Welcome!

Brainstorm

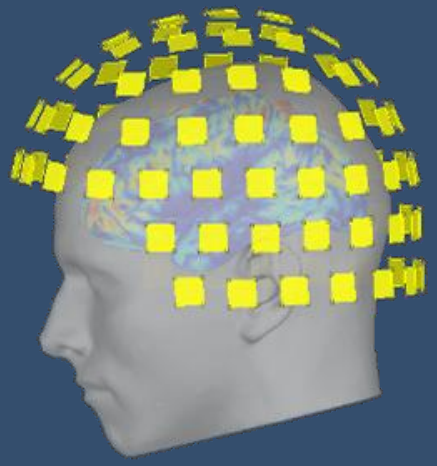
http://neuroimage.usc.edu/brainstorm

Brainstorm, August 7th, 2025, Mexico City

CAMELICE 2025

Brainstorm

http://neuroimage.usc.edu/brainstorm



Takfarinas MEDANI

Research Scientist

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University of Southern California

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McGill

neuro UTHealth

August 2025

Investigators & Contributors

Investigators

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Engineers

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Raymundo Cassani
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Marc Lalancette
MEG manager, MNI

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Post-doc

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Martinos Ctr, MGH

Yash Vakilna,
RA, UTHealth
Houston, USA

And...
Matti Hamalainen
Antoine Ducorps
Denis Schwartz
…

NIRSTORM

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Edouard Delaire
Concordia

This software was generated primarily with support from the **National Institutes of Health** (**NIH**) under grants **R01-EB026299**, **2R01-EB009048**, **R01-EB009048**, **R01-EB002010** and **R01-EB000473**.

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Brainstorm

Agenda

- **Lecture (~30min)**

  Brainstorm Overview:

  A Multimodal Tool for Evaluation of Epilepsy

  - EEG/MEG & electromagnetic source imaging?
  - Quick tour of Brainstorm's core features.

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- **Hands-On Demo (~45min) [with EEG]**

  Electrical Source Imaging with Brainstorm

  - Getting started: loading anatomy & data files
  - Sensor-level pipeline: filtering, epoching & plotting
  - Source-level pipeline: forward models & inverse solutions

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  - Overview Brainstorm's features and how it can be used for multimodal e-phys data analysis.

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- **Objective:**
  - Overview Brainstorm's features and how it can be used for multimodal e-phys data analysis.
- **Scan QR and register (add your email):**
  - To receive **the course materials** [slides and software]
  - Walkthrough to reproduce the Demo

Brainstorm

let's start with a quick poll!

Brainstorm
http://neuroimage.usc.edu/brainstorm

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

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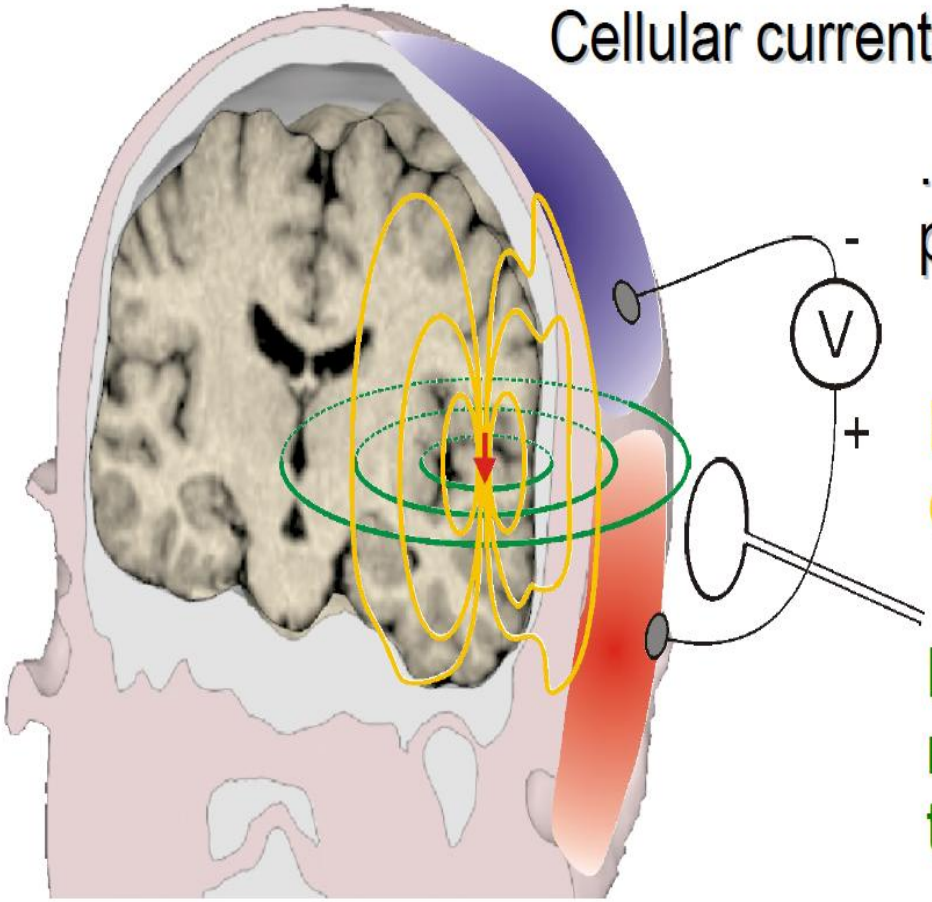
- Are you currently using Brainstorm software?
  - If Yes : Raise your hand

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

Outline

- Overview Electromagnetic Brain Mapping
- Brainstorm Software
- Brainstorm User Interface
- Brainstorm Workflow
  - Review and Import Data
  - Data Co-registration
  - Data Analysis: Sensor and Source Level
  - Overview of the features/functionalities
- What's New?
- Today's Demo

Electroencéphalographie (EEG) & Magnétoencéphalographie (MEG)



Cellular currents in an active neuron population...

... give rise to extracranial electric potentials and magnetic fields

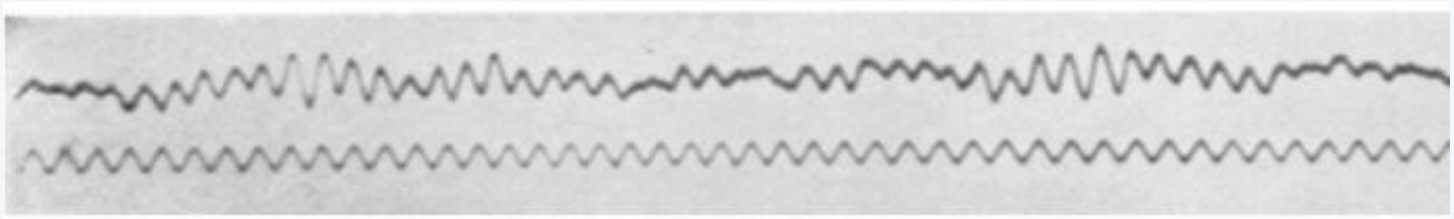
EEG = measuring the potential differences on the scalp

MEG = measuring neuromagnetic fields outside of the head

MEG and EEG track electric brain activity by measuring the electromagnetic fields generated by neurons

The first EEG measurement

- Hans Berger recorded the first human EEG
  - Alpha waves in 1924



  - *Upper trace: Human EEG*
  - *Lower trace: 10-Hz timing signal*

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The first MEG measurement

- MEG became practical only after the SQUID (superconducting quantum interference device) sensor was invented

- David Cohen made the first MEG measurement with a SQUID in 1972 at MIT

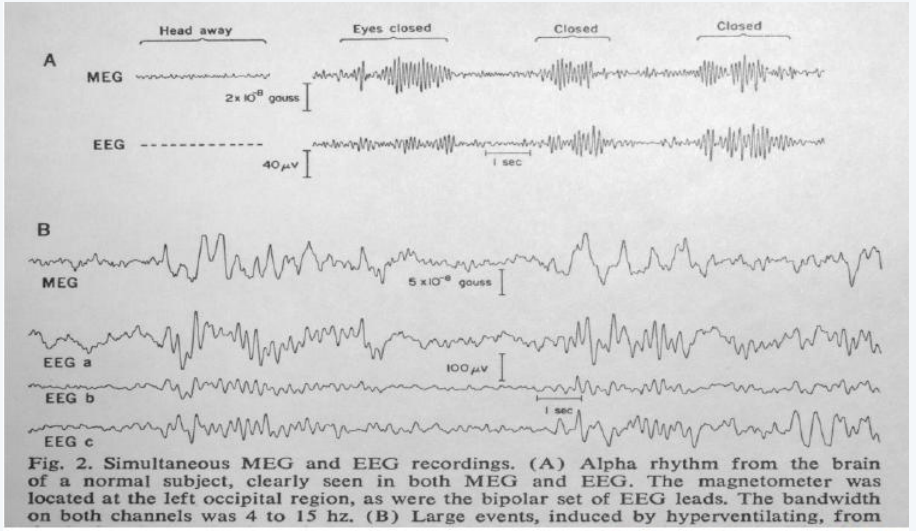
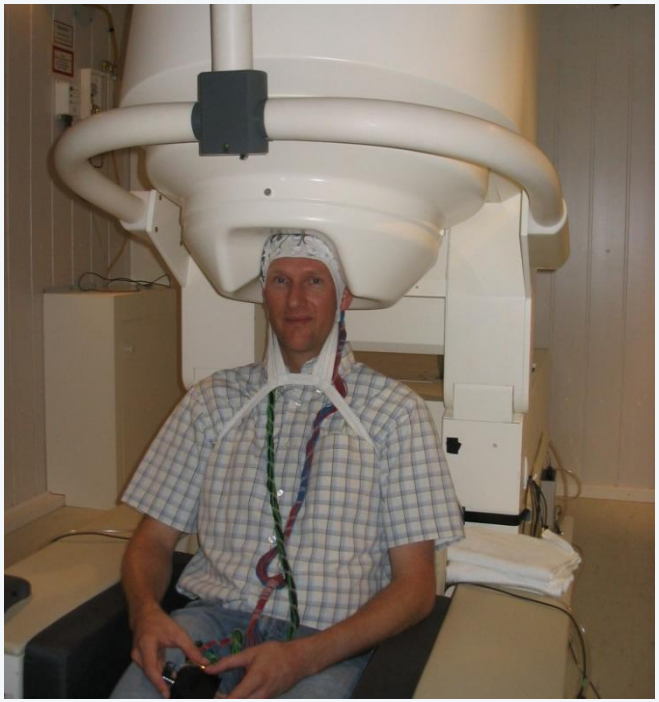


Fig. 2. Simultaneous MEG and EEG recordings. (A) Alpha rhythm from the brain of a normal subject, clearly seen in both MEG and EEG. The magnetometer was located at the left occipital region, as were the bipolar set of EEG leads. The bandwidth on both channels was 4 to 15 hz. (B) Large events, induced by hyperventilating, from

Cohen, Science 1972

Brainstorm

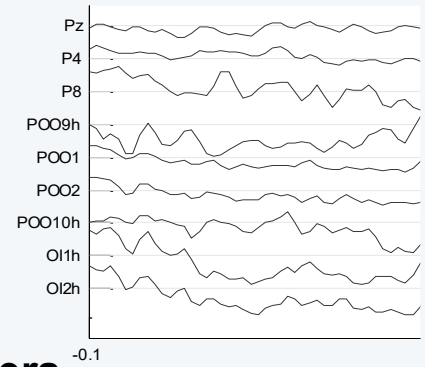
Electromagnetic Brain Mapping & Applications

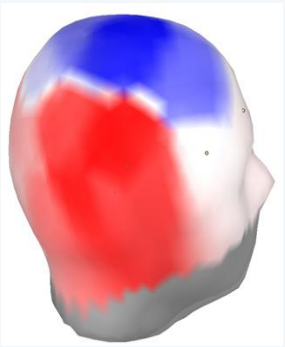


EEG

MEG

Data recording
EEG ~ uVolt
MEG~ fTesla



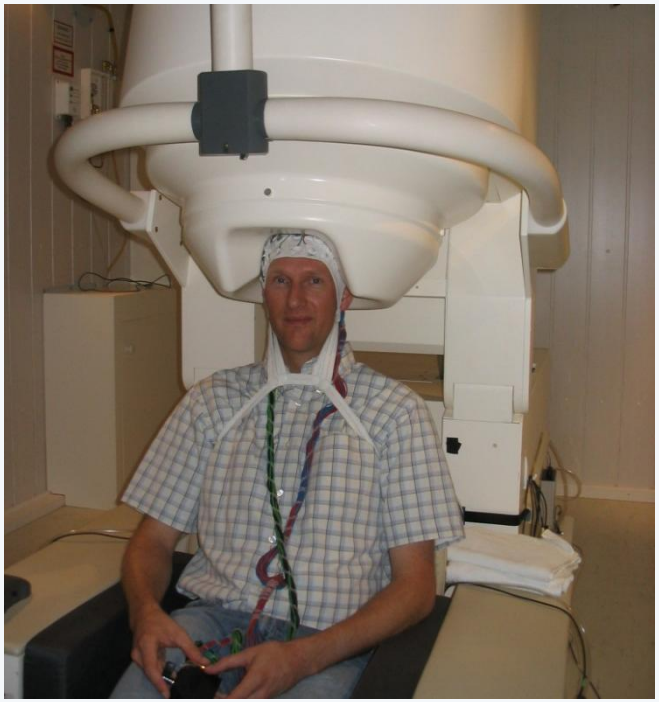


Sensor level analysis

- **Early Diagnosis of Neurological Disorders** (e.g., Parkinson's, Alzheimer's, Epilepsy)
- **Disorders of Consciousness / Brain States**
- **Brain Network Connectivity**
- **Mapping Behavior to Brain Activity**
- **High time resolution & Good spatial resolution**

Brainstorm

Electromagnetic Brain Mapping & Applications



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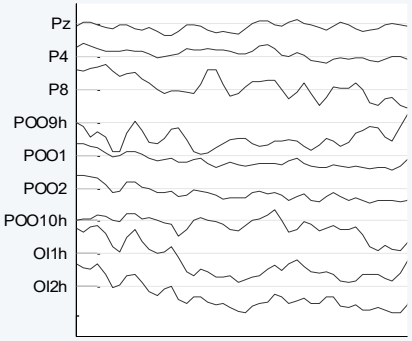

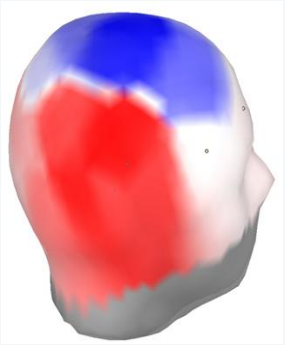

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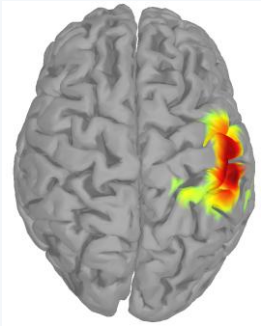

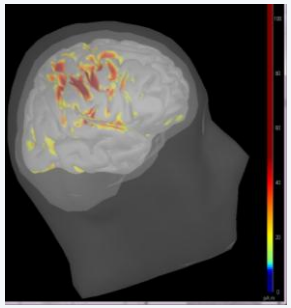

Source level analysis

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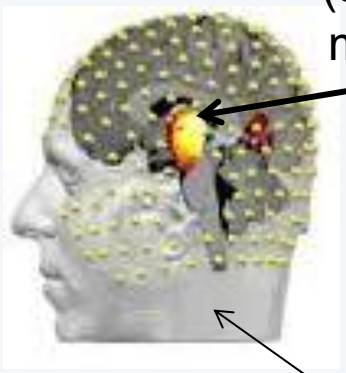
From Sensor level to Source level

- **Forward and Inverse problem**
  - **Source Reconstruction**
    - Signal processing
    - Inverse solution

Inverse Problem

Forward Problem



Dipole (source model)

Volume conductor (Head model)

  - Solving the forward problem
    - Model the head model (volume conductor)
    - Model the source (as active dipoles)

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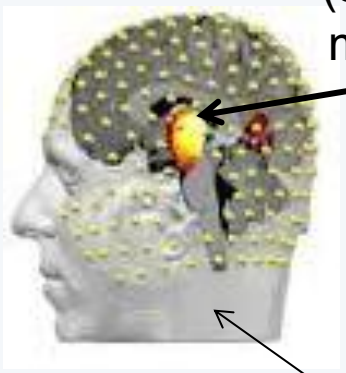

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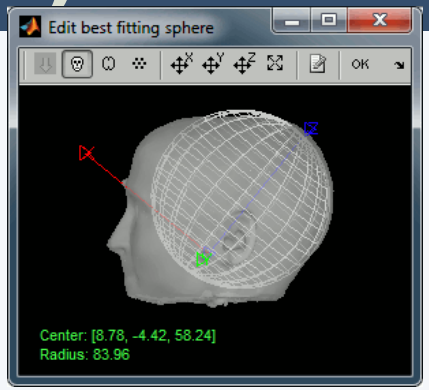
Modeling the head (volume conductor)

- **Spherical head model, (EEG)**
  - Analytical solution
  - Quick but not realistic solution



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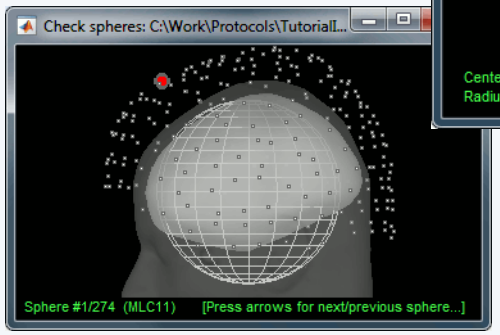
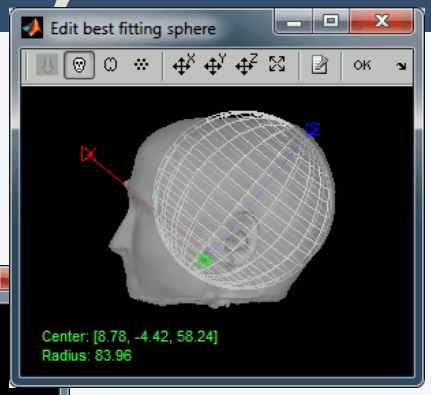
- **Overlapping sphere, (MEG)**
  - Analytical solution
  - Maybe sufficient !
-





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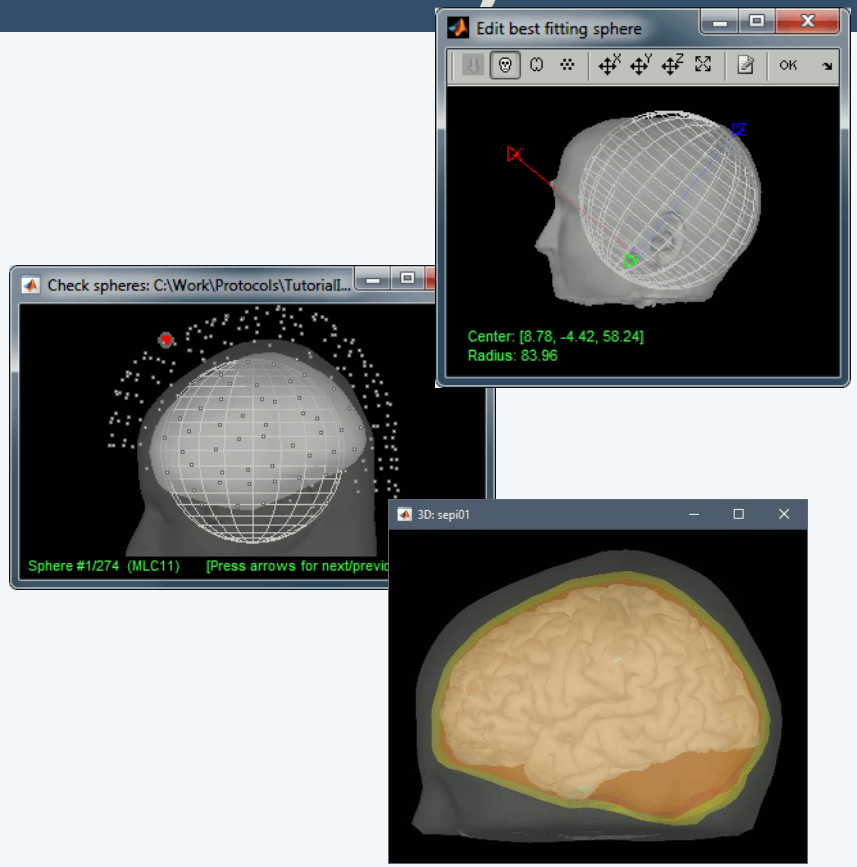
  - Surface mesh=> BEM
    - Isotropic conductivity
    - Up to 3 layers (brain, skull and scalp)



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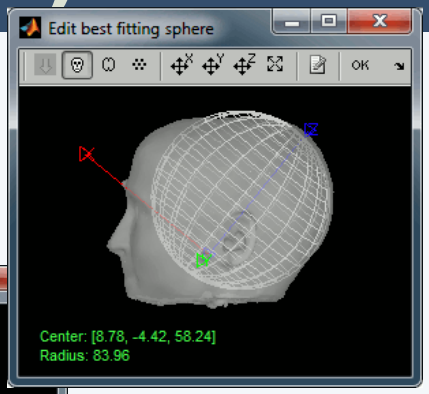
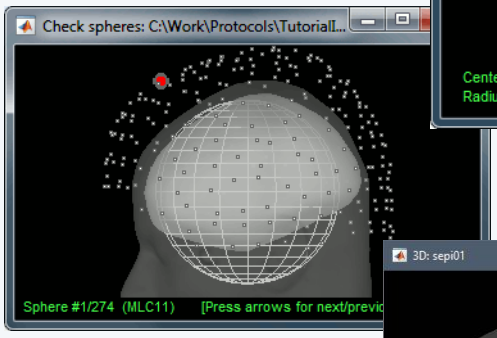
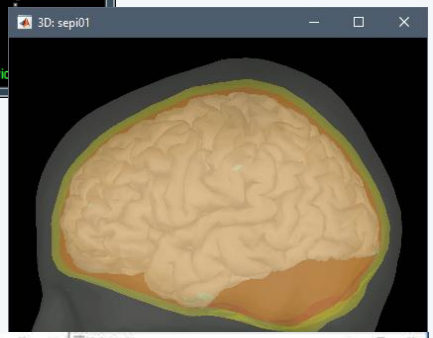
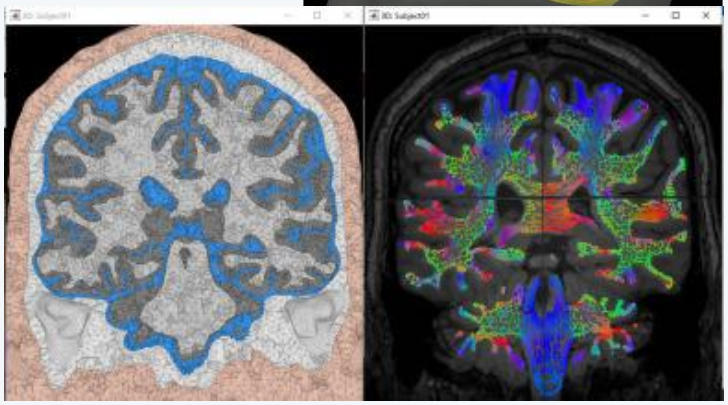
  - Surface mesh=> BEM
    - Isotropic conductivity
    - Up to 3 layers (brain, skull and scalp)
  - Volume mesh => FEM
    - More realistic (derived from MRI)
    - Anisotropic (derived from DWI/DTI)



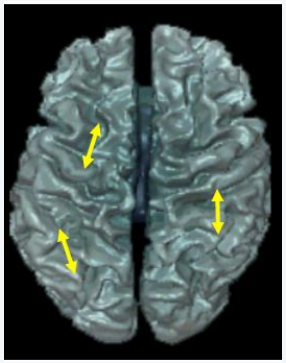


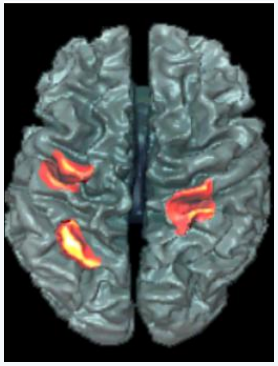




Modeling the source (inverse solution)

- **Two main approaches for inverse modeling**
  - Source Localization vs Source Imaging
    - Point-like (or few) source vs Distributed source
    - Focal/localized vs broad and smooth
      - Eg: Focal Epilepsy vs Cognitive mapping
      - Steady-state or resting-state (ongoing activity)
      - Event-based (stimulus, response, spike…)
    - Dipole fit vs MNE (sLORETA, dSPM, …)





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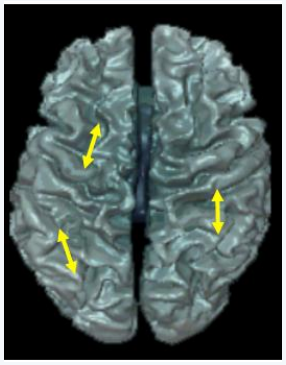

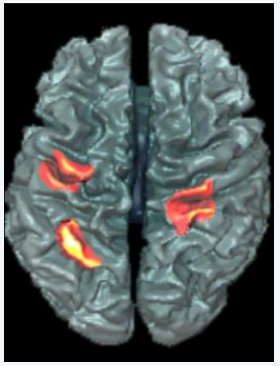

- **Dipole fit:** find the best dipole (position, orientation, and amplitude) to fit the data with minimum residual
- **MNE:** ill-posed problem, many sources (all the cortex vertices or all the brain volume)
  - Adding constraints to the source:
    - Smoothness (regularization)
    - Source strength,…
- Other methods exist: Spatial filtering (beamformer LCMV), MEM, …

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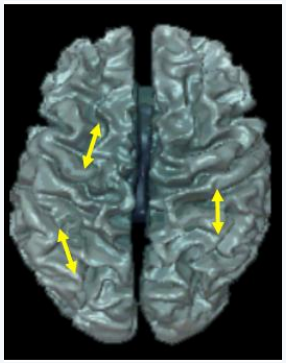

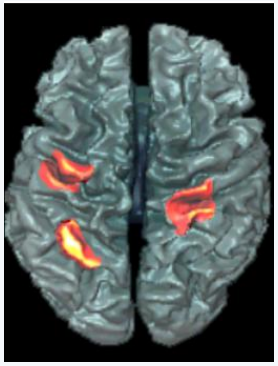

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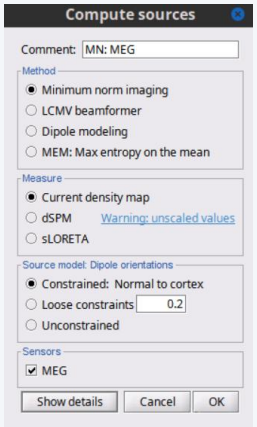
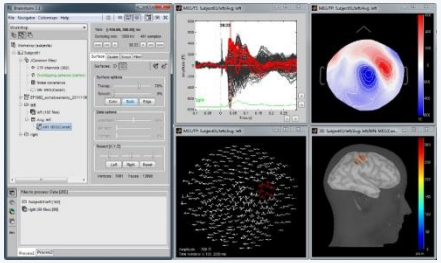


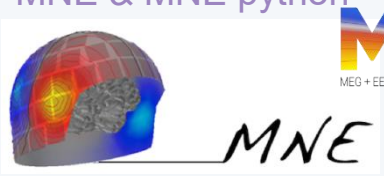
Software Tools for MEG/EEG

Brainstorm



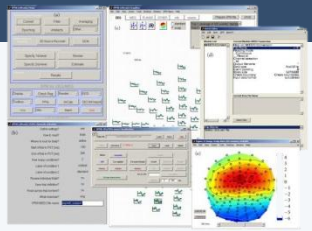
http://neuroimage.usc.edu/brainstorm/

MNE & MNE python



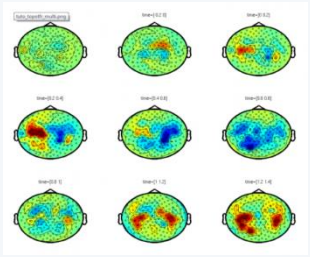
http://martinos.org/mne/stable/index.html

SPM



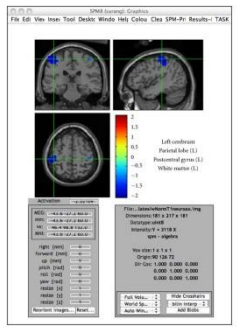
http://www.fil.ion.ucl.ac.uk/spm/software/

Fieldtrip



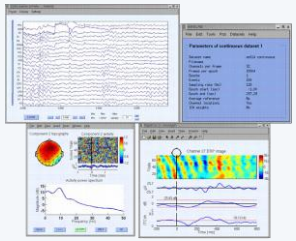
http://www.fieldtriptoolbox.org/

NutMEG



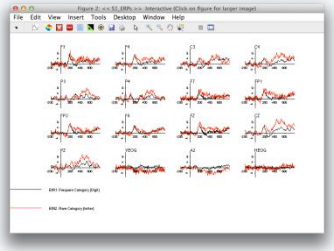
http://nutmeg.berkeley.edu/

EEGLAB



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

ERPLAB



http://erpinfo.org/erplab/

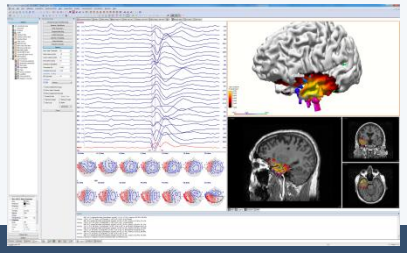
rtMEG: Real time MEG software interface
BCILAB: Open source Matlab toolbox for brain-computer interfaces
NFT: Neuroelectromagnetic forward head modeling
OpenMEEG: Neuroelectromagnetic BEM forward head modeling
DUNEuro: Neuroelectromagnetic FEM forward head modeling

