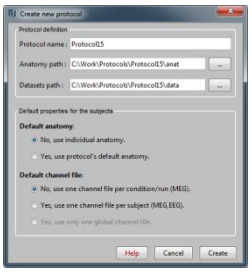
MEMORY: Close all your applications, including web browsers
INTERNET: Internet connection needed for the MNI normalization

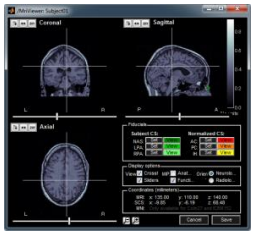
8:30-9:15 Onsite assistance in installing the material for the training session

9:15-9:45 Lecture: Introduction to Brainstorm

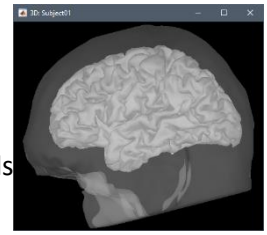
9:45-10:45 Import anatomy 1hr



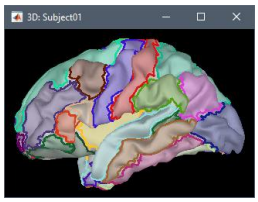
- Start Brainstorm: from Matlab or stand-alone
- Create new protocol "Workshop":
  No, use individual anatomy
  No, use one channel file per acquisition run
- Create new subject:
  Introduction to database explorer: protocols, exploration modes, popup
  Switch to anatomy view: 1st button above database explorer
  Right-click on protocol top node > New subject: Subject01



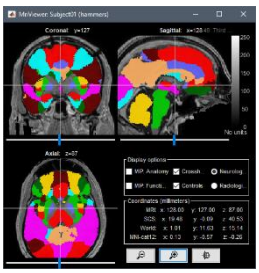
- Import T1 pre-implantation + CAT12 segmentation:
  Right-click on Subject01 > **Import anatomy folder**
  Select format: **CAT12**
  Select folder: workshop_cuttingeeg/derivatives/cat12/sub-01_ses-pre
  Number of vertices: 15000
  Introduction to the MRI viewer: Click, mouse wheel, color bar, popup
  Compute MNI normalization / MAFF8: set default positions for the fiducials
  Coordinate systems: MRI, SCS, World, MNI



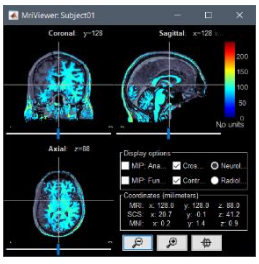
- How to run CAT12 segmentation from Brainstorm
- Display cortex:
  Close figure, double-click on cortex_15002V (low-resolution pial surface)
  3D figure: Rotation, zoom, predefined views
  Surface tab: Smooth slider, sulci, edges
  Scout tab: Parcellations of the surface vertices



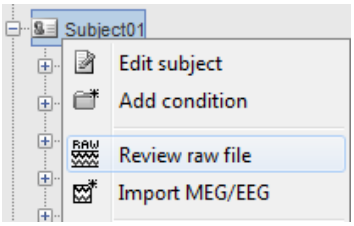
- Volume parcellations: AAL3, Hammers, tissues
  Adjust transparency, change the atlas, non-linear MNI transformation
  Add MNI parcellation: Schaefer2018_100_7net



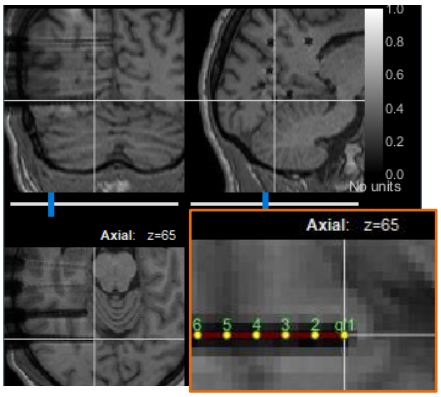
- Import T1 post-implantation:
  Right-click on Subject01 > **Import MRI**
  Select file: /sub-01/ses-postimp/anat/sub-01_ses-postimp_T1w.nii.gz
  Apply transformation: **YES**
  How to register: **IGNORE** (volumes are already co-registered with SPM)
  Reslice the volume: **YES** (so we can overlay them)
  Surface tab: Adjust threshold with slider "Data options: Amplitude"
- Rename the volumes **T1pre** and **T1post**
- **Close all**: Big cross on the top-right, close all the figures and empty memory



