Scanning Multiple Mice Simultaneously in a Siemens Inveon Multi-Modality Micro PET/CT System.

D. Stanley, M. Lin, J. Liu, M. Long, M. Xiao, T. Anthony, A. Singh, G. Hao, X. Sun

Introduction:

The high rate of studies being done on mice with tumors has created a demand for more mice to be scanned. Improved statistical accuracy and delays in future developments have been delayed because the demand cannot be met by traditional single mouse scans. This has warranted a need for new methods to scan a larger volume of mice and increase productivity as the field grows. Additional PET/CT scanning devices as well as employees to perform these scans would be impractical and wasteful due to financial capabilities. One possible solution that is sought after in this experiment is one that allows use of the same previous equipment with a few minor modifications that allow multiple mice to be scanned simultaneously.

The system used for this project is a Siemens Inveon Multi-Modality Micro PET/CT System was intended for scanning one mouse at a time on a carbon fiber animal bed. There are three major obstacles to overcome when modifying the equipment for this machine to scan numerous mice at once: (1) constructing mice beds that do not have a high uptake of Beta Plus radiation in PET or X-rays in CT; (2) adjusting the amount and flow of Isoflurane used to anesthetize the mice, and; (3) creating a way of injecting up to six mice simultaneously with the same radio-isotope.

There are already known substances available to laboratories which allow PET/CT scans to be performed while losing relatively minimal amounts of accuracy and supporting the animals bodies, but these are not readily available in the sizes and shapes required for our equipment. Thus, hand crafted beds must be designed to fulfill the requirements for said experiment. The test material in this set of experiments is plexi-glass coupled with the original carbon fiber bed and Blue CT Foam.

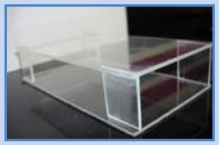
Since the Inveon has a single enclosed input and output for gases (anesthesia and oxygen) the input will have to be split into six directions, each with a mouse nose cone and an on/off valve so that an undecided number of mice can be scanned at any given time. Since the excess hose is quite large when not in use, it will also have to be easily detachable. The machine's bore is very compact with a 10cm diameter, so selecting the right size hose and nose cones will be essential when trying to place the mice, the bed and the hoses all inside of the scanning areas.

Hypothesis:

If a Siemens Inveon Multi-modality PET/CT Scan machine is properly altered so that the anesthesia flow and direction can support up to six mice; the injection method is modified so that multiple mice can be simultaneously injected without a separation of preparation time and multiple animal beds are constructed so that mice can fit inside the PET/CT bore then the results should allow an increased workload for studies.

Six Animal Bed

Four Animal Bed

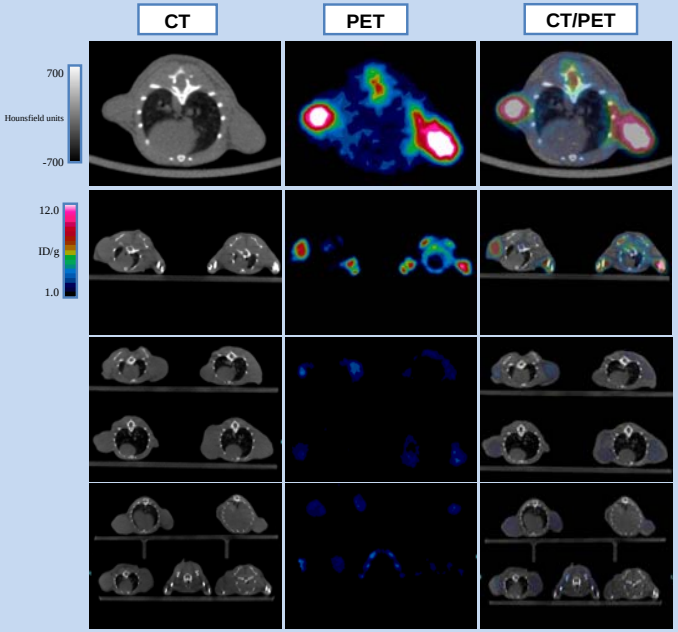


Two Animal Bed
(shown attached to carbon fiber and Blue CT foam)

