Parador de Antequera

JORNADAS SARH

Nuevas Técnicas y Retos de los Sistemas de Planificación de Tratamientos de Radioterapia

Antequera, 23 de octubre 2026



SOCIEDAD ANDALUZA DE RADIOFÍSICA HOSPITALARIA

www.sarh.es

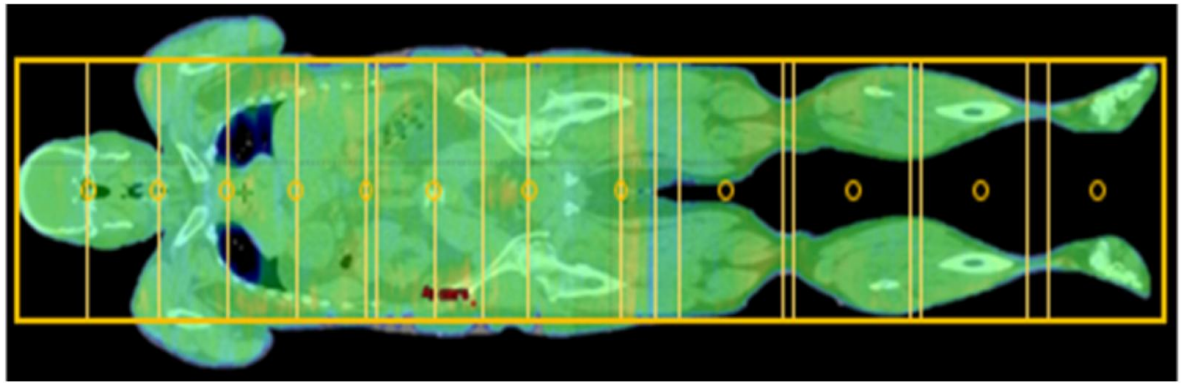


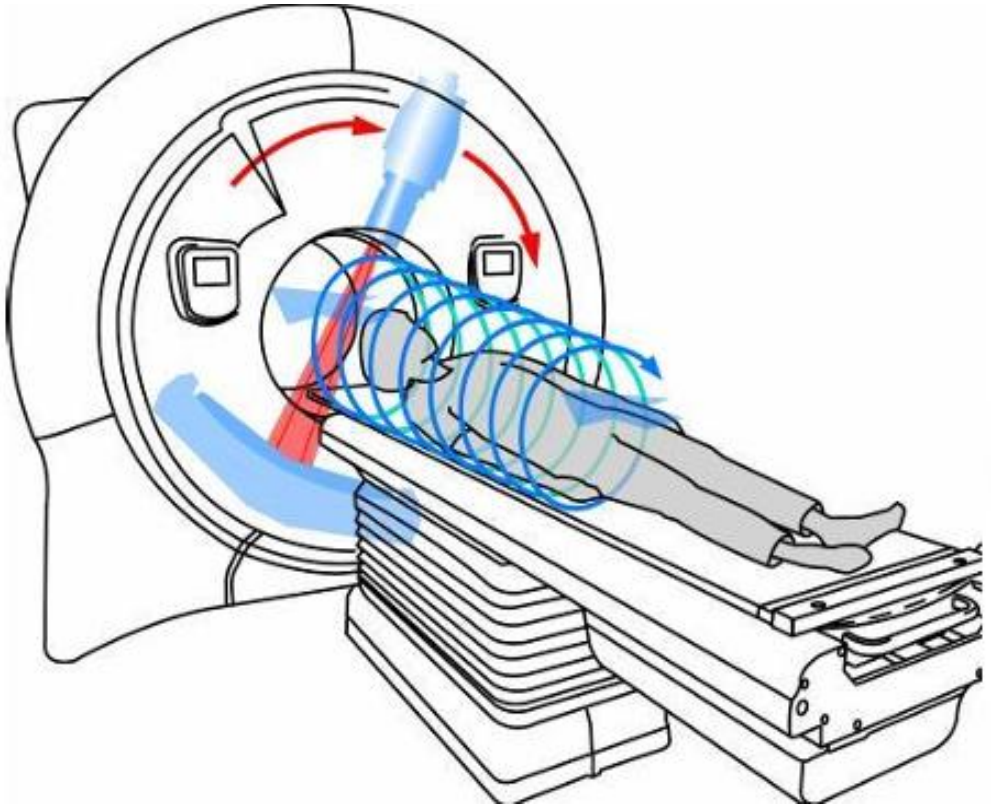
Irradiación Corporal Total en modo de Tratamiento Helicoidal. Radixact

Sara C. Moral Sánchez/ Félix Navarro Guirado
UGC de Radiofísica y Protección Radiológica
Hospital Regional Universitario de Málaga

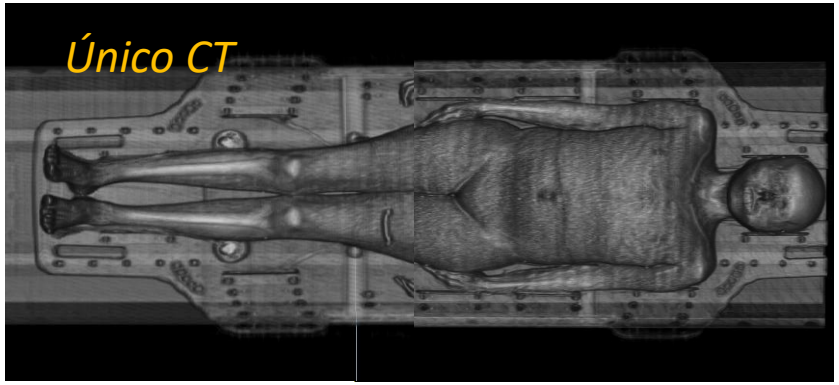
ICT: Elección del acelerador



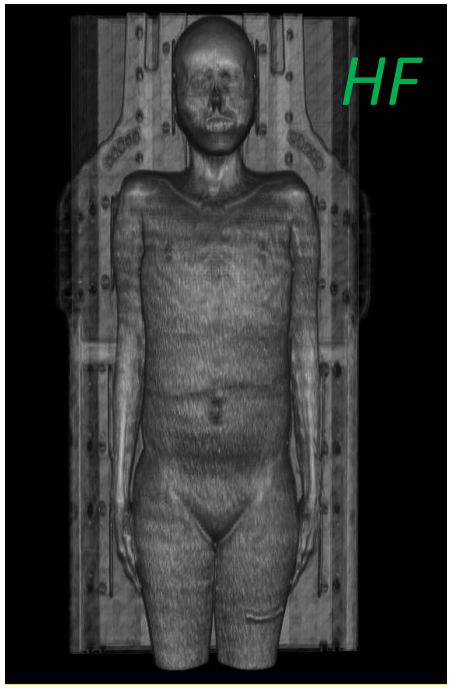


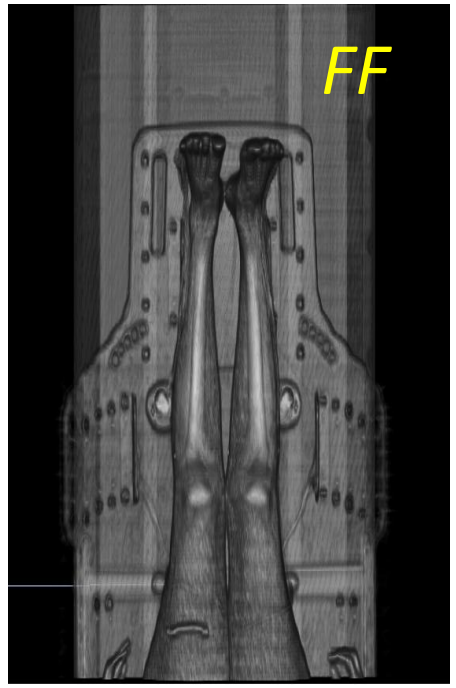


Longitud<135cm

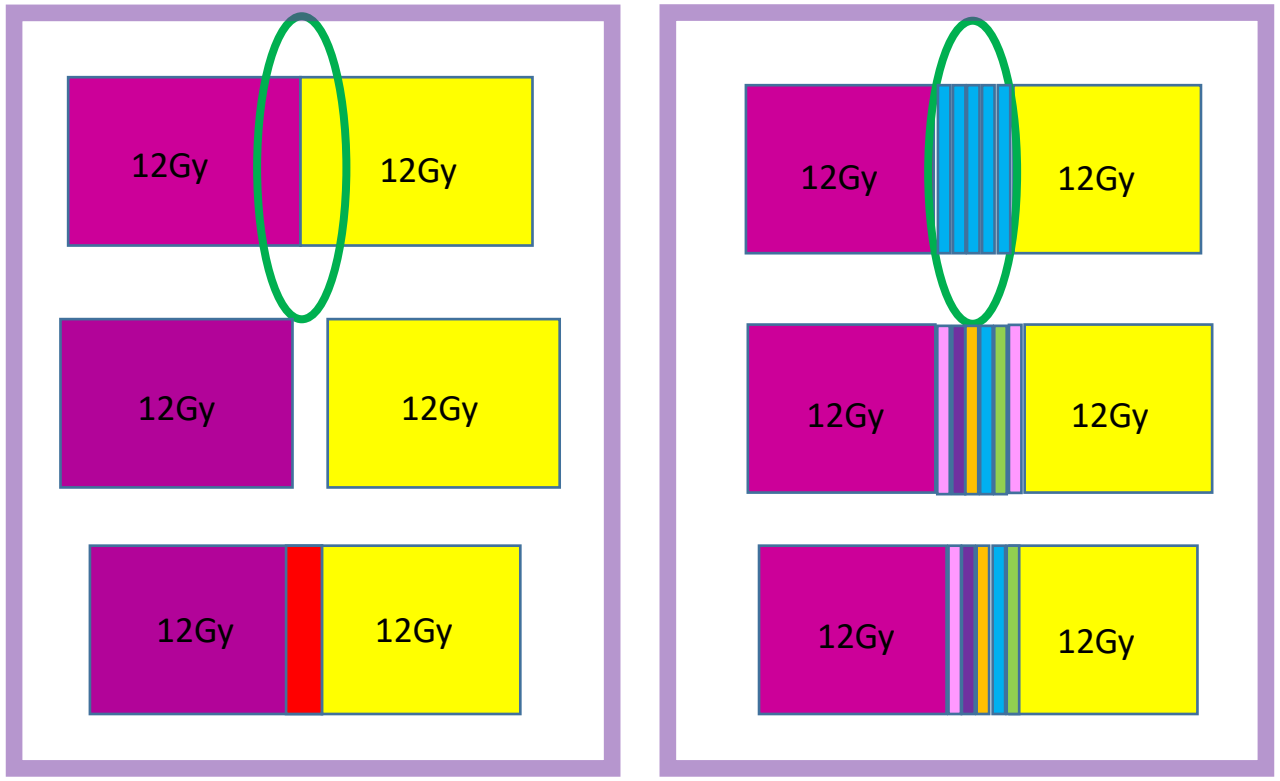


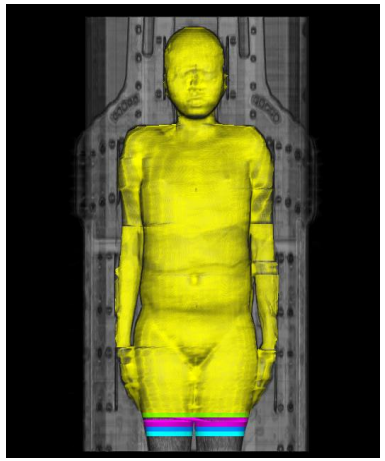
Longitud>135cm

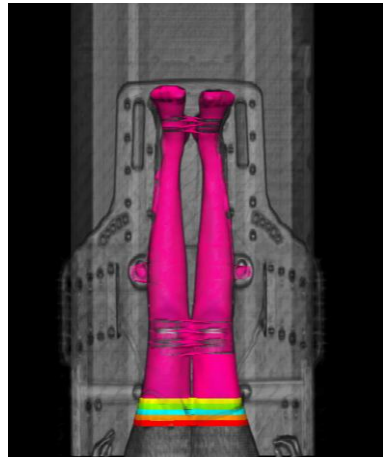




Unión de gradiente volumétrico



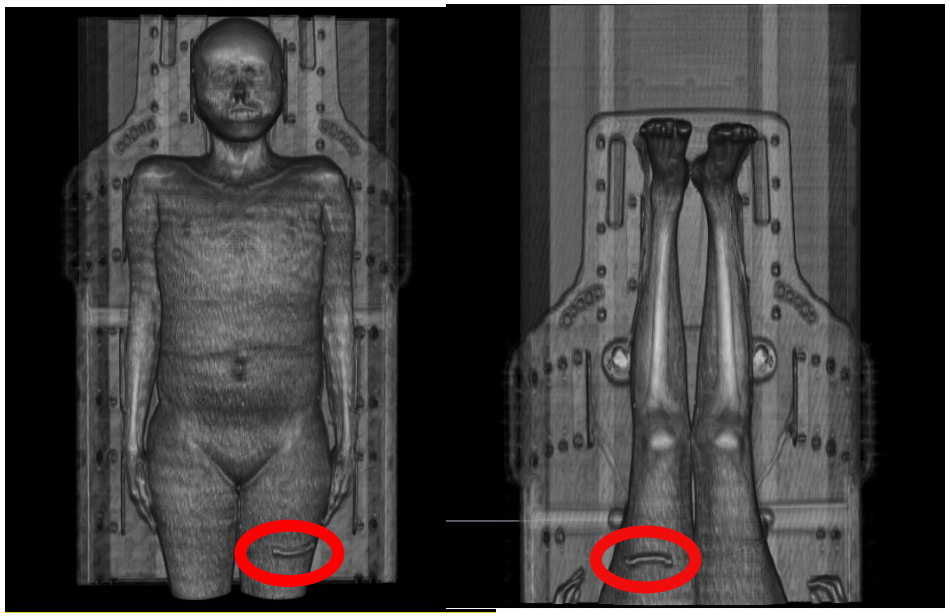




- 2 CT: HF y FF de 5mm
- Para prescripción de 12 Gy ((1,5Gy x 2) x 4)): Unión de 5 escalones de 2cm y dosis de prescripción: 10, 8, 6, 4 y 2Gy en cada escalón