10:45-11:20 SEEG contact positions 35 min



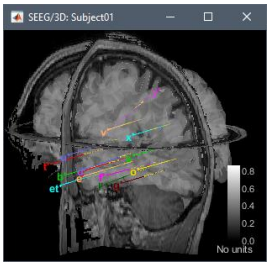
- Switch to functional view : 2nd button above database explorer
- Create link to SEEG recordings:
  Right-click on Subject01 > **Review raw file**
  Select format: **SEEG: Deltamed/Micromed/…**
  Select file: sub-01/ses-postimp/ieeg/sub-01_... _ieeg.eeg
  Double click on the channel file: Missing 3D positions
- Mark electrode **g '**:
  Right-click on channel file > MRI registration > Edit: **T1post**
  Tab iEEG: Select **g '**: **DIXI D08-12AM** Microdeep
  Set tip: [X=115, Y=64, Z=65] - Axial view: Lowest horizontal
  Set entry: [X=76, Y=64, Z=64]
  Menu Contacts > Save modifications
- Contacts > Compute atlas labels
  File selection: Cancel (do not save) / Keep default options



SEEG contact labels

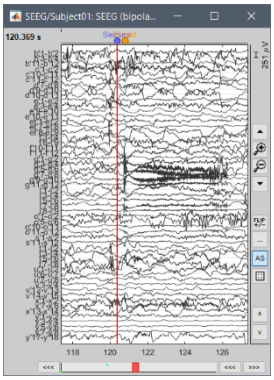
Channel	SCS	aal3	hammers	tissues_cat12	Schaefer2018_100_7net (MNI-cat12)
g'1	[-46.734,12.724,33.596]	Left Lingual gyrus	OL lingual gyrus L	Gray	Vis_3 L
g'2	[-46.713,16.224,33.526]	Left Lingual gyrus	OL lingual gyrus L	White	Vis_3 L
g'3	[-46.692,19.723,33.455]	Left Lingual gyrus	OL lingual gyrus L	White	Vis_3 L
g'4	[-46.671,23.222,33.385]	Left Lingual gyrus	OL lingual gyrus L	White	Vis_2 L
g'5	[-46.649,26.721,33.315]	Left Lingual gyrus	OL lateral remainder occipital lobe L	Gray	Vis_2 L
g'6	[-46.628,30.220,33.244]	N/A	OL lateral remainder occipital lobe L	White	N/A

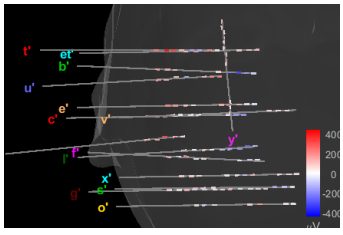
- Import positions for all the electrodes
  Right-click on channel file > Add EEG positions > Import from file
  Select format: **EEG: BIDS electrodes.tsv, subject space mm**
  Select file: sub-01/ses-postimp/ieeg/..._**space-Other**_electrodes.tsv
  Scaling factor: 1
  Double-click on channel file, Move slices, Add cortex from Surface tab

