

AbstractID: 11910 Title: Preclinical Image Guided Microirradiators: Concepts, Design and Implementation

We will introduce small animal image guided microirradiators by reviewing the concepts and requirements for high resolution and high conformality irradiation of tumors implanted in small animal limbs (xenograft tumor models), animal organs and spontaneous tumor models. We will present two preclinical microirradiators developed by our group, a brachytherapy based microirradiator and an orthovoltage x-ray source based microirradiator.

The brachytherapy irradiator has been constructed around a commercial ^{192}Ir high-dose rate (HDR) remote afterloader source in a teletherapy geometry. The system consists of a set of exchangeable tungsten collimators (from 2.5 to 5.5 mm diameter) mounted on an aluminum cylindrical support. An HDR catheter is then used to transport the source to the pre-determined dwell position that centers the source at the collimator hole. With this microirradiator, the anatomical image is obtained using an external clinical CT operated at maximum resolution and coregistration is achieved using fiducial markers.

The x-ray orthovoltage microirradiator has an onboard cone beam microCT subsystem for submillimeter low dose anatomical imaging. The microCT and the orthovoltage x-ray source are aligned using a common rotation axis in a tandem configuration. An axial motorized animal bed transfers the animal from the microCT subsystem to the microirradiation subsystem. The microCT subsystem was constructed using an 80 kVp micro-focus x-ray source with a $75 \times 75 \mu\text{m}^2$ focal spot and a flat panel amorphous silicon detector with 1024×1024 pixels. The orthovoltage irradiator subsystem was constructed using a 320 kVp x-ray source with dual focus spots ($0.4 \times 0.4 \text{ mm}^2$ at 800W and $1 \times 1 \text{ mm}^2$ at 1800 W). The orthovoltage beam is collimated using orthogonal jaws and exchangeable apertures. The treatment beam can be aimed at different latitudinal and longitudinal angles in steps of 2 arcmin. and translated at $100 \mu\text{m}$ steps (x, y and z). The beam cross sections can be modulated with submillimeter precision using steps of $50 \mu\text{m}$. The system is designed to deliver a maximum dose rate of 40 Gy/ min.

These irradiators are operated under a common small animal irradiation facility that accepts campus wide preclinical projects. We will conclude our presentation by presenting examples of ongoing radiobiological projects that will allow us to illustrate the performance and operation of both irradiators.