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# Verification of Small Field Conformal Arc Dose Distributions with SRS Mapcheck

Vadim L. Stakhursky[1], Paul Robert Sullivan, PhD[2], Taindra Neupane[2], Yevgeniy Vinogradskiy, PhD[2] and Karen E. Mooney PhD[2],
[(1)]Jefferson Einstein, Philadelphia, PA, [(2)]Thomas Jefferson University, Philadelphia, PA

## ABSTRACT

SRS Mapcheck is an attractive solution for small field dose validation and could be utilized for dose profile measurements as well as central axis (peak output) validation due to its relatively dense detector spacing and small detector size.

In this study we attempt to calibrate SRS Mapcheck readings by comparing the measurements to small ion chamber data.

Even small chamber data is affected by a non uniform dose distribution for small srs fields. We use dose distribution convolution over the chamber volume to calculate partial volume effect. These corrected ion chamber readings were compared to SRS Mapcheck central axis data.

Excellent agreement was observed between Mapcheck and ion chamber measured doses for field sizes 5mm and larger. For smaller fields the error can exceed 4.4%.

## CONTACT

Vadim Stakhursky

Thomas Jefferson University, Philadelphia, PA

Vadim.Stakhursky@jefferson.edu

## INTRODUCTION

Purpose: SunNuclear SRS mapcheck diode array is a convenient option for 2D dose mapping combining small detector and relatively small 3.5mm detector grid size in axial direction (2.5mm in diagonal direction). We investigate the utility of SRS mapcheck in validating the dosimetry of sub-centimeter conformal arc fields.

## METHODS AND MATERIALS

Full conformal arcs 6x fields intended for treatment of spherical targets of 4-20mm diameters were created in Eclipse treatment planning system. Dose distribution was measured by localizing SRS Mapcheck array inside of SRS head phantom at plan isocenter by using combination of orthogonal KV, and CBCT imaging on Varian TrueBeam Edge (HD MLC).
In addition, the isocenter dose was measured by placing Exradin A16 pinpoint chamber inside of the SRS head phantom. The obtained data was compared to Eclipse TPS AAA predictions. Eclipse TPS dose profiles were used to compute chamber corrections due to volume averaging effect.

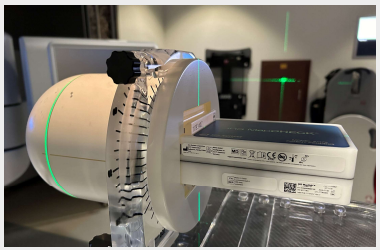

**Figure 1.** SRS Mapcheck Head Phantom with SRS diode array set up for the measurements.

**Figure 2.** Exradin A16 pinpoint chamber 0.007cc collection volume. 1mm diameter equivalent.

## RESULTS

- Mapcheck measurements showed good agreement with Eclipse TPS calculated dose distribution. Array central axis dose reading overestimated the dose at the isocenter. Small field correction feature of SRS Mapcheck software was used to reduce the discrepancies. With the correction on, the excess increased for smaller fields and varied from 0.4% for 20mm field, 3% for 10mm field to 10.5% for 4mm field.
- TPS dose predictions were in good agreement with pinpoint chamber dose measurements (maximum error 2.3% average error 1.1%). Chamber volume averaging correction was calculated via convolution of TPS calculated dose profiles with chamber geometry and varied from 0.999 for 10mm fields to 0.953 for 4mm fields.
- SRS Mapcheck long term stability was assessed by remeasuring 6mm field multiple times during the 8 week period. Measured max dose variations were less than 1.1%.

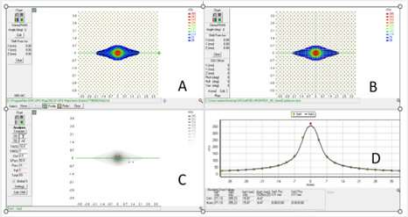


**Figure 3.** Comparison of SRS Mapcheck central axis reading vs Eclipse treatment planning dose calculation. The solid black line represents interpolated Eclipse dose prediction (exported with 1mm dose grid resolution). The yellow and red circles represent Mapcheck dose readings, available at 3.5mm resolution in x- and y- axis direction. Diagonal profiles are also available at a higher special resolution of 2.5 mm. Gamma analysis was performed to compare the measured and Eclipse calculated profiles with 1% difference / 0.5mm distance parameters and show a passing rate of 92.8%. For this plan created to irradiate a 6mm diameter target, excellent agreement between data is noted in the shoulder area of the dose profiles.

| Field Size, mm | Eclipse AAA | Exradin A16 | Exradin with Volume Correction | SRS Mapcheck | Error, % |
|---|---|---|---|---|---|
| 4 | 100 | 100.9 | 105.9 | 110.5 | 4.4% |
| 5 | 100 | 102.3 | 105.8 | 108.1 | 2.2% |
| 6 | 100 | 101 | 104.2 | 104.5 | 0.3% |
| 10 | 100 | 101.7 | 101.8 | 100.4 | -1.4% |

**Table 1.** Comparison of SRS Mapcheck central axis reading (maximum dose) vs Eclipse treatment planning calculation and Exradin A16 pinpoint chamber measurements. Because of the narrow beam dose distribution, the measures chamber dose suffer from volume averaging effect. Volume correction factor is computed by convolution of beam profile with chamber geometry. Exradin A16 corrected reading matches SRS Mapcheck CAX data within 4.4%.

## DISCUSSION

Several small field effects need to be addressed when cross comparing dose measuring devices for small fields. We reviewed Eclipse calculated dose distributions, small farmer chamber readings and data from SRS Mapcheck with and without small field corrections. Excellent agreement between data was noted for SRS plans for targets with diameter equal to 1cm or larger.

Excellent agreement (less than 3% error) was also observed when comparing small volume A16 Chamber measurements against Eclipse dose predictions (see Table 1). However when chamber partial volume effect was included in the calculation by convoluting the beam profile with the small chamber charge collecting volume, the ion chamber data exceeded Eclipse predictions progressively from 1.8% for 1cm field to 5.9% for 4mm field.

SRS Mapcheck measurements accurately reproduced beam shape for all irradiated fields. The measured central axis dose (maximum dose) exceeded Eclipse prediction for all irradiated plans. The trend was similar to ion chamber measurements, with error increasing for smaller fields, from 0.4% for 1cm field to 10.5% for 4mm field.

Both SRS Mapcheck and ion chamber overestimated the central axis dose compared to Eclipse. SRS Mapcheck software includes an option to reduce the readings by employing “small field” corrections. In this study, the “small field” correction ranged from 1% to 3.3% (larger for smaller fields) and effectively reduced the readings.

SRS Mapcheck central axis measurements were matching ion chamber data well for all small fields with the exception of 4mm field where discrepancy reached 4.4%.

## CONCLUSIONS

SRS Mapcheck can be utilized for small field validation (4mm+) with expected uncertainty of no more than 4.4%.