

Varian Surface Applicators PDD and Profile Analysis

Jack Neylon, PhD

Inventory

Surface Applicator Set

The surface applicator set uses a tungsten shell plus inserts to create a superficial treatment device.

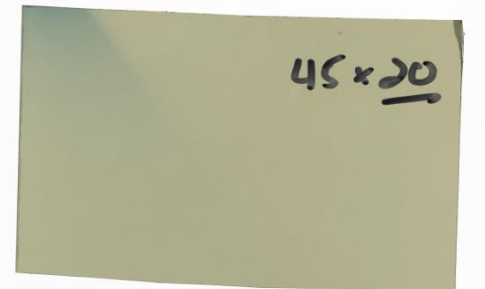
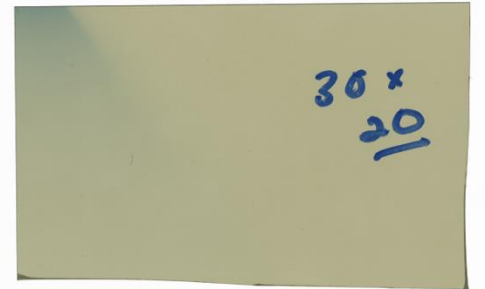
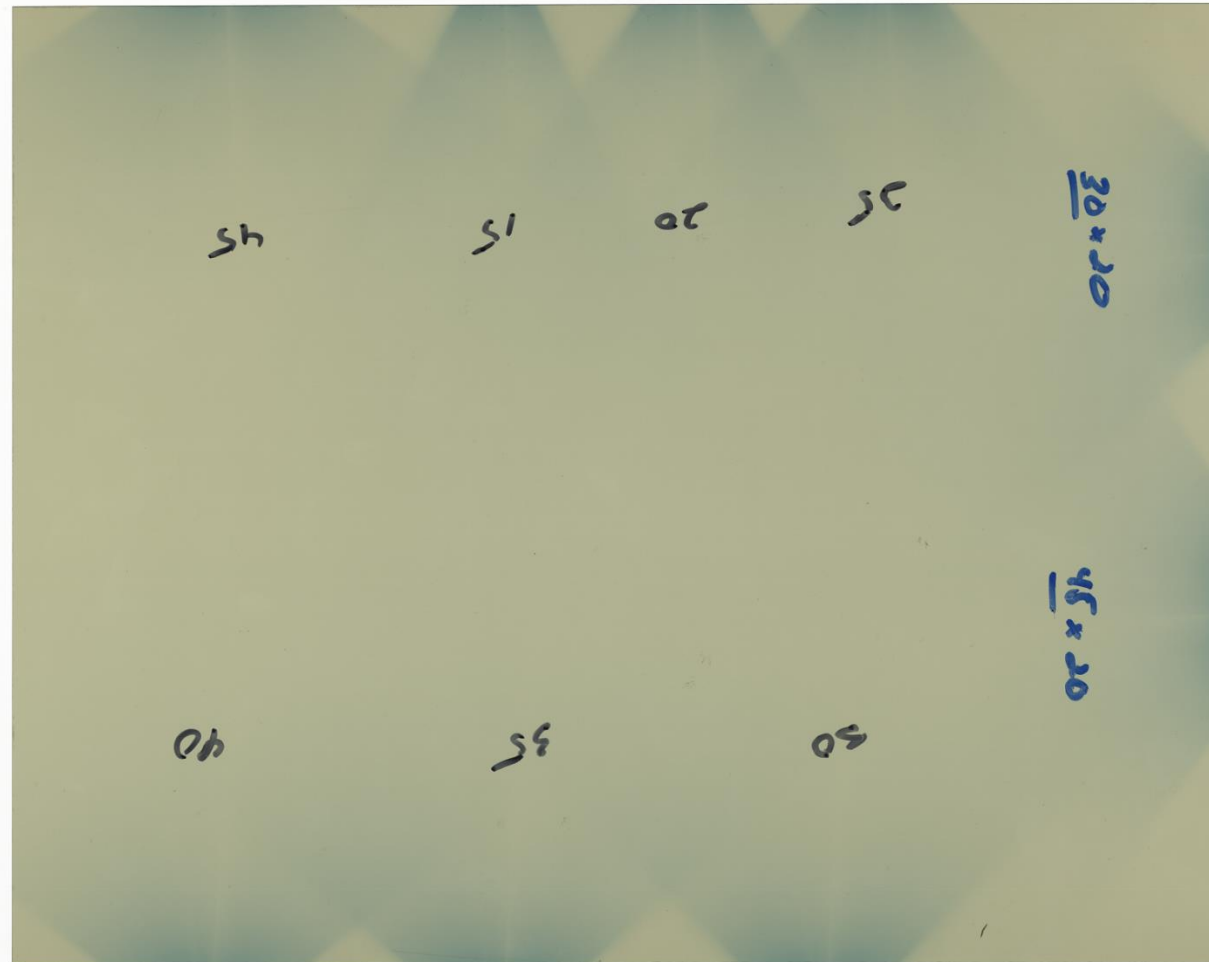
Set Inventory

Set Numbers	Component	Part Number
GM11004590	SA Shielded Cone (15-25mm)	GM11003410
	15mm Round Inset (SA Cone)	GM11003570
	20mm Round Inset (SA Cone)	GM11003680
	25mm Round Inset (SA Cone)	GM11003590
	BA Shielded Cone (30-45mm)	GM11003580
	30mm Round Inset (BA Cone)	GM11003520
	35mm Round Inset (BA Cone)	GM11003610
	40mm Round Inset (BA Cone)	GM11003620
	45mm Round Inset (BA Cone)	GM11003630
	30x20mm Oval Inset (BA Cone)	GM11003640
	45x25mm Oval Inset (BA Cone)	GM11003650



PDD Analysis

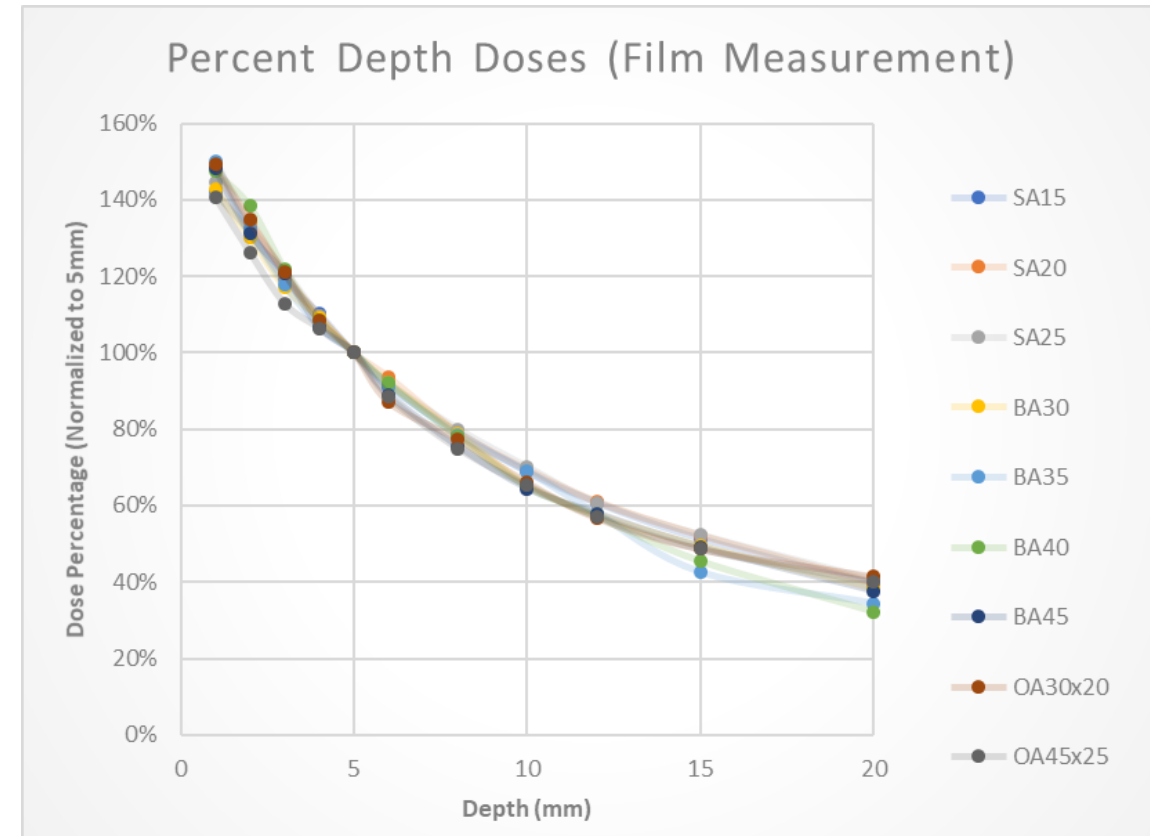
- Percent Depth Dose profiles were acquired using EBTXD gafchromic film by sandwiching between two 5cm slabs of solid water



PDD Analysis

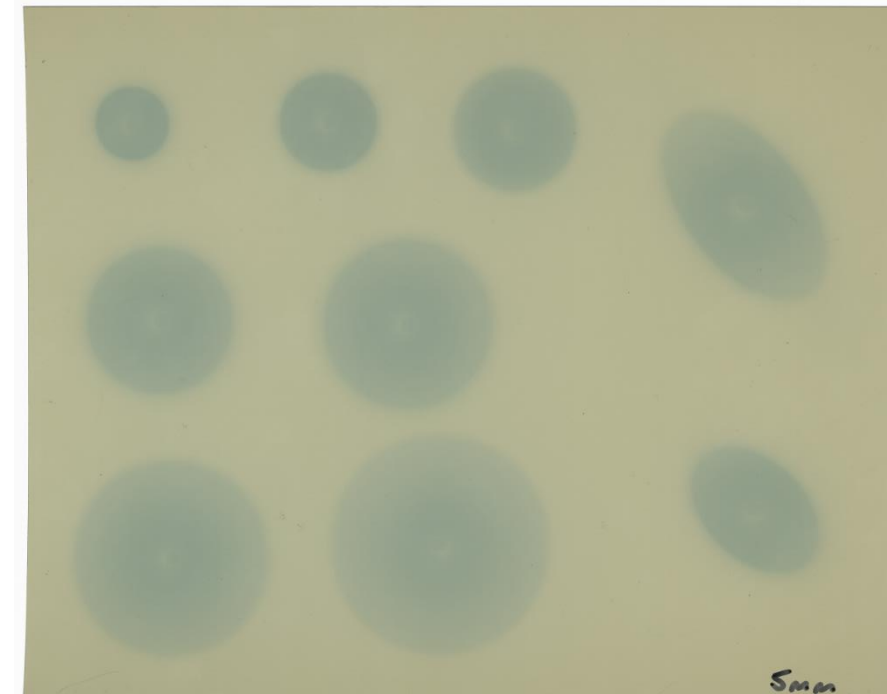
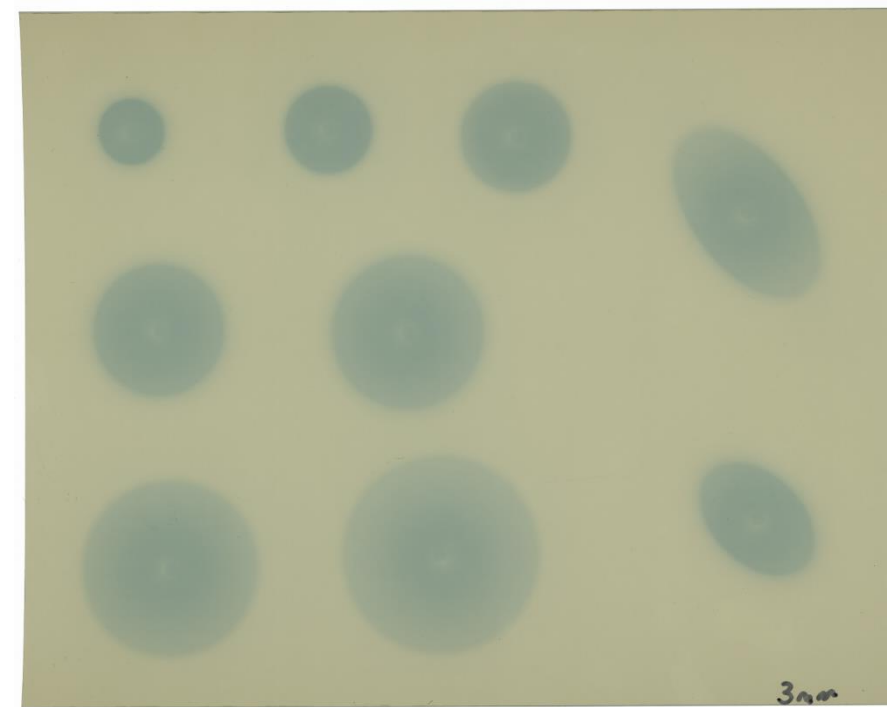
- Custom script was developed to automated detection of central axis (CAX) and extract the PDD
 - See Appendix A for detailed methods and results
- Results below are normalized to 5mm depth
- Results agree with literature within ~5% (≥ 2 mm depth)

Depth (mm)	SA15	SA20	SA25	BA30	BA35	BA40	BA45	OA30x20	OA45x25
1	142%	148%	145%	143%	150%	147%	148%	149%	141%
2	132%	134%	133%	130%	132%	138%	131%	135%	126%
3	119%	120%	121%	117%	118%	122%	121%	121%	113%
4	110%	110%	110%	109%	107%	109%	107%	109%	106%
5	100%	100%	100%	100%	100%	100%	100%	100%	100%
6	91%	94%	92%	92%	92%	92%	89%	87%	88%
8	79%	79%	80%	79%	78%	78%	76%	77%	75%
10	69%	69%	70%	65%	69%	65%	64%	66%	65%
12	61%	61%	61%	58%	58%	57%	58%	57%	57%
15	51%	52%	52%	49%	43%	45%	49%	49%	49%
20	39%	40%	40%	38%	34%	32%	38%	41%	40%



Profile Analysis

- Cross Profiles at 3mm and 5mm depths were acquired using EBTXD gafchromic film
- 5cm solid water was used for backscatter, 3mm SW between film planes, and 2mm SW on top
- Custom scripts were developed to extract profile diameters at 90% (normalized to in-plane CAX)
- All applicators showed good centricity when comparing profiles in multiple directions
- See Appendix B for detailed methods and results
- Isodose plots for each applicator can be found in the following slides, and used for applicator selection during planning.



Isodose Diameters

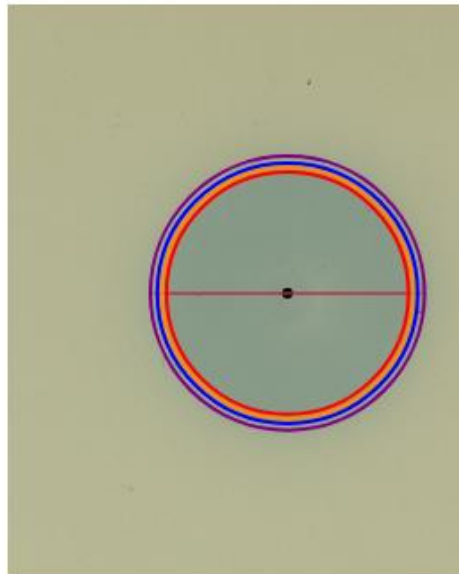
- These tables list the approximate diameters for the specified isodose levels at 3mm and 5mm depths, normalized to the Acuros calculated dose.
- Emphasis placed on the 90% isodose level.

Isodose Level	APPLICATOR (Isodose Diameters (mm) @ 3mm Depth)										
	SA15	SA20	SA25	BA30	BA35	BA40	BA45	OA30x20 Major	OA30x20 Minor	OA45x25 Major	OA45x25 Minor
100	17.9	22.7	22.0	23.0	20.7	26.1	25.4	20.3	18.6	20.3	18.3
90	18.6	24.4	25.7	28.1	27.1	31.2	31.2	26.4	24.0	26.8	25.7
75	19.3	25.1	29.5	35.6	35.2	39.3	39.3	34.9	25.7	35.6	31.8
50	20.3	26.1	31.8	38.3	43.7	50.1	53.8	38.6	26.4	51.8	32.5

Isodose Level	APPLICATOR (Isodose Diameters (mm) @ 5mm Depth)										
	SA15	SA20	SA25	BA30	BA35	BA40	BA45	OA30x20 Major	OA30x20 Minor	OA45x25 Major	OA45x25 Minor
100	20.3	25.1	25.1	22.7	19.6	27.1	26.8	15.9	8.8	21.3	20.3
90	20.7	27.1	29.1	29.5	29.1	33.2	33.5	26.8	25.7	29.5	28.4
75	21.3	28.1	33.5	38.9	39.3	42.3	43.0	36.9	28.8	39.6	35.6
50	22.7	29.5	35.9	42.7	48.8	55.5	59.9	43.0	29.5	57.6	36.2

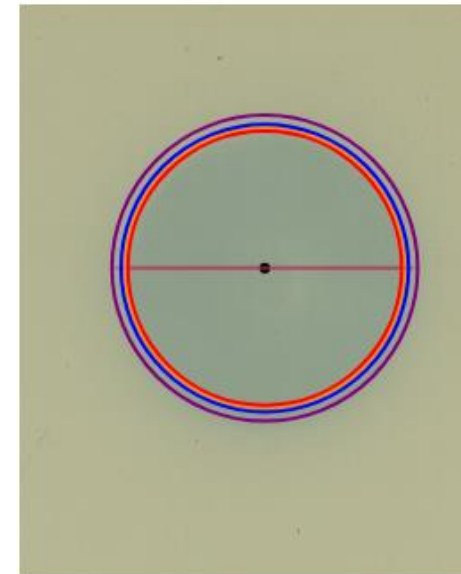
SA15 Isodoses

SA15 3mm Isodose Lines (Normalized to 320.0 cGy)



- Center
- 50% Diameter = 20.3 mm
- 75% Diameter = 19.3 mm
- 90% Diameter = 18.6 mm
- 100% Diameter = 17.9 mm
- 50%
- 75%
- 90%
- 100%

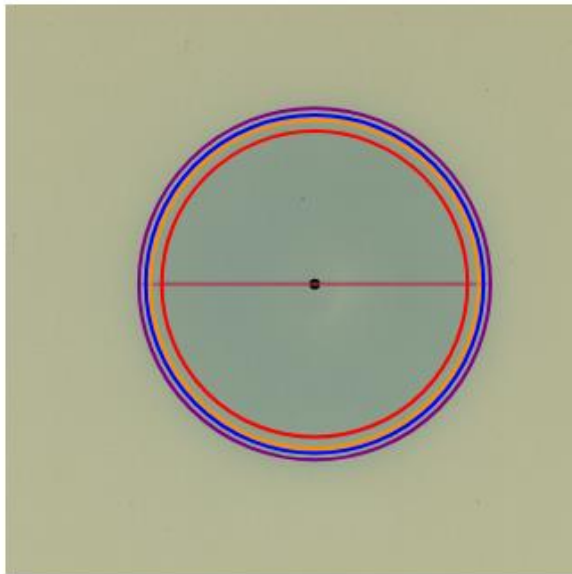
SA15 5mm Isodose Lines (Normalized to 260.0 cGy)



- Center
- 50% Diameter = 22.7 mm
- 75% Diameter = 21.3 mm
- 90% Diameter = 20.7 mm
- 100% Diameter = 20.3 mm
- 50%
- 75%
- 90%
- 100%

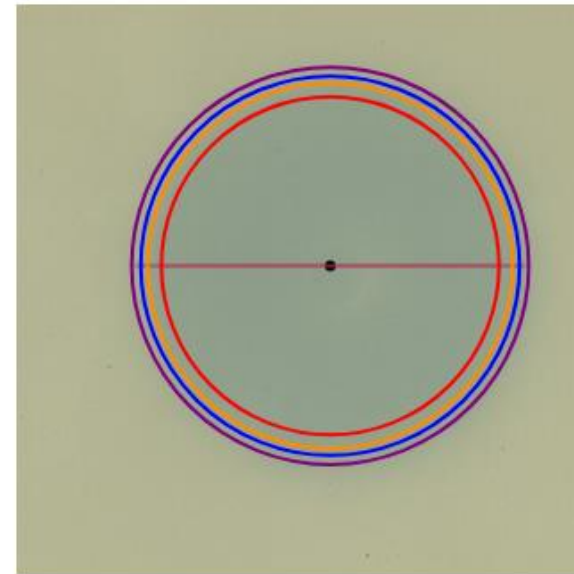
SA20 Isodoses

SA20 3mm Isodose Lines (Normalized to 310.0 cGy)



- Center
- 50% Diameter = 26.1 mm
- 75% Diameter = 25.1 mm
- 90% Diameter = 24.4 mm
- 100% Diameter = 22.7 mm
- 50%
- 75%
- 90%
- 100%

