**Introduction**

Math Resolutions, LLC, is in the process of extending their Dosimetry Check (DC) quality assurance software to include TomoTherapy treatments. Data collected from TomoTherapy’s MVCT detectors during an in-air, no table delivery is processed and compared to the planned treatment dose to allow for pre-treatment QA without the use of phantoms and external detectors. This study presents an overview of our initial experience at the University of Virginia developing, implementing, and verifying this novel QA strategy.

**Methods**

Low modulation and high modulation cheese phantom plans as well as patient plans (including prostate, GYN, spine, and pelvis) were used to test the Dosimetry Check in-air analysis software. For all evaluations the treatment table was removed from the archived .xml sinogram file of each plan using software provided by Accuray. The resulting in-air calibration plans were delivered with the treatment table retracted out of the bore. The MVCT exit detector data was extracted from the TomoTherapy treatment system and imported into Dosimetry Check along with the TomoTherapy calculated planned dose. Contoured structures can also be imported into the DC software. The fluence maps were reconstructed and used to recalculate the dose. To test the robustness of the system, several different types of sinogram and MLC errors were intentionally introduced before delivery. These errors include reducing the leaf open time to 90%, increasing the whole sinogram by 20%, closing several leaves for part of the sinogram, and scaling certain leaf openings by various percentages.

**Results**

The percent difference between the planned dose and the dose calculated from the exit detectors by Dosimetry Check ranged between 0.62% for a simple low modulation cheese phantom plan with a cylindrical target to 7.9% for a high modulation 2.5cm T1 vertebra plan. The average percent difference for the 8 unedited plans tested was 4.3%. The gamma indices reported range from 85.7% to 99.2% (average of 95.8%) <1 over the overall calculation area for the plans tested using a gamma of 3% and 3mm. For the area receiving over 80% of the prescribed dose, the gamma ranged from 77.5% to 96.9% <1, with the average being 88.6%.

The induced error plans did show predictable outcomes. For example, for one pelvis case, the in-air analysis showed a percent difference of +2.0% between the TPS and DC. The leave open time was intentionally reduced to 90% and the resulting percent difference was -8.3%. Figures 4 and 5 show an example of the analysis results for a bladder case (Fig. 4) and the error induced counterpart (Fig. 5) - the percent differences were +3.9% and -19.9%, respectively.

**Conclusions**

The results of our investigation of the pre-treatment in-air component of Math Resolutions’ new product-in-development demonstrate that it has the potential to be a useful and practical tool for TomoTherapy QA but needs further adjustments to increase accuracy and become clinically efficient. Part of the performance issue can be attributed to the fact that the program are in single thread, therefore it only utilize ¼ of the computing power of our workstation possesses. Parallelize the calculation can theoretically reduce the processing time to 25% of the original value. However, memory consumption may be a limiting factor in the parallelization effort as the single threaded program already consumes over 2GB of memory. We believe the program needs significant improvement to be clinically acceptable.

The company is continuing to make corrections as the beta sites (Virginia, California, Italy, and Netherlands) report issues. For example, since our data was collected, a procedure and mechanism has been received to correct the energy dependency of the TomoTherapy detectors. Further testing will determine the extent to which these updates will account for the degree of errors we have observed.