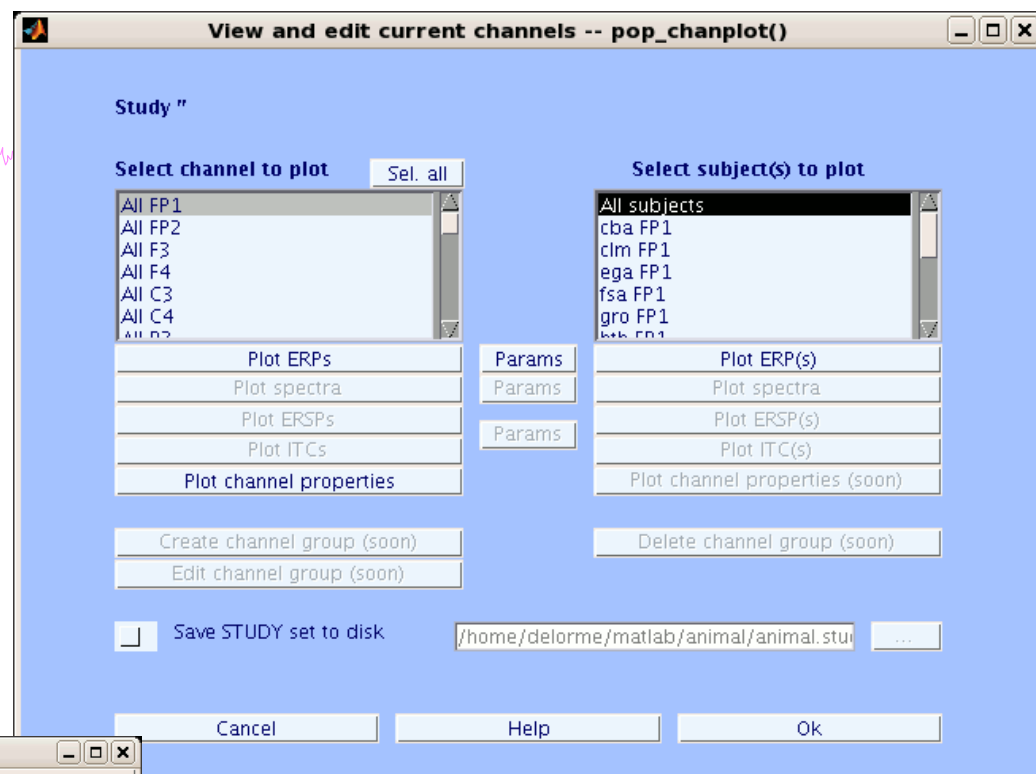
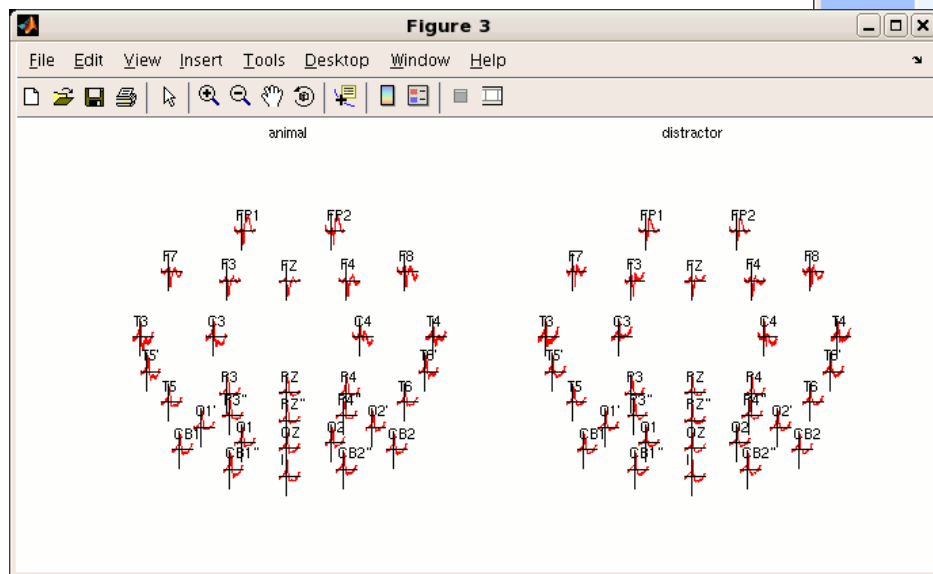
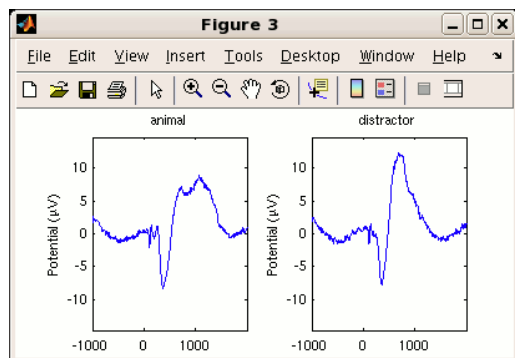


Components

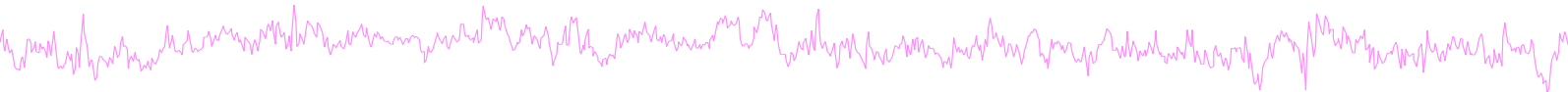
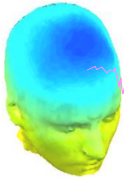


Channels





3. Cluster components



EEGLAB v6.0b

File Edit Tools Plot **Study** Datasets Help

STUDY set: Attention

Study filename:
Study task name
Nb of subjects
Nb of conditions
Nb of sessions
Nb of groups
Epoch consistency yes
Channels per frame 31
Channel locations yes
Clusters 1
Status Pre-clustered
Total size (Mb) 32.4

Edit study info
Precompute channel measures
Plot channel measures
Precompute component measures
Build preclustering array
Cluster components
Edit/plot clusters

Select and compute component measures for later clustering -- pop_preclust()

