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JOINT AAPM | COMP MEETING

A Web-Based Semi-Automatic Film Analysis Tool for Repeat Verification of Varian GYN Ring Applicator Dwell Positions

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ABSTRACT

Purpose: Varian recommends repeated verification of the GYN Ring applicators for the Bravos HDR afterloaders after source exchanges—to account for source wire mechanical variations. To reduce uncertainties of manual film-based QA, I developed a web-based, semi-automated analysis tool.

Methods: A standalone HTML/JavaScript application was developed to analyze scanned film without proprietary software. The tool utilizes spatial calibration, binary thresholding, and geometric masking. A semi-automated, geometry-constrained connected-component algorithm detects dwell positions, allows manual refinement, and exports coordinates for treatment planning system comparison.

Results: The application provides rapid, reproducible dwell position identification with minimal user interaction, enabling efficient implementation of vendor-recommended periodic QA.

Conclusion: This web-based film analysis tool offers a practical, efficient solution for routine Bravos HDR Ring applicator verification, especially when paired with the dedicated 3D-printed jig.

INTRODUCTION

- **Clinical Challenge**: Periodic verification of HDR ring applicator dwell positions is critical (especially after source wire exchanges), but traditional film analysis is highly labor-intensive and impractical for frequent routine QA.
- **Platform Accessibility**: Commercially available film analysis tools often require proprietary software, complex platform-specific installations, or specialized scripting dependencies, which limits widespread clinical adoption.
- **The Webapp Solution**: A standalone, single-HTML/JavaScript web application eliminates these barriers, offering a vendor-agnostic, cross-platform tool accessible from any browser without installation.
- **AI-Assisted Development**: Utilizing Gemini® as an AI collaborator allowed a medical physicist to rapidly build and deploy a sophisticated clinical tool, demonstrating that powerful programming is achievable even with limited JavaScript/HTML expertise.

METHODS AND MATERIALS

- **Web Framework & UI Design**
  - Architecture: Built as a single, lightweight HTML5/JavaScript standalone application that runs entirely client-side in any web browser without server-side dependencies.
  - Responsive GUI: Utilizing modern CSS and modular JavaScript allowed for a fast, elegant, and responsive user interface
- **Core Image Processing Toolkit**
  - Seamless I/O: Supports instant drag-and-drop file loading (TIFF, JPEG, PNG)
  - Pre-Processing Suite: Multi-degree image rotation, precise cropping, spatial calibration via automated DPI meta-resolution extraction, window/level adjustments, and denoising filters.
- **Semi-Automated Dwell Detection Algorithm**
  - Smart Thresholding: Otsu-based histogram to dynamically separate high-intensity dwell spots from film background artifacts.
  - Connected-Component Analysis: Detects candidate dwell locations by enforcing strict geometric constraints based on expected ring radius, dwell spot size, and angular distribution.
  - Interactive Refinement
- **Session Management & Data Export**
  - Multi-User / Multi-Session Comparison: Handle multiple independent evaluation sessions simultaneously, enabling efficient visualization and direct comparison across different trials.
  - Streamlined Export: Instantly maps and angularly sorts detected coordinates, allowing users to copy spreadsheet-ready data directly to the clipboard for rapid external QA logging

