

Dozimetrická verifikácia SRS s E2E fantómom Steev

6. konferencia SSRO, 2024

Martin Jasenčák, Matúš Zgola, Miroslav Olejár, Vladimír Vojtek

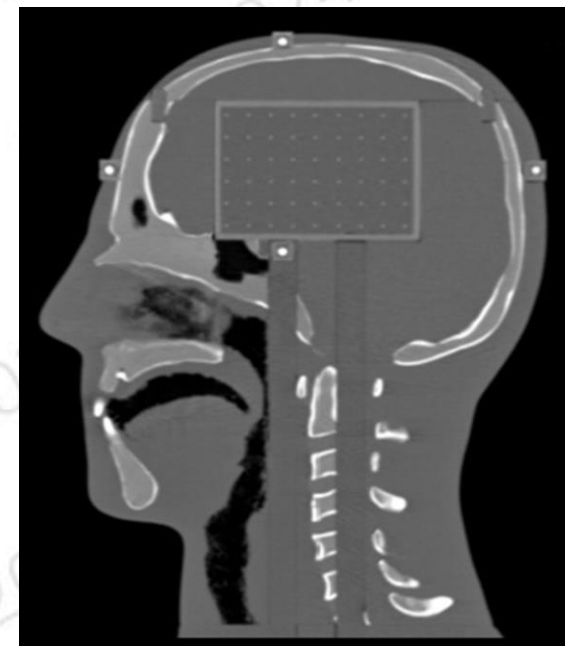
Východoslovenský onkologický ústav, a.s.



*Prehlasujem, že nie som pri prezentovaní uvedenej témy
v konflikte záujmov.*

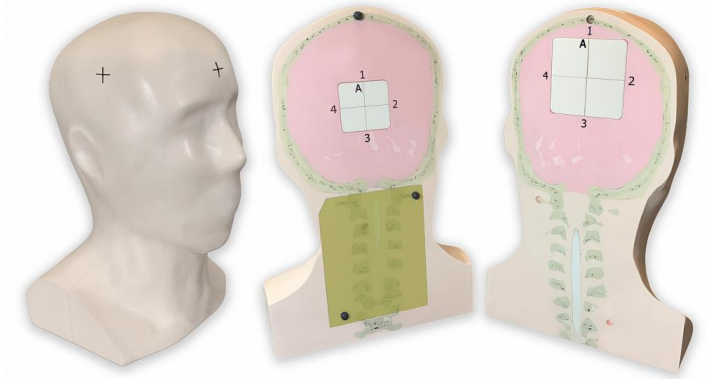
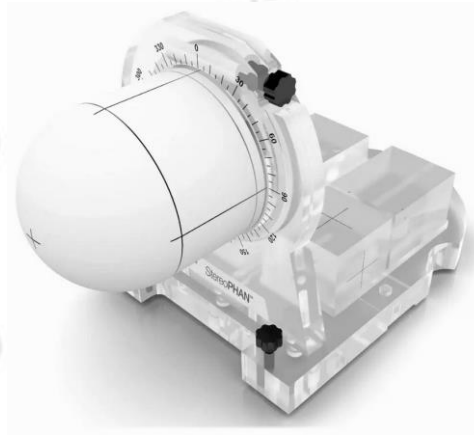
Obsah

1. E2E fantómy & STEEV
2. rôzne, simulované
situačné scenáre



End-to-end fantómy

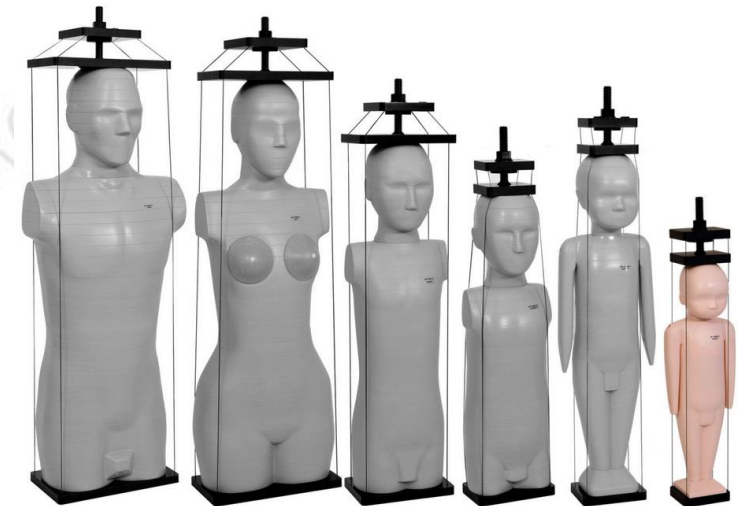
Radiosurgery test phantom LUCY®



Fantome SRS MAX-HD



The DP-1000 is the most comprehensive "End-to-End" phantom that evaluates the entire radiotherapy process for Simulation, Treatment Planning, Imaging, and Delivery, including TG-53, TG-66, and TG-142.



End-to-end fantóm STEEV (CIRS)

- patentované, tkanivo-ekvivalentné materiály
- lineárny absorpčný koeficient sa líši od skutočného tkaniva o 0-0,7% (pre 6-10MV)
- obsahuje tkanivá/orgány:
kosti lebky (komp. aj hub.), mozog, stavce C1-C7 (aj medzist. platničky), hrtan, priedušnica, dutiny (prinosové, čelové, ústna), miecha, zuby (sklovina, dentín, koreň), axilárne a tvárove nervy



End-to-end fantóm STEEV

- množstvo príslušenstva

WINSTON LUTZ CUBE
MODEL 038-10



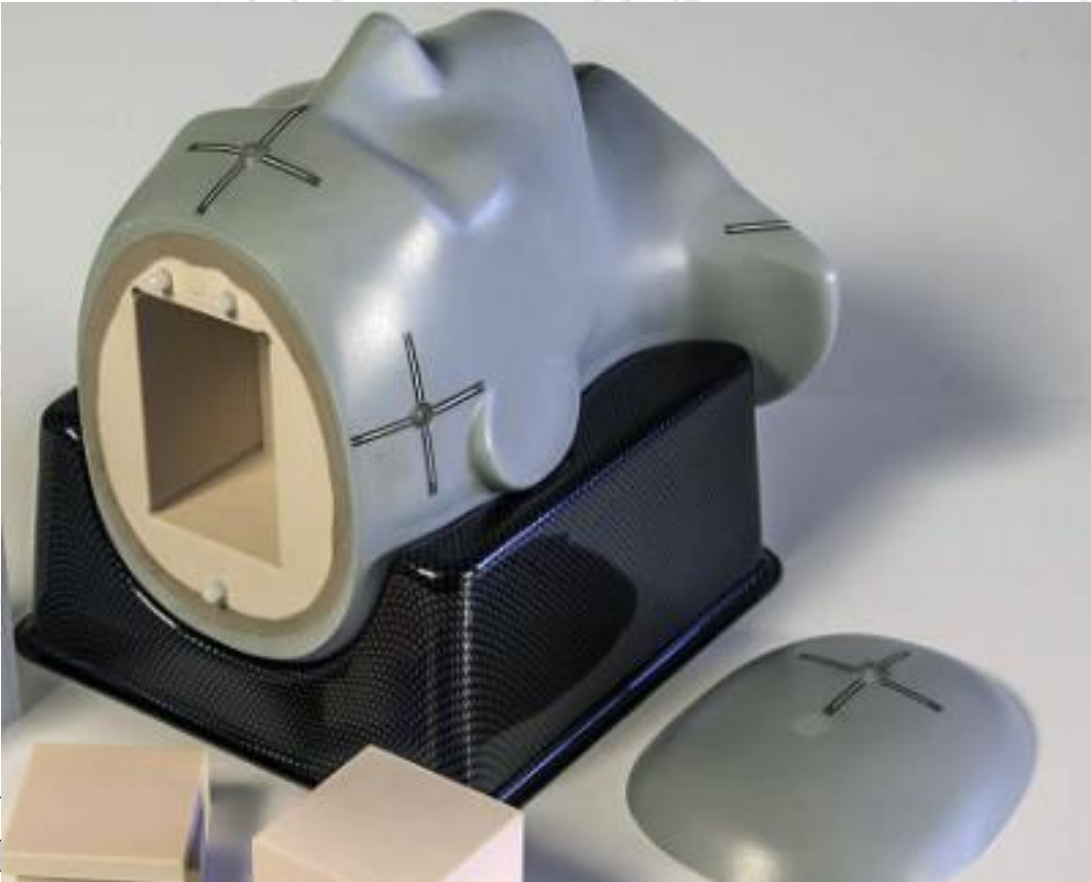
MR/PET/CT SPATIAL 3D DISTORTION INSERT
MODEL 038-14



MODEL 038 OPTIONAL ACCESSORIES

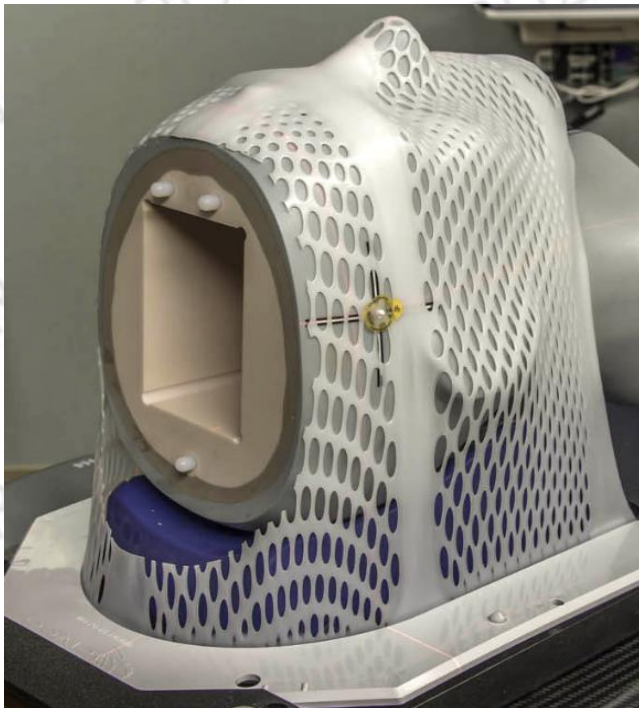
QTY	PART NO.	DESCRIPTION
1	038-01	Shoulders (additional 100 mm width)
1	038-02	ABS Vacuum formed cradle
1	038-03-CvXX-XX	Ion Chamber Dosimetry Kit: (1) 63.5 mm Cube with Ø30 mm Spherical Target Cavity, (2) Ø12.7mm Sleeves for adapting Ion cavity, (1) Solid plug with Ø 2.5 mm aluminum oxide BB in ISO center, (1) Solid plug
1	038-04-CvXX-XX	Variable Ion Chamber Position Dosimetry Kit: (1) 63.5 mm Cube with cavity thru hole, (2) Ø12.5 mm Sleeves for adapting Ion cavity, (1) Solid cavity plug with Ø 2.5 mm aluminum oxide BB in ISO center, (1) Solid cavity plug, (1)Spacer plug set to accommodate cavity at different positions
1	605-FC	Film Stack
1	038-05	Film Cube for Single Film Dosimetry with Ø30 mm target
1	038-06	TLD Dosimetry Cube
1	605-GC	Gel Cassette (includes B6 Gel Container)
1	038-09	Electron Density Cube with Real Water Electron Density plug (Water Equivalent Material Surrounding Removable Ø 1" Vial)
1	038-10	Cube 63.5mm with Centroid & Offset Ø5mm targets
1	038-11	MR/CT/PET Target Cube with Ø30mm target
1	038-12	MR/CT/PET Target Cube with 25 cc Organic target
1	038-13	MR/CT/PET Target Cube with 12.5 cc Organic target
1		MR/CT/PET Spatial 3D Distortion rectangular insert

