Feasibility of an In-House Python Script for Automated EPID-Based Machine Quality Assurance Analysis

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2026 JULY 19–22 VANCOUVER, BC
JOINT AAPM | COMP MEETING

HealthCare MARKEY CANCER CENTER

BACKGROUND

- Commercial QA analysis software can be limited by cost and workflow efficiency.
- Electron portal imaging devices (EPIDs) are widely available on modern linear accelerators and provide an accessible source of QA imaging data
- An in-house Python script was developed for automated analysis of EPID-based QA as a low-cost alternative with the potential to streamline QA workflows and improve consistency in clinical practice.

SPECIFIC AIMS

1. Evaluate the script's accuracy by comparing its QA results with those generated using current departmental manual measurement techniques.
2. Quantify the reduction in analysis time achieved through use of the script for monthly QA procedures.

METHODS AND MATERIALS

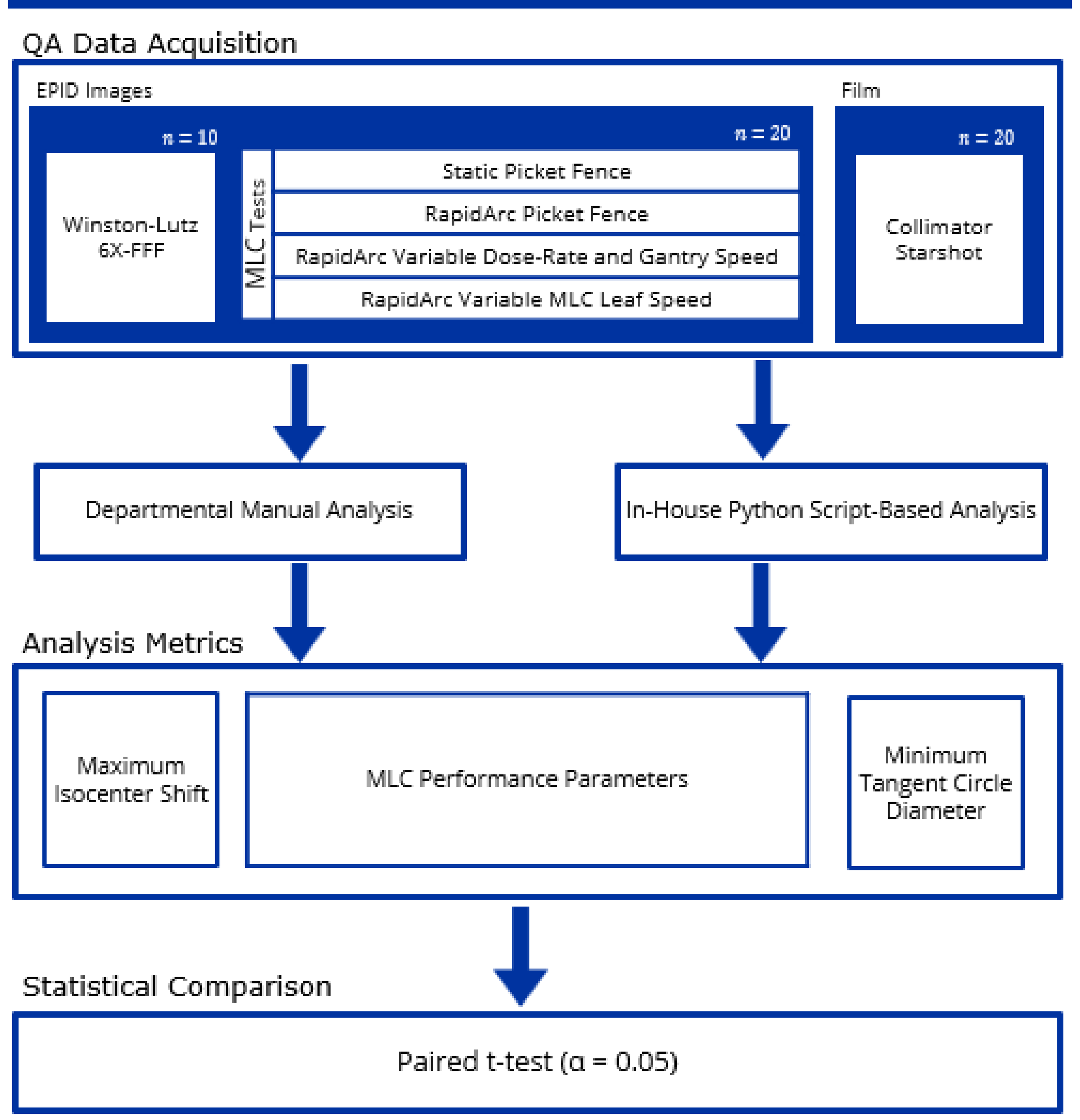

Figure 1*: Workflow of the QA analysis. QA data were acquired according to TG-198*[1] *recommendations. MLC analysis metrics were defined by Ling et al.*[2]

RESULTS

Winston-Lutz

- Demonstrated agreement between manual and script-based methods ($p=0.57$).

