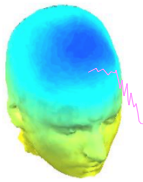
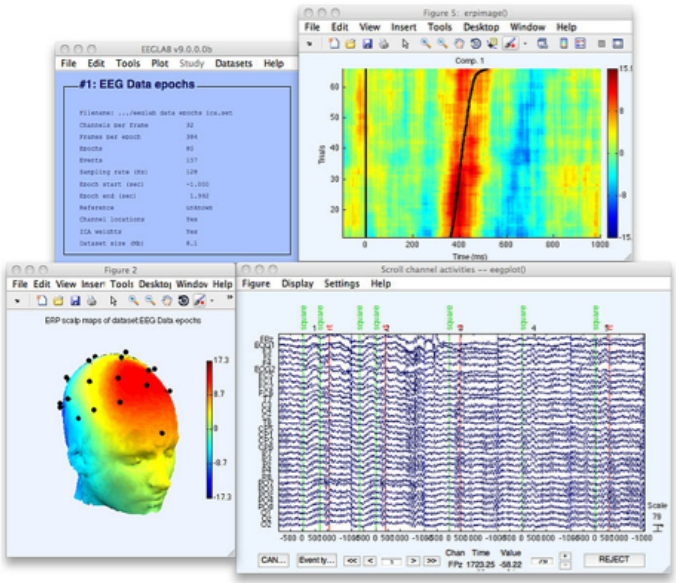
EEGLAB overview

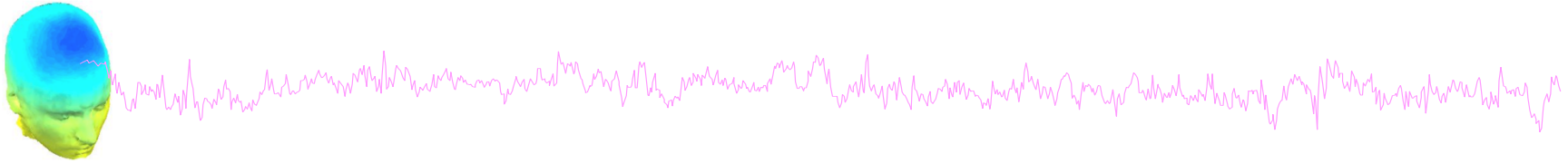


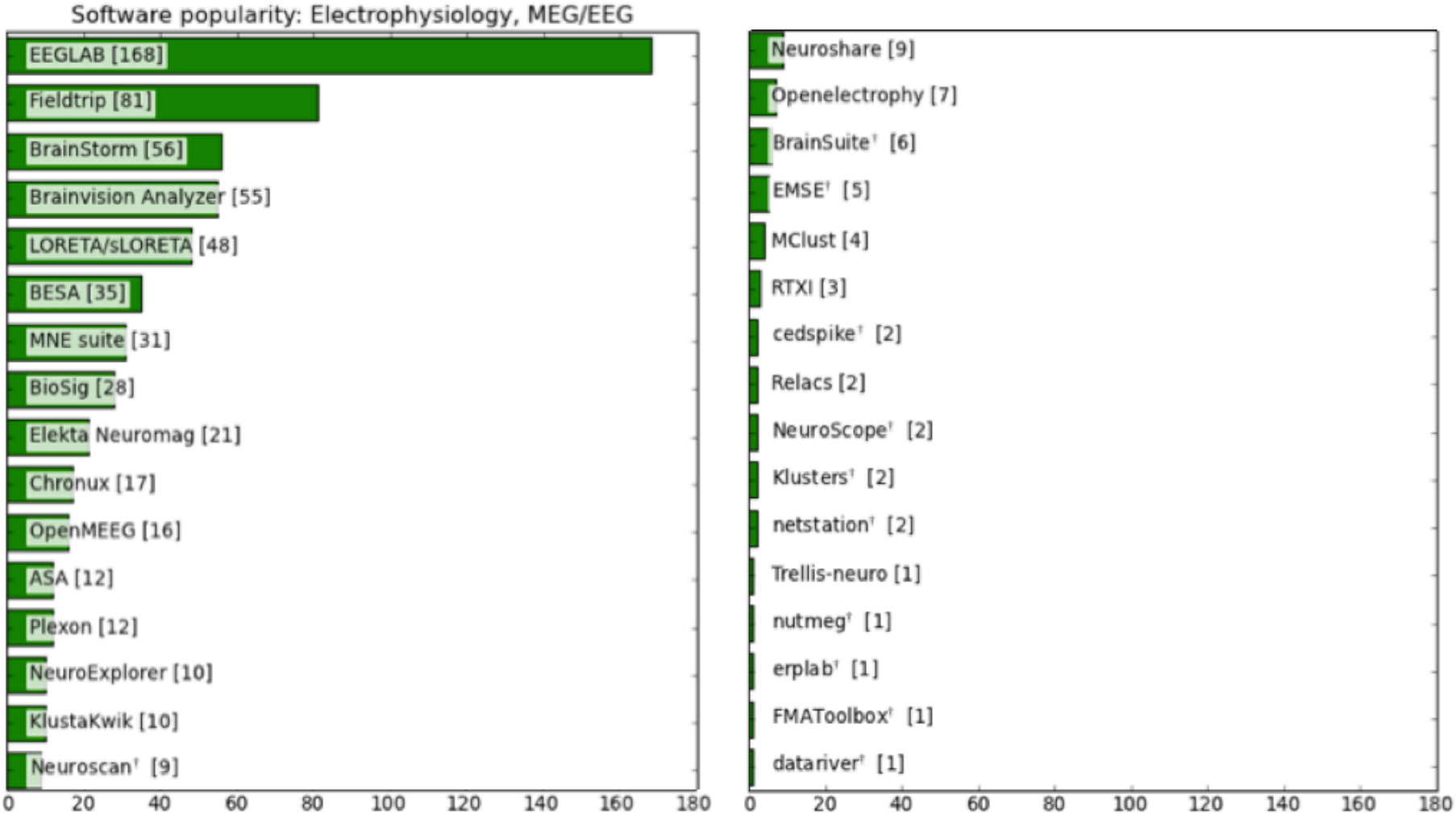
- Collection of about 600 functions (70 000 lines of code)
- About 100 000 download over the past 10 years
- 6 500 users on the discussion list and 10 500 on the diffusion list
- NIH funding since 2003



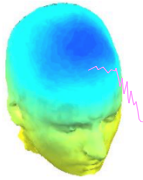
http://sccn.ucsd.edu/eeglab
http://sccn.ucsd.edu/wiki/eeglab

Hanke & Helcencko, 2011, Frontier in Neuroinformatics





EEGLAB standard processing pipeline



Single subject

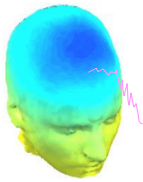
1. Import binary data, events and channel location
2. Edit, Re-reference, Resample, High pass filter data
3. Reject artifacts in continuous data by visual inspection
4. Extract epochs from data & reject artifactual epochs
5. Visualize data measures
6. Perform ICA decomposition
   - Perform source localization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

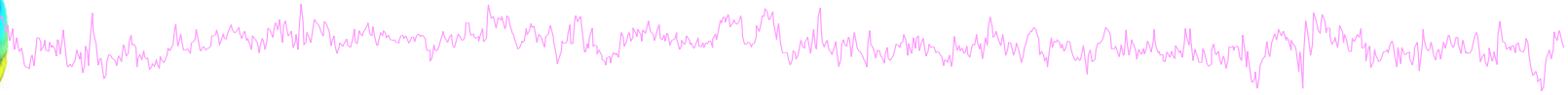
Multi-subjects

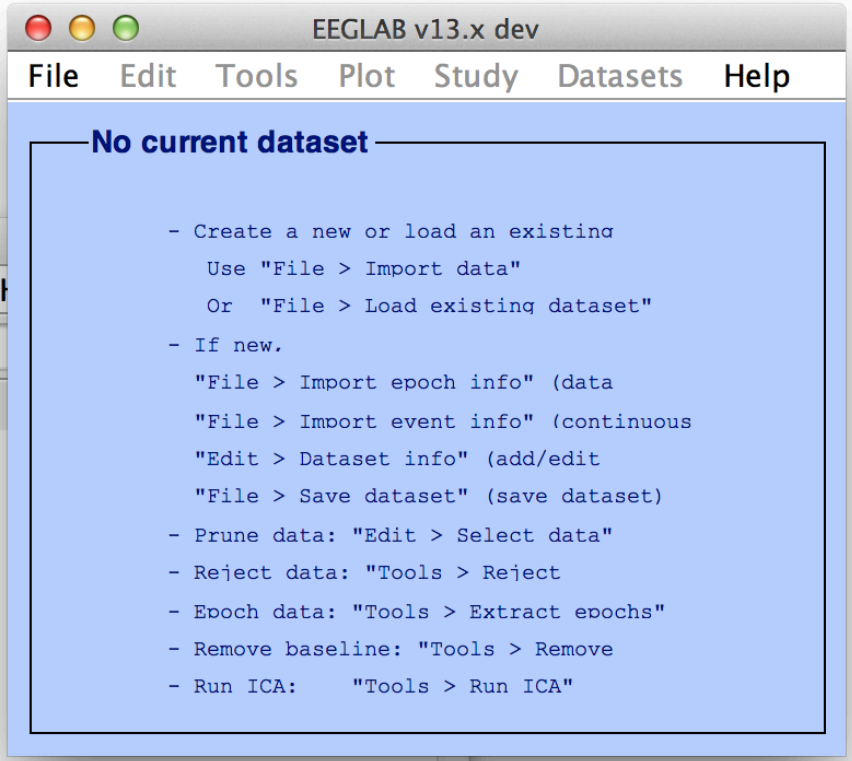
1. Build study and STUDY design
2. Pre-compute measures
3. Cluster components
4. Analyze clusters

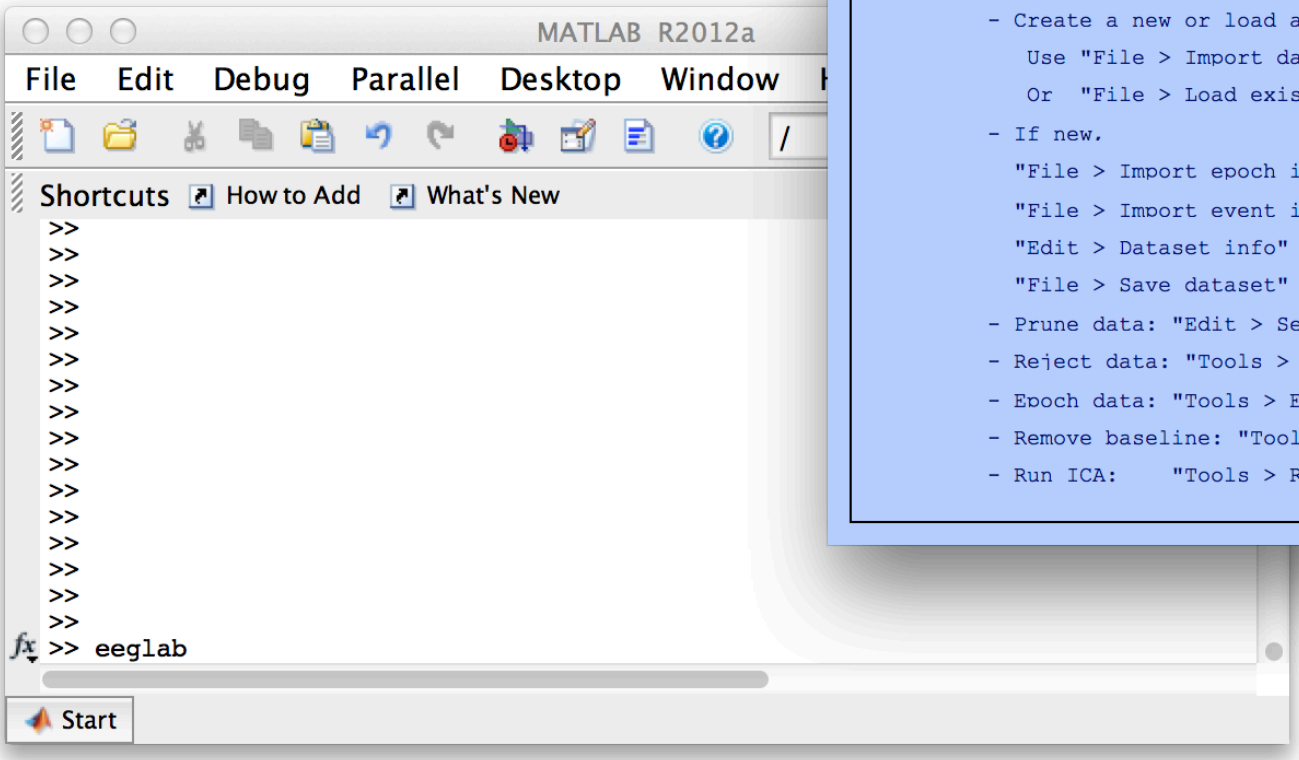
Advanced analysis using scripting and EEGLAB command line functions

