

# **EEG Preprocessing in EEGLAB**

Arnaud Delorme



# Why preprocess data?



EEG data out of the recording device is a continuous unprocess signal. It is like measuring a difference of potential on an oscilloscope.

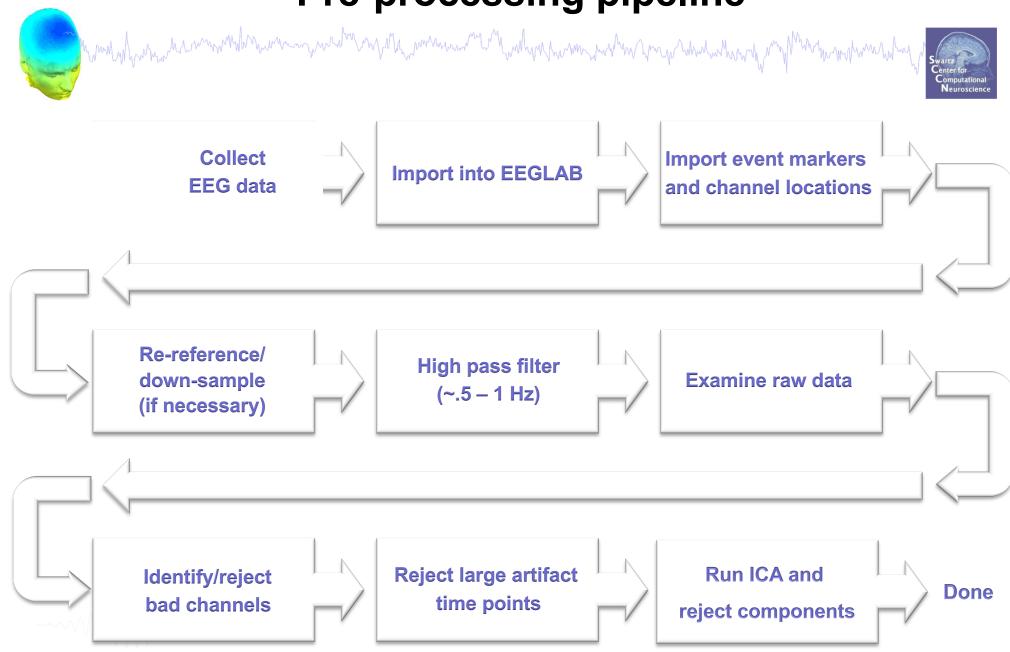


To make sense of the data, we need to:

- Extract meaningful measures from it (such as brain oscillations; brain source activations)
- Compare brain data in different conditions
- Assess reliable changes due to external stimuli (event-related potentials)

Before we do all that, we apply a series of transformation to the data.

#### **Pre-processing pipeline**



# Installing EEGLAB and data folder



- Download and install Matlab (2008b or later)
- Download EEGLAB (http://www.sccn.ucsd.edu/eeglab)

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

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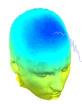
# The EEGLAB Matlab software



#### main graphic interface

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#### Importing a dataset



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Import data	Using EEGLAB functions and plugins	From ASCII/float file or Matlab array
Import epoch info	Using the FILE-IO interface	From Netstation .mff (FILE-IO toolbox)
Import event info	Using the BIOSIG interface	From Netstation binary simple file
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Memory and other options		From ANT EEProbe .AVR file
History scripts		From BCI2000 .DAT file
Quit		From BIOPAC MATLAB files



	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. Recvhdr 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
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# Install extension for importing data files

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Extensions available for install on the internet Install Plugin Vers. Description Score **BDFimport** 1.10 1920 Import BDF data files Doc ANTeepimport 1.13 1436 Import ANT .cnt data and trigger files Doc MFFimport 2.1 978 Import MFF files from the EGI company Doc BCI2000import 0.36 861 Import BCI2000 data files biopac 1.00 771 Import BIOPAC data files Doc loadcurry 2.0 623 Import Neuroscan Curry 6, 7 and 8 data files erpssimport 1.01 611 Import ERPSS data files NihonKoden 1.01 585 Import Nihon Koden M00 files loadhdf5 1.1 534 Load hdf5 files recorded with g.recorder neuroimaging4d 528 Import Neuroimaging4d data files 1.00 **INSTEPascimport** 1.00 526 Import INSTEP ASCII data files Update 5 i i **Installed extensions** Dea Plugin Vers. Score Description Doc Import multiple data files formats Biosig 3.3.0 22642 Doc Fileio Import multiple data files formats 170623 9130 Doc hva-io 1513 4299 Import Brain Vision Analyser data files xdfimport 1.13 879 Import files in XDF format < Prev. page Next page > Cancel Ok

#### **Supported data formats**

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#### EEGLAB tutorial: https://sccn.ucsd.edu/wiki/A01: Importing Continuous and Epoched Data

#### Supported Data Formats

File Format 🔶	File Extension \$	File type 💠	Events 💠	Channel Labels 🜲	EEGLAB \$	Biosig \$	File IO 💠	Support \$
ANT EEProbe	.avr	_	_	_	_	_	_	Comments
ANT EEProbe	.cnt	-	-	_	У	у	у	Comments
ASCII	.txt	_	-	_	у	у	-	Comments
BCI2000	.bci2000	continuous	-	_	р	-	_	Comments
BCI2000	.gdf	continuous	_	_	р	_	_	Comments
Biologic	.eeg	-	-	_	_	_	_	Comments
Biopac	.mat/.acq	_	_	_	p (see comments)	_	_	Comments
Biosemi	.bdf	continuous	Channel	_	У	У	У	Comments
Blackrock	.NEV .NSx	_	_	_	see comments	-	-	Comments
Brain Vision Analyzer	.mat	continuous & segmented	Embedded	_	У	У	n	Comments
Brain Vision Analyzer	.vhdr	_	file	_	У	У	n	Comments
BrainStorm	.vsm	_	_	_	_	-	-	Comments
Cogniscan	-	-	-	_	р	-	-	Comments
Compumedics Profusion	.raw	-	-	_	see comments	-	-	Comments
CTF/BrainStorm	.ctf	-	-	_	У	У	У	Comments
EGI/Netstation	.RAW	continuous & segmented	Channel	_	У	у	у	Comments
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Emotiv	.edf	_	_	_	y (see comments)	y (see comments)	y (see comments)	Comments
ERPSS	.raw	_	_	_	у	n	n	Comments
ERPSS	.rdf	_	_	_	У	n	n	Comments
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EDF+	.edf	_	Channel	_	у	у	n	Comments
INSTEP	.asc	_	_	_	У	n	n	Comments
Matlab Array	.mat	_	Channel	_	у	у	n	Comments
Micromed	_	_	_	_	р	-	-	Comments
Neuroimaging4D	.m4d	_	_	_	у	n	n	Comments
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Spike2	.mat	_	_	_	y (see comments)	n	n	Comments



BIOSIG: <u>http://pub.ist.ac.at/~schloegl/biosig/TESTED</u>

File-IO: http://www.fieldtriptoolbox.org/development/fileio

# Sample data: basic P300 paradigm

#### WMM WMW WW Swartz Center for Computational Neuroscience

#### File

SimpleOddball.set

#### Data

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

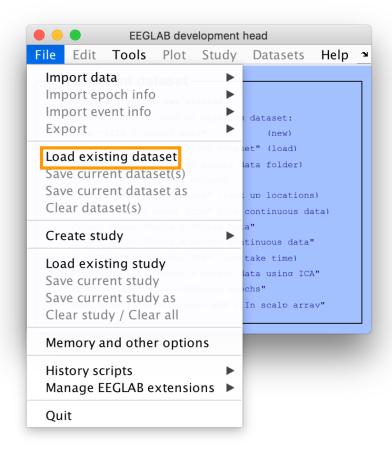
#### Task

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

#### Load a dataset

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#### Load "SimpleOddball.set"

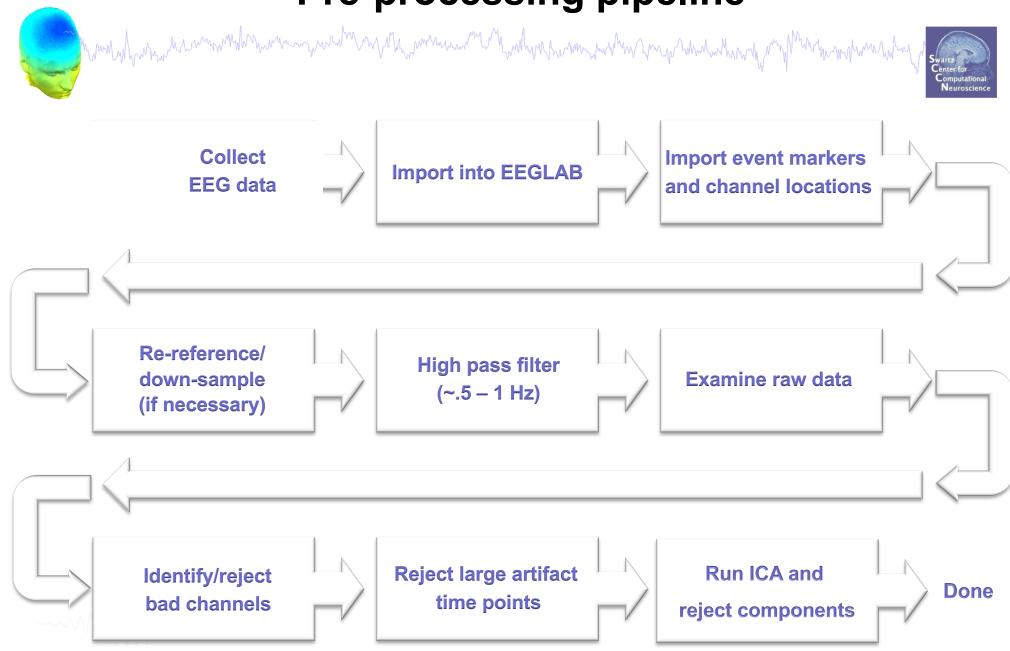
# 



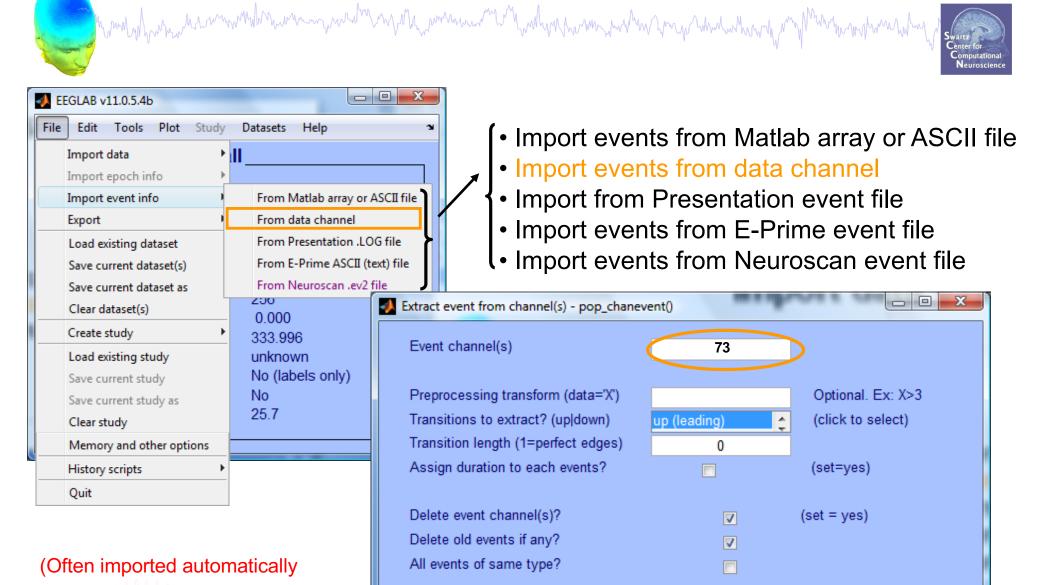


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#### **Pre-processing pipeline**



#### Import data events



Help

during data import)

