AbstractID: 13729 Title: Improving the accuracy of Monte Carlo spread-out Bragg peak treatment head models using beam current modulation optimization

Purpose: For challenging clinical cases Monte Carlo methods can help to verify the accuracy of proton beam planning results based on the pencil beam algorithm. However, the use of Monte Carlo methods as a verification tool requires an accurate model of the proton fields generated in the treatment head. This paper presents a novel approach to improve upon the achievable accuracy of Monte Carlo models of proton beam treatment heads. We will also demonstrate the usefulness of this approach by presenting commissioning results of two treatment head models at our facility.

Methods and Materials: The achievable accuracy of our treatment head model was examined by quantifying the impact of uncertainties in material and beam parameters on SOPB dose distributions. A novel approach to improve this accuracy was developed by optimizing the beam current modulation function defined in our Monte Carlo model to produce clinically acceptable SOBP dose distributions. Finally, this method was utilized for the commissioning two models of SOBP proton beam treatment heads at our facility.

Results: Uncertainty in material density led to the largest impact on the SOBP dose distributions (less than 4%). The impact of mean ionization potential uncertainties was smaller (less than 2%). We did not detect a statistically significant influence of clinically relevant beam energy spreads and spot sizes on the SOBP dose distribution. The optimization of our beam current modulation functions allowed us to fully commission two treatment head models at our facility.

Conclusion: Several proton beam therapy centers are now operational or being planned and constructed, which promises the future need for Monte Carlo modeling of proton beam therapy treatment heads. The methodology and results presented in this paper will help accommodate the commissioning of new Monte Carlo simulated treatment heads.