AbstractID: 9345 Title: Monte Carlo investigation of the new Cyberknife with a high dose rate

Purpose: This work is aimed at improving beam characteristics by Monte Carlo simulations of the new 6MV Cyberknife (Accuray Inc, Sunnyvalle, CA) linear accelerator (LINAC) with an 800MU/min dose rate.

Materials and methods: The BEAMnrc code was used for the linac simulation and the MCSIM code was used for dose calculations in a water phantom. The new linac design included a thinner tungsten target with copper backing and an aluminum plug inserted in the primary collimator opening. The lead slab above the ion chamber was removed from the old model. The effects of the aluminum plug with different length, the impact of the sealed ion-chamber on the beam and the effects of the dimensions of the primary collimator opening were also investigated for optimal beam characteristics.

Results: After many iterations of trial and error with the electron parameters, the final electron energy was chosen to be 6.8MeV and a parallel circular electron beam with a 2.5mm FWHM Gaussian distribution was used as the initial electron source. The agreement on PDDs and dose profiles between Monte Carlo simulations and measurements was excellent for all the cone sizes. Reducing the length of the aluminum plug from 9.58mm to 4.58mm led to a 4.3% increase in the dose rate, a slightly softer beam and little change to the dose at the buildup region. Replacing the open ion-chamber with the sealed ion-chamber led to a 4% increase in the dose rate and no significant change in the relative dose distribution. Reducing the straight portion of the primary collimator opening from 3.05cm to 1.05cm led to much flatter dose profiles.

Conclusions: Monte Carlo simulations were performed successfully for the new linac geometry of the 800MU/min Cyberknife system. The linac geometry can be modified to further improve the system performance.