BIOMAG - 2018 Challenge

Localization of MEG seizures onset

Denis Engemann, Alexandre Gramfort, Hicham Janati, Joan Massich

Parietal Team, INRIA, CEA Neurospin, Université Paris-Saclay

https://github.com/massich/epilepsy-biomag-2018

Methodology

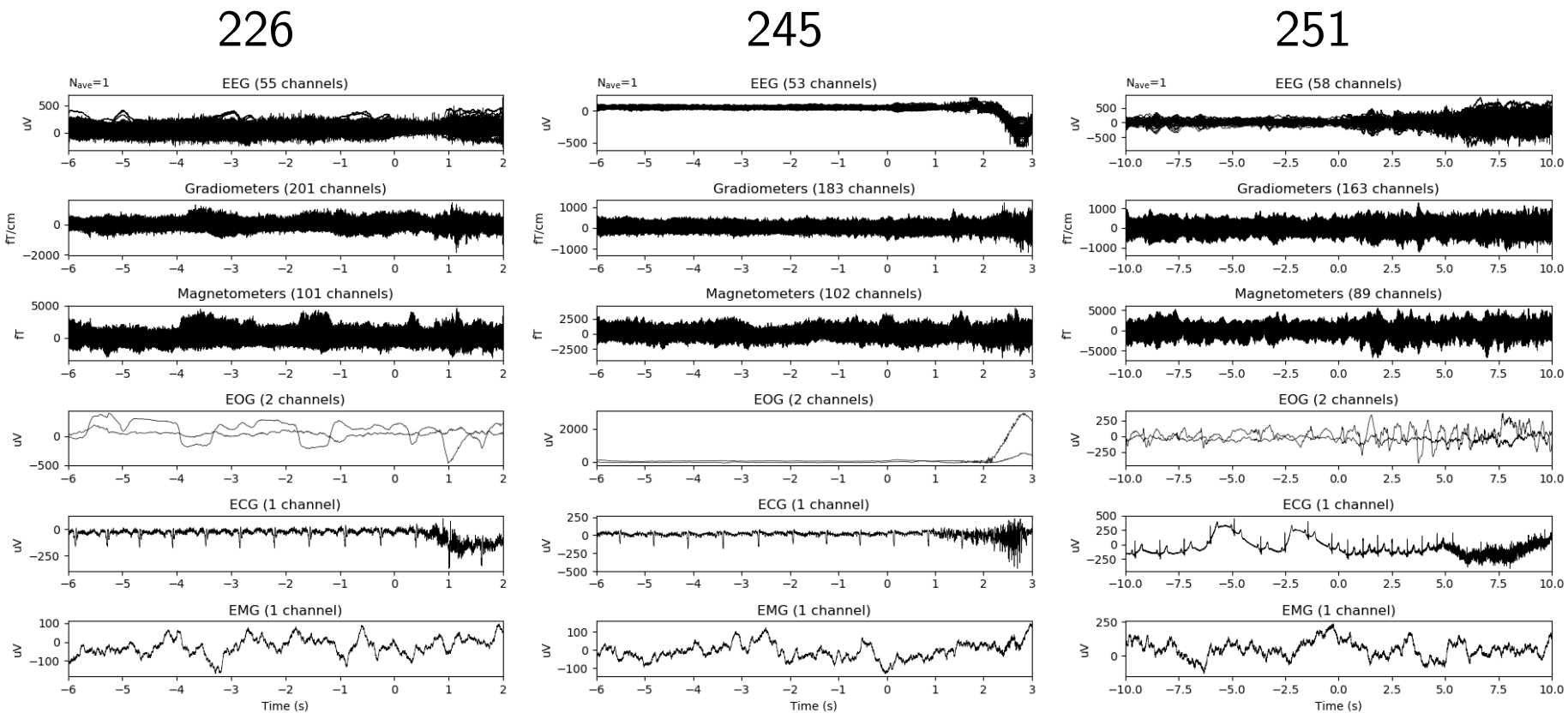
Our pipeline consists in the following steps:

1. Clean up data (Select time segment and mark bad channels)
2. Compute ICA and manually select a component: dipolar and matching the seizure onset
3. Compute forward model using 1 Layer BEM
4. Fit an equivalent current dipole (ECD) to the ICA topography

Remark: All analysis was done using MNE-Python, FreeSurfer and Nilearn.
Remark: We only used the MEG channels
Remark: We used Picard[1] to compute ICA