The EEGLAB Matlab software



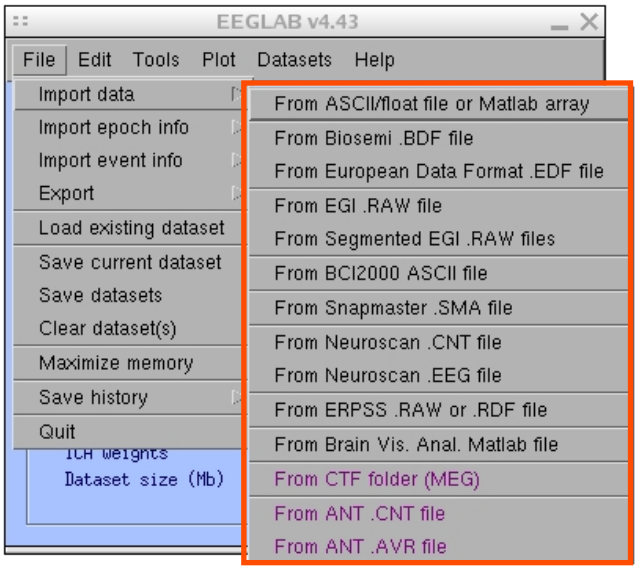




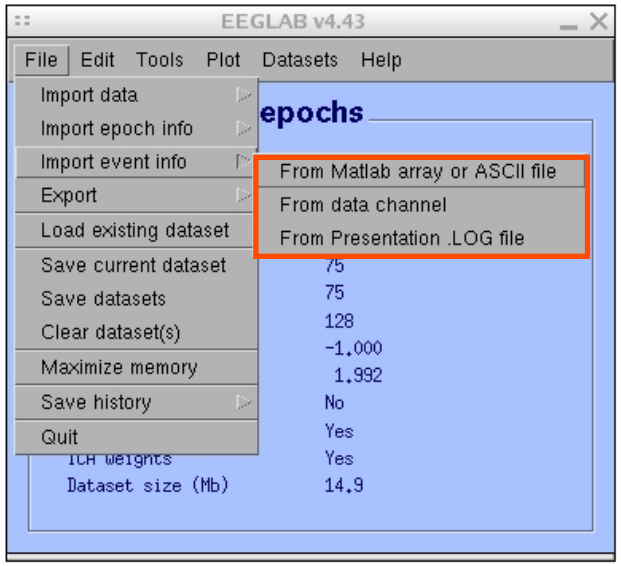


1. Importing data

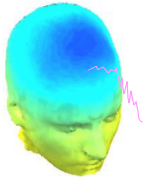
Import/load data



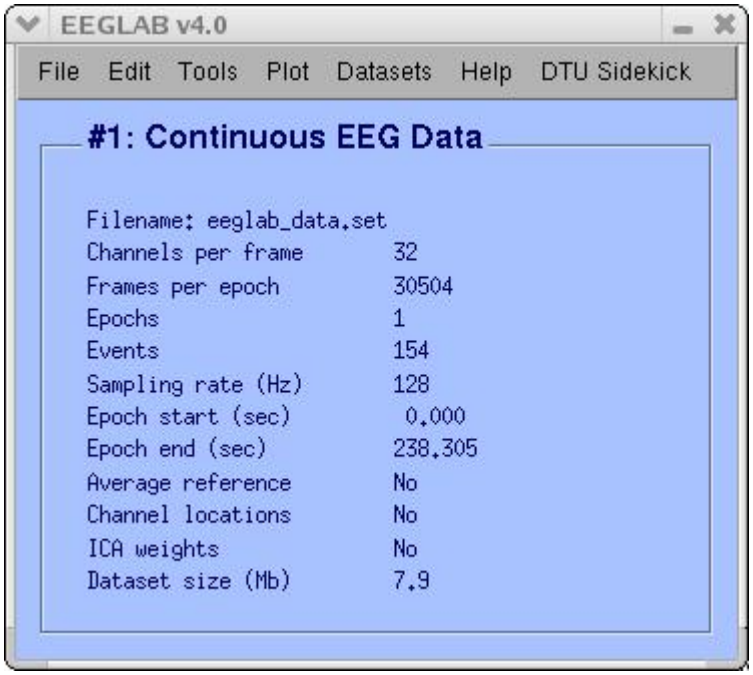
Import events



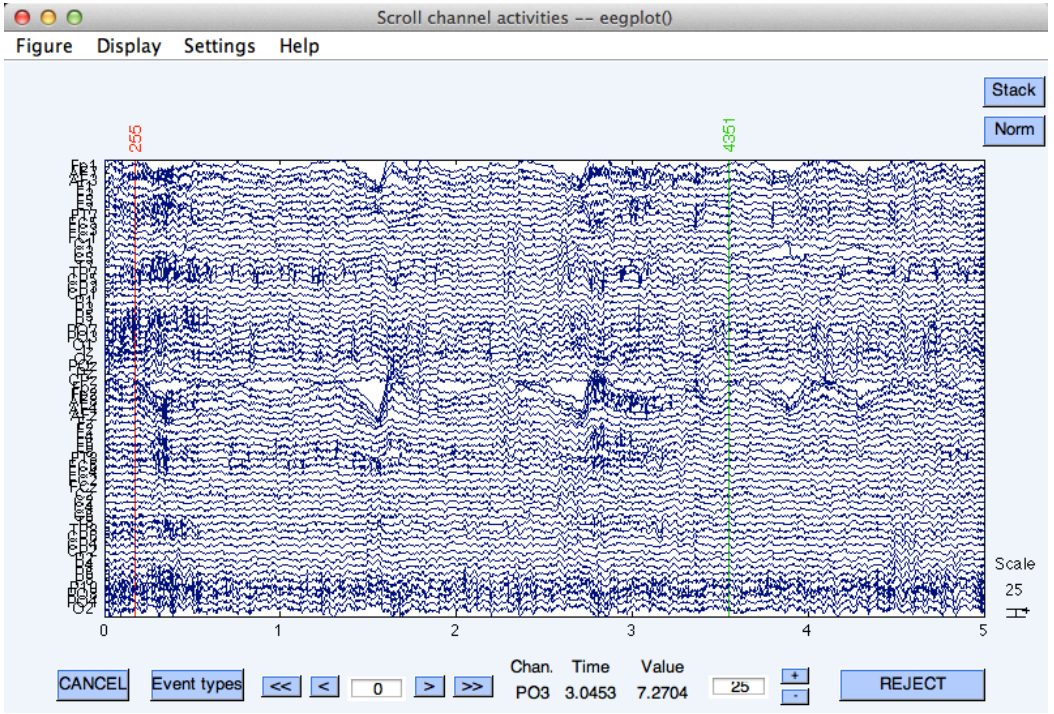
1. Importing data



Data info

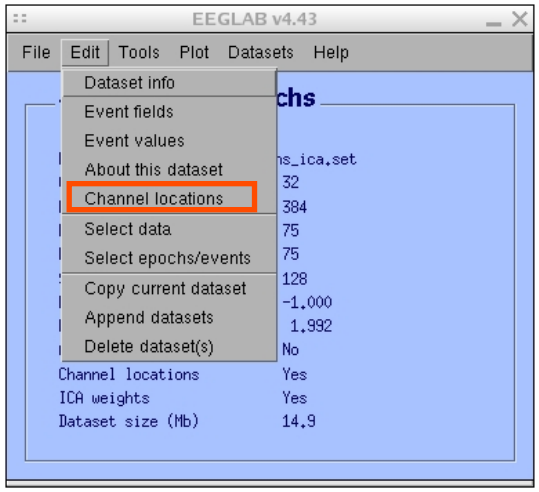


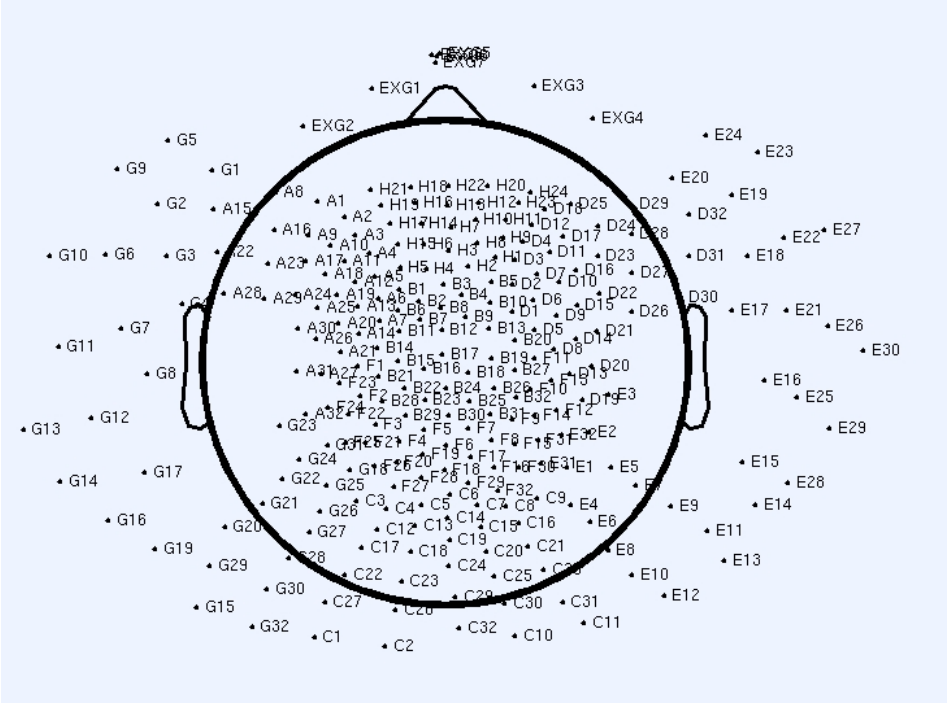
Scrolling data



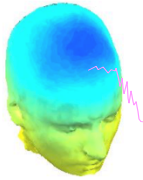
1. Importing channel location

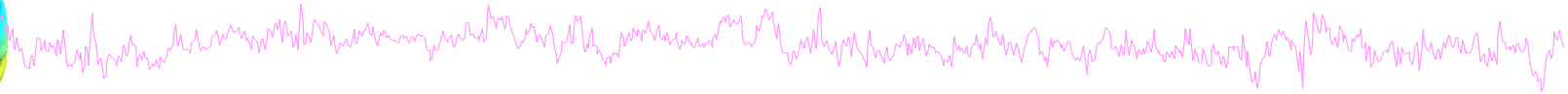
Import channel location



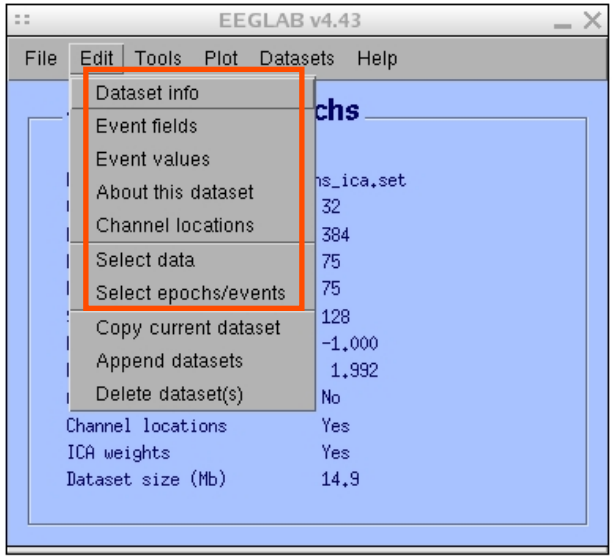


2. Edit, Re-reference, Resample, High pass filter data

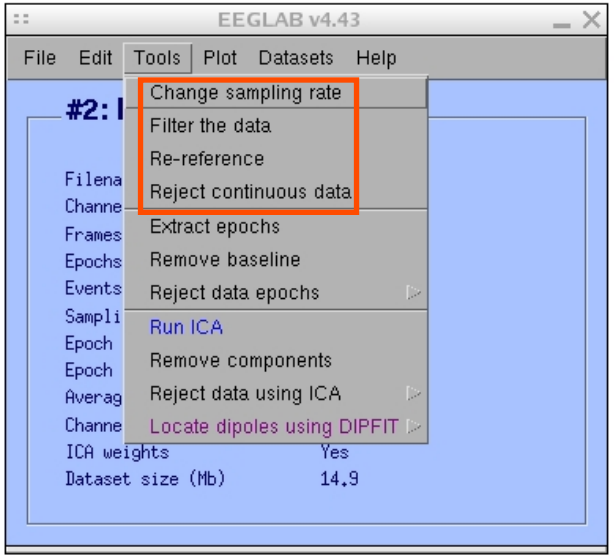




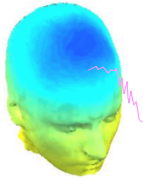
Edit/select data

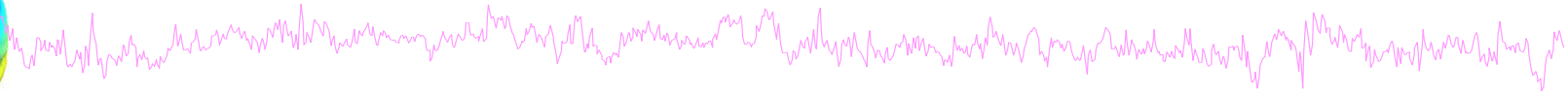


Preprocessing data

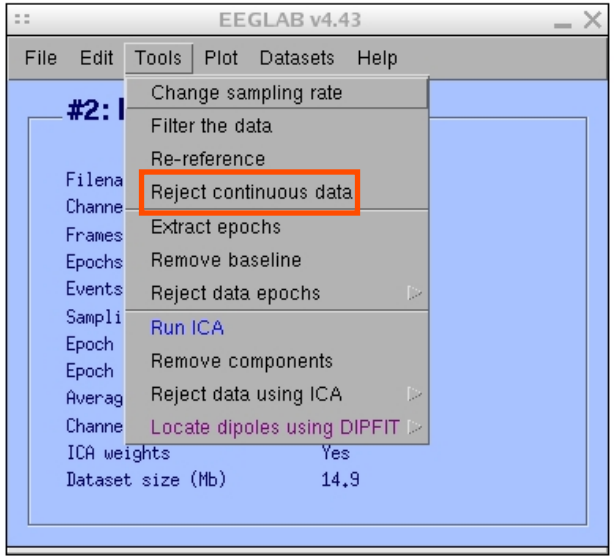


3. Reject artifacts in continuous data by visual inspection

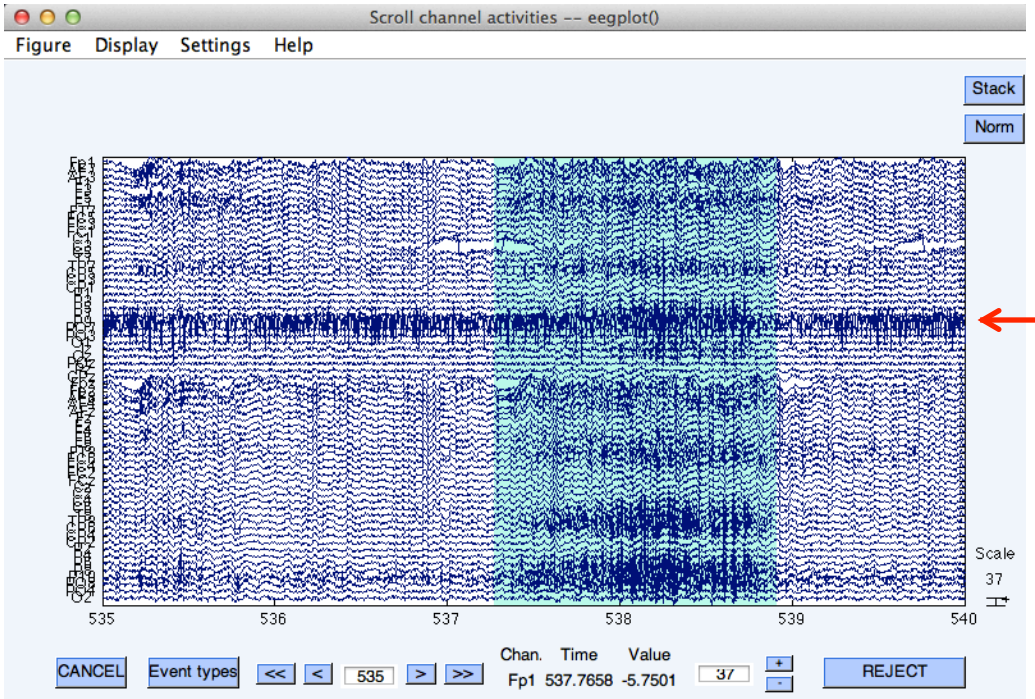




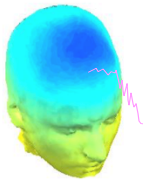
Data info



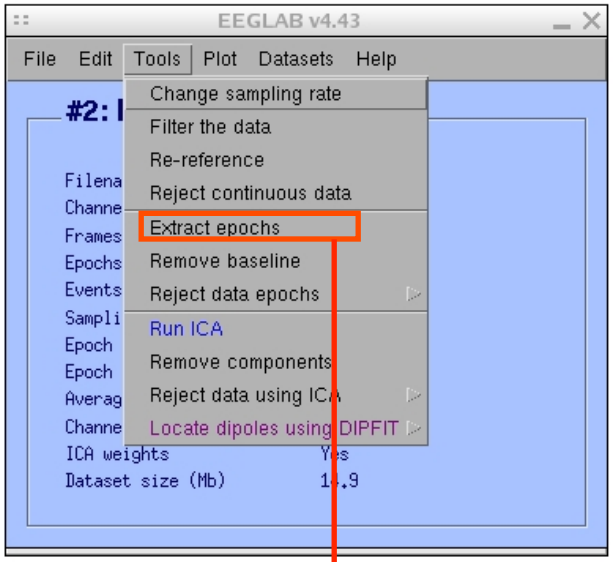
Reject portions of continuous data

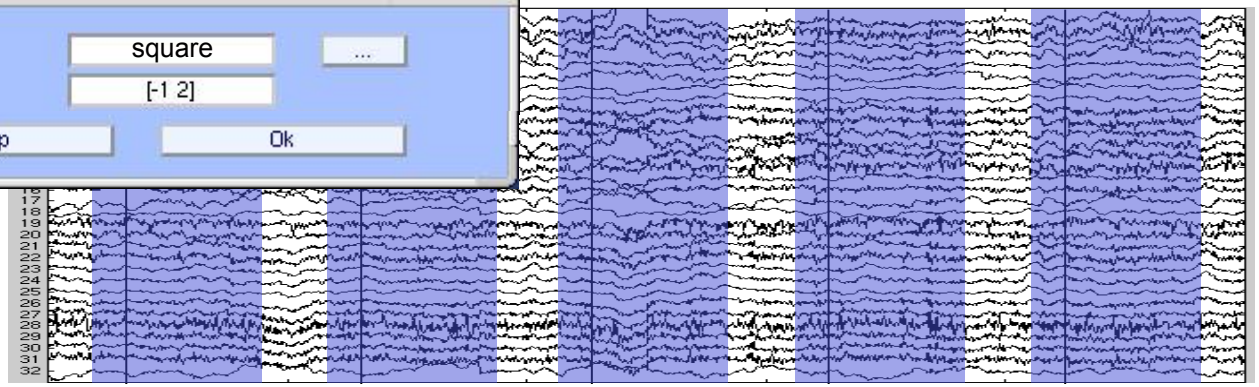


4. Extract epochs from data & reject artifactual epochs



Preprocessing data





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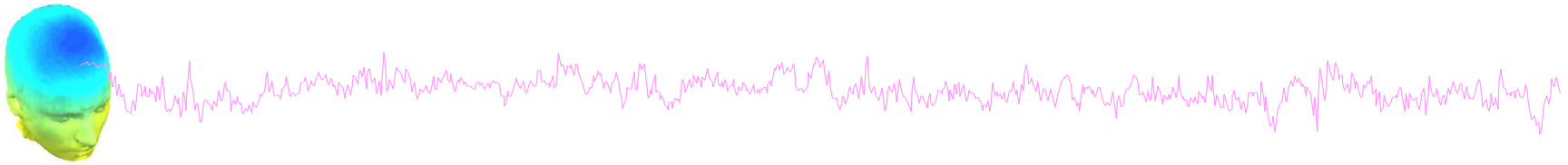
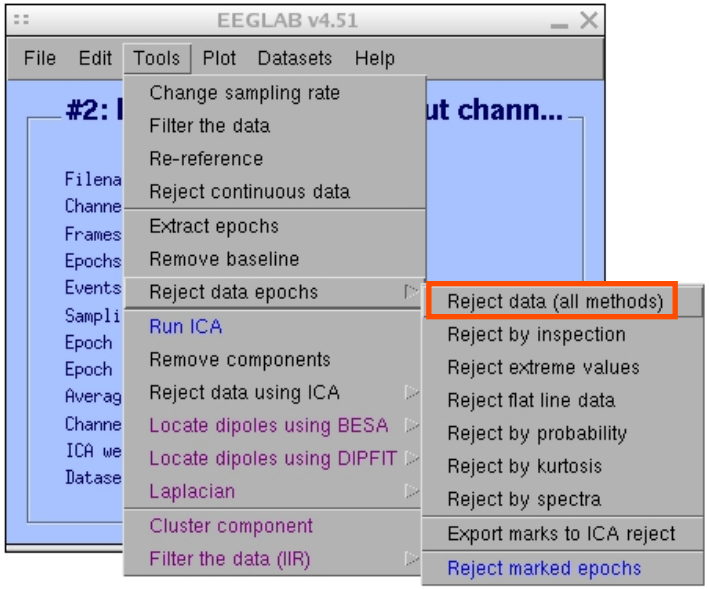
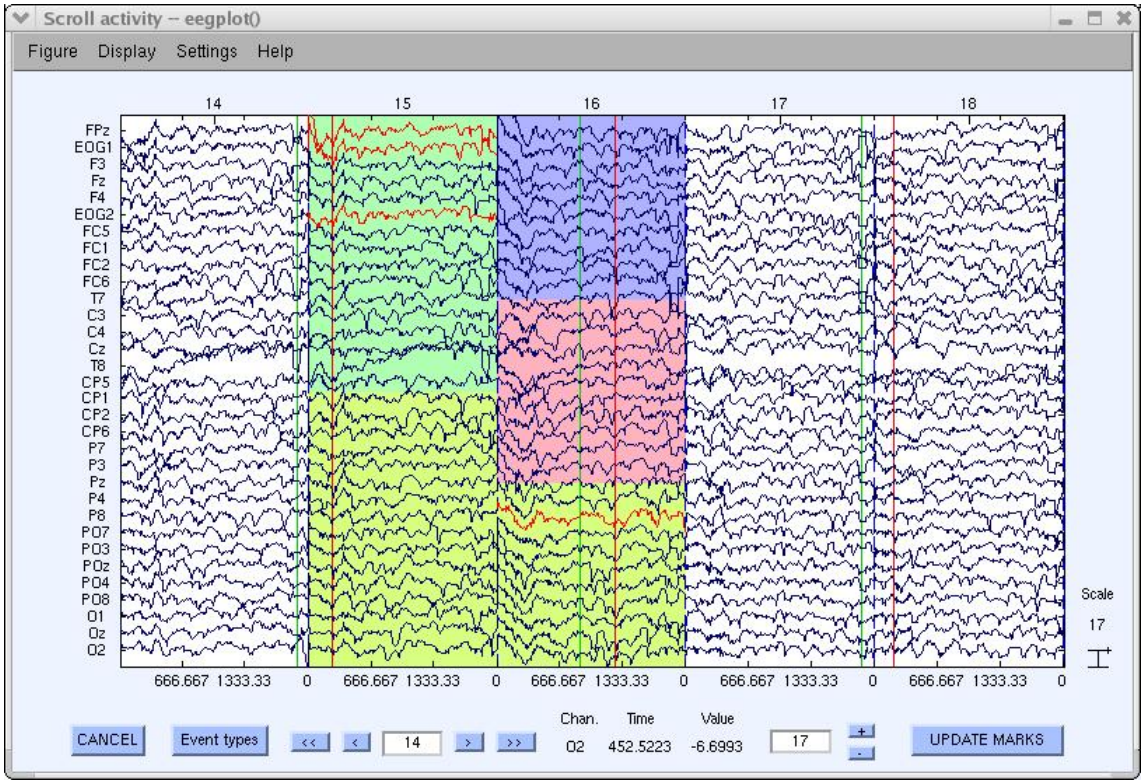
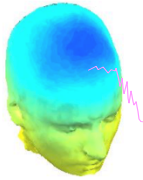


