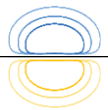
Preparation of the participant

EOG, ECG, HPI coils : what, why and how



Introduction

In this module you will learn why EEG, ECG and HPI coils are important and how to attach them to the participant.

The video titled subject's preparation shows how to prepare the subject and place the different material.

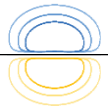
Materiel needed for the preparation

Treatment of the participant

You are going to touch the skin of your participant. You should have clean hand and nails before doing it. Hand sanitizer is at your disposal in the lab.

1. You need to scrub the regions of the face and neck where you are going to place the electrodes. Scrubbing the skin will allow a good impedance of the electrodes and thus a good signal will be recorded. To scrub the skin, we use an abrasive gel on a cotton pad. Make sure to scrub gently. You do not need to scrub much, 3 to 5 circular wipes are enough. Be careful not to scrub to hard, you don t want to hurt your participant.
2. Once you are done, you will now use alcohol pads to get rid of the abrasive gel on the same regions and degreased the skin. Cleaning the skin with alcohol will degrease the skin and allow the electrodes to stick better. You should also use the alcohol to clean the surface of the skin where the HPI are going to be placed.

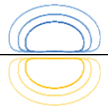
Do not forget to ask your participant to notify you if you are not scrubbing to hard or if the product don t hurt him/her.



Material : Electrodes

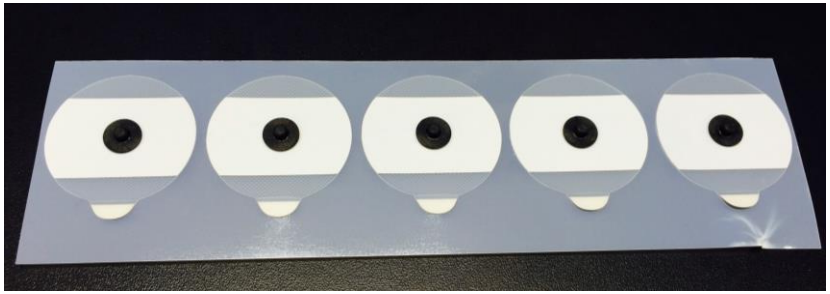
Simultaneous acquisition of EOG (horizontal and vertical) and ECG is recommended for several reasons (From Gross et al. 2013 Neuroimage. *Good practice for conducting and reporting MEG research*):

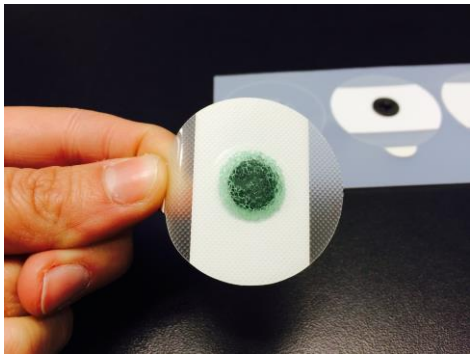
- Eye movements/blinks may be induced by experimental conditions, task and instructions in a non-trivial way (Picton et al., 2000). **Recording the EOG allows for comparison of eye movements/blinks between conditions.**
- The magnetic field generated by the heart is several orders of magnitude stronger than the field generated by the brain and may contribute as a strong source of artifacts to the data recorded at the MEG sensors. **ECG components in the data may have a detrimental effect on source reconstruction and confound the interpretation of connectivity estimates.**
- In general, both EOG and ECG components can have a **detrimental effect** on single trial analysis (e.g. by affecting single trial phase and amplitude estimates to a variable degree at different frequencies).
- EOG/ECG signals **facilitate artifact rejection and correction** by acting as references.



Material : Electrodes

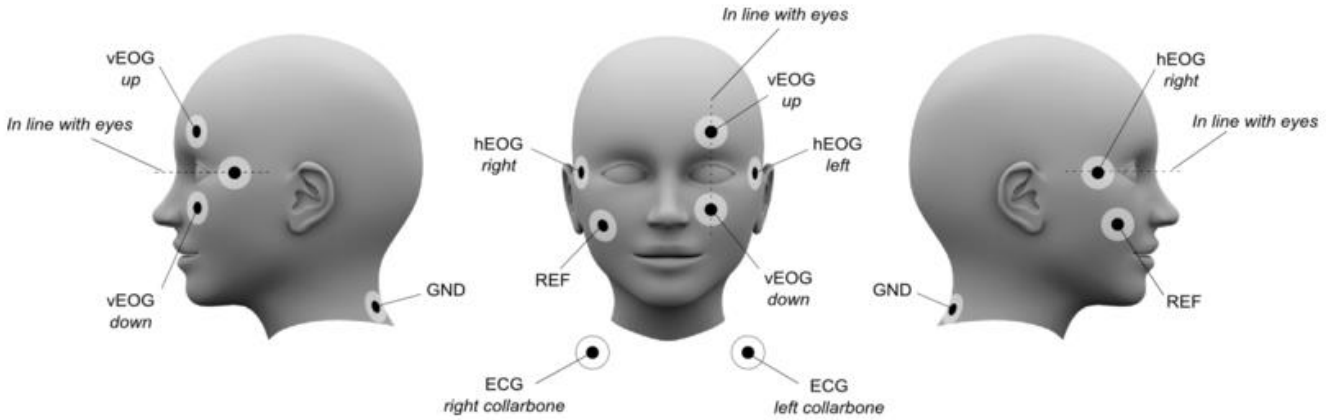
The bipolar electrodes are connected to the electrode interface panel on the side panel of the gantry inside the magnetically shielded room.





adhesive disposable Pre-gelled electrodes used for EOG and ECG.