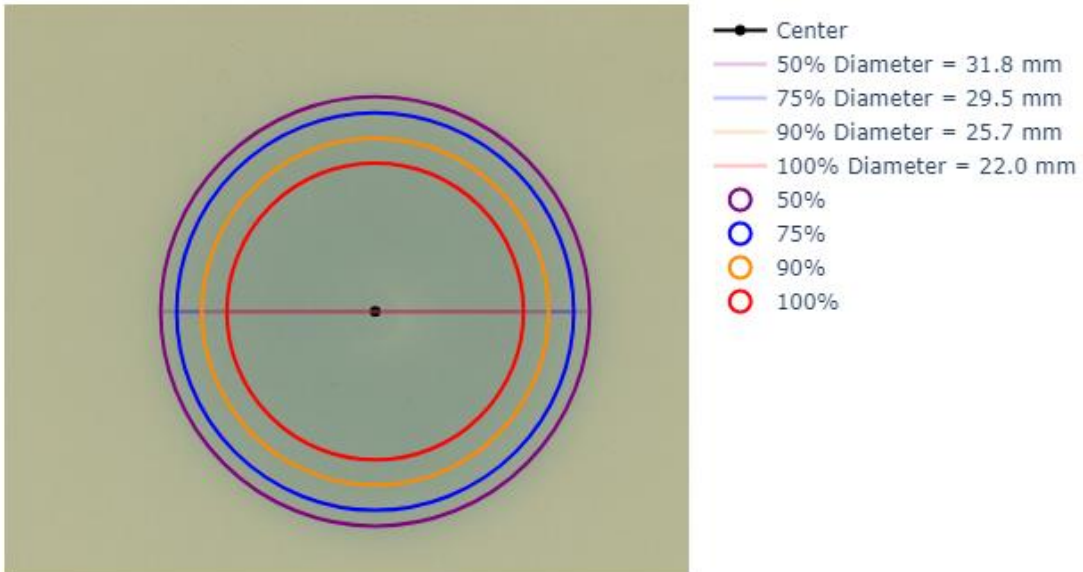
SA20 5mm Isodose Lines (Normalized to 255.0 cGy)



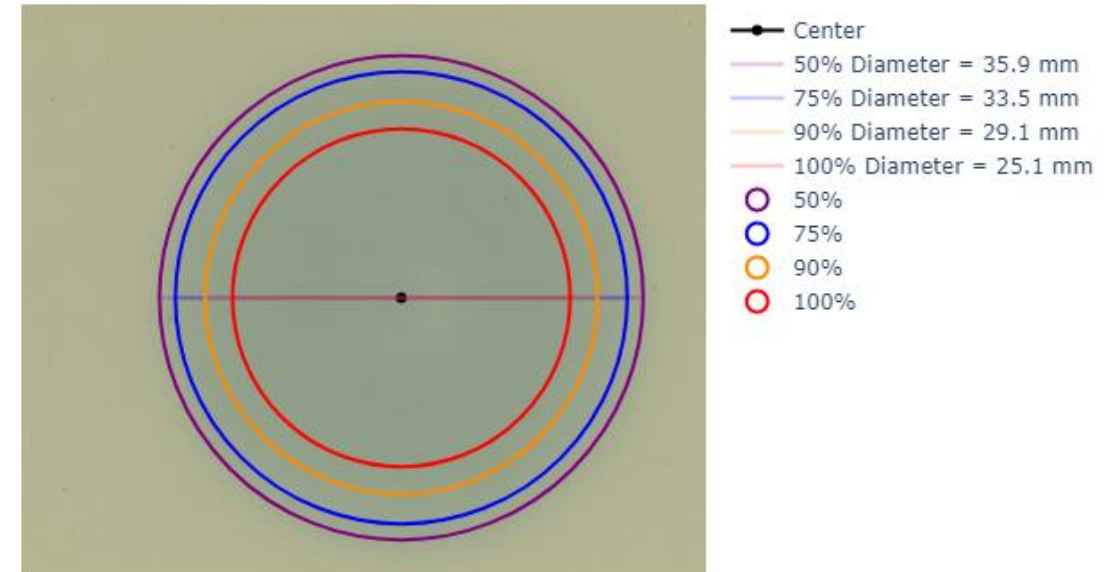
- Center
- 50% Diameter = 29.5 mm
- 75% Diameter = 28.1 mm
- 90% Diameter = 27.1 mm
- 100% Diameter = 25.1 mm
- 50%
- 75%
- 90%
- 100%

SA25 Isodoses

SA25 3mm Isodose Lines (Normalized to 310.0 cGy)

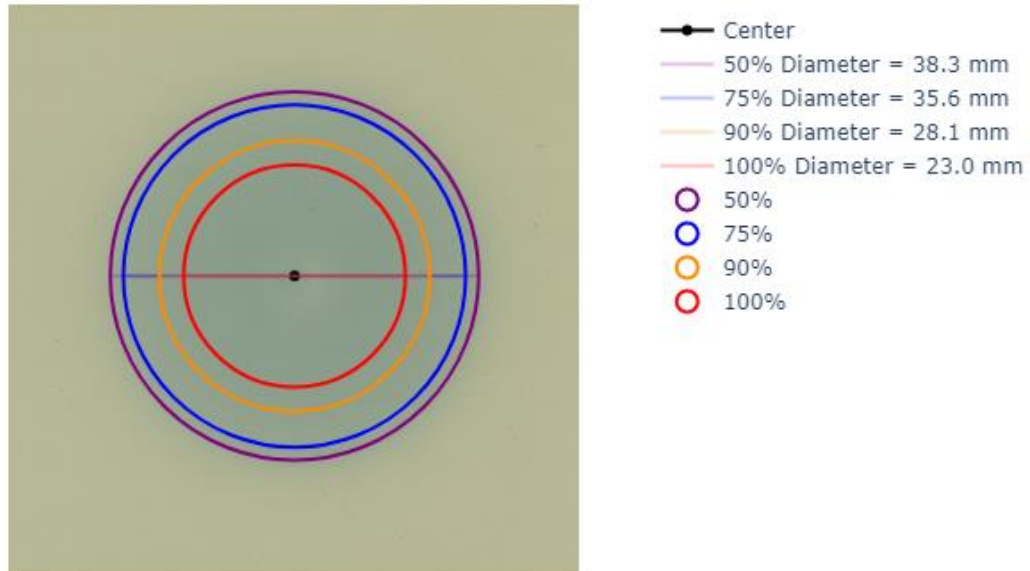


SA25 5mm Isodose Lines (Normalized to 255.0 cGy)

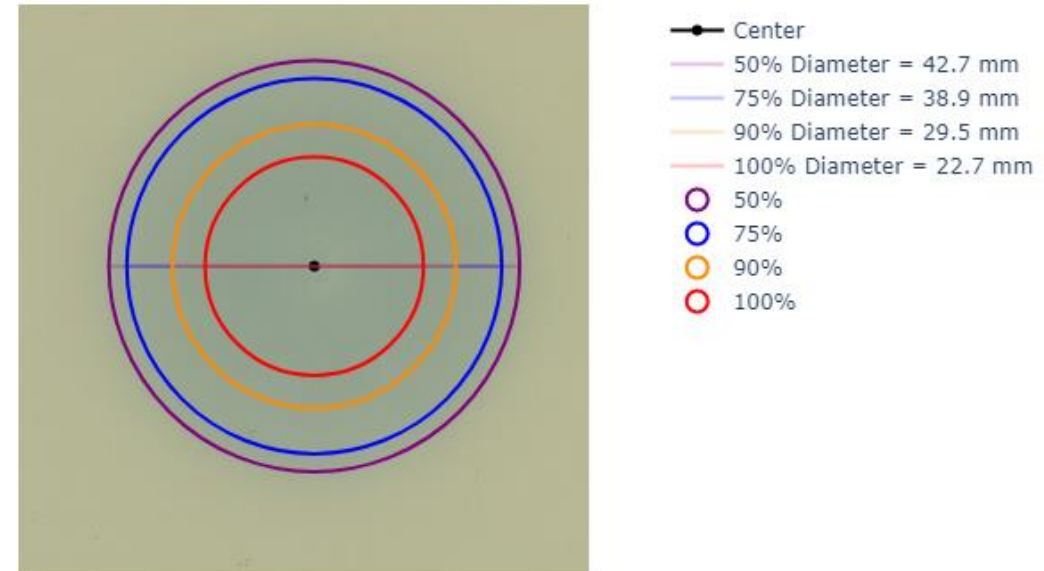


BA30 Isodoses

BA30 3mm Isodose Lines (Normalized to 300.0 cGy)

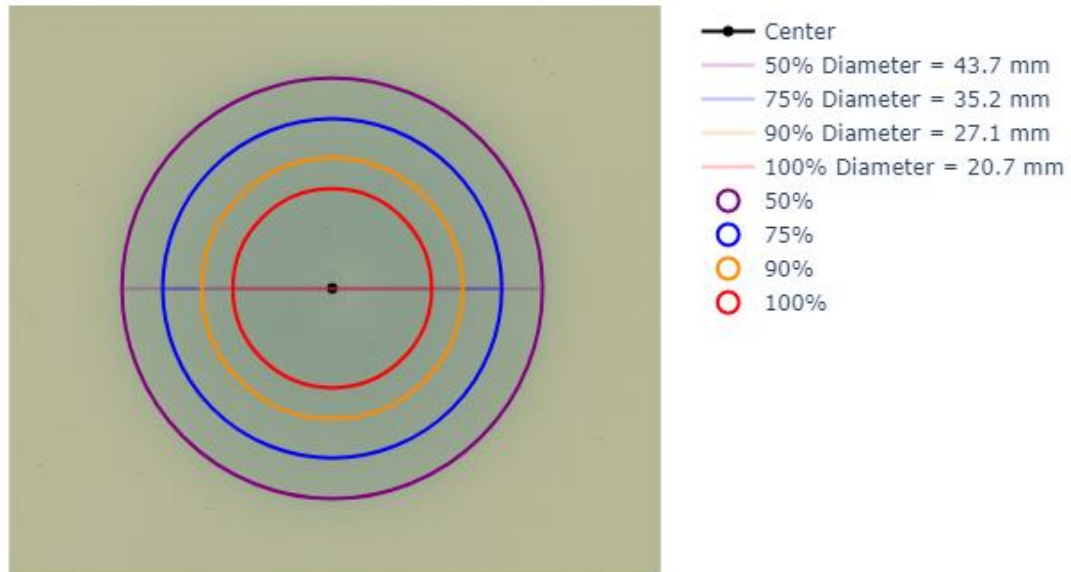


BA30 5mm Isodose Lines (Normalized to 250.0 cGy)

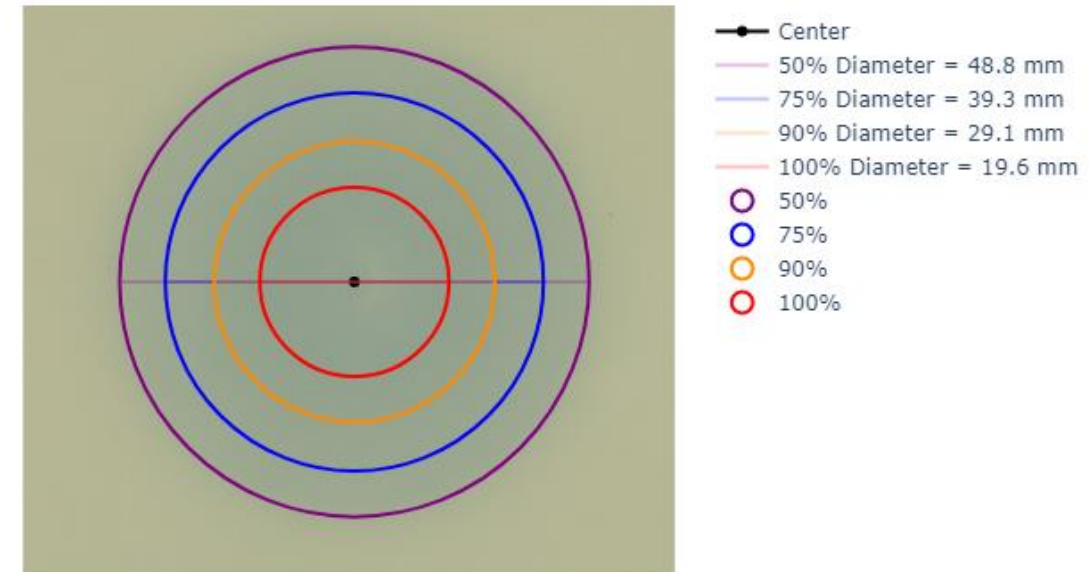


BA35 Isodoses

BA35 3mm Isodose Lines (Normalized to 300.0 cGy)

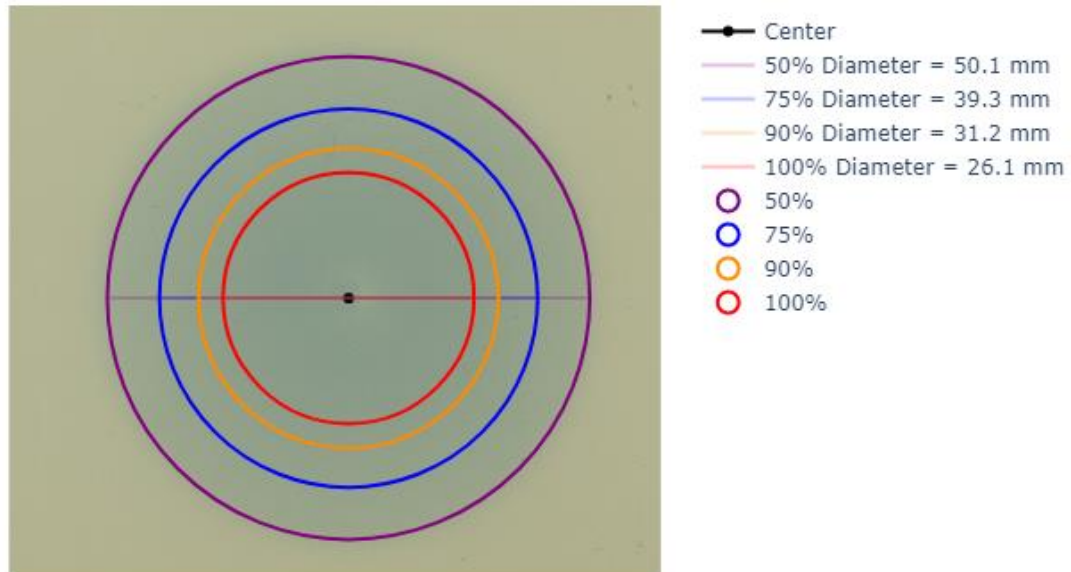


BA35 5mm Isodose Lines (Normalized to 250.0 cGy)

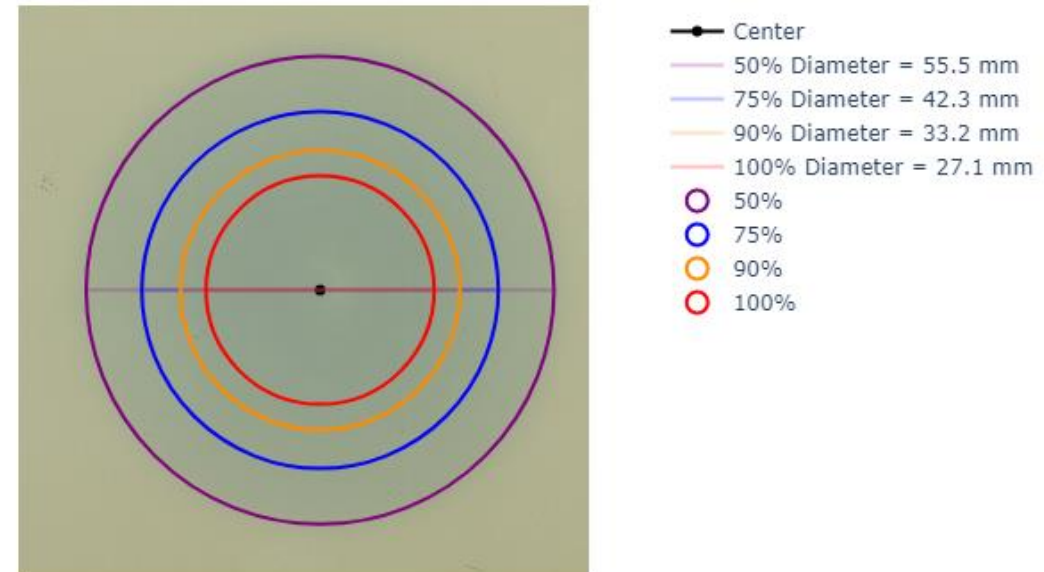


BA40 Isodoses

BA40 3mm Isodose Lines (Normalized to 300.0 cGy)

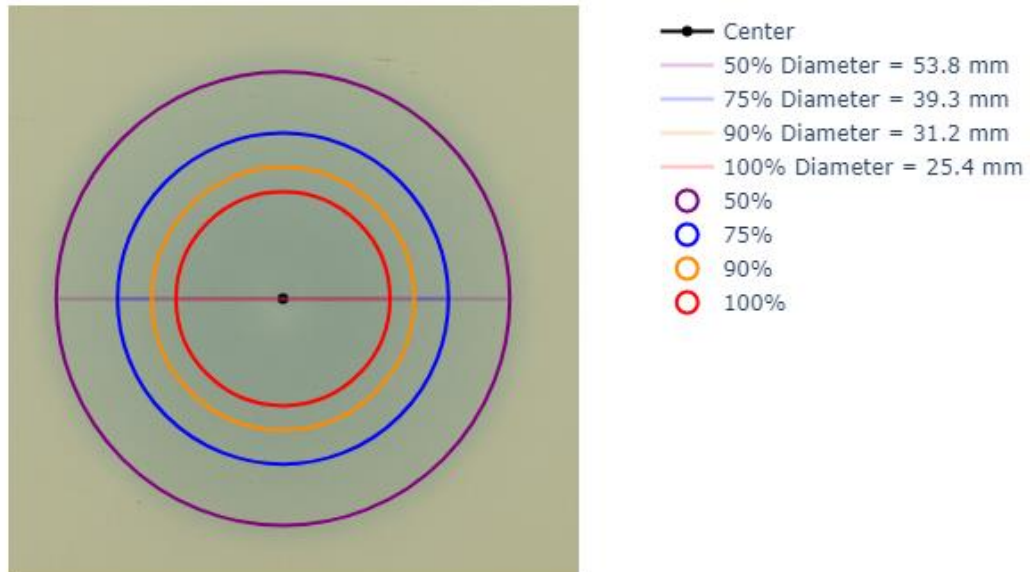


BA40 5mm Isodose Lines (Normalized to 250.0 cGy)

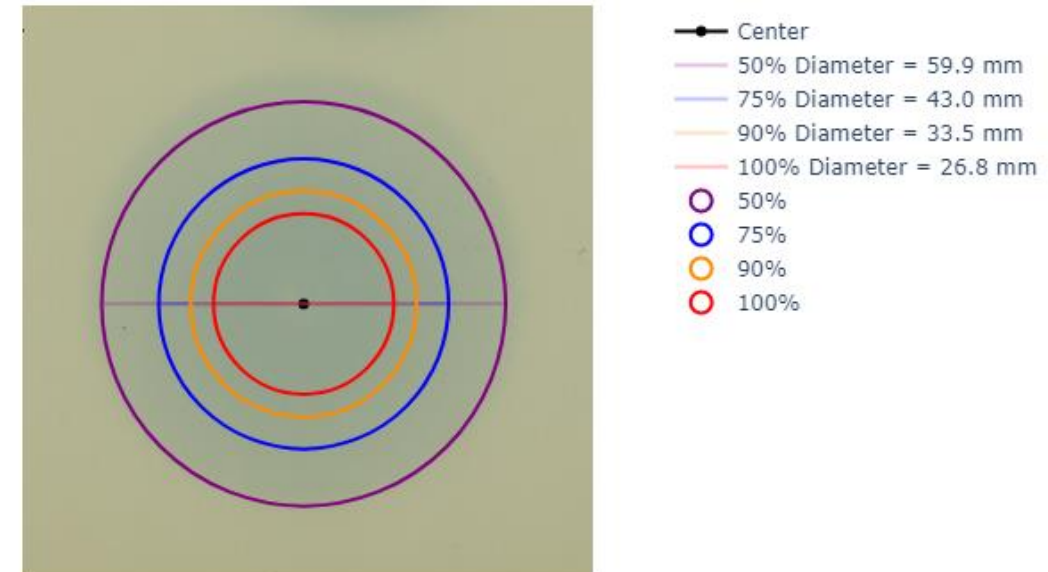


BA45 Isodoses

BA45 3mm Isodose Lines (Normalized to 275.0 cGy)

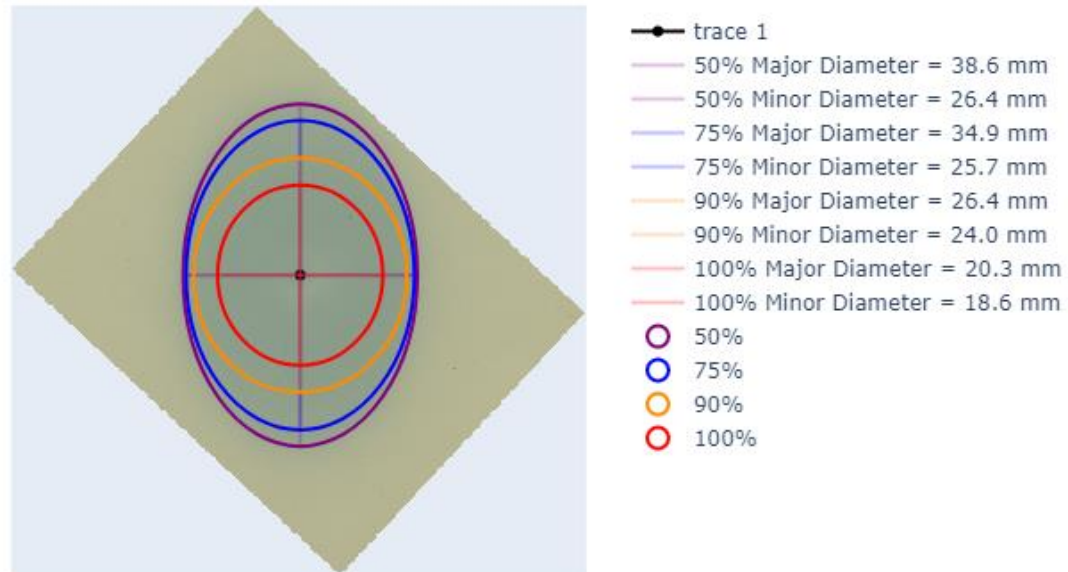


BA45 5mm Isodose Lines (Normalized to 230.0 cGy)