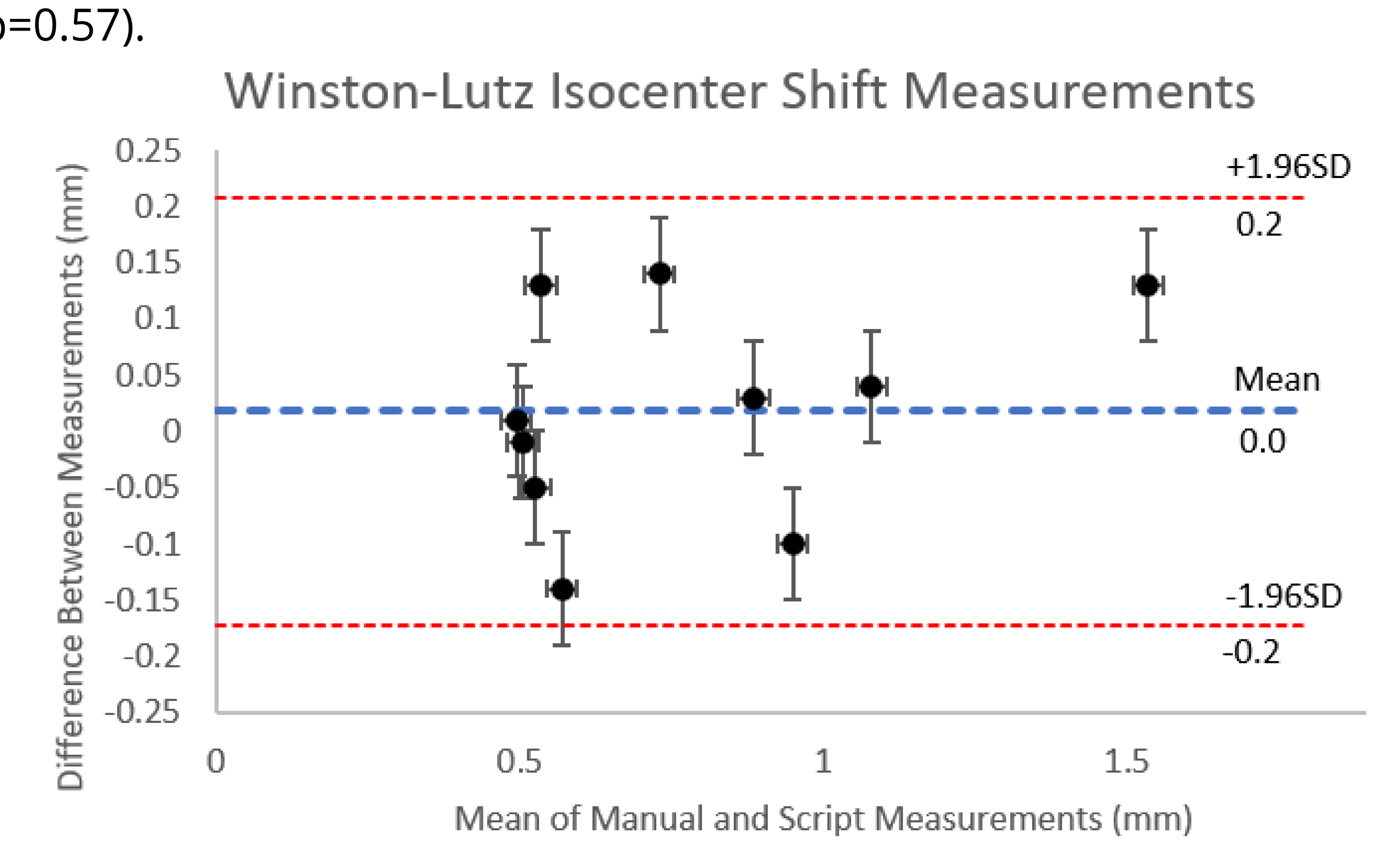

Figure 2*: Bland-Altman plot comparing Winston-Lutz isocenter shift measurements obtained using manual and script-based analysis. All data points fall within the 95% limits of agreement.*

Collimator Starshot

- Demonstrated a statistically significant difference between methods ($p<0.05$).
- Script-based values were lower than manual values in 18 of 20 cases.
- Differences are likely attributable to operator-dependent variability in manual line placement.
- Automated analysis reduces subjectivity, improving measurement consistency and reproducibility.

