Electrophysiology

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Contents

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Group term for:

- Local field potentials (single cell, multi-unit recordings)
- Electrocorticography (ECoG)
- Electroencephalography (EEG)
- Magnetoencephalography (MEG)

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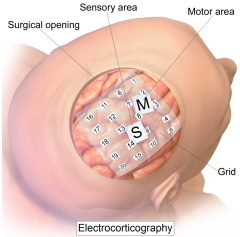
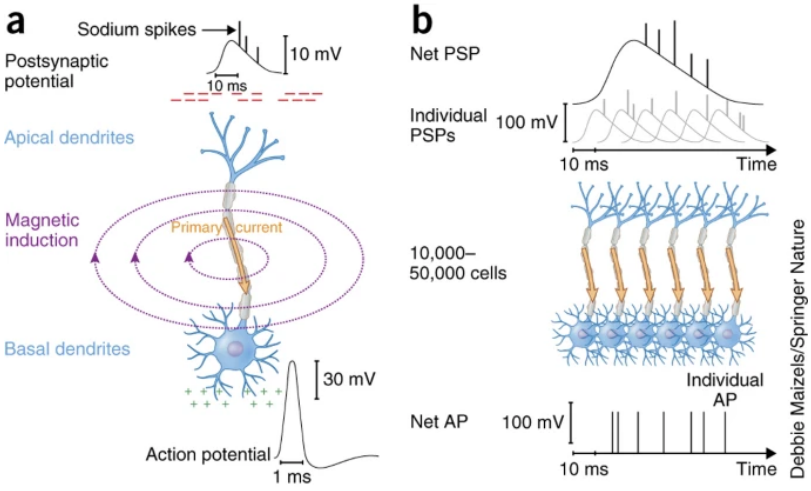


(Figure from https://en.wikipedia.org/wiki/Electrocorticography)

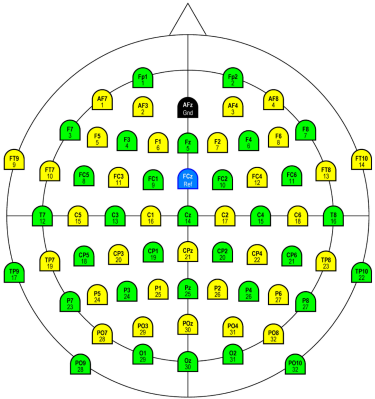
Origin of the EEG & MEG signal



(Figure from Baillet, 2017)

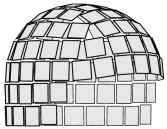
Electroencephalography (EEG)

Brianproducts cap

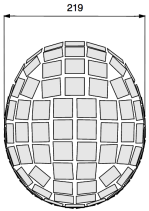


Brianproducts acticap standard layout

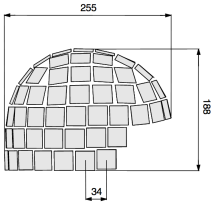
Magnetoencephalography (MEG)



Sensor array, right frontal view



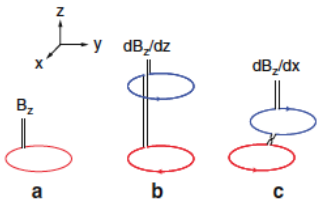
Sensor array, top view



Sensor array, side view.

MEG sensor types

Fig. 3 Typical pickup coils used in MEG measurements. (a) Magnetometer, (b) axial first-order gradiometer, and (c) planar first-order gradiometer



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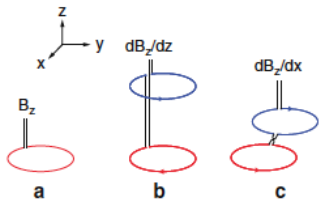
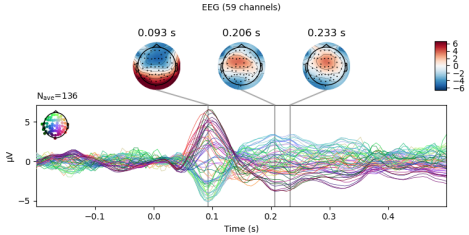


