Purpose: To determine the capabilities of bioluminescent imaging for planning and monitoring response for pre-clinical radiation therapy.

Method and Materials: Four experimental subjects were studied: IVIS XPM-2 luminescent phantom (Xenogen, Alameda, CA), SCID mouse with a subcutaneous luciferase-expressing teratoma, nude mouse with an orthotopic A549 lung tumor, and a nude mouse with an orthotopic luciferase-expressing U87 brain tumor. BLI images were obtained both a Xenogen IVIS 3D, for multiple projection angles, and a Xenogen IVIS Spectrum BLI system for multi-spectral imaging. CT data was collected using an RS120 microCT scanner (GE Heath Care, Milwaukee, WI). CT and BLI images were imported, registered and analyzed in the RT_Image software package. Treatment planning was conducted in RT_Image using a single beam delivery based on 2D projections from different angles. The 2D distance from the center of mass (COM) of the beam's eye view BLI to the center of the CT-identified target was measured. Bioluminescence tomography and CT were compared in 3D.

Results: For the XPM-2 phantom, the distance from the treatment beam to the COM of the target was found to be 4.25 mm for 0 degree BLI projection, 1.75 mm for the 180 degree BLI projection, and 0.975 mm for 0 degree BLI projection using the surface projection. The subcutaneous teratoma model produced sub-millimeter distance to COM in each visible projection.

Conclusions: Using beam's eye view BLI alone does not offer a precise targeting option for every BLI case. Geometry of the subject and depth of the luminescent source affects how the signal is observed. Beam alignment based on the view alone without compensation for these factors, will likely result in mistargeting except for a few special cases. In these cases 3D BLI solutions are more robust for treatment planning. Surface sources, such as subcutaneous tumors, offer straightforward BLI targeting.