Magnetoencephalography (MEG) Facility

Standard Operating Procedures (SOPs)

Version 1.1

April 2007

Contents

Also part of the present SOPs are:

Attachment I: Changing Gantry Position
Attachment II: Helium Refill

1 Access to the Magnetoencephalography, or MEG, facility

Access to the MEG facility is restricted to Authorised Persons, that is, MEG Operators, MEG Researchers and MEG Support.

All Authorised Persons are trained in MEG methods and theory and are familiar with the relevant H&S procedures and MEG SOPs.

MEG Operators have been trained to prepare and conduct MEG experiments and are familiar with the relevant H&S procedures and MEG SOPs. Only MEG Operators are allowed to operate the MEG acquisition computer.

MEG Researchers are scientists at the CBSU and outside who are actively taking part in ongoing MEG research at the MEG laboratory. They are granted access to the MEG laboratory on a temporal basis.

MEG Research Support Staff, also sometimes called **MEG Support**, are allowed into the MEG laboratory for specific tasks, especially Helium refill and lab maintenance.

Visitors and all CBSU members without MEG authorisation can only enter the MEG laboratory when accompanied by an Authorised Person. The Authorised Person is always responsible for the visitor.

Before entering the Magnetically Shielded Room, or **MSR**, where the MEG Device is located, all persons must **de-metallise**. This is important to avoid damaging equipment.

Demetallising means to take off/out

- mobile phones and any other electronic devices (PDA, iPod, memory stick etc)
- watch
- keys and purse
- shoes
- hairpins
- jewellery (rings, etc)
- piercing
- any metal-containing clothes (belt, necklace, bra)
- other metallic objects

Lockers for storing these utensils are provided in the MEG preparation room.

It is also important to check the possibility of carrying minor amounts of metallic materials, e.g. in the hair, and to remove them before entering the MSR. Some substances used for hair colouring also contain minor amounts of metal.

2 MEG hazards and safety procedures

Safety issues arise in the context of Helium refill, experiment preparation and device manipulation.

2.1 Preparation for experiment: device related

- The dewar position can be changed between upright and supine only by the MEG Operator.
- The dewar position can only be changed when no volunteer or other person is placed under the device
- Chair/bed should be removed prior to the change of dewar position
- After changing the position of the MEG helmet and dewar, it is important to wait until the green light of the Power Supply Unit at the back wall inside the MSR lights up. Only if the green light is on and the dewar is therefore in its SAFETY POSITION can a subject be placed under the device.
- Inserting the head into the MEG helmet can be risky, as there is a risk of causing neck and head injuries. In the upright position, this is done by lifting the pedal-operated chair with volunteer in it until the head is well within the device. In the supine position, this is done by moving/sliding the bed with the MEG volunteer on it towards the device. It is essential to perform these operation slowly, and to obtain continuous feedback from the participant about their comfort and well-being.

Procedures for changing the position of the MEG system are described in detail in the **MEGSOP Attachment I**, which is part of the present SOPs.

2.2 Preparation for experiment: manual handling of subjects

An experiment is carried out by collaborative action of MEG Operator and Researcher. However, the roles of Operator

and Researcher differ in their responsibilities and specific tasks.

The **MEG Operator** involved in a particular study is responsible for subject health and safety and should take the lead role in handling subjects. The Operator is also responsible that no metallic objects are taken into the MSR.

Risks relate to the fixing of objects to the body and, in some cases, use of stimulation materials. These issues must be covered by ethics permissions submitted in ethics proposals by the responsible researcher.

- attaching electrodes and coils to the scalp and skin: as rubbing of the skin surface is required here, this can lead to minor injuries, and in extreme cases, bleeding. For precaution, gloves must be put on by those who engage in attaching equipment to the body.
- The MEG Laboratory includes an electric stimulator. Use of this stimulator must be in accordance with the relevant regulations and covered by a separate ethics proposal.
- EEG electrodes can be attached to the body and should connect with the relevant plugs of the EEG amplification unit. The ground connection of the pre-amplified must be used (not external grounding).

2.3 Preparation for experiment: stimulus delivery and instruction of subject for the experiment

It is the responsibility of the **MEG Researcher**

- to set up and control stimulus delivery, possibly in collaboration with MEG Support Staff and Operator,
- to instruct subjects properly regarding the experimental task.

It is important to note that stimulus delivery in the machine bears risks, too. These include the risk of causing hearing deficits by very loud acoustic stimuli and the induction of epileptic activity in vulnerable subjects by bright flickering light (10 Hz). Stimulation with loud noise, bright flickering light and other possible hazards should therefore be avoided. If an experiment requires such stimulation, these hazards should be covered in the ethics application and appropriate measures should be put in place to deal with them.

2.4 Cryogens

There should be no hazards from cryogens provided adequate attention has been paid to the provision of venting directly to the outside of the building of all potential sources of helium following normal boil-off or in the event of a pressure release valve bursting. However, for completeness and as a warning, reference is made to some of the potential hazards.

The hazards in the use of low temperature liquefied gases for MR systems are:

- Asphyxiation in oxygen-deficient atmospheres.
- Cold burns, frostbite and hypothermia from the intense cold.
- Over-pressurisation from the large volume expansion of the liquid following evaporation.

Hazards related to handling of liquid Helium are dealt with in detail in the **MEGSOP ATTACHMENT II** on Helium refill, which is part of the present SOPs.

2.4.1 Asphyxiation

Asphyxia is a condition of severely deficient supply of oxygen to the body that arises from being unable to breathe normally and may be the result of a lack of oxygen. Helium is colourless odourless gas.

Evaporation of large amounts of liquid helium and the resulting accumulation of helium gas may produce a locally oxygen-deficient atmospheres, which can cause asphyxia. Atmospheres containing less than 18% oxygen are potentially dangerous and entry into atmospheres containing less than 20% oxygen is not recommended. Atmospheres containing less than 10% oxygen can result in brain damage and death.

Exposure to an oxygen deficient atmosphere (less than 20%) may cause:

- Dizziness

- Drowsiness
- Nausea
- Vomiting
- Excess Salivation
- Diminished Mental Alertness
- Loss of consciousness and Death

Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness **without warning** or **symptoms** and so quickly (it only takes two breaths to become unconscious) that the individuals cannot help or protect themselves.

2.4.2 Cold burns, frostbite and hypothermia

Liquid helium or even its cold gases can damage the skin producing an effect similar to a heat burn. Unprotected parts of the skin that come into contact with uninsulated items of cold equipment may also stick fast to skin, the flesh being torn on removal.

The cold vapours from liquefied gases may cause frostbite given prolonged or severe exposure to unprotected parts. A symptom is local pain but sometimes no pain is felt or it is short-lived.

Transient exposure to very cold gas produces discomfort in breathing and can provoke an attack of asthma in susceptible people.

2.4.3 Handling cryogens

The cryogen, liquid helium, is handled exclusively by MEG Support Staff and by employees of the supplier, Elekta-Neuromag, specially trained for this task.

<u>CBSU health and safety procedures</u>

- Training authorised by cryogen suppliers, Elekta-Neuromag or CBSU MEG Support Staff must be undertaken before personnel operate and replenish the cryogens.

- Maintenance of cryogenic plant must have been authorised by the appropriate senior site engineer, physicist or technician to ensure that it is safe to carry out such work, and those involved must be accompanied by an Authorised Person while in the Controlled Area.

- Pipes or metalwork that are not insulated must not be touched by unprotected parts of the body.

- In the event of unusual venting, immediately inform Lab Manager and MEG Support and contact the He supplier.

- No unauthorised person, at any time, should operate or tamper with cryogenics, valves, etc.

The handling of liquid Helium, along with its hazards, is dealt with in detail in the **MEGSOP ATTACHMENT II** on Helium refill, which is part of the present SOPs.

3 Management of the MEG Unit

3.1 Responsibility and organisation

3.1.1 Responsible Persons

Head of MEG and EEG
Dr. Friedemann Pulvermüller
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge CB2 2EF
Telephone: 01223 355 294 x670
Fax: 01223 359 062
Email: friedemann.pulvermuller@mrc-cbu.cam.ac.uk

Responsibility: Overseeing research carried out in the MEG laboratory. Authorisation, in agreement with the Lab Manager, of access to the MEG lab. Chairing the MEG Management Committee (MEGMC), which manages the effective use of the MEG facility. Overseeing, in collaboration with the MEG Lab Manager, system operation, Helium refill and system tuning.

MEG Laboratory Manager

Dr. Yury Shtyrov
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge CB2 2EF
Telephone: 01223 355 294 x832
Fax: 01223 359 062
Email: yury.shtyrov@mrc-cbu.cam.ac.uk

Responsibility: Day-to-day management of MEG laboratory. Authorisation, in agreement with the Head of MEG/EEG, of access to the MEG lab. Liasing with H&S and technical staff in MEG lab management. Overseeing, in collaboration with the Head of MEG, system operation, Helium refill and system tuning.