(Fig 3 from Lee & Kim, 2019, Sensors helmet: stock photo)

Comparing EEG & MEG



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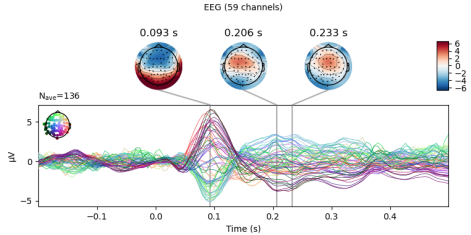

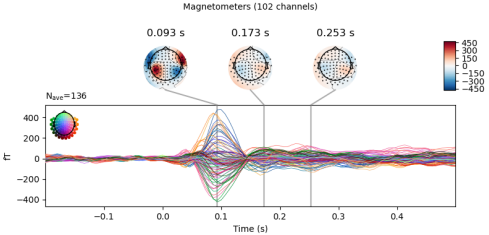

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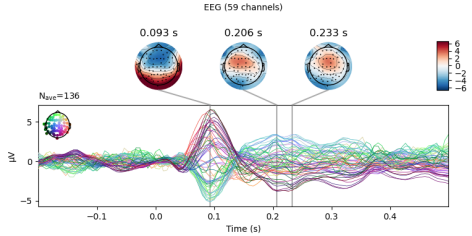
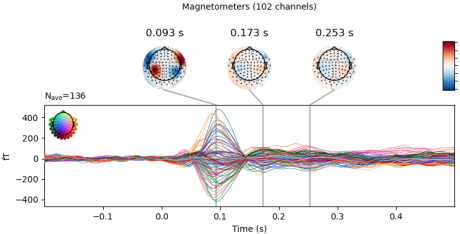
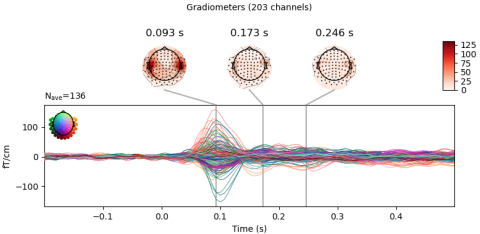
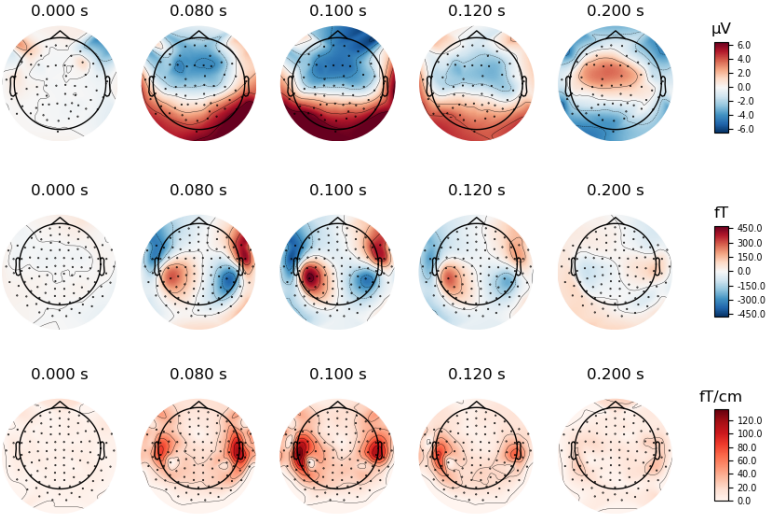