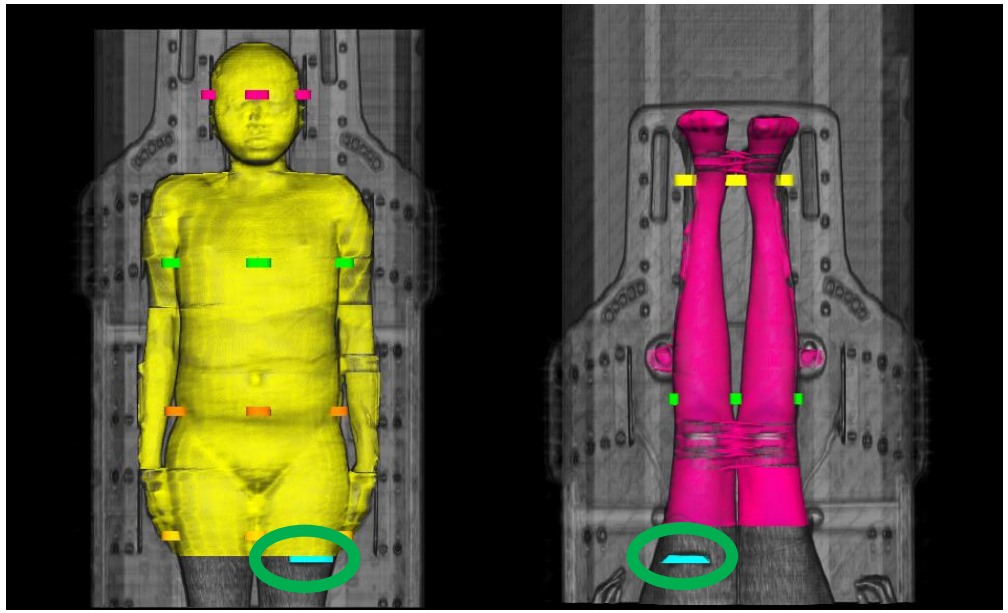
Simulación

Marcador en pierna izquierda (HF/FF)

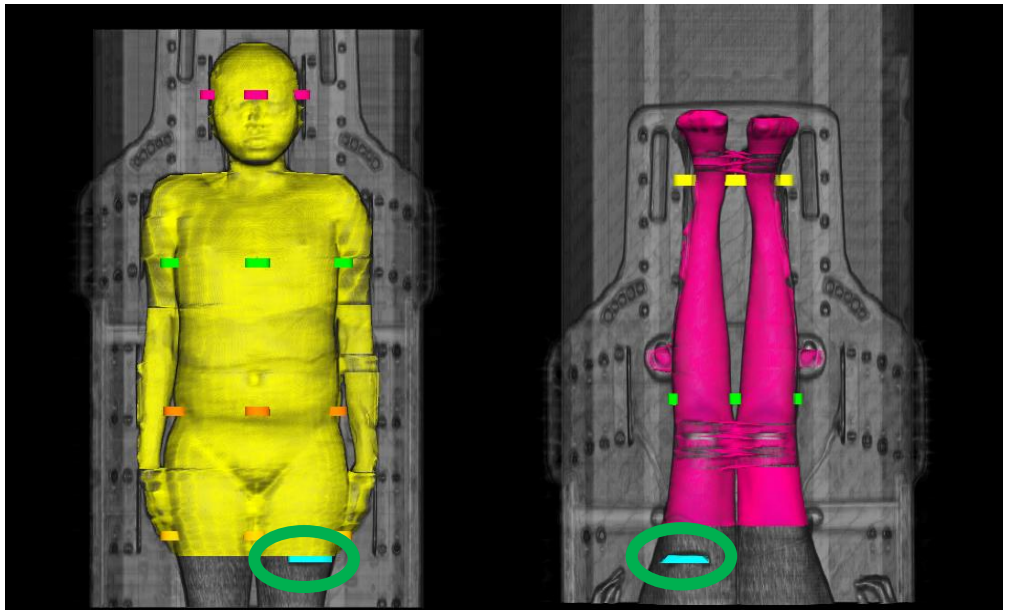


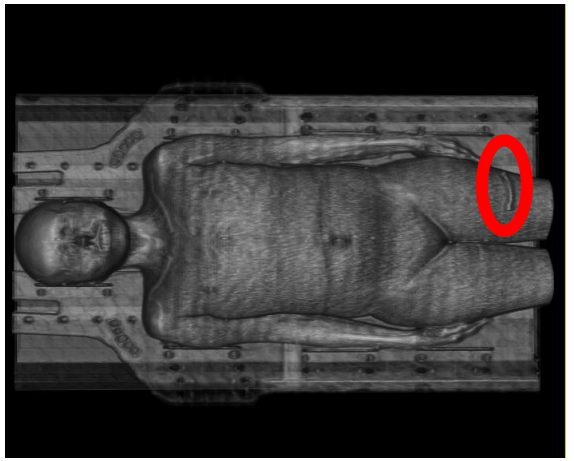
Planificación

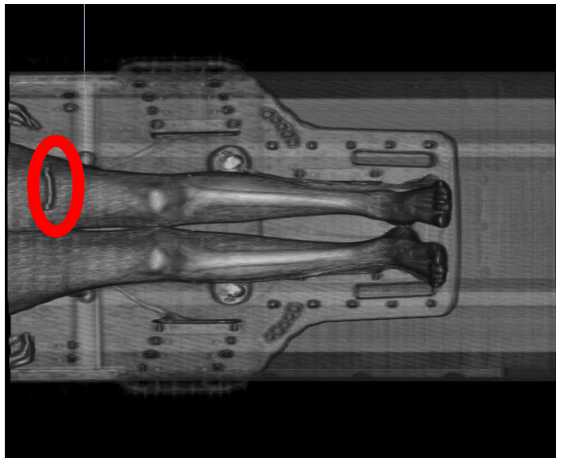
En HF: límite superior del escalón de **10Gy**
En FF: límite inferior del escalón de **2Gy**

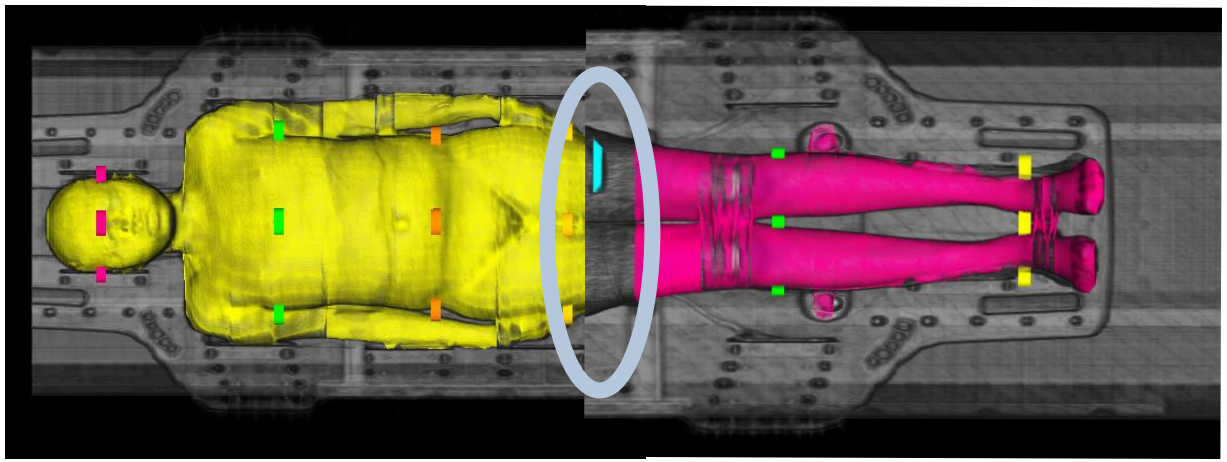


Suma de gradientes opuestos = Dosis de Prescripción

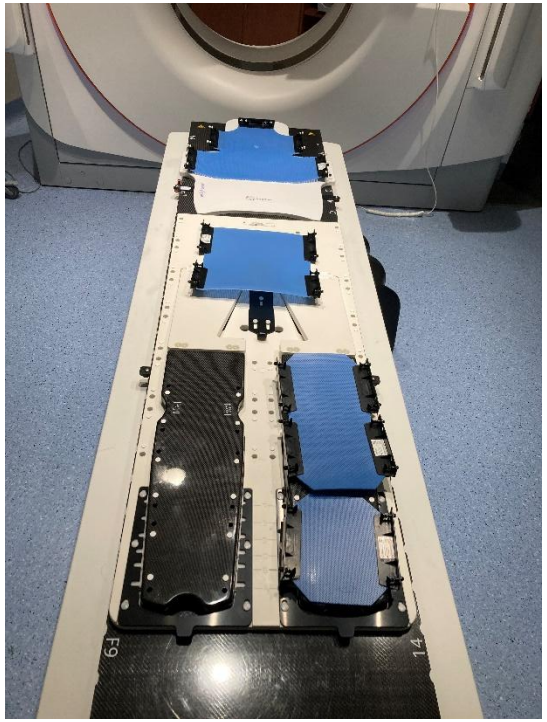




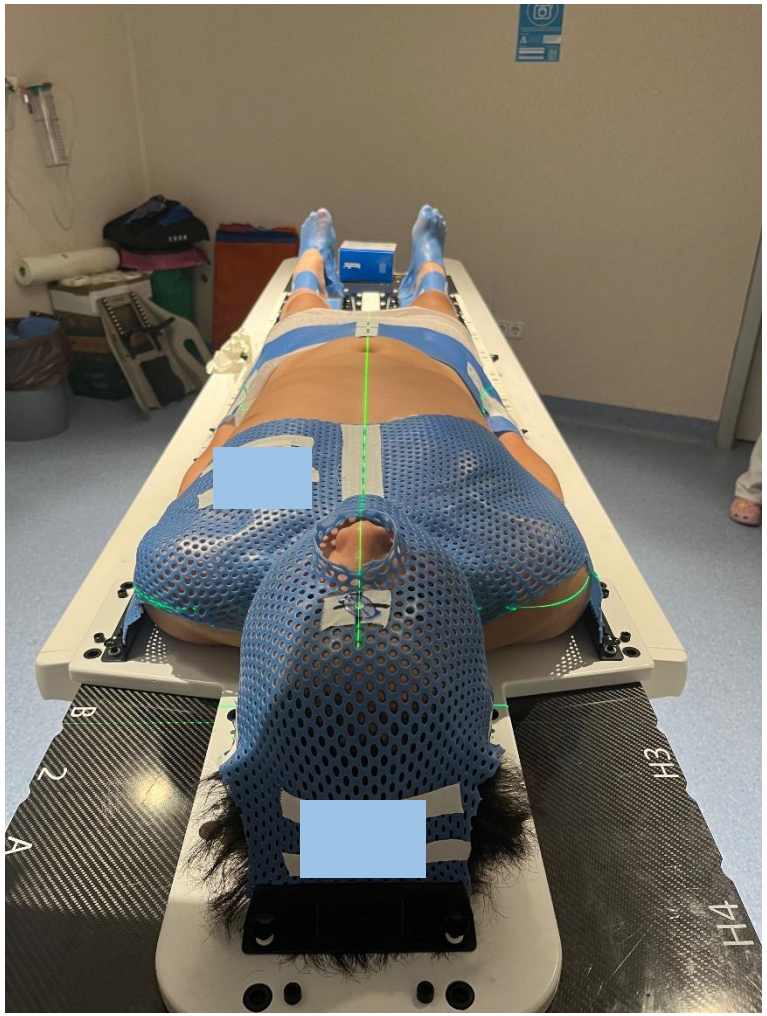




- Inmovilizadores:
  - Tableros inmovilizadores de cabeza y cuello y de extremidades
  - Máscara de Cabeza y Cuello; Máscara de pelvis (o de otra localización adaptada);Mascaras de piernas o de pies + tobillos; Tubifix para las manos/dedos; Tatuajes sobre piel en pelvis
  - Marcador en pierna izquierda (por debajo de la mano)



