Contents

September 2021

Response devices and connections with the MEG

We have a range of different response systems which you can use with your MEG study. Please check the document "Peripherical devices in the MEG lab" for a summary list with links to the specs

The fORP 932 response system

The fORP system is used by most researchers. It includes a fORP 932 interface box which can be connected to either: bimanual buttons (two buttons for each hand); a trackball with two buttons; a joystick; or bimanual grip-force transducers. More info and specs about these devices can be found in the Peripherical Devices document on the WIN intranet.

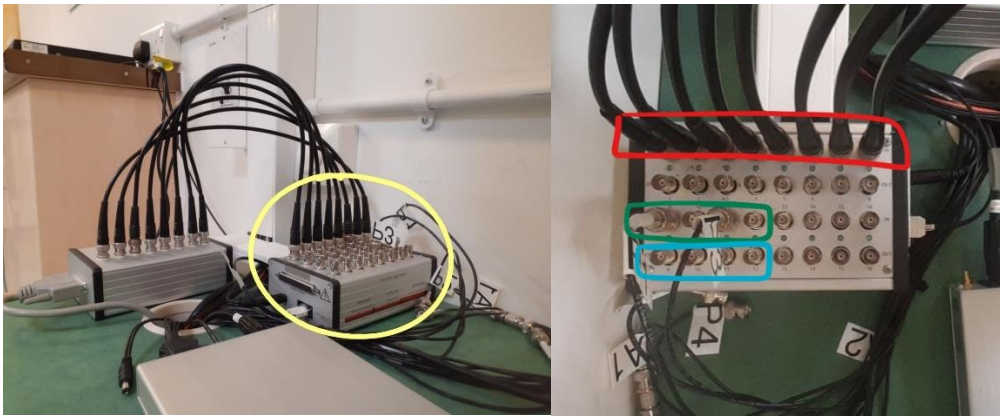
Left to right: interface box; bimanual buttons; trackball; joystick; bimanual grip force transducers.

Digital connections with the MEG system

It is often necessary to input external digital signals to be saved with the MEG data – usually triggers from the stimulus program, and sometimes button-press responses from the participant. This document explains some of the key components used to do this.

Stimulus Trigger Interface Units

There are two Stimulus Trigger Interface Units which are used to input or output TTL signals from the MEG. One of the units is in the RF cabinet, and one is on the desktop



These units are set-up to mirror each other, so input into one is also happening in the other. Note: if required the units can be made independent to provide 32 lines.

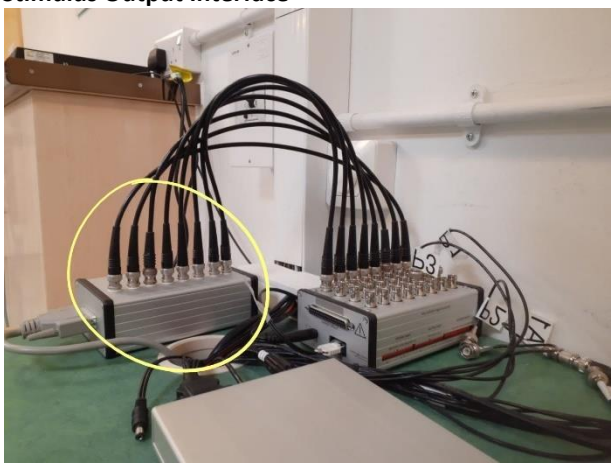
The Stimulus Trigger Interface Unit allows BNC cables to carry TTL input or output to or from the MEG.

Each trigger unit has a power supply and an optical connection to the MEG system. The BNC ports on the top of the unit are for sending TTL signals to or from the MEG system. Inputs **TO** the MEG system go to the ports on the first and third rows (IN), whereas outputs **FROM** the MEG go from the ports on the second and fourth rows (OUT). Input to the unit is also mirrored on the corresponding output line, as well as going to the MEG system.

Most common settings in brief:

- Inputs from the stimulus machine (normally stimmeg, and via the output interface described below) to the MEG go into BNC ports 1-8, first row of the unit on the desktop (red rectangle on figure above). These are used to register triggers from the stimulus program with the MEG data.
- With the fORP responders, inputs from the fORP response devices (P1-P4) to the MEG go into BNC ports 9-12, third row of the unit on the desktop (green rectangle on figure above).
- If you are using the fORP response devices then you should not (normally) have any connections to the Stimulus Trigger Interface Unit in the RF-cabinet, or to either OUT line of the unit on the desktop - you should disconnect any of these connections unless you are certain they are needed.