MR/PET/CT SPHERICAL TARGET INSERT
MODEL 038-11



End-to-end fantóm STEEV – polohovanie/fixácia

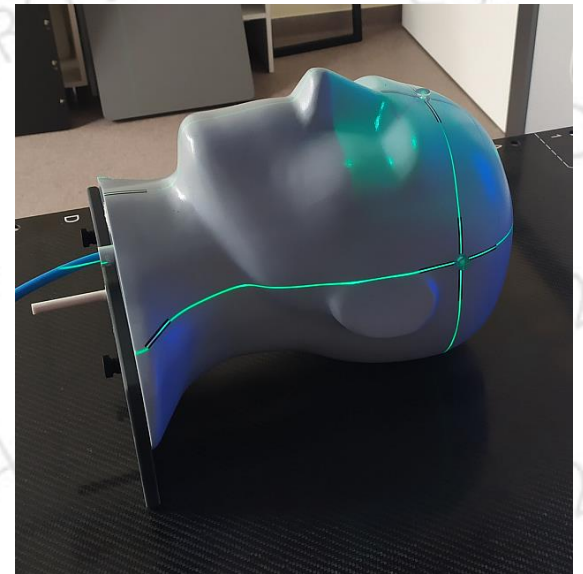
A) maska



B) rám



C) voľne



Začlenenie E2E fantómu do verifikácie

Dve alternatívy pracovného postupu:

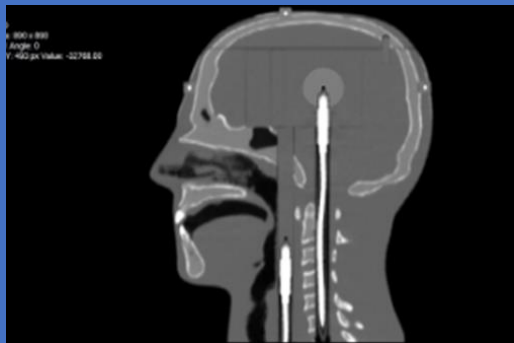
1. „cesta pacienta“

2. verifikačný fantóm v TPS

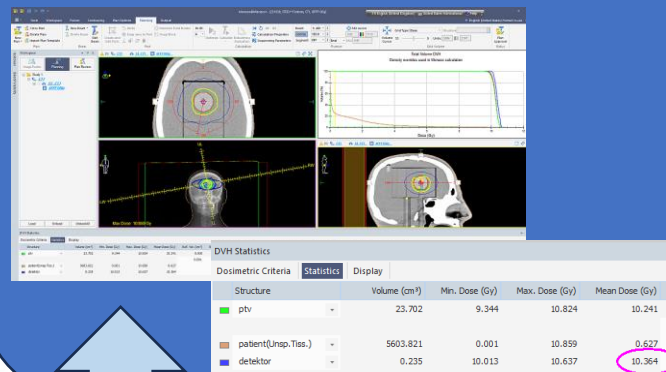
Začlenenie E2E fantómu do verifikácie

1. „cesta pacienta“ (End-to-End verifikácia)

CT-Steep



TPS-Steep



RT plán „de novo“ alebo
import z DB pacientov

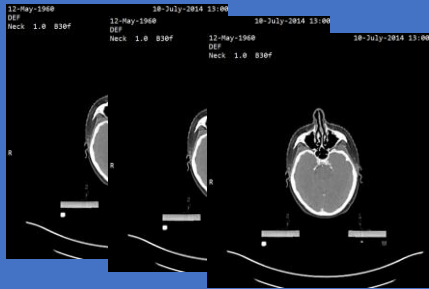
LU-Steep



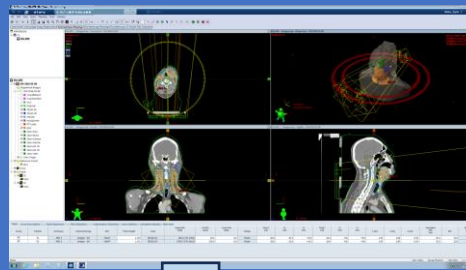
Začlenenie E2E fantómu do verifikácie

2. verifikačný fantóm v TPS

CT-pacient



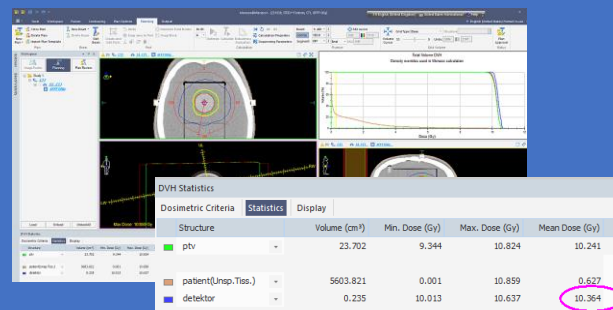
TPS - pacient



LU-pacient



TPS - Steev



LU-Steev



Očakávania ☺

Received: 16 April 2017 | Revised: 12 June 2017 | Accepted: 26 June 2017

DOI: 10.1002/acm2.12146

AAPM REPORTS & DOCUMENTS

AAPM-RSS Medical Physics Practice Guideline 9.a. for SRS-SBRT

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The American Association of Physicists in Medicine (AAPM) is a non sional society whose primary purposes are to advance the science, e professional practice of medical physics. The AAPM has more than 8,(and is the principal organization of medical physicists in the United Sta The AAPM will periodically define new practice guidelines for medical tice to help advance the science of medical physics and to improve t service to patients throughout the United States. Existing medical ph guidelines will be reviewed for revision or renewal, as appropriate, anniversary or sooner.

Each medical physics practice guideline represents a policy statement b has undergone a thorough consensus process in which it has been extensive review, and requires the approval of the Professional Council. The medical physics practice guidelines recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guidelines and technical standards by those entities not providing these services is not authorized.

TABLE 1 Minimum SRS-SBRT relevant equipment QA and tolerances for C-arm linac systems.		
Frequency	Test	Tolerance
Daily	Laser localization — only if using SRS techniques relying on lasers for target localization (e.g., frame-based SRS without X-ray IGRT)	1 mm
	Collimator size indicator for clinically relevant aperture	2 mm total
	Radiation isocentricity test (limited gantry and couch positions) — maximum deviation in center of target object relative to each projection's beam central axis	1.0 mm SRS, 1.5 mm SBRT
	IGRT positioning/repositioning	1 mm SRS, 2 mm SBRT
	Imaging subsystem interlocks	Functional
	Stereotactic interlocks — cone size, backup jaws	Functional
	Accelerator output constancy	±3%
Monthly	Radiation isocentricity test — covering complete range of gantry, couch, collimator positions used clinically — maximum deviation in center of target object relative to each projection's beam central axis <i>*Note: If both MLC and fixed conical collimators are used, both must be evaluated at least monthly</i>	1.0 mm SRS, 1.5 mm SBRT
	Treatment couch position indicators: relative over the maximum clinical range	1 mm/0.5°
	Output constancy at relevant dose rates	2%
Annually	SRS arc rotation mode (if used clinically)	1 MU, 1°
	MU linearity (≥5 MU to highest MU used clinically)	±2%
	Accelerator output	±1.5%
	Coincidence of radiation and mechanical isocenter	±1.0 mm maximum 3-D displacement from center of target object
	Verification of small-field beam data — relative output factors for cones and/or MLC	±2% from baseline for >1.0 cm apertures, ±5% from baseline for ≤1.0 cm apertures
	E2E localization assessment "hidden target test" using SRS frame and/or IGRT system	1.0 mm
	E2E dosimetric evaluation using SRS frame and/or IGRT system	±5% measured vs. calculated

Očakávania 😊

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TABLE 1 Minimum SRS-SBRT relevant equipment QA and tolerances for C-arm linac systems.		
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	IGRT positioning/repositioning	1 mm SRS, 2 mm SBRT
	Imaging subsystem interlocks	Functional
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Monthly	Radiation isocentricity test — covering complete range of gantry, couch, collimator positions used clinically — maximum deviation in center of target object relative to each projection's beam central axis <i>*Note: If both MLC and fixed conical collimators are used, both must be evaluated at least monthly</i>	1.0 mm SRS, 1.5 mm SBRT
	Treatment couch position indicators: relative over the maximum clinical range	1 mm/0.5°
	Output constancy at relevant dose rates	2%
Annually	SRS arc rotation mode (if used clinically)	1 MU, 1°
	MU linearity (≥5 MU to highest MU used clinically)	±2%
	Accelerator output	±1.5%
	Coincidence of radiation and mechanical isocenter	±1.0 mm maximum 3-D displacement from center of target object
	Verification of small-field beam data — relative output factors for cones and/or MLC	±2% from baseline for >1.0 cm apertures, ±5% from baseline for ≤1.0 cm apertures
	E2E localization assessment "hidden target test" using	1.0 mm

E2E dosimetric evaluation using SRS frame and/or IGRT system

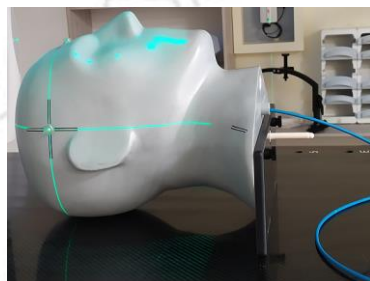
±5% measured vs. calculated

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Verifikácia....