MEG Operators

There are at present three (designated) MEG Operators, including the holder of the Research Support Postdoctoral Position for MEG research.

Responsibility: Assisting research carried out in the MEG laboratory. Contributing to the administration of the MEG facility. Day-to-day care for the functionality of the MEG facility, including daily Helium readings and system tuning, functionality checks, regular phantom measurements etc. Liasing with suppliers; ordering consumables.

MEG Administrator

Responsibility: Administration of the MEG facility. Overseeing MEG bookings. Documentation of MEG usage. Assisting at MEG Meetings. Liasing with suppliers. Assisting the Head of MEG in coordinating MEMC meetings. Writing minutes, letters related to MEG lab operation as advised by MEMC. Booking volunteers. Documenting studies, registered users etc. Updating SOPs in agreement with the Head and Manager.

MEG Support Coordinator

Mr Gary Chandler
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge CB2 2EF

Telephone: 01223 355 294 x411
Fax: 01223 359 062
Email: gary.chandler@mrc-cbu.cam.ac.uk

Responsibility: Helium refills, coordinating technical support for the MEG laboratory.

CBSU Health and Safety Coordinator
Mr Gary Chandler
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge CB2 2EF
Telephone: 01223 355 294 x411
Fax: 01223 359 062
Email: gary.chandler@mrc-cbu.cam.ac.uk

Responsibility: Implementation, supervision and maintenance of general health and safety procedures as required by *the UK Health and Safety at Work etc Act 1974*.

CBSU Director
Professor William Marslen-Wilson
MRC Cognition and Brain Sciences Unit
15 Chaucer Road
Cambridge CB2 2EF
Telephone: 01223 355 294 x230
Fax: 01223 359 062
Email: william.marslen-wilson@mrc-cbu.cam.ac.uk

Responsibility: General management of the Cognition and Brain Sciences Unit, including all health and safety related issues.

3.1.2 Access for Personnel

The MEG machine and the related equipment is contained within a designated **Controlled Area** (cf. Appendix A). Free access to the Controlled Area shall be given only to Authorised Persons.

Visitors and other unauthorised persons shall have access only if accompanied by an Authorised Person who will take on the full responsibility for the presence of the

Unauthorised Person or persons for the duration of their presence in the Controlled Area.

The MEG lab manager shall formally approve, in agreement with the Head of MEG/EEG, certification of a member of staff as an Authorised Person when the member of staff has satisfactorily completed training in their responsibilities and the safety requirements of MR equipment.

Criteria for authorisation are mentioned under 3.3.1.

The MEG Administrator shall maintain a list of all Authorised Personnel, divided into the different subcategories, together with full details of their training and certification with ready access available to the Authorised Persons and the designated MEG Laboratory Associate.

3.2 Controlled area

3.2.1 Definition of Controlled Area

The controlled area includes:

- The Control Room including the MSR
- The preparation room

3.2.2 Access to Controlled Area

Access to the Controlled Area is provided by self-locking doors. The devices for operating the locks are:

- The Control Room including the MSR: plastic card
- The preparation room: key

The key is kept in the Control Room. Only Authorised Persons have access to the key. Sharing of keys is only permitted in an emergency.

3.3 Access Control

Entry to the MEG laboratory is controlled by an access card. Access privileges will be upgraded to include the MEG facility

upon completion of the relevant training. Those completing the relevant training and not having a Unit card will be assigned a temporary one whilst they carry out their research at the CBSU.

3.3.1 Access for Personnel

The authorisation for MEG Laboratory access rests with the MEG Lab Manager and must be endorsed by the Head of MEG and EEG.

An individual shall only be Authorised and granted access after satisfactory completion of the local MEG Authorisation Procedure. This includes

1. A practical introduction to the MEG lab by an MEG Operator or experienced MEG Researcher.
2. Studying the current version of the MEG SOP document.
3. Successfully passing a structured interview about MEG methods and safety ("Screening for MEG Suitability").

In order to be granted the status of an MEG Researcher or MEG Operator, individuals must obtain additional qualification, which may include, depending on individual background, qualification and skill:

4. Attendance of the Panel Induction for Subject Testing
5. MEG Lab Experience gained through attendance to and participation in recordings in the MEG Laboratory, supervised by an MEG Operator.
6. Attending MEG Methods lectures or studying MEG Methods literature.

MEG Lab Manager and Head will decide on an individual basis whether some of the conditions can be waived.

MEG Authorisation to researchers is given temporarily for the time of their research project. During the time of MEG Lab Experience, the individual has the status of a visitor.

MEG Operator status will be subject to additional qualifications, especially an extended period of training in the lab.

All MEG Authorised Persons must make sure that they conform at all times to the rules set up in the SOP document

and the other rules that apply for research at MRC in general and CBSU specifically.

3.3.2 Responsibilities of Personnel

- On entering the Controlled Area, all personnel must at all times comply with the CBSU Standard Operating Procedures.

- All unauthorised personnel, including visitors, patients and unauthorised staff, shall have access only if accompanied by an Authorised Person.

- The Authorised Person will take on the full responsibility for the presence of the unauthorised person or persons for the duration of their presence in the Controlled Area.

- All Authorised Personnel who act as volunteers for recordings must conform to the appropriate requirements referred to in the sections about volunteer management (cf. 3.6 and 3.7).

- Authorised personnel can screen workmen, cleaners, engineers and other visitors for entry to the MSR.

- Lost or mislaid cards must be reported to the CBSU Administrator immediately so that all access privileges on the card can be suspended.

3.3.3 Special categories of Personnel

Here are the main categories of MEG personel:

MEG Authorised Person	A person who has free access to the Controlled MEG lab Area. The selection and certification of a person for authorisation rests with the MEG Facility Manager and must be endorsed by the Head of MEG/EEG. Certification of an individual shall only be authorised after satisfactory completion of the MEG Authorisation Procedure (3.3.1).

MEG Operator	An authorised person who has been trained to run the MEG device.
MEG Researcher	An authorised person who is a researcher and is leading, or participating in, an ongoing MEG study.
MEG Support or MEG Technical Staff	An authorised person who is technical staff with a specific function in he MEG laboratory (e.g Helium refill, computer installation).

3.3.4 Required staffing levels for scanning

MEG recordings in volunteers during Official Opening Hours of the CBSU require that an MEG Operator and an MEG Researcher be present.

MEG recordings in volunteers outside Official Opening Hours of the CBSU require that an MEG Operator and an MEG Researcher be present.

For **phantom recordings** the minimum requirement is one MEG Operator.

3.4 Persons allowed in the MEG lab

3.4.1 Participants

It is not anticipated that any MEG for diagnostic purposes will be performed at the MRC Cognition and Brain Sciences Unit. Most studies will be in healthy control participants who are volunteers and will have been pre-screened for any neurological illnesses as well as any history of head injury, psychiatric disturbance or substance abuse.

However, for some studies it may be desirable to record from 'stable' patients; that is, participants who have a neurological history, but who do not require ongoing medical attention and for whom MEG poses no significant risks over and above those that apply to a normal healthy participant. Possible groups include stable stroke patients, mild Parkinson's disease and early stage Alzheimers Disease. In these and all other cases, patient studies can in principle be

conducted in the MEG facility, but always requires prior approval by the Local Ethics Research Committee.

All participants must be screened before exposure (cf. 3.7 and Appendix D).

Only MEG Operators or personnel that have been appropriately trained and are experienced in the use of the MEG equipment are allowed to run experiments.

Written informed consent must be obtained from all participants.

3.4.2 Staff

Only MEG Authorized Persons shall have free access to the Controlled Area.

Unauthorised staff shall be subject to the procedures for the general public (see below).

3.4.3 General public

All unauthorised personnel, including unauthorised staff and the general public, must be screened for a wide range of factors (cf. 3.7 and Appendix D) and seek authority to enter the Controlled Area. They must be accompanied by an MEG Authorised Person at all times when visiting the MEG facility.

3.4.4 Cleaning and maintenance staff

Cleaning and maintenance staff (e.g. estates and engineering staff) requiring access to the Controlled Area may only do so as unauthorised personnel and must undergo screening (cf. 3.7 and Appendix D). They may only gain access to the Controlled Area under direct supervision of an Authorised Person. The MEG Support Coordinator will oversee the cleaning of the lab and instruct cleaning personnel appropriately. Lab cleaning is done in conjunction with the Helium refill and maintenance.

In case MEG Support Staff or MEG Operators volunteer for cleaning, the member of staff carrying out the cleaning will ensure that Health and Safety Rules are observed.

A request for access of cleaning personnel needs to be made and requires approval of the MEG Lab Manager and Head of MEG/EEG.

3.5 Control of equipment

3.5.1 Equipment policy

No equipment can be taken into the Magnetically Shielded Room (MSR) without approval of the Manifacturer or the Head and Manager of MEG.

