

## Dosimetric Analysis Report

Date of report: -  
Date of irradiation: -  
Treatment Planning System: Elements  
Number of target volumes (PTVs): 6  
Institution: -

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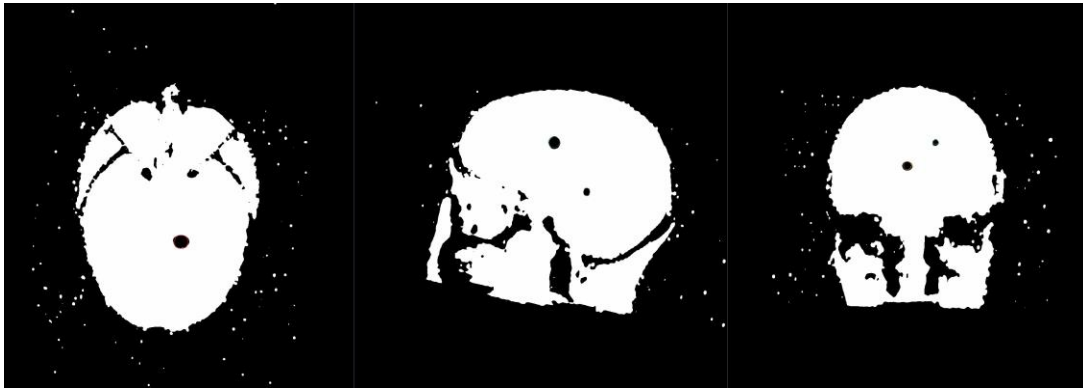
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### 3D Relative Dosimetry (Gel)

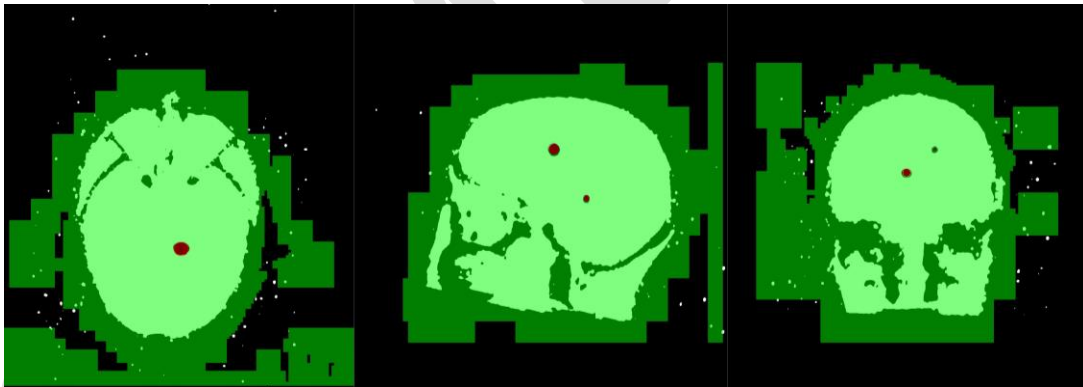
#### **PART I:** *Qualitative comparison*

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.

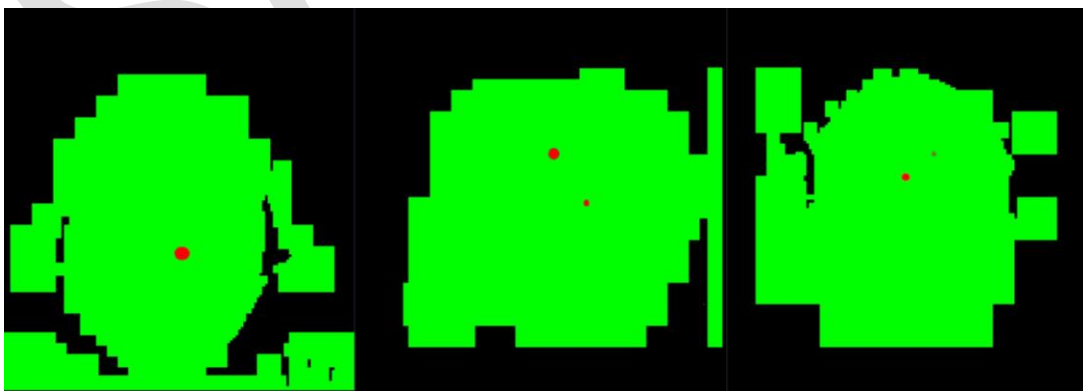
**MRI (actually delivered dose) blended with TPS (calculated dose)**



**MRI 100% - RTDOSE TPS 0%**



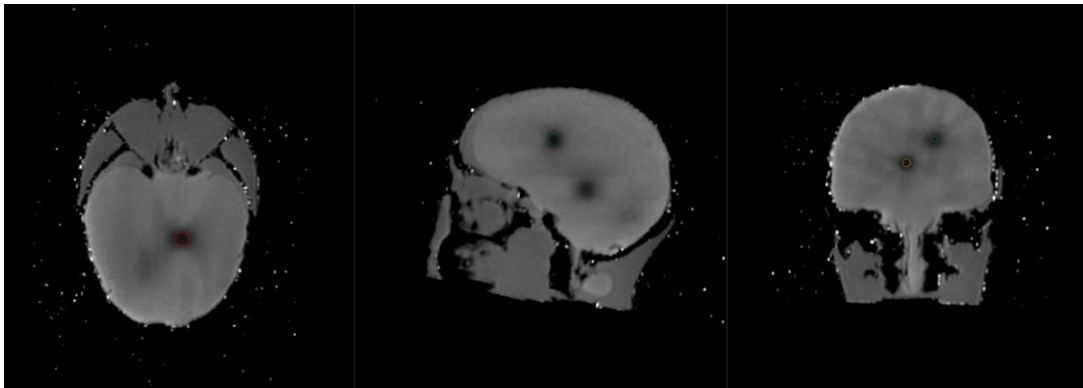
**MRI 50% - RTDOSE TPS 50%**



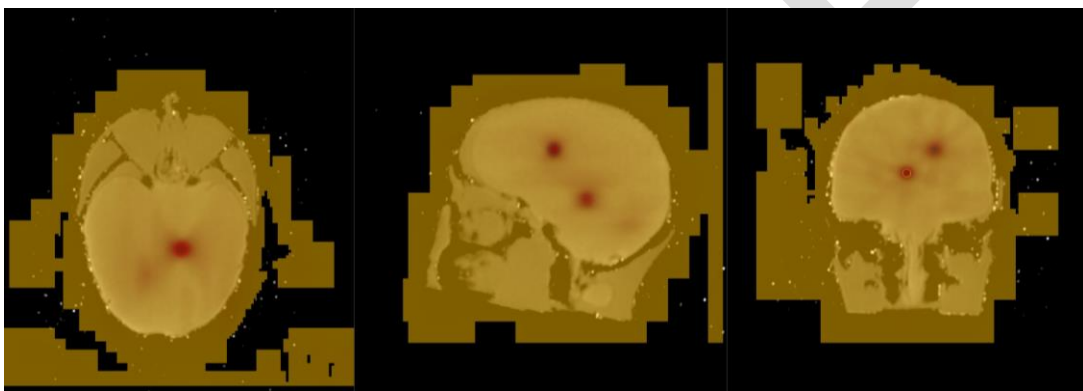
**MRI 0% - RTDOSE TPS 100%**

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

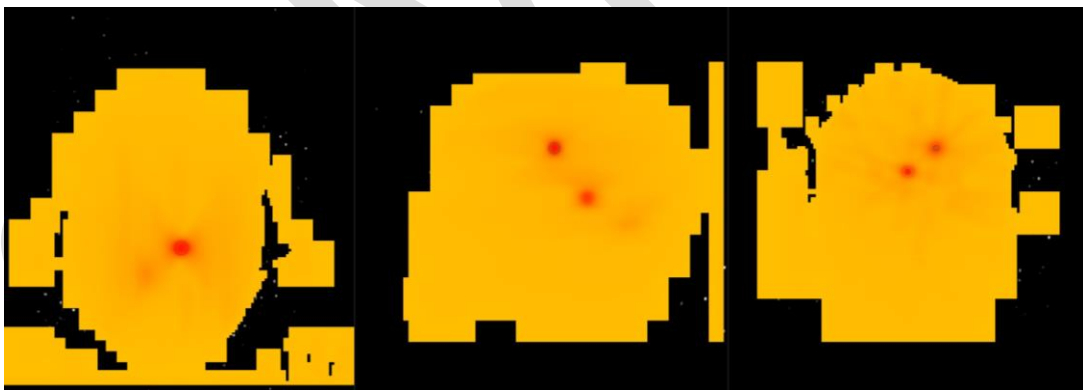
**MRI (actually delivered dose) blended with TPS (calculated dose)**



**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.

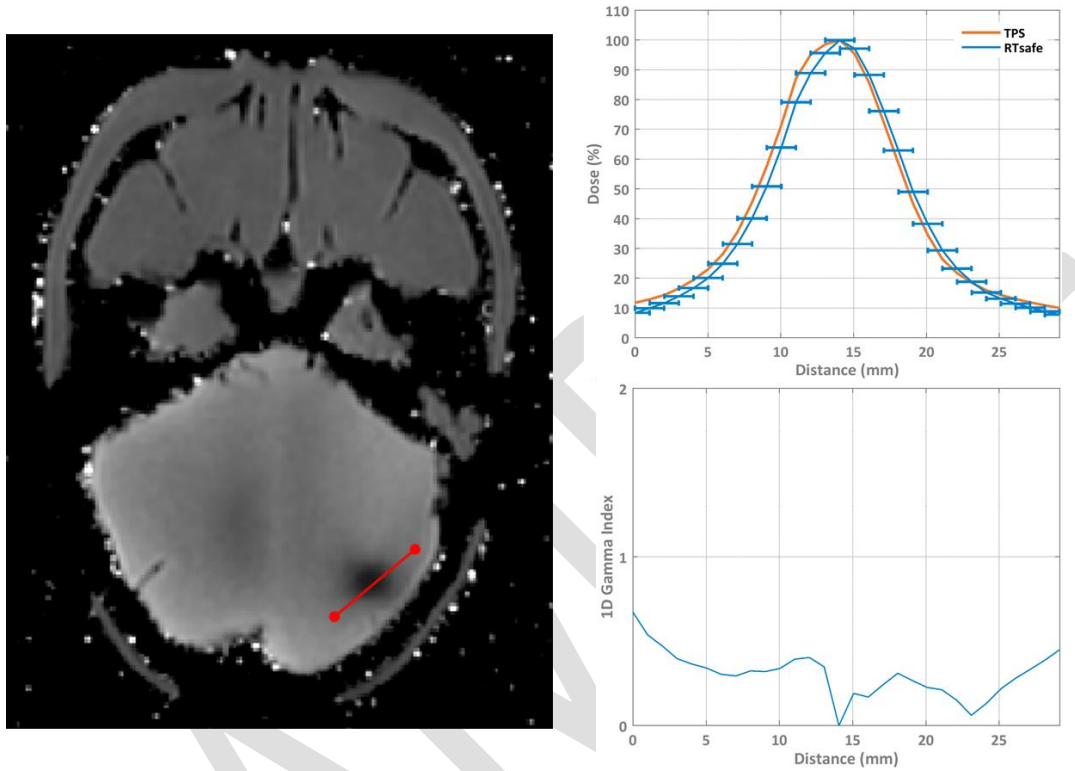
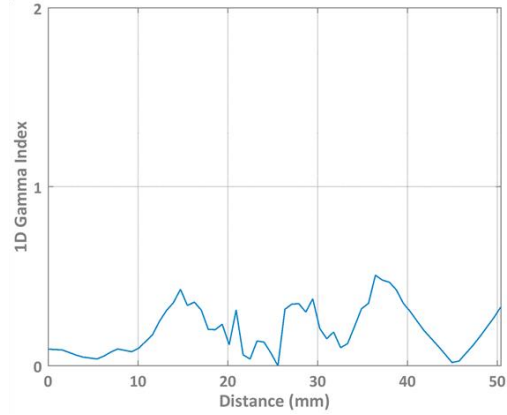
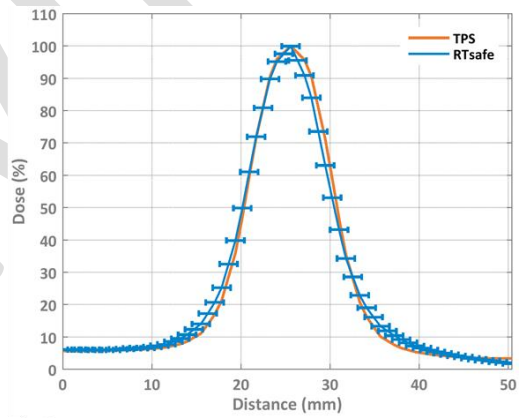
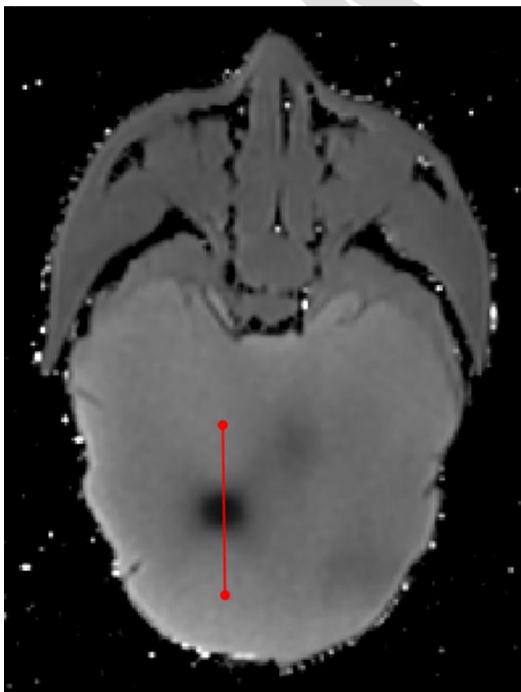
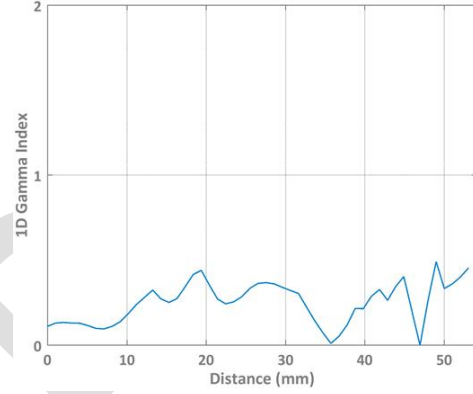
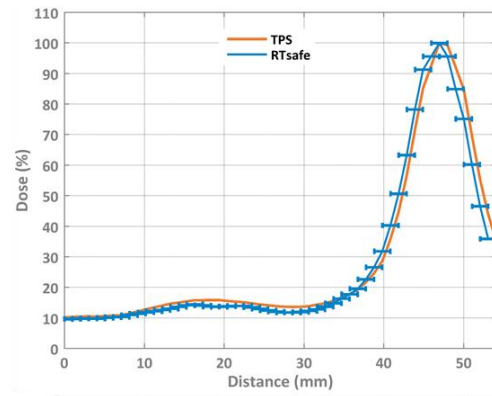
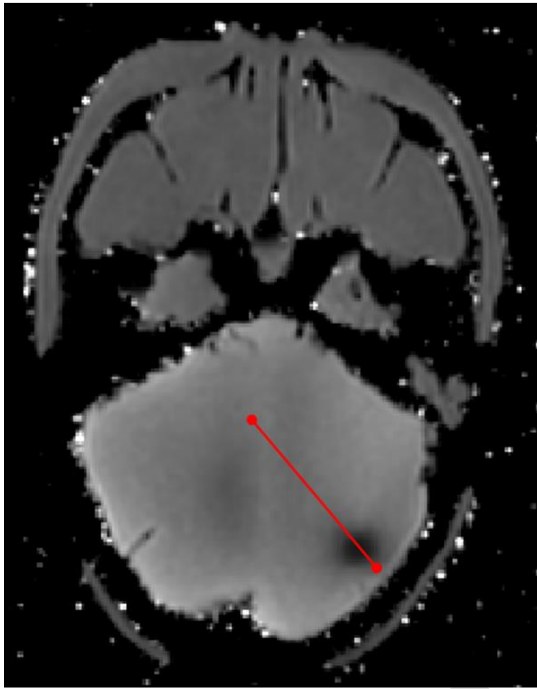
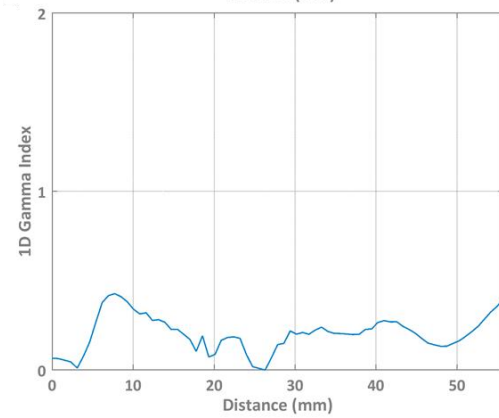
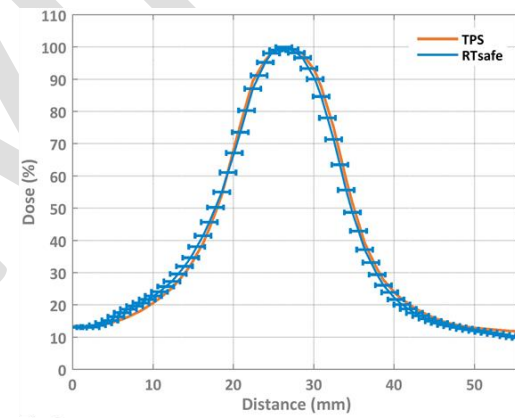
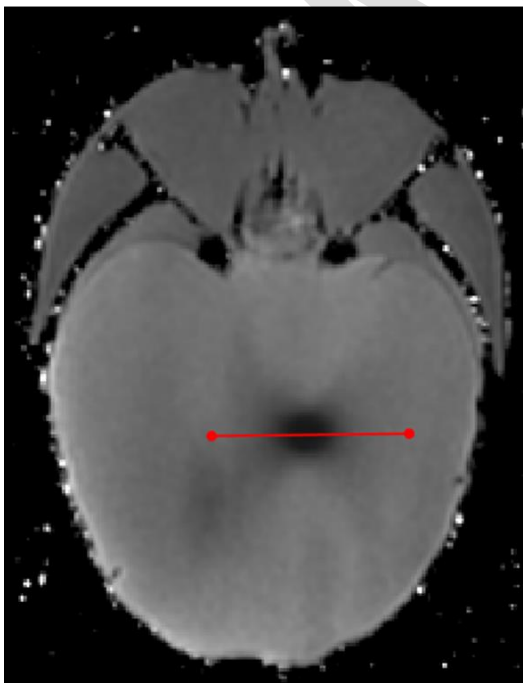
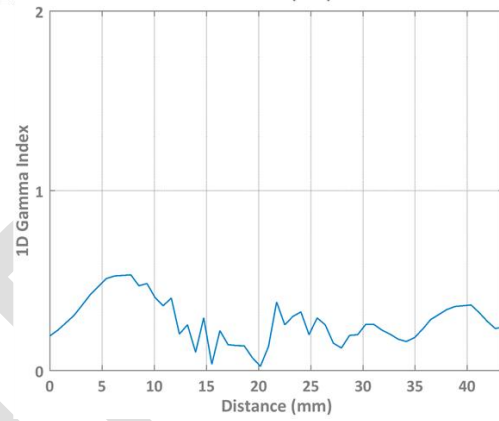
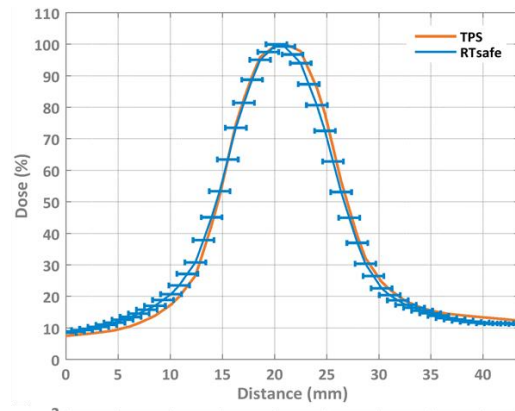
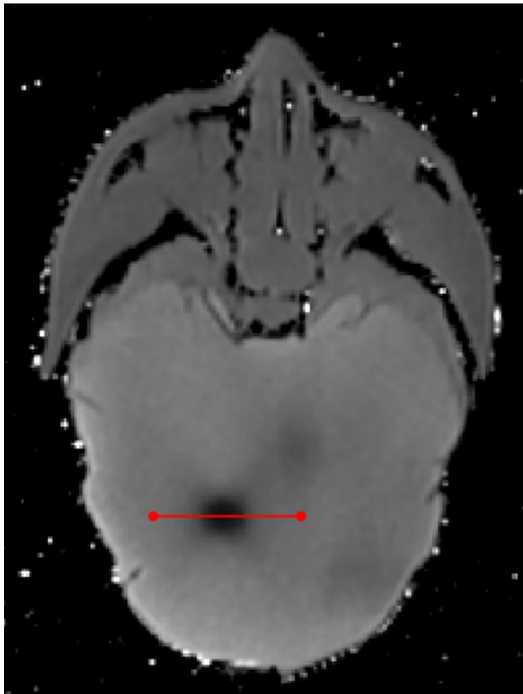
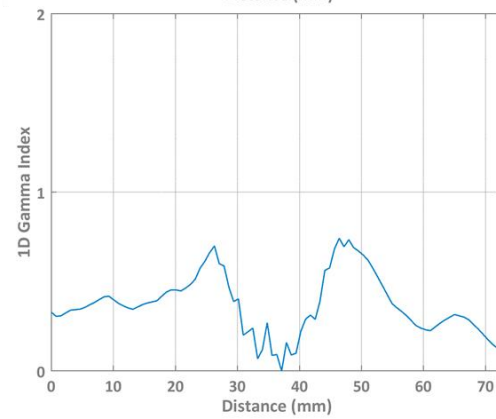
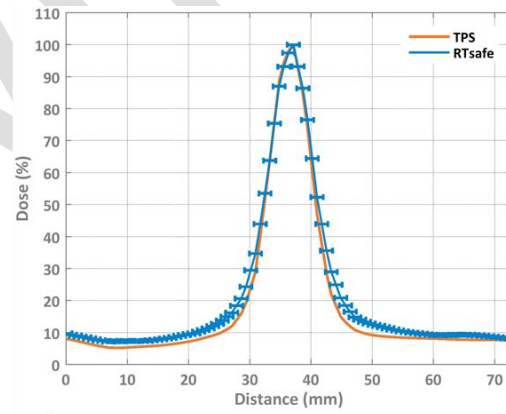
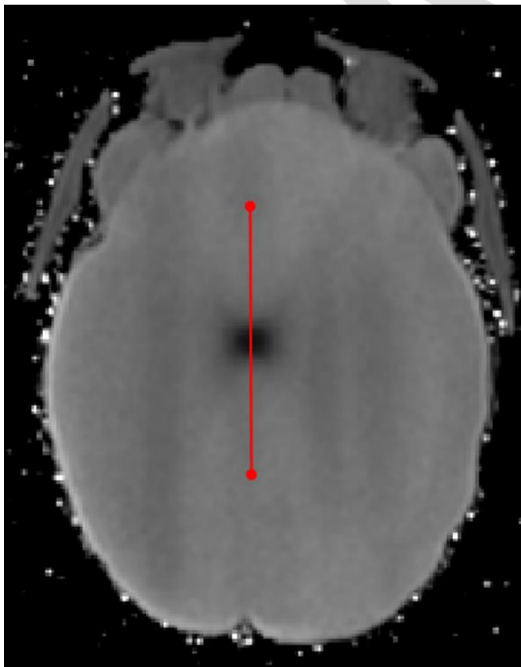
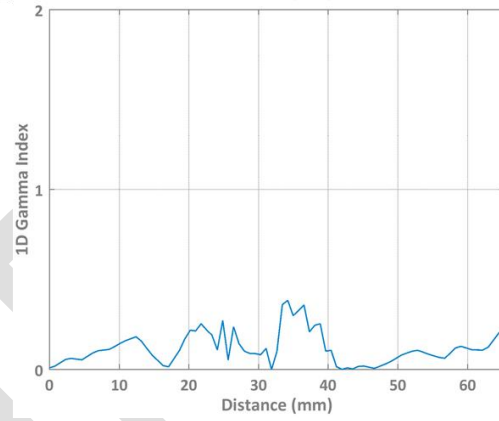
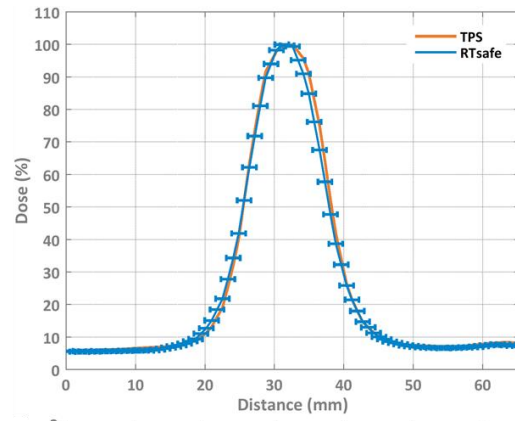
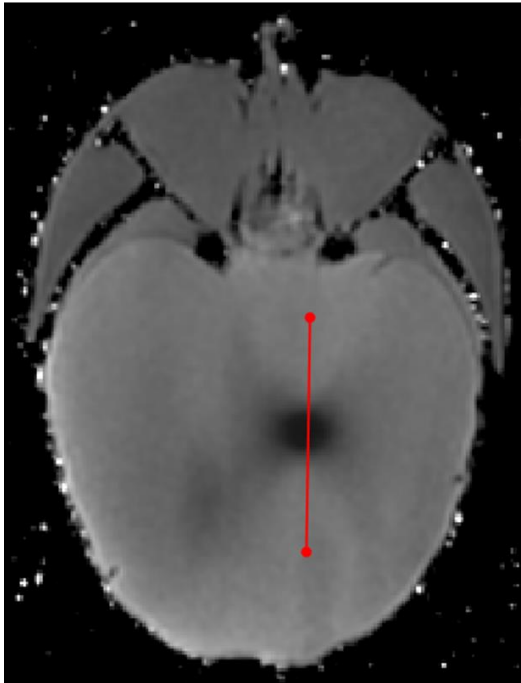