Seven electrodes will be placed on the face and neck of the participant.



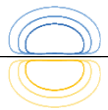
Placement of the EOG and ECG electrodes

Material : Electrodes

The disposable electrodes already contain conductive gel in the center, so you don't need to add any yourself. When placing the electrode, apply pressure around the electrode on the white surface. Do not press on the center to avoid spreading the gel underneath the adhesive border.

We start by attaching the electrodes above the collarbones. Then we place the ground electrode at the back of the neck.

The adhesive electrodes are large, so for the 4 electrodes around the eyes we cut them so they can be placed closer to the eyes. When placing the 4 electrodes around the eyes make sure that the electrodes are in line with the eyes: horizontally and vertically in line with the center of the eye.



Material : Impedance meter

Impedance needs to be check to verify if the electrodes make a good contact with the skin and thus if you will record a good signal. If the impedance is below 20 kOhm the signal will be good (the smaller the better) but if it above this threshold then you might want to improve the impedance by cleaning the skin again and placing new electrodes. To measure the impedance we use an impedance meter.

Impedance meter with cables

Material : Impedance meter

1 - Connect the three cables to the electrodes according to the label.

2 – Click in the middle white button to turn SIGGI on and select Impedance .

2 – Click in the middle white button to turn SIGGI on

select Impedance by pressing again on the white button.

Material : Impedance meter

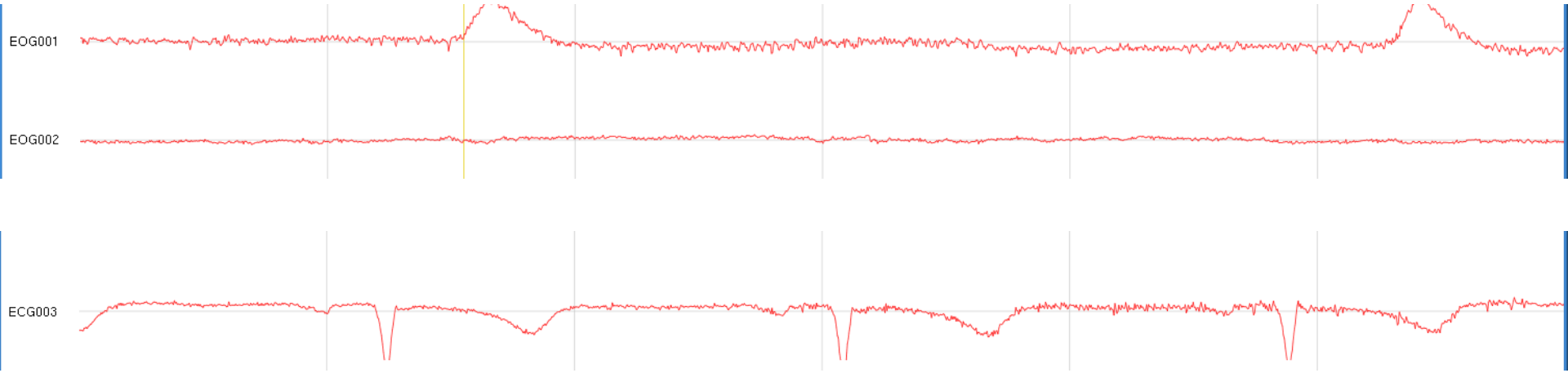
3 – Read the impedance for each channel

Impedance for the electrode attached to the cable

Impedance for the Reference

Impedance for the Ground

During the MEG recording you are able to visualized the EEG end ECG.



Once the participant is in the scanner and before your experiment start, to verify the signal from the EEG and ECG, you are encouraged to ask your participant to blink many times. You can check quickly if the signal from the EOG is good.
You also should check the quality of the ECG signal before the experiment start by visualizing it.

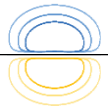
Module: Digitalization

HPIcoils and anatomical landmarks

why and how

Why

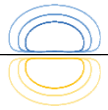
Head positioning should be monitored either continuously throughout the acquisition or at the start and end of the recording. The MEG acquisition is done only with respect to the MEG device, instead of the anatomy of the subject. Therefore, MEG devices include a subsystem to determine the position of the head with respect to the MEG sensors. As MEG (unlike MRI) cannot directly measure the position of the head, small coils known as Head Position Indicator coils (HPI) placed at known locations on the scalp of the subject, when energized, will generate a magnetic field that helps us to localize the position of head in a three-dimensional space, with respect to the MEG sensor array. If continuous head position tracking is enabled, generally small movements are acceptable with a maximum error of 5 mm.



