AbstractID: 11680 Title: Nuclear Model Evaluation of Uncertainties in Therapeutic Absorbed Dose and Secondary Neutron Production in Proton Radiotherapy using MCNPX

Purpose: To evaluate differences in nuclear physics models of MCNPX for uncertainties in 1) the dosimetric characteristics of the therapeutic dose for SOBP and cross-field profiles and 2) stray neutron fields produced in a proton therapy unit using the default Bertini model option as the baseline. **Methods and Materials:** The general purpose Monte Carlo N-Particle eXtended (MCNPX) code was used to calculate the therapeutic absorbed dose and spectral neutron fluence with three nuclear model options: the Bertini Model, the Cascade Exciton Model (CEM), and the Liège Intra-Nuclear Cascade Model (INCL4). Each model is included as a physics option in MCNPX. For initial beam energy of 160 MeV, dose calculations were carried out in a water phantom positioned 24 cm downstream of the nozzle exit while in-air calculations of the neutron spectral fluence were tallied in spheres positioned at isocenter, 100 cm downstream of isocenter and at lateral distances of ± 100 cm off-axis. Calculations of secondary neutrons produced external to the nozzle housing were evaluated among the models for several parameters including the ambient neutron dose equivalent per therapeutic absorbed dose. **Results:** Our results indicate that calculations of the therapeutic absorbed dose were in close agreement (≤1% difference) for all nuclear model options. On the other hand, the differences in the neutron spectral fluence calculations typically varied by a factor of 2 or more among the models. **Conclusions:** We found that all three inelastic nuclear interaction models provided excellent agreement in the therapeutic dose distributions. However, we observed substantial differences in the neutron spectral fluence calculations that suggest further investigation may be desirable for estimating the out of field radiation exposure uncertainties among the models.