Figure: (left) Slice of the derived T2 maps of the irradiated phantom. High dose regions correspond to darker areas. (right) 1D profile comparison between calculated (TPS) and measured (RTsafe) dose distributions at the location depicted by the red line. Error bars correspond to  $\pm 1$  mm spatial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

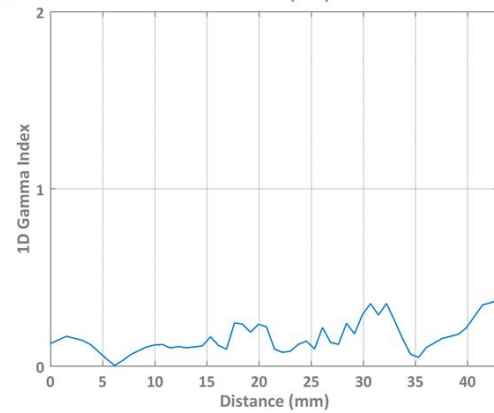
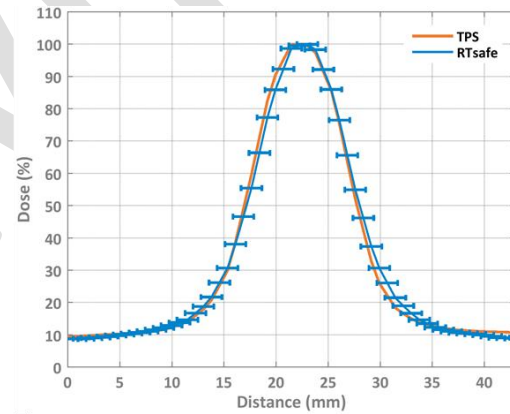
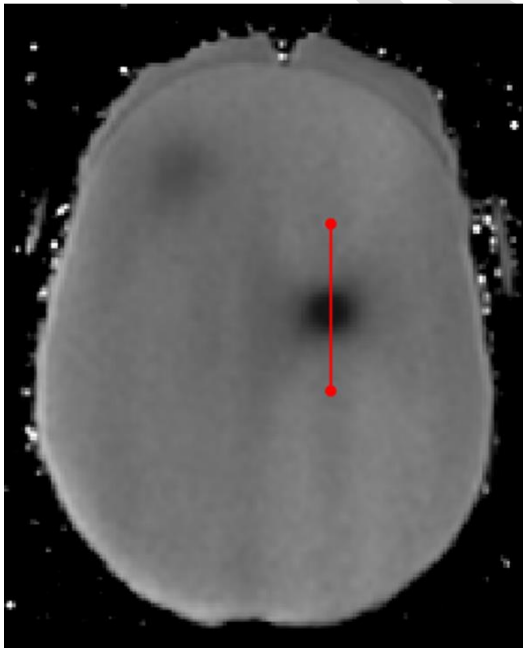
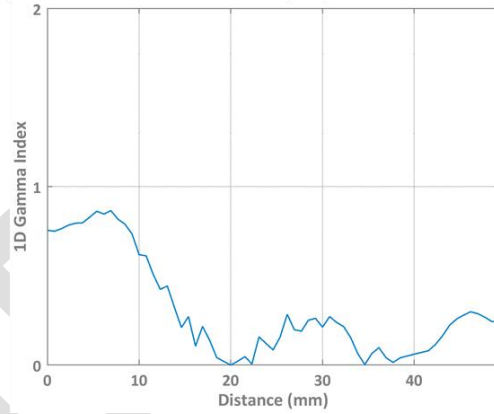
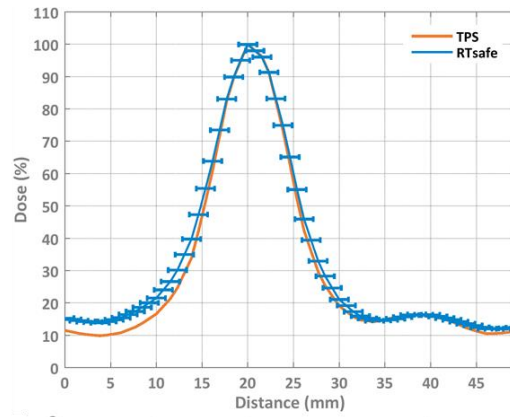
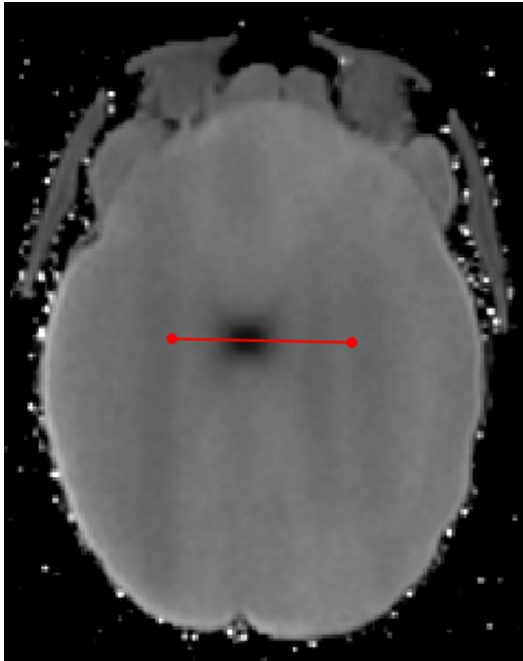
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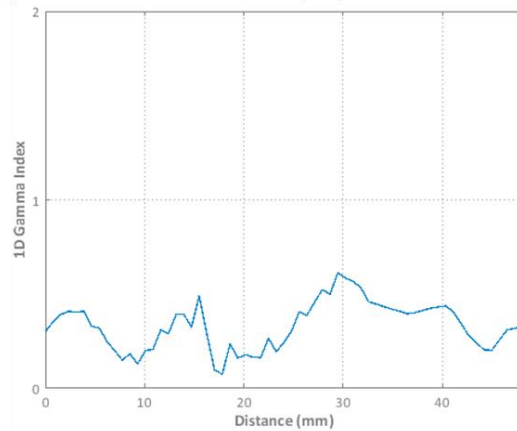
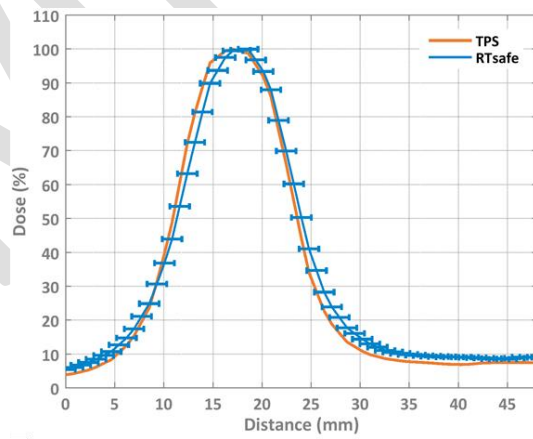
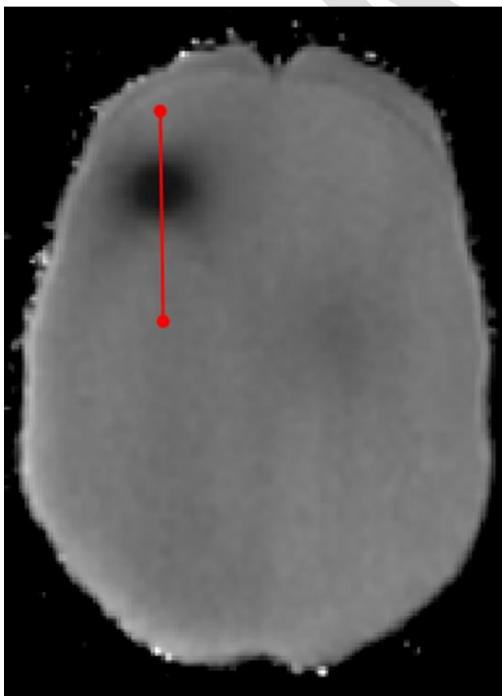
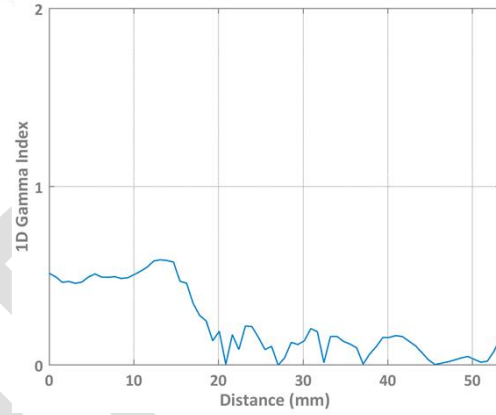
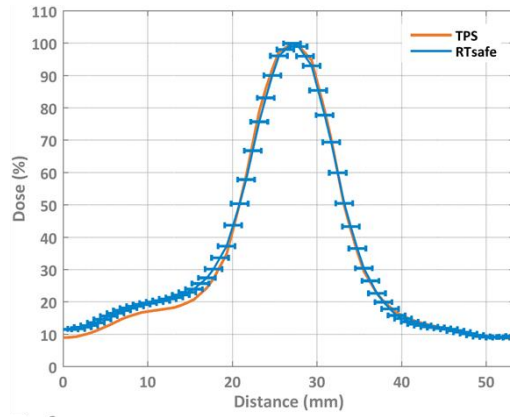
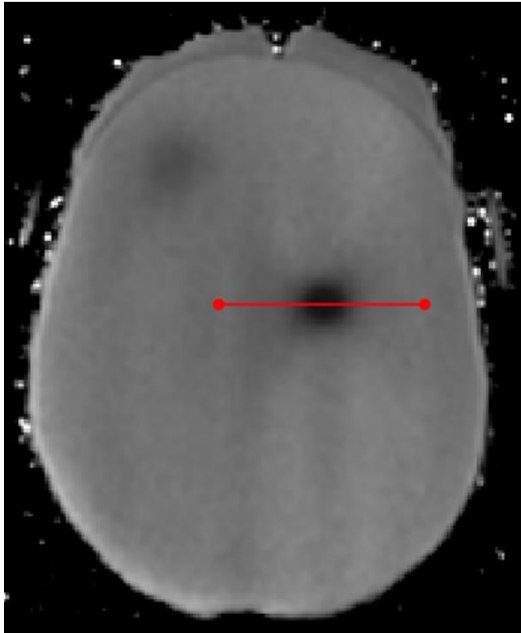


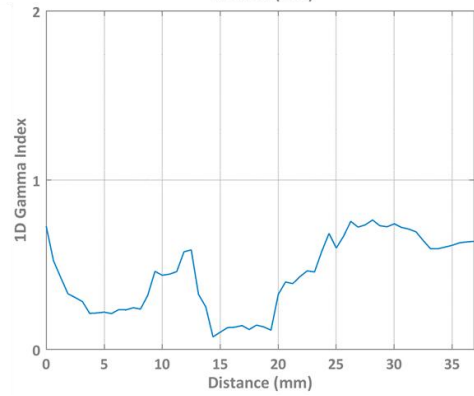
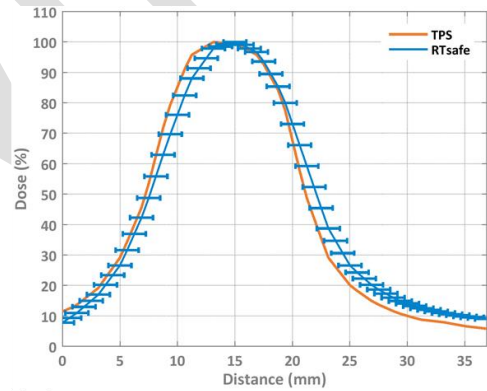
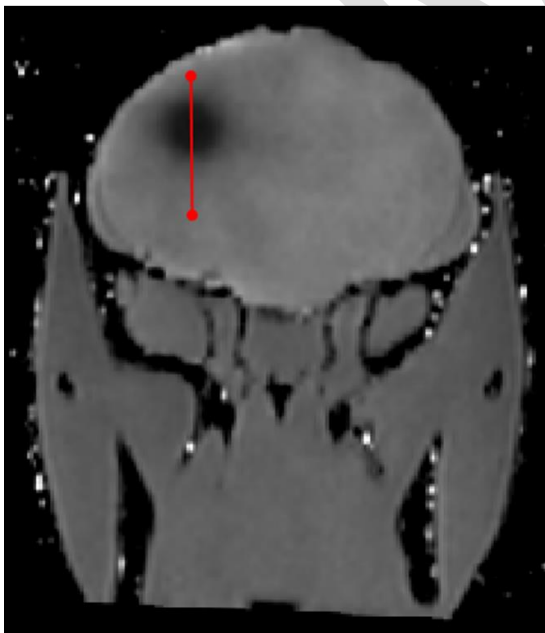
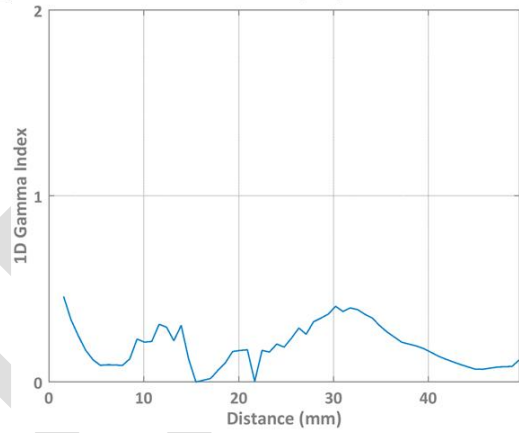
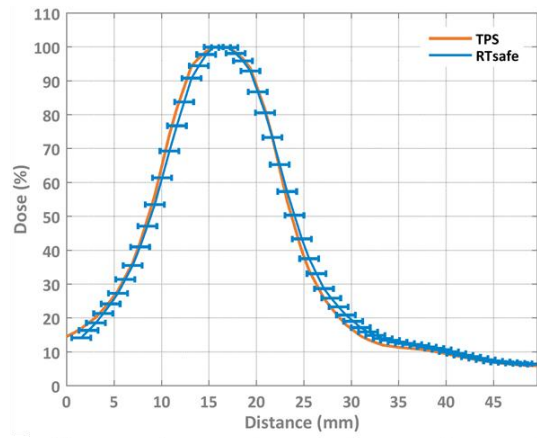
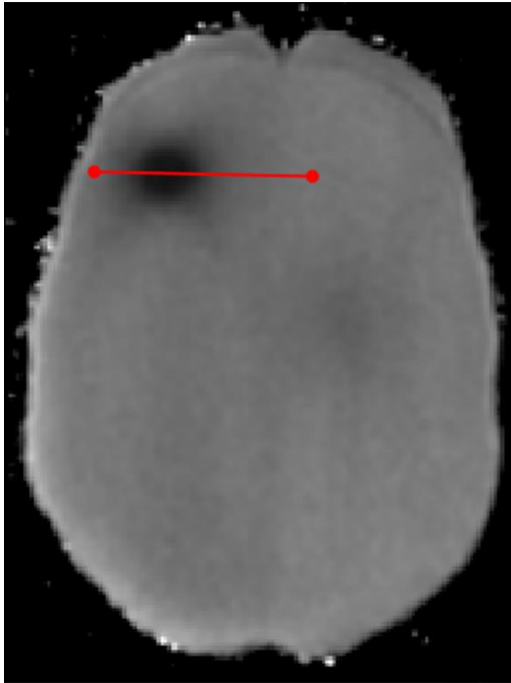