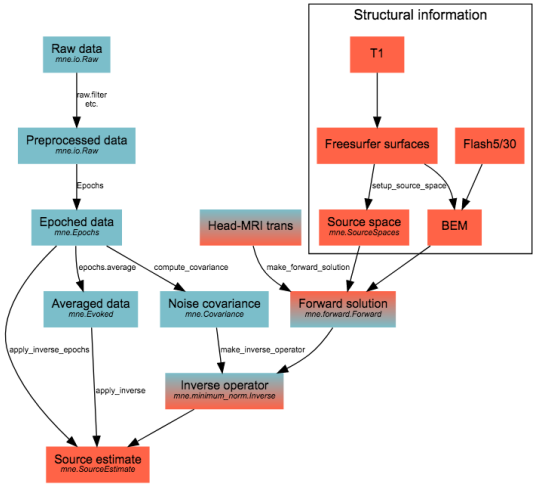


Comparing EEG & MEG: topographies



Processing of EEG/MEG data

Workflow



(Figure from https://mne.tools/stable/overview/cookbook.html)

Preprocessing: standard steps

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- Lowpass filter

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  Methods:

Preprocessing: standard steps

- Lowpass filter
- Highpass filter
- Artefact rejection
  - Ocular artifacts (EOG)
  - Heartbeat artifacts (ECG)
  - Power line noise

  Methods:
  - Thresholding

Preprocessing: standard steps

- Lowpass filter
- Highpass filter
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  - Ocular artifacts (EOG)
  - Heartbeat artifacts (ECG)
  - Power line noise

  Methods:
  - Thresholding
  - ICA

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- Lowpass filter
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  - Heartbeat artifacts (ECG)
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  Methods:
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  - ICA
- (Rereference)

Preprocessing: standard steps

- Lowpass filter
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  - Heartbeat artifacts (ECG)
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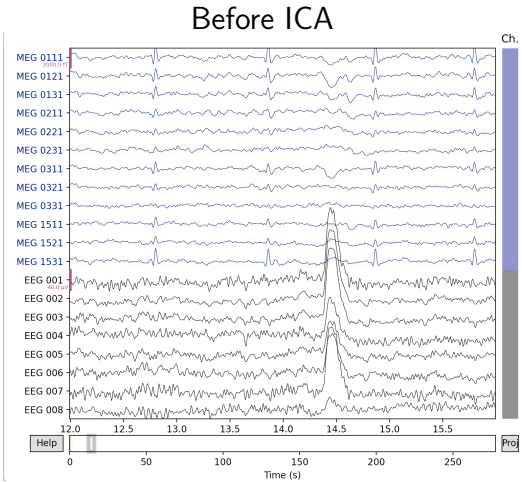
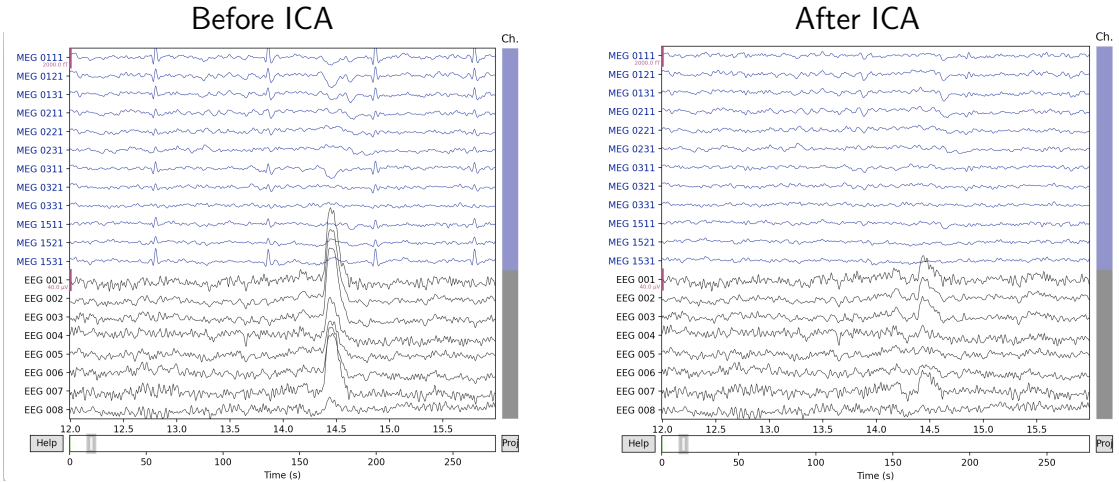
  Methods:
  - Thresholding
  - ICA
- (Rereference)
- Epoching