[1] Pierre Ablin, Jean-Francois Cardoso, Alexandre Gramfort Faster independent component analysis by preconditioning with Hessian approximations IEEE Transactions on Signal Processing, 2018

Raw cleaned data

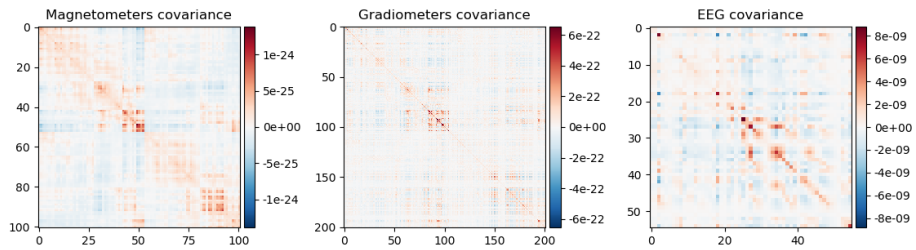


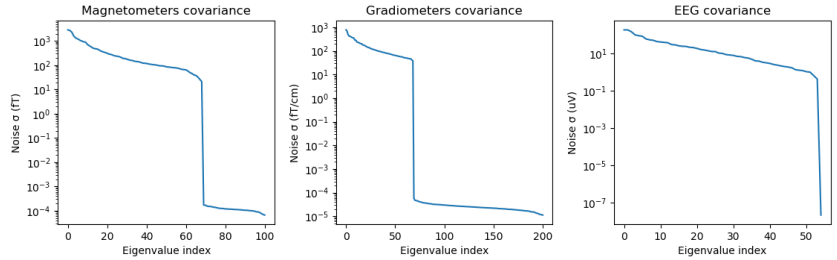
Remark: We used visual inspection of the signal to select the time of interest and mark bad channels. Here follows a summary:

	226	245	251
time interval (in sec.):	(-6, 2)	(-6, 3)	(-10, 10)
num. of bad channels:	14	32	61

