

# In Vivo Dosimetry of Conventional and Rotational Intensity Modulated Radiotherapy Using Integral Quality Monitor (IQM)



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RADIATION ONCOLOGY &  
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## Introduction

Integral quality monitor (IQM) is an independent and on-line treatment verification system. It is designed to monitor the accuracy of delivery in segment-by-segment for each treatment field by measuring a checksum of each segment. The IQM device consists of a large area ion chamber, electrometer, inclinometer for arc verification, and barometer/thermometer. The device transfers measurement data to the management software via bluetooth connection. The IQM validates the accuracy in real time by comparing either the calculated plan or the reference from the treatment.

## Purpose

- To investigate the accuracy, sensitivity and constancy of IQM for conventional intensity modulated radiation therapy (IMRT) and rotational volumetric modulated arc therapy (VMAT)

## Materials/Methods

- A beta-version IQM system was commissioned on an Elekta Infinity LINAC equipped with 160-MLCs Agility head.
- The stationary and rotational dosimetric constancy of IQM was evaluated, using five-field IMRT and single- and double-arc VMAT plans for prostate and head-and-neck (H&N) patients.
- The plans were repeated three times for each measurement over several days to assess the constancy of IQM response.
- Picket fence (PF) fields were used to evaluate the sensitivity of detecting MLC leaf errors. A single leaf offset was intentionally introduced during delivery of various PF fields with segment apertures of 3x1, 5x1, 10x1, and 24x1cm<sup>2</sup>. Both 2mm and 5mm decrease in a single MLC leaf width were used.



Figure 1. View of IQM mounting on the gantry

## Data/Results

Repeated IQM measurements of prostate and H&N IMRT deliveries showed 0.4 and 0.5% average standard deviation (SD) for segment-by-segment comparison and 0.1 and 0.2% for cumulative comparison. The corresponding SDs for VMAT deliveries were 6.5, 9.4% and 0.7, 1.3%, respectively. Statistical analysis indicates that the dosimetric differences detected by IQM were significant ( $p < 0.05$ ) in all PF test deliveries. The largest average IQM signal response of a 2 mm leaf error was found to be 2.1% and 5.1% by a 5mm leaf error for 3x1 cm<sup>2</sup> field size. The same error in 24x1 cm<sup>2</sup> generates a 0.7% and 1.4% difference in the signal.

