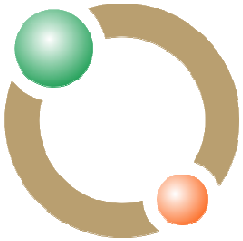
Radioterapia de Intensidad Modulada IMRT con colimador multiláminas

Daniel Venencia, Físico Medico
Instituto de Radioterapia, Córdoba, ARGENTINA

Curso de Actualización en Protección Radiológica
Córdoba, 21 al 23 de Noviembre 2013

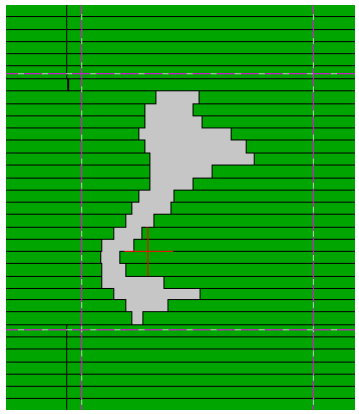


INSTITUTO DE RADIOTERAPIA
FUNDACIÓN MARIE CURIE

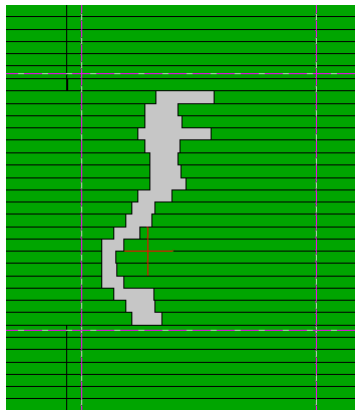
IMRT

- 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

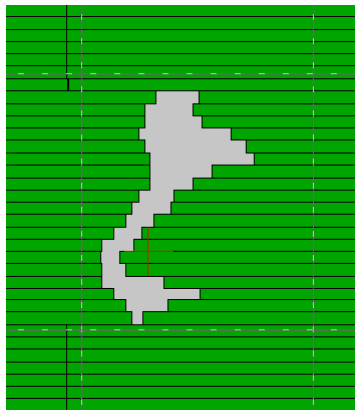


Sliding windows

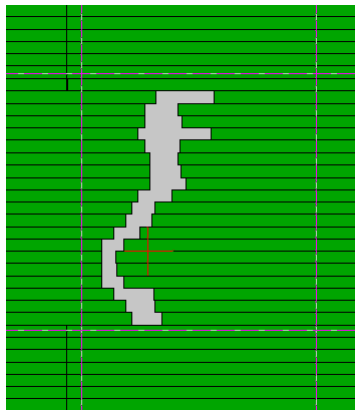
IMRT

- 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?**



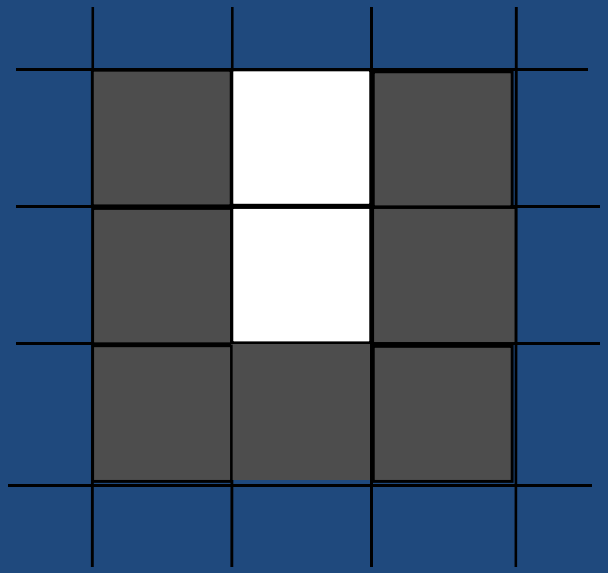
Step & shoot



Sliding windows

2. Niveles de intensidad

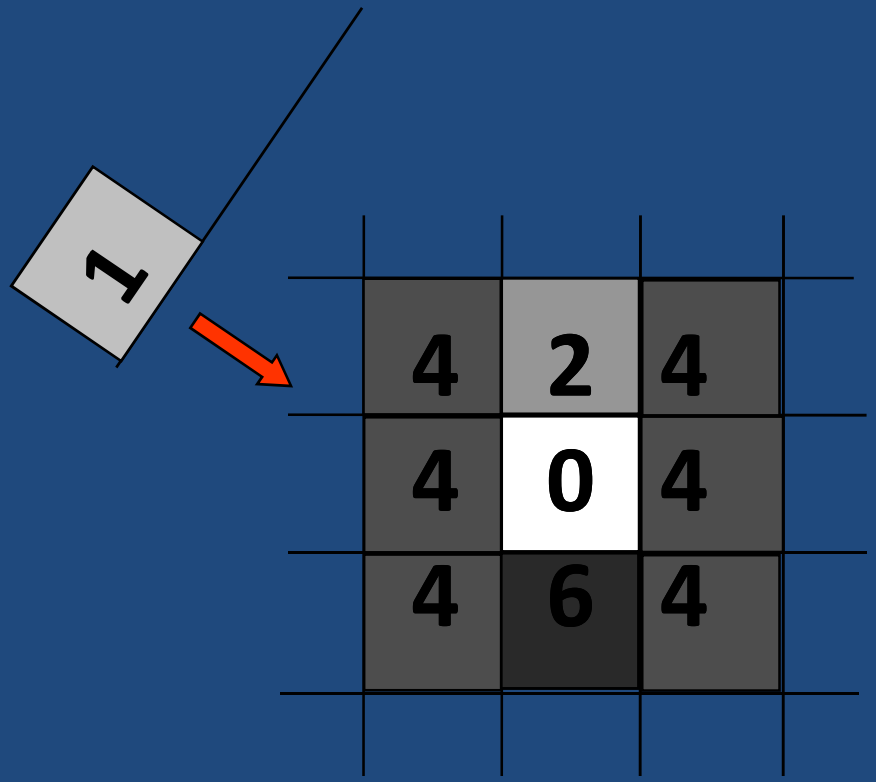
Objetivo :

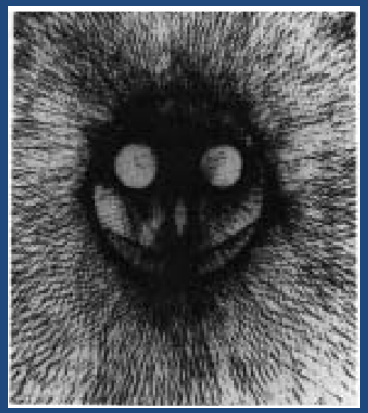


Consideremos:

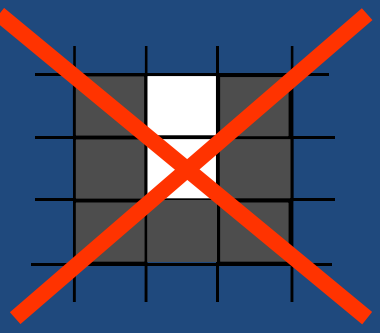
- Colimación estándar = colimación binaria
- Supongamos que nuestro haz no tiene atenuación.

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 del oscuridad. Pero para obtener una solución algunas de las líneas debían tener oscuridad negativa.





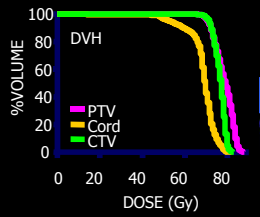
Objetivo :



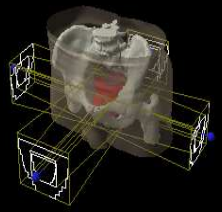
RT no existen niveles negativos y
NO todas las incidencias son posibles!

IMÁGENES

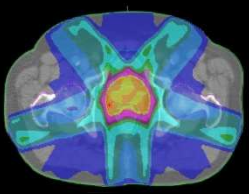
CONTORNO ESTRUCTURAS



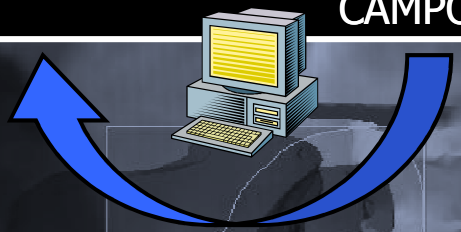
LIMITES



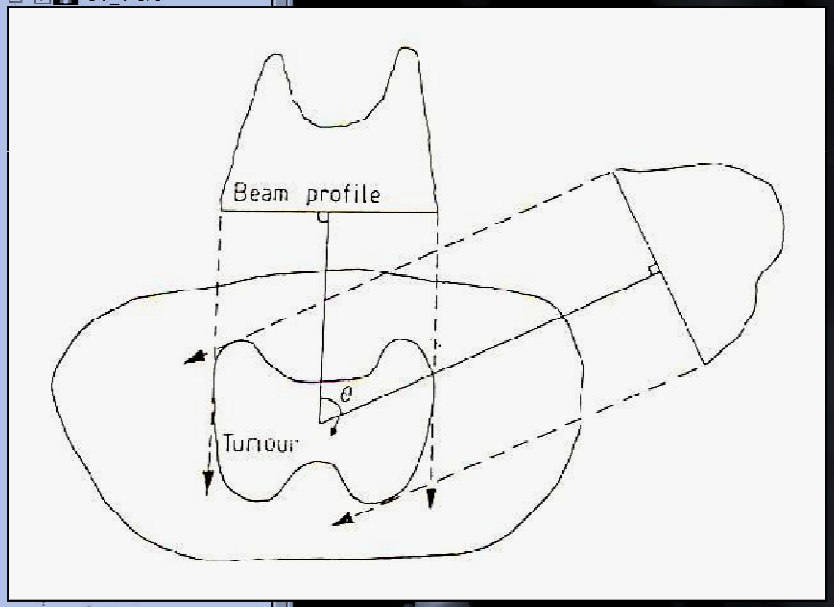
UBICACIÓN CAMPOS



CALCULO DE DOSIS



OPTIMIZACIÓN COMPUTADA (inversa)



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

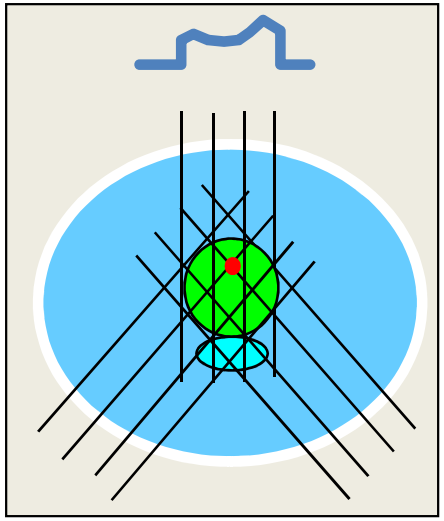
FUNCION OBJETO tipo cuadrática

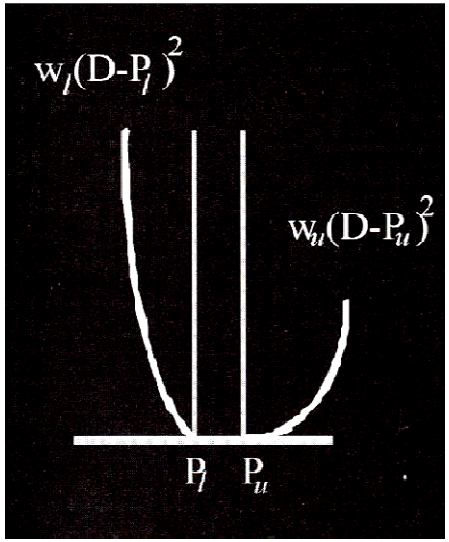
$$F_{PTV} = \frac{1}{N_t}\left[\sum_{i=1}^{N_t}\left(D_i - D_{presc}\right)^2 + w_{t,\min}\cdot\sum_{i=1}^{N_t}\left(D_i - D_{\min}\right)^2 + w_{t,\max}\cdot\sum_{i=1}^{N_t}\left(D_i - D_{\max}\right)^2\right]$$

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.

