

Dosimetric Analysis Report

Date of report: Month DD YYYY
Date of irradiation: Month DD YYYY
Phantom type: Prime
Phantom S/N: -
Gel insert Kit S/N: -
Film Insert Kit S/N: -
Film piece number: 1
Ion Chamber Insert Kit S/N: -
Point dosimeter type/model: -
Treatment Planning System: -
Number of target volumes (PTVs): 5
Institution: -

Table of Contents

3D Relative Dosimetry (Gel)

PART I: <i>Qualitative comparison</i>	3
PART II: <i>Profiles comparison</i>	5
PART III: <i>2D Gamma Index comparison</i>	12
PART IV: <i>3D Gamma Index comparison</i>	16
PART V: <i>DVH comparison</i>	18
PART VI: <i>DVH metrics comparison</i>	19
PART VII: <i>Geometry metric - Offset</i>	20
PART VIII: <i>Stereotactic radiosurgery plan quality metrics</i>	21

2D Absolute Dosimetry (Film)

PART I: <i>Profiles comparison</i>	22
PART II: <i>2D Gamma Index comparison</i>	24
PART III: <i>3D Gamma Index comparison</i>	28

Point Absolute Dosimetry (Ion Chamber)

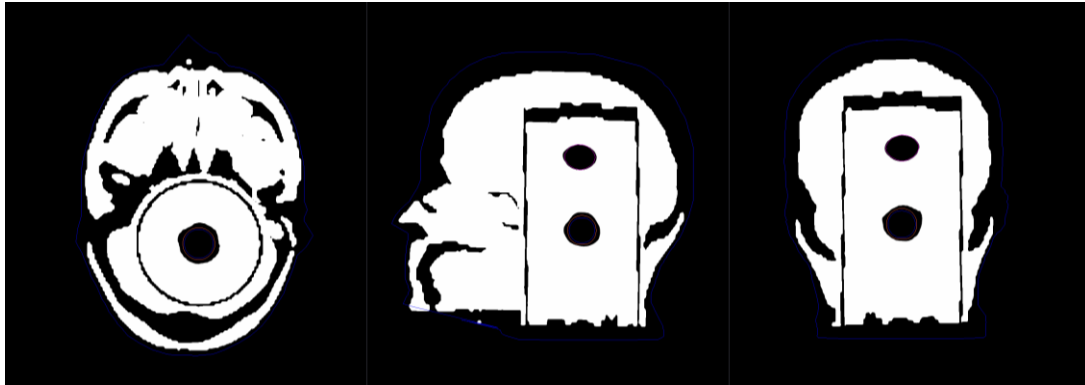
PART I: <i>Point dose comparison</i>	29
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3D Relative Dosimetry (Gel)

PART I: *Qualitative comparison*

Image registration between post-irradiation MRI and planning RTDose TPS data with structures of the Gel phantom. This is to demonstrate the coincidence of each treated target to its planned location.

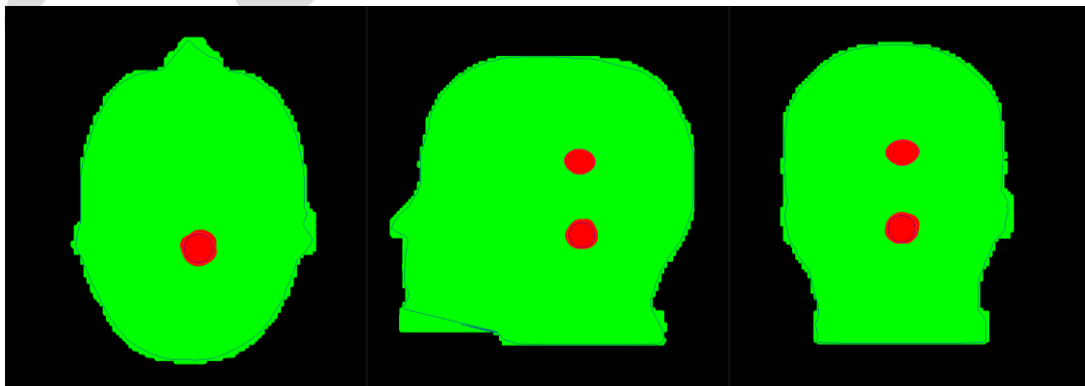
MRI (actually delivered dose) blended with TPS (calculated dose)



MRI 100% - RTDOSE TPS 0%



MRI 50% - RTDOSE TPS 50%



MRI 0% - RTDOSE TPS 100%

(Brightness and contrast adjusted so that only high dose areas are depicted)

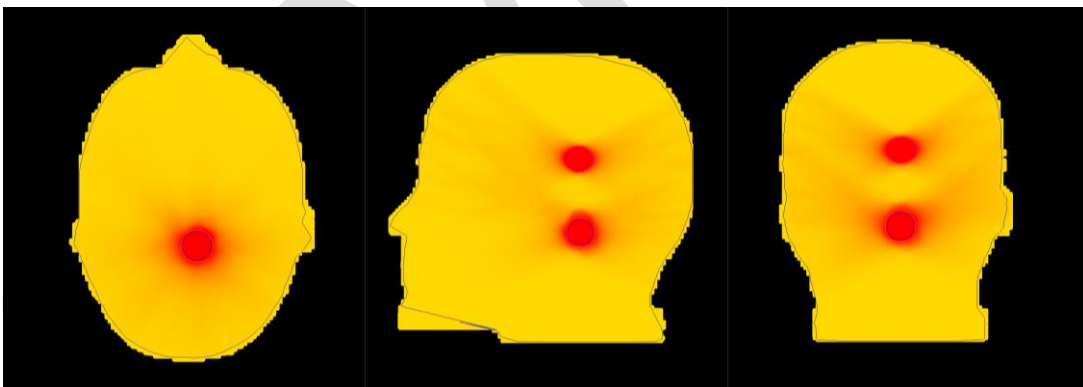
MRI (actually delivered dose) blended with TPS (calculated dose)



MRI 100% - RTDOSE TPS 0%



MRI 50% - RTDOSE TPS 50%



MRI 0% - RTDOSE TPS 100%

(Brightness and contrast adjusted so that also low dose areas are depicted)

PART II: Profiles comparison

Indicatively, a number of relative dose profiles for both the measured and TPS-calculated datasets are presented in the following figures. In order to quantitatively assess agreement between the two datasets, 1D gamma index calculations are also included. Passing criteria were 2 mm distance-to-agreement and 5% dose difference.

