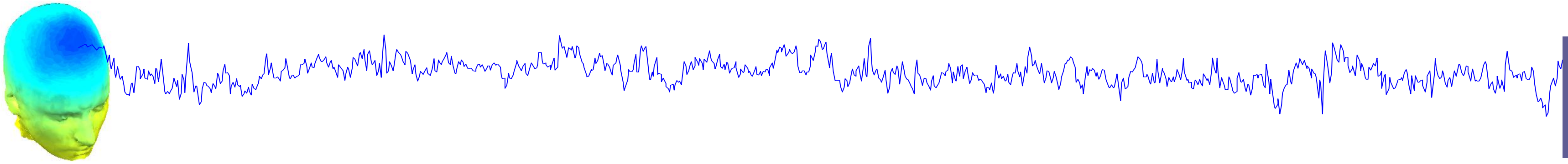
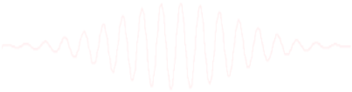


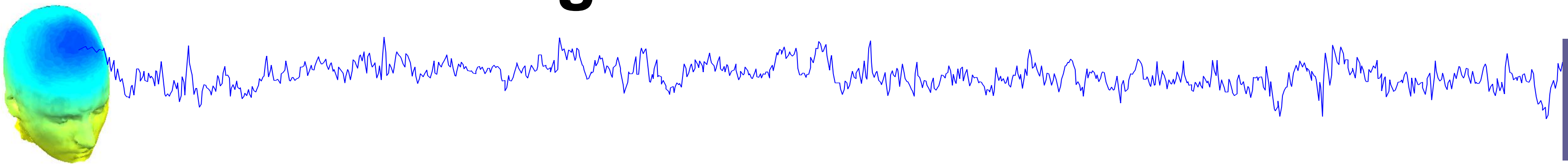
EEG Preprocessing

Importing, rejecting, and preparing data for ICA decomposition

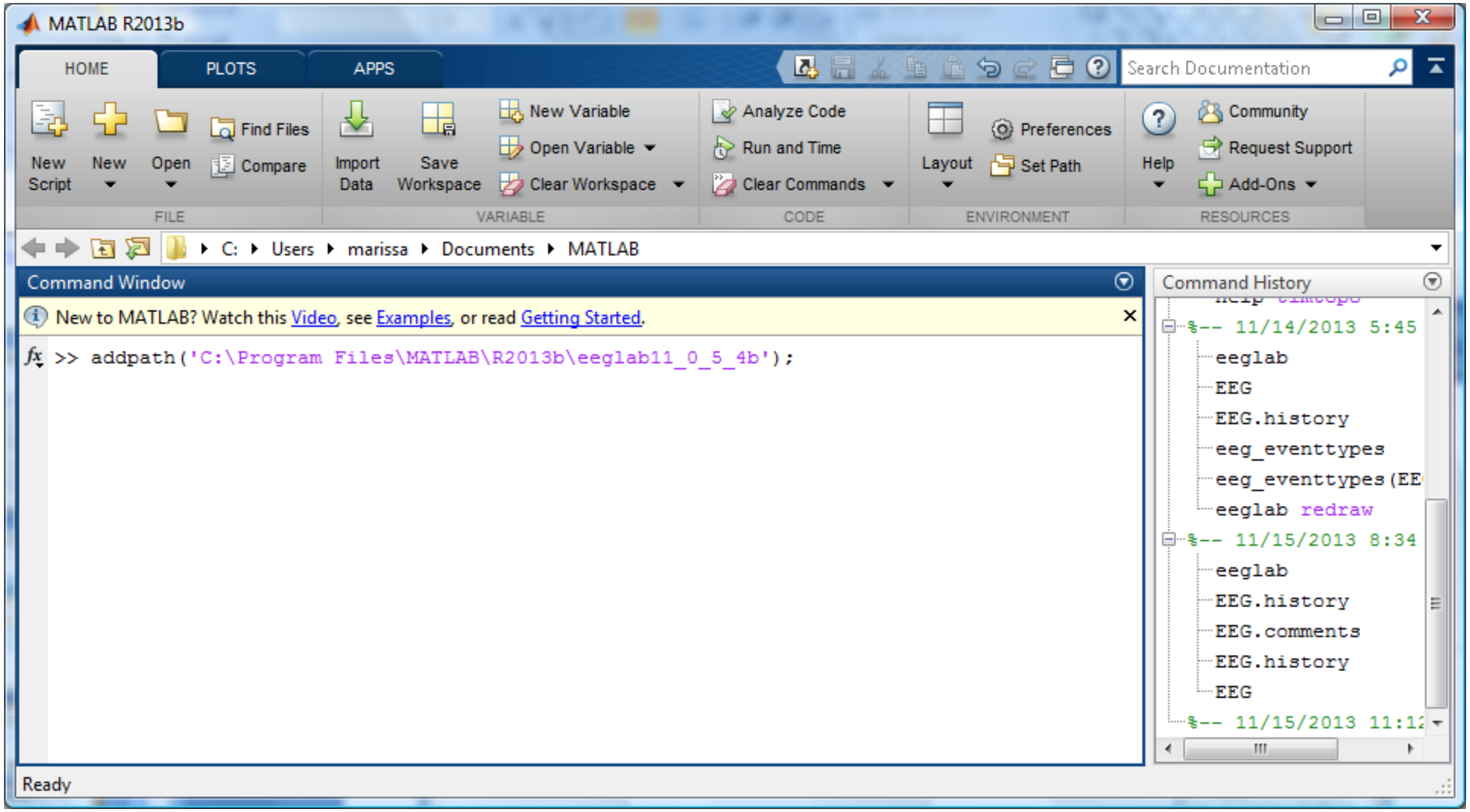
EEGLAB Workshop XXIV
Aspet, France
July 4, 2017
Day 1, 11:30-12:30



Installing EEGLAB and data folder



- Start Matlab
- Add the EEGLAB folder to your Matlab path:



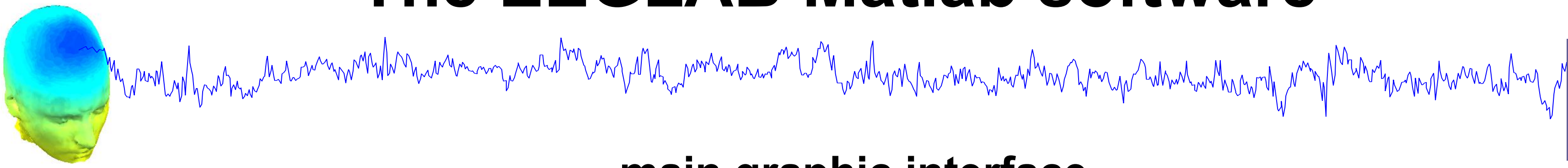
MATLAB R2013b
HOME
PLOTS
APPS
Search Documentation
New Script
New
Open
Find Files
Compare
FILE
Import Data
Save Workspace
New Variable
Open Variable
Clear Workspace
VARIABLE
Analyze Code
Run and Time
Clear Commands
CODE
Layout
Preferences
Set Path
ENVIRONMENT
Help
Community
Request Support
Add-Ons
RESOURCES
C: ▸ Users ▸ marissa ▸ Documents ▸ MATLAB
Command Window
Command History
Ready

New to MATLAB? Watch this Video, see Examples, or read Getting Started.

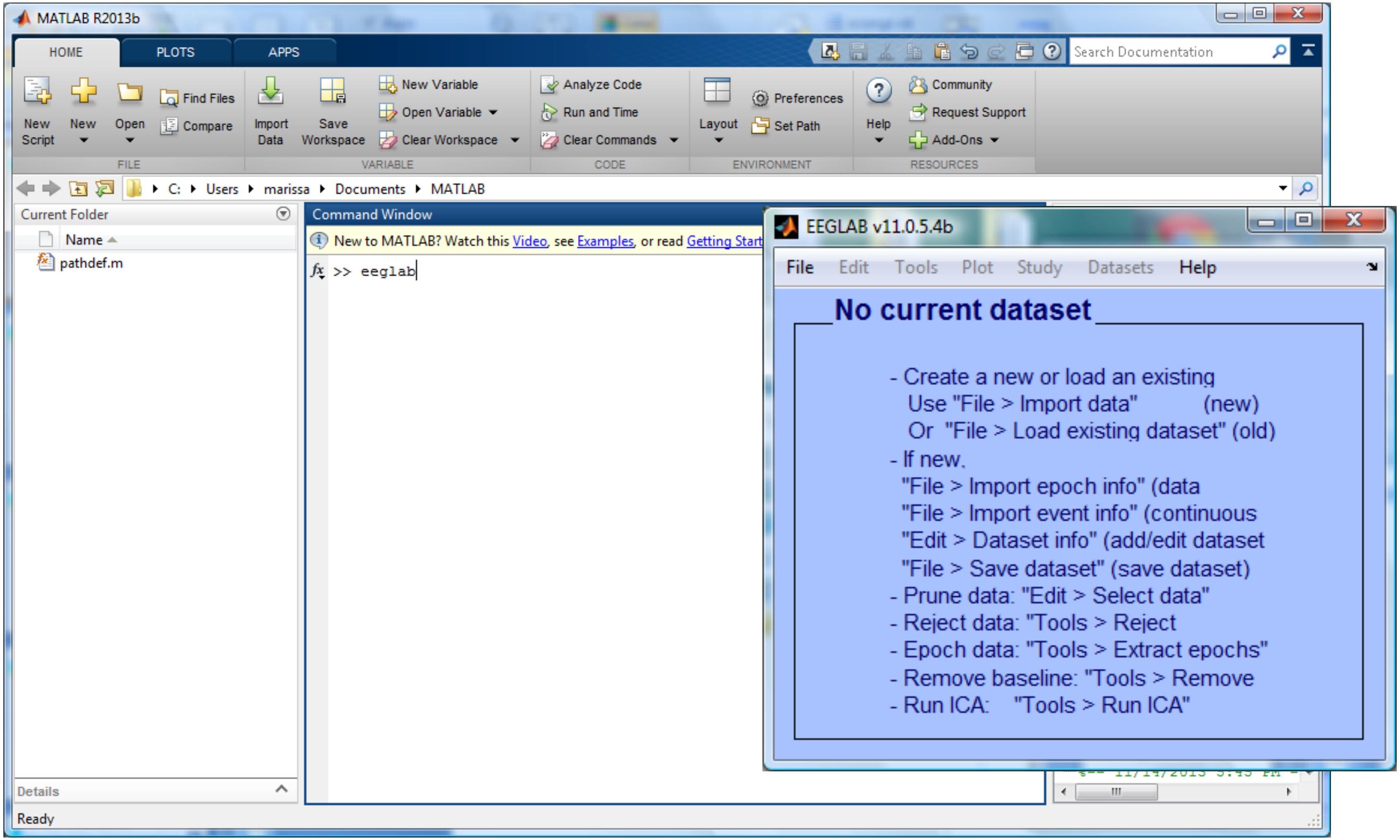
```
>> addpath('C:\Program Files\MATLAB\R2013b\eeglab11_0_5_4b');
```

```
%-- 11/14/2013 5:45
eeglab
EEG
EEG.history
eeg_eventtypes
eeg_eventtypes(EE
eeglab redraw
%-- 11/15/2013 8:34
eeglab
EEG.history
EEG.comments
EEG.history
EEG
%-- 11/15/2013 11:1
```

The EEGLAB Matlab software



main graphic interface


MATLAB R2013b
HOME
PLOTS
APPS
Search Documentation
New Script
New
Open
Find Files
Compare
FILE
Import Data
Save Workspace
New Variable
Open Variable
Clear Workspace
VARIABLE
Analyze Code
Run and Time
Clear Commands
CODE
Layout
Preferences
Set Path
ENVIRONMENT
Help
Community
Request Support
Add-Ons
RESOURCES
C:
Users
marissa
Documents
MATLAB
Current Folder
Name
pathdef.m
Details
Ready
Command Window
EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help

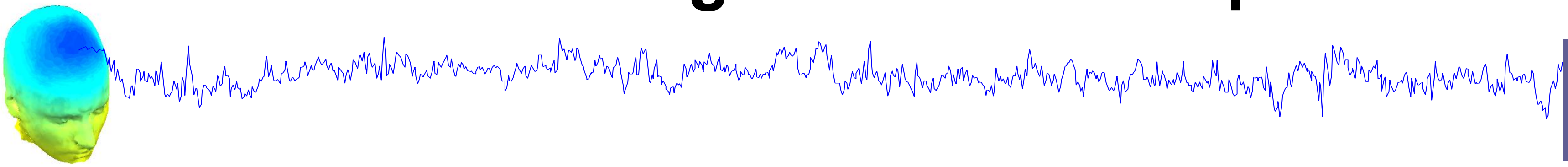
New to MATLAB? Watch this Video, see Examples, or read Getting Start

```
>> eeglab
```

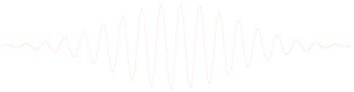
No current dataset

- Create a new or load an existing
  Use "File > Import data"   (new)
  Or "File > Load existing dataset" (old)
- If new,
  "File > Import epoch info" (data
  "File > Import event info" (continuous
  "Edit > Dataset info" (add/edit dataset
  "File > Save dataset" (save dataset)
- Prune data: "Edit > Select data"
- Reject data: "Tools > Reject
- Epoch data: "Tools > Extract epochs"
- Remove baseline: "Tools > Remove
- Run ICA: "Tools > Run ICA"

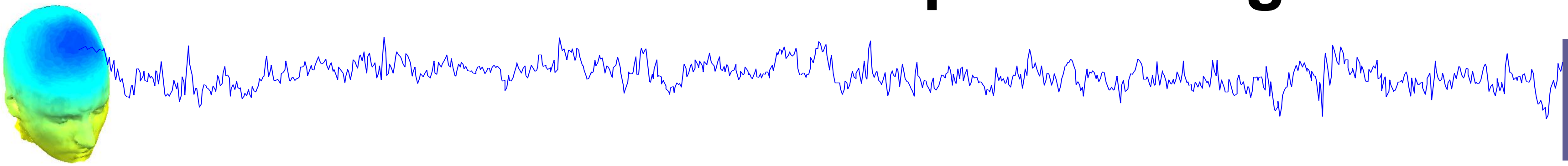
“Secrets” to a good ICA decomposition



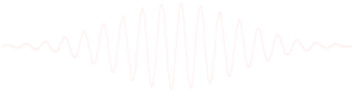
- Garbage in… garbage out (it’s not magic)
- Remove large, non-stereotyped artifacts
- Do you have enough data? (based mostly on time, not frames)
- High-pass filter to remove slow drifts (no low-pass filter needed)
- Remove bad channels



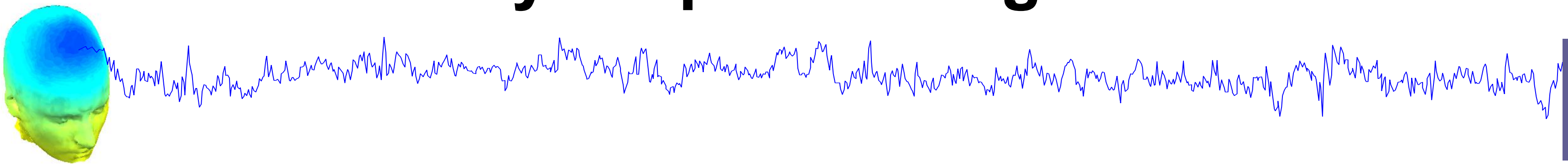
The Goal of Preprocessing



- Create a complete EEGLAB data set with
  - EEG
  - Channel Locations
  - Events
- Preprocess the EEG data to yield optimal ICA decompositions
  - Re-referencing
  - High Pass Filtering
  - Remove bad channels, noisy segments of data
- Run ICA decomposition

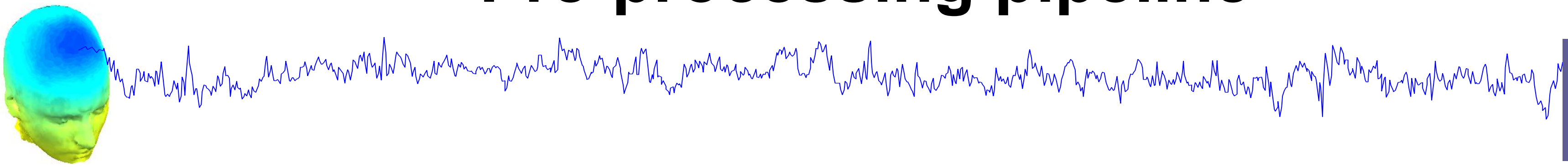


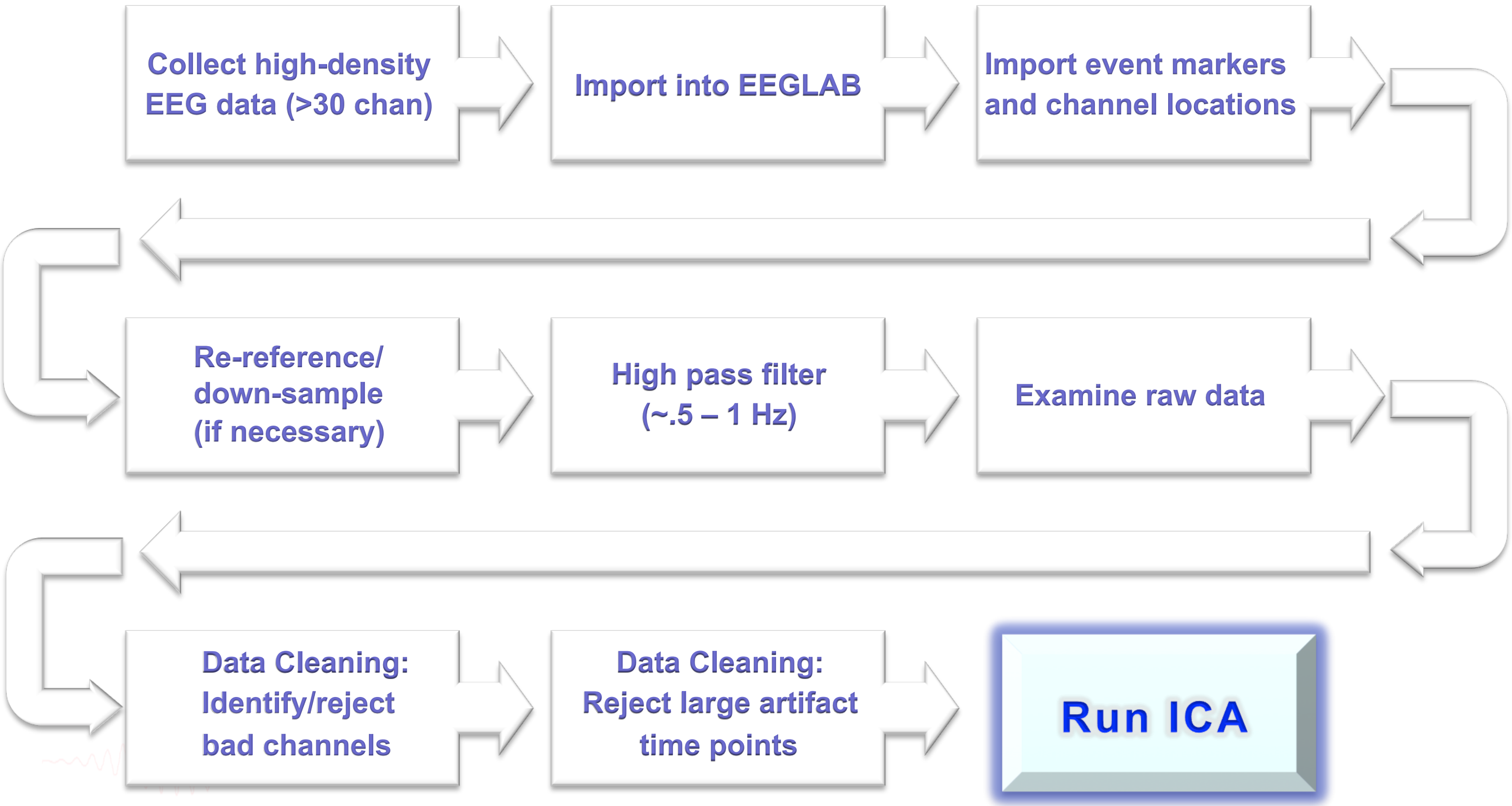
Many Preprocessing Variants



- Resources
  - EEGLAB wiki “Quick Tutorial on Rejection”
    - http://sccn.ucsd.edu/wiki/Quick_Rejection_Tutorial
  - Makoto’s Preprocessing Pipeline
    - http://sccn.ucsd.edu/wiki/Makoto%27s_preprocessing_pipeline
  - Bigdely-Shamlo et al (2015): PREP Pipeline
    - http://dx.doi.org/10.3389/fninf.2015.00016
  - EEGLAB Plugins
    - Kothe’s clean_rawdata plugin
    - Miyakoshi’s trimOutlier plugin

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

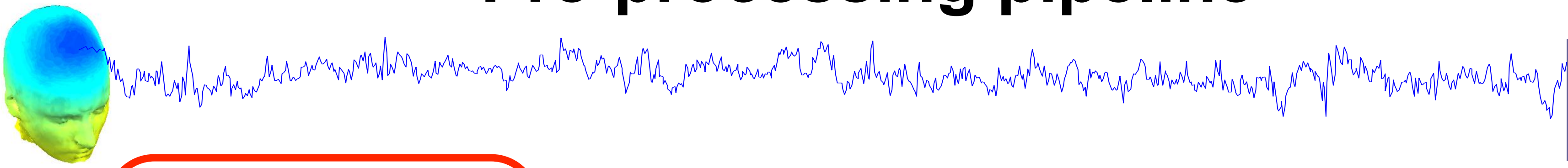
Examine raw data

Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

Run ICA

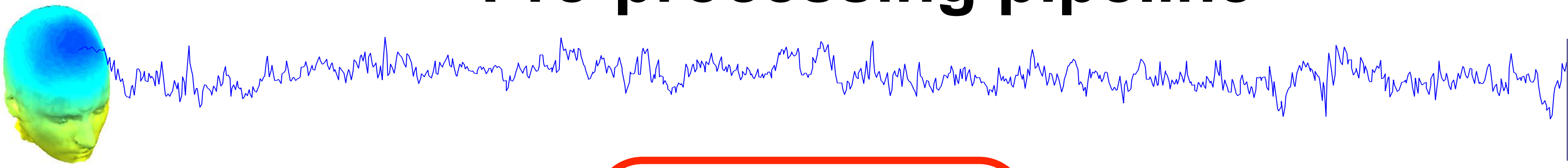
Pre-processing pipeline

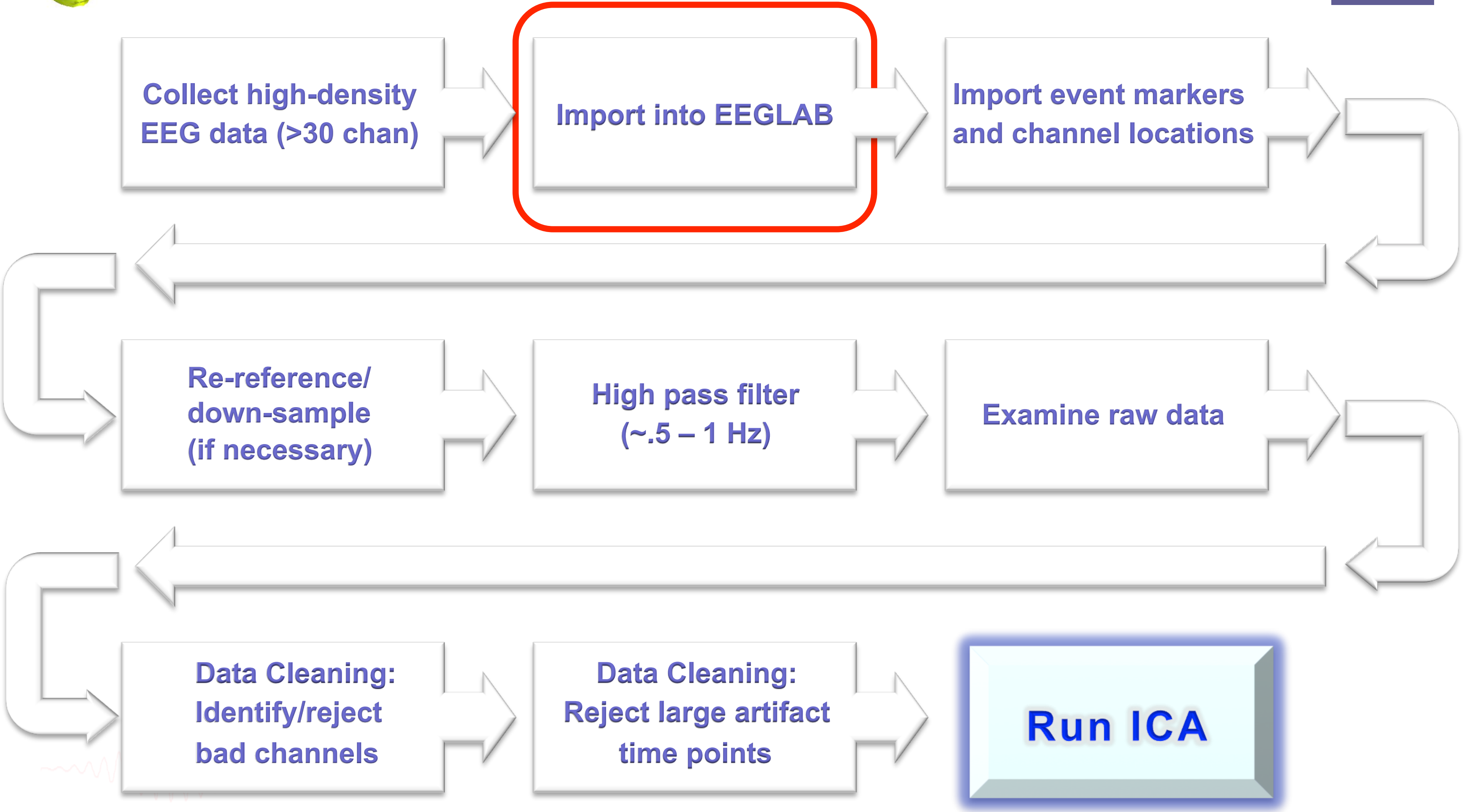


Swartz Center for Computational Neuroscience

- Collect high-density EEG data (>30 chan)
- Import into EEGLAB
- Import event markers and channel locations
- Re-reference/ down-sample (if necessary)
- High pass filter (~.5 – 1 Hz)
- Examine raw data
- Data Cleaning: Identify/reject bad channels
- Data Cleaning: Reject large artifact time points
- **Run ICA**

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

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High pass filter (~.5 – 1 Hz)

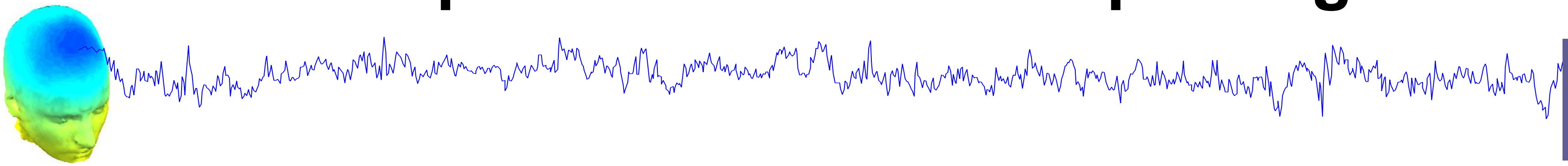
Examine raw data

Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

Run ICA

Sample data: basic P300 paradigm



File

SimpleOddball.set

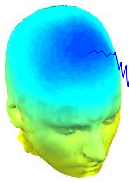
Data

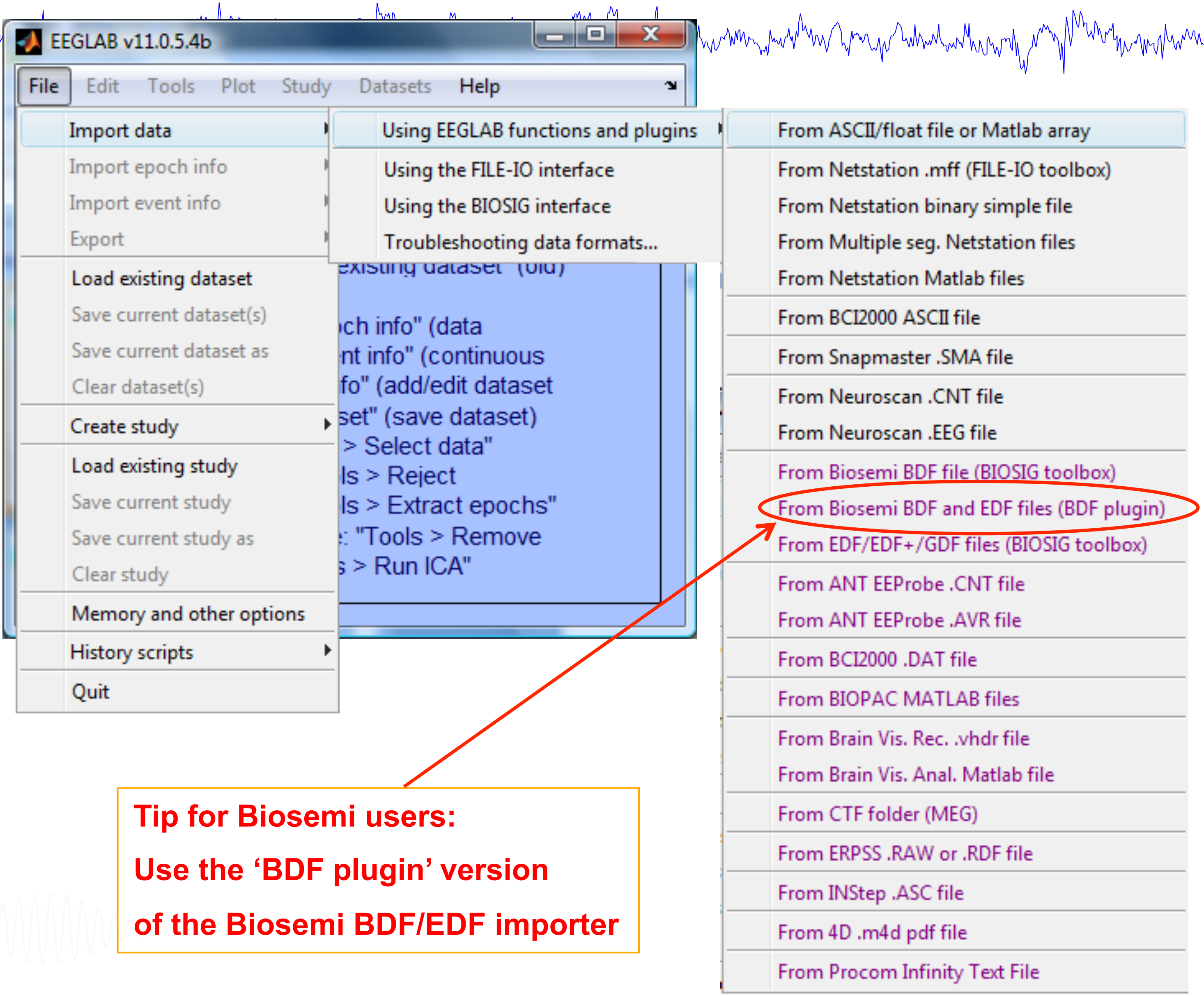
64 channel EEG, 256 Hz sampling rate, Biosemi system, re-referenced during import to averaged left and right mastoid electrodes

Task

speeded button press response to star shape (no response to circle shape), 100 ms presentation duration, 200 trials

Importing a dataset



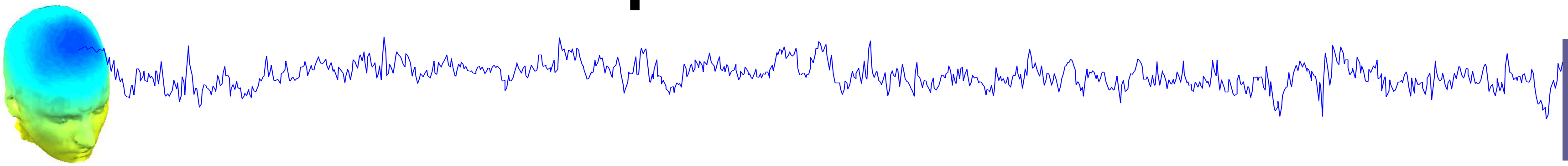

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study
Memory and other options
History scripts
Quit
Using EEGLAB functions and plugins
Using the FILE-IO interface
Using the BIOSIG interface
Troubleshooting data formats...
From ASCII/float file or Matlab array
From Netstation .mff (FILE-IO toolbox)
From Netstation binary simple file
From Multiple seg. Netstation files
From Netstation Matlab files
From BCI2000 ASCII file
From Snapmaster .SMA file
From Neuroscan .CNT file
From Neuroscan .EEG file
From Biosemi BDF file (BIOSIG toolbox)
From Biosemi BDF and EDF files (BDF plugin)
From EDF/EDF+/GDF files (BIOSIG toolbox)
From ANT EEProbe .CNT file
From ANT EEProbe .AVR file
From BCI2000 .DAT file
From BIOPAC MATLAB files
From Brain Vis. Rec. .vhdr file
From Brain Vis. Anal. Matlab file
From CTF folder (MEG)
From ERPSS .RAW or .RDF file
From INStep .ASC file
From 4D .m4d pdf file
From Procom Infinity Text File
existing dataset" (old)
ch info" (data
nt info" (continuous
fo" (add/edit dataset
set" (save dataset)
> Select data"
ls > Reject
ls > Extract epochs"
: "Tools > Remove
s > Run ICA"

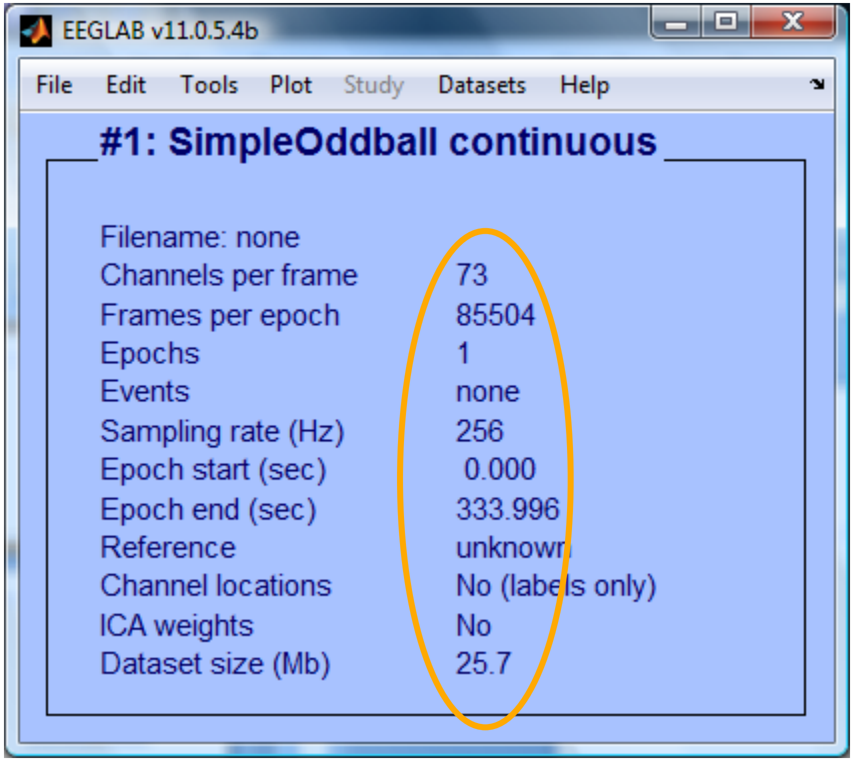
Tip for Biosemi users:

Use the 'BDF plugin' version

of the Biosemi BDF/EDF importer

Imported EEG data



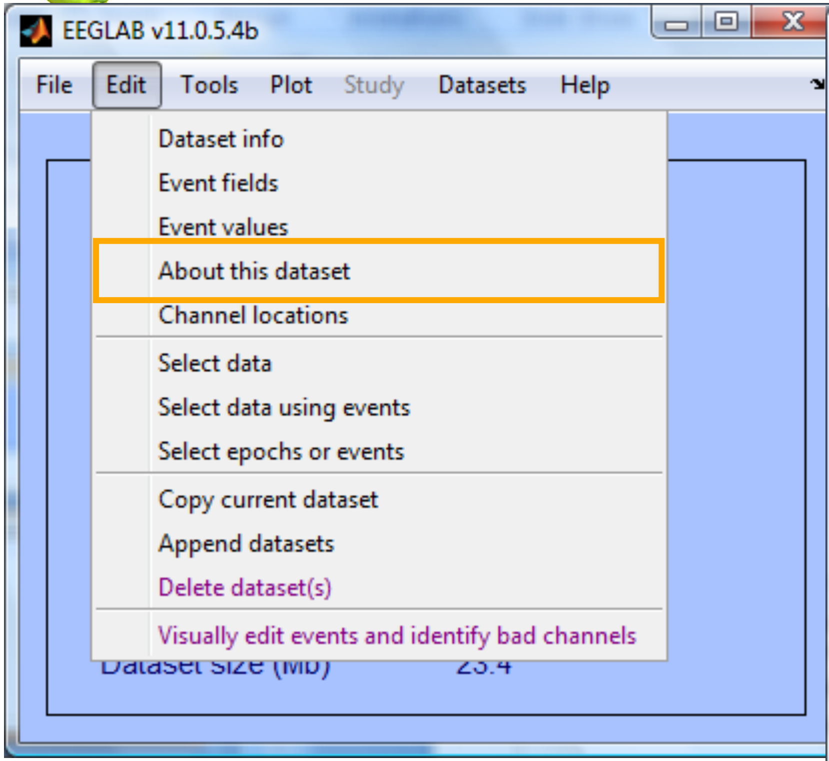

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help

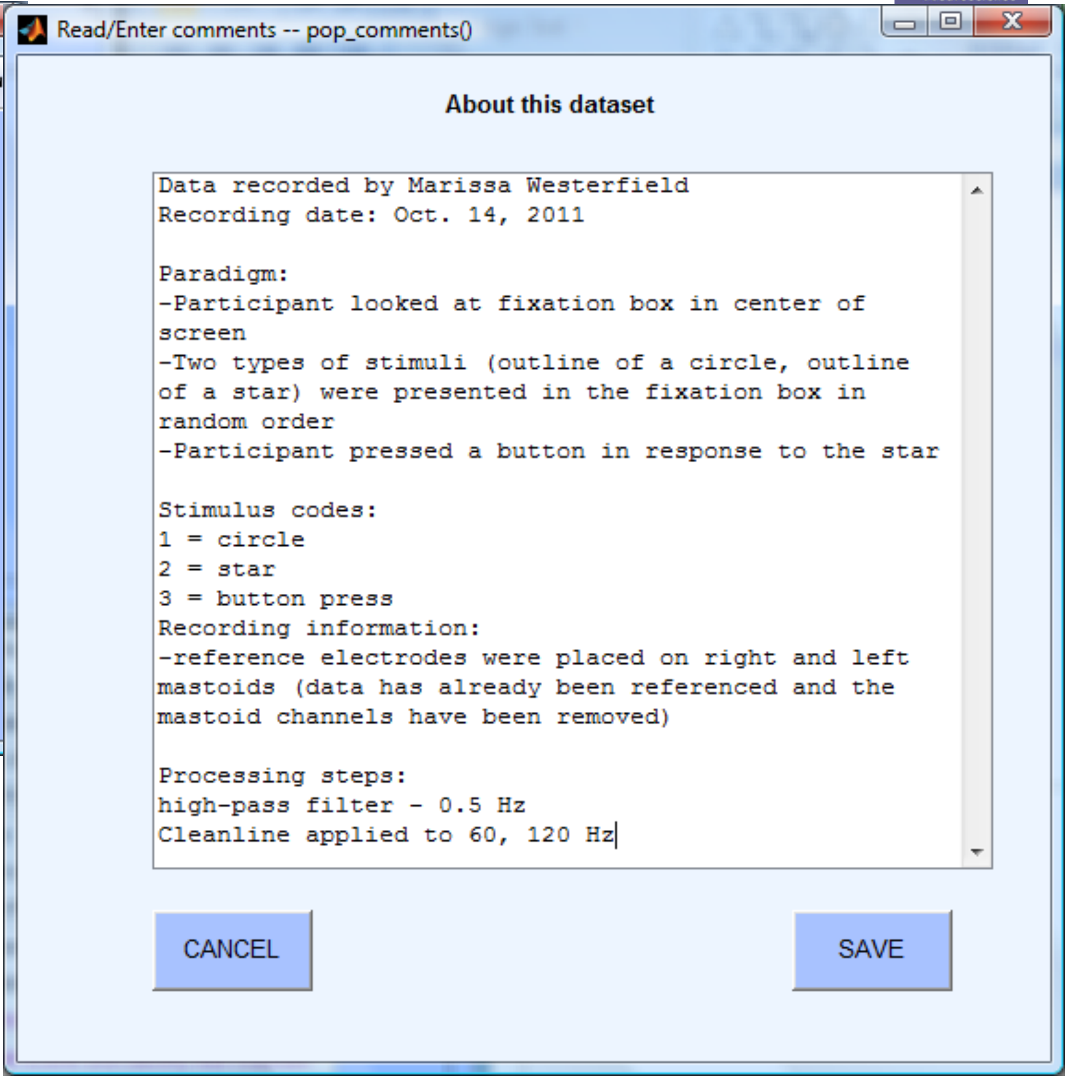
#1: SimpleOddball continuous

Filename: none

Channels per frame	73
Frames per epoch	85504
Epochs	1
Events	none
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	unknown
Channel locations	No (labels only)
ICA weights	No
Dataset size (Mb)	25.7