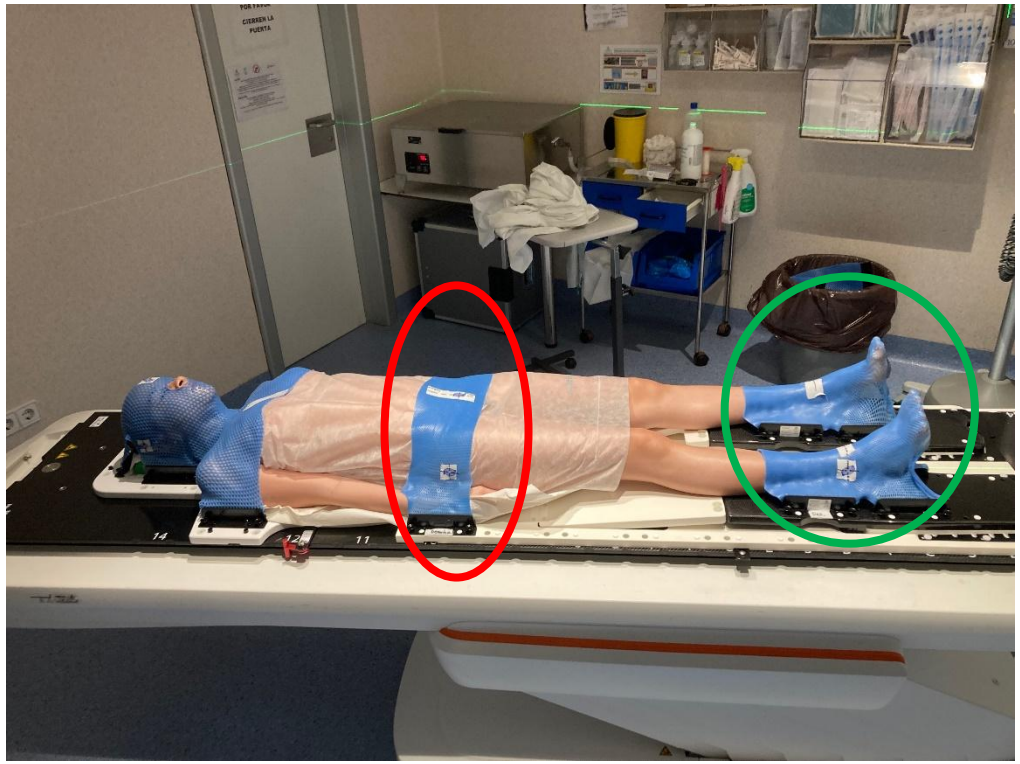
HF



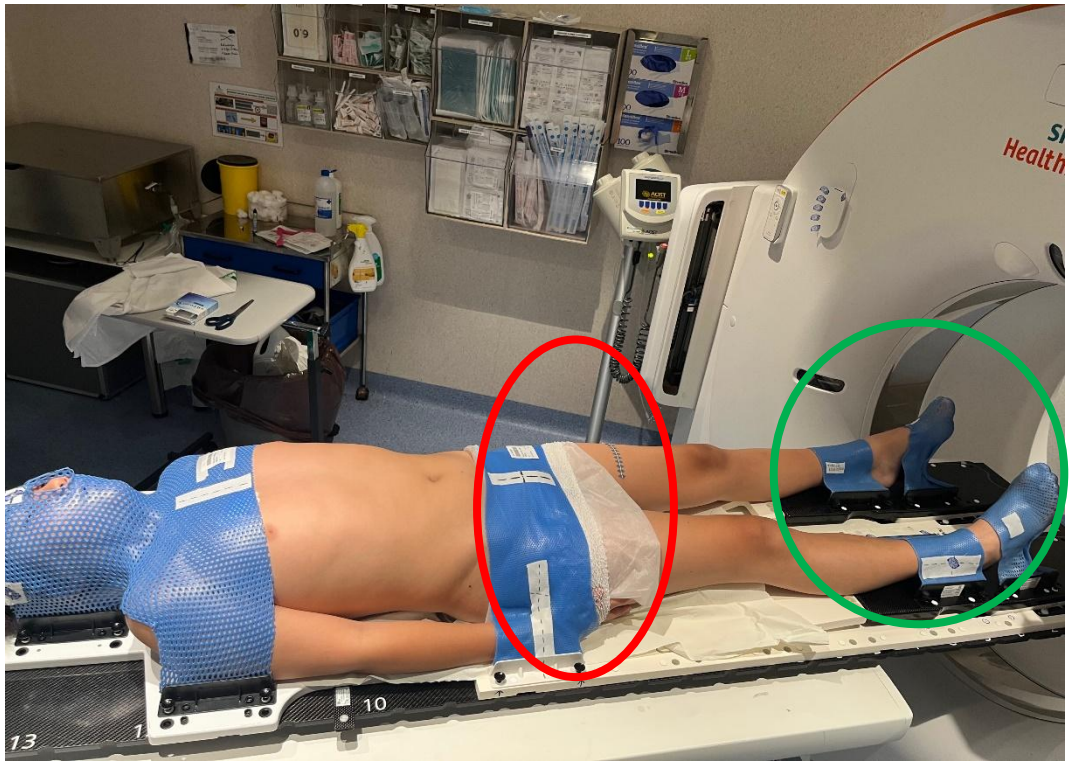
FF



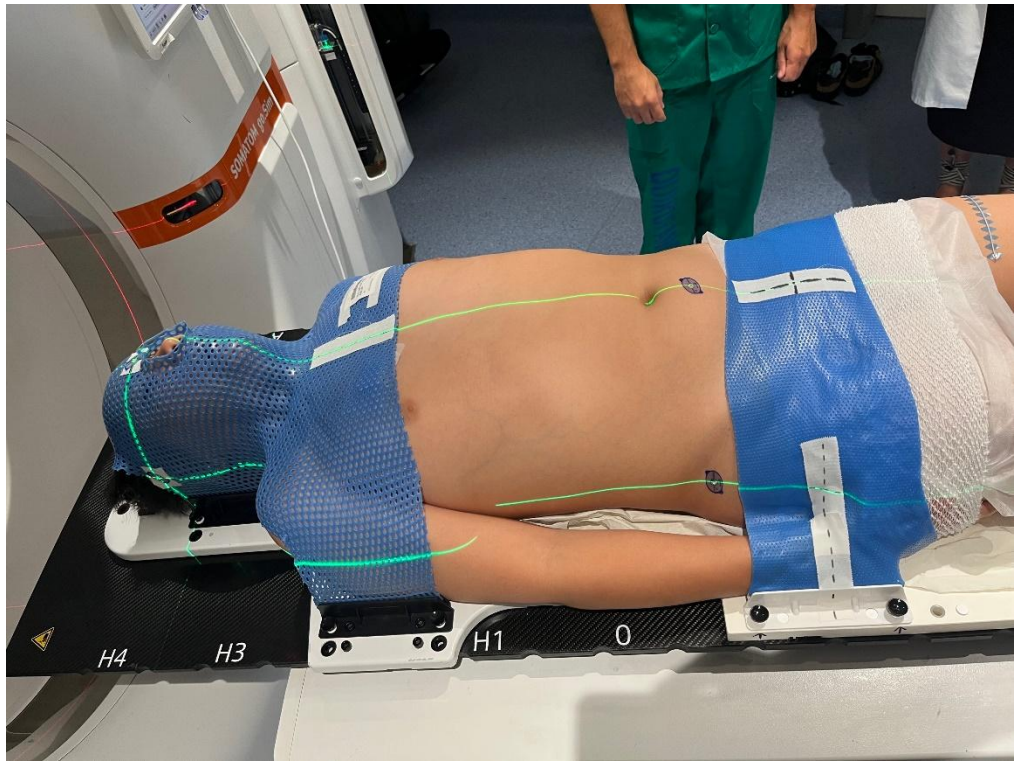
Primera paciente

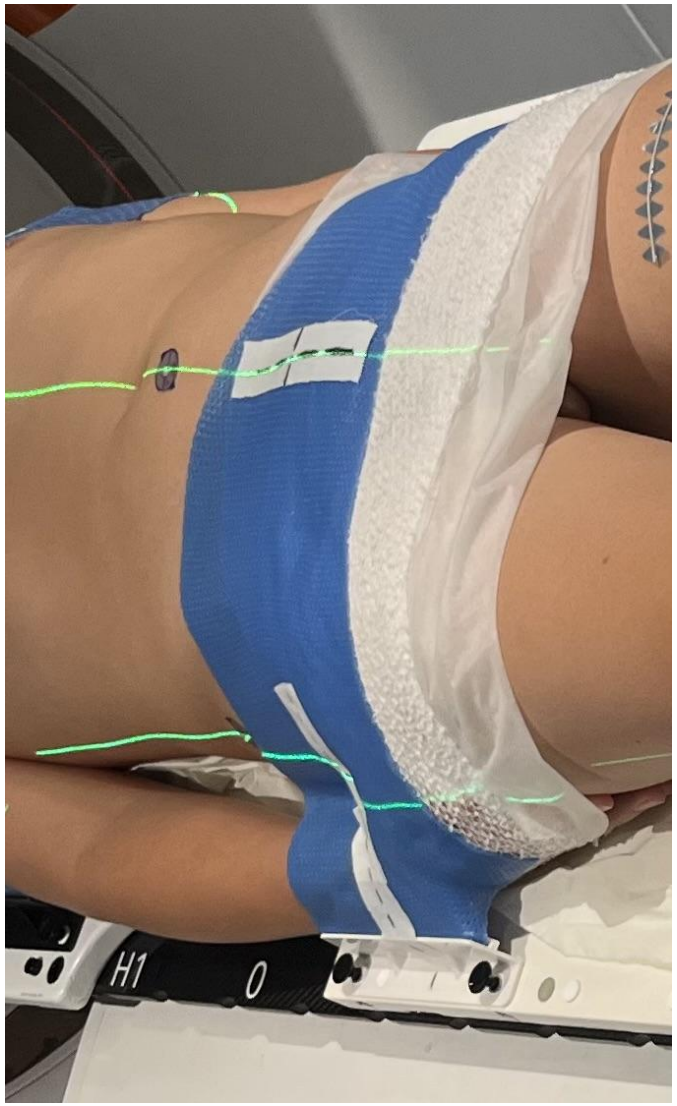


Segundo paciente

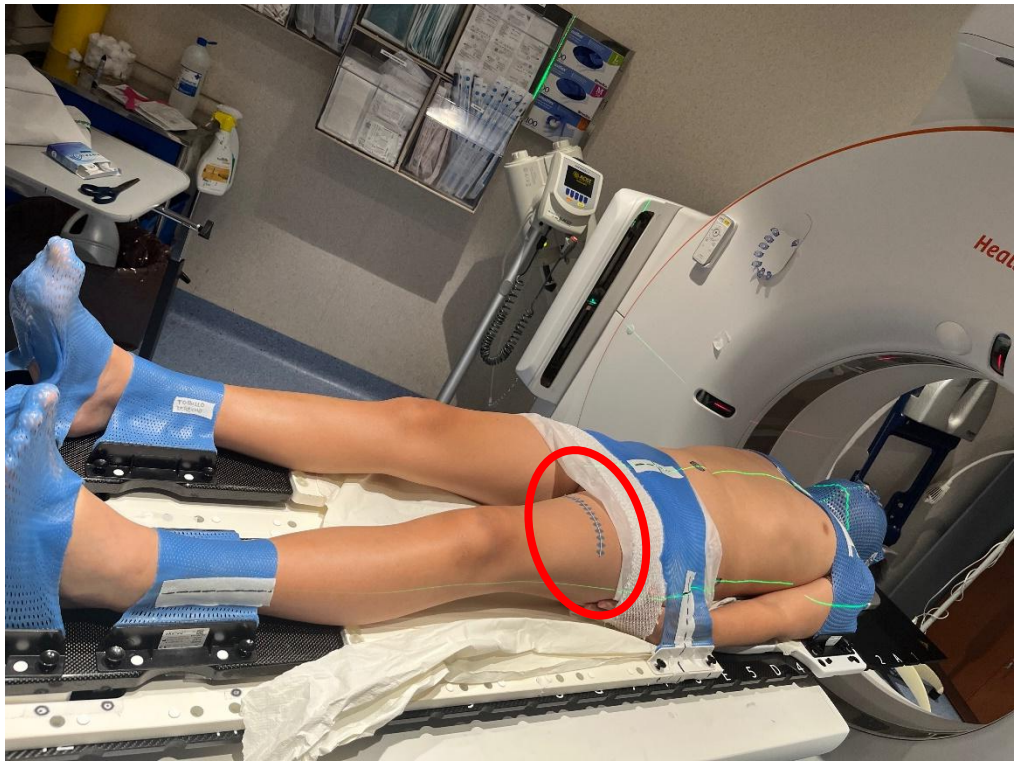


Tubifix y tatuajes en pelvis

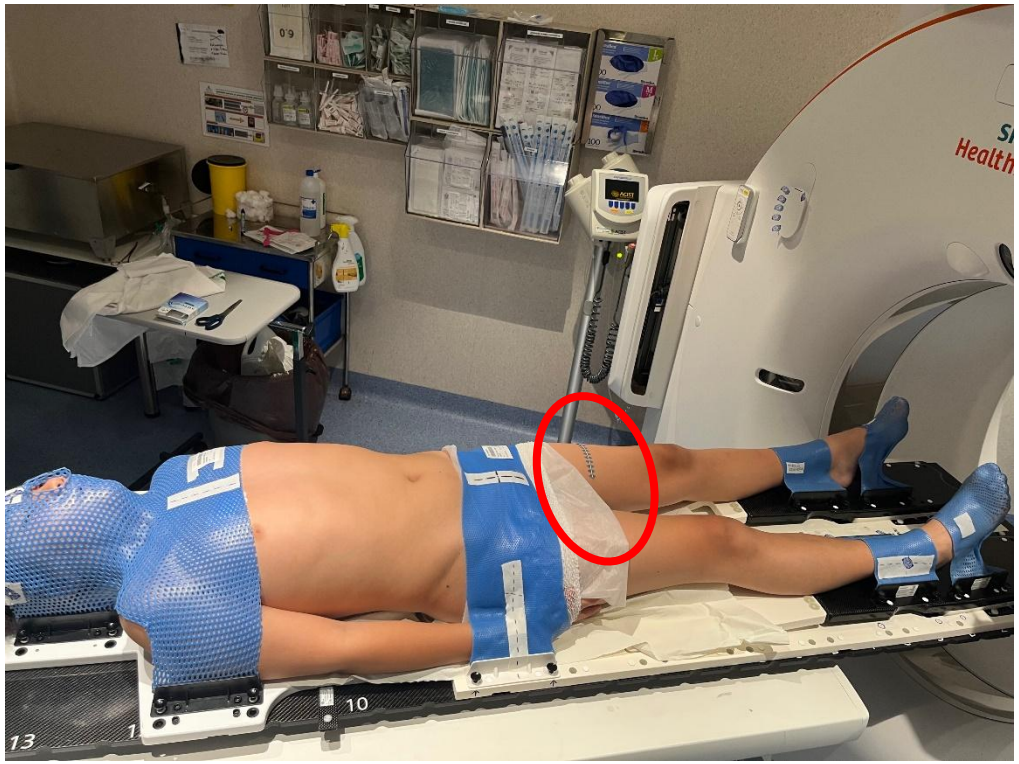




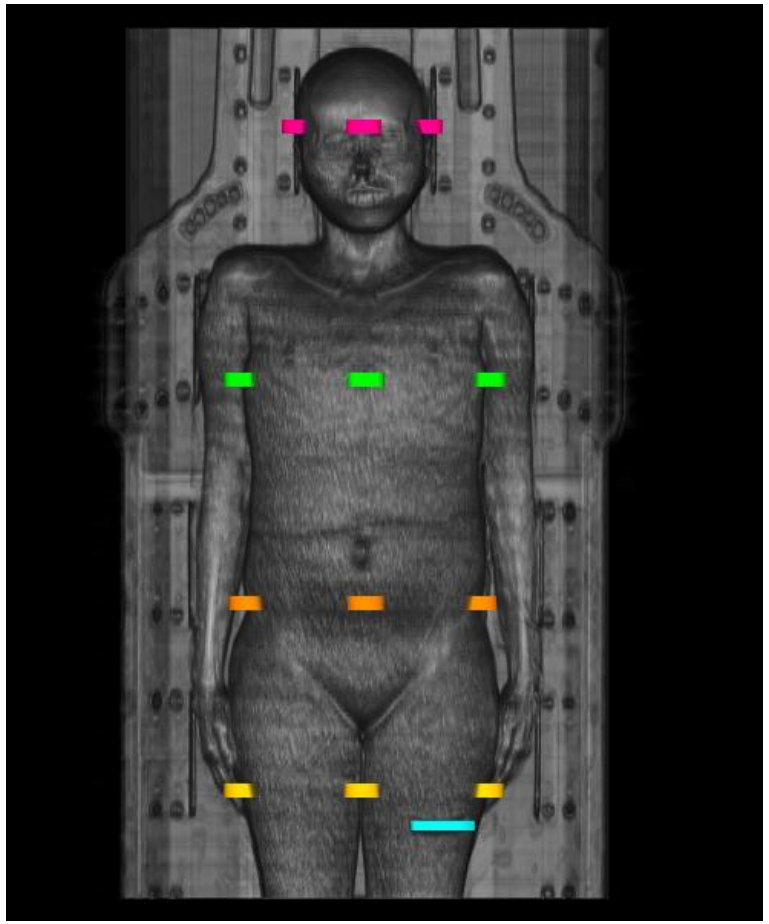
Marcador_HF

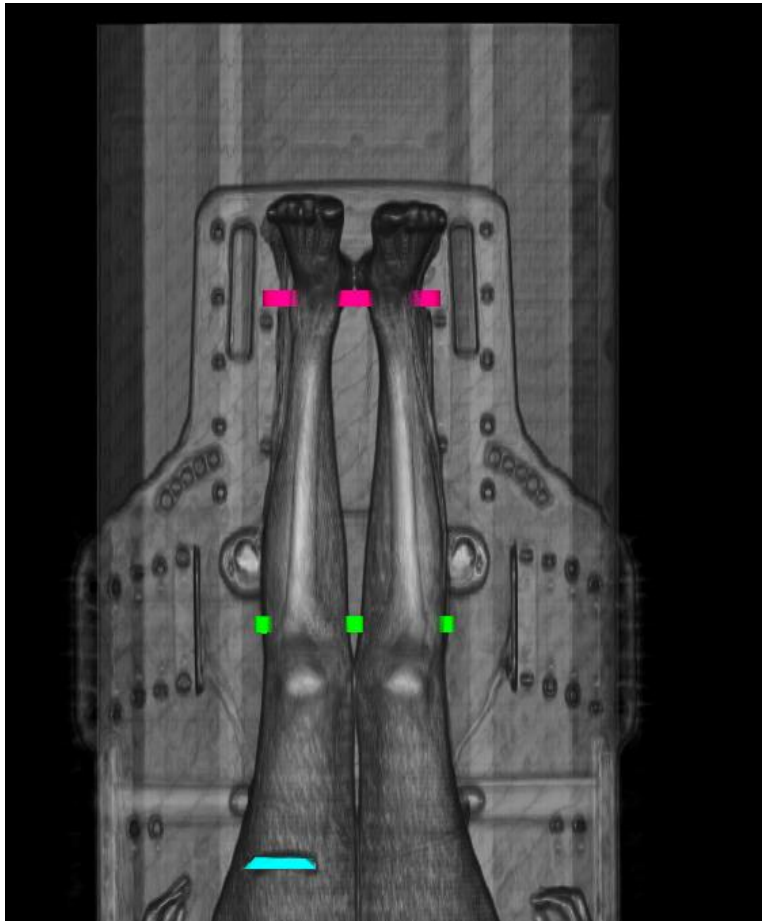


Marcador_FF

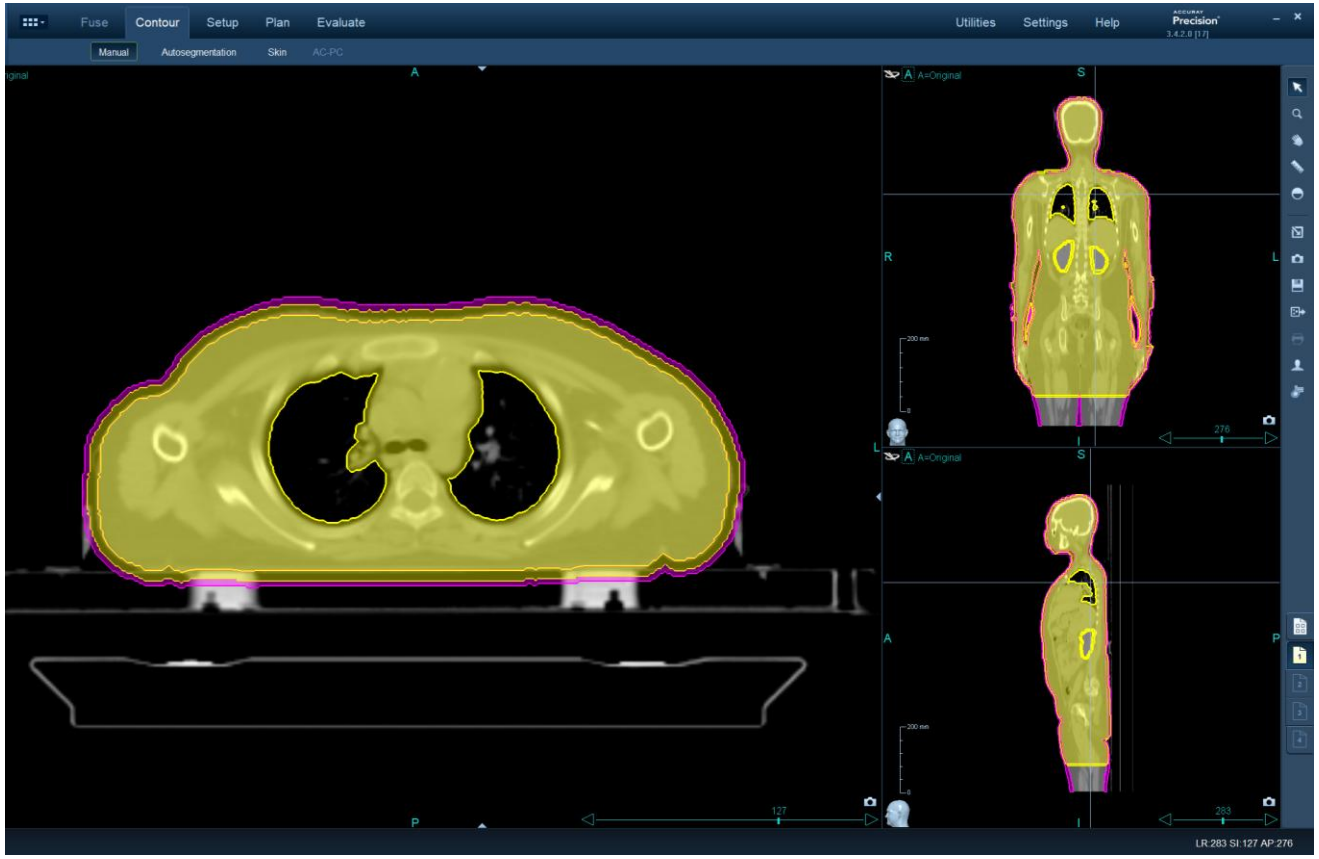


Alineación y centrajes





PTV Superior =+5mm, -(pulmones-2mm), -riñones, -gradiente



Body + Bolus Virtual



Bolus Virtual en Tomo_2015

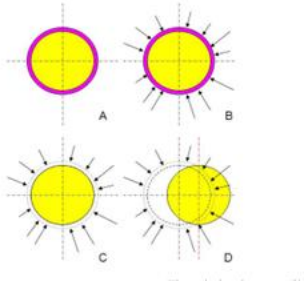
JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 16, NUMBER 6, 2015

Virtual bolus for total body irradiation treated with helical tomotherapy

Gilles Moliner,[1] Françoise Izar,[2] Régis Ferrand,[1] Manuel Bardies,[3] Soléakhéna Ken,[1] Luc Simon[1,3a]
Departement of Medical Physics,[1] Institut Universitaire du Cancer de Toulouse, Toulouse, France; Departement of Radiation Oncology,[2] Institut Universitaire du Cancer de Toulouse, Toulouse, France; UMR 1037 Team 15,[3] INSERM, Toulouse, France
uhqd75@gmail.com

Received 27 January, 2015; accepted 17 June, 2015

"This VB **(VB5+3, ρ=0.4)** insures good dose coverage (V95% > 95%) for setup errors of up to 2.9 cm "



Bolus Virtual en Tomo_2024

Radiotherapy and Oncology 197 (2024) 110366

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

