

Erste Erfahrungen mit Mobius 3D und Mobius Fx

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Stand der Technik in Bamberg

- 2 Elekta Synergy (100% Tandem-Betrieb)
- 1 Tomotherapie
- IGRT: 2mal kV-CBCT; 2mal MV-EPID, 1mal MVCT
- Linacs : 90% IMRT (alles VMAT) plus Tomo (100% IMRT)
- Planungssysteme
 - Philips Pinnacle Vers. 9.8 - Smart Enterprise
 - Tomotherapie: Volo
- Second-Check: Imsure und **Mobius**
- Umfangreiche Meßausstattung
 - Arccheck, Delta4, PTW729 + SRS1000

Aktuelle Problematik

- Zahl der Patienten steigt > **mehr Pläne**
- IGRT > Anatomische Veränderungen jetzt beobachtbar
– > Replanning > **mehr Pläne**
- Insgesamt weitere Verdichtung der Arbeitsabläufe in der Strahlentherapie
- Investition in neu Geräte/Entwicklungen und/oder Personal?
- > **Automatisierung** der Arbeitsabläufe statt Personal
- Teillösung schon realisiert: PatientenQA optimiert!

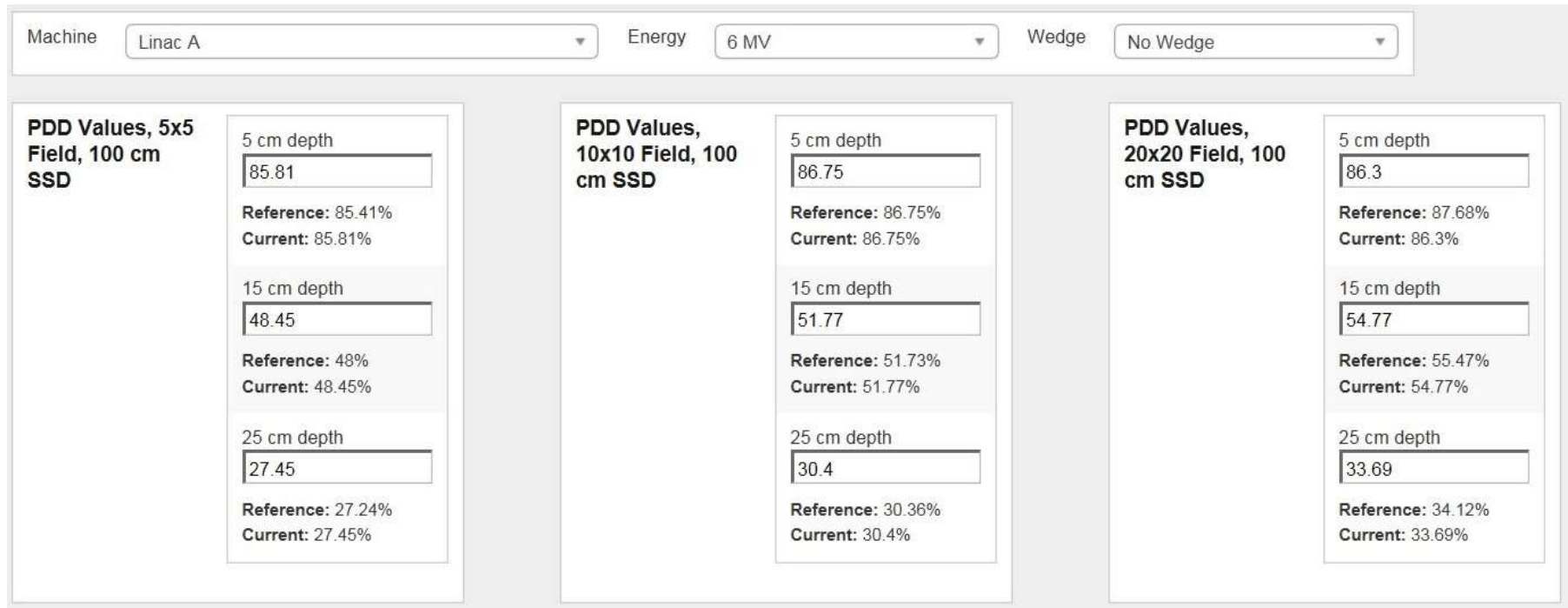
Aktuelle Arbeitsweise

- Planungprozess optimiert
 - Schnelle Hardware, Standardisierte Planungs - Protokolle
- Bestrahlungsablauf durch VMAT zeit-optimiert:
 - 10-min.-Takt inkl. IGRT, RT-Zeit zw. 2 und 3,5 min.
- Bottle-Neck: PatientenQA
- **Linacs:**
 - **Mobius3D und Fx**
 - **ca. 10 % wird gemessen (exemplarisch, „Ausreißer“)**
 - **Machine-QA > DIN-konform**
- Tomo:
 - Jeder Plan wird nach wie vor gemessen
 - Delta4, Arccheck und PTW Oktavius SRS1000

Mobius 3D

- Server mit Betriebssystem Ubuntu (Linux)
 - Läuft im Hintergrund
- Standard Linac-Modelle vorhanden
 - Individuell modellierbar (begrenzt)
- Zugriff von jedem PC im Netz über Webbrowser
- Export von VMAT-Plänen vom Planungssystem
 - Dicom: RT-Plan, RT-Structure-Set, RT-Dose und RT-Image (CT-Dataset)
- Mobius 3D beginnt nach Import automatisch mit der Berechnung
- Auswerte-Kriterien festlegen und speichern:
 - 3%/3mm, Targetstrukturen, Risikoorgane etc.

3 Stützstellen



Mobius 3D - Modell - Profil

Off-Axis Ratios at 5 cm Depth, 40x40 Field, 100 cm SSD

1 cm	2.5 cm	5 cm	7.5 cm	10 cm	15 cm	20 cm
100.1	101	101.6	101.9	103	102.6	97.1
Reference: 100.2% Current: 100.1%	Reference: 100.7% Current: 101%	Reference: 101.5% Current: 101.6%	Reference: 102% Current: 101.9%	Reference: 103.3% Current: 103%	Reference: 103.4% Current: 102.6%	Reference: 97.2% Current: 97.1%

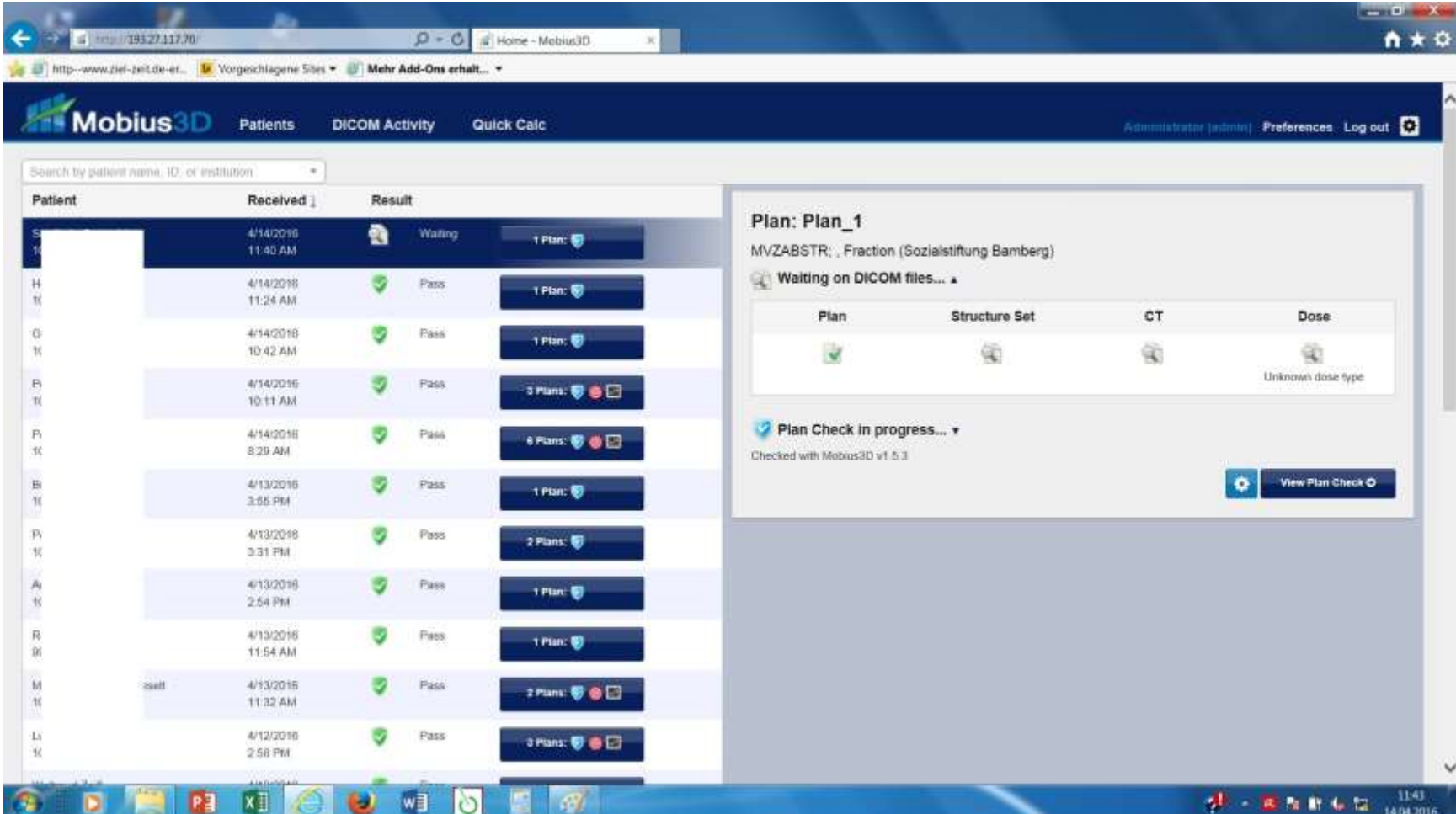
Output Factors (including Wedge Factors) at 10 cm Depth, 100 cm SSD

