AbstractID: 11516 Title: Improving the efficiency of Monte Carlo by using systematic sampling in phase space reconstruction: feasibility study

Purpose: Generalized source model is effective in characterizing the radiation source for the implementation of Monte Carlo dose calculation. The purpose of this research is to investigate a systematic sampling method in source phase space reconstruction to reduce uncertainty of the MC dose calculation.

Method and Materials: As a computer random sampling method, MC introduces statistical uncertainties in each random sampling step during simulation. Uncertainty of final result can be reduced by reducing the sampling uncertainty in any of the step. In our study, a systematic sampling method was used to reduce the uncertainty in source phase space reconstruction. The basic idea of the systematic sampling is to divide the sampling range into small intervals and sample from each interval. For a distribution f(x), $a \le x \le b$. instead of sampling x between a and b, we divide the space between a and b into small intervals: $d_1 \le d_2 \le d_3 \le \ldots\ldots \le d_n$, where $d_1=a$, $d_n=b$, and sample x from each interval with a new distribution $f_i(x)$.

Results: Particle energy and location sampling in phase space reconstruction have been tested using the systematic sampling. For particle location sampling from a 10x10 cm^2 field, the field was divided into 100 small units and N/100 particles were uniformly sampled from each unit. The sampling uncertainty was reduced to 1/10 compare to the direct sampling and a more uniform distribution was found in a 2D distribution map. For particle energy sampling, energy distribution was divided to N bins from the minimum energy to the maximum. Number of particles sampled from each bin depends on the probability density. There is no fluctuation in dose contribution if particle energy were sampled using the systematic method.

Conclusion: Phase space reconstruction from the source model using the systematic sampling can significantly reduce the sampling uncertainty and therefore can reduce the uncertainty in MC dose calculation.