



Automated Workflow for EEG and sEEG Electrode Localization and Labeling in Brainstorm for Advanced Neuroimaging



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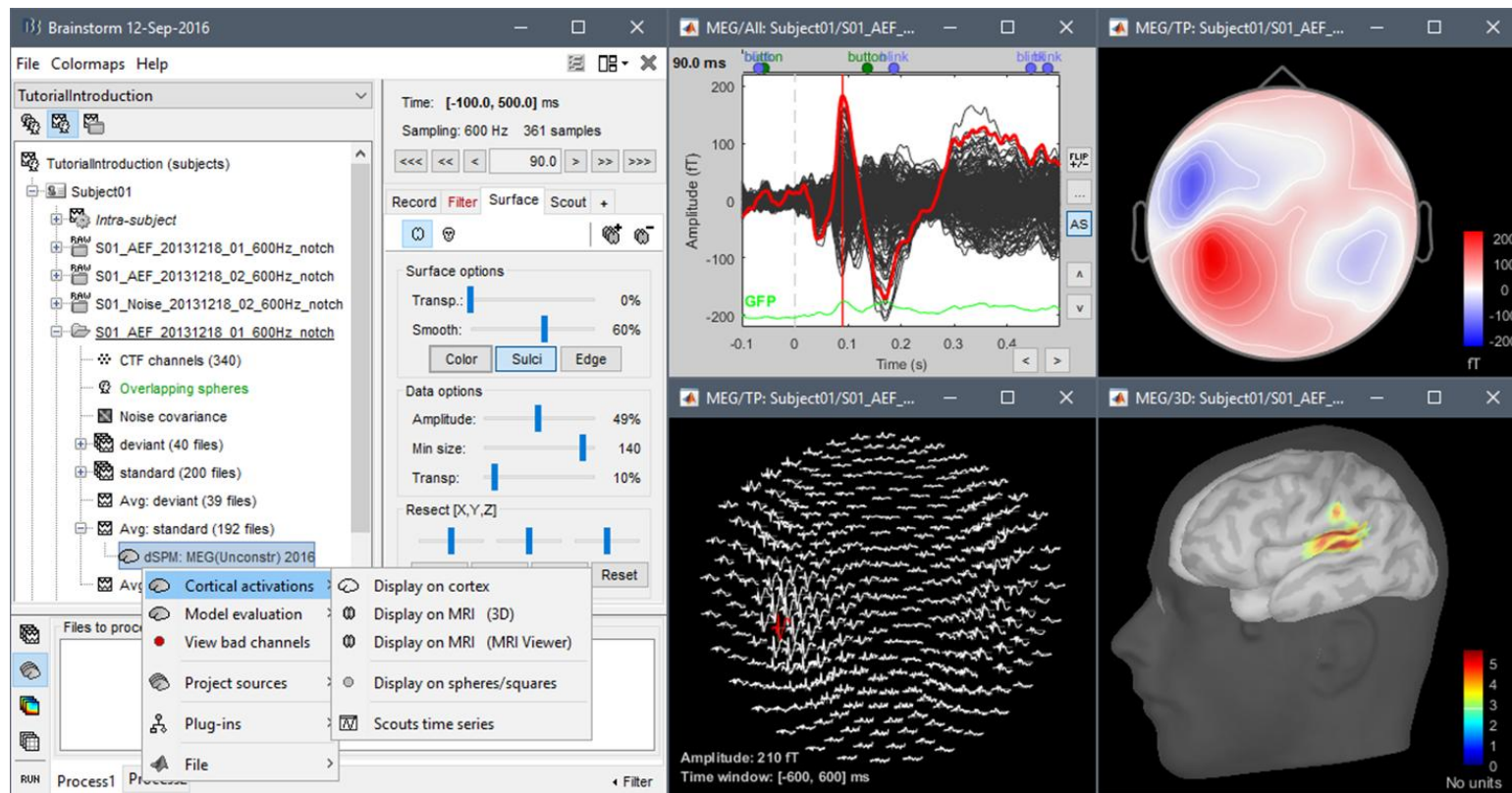