- Steev
- elektrometer
- IK Semiflex 3D
- tlakomer
- teplomer

DVH Statistics					
Dosimetric Criteria	Statistics	Display			
Structure	Volume (cm³)	Min. Dose (Gy)	Max. Dose (Gy)	Mean Dose (Gy)	
ptv	23.702	9.344	10.824	10.241	
patient(Unsp.Tiss.)	5603.821	0.001	10.859	0.627	
detektor	0.235	10.013	10.637	10.364	



$$D = M * N_w * k_{t,p} * k_{QQ_0}$$



VERIFIKÁCIA PLÁNU OŽAROVANIA - VERSA HD

RČ pacienta	Meno pacienta	Názov plánu

Dozimetrické vybavenie

- CIRS Steev Phantom
- 30 mm Diameter Target Cube 038-03-CV57-9
- Semiflex 3D TM31021-142524, NdW=5,870.108 Gy/C (Overenie 22.2.2024)
- Elektrometer Multidose T10004-01331

Postup

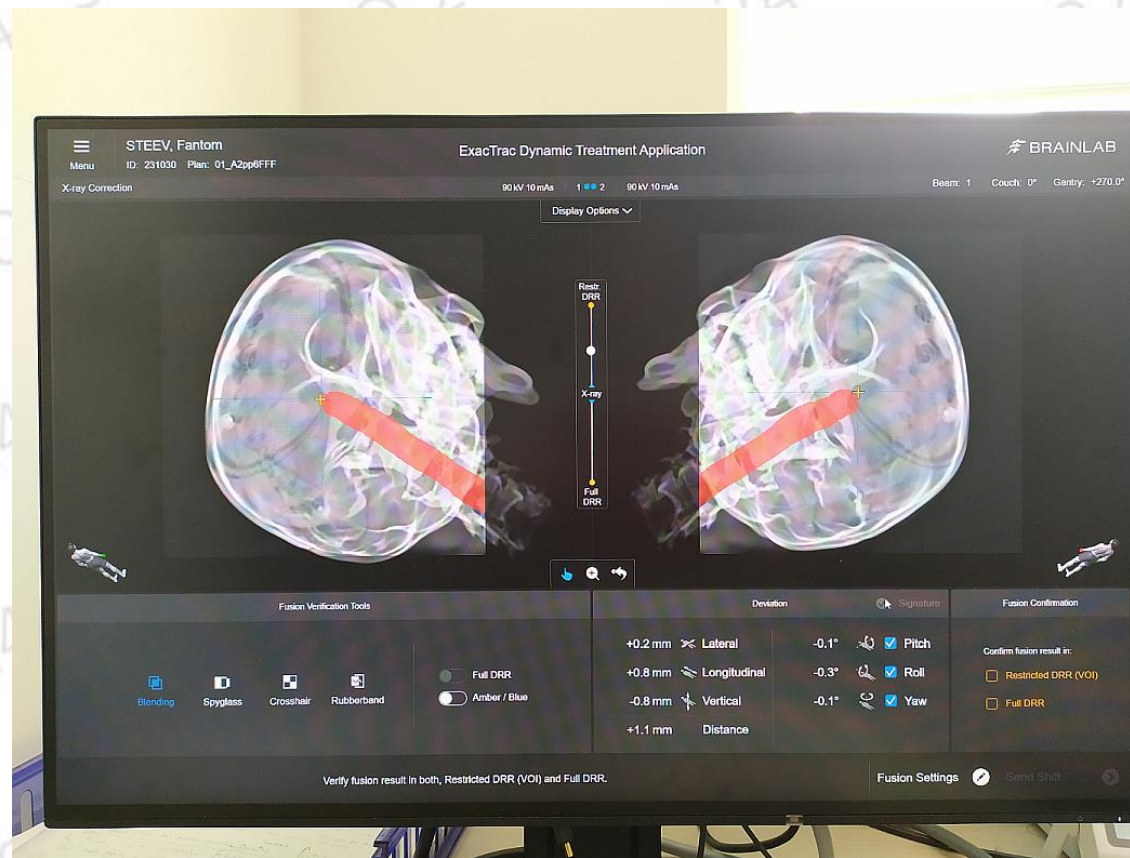
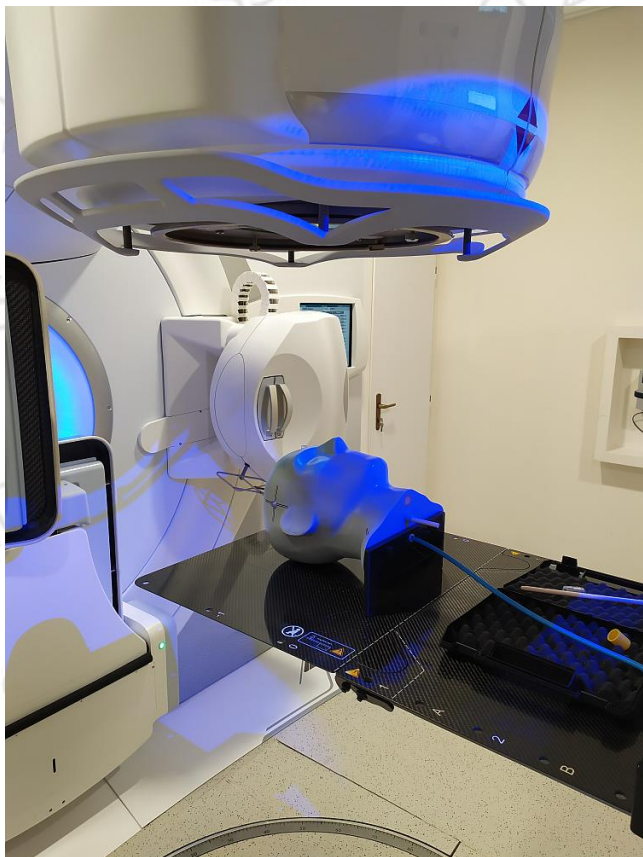
- 1.) Pre nastavenie fantómu použiť v Mosaic pacienta Steev Fantom 231030 a použiť systém ETD. Po nastavení zavrieť pacienta v iGuide, avšak nehybným stolom (Do not move).
- 2.) Otvorím v Mosaic pacienta, ktorého verifikujem. V ETD zvolím "Reject and auto-authorize. V iGuide odmietnem posun do Drive (Cancel) → Accept current position (Optimization Movement) → Imaging Completed → Zadať nuly.
- 3.) V Mosaic → Override a AutoSetup.
- 4.) Odčítať plán a zaznamenať zmeranú dávku. Vyhodnotiť relatívnu odchýlku.

Vyhodnotenie

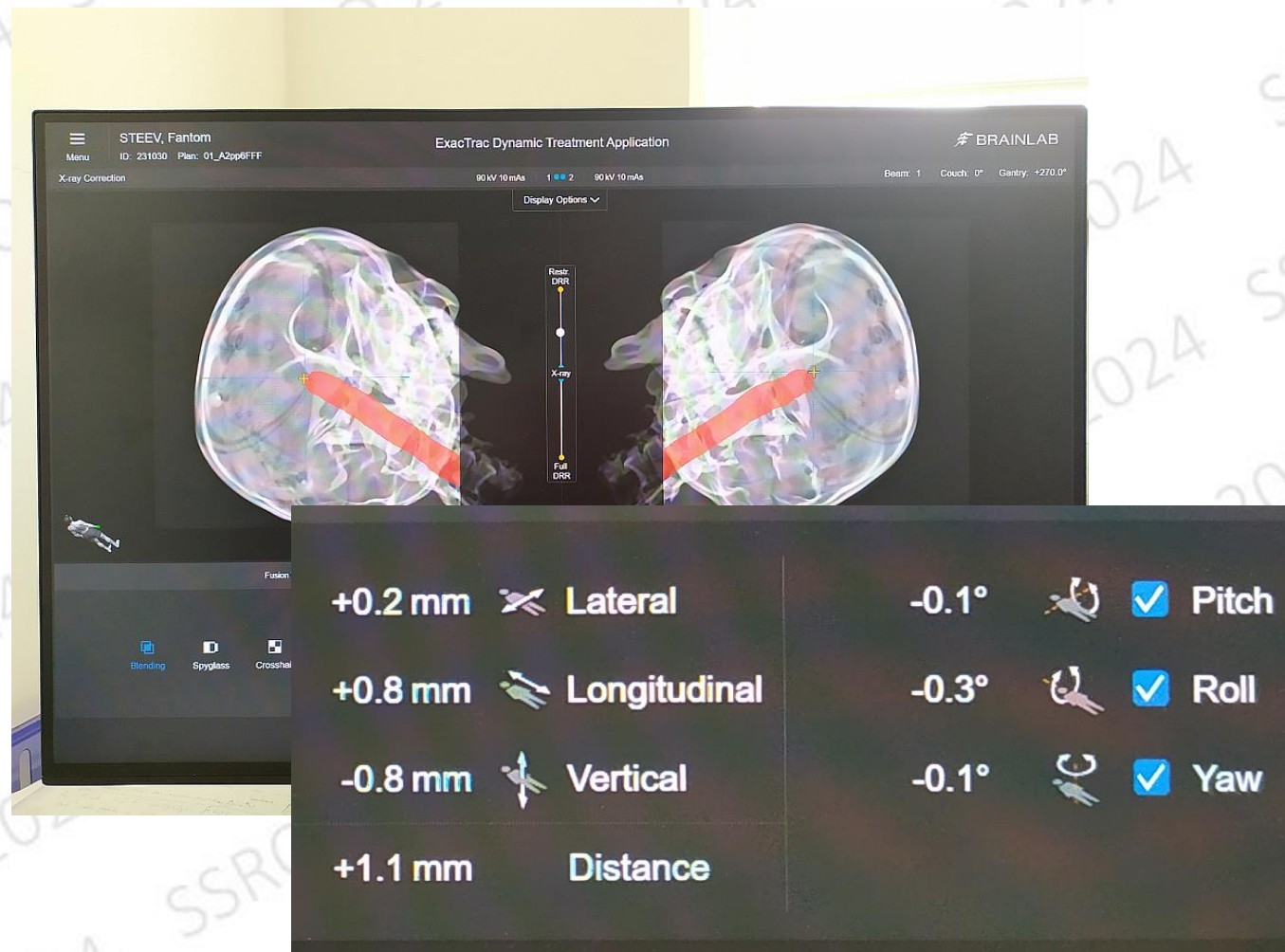
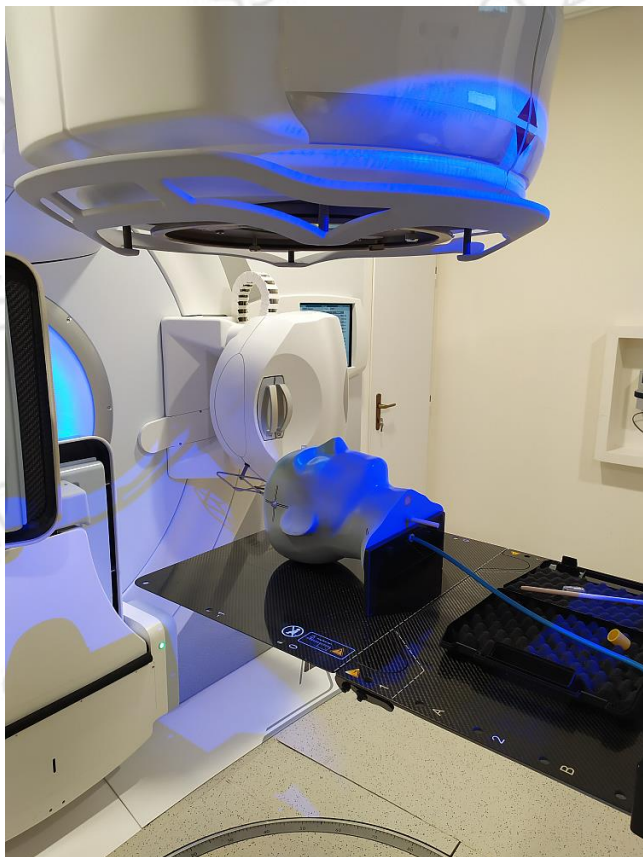
Mean hodnota dávky pre Semiflex3D z TPS (D_{TPS})					=		G
Nameraná dávka (D_M)=	Odpočet z elektromera	*	k_{QQ}		=	D_M	
	Gy	*	<input type="checkbox"/> 6MV	0.9911	=		G
			<input type="checkbox"/> 6MV FFF	0.9922			
			<input type="checkbox"/> 10MV	0.9819			
			<input type="checkbox"/> 10MV FFF	0.9841			
Relatívna odchýlka $\Delta=(D_M-D_{TPS})/D_{TPS}*100$					=		%

