Purpose: Novel small animal micro-irradiators are becoming available for pre-clinical research but they lack dedicated treatment planning systems. The purpose of this study is to develop both a Monte Carlo (MC) model and a portal dose prediction model of a small animal micro-IR to enable forward dose calculations and compare the planned against the delivered treatment.

Methods: A MC model of a small animal micro-IR from the x-ray tube assembly to the detector was developed. The model was compared to radiochromic film and portal images for validation. A portal dose calibration model was also developed and portal dose images were compared to film measurements. A rodent was irradiated with 1 Gy at 225 kVp (0.32 mm Cu) while portal images were acquired. A simulated portal image from the MC model was compared to the portal image acquired during irradiation.

Results: Simulations of the MC model's x-ray spectra, beam profile, and half value layer thicknesses agreement within 2 % against measurements or external calculations. The portal dose prediction model resulted with 63% of pixels with a gamma value less than 1 for a gamma criterion of 5% 0.8 mm. A visual comparison between the simulated portal image and acquired portal image during irradiation of a rodent show good agreement but intensity values around regions of bone deviate from the acquired portal image.

Conclusion: We have demonstrated that we can simulate the entire irradiation process of a small animal micro-irradiator and generate comparable predicted portal images compared to acquired portal images. We believe that further refinement to the tissue and density assignment in the MC model will improve our results.