Brainstorm

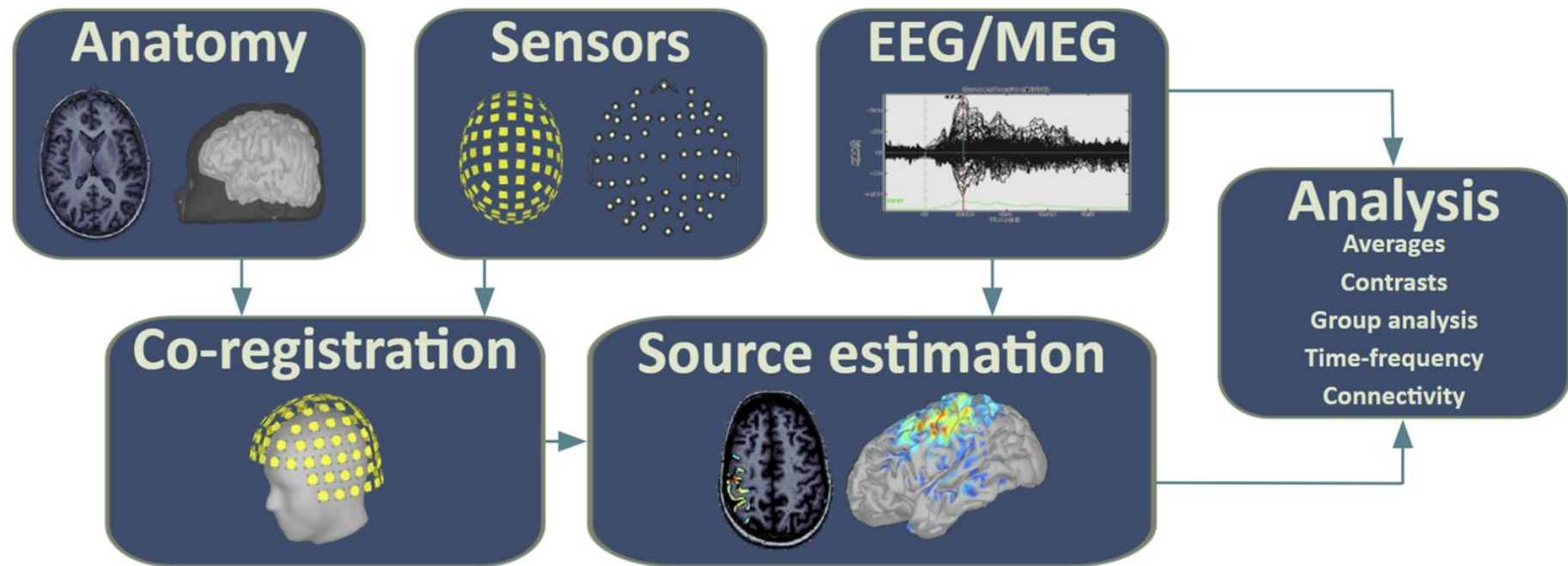
- Free and open-source application (GPL licence)
- Built on MATLAB & Java : platform independent
- Stand-alone version available
- Interface-based: **click, drag, drop**
- No MATLAB experience required
- Daily software updates
- Supports most common file formats
- Educational resources and active users' community [Website, Forum, GitHub, ...]