X1/X2: 1/1 cm Y1/Y2: 1/1 cm	X1/X2: 1.5/1.5 cm Y1/Y2: 1.5/1.5 cm	X1/X2: 2.5/2.5 cm Y1/Y2: 2.5/2.5 cm	X1/X2: 5/5 cm Y1/Y2: 5/5 cm	X1/X2: 7.5/7.5 cm Y1/Y2: 7.5/7.5 cm
0.796	0.848	0.903	1	1.056
Reference: 0.7881 Current: 0.796	Reference: 0.8427 Current: 0.848	Reference: 0.9025 Current: 0.903	Reference: 1 Current: 1	Reference: 1.058 Current: 1.056
X1/X2: 10/10 cm Y1/Y2: 10/10 cm	X1/X2: 12.5/12.5 cm Y1/Y2: 12.5/12.5 cm	X1/X2: 15/15 cm Y1/Y2: 15/15 cm	X1/X2: 17/17 cm Y1/Y2: 17/17 cm	X1/X2: 20/20 cm Y1/Y2: 20/20 cm
1.095	1.122	1.142	1.153	1.161
Reference: 1.099 Current: 1.095	Reference: 1.123 Current: 1.122	Reference: 1.143 Current: 1.142	Reference: 1.153 Current: 1.153	Reference: 1.162 Current: 1.161

Mobius Fx

- Zusätzliche Installation von Mobius-Log auf PC
 - Für jeden Linac getrennte Installation
 - Bei uns auf iView-Rechner von Elekta
- Mobius-Log hört über die iCom-Fx-Schnittstelle während der Bestrahlung mit und erzeugt eigene Log-Files
- Nach beendeter RT beginnt automatisch die Kontrollrechnung
 - zusätzlich werden Geometrie-Daten ausgewertet: z.B. Gantry-Position und MLC-Position
- Vergleich mit Plan vom TPS und von Mobius 3D (Voraussetzung: Mobius 3D ist vorhanden!)

Mobius - Web-Oberfläche



The screenshot displays the Mobius3D web application interface. The top navigation bar includes 'Patients', 'DICOM Activity', and 'Quick Calc'. A search bar is located above the patient list. The patient list table has columns for Patient, Received, and Result. The right-hand panel shows details for 'Plan: Plan_1', including 'MVZABSTR: , Fraction (Sozialstiftung Bamberg)', 'Waiting on DICOM files...', and a table with columns 'Plan', 'Structure Set', 'CT', and 'Dose'. A 'Plan Check in progress...' status is also visible.

Patient	Received	Result
S T	4/14/2016 11:40 AM	Waiting
H K	4/14/2016 11:24 AM	Pass
G W	4/14/2016 10:42 AM	Pass
P K	4/14/2016 10:11 AM	Pass
P K	4/14/2016 8:29 AM	Pass
B K	4/13/2016 3:55 PM	Pass
P K	4/13/2016 3:31 PM	Pass
A K	4/13/2016 2:54 PM	Pass
R B	4/13/2016 11:54 AM	Pass
M K	4/13/2016 11:32 AM	Pass
L K	4/12/2016 2:58 PM	Pass

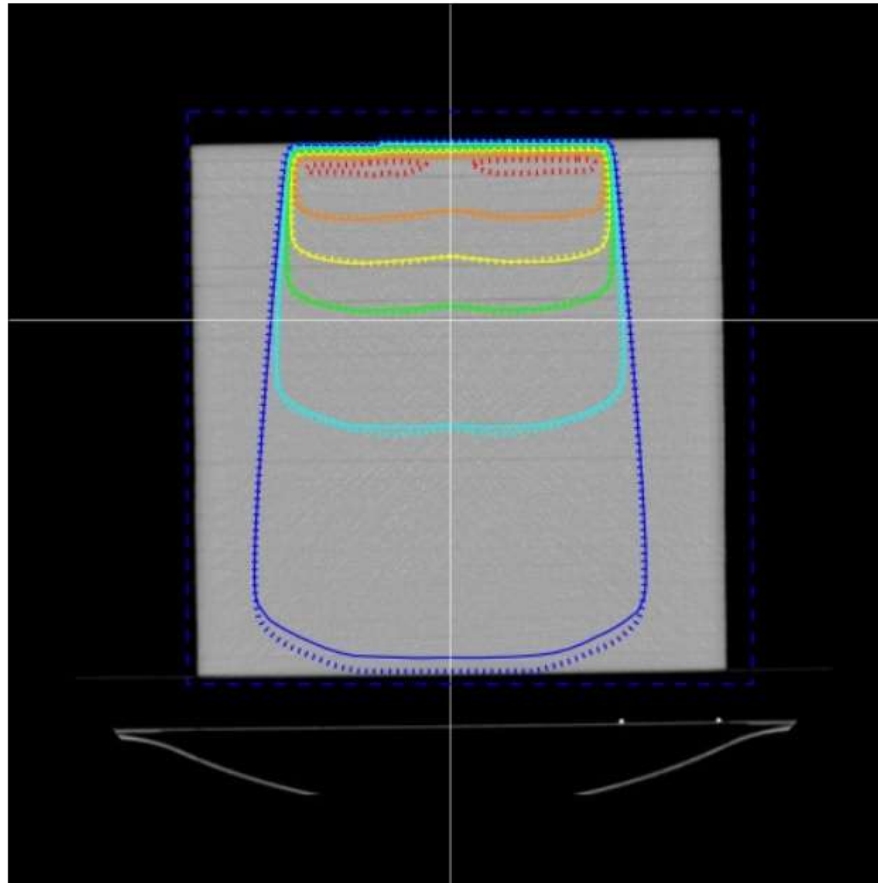
Plan	Structure Set	CT	Dose
✓	📁	📁	Unknown dose type

Mobius 3D - Standardplan

Stehfeld: 20x20cm

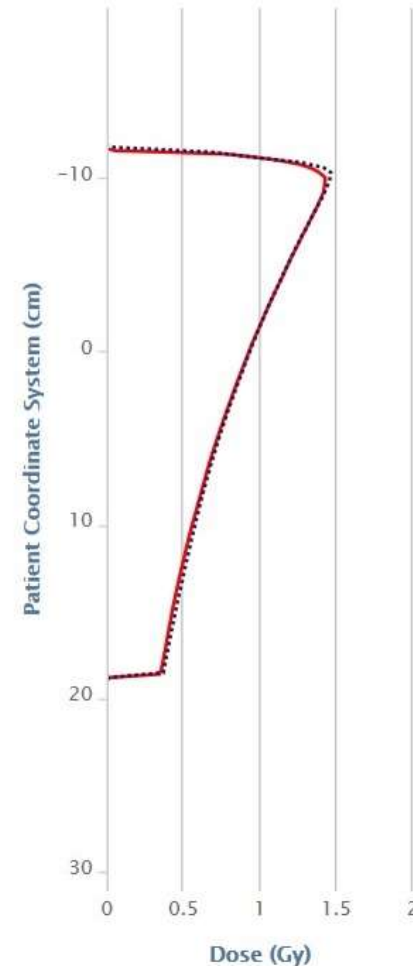
Transverse Gamma	Transverse Isodose	Coronal Gamma	Coronal Isodose	Sagittal Gamma	Sagittal Isodose
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Transverse Plane at 0 cm from Isocenter



CT Table Height specified in CT DICOM: 26.9 cm; CT couch removed.
TPS (Solid), Mobius3D (Dashed)

