AbstractID: 4907 Title: Evaluation of a 2D-3D registration method for external beam radiation therapy

Purpose: To implement and validate a 2D-3D registration method for determining 3D patient position in external beam radiotherapy using orthogonal EPID images and megavoltage digitally reconstructed radiographs (MDRRs). To test the methods dependence on cost function, image pre-processing and parameter space sample density, and determine the dependence of registered rotations on setup translations and *vice versa*.

Method and Materials: Orthogonal EPID image of a humanoid phantom in different poses (3D rotations and translations) were acquired in anterior-posterior and latero-lateral view. The EPID images were registered with a data base of orthogonal MDRRs, calculated as projection images through the phantom's CT data set at rotation angles within ±5°. Registration results were compared for three different cost functions (least-squares, cross-correlation and mutual information), different image pre-processing techniques (unsharp masking, histogram matching) and for isolated and combined rotations and translations. The influence of setup translations on registration results for rotations, and *vice versa*, was investigated and compared with a simple model.

Results: Image pre-processing improves registration precision by more than a factor 2. Three dimensional translations were registered with better than 0.5 mm (one standard deviation) when no rotations were present. Three-dimensional rotations registered with a precision of better than 0.2° (1 SD) when no translations were present. Combined rotations and translations of up to 4° and 15 mm were registered with a precision of better than 0.4° and 0.7 mm respectively. Mutual information resulted in the most precise registration. Setup translations influence registered rotations, mostly following a simple theoretical model, but not *vice versa*.

Conclusion:
Precise registration requires image pre-processing and benefits from interpolation of the parameter space. Influence of object translation on registration of out-of-plane rotations can be significant; these "pseudo rotations" can be corrected using the theoretical model when only one projection image is used for registration (e.g. fluoroscopy).