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Assessing the Need for High-Resolution Array Measurements in CyberKnife Perpendicular Composite QA

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Objective

CyberKnife stereotactic treatments are delivered using a step-and-shoot technique, with patient-specific QA verification plans for diode array measurements typically generated and evaluated in a perpendicular composite geometry.

This study investigates whether the increased spatial resolution of SRS MapCHECK is required to identify delivery-related dosimetric discrepancies compared to MapCHECK® 1 for CyberKnife SRS and SBRT plans.

Methods

- ❑ Twelve CyberKnife SRS and SBRT treatment plans, including lung, brain, prostate, and spine cases, were selected for this study.
- ❑ All plans had previously undergone patient-specific QA using MapCHECK® 1, with gamma analysis performed using 3%/2 mm criteria and a 10% dose threshold.
- ❑ The same patient plans were used to generate verification plans for SRS MapCHECK measurements.
- ❑ SRS MapCHECK was calibrated according to institutional patient-specific QA protocols, and measurements were performed under identical delivery conditions

Results

- ❑ For all treatment sites, MapCHECK® 1 demonstrated agreement above 95%, with an average gamma passing rate of 98.4% ± 1.6% using the 3%/2 mm criteria.
- ❑ In comparison, SRS MapCHECK achieved gamma passing rates above 90%, with an average of 94.3% ± 2.7% under the same 3%/2 mm criteria.
- ❑ The higher diode concentration of the SRS MapCHECK enables detection of greater dose discrepancies; however, the measured values remain above the recommended action level.

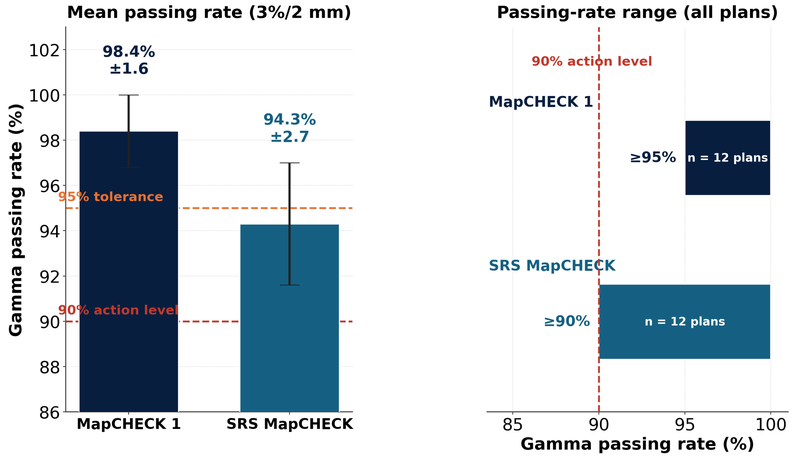

Figure 1. *Gamma passing rates (3%/2 mm, 10% threshold) for MapCHECK 1 and SRS MapCHECK across 12 CyberKnife SRS/SBRT plans. Dashed lines mark the 95% tolerance and 90% TG-218 action levels.*

Key findings

- **MapCHECK 1: 98.4% ± 1.6%** mean gamma passing rate (3%/2 mm)
- **SRS MapCHECK: 94.3% ± 2.7%** mean gamma passing rate under the same criteria
- All 12 SRS/SBRT plans stayed above the **90% TG-218 action level** with both arrays
- The denser SRS MapCHECK detected larger local dose discrepancies, yet none exceeded the clinical action level

Conclusion

- ❑ For CyberKnife perpendicular composite patient-specific QA, both MapCHECK® 1 and SRS MapCHECK met institutional acceptance criteria consistent with TG-218.
- ❑ While the higher detector density of SRS MapCHECK can reveal more localized dose discrepancies, it did not identify clinically significant delivery issues beyond those detected with MapCHECK® 1 in routine SRS/SBRT verification.
- ❑ Given its greater sensitivity to calibration and output stability, SRS MapCHECK may be most beneficial when higher spatial sampling is expected to influence clinical decisions.

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