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Implementation of a high resolution diode array for end-to-end dosimetry in gamma knife radiosurgery

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1. Background-Aim

Gamma knife stereotactic radiosurgery delivers very conformal and high gradient dose to lesions in the brain while end-to-end dosimetry verification methods are generally missing for such applications.

In this work the suitability of a high resolution diode array for end-to-end verification in gamma knife radiosurgery applications was investigated

2. Materials & Methods

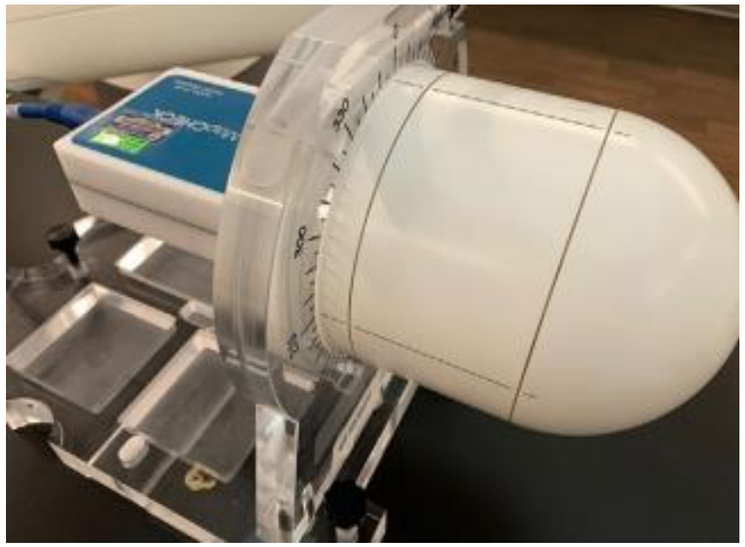

Figure 1. The SRS MapCHECK diode array positioned within the StereoPHAN phantom

A commercially available dosimetry system for SRS/SRT application (Sun Nuclear, USA) involving SRS MapCHECK diode array and the StereoPHAN phantom was employed.

The detector array consisted of 1013 diodes allowing a dose measurement resolution of 2.5 mm.

2. Materials & Methods

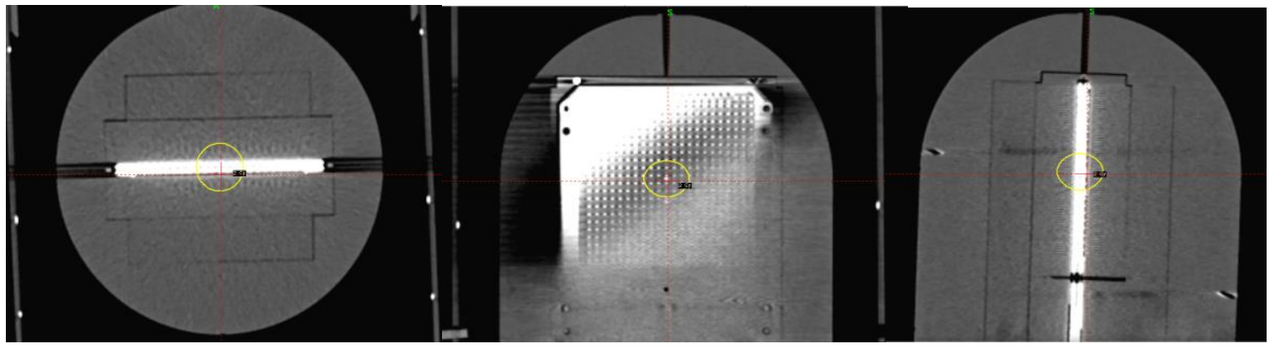

Figure 2. Axial, coronal and sagittal CT images of the 16 mm shot plan

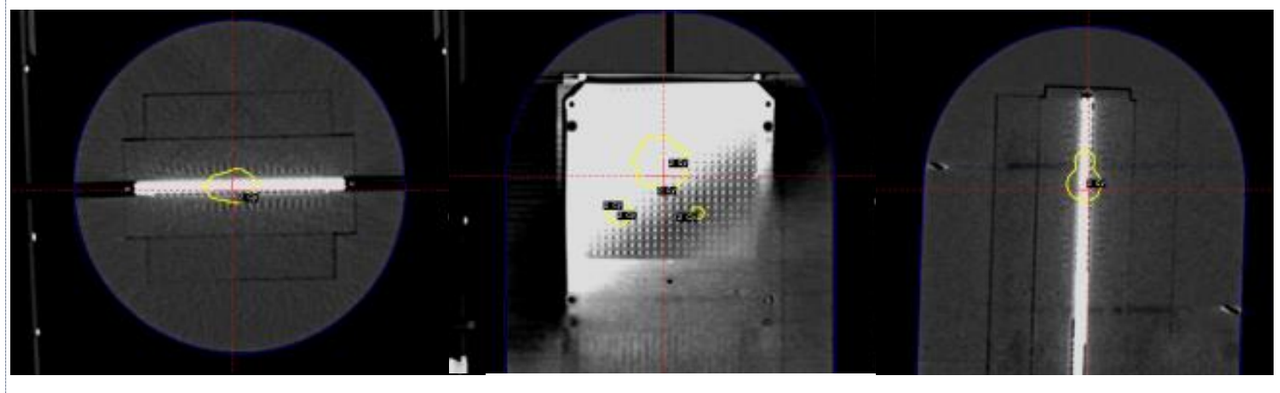

Figure 3. Axial, coronal and sagittal CT images of the multiple shots plan with three spherically-shaped targets

The StereoPHAN phantom with the SRS MapCHECK positioned in the coronal plane was utilized to accurately reproduce every link of four frame-based gamma knife applications, involving

a) three single shot plans using the different available collimators (4mm, 8mm and 16mm) of a Perfexion uni and

b) one multiple shots plan with three spherically-shaped targets and

all located in the diode array plane.

