

Dosimetric Evaluation of MiniGrid and Minibeam Collimators in Spatial Fractionated Radiotherapy Techniques

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Co. Supervisor: **Prof. Olivier Seksek**

Presentation overview

- Context: radiotherapy (RT) and spatial fractionation Radiotherapy (SFRT)
- Thesis goals
- Methods & results
- conclusions
- Future perspectives

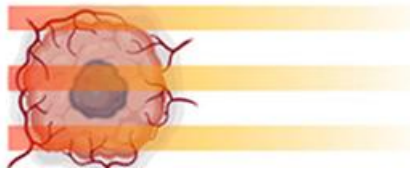
Spatially Fractionated RadioTherapy (SFRT): Techniques

Conventional-RT



Uniform field

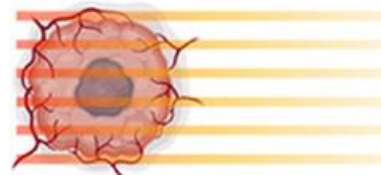
GRID-RT



cm wide beams

beam width (bw) = 1 — 2 cm
ctc = 2 — 4 cm

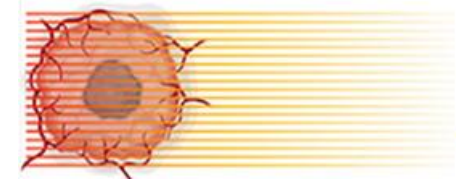
Minibeam-RT (MBRT)



≤100 μm wide beams

bw = 0.5 — 1 mm
ctc = 1 — 4 mm

Microbeam-RT (MRT)



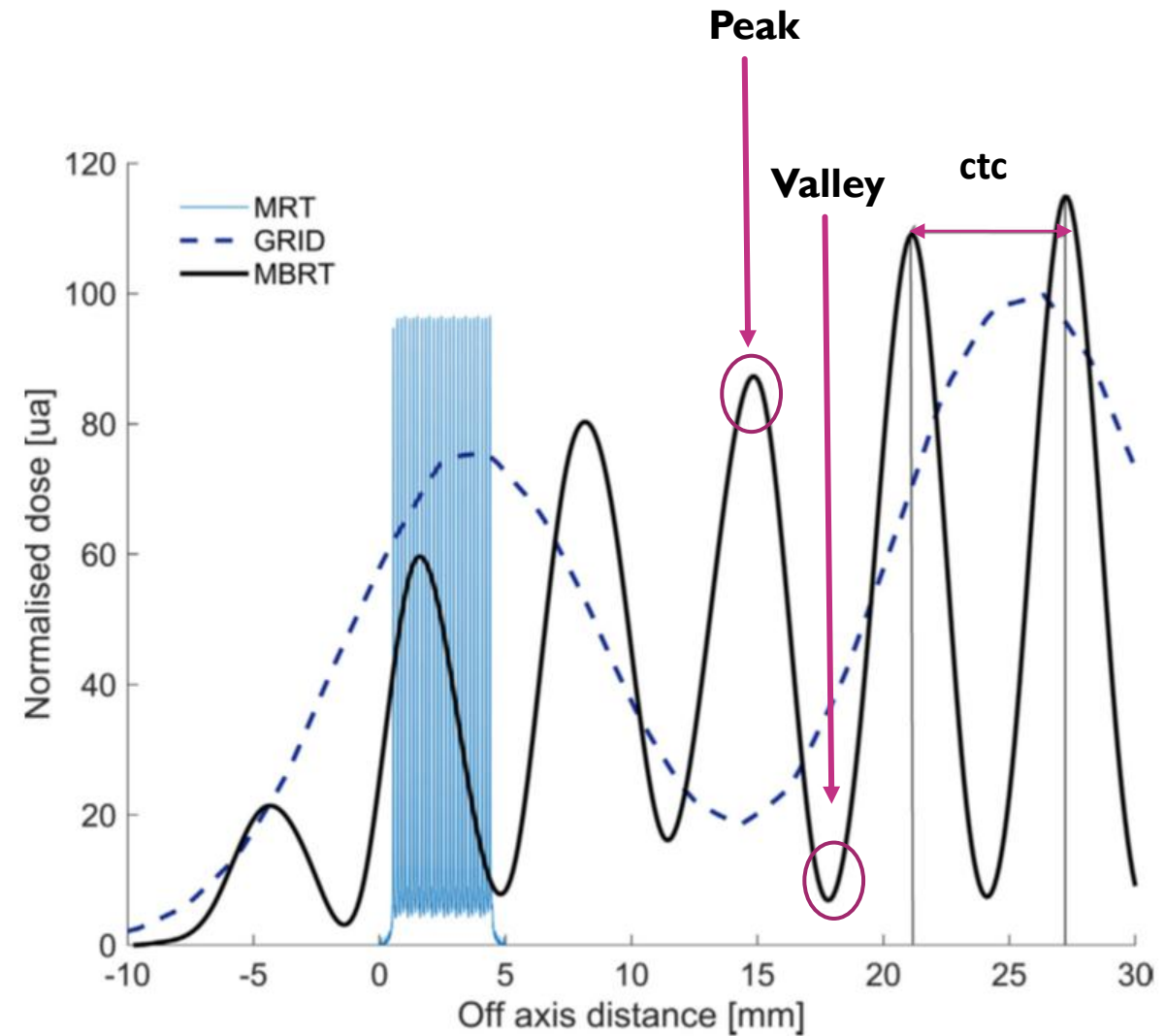
> 300 μm wide beams

bw = 50 — 100 μm
ctc = 200 — 400 μm


Spatially Fractionated RadioTherapy (SFRT)

