Artifact rejection and running ICA

Task 1

Reject bad channels

Task 2

Reject continuous data

Task 3

Reject data epochs

Task 4

Run ICA

Task 5

Plot components

Exercise...

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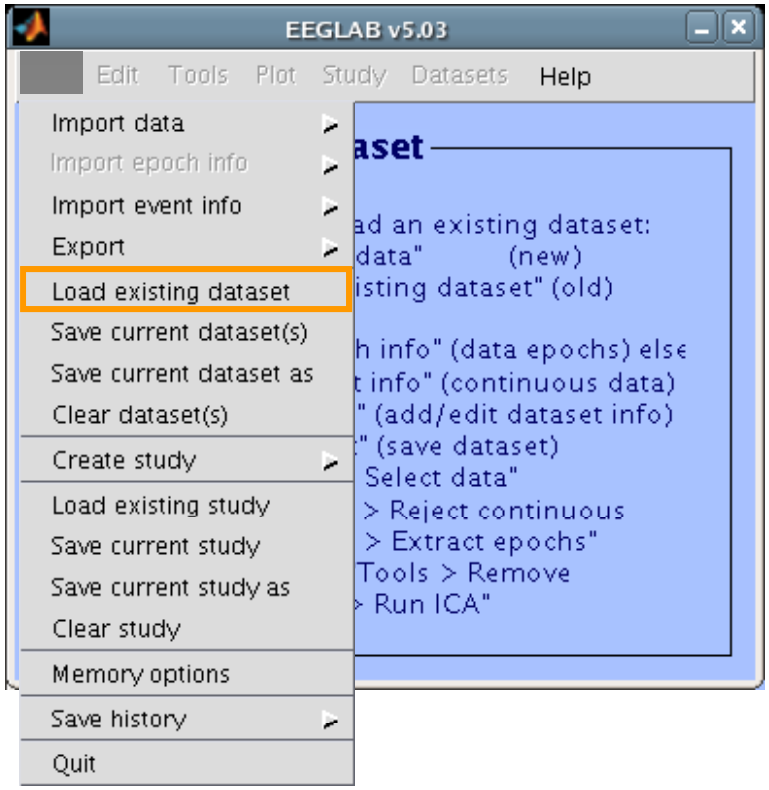
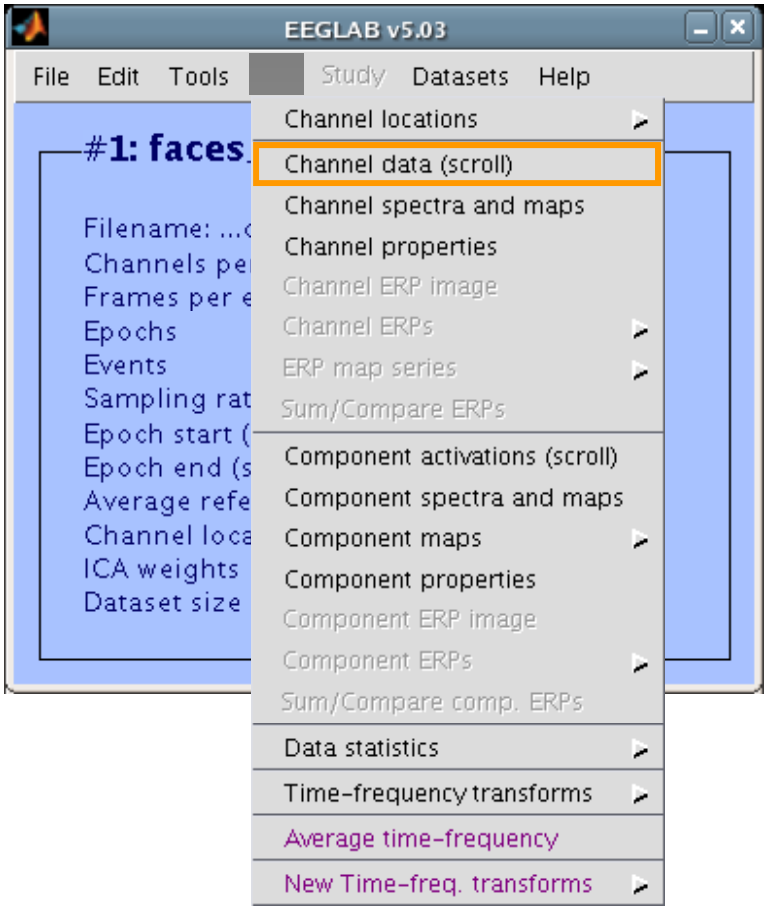
Exercise...

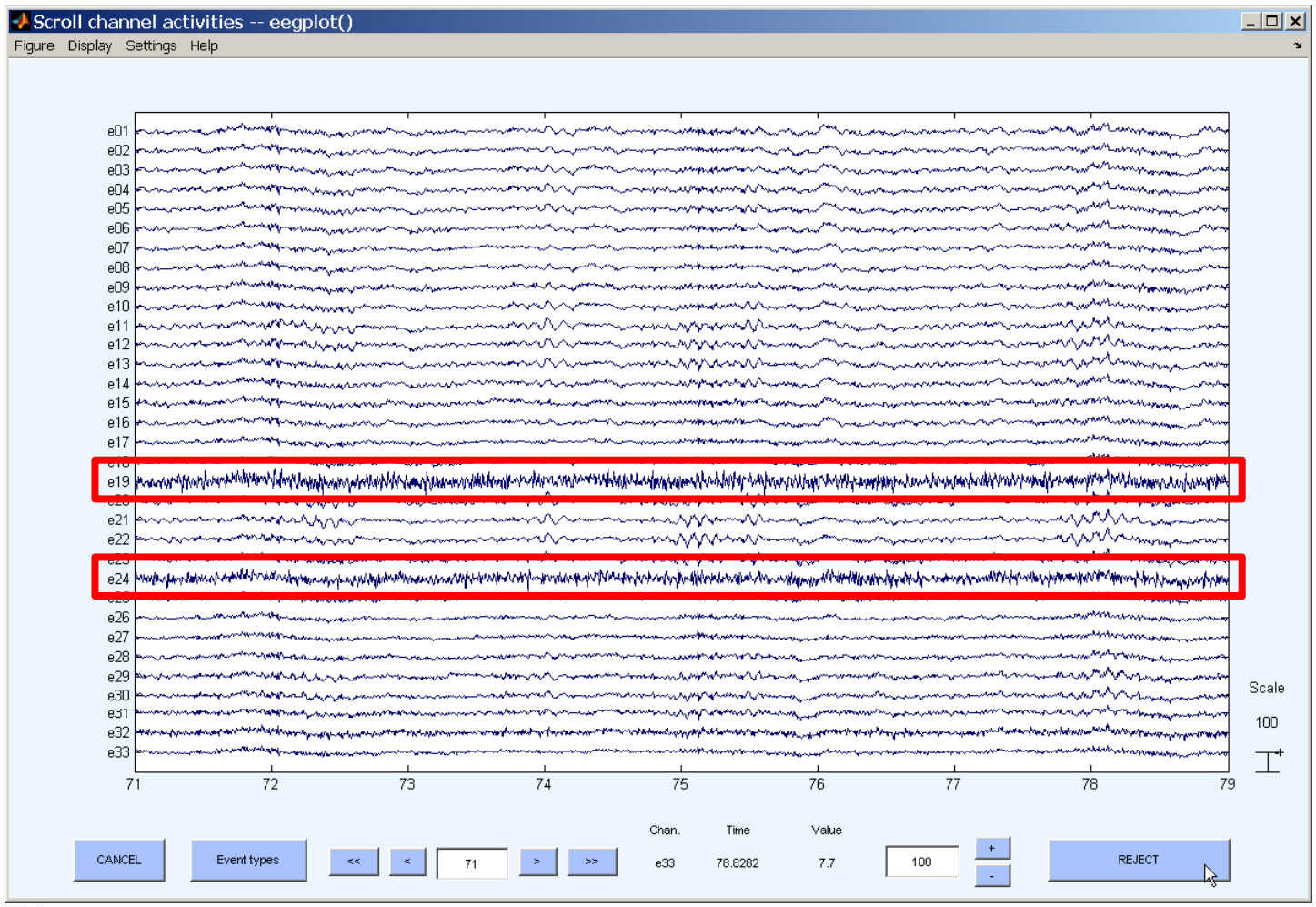
Load/scroll data





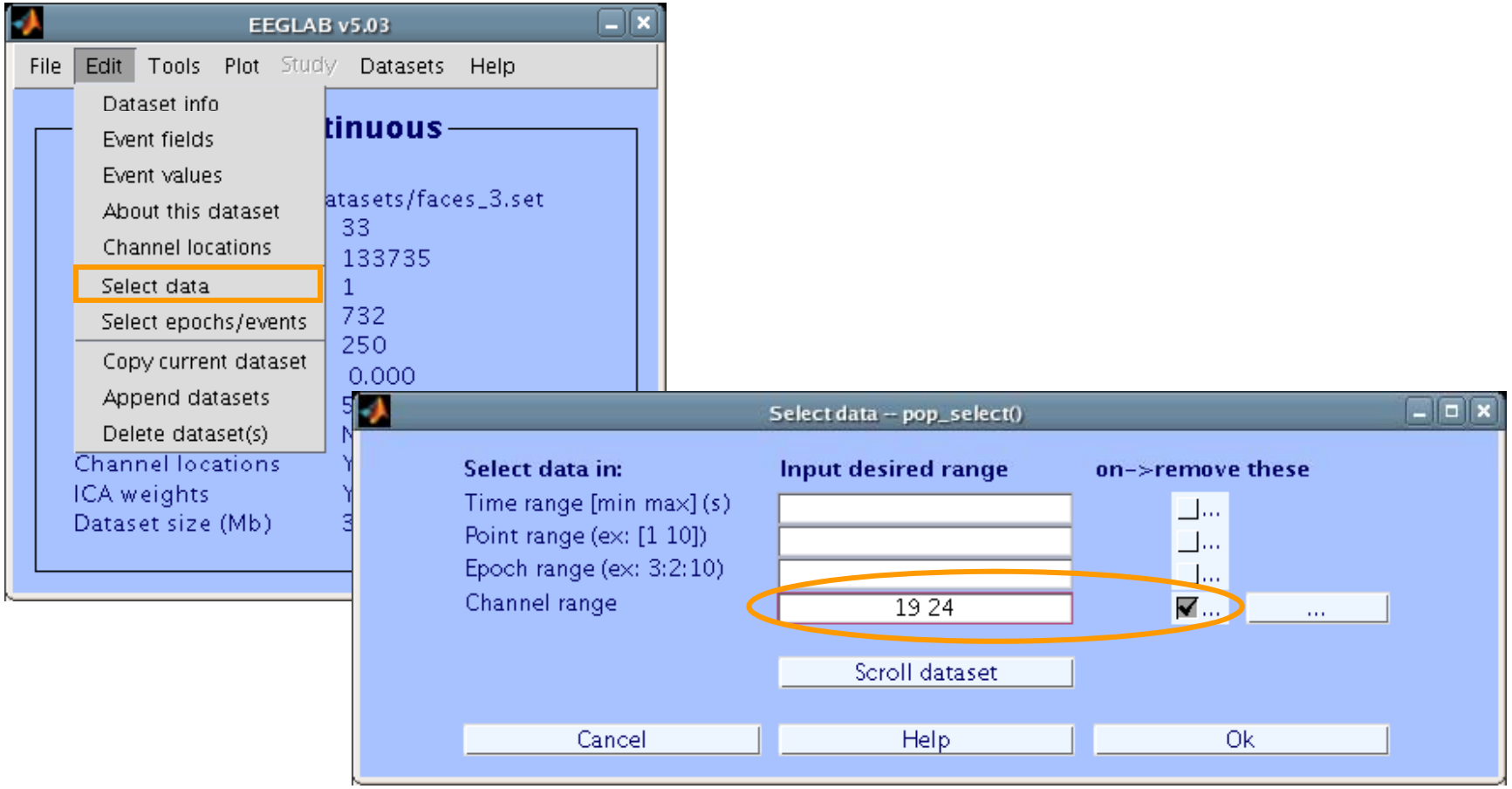

```
>> EEG = pop_loadset('faces_3.set', '...\data\');
>> [ALLEEG EEG CURRENTSET] = eeg_store(ALLEEG, EEG, 0);
```

Reject bad channels



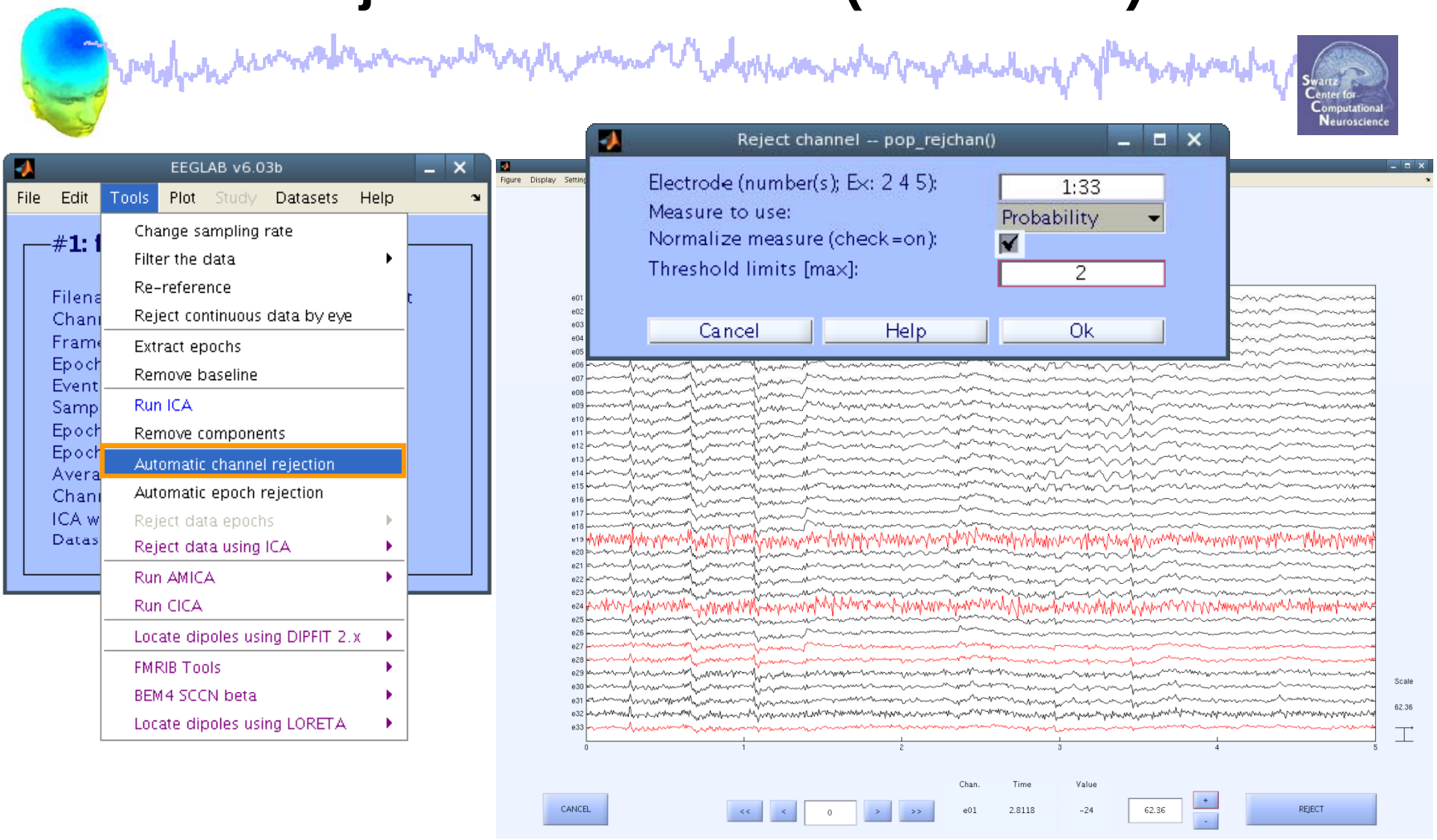

```
>> pop_eegplot(EEG, 1, 1, 1);
```

Reject bad channels (manually)



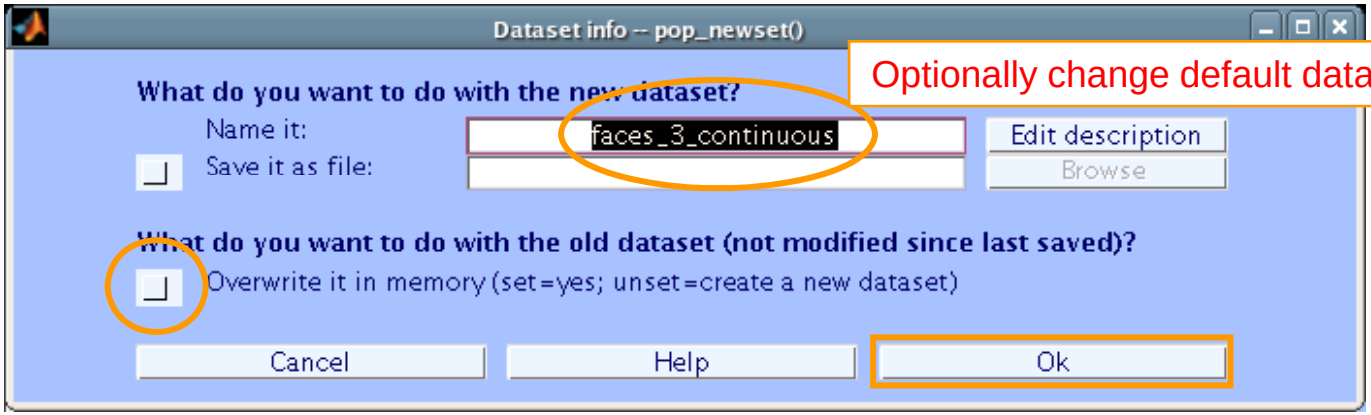

```
EEG = pop_select(EEG, 'nochannel', [19 24]);
```

Reject bad channels (automatic)