2. Materials & Methods

Array calibration was performed using a 6MV linear accelerator while dose calibration was performed using the 16mm gamma knife collimator.

Prescription dose was 18 Gy in 1 fraction for all the targets and plans.

Calculations were performed using GammaPlan treatment planning system with a dose calculation grid of $1mm^3$.

Measured and calculated doses were compared using the absolute dose global 3D Gamma Index (GI) test with 5%/1mm passing criteria based on the national authorities' requirements for stereotactic radiosurgery applications.

3. Results

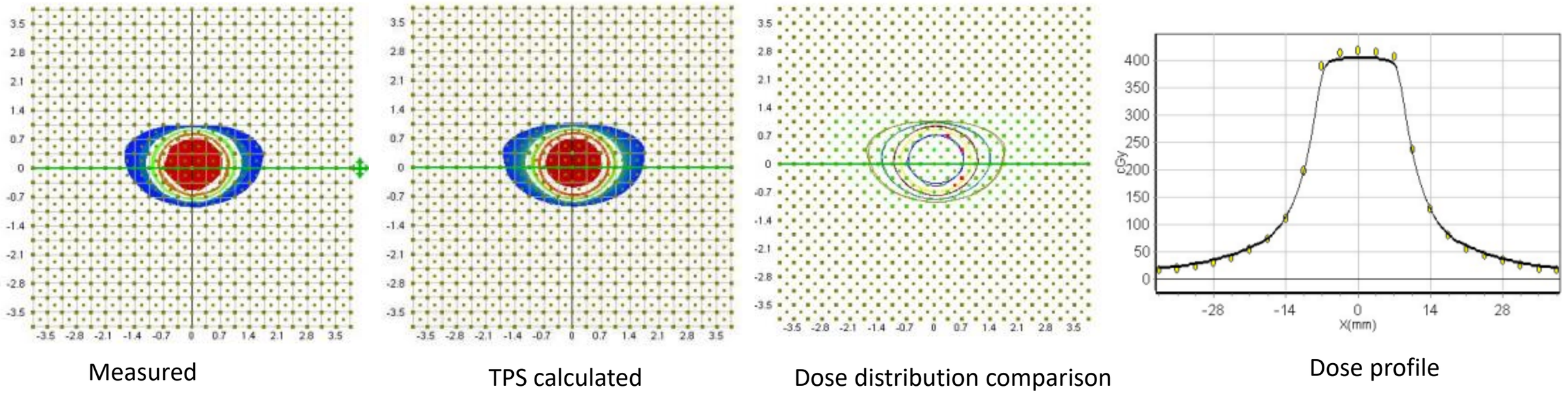

Figure 4. Dose distribution comparison for the 16 mm shot plan

Gamma index passing rates were found to be 97%, ,10%, 96% and 99 % for the multiple shots, 4mm , 8 mm and 16 mm single shot plans, respectively.

3. Results

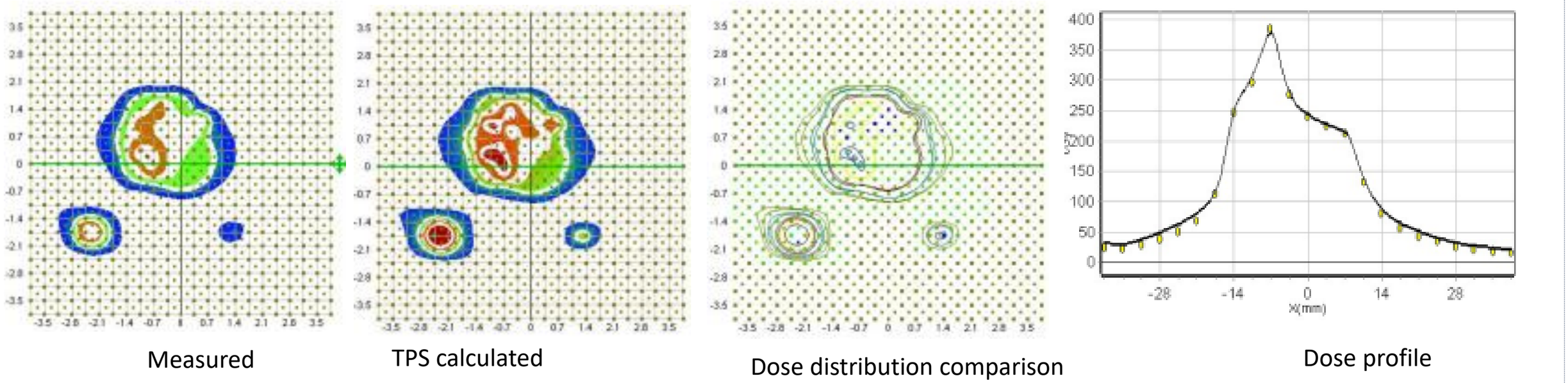

Figure 5. Dose distribution comparison for the multiple shots plan with three spherically-shaped targets

Gamma index passing rates were found to be 97%, ,10%, 96% and 99 % for the multiple shots, 4mm , 8 mm and 16 mm single shot plans, respectively.

4. Conclusions

In this study, the use of a high-resolution diode was investigated for end-to-end dosimetry verification in gamma knife radiosurgery applications and was found feasible.

Gamma index passing rates were found >95% for all available collimators (4mm, 8mm and 16 mm) using 5%/1mm passing criteria based on the national authorities' requirements for stereotactic radiosurgery applications.