Ok

Cancel

#### Appearance of an event channel in raw data

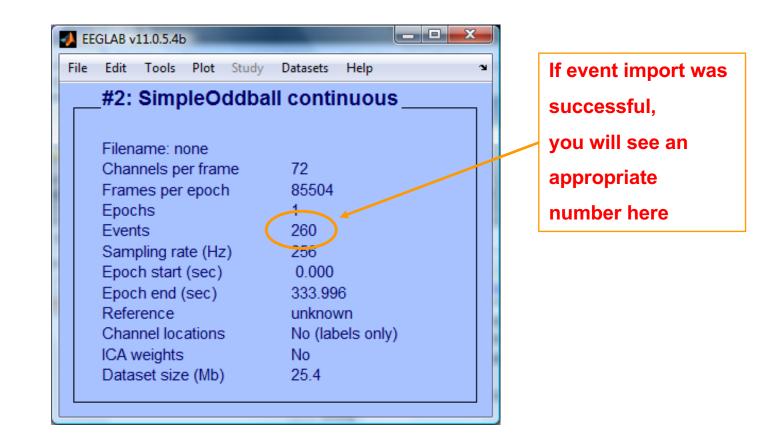


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#### Imported data events

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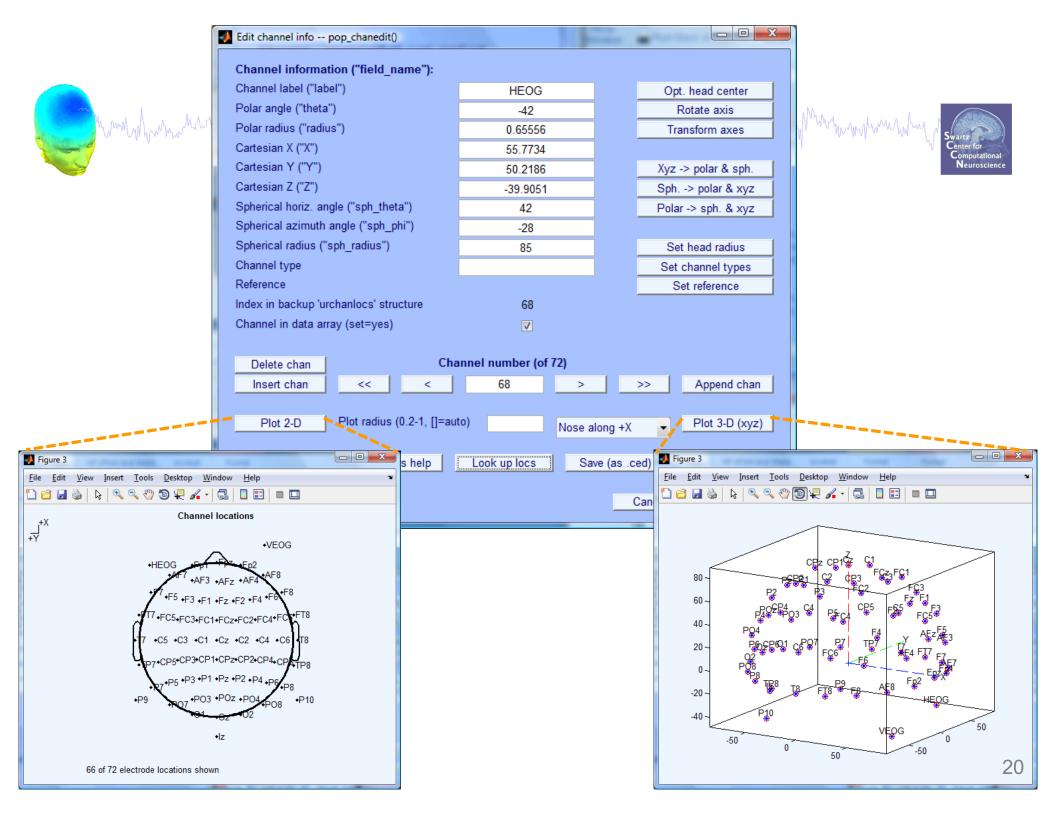




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#### Import channel locations

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File			Channel label ("labe	el")	ſ	Fp1		O	pt. head center	ince
Event fields       Cartesian X ("X")       80.784         Event fields       Xyz > polar & sph.         Channel locations       Sph. > polar & xyz         Select data       Spherical hora: angle ("sph_theta")       17.926         Schedt pocks or events       Spherical hora: angle ("sph_theta")       26.93         Select data       Spherical hora: angle ("sph_theta")       36.5         Select data       Select data       State indice         Correct dataset       Spherical hora: ("sph_radius")       85.5         Select data       Set head radius       Set reference         Index in backup furchanlocs' structure       1       Channel types         Reference       Index in backup furchanlocs' structure       1         Channel in data array (set=yes)       V       Delete chan         Delete chan       Channel number (of 72)       Insert chan         Usations       Save (other types)       Read locs help       Look up locs       Save (other types)         Beta shords file       formaats       supported       Nose along +X < Plot 3-D (xyz)       Read locs help       Look up locs       Save (other types)         Help       Cancel       Ok       Use DELSA file for 4-shell dipft spherical model       Use DELSA file for 4-shell dipft spherical model       Use DELS	EEGLAB v11.0.5.4b		Polar angle ("theta")	)		-17.926				
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#### **Imported channel locations**



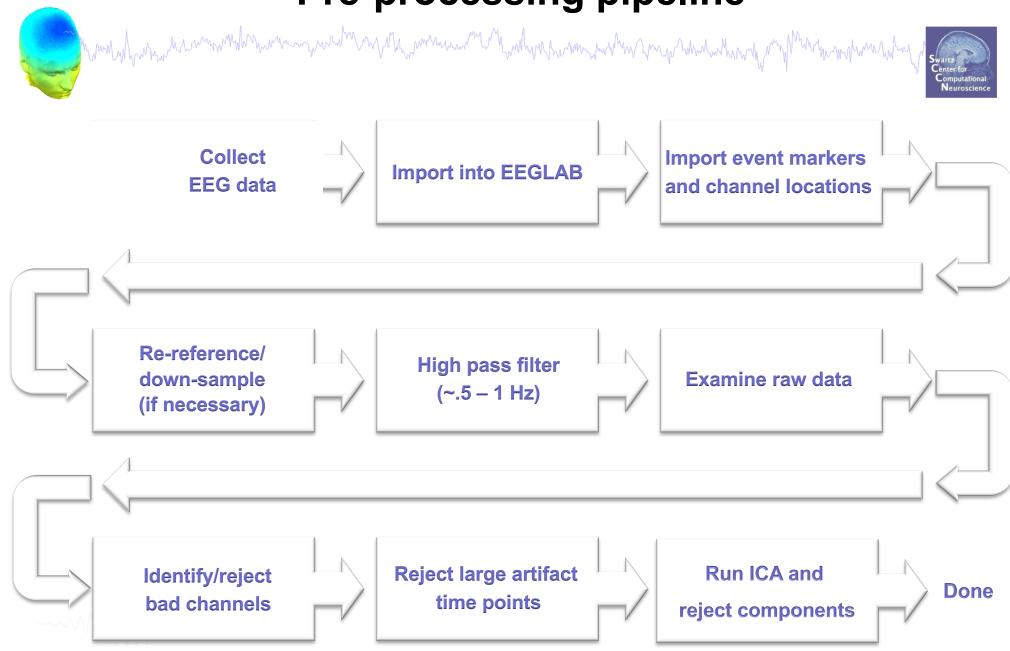
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	Char	nnel loc	ations	; (	Yes			
	ICA v	veights			No			
		set size			25.5			



#### **Comments and dataset history**

EGLAB v11.0.5.4b	Read/Enter comments pop_comments()
Edit Tools Plot Study Datasets Help	About this dataset
Dataset info	
Event fields	Data recorded by Marissa Westerfield
Event values	Recording date: Oct. 14, 2011
About this dataset	De une del entre
	Paradigm: -Participant looked at fixation box in center of
Channel locations	screen
Select data	-Two types of stimuli (outline of a circle, outline
	of a star) were presented in the fixation box in
Select data using events	random order
Select epochs or events	-Participant pressed a button in response to the star
Copy current dataset	
	Stimulus codes:
Append datasets	1 = circle
Delete dataset(s)	2 = star
	3 = button press Recording information:
Visually edit events and identify bad channels	-reference electrodes were placed on right and left
Dataset size (IND) 23.4	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
	CANCEL SAVE

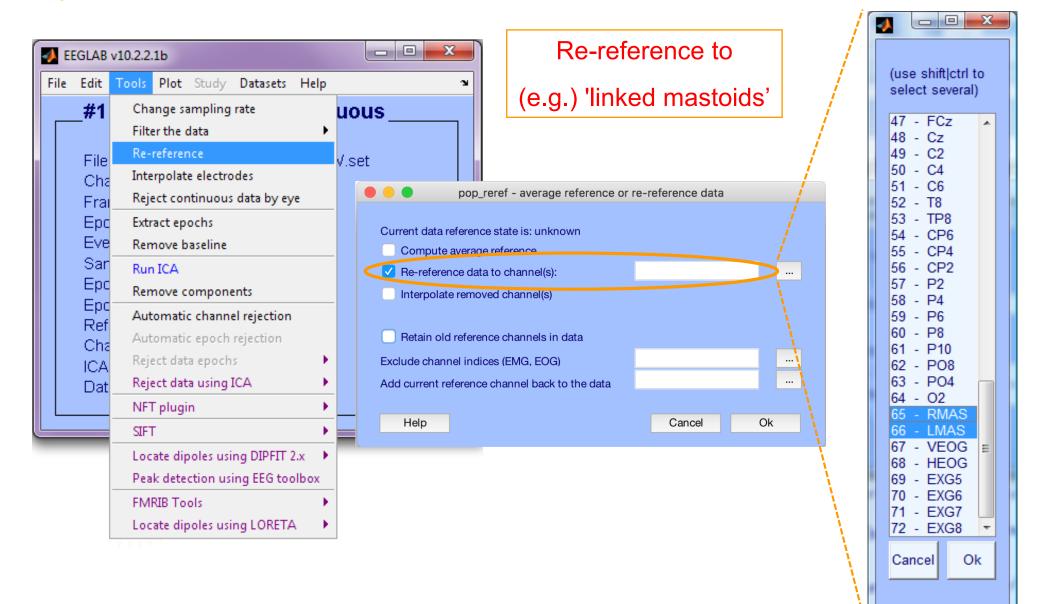
#### **Pre-processing pipeline**



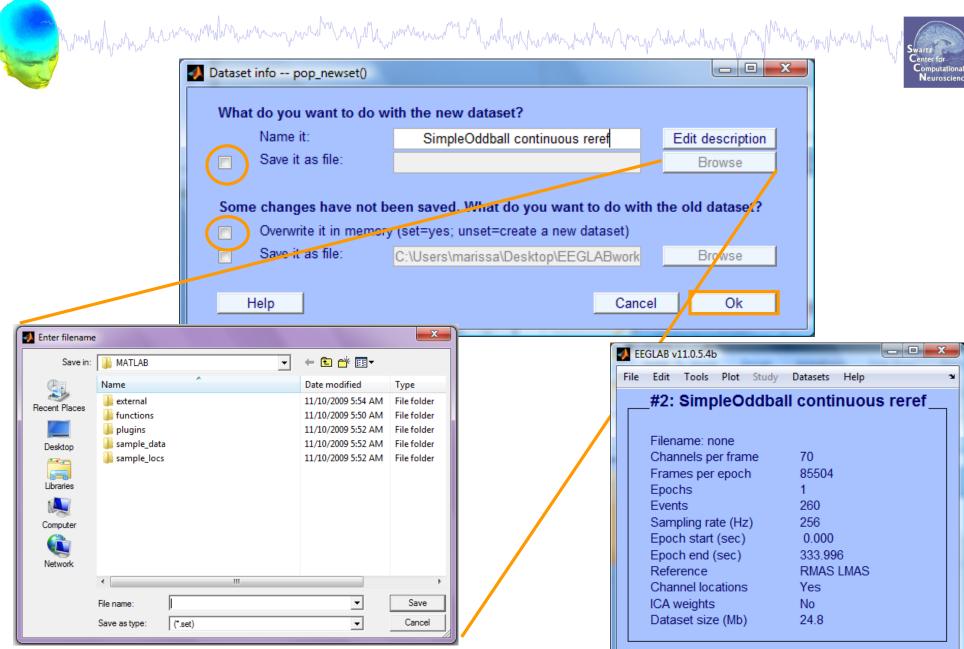
### **Re-reference data (if necessary/desired)**

