Purpose: The analytical algorithms which are used widely for proton treatment planning in the current clinical practice may have significant dosimetric uncertainties in highly heterogeneous regions. The aim of this study is the assessment of the potential clinical impact of these uncertainties.

Methods: A cohort of 8 patients with local (in field) recurrences, originally treated for lung cancer at our institution, was selected for this study. CT scans and treatment plans were used to assemble the input files for the Monte Carlo (MC) code MCNPX. The total energy deposition inside the patient volume was computed with statistical uncertainty of less than 2% and converted to dose-in-water. The results were compared to the dose computed by the clinical treatment planning system (TPS). The area of the recurrence was contoured on the follow-up PET/CT study for each of the patients and registered to the planning CT.

Results: While there is acceptable agreement between the TPS and the Monte Carlo dose in homogeneous regions, there are noticeable differences caused by heterogeneities. The regions of largest differences are the points around and beyond the distal edge and points around the lateral penumbra and in several patients the target has received lower then the prescribed dose. The area of the recurrence corelates well with the MC predicted underdosed area of the target.

Conclusions: The uncertanties in analytical dose algorithms used in clinical TPSs may result in suboptimal target coverage increasing the possibility of tumor recurrence. Accurate Monte Carlo simulations can be used to predict and avoid the situations in which the analytical algorithms have high uncertanties providing for more robust treatment planning.