Vertical Dose Profile

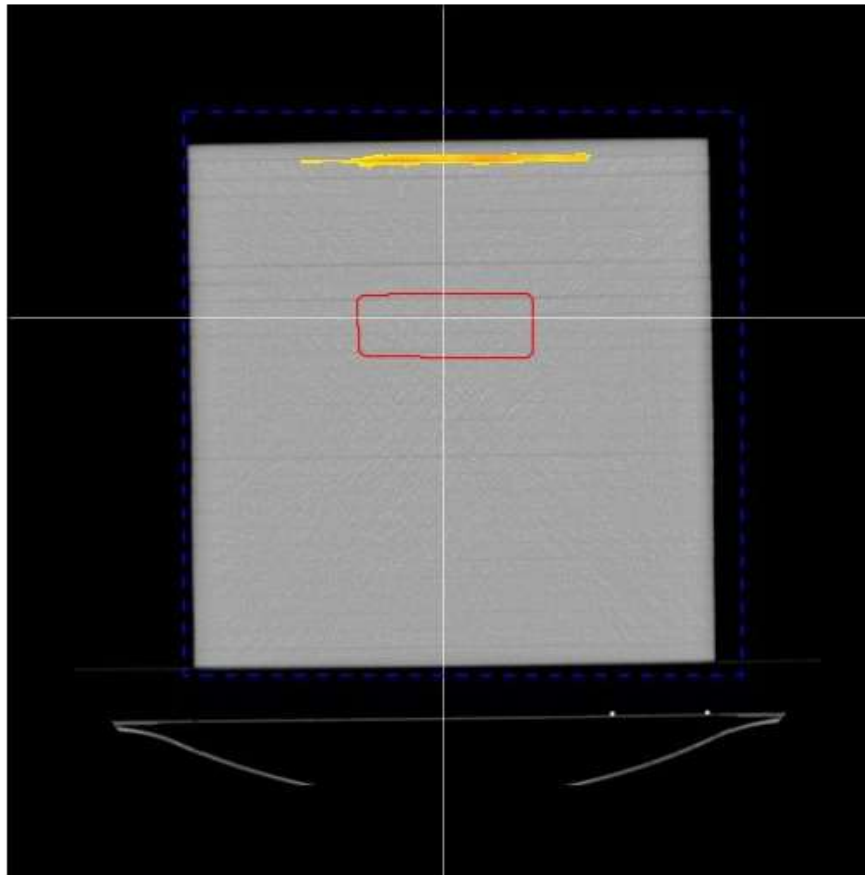


Mobius 3D - Standardplan

Stehfeld: 20x20cm

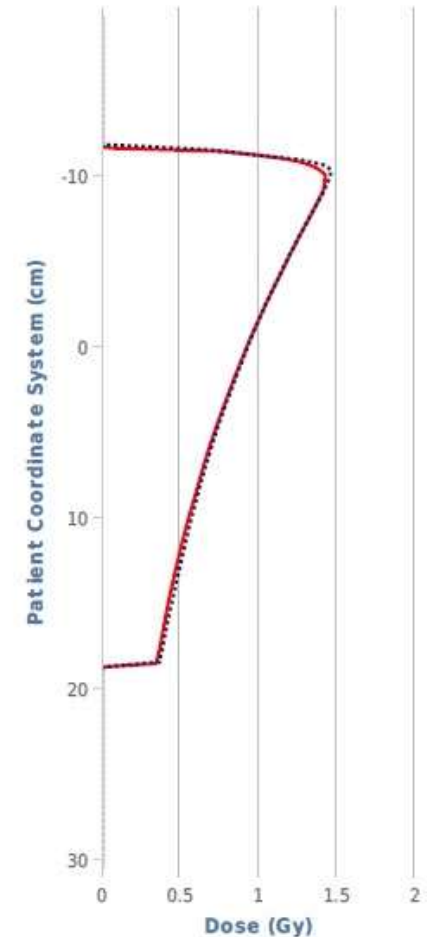
Transverse Gamma

Transverse Plane at 0 cm from Isocenter



CT Table Height specified in CT DICOM: 26.9 cm; CT couch removed.

Vertical Dose Profile

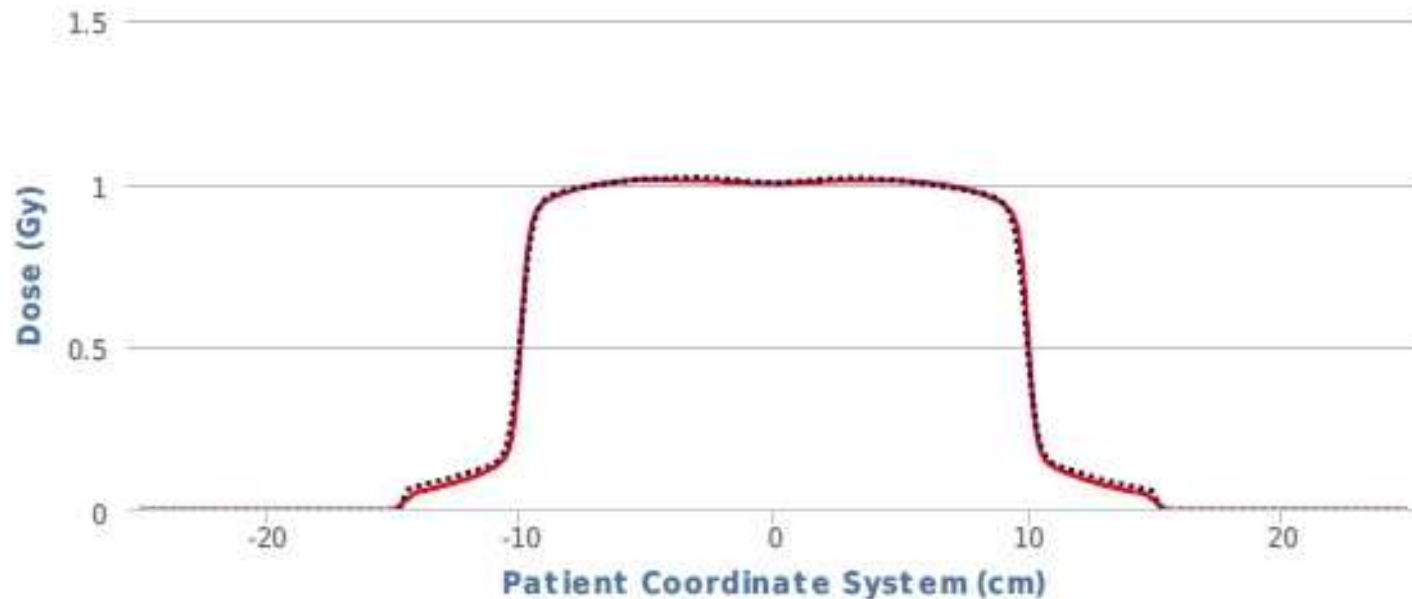


Solid: TPS; Dashed: Mobius

Mobius 3D - Standardplan

Stehfeld: 20x20cm

Horizontal Dose Profile



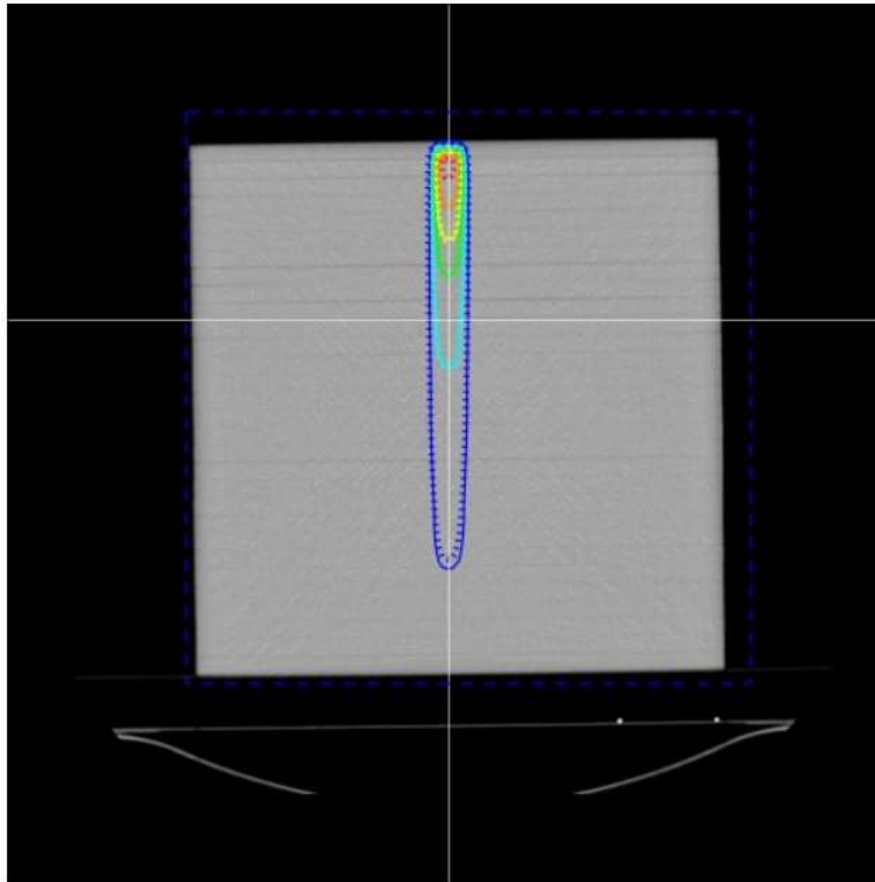
Solid: TPS; Dashed: Mobius3D

Mobius 3D - Standardplan

Stehfeld: 2x2cm

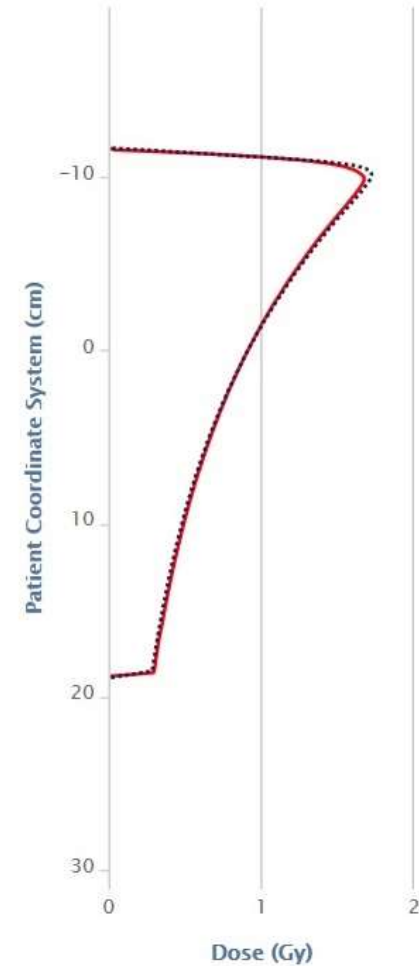
Transverse Gamma	Transverse Isodose	Coronal Gamma	Coronal Isodose	Sagittal Gamma	Sagittal Isodose
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Transverse Plane at 0 cm from Isocenter