All equipment taken into the MSR must not be ferromagnetic or electrically charged. If in doubt, please consult the lab manager. Special attention must be paid to metallic tools previously used in strong magnetic fields (e.g. MR facility), as they may be magnetic. Special non-ferromagnetic equipment and non-electrostatic equipment should be used in the MSR exclusively.

Here are some examples of pieces of equipment that should under no circumstances enter the MSR (this list is clearly non-exhaustive):

- cellular phones,
- computers,
- iron tools,
- power-operated tools
- keys

Before taking any new equipment into the MSR, whose magnetic properties are not fully known, it must be tested for magnetic artifacts. The MEG Lab Manager or Head must be contacted before any new equipment can be taken into the MSR. Note that even nonmetallic objects can be magnetic and cause major artifacts (e.g. electrostatically charged cushions).

3.5.2 Responsibility for entry

Control of equipment entering the MSR on a day-to-day

basis is the responsibility of the MEG Operator responsible for the examination at the time. The opinion of the Lab Manager or Head should be sought whenever in doubt about whether an object can enter the MSR.

3.6 Volunteer management: General considerations

3.6.1 Volunteers

The term volunteer shall include

- Healthy members of the public volunteering for a MEG study
- Members of staff participating in experimental trials
- 'Stable patients' volunteering for a MEG study

3.6.2 Prerequisites for MEG experiment

For all MEG experiments of volunteers the following prerequisites must be fulfilled (see Appendices):

- Approval from a research ethics committee (LREC, CPREC) must be obtained prior to the examination.
- Written information about MEG procedures must be made available to all volunteers before their experiment.
- Written informed consent must be obtained before the examination
- All volunteers must be screened before exposure.

N.B.: The appendices give forms that have been approved previously in the context of specific projects. Each principle researcher conducting a study is responsible for generating a form appropriate as a part of his or her own study. **The materials in the appendices can only serve as a starting point here; they need to be adjusted to requirements of specific experimental conditions, task demands, subject populations etc.**

3.6.3 Responsibility for volunteers whilst in the Controlled Area

The MEG Operator will remain responsible for the safety, health and well-being of the volunteer throughout the period that the volunteer is within the MEG Laboratory.

3.6.4 Insurance cover for volunteers

Negligent harm. This will be covered by the MRC.

Non-negligent harm. The MRC does not provide cover for non-negligent harm. However it takes a sympathetic view of non-negligent claims.

Only MEG research with a responsible CBSU scientists as lead scientist or scientific collaborator will be insured by the MRC. Studies carried out by non CBSU members must have insurance cover through different routes.

Insurance covers both volunteers and MRC researchers themselves who carry out the experiments.

The MRC will not be liable for MEG researchers who are not MRC staff and not sponsored by a member of MRC staff, and who cause negligent or non-negligent harm to an MEG participant. Such researchers may therefore wish to seek their own insurance.

Medical doctors are advised to arrange adequate personal insurance against claims for negligent and non-negligent harm. The University and MRC based insurances may not cover all types of claims against medical doctors.

3.6.5 Implanted medical devices

Implanted medical devices fall into two main categories:

- Active implanted medical devices - such as pacemakers, defibrillators, neurostimulators, cochlear implants and drug pumps, where functionality is dependent upon an energy source such as electrical, mechanical or pneumatic power.

- Non-active implanted medical devices - which are passive in that they require no power source for their function, for example hip/knee joint replacements, heart valves, aneurysm clips, coronary stents and breast implants.

Both types of implanted medical devices frequently contain metallic components which render the device incompatible with MEG and may cause artefacts which can affect the quality of the recorded data.

It is recommended to exclude subjects with implants from MEG recordings.

3.6.6 Metallic foreign bodies

Metallic objects such as bullets, pellets, shrapnel, or other types of metallic fragments, in particular ferromagnetic objects, may be present in the body. Also, volunteers who are or have been involved in the manufacture of metal products may carry metal in parts of their body. This may lead to artifacts in the recorded data. The use of such subjects is therefore not recommended, but, in an MEG setting, not worrying otherwise.

3.6.7 Tattoos, makeup, dyes

Tattoos, hair dyes and eye makeup may contain iron oxide or other ferromagnetic substances that are conductive. This is a potential artifact source, too. Artifacts usually surface in a pre-recording and lead to the exclusion of the volunteer. It is therefore recommended to screen the volunteers prior to experiments, and instruct them accordingly.

3.6.8 Body piercings

Ferromagnetic body piercings will also cause magnetic field changes and therefore artifacts.

All body piercings must therefore be removed before the volunteer enters the MSR.

3.7 Volunteer management: Recordings

3.7.1 Preparation

Identification: The MEG Operator must ensure that the volunteer is correctly identified.

Reassurance and explanation: A suitably trained person should describe the examination to the volunteer, explaining the sights, sounds and experiences to be anticipated, and predicting the likely length of examination.

The MEG researcher must ascertain that the stimulation procedures are in place and properly adjusted. The subject should be instructed as appropriate for the experiment.

3.7.2 Screening

Before booking in volunteers for an examination experimenters will obtain an information sheet that covers major questions in MEG experimenting. This leaflet will mention exclusion criteria, such as implanted stimulators, metal implants in the head, tattoos etc.

Before booking in volunteers for an examination, volunteers will be pre-screened in order to prevent an inappropriate experiment being booked.

On arrival in the unit volunteers will be asked to complete a screening form (cf. Appendix D). The responsible MEG Operator will then review the screening form with the volunteer. The screening form must be signed by the volunteer and the MEG Operator. Operator will then prepare the volunteer for the MEG recording. This includes the removal of all ferromagnetic, electronic or electrostatically charged objects from the volunteers body/clothes (e.g. mobile phones, radios, PDAs, music players, watches, credit cards, jewellery, hairpins, body piercings, hearing aids, spectacles, metal-containing clothing, shoes, belt, etc). The volunteers will be asked to store these items in one of the lockers provided in the preparation room.

Before entering the MSR, the responsible MEG Operator must ensure that the volunteer has completed the screening form and that he/she has no MEG incompatible items on

him/her. The use of a hand-held metal detector will facilitate this procedure.

3.7.3 Positioning

Positioning of the subject in the machine and changes of gantry position can only be done by an MEG Operator.

Two issues are important here: patient comfort and patient safety. Time taken to ensure that the patient is comfortable will lead to greater patient compliance with the recording and experiment. Importantly, reduced comfort leads to tension and thereby enhanced muscle activity, which constitutes the major source of artifact in non-invasive neurophysiological recordings with MEG or EEG.

With regard to patient safety, the prevention of injury is the major concern. Attention must be drawn to the appropriate adjustment of the dewar and the careful adjustment of hight of the seat, avoiding any pressure exerted onto the subject's head.

Placing a subject in the MEG device always requires continuous monitoring of any discomfort, report of pressure felt etc. To this end, the video and auditory communication system between MSR and control area must always be switched on, so that the subject can communicate with the MEG Operator and Researcher.

3.7.4 Comfort

Adequate lighting and ventilation in the MSR interior are important. Care should be taken if pillows, blankets or covers are used to ensure that they are MEG compatible and that heat loss is not inhibited. The MEG operator should regularly attend to and check the proper functioning of the air conditioning system. At all times during experiment the volunteer must be in a position to make contact with the operator and give warning of any discomfort or concern. To this, **the intercom and video recorder must always be switched on whenever the MSR door is locked with a human volunteer or any other person inside the MSR**.

3.7.5 Communication

For communication between the volunteer and the person who is scanning, a two-way intercom is available. Recorded music or narrative of the patient's choice can be made available during structural brain scans and during the set-up period. **Intercom and video recorder must always switched on whenever the MSR door is locked, so that the subject can communicate to the MEG personnel.**

3.8 Data management

Published data have to be available for at least 5 years after publication date. There is therefore a need for data storage. This needs to be done in accord with Data Protection regulations.

3.8.1 Minimum data required

The following is regarded as the minimum data that should be retained from a given participant:

- The subject's name or reference, sex and age.
- Date of recording.
- Experiment ID.
- The approximate time spent in the MSR.

This information should be held with a copy of the patient/volunteer consent form, including a signed statement showing confirmation of full explanation given and medical screening conducted. The MEG Administrator will keep track of this.

3.8.2 Neurophysiological data files

Data files storing neurophysiological data and associated information are in electronic form and stored on the subject data management system provided by the manufacturer.

All information stored on the system will be linked. Never is a person's name stored together with her or his data. The CBSU volunteer number is used for identification. When the recording computers asks for the last and first names of the

volunteer, the CBSU ID number must be entered instead. The link between personal information and ID number can only be stored in ecrypted format or in locked cabinets.

All data acquired and volunteer records should be held in safe keeping for a period that ensures compliance with the current guidance from the Department of Health and the Medical Research Council. It should be in a form from which full details can be retrieved within this period if required.