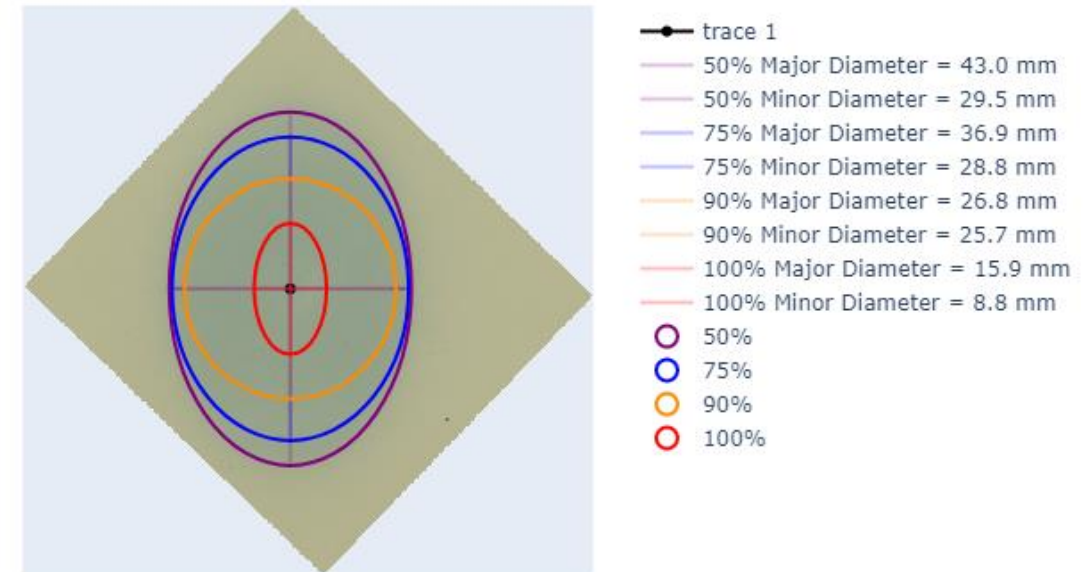


OA30x20 Isodoses

OA30x20 3mm Isodose Lines (Normalized to 300.0 cGy)

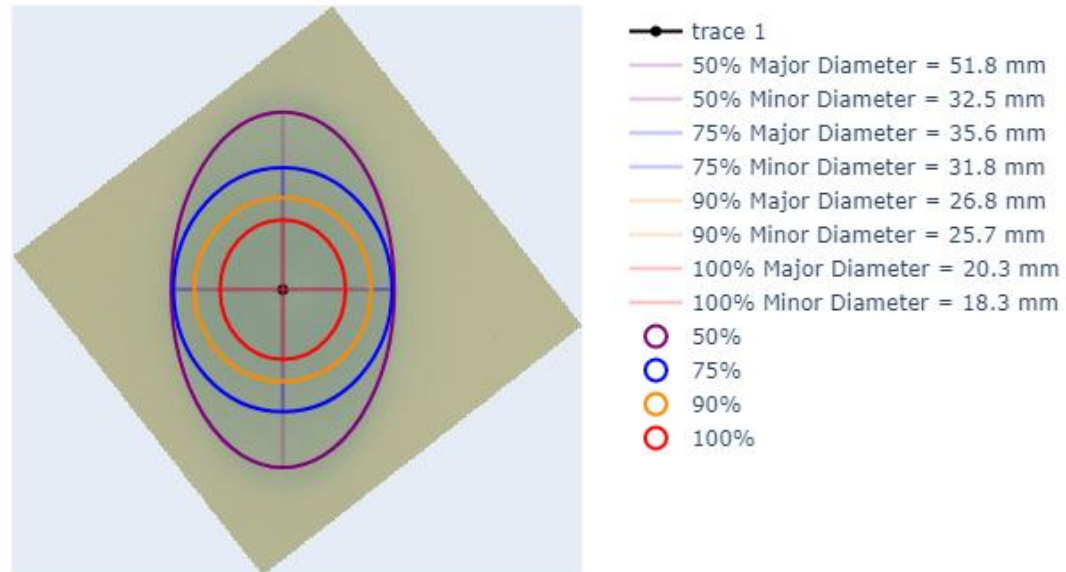


OA30x20 5mm Isodose Lines (Normalized to 250.0 cGy)

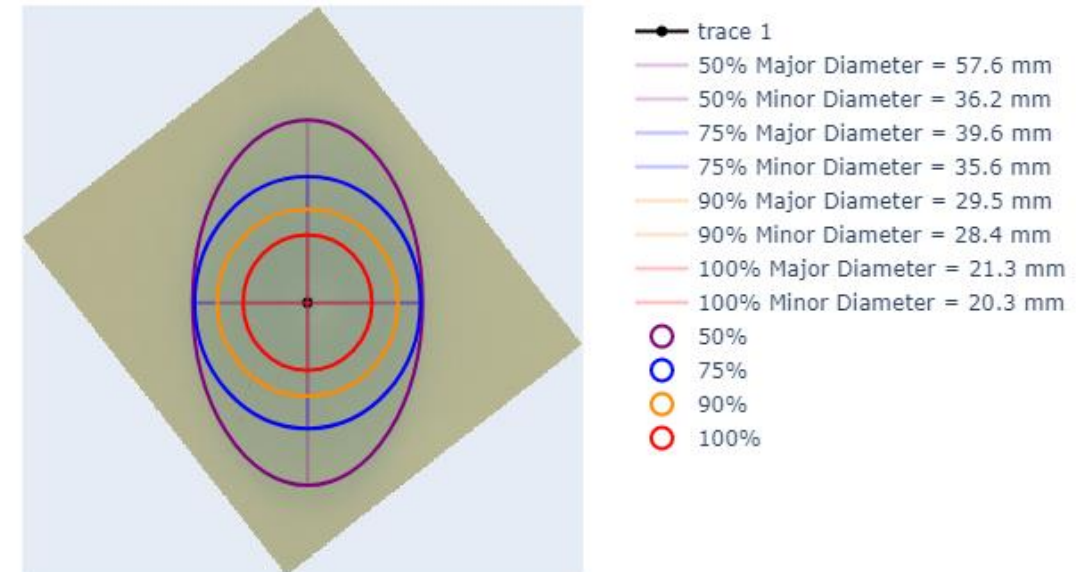


OA45x25 Isodoses

OA45x25 3mm Isodose Lines (Normalized to 300.0 cGy)



OA45x25 5mm Isodose Lines (Normalized to 250.0 cGy)

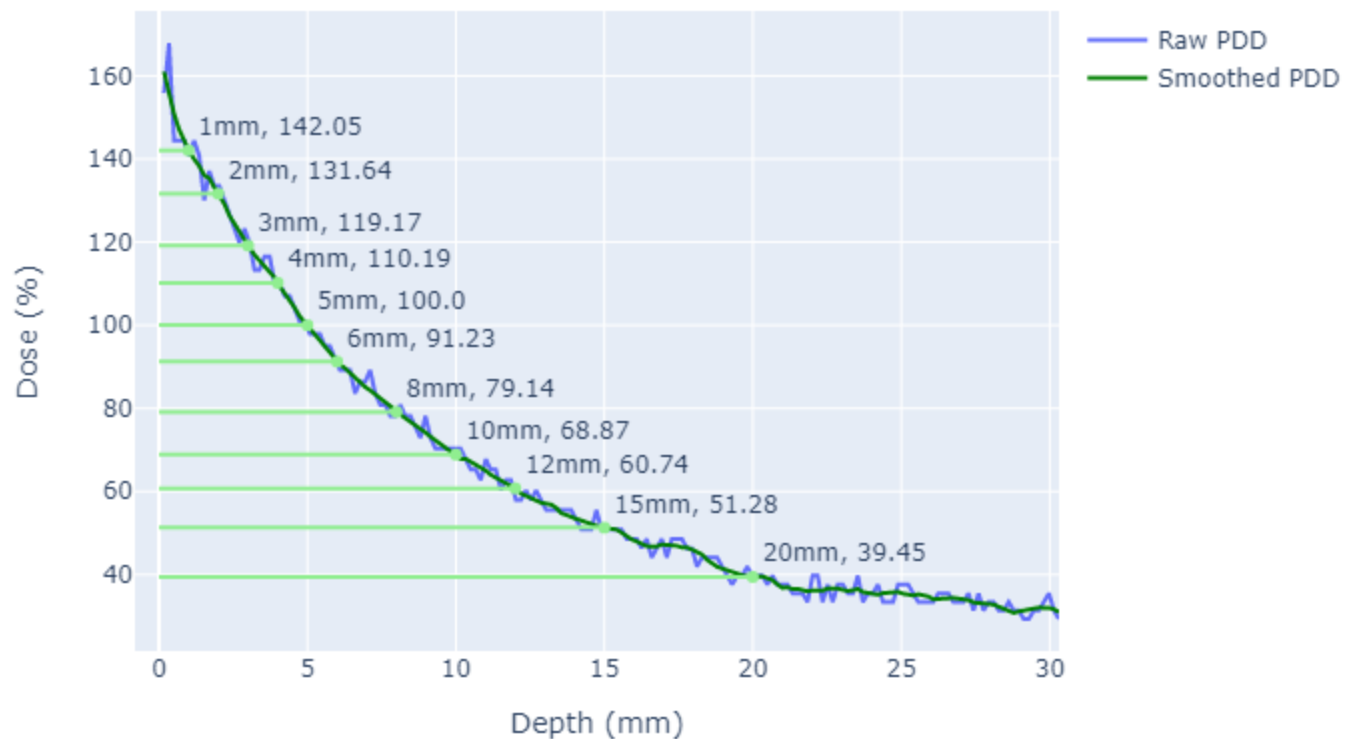


Appendix A – PDD Analysis

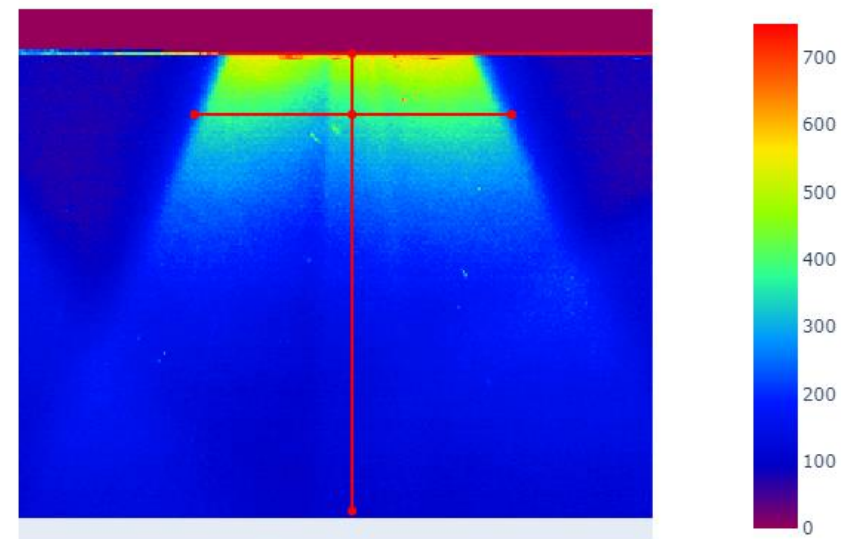
- Python scripts developed to apply film calibration to films and convert to dose
- Due to the vertical orientation of the source for these applicators, it is not trivial to find the central axis, as the dose dips in the center due to self-shielding
- To overcome this, a cross profile was taken at 4mm depth beyond maximum dose
- From the cross profile, all peaks were identified, and FWHM widths were calculated
- Using the largest FWHM, the center of the distribution was found
- The following slides display results for each Cone Inset

