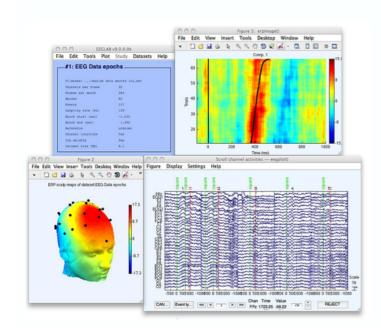
EEGLAB overview

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

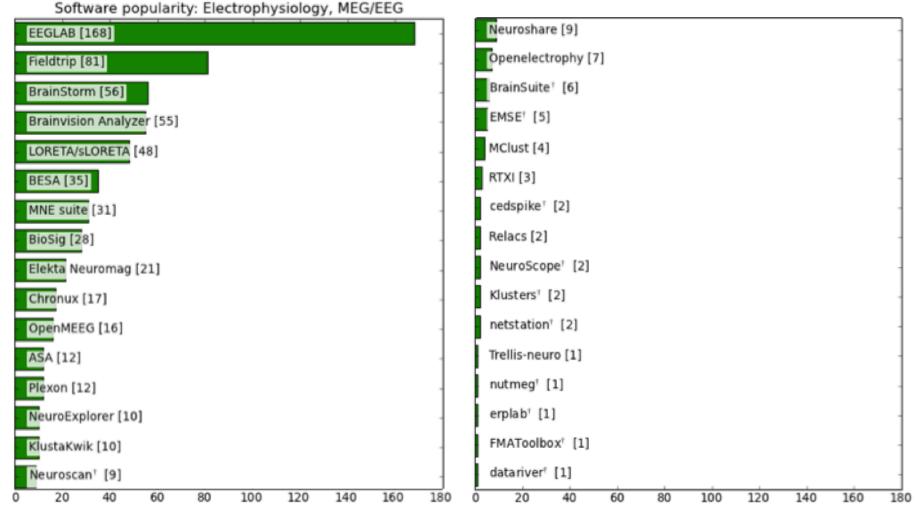
http://sccn.ucsd.edu/eeglab http://sccn.ucsd.edu/wiki/eeglab



Hanke & Helcencko, 2011, Frontier in Neuroinformatics

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EEGLAB standard processing pipeline

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Single subject

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

Multi-subjects

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

Advanced analysis using scripting and EEGLAB command line functions

The EEGLAB Matlab software

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MATLAB R2012a Debug Parallel Desktop Edit Window File Ŷ 0 E 1 Shortcuts 🖪 How to Add 🖪 What's New >> >> >> >> >> >> >> >> >> >> >> >> >> >> >> >> ∫x >> eeglab 📣 Start

FEGLAB v13.x dev File Edit Tools Plot Study Datasets Help -No current dataset -- Create a new or load an existing Use "File > Import data" Or "File > Load existing dataset" - If new, "File > Import epoch info" (data "File > Import event info" (continuous "Edit > Dataset info" (add/edit "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"

1. Importing data

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Import/load data

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Import event info 🛛 🗘	From European Data Format .EDF file						
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Load existing dataset	From Segmented EGI .RAW files						
Save current dataset	From BCI2000 ASCII file						
Save datasets	From Snapmaster .SMA file						
Clear dataset(s)	From Neuroscan .CNT file						
Maximize memory	From Neuroscan .EEG file						
Save history	From ERPSS .RAW or .RDF file						
Quit	From Brain Vis. Anal. Matlab file						
Dataset size (Mb)	From CTF folder (MEG)						
	From ANT .CNT file						
	From ANT .AVR file						

Import events

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Dataset size (Mb)	14.9					



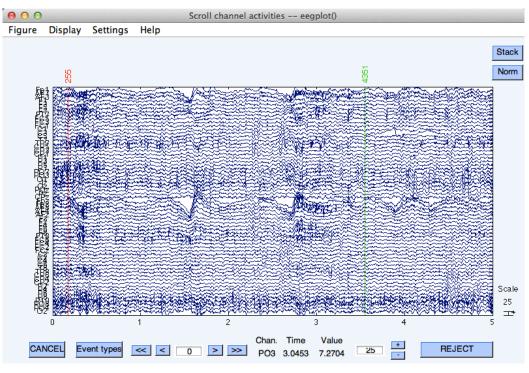
1. Importing data

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Data info

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	ICA wei	ghts		No			
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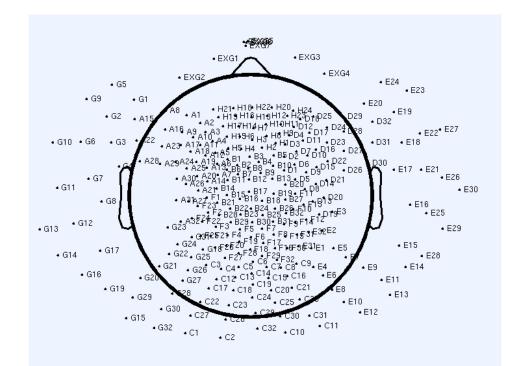


1. Importing channel location

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Import channel location

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		ICA weights	Yes			
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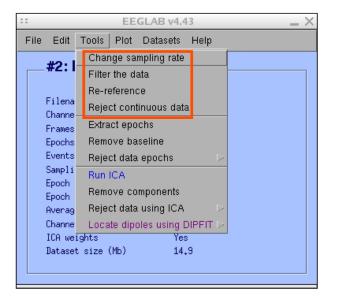