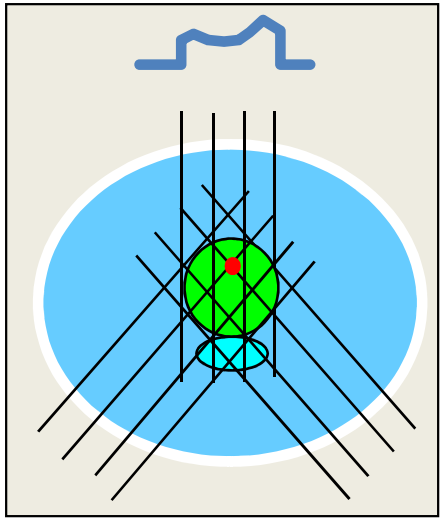




FUNCION OBJETO tipo cuadrática

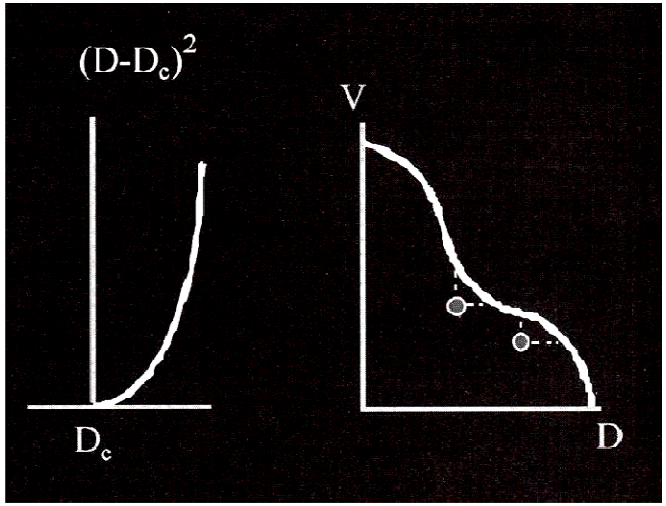
$$F_{OAR} = \frac{1}{N_{OAR}} \left[w_{OAR,\max} \cdot \sum_{i=1}^{N_{OAR}} (D_i - D_{\max})^2 + w_{OAR,dv} \cdot \sum_{i=1}^{N_{dv}} (D_i - D_{dv})^2 \right]$$

Suma sobre todos los elementos de volumen (voxel)



donde

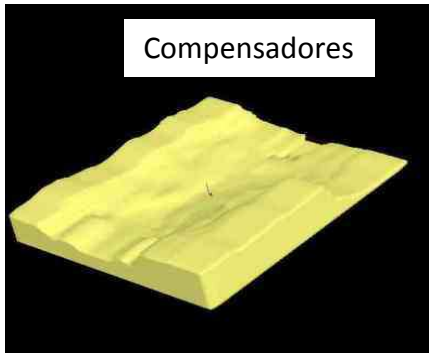
OAR	órgano de riesgo
N_{OAR}	es el numero de puntos en el órgano de riesgo.
D_{dv}	dosis de restricción dosis volumen
N_{dv}	numero de voxels cuya dosis debe estar por debajo de D_{dv}
$w_{OAR,max}$ y $w_{OAR,dv}$	penalidades relativas.

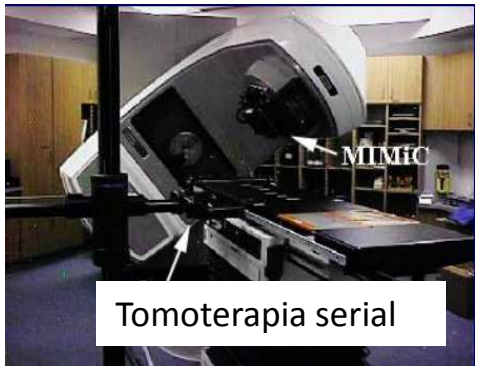


La cobertura del volumen blanco (PTV) compite con la protección de los organos de riesgo (OAR)

Tipos de IMRT

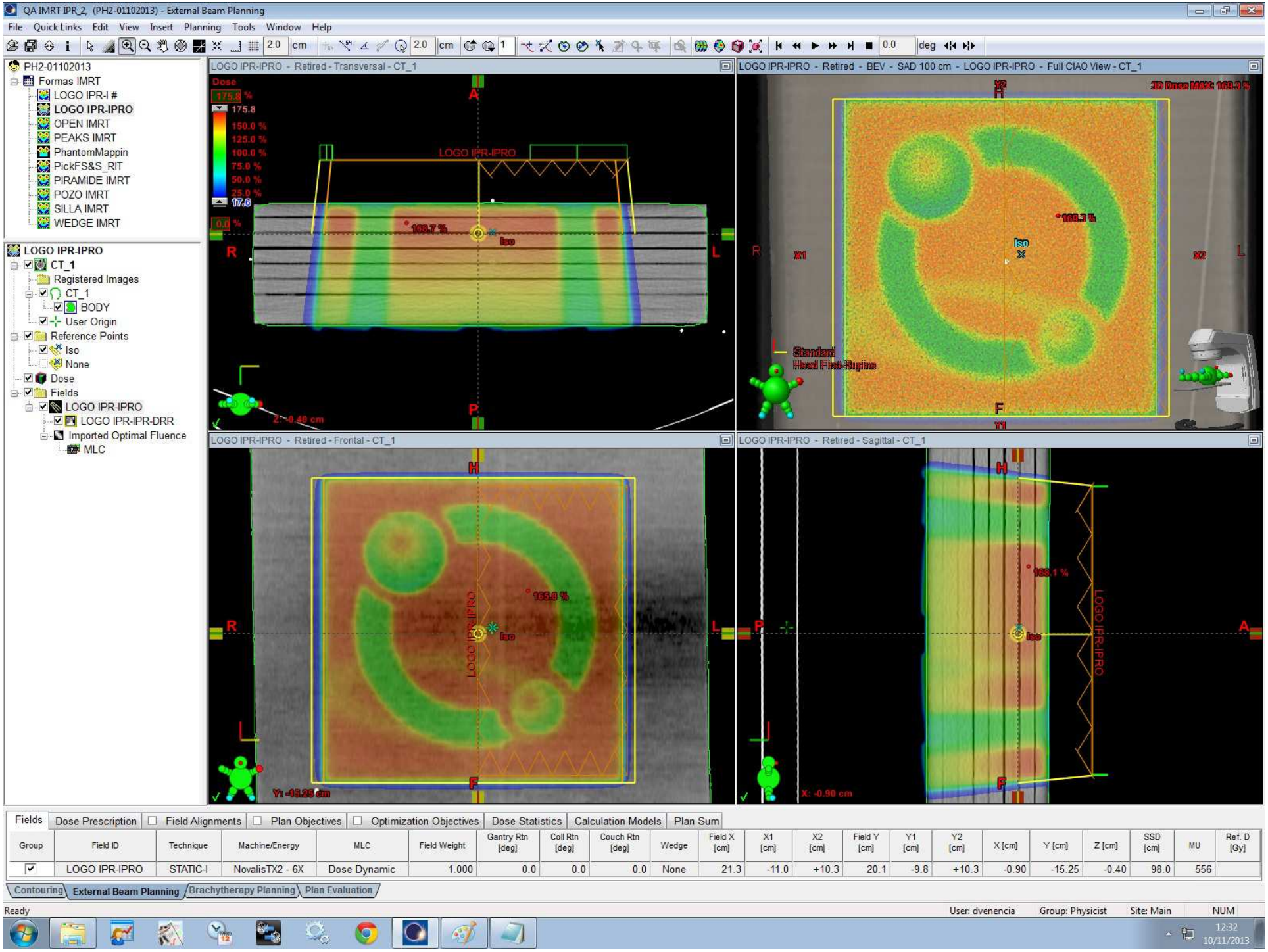
Compensadores



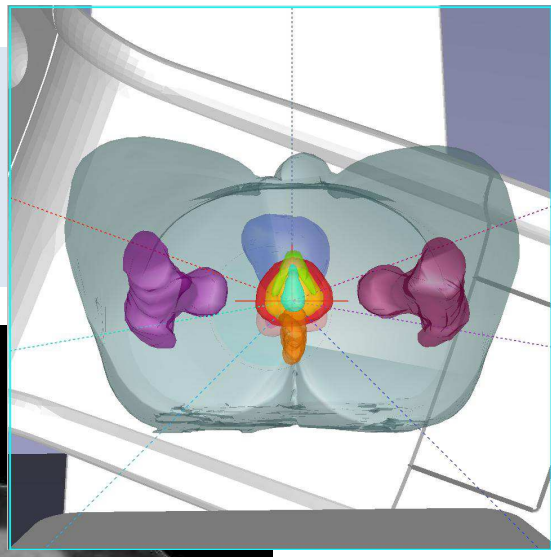


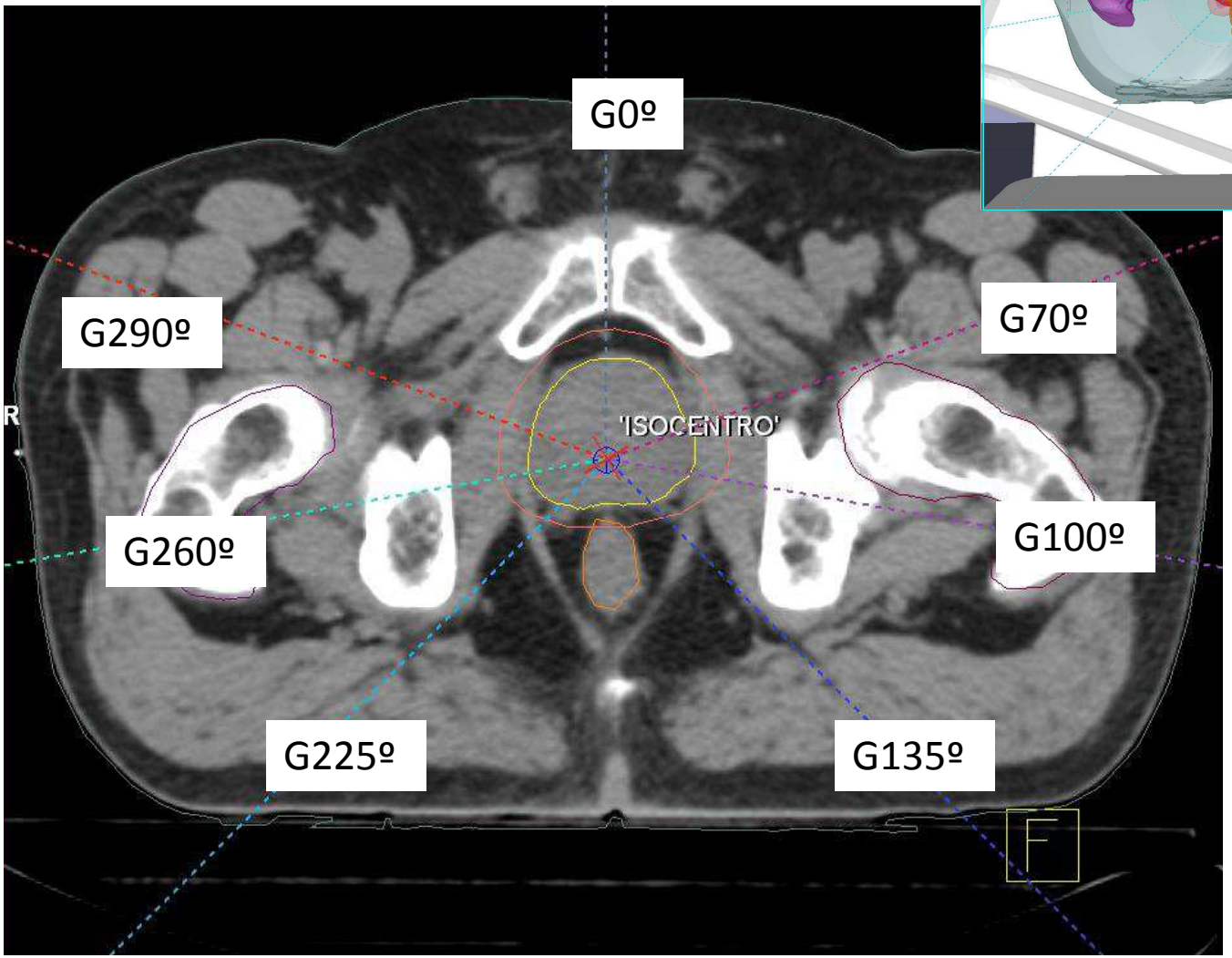
Tomoterapia helicoidal

Otros…


QA IMRT IPR_2, (PH2-01102013) - External Beam Planning
File Quick Links Edit View Insert Planning Tools Window Help
PH2-01102013
Formas IMRT
LOGO IPR-I #
LOGO IPR-IPRO
OPEN IMRT
PEAKS IMRT
PhantomMappin
PickFS&S_RIT
PIRAMIDE IMRT
POZO IMRT
SILLA IMRT
WEDGE IMRT
LOGO IPR-IPRO
CT_1
Registered Images
CT_1
BODY
User Origin
Reference Points
Iso
None
Dose
Fields
LOGO IPR-IPRO
LOGO IPR-IPR-DRR
Imported Optimal Fluence
MLC
LOGO IPR-IPRO - Retired - Transversal - CT_1
LOGO IPR-IPRO - Retired - BEV - SAD 100 cm - LOGO IPR-IPRO - Full CIAO View - CT_1
LOGO IPR-IPRO - Retired - Frontal - CT_1
LOGO IPR-IPRO - Retired - Sagittal - CT_1
Fields
Dose Prescription
Field Alignments
Plan Objectives
Optimization Objectives
Dose Statistics
Calculation Models
Plan Sum
Group
Field ID
Technique
Machine/Energy
MLC
Field Weight
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 [Gy]
LOGO IPR-IPRO STATIC-I NovalisTX2 - 6X Dose Dynamic 1.000 0.0 0.0 0.0 None 21.3 -11.0 +10.3 20.1 -9.8 +10.3 -0.90 -15.25 -0.40 98.0 556
Contouring
External Beam Planning
Brachytherapy Planning
Plan Evaluation
Ready
User: dvenencia
Group: Physicist
Site: Main
NUM
12:32
10/11/2013

Campos de tratamiento





Restricciones Dosis Volumen – Ejemplo

Los valores de dosis pueden variar según criterio medico.