Comments and dataset history


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)
Visually edit events and identify bad channels
Dataset size (Mb)
23.4


Read/Enter comments -- pop_comments()
CANCEL
SAVE

About this dataset

Data recorded by Marissa Westerfield
Recording date: Oct. 14, 2011

Paradigm:
- Participant looked at fixation box in center of screen
- Two types of stimuli (outline of a circle, outline of a star) were presented in the fixation box in random order
- Participant pressed a button in response to the star

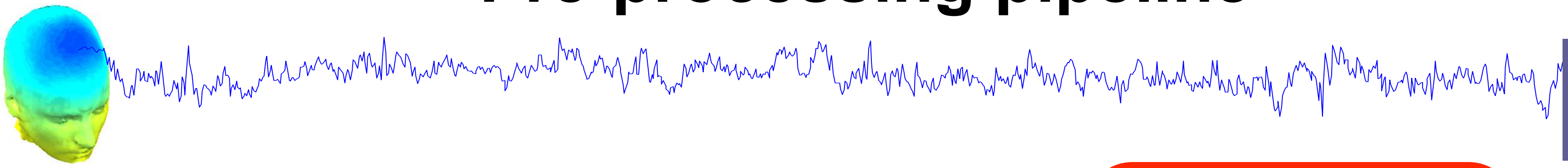
Stimulus codes:
1 = circle
2 = star
3 = button press
Recording information:
- reference electrodes were placed on right and left mastoids (data has already been referenced and the mastoid channels have been removed)

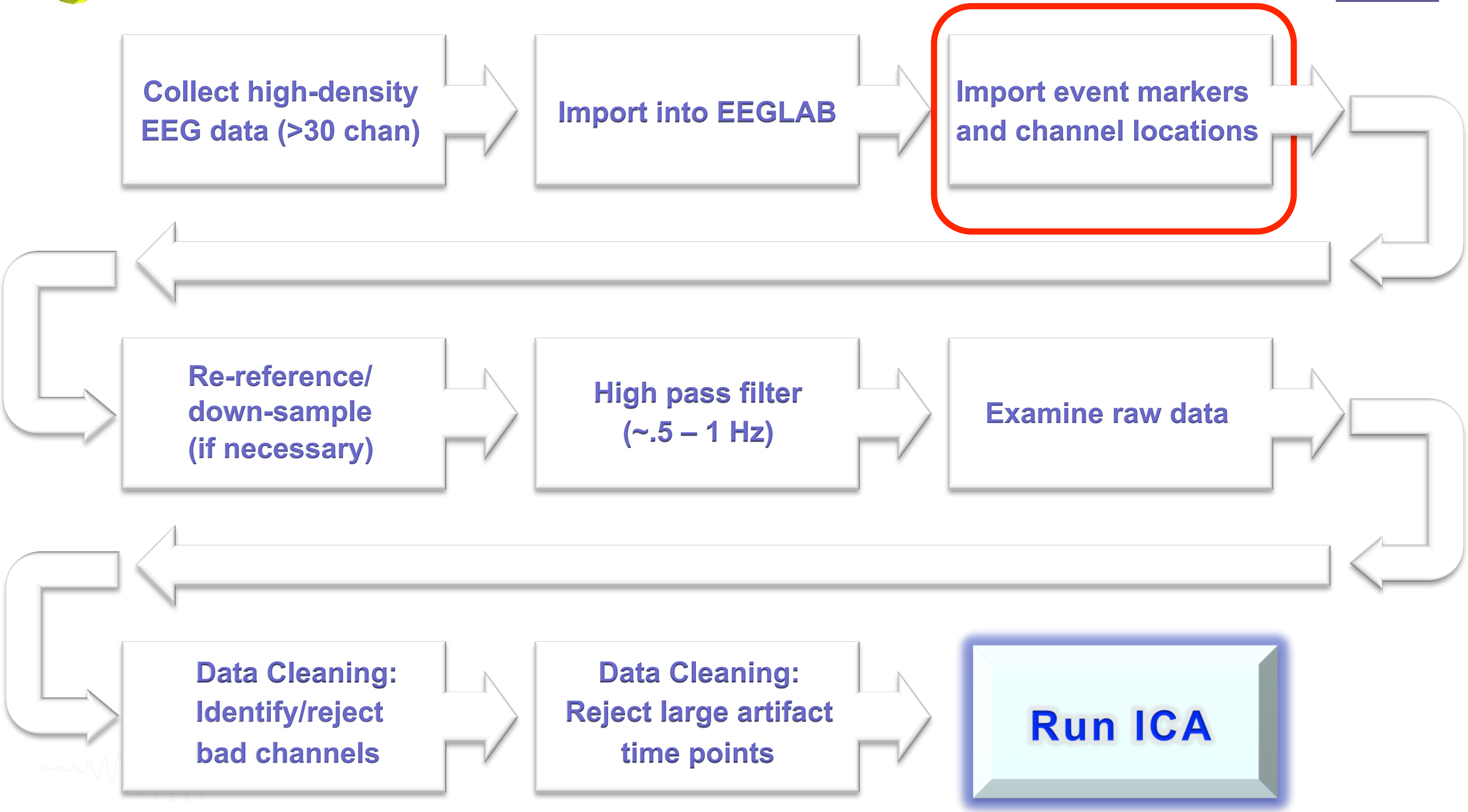
Processing steps:
high-pass filter - 0.5 Hz
Cleanline applied to 60, 120 Hz

Also:
`>> EEG.comments`

and
`>> EEG.history`

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

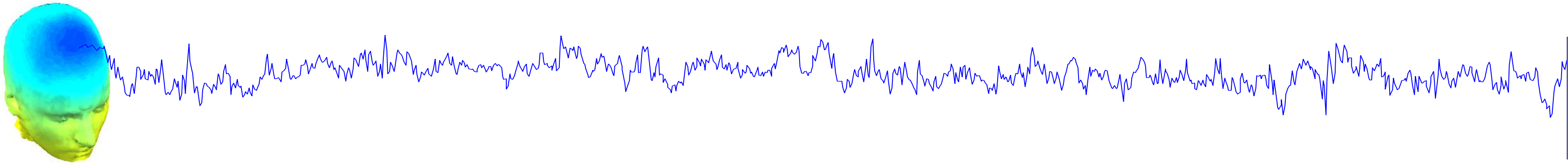
Examine raw data

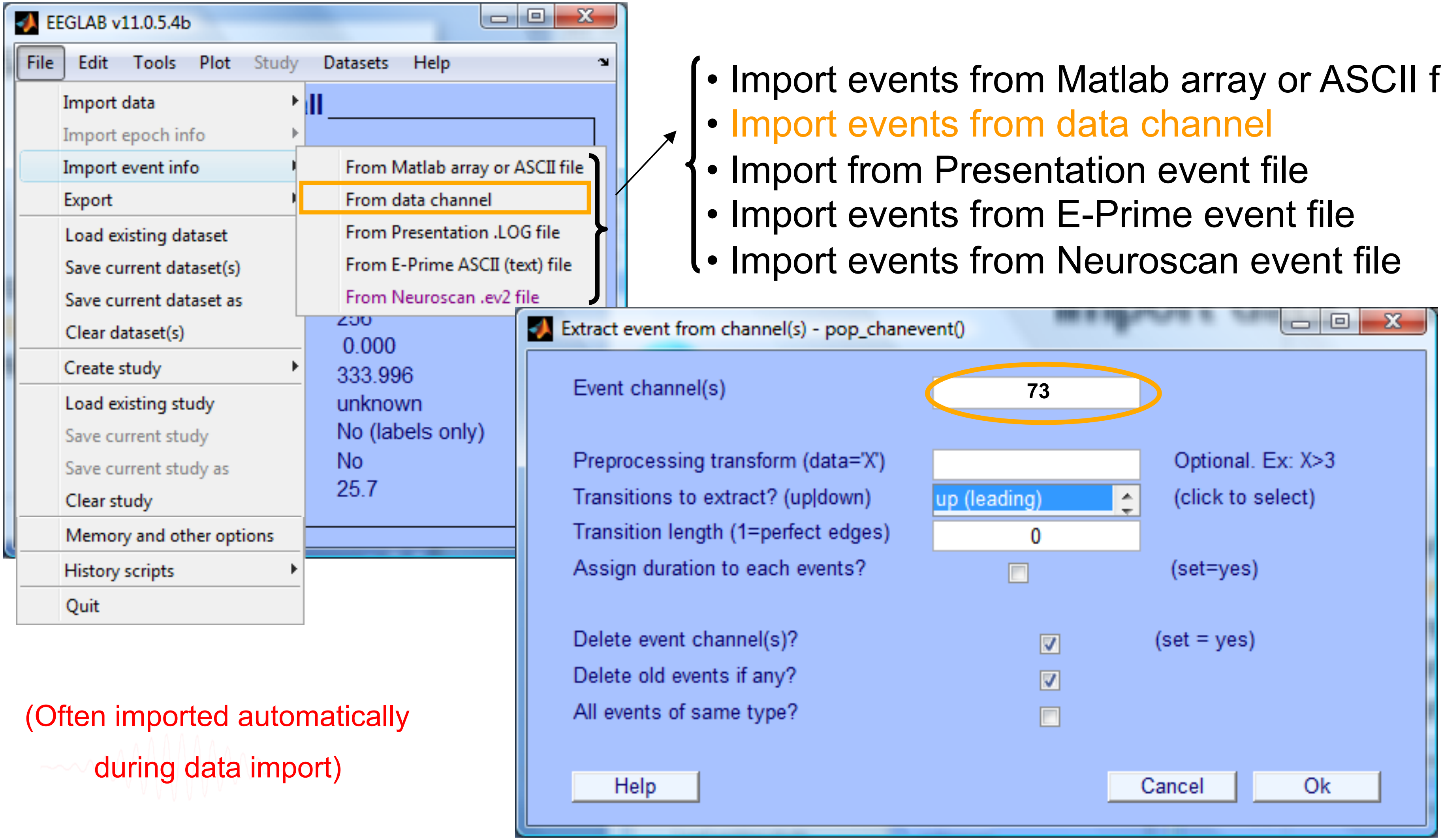
Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

Run ICA

Import data events




EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study
Memory and other options
History scripts
Quit
From Matlab array or ASCII file
From data channel
From Presentation .LOG file
From E-Prime ASCII (text) file
From Neuroscan .ev2 file
256
0.000
333.996
unknown
No (labels only)
No
25.7
Help
Cancel
Ok

- Import events from Matlab array or ASCII file
- Import events from data channel
- Import from Presentation event file
- Import events from E-Prime event file
- Import events from Neuroscan event file

Extract event from channel(s) - pop_chanevent()

Event channel(s): 73

Preprocessing transform (data='X'): Optional. Ex: X>3

Transitions to extract? (up|down): up (leading) (click to select)

Transition length (1=perfect edges): 0

Assign duration to each events? ☐ (set=yes)

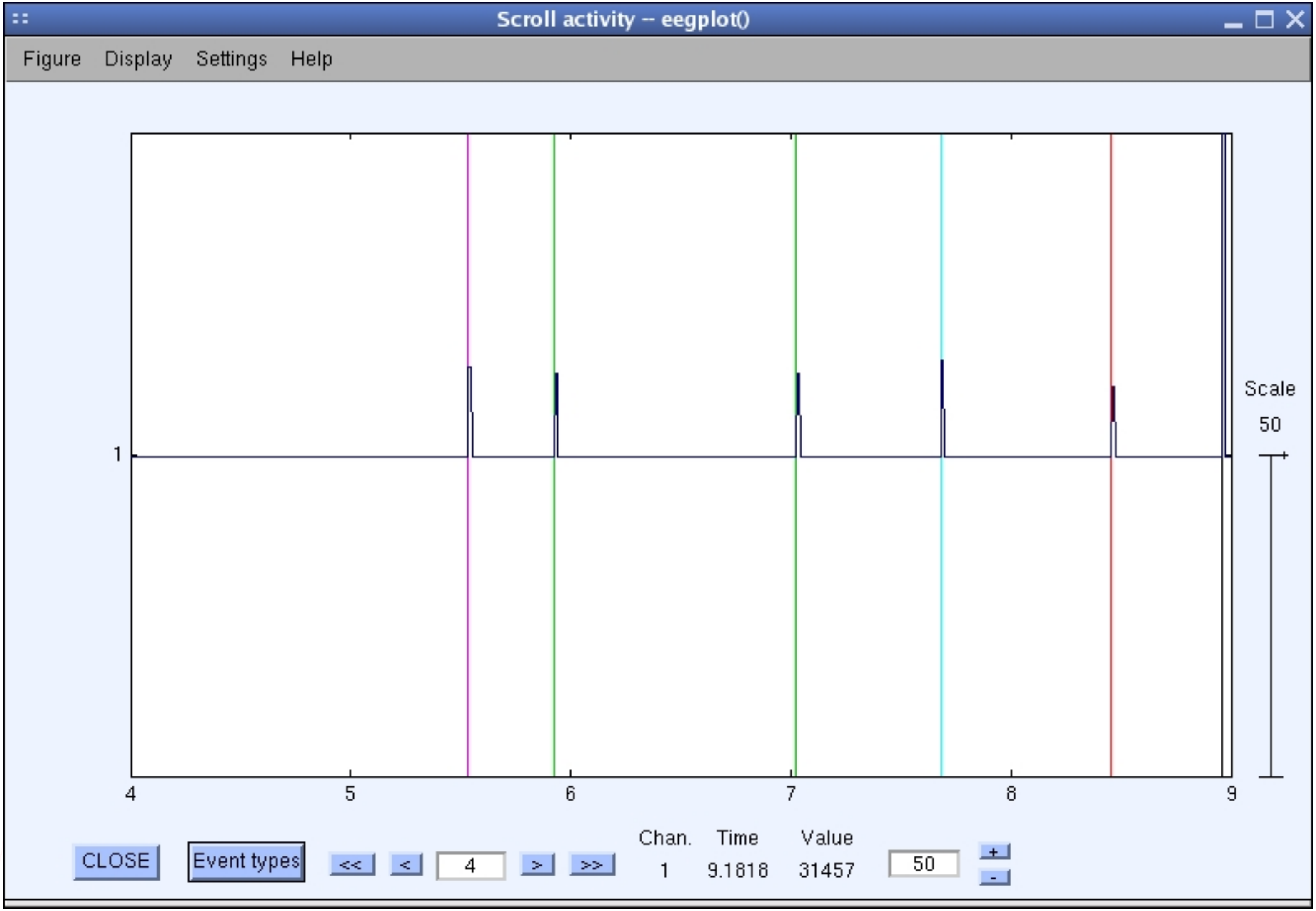
Delete event channel(s)? ☑ (set = yes)

Delete old events if any? ☑

All events of same type? ☐

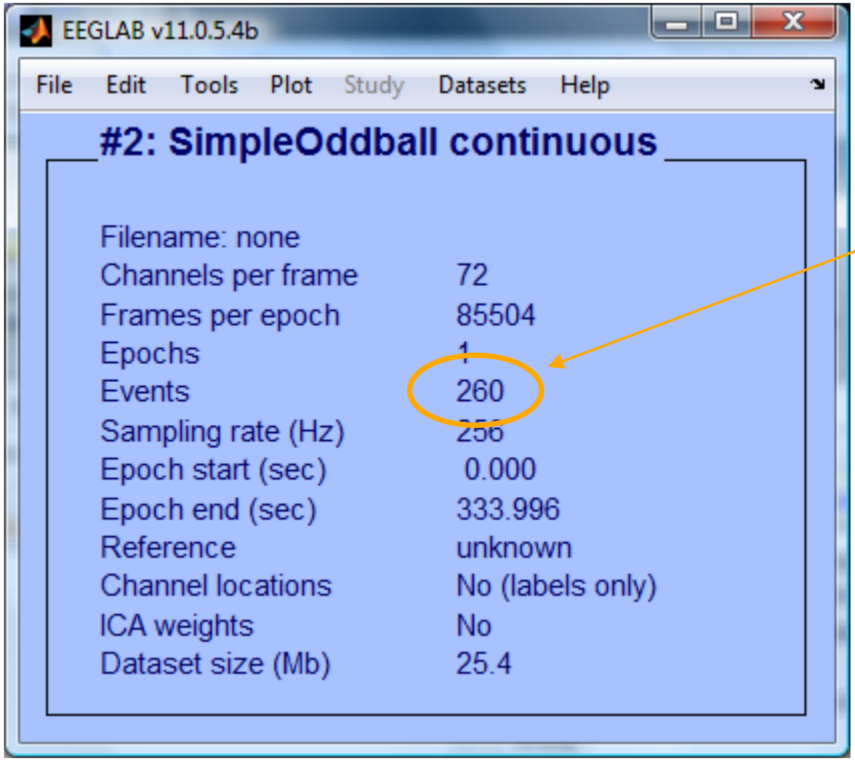
(Often imported automatically during data import)

Appearance of an event channel in raw data


Scroll activity -- eegplot()
Figure
Display
Settings
Help
1
4
5
6
7
8
9
Scale
50
CLOSE
Event types
<<
<
4
>
>>
50
+
-

Chan. Time Value
1 9.1818 31457

Imported data events


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help

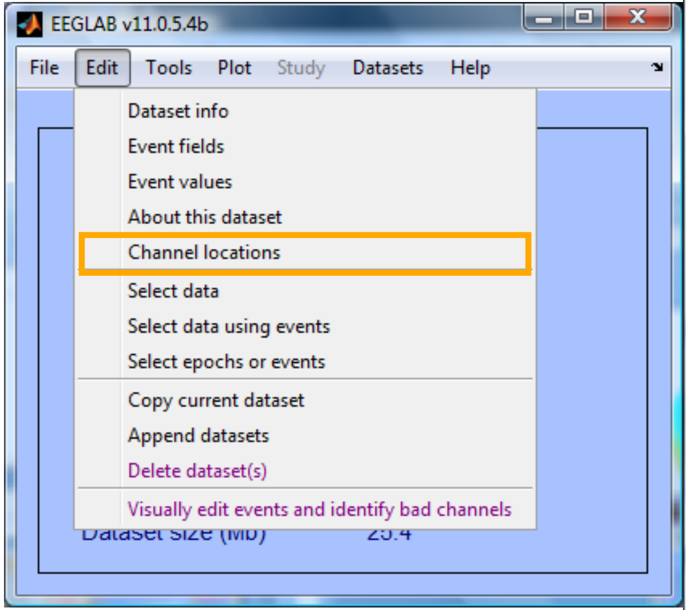
#2: SimpleOddball continuous

Filename: none

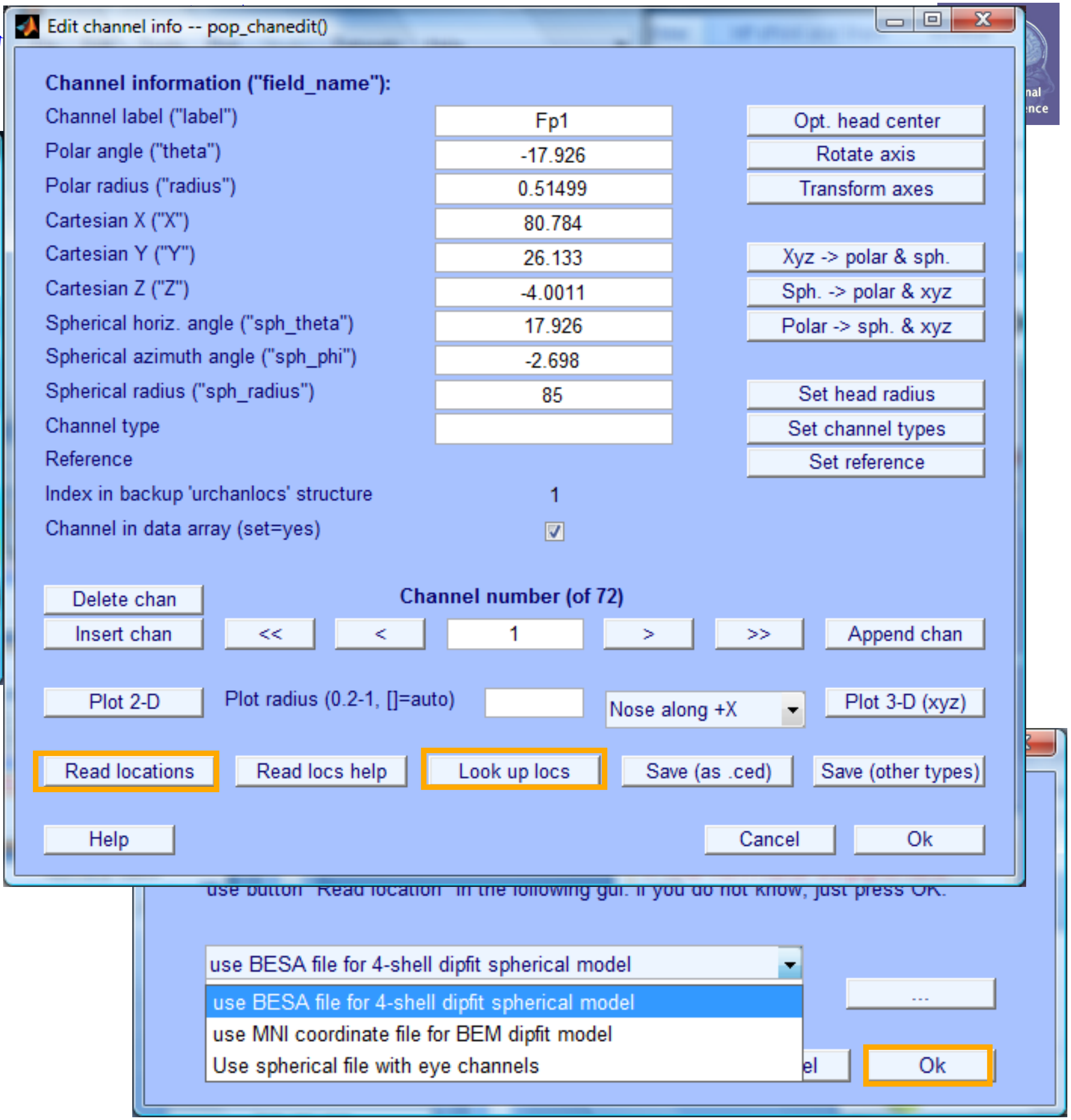
Channels per frame	72
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	unknown
Channel locations	No (labels only)
ICA weights	No
Dataset size (Mb)	25.4

If event import was successful, you will see an appropriate number here

Import channel locations


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)
Visually edit events and identify bad channels
Dataset size (Mb)
25.4

7 file formats supported (Polhemus, BESA, …)


Edit channel info -- pop_chanedit()
Opt. head center
Rotate axis
Transform axes
Xyz -> polar & sph.
Sph. -> polar & xyz
Polar -> sph. & xyz
Set head radius
Set channel types
Set reference
Delete chan
Insert chan
<<
<
>
>>
Append chan
Plot 2-D
Plot 3-D (xyz)
Read locations
Read locs help
Look up locs
Save (as .ced)
Save (other types)
Help
Cancel
Ok
...
el
Ok

Channel information ("field_name"):

Channel label ("label")	Fp1
Polar angle ("theta")	-17.926
Polar radius ("radius")	0.51499
Cartesian X ("X")	80.784
Cartesian Y ("Y")	26.133
Cartesian Z ("Z")	-4.0011
Spherical horiz. angle ("sph_theta")	17.926
Spherical azimuth angle ("sph_phi")	-2.698
Spherical radius ("sph_radius")	85
Channel type	
Reference	
Index in backup 'urchanlocs' structure	1
Channel in data array (set=yes)	☑

Channel number (of 72) 1

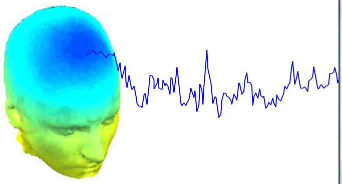
Plot radius (0.2-1, []=auto)

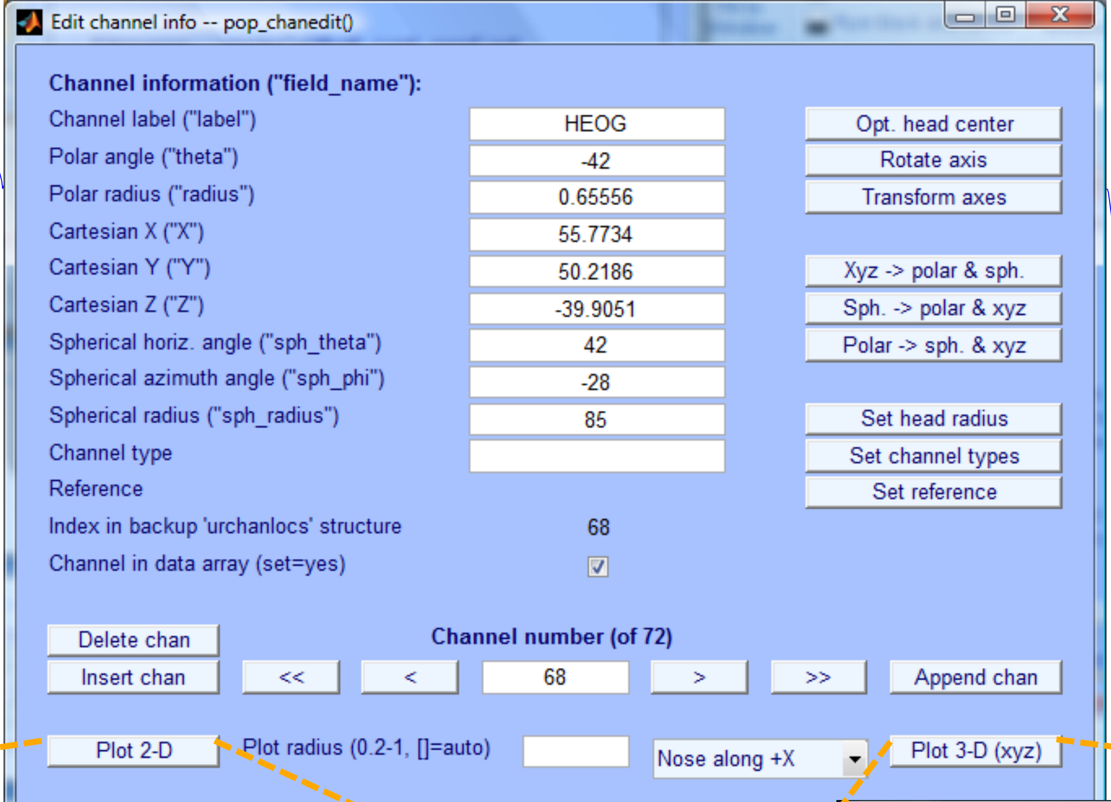
Nose along +X

use button "Read location" in the following gui. If you do not know, just press OK.

use BESA file for 4-shell dipfit spherical model

- use BESA file for 4-shell dipfit spherical model
- use MNI coordinate file for BEM dipfit model
- Use spherical file with eye channels





Edit channel info -- pop_chanedit()

Channel information ("field_name"):

Channel label ("label")	HEOG
Polar angle ("theta")	-42
Polar radius ("radius")	0.65556
Cartesian X ("X")	55.7734
Cartesian Y ("Y")	50.2186
Cartesian Z ("Z")	-39.9051
Spherical horiz. angle ("sph_theta")	42
Spherical azimuth angle ("sph_phi")	-28
Spherical radius ("sph_radius")	85
Channel type	
Reference	
Index in backup 'urchanlocs' structure	68
Channel in data array (set=yes)	☑

Channel number (of 72): 68

Plot radius (0.2-1, []=auto):

Nose along +X

Opt. head center
Rotate axis
Transform axes
Xyz -> polar & sph.
Sph. -> polar & xyz
Polar -> sph. & xyz
Set head radius
Set channel types
Set reference
Delete chan
Insert chan
<<
<
>
>>
Append chan
Plot 2-D
Plot 3-D (xyz)
s help
Look up locs
Save (as .ced)
Can

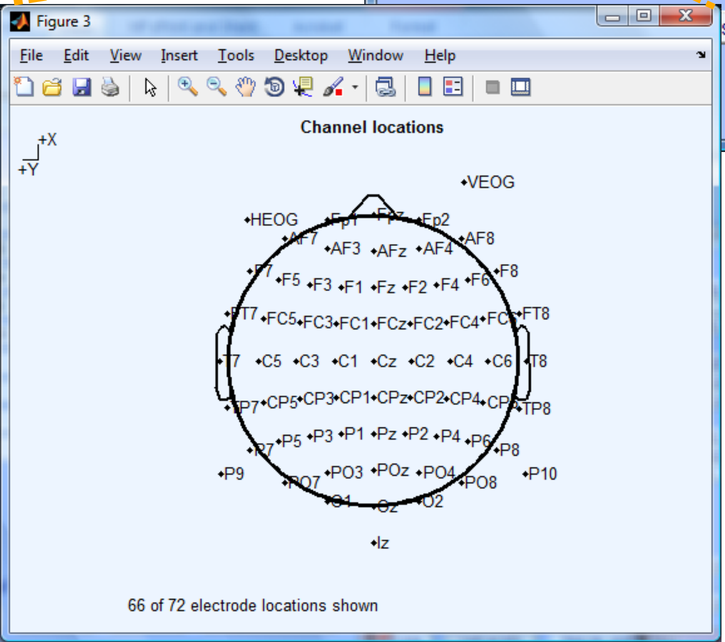


Figure 3
File Edit View Insert Tools Desktop Window Help
Channel locations
+X
+Y
VEOG
HEOG
Fp1
Fpz
Fp2
AF7
AF3
AFz
AF4
AF8
F7
F5
F3
F1
Fz
F2
F4
F6
F8
FT7
FC5
FC3
FC1
FCz
FC2
FC4
FC6
FT8
T7
C5
C3
C1
Cz
C2
C4
C6
T8
TP7
CP5
CP3
CP1
CPz
CP2
CP4
CP6
TP8
P7
P5
P3
P1
Pz
P2
P4
P6
P8
P9
PO7
PO3
POz
PO4
PO8
P10
O1
Oz
O2
Iz

66 of 72 electrode locations shown

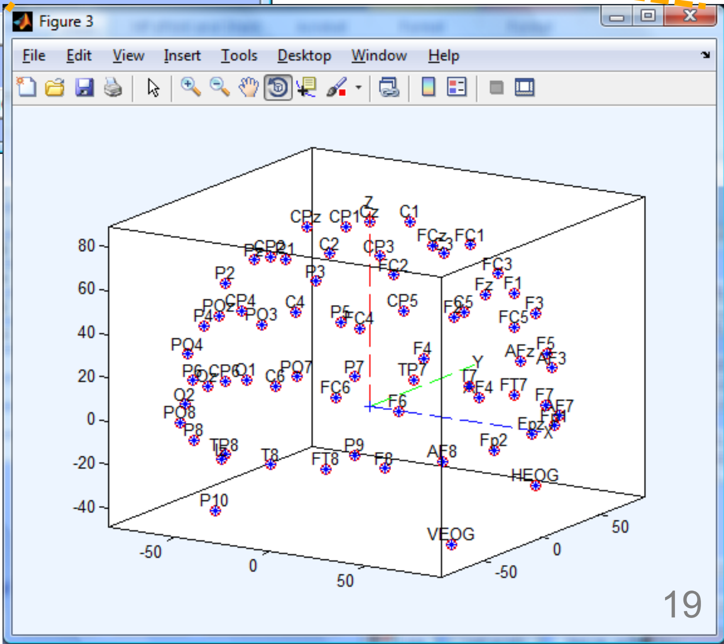
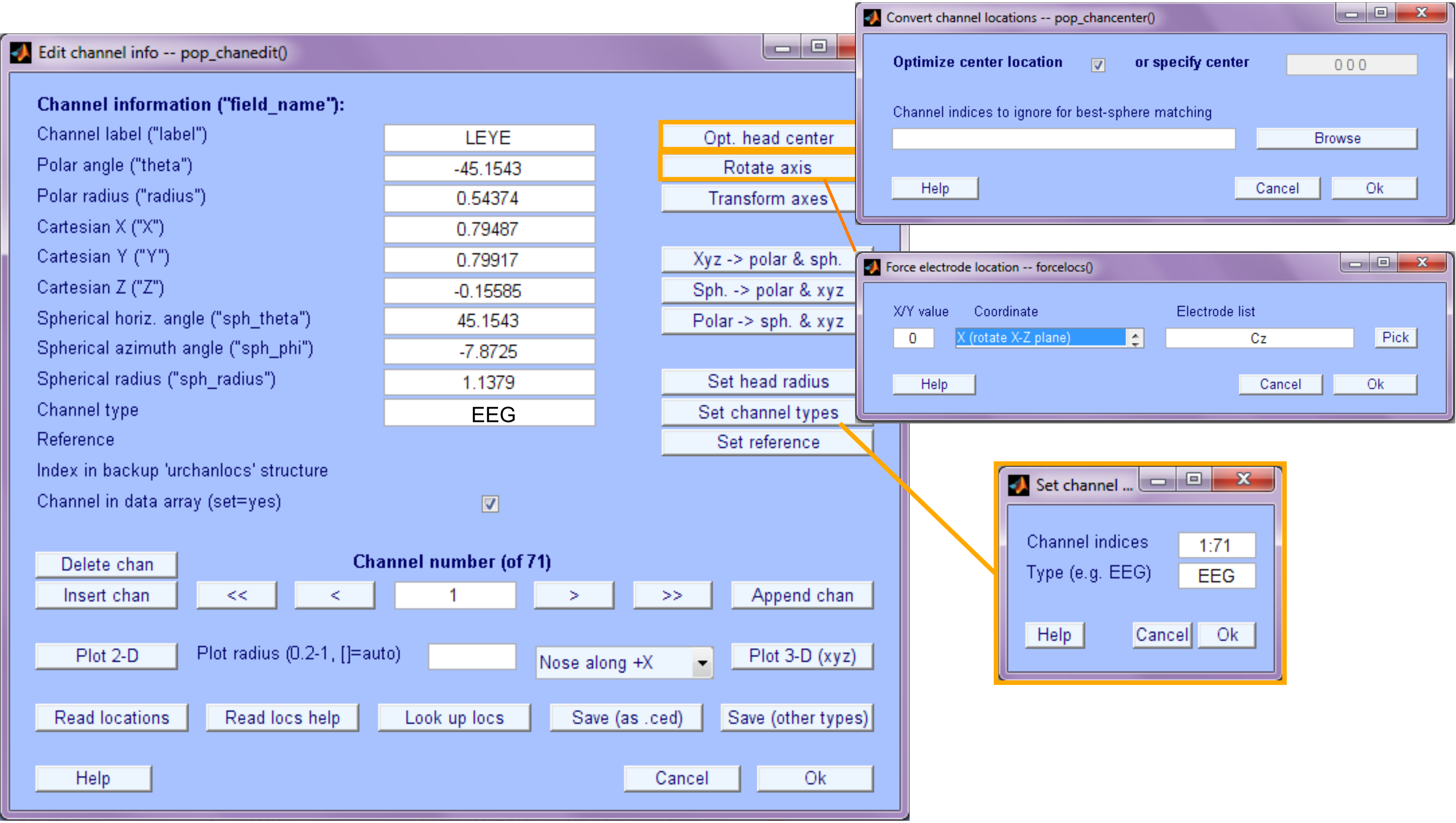


Figure 3
File Edit View Insert Tools Desktop Window Help
80
60
40
20
0
-20
-40
-50
0
50
50
0
-50
Z
Y
X
HEOG
VEOG
P10

Import channel locations



Edit channel info -- pop_chanedit()

Channel information ("field_name"):

Channel label ("label")	LEYE
Polar angle ("theta")	-45.1543
Polar radius ("radius")	0.54374
Cartesian X ("X")	0.79487
Cartesian Y ("Y")	0.79917
Cartesian Z ("Z")	-0.15585
Spherical horiz. angle ("sph_theta")	45.1543
Spherical azimuth angle ("sph_phi")	-7.8725
Spherical radius ("sph_radius")	1.1379
Channel type	EEG
Reference	
Index in backup 'urchanlocs' structure	
Channel in data array (set=yes)	☑

Channel number (of 71): 1

Plot radius (0.2-1, []=auto)

Nose along +X

Convert channel locations -- pop_chancenter()

Optimize center location ☑ or specify center 0 0 0

Channel indices to ignore for best-sphere matching

Force electrode location -- forcelocs()

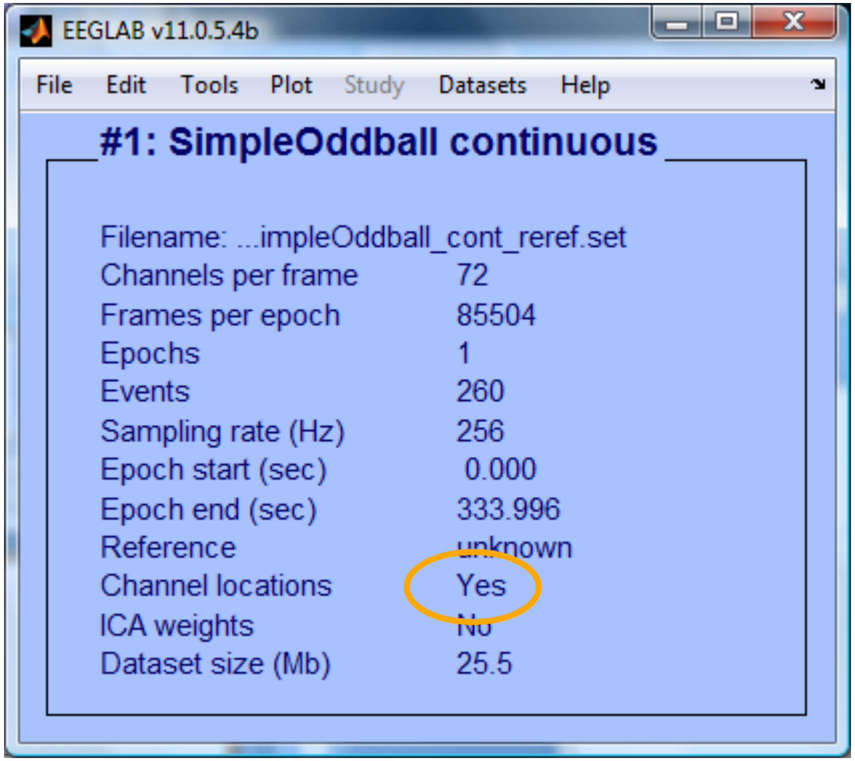
X/Y value	Coordinate	Electrode list
0	X (rotate X-Z plane)	Cz

Set channel ...