2. Edit, Re-reference, Resample, High pass filter data

Edit/select data

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Preprocessing data



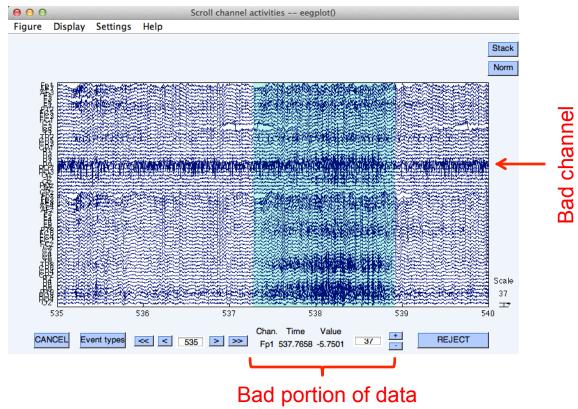
3. Reject artifacts in continuous data by visual inspection

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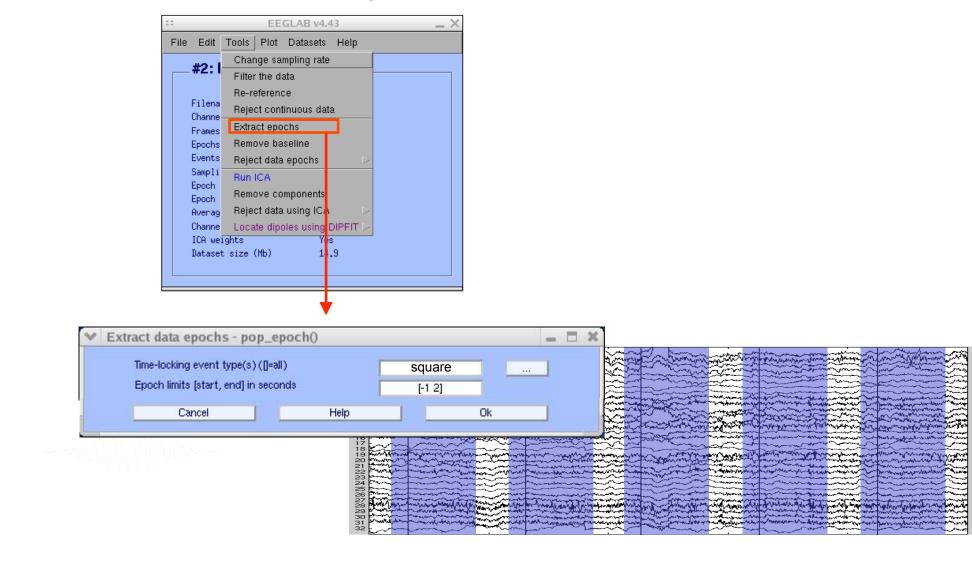
Data info

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File Edit #2:1 Filena Channe Frames Epochs Events Sampli Epoch Averag Channe ICA we	Change sampling rate Filter the data Re-reference Reject continuous data Extract epochs Remove baseline Reject data epochs Run ICA Remove components Reject data using ICA Locate dipoles using DIPFIT >
Datase	t size (Mb) 14.9

Reject portions of continuous data



4. Extract epochs from data & reject artifactual epochs

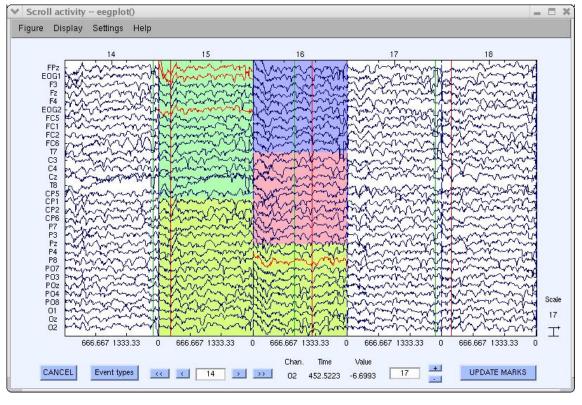


4. Extract epochs from data & reject artifactual epochs

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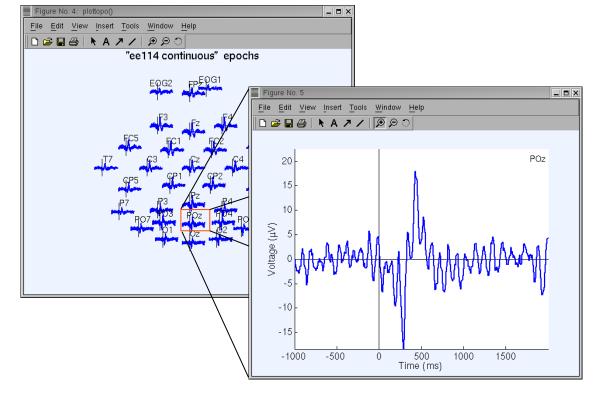
Different color = different rejection methods



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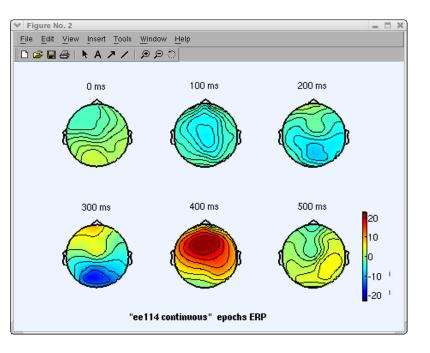
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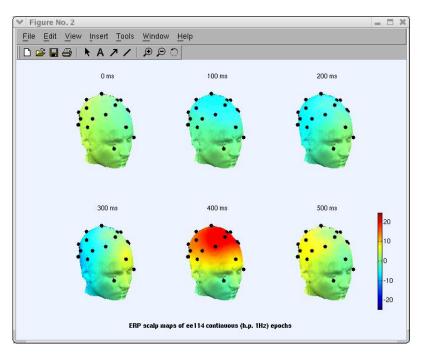
Plot ERP



Plot ERP map series

	EEGLAB v4.43	_ ×
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	Sum/Compare comp. ERPs	
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	Time-frequency transforms	