RESULTS AND CONCLUSION

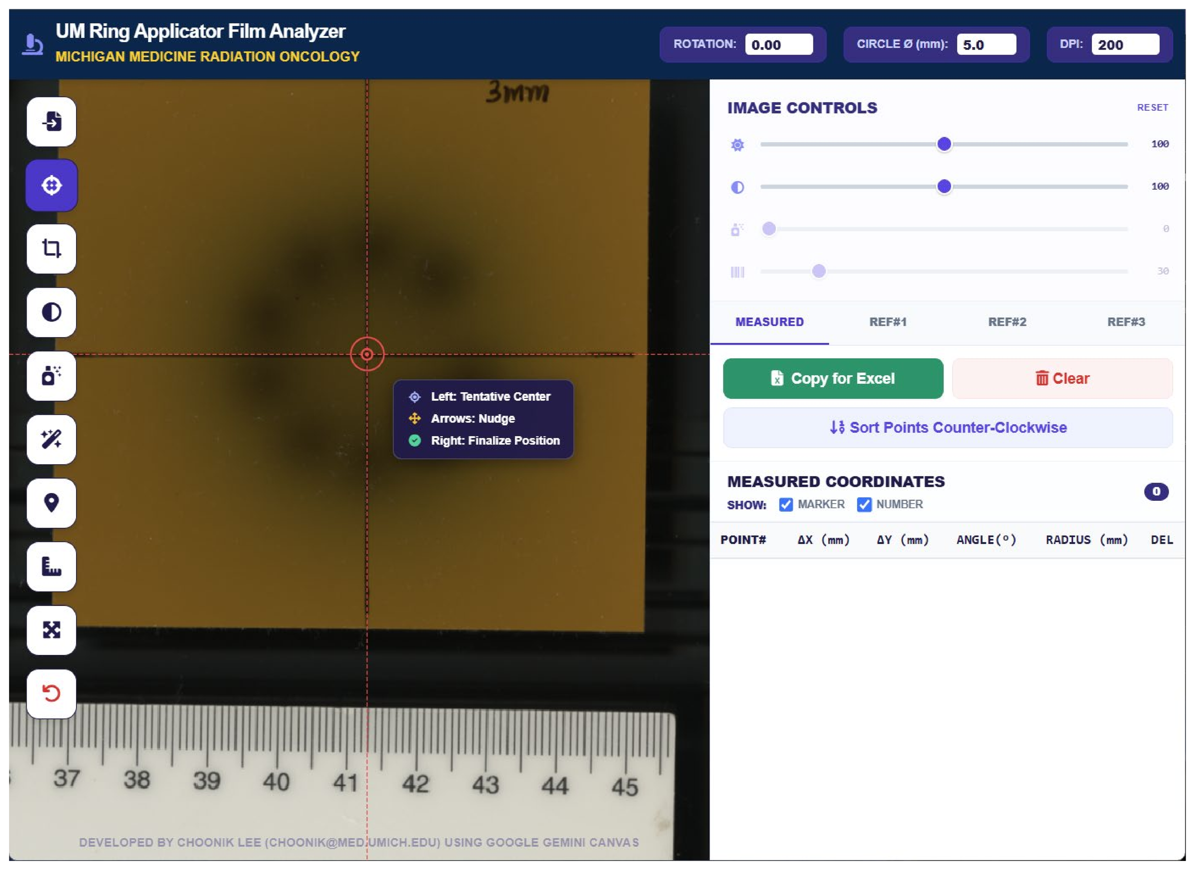

Figure 1. Importing film image. Note the automatic DPI extraction, helper tooltips. Mouse wheel control for rotation.