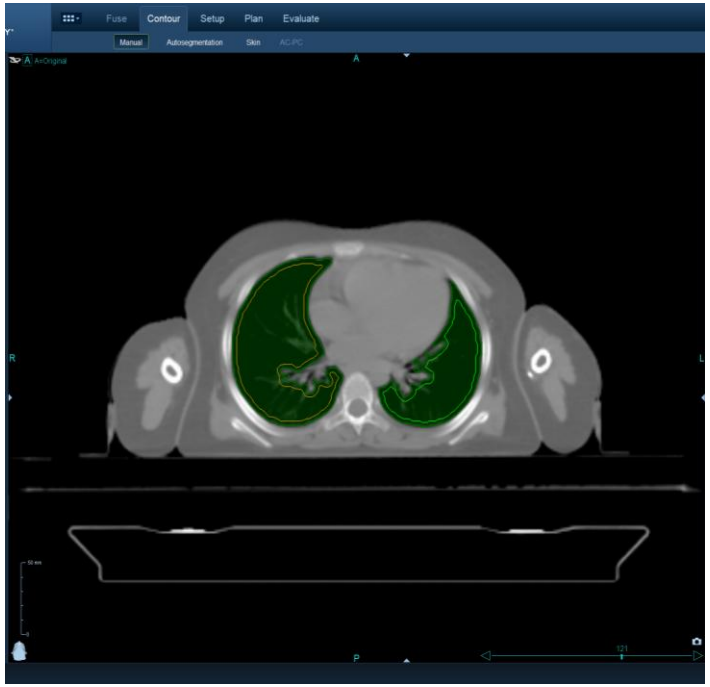
ELSEVIER

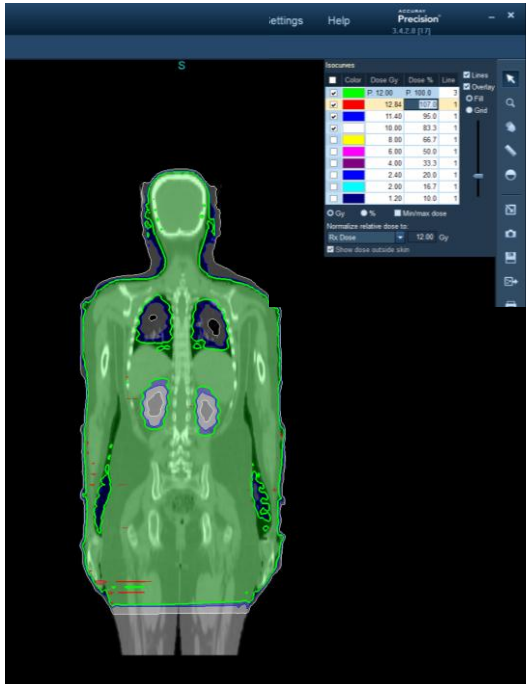
Technical recommendations for implementation of Volumetric Modulated Arc Therapy and Helical Tomotherapy Total Body Irradiation

Enrica Seravalli[a], Mirjam E. Bosman[a], Chunhui Han[b], Christoph Losert[c], Montserrat Pazos[c], Per E Engström[d], Jacob Engellau[e], Christian P.L. Fulcheri[f], Claudio Zucchetti[f], Simonetta Saldi[g], Carlos Ferrer[h], Abrahams Ocanto[i], Susan M. Hiniker[j], Catharine H. Clark[k,l,m,n], Mohammad Hussein[i], Sarah Misson-Yates[o,p,q], Daria A. Kobyzeva[r], Anna A. Loginova[r], Bianca A.W. Hoeben[a,s,*]

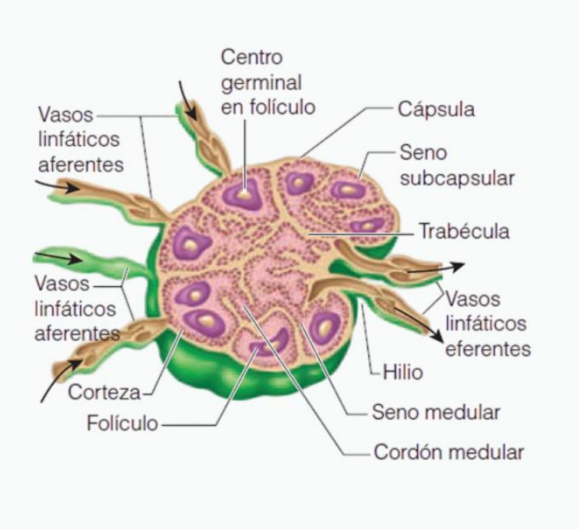
" An option is using a bolus density of **0.6 g/cc** (water) corresponding to **– 400HU**; occurrence of high fluence in the tissue-air border is avoided with negligible (attenuating) impact on the dose distribution"

Generamos dos estructuras: pulmones -2mm y -3mm.





Generamos un anillo alrededor de los riñones.





Radiotherapy and Oncology 173 (2022) 119–133

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Guidelines

ESTRO ACROP and SIOPE recommendations for myeloablative Total Body Irradiation in children

- Consider limiting the mean lung dose to <8 Gy.
- Consider limiting the mean kidney dose to ≤10 Gy.
- Consider reducing the lens dose to <12 Gy to decrease the risk of severe cataracts. For children with a high risk of CNS recurrence*, eye shielding should not be applied during conventional TBI.