Channel indices	1:71
Type (e.g. EEG)	EEG

Opt. head center
Rotate axis
Transform axes
Xyz -> polar & sph.
Sph. -> polar & xyz
Polar -> sph. & xyz
Set head radius
Set channel types
Set reference
Delete chan
Insert chan
<<
<
>
>>
Append chan
Plot 2-D
Plot 3-D (xyz)
Read locations
Read locs help
Look up locs
Save (as .ced)
Save (other types)
Help
Cancel
Ok
Browse
Pick

Imported channel locations

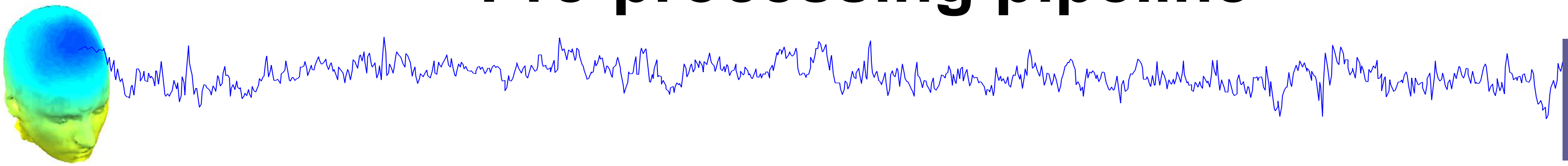

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help

#1: SimpleOddball continuous

Filename: ...impleOddball_cont_reref.set

Channels per frame	72
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	25.5

Pre-processing pipeline



Swartz Center for Computational Neuroscience

Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

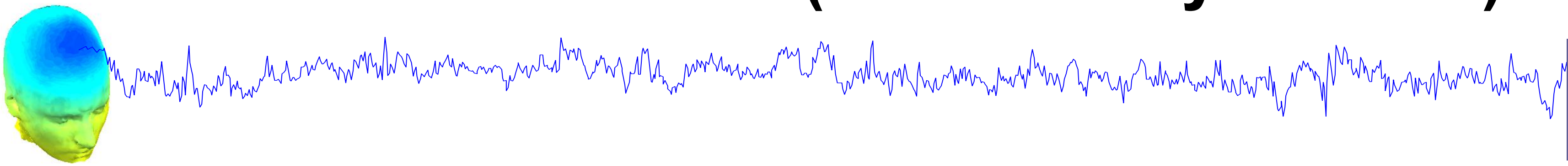
Examine raw data

Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

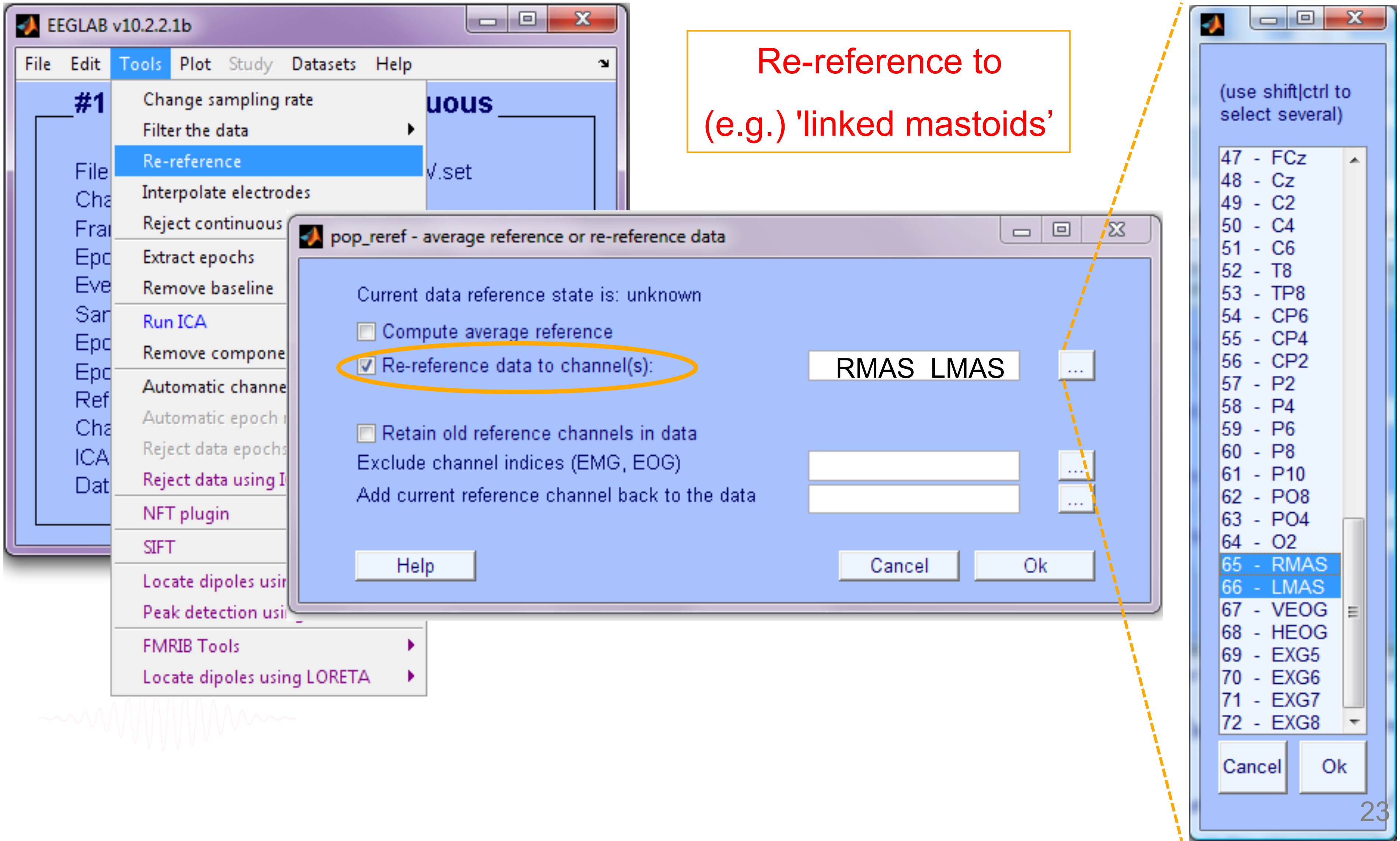
Run ICA

Re-reference data (if necessary/desired)



Re-reference to

(e.g.) 'linked mastoids'


EEGLAB v10.2.2.1b
File
Edit
Tools
Plot
Study
Datasets
Help
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous
Extract epochs
Remove baseline
Run ICA
Remove compone
Automatic channe
Automatic epoch
Reject data epochs
Reject data using I
NFT plugin
SIFT
Locate dipoles usi
Peak detection usi
FMRIB Tools
Locate dipoles using LORETA
#1
uous
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Eve
Sar
Epo
Epo
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Cha
ICA
Dat
.set

pop_reref - average reference or re-reference data

Current data reference state is: unknown

☐ Compute average reference

☑ Re-reference data to channel(s): RMAS LMAS

☐ Retain old reference channels in data

Exclude channel indices (EMG, EOG)

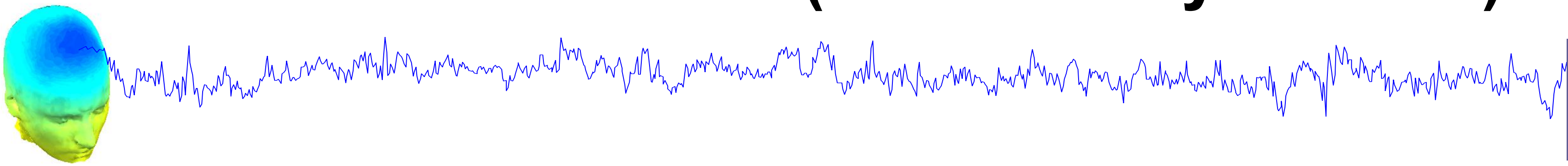
Add current reference channel back to the data

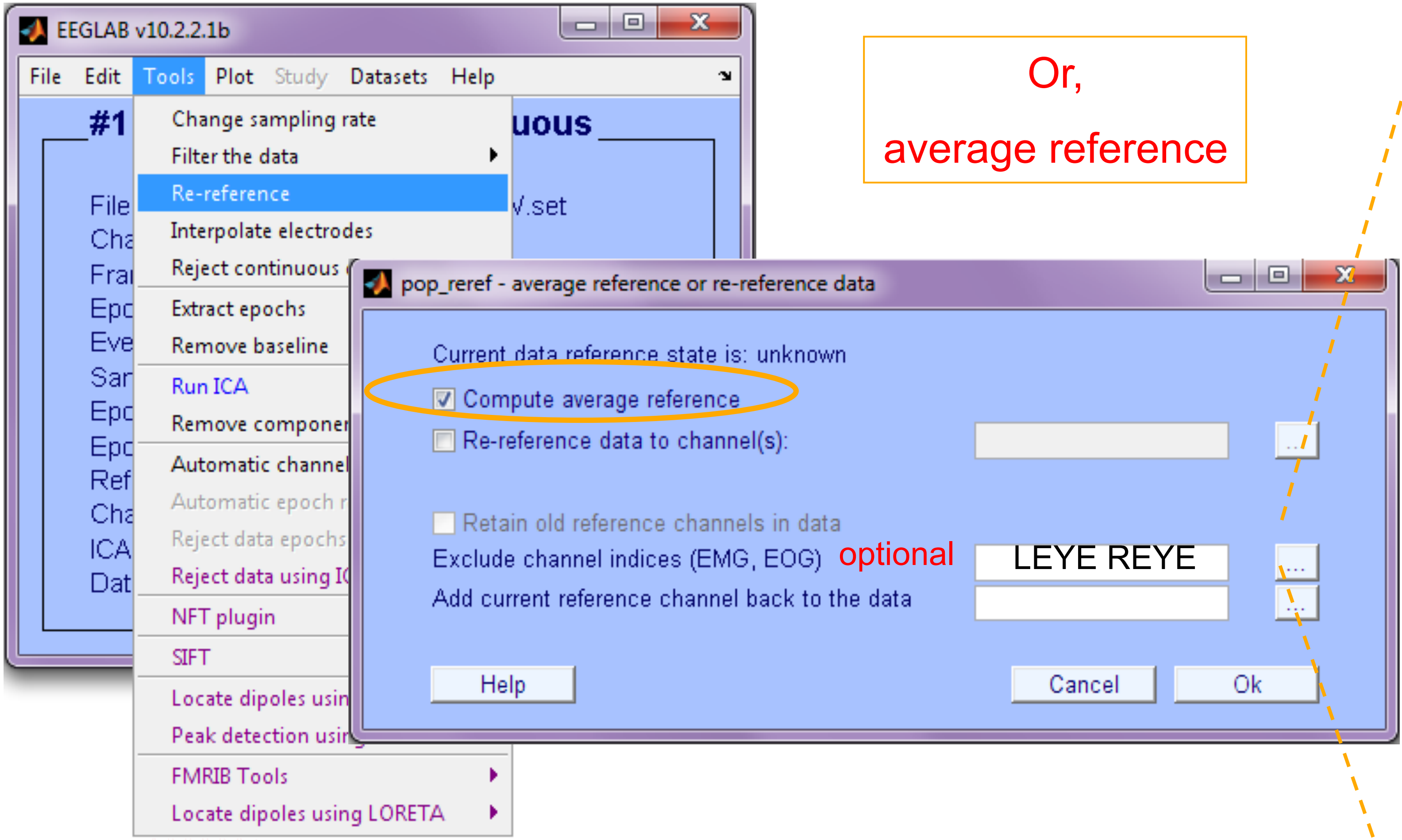
...
Help
Cancel
Ok

(use shift|ctrl to select several)

47 - FCz
48 - Cz
49 - C2
50 - C4
51 - C6
52 - T8
53 - TP8
54 - CP6
55 - CP4
56 - CP2
57 - P2
58 - P4
59 - P6
60 - P8
61 - P10
62 - PO8
63 - PO4
64 - O2
65 - RMAS
66 - LMAS
67 - VEOG
68 - HEOG
69 - EXG5
70 - EXG6
71 - EXG7
72 - EXG8

Re-reference data (if necessary/desired)




EEGLAB v10.2.2.1b
File
Edit
Tools
Plot
Study
Datasets
Help
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous
Extract epochs
Remove baseline
Run ICA
Remove componen
Automatic channel
Automatic epoch r
Reject data epochs
Reject data using I
NFT plugin
SIFT
Locate dipoles usin
Peak detection usi
FMRIB Tools
Locate dipoles using LORETA
#1
uous
File
Cha
Fra
Epc
Eve
Sar
Epc
Epc
Ref
Cha
ICA
Dat
.set
pop_reref - average reference or re-reference data
Help
Cancel
Ok

Current data reference state is: unknown

☑ Compute average reference

☐ Re-reference data to channel(s):

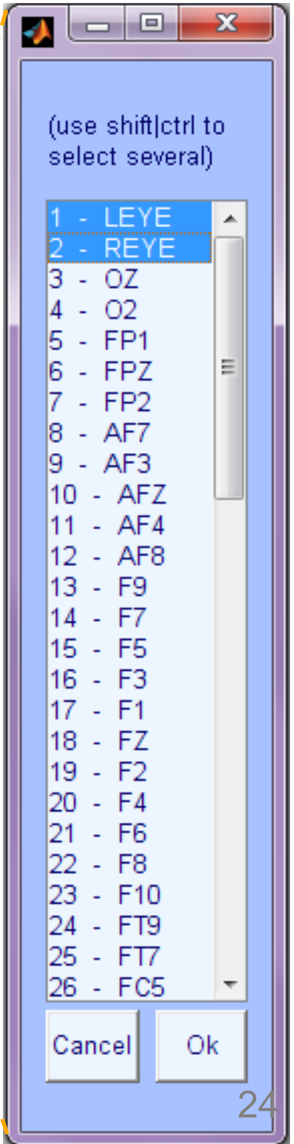
☐ Retain old reference channels in data

Exclude channel indices (EMG, EOG) optional LEYE REYE

Add current reference channel back to the data

Or,

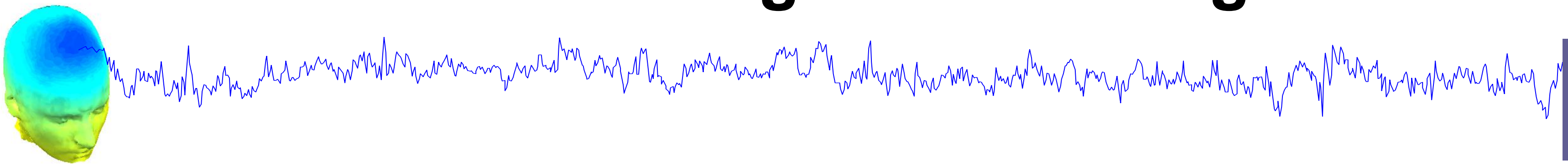
average reference

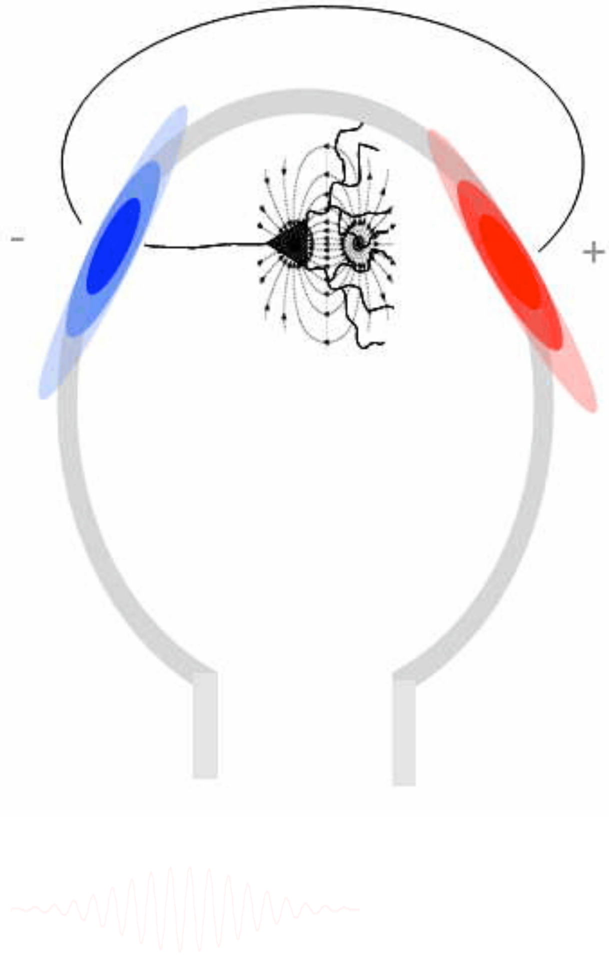


(use shift|ctrl to select several)

1 - LEYE
2 - REYE
3 - OZ
4 - O2
5 - FP1
6 - FPZ
7 - FP2
8 - AF7
9 - AF3
10 - AFZ
11 - AF4
12 - AF8
13 - F9
14 - F7
15 - F5
16 - F3
17 - F1
18 - FZ
19 - F2
20 - F4
21 - F6
22 - F8
23 - F10
24 - FT9
25 - FT7
26 - FC5

On Average Referencing

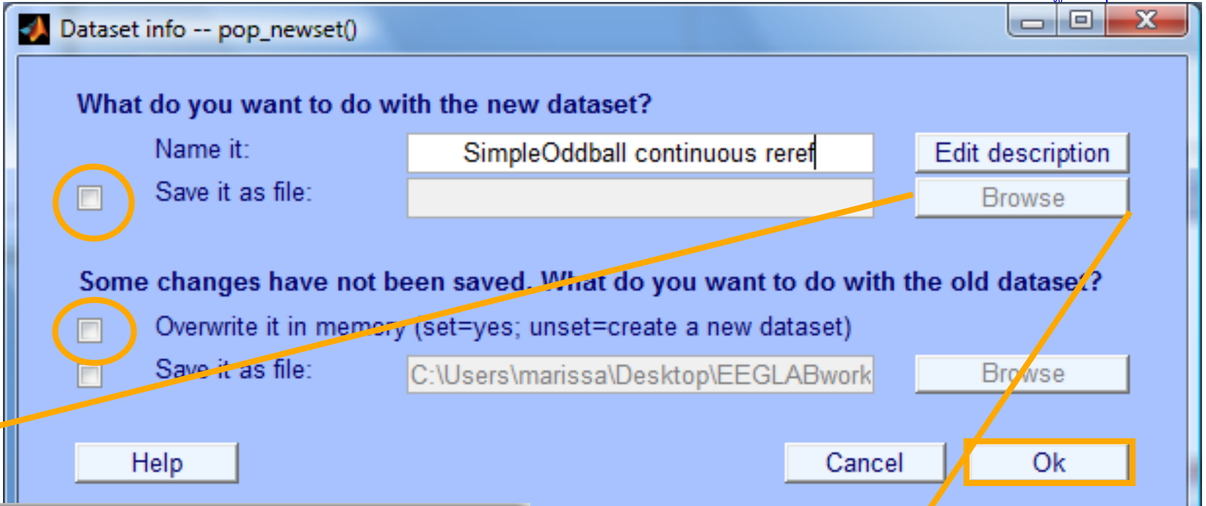




In theory, positive and negative current across entire head should balance—no net current source or sink: Average referencing enforces this.

In practice, depends on distribution of electrodes.

Save new dataset, keep old one



Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it: SimpleOddball continuous reref

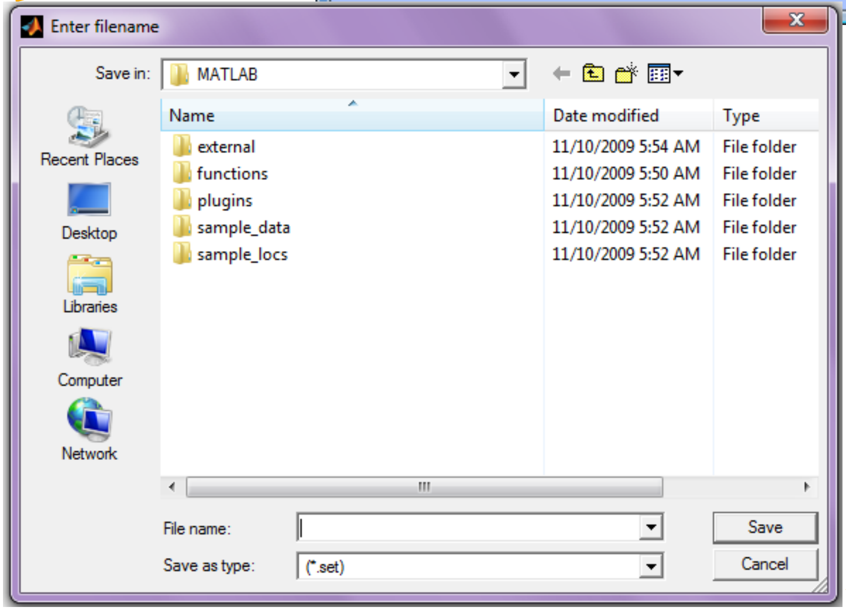
☐ Save it as file:

Some changes have not been saved. What do you want to do with the old dataset?

☐ Overwrite it in memory (set=yes; unset=create a new dataset)

☐ Save it as file: C:\Users\marissa\Desktop\EEGLABwork

Edit description
Browse
Browse
Help
Cancel
Ok



Enter filename

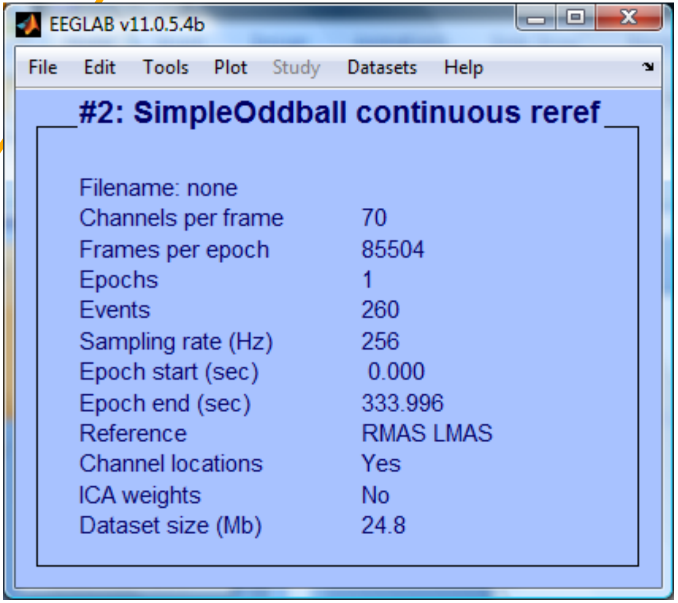
Save in: MATLAB

Name	Date modified	Type
external	11/10/2009 5:54 AM	File folder
functions	11/10/2009 5:50 AM	File folder
plugins	11/10/2009 5:52 AM	File folder
sample_data	11/10/2009 5:52 AM	File folder
sample_locs	11/10/2009 5:52 AM	File folder

File name:

Save as type: (*.set)

Recent Places
Desktop
Libraries
Computer
Network
Save
Cancel



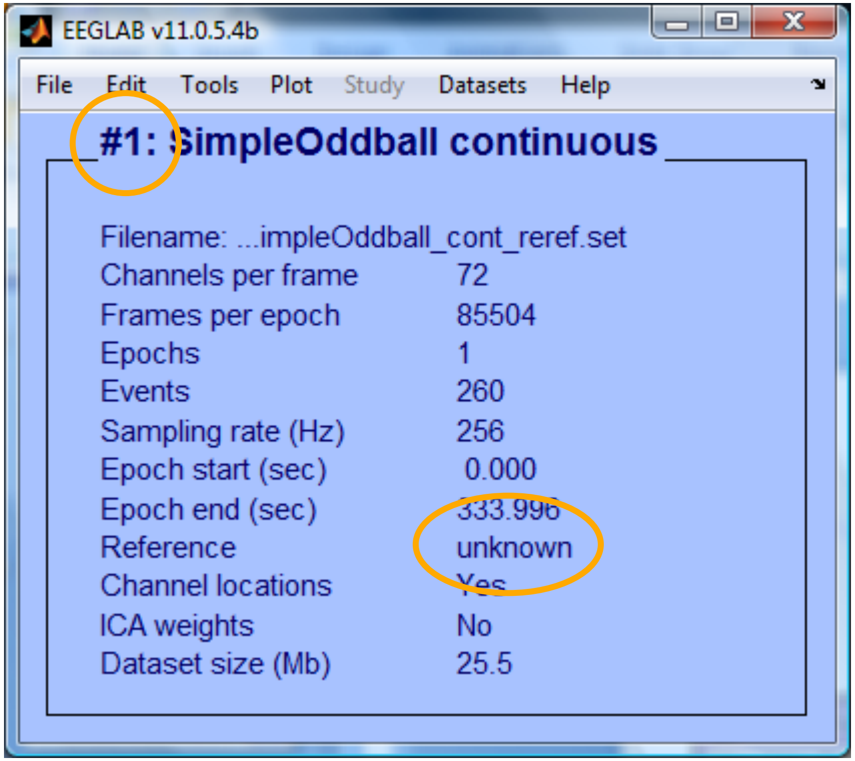
EEGLAB v11.0.5.4b

File
Edit
Tools
Plot
Study
Datasets
Help

#2: SimpleOddball continuous reref

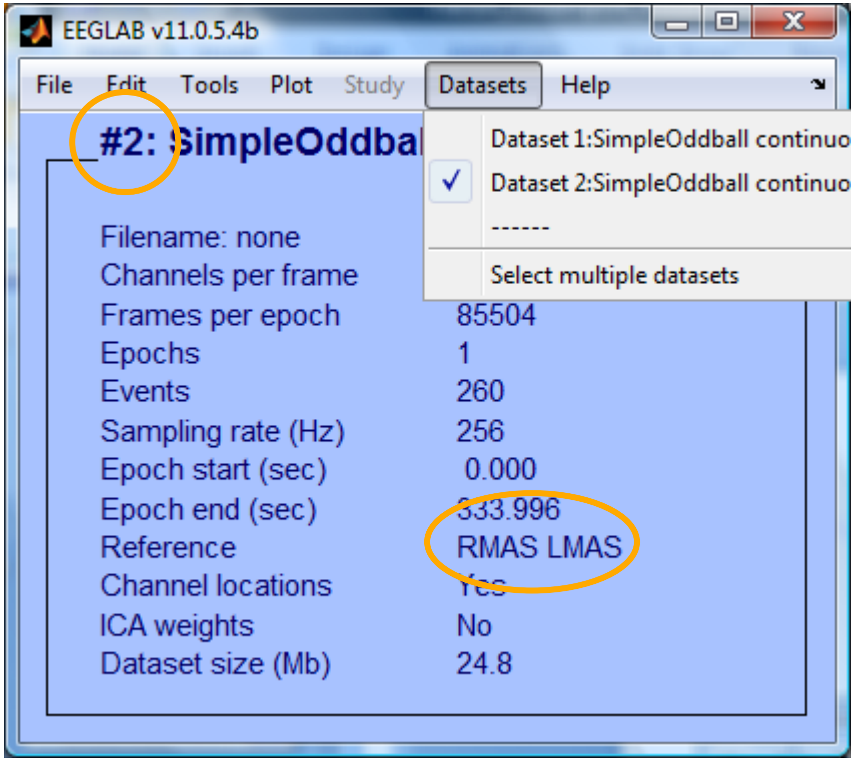
Filename: none	
Channels per frame	70
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	RMAS LMAS
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	24.8

Multiple active datasets (ALLEEG)


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help

#1: SimpleOddball continuous

Filename: ...impleOddball_cont_reref.set	
Channels per frame	72
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	25.5

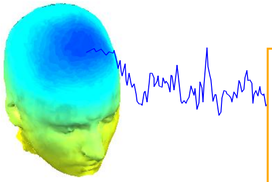

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset 1:SimpleOddball continuo
✓ Dataset 2:SimpleOddball continuo

Select multiple datasets

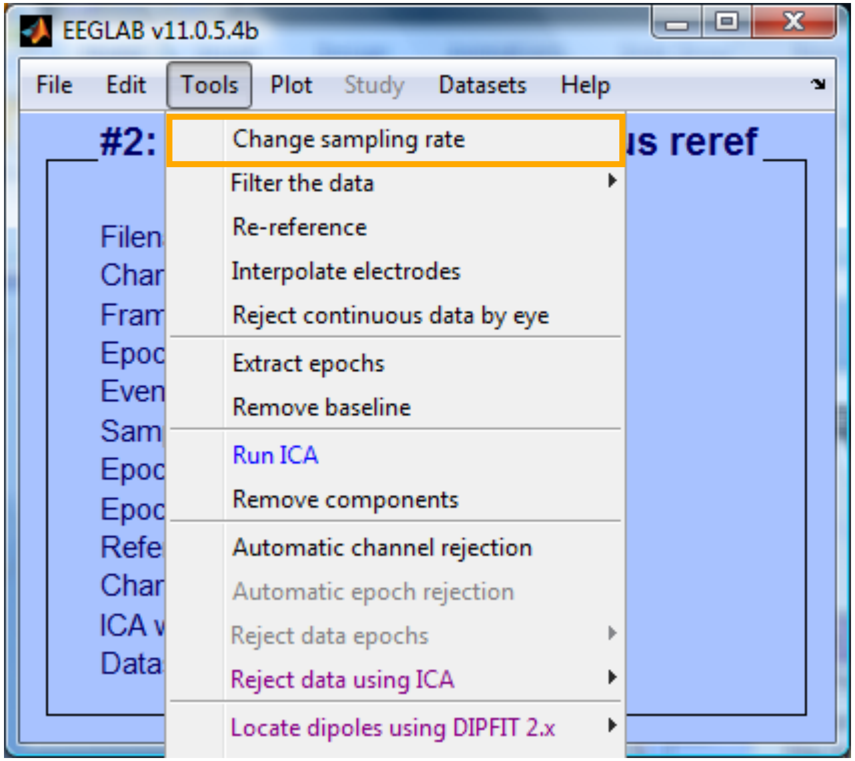
#2: SimpleOddbal

Filename: none	
Channels per frame	
Frames per epoch	85504
Epochs	1
Events	260
Sampling rate (Hz)	256
Epoch start (sec)	0.000
Epoch end (sec)	333.996
Reference	RMAS LMAS
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	24.8

Resample data (if desired)



Reason: Reduce space, time. But keep nyquist and ICA data length requirements in mind…


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#2:
us reref
Filen
Char
Fram
Epoc
Even
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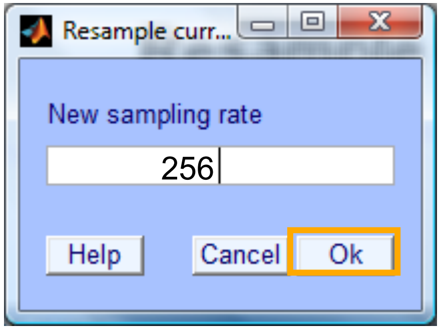
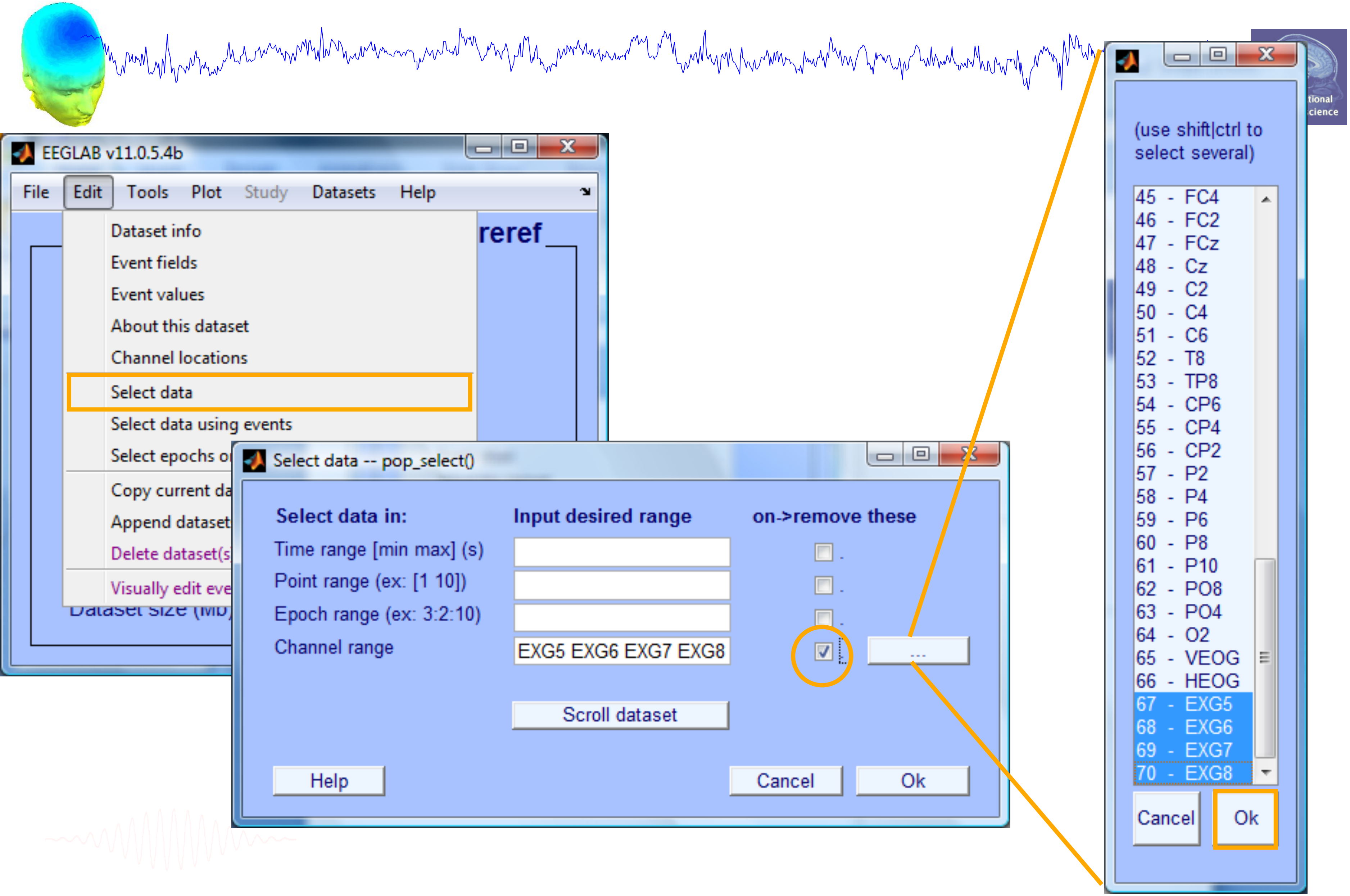
Epoc
Refe
Char
ICA v
Data
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x


Resample curr...
Help
Cancel
Ok

New sampling rate: 256

Remove unwanted channels


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or
Copy current da
Append dataset
Delete dataset(s
Visually edit eve
reref
Dataset size (Mb)
Select data -- pop_select()
Select data in:
Input desired range
on->remove these
Scroll dataset
Help
Cancel
Ok
...
(use shift|ctrl to select several)
Cancel
Ok

Time range [min max] (s): ☐

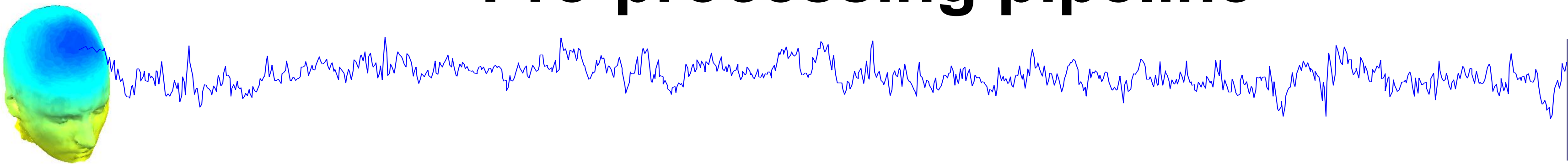
Point range (ex: [1 10]): ☐

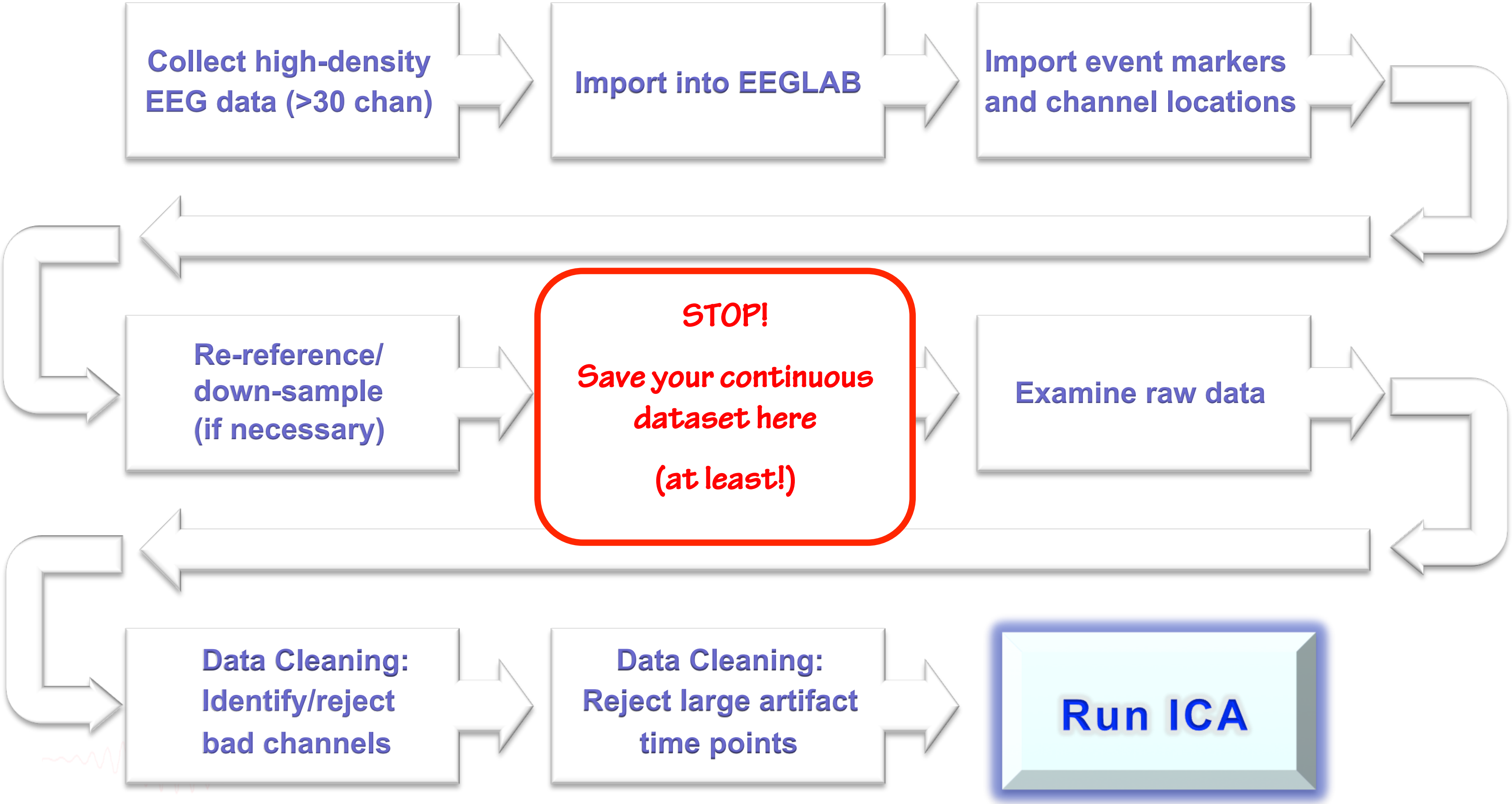
Epoch range (ex: 3:2:10): ☐

Channel range: EXG5 EXG6 EXG7 EXG8 ☑

45 - FC4
46 - FC2
47 - FCz
48 - Cz
49 - C2
50 - C4
51 - C6
52 - T8
53 - TP8
54 - CP6
55 - CP4
56 - CP2
57 - P2
58 - P4
59 - P6
60 - P8
61 - P10
62 - PO8
63 - PO4
64 - O2
65 - VEOG
66 - HEOG
67 - EXG5
68 - EXG6
69 - EXG7
70 - EXG8

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

STOP!

Save your continuous dataset here

(at least!)

