AbstractID: 10305 Title: Integration of Cone Beam CT Imaging and a Small Animal Conformal RT Device Using a 6DOF Robotic Arm

Purpose: To integrate cone beam computed tomography (CBCT) imaging technology into a small animal conformal radiation therapy device (SACRTD) using a six degrees of freedom (6DOF) high accuracy/precision robotic arm.

Method and Materials: A 225kV dual focus (0.4mm and 3mm) X-ray tube (GE Seifert Isovolt Titan) is used for both radiation and imaging. An industrial robot (Adept Viper S650) is used for positioning and motion of a small animal for targeted radiation delivery and CBCT imaging with positional repeatability of ±0.020 mm in XYZ direction and angular precision of $\pm 0.2^{0}$. A series of 2D-radiographic projection images were recorded in cone beam mode with a flat panel amorphous silicon detector (Perking Elmer), which captures 1024 by1024 pixels images (200μm pixel size) at a frame rate of 7.5Hz. An open source CBCT reconstruction tool (OSCAR-2, University of Toronto) using Feldkamp-Davis-Kress (FDK) filtered back projection algorithm was employed for CBCT image reconstruction.

Results: Initial testing of the CBCT system using phantoms and mice was successful. Radiographs were cropped and downsampled to a spatial resolution of 0.4mm. Reconstructed matrices had dimensions of 181×267×97 voxels with 0.3mm×0.3mm×0.3mm voxel spacing. With the current computer the entire acquisition and reconstruction procedure takes < 7 minutes. The OSCAR-2 algorithm offers various reconstruction filters, but more sophisticated tools specific for small animal imaging are needed to improve the quality of CBCT images.

Conclusion: This work demonstrated that a 6DOF robot is an excellent device for moving/rotating a small laboratory animal for acquiring high spatial resolution radiographs with the necessary accuracy and precision for successful CBCT reconstruction. It also demonstrated that an open source CBCT software tool could be adapted to work with the SACRTD. The integration of CBCT imaging into the SACRTD opens new research paths requiring image guided radiation delivery to specific structures/volumes in small animals.