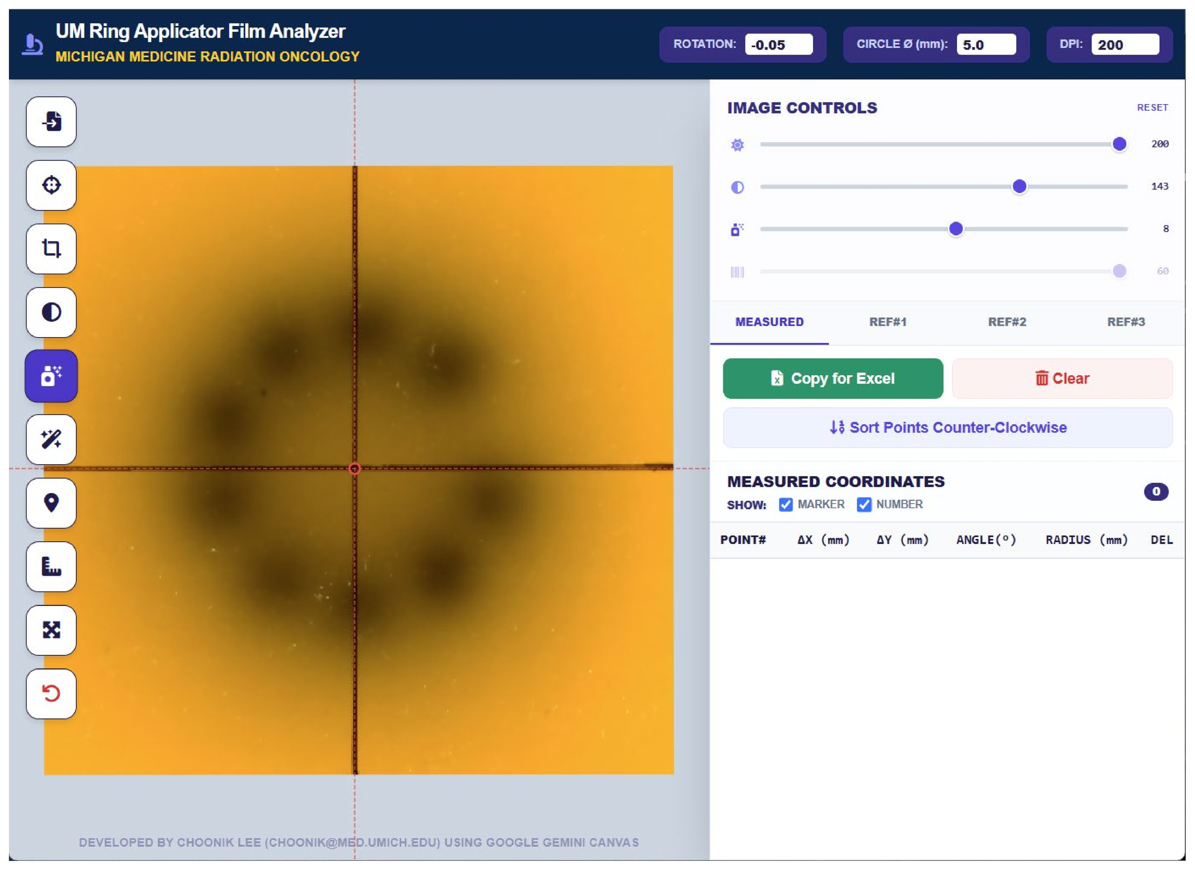

Figure 2. Basic operations, including cropping, window/leveling, denoising.