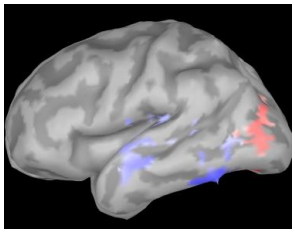


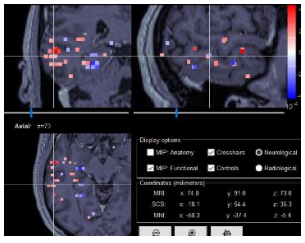
11:20-11:45 Review the recordings 25 min

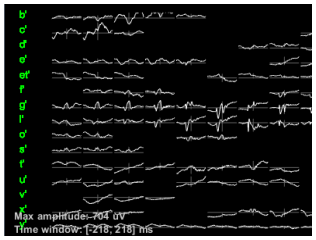
- Review SEEG: Right-click on "Link to raw file" > SEEG > **Display time series**
  Display in columns: Button [~] in the Record tab
  Amplitude: Buttons and shortcuts, Display menu
  Time: Display windows of **10 seconds**, Scroll with F3, Auto-Scale button
  Select bad channels (o'1) + right click > Channels > **Mark selected as bad**
  Montages: **SEEG (Bipolar 1)** - Create personal montages + shortcuts
  Online filters
- Right-click on "Link to raw file" > SEEG > **2D Layout**
- Change the window layout to "Tiled"
- Other menus: **Display on cortex, Display on MRI (MRI Viewer), 3D Electrodes (Head)**



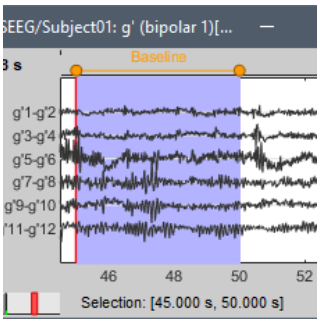








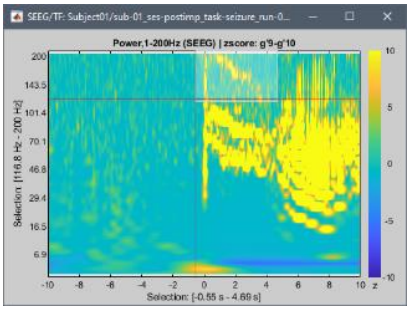
Epileptogenicity maps



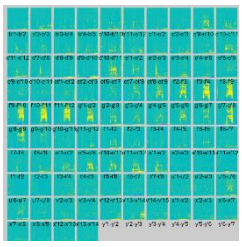
Import epochs of interest 15 min

- Baseline:
  - Change montage: **SEEG (bipolar 1)**
  - Create a new category of events: **Add group** > **Baseline**
  - Select time: **45s - 50s** (right-click > Time selection > Set selection)
  - Add baseline event
- Close figure, save modifications
- Import seizure:
  - Right-click on "Link to raw file" > Import in database
  - **Use events**: **Seizure**, Epoch time: **[-10000, +40000] ms**
  - **NO Remove DC offset**
  - Do **NOT** select: Create a separate folder for each event type
- Import baseline:
  - Right-click on "Link to raw file" > Import in database
  - Use events: **Baseline**
- Apply bipolar montage:
  - Drag and drop the two imported files in the Process1 box
  - Run > Process Standardize > **Apply montage**:
  - Montage name: **Subject01: SEEG (bipolar 2)**
  - Create new folders: **YES**

Time-frequency analysis OPTIONAL 5min



- In Process1: Select "Seizure"
- Select process: **Extract > Extract time > [-10, +10]s**
- Add process: Frequency > **Time-frequency (Morlet wavelets)**:
  - Sensor types: **SEEG**
  - **Log 1:40:200**, Central frequency: **1Hz**, Time resolution: **10s**
- Add process: Standardize > **Baseline normalization**:
  - Baseline: **[-7.5, -2.5]** s, **Z-score**, **Overwrite**
- Run, right-click on result > All channels
- Look for the highest frequency band with significant activity:
  - Hypothesis: the closest to the seizure onset zone, the highest the frequency
  - Smooth display, Set colormap max to [-10,+10]z, Change colormap to Parula
  - Frequency band of interest: **120-200 Hz**