Stimulus Output Interface

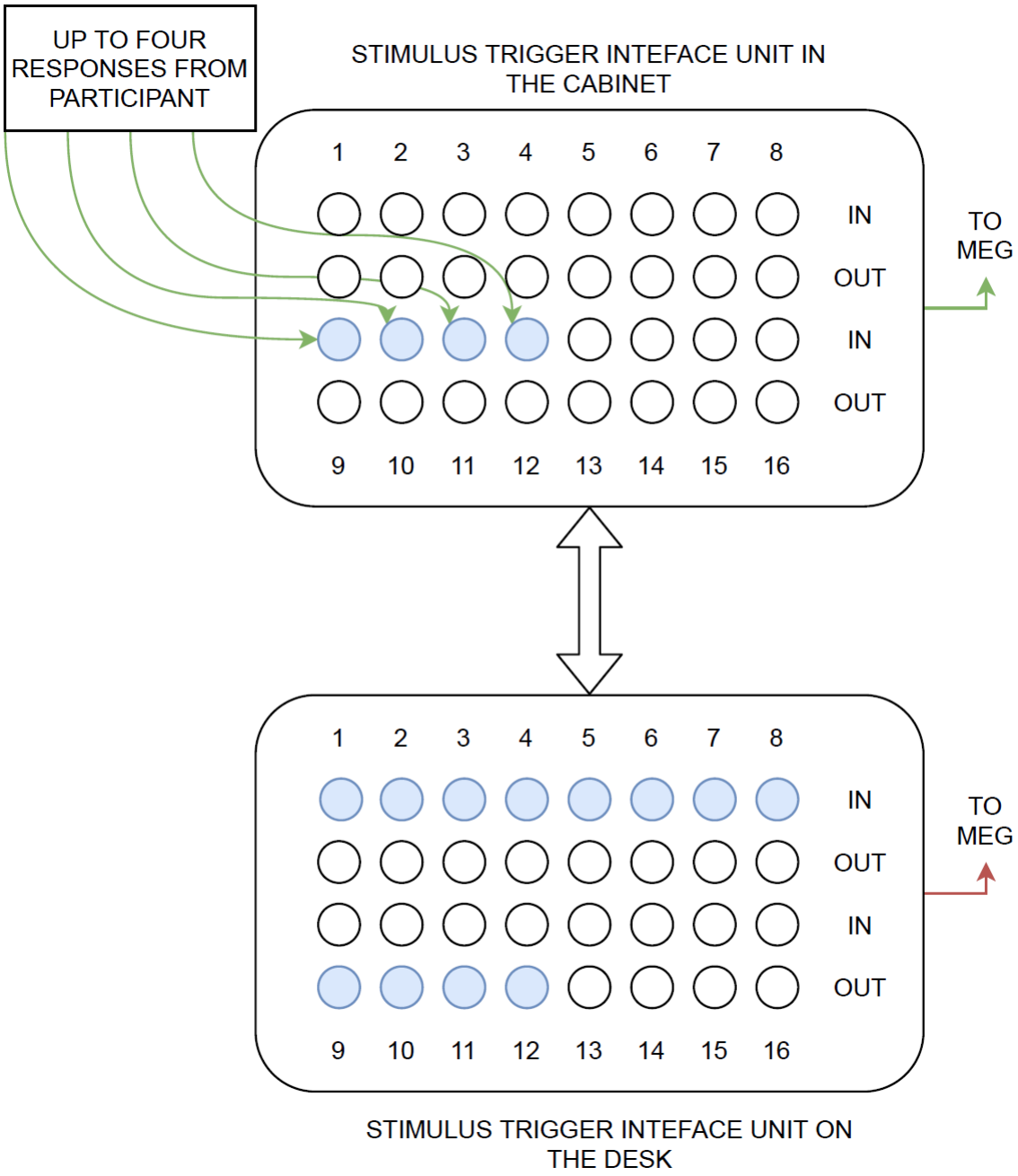


The Stimulus Output Interface on the desktop links the stimulus computer with the trigger interface unit above for communication with the MEG system. Historically, different types of connector have been used on the side of the Stimulus Output interface, but the default is a standard parallel connector (beige connector from stimulus machine).
If you use a different connector then the following settings will change. Parallel connectors have data lines and status lines. Data lines go out and status lines feedback in.