CT Table Height specified in CT DICOM: 26.9 cm; CT couch removed.
TPS (Solid), Mobius3D (Dashed)

Vertical Dose Profile

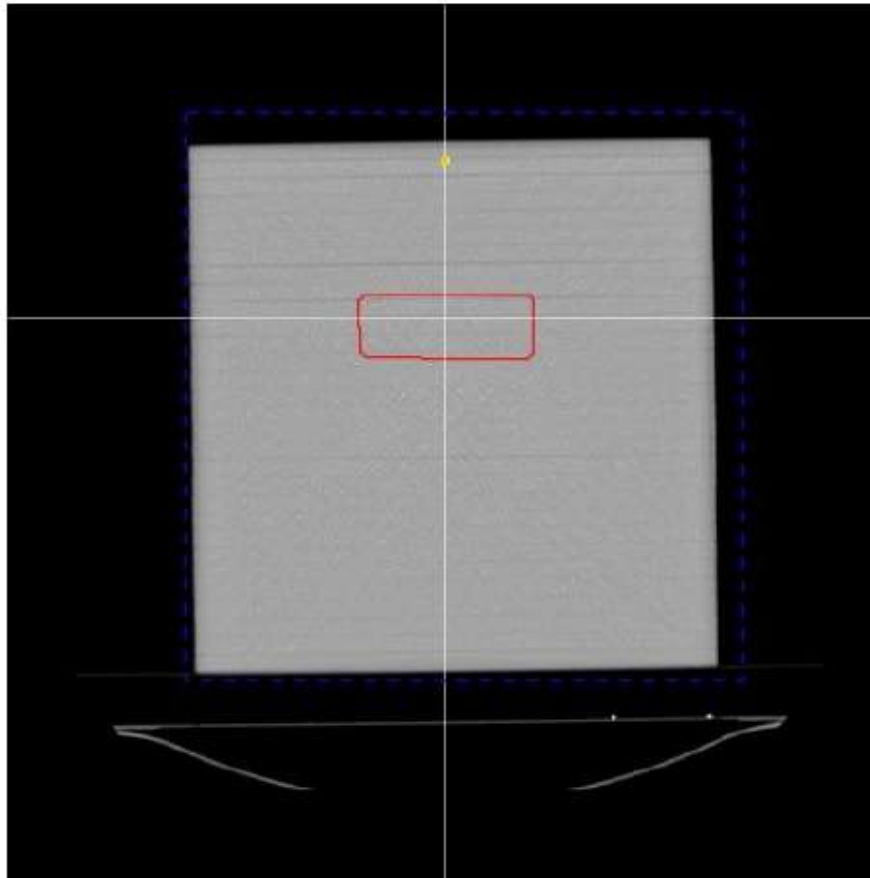


Mobius 3D - Standardplan

Stehfeld: 2x2cm

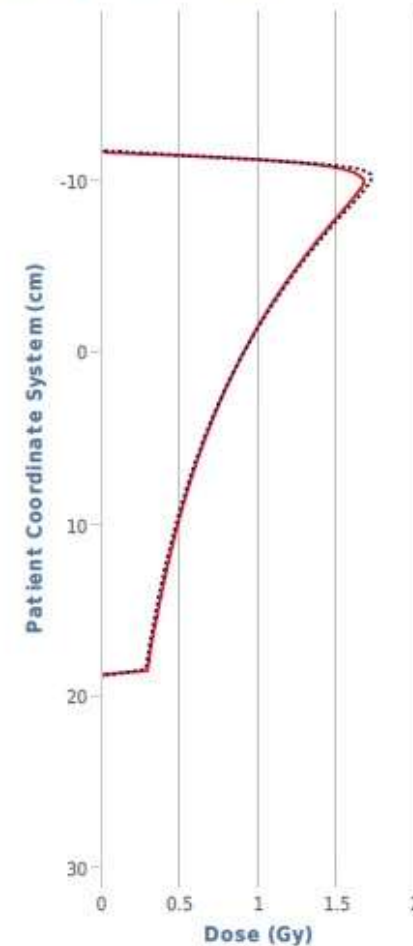
Transverse Gamma

Transverse Plane at 0 cm from Isocenter



CT Table Height specified in CT DICOM: 26.9 cm; CT couch removed.

