

Radioterapia de Intensidad Modulada IMRT con colimador multiláminas

Curso de Actualización en Protección Radiológica

Córdoba, 7 al 9 de Abril 2016

Dr. Daniel Venencia, Físico Medico

Instituto de Radioterapia – Fundación Marie Curie

Córdoba, ARGENTINA

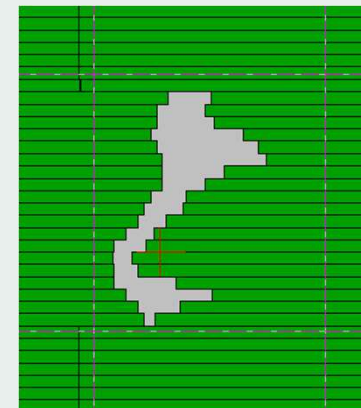


INSTITUTO DE RADIOTERAPIA
FUNDACIÓN MARIE CURIE

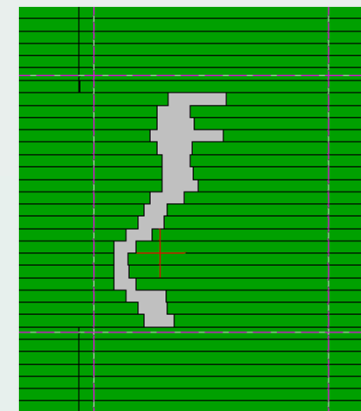
IMRT



- Tratamiento que utiliza haces de radiación de intensidad no uniforme generados a partir de un proceso de optimización con planificación inversa
- IMRT con MLC
 - **Estático** (*Step&Shoot*)
 - entrega de secuencia de posiciones estáticas de MLC
 - **Dinámico** (*Sliding windows*)
 - movimiento continuo de pares de laminas durante la irradiación.



Step & shoot



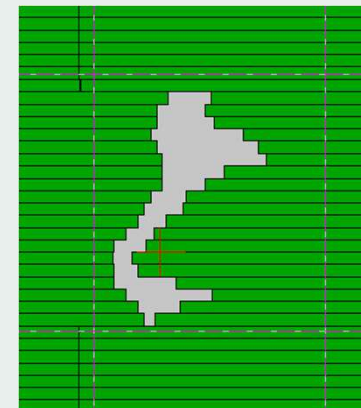
Sliding windows



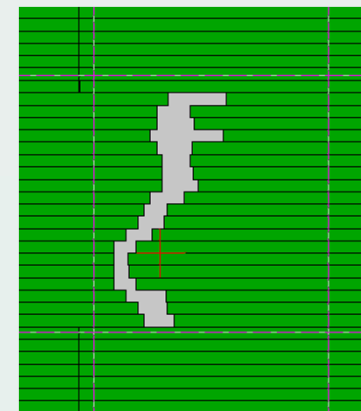
IMRT



- Tratamiento que utiliza haces de radiación de intensidad no uniforme generados a partir de un proceso de optimización con planificación inversa
- Porque es necesario que la intensidad del haz **NO** se uniforme?



Step & shoot

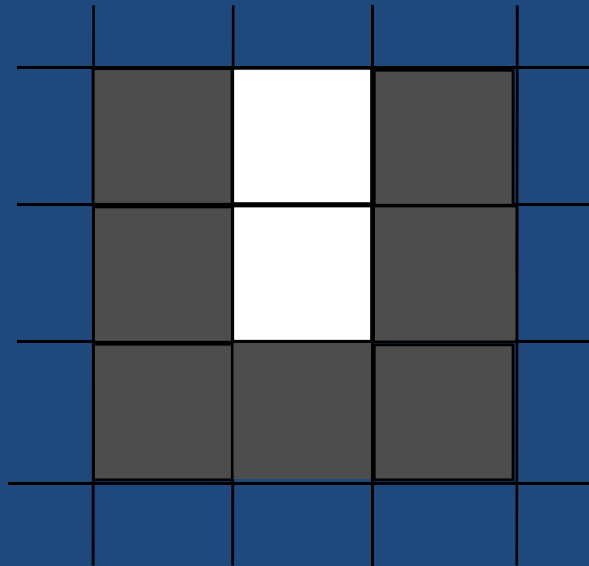


Sliding windows



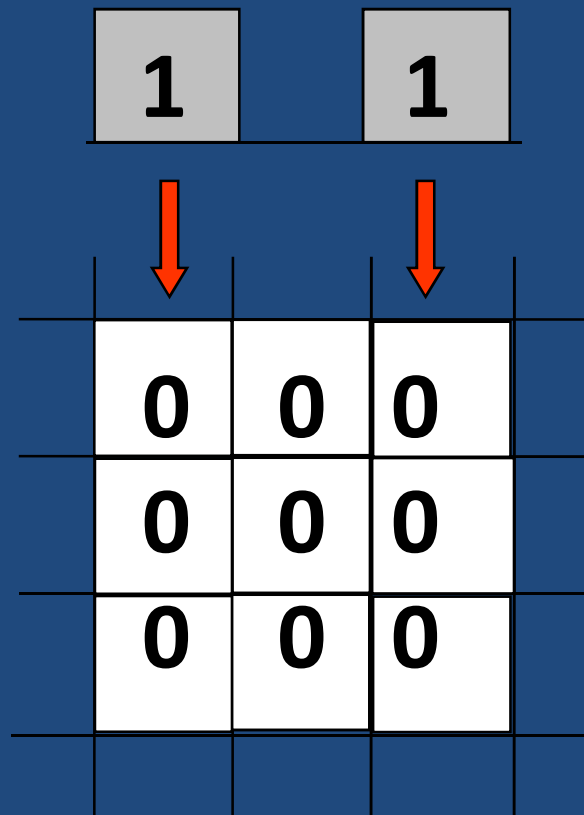
2. Niveles de intensidad

Objetivo :

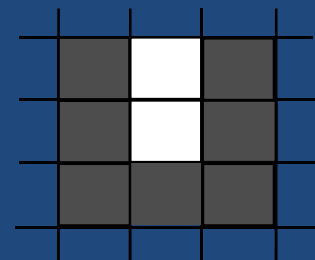


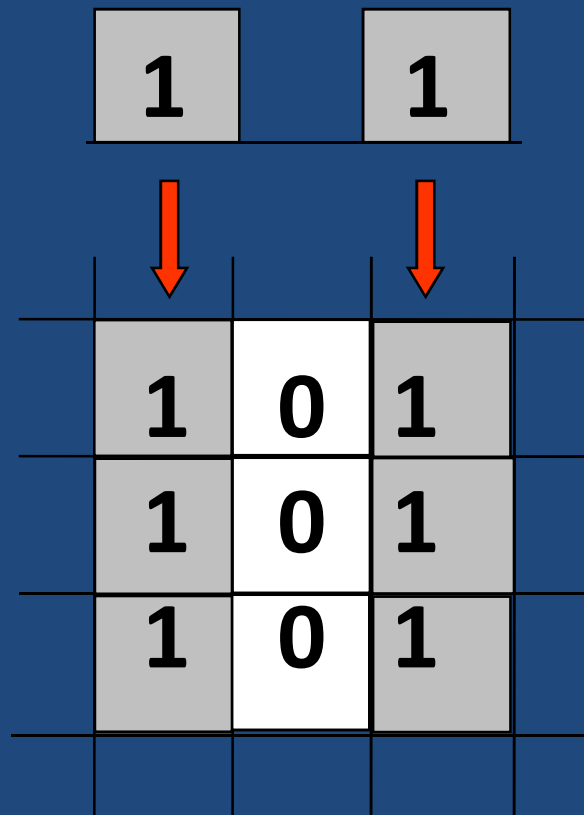
Consideremos:

- Colimación estándar = colimación binaria
- Supongamos que nuestro haz no tiene atenuación.

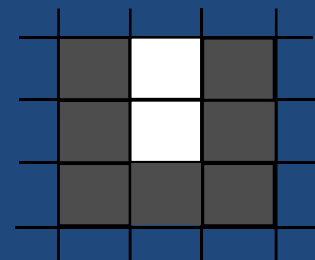


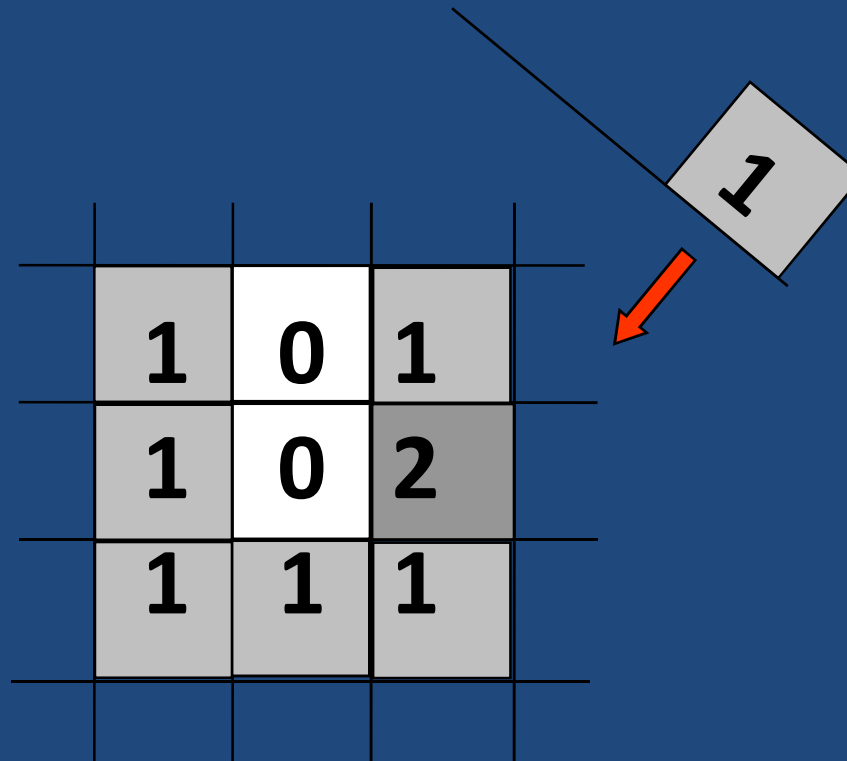
Objetivo :



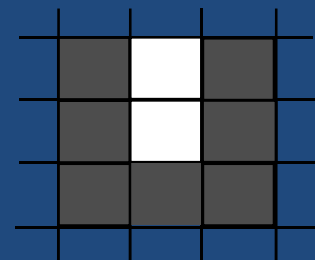


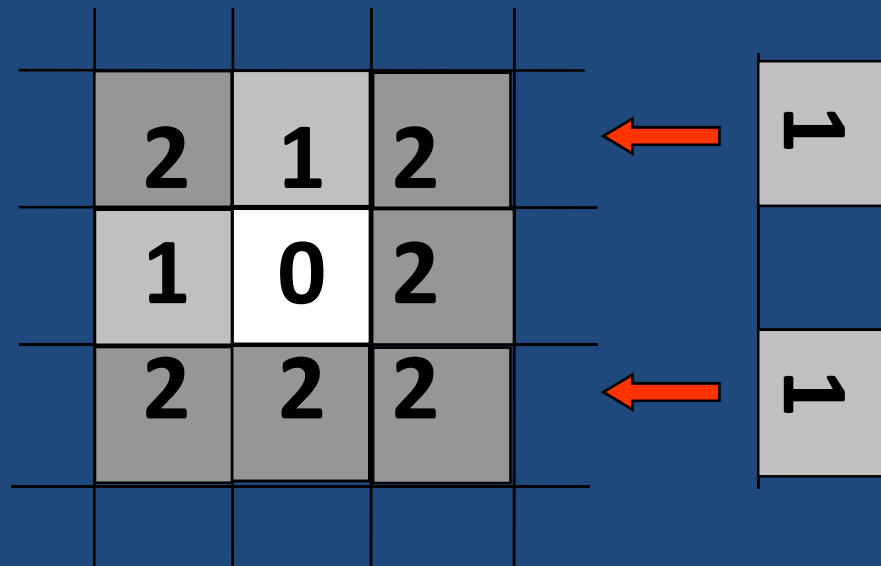
Objetivo :



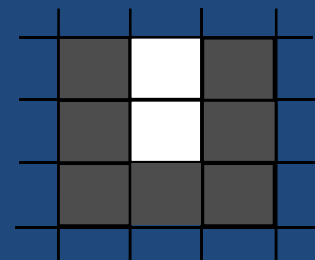


Objetivo :

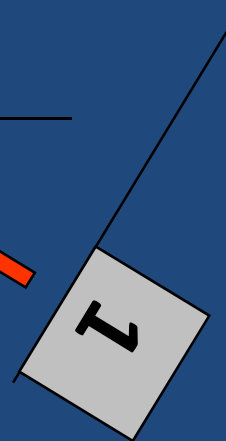




Objetivo :



	2	1	2
	2	0	2
	2	3	2



Objetivo :

	2	1	2
	2	0	2
	2	3	2

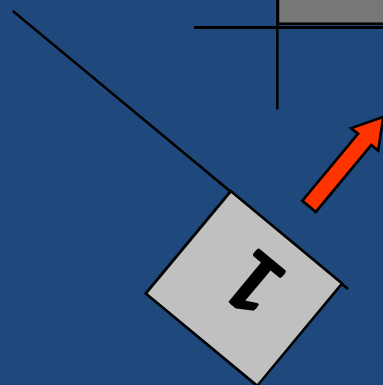
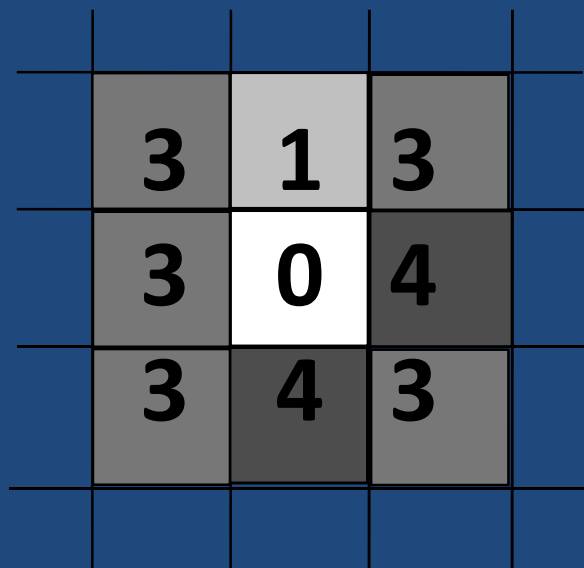
	3	1	3
	3	0	3
	3	3	3



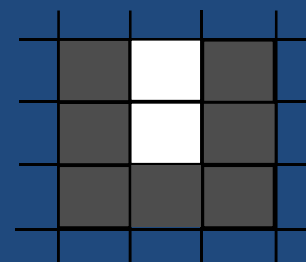
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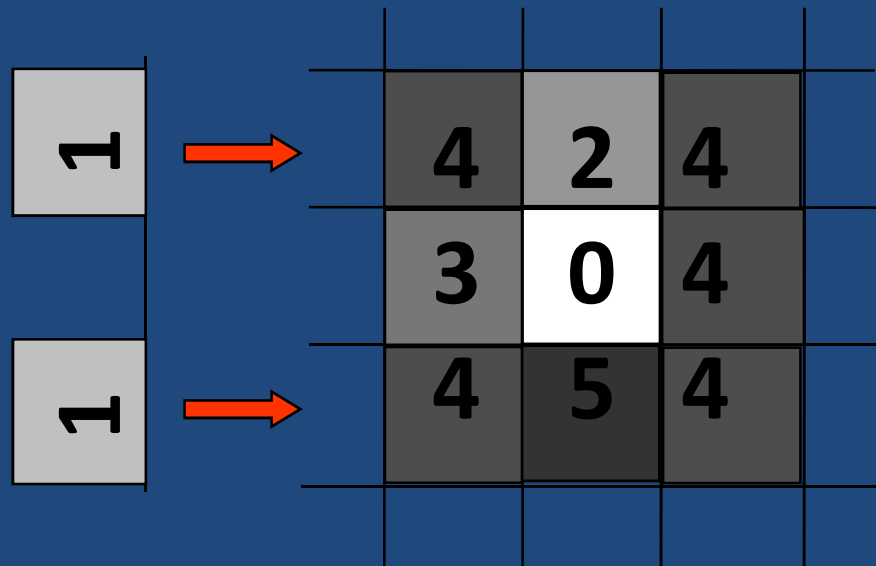
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Objetivo :