Why

Information about the patient's head position, orientation, and shape is obtained by digitizing (3D digitizer) the standard fiducial points, HPI coils, and the required additional points creating Cartesian co-ordinates in a 3D space. Digitization of four HPI coils, and landmarks, which include three bony fiducial points (Nasion, left, and right pre-auricular points), and additional points, is performed

The HPI coil positions, and hence the head position, are estimated from the coil signals. This estimation is done several times per second, allowing the system to track also relatively fast movements. Once the head position is estimated, the MEG signals are transformed to a reference head position. This conversion is sequentially performed at each time point throughout the continuous (raw) data file.



Material : HPI coils

In order to be able to locate signal sources relative to the head, one must know the position of the head within the probe. For this purpose we use a head position indicator (HPI) system. Before the measurement, one attaches small coils with skin tape to the head and digitizes their locations on the head.

Before and during recording a small current will run through the HPI coils. This generates magnetic fields that can be localized in the helmet. It is very important to make sure that all the coils are well fixated to the subject's head so they don´t move. Five coils are available but we are going to use only 4 (we discard the YELLOW one).

HPI coils

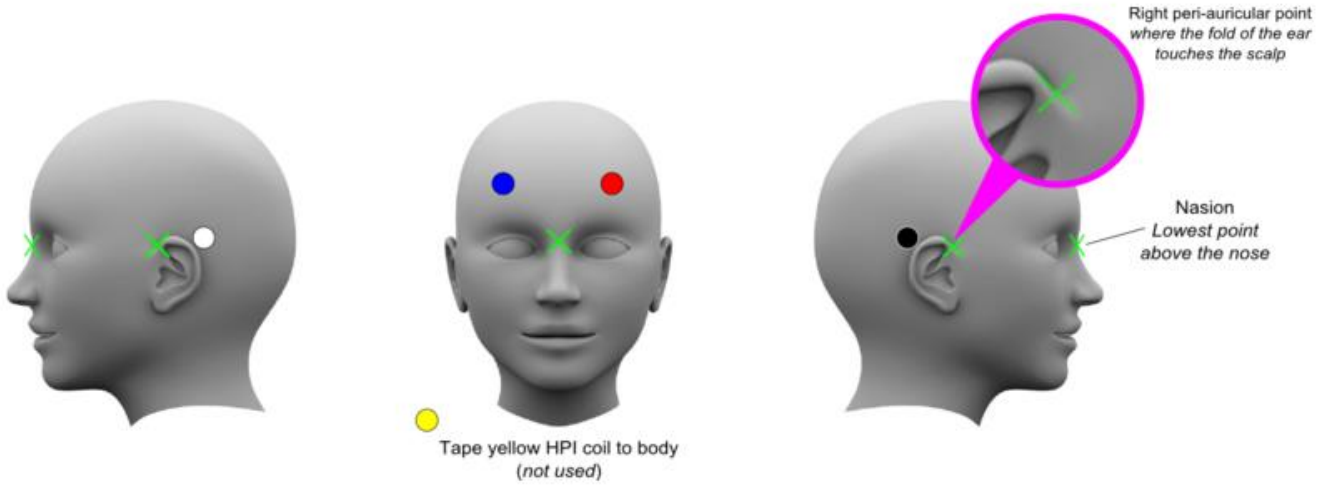
Material : HPI coils

The coils are placed so that two are behind the ears as high as possible without being on the hair, and two on the forehead well separated but not on the hair. The four coils needs to be inside the MEG helmet.

The most precise HPI information is obtained when the coils are as far apart as possible but still within the sensor helmet. Try avoiding situation where coils form a nearly perfect square.

The figure below shows where to place the coils on the head. The color are important 4 coils are used during the measurement (the yellow coils is discarded).

CAUTION! Do not use conducting EEG paste to attach HPI coils.



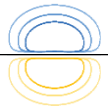
Placement of the HPI coils

Digitalization

The digitization system is equipped with a tracker which trace head movements during the digitization. **The subject should be seated on the HPI chair. Place the tracker firmly on the subject's head with skin tape.** This should not move during the digitalization. Check that nasion and the coil centers are still accessible with the Isotrak stylus.

Make sure the digitization chair is sufficiently far (over 1.5 m) from large metal objects and that the door to the MSR and the door of the cabinet are closed as they severely distort the digitizer and compromise its accuracy. Tell the subject to avoid excessive head movement.

The digitization can be done from the acquisition computer, but to make it easy we have installed an external terminal and a touch screen on the wall next to the Polhemus. You have to make sure that the polhemus is turned on and that the digitalize program on the acquisition system is not open. If it is, you need to close it before starting.