Commercial Products

Vendor software

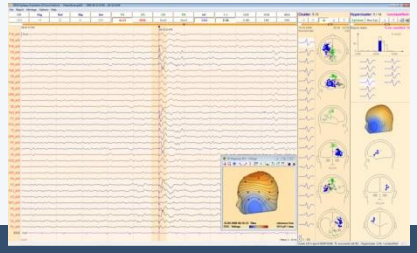
Elekta Neuromag
CTFMEG
EGI: Net Station 5
BioSemi

Curry



http://compumedicsneuroscan.com/

BESA

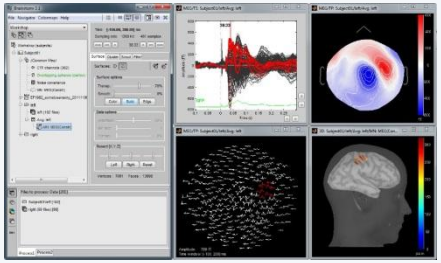


http://www.besa.de/

Brainstorm

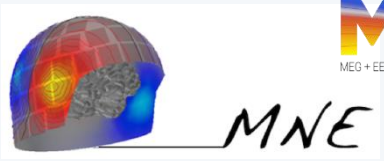
Software Tools for MEG/EEG

Brainstorm



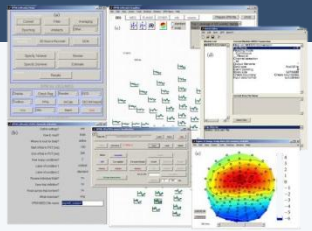
http://neuroimage.usc.edu/brainstorm/

MNE & MNE python



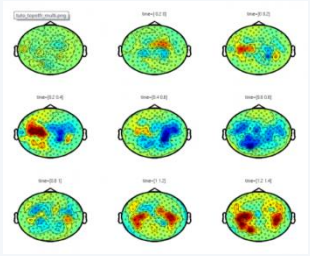
http://martinos.org/mne/stable/index.html

SPM



http://www.fil.ion.ucl.ac.uk/spm/software/

Fieldtrip



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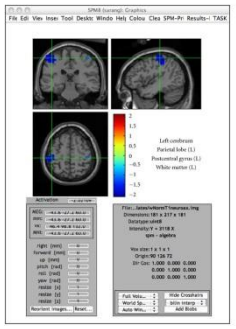

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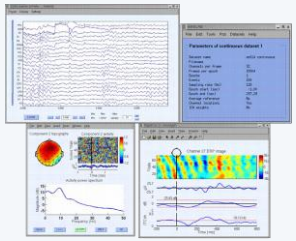
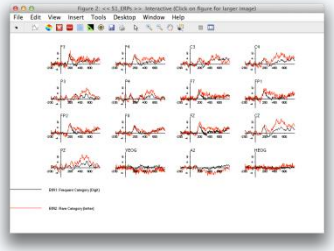
EEGLAB



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

ERPLAB



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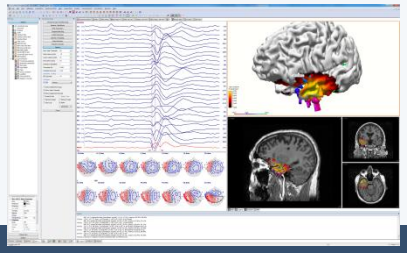

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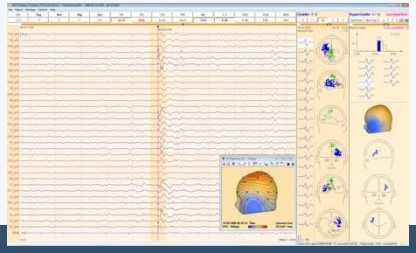
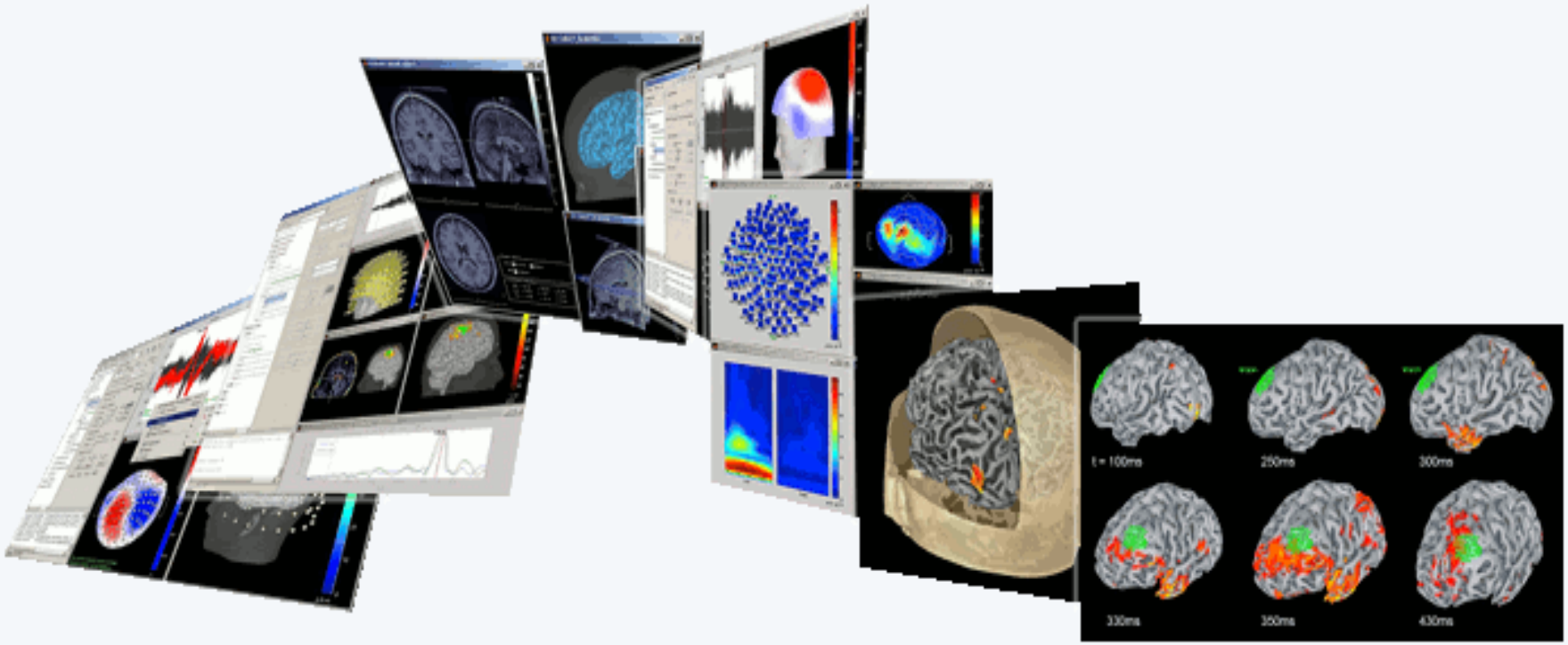
BESA



http://www.besa.de/

Brainstorm

Overview of the Brainstorm Software



Brainstorm

Brainstorm

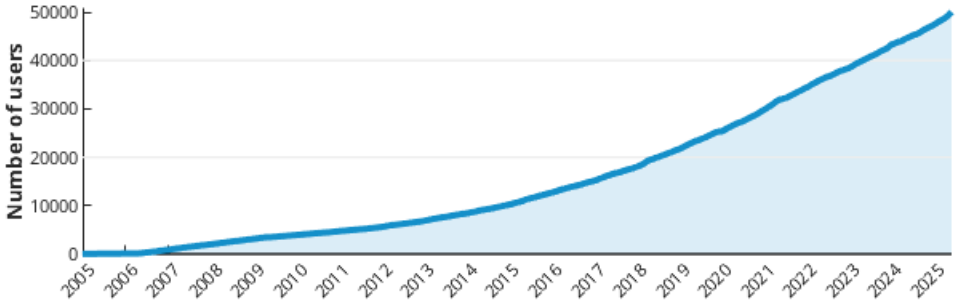
- The project started at the end of the 1990's
- A free and open-source application (GPL)
- Matlab & Java: Platform-independent
- Stand-alone version also available
- Interface-based: **click, drag, drop**
- No Matlab/coding experience required
- **Supports most common file formats**
- Daily updates of the software
- Educational resources & active users' community (~50k registered users) [Website, Forum, GitHub, …]

User community (2025)

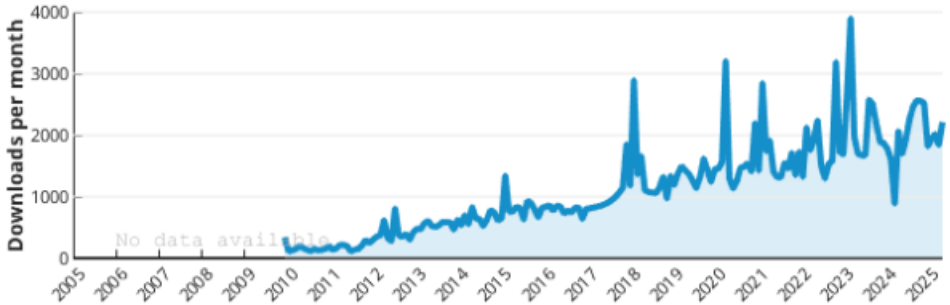
- >50,000+ users registered on the website

Software statistics: July 2025

Number of user accounts registered on the website: **50,051**



Number of software downloads per month: (12-month average = **2340/month**)



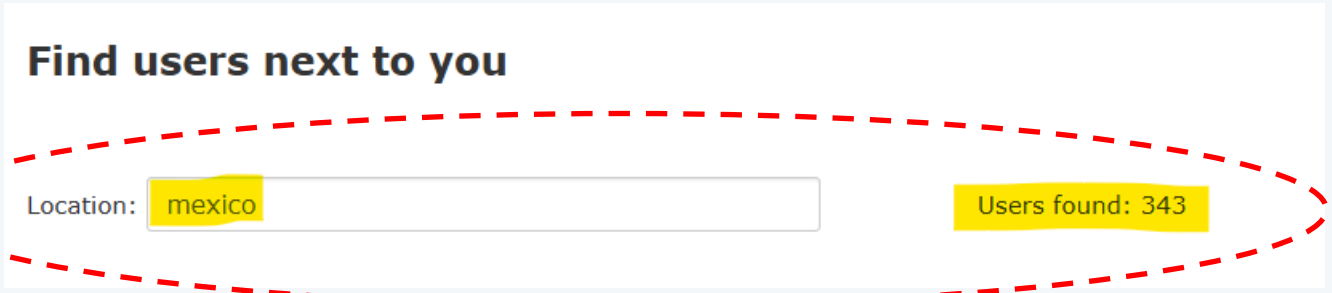
Number of messages posted on the forum: **60,907**

https://neuroimage.usc.edu/brainstorm/Community

Brainstorm

User community (2025)

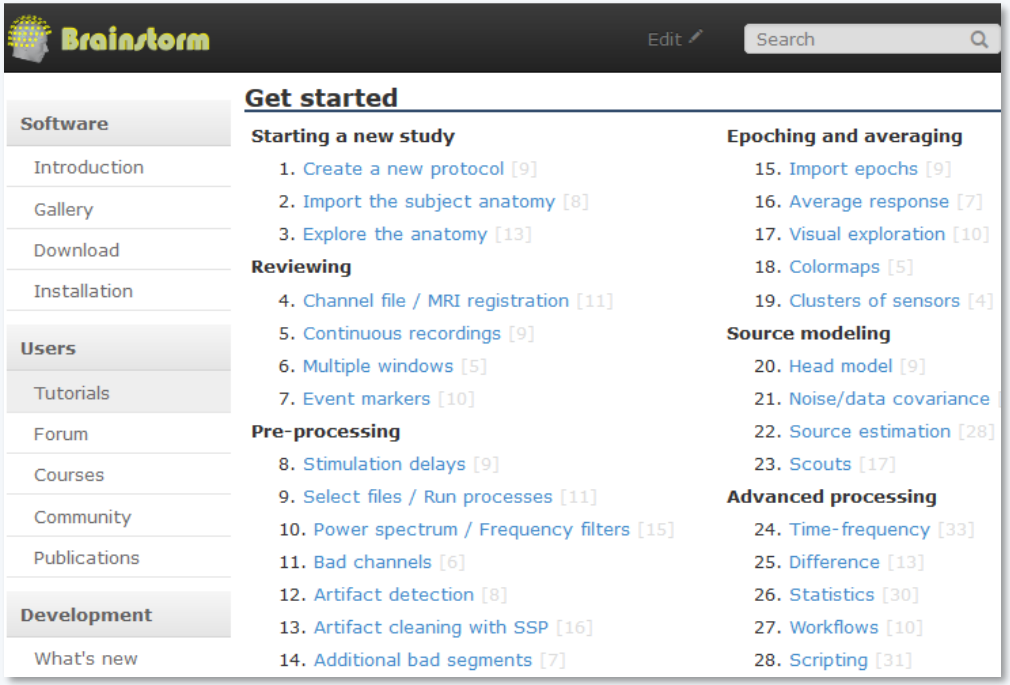
- >50,000+ users registered on the website

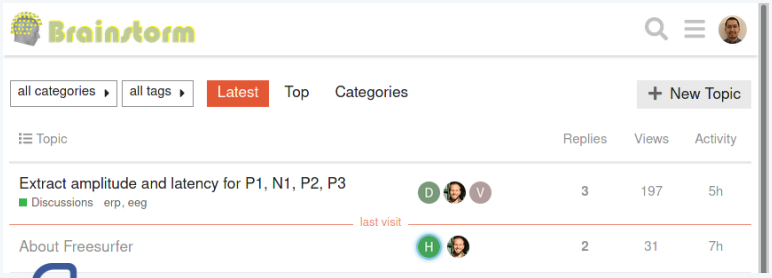


Brainstorm

User support

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





@BrainstormSoftware

@brainstorm2day

@brainstorm-tools

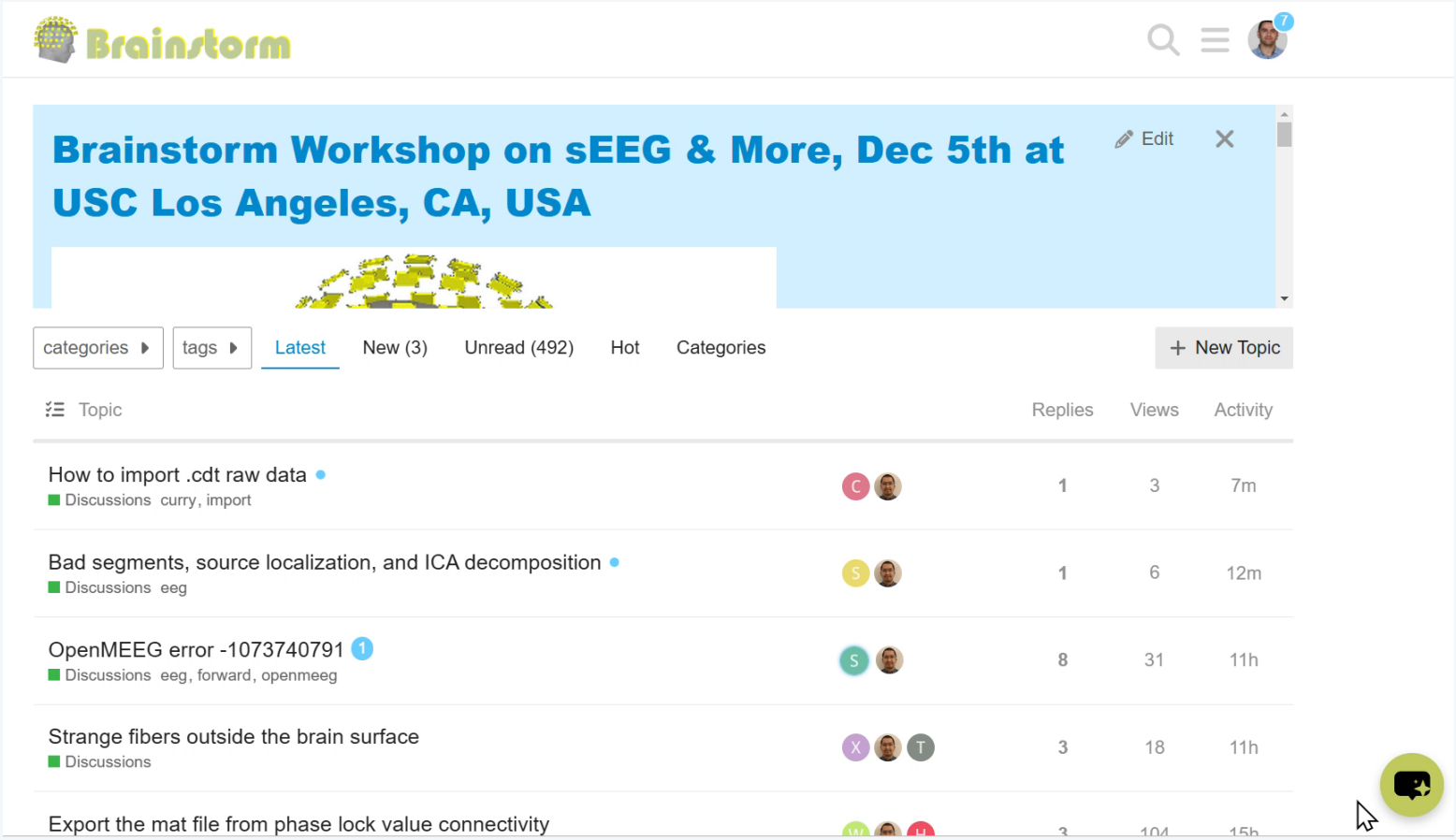
@ brainstorm-neuroimage

@Brainstorm Software

Brainstorm

User support

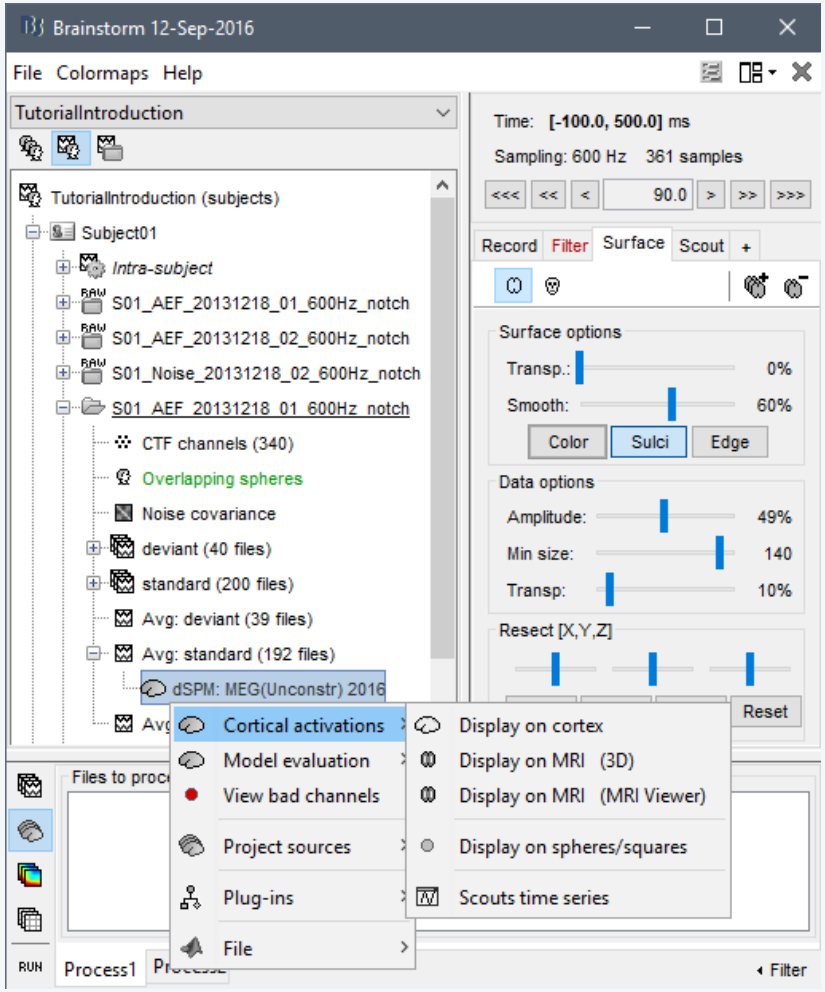
- Forum Brainstorm Chabot



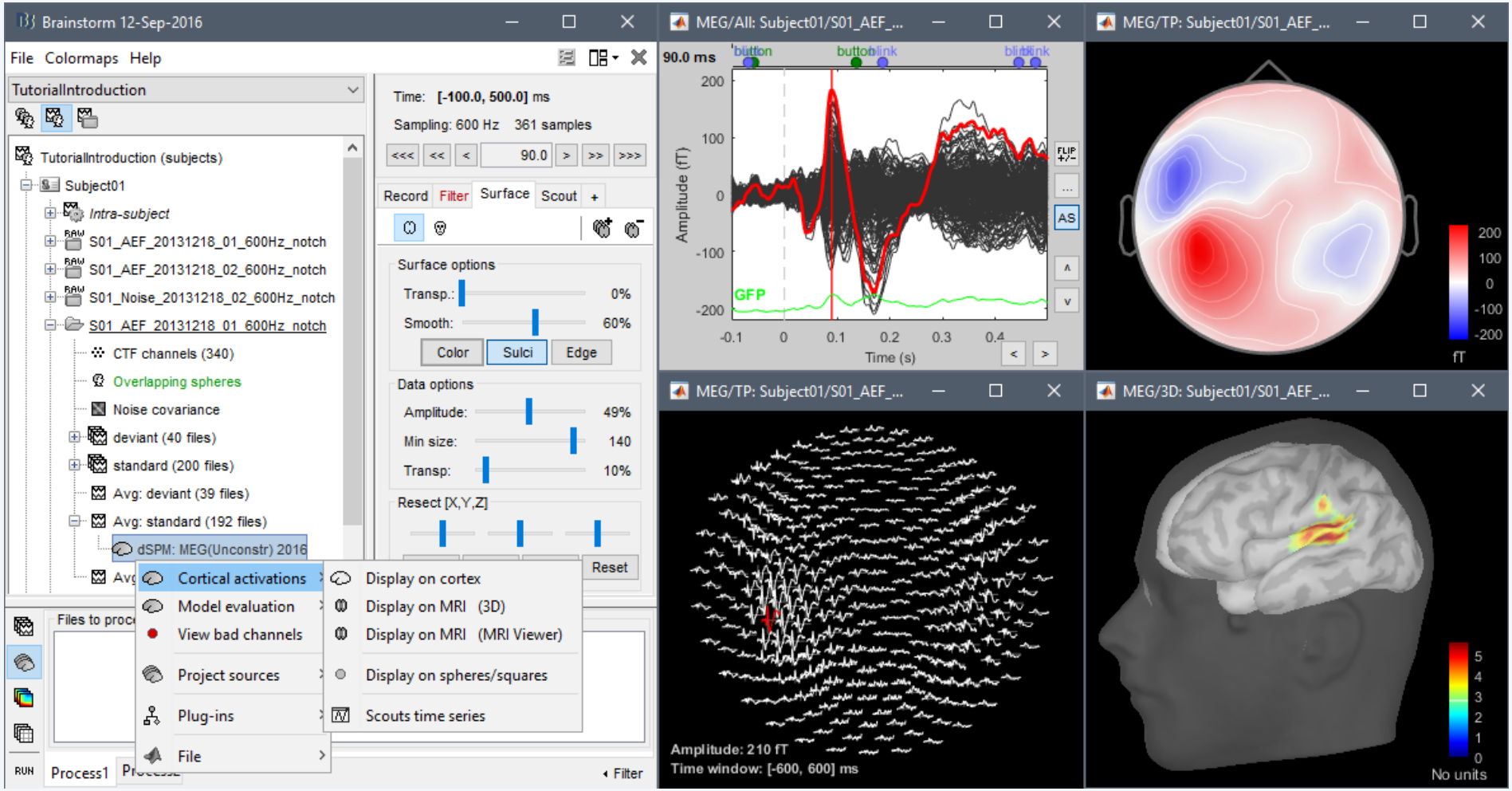
https://neuroimage.usc.edu/forums/

Brainstorm

Graphic interface

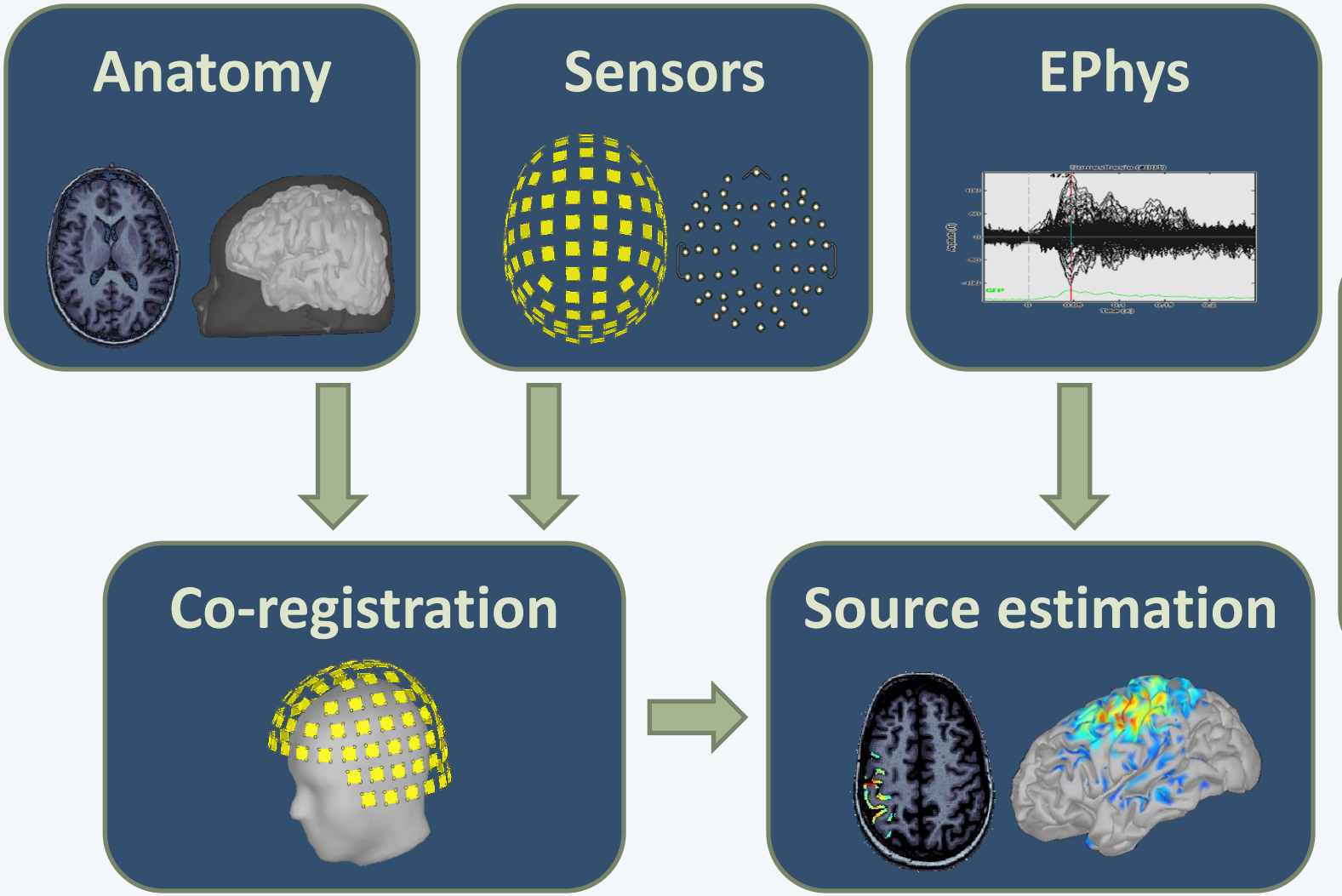


Graphic interface



Brainstorm

Workflow



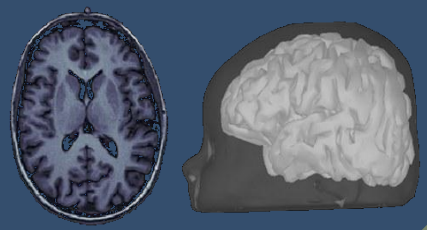
Brainstorm

Workflow

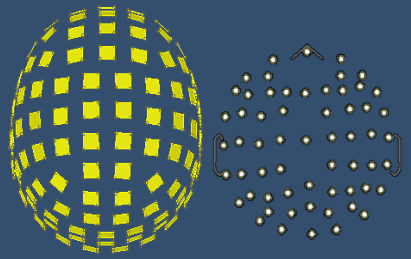
MRI, CT, DWI, PET

EEG, MEG, iEEG, fNIRS (~fMRI)