Dátum	
Meranie vykonal	

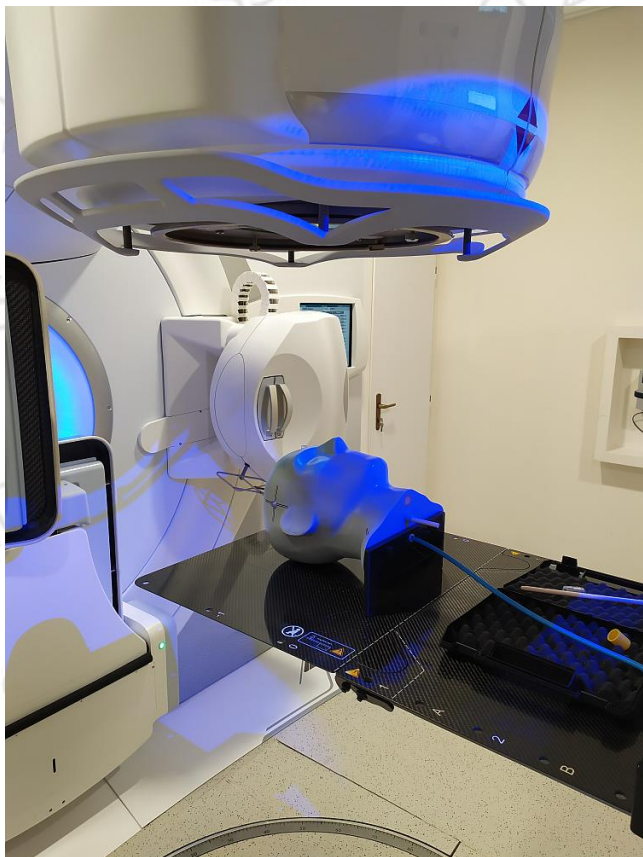
Verifikácia....



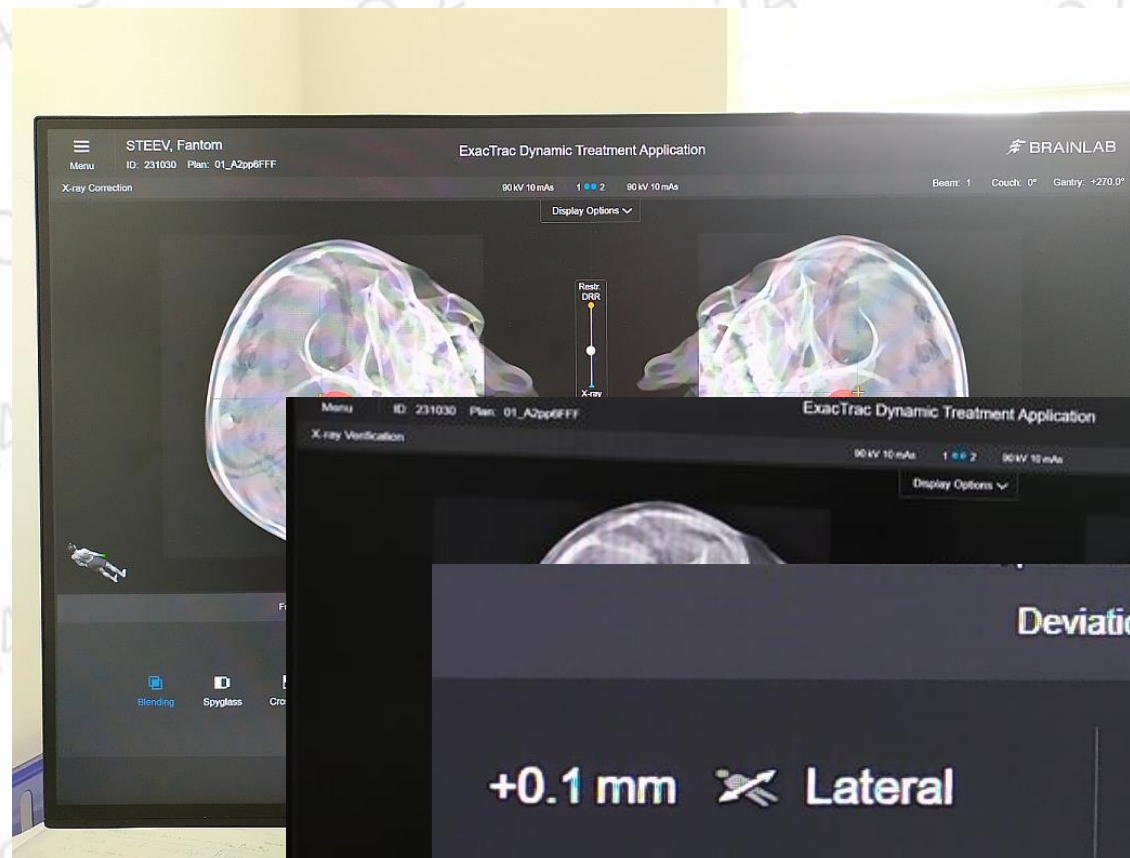
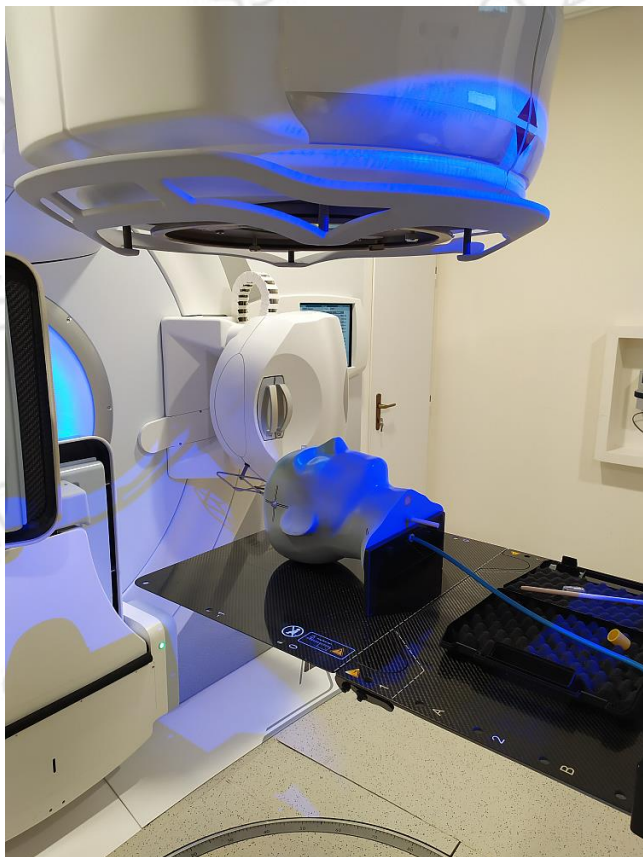
Verifikácia....



Verifikácia....



Verifikácia....