Vertical Dose Profile

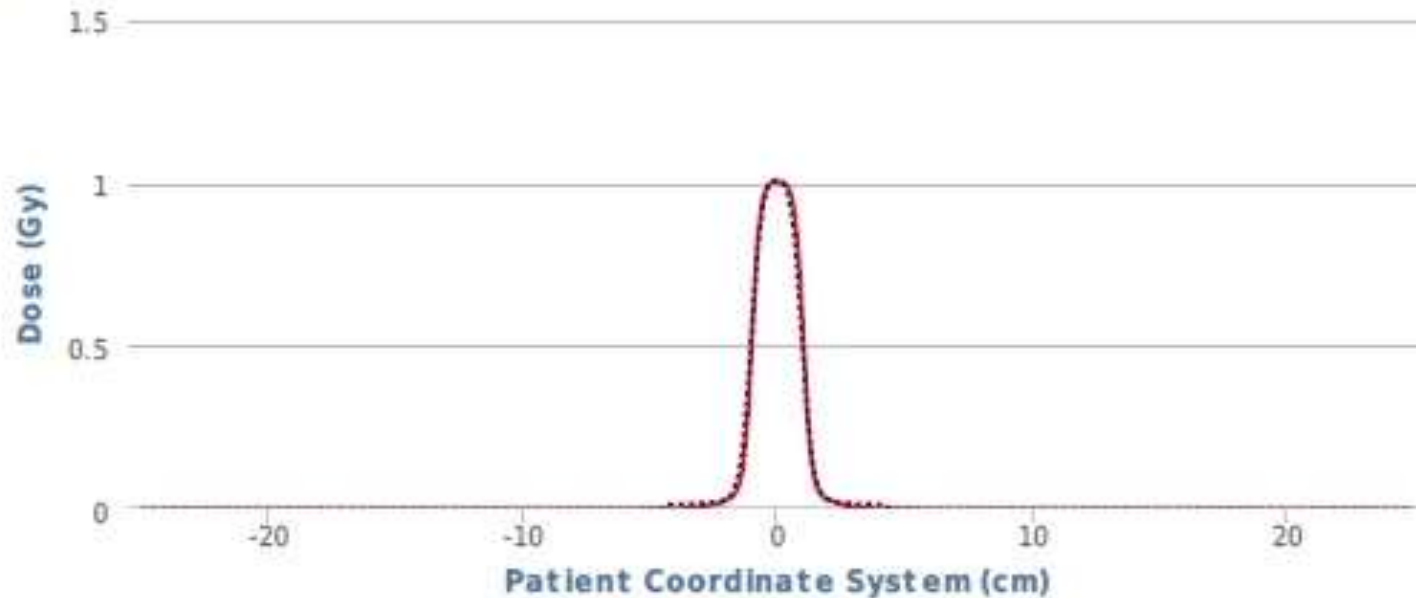


Solid: TPS; Dashed: Mobius

Mobius 3D - Standardplan

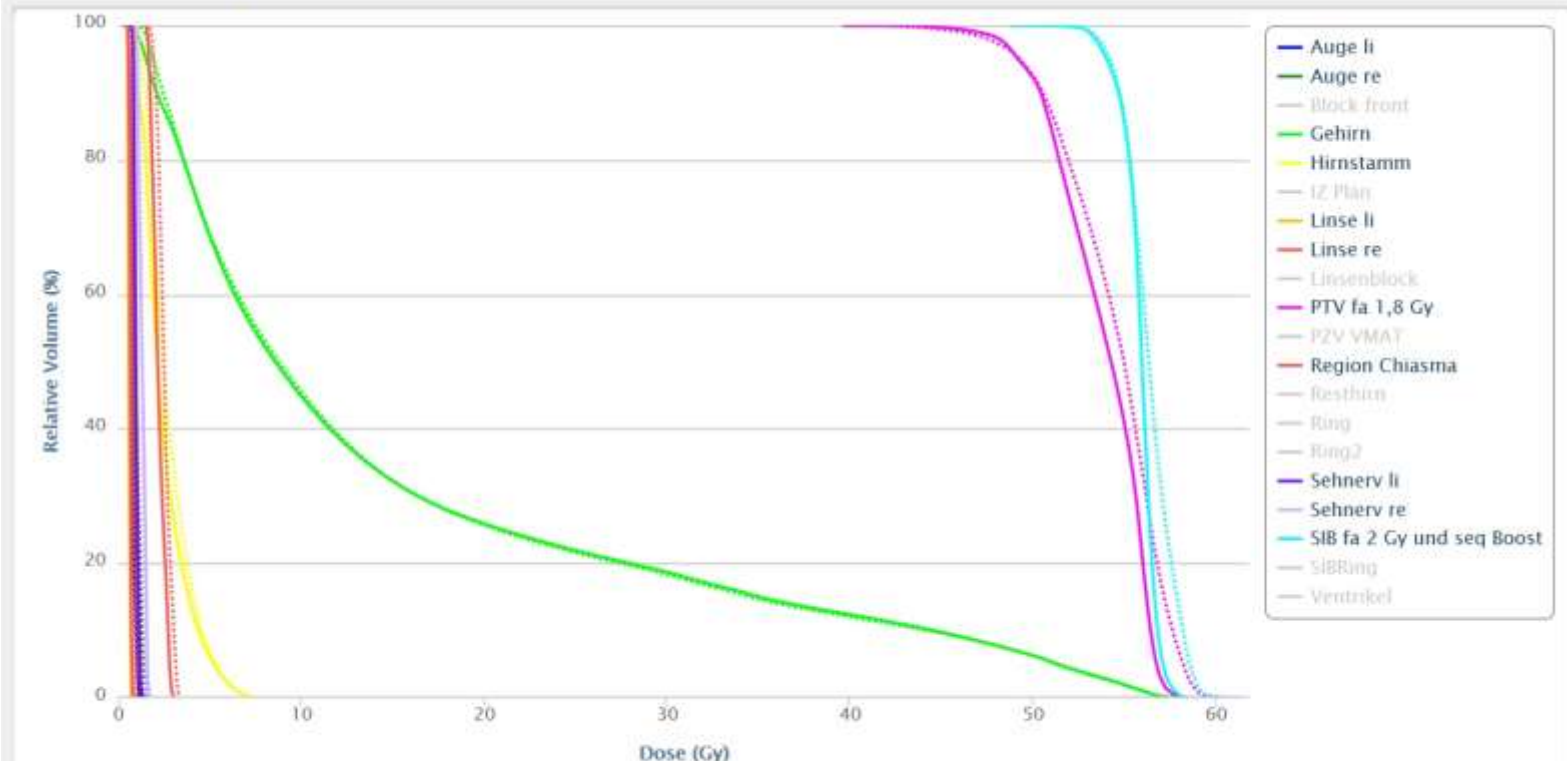
Stehfeld: 2x2cm

Horizontal Dose Profile













Solid: TPS; Dashed: Mobius3D

DVH Graph ▲




Target Coverage ▲

TPS Name	Mean Dose			90% Coverage			Stray Voxels		
	TPS	M3D	% Diff	TPS	M3D	% Diff			
 PTV fa 1,8 Gy	53.7 Gy	54.4 Gy	1.1% 	50.4 Gy	50.5 Gy	0.19% 	None		
 SIB fa 2 Gy und seq Boost	55.8 Gy	56.4 Gy	0.92% 	54.7 Gy	54.7 Gy	0.13% 	None		

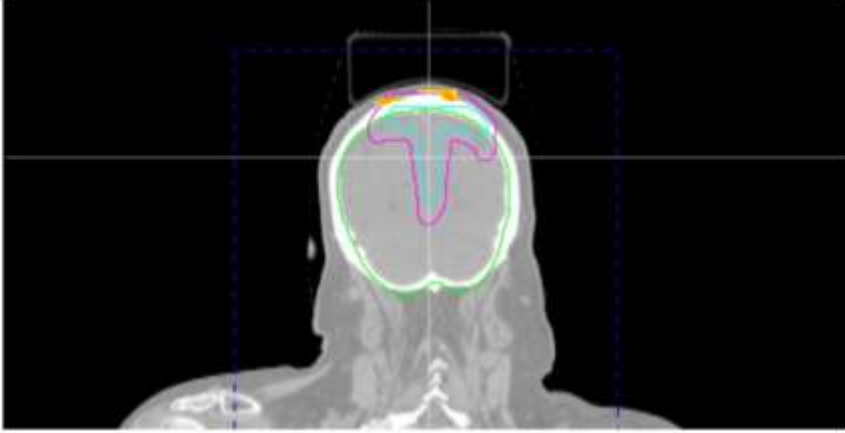
Mobius 3D

3D Gamma ▲

Passing Rate	Criteria	Reference Dose	Threshold Dose	TPS Voxels	M3D Voxels
98.3% 	3% / 3 mm	58.9 Gy (Max Dose)	5.89 Gy	4 mm	3 mm

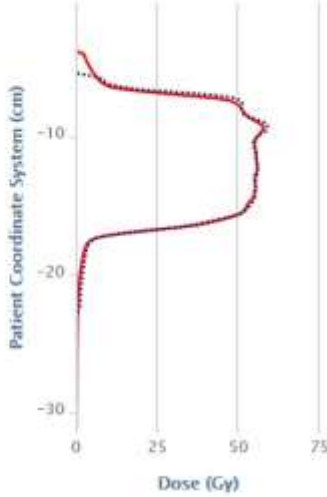
Transverse Gamma Transverse Isodose **Coronal Gamma** Coronal Isodose Sagittal Gamma Sagittal Isodose

Coronal Plane at 0 cm from Isocenter

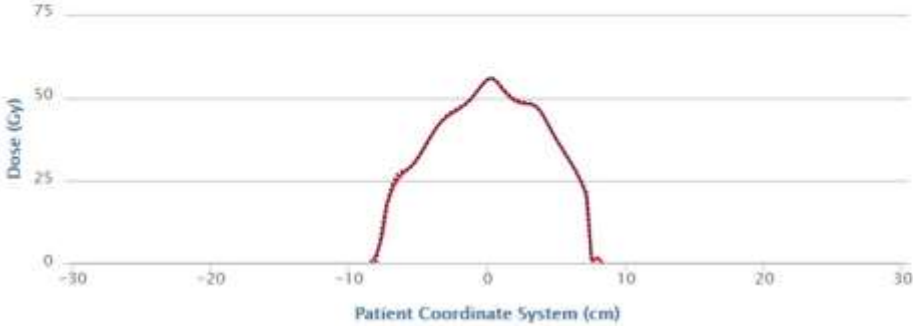


CT Table Height specified in CT DICOM: 19.1 cm, CT couch removed.

Vertical Dose Profile

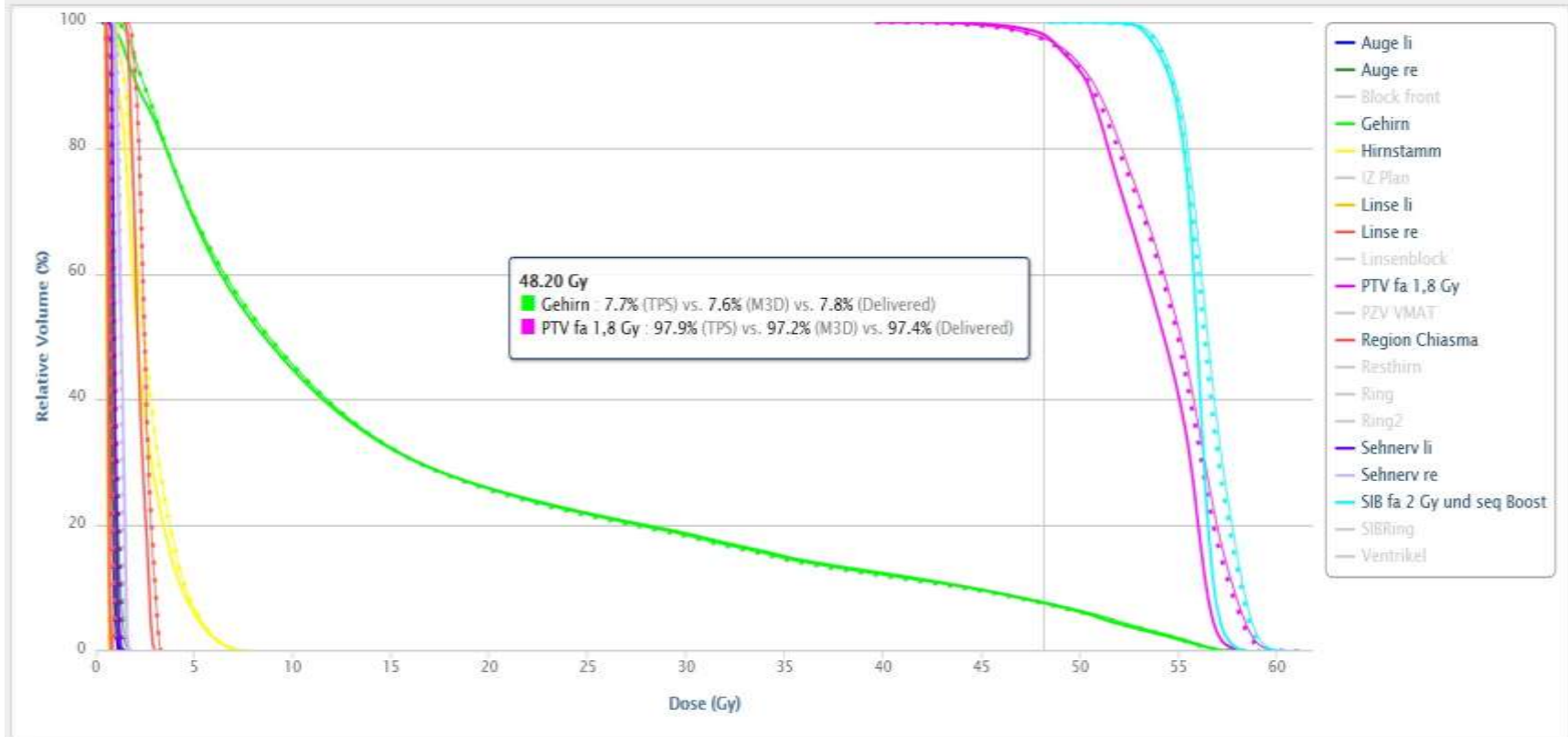


Horizontal Dose Profile



Gamma	M3D Dose
■	≥ 2.0 Hottest
■	1.5 Hotter
■	1.0 Hot
■	-1.0 Cool
■	-1.5 Cooler
■	≤ -2.0 Coolest