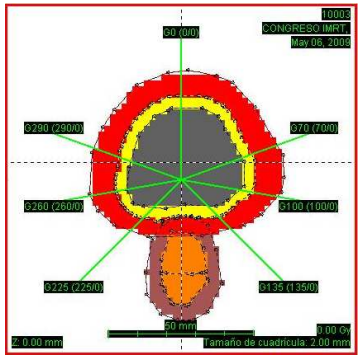
Volumen blanco

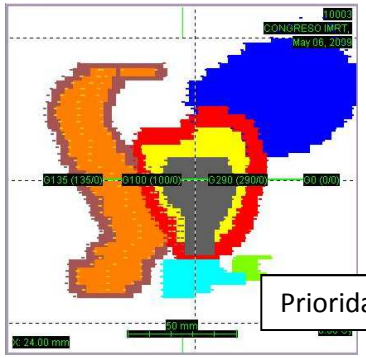
- Próstata (CTV_1)
  - $D_{mínima}$ = Dosis prescripta (80Gy)
  - $D_{máxima}$ < 110 % Dosis prescripta
  - Nº de fracciones = 40
- PTV
  - D95 = 80Gy
  - $D_{máxima}$ < 110% Dosis prescripta
- $D_{máxima}$ alejado de uretra región central

Organos de riesgo

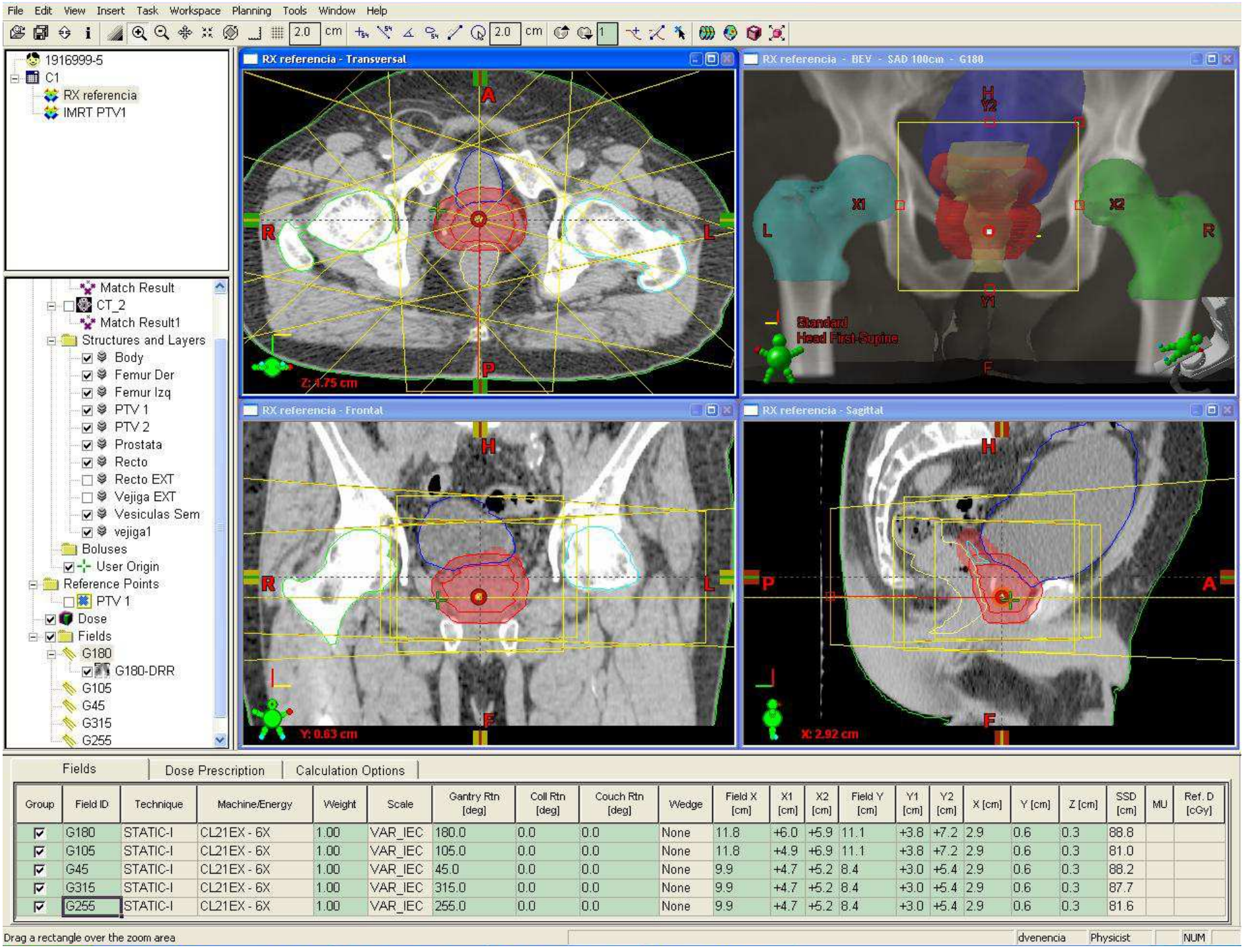
- Recto
  - V40 entre 35% - 45%
  - V65 < 20%
  - Pared Posterior < 44Gy
- Vejiga
  - V40 < 40%
  - D25 < 65Gy
- Cabezas femorales
  - V50 < 10%