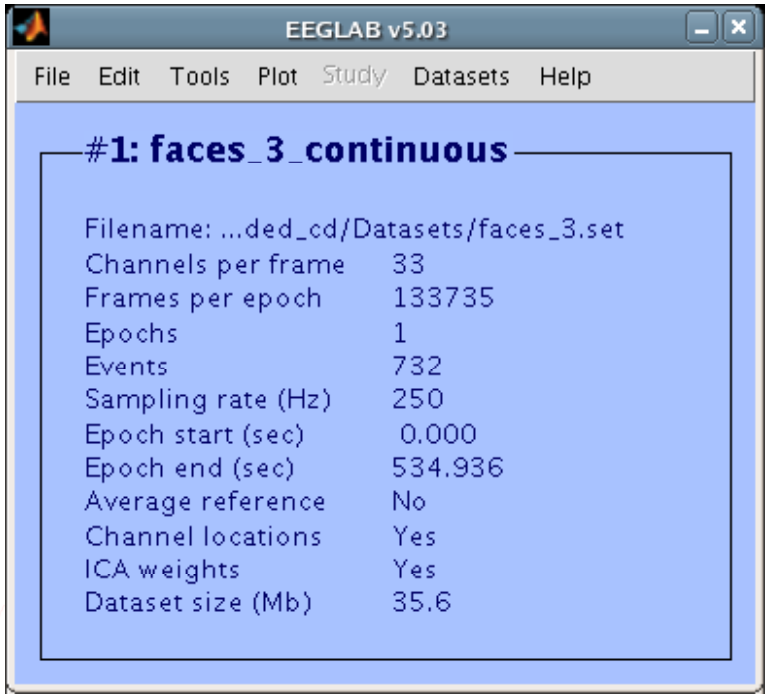


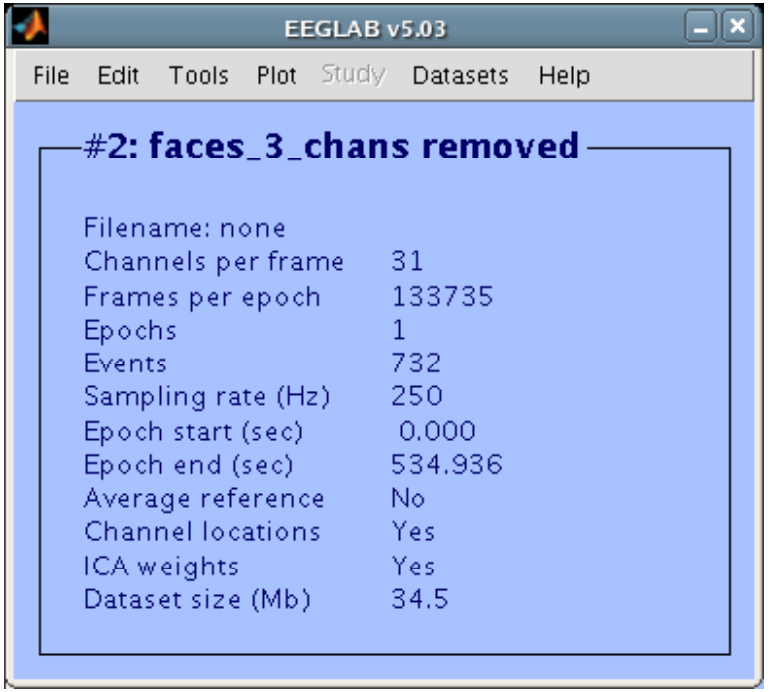

```
>> EEG = pop_rejchan(EEG,  'elec',[1:33] , 'threshold',2,...
 'norm', 'on', 'measure', 'prob');
```

Reject bad channels



Optionally change default dataset name





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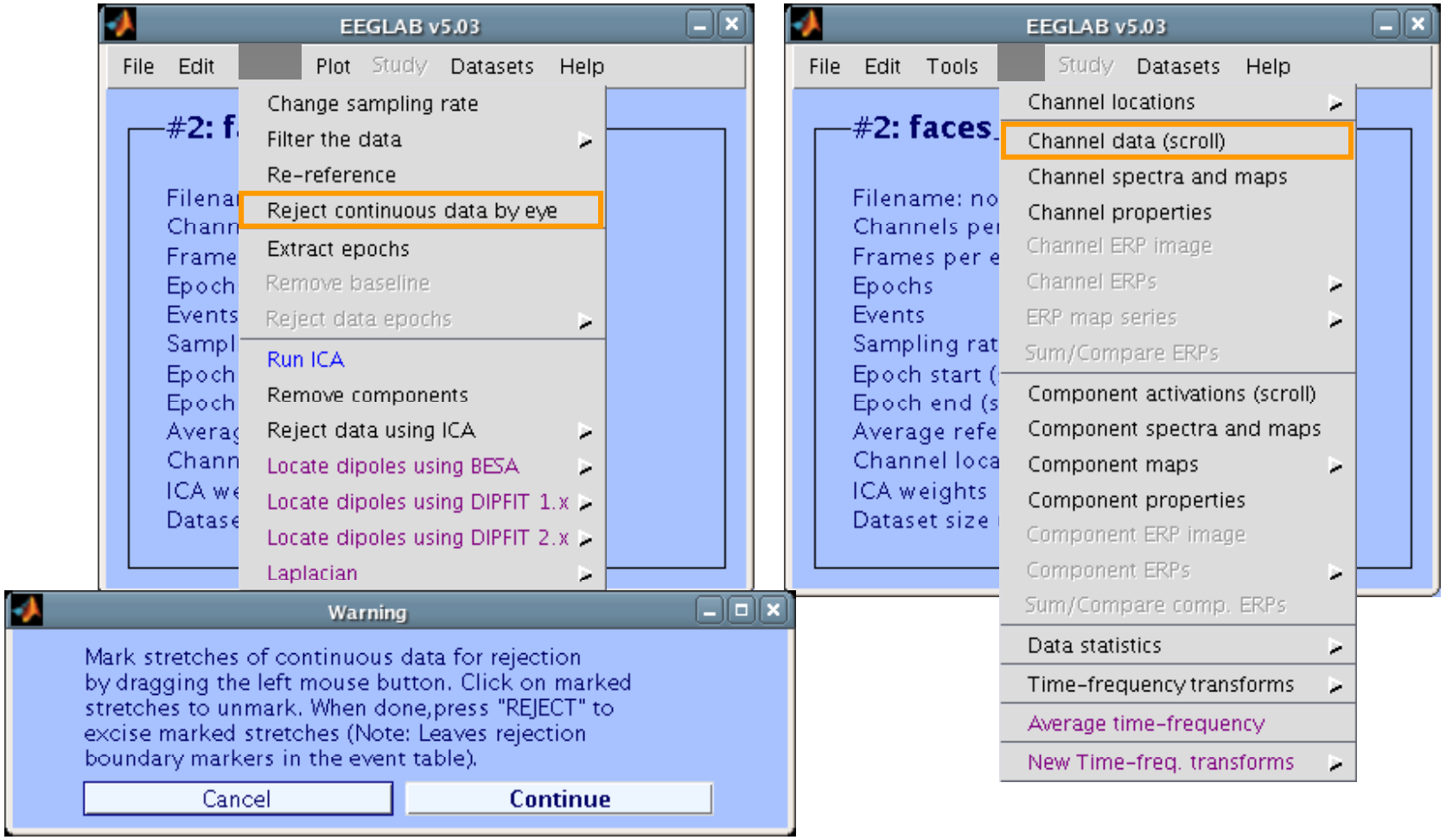
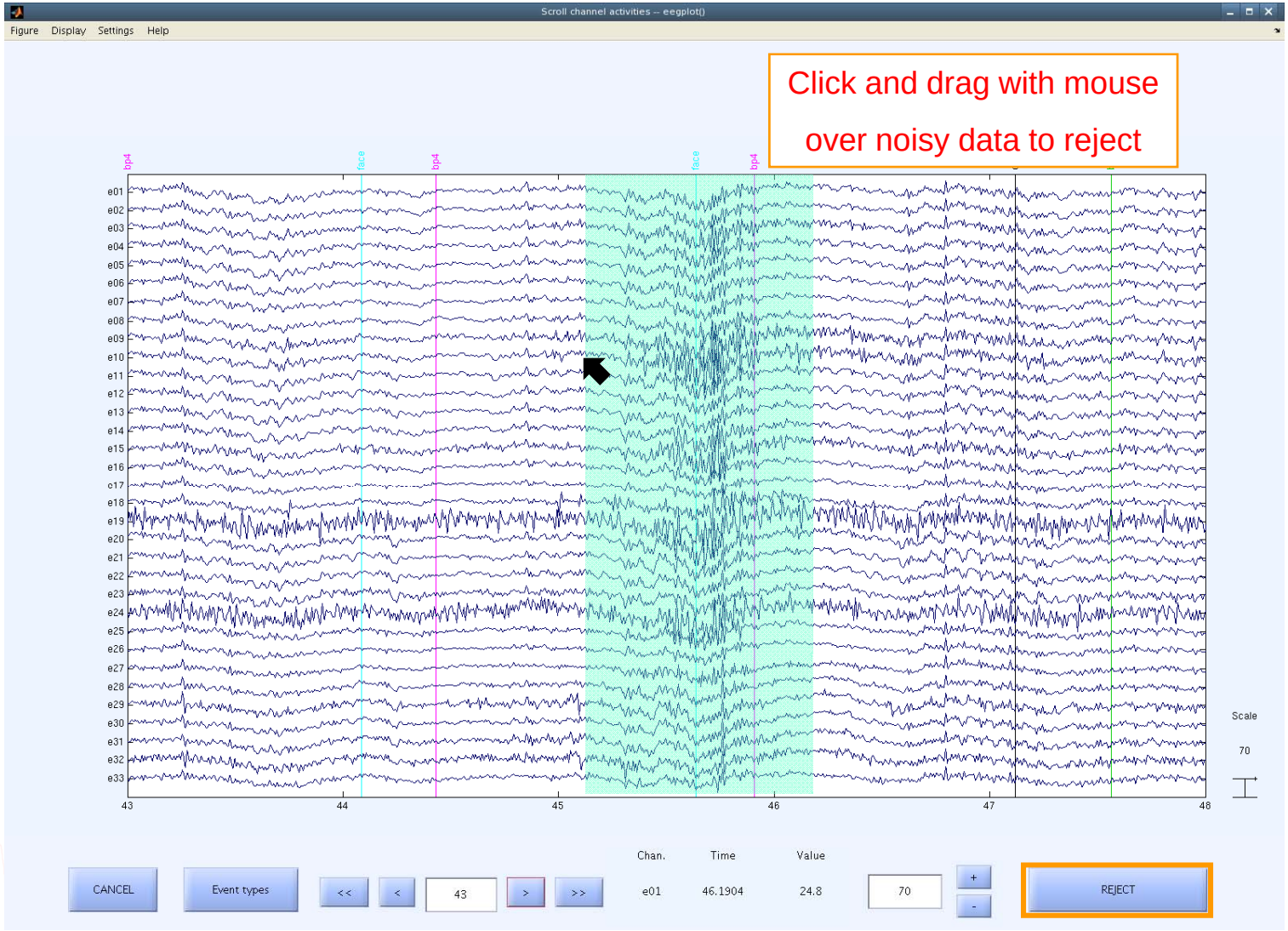
Reject continuous data

Equivalent!!



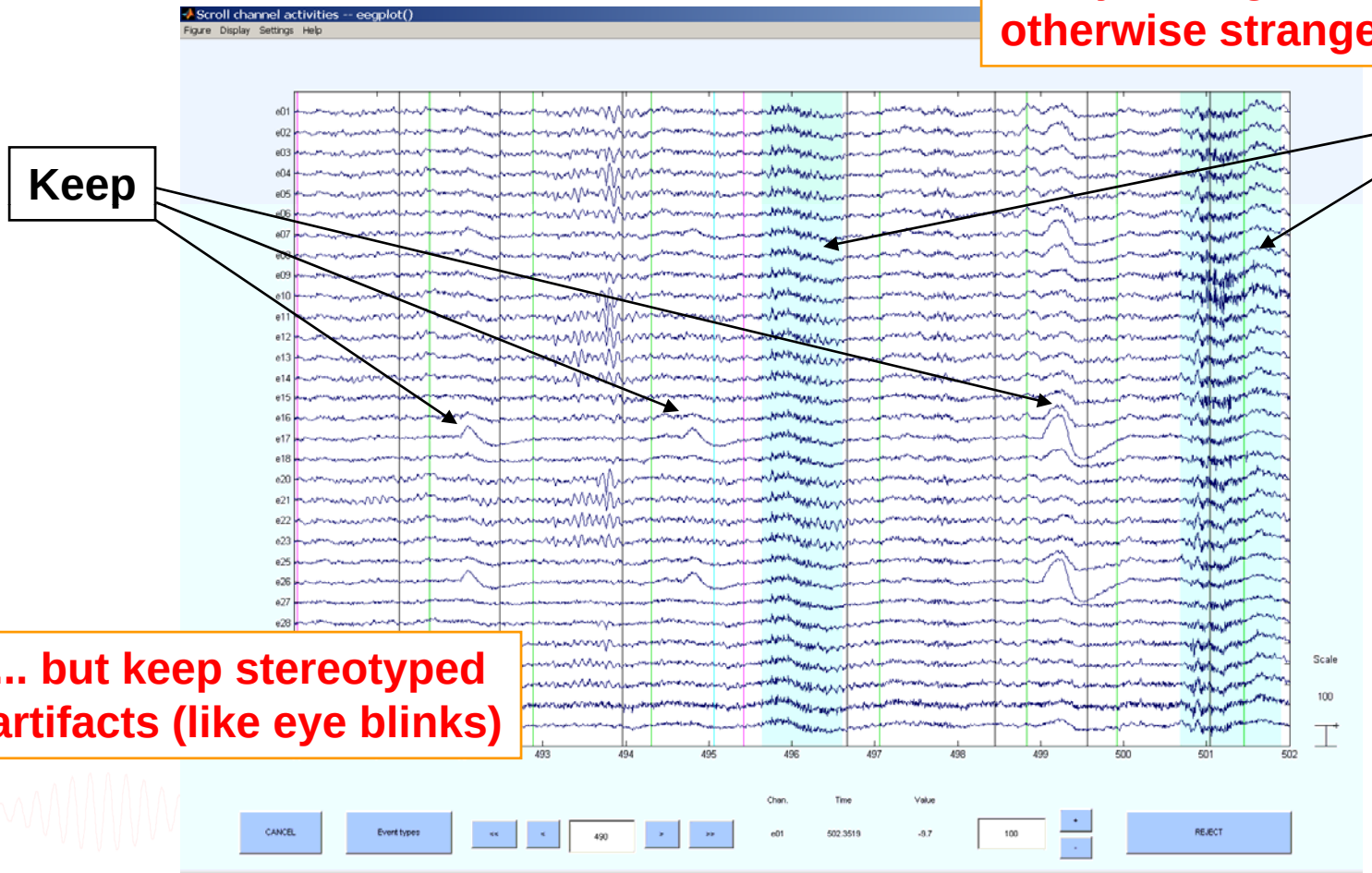
Reject continuous data



Reject continuous data

To prepare data for ICA:

Reject large muscle or otherwise strange events...



... but keep stereotyped artifacts (like eye blinks)

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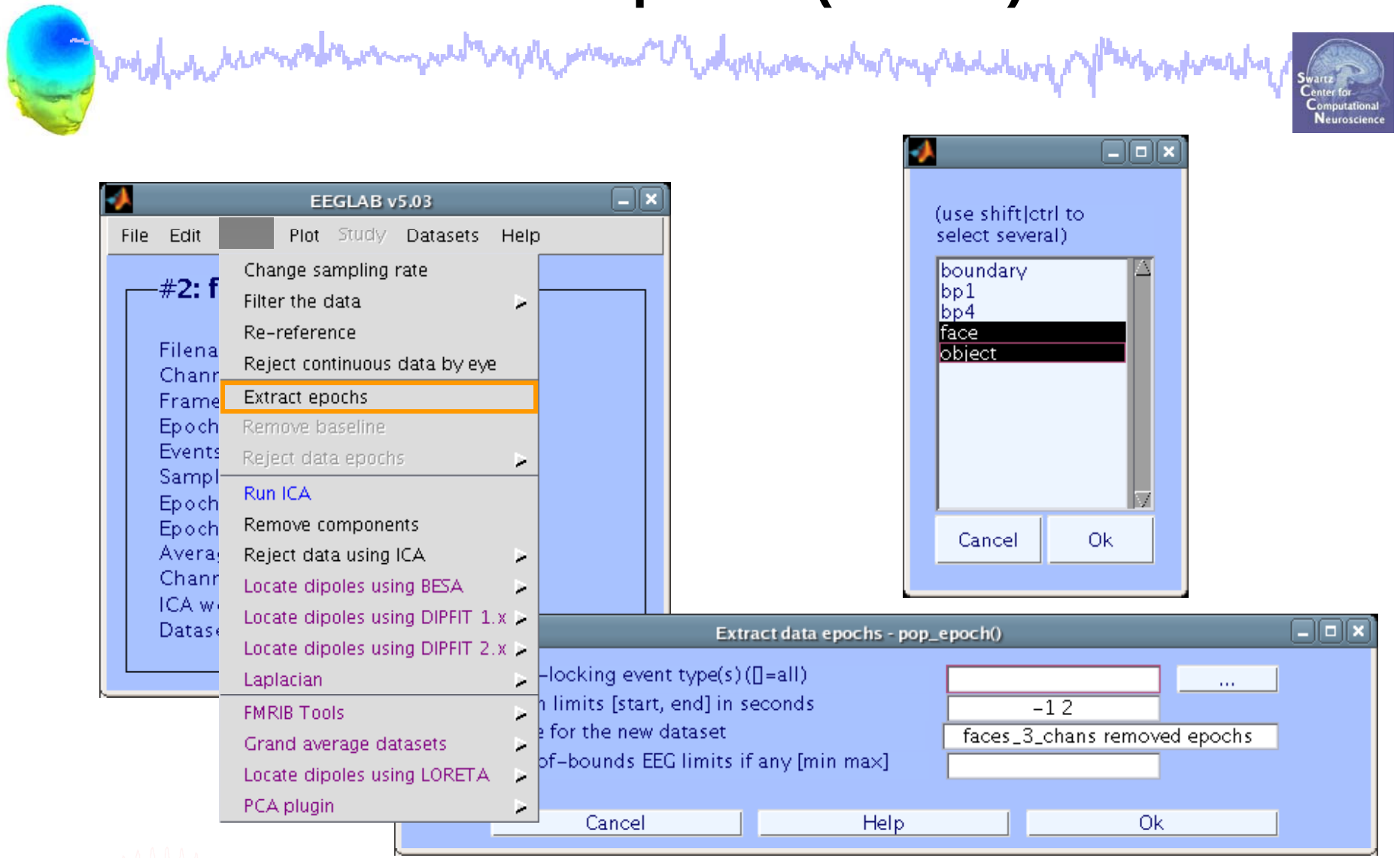
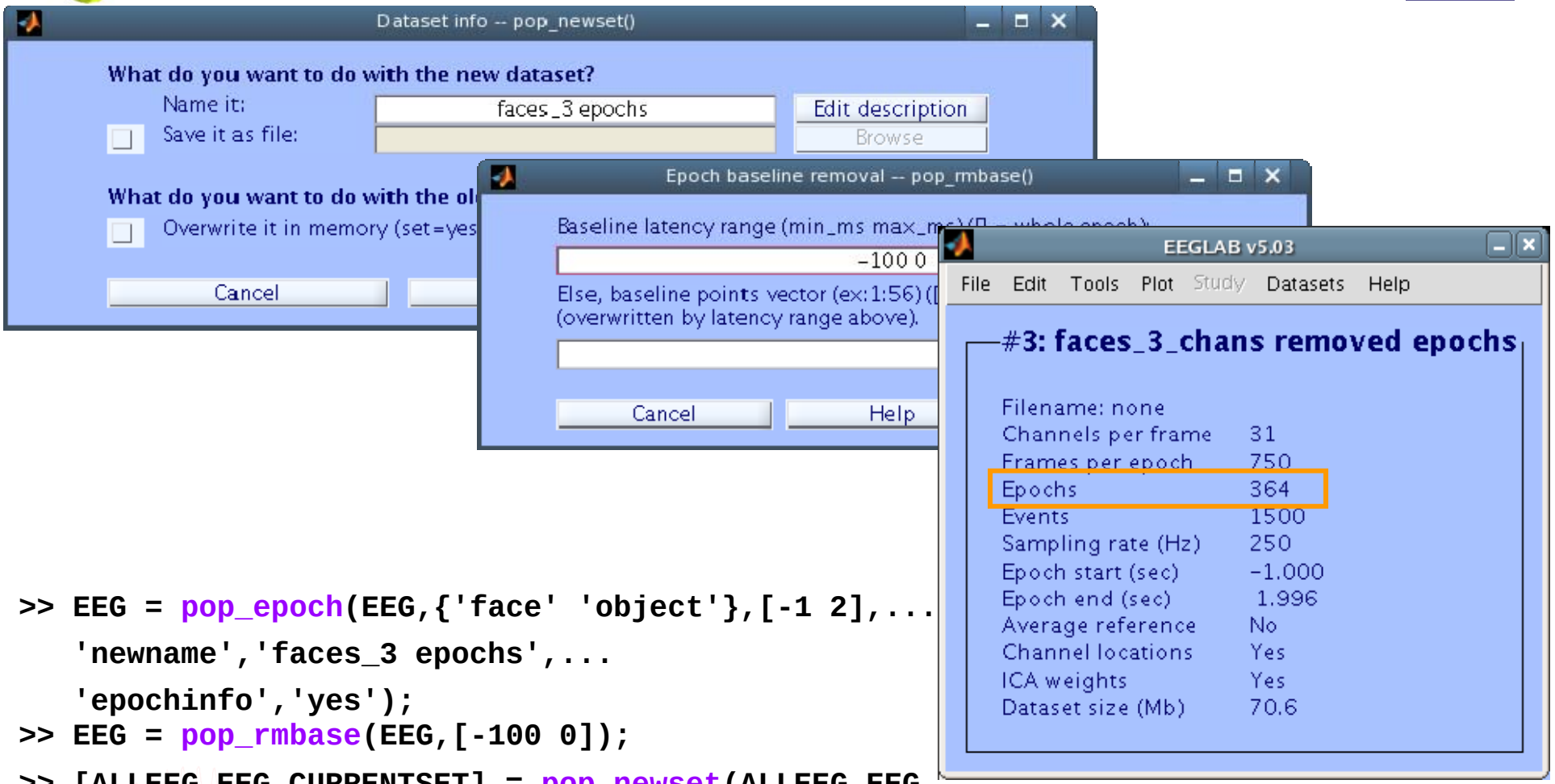
Exercise...