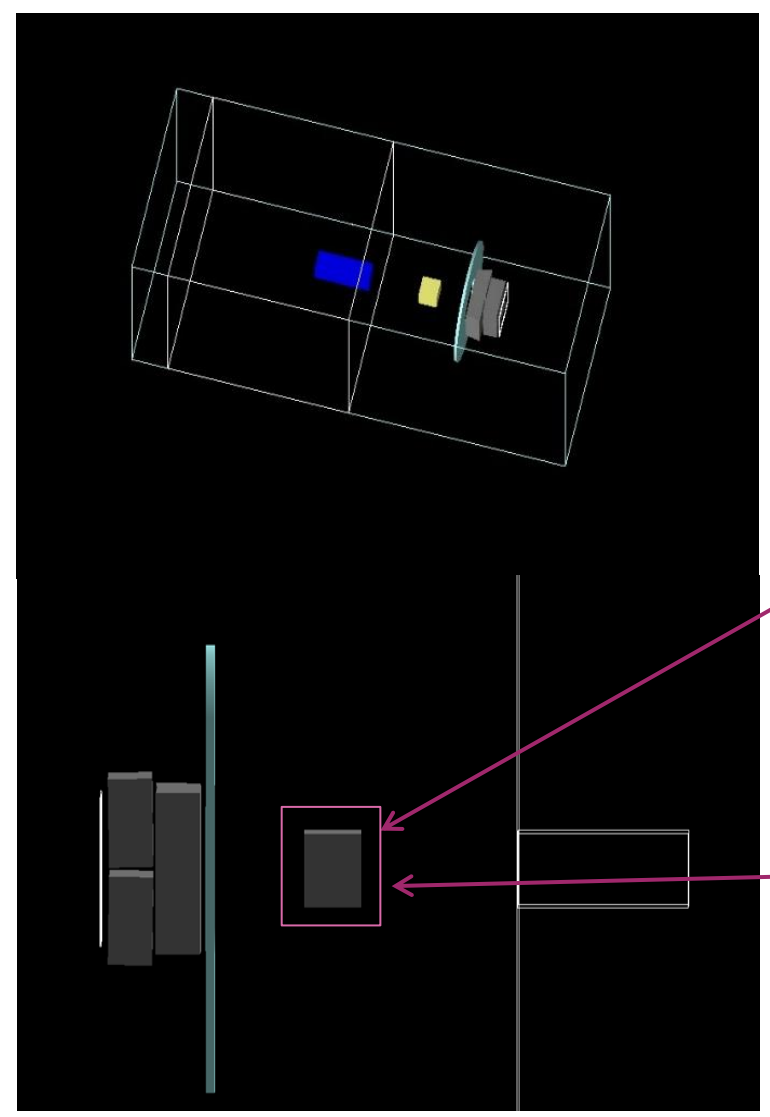
SFRT uses a strong spatial modulation of the dose to spare normal tissue and maintain tumor control.

$$PVDR = \frac{D_{Peak}}{D_{Valley}}$$



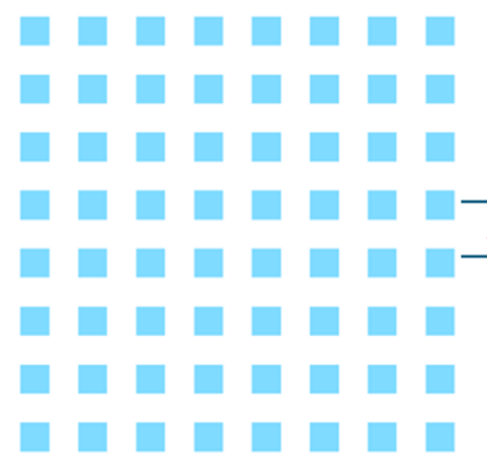
This thesis aims to advance **SFRT** by **optimising collimator** geometries, beam parameters, and dose modulation, while exploring the potential of **Minigrid** and **Minibeam** techniques for improving tumour control and normal tissue sparing in challenging oncological applications.

