PiMAL 6.0
Software Release Note

March 2025

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1.0 Introduction

This document outlines the modifications, additions, and/or removal of features from Phantom with Moving Arms and Legs (PiMAL) 5.0 to PiMAL 6.0.

All modifications are based on items entered into RCD software issue tracker as a source for the basis of a change.

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2.0 Abbreviations and Definitions

Table 2-1. Abbreviations and definitions.

Term	Definition
CP	change package number (gitlab version identifier)
DLL	dynamic-link library
GUI	graphical user interface

3.0 Base Line Code

The changes identified here have been incorporated into the baseline of PiMAL. PiMAL has the following project dependency as noted in Table 3-3.

Table 3-1. GIT attributes.

Git Location	Revision ID (Commit SHA)
https://gitlab.com/RCD-1/pimal/-/tags/PIMALv4.1.0	90b0d82453f2cb76a80b44ae179033068aa375d3
https://gitlab.com/RCD-1/pimal/-/tags/v5.0	2e62f5fc1215b1d5d67029933e8d36d9eb79acc3
https://gitlab.com/RCD-1/pimal/-/tags/v6.0	237929e2bcb47af916202a4867ed3a23f3770cb3

Table 3-2. Executable attributes (latest release).

Executable Name	PiMAL-6.0.exe
MD5sum	`8f1e4800ecb4ae360462cb4e22a830f2`
SHA256	`6c49a580a1214b3e570b23b76fe57a691d428774c0e7073066e5eac1442641fd`
SHA512	`1e54b189b35b49780ff7db5b644149fdb00fcb7724b5f6babebffbefc547026a7719fade6b88eae7d7c620a4b4ef65452947ca50227c8a57f6a0191b4571763d`

Table 3-3. Dependency attributes (for latest release).

Software	Version	Git Location / Group ID	Revision ID (Commit SHA)
JDK	21	n/a	n/a
formats	n/a	https://gitlab.com/RCD-1/utilitiesjava/-/tags/utilities_v2.0	3714305b7dac46253827bc4a0361ae496db588c0
files	2.0		
mcnpUtilities	2.0		
render3D	2.0		
commons-collections4	4.1	org.apache.commons	n/a
gluegen-rt-main	2.4.0	org.jogamp.gluegen	n/a

Software	Version	Git Location / Group ID	Revision ID (Commit SHA)
java3d-core	1.7.1	org.jogamp.java3d	n/a
java3d-util	1.7.1	org.jogamp.java3d	n/a
joal-main	2.4.0	org.jogamp.joal	n/a
jogl-all-main	2.4.0	org.jogamp.jogl	n/a
vecmath	1.7.1	org.jogamp.java3d	n/a

4.0 Modifications

The following sub-sections outline the changes made from PiMAL version 5.0 to PiMAL version 6.0. A high-level summary of modification packages is provided in Table 4-1. The following subsections provide more detail on the software modifications as they relate to impacts on the user.

Table 4-1. Summary of modification packages.

Version	Issue #	Developer Description	Section(s)
5.0 (CP2)	-	Major Release.	-
6.0 (CP3-7)	18, 19, 23, 49, 50, 55, 62, 63, 65, 68, 72	This version is a major rewrite of PiMAL to update the visual graphics library for displaying human and animal phantoms. Additional dose inputs are available to the user to translate MCNP tally information to effective dose estimates. Various enhancements, see following sections for details. Major Release.	4.1, 4.2

4.1. Added and Modified Features

4.1.1. Update to Visual Graphics Dependencies

A compatibility issue was discovered with PiMAL resulting in the unexpected inability to compile or execute the original source code after testing on Windows 11. This resulted from the use of outdated and no longer supported 3-D rendering libraries. This necessitated an overhaul of these libraries and several other auxiliary functions to ensure compatibility on new operating systems.

Overall, this modernization effort has also made the code base more manageable such that future improvements or bug fixes will be easier to diagnose and resolve.