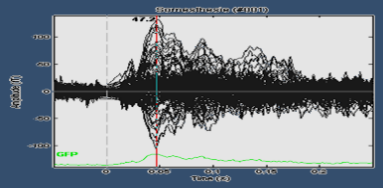
Anatomy



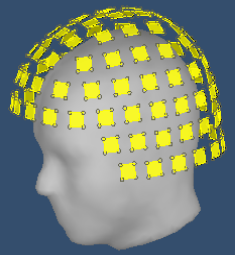
Sensors



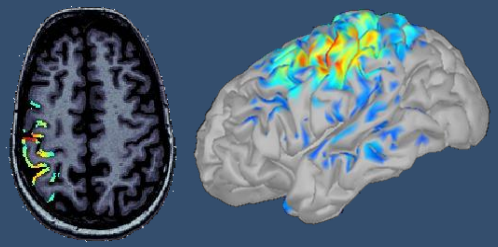
EPhys



Co-registration



Source estimation



Analysis

Averages
Statistics
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

Single subject → Group Analysis

Anatomy
Link recordings
MRI registration

Importing

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Events
Epoching
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Time-frequency

Analysis of the experimental data

Loop:
all acquisition runs
all subjects

Single subject → Group Analysis

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Link recordings
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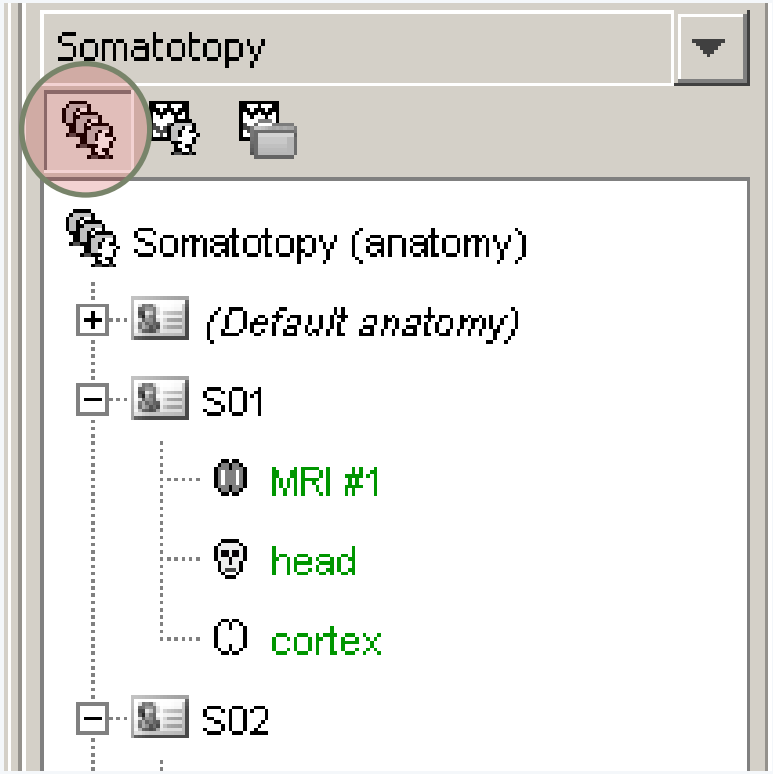
Sources
Time-frequency

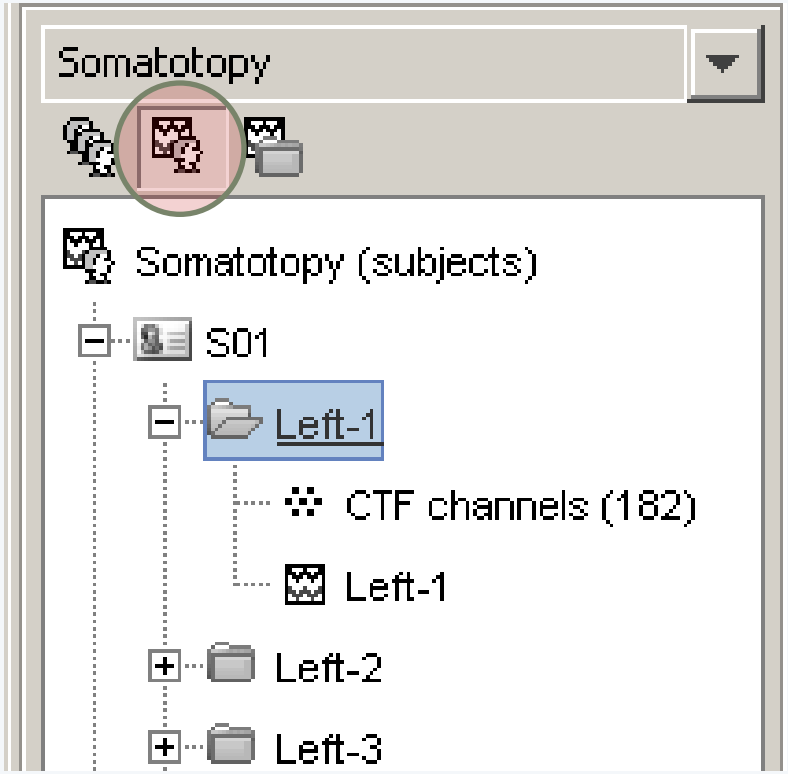
Analysis of the experimental data

Loop:
all acquisition runs
all subjects

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

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
Bad channels
Artifacts
Correction
Bad segments

Markers
Epoching
Averaging
Sources
Time-frequency

- One-click import of the MRIs (raw or segmentation): **FreeSurfer, BrainSuite, BrainVISA, CIVET, CAT/SPM**
- Import and place fiducials in the MRI

Brainstorm

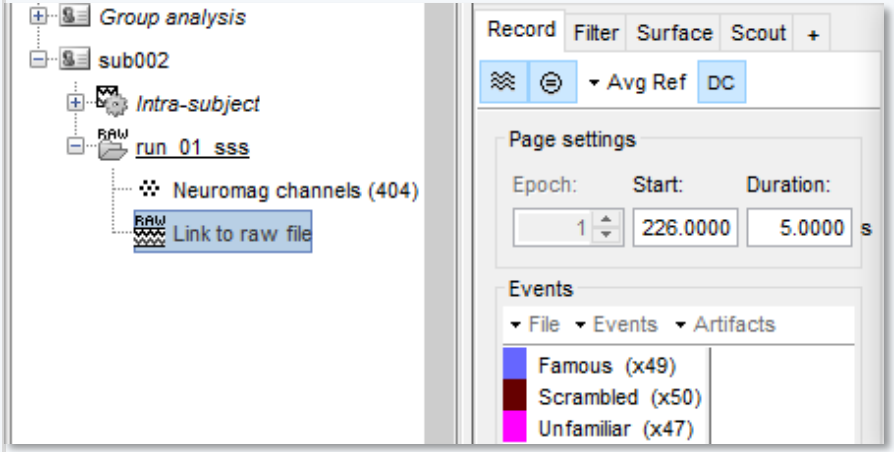
Import

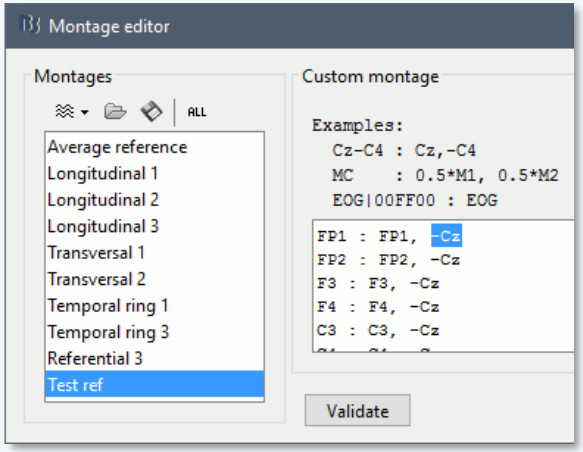
Anatomy
Link recordings
MRI registration

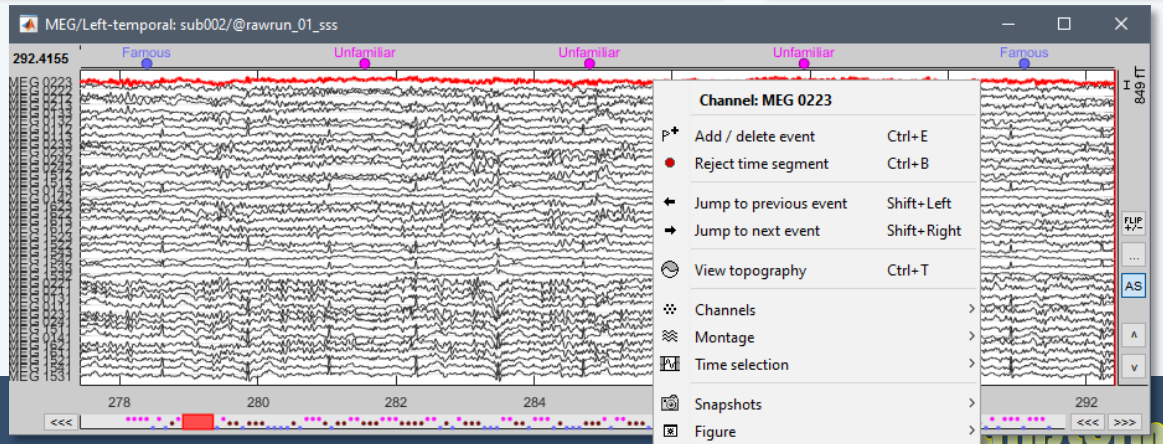
PSD
Filters
Bad channels
Artifacts
Correction
Bad segments

Markers
Epoching
Averaging
Sources
Time-frequency

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







Import

Anatomy
Link recordi
MRI registrat

PSD
Filters
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Sources
Time-frequency

e database (no copy)

xible montage editor

Supported file formats

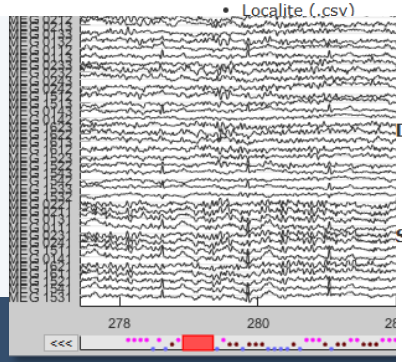
EEG / Electrophysiology
- ADInstruments LabChart (.adicht)
- ANT ASA (.msm/.msr)
- ANT EEProbe (.cnt, .avr)
- Axion AxIS (.raw)
- BCI2000 (.dat)
- BDF / BDF+ (Biosemi 24bit binary)
- BESA exports (.avr, .mul)
- BIDS-formatted datasets
- BIOPAC AcqKnowledge (.acq)
- Blackrock NeuroPort (.nev, .nsX)
- BrainVision BrainAmp (.eeg)
- BrainVision Analyzer (.txt)
- Cartool binary files (.ep, .eph)
- CED Spike2 (.smr, .smrx, .son)
- Compumedics ProFusion Sleep (.rda)
- Curry 6-7 (.dat/.dap/rs3)
- Curry 8 (.cdt/.dpa)
- Deltamed Coherence-Neurofile export (.txt/.bin)
- EDF / EDF+ (European Data Format)
- EEGLab sets (.set)
- ERPLab results (.erp)
- EGI NetStation epoch-marked file (.raw/.epoc)
- EGI-Philips (.mff)
- EmotivPRO (.edf)
- FieldTrip structures (.mat)
- g.tec / g.Recorder (.mat, .hdf5)
- Intan (.rhd, .rhs)

MEG
- CTF (.ds folders)
- Elekta Neuromag FIFF (.fif)
- BTi / 4D Neuroimaging
- KRISS MEG (.kdf)
- BabyMEG system (.fif)
- Ricoh MEG (.sqd, .c
- Yokogawa / KIT (.s
- York Instruments M
- MEG-BIDS formatte

fNIRS
- Brainsight NIRS (.n
- SNIRF (.snirf)

Other recordings
- EyeLink eye tracke
- Tobii Pro Glasses (.

Sensors locations
- ANT Xensor (.elc)
- BESA (.sfp, .elp, .e
- BrainVision CapTral
- BrainVision electroc
- Cartool (.xyz, .els)
- Curry (.res, .rs3)
- EEGLab (.ced, .xyz
- EETrak (.elc)
- EGI (.sfp)
- EMSE (.elp)
- Localite (.csv)



- Micromed (.trc)
- Muse (.csv)
- Neuralynx (.ncs)
- Neurodata Without Borders (.nwb)
- Neuroelectrics (.easy, .nedf)
- NeurOne (.bin)
- Neuroscan (.cnt, .eeg, .avg, .dat)
- NeuroScope (.eeg, .dat)
- Nicolet (.e)
- Nihon Kohden (.EEG)
- Open Ephys flat binary (*.dat)
- Plexon (.plx, .pl2)
- Ripple Trellis (.nev, .nsX)
- The Virtual Brain (.h5)
- Tucker Davis Technologies (.tdt)
- Wearable Sensing (.csv)
- Any type of ASCII (text) files

Data structures of similar applications
- EEGLAB
- FieldTrip
- MNE-Python
- SPM12

Dipole models
- Elekta Neuromag XFit (.bdip)
- CTF's DipoleFit (.dip)

Surface atlases
- BrainSuite (.dfs)
- FreeSurfer (.annot, .label)
- Gifti texture (.gii)
- SUMA atlas (.dset)

- ASCII arrays

MRI volumes
- Analyze (.img/.hdr)
- BESA MRI (.vmr)
- BrainVISA GIS (.ima/.dim)
- CTF (.mri)
- DICOM (using SPM converter)
- MINC (.mnc)
- MGH (.mgh, .mgz)
- Neuromag (.fif)
- Nifti-1 (.nii, .nii.gz)

Surface meshes
- ASCII (.tri)
- BESA MRI (.srf)
- BrainVISA (.mesh)
- BrainSuite (.dsgl, .dfs)
- Curry BEM surfaces (.db*, .s0*)
- FreeSurfer (lh.*, rh.*)
- FSL: VTK (.vtk)
- FSL: Geomview (.off)
- Wavefront/MNI obj (.obj)
- Neuromag (.fif)
- SimNIBS/Gmsh (.msh)
- 3D masks or atlases from MRI files

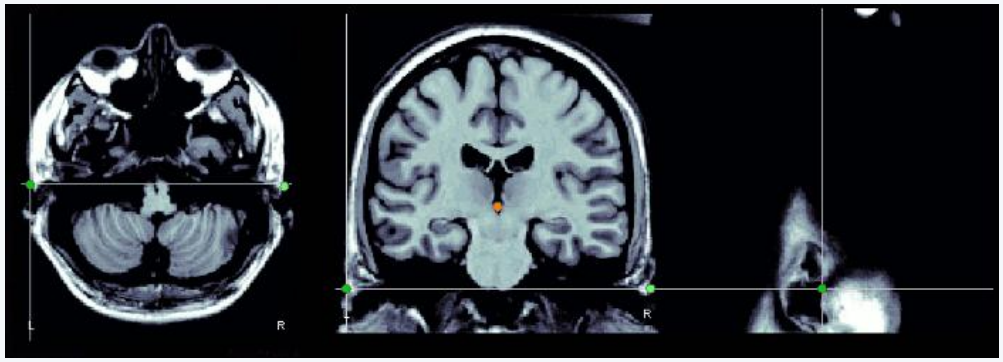
Co-registration MEEG / MRI (1)

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/FastTrack)



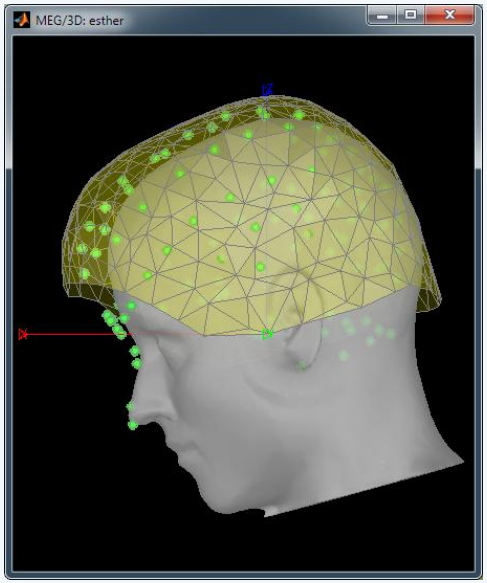
Co-registration MEEG / MRI (2)

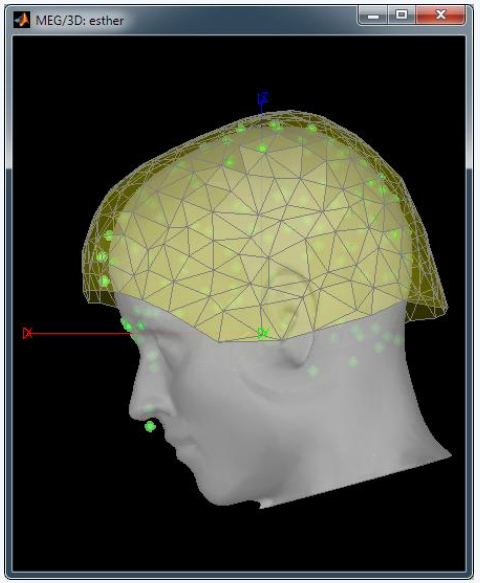
Anatomy
Link recordings
MRI registration

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/Fastrack interface included in Brainstorm





Quality control

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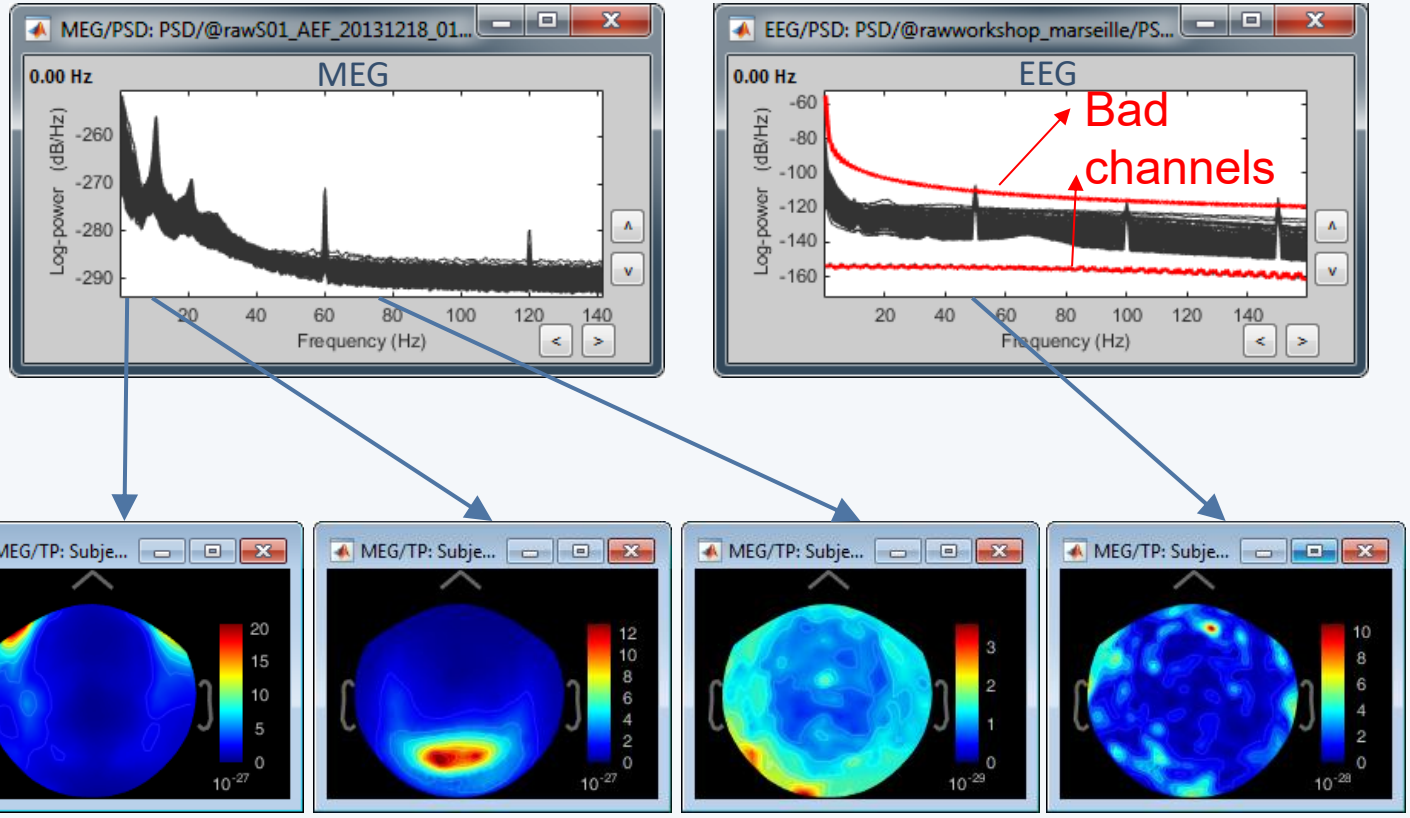
- Power spectrum density for quality control



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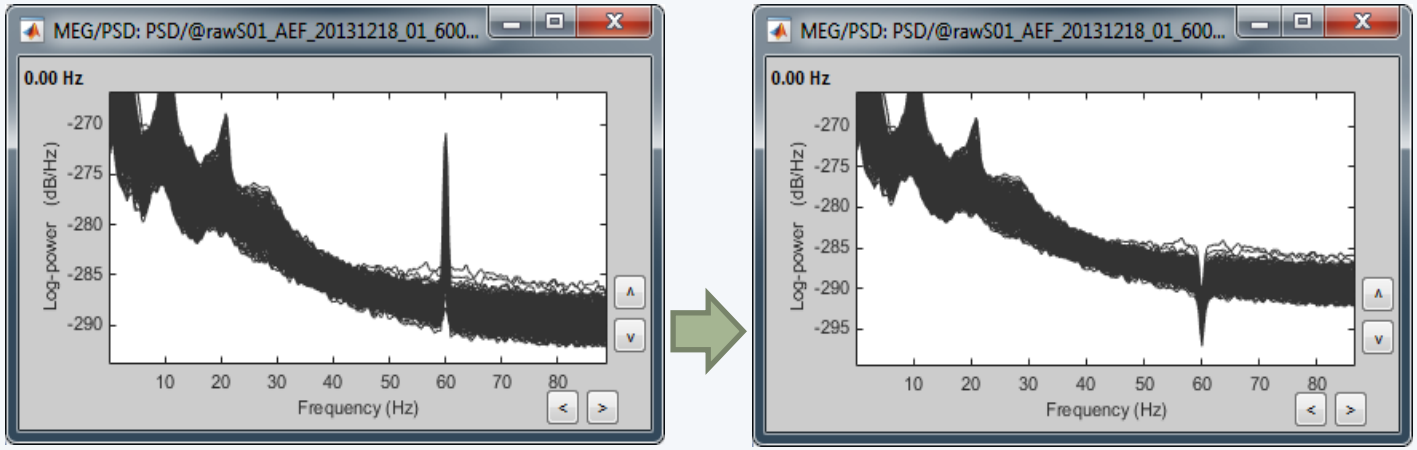
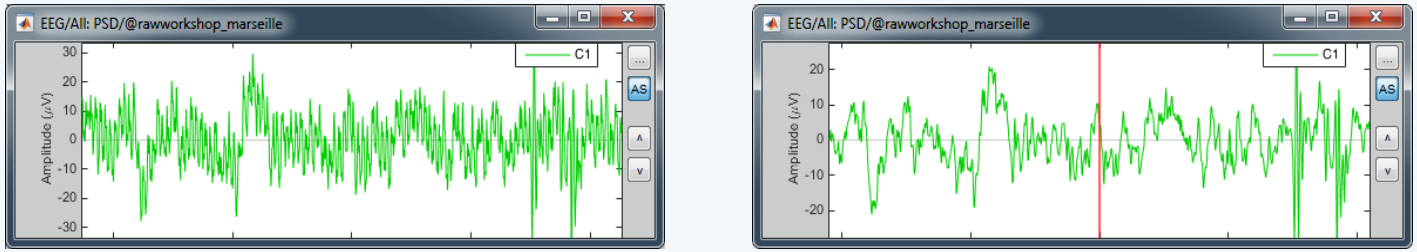
- **Notch filter**: Removes 50Hz/60Hz power line noise (and harmonics)

PSD



Signal



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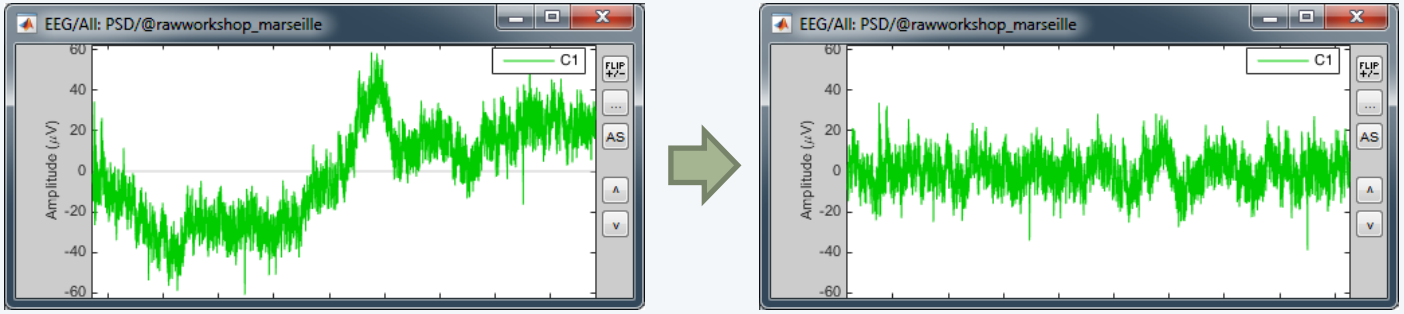
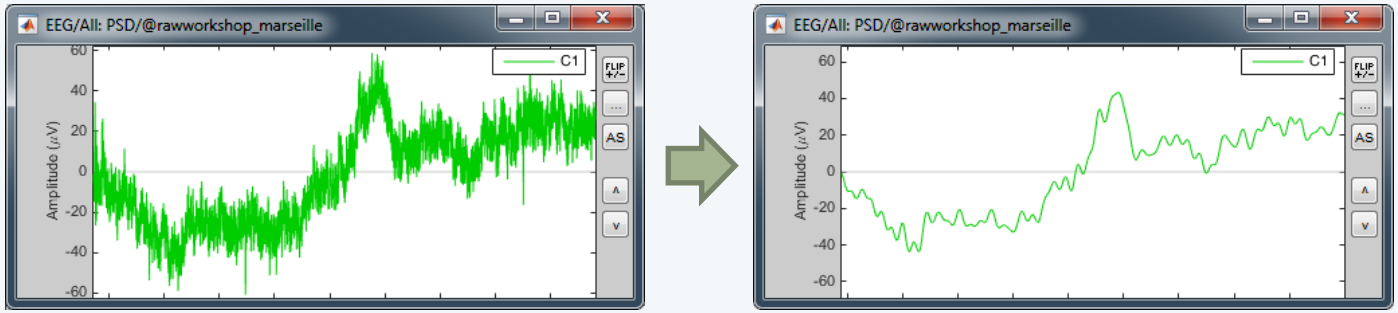
- **High-pass filter**: Removes slow components (eye movements, breathing, sensor drifts…)



- **Low-pass filter**: Remove high-frequencies components



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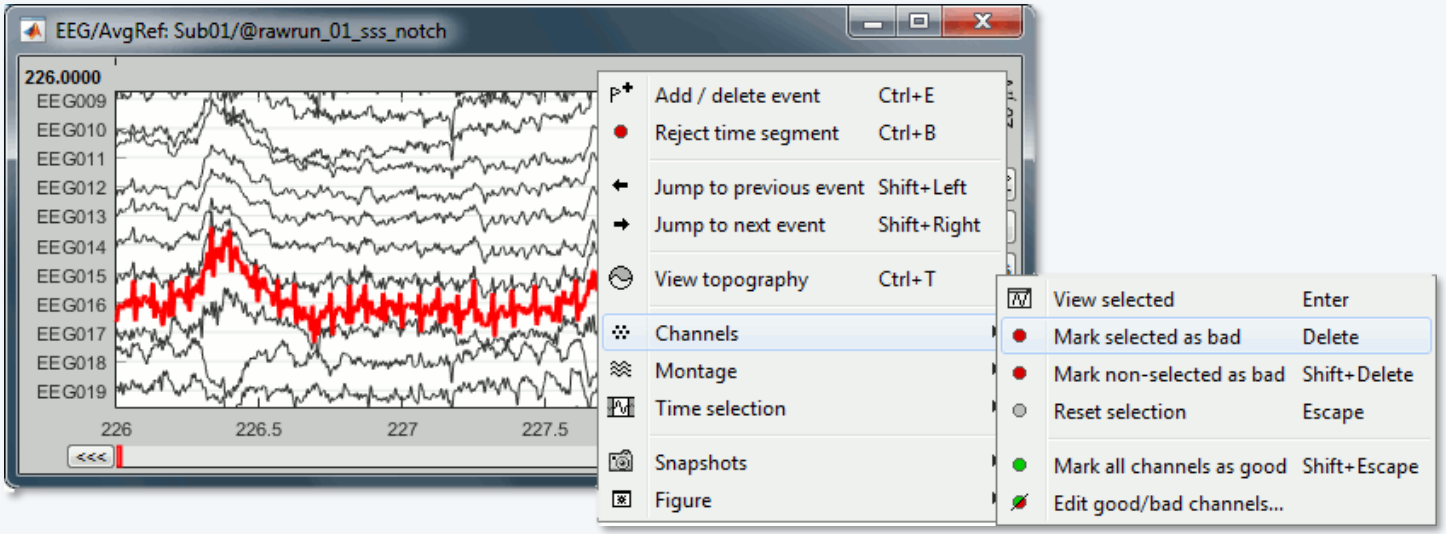
- Manual inspection of the recordings
- Interactive selection of bad channels
- Re-reference the EEG if necessary (Average ref)