TOPAS visualization of LINAC 

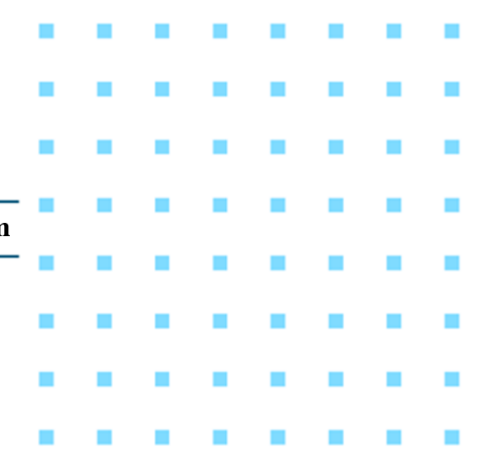


$$PVDR = \frac{D_{Peak}}{D_{Valley}}$$

a) MGRT-1.32

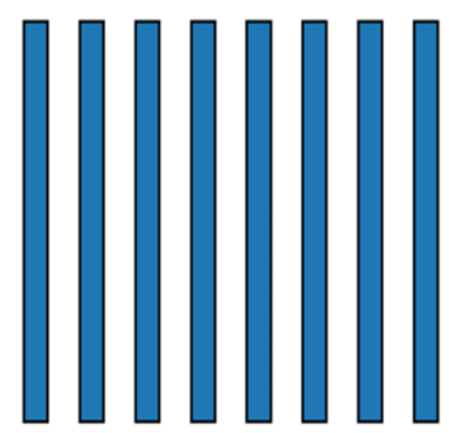


b) MGRT-0.66

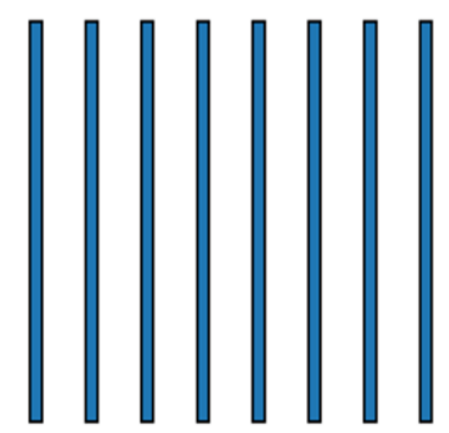


cte = 3.6 mm

a) MBRT-1000 μm



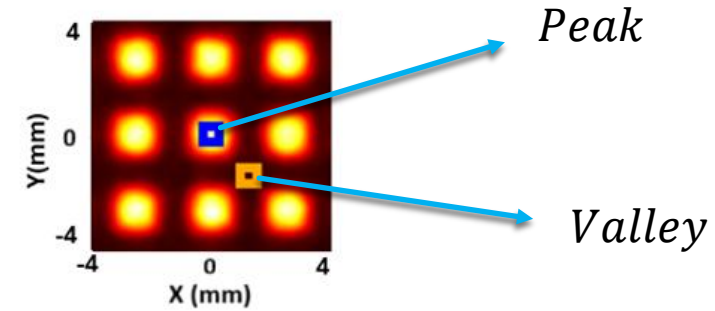
b) MBRT-500 μm



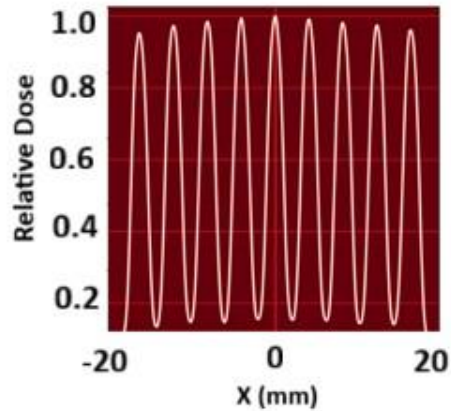
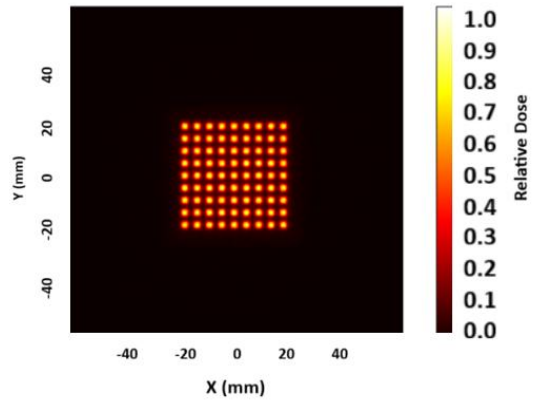
MGRT Collimator: This collimator type includes a grid structure with two beam widths:

- Beam width 1: 1.32 mm,
 - Beam width 2: 0.66 mm,
- etc 3.6 mm

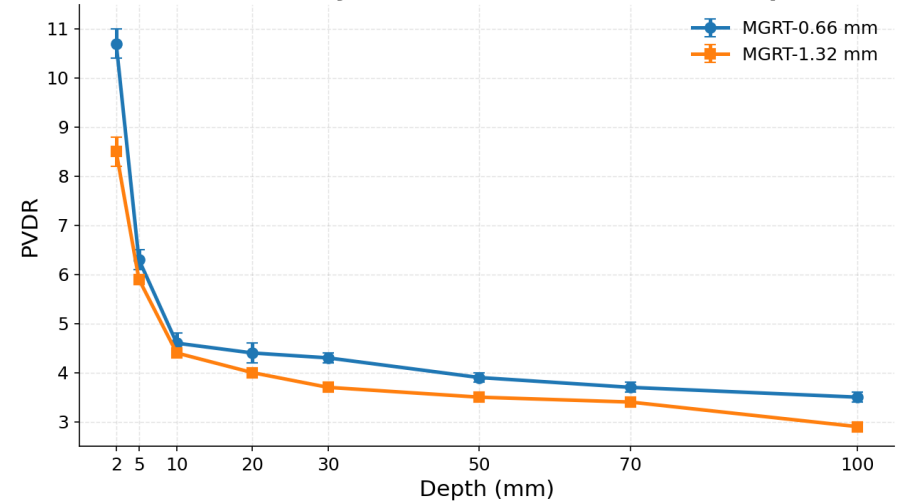
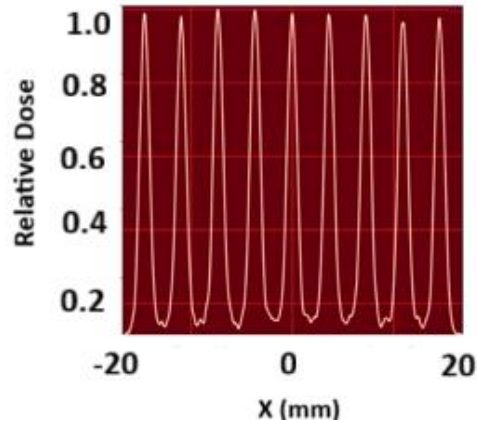
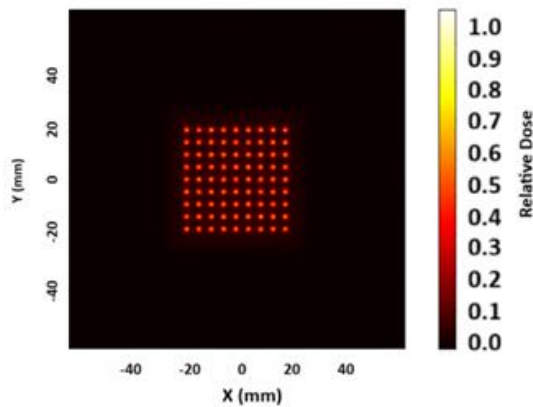
$$PVDR = \frac{D_{Peak}}{D_{Valley}}$$



MGRT 1.32 mm



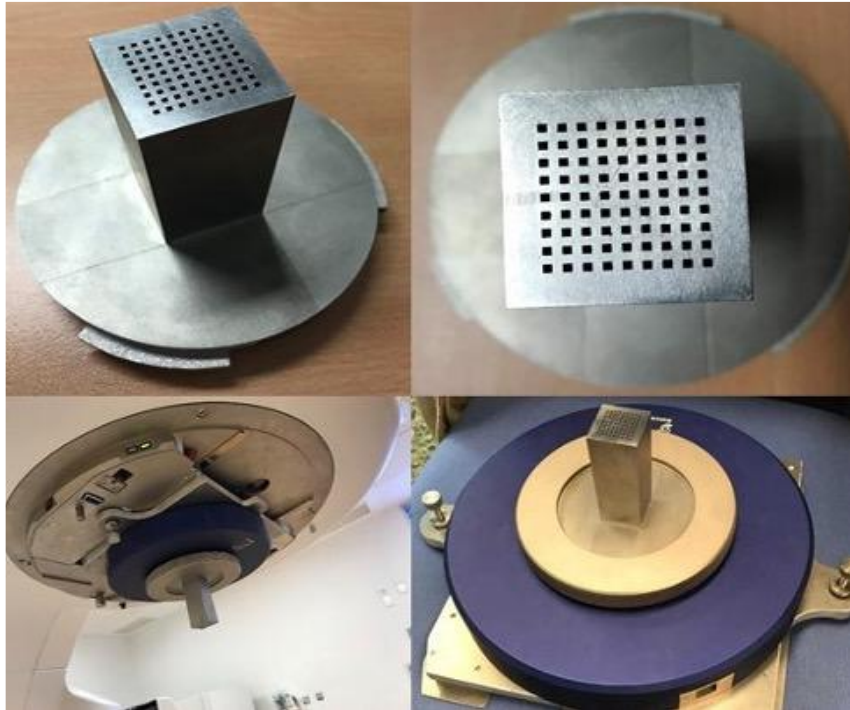
MGRT 0.66 mm



Smaller beam (≤ 1 mm at the isocenter) and higher PVDR (up to 9)

- Smaller beams (≤ 1.32 mm)
- Higher PVDR in normal tissues [Acuña et al., 2025]

