AbstractID: 7732 Title: Differences in predicted beam range, lateral scatter and absolute dose between proton Monte Carlo and pencil-beam dose calculation considering single fields and full plans for head and neck tumors

Introduction: Monte Carlo based dose calculation is considered to be more accurate than analytical methods. We were interested in the potential impact of the clinical use of proton Monte Carlo dose calculation in particular in areas of frequent tissue interfaces and density variations, i.e. in the head and neck region.

Methods: The Monte Carlo code Geant4 was used to simulate the treatment head geometry, patient geometry based on CT as well as treatment room setup and treatment plan parameters. Ten patient plans (para-spinal tumors and tumoprs in the nasopharynx and para-nasal sinus area) were analyzed in terms of dose distributions and dose-volume histograms. Analysis was done considering individual fields and total plans.

Results: In general, the Monte Carlo and the pencil-beam algorithm agree very well in soft tissue in terms of the beam range and the lateral fall-off. The 80%-20% fall-off and the position of the respective isodose lines are typically within 1 mm. However, the agreement in range is not as good in the presence of large density variations in the beam path. Differences are pronounced if the end of range is within bony structure and downstream of thick bony inhomogeneities. Further, clinically significant discrepancies in range prediction are visible if density variations are parallel to the beam direction. By interpreting the results one has to take into account that the pencil-beam algorithm reports dose-to-water while the Monte Carlo calculates dose-to-tissue. Further, our planning system only specifies relative doses while the Monte Carlo dose distribution is in absolute values.

Conclusion: The pencil-beam algorithm is less sensitive to geometrical complexities and frequent density variations, i.e. bone-soft tissue, bone-air or air-soft tissue interfaces. Significant discrepancies can be seen in the case of inhomogeneities that are tangential to the beam.