SA15 PDD

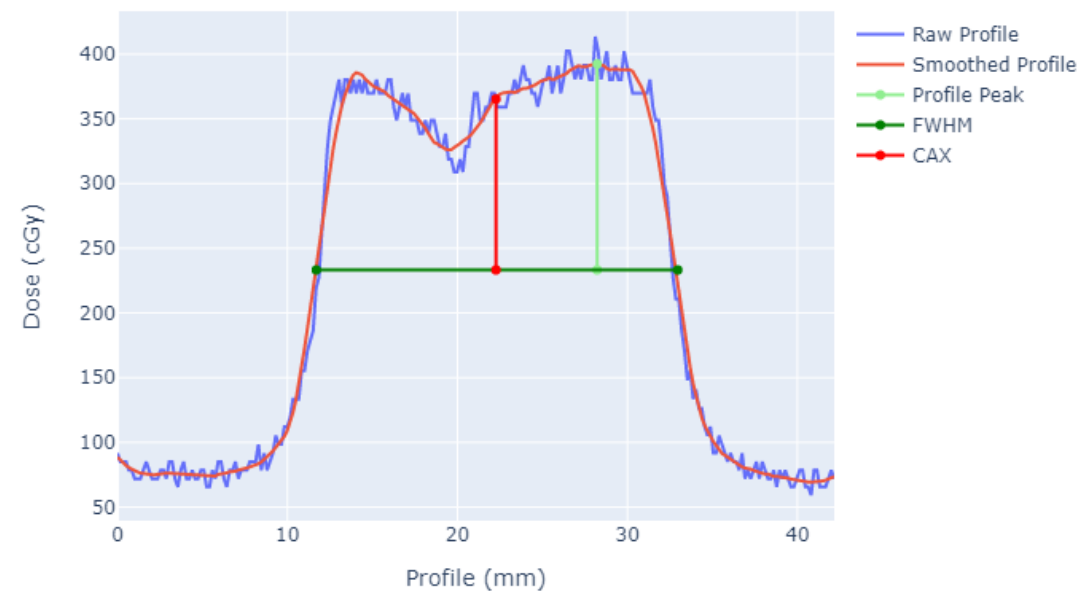
SA15 CAX PDD



SA15 Dose Map

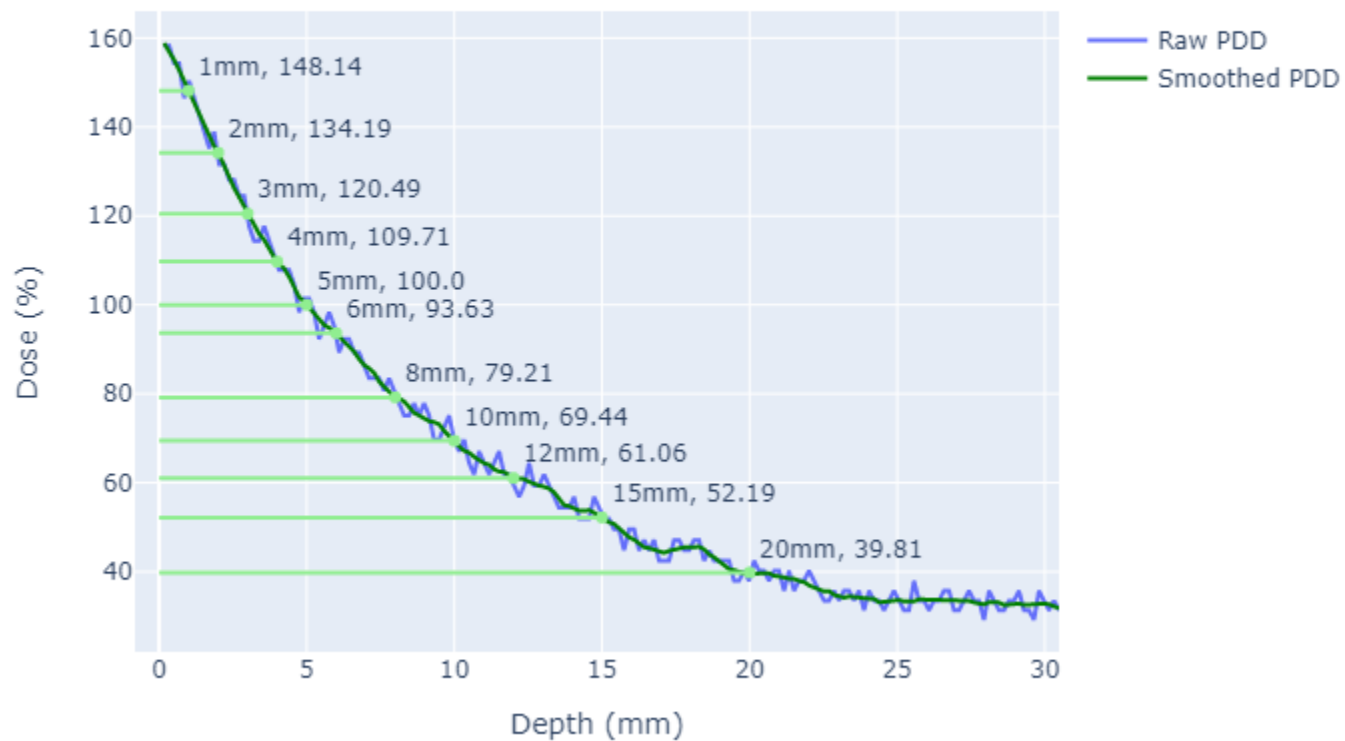


SA15 Cross Profile at 4mm, to Identify CAX

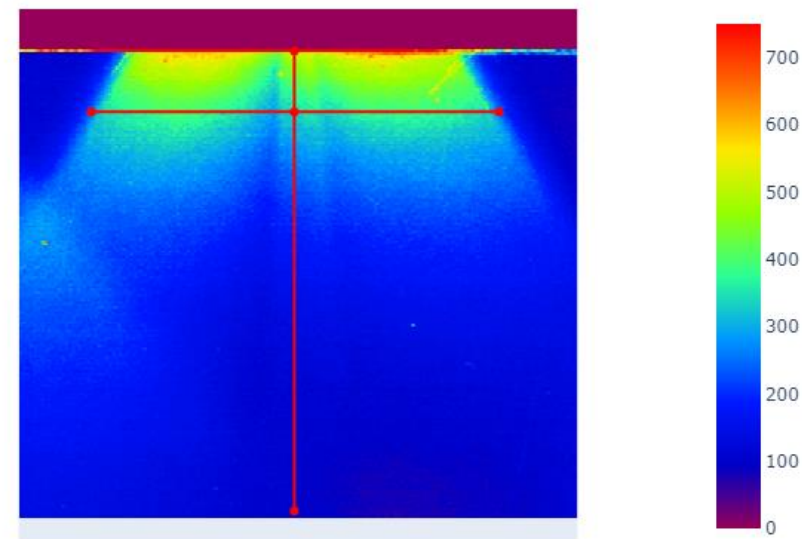


SA20 PDD

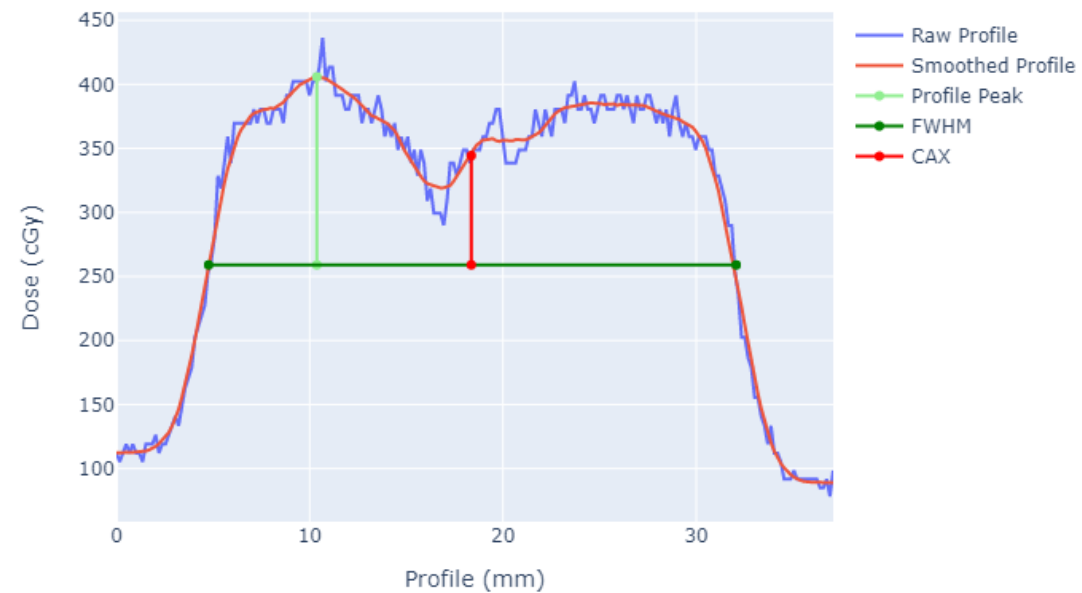
SA20 CAX PDD



SA20 Dose Map

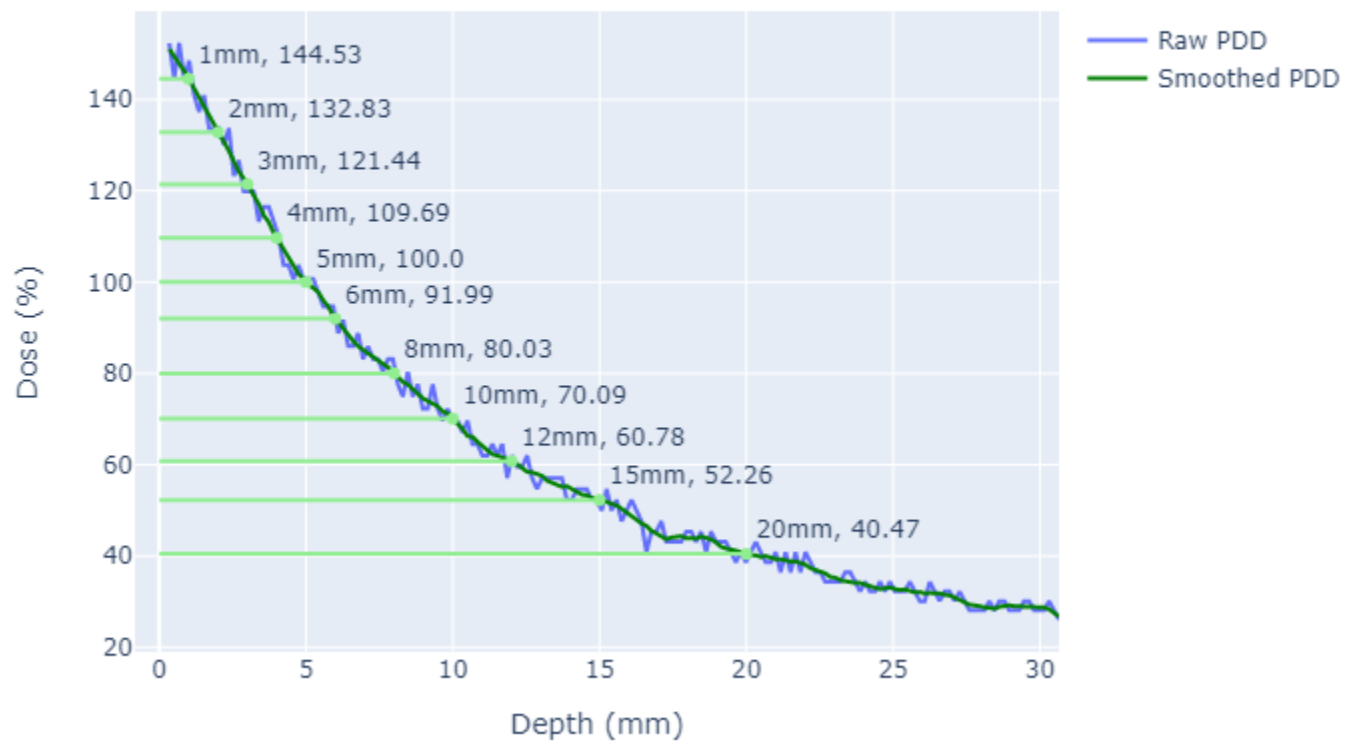


SA20 Cross Profile at 4mm, to Identify CAX

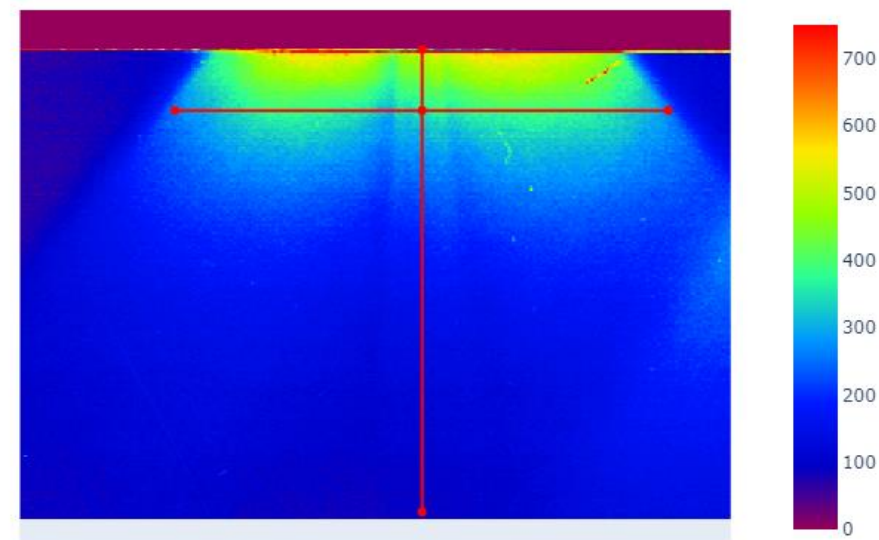


SA25 PDD

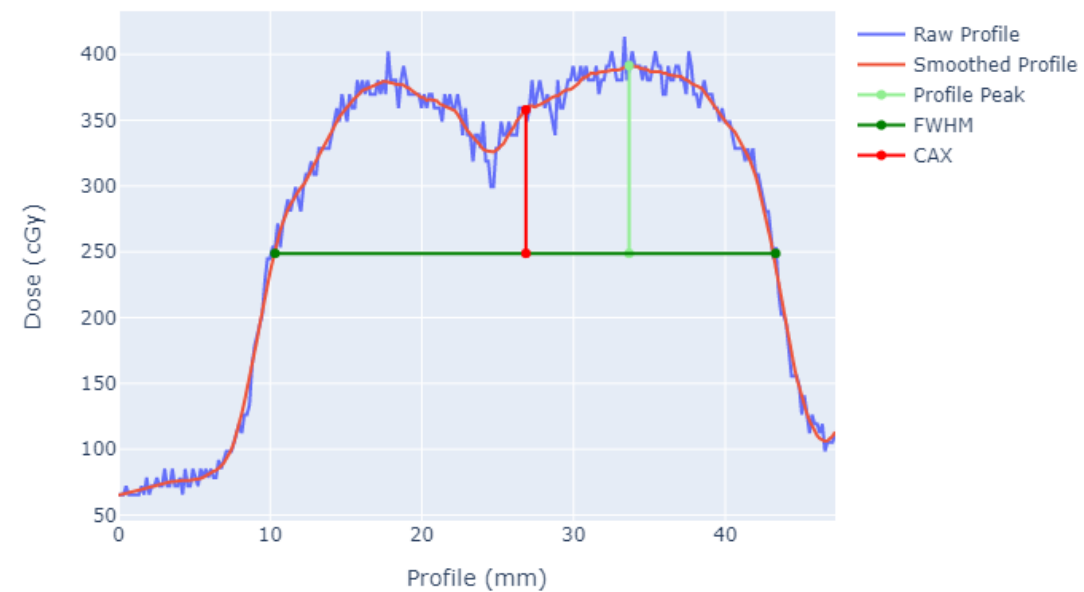
SA25 CAX PDD



SA25 Dose Map

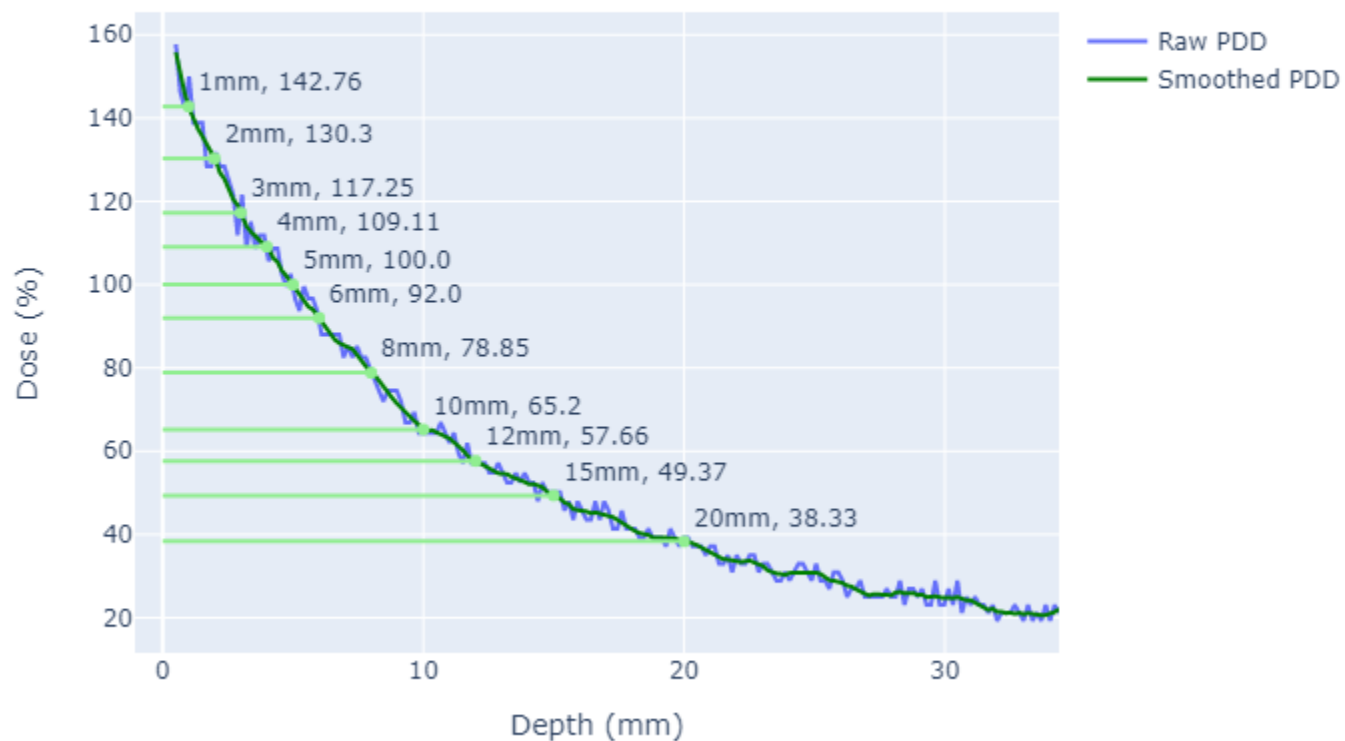


SA25 Cross Profile at 4mm, to Identify CAX

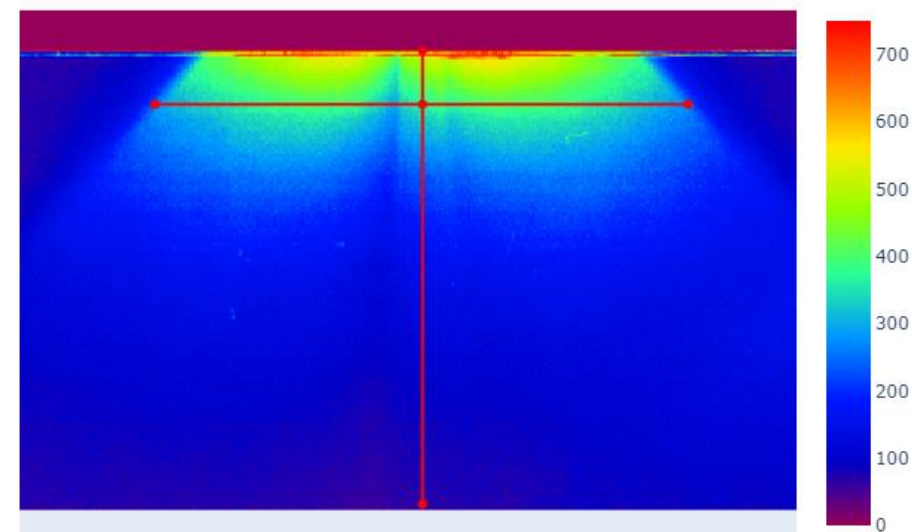


BA30 PDD