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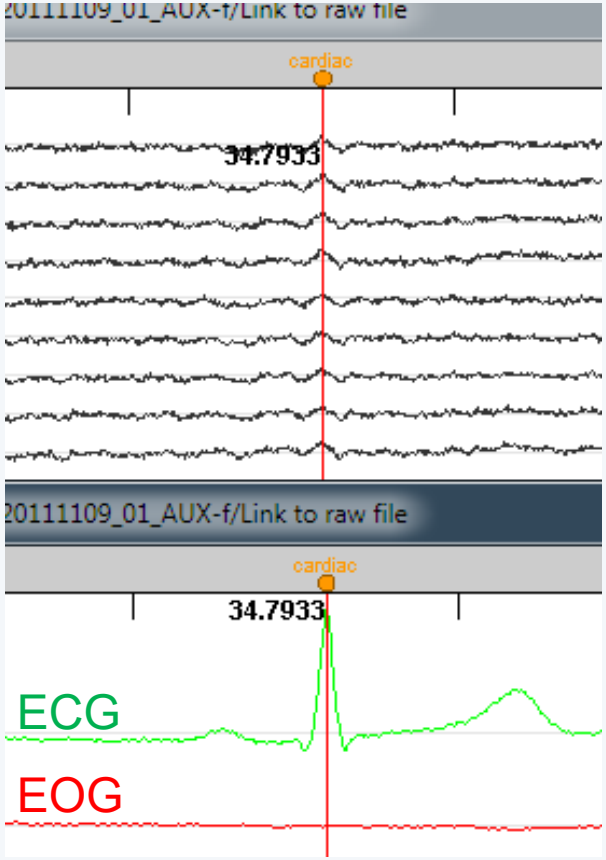
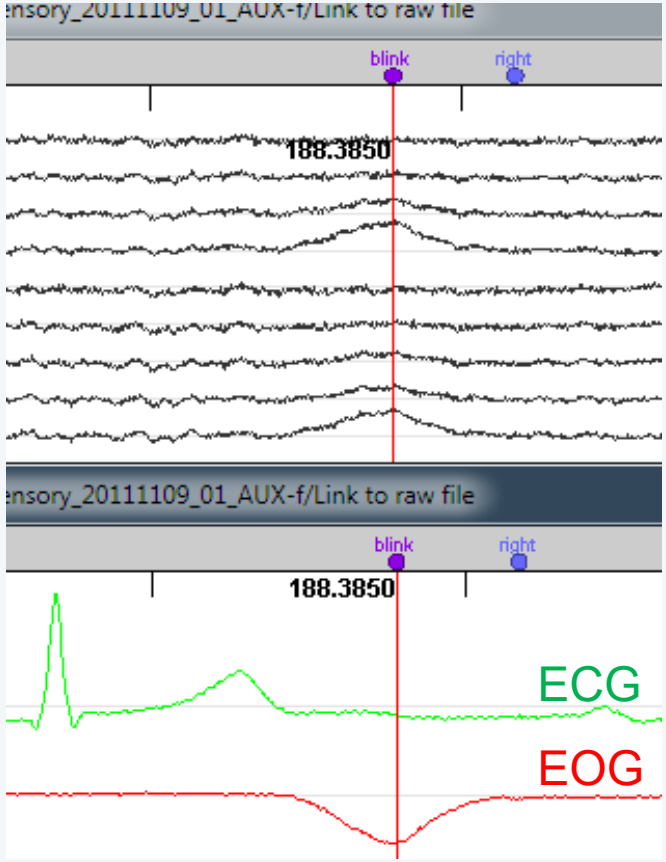
- Automatic detection of blinks and heartbeats (peak detection, or explicit amplitude threshold)





Brainstorm

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**

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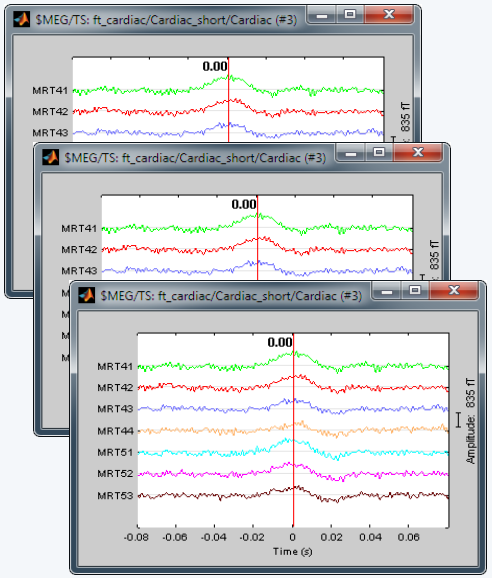
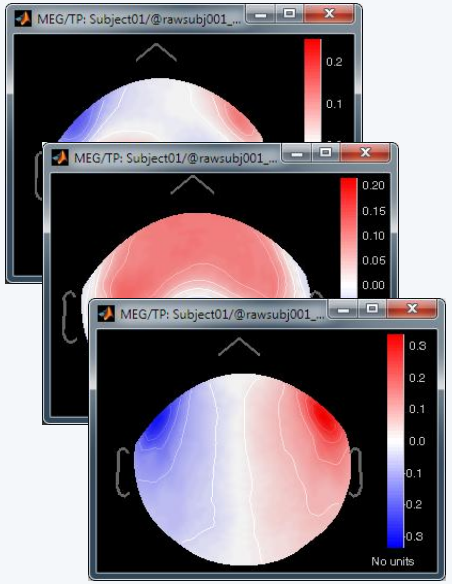
- Correction with Signal Space Projections (SSP)

Detect artifacts



PCA

Spatial components



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

Brainstorm

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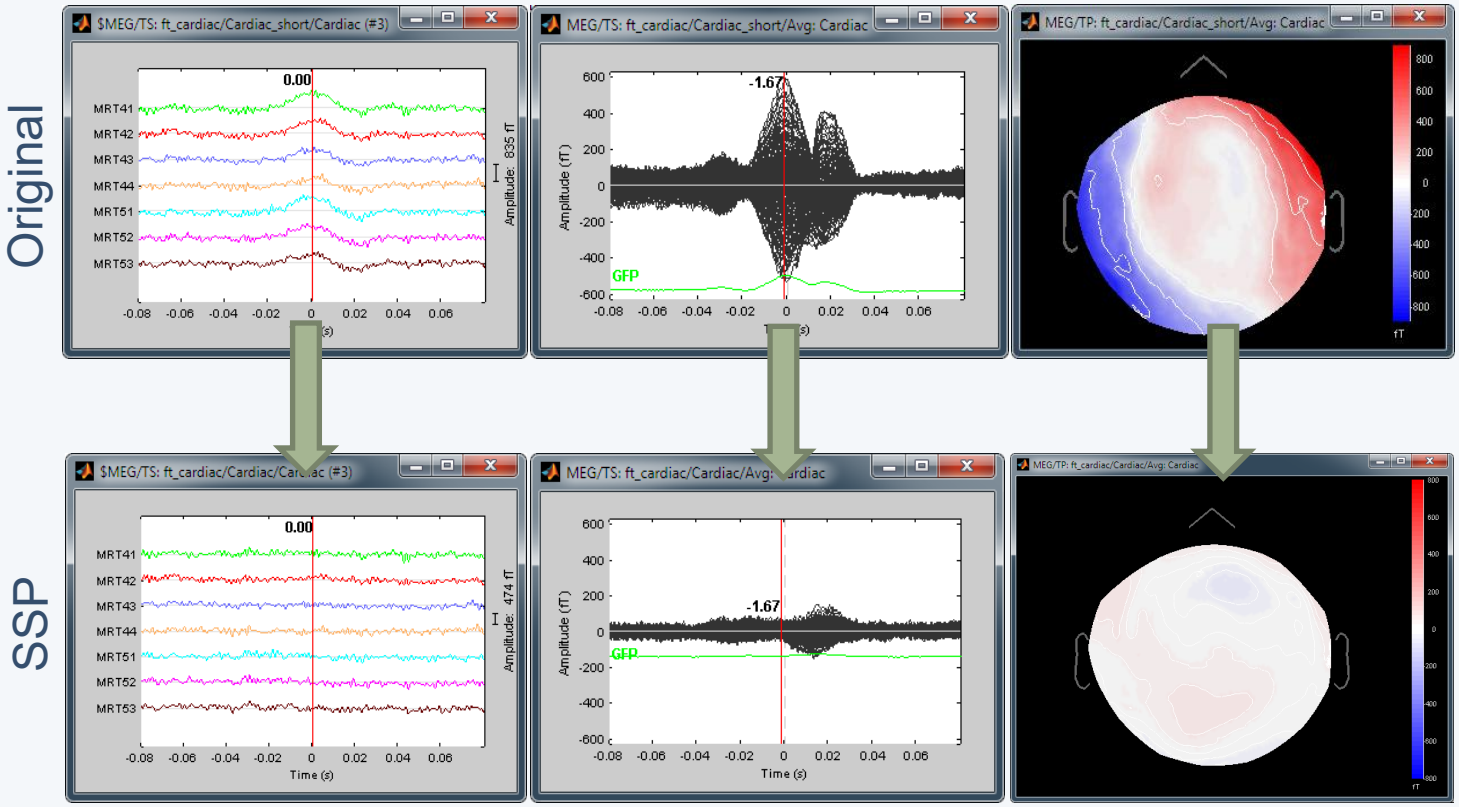
- Example: Cardiac artifact



Brainstorm

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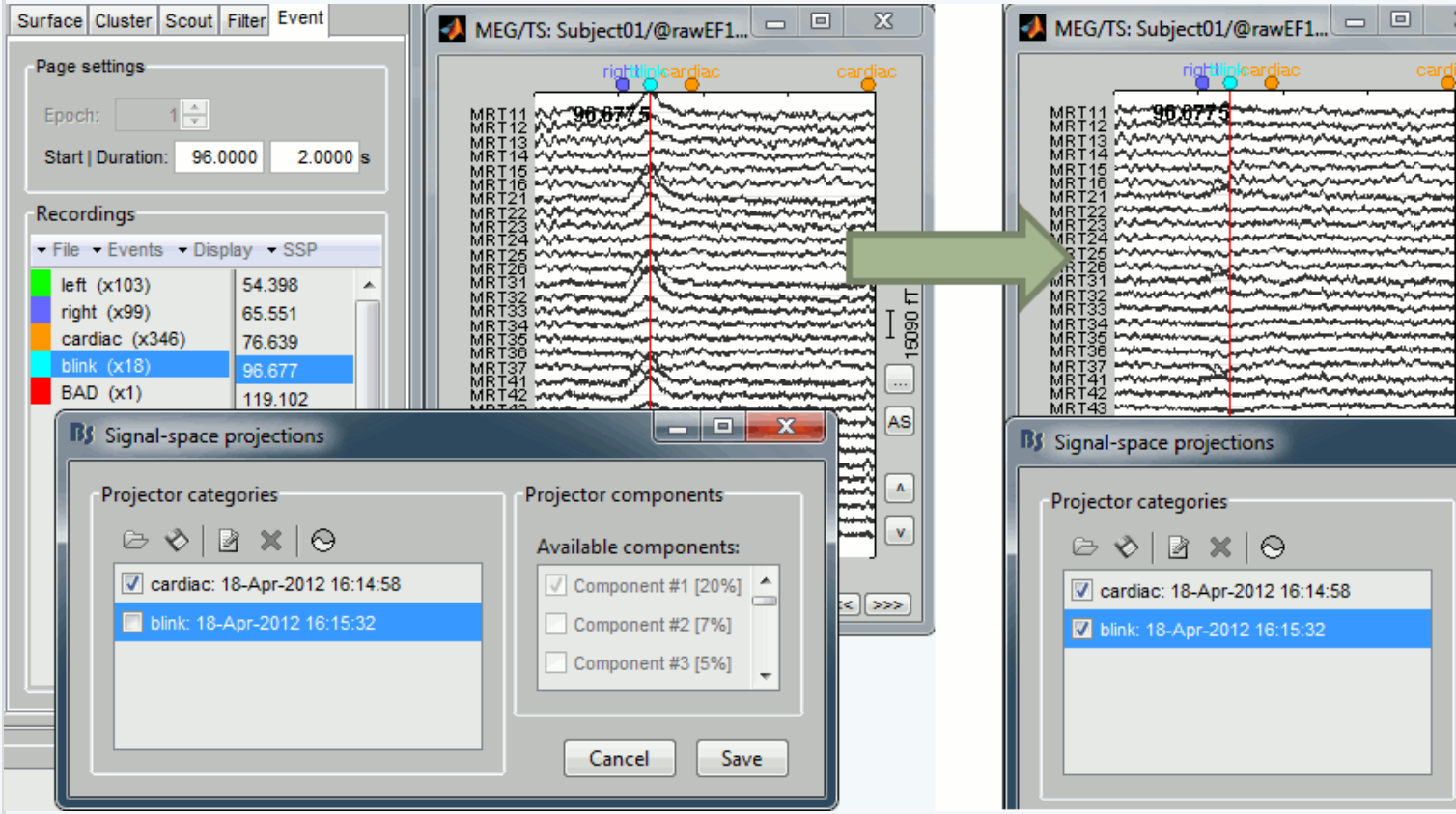
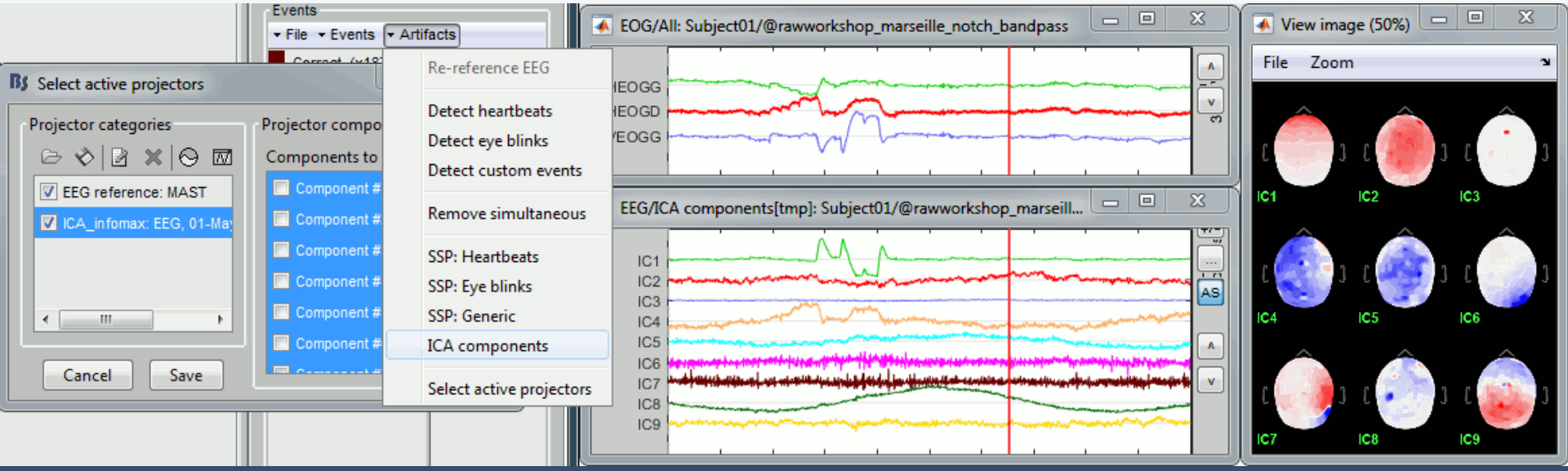
- Example: Blink



Brainstorm

Pre-processing

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



Brainstorm

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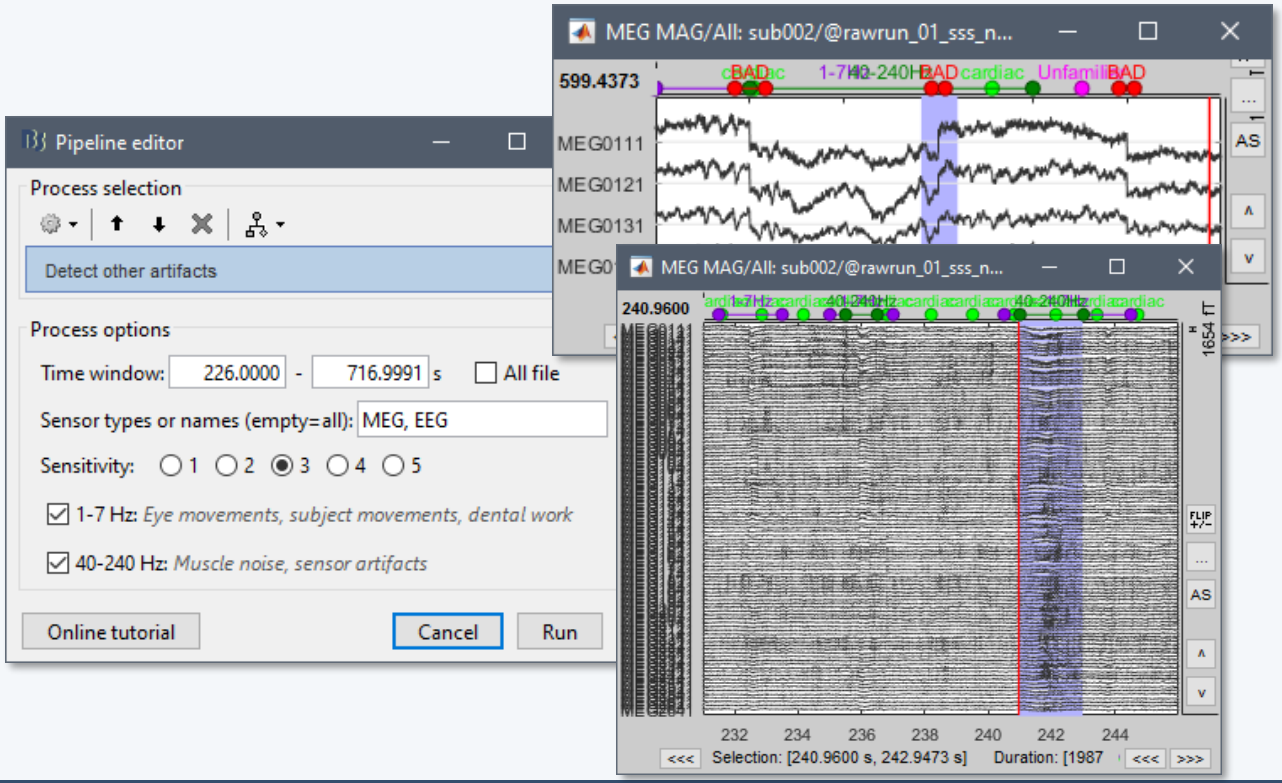
- Automatic detection of artifacts (RMS-based)
- Manual screening of all the recordings is advised (scroll all the sensors by pages of 10-20s)
- Exclude: Blinks, movements, SQUID jumps



Brainstorm

Epoching

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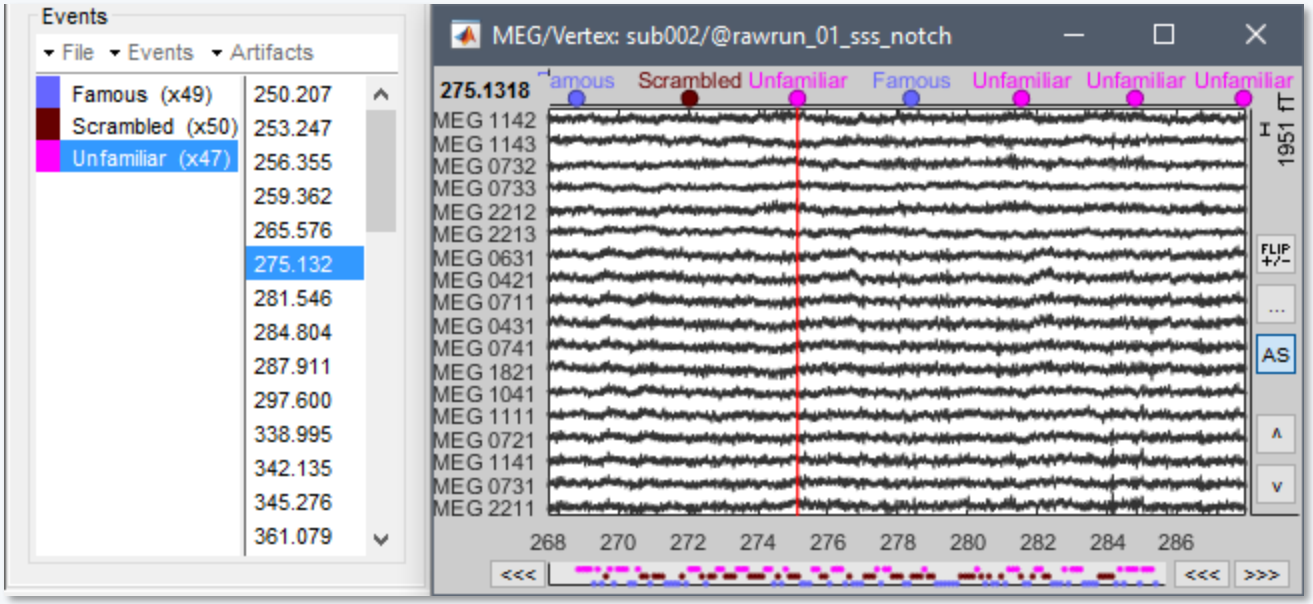
Markers
Presentation
Sensor
Manual

- Two types of experiments:
  - Steady-state or resting-state (ongoing activity)
  - Event-based (stimulus, response, spike…)

- How to get event markers in the recordings?



Brainstorm

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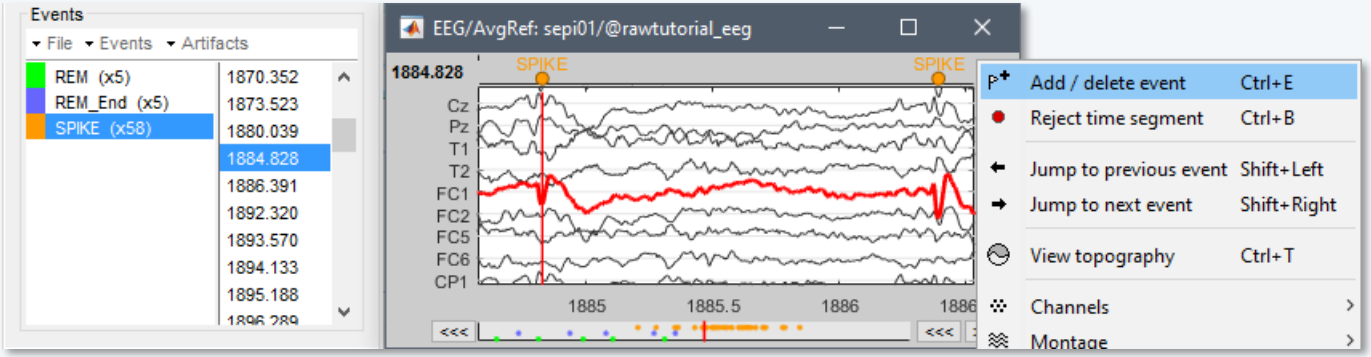
- Reading the triggers save by the recording/presentation software
- Reading information recorded on the subject side (photodiode, microphone, response box)
- **Manual or automatic marking of biological or behavioral events, post-acquisition (*epileptic spikes, sleep spindles*, rat position in a box…)**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



Brainstorm

Epoching

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Epoching
Combine
Extract
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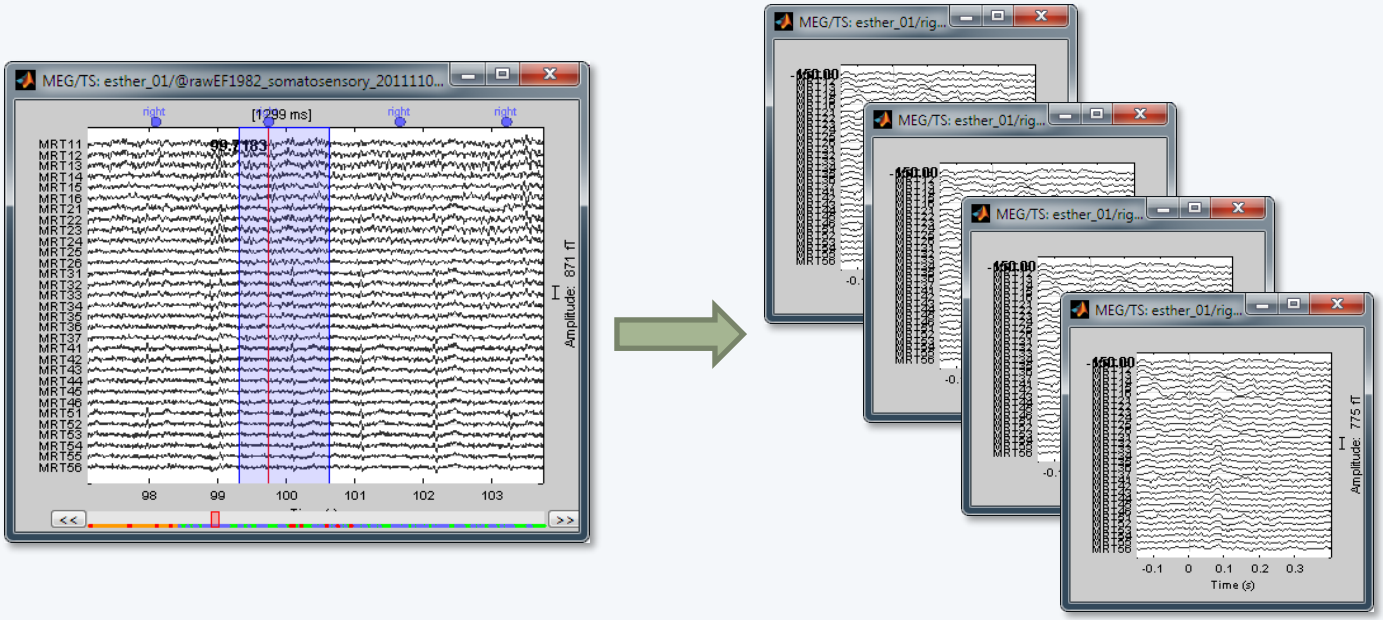
Process

- Epochs = Trials = **Short blocks of recordings around an event of interest (spikes, trigger, …).**
- Epoching = Extracting epochs from the continuous recordings and saving them.



Brainstorm

Epoching

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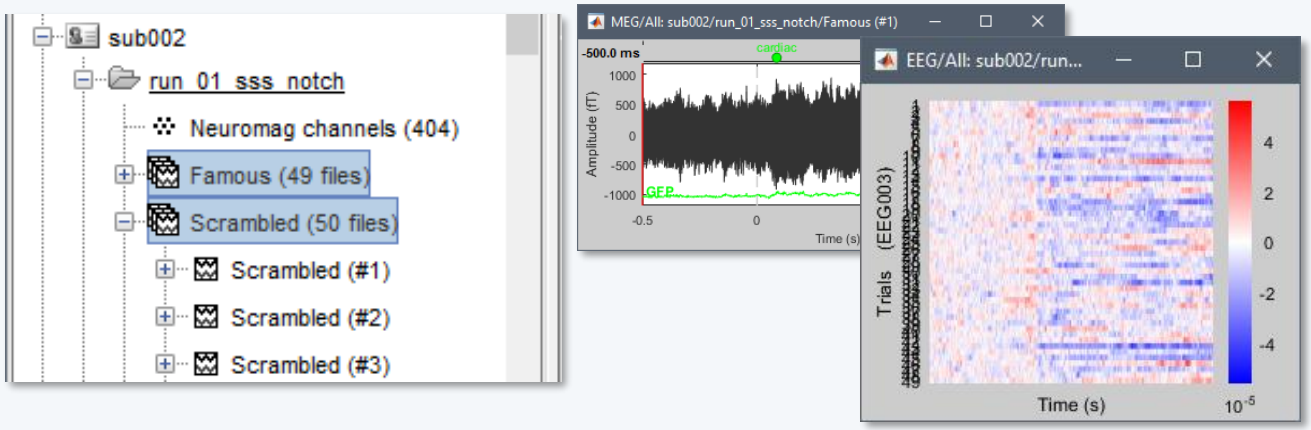
- In Brainstorm, each imported epoch is an independent file in the database.
- Accessible by event type or individually.



- 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).

