AbstractID: 12774 Title: Energy Dependency and Dosimetric modeling in Small Animal Stereotactic Irradiaton

Purpose: Small animal irradiation provides an invaluable tool for preclinical studies to assess and optimize new treatment strategies such as SBRT. However, dosimetric accuracy for beams that are clinically and geometrically scaled for the small animal model is uniquely challenged by low energies and minute field sizes. Recent experiences with GafChromic film have evinced energy dependencies that preclude standard methods of dosimetric calibration with MV beams. Characterization of such dependencies has led to comprehensive recommissioning of the small animal stereotactic beam model based on the AAPM TG-61 protocol to maximize the accuracy required by preclinical, foundational research.

Method and Materials: The irradiator couples a commercial x-ray device (XRAD 320, Precision X-Ray Inc., N. Branford, CT) with a custom collimation system to produce 1-10 mm diameter beams and a 50 mm reference beam. Absolute calibrations were performed using TG-61 methodology. Beam HVL's and timer error were measured with an ionization chamber. PDD, output factors (OF), and OAR were measured using EBT-2, a radiochromic film from ISP, diode, and pinpoint ionization chamber at 19.76 and 24.76 cm SSD. Results were compared with Monte Carlo simulations.

Results: Absolute calibration for irradiator reference conditions were measured as 19.95 and 19.79 Gy/min for in-air and in-water methods respectively, agreeing within 0.8%. Beam quality at 250 kVp and 15 mAs was measured to be 0.45 mm Cu. PDD data demonstrate typical increased penetration with increasing field size. For collimators >5 mm, output factors measured using film, chamber, and diode were within 3% agreement. For smaller collimators, output factors measured with film agree well with Monte Carlo simulation results.

Conclusion:
Careful application of TG-61 methodology is essential for both commissioning small animal treatment beams and mitigating Gafchromic film energy dependencies. This enables beam modeling and subsequent small animal treatment planning with the accuracy required of preclinical studies.