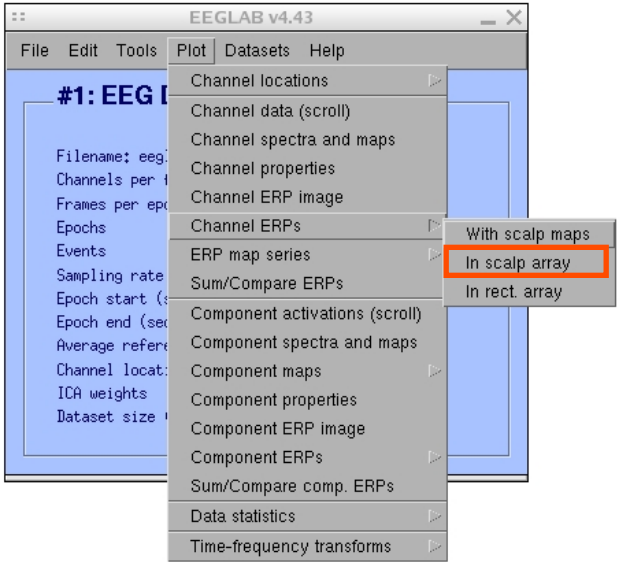


Different color = different rejection methods

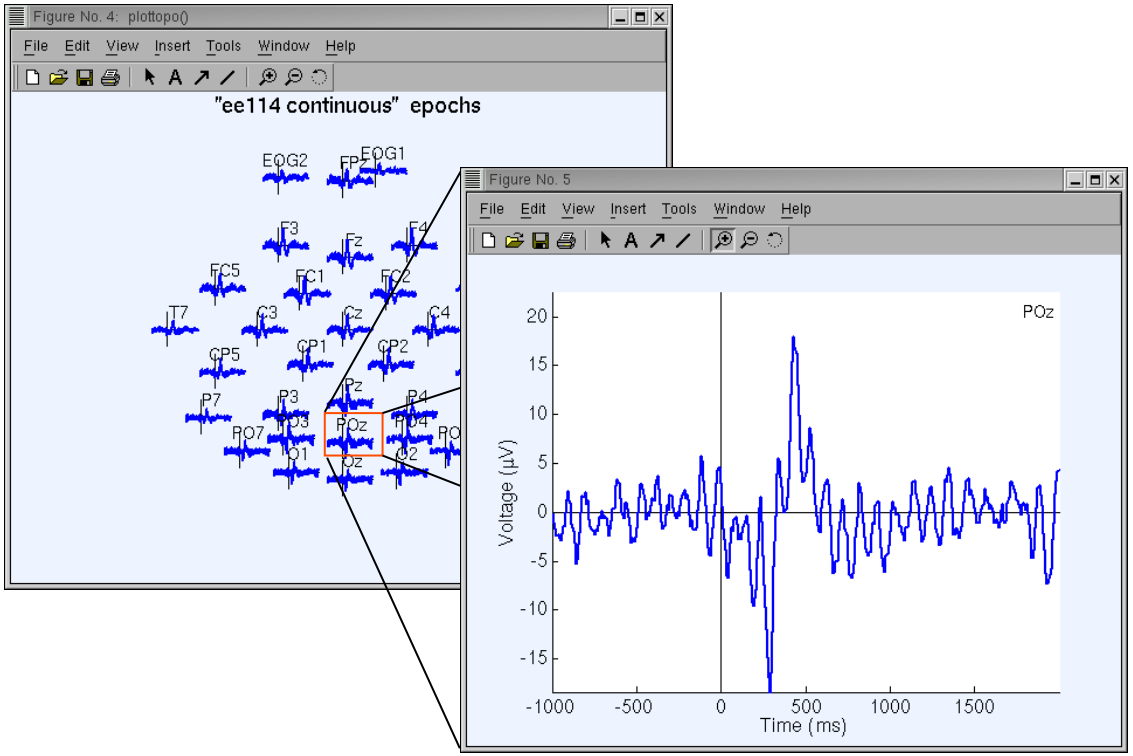


5. Visualize data measures



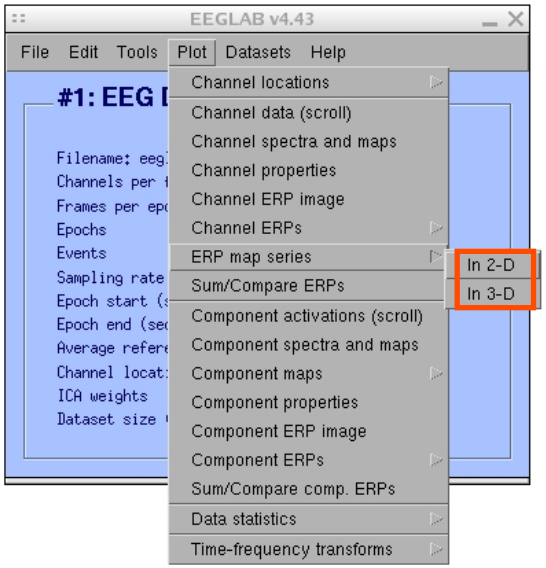


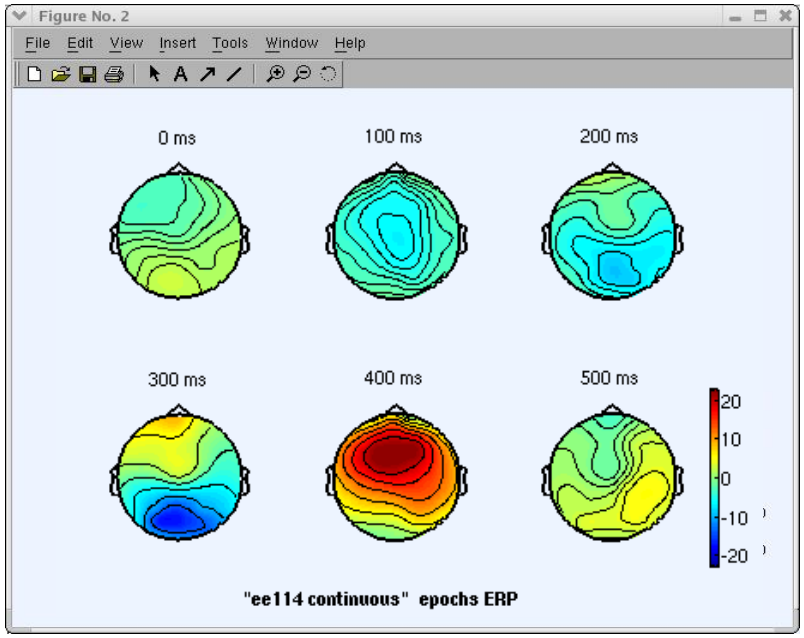
Plot ERP

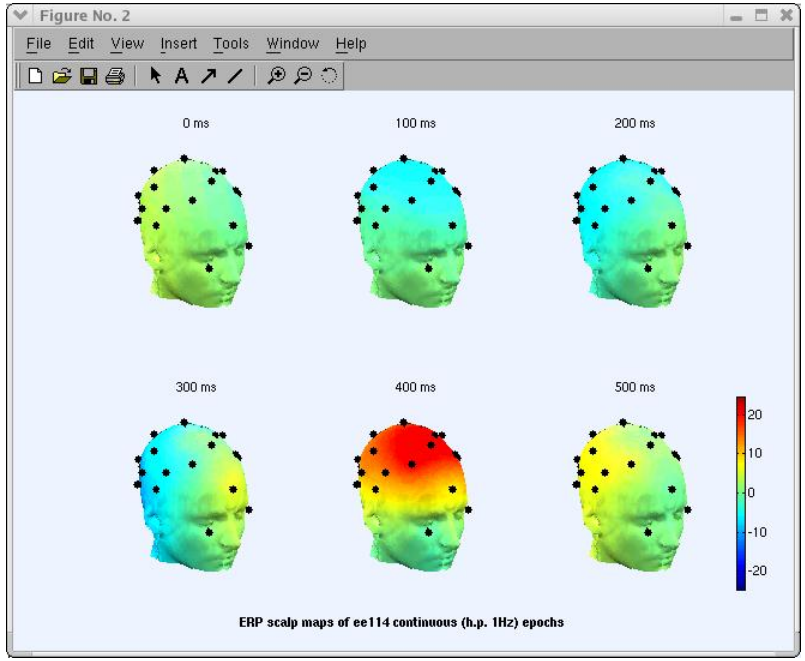


5. Visualize data measures

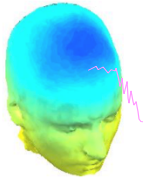
Plot ERP
map series



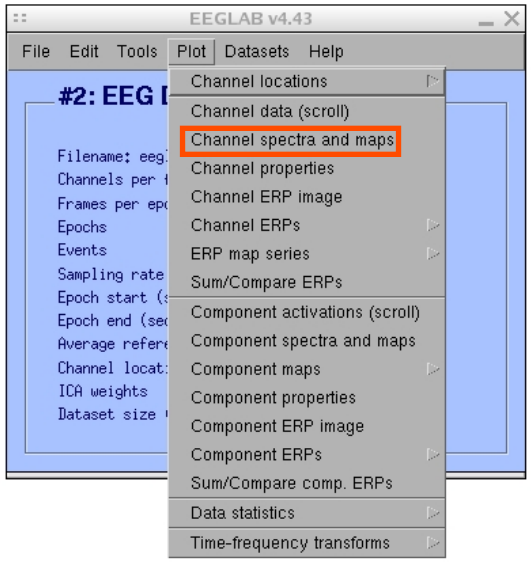


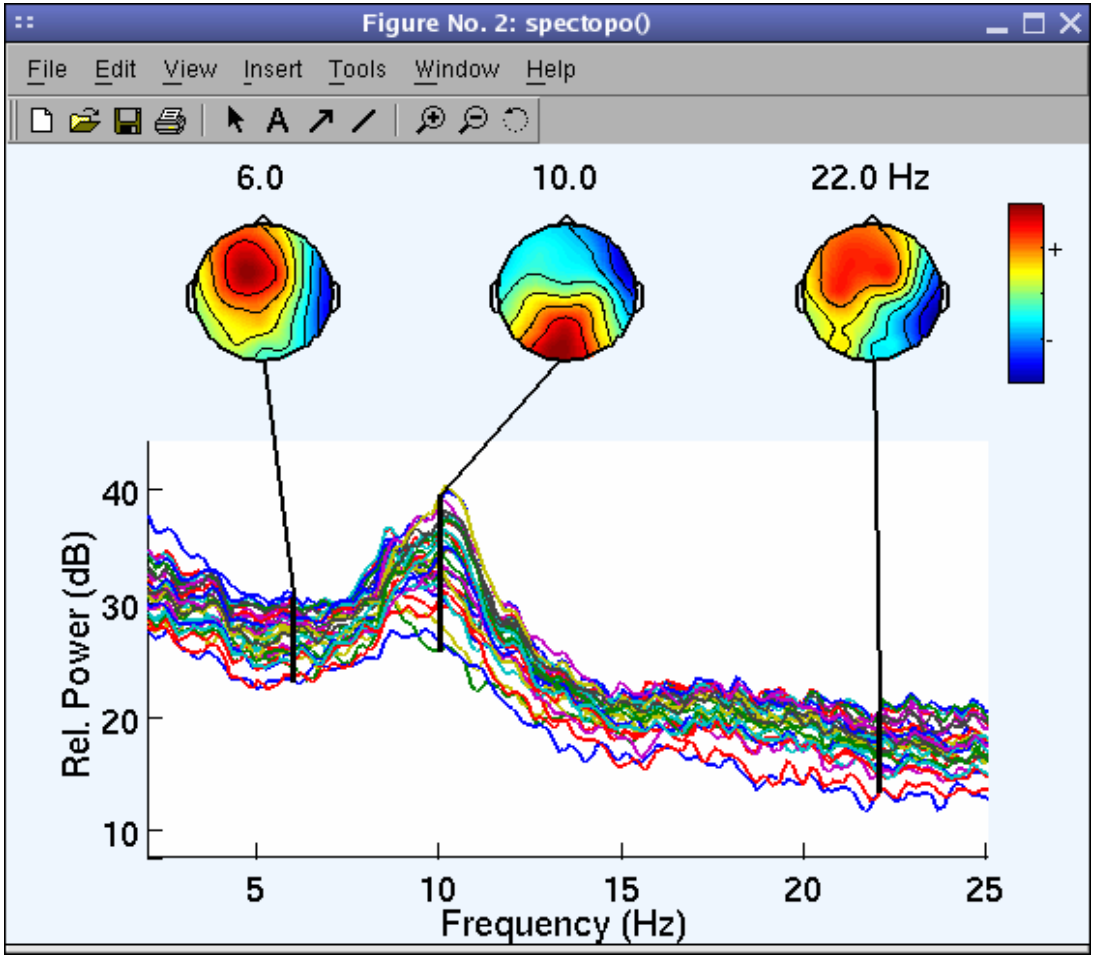


5. Visualize data measures



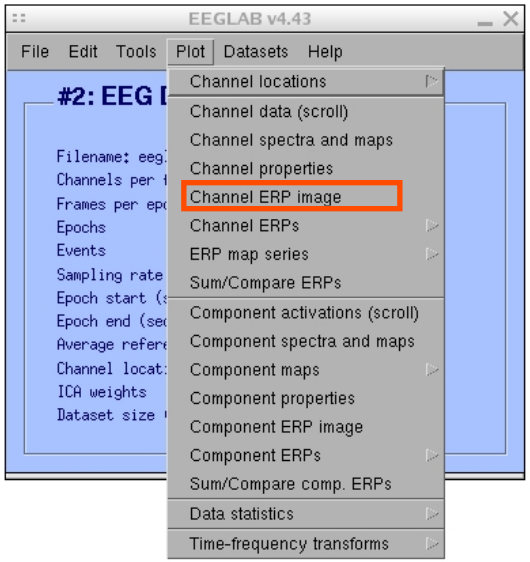
Plot data spectrum and maps

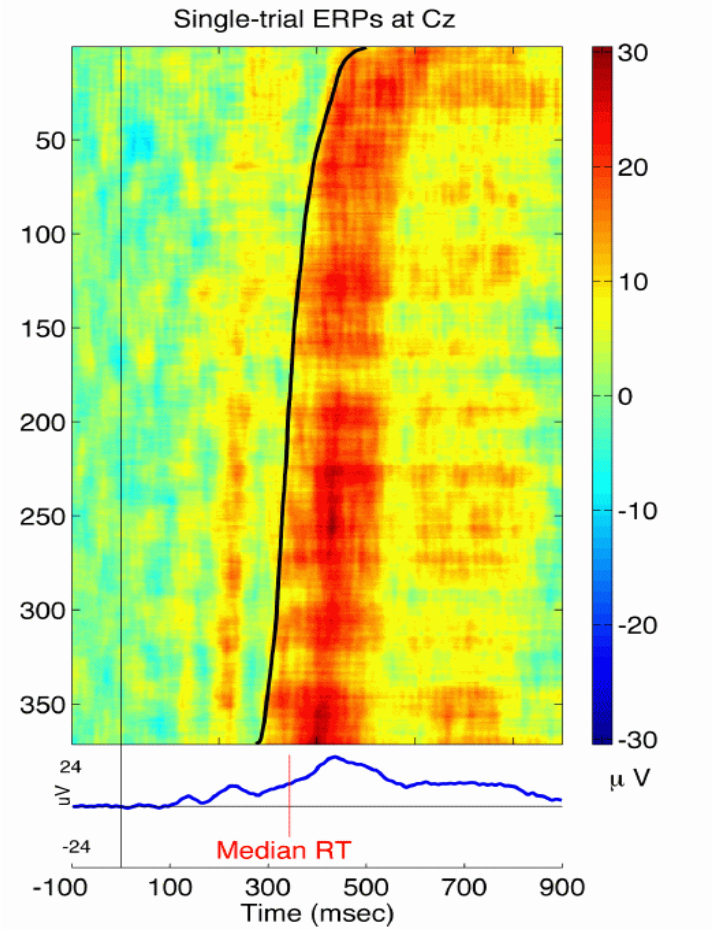




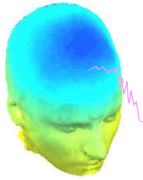
5. Visualize data measures

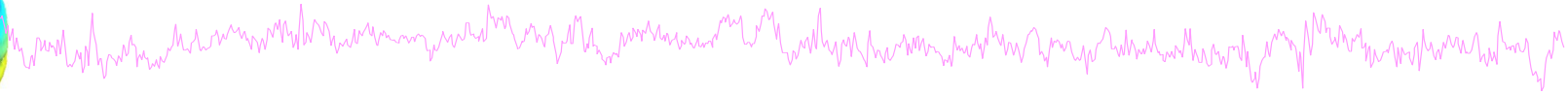
Plot channel ERPimage





EEGLAB standard processing pipeline