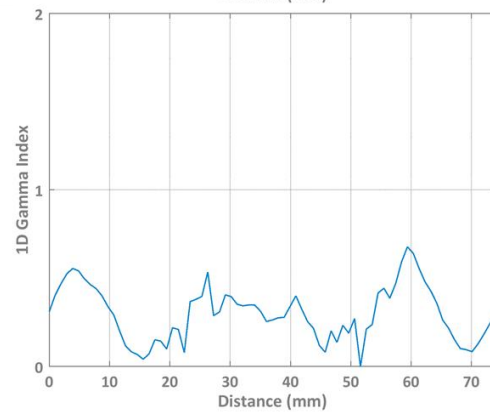
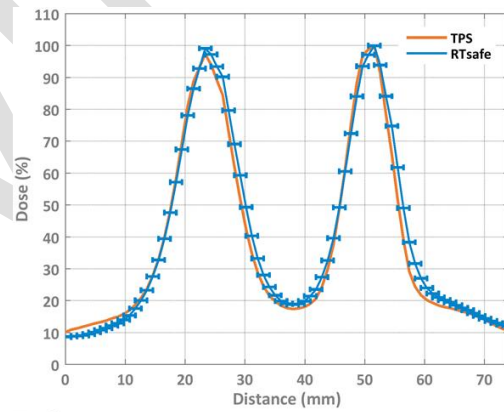
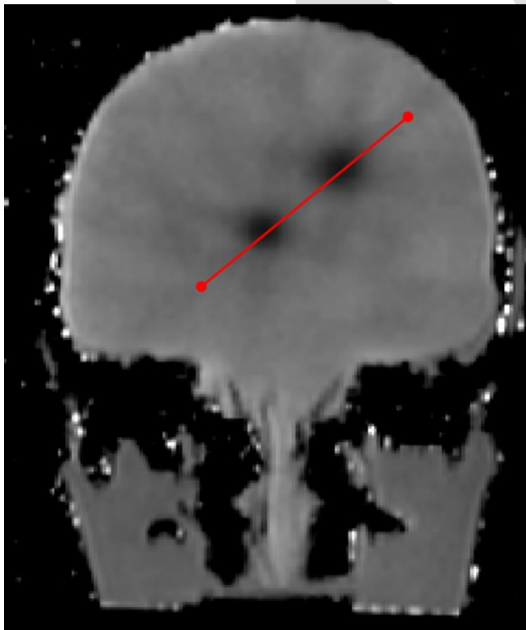
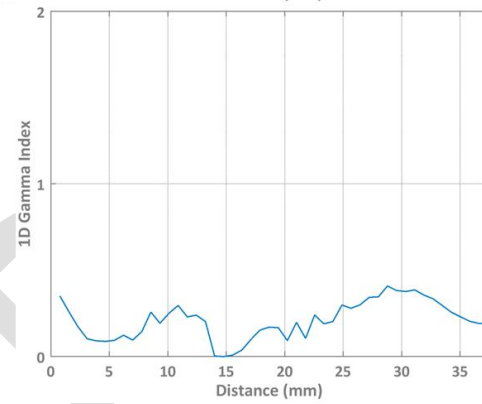
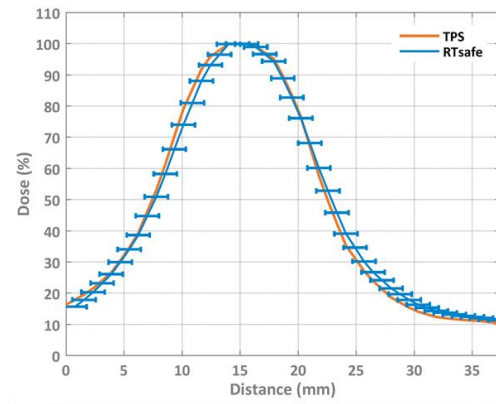
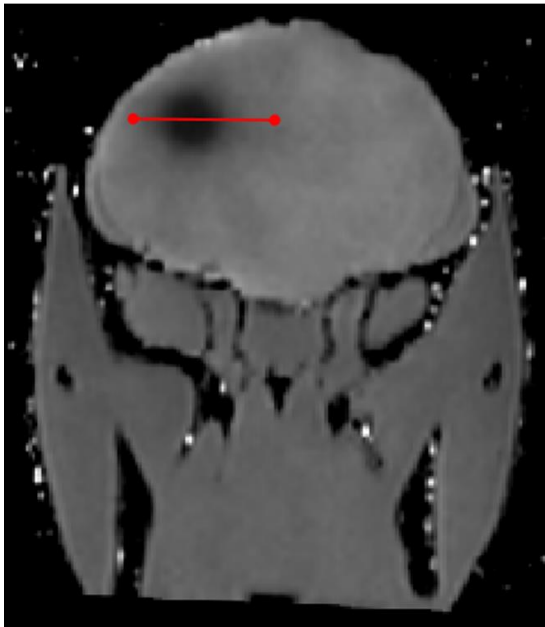


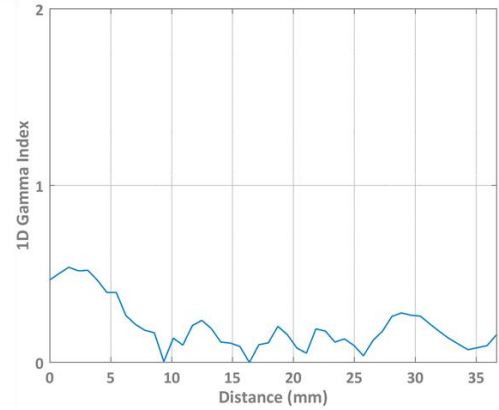
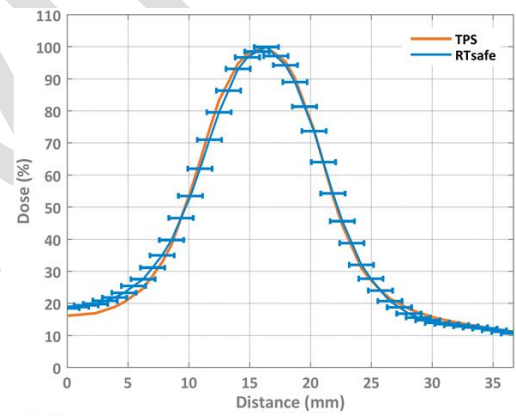
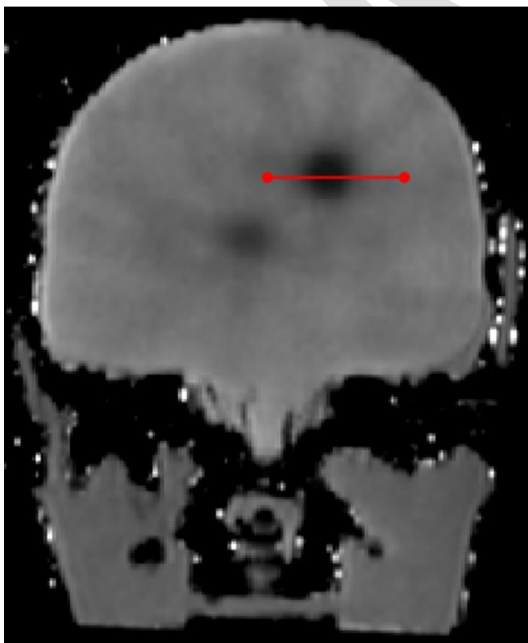
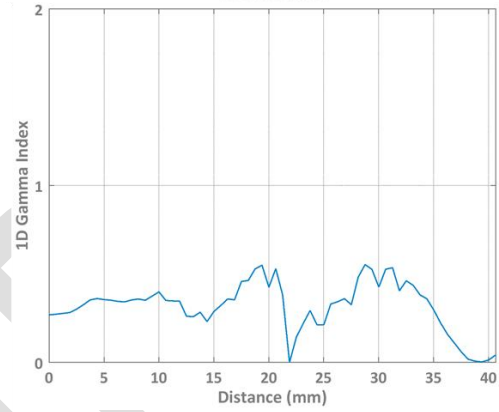
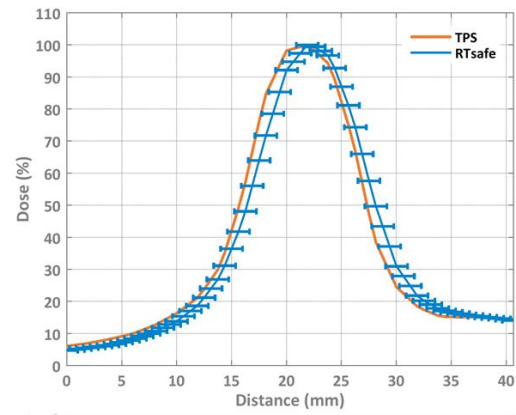
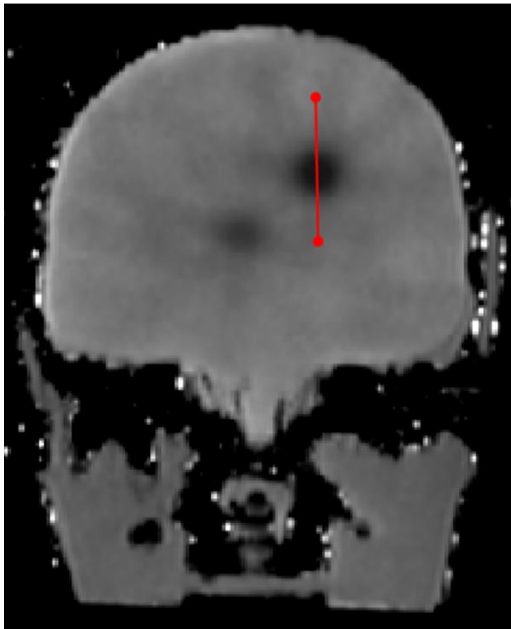


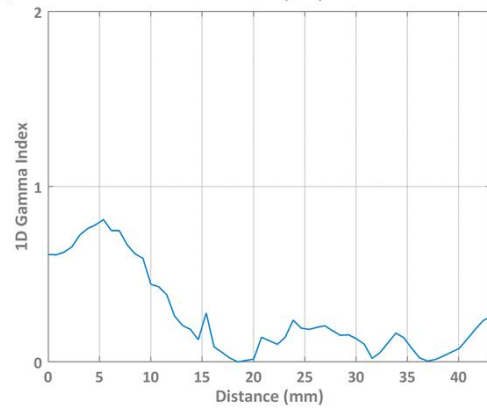
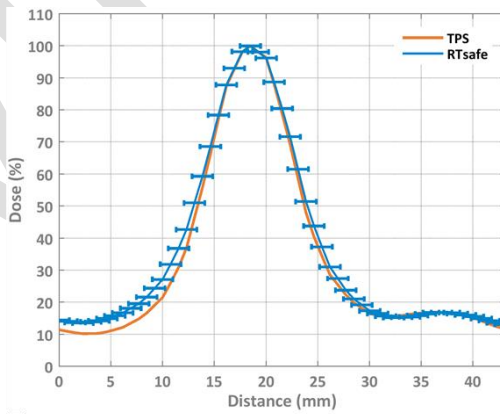
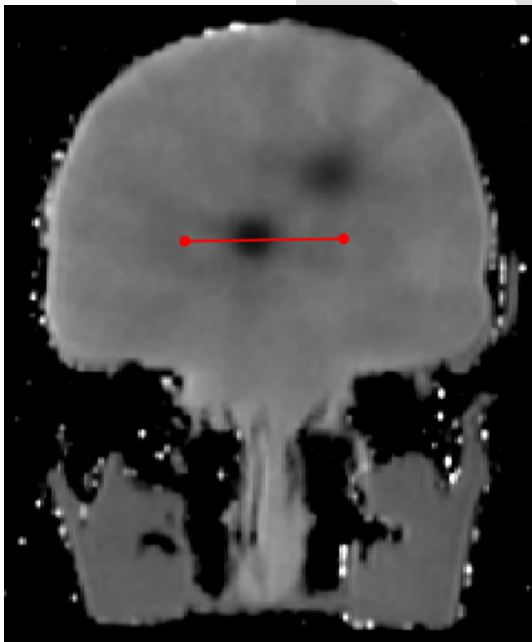
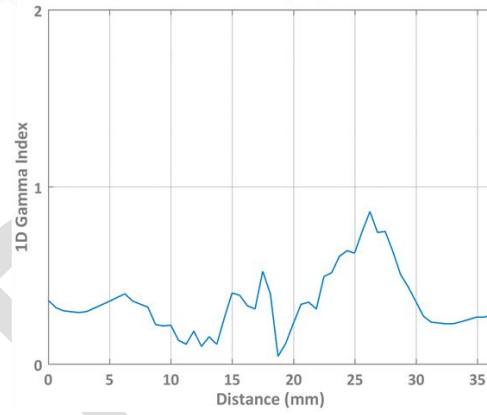
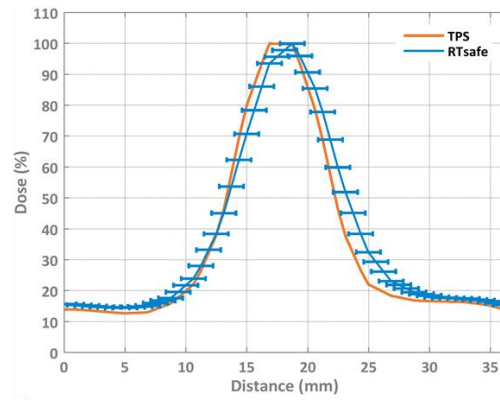
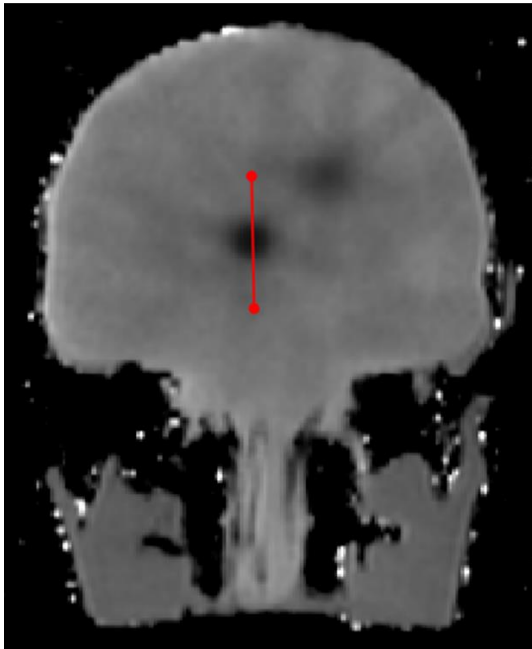


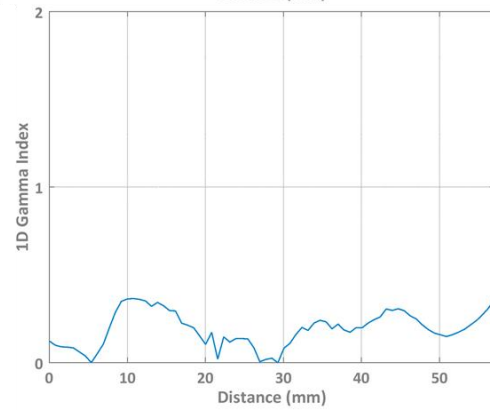
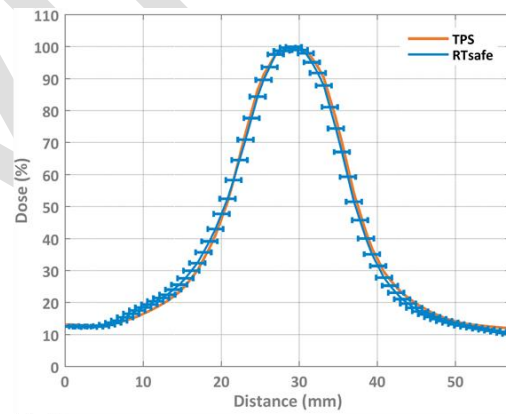
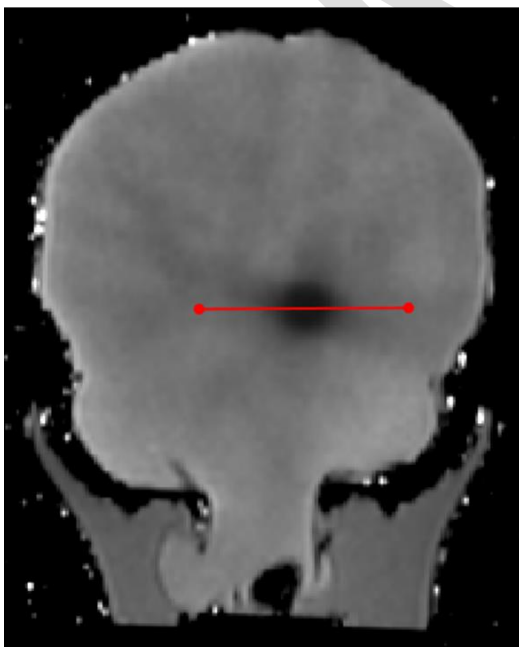
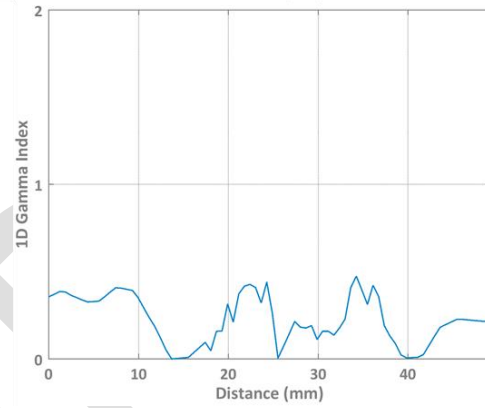
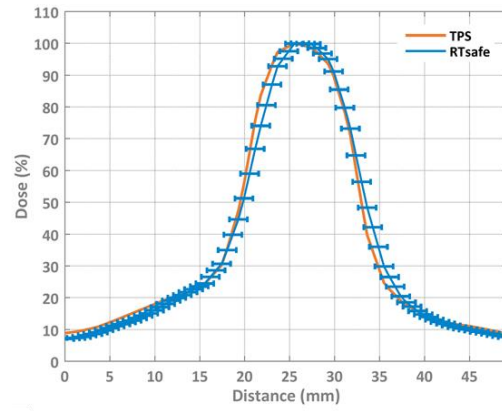
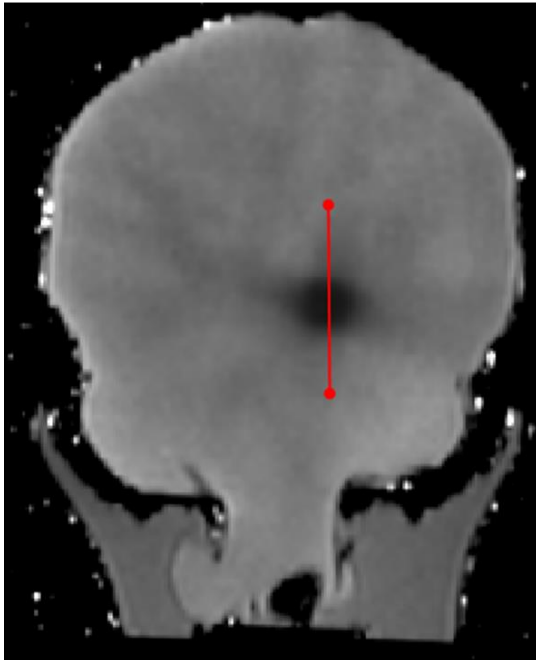




