

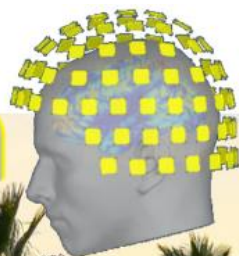
# Brainstorm Workshop Los Angeles 2024

# Welcome!

# Brainstorm

<http://neuroimage.usc.edu/brainstorm>

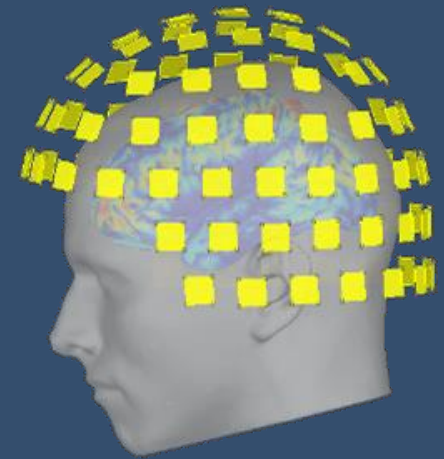
Brainstorm Workshop,  
December 5<sup>th</sup>, USC,  
Los Angeles



MEG and EEG analysis using

# Brainstorm

<http://neuroimage.usc.edu/brainstorm>



**USC** University of  
Southern California



neuro UTHHealth



**December 2024**

# Let's start with a quick poll!





- **Are you currently using Brainstorm software?**
  - If Yes : Raise your hand



# Let's start with a quick poll!



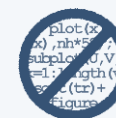
- Are you currently using Brainstorm software?
  - If Yes : Raise your hand 
- For those who aren't using it... yet, are you aware of Brainstorm and its applications?“
  - If Yes : Raise your hand 

# Outline

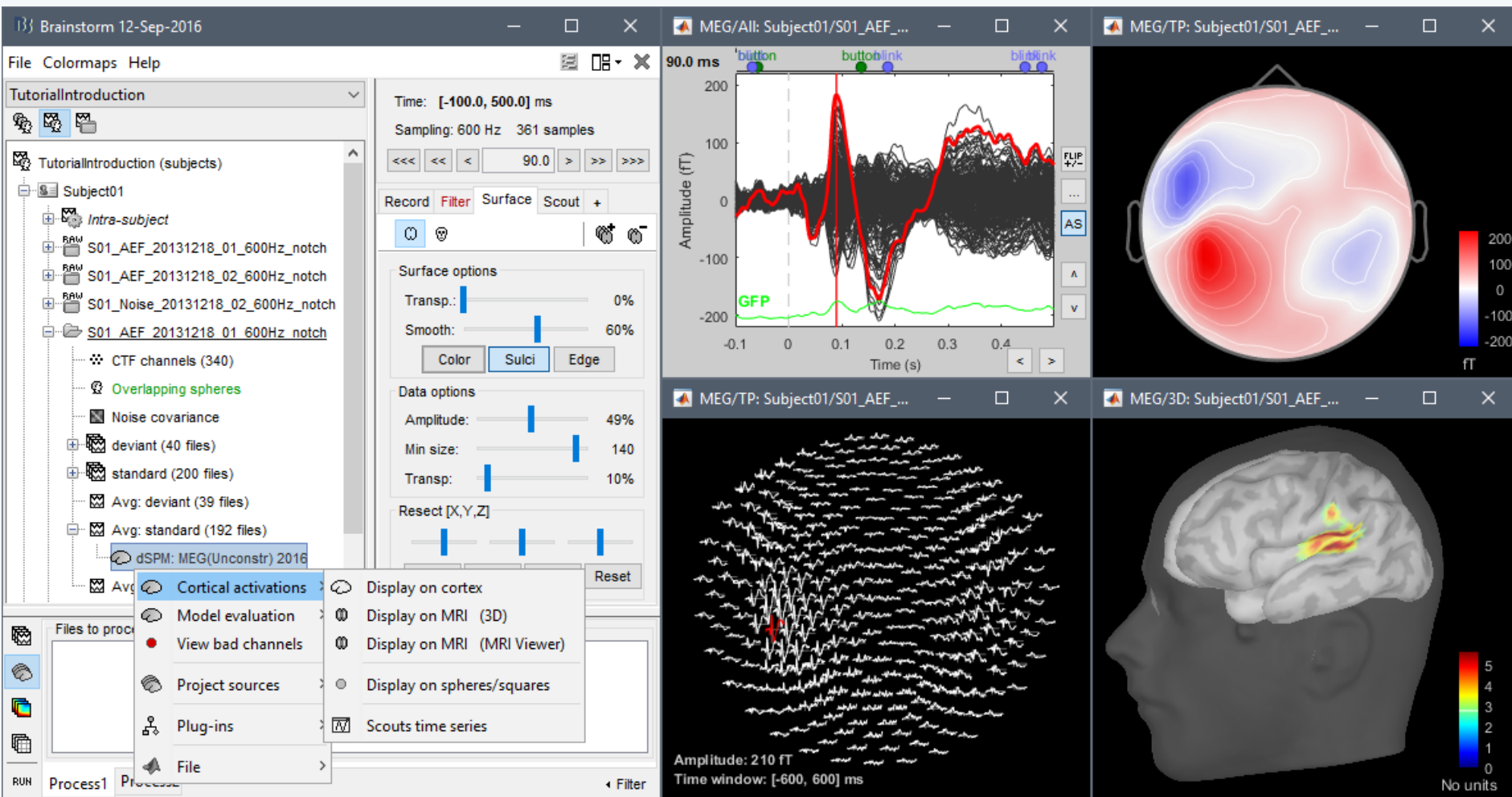
- Brainstorm Software
- Brainstorm GUI
- Brainstorm Workflow
  - Review and Import Data
  - Data Co-registration
  - Data Analysis: Sensor and Source Level
  - Single Subject and Group level Analysis
- What's New?
- Today's Workshop

# Brainstorm

- A free and open-source application (GPL)
- Matlab & Java: Platform-independent
- Stand-alone version also available
- Interface-based: **click, drag, drop**
- No Matlab experience required
- Daily updates of the software
- Supports most common file formats
- Educational resources & active users' community [Website, Forum, GitHub, ...]

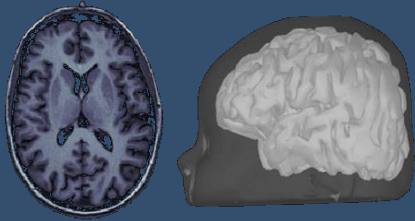


# Graphic interface

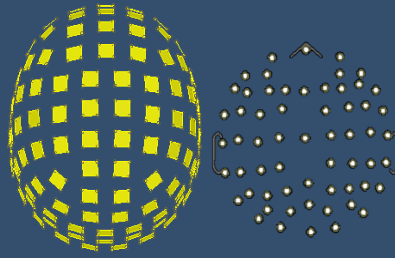


# Workflow

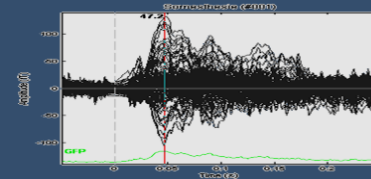
Anatomy



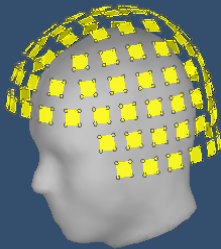
Sensors



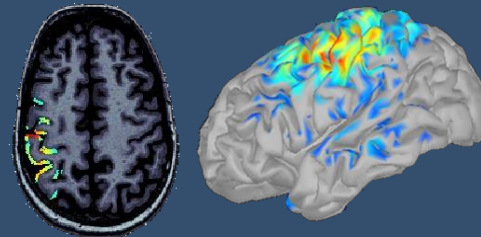
EEG/MEG



Co-registration



Source estimation



Analysis

Averages  
Contrasts  
Group analysis  
Time-frequency  
Connectivity



# Single subject

Anatomy  
Link recordings  
MRI registration

Importing

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Pre-processing

Events  
Epoching  
Averaging  
Sources  
Time-frequency

Analysis of the  
experimental data

Loop:  
all acquisition runs  
all subjects

# Single subject

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Time-frequency

Analysis of the  
experimental data

Loop:  
all acquisition runs  
all subjects

**Similar workflow for most modalities: EEG, MEG, sEEG, fNIRS, etc.**

# Import

## Anatomy

Link recordings  
MRI registration

PSD

Filters

Bad channels

Artifacts

Correction

Bad segments

Markers

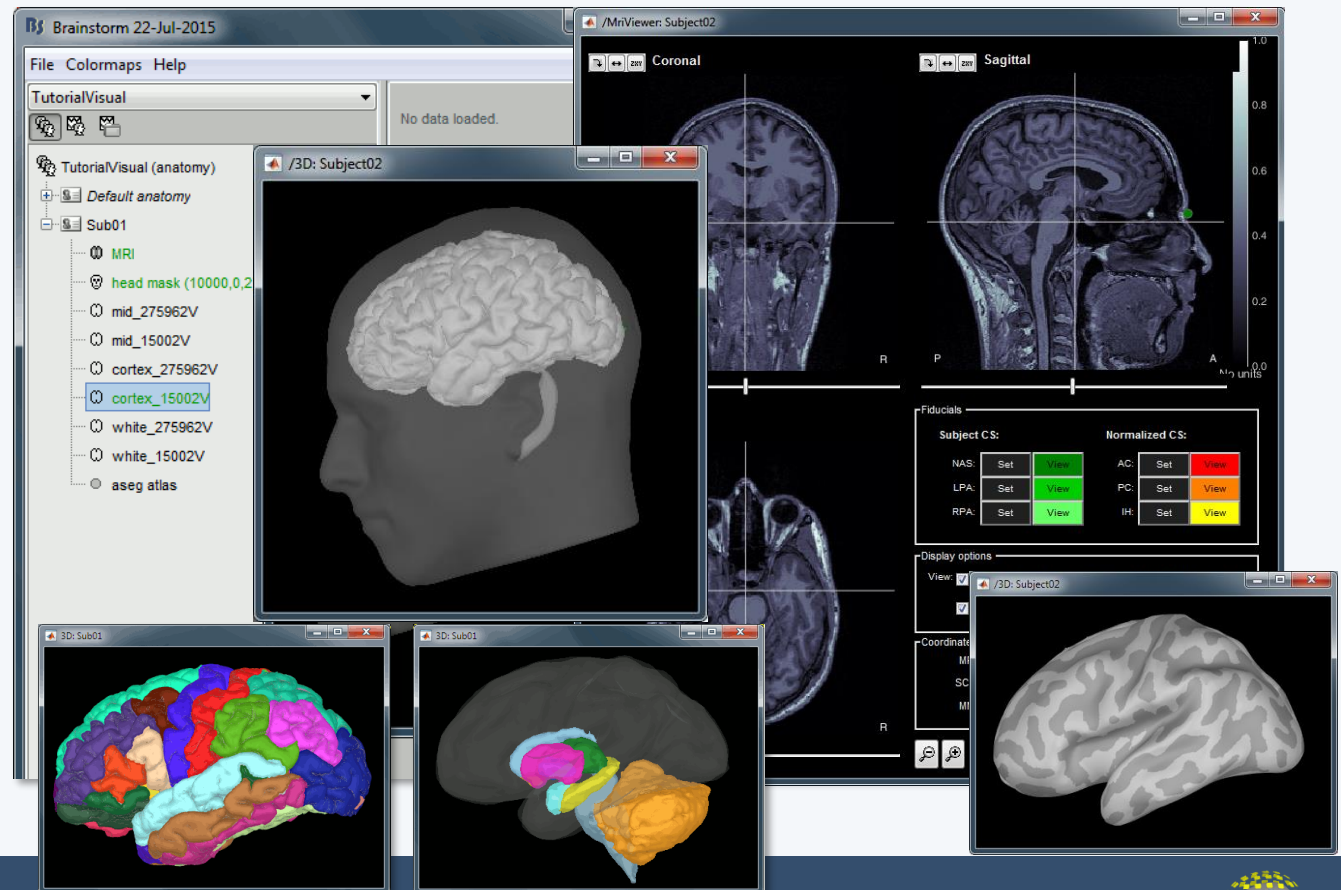
Epoching

Averaging

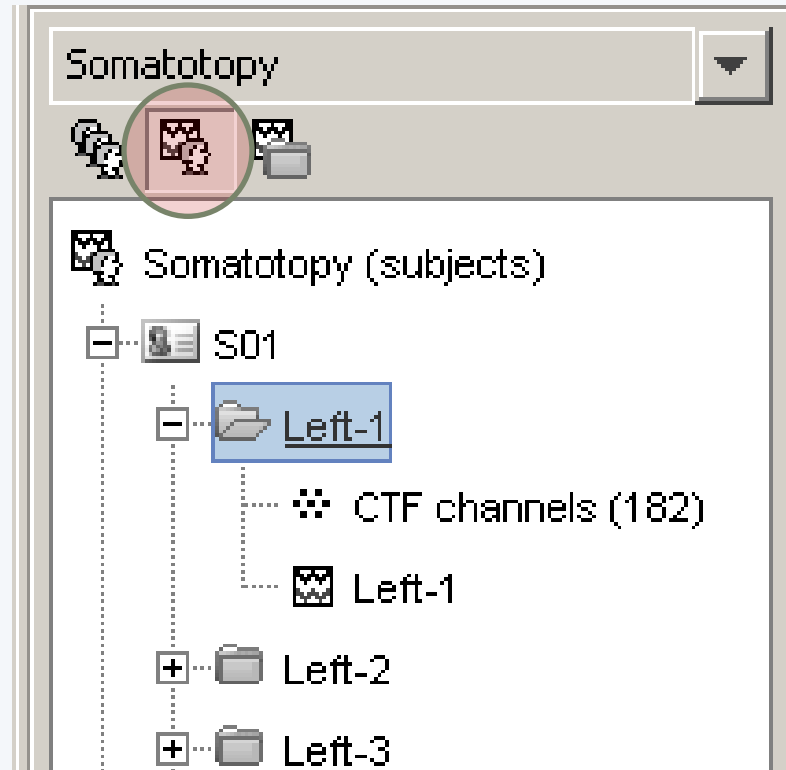
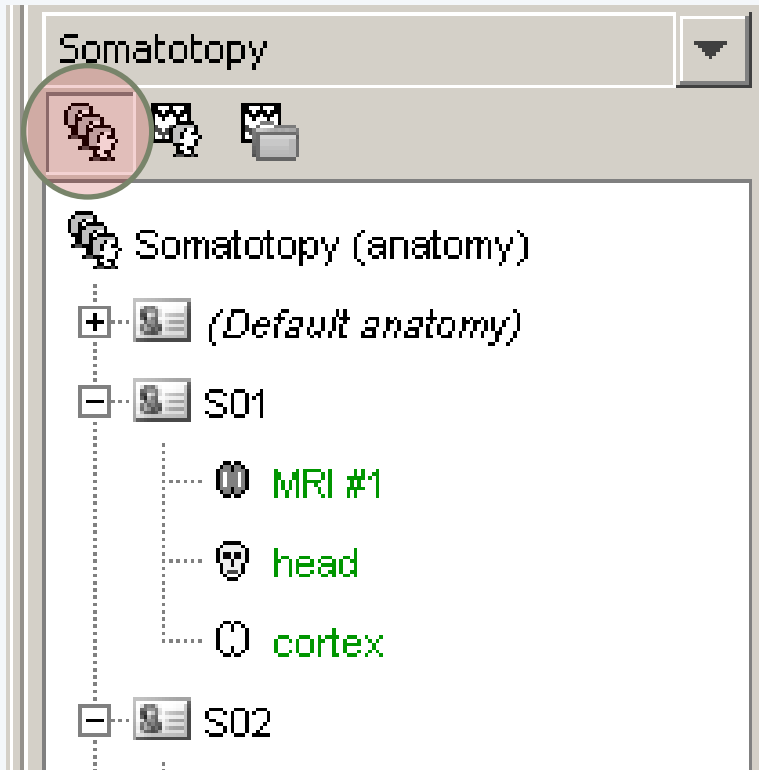
Sources

Time-frequency

- One-click import of the T1 segmentation: FreeSurfer, BrainSuite, BrainVISA, CIVET, CAT
- Import and place fiducials in the MRI (N,L,R)



# Database



- Three levels:
  - Protocol
  - Subject
  - Condition
- Popup menus
- All files saved in Matlab .mat
- Same architecture on the disk

# Import

Anatomy

Link recordings

MRI registration

PSD

Filters

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Artifacts

Correction

Bad segments

Markers

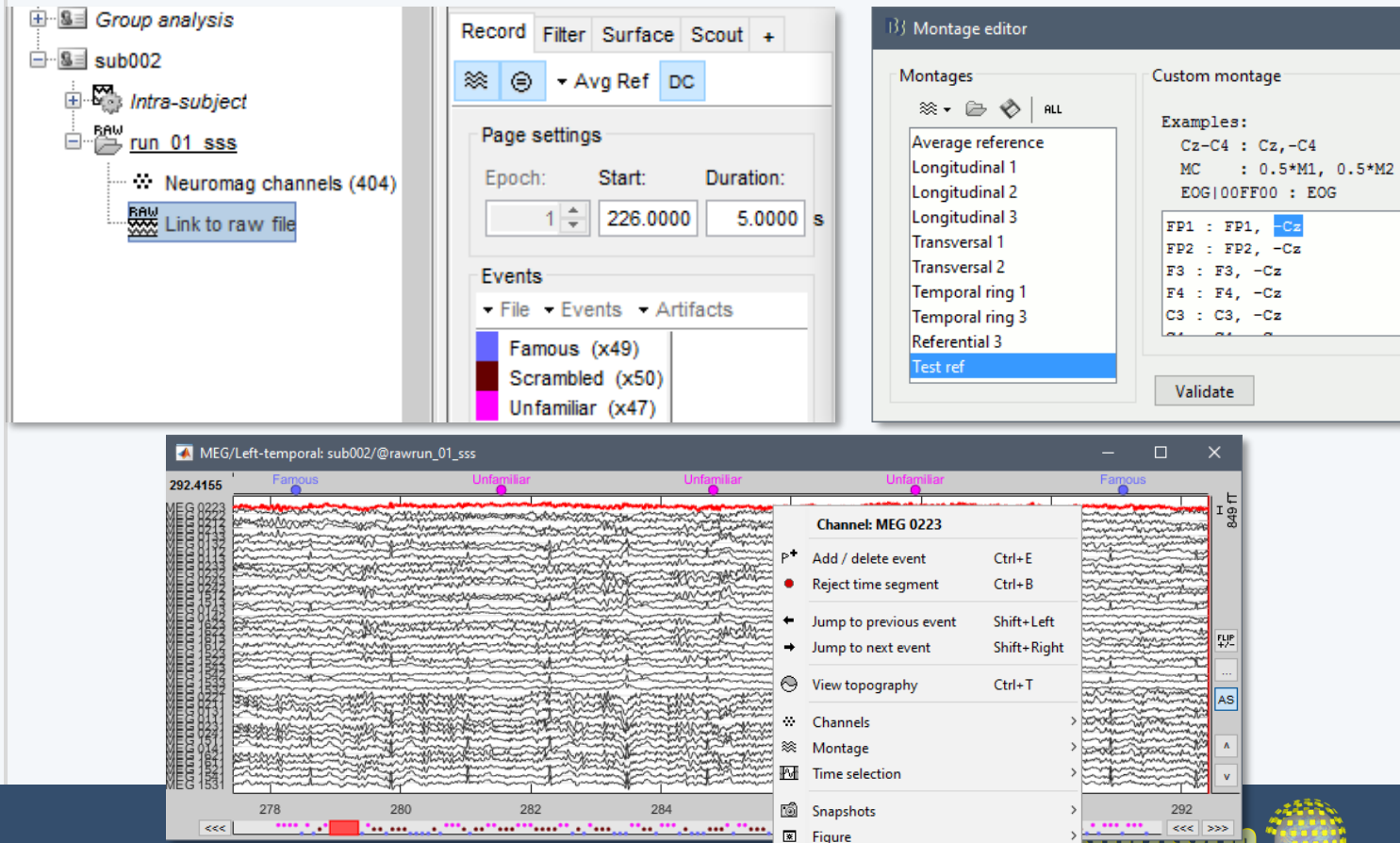
Epoching

Averaging

Sources

Time-frequency

- Original files linked to the database (no copy)
- Rich data viewer with flexible montage editor
- Optimized reading functions