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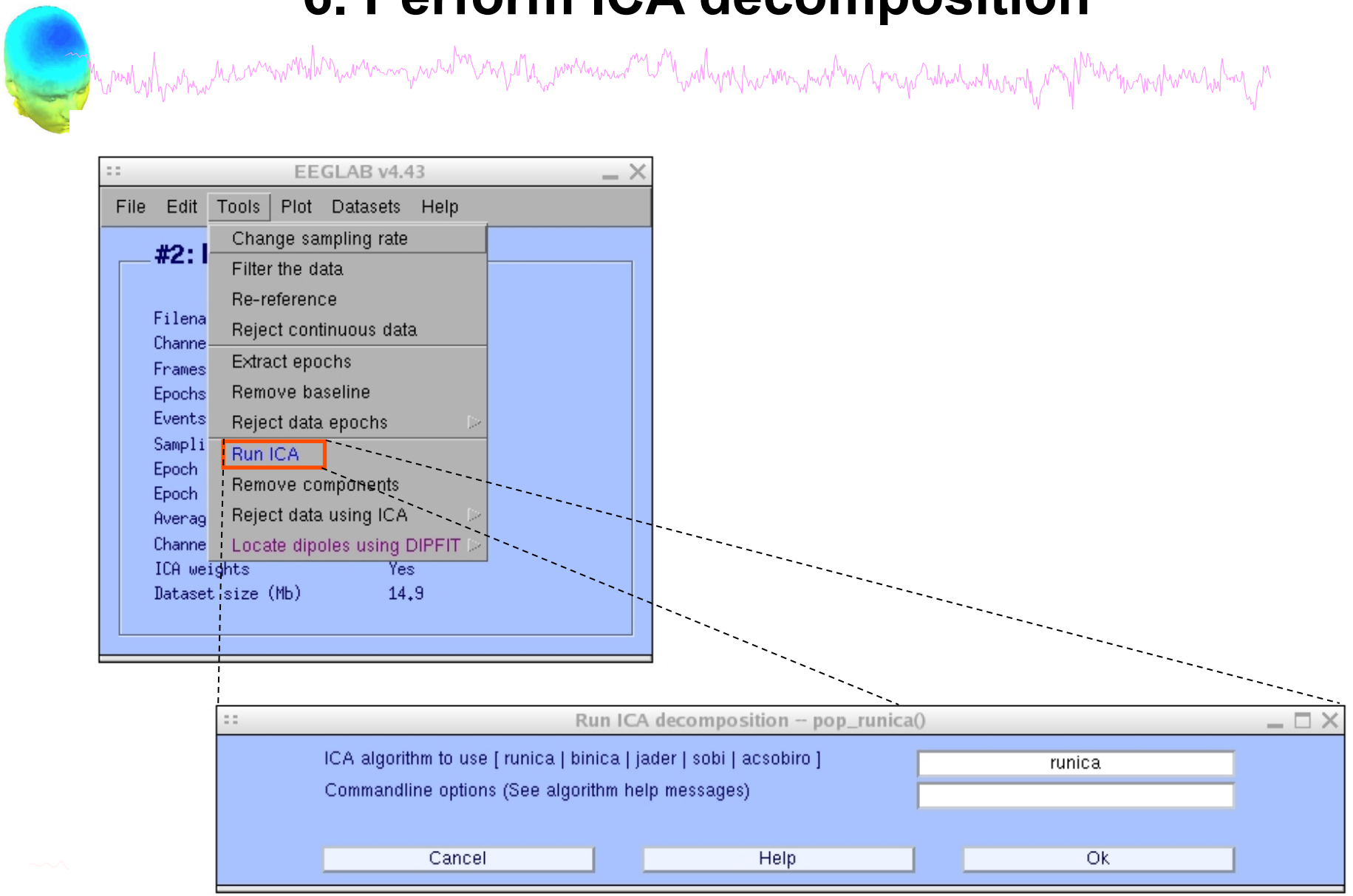
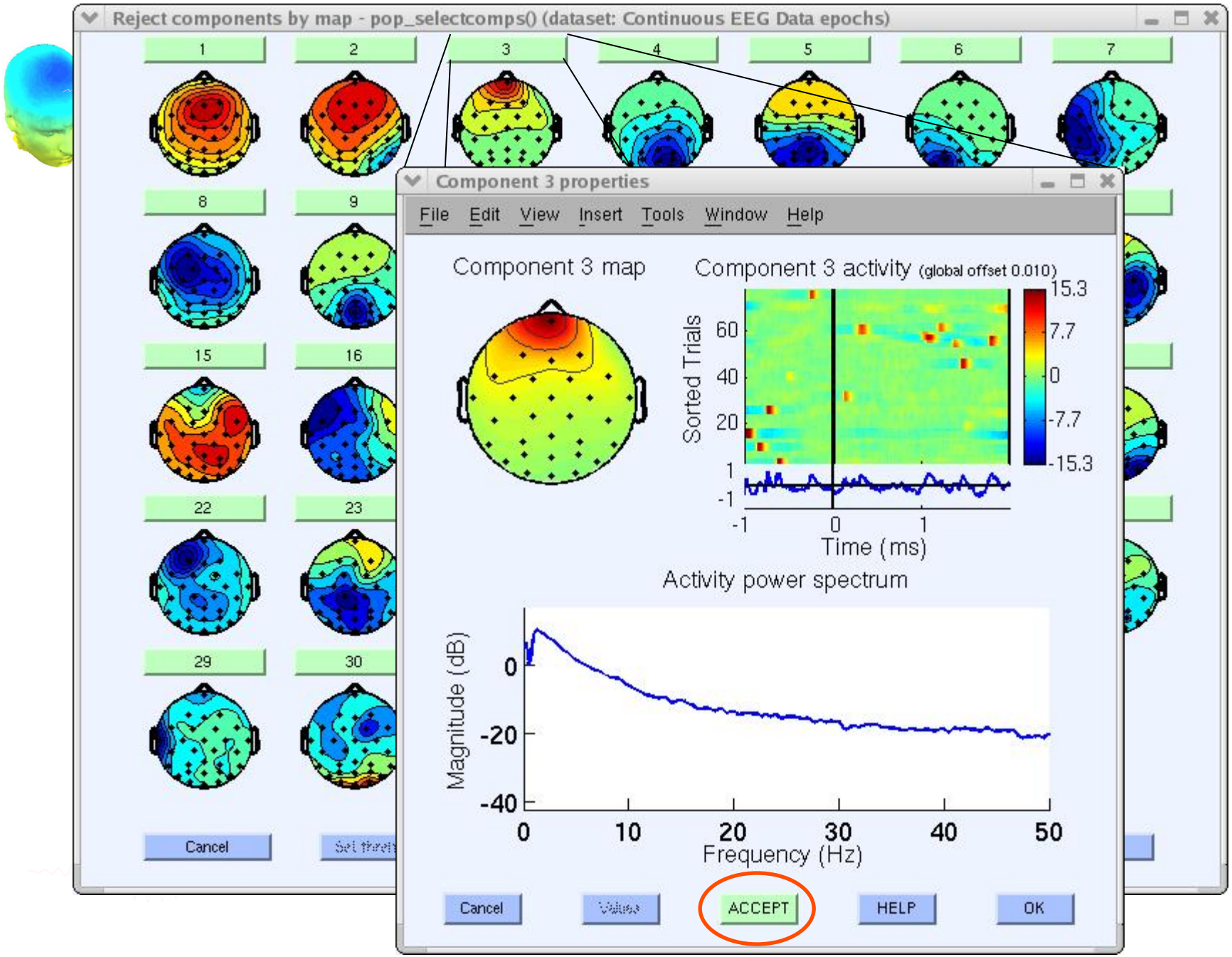
4. Analyze clusters

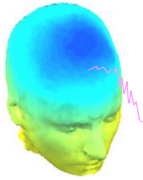
Advanced analysis using scripting and EEGLAB command line functions

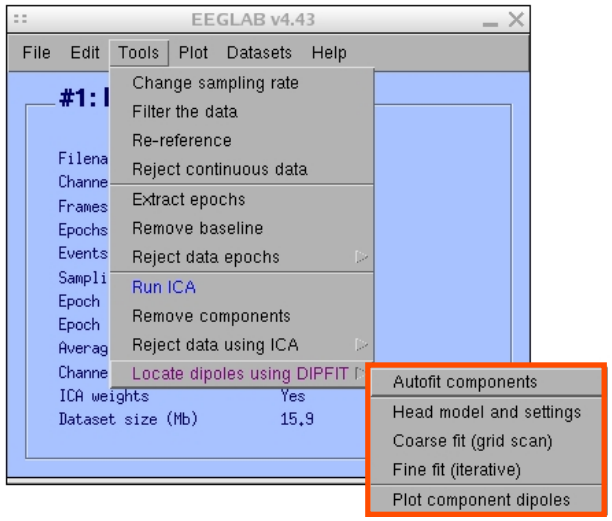
6. Perform ICA decomposition

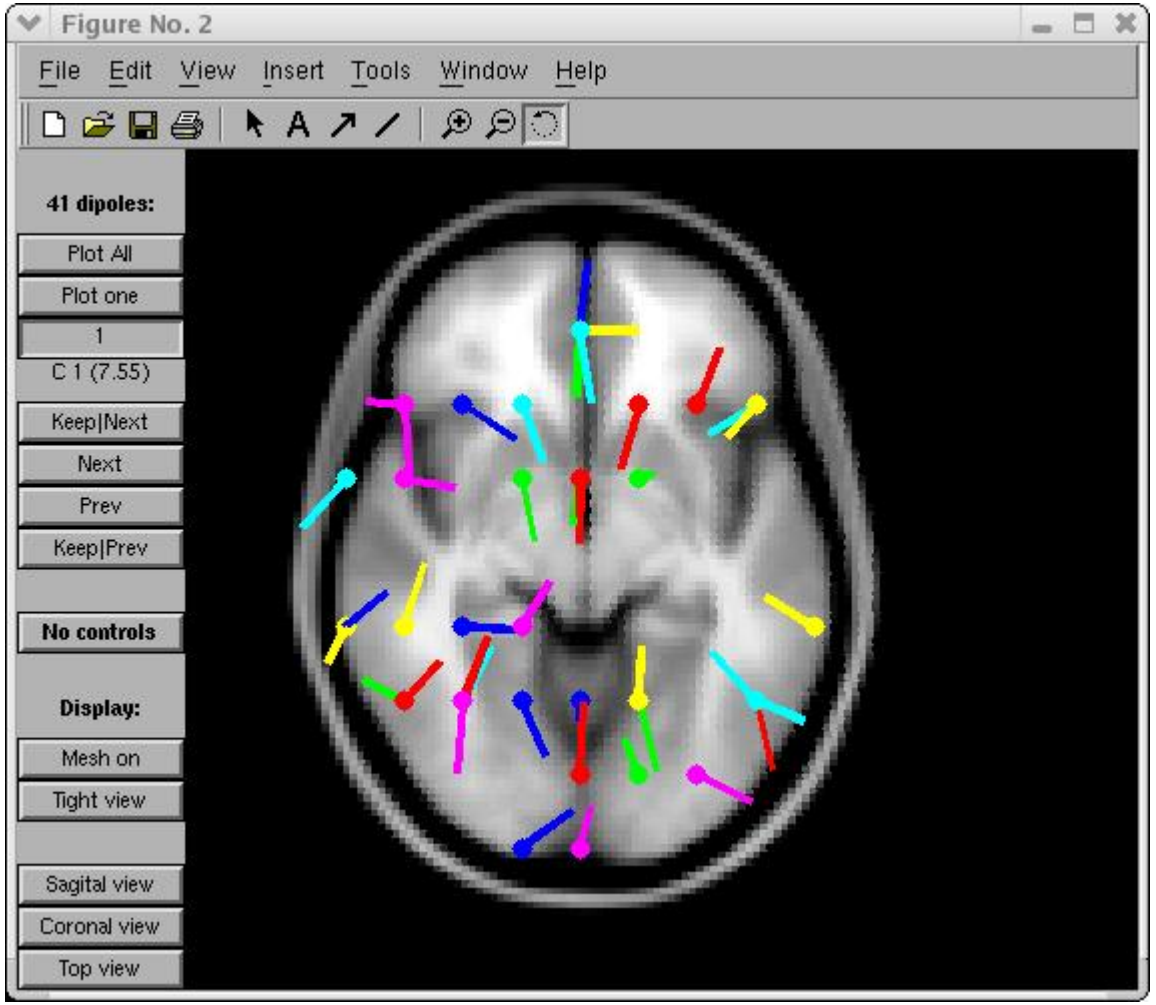



Reject components by map - pop_selectcomps() (dataset: Continuous EEG Data epochs)
1
2
3
4
5
6
7
8
9
15
16
22
23
29
30
Cancel
Component 3 properties
File Edit View Insert Tools Window Help
Component 3 map
Component 3 activity (global offset 0.010)
Sorted Trials
60
40
20
1
-1
15.3
7.7
0
-7.7
-15.3
-1
0
1
Time (ms)
Activity power spectrum
Magnitude (dB)
0
-20
-40
0
10
20
30
40
50
Frequency (Hz)
Cancel
ACCEPT
HELP
OK