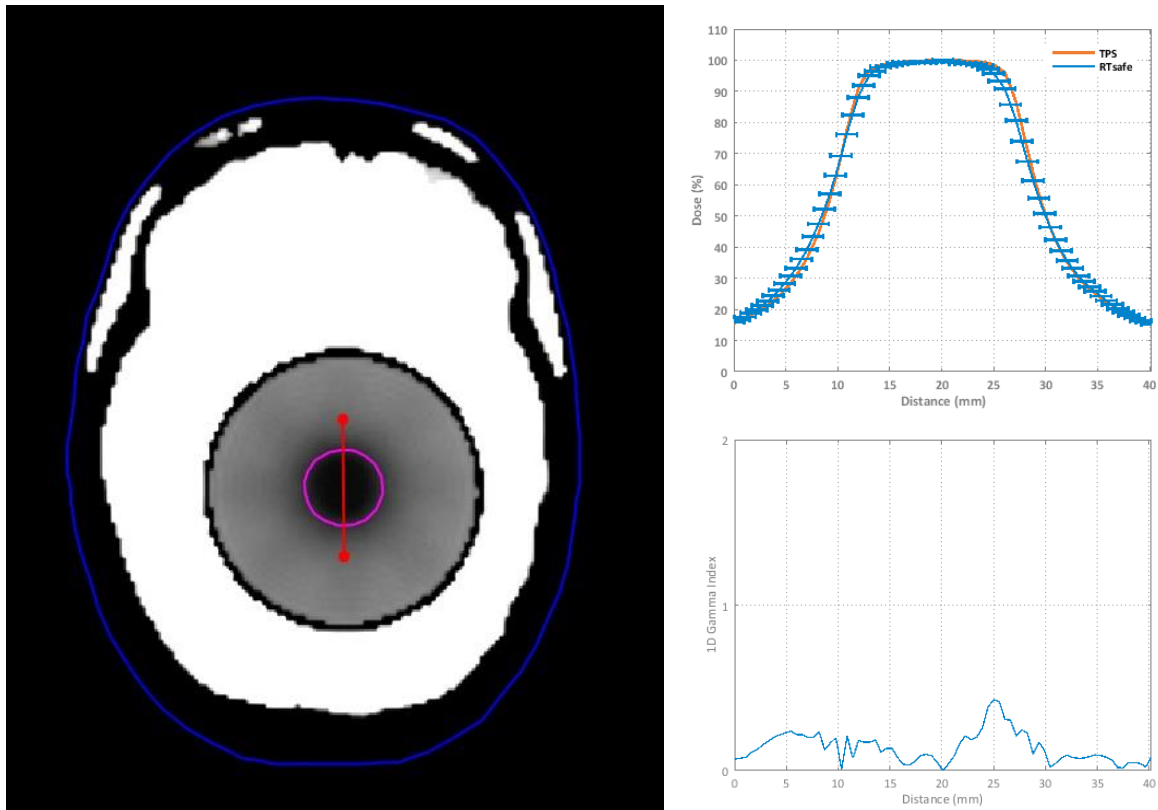
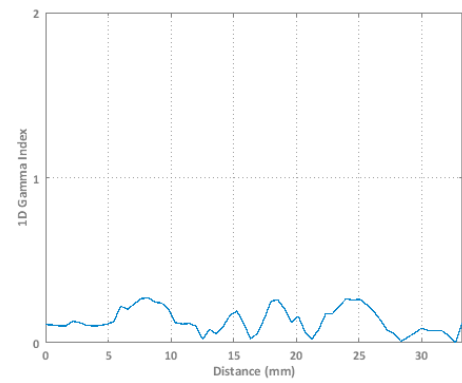
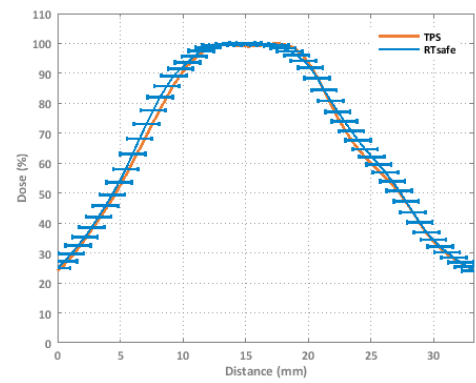
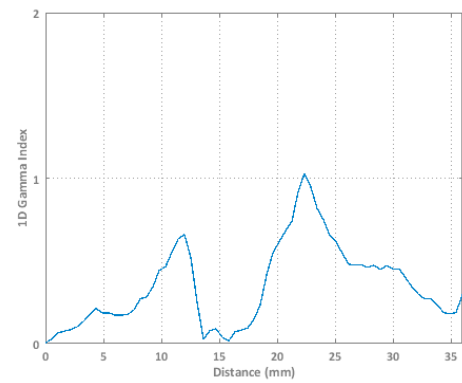
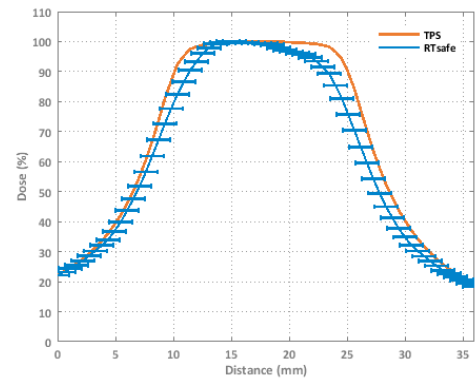
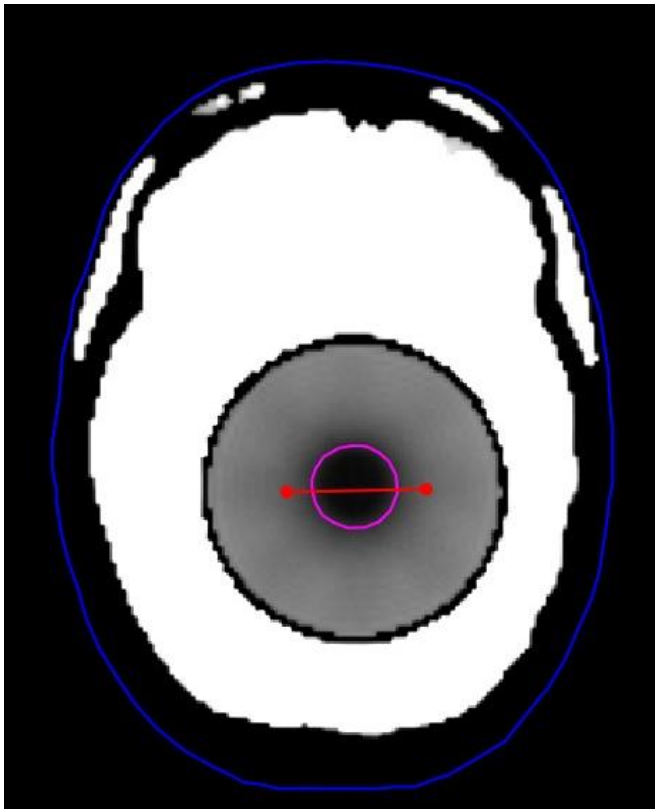
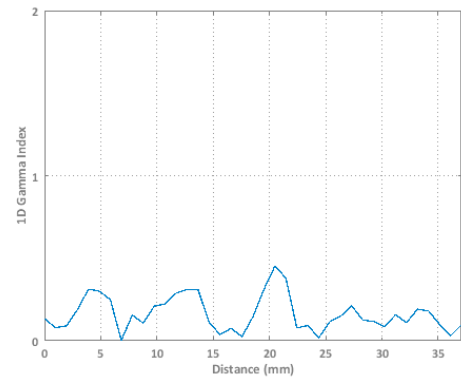
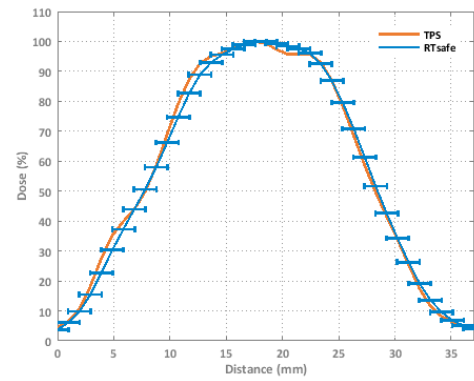
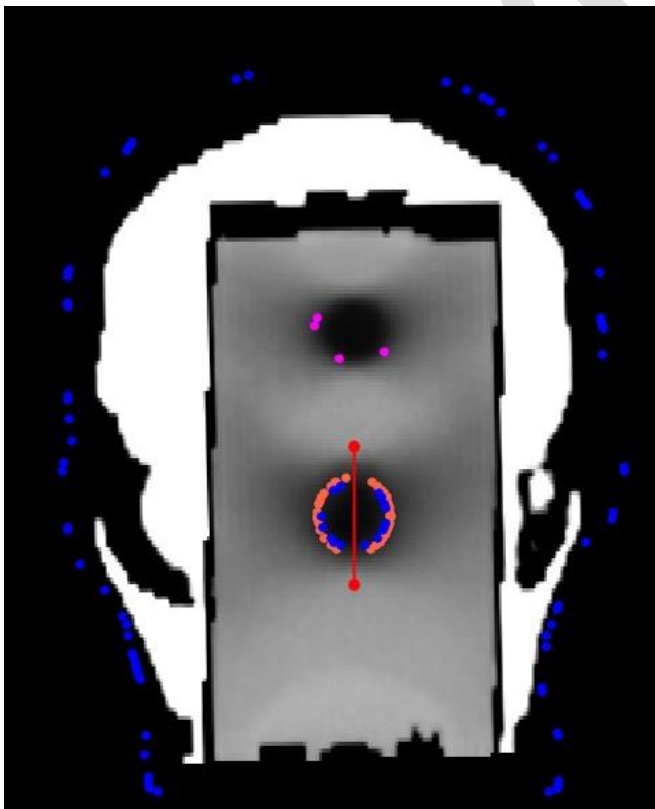
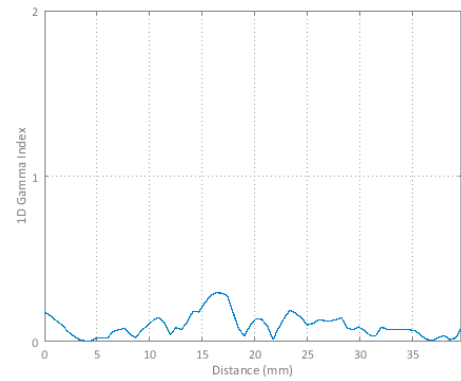
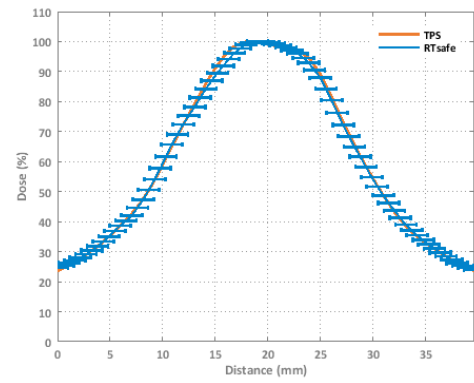
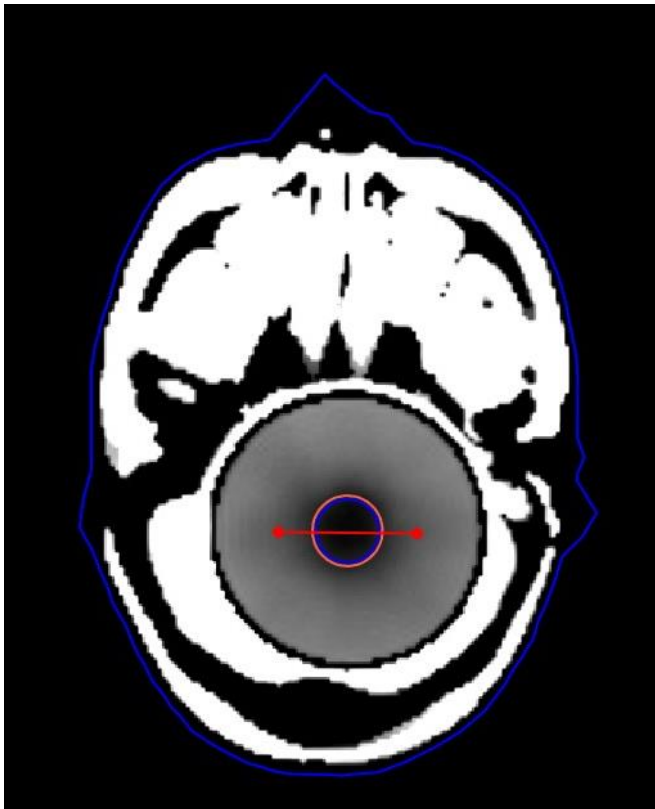
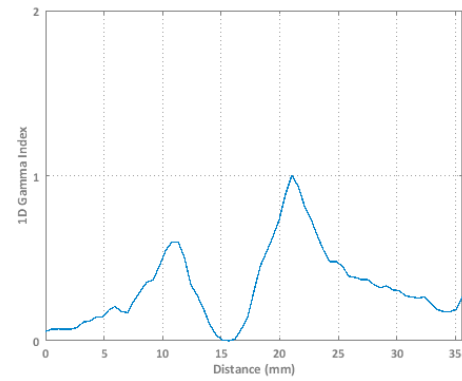
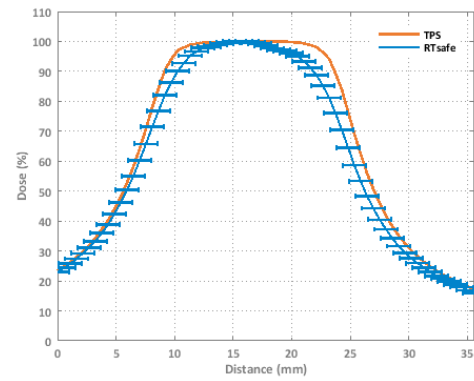
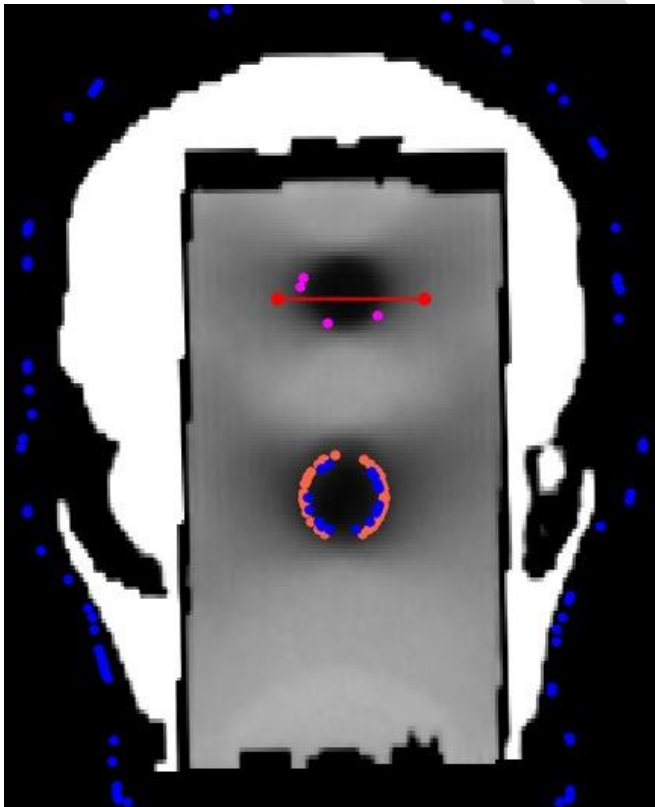
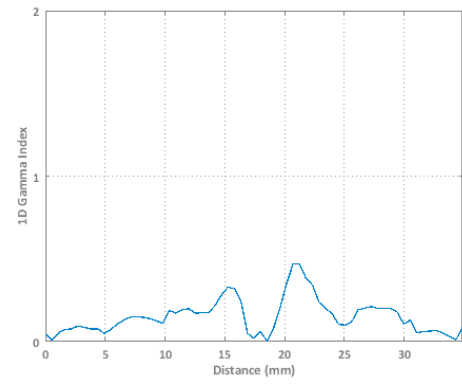
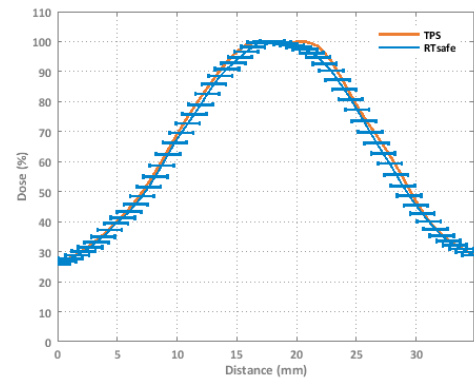
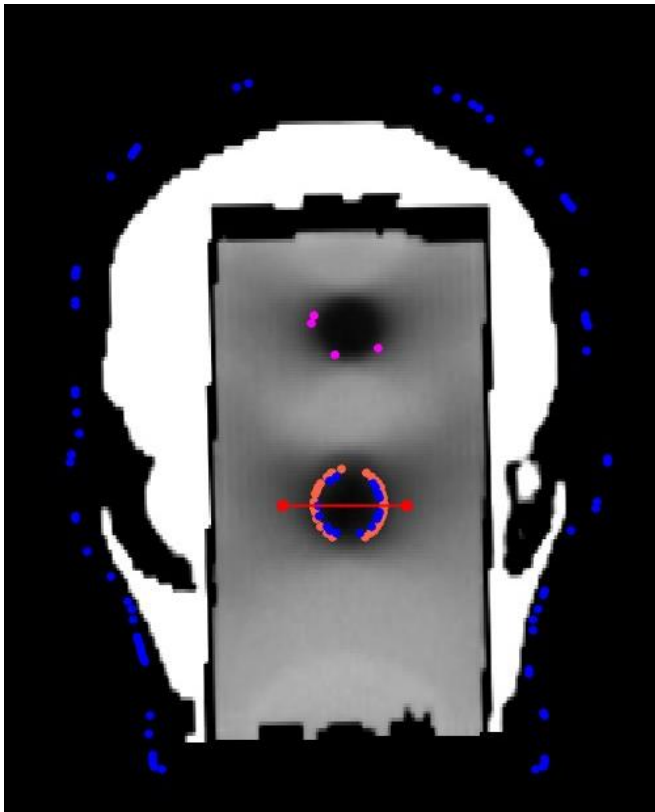