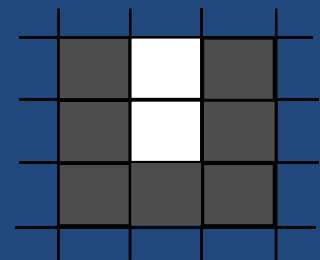


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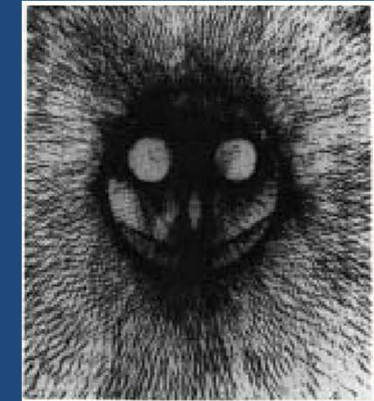
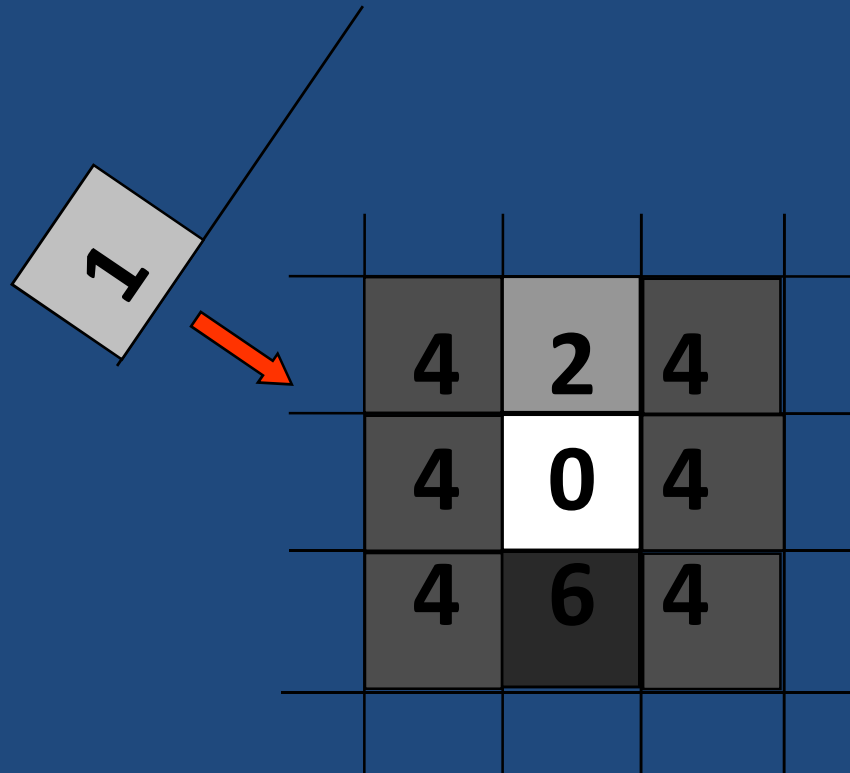




Objetivo :

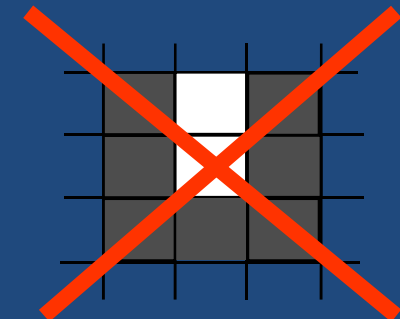


G. Birkhoff 1940, estableció que un dibujo 2D de forma arbitraria podría ser descrito por la superposición de una serie de líneas rectas desde diferentes direcciones y con diferentes niveles de oscuridad. Pero para obtener una solución algunas de las líneas debían tener oscuridad negativa.

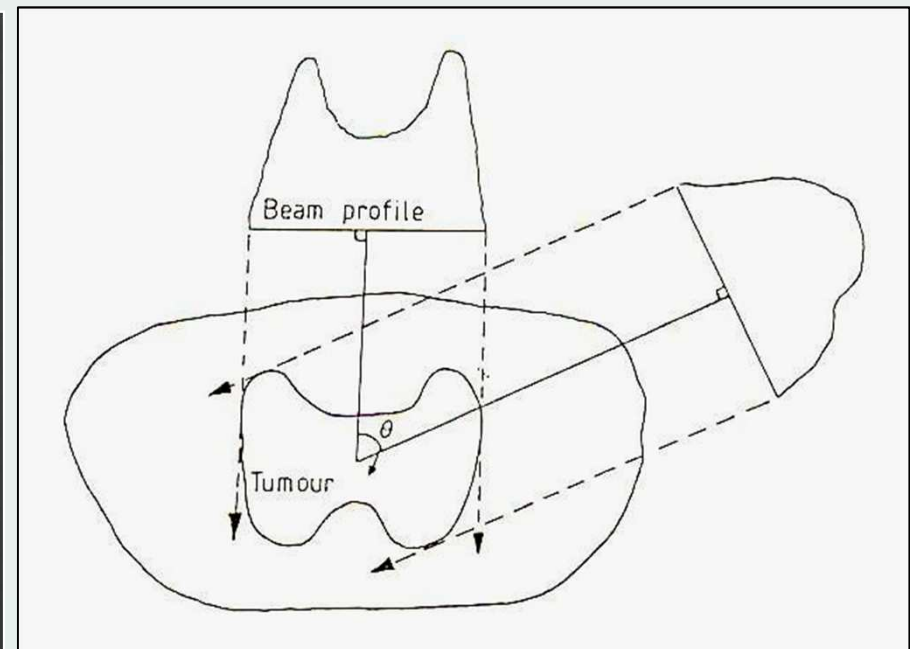
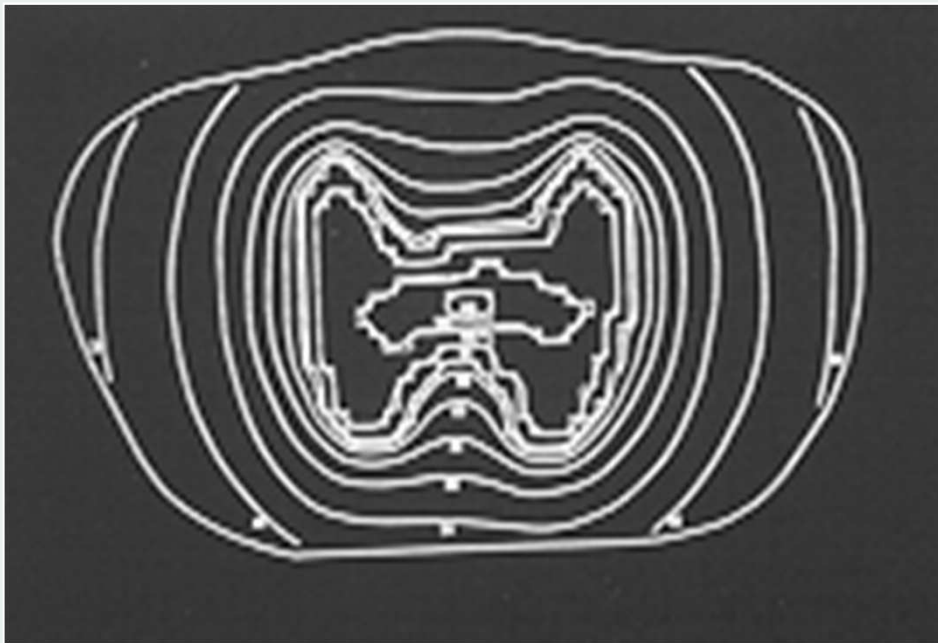


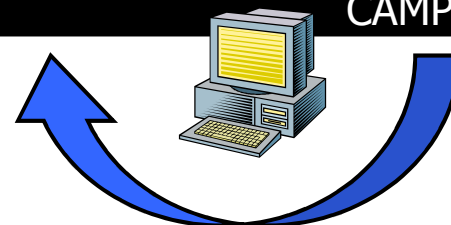
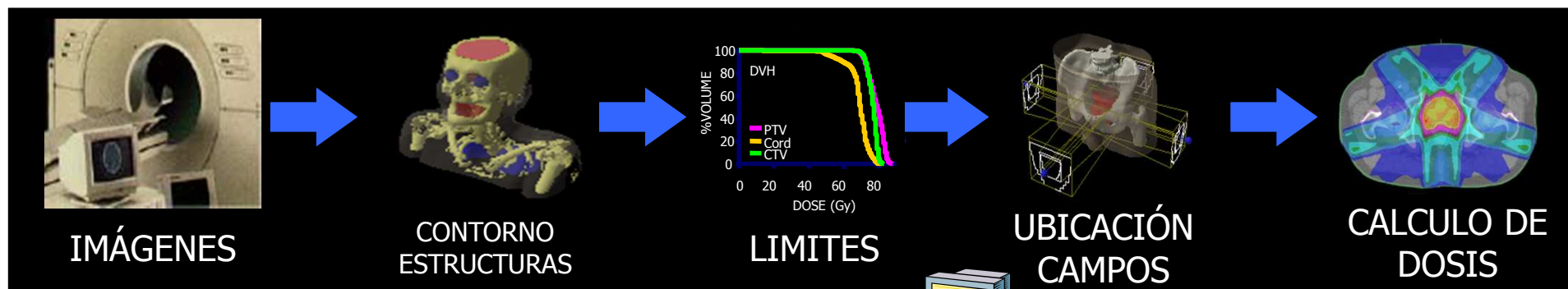
RT no existen niveles negativos y
NO todas las incidencias son posibles!

Objetivo :

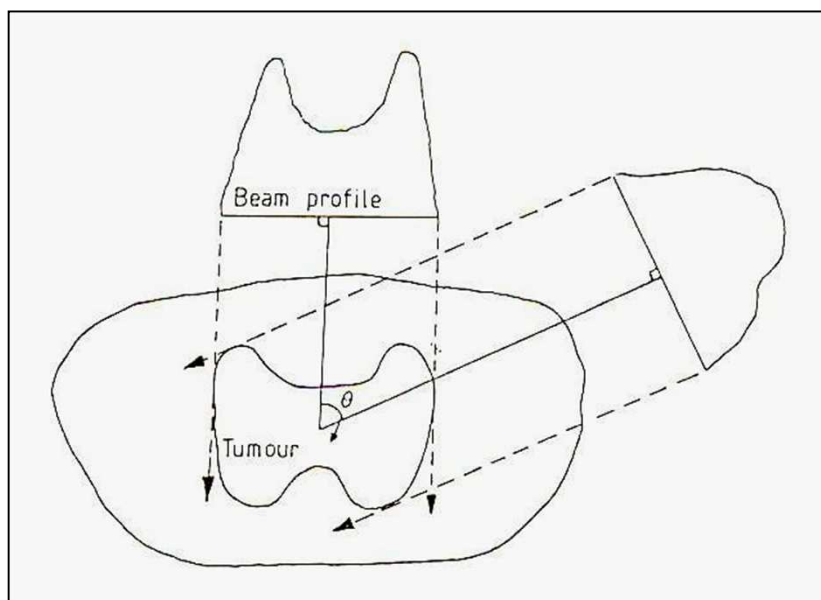


En 1988 Brahme demostró que campos de radiación con intensidad modulada pueden conducir a distribuciones de dosis cóncavas, lo cual podrían proteger mas los tejidos sanos.





OPTIMIZACIÓN
COMPUTADA
(inversa)



Brahme, A. " Optimization of stationary and moving beam radiation therapy techniques", *Radiother. Oncol.* 12:129-140, (1988)

FUNCION OBJETO tipo cuadrática

$$F_{PTV} = \frac{1}{N_t} \left[\sum_{i=1}^{N_t} (D_i - D_{presc})^2 + w_{t,min} \cdot \sum_{i=1}^{N_t} (D_i - D_{min})^2 + w_{t,max} \cdot \sum_{i=1}^{N_t} (D_i - D_{max})^2 \right]$$

Suma sobre todos los elementos de volumen (voxel)

donde

PTV

volumen blanco de planificación

N_t

es el numero de puntos en el volumen de tratamiento.

D_i

es la dosis en el voxel i como función de la intensidad del elemento del haz

D_{presc}

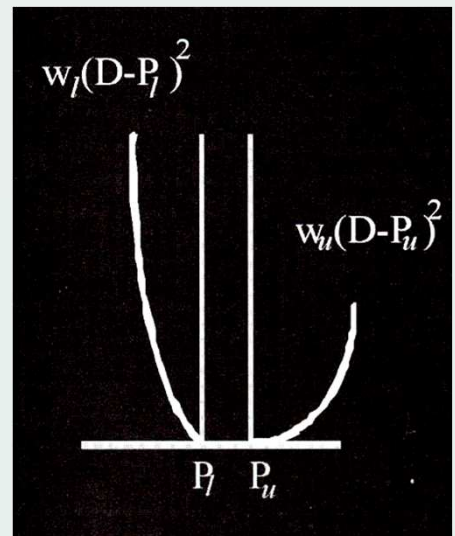
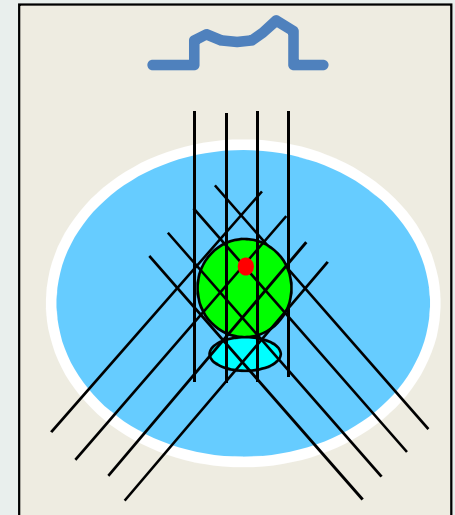
es la dosis prescripta.

D_{min} y D_{max}

son las dosis de tolerancia máxima y mínima.

$w_{t,min}$ y $w_{t,max}$

son penalidades (factores de peso) asociadas a la dosis máxima y mínima.



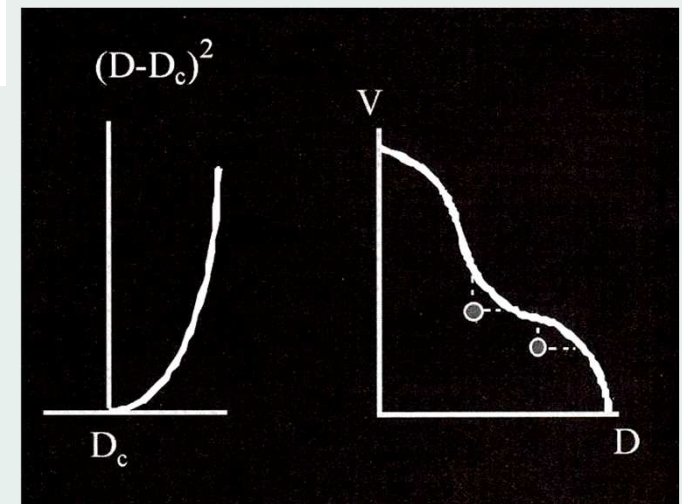
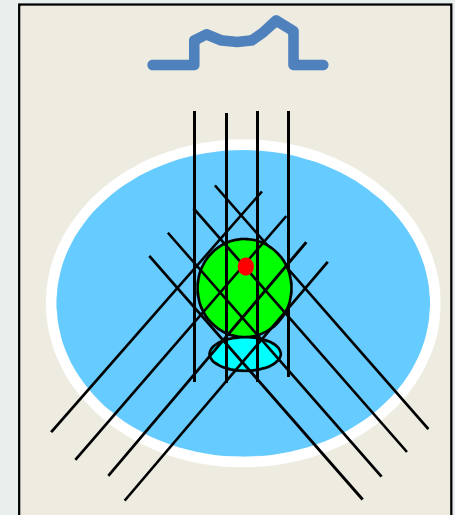
FUNCION OBJETO tipo cuadrática

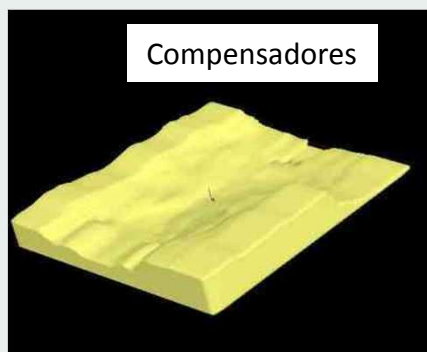
$$F_{OAR} = \frac{1}{N_{OAR}} \left[w_{OAR,max} \cdot \sum_{i=1}^{N_{OAR}} (D_i - D_{max})^2 + w_{OAR,dv} \cdot \sum_{i=1}^{N_{dv}} (D_i - D_{dv})^2 \right]$$

Suma sobre todos los elementos de volumen (voxel)

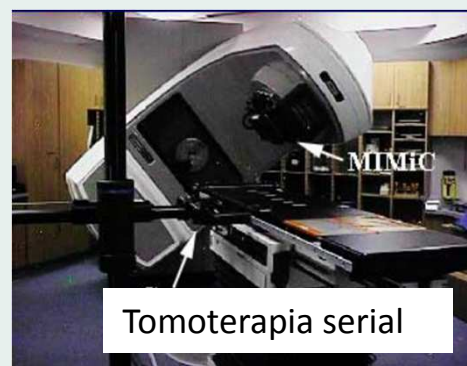
donde	OAR	órgano de riesgo
	N_{OAR}	es el numero de puntos en el órgano de riesgo.
	D_{dv}	dosis de restricción dosis volumen
	N_{dv}	numero de voxels cuya dosis debe estar por debajo de D_{dv}
	$w_{OAR,max}$ y $w_{OAR,dv}$	penalizaciones relativas.