Localizing components







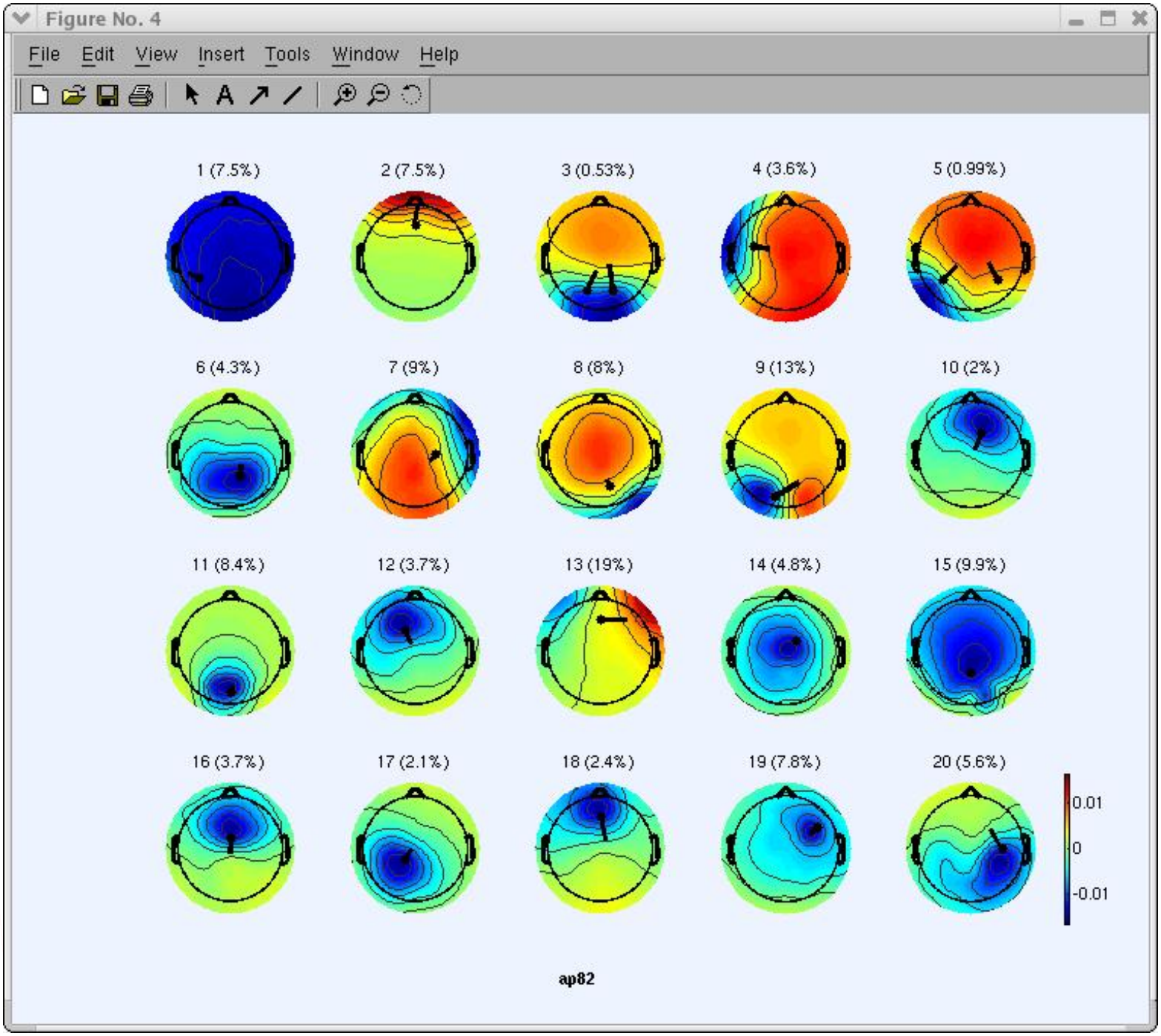


Figure No. 4
File Edit View Insert Tools Window Help
1 (7.5%)
2 (7.5%)
3 (0.53%)
4 (3.6%)
5 (0.99%)
6 (4.3%)
7 (9%)
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9 (13%)
10 (2%)
11 (8.4%)
12 (3.7%)
13 (19%)
14 (4.8%)
15 (9.9%)
16 (3.7%)
17 (2.1%)
18 (2.4%)
19 (7.8%)
20 (5.6%)
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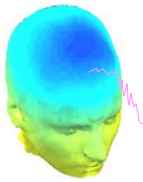
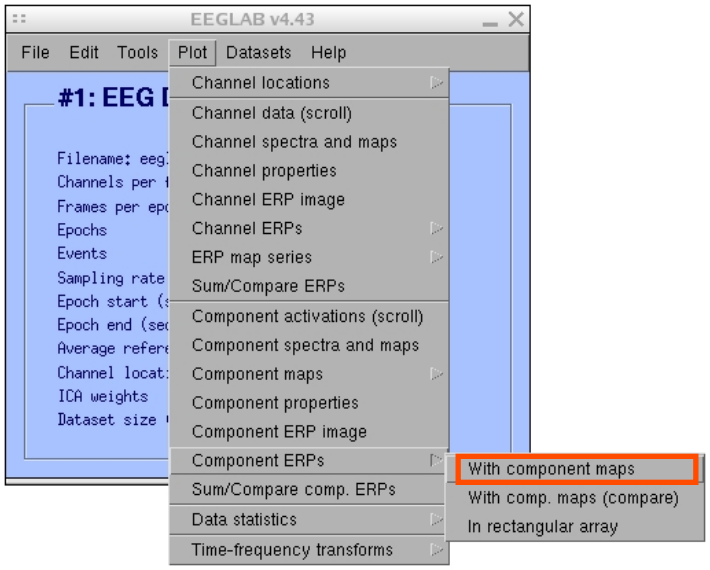
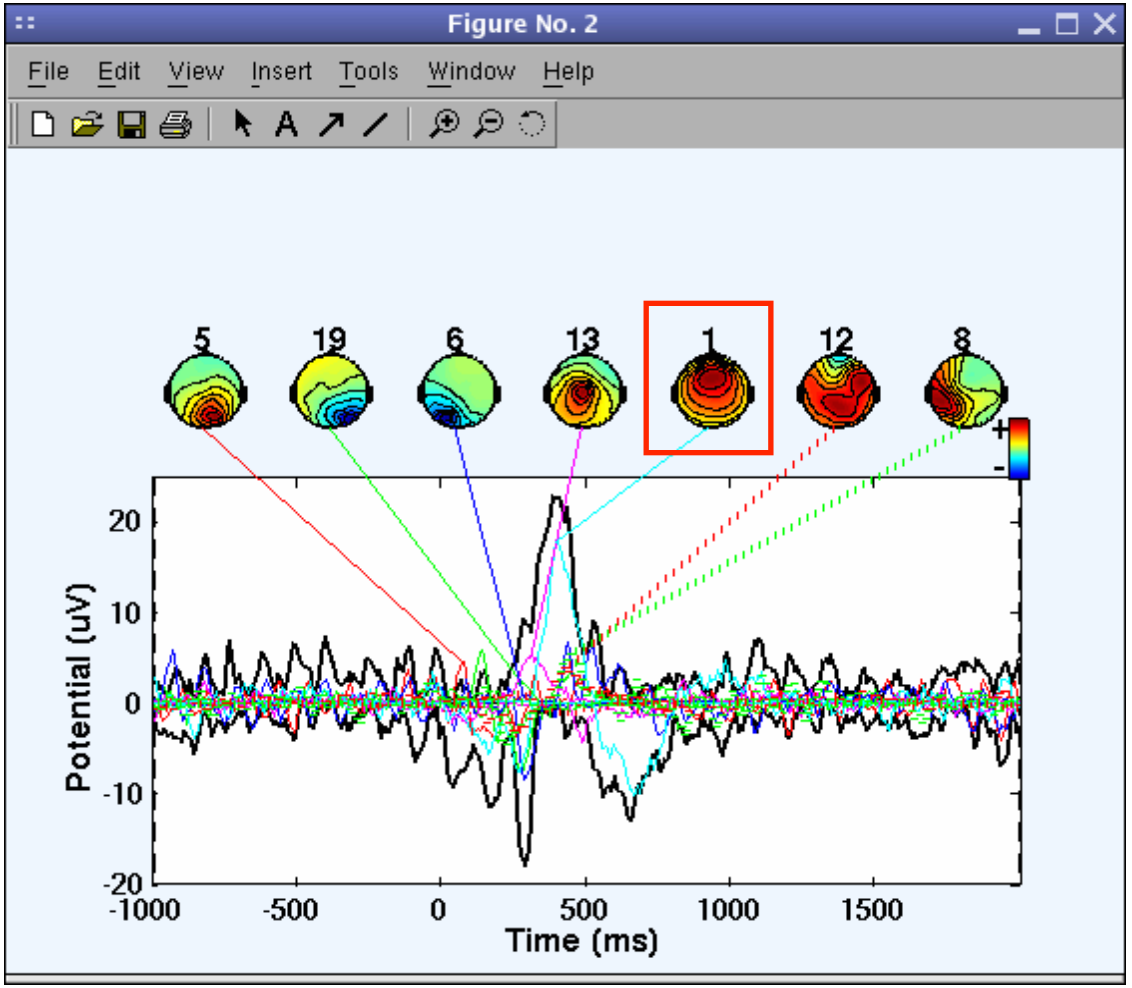
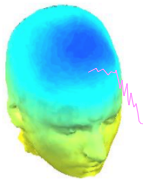
-0.01
ap82

Component contribution to the ERP

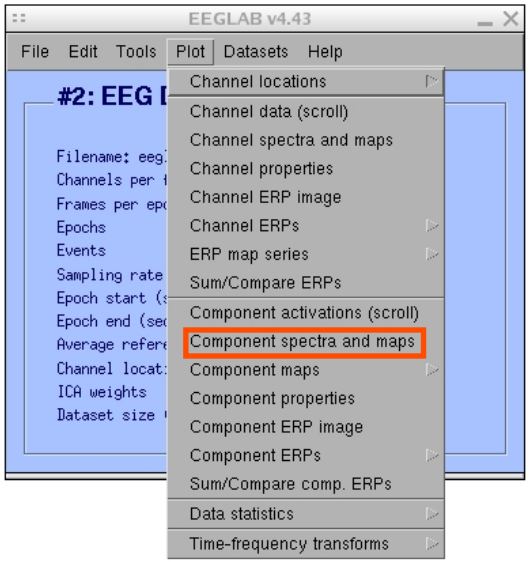


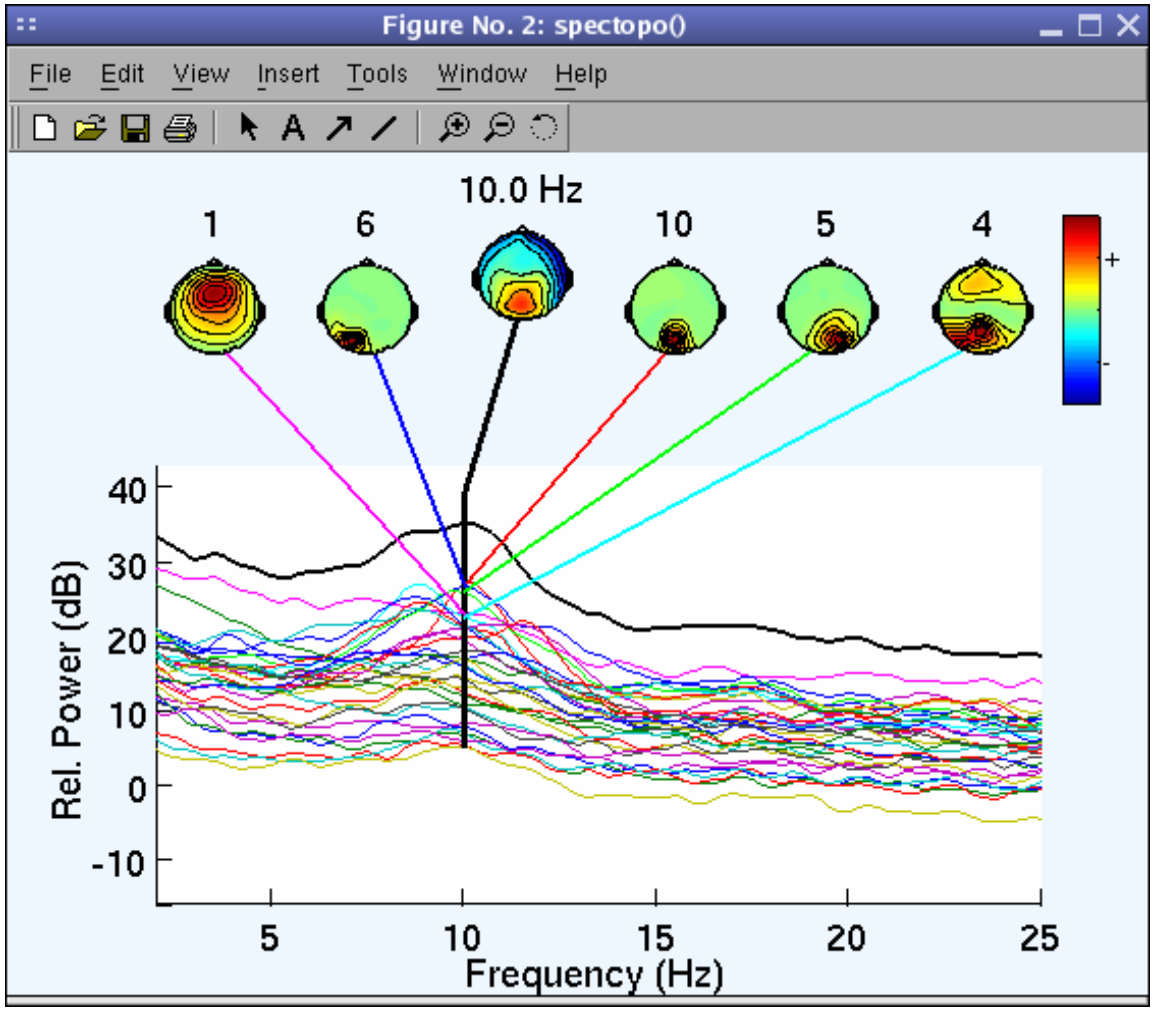




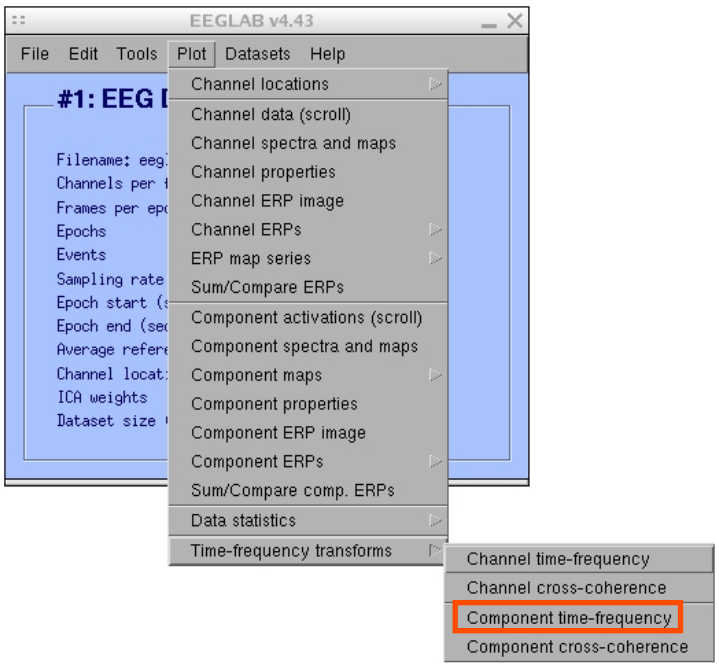


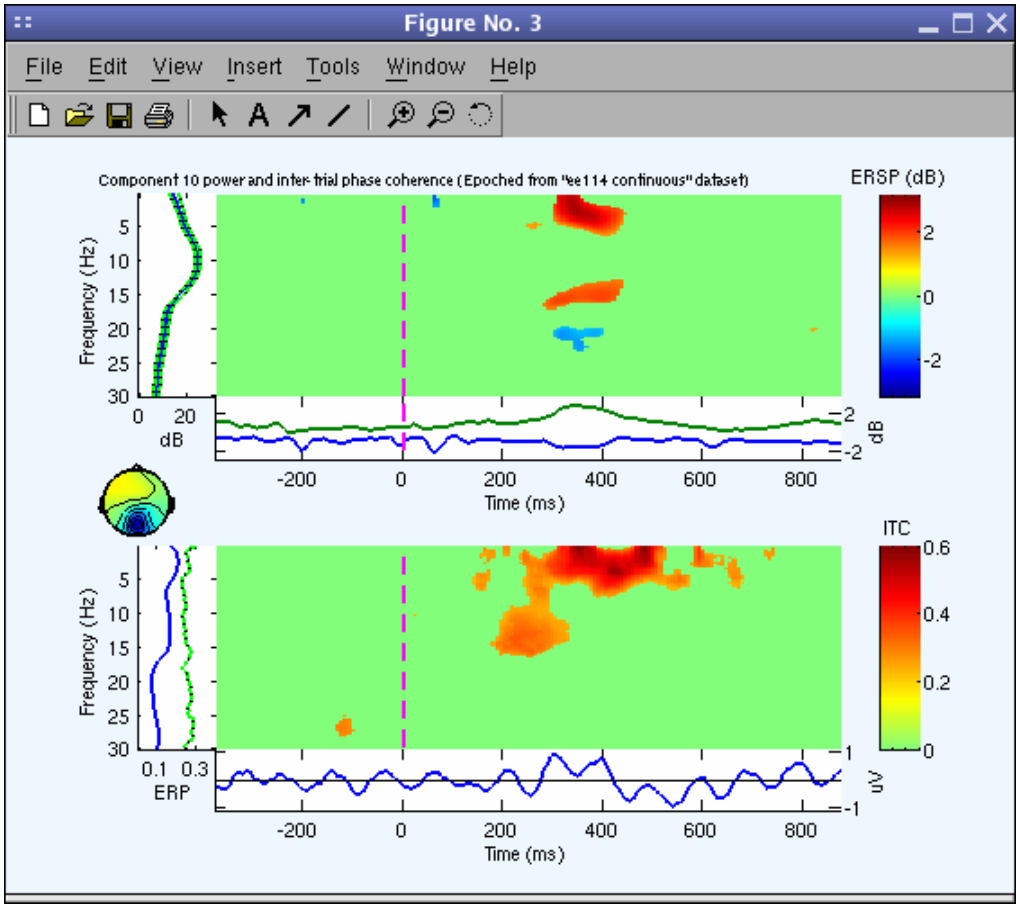
Component contribution to the EEG spectrum