3.8.3 Data protection and confidentiality

Members of the MRC Cognition and Brain Sciences Unit (CBSU) and members of the research group will have access to the data. It is possible that the data may be used by researchers working with the CBSU for other similar ethically approved research protocols, where the same standards of confidentiality will apply. It may also be disclosed to researchers working outside the CBSU if that person is working in close collaboration with researchers scanning within CBSU. In this case that non-CBSU person must have signed a Code of Conduct guaranteeing that the data will be kept confidential & secure.

The MRC complies with the requirements of the Data Protection Act 1998 with regard to the collection, storage, processing and disclosure of personal information and is committed to upholding the Acts core Data Protection Principles. All enquires concerning access to data held by the Cognition and Brain Sciences Unit should be addressed to the Freedom of Information Liaison Officer at the Unit in the first instance.

3.8.4 Abnormal findings

The Cognition and Brain Sciences Unit is a cognitive neuroscience research unit and does not provide any diagnostic services. This policy will be clearly stated on the volunteer information sheet.

However, in order to ensure that only participants with appropriately healthy brains are included in our studies, and also to pick up any major abnormalities that do occur, MEG and EEG recordings are screened by CBSU science staff for obviously abnormal neurophysiological activity (spike-wave complexes, local slow wave activity etc.). In the event that a significant abnormality is noticed by the MEG operator in

charge, this will be brought to the attention of the Lab Manager or Head of MEG. The issue may be discussed with a neurologist affiliated with CBSU or with the MEG Management Committee, who will take necessary steps. It may be necessary to exclude such participants from this and future studies in which case the reasons for the exclusion will not be fed back to the researcher or the individual concerned.

3.9 Staff training

To avoid accidents, it is essential that all personnel associated with MEG equipment be adequately trained (see also Section 3.3.1).

The training of all appropriate categories of staff in terms of their normal duties and those in the event of an emergency is essential before installation and for all new staff subsequent to installation. Regular reviews of the training status as well as updates and refresher training for all staff will be required.

4 Emergency procedures

4.1 General considerations

An emergency can relate to the well-being of volunteers in the laboratory, to an environmental emergency such as a fire or a threat to a member of staff. Careful consideration must be given to setting up the correct form of training for the specialist staff involved in any form of emergency which needs their entry into the MEG Laboratory, and the necessary liaison with the appropriate groups both within and outside the establishment.

Caution Consideration will need to be given to the provision of the necessary supervision and control should an emergency such as a fire occur out of hours.

4.2 Location of rescue equipment

An Heartstart FRx Automated External defibrillator, AED, along with an oxygen cylinder and a comprehensive first aid kit is based in the 'Elbow' at the top end of the south wing of the main CBSU building. In an emergency within the MEG Facility, the AED, along with the oxygen cylinder, will be brought to the MEG Laboratory by one of the first aiders.

A second AED is based in the kitchen of the Imaging Facility, along with a comprehensive first aid kit (including a burns kit) and a first aid blanket. The kitchen door carries appropriate signage.

All CBSU first aid staff will have had training in using the AED equipment. **In case of medical emergencies, first aid staff must be contacted, on the internal telephone network, by a 888 call.**

4.3 Evacuation and access routes

4.3.1 Evacuation of the MEG laboratory, escape routes

In the event of the fire alarms sounding the member of staff in charge of the building at that time (e.g. Head of MEG/EEG Qualified Operator, Authorised person)

- will ensure everyone in the laboratory evacuates by a fire escape and makes their way to an assembly point, where they must remain until instructed otherwise.
- check all rooms (including MSR) are empty of people.
- collect the AED, first aid kit and first aid blanket if safe to do so.
- make their way to the main entrance of the CBSU in the front car park and report to the head fire officer attending.

Escape routes are indicated on the map in Appendix F.

4.4 Medical emergencies

4.4.1 General consideration

In the event of a medical emmergency (e.g. cardiac arrest), the experiment should be terminated immediately. The patient/volunteer should be removed from the MSR at the first opportunity.

4.4.2 Emergency procedures

- The MEG Operator will terminate the recording
- And Check the condition of the volunteer/patient and make an assessment as to whether urgent additional help is needed.

IF THIS IS AN EMERGENCY AND URGENT HELP IS NEEDED:

- Call 888 to summon CBSU first aiders to the facility (during Unit working hours only)

- Call (9-) 999 for an emergency ambulance

  Report our location
  MRC Cognition and Brain Sciences Unit
  15 Chaucer Road, Cambridge, CB2 7EF
  Emergency Telephone 01223 355294
  - Switchboard must repeat this back to you!

  Report what has happened
  Details of the medical emergency (e.g. suspected cardiac arrest)
  Details of the patient (e.g. female approx 25 years old)

- DURING UNIT WORKING HOURS: inform Reception on 100 and ask them to send somebody outside to wait for the ambulance and direct it where to go.
- OUTSIDE OF UNIT WORKING HOURS: a person should be dispatched to the front car park to direct the ambulance

Report incident

Inform at least one of the following persons

- MEG lab manager
  - Head of MEG/EEG
  - Director

4.5 Oxygen Depletion Alarm

The MSR room is monitored by a sophisticated Oxygen Monitoring System. In the unlikely case of Helium evaporation into the MSR, the Oxygen Monitoring System will raise an alarm via the visual beacon and sounder in the Meg room.
SEE Appendix H:

The following steps should therefore be followed immediately:

If there is a subject in the MSR room:
Hit the emergency open button on the MSR and get them out immediately.
Evacuate the Meg Room.
If possible Hit the Emergency Power Button (labelled RED button to the right of the Main room door) to isolate the MEG equipment as you leave the room
If possible leave the main lab door open and open the door to the garden to aid ventilation.
If Medical Assistance is required follow Emergency Procedure 4.4.2
Do not re-enter the room until authorised and the Oxygen Monitoring Panel in room 441 show the levels are safe to do so.

If the MSR is empty:
Evacuate the meg room
If the MSR door is closed do not open it.
If possible Hit the Emergency Power Button (labelled RED button to the right of the Main room door) to isolate the MEG equipment as you leave the room
If possible leave the main lab door open and open the door to the garden to aid ventilation.
If Medical Assistance is required follow Emergency Procedure 4.4.2
Do not re-enter the room until authorised and the Oxygen Monitoring Panel in room 441 show the levels are safe to do so.

In both cases

Inform at least one of the following persons

– MEG lab manager
– Head of MEG/EEG
– Director

4.6 Fire

4.6.1 General considerations

All fire alarms in the main Unit and the MEG facility are automatically linked to Cambridge Fire Station. Breaking the glass at one of the alarm points will result in the fire brigade making their way to the Unit.

4.6.2 Emergency procedures (Fire)

ON DISCOVERING A FIRE:

- On discovering a fire in the MEG facility, raise the fire alarm by breaking the glass on one of the fire alarm points.
- Terminate all MEG procedures
- Evacuate (see *Evacuation* below)

ON HEARING THE FIRE ALARM:

- Terminate all MEG procedures
- Evacuate (see *Evacuation* below)