Brainstorm

Epoching

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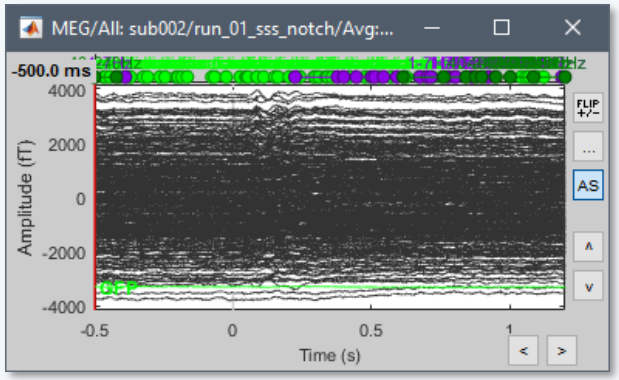
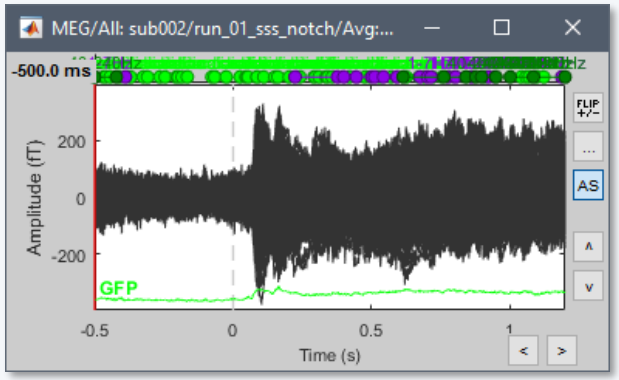
- Processing steps that can be applied on epochs:
  - **DC offset correction**: Subtract the average estimated over a baseline period
  - **Detrending**: Subtract a linear trend estimated over a reference period
  - **Resampling**: Decrease the sampling rate
- This dataset: DC correction, baseline=[-500,0]ms





Brainstorm

Sensor level analysis

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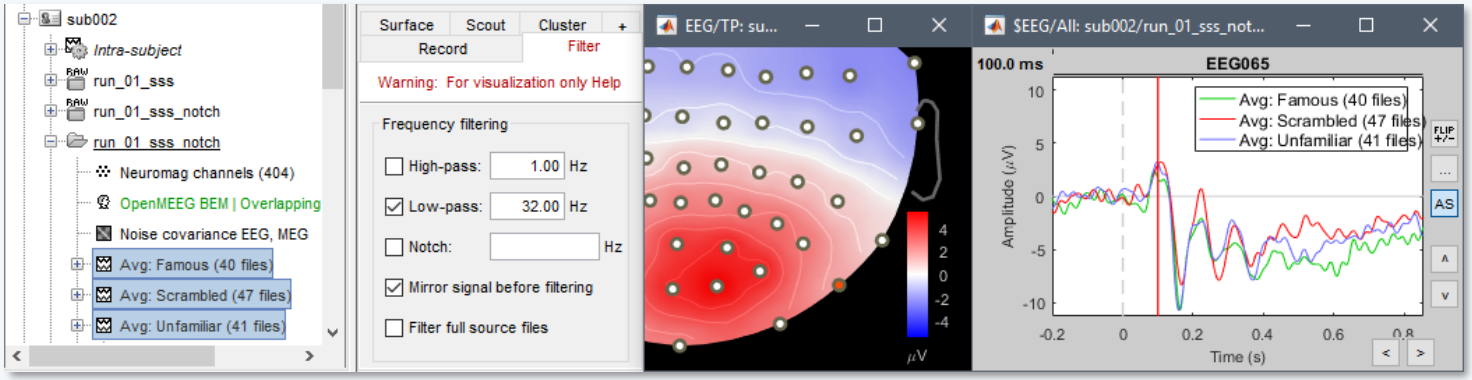
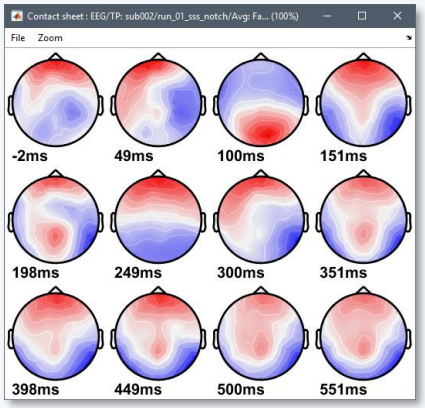
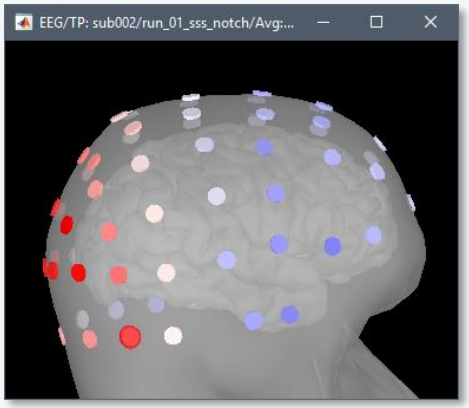
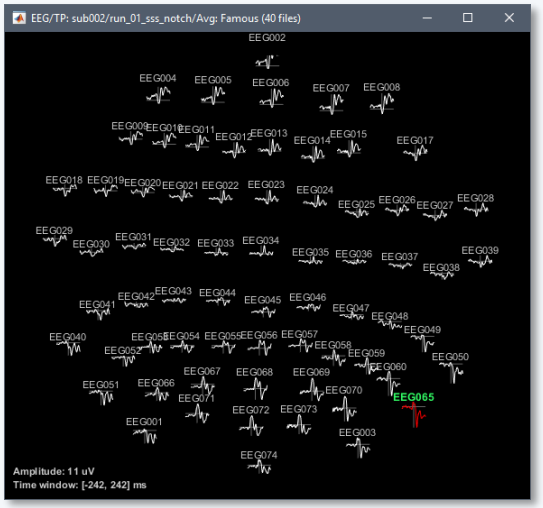
- ERP & Sensor Cluster









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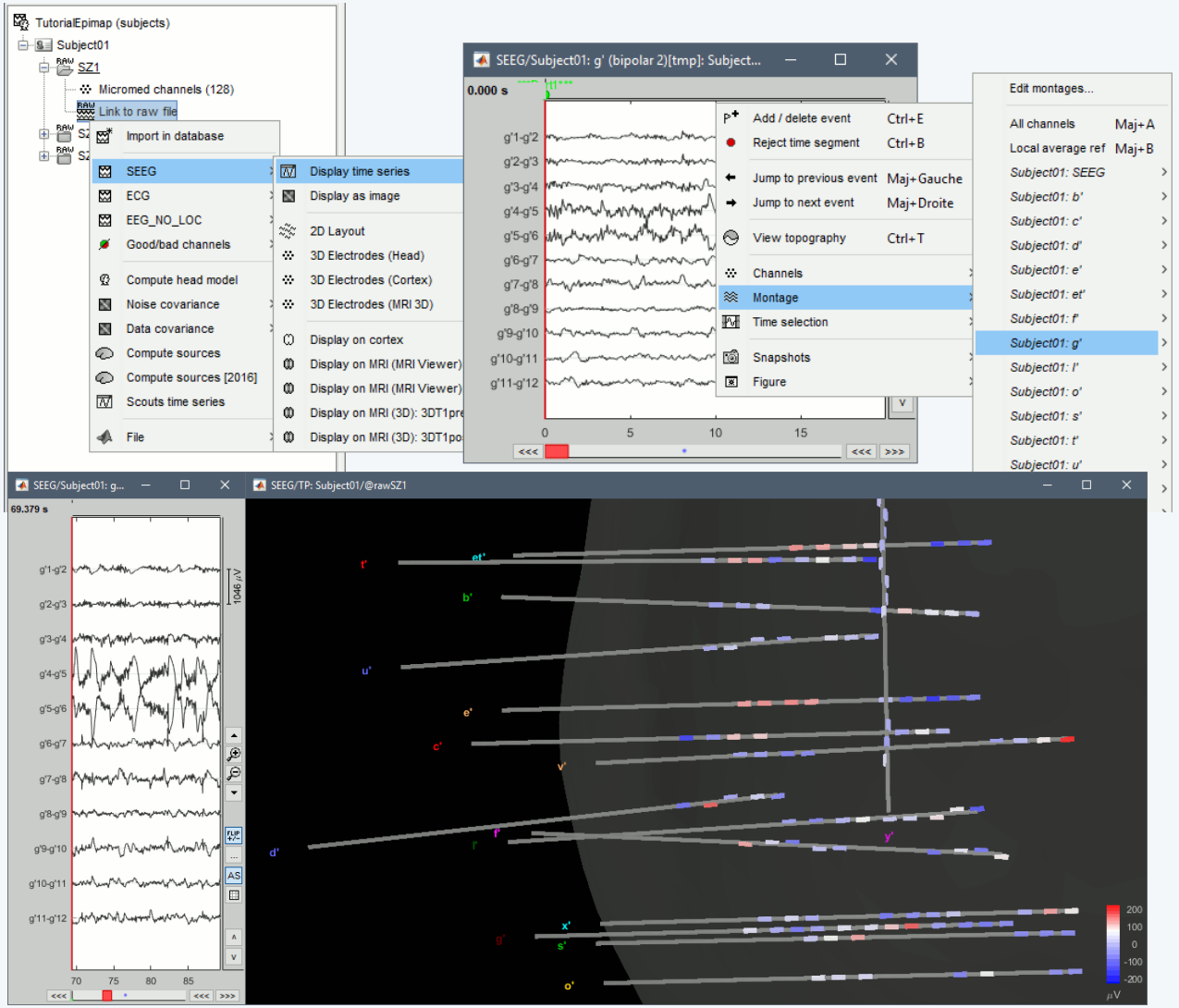
- SEEG time series & Montages



Sensor level analysis

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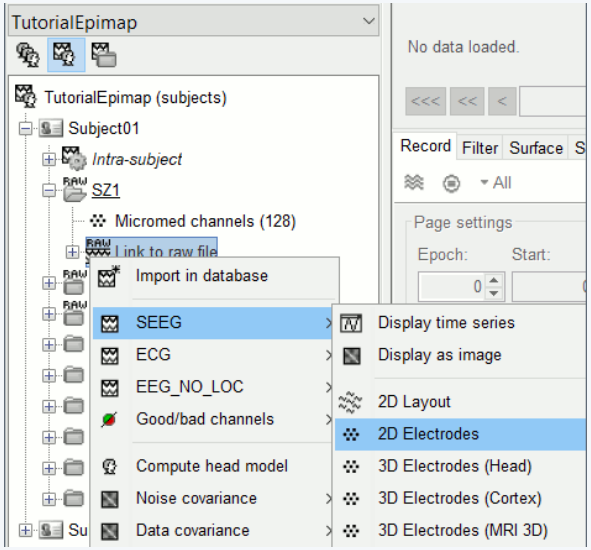
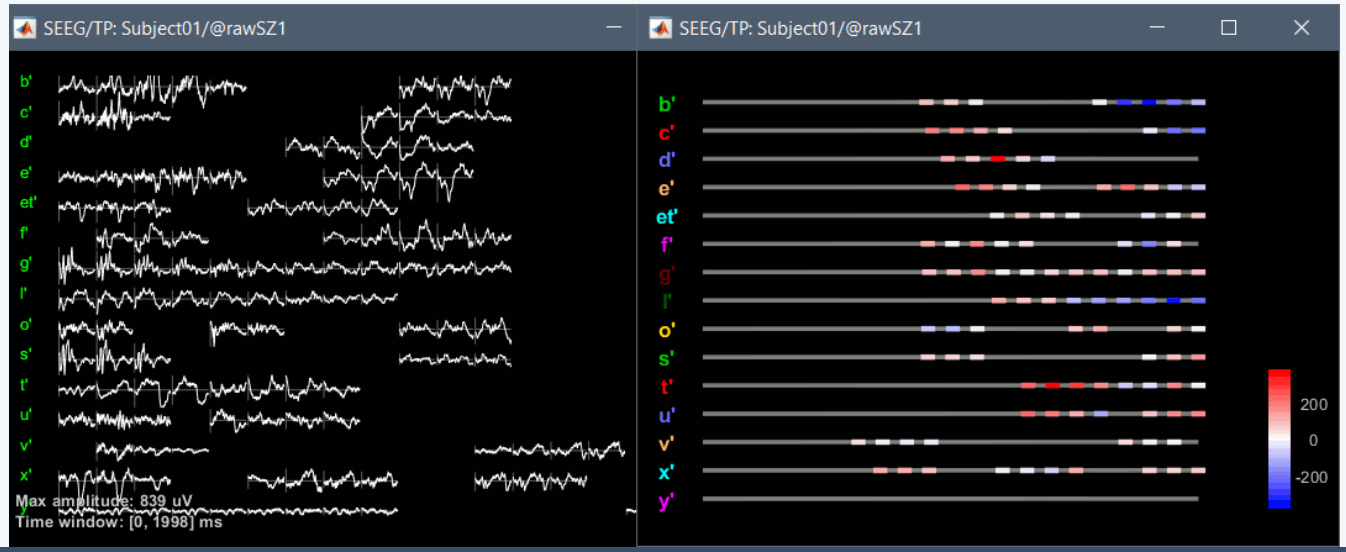
- SEEG time series : 2D topography





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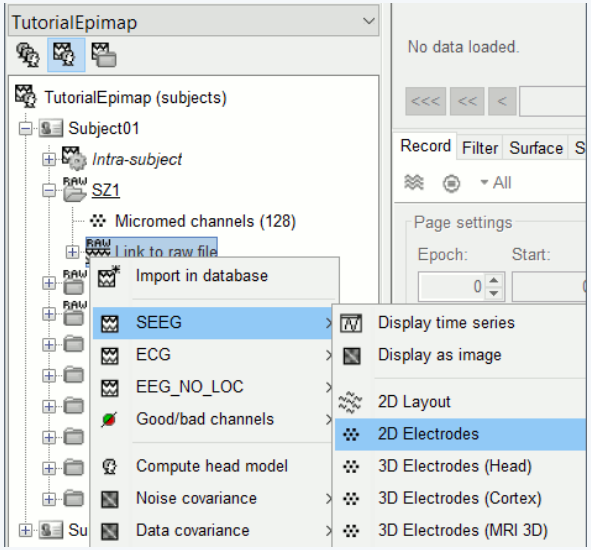
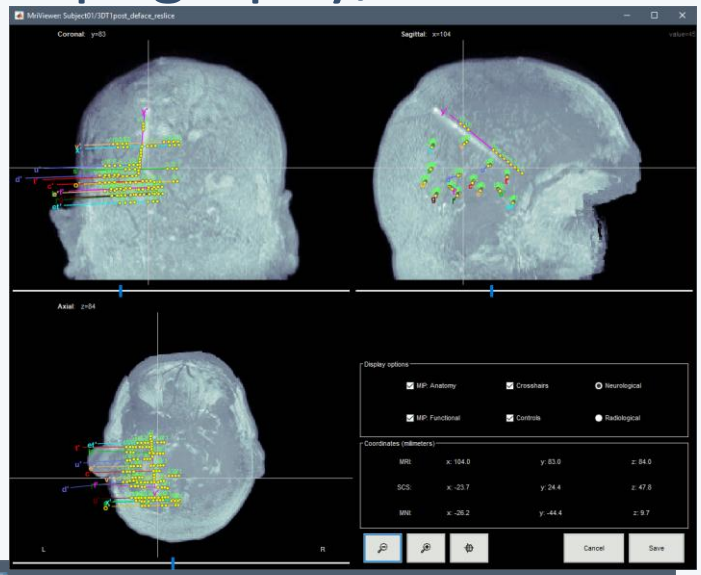
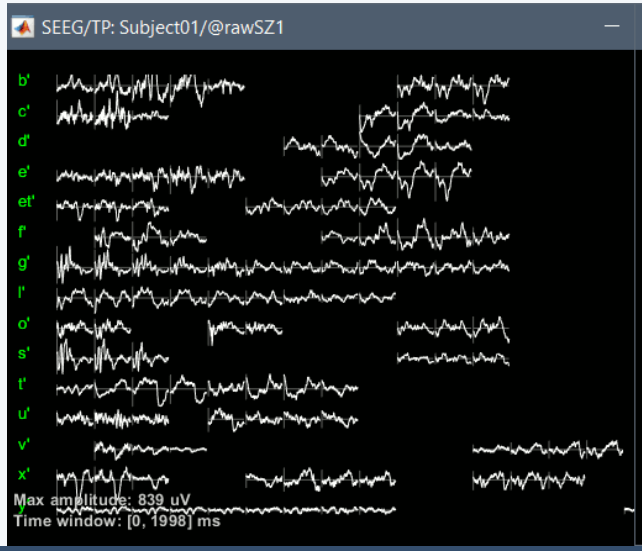
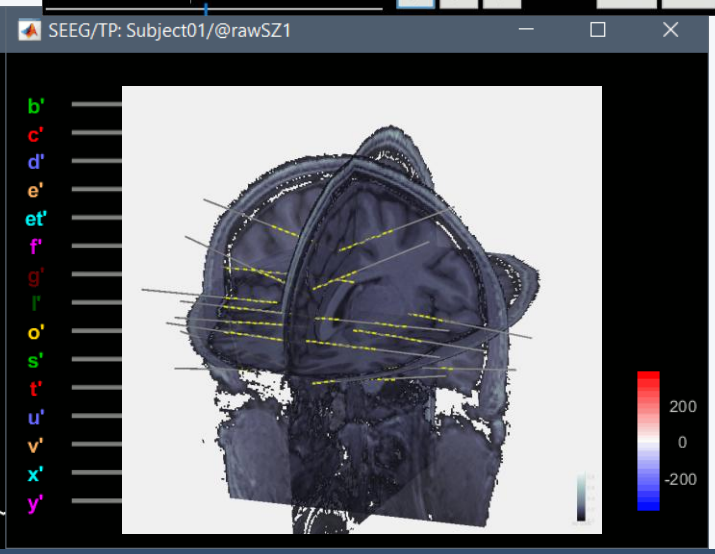
- SEEG time series : 2D topography/ 3D









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Sensor level analysis

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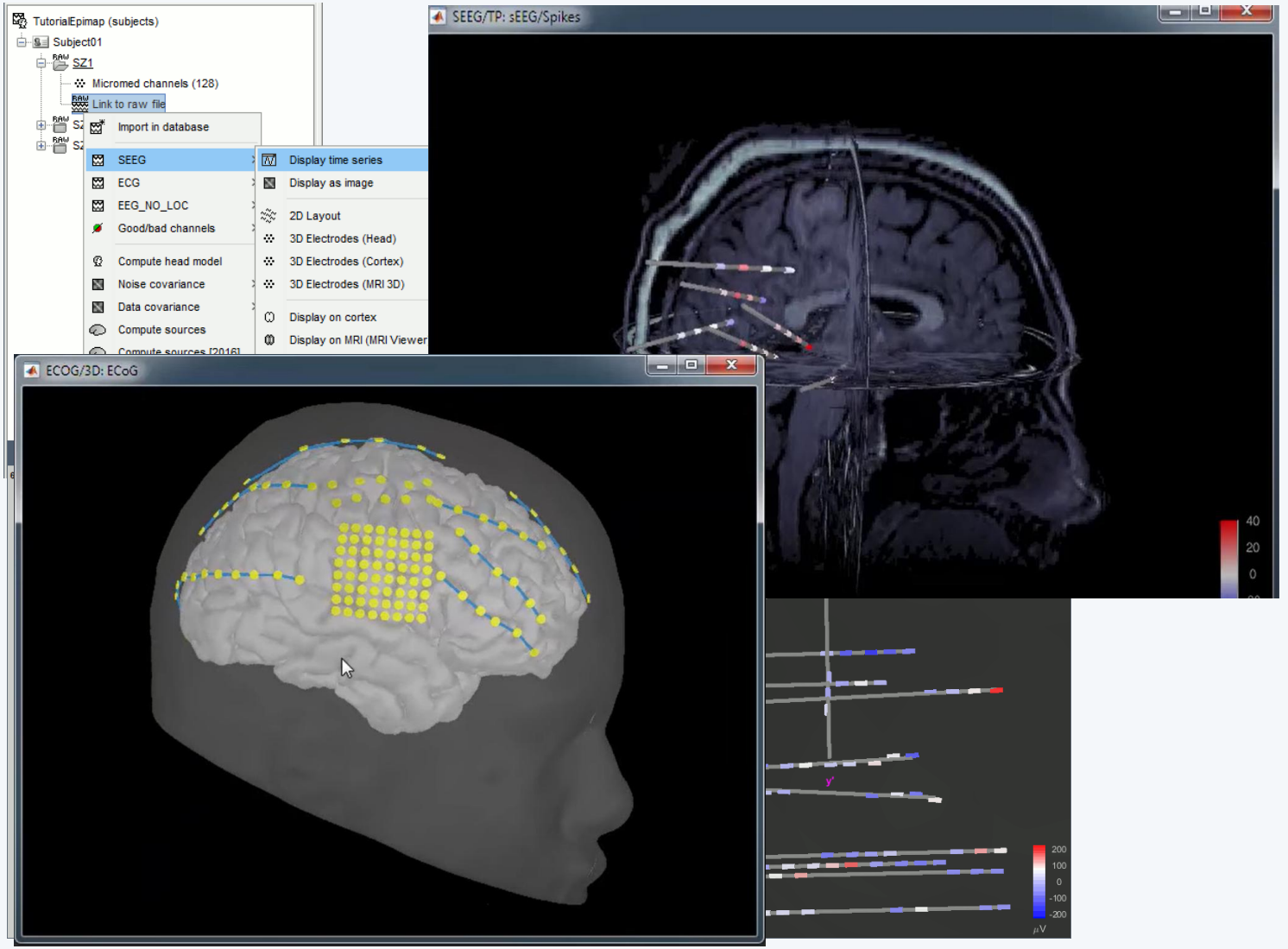
- ECOG also supported …



Brainstorm

Video-EEG/sEEG: Synchronization

- EEG recordings and epileptogenicity maps can be reviewed with synchronized video… when available

Brainstorm

Some references -sEEG-

- Good Coverage is Important!

Epilepsy Research 128 (2016) 68–72

Contents lists available at www.sciencedirect.com

Epilepsy Research

journal homepage: www.elsevier.com/locate/epilepsyres

Short communication

Simultaneous SEEG-MEG-EEG recordings Overcome the SEEG limited spatial sampling

Martine Gavaret[a,b], Anne-Sophie Dubarry[a,c], Romain Carron[a,d], Fabrice Bartolomei[a,b], Agnès Trébuchon[a,b,1], Christian-George Bénar[a,*,1]

NeuroImage 260 (2022) 119438

Contents lists available at ScienceDirect

NeuroImage

journal homepage: www.elsevier.com/locate/neuroimage

Advances in human intracranial electroencephalography research, guidelines and good practices

Manuel R. Mercier[a,*], Anne-Sophie Dubarry[b], François Tadel[c], Pietro Avanzini[d], Nikolai Axmacher[e,f], Dillan Cellier[g], Maria Del Vecchio[d], Liberty S. Hamilton[h,i,j], Dora Hermes[k], Michael J. Kahana[l], Robert T. Knight[m], Anais Llorens[n], Pierre Megevand[o], Lucia Melloni[p,q], Kai J. Miller[r], Vitória Piai[s,t], Aina Puce[u], Nick F Ramsey[v], Caspar M. Schwiedrzik[w,x], Sydney E. Smith[y], Arjen Stolk[s,z], Nicole C. Swann[aa], Mariska J Vansteensel[v], Bradley Voytek[g,y,ab,ac], Liang Wang[ad,ae], Jean-Philippe Lachaux[af,1], Robert Oostenveld[s,ag,1]

Excellent Reference Paper on Good Practices

HUMAN BRAIN MAPPING Open Access

Research Article | Free to Read

sLORETA allows reliable distributed source reconstruction based on subdural strip and grid recordings

Matthias Dümpelmann, Tonio Ball, Andreas Schulze-Bonhage

First published: 26 May 2011 | https://doi.org/10.1002/hbm.21276 | Citations: 44

Source Reconstruction

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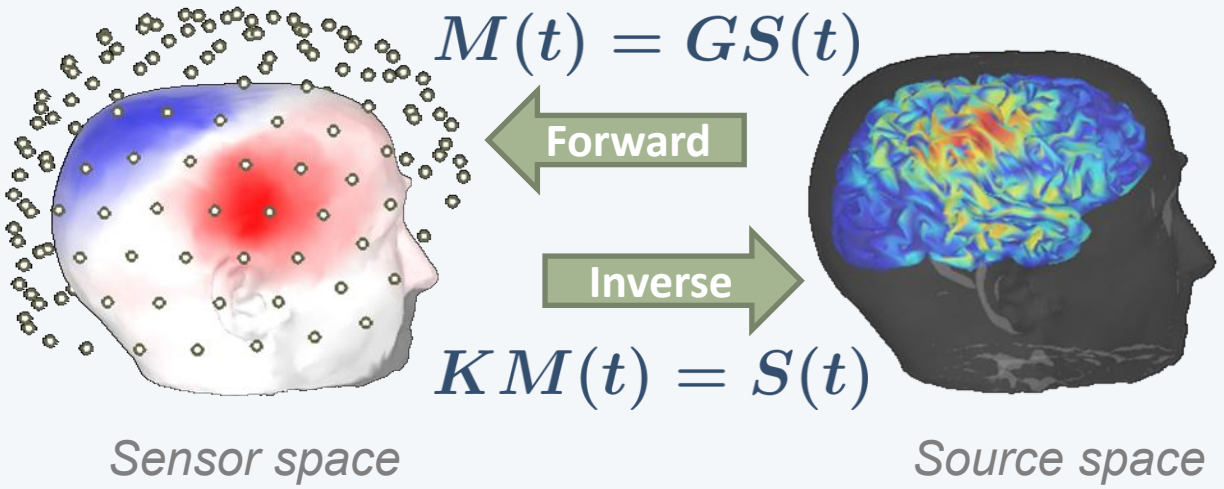
$M(t)$ Sensor space: EEG or MEG sensors

$S(t)$ Source space: Cortex or full head volume

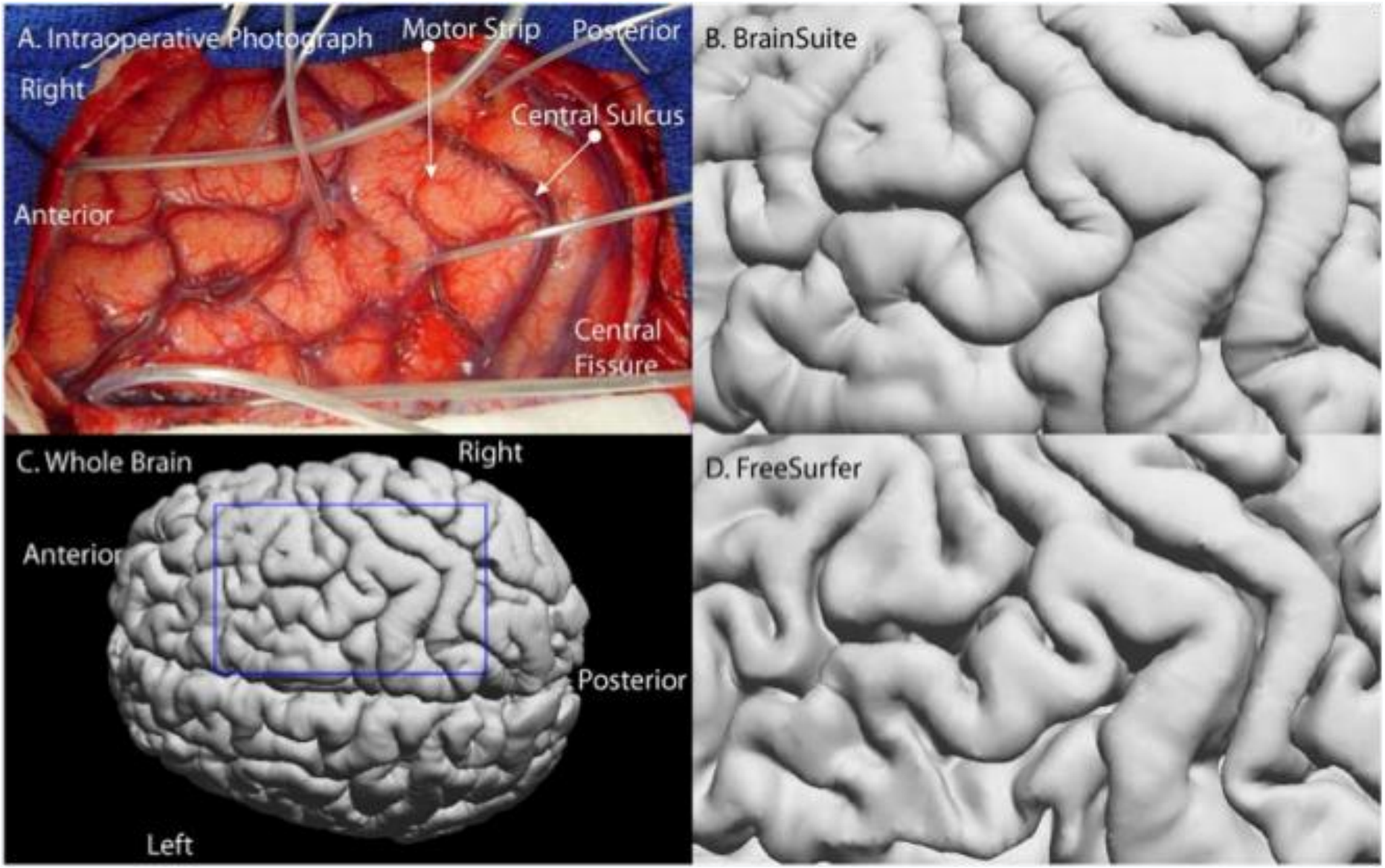
G Forward model: Overlapping spheres (MEG)
OpenMEEG BEM/DUNEuro FEM (EEG)

K Inverse model: **Minimum norm estimates**
Beamformers



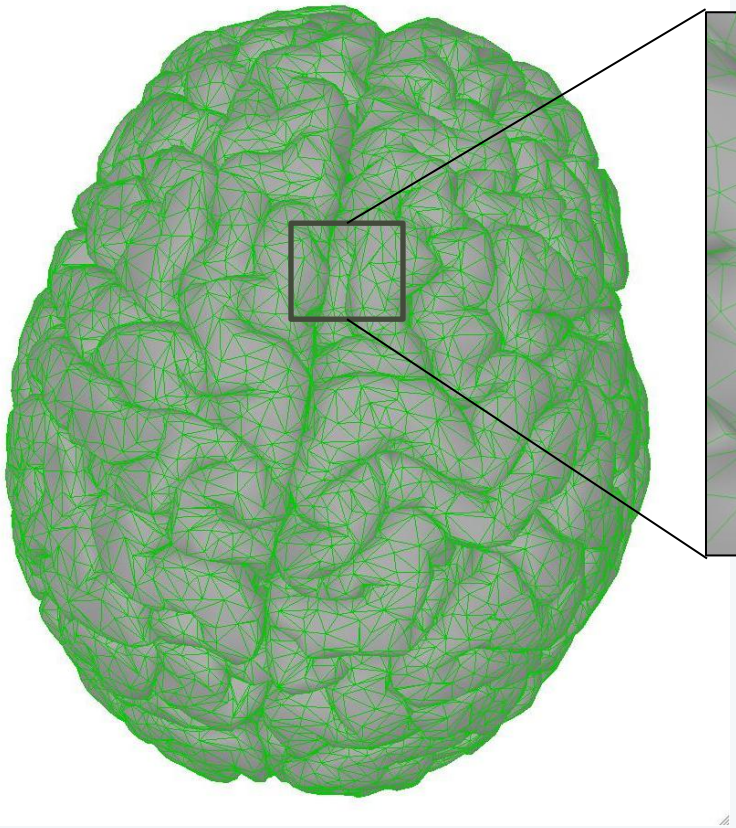
Brainstorm

Source Space: Cortical Surface (MRI Segmentation)



Brainstorm

Cortical Surface: Modeling of sources



Thousands of triangles & vertices

~250k labeled vertices spanning 192,152 square mm

Brainstorm:
15,000 vertex for cortex model

Each Vertex Models an ~1 square mm Cortical Column

Columns are nominally radial (gyri), tangential (sulci), or some combination.