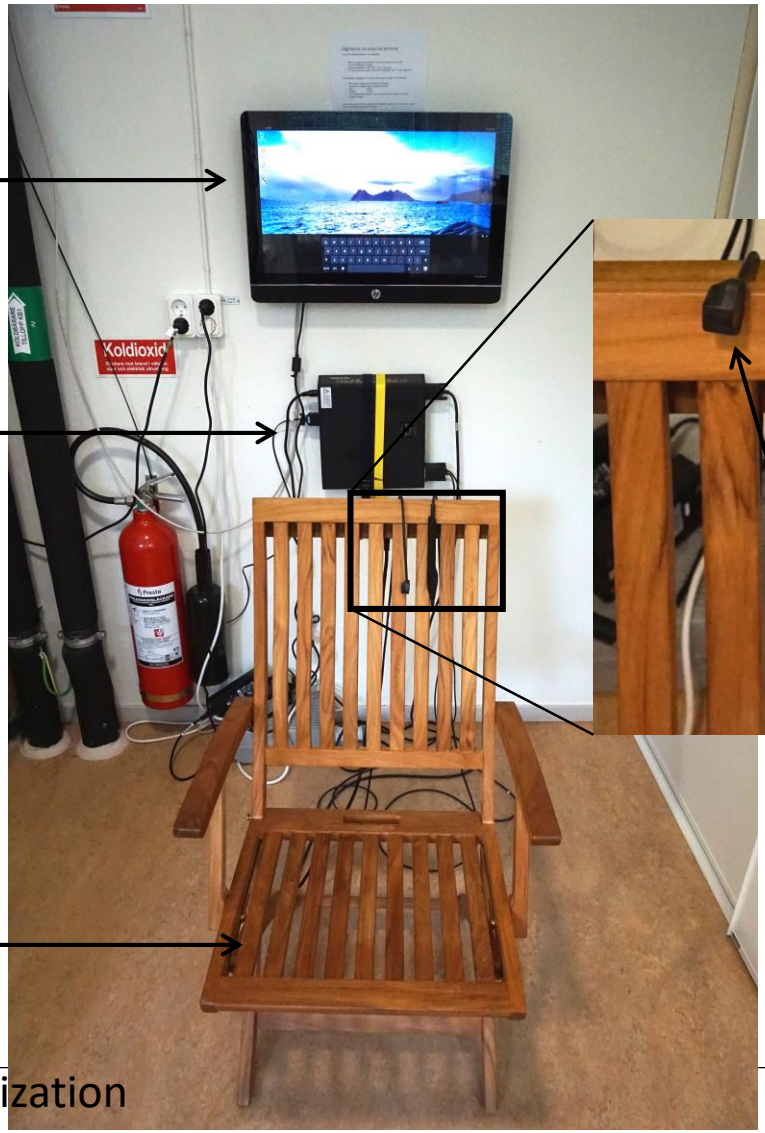


Digitalization

External terminal
Touch screen

Polhemus
On/off switch
button

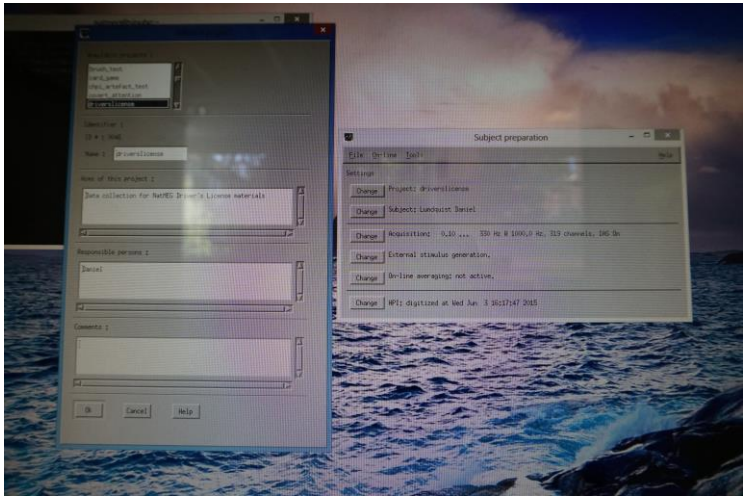
HPI chair

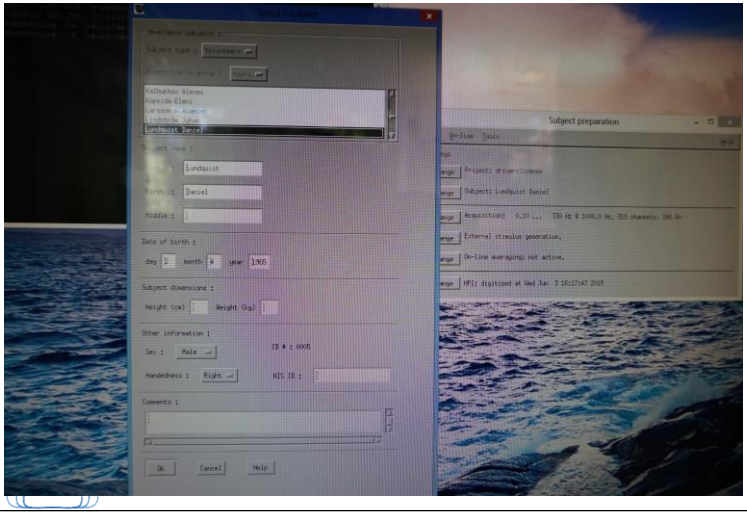


Tracker
Need to be attached between the eyebrows of the subject with skin tape.