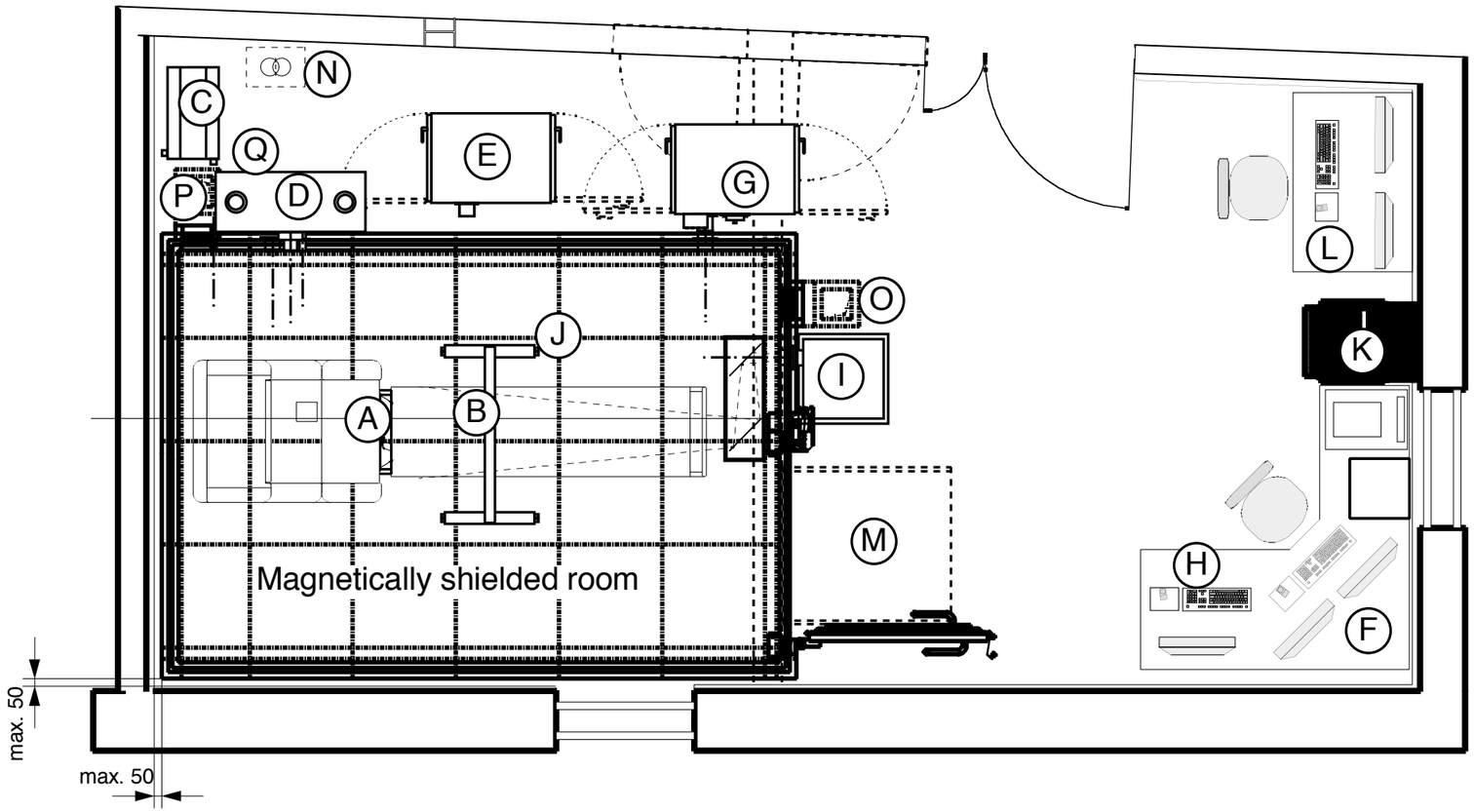
Evacuation

- All occupants must immediately make their way to a fire assembly point.
- Staff with volunteers/patients/visitors should escort them to the assembly point.
- The MEG Operator will be responsible for collecting the AED and first aid equipment on route if safe to do so and checking that the rooms are empty on their way out. They will need to report to the senior fire officer attending.
- Assemble at the meeting point in the car park and do not re-enter the building until it has been declared safe by a suitably qualified person.

Rev.	Date	Drawn	Description

APPENDIX A: MEG LAB AREA AND MSR (AUTHORISED STAFF ONLY)

N.B. Main electronics and stimulus electronics cabinets will be built as mirror images from standard



LEGEND:

A:	Probe unit
B:	Patient bed or chair
C:	Lifting motor unit
D:	Electronics feedthrough filter
E:	Main electronics cabinet
F:	Data acquisition workstation
G:	Stimulator cabinet
H:	Stimulus control
I:	Video projector
J:	Back projection screen (movable)
K:	3-D digitization
L:	Analysis workstation
M:	Ramp 1:8
N:	Isolation transformers – exact location t.b.d. (can be wall mounted, preferably > 3m away from room)
O:	Air inlet
P:	Air outlet
Q:	Helium safety exhaust duct out (Ø100 mm) - connect to duct outside the building

Note: liquid Helium storage t.b.d.

Note		Product	Included in	Title
		Elekta Neuromag	Site plan	MRC-CBU MEG Facility Proposal for equipment layout
Date	30.6.2006			Part/drawing n:o
Drawn	JKn	Elekta Neuromag Oy		
Chkd.				
Appr.				

Appendix B: Power Switches

- When removing power or restarting the the system it is important that the following procedure is followed to prevent damage to the system.

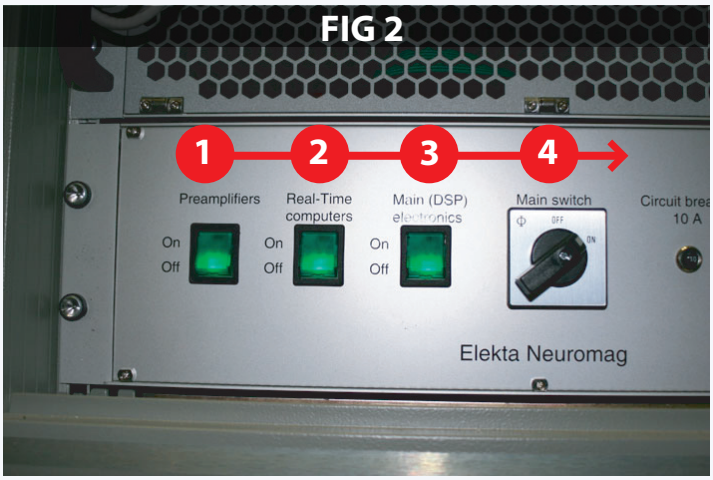
  Switch location can be found in the rear of the rack **(see Fig 1)**

FIG 1

- **Switching Power Off - left to right (see Fig 2)**

  1. Preamplifiers
  2. Real Time Computers
  3. Main DSP
  4. Main Switch to Off

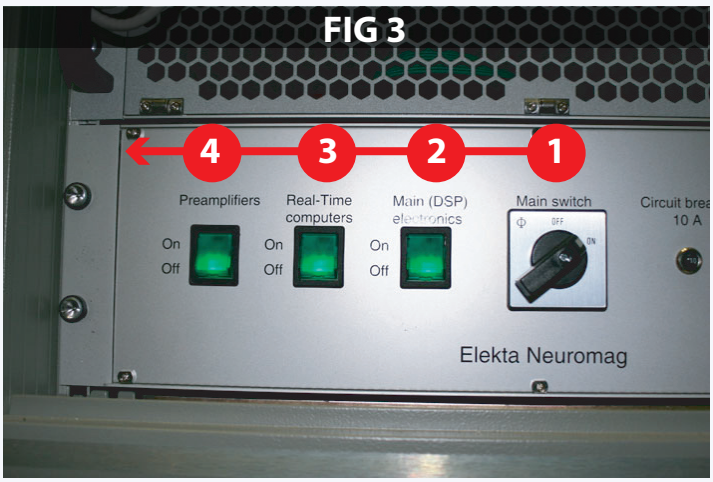
FIG 2



- **Switching Power Back On - right to left (see Fig 3)**

  1. Main Switch to ON
  2. Main DSP
  3. Real Time Comuters
  4. Preamplifiers

FIG 3



Appendix C: Volunteer Information Sheet

General information about MEG/EEG experiments

- **Standard information sheet approved by CPREC 10/2006 in the context of a specific ethics proposal.**
- **This form needs adjustment to individual experiments and subsequent separate ethics approval.**

General Volunteer Information about MEG experiments

The human Magnetoencephalogram (MEG) records the small changes in magnetic fields at the surface of the head generated by nerve cell activity inside the brain. In the MRC COGNITION AND BRAIN SCIENCES UNIT, we are now using this technique for measuring brain activity related to human perception and cognition.

The experiments address questions about the brain basis of human cognition. We will be happy to explain to you, in case you are interested, the ideas and hypotheses that motivate the experiments. However, such explanation has to wait until after the experiment, as knowledge about the hypotheses of an experiment may influence the participants' behaviour and strategies. You can withdraw from the experiment whenever you like without giving a particular reason. The following paragraphs are designed to inform you about some general aspects of the methodology.

You are not exposed to external electrical or magnetic fields. The top of your head will simply be positioned within a helmet-like device that can measure the very weak magnetic fields produced as a normal consequence of activity in your brain. Possibly, a handful of sensors will also be attached to your forehead with tape (which should not cause discomfort nor leave any mark), just to measure the precise position of your head relative to the helmet. During a typical experiment, for example, you might be presented with visual words or pictures on a screen in front of you, or hear sounds or words through headphones, and may be asked to press buttons with your fingers according to a simple task. The precise experimental procedures will of course be explained in more detail and you will be given the opportunity to practice and ask questions.

The experimental session typically takes about 1 hour. Preparation time for a simple experiment is usually about 15 minutes. However, this can vary depending on the type of experiment, and you will be informed about the specific details before the experiment.

Because the magnetic signals we measure are very weak, we would like to avoid any possible source of recording artefacts. In particular, it is important that muscle activity, eye movements and eye blinks are minimised (though, of course, not completely suppressed). We will therefore ask you to sit or lie as still as possible during the experiment.

We assure you that the data we acquire will be kept confidential. Details of the data storage will be clarified on a different form.

You will be paid for your participation. Payment will be for the entire time spent in the lab (including preparation etc.). The current rate is £ 10 per hour.

Again, we emphasise that questions about the background of the experiment or the procedures are always welcome. In addition, we would appreciate your feedback about your impression of the experiment.

