

Phantom Mouse for Combined PET, RT, and CT Scanner

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Function: This project is for the design and development of a mouse phantom that will be used to characterize and test the micro collimator of an open source small animal imaging and therapy system. This machine includes micro CT, micro PET, and micro RT tests, and thus the mouse phantom must be compatible with all three systems. Ultimately, the system will be used to treat and image mice, rats and other small animals. The phantom will be designed for effective calibration and testing of the device while also researching the effects of radioactive materials placed inside the device to track radiation dosage distribution.

Client Requirements:

- Appear anatomically similar to a rat
- Fit the 12cm diameter bore of the scanner
- Physically scan similar to a rat
- Be able to detect radiation via inserts
- Contain radiation inserts without contamination to the rest of the phantom
- Contain 3 different tissue types of accurate densities: bone, muscle, lung
- Contain inserts for vital organs such as the heart, kidneys, lungs, and liver
- Separable in different pieces with minimal air gaps

Design Requirements:

1. Physical and Operational Characteristics

- Performance requirements:* The phantom should be able to fit inside the 12 cm diameter tube of the scanner while attached to the loading table. The phantom may be submitted to repetitive use depending on the needs of the researchers.
- Safety:* The device will not be used on human subjects so there are little safety concerns involved. When radiation is used in conjunction with the device safety precautions will have to be taken to avoid human contact with any harmful elements.
- Accuracy and Reliability:* A high level of accuracy is required in the design, as it will be used to calibrate the scanner being built. The phantom will need to mimic the anatomical features of the rat, including the bones, lung, and muscle tissue.
- Life in Service:* The phantom should be able to withstand repetitive use. Also radioactive materials will be used that must not be allowed to contaminate the device.

- e. *Shelf Life*: The shelf life of the phantom should be an indefinite amount of time. The device should maintain working order until the machine is built and testing has been completed.
 - f. *Operating Environment*: The phantom will be exposed to radioactive material and must be able to withstand the radiation while remaining un-contaminated. It will be used at standard room temperature and exposed to the elements of the RT, PET, and CT scanners.
 - g. *Ergonomics*: The device should experience little human contact besides the placement on the scanning platform and the removal of the device for storage.
 - h. *Size*: The phantom needs to be able to fit inside the 12 cm diameter scanner tube. Also the phantom is to come apart into two or three pieces. This will allow for removal of the bones and possible radioactive material placement.
 - i. *Weight*: The device should not exceed 2 Kg.
 - j. *Materials*: Material restrictions are limited to densities that mimic the real rat tissue while also being capable of placement in all three scanners
 - k. *Aesthetics, Appearance, and Finish*: The physical shape and form of the phantom should resemble the anatomical properties of a rat, as the goal of the project is to make sure the device scans like a rat.
2. **Production Characteristics**
- a. *Quantity*: One phantom is initially to be designed. Depending on the final design decided on a mold might be produced that will allow for multiple phantoms to be produced.
 - b. *Target Product Cost*: Product cost should not exceed a few hundred dollars.
3. **Miscellaneous**
- a. *Standards and Specifications*: FDA approval is not required.
 - b. *Customer*: Customer is willing to try a variety of tactics to reach the final goal as long as the phantom accomplishes the desired functionality.
 - c. *Patient-related concerns*: The main concern for the cleanliness and storage of the device if only one is produced is that the radioactive materials used in the test trials not contaminate the device.
 - d. *Competition*: There are similar items that exist on the market today but they cost large sums of money. The goal of this project is to create an inexpensive, yet effective, alternative to these devices, which also accomplishes the necessary calibration and research.