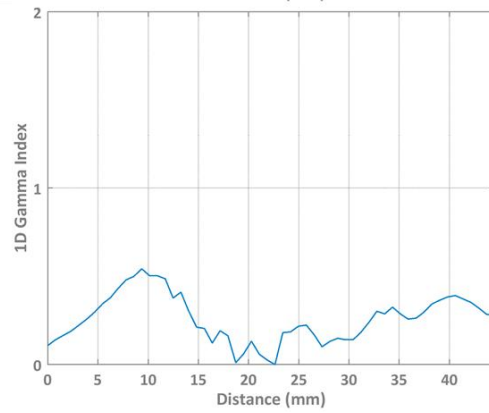
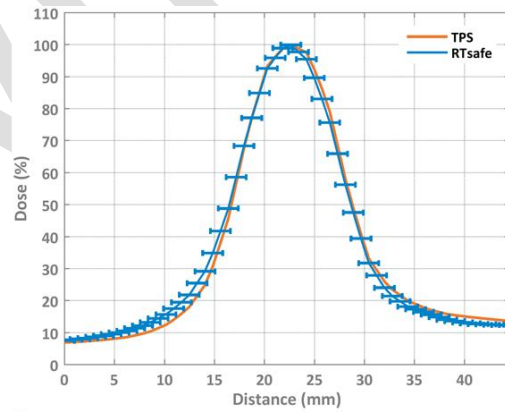
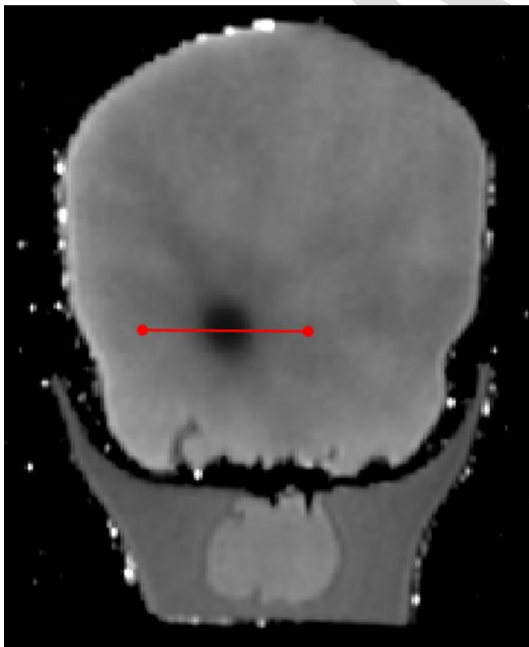
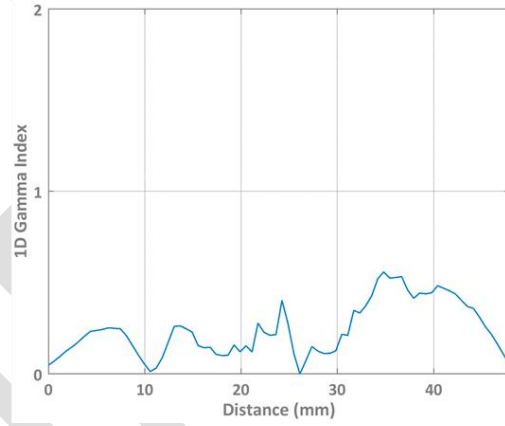
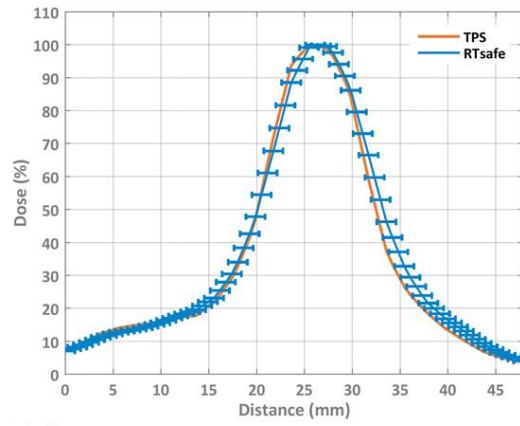
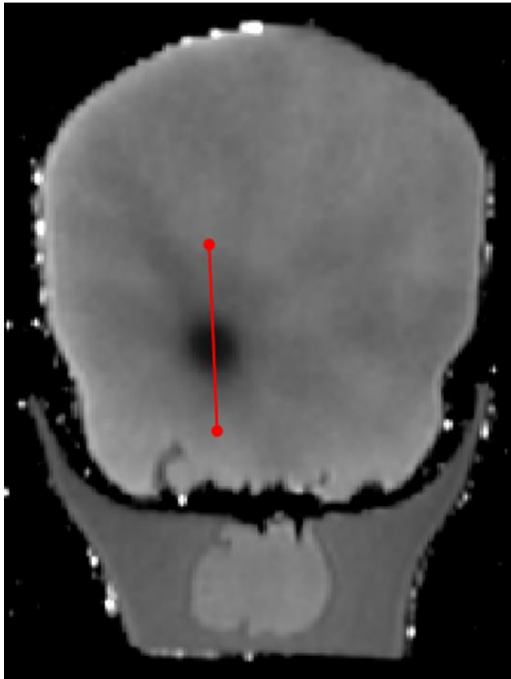




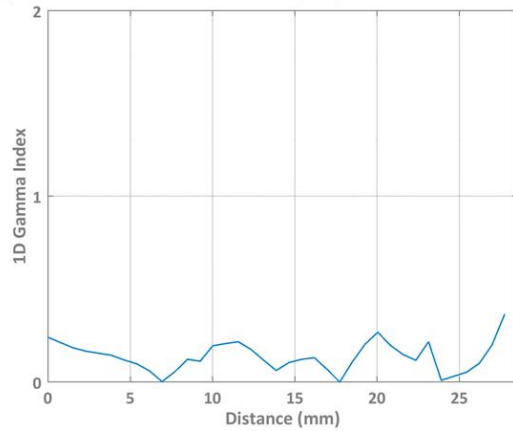
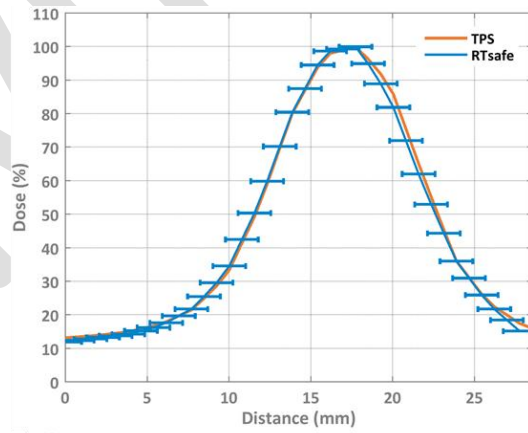
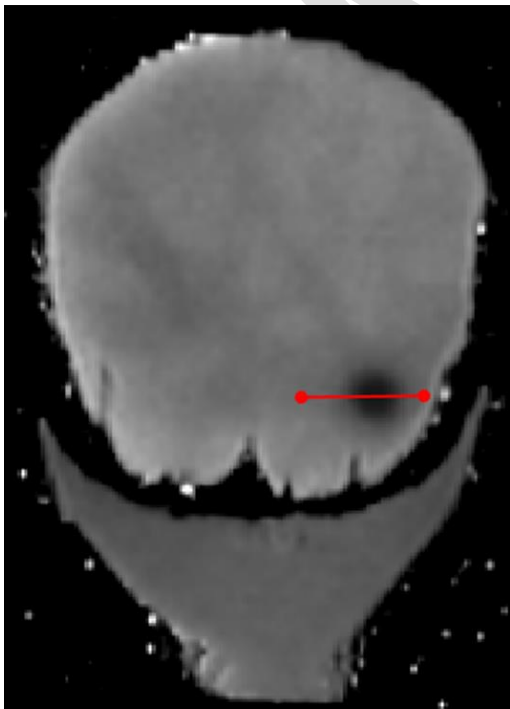
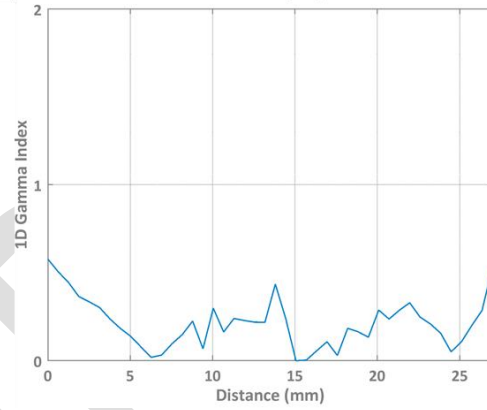
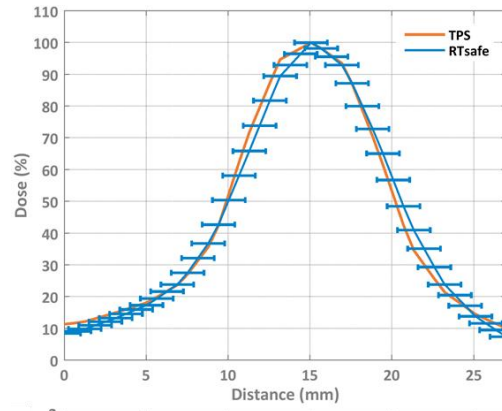
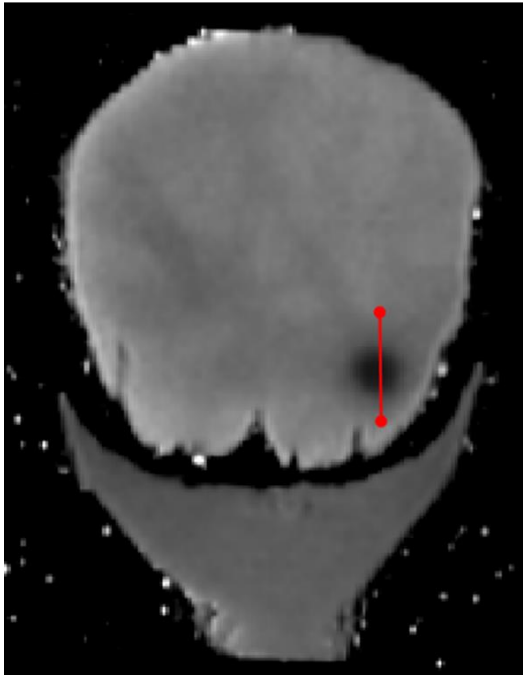


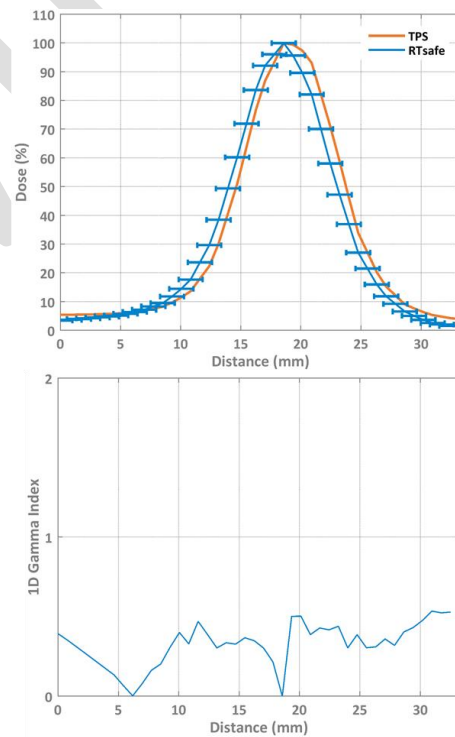
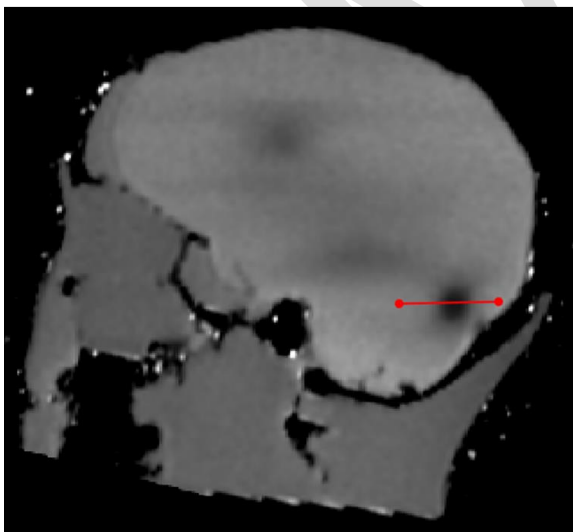
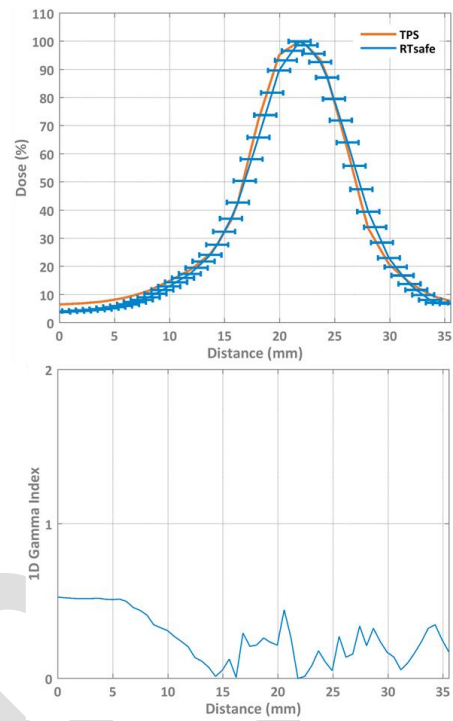
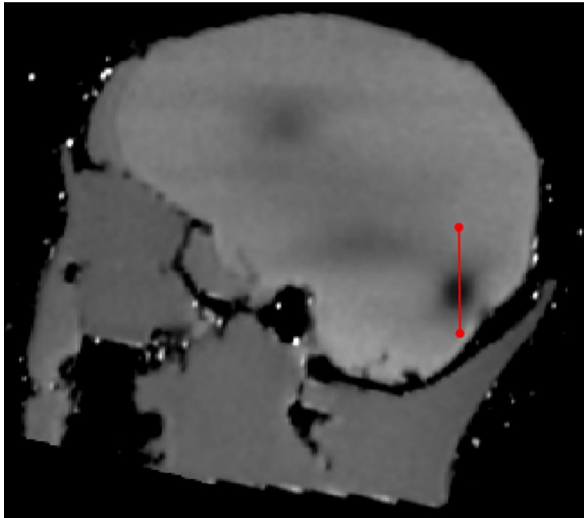


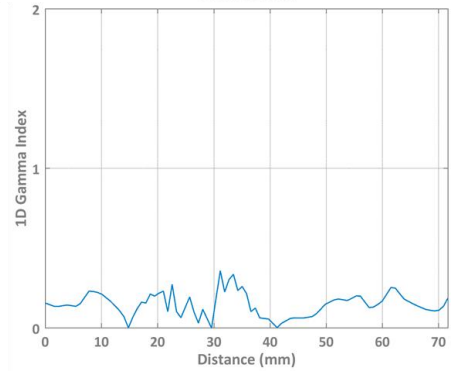
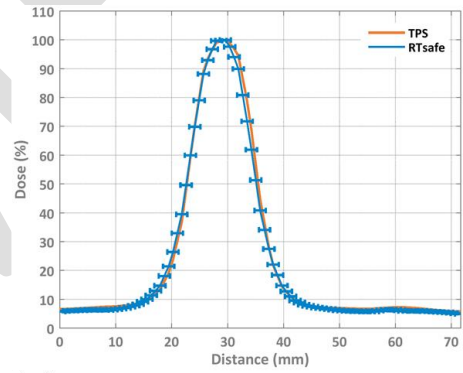
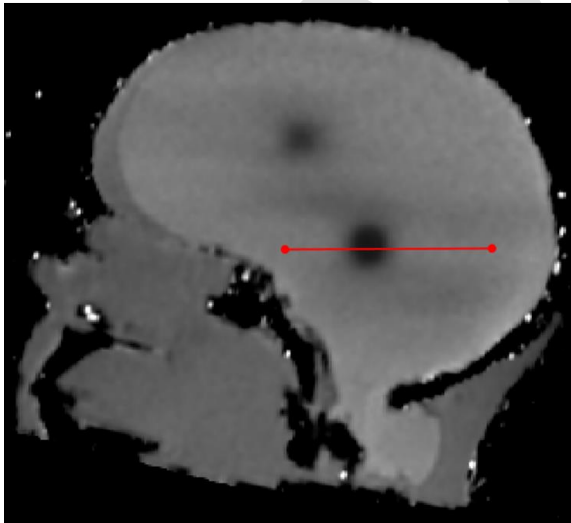
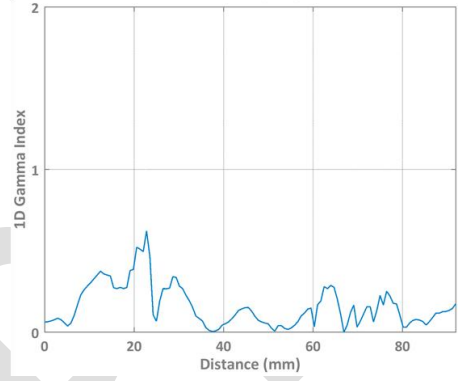
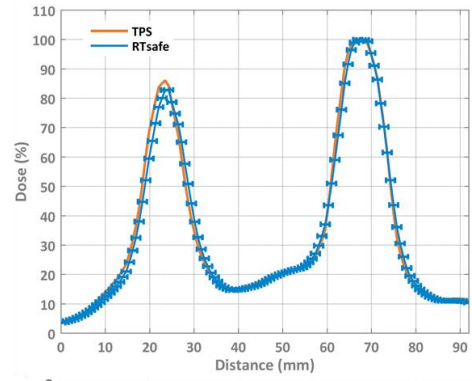
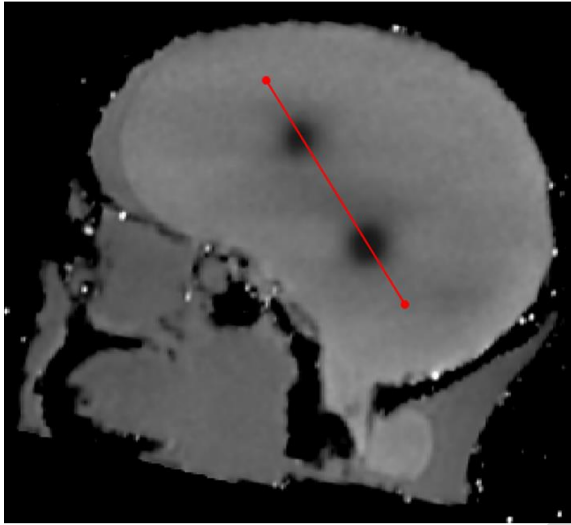


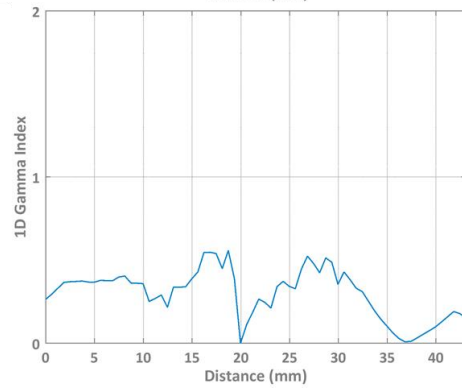
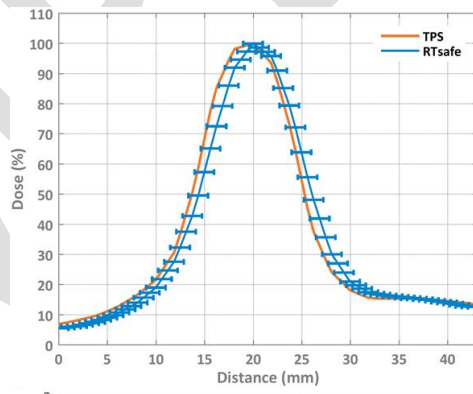
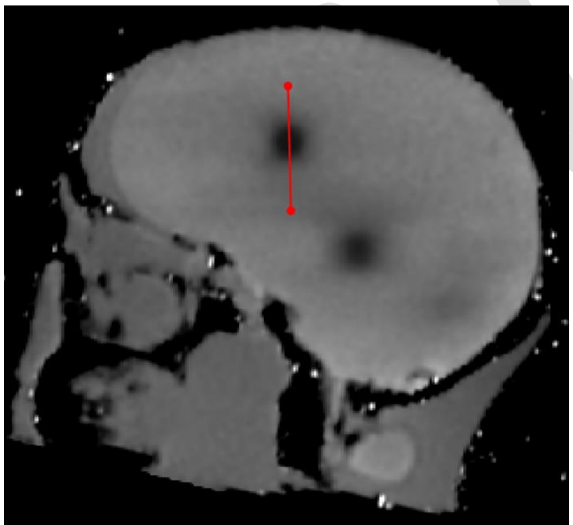
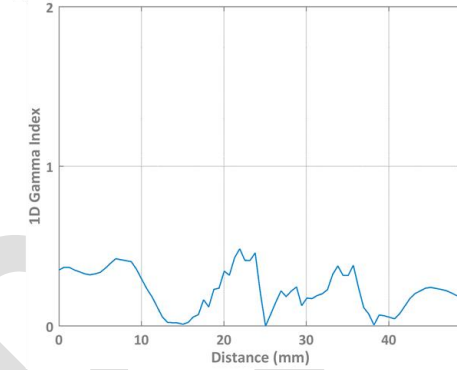
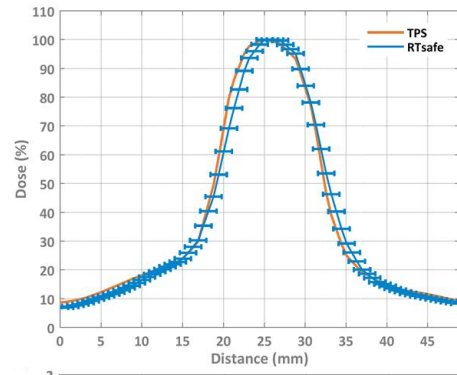
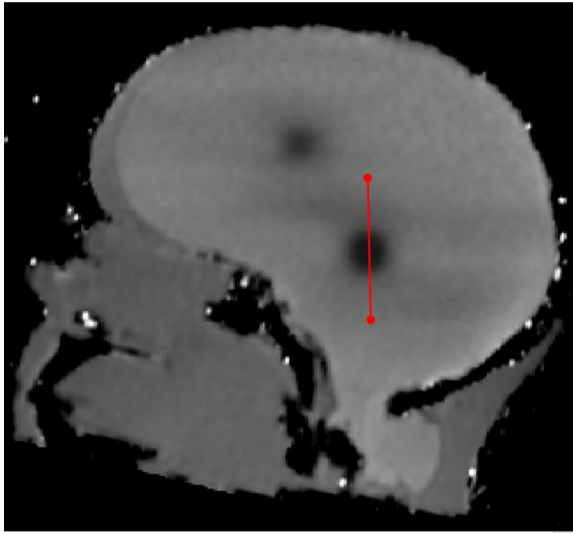