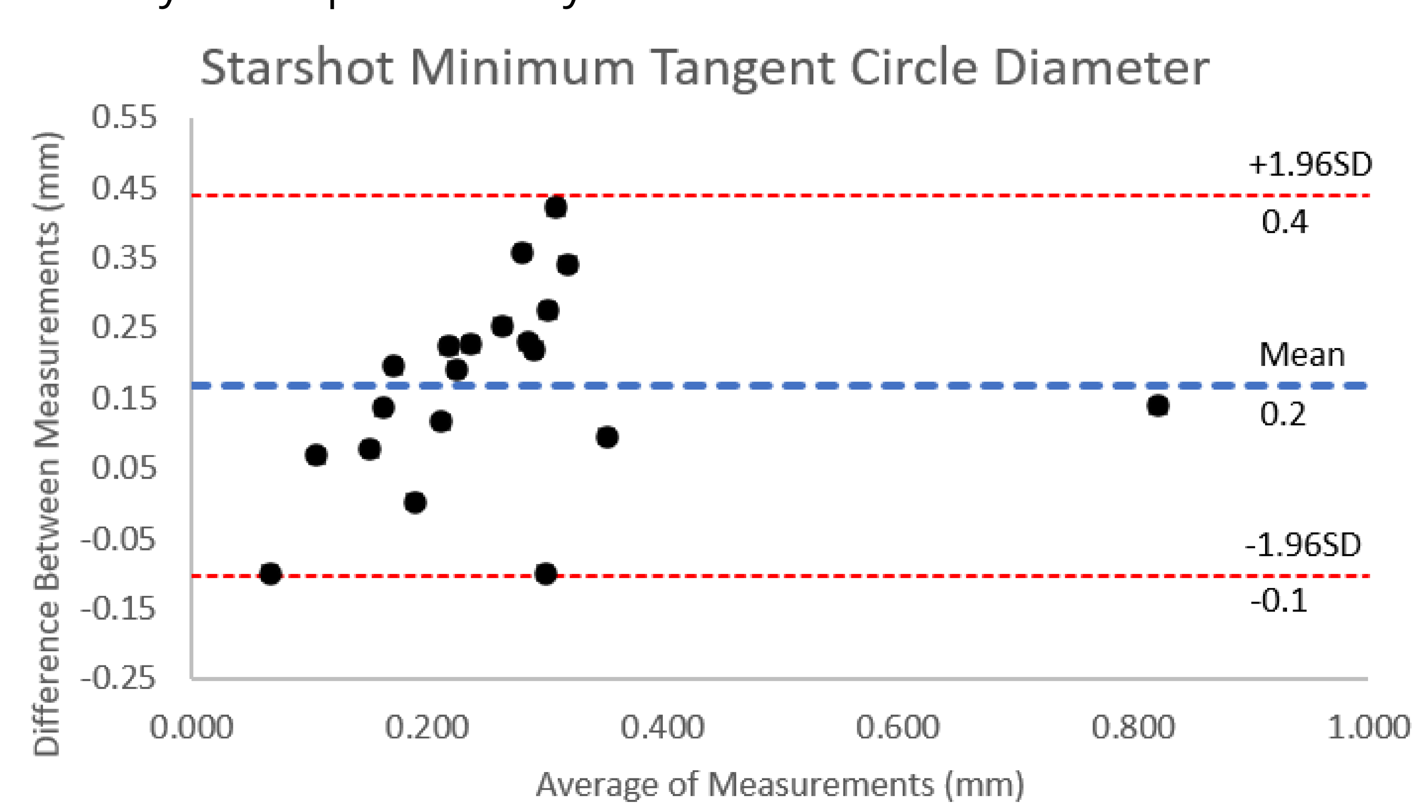

Figure 3*: Bland-Altman plot comparing manual and script-based starshot analysis. All data points fall within the 95% limits of agreement.*

MLC Tests

- All cases that passed manual QA criteria also passed using script-based analysis, indicating consistent clinical pass/fail classification.

RapidArc Variable Dose-Rate and Gantry Speed						
0.00*	0.00*	0.00*	0.01	0.00*	0.00*	0.00*

RapidArc Variable MLC Leaf Speed			
0.00*	0.56	0.00*	0.00*

RapidArc Picket Fence	Static Picket Fence
0.24	0.07

Table 1*: p-values from paired t-tests comparing manual and script-based MLC QA analysis.*
**Indicates α < 0.05*

Timing

Table 2*: Mean (SD) percentage reduction in QA analysis time for script-based analysis relative to manual analysis.*

QA Test	Percentage Reduction in Time Required for QA Analysis
Winston-Lutz	47.2 (8.1)
Collimator Starshot	55.5 (4.8)
MLC Tests	37.7 (9.2)

CONCLUSION

- The in-house Python script demonstrated strong agreement with manual analysis for Winston–Lutz QA, with no significant difference observed between methods.
- For starshot analysis, a systematic difference was observed, likely reflecting reduced user-dependent variability in automated line placement, while maintaining overall agreement within Bland–Altman limits.
- MLC QA results showed consistent clinical pass/fail outcomes between methods despite mixed statistical differences.
- Across all QA workflows, the script substantially reduced analysis time, supporting its potential as an efficient and reliable alternative for routine EPID-based QA.

REFERENCES

1. Hanley, J, et al. (2021). AAPM Task Group 198 report: An implementation guide for TG 142 quality assurance of medical accelerators. *Medical Physics, 48*(10).
2. Ling, C. C., et al. (2008). Commissioning and quality assurance of RapidArc radiotherapy delivery system. *International Journal of Radiation Oncology*Biology*Physics, 72*(2), 575-581.