DVH Graph ▲



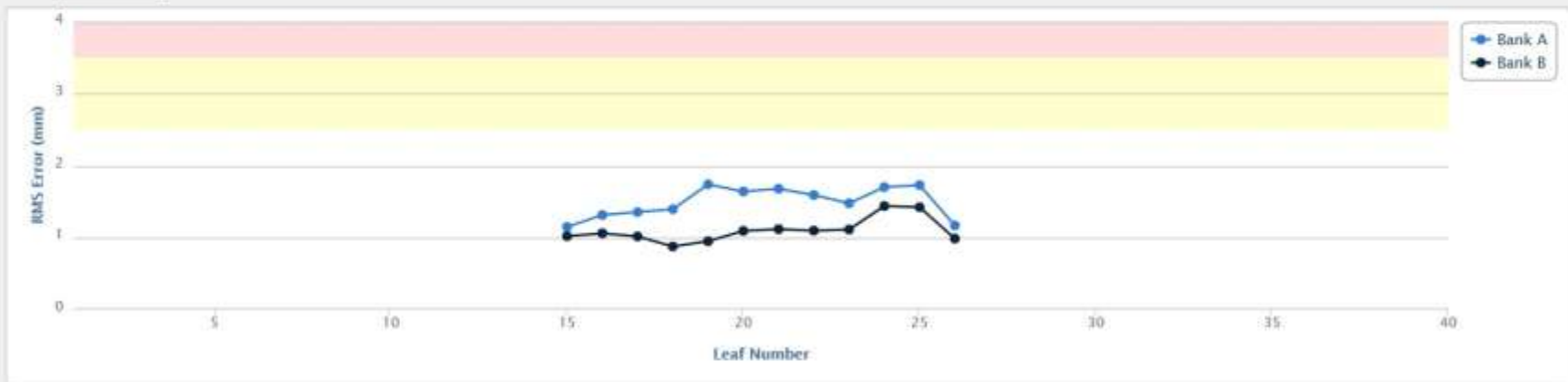
Thick Solid: TPS; Dashed: Mobius3D; Thin Solid: Delivered (MobiusFX)

3D Gamma ▲

Passing Rate	Criteria	Reference Dose	Threshold Dose	TPS Voxels	MFX Voxels
98.1% 	3% / 3 mm	58.9 Gy (Max Dose)	5.89 Gy	4 mm	3 mm

RMS Values ▲

Beam:



	X1	X2	Y1	Y2	Collimator	Gantry
RMS Error	--	--	0.2 mm	0.29 mm	0.2°	0.6°

Mobius 3D - Grenzen

Target Coverage	DVH Limits	3D Gamma	Deliverable
			

Target Coverage

TPS Name	Mean Dose			90% Coverage			Stray Voxels	
	TPS	M3D	% Diff	TPS	M3D	% Diff		
 PTV II RMS AK	2.04 Gy	2.06 Gy	0.12% 	0.97 Gy	0.93 Gy	-0.21% 	None	
 PTV re RMS AK	14.2 Gy	14.6 Gy	2.71% 	11.8 Gy	12.8 Gy	6.55% 	None	

3D Gamma

Passing Rate	Criteria	Reference Dose	Threshold Dose	TPS Voxels	M3D Voxels
99.5% 	3% / 3 mm	16.4 Gy (Max Dose)	1.64 Gy	4 mm	3 mm

Mobius Fx - Grenzen

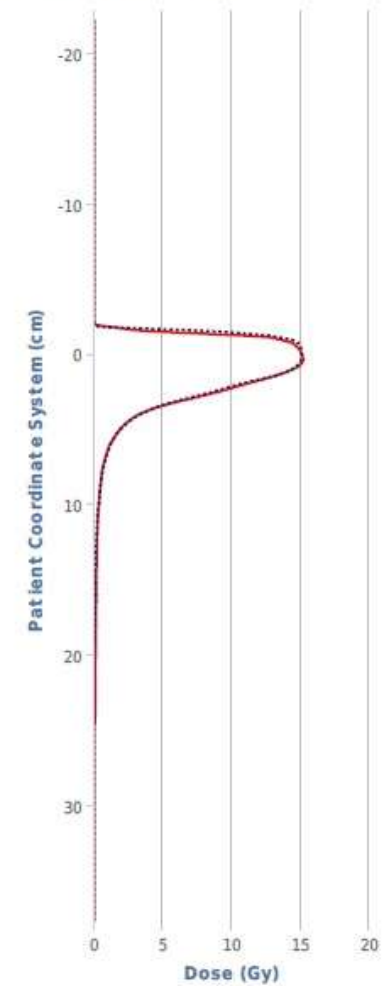
Transverse Gamma

Transverse Plane at 0 cm from Isocenter

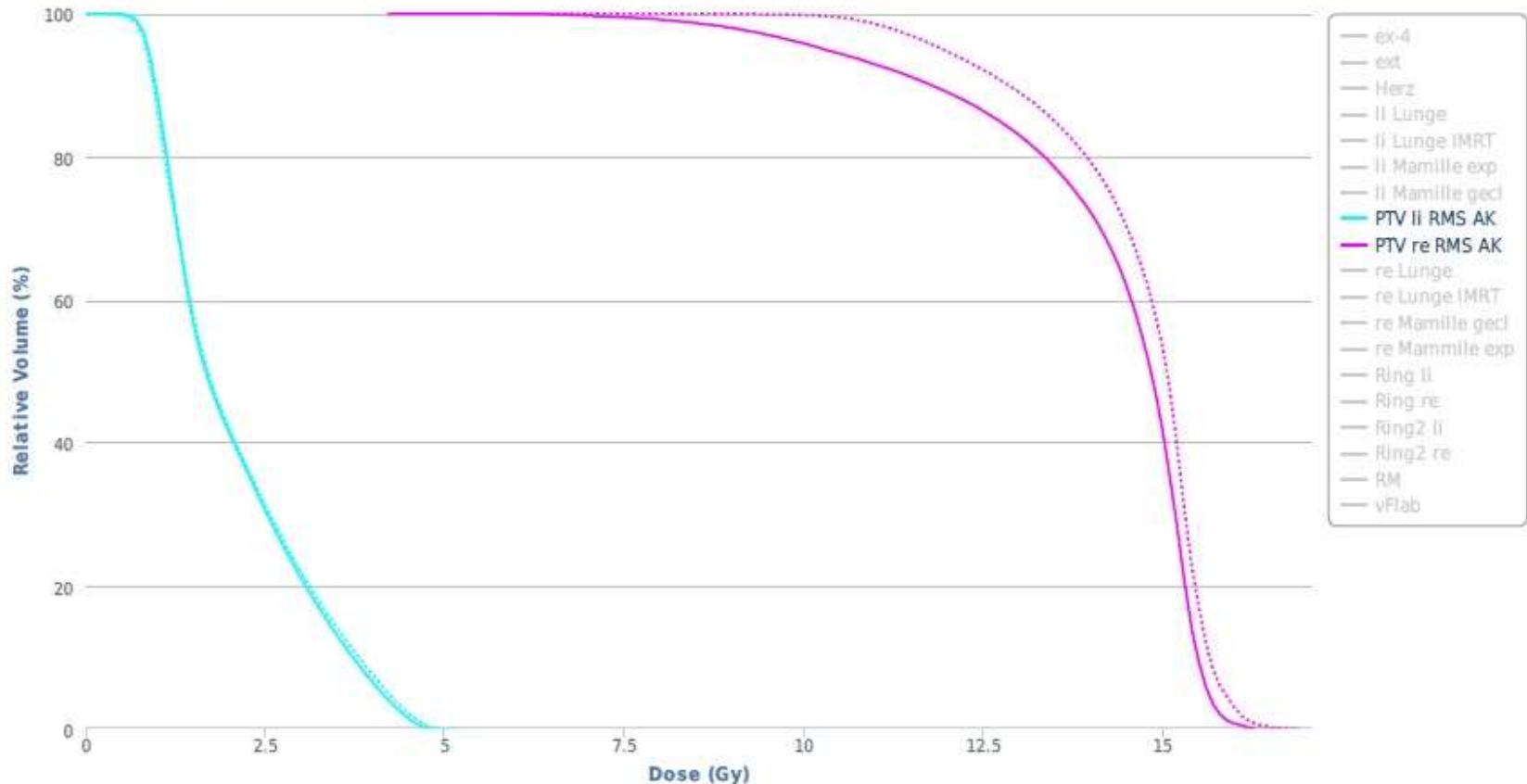


CT Table Height specified in CT DICOM: 25.3 cm; CT couch removed.