Graphical interface

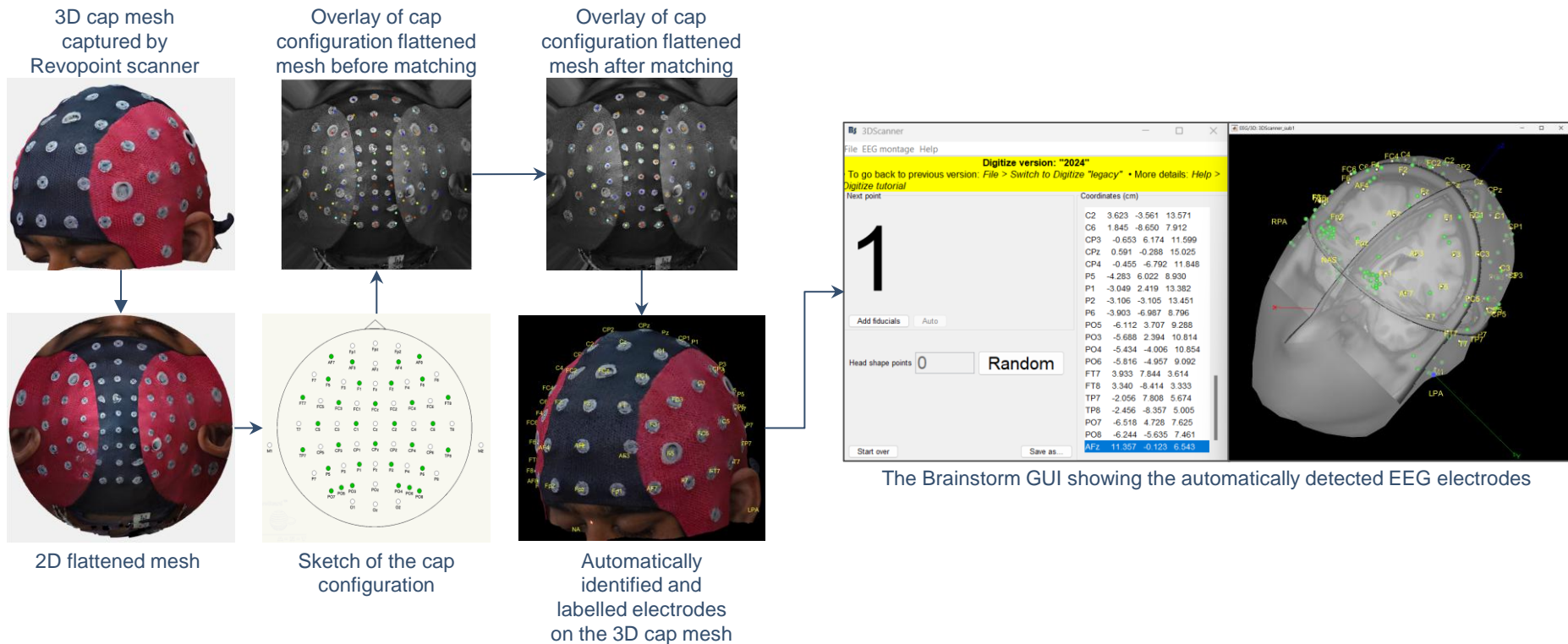


Workflow

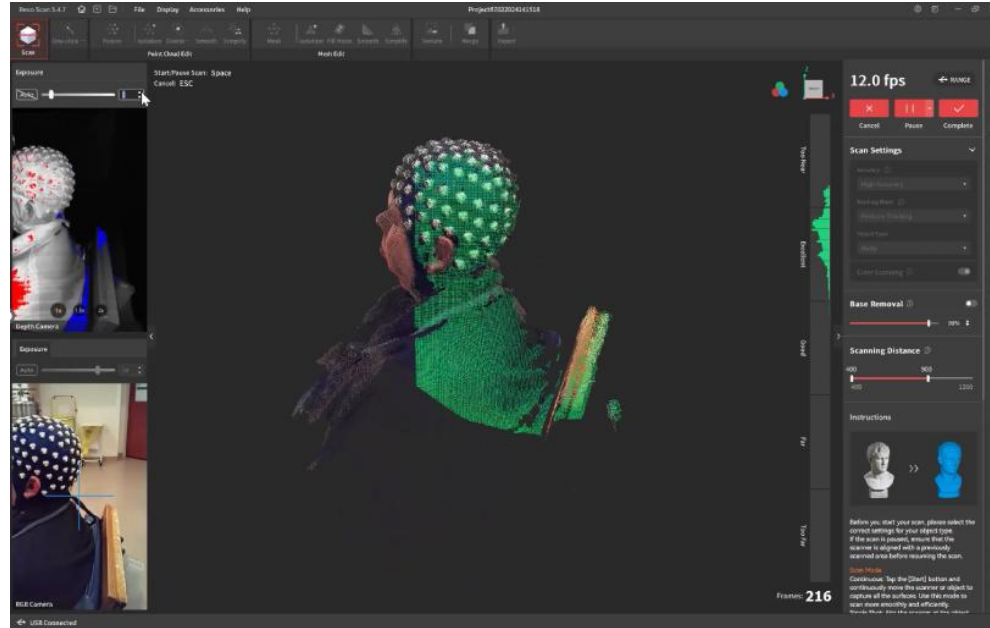


Automatic EEG Electrode Localization and Labeling

Workflow



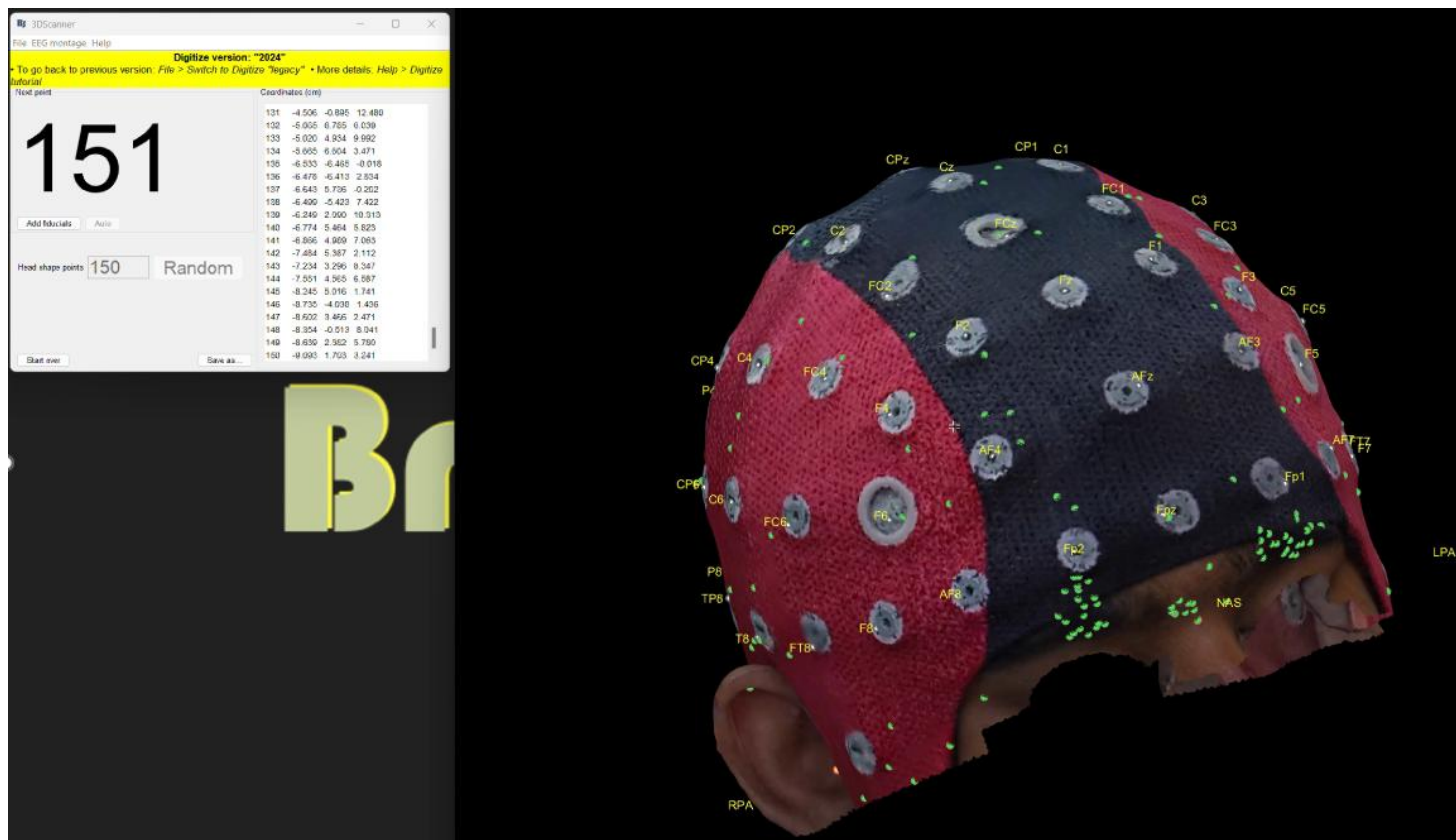
Revopoint



<https://www.revopoint3d.com/products/handheld-3d-scanner-range>

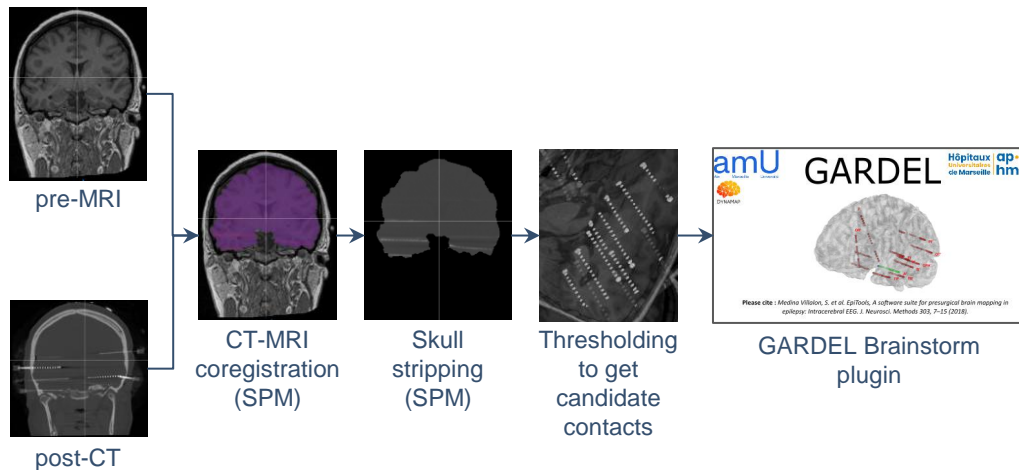


Demo

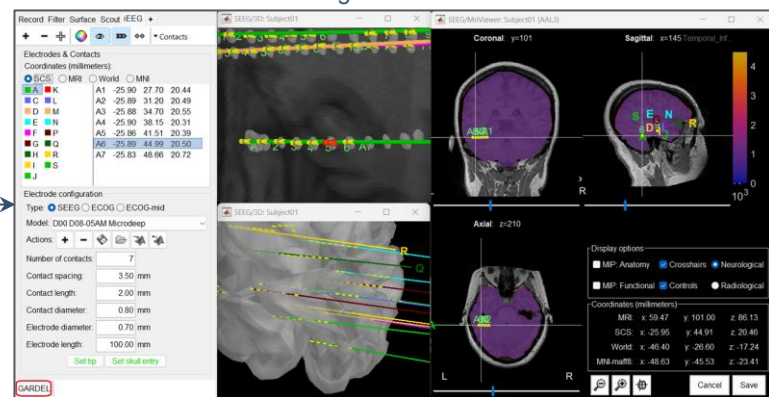