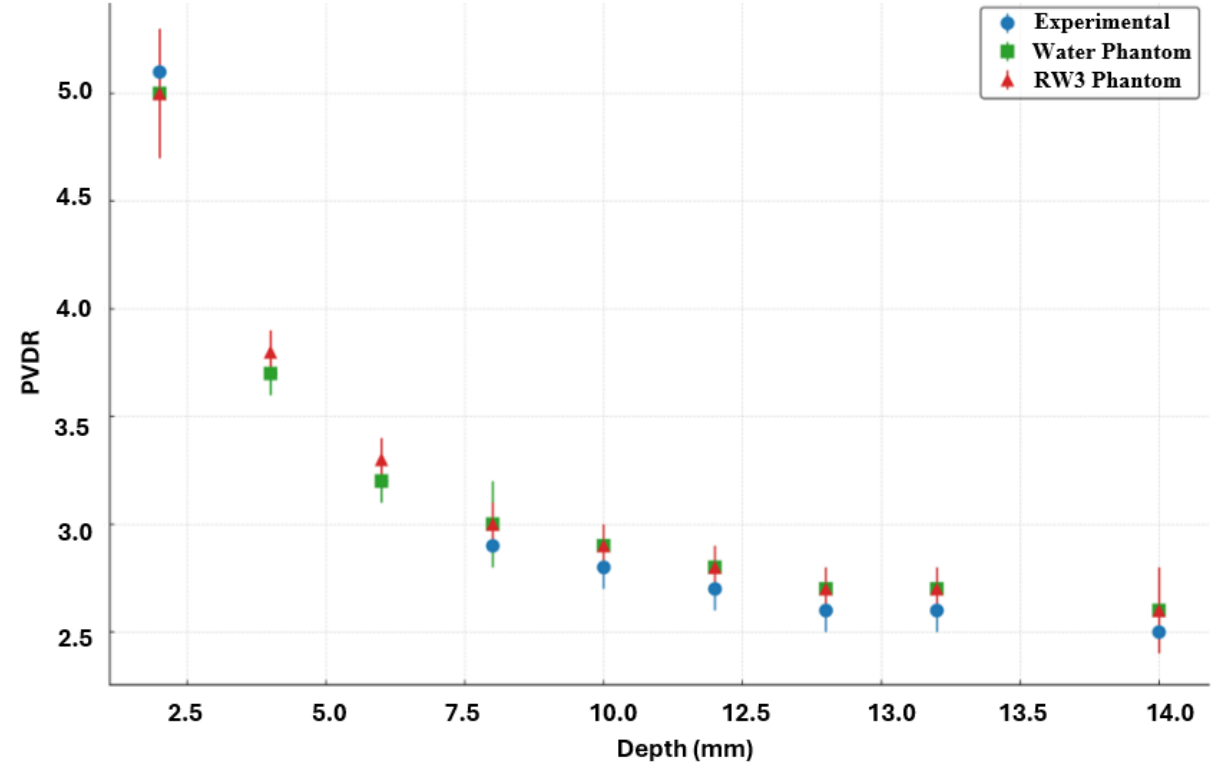
LINAC



FFF TrueBeam (6 MV X-rays)

10 cm thick steel collimator,
1.3 x 1.3 mm²

MC code validation



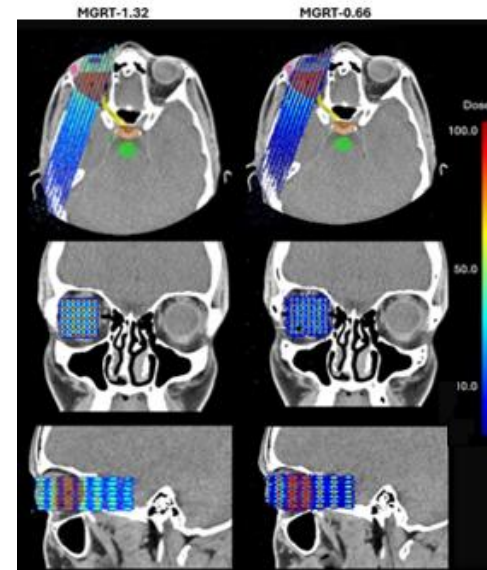
Treatment Planning System (TPS)