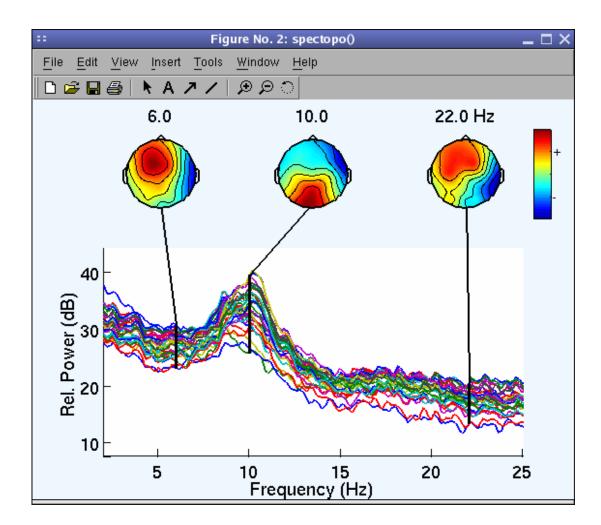




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Plot data spectrum and maps

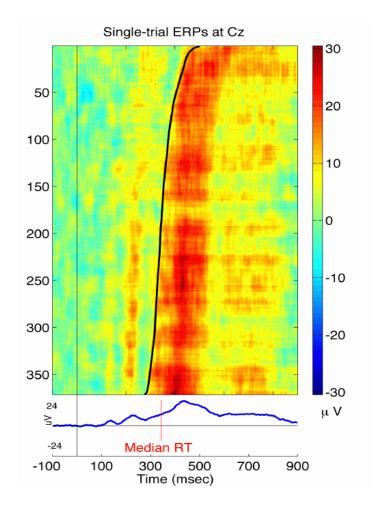
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Plot channel ERPimage

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EEGLAB standard processing pipeline

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Single subject

- 1. Import binary data, events and channel location
- 2. Edit, Re-reference, Resample, High pass filter data
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- 5. Visualize data measures
- 6. Perform ICA decomposition
 - Perform source localization of components
 - Analyze components contribution to ERP
 - Analyze components contribution to spectrum

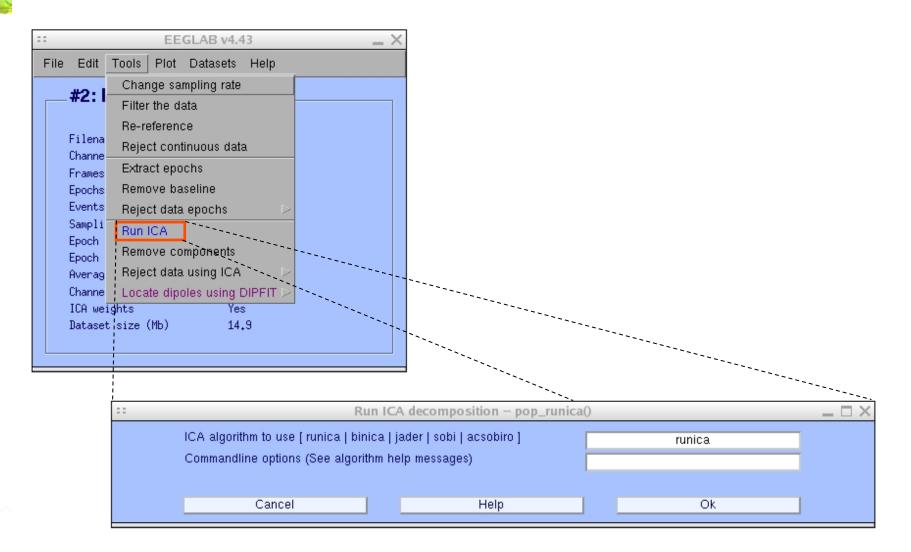
Multi-subjects

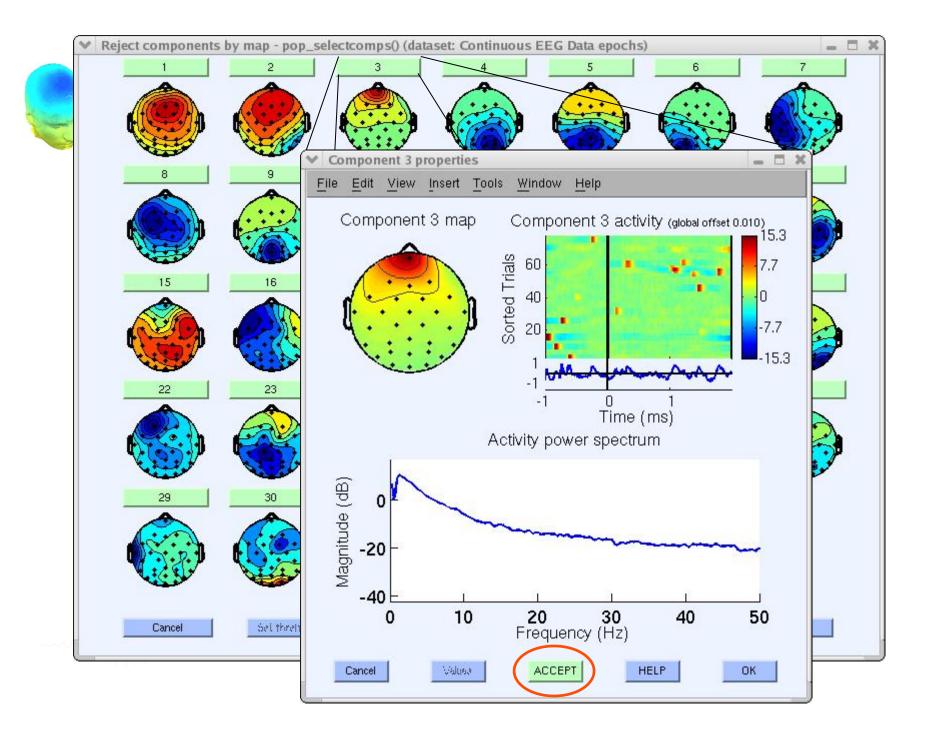
- 1. Build study
- 2. Pre-compute measures
- 3. Cluster components
- 4. Analyze clusters

