

Motion of electronic portal imaging devices and clinical implications for multi-leaf collimator quality assurance

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INTRODUCTION

In radiotherapy treatments such as intensity modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT), verification of the performance of the multileaf collimator (MLC) is an essential part of the linac QA.

AIM

To investigate the source of consistent -up to 2mm longitudinal and lateral- MLC shift observations for 10 Varian (6 C-series and 4 TrueBeam) linear accelerators VMAT weekly MLC QA using an electronic portal imaging device (EPID).

METHOD

Picket fence test images of VMAT vs. static field with the same MLC sequences are routinely compared for weekly MLC QA at our institution. Our test method is as follows: first, the MLC picket fence pattern is acquired with the static gantry at four cardinal angles and collimator angles at 0° and 90°. Second, the same MLC pattern is acquired with VMAT delivery with gantry speed in two ranges (0.5-1.8 °/s and 1.8-4.8 °/s), to find out if the geometric difference is from MLC or the EPID. As a stationary reference point, a front pointer is placed on the couch and aligned to the rotation isocenter, and its shadow projected on all acquired MLC picket fence pattern.

Figure 1 shows an error related to the EPID sag on the VMAT MLC picket fence (the left image is VMAT and the right one is static). It acquired by EPID with static gantry on a Trilogy machine. Figure 2 shows the sample of the picket fence pattern created using VMAT. The image on the top left is the MLC pattern with the shadow of the front pointer. and two images on the right up to 2mm (Longitudinal and Lateral) differences on the edge side of picket fence pattern. The red arrow line shows the area that the EPID sag appeared . The image of the front pointer on MLC patterns gives us an estimation of error between the isocenter of the MLC pattern created by VMAT to static one.

Figure 2,the picture on the middle shows the profile along collimator axes, and the Gamma analysis of the error indicates that the area dose difference criteria didn't pass, but the Gamma value passed.

EPID sag errors on MLC patterns mostly appear on our Trilogy machines. All 4 TrueBeam machines pass the daily machine performance check (MPC), which uses EPID within a 1 mm error. For errors related to EPID sag, different gantry speed showed the same differences, which suggests it is gantry speed independent. Different images from different collimator or gantry angles indicate that the mismatch is from the EPID motion for different gantry angles. The difference was up to 1 mm.