Build pre-clustering matrix for STUDY 'Attention'
Select the cluster to refine during sub-clustering (any existing sub-hierarchy will be overwritten)

ParentCluster 1 (181 ICs)

(note: only measures that have been precomputed may be used)

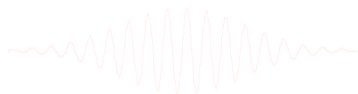
Load	Dims.	Norm.	Rel. Wt.	
<input checked="" type="checkbox"/> spectra	10	<input checked="" type="checkbox"/>	1	Freq. range [Hz] 3 25
<input checked="" type="checkbox"/> ERPs	10	<input checked="" type="checkbox"/>	1	Time range [ms] 0 600
<input checked="" type="checkbox"/> dipoles	3	<input checked="" type="checkbox"/>	10	
<input type="checkbox"/> scalp maps	10	<input checked="" type="checkbox"/>	1	Use channel values
<input checked="" type="checkbox"/> ERSPs	20	<input checked="" type="checkbox"/>	1	Time range [ms] 0 1500
<input checked="" type="checkbox"/> ITCs	10	<input checked="" type="checkbox"/>	1	Time range [ms] 0 600
<input type="checkbox"/> Final dimensions	10			

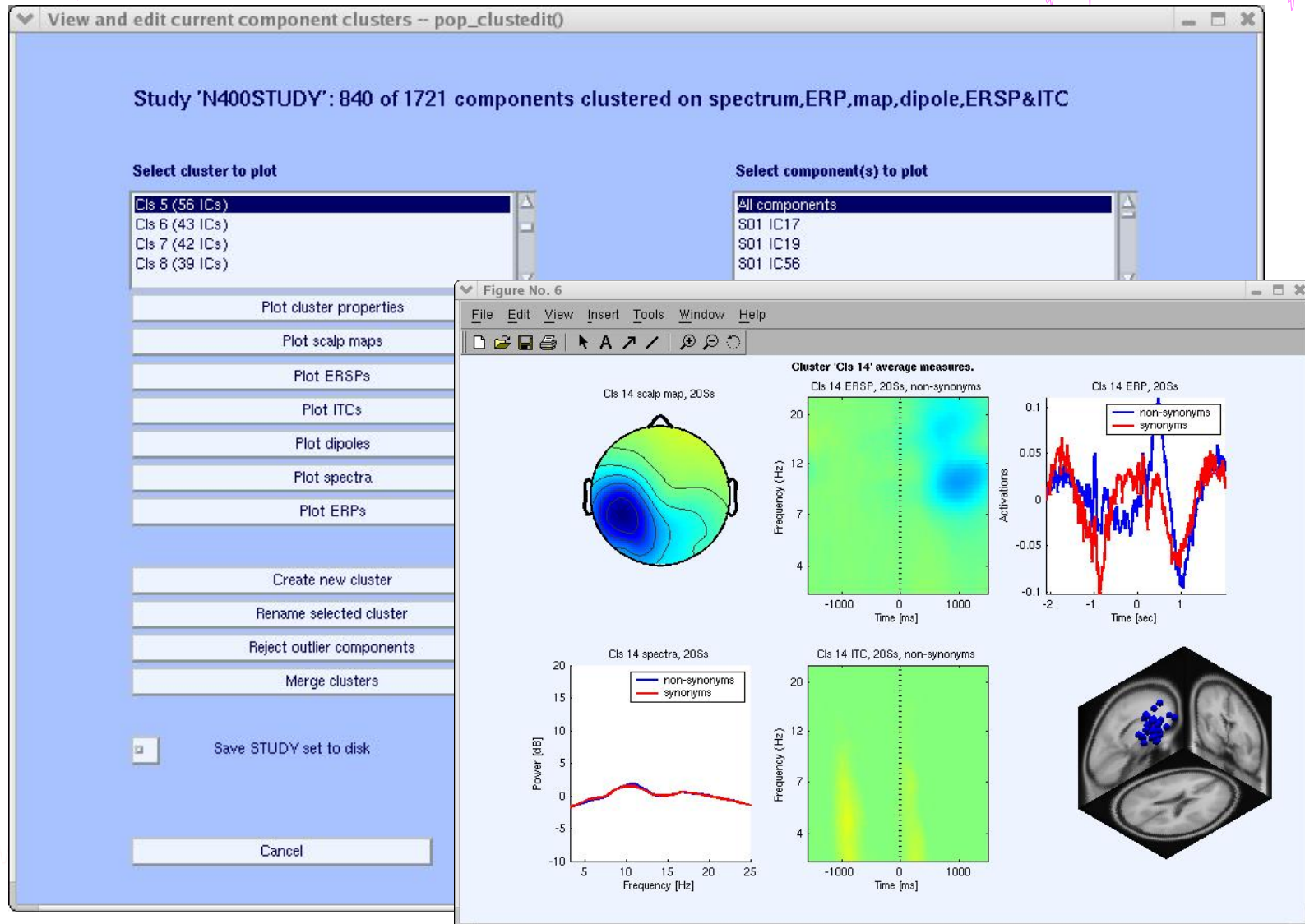
☒ Absolute values

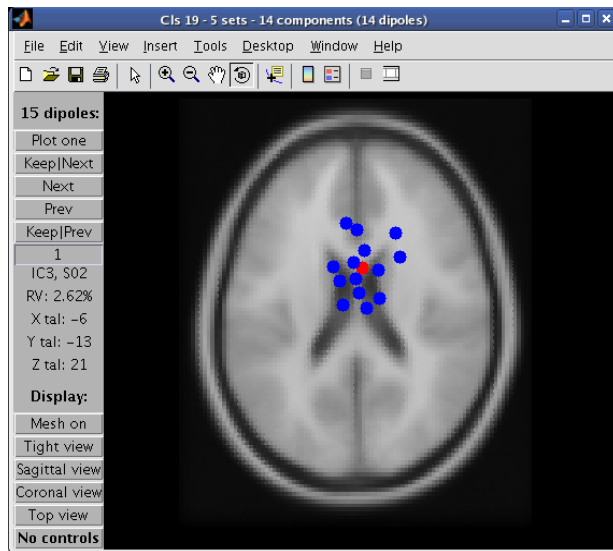
Freq. range [Hz] 3 45
Freq. range [Hz] 2 30

☐ Save STUDY to file /home/julie/WorkshopSD2007/STUDY/attention.study ...