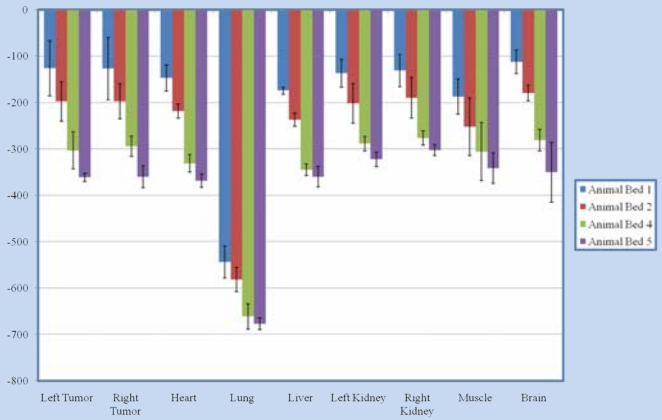
Six-way manifold attached to inside wall of Inveon

Hoses and nose cones attached to six animal bed in front of the PET/CT bore

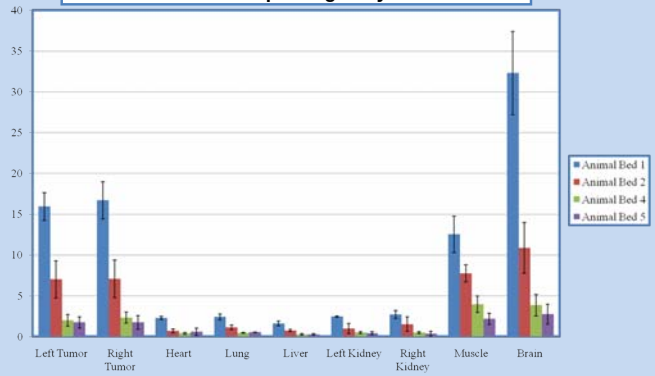
Butterfly catheter attached to syringe



Average Radio-density per Organ by Animal Bed in Hounsfield Units



Average Percent Injected Dose per Gram Uptake of ^{18}F in PET Scan per Organ by Animal Bed



Conclusions:

When the uptake levels are compared on the first graph, it is clear that the Beta Plus emissions are heavily absorbed in either the plexi-glass or the other mouse bodies present. When a comparison is made between all of the mice organ absorption levels in the five animal bed it is clear from images and data that the middle mouse on the bottom row has a lower injected dose per gram than its surrounding test subjects and their overall average. This means that other mice are blocking (i.e. absorbing) the beta plus emissions from being detected by the machine. This is a problem that could be solved using attenuation to correct the amount of blocked beta plus rays that come from mice enclosed in the center of the bed as well as for the other mice who block radiation on a single side of other mice.

The alterations on the anesthesia input of the machine have been successful after a few modifications. The anesthesia machine and Flow-meter can readily sustain the volume of Isoflurane needed to anesthetize five mice at once without leaking or disconnecting hoses. The machine has an available six way manifold meant to be directly connected to the device on the outsides that was repositioned on the inside front of the apparatus wall that allowed room for the bed to progress and retract without constricting any flow of anesthesia. One to six mice can be properly anesthetized at the proper level without leaks in the machine and without the animals waking up from an insufficient amount anesthesia.

The injection dilemma was solved by using butterfly catheters to allow for placement of all the needles into each respective test subject prior to full injection in each. This allows the syringes to be set down while other mice are prepped and allows for simultaneous injection.

Future Directions:

The future experiments should proceed by solving the need for a calibration and an attenuation correction for all different size mice beds and positioning. This could be extended to other PET/CT machine models.

Acknowledgements:

I would like to thank UT Southwestern and the S.T.A.R.S. Program for allowing me to take part in this research program; Dr. Ravnik and Lynn Tam for their gracious patience and guidance in the program; Dr. Xiankai Sun for opening up his laboratory to me; the Department of Radiology for working with and around me; Dr. Carl Knight, Norma Mendoza and Laura Thomason for their work at Eastfield College to further students learning opportunities; and especially Michael Long for his much needed direction and help everyday of this project.