Parallel Port Pin	Direction	Name	Stimulus Output Port	Stimulus Trigger Interface Port
2	Out	Data-0	7	1 IN
3	Out	Data-1	6	2 IN
4	Out	Data-2	5	3 IN
5	Out	Data-3	4	4 IN
6	Out	Data-4	3	5 IN
7	Out	Data-5	2	6 IN
8	Out	Data-6	1	7 IN
9	Out	Data-7	P4	8 IN
11	In	Status-7 (inverted)	8	12 OUT
12	In	Status-5	P3	11 OUT
13	In	Status-4	P2	10 OUT
15	In	Status-3	P1	9 OUT
25	Ground			

All other pins are not connected

Summary of typical MEG to stimulus computer connections



Always remember to shut the cabinet doors before recording MEG data, and to verify your stimulus program is interpreting the response values correctly.

Analogue connections with the MEG system Analogue inputs to the MEG system are used for the eye tracker, photodiode, and force-grip responders.

Any analogue input to the MEG must come via one of the twelve BNC ports on the Analog Input Interface in the RF-cabinet in the MEG lab. For equipment physically located on the desktop, there are six BNC cables which go through the ceiling space to provide connections between the RF cabinet and the desktop. The current lab

default set-up is that the BNC cables numbered 1-6 go into MISC channels 1-6 and are used for the eyetracker. BNC cables numbered 7 and 8 are used for the force-grip responders. 9 to 12 are open for other needs (if requested). MISC 4 is used for the photodiode together with a short BNC cable in the RF cabinet.

Trigger-to-stimulus accuracy

In general, there will be a measurable delay between trigger and stimulus onset, which needs to be considered during data analysis. For each new project, delays should be determined making sure they are of constant length. Please contact OHBA staff for help.

Eyetracker connections

Analogue output of the eyetracking signal can be saved with the MEG data by the method described here. The analogue output of the eyetracking data uses up to six channels, DAC 0-5. Eyelink manual should be referred to for more information. The default at OHBA is for the eyetracker to be in binocular mode, and for only channels DAC 0-2 to be recorded with the MEG data. Thus, these channels are sending information on the left eye horizontal position, the left eye vertical position, and the left eye pupil size respectively.

The BNC connectors DAC 3-5 are also wired to the Eyetracker input, and so it is possible to also record the data from the right eye. However, we only have five RF-filtered BNC cables and so the sixth line would be unfiltered. Also, this would increase the MEG dataset size and it is not considered that this would significantly help with analysis. Make sure the correct MISC channels are selected in your Project Settings. So, if you are using the Eyetracker and want to record analogue data from the left eye, make sure MISC 1-3 are selected. If you are not using the Eyetracker then you should ensure MISC 1-3 are not selected - unless of course they are being used for something else.

On the day of MEG recording

Noise level check for the MEG system

If the MEG system has been tuned that day, then it is normally not necessary for the system to be tuned again before scanning. Usually, one of the MEG team members would have already tuned the system and they will carry on further tuning if necessary. If someone has taken a metal item into the shielded room (mobile phones are particularly bad) then re-tuning may be necessary.

Please ask a core member of OHBA MEG staff for help. **Tuning should only be performed by train staff/researchers.**

How to check the noise levels of the MEG sensors

- Log into sinuhe.
- Open the Neuromag interface and then click on the ‘Acquisition’ icon.
- Check there are no unauthorised objects in the MSR and close the MSR door.
- Under ‘Settings’ click ‘Change Project’ and select your project.
- Select ‘Tools’ then ‘Tuner’ then ‘Commands’ and then ‘Reset electronics’.
- Click ‘Measure noise’ – large button in bottom left.
- Allow the system to cycle through its measurements a couple of times. The majority
- of red bars should be in the 2-3 range, though some may go up to around 5. If this looks fine then you can finish and carry on, else the system may need tuning.
- Press the ‘Stop measurement’ button and then press again when it says ‘Stop collector’.

Plastic frames and lenses guide

Before starting your study, it is important to have considered whether you want participants who have contact lenses to wear their lenses or to use the plastic glasses. You should ask your participant whether they need optical correction BEFORE they come to take part in your MEG experiment.
If they need optical correction, and you are going to use the plastic glasses, then ask them to send you a copy of their prescription in advance.

Main reasons to get the prescription in advance:

1. Most people have no idea what their prescription is, and they may forget to bring it with them on the day.
2. Not all prescriptions can be corrected for with the plastic glasses – and if they can't be corrected you may not want to scan them.
3. Not all prescriptions are written the same and you may need time to decipher it.

