

 LUND UNIVERSITY Lund University Bioimaging Center	Operational rules, workflows and routines at the PET/SPECT/CT unit at BMC A09	
	Prepared by: Marie Sydoff	Approved by: Freddy Ståhlberg
	Counter-signed by: Ritha Gidlöf	Latest updated: 180305 Valid from: 180312

Operational rules, workflow and routines at the PET/SPECT/CT unit at BMC A09

1. General

- It is mandatory that everyone who will be working in the PET/SPECT/CT facility (i.e. the person who is present at the imaging experiment) has received radiation safety education and an introduction to the facility. Contact LBIC's radiation safety officer/researcher, Marie Sydoff, either by telephone: 046-22 20541, or via mail at: marie.sydoff@med.lu.se, to receive these instructions/educations prior to the experiment.
- The PET/SPECT/CT laboratories are classified as *restricted area* (kontrollerat område), i.e. meaning that only a limited number of persons have access to the laboratories, only the PET/SPECT staff and the scientists/persons who have passed the radiation safety educations. Visitors (including the animal staff or other) have to contact the PET/SPECT staff before entering.
- The following rules for the PET/SPECT/CT facility located in the conventional animal department at BMC have been specified as a specific complement of the *General rules for the conventional animal department at BMC*. Questions regarding the rules for the conventional animal department can be put to: Fanny Wennerström at fanny.wennerstrom@med.lu.se or 046-222 14 20.
- It is the duty of each research group leader, as well as the PET/SPECT staff to ensure compliance with the rules. Failure to adhere to these rules may result in the termination of the study by the steering committee of LBIC.
- The LBIC personnel should always be contacted to clarify any doubts regarding safety issues related to the PET/SPECT/CT facility.

1.1. Staff

- Experiments and service on the PET/CT or SPECT/CT cameras will primarily be performed by LBIC staff unless otherwise agreed. The LBIC staff will work in close collaboration with the research groups before, during and after the experiments.
 - Marie Sydoff, radiation protection officer/researcher, marie.sydoff@med.lu.se, 046-22 20541

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- Ritha Gidlöf, radiochemist/researcher, ritha.gidlof@med.lu.se, 046-222 09 33
- Phone number to the SPECT/CT room: 046-222 05 85
- Phone number to the PET/CT room: 046-222 05 88
- The following is an overview of the service/tasks that might be provided by the staff at the PET/SPECT/CT. Other services might be arranged upon agreement.

Table 1: Overview of possible roles of the responsible scientist and our staff.

Imaging Experiment – Two roles	
Staff Roles	Scientist Roles
Initial discussion and design of experimental layout	All animal care according to regulations and compliance in BMC animal house
Writing adequate parts of the application form to the research board	Anesthesia handling
Radiation Safety Education	Preparation and injection of tracers
Introduction in the facility	Positioning, monitoring and placement of animal in the animal chambers
Imaging system QC	Heating and monitoring the animals' well-being
Assisting in delivery and receiving of radiotracers	Transportation and storage of animal in the radioactive animal rooms
Assisting with anesthesia systems	Clean-up and waste handling according to the routines and rules
Acquisition, processing, storage and analysis of images	
Scheduling	
Assisting with waste handling	

1.2. Laboratory space – orientation and safety

- The PET/SPECT/CT facility is located in the conventional animal department and the *General rules* apply.

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- Only the scientists that have scheduled for experiments on a specific occasion are allowed to enter this restricted area. The PET/SPECT staff should be informed in advance when guests would like to visit. When you want to invite guests who do not have access to the animal house, the contact person at BMC animal house (Fanny Wennerström) has to be informed.
- The whole PET/SPECT/CT facility is a *restricted area*, i.e. only a limited number of persons have access to it, primarily the staff and the scientists who work with radioactive materials and who has received adequate radiation safety education.
- Access to the facility is issued by the contact person Fanny Wennerström after notification by LBIC staff (after passed radiation safety education and introduction in our facility).
- The function of the different laboratory spaces are described in Figure 1 and in the text below.