Extract Epochs (review)

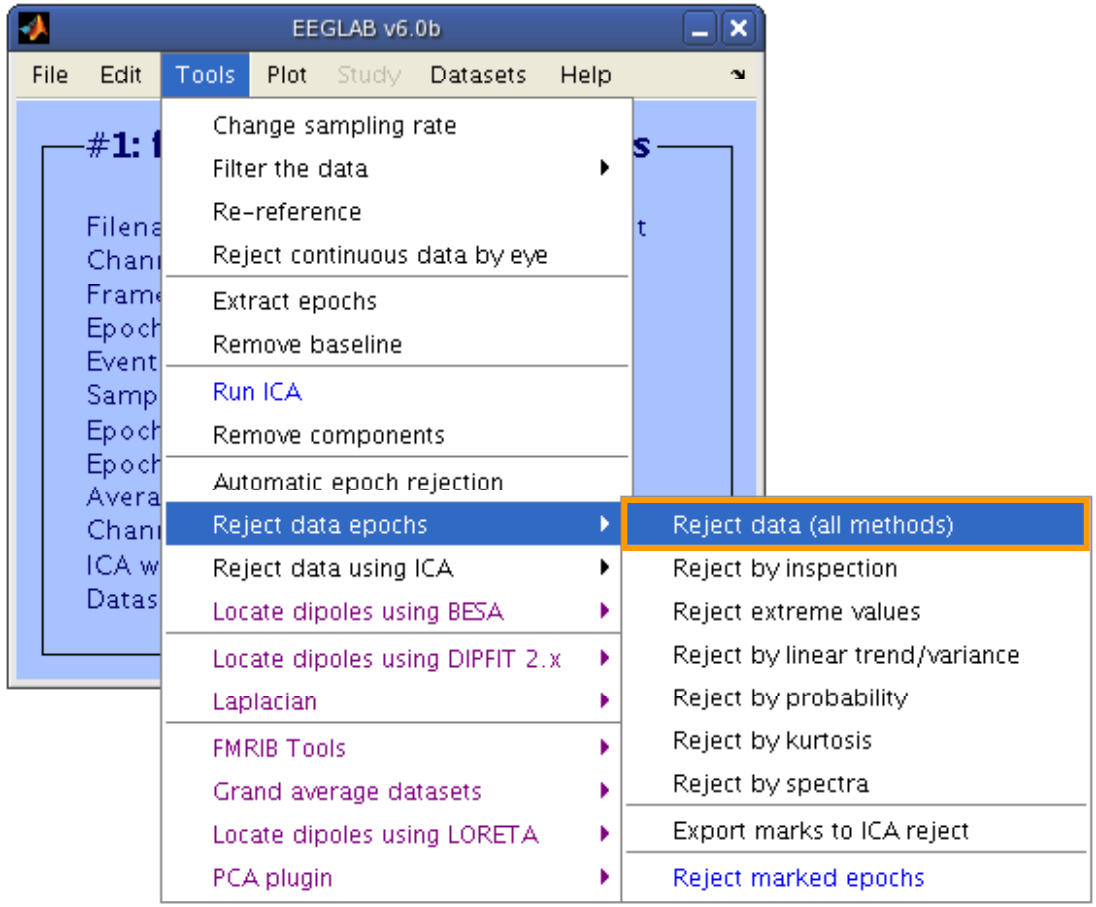


Extract epochs (review)




```
>> EEG = pop_epoch(EEG,{'face' 'object'},[-1 2],...
   'newname','faces_3 epochs',...
   'epochinfo','yes');
>> EEG = pop_rmbase(EEG,[-100 0]);
>> [ALLEEG EEG CURRENTSET] = pop_newset(ALLEEG,EEG,...
   CURRENTSET,'setname','faces_3 epochs');
```

Reject data epochs



Reject data epochs

visual inspection

probability

Reject trials using data statistics - pop_rejmenu()

Mark trials by appearance | Scroll Data | Marked trials 0

Find abnormal values
Upper limit(s) (uV): 25 | Lower limit(s) (uV): -25
Start time(s) (ms): -1000 | Ending time(s) (ms): 1996
Electrode(s): 1:31 | Currently marked trials 0
Calc / Plot | Help

Find abnormal trends
Max slope (uV/epoch): 50 | R-squared limit (0 to 1): 0.3
Electrode(s): 1:31 | Currently marked trials 0
Calc / Plot | Help

Find improbable data
Single-channel limit (std. dev.): 5 | All channels limit (std. dev.): 5
Electrode(s): 1:31 | Currently marked trials 0
Calculate | Scroll Data | Plot | Help

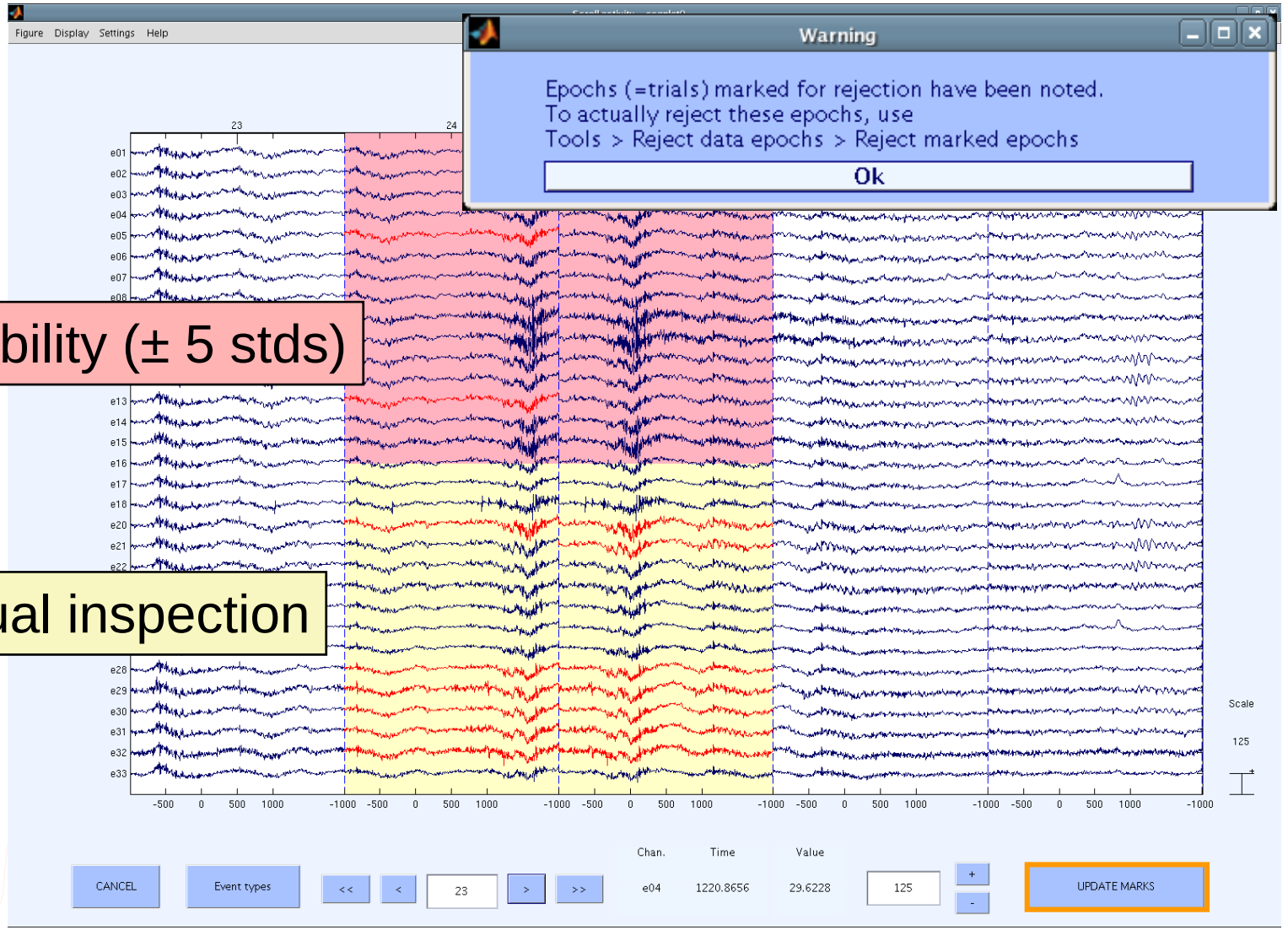
Find abnormal distributions
Single-channel limit (std. dev.): 5 | All channels limit (std. dev.): 5
Electrode(s): 1:31 | Currently marked trials 0
Calculate | Scroll Data | Plot | Help

Find abnormal spectra (slow)
Upper limit(s) (dB): 25 | Lower limit(s) (dB): -25
Low frequency(s) (Hz): 0 | High frequency(s) (Hz): 50
Electrode(s): 1:31 | Currently marked trials 0
Calc / Plot | Help

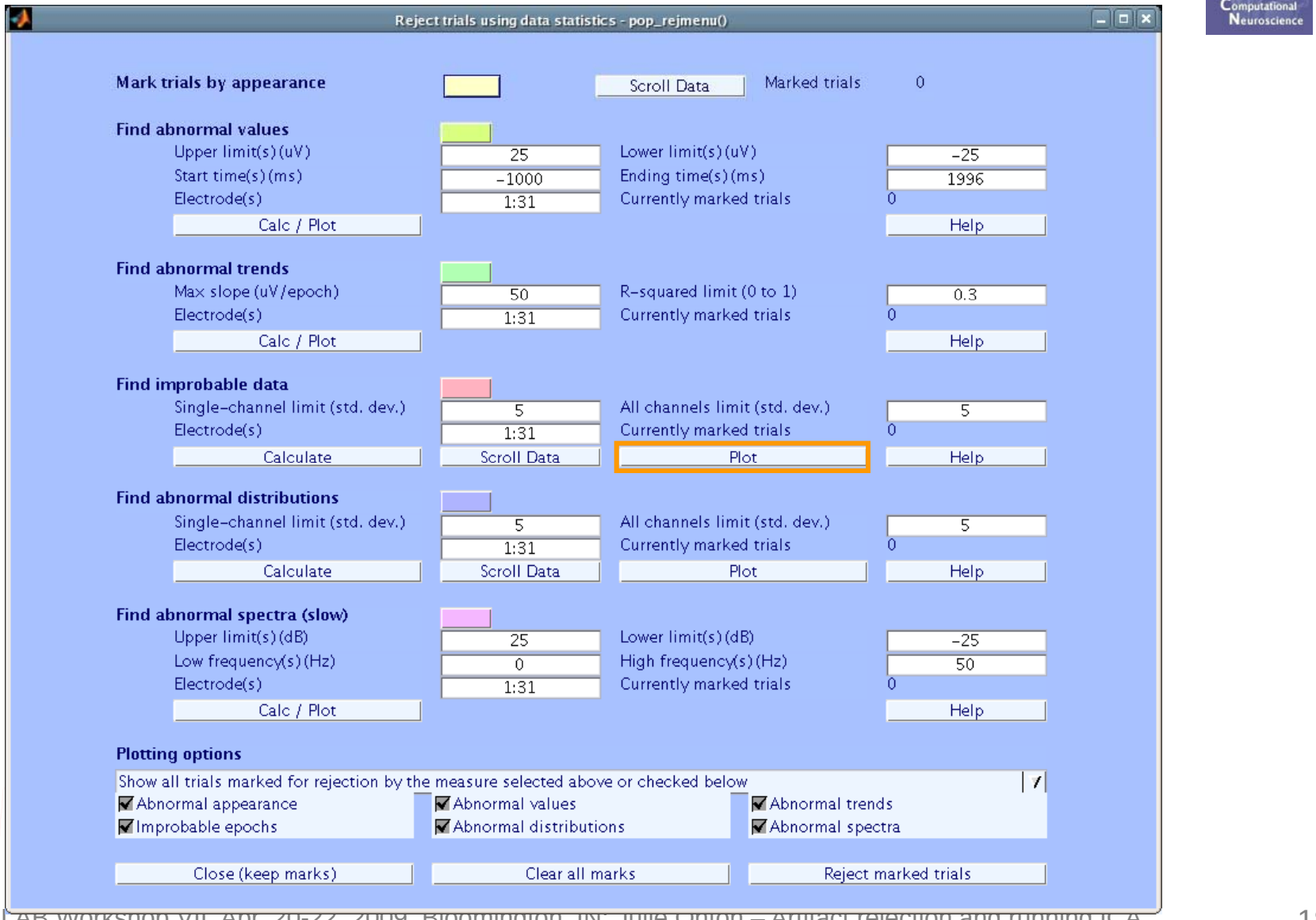
Plotting options
Show all trials marked for rejection by the measure selected above or checked below
☑ Abnormal appearance ☑ Abnormal values ☑ Abnormal trends
☑ Improbable epochs ☑ Abnormal distributions ☑ Abnormal spectra