La cobertura del volumen blanco (PTV)
compite con la protección de los organos de
riesgo (OAR)





Tipos de IMRT

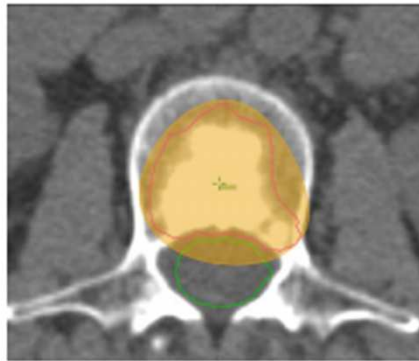


Otros...

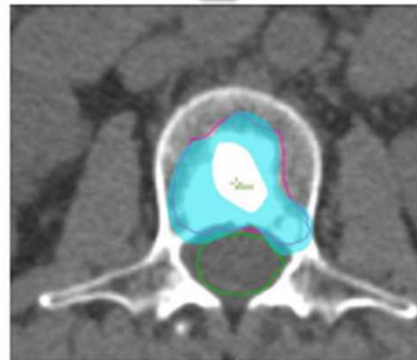
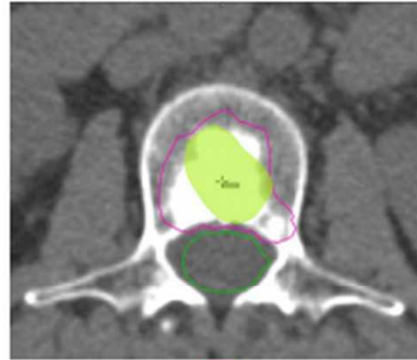
IMRT con MLC



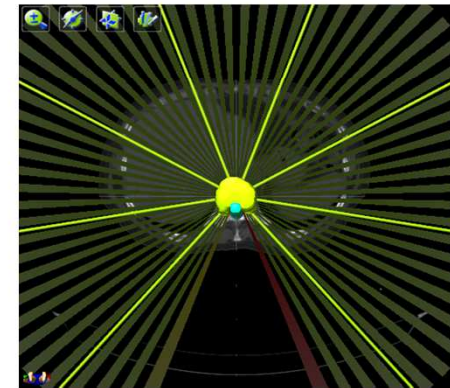
HybridARC con MLC



Standard Dynamic
Conformal Arc



Enhanced Dynamic
Conformal Arc and IMRT



HybridArc

VMAT/RapidARC



Campos CRT3D - IMRT

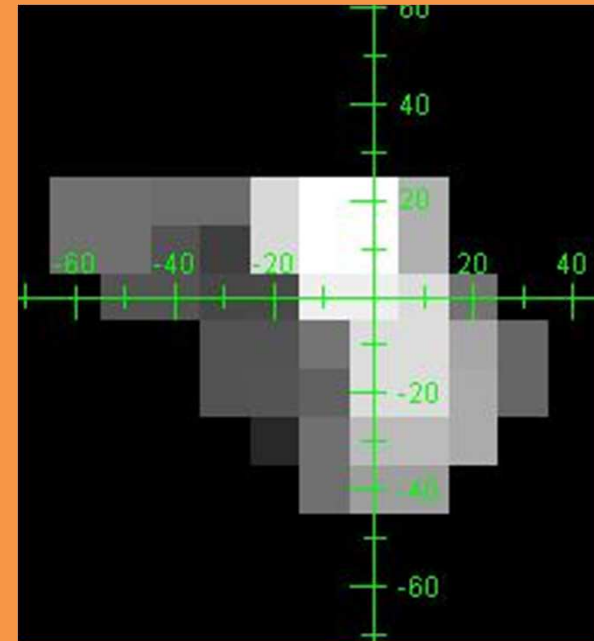
CRT 3D



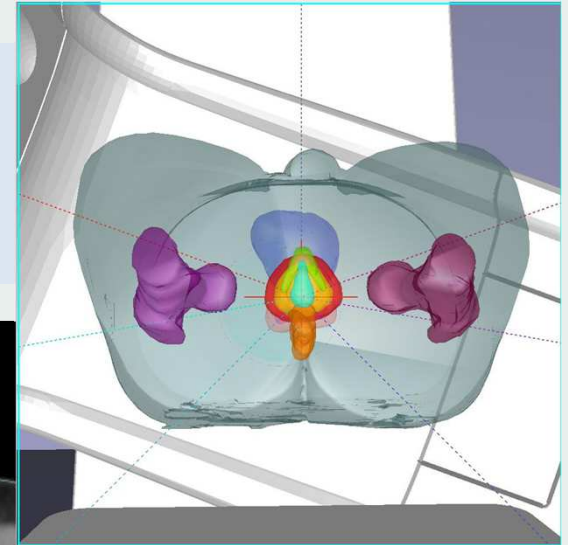
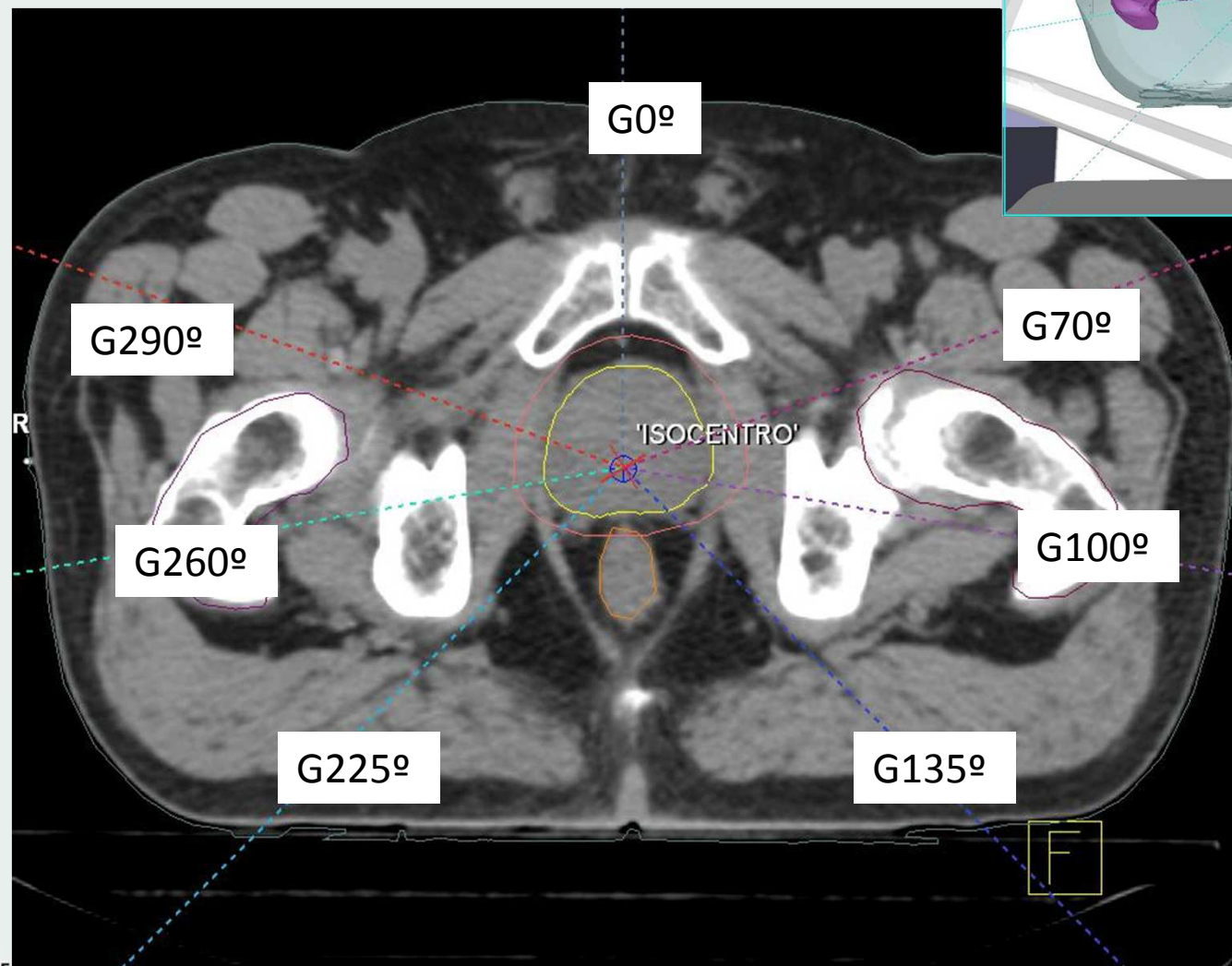
IMRT dinámico



IMRT Secuencial



Campos de tratamiento

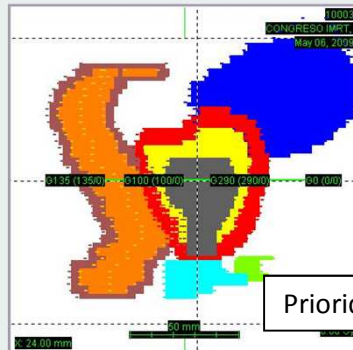
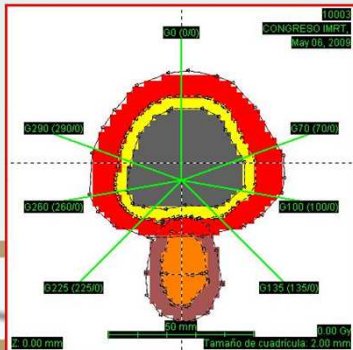


Restricciones Dosis Volumen – Ejemplo

Los valores de dosis pueden variar según criterio medico.

Volumen blanco

- Próstata (CTV₁)
 - D_{mínima} = Dosis prescrita (80Gy)
 - D_{máxima} < 110 % Dosis prescrita
 - N° de fracciones = 40
- PTV
 - D₉₅ = 80Gy
 - D_{máxima} < 110% Dosis prescrita
- D_{máxima} alejado de uretra región central

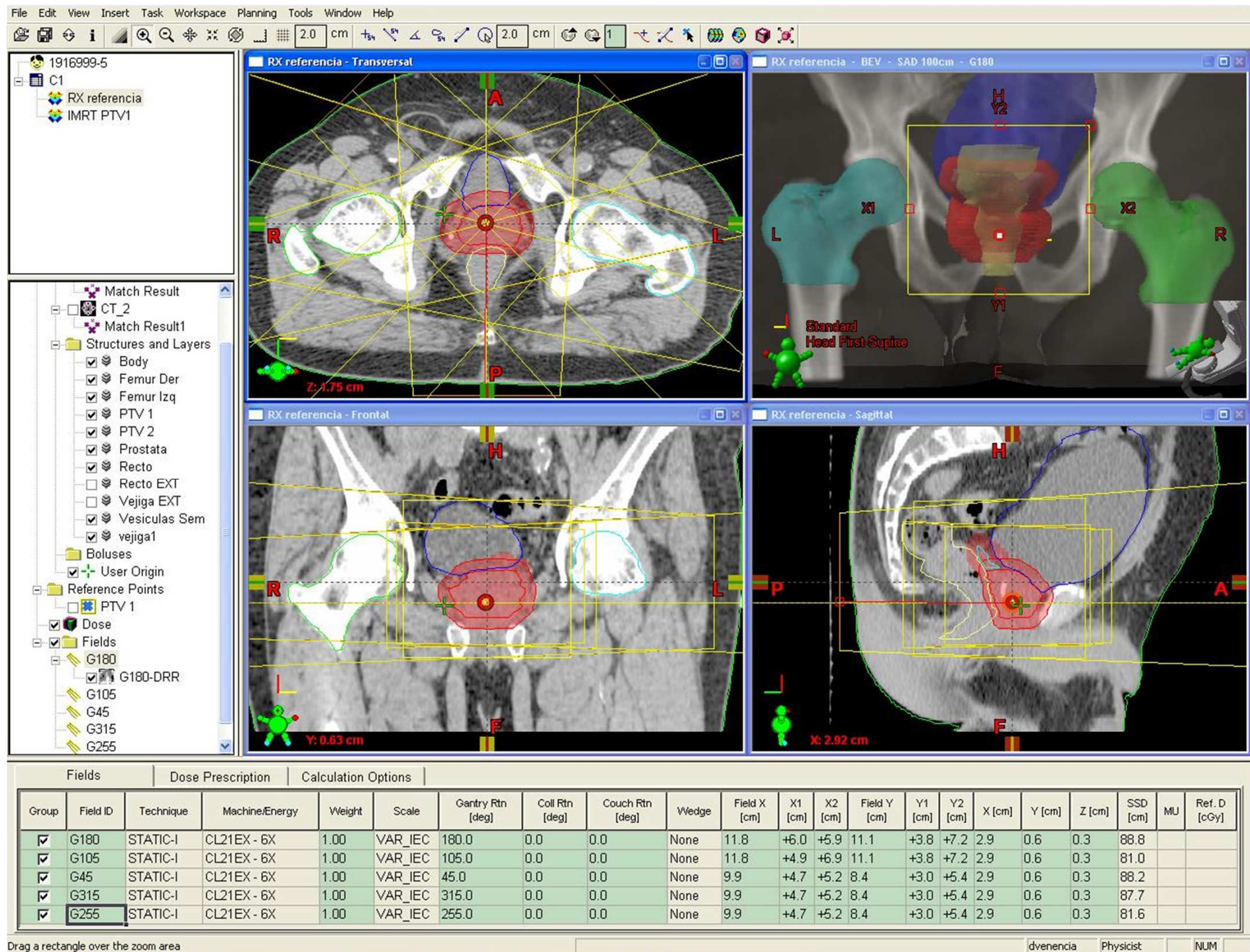


Prioridad de superposición

Organos de riesgo

- Recto
 - V40 entre 35% - 45%
 - V65 < 20%
 - Pared Posterior < 44Gy
- Vejiga
 - V40 < 40%
 - D25 < 65Gy
- Cabezas femorales
 - V50 < 10%
- Bulbo peneano
- Cuerpos cavernosos





File Edit View Insert Task Workspace Planning Tools Window Help

Optimize... F7
Calculate Leaf Motions... F11

Calculation
Create Verification Plan...

Plan Normalization...
Isodose Levels...
Compensator Isolevels...

Dose Volume Histogram...
Plan Comparison DVH...

Verify MLC Leaf Positions...
Field Weight... F3
Change Treatment Units...
Merge Subfields
Edit Compensator...

Reference Point Organizer...
Plan Organizer...
Save Plan as Template...

Move Plan to Treatment... F4
Move Plan to Simulation...

Enable Digitizer

CT_SC

C2

Plan1

IMRT PTV Ver

IMRT PTV11

IMRT PTV12

IMRT PTV13

IMRT PTV14

IMRT PTV15

IMRT PTV16

RX referencia

IMRT PTV

IMRT PTV

CT_SC

Structures and Layers

☒ Recto EXT.