Radiotherapy and Oncology 197 (2024) 110366

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Technical recommendations for implementation of Volumetric Modulated Arc Therapy and Helical Tomotherapy Total Body Irradiation

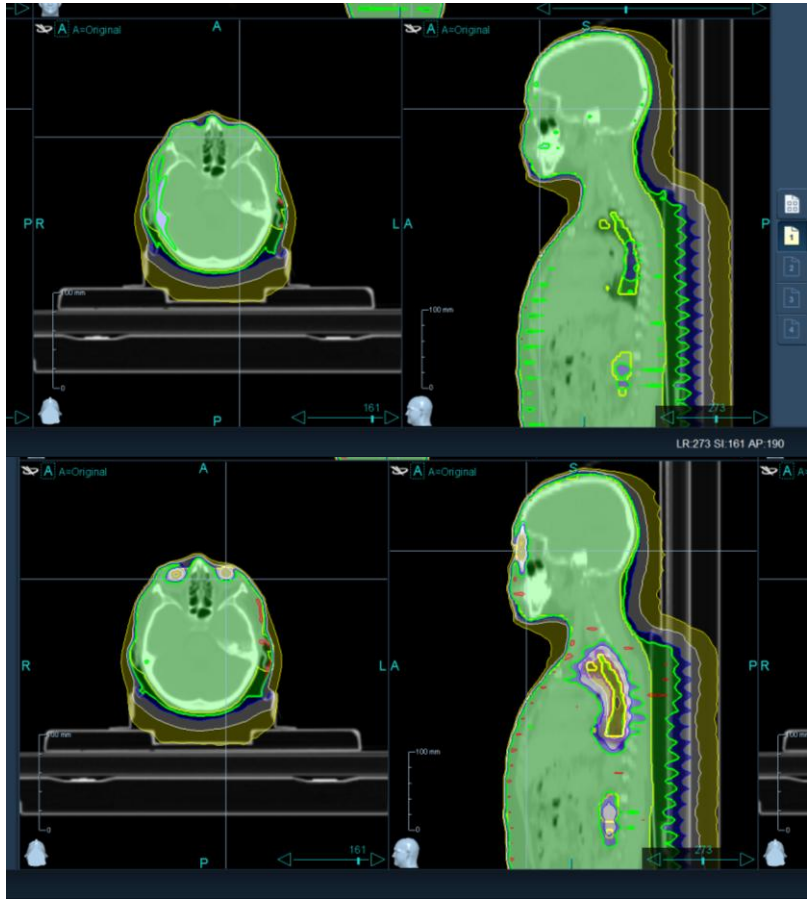
En cuanto a los objetivos en PTVs:

- V90% >98% y V95% > 90%
- V110%<5% y V120%<1%

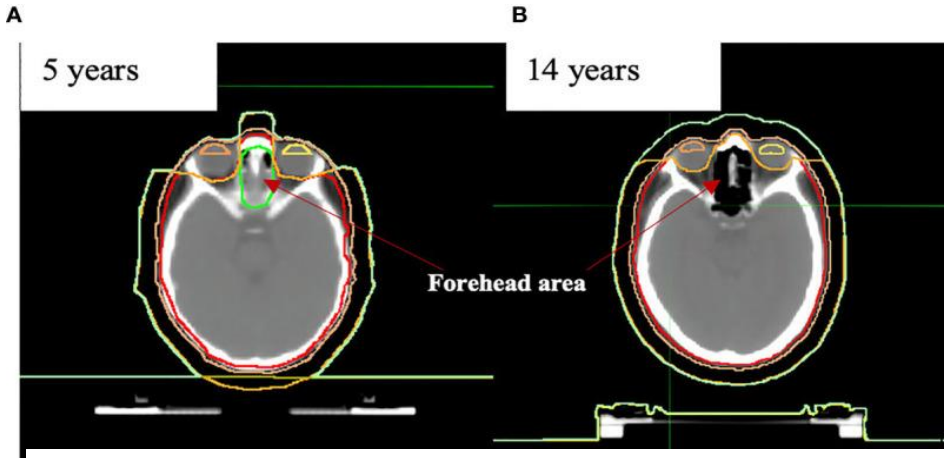
Objetivos de dosis para 1,5/2Gy :

- Dosis media en pulmón < 8Gy
- Dosis media en riñones < 8-10Gy
- Dosis media en cristalinos < 6Gy

Cristalinos: ¿Nada/Todo/90%, Dmáx, media?



[121] Kobyzeva D, Shelikhova L, Loginova A, Kanestri F, Tovmasyan D, Maschan M, et al. Optimized conformal total body irradiation among recipients of TCRalphabeta/CD19-depleted grafts in pediatric patients with hematologic malignancies: single-center experience. Front Oncol 2021;11:785916.



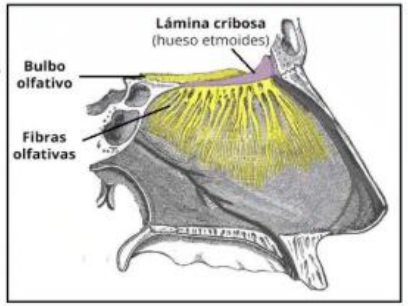
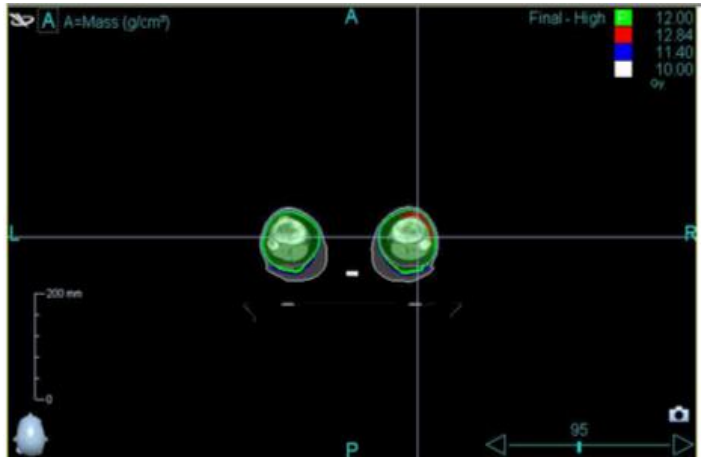


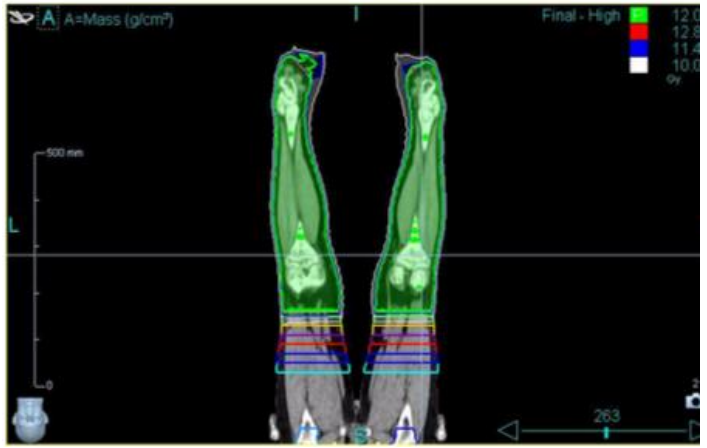
TABLE 2 | Dose prescriptions with "target" and "acceptable" values.

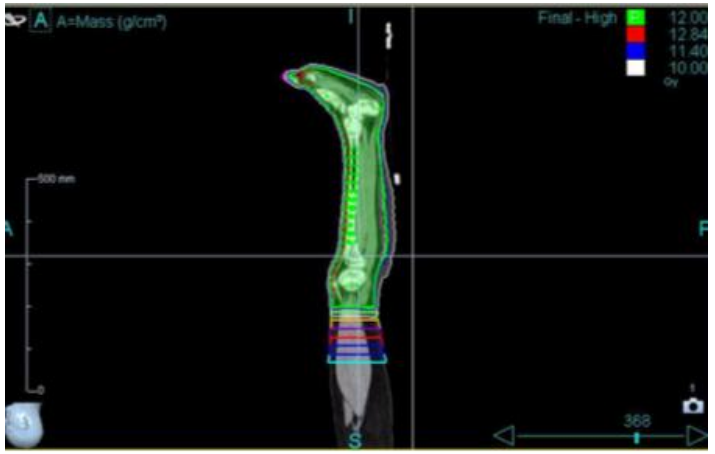
Structure	Target value	Acceptable value
Forehead	D98% >11.4 Gy D2% <13 Gy	D95% >11.4 Gy D5% <13 Gy
Lenses	As low as achievable	

220 pacientes con 135 planificados en Tomo. 2021

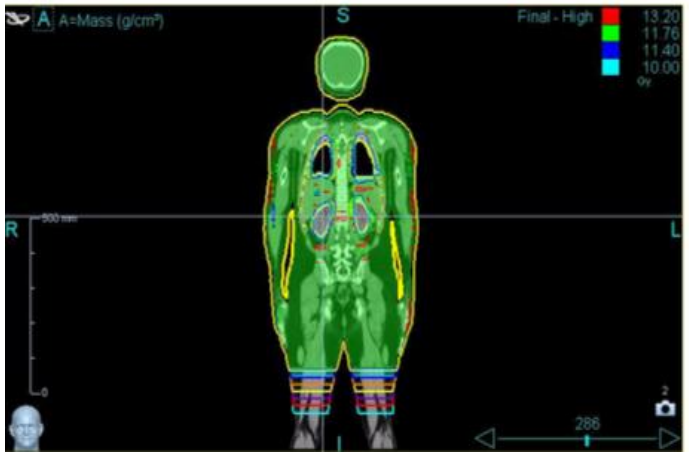
Del módulo de planificación al módulo de fusión: PreciseRTX