Automatic sEEG Electrode Localization and Labeling

Workflow



Brainstorm GUI showing the automatic detected contacts



Automated anatomical labeling

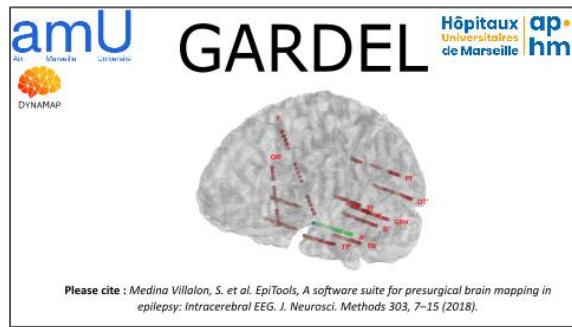
Channel	SCS	AAL3 (MNI-linear)	Hammers83 (MNI-linear)
A1	[-25.898, 27.697, 20.438]	Fusiform L	PosteriorTL L
A2	[-25.887, 31.200, 20.493]	Fusiform L	PosteriorTL L
A3	[-25.876, 34.703, 20.548]	Fusiform L	PosteriorTL L
A4	[-25.904, 38.149, 20.313]	Fusiform L	PosteriorTL L
A5	[-25.860, 41.507, 20.388]	Temporal_Inf L	PosteriorTL L
A6	[-25.893, 44.988, 20.504]	Temporal_Inf L	PosteriorTL L
A7	[-25.828, 48.665, 20.721]	Temporal_Inf L	PosteriorTL L
C1	[-8.279, -32.993, 53.327]	Insula R	Insula R
C2	[-8.319, -36.495, 53.384]	Rolandic_Oper R	G_sup_temp_cent R
C3	[-8.358, -39.998, 53.441]	Rolandic_Oper R	PL Rest R
C4	[-8.395, -43.297, 53.419]	Rolandic_Oper R	PL Rest R

