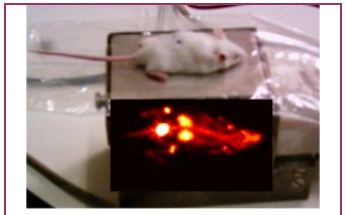
Evaluation and development of dedicated SPECT/PET imaging systems

Dedicated PET/SPECT imaging systems are a peak research field in Nuclear Medicine. They are used both in preclinical small animal imaging, as well as imaging of small organs and mainly breast and brain. In collaboration with foreign and national groups, we are working on the evaluation and development of SPECT and PET prototypes.

Three systems have been evaluated and are used for research purposes: a) a mouse sized gamma camera suitable for small animal imaging, which is based on 2 H8500 PSPMTs coupled to a pixelized NaI(Tl) crystal, b) a camera suitable for scintimammography, based on a R3292 PSPMT and a NaI(Tl) crystal and c) the first working PT prototype in Greece, based on 2 H8500 PSPMTs and LSO scintillators.

Our group has significant know-how and aims to develop a number of dedicated imaging systems that will be used in Greece or abroad for preclinical and clinical applications. In addition, existing systems are upgraded; the final goal is the development of an integrated SPECT and PET tomograph.

Moreover, we assess the performance of other system components and novel signal acquisition and analysis techniques.



Mouse sized camera

Scintimammography camera

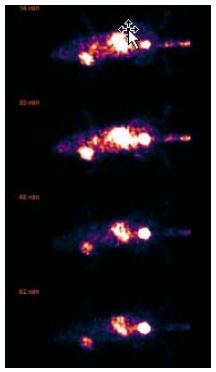
Dual head PET camera

Small animal imaging

SPECT imaging

The mouse sized camera has a field of view of 5x10cm. It is based on 2 Position Sensitive Photomultipliers (PSPMTs) H8500 and a pixelized (1x1mm pixels) NaI(Tl) crystal. The system is the results of our collaboration with the «Detector and Imaging Group» of Jefferson Lab.

The size of the camera allows the performance of kinetic studies in anaesthetized small animals. It is used for the dynamic evaluation of new diagnostic and therapeutic radiopharmaceuticals in collaboration with the «Institute of Radioisotopes and Radiodiagnostic Products» of «Demokritos» N.C.S.R.

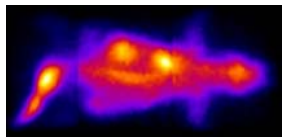


Dynamic tumor imaging study

The system is upgraded to a tomographic one, by attaching the camera on a rotating gantry. Our final goal is the construction of a SPECT/CT system.

PET imaging

PET technology is in its early steps in Greece. In collaboration with the «Detector and Imaging Group» of Jefferson Lab our group has the first research PET prototype in Greece. It is a dual head system, based on 2 H8500 PSPMTs, LSO scintillators and FPGA readout.

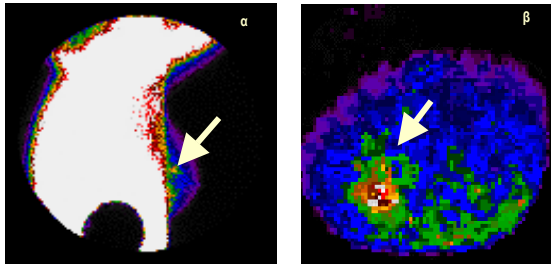


Mouse injected with FDG

Imaging studies in normal mice injected with FDG have been carried out. The system is attached to a rotating base and in collaboration with the «Institute of Radioisotopes and Radiodiagnostic Products» of «Demokritos» N.C.S.R. it is used for the development of new PET radiopharmaceuticals.

Scintimammography

Scintimmamography with dedicated systems can provide complementary information to the standard X-rays mammography, which can be very useful in a number of clinical cases. There is significant research activity in the field worldwide. Our group has a dedicated gamma camera, with 10cm field of view, based on a R3292 PSPMT, which has been used in scntimmamography studies by University of Rome “La Sapienza”.

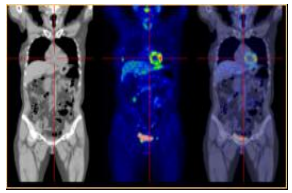


Comparative imaging of a small tumor with (a) a clinical Anger γ-camera and (b) a dedicated R3292 camera

The system has been tested using phantoms and at the moment imaging of breast phantoms is carried out. In addition pilot clinical trials are designed.