There are three different frame sizes available at OHBA. The smallest frames fit best in the helmet. You may need to use the medium frames if the prescription is strong (to get a truer pupillary distance).
We cannot correct for astigmatism, we only have spherical lenses. The strength of lenses is measured in dioptres (D). Our lenses range from -8.0 to +8.0 dioptres in half dioptre steps.

Understanding an optical prescription
There are many web pages explaining how to read an optical prescription. Participants can request a copy of their current prescription from their optician. All opticians will provide this without charge, unless the prescription is more than two years old in which case they may not consider it valid. Not all prescriptions will be presented in the same format.

OD or **RE**: right eye.
OS or **LE**: left eye.
OU or **BE**: both eyes.

- **Sphere (Sph)** All our lenses are spherical, this is the only thing we can correct for. Spherical lenses correct equally in all meridians. The value shows dioptres. '+' for correcting long-sightedness (hyperopia). '-' for correcting short-sightedness (myopia). Plano or Pl or infinity sign means zero power.
- **Cylinder (Cyl) and Axis.** Values in these boxes indicate your participant has astigmatism. This means that the focus of the eye varies at different meridians. We cannot correct for astigmatism, but if it is quite minor you may be able to ignore it and obtain satisfactory correction.
- **DS in the Cyl box indicates Dioptres Sphere i.e. no astigmatism.** The Cyl value is in dioptres, the Axis is in degrees.
- **Distance / Intermediate / Near/** The Distance (Dist, DV) readings are appropriate for viewing stimuli in the MEG.
- **Add or Near (Reading Addition, Rdg Add, NV).** Additional correction for near vision, this should not be required for viewing in the MEG.
- **Prism and Base.** These are values for aligning the eyes by adjusting the position of the focussed image. We cannot correct for this.

- **Visual Acuity (VA).** This is the visual acuity AFTER correction. 6/6 is considered normal. 6/3 is better than normal. If the denominator is greater than 6 this means the person cannot be corrected to normal, even with the best lenses available.
- **Pupillary distance (PD)** The distance between the pupil centres in mm, it is often not recorded on prescriptions. For the prescription to be correct, the optical centre of the lens needs to be in front of the pupil. The small frames, which fit best in the MEG helmet, are designed for children. Thus, the participant is likely to not be looking through the optical centres of the lenses. With small corrections (< 4 D) this may not make a noticeable difference, but for large corrections the lens required may be different from that on the prescription. If your participant has a strong prescription the medium size frames may be better.

Practicalities

Looking at the prescription will give you an indication of whether our lenses are going to able to correct your participant's sight. However, on the day you may need to try several lenses to find the ones your participant is most comfortable with.

Things to check before bringing your participant in:

- Sphere values are within our range (-8.0 to +8.0 D).
- Cylinder values are zero (or probably ok up to ~ 2.0 D).
- Ignore near vision values (Add, NV).
- Anyone with a prism value may be best avoided.
- Anyone with a visual acuity with a denominator greater than the numerator may be best avoided.

The small frames and lenses are stored in the lab. Please ask for the medium frames in advance of your study if you are going to need them.

Making the correct glasses:

The strength of the lenses is indicated on their sides with marker pen.
'+' lenses have a BLACK line for each full dioptre, and an ORANGE line for half a dioptre.
'-' lenses have a GREEN line for each full dioptre, and a PURPLE line for half a dioptre.
The lenses are also stored in foam envelopes with labels that should tally with the markings on the side.

1. Select the lenses you think you are going to need (note left and right lenses are different shapes).
2. Give your participant a lens to hold in front of their eye and ask them to view the projector screen. Ensure they hold the lens straight, and at the normal distance from their eye. With strong prescriptions (> 4 D) this can make a big difference.
3. Offer different lenses until they get the best vision. After each lens has been tried, return it to the box in the correct place.
4. Once the correct lenses have been selected, push them into the frames and check again that the participant has good vision.
5. If your participant is going to be wearing glasses then ensure any electrodes fitted around the area will not be squashed by the frame.

Intercom guide

The MEG system is fitted with an intercom that can be used for two- or one-way communication.
You should have the intercom in listening (one-way) mode while recording so that the participant can alert you if they need to stop the experiment.
Participants can hear loud noises from the control room directly through the MSR. Ensure the changing room door is closed and speak quietly, if at all, during recordings.
Usage of the intercom is summarised below:

1. Press the lower volume button, '11', and T for a 3 to 4 seconds. This will produce a sound. In this state you can hear the participant, but they cannot hear the control room (one-way). Lower or raise the volume as you need. If the button T is not press long enough, the communication will be two-way the entire time.
2. To speak to the participant, hold the T button down while speaking into the intercom. While holding the T button down you cannot hear the participant. When you release the T button it returns to listening mode.
3. To switch the intercom off, press X.