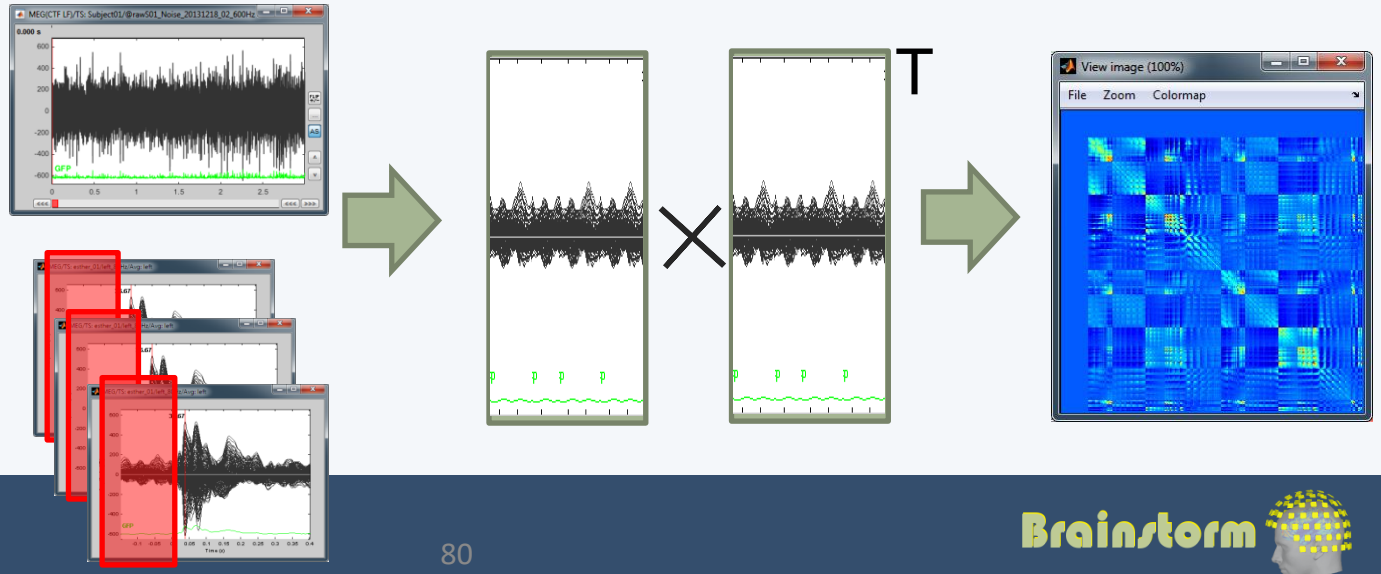
Noise covariance

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, …



Brainstorm

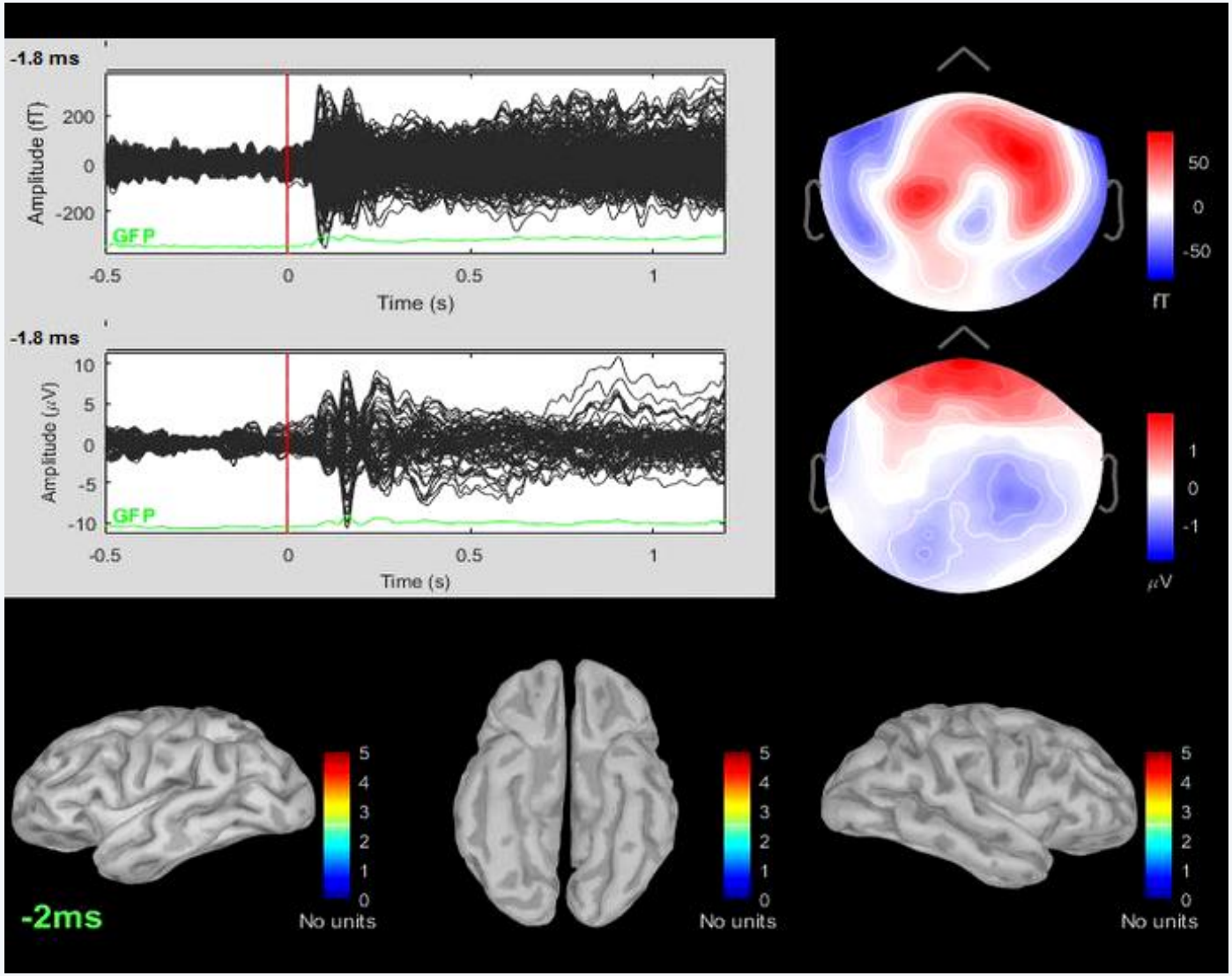
Source level analysis

Anatomy
Link recordings
MRI registration

PSD
Filters
Bad channels
Artifacts
Correction
Bad segments

Markers
Epoching
Averaging
Sources
Time-frequency

Example: Famous faces



Brainstorm

Source level analysis

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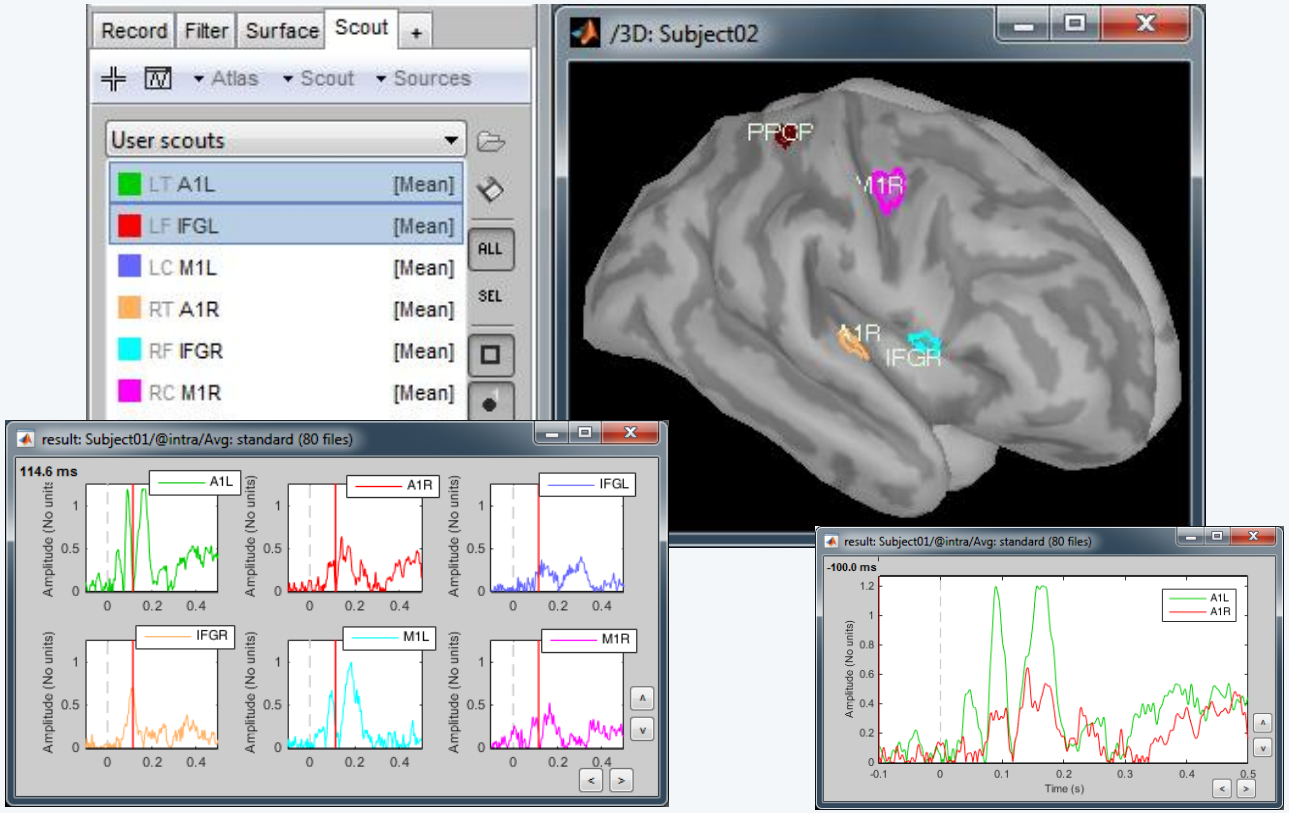
Time-frequency

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



Brainstorm

Source level analysis

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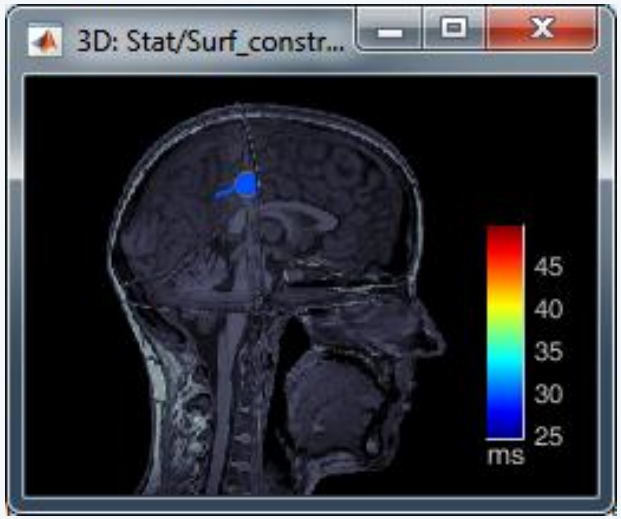
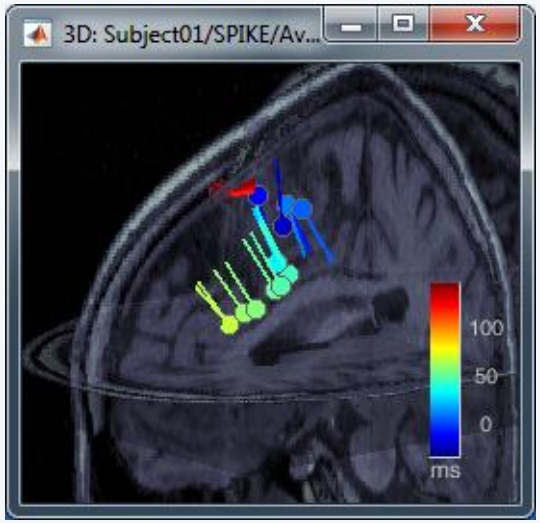
Sources
Time-frequency

- Dipole scanning
  Compute a distributed source model, then find the most significant dipole at each time sample.
- Dipole fitting (FieldTrip)
  Non-linear search of the dipoles that minimizes the residuals (data explained - recordings)





Source level analysis

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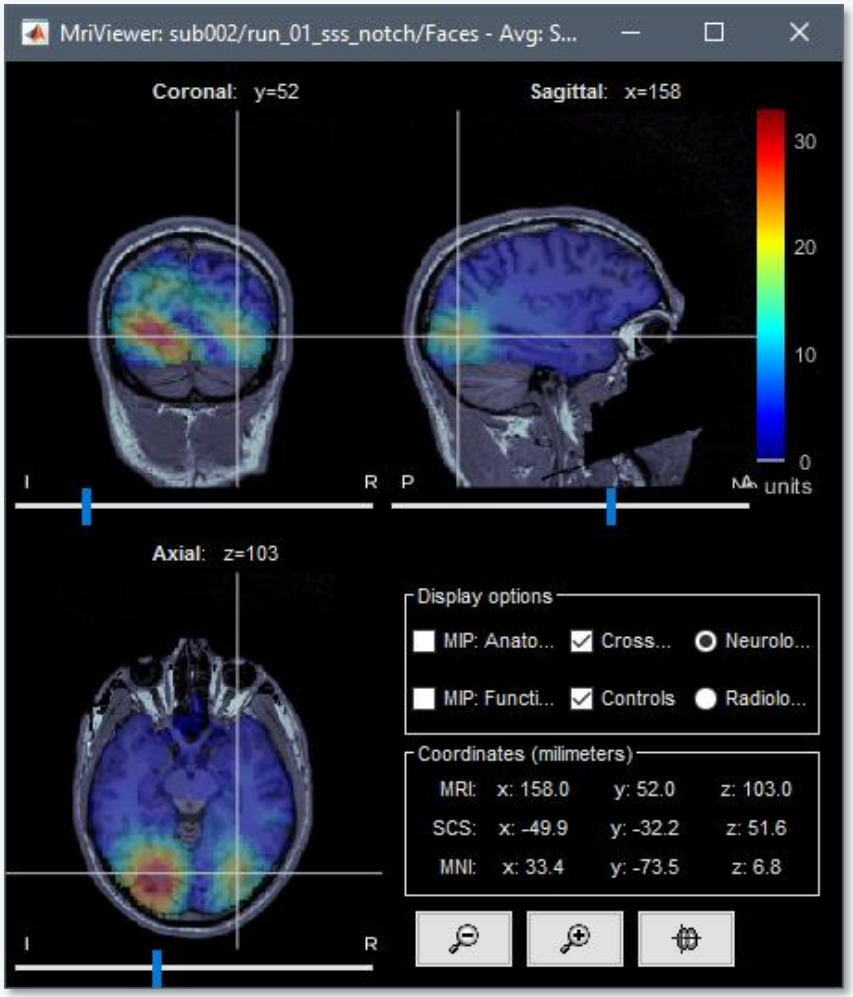
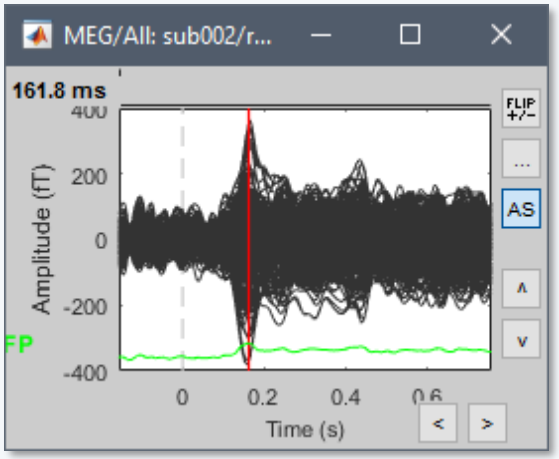
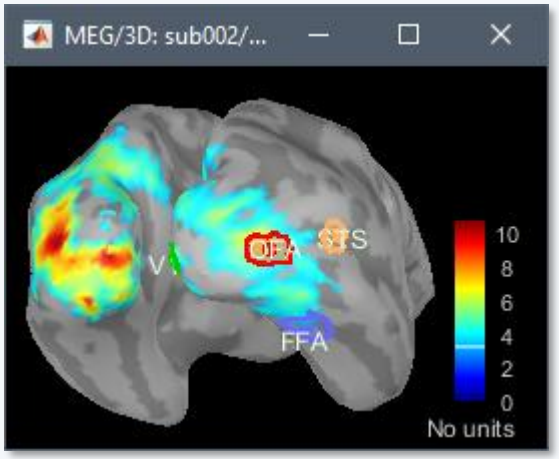
Sources
Time-frequency

- Volume Source







Brainstorm

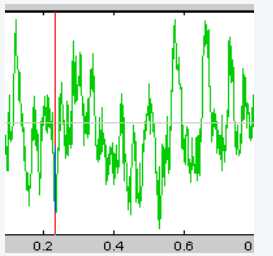
Time-frequency

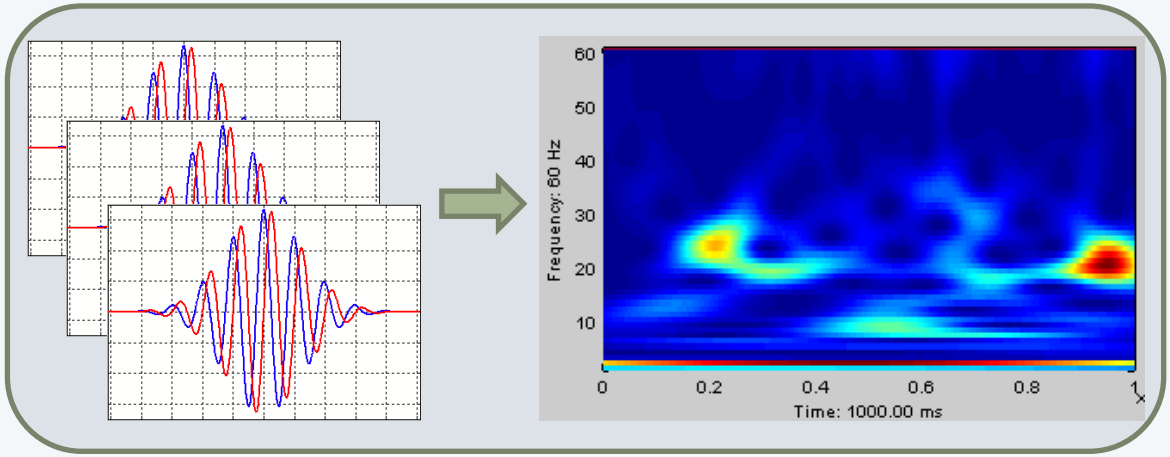
Anatomy
Link recordings
MRI registration

PSD
Filters
Bad channels
Artifacts
Correction
Bad segments

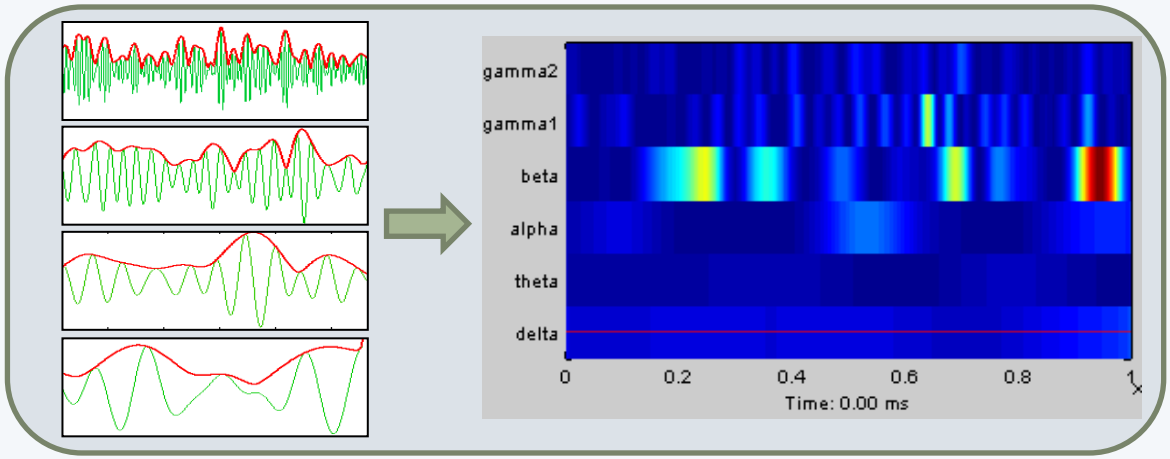
Markers
Epoching
Averaging
Sources
Time-frequency

Morlet wavelets



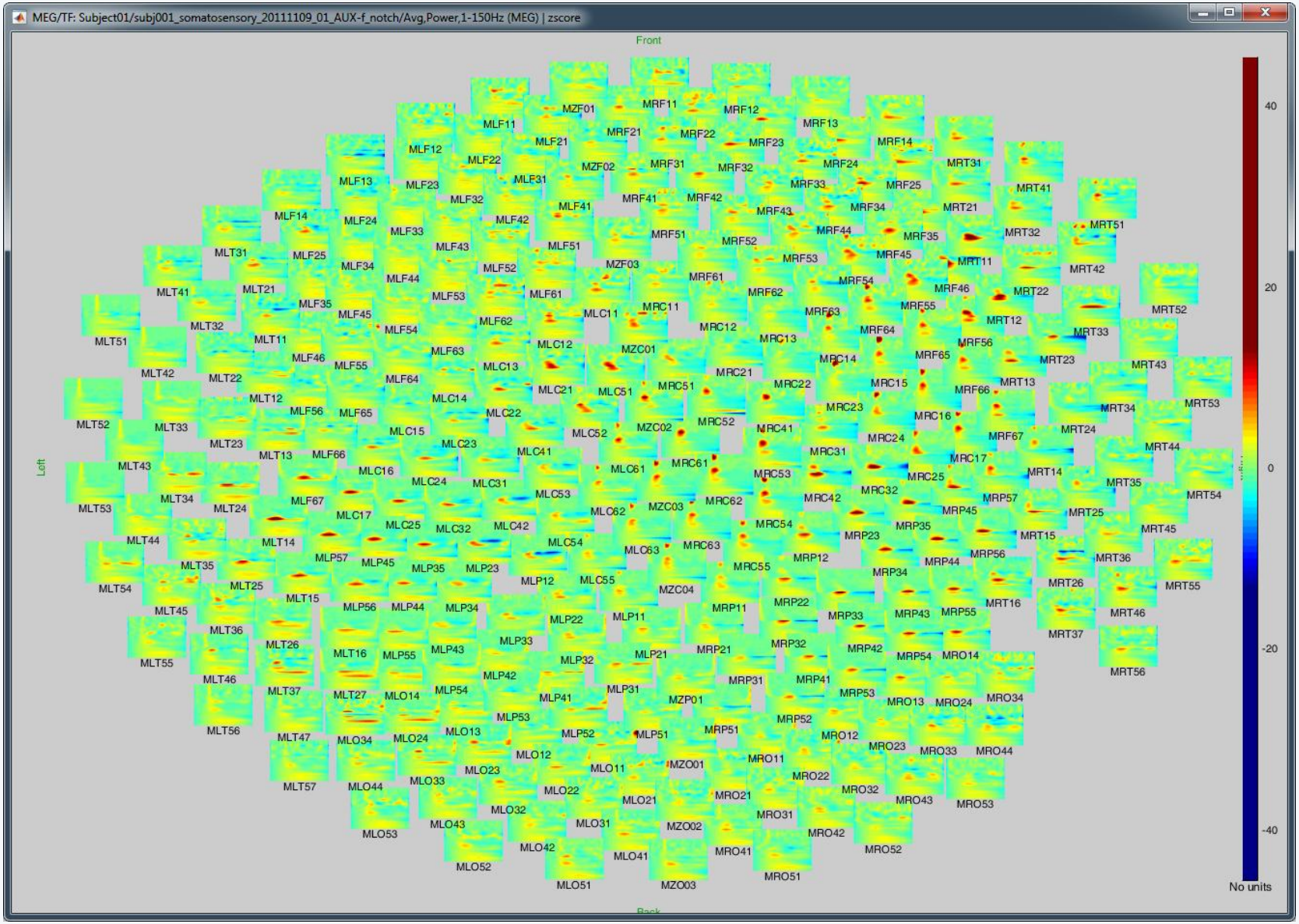


Hilbert transform + band-pass filter



Brainstorm

Time-frequency



Brainstorm

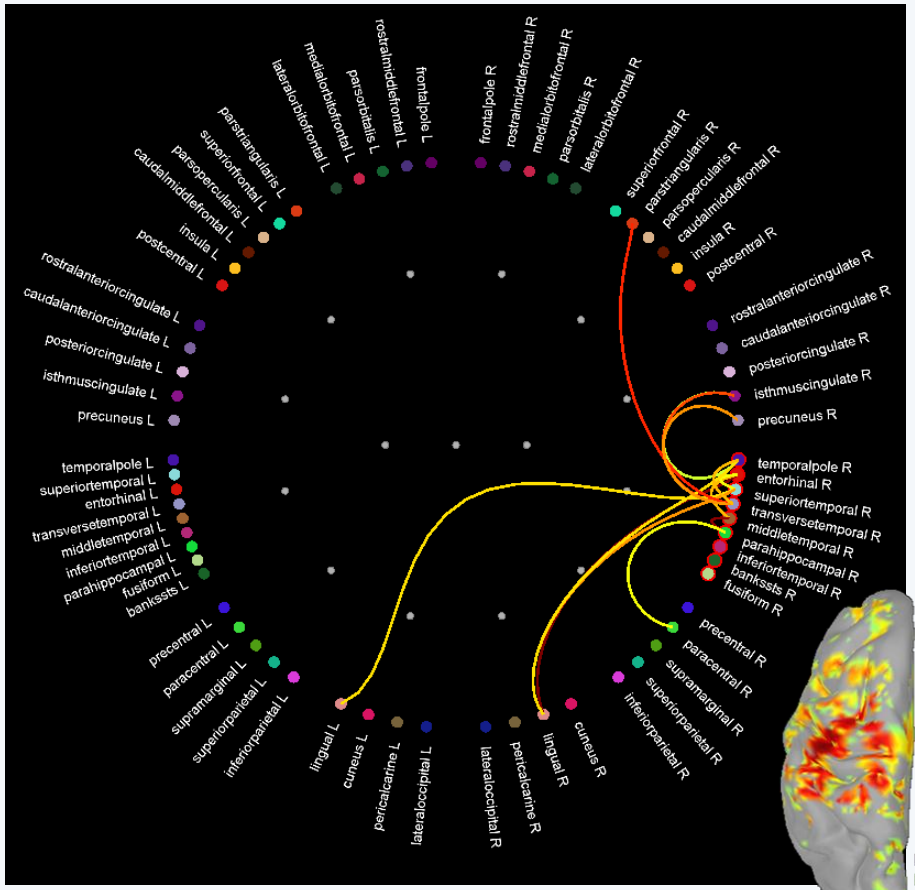
Other measures

Anatomy
Link recordings
MRI registration

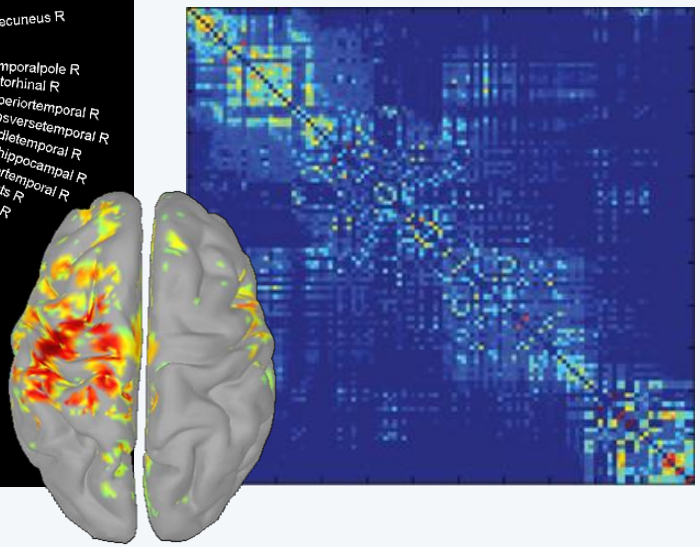
PSD
Filters
Bad channels
Artifacts
Correction
Bad segments