Verifikácia SRS/SBRT so Steev - súbor

- náhodne vybraných 11 pacientov
- 12.4.-15.5.2024 36 meraní (spolu)
- 8x 6FFF, 3x10FFF
- anat.oblasti: stavec, mozog MTS, pľúca, prostata, LU
- dávka/fr. (v meranom bode): 9,515-35,717 Gy

Verifikácia SRS/SBRT so Steev - súbor

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1	Versa1	Versa2	Versa1	Versa1	versa2	Versa2	Versa1	Versa1
							12.04.2024	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024
Pacient1	stavec	16.592	1	1	1	6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513	1	3	3	6FFF	1.48						-1.16		
Pacient3	hlava	9.735		4	4	6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701	5	1	1	6FFF			0.65					-0.618	
Pacient5	prostata	9.515	5	1	1	10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717	1	1	1	6FFF			0.78				1.04		
Pacient7	uzlina	10.26	5	1	1	10FFF			0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04	5	1	1	6FFF				0.7			1.6	0.46	0.38
Pacient9	prostata	10.087	5	1	1	10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594	1	2	1	6FFF		1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613	1	3	1	6FFF				1.4			0.7	1.09	

Hodnoty v tabuľke sú relatívne chyby v [%]

Verifikácia SRS/SBRT so Steev - súbor



	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1	Versa1	Versa2	Versa1	Versa1	versa2	Versa2	Versa1	Versa1
							12.04.2024	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024
Pacient1	stavec	16.592		1	1	1 6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513		1	3	3 6FFF	1.48						-1.16		
Pacient3	hlava	9.735			4	4 6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701		5	1	1 6FFF			0.65					-0.618	
Pacient5	prostata	9.515		5	1	1 10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717		1	1	1 6FFF			0.78				1.04		
Pacient7	uzlina	10.26		5	1	1 10FFF			0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04		5	1	1 6FFF				0.7			1.6	0.46	0.38
Pacient9	prostata	10.087		5	1	1 10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594		1	2	1 6FFF		1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613		1	3	1 6FFF				1.4			0.7	1.09	

Hodnoty v tabuľke sú relatívne chyby v [%]

1. scenár.....

Opakované meranie (simulácia frakcionovanej liečby)

20 fr. 11 fr.?

Opakované meranie (= 4 frakcie „liečby“)

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1	Versa1	Versa2	Versa1	Versa1	versa2	Versa2	Versa1	Versa1
							12.04.2024	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024
Pacient1	stavec	16.592	1	1	1 6FFF					1.2			2.46		1.36
Pacient2	hlava	23.513	1	3	3 6FFF		1.48						-1.16		
Pacient3	hlava	9.735		4	4 6FFF					-0.36	-0.45		0.33		
Pacient4	pulmo	9.701	5	1	1 6FFF				0.65					-0.618	
Pacient5	prostata	9.515	5	1	1 10FFF					0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717	1	1	1 6FFF				0.78				1.04		
Pacient7	uzlina	10.26	5	1	1 10FFF				0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04	5	1	1 6FFF					0.7			1.6	0.46	0.38
Pacient9	prostata	10.087	5	1	1 10FFF					1.12			2.11	0.78	
Pacient10	stavec	15.594	1	2	1 6FFF			1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613	1	3	1 6FFF					1.4			0.7	1.09	

SRS/SBRT – 1-5 fr.

Opakované meranie (= 4 frakcie „liečby“)

	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024	Priemer (%)	Interval	hodn.Intervalu
Pacient5			0.18	-0.15	0.96	1.05			0.51	[-0.15;1.05]	1.20
Pacient7		0.42				2.24	0.39	0.49	0.89	[0.39;2.24]	1.85
Pacient8			0.7			1.6	0.46	0.38	0.79	[0.38;1.60]	1.22
Pacient10	1.03	2.73		2.28	3.9	4.54	2.1		2.76	[1.03;4.54]	3.51

Priemer je sumárna relatívna chyba v dodanej dávke voči TPS.

Opakované meranie (= 4 frakcie „liečby“)

1.5. !



	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024	Priemer (%)	Interval	hodn.Intervalu
Pacient5			0.18	-0.15	0.96	1.05			0.51	[-0.15;1.05]	1.20
Pacient7		0.42				2.24	0.39	0.49	0.89	[0.39;2.24]	1.85
Pacient8			0.7			1.6	0.46	0.38	0.79	[0.38;1.60]	1.22
Pacient10	1.03	2.73		2.28	3.9	4.54	2.1		2.76	[1.03;4.54]	3.51

Priemer je sumárna relatívna chyba v dodanej dávke voči TPS.

2. scenár.....

Presun pacientov medzi strojmi

(vo VOÚ,a.s. 2xVersaHD – spoločný model v TPS)

Presun medzi strojmi – relatívna chyba (%)

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1	Versa1	Versa2	Versa1	Versa1	versa2	Versa2	Versa1	Versa1
							12.04.2024	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024
Pacient1	stavec	16.592		1	1	1 6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513		1	3	3 6FFF	1.48						-1.16		
Pacient3	hlava	9.735			4	4 6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701		5	1	1 6FFF			0.65					-0.618	
Pacient5	prostata	9.515		5	1	1 10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717		1	1	1 6FFF			0.78				1.04		
Pacient7	uzlina	10.26		5	1	1 10FFF			0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04		5	1	1 6FFF				0.7			1.6	0.46	0.38
Pacient9	prostata	10.087		5	1	1 10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594		1	2	1 6FFF		1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613		1	3	1 6FFF				1.4			0.7	1.09	

Presun medzi strojmi – relatívna chyba (%)

	Versa1	Versa2	Versa1	versa2	Versa2	Versa1	Versa1	Priemer (%)	Interval	hodn.Intervalu
	18.04.2024	18.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024			
Pacient4		0.65				-0.618		0.02	[-0.618;0.650]	1.27
Pacient7		0.42			2.24	0.39	0.49	0.89	[0.39;2.24]	1.85
Pacient10	1.03	2.73	2.28	3.9	4.54	2.1		2.76	[1.03;4.54]	3.51

Priemer je sumárna relatívna chyba v dodanej dávke voči TPS.

Presun medzi strojmi – relatívna chyba (%)

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1 12.04.2024	Versa1 18.04.2024	Versa2 18.04.2024	Versa1 19.04.2024	Versa1 25.04.2024	versa2 01.05.2024	Versa2 01.05.2024	Versa1 09.05.2024	Versa1 15.05.2024
Pacient1	stavec	16.592		1	1	1 6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513		1	3	3 6FFF	1.48						-1.16		
Pacient3	hlava	9.735			4	4 6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701		5	1	1 6FFF			0.65					-0.618	
Pacient5	prostata	9.515		5	1	1 10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717		1	1	1 6FFF			0.78				1.04		
Pacient7	uzlina	10.26		5	1	1 10FFF			0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04		5	1	1 6FFF				0.7		?	1.6	0.46	0.38
Pacient9	prostata	10.087		5	1	1 10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594		1	2	1 6FFF		1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613		1	3	1 6FFF				1.4			0.7	1.09	

Presun medzi strojmi – relatívna chyba (%)

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1 12.04.2024	Versa1 18.04.2024	Versa2 18.04.2024	Versa1 19.04.2024	Versa1 25.04.2024	versa2 01.05.2024	Versa2 01.05.2024	Versa1 09.05.2024	Versa1 15.05.2024
Pacient1	stavec	16.592		1	1	1 6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513		1	3	3 6FFF	1.48						-1.16		
Pacient3	hlava	9.735			4	4 6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701		5	1	1 6FFF			0.65					-0.618	
Pacient5	prostata	9.515		5	1	1 10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717		1	1	1 6FFF			0.78				1.04		
Pacient7	uzlina	10.26		5	1	1 10FFF			0.42					0.39	0.49
Pacient8	pulmo	13.04		5	1	1 6FFF				0.7			1.6	0.46	0.38
Pacient9	prostata	10.087		5	1	1 10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594		1	2	1 6FFF		1.03	2.73		2.28			2.1	
Pacient11	hlava	12.613		1	3	1 6FFF				1.4			0.7	1.09	

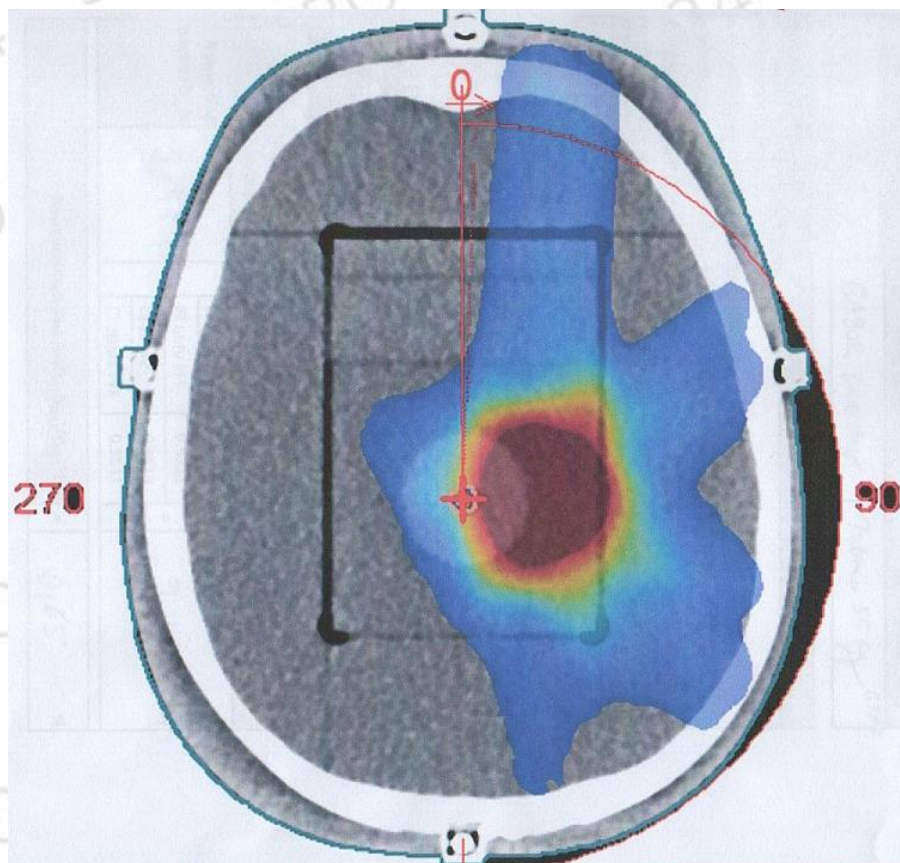
Presun medzi strojmi – relatívna chyba (%)

	Versa1	Versa2	Versa1	versa2	Versa2	Versa1	Versa1	Priemer (%)	Interval	hodn.Intervalu
	18.04.2024	18.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024			
Pacient4		0.65				-0.618		0.02	[-0.618;0.650]	1.27
Pacient7		0.42				0.39	0.49	0.43	[0.39;0,49]	0.10
Pacient10	1.03	2.73	2.28			2.1		2.04	[1.03;2.73]	1.70

Priemer je sumárna relatívna chyba v dodanej dávke voči TPS.