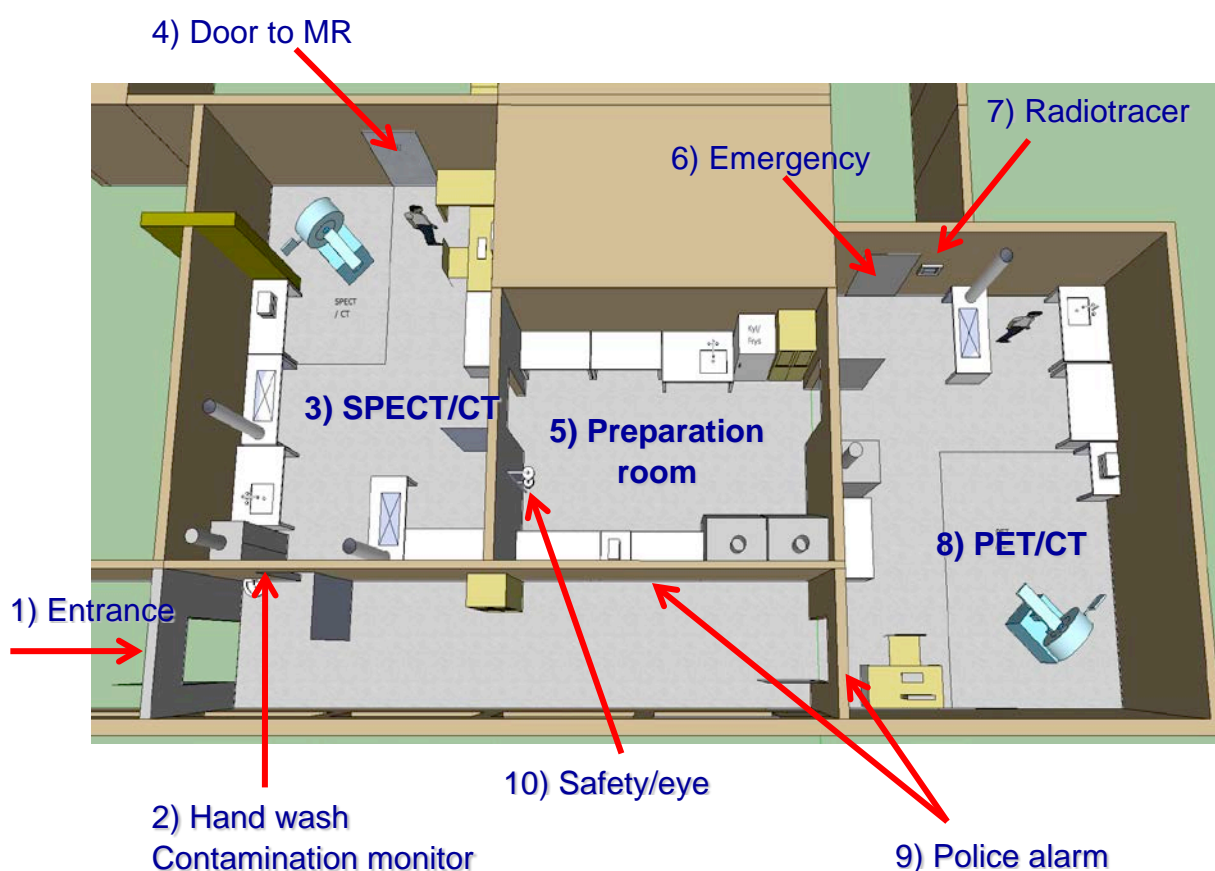


Figure 1. Laboratory space at the PET/SPECT/CT facility in BMC A09

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1) Entrance to the PET/SPECT/CT facility

- Entrance/exit to the PET/SPECT/CT facility from this door.
- A changing zone is marked with yellow/black tape.
- There is a sink for washing and disinfecting hands after work.

2) Contamination detector

- A contamination monitor is attached on the wall for checking possible radioactive contamination before leaving the facility.