# Co-registration MEEG / MRI (I)

Anatomy

Link recordings

**MRI registration**

PSD

Filters

Bad channels

Artifacts

Correction

Bad segments

Markers

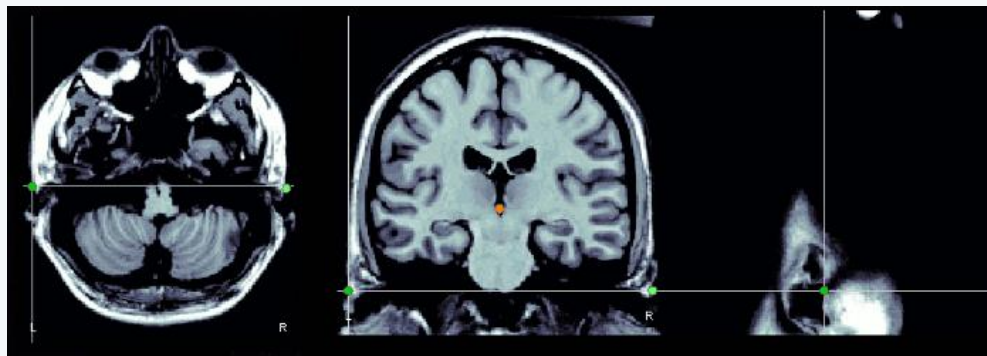
Epoching

Averaging

Sources

Time-frequency

- Basic estimation based on three points: Nasion (NAS), Left ear (LPA), Right ear (RPA)
- MRI: Marked in the volume with the MRI Viewer
- MEEG: Obtained with a tracking system (Polhemus)



# Co-registration MEEG / MRI (2)

Anatomy

Link recordings

**MRI registration**

PSD

Filters

Bad channels

Artifacts

Correction

Bad segments

Markers

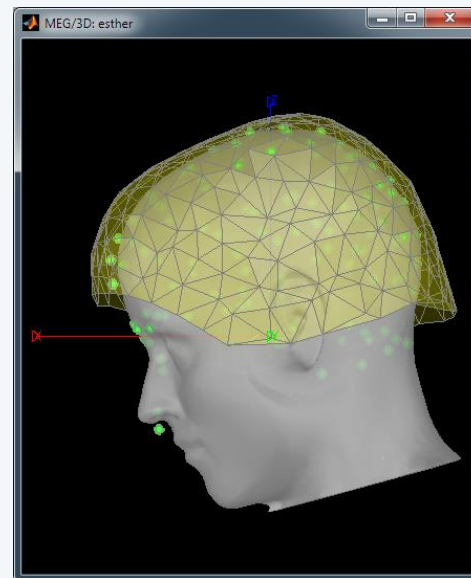
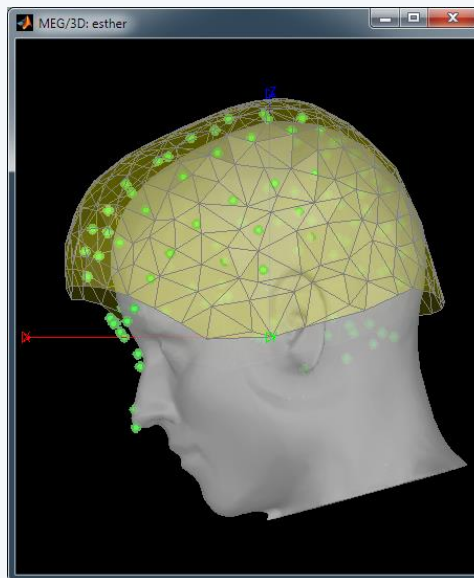
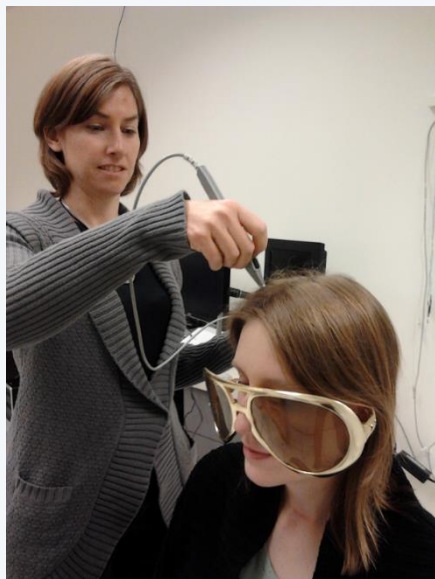
Epoching

Averaging

Sources

Time-frequency

- Automatic adjustment based on head shape: Fitting Polhemus points on the MRI head surface
- Final registration must be checked manually
- Polhemus driver included in Brainstorm



# Quality control

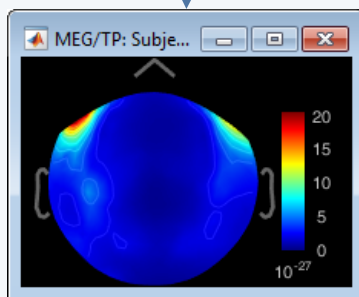
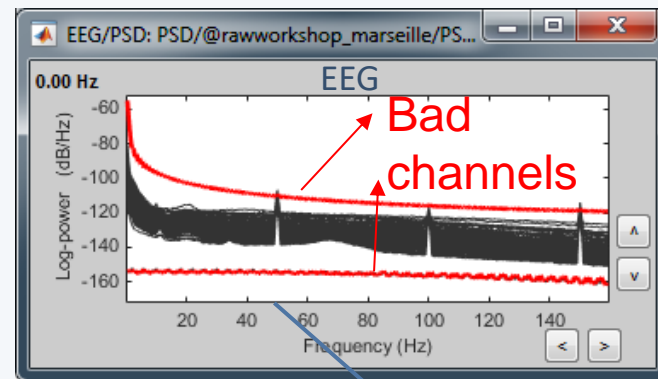
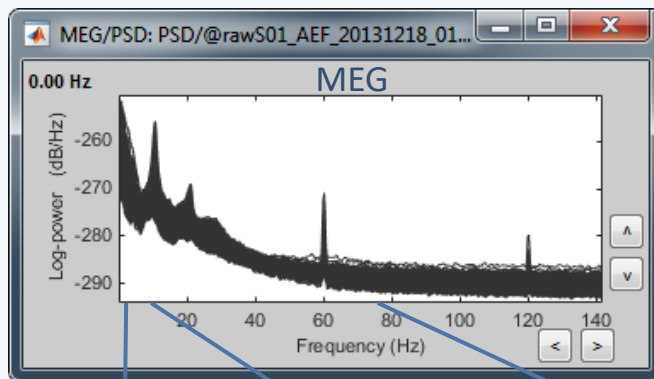
Anatomy  
Link recordings  
MRI registration

## PSD

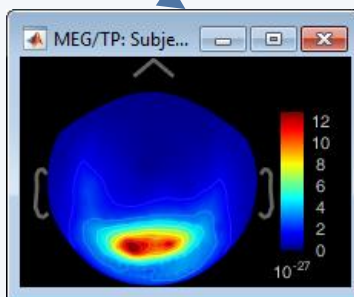
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency

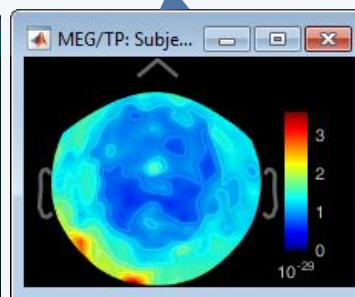
- Power spectrum density for quality control



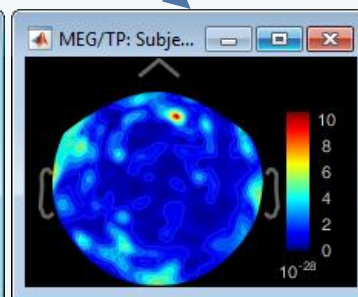
< 3Hz: Eyes



10Hz: Alpha



> 40Hz: Muscle



50/60Hz



# Pre-processing

Anatomy  
Link recordings  
MRI registration

PSD

## Filters

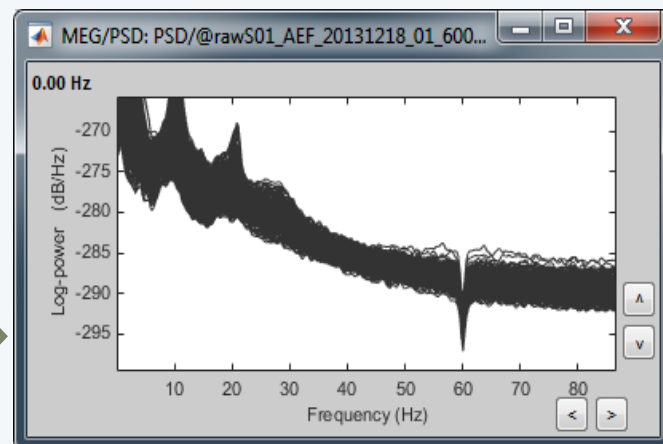
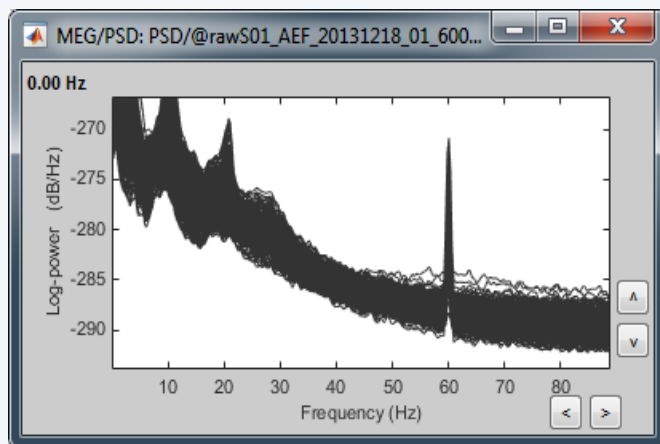
Bad channels  
Artifacts  
Correction  
Bad segments

Markers

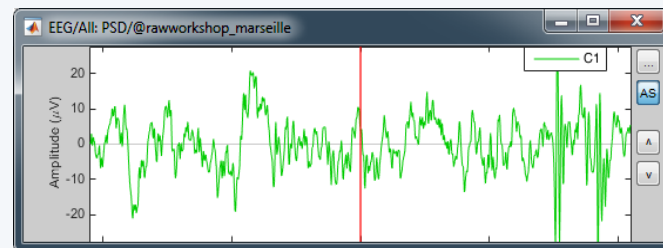
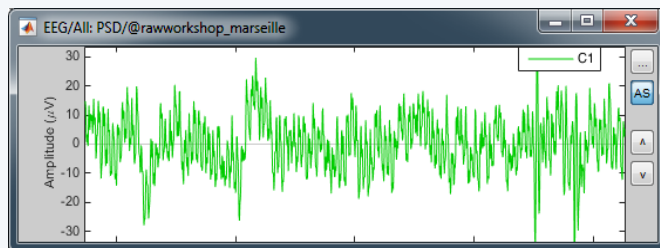
Epoching  
Averaging  
Sources  
Time-frequency

- Notch filter: Removes 50Hz/60Hz power line noise (and harmonics)

PSD



Signal



# Pre-processing

Anatomy  
Link recordings  
MRI registration

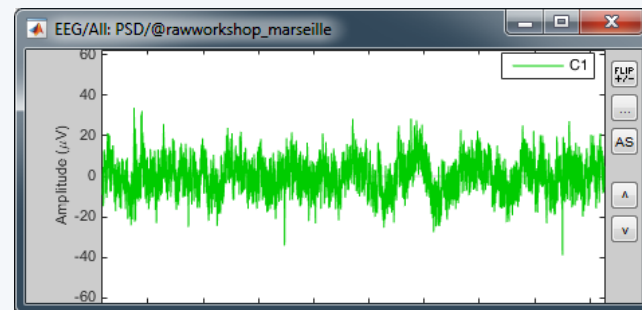
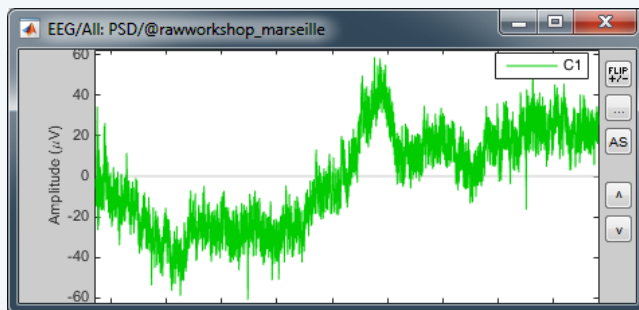
PSD

## Filters

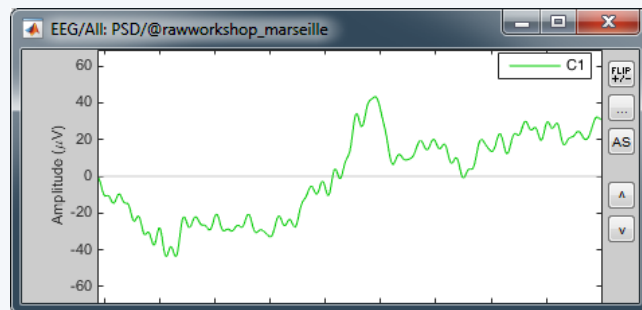
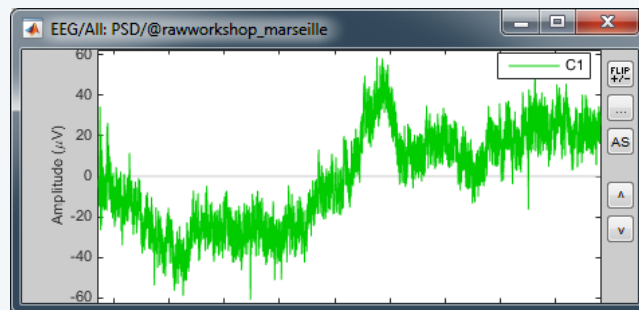
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency

- High-pass filter: Removes slow components (eye movements, breathing, sensor drifts...)



- Low-pass filter: Remove high-frequencies



# Pre-processing

Anatomy  
Link recordings  
MRI registration

PSD

Filters

**Bad channels**

Artifacts

Correction

Bad segments

Markers

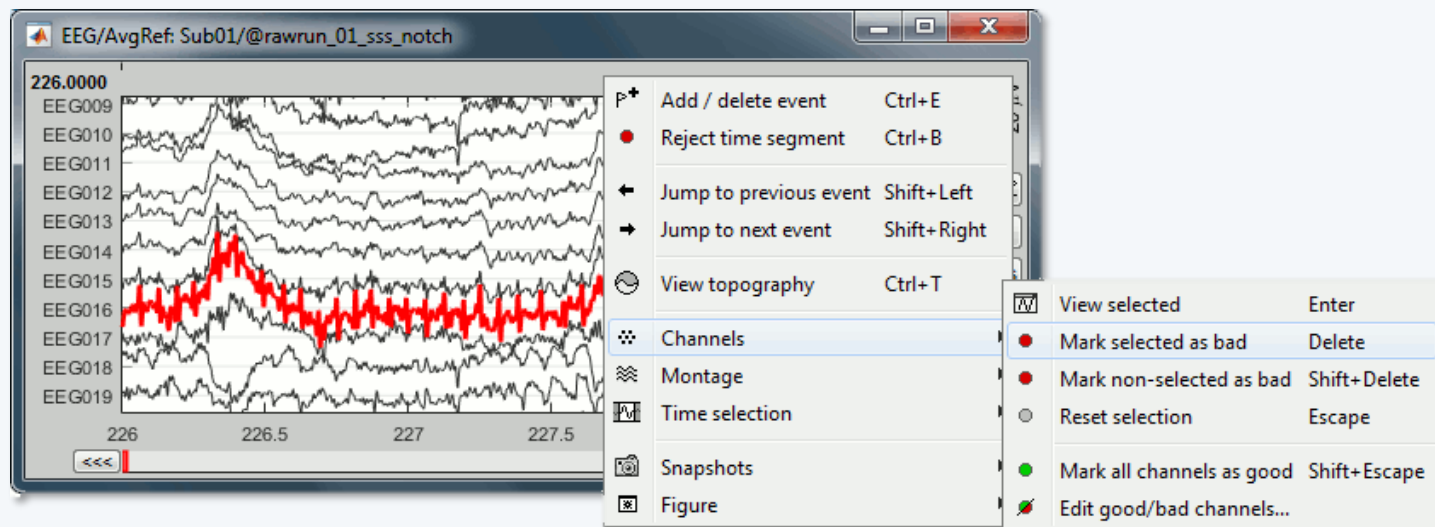
Epoching

Averaging

Sources

Time-frequency

- Manual inspection of the recordings
- Interactive selection of bad channels
- Re-reference the EEG if necessary (Average ref)



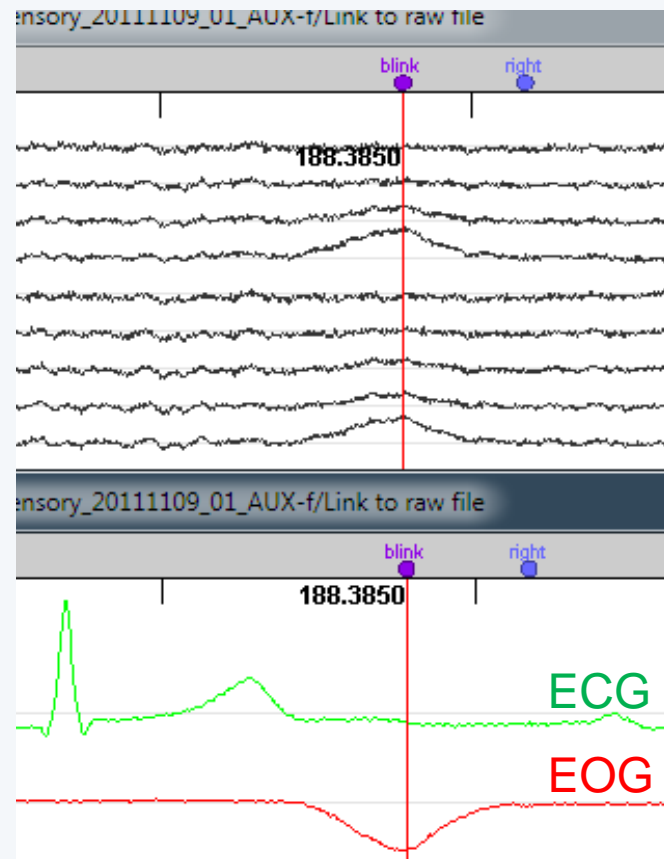
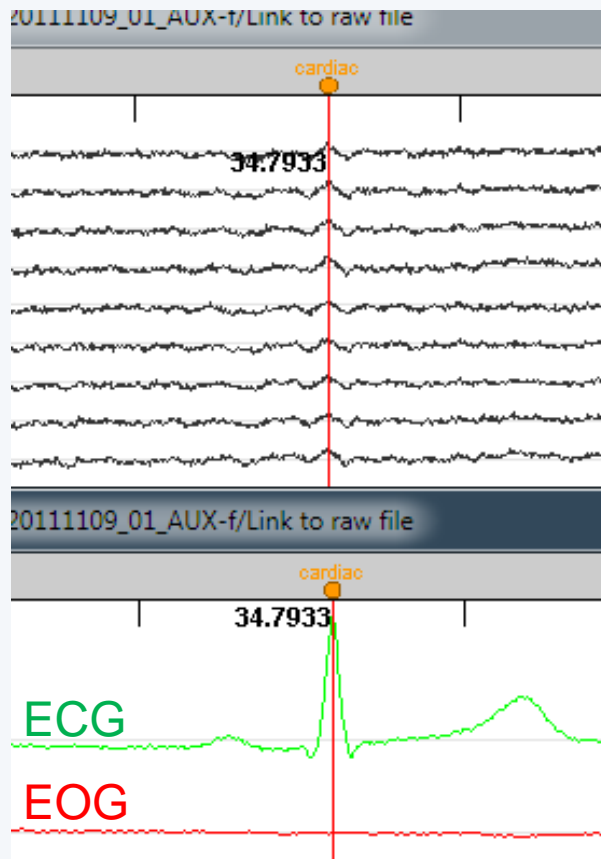
# Pre-processing