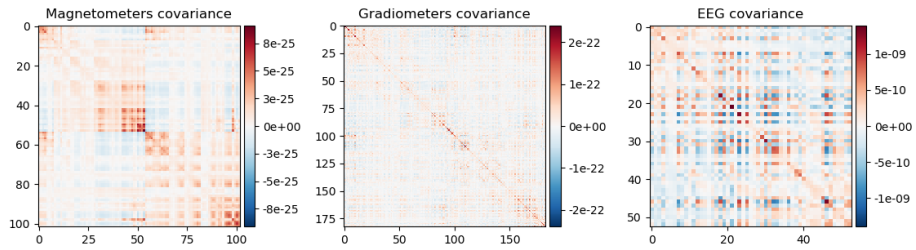
Noise covariance analysis

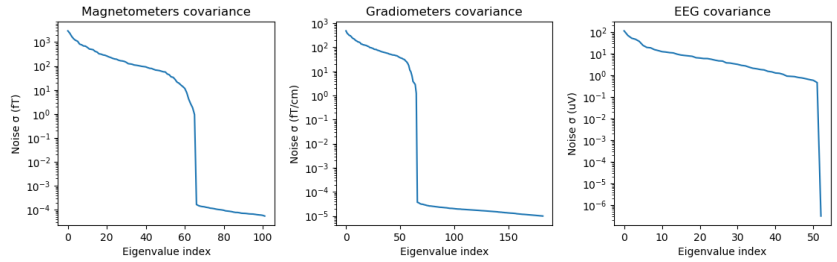
226



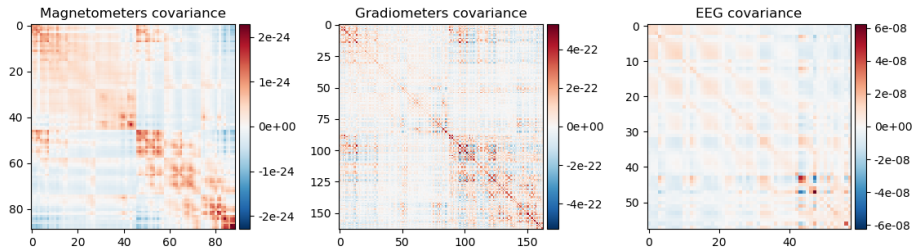


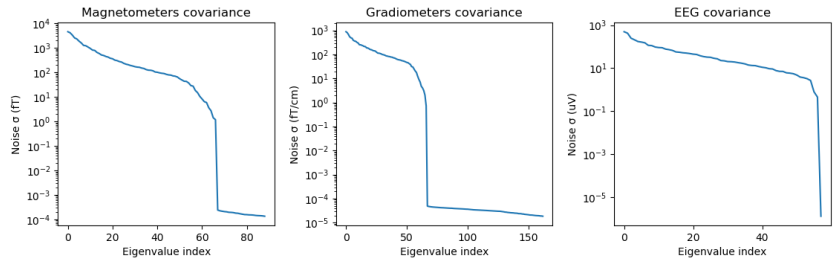
245





251

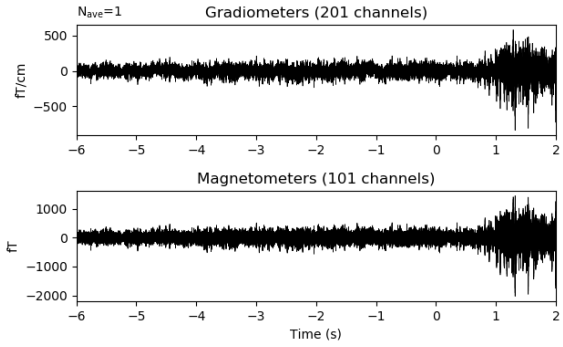


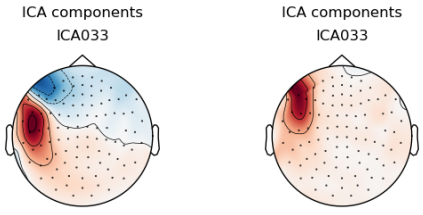


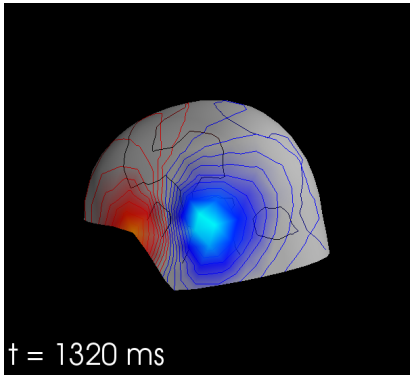
Remark: We also used the covariance of the noise to spot high-variance channels that we marked as bad (left figure shows final results). Finally we use the rank of the resulting noise covariance matrices (right figures) to set the number of ICA components.