Advanced analysis using scripting and EEGLAB command line functions

6. Perform ICA decomposition

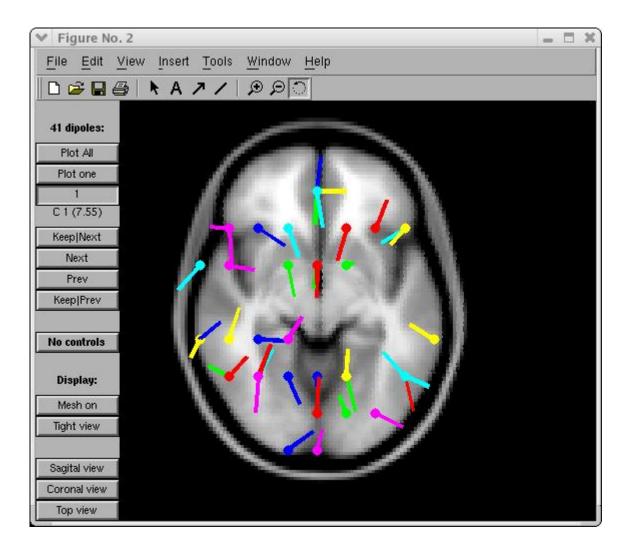
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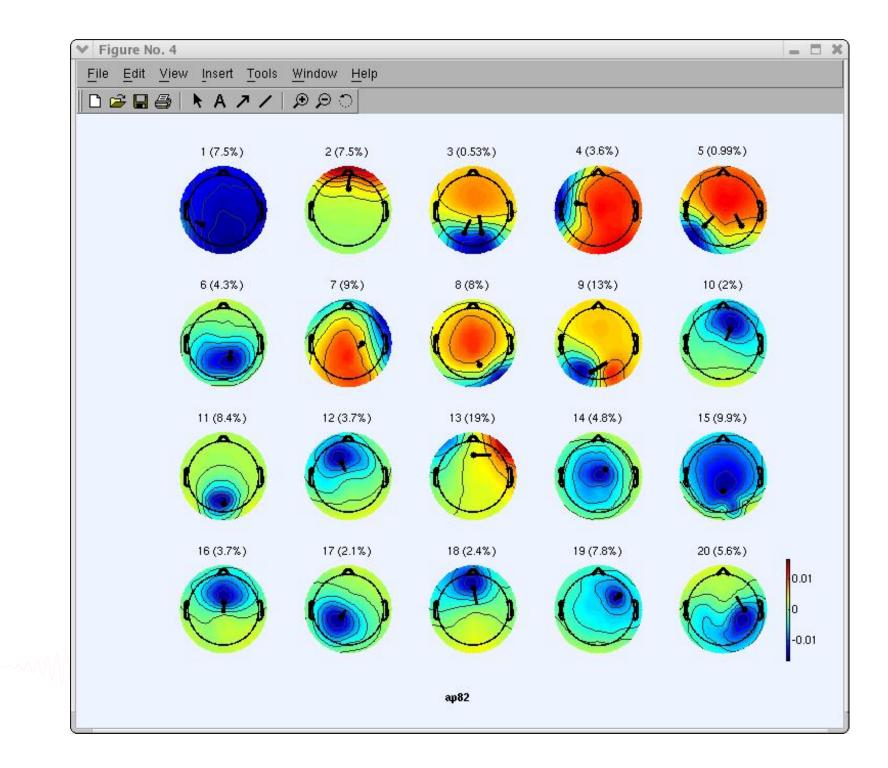




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		Plot component dipoles

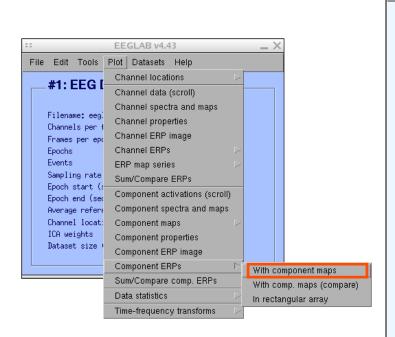






Component contribution to the ERP

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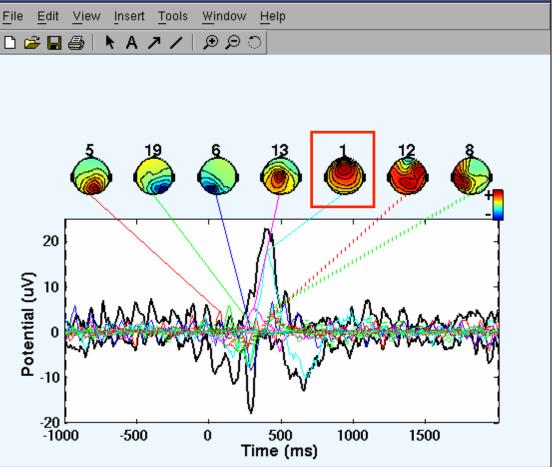
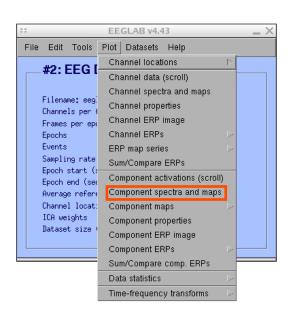