Reconstruction and processing of SPECT/PET images

Our group is activated in image reconstruction and processing of SPECT and PET clinical images. Iterative reconstruction algorithms have been developed (MLEM, OSEM), as well as an opensource reconstruction toolkit (QSPECT). Moreover, we have research activity in the field of attenuation correction in SPECT/CT and PET/CT. In addition, we collaborate with national clinical groups and we work on processing of clinical SPECT and PET data.



Clinical PET/CT images

Dosimetry in Nuclear Medicine

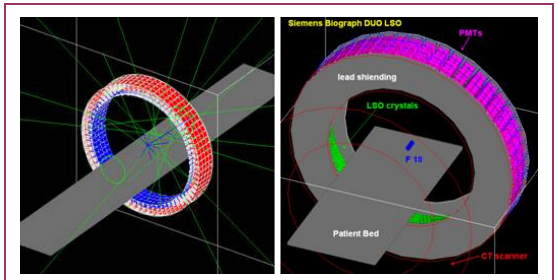
Dose calculation in Nuclear Medicine is an open research field. The combination of functional information and anatomical information can provide valuable information for personalized dosimetry.

A software that uses SPECT/CT or PET/CT data has been developed. The software uses pre calculated dose kernels,

which are based on Monte Carlo simulations. Both functional and anatomical data are used to select the proper dose kernels for dose calculation in each voxel.

Monte Carlo simulations in Nuclear Medicine

Monte Carlo simulations are increasingly used in Nuclear Medicine to model imaging systems and to develop and assess tomographic reconstruction algorithms and correction methods for improved image quantification. We are mainly using GATE Monte Carlo simulation toolkit, which is becoming a standard in Nuclear Medicine. Dedicated and clinical systems have been modeled; we are using GATE for the optimization of systems parameters. In addition, we study the optimization of injected dose, using GATE and anthropomorphic phantom simulations.



Simulation of clinical systems with GATE

Our group collaborates with openGATE collaboration, an international network of 25 laboratories, which are working in the development and maintenance of GATE.

Other activities

Our group provides technical support in software in the field of Nuclear Medicine. One of our major goals is the collaboration with academic institutions, industry, hospitals and nuclear doctors. There is significant knowhow in processing of clinical data and development of custom applications.

Research Programs

Although the group exists for one year, we participates in two European Projects, which have been recently approved in terms of FP7. The first is NANOTHER, which is focused on the development of novel diagnostic and therapeutic nanoparticles. The second is EURIPIDES, which aims to develop and evaluate novel imaging probes, which are markers for the function of the multidrug transporters that form part of the blood-brain barrier. We are responsible for the SPECT and PET evaluation of novel radiolabelled tracers in small animals.

Collaborations

Our group collaborates with many foreign laboratories, such as Detector and Imaging Group of Jlab, Crump Institute for Molecular Imaging of UCLA (US), University of Rome “La Sapienza” (Italy), Univerisdad Politıcnica de Madrid (Spain), Hammersmith Hospital (UK), etc, as well as national research groups such as «Institute of Radioisotopes and Radiodiagnostic Products» of «Demokritos» N.C.S.R, School of Electrical and Computer Engineering of National Technical University of Athens, Medical School of University of Patras, Medical School of University of Thessalia, Nuclear Medicine Department of Evangelismos Hospital, etc.

We are willing to establish new collaborations, participate in FP7 or other research proposals, as well as training and educational networks and student exchange programs.

Conferences & Awards

Our group has already participated in national and international conferences with more that 20 articles; In addition we have co-organized sessions related to nuclear medicine technology and we have received two awards. In addition, we participated in Medical Instrumentation Exhibition “MEDICEXPO 2008” and recently in the “Science and Technology National Festival”

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Nuclear Imaging Research Group

About us

The Nuclear Imaging Research Group belongs to the Department of Medical Instruments Technology, of Technological Educational Institute of Athens.

The group was established in 2007 and is activated in Medical Imaging using Nuclear Medicine techniques and mainly in:

- *Evaluation and development of dedicated SPECT/PET imaging systems*
- *Small animal imaging using SPECT/PET*
- *Scintimammography*
- *Reconstruction and processing of SPECT/PET images*
- *Dosimetry in Nuclear Medicine*
- *Monte Carlo simulations in Nuclear Medicine*
- *Other relative activities*

Currently the group has 8 members; one assistant professor, 4 PhD students and 3 master students.