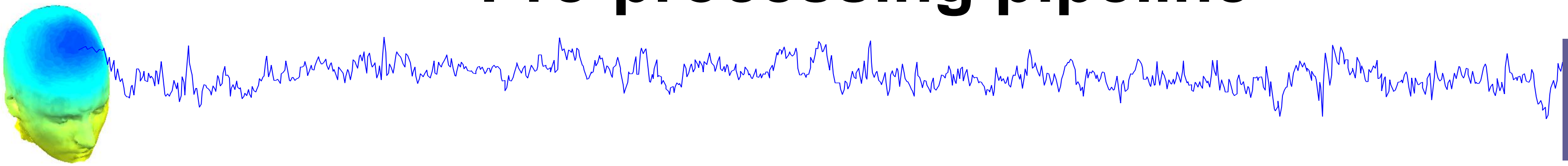
Examine raw data

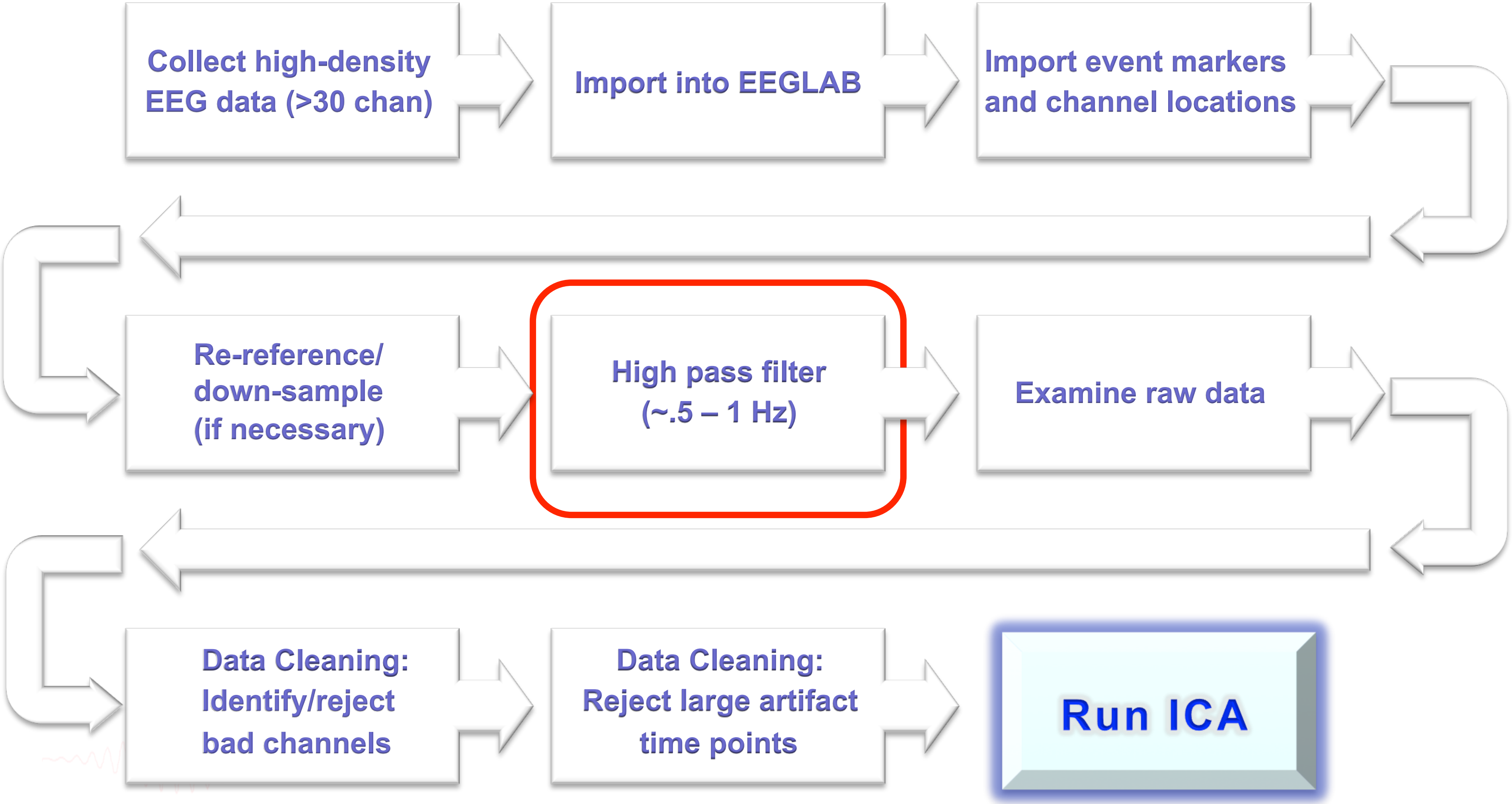
Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

Run ICA

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

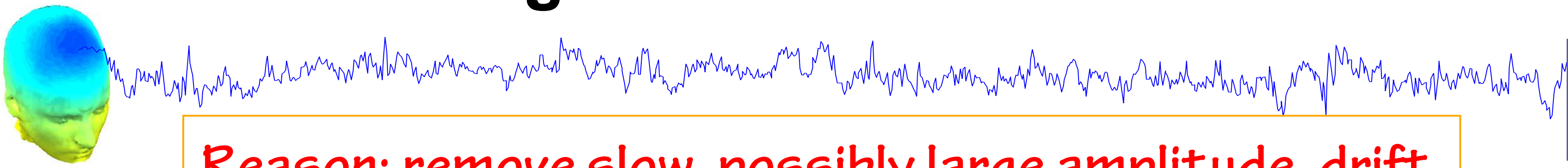
Examine raw data

Data Cleaning: Identify/reject bad channels

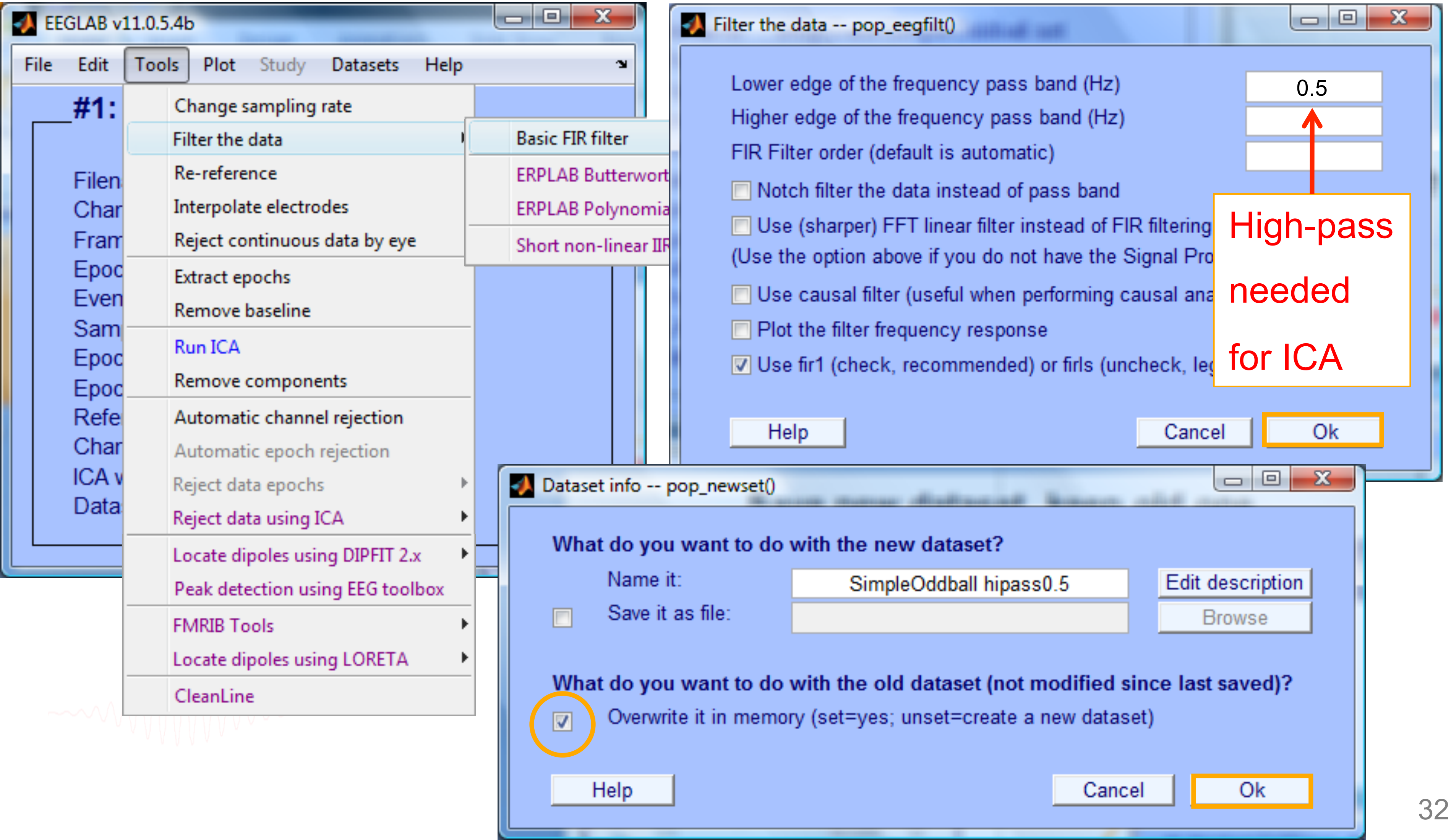
Data Cleaning: Reject large artifact time points

Run ICA

High-Pass Filter the data



Reason: remove slow, possibly large amplitude, drift


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#1:
Filen
Char
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Refe
Char
ICA v
Data
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA
CleanLine
Basic FIR filter
ERPLAB Butterwort
ERPLAB Polynomia
Short non-linear IIR

Filter the data -- pop_eegfilt()

Lower edge of the frequency pass band (Hz): 0.5

Higher edge of the frequency pass band (Hz):

FIR Filter order (default is automatic)

☐ Notch filter the data instead of pass band

☐ Use (sharper) FFT linear filter instead of FIR filtering

(Use the option above if you do not have the Signal Pro

☐ Use causal filter (useful when performing causal ana

☐ Plot the filter frequency response

☑ Use fir1 (check, recommended) or firls (uncheck, leg

Help
Cancel
Ok

High-pass needed for ICA

Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it: SimpleOddball hipass0.5

Edit description

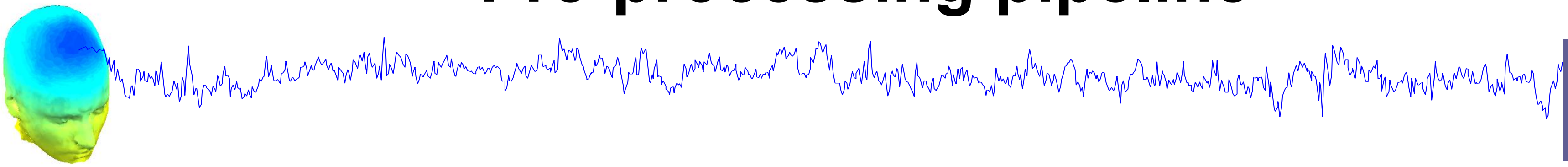
☐ Save it as file:

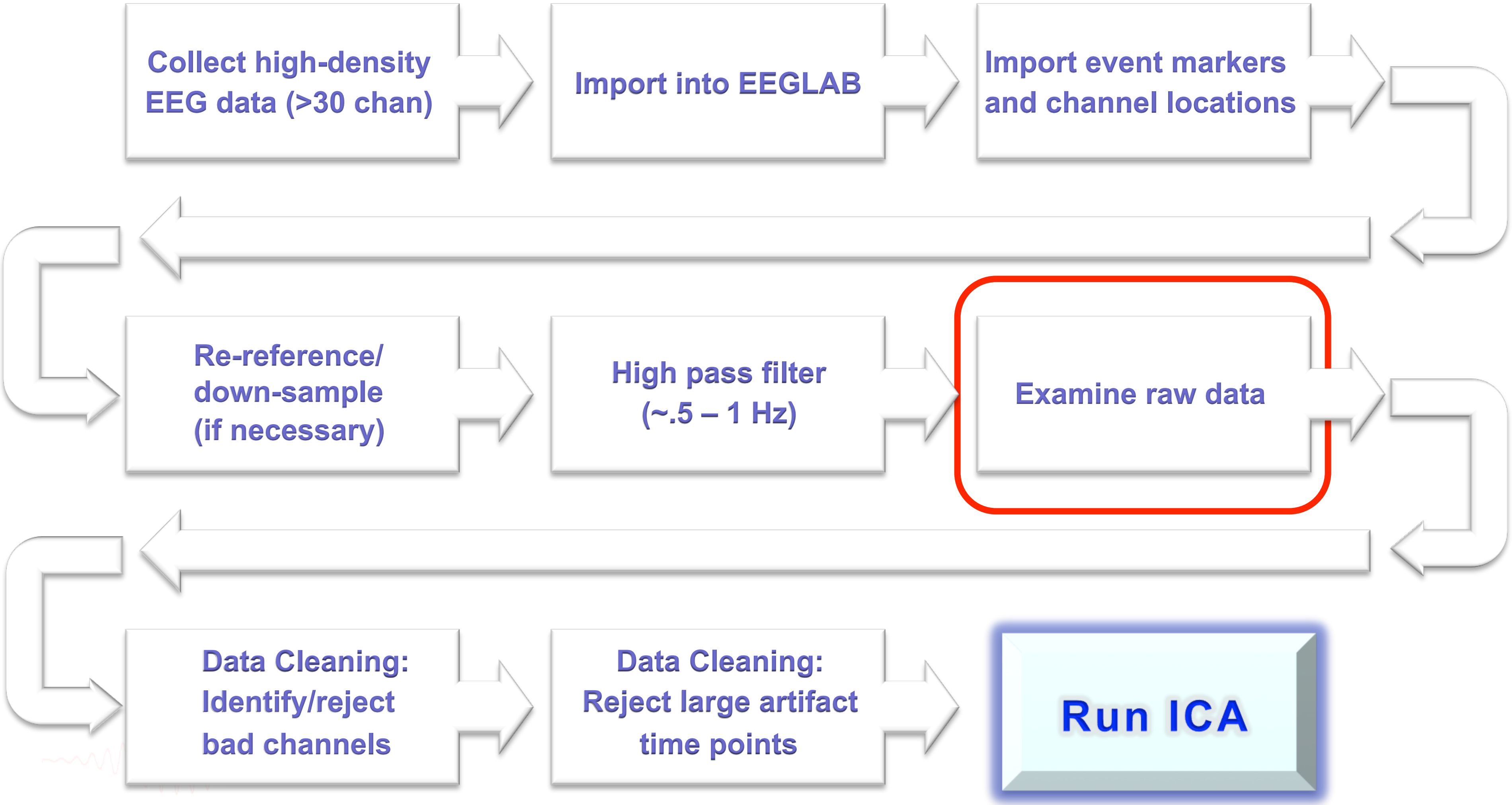
What do you want to do with the old dataset (not modified since last saved)?

☑ Overwrite it in memory (set=yes; unset=create a new dataset)

Help
Cancel
Ok

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

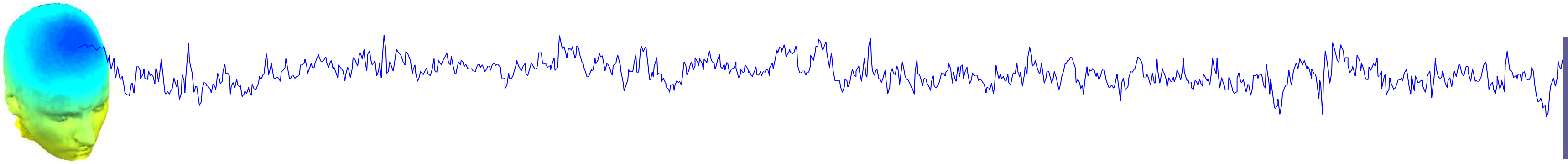
Examine raw data

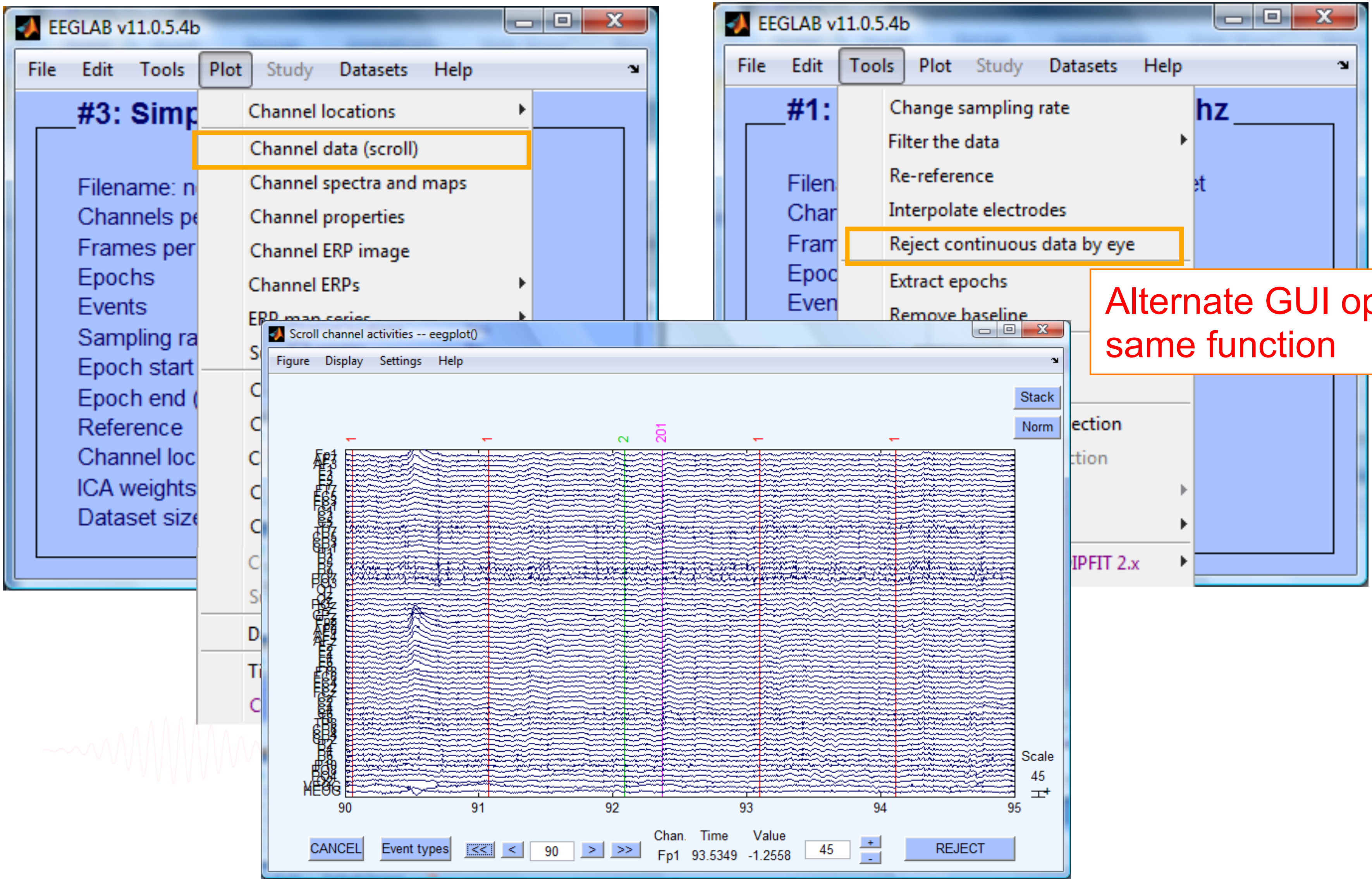
Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

Run ICA

Scroll channel data




EEGLAB v11.0.5.4b
File Edit Tools Plot Study Datasets Help
#3: Simp
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
EEGLAB v11.0.5.4b
File Edit Tools Plot Study Datasets Help
#1:
hz
Filen
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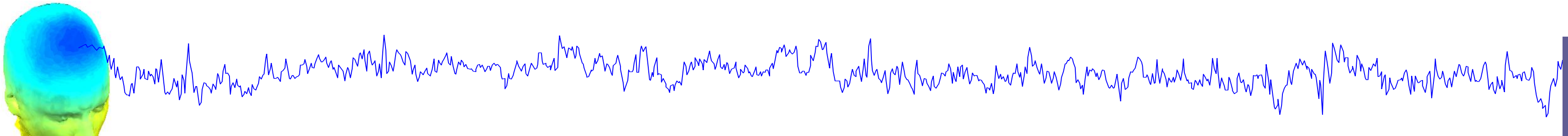
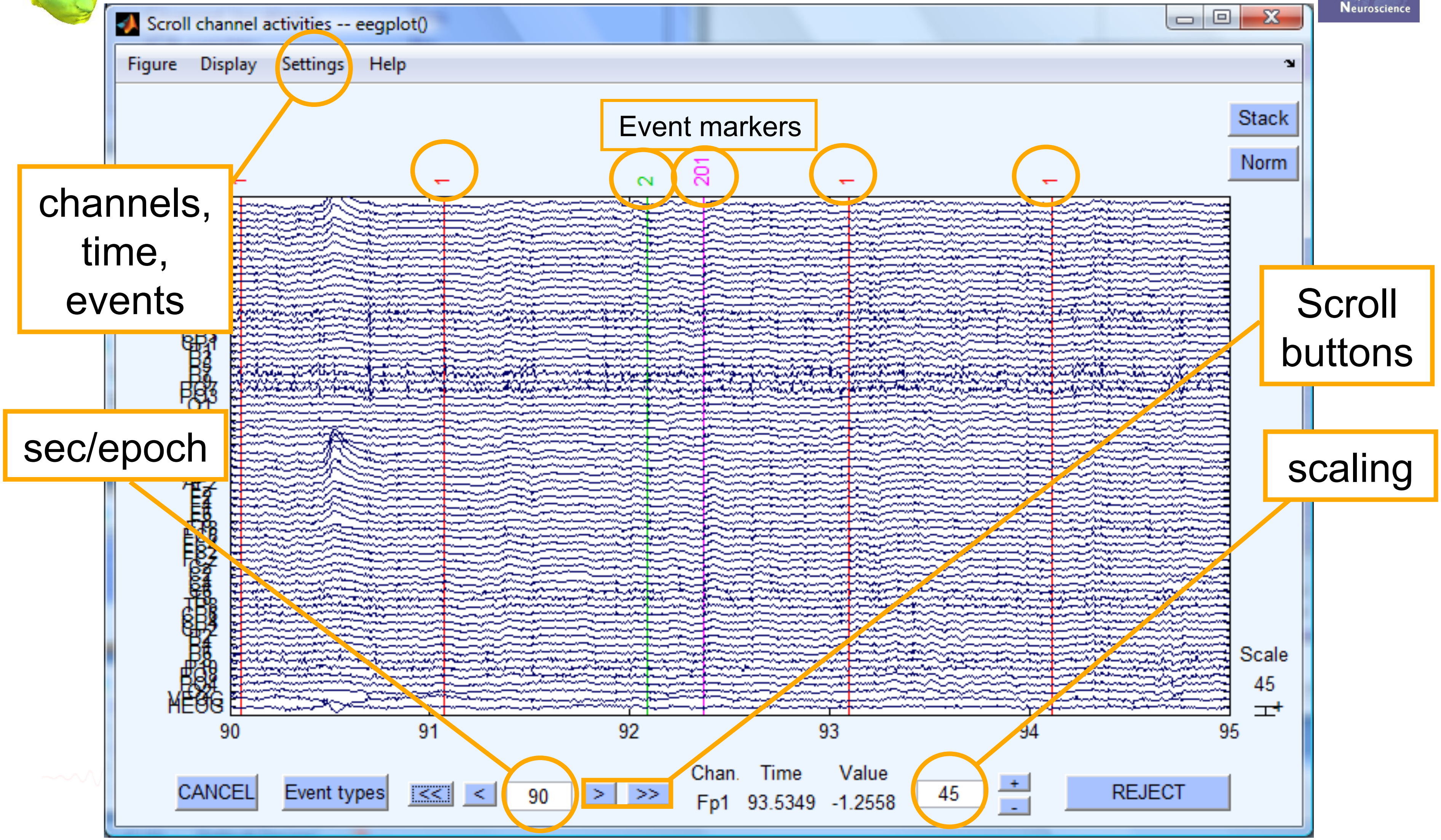
Even
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
ection
ction
IPFIT 2.x
Scroll channel activities -- eegplot()
Figure Display Settings Help
Stack
Norm
1
1
2
201
1
1
Fp1
HEOG
90
91
92
93
94
95
Scale
45
CANCEL
Event types
<<
<
90
>
>>
Chan. Time Value
Fp1 93.5349 -1.2558
45
+
-
REJECT

Alternate GUI option, same function

Scroll channel data




Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
Stack
Norm
1
2
201
1
1
MEOG
HEOG
90
91
92
93
94
95
Scale
45
CANCEL
Event types
<<
<
>
>>
+
-
REJECT

Chan. Time Value
Fp1 93.5349 -1.2558

Sec/epoch: 90

Scale: 45

Event markers

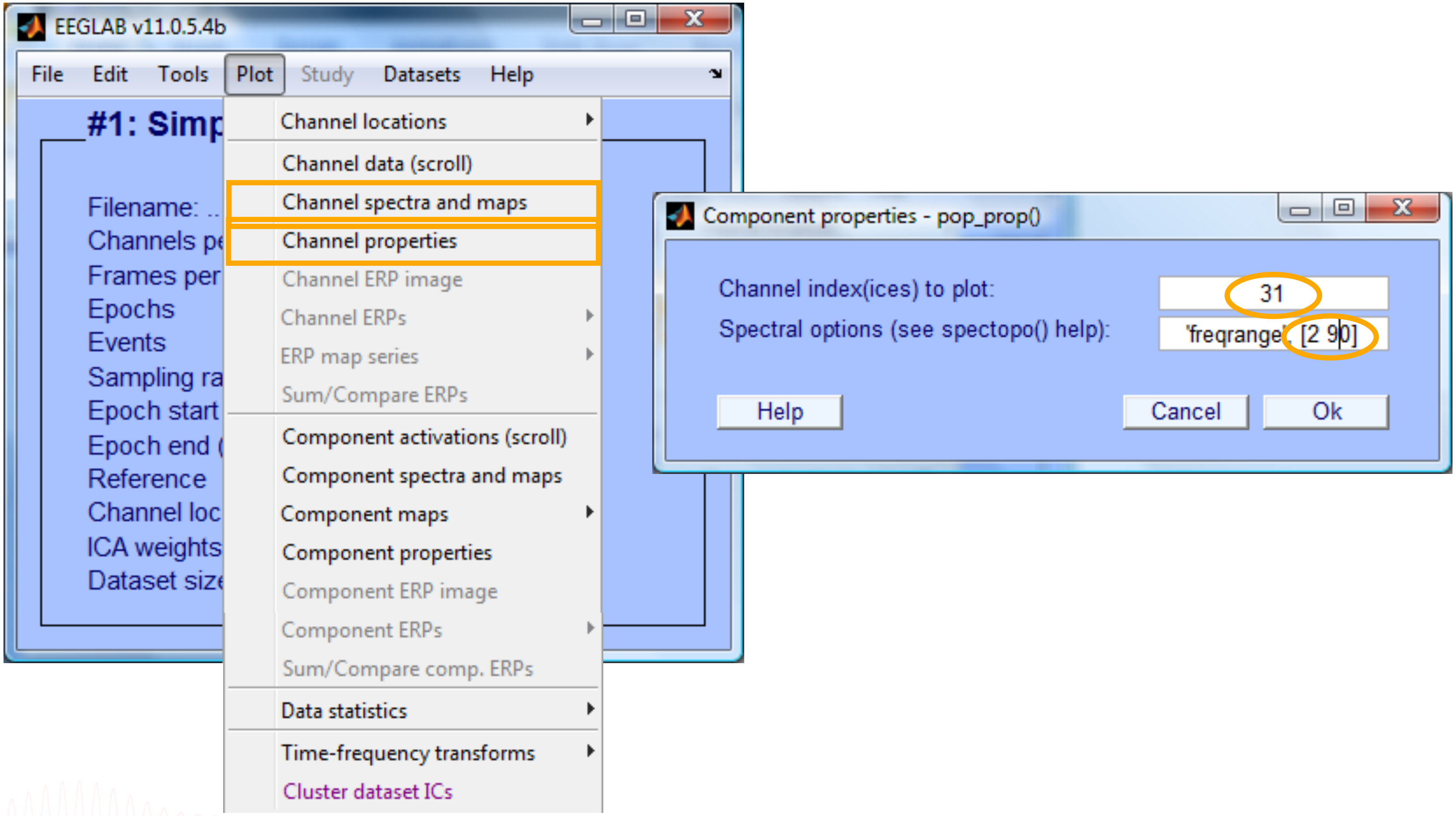
channels, time, events

sec/epoch

Scroll buttons

scaling

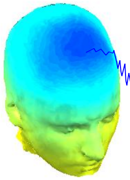
Plot channel spectra


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#1: Simp
Filename: ..
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs
Component properties - pop_prop()
Help
Cancel
Ok

Channel index(ices) to plot: 31

Spectral options (see spectopo() help): 'freqrange', [2 90]

Plot channel spectra



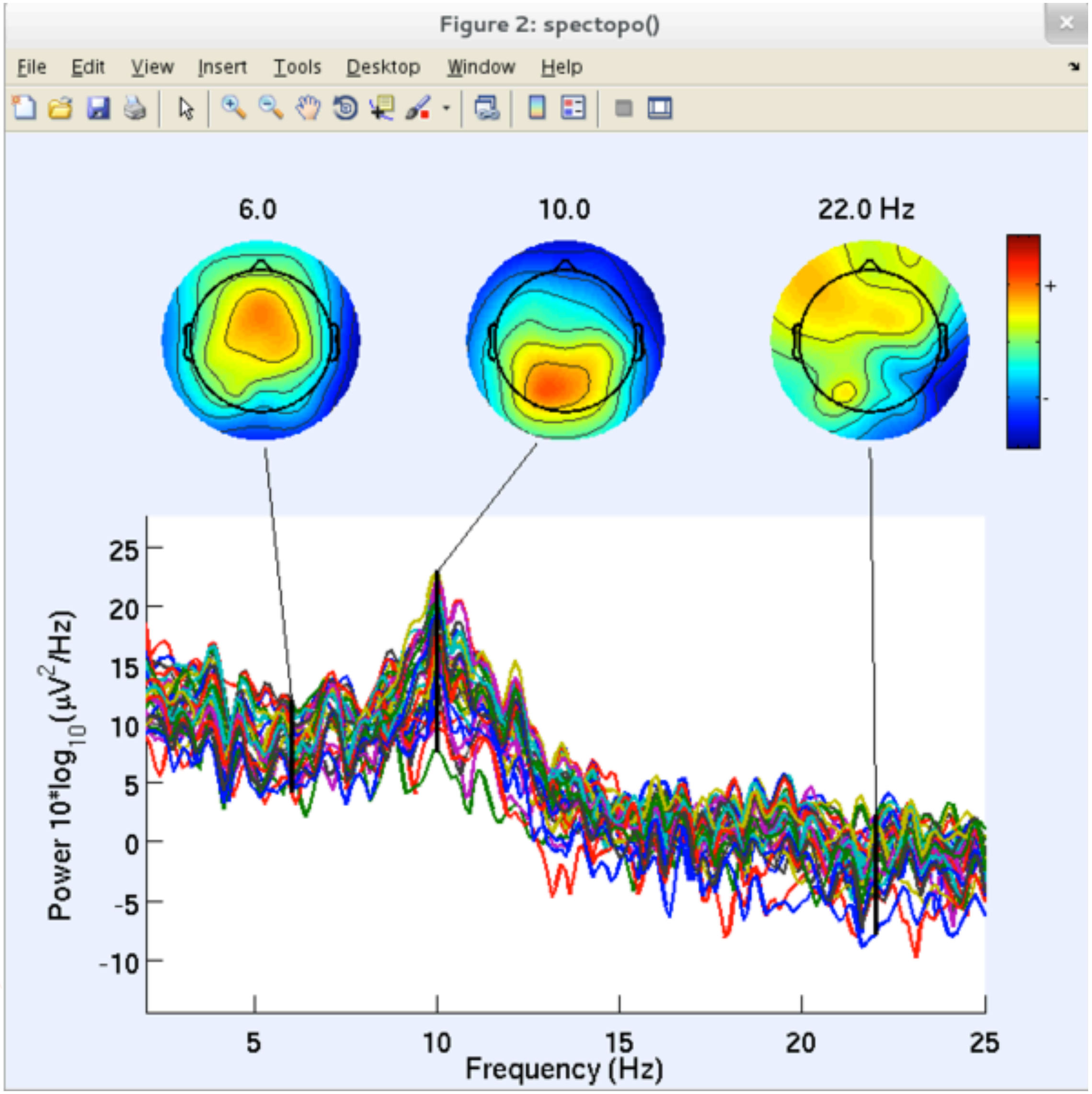
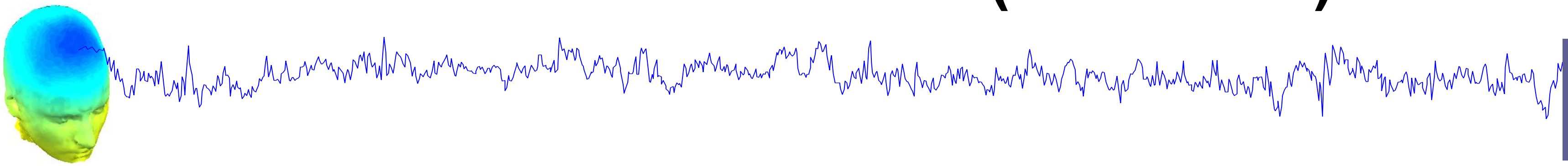
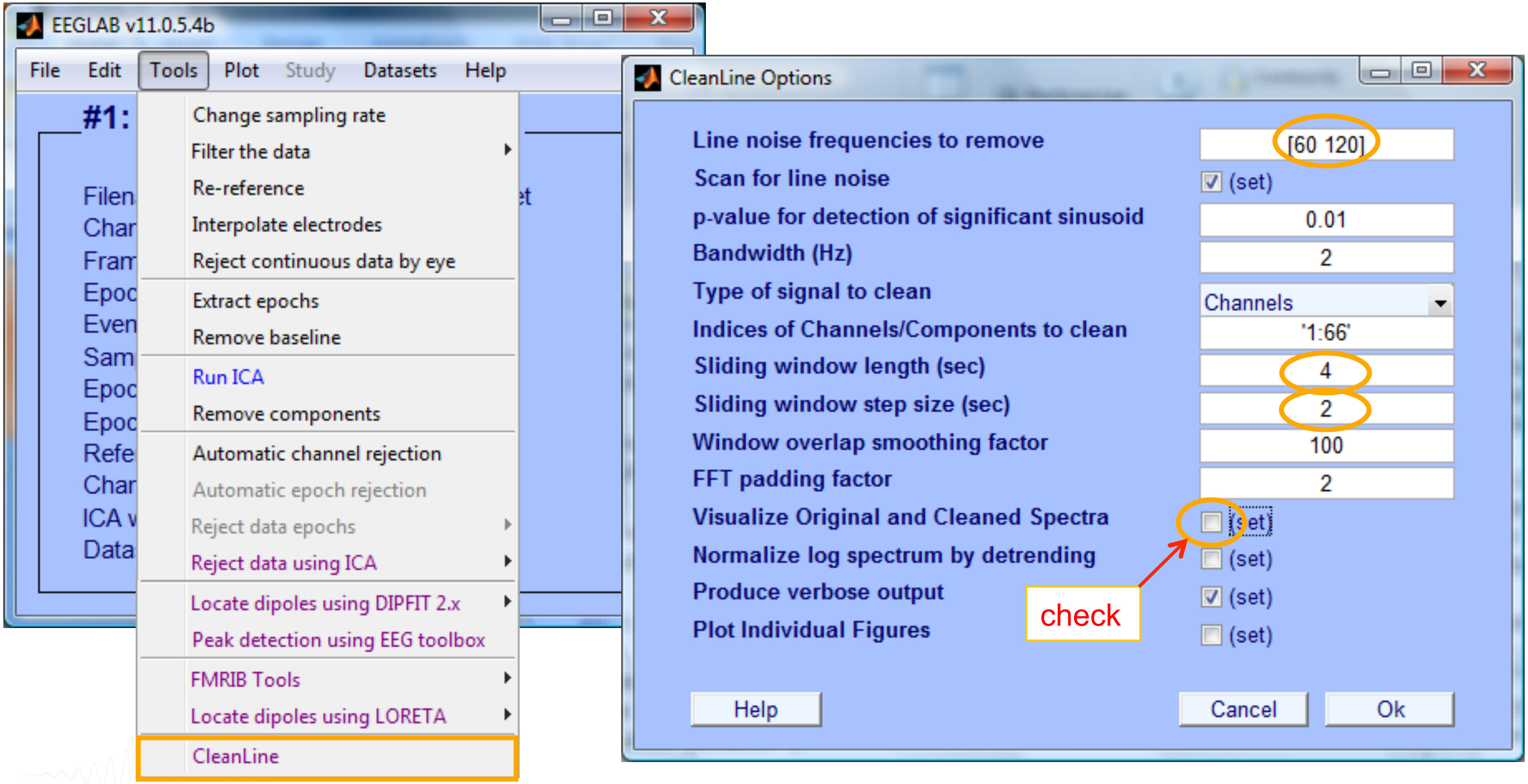


Figure 2: spectopo()
File
Edit
View
Insert
Tools
Desktop
Window
Help
6.0
10.0
22.0 Hz
+
-
Power 10*log$_{10}$(μV^2/Hz)
25
20
15
10
5
0
-5
-10
5
10
15
20
25
Frequency (Hz)

Remove line noise (Cleanline)

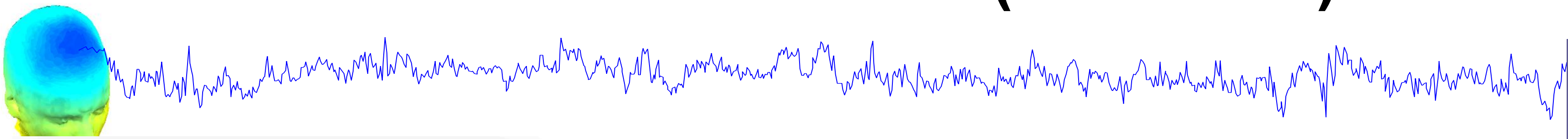


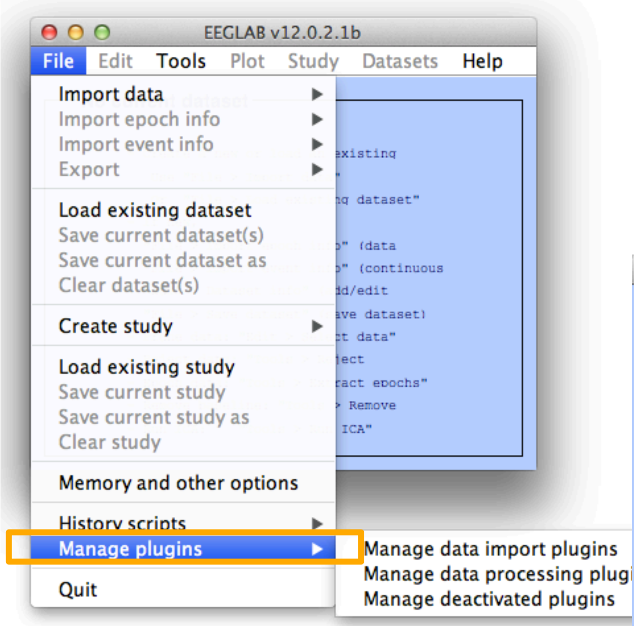

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#1:
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA
CleanLine
CleanLine Options
Help
Cancel
Ok

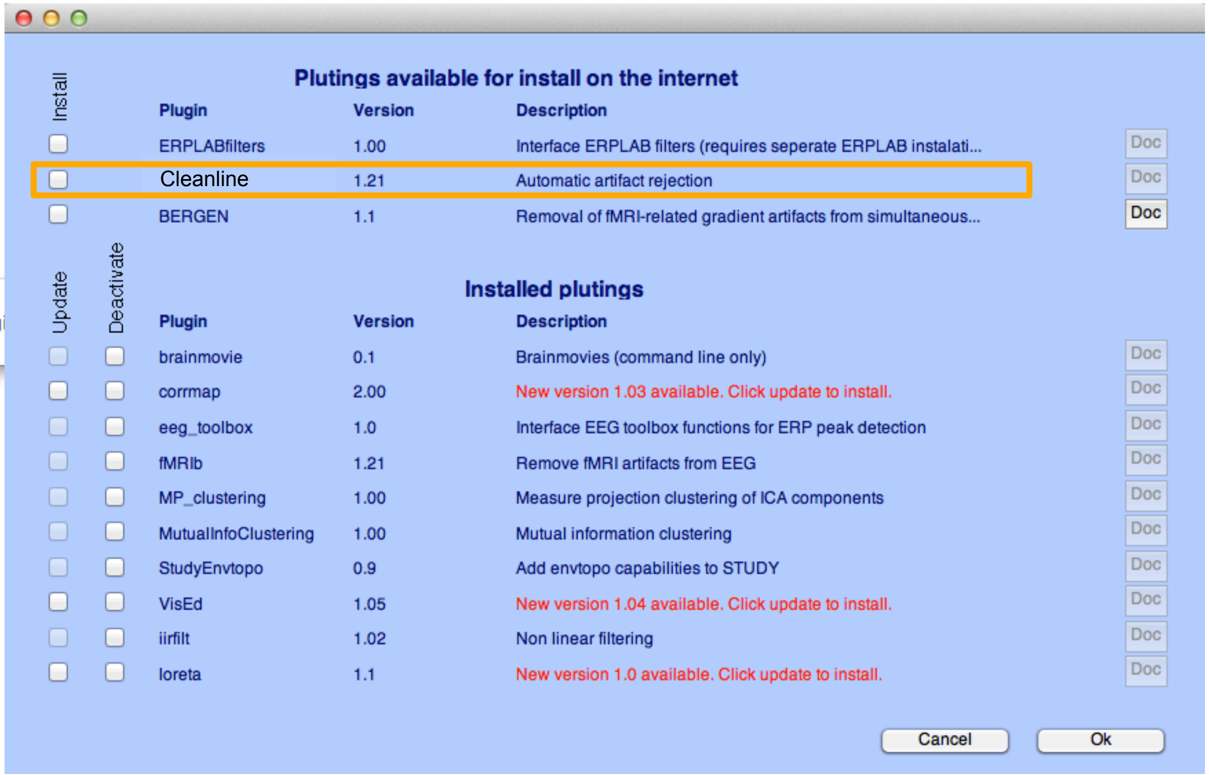
Line noise frequencies to remove: [60 120]
Scan for line noise: ☑ (set)
p-value for detection of significant sinusoid: 0.01
Bandwidth (Hz): 2
Type of signal to clean: Channels
Indices of Channels/Components to clean: '1:66'
Sliding window length (sec): 4
Sliding window step size (sec): 2
Window overlap smoothing factor: 100
FFT padding factor: 2
Visualize Original and Cleaned Spectra: ☐ (set)
Normalize log spectrum by detrending: ☐ (set)
Produce verbose output: ☑ (set)
Plot Individual Figures: ☐ (set)

check

Remove line noise (Cleanline)