- Bulbo peneano
- Cuerpos cavernosos



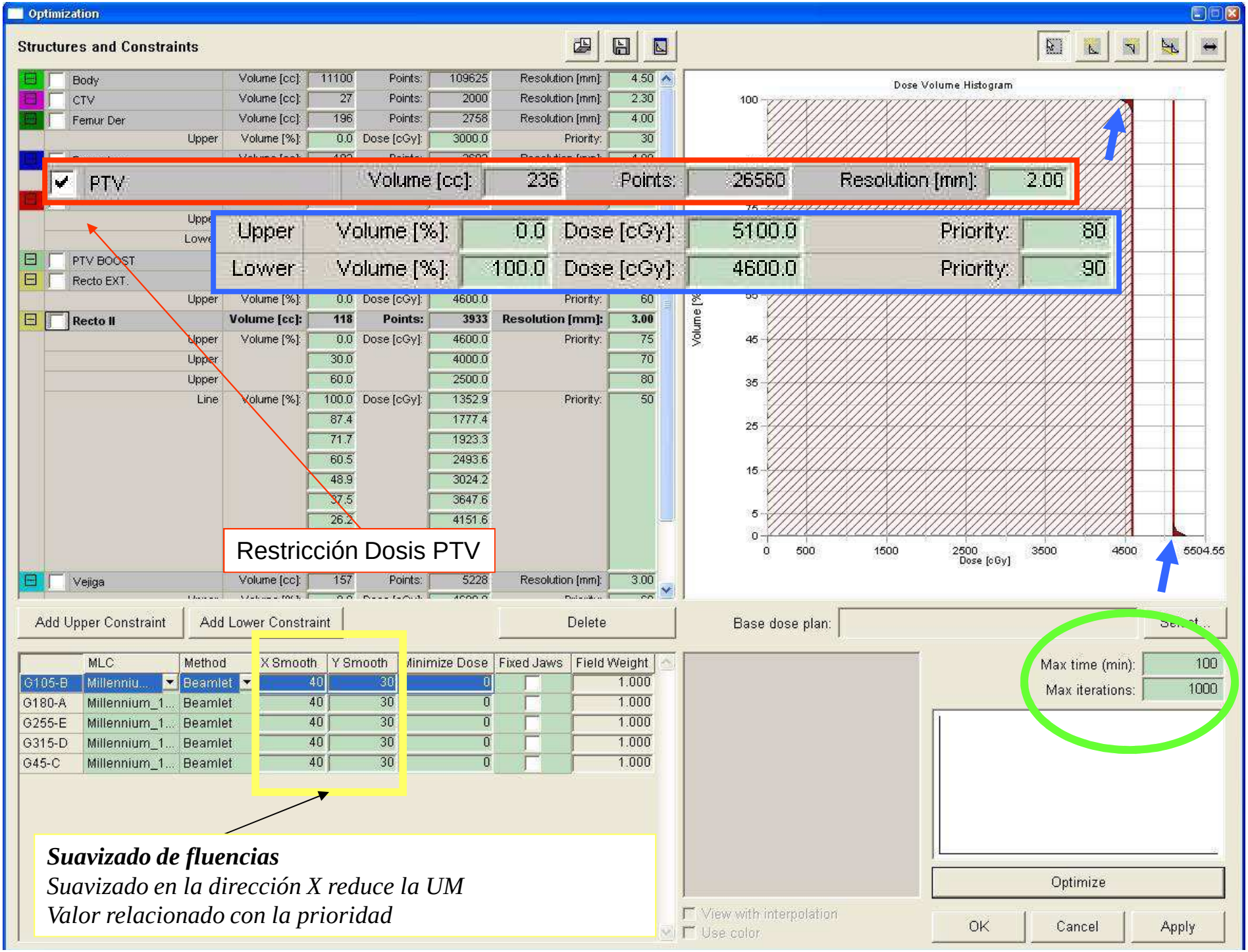


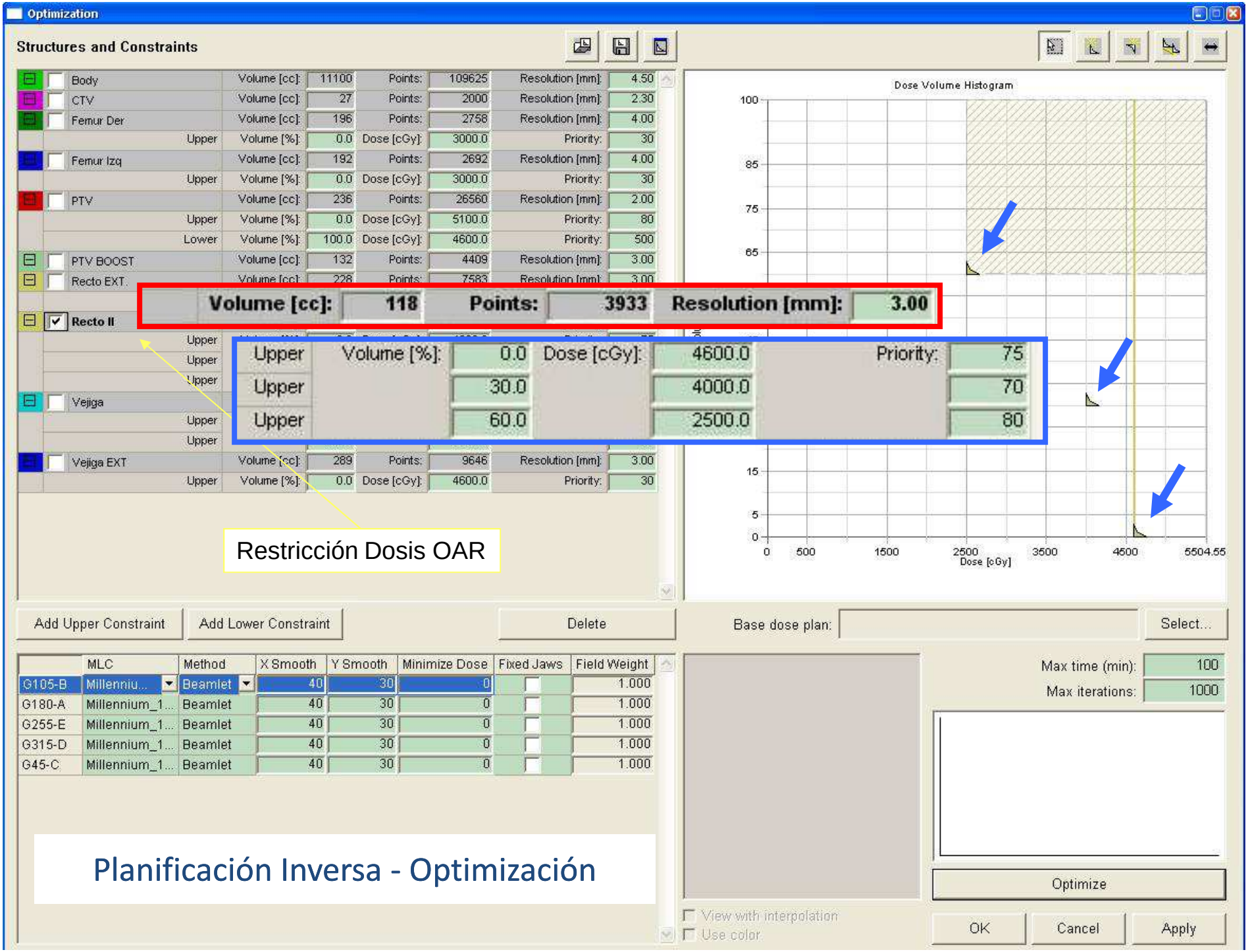
Prioridad de superposición

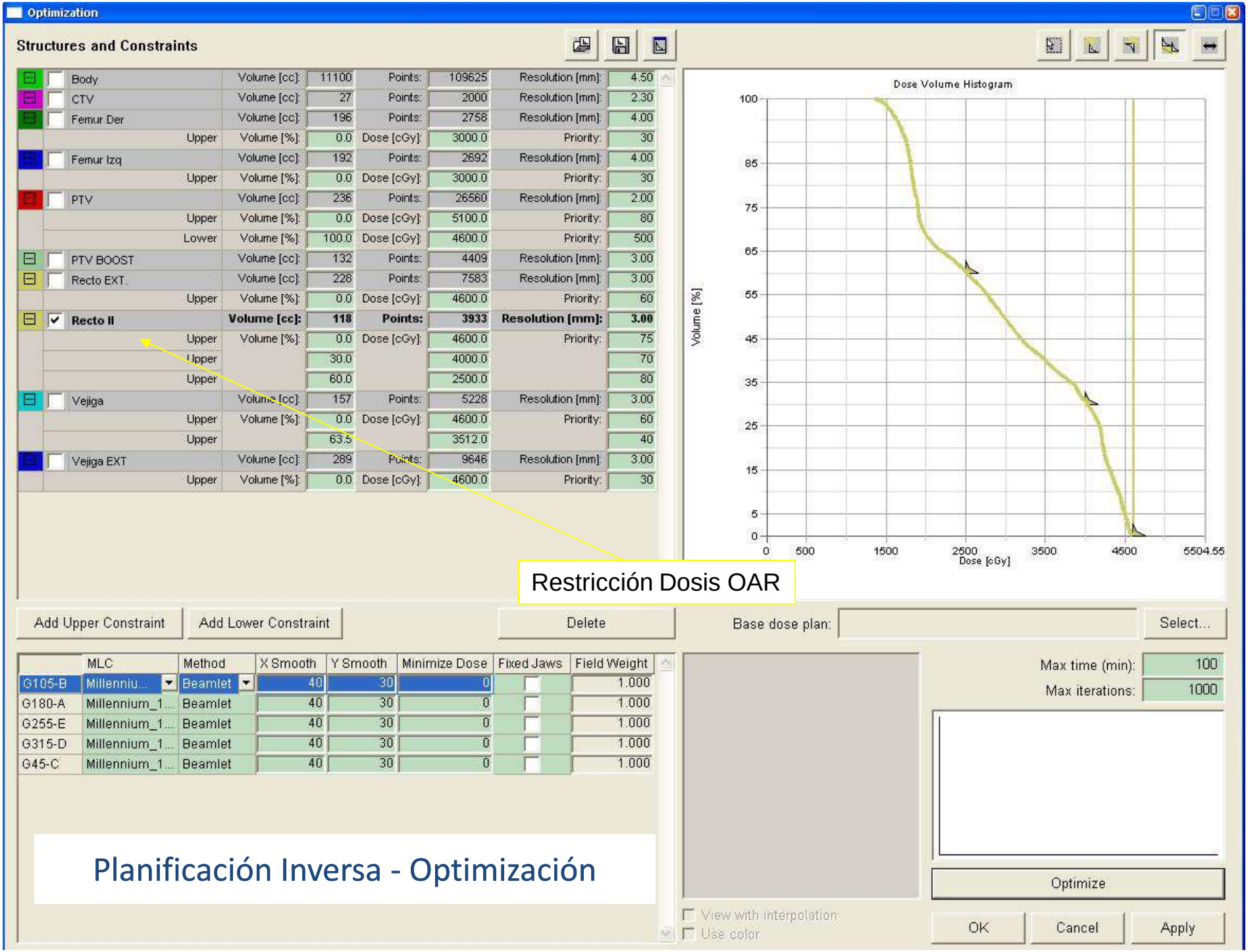


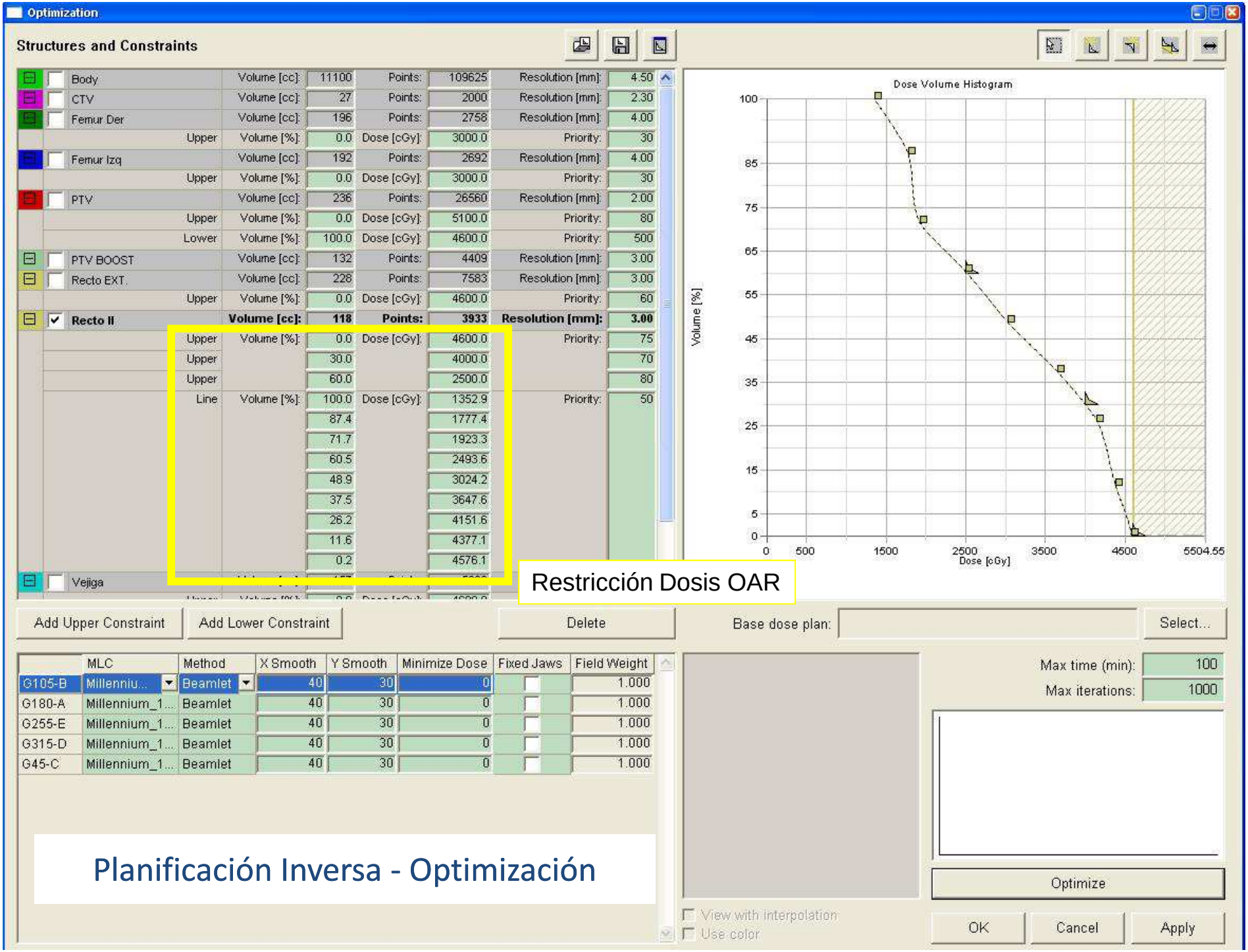
Group	Field ID	Technique	Machine/Energy	Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☑	G180	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	180.0	0.0	0.0	None	11.8	+6.0	+5.9	11.1	+3.8	+7.2	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	9.9	+4.7	+5.2	8.4	+3.0	+5.4	2.9	0.6	0.3	88.2		
☑	G315	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	315.0	0.0	0.0	None	9.9	+4.7	+5.2	8.4	+3.0	+5.4	2.9	0.6	0.3	87.7		
☑	G255	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	255.0	0.0	0.0	None	9.9	+4.7	+5.2	8.4	+3.0	+5.4	2.9	0.6	0.3	81.6		

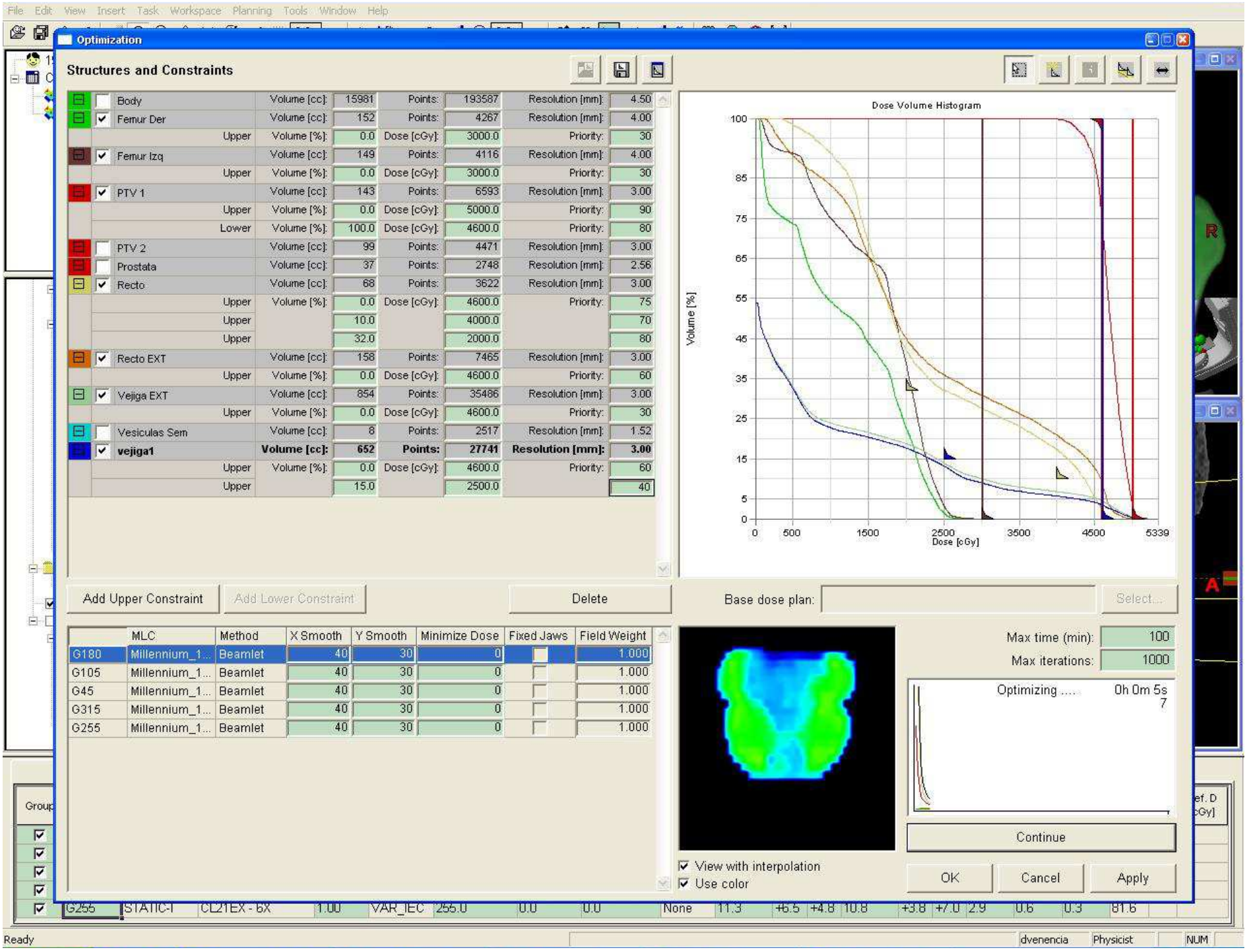
Group	Field ID	Technique	Machine/Energy	Weight	Scale	Gantry Rtn [deg]	Coll Rtn [deg]	Couch Rtn [deg]	Wedge	Field X [cm]	X1 [cm]	X2 [cm]	Field Y [cm]	Y1 [cm]	Y2 [cm]	X [cm]	Y [cm]	Z [cm]	SSD [cm]	MU	Ref. D [cGy]
☑	G105-B	STATIC-I	CL21EX - 6X	1.00	VAR_IEC	105.0	350.0	0.0	None	12.3	+4.3	+8.0	9.8	+3.3	+6.5	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		