hand have a second with the second with the second of the



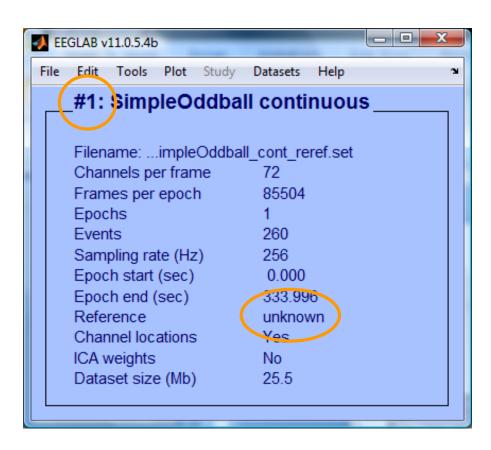


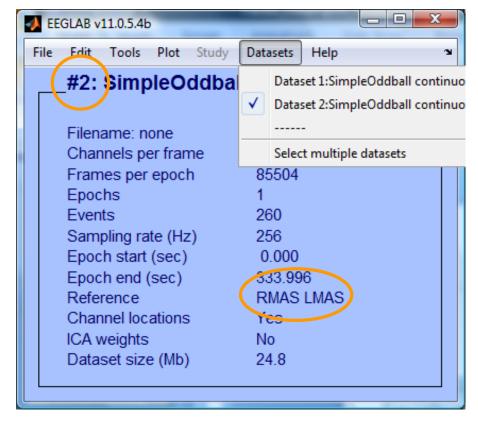
#### Save new dataset, keep old one



#### **Multiple active datasets**







### **Re-reference data (if necessary/desired)**



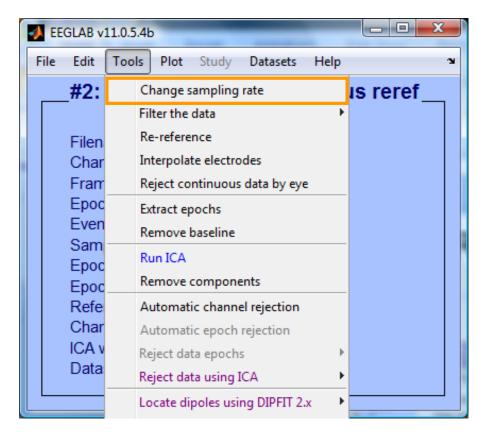
e E	dit	Fools Plot Study Datasets He	lp	L.	average	e reference		(use shift ctrl to select several)
;	#1	Change sampling rate Filter the data	۰ ۱	ious	average			1 - LEYE 2 - REYE
I	File	Re-reference	/	. eref -	average reference or	re-reference data		3 - OZ
(	Cha	Interpolate electrodes					1	4 - 02
I	Frai_	Reject continuous data by eye	_	Current data reference state	is: unknown		/	5 - FP1 6 - FPZ
I	Epc	Extract epochs		Compute average refere	nce		i	7 - FP2
	Eve	Remove baseline		Re-reference data to cha	annel(s):			8 - AF7 9 - AF3
	Sar	Run ICA		Interpolate removed cha	nnel(s)		- i -	9 - AF3
	Epc	Remove components					· / · · · ·	11 - AF4
	Epc-	Automatic channel rejection		Retain old reference cha	nnels in data		-i	12 - AF8 13 - F9
	Ref Cha	Automatic epoch rejection		Exclude channel indices (EM	IG, EOG)	LEYE REYE		14 - F7
	ICA	Reject data epochs	•	Add current reference chann	el back to the data			15 - F5
	Dat	Reject data using ICA	•					16 - F3 17 - F1
	Dat_	NFT plugin	•	Help		Cancel	Ok	18 - FZ
		SIFT	•					19 - F2 20 - F4
-	-	Locate dipoles using DIPFIT 2.x	÷					20 - 14 21 - F6
							N. S.	22 - F8
	-	Peak detection using EEG toolbo	<u> </u>				N N	23 - F10 24 - FT9
		FMRIB Tools					N. S.	25 - FT7
		Locate dipoles using LORETA						26 - FC5 🔻

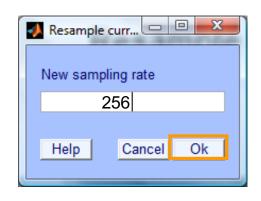
### **Resample data (if desired)**

many how we want when a second when a second when the second of the seco

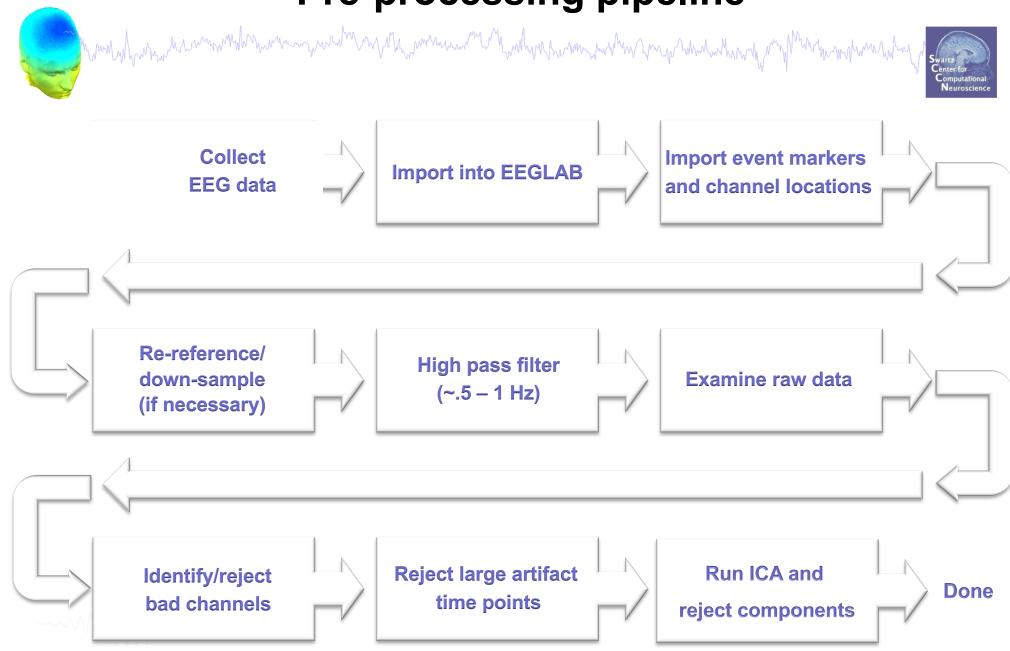


#### Reason: Reduce space, time.





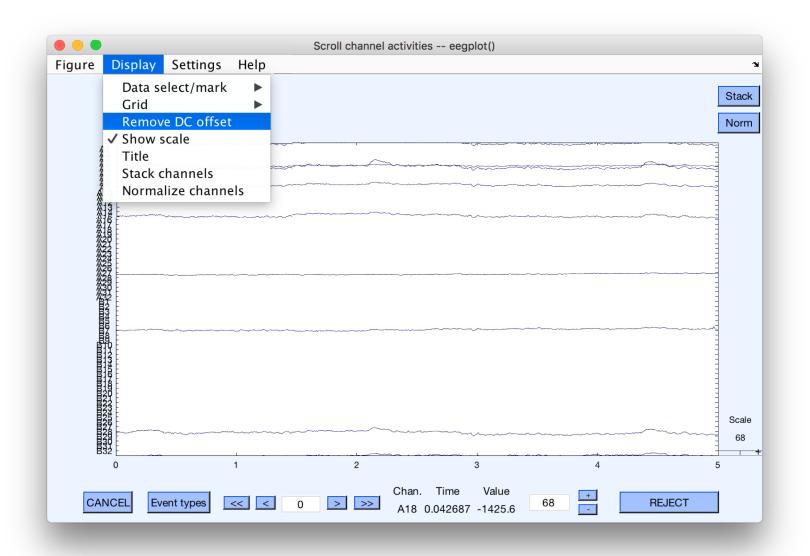
#### **Pre-processing pipeline**



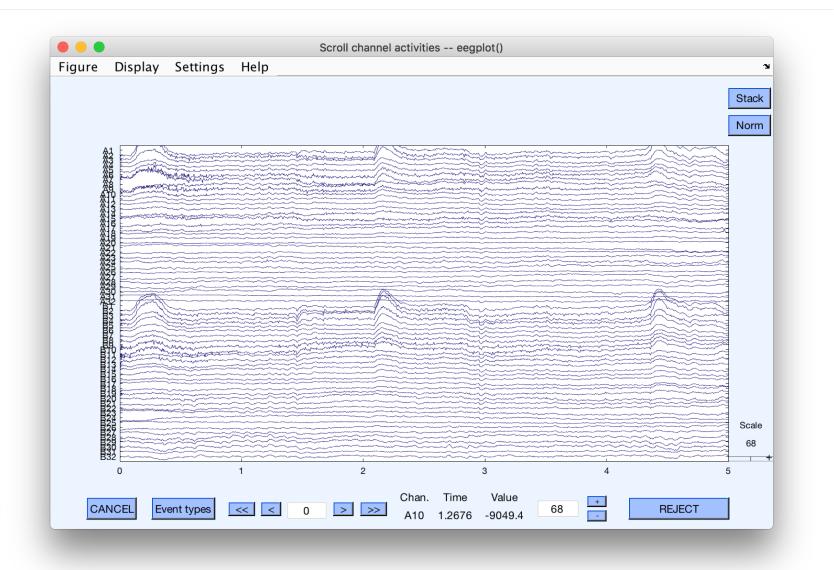
#### Scroll channel data

🣣 EE	GLAB v	11.0.5.4b			-	-		
File	Edit	Tools	Plot	Study	Datasets	Help		,
	#3:	Simp		Channel I	ocations		•	
				Channel	data (scroll)			
	Filen	ame: n		Channel	spectra and	maps		
	Char	nels pe		Channel	properties			
	Fram	nes per		Channel	ERP image			
	Epoc			Channel I	ERPs		►	
	Even			ERP map	series		►	
		pling ra		Sum/Cor	npare ERPs			
		h start		Compon	ent activatio	ons (scro	oll)	
		h end ( rence			ent spectra	-	-	
		nel loc		Compone			•	
	ICA v	veights			ent properti	es		
	Data	set size			ent ERP ima			
				Compone		5-	•	
_					npare comp	FRDe		
				Data stati		A LIVES		
				Time-free	quency tran	sforms	•	
				Cluster da	ataset ICs			

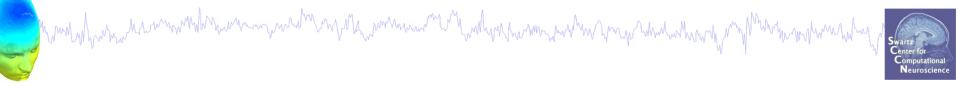






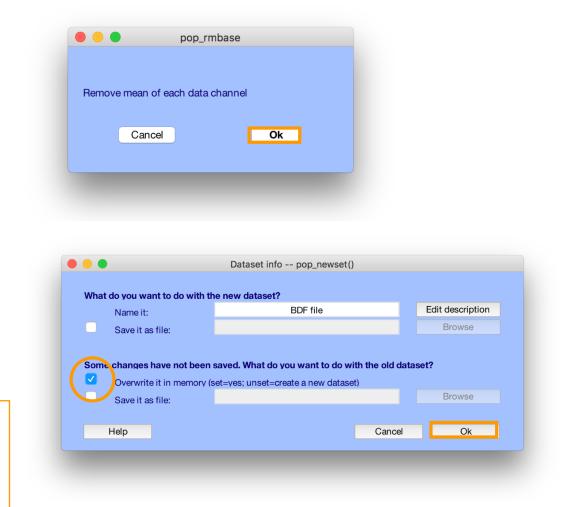


### **Remove DC offset**



File Ec	EEGLAB development head           it         Tools         Plot         Study         Datasets         Help	ъ
#1:	Change sampling rate	
	Filter the data	
Filer	Re-reference	
Chanr	Interpolate electrodes	
Frame	Reject continuous data by eve	
Epoch		
Event		
Sampl		
Epoch	stade Run ICA	
Epoch	en Remove components	
Refei	Automatic channel rejection	
Chanr	Automatic continuous rejection	
ICA V	Automatic anach raigetion	
Datas	Reject data epochs	
	Reject data using ICA	
	Artifact removal using AAR 1.3	
	CleanLine	

DC offsets introduce large filter artifact at signal boundaries, so it better to remove them prior to filter the signal.