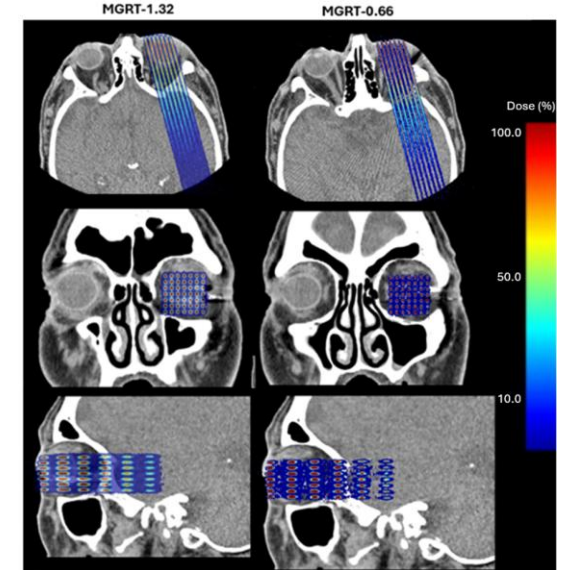
Treatment planning for Ocular Tumour



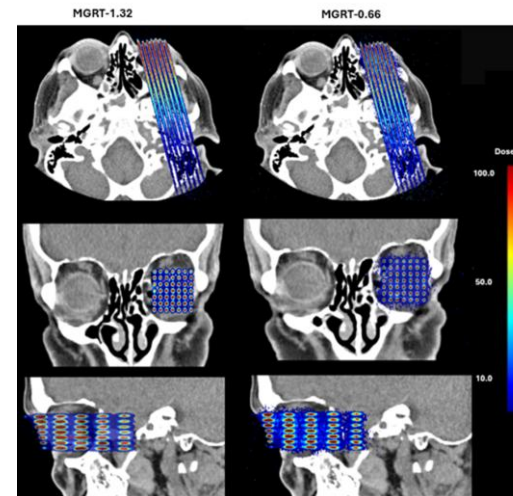
Contouring Methodology



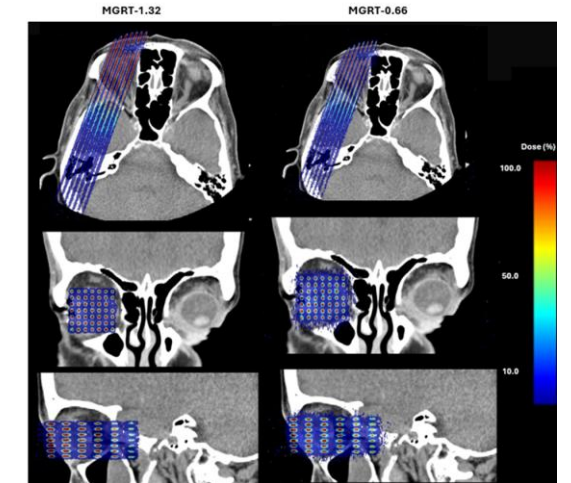
Case 1



Case 2

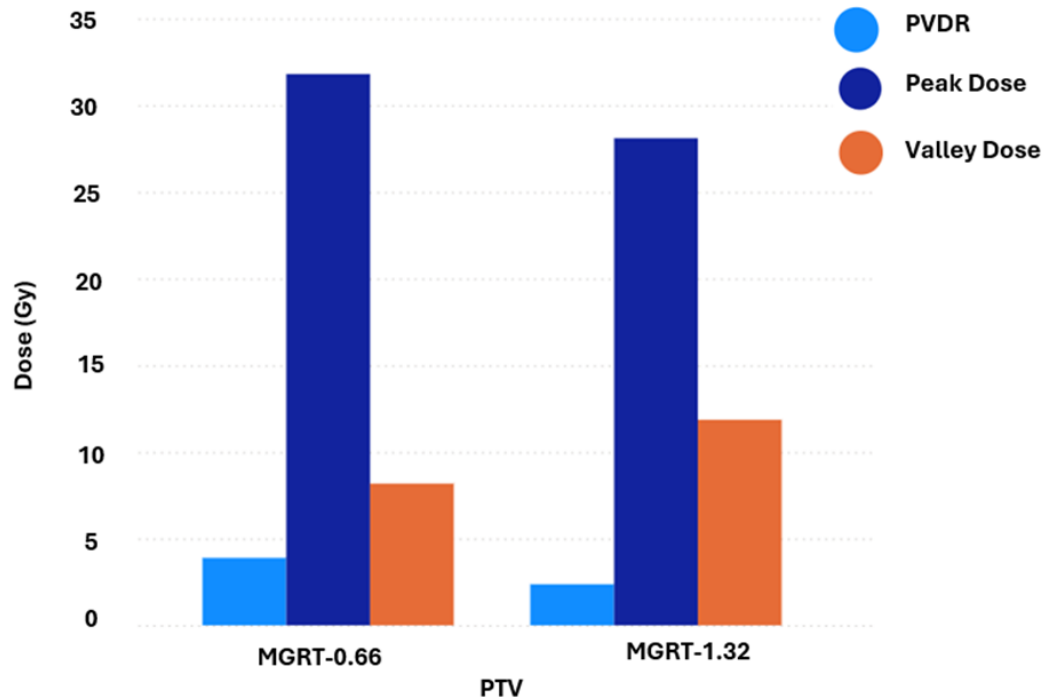


Case 3



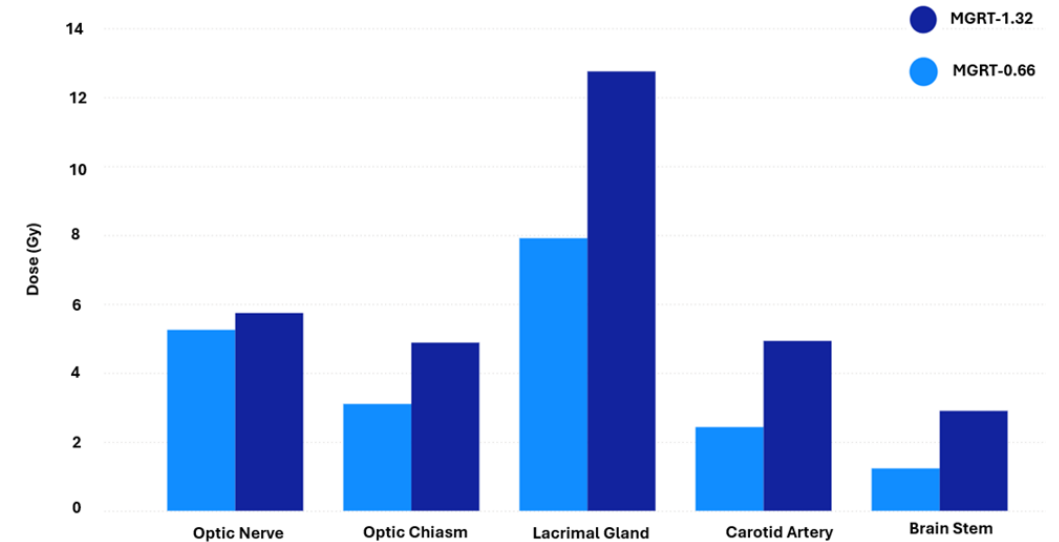
Case 4

Treatment planning for Ocular Tumour



PVDR for the PTV in both MGRT configurations (1.32 mm and 0.66 mm beam widths) under a prescribed dose of 20 Gy.