Vertical Dose Profile



DVH Graph



Solid: TPS; Dashed: Mobius3D

Outside-Air-Treshold? > gecl. ZV!

Mobius Fx - Warnungen

Target Coverage	DVH Limits	3D Gamma	Deliverable
			

Target Coverage

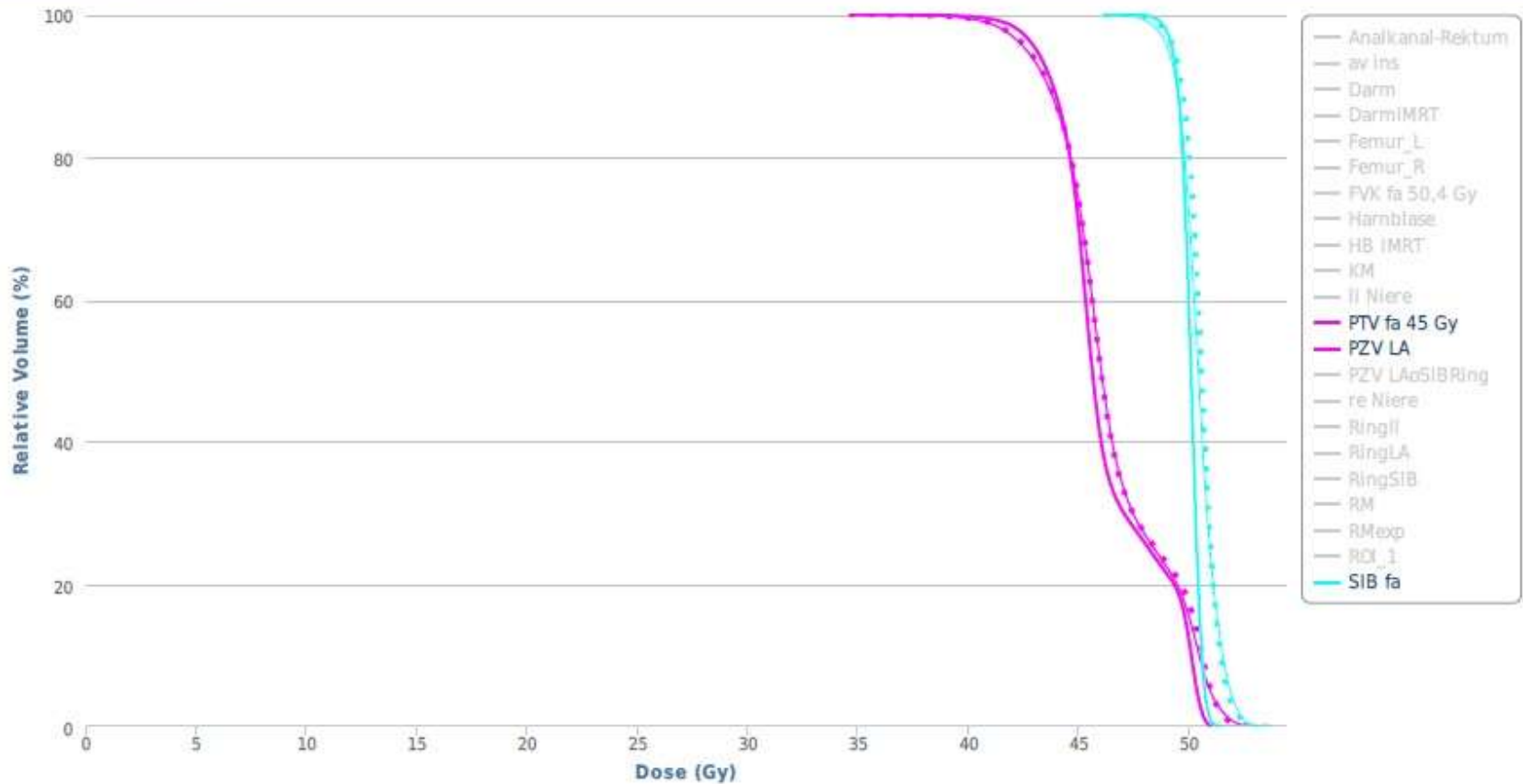
TPS Name	Mean Dose				90% Coverage			
	TPS	M3D	Delivered	% Diff	TPS	M3D	Delivered	% Diff
PTV fa 45 Gy	46.3 Gy	46.6 Gy	46.5 Gy	0.44% 	43.8 Gy	43.7 Gy	43.6 Gy	-0.41% 
PZV LA	46.3 Gy	46.6 Gy	46.5 Gy	0.44% 	43.8 Gy	43.7 Gy	43.6 Gy	-0.42% 
SIB fa	50 Gy	50.5 Gy	50.4 Gy	0.74% 	49.5 Gy	49.7 Gy	49.4 Gy	-0.07% 

3D Gamma

Passing Rate	Criteria	Reference Dose	Threshold Dose	TPS Voxels	MFX Voxels
99.1% 	3% / 3 mm	52.1 Gy (Max Dose)	5.21 Gy	4 mm	3 mm

Mobius Fx - Warnungen

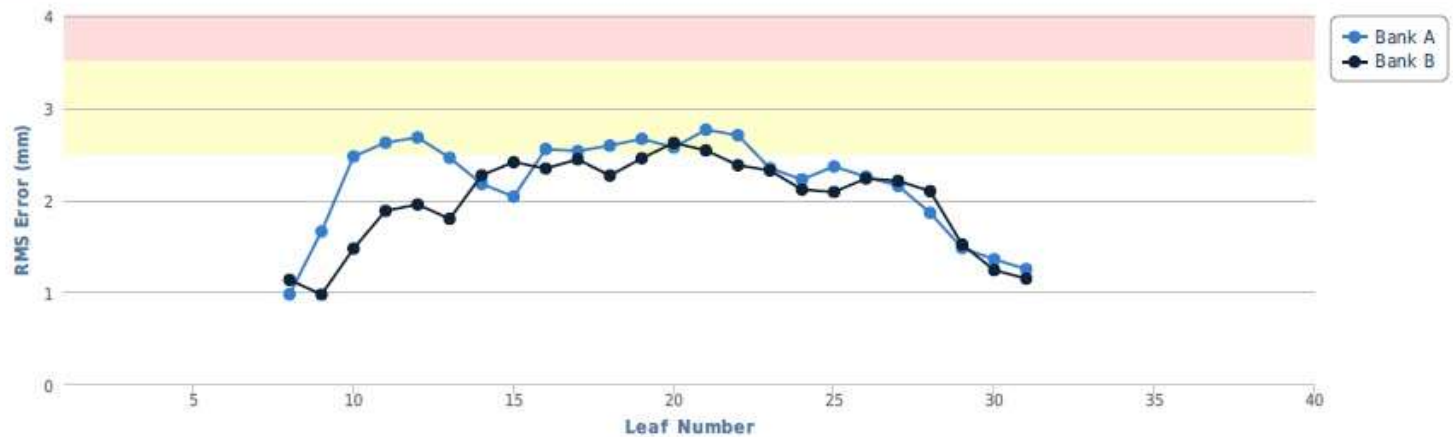
DVH Graph



Thick Solid: TPS; Dashed: Mobius3D; Thin Solid: Delivered (MobiusFX)

