# Dosimetric evaluation of a 2D multidetector dedicated to stereotactic radiotherapy

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## Introduction

The SRS MapCHECK™ (SRSMC) manufactured by SunNuclear coupled with the phantom StereoPHAN is a new multi detector dedicated to the control of SRS/SBRT plans delivered in radiotherapy. It is composed of 1013 silicon diodes covering an active array size of 7.7 x 7.7cm² and inserted in PMMA.

We propose here to evaluate its dosimetric performances before focusing on clinical plan controls.

## Methods

| | | | | |
|---|---|---|---|---|
| **LINAC** | | Truebeam Novalix STx (Varian) | | |
| **MLC** | | 120 HD | | |
| **Energies** | | X6 | X6FFF* | X10FFF* |
| **Default settings** | **Pulse rates** | 600 | 1400 | 2400 |
| | **MU number** | 100 | | |
| | **Source detector distance** | 100 cm | | |
| | **Field size** | 5x5 cm² | | |

* Free Flattening Filter

**SRSMC out of StereoPHAN:**

- ✓ **Calibration accuracy**: comparaison of measurements (field size 8x8cm²) with the SRSMC oriented at 0° (usual position) and at 180°. For each orientation, 10 measurements were made and averaged. The two dose matrices obtained were subtracted after being properly rotated.
- ✓ **Repeatability** of the central diode: evaluated by calculating the Relative Standard Deviation (RSD) of 20 consecutive readings.
- ✓ **Linearity response**: determinated by measuring SRSMC response for beams with a number of monitor units (MU) ranging from 5 to 10 000.
- ✓ **Dose per pulse**: evaluated by varying source-detector-distance from 70 cm to 130 cm and comparing the results with an ionisation chamber (0.3cc PTW).
- ✓ **Pulse rate dependence**: evaluated by measuring the response for different repetition rates ranging from 10 to 600 MU/min for X6, 80 to 1400 MU/min for X6FFF and 80 to 2400 MU/min for X10FFF.

**SRSMC inserted in StereoPHAN:**

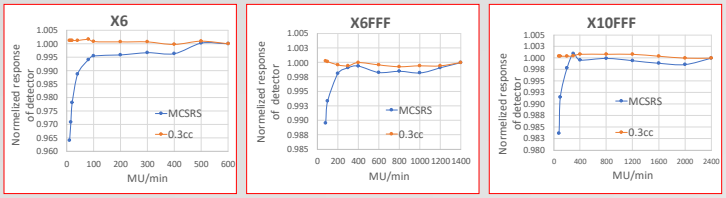
- ✓ **Angular response**: evaluated with the SRSMC inserted in the StereoPHAN and for several incidences angle beam 360° around the phantom.
- ✓ **Field size dependance**: evaluated for field of 1 to 7 cm² and compared with 5 averaged GafChromic films XD (Aschland) measurements.
- ✓ **Patient plans control**: The dose distributions (only X6 and X6FFF) of 284 RapidArc (coplanar and not coplanar) and IMRT stereotactic treatment plans calculated with the TPS Eclipse (Varian) were measured and compared using the Gamma-Index method. The rate of plans with a score greater than 95% for different γ-index criteria were calculated.

All measurements are collected with the dedicated software SNC Patient (Sun Nuclear).

## Results

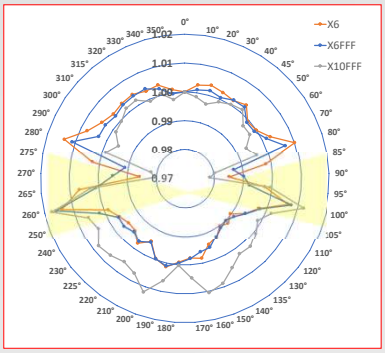
| | | X6 | X6FFF | X10FFF |
|---|---|---|---|---|
| ✓ **Calibration accuracy** | Maximum diode difference | 0.7% | 1.2% | 1.3% |
| | Maximum difference for 99% of the diodes | 0.41% | 0.76% | 0.9% |
| ✓ **Repeatability** | Relative Standard Deviation | 0.05% | 0.05% | 0.05% |
| ✓ **Linearity** | Relative Standard Deviation | 0.33% | 0.23% | 0.24% |
| ✓ **Dose per pulse** | Maximum difference between SRSMC and 0.3cc | 0.8% | 0.3% | 0.6% |

✓ **Pulse rate dependence**



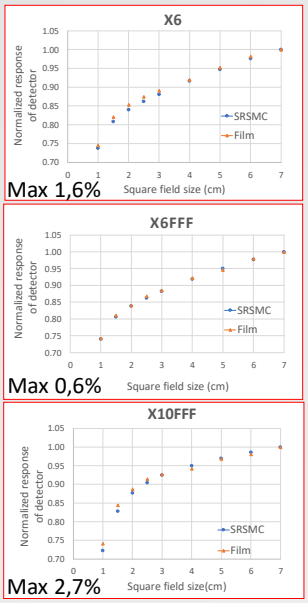

Maximum difference 0.6% (X6), 1% (X6FFF) and 1.6% (X10FFF) for a dose rate of 80MU/min. For X6, with a very low dose rate of 10MU/min the difference reaches 3.6%.

✓ **Angular dependence**

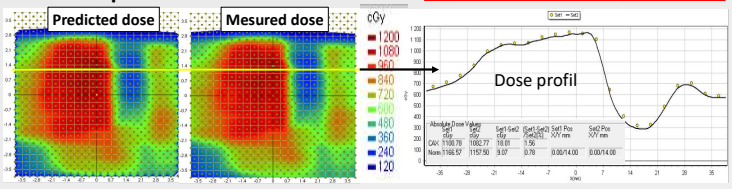



Less than 1% excepted for angles 85° to 100° and 260° to 280° with a maximum deviation of 2.3%. For these angulations the beam passes through the entire plane of the diodes. This may be a problem for some IMRT beams.

✓ **Field size dependence**




✓ **Patient plans control**




| γ-index Criteria (Threshold = 10%) | Rate of plans with a gamma index score > 95% |
|---|---|
| 3%/2mm | 98.2% |
| 3%/1mm | 90.5% |
| 2.5%/2mm | 92.6% |
| 2%/2mm | 78.5% |

## Conclusion

The SRS MapCHECK coupled with the StereoPHAN is an interesting 2D detector solution, user-friendly and less time consumming comparing to gafchromic films, for the control of RapidArc and IMRT stereotactic radiotherapy treatment plans. However, it has some limitations:

- for field sizes less than 1.5 x1,5 cm² (especially for X10FFF)
- for very low dose rate (less than 20 MU/min)
- for beam angles around 90° and 270° due to the beam passing through the diodes plan

For classical gamma index criteria (3%/2mm) 98,2% of treatment plans are validated. For more accurate criteria (3%/1mm or 2,5%/2mm) more than 90% of the treatment plans pass the control successfully.

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