Meranie na okraji PTV (dávkový gradient)

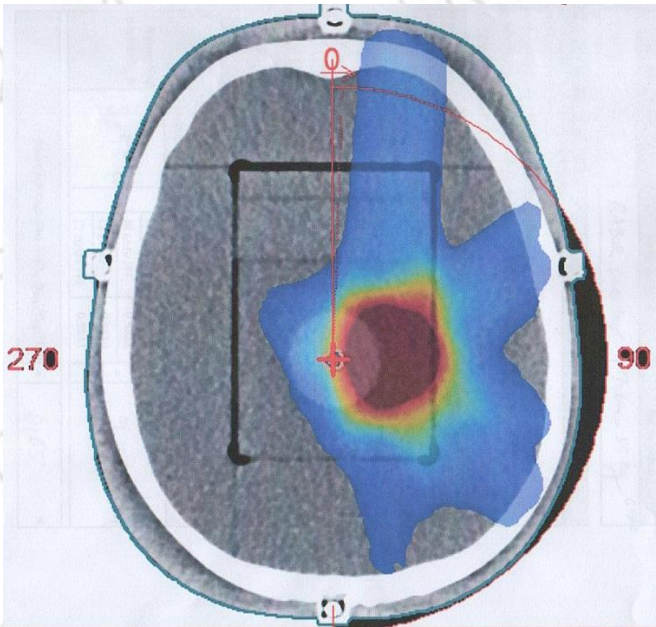
Meranie na okraji PTV (dávkový gradient)



- SBRT plán – pľúca
- predpis 11Gy/fr.
- meraná oblasť 9.701Gy (88%)

	regio	TPS (Gy)	fr	arc	uhlystola	ener.	Versa1 12.04.2024	Versa1 18.04.2024	Versa2 18.04.2024	Versa1 19.04.2024	Versa1 25.04.2024	versa2 01.05.2024	Versa2 01.05.2024	Versa1 09.05.2024	Versa1 15.05.2024
Pacient1	stavec	16.592	1	1	16FFF					1.2			2.46		1.36
Pacient2	hlava	23.513	1	3	36FFF	1.48							-1.16		
Pacient3	hlava	9.735		4	46FFF					-0.36	-0.45		0.33		
Pacient4	pulmo	9.701	5	1	16FFF				0.65					-0.618	
Pacient5	prostata	9.515	5	1	110FFF					0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717	1	1	16FFF				0.78				1.04		
Pacient7	uzlina	10.26	5	1	110FFF				0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04	5	1	16FFF					0.7			1.6	0.46	0.38
Pacient9	prostata	10.087	5	1	110FFF					1.12			2.11	0.78	
Pacient10	stavec	15.594	1	2	16FFF			1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613	1	3	16FFF					1.4			0.7	1.09	

Meranie na okraji PTV - relatívna chyba (%)



	ener.	Versa2	Versa1	Priemer (%)	Interval	hodn.Intervalu
		18.04.2024	09.05.2024			
Pacient4	6FFF	0.650	-0.618	0.020	[-0.618;0.650]	1.268

Absorbovaná dávka pri prerušení ožarovania
(Inhibit/Interlock, Interrupt,...)

Absorbovaná dávka pri prerušení ožarovania

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1	Versa1	Versa2	Versa1	Versa1	versa2	Versa2	Versa1	Versa1
							12.04.2024	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024
Pacient1	stavec	16.592	1	1	1	6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513	1	3	3	6FFF	1.48						-1.16		
Pacient3	hlava	9.735		4	4	6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701	5	1	1	6FFF			0.65					-0.618	
Pacient5	prostata	9.515	5	1	1	10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717	1	1	1	6FFF			0.78				1.04		
Pacient7	uzlina	10.26	5	1	1	10FFF			0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04	5	1	1	6FFF				0.7			1.6	0.46	0.38
Pacient9	prostata	10.087	5	1	1	10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594	1	2	1	6FFF		1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613	1	3	1	6FFF				1.4			0.7	1.09	

Absorbovaná dávka pri prerušení ožarovania

- Prerušenie ožarovania z technickej príčiny s následným „dožiarením“ vs riadna frakcia bez prerušovania (MLC Error – v tomto prípade)

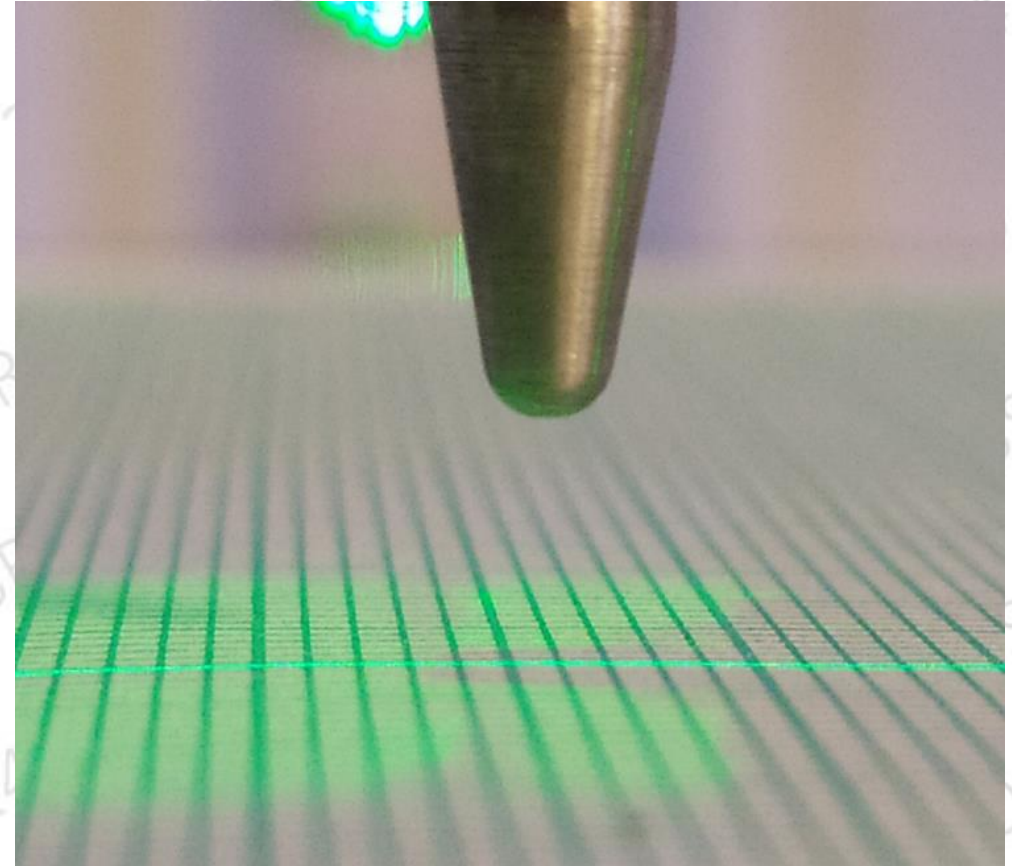
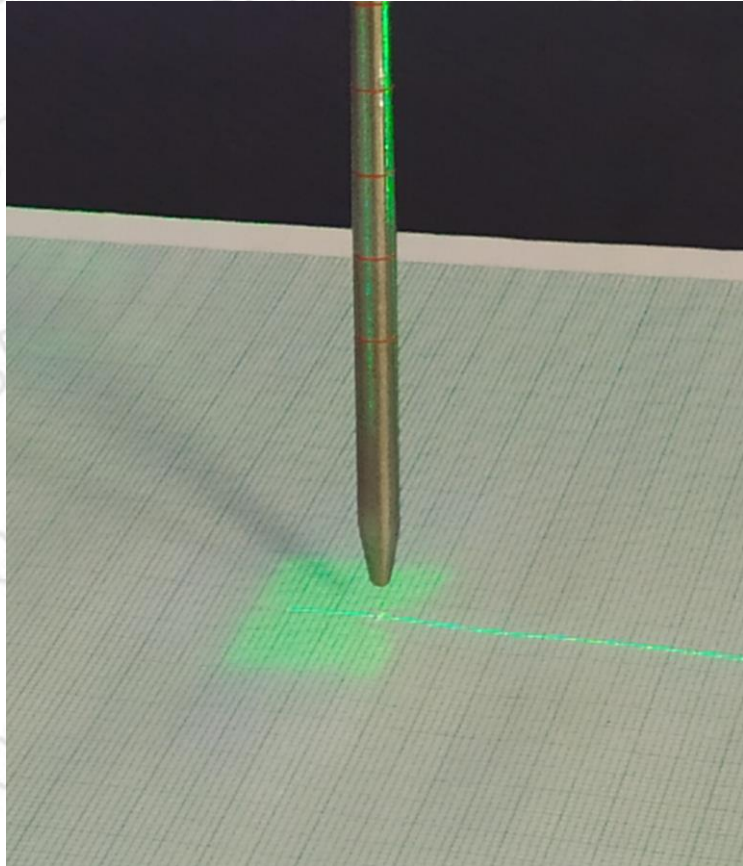
	regio	TPS (Gy)	Versa2	Versa2
			01.05.2024	01.05.2024
Pacient5	prostata	9.515	9.606	9.615
	Rel.rozdiel medzi meraniami		0.09%	

Rotácia stola pri verifikácii

(zmeriam každý Arc s reálnym natočením stola)