Cancel Help Ok







View and edit current

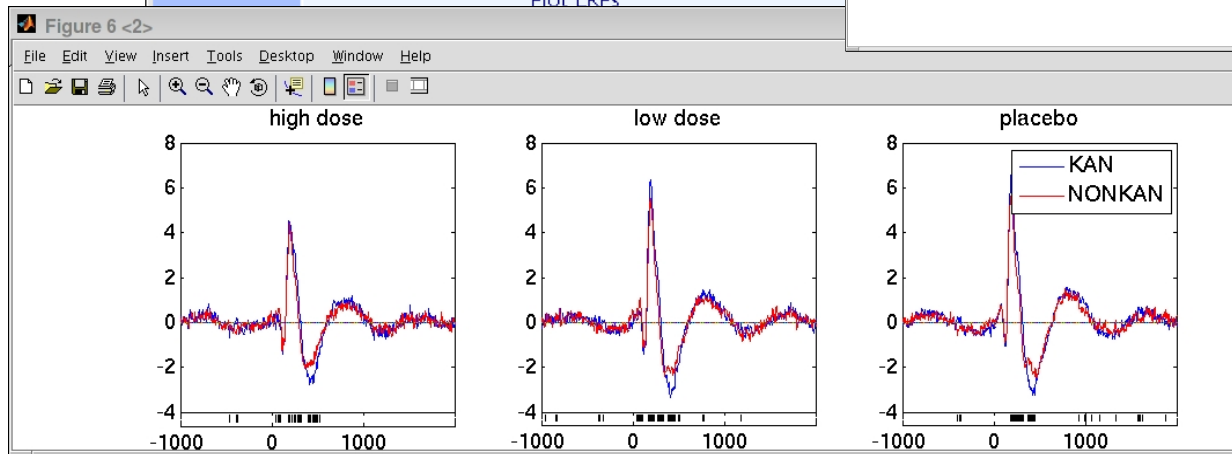
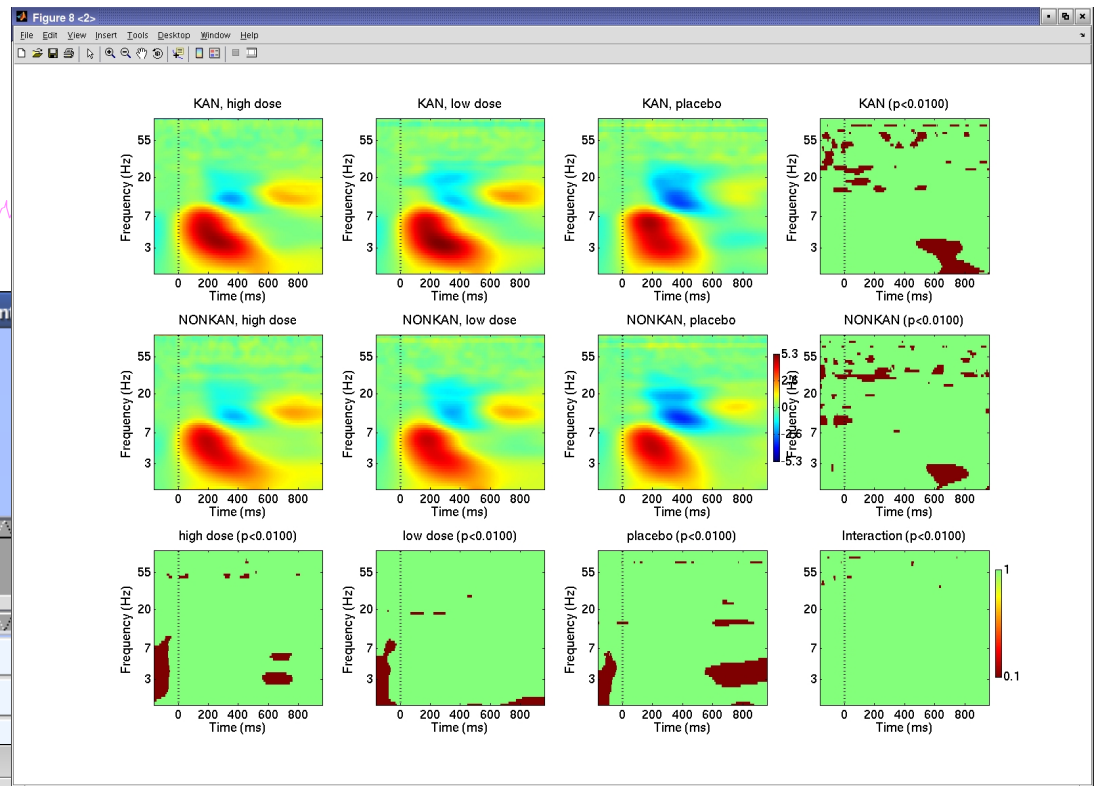
nts clustered

Clis 17 (8 ICs)
Clis 18 (14 ICs)
Clis 19 (14 ICs)
Outliers Clis 17 20 (1 ICs)

Plot scalp maps

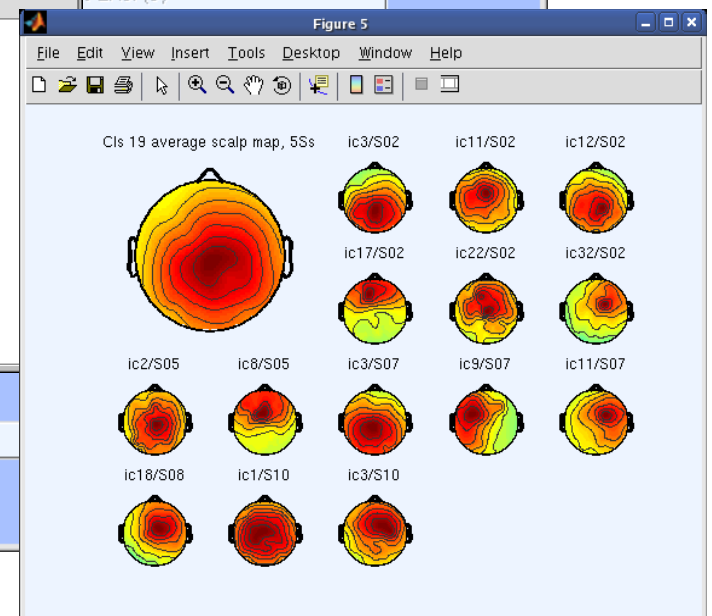
Plot dipoles

Plot ERPs

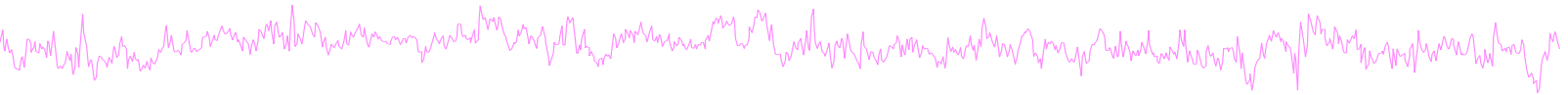
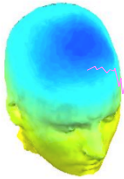