$$PVDR = \frac{D_{Peak}}{D_{Valley}}$$



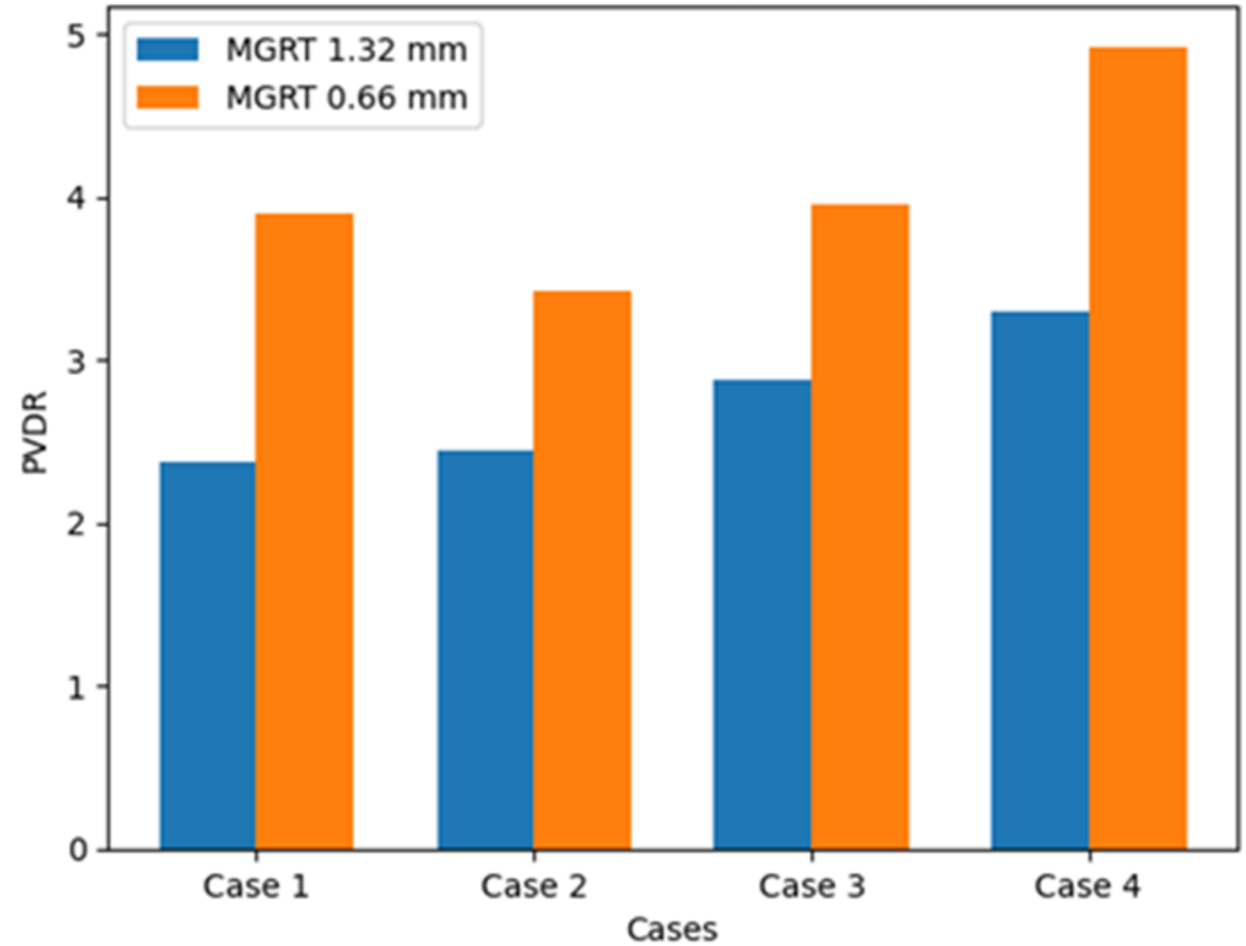
shows the mean dose delivered of the organs at risk for MGRT treatment plans with beam widths of 1.32 mm and 0.66 mm.