3) SPECT/CT room – Room 0948c

- Before entering the SPECT/CT room, protective lab coat and separate shoes or shoe protection have to be used. This changing zone is marked with yellow/black tape on the floor.
- In the SPECT/CT room, there is a SPECT/CT camera, a work station for acquisition of scans, an animal cabinet, a ventilated dissection bench and a washing bench.
- Animal preparation is performed on the ventilated bench, where isoflurane equipment for anaesthesia is available; one is attached to the wall close to the camera; one is a mobile equipment placed by the ventilated bench.

4) Door to MR room

- This door should only be used when projects require so, not for shortcut to MR.

5) Preparation room

This room is for preparing injections and other samples and includes:

- CO₂ hood for euthanization of animals,
- Fume hood with lead shielding for preparing radiotracers and radioactive syringes.
- Dose calibrator for measuring activity; scale for weighing organs and/or substances
- Centrifuge for blood samples
- Freezer/refrigerator for storage of samples
- Cabinets for storing tubes, syringes, needles, papers, gloves and other consumables.
- Radioactive waste container (with lead shielding) for throwing possibly contaminated disposables used in the lab.

6) Emergency exit

- This door may only be opened in the case of emergency. Opening this door breaks the “seal” to the animal house and the alarm will go off.

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7) Radiotracer slot - genomräckningslucka

- This box may only be used for delivery of radiotracers and must NOT be used for any other purposes.
- Only a limited number of persons have access to this box (right now only the PET/SPECT staff). Before delivery or receiving of radiotracers the staff has to be informed.
- The key to the ethanol cabinet is always stored in this box.
- Transportation, delivery and receiving of radiotracers are described in a separate document; "General Radiation Safety Rules for work in PET/SPECT/CT facility BMC A09".
- When receiving the radiotracers in a lead shielding, the lead shielding has to be disinfected with ethanol before further transportation into the preparation room.
- Always make a note in the log book of which isotope, activity amount and date. The log book is placed on the shelf close to the radiotracer slot.

8) PET/CT room, Room 0948c

- Before entering the PET/CT room, a protective lab coat and separate shoes or shoe protection have to be used. This changing zone is marked with yellow/black tape.
- In the PET/CT room, there is a PET/CT camera, a work station for acquisition of scans, an animal cabinet, a ventilated dissection bench and a washing bench.
- Animal preparation is performed on the ventilated bench, where isoflurane equipment for anaesthesia are available; one is attached to the wall close to the camera; one is a mobile equipment placed by the ventilated bench.

9) Police alarm

- There is a button for police alarm close to the door of the PET/CT room and one in the corridor. This may only be used in case of emergency (assault).
- The alarm is directly connected to the police.

2. ANIMAL HANDLING AND EXPERIMENTS

2.1. Scheduling an experiment

- Prior to scheduling an experiment in the PET/SPECT/CT facility, the form *LBIC experiment request form* regarding the project and the animals (including the ethical permit number, drugs administered, surgical procedures done, implants, etc.) needs to be completed and signed by the principle investigator and the responsible scientist.
- The responsible scientist (i.e. the person who will be present at the experiment occasion) must have gone through a radiation safety education.

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- The responsible scientist must have gone through an introduction to the facility together with our staff before commencing work in our facility. This introduction has to be renewed after one year of inactivity.

2.2. General animal handling

- The responsible scientist has the main responsibility for the wellbeing of the animals at all times.
- All persons who have animals in the department must leave a telephone number where they can be reached during working hours and after normal working hours.
- All transport of *non-radioactive* animals will be handled by the staff of the animal department. If the animals from the C-corridor will be transported back from an LBIC facility, consult with Fanny Wennerström for further instructions.
- All transport of animal cages must be done in cabinets that are ventilated or have a filter top. This also applies to empty used cages, which must be placed in the designated area on the unclean side of the dishwashing room.
- All work with animals inside the laboratory should be done at ventilated work benches.
- Equipment for anaesthesia and animal positioning related to the experiment is provided for in the lab.
- Most of the dissection tools and consumables (syringes, needles, paper, tubes) are provided for in the lab.
- For the benefit and comfort of everyone, leave the laboratory in the condition in which you would like to find it.