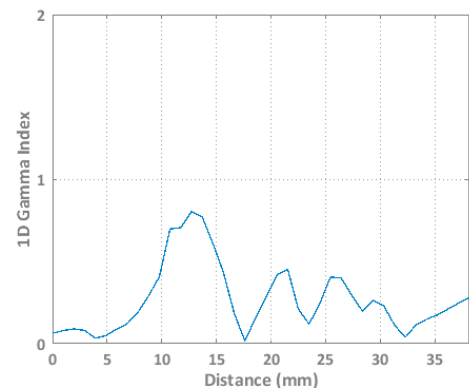
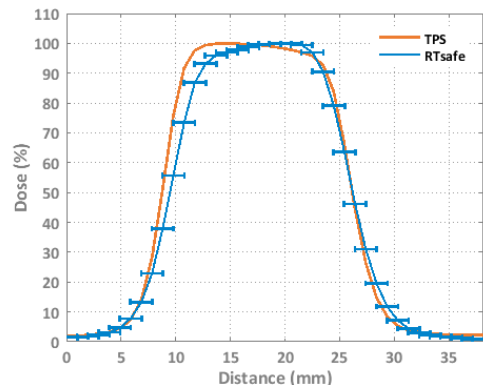
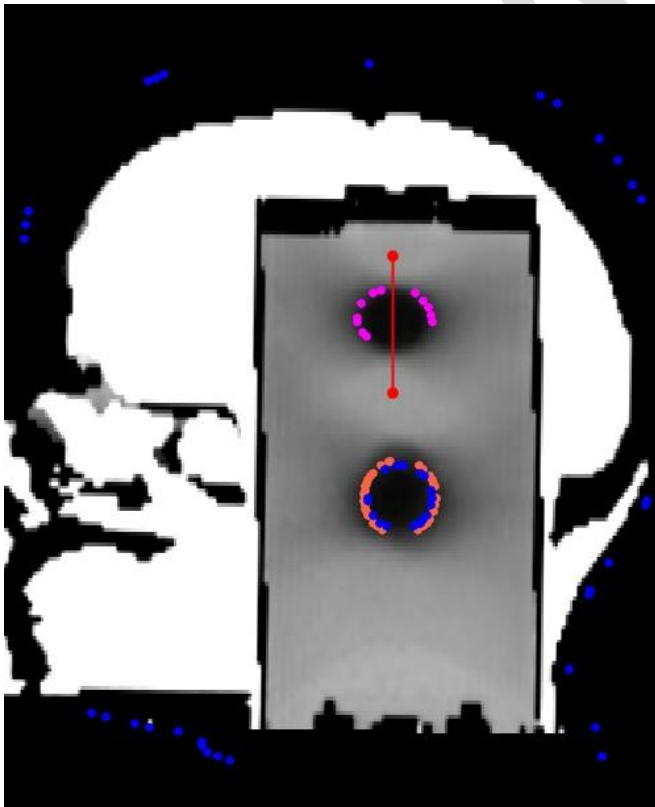
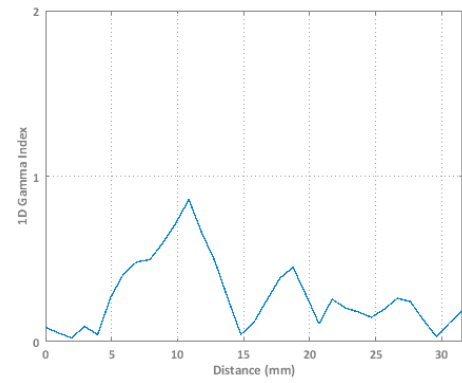
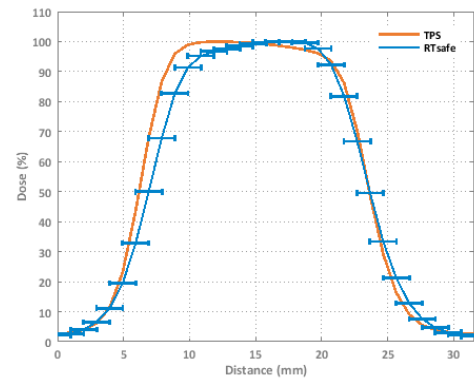
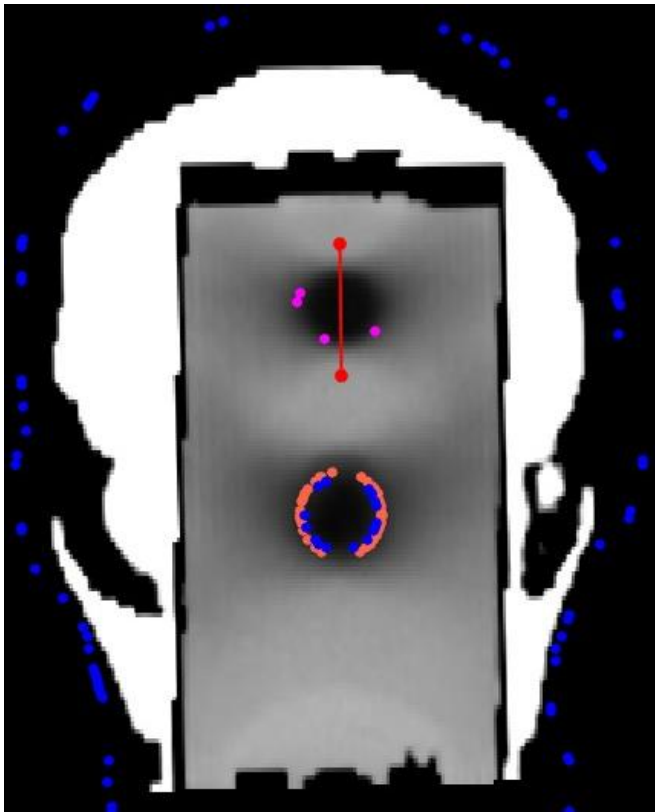
Figure: (left) Slice of the derived T2 maps of the irradiated phantom. High dose regions correspond to darker areas. (right) 1D profile comparison between calculated (TPS) and measured (RTsafe) dose distributions at the location depicted by the red line. Error bars correspond to ± 1 mm spatial uncertainty. 1D gamma index calculations are also given using passing criteria 5%/2mm.