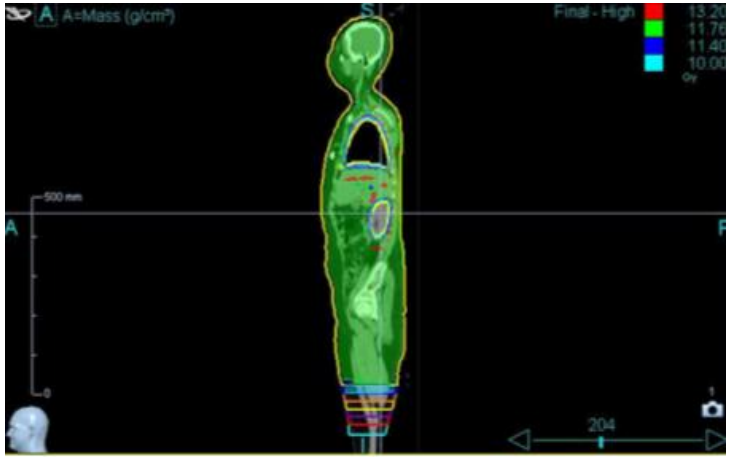






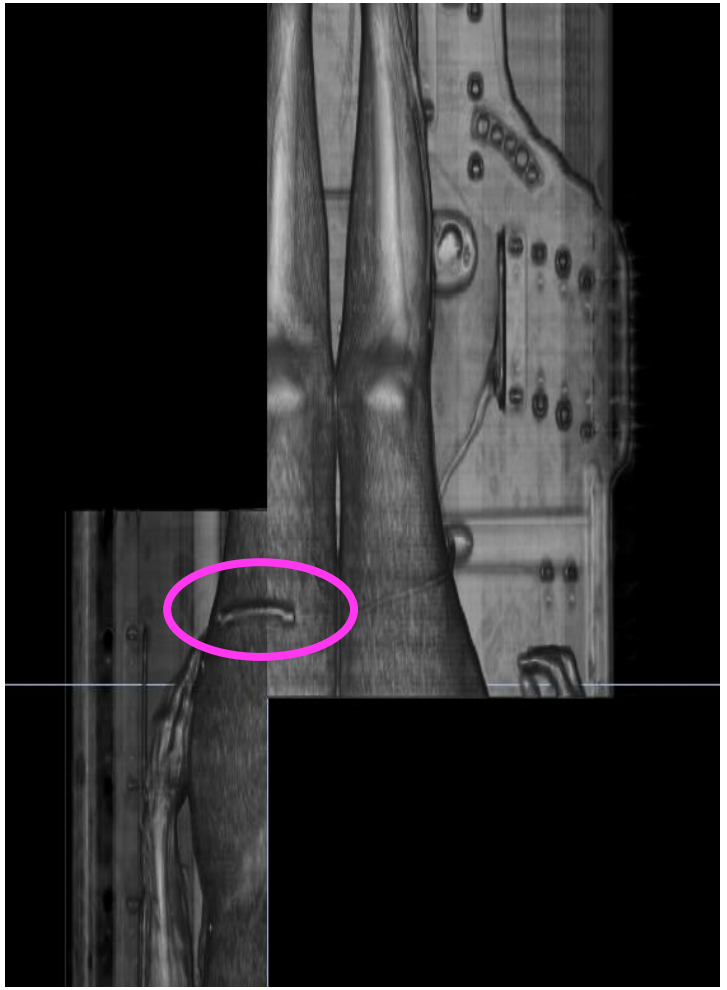




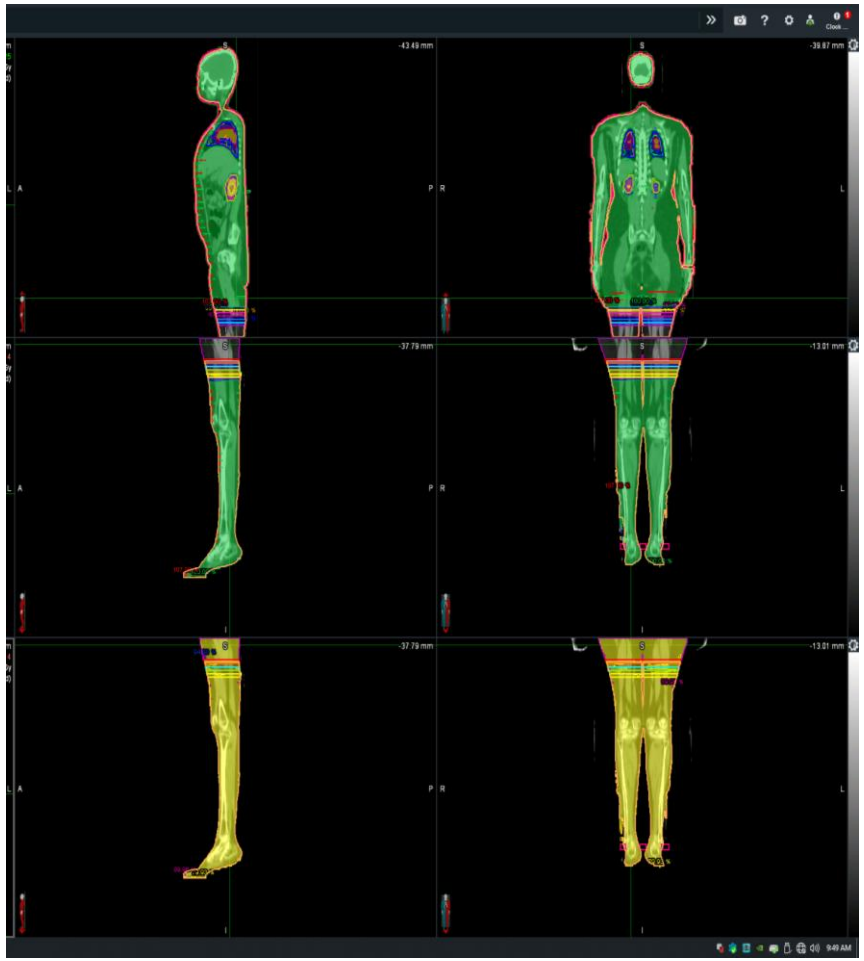


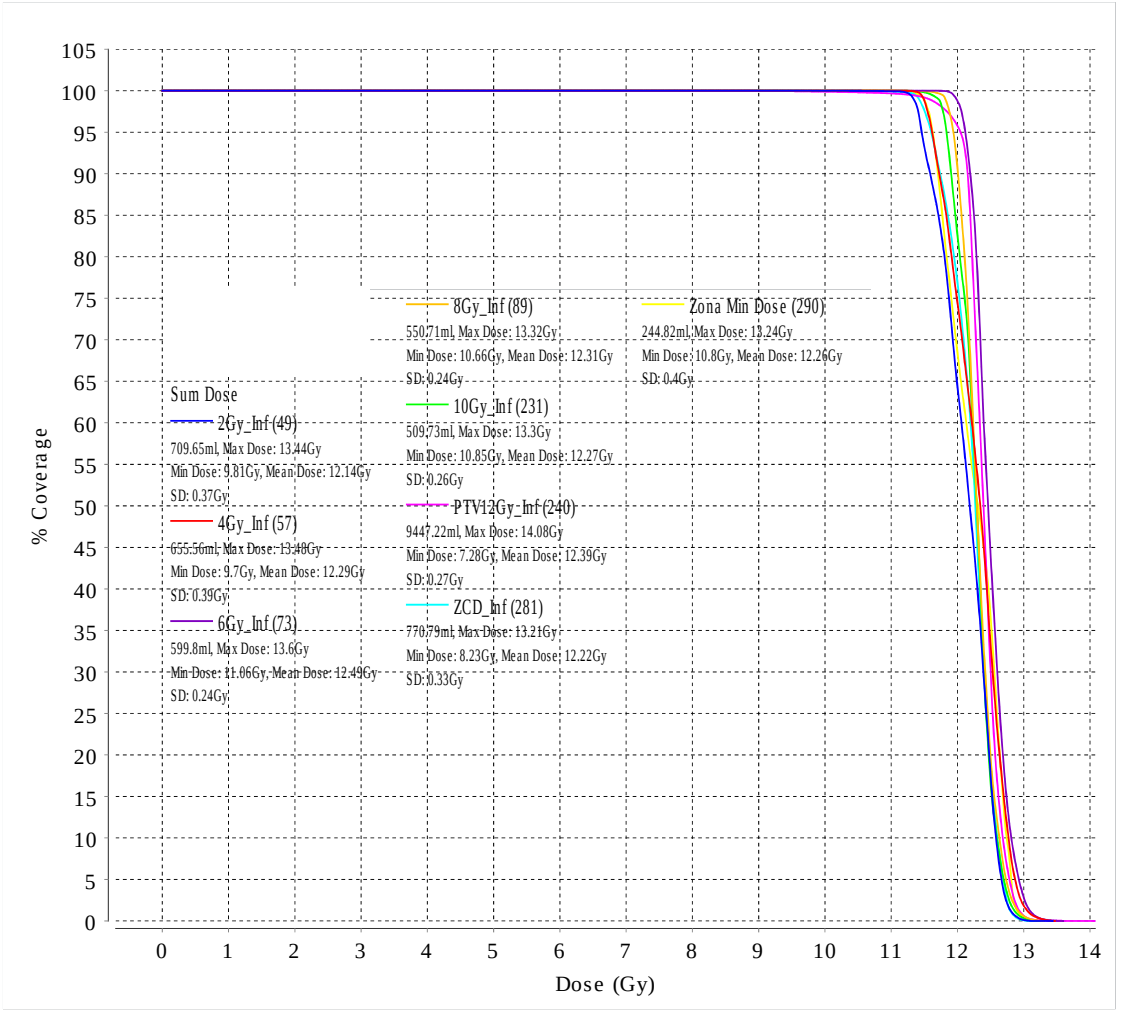
PreciseRTX: Fusión rígida / Fusión deformada





"Suma de dosis" con *PreciseRTX. Utilidad*



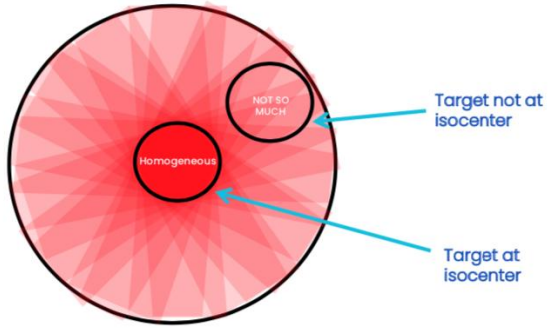


Thread effect_2005/2011

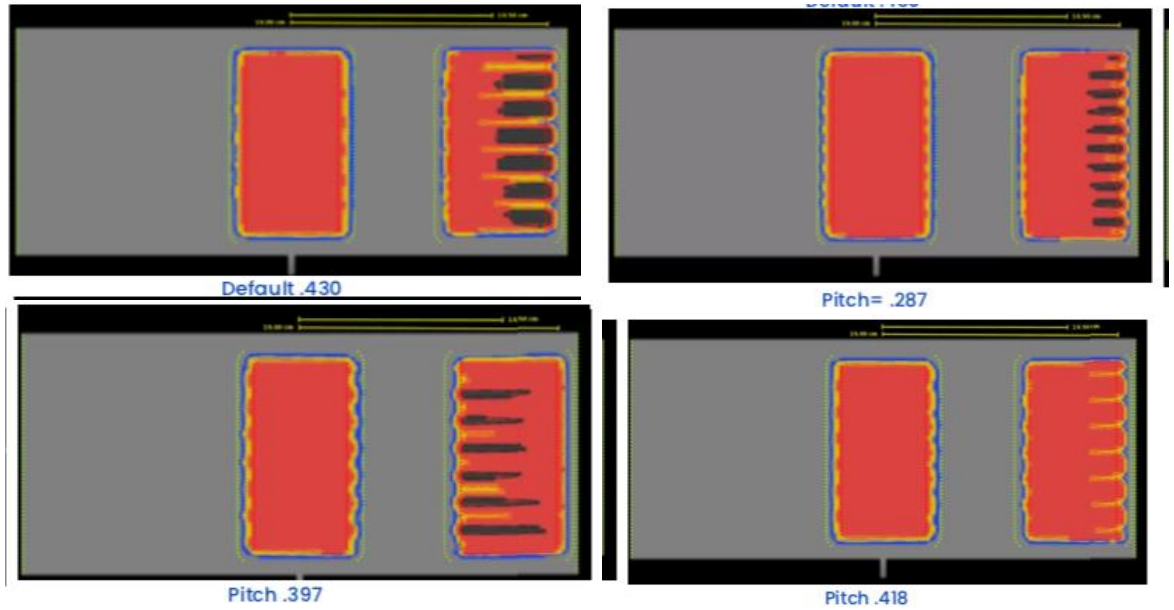
Pitch Selection – Effect on Dose Homogeneity

Radixact®

- Optimal pitches will vary depending on the plan field width and target axial offset from the isocenter.



For illustrative purposes only, diagram uses a limited number of projections and does not account for couch and/or MLC movement



> Med Phys. 2005 May;32(5):1414-23. doi: 10.1118/1.1896453.

The helical tomotherapy thread effect

M W Kissick [1], J Fenwick, J A James, R Jeraj, J M Kapatoes, H Keller, T R Mackie, G Olivera, E T Soisson

Affiliations + expand

PMID: 15984692 DOI: 10.1118/1.1896453

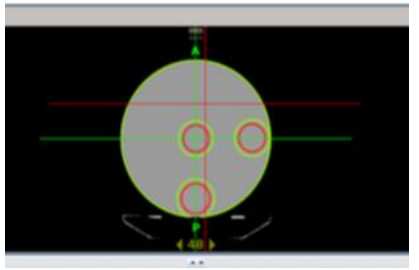
> Med Phys. 2011 Nov;38(11):5945-60. doi: 10.1118/1.3644842.

Theoretical analysis of the thread effect in helical TomoTherapy

Mingli Chen [1], Yu Chen, Quan Chen, Weiguo Lu

Affiliations + expand

PMID: 22047359 DOI: 10.1118/1.3644842



En nuestro caso

TABLE II. An example of optimal pitches from Fig. 9. For each of the four largest five optimal pitches for four different jaw profiles: square (square (real profile 1.05 cm), respectively.

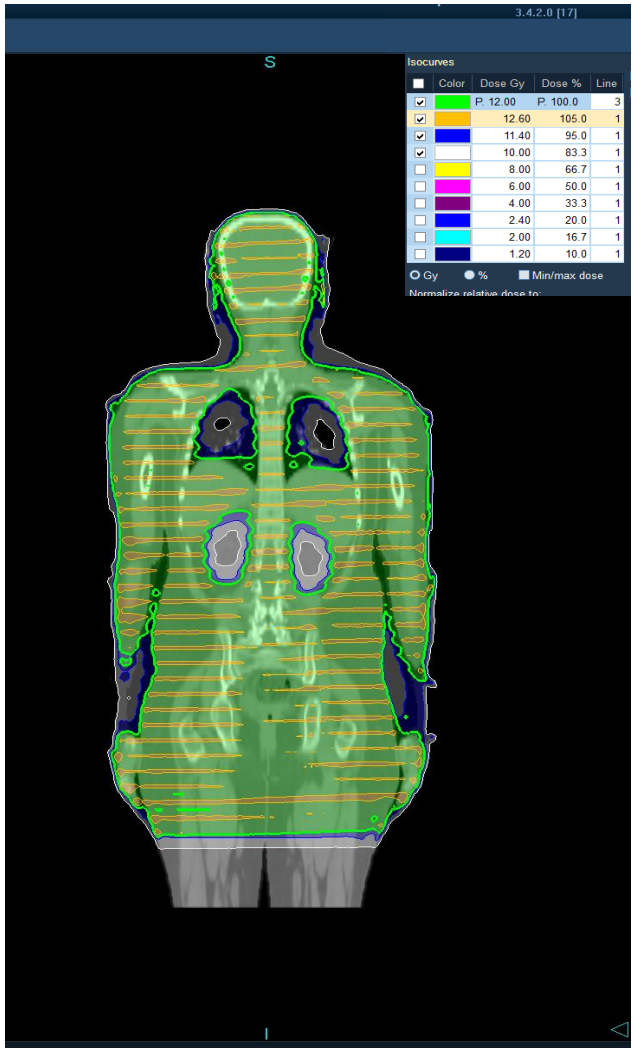
1.0 - 3.0 Gy per fraction

Off axis: 5 cm				Off axis: 10 cm				Off axis: 15 cm				Off axis: 20 cm			
Square	5.02 cm	2.5 cm	1.05 cm	Square	5.02 cm	2.5 cm	1.05 cm	Square	5.02 cm	2.5 cm	1.05 cm	Square	5.02 cm	2.5 cm	1.05 cm
0.438	0.4440	0.446	—	0.4230	0.4330	0.436	—	0.4060	0.4180	0.420	—	0.3870	0.3970	0.397	—
0.227	0.2310	0.233	—	0.2210	0.2250	0.225	—	0.2110	0.2150	0.212	—	0.1960	0.2000	0.197	—
0.184	0.1870	—	—	0.1790	0.1820	—	—	0.1690	0.1720	—	—	0.1560	0.1590	—	—

Medical Physics, Vol. 38, No. 11, November 2011

Dx Vx Values

DVH	Dose (Gy)	Dose (% of 12.00 Gy Rx Dose)	Volume (cm³)	Volume (%)	Criteria	Value	
PTV12Gy_Sup	11.76	**98.0**	45644.83	96.2	Volume (%) > 95.0	96.2	✓
PTV12Gy_Sup	11.40	**95.0**	46447.36	97.9	Volume (%) > 95.0	97.9	✓
PTV12Gy_Sup	**13.00**	108.3	973.26	2.1	Volume (%) < 5.0	2.1	✓
PTV12Gy_Sup	13.20	**110.0**	336.59	0.7	Volume (%) < 2.0	0.7	✓
PTV12Gy_Sup	14.40	**120.0**	0.47	0.0	Volume (%) < 1.0	0.0	✓
PTV12Gy_Sup	12.38	103.2	23726.50	**50.0**			





Repercusión en el tiempo de tratamiento

HF

Field Width (cm):	5.0, Dynamic	Red Lasers Offset (IECf, mm):	X: 3.07 Y: 164.97 Z: 3.65
Pitch:	0.397	Couch Travel (mm):	1109.2
Modulation Factor / Actual:	3.000 / 2.6	Couch Speed (mm/sec):	0.9
Sinogram Segments:	18.2	Gantry Period (sec):	21.7
Beam On Time (sec):	1202.0	Gantry Rotations:	54.7