EEGLAB v12.0.2.1b
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study
Memory and other options
History scripts
Manage plugins
Quit
Manage data import plugins
Manage data processing plugi
Manage deactivated plugins



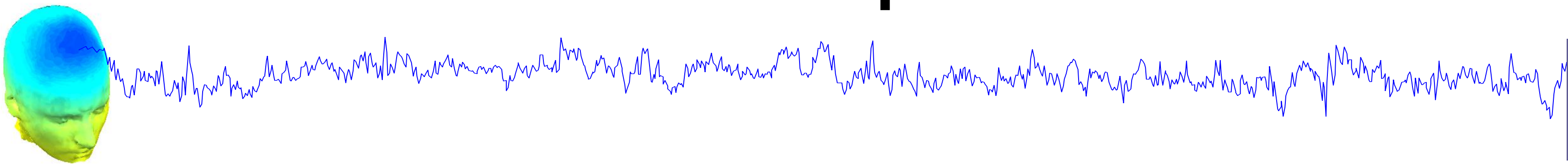
Plutings available for install on the internet

Install	Plugin	Version	Description	
☐	ERPLABfilters	1.00	Interface ERPLAB filters (requires seperate ERPLAB instalati...	Doc
☐	Cleanline	1.21	Automatic artifact rejection	Doc
☐	BERGEN	1.1	Removal of fMRI-related gradient artifacts from simultaneous...	Doc

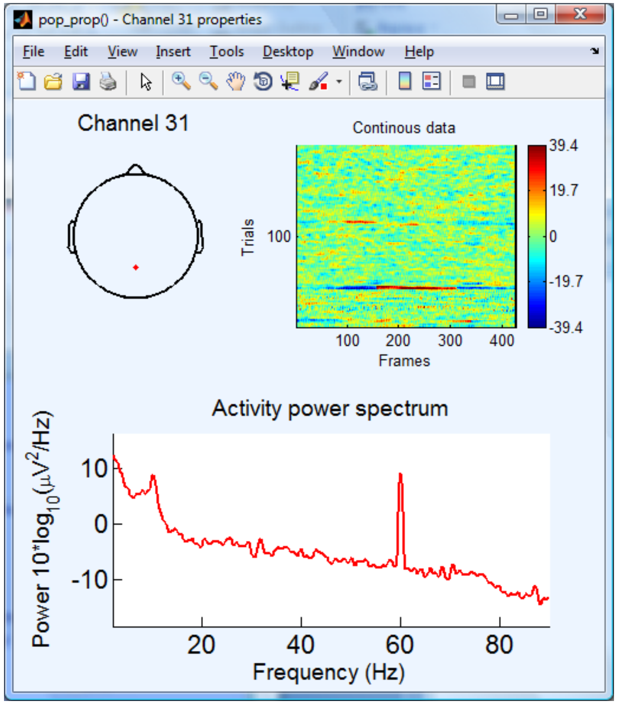
Installed plutings

Update	Deactivate	Plugin	Version	Description	
☐	☐	brainmovie	0.1	Brainmovies (command line only)	Doc
☐	☐	corrmap	2.00	New version 1.03 available. Click update to install.	Doc
☐	☐	eeg_toolbox	1.0	Interface EEG toolbox functions for ERP peak detection	Doc
☐	☐	fMRIb	1.21	Remove fMRI artifacts from EEG	Doc
☐	☐	MP_clustering	1.00	Measure projection clustering of ICA components	Doc
☐	☐	MutualInfoClustering	1.00	Mutual information clustering	Doc
☐	☐	StudyEnvtopo	0.9	Add envtopo capabilities to STUDY	Doc
☐	☐	VisEd	1.05	New version 1.04 available. Click update to install.	Doc
☐	☐	iirfilt	1.02	Non linear filtering	Doc
☐	☐	loreta	1.1	New version 1.0 available. Click update to install.	Doc

Filter comparisons

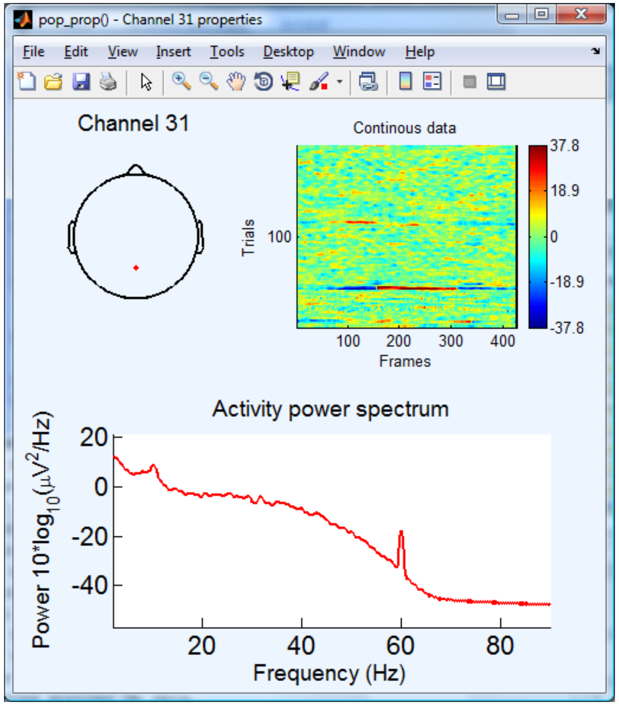


0.5 Hz high-pass filter



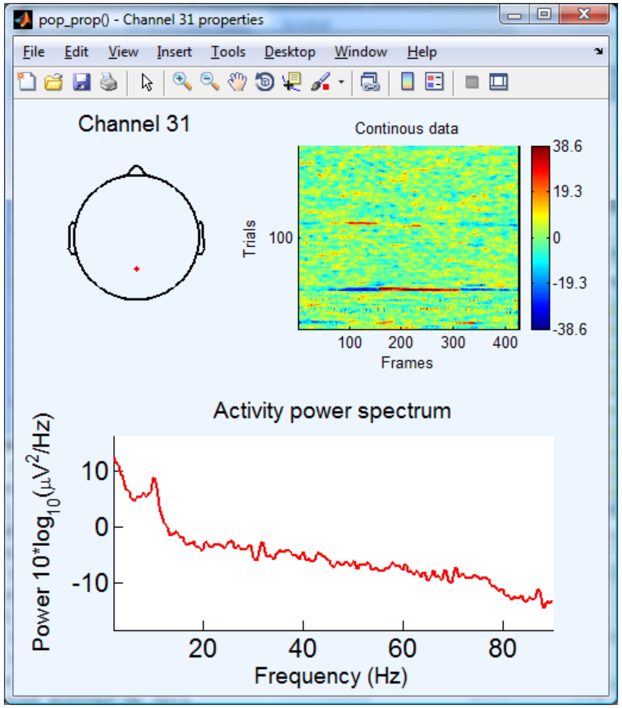
pop_prop() - Channel 31 properties
File Edit View Insert Tools Desktop Window Help
Channel 31
Continous data
Trials
100
39.4
19.7
0
-19.7
-39.4
100 200 300 400
Frames
Activity power spectrum
Power 10*log10(μV2/Hz)
10
0
-10
20 40 60 80
Frequency (Hz)

0.5 Hz high-pass filter
50 Hz low-pass filter



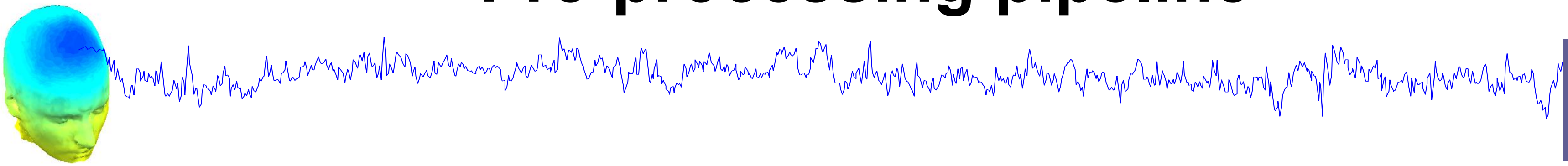
pop_prop() - Channel 31 properties
File Edit View Insert Tools Desktop Window Help
Channel 31
Continous data
Trials
100
37.8
18.9
0
-18.9
-37.8
100 200 300 400
Frames
Activity power spectrum
Power 10*log10(μV2/Hz)
20
0
-20
-40
20 40 60 80
Frequency (Hz)

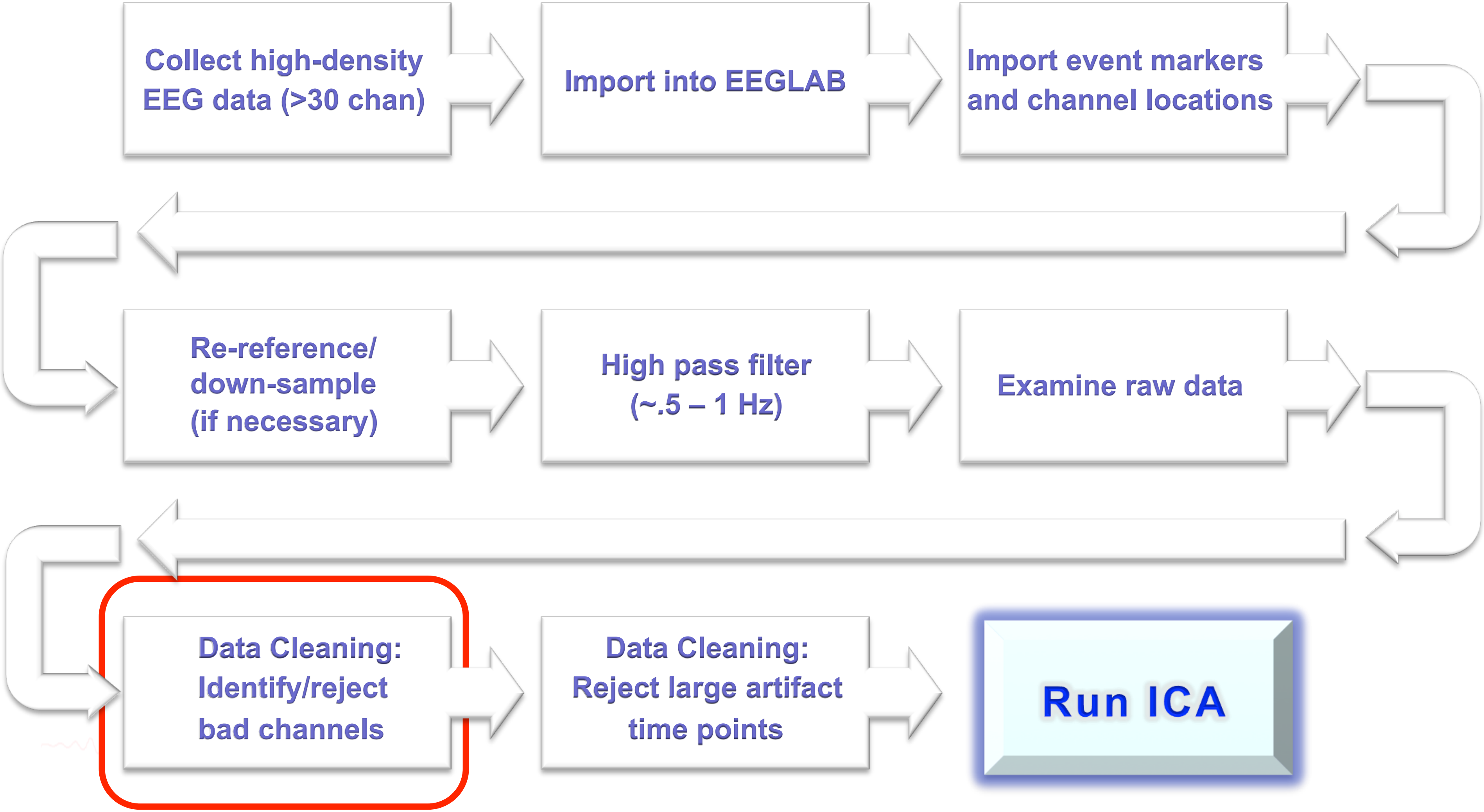
0.5 Hz high-pass filter
Cleanline



pop_prop() - Channel 31 properties
File Edit View Insert Tools Desktop Window Help
Channel 31
Continous data
Trials
100
38.6
19.3
0
-19.3
-38.6
100 200 300 400
Frames
Activity power spectrum
Power 10*log10(μV2/Hz)
10
0
-10
20 40 60 80
Frequency (Hz)

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

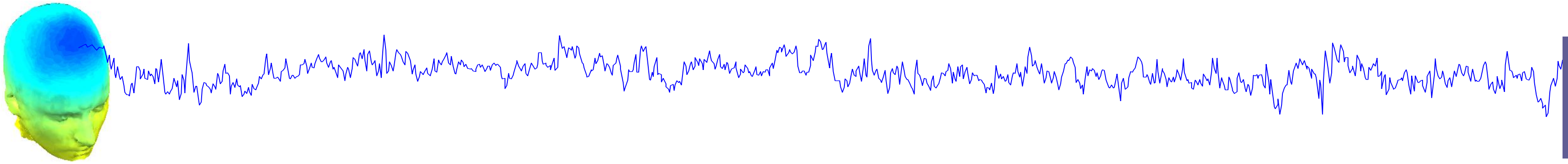
High pass filter (~.5 – 1 Hz)

Examine raw data

Data Cleaning: Identify/reject bad channels

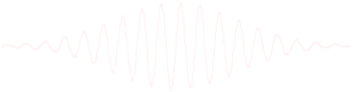
Data Cleaning: Reject large artifact time points

Run ICA

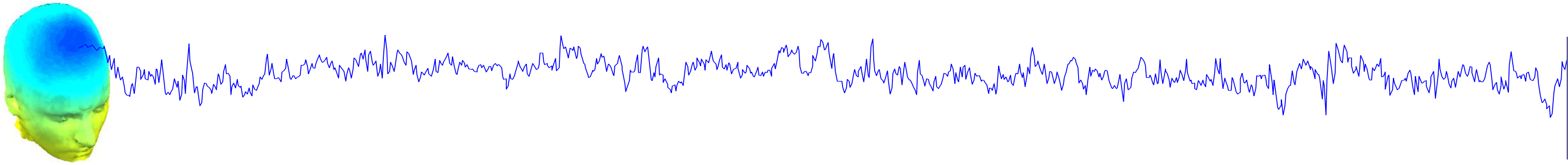


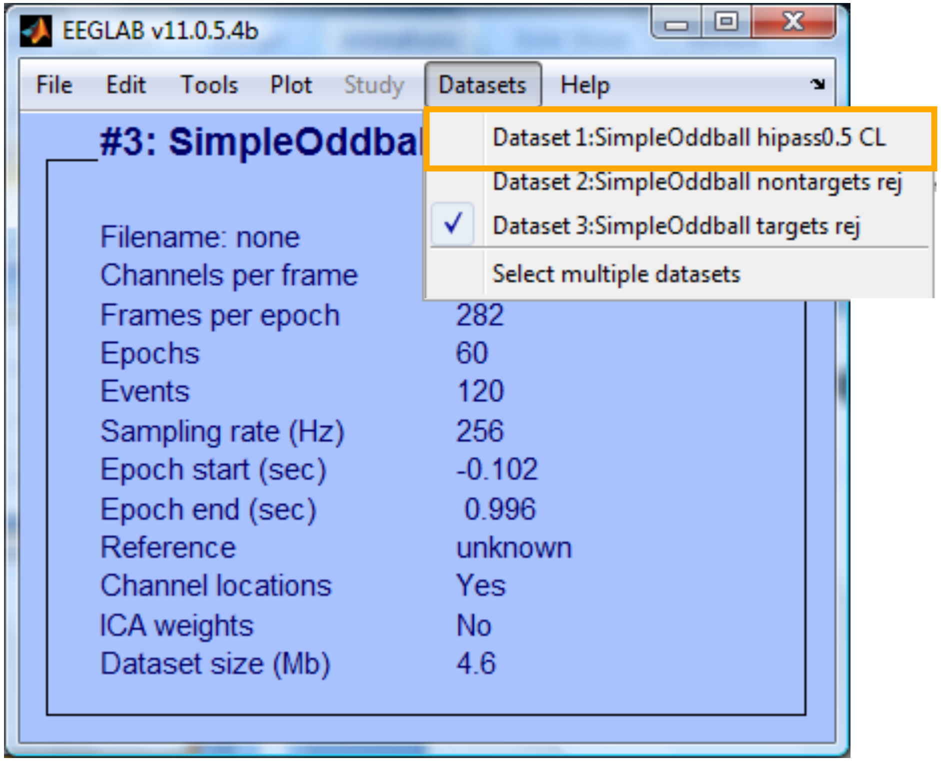
Data Cleaning for ICA

Variant 1: Continuous Data



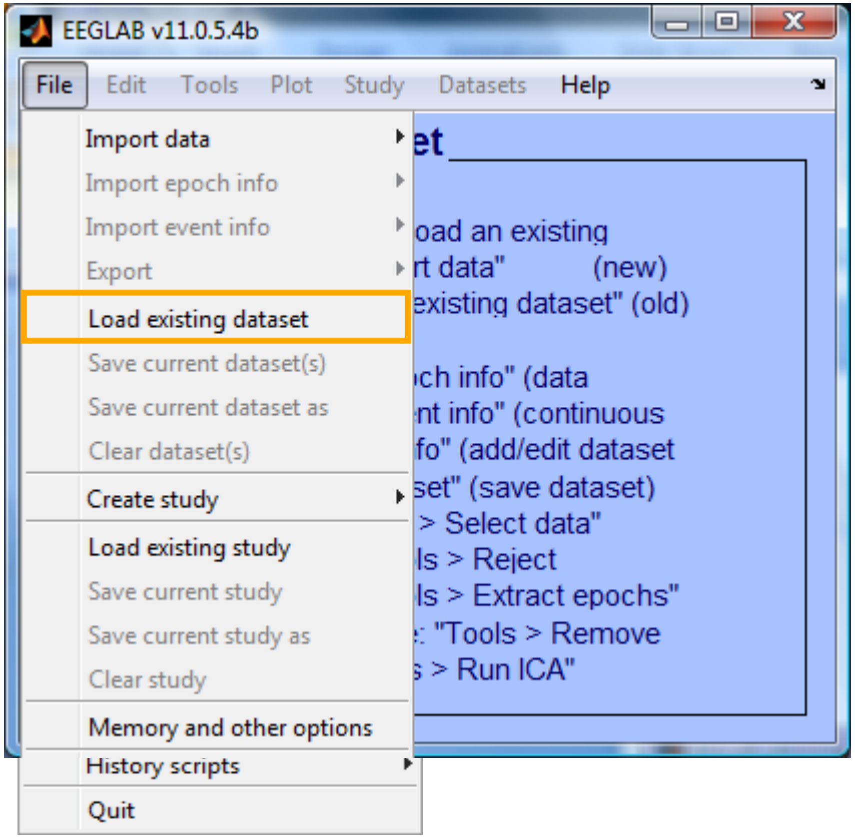
Continuous EEG dataset




EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset 1:SimpleOddball hipass0.5 CL
Dataset 2:SimpleOddball nontargets rej
✓ Dataset 3:SimpleOddball targets rej
Select multiple datasets

#3: SimpleOddbal

Filename: none	
Channels per frame	
Frames per epoch	282
Epochs	60
Events	120
Sampling rate (Hz)	256
Epoch start (sec)	-0.102
Epoch end (sec)	0.996
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	4.6

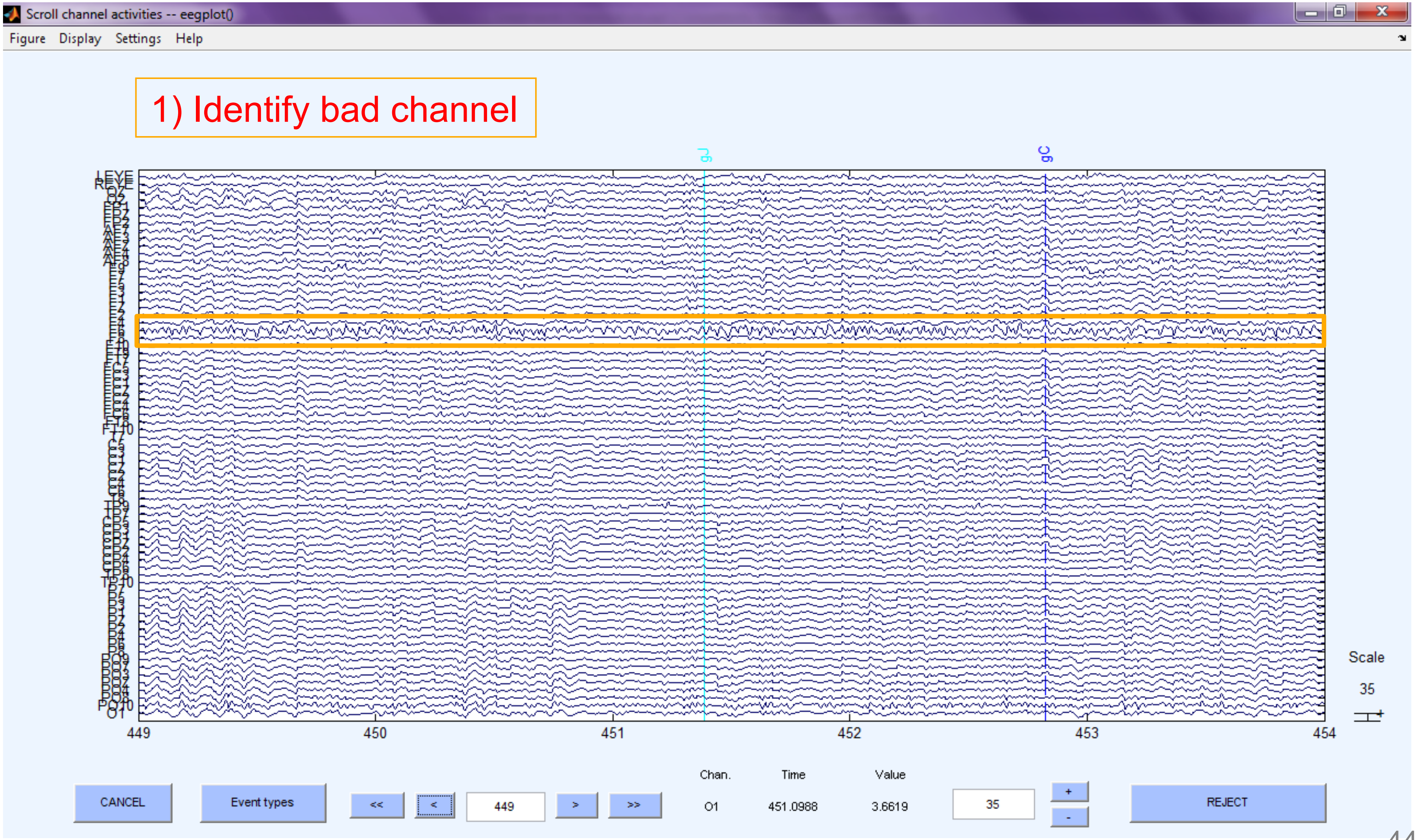

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study
Memory and other options
History scripts
Quit

et

oad an existing
rt data" (new)
existing dataset" (old)

ch info" (data
nt info" (continuous
fo" (add/edit dataset
set" (save dataset)
> Select data"
ls > Reject
ls > Extract epochs"
: "Tools > Remove
s > Run ICA"

Manually identifying bad channels

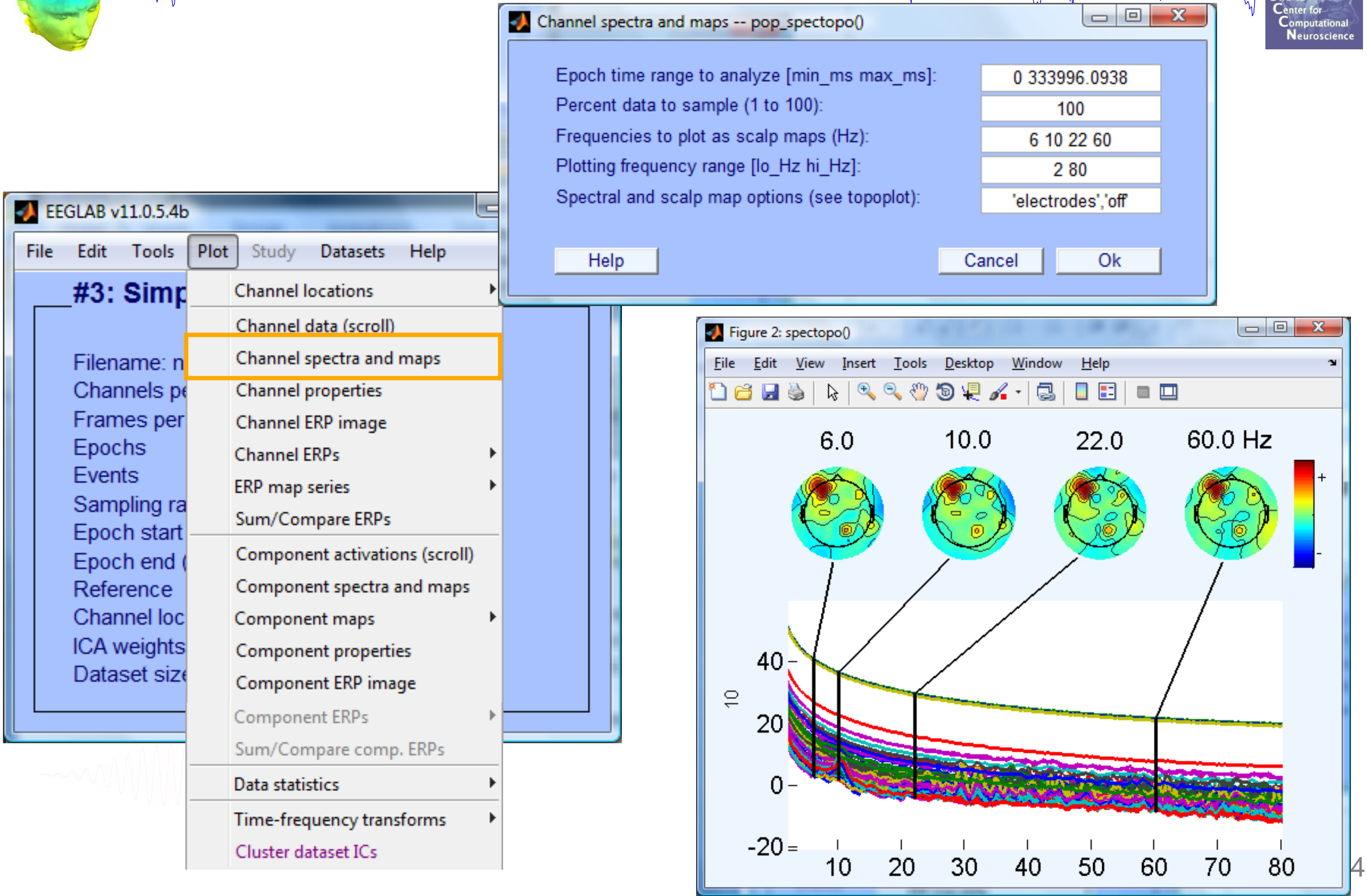


Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
LEYE
REYE
FT10
TP10
PO10
O1
449
450
451
452
453
454
Scale
35
CANCEL
Event types
<<
<
449
>
>>
35
+
-
REJECT

1) Identify bad channel

Chan.	Time	Value
O1	451.0988	3.6619

Manually identifying bad channels



Channel spectra and maps -- pop_spectopo()

Epoch time range to analyze [min_ms max_ms]: 0 333996.0938

Percent data to sample (1 to 100): 100

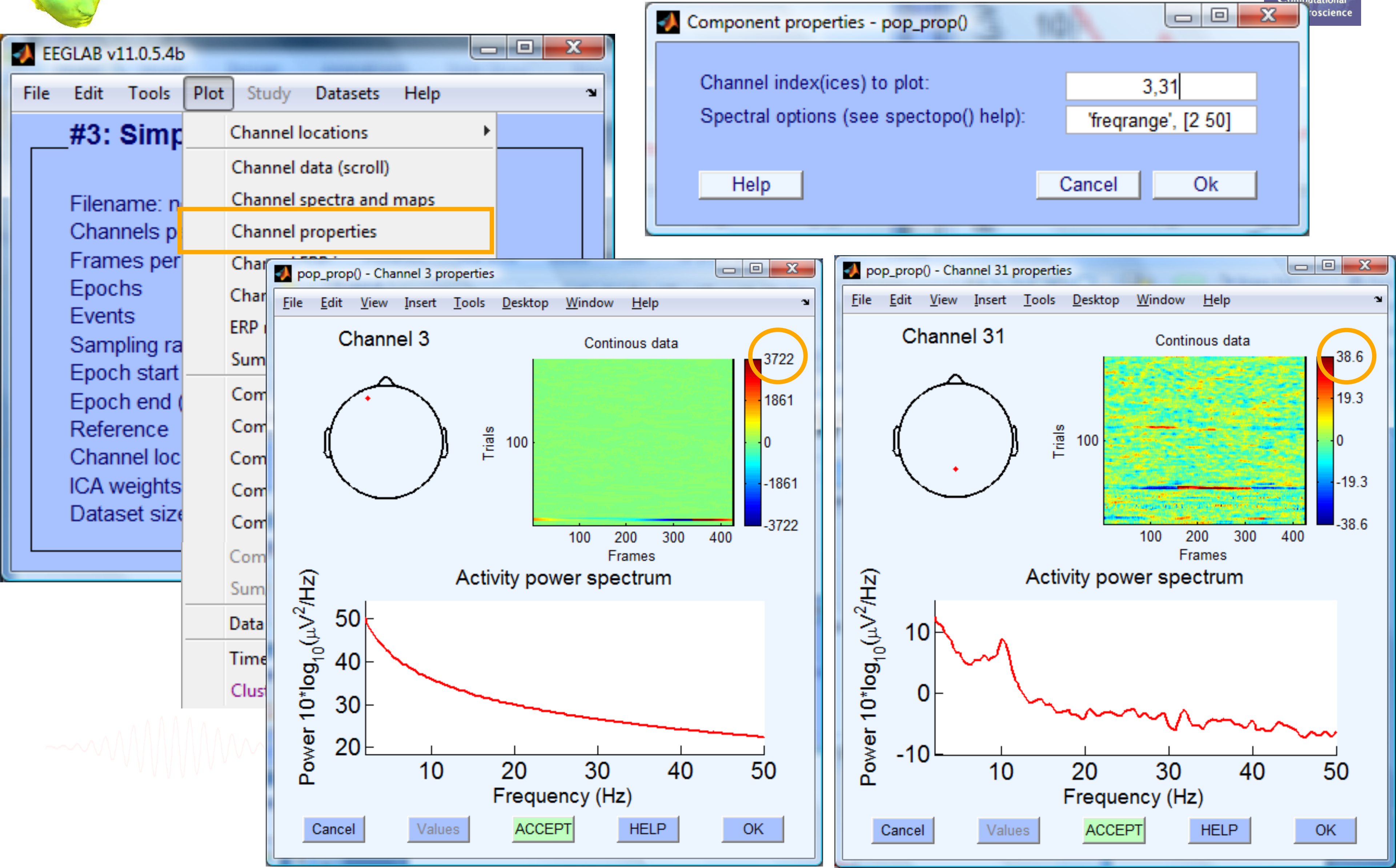
Frequencies to plot as scalp maps (Hz): 6 10 22 60

Plotting frequency range [lo_Hz hi_Hz]: 2 80

Spectral and scalp map options (see topoplot): 'electrodes','off'

Help
Cancel
Ok
EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#3: Simp
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs
Figure 2: spectopo()
File
Edit
View
Insert
Tools
Desktop
Window
Help
6.0
10.0
22.0
60.0 Hz
+
-
10
40
20
0
-20
10
20
30
40
50
60
70
80

Manually identifying bad channels



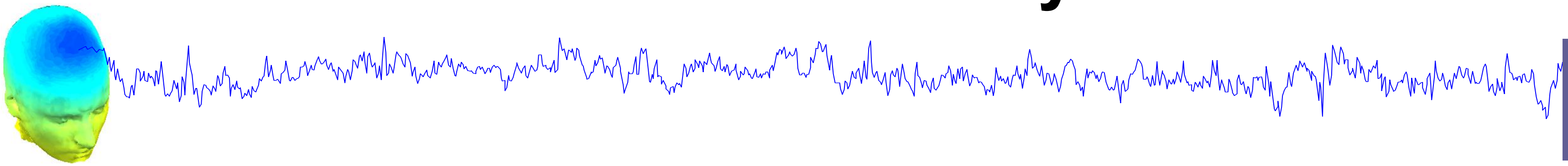
Component properties - pop_prop()

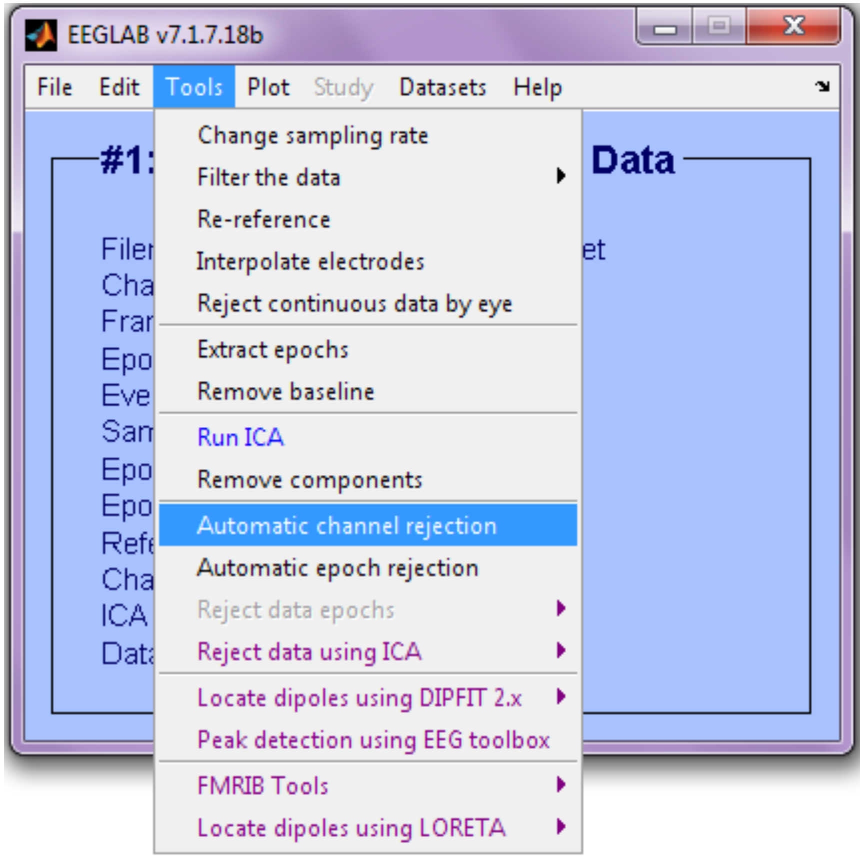
Channel index(ices) to plot: 3,31

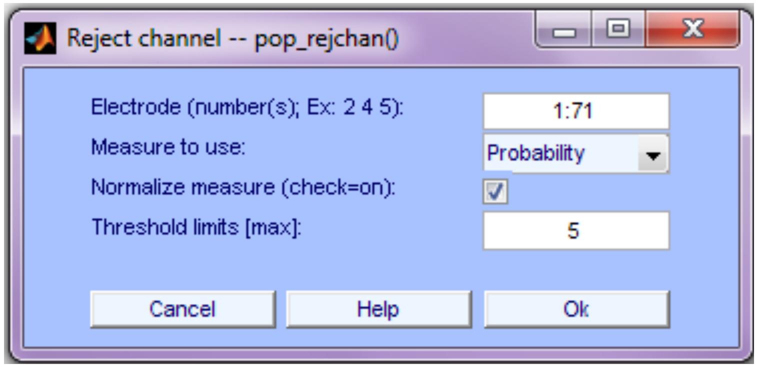
Spectral options (see spectopo() help): 'freqrange', [2 50]

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#3: Simp
Filename: n
Channels p
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Chan
Char
ERP
Sum
Com
Com
Com
Com
Com
Com
Sum
Data
Time
Clust
Help
Cancel
Ok
pop_prop() - Channel 3 properties
File Edit View Insert Tools Desktop Window Help
Channel 3
Continous data
Trials
100
3722
1861
0
-1861
-3722
100 200 300 400
Frames
Activity power spectrum
Power 10*log10(μV²/Hz)
50
40
30
20
10 20 30 40 50
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK
pop_prop() - Channel 31 properties
File Edit View Insert Tools Desktop Window Help
Channel 31
Continous data
Trials
100
38.6
19.3
0
-19.3
-38.6
100 200 300 400
Frames
Activity power spectrum
Power 10*log10(μV²/Hz)
10
0
-10
10 20 30 40 50
Frequency (Hz)
Cancel
Values
ACCEPT
HELP
OK

Auto-detection of noisy channels




EEGLAB v7.1.7.18b
File
Edit
Tools
Plot
Study
Datasets
Help
#1:
Data
Filer
Cha
Frar
Epo
Eve
Sam
Epo
Epo
Refe
Cha
ICA
Data
et
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA


Reject channel -- pop_rejchan()

