# Monte Carlo Based Techniques for Photon Dose Calculations

The application of Monte Carlo dose calculation methodology for photon radiation therapy is imminent due to its ability to accurately predict dose deposition in any media and advances in high speed computing technology. This presentation relates experiences gathered from integration and implementation of two Monte Carlo based dose algorithms into a commercial treatment-planning program. The two Monte Carlo based dose calculation algorithms are Monte Carlo Vista (MCV), a local adaptation of the SLAC/NRC EGS4 code with integration into the Pinnacle treatment planning system, and the LLNL developed PEREGRINE Monte Carlo code. Both algorithms were interfaced, acceptance tested, commissioned, and inter-compared with each other, measurements, and with other dose calculation algorithms.

Commissioning tests required for Monte Carlo based algorithms are divided into four categories: 1) ensuring beam orientations and devices used are as specified by the treatment planning system, 2) adjusting phase space data by matching Monte Carlo generated dose distributions to measurements, 3) determining the Monte Carlo particle-to-measured dose calibration (output factor calibration), and 4) comparing measured and calculated dose distributions for a variety of beam conditions. Application of these tests to the two Monte Carlo codes will be presented.

Prior to comparing Monte Carlo dose distributions with other algorithms, dose values must be converted from absorbed-dose-to-material to absorbed-dose-to water. In phantom dose distributions computed with MCV, PEREGRINE, and Pinnacles' collapsed cone convolution algorithm will be compared with measurements. Monte Carlo dose distributions for clinical lung, breast, and head and neck treatment plans will be inter-compared with those computed with the collapsed cone convolution algorithm. All plan evaluation is performed using a single treatment-planning platform to ensure uniform evaluation of parameters. For clinical cases, the clearest way to see the dose difference is to use dose difference histograms and dose difference plots.

Due to the superior accuracy of Monte Carlo algorithms, they will routinely be used for dose computation in the 21$^{st}$ century. The improved knowledge of patient dose distributions should reduce treatment dose uncertainty and improve evaluation of patient response data, hence, improve patient outcomes.