# Evaluation of an IGRT System for Mobile Targets

**Purpose:** Evaluate accuracy/precision of Novalis (BrainLAB$^{®}$) IGRT in treating mobile targets.

**Method and Materials:** Novalis IGRT is an automated 6D patient positioning/verification system using infra-red (IR) markers and stereoscopic X-ray image guidance. We used two respiratory motion phantoms in end-to-end hidden-target-test mode. A 2mm diameter marker was placed on high sensitivity Gafchromic film. Phantoms were irradiated with treatment fields collimated by a 10mm cone. Difference between centers of irradiated field and marker location yielded system accuracy. Irradiations were performed with phantom in both static and dynamic modes. Static phantom treatments corrected for known target displacements and established IGRT system baseline. In dynamic mode, the following geometries were considered: (a) Gated setup-Gated treatment. (b) Gated setup-Ungated (free-breathing) treatment. (c) Ungated setup-Ungated treatment. The last case corresponds to treatments using larger ITV margins derived from end inhale/exhale scans. All X-ray fusion was based on implanted internal fiducial markers. System accuracy was studied as a function of breathing cycle(1.5-12sec/cycle), amplitude(0-1cm), gate-level(0-50%) and gate-window(10-30%).

**Results:** Novalis IGRT gave excellent results for repeat irradiation in the static mode (mean error = 0.22±0.11mm; max = 0.44mm). For mobile targets, best results were obtained for fully gated treatments (gated setup-gated treatment): mean error = 0.14±0.45mm, max = 0.67mm. However, for gated setups and ungated treatments, system accuracy dropped somewhat with mean error = 0.61 ±1.08mm, max = 2.13mm. Fully ungated treatments had the worst outcome, mean error = 3.78±6.94mm, max = 12.20mm. Here the maximum error is caused by fusion of orthogonal X-rays taken at opposite phases of breathing cycle (worst-case scenario). No systematic dependence was noted on the breathing cycle, amplitude, or gate-level and window.

**Conclusion:** Novalis IGRT offers highly accurate and precise treatments for static and mobile targets. For mobile targets gated IGRT is strongly recommended.