Epileptogenicity maps 20min

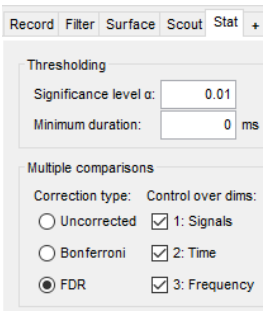
- Requires SPM to be installed
- Epileptogenicity maps in volume:

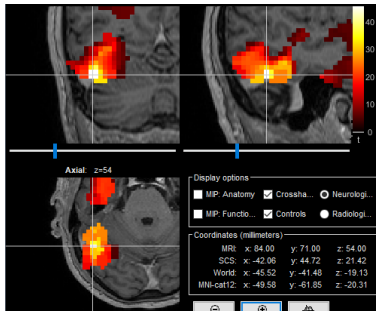
  In Process2: A=Baseline, B=Seizure, Process **Epilepsy > Epileptogenicity maps**

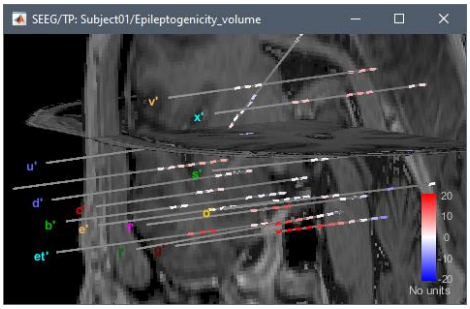
  Frequency band: **120-200 Hz**, Latency: **0**, **Volume**

  Right-click on "source" > Cortical activations > Display on MRI (MRI viewer)

  Right-click on "recordings" > SEEG > 3D electrodes (MRI 3D)







- Epileptogenicity maps on cortex surface:

  In Process2: A=Baseline, B=Onset, Process **Epilepsy > Epileptogenicity maps**

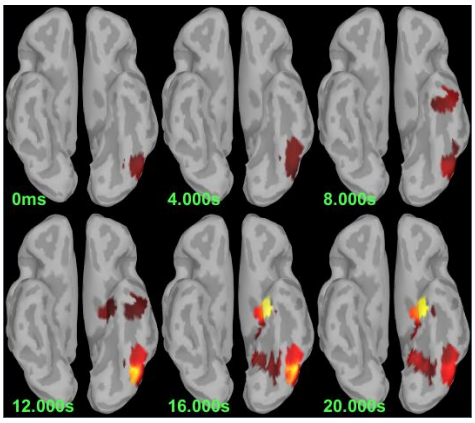
  Frequency band: **120-200 Hz**, Latency: **0:2:20**, **Surface**

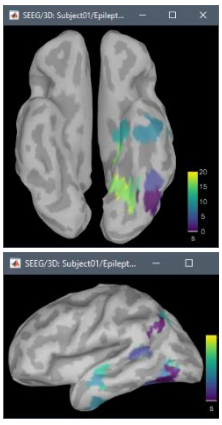
  Double click on the two "source files":

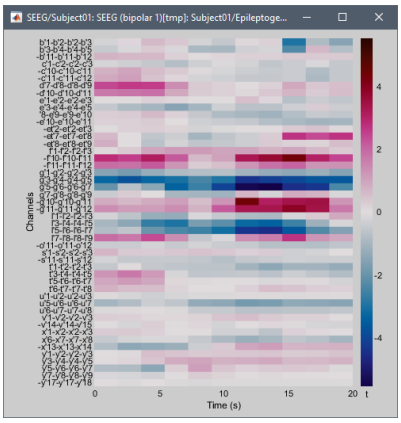
  EI_..._120_200_3: Epileptogenicity maps are now time resolved

  Delay_..._120_200_3_50: Delay map = all the epileptogenicity maps (p<0.05) overlayed for all the time points, colormap=seconds

