

AbstractID: 11907 Title: An Integrated Robotic-Based Irradiation System for Small Animal Research

An integrated, image-guided irradiation system for small animal research has been developed. The system is capable of precise, accurate, reproducible and quantifiable 3D conformal delivery of radiation dose distributions to organs/tumors. The main hardware components are: (1) A Seifert Isovolt Titan 225 kV X-ray tube with beam collimation provided by a custom-made variable diameter "cone" or a set of motor-driven symmetric "jaws", thereby allowing field sizes from 0.5 mm in diameter to 7 cm square field at ~33.5 cm SSD. (2) A six-degrees-of-freedom (6DOF) robotic arm (Adept Viper s650) was integrated for precise animal positioning/motion (repeatability of ± 0.020 mm in XYZ direction and angular precision of $\pm 0.2^\circ$). The system is housed in a custom 6 x 6 x 6 ft³ shielded enclosure inside a laboratory. When the beam is aimed horizontally to (3) a flat panel amorphous silicon detector (XRD 0820 CN3, Perkin Elmer, Fremont, CA) a series of 2D-radiographs can be recorded while the robot rotates the animal. Each image is composed of 1024 by 1024 pixels with a 200 μ m pixel size at a frame rate of 7.5 Hz. An open source cone beam computed tomography (CBCT) reconstruction tool (OSCAR-2, University of Toronto) using the Feldkamp-Davis-Kress (FDK) filtered back projection algorithm was implemented for CBCT image reconstruction. Thus, targeting can be accomplished by the use of orthogonal radiographs and/or CBCT. A dose engine and CBCT-based treatment planning are ongoing projects.

Dosimetric measurements and preliminary animal experiments have demonstrated the basic capabilities of the system in terms of radiation dose, dose rate and precision targeting. The system has also been used successfully in experiments to detect the molecular signaling occurring after spatially fractionated radiation therapy (GRID) *in vivo*.

A description of the system and a summary of experiments performed to date will be presented.

Learning Objectives:

1. Appreciate the challenges of developing a high precision 3D conformal irradiator for small animals.
2. Learn about the main hardware components of the system and their integration.
3. Understand the advantages of using a 6DOF robot for imaging (motion) and beam delivery (positioning).
4. Learn about some of the potential research projects that such a system can make possible.

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