Electrode (number(s); Ex: 2 4 5): 1:71

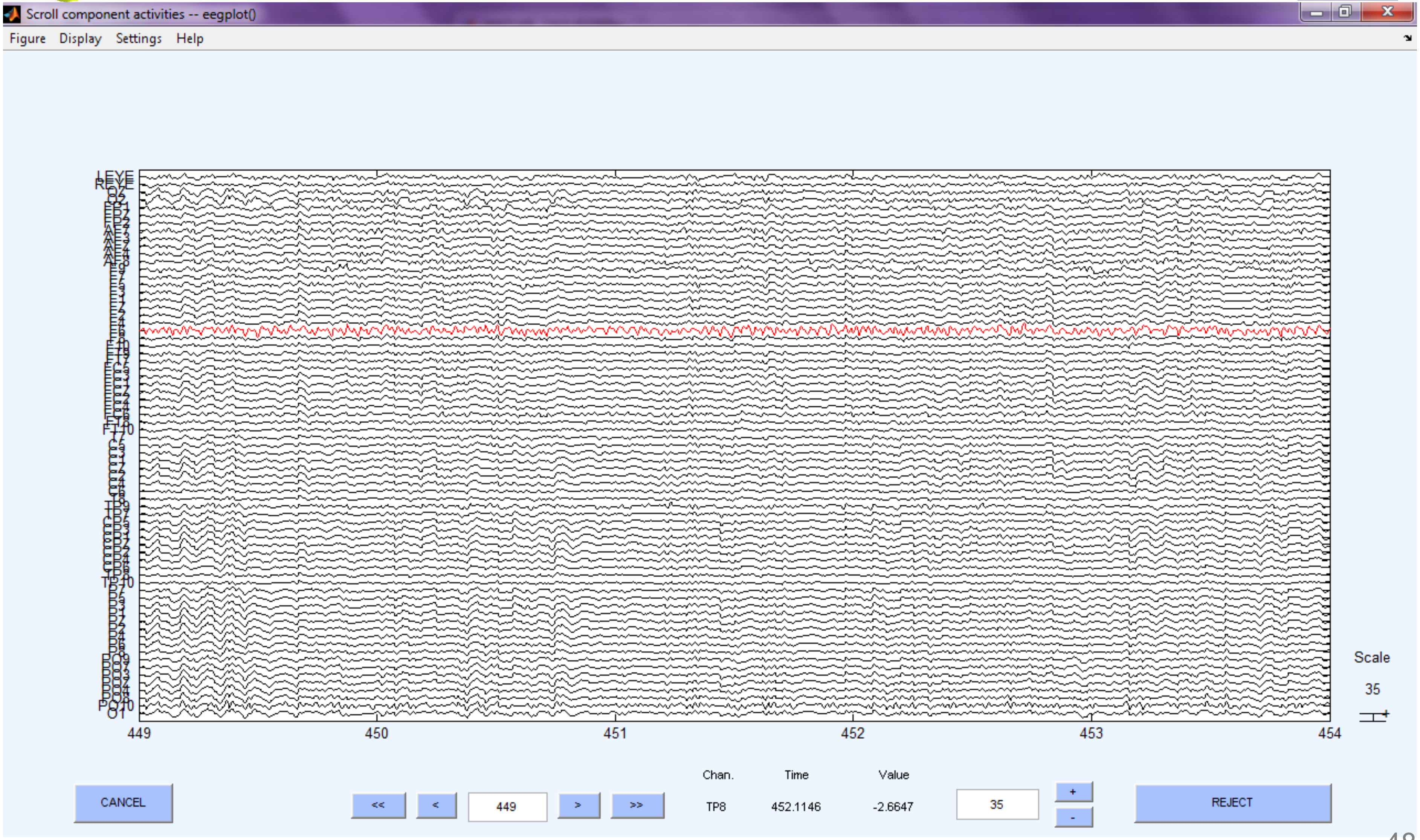
Measure to use: Probability

Normalize measure (check=on): ☑

Threshold limits [max]: 5

Cancel
Help
Ok

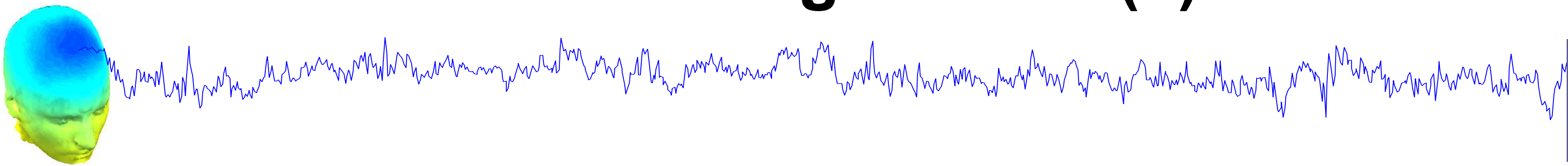
Auto-detected noisy channel

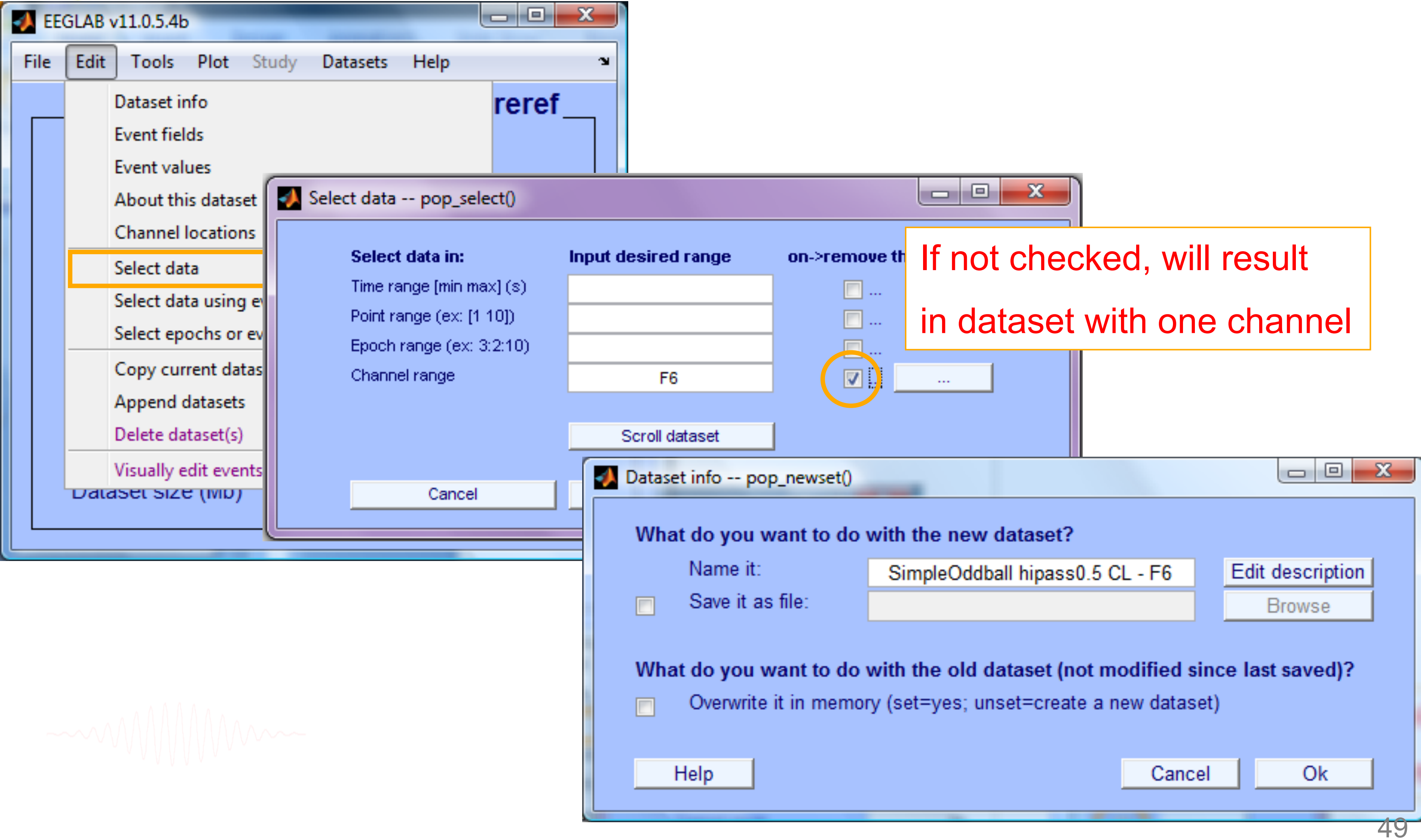

Scroll component activities -- eegplot()
Figure
Display
Settings
Help
LEYE
REYE
FT10
TP10
PO10
O1
449
450
451
452
453
454
Scale
35
CANCEL
<<
<
449
>
>>
+
-
REJECT

Chan.	Time	Value
TP8	452.1146	-2.6647

35

Removing channel(s)




EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using e
Select epochs or ev
Copy current datas
Append datasets
Delete dataset(s)
Visually edit events
reref
Dataset size (Mb)

Select data -- pop_select()

Select data in:	**Input desired range**	**on->remove th**
Time range [min max] (s)		☐ ...
Point range (ex: [1 10])		☐ ...
Epoch range (ex: 3:2:10)		☐ ...
Channel range	F6	☑ ...

Scroll dataset
Cancel

If not checked, will result in dataset with one channel

Dataset info -- pop_newset()

What do you want to do with the new dataset?

Name it: SimpleOddball hipass0.5 CL - F6

☐ Save it as file:

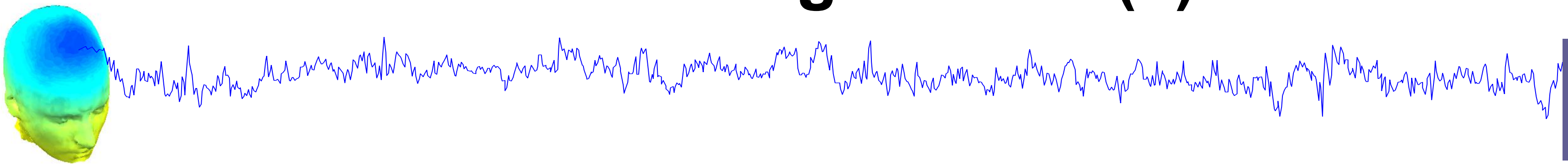
Edit description
Browse

What do you want to do with the old dataset (not modified since last saved)?

☐ Overwrite it in memory (set=yes; unset=create a new dataset)

Help
Cancel
Ok

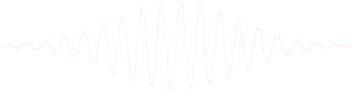
Removing channel(s)



- You may want to interpolate bad channels rather than remove them altogether. Don't do this!

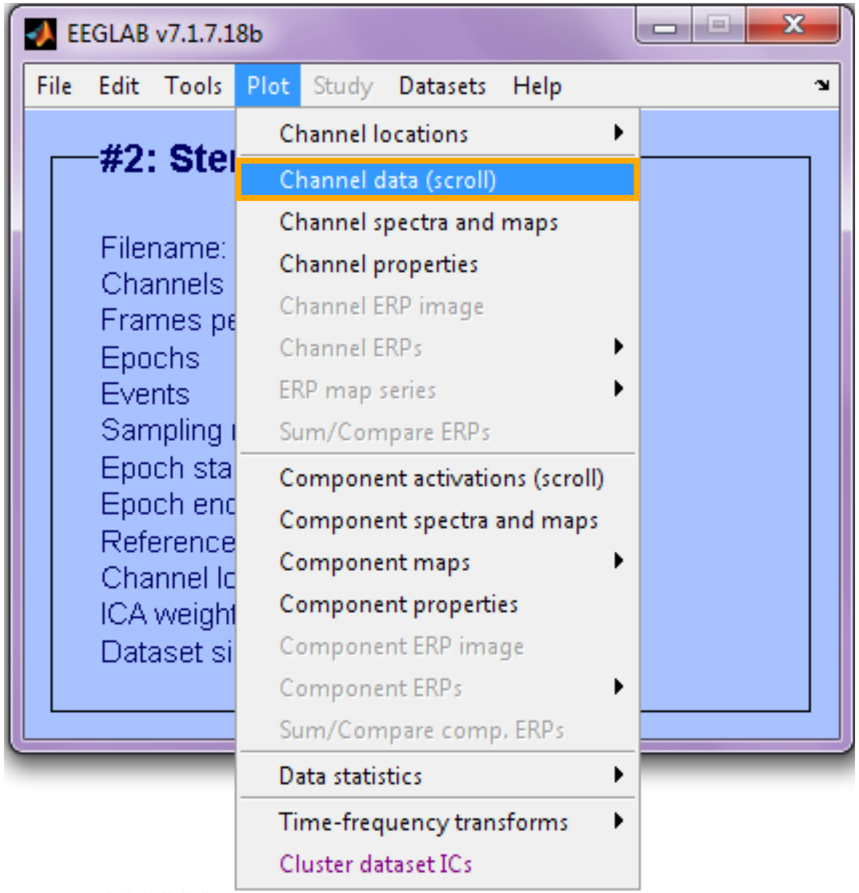
- The loss in dimensionality will affect the ICA decomposition

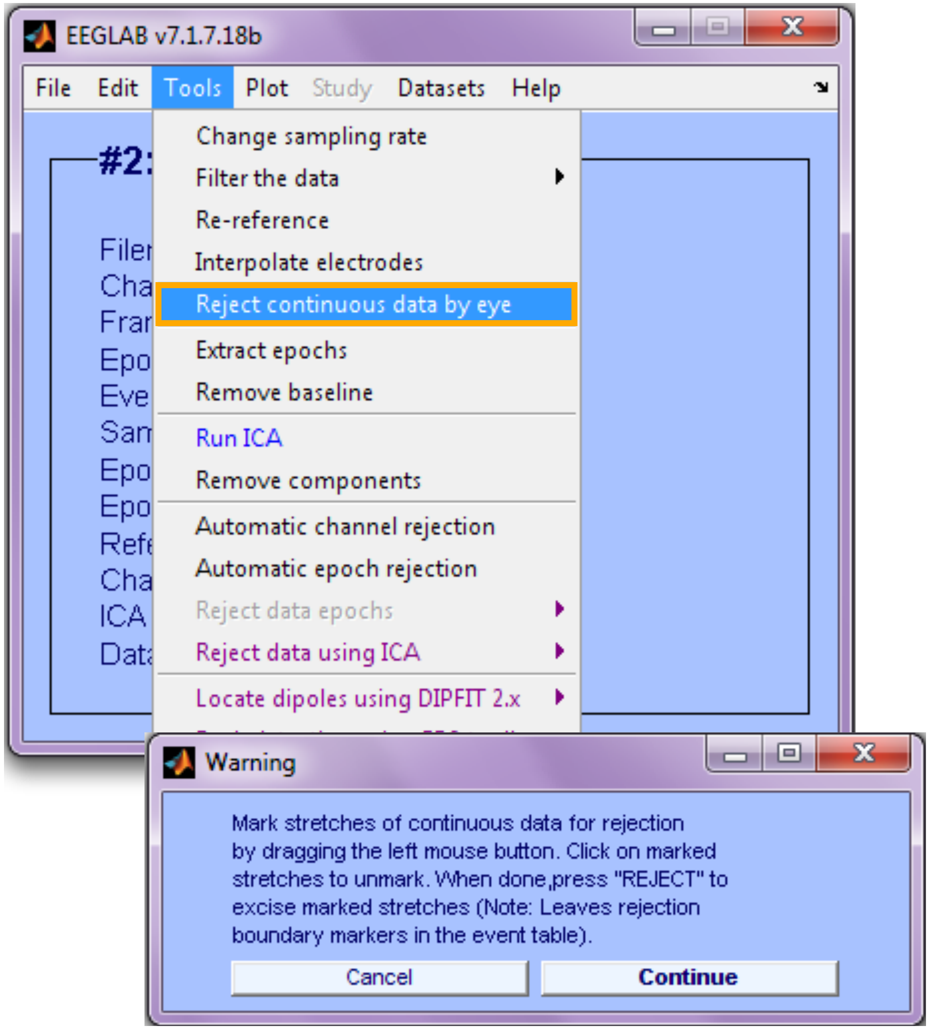
- Preferred solution:
  - **Delete** the bad channels before running ICA
  - STUDY tools will interpolate missing channels automatically



Reject continuous data

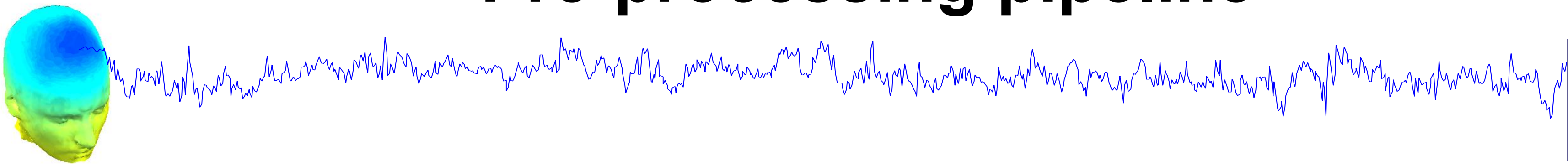
Equivalent


EEGLAB v7.1.7.18b
File
Edit
Tools
Plot
Study
Datasets
Help
#2: Ste
Filename:
Channels
Frames pe
Epochs
Events
Sampling
Epoch sta
Epoch end
Reference
Channel lo
ICA weight
Dataset si
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs

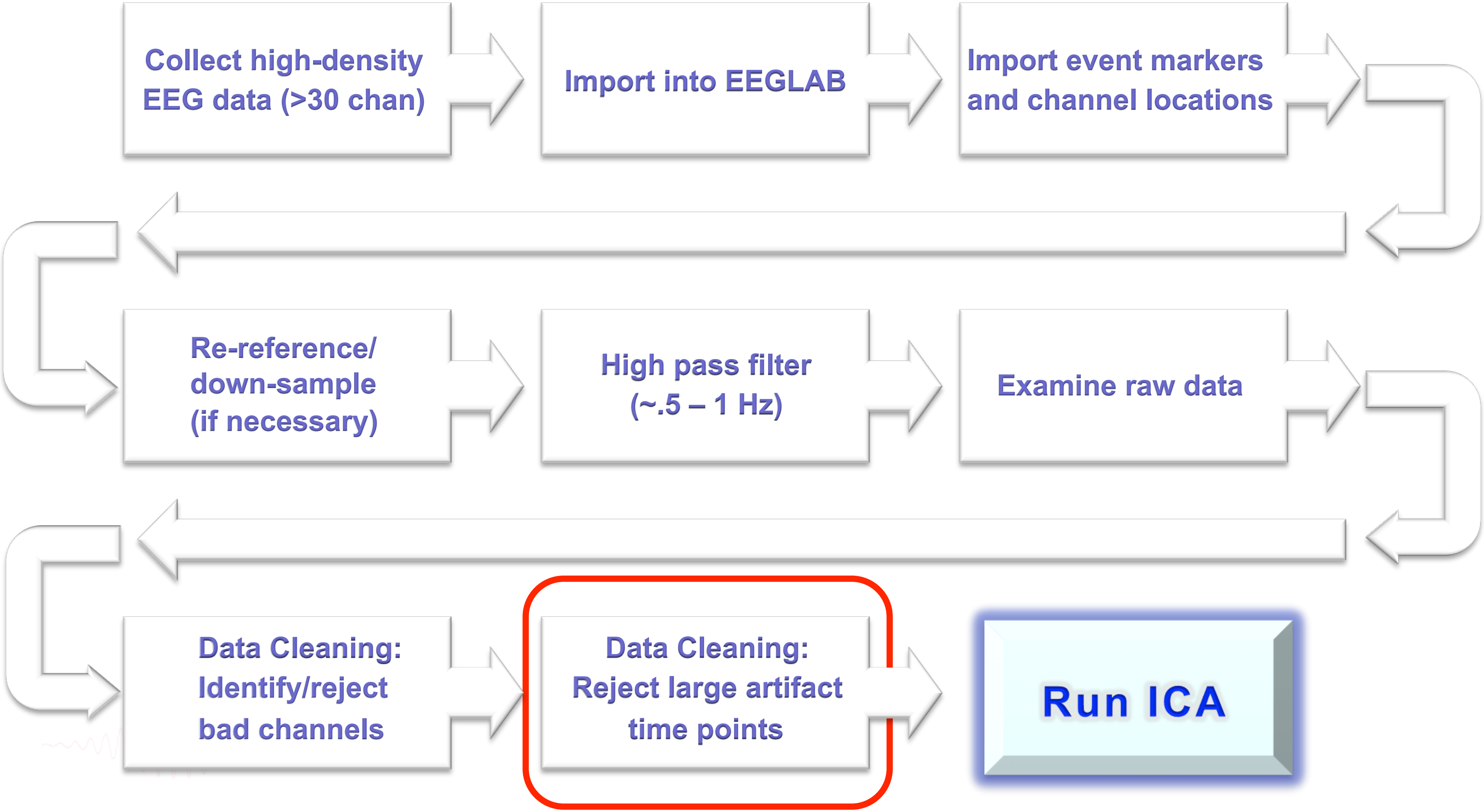

EEGLAB v7.1.7.18b
File
Edit
Tools
Plot
Study
Datasets
Help
#2:
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Warning
Cancel
Continue

Mark stretches of continuous data for rejection by dragging the left mouse button. Click on marked stretches to unmark. When done,press "REJECT" to excise marked stretches (Note: Leaves rejection boundary markers in the event table).

Pre-processing pipeline



Swartz Center for Computational Neuroscience



Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

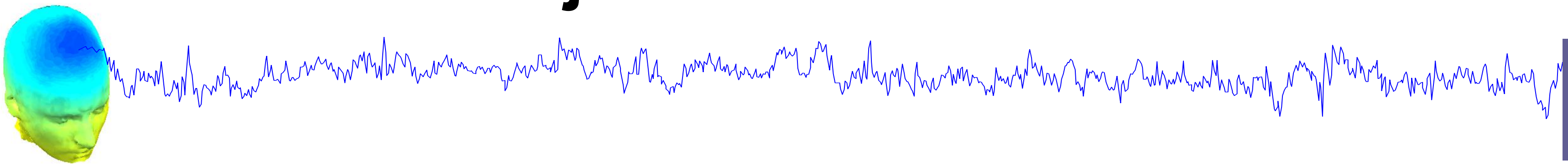
Examine raw data

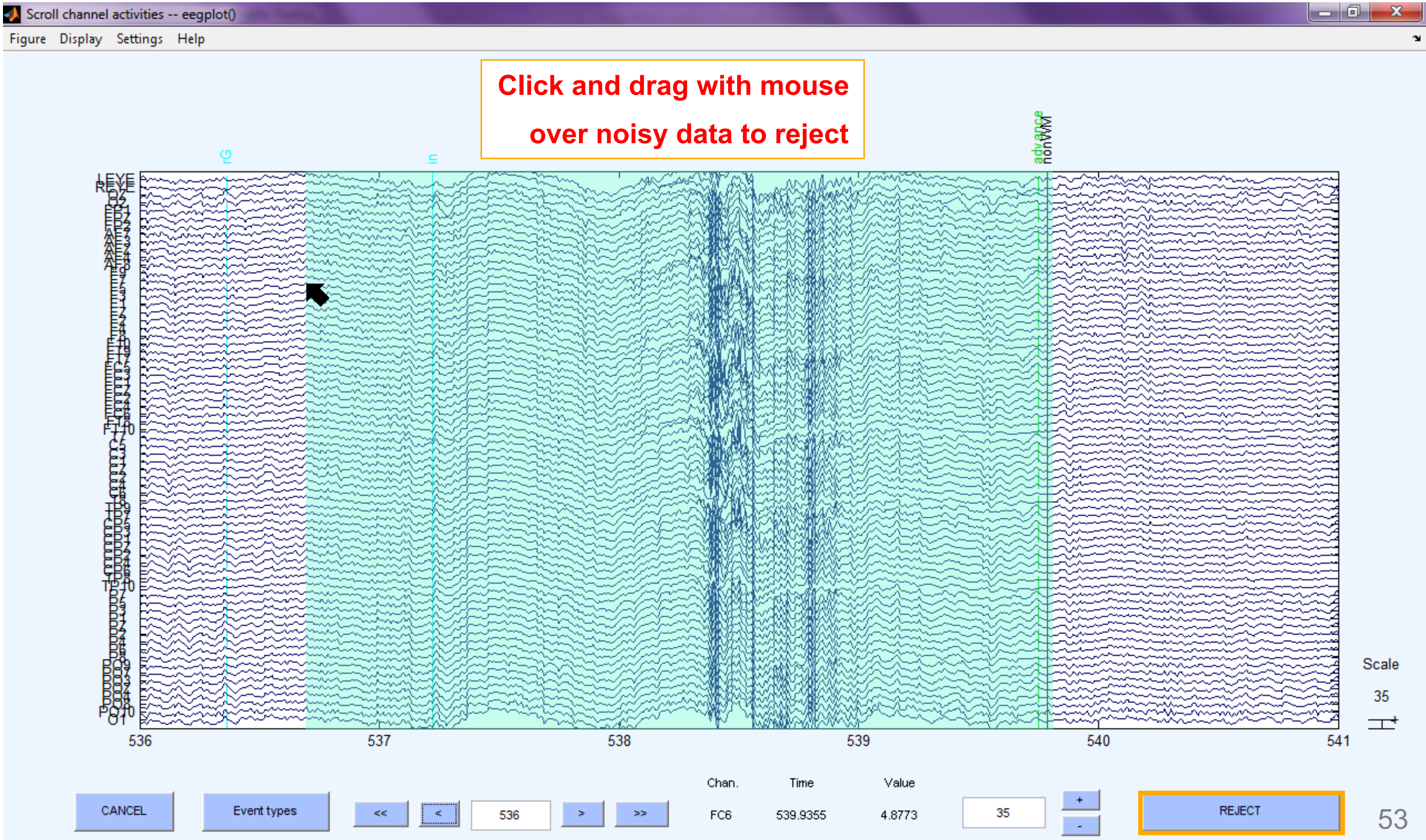
Data Cleaning: Identify/reject bad channels

Data Cleaning: Reject large artifact time points

Run ICA

Reject continuous data

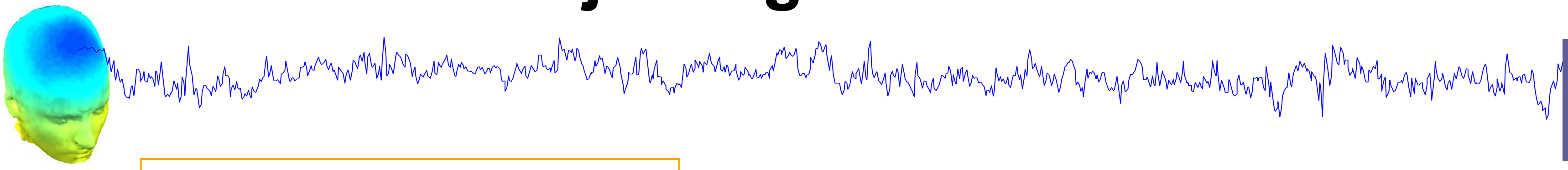



Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
rG
in
advance
nonWM
536
537
538
539
540
541
Scale
35
CANCEL
Event types
<<
<
536
>
>>
35
+
-
REJECT

Click and drag with mouse over noisy data to reject

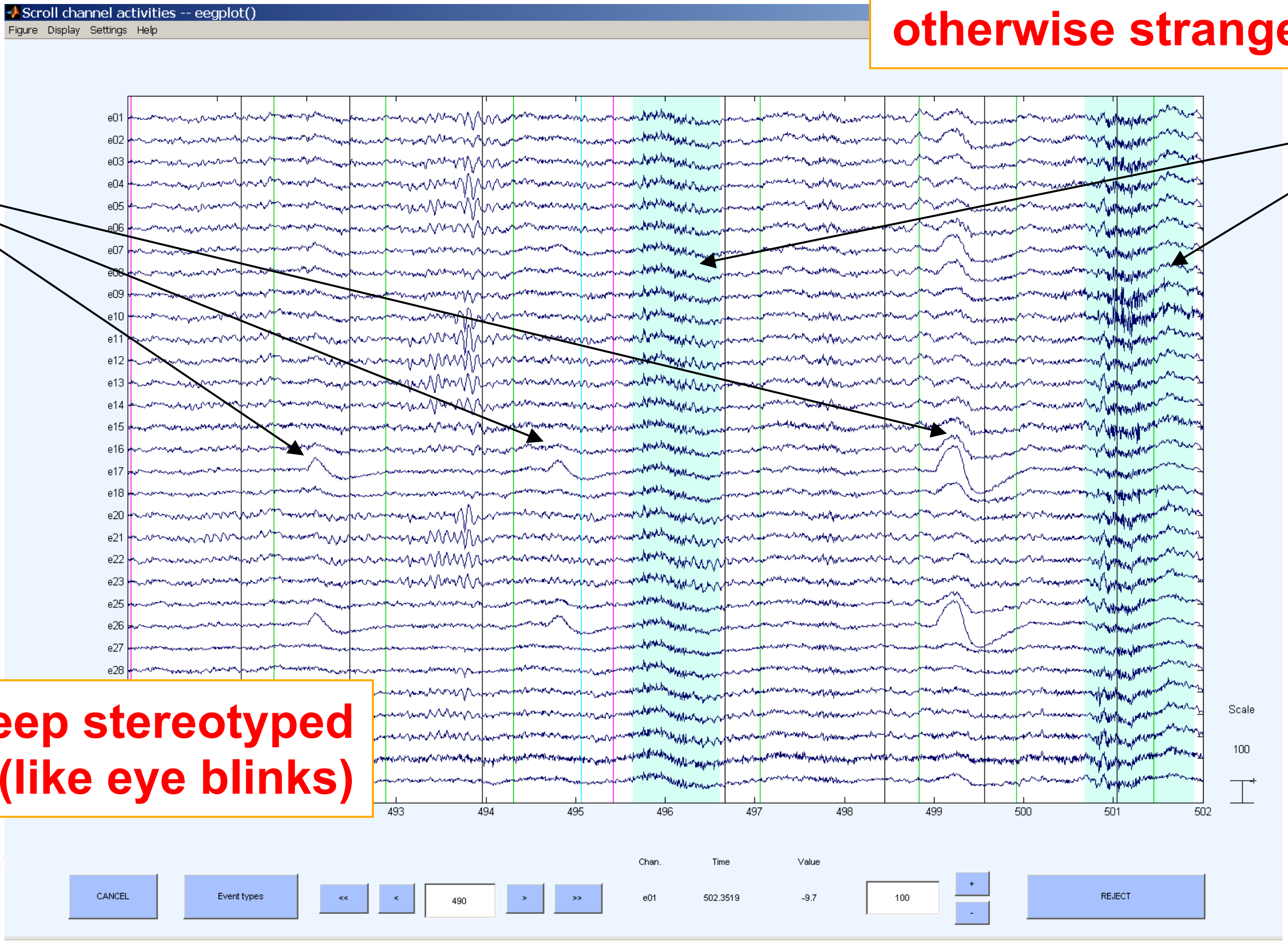
Chan.	Time	Value
FC6	539.9355	4.8773

Rejecting data for ICA



To prepare data for ICA:

Reject large muscle or otherwise strange events...


Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
e01
e02
e03
e04
e05
e06
e07
e08
e09
e10
e11
e12
e13
e14
e15
e16
e17
e18
e20
e21
e22
e23
e25
e26
e27
e28
493
494
495
496
497
498
499
500
501
502
Scale
100
CANCEL
Event types
<<
<
490
>
>>
100
+
-
REJECT

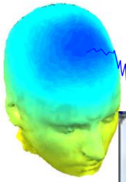
Chan. e01
Time 502.3519
Value -9.7

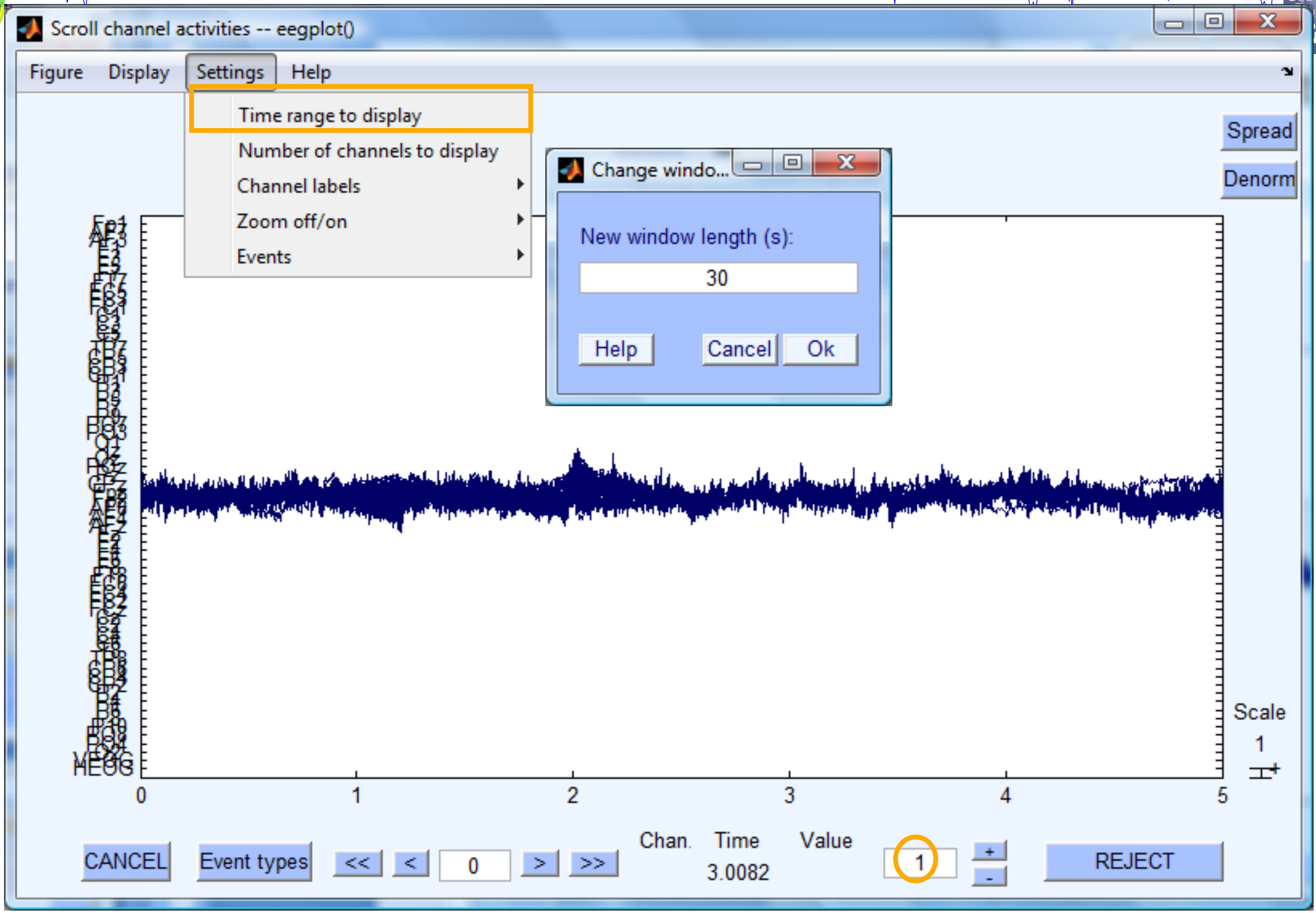
Reject

Keep

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

Fast (but sloppy) artifact rejection





Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
Time range to display
Number of channels to display
Channel labels
Zoom off/on
Events
Spread
Denorm
Change windo...
Help
Cancel
Ok
0
1
2
3
4
5
Scale
1
+
-
CANCEL
Event types
<<
<
>
>>
REJECT

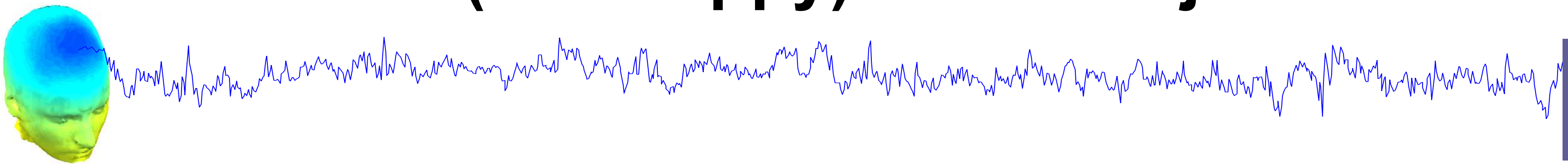
New window length (s): 30

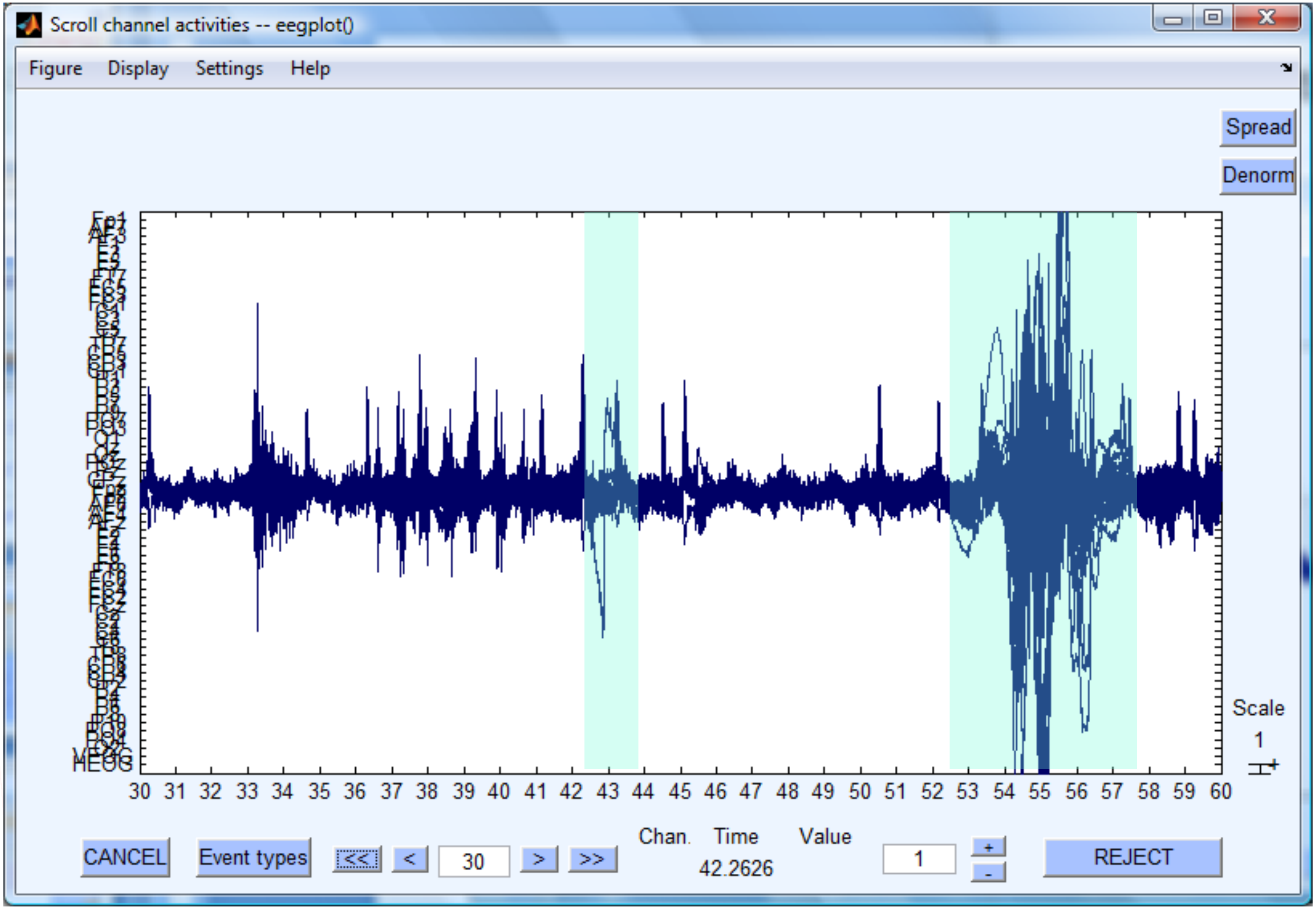
Chan. Time 3.0082 Value

0

1

Fast (but sloppy) artifact rejection

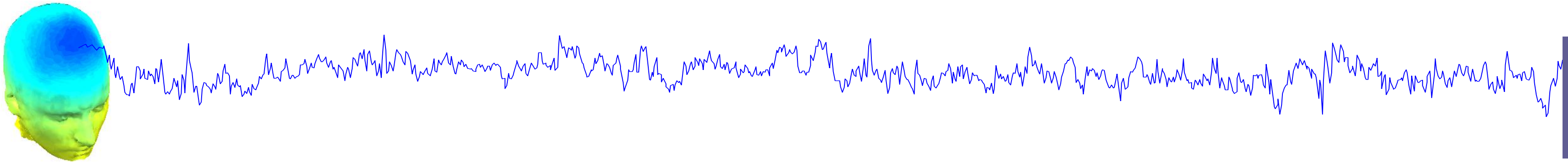



Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
Spread
Denorm
Fp1
AF3
Scale
1
30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
CANCEL
Event types
<<
<
>
>>
+
-
REJECT