  Right-click on "recordings" file > SEEG > Display as image





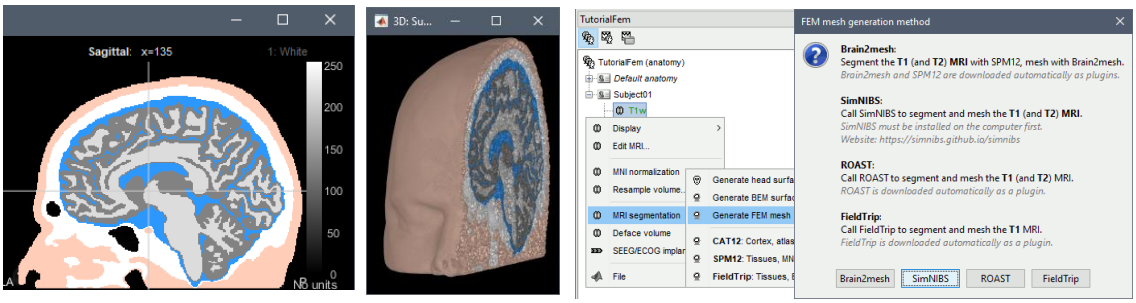


- Additional topics, if any time left:
  - Guidelines panel: Simplified interface for this pipeline, designed for clinicians
  - ECOG example
  - Montage editor

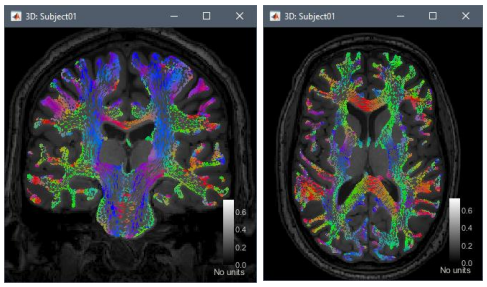
FEM Modeling 15min

Brainstorm FEM tutorial: MEG/EEG Median nerve stimulation
https://neuroimage.usc.edu/brainstorm/Tutorials/FemMedianNerve

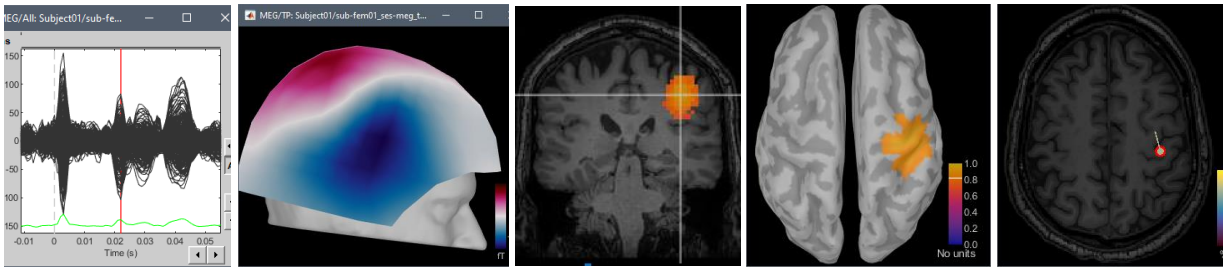
1) Segmentation
- Obtain a good segmentation of the head tissues : GM, WM, CSF, skull, skin
- Create a 3D tetrahedral mesh of the head tissues: Brain2mesh, SimNIBS, ROAST, FieldTrip



2) Evaluate tissue anisotropy
- Compute DTI tensors from DWI images (BrainSuite Diffusion Pipeline)
- Compute anisotropic conductivity tensors for the tetrahedral elements of the white matter



3) Estimate sources
- Compute FEM forward model with DUNEuro
- Minimum norm source imaging



Future applications:
- Modeling local currents around implanted electrodes for SEEG and DBS
- Modeling of intracranial currents for transcranial stimulations tACS/tDCS