Treatment planning for Ocular Tumour

Peak-to-valley dose ratio (PVDR) within the PTV for MGRT plans

- Expected to better exploit dose–volume effects than GRID_1.32 therapy
- PVDR > 3 in all cases

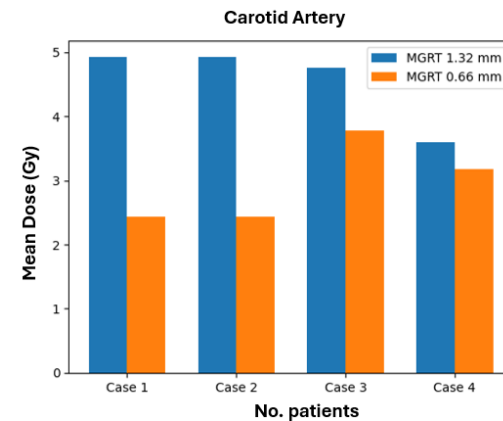
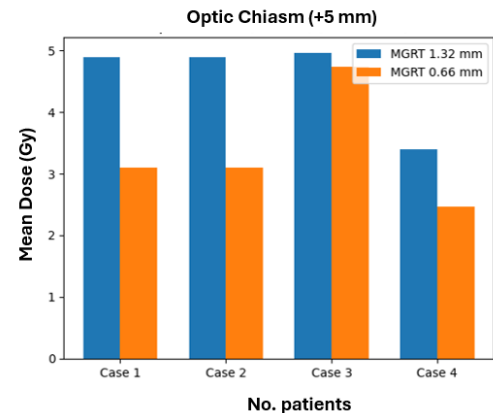
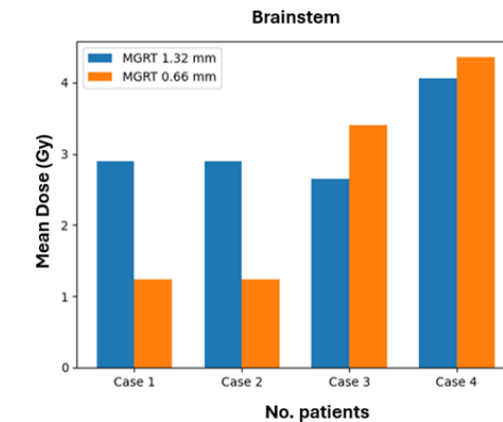
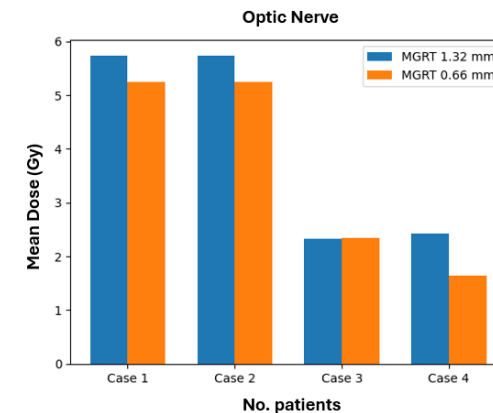
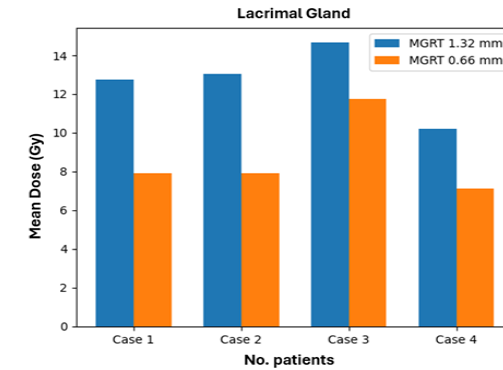
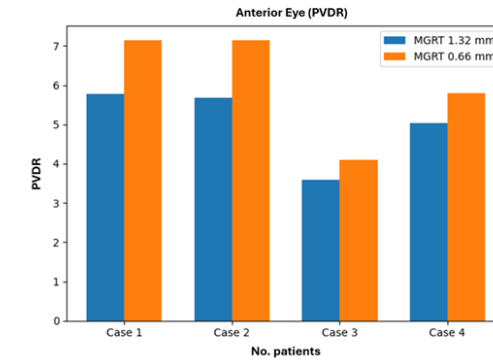
$$PVDR = \frac{D_{Peak}}{D_{Valley}}$$



- Smaller beams (≤ 1.32 mm)
- Higher normal tissue sparing [Acuña et al., 2025]

Treatment planning for Ocular Tumour

- Lower mean doses to several OARs, including the lacrimal gland and carotid artery, were observed with the 0.66 mm configuration.
- The optic nerve doses were comparable between both beam configurations in some cases.
- Variations in brainstem and optic chiasm doses demonstrate the influence of patient anatomy and beam arrangement on dose distribution.
- Narrower beam widths showed greater potential for normal tissue sparing while maintaining dose heterogeneity.



- SFRT demonstrates strong potential to improve the therapeutic ratio by combining effective tumour irradiation with enhanced normal tissue sparing.
- collimator geometry, beam width, and beam spacing strongly influence dose distribution and PVDR values.
- Accurate dosimetric modelling is essential for the optimisation and future clinical implementation of SFRT techniques.
- Further biological studies and experimental validation are required before routine clinical translation.

Optimization of dosimetry and QA protocols

Development of accurate and clinically relevant dose prescription strategies

Establishment of regulatory guidelines and dosimetric standardization for clinical implementation.

Improvement of treatment delivery precision and patient-specific verification methods.

Translation of SFRT from preclinical research to routine clinical practice

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THANK YOU FOR YOUR ATTENTION

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