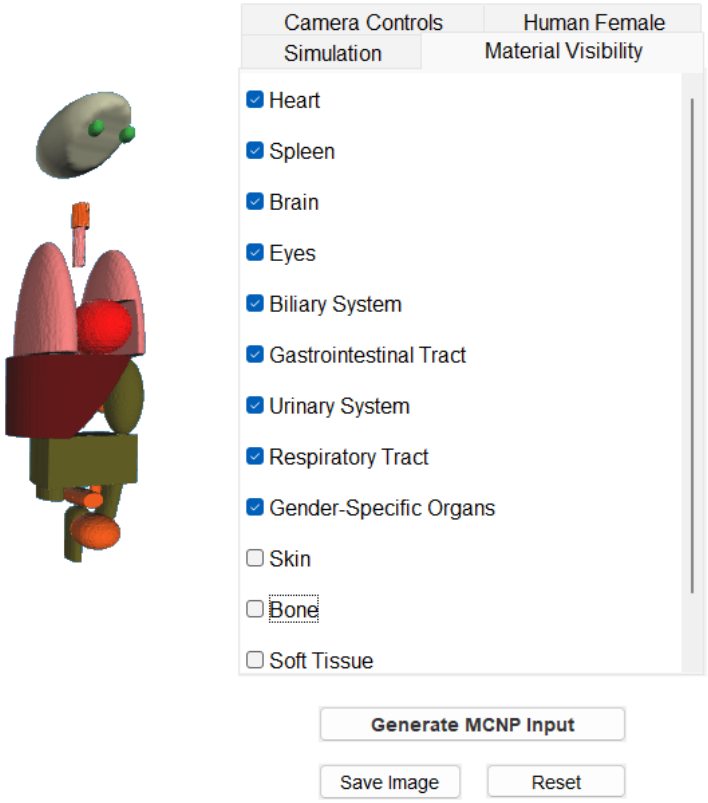

Figure 4-1.Phantom with updated graphics dependencies.

4.1.2. Companion Animal Base Models Added to Phantom Library

The user can now choose to add a cat, dog, or horse phantom to the model. Each companion animal base model has limbs articulable in the height and long

axis directions of the animals (x and z dimensions in the default configuration). Additionally, each companion animal is scalable by weight.

Options for positional configuration include single animal alone and single animal alongside the human phantom. The position of the animal is movable within the PiMAL GUI and will generate an MCNP input deck according to the users pre-selected configuration.

PiMAL is not built for the purposes of computing dose to the animals, and as such, the exposure path is always to the human whether the source is from:

- distributed source internal to the human,
- external source, or
- source internal to the animal.

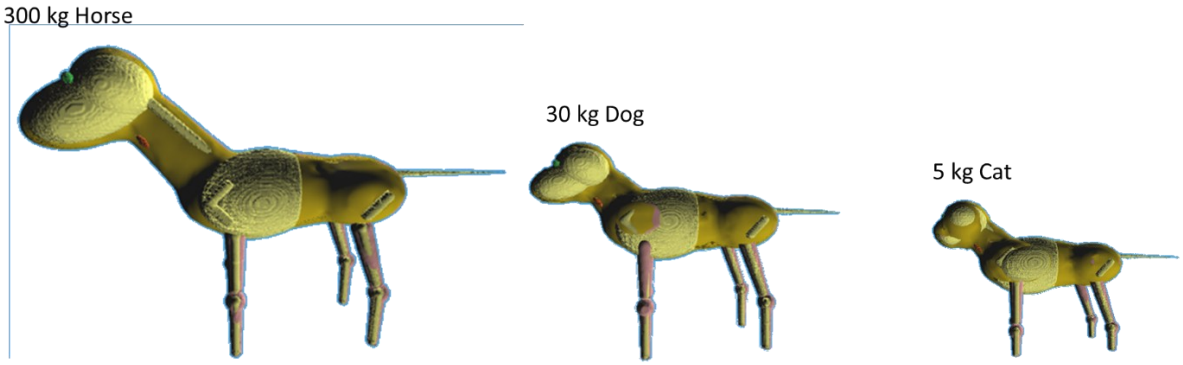

Figure 4-2.Animal phantoms and example masses.

4.1.3. Updated Simulation Tab

The simulation tab has been updated to include a more comprehensive list of nuclides that will reflect a broader range of simulation environments for diagnostic and therapeutic purposes.

Simulation tab no longer asks user to change number of particles, as this has led to confusion about activity/intensity and its use in scaling results. The number of particles simulated for the MCNP run is now preset in the generated input file which can be manually modified by the user within PiMAL.

Inputs related to the source configuration have been added for clarity and to aid the user to translate MCNP tally information into estimates of effective dose. Figure 4-3 identifies the source configurations allowed as well as the associated inputs used to calculate effective dose.

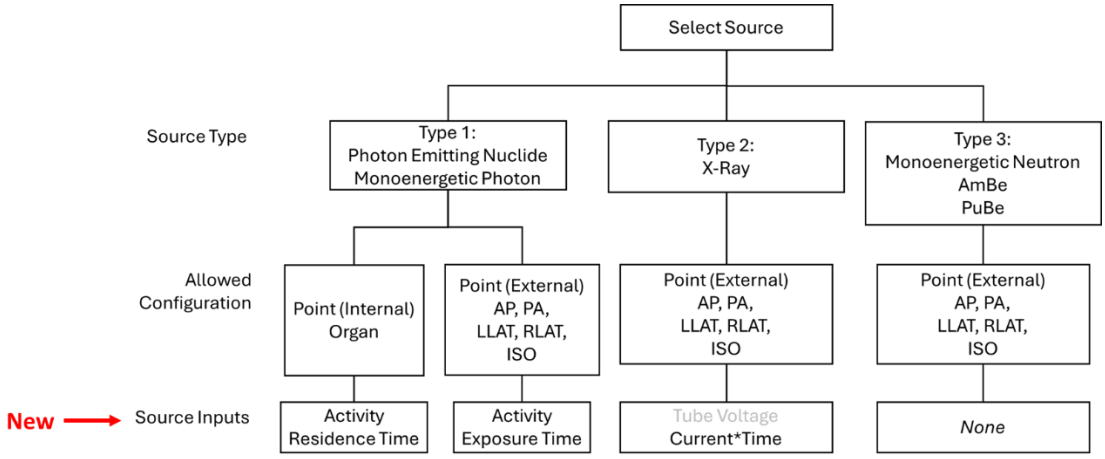

Figure 4-3.PiMAL source configurations.