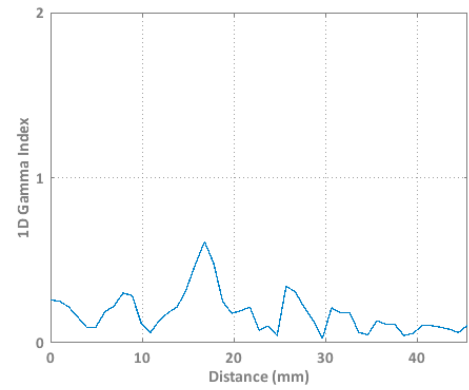
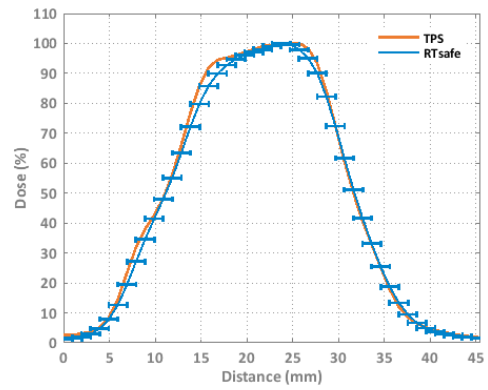
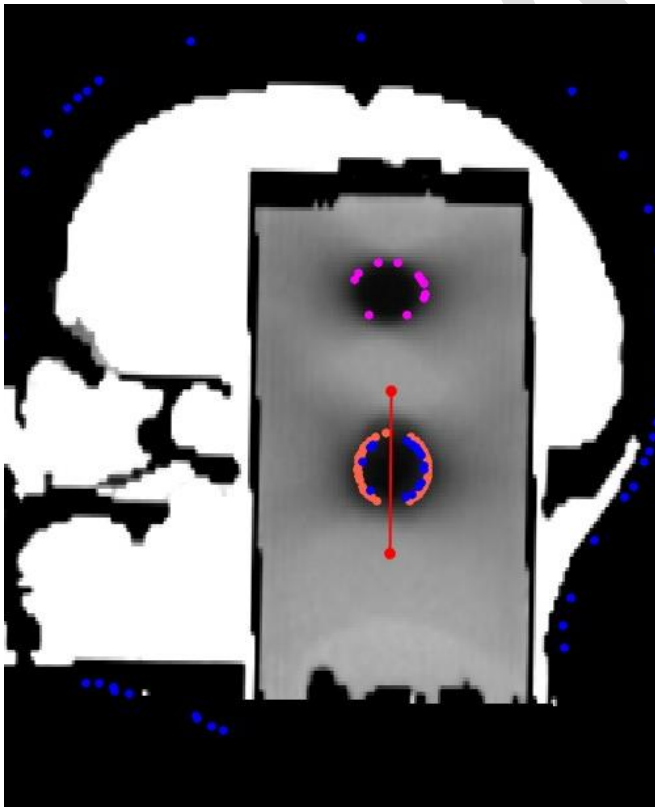
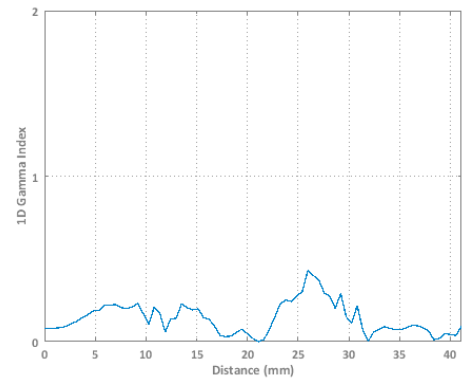
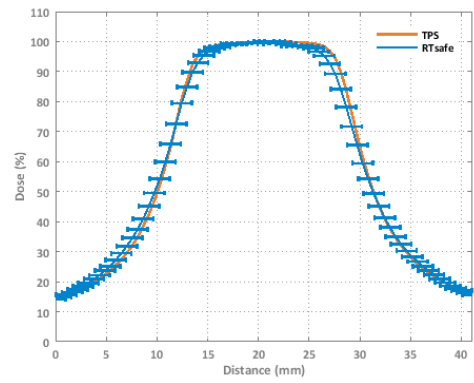
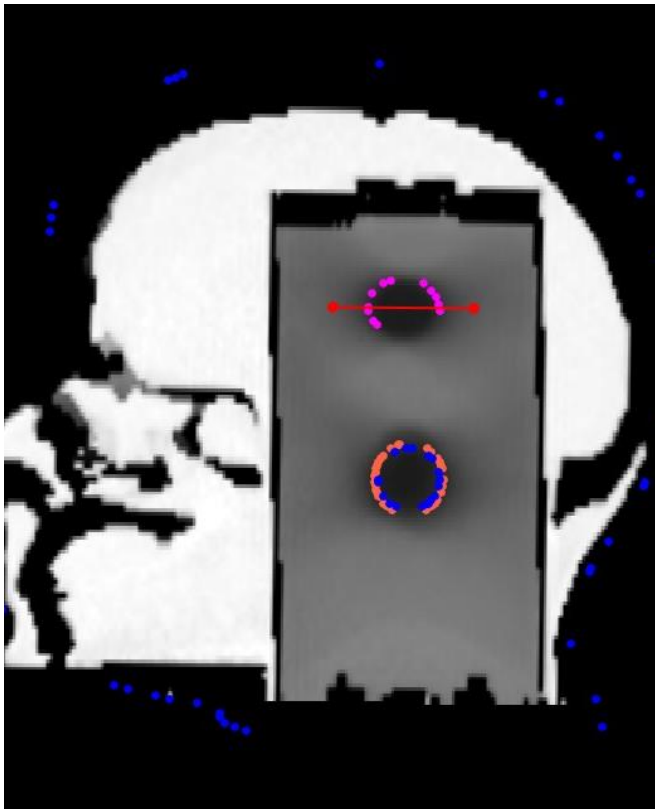
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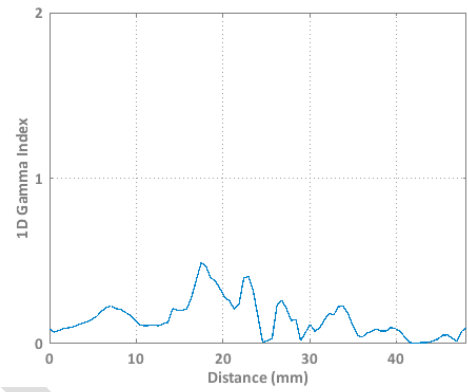
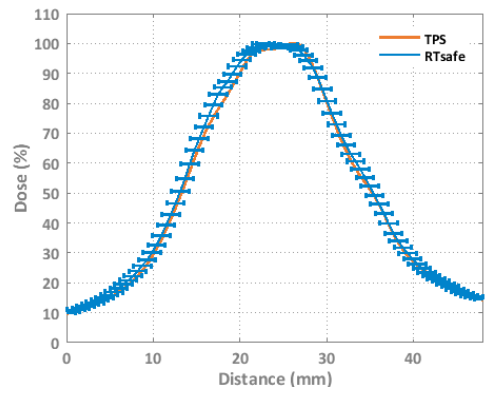
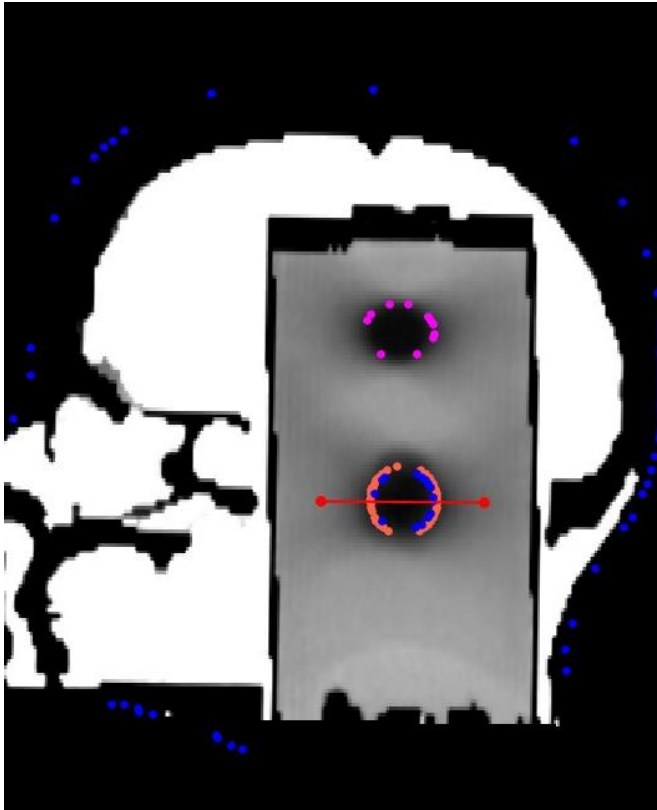












PART III: 2D Gamma Index comparison

For selected slices of the irradiated phantom, 2D gamma index calculations are presented in the following figures. Again, passing criteria were 2 mm distance-to-agreement and 5% dose difference. However, a dose threshold of 1% has been applied to exclude corresponding voxels from the gamma index calculations. Isodose lines are also plotted to assist comparison.