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
**Artifacts**  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency

- Automatic detection of blinks and heartbeats (peak detection, or explicit amplitude threshold)



# Artifact correction

- Two categories of artifacts:
  - Well defined, reproducible, short, frequent:
    - Heartbeats, eye blinks, eye movements, some stimulators
    - Unavoidable and frequent: we cannot just ignore them
    - **Can be modeled and removed from the signal efficiently**
      - ICA, SSP
  - All the other events that can alter the recordings:
    - Movements, building vibrations, metro nearby...
    - Too complex or not repeated enough to be modeled
    - **Safer to mark them as bad segments, and ignore them**

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts

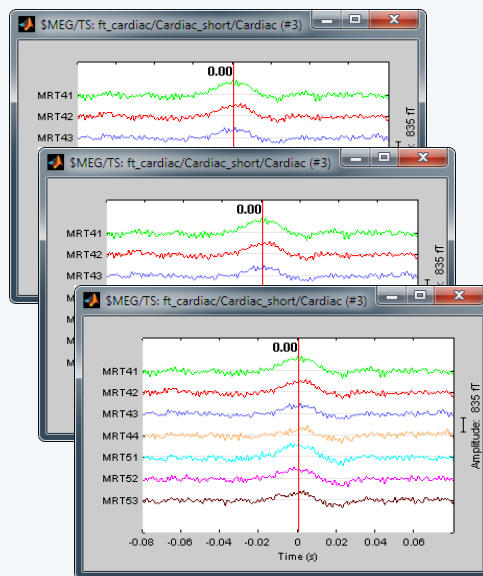
## Correction

Bad segments

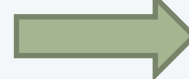
Markers  
Epoching  
Averaging  
Sources  
Time-frequency

- Correction with Signal Space Projections (SSP)

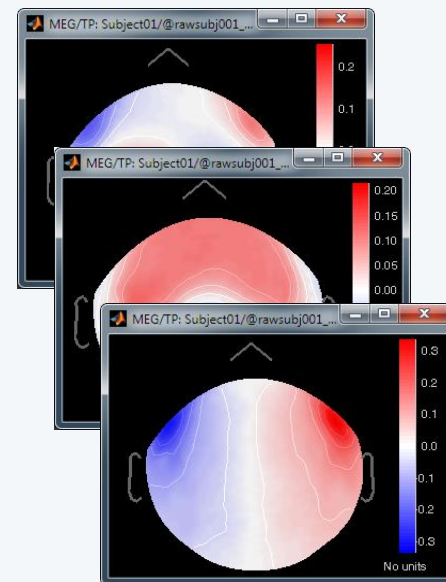
### Detect artifacts



PCA



### Spatial components



Select components and compute a linear projector to remove their contribution from the recordings

# Pre-processing

Anatomy  
Link recordings  
MRI registration

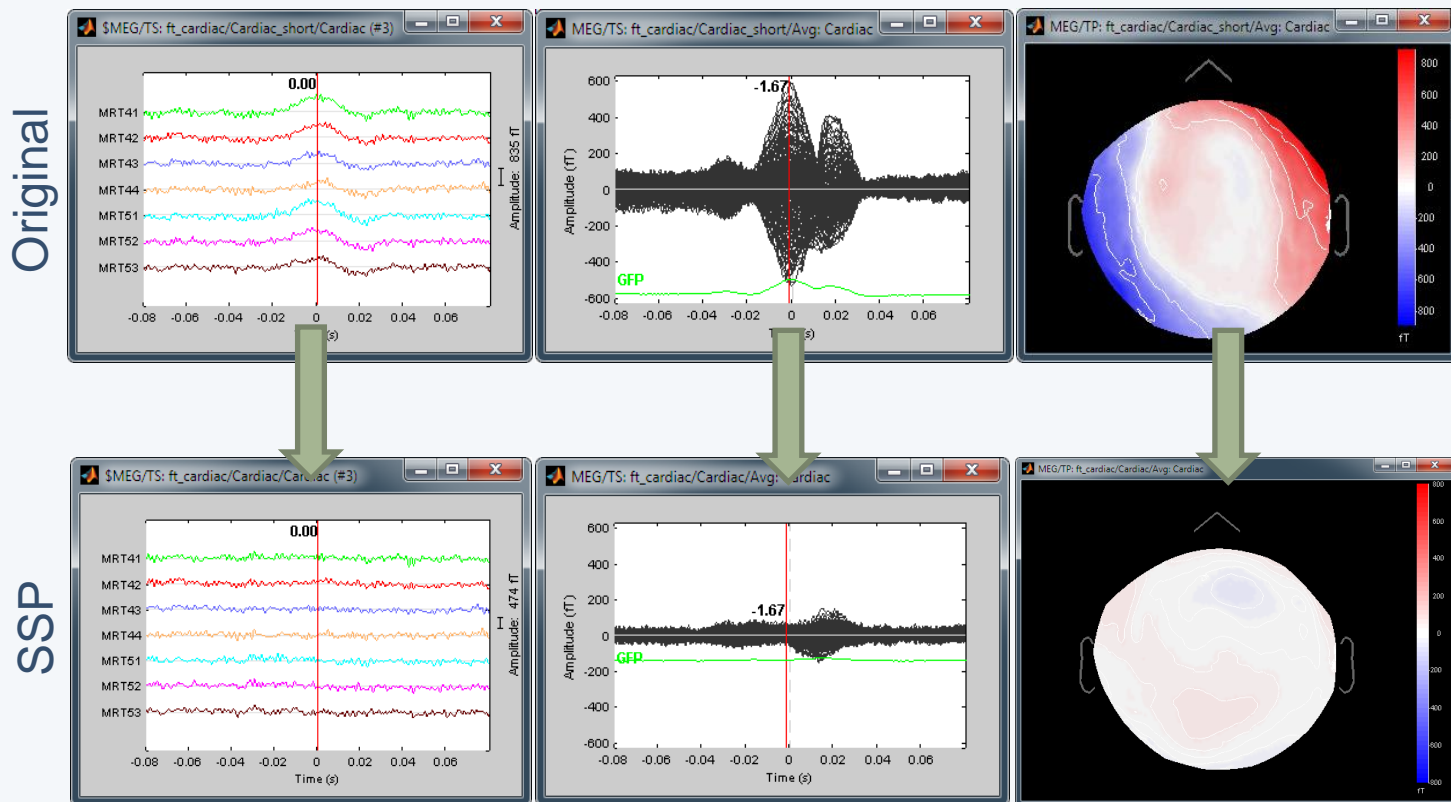
PSD  
Filters  
Bad channels  
Artifacts

## Correction

Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency

- Example: Cardiac artifact



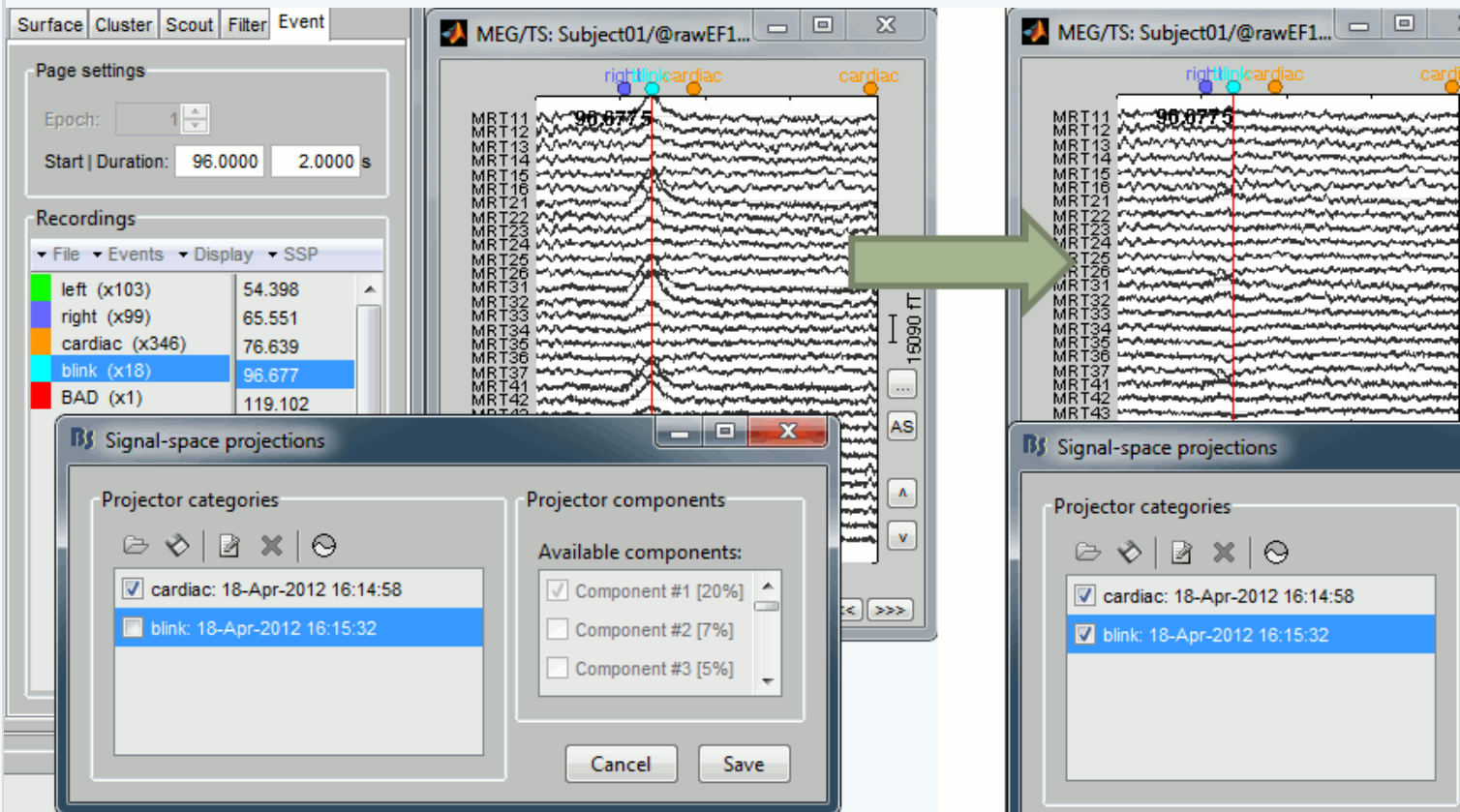
# Pre-processing

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
**Correction**  
Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency

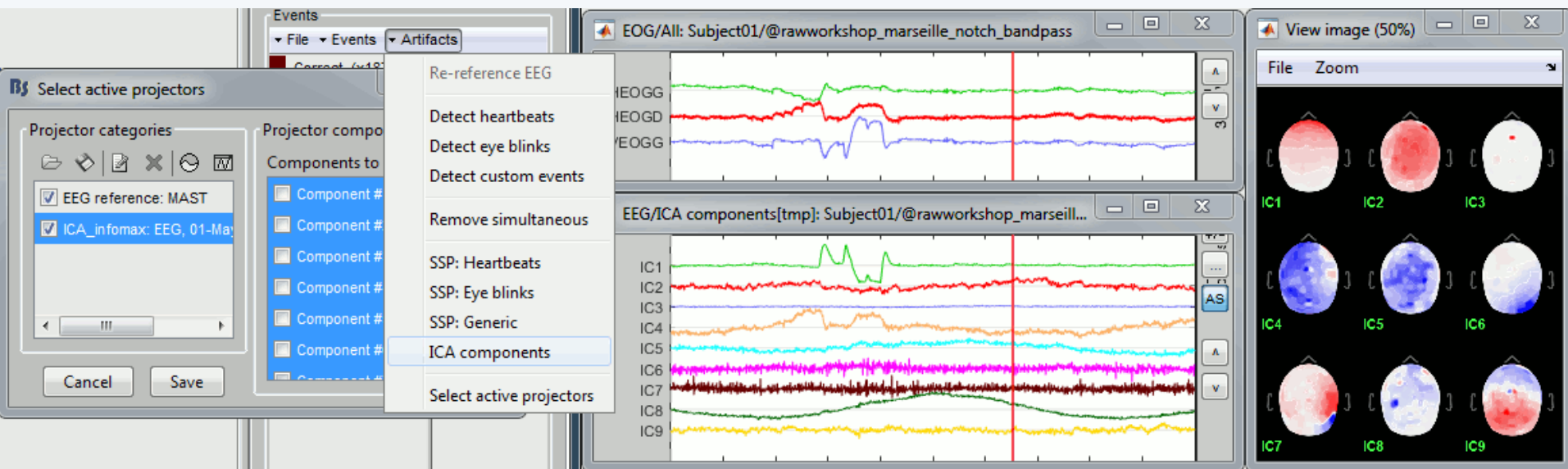
- Example: Blink





# Pre-processing

- Independent component analysis (ICA):
  - Popular in the EEG literature
  - Alternative to SSP for low number of sensors
  - Already implemented: Infomax and JADE (EEGLAB)



# Pre-processing

Anatomy  
Link recordings  
MRI registration

PSD

Filters

Bad channels

Artifacts

Correction

**Bad segments**

Markers

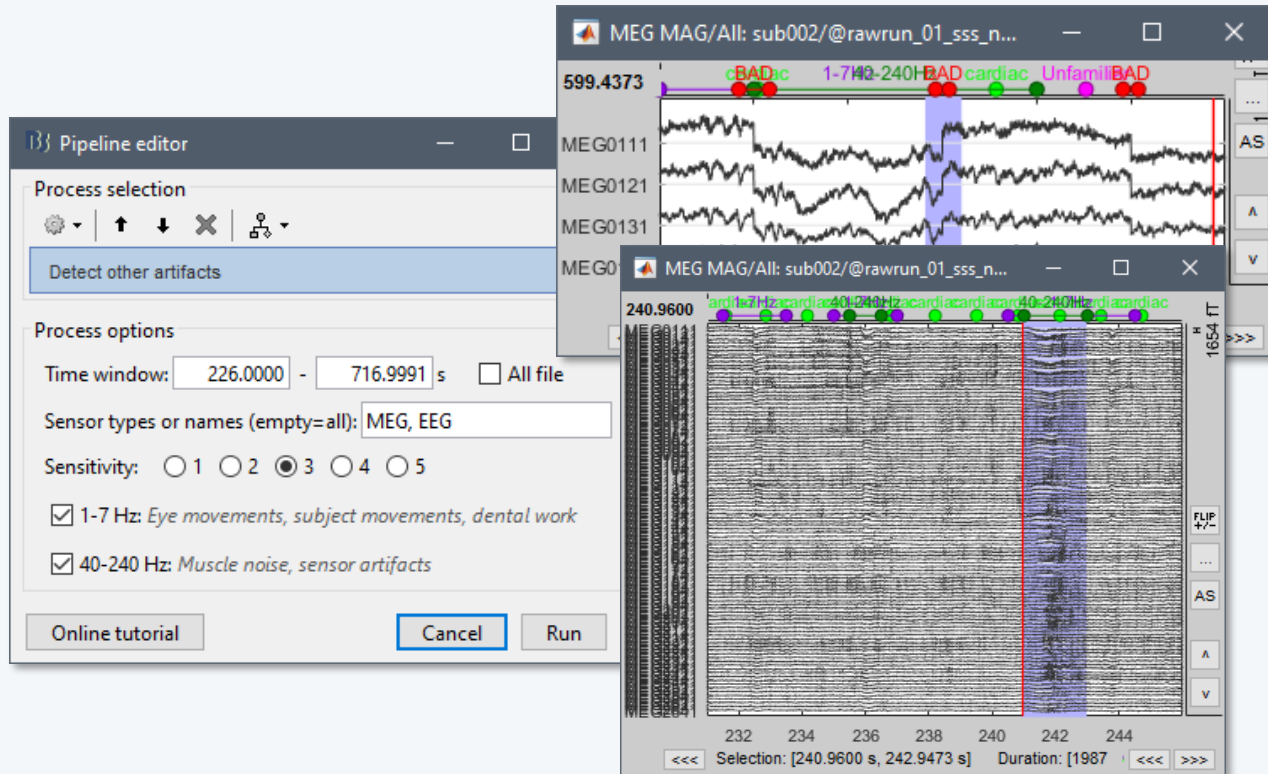
Epoching

Averaging

Sources

Time-frequency

- Automatic detection of artifacts (RMS-based)
- Manual screening of all the recordings is advised (scroll all the sensors by pages of 10-20s)
- Exclude: Blinks, movements, SQUID jumps



# Epoching

Anatomy  
Link recordings  
MRI registration

PSD

Filters

Bad channels

Artifacts

Correction

Bad segments

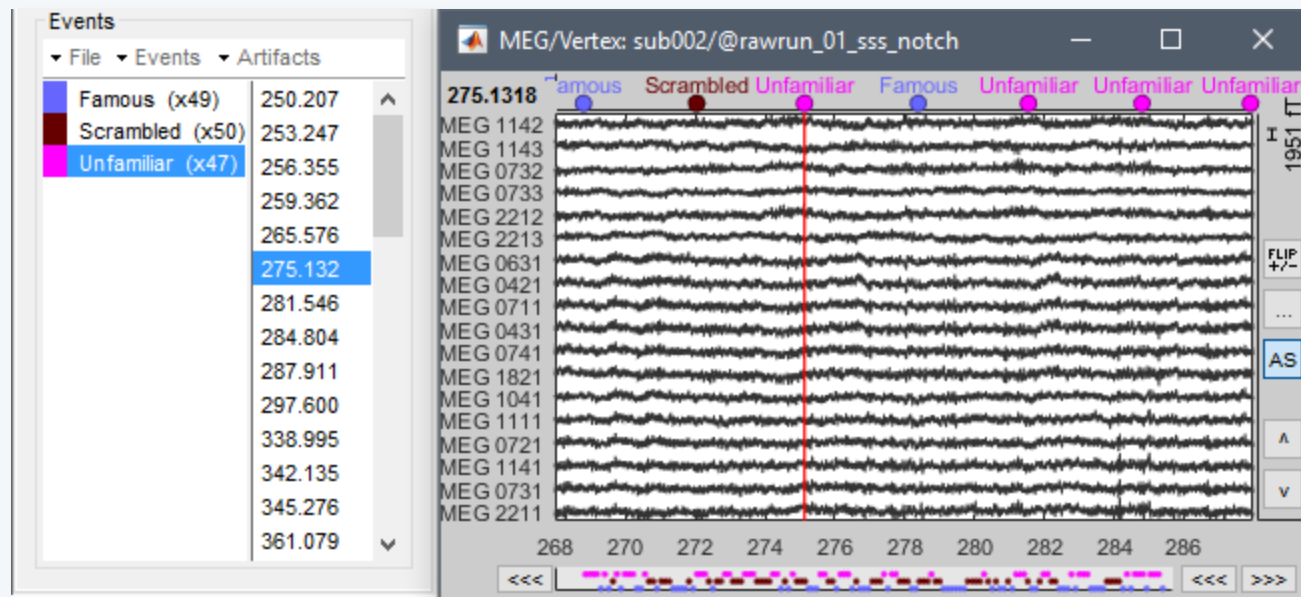
## Markers

Presentation

Sensor

Manual

- Two types of experiments:
  - Steady-state or resting-state (ongoing activity)
  - Event-based (stimulus, response, spike...)
- How to get event markers in the recordings?