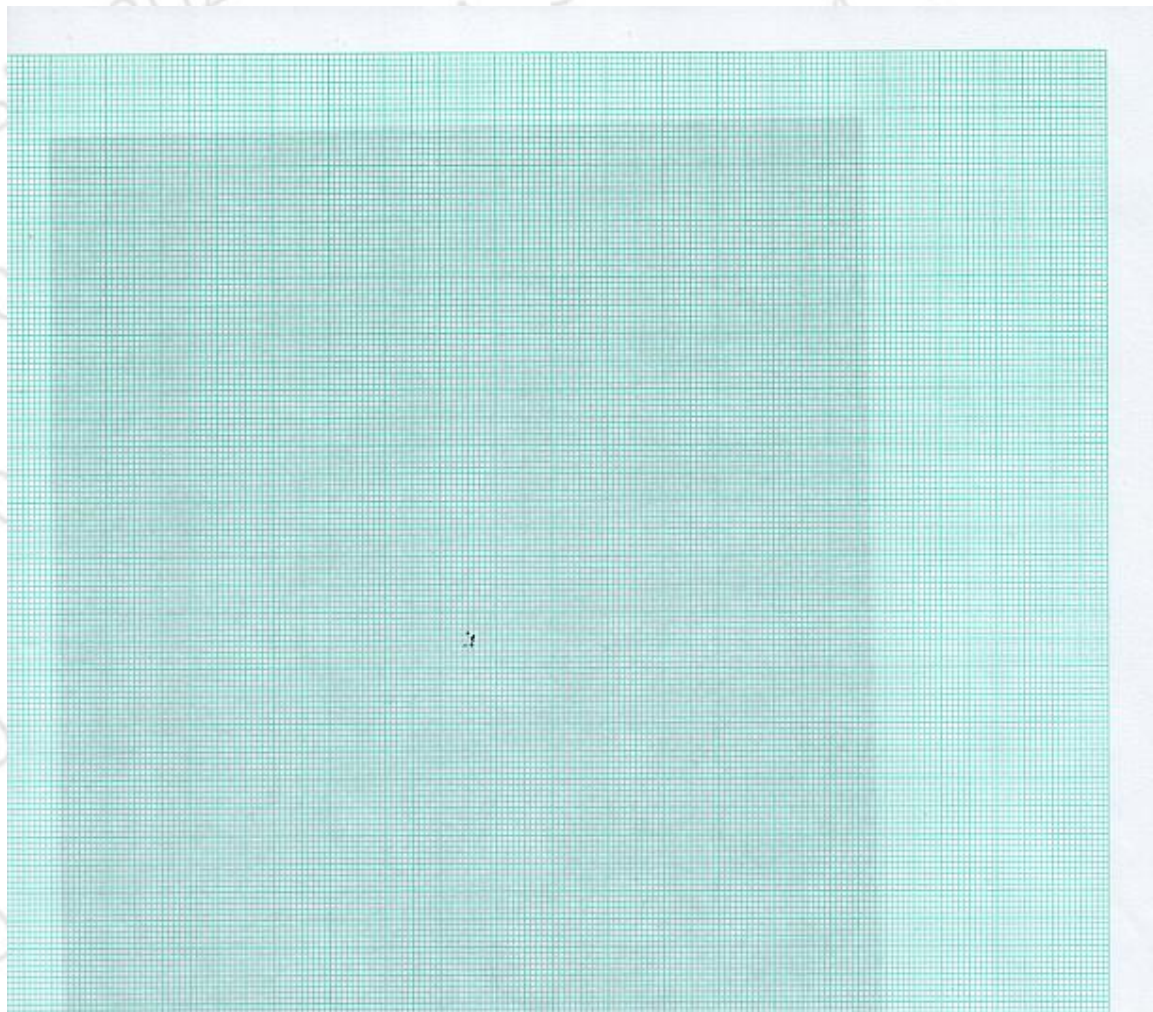
(Väčšinou sa stôl „nuluje“. Pacient ale rotácie má!)

Nepresnosť osi rotácie stola sa dá zistiť aj pointrom

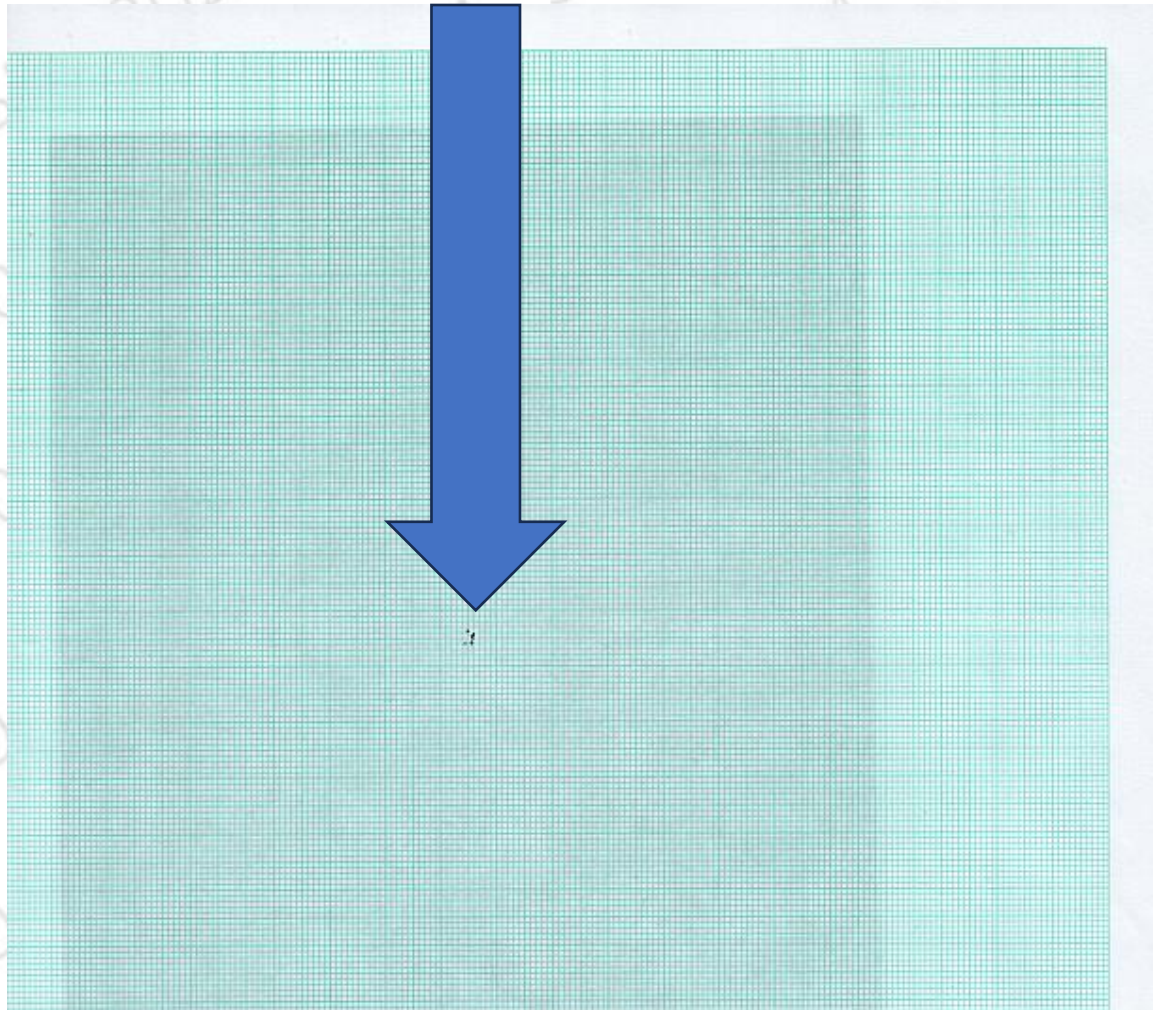


NEMÁ SA TO OVEROVAŤ POINTROM!!! Ale ak by sme chceli....

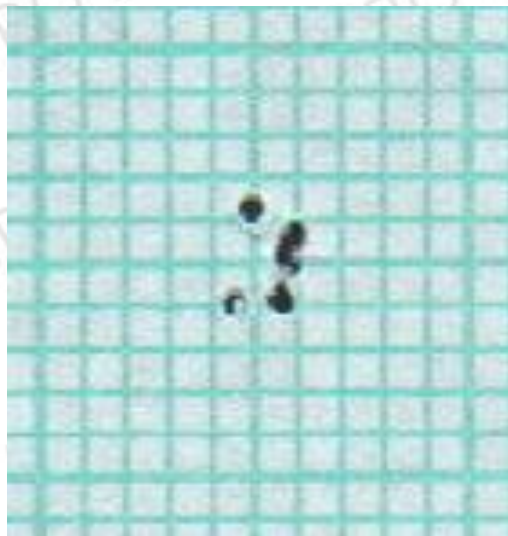
Nepresnosť osi rotácie stola sa
reálne vyskytuje



Nepresnosť osi rotácie stola sa
reálne vysky tu je



Nepresnosť osi rotácie stola sa
reálne vyskytuje



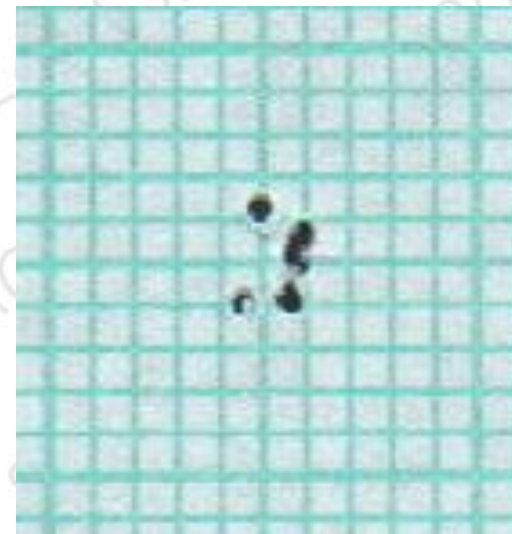
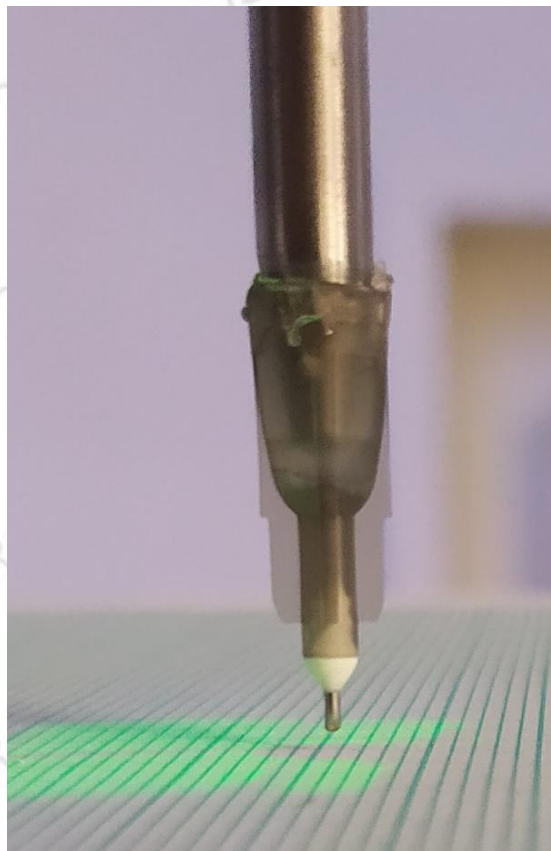
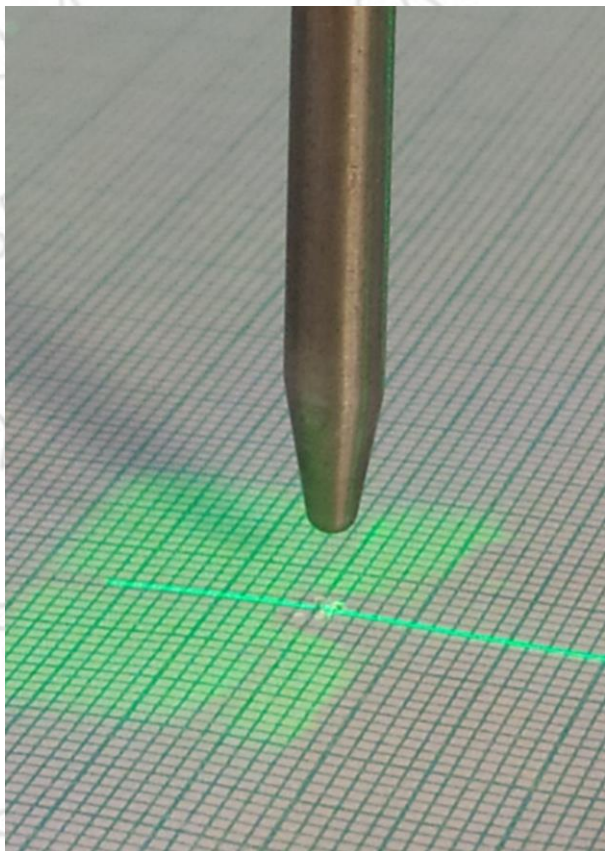
Takéto overenie možno vykonať (aj) takto....