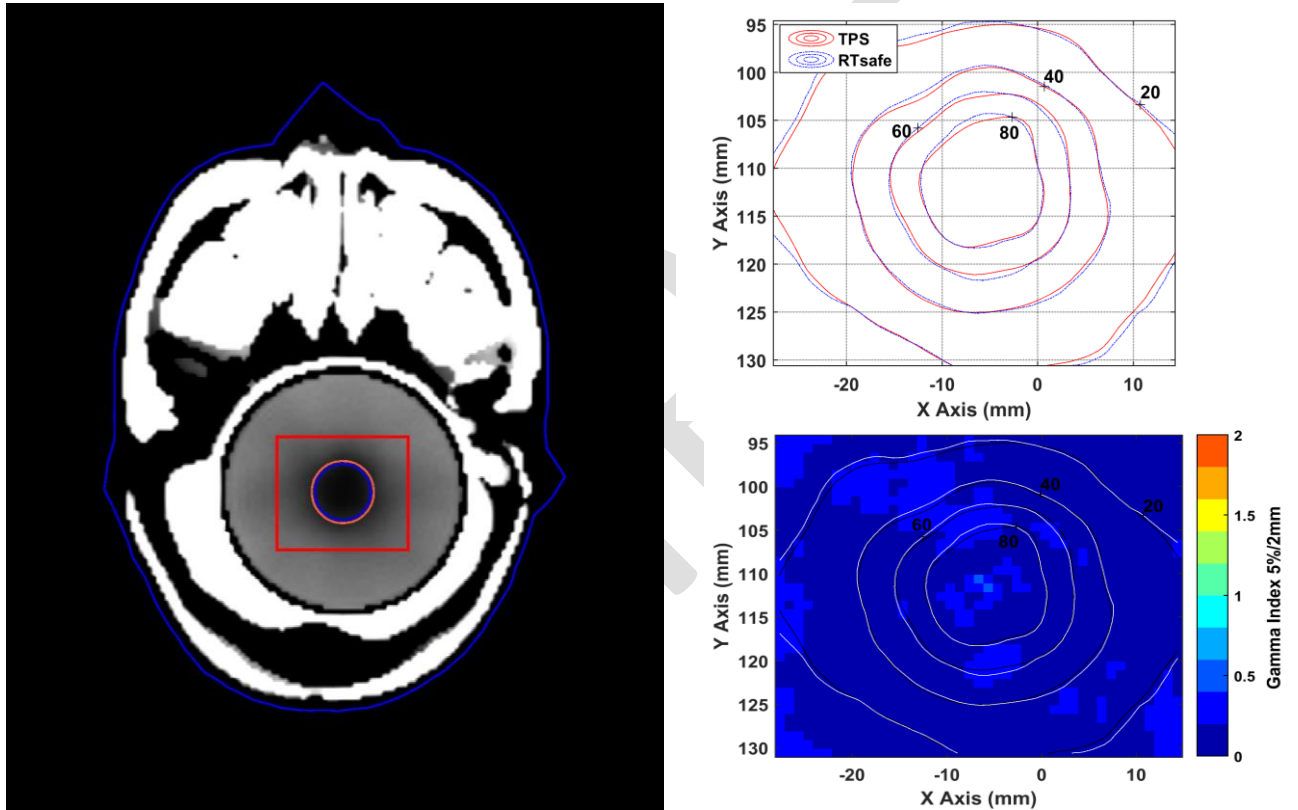
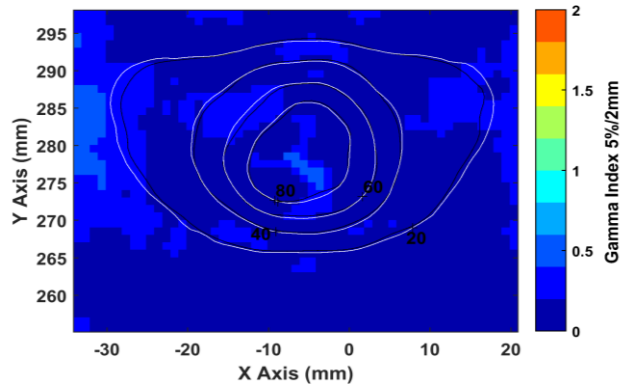
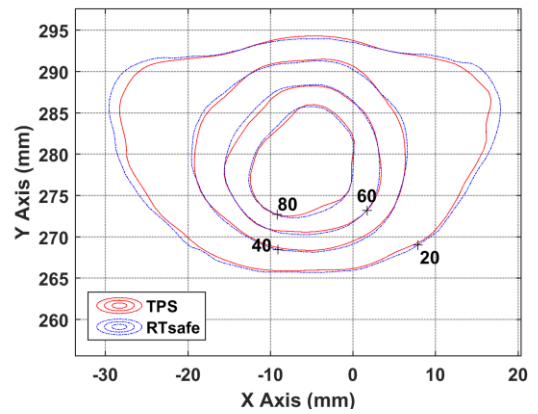
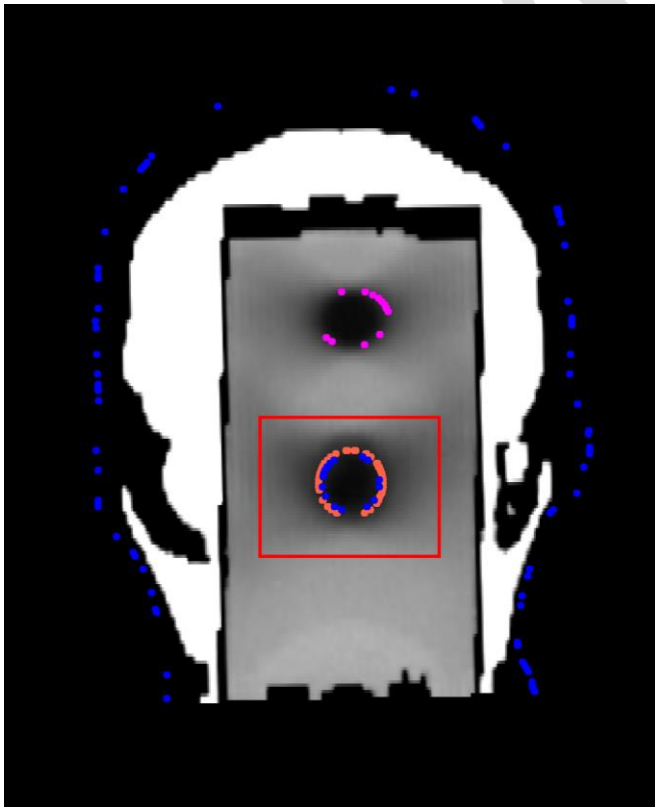
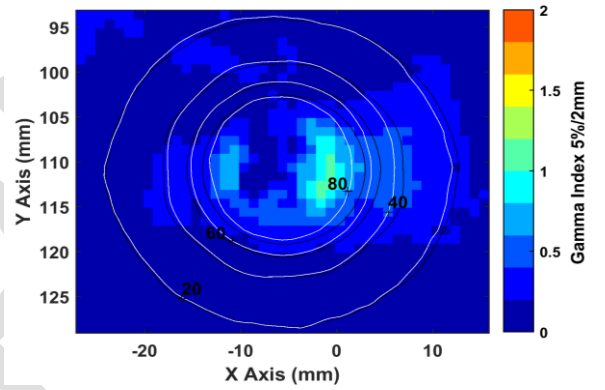
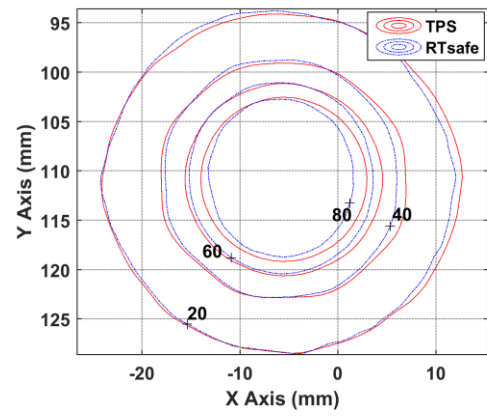
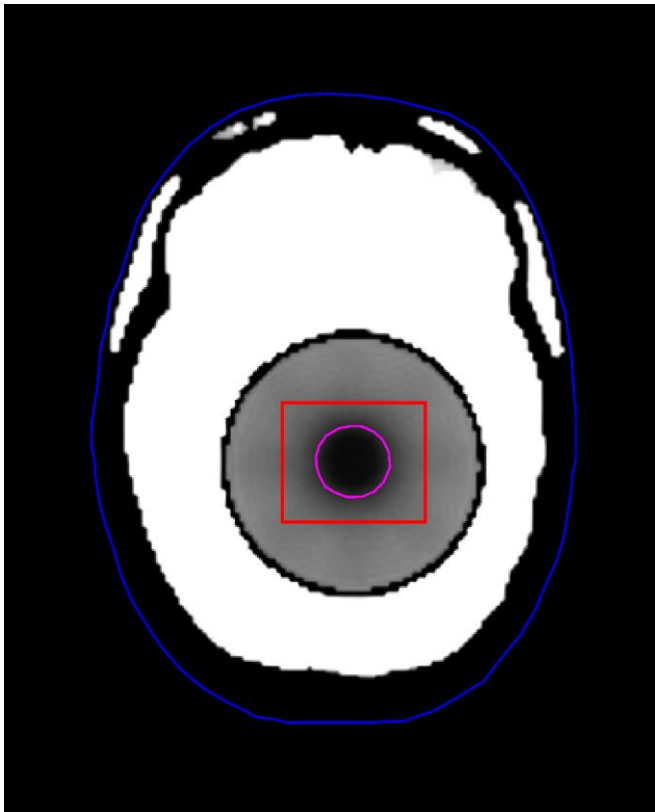
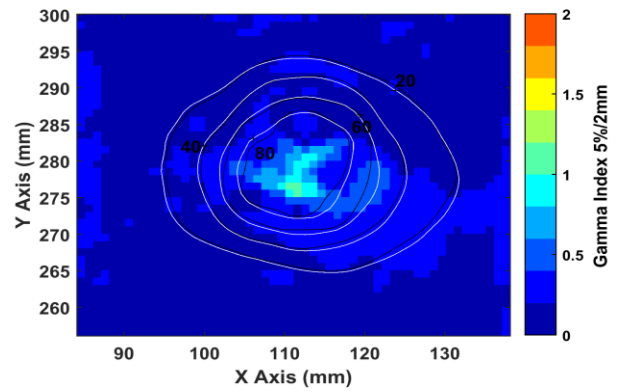
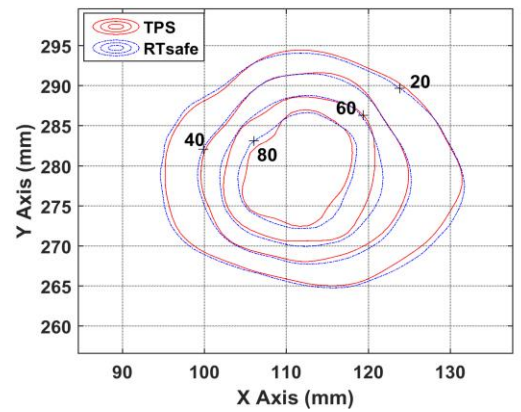
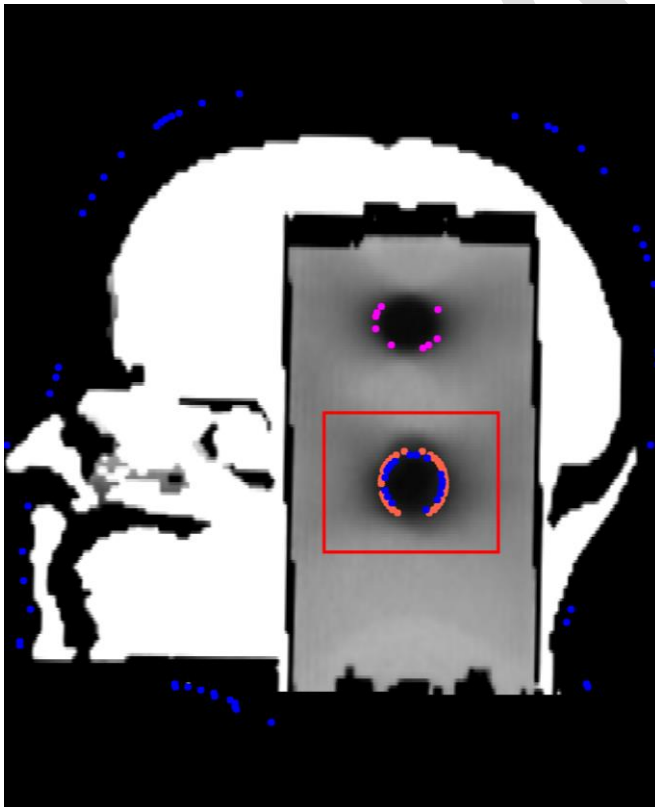
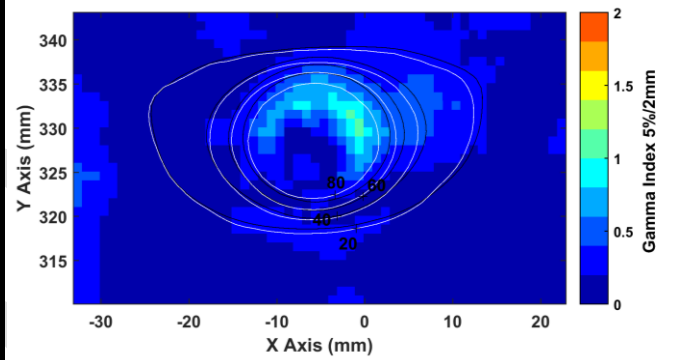
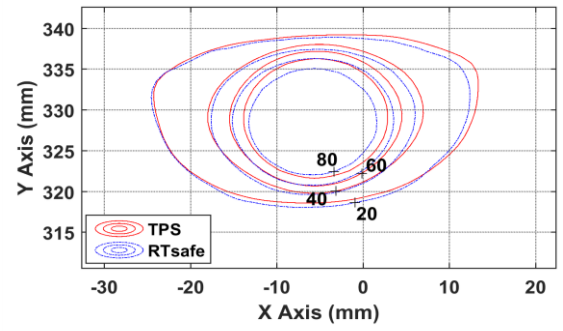
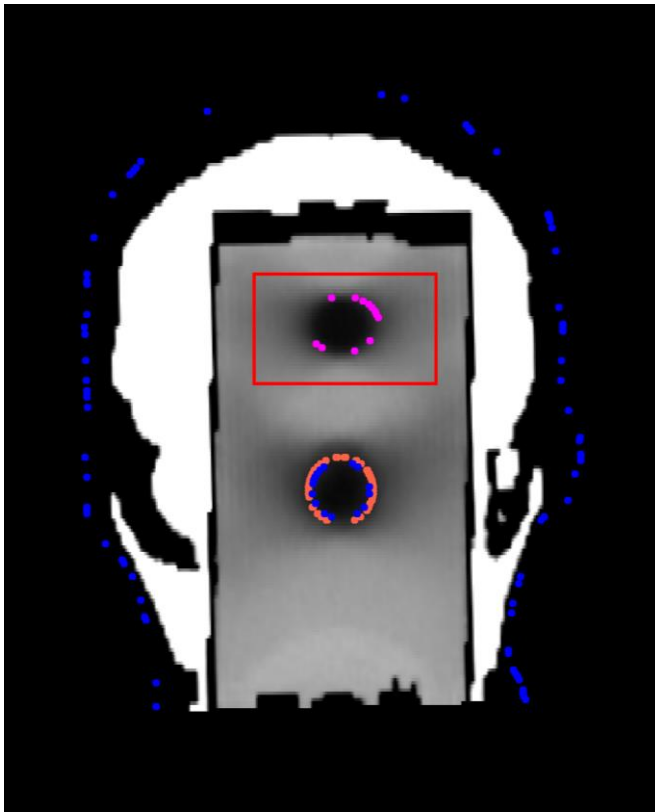
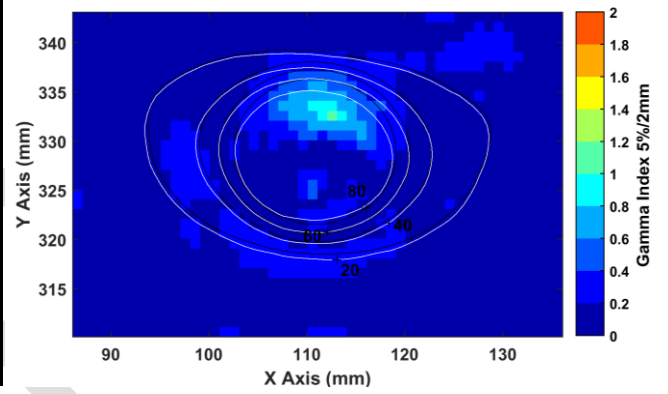
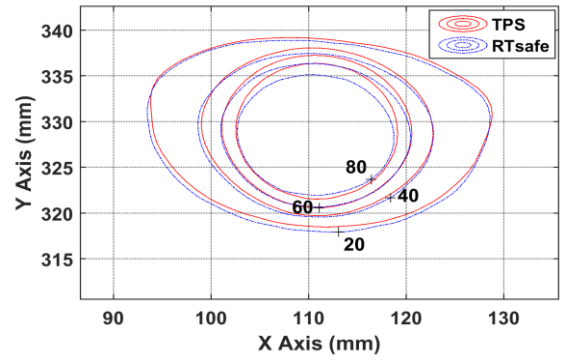
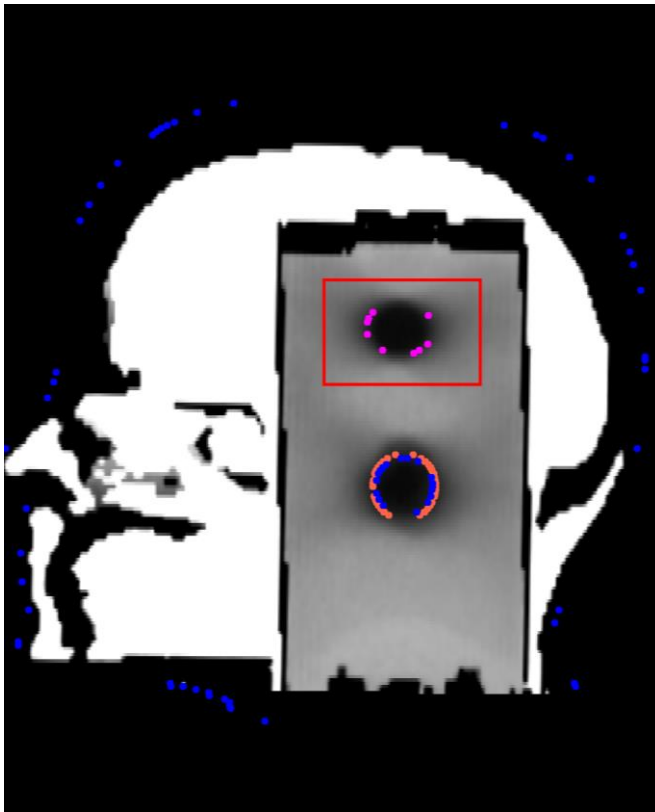