Automated anatomical labeling



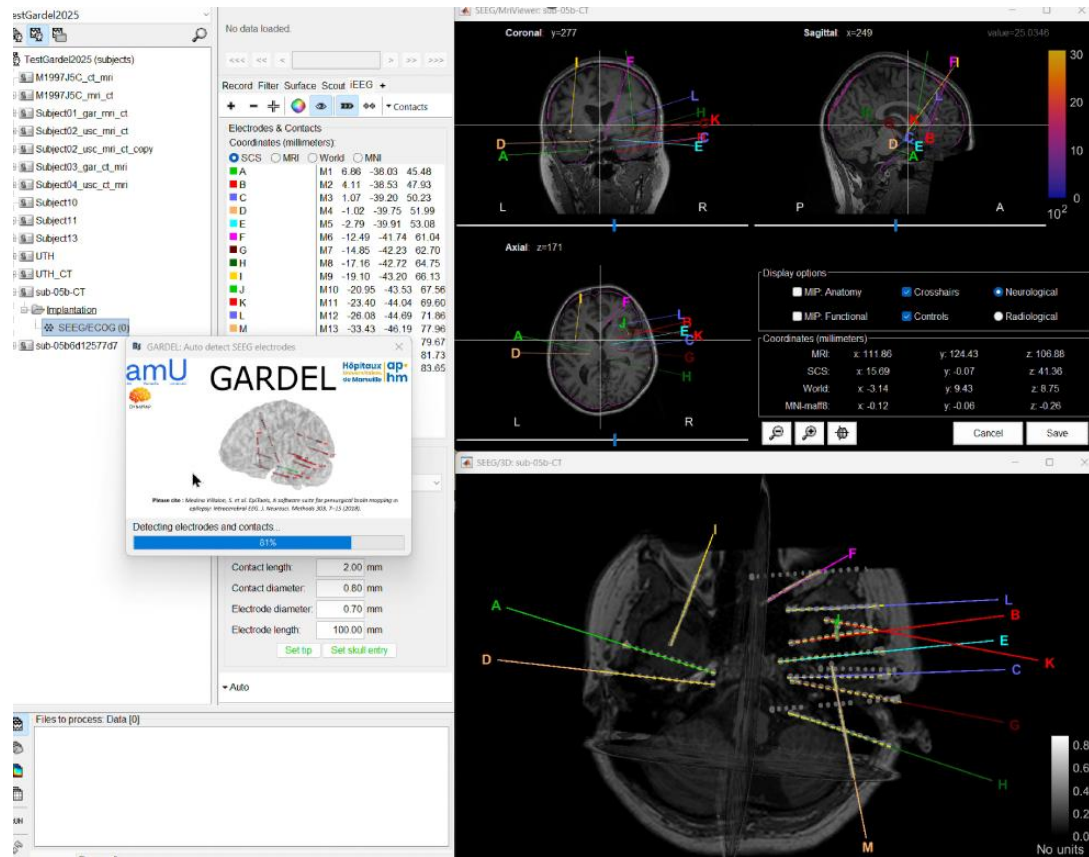
GARDEL algorithm

- **Electrode Grouping:** Detected contacts are grouped into electrodes based on their spatial proximity and orientation.
- **Contact Separation:** Morphological operations and watershed segmentation are applied to separate individual contacts within each electrode.
- **Correction & Reconstruction:** The algorithm checks for missed or over-segmented contacts by analyzing inter-contact distances and reconstructs missing contacts based on typical electrode geometry.
- Electrode detection order in GARDEL is determined by the sequence in which the image processing algorithm finds clusters in the CT volume, not by anatomical labeling or implantation order.



S Medina Villalon et. al., EpiTools, A software suite for presurgical brain mapping in epilepsy: Intracerebral EEG. (DOI: [10.1016/j.jneumeth.2018.03.018](https://doi.org/10.1016/j.jneumeth.2018.03.018))

Demo



Limitations of GARDEL

- Requires minimal but necessary user interaction for manual electrode naming.
- Performance may be reduced for oblique or complex electrode configurations, or when electrodes overlap or are poorly distinguishable in CT images.
- Assumes a consistent inter-contact distance within each electrode, limiting flexibility for arrays with variable spacing.
- Manual review and correction remain essential to ensure optimal accuracy.

All the necessary post processing can be done directly within Brainstorm








S Medina Villalon et. al., EpiTools, A software suite for presurgical brain mapping in epilepsy: Intracerebral EEG. (DOI: [10.1016/j.jneumeth.2018.03.018](https://doi.org/10.1016/j.jneumeth.2018.03.018))

SEEG post processing in Brainstorm

Manual implantation






Choose the model

Electrode configuration
Type: ☒ SEEG ☐ ECOG ☐ ECOG-mid
Model: PMT 2102-16-093/2102-16-103
Actions:     
Number of contacts: 16
Contact spacing: 4.43 mm
Contact length: 2.00 mm
Contact diameter: 0.80 mm
Electrode diameter: 0.70 mm
Electrode length: 68.50 mm
Set tip Set skull entry

Define name of electrode

Record Filter Surface Scout iEEG +
Electrodes & Contacts
Coordinates (millimeters):
☒ SCS ☐ MRI ☐ World ☐ MNI
Add electrode
Electrode label: POP
OK Cancel

SEEG/MriViewer: Subject01 (aal3)

