3D surface image guidance (3D SIG) has been shown to significantly improve patient positioning accuracy in the treatment of breast cancer. While the reduction in positioning uncertainty has been well documented, limited information is available regarding the dosimetric consequences of setup tolerances associated with breast radiation therapy techniques. The purpose of this study was to determine the magnitude of dose-delivery errors associated with acceptable setup tolerances of 3 mm/3° and 5 mm/5° for set-up and monitoring with 3D SIG for whole breast radiation treatment techniques.

Five test patients were selected for direct simulation of the maximum acceptable deviation from reference position for tangential beams using a field-in-field (FinF) technique. Dosimetric impact was determined by simulating the maximum allowable patient translations and rotations, recalculating the dose distribution, and propagating the dosimetric error for a full treatment course to examine the potential impact on target coverage and critical structure sparing. Direction of rotation and translation were chosen to have the greatest negative impact on the dose distribution for target coverage and normal tissue sparing, to illustrate worst case scenario dose consequences. For the planned and off-set positions, dosimetric consequences were evaluated by examining the plan maximum dose, the percent coverage of the prescription dose for the lumpectomy bed, the V20 Gy and V13 Gy percentages for the ipsilateral lung, and the maximum point dose to the heart. The results are shown in Table I below.

For both 3 mm/3° and 5 mm/5° off-sets in relatively large-breasted patients (> 500 cc) there was not a significant change in the dose distribution for the analyzed FinF plans. Tumor bed coverage was negligibly impacted for these patients. The ipsilateral lung V20 Gy and V13 Gy had a maximum observed increase of 5.4% and 5.7%, respectively. Maximum point dose to the heart increased by a maximum of about 8% for those patients being treated to the left breast. The patient with the largest dosimetric impact was relatively small-breasted with a lumpectomy cavity in close proximity to the field borders. As tumor bed coverage and ipsilateral lung dose were heavily impacted at the extreme position for the studied tolerances, it may be beneficial to utilize an appropriately tighter tolerance in patients with breast volume < 500 cc with tumor bed volumes near the periphery of the field apertures.