NASLEDOVNÝ POSTUP VÝSLOVNE NEODPORÚČAME!!!

Nasleduje návod.....



Nepresnosť osi rotácie stola



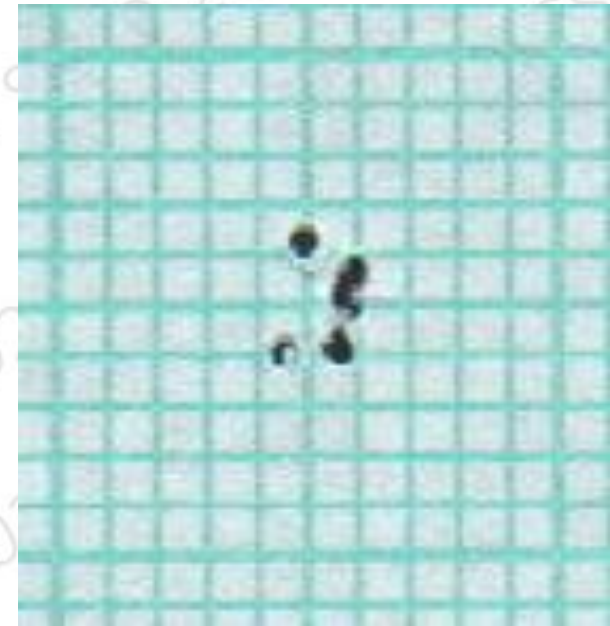
UVEDENÝ POSTUP NEODPORÚČAME!!!

Pointer je takmer určite trochu krivo.....

Uvedený výsledok je pre názornosť

Rotácia stola sa overuje cez fantómy s „guličkou“ a MV portál
(W-L testom)!!!

ako je to teda u nás?.....



Rotácia stola pri verifikácii

Rotácia stola pri verifikácii

	regio	TPS (Gy)	fr	arc	uhly stola	ener.	Versa1	Versa1	Versa2	Versa1	Versa1	versa2	Versa2	Versa1	Versa1
							12.04.2024	18.04.2024	18.04.2024	19.04.2024	25.04.2024	01.05.2024	01.05.2024	09.05.2024	15.05.2024
Pacient1	stavec	16.592		1	1	1 6FFF				1.2			2.46		1.36
Pacient2	hlava	23.513		1	3	3 6FFF	1.48						-1.16		
Pacient3	hlava	9.735			4	4 6FFF				-0.36	-0.45		0.33		
Pacient4	pulmo	9.701		5	1	1 6FFF			0.65					-0.618	
Pacient5	prostata	9.515		5	1	1 10FFF				0.18	-0.15	0.96	1.05		
Pacient6	pulmo	35.717		1	1	1 6FFF			0.78				1.04		
Pacient7	uzlina	10.26		5	1	1 10FFF			0.42				2.24	0.39	0.49
Pacient8	pulmo	13.04		5	1	1 6FFF				0.7			1.6	0.46	0.38
Pacient9	prostata	10.087		5	1	1 10FFF				1.12			2.11	0.78	
Pacient10	stavec	15.594		1	2	1 6FFF		1.03	2.73		2.28	3.9	4.54	2.1	
Pacient11	hlava	12.613		1	3	1 6FFF				1.4			0.7	1.09	

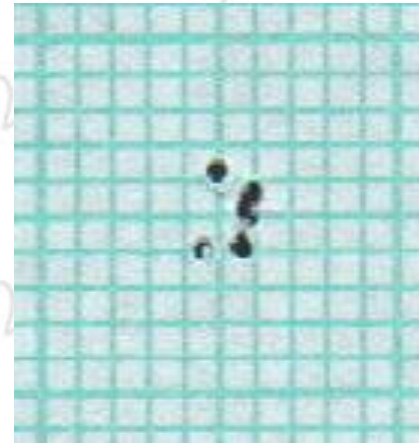
Rotácia stola pri verifikácii

	regio	TPS (Gy)	fr	uhly stola	Versa1 12.04.	Versa1 19.04.	Versa1 25.04.	Versa2 01.05.	Priemer (%)	Interval	hodn.Int ervalu
Pacient2	hlava	23.513	1	3	1.48			-1.16	0.16	[-1.16; 1.48]	2.64
Pacient3	hlava	9.735	1	4		-0.36	-0.45	0.33	-0.16	[-0.45;0.33]	0.75

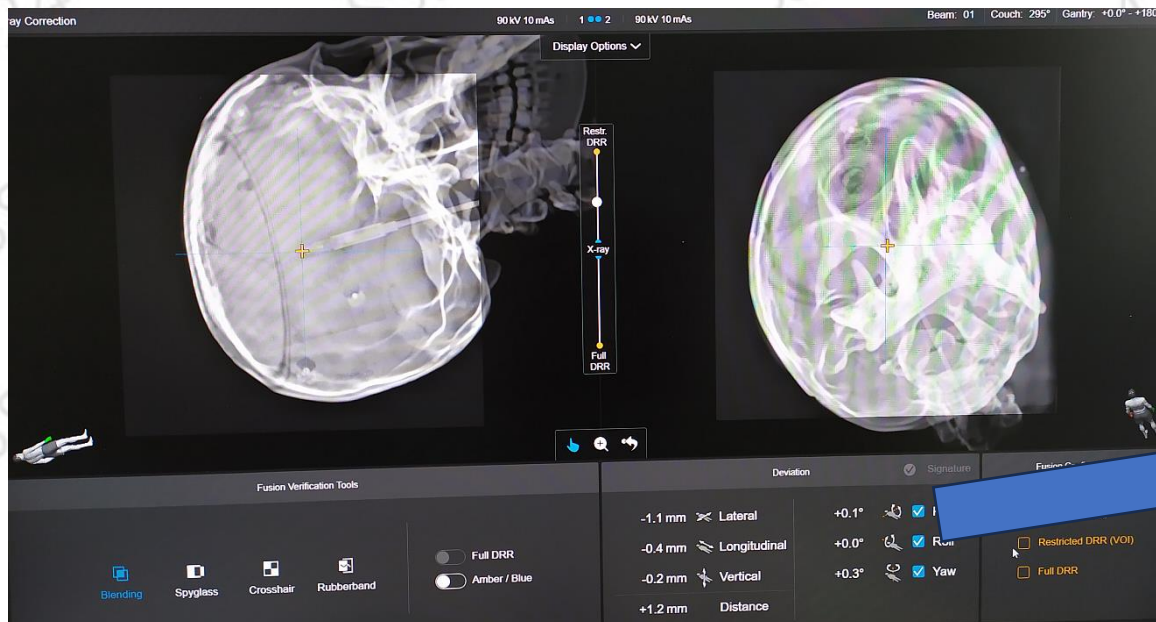
Priemer je sumárna relatívna chyba v dodanej dávke voči TPS.

Výsledok je výborný preto, lebo máme málo „neizocentrický“ stôl. A môže tu byť aj vplyv veľkosti detektora – môže byť veľký na tak malú zmenu.

Takéto (veľké) vyosenie stola



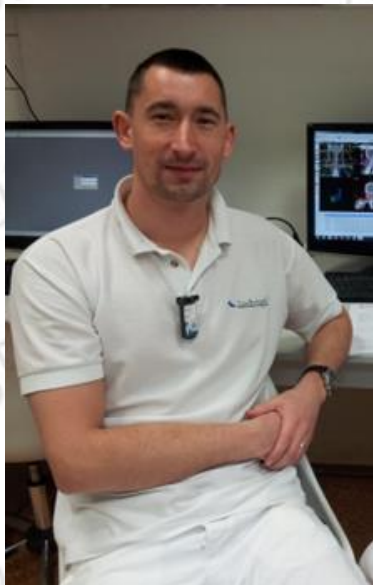
dokáže ExacTrac vykompenzovať.



Deviation			Signature
-1.1 mm		Lateral	+0.1°  <input checked="" type="checkbox"/> Pitch
-0.4 mm		Longitudinal	+0.0°  <input checked="" type="checkbox"/> Roll
-0.2 mm		Vertical	+0.3°  <input checked="" type="checkbox"/> Yaw
+1.2 mm		Distance	

Záver – „Take home message“

- kvalitný, antropomorfný fantóm je veľmi užitočná pomôcka pre overenie situácii, kedy nemáme istotu „čo sa deje“
- v našom súbore pacientov (plánov) sme zistili skupinovú relatívnu chybu veľkosti 1,19% pre energiu 6FFF a 0,87% celkovo pre skupinu s 10FFF (aj pri započítaní meraní z 1.5.2024)
- odporúčame fyzikom nechodievalť do práce v dni pracovného pokoja
- neodporúčame upravovať a/alebo používať pomôcky v rozpore s návodom výrobcu



Ďakujem/e Vám za pozornosť!



a STEEV