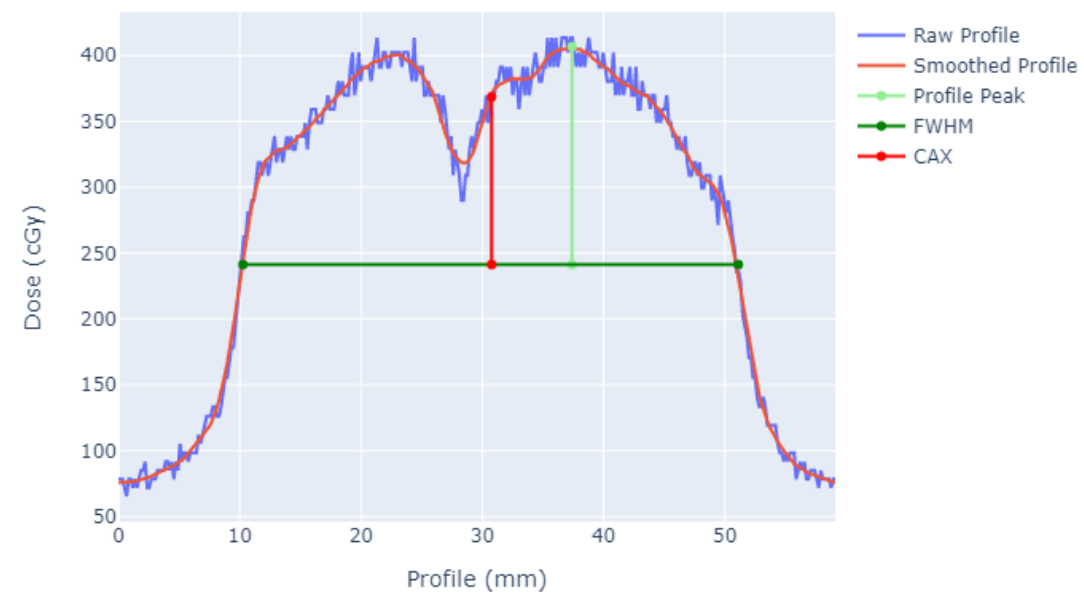
BA30 CAX PDD



BA30 Dose Map

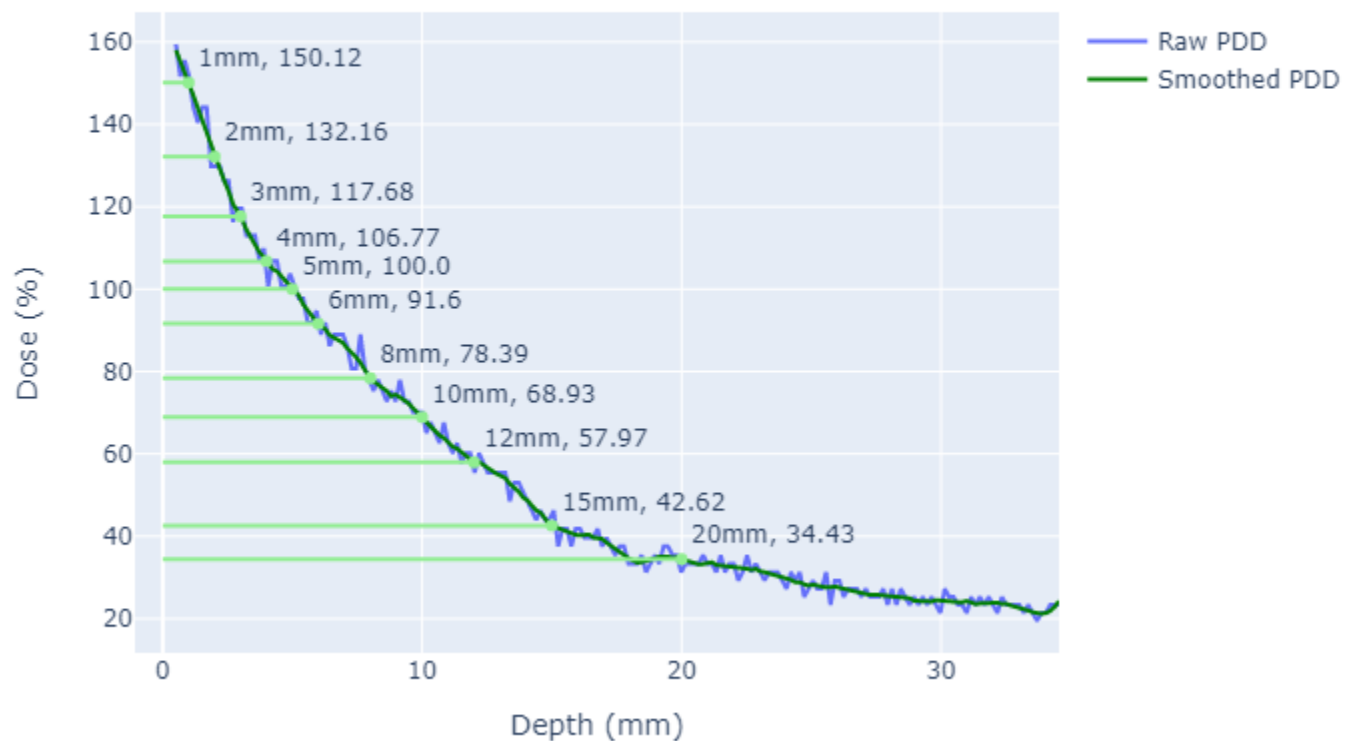


BA30 Cross Profile at 4mm, to Identify CAX

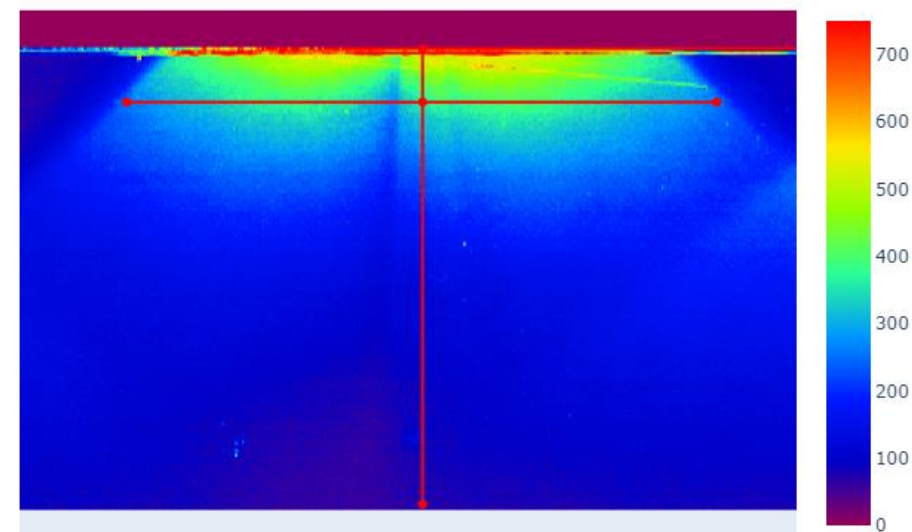


BA35 PDD

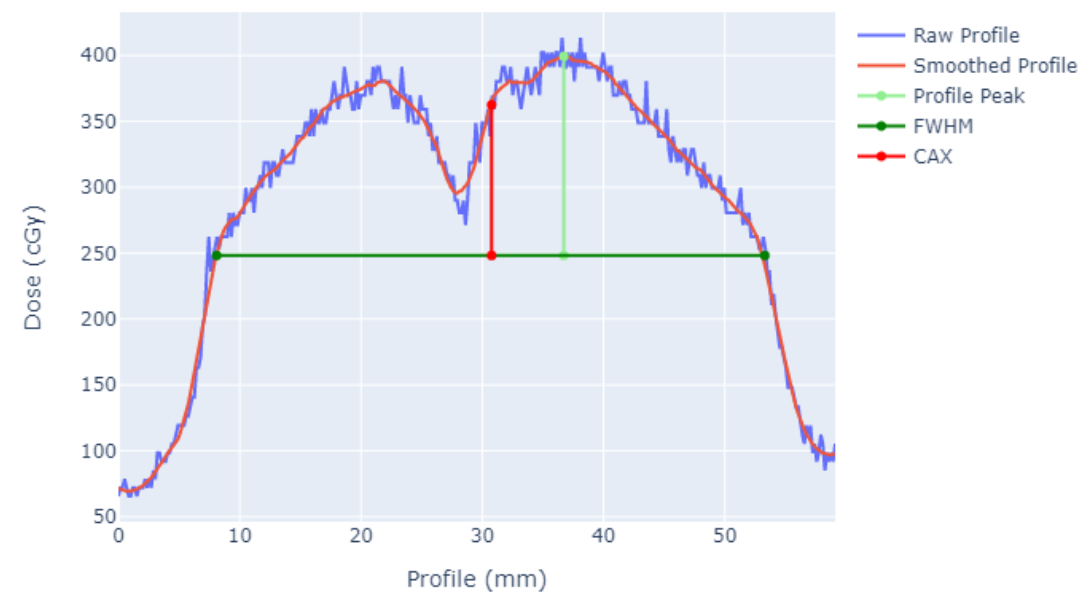
BA35 CAX PDD



BA35 Dose Map

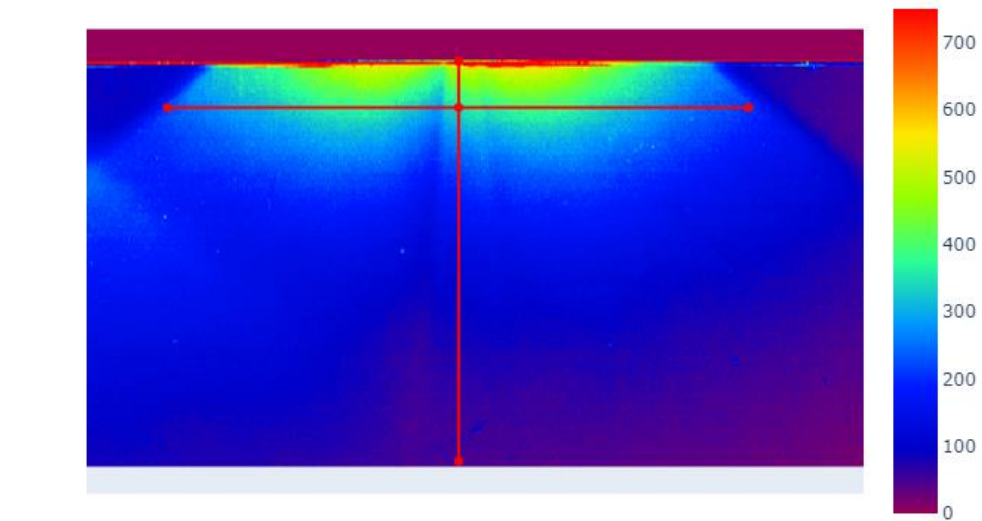
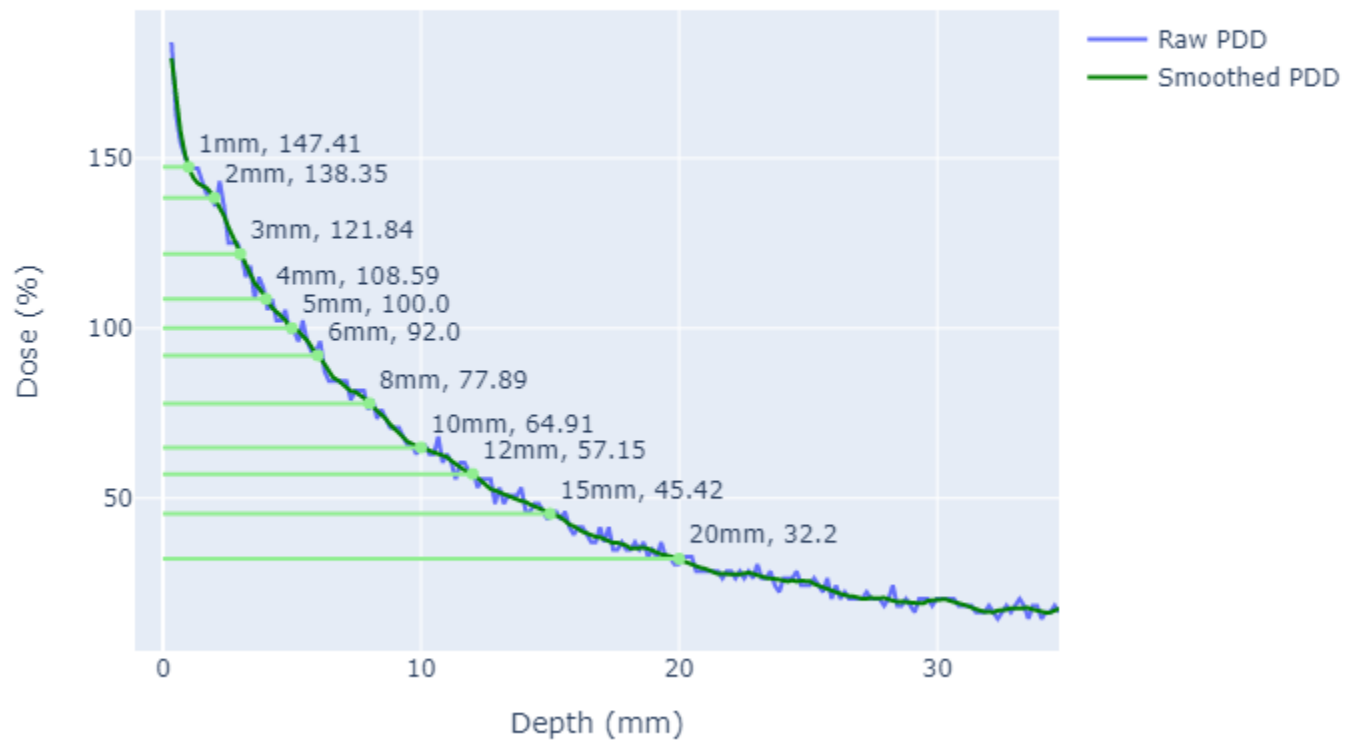


BA35 Cross Profile at 4mm, to Identify CAX

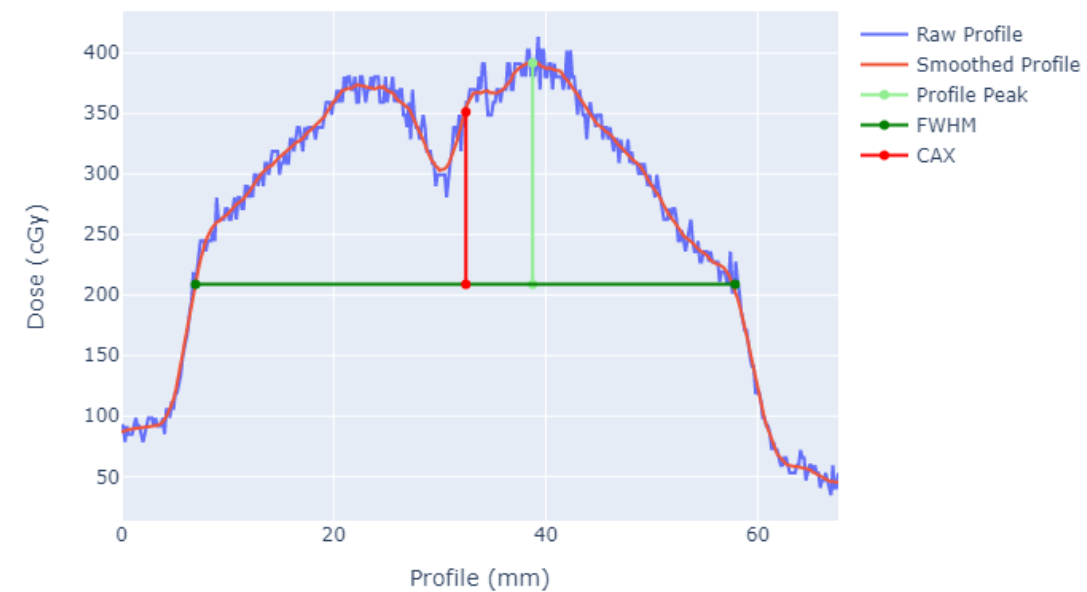


BA40 PDD

BA40 CAX PDD

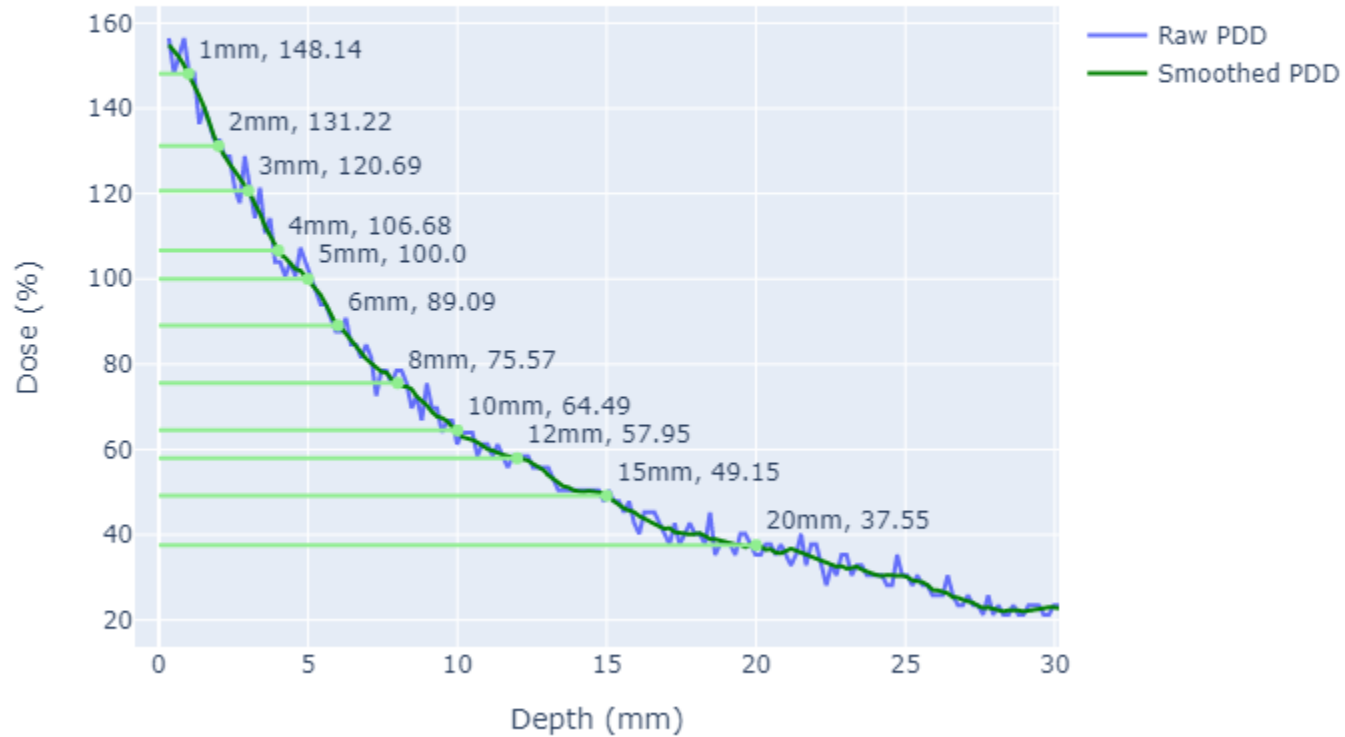


BA40 Cross Profile at 4mm, to Identify CAX

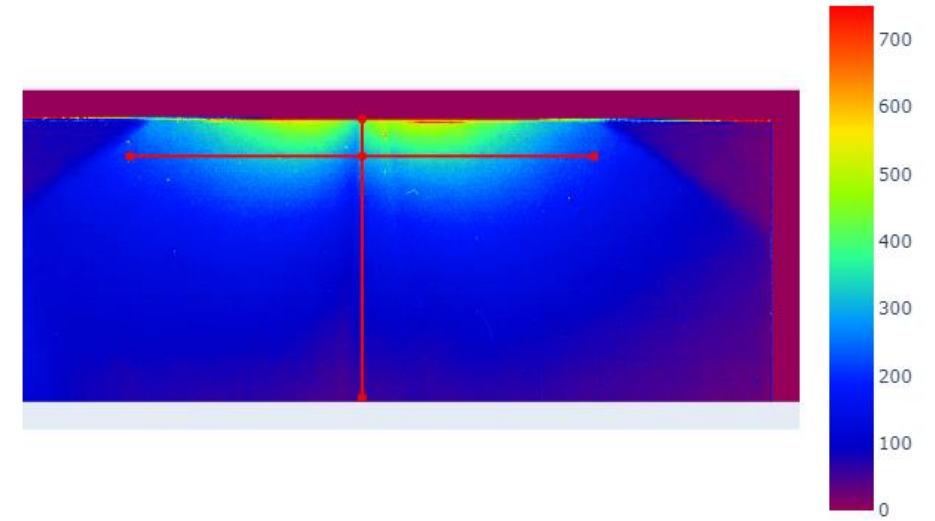
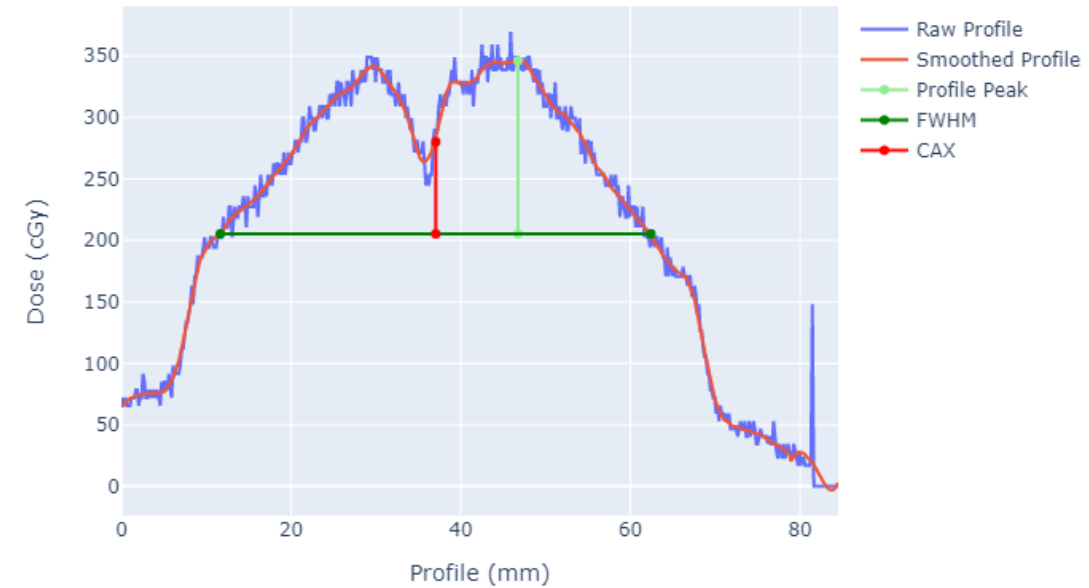