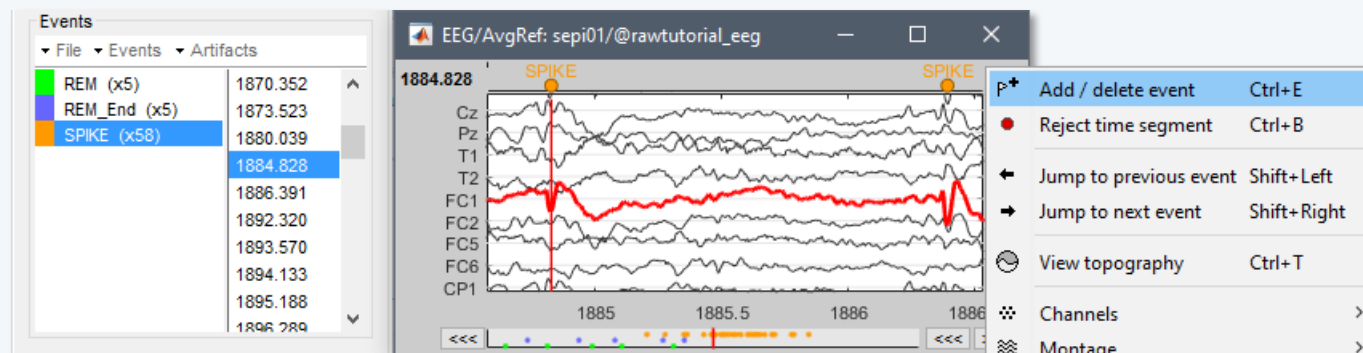
# Epoching

Anatomy  
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Bad segments

Markers  
Presentation  
Sensor  
**Manual**

- Reading the triggers save by the presentation software (includes jittered OS delays)
- Reading information recorded on the subject side (photodiode, microphone, response box)
- Manual or automatic marking of biological or behavioral events, post-acquisition (epileptic spikes, sleep spindles, rat position in a box...)
- Optimized workflow for clinicians (keyboard and mouse shortcuts, workspace...)



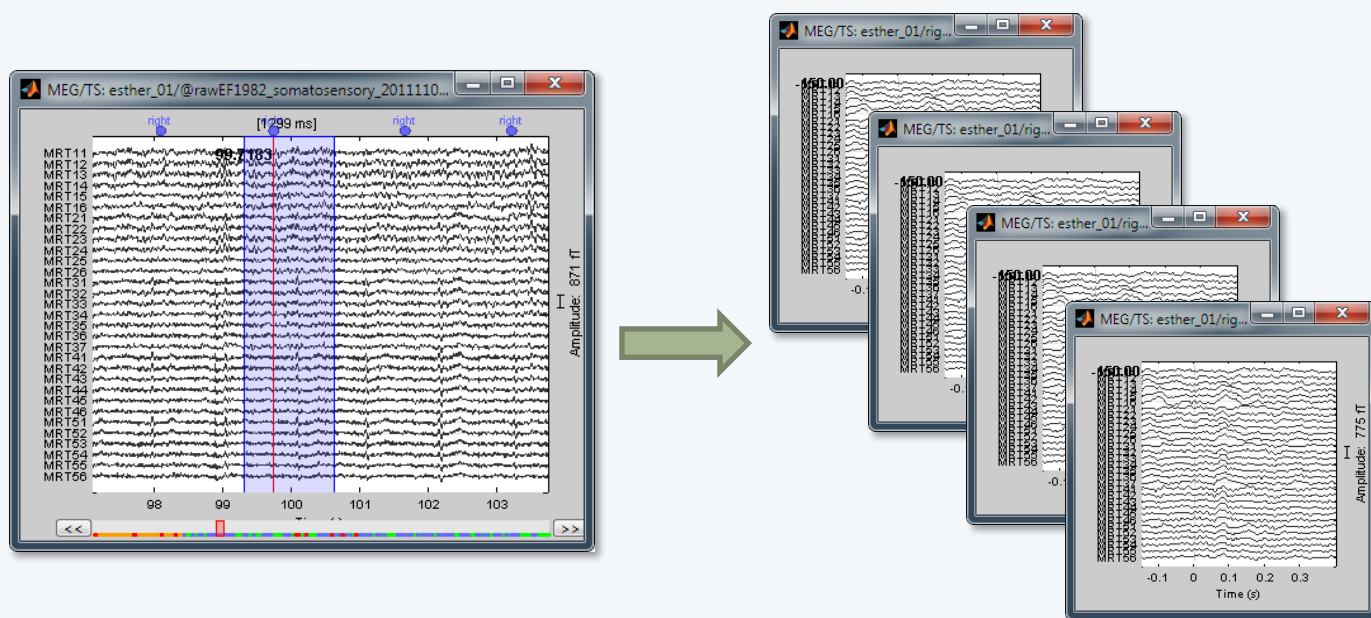
# Epoching

Anatomy  
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Bad segments

Markers  
Epoching  
Combine  
**Extract**  
Length  
Process

- Epochs = Trials = Short blocks of recordings around an event of interest.
- Epoching = Extracting epochs from the continuous recordings and saving them.



# Epoching

Anatomy  
Link recordings  
MRI registration

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Markers

Epoching

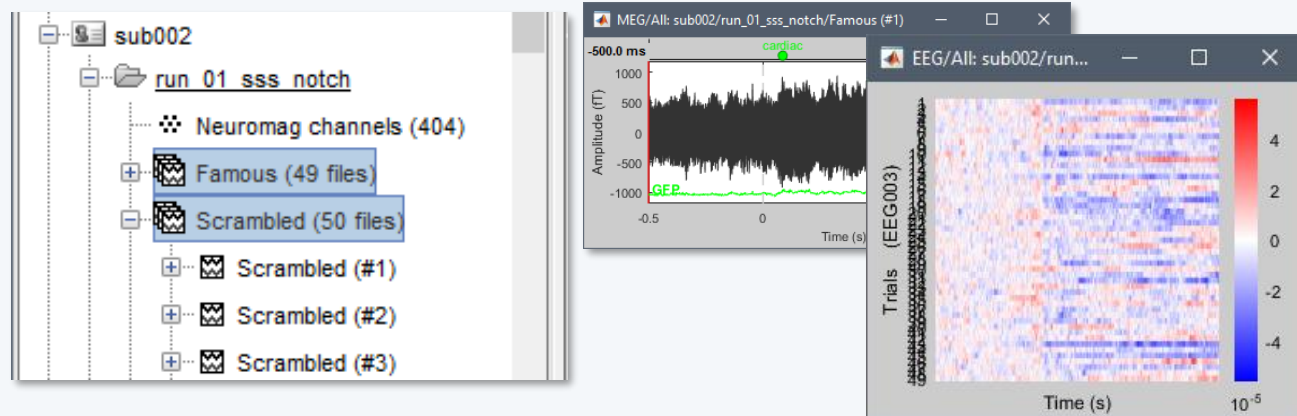
Combine

**Extract**

Length

Process

- In Brainstorm, each imported epoch is an independent file in the database.
- Accessible by event type or individually.



- In other programs, all the epochs from one run are saved in one single file (one file per event type, or one file with all the events).

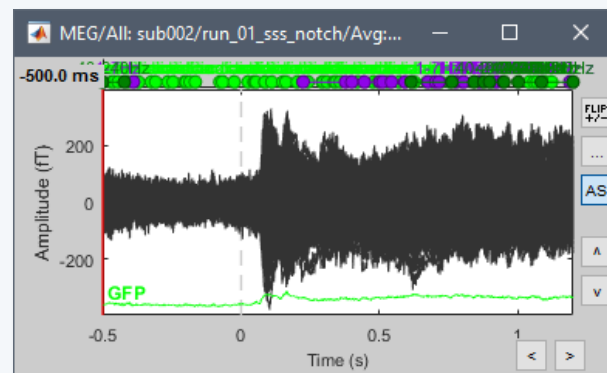
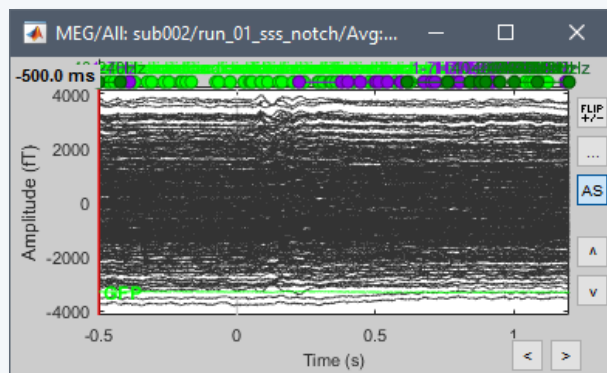
# Epoching

Anatomy  
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Markers  
Epoching  
Combine  
Extract  
Length  
**Process**

- Processing steps that can be applied on epochs:
  - **DC offset correction:** Subtract the average estimated over a baseline period
  - **Detrending:** Subtract a linear trend estimated over a reference period
  - **Resampling:** Decrease the sampling rate
- This dataset: DC correction, baseline= $[-500,0]$ ms



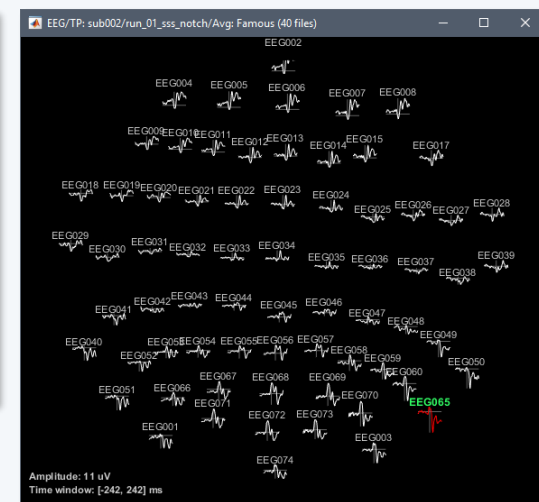
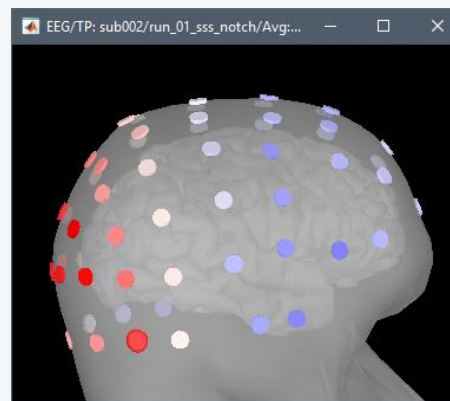
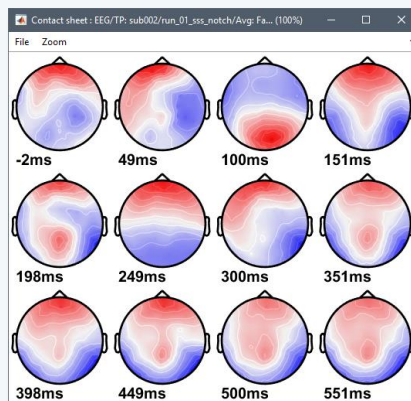
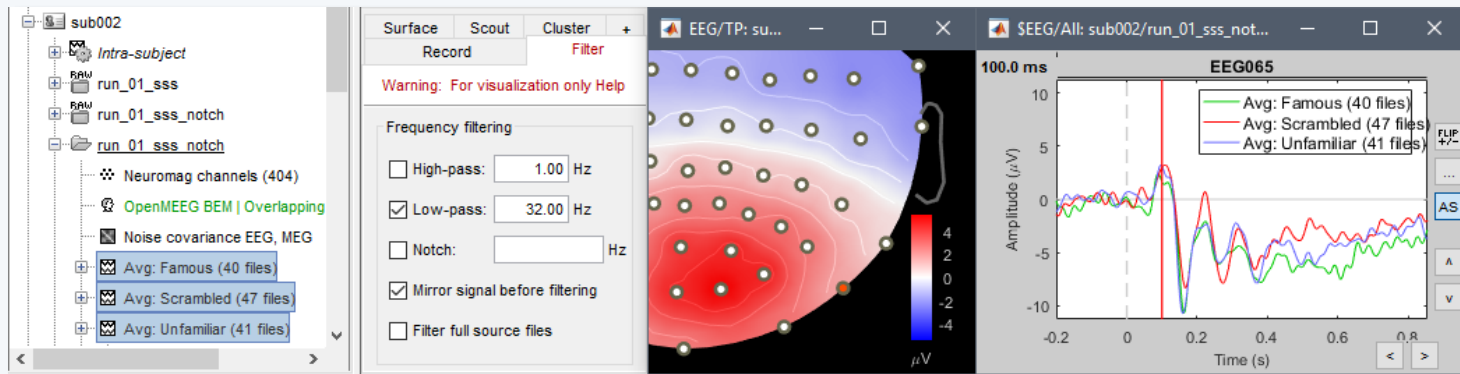
# Sensor level analysis

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
**Averaging**  
Sources  
Time-frequency

- ERP & Sensor Cluster

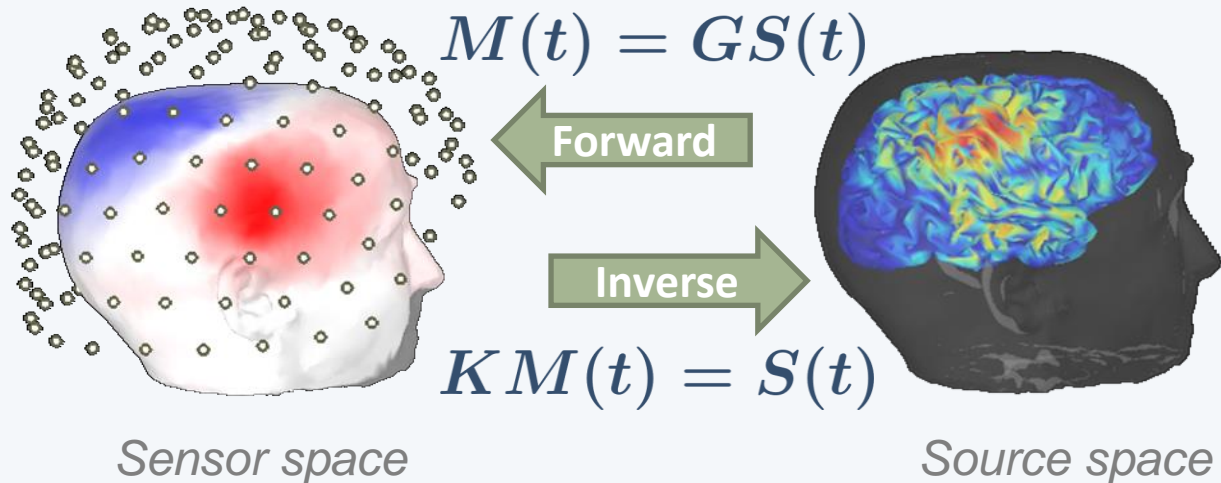




# Source Reconstruction

Anatomy  
Link recordings  
MRI registration  
  
PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments  
  
Markers  
Epoching  
Averaging  
**Sources**  
Time-frequency

$M(t)$  Sensor space: EEG or MEG sensors  
 $S(t)$  Source space: Cortex or full head volume  
 $G$  Forward model: Overlapping spheres (MEG)  
OpenMEEG BEM/DUNEuro FEM (EEG)  
 $K$  Inverse model: **Minimum norm estimates**  
Beamformers  
Separately for MEG and EEG



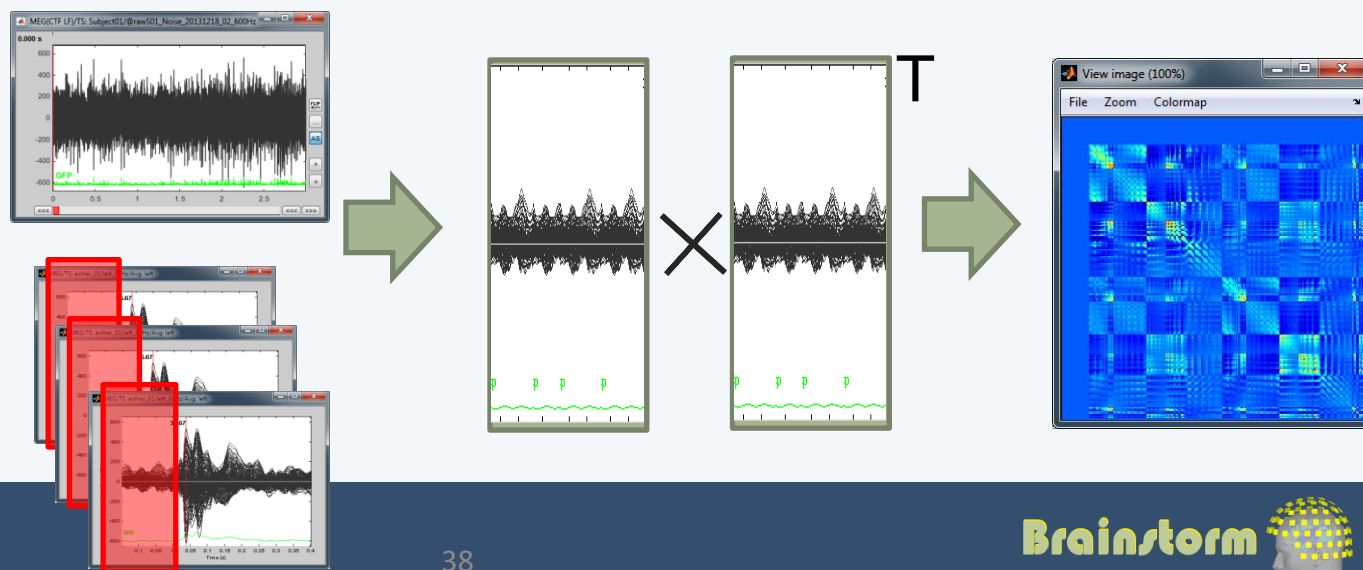
# Noise covariance

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
**Sources**  
Time-frequency

- The MNE model requires an estimation of the level of noise of the sensors
- Noise covariance matrix = covariance of segments that do not contain any “meaningful” data
- Empty room, pre-stim baseline, resting