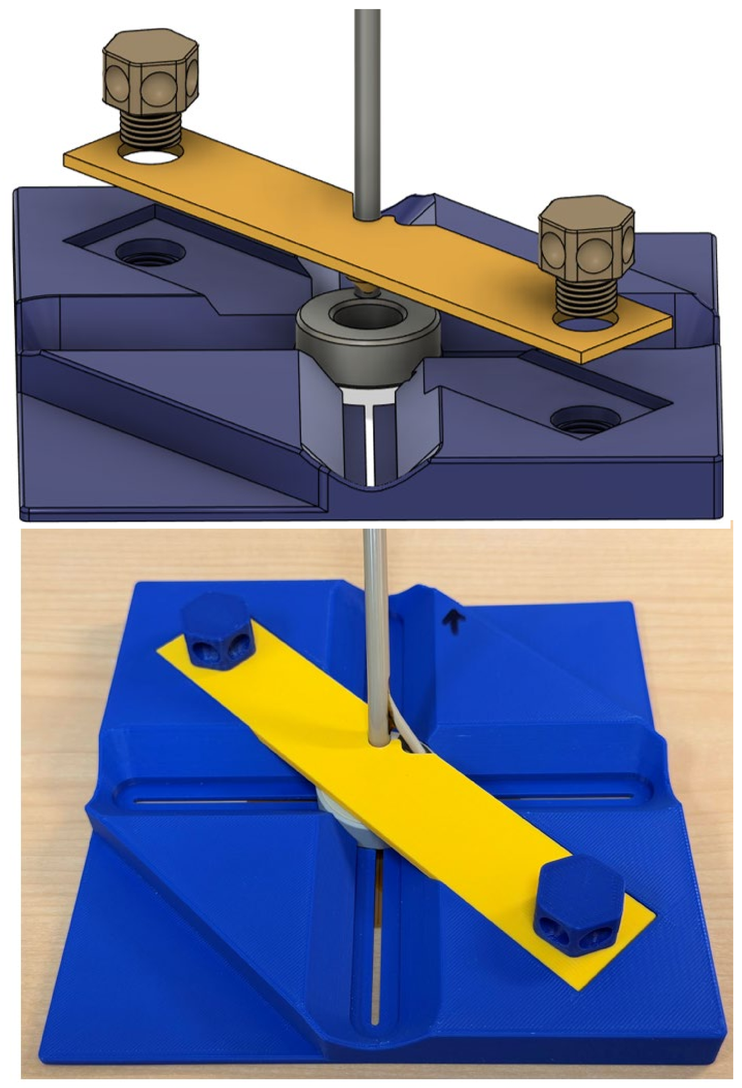

Figure 5. Dedicated 3D-printed film jig

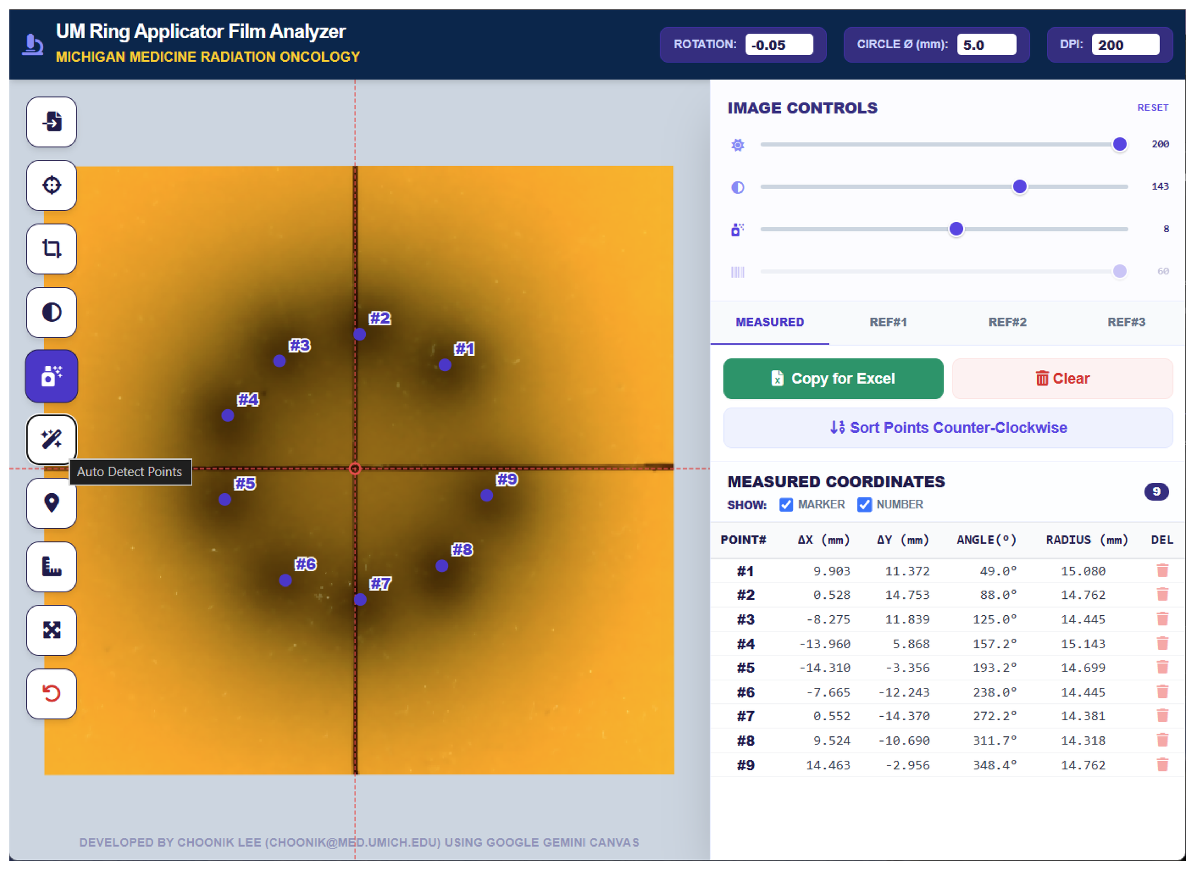

Figure 3. One-click automatic smart detection of the dwell position and calculation of the geometric information of each dwell.