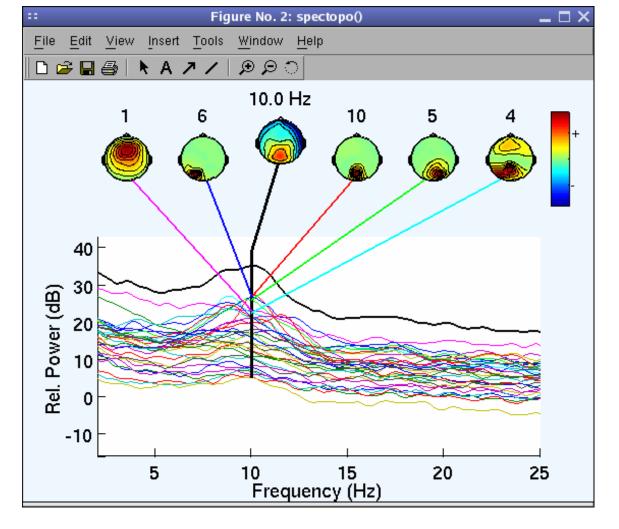
Figure No. 2

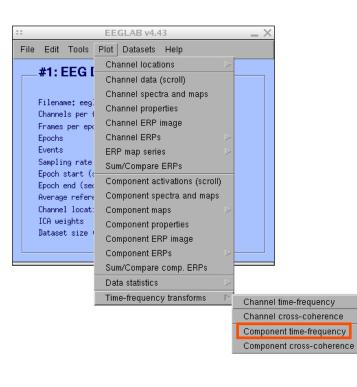
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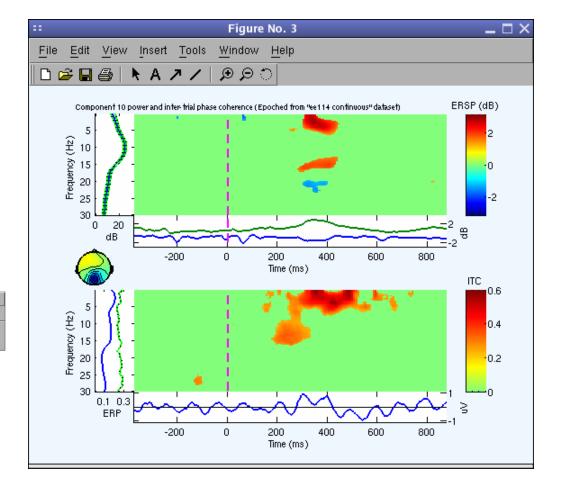
Component contribution to the EEG spectrum



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EEGLAB standard processing pipeline

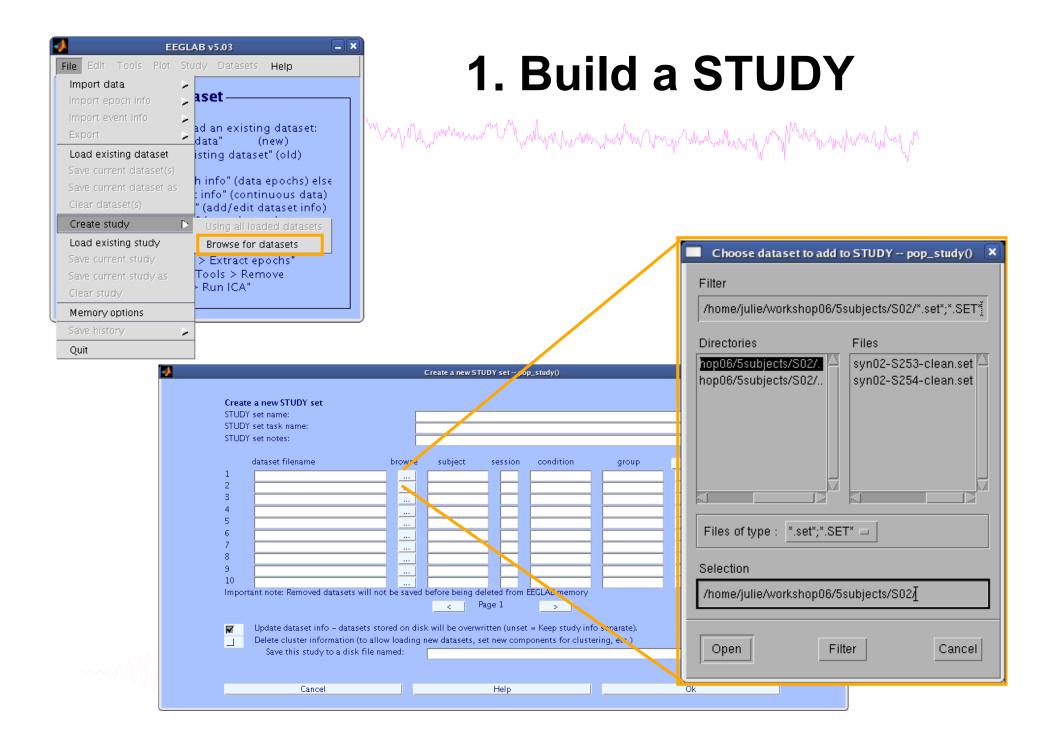


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Multi-subjects

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

Advanced analysis using scripting and EEGLAB command line functions



😑 🔿 🕥 EEGLAB v			v9.0.0.0ł)	_			
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idit STUDY design