☒ Body

☒ CTV

☒ Femur Der

☒ Femur Izq

☒ PTV

☒ PTV BOOST

☒ Recto II

☒ Vejiga

☒ Vejiga EXT

Boluses

☒ User Origin

Reference Points

☐ PTV

☒ Dose

Fields

☒ G105-B

☒ G180-A

☒ G255-E

☒ G315-D

☒ G45-C

IMRT PTV - Model View

Standard Head First-Supine

IMRT PTV - Sagittal

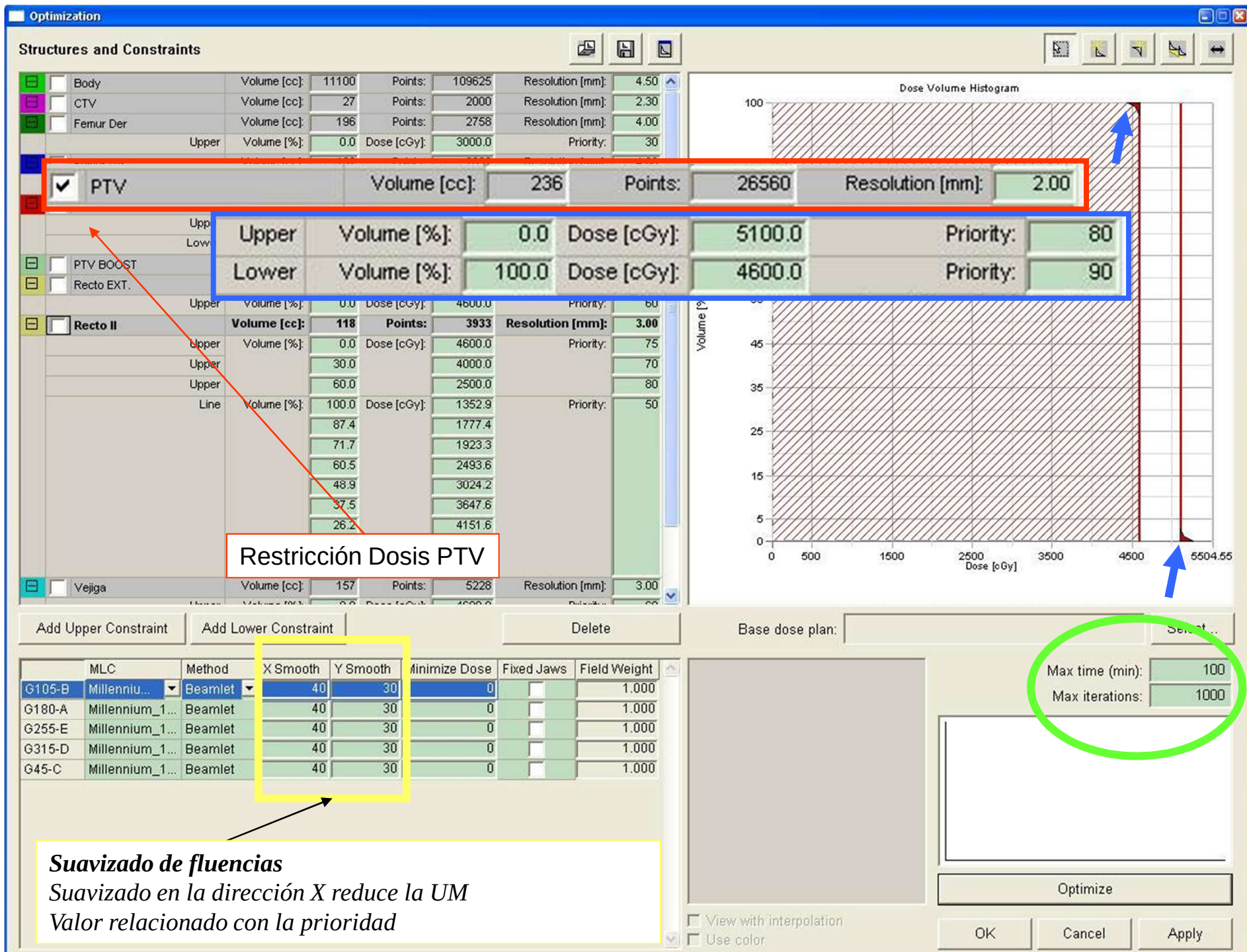
Y: 1.56 cm

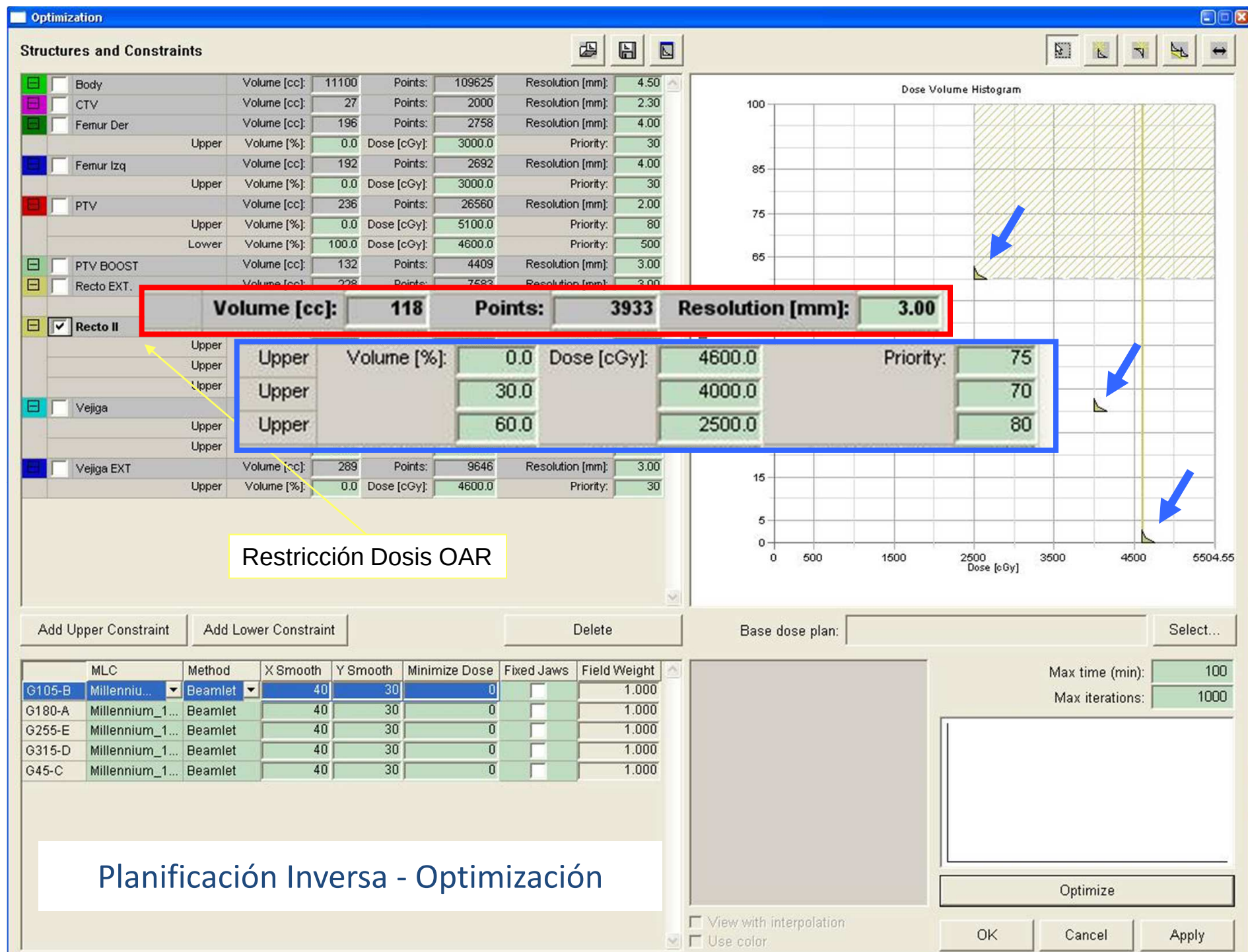
X: 2.04 cm

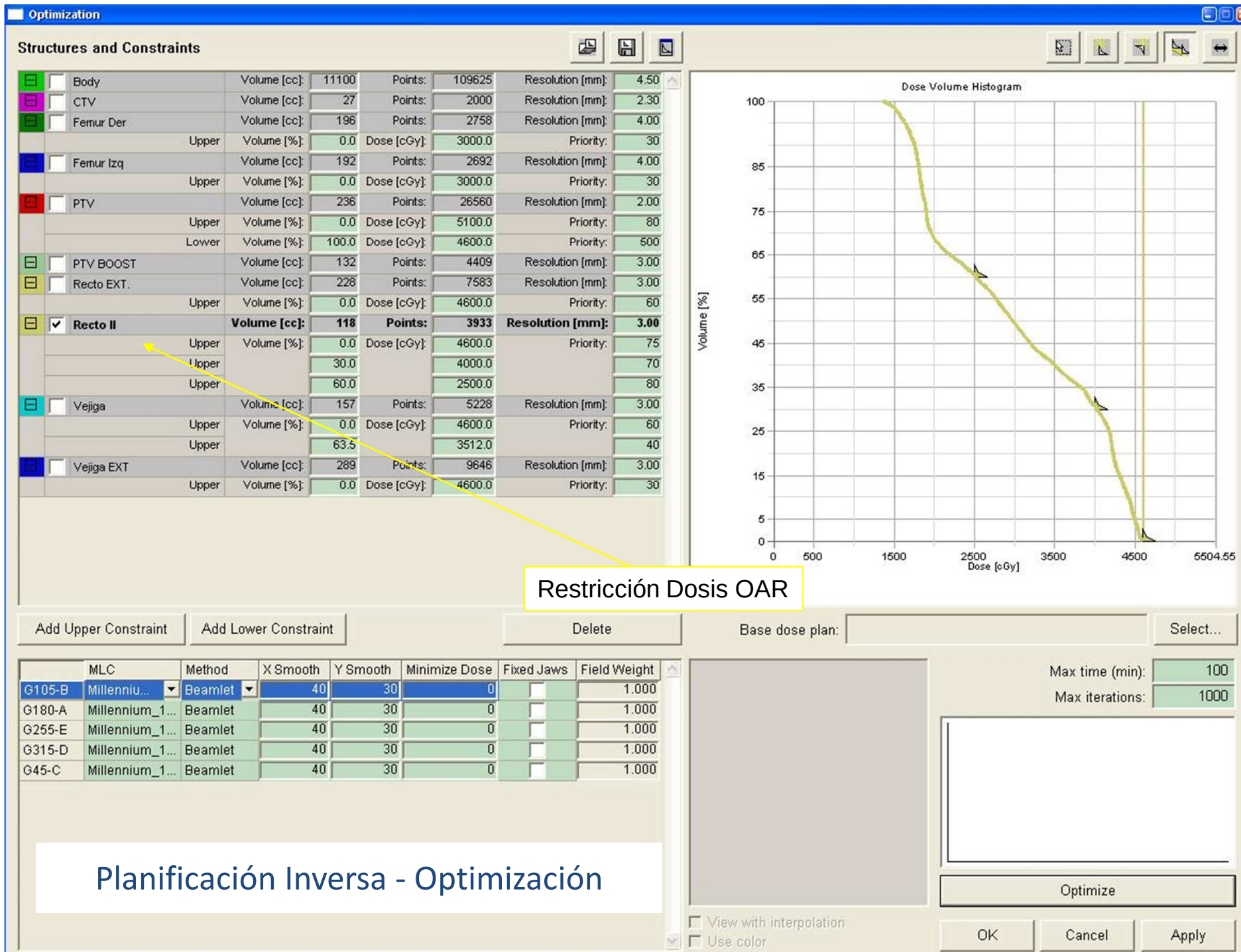
Fields		Dose Prescription		Calculation Options																	
Group	Field ID	Technique	Machine/Energy	Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☒	G105-B	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	105.0	350.0	0.0	None	12.3	+4.3	+8.0	9.8	+3.3	+6.5	2.0	0.2	-0.5	82.8		
☒	G180-A	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	180.0	0.0	0.0	None	13.3	+6.5	+6.8	9.3	+3.5	+5.8	2.0	0.2	-0.5	89.3		
☒	G255-E	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	255.0	10.0	0.0	None	11.8	+7.5	+4.3	10.0	+3.5	+6.5	2.0	0.2	-0.5	83.7		
☒	G315-D	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	315.0	10.0	0.0	None	13.3	+8.5	+4.8	10.0	+3.5	+6.5	2.0	0.2	-0.5	91.7		
☒	G45-C	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	45.0	350.0	0.0	None	12.5	+4.5	+8.0	10.0	+3.5	+6.5	2.0	0.2	-0.5	91.8		

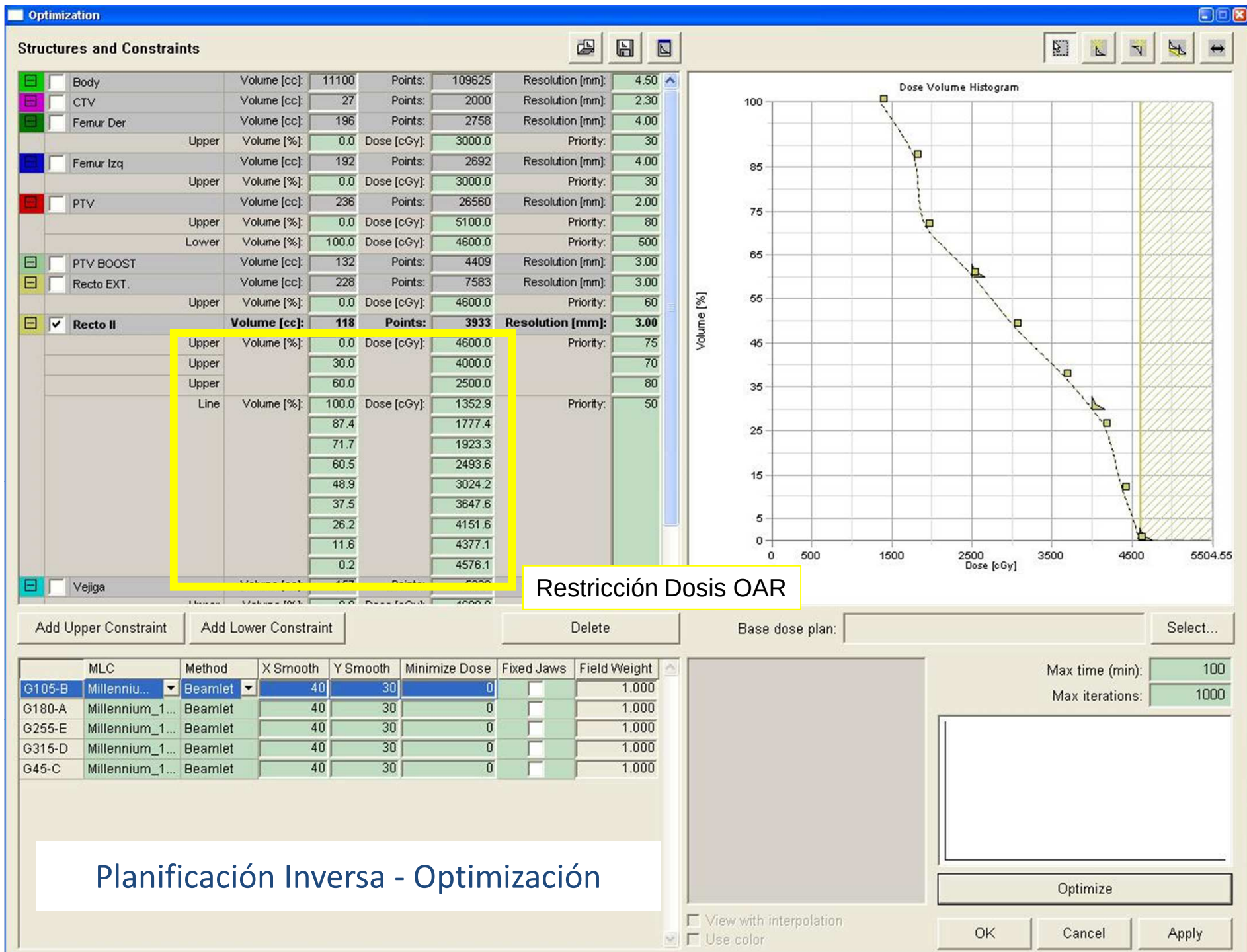
Opens the IMRT optimization dialog.