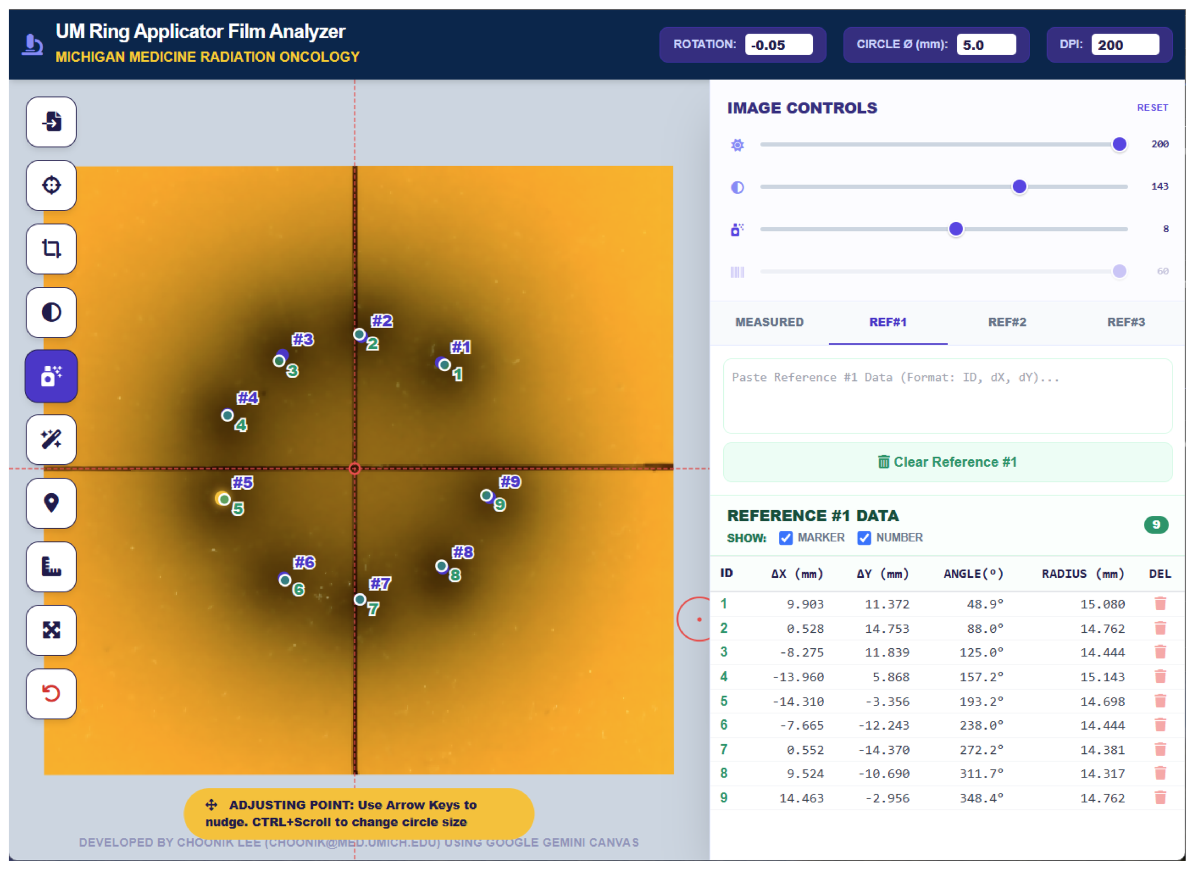

Figure 4. Overlap of two data sets for easy comparison of the reference or historic datasets.

Table 1. Detailed geometric information about the identified dwell positions

MEASURED COORDINATES 9

SHOW: ☑ MARKER ☑ NUMBER

POINT#	ΔX (mm)	ΔY (mm)	ANGLE(°)	RADIUS (mm)	DEL
#1	9.903	11.372	49.0°	15.080	
#2	0.528	14.753	88.0°	14.762	
#3	-8.275	11.839	125.0°	14.445	
#4	-13.960	5.868	157.2°	15.143	
#5	-14.310	-3.356	193.2°	14.699	
#6	-7.665	-12.243	238.0°	14.445	
#7	0.552	-14.370	272.2°	14.381	
#8	9.524	-10.690	311.7°	14.318	
#9	14.463	-2.956	348.4°	14.762	