Recording EEG with MEG

Equipment:

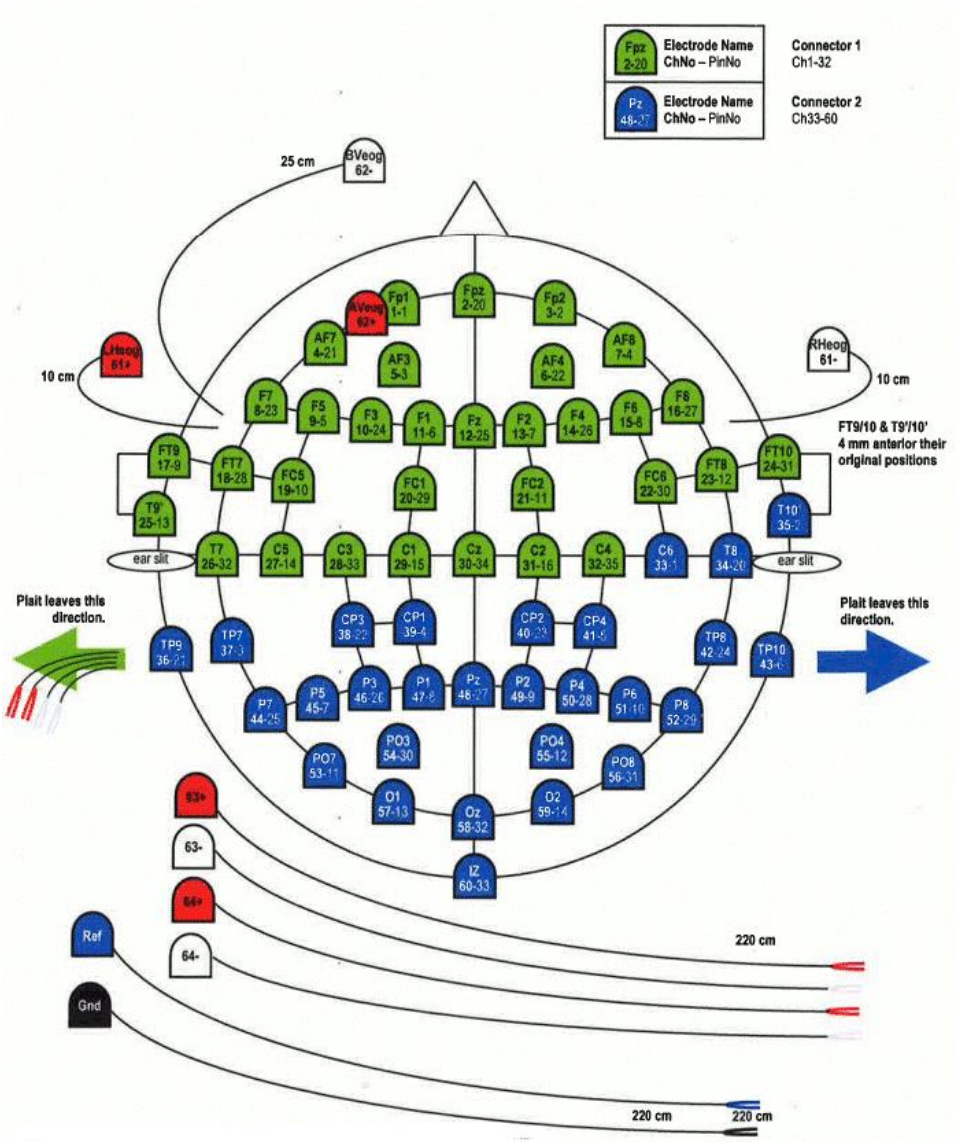
- MEG compatible EEG cap (Easycap)
- Siggi II impedance meter
- Abralyt 2000 (grey, abrasive) and Signa (green) gel
- Measuring tape
- General consumables: tape, washers (2 sizes), cotton swabs, 10 ml syringes, alcohol swabs

Please do let the technician know if some of these consumables are not available or running low.

If possible, have the participants wash their hair (either at home if they live nearby or if it is possible in the EEG lab). Have them use baby shampoo. This will reduce capping time greatly.