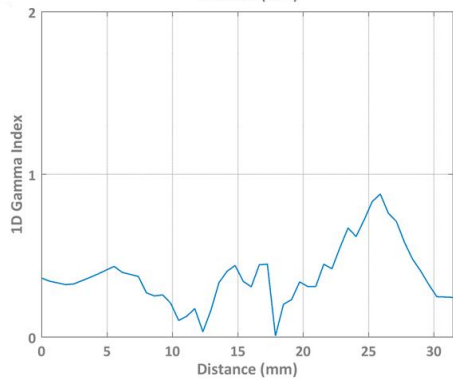
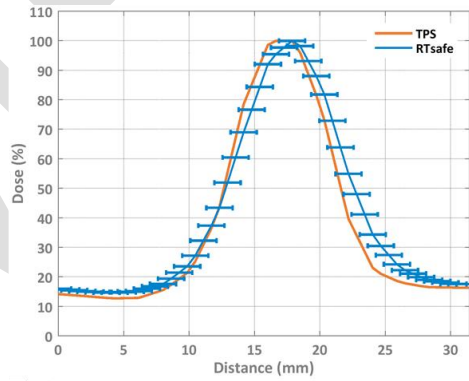
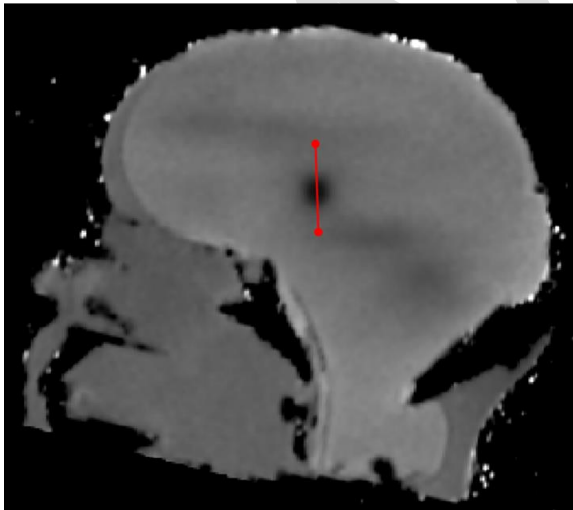
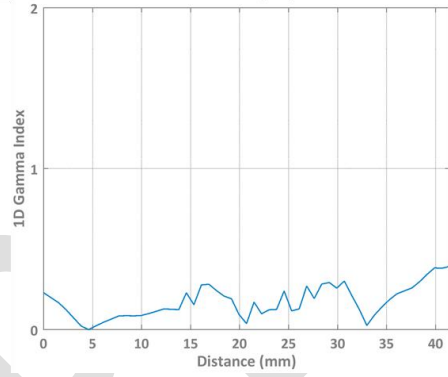
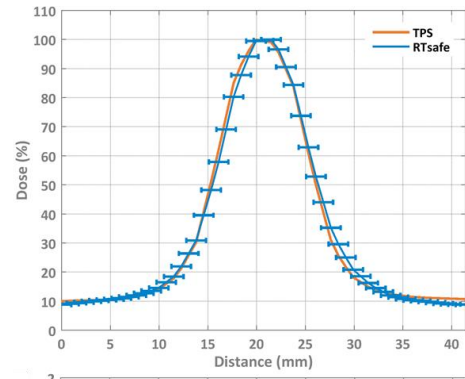
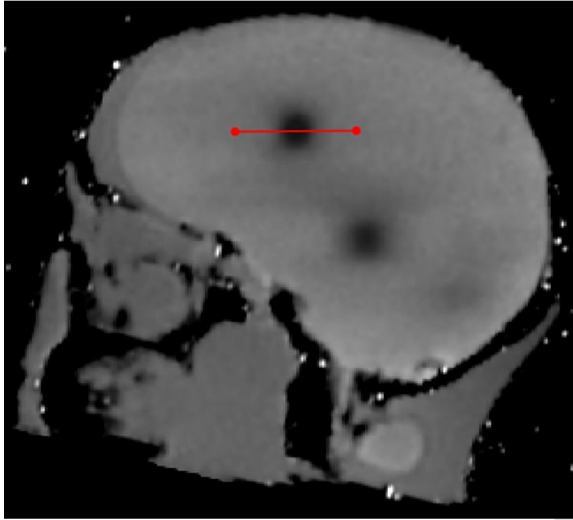


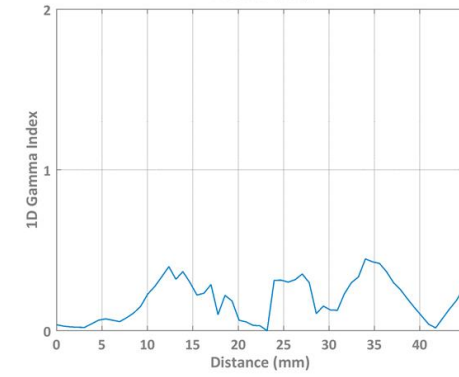
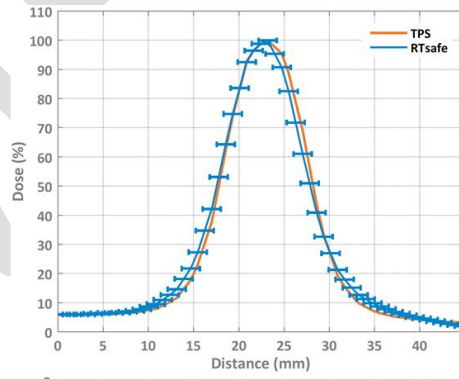
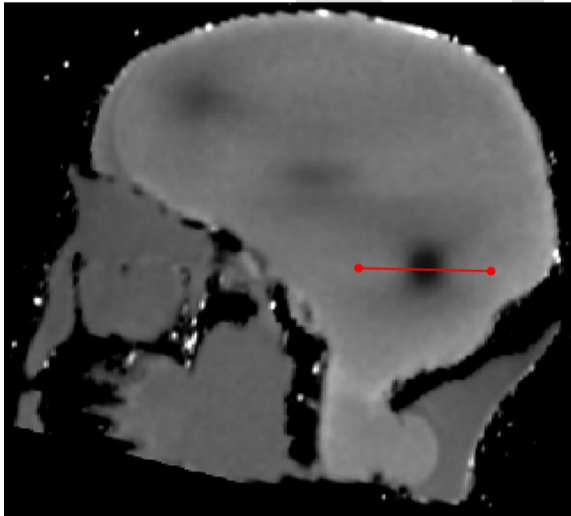
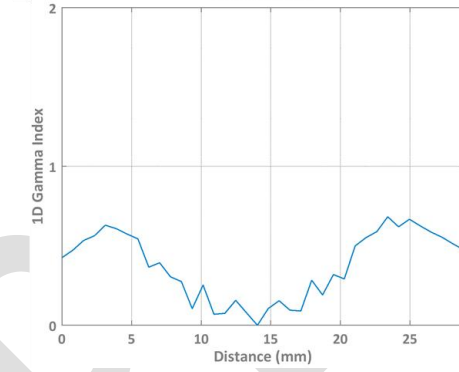
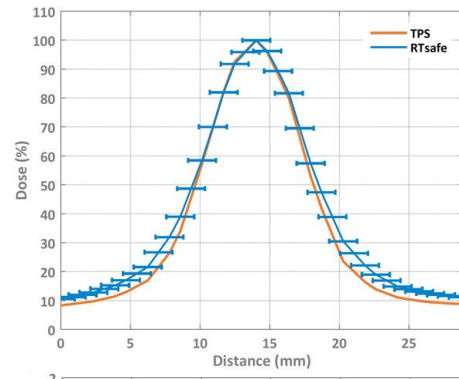
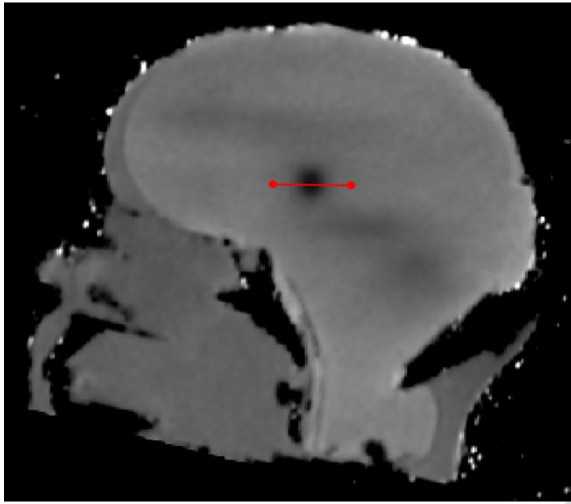


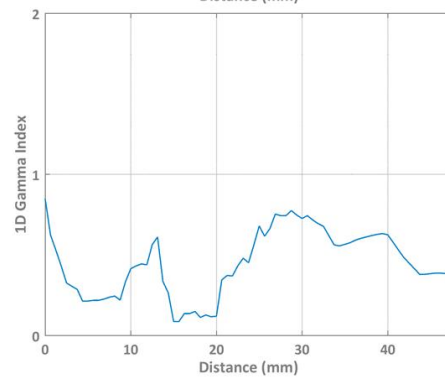
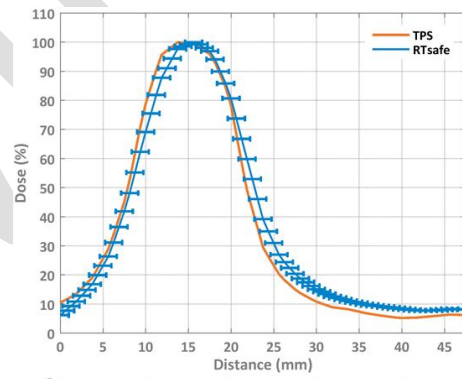
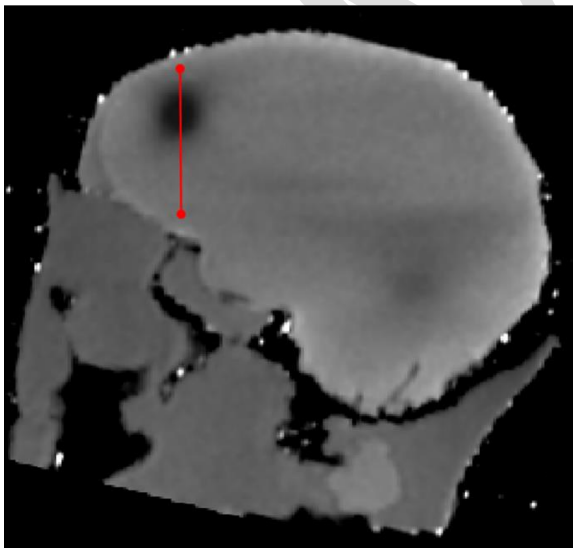
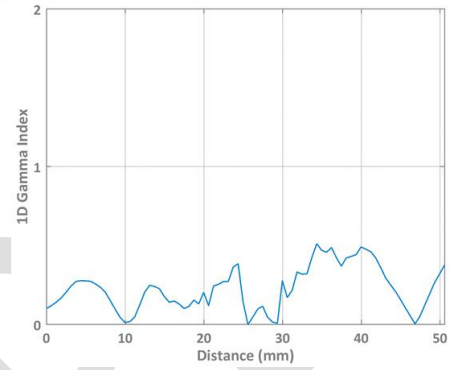
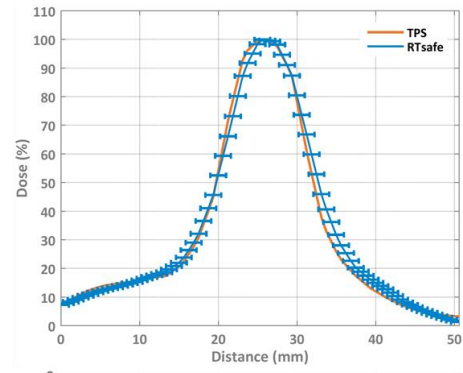
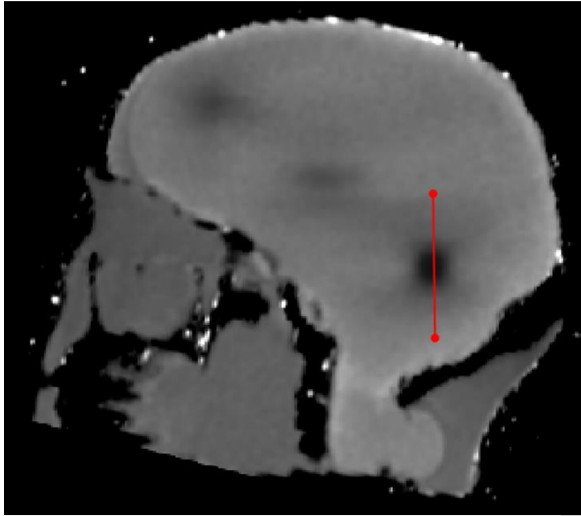




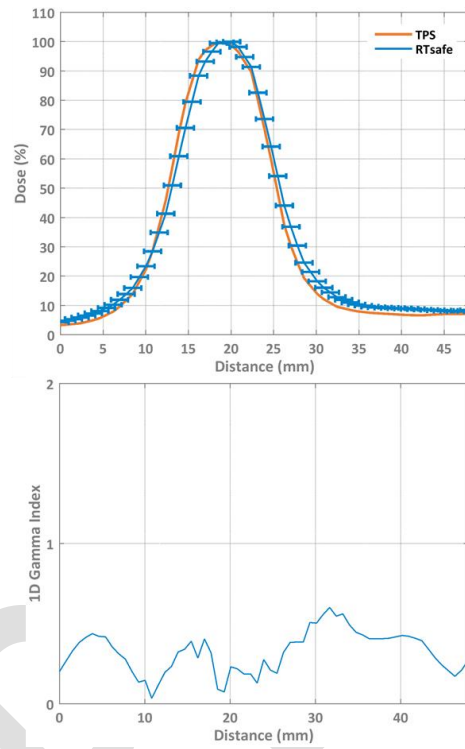
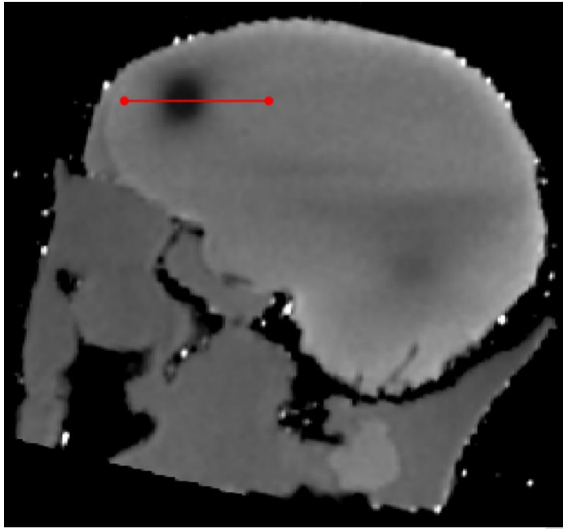












### PART III: 2D Gamma Index comparison

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.