dvenencia Physicist NUM





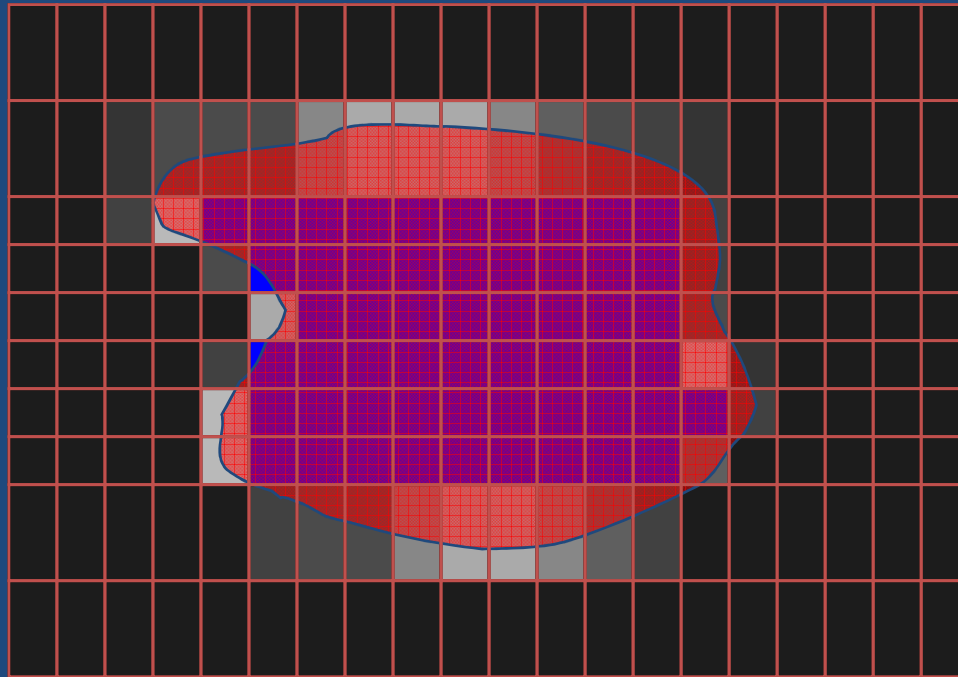




Pre-Optimización

- Cada haz se divide en beamlets
 - Ancho de la lamina del MLC x 2.5mm

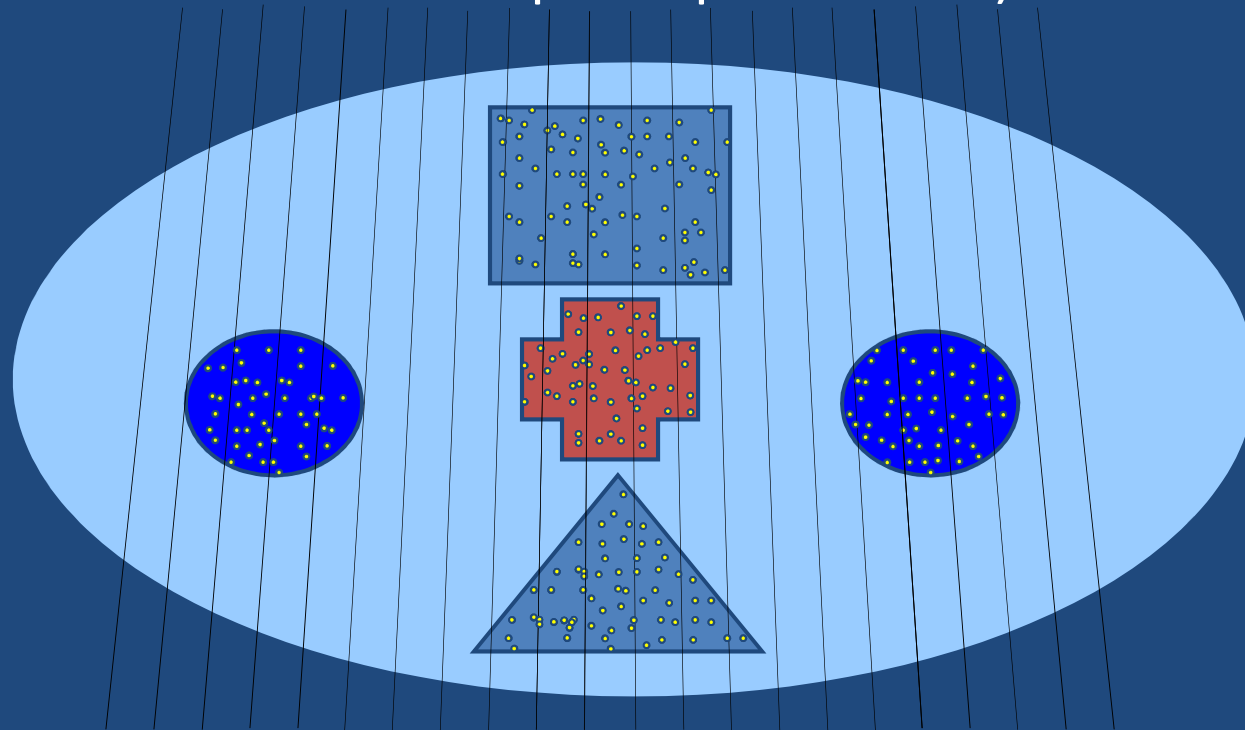
w_{MLC} {



Ej. 2.5mm

Pre-Optimización

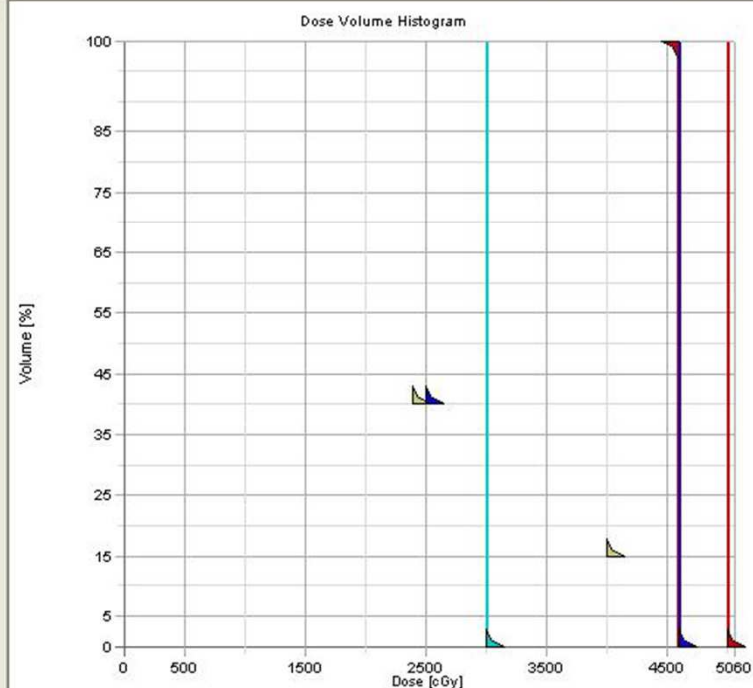
- Puntos de dosis distribuidos aleatorios
- Grilla de beamleat (ancho de lamina $\times$ paso)
- Calculo de dosis en puntos dentro de cada fan-line (Matriz de coeficientes para optimización)



Optimization

Structures and Constraints

		Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Body	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
☒	Femur Der	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	90
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	80
☒	PTV 2	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Prostata	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
☒	Recto	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper	Volume [%]:	15.0	Dose [cGy]:	4000.0	Priority:	70
	Upper	Volume [%]:	40.0	Dose [cGy]:	2400.0	Priority:	80
☒	Recto EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	Vesiculas Sem	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
☒	vejiga1	Volume [cc]:	40.0	Dose [cGy]:	2500.0	Priority:	40
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper	Volume [%]:	40.0	Dose [cGy]:	2500.0	Priority:	40



Add Upper Constraint

Add Lower Constraint

Delete

Base dose plan:

Select...

	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Max time (min):

100

Max iterations:

1000

Starting optimization 36% 0h 0m 6s 0

Stop

☐ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
cGy]

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00

	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	80
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper	Volume [%]:	10.0	Dose [cGy]:	4000.0	Priority:	70
	Upper	Volume [%]:	32.0	Dose [cGy]:	2000.0	Priority:	80
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper	Volume [%]:	15.0	Dose [cGy]:	2500.0	Priority:	40

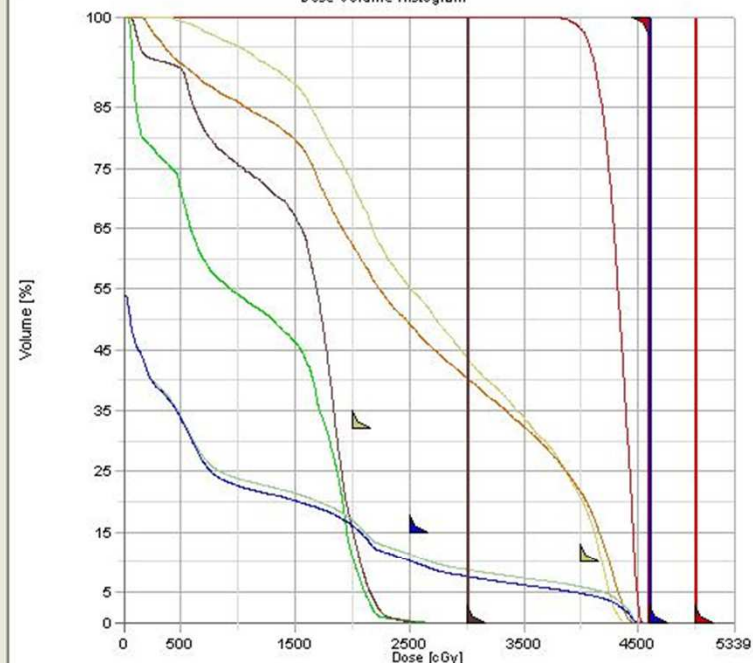
Add Upper Constraint

Add Lower Constraint

Delete

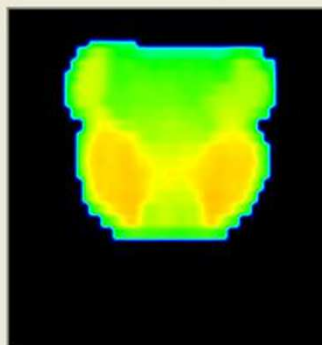
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...



Max time (min):

100

Max iterations:

1000

Optimizing 0h 0m 18s

2

Continue

OK

Cancel

Apply

Ref. D
[cGy]

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	90
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	80
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper		10.0		4000.0		70
	Upper		32.0		2000.0		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

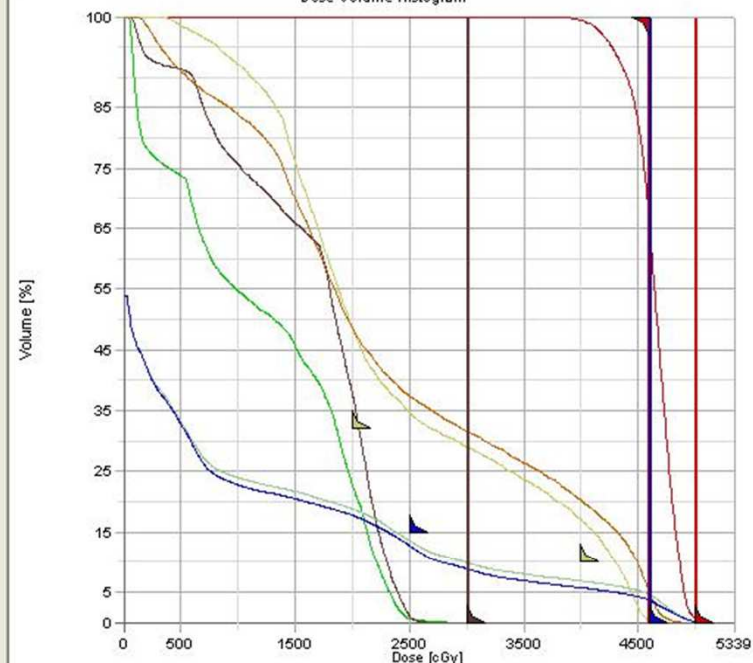
Add Upper Constraint

Add Lower Constraint

Delete

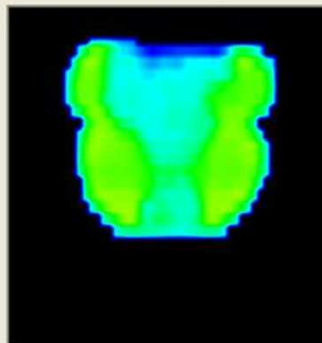
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...



Max time (min):

100

Max iterations:

1000

Optimizing ... 0h 0m 7s

5

Continue

OK

Cancel

Apply

Ref. D
[cGy]

Group

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00

	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	80
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper	Volume [%]:	10.0	Dose [cGy]:	4000.0	Priority:	70
	Upper	Volume [%]:	32.0	Dose [cGy]:	2000.0	Priority:	80
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper	Volume [%]:	15.0	Dose [cGy]:	2500.0	Priority:	40

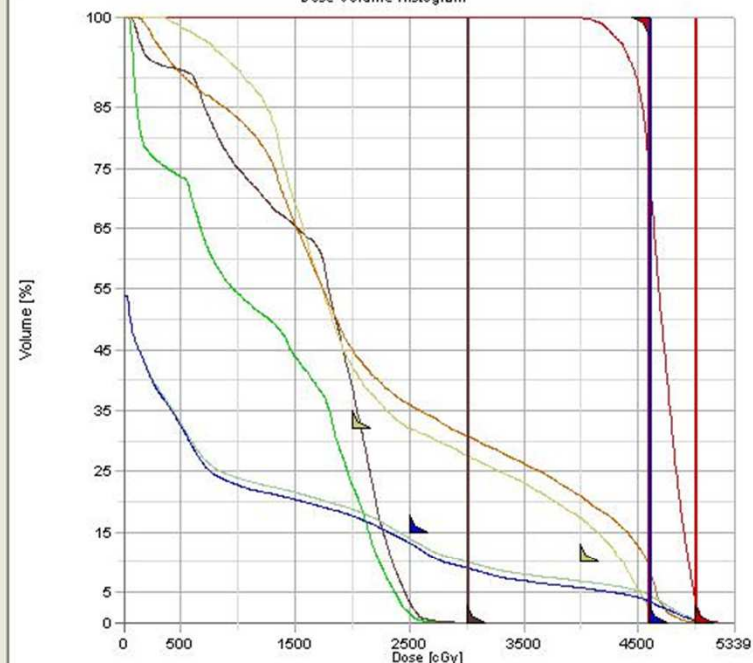
Add Upper Constraint

Add Lower Constraint

Delete

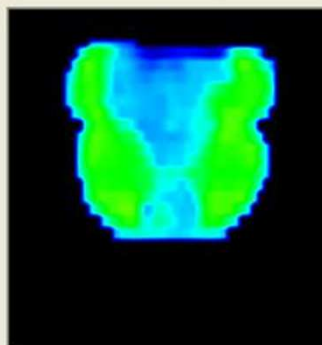
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☒	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...



Max time (min):

100

Max iterations:

1000

Optimizing 0h 0m 5s

Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
[cGy]

Group

Ready

dvenencia Physicist

NUM

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	90
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	80
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper		10.0		4000.0		70
	Upper		32.0		2000.0		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

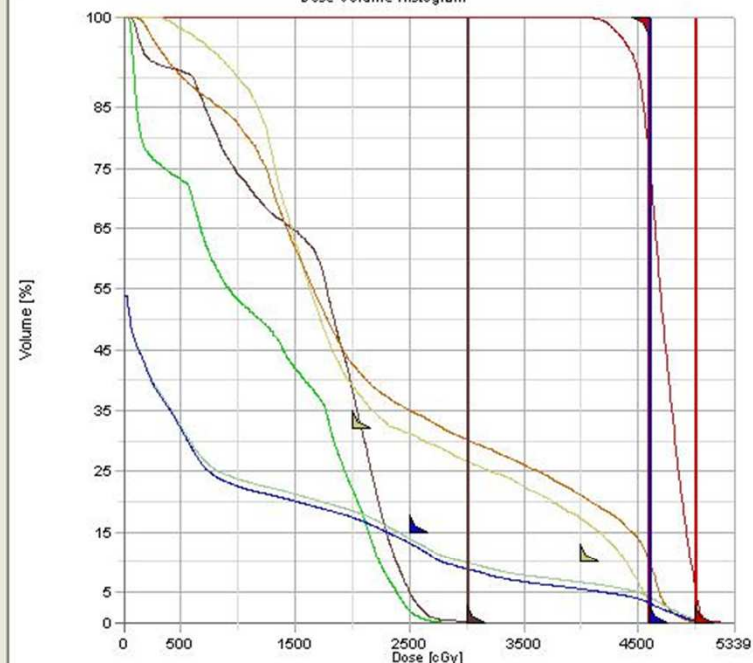
Add Upper Constraint

Add Lower Constraint

Delete

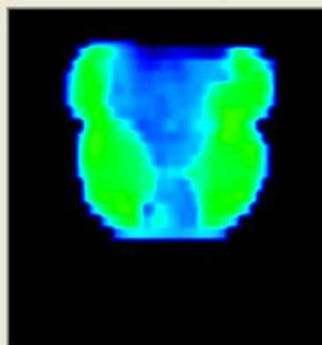
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☒	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...



Max time (min):

100

Max iterations:

1000

Optimizing ...

0h 0m 7s

10

Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
[cGy]

G255	STATIC-1	CL21EX - 6X	1.00	VAR_JEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6
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Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	90
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	80
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper		10.0		4000.0		70
	Upper		32.0		2000.0		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

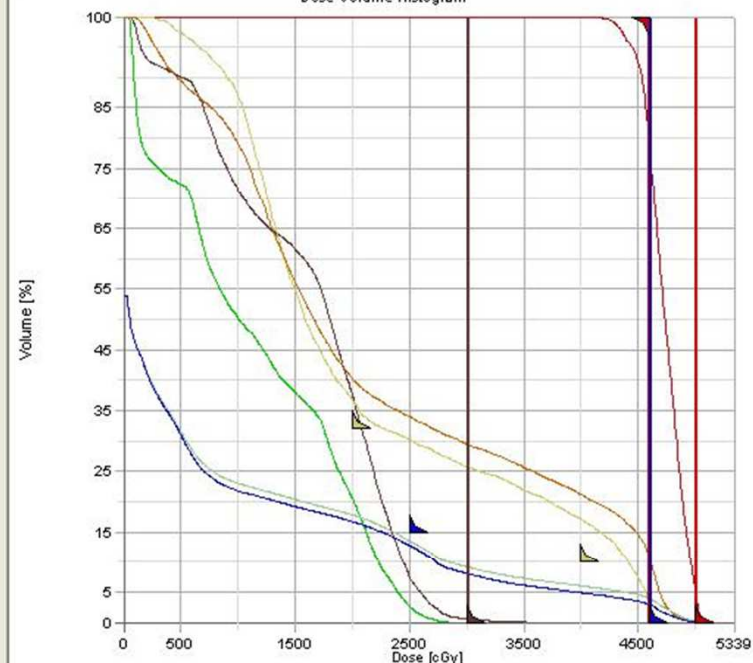
Add Upper Constraint

Add Lower Constraint

Delete

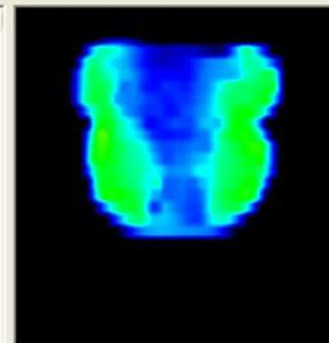
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☒	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...