### **High-Pass Filter the data**



#### Reason: remove slow, possibly large amplitude, drift

#1	1:	Change sampling rate				L	ower edge of the frequency pass	s band (Hz)		C	.5
		Filter the data		Basic FIR filter			igher edge of the frequency pas	s band (Hz)			
File	len	Re-reference Interpolate electrodes Reject continuous data by eye		ERPLAB Butterw	orth Filter	th Filter	IR Filter order (Mandatory even. Default is		s automatic*)		
Ch	har			ERPLAB Polynomial Detrending Short non-linear IIR filter		ng	See help text for a description of the default lanual definition is recommended.	the default fi	ilter orde	High	nas
	am							d.			
-	Epoc Even Sam —	Extract epochs					Notch filter the data instead of	of pass band		need	
		Remove baseline					Use minimum-phase converted causal filte		er (non-li	(non-li for ICA	
	boc	Run ICA					Plot frequency response		L		
	ooc	Remove components	_			С	hannel type(s)				
	efe	Automatic channel rejection					R channel labels or indices				
	har	Automatic epoch rejection									
	A v ata:	Reject data epochs 🕨					Help		Cano	el	Ok
Da	ala	Reject data using ICA	<u>}</u>				Dataset info pop_newset()				
		Locate dipoles using DIPFIT 2.x		- What do your	want to do with	the	now datacat?				
		Peak detection using EEG toolbox		What do you want to do with t Name it:		i ule i	BDF file		Edit descrij	otion	
		FMRIB Tools	•	Save it as file:					Brows	Э	
		Locate dipoles using LORETA									
		CleanLine		Some change	es have not bee	en sav	ved. What do you want to do with t	he old dataset	?		
	V V V V			🛛 🗹 🖉 Overw	rite it in memory	v (set=	=yes; unset=create a new dataset)		Brows		



•	0	0	FF	CLAR	12.0.2.	lh	
~	le	Edit	Tools			and the second	Help
	Imp	ort ev	i <b>ta</b> boch info rent info	ev or 1		kisting	
	Sav Sav	e curr	ting data ent datas ent datas aset(s)	set(s)	ioob (bb) ioob (bb) ioob (bb)	g dataset" " (data " (continuous 1/edit	
	Cre	ate sti	udy		Image: A transmission of the second secon	ve dataset) t data"	
	Sav Sav	e curr	ting study ent study ent study dy	ý	00 2 800 50 "200000" >	ect act epochs" Remove ICA"	
	Mer	nory a	ind othei	r optio	ons		
	Hist	tory so	ripts		•		
	Mar	nage p	olugins		•	Manage d	
	Qui	t				Manage d Manage d	





#### 00

폐		Plut	tings availab	le 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
Update	Deactivate			Installed plutings	
đ	Ē	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

CleanLine uses an approach for line noise removal advocated by Partha Mitra and Hemant Bokil in

"Observed Brain Dynamics" (2007), Chapter 7.3.4.

```
Cancel
```

Ok

### **Remove line noise (Cleanline)**

hand have a second with a second with a second with a second of the seco

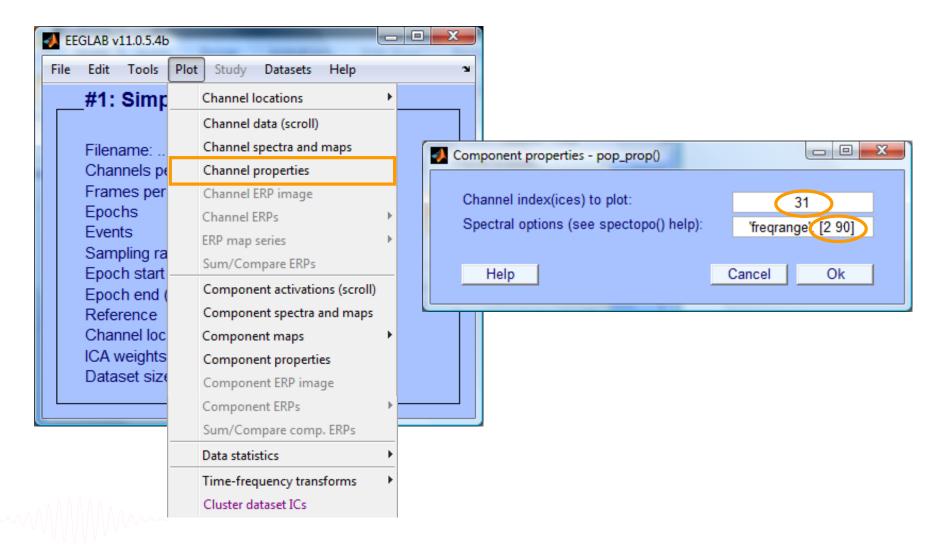


e Edit	Tools Plot Study Datasets Help	CleanLine Options
<b>#1:</b> Filen Char Fram Epoc Even Sam Epoc	Change sampling rate Filter the data Re-reference Interpolate electrodes Reject continuous data by eye Extract epochs Remove baseline Run ICA Remove components	Line noise frequencies to remove Scan for line noise p-value for detection of significant sinusoid Bandwidth (Hz) Type of signal to clean Indices of Channels/Components to clean Sliding window length (sec) Sliding window step size (sec) Channels (60 120) (60 120) (set) 0.01 2 Channels (hannels (hannels (hannels) (hannels (hannels)
Epoc Refe Char ICA v Data	Automatic channel rejection Automatic epoch rejection Reject data epochs Reject data using ICA	Window overlap smoothing factor       100         FFT padding factor       2         Visualize Original and Cleaned Spectra       [set]         Normalize log spectrum by detrending       (set)         Produce verbose output       V (set)
	Locate dipoles using DIPFIT 2.x Peak detection using EEG toolbox FMRIB Tools Locate dipoles using LORETA CleanLine	Plot Individual Figures     check     (set)       Help     Cancel     Ok

