AbstractID: 3165 Title: Comparison of pencil beam algorithm and Monte Carlo dose calculation for proton therapy of paranasal sinus cancer.

Purpose: To verify the accuracy of the pencil beam algorithm implemented in the FOCUS (CMS) proton treatment planning program with a GEANT4 based Monte Carlo code. Due to the presence of large air cavities and tissue inhomogeneities, paranasal sinus (PNS) cancer brings challenges to radiotherapy treatment planning.

Method and Materials: GEANT4 based Monte Carlo methods have been used to simulate multiple PNS cases for the purpose of examining the reliability of the pencil beam algorithm. To guarantee the accuracy of the results by Monte Carlo, the proton treatment nozzle and the patient geometry were modeled in great details, and all related physics processes were included. Different conversion methods for assigning material properties to different Hounsfield units were applied and tested. Electron densities in the Monte Carlo were normalized to the ones used by FOCUS.

Results: Monte Carlo and FOCUS present a very good agreement in dose distributions, except for in low-density air cavities. Monte Carlo reports a significantly lower dose in air than FOCUS, primarily due to a much lower mass stopping power in air than in water. Air cavities, included accidentally in planning contours can cause significant errors in DVHs. With air regions excluded, the DVHs for target structures of Monte Carlo and FOCUS show a good agreement. Differences could be seen in low dose regions and close to material interfaces. However, they are insignificant in most cases. Important, in particular for proton therapy with sharp dose fall-offs, is the fact that the beam ranges agree very well.

Conclusion: This work indicates that the pencil beam algorithm in FOCUS (CMS) is reliable for cases involving large air cavities and bony tissues. However, air cavities should not be included when volumes are drawn for treatment planning.