Manually selected ICA component

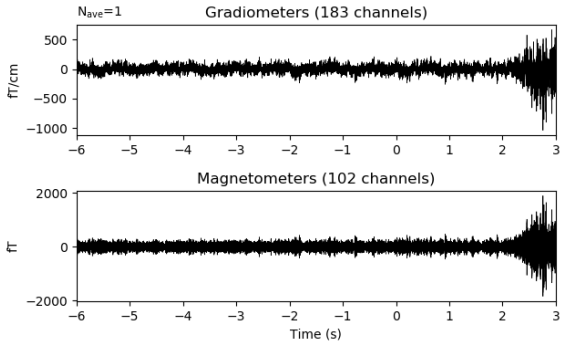
226

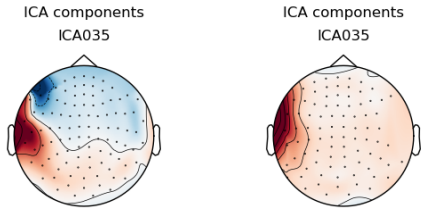


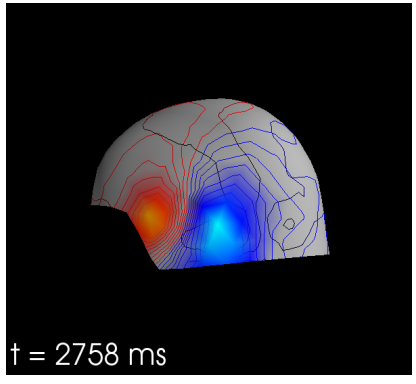




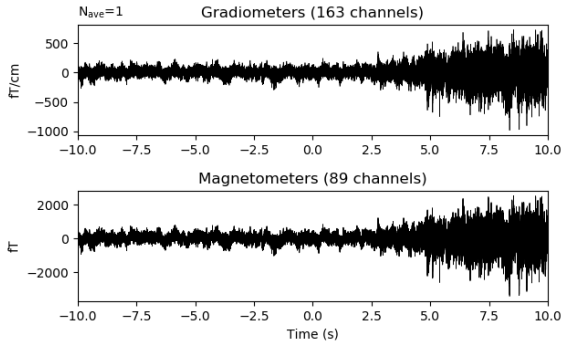
245

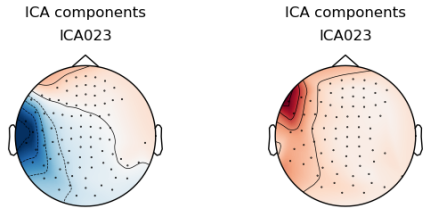


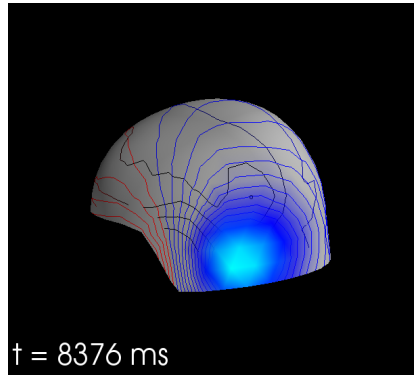




251

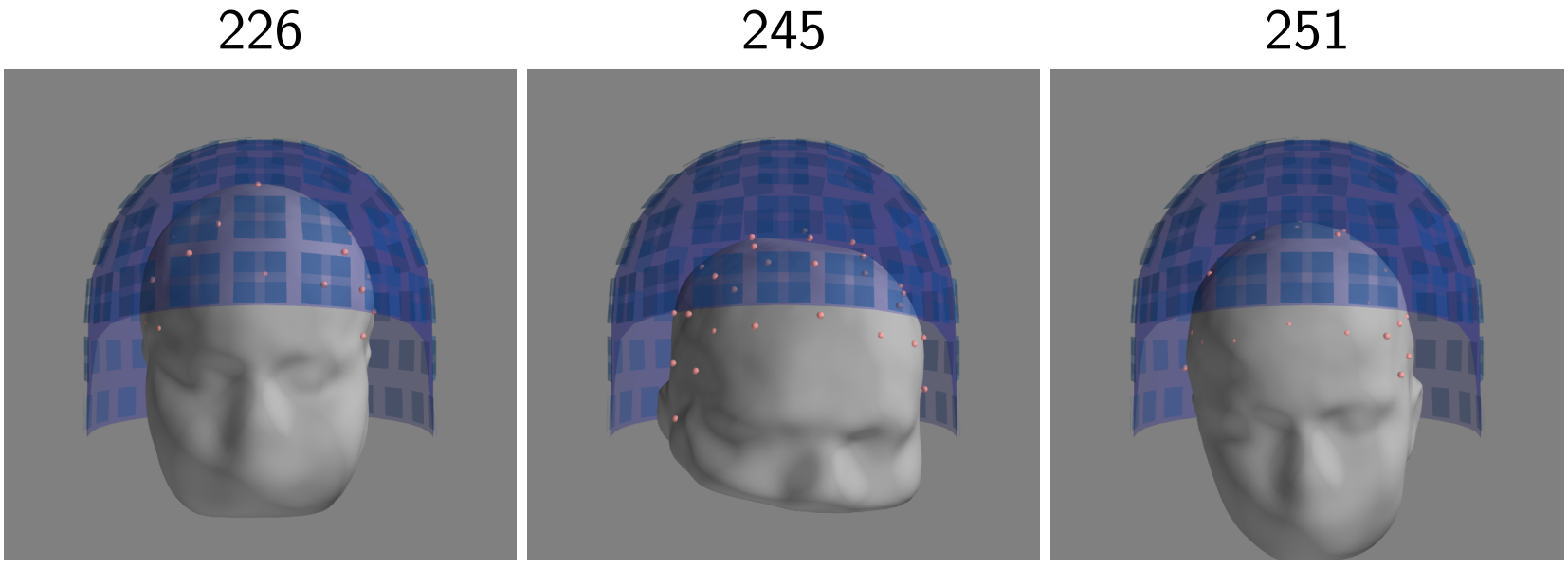






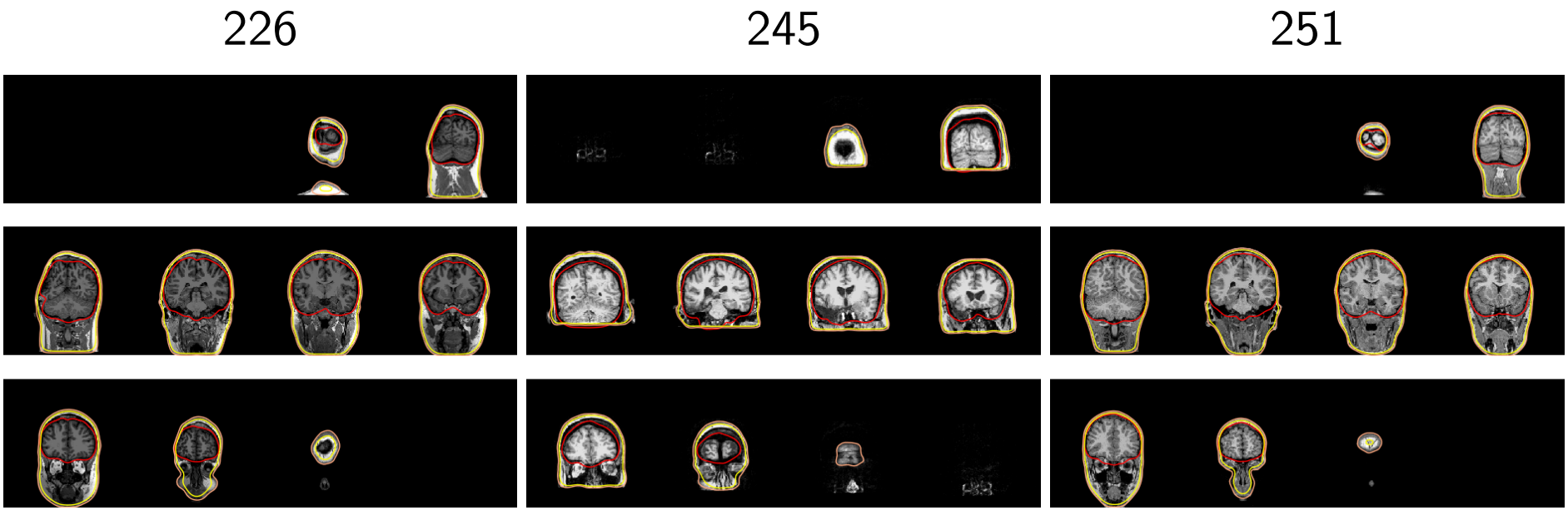
Remark: From all the ICA components, we manually selected the one which was both dipolar and temporally correlated with the seizure onset.