Max time (min):

100

Max iterations:

1000

0h 0m 21s
21

Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
[cGy]

Group

Ready

dvenencia

Physicist

NUM

Optimization

Structures and Constraints

	☐	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
	☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
	☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
	☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	90
		Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	200
	☐	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
	☐	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
	☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
		Upper		10.0		4000.0		70
		Upper		32.0		2000.0		80
	☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
	☐	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
	☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
		Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
		Upper		15.0		2500.0		40

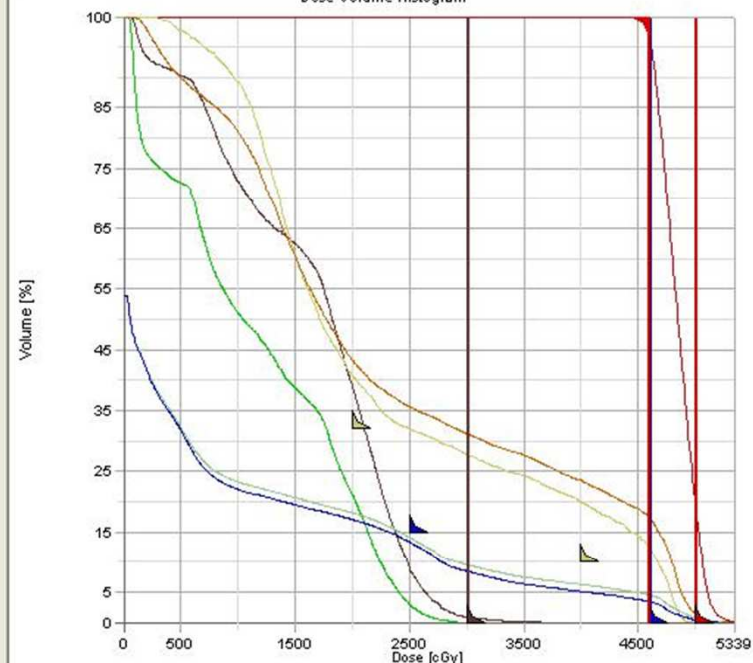
Add Upper Constraint

Add Lower Constraint

Delete

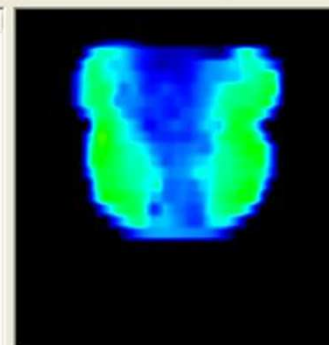
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...

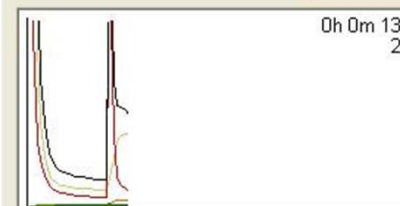


Max time (min):

100

Max iterations:

1000

0h 0m 13s
27

Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

G255	STATIC-1	CL21EX - 6X	1.00	VAR_JEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6
------	----------	-------------	------	---------	-------	-----	-----	------	------	------	------	------	------	------	-----	-----	-----	------

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	90
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	200
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	75
	Upper		15.1		4000.0		70
	Upper		32.0		2000.0		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

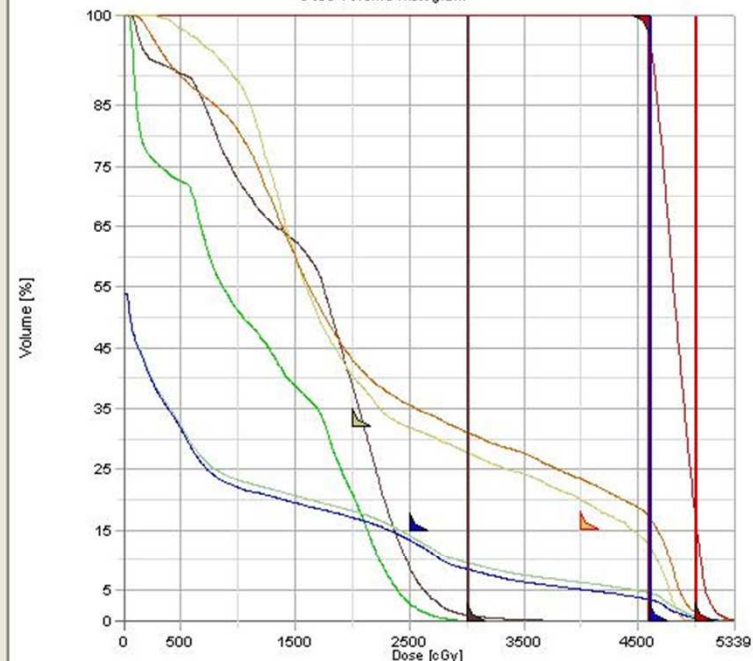
Add Upper Constraint

Add Lower Constraint

Delete

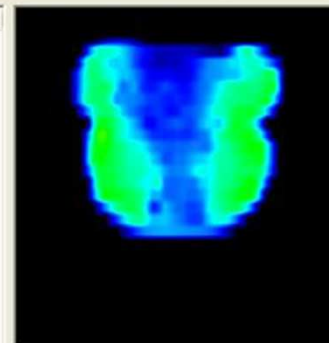
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☒	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...



Max time (min):

100

Max iterations:

1000

Optimizing ...

0h 0m 16s

34

Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
cGy]

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	150
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	200
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	85
	Upper		16.3		4000.0		70
	Upper		35.6		2000.0		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

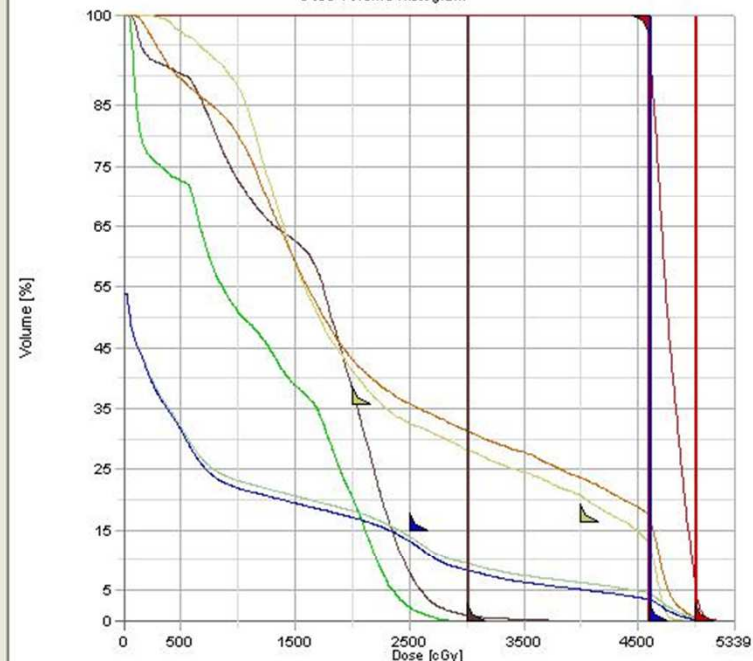
Add Upper Constraint

Add Lower Constraint

Delete

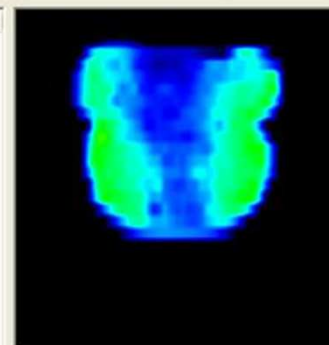
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...

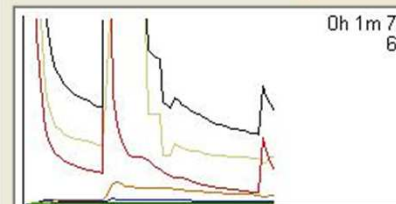


Max time (min):

100

Max iterations:

1000

0h 1m 7s
66

Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

G255	STATIC-1	CL2TEX - 6X	1.00	VAR_JEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6
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Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	150
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	100
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	85
	Upper		17.5		4012.9		70
	Upper		38.1		2012.9		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

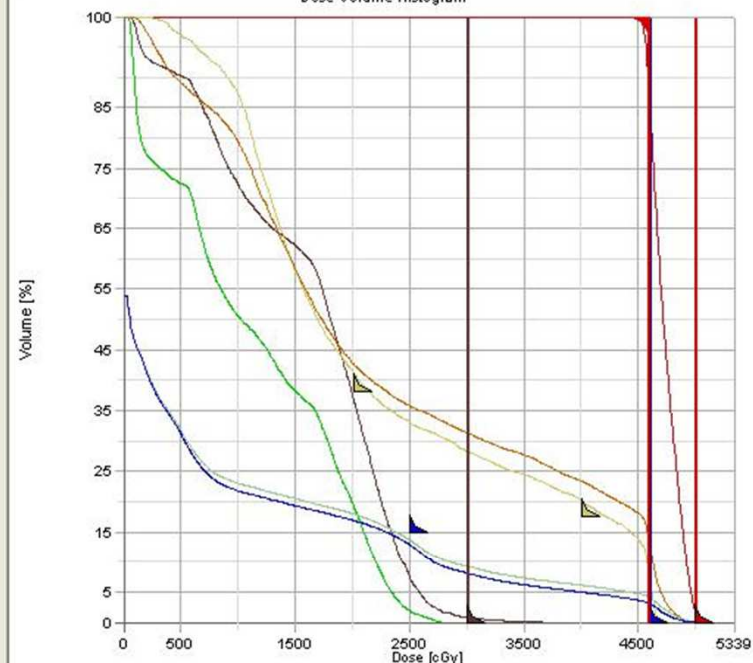
Add Upper Constraint

Add Lower Constraint

Delete

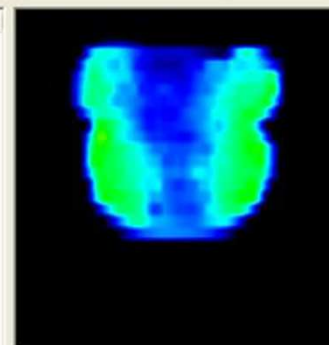
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☒	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...

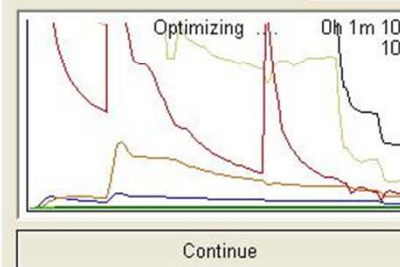


Max time (min):

100

Max iterations:

1000

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Group

☒	G255	STATIC-1	CL21EX - 6X	1.00	VAR_JEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6
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Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	150
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	100
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	85
	Upper		17.5		4012.9		70
	Upper		38.1		2012.9		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

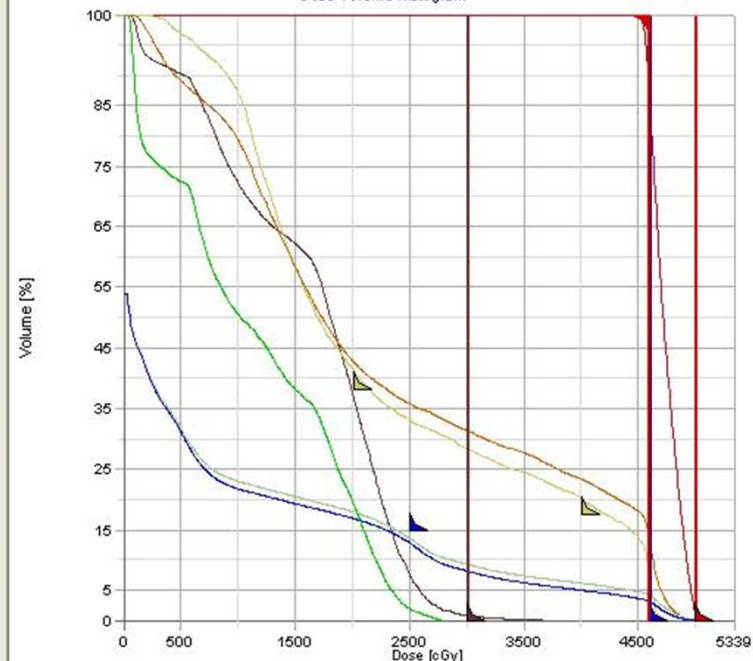
Add Upper Constraint

Add Lower Constraint

Delete

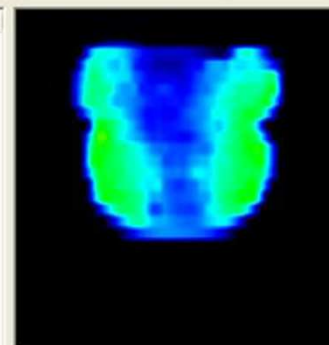
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☒	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...

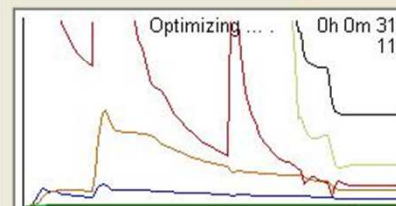


Max time (min):

100

Max iterations:

1000



Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
[cGy]

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	150
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	100
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	85
	Upper		17.5		4012.9		70
	Upper		38.1		2012.9		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

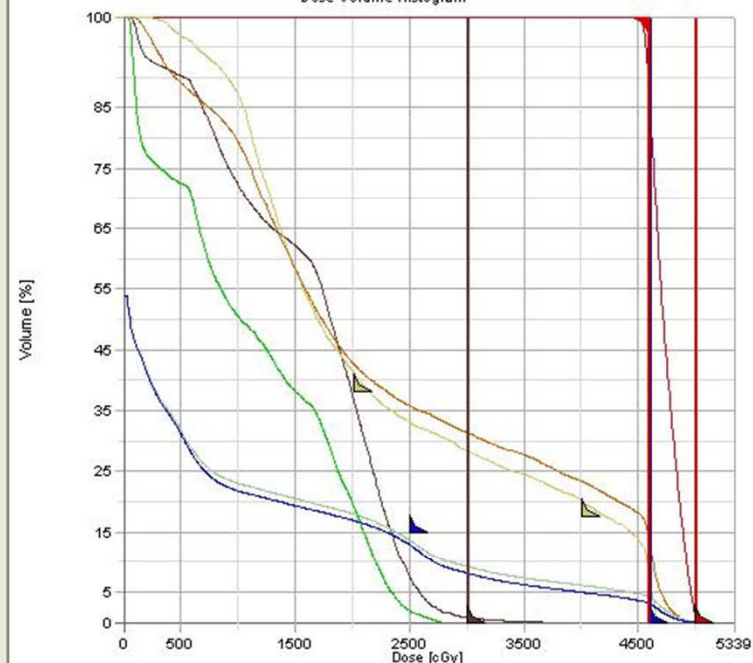
Add Upper Constraint

Add Lower Constraint

Delete

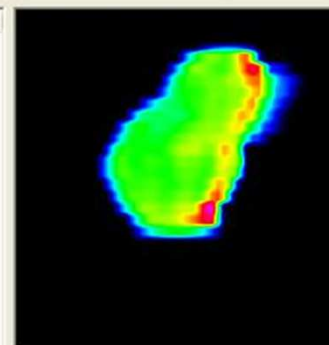
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☒	1.000
G45	Millennium_1...	Beamlet	40	30	0	☐	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...

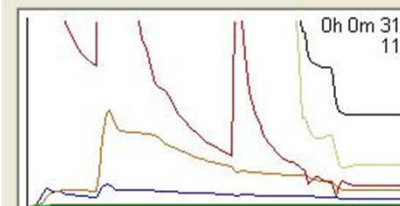


Max time (min):

100

Max iterations:

1000



Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

G255	STATIC-1	CL21EX - 6X	1.00	VAR_JEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6
------	----------	-------------	------	---------	-------	-----	-----	------	------	------	------	------	------	------	-----	-----	-----	------

Optimization

Structures and Constraints

☒	Body	Volume [cc]:	15981	Points:	193587	Resolution [mm]:	4.50
☒	Femur Der	Volume [cc]:	152	Points:	4267	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	Femur Izq	Volume [cc]:	149	Points:	4116	Resolution [mm]:	4.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	3000.0	Priority:	30
☒	PTV 1	Volume [cc]:	143	Points:	6593	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	5000.0	Priority:	150
	Lower	Volume [%]:	100.0	Dose [cGy]:	4600.0	Priority:	100
☒	PTV 2	Volume [cc]:	99	Points:	4471	Resolution [mm]:	3.00
☒	Prostata	Volume [cc]:	37	Points:	2748	Resolution [mm]:	2.56
☒	Recto	Volume [cc]:	68	Points:	3622	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	85
	Upper		17.5		4012.9		70
	Upper		38.1		2012.9		80
☒	Recto EXT	Volume [cc]:	158	Points:	7465	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
☒	Vejiga EXT	Volume [cc]:	854	Points:	35486	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	30
☒	Vesiculas Sem	Volume [cc]:	8	Points:	2517	Resolution [mm]:	1.52
☒	vejiga1	Volume [cc]:	652	Points:	27741	Resolution [mm]:	3.00
	Upper	Volume [%]:	0.0	Dose [cGy]:	4600.0	Priority:	60
	Upper		15.0		2500.0		40

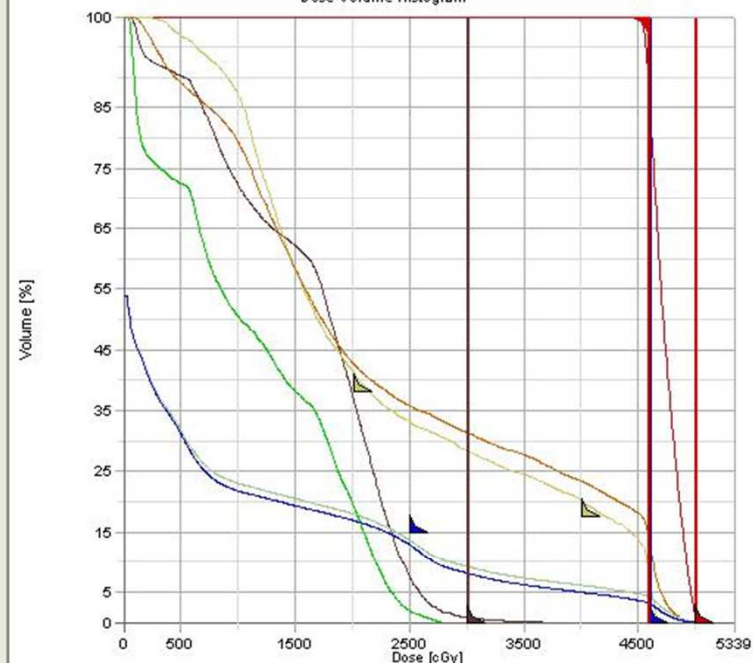
Add Upper Constraint

Add Lower Constraint

Delete

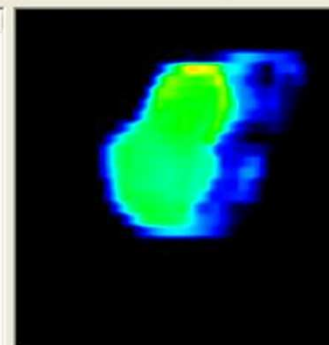
	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
G180	Millennium_1...	Beamlet	40	30	0	☐	1.000
G105	Millennium_1...	Beamlet	40	30	0	☐	1.000
G45	Millennium_1...	Beamlet	40	30	0	☒	1.000
G315	Millennium_1...	Beamlet	40	30	0	☐	1.000
G255	Millennium_1...	Beamlet	40	30	0	☐	1.000

Dose Volume Histogram



Base dose plan:

Select...