Optimization
Structures and Constraints
Body Volume [cc]: 11100 Points: 109625 Resolution [mm]: 4.50
CTV Volume [cc]: 27 Points: 2000 Resolution [mm]: 2.30
Femur Der Volume [cc]: 196 Points: 2758 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
PTV Volume [cc]: 236 Points: 26560 Resolution [mm]: 2.00
Upper Volume [%]: 0.0 Dose [cGy]: 5100.0 Priority: 80
Lower Volume [%]: 100.0 Dose [cGy]: 4600.0 Priority: 90
PTV BOOST
Recto EXT.
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 60
Recto II Volume [cc]: 118 Points: 3933 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 75
Upper 30.0 4000.0 70
Upper 60.0 2500.0 80
Line Volume [%]: 100.0 Dose [cGy]: 1352.9 Priority: 50
87.4 1777.4
71.7 1923.3
60.5 2493.6
48.9 3024.2
37.5 3647.6
26.2 4151.6
Vejiga Volume [cc]: 157 Points: 5228 Resolution [mm]: 3.00
Dose Volume Histogram
Volume [%]
Dose [cGy]
0 500 1500 2500 3500 4500 5504.55
Restricción Dosis PTV
Add Upper Constraint
Add Lower Constraint
Delete
Base dose plan:
MLC Method X Smooth Y Smooth Minimize Dose Fixed Jaws Field Weight
G105-B Millenniu... Beamlet 40 30 0 1.000
G180-A Millennium_1... Beamlet 40 30 0 1.000
G255-E Millennium_1... Beamlet 40 30 0 1.000
G315-D Millennium_1... Beamlet 40 30 0 1.000
G45-C Millennium_1... Beamlet 40 30 0 1.000
Max time (min): 100
Max iterations: 1000
Optimize
View with interpolation
Use color
OK
Cancel
Apply
Suavizado de fluencias
Suavizado en la dirección X reduce la UM
Valor relacionado con la prioridad


Optimization
Structures and Constraints
Body Volume [cc]: 11100 Points: 109625 Resolution [mm]: 4.50
CTV Volume [cc]: 27 Points: 2000 Resolution [mm]: 2.30
Femur Der Volume [cc]: 196 Points: 2758 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
Femur Izq Volume [cc]: 192 Points: 2692 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
PTV Volume [cc]: 236 Points: 26560 Resolution [mm]: 2.00
Upper Volume [%]: 0.0 Dose [cGy]: 5100.0 Priority: 80
Lower Volume [%]: 100.0 Dose [cGy]: 4600.0 Priority: 500
PTV BOOST Volume [cc]: 132 Points: 4409 Resolution [mm]: 3.00
Recto EXT. Volume [cc]: 228 Points: 7583 Resolution [mm]: 3.00
Volume [cc]: 118 Points: 3933 Resolution [mm]: 3.00
Recto II
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 75
Upper 30.0 4000.0 70
Upper 60.0 2500.0 80
Vejiga
Vejiga EXT Volume [cc]: 289 Points: 9646 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 30
Restricción Dosis OAR
Dose Volume Histogram
100
85
75
65
15
5
0
0
500
1500
2500
3500
4500
5504.55
Dose [cGy]
Add Upper Constraint
Add Lower Constraint
Delete
Base dose plan:
Select...
MLC Method X Smooth Y Smooth Minimize Dose Fixed Jaws Field Weight
G105-B Millenniu... Beamlet 40 30 0 1.000
G180-A Millennium_1... Beamlet 40 30 0 1.000
G255-E Millennium_1... Beamlet 40 30 0 1.000
G315-D Millennium_1... Beamlet 40 30 0 1.000
G45-C Millennium_1... Beamlet 40 30 0 1.000
Max time (min): 100
Max iterations: 1000
Optimize
View with interpolation
Use color
OK
Cancel
Apply
Planificación Inversa - Optimización


Optimization
Structures and Constraints
Body Volume [cc]: 11100 Points: 109625 Resolution [mm]: 4.50
CTV Volume [cc]: 27 Points: 2000 Resolution [mm]: 2.30
Femur Der Volume [cc]: 196 Points: 2758 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
Femur Izq Volume [cc]: 192 Points: 2692 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
PTV Volume [cc]: 236 Points: 26560 Resolution [mm]: 2.00
Upper Volume [%]: 0.0 Dose [cGy]: 5100.0 Priority: 80
Lower Volume [%]: 100.0 Dose [cGy]: 4600.0 Priority: 500
PTV BOOST Volume [cc]: 132 Points: 4409 Resolution [mm]: 3.00
Recto EXT. Volume [cc]: 228 Points: 7583 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 60
Recto II Volume [cc]: 118 Points: 3933 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 75
Upper 30.0 4000.0 70
Upper 60.0 2500.0 80
Vejiga Volume [cc]: 157 Points: 5228 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 60
Upper 63.5 3512.0 40
Vejiga EXT Volume [cc]: 289 Points: 9646 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 30
Dose Volume Histogram
Volume [%]
100
85
75
65
55
45
35
25
15
5
0
0
500
1500
2500
3500
4500
5504.55
Dose [cGy]
Restricción Dosis OAR
Add Upper Constraint
Add Lower Constraint
Delete
Base dose plan:
Select...
MLC Method X Smooth Y Smooth Minimize Dose Fixed Jaws Field Weight
G105-B Millenniu... Beamlet 40 30 0 1.000
G180-A Millennium_1... Beamlet 40 30 0 1.000
G255-E Millennium_1... Beamlet 40 30 0 1.000
G315-D Millennium_1... Beamlet 40 30 0 1.000
G45-C Millennium_1... Beamlet 40 30 0 1.000
Max time (min): 100
Max iterations: 1000
Optimize
View with interpolation
Use color
OK
Cancel
Apply
Planificación Inversa - Optimización


Optimization
Structures and Constraints
Body Volume [cc]: 11100 Points: 109625 Resolution [mm]: 4.50
CTV Volume [cc]: 27 Points: 2000 Resolution [mm]: 2.30
Femur Der Volume [cc]: 196 Points: 2758 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
Femur Izq Volume [cc]: 192 Points: 2692 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
PTV Volume [cc]: 236 Points: 26560 Resolution [mm]: 2.00
Upper Volume [%]: 0.0 Dose [cGy]: 5100.0 Priority: 80
Lower Volume [%]: 100.0 Dose [cGy]: 4600.0 Priority: 500
PTV BOOST Volume [cc]: 132 Points: 4409 Resolution [mm]: 3.00
Recto EXT. Volume [cc]: 228 Points: 7583 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 60
Recto II Volume [cc]: 118 Points: 3933 Resolution [mm]: 3.00
Upper Volume [%]: 0.0 Dose [cGy]: 4600.0 Priority: 75
Upper 30.0 4000.0 70
Upper 60.0 2500.0 80
Line Volume [%]: 100.0 Dose [cGy]: 1352.9 Priority: 50
87.4 1777.4
71.7 1923.3
60.5 2493.6
48.9 3024.2
37.5 3647.6
26.2 4151.6
11.6 4377.1
0.2 4576.1
Vejiga
Dose Volume Histogram
Volume [%]
Dose [cGy]
100
85
75
65
55
45
35
25
15
5
0
0
500
1500
2500
3500
4500
5504.55
Restricción Dosis OAR
Add Upper Constraint
Add Lower Constraint
Delete
Base dose plan:
Select...
MLC Method X Smooth Y Smooth Minimize Dose Fixed Jaws Field Weight
G105-B Millenniu... Beamlet 40 30 0 1.000
G180-A Millennium_1... Beamlet 40 30 0 1.000
G255-E Millennium_1... Beamlet 40 30 0 1.000
G315-D Millennium_1... Beamlet 40 30 0 1.000
G45-C Millennium_1... Beamlet 40 30 0 1.000
Max time (min): 100
Max iterations: 1000
Optimize
View with interpolation
Use color
OK
Cancel
Apply
Planificación Inversa - Optimización

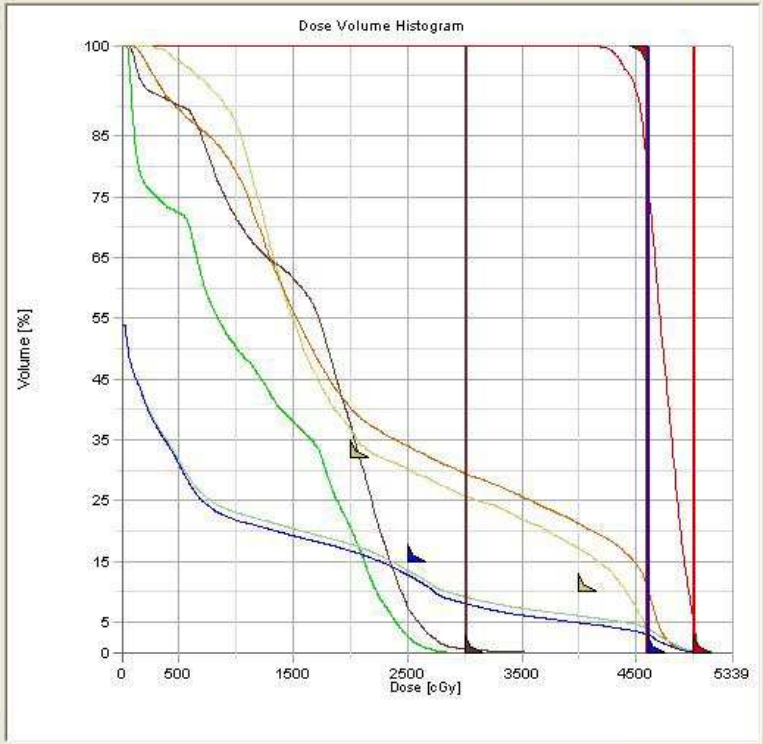

Optimization
Structures and Constraints
Body Volume [cc]: 15981 Points: 193587 Resolution [mm]: 4.50
Femur Der Volume [cc]: 152 Points: 4267 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 Dose [cGy]: 3000.0 Priority: 30
Femur Izq Volume [cc]: 149 Points: 4116 Resolution [mm]: 4.00
Upper Volume [%]: 0.0 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
Dose Volume Histogram
Volume [%]
Dose [cGy]
0 500 1500 2500 3500 4500 5339
0 5 15 25 35 45 55 65 75 85 100
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
Optimizing 0h 0m 5s
7
Continue
View with interpolation
Use color
OK
Cancel
Apply
Ready

File Edit View Insert Task Workspace Planning Tools Window Help

Optimization

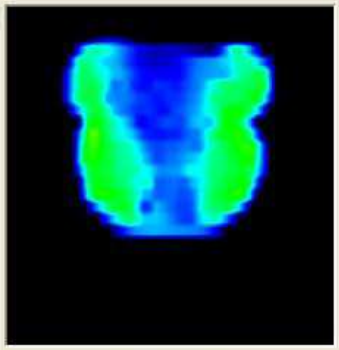
Structures and Constraints

☐	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 | 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