30

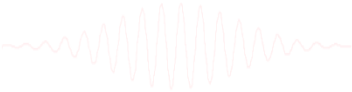
Chan. Time Value
42.2626

1

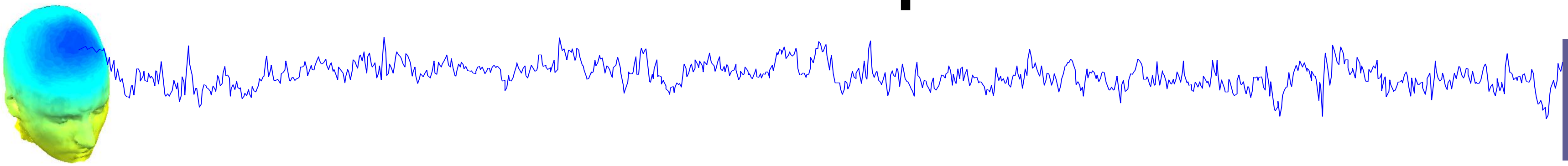


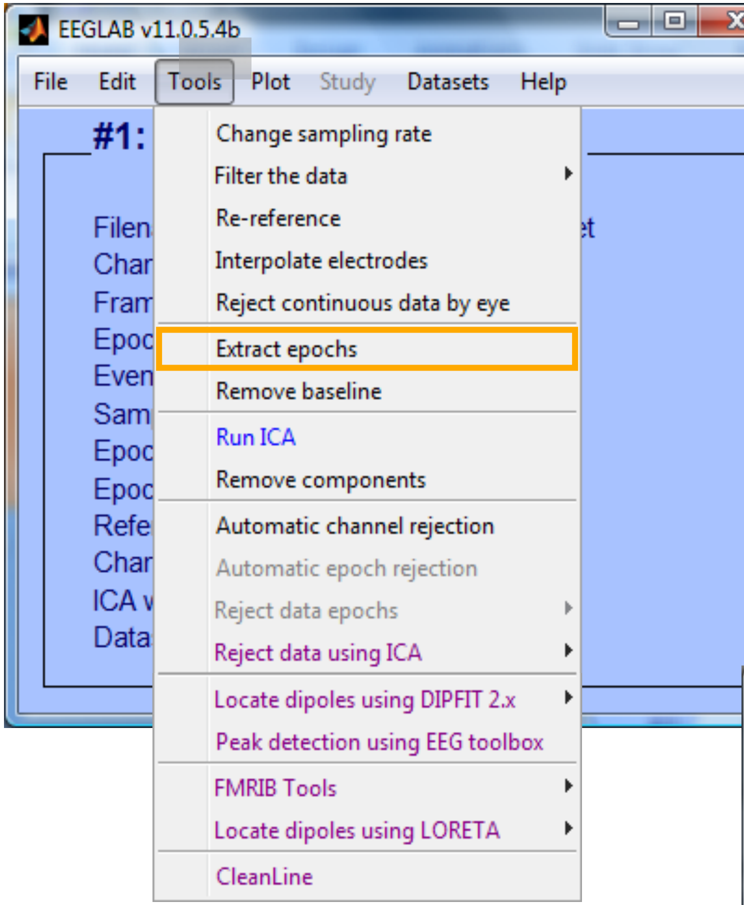
Data Cleaning for ICA

Variant 2: Epoched Data



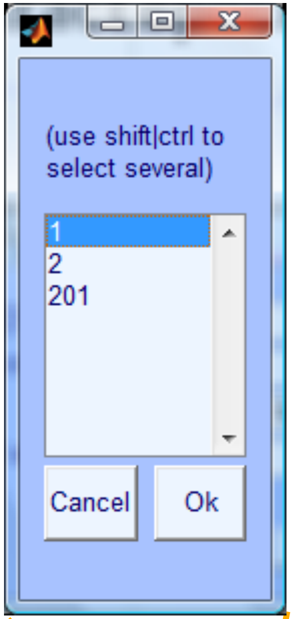
Extract epochs



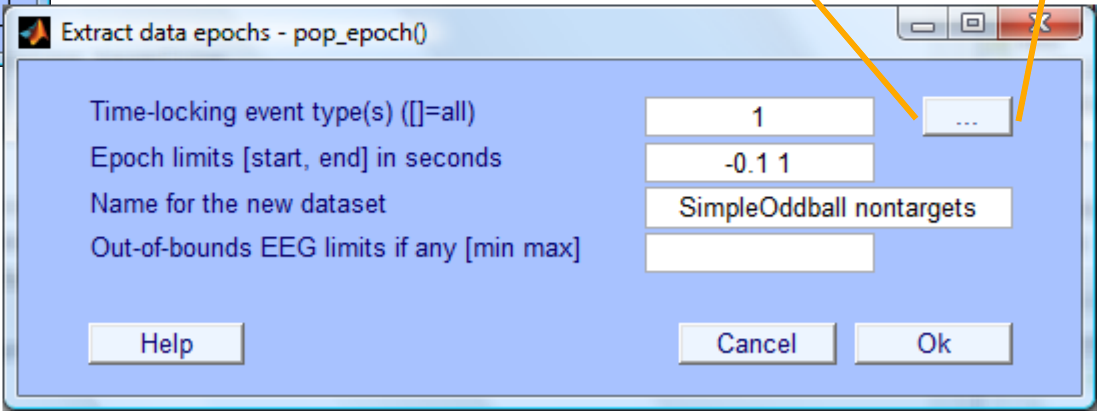


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#1:
Change sampling rate
Filter the data
Re-reference
Interpolate electrodes
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic channel rejection
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using DIPFIT 2.x
Peak detection using EEG toolbox
FMRIB Tools
Locate dipoles using LORETA
CleanLine

```
>> eeg_eventtypes(EEG)
   1       140
   2       60
   201     60
```



(use shift|ctrl to select several)
1
2
201
Cancel
Ok



Extract data epochs - pop_epoch()

Time-locking event type(s) ([]=all): 1

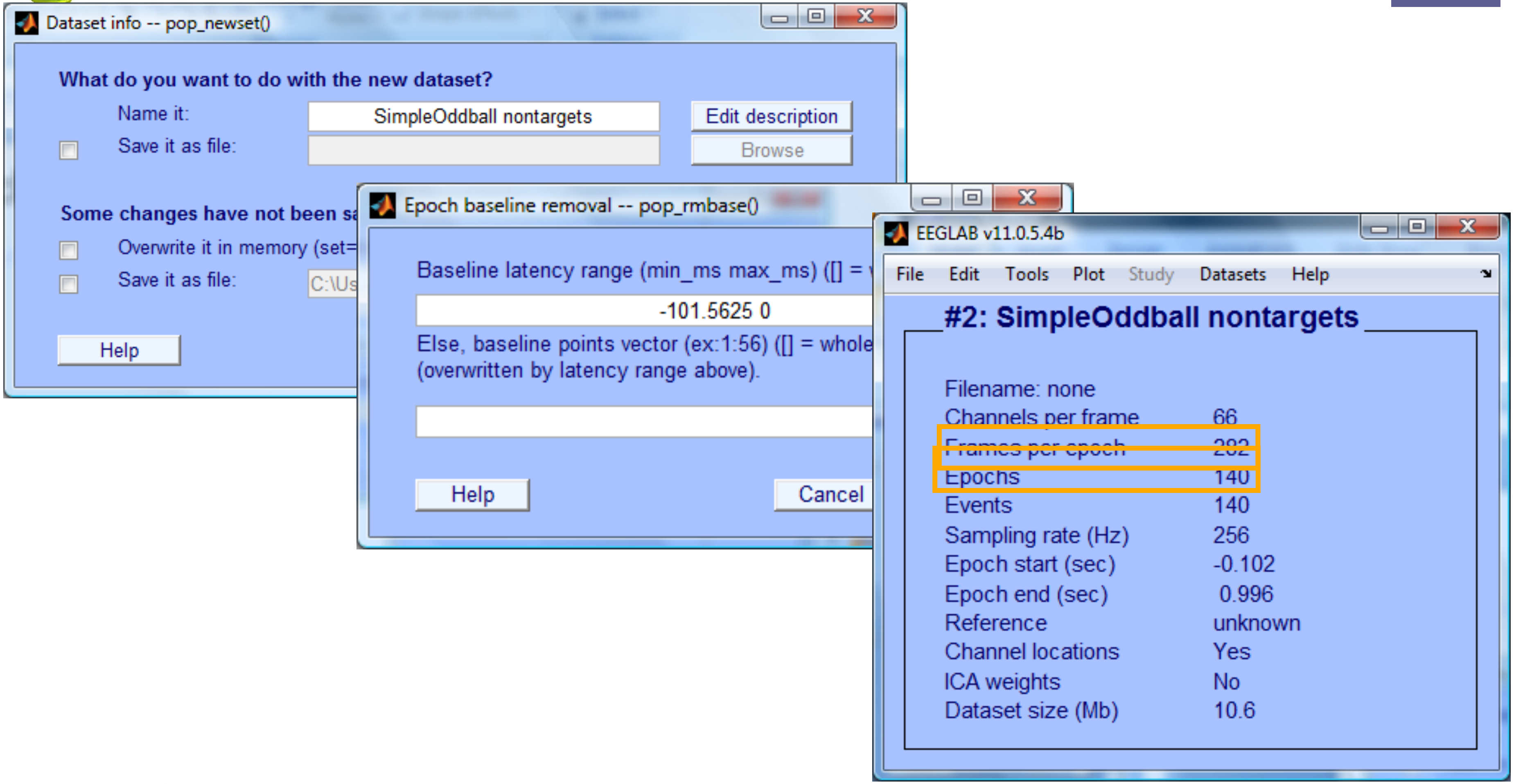
Epoch limits [start, end] in seconds: -0.1 1

Name for the new dataset: SimpleOddball nontargets

Out-of-bounds EEG limits if any [min max]:

...
Help
Cancel
Ok

Extract epochs


Dataset info -- pop_newset()
Edit description
Browse
Help
Epoch baseline removal -- pop_rmbase()
Help
Cancel
EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help

What do you want to do with the new dataset?

Name it: SimpleOddball nontargets

☐ Save it as file:

Some changes have not been sa

☐ Overwrite it in memory (set=

☐ Save it as file: C:\Us

Baseline latency range (min_ms max_ms) ([] = w

-101.5625 0

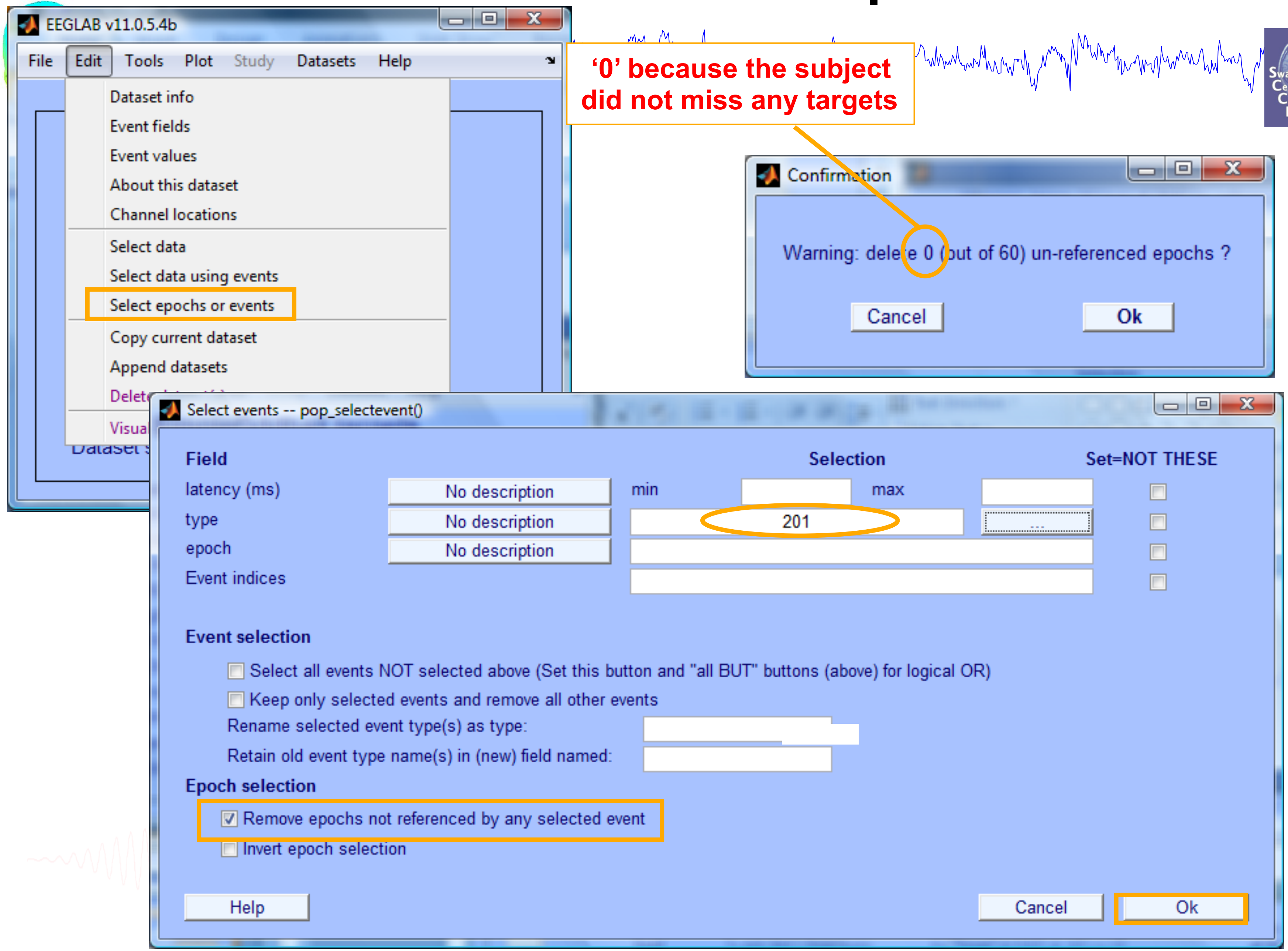
Else, baseline points vector (ex:1:56) ([] = whole

(overwritten by latency range above).

#2: SimpleOddball nontargets

Filename: none	
Channels per frame	66
Frames per epoch	282
Epochs	140
Events	140
Sampling rate (Hz)	256
Epoch start (sec)	-0.102
Epoch end (sec)	0.996
Reference	unknown
Channel locations	Yes
ICA weights	No
Dataset size (Mb)	10.6

Select a subset of epochs


EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Dataset info
Event fields
Event values
About this dataset
Channel locations
Select data
Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete
Visual
Select events -- pop_selectevent()
Confirmation
Cancel
Ok
Help

‘0’ because the subject did not miss any targets

Warning: delete 0 (out of 60) un-referenced epochs ?

Field		Selection			Set=NOT THESE
latency (ms)	No description	min		max	☐
type	No description	201		...	☐
epoch	No description				☐
Event indices					☐

Event selection

☐ Select all events NOT selected above (Set this button and "all BUT" buttons (above) for logical OR)

☐ Keep only selected events and remove all other events

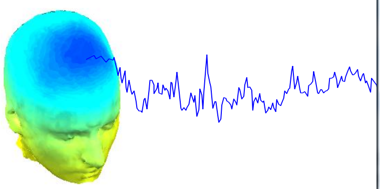
Rename selected event type(s) as type:

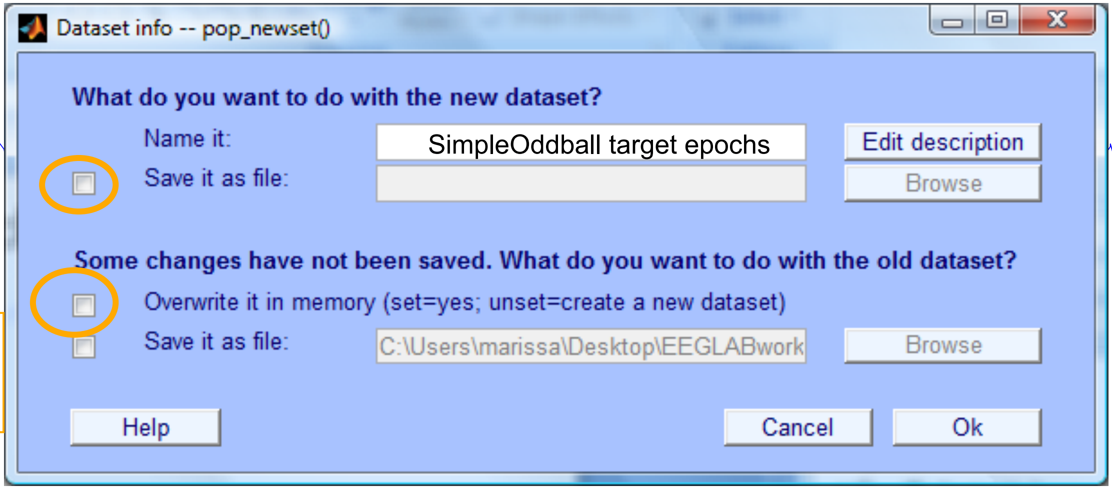
Retain old event type name(s) in (new) field named:

Epoch selection

☑ Remove epochs not referenced by any selected event

☐ Invert epoch selection





Dataset info -- pop_newset()

What do you want to do with the new dataset?

☐ Name it: SimpleOddball target epochs

☐ Save it as file:

Some changes have not been saved. What do you want to do with the old dataset?

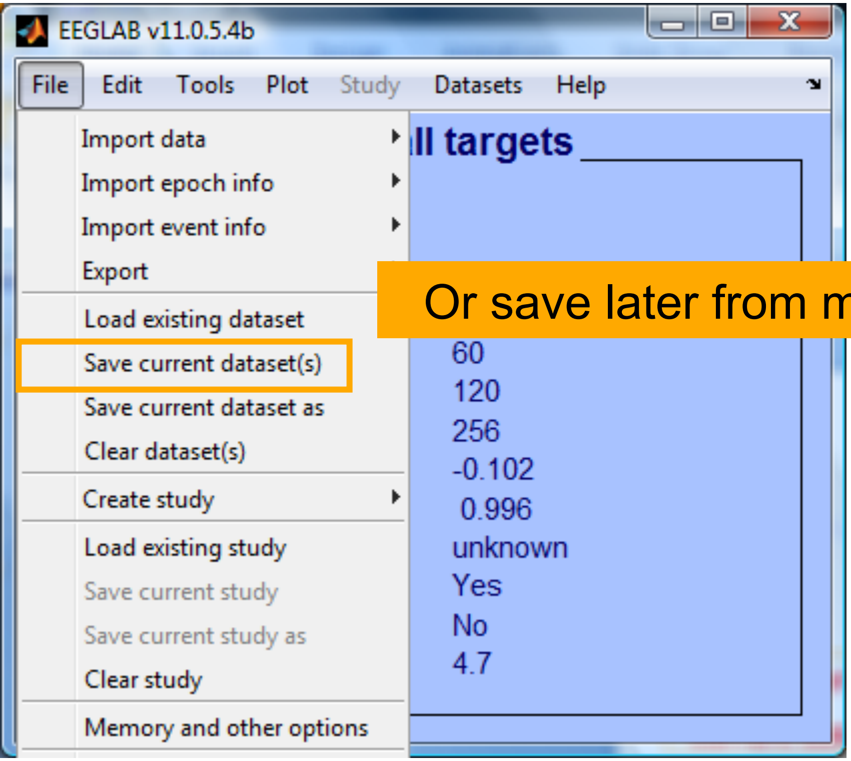
☐ Overwrite it in memory (set=yes; unset=create a new dataset)

☐ Save it as file: C:\Users\marissa\Desktop\EEGLABwork

Edit description
Browse
Browse
Help
Cancel
Ok

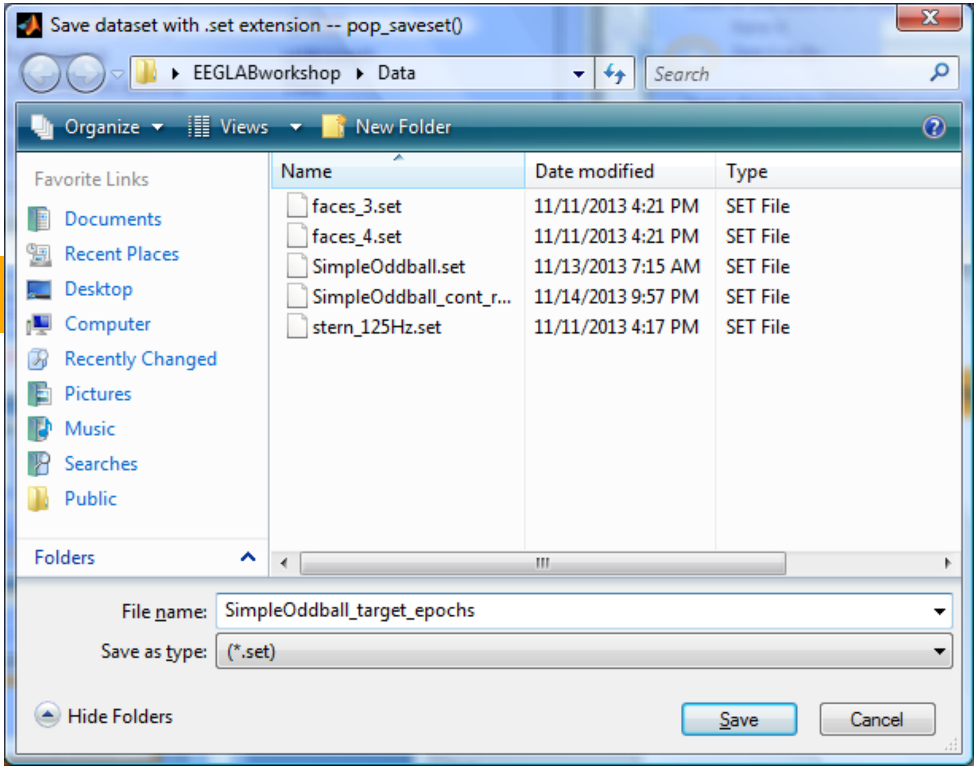
'Do not overwrite current dataset'

Save dataset (optional)



EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
Import data
Import epoch info
Import event info
Export
Load existing dataset
Save current dataset(s)
Save current dataset as
Clear dataset(s)
Create study
Load existing study
Save current study
Save current study as
Clear study
Memory and other options
ll targets
60
120
256
-0.102
0.996
unknown
Yes
No
4.7

Or save later from menu



Save dataset with .set extension -- pop_saveset()

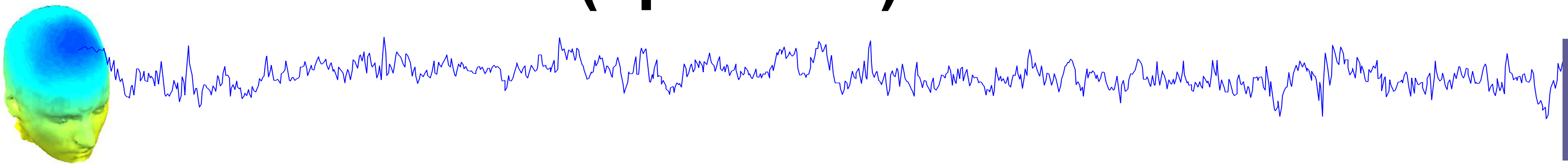
Name	Date modified	Type
faces_3.set	11/11/2013 4:21 PM	SET File
faces_4.set	11/11/2013 4:21 PM	SET File
SimpleOddball.set	11/13/2013 7:15 AM	SET File
SimpleOddball_cont_r...	11/14/2013 9:57 PM	SET File
stern_125Hz.set	11/11/2013 4:17 PM	SET File

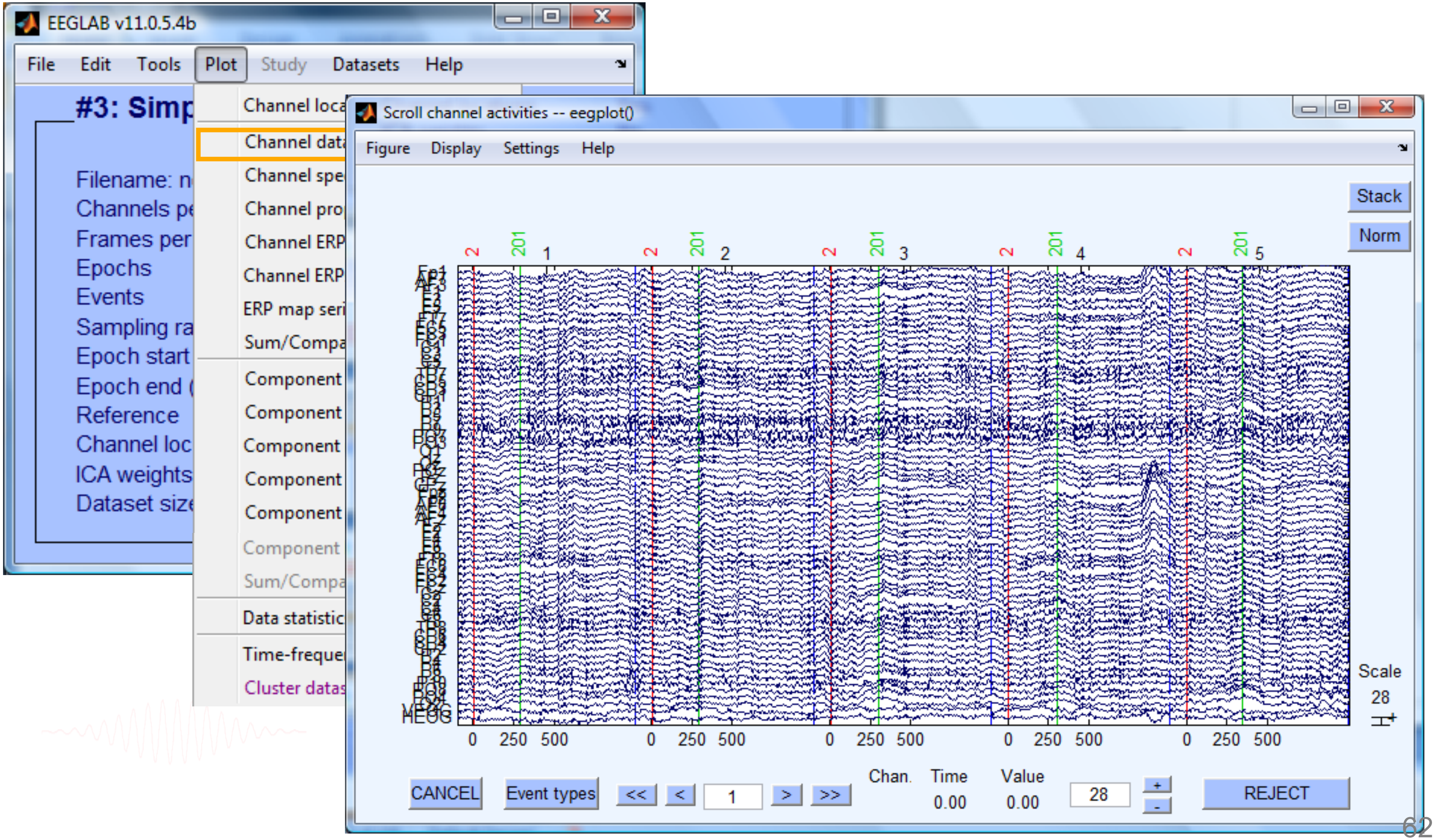
File name: SimpleOddball_target_epochs

Save as type: (*.set)

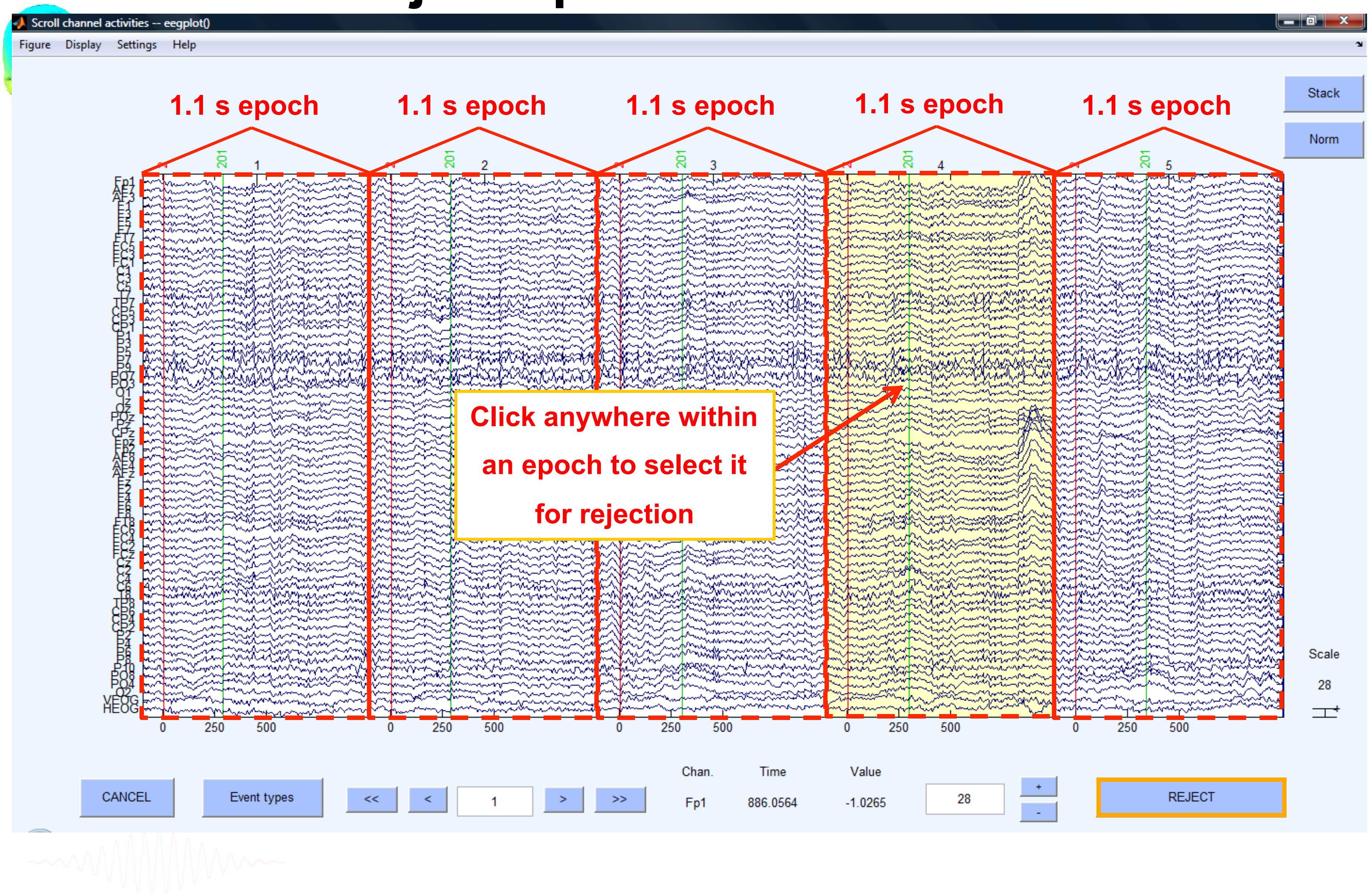
EEGLABworkshop
Data
Search
Organize
Views
New Folder
Favorite Links
Documents
Recent Places
Desktop
Computer
Recently Changed
Pictures
Music
Searches
Public
Folders
Hide Folders
Save
Cancel

Scroll (epoched) channel data




EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#3: Simp
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel loca
Channel data
Channel spe
Channel pro
Channel ERP
Channel ERP
ERP map seri
Sum/Compa
Component
Component
Component
Component
Component
Component
Sum/Compa
Data statistic
Time-freque
Cluster datas
Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
Stack
Norm
2
201
1
2
3
4
5
Fp1
AF3
HEOG
0
250
500
Scale
28
CANCEL
Event types
<<
<
1
>
>>
Chan.
Time
0.00
Value
0.00
28
+
-
REJECT

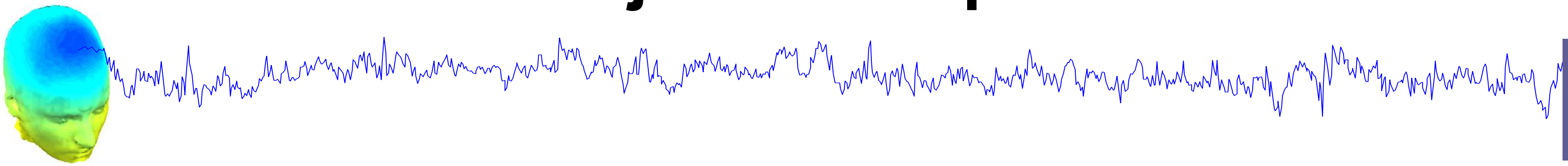
Reject epochs with artifact

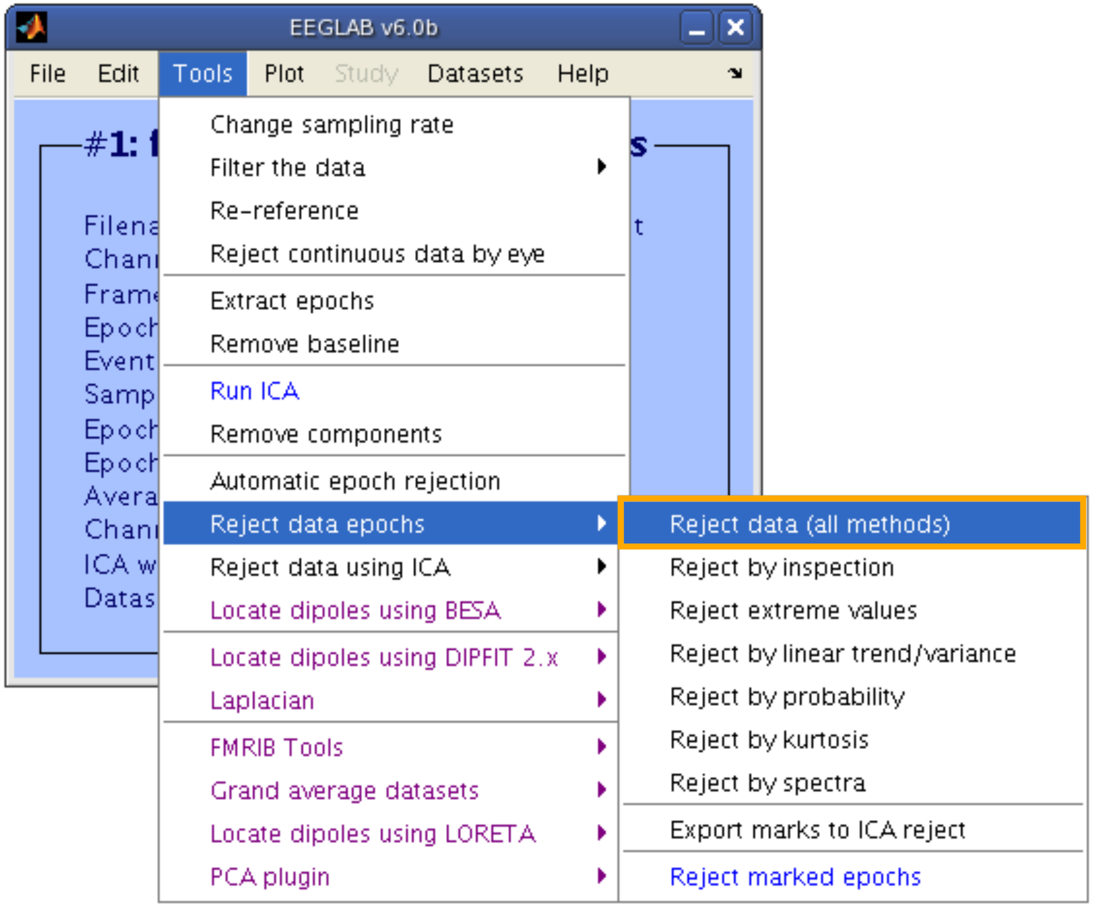

Scroll channel activities -- eegplot()
Figure
Display
Settings
Help
1.1 s epoch
1.1 s epoch
1.1 s epoch
1.1 s epoch
1.1 s epoch
201
1
2
3
4
5
Fp1
VEOG
HEOG
0
250
500
Stack
Norm
Scale
28
CANCEL
Event types
<<
<
>
>>
+
-
REJECT

Chan.	Time	Value
Fp1	886.0564	-1.0265

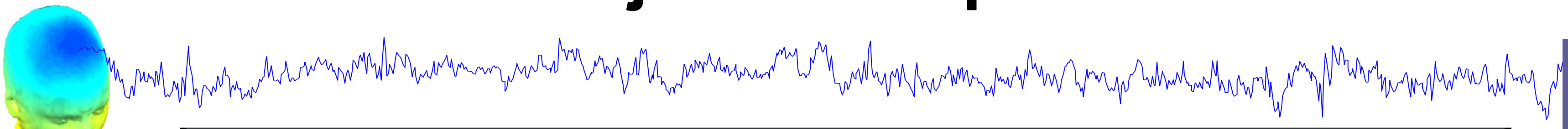
Click anywhere within an epoch to select it for rejection

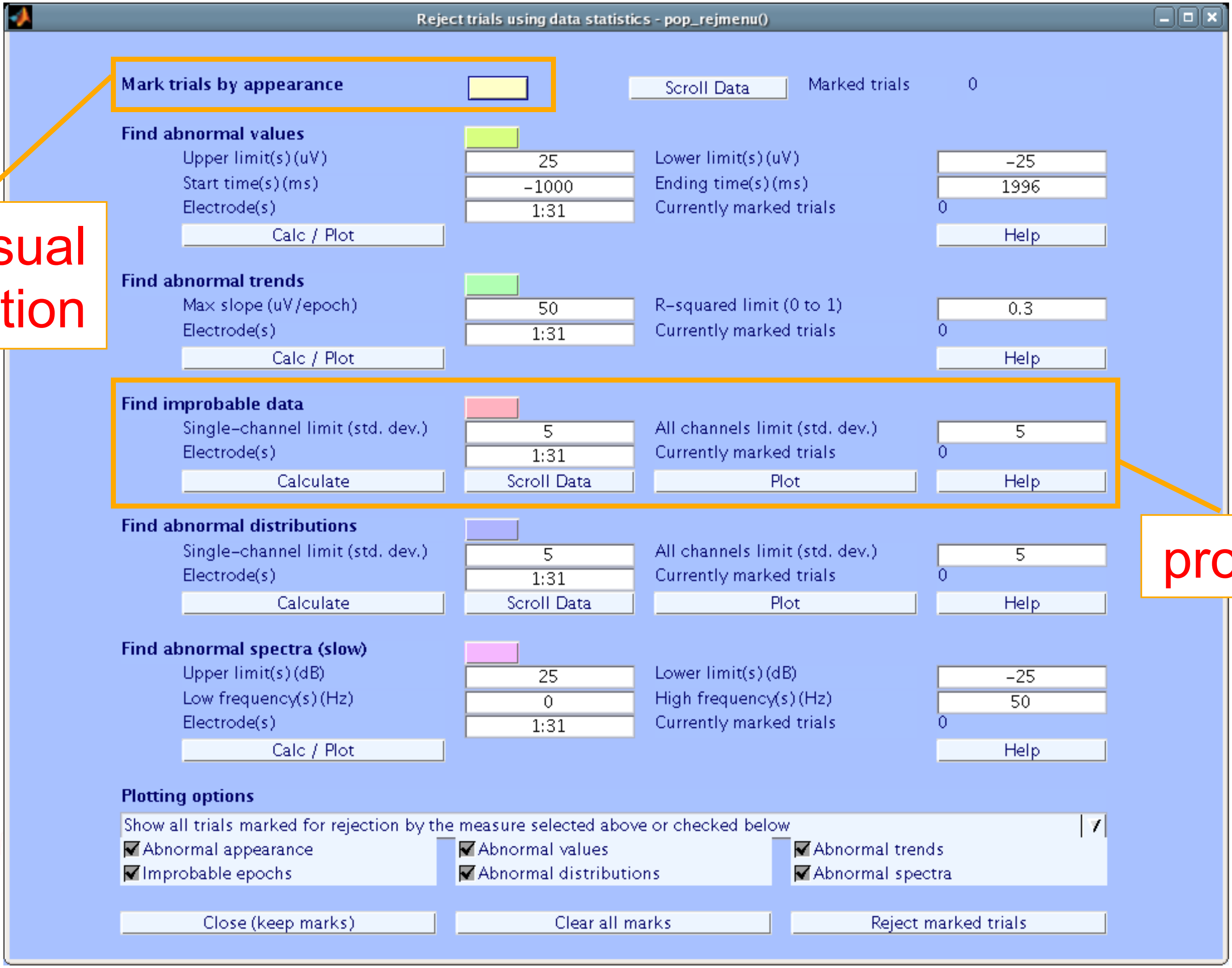
Reject data epochs




EEGLAB v6.0b
File
Edit
Tools
Plot
Study
Datasets
Help
#1:
Filena
Chan
Frame
Epoch
Event
Samp
Epoch
Epoch
Avera
Chan
ICA w
Datas
Change sampling rate
Filter the data
Re-reference
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using BESA
Locate dipoles using DIPFIT 2.x
Laplacian
FMRIB Tools
Grand average datasets
Locate dipoles using LORETA
PCA plugin
Reject data (all methods)
Reject by inspection
Reject extreme values
Reject by linear trend/variance
Reject by probability
Reject by kurtosis
Reject by spectra
Export marks to ICA reject
Reject marked epochs