ICA



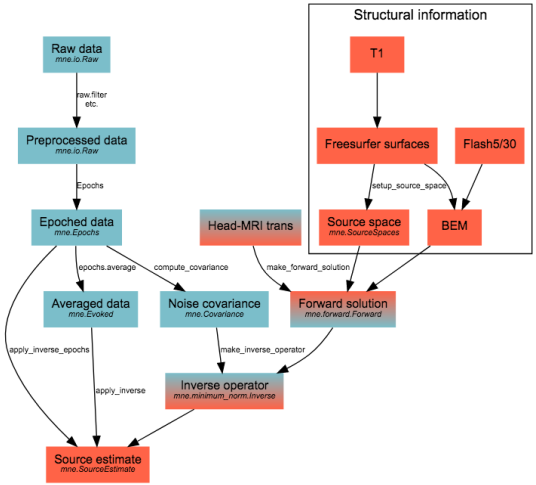
(Figure from https://mne.tools/stable/auto_tutorials/intro/plot_10_overview.html)

ICA



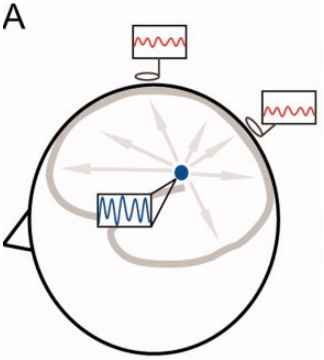
(Figure from https://mne.tools/stable/auto_tutorials/intro/plot_10_overview.html)

Workflow



(Figure from https://mne.tools/stable/overview/cookbook.html)

Volume conduction



(Figure from Schoffelen & Gross, 2009)

Volume conduction

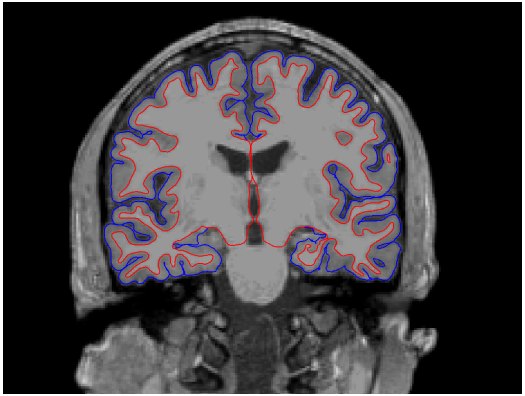
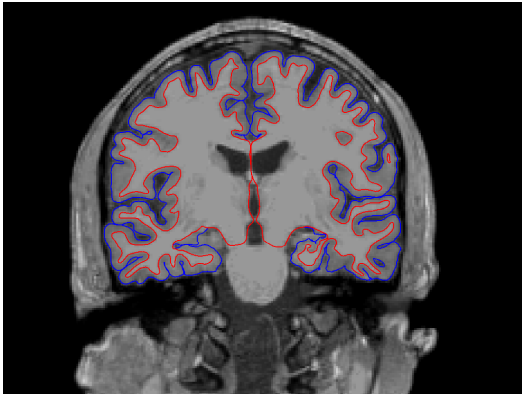


