AbstractID: 8940 Title: Monte Carlo study of proton beam energy spectra downstream of density heterogeneities and the influence of multiple Coulomb and nuclear scatterings on the Bragg peak distal falloff

**Purpose:** To investigate the proton beam energy and angular spectra downstream of density heterogeneities and the influence of multiple Coulomb scattering (MCS) and nuclear scattering (NS) on the Bragg peak distal falloff. **Method and Materials:** The investigation was performed using Monte Carlo (MC) simulations with MCNPX. Six geometries including a homogeneous slab of bone and five different heterogeneities were studied. The contribution of MCS and NS processes on the energy and angular spectra, and distal falloff width was investigated using different physics options in the simulations including: i) MCS and NS processes turned on; ii) MCS turned off and NS turned on; iii) MCS turned on and NS turned off; and iv) MCS and NS turned off. **Results:** The distal falloff width shows an increase for all the heterogeneities when compared to the homogeneous geometry. Using different physics options it was confirmed that MCS is the main process that leads to the increase in the distal falloff width. On one hand, the contribution of MCS in the distal falloff width depends on the heterogeneity. On the other hand, the contribution of NS has only a small dependence on the heterogeneity. The shape of the energy and angular spectra shows a strong dependence on the geometry. **Conclusion:** It is confirmed that the degradation of the Bragg peak and consequent increase of the distal falloff width is mainly due to MCS process occurring in the heterogeneities. Further analysis showed that NS process contributes to about 5 % of the distal falloff width and has only small dependence on heterogeneity. A correlation between the distal falloff widths and the shape of the energy spectra is found. It is proposed a methodology based on the shape of the energy spectra to predict the distal falloff width for simple heterogeneities.