AbstractID: 8532 Title: Should a Gaussian probability density function be used to approximate respiration induced dosimetric effects for proton radiotherapy?

Purpose:
To compare the dose distributions generated by convolving a static dose distribution using a patient specific respiratory probability density function (R-PDF) with those generated using a generic Gaussian PDF (G-PDF) for proton therapy of lung cancer.

Method and Materials:
The R-PDFs were obtained by identifying the centroid motion of the targets from the 4D-CT scans of a phantom (CIRS Model 008 Dynamic Thorax) and a representative lung cancer patient. The CMS XiO® Treatment Planning System commissioned with 208 MeV nominal proton beam data from a passive scattering beam line at a proton therapy center was used for the static dose calculation. The dose convolution results from four different G-PDFs with standard deviations (SD) of 0.2, 0.3, 0.4, and 0.5 multiplying by the peak-to-peak motion amplitude (letter "A", 1.60cm in the phantom and 1.75cm in the patient) were compared to the R-PDF convolved dose distributions using a commercial dosimetry analysis package (OmniPro I'mRT).

Results:
Respiration-induced dose error was 29% and 16% of the prescribed dose (PD) compared to the static doses in the phantom and patient, respectively. The G-PDF with SD of 0.4A most closely approximates the R-PDF whilst the maximum dose disagreements (MDDs) between the convolved doses using the two methods were 6% and 4% of the PD in phantom and patient, respectively. When G-PDFs with SD of 0.2A and 0.5A were used to approximate the R-PDF, the resulting MDDs were 19% and 12% in the phantom respectively, and 12% and 10% in the patient, respectively. When the G-PDF with SD of 0.3A was used to approximate the R-PDF, the resulting MDDs were 10% in the phantom and 8% in the patient.

Conclusion:
A Gaussian function should not be used to approximate a patient specific respiratory PDF since it can lead to clinically significant dose errors.