

AbstractID: 8566 Title: Determination of the optimum statistical uncertainty and voxel size to perform Monte Carlo based dose calculation in the context of radiotherapy

Purpose: To evaluate the influence of statistical uncertainty and voxel size on target dose volume histograms (DVH) calculated with a Monte Carlo based treatment planning system (TPS). To determine the maximum uncertainty level and voxel size acceptable in the context of external beam radiotherapy. **Method and Materials:** First, the effect of increasing voxel sizes was investigated by studying the display of material and mass density matrices related to patient CT images. Then, the dose calculations were performed using the TPS ISOgrayTM (Dosisoft) based on a fast Monte Carlo simulation code called PENFAST. The dose deposition due to electron beams was calculated for one breast plan. Intramammary node DVH were calculated first for increasing statistical uncertainty (1σ) levels of 0.7%, 1%, 1.3%, 2%, 3% and 6%, and secondly by increasing voxel sizes from $2\times 4\times 2\text{ mm}^3$ to $8\times 8\times 8\text{ mm}^3$. The same study was conducted for one medulloblastoma radiotherapy plan. Spinal cord DVH were calculated for uncertainty levels (1σ) of 1.3%, 1.7%, 2%, 3%, 5%, 12% and voxel sizes from $2.1\times 3\times 2.1\text{ mm}^3$ to $5.7\times 6\times 5.7\text{ mm}^3$. **Results:** The consequence of increasing voxel sizes is the blurring of material and mass density matrices by averaging values contained in neighbouring voxels which must be avoided at the interface between heterogeneities. The study of the DVH for both breast and medulloblastoma plans showed that they were not modified for statistical uncertainty levels (1σ) below 2% and voxel sizes below $4\times 4\times 4\text{ mm}^3$. **Conclusion:** This work indicates that, in clinical context, to save computation time while keeping the reliability of the target DVH for clinical use, Monte Carlo based dose calculation can be performed with uncertainty level (1σ) below 2% and voxel size which must not be greater than $4\times 4\times 4\text{ mm}^3$.

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