# Source level analysis

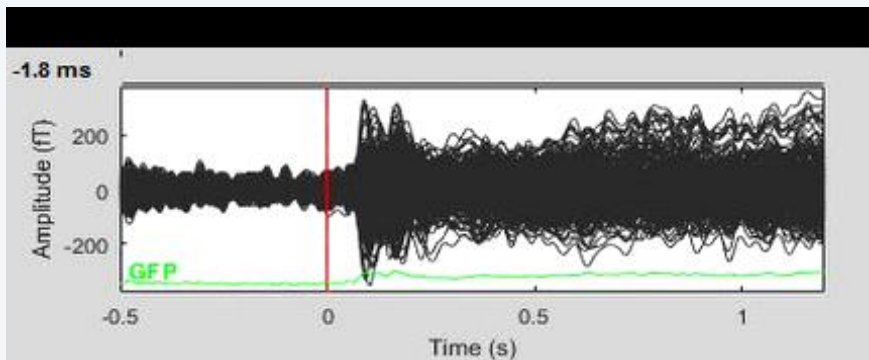
Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
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Artifacts  
Correction  
Bad segments

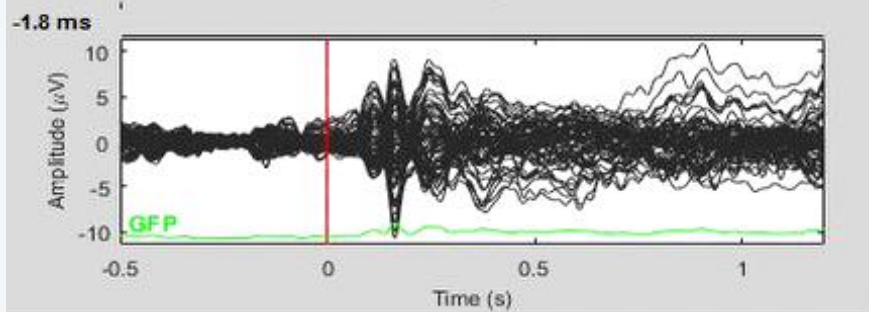
Markers  
Epoching  
Averaging  
**Sources**  
Time-frequency

Example: Famous faces

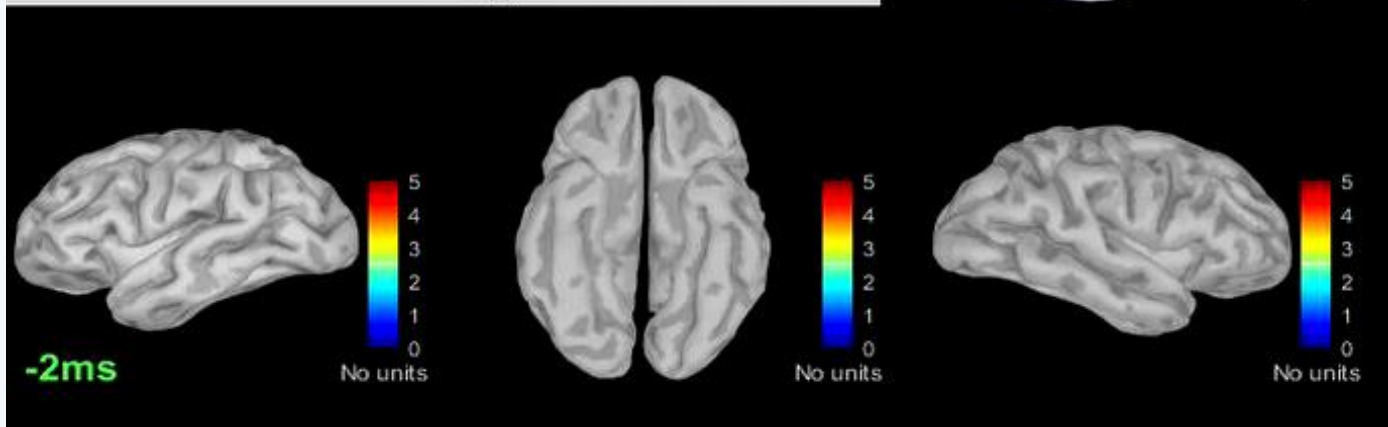
MEG



EEG



MEG sources



# Source level analysis

Anatomy  
Link recordings  
MRI registration

PSD

Filters

Bad channels

Artifacts

Correction

Bad segments

Markers

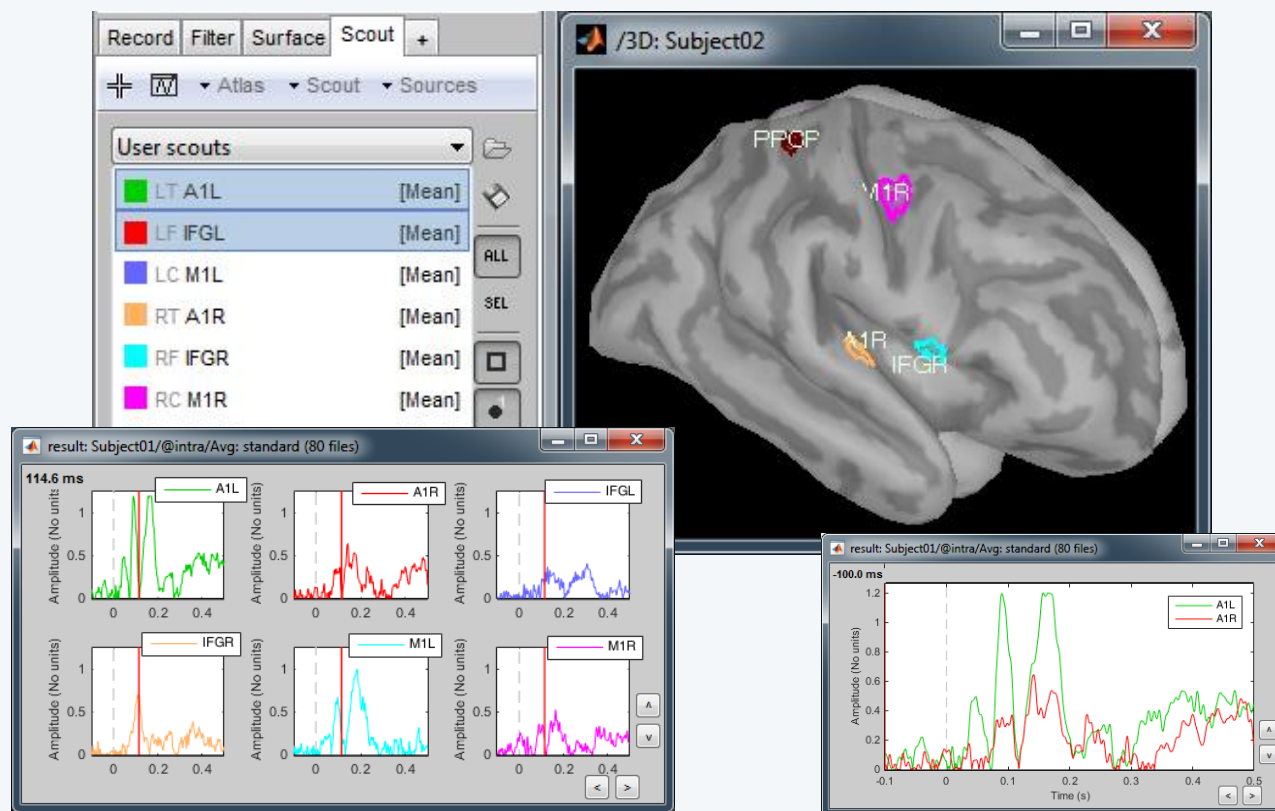
Epoching

Averaging

**Sources**

Time-frequency

- Regions of interest at cortical level (scouts)
  - = Subset of a few dipoles in the brain
  - = Group of vertices of the cortex surface



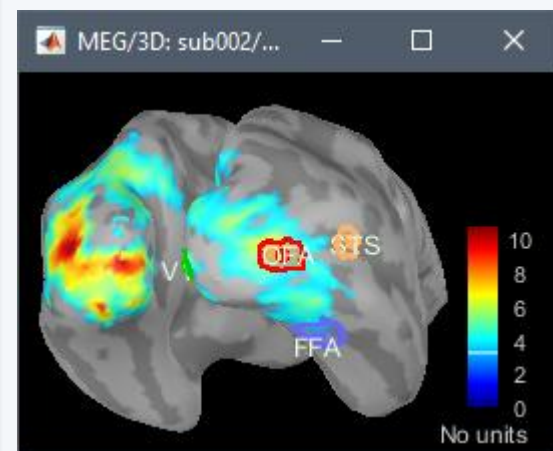
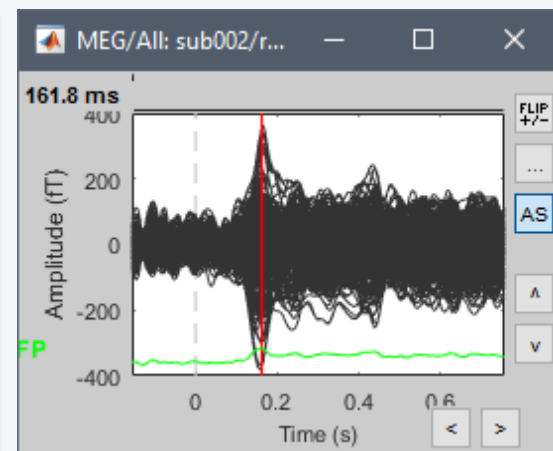
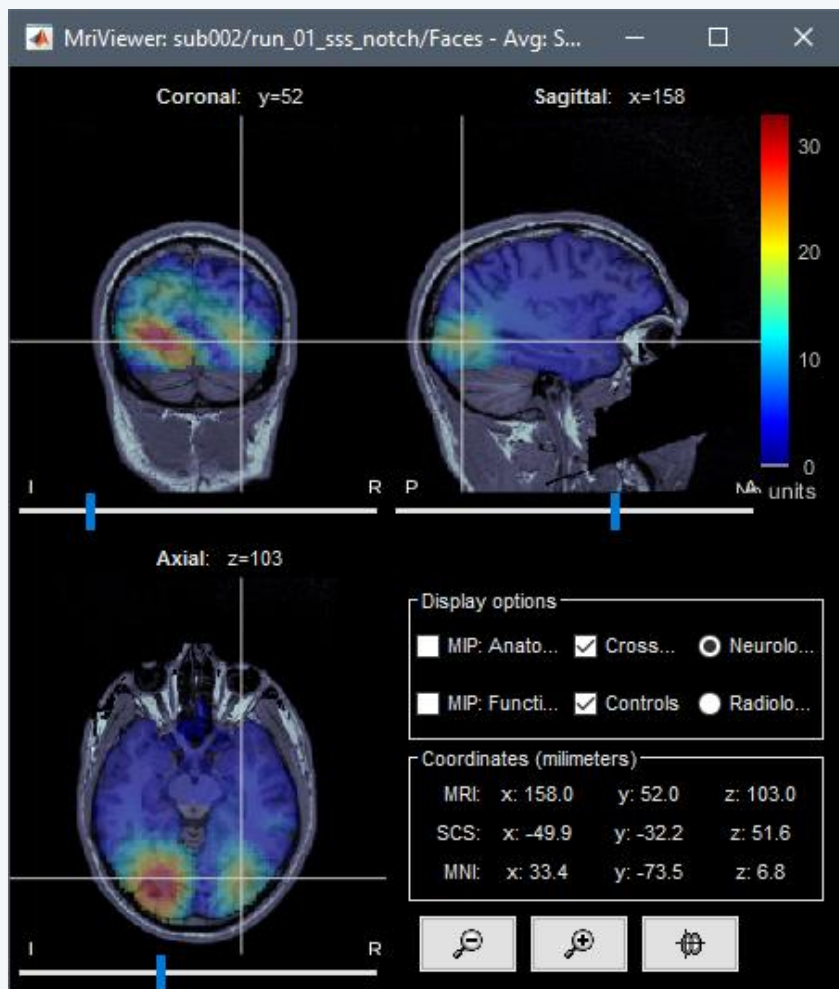
# Source level analysis

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
**Sources**  
Time-frequency

- Volume Source

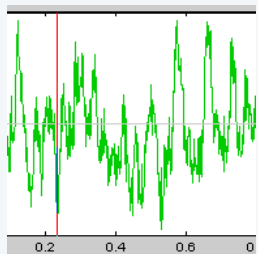


# Time-frequency

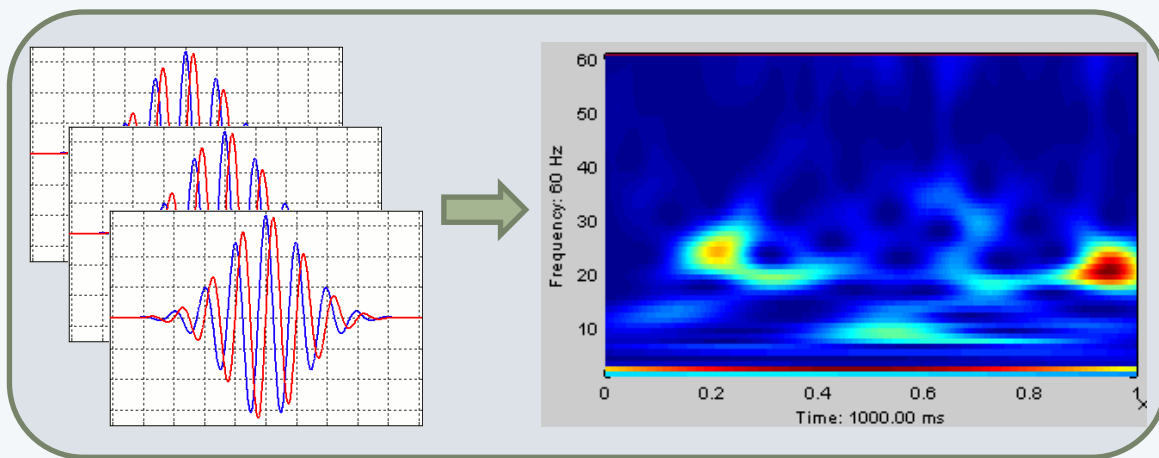
Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

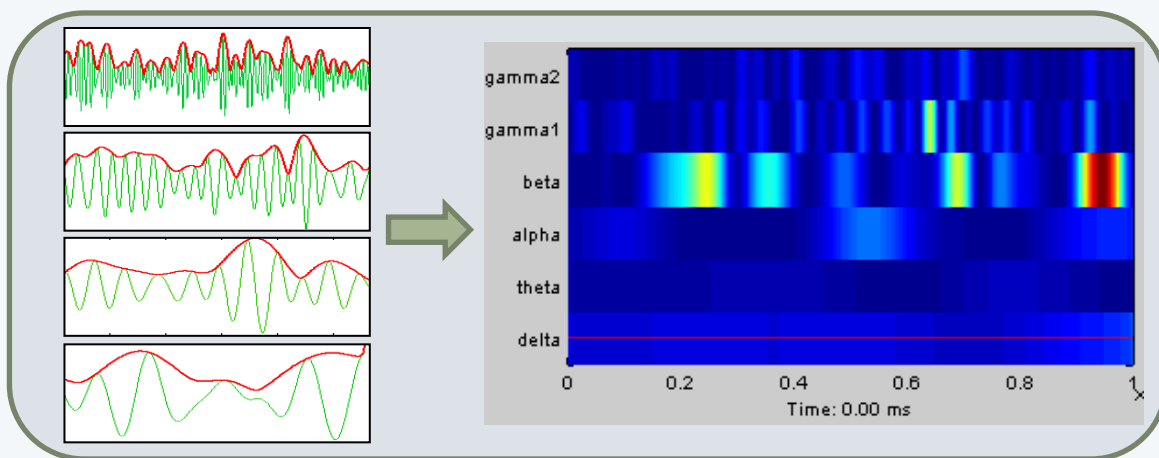
Markers  
Epoching  
Averaging  
Sources  
**Time-frequency**



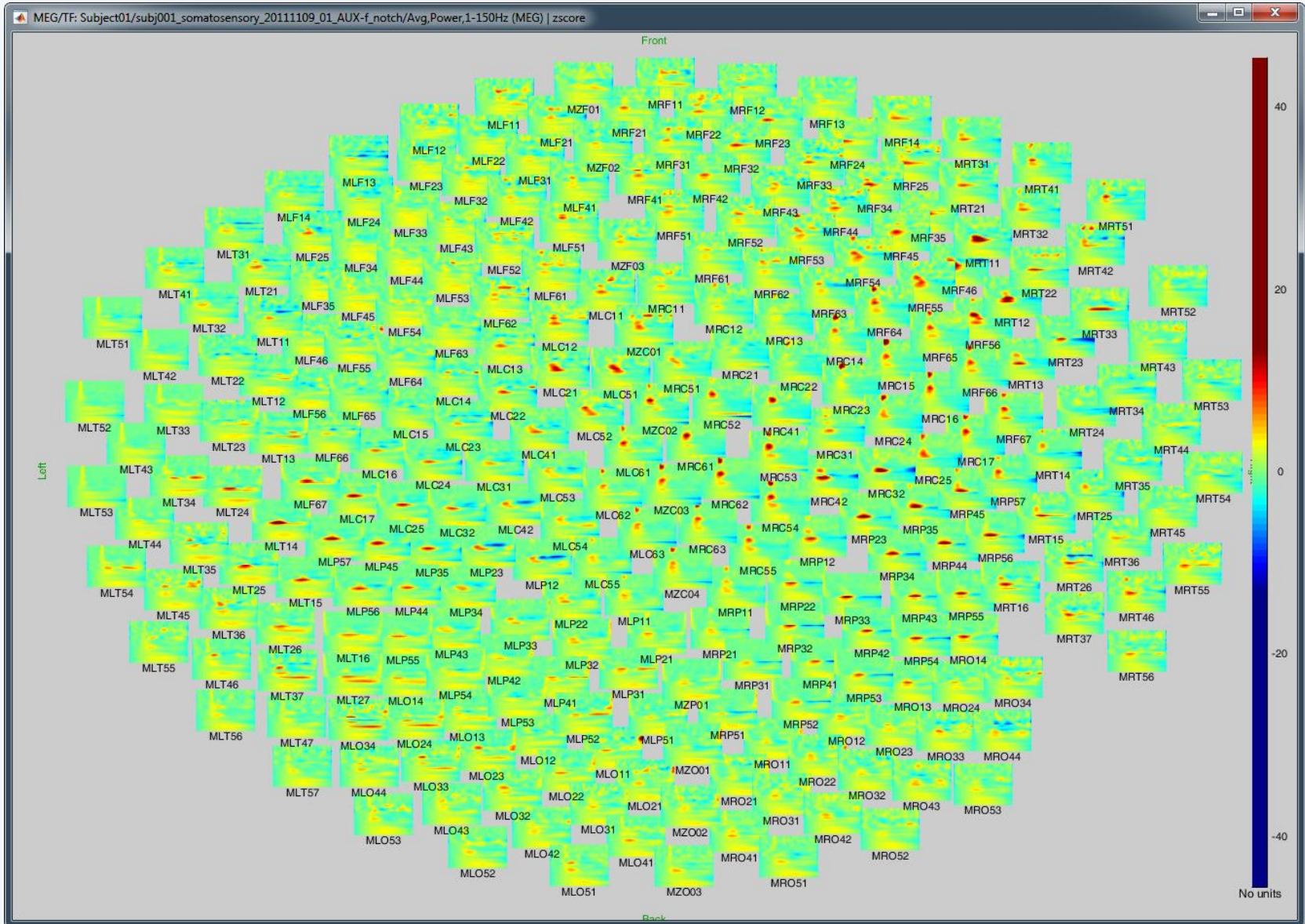
## Morlet wavelets



## Hilbert transform + band-pass filter



# Time-frequency



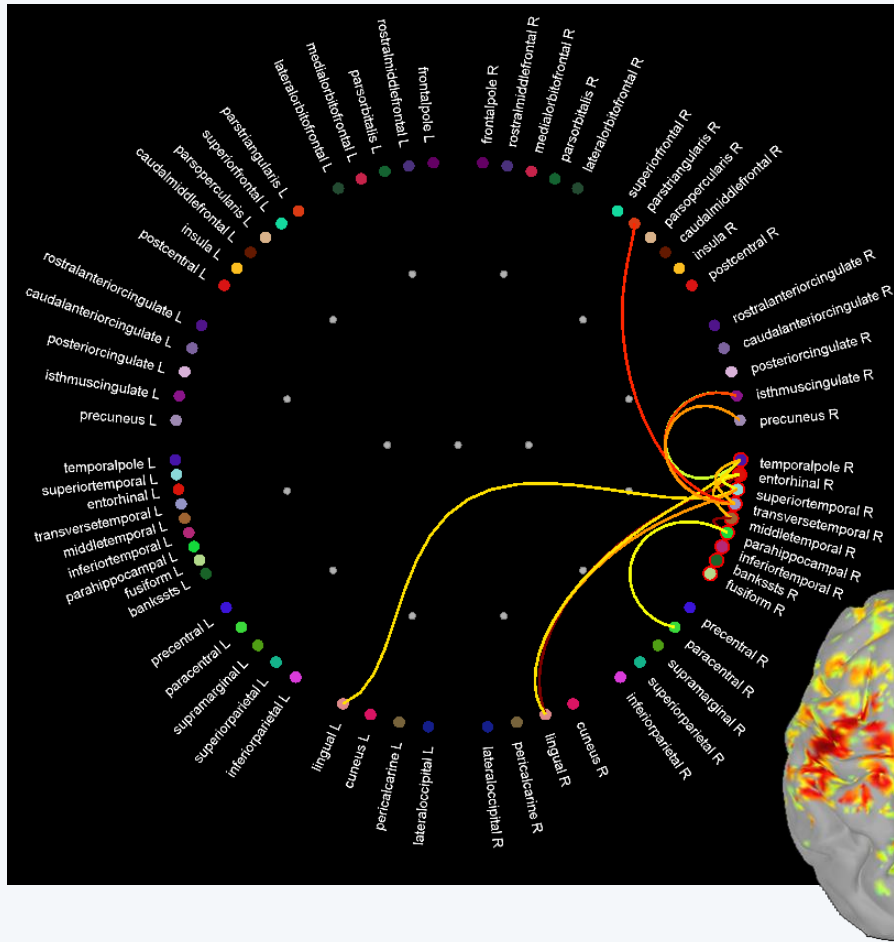
# Other measures

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency  
**Other measures**

- **Connectivity measures**



- Correlation
- Coherence
- Phase locking value
- Granger causality





Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
Averaging  
Sources  
Time-frequency  
**Other measures**

