AbstractID: 9621 Title: Characterization of Clinical CBCT and MVCT Systems based on Fundamental MTF, NPS and DQE Measurements Using a Conventional CatPhan Phantom

Purpose: In image guided radiation therapy (IGRT), the performance of image guidance modalities like kilovoltage cone-beam computed tomography (CBCT) and megavoltage computed tomography (MVCT) systems is qualitatively verified with a vendor-provided CatPhan phantom. For a more meaningful QA tool, a methodology to use CatPhan phantoms for fundamental measurements of modulation transfer function (MTF), noise power spectrum (NPS) and detective quantum efficiency (DQE) for CBCT and MVCT systems is presented.

Method and Materials: We have extended the method of using bar-pattern line-pairs for MTF measurement (that we recently validated for megavoltage imaging) to CBCT and MVCT imagers by using line-pair inserts within the CatPhan for axial plane MTF measurement. The MTF was also obtained by evaluating a point response from a tungsten carbide bead insert to validate our method. Axial slices representing homogenous water-equivalent regions of the CatPhan were used to measure NPS that along with the MTF was used to compute DQE. The photon fluence contribution to each slice of the CatPhan was estimated from ion-chamber dose measurements in a water phantom for identical image settings and Monte Carlo simulation based fluence – dose factors. Phantom set-up was typically completed within a minute and all analyses were conducted by an automated software program within seconds.

Results: Good agreement was observed between MTF curves obtained from the bar-pattern and point response methods. Our CatPhan based QA methodology was applied to a Varian Trilogy CBCT system as well as a Hi-Art Tomotherapy unit.

Conclusion: CatPhan based MTF, NPS and DQE measurements for CBCT and MVCT QA present several advantages including simplicity, speed and the use of widely acclaimed radiographic metrics. They can be easily extended to quantify several factors that affect image quality (beam settings, filtering, sampling, reconstruction, field size, etc).