Figure: (left) Slice of the derived T2 maps of the irradiated phantom. High dose regions correspond to darker areas. (right) 2D comparison between calculated (TPS) and measured (RTsafe) dose distributions at the location depicted by the red contour. 2D gamma index calculations are also given using passing criteria 5%/2mm.

The same figure caption applies to all following figures in Part III.







PART IV: 3D Gamma Index comparison

Gamma index calculations were also performed in 3D using a variety of passing criteria and a low-dose cut off threshold of 1%. For the indicative targets considered, gamma index comparison was performed within a volume of interest that includes the target(s) along with an extended region of surrounding soft tissue. Corresponding results are summarized in the following table. Moreover, histograms of the corresponding 3D gamma values are given in the following figures.

Table: Results for the 3D gamma index test, comparing gel-measured (reference) with the TPS-calculated (evaluated) dose distributions using a variety of passing criteria. Note that the volume of interest considered for each target includes the total contoured volume along with an extended area of surrounding soft tissue.

Structure	Passing criteria		Passing Rate
	DTA (mm)	DD (%)	GI ≤ 1 (%)
Inf margin	2	5	100.00
	1	5	100.00
	2	3	100.00
Sup margin	2	5	99.96
	1	5	99.42
	2	3	99.86

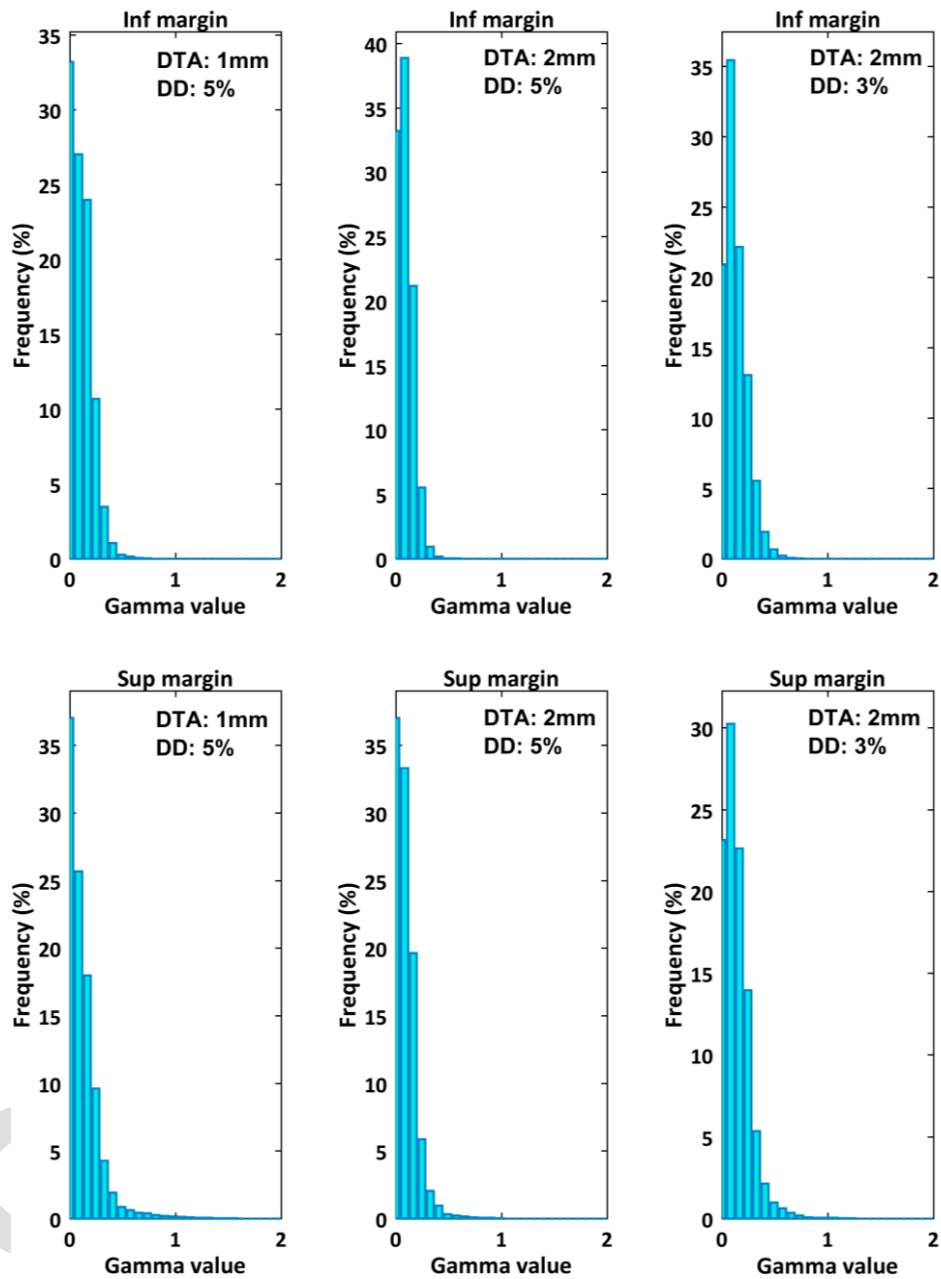
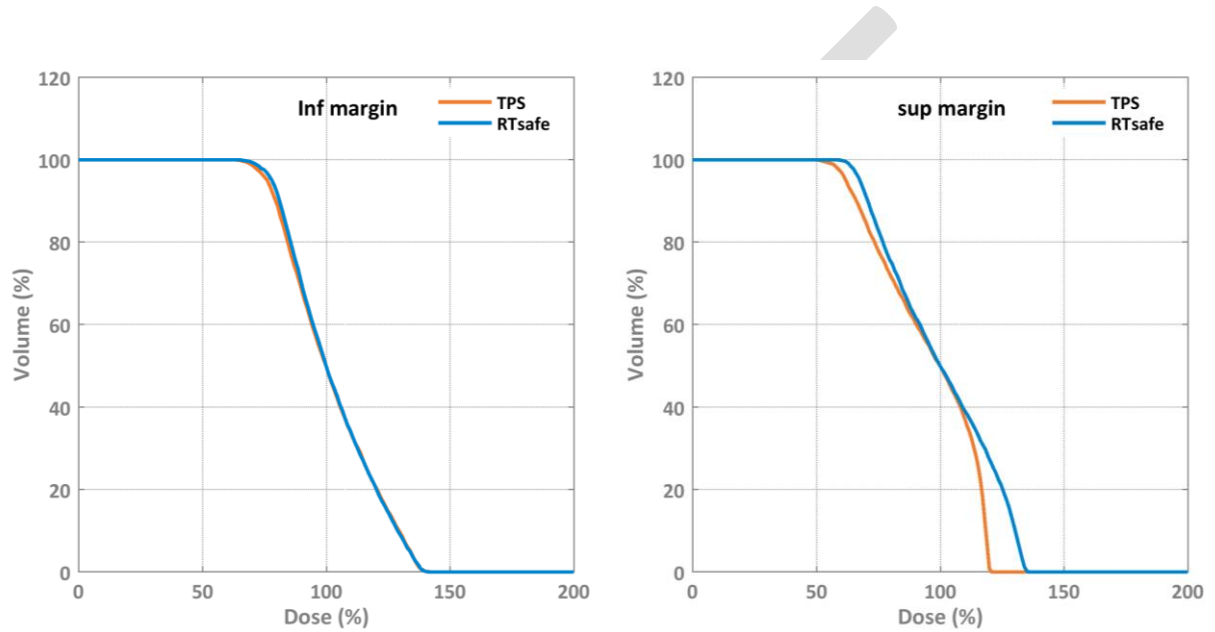


Figure: Histograms for the calculated gamma values of the 3D gamma index comparison test using a variety of passing criteria. The volume of interest considered for each target includes the total contoured volume along with an extended area of surrounding soft tissue.