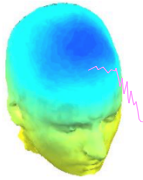


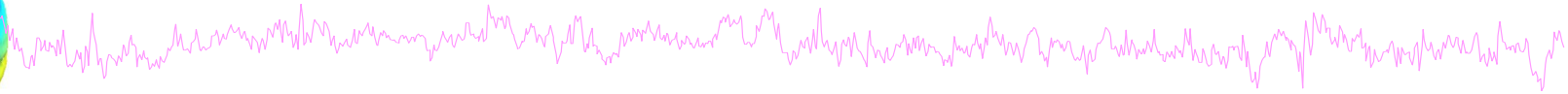
Component time-frequency





EEGLAB standard processing pipeline





Single subject

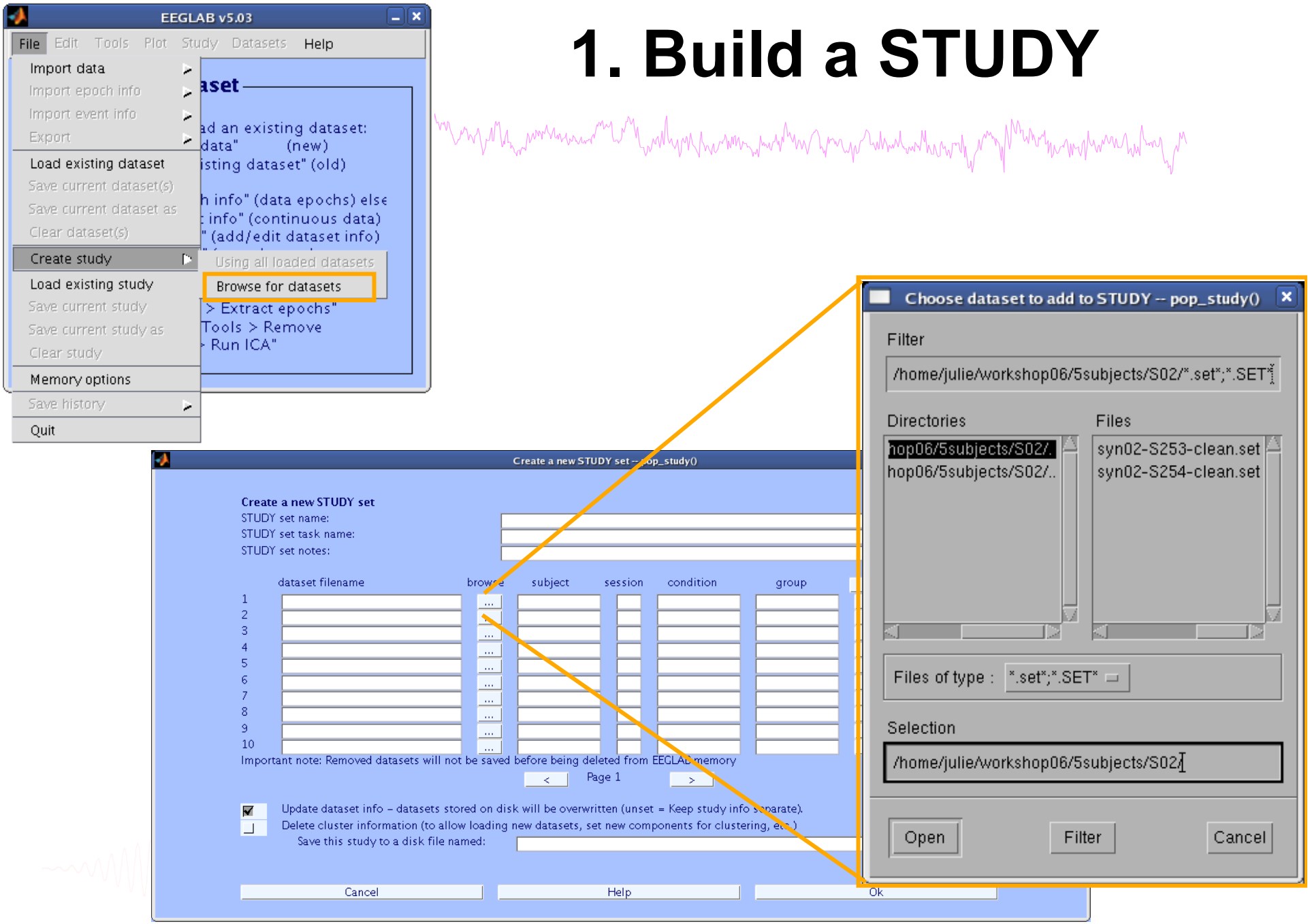
1. Import binary data, events and channel location
2. Edit, Re-reference, Resample, High pass filter data
3. Reject artifacts in continuous data by visual inspection
4. Extract epochs from data & reject artifactual epochs
5. Visualize data measures
6. Perform ICA decomposition
   - Perform source localization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

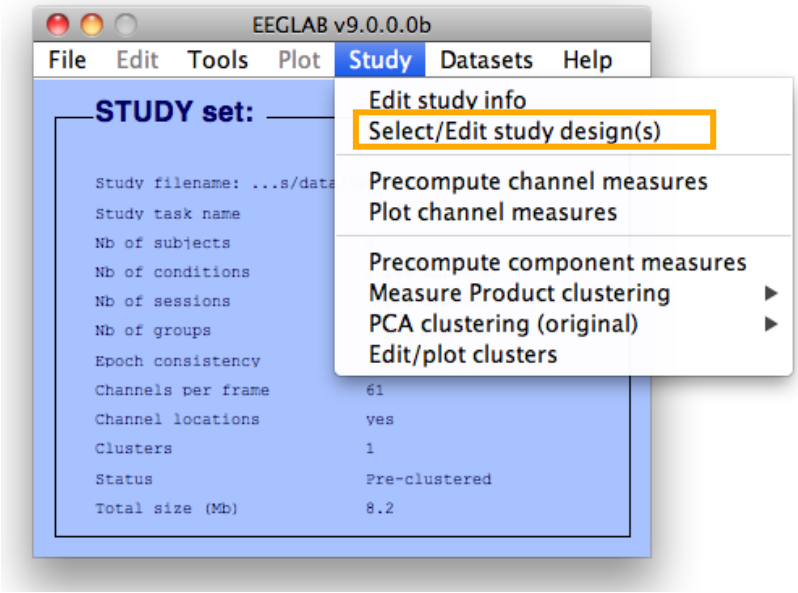
Multi-subjects

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

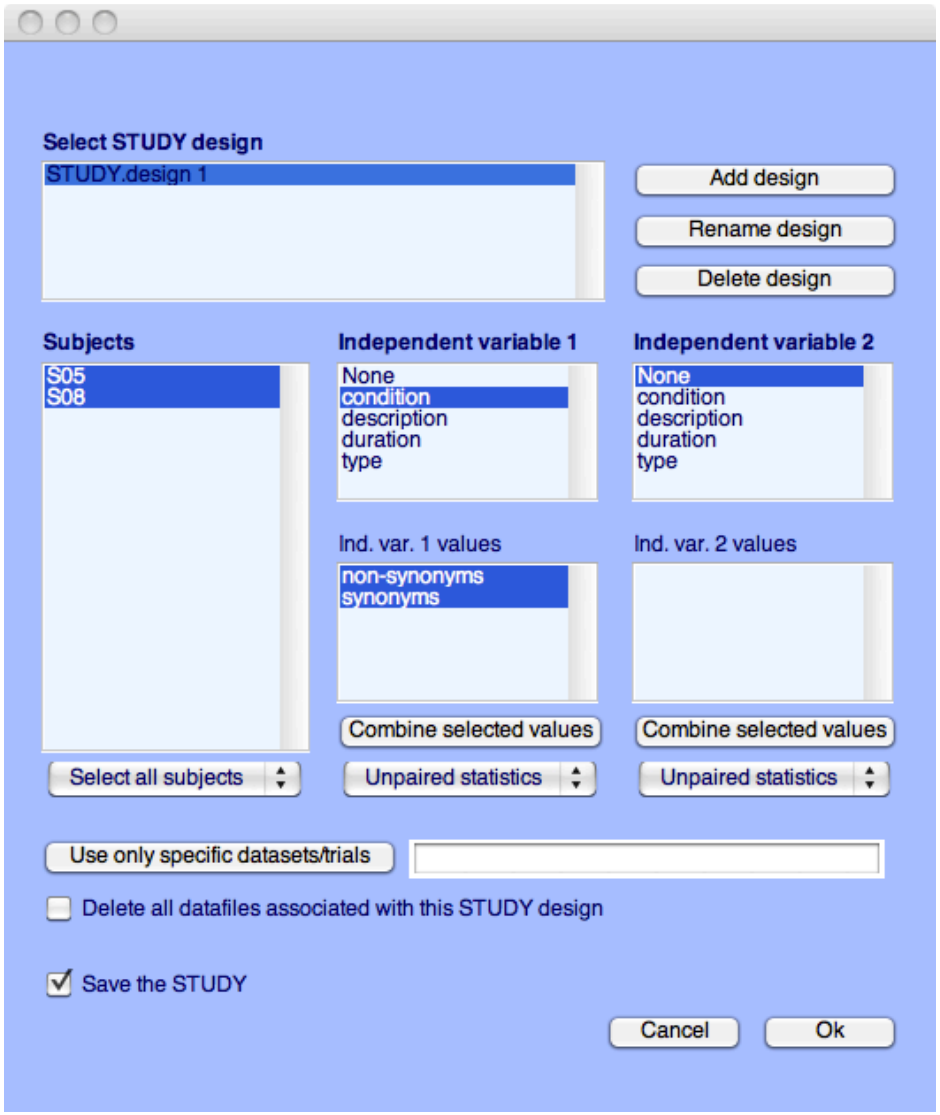
Advanced analysis using scripting and EEGLAB command line functions

