# AbstractID: 14071 Title: Dosimetric impact of intrinsic uncertainties of deformable registration algorithms

**Purpose:** Most deformable image registration (DIR) algorithms require utilize user-selectable parameters. Inappropriate parameter values may lead to severe under-performance. This work addresses optimal user-selected DIR parameter values for Pinnacle$^3$'s thin plate spline (TPS) algorithm based on the effect of estimated displacement vector fields (DVFs) uncertainties on dose.

**Method and Materials:** The contour-based TPS algorithm implemented in a research version of Pinnacle$^3$ v.8.1 is evaluated with a 4D lung CT set. User dependent parameters studied are: selection and number of contoured reference regions, number of vertices used to create the reference region meshes, and the number of sampled vertices in meshes. For varied parameter sets, DVF intrinsic uncertainty ($\sigma_i$) is evaluated by a recursive point dispersion remapping algorithm. Uncertainty maps for each parameter set are used to evaluate the DVF induced dose uncertainty ($\sigma_D$) in each voxel.

**Results:** The TPS algorithm uncertainty improves with the number of mesh points ($\sigma_i$ 15% lower, maximum $\sigma_i$ ~30% lower), but with longer computation times. Inclusion of the external body contour improves results (60% $\sigma_i$ reduction, maximum $\sigma_i$ ~45% lower). Volume with >1 Gy $\sigma_D$ is reduced from ~250 cm$^3$ to ~10 cm$^3$ by increasing the number of mesh points and to ~14 cm$^3$ by including the body contour. Maximum $\sigma_D$ is reduced from 13.7 Gy to 9.3 Gy with more mesh points and to 7.4 Gy with the body contour.

**Conclusion:** Appropriate DIR parameter selection improves 4D mapping precision. Pinnacle$^3$'s TPS performs best with the external body as a reference region. Use of four to six regions is found to be adequate, provided regions are not small. Increasing the number of mesh construction vertices or the number of sampled vertices results in a moderate improvement at the cost of increased computation time.

**Conflict of Interest** Supported by NIH-P01CA116602 and Philips Medical Systems