The same figure caption applies to all following figures in Part IV.

PART V: DVH comparison

Comparison between planned and measured relative dose distributions is presented in the following figures, in terms of cumulative Dose Volume Histograms (DVHs) for all PTVs. All dose distributions were normalized to the corresponding $D_{50\%}$ metric (i.e., the minimum dose received by at least the 50% of the volume) of each structure.



Figures: cumulative Dose Volume Histograms derived from the calculated (TPS) and measured (RTsafe) dose distributions for all the structures considered.

The same figure caption applies to all following figures in Part V.

PART VI: DVH metrics comparison

Using the aforementioned normalization (100% corresponds to $D_{50\%}$), metrics derived from the above DVHs are given in the following table.

Table: Indicative dose volume metrics for the structures considered.

Structure	Mean (%)		D95 (%)	
	TPS	Meas.	TPS	Meas.
Inf margin	102.04	102.52	76.25	78.13
Sup margin	95.76	100.51	61.97	67.60

PART VII: Geometry metric - Offset

Spatial offsets are measured independently for each target by comparing in 3D the center-of-mass of the polymerized area with the center-of-mass of the planned high-dose area. The center of mass of each distribution was calculated by averaging the center of masses of the distributions derived by applying a range of dose thresholds, taking into account the dose gradient of each target. Results are given in the following table.

Table: Distance from isocenter and Distance between the center-of-masses of TPS and RTsafe 3D dose distributions (Geometry metric) for the structures considered.

Structure	Distance from ISO (mm)	Geometry metric - Offset (mm)
Inf margin	-	0.15
Sup margin	-	0.53

PART VIII: Stereotactic radiosurgery plan quality metrics

Using the following equations, plan quality metrics for gel measurements and TPS calculations are presented in the following table for each target. For the plan quality metrics calculations, a prescription dose of 120 Gy was used.

$$^1 CI_{Paddick} = \frac{TV_{PIV}^2}{TV \times V_{RI}}, \text{ Paddick conformity index}$$

$$^2 CI_{RTOG} = \frac{V_{RI}}{TV}, \text{ RTOG conformity index}$$

$$^3 Q = \frac{I_{min}}{RI}, \text{ Quality of coverage}$$

$$^4 HI_{RTOG} = \frac{I_{max}}{RI}, \text{ RTOG homogeneity index}$$

$$^5 GI_{Paddick} = \frac{V_{50\%}}{V_{100\%}}, \text{ Paddick gradient index}$$

where, TV_{PIV} : target volume covered by the prescription isodose

TV : target volume

V_{RI} : total volume covered by the prescription isodose

I_{min} : minimum dose given to the target

I_{max} : maximum dose given to the target

RI : prescription isodose

$V_{50\%}$: volume covered by the 50% of prescription dose

$V_{100\%}$: volume covered by the 100% of prescription dose

Table: Indicative indices for the PTVs.

Index	Inf margin		Sup margin	
	TPS	RTsafe	TPS	RTsafe
CI_Paddick¹	0.82	0.78	0.91	0.90
CI_RTOG²	1.16	1.27	1.03	0.93
Q³	0.88	0.93	0.83	0.85
HI_RTOG⁴	1.96	2.01	1.99	1.94
GI_Paddick⁵	3.11	3.08	2.57	2.71

2D Absolute Dosimetry (Film)

PART I: Profiles comparison

Indicatively, a number of absolute dose profiles for both the film-measured and TPS-calculated datasets are presented in the following figures.

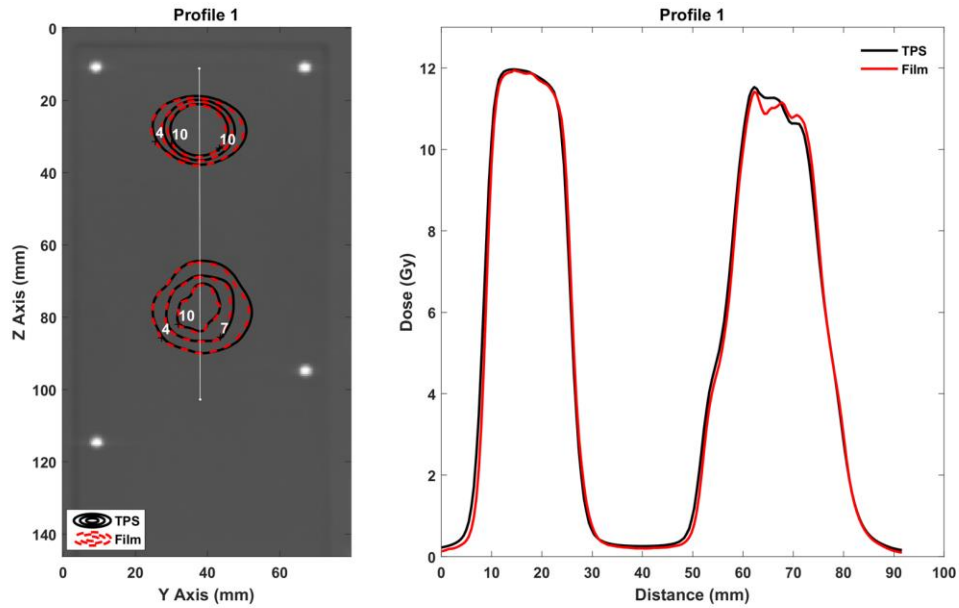
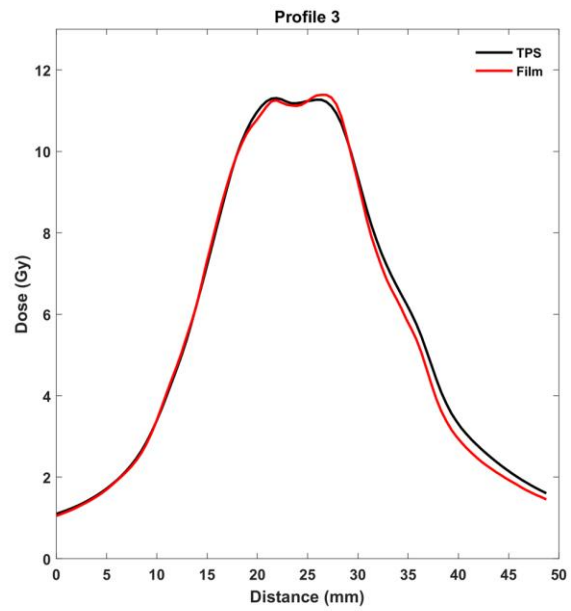
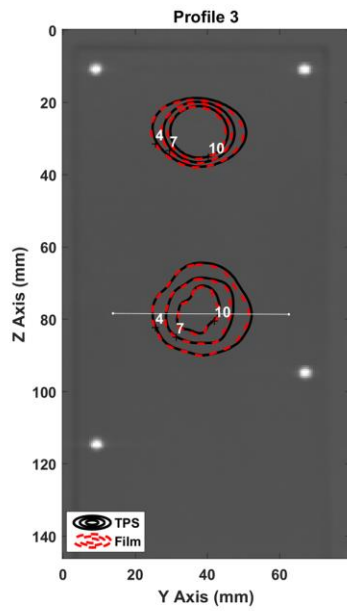
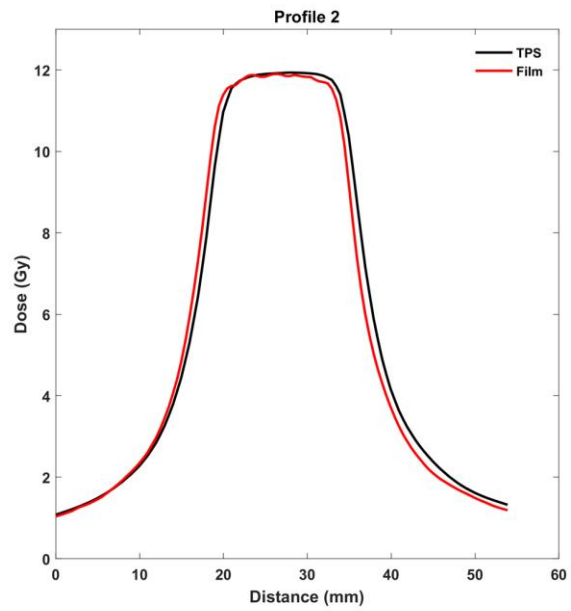
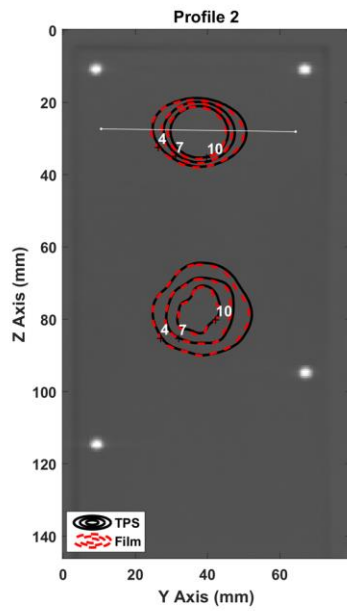


Figure: (left) Slice of the reconstructed CT scan of the film phantom. Contours correspond to TPS calculations (black) and film measurements (red) in Gy. (right) 1D profile comparison between calculated (TPS) and measured (Film) dose distributions at the location depicted by the white line.

The same figure caption applies to all following figures in Part I.



PART II: 2D Gamma Index comparison

For the slice between film insert slabs of the film phantom, local 3D gamma index calculations (i.e., reference data: 2D film measurements, evaluated data: 3D TPS calculations) are presented in the following figures. Passing criteria were 3 mm distance-to-agreement and 3% dose difference, 2 mm and 3%, 1 mm and 3%, as well as 2 mm and 2%. However, a dose threshold of 1.2 Gy (10% of the maximum dose) has been applied to exclude corresponding voxels from the gamma index calculations. Isodose lines are also plotted to assist comparison.