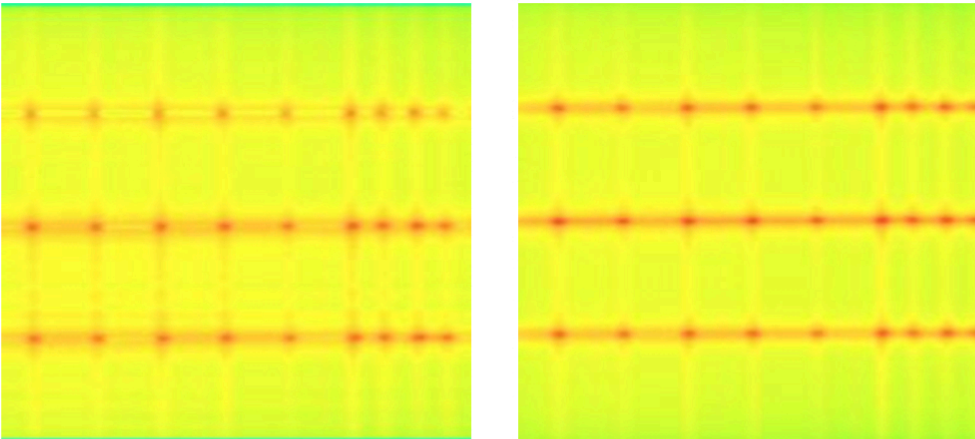
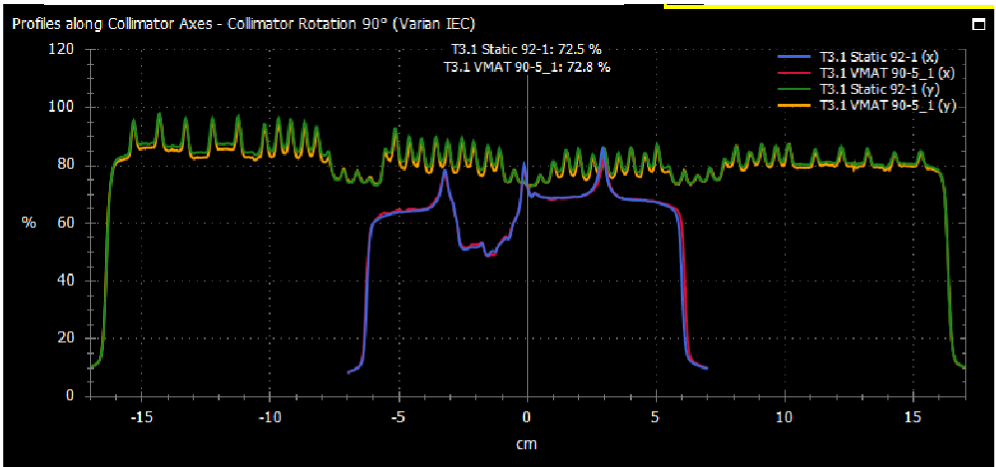
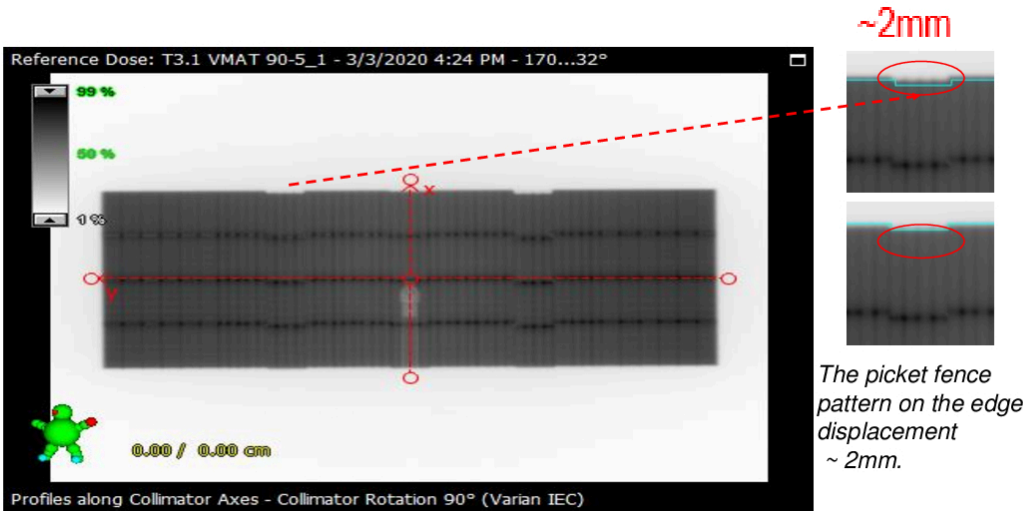


Figure 1. error related to the EPID sag on the MLC picket fence with VMAT on the left side and the Picket fence acquired By EPID with static gantry on the right image (Trilogy).



Gamma (3.0 %, 3.0 mm)	Value	Tol.	Abs. Dose Difference	Value	Tol.
Area Gamma < 1.0	99.4 %	95.0 %	Max. Dose Difference	33.8 %	
Maximum Gamma	3.63		Avg. Dose Difference	0.8 %	
Average Gamma	0.17		Area Dose Diff > 1.0 %	18.8 %	10.0 %
Area Gamma > 0.8	1.0 %		Area Dose Diff > 2.0 %	5.7 %	5.0 %
Area Gamma > 1.2	0.3 %				

Failed

Figure 2. The picture on the top shows the sample of VMAT picket fence pattern Gamma analysis with the shadow of the front pointer 90. The image on the middle shows the x and y profile. The blue and red curves are x profile and green and yellow curves are y profile for static and VMAT (Trilogy). The Gamma and area dose differences are in the bottom image.

CONCLUSIONS

The EPID motion of up to 1mm for different gantry angles during VMAT is not easily detected even with the daily MPC. Considering this finding, the meaning of the Gamma passing rate of EPID-based VMAT verification system needs to be revisited.

REFERENCES

[1] Kalavagunta, C., Yang, X., Xu, H., Zhang, B., Mossahebi, S., Sawant, A. and Yi, B. (2016), TU-FG-201-02: Is Weekly MLC QA Necessary? Two Year EPID-Based Weekly MLC QA Experience at the University of Maryland. Med. Phys., 43: 3753-3753. doi:10.1118/1.4957525

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