

Designing Compensators Using the Pinnacle³ Treatment Planning System Accounting for Scatter from Compensators

Dose in photon fields using compensators or other physical attenuators can be affected by many factors including beam energy, field size, depth of interest, compensator location, and construction details of compensators. In this work, we investigated the variation in compensator transmission for these parameters and the accuracy of the Pinnacle³ treatment planning system (PTPS, ADAC Laboratory) in calculating doses for compensators. Our compensators were constructed of fine steel balls solidified with wax in molds of styrofoam cut with an automatic milling machine (HEK AUTIMO 2.5D). Transmission factors of sheets of this material at various thickness were measured and calculated using a separate non-clinical convolution/superposition algorithm that accounts for both the scatter and the beam hardening effects from the compensators. The change of compensator transmission with beam geometry and compensator thickness was thoroughly evaluated. Based on these results, density of the compensator materials input to the PTPS was determined and modified for various treatment conditions to obtain accurate transmission calculations from the PTPS. Our results showed that the PTPS calculation accounts for only the beam hardening effect of the compensators. Yet scatter from the compensators can be significant and can cause a change of more than 5% in the compensator transmission. By appropriately adjusting the density of the compensator material in the PTPS, the accuracy of the PTPS calculation can be improved significantly to agree with measured data.