Close (keep marks) | Clear all marks | Reject marked trials

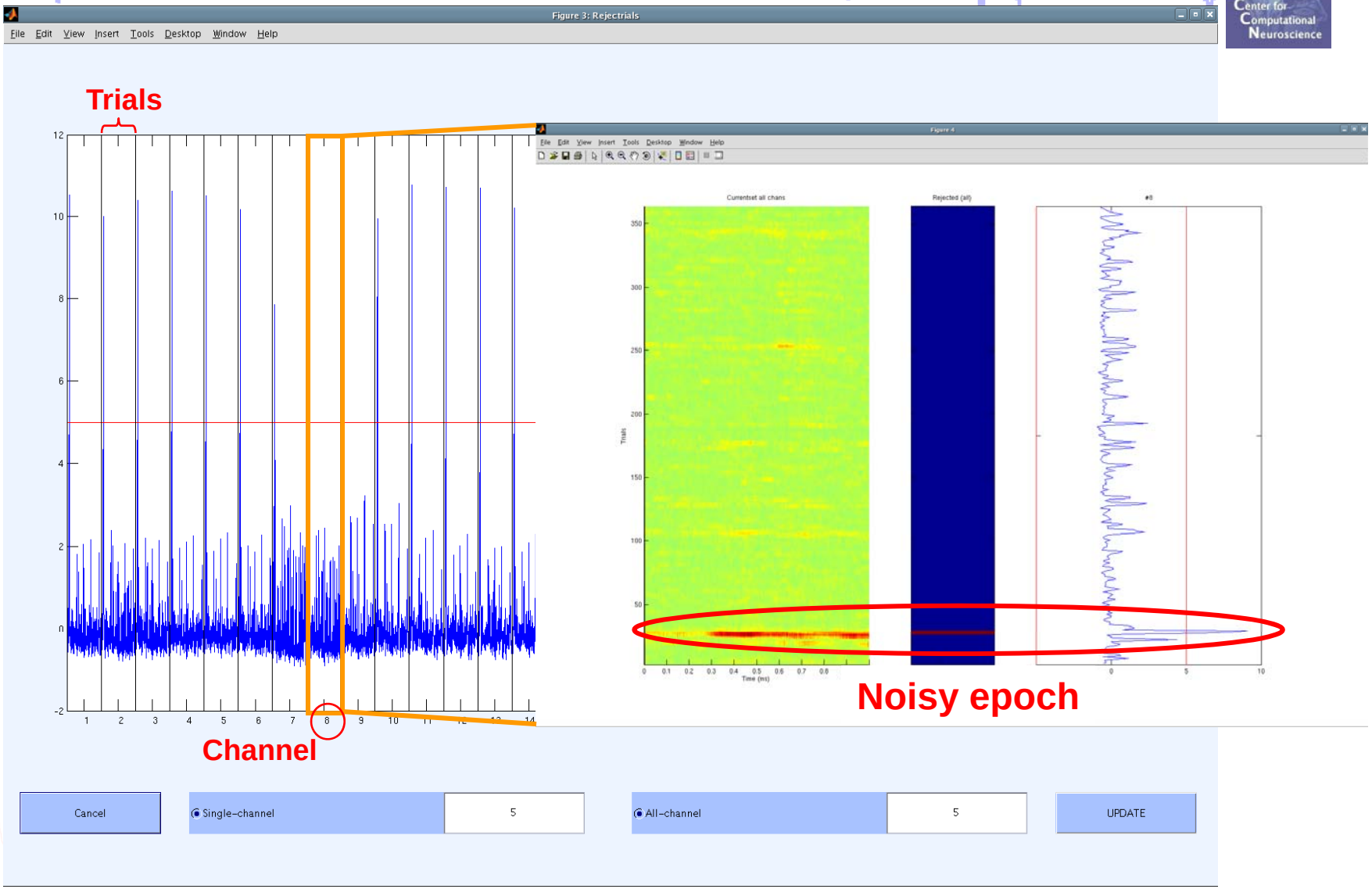
Reject data epochs



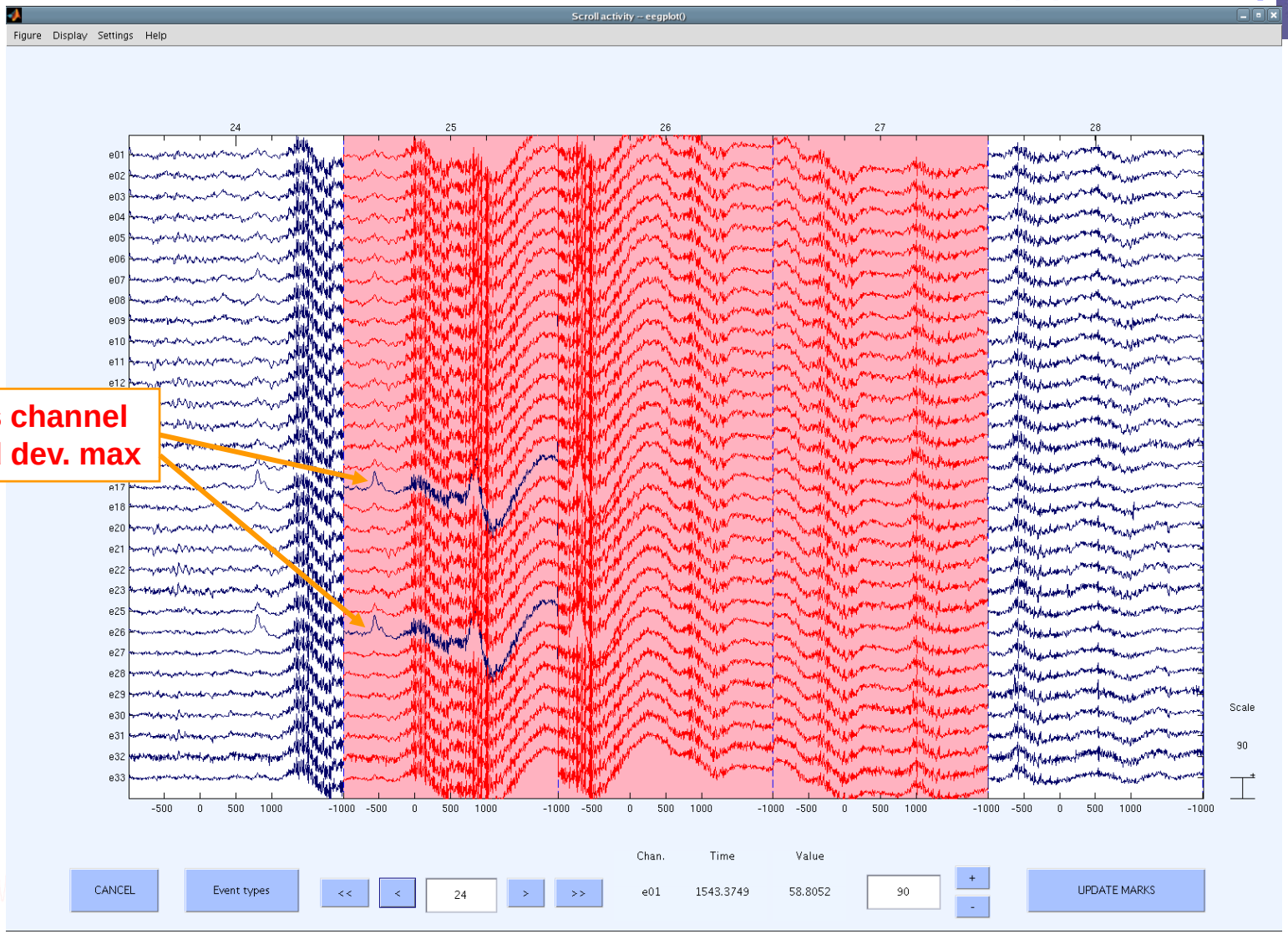
Plot channel measures over time



Reject data epochs

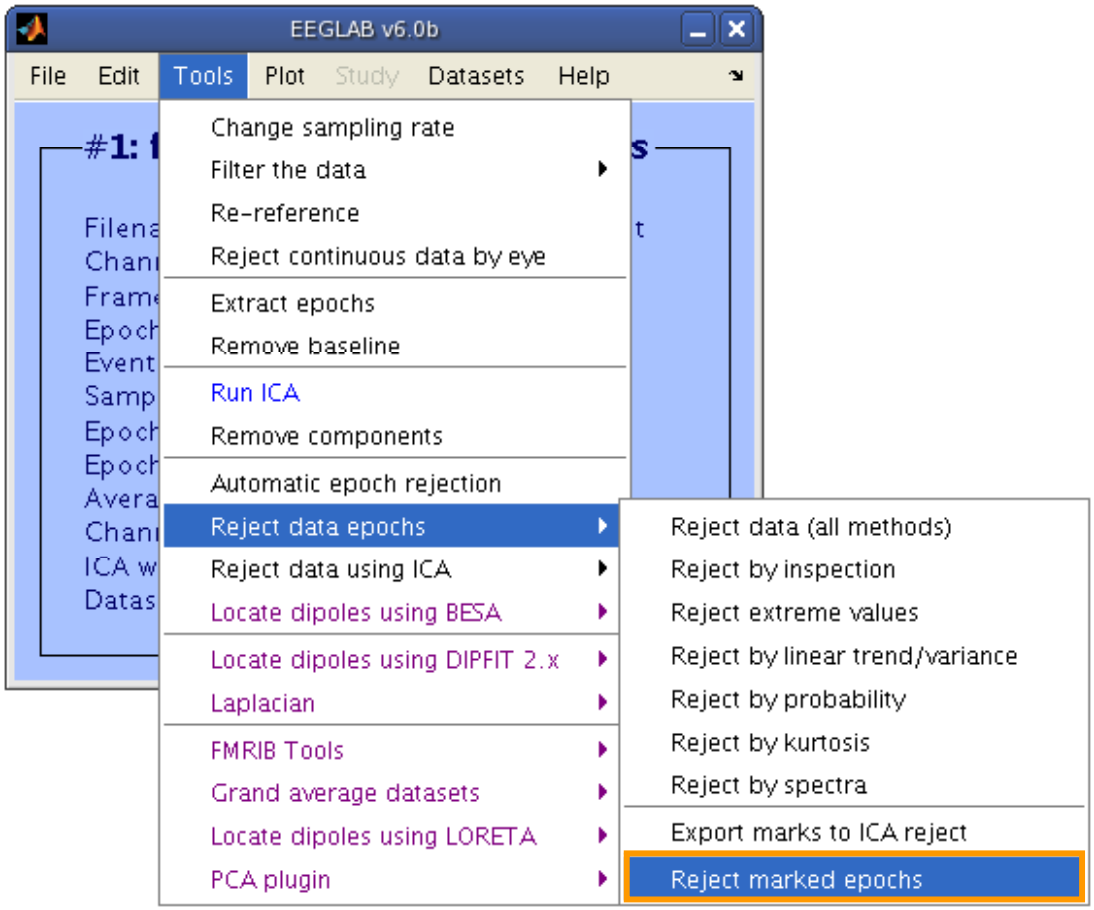


Reject data epochs



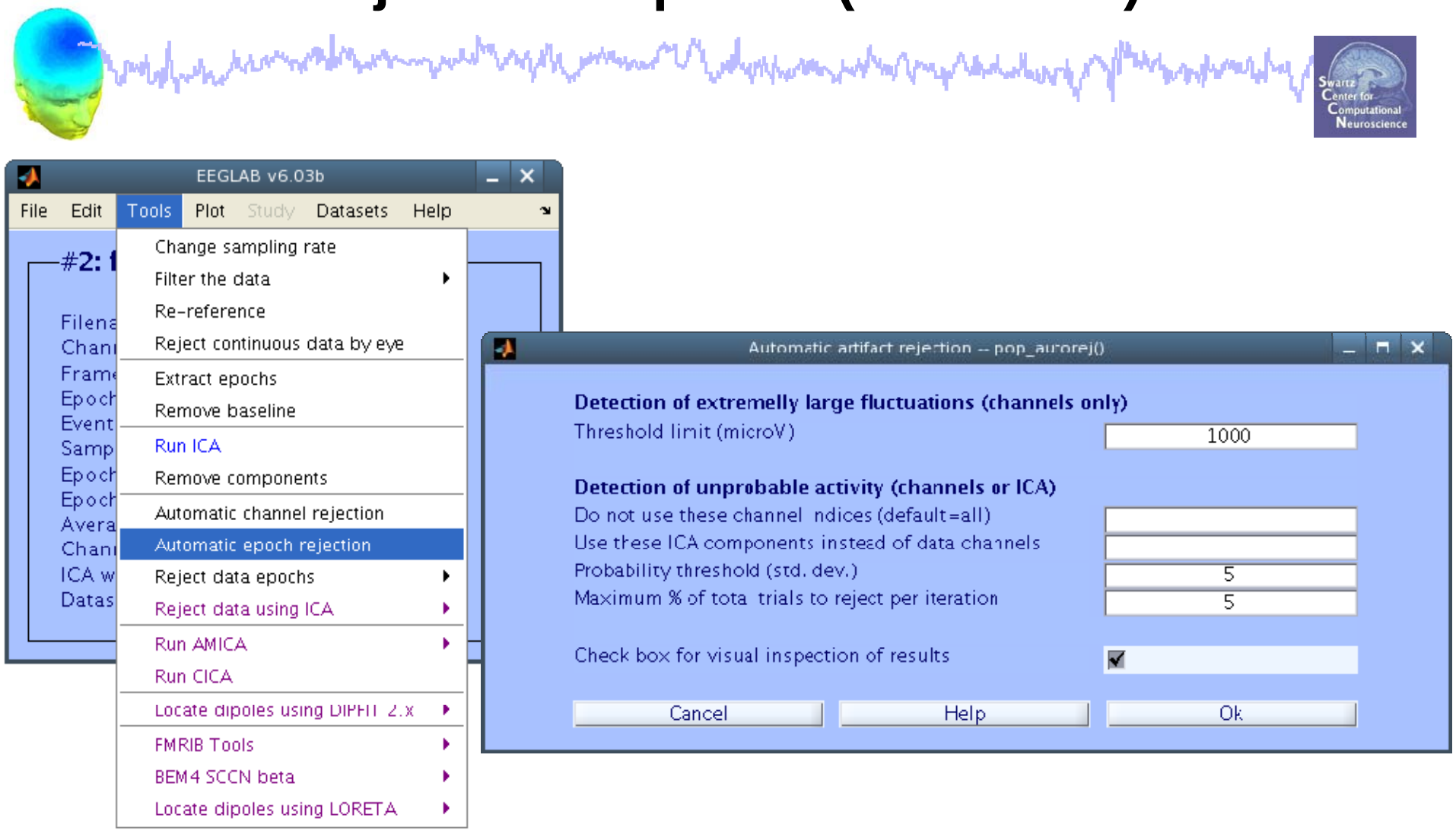
Exceeds channel standard dev. max

Reject data epochs



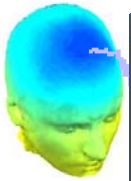

```
>> EEG = pop_jointprob(EEG,1,[1:31],5,5,0,0);
>> EEG = pop_rejepoch(EEG,find(EEG.reject.rejglobal),0);
```

Reject data epochs (automatic)




```
>> EEG = pop_autorej(EEG,  'nogui', 'on', 'eegplot', 'on');
```

Reject data epochs (automatic)

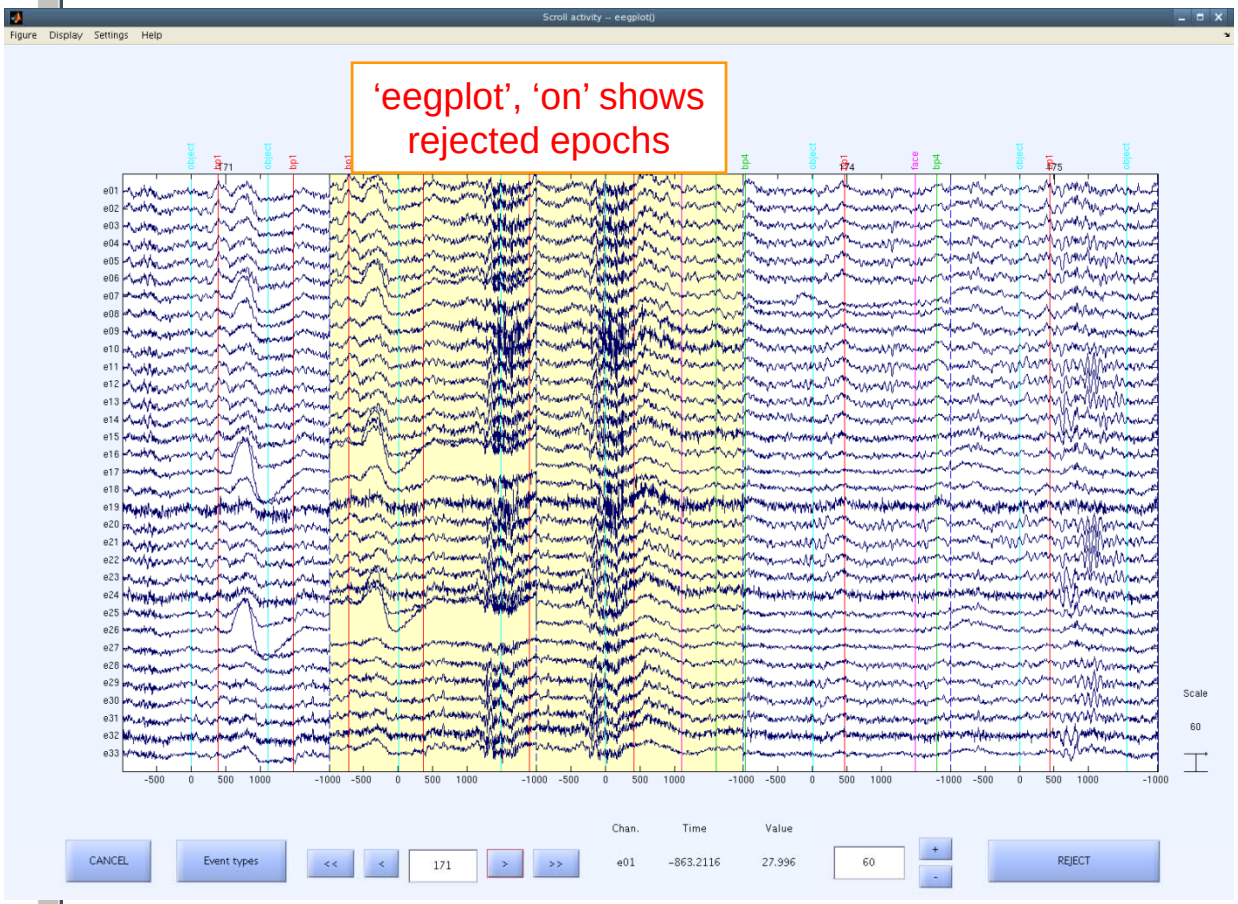


julie@doing:/home/julie

File Edit View Terminal Tabs Help

```
>>
Running auto rejection protocol...
33 channel selected
0/182 trials marked for rejection
Computing joint probability for channels...
Computing all-channel probability...
5/182 trials marked for rejection
5 trials marked for rejection
5/182 trials rejected
Removing 5 trial(s)...
Pop_select: removing 22 unreferenced events
Computing joint probability for channels...
Computing all-channel probability...
3/177 trials marked for rejection
3 trials marked for rejection
3/177 trials rejected
Removing 3 trial(s)...
Pop_select: removing 14 unreferenced events
Computing joint probability for channels...
Computing all-channel probability...
4/174 trials marked for rejection
4 trials marked for rejection
4/174 trials rejected
Removing 4 trial(s)...
Pop_select: removing 16 unreferenced events
Computing joint probability for channels...
Computing all-channel probability...
3/170 trials marked for rejection
3 trials marked for rejection
3/170 trials rejected
Removing 3 trial(s)...
Pop_select: removing 14 unreferenced events
Computing joint probability for channels...
Computing all-channel probability...
3/167 trials marked for rejection
3 trials marked for rejection
3/167 trials rejected
Removing 3 trial(s)...
Pop_select: removing 12 unreferenced events
Computing joint probability for channels...
Computing all-channel probability...
1/164 trials marked for rejection
1 trials marked for rejection
1/164 trials rejected
Removing 1 trial(s)...
Pop_select: removing 4 unreferenced events
Computing joint probability for channels...
Computing all-channel probability...
0/163 trials marked for rejection
0 trials marked for rejection
0/163 trials rejected
Final kurotsis reject...
Computing kurtosis for channels...
Computing all-channel kurtosis...
3/163 trials marked for rejection
3 trials marked for rejection
>>
```

Iterative rejection based on probability



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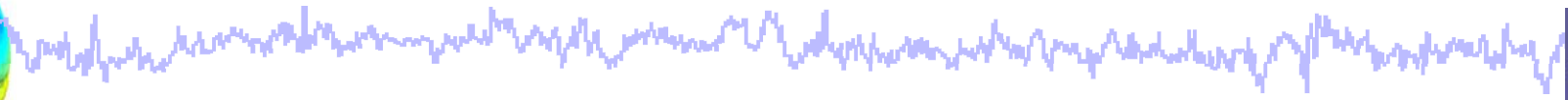
Exercise...