Coregistration



Remark: Coregistrations for 245 and 251 exhibit tilted heads which could suggest poor alignment of the MRI-device coordinates. Although it is hard to assess without pictures of the acquisition.

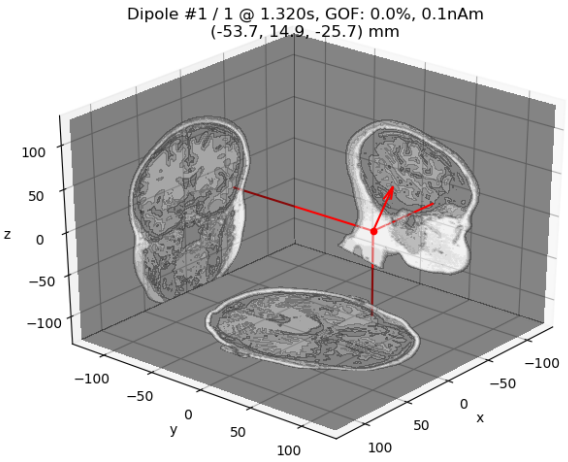
Boundary Element Model

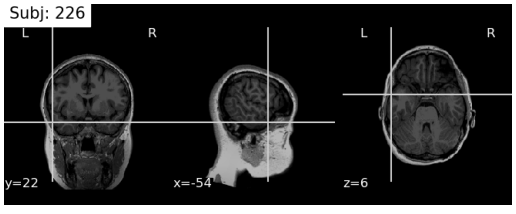


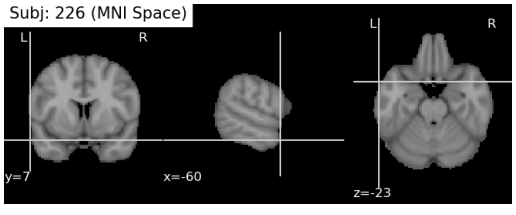
Remark: We use a Boundary Element Method (BEM) with one layer to solve the forward problem.