BA45 PDD

BA45 CAX PDD

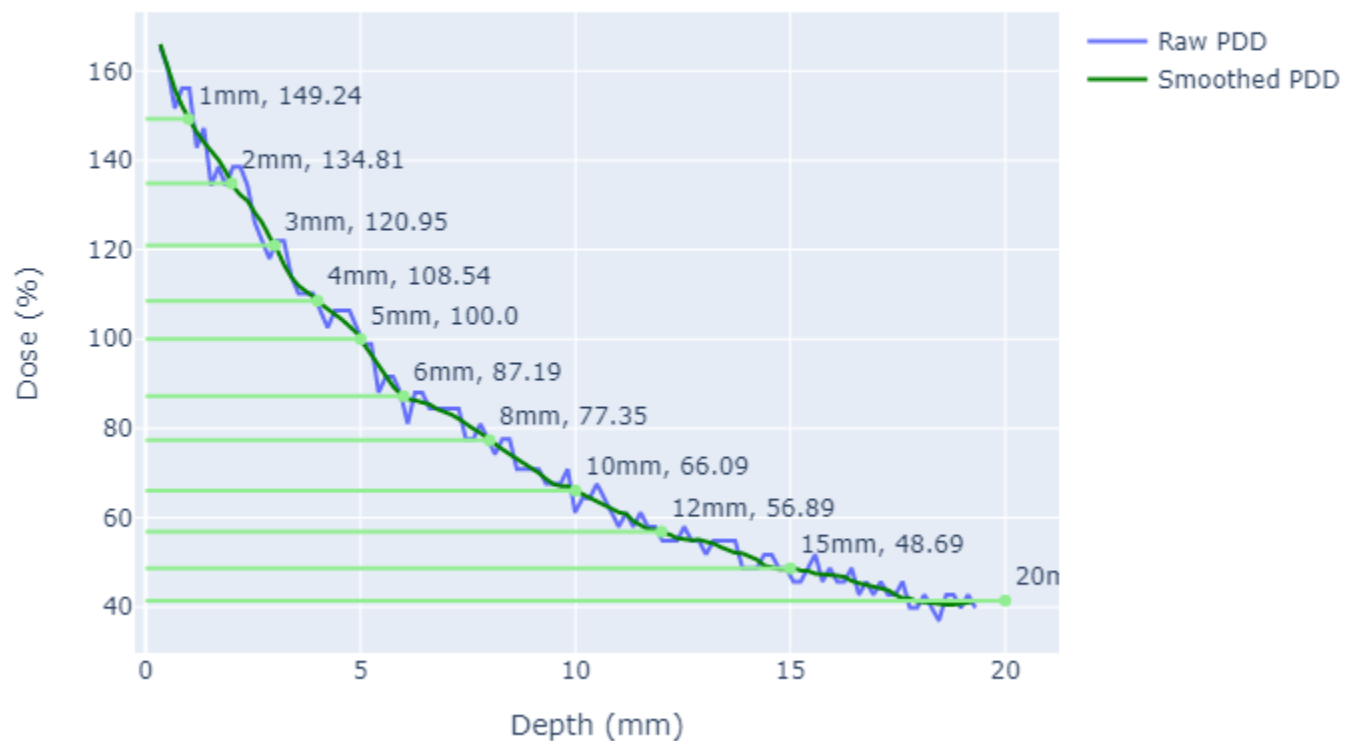


BA45 Cross Profile at 4mm, to Identify CAX

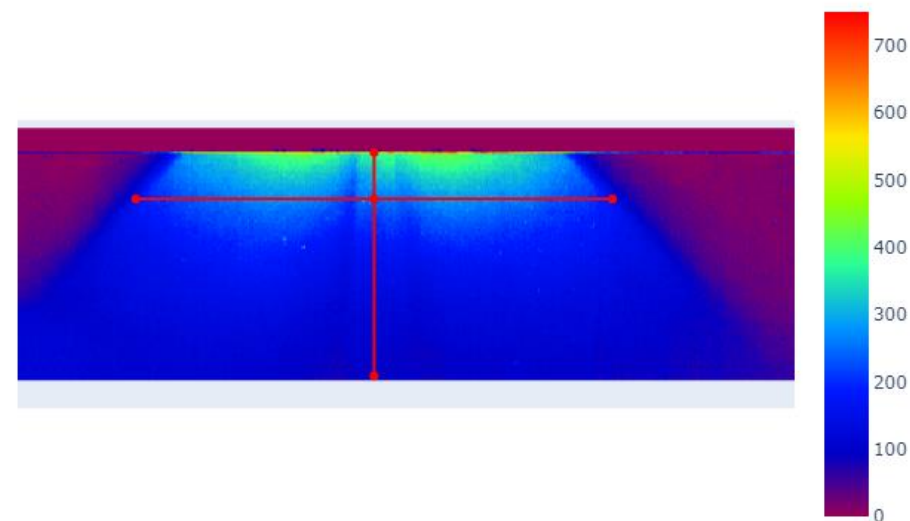


OA30x20 PDD

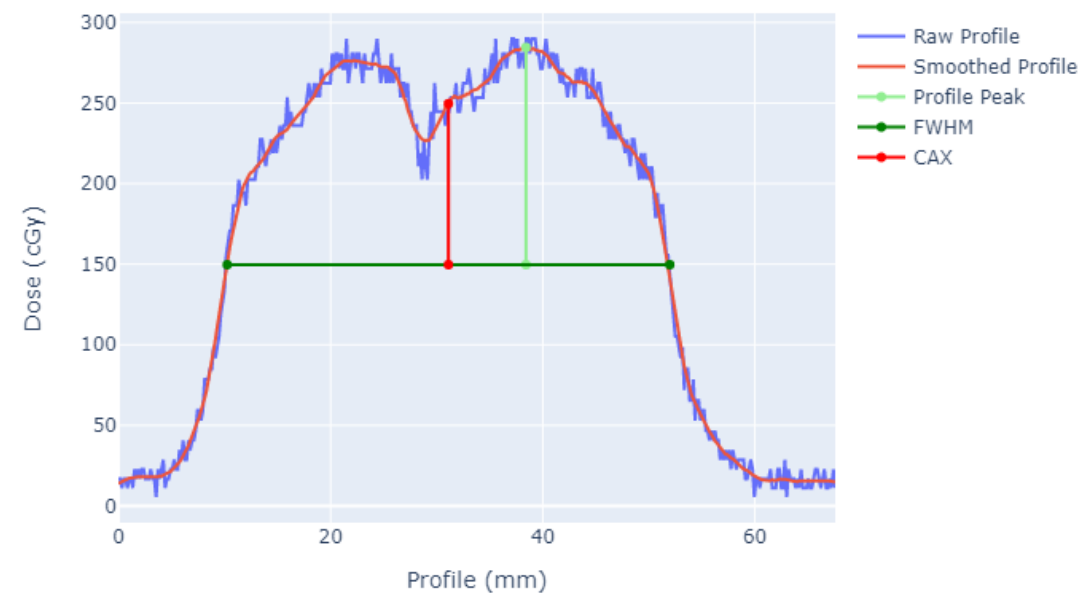
OA30x20 Major Axis CAX PDD



OA30x20 Major Axis Dose Map

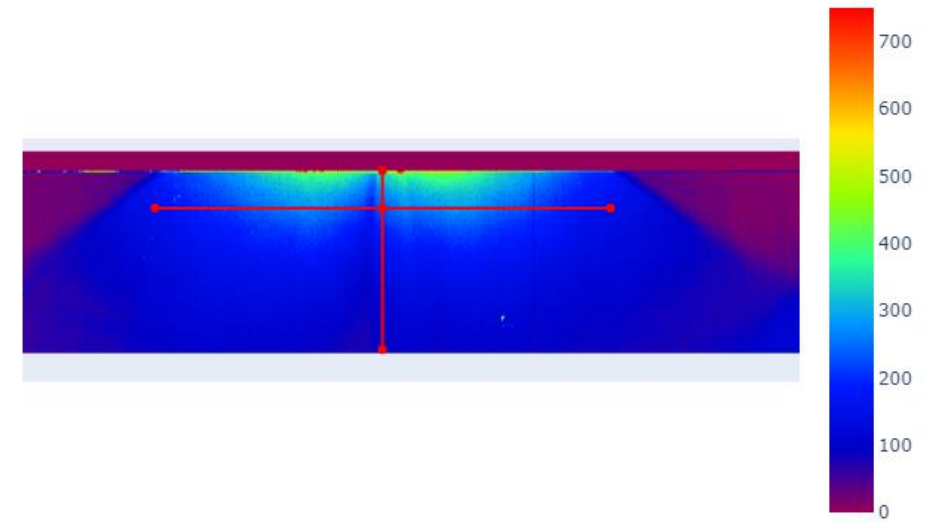
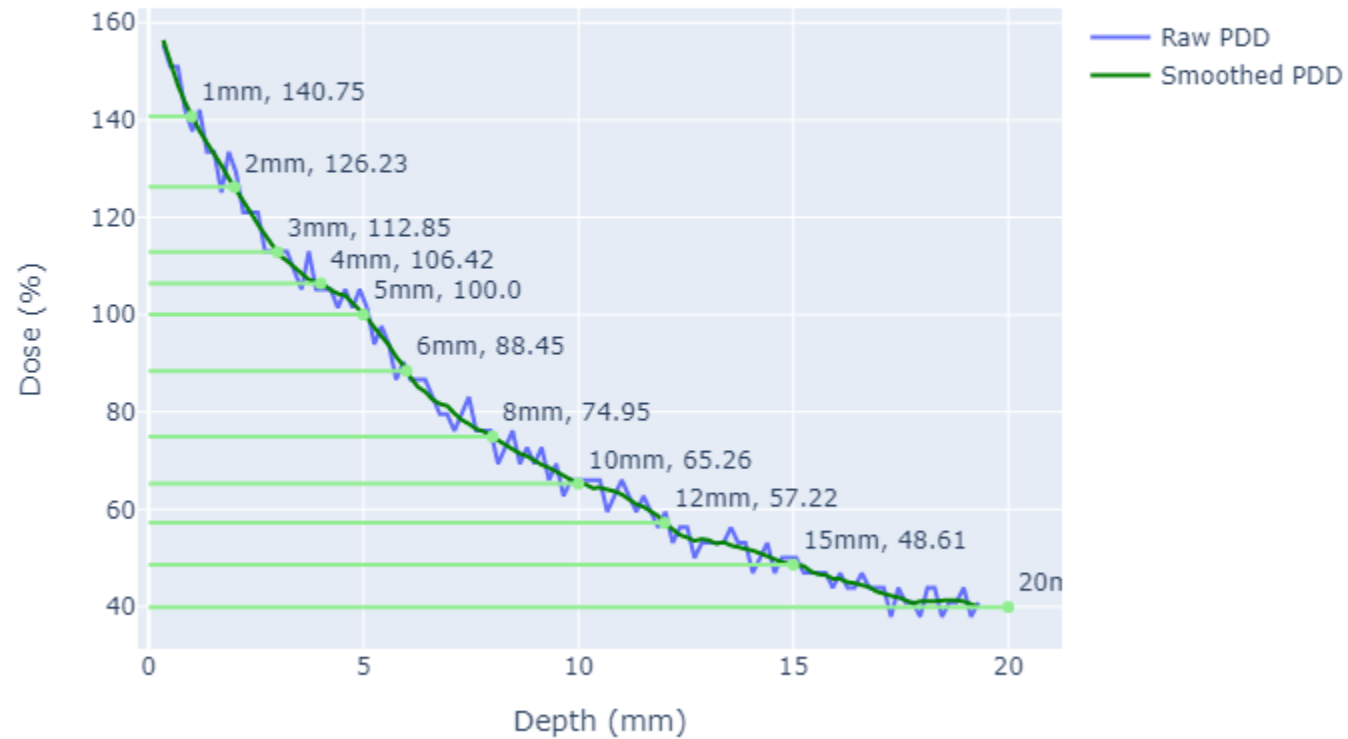


OA30x20 Major Axis Cross Profile at 4mm, to Identify CAX

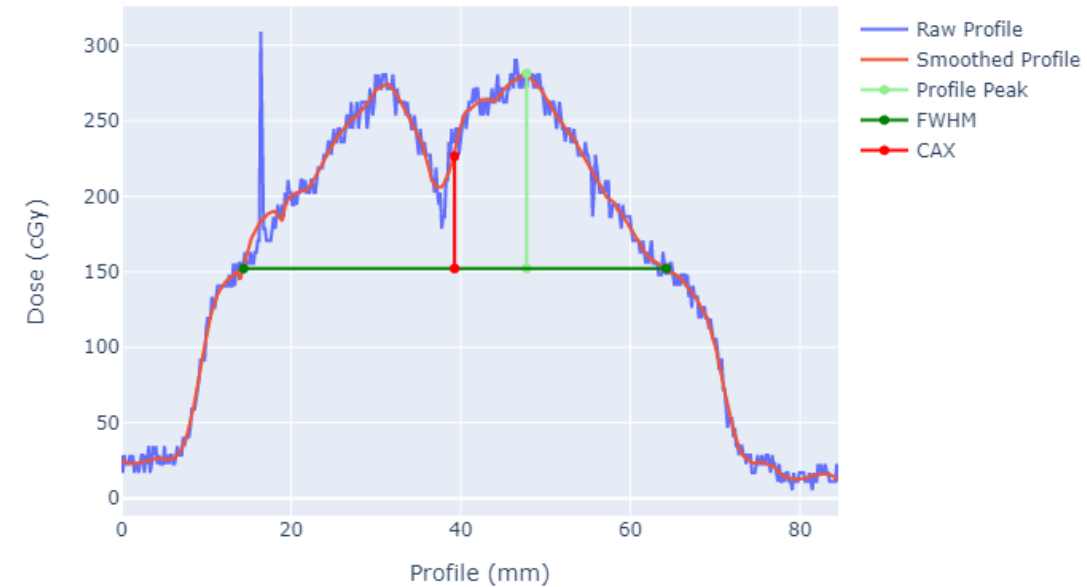


OA45x25 PDD

OA45x25 Major Axis CAX PDD



OA45x25 Major Axis Cross Profile at 4mm, to Identify CAX



Appendix B – Profile Analysis

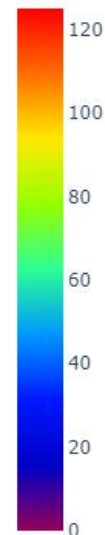
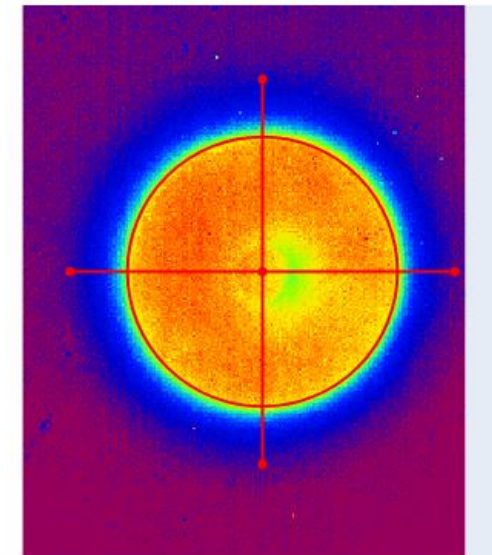
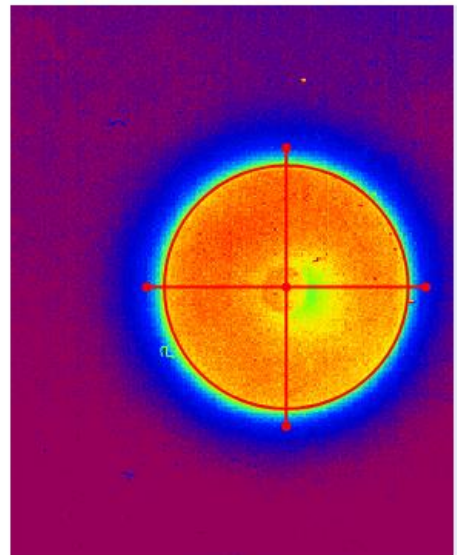
- Python scripts developed to apply film calibration to films and convert to dose
- The center of the distribution was found automatically, by thresholding at 10% the maximum dose, then finding the minimum circle that encompassed the resulting binary mask
- The dose map was normalized according to Acuros calculation
- The minimum spanning disk was acquired at the 90% isodose level to determine the diameter of the therapeutic coverage
- A similar process was followed for the elliptical applicators, but fitting an ellipse and finding major and minor axes
- Vertical and Horizontal profiles were also taken through the center, in order to assess centricity of the source and dose distribution
- The following slides display results for each Cone Inset

SA15_3mm Dose Map (Normalized to 320.0 cGy)

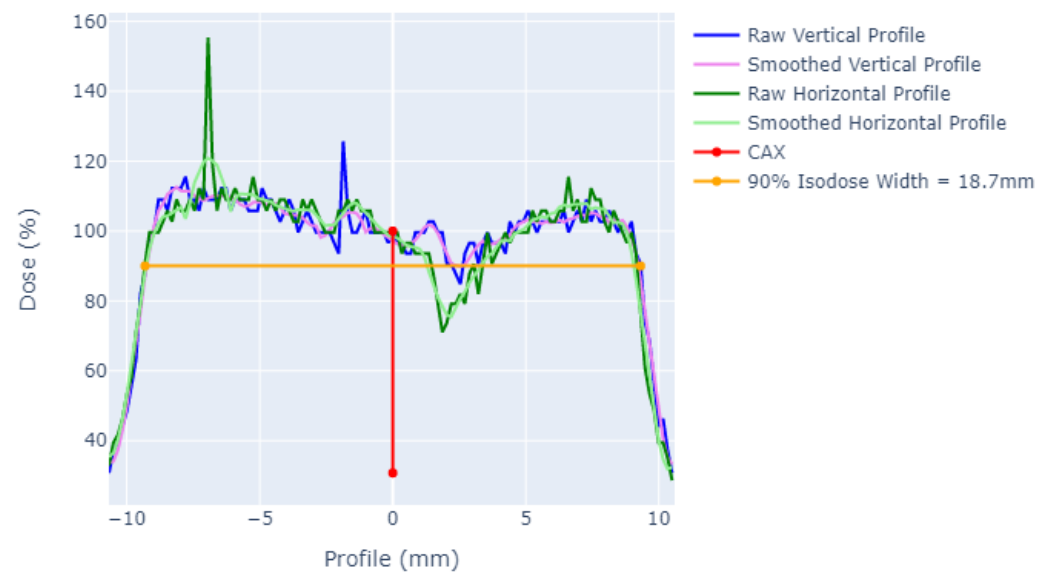
SA15_5mm Dose Map (Normalized to 260.0 cGy)

SA15 Profiles

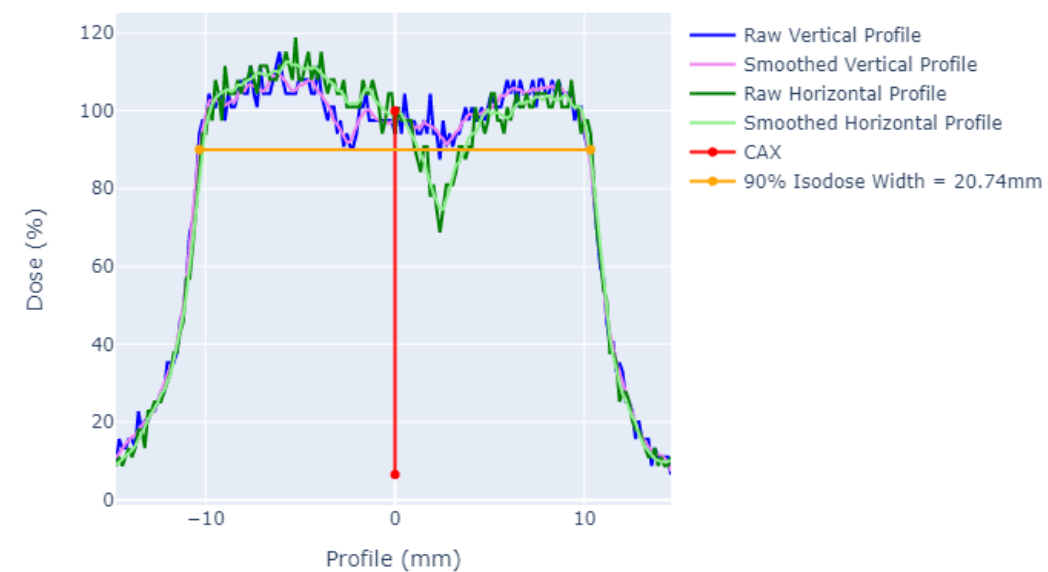
Depth	90% Isodose Width (mm)
3 mm	18.7
5 mm	20.7



SA15_3mm Cross Profiles



SA15_5mm Cross Profiles

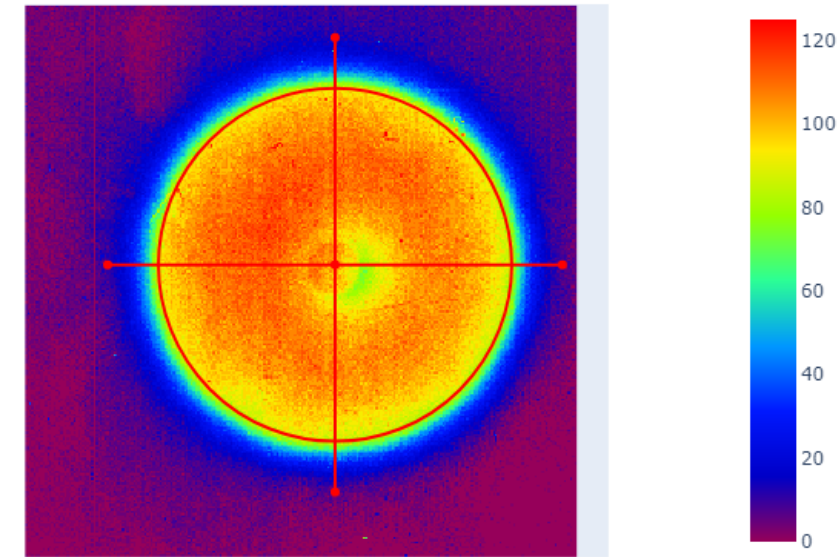
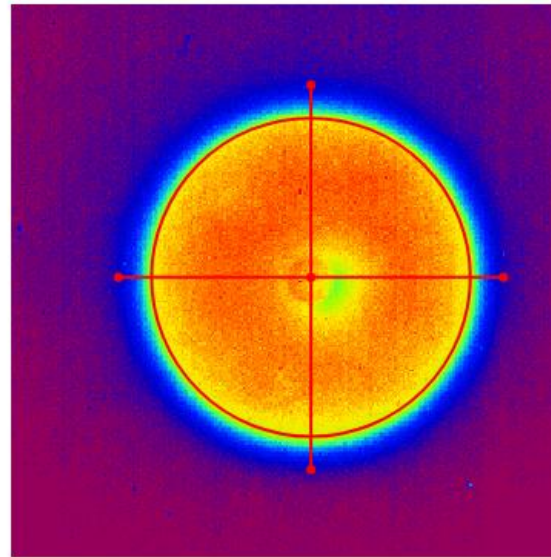


SA20_3mm Dose Map (Normalized to 310.0 cGy)

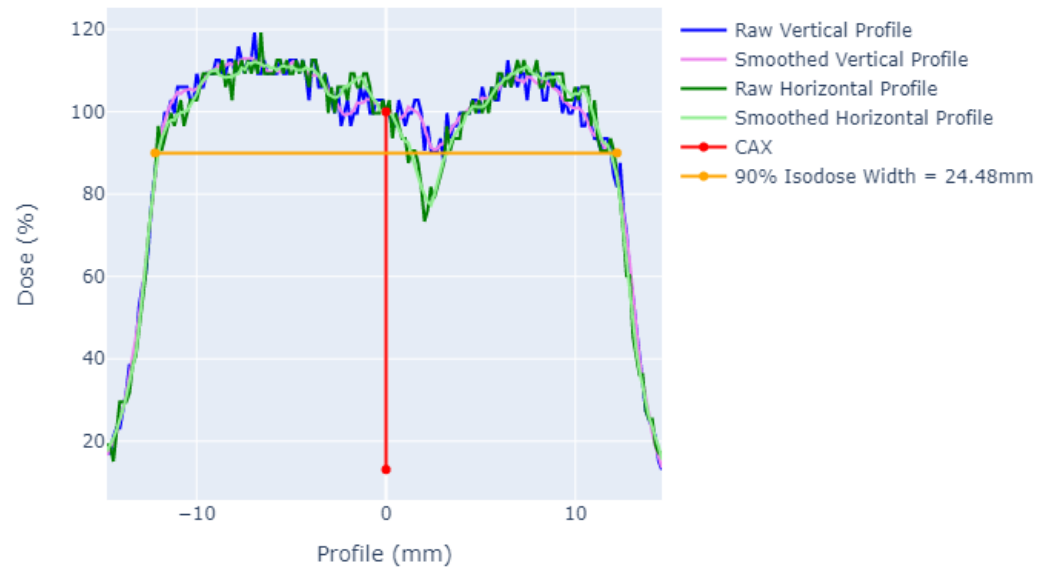
SA20_5mm Dose Map (Normalized to 255.0 cGy)

SA20 Profiles

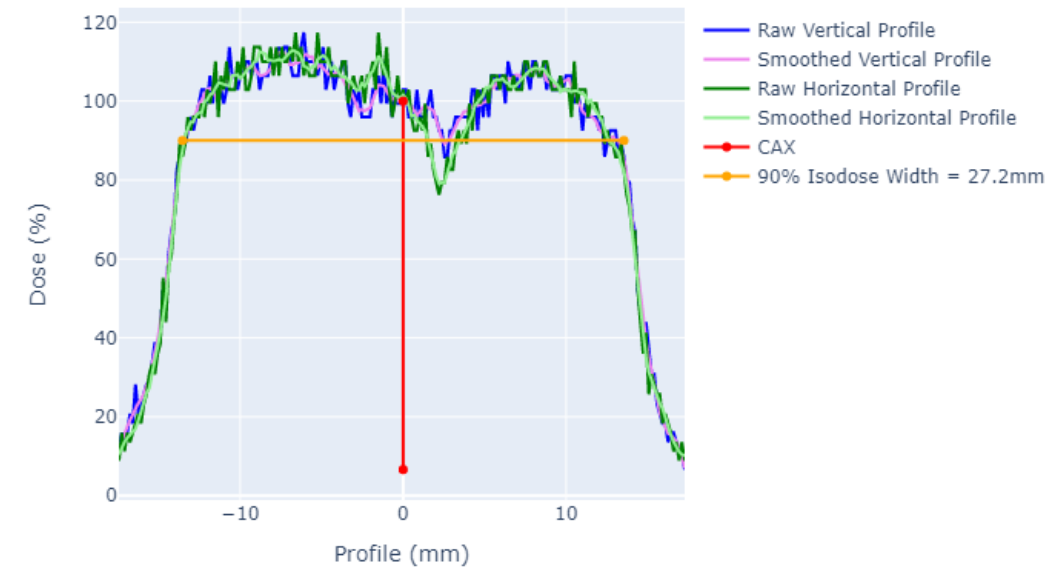
Depth	90% Isodose Width (mm)
3 mm	24.5
5 mm	27.2



