**The effect of Monte Carlo noise on radiotherapy treatment plan evaluation**

Routine clinical Monte Carlo treatment planning is on the horizon. However, some new challenges need to be addressed. One such challenge is the statistical uncertainty inherent in all Monte Carlo calculations. Precision is traded for accuracy. Hence we need to determine the noise, or uncertainty level, at which dose distributions are not significantly affected, in order to calculate sufficiently precise dose in the minimum time.

To study the effect of noise on radiotherapy treatment plan evaluation, a 'noise free' plan was necessary. A noise free plan calculated using Monte Carlo would take $\infty$ time, and hence it was necessary to determine the relationship between noise and dose. We assumed that dose is proportional to the number of interactions, and hence expect the noise level to have a $\sqrt{dose}$ dependence. This relationship was applied to a collapsed cone convolution calculated plan, creating dose distributions with noise levels of 0, 1, 2, 4, 8 and 16% at the maximum dose point.

The noise function was found to be proportional to $\sqrt{dose}$, validating the proportionality of dose and interaction number. Critical structure DVHs and biological indices are less sensitive to calculation noise than those of the target. Systematic errors affect biological indices significantly more than random noise. A random noise level of < 2% does not significantly affect isodose lines, DVHs or biological indices.