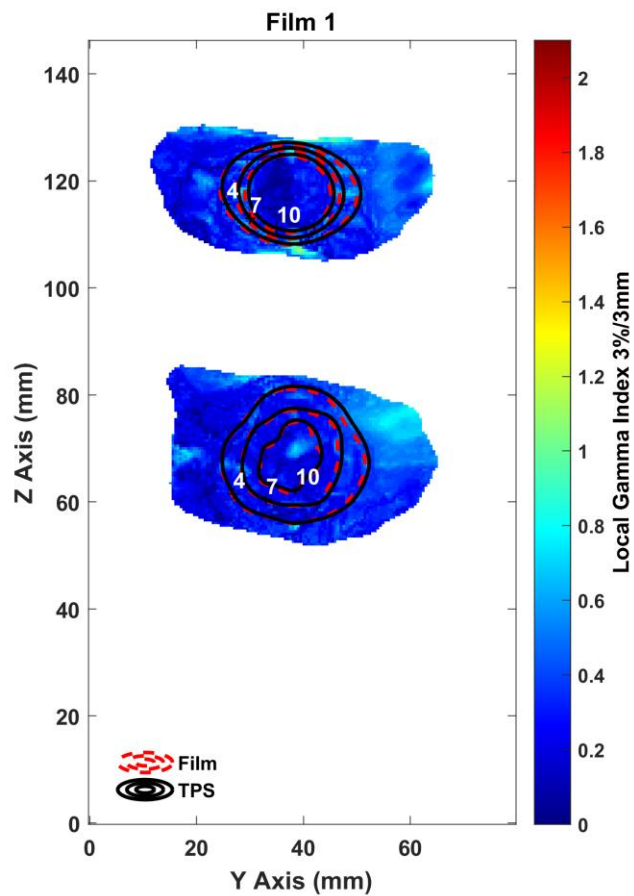


Figure: 2D comparison between calculated (TPS) and measured (Film) dose distributions in Gy values applying a threshold of 1.2 Gy (10% of the maximum dose). Local 3D gamma index calculations are given using passing criteria 3%/3mm.

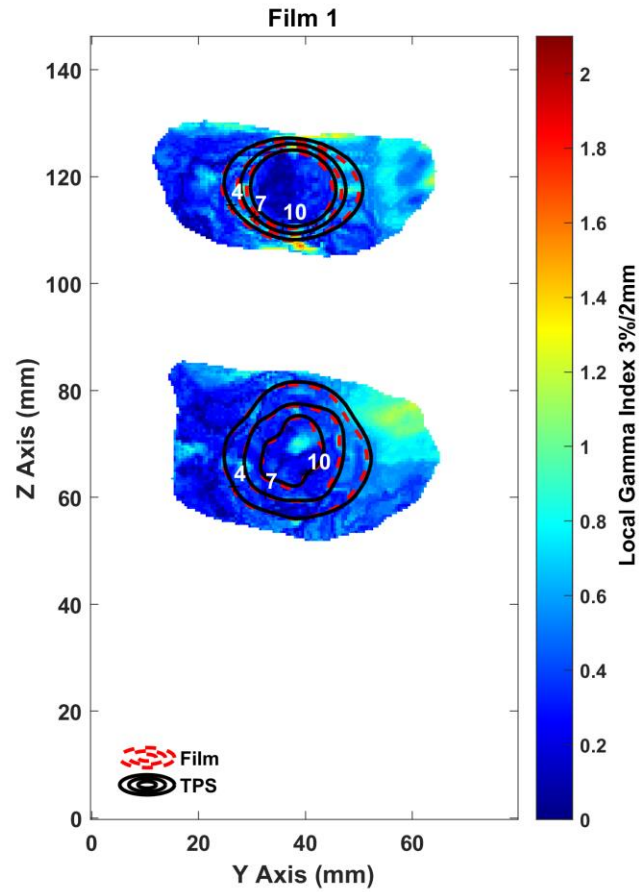


Figure: 2D comparison between calculated (TPS) and measured (Film) dose distributions in Gy values applying a threshold of 1.2 Gy (10% of the maximum dose). Local 3D gamma index calculations are given using passing criteria 3%/2mm.

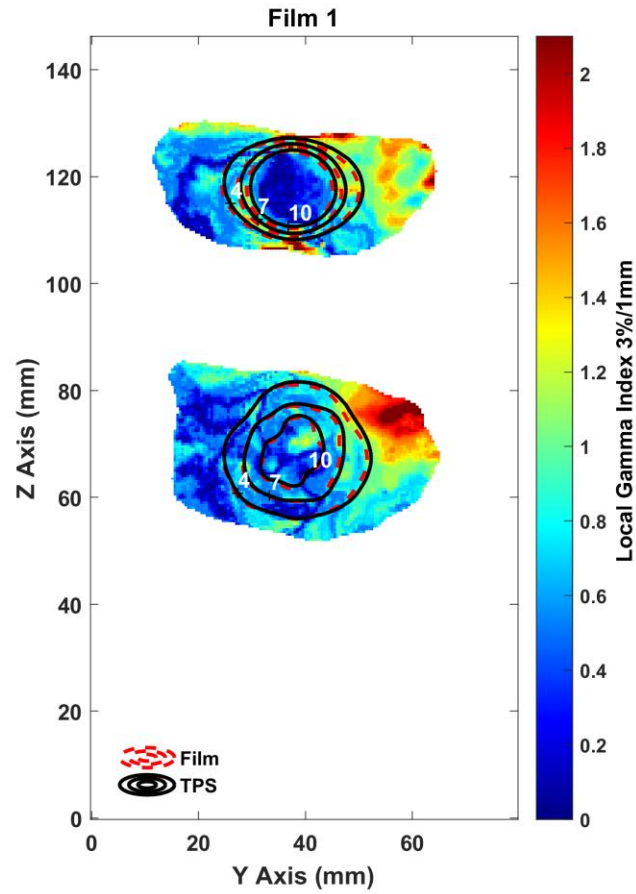


Figure: 2D comparison between calculated (TPS) and measured (Film) dose distributions in Gy values applying a threshold of 1.2 Gy (10% of the maximum dose). Local 3D gamma index calculations are given using passing criteria 3%/1mm.

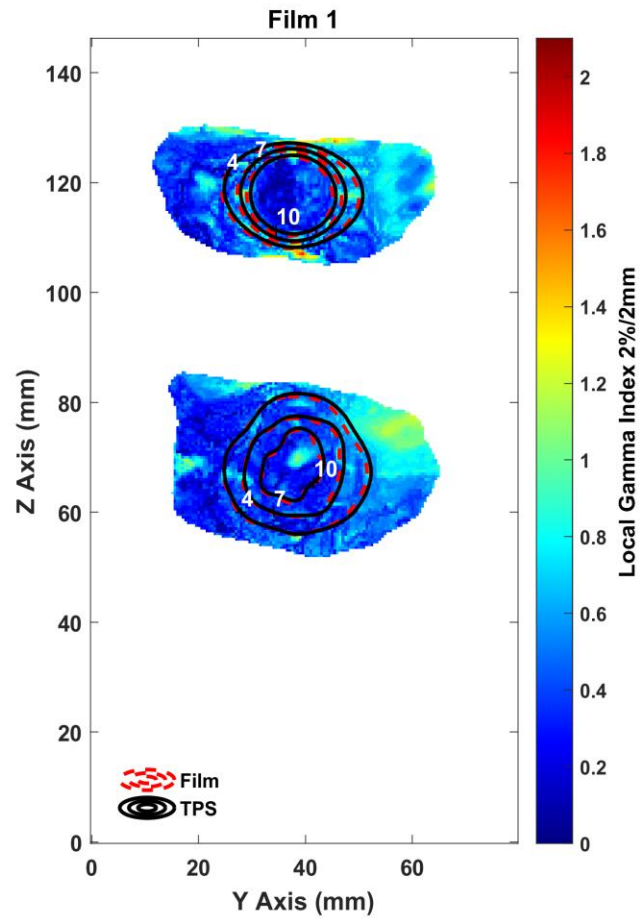


Figure: 2D comparison between calculated (TPS) and measured (Film) dose distributions in Gy values applying a threshold of 1.2 Gy (10% of the maximum dose). Local 3D gamma index calculations are given using passing criteria 2%/2mm.

PART III: 3D Gamma Index comparison

Local gamma index calculations were also performed in 3D using a variety of passing criteria and a low-dose cut off threshold of 1.2 Gy (10% of the maximum dose). For the indicative targets considered, gamma index comparison was performed within a volume of interest that includes the target(s) along with an extended region of surrounding tissue. Corresponding results are summarized in the following table.

Table: Results for the local 3D gamma index test, comparing film-measured (reference) with the TPS-calculated (evaluated) dose distributions using a variety of passing criteria. Note that passing rates were calculated using a threshold of 1.2 Gy (10% of the maximum dose).

Structure	Passing criteria		Passing Rate
	DTA (mm)	DD (%)	GI ≤ 1 (%)
Targets	3	3	99.95
	2	3	97.18
	1	3	71.61
	2	2	96.15

Point Absolute Dosimetry (Ion Chamber)

PART I: *Point dose comparison*

The ion chamber's sensitive volume was identified in the reference CT scan and a relevant structure was contoured. Mean TPS calculated dose in the structure was compared against corresponding IC absolute dose measurements.

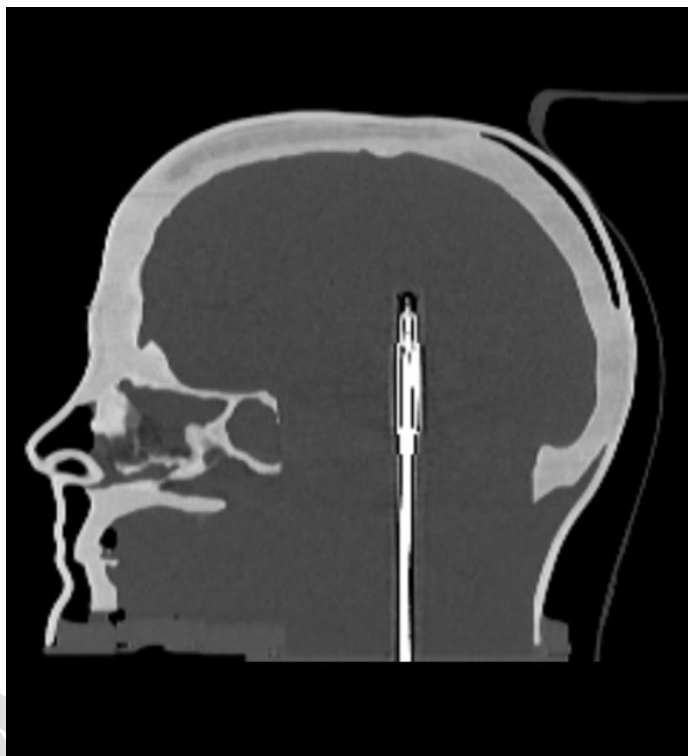


Figure: A central sagittal slice of the phantom CT scan with the ion chamber insert.

Table: Results for the absolute point dose comparison. Absolute ion chamber dose measurement (reference) is compared with the TPS-calculated (evaluated) mean dose in the contoured structure for the sensitive volume of the ion chamber.

Structure	Mean Dose (Gy)		Difference (%)
	TPS	Meas.	
Ion chamber	11.865	12.137	-2.24

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