Appendix D: Screening form

3.0 MRI SCREENING FORM

MRC Cognition and Brain Sciences Unit
15, Chaucer Road, Cambridge CB2 2EF Tel: 01223 355294

MRC Cognition and Brain Sciences Unit

VOLUNTEER

Subject ID: _____ Scan I.D. _____

Date: ___/___/___ Principal Investigator/Lab: _____

Last Name: _____ First Name: _____ Height: _____ Weight: _____

Birthdate: ___/___/___ Email Address: _____

Address: _____ City: _____

Post Code: _____ Phone:(Home) _____ (Work) _____

GP's Name & address: _____

_____

1. Have you ever had surgery or other invasive procedures? ☐ Yes ☐ No

Type and Date: _____

Type and Date: _____

2. Have you had any previous MRI studies? Please detail: _____ ☐ Yes ☐ No

_____ Date: ___/___/___

_____ Date: ___/___/___

Facility Name & Location _____

3. Have you ever worked as a machinist, metal worker, or in any profession or hobby grinding metal? ☐ Yes ☐ No

4. Have you had an injury to the eye involving a metallic object (e.g., metallic slivers, shavings, foreign body)? ☐ Yes ☐ No

5. Are you pregnant, experiencing a late menstrual period, or having fertility treatments? ☐ Yes ☐ No

6. Are you currently taking or have recently taken any medication? ☐ Yes ☐ No

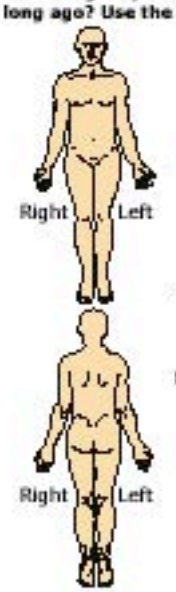
Please List: _____

7. Do you have drug allergies or have you had an allergic reaction? ☐ Yes ☐ No

Please List:

Some of the following items may be hazardous to your safety or may interfere with the MRI exam. Please check the correct answer for each of the following. If you checked yes, please give more information. E.g. Type of material? How long ago? Use the diagram to indicate where on your body?

	Yes	No
Cardiac pacemaker	☐	☐
IUD or diaphragm	☐	☐
Aneurysm clip or brain clip	☐	☐
Carotid artery vascular clamp	☐	☐
Neurostimulator	☐	☐
Insulin or infusion pump	☐	☐
Implanted drug infusion device	☐	☐
Spinal fusion stimulator	☐	☐
Harrington rods (spinal rod)	☐	☐
Aortic clips	☐	☐
Internal pacing wires	☐	☐
Venous umbrella	☐	☐
Artificial heart valve/prosthesis	☐	☐
Artificial limb or joint	☐	☐
Ear tubes	☐	☐
Wig, toupee, or hair implants	☐	☐
Body piercing(s)	☐	☐
Metal or wire mesh implants	☐	☐
Pessary or bladder ring	☐	☐
Swan-Ganz catheter	☐	☐
Claustrophobia	☐	☐
Underwired Bra	☐	☐



	Yes	No
Shrapnel, buckshot, or bullets	☐	☐
Implant held in place by a magnet	☐	☐
Shunt (spinal or intraventricular)	☐	☐
Tattooed eyeliner or eyebrows	☐	☐
Transdermal delivery patch (nicoderm)	☐	☐
Metal fragments(eye, head, ear, skin)	☐	☐
Facelift or other cosmetic surgery	☐	☐
Implanted cardiac defibrillator	☐	☐
Cochlear, otologic, or ear implant	☐	☐
Stents, filters, coils for blocked arteries	☐	☐
Electrodes (on body, head or brain)	☐	☐
Wire sutures or surgical staples	☐	☐
Prosthesis (eye/orbital, penile, etc.)	☐	☐
Metal rods in bones; joint replacements	☐	☐
Bone/joint pin, screw, nail, wire, plate	☐	☐
Asthma or breathing disorders	☐	☐
Seizures or motion disorders	☐	☐
Vascular access port or catheters	☐	☐
Other implants in body or head	☐	☐
Hearing aid (Remove before entry)	☐	☐
Dentures (Remove before entry)	☐	☐

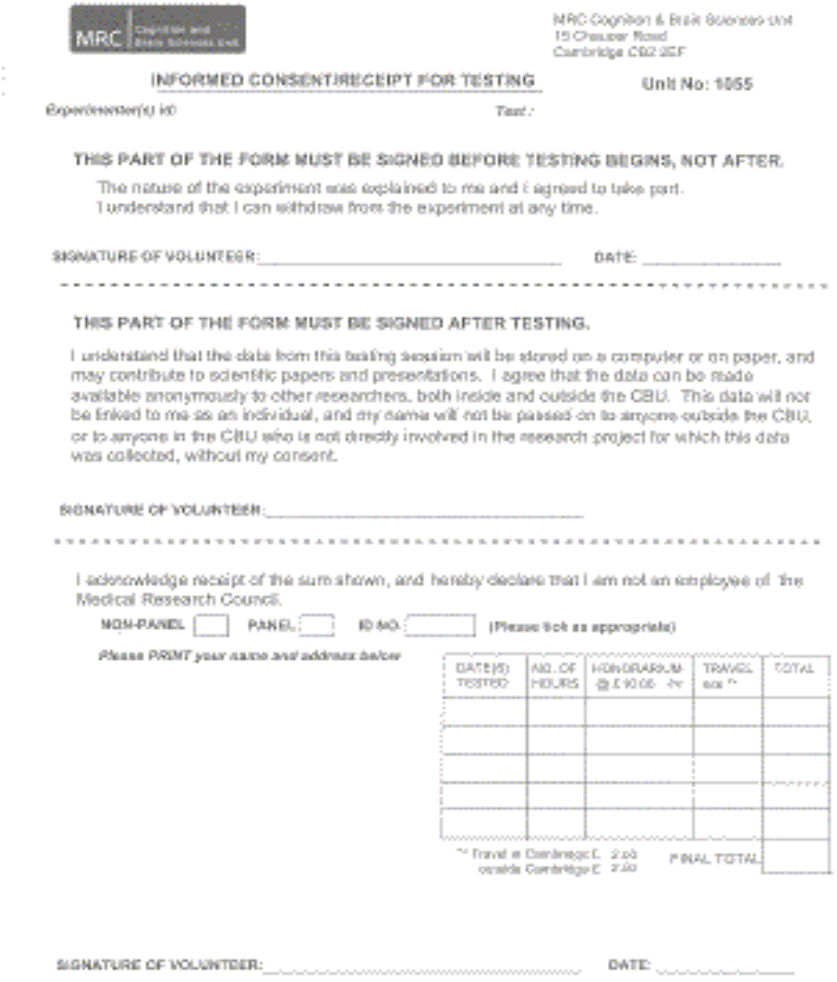
Please remove **all metallic objects** before you enter the magnet room including: keys, hair pins, barrettes, jewellery, watch, safety pins, paperclips, money clip, credit cards, coins, pens, belt, metal buttons, pocket knife, & clothing with metal in the material. **Earplugs are required during the MRI examination.**

Your Signature _____ Date: ___/___/___

Authorised staff name _____ Authorised staff signature _____

Appendix E: Consent form

- Standard consent form approved by CPREC 10/2007 for a specific experimental program.
- This needs adjustment and ethics approval for use in individual experiments.



MRC Cognition and Brain Sciences Unit

MRC Cognition & Brain Sciences Unit
15 Chaucer Road
Cambridge CB2 2EF

INFORMED CONSENT/RECEIPT FOR TESTING

Unit No: 1955

Experimenter(s) Initials: Test:

THIS PART OF THE FORM MUST BE SIGNED BEFORE TESTING BEGINS, NOT AFTER.

The nature of the experiment was explained to me and I agreed to take part.
I understand that I can withdraw from the experiment at any time.

SIGNATURE OF VOLUNTEER: DATE:

THIS PART OF THE FORM MUST BE SIGNED AFTER TESTING.

I understand that the data from this testing session will be stored on a computer or on paper, and may contribute to scientific papers and presentations. I agree that the data can be made available anonymously to other researchers, both inside and outside the CBU. This data will not be linked to me as an individual, and my name will not be passed on to anyone outside the CBU, or to anyone in the CBU who is not directly involved in the research project for which this data was collected, without my consent.

SIGNATURE OF VOLUNTEER:

I acknowledge receipt of the sum shown, and hereby declare that I am not an employee of the Medical Research Council.