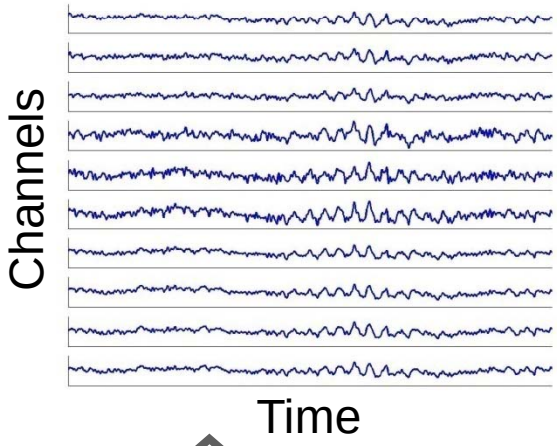
Independent Component Analysis



x = scalp EEG

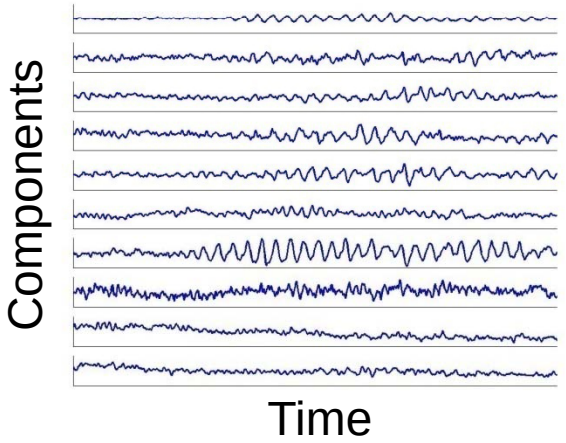
W = unmixing matrix

u = sources



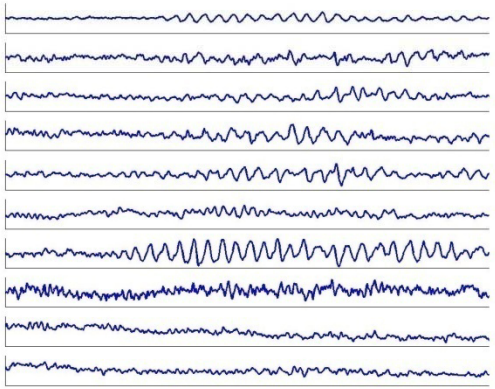
W*x = u

ICA



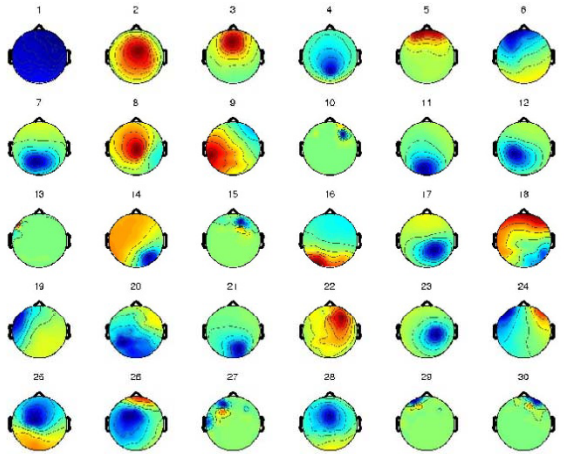
x = W^{-1}*u

u = sources

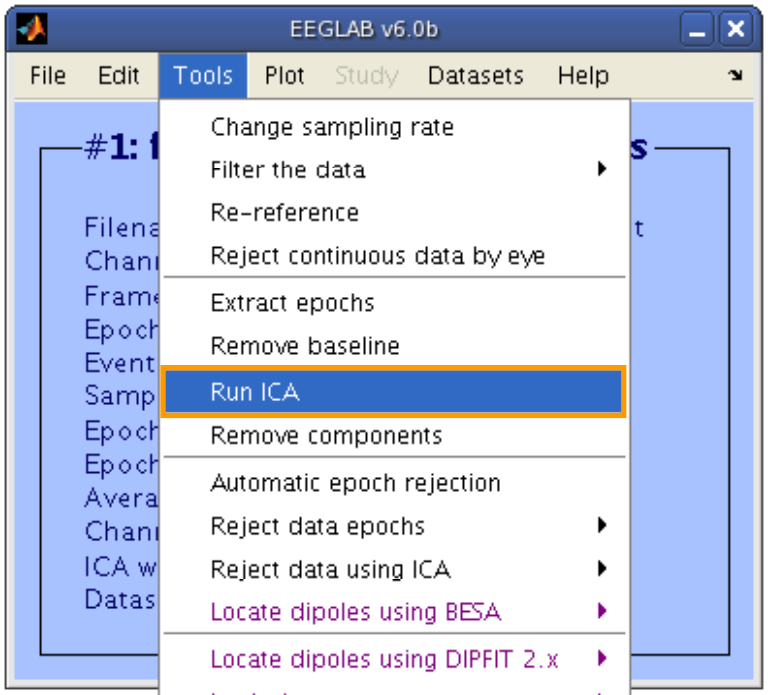


*

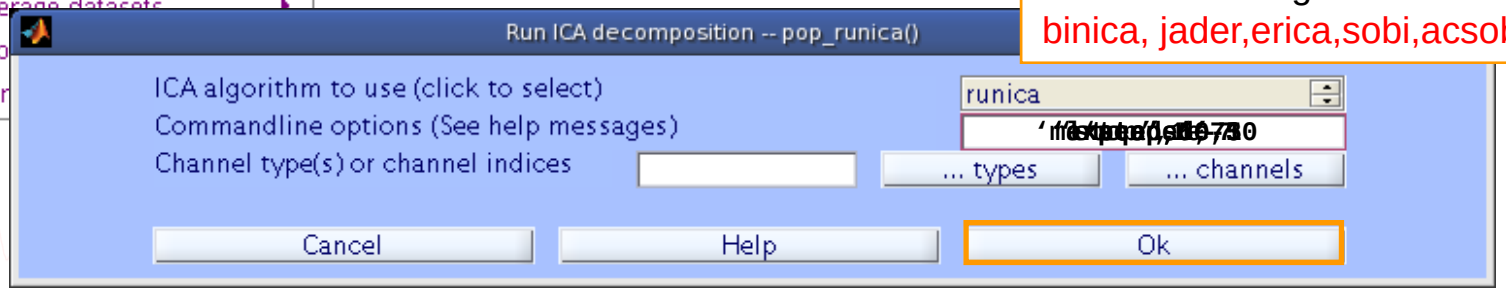
W^{-1} (scalp projections)



Runica options

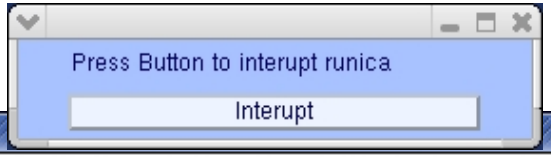


Option	Default	Comments
'extended'	0	1 is recommended to find sub-gaussians
'stop'	1e-7	final weight change → stop
'lrate'	determined from data	too small → too long… too large → wts blow up
'maxsteps'	512	more channels → more steps
'pca'	0 or EEG.nbchan	Decompose only a principal data subspace



Other algorithms:
binica, jader,erica,sobi,acsobiro

Runica progress…



csh

```
Input data size [33,133175] = 33 channels, 133175 frames/nFinding 33 ICA components using extended ICA.
Kurtosis will be calculated initially every 1 blocks using 6000 data points.
Decomposing 122 frames per ICA weight ((1089)^2 = 133175 weights, Initial learning rate will be 0.001, block size
Learning rate will be multiplied by 0.98 whenever angledelta >= 60 deg.
More than 32 channels: default stopping weight change 1E-7
Training will end when wchange < 1e-07 or after 512 steps.
Online bias adjustment will be used.
Removing mean of each channel ...
Final training data range: -171.806 to 179.094
Computing the sphering matrix...
Starting weights are the identity matrix ...
Sphering the data ...
Beginning ICA training ... first training step may be slow ...
step 1 - lrate 0.001000, wchange 16.85061324, angledelta  0.0 deg
step 2 - lrate 0.001000, wchange 0.26760405, angledelta  0.0 deg
step 3 - lrate 0.001000, wchange 0.79058323, angledelta 104.0 deg
step 4 - lrate 0.000980, wchange 0.66700031, angledelta 147.2 deg
step 5 - lrate 0.000960, wchange 0.62849071, angledelta 146.5 deg
step 6 - lrate 0.000941, wchange 0.73967955, angledelta 150.7 deg
step 7 - lrate 0.000922, wchange 0.73727229, angledelta 151.6 deg
step 8 - lrate 0.000904, wchange 0.74051387, angledelta 137.9 deg
step 9 - lrate 0.000886, wchange 0.74536137, angledelta 156.0 deg
step 10 - lrate 0.000868, wchange 0.72101402, angledelta 143.7 deg
step 11 - lrate 0.000851, wchange 0.14690114, angledelta 102.5 deg
step 12 - lrate 0.000834, wchange 0.11822100, angledelta 114.3 deg
step 13 - lrate 0.000817, wchange 0.75552966, angledelta 100.6 deg
step 14 - lrate 0.000801, wchange 0.26739750, angledelta 109.1 deg
step 15 - lrate 0.000785, wchange 0.12123251, angledelta 94.2 deg
step 16 - lrate 0.000769, wchange 0.10285606, angledelta 110.7 deg
step 17 - lrate 0.000754, wchange 0.09770499, angledelta 118.6 deg
step 18 - lrate 0.000739, wchange 0.09544428, angledelta 117.1 deg
```

csh

```
step 241 - lrate 0.000002, wchange 0.00000082, angledelta 101.5 deg
step 242 - lrate 0.000001, wchange 0.00000061, angledelta 96.1 deg
step 243 - lrate 0.000001, wchange 0.00000057, angledelta 97.5 deg
step 244 - lrate 0.000001, wchange 0.00000054, angledelta 93.7 deg
step 245 - lrate 0.000001, wchange 0.00000055, angledelta 100.3 deg
step 246 - lrate 0.000001, wchange 0.00000047, angledelta 96.9 deg
step 247 - lrate 0.000001, wchange 0.00000046, angledelta 91.3 deg
step 248 - lrate 0.000001, wchange 0.00000045, angledelta 101.5 deg
step 249 - lrate 0.000001, wchange 0.00000041, angledelta 103.1 deg
step 250 - lrate 0.000001, wchange 0.00000036, angledelta 95.5 deg
step 251 - lrate 0.000001, wchange 0.00000033, angledelta 92.1 deg
step 252 - lrate 0.000001, wchange 0.00000029, angledelta 97.4 deg
step 253 - lrate 0.000001, wchange 0.00000030, angledelta 95.8 deg
step 254 - lrate 0.000001, wchange 0.00000023, angledelta 94.2 deg
step 255 - lrate 0.000001, wchange 0.00000023, angledelta 97.6 deg
step 256 - lrate 0.000001, wchange 0.00000023, angledelta 97.1 deg
step 257 - lrate 0.000001, wchange 0.00000021, angledelta 92.0 deg
step 258 - lrate 0.000001, wchange 0.00000020, angledelta 99.1 deg
step 259 - lrate 0.000001, wchange 0.00000019, angledelta 95.0 deg
step 260 - lrate 0.000001, wchange 0.00000015, angledelta 98.3 deg
step 261 - lrate 0.000001, wchange 0.00000014, angledelta 99.0 deg
step 262 - lrate 0.000001, wchange 0.00000014, angledelta 94.3 deg
step 263 - lrate 0.000001, wchange 0.00000013, angledelta 95.4 deg
step 264 - lrate 0.000001, wchange 0.00000012, angledelta 94.1 deg
step 265 - lrate 0.000001, wchange 0.00000011, angledelta 96.1 deg
step 266 - lrate 0.000001, wchange 0.00000010, angledelta 94.8 deg
step 267 - lrate 0.000001, wchange 0.00000010, angledelta 94.5 deg
step 268 - lrate 0.000001, wchange 0.00000010, angledelta 97.7 deg
step 269 - lrate 0.000001, wchange 0.00000008, angledelta 95.1 deg
Sorting components in descending order of mean projected variance ...
Permuting the activation wave forms ...
>>
>>
```

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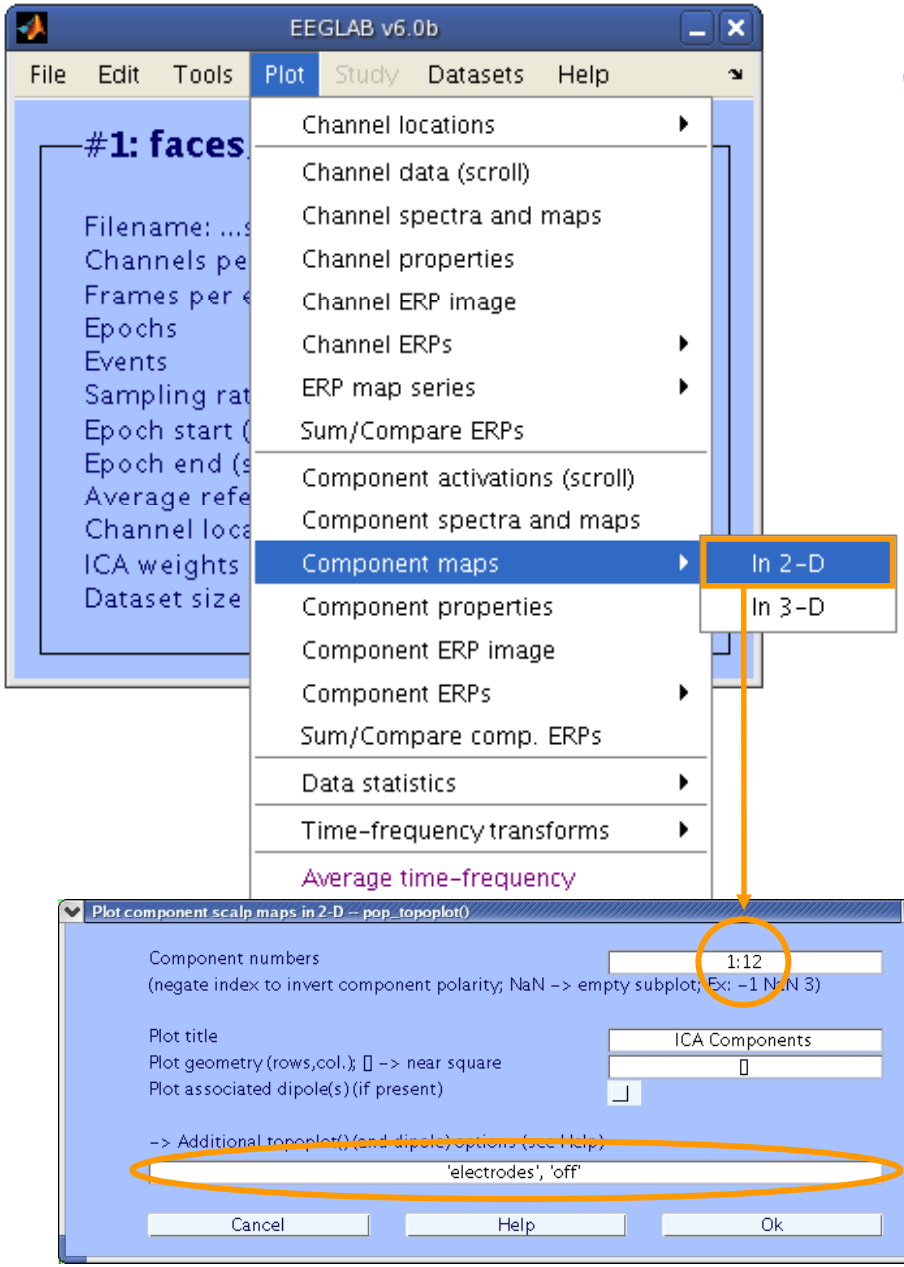
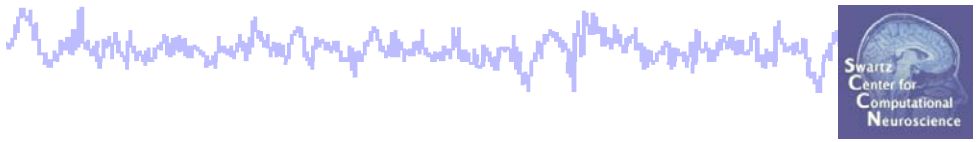
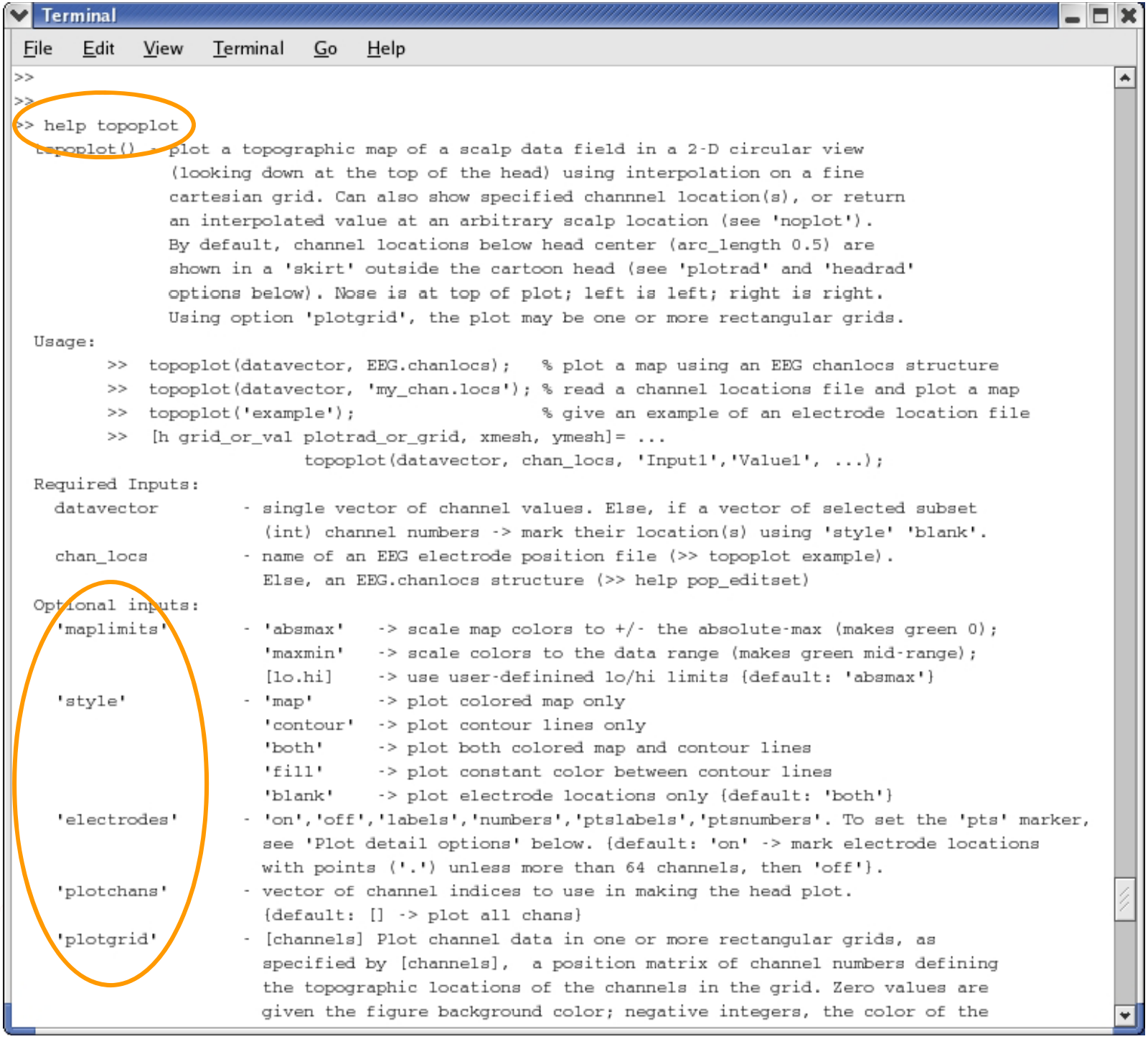
Plot components

Exercise...