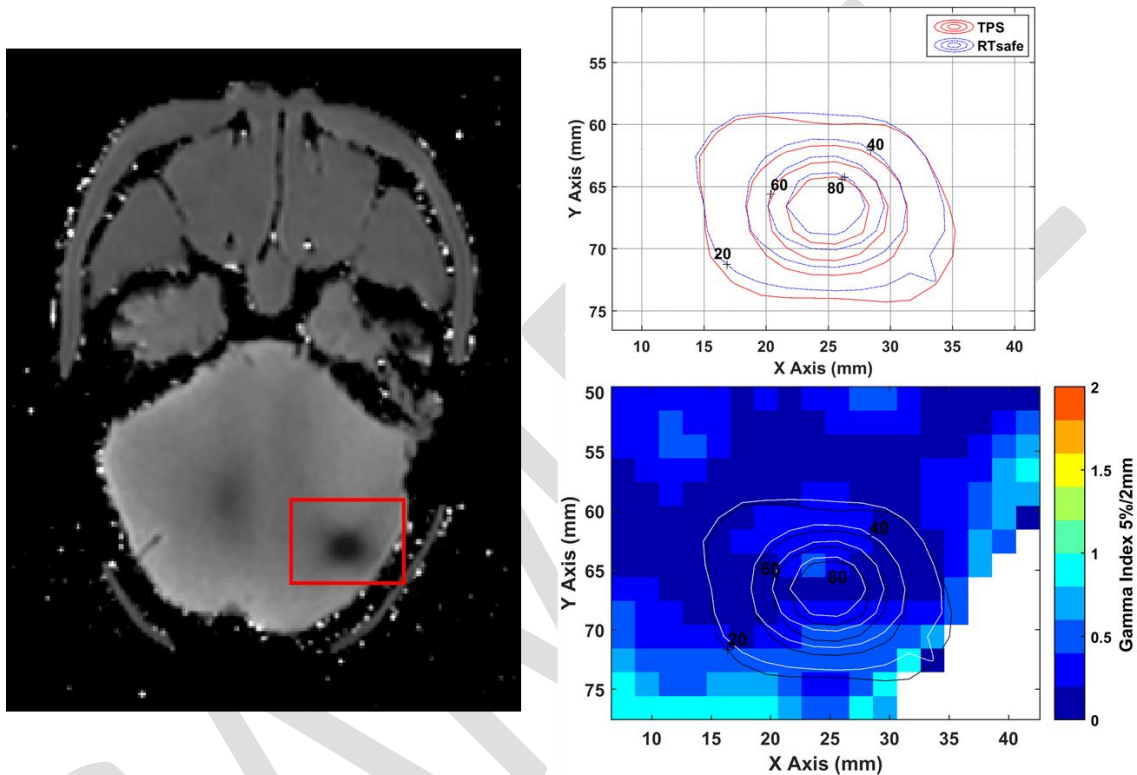
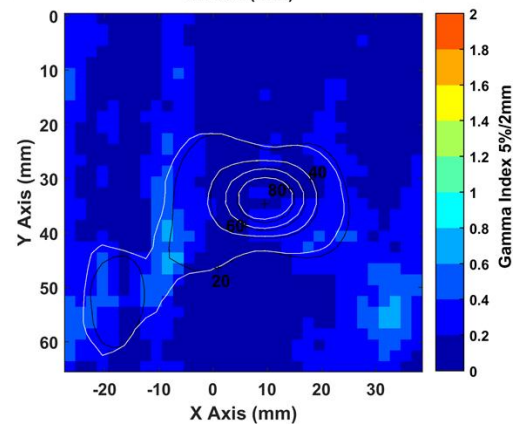
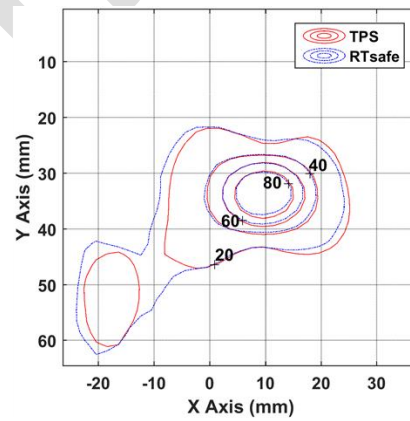
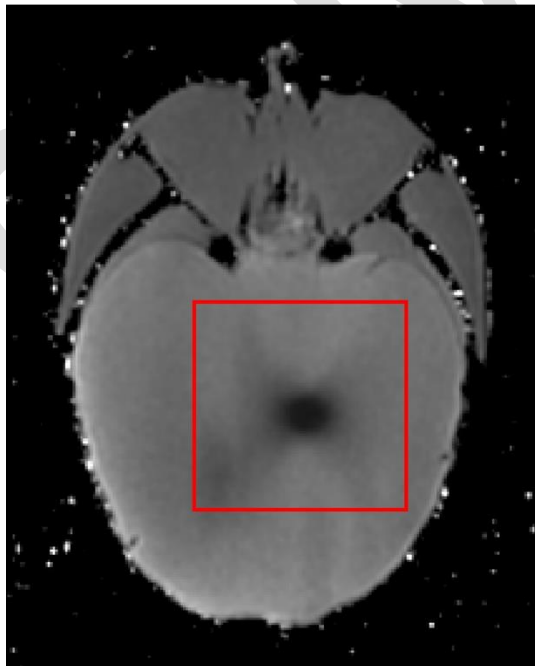
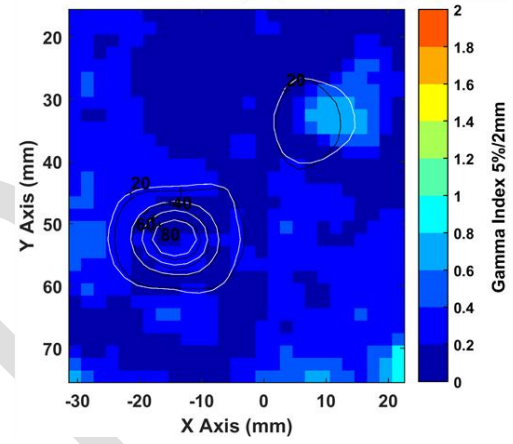
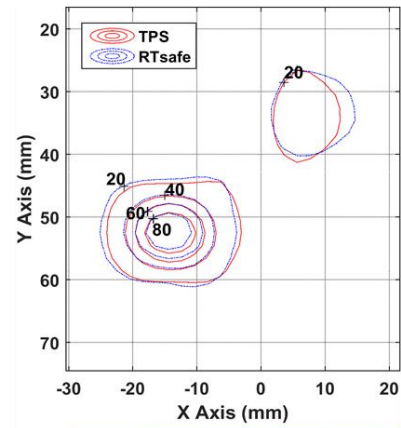
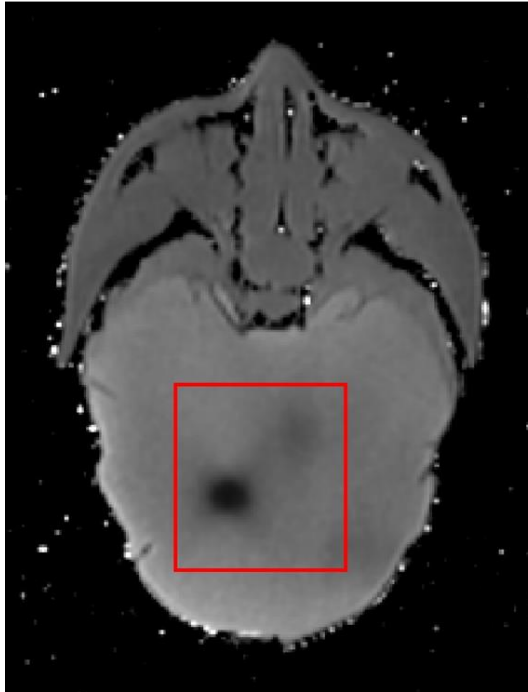
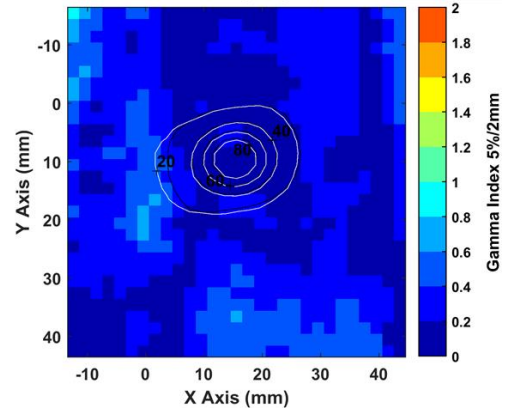
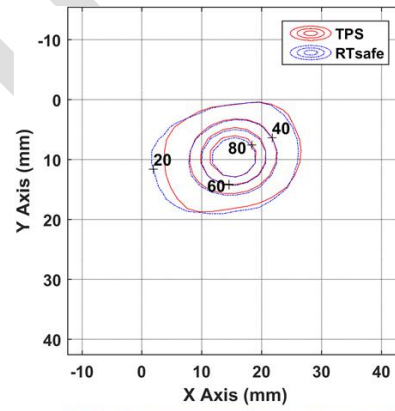
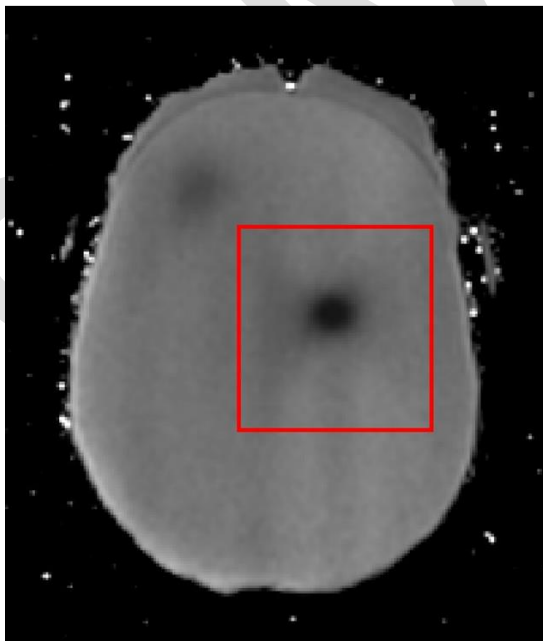
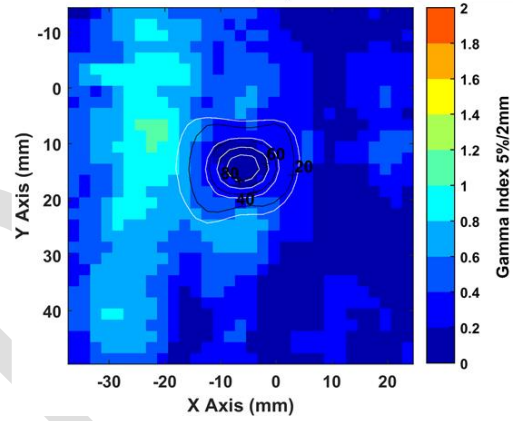
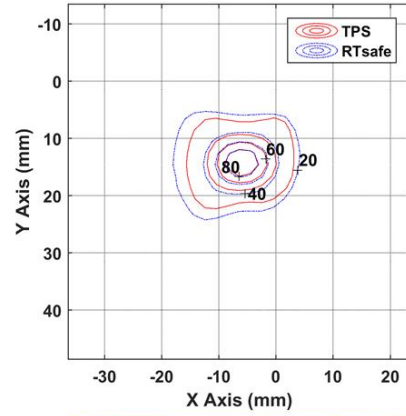
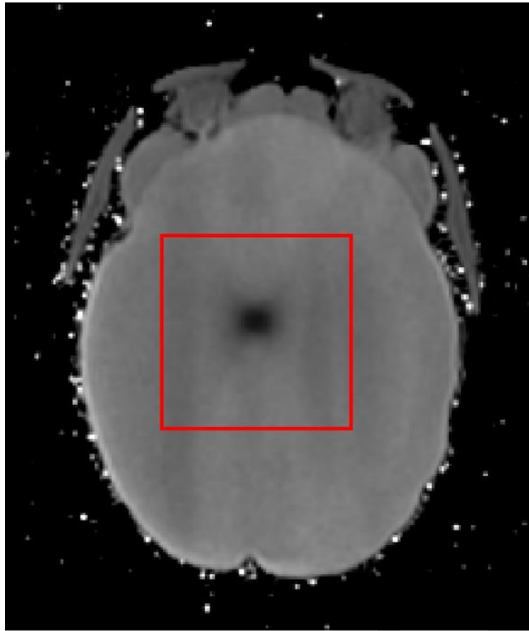
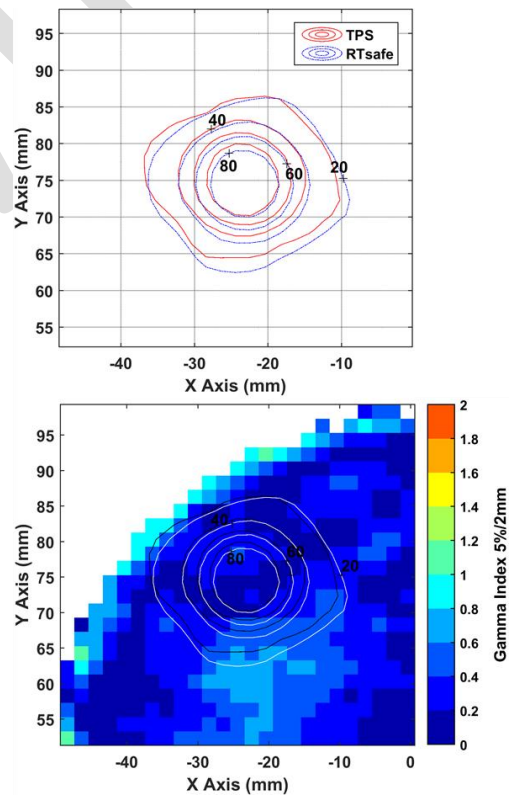
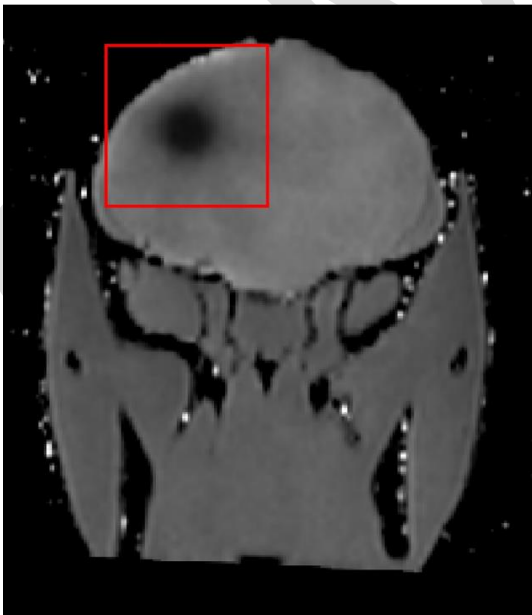
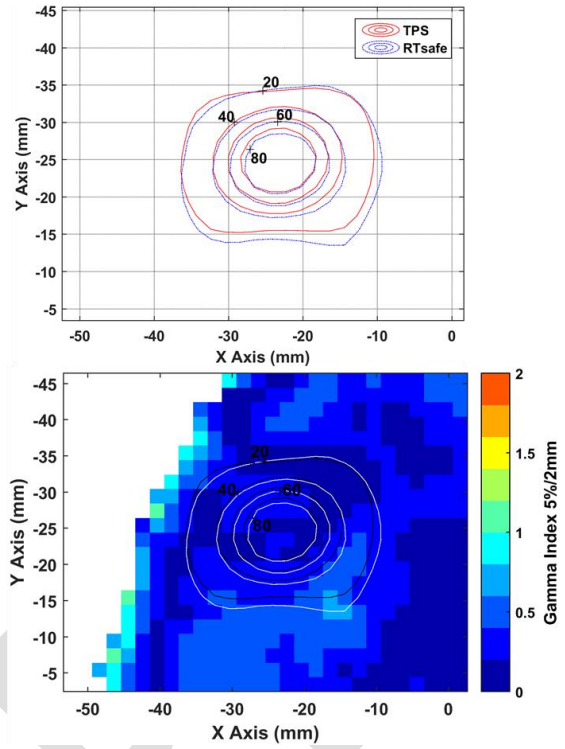
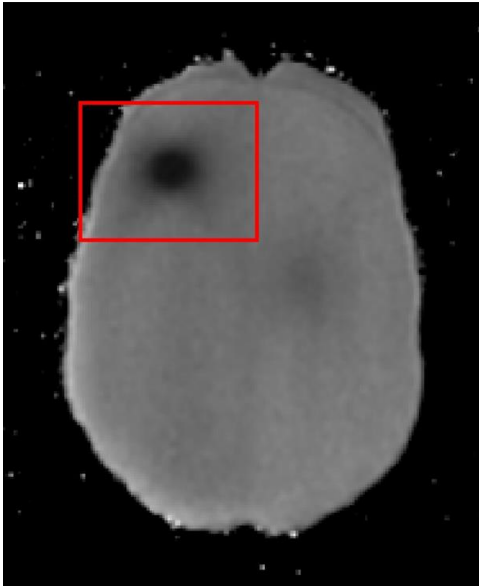


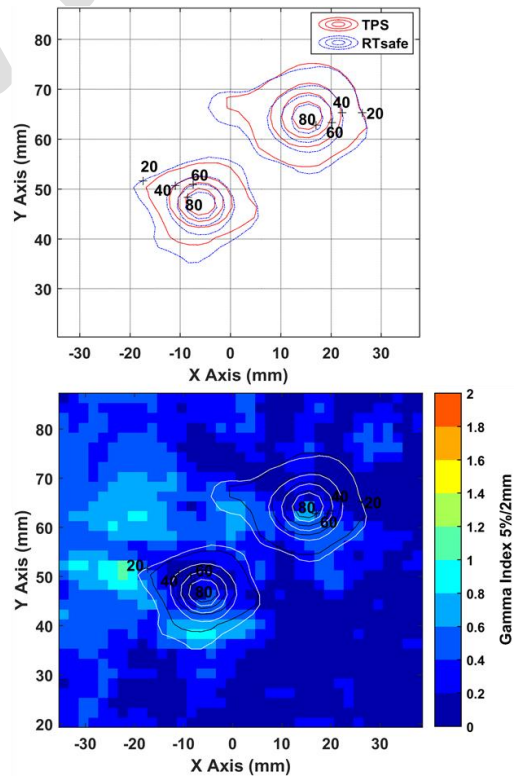
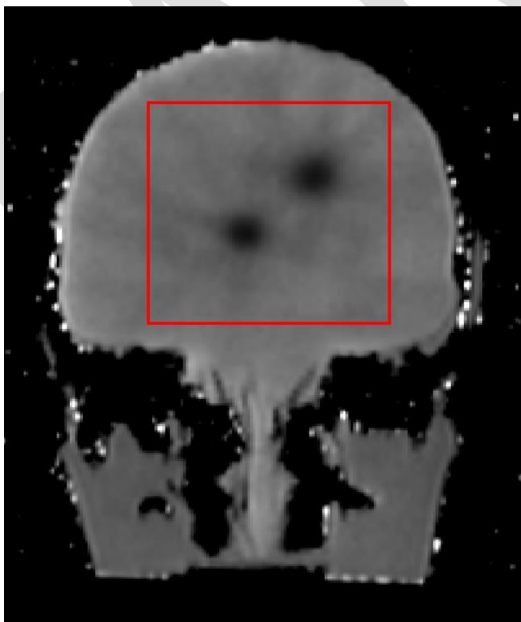
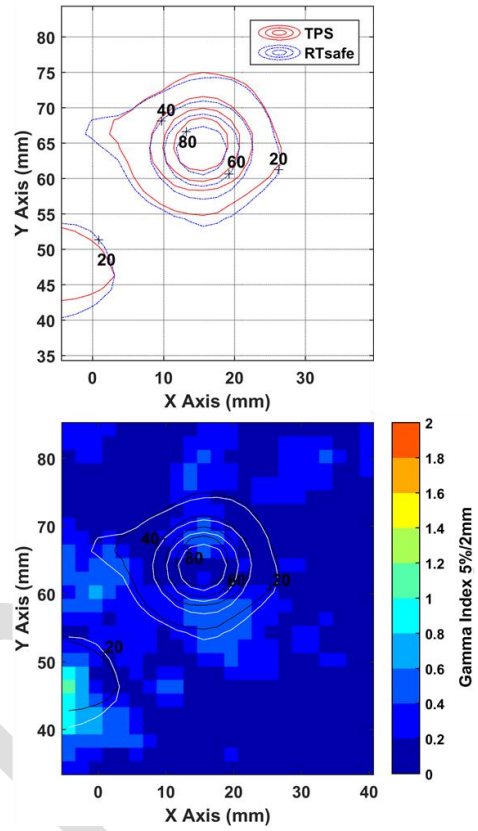
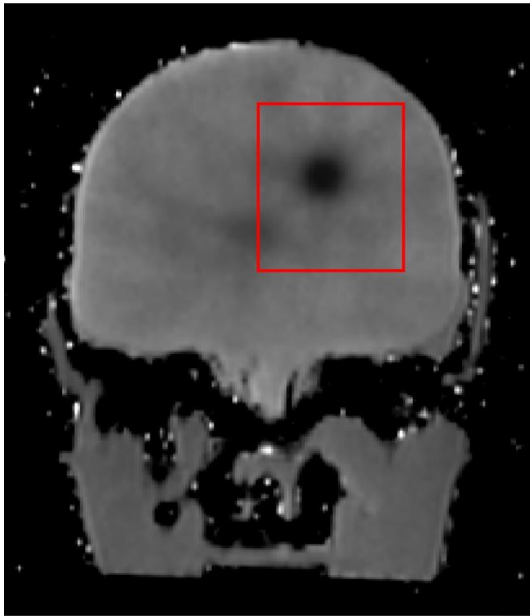
Figure: (left) Slice of the derived T2 maps of the irradiated phantom. High dose regions correspond to darker areas. (right) 2D comparison between calculated (TPS) and measured (RTsafe) dose distributions at the location depicted by the red contour. 2D gamma index calculations are also given using passing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

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

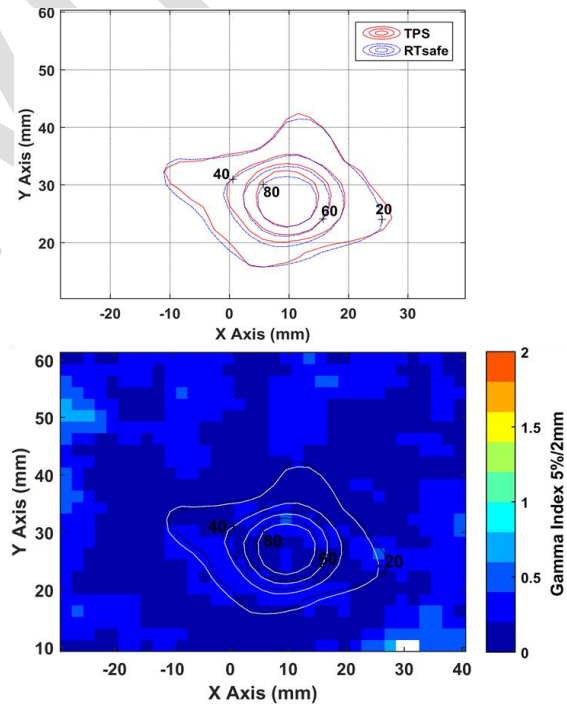
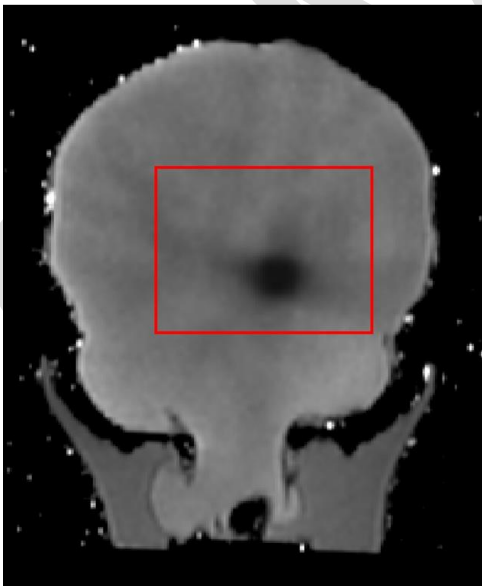
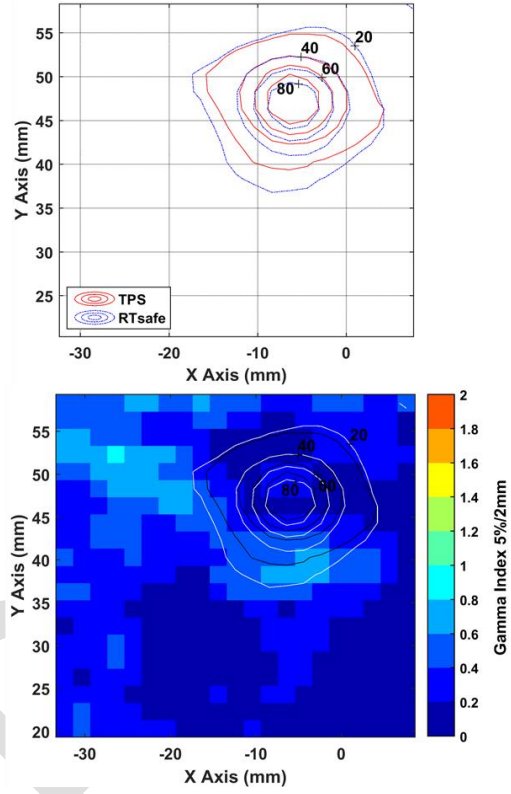
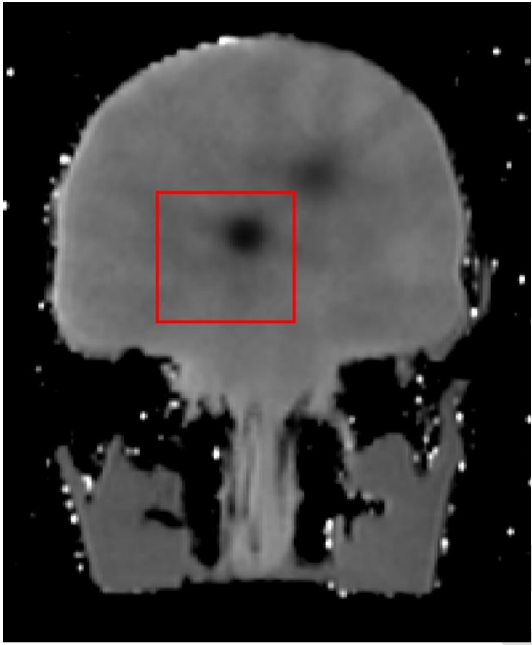