Mobius Fx - Warnungen

☰ RMS Values



Beam: ▾

	X1	X2	Y1	Y2	Collimator	Gantry
RMS Error	--	--	0.42 mm	0.38 mm	0.1°	0.7°

Mobius Fx - Alarm

Target Coverage	DVH Limits	3D Gamma	Deliverable
			

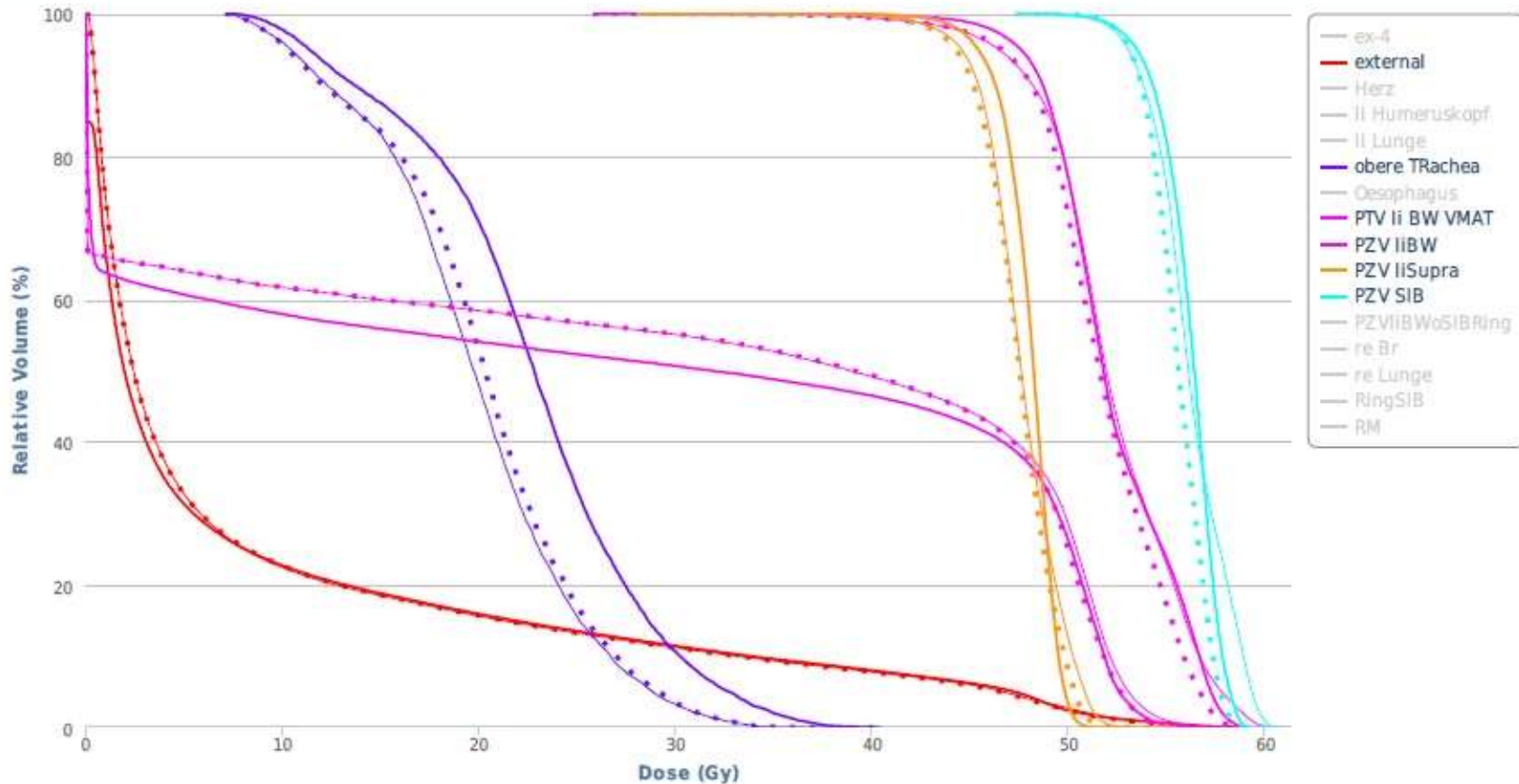
Target Coverage

TPS Name	Mean Dose				90% Coverage			
	TPS	M3D	Delivered	% Diff	TPS	M3D	Delivered	% Diff
 PTV II BW VMAT	26.3 Gy	28 Gy	28.1 Gy	2.99% 	0 Gy	0 Gy	0 Gy	0% 
 PZV IIBW	52.2 Gy	51.7 Gy	52.1 Gy	-0.11% 	48.7 Gy	48.1 Gy	48.2 Gy	-0.86% 
 PZV IISupra	48 Gy	47.4 Gy	47.6 Gy	-0.59% 	46.3 Gy	45.1 Gy	45.4 Gy	-1.44% 
 PZV SIB	56.2 Gy	55.5 Gy	56.2 Gy	0.08% 	54.3 Gy	53.7 Gy	53.8 Gy	-0.82% 

3D Gamma

Passing Rate	Criteria	Reference Dose	Threshold Dose	TPS Voxels	MFV Voxels
91.5% 	3% / 3 mm	59.6 Gy (Max Dose)	5.96 Gy	4 mm	3 mm

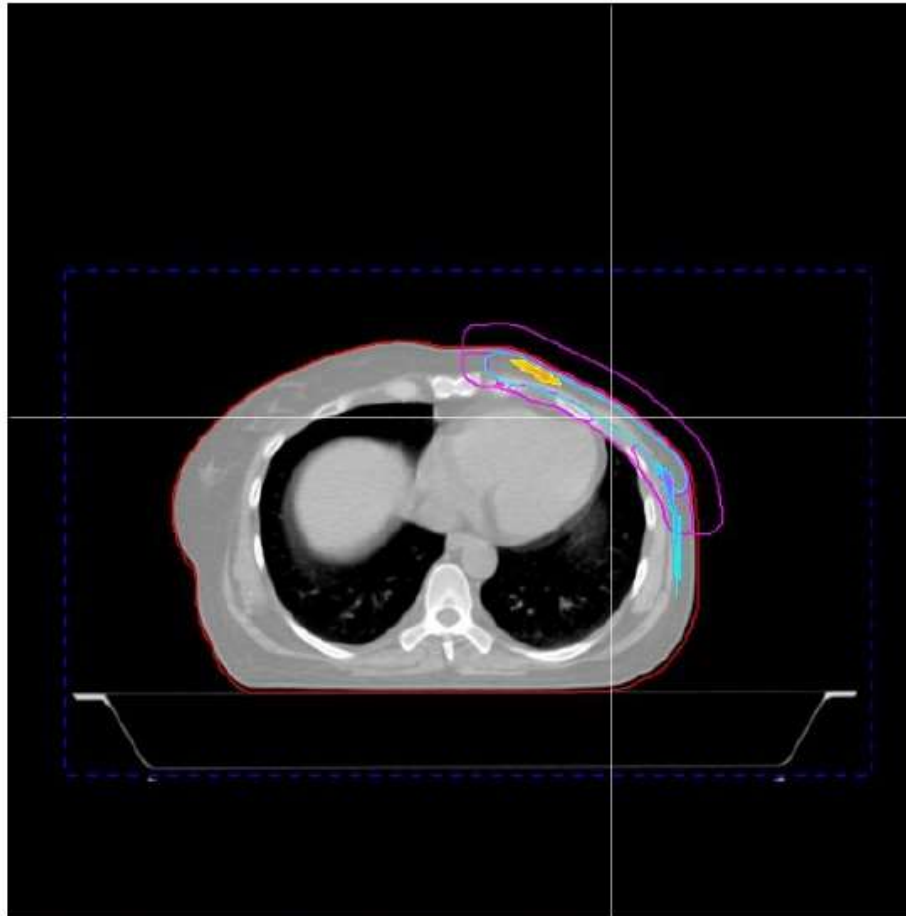
DVH Graph



Thick Solid: TPS; Dashed: Mobius3D; Thin Solid: Delivered (MobiusFX)

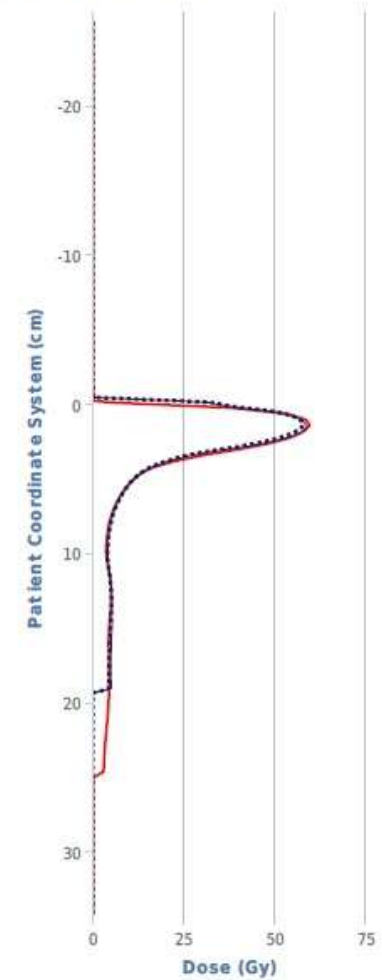
Transverse Gamma

Transverse Plane at 0 cm from Max Dose



CT Table Height specified in CT DICOM: 19.9 cm; CT couch removed.

Vertical Dose Profile



☰ RMS Values



Beam:

	X1	X2	Y1	Y2	Collimator	Gantry
RMS Error	--	--	3.92 mm	3.32 mm	0.2°	8.6°

Mobius Fx - Alarm

Beam	3a	4a
		
Data Transfer	Alert	Alert
Energy (MV)	6	6
MU	224 	258 
Segments	176.0	176.0
X1 / X2 Jaws (cm)	5.4 to 11.7 2.04 to 10.5	2.01 to 12.5 2.07 to 13
Y1 / Y2 Jaws (cm)	11 to 15 11.5 to 16	11 to 15 11.5 to 16
Wedge	None	None
MLC	VMAT	VMAT
Rotation	VMAT	VMAT
Gantry	180° to 280.3°	280.2° to 180.3°
Collimator	339.8° to 339.9°	339.8°
Couch	0°	0°
Delivery Time	1 min 4 sec	1 min 3 sec
Beam On	85.4%	87.6%

- Neuplanung da BW angeschwollen war
- Mobius vergleicht ursprünglichen Plan (Mobius3D) mit Neuplan (MobiusFx)
- Die Pläne sind ähnlich aber nicht identisch

- Mobius gut und schnell integriert
- Kombination von Mobius 3D und Mobius Fx ist DIN-konform
- Machine-QA-Programm nach DIN
- Monatliche Pat-QA (Tandem)
- Verbesserungspotential:
 - Modell individuell besser anpassbar (bei uns nicht die aktuellste Version)
 - Outside-Air-Threshold
 - Schichten und Profile wählbar
- Tomotherapie?