NON-PANEL ☐ PANEL ☐ ID NO. ☐ (Please tick as appropriate)

Please PRINT your name and address below

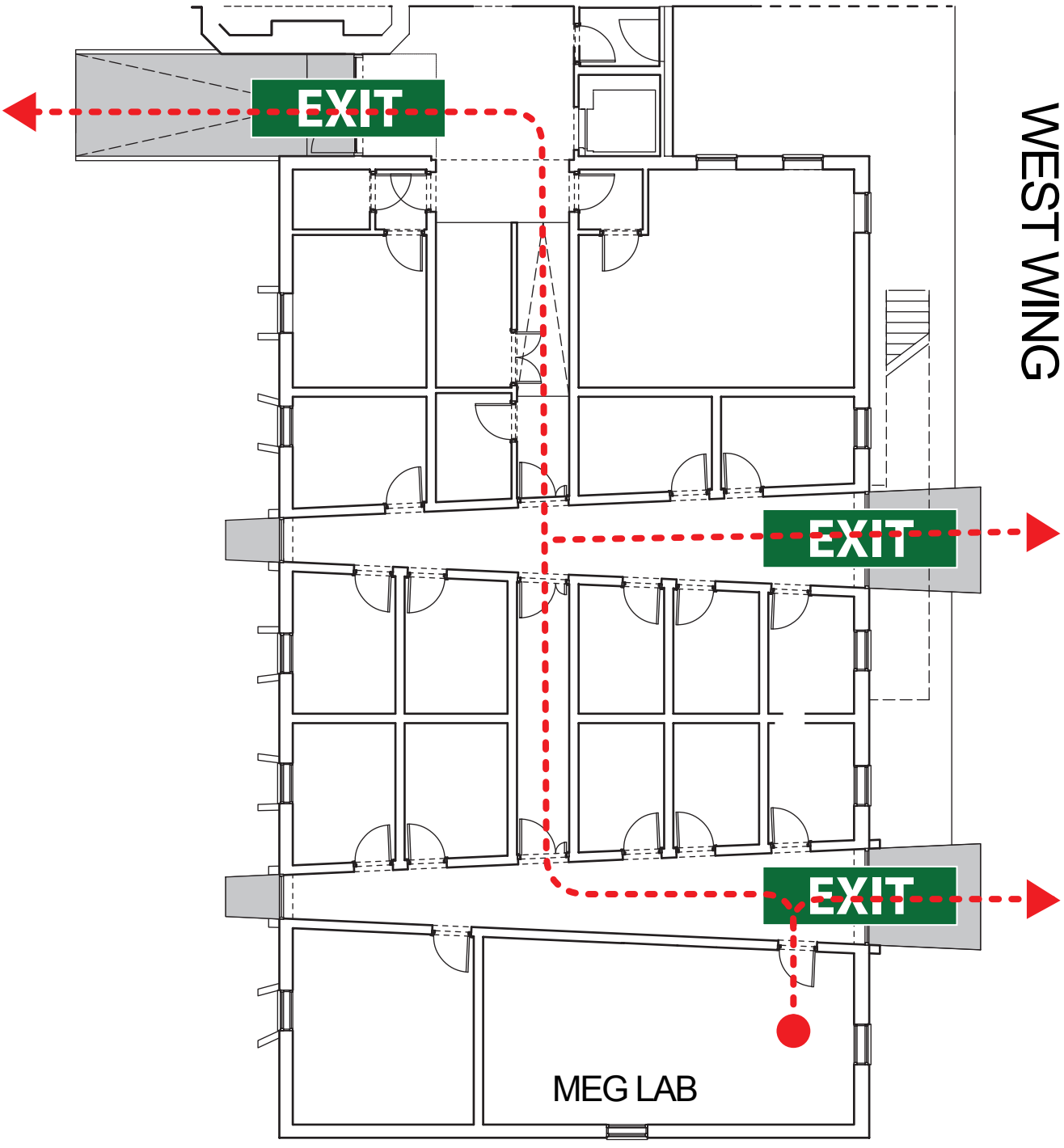
DATE(S) TESTED	NO. OF HOURS	HONORARIUM @£10.00 /hr	TRAVEL exp **	TOTAL

** Travel in Cambridge £ 2.50
outside Cambridge £ 7.50

FINAL TOTAL

SIGNATURE OF VOLUNTEER: DATE:

WEST WING MEG LAB EXIT ROUTES



KEY:

EXIT = EXIT POINTS

= EXIT ROUTES FROM MEG LAB

Appendix G: Definition of Terms

MEG Authorised Person	A person who has free access to the Controlled MEG lab Area. The selection and certification of a person for authorisation rests with the MEG Facility Manager and must be endorsed by the Head of MEG/EEG. Certification of an individual shall only be authorised after satisfactory completion of the local MEG Authorisation Procedure.
MEG Operator	An authorised person who has been trained to run the MEG device.
MEG Researcher	An authorised person who is a researcher and is leading, or participating in, an ongoing MEG study.
MEG Support or MEG Technical Staff	An authorised person who is technical staff with a specific function in he MEG laboratory (e.g Helium refill, computer installation).
Controlled Area	The controlled area includes the MEG laboratory, MEG preparation room and any additional rooms used exclusively for MEG purposes.
MEG laboratory	Space in the West Wing of the CBSU where MSR and Control Room are situated.
MSR, Magnetically Shielded Room	Core of the MEG laboratory where the MEG device is situated. The MSR is magnetically and acoustically shielded.
Control Room	Main room of the MEG laboratory, where computers for stimulation, data acquisition and evaluation are located along with amplifiers and a range of stimulation devices.
Preparation Room	Room close to the MEG laboratory where subjects are being prepared for the experiment, verbally instructed and pre-tested.
Non-	As equipment taken into the MSR must

ferromagnetic **Non-electrostatic**	be non-ferromagnetic and without electrostatic charges. Most metals are ferromagnetic, but there are a few, including aluminium, high quality steel, pure gold, that meet this condition.
Official Opening Hours	The Official Opening Hours of the CBSU are: Mon-Thu 9:00-17:30 and Fri 9:00-16:30

Appendix H: Oxygen Depletion Alarm

- At 19% Oxygen the beacon will start flashing. (**see Fig 1**)
- At 17% Oxygen the Alarm will Sound. (**see Fig 1**)

In either case the MEG room must be evacuated immediately.

- If there is a subject in the MSR Hit the emergency open on the MSR door and get the subject out immediately. (**see Fig 2**)
- If the MSR is empty and the door is closed do not open it.
- If possible hit the RED Power Isolation Button on leaving the MEG Room. (**see Fig 3**)
- If possible leave the main lab door open and open the door to the garden to aid ventilation.
- Do not re-enter the Meg Lab until authorised to do so and the Oxygen Monitoring Equipment in room 441 shows the levels are safe. (**see Fig 4**)

FIG 1

FIG 2

FIG 3

FIG 4

Helium fill procedure for the MEG unit:

In the event of an insoluble problem or physical threat to the safety of the operators during this procedure, the Dewar, Gantry and area involved should simply be evacuated. No serious harm can come to the equipment if it is allowed to vent unchecked.

1. Ensure the room is prepared for the fill procedure. The door should be fully opened, the ramp should be in position ***(Figure 1a)***, the MEG gantry should be in its lowered position ***(Figure 1b - see page 3)*** (For details on lowering the gantry – see "Raising and lowering the MEG Gantry" instruction sheet.) and the MEG chamber should be free of all obstructions.

2. Ensure you have all the correct equipment to hand. To wit – Two persons who must be present at all times during the fill. Both of whom should be taller than 1.7m (5'6") with at least one weighing no less than 75Kg (12St). Also:

- Ring seals for both main vent and charging vent,
- Threaded main vent cap,
- Ribbed charging vent cap,
- Two butterfly screw clamps,
- Spherical pump with tubing and roller valve,
- Gloves,
- Transfer pipe,
- Transfer pipe seal (fitted to the stubby end of the transfer pipe),
- Transfer pipe attachment assembly (brass screw cap, two rubber washers, metal washer)
- Cutting implement,
- Helium storage shed key.

3. Move a full tank of helium out onto the apron in front of the door into the unit. Cut away all ties securing valves and the plastic cover of the main vent.

4. Mount the ring seals onto the main and charging vents before covering with the Threaded and Ribbed vent caps ***(Figures 4a, 4b and 4c)***. Fasten both in place with the butterfly screw clamps. Be aware that the Dewar may come with sealing rings permanently fitted in one or both positions, in which case it's unnecessary to use ours. The ribbed cap may already have the pump and tubing attached. This is not a problem and does not need to be removed. ***(Figure 4d)***

5. If not already in position, the two rubber washers, the metal washer and the brass screw connector should be placed along the shaft of the fill pipe. These should ordinarily be there already, however they *must* be present and so should be checked for before proceeding. These four items form the transfer pipe attachment assembly. ***(Figure 5)***

FIG.1a

FIG.4a

FIG.4b

FIG.4c

FIG.4d

FIG.5

- **6.** One person (wearing gloves) should support the stubby end of the transfer pipe as the other person introduces the pipe into the main vent through the threaded cap ***(Figure 6)***. The transfer valve should be closed and the charging vent should be opened. This may result in partial or full inflation of the pump sphere.