Fig: MNE sample data, made with Freeview

Volume conduction



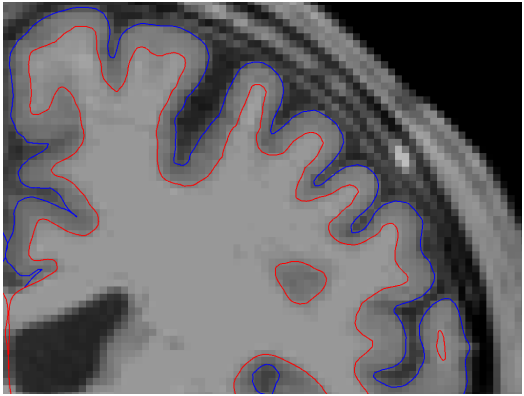
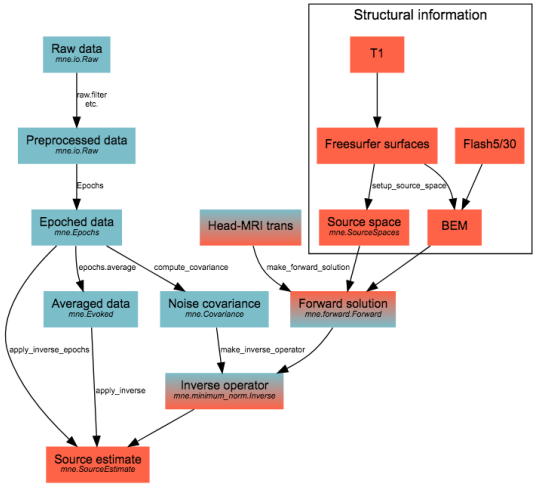


Fig: MNE sample data, made with Freeview

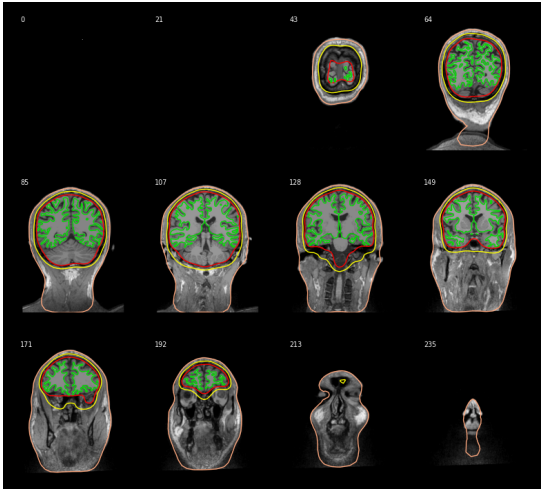
Source reconstruction

Workflow



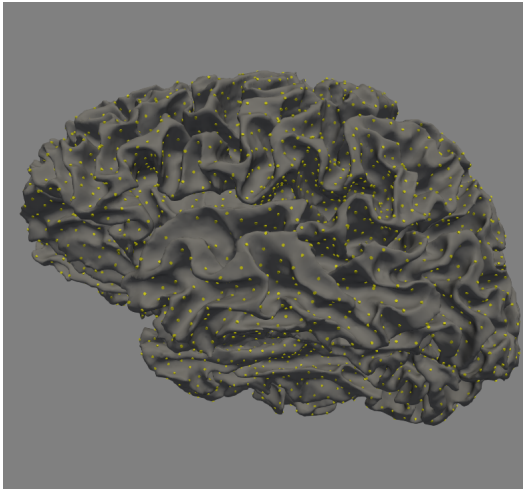
(Figure from https://mne.tools/stable/overview/cookbook.html)

Boundary element method (BEM)



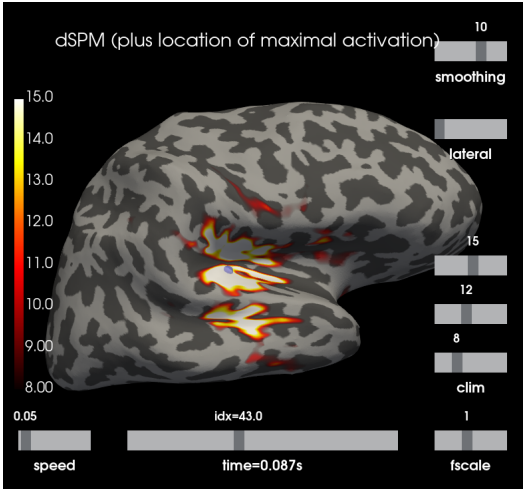
(Figure from https://mne.tools/stable/auto_tutorials/source-modeling/plot_forward.html)