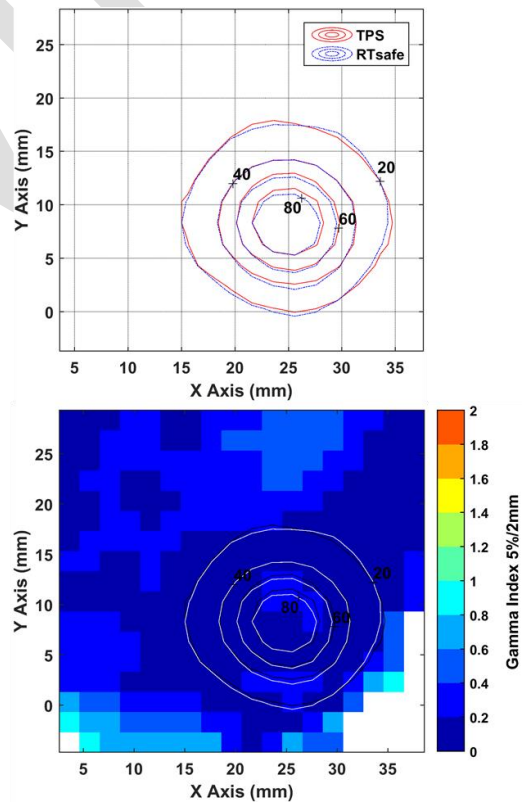
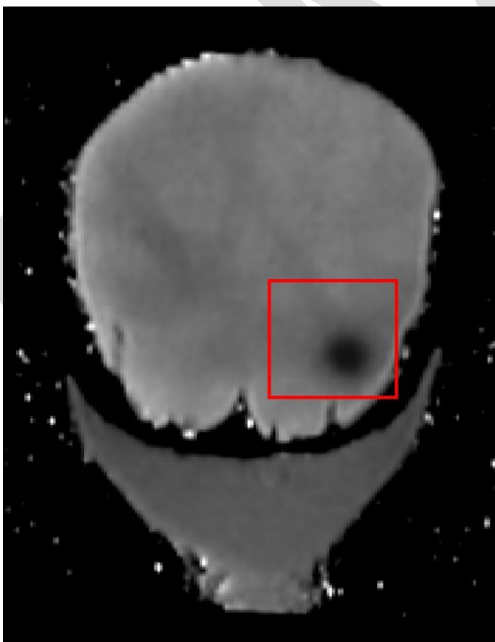
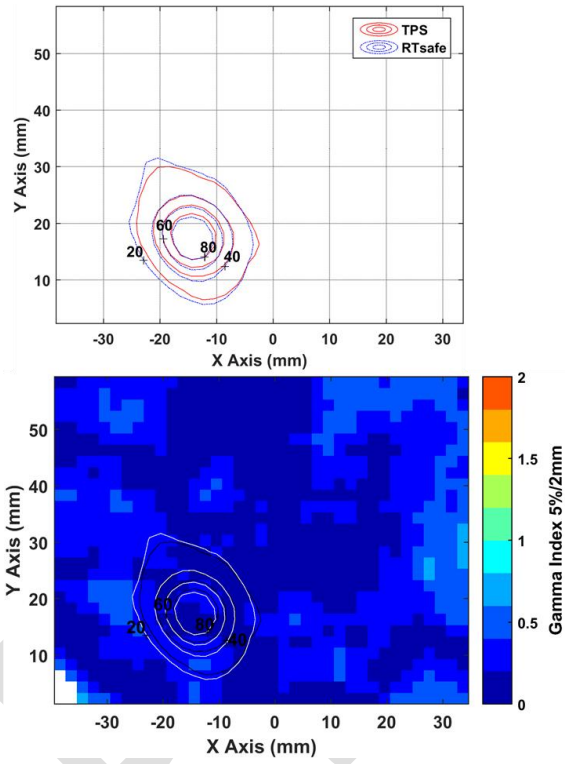
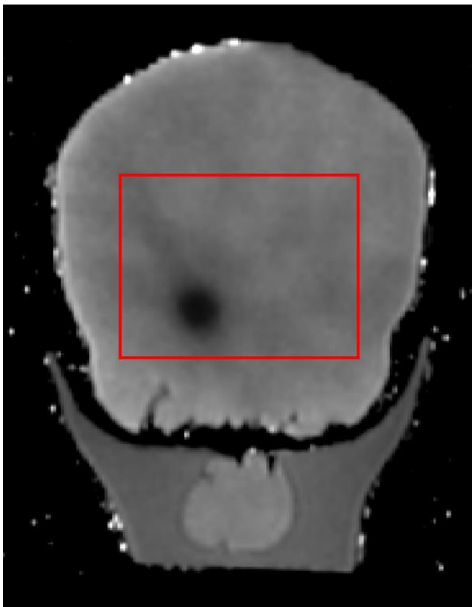


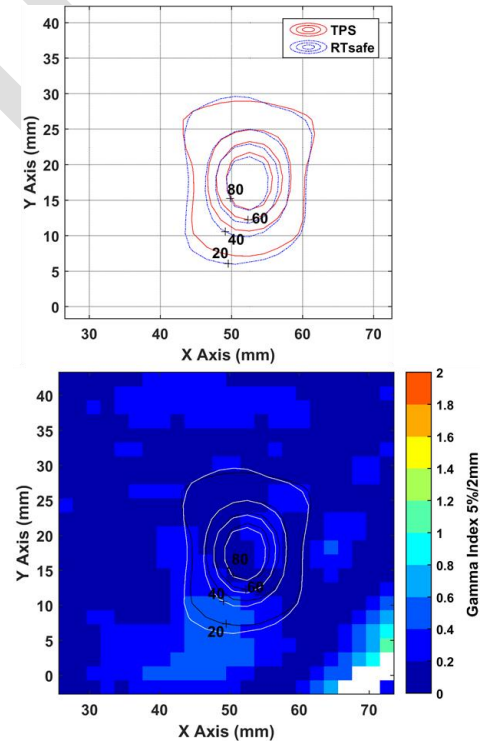
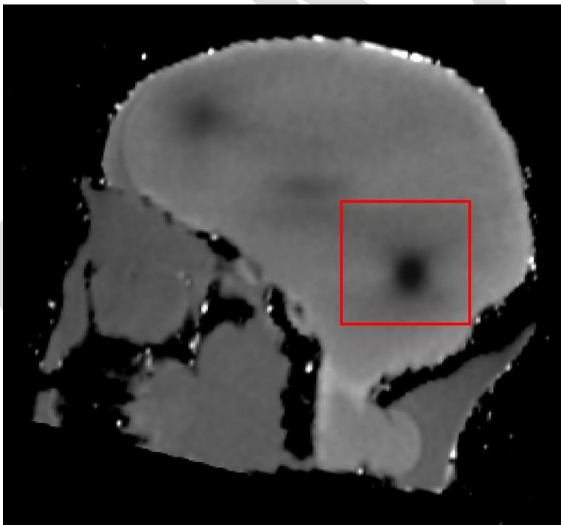
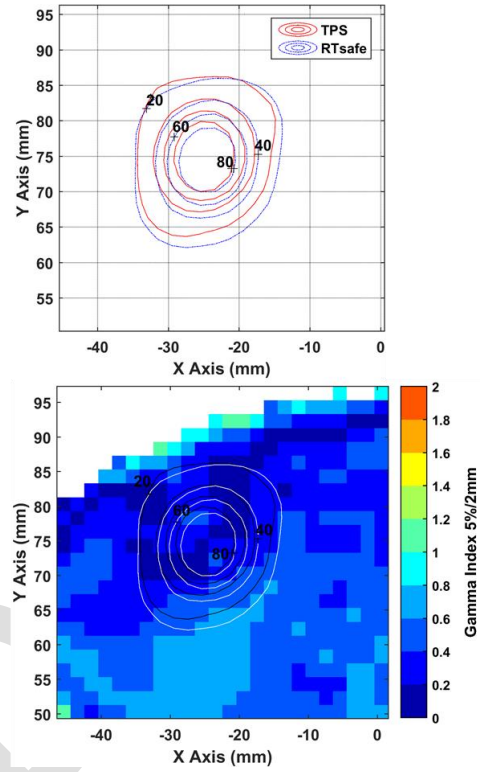
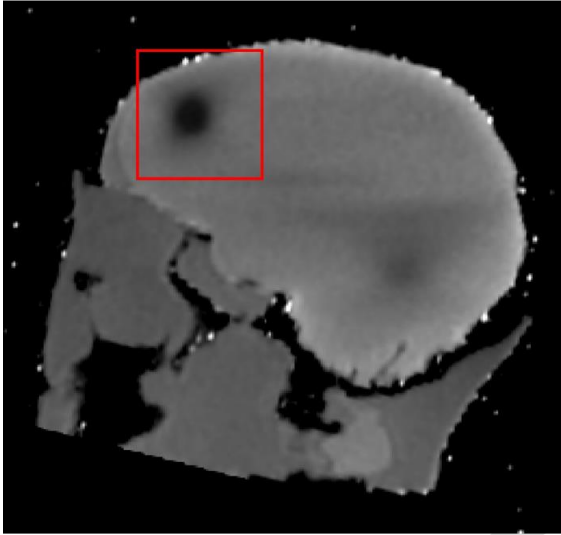


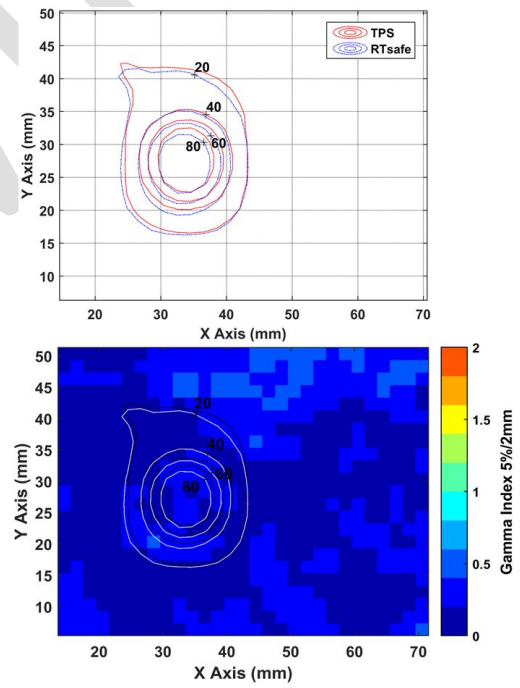
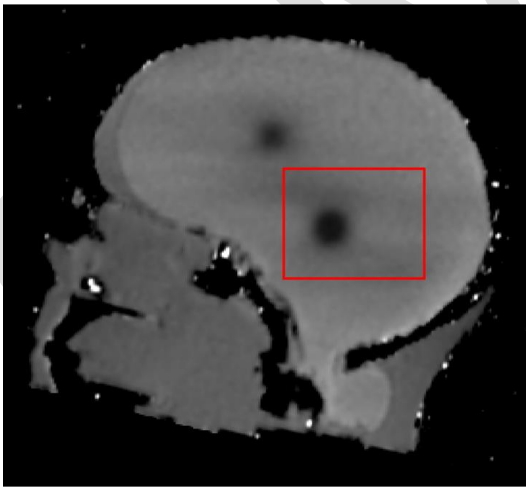
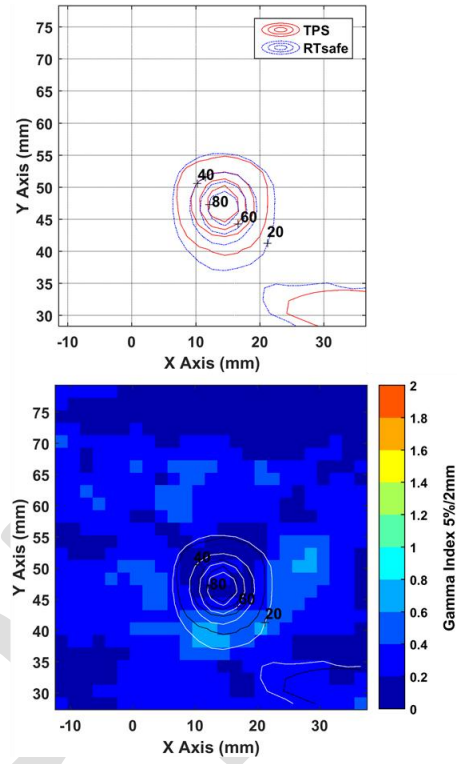
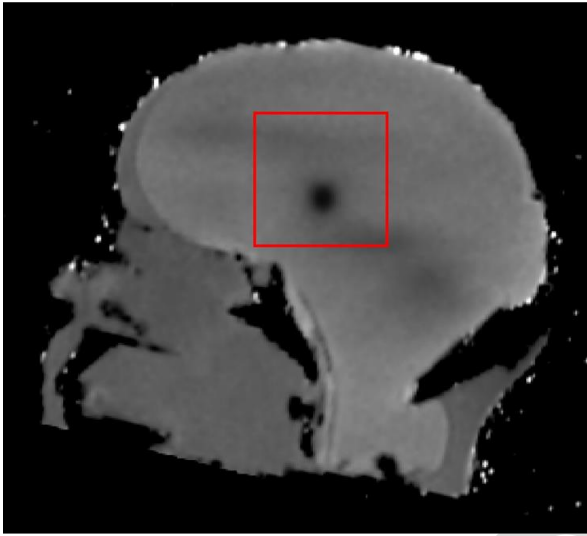


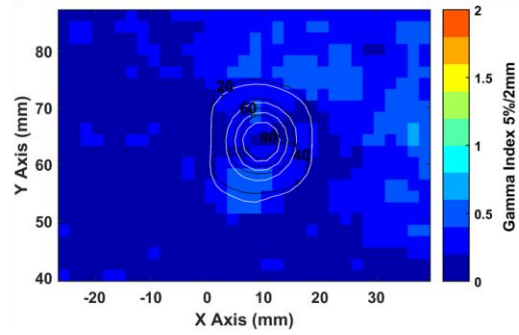
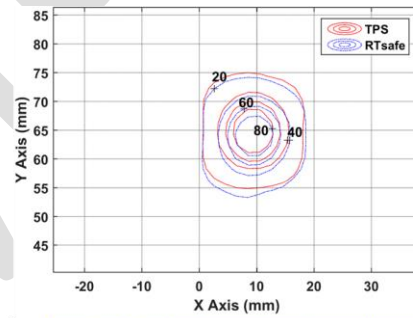
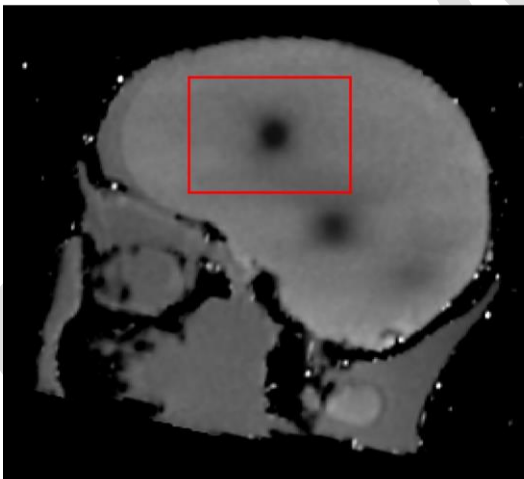
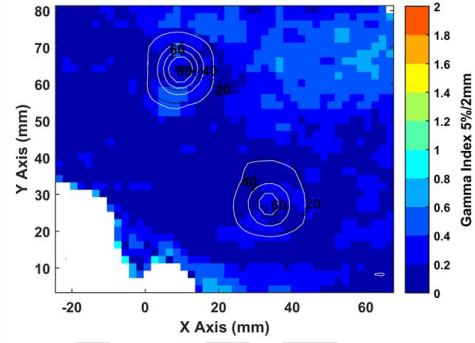
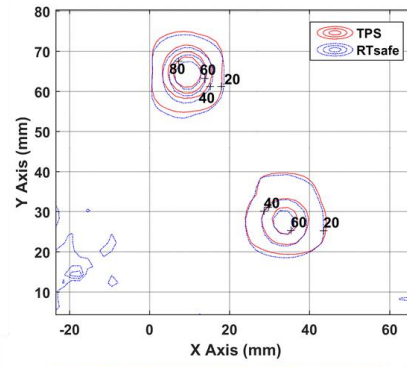
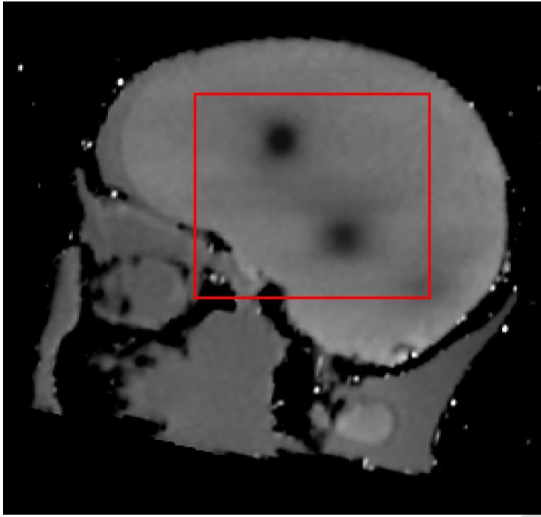


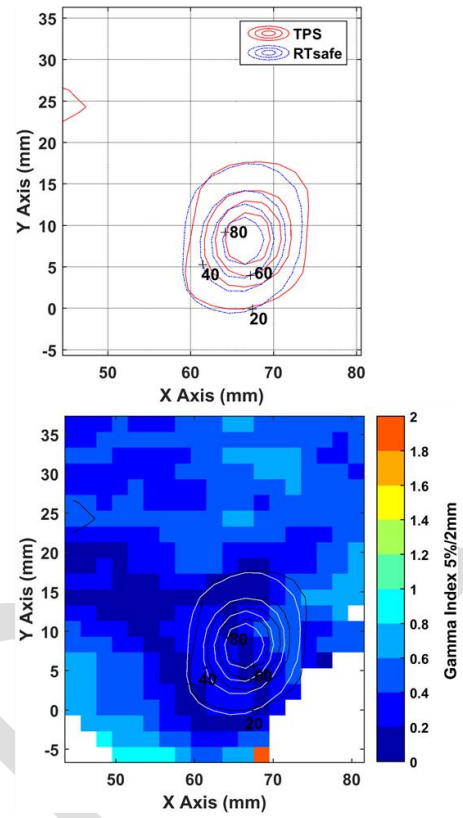
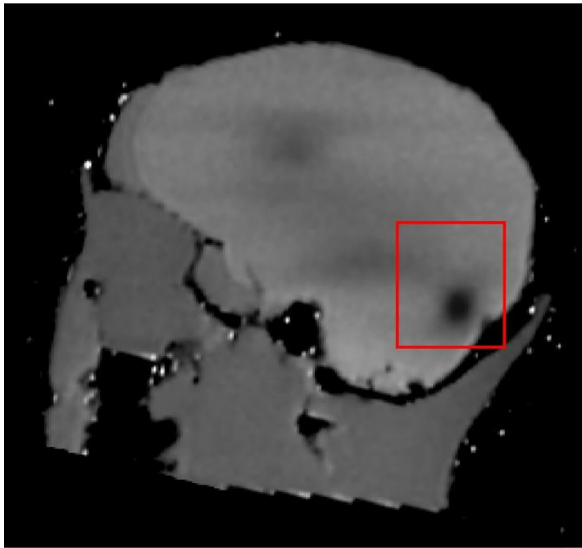












#### **PART IV: 3D Gamma Index comparison**

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 $\leq$ 1 (%)
Met 01 6mm	2	5	100.00
	1	5	99.91
	2	3	99.34
	1	3	96.21
Met 02 10mm	2	5	99.93
	1	5	99.85
	2	3	99.78
	1	3	99.33
Met 03 8mm	2	5	99.96
	1	5	99.92
	2	3	99.86
	1	3	99.20
Met 04 8mm	2	5	99.93
	1	5	99.92
	2	3	99.54
	1	3	99.19
Met 05 10mm	2	5	99.85
	1	5	98.50
	2	3	98.28