- **And more ...**

- **Source modeling**

- Volume source estimation
    - Deep cerebral structures
    - Realistic head model: BEM with OpenMEEG
    - Dipoles: Scanning and displaying
    - Dipoles: FieldTrip dipole fitting
    - Maximum entropy on the mean (MEM)
    - Other beamforming methods
    - Simulations

- **Finite Element Modeling**

- Realistic head model: FEM with DUNEuro
    - FEM mesh generation
    - FEM tensors estimation
    - FEM median nerve example

- **Signal processing**

- Machine learning: Decoding / MVPA
    - Phase-amplitude coupling: Method
    - Phase-amplitude coupling: Example
    - Partial Least Squares (PLS)
    - Epileptogenic Zone Fingerprint
    - FOOOF: Fitting Oscillations & One-Over-F
    - SPRINT: Spectral Param. Resolved in Time

- **Connectivity**

- Functional connectivity
    - Corticomuscular coherence
    - Connectivity graphs
    - Virtual fibers for connectivity
    - Granger causality

- **Brain-fingerprinting**

- Brain-fingerprinting

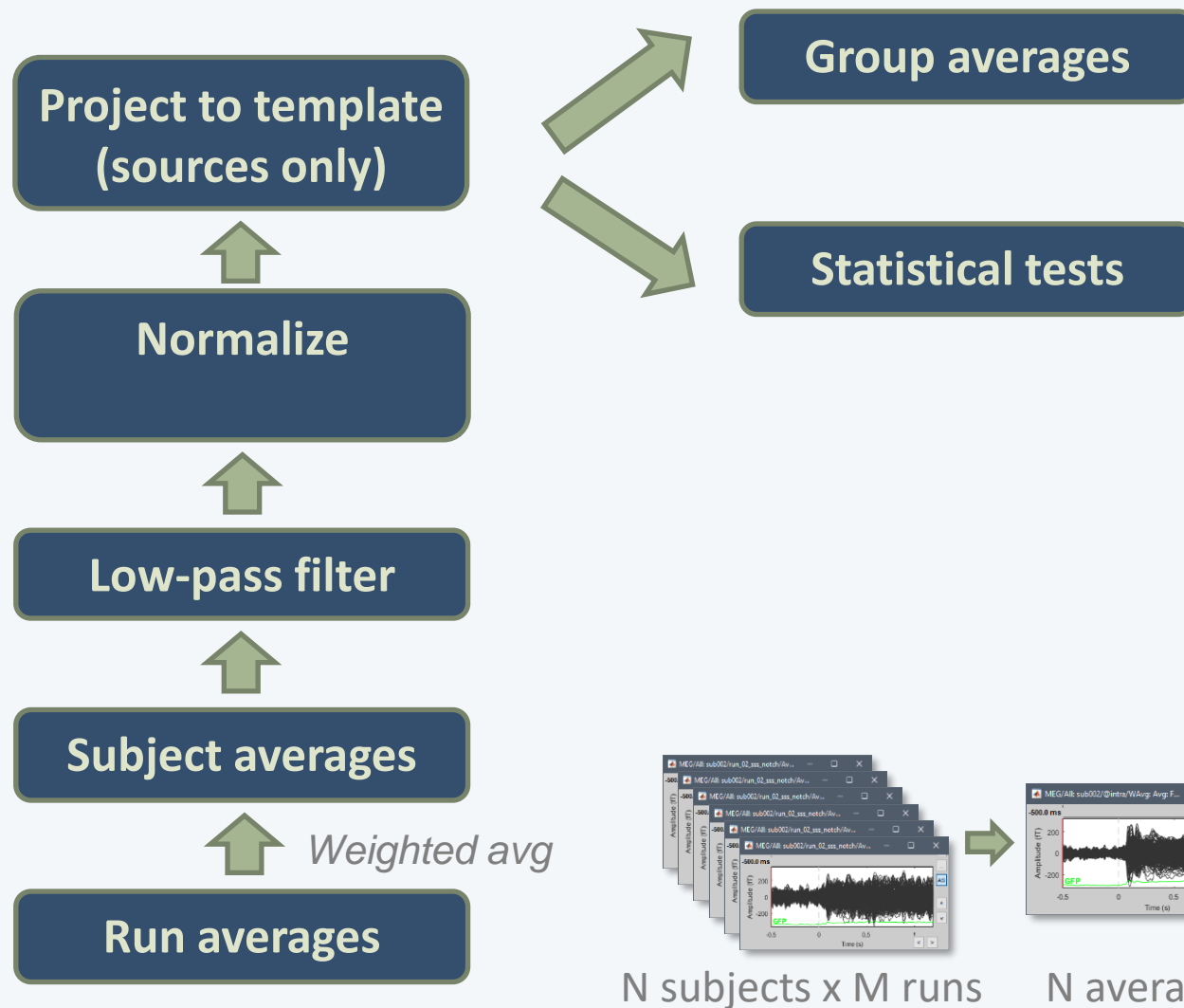
<https://neuroimage.usc.edu/brainstorm/Tutorials>

# Group analysis & Scripting

Anatomy  
Link recordings  
MRI registration

PSD  
Filters  
Bad channels  
Artifacts  
Correction  
Bad segments

Markers  
Epoching  
**Averaging**  
**Sources**  
**Time-frequency**



# Quality control

Subject averages

Low-pass

Normalize

Project

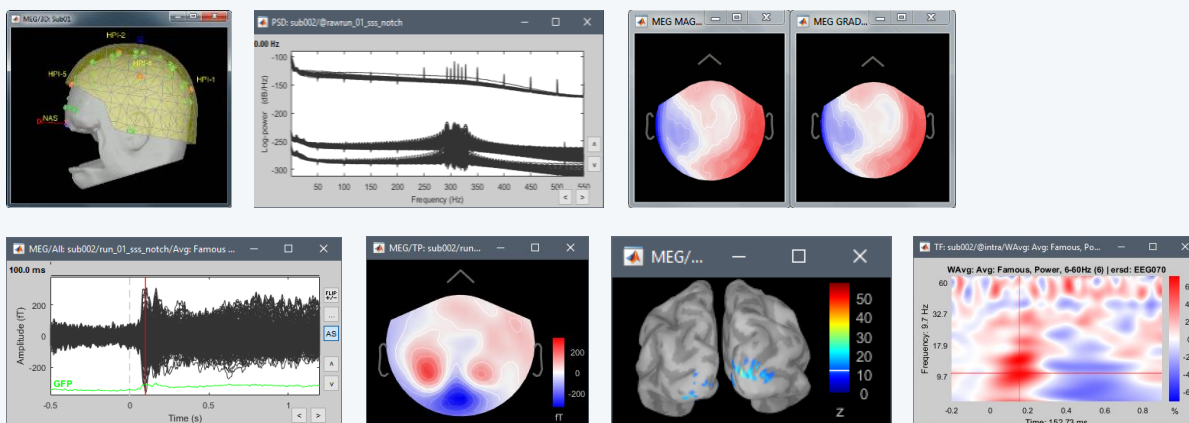
Group averages

Group statistics

**Quality control**

Workflow

- When scripting the analysis, we recommend always to check visually the following items for each run separately:
  - MRI/sensors registration
  - PSD before and after filters
  - SSP and ICA component topographies
  - ERP/ERF: Sensors time series
  - ERP/ERF: Sensors topo of primary response
  - ERP/ERF: Sources of primary response
  - Any other metric of interest



# Quality control

Subject averages

Low-pass

Normalize

Project

Group averages

Group statistics

Quality control

Workflow

- Execution reports with snapshots saved in HTML

The screenshot shows a software interface with a tree view of processing steps. The tree is organized as follows:

- TutorialGroup (subjects)
  - Group analysis
    - Common files
    - Intra-subject
      - Avg: WAvg: Avg: Faces (16 files) | low(32Hz) | tim
      - Avg: WAvg: Avg: Famous (16 files) | low(32Hz) | ti
      - Avg: WAvg: Avg: Scrambled (16 files) | low(32Hz)
      - Avg: WAvg: Avg: Unfamiliar (16 files) | low(32Hz) |
      - Faces - Scrambled
      - Famous - Unfamiliar
      - mean(|Faces-Scrambled) | MEG
      - mean(|Faces-Scrambled) | EEG
      - mean(|Faces)-mean(|Scrambled) | MEG
      - mean(|Faces)-mean(|Scrambled) | EEG
      - Faces - Scrambled: Cluster t-test EEG
      - Famous - Unfamiliar: Cluster t-test EEG
      - Faces - Scrambled: Parametric t-test
      - Faces - Scrambled: Permutation t-test
      - Famous - Unfamiliar: Parametric t-test
      - |Faces-Scrambled|=0: Parametric Chi2 test | MEG
      - log(|Faces-Scrambled)=0: Parametric Chi2 test | ME
      - |Faces|=Scrambled: Parametric t-test | MEG
      - |Faces-Scrambled|=0: Parametric Chi2 test | EEG
      - log(|Faces-Scrambled)=0: Parametric Chi2 test | ME
      - |Faces|=Scrambled: Parametric t-test | MEG

The screenshot shows an HTML execution report window titled "Report: C:\Users\francois\brainstorm\reports\report\_TutorialScript\_130125\_1735.mat". The report indicates "0 errors and 3 warnings".

**Warnings:**

- process\_import\_freesurfer**: process\_import\_data\_raw. Warning: [No input]. Errors detected in the events of the AUX file (markers at the beginning of a trial): Removed 1 x "left": 82.500, Removed 1 x "right": 276.000. (25-Jan-2013 17:26:36)
- process\_sin\_remove**: Warning: Subject01@[rawsubj001\_somatosensory\_20111109,...] Cannot overwrite native files. (25-Jan-2013 17:33:29)
- process\_evt\_detect\_eog**: Info: Subject01@[rawsubj001\_somatosensory\_20111109,...] EEG058: 30 events detected in 2 categories. (25-Jan-2013 17:33:31)

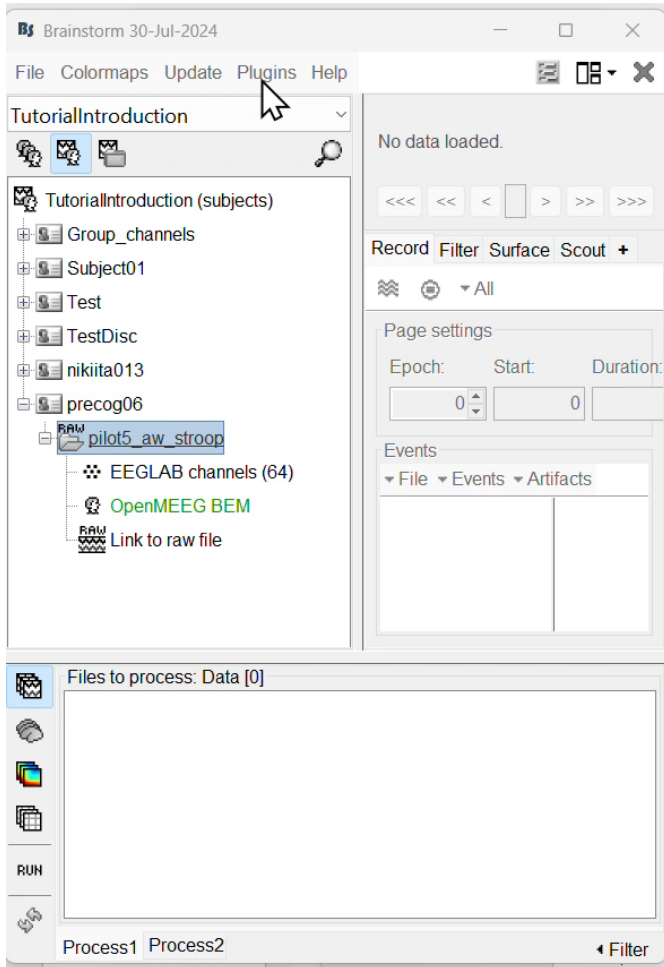
**Initial files:** [No input]

**Intermediate files:** A list of files including Subject01@[rawsubj001\_somatosensory\_20111109\_01\_A, Subject01@[rawsubj001\_somatosensory\_20111109\_01\_A, Subject01@[left/data\_average\_130125\_1734.mat, Subject01@[left/data\_left\_trial001.mat [deleted], Subject01@[left/data\_left\_trial001.bl.mat [deleted], Subject01@[left/data\_left\_trial001.bl\_timeoffset.mat, Subject01@[left/data\_left\_trial002.mat [deleted], Subject01@[left/data\_left\_trial002.bl.mat [deleted], Subject01@[left/data\_left\_trial002.bl\_timeoffset.mat, Subject01@[left/data\_left\_trial003.mat [deleted], Subject01@[left/data\_left\_trial003.bl.mat [deleted], Subject01@[left/data\_left\_trial003.bl\_timeoffset.mat.

Below the report, there are two windows showing "Snapshots". Each window displays a 3D brain model with a green mesh and a corresponding time-series plot of "Amplitude (T)" vs "Time (s)". The plots show a sharp peak around 0.05s, with a green line labeled "GFP" indicating the event. The top plot is for "Subject01@[right/data\_average\_130125\_1254.mat" and the bottom plot is for "Subject01@[left/data\_average\_130125\_1254.mat".

# What's New?

- Brainstorm Plugin Manager: Brainstorm as a hub!



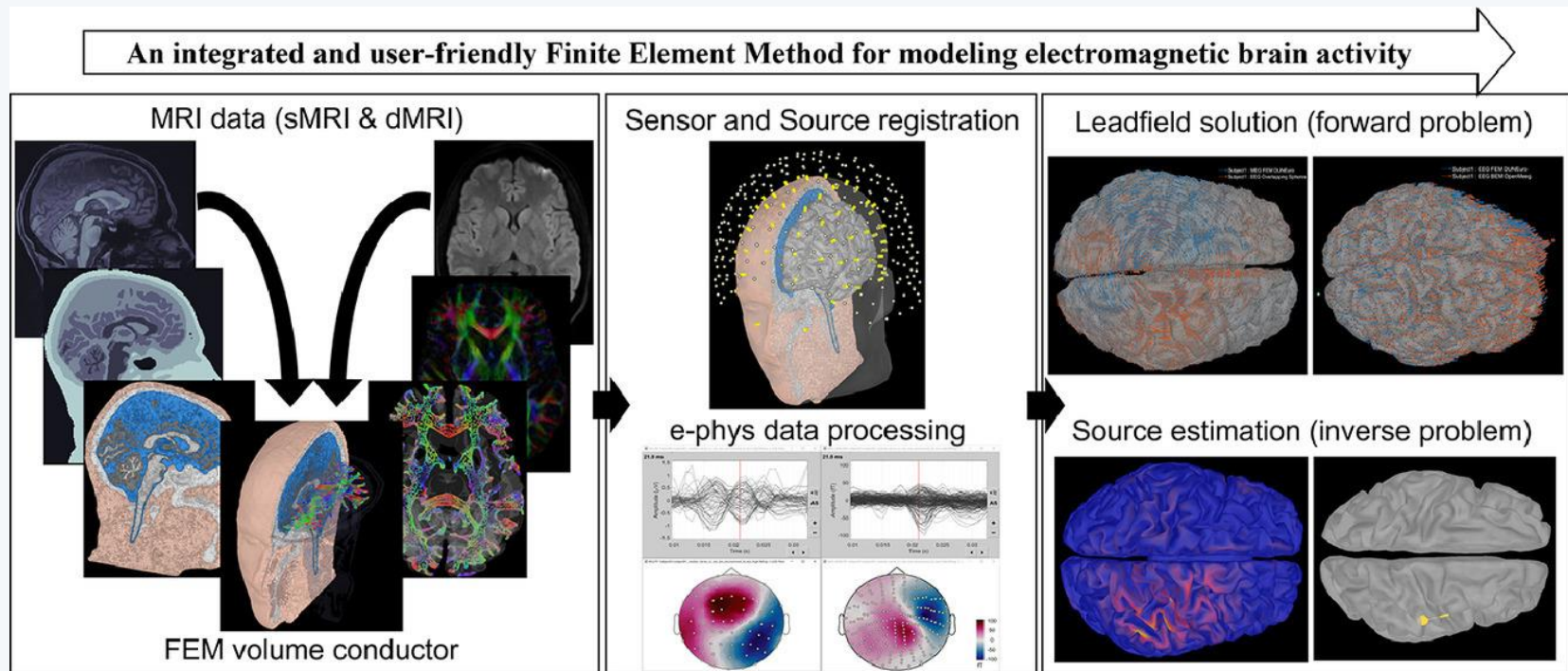
The central graphic is a brain with a grid of yellow dots, surrounded by logos for various plugins and tools. The logos include DUNEuro, BrainSuite, SPM12 (https://www.fil.ion.ucl.ac.uk/spm/), cat (Computational Anatomy Toolbox), OpenMEEG (http://openmeeg.gforge.inria.fr), GARDEL (Hôpitaux de Marseille), FieldTrip (Oostenveld R, Fries P, Maris E, Schoffele JM (2011) FieldTrip: Open Source Software for Advanced Analysis of MEG, EEG, and Invasive Electrophysiological Data, Computational Intelligence and Neuroscience, 2011), and NIRSTORM (https://github.com/Nirstorm). To the right, there is a list of plugins under the heading '... and more':