Cancel

Help



EEGLAB standard processing pipeline



Single subject

1. Import binary data, events and channel location
2. Edit, Re-reference, Resample, High pass filter data
3. Reject artifacts in continuous data by visual inspection
4. Extract epochs from data & reject artifactual epochs
5. Visualize data measures
6. Perform ICA decomposition
 - Perform source localization of components
 - Analyze components contribution to ERP
 - Analyze components contribution to spectrum

Multi-subjects

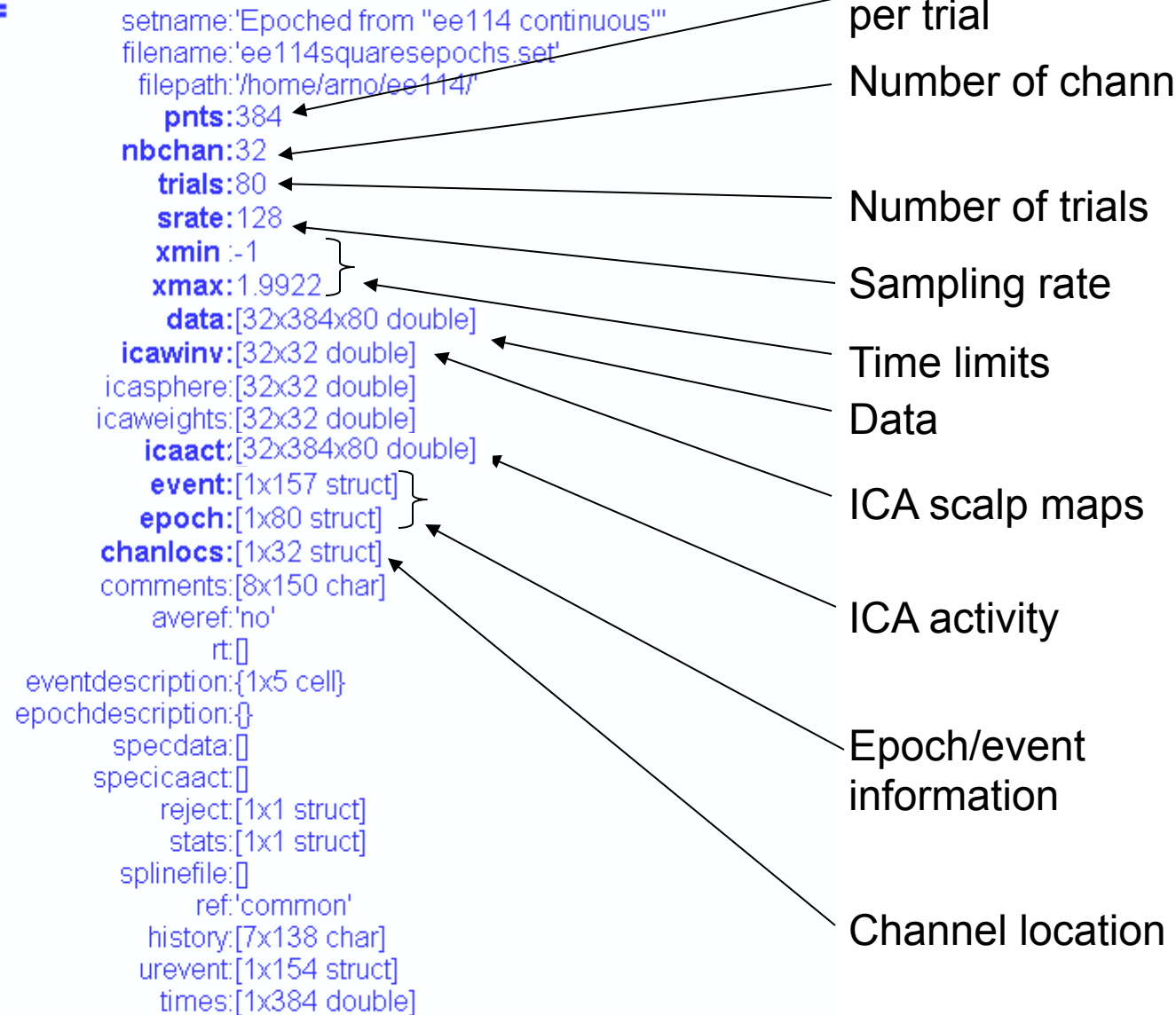
1. Build study and design
2. Pre-compute measures
3. Cluster components
4. Analyze clusters



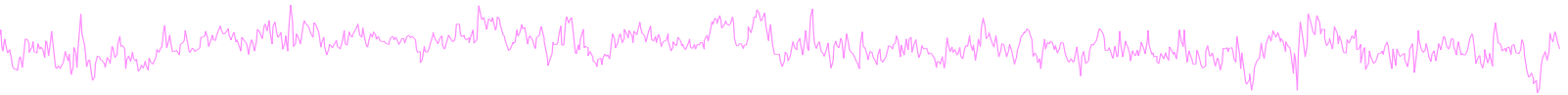
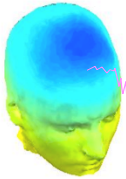
Advanced analysis using scripting and EEGLAB command line functions

EEG structure

EEG =



3 levels of functions



Administrative functions: handle EEG and ALLEEG structures

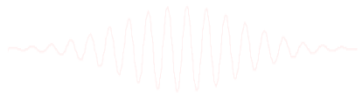
`eeglab()`, `eeg_checkset()`, `pop_delset()`, ...