Fit an equivalent current dipole (ECD)

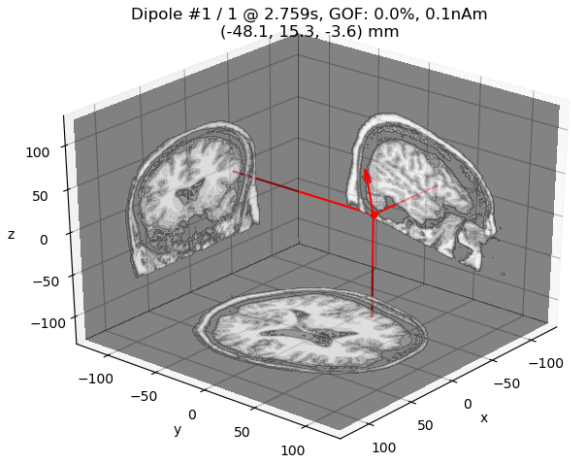
226

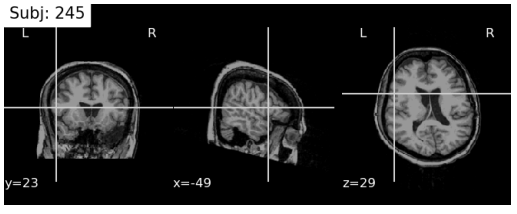


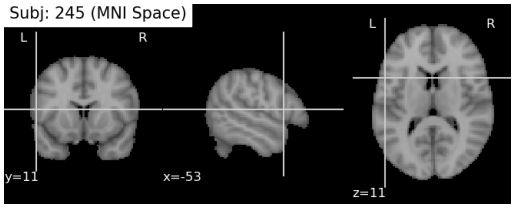




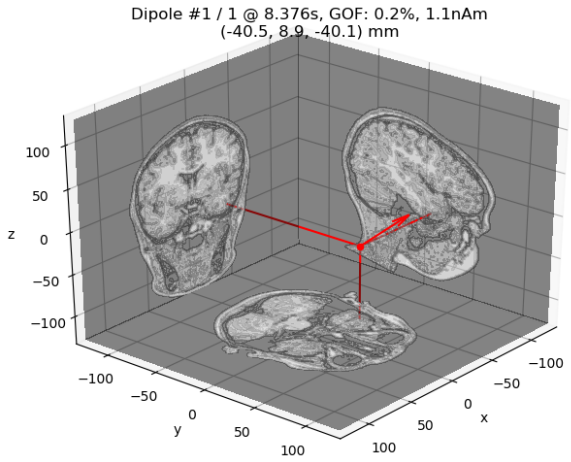
245

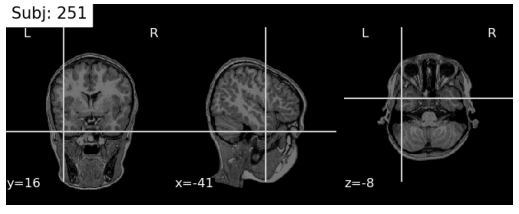


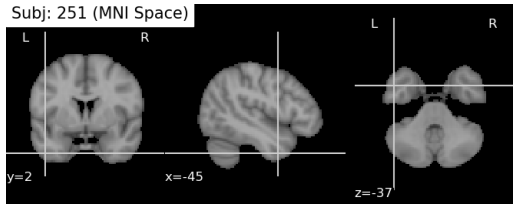




251







1st row: Dipole location in subject's MRI in 3D.

2nd row: Dipole location in subject's MRI coordinates (2D slices)

3rd row: Dipole location in subject's MNI template brain (2D slices)

Results Summary

	MNI			TAL		
	x	y	z	x	y	z
226:	-60	7	-23	-58	2	-17
245:	-53	11	11	-50	8	12
251:	-45	2	-37	-44	-2	-29

Table 1: ECD location for each subject using MNI and TAL template brain coordinates.

Remark: TAL coordinates were computed from MNI coordinates using this Bioimage Suit webtool.