- external
- brainentropy
- buzsakilab
- CEDS64ML
- dba
- easyh5
- edfimport-1.0.4
- eeglab
- eeprobe
- ez\_fingerprint
- fieldtrip
- fraschini
- freesurfer
- gibbon
- icp
- ImaGIN
- intan
- jsnrify
- label
- mia
- mne
- mominc
- mosher
- numpy-matlab
- octave
- openmeeg
- other
- plexon
- ricoh
- scilearnlab
- ScreenCapture
- son-2.32
- spm
- SurfStat
- trk
- yokogawa

- Interoperability with other tools
- Documentation & Reproducibility

# What's New?

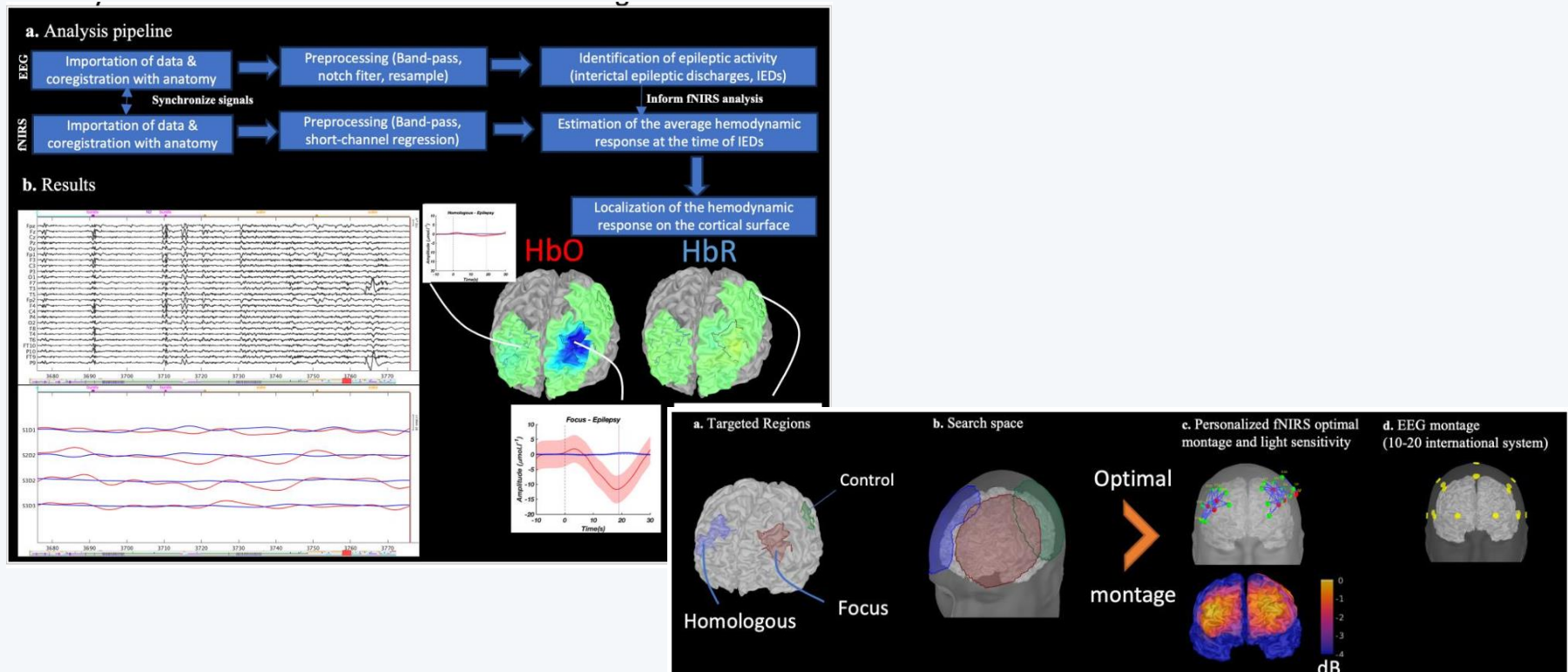
- Brainstorm - DUNEuro: An integrated and user-friendly Finite Element Method for modeling electromagnetic brain activity



Takfarinas Medani, Juan Garcia-Prieto, Francois Tadel, Marios Antonakakis, Tim Erdbrügger, Malte Höltershinken, Wayne Mead, Sophie Schrader, Anand Joshi, Christian Engwer, Carsten H. Wolters, John C. Mosher, Richard M. Leahy  
(<https://doi.org/10.1016/j.neuroimage.2022.119851>)

# What's New?

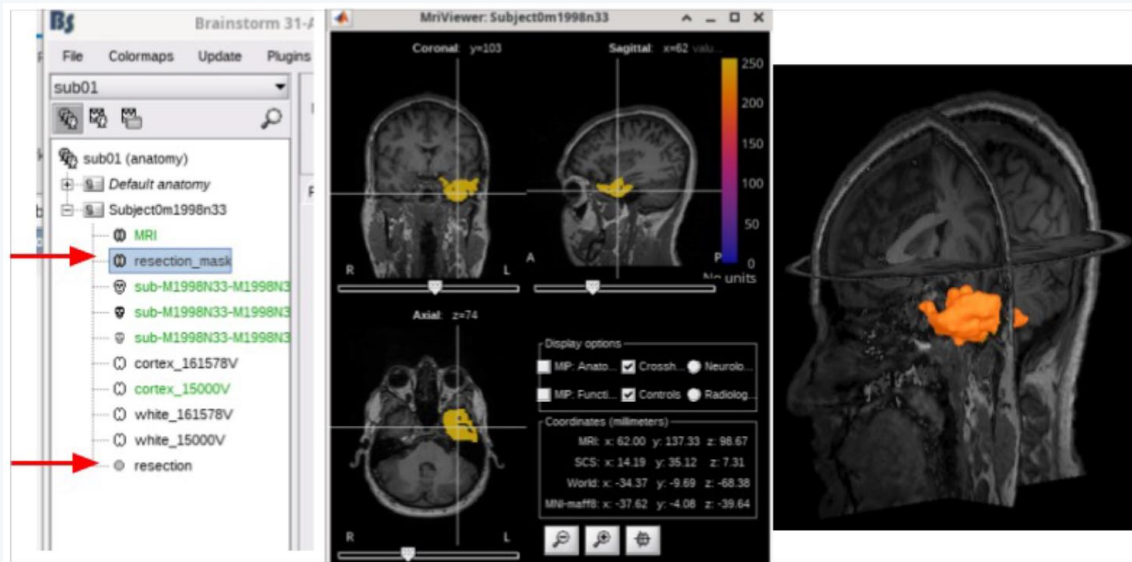
- **NIRSTORM**: a Brainstorm extension dedicated to functional Near Infrared Spectroscopy (fNIRS) data analysis, advanced 3D reconstructions, and optimal probe design



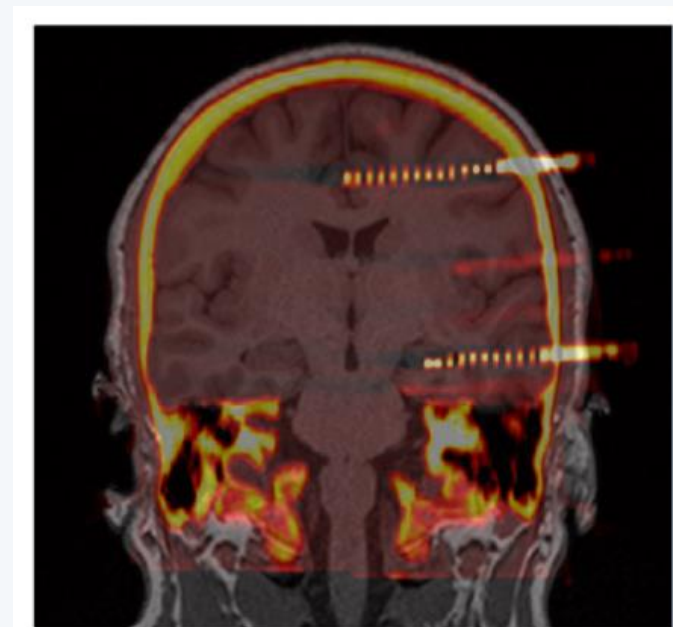
Édouard Delaire, Thomas Vincent, Zhengchen Cai, Alexis Machado, Laurent Hugueville, Denis Schwartz, Francois Tadel, Raymundo Cassani, Louis Bherer, Jean-Marc Lina, Mélanie Péligrini-Issac, Christophe Grova (<https://www.biorxiv.org/content/10.1101/2024.09.05.611463v1>)

# What's New?

- CT-MRI volume co-registration and Resection labeling



pre/post op resection volume detection



CT-MRI registration

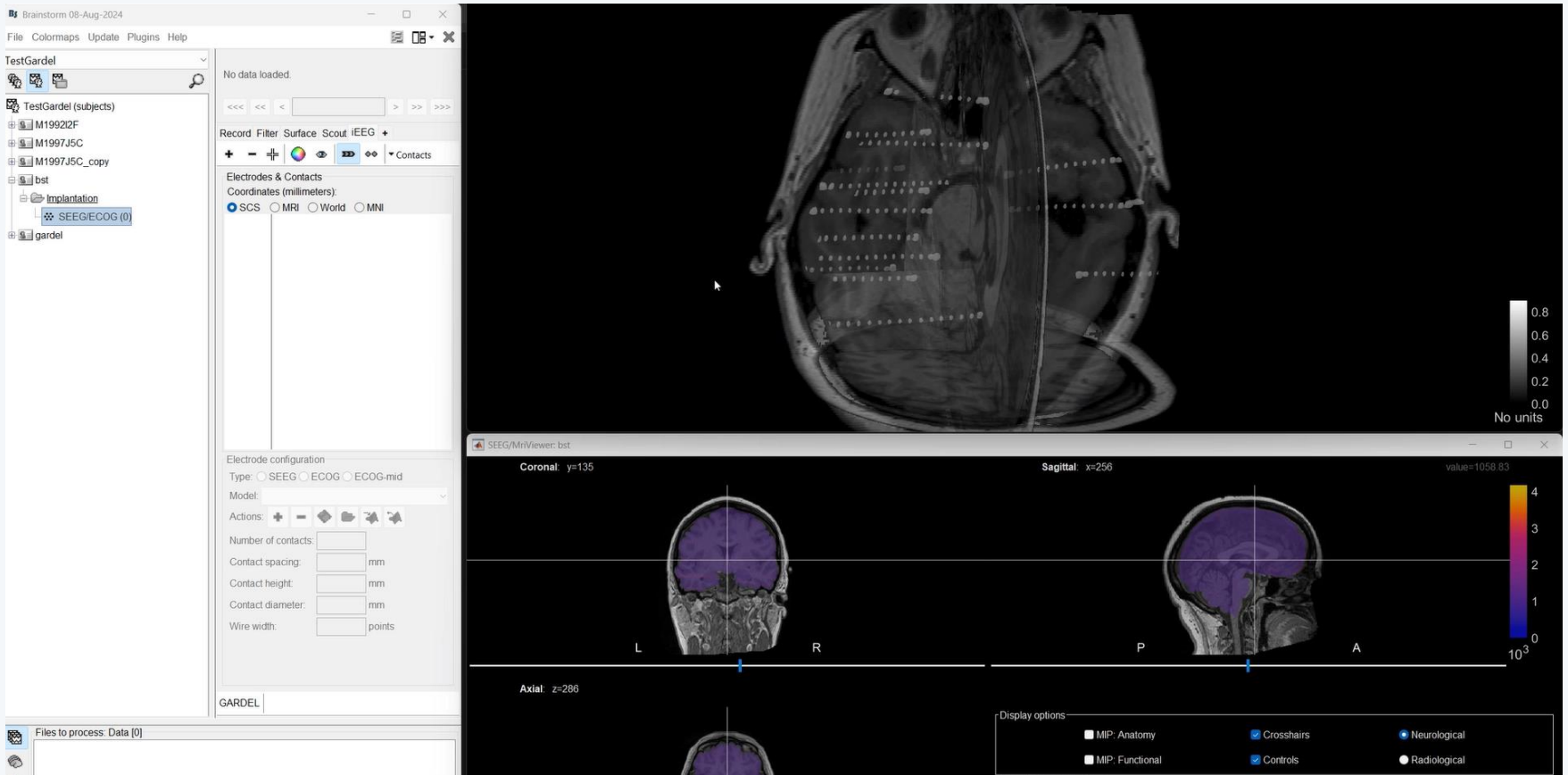
A Joshi, Chinara, T. Medani and brainstorm team

[https://neuroimage.usc.edu/brainstorm/Tutorials/SegBrainSuite?highlight=%28resection%29#Resection\\_labeling](https://neuroimage.usc.edu/brainstorm/Tutorials/SegBrainSuite?highlight=%28resection%29#Resection_labeling)



# What's New?

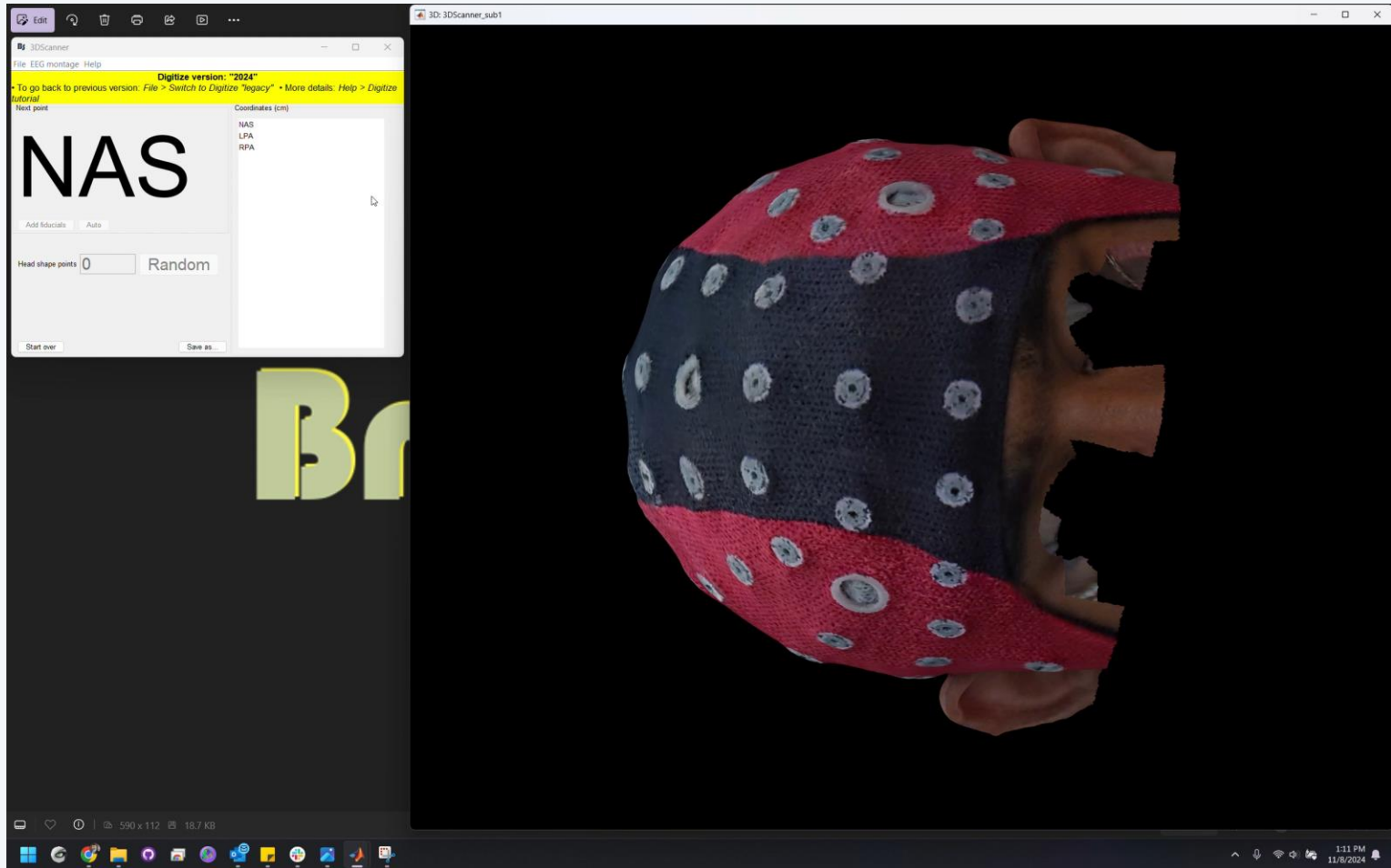
- Automated sEEG Electrode Localization and Labeling



Chinara, S. Medina, A. Joshi, [C-G Béнар](https://neuroimage.usc.edu/brainstorm/Tutorials/leegContactLocalization), T. Medani and brainstorm team: <https://neuroimage.usc.edu/brainstorm/Tutorials/leegContactLocalization>  
Medina Villalon et al. EpiTools, 2018 doi: 10.1016/j.jneumeth.2018.03.018

# What's New?

- Automated EEG Electrode Localization and Labeling



Chinara, A Joshi, Vakilna, Medani, and brainstorm team: <https://neuroimage.usc.edu/brainstorm/Tutorials/TutDigitize3dScanner>

# Co-registration MEEG / MRI (2)

Anatomy

Link recordings

**MRI registration**

PSD

Filters

Bad channels

Artifacts

Correction

Bad segments

Markers

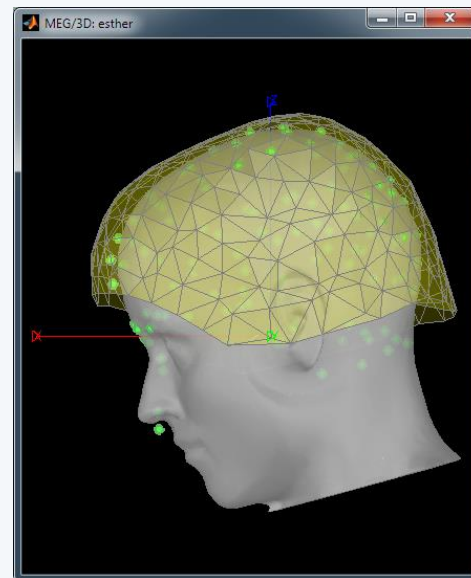
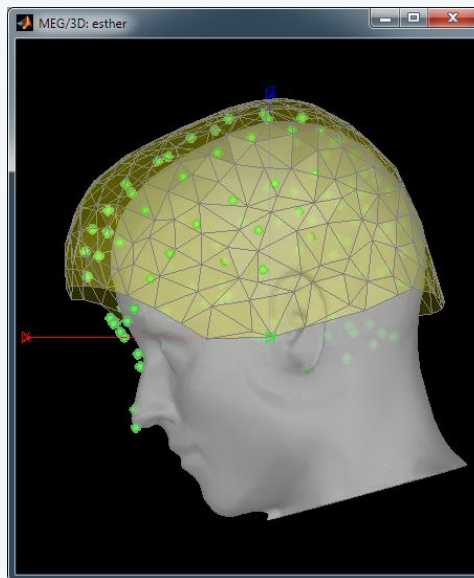
Epoching