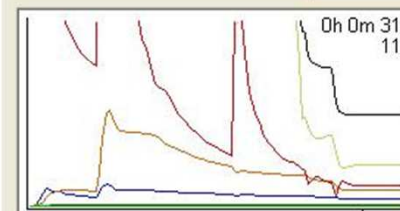


Max time (min):

100

Max iterations:

1000



Continue

☒ View with interpolation☒ Use color

OK

Cancel

Apply

Ref. D
[cGy]

G255	STATIC-1	CL21EX - 6X	1.00	VAR_JEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6
------	----------	-------------	------	---------	-------	-----	-----	------	------	------	------	------	------	------	-----	-----	-----	------

File Edit View Insert Task Workspace Planning Tools Window Help

2.0 cm 2.0 cm 1

1916999-5

- C1
 - RX referencia
 - IMRT PTV1

☒ Femur Izq
☒ PTV 1
☐ PTV 2
☐ Prostata
☒ Recto
☐ Recto EXT
☐ Vejiga EXT
☐ Vesiculas Sem
☒ vejiga1
☐ Boluses
☒ User Origin
☐ Reference Points
☐ PTV 1
☒ Dose
☐ Fields
☐ G180
☒ G180-DRR
☐ Fluence
☐ G105
☐ Fluence
☐ G45
☐ Fluence
☐ G315
☐ Fluence
☐ G255
☐ Fluence

RX referencia - Transversal

RX referencia - BEV - SAD 100cm - G45

RX referencia - Frontal

RX referencia - Sagittal

Leaf Motion Calculation Options

	Delivery Method	Intensity Levels	Fixed Jaws
G180	Sliding Window		☐
G105	Sliding Window		☐
G45	Sliding Window		☐
G315	Sliding Window		☐
G255	Sliding Window		☐
	Sliding Window		
	Multiple Static Segments		
	None		

OK Cancel

Z: 1.75 cm

Y: 0.63 cm

X: 2.92 cm

Fields

Dose Prescription

Calculation Options

Group	Field ID	Technique	Machine/Energy	Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☒	G180	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	180.0	0.0	0.0	None	11.8	+6.0	+5.9	11.1	+3.8	+7.2	2.9	0.6	0.3	88.8		
☒	G105	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	105.0	0.0	0.0	None	11.8	+4.9	+6.9	11.1	+3.8	+7.2	2.9	0.6	0.3	81.0		
☒	G45	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	45.0	0.0	0.0	None	12.0	+4.9	+7.1	10.9	+3.8	+7.1	2.9	0.6	0.3	88.2		
☒	G315	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	315.0	0.0	0.0	None	12.4	+7.3	+5.1	10.7	+3.8	+6.9	2.9	0.6	0.3	87.7		
☒	G255	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	255.0	0.0	0.0	None	11.3	+6.5	+4.8	10.8	+3.8	+7.0	2.9	0.6	0.3	81.6		

Ready

dvenencia

Physicist

NUM

Control de calidad del Acelerador

- QA MLC →
- IMRT con MLC
 - **Integridad mecánica** del sistema de tratamiento
 - **Preciso posicionamiento** espacial y temporal del MLC
 - Mayor desgaste en IMRT versus CRT3D
 - **Estabilidad del haz** de radiación para pequeñas numero de UM (step&shoot)

INDICE

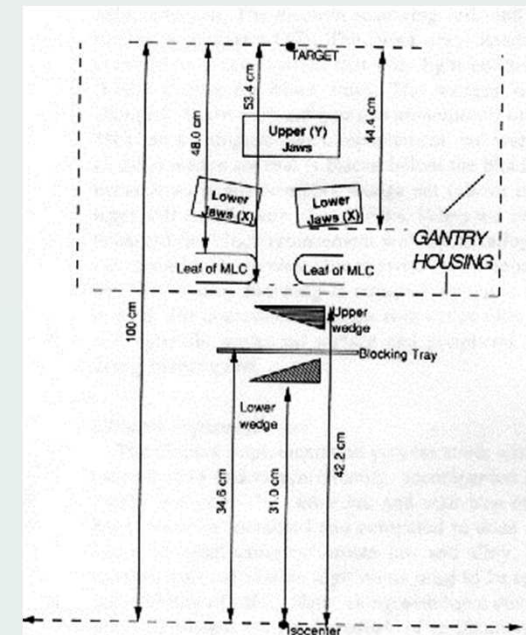
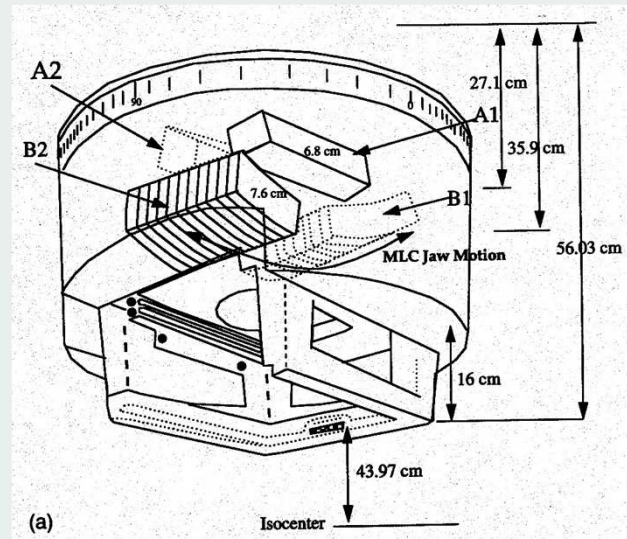
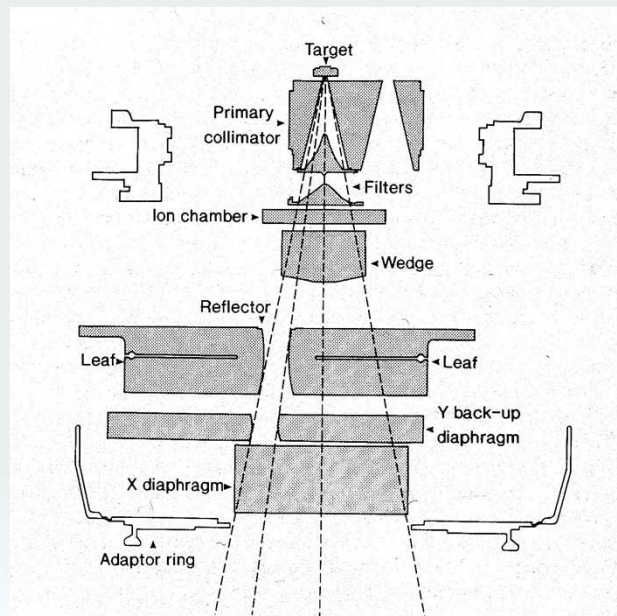
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Actualización IAEA-TecDoc-1151



Control de calidad del Acelerador

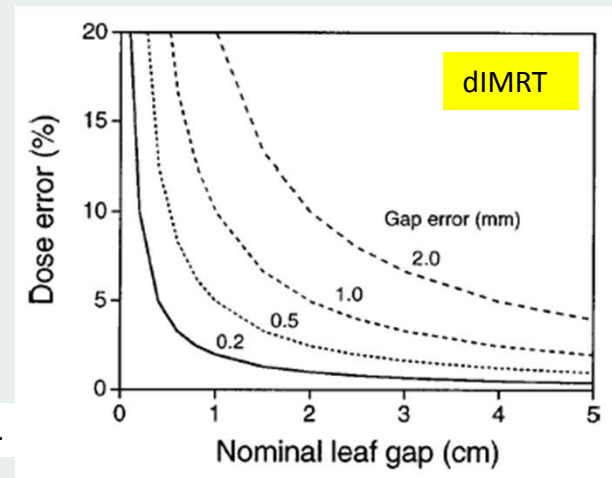
- **MLC** – componente mas critica
 - Exactitud y reproducibilidad del posicionamiento de las laminas
 - Exactitud de la velocidad de movimiento de laminas (solo dMLC)



Exactitud de **posicionamiento** de laminas

- Los errores en la posición de las láminas producen un error en la dosis entregada proporcional a:

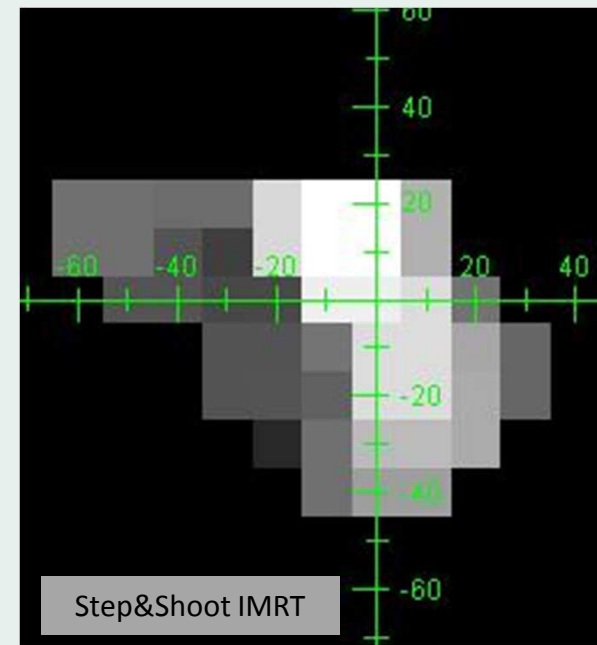
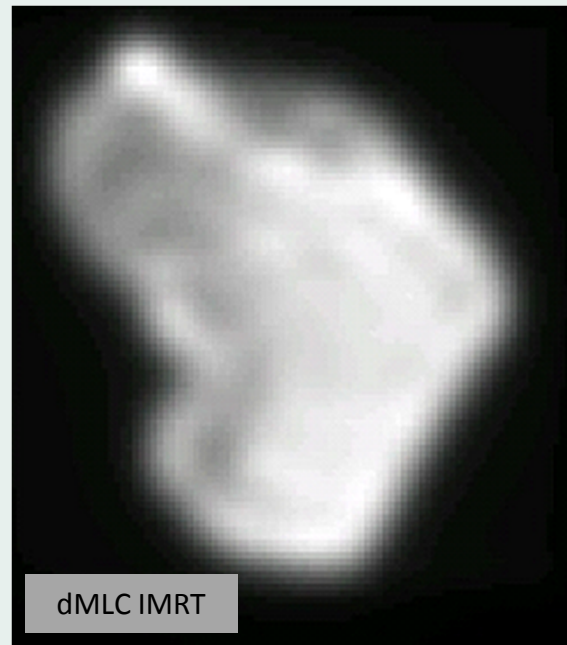
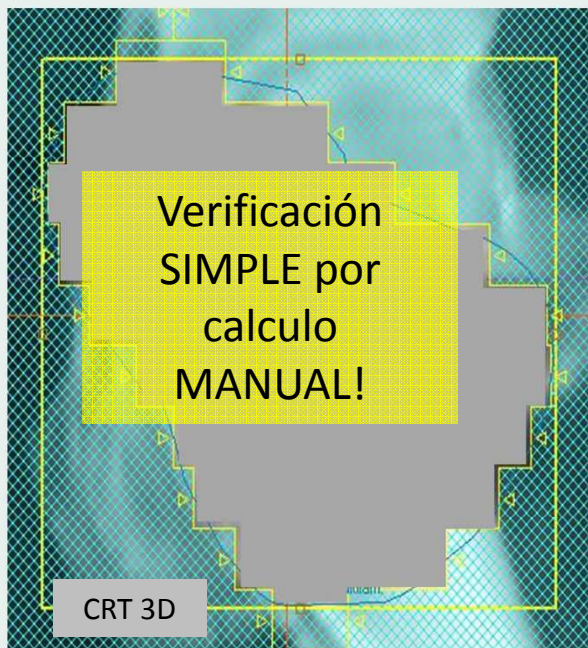
$$\text{Error Dosis} \propto [\text{Error del GAP} / \text{Ancho de GAP}]$$



Exactitud de posicionamiento de laminas

Tolerancia:

- 3DCRT / IMRT S&S $\pm 1.0\text{mm}$
- dIMRT $\pm 0.2\text{mm}$



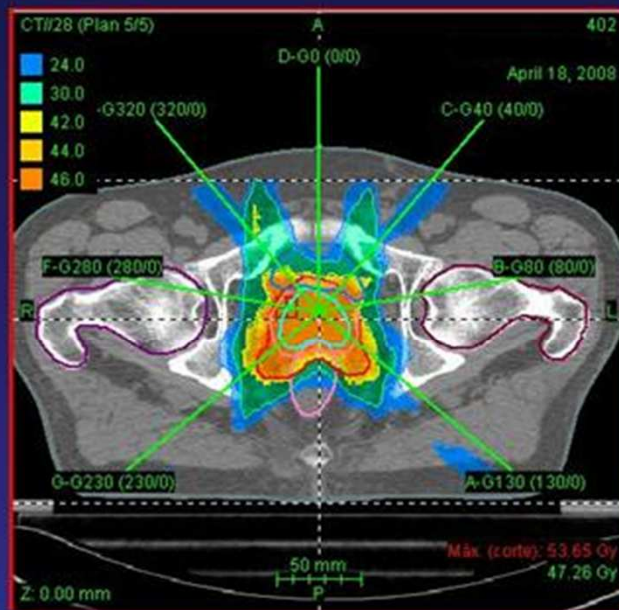
Como verificamos la dosis entregada por cada campo ?