	1	3	86.98
	2	5	99.35
Met 06 6mm	1	5	97.72
	2	3	95.61
	1	3	90.89

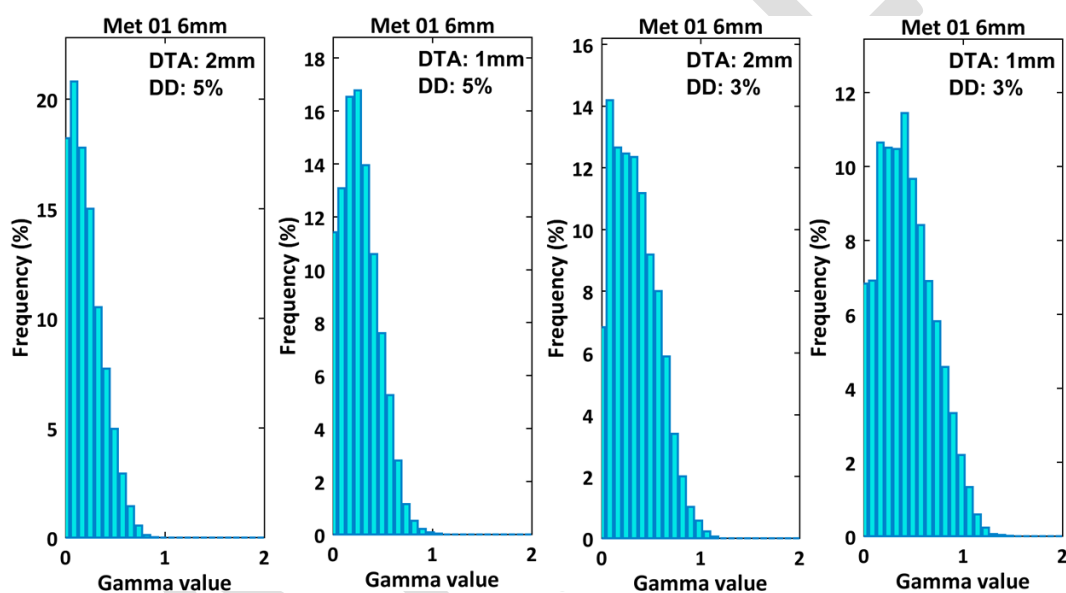
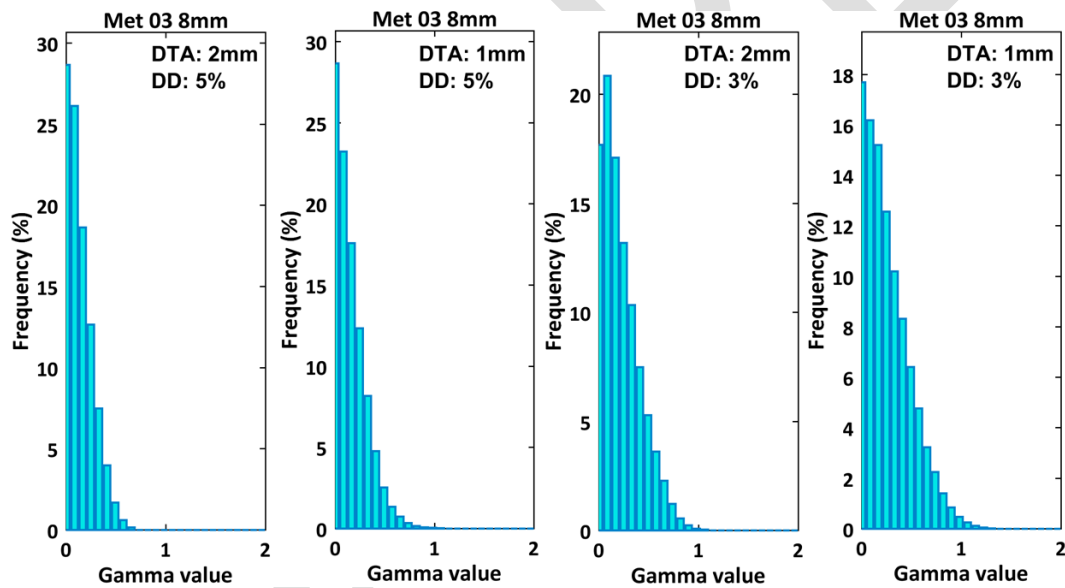
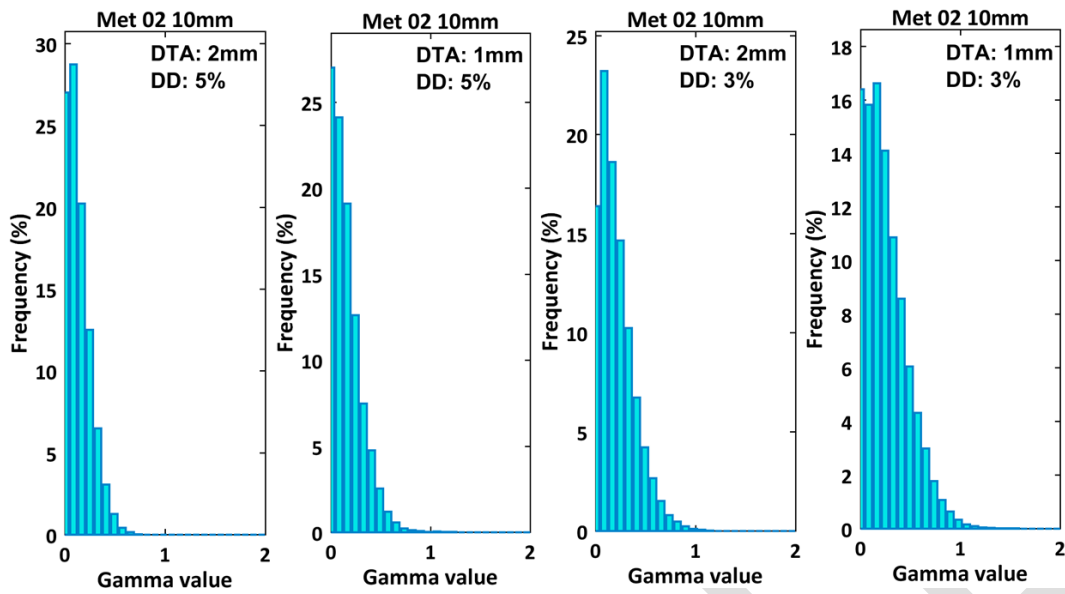
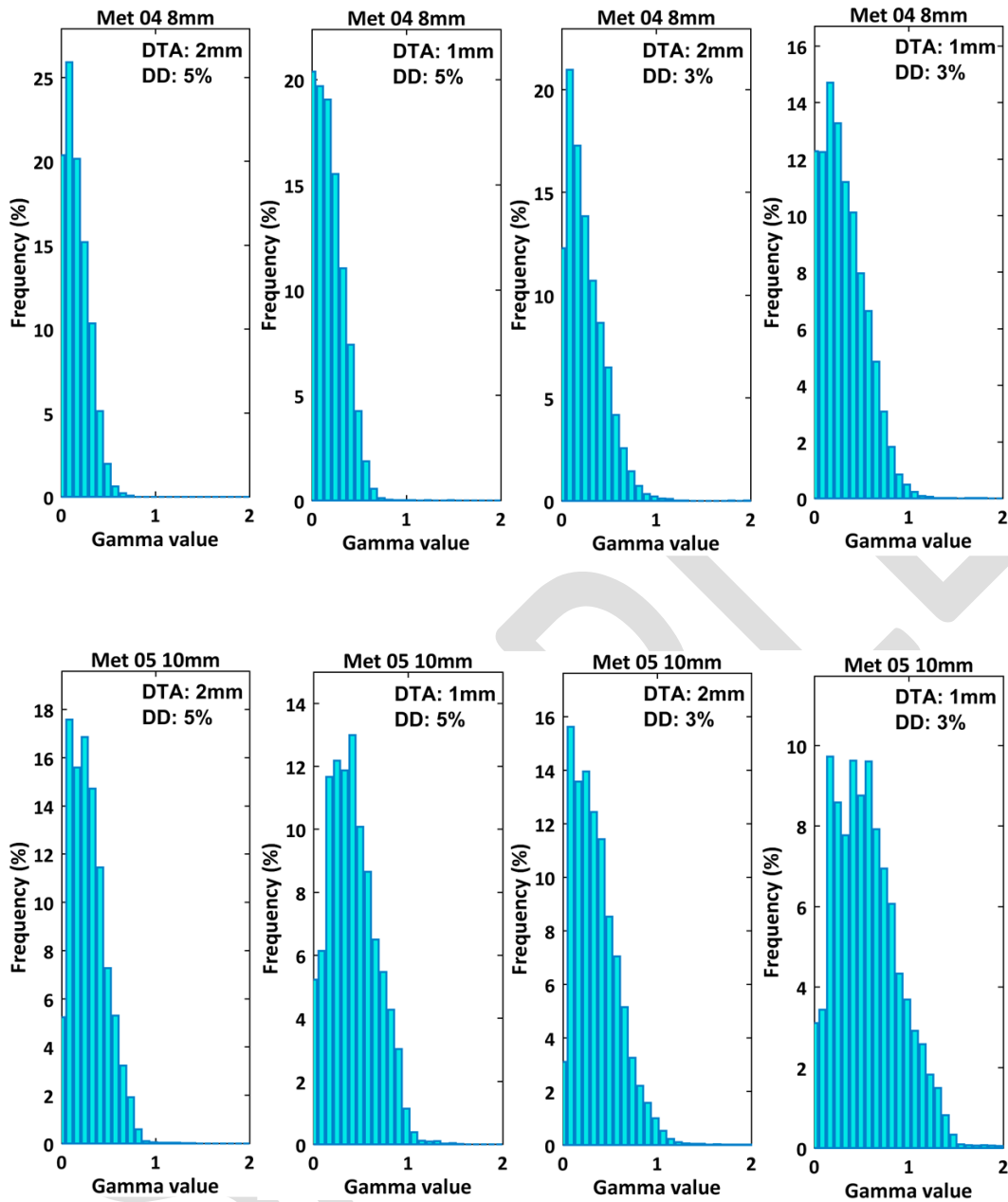


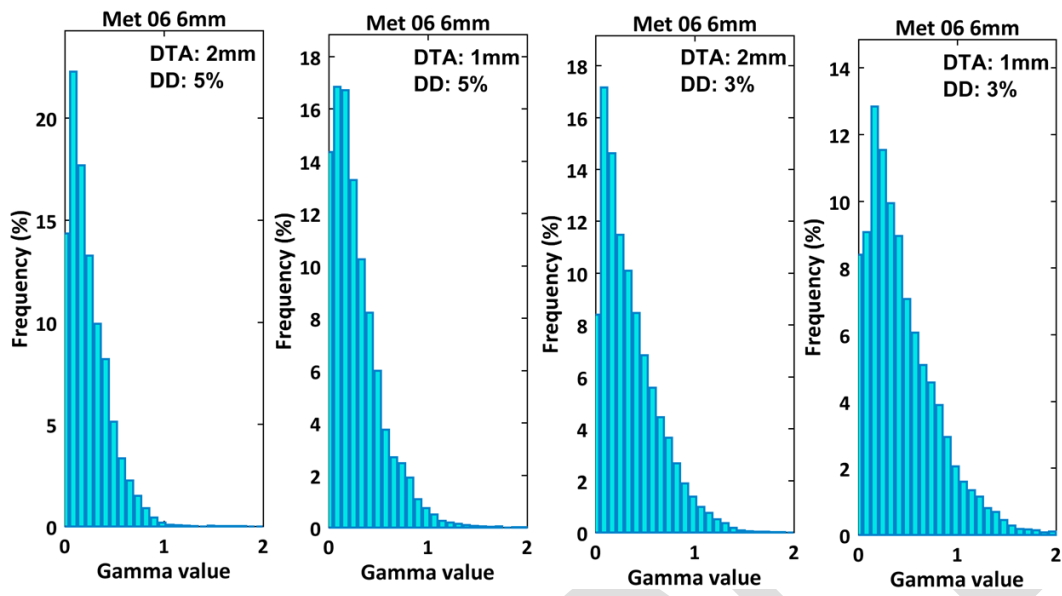
Figure: Histograms for the calculated gamma values of the 3D gamma index comparison test using a variety of passing criteria. The volume of interest considered for each target includes the total contoured volume along with an extended area of surrounding soft tissue.

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



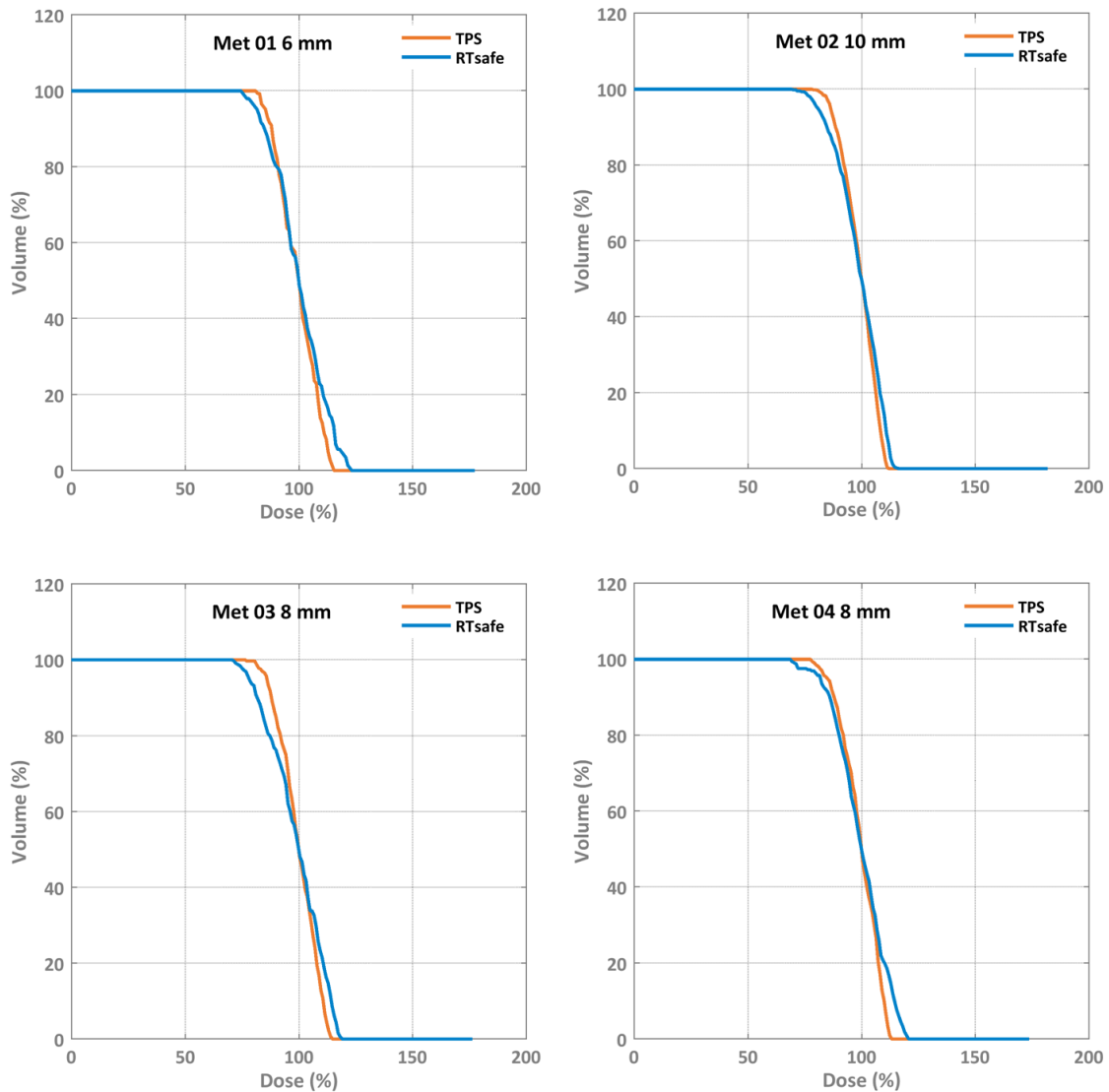






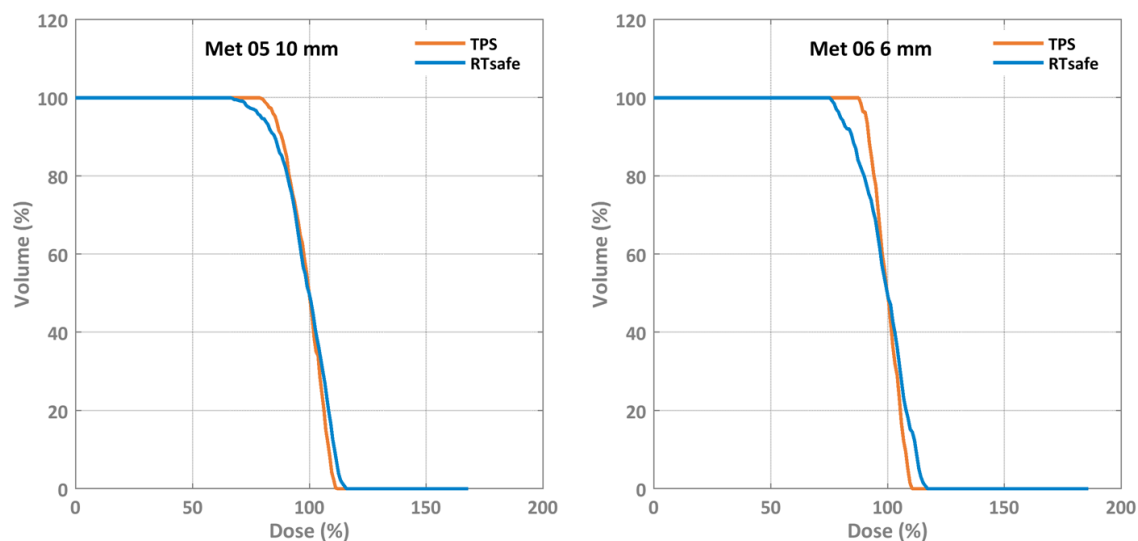
## PART V: DVH comparison

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.

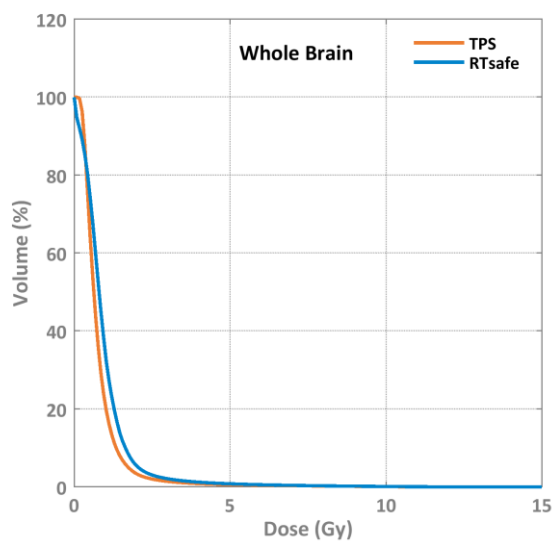


Figures: cumulative Dose Volume Histograms derived from the calculated (TPS) and measured (RTsafe) dose distributions for all the structures considered.

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



Comparison between planned and measured absolute dose distributions is presented in the following figure, in terms of cumulative Dose Volume Histogram (DVH) for the Whole Brain.



## 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.
Met 01 6mm	99.42	100.23	85.40	81.71
Met 02 10mm	99.29	98.94	86.44	80.77
Met 03 8mm	99.83	99.05	85.98	78.13
Met 04 8mm	99.53	99.85	84.93	81.39
Met 05 10mm	98.97	98.81	85.56	79.51
Met 06 6mm	99.85	99.08	90.45	79.95

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 (Gy)		D95 (Gy)	
	TPS	Meas.	TPS	Meas.
Whole Brain	0.80	0.95	0.27	0.08

**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.*

<b>Structure</b>	<b>Distance from ISO (mm)</b>	<b>Geometry metric - Offset (mm)</b>
<b>Met 01 6mm</b>	14.98	0.59
<b>Met 02 10mm</b>	17.37	0.51
<b>Met 03 8mm</b>	32.69	0.78
<b>Met 04 8mm</b>	38.53	0.46
<b>Met 05 10mm</b>	65.85	0.79
<b>Met 06 6mm</b>	57.49	0.77



## 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 8.5 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 PTV.

Index	Met 01 6mm		Met 02 10mm		Met 03 8mm	
	TPS	RTsafe	TPS	RTsafe	TPS	RTsafe
<b>CI_Paddick<sup>1</sup></b>	0.86	0.73	0.86	0.77	0.86	0.70
<b>CI_RTOG<sup>2</sup></b>	1.05	0.97	1.04	0.85	1.08	0.92
<b>Q<sup>3</sup></b>	0.96	0.86	0.91	0.78	0.91	0.82
<b>HI_RTOG<sup>4</sup></b>	1.35	1.40	1.28	1.28	1.35	1.36
<b>GI_Paddick<sup>5</sup></b>	4.62	6.05	3.83	4.65	3.86	4.81

Index	Met 04 8mm		Met 05 10mm		Met 06 6mm	
	TPS	RTsafe	TPS	RTsafe	TPS	RTsafe
<b>CI_Paddick<sup>1</sup></b>	0.83	0.80	0.84	0.78	0.87	0.63
<b>CI_RTOG<sup>2</sup></b>	1.09	1.02	1.14	1.09	1.07	0.92
<b>Q<sup>3</sup></b>	0.93	0.81	0.95	0.80	0.97	0.83
<b>HI_RTOG<sup>4</sup></b>	1.34	1.40	1.36	1.39	1.22	1.26
<b>GI_Paddick<sup>5</sup></b>	3.91	4.71	3.36	4.03	5.42	6.70

***Disclaimer***

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