Averaging

Sources

Time-frequency

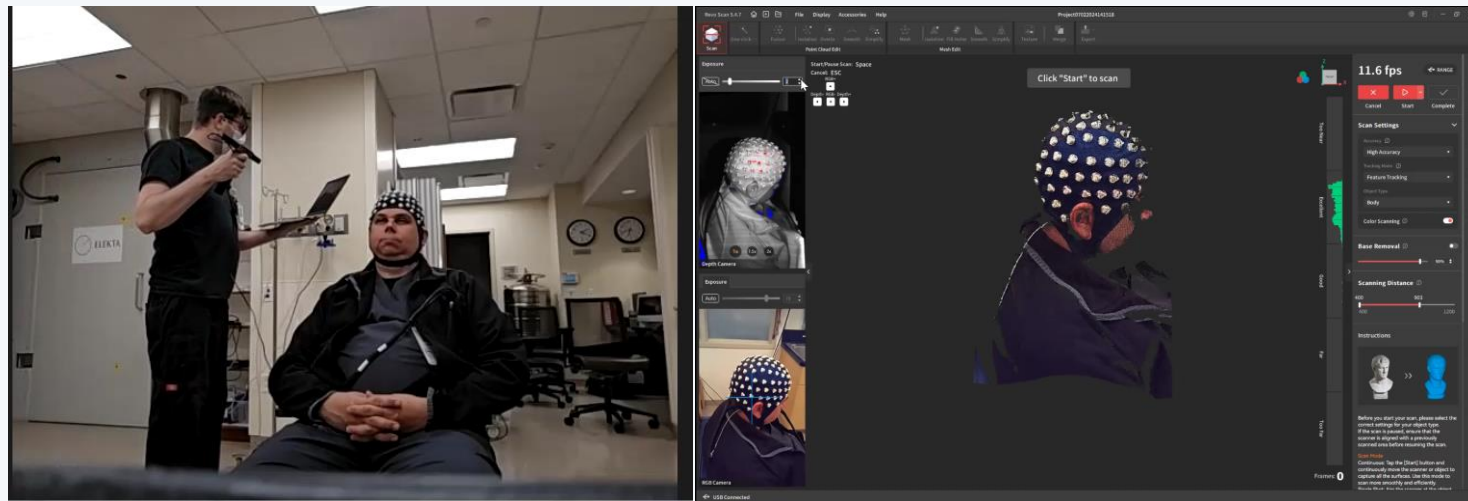
- Automatic adjustment based on head shape: Fitting Polhemus points on the MRI head surface
- Final registration must be checked manually
- Polhemus driver included in Brainstorm



# Co-registration EEG / MRI (3)

Anatomy  
MRI registration

- 3D for scanning EEG scalp electrode



<https://neuroimage.usc.edu/brainstorm/Tutorials/TutDigitize3dScanner>

# What's New?

## And more!!



Edit

Search

### Software

Introduction

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Installation

### Users

Tutorials

Forum

Courses

Community

Publications

### Development

What's new

What's next

About us

Contact us

Contribute

### Developers

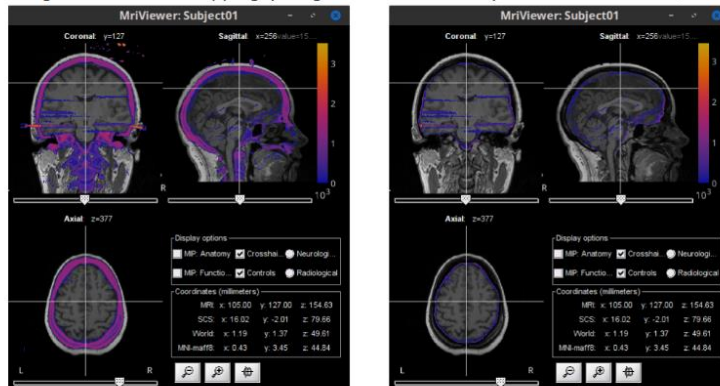
## What's new

Brainstorm is in a very active development state: small or major bug fixes and improvements are issued almost everyday. To update your version of the software easily: [Install and update](#). See also the full list of updates: [brainstorm3/doc/updates.txt](#) | [All GitHub commits](#)

### November 2024

#### | Anatomy

- Add NIRS template: 'Colin27\_4NIRS\_2024' [↗](#)
- Integration of skull stripping (using SPM or BrainSuite) within Brainstorm [↗](#)

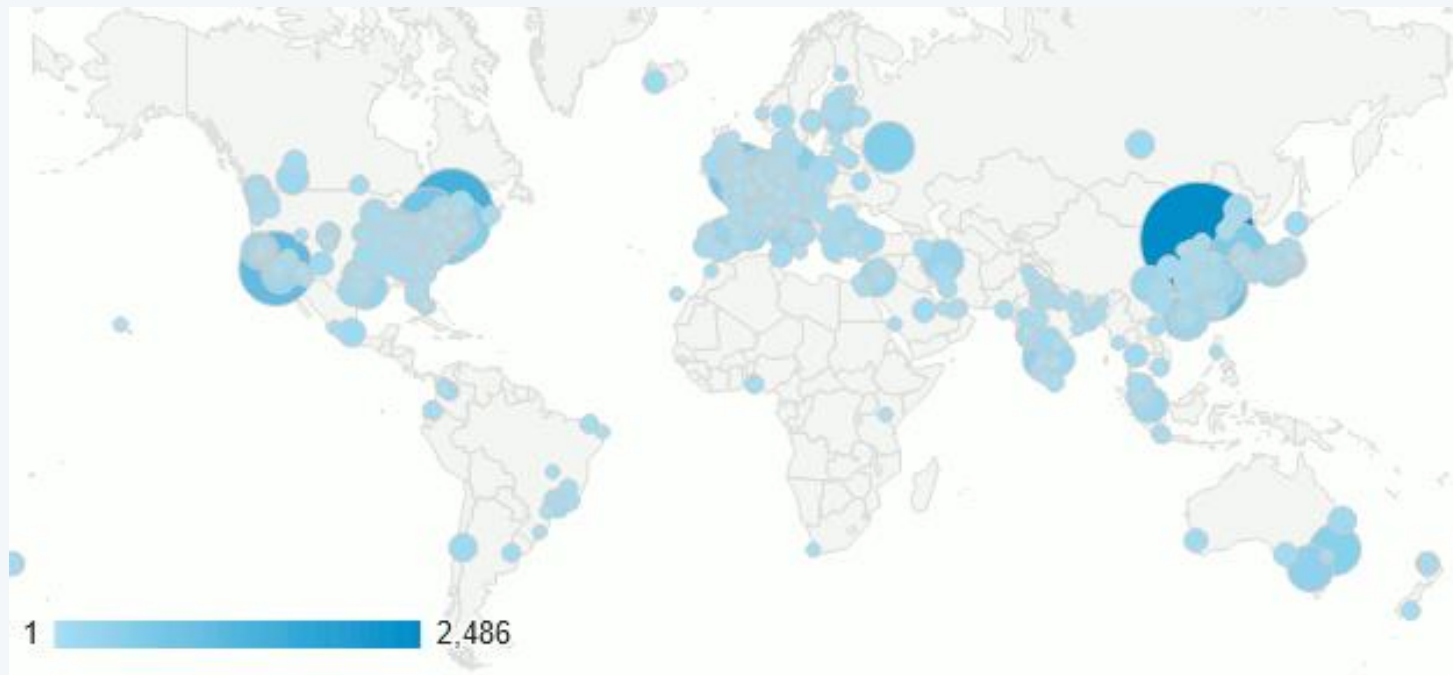


#### | SEEG/ECOG

<https://neuroimage.usc.edu/brainstorm/News>

# User community (2024)

- >45,000+ users registered on the website



**Find users next to you**

Location:

Users found: 847

# User support

- Online tutorials: 30-hour self-training program
- Active user forum: 150 posts/month
- Daily updates: 1500 downloads/month

**Brainstorm** Edit Search

**Get started**

**Software**

- Introduction
- Gallery
- Download
- Installation

**Users**

- Tutorials
- Forum
- Courses
- Community
- Publications

**Development**

- What's new

**Starting a new study**

1. Create a new protocol [9]
2. Import the subject anatomy [8]
3. Explore the anatomy [13]

**Reviewing**

4. Channel file / MRI registration [11]
5. Continuous recordings [9]
6. Multiple windows [5]
7. Event markers [10]

**Pre-processing**

8. Stimulation delays [9]
9. Select files / Run processes [11]
10. Power spectrum / Frequency filters [15]
11. Bad channels [6]
12. Artifact detection [8]
13. Artifact cleaning with SSP [16]
14. Additional bad segments [7]

**Epoching and averaging**

15. Import epochs [9]
16. Average response [7]
17. Visual exploration [10]
18. Colormaps [5]
19. Clusters of sensors [4]

**Source modeling**

20. Head model [9]
21. Noise/data covariance
22. Source estimation [28]
23. Scouts [17]

**Advanced processing**

24. Time-frequency [33]
25. Difference [13]
26. Statistics [30]
27. Workflows [10]
28. Scripting [31]

**Brainstorm** Search [User Profile]

all categories all tags Latest Top Categories + New Topic

Topic	Replies	Views	Activity
Extract amplitude and latency for P1, N1, P2, P3 Discussions erp, eeg	3	197	5h
About Freesurfer	2	31	7h

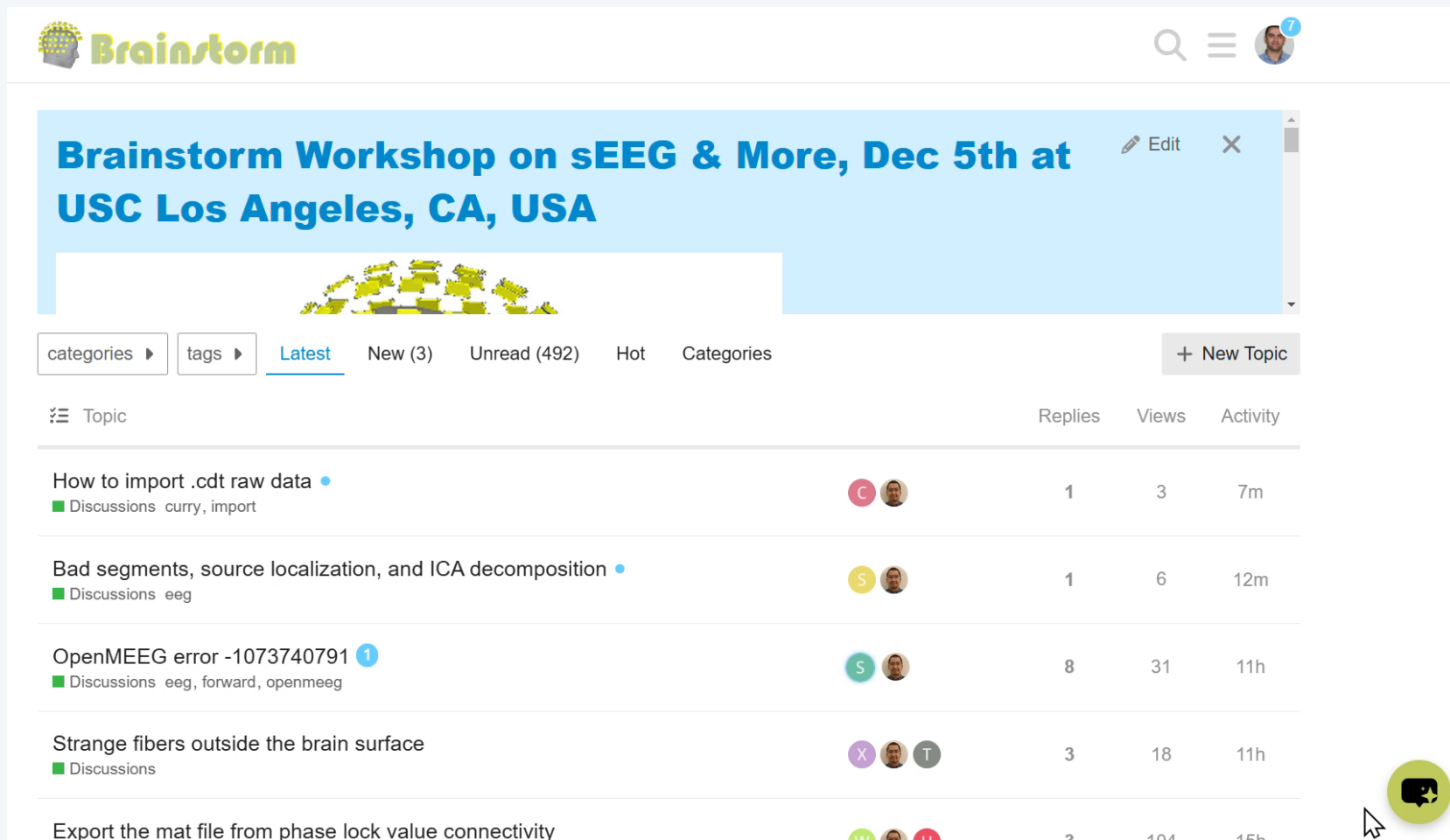
@BrainstormSoftware

@brainstorm2day

@brainstorm-tools

@brainstorm-neuroimage

- Brainstorm Chabot



The screenshot shows the Brainstorm forum interface. At the top left is the Brainstorm logo. On the right, there are search, menu, and user profile icons. A blue banner at the top contains the text: "Brainstorm Workshop on sEEG & More, Dec 5th at USC Los Angeles, CA, USA". Below the banner is a grid of yellow sticky notes. The main content area has navigation tabs: "categories", "tags", "Latest" (selected), "New (3)", "Unread (492)", "Hot", and "Categories". A "+ New Topic" button is on the right. Below the tabs is a table of discussion topics with columns for "Topic", "Replies", "Views", and "Activity".

Topic	Replies	Views	Activity
How to import .cdt raw data • ■ Discussions <a href="#">curry, import</a>	1	3	7m
Bad segments, source localization, and ICA decomposition • ■ Discussions <a href="#">eeg</a>	1	6	12m
OpenMEEG error -1073740791 1 ■ Discussions <a href="#">eeg, forward, openmeeg</a>	8	31	11h
Strange fibers outside the brain surface ■ Discussions	3	18	11h
Export the mat file from phase lock value connectivity	3	104	15h



# Contributors

## Investigators



Sylvain Baillet  
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Richard Leahy  
*USC*



John Mosher  
*UT Health*



Dimitrios Pantazis  
*MIT*

## Engineers



François Tadel  
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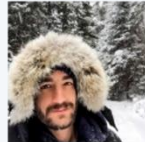


Raymundo Cassani  
*Software, MNI*



Marc Lalancette  
*MEG manager, MNI*

## McGill



Konstantinos Nasiotis  
*Post-doc*

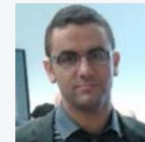


Soheila Samiee  
*PhD student*



Jeremy Moreau  
*PhD student*

## USC



Takfarinas Medani  
*Research Scientist*



Anand Joshi  
*RA Professor*



Chinmay Chinara  
*Software, USC*

## Collaborators



Elizabeth Bock  
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Guiomar Niso  
*Politécnica Madrid*



Juan García-Prieto  
*Martinos Ctr, MGH*



Yash Vakilna,  
RA, UTHealth  
Houston, USA

## NIRSTORM



Christophe Grova  
*Concordia*



Thomas Vincent  
*Montreal Heart Inst.*



Edouard Delaire  
*Concordia*

# Upcoming Brainstorm Events

=====

📍 Breckenridge, CO, USA

Date: March 3, 2025

Location: Breckenridge, CO

Time: 8:30 AM – 5:45 PM

Focus: Advanced [training](#) in Brainstorm's features for stereotactic EEG (sEEG) analysis.

Special Note: Part of the International Conference on Artificial Intelligence in Epilepsy and Neurological Disorders.

Early Bird Registration: Closes on December 15, 2024—take advantage of reduced rates!

Program & Registration: <https://lnkd.in/dqT7w3tP>

=====

📍 Hyderabad, India

Date: April 7, 2025

Location: Hyderabad, India

Time: 3:00 PM – 5:30 PM

Focus: Brainstorm overview presentation and demo on EEG and MEG analysis.

Special Note: Part of the International Conference on Acoustics, Speech, and Signal Processing ([ICASSP](#)).

Program & Registration: <https://lnkd.in/diVwMDRz>

=====

👤 Host a Workshop

Looking to organize a tailored Brainstorm workshop for your lab, university, or team? Whether you need to advance your knowledge or stay at the forefront of cutting-edge methods, we're here to help!

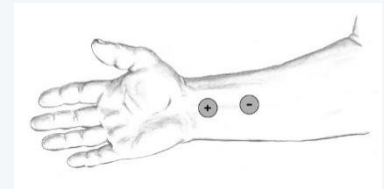
📧 DM us here or Contact us at [brainstorm-l@maillist.usc.edu](mailto:brainstorm-l@maillist.usc.edu) to discuss your needs.

# Today's event!

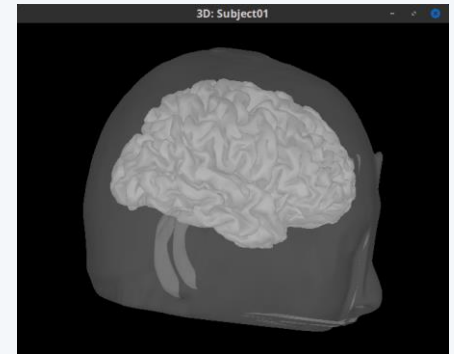
- Agenda
  - Morning Session :
    - Hands-On Brainstorm [EEG and MEG Analysis ]
  - Afternoon Session:
    - Hands-On Brainstorm [SEEG Analysis]

## Median nerve stimulation

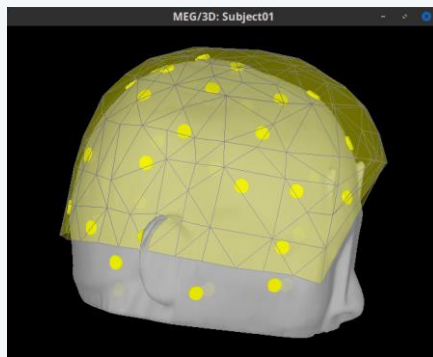
- Right arm stimulation: monophasic square-wave duration 0.3 ms at 2.8 Hz
- 1 participant / 1 run / 336 stimuli
- Individual MRI, processed with CAT12
- MEG: Yokogawa 160 axial gradiometers @ 2000 Hz
- EEG: Nihon Kohden 41 electrodes @ 2000 Hz



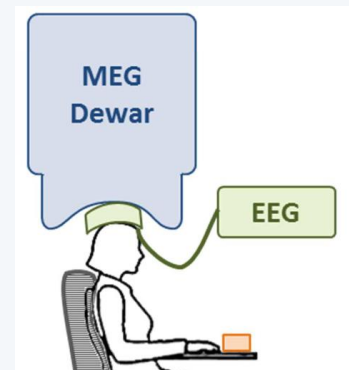
Median nerve percutaneous stimulation



Scalp and cortical surface



EEG electrodes and MEG helmet



Simultaneous MEG and EEG acquisition

# Feedback Brainstorm software & workshop

- Your feedback helps improve Brainstorm workshops and shape future sessions—share your thoughts!



<https://docs.google.com/forms/d/e/1FAIpQLSdLTYBkoWfdHyKYPXKd8wpQCdWw2fvRn0bgywO4JfVv0WgT9w/viewform>

# Brainstorm team today



Chinmay  
Chinara



Yash Vakilna



Woojae  
Jeong



Takfarinas  
Medani



Anand  
Joshi



John  
Mosher



Richard  
Leahy