1. Place the towel on participant's shoulders. Before placing the cap on, it is useful to attach the 2 HPI coils that are placed behind the ears. Use tape and move as much hair out of the way and press gently to ensure they do not move.
2. Measure for cap size using the tape measure – place the measure around the largest part of the head and read from the back of the participant's head. To place the cap, pull the front over the participant's forehead and ask them to hold it in place with two hands then pull it back gently from behind. To ensure it is central (using electrode Cz), measure the participant's head from ear to ear and divide this number in half. Do the same from the top of the nose to the back of the head (where it dips). This will give you the central position where can move Cz in place. It is easiest to place wide palms on the cap and move gently. Check from the front of the participant that it looks straight and is comfortable over both ears. If the participant is wearing a mask, it is useful to put the string behind the ears is over the cap, so you may need to adjust this.
3. Apply the ground electrode to the *nasion* area (clean area with an alcohol wipe and fill the electrode with green gel as per applying electrodes for standard MEG scanning). Other electrodes (e.g. for ECG and EOG) can be applied now or later as preferred.
4. Once the cap is in place, use the blunt end of the cotton sticks to move any hair out of the way. You will need to do this in all 60 electrodes. Some areas of the head are more sensitive than others, so be careful not to press hard. Once you see the scalp in all 60 electrodes, use the cotton pad and alcohol and rub a small amount on the skin. This is to remove any remaining natural oil on the hair/skin.
5. Now you can use the grey abrasive gel to create a good connection between each electrode and the skin. Place the syringe with gel in each hole, twist the cotton pad a few times, and then re-fill the hole with more grey gel. Again, be careful not to be rough and check with the participant that it feels OK. Grey gel must be used only on EEG electrodes 1 to 60. For all other electrodes, green gel needs to be used. Before impedance checking it is important to have the reference and ground in place. To do this, attach the blue small electrode to the side of the nose (reference), and black electrode on the cheek (ground).

6. The impedance meter measures the front (1-32, yellow) and back of the head (33 – 60, green) separately. To use, plug in either to the Siggi II meter (including the ref and ground), turn it on and work your way through each electrode number by moving the wheel (left or right. Turn it right to check the channels in order). A laminated copy of the below diagram is kept next to the Polhemus and should not be removed from the MEG lab. Aim for an impedance reading around 10 kOhm. If the channels have a way higher reading, wiggle and twist with a cotton swab in the electrode to improve the conductance (by moving hair out of the way and gently scrubbing the scalp). If all channels have very high values, make sure your cabling (ref and ground) is well connected. Once done bot half of the electrodes have been checked, unplug the impedance meter.



7. On the MEG acquisition computer, ensure you have the correct settings loaded for your project, and that these settings have the EEG channels selected. After digitising the head coils, you need to digitise the location of each electrode. First, digitise the approximate location of the reference. Next, work through all of the electrodes in the order 1-60 set out on the diagram.

Recording EMG with MEG

If you want to record EMG activity, then you may find the following paper useful for guiding your electrode positions: *Recommendations for the standardization of lead positions in surface electromyography. Zipp P. Eur J Appl Physiol. 1982. 50:41-54*.

If you are recording forearm flexor muscle activity, as associated with using the fORP grip responders, a local reference should be placed on the elbow. A typical MEG recording will have bipolar electrodes for ECG, vertical EOG, and horizontal EOG. This leaves space on the gantry for one more set of bipolar electrodes. If you want to record EMG from both arms then you will need to use the head box. The default in this case is to use EEG1-2 for the right arm, and EEG3-4 for the left arm. You need to ensure these EEG channels are selected in your project settings for the MEG acquisition.

Nerve stimulation with Digitimer

The Digitimer can be used for nerve stimulation in the MEG. It should only be used by trained researchers - if you want to use it please ask Sven Braeutigam for training.
The product sheet for the Digitimer is in the Manual section on the WIN intranet. The latency from trigger to pulse is negligible. Note that the felt pads are not disposable, they should be left to dry after use and then re-used.

Post data collection

Please refer to IT Support - Home (ox.ac.uk) and specifically to the section Managing Your Data for the post data collection part of your study if more details are needed. Please could contact MEG admin if you suspect that one or more data sets have been recorded without subject anonymisation.

Other documentation

Megin and MEG peripheral devices specs and manuals

Starting or Restarting MEG projects

MEG short guide

WIN IT Computer User Guide