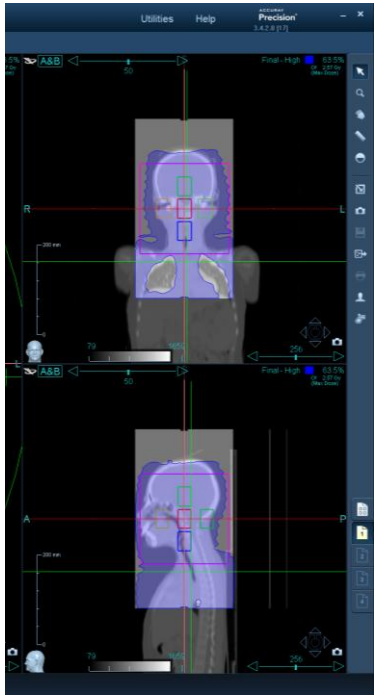
FF

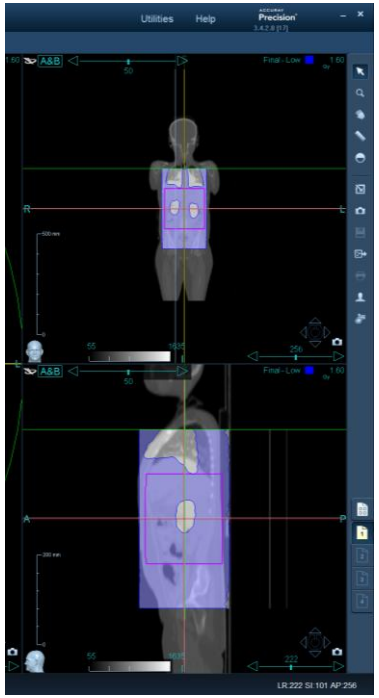
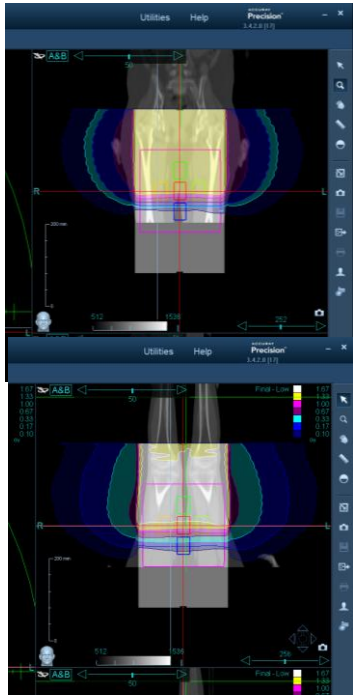
Field Width (cm):	5.0, Dynamic	Red Lasers Offset (IECf, mm):	X: 0.00 Y: 104.31 Z: 15.66
Pitch:	0.397	Couch Travel (mm):	761.3
Modulation Factor / Actual:	2.000 / 1.8	Couch Speed (mm/sec):	1.6
Sinogram Segments:	12.0	Gantry Period (sec):	12.2
Beam On Time (sec):	463.8	Gantry Rotations:	36.1

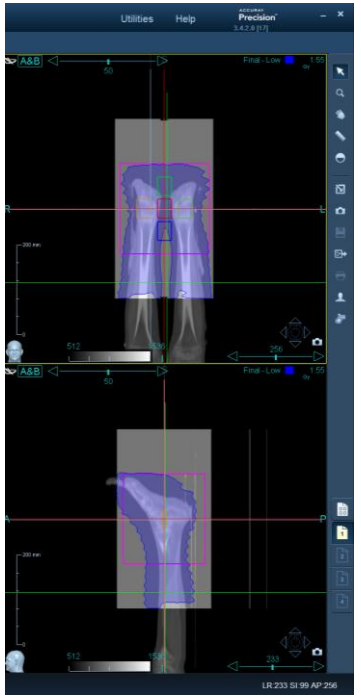
Poco más de **20min** para tratar la parte superior y **8min** para la inferior.

El tiempo de adquisición cada kVCT no es superior a **1.5min**

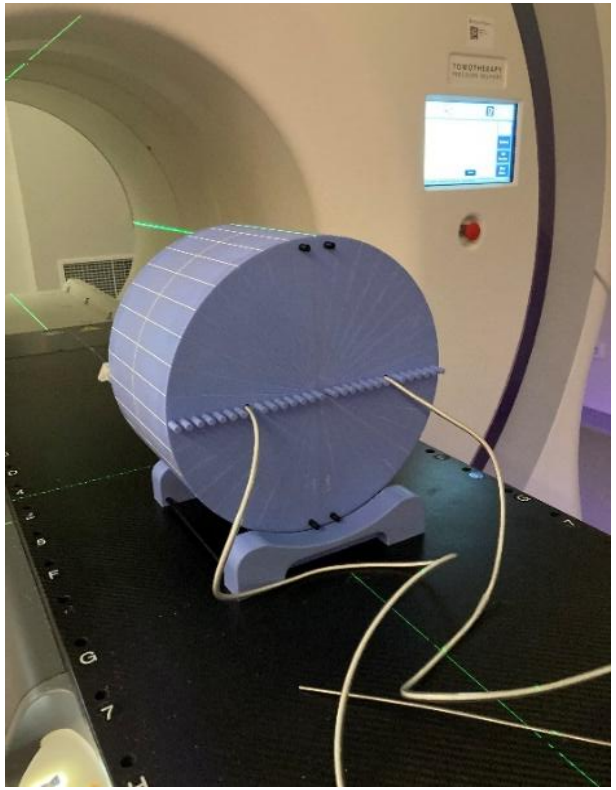
Medidas planares con Delta4 de las distribuciones a lo largo de todo el cuerpo



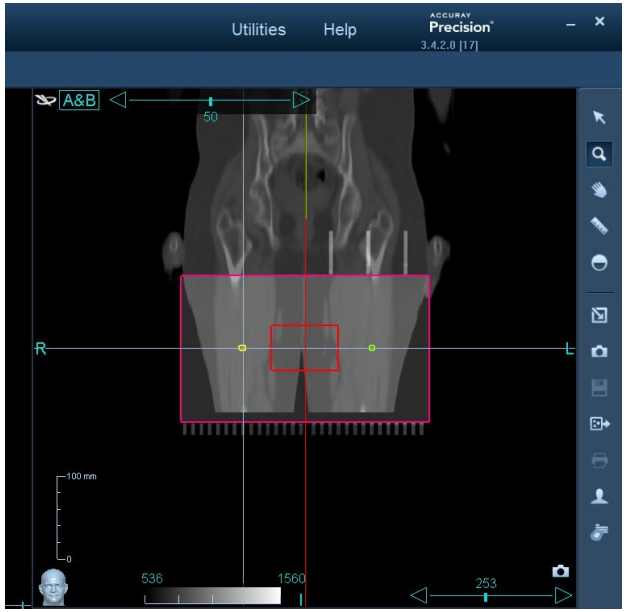





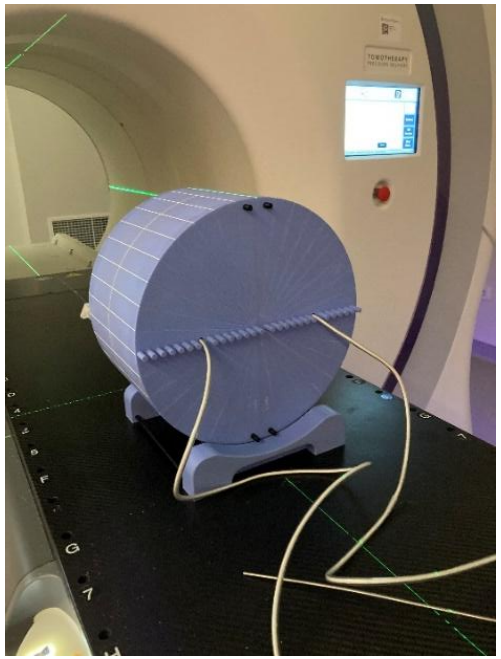
Medidas de dosis absoluta en ambas piernas y en cada escalón







Medidas de dosis absoluta en ambas piernas y en cada escalón. Diferencias < 5%



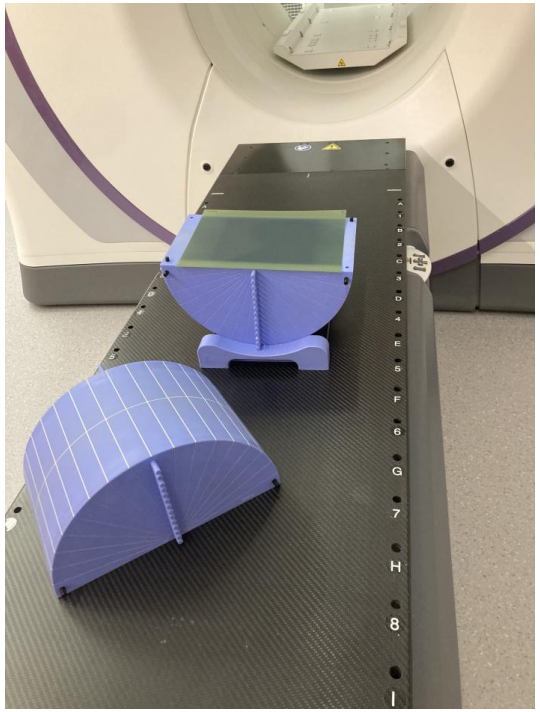
ID	Marca	Modelo	N/S	Kelec (Q)
1	Standard Im	Tomoelectrom		0,998

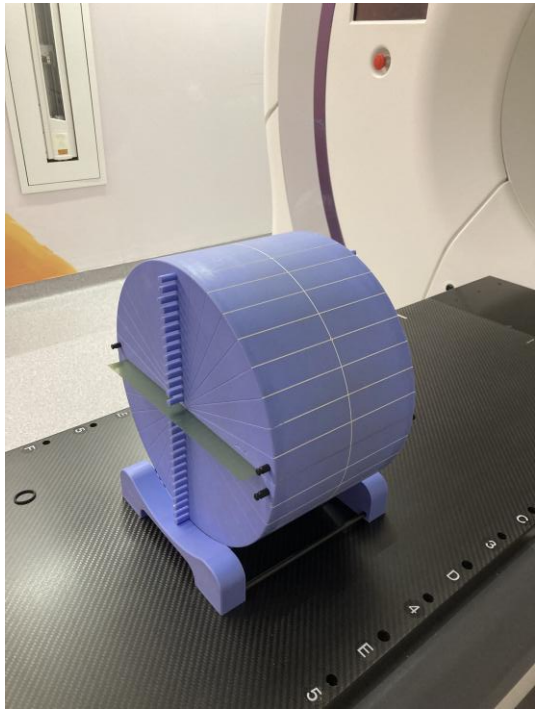
1	Standard Im	Exradin A1SL	XW233457	5,81E-01	1,0043	1	0,9988	0,58289841	
2	Standard Im	Exradin A1SL	XW233452	5,58E-01	1,0043	1	0,9988	0,55992754	

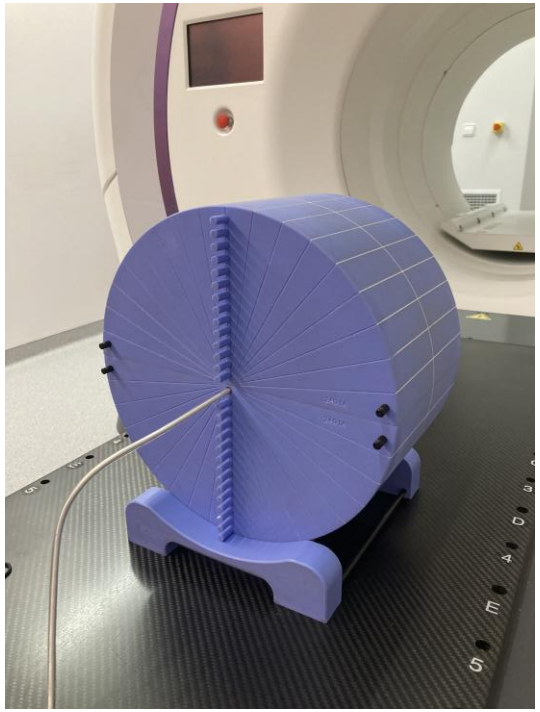
Planificación Cabeza-Pies (HF)				Medida a +8cm			Medida a -7,5cm		
		Temp	Presion	nC	Cámara	D (Gy)	nC	Cámara	D (Gy)
Zona de 10Gy de la unión	-580	20,8	762,5	2,42	1	1,397	2,60	2	1,442
Zona de 8Gy de la unión	-590	20,8	762,5	1,98	1	1,143	1,97	2	1,093
Zona de 6Gy de la unión	-600	20,8	762,5	1,39	1	0,803	1,55	2	0,860
Zona de 4Gy de la unión	-610	20,9	762,3	0,99	1	0,570	0,91	2	0,507
Zona de 2Gy de la unión	-620	20,8	761,9	0,51	1	0,292	0,57	2	0,318

Planificación Pies-Cabeza (FF)				Medida a +7,5cm			Medida a -8cm		
		Temp	Presion	nC	Cámara	D (Gy)	nC	Cámara	D (Gy)
Zona de 2Gy de la unión	-353	20,9	761	0,54	2	0,300	0,57	1	0,330
Zona de 4Gy de la unión	-343	20,9	761	0,9	2	0,500	0,88	1	0,509
Zona de 6Gy de la unión	-333	20,9	761	1,45	2	0,806	1,47	1	0,851
Zona de 8Gy de la unión	-323	21,3	762	1,99	2	1,106	2,02	1	1,169
Zona de 10Gy de la unión	-313	20,9	761	2,56	2	1,423	2,42	1	1,401