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2. Pre-compute measures

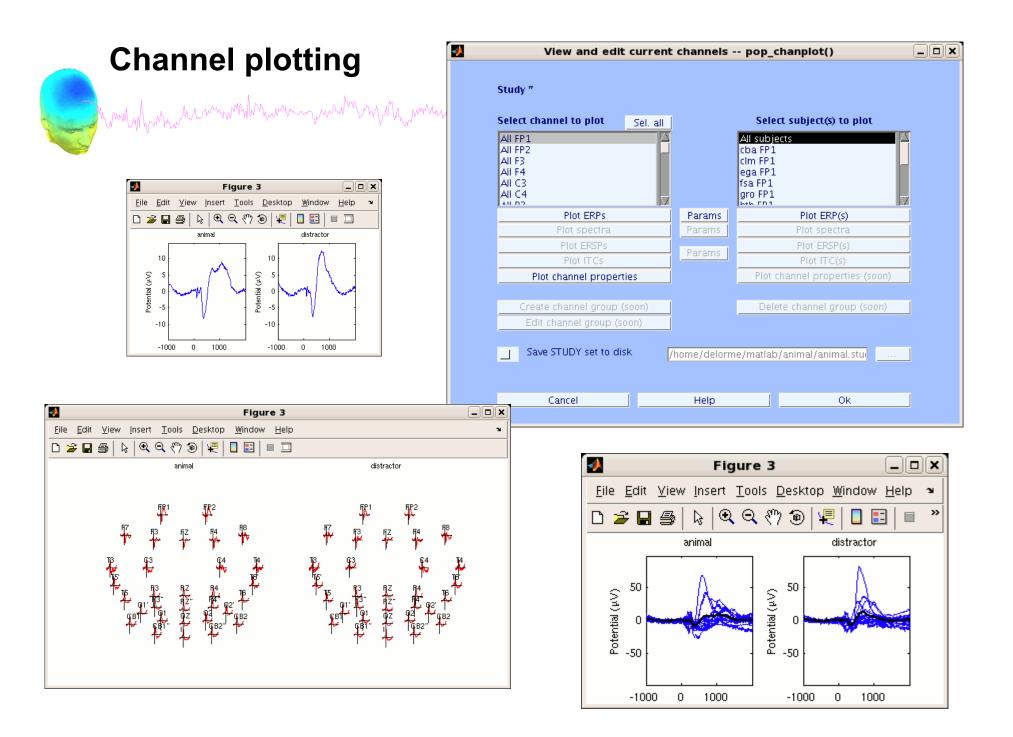
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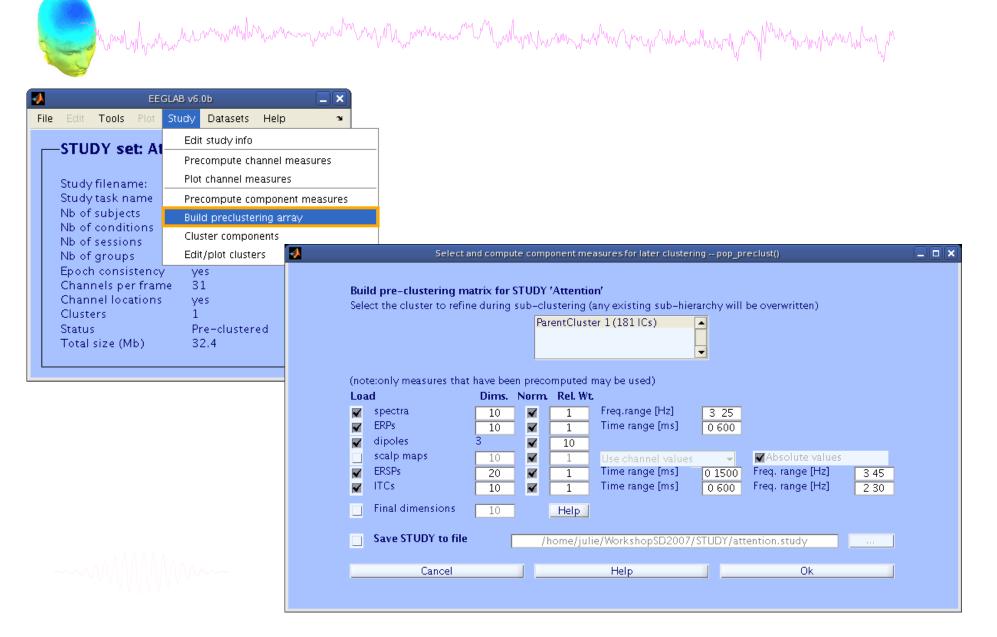
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Channel list (default:all)									
7									
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Remove ICA artifactual components pre-tagged in each dataset									
ParentCluster 1									
Remove artifactual ICA cluster or clusters (hold shift key)									
List of measures to precompute									
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🗏 пся 🛄	Time/freq. parameters	ies, [5 0.5], filleds, 100							
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Save single-trial measures for single-trial statistics - requires disk space									
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Help		Cancel Ok							