Record Filter Surface Scout iEEG +
Electrodes & Contacts
Coordinates (millimeters):
☒ SCS ☐ MRI ☐ World ☐ MNI
☒ POP
POP14 -31.0 -36.6 71.4
POP15 -33.9 -36.6 74.8
POP16 -36.9 -36.5 78.1
Electrode configuration
Type: ☒ SEEG ☐ ECOG ☐ ECOG-mid
Model: PMT 2102-16-093/2102-16-103
Actions:     
Number of contacts: 16
Contact spacing: 4.43 mm
Contact length: 2.00 mm
Contact diameter: 0.80 mm
Electrode diameter: 0.70 mm
Electrode length: 68.50 mm
Set tip Set skull entry

Coronal: y=149
Sagittal: x=115Right Inferior ...
Axial: z=322
Display options:
☐ MIP: Anatomy ☒ Crosshairs ☒ Neurological
☐ MIP: Functional ☒ Controls ☐ Radiological
Coordinates (millimeters):
MRI: x: 138.00 y: 69.84 z: 150.94
SCS: x: -36.60 y: -36.01 z: 77.85
World: x: 30.43 y: -19.07 z: 45.65
MNI-cat12: x: 36.90 y: -44.55 z: 49.64
Cancel Save

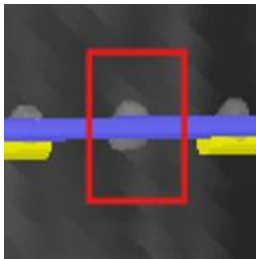
POP

Set the tip and skull entry to get the rendered electrode

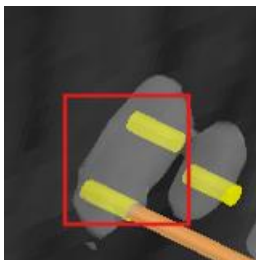
SEEG post processing in Brainstorm

Add / Remove contacts

- Some contacts might be missing for an electrode (in which case the missing contacts needs to be added).



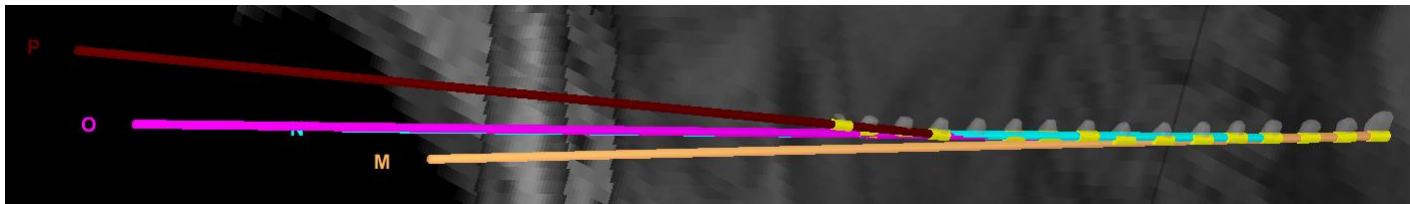
- There could be wrong detection of contacts (in which case those contacts needs to be removed).



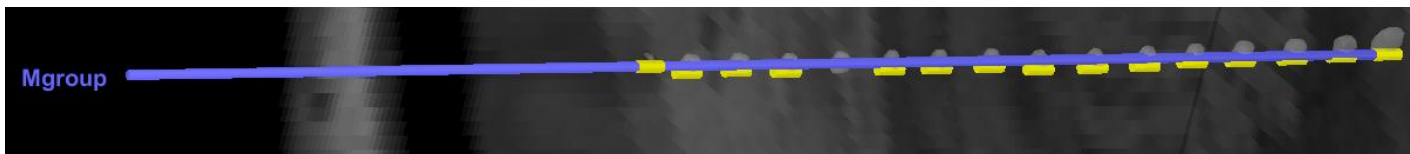
SEEG post processing in Brainstorm

Merge electrodes

- There could be contacts being grouped into different electrodes even though they should be part of just one (in which case they need to be merged).