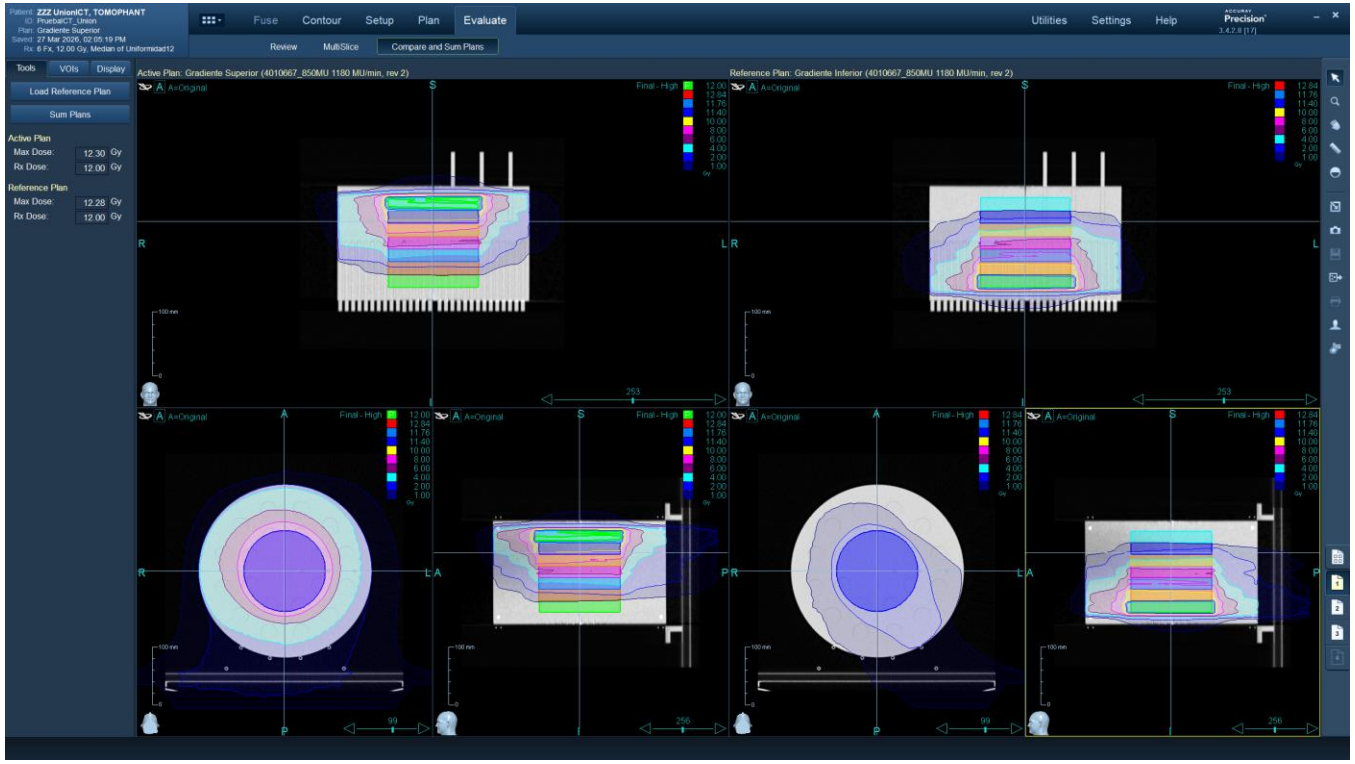
Evaluación de la uniformidad y robustez de nuestra unión

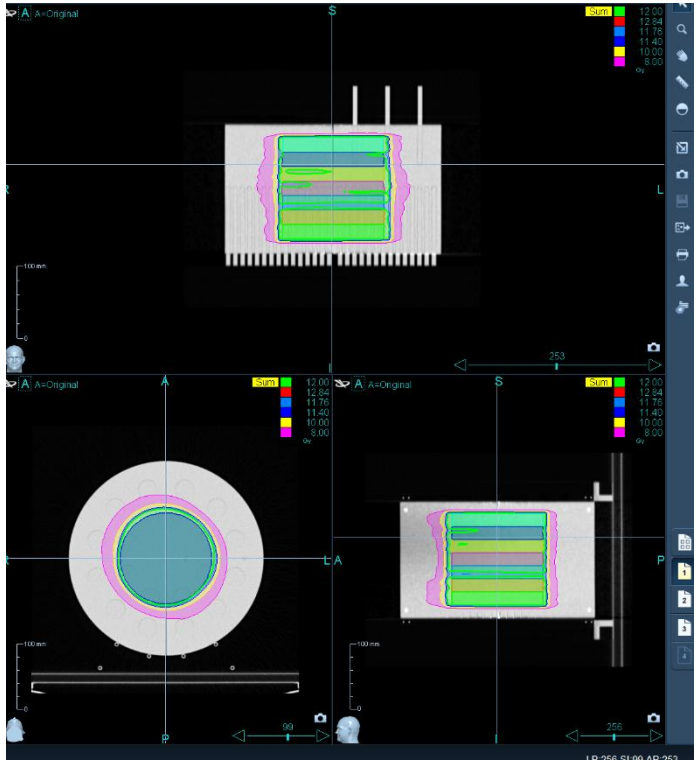




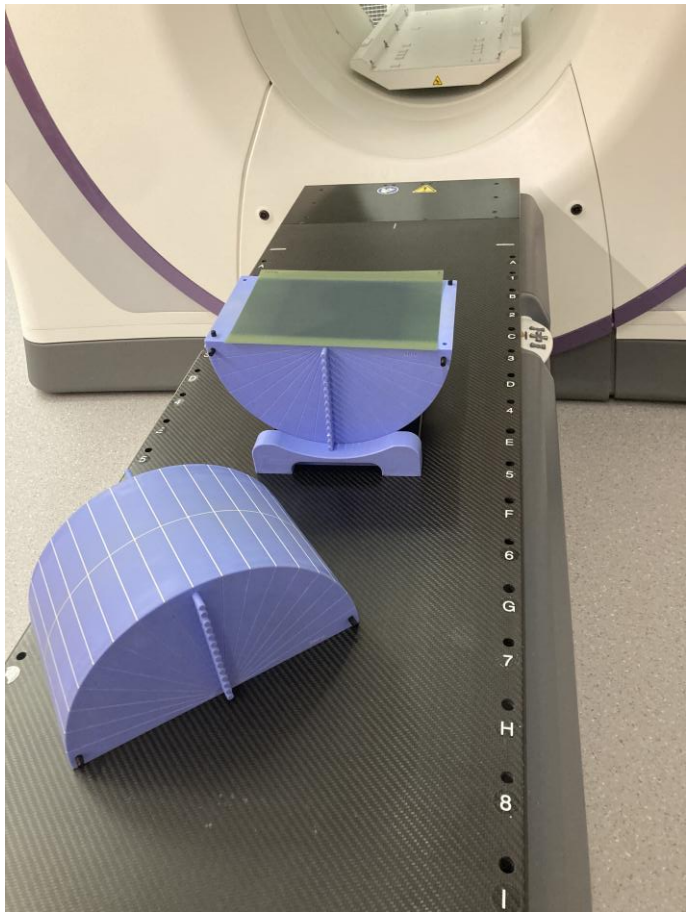


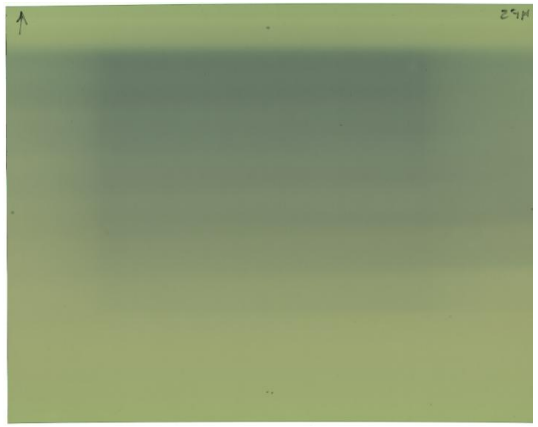
Un "paciente" con la misma geometría que nuestro maniquí !



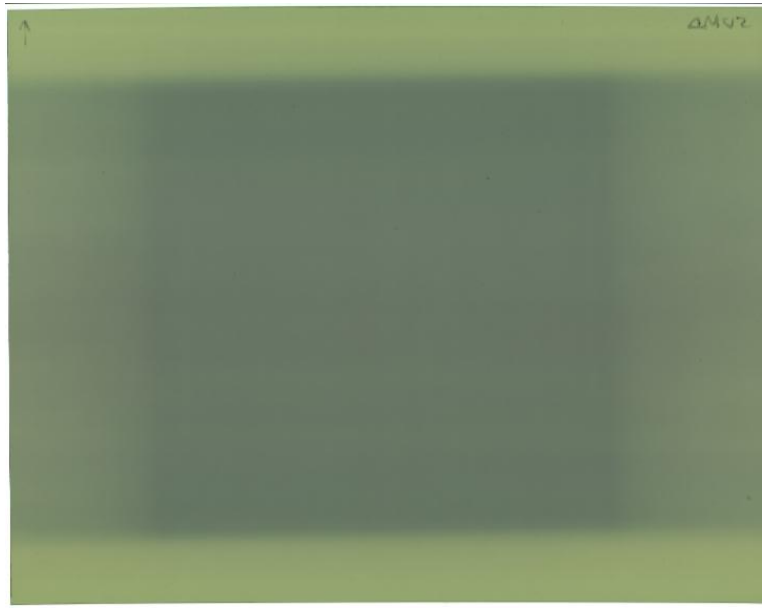


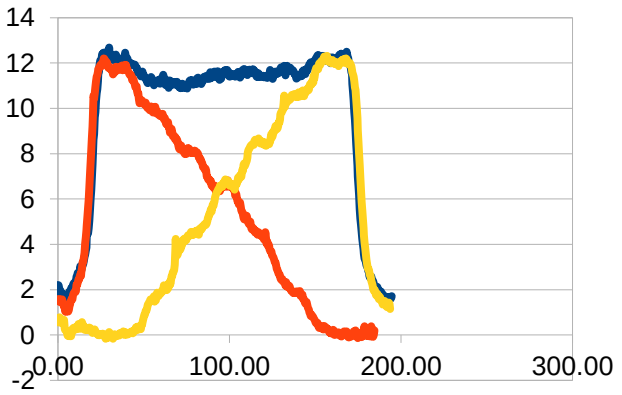
Variación del perfil dentro del 5% DP



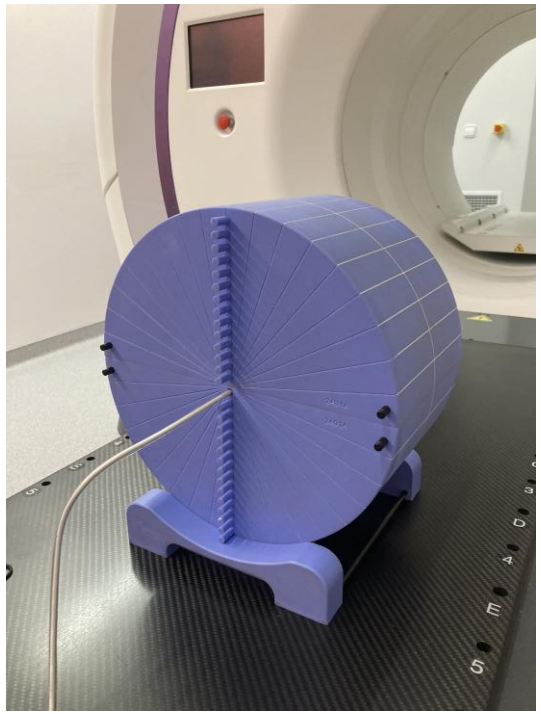


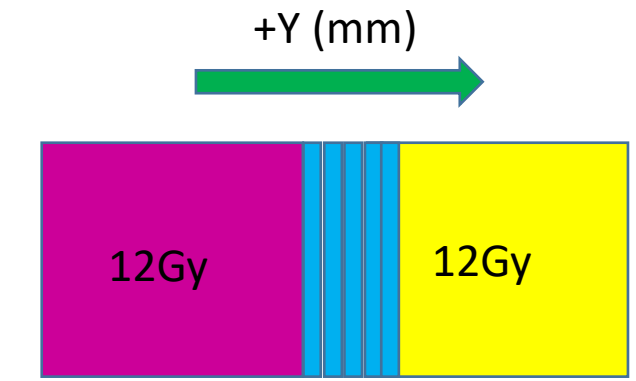


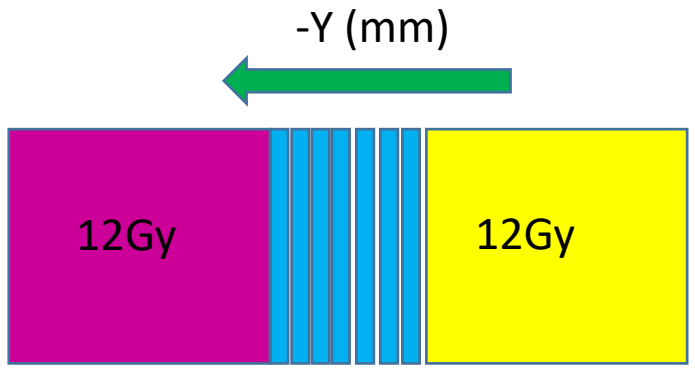


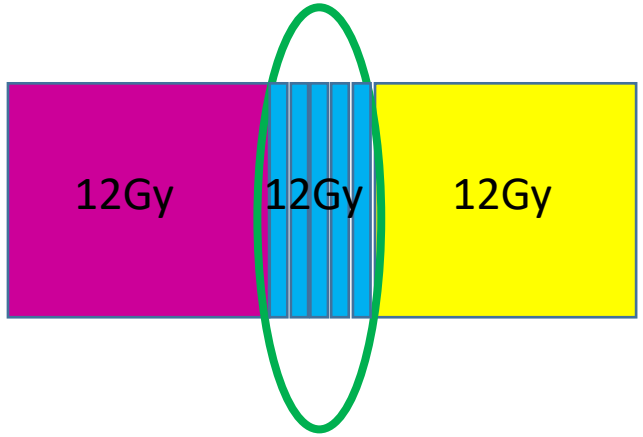


Simulamos errores de posicionamiento de 5mm en sentido longitudinal









+5mm	2,083	1,18 %	1 %
+10mm	2,240	8,78 %	9 %
+15mm	2,367	14,96 %	15 %
+20mm	2,377	15,45 %	15 %
-5mm	2,036	-1,12 %	-1 %
-10mm	1,903	-7,58 %	-8 %
-15mm	1,771	-14,02 %	-14 %
-20mm	1,713	-16,83 %	-17 %


https://www.bañosarabesjaen.es/work/manuel-moral/
Muchas gracias
Gracias a nuestras compañeras Ruth Romero y Patricia Sánchez del Puerta del Hierro (Madrid) y a Delphine Rebullida (de Accuray).

Parador de Antequera

JORNADAS SARH

Nuevas Técnicas y Retos de los Sistemas de Planificación de Tratamientos de Radioterapia

Antequera, 23 de octubre 2026



SOCIEDAD ANDALUZA DE RADIOFÍSICA HOSPITALARIA

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