Markers
Epoching
Averaging
Sources
Time-frequency
Other measures

- Connectivity measures



- Correlation
- Coherence
- Phase locking value
- Granger causality



Brainstorm

Other measures

Anatomy
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MRI registration

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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

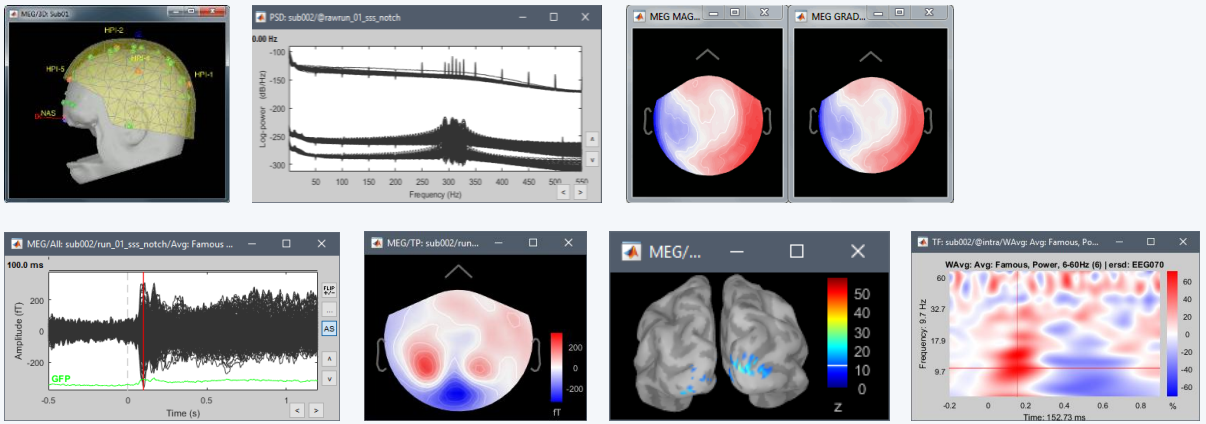
Quality control

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/sensor 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



Brainstorm

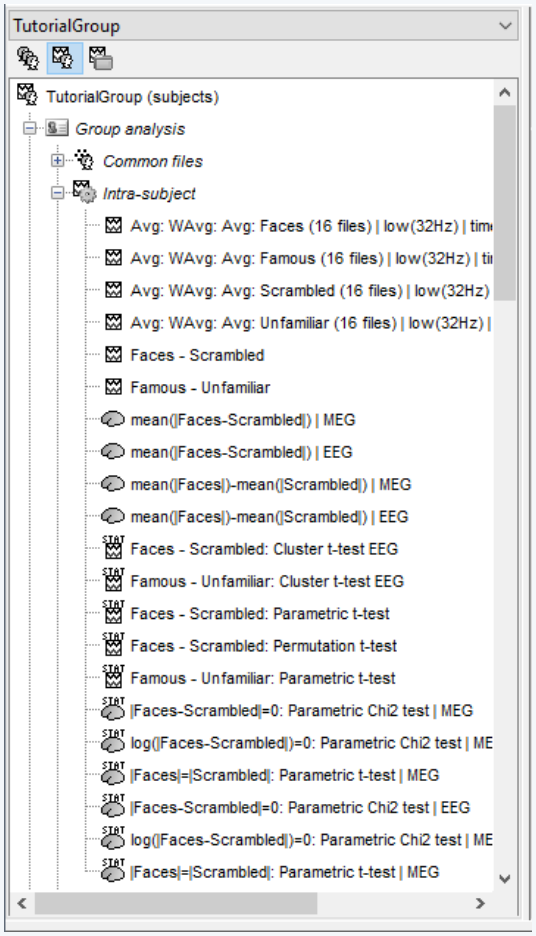
Quality control

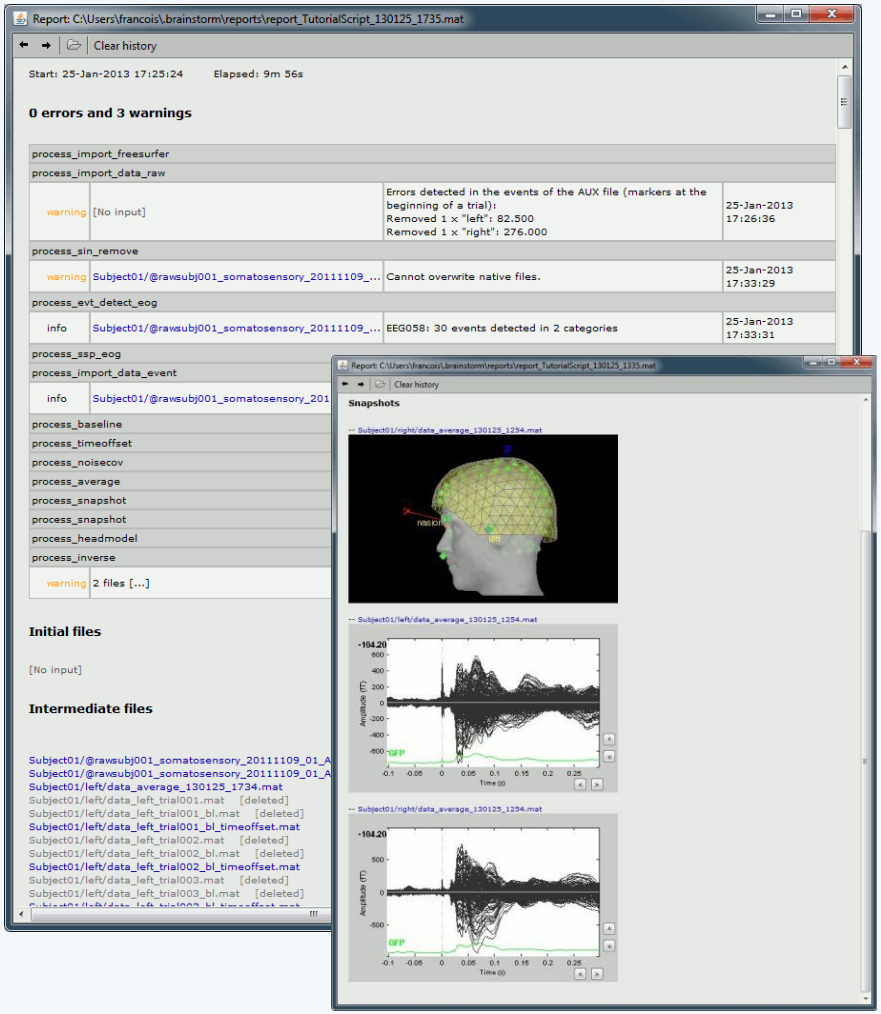
Subject averages
Low-pass
Normalize
Project

Group averages
Group statistics

Quality control
Workflow

- Execution reports with snapshots saved in HTML





Brainstorm

Add your code to Brainstorm

- Direct manipulation of the files in Matlab
- Use the menu “Run Matlab command”
- Write a plugin:
  - Well documented API
  - Lots of example (170 functions written as plugins)
  - Open-source GitHub repository
- Write your Brainstorm scripts

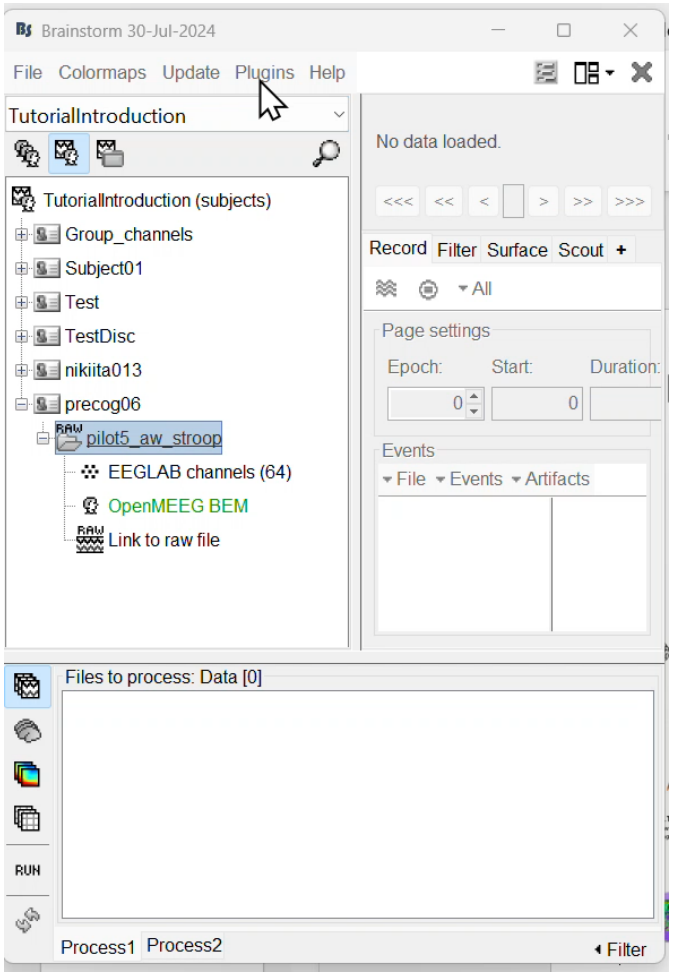
Tutorial 28: Scripting

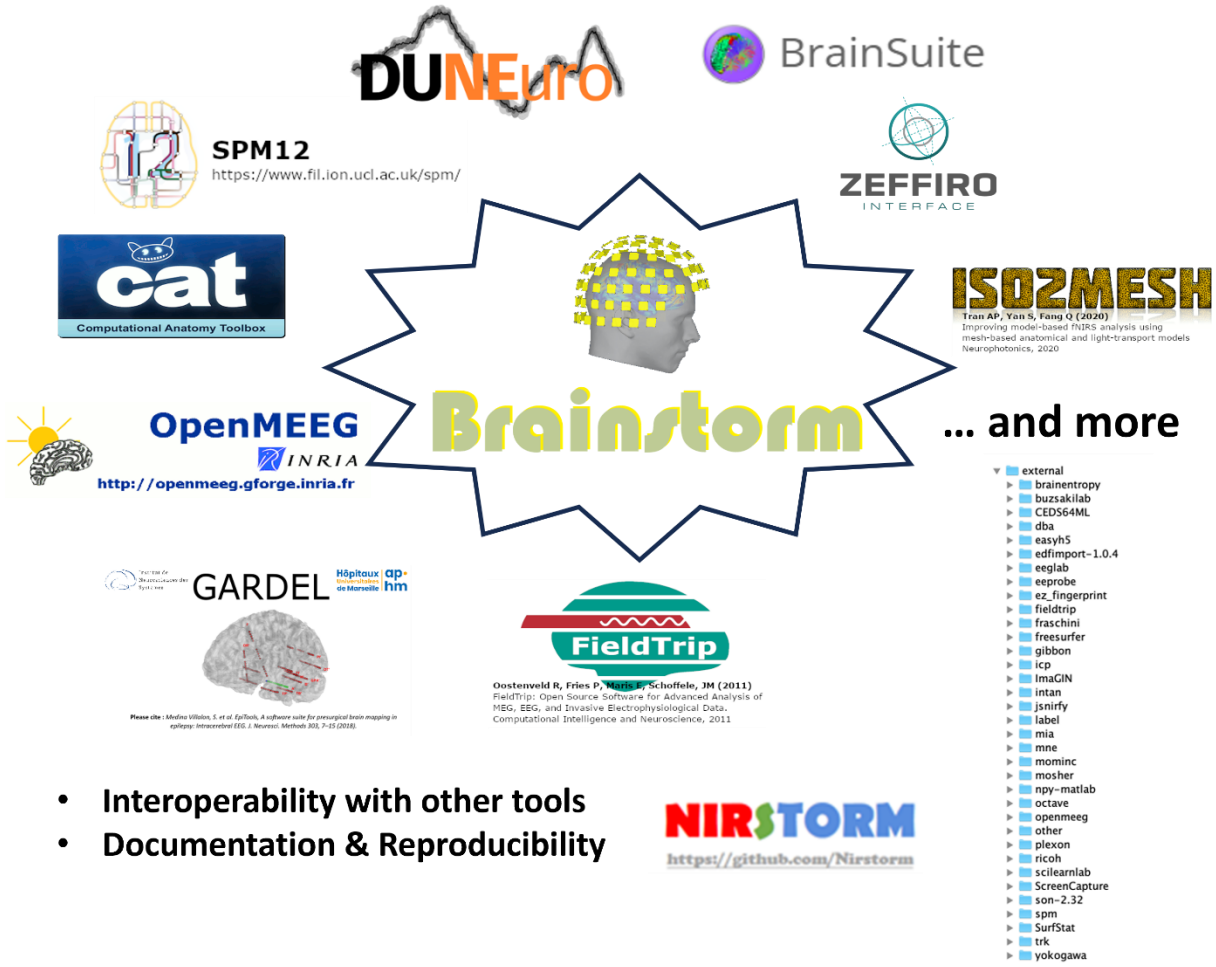
Authors: Francois Tadel, Elizabeth Bock, Matthias Sure, Sylvain Baillet

The previous tutorials explained how to use Brainstorm in an interactive way to process one subject with two acquisition runs. In the context of a typical neuroimaging study, you may have tens or hundreds of subjects to process in the same way, it is unrealistic to do everything manually. Some parts of the analysis can be processed in batches with no direct supervision, others require more attention. This tutorial introduces tools and tricks that will help you assemble an efficient analysis pipeline.

What's New?

- **Brainstorm Plugin Manager: Brainstorm as a hub!**





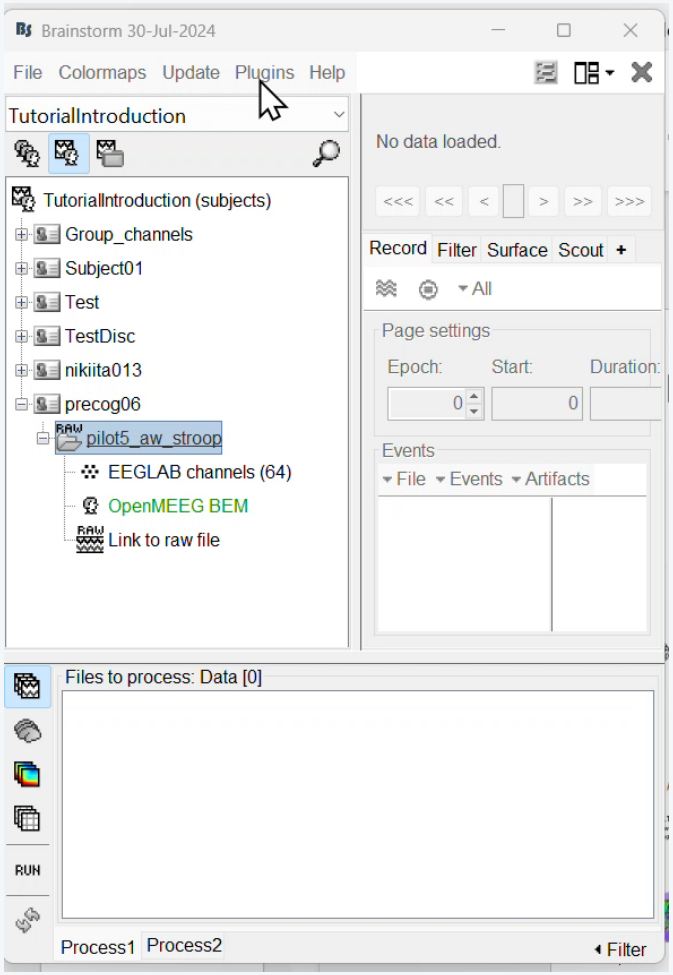
- **Interoperability with other tools**
- **Documentation & Reproducibility**

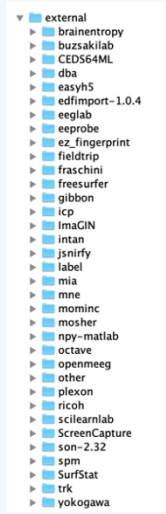
NIRSTORM
https://github.com/Nirstorm

Brainstorm

What's New?

- **Brainstorm Plugin Manager: Brainstorm as a hub!**



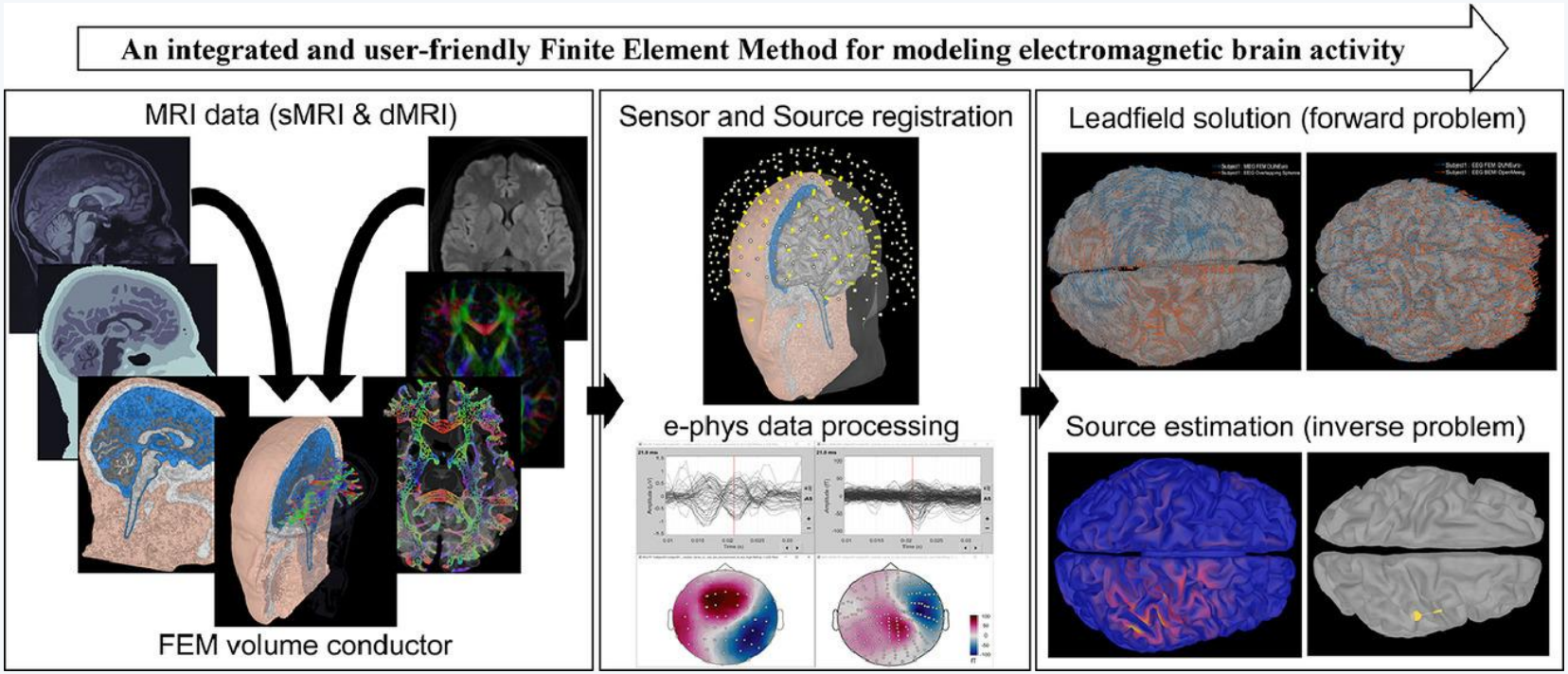


- Interoperability with other tools
- Documentation & Reproducibility

Brainstorm

What's New?

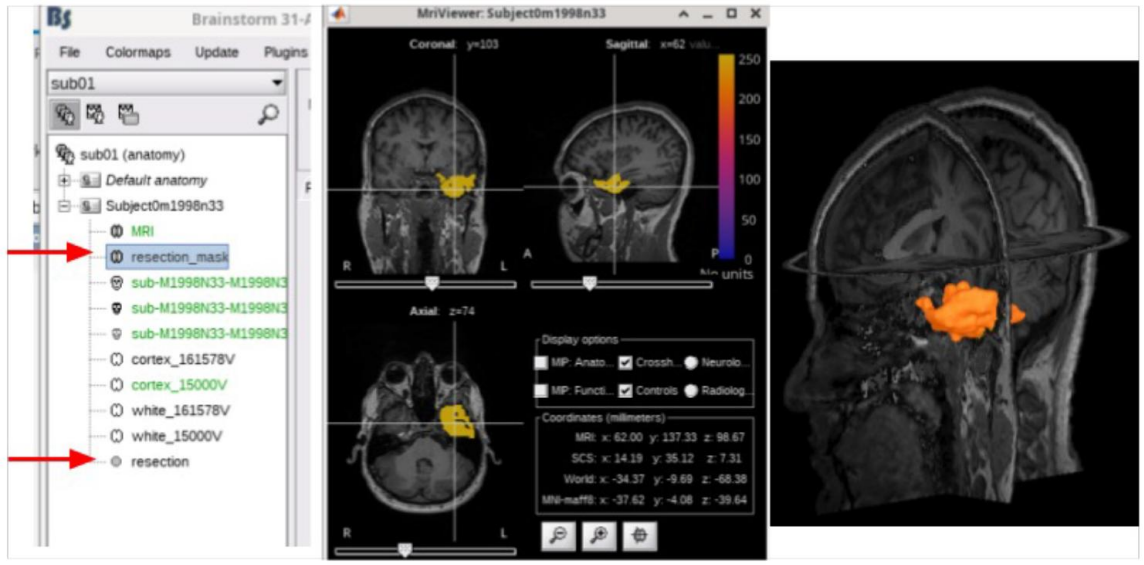
- **Brainstorm - DUNEuro: An integrated and user-friendly Finite Element Method for modeling electromagnetic brain activity**



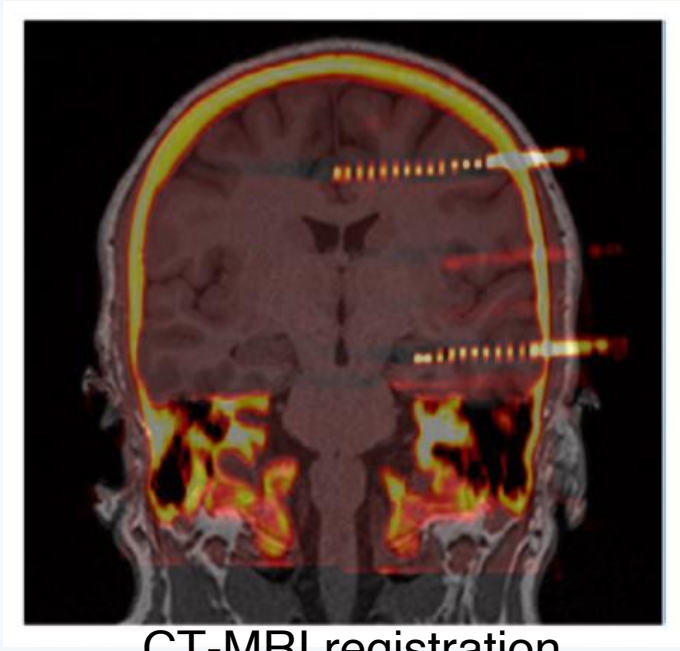
Takfarinas Medani, Juan Garcia-Prieto, Francois Tadel, Marios Antonakakis, Tim Erdbrügger, Malte Höltershinken, Wayne Mead, Sophie Schrader, Anand Joshi, Christian Engwer, Carsten H. Wolters, John C. Mosher, Richard M. Leahy
(https://doi.org/10.1016/j.neuroimage.2022.119851)

What's New?

- **CT-MRI volume co-registration and Resection delineation and labeling**



pre/post op resection volume detection

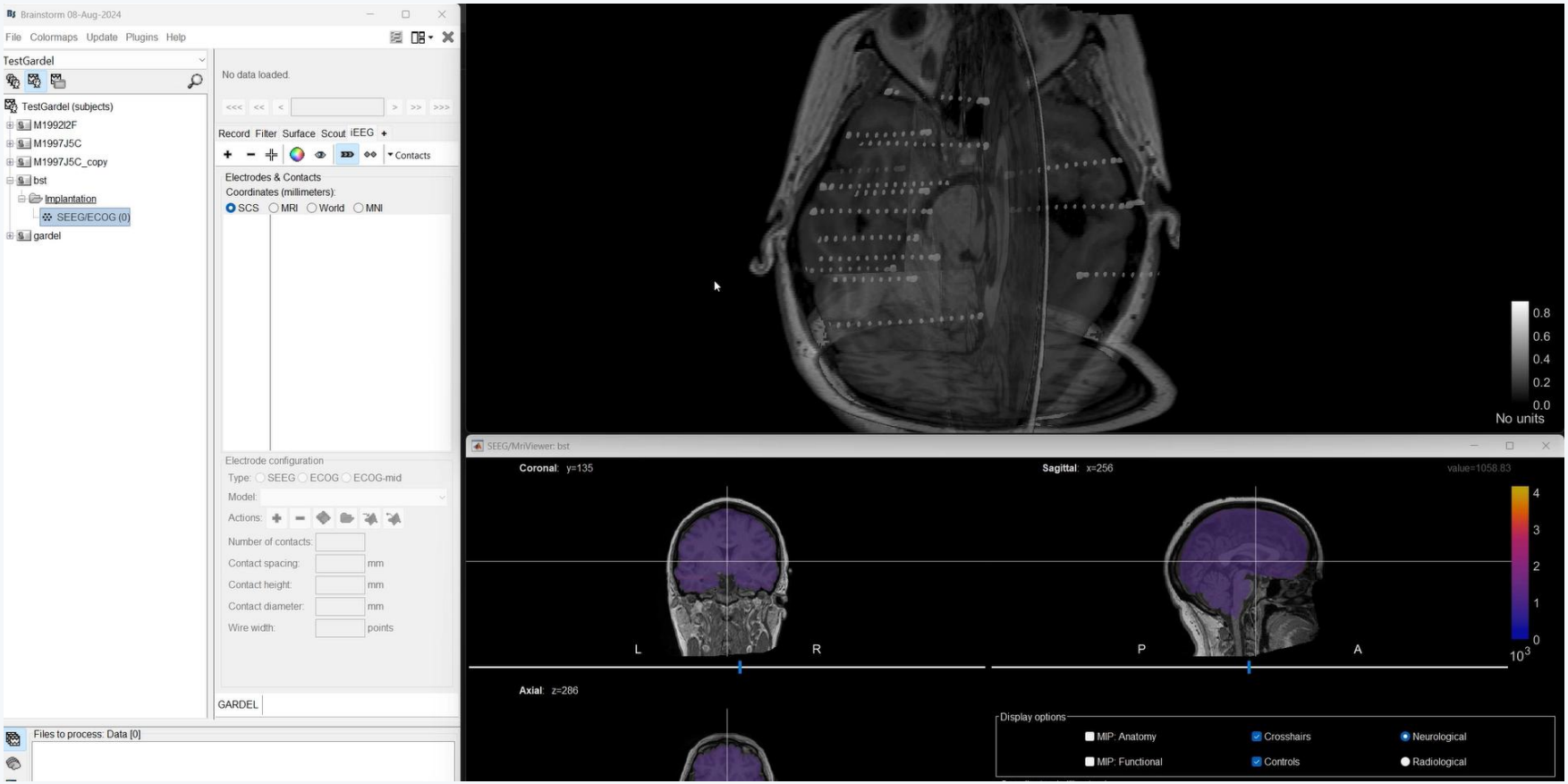


CT-MRI registration

A Joshi, Chinara, T. Medani and brainstorm team
https://neuroimage.usc.edu/brainstorm/Tutorials/SegBrainSuite?highlight=%28resection%29#Resection_labeling

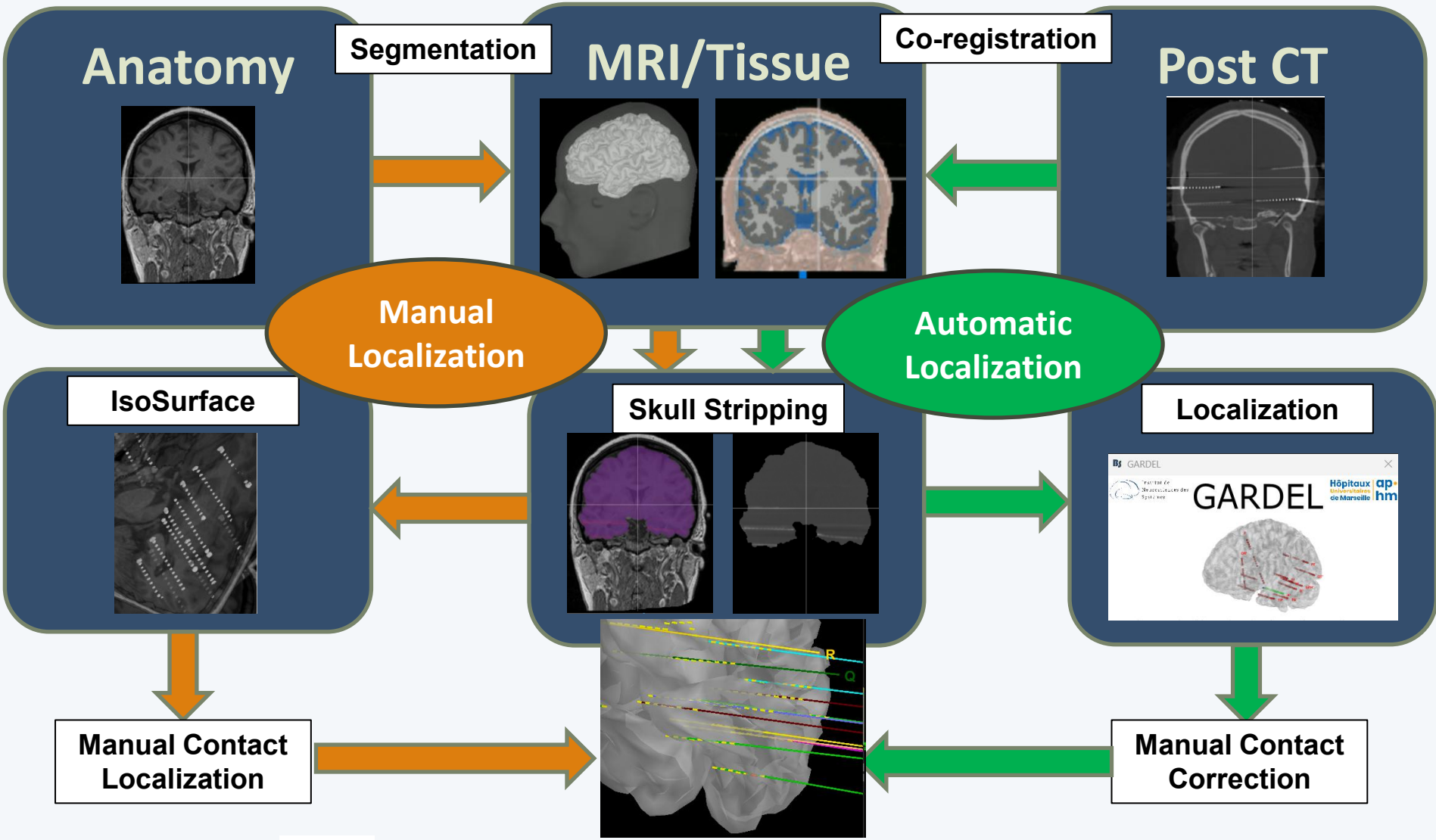
What's New?