### **Plot channel properties**

man have a second and the second and





#### **Filter comparisons**

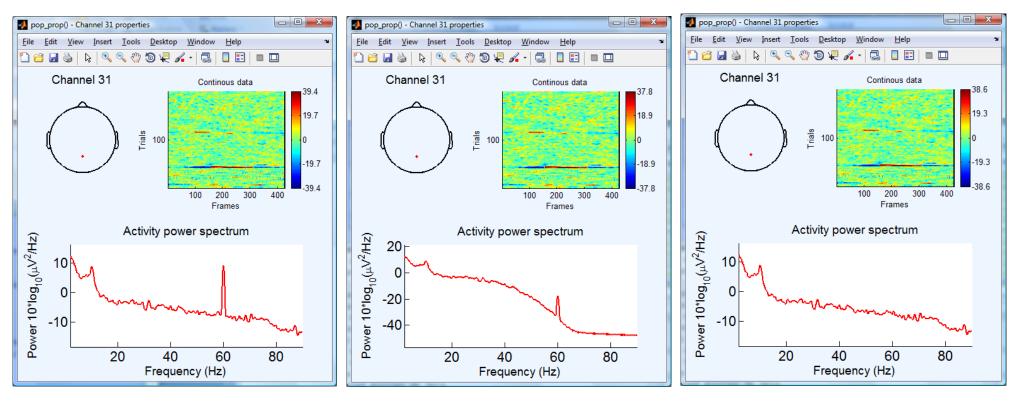
and the second and th

Swartz Center for Computational Neuroscience

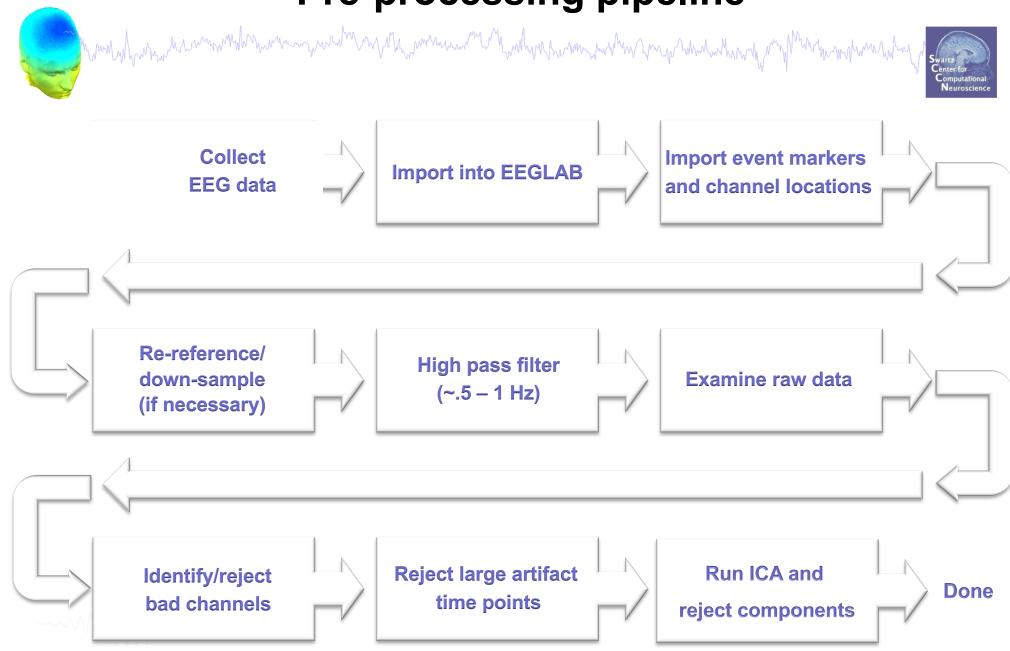
#### 0.5 Hz high-pass filter

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

#### 0.5 Hz high-pass filter Cleanline

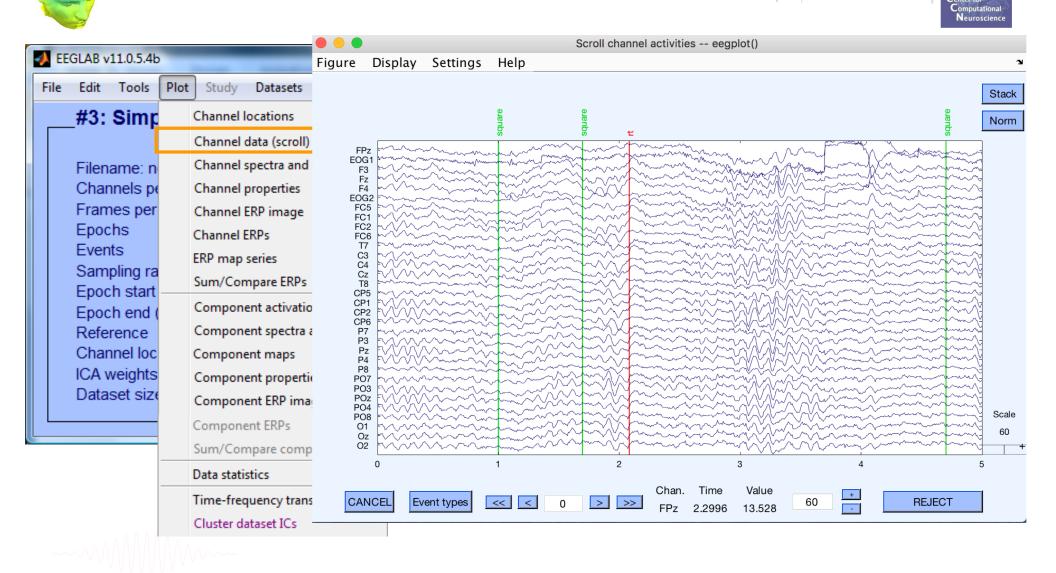


#### **Pre-processing pipeline**

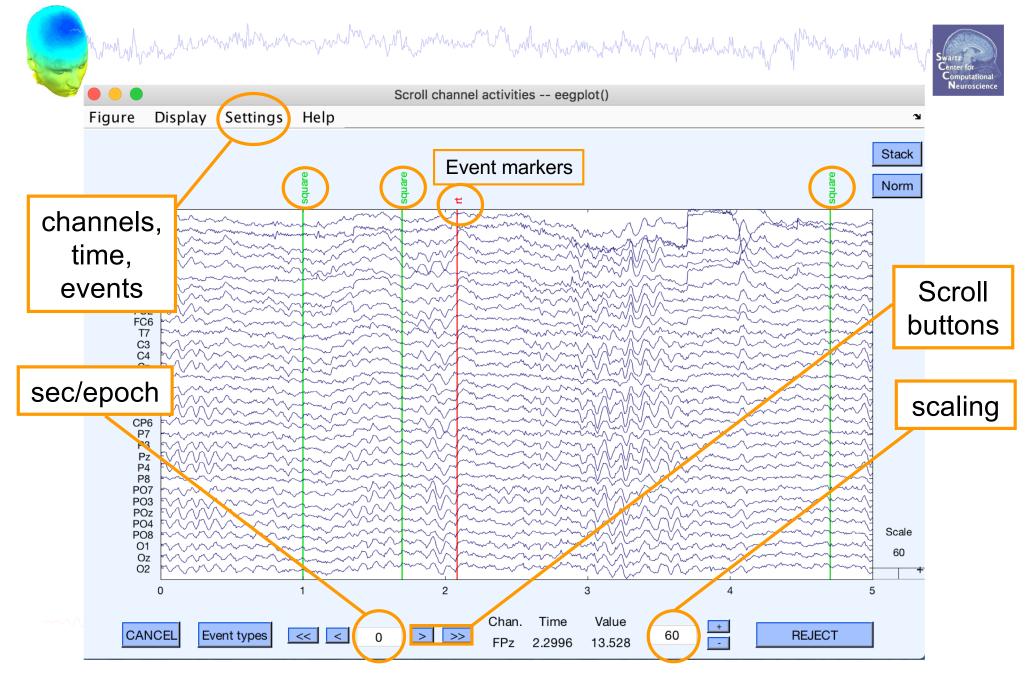


#### Scroll channel data

hand have a second when a seco



#### Scroll channel data

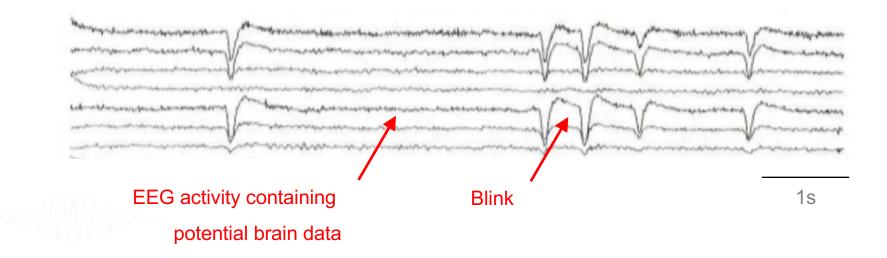


# **EEG** artifacts

# www.hander.h

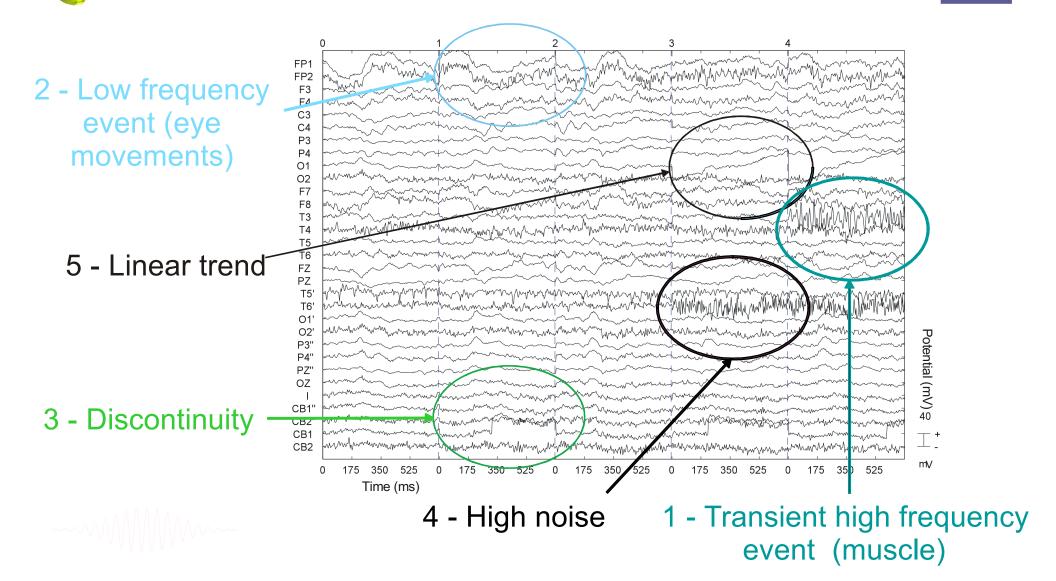


The amplitude of artifacts (such as eye movements) is often larger than the amplitude of brain data which potentially decrease signal/noise ratio, bias data analysis and potential results



# **Type of artifacts**

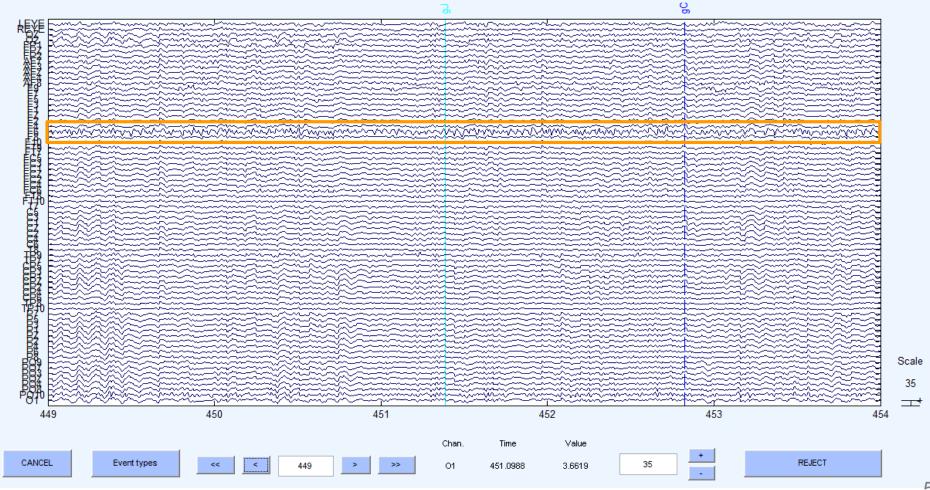
Manufaller and a second and the seco



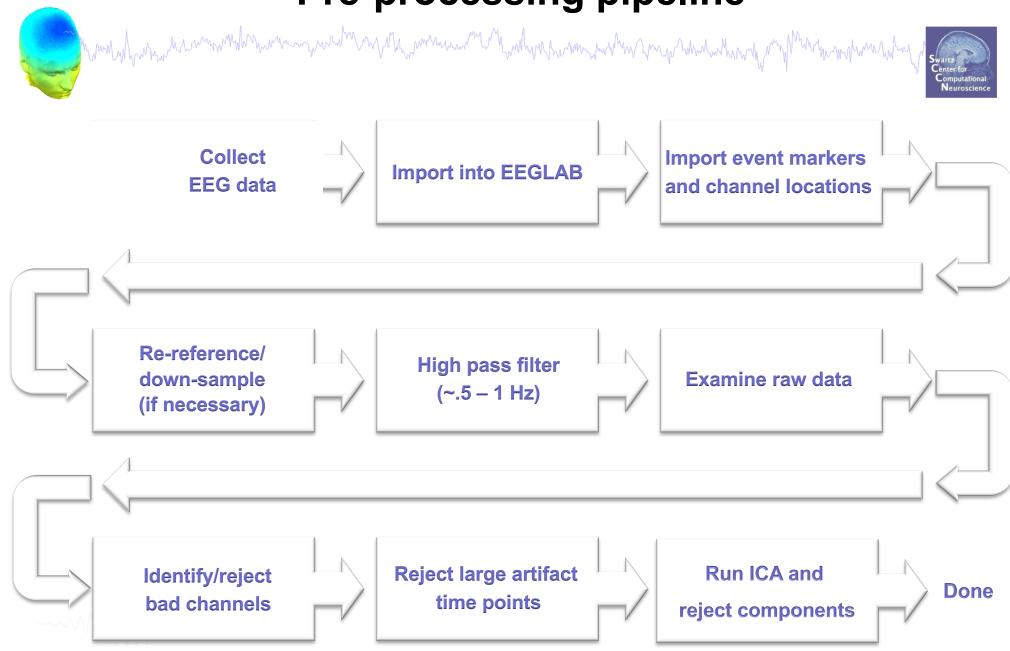
#### Looking for bad channels



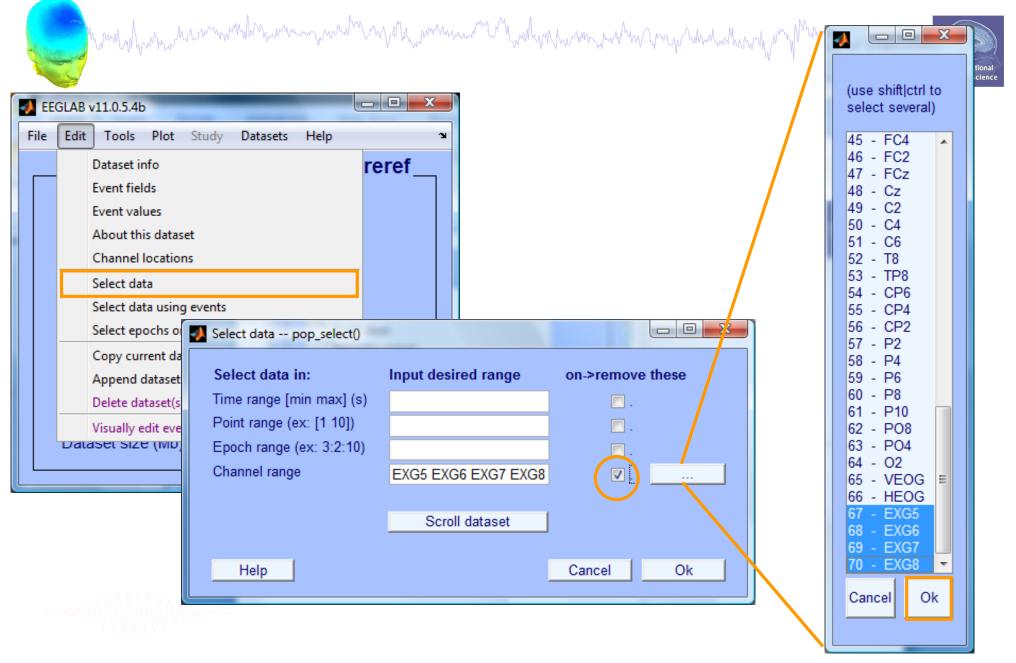
Figure Display Settings Help



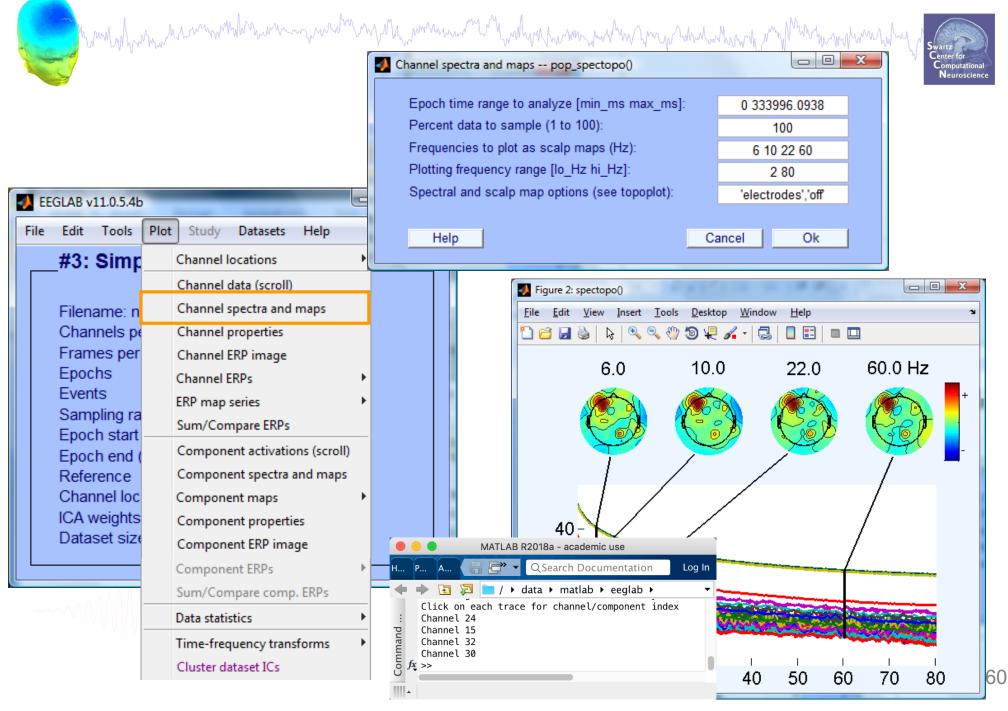
#### **Pre-processing pipeline**



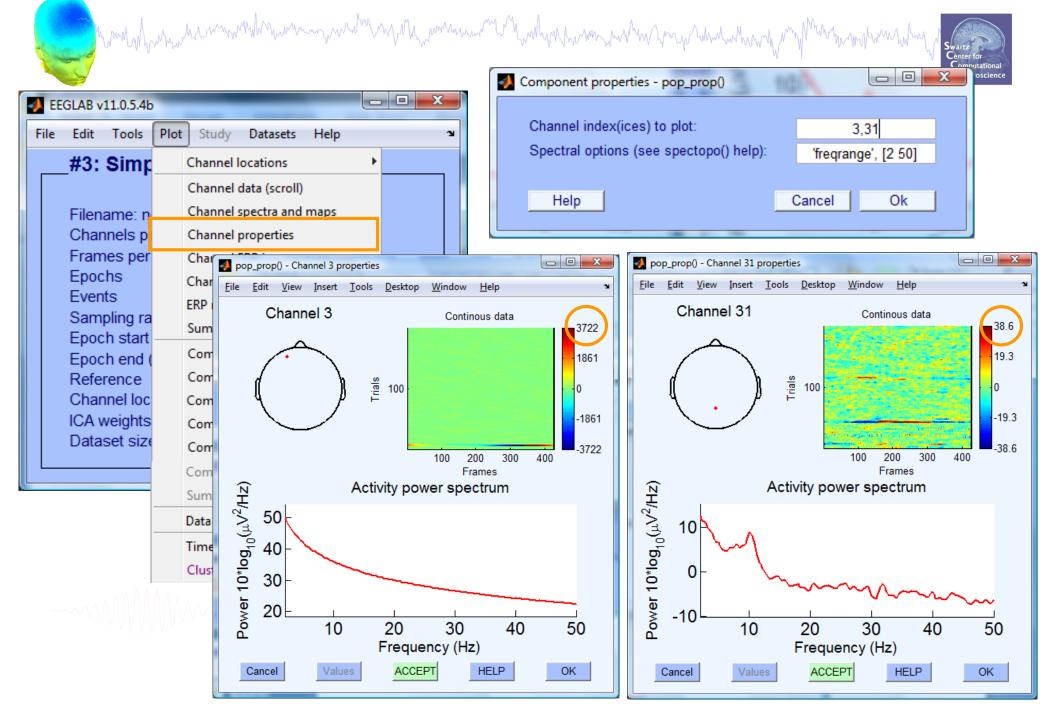
#### **Remove unwanted channels**



#### Manually identifying bad channels



#### Manually identifying bad channels



### **Removing channel(s)**

		Munutul	Mundah	mandana	Murhand	monthenty	har war when when	Mary Markan	manyman	mannym	Swartz Center for Computational Neuroscience	e
-	EEC	LAB v11.0.5.4b			x							
Fi	le	Edit Tools	Plot Stu	udy Datasets Help	r							
		Dataset inf	o	rere	f							
[		Event field	s									
		Event value	1	_					~			
		About this		Select data pop_select()					×			
		Channel lo		Select data in:	Input d	lesired range	on->remov	et If not	checke	ed, will	result	
		Select data		Time range [min max] (s)					onconc	, wiii	result	
		Select data Select epo	-	Point range (ex: [1 10])				in dat	aset wi	ith one	channel	
		Copy curre		Epoch range (ex: 3:2:10)								
		Append da		Channel range		F6						
		Delete data				Scroll dataset	1					
		Visually ed			. 🚺	Dataset info po	p newset()					x
		Dataset size	(UND)	Cancel	┙┥┍╸			-				
Ľ			(			What do you v	want to do w	vith the new da	ataset?			
						Name it:	-	SimpleOddbal	l hipass0.5 (	CL - F6	Edit description	
						Save it as	s file:				Browse	
						What do you y	vant ta da u	ith the old det	taget (not m	adified aim	va last saved\2	
						-		(set=yes; unse			e last saved)?	
						Overwrite	ic in memory	(oor yes, anse	or orotato a r	ion databet)		
						Help				Cancel	Ok	
												67

#### **Auto-detection of noisy channels**

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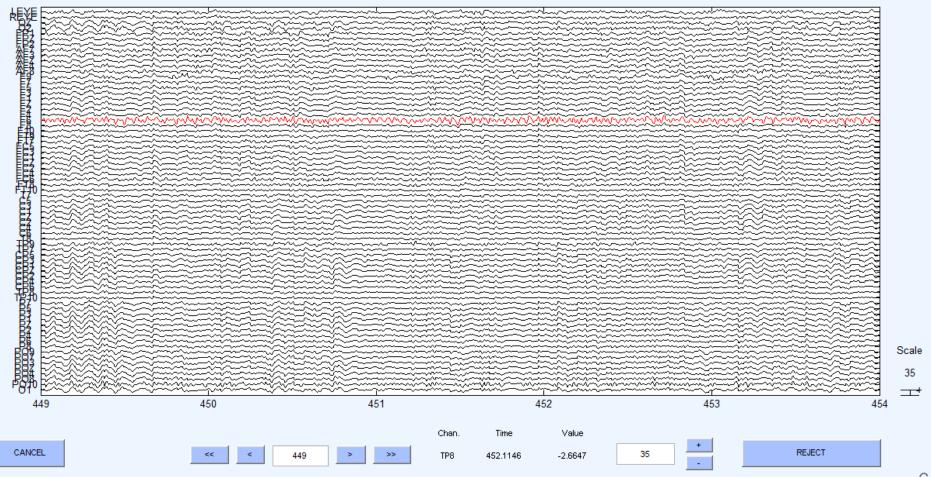
🍌 EEGLAB	v7.1.7.18b	
File Edit	Tools Plot Study Datasets Help	ч
<b></b> #1	Change sampling rate Filter the data Data	٦
File	Reject continuous data by eve	
Frai Epo Eve	Extract epochs	
San Epo Epo	Remove components	
Ref Cha	Automatic channel rejection Automatic epoch rejection	
ICA Dat	Reject data using ICA	
	Locate dipoles using DIPFIT 2.x       Peak detection using EEG toolbox	
	FMRIB Tools Locate dipoles using LORETA	

1	🛃 Reject channel pop_rejchan()
	Electrode (number(s); Ex: 2.4.5): 1:71
l	Measure to use: Probability 🚽
	Normalize measure (check=on):
	Threshold limits [max]: 5
	Cancel Help Ok
l	

See also clean\_rawdata plugin of EEGLAB

#### **Auto-detected noisy channel**





#### **Removed channel(s)**

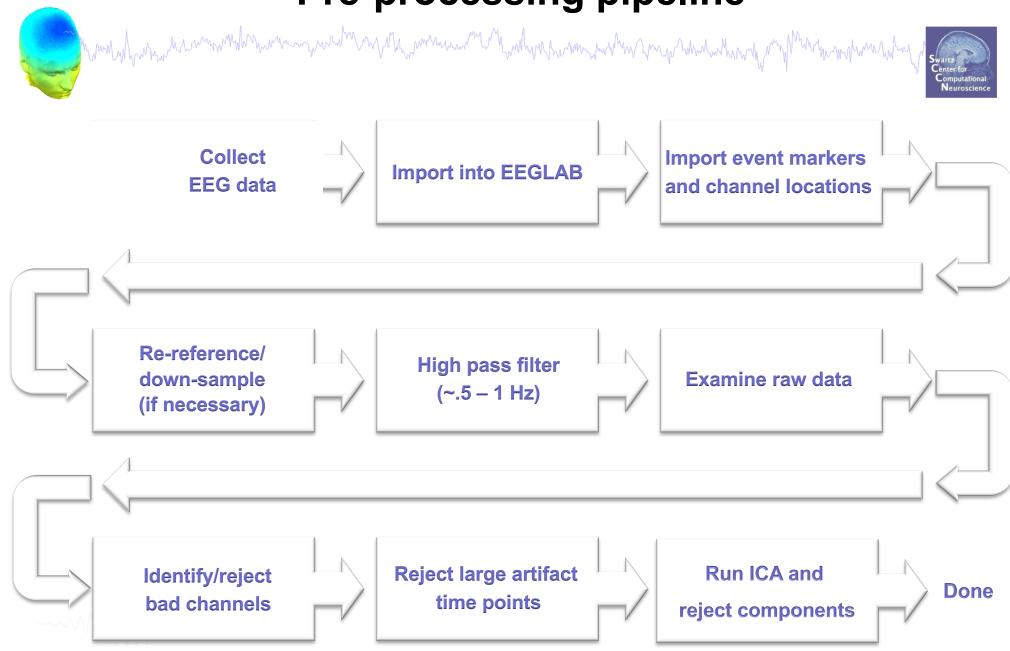


- In EEGLAB, removed channels are not only labeled for rejection, they are actually removed from the data.
- Interpolating channels instead of removing them?

and the second water and the second water and the second water and the second and

**EEGLAB** development head Interpolate channel(s) -- pop\_inte... File Edit Tools Plot Study Datasets Help 🏻 Change sampling rate What channel(s) do you want to interpolate #1: Co Filter the data none selected Re-reference Filenam Select from removed channels Interpolate electrodes Channel Reject continuous data by eye Select from data channels Frames Epochs Extract epochs Use specific channels of other dataset Events Remove baseline Use all channels from other dataset Samplin **Run ICA** Epoch s Epoch e **Remove components** Referen Interpolation method 0 Spherical Automatic channel rejection Channel Automatic continuous rejection ICA weig Automatic epoch rejection Dataset Ok Help Cancel Reject data epochs Reject data using ICA Artifact removal using AAR 1.3 CleanLine

#### **Pre-processing pipeline**

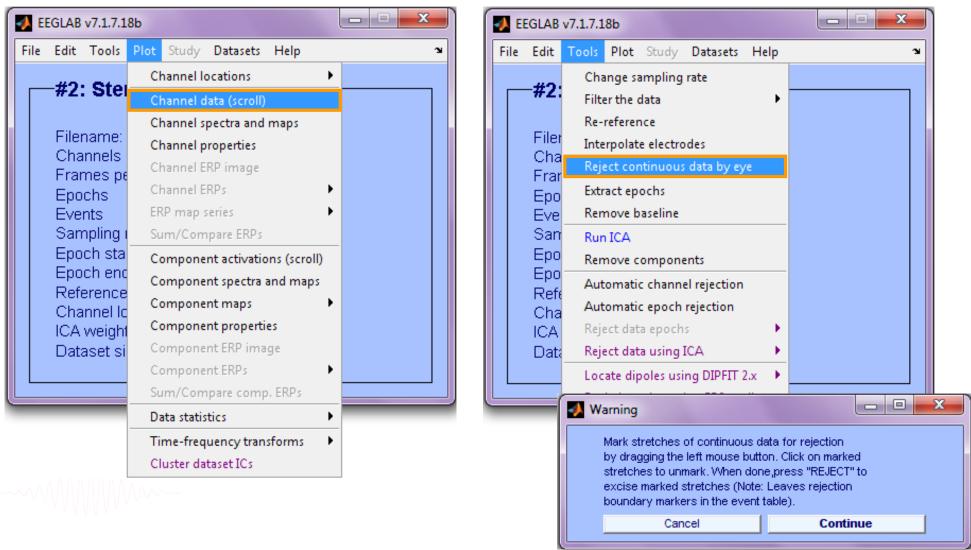


#### **Reject continuous data**

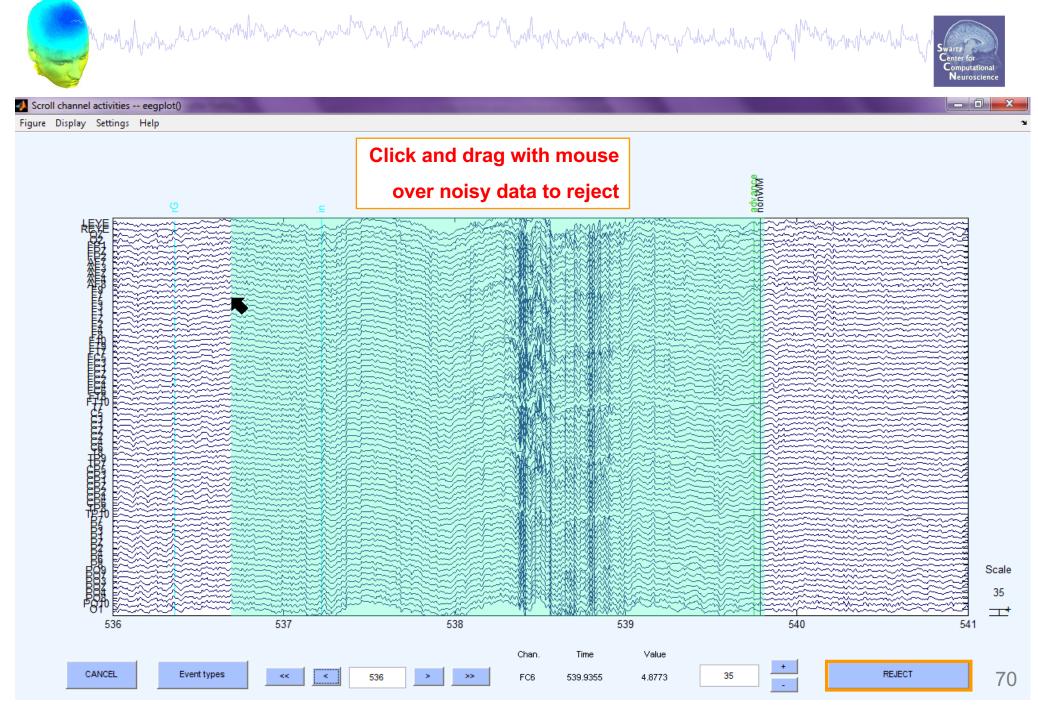
hand have many how we have a second when the second of the second when the second of the second when the second of the second of



#### Equivalent



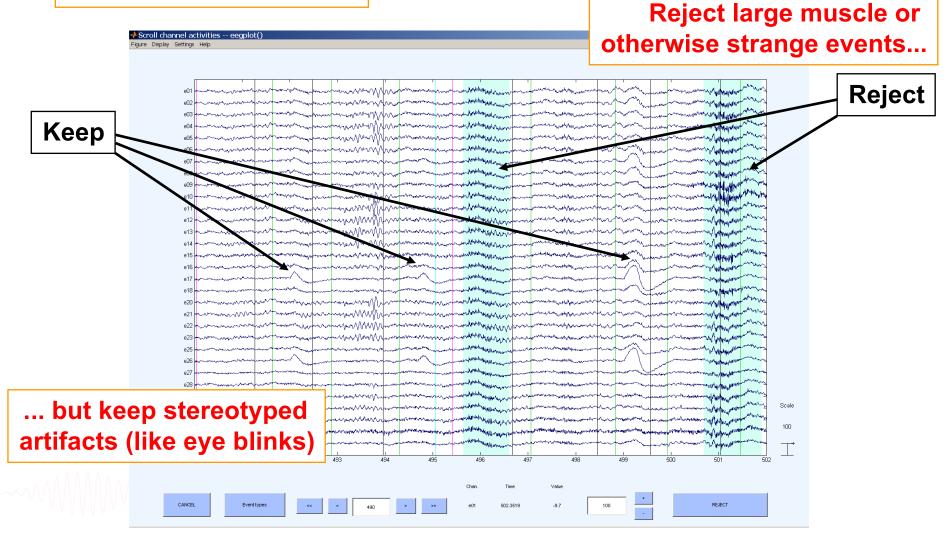
#### **Reject continuous data**



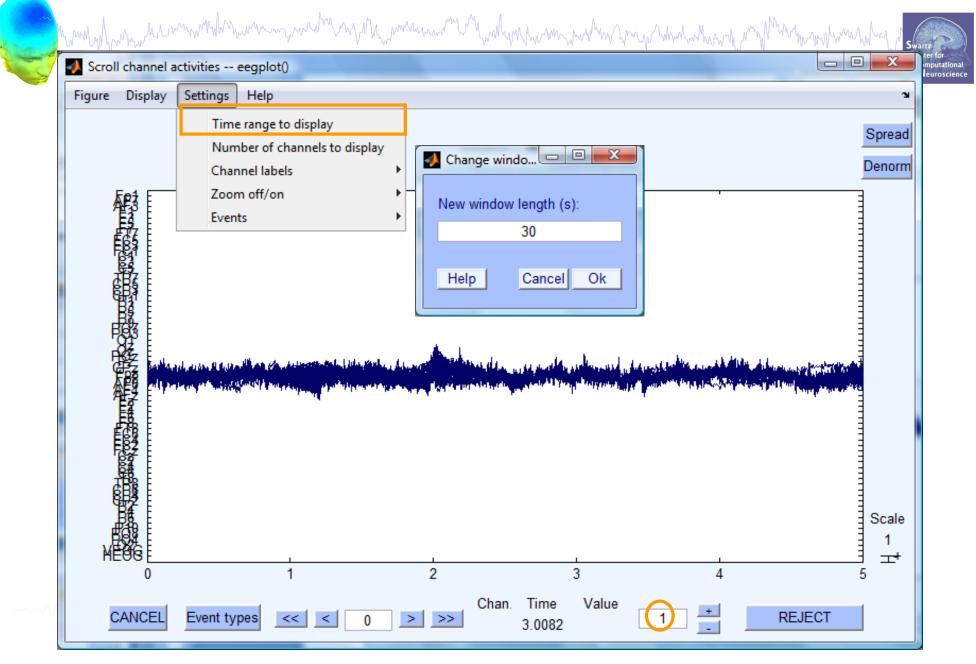
### **Rejecting data for ICA**

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#### To prepare data for ICA:

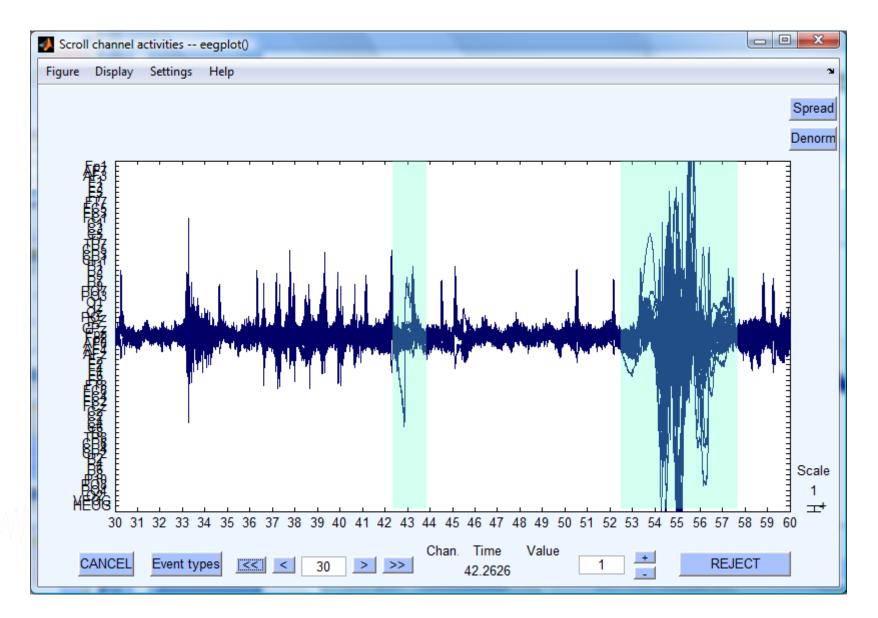


#### Fast manual artifact rejection



#### Fast manual artifact rejection





#### Automatic rejection of continuous data

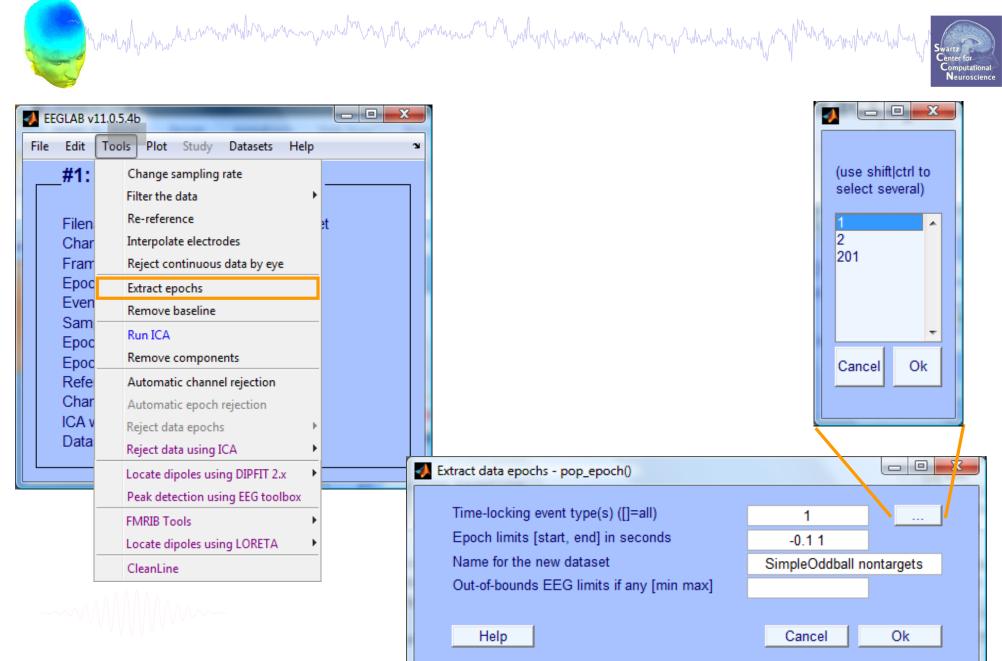


•		EEGL	AB deve	elopment	head		
File	Edit	Tools	Plot	Study	Datasets	Help	ъ
	#1: EE	Filter	ge san the da ferenc		ate	•	
	Filename Channels	Inter	oolate	electrod			
1	Frames p	кејес	t conti	nuous a	ata by eye		
1	Epochs	Extra	ct epo	chs			
	Events	Remo	ove bas	seline			
	Sampling Epoch st	Run I	C۵				
	Epoch sc Epoch en			nponent	ts		
	Referenc Channel	Auto	matic c	hannel	rejection		
	ICA weiq	Auto	matic c	ontinuo	us rejection	n	
1	Dataset			poch re	jection		
		-		epochs	•	•	
		-		using IC			
		Artila	ict rem	iovai usi	ng AAR 1.3		
		Clear	Line				
		SIFT					
		Clear	i conti	nuous d	ata using A	SR	

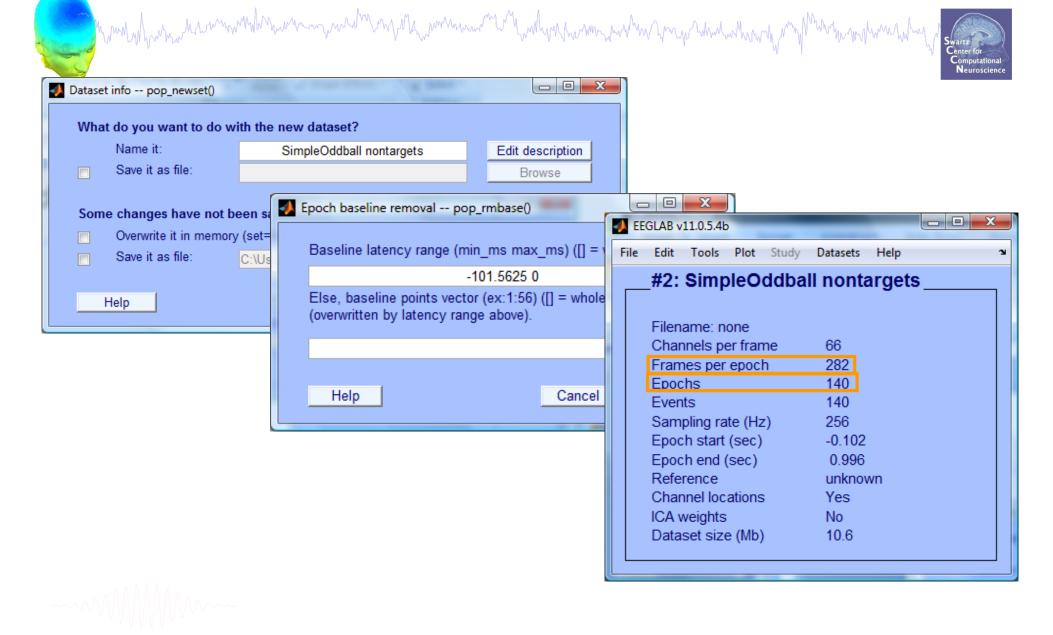
Channel range	[1:32]
Frequency range (Hz)	20 40
Frequency threshold in dB	10
Epoch segment length (s)	0.5
Minimum number of contiguous epochs	4
Add trails before and after regions (s)	0.25
Use hanning window before computing FFT	✓
Са	ncel Ok

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#### **Extract epochs**



#### **Extract epochs**



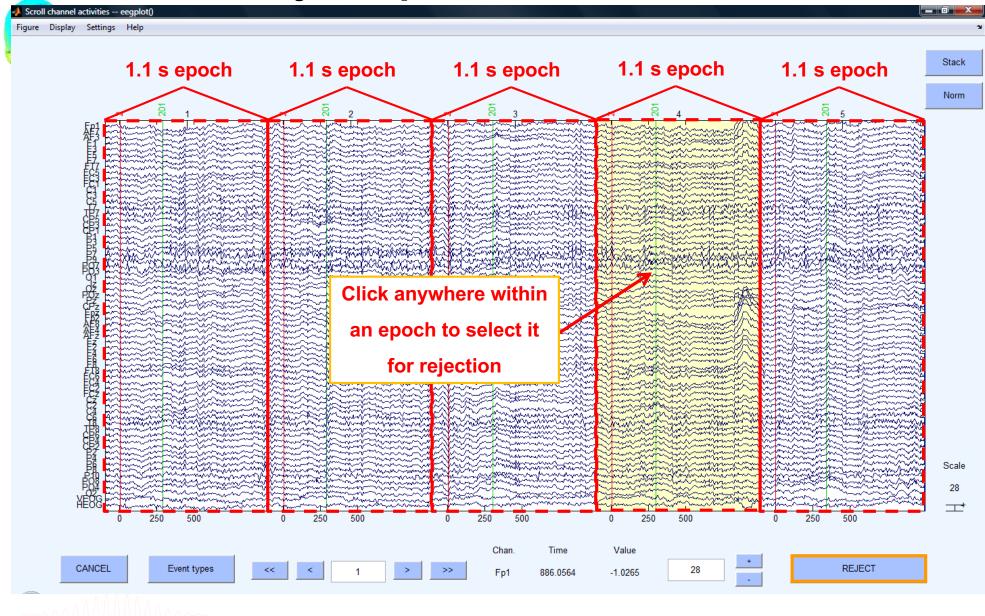
#### Scroll (epoched) channel data

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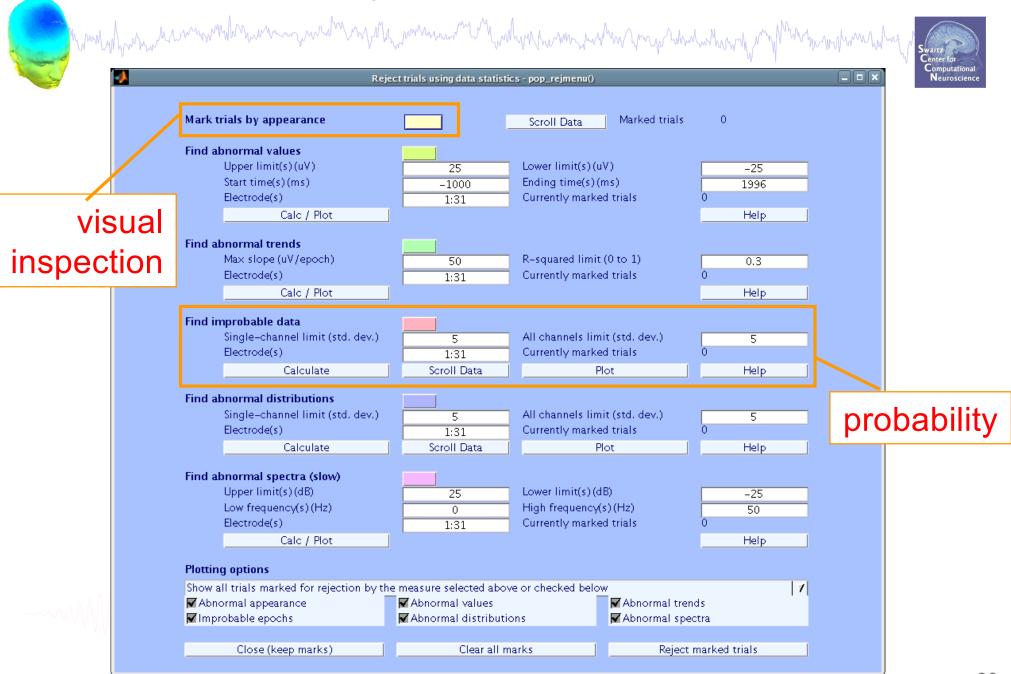
File	Edit Tools		Datasets Help 🏾 🖌	
_	_#3: Simp	Channel loca	Scroll channel activities eegplot()	
		Channel data		3
	Filename: n	Channel spe	£	Stack
	Channels pe	Channel pro		
	Frames per	Channel ERP		Norm
	Epochs	Channel ERP		
	Events	ERP map seri		
	Sampling ra Epoch start	Sum/Compa		
	Epoch end (	Component		
	Reference	Component		
	Channel loc	Component		
	ICA weights	Component		
	Dataset size	Component		
		Component		
		Sum/Compa		
		Data statistic		
		Time-freque		
		Cluster datas	LIM. I. I. W. A. WARNAR, M. T. WARNAR, M. T. WARNAR, M. T. WARNAR, M.	Scale 28
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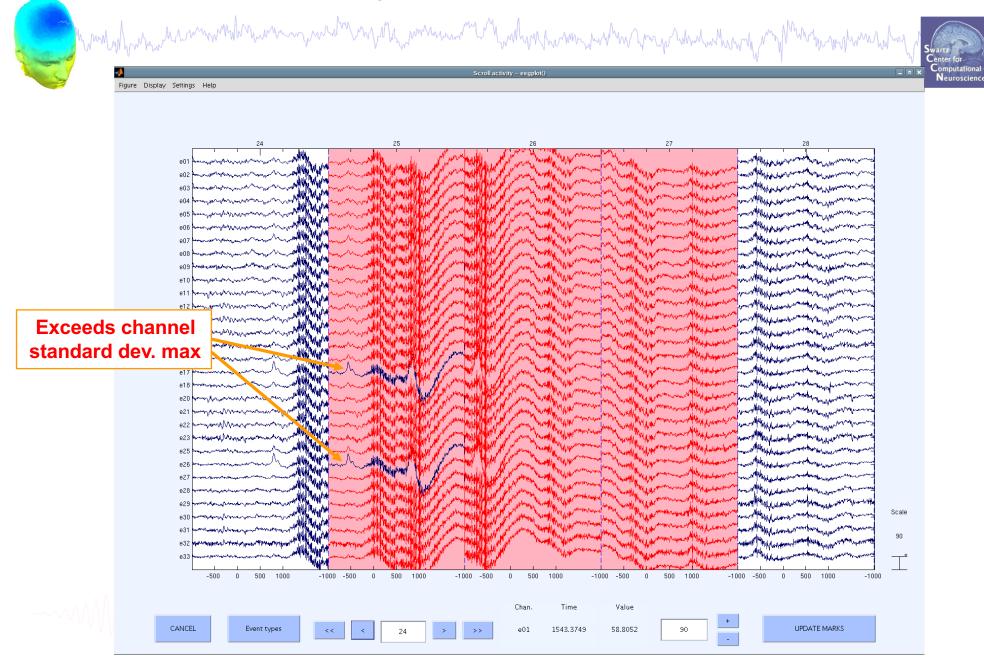
#### **Reject epochs with artifact**





<u>/</u>	_		EEGL	AB v6.	0b				X)	
File	Edit	Tools	Plot St	udy	Datasets	Help			ъ	
	-# <b>1: 1</b> Filena Chanı Frame Epoch Event	Filter Re-r Reje Extra	ige sam the dat eferenci ct contin act epoc ove bas	a e uous hs	rate data by ey	•	<b>s</b> -			
	Samp Epoch Epoch Avera		ove com	-	nts ejection		-			
	Chani	Reje	ct data (	epoch	s	•		Reje	ct d	lata (all methods)
	ICA w	Reje	ct data i	using	ICA	•		Reje	ct b	y inspection
	Datas	Loca	te dipol	es usi	ng BESA	•		Reje	ct e	extreme values
		Loca	te dipol	es usi	ng DIPFIT 2	.x. 🕨		Reje	ct b	y linear trend/variance
		Lapla	acian			•		Reje	ct b	y probability
		FMRI	B Tools			•		Reje	ct b	iy kurtosis
		Gran	d avera	ge da	tasets	•		Reje	ct b	iy spectra
		Loca	te dipol	es usi	ng LORETA			Expo	rt r	marks to ICA reject
		PCA	plugin			•		Reje	ct n	narked epochs

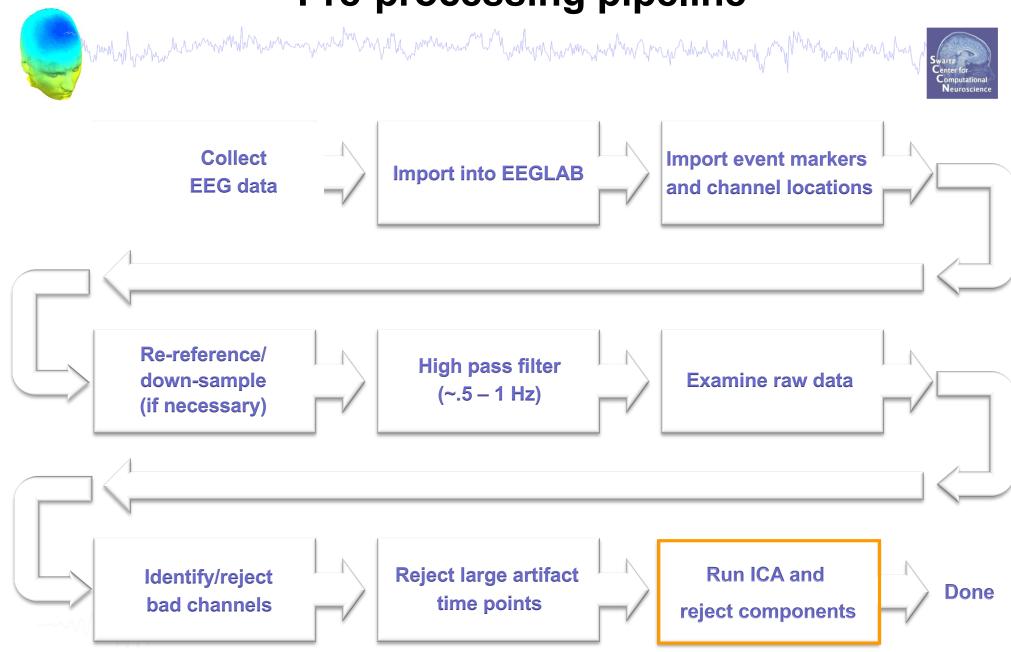






-			EE	GLAB v6	.0b			_) ×		
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#### **Pre-processing pipeline**



#### Acknowledgements

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#### Scott Makeig



#### Marissa Westerfield



#### Julie Onton





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## **Exercises**



- Load time SimpleOddball.set dataset
- 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