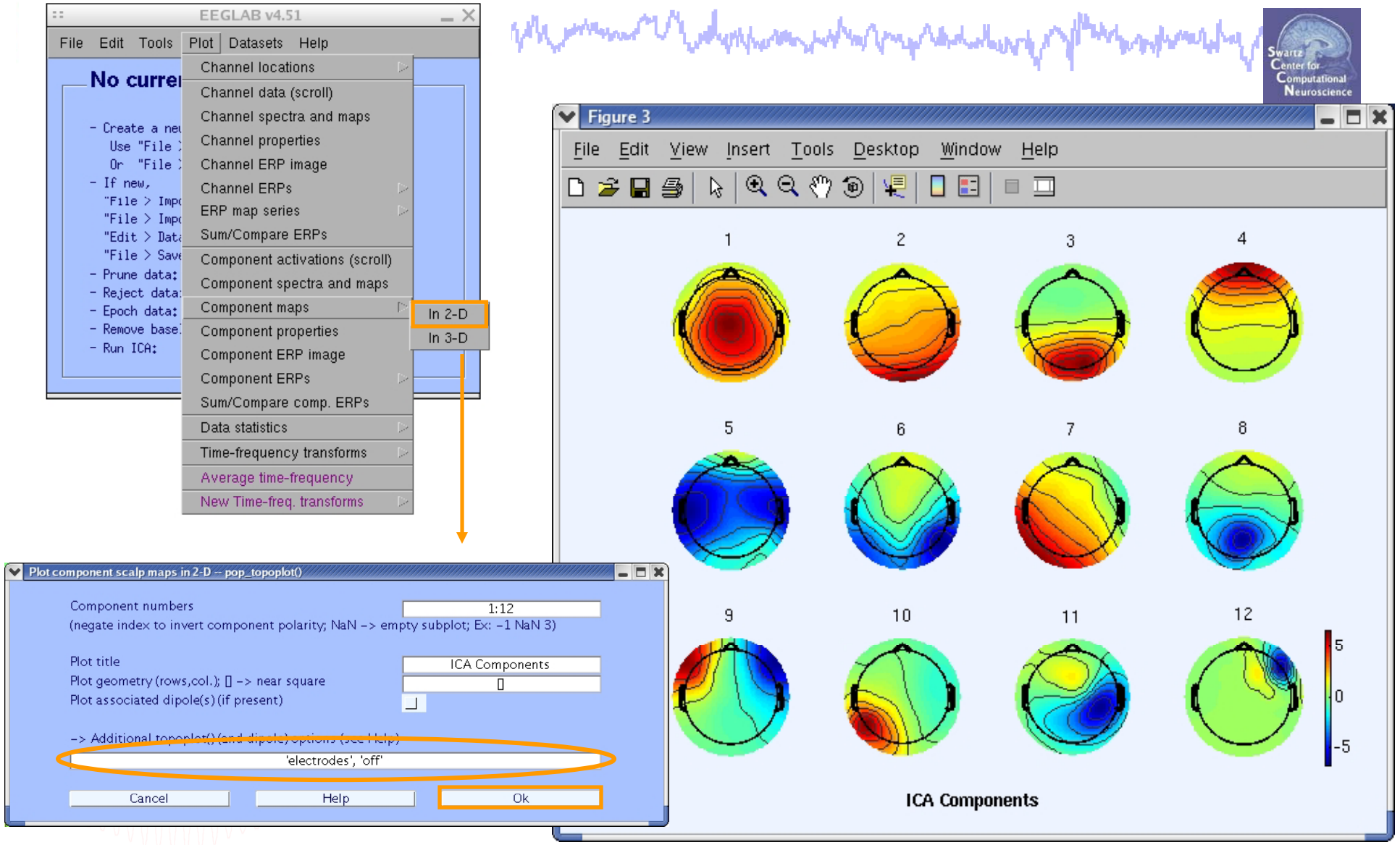
Plot ICA scalp maps



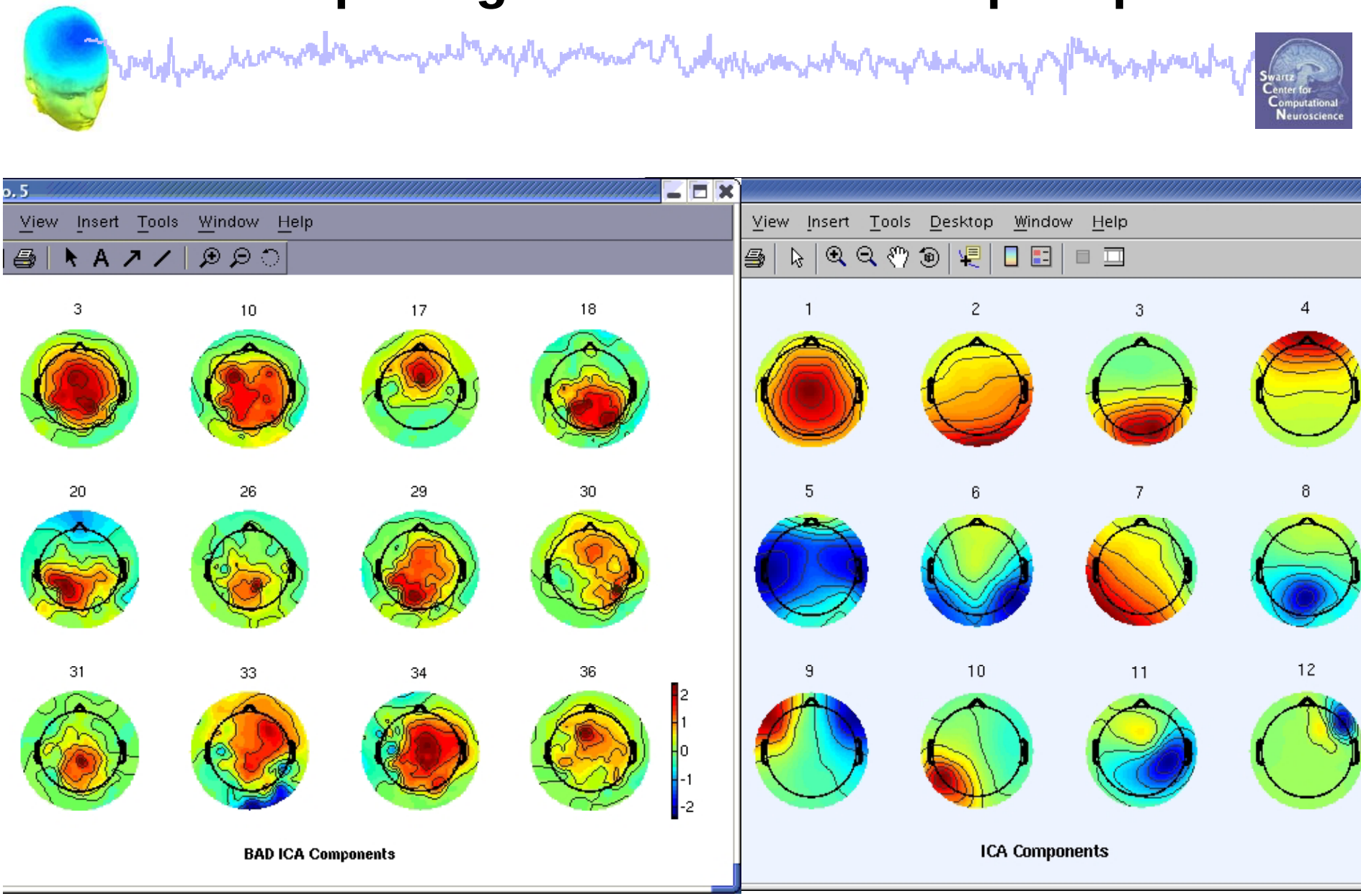



Terminal
File Edit View Terminal Go Help
>>
>>
>> help topoplot
topoplot() - plot a topographic map of a scalp data field in a 2-D circular view
(looking down at the top of the head) using interpolation on a fine
cartesian grid. Can also show specified channnel location(s), or return
an interpolated value at an arbitrary scalp location (see 'noplot').
By default, channel locations below head center (arc_length 0.5) are
shown in a 'skirt' outside the cartoon head (see 'plotrad' and 'headrad'
options below). Nose is at top of plot; left is left; right is right.
Using option 'plotgrid', the plot may be one or more rectangular grids.
Usage:
>> topoplot(datavector, EEG.chanlocs); % plot a map using an EEG chanlocs structure
>> topoplot(datavector, 'my_chan.locs'); % read a channel locations file and plot a map
>> topoplot('example'); % give an example of an electrode location file
>> [h grid_or_val plotrad_or_grid, xmesh, ymesh]= ...
topoplot(datavector, chan_locs, 'Input1','Value1', ...);
Required Inputs:
datavector - single vector of channel values. Else, if a vector of selected subset
(int) channel numbers -> mark their location(s) using 'style' 'blank'.
chan_locs - name of an EEG electrode position file (>> topoplot example).
Else, an EEG.chanlocs structure (>> help pop_editset)
Optional inputs:
'maplimits' - 'absmax' -> scale map colors to +/- the absolute-max (makes green 0);
'maxmin' -> scale colors to the data range (makes green mid-range);
[lo.hi] -> use user-definined lo/hi limits {default: 'absmax'}
'style' - 'map' -> plot colored map only
'contour' -> plot contour lines only
'both' -> plot both colored map and contour lines
'fill' -> plot constant color between contour lines
'blank' -> plot electrode locations only {default: 'both'}
'electrodes' - 'on','off','labels','numbers','ptslabels','ptsnumbers'. To set the 'pts' marker,
see 'Plot detail options' below. {default: 'on' -> mark electrode locations
with points ('.') unless more than 64 channels, then 'off'}.
'plotchans' - vector of channel indices to use in making the head plot.
{default: [] -> plot all chans}
'plotgrid' - [channels] Plot channel data in one or more rectangular grids, as
specified by [channels], a position matrix of channel numbers defining
the topographic locations of the channels in the grid. Zero values are
given the figure background color; negative integers, the color of the

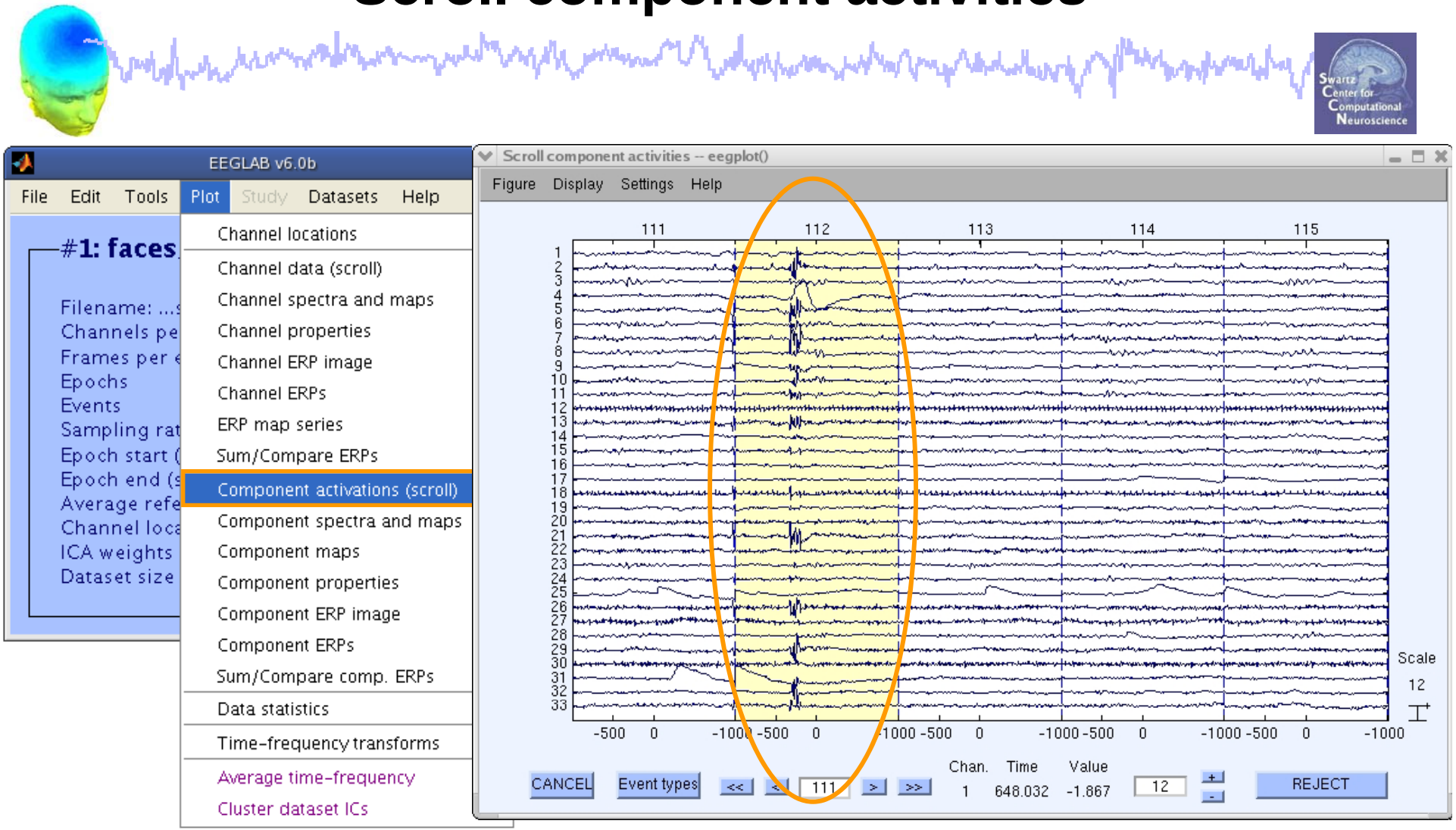
Plot ICA scalp maps



Compare 'good' and 'bad' scalp maps

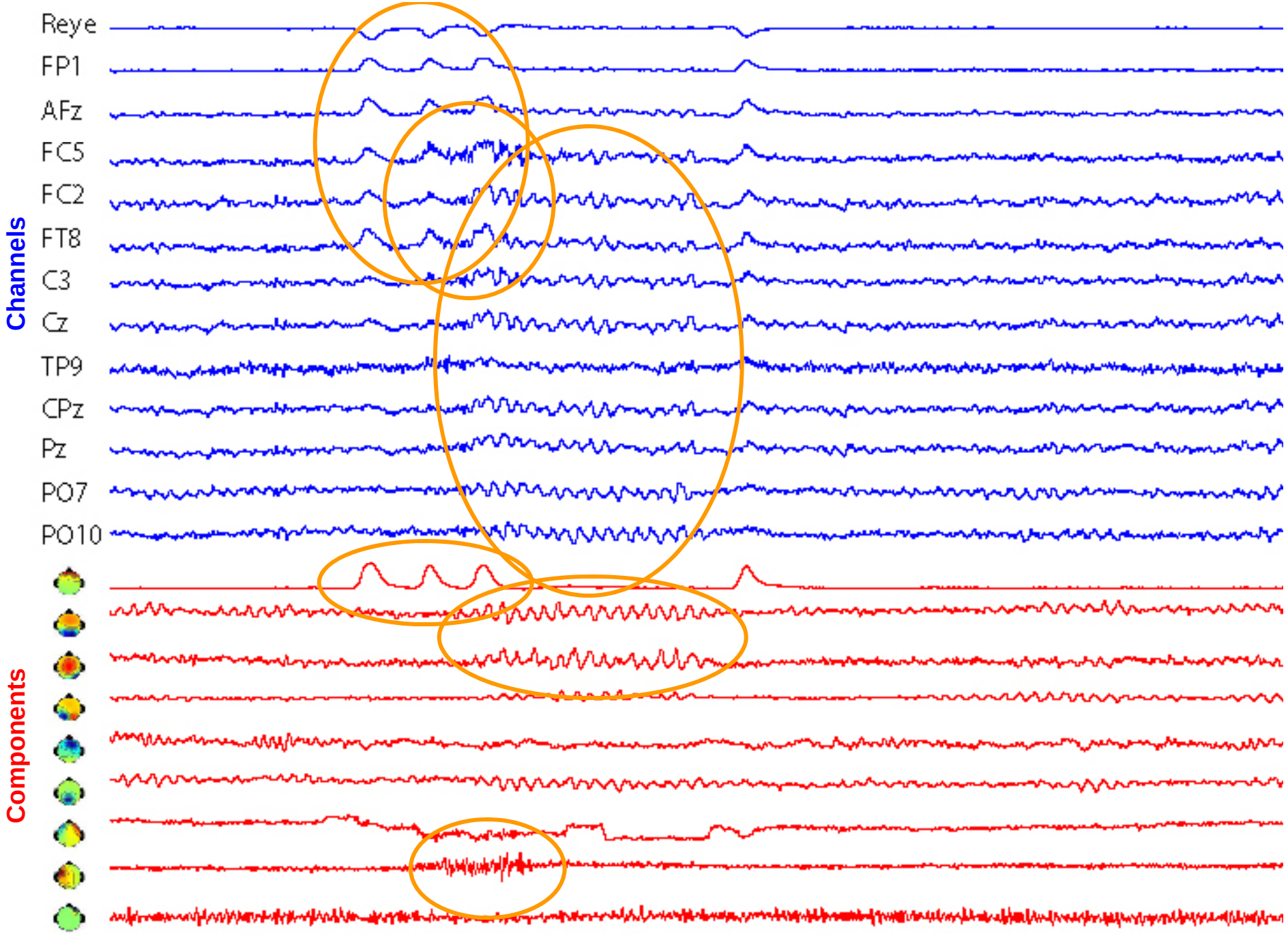


Scroll component activities

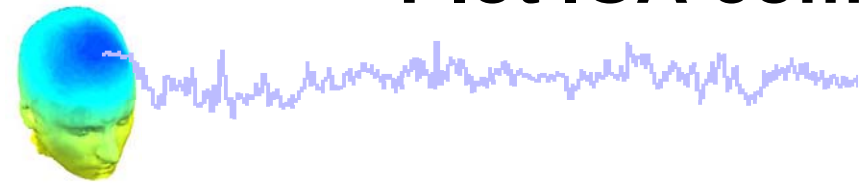


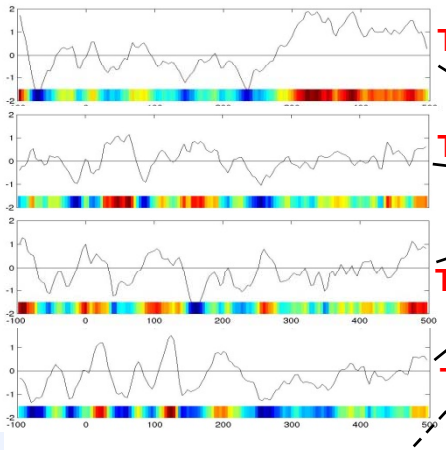
Time periods that are not independent across ICs