- **(Semi-) Automated sEEG Electrode Localization and Labeling**



Chinara, S.Medina, A Joshi, C-G Bénar , T.Medani and brainstorm team: https://neuroimage.usc.edu/brainstorm/Tutorials/IeegContactLocalization
Medina Villalon et al. EpiTools, 2018 doi: 10.1016/j.jneumeth.2018.03.018

sEEG : Co-registration & contact localization

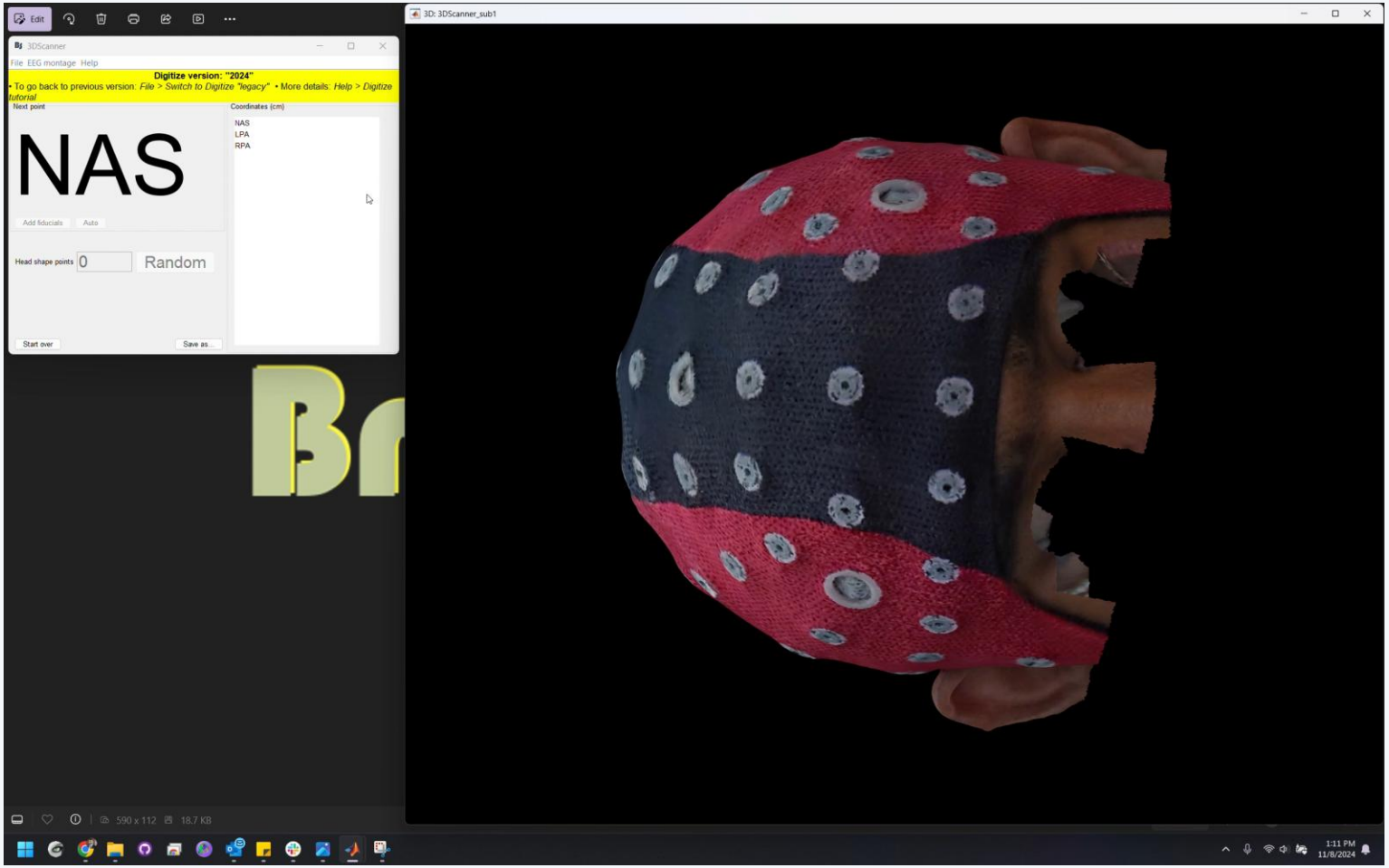


Chinara, S.Medina, A Joshi, C-G Bénar, T.Medani and brainstorm team: https://neuroimage.usc.edu/brainstorm/Tutorials/IeegContactLocalization
Medina Villalon et al. EpiTools, 2018 doi: 10.1016/j.jneumeth.2018.03.018

Brainstorm

What's New?

- **Automated EEG Electrode Localization and Labeling**



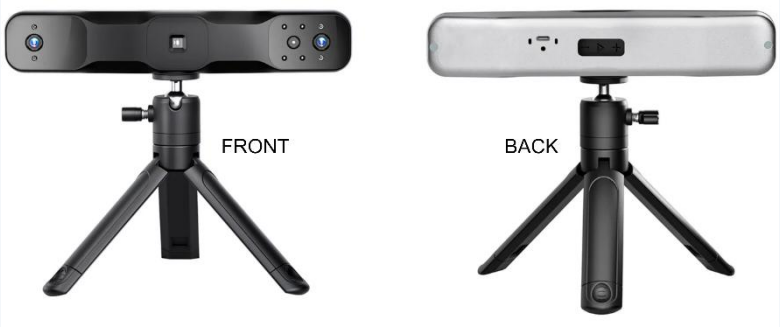
Chinara, A Joshi, Vakilna, Medani, and brainstorm team: https://neuroimage.usc.edu/brainstorm/Tutorials/TutDigitize3dScanner

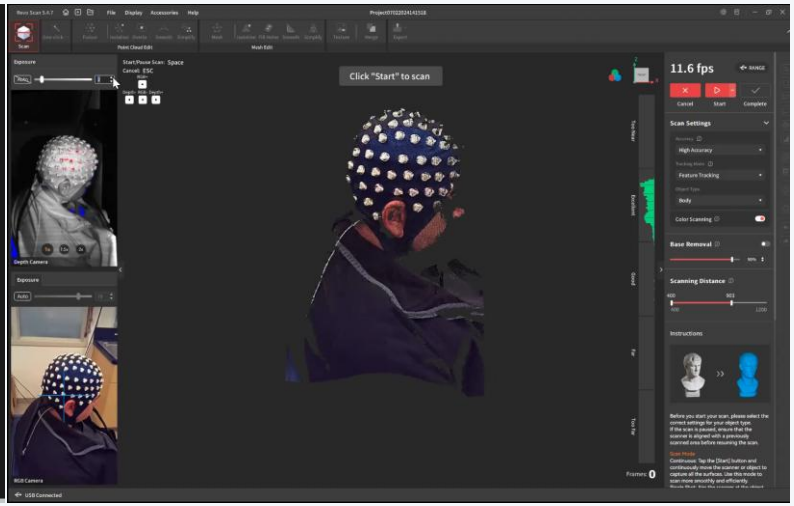
Co-registration EEG / MRI (3)

Anatomy

MRI registration

- 3D for scanning EEG scalp electrode





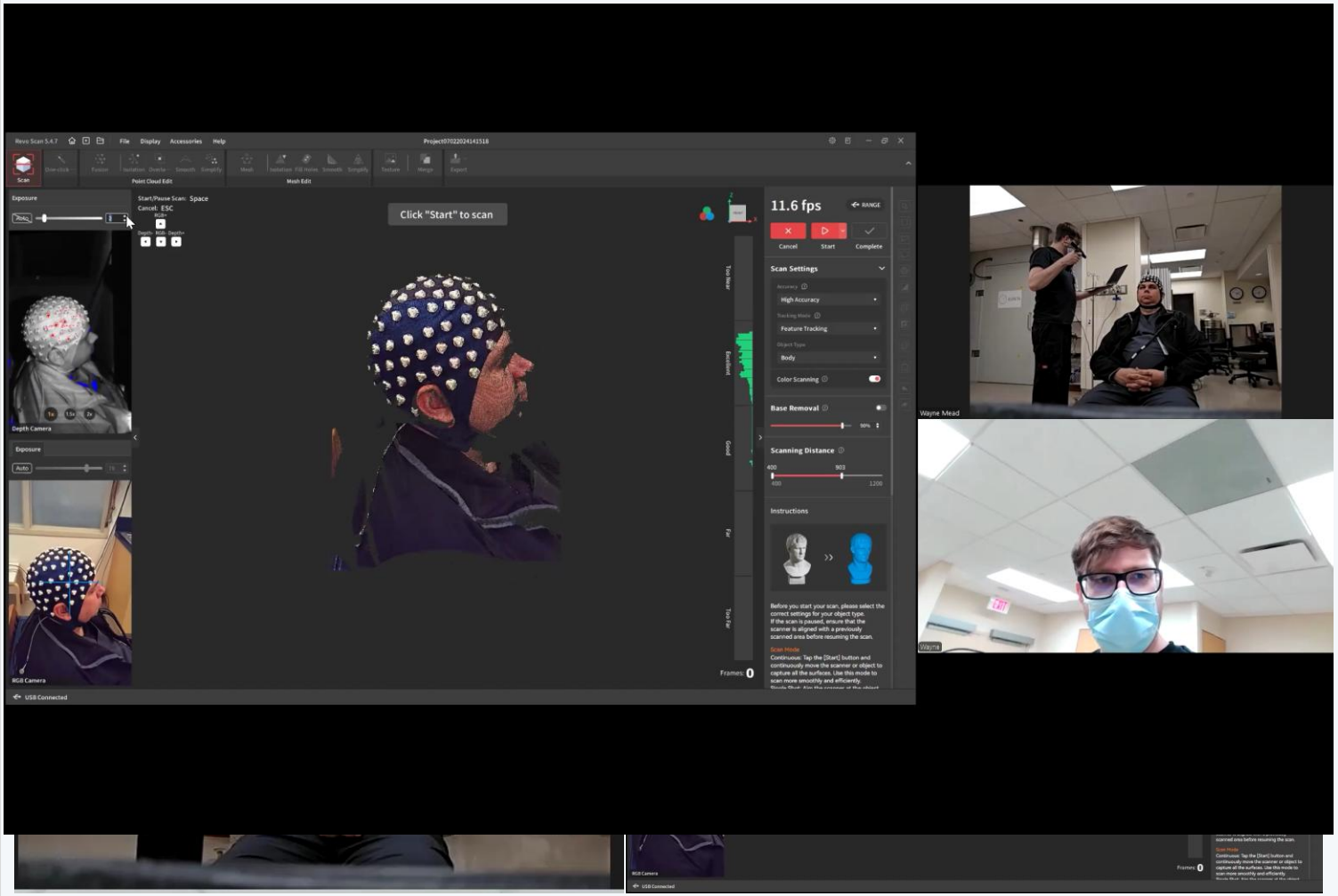
https://neuroimage.usc.edu/brainstorm/Tutorials/TutDigitize3dScanner

Brainstorm

Co-registration EEG / MRI (3)

Anatomy

MRI registration

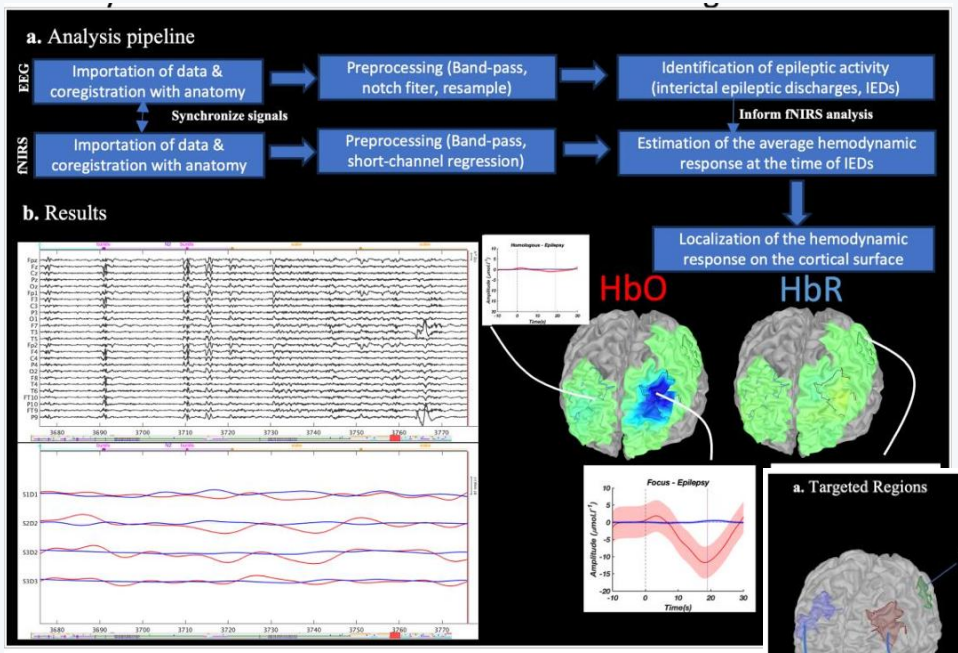


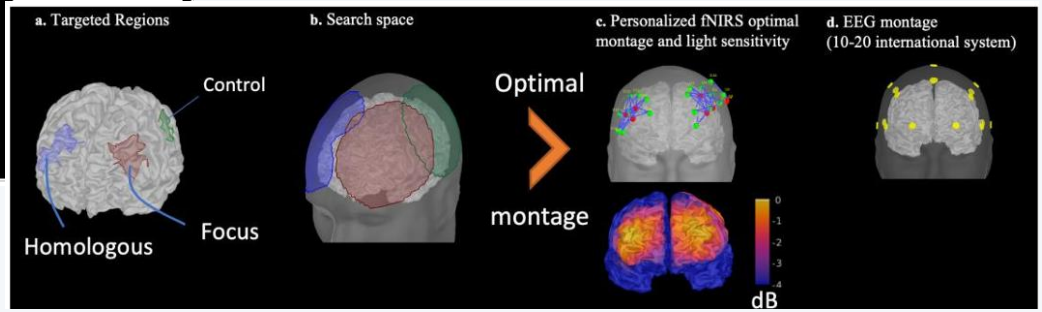
https://neuroimage.usc.edu/brainstorm/Tutorials/TutDigitize3dScanner

Brainstorm

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 Pélégrini-Issac, Christophe Grova (https://www.biorxiv.org/content/10.1101/2024.09.05.611463v1)

What's New?

ANNALS of Clinical and Translational Neurology
Open Access
AMERICAN NEUROLOGICAL ASSOCIATION
THE HOME FOR ACADEMIC NEUROLOGY

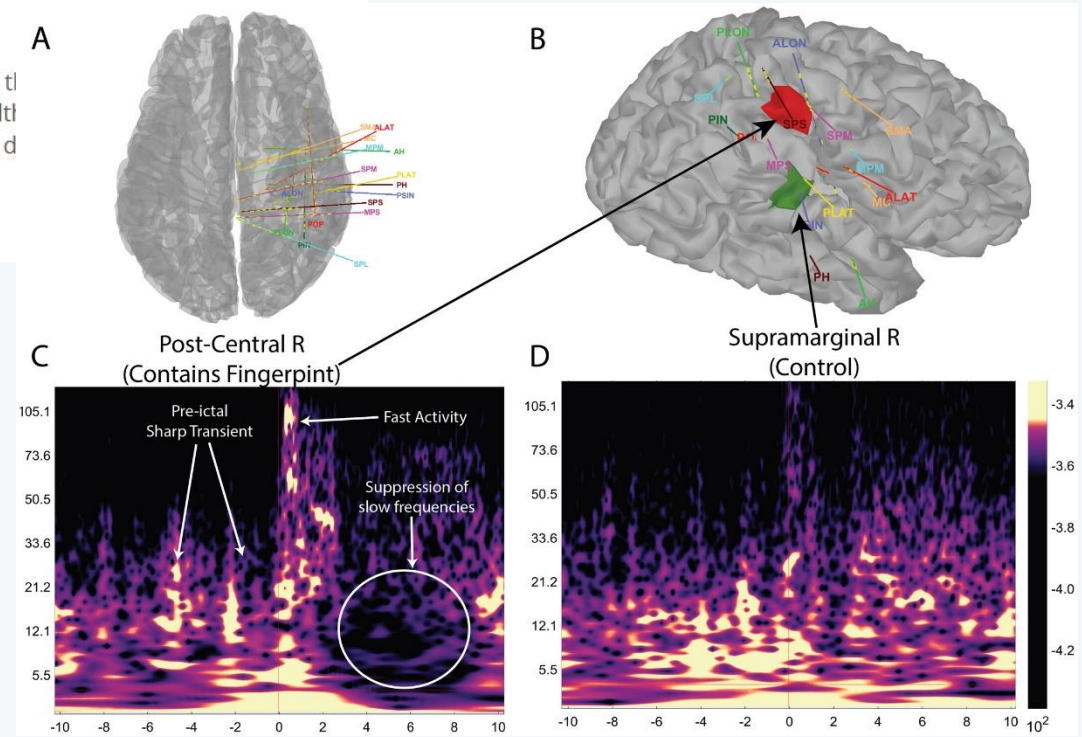
CASE STUDY | Open Access

Time-Frequency Fingerprint Analysis in SEEG Source-Space to Identify the Epileptogenic Zone

Yash Shashank Vakilna, Deniz Atilgan, Johnson Hampson, Chinmay Chinara, Takfarinas Medani, Richard M. Leahy, Nuria Lacuey, Samden D. Lhatoo, Sandipan Pati, John C. Mosher, Jay R. Gavvala

First published: 01 July 2025 https://doi.org/10.1002/acn3.70115

Funding: Research reported in this publication was supported in part by t
Biomedical Imaging and Bioengineering of the National Institutes of Healt
R01EB026299. The content is solely the responsibility of the authors and d
the official views of the National Institutes of Health.
Yash Shashank Vakilna and Deniz Atilgan equal contribution.



Brainstorm

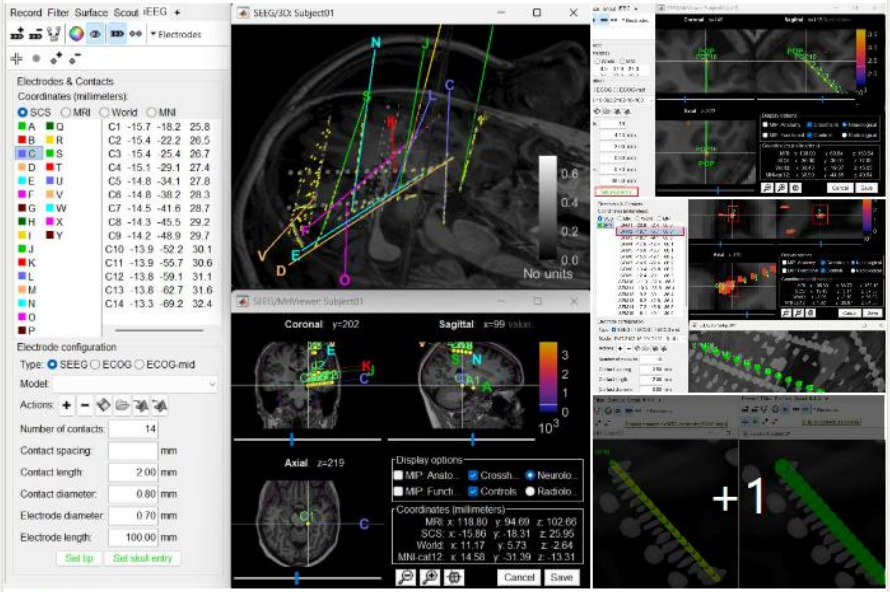
What's New?

By Takfarinas MEDANI, PhD • 8/5/2025 Pinned •••

Brainstorm Multimodal Neuroimaging
502 followers
2d • Edited •

🧠 Introducing sEEG-suite: Brainstorm's Pipeline for Multimodal sEEG Analysis 🚀

We're excited to announce the release of sEEG-suite, a powerful and ...more



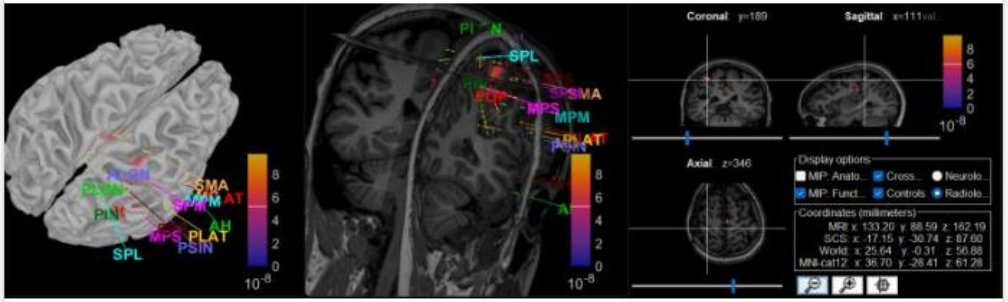
Elizabeth Bock and 82 others 3 comments · 13 reposts

Like Comment Repost

Brainstorm Multimodal Neuroimaging reposted this

Sylvain Baillet • 1st
Professor & Canada Research Chair | Associate Dean, Research (Faculty of Medicin...
1d •

🧠 🚀 Announcing **sEEG-SUITE for Brainstorm**: free, open-source pipeline for multimodal intracranial electrophysiology & epilepsy research.
CT→MRI→sEEG coregistration, GARDEL contact localization, atlas-based labelling of electrodes, seizure fingerprinting, source analysis—all in one GUI.
https://lnkd.in/eUuJmrXV
supported by The National Institutes of Health.



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Brainstorm

What's New?

And more...!!

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- Introduction
- Gallery
- Download
- Installation

Users
- Tutorials
- Forum
- Courses
- Community
- Publications

Development
- What's new
- What's next
- About us
- Contact us
- Contribute

Developers
- Neuroimage admin

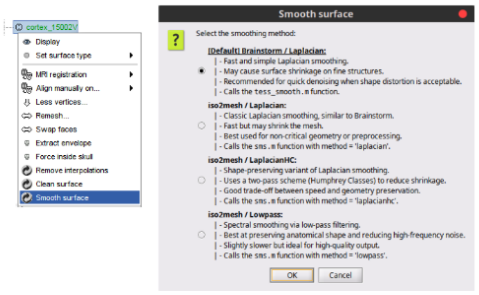
What's new

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

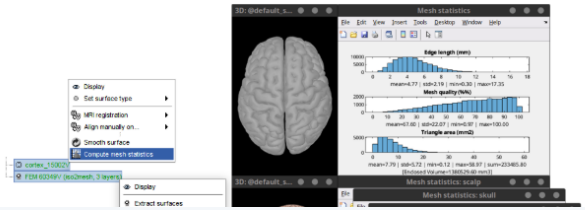
July 2025

Anatomy

- On importing NIfTI files, **vox2ras** transformation from `sform` is preferred over `qform` if both are present
- Allow non-interactive call for `tess_force_envelop.m`
- Add various methods to smooth a surface mesh



- Compute mesh statistics for surface and volume meshes



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

Brainstorm

Upcoming Brainstorm Events

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📍 **Hyderabad, India**

Date: April 7, 2025

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

Part of the International Conference on Acoustics, Speech, and Signal Processing (ICASSP).

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📍 **Brisbane, Australia**

Date: June 24-28, 2025

Focus: Software Demo.

Part of *OHBM 2025*

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📍 **Mexico City, Mexico**

Date: August 07, 2025

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

Part of *CAMELICE Meeting*

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📍 **Aix-en-Provence, France**

Date: October 27–31, 2025

Focus: Brainstorm full course (5 days) and hands-on on EEG and MEG analysis.

Part of *PracticalMEEG events*

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👩‍🏫 **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 to discuss your needs.

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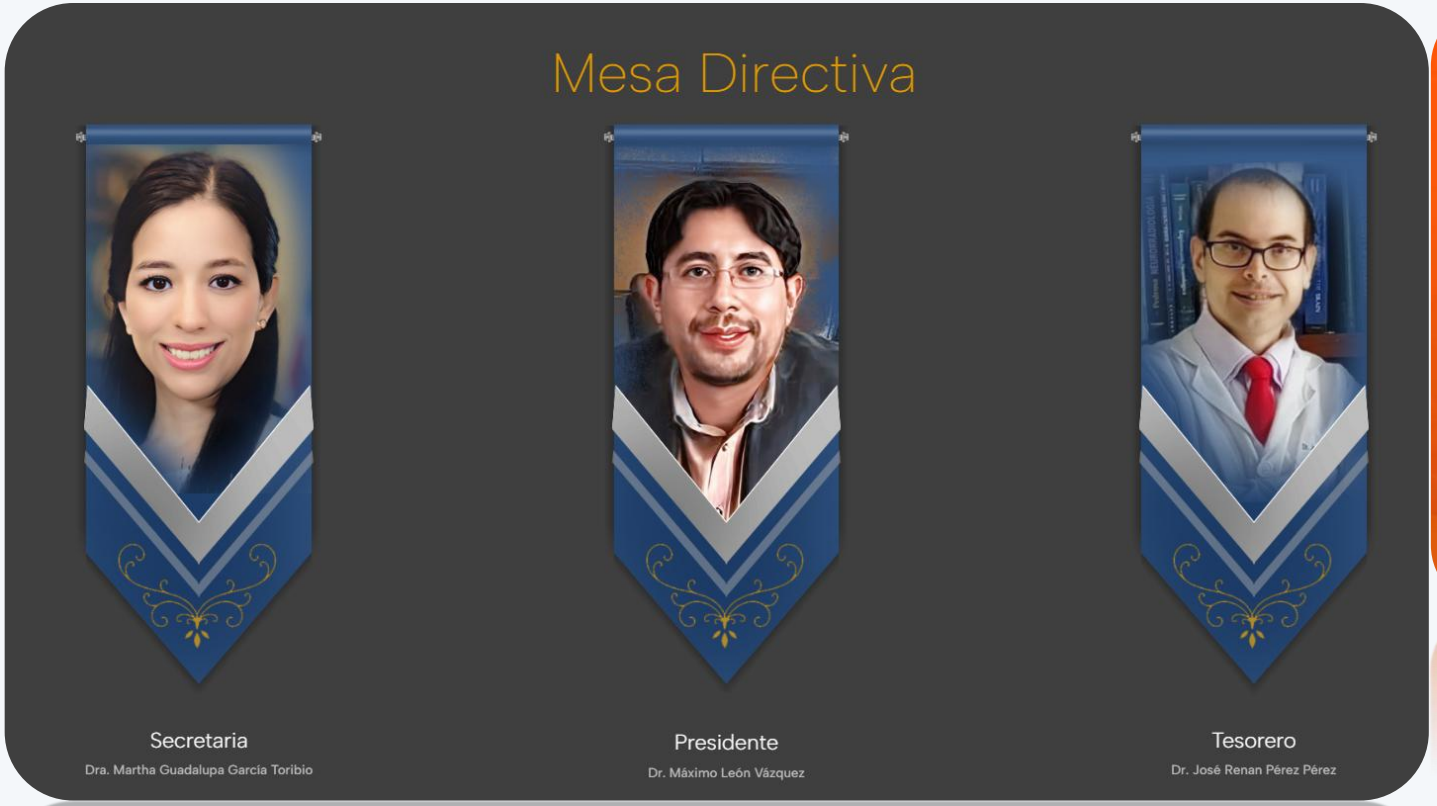
Muchas Gracias.



et al.

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Feedback Brainstorm software & workshop

- Scan QR and register (add your email):
  - To receive the course materials
- Share your feedback to improve Brainstorm workshops/courses and shape future sessions…
- Share your thoughts!
  - Features to add
  - …

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- Q&A?

Live Demo