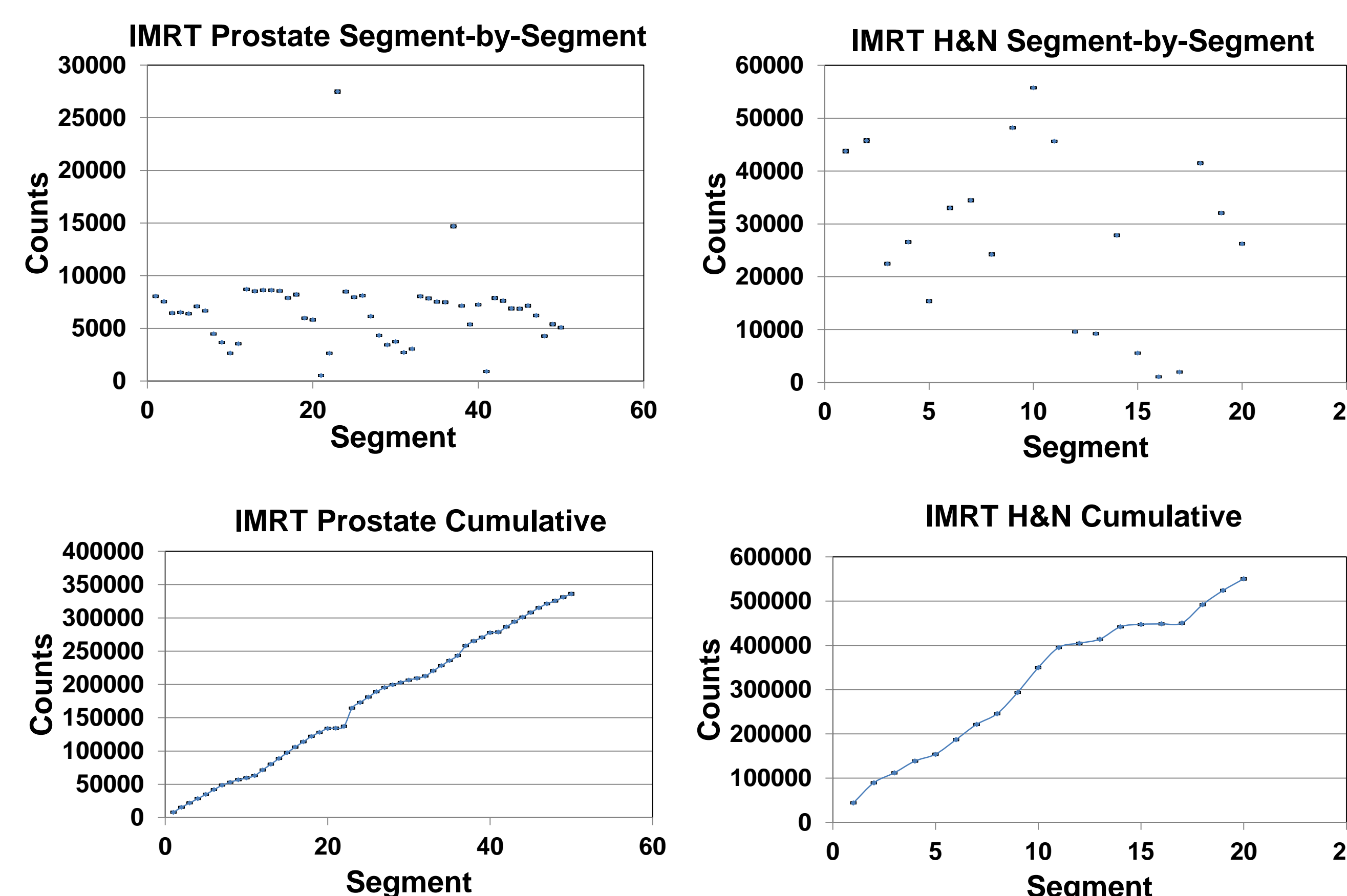


Figure 2. IQM constancy test for step-and-shoot IMRT prostate and H&N fields

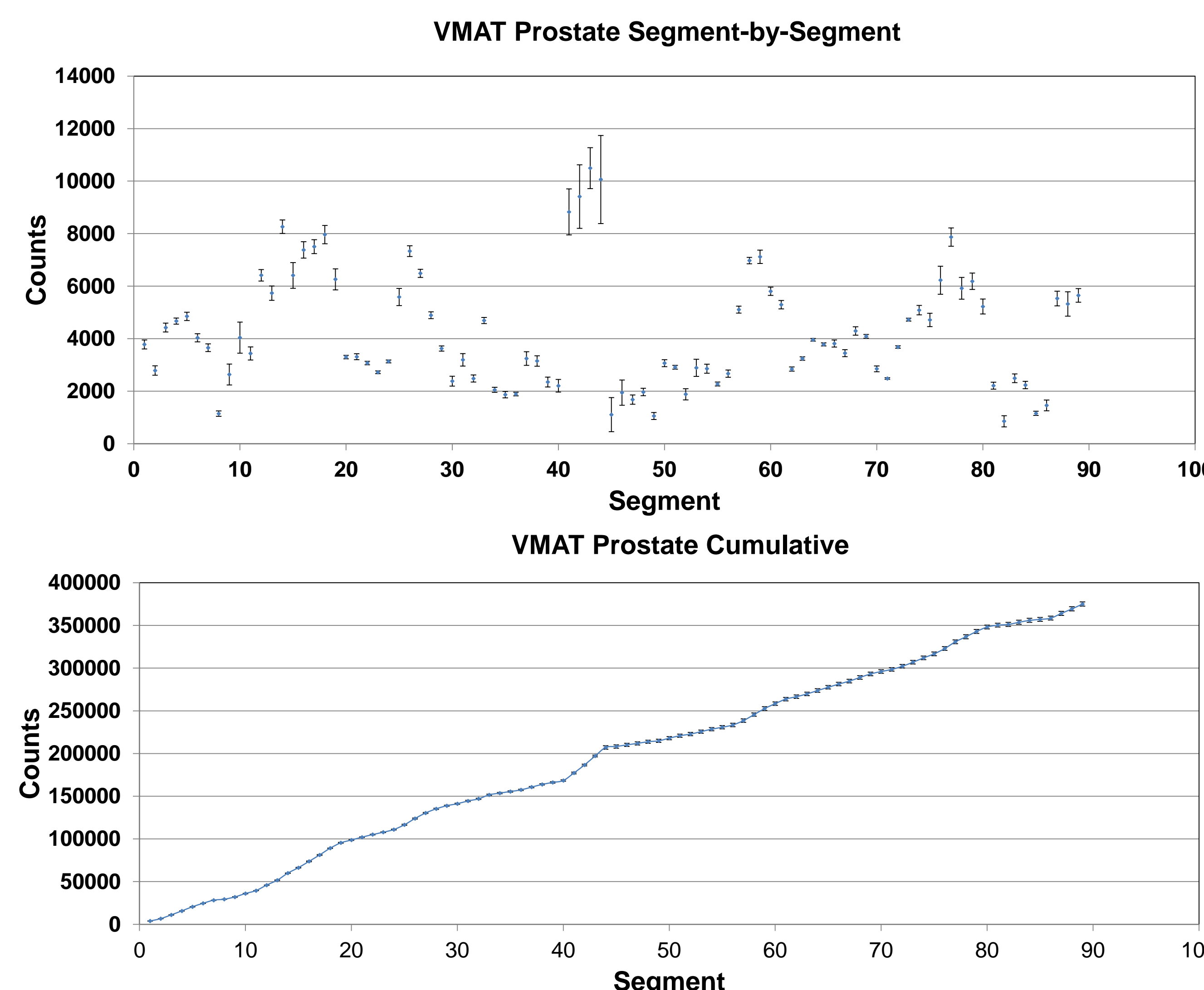


Figure 3. IQM constancy test for VMAT prostate fields

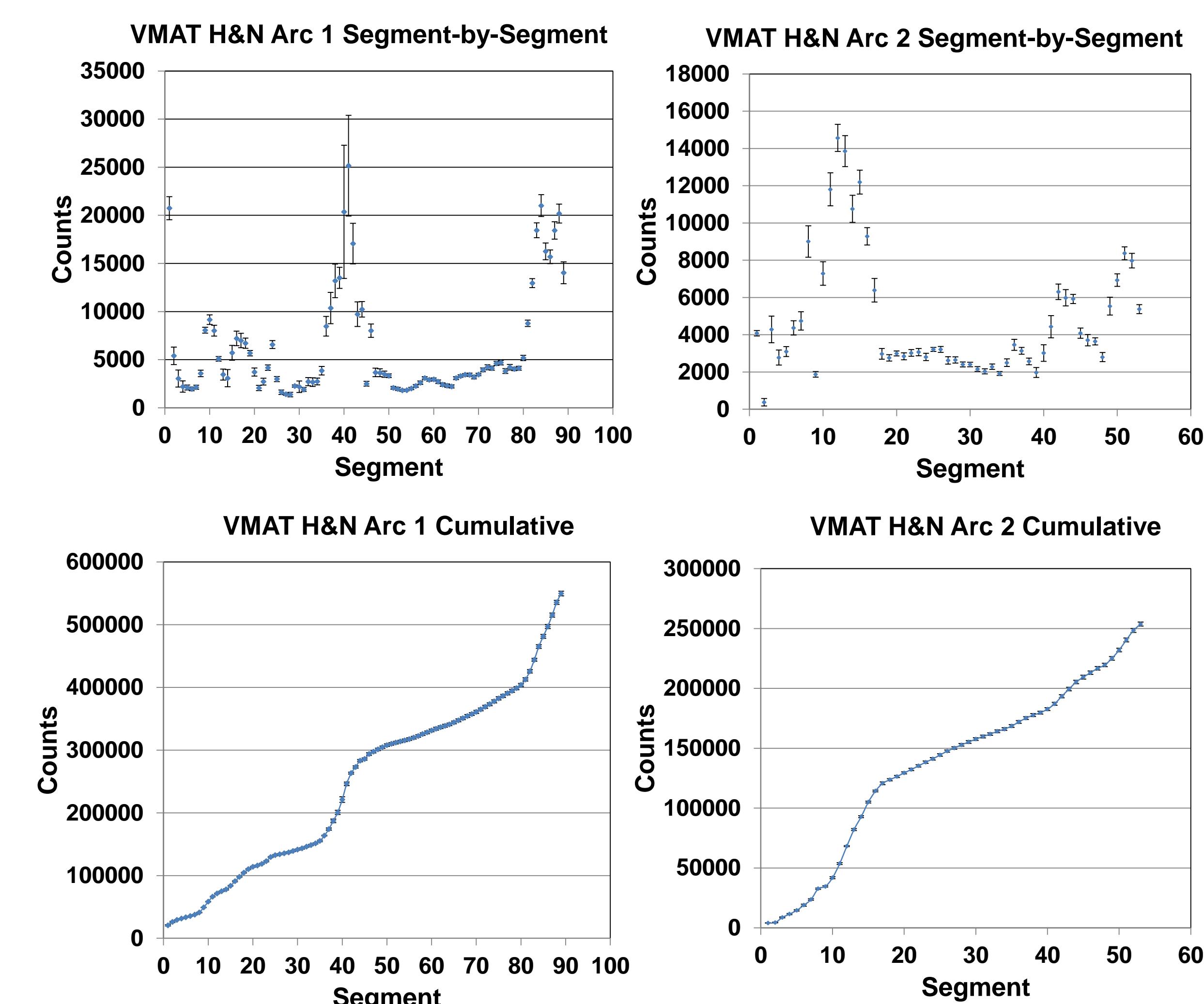


Figure 4. IQM constancy test for VMAT H&N fields

Table 1. IQM sensitivity test on MLC leaf error

FS	2mm offset		5mm offset	
	p value	Avg diff (%)	p value	Avg diff (%)
3x1	0.0005	2.08	0.0005	5.13
5x1	0.0005	1.16	0.0005	3.27
10x1	0.0005	1.01	0.0005	2.73
24x1	0.0005	0.66	0.0005	1.39

## Conclusions

- IQM provides an effective means for real-time dosimetric verification of IMRT/VMAT treatment delivery
- Small MLC leaf error can be detected. The sensitivity is more pronounced for the small field. It could be beneficial for the stereotactic treatment
- For VMAT delivery, the cumulative dosimetry of IQM needs to be used in clinical practice