Isotrak stylus

Digitalization





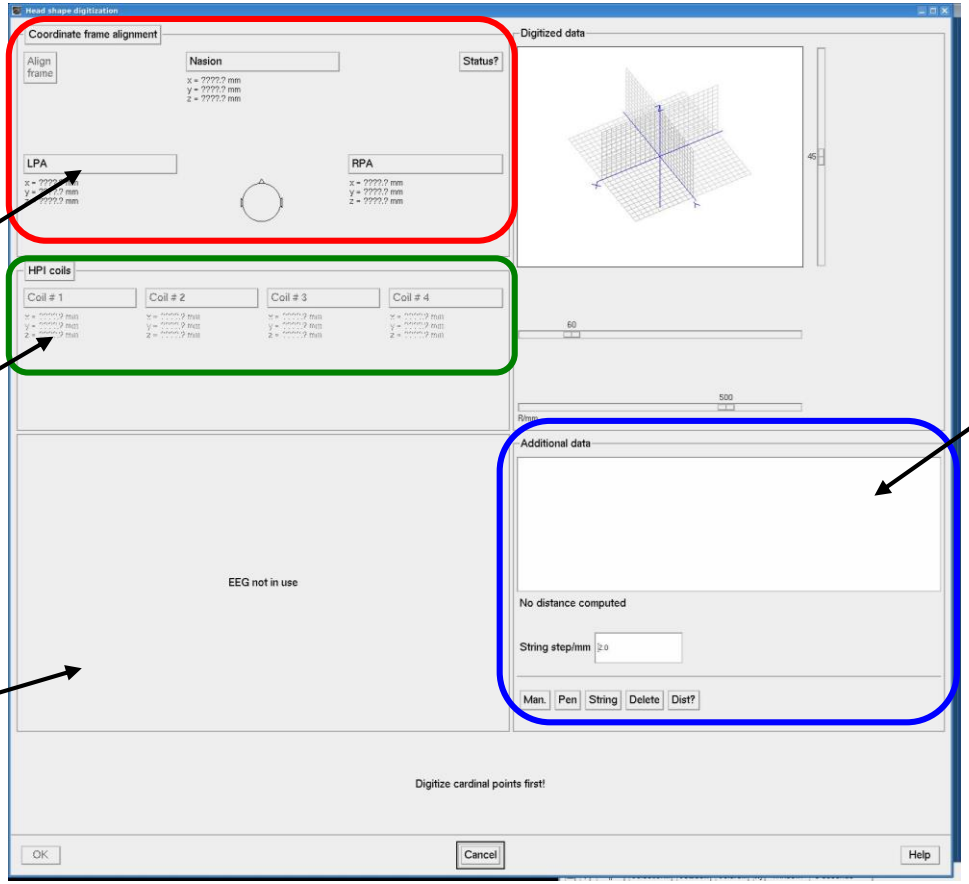
Tap on the touch screen to turn it on.
Press the first change button to select your project on the menu.
Then, press the second Change button to select your subject.

Finally press the last Change button to start the HPI dialog. When you click the HPI **Change** button, *megacq* connects to and initializes the 3D digitizer (also referred as “Isotrak” in the software) used for this purpose. Digitizer initialization takes a few seconds. You are informed about this in a dialog. Once the initialization is complete the HPI dialog appears.

Define coordinate frame (fiducials)

Mark HPI-coils

(EEG)

