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Three-fold Acceleration of TG-142 Monthly Dosimetry Quality Assurance Using a Commonly Available Ion Chamber Array

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INTRODUCTION

Monthly TG-142 dosimetry quality assurance (QA) remains labor-intensive, creating workflow burden in high-throughput clinical environments.

Although *ion chamber arrays* (such as SNC IC Profiler) are widely available in many radiation therapy clinics practices today, their use for comprehensive TG-142 monthly dosimetry QA has not been fully utilized or optimized.

This study developed and validated a streamlined, TG-142–compliant monthly dosimetry QA workflow that substantially accelerates execution time by 3-folds without compromising dosimetric accuracy or reproducibility.

METHODS AND MATERIALS

A consolidated monthly QA workflow was developed using a clinical MV linear accelerator (Siemens Healthineers Varian TrueBeam, Palo 'Alto, CA), a commercially available ion chamber array (SNC IC Profiler, Melbourne, FL) with a dose-calibrated central-axis ion chamber (calibrated with 6x,100cm SSD, buildup dmax 1.5cm, 10x10 field for 1cGy/MU) and the quad wedges.

For photons (6x, 6fff,10x,10fff,15x) and electrons (6E,9E,12E,16E,18E), IC Profiler with respective Quad Wedge were measured once to simultaneously evaluate:
- Beams Output
- Energy Check (PDD10cm for photons and R50 for electrons)
- Flatness & Symmetry
- Light Field Profile

Then the separate measurements for Photon's relative dosimetry tests were performed:
- Respiratory Gating Output Constancy with RGSC "Frog" on moving stand
- Enhanced Dynamic Wedge (EDW) and the Wedge Factor

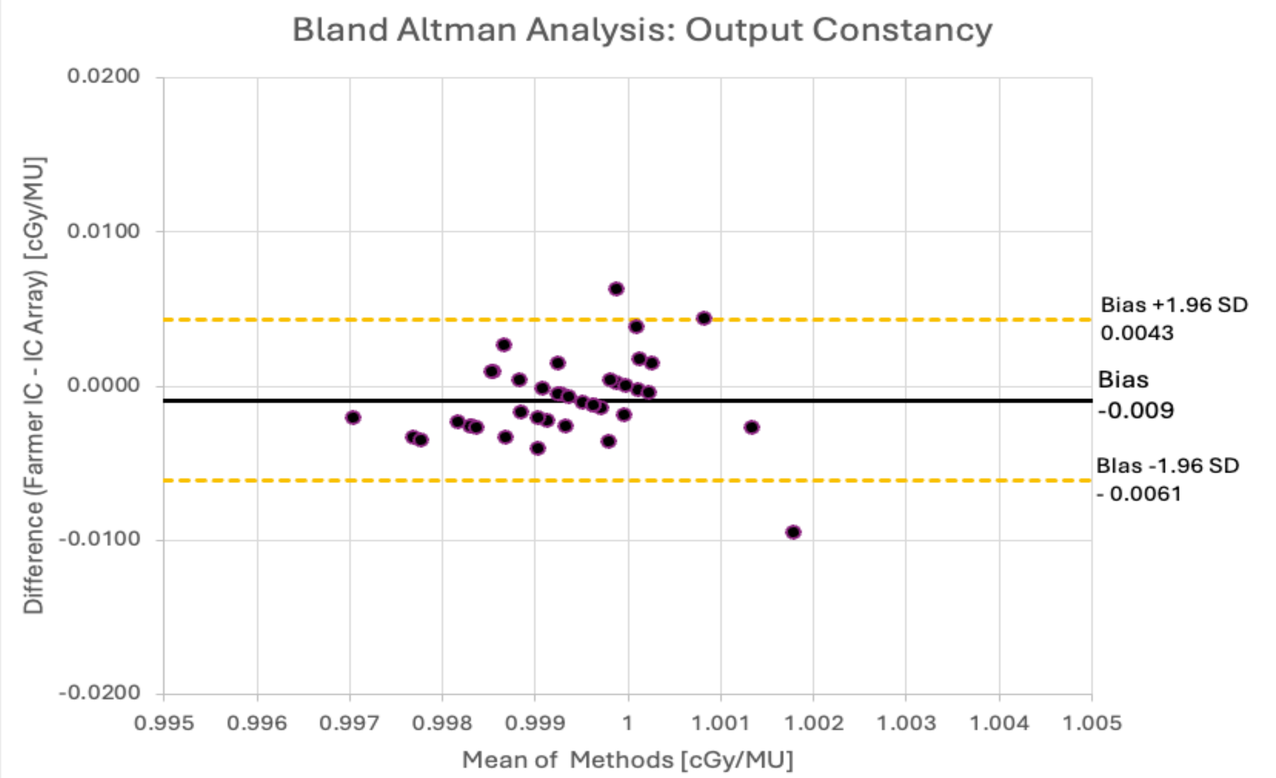
The workflow was benchmarked against ***conventional*** TG-142 monthly QA procedures using a Farmer ion chamber (PTW 30013, PTW-Freiburg GmbH, Freiberg, Germany) and solid water phantom.

Agreement between methods, measurement reproducibility, and total QA execution time were evaluated over repeated monthly measurements.

Table 1. Total Time of Linac Monthly QA, Dosimetry

	IC + SW, and ICP	ICP Only
Electron Output IC + SW	Setup 40 min, BeamON 25min	x
Photon Output IC + SW	Setup 40 min, BeamON 25min	x
Photon Resp.Gating Output IC + SW	BeamON 25 min.	x
Photon Resp.Gating Output ICP	x	BeamON 20 min.
Photon Wedge Factor IC + SW	BeamON 25 min.	x
Photon Wedge Factor ICP	x	BeamON 20 min.
Photon and Electron Energy, Flat.&Symm (and Output)	Setup 10 min BeamON 20 min	Setup 10 min., BeamON 20 min
Total Time	**3 hours 30 minutes**	**1 hour 10 minutes**

RESULTS



Bland–Altman analysis comparing monthly output constancy measurements obtained using a commercially available ion chamber array and a reference Farmer ion chamber across multiple dosimetry output QA months (n = 40 paired measurements). The difference is defined as Farmer chamber minus IC Array output (cGy/MU), plotted against the mean of the two methods. The solid horizontal line indicates the mean bias, and the dashed lines represent the 95% limits of agreement (±1.96 SD). The narrow limits of agreement and absence of magnitude-dependent trends demonstrate strong equivalence between methods, with all differences well within TG-142 tolerances, supporting the suitability of the array-based workflow for routine monthly dosimetry QA.

The proposed workflow achieved a three-fold reduction in monthly dosimetry QA time, decreasing execution from approximately 3hr.30min. to 1hr.10min. without loss of dosimetric fidelity.

All evaluated constancy metrics remained within TG-142 tolerances, and measurement reproducibility was comparable to standard ion chamber techniques.

CONCLUSIONS

A TG-142–compliant monthly dosimetry QA workflow using a commonly available ion chamber array enables a three-fold reduction in QA time while maintaining dosimetric accuracy.

This readily adoptable approach enables efficient, standards-compliant monthly QA and may inform future guidance on array-based monthly QA implementation without compromising patient safety.

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