Purpose:To evaluate the positioning accuracy of the BrainLAB ExacTrac Image Guidance System under gating conditions.

Methods:Two types of phantoms were used in measurements: an anthropomorphic RANDO head phantom and a BrainLAB ExacTrac Gating Phantom. Our setup included a Varian Novalis Tx radiosurgery system equipped with the ExacTrac 6D IGRT. This system consists of an infrared positioning system for the initial patient positioning and patient tracking, and a stereoscopic kV X-ray imaging system for final localization using internal markers or anatomy. Uncertainties were broken down into individual components, and the different BrainLAB fusion modalities (internal markers and bony fusion) were used to compare the effect of slice thickness on positional accuracy. Gating uncertainties were deduced with varying tumor motion amplitudes and window sizes in conjunction with a hidden target test.

Results:Our results of CT slice thickness dependence for both fusion algorithms with the hidden target test gave similar deviation (<0.7mm), and were reasonably consistent up to a 5 mm slice width. Tumor motion and gating window size yielded an uncertainty of up to 1 mm for the parameters tested. Combining a non-gating uncertainty of 0.9 mm with the gating uncertainty resulted in a geometrical accuracy of 1.6 ± 0.7 mm for 2.25 cm tumor amplitude and a 30% window size. For tumor motions up to 3 cm and gating window sizes up to 30%, the localization accuracy remained within 2 mm.

Conclusions:We have tested the gating window and tumor amplitude effects on the spatial accuracy of the ExacTrac System equipped Novalis Tx linac for stereotactic body radiation therapy. While the CT slice thickness, mechanical deviation of the linac and gating window size contribute to uncertainty, the system provides an external modality that allows for localization accuracy of less than 2 mm for gated delivery.