☑ View with interpolation
☑ Use color

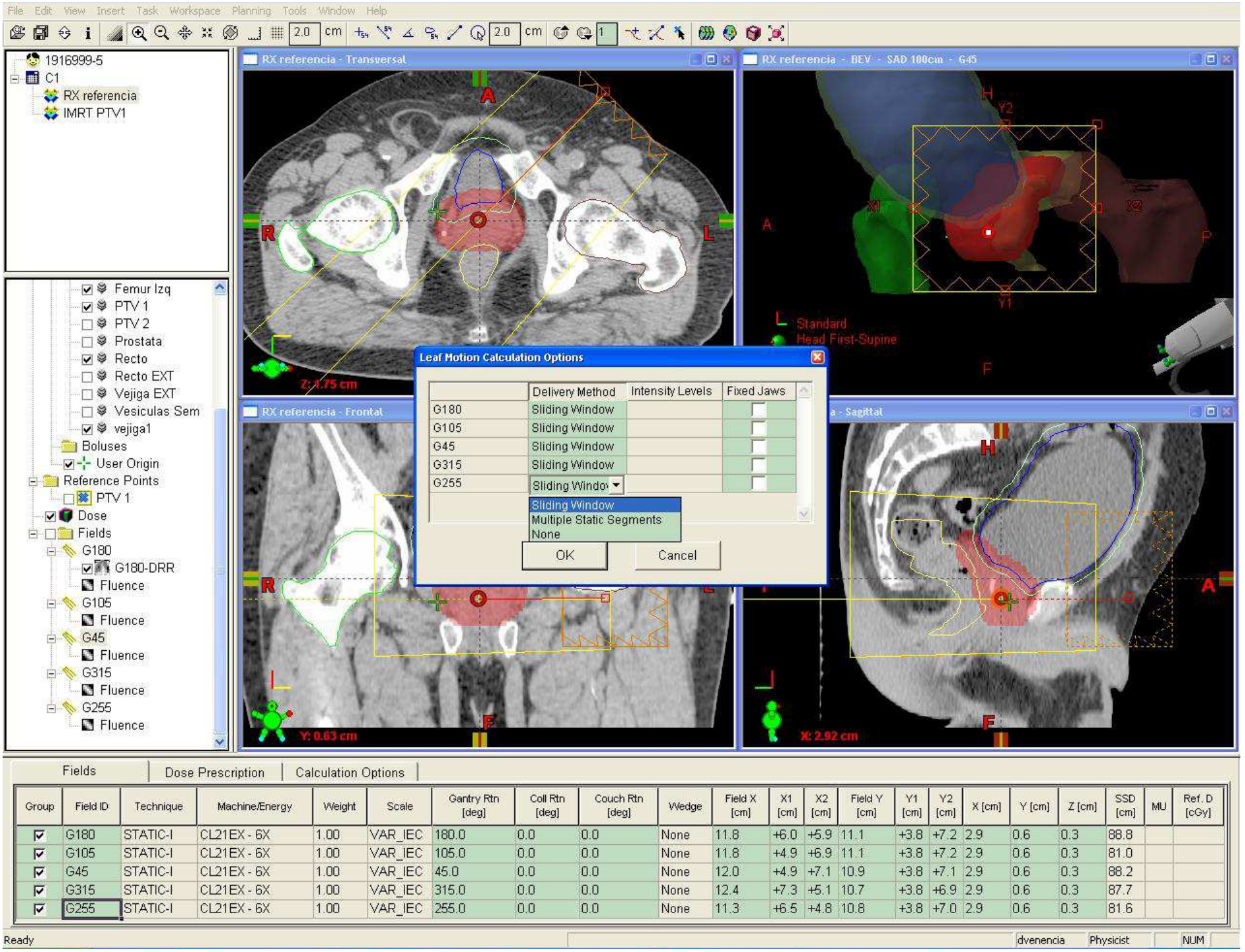
Max time (min): 100
Max iterations: 1000

Continue

OK | Cancel | Apply

☑	G255	STATIC-1	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

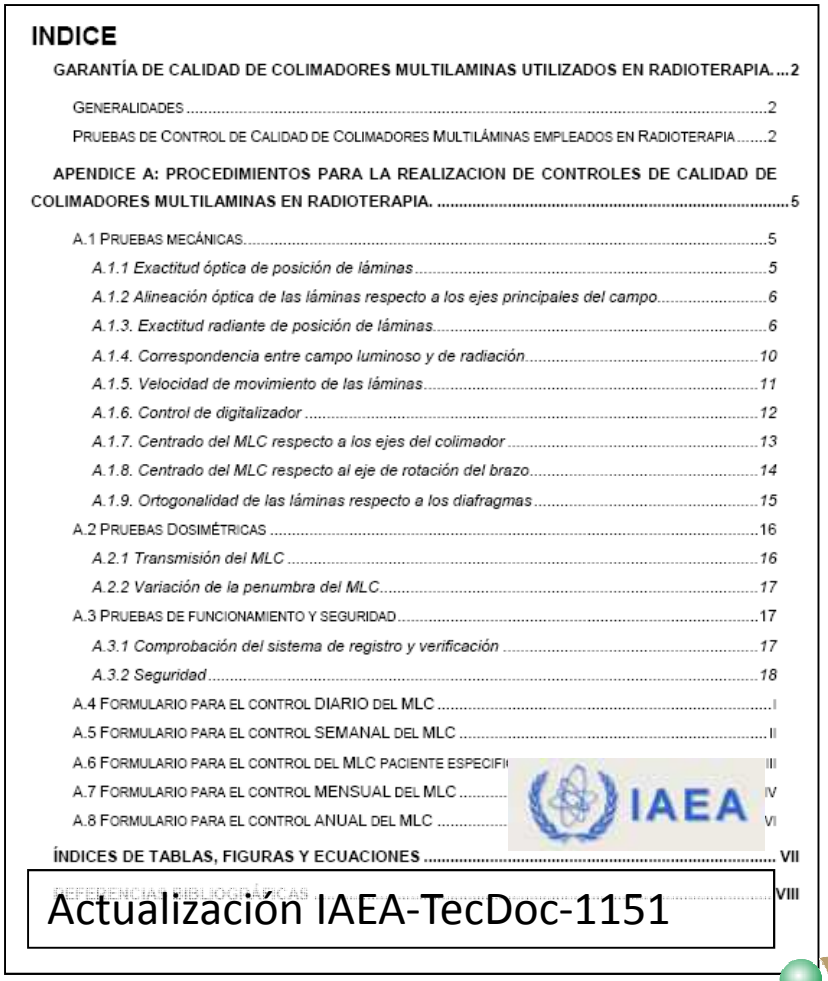


Fields | Dose Prescription | Calculation Options

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		

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)



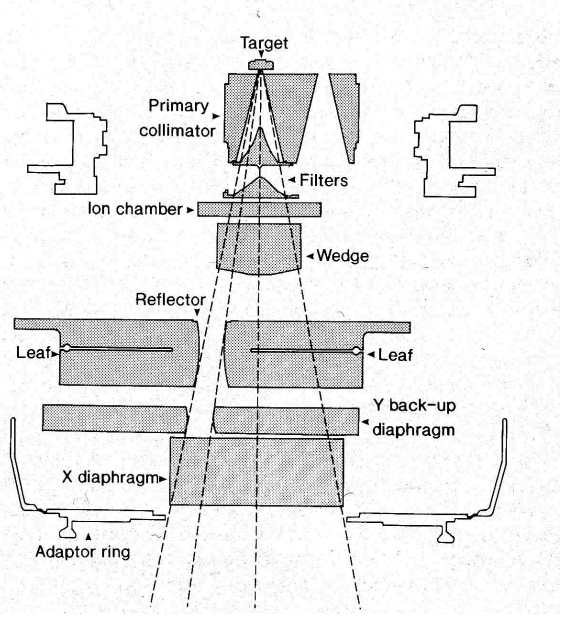
INDICE

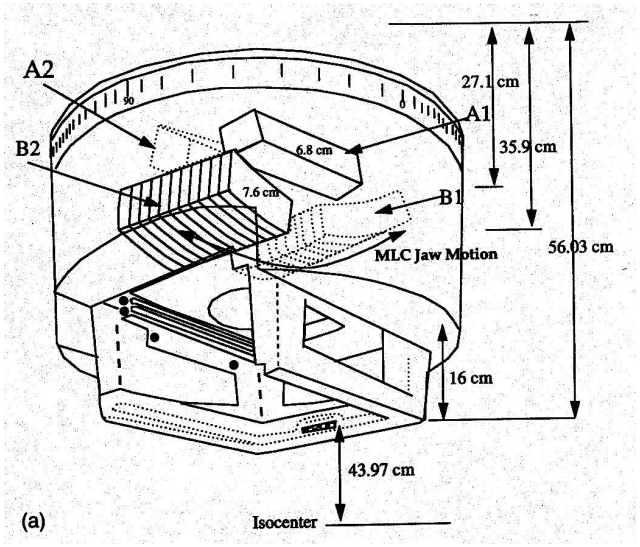
IAEA

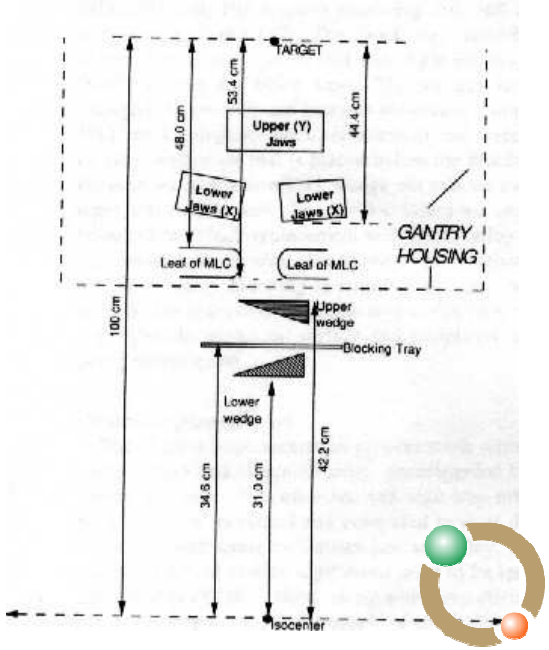
Actualización IAEA-TecDoc-1151

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)



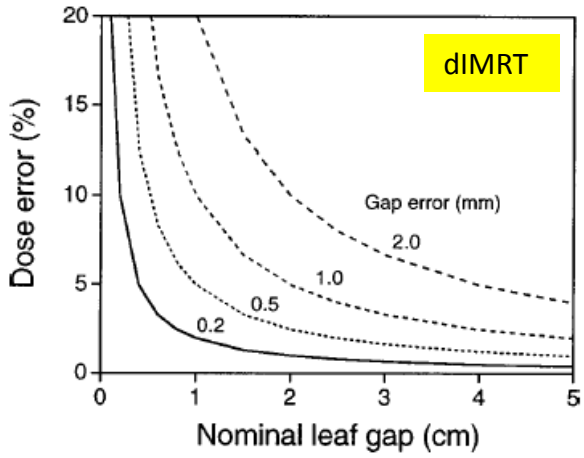




Exactitud de **posicionamiento** de laminas

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

Error Dosis α [Error del GAP / Ancho de GAP]

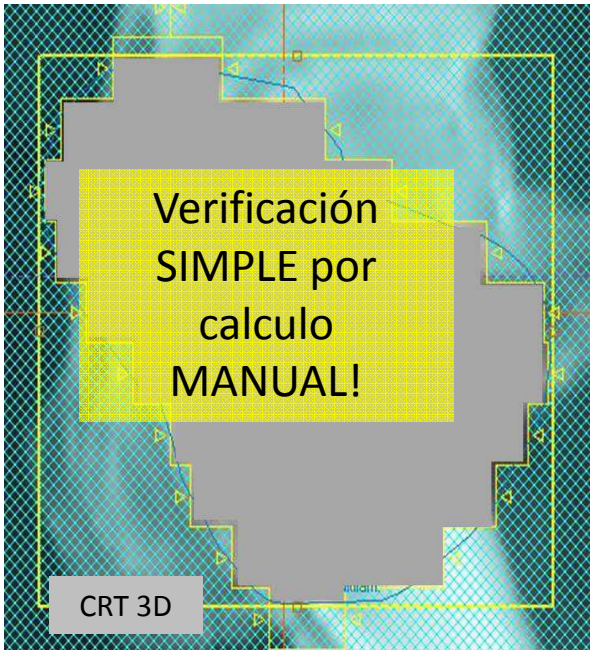


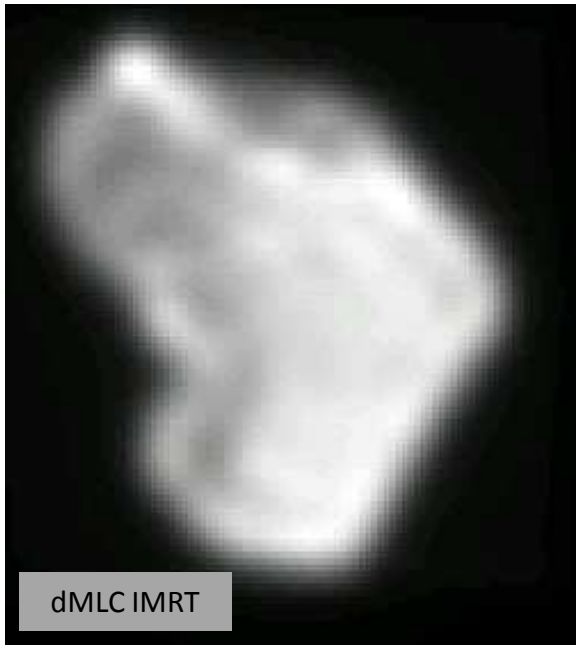
T. LoSasso, Med. Phys. 25(10), 1998.

