An alternative approach to verify 6FFF beam dosimetry for Ethos and MR Linac without using a 3D water tank

Yao Hao[1], Bin Cai[1], Olga Green[1], Nels Knutson[1], Sridhar Yaddanapudi[2], Tianyu Zhao[1], Vivian Rodriguez[1], Matthew Schmidt[1], Sasa Mutic[1], Baozhou Sun[1]

1 Department of Radiation Oncology, Washington University School of Medicine, St. Louis, MO

2 Department of Radiation Oncology, University of Iowa, Iowa City, IA

JULY 12–16 2020 VIRTUAL JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

INTRODUCTION

The current approach for linac beam dosimetry verification are typically performed utilizing a 3D water tank system. The entire 3D beam scanning process is cumbersome, labor intensive, error prone and costly. This is especially challenging for the new Ethos system and MR linacs. This work proposes an alternative approach to verify 6FFF beam dosimetry for Ethos (Varian Medical Systems, Palo Alto, CA), MRIdian ViewRay (ViewRay, Cleveland, OH) and other Linacs with 6FFF beam with 2D ion chamber arrays.

METHOD

The PDD and profiles of an Ethos system, an MR linac and several linacs with 6FFF beams were measured at the nominal beam current with a TG-51 compliant 1D tank and 2D ion chamber arrays, respectively. The beam energy was detuned by changing the bending magnet current on one of the TrueBeam linac. The PDD and profiles were measured for the detuned beam energy. Several profiles features were calculated. Correlations between profiles features and PDDs were evaluated for the sensitivity of beam energy to beam profile changes.

One Varian Ethos, one ViewRay MR-linac, one Elekta VersaHD and eight dosimetric-matched Varian TrueBeam (TB) linacs were studied. Bending magnet current was detuned from nominal current to test the sensitivity of changes of PDD and beam profiles on a Varian TrueBeam linac. All the profile measurements were performed using SAD setup. Multiple field sizes and different build up were investigated. Here, the profiles were shown for the field size of 24cm x 24cm profiles with an inherent buildup of the ion chamber arrays (~8 mm). We present two FFF features: slope and unflatness. They are defined as (Fogliata et al):

$$\text{Slope} = \frac{D_1 - D_2}{x_1 - x_2} \qquad \text{Unflatness} = \frac{D_{\text{central axis}}}{D_{\text{off-axis}}}$$

(D1 = dose level at point x1 = (FS/2)*2/3, D2 = dose level at x2 = (FS/2)*1/3, Dcentral axis = dose level at central axis (renormalization factor), Doff-axis = dose level at 80% of the field size.)

RESULTS

Strong correlations were found between profiles and PDDs for all the Linacs with 6FFF beam we investigated. Both the profile slope and unflatness are proportional to PDD at 10 cm depth of the beam. The correlations with PDD are 0.97 and 0.86 for slope and unflatness, respectively. In our experiment, less than 0.5% of PDD change can be observed on the profile variations.

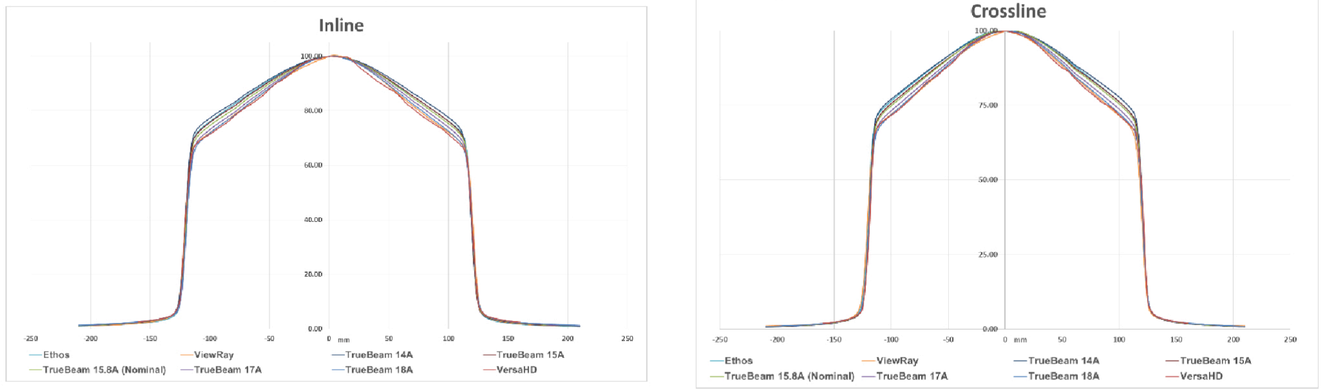

Figure 1 show inline and crossline profile of Ethos system, MR linac and TrueBeam detuned with different PDD.

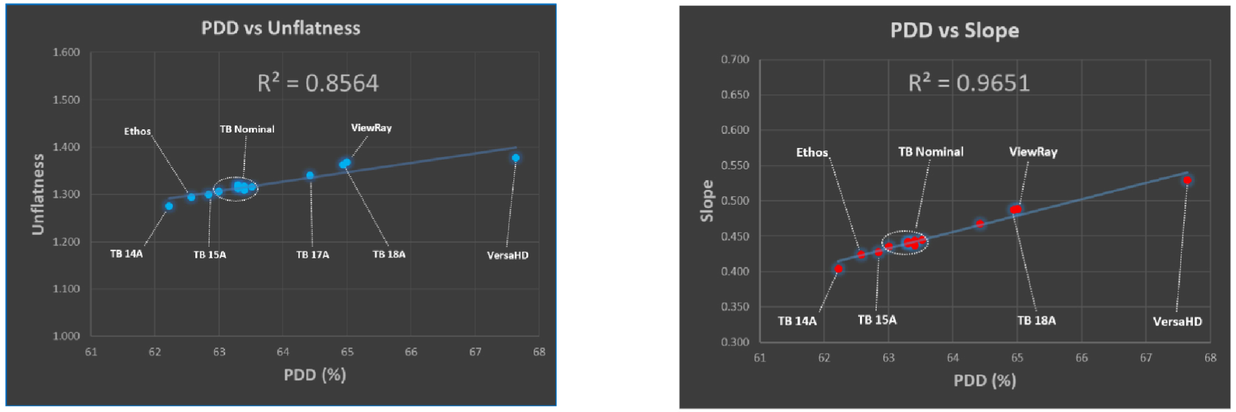

Figure 2 show correlation between PDD and slope, PDD and unflatness across all the linacs with 6FFF we investigated.

CONCLUSIONS

Our work shows the feasibility of verifying 6FFF beam quality of Ethos, MR Linac and other Linacs by using 2D ionization chambers array devices. This new approach provides a simplified method for routine beam quality check without using 3D water tank system while maximizing cost effectiveness and efficiency.

REFERENCES

Fogliata et al.: Definition of parameters for quality assurance of flattening filter free (FFF) photon beams in radiation therapy. Med. Phys. 39 (10), October 2012
Fogliata et al.: Flattening filter free beams from TrueBeam and Versa HD units: Evaluation of the parameters for quality assurance. Med. Phys. 43(1), January 2016

CONTACT INFORMATION

haoyaofsh@gmail.com