1. Build a STUDY

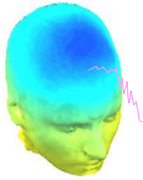


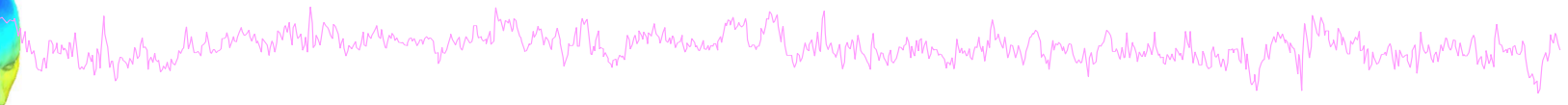


:dit STUDY design

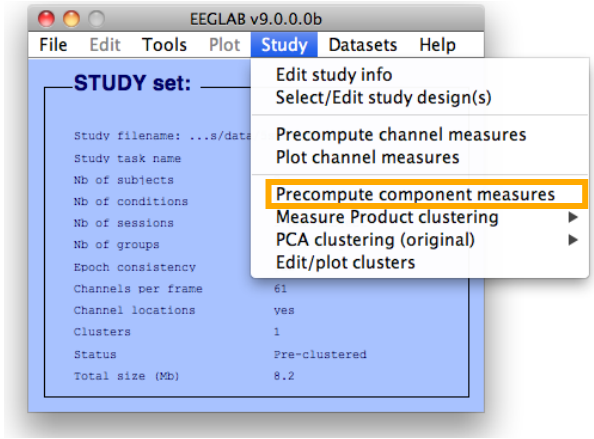


2. Pre-compute measures

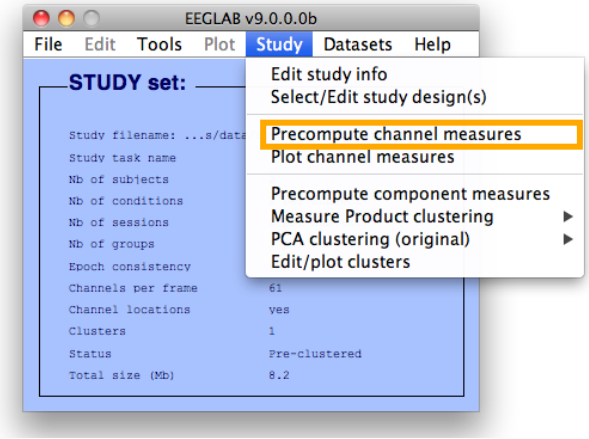


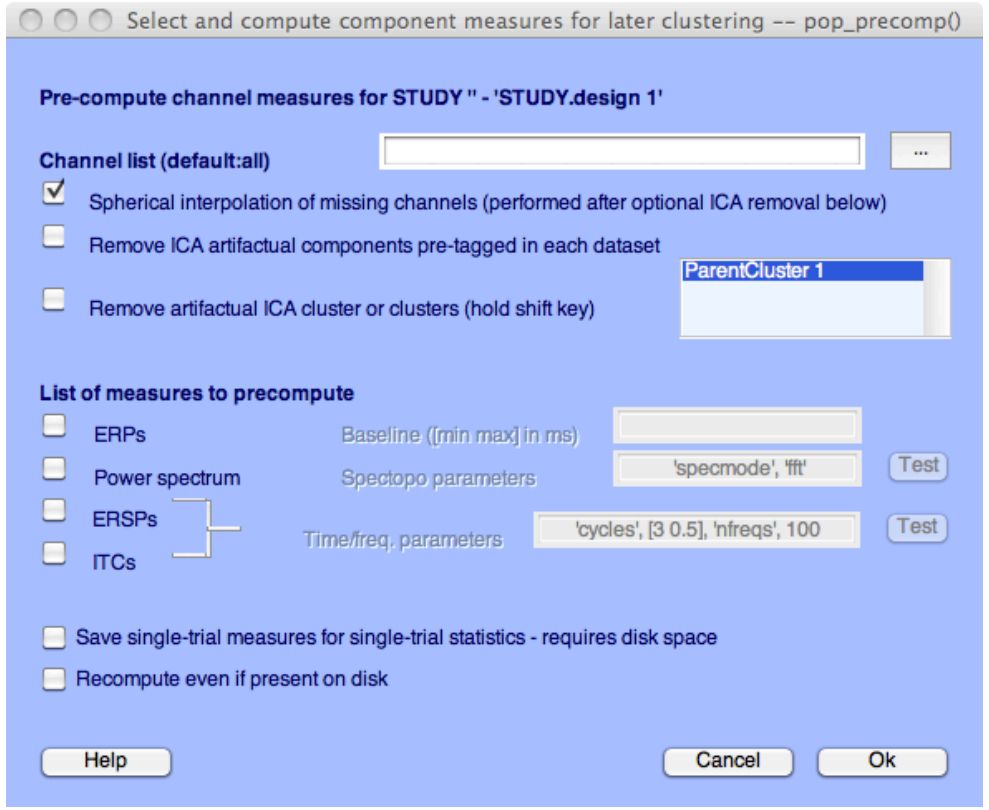


Components

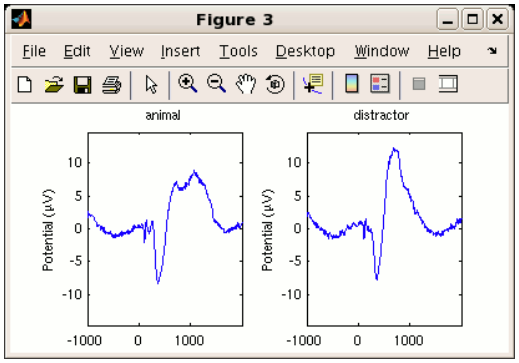


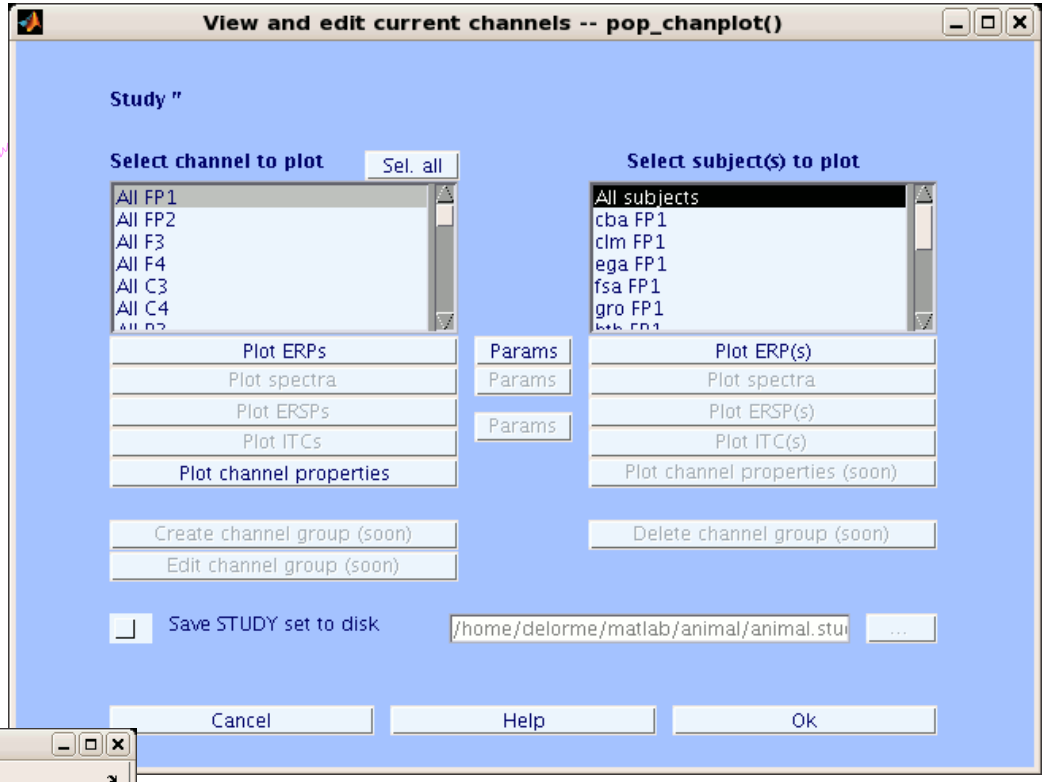
Channels

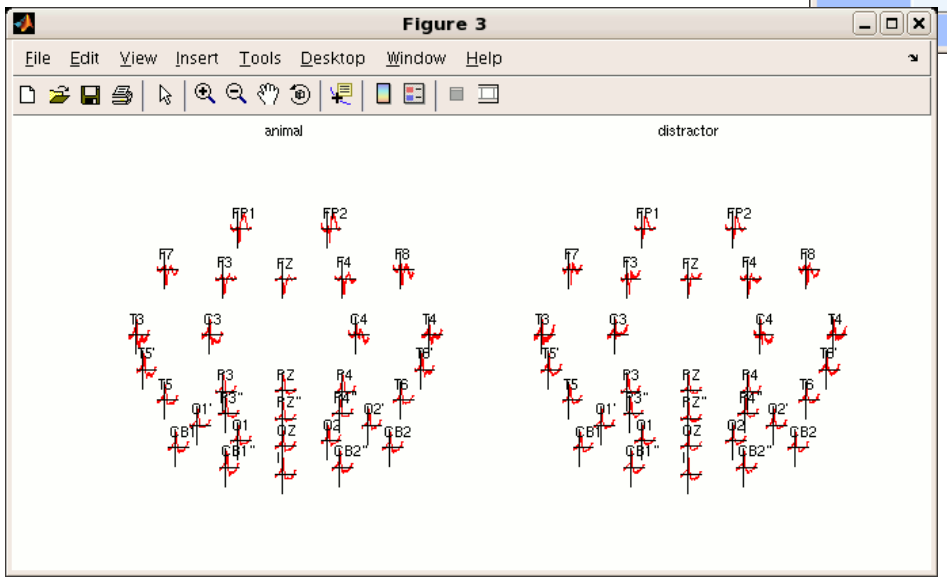


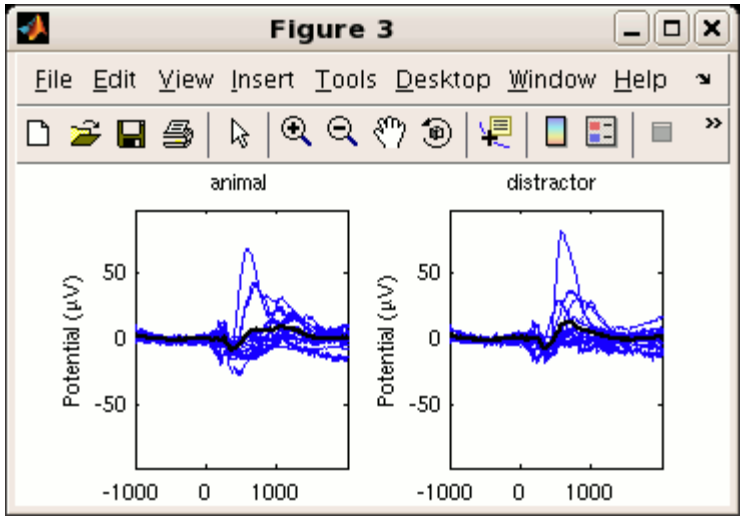


Channel plotting

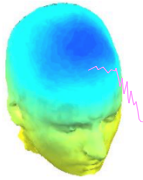


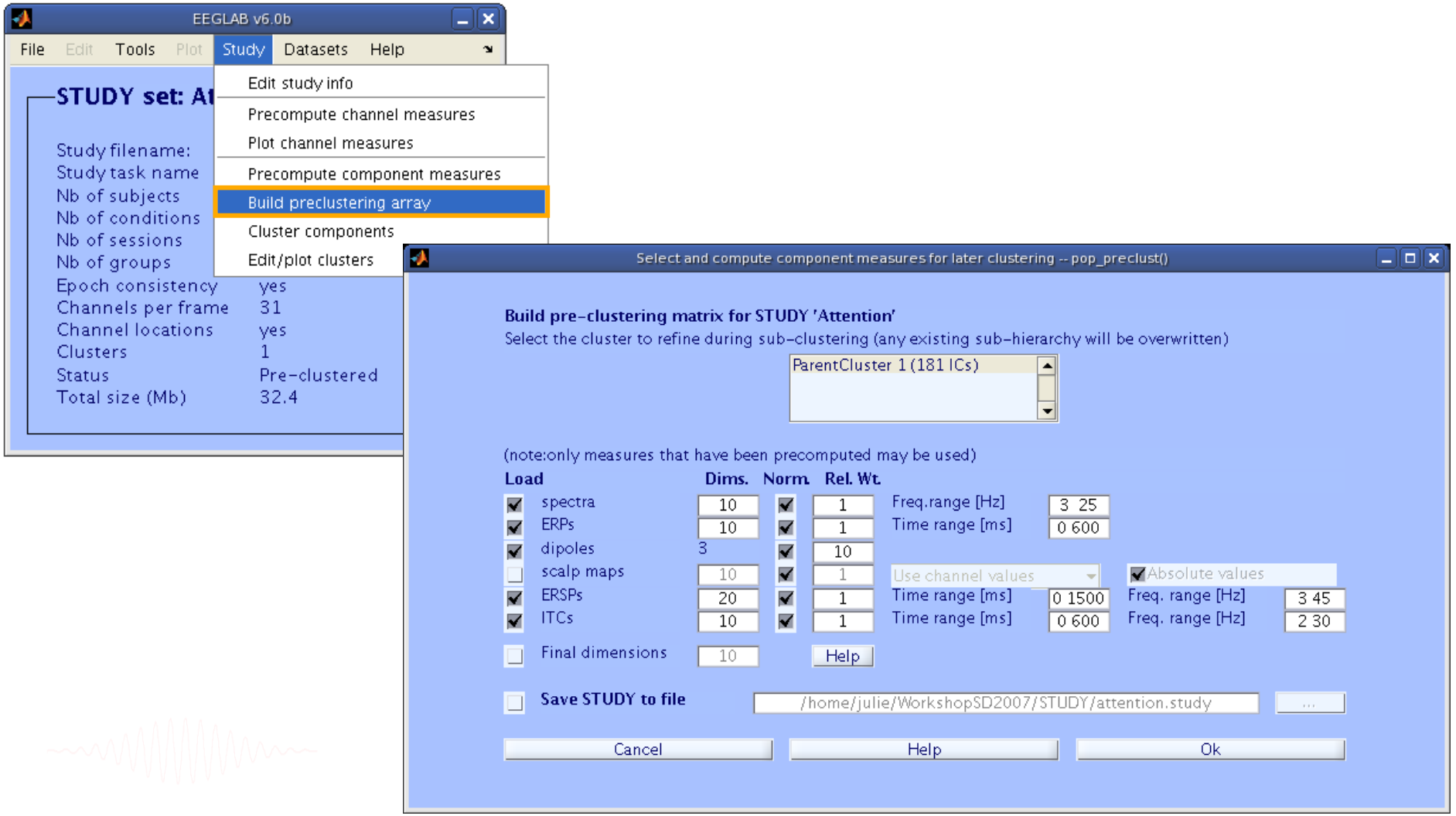




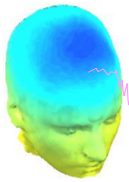


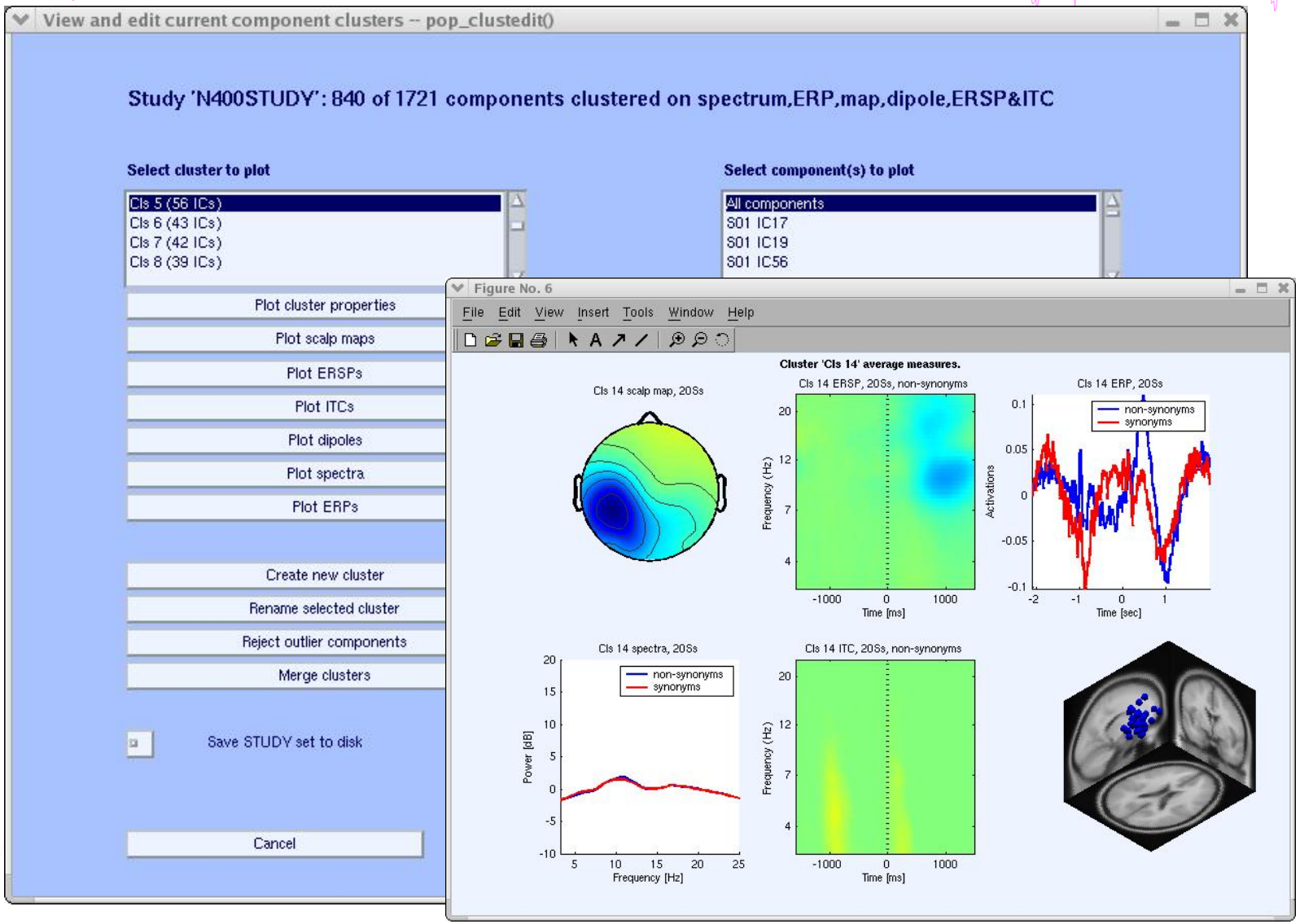
3. Cluster components

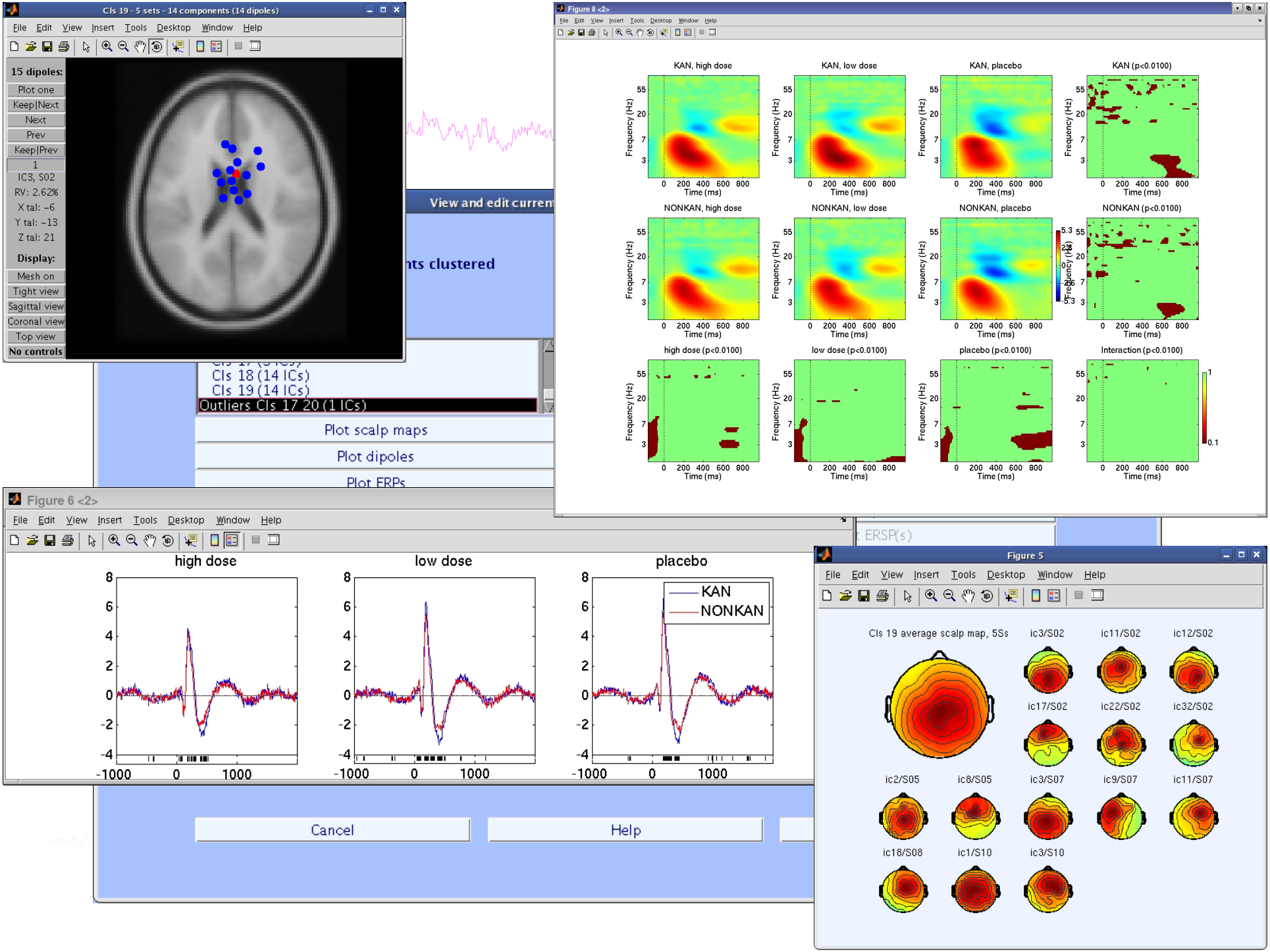




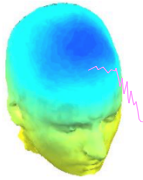
4. Analyze clusters

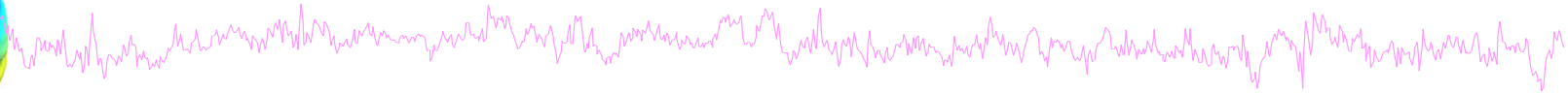





Cls 19 - 5 sets - 14 components (14 dipoles)
File Edit View Insert Tools Desktop Window Help
15 dipoles:
Plot one
Keep|Next
Next
Prev
Keep|Prev
1
IC3, S02
RV: 2.62%
X tal: -6
Y tal: -13
Z tal: 21
Display:
Mesh on
Tight view
Sagittal view
Coronal view
Top view
No controls
View and edit curren
nts clustered
Cls 18 (14 ICs)
Cls 19 (14 ICs)
Outliers Cls 17 20 (1 ICs)
Plot scalp maps
Plot dipoles
Plot ERPs
Figure 8 <2>
KAN, high dose
KAN, low dose
KAN, placebo
KAN (p<0.0100)
NONKAN, high dose
NONKAN, low dose
NONKAN, placebo
NONKAN (p<0.0100)
high dose (p<0.0100)
low dose (p<0.0100)
placebo (p<0.0100)
Interaction (p<0.0100)
Frequency (Hz)
Time (ms)
Figure 6 <2>
File Edit View Insert Tools Desktop Window Help
high dose
low dose
placebo
KAN
NONKAN
Cancel
Help
ERSP(s)
Figure 5
File Edit View Insert Tools Desktop Window Help
Cls 19 average scalp map, 5Ss
ic3/S02
ic11/S02
ic12/S02
ic17/S02
ic22/S02
ic32/S02
ic2/S05
ic8/S05
ic3/S07
ic9/S07
ic11/S07
ic18/S08
ic1/S10
ic3/S10