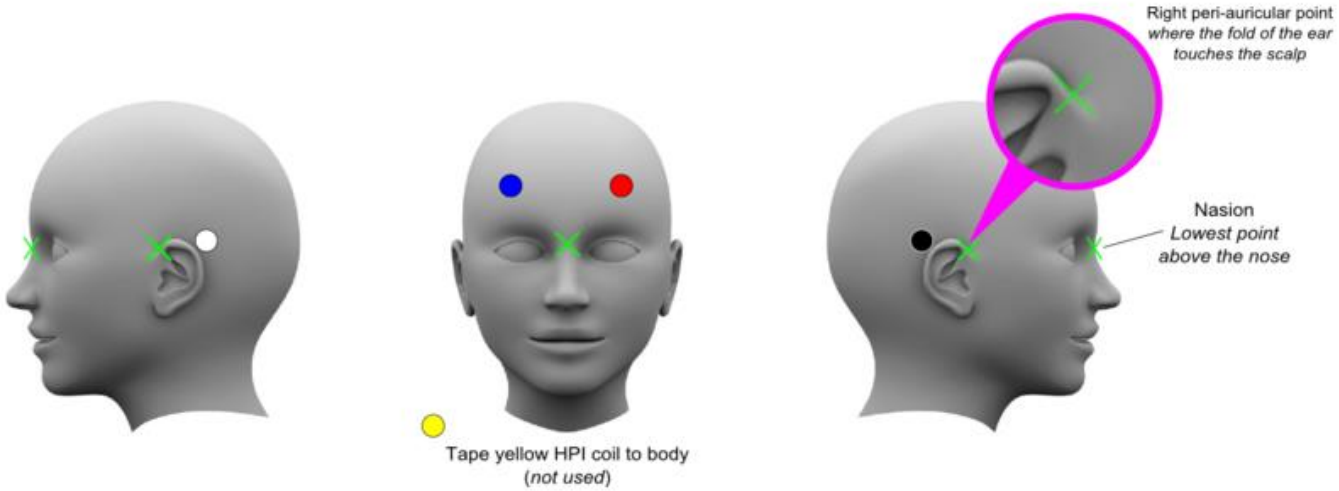


Head-points

The left section of the dialog contains the controls for the tasks which are necessary to complete the HPI procedure. The lower right section (**Additional data**) contains controls for optional items. The label above the dialog buttons will dynamically indicate the task to be performed next.

Digitalization

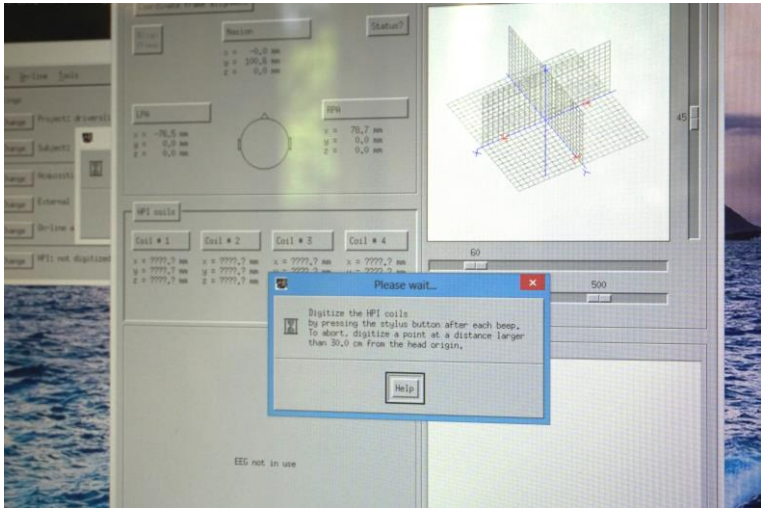
To digitize, position the tip of the 3D digitizer stylus at the desired point and click the corresponding button in the HPI dialog. Start by digitize the anatomical landmarks: the nasion and the two auricular points. Be sure to record which points were used to be able to correctly identify them later on the anatomical MR images. Digitize the landmarks in any order; the system will automatically associate the points with proper landmarks.



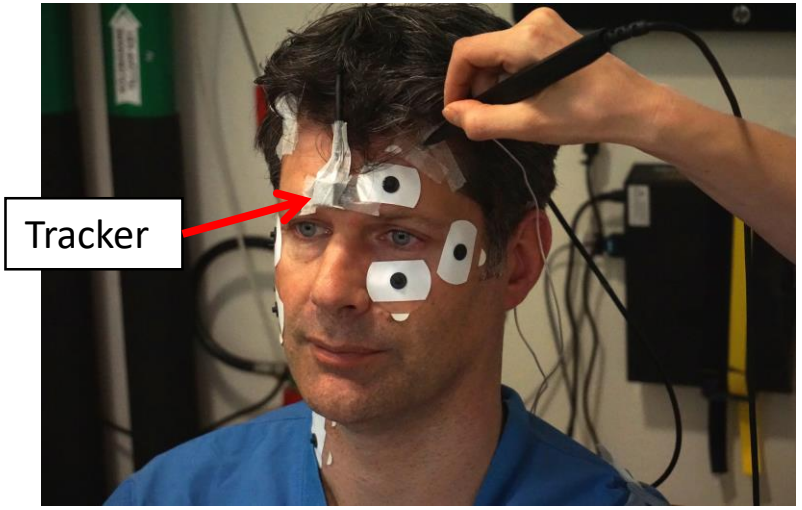
X = anatomical landmarks to digitalize

Digitalization

Digitize the HPI coils (order does not matter).
By placing the pen in the middle of the coil and press the stylus' button.