2.3. Before the experiment

- Information provided in the *experiment request form* will be considered.
- Although the responsible scientist has received radiation safety training, we recommend every responsible scientist to discuss the layout of each experiment with our radiation safety officer/researcher Marie Sydoff prior to each specific experiment. This in order to get an in-depth risk assessment of the critical

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task/operation related to the radiation dose, and to make sure that the responsible scientist is aware of the possible risks.

- The responsible scientist should also discuss with the staff about the storage of radioactive animals in the specific experiment.
- The responsible scientist should discuss with the staff to arrange the delivery of radiotracers (what time to receive, and who will deliver etc).
- If there are instruments to be brought into our facility, discuss with the staff to arrange this.
- The responsible scientist is responsible for the following:
 - The well-being of the animals during storage and experiment. The responsible scientist is encouraged to comment if the storage conditions are not optimal and need improvement.
 - Establish a contact with the animal house staff to agree upon the time for animal transport
 - Organize the transport of the animals to the PET/SPECT/CT facility and store those in the designated area well before the experiment. Also, give them water and food as well as cleaning of the cages.
 - All animals must be in labeled boxes with top filters. The labeling of each individual animal (if more than one per box) should be stated clearly on the box.
 - If special arrangements are required, discuss with the staff beforehand.

2.4. During the experiment

- Information provided in the *experiment request form* will be considered.
- Before starting the work, all the work spaces have to be checked for possible contamination using a detector. Note the background level using the contamination detector in the preparation room and put this note in the log book in the preparation room.
- The responsible scientist is responsible for the following during the experiment:
 - Handling of radioactive materials. This should be done in the hood in the preparation room.
 - Preparation of radiotracers and measurements with the dose calibrator.
 - Performing injections of radiotracers or contrast agents.
 - Anesthetizing and positioning of the animals in the camera bed. The staff will assist if desired.

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- Monitoring of the animal's temperature, respiratory rate and cardiac rhythm.
 - Monitoring of the animal while waking up after experiments.
 - Performing euthanization of the animals according to the permit in a well-ventilated designated area (either in the CO₂ hood or on the ventilated dissection bench.
 - Performing dissection of the animals.
 - Changing cages (cage materials, water, food) during the storage time of the animals in the radioactive animal room until they are declassified from radiation by the PET/SPECT staff OR this could be done by the animal house staff after discussions.
- The LBIC staff will perform scanning, acquisition of images and will be available for assistance if not otherwise agreed.
 - The staff will help with the classifying/declassifying of the radioactive animals and cages so that the right handling and storage are performed.
 - The radioactive animals and cages are stored in the radioactive animal room in the designated area.
 - For the safety of everyone, all cages that have been used for radioactive animals have to be declassified from radiation by PET/SPECT staff before they are put for washing.
 - Right now, we can only offer the use of a limited number of isotopes (see table 2). This list will eventually be expanded with time when we have set up the working routines for other type of isotopes.
 - Following are the different experiment settings. The right experimental setting should be considered **prior to the actual day** of experiments.

Experiment setting 1:

Handling of radioactive animals – Short experiment

- Short experiment means the animals will be euthanized directly after the imaging sessions.
 - The radioactive waste (cadavers) shall be put in a plastic bag with a full declaration of isotope, amount, date and name. This shall be put in the freezer in the preparation room.
 - Contaminated cages will be left in the radioactive animal room or in the SPECT/PET room. These cages will be measured for radioactivity using a contamination detector. The responsible scientist must inform the

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PET/SPECT staff of any contaminated cages in order to classify them before they are put to the washing department or in the freezer room for decay.

- The responsible scientist has to label the bag around the cage with isotope type, date and signature to facilitate our work. It is also important that the bag is marked with “Do not throw away!” clearly visible.
- Short experiment can also mean that the animals will be injected and scanned only once but will not be euthanized after imaging.
 - Before they are allowed to go back to their original room, they have to be transported to our radioactive room (Room B8/B9) for decay at least overnight (depending on the half-time of the injected isotope).
 - The animals and cages will thereafter be declassified from radiation according to the above statement.