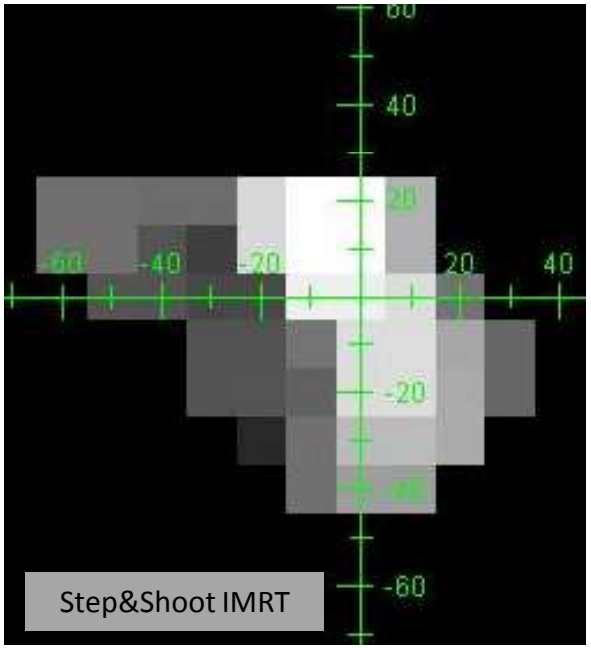
Exactitud de **posicionamiento** de laminas

Tolerancia:

- 3DCRT / IMRT S&S ±1.0mm
- dIMRT ±0.2mm

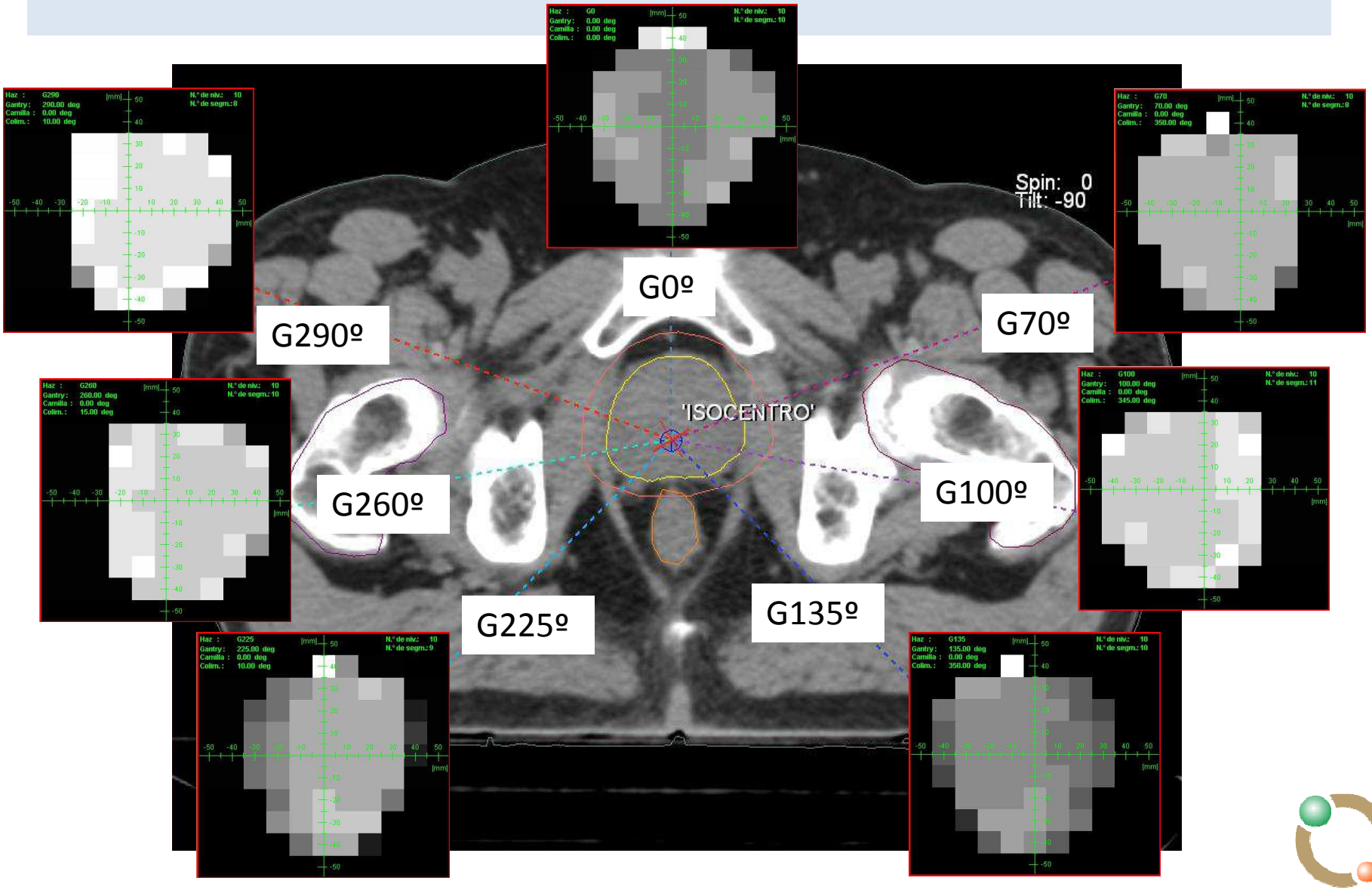




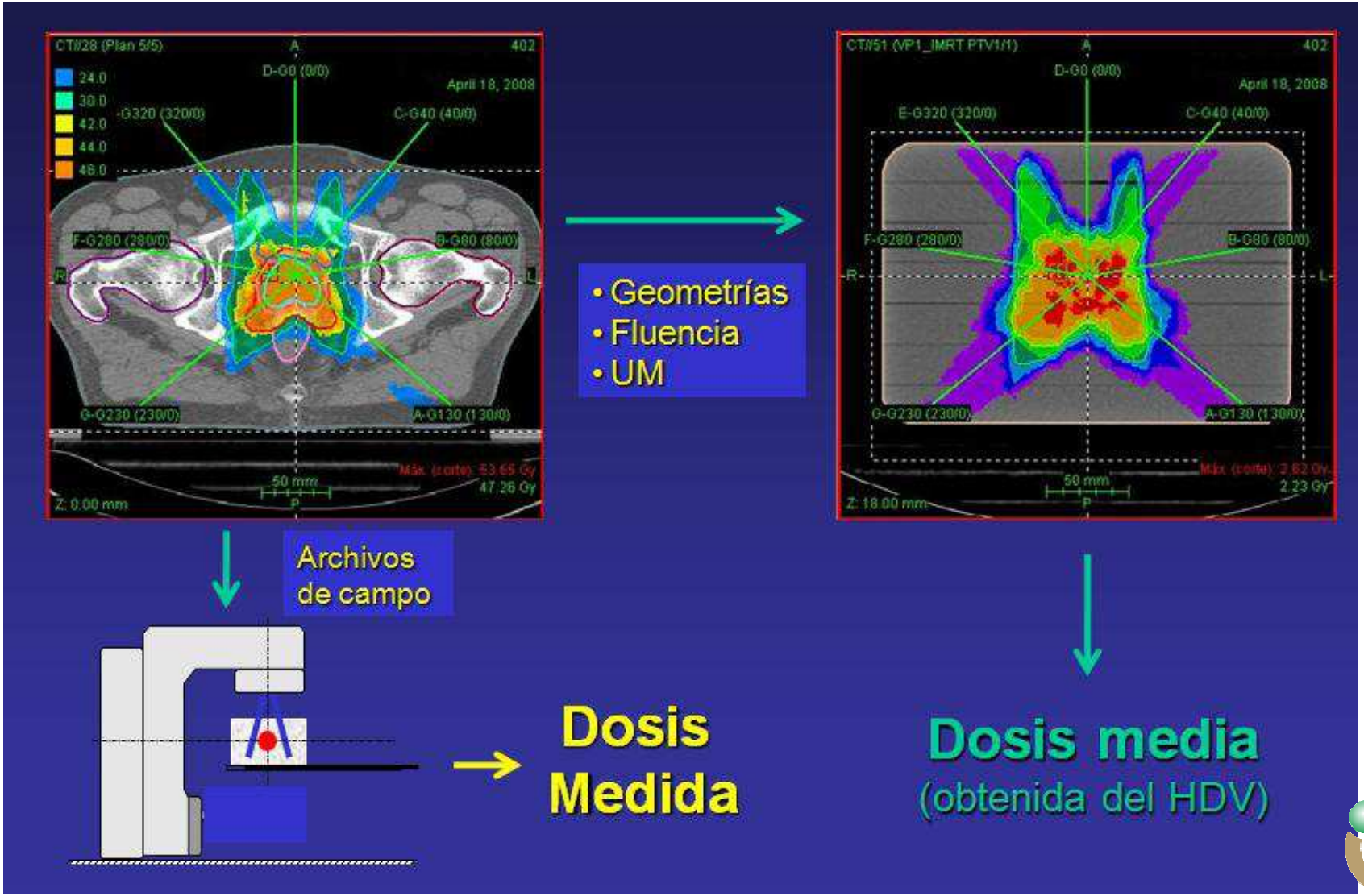


Como verificamos la dosis entregada por cada campo ?

Fluencias – Niveles de intensidad



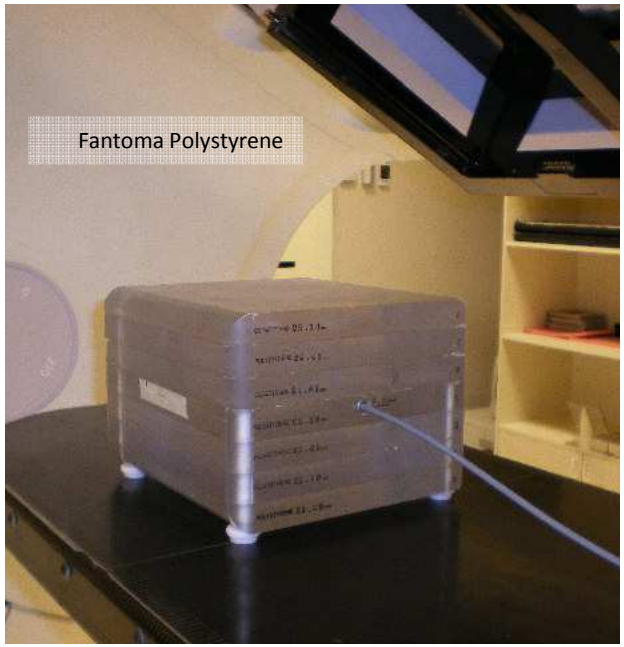
2. Medición de la dosis total para el PLAN



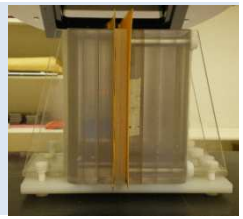
2. Medición de la dosis total para el PLAN