should be removed and ICA run again for better decomposition

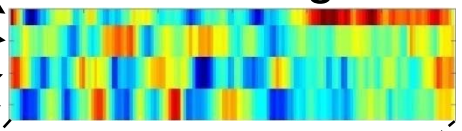

Channels
Components
Reye
FP1
AFz
FC5
FC2
FT8
C3
Cz
TP9
CPz
Pz
PO7
PO10

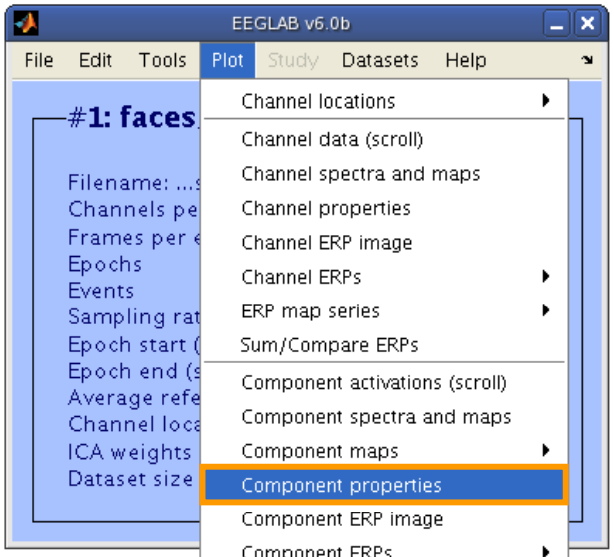
Plot ICA component properties

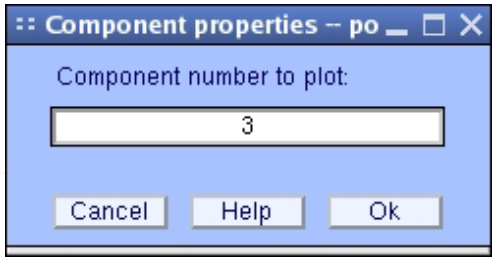


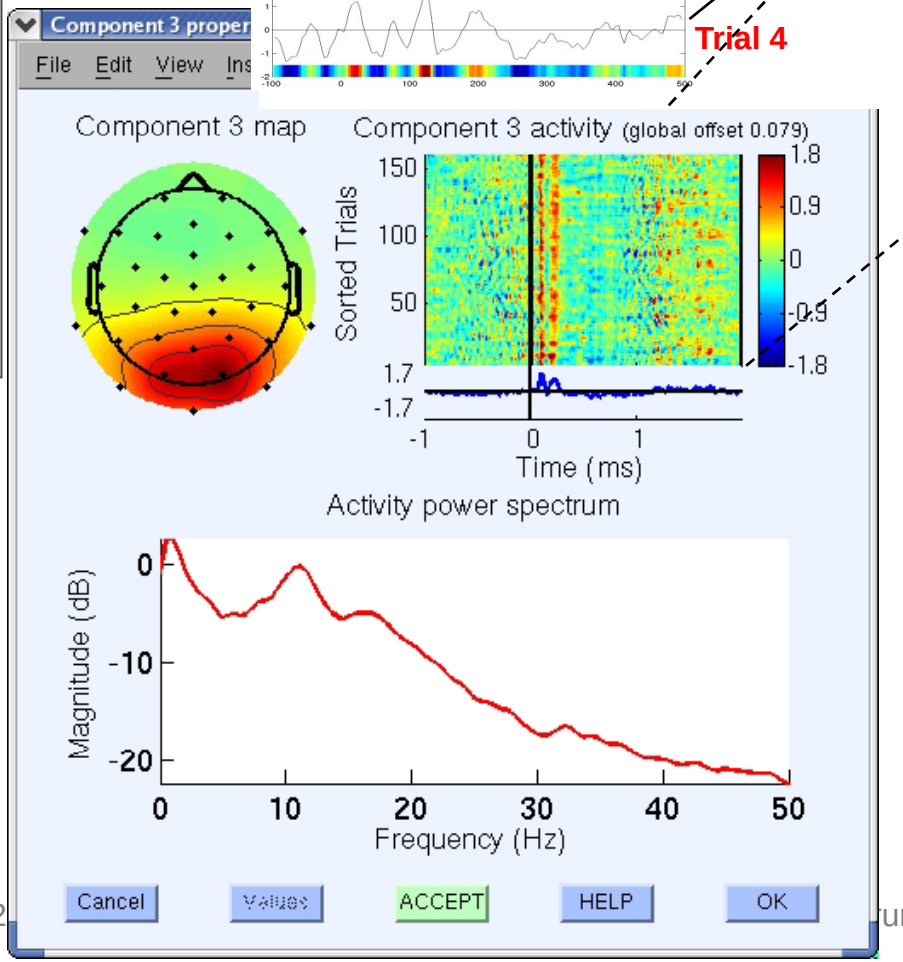


ERP Image

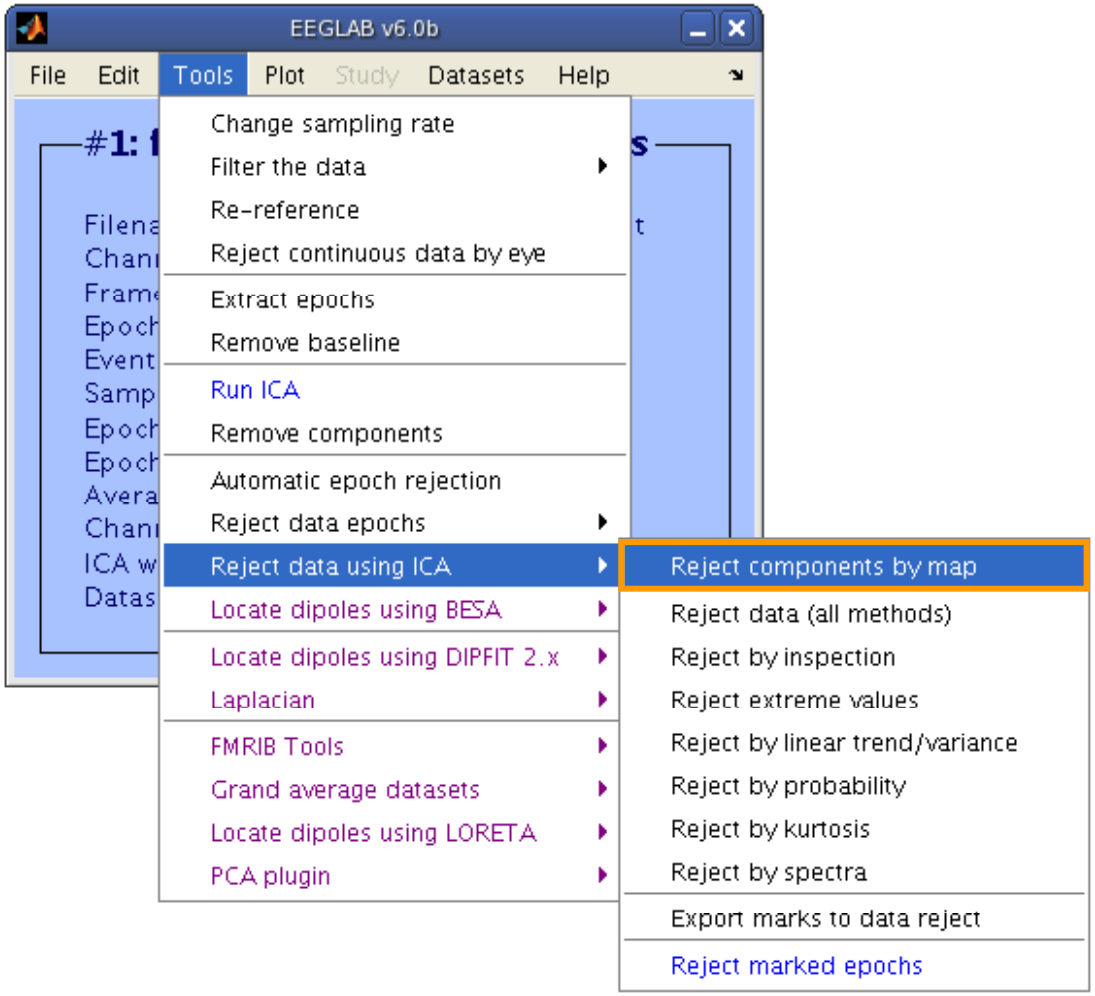




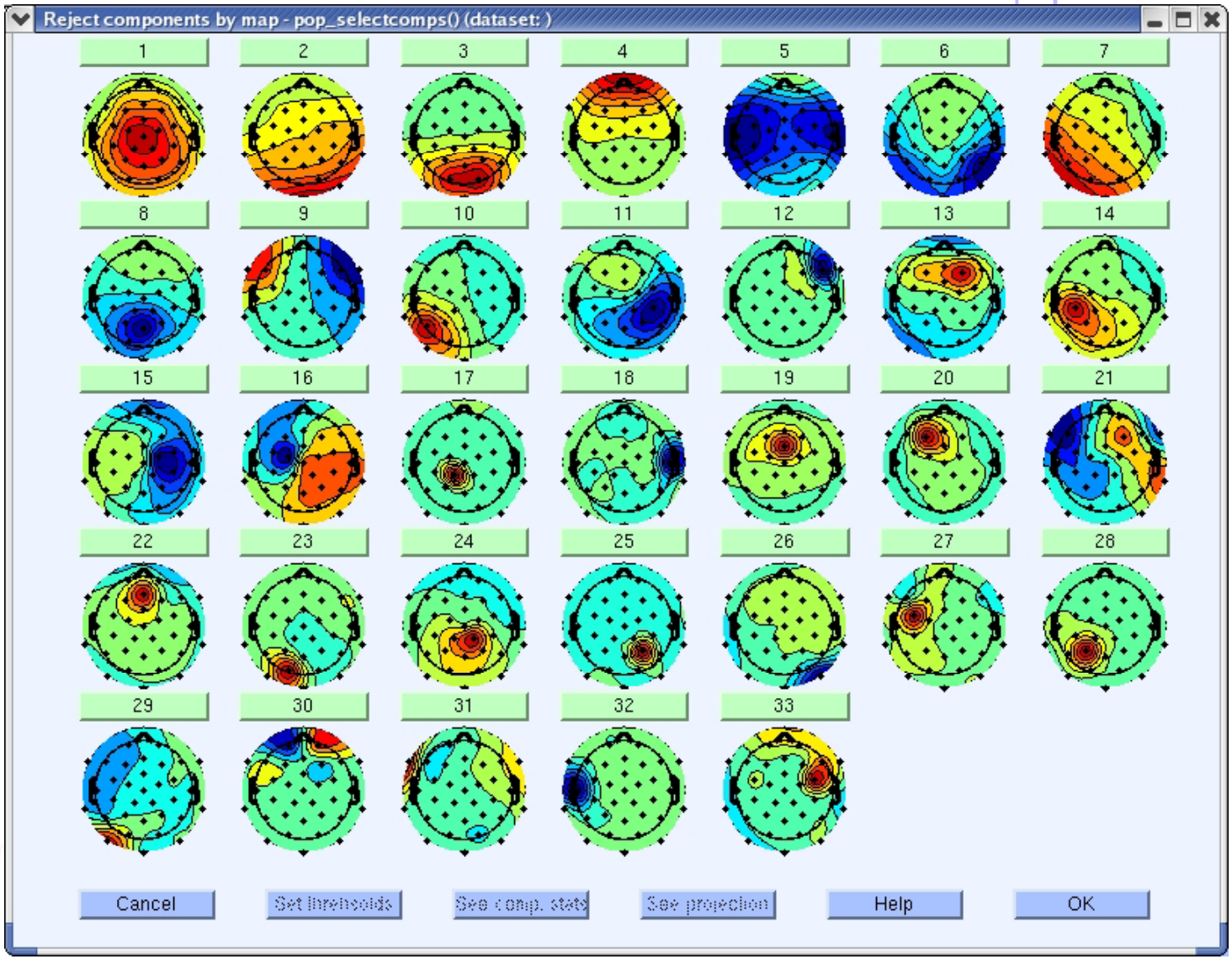


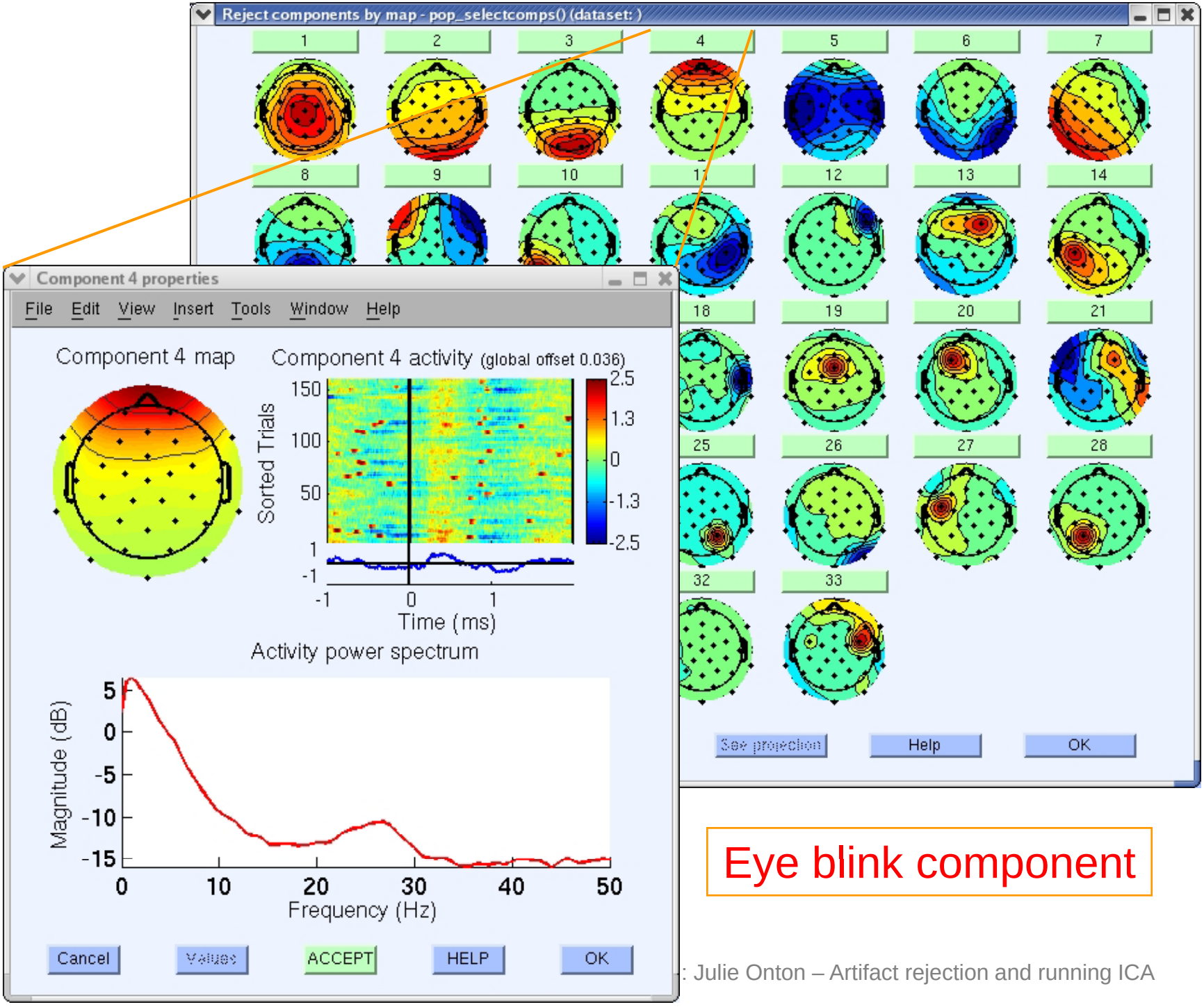


Reviewing component properties

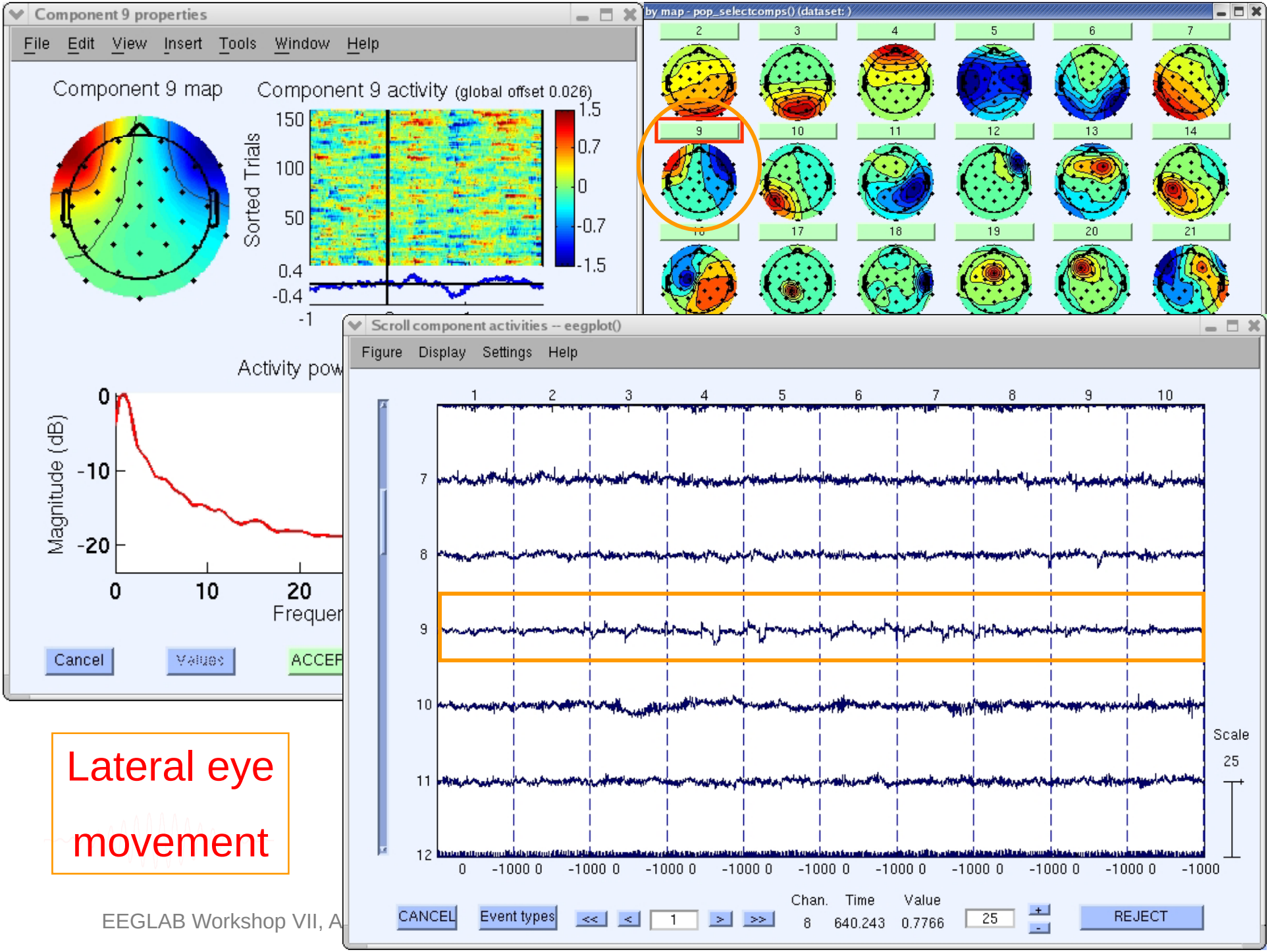


Component scalp maps/properties

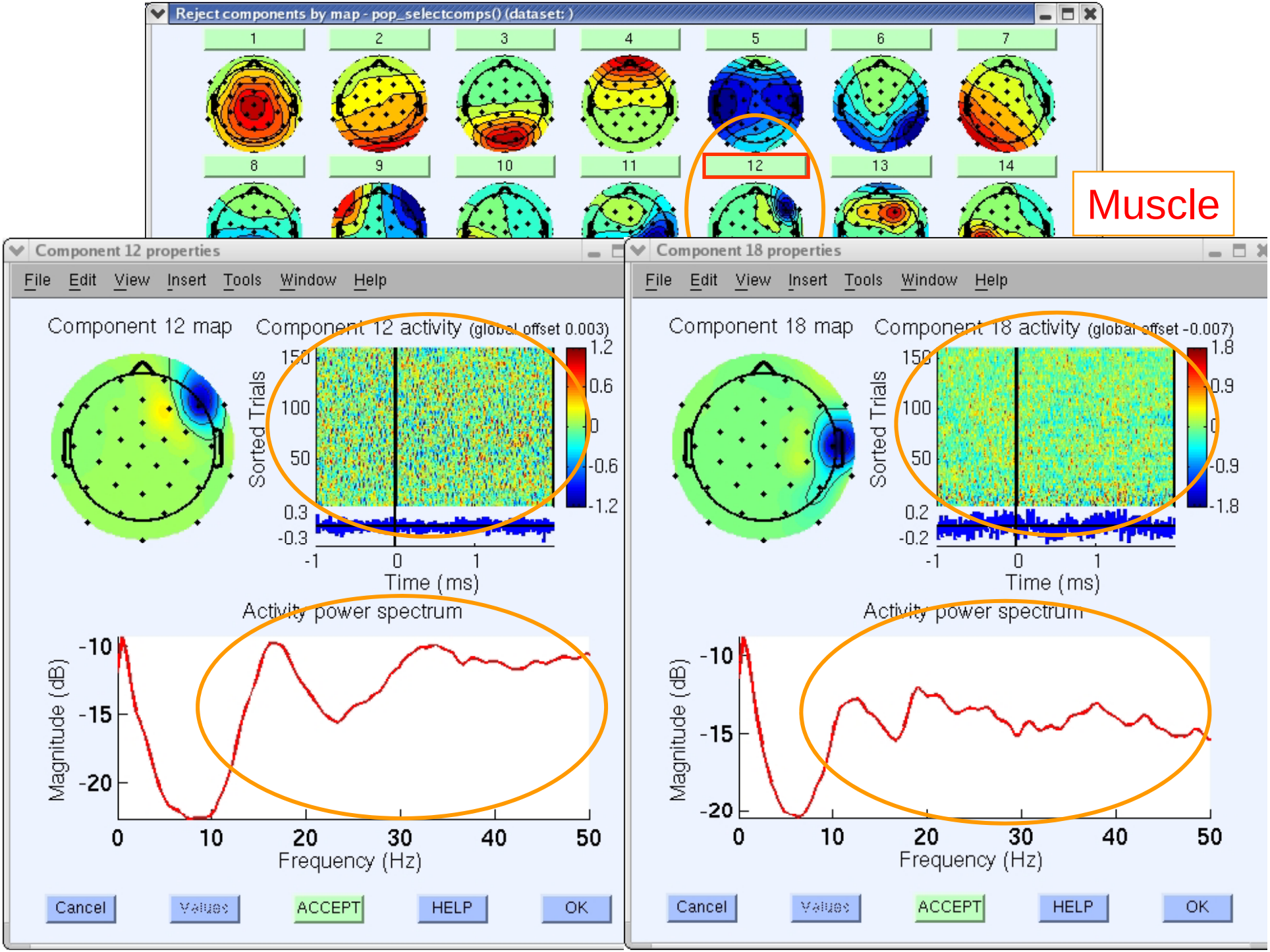


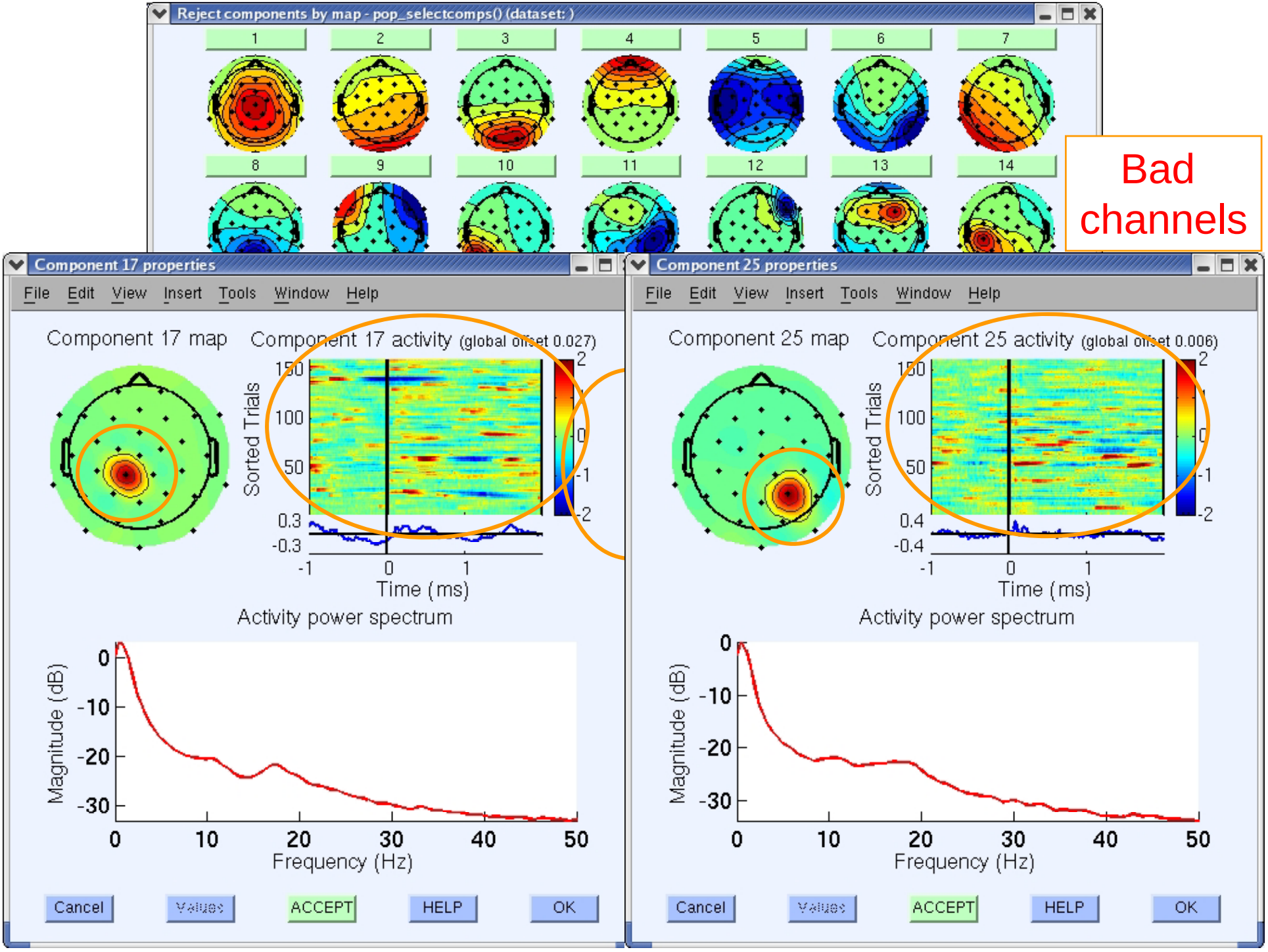


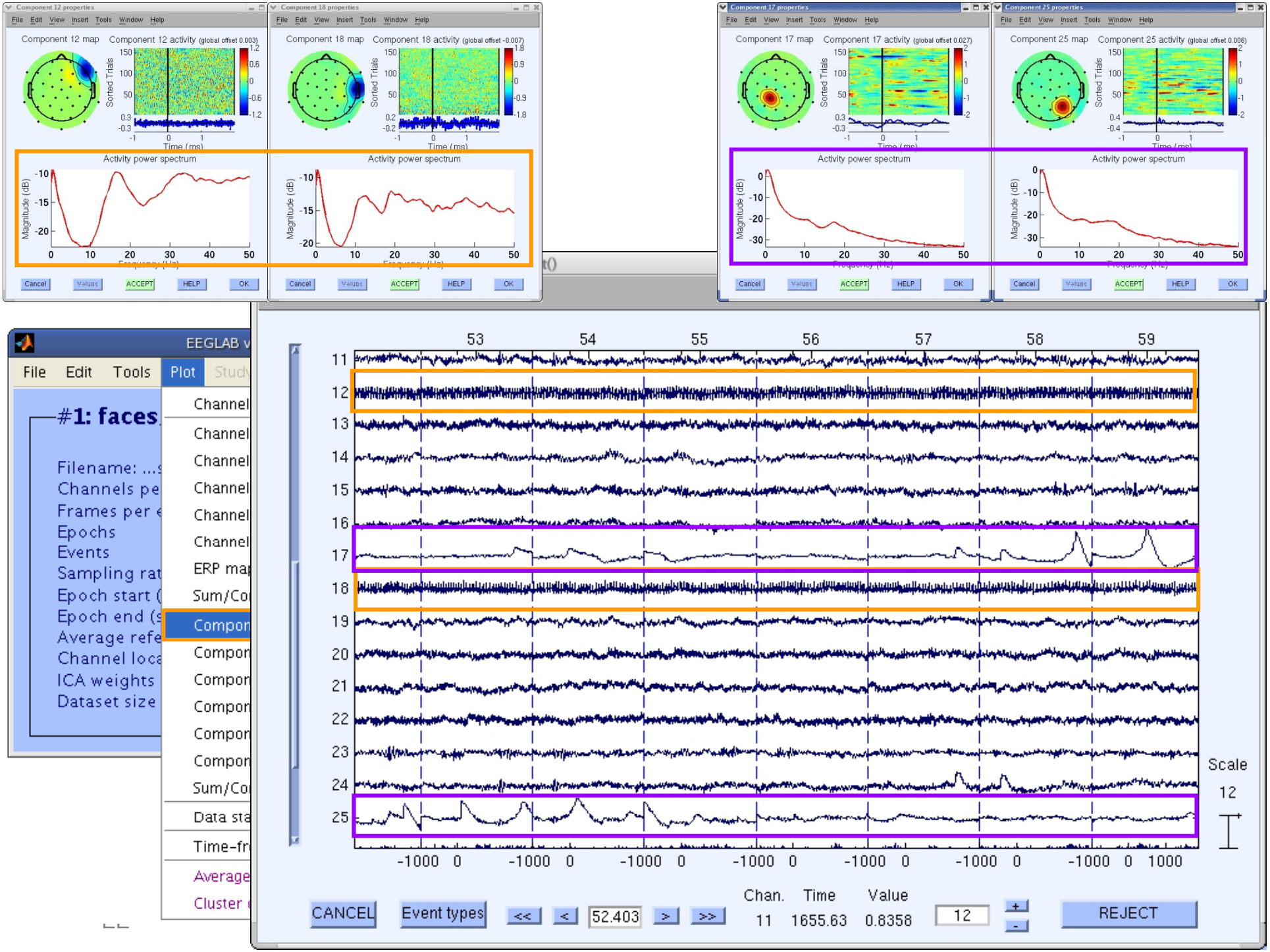
Eye blink component

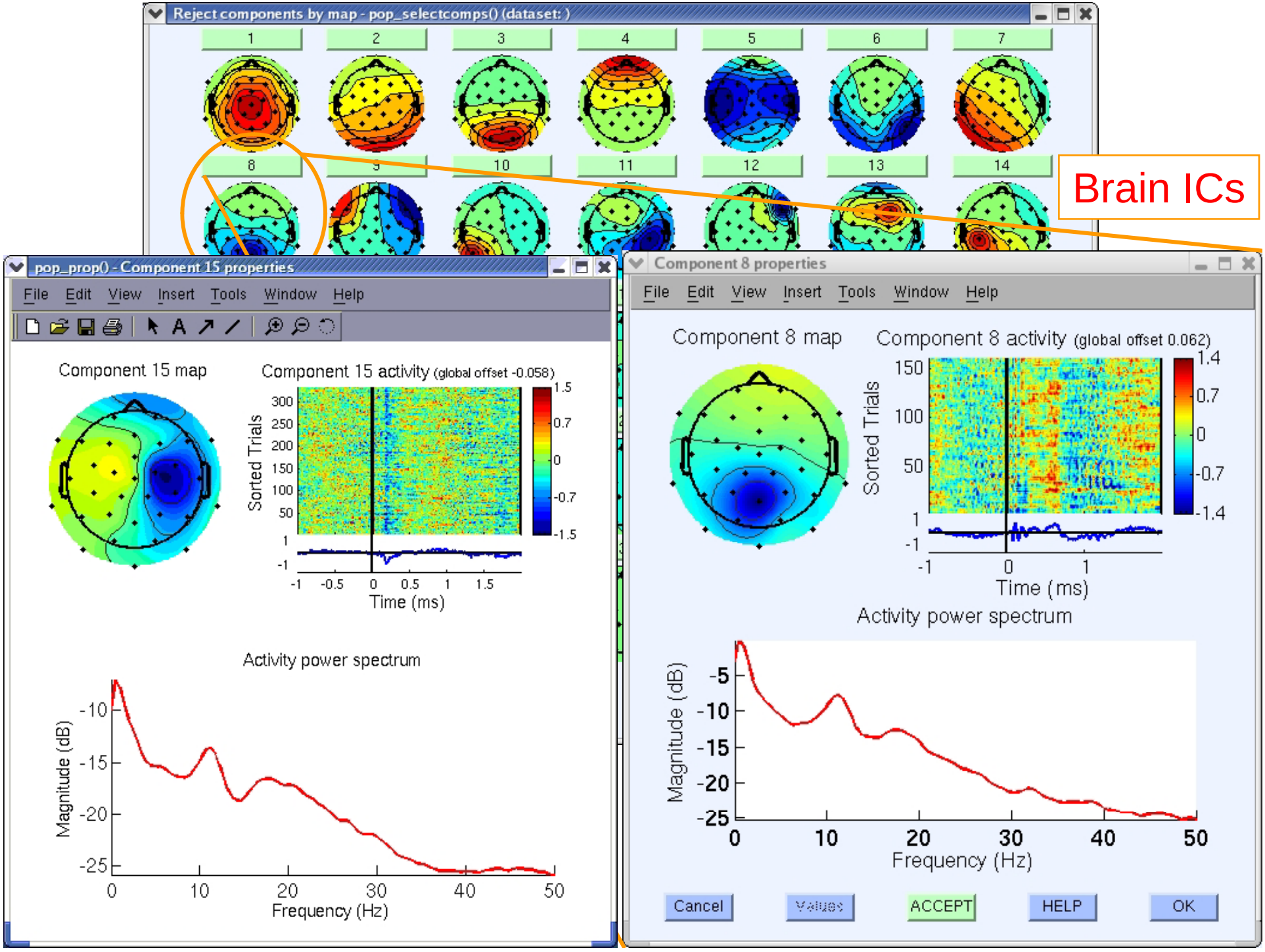


Lateral eye movement

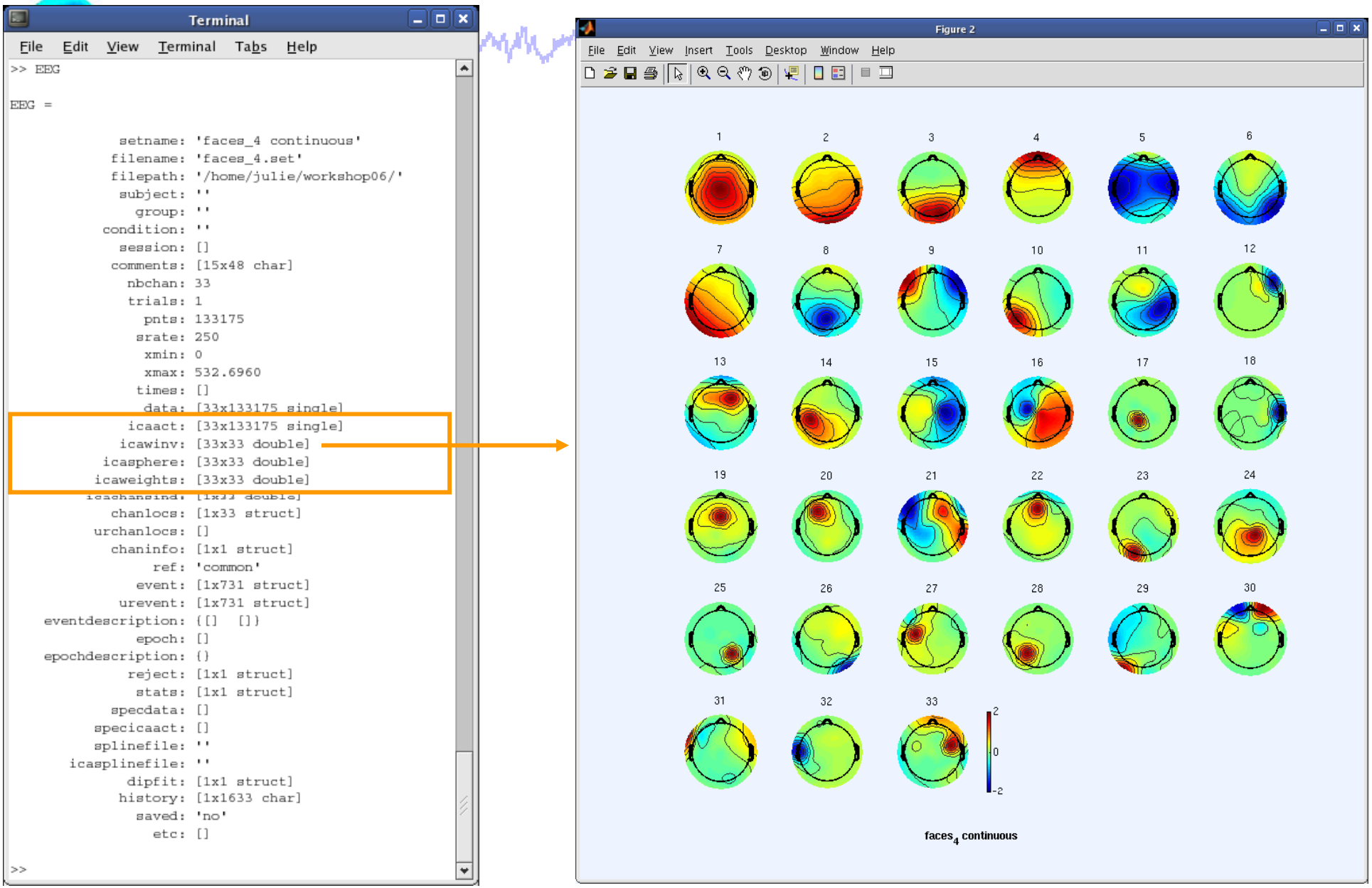

Reject components by map - pop_selectcomps() (dataset:)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Muscle
Component 12 properties
File Edit View Insert Tools Window Help
Component 12 map
Component 12 activity (global offset 0.003)
Sorted Trials
Time (ms)
Activity power spectrum
Magnitude (dB)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK
Component 18 properties
File Edit View Insert Tools Window Help
Component 18 map
Component 18 activity (global offset -0.007)
Sorted Trials
Time (ms)
Activity power spectrum
Magnitude (dB)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Reject components by map - pop_selectcomps() (dataset:)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Bad channels
Component 17 properties
File Edit View Insert Tools Window Help
Component 17 map
Component 17 activity (global offset 0.027)
Sorted Trials
Time (ms)
Activity power spectrum
Magnitude (dB)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK
Component 25 properties
File Edit View Insert Tools Window Help
Component 25 map
Component 25 activity (global offset 0.006)
Sorted Trials
Time (ms)
Activity power spectrum
Magnitude (dB)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK


Component 12 properties
Component 12 map
Component 12 activity (global offset 0.003)
Activity power spectrum
Component 18 properties
Component 18 map
Component 18 activity (global offset -0.007)
Activity power spectrum
Component 17 properties
Component 17 map
Component 17 activity (global offset 0.027)
Activity power spectrum
Component 25 properties
Component 25 map
Component 25 activity (global offset 0.006)
Activity power spectrum
Sorted Trials
Time (ms)
Magnitude (dB)
Frequency (Hz)
File Edit View Insert Tools Window Help
Cancel
Values
ACCEPT
HELP
OK
EEGLAB
File Edit Tools Plot
#1: faces
Filename:
Channels per
Frames per
Epochs
Events
Sampling rat
Epoch start
Epoch end
Average refe
Channel loca
ICA weights
Dataset size
Channel
ERP map
Sum/Co
Compon
Data sta
Time-fr
Average
Cluster
53 54 55 56 57 58 59
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
-1000 0 1000
Scale
12
CANCEL
Event types
<< < 52.403 > >>
Chan. Time Value
11 1655.63 0.8358
12
+
-
REJECT


Reject components by map - pop_selectcomps() (dataset:)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Brain ICs
pop_prop() - Component 15 properties
File Edit View Insert Tools Window Help
Component 15 map
Component 15 activity (global offset -0.058)
Sorted Trials
Time (ms)
Activity power spectrum
Magnitude (dB)
Frequency (Hz)
Component 8 properties
File Edit View Insert Tools Window Help
Component 8 map
Component 8 activity (global offset 0.062)
Sorted Trials
Time (ms)
Activity power spectrum
Magnitude (dB)
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

ICA weights in EEG structure



Exercise

- **ALL**

  - Load faces_3.set or faces_4.set

  - Epoch the data on faces and objects

  - From Reject data epochs->All methods menu

  - Scroll the data and perform visual rejection

  - Try other rejection protocols and compare

  - Explore channel probability and abnormal distribution plots

  - Find and identify artifact ICs

  - How can you be sure that an IC is artifact?