Experiment setting 2:

Handling of radioactive animals – Longitudinal experiment

- A longitudinal experiment means that the animals will be re-injected and/or re-imaged the day/days after. During this time, the animals are radioactive and they have to be stored in our radioactive animal room (B8).
- After imaging, the radioactive animals are transported by the responsible scientist to the radioactive animal room (B8).
- The very short exposure time to passing-by persons (förbipasserande) during the transportation constitutes no radiation hazard.
- Depending on the level of radiation (which will be estimated for each animal regarding to the injected dose and half-life of the isotope used), the animals will be labeled with the color of **GREY** (low radiation risk) **BLUE** (intermediate radiation risk) or **VIOLET** (high radiation risk). Our staff will help with the color classification if needed.
- The animals shall then be placed in the IVC racks according to the color tags in room B8.
- During the time the animals are stored in the radioactive animal room, the animals will be taken care of by the animal department staff OR the responsible scientist of the project, depending on the agreement between the responsible scientist and the contact person at the animal house.

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- Dirty cages are put in the designated area in the animal room for decay. Label the cages properly with isotope, date, signature and “Do not throw away” clearly visible on the bag.
- The PET/SPECT staff will measure these cages and declassify them from radiation.

List of isotopes	
Short half-life ($T_{1/2} < 10$ h)	Long half-life ($T_{1/2} > 10$ h)
^{11}C (20 min) PET*	^{111}In (3 d) SPECT
^{68}Ga (68 min) PET	^{89}Zr (3 d) PET
^{18}F (110 min) PET	^{90}Y (3 d) SPECT
$^{99\text{m}}\text{Tc}$ (6 h) SPECT	^{64}Cu (12.7 h) PET
^{211}At (7h) SPECT*	^{177}Lu (7 d) SPECT
	^{123}I (13.3 h) SPECT
	^{124}I (4 days) PET
	^{125}I (60 days) SPECT
	^{131}I (8 days) SPECT

Table 2: Isotopes that may be used for studies on PET/SPECT/CT.

2.5. After the experiment

- After the experiment, when all animals have been cleared in any way (either brought back to their animal room, to the radioactive room or terminated), the work space have to be cleaned in a proper way (see 2.6).
- Monitor the work space for possible contamination using a contamination detector and make a note in the log book.
- Throw all paper towels, gloves and other disposables in the waste container.
- Make sure to collect all your belongings.
- The animals are not to be stored in the PET/SPECT facility overnight. If the animals are transported back to their original room, the animal staff has to be contacted. The animals are not allowed to be brought back to the C-corridor. Contact Fanny Wennerström for further instructions regarding animal handling.

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- The radioactive cadavers will be put in plastic bags and put in the freezer for decay (see separate instructions in the Radiation Safety Manual).
- Non-radioactive biological waste and regular waste will be handled according to the *General rules* for the animal house.

2.6. Cleaning procedures

- All surfaces that has been in direct/indirect contact with animals shall be cleaned with first water, and later with ethanol after handling of every animal.
- The cylinder of the animal bed shall be wiped off with a damp paper tissue before inserting the animal in the scanner (**no ethanol or any other disinfecting solutions may be used**).
- Cleaning procedures for the animal bed and the anesthetizing box.
 - In between animals of the same project: The anesthetizing boxes (sövbox and uppvakningsbox) shall be cleaned with ethanol. The animal bed shall be wiped off with a damp paper tissue. **NO ethanol or any other disinfecting solution may be used for the animal bed.** The animal bed should be measured for possible contamination using a detector. This is done by the responsible scientist.
 - In between different projects: The anesthetizing box will be cleaned with water, then DesiDos (wait 20 min) and then rinsed by water. The animal bed will be disassembled and a vacuum pipette is used to blow through the channels. The animal bed will be disinfected in a mobile H₂O₂ system. This is done by the PET/SPECT staff.
- The dissection tools will be wiped off with paper tissue, rinsed with water and then with Virkon, alternatively they will be disinfected in H₂O₂ system or will be autoclaved.
- The CO₂ lid is rinsed with water and then with ethanol.