SA20_3mm Cross Profiles



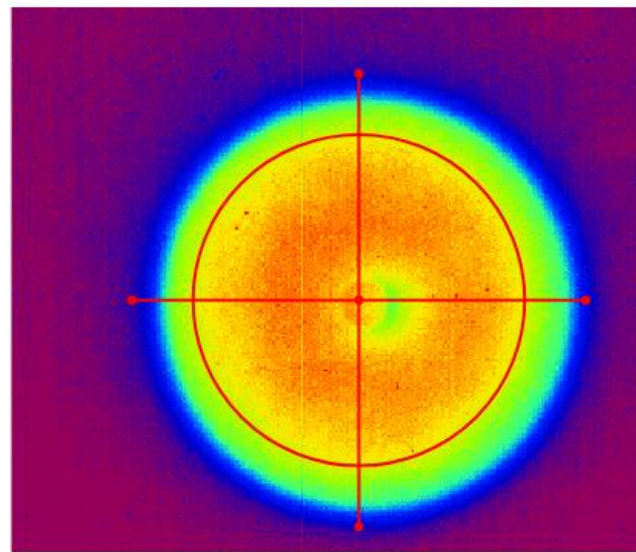
SA20_5mm Cross Profiles



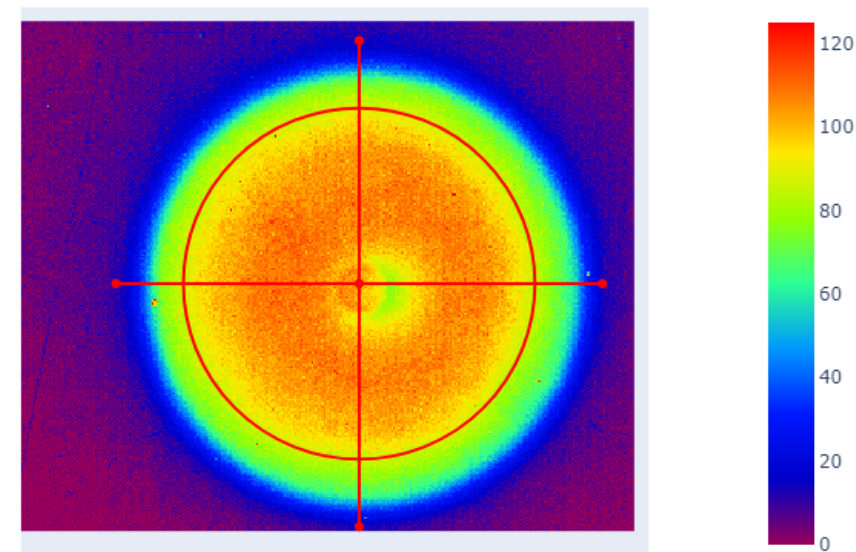
SA25 Profiles

Depth	90% Isodose Width (mm)
3 mm	25.8
5 mm	29.2

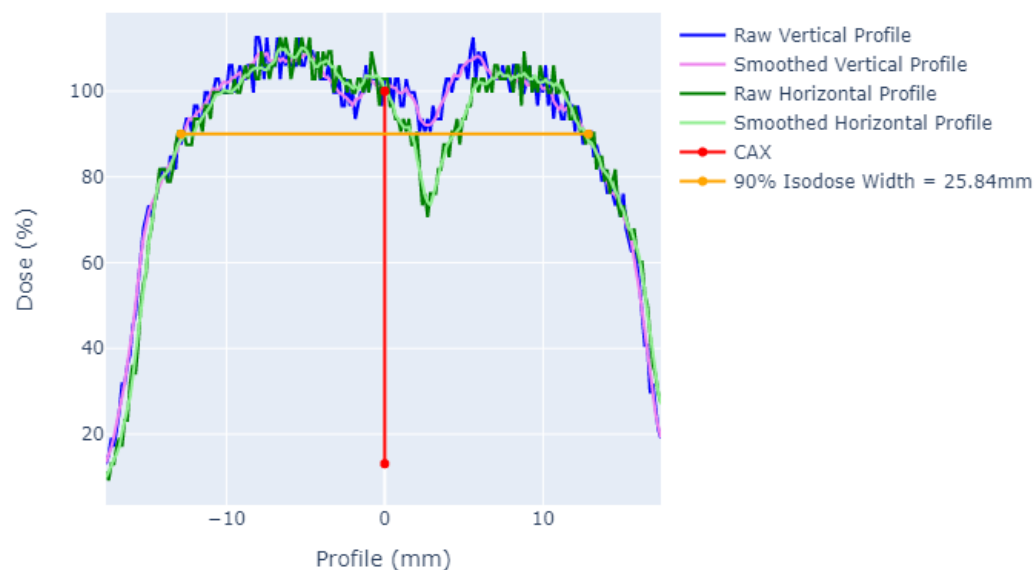
SA25_3mm Dose Map (Normalized to 310.0 cGy)



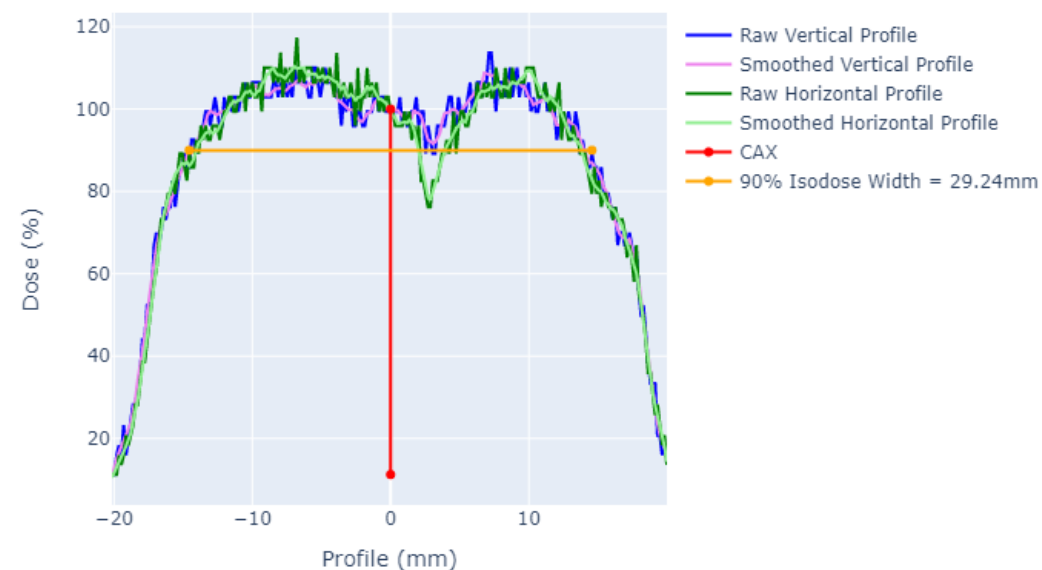
SA25_5mm Dose Map (Normalized to 255.0 cGy)



SA25_3mm Cross Profiles



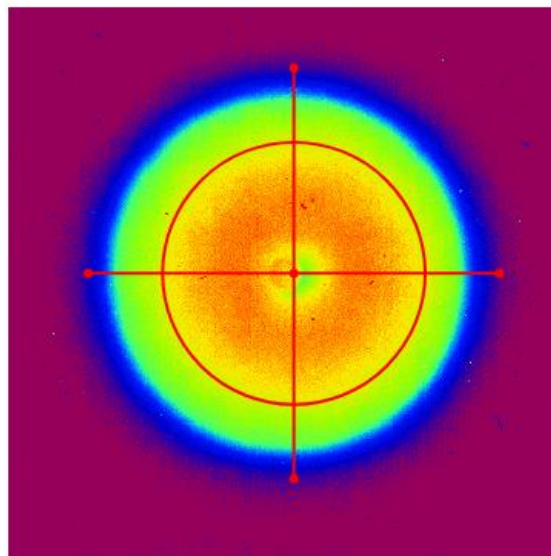
SA25_5mm Cross Profiles



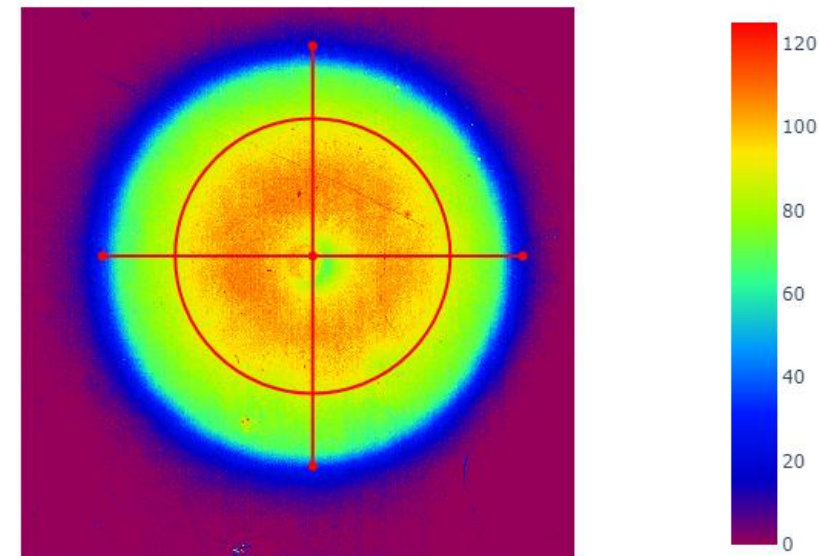
BA30 Profiles

Depth	90% Isodose Width (mm)
3 mm	28.2
5 mm	29.6

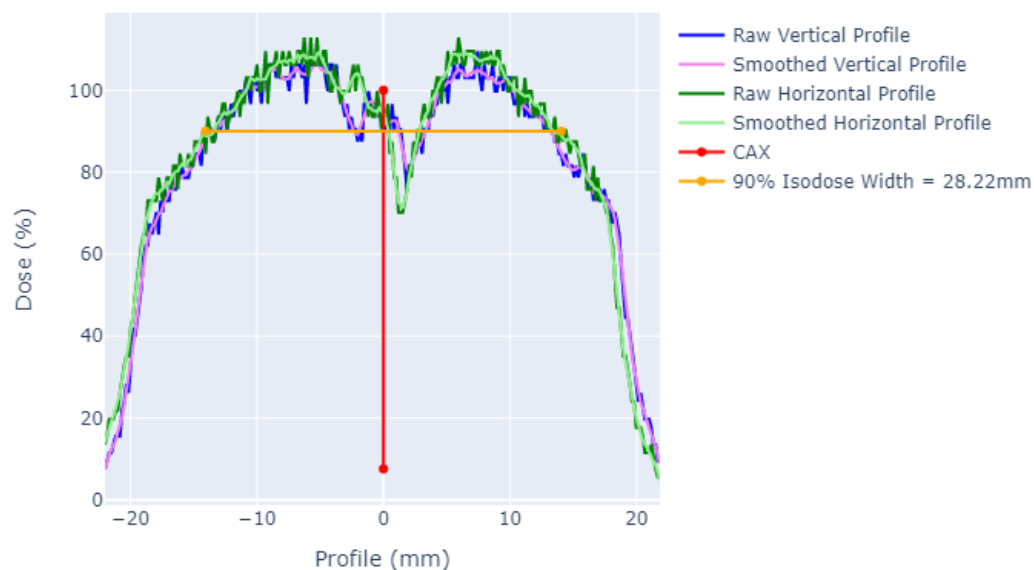
BA30_3mm Dose Map (Normalized to 300.0 cGy)



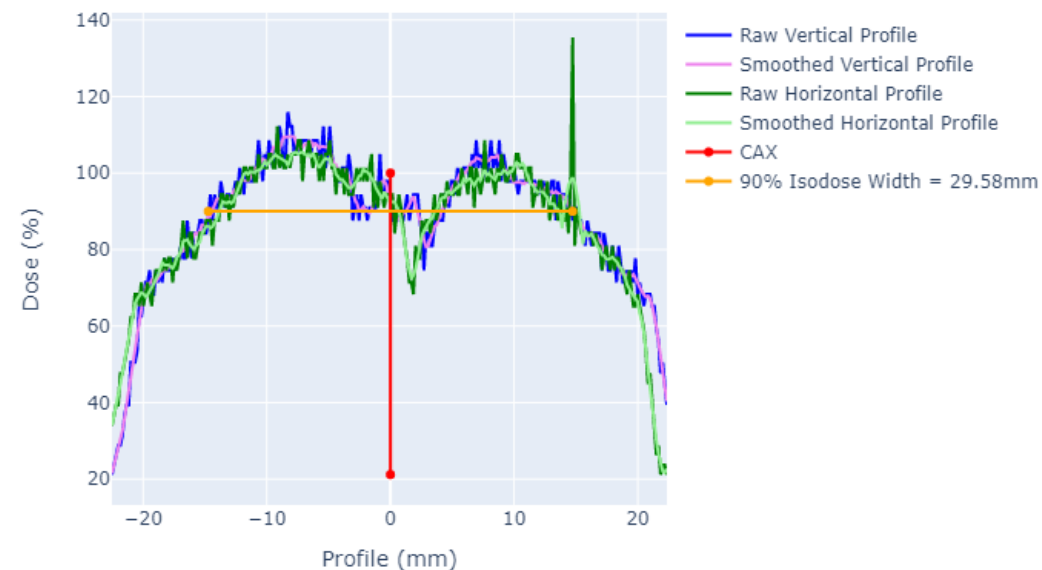
BA30_5mm Dose Map (Normalized to 250.0 cGy)



BA30_3mm Cross Profiles



BA30_5mm Cross Profiles

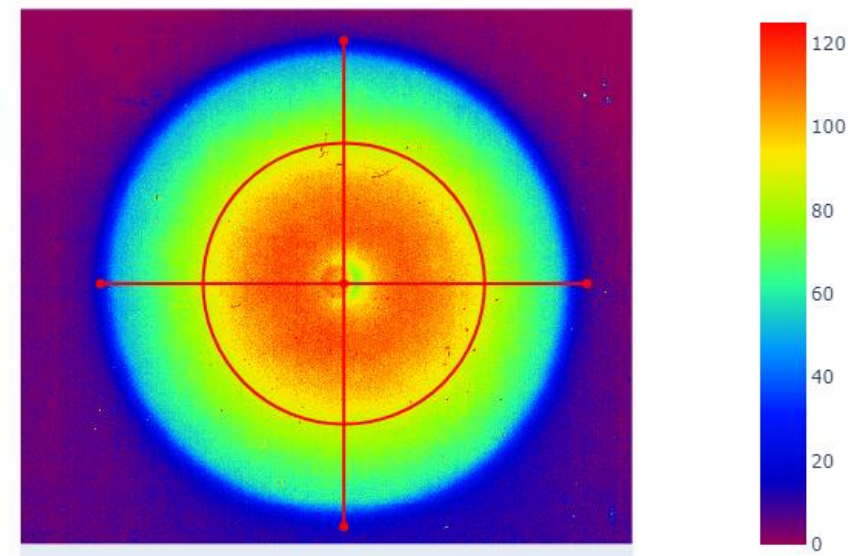
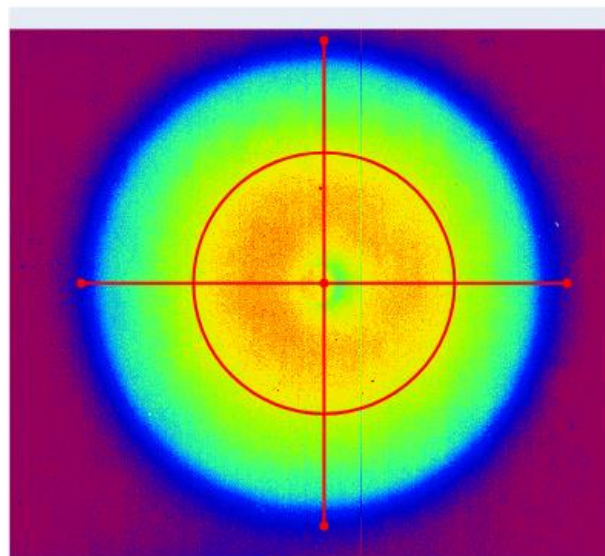


BA35_5mm Dose Map (Normalized to 250.0 cGy)

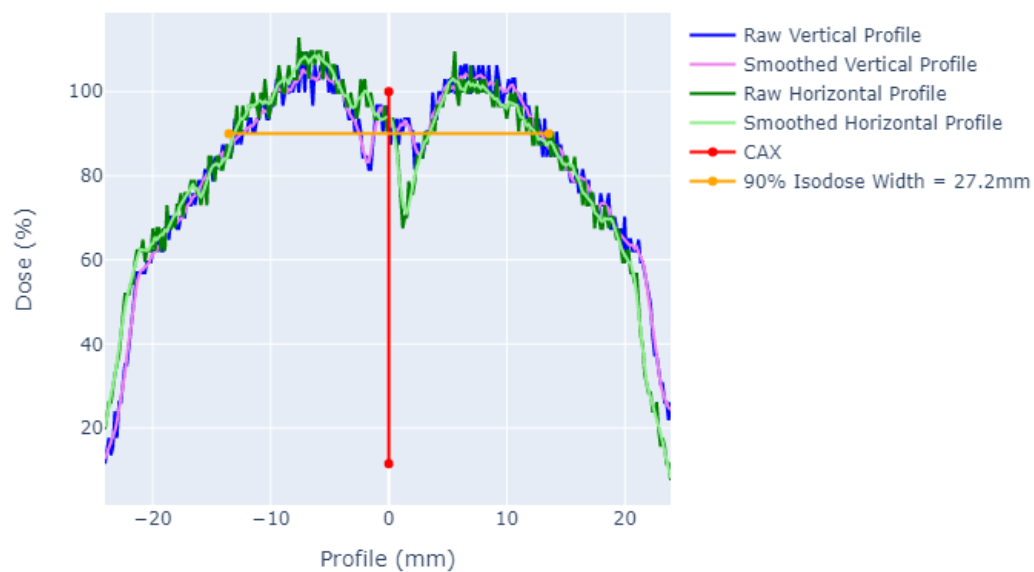
BA40_3mm Dose Map (Normalized to 300.0 cGy)

BA35 Profiles

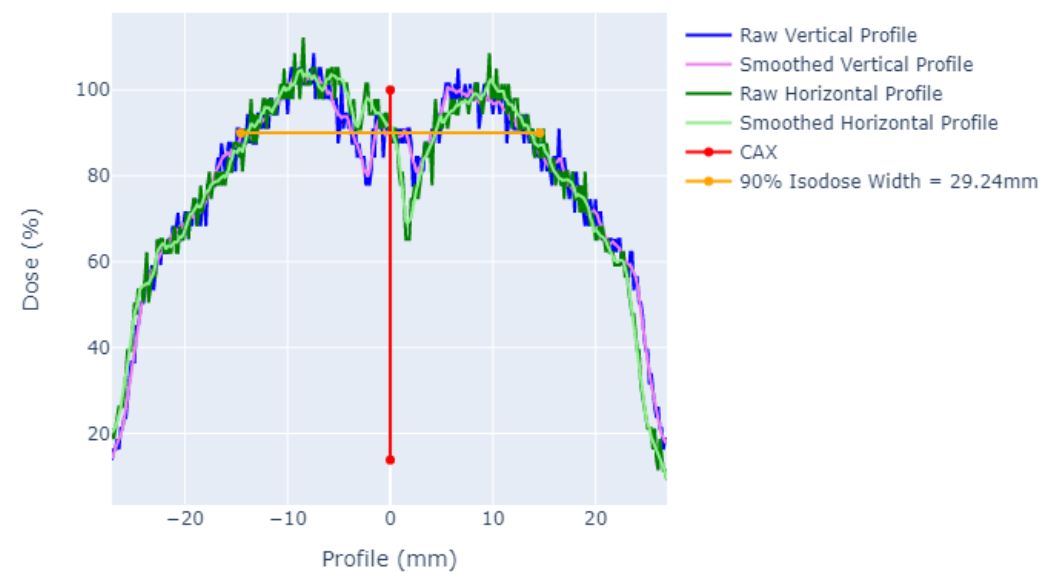
Depth	90% Isodose Width (mm)
3 mm	27.2
5 mm	29.2



BA35_3mm Cross Profiles



BA35_5mm Cross Profiles

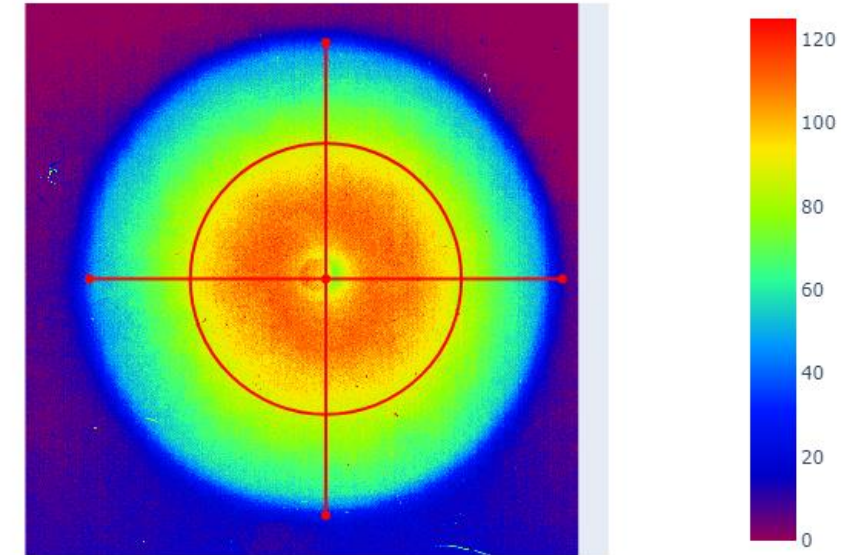
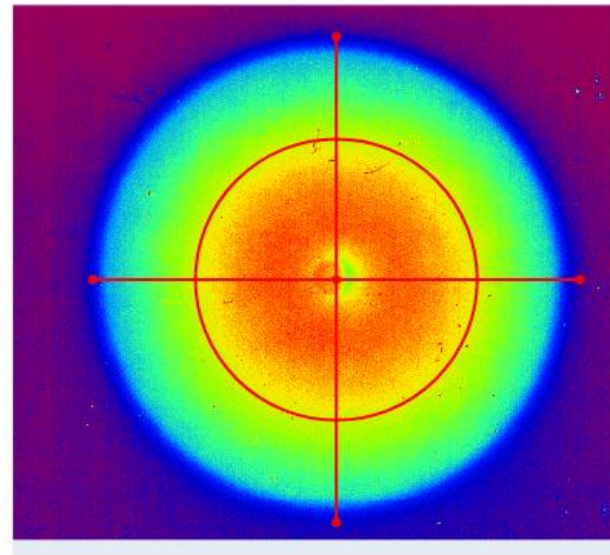


BA40_3mm Dose Map (Normalized to 300.0 cGy)