Surface based source space



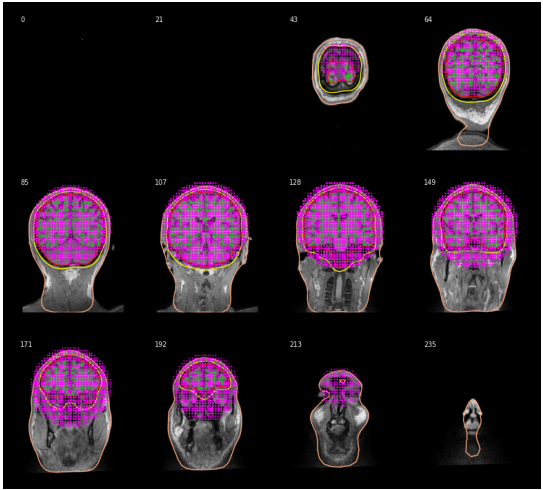
(Figure from https://mne.tools/stable/auto_tutorials/source-modeling/plot_forward.html)

Source reconstruction: Minimum-norm estimation (MNE)



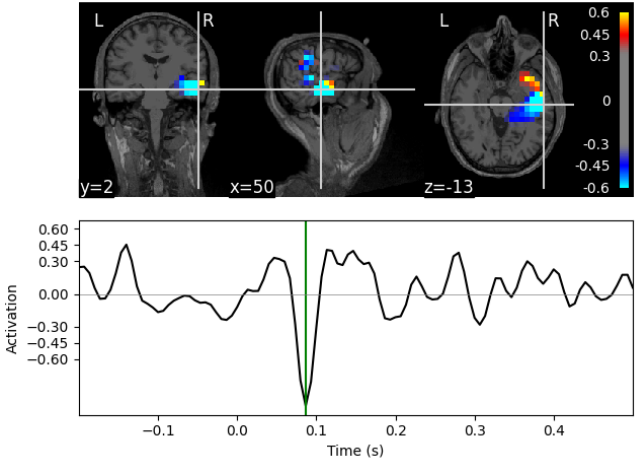
(Figure from https://mne.tools/stable/auto_tutorials/source-modeling/plot_mne_dspm_source_localization.html)

Volumetric source space



(Figure from https://mne.tools/stable/auto_tutorials/source-modeling/plot_forward.html)

Source reconstruction: LCMV beamformer



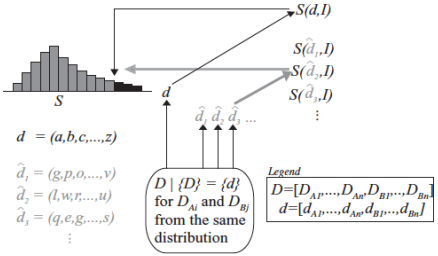
(Figure from https://mne.tools/stable/auto_tutorials/source-modeling/plot_mne_dspm_source_localization.html)

Statistical assessment of M/EEG data

Permutation tests

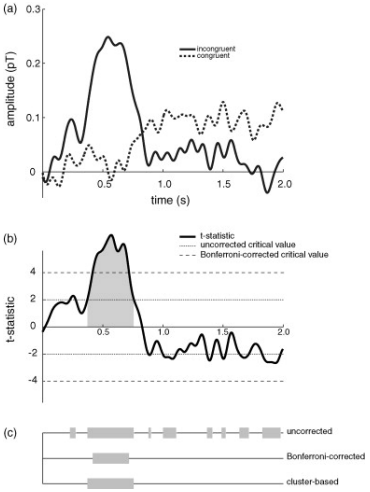
Pros:

- Works with non-Gaussian data
- Can handle multiple comparisons problem



(Figure from Maris, 2012)

Permutation tests



(Figure from Maris & Oostenveld, 2007)

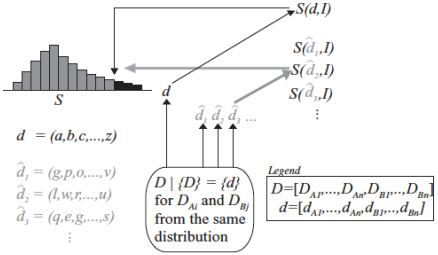
Permutation tests

Pros:

- Works with non-Gaussian data
- Can handle multiple comparisons problem

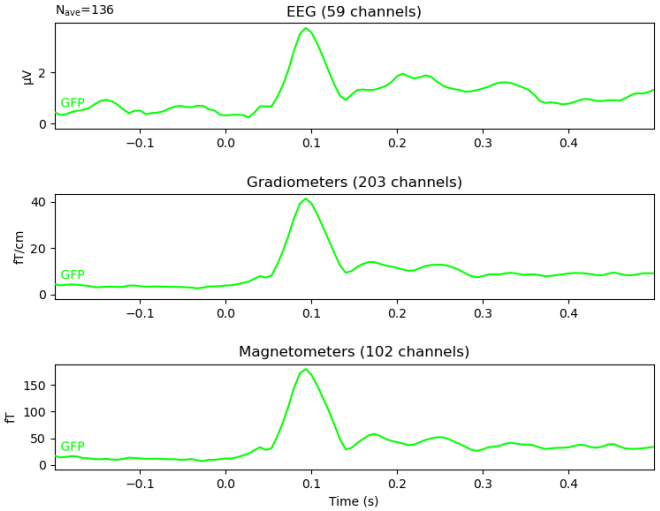
Cons:

- Only tell us that there is *a* difference



(Figure from Maris, 2012)

Global field power



Optically-pumped magnetometers (OPMs)

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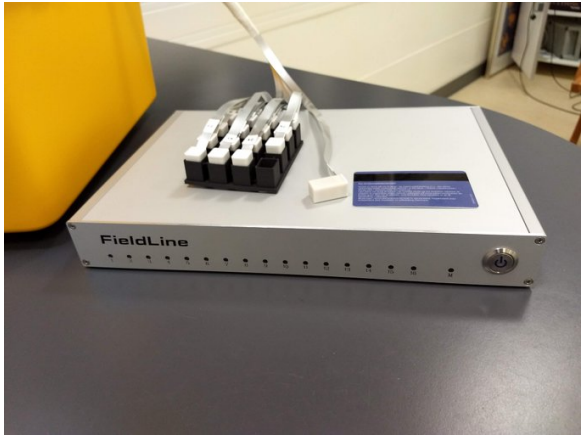

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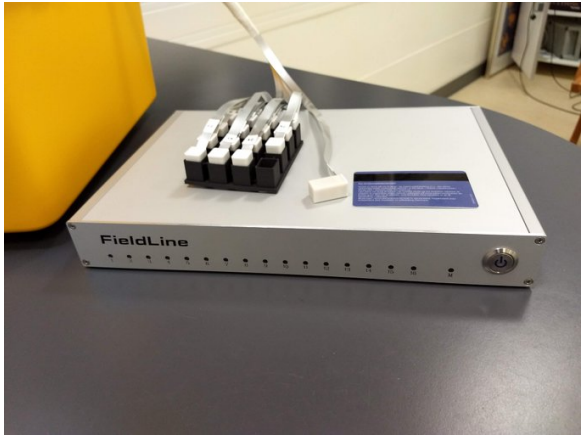

Questions?

References I

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