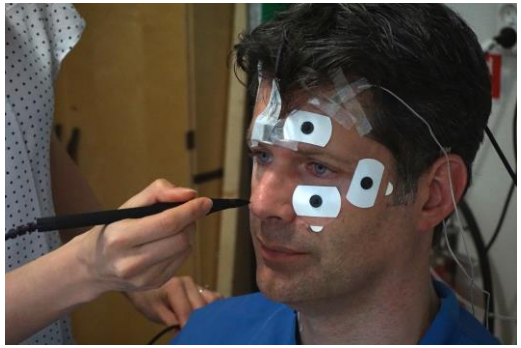
Screen shot of the touch screen
before the digitalization of the coils

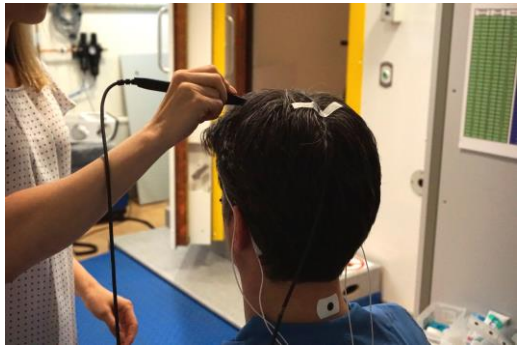


digitalization of the red coil

Digitalization

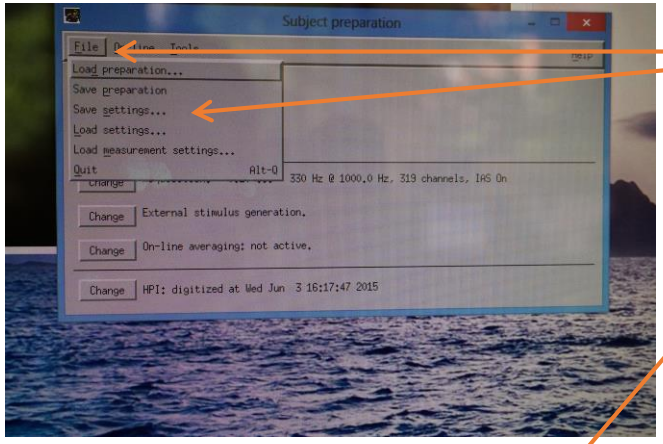
You should digitize **additional points** to obtain information about the head shape, which allows more accurate alignment with the anatomical MR images.
You can digitalized the eyebrows, nose, and the shape of the head by slicing the head into equal portions.
Press the center of the stylus continually while digitalizing those regions.
At least 150 additional points are necessary.

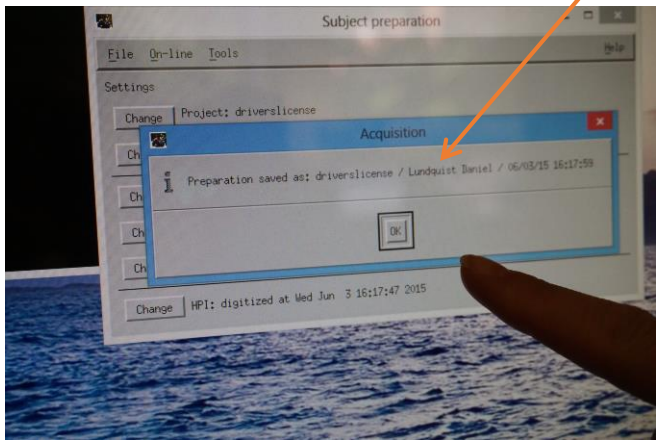




Once you have completed the digitization, place the pen in the air far away from the participant and click to finish the digitalization

Digitalization





When you are finish click on
File -> Save preparation
Note timestamp.

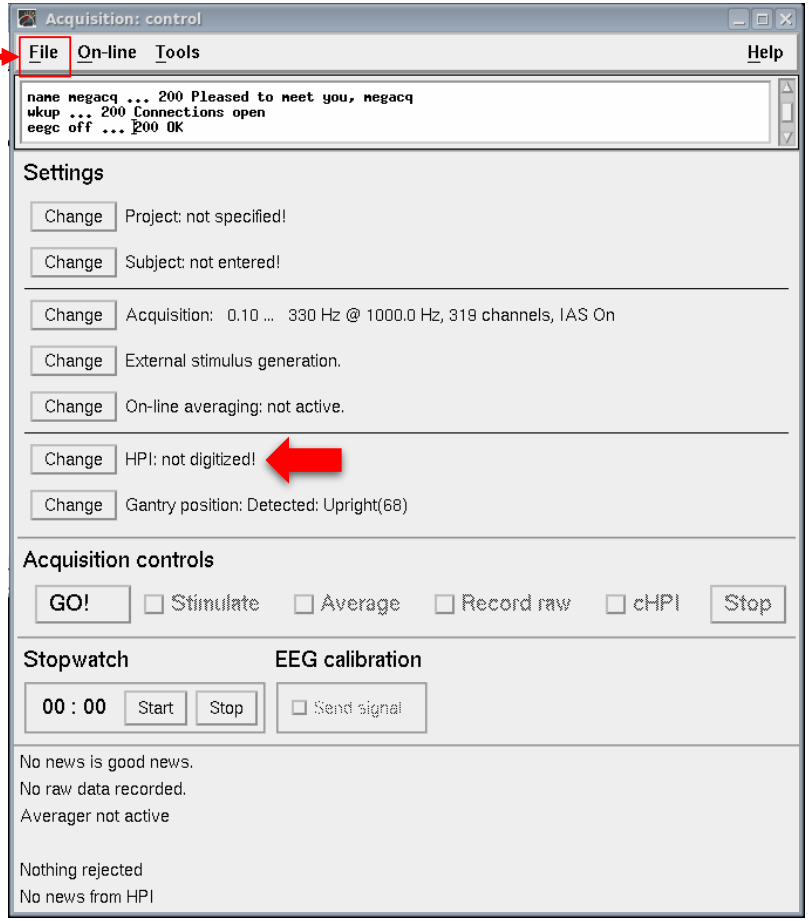
Load this preparation in Acquisition on the acquisition PC:
File -> Load preparation

