Università degli Studi di Padova

Dipartimento di Fisica e Astronomia "Galileo Galilei"

M.Sc. Degree in Physics

Research Activity report

Titolo figo

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1 Aims of the experiment

The aims of the activity were

- compute S-values regarding organ-organ effects with $64Cu$ and validate them with the article Xie (mettici la bibliografia figa);
- compute S-values regarding biodistribution-organ using Catania's measurements;
- compute S-values regarding organ-organ effects with $47Sc$;
- compute S-values regarding biodistribution-organ using Mueller's biodistribution of 2014 (anche qua biblio figa)

2 Introduction

2.1 Moby and GEANT4

Besides enabling the study of disease in its natural state, in vivo small animal imaging assays are used to guide the discovery and development of new treatments of human disease. Mice are widely used in preclinical research studies to develop and test new treatments and imaging methods for human diseases (Hanahan 1989, Tuveson and Hanahan 2011, Deroose et al 2007). Radiotracer techniques using positron emission tomography (PET) are commonly used to provide in vivo functional imaging noninvasively in small animals, thus enabling us to track molecular processes associated with various diseases.

PET offers the important advantage that each animal can be studied repeatedly and as such, each animal could serve as its own control in longitudinal studies. In such studies, the animal is administered significant levels of radioactivity that result in radiation doses that can change gene expression, tumour characteristics and in some cases cause lethality (Funk et al 2004). Therefore, the dosimetric features of the various radiotracers used in PET require special attention and need to be accurately estimated in laboratory animal experiments.

In this work, it has been used

- **MOBY (v. 2.0)**, a 4-dimensional whole-body mouse model, to produce 4 voxel-based mouse models of different body masses and sizes.
- **GEANT4 (v. 10.7.0)**, a software for the Montecarlo simulation of the passage of particles through matter, to compute S-values for 16 organs from the positron emitting radionuclides ^{64}Cu and ^{47}Sc. Gammas were considered in the S-val calculations.

In addition, the absorbed dose for some representative radiotracers was assessed using the biodistribution data taken from Catania measurements or l'altra che non ricordo.

2.2 Misure di Catania

boh trova l'articolo pubblicato, ruba l'abstract e parafrasalo

3 Computing S-values organ-organ for ^{64}Cu

	lungs	heart	kidneys	liver	pancreas	spleen	intestine	brain
kidney	9.16 e-05	2.14 e-05	6.62 e-02	2.71 e-04	1.25 e-03	2.48 e-04	2.79 e-04	5.22 e-06
spleen	4.16 e-05	3.04 e-05	5.04 e-04	4.74 e-05	3.47 e-03	2.10 e-01	4.23 e-05	6.64 e-06
testicular	1.71 e-05	4.08 e-06	1.59 e-05	6.62 e-06	1.32 e-05	1.19 e-05	2.51 e-05	1.90 e-06
brain	1.11 e-05	1.49 e-05	4.65 e-06	1.05 e-05	5.74 e-06	8.52 e-06	4.06 e-06	2.46 e-02
thyroid	2.66 e-05	6.82 e-05	8.25 e-06	2.10 e-05	9.82 e-06	1.03 e-05	7.31 e-06	1.06 e-04
heart	1.08 e-03	2.10 e-01	2.26 e-05	3.28 e-04	3.25 e-05	2.90 e-05	1.69 e-05	1.84 e-05
liver	2.55 e-04	1.94 e-04	2.16 e-04	1.26 e-02	3.45 e-04	4.13 e-05	1.52 e-04	9.82 e-06
lung	3.08 e-02	6.55 e-03	2.86 e-05	9.47 e-04	3.51 e-05	2.72 e-05	1-72 e-05	2.25 e-05
pancreas	1.57 e-04	3.45 e-05	1.29 e-03	2.84 e-04	5.83 e-02	1.38 e-03	7.84 e-04	6.73 e-06
skin	1.70 e-05	1.63 e-05	1.64 e-05	1.65 e-05	3.14 e-05	8.85 e-05	2.14 e-05	2.58 e-05
bladder	4.36 e-05	7.44 e-06	2.26 e-05	1.12 e-05	2.00 e-05	1.42 e-05	6.35 e-05	2.81 e-05
stomach	1.76 e-04	4.84 e-05	1.25 e-04	6.33 e-04	4.93 e-03	3.94 e-03	1.36 e-04	9.24 e-06
celebral cortex	8.06 e-06	9.12 e-06	6.45 e-06	9.67 e-06	7.12 e-06	4.75 e-06	3.80 e-06	4.40 e-02
vas deferens	3.40 e-05	3.61 e-06	1.95 e-05	1.01 e-05	1.78 e-05	1.37 e-05	4.75 e-05	2.03 e-06
small intestine	5.26 e-03	1.81 e-05	1.09 e-04	1.15 e-04	4.09 e-04	4.31 e-05	1.28 e-02	3.42 e-06
large intestine	5.28 e-03	1.48 e-05	2.44 e-04	4.83 e-05	3.28 e-04	5.63 e-05	1.13 e-02	3.73 e-06

Table 1: S-values organ-organ. Organs on the top are **targets**, organs on the left are the **sources**.

4 Conclusions

In order to summarize the obtained results, we can state that the energy calibration results are satisfying for both the two detectors, in particular the one for the HPGe results highly accurate.
As far as the efficiency is concerned, we obtained:

- **HPGe**: a well-fitting function (i.e. a reliable prediction of the efficiencies values) for high energy, while a phenomenological result for low energies;
- **NaI**: a not reliable fit at any energy.

Some radioactive samples present in the laboratory were analyzed to identify the gamma transitions and determine the activity of the radionuclides of interest (complete results are shown in **??**): different values were obtained for the two detectors, yet the discrepancy between them could be explained taking into account the approximations introduced in the experimental procedure.
Finally, an indoor Radon measurement was performed: the resulting activity is beyond the legal limit for working environments, but this might be explained considering the fact that the measure was carried out in a small and poorly ventilated room where a high concentration of Radon is expected.

5 Appendix