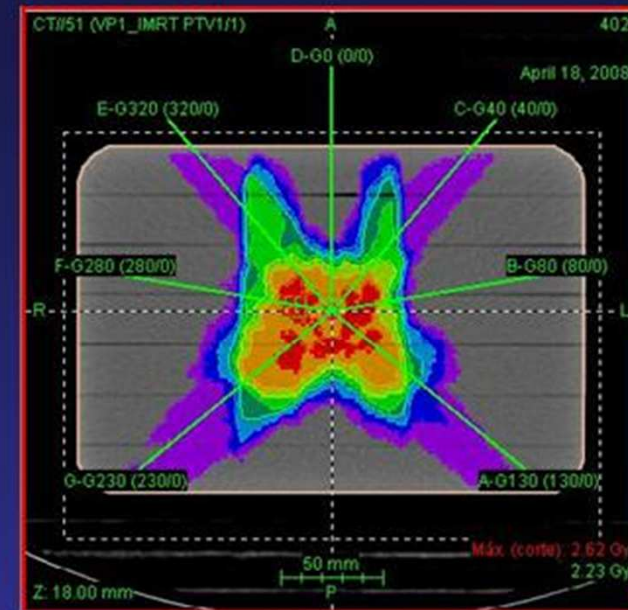
Fluencias – Niveles de intensidad



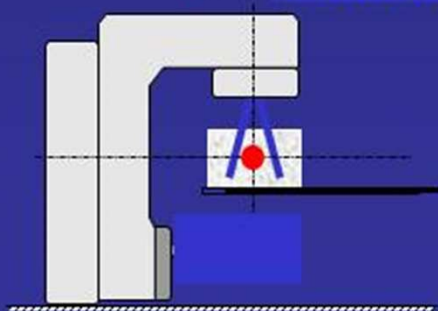
2. Medición de la dosis total para el PLAN



- Geometrías
- Fluencia
- UM



Archivos
de campo



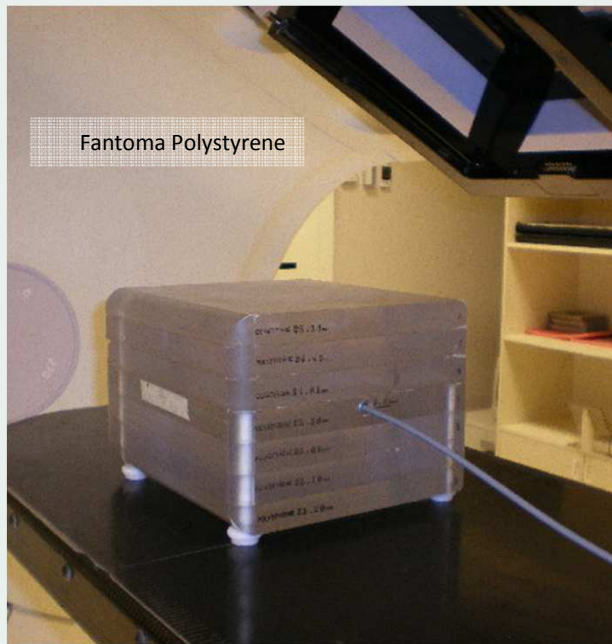
**Dosis
Medida**

Dosis media
(obtenida del HDV)

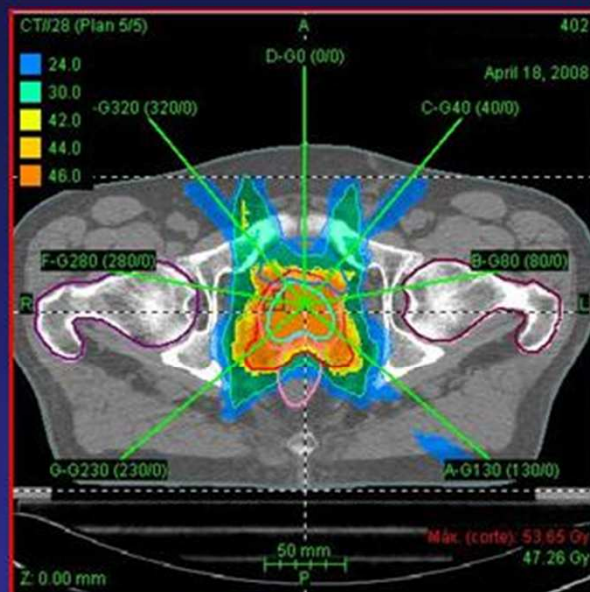
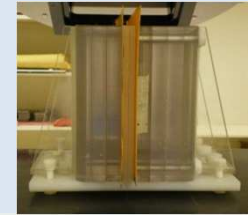
2. Medición de la dosis total para el PLAN

Criterio de tolerancia

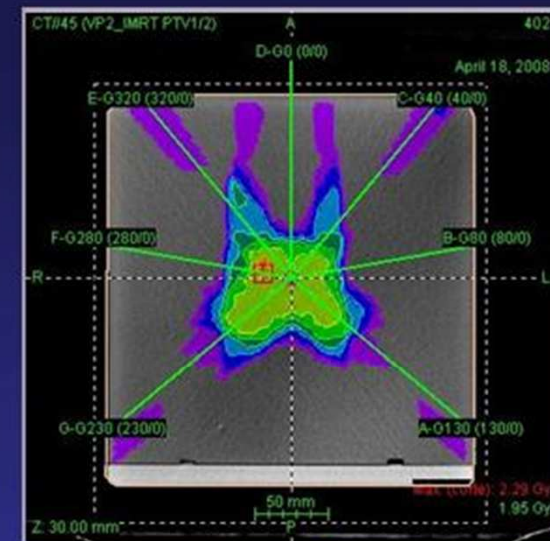
- Dosis calculada vs medida $< 3\%$
- Dosis calculada vs medida 3%-5% se debe analizar la discrepancia
- Dosis calculada vs medida $> 5\%$ el plan debe ser rechazado



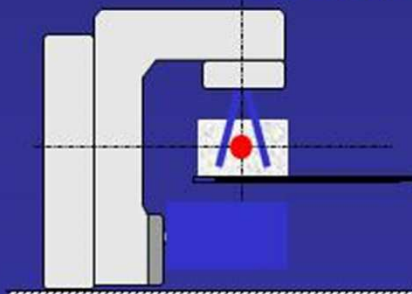
3. Medición de distribución de dosis total para el PLAN



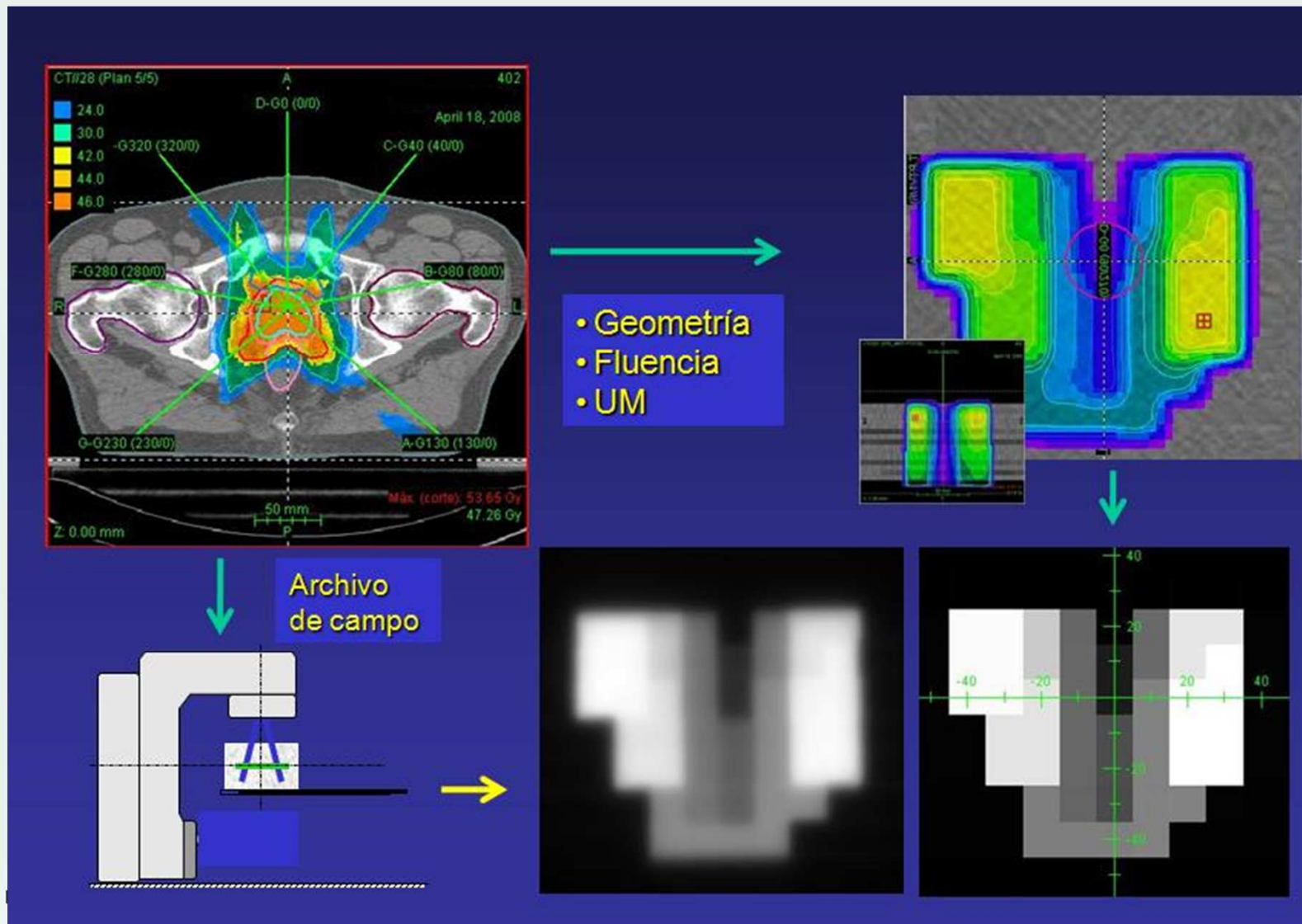
- Geometrías
- Fluencia
- UM



Archivos de
campo (LANTIS)



4. Medición de distribución campo independiente





IMRT Global Parameters

Palette:

2

Display Units:

cm

☐ Fine Tune Registration

Automated Register Adjustment-

Angle: -0.375 degrees

Scale: 0.997

Shift X: 0.217 cm Y: -0.117 cm

Image Normalization

Target Normalization

281.875 293.999 301.875

Center Value in Slider

Ref. Normalization: 243.5238

Ting Factor: 0.831

Cramb Factor: 1.003

Tolerances

Difference Tol. (%)

0 3 100

DTA Tol. (mm)

0 3 10

Gamma Tol.

0.5 1 5

DTA & Analysis Parameters

High Grad. Thresh. (%/cm)

0 30 100

High Dose Thresh. (%)

0 3 04.182

☐ Apply to all plots.

DTA Search Radius: 1.0cm

DTA Precision(±%): 0.5

Save/Restore Layouts

Save Current Layout

Restore Saved Layout

Comments

Plot Layout

1

1x2

2x2

2x3

Close IMRT Analysis

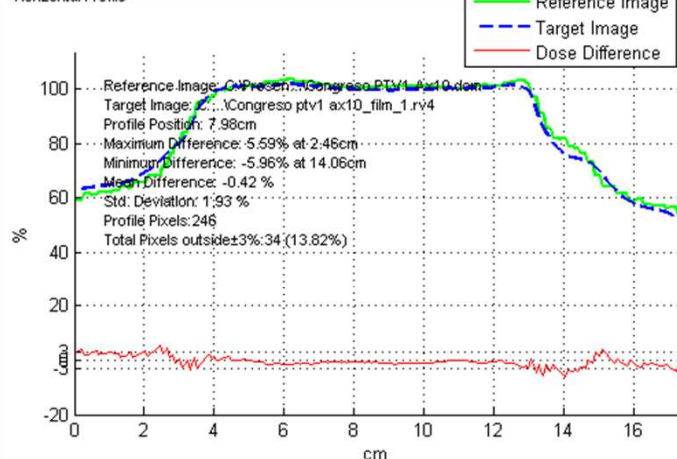
Target: ...Congresso pTV1 ax10_film_1.rv4

Profile > Horizon...

Report Options

Plot Options

Horizontal Profile



Subtraction > To...

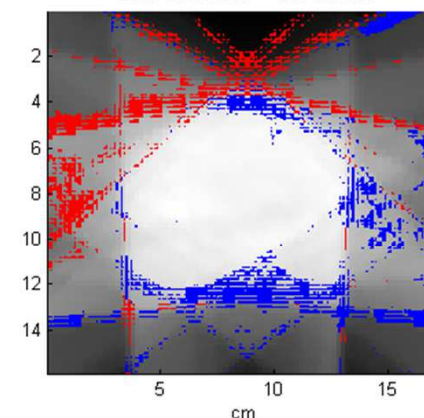
Report Options

Plot Options

Subtraction Pass/Fail Plot on Reference image.

Dose differences < -3% are blue.

Dose differences > +3% are red.



Reference: ...Congresso PTV1 Ax10.dcm

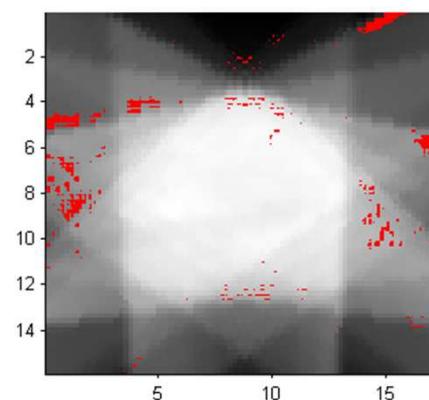
Gamma > Gamm...

Report Options

Plot Options

Gamma Pass/Fail Plot on Reference image.

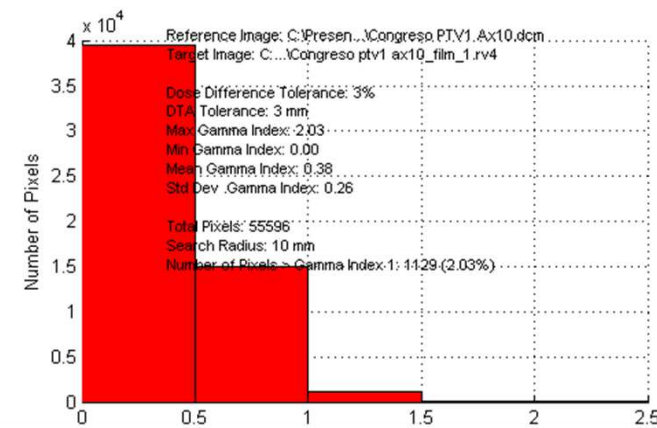
Gamma Index > 1 are red.



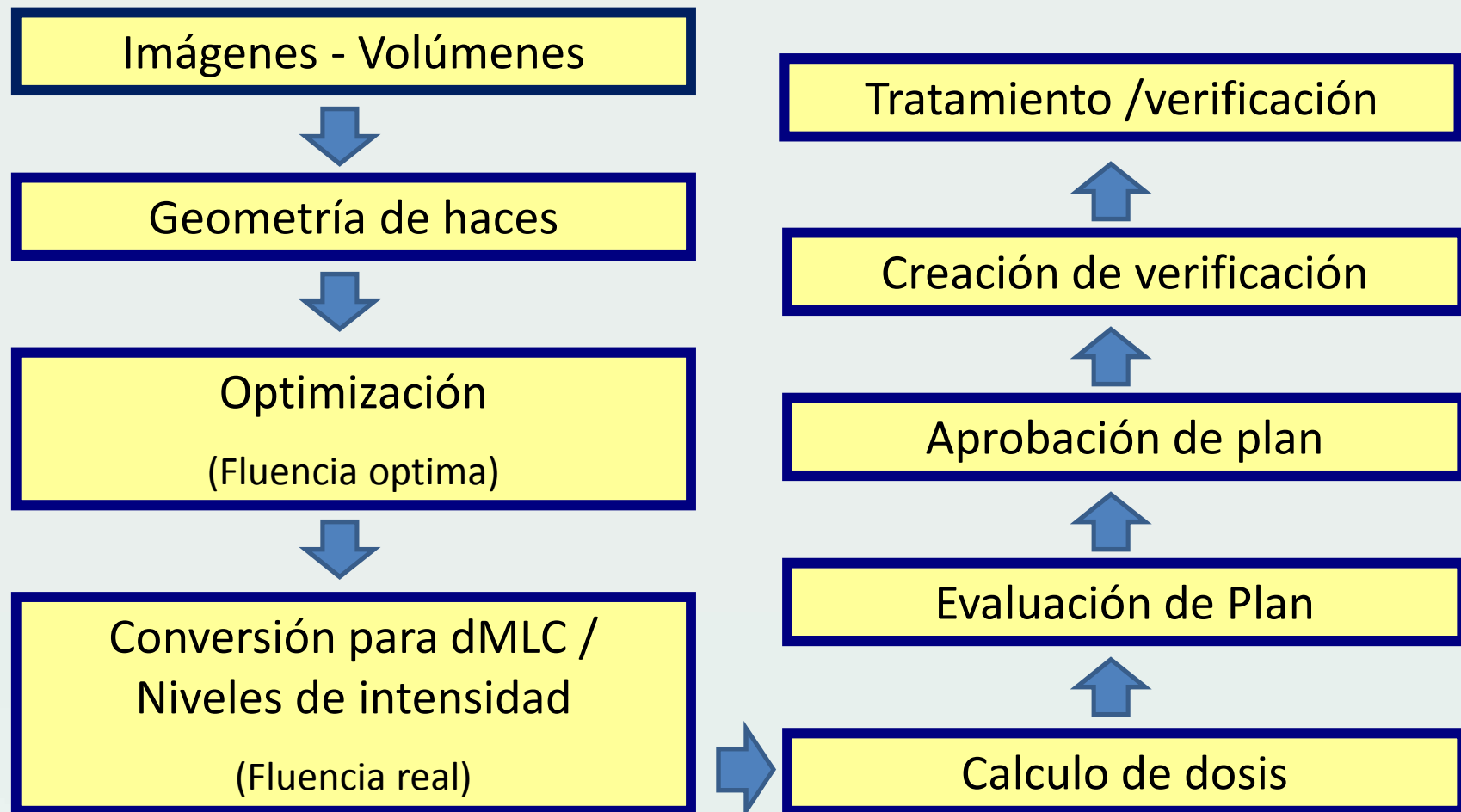
Gamma > Histog...

Report Options

Gamma Histogram



Proceso IMRT



Algunas conclusiones...

- Las 2 modalidades de IMRT con ángulos fijos de gantry son *“step&shoot”* y *“sliding windows”*
- IMRT requiere de un estricto control de calidad del equipo de tratamiento y cada planificación
- El control de calidad paciente específico es un proceso indirecto y debe ser realizado en forma independiente debido a que la intensidad de los campos es variable no siendo posible un cálculo sencillo en forma independiente
- El control de calidad de un plan de IMRT debe ser finalizado previo al inicio del tratamiento del paciente.
- IMRT utiliza haces de radiación de intensidad no uniforme generados a partir de un proceso de optimización