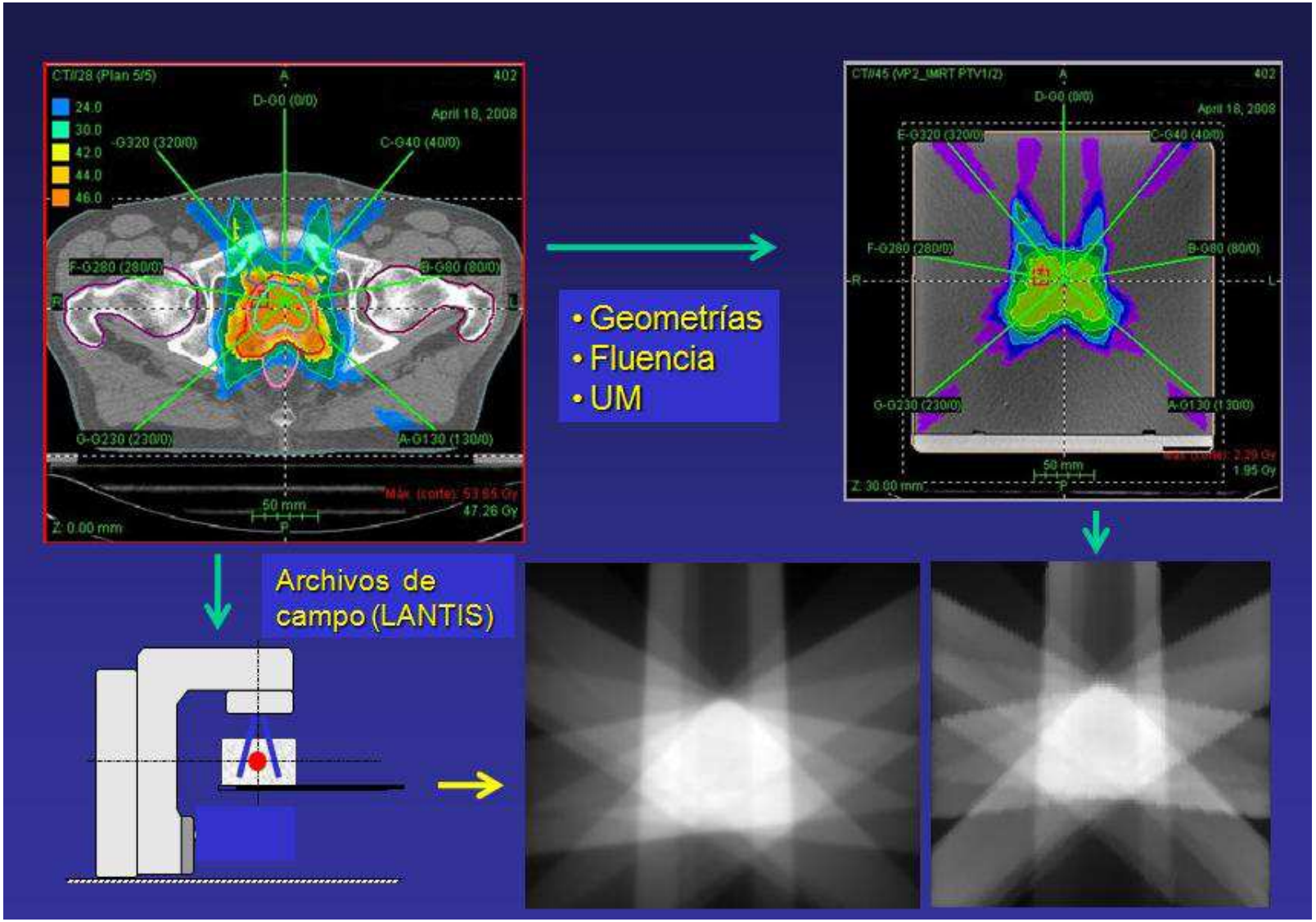
Criterio de tolerancia

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

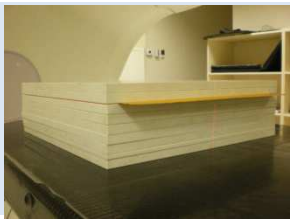


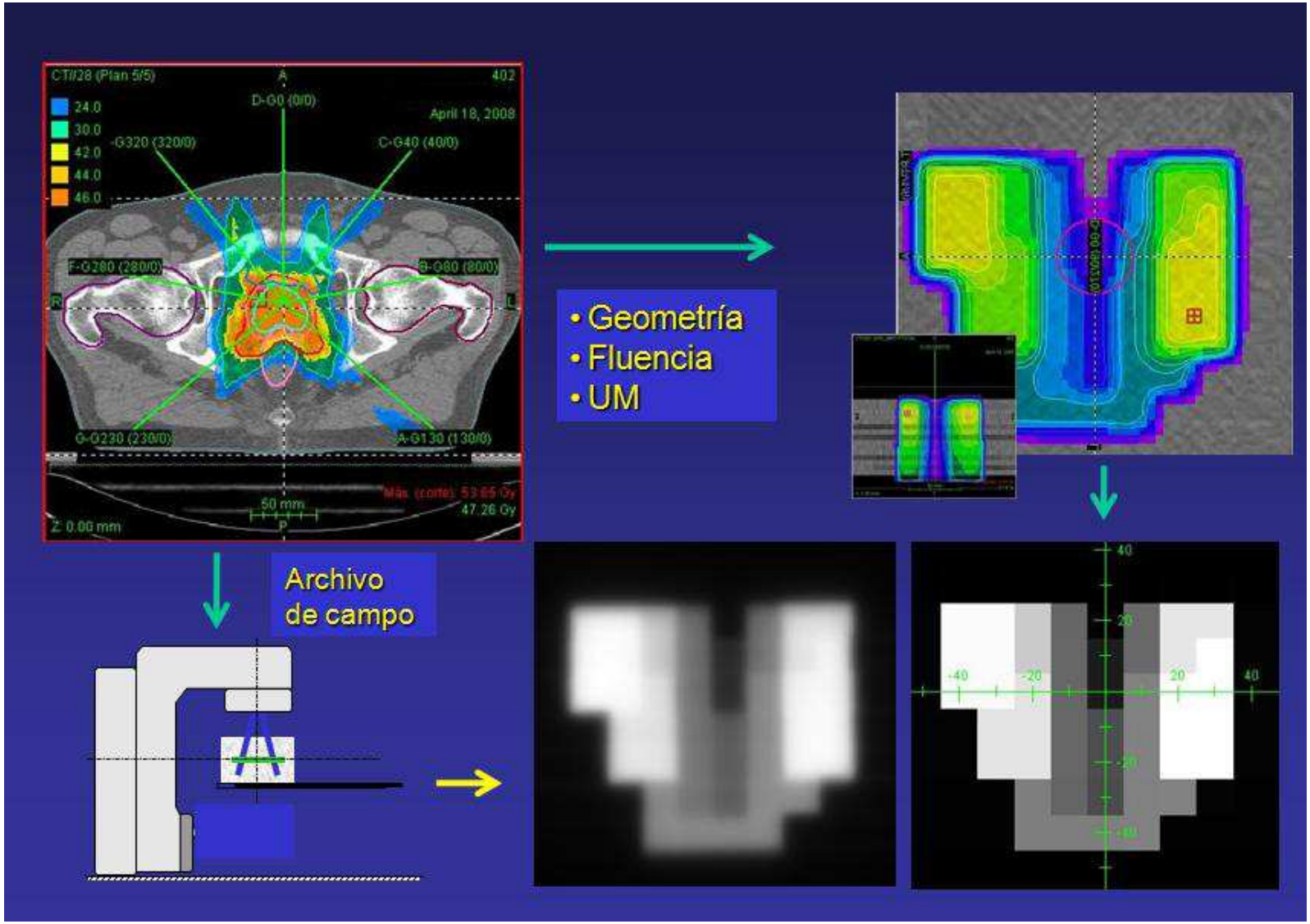
3. Medición de distribución de dosis total para el PLAN





4. Medición de distribución campo independiente





RIT113 IMRT Analysis

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

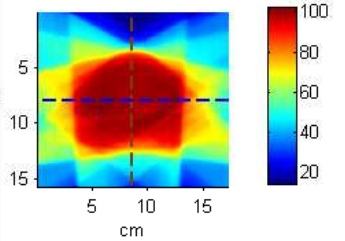
Image Normalization
Target Normalization
281.875 293.999 301.875
Center Value in Slider
Ref. Normalization: 243.5238
Ting Factor: 0.831
Cramb Factor: 1.003

Tolerances
Difference Tol. (%): 0 3 100
DTA Tol. (mm): 0 3 10
Gamma Tol.: 0.5 1 5

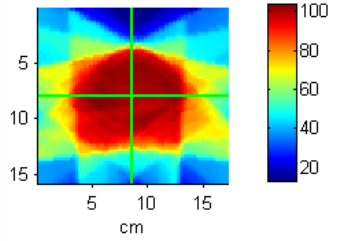
DTA & Analysis Parameters
High Grad. Thresh. (%/cm): 0 30 100
High Dose Thresh.(%): 0 3 04.182
Apply to all plots.
DTA Search Radius: 1.0cm
DTA Precision(±%): 0.5

Save/Restore Layouts
Save Current Layout
Restore Saved Layout
Comments
Plot Layout: 1 1x2 2x2 2x3
Close IMRT Analysis

Target: ...\Congreso ptv1 ax10_film_1.rv4

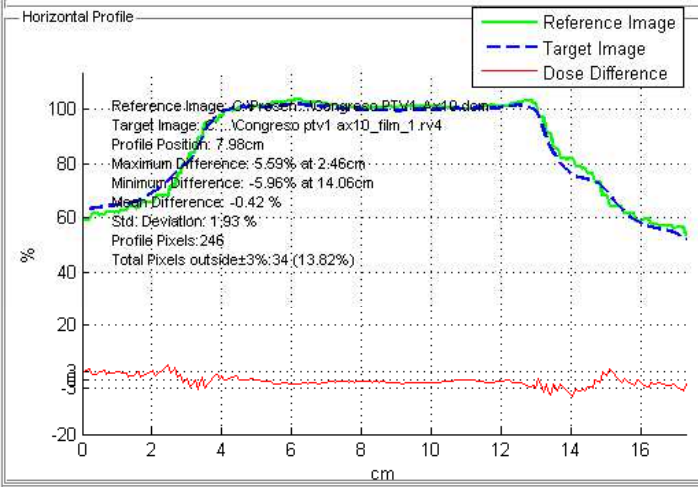


Reference: ...\Congreso PTV1 Ax10.dcm



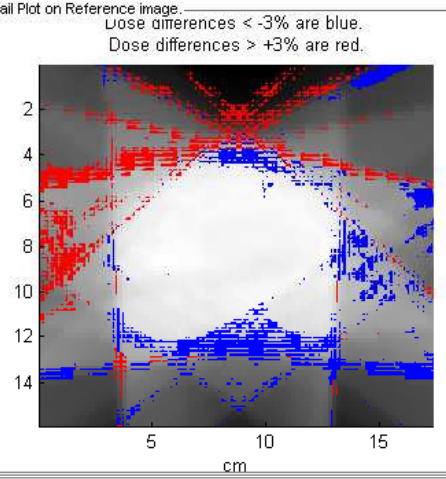
Profile > Horizon... | Report Options | Plot Options

Horizontal Profile



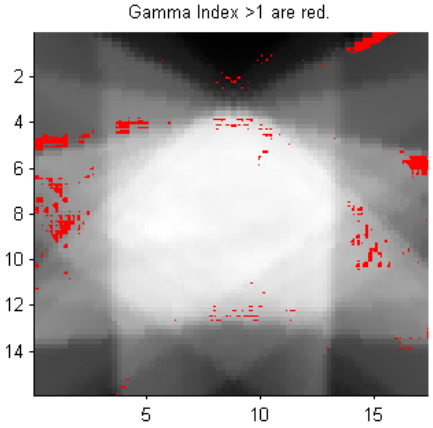
Subtraction > To... | Report Options | Plot Options

Subtraction Pass/Fail Plot on Reference image.



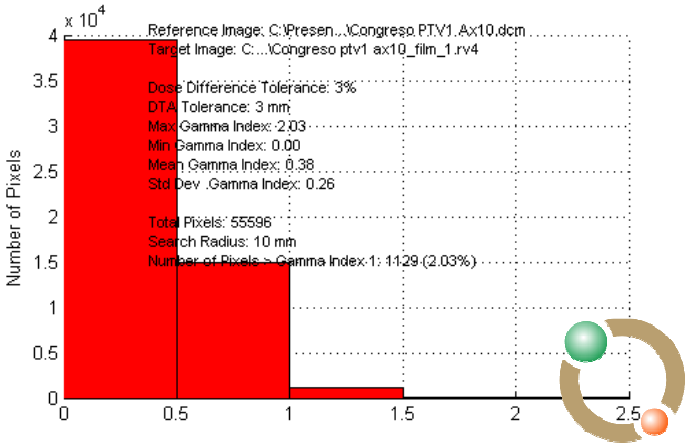
Gamma > Gamm... | Report Options | Plot Options

Gamma Pass/Fail