Pop functions: interactive functions using EEG structure

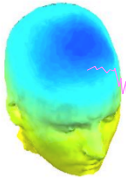
`pop_erpimage()`, `pop_topoplot()`, `pop_envtopo()`, ...

Signal processing functions: perform signal processing

`erpimage()`, `topoplot()`, `envtopo()`, ...

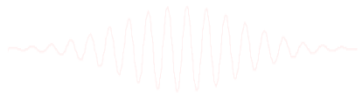


Command line tools

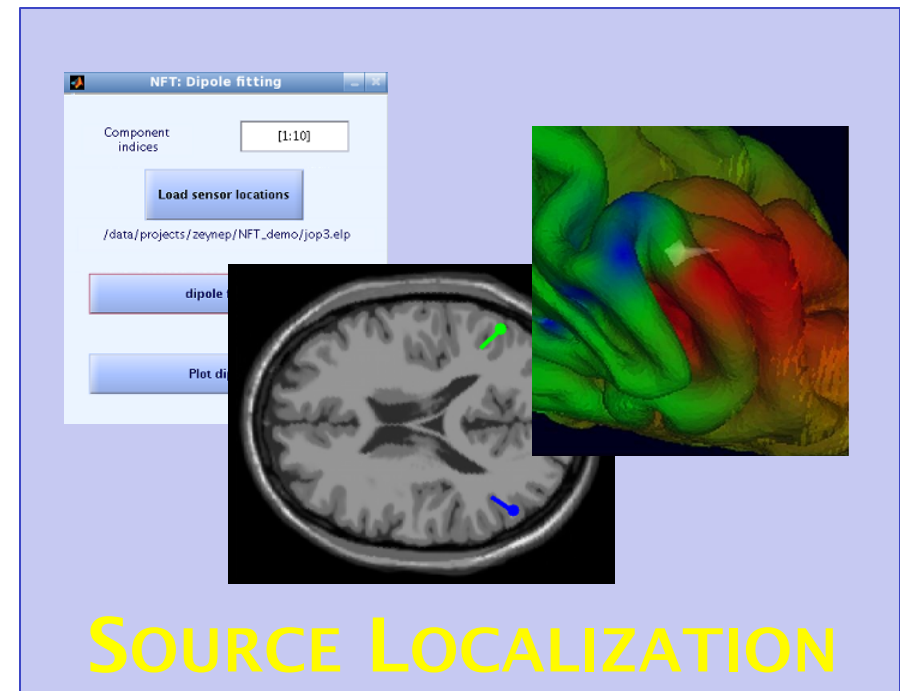
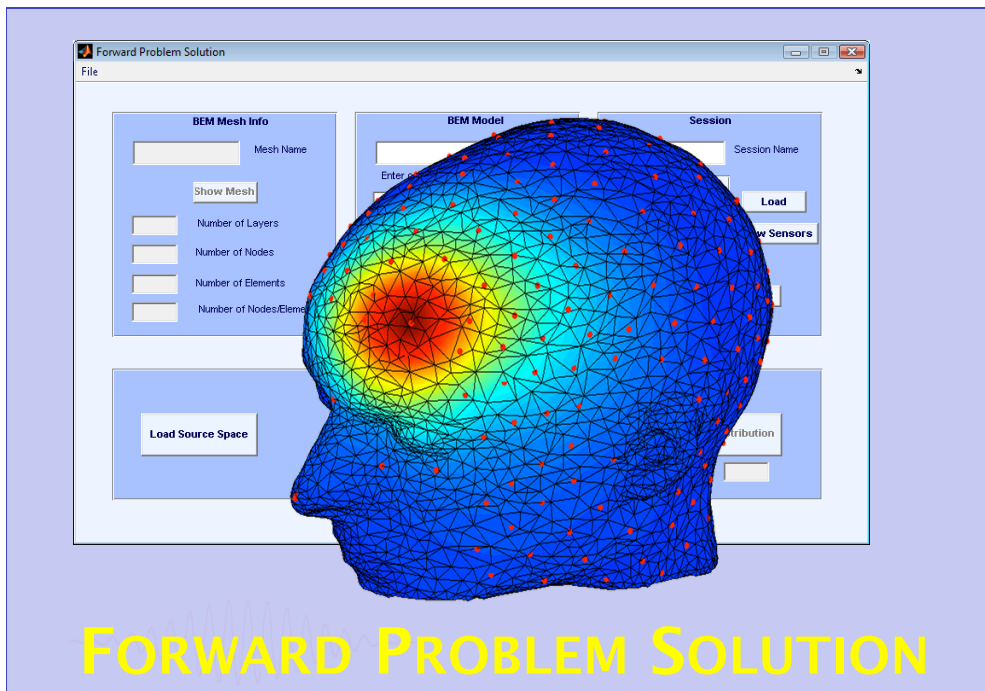
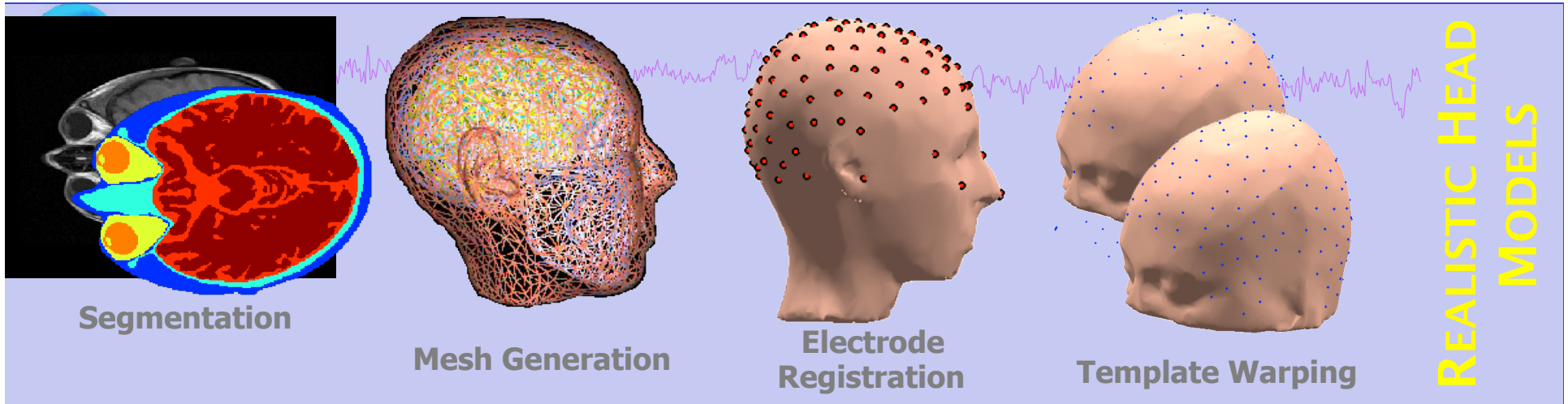


(“eegh” Menus write both dataset and global history)

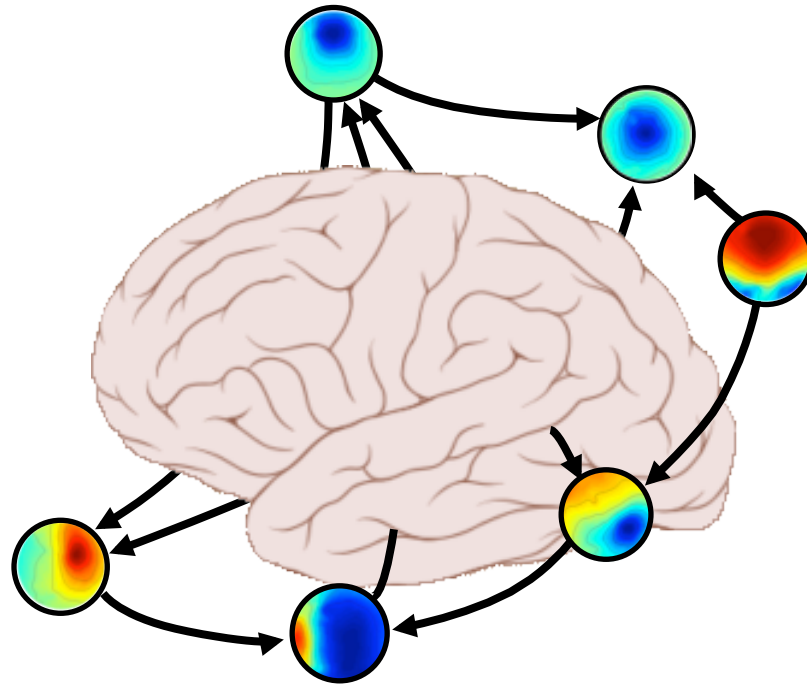
- Automated processing on groups of subjects (possibly on several processors).
- Richer options for plotting and processing functions (time-frequency decompositions, ...)
- Custom processing...



NFT: Neuroelectromagnetic Forward Head Modeling Toolbox



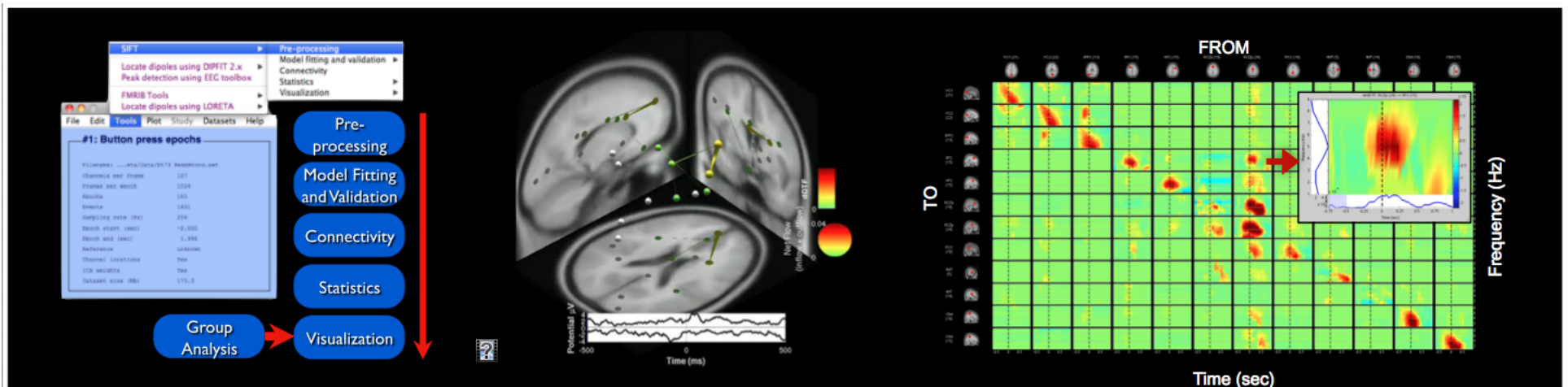
<http://sccn.ucsd.edu/nft>



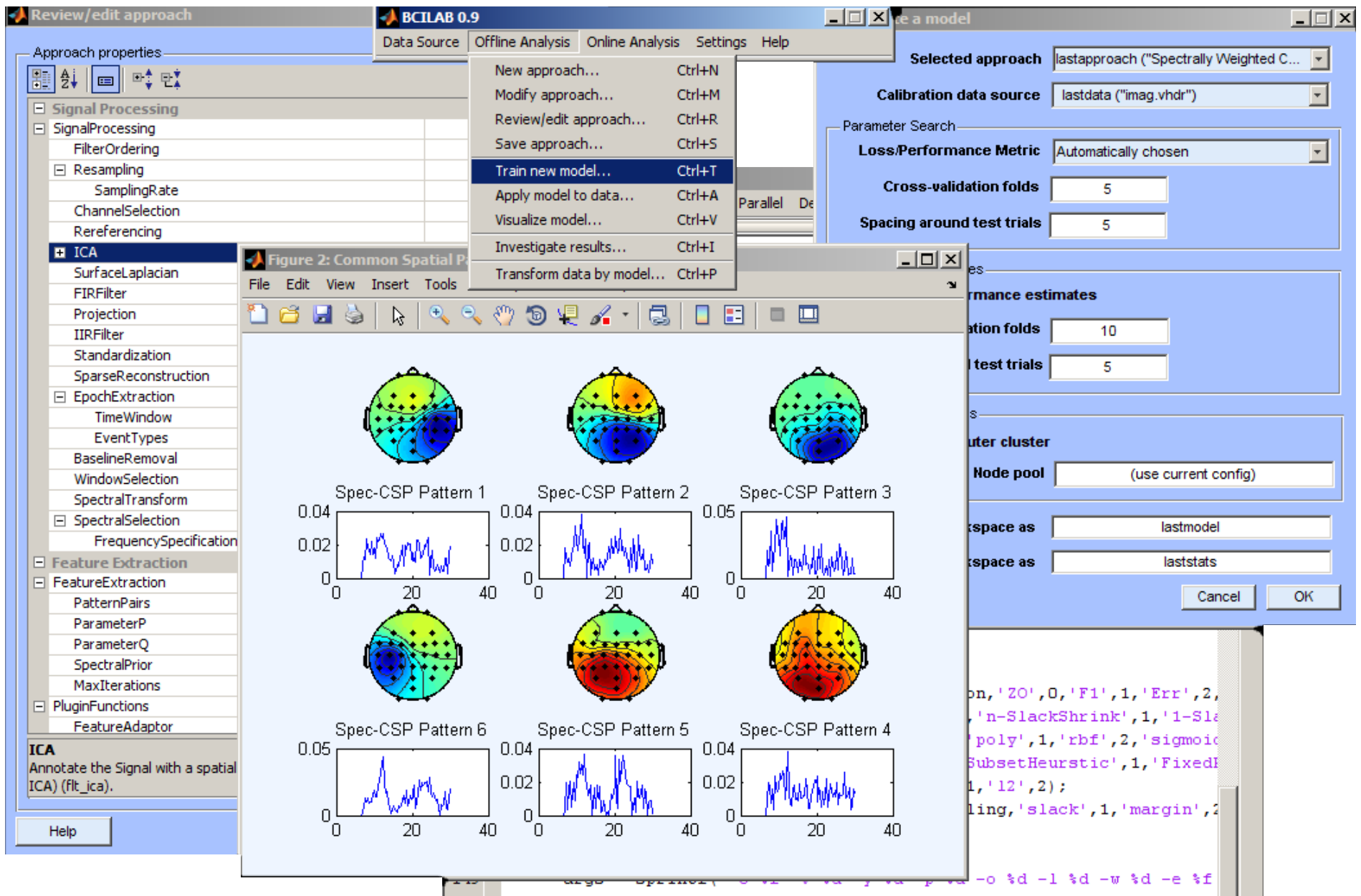
SIFT

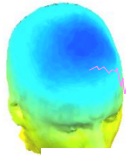
Source Information Flow Toolbox

"It makes you cool"

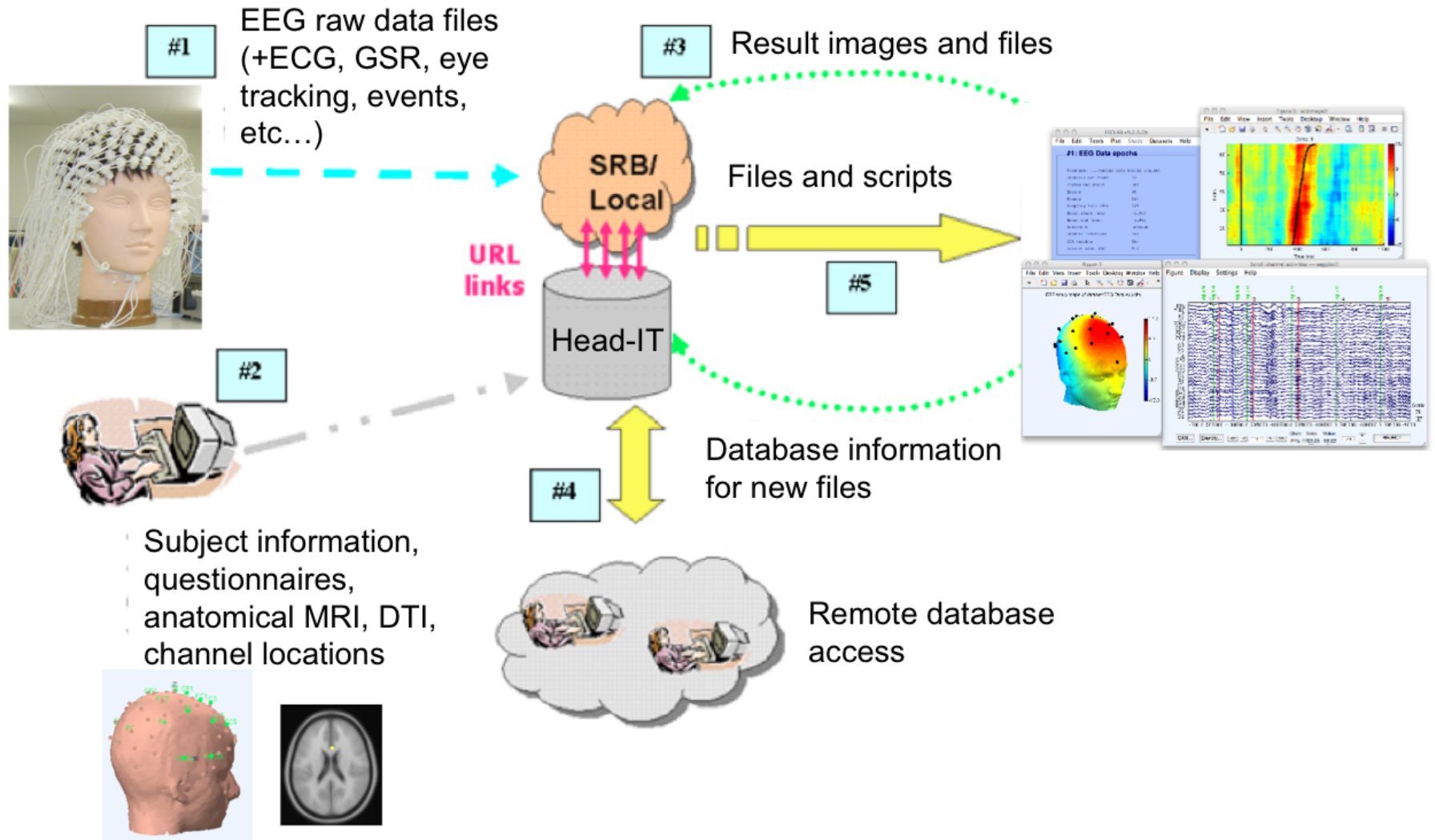


BCILAB - C. Kothe

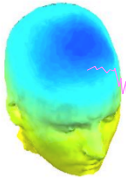




EEG database: HEAD-IT framework



Pros/Cons of Matlab based open source



- Pros
 - Easy to program, highly modular and extendable
 - Not dependent on any platform (64-bit)
 - Large community of users (latest development in signal processing research)
 - Cannot imagine more powerful scripting capabilities
- Cons
 - Matlab required for which you have to pay
 - Large memory requirements
 - Matlab bugs, possible version differences, cross-platform compatibility problems

Tuesday, June 18th

7:00 - 8:30 Breakfast

Overview and ICA Theory/Practice

8:30 – 9:30 -- Mining event-related brain dynamics I (Scott Makeig)

9:30 – 10:00 -- EEGLAB overview (Arnaud Delorme)

-- Break--

10:15 – 11:15 -- ICA theory (Tim Mullen)

11:15 – 12:00 -- Data import, Artifact rejection and running ICA (Claire Braboszcz)

12:00-13:00 Lunch --

ICA and time-frequency

13:00 – 14:00 -- Importing data, rejecting data, and performing ICA decomposition practicum (Claire Braboszcz)

14:00 – 15:00 -- Evaluating ICA components practicum (Arnaud Delorme)

-- Break--

15:30 – 17:00 -- Time-frequency decompositions: Theory and practice (Tim Mullen)

17:00 – 19:00 -- Data and processing assistance available

19:00 -- Dinner

Wednesday, June 19st

7:30 - 8:30 Breakfast

Overview and ICA Theory/Practice

8:30 – 9:00 -- Why cluster ICA components? (Scott Makeig)

9:00 – 10:00 -- Group analysis using EEGLAB studies: Methods to cluster ICA components (Arnaud Delorme)

-- Break--

10:15 – 11:15 -- Group analysis using EEGLAB studies: Methods to plot data and compute statistics (Arnaud Delorme)

11:15 – 12:00 -- Scripting to manipulate EEGLAB studies for group analysis (Arnaud Delorme)

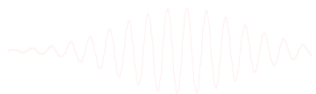
12:00-13:00 Lunch --

ICA, time-frequency and information flow

13:00 – 14:00 -- Robust statistics: central tendency, dispersion and inference (Guillaume Rousselet)

14:00 – 14:30 -- Statistical estimation in EEGLAB (Arnaud Delorme)

14:45-18:00-- Excursion to Saint-Bertrand-de-Comminges (<http://en.wikipedia.org/wiki/Saint-Bertrand-de-Comminges>)



Thursday, June 20th

7:30 - 8:30 Breakfast

Source Localization

8:30 – 9:30 -- Forward and inverse models - the Dipfit plugin (Robert Oostenveld)

9:30 – 10:00 -- The Neuroelectromagnetic Forward Head Modeling (NFT) EEGLAB plugin (Scott Makeig)

-- Break--

General Linear Modeling

10:15 – 12:00 -- Theory and practice of applying general linear models to EEG data using the LIMO EEGLAB plug-in (Cyril Pernet)

12:00-13:00 Lunch --

Source information flow

13:00 – 14:00 -- Source information flow and Granger-Causal modeling tools (Tim Mullen)

14:00 – 15:00 -- SIFT toolbox: Theory and live demo (Tim Mullen)

-- Break--

15:30 – 17:00 -- SIFT toolbox: practicum (Tim Mullen)

17:00 – 19:00 -- Data and processing assistance available

19:00 -- Dinner

22:00 - 24:00 -- SIFT hackathon, meet with Tim Mullen and his computer at the bar - ask anything you like

22:00 - 24:00 -- LIMO hackathon, meet with Cyril Pernet and his computer at the bar - ask anything you like

Friday, June 21st

7:30-8:30 -- Breakfast

8:30 – 9:30 -- Mining event-related brain dynamics II (Scott Makeig)

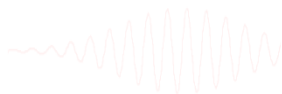
9:30 – 10:00 -- Using and building EEGLAB plug-ins (Arnaud Delorme)

-- Break--

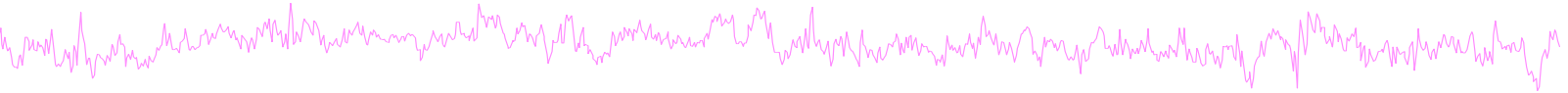
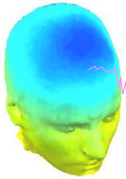
10:15 – 11:30 -- Practicum, small group projects

11:30 – 12:00 -- Participant project presentations and general discussion

12:00 -- Lunch



EEGLAB articles



Delorme, A., Makeig, S. (2004) EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, 134(1), 9-21.

Makeig, S., Debener, S., Onton, J., Delorme, A. (2004) Mining event related dynamics. *Trends in cognitive Neuroscience*, 8(5), 204-210.

Delorme, A., Kothe, C., Bigdely, N., Vankov, A., Oostenveld, R., Makeig, S. Matlab Tools for BCI Research? In "human-computer interaction and brain-computer interfaces". Editors : Tan, D. and Nijholt, A. To appear in 2010. Springer Publishing.

Delorme, A., Mullen, T., Kothe, C., Bigdely-Shamlo, N., Akalin, Z., Vankov, A., Makeig, S. EEGLAB, MPT, NetSIFT, NFT, BCILAB, and ERICA: New tools for advanced EEG/MEG processing. *Computational Intelligence*, accepted.

Delorme, A., Makeig, S. Open Source Programming for Interpreted Language: Graphic Interface and Macro Bridging Interface. IEEE International Conference on Signal Image Technology and Internet Based Systems. In press.