- **7.** Once the transfer tube is inserted sufficiently to come into contact with the top of the main vent valve, the transfer pipe attachment assembly should be slid down to the top of the Dewar and tightened finger tight only. The rubber tubing seal on the stubby end of the transfer tube should be removed and the longer end of the transfer pipe should be inserted slowly into the Dewar. ***(Figures 7a and 7b)***

- **8.** The sphere pump should be fully inflated at this point and a close eye should be kept on the pressure valve to ensure it doesn't go too high (Above 0.25). If the pressure does climb to unacceptable levels by accident then it will be released via spring-loaded escape valves around the neck of the Dewar. The pressure can be released using the blue roller valve ***(Figure 8)*** connected to the pump, however care should be taken not to release all the pressure as this is useful for the fill process.

- **9.** As the transfer tube is lowered, a rushing noise should be heard and a shimmer may be seen escaping from the tube's open end. If there is any gas escaping from the neck of the Dewar around the transfer tube, tighten the brass collar down until it stops. Eventually, white mist will begin issuing from the transfer tube ***(Figure 9a)***. As the tube is lowered still further the rushing will intensify and the sound will deepen until the jet emanating from the nozzle takes on the appearance of a Bunsen-burner flame ***(Figure 9b)***. At this point, re attach the rubber tubing cap to the end of the stubby end, sealing it. This operation should be performed by someone wearing gloves.

- **10.** With the transfer tube re-capped, continue lowering the tube into the Dewar until it hits the bottom ***(Figure 10 - see page 3)***. Remember to keep an eye on the pressure gauge at all times.

- **11.** The Dewar can now be wheeled into the MEG chamber. The transfer tube should, at all times, be supported to prevent undue strain from causing stress damage to the tube's internal structures. It should be noted that passing successfully through the door into the building is not a guarantee that the Dewar will fit into the MEG chamber. However, if a Dewar with transfer tube attached will fit into the MEG facility then it should pass through the door of the chamber. No-one entering the MEG chamber should have any metal or electronic items on them.


FIG.6


FIG.7a


FIG.7b


FIG.8


FIG.9a


FIG.9b

12. It can be useful to take a helium level reading at this point to give a baseline for the fill. Except under special circumstances, it's unlikely that a fill will take place if the MEG is over 40% full.

13. The Dewar should be wheeled up to the front of the MEG and steadied in place there, with the tubing laid out on the floor with the sphere pump so as to avoid kinks in the piping and things being trapped under wheels and feet (The pressure dial underneath the MEG filler cap should be consulted to ensure the pressure within the MEG is zero before any further actions are taken). One member of the pair should be stationed at the left of the MEG, ready to extract the gantry fill-plug and control the pressure-release valve while the other will be inserting the hose.

14. The team-member on the left (looking at the unit) should loosen the gantry plug until it can be pulled out easily. It should be left in place until ready. The filler should remove the tubing from the tip of the transfer tube and watch the vapour issue forth ***(Figure 14a)***. When the stream has, once again, assumed the form of a Bunsen flame the filler should signal the valve operator to remove the plug. The filler will now, rapidly, bring the transfer tube in and insert it into the fill tube ***(Figure 14b)***. This will now be screwed securely into place. It should be noted that these larger plugs and tubes should never be attached too securely and should be screwed only to finger tightness.

15. While fitting the transfer tube, the person conducting the operation should keep an eye on the gantry pressure indicator. The optimal pressure is between 0.07 and 0.9. If the pressure appears to be increasing above this then the filler should notify the valve controller to open his release valve and release some of the gaseous Helium. The pressure should not be permitted to rise above 0.9. ***(Figure 15)***

16. With everything fitted together, the internal pressure within the gantry should begin to fall towards zero. At this point one of the personnel should begin pumping the spherical pump. This agitates the liquid helium and causes it to begin to flow. Pressure within the Dewar should be pumped to around .5, however it may not be possible to bring the pressure up this high. Once the pressure within the gantry begins climbing to around 0.08, the pumping may be discontinued and the siphoning action of the cryogenic fluid will maintain the process.

17. Sometimes the siphoning operation may be reluctant to continue as expected. In these cases it may be necessary to pump the system more vigorously and in the face of higher back-pressure. In this case, it's vital to have someone weighing in excess of 75Kg to perform the pumping as any lower weight will be insufficient to compress the pump. If the siphoning operation is functioning optimally, the unit should fill at a rate of approximately 10% per 5 minutes. This will rapidly drop to nothing as the liquid helium is exhausted. The best way to judge this is from the MEG control console as the meter on the side of the MEG is less accurate.

FIG.10

FIG.14a

FIG.14b

FIG.15

FIG.1b

18. As the supply of available liquid Helium in the Dewar comes to an end, pressure within the Gantry will either maintain at a constant level or decrease rapidly. At the same time, the transfer-rate will drop to zero. At this point, only gaseous Helium remains in the Dewar and further pumping is pointless. If the pressure within the Dewar and the Gantry are individually or collectively high then the pressure must be released via the control valve on the side of the unit or the pump/tube valve on the Dewar.

19. The pressure dial underneath the MEG filler cap should be consulted to ensure the pressure within the MEG is zero before any further action is taken. One of the team should unscrew the transfer tube from the Gantry fitting and remove and re-cap it. Simultaneously, the other member of the team should re-insert the Gantry plug.

20. Open the travelling valve, close all other valves and wheel the unit back outside.

21. Vent any pressure that has accumulated while the Dewar was being transported by opening the roller-valve and unfasten the brass coupling that is holding the transfer tube into the Dewar. Be certain whoever does this is wearing cryo-gloves.

22. Once the fitting is completely unscrewed, extract the transfer tube out of the top of the tank, again with the second member of the team supporting the stubby end of the tube. The rubber washers and coupling should be left stuck to the rod body. Once the tube is fully exposed, store it inside next to the radiator. Close the main valve on the top of the Dewar, remove all the fittings you added at the beginning of the process and move Dewar back into the Helium storage shed.

Notes:

• Anyone handling or coming into close proximity with liquid Helium should wear gloves to protect their skin from accidental exposure and cold burns.

• The individual controlling the end of the transfer tube that inserts into the Gantry should wear the protective visor in case of splashback.

• At 0.14 Bar, the primary safety cap on the Gantry will blow. A pressure release valve activates at 0.1 Bar however care should be taken when filling the gantry to ensure that the pressure does not spike when connecting the transfer tube. This can be difficult because of the necessity of wearing gloves, tightening the attachment on the hose and the clouds of vapour produced by the liquid Helium.

• The pressure dial underneath the MEG filler cap should be consulted to ensure the pressure within the MEG is zero before any actions are taken as this can cause a blowback.

• The pressure release vent on the side of the Gantry should never be opened when there is no pressure within the Gantry as this can allow air to enter the Gantry and taint the liquid Helium supply.

RAISING AND LOWERING THE MEG GANTRY:

RAISING THE GANTRY

1. Stand everyone clear of the moving parts of the system. No-one should be laying in the unit at this time. (Figure 1)

2. The indicator light on the rear of the unit should be showing green (OK). (Figure 2)

3. Depress the 'Up' key to the rear of the unit. The yellow (Tension) indicator should illuminate and the unit should begin to rotate upwards. (Figures 3 and 4)

4. Continue to depress the 'Up' button until the yellow (Limit) light illuminates in addition to the yellow (Tension) light. (Figure 5)

5. Tap the 'Down' button until the yellow (Limit) light extinguishes and the yellow (Tension) light is replaced by the green (OK) light. (Figure 6)

6. The gantry is now in position for scanning of seated patients. (Figure 8)

LOWERING THE GANTRY

1. Stand everyone clear of the moving parts of the system. No-one should be sitting in the unit at this time. (Figure 8)

2. The indicator light on the rear of the unit should be showing green (OK). (Figure 2)

3. Depress the 'Up' key to the rear of the unit. The yellow (Tension) indicator should illuminate and the unit should begin to rotate upwards. Almost instantly, the yellow (Limit) light should illuminate. At this point, release the 'Up' key. (Figures 3, 4 and 5)

4. Depress the green latch lever on the rear of the MEG. (Figure 7)

5. Keep the latch lever depressed as you also depress the 'Down' button on the rear of the MEG. The yellow (Limit) light should go out but the yellow (Tension) light will remain lit. (Figures 6 and 4)

6. The MEG gantry should begin to rotate downwards until it finally reaches its fully lowered position. As it reaches the supine position, the yellow (Tension) light will go out and the green (OK) light will illuminate. (Figures 1 and 2)

CAUTION.....

If, at any point during the procedures, the red (Fault) light should illuminate. If possible, lower the gantry to the supine position and report the fault to Elekta.

Never attempt to scan with the gantry in any position other than in the fully up and locked position (resting on the latch) or the fully down position (resting on the stops). The green ok LED must be on in either position.

Raising the gantry from the supine to seated positions will cause the helium level meter to under-read by approximately 20%. Helium readings should only be taken in the supine position.

FIG 1

FIG 2

FIG 3

FIG 4

FIG 5

FIG 6

FIG 7

FIG 8