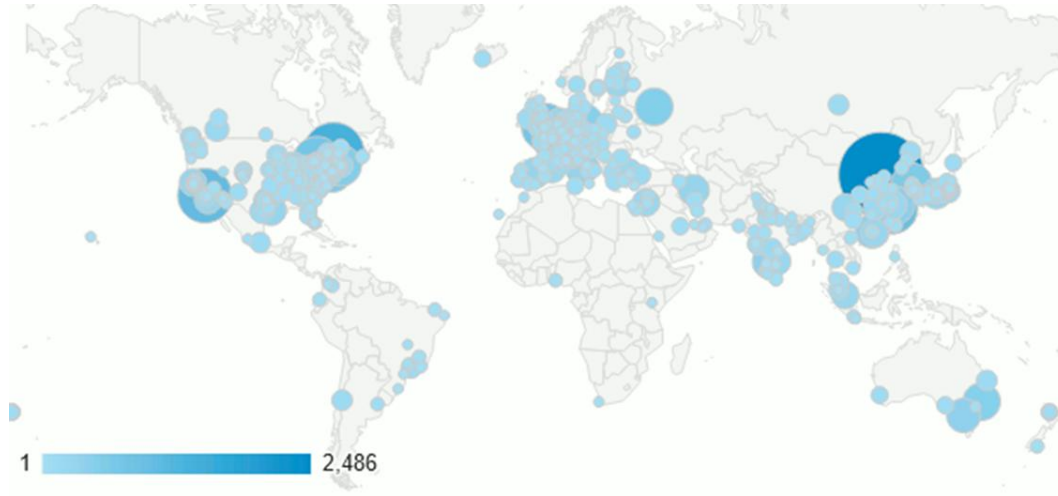
BEFORE



AFTER

User community (2025)

48,000+ users registered on the website



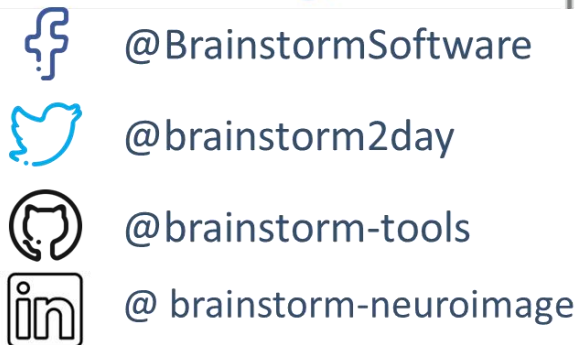
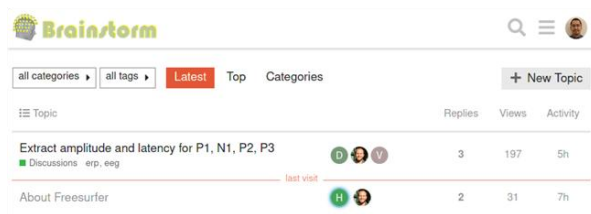
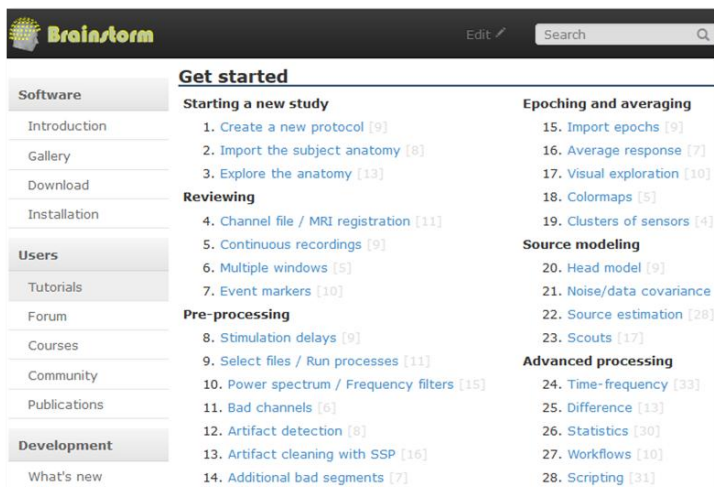
Find users next to you

Location:

Users found: 919

User support

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



User support - Brainstorm Chatbot



Brainstorm Workshop on sEEG & More, Dec 4-5, 2024 USC Los Angeles, CA, USA

categories ▾ tags ▾ Latest New (3) Unread (492) Hot Categories

☰ Topic

How to import .cdt raw data •

■ Discussions curry, import

Bad segments, source localization, and ICA decomposition •

■ Discussions eeg

OpenMEEG error -1073740791 1

■ Discussions eeg, forward, openmeeeg

Strange fibers outside the brain surface

■ Discussions

Export the mat file from phase lock value connectivity



ChatBrainstorm3



formats on the Brainstorm website if you are unsure about the compatibility of your dataset.

how can I import EEG data

To import EEG data into Brainstorm, follow these steps:

1. **Link Continuous Recordings:** First, ensure that your continuous MEG/EEG recording is linked to your Brainstorm database. If it is not already done, you can review continuous recordings by following the appropriate tutorial.

2. **Import the EEG File:**

• Right

Message...



Powered By Chatbase.co

3

18

11h



The team

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Edouard Delaire
Concordia

Thank You !