4.1.4. Updated MCNP Running

The linking of MCNP to the PiMAL interface has been updated for easier use, with more user-friendly instruction and installation. This has been tested up to MCNP version 6.2.

4.1.5. Source Points Display

The number of source points to display the size and color as well is now available under preferences in the main window.

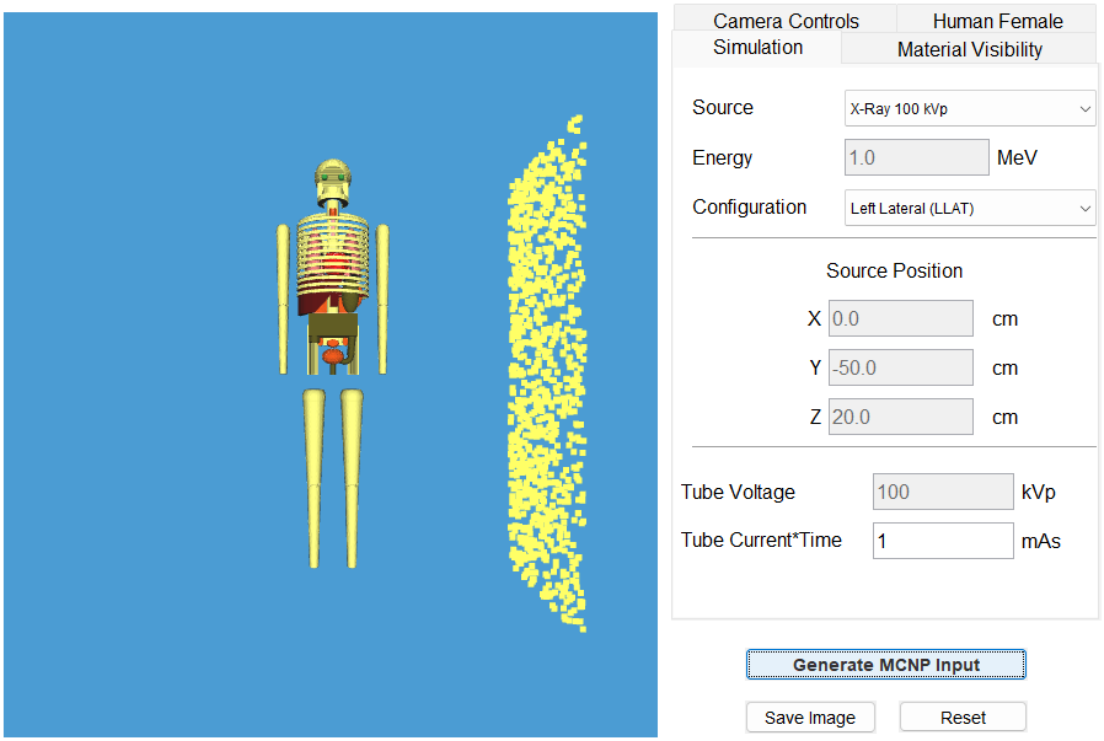

Figure 4-4.Display of source paticles after MCNP run example.

4.1.6. MCNP Output form

Execution of an MCNP input no longer overwrites a previous MCNP run to allow for comparison of runs.

The organ dose output form now calculates effective dose from three selectable ICRP methodologies (ICRP 26, ICRP 60 and ICRP 107) for the appropriate source types (photons).

The organ dose output form can now be exported to a CSV file for easier use in excel format or other text and statistics software packages.

Organ doses have been expanded to include more information. Now available are 30 organ doses, changed from the original 25.

Warnings present in the MCNP out file are now collected and reported. They are available for quick view under the MCNP Errors/Warnings tab.

4.1.7. MCNP Input File

The MCNP input file has been modified to correspond to ICRP 89 (2002)'s organ mass and materials. This is to better represent the dose per unit mass calculations in the tally specifications.

Lymph nodes were added to the base models.

Male genitals were modified to reflect anatomy, and cell numbering was updated to be the same as the female mathematical phantom for easier comparison between models.

4.2. Removed Features

4.2.1. Two-Dimensional Phantom View

During the update and rewrite required to the visual graphics libraries (Section 4.1.1) for displaying the phantoms, the implementation of the two-dimensional phantom is removed. The version 5.0 only provided an outline of the torso as a whole with no details of the organs or structures. Future implementations are envisioned a true cut-plane of the 3D model with details of the structures visible if interest exists.

4.2.2. Voxel Phantom

Being that the voxel phantoms were narrow scoped (e.g., single male, mass, and age) and not movable, they were also removed. For future implementation it is recommended to properly account for age and body mass in any additional modeling capability. These phantoms also require rebuilding after the graphics library updates (Section 4.1.1).