Remove the tracker from the participant's forehead.

Digitalization

On Acquisition PC

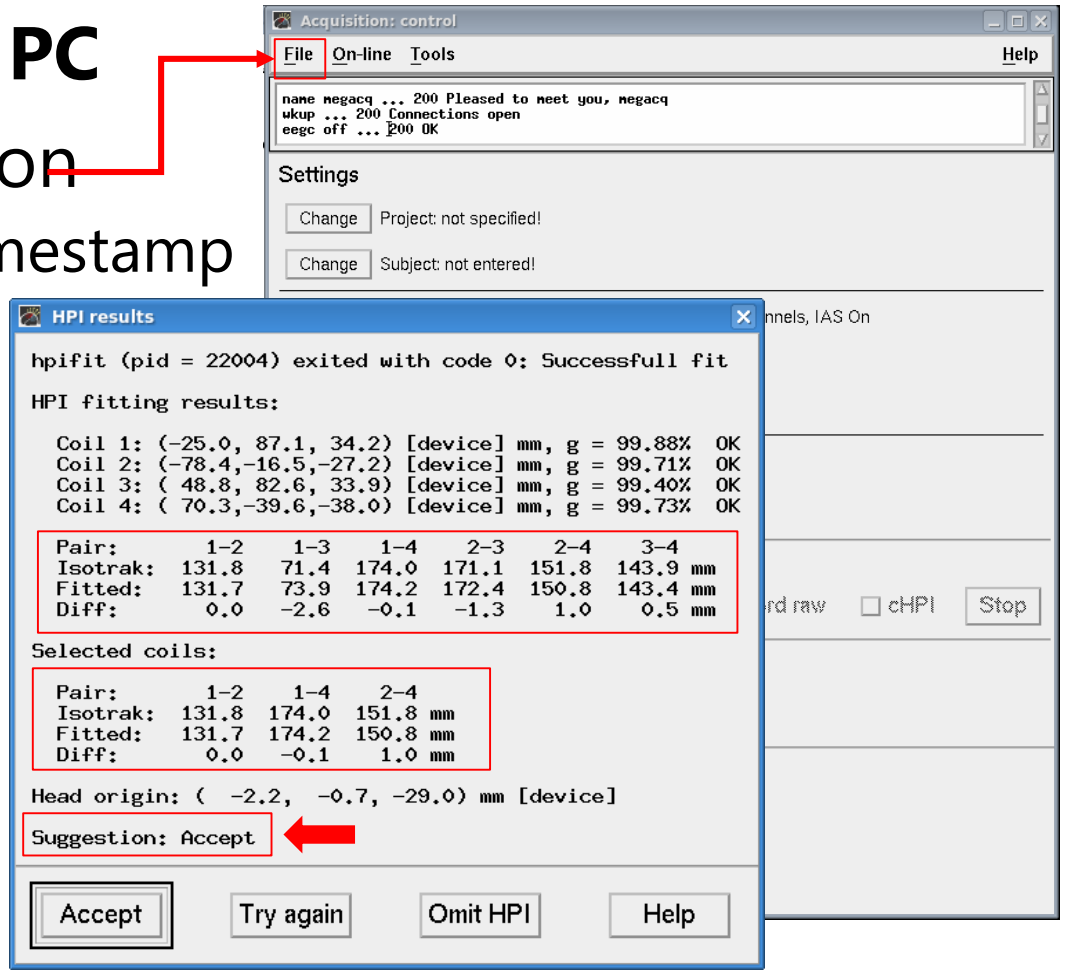
- Load preperation
  - Remember timestamp
- Press "GO"
- Check HPI fit



Digitalization

On Acquisition PC

- Load preperation
  - Remember timestamp
- Press "GO"
- Check HPI fit



How

The digitalization is now over. Your participant is ready to be placed in the MEG room.

If you want to see how to digitalize please watch the video titled : Digitalization

Thank you for taking part of this module.