Reject data epochs





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

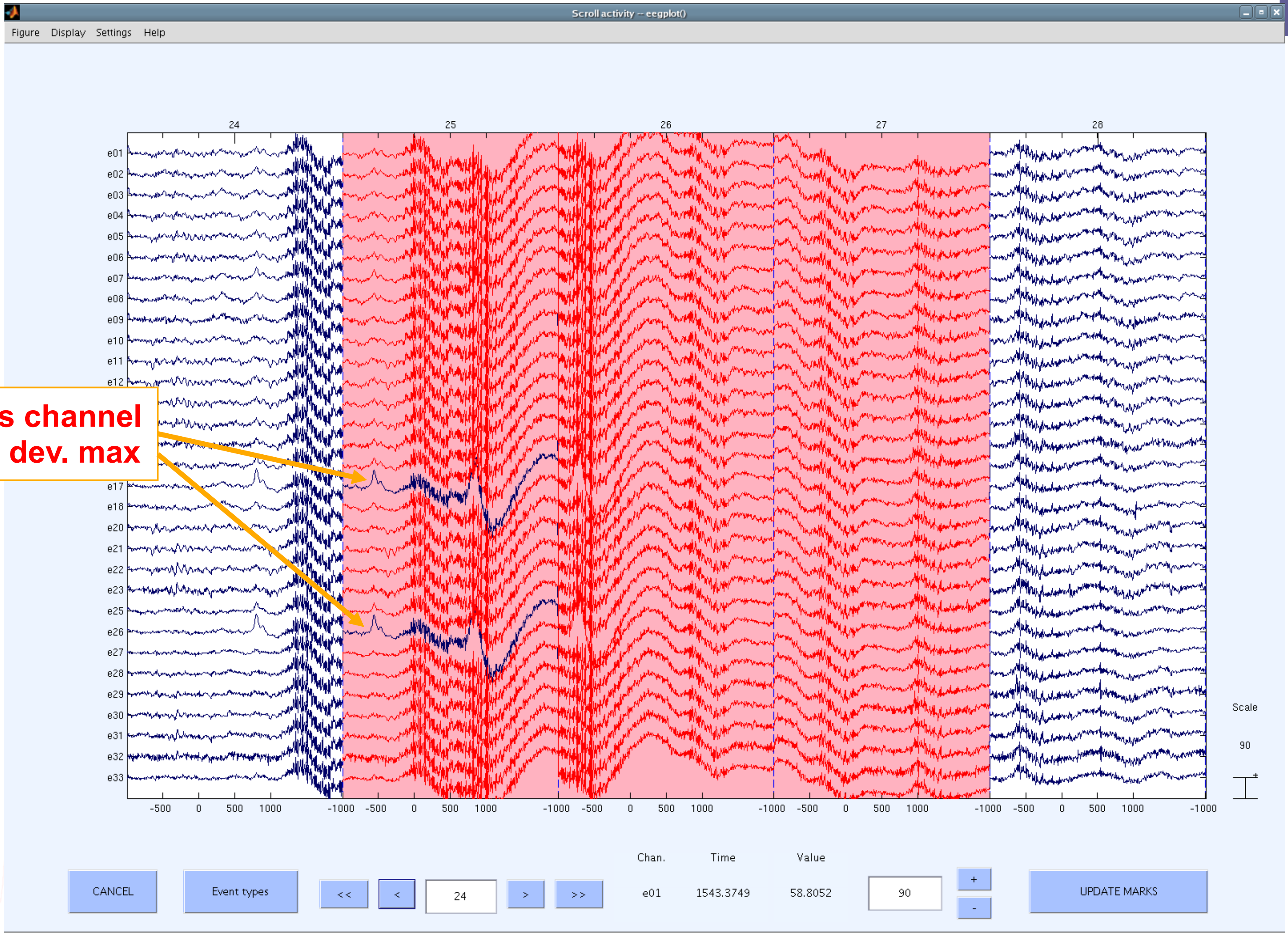
☑ Abnormal appearance ☑ Abnormal values ☑ Abnormal trends
☑ Improbable epochs ☑ Abnormal distributions ☑ Abnormal spectra

Close (keep marks) Clear all marks Reject marked trials

visual inspection

probability

Reject data epochs


Scroll activity -- eegplot()
Figure
Display
Settings
Help
24
25
26
27
28
e01
e02
e03
e04
e05
e06
e07
e08
e09
e10
e11
e12
e17
e18
e20
e21
e22
e23
e25
e26
e27
e28
e29
e30
e31
e32
e33
-500
0
500
1000
-1000
Scale
CANCEL
Event types
<<
<
>
>>
+
-
UPDATE MARKS

Chan. e01

Time 1543.3749

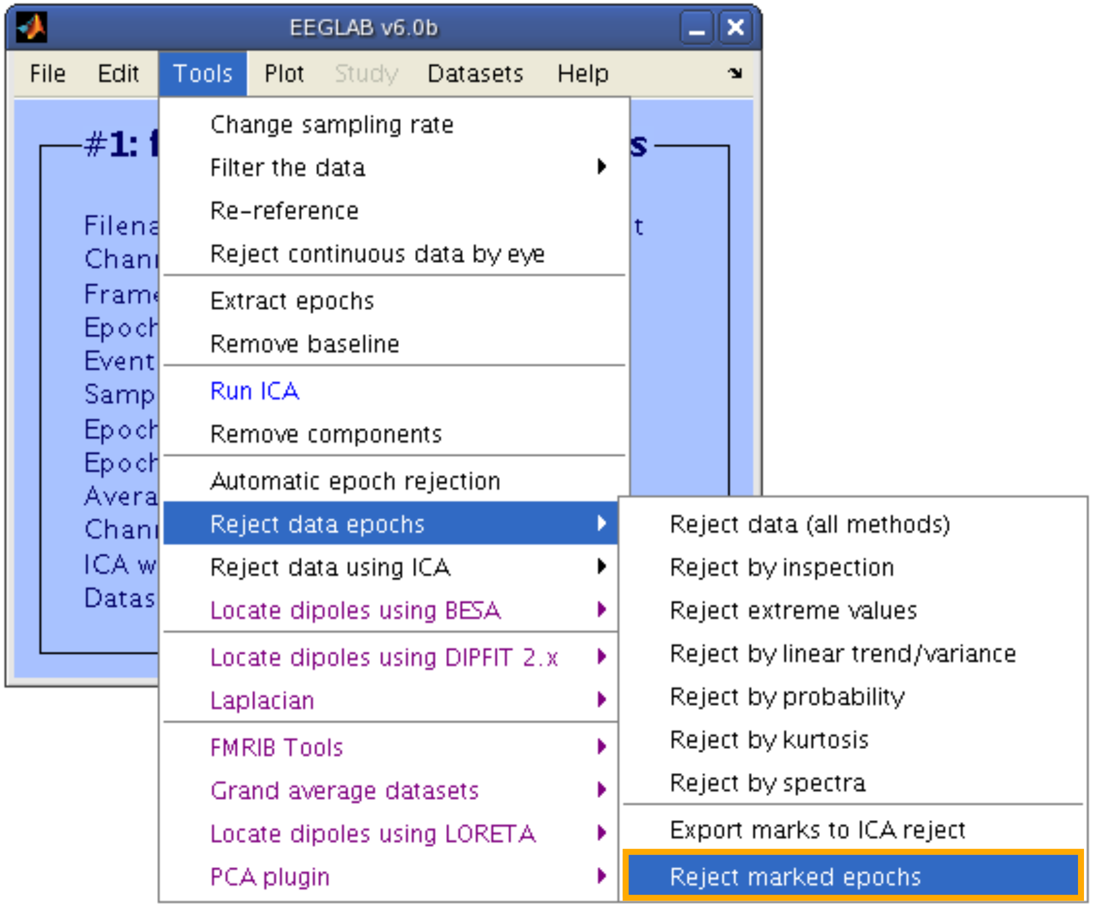
Value 58.8052

Scale 90

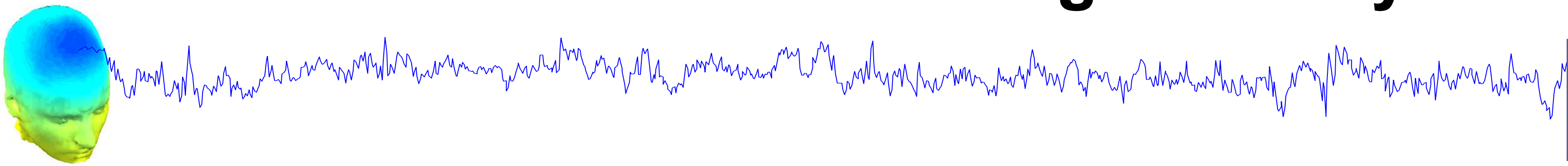
Epoch 24

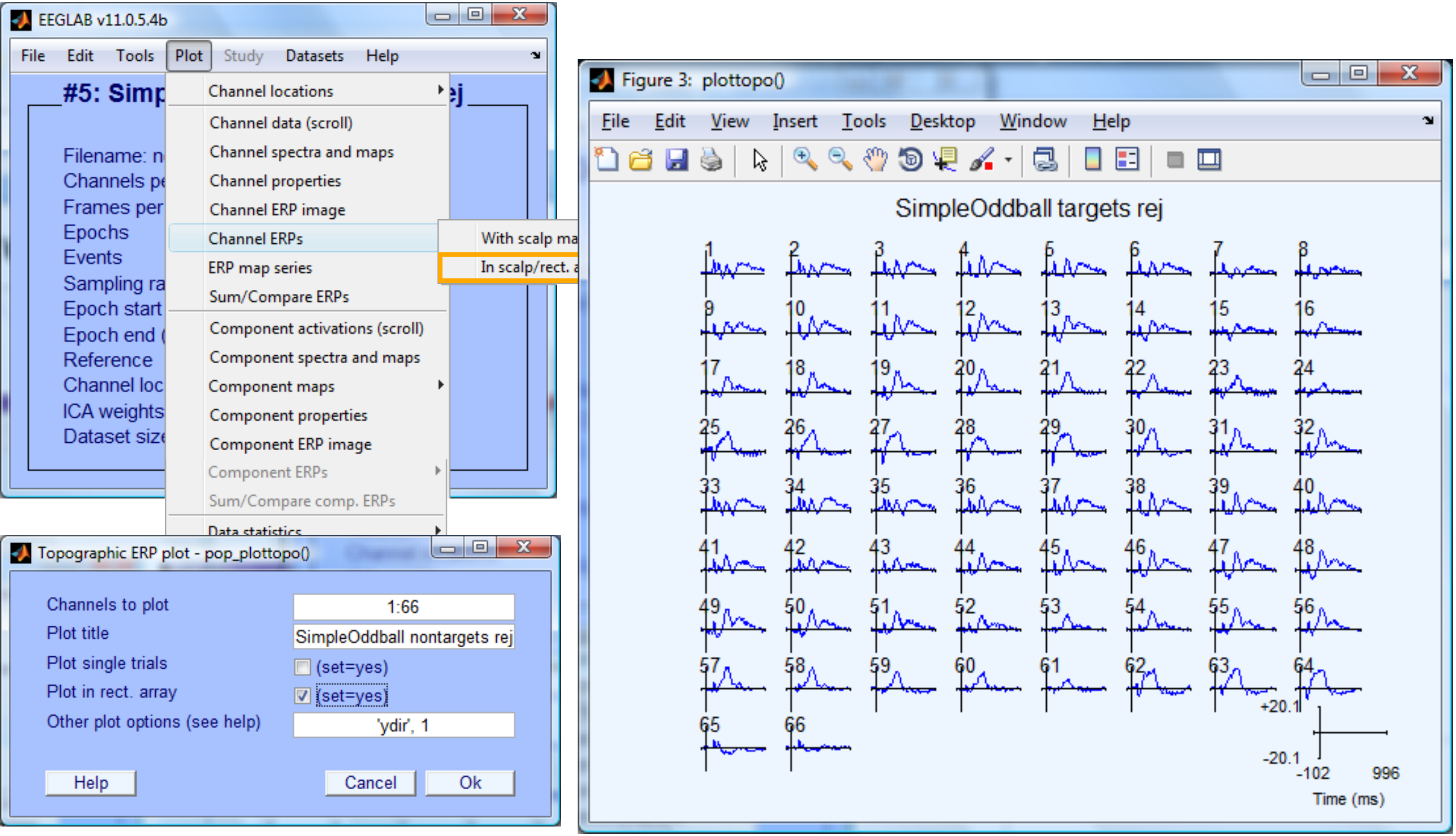
Exceeds channel standard dev. max

Reject data epochs


EEGLAB v6.0b
File
Edit
Tools
Plot
Study
Datasets
Help
Change sampling rate
Filter the data
Re-reference
Reject continuous data by eye
Extract epochs
Remove baseline
Run ICA
Remove components
Automatic epoch rejection
Reject data epochs
Reject data using ICA
Locate dipoles using BESA
Locate dipoles using DIPFIT 2.x
Laplacian
FMRIB Tools
Grand average datasets
Locate dipoles using LORETA
PCA plugin
Reject data (all methods)
Reject by inspection
Reject extreme values
Reject by linear trend/variance
Reject by probability
Reject by kurtosis
Reject by spectra
Export marks to ICA reject
Reject marked epochs

Visualize ERP in rectangular array





Channels to plot: 1:66

Plot title: SimpleOddball nontargets rej

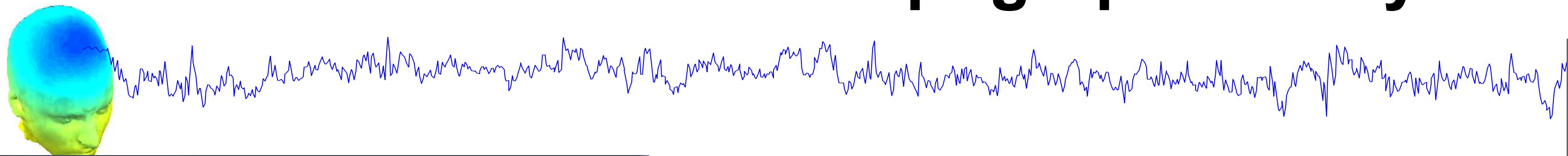
Plot single trials ☐ (set=yes)

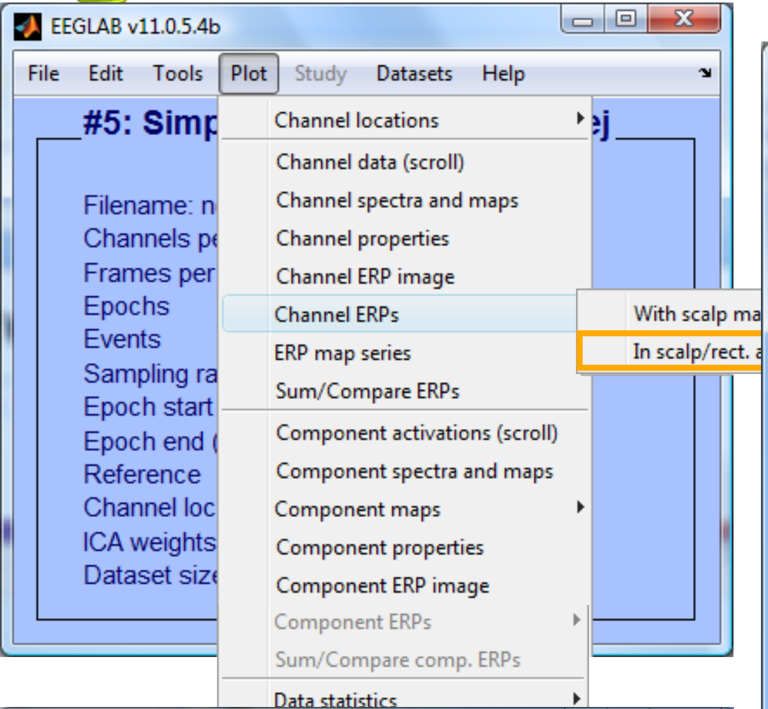
Plot in rect. array ☑ (set=yes)

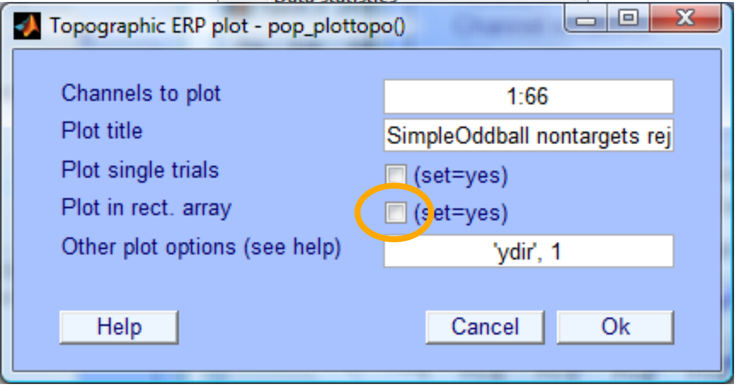
Other plot options (see help): 'ydir', 1

EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#5: Simp
ej
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
With scalp ma
In scalp/rect. a
Topographic ERP plot - pop_plottopo()
Help
Cancel
Ok
Figure 3: plottopo()
File
Edit
View
Insert
Tools
Desktop
Window
Help
SimpleOddball targets rej
1 2 3 4 5 6 7 8
9 10 11 12 13 14 15 16
17 18 19 20 21 22 23 24
25 26 27 28 29 30 31 32
33 34 35 36 37 38 39 40
41 42 43 44 45 46 47 48
49 50 51 52 53 54 55 56
57 58 59 60 61 62 63 64
65 66
+20.1
-20.1
-102
996
Time (ms)

Visualize ERP in topographic array




EEGLAB v11.0.5.4b
File
Edit
Tools
Plot
Study
Datasets
Help
#5: Simp
ej
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
With scalp ma
In scalp/rect. a


Topographic ERP plot - pop_plottopo()

Channels to plot: 1:66

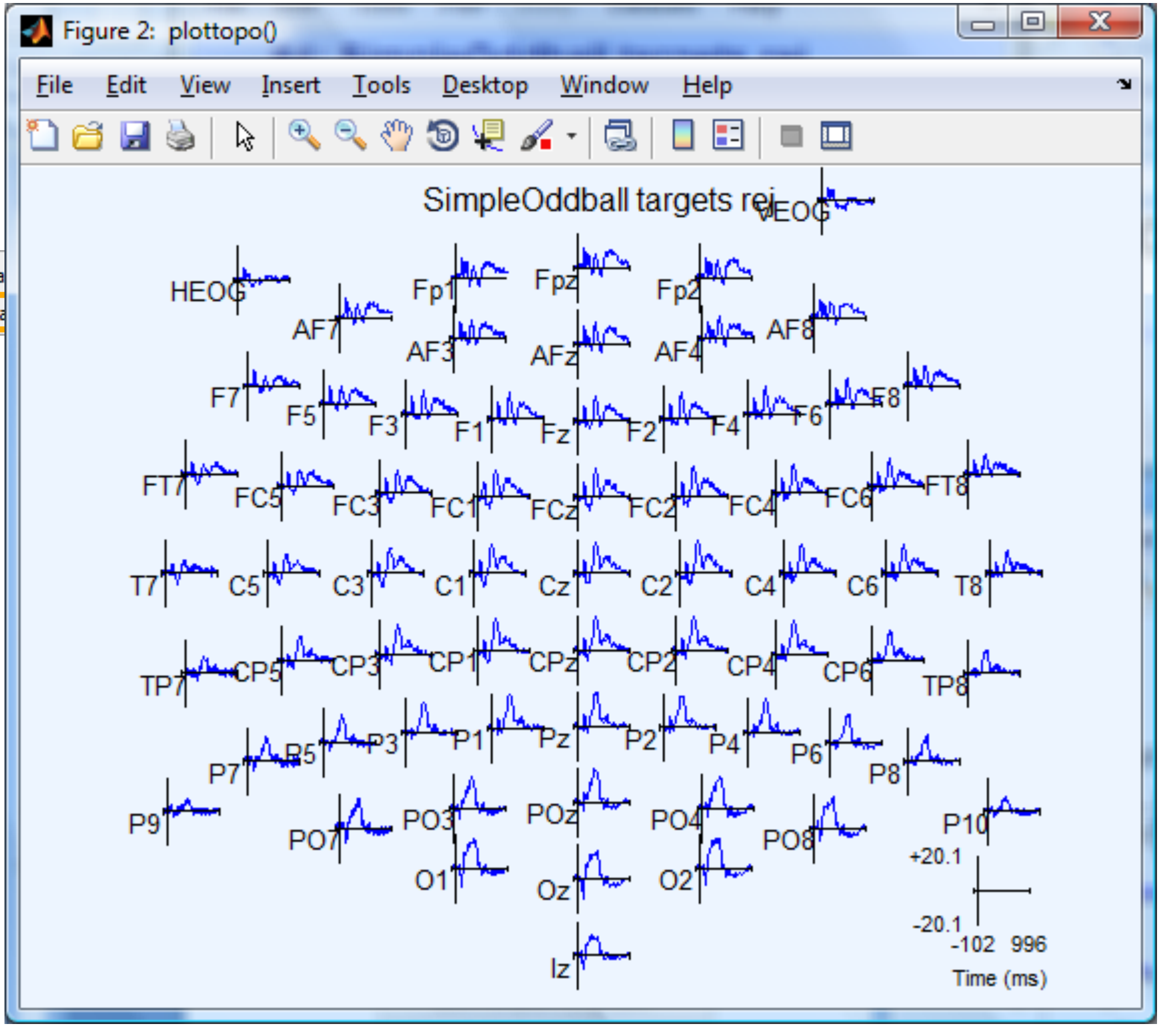
Plot title: SimpleOddball nontargets rej

Plot single trials ☐ (set=yes)

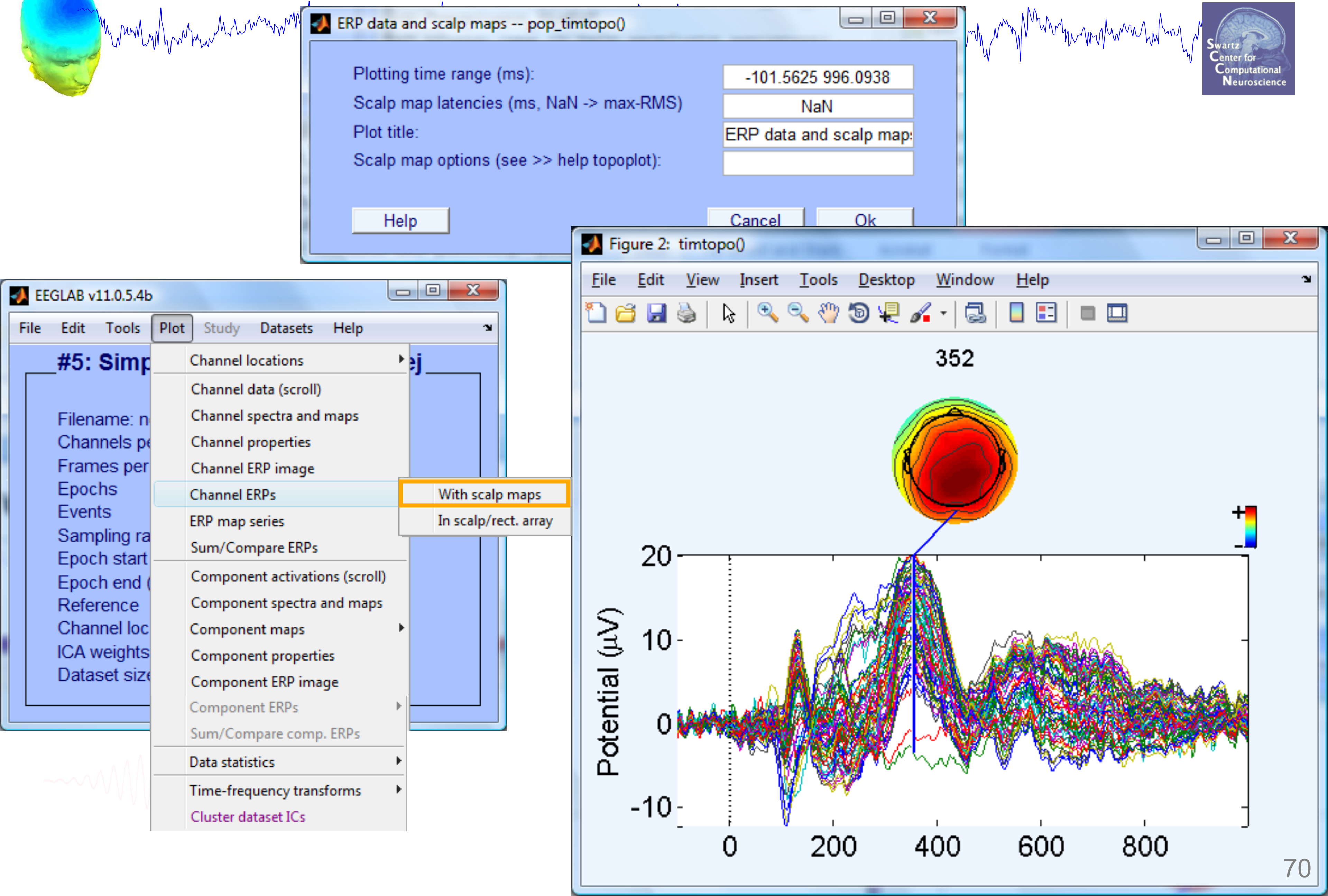
Plot in rect. array ☐ (set=yes)

Other plot options (see help): 'ydir', 1

Help
Cancel
Ok



Visualize ERP scalp distribution



ERP data and scalp maps -- pop_timtopo()

Plotting time range (ms): -101.5625 996.0938

Scalp map latencies (ms, NaN -> max-RMS): NaN

Plot title: ERP data and scalp map:

Scalp map options (see >> help topoplot):

Help
Cancel
Ok
EEGLAB v11.0.5.4b
File
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Datasets
Help
#5: Simp
ej
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs
With scalp maps
In scalp/rect. array
Figure 2: timtopo()
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Window
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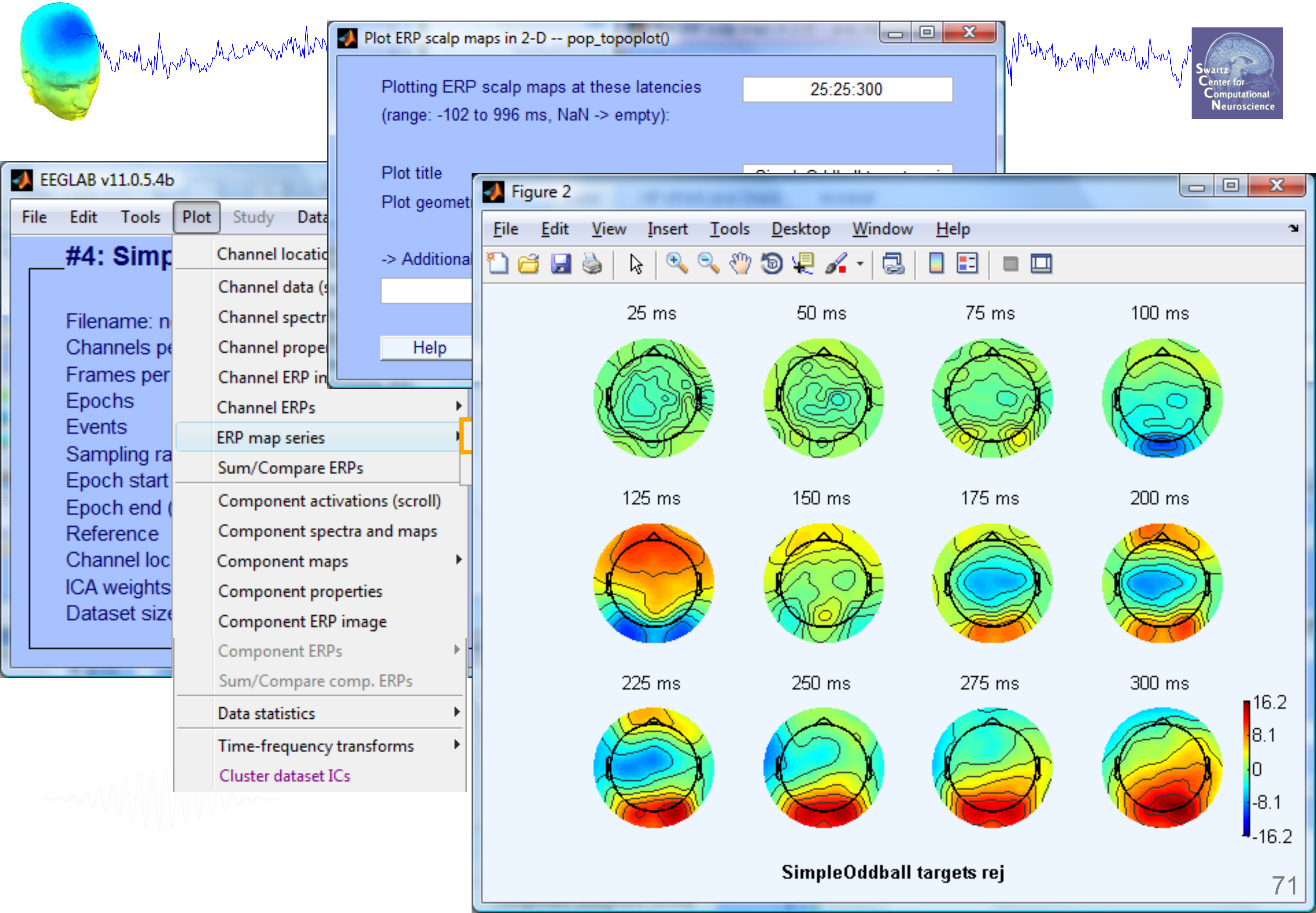
352
+
-
Potential (µV)
20
10
0
-10
0
200
400
600
800

Visualize channel ERPs in 2D



Plot ERP scalp maps in 2-D -- pop_topoplot()

Plotting ERP scalp maps at these latencies (range: -102 to 996 ms, NaN -> empty): 25:25:300

EEGLAB v11.0.5.4b
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ERP map series
Sum/Compare ERPs
Component activations (scroll)
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs
Plot title
Plot geomet
-> Additiona
Help
Figure 2
File
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View
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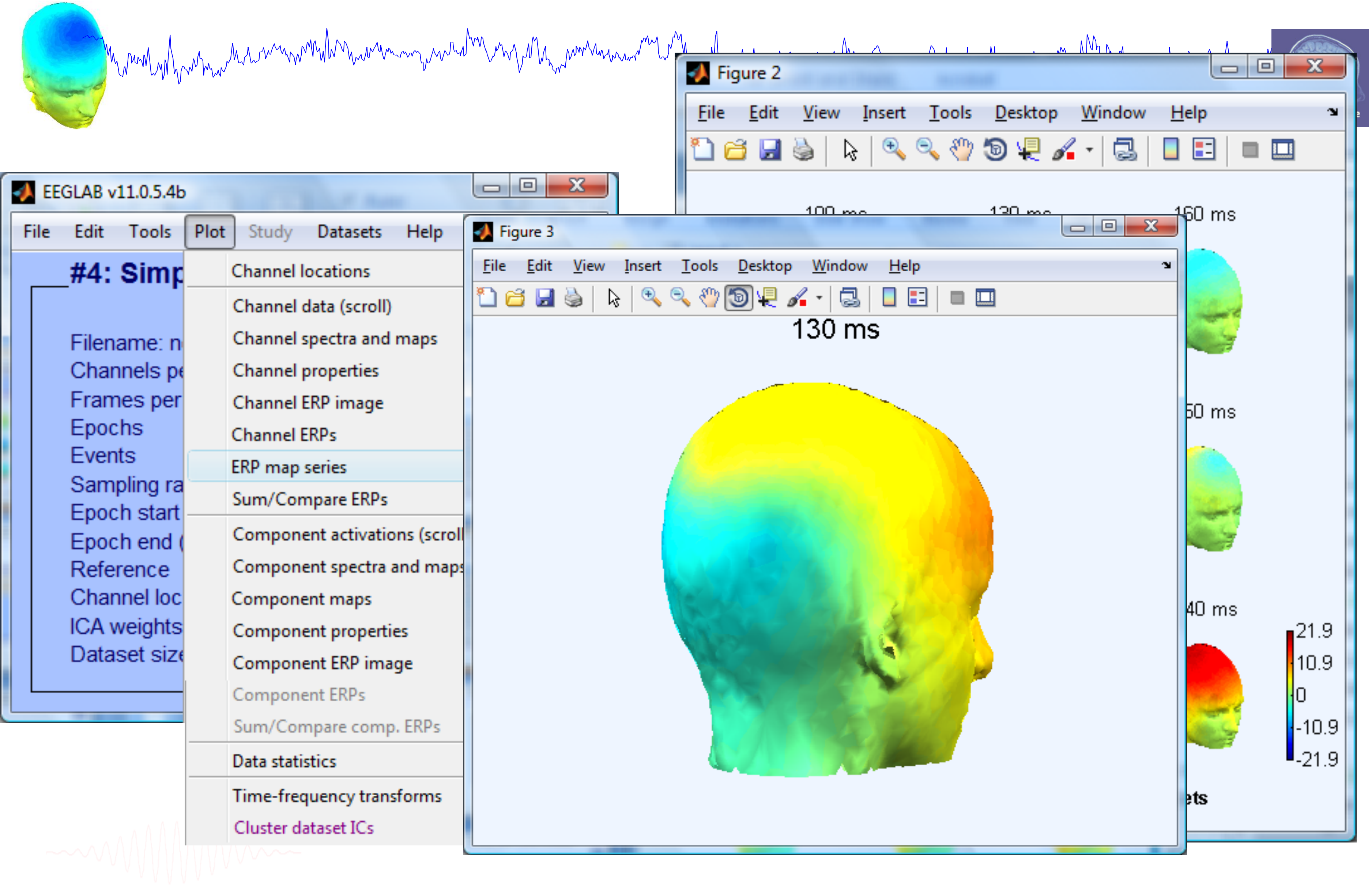
Tools
Desktop
Window
Help
25 ms
50 ms
75 ms
100 ms
125 ms
150 ms
175 ms
200 ms
225 ms
250 ms
275 ms
300 ms
16.2
8.1
0
-8.1
-16.2
SimpleOddball targets rej

Swartz Center for Computational Neuroscience

Visualize channel ERPs in 3D


EEGLAB v11.0.5.4b
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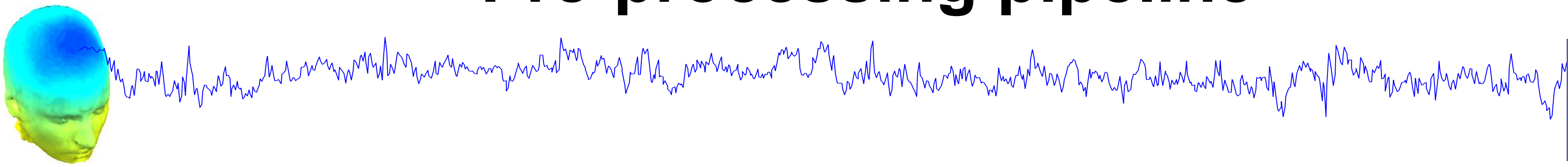
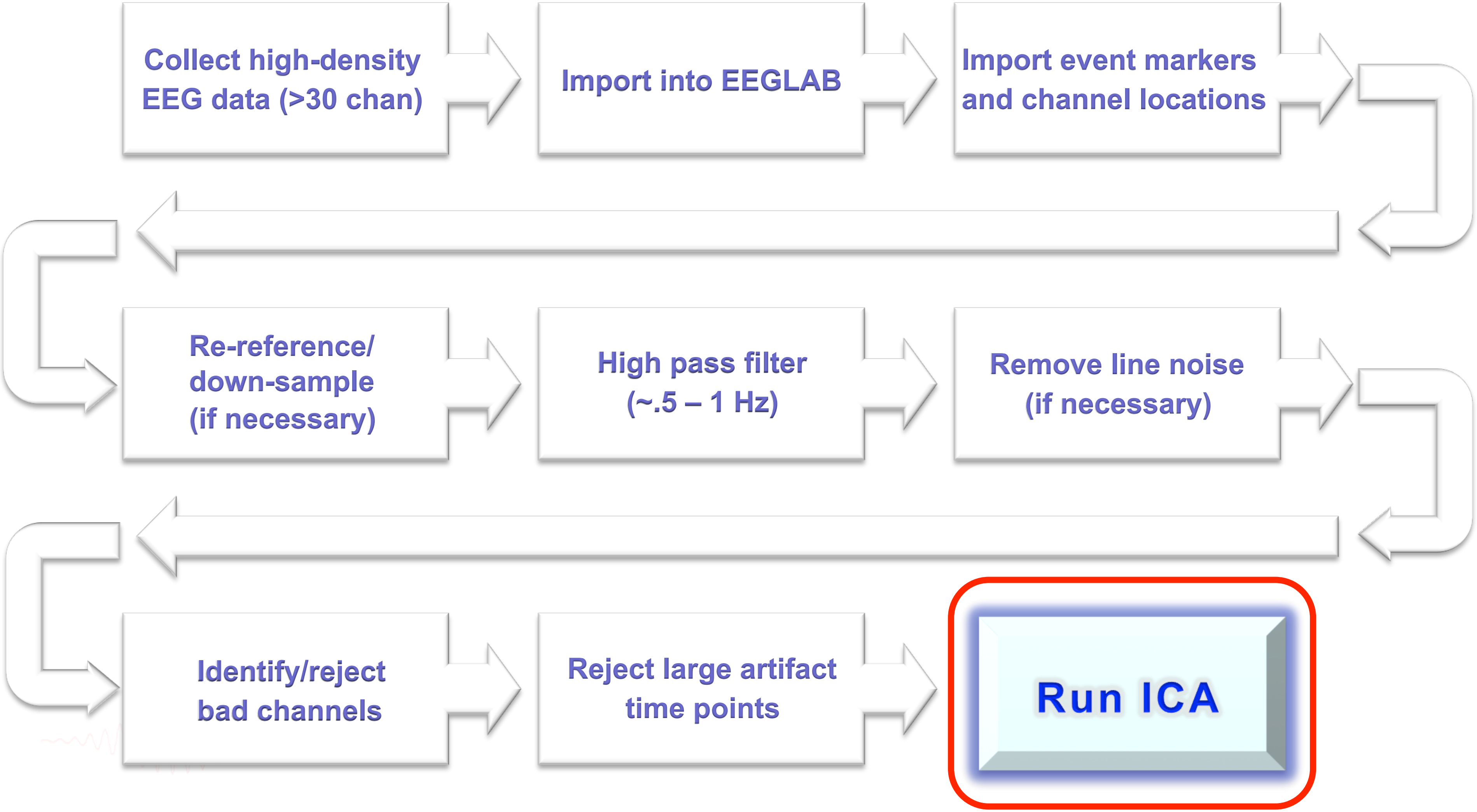
Plot
Study
Datasets
Help
#4: Simp
Filename: n
Channels pe
Frames per
Epochs
Events
Sampling ra
Epoch start
Epoch end (
Reference
Channel loc
ICA weights
Dataset size
Channel locations
Channel data (scroll)
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs
ERP map series
Sum/Compare ERPs
Component activations (scroll
Component spectra and maps
Component maps
Component properties
Component ERP image
Component ERPs
Sum/Compare comp. ERPs
Data statistics
Time-frequency transforms
Cluster dataset ICs
Figure 2
File
Edit
View
Insert
Tools
Desktop
Window
Help
100 ms
130 ms
160 ms
50 ms
40 ms
21.9
10.9
0
-10.9
-21.9
ets
Figure 3
File
Edit
View
Insert
Tools
Desktop
Window
Help
130 ms

Pre-processing pipeline





Collect high-density EEG data (>30 chan)

Import into EEGLAB

Import event markers and channel locations

Re-reference/ down-sample (if necessary)

High pass filter (~.5 – 1 Hz)

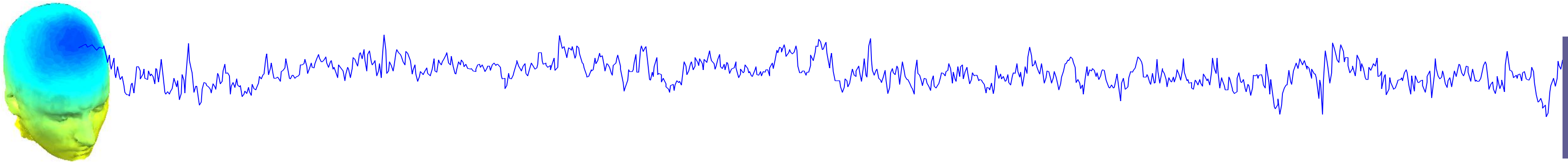
Remove line noise (if necessary)

Identify/reject bad channels

Reject large artifact time points

Run ICA

Exercises



- Preprocess data of your choice or load a previously filtered dataset e.g.SimpleOddball.set
- Identify bad channel(s) using auto-detection tool; plot channel properties of flagged channels
- Identify and remove non-task portions of continuous data; see if the previously flagged channels are still identified as bad
- Epoch on event of interest. Scroll the epoched data and perform visual rejection of epochs
- Explore the automated artifact rejection tools
- Run ICA