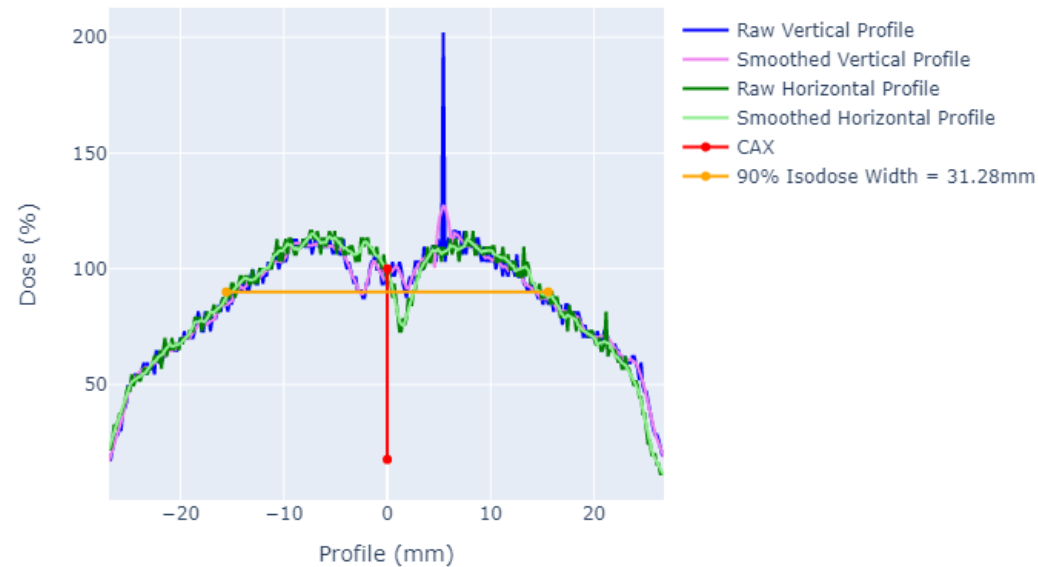
BA40_5mm Dose Map (Normalized to 250.0 cGy)

BA40 Profiles

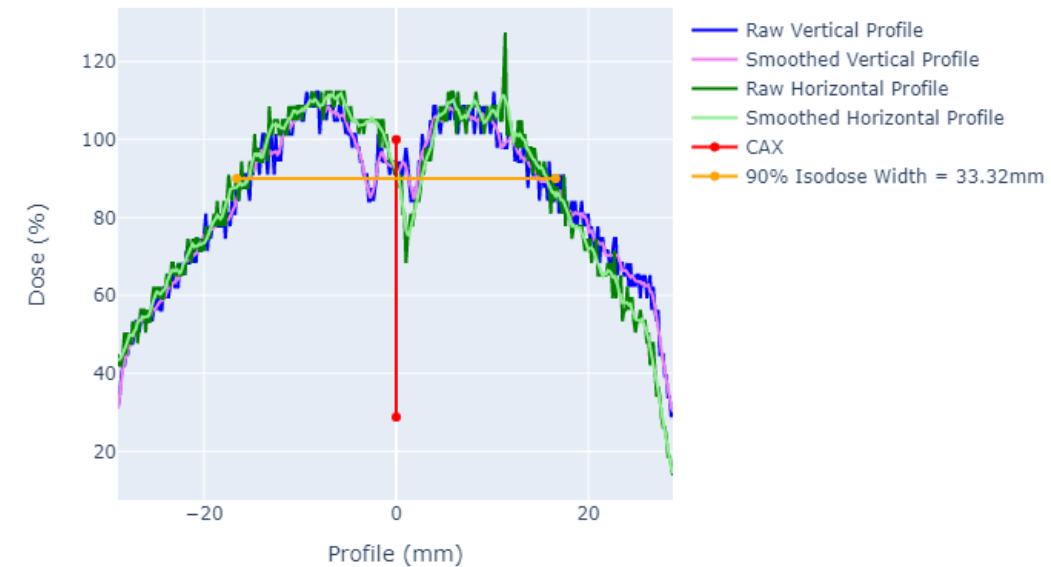
Depth	90% Isodose Width (mm)
3 mm	31.3
5 mm	33.3



BA40_3mm Cross Profiles



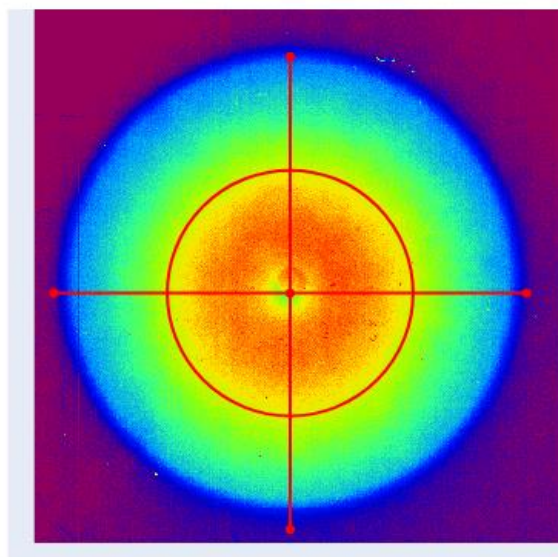
BA40_5mm Cross Profiles



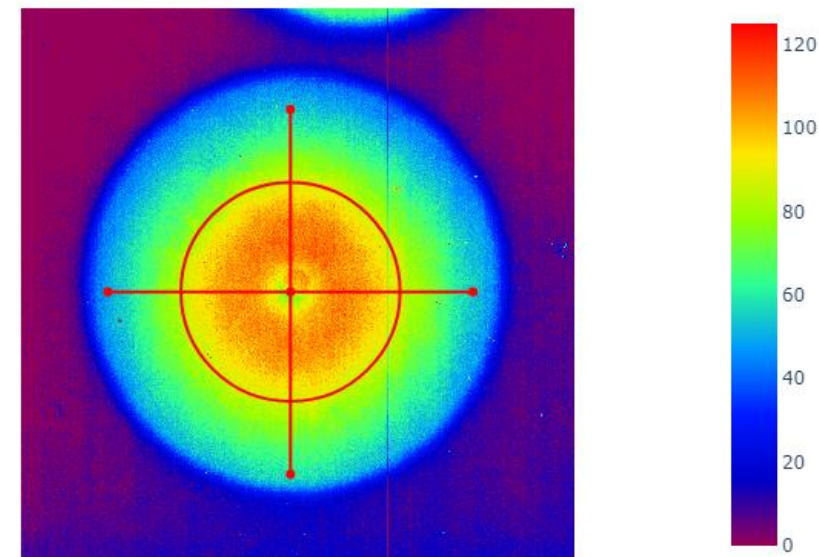
BA45 Profiles

Depth	90% Isodose Width (mm)
3 mm	31.3
5 mm	33.7

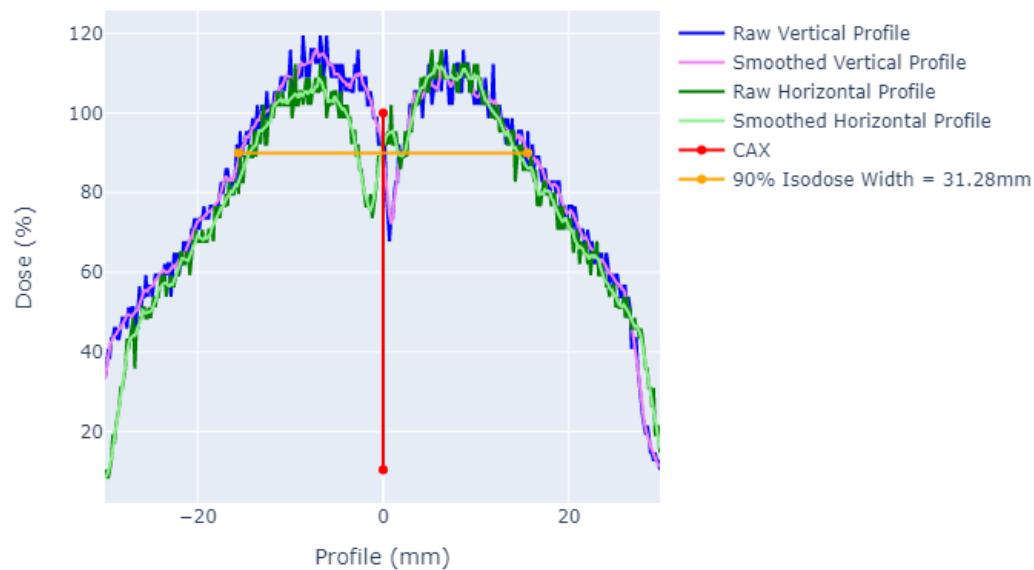
BA45_3mm Dose Map (Normalized to 275.0 cGy)



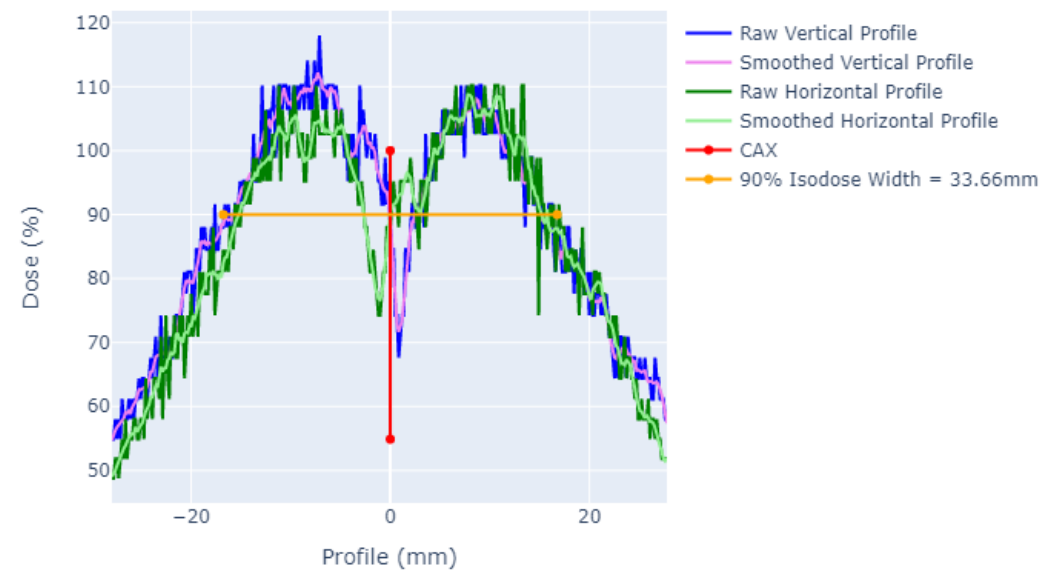
BA45_5mm Dose Map (Normalized to 230.0 cGy)



BA45_3mm Cross Profiles



BA45_5mm Cross Profiles

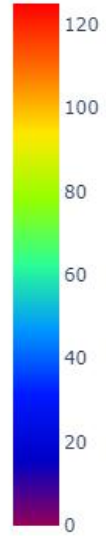
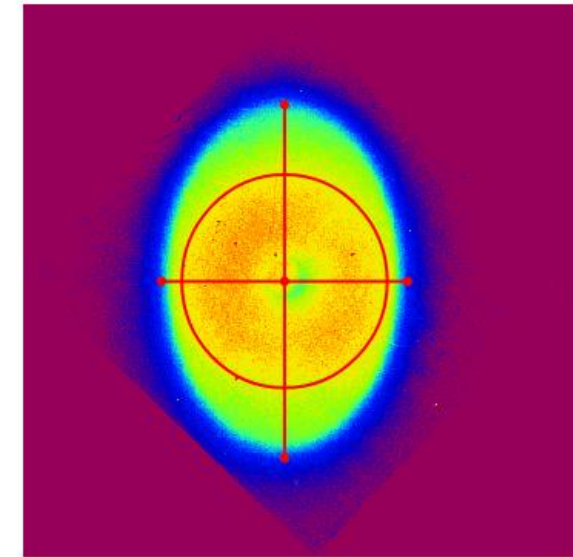
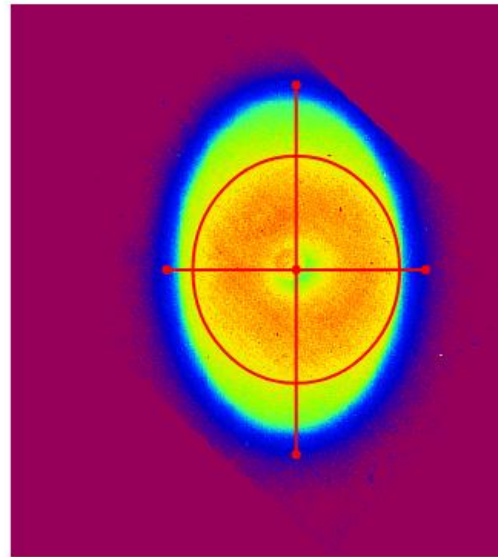


OA30x20_3mm Dose Map (Normalized 300.0 cGy)

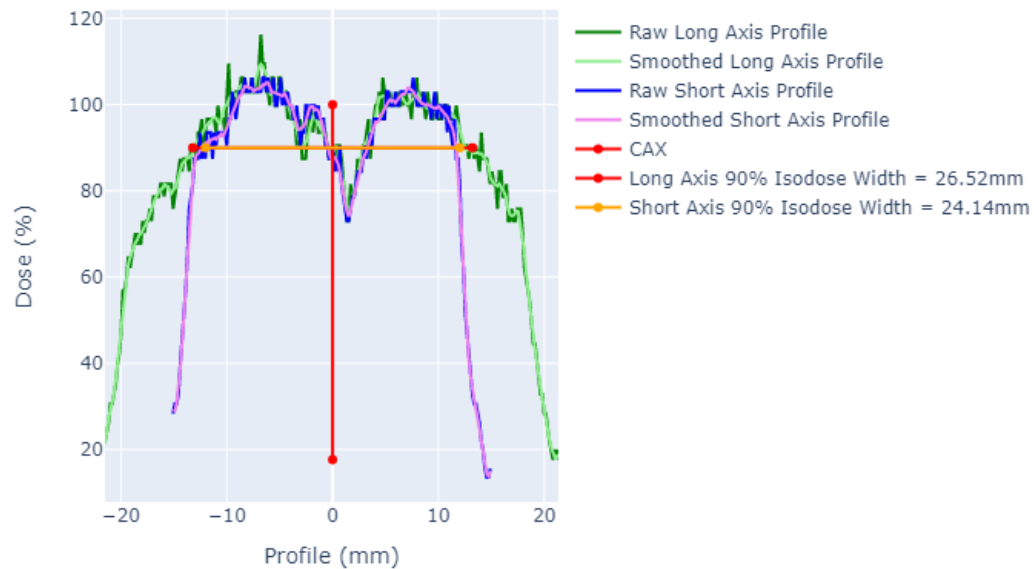
OA30x20_5mm Dose Map (Normalized 250.0 cGy)

OA30x20 Profiles

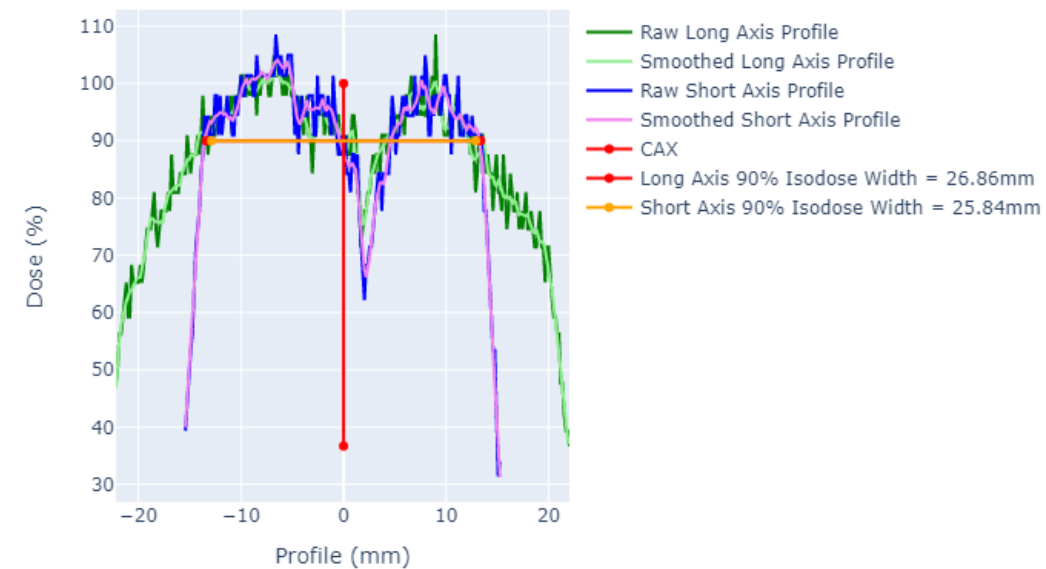
	90% Isodose Width (mm)	
Depth	Major Axis	Minor Axis
3 mm	26.5	24.1
5 mm	26.7	25.8



OA30x20_3mm Cross Profiles

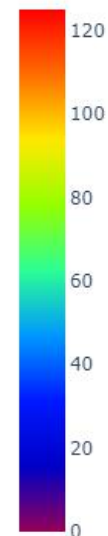
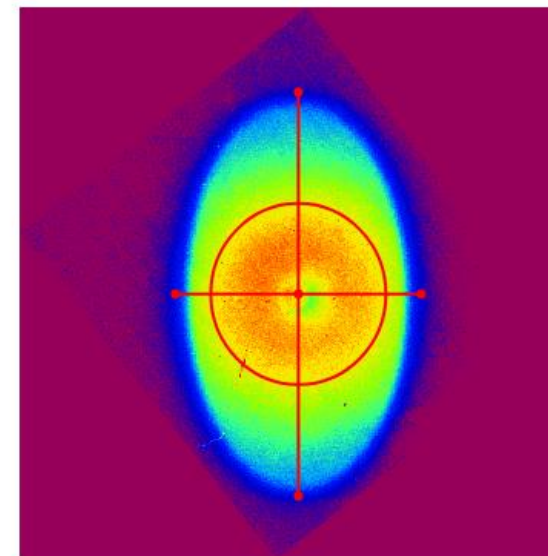
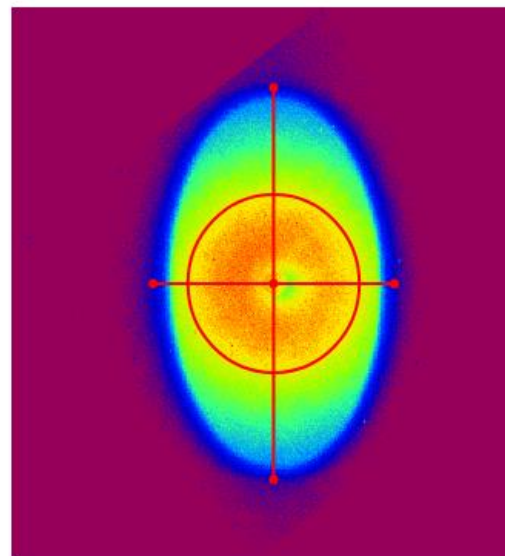


OA30x20_5mm Cross Profiles

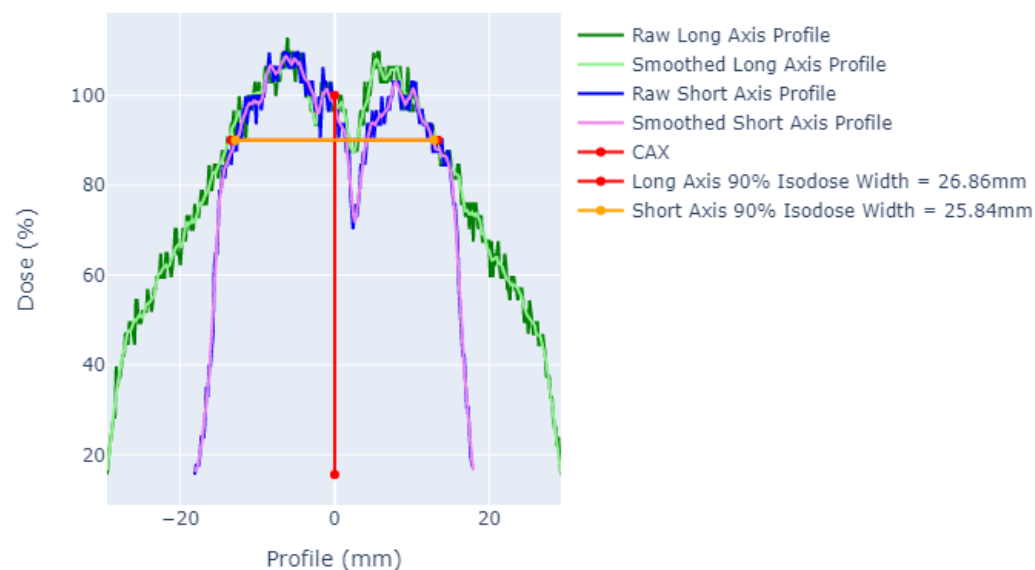


OA45x25 Profiles

	90% Isodose Width (mm)	
Depth	Major Axis	Minor Axis
3 mm	26.9	25.8
5 mm	29.6	28.6



OA45x25_3mm Cross Profiles



OA45x25_5mm Cross Profiles