EEGLAB standard processing pipeline





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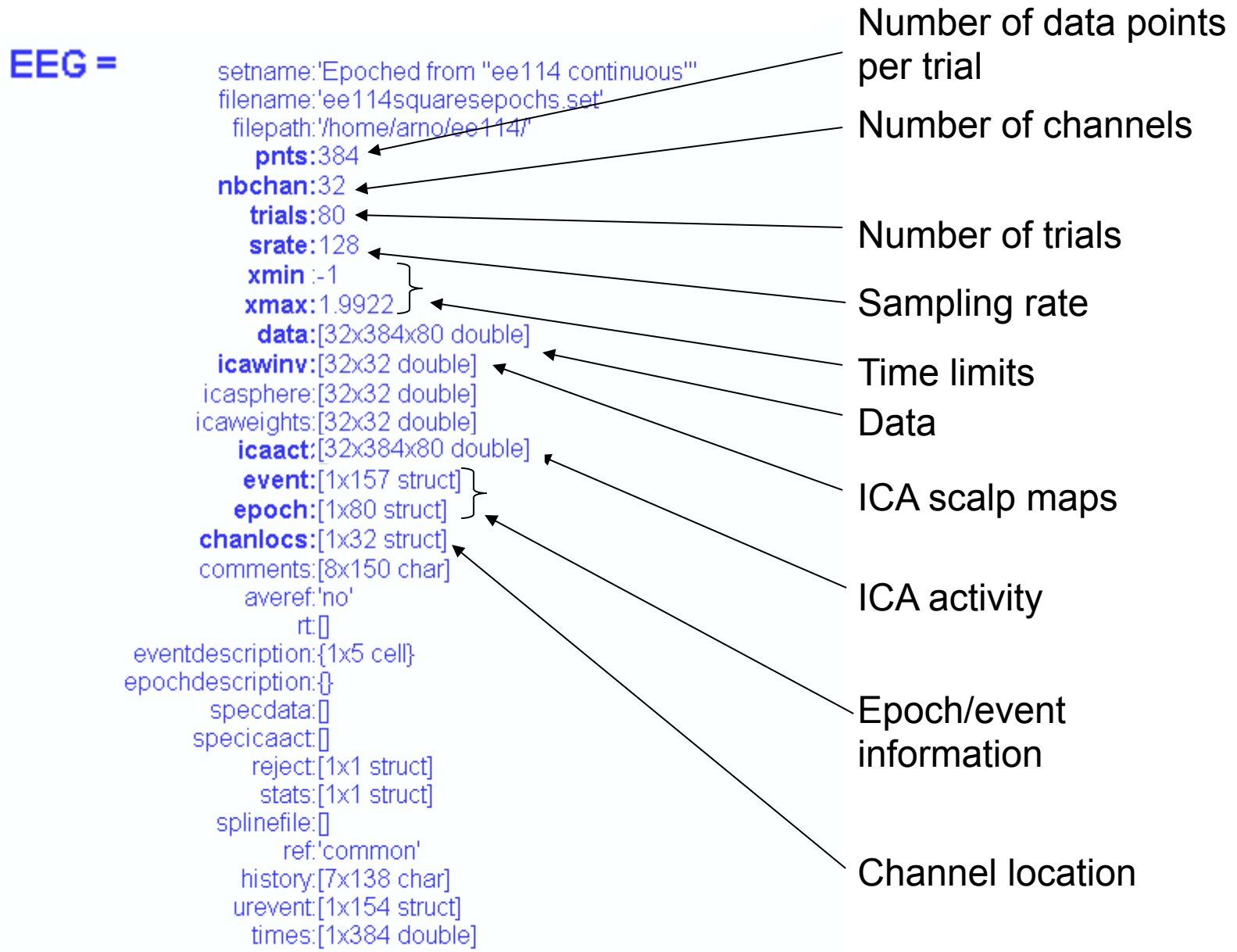
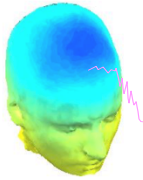
Advanced analysis using scripting and EEGLAB command line functions

EEG structure



3 levels of functions



Administrative functions: handle EEG and ALLEEG structures

eeglab(), eeg_checkset(), pop_delset(), …

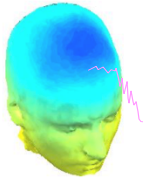
Pop functions: interactive functions using EEG structure

pop_erpimage(), pop_topoplot(), pop_envtopo(), …

Signal processing functions: perform signal processing

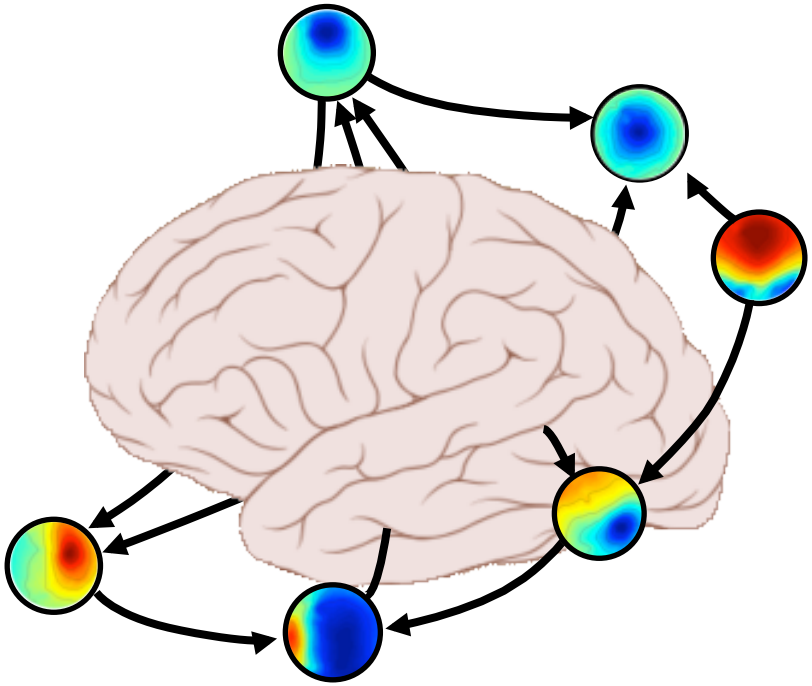
erpimage(), topoplot(), envtopo(), …

Command line tools



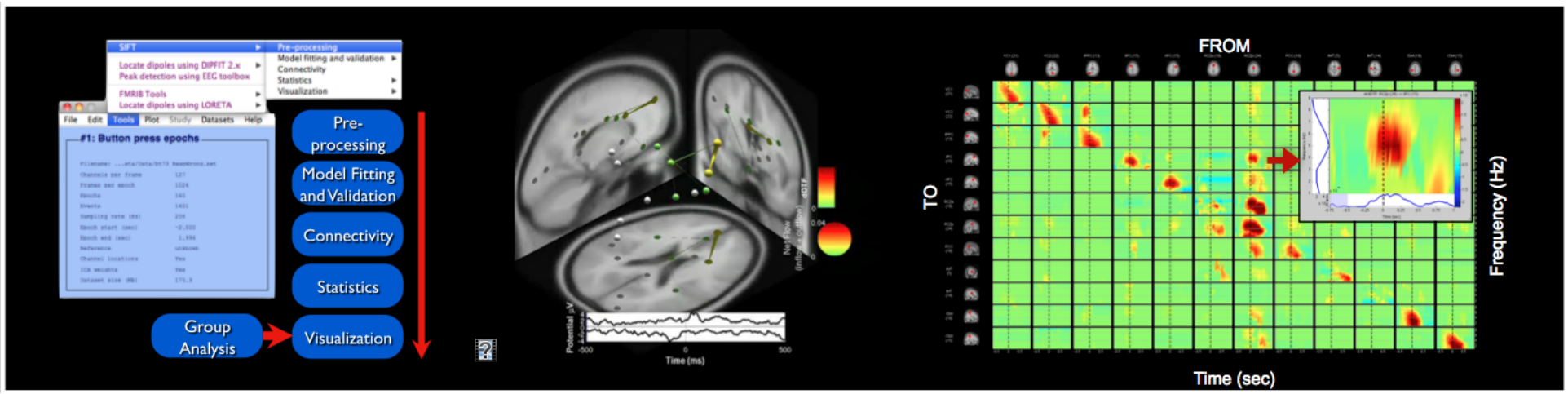
("eegh" Menus write both dataset and global history)

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

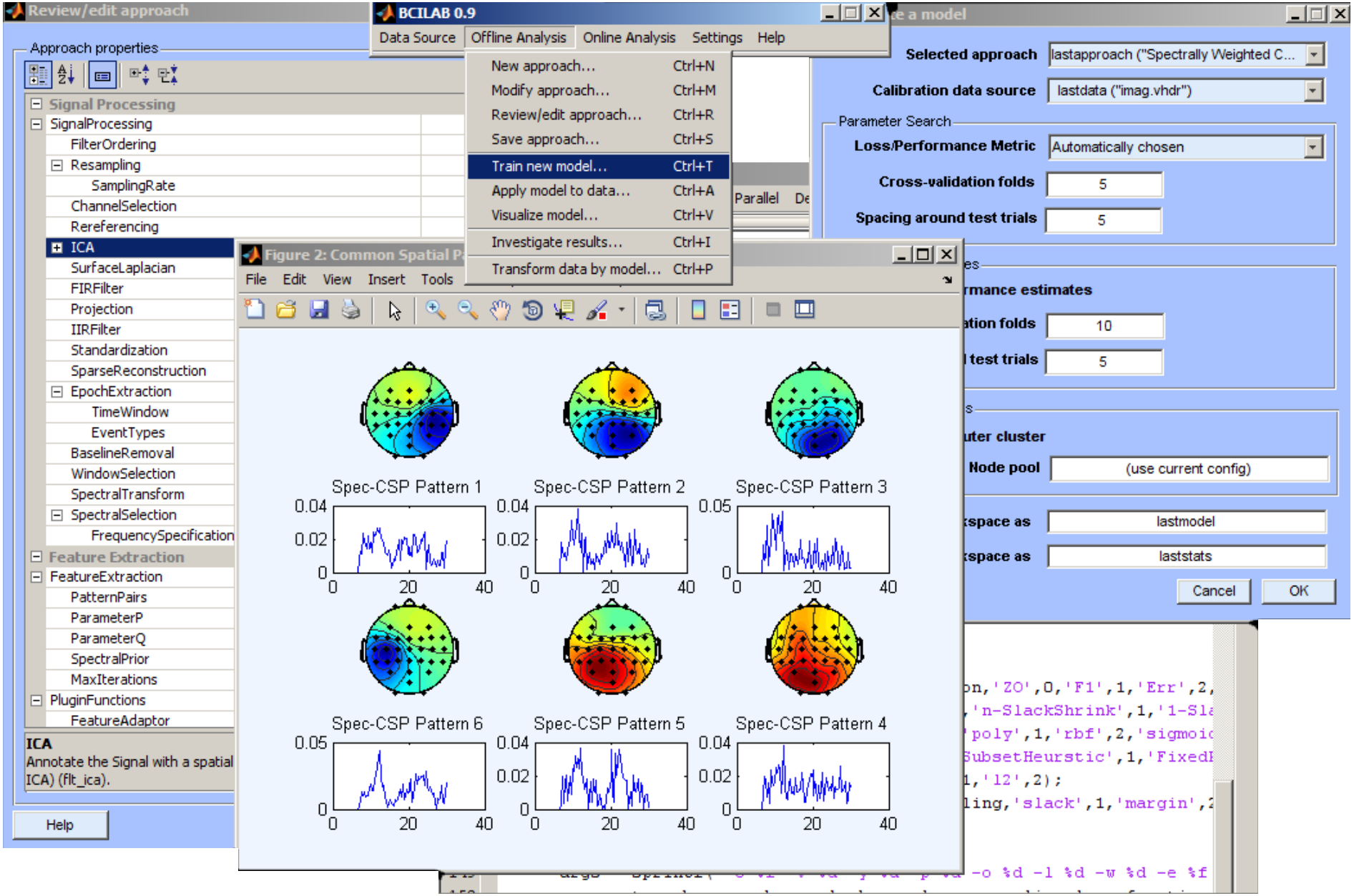


SIFT

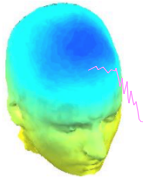
Source Information Flow Toolbox



BCILAB - C. Kothe



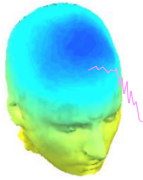
Pros/Cons of Matlab based open source

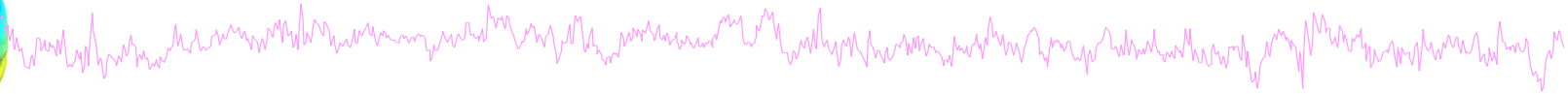


- Pros
  - Easy to program, highly modular and extendable
  - Not dependent on any platform (64-bit) and highly optimized
  - Large community of users (latest development in signal processing research)
  - Powerful scripting capabilities

- Cons
  - Matlab required for which you have to pay
  - Large memory requirements
  - Matlab bugs, possible version differences, cross-platform compatibility problems
  - Poor graphical interface

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., Mullen, T., Kothe, C., Bigdely-Shamlo, N., Akalin, Z., Vankov, A., Makeig, S. (2011) EEGLAB, MPT, NetSIFT, NFT, BCILAB, and ERICA: New tools for advanced EEG/MEG processing. Computational Intelligence, article ID 130714.

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

Delorme, A., Makeig, S. (2009) Open Source Programming for Interpreted Language: Graphic Interface and Macro Bridging Interface. 2009 Fifth International Conference on Signal-Image Technology & Internet-Based Systems (SITIS, indexed in IEEE), Nov. 29 2009-Dec. 4 2009, 430-434.

Delorme, A., Palmer, J., Onton, J., Oostenveld, R., Makeig, S. (2012) Independent EEG sources are dipolar.PLoS One, 7(2).

Delorme, A., Miyakoshi., M., Jung, T.P., Makeig, S. (2014) Grand average ERP-image plotting and statistics: A method for comparing variability in event-related single-trial EEG activities across subjects and conditions. J Neurosci Methods. 2014 Oct 22. pii: S0165-0270(14)00363-X. doi: 10.1016/j.jneumeth.2014.10.003

Workshop program (and PDFs)

Day 1 - Wednesday, 2nd of September, 2015

8:30 – 9:00 Morning refreshments at the Bar in The Edge

9:00 – 10:15 Mining event-related brain dynamics I (Scott Makeig)
10:15 – 10:45 EEGLAB overview (Arnaud Delorme)

10:45 – 11:00 Break. Tea and Coffee Served in the Bar in The Edge

11:00 – 11:45 ICA theory (Arnaud Delorme)
11:45 – 12:30 ICA evaluation (John Iversen)

12:30 – 14:00 Lunch Served in The Bar in The Edge

14:00 – 15:30 Importing data, rejecting data, and performing ICA decomposition (John Iversen)

15:30 – 15:45 Break—Tea and Coffee Served in the Bar in The Edge

15:45 – 17:00 Evaluating ICA components practicum (John Iversen)

17:00 - 19:00 Poster Session and Social, held in The Bar

Day 2 - Thursday, 3rd September, 2015

8:30 – 9:00 Morning refreshments at the Bar in The Edge

9:00 – 9:45 Why cluster ICA components? (Scott Makeig)
9:45 –10:45 Creating a STUDY and STUDY design (Arnaud Delorme)

10:45 -11:00 Break. Tea and Coffee Served in the Bar in The Edge

11:00 - 12:30 EEGLAB STUDY statistics and plotting (Arnaud Delorme)

12:30 – 14:00 Lunch Served in The Bar in The Edge

14:00 – 15:30 Statistics and LIMO EEG (Cyril Pernet)
15:30 – 15:45 LIMO EEGLAB integration (Arnaud Delorme)

15:45 – 16:00 Break—Tea and Coffee Served in the Bar in The Edge

16:00 - 21:00 Group excursion to Yorkshire Sculpture Park. Coaches leave at 16:00

Day 3 - Friday, 4th September, 2015

8:30 – 9:00 Morning refreshments at The Bar in The Edge

9:00 – 10:45 Time-frequency decomposition: Theory and practice (John Iversen)

10:45 – 11:00 Break—Tea and Coffee Served in the Bar in The Edge

11:00 – 11:45 Forward and inverse source imaging - Dipfit, NFT, and NIST (Scott Makeig)

11:45 – 12:30 New directions in source imaging (Scott Makeig)

12:30 - 14:00 Lunch Served in The Bar in The Edge

14:00 – 14:45 EEGLAB basic scripting (John Iversen)

14:45 – 15:45 EEGLAB scripting for custom plotting (John Iversen)

15:45 – 16:00 Break.Tea and Coffee Served in the Bar in The Edge

16:00 – 17:00 EEGLAB scripting for STUDY data (Arnaud Delorme)

Day 4 - Saturday, 5th September, 2015

8:30 – 9:00 Morning refreshments at The Bar in The Edge

9:00 – 10:00 Mining event-related brain dynamics II (Scott Makeig)

10:00 – 10:45 EEGLAB Challenge Practicum (all)

10:45 - 11:00 Break—Tea and Coffee Served in the Bar in The Edge

11:00 – 11:30 EEGLAB Challenge Practicum (all)

11:30 – 12:30 Participant Challenge presentations, Q & A, and closing remarks (all)

12:30 – 13:30 Lunch Served in The Bar in The Edge.

13:30 - Close