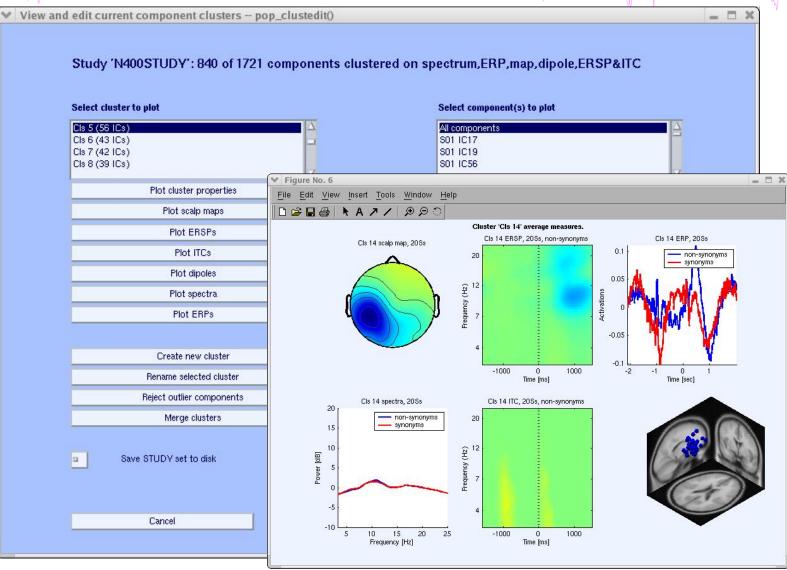


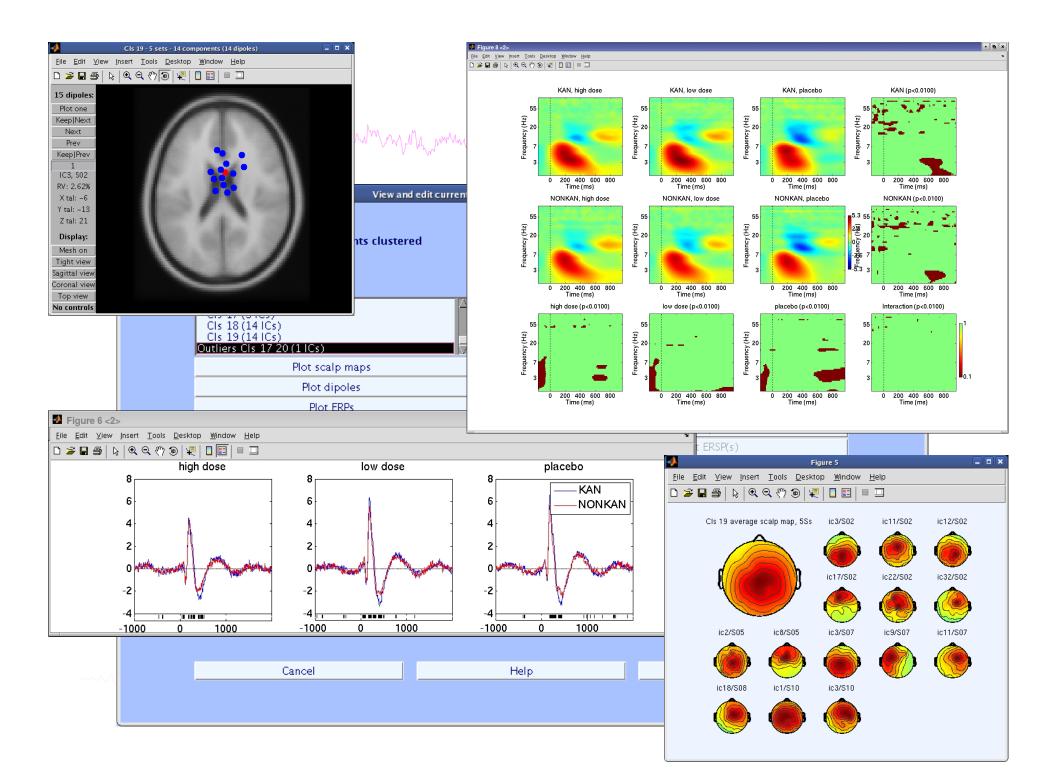
3. Cluster components



4. Analyze clusters







EEGLAB standard processing pipeline



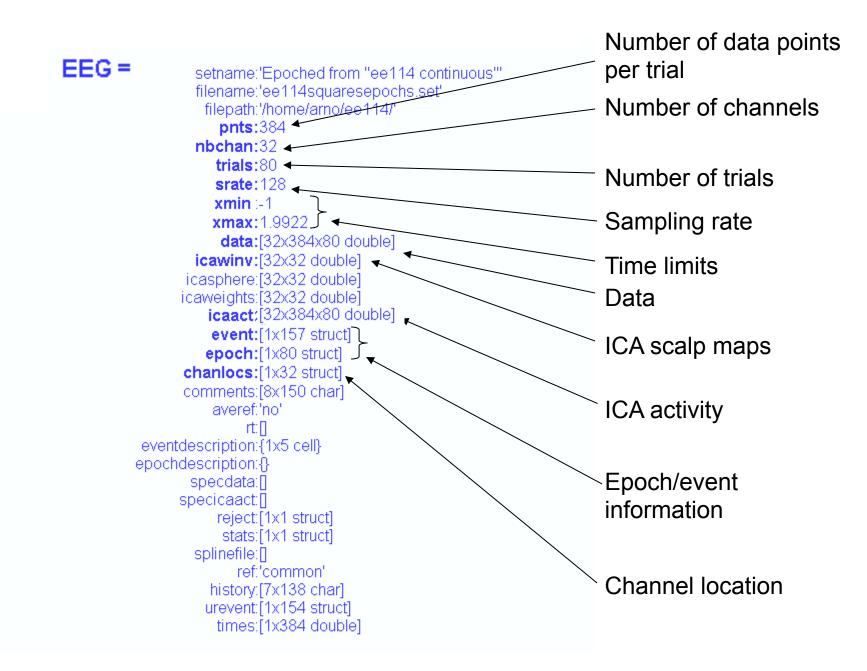
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Advanced analysis using scripting and EEGLAB command line functions

EEG structure



3 levels of functions

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Administrative functions: handle EEG and ALLEEG structures eeglab(), eeg_checkset(), pop_delset(), ...

Pop functions: interactive functions using EEG structure pop_erpimage(), pop_topoplot(), pop_envtopo(), ...

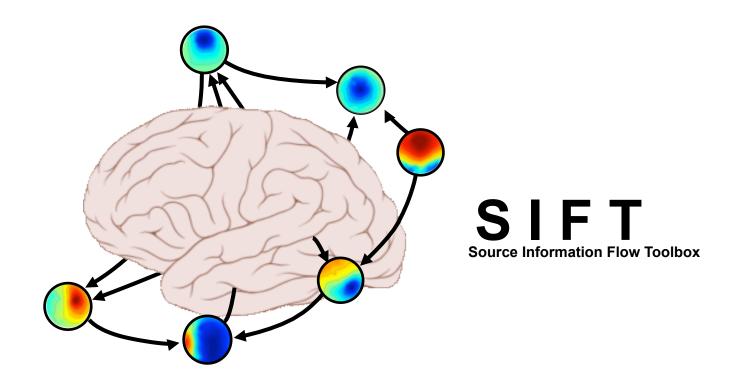
Signal processing functions: perform signal processing erpimage(), topoplot(), envtopo(), ...

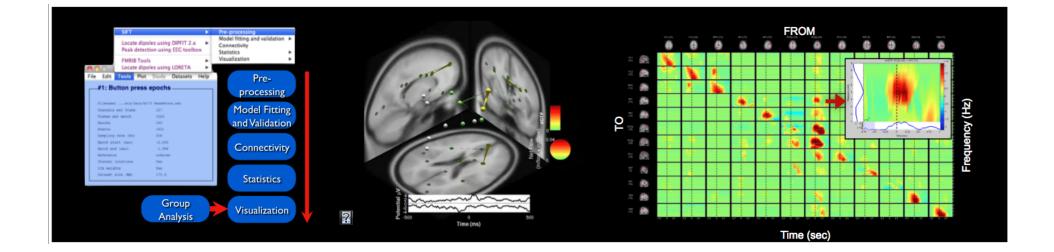


("eegh" Menus write both dataset and global history)

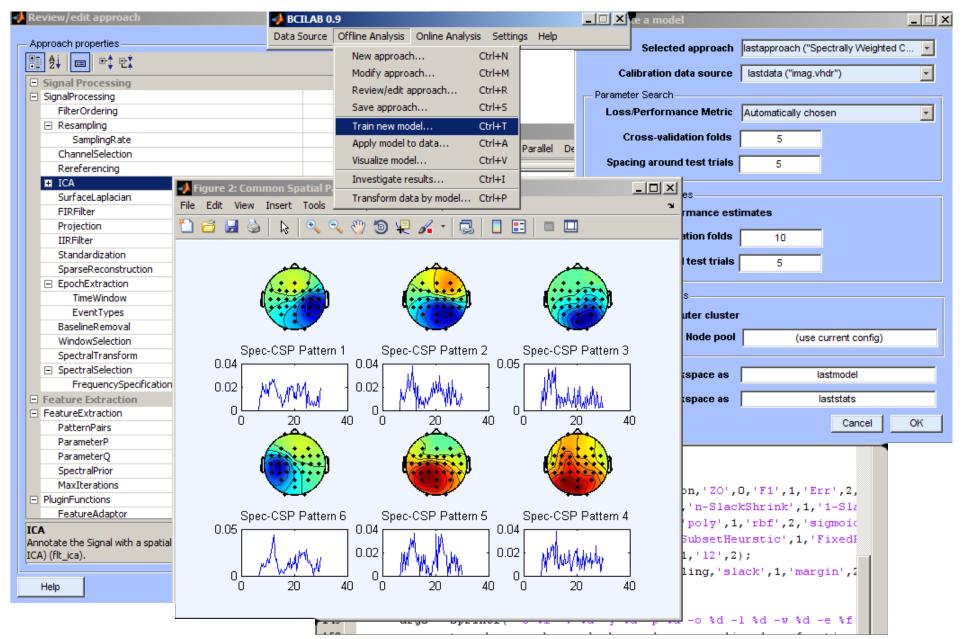
- Automated processing on groups of subjects (possibly on several processors).
- Richer options for plotting and processing functions (time-frequency decompositions, ...)
- Custom processing...







BCILAB - C. Kothe



Pros/Cons of Matlab based open source

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

EEGLAB articles

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

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

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

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

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

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

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

Workshop program (and PDFs)

Day 1 - Wednesday, 2nd of September, 2015

- 8:30 9:00 Morning refreshments at the Bar in The Edge
 - 9:00 10:15 Mining event-related brain dynamics I (Scott Makeig) 10:15 – 10:45 EEGLAB overview (Arnaud Delorme)
- 10:45 11:00 Break. Tea and Coffee Served in the Bar in The Edge
 - 11:00 11:45 ICA theory (Arnaud Delorme)
 - 11:45 12:30 ICA evaluation (John Iversen)
- 12:30 14:00 Lunch Served in The Bar in The Edge
 - 14:00 15:30 Importing data, rejecting data, and performing ICA decomposition (John Iversen)
- 15:30 15:45 Break—Tea and Coffee Served in the Bar in The Edge
 - 15:45 17:00 Evaluating ICA components practicum (John Iversen)
- 17:00 19:00 Poster Session and Social, held in The Bar

Day 2 - Thursday, 3rd September, 2015

- 8:30 9:00 Morning refreshments at the Bar in The Edge
 - 9:00 9:45 Why cluster ICA components? (Scott Makeig)
 - 9:45 -10:45 Creating a STUDY and STUDY design (Arnaud Delorme)
- 10:45 -11:00 Break. Tea and Coffee Served in the Bar in The Edge
 - 11:00 12:30 EEGLAB STUDY statistics and plotting (Arnaud Delorme)
- 12:30 14:00 Lunch Served in The Bar in The Edge
 - 14:00 15:30 Statistics and LIMO EEG (Cyril Pernet)
 - 15:30 15:45 LIMO EEGLAB integration (Arnaud Delorme)
- 15:45 16:00 Break—Tea and Coffee Served in the Bar in The Edge
- 16:00 21:00 Group excursion to Yorkshire Sculpture Park. Coaches leave at 16:00

Day 3 - Friday, 4th September, 2015

- 8:30 9:00 Morning refreshments at The Bar in The Edge
 - 9:00 10:45 Time-frequency decomposition: Theory and practice (John Iversen)

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

- 11:00 11:45 Forward and inverse source imaging Dipfit, NFT, and NIST (Scott Makeig)
- 11:45 12:30 New directions in source imaging (Scott Makeig)

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

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

- 14:45 15:45 EEGLAB scripting for custom plotting (John Iversen)
- 15:45 16:00 Break. Tea and Coffee Served in the Bar in The Edge
 - 16:00 17:00 EEGLAB scripting for STUDY data (Arnaud Delorme)

Day 4 - Saturday, 5th September, 2015

- 8:30 9:00 Morning refreshments at The Bar in The Edge
 - 9:00 10:00 Mining event-related brain dynamics II (Scott Makeig)
 - 10:00 10:45 EEGLAB Challenge Practicum (all)
- 10:45 11:00 Break-Tea and Coffee Served in the Bar in The Edge
 - 11:00 11:30 EEGLAB Challenge Practicum (all)
 - 11:30 12:30 Participant Challenge presentations, Q & A, and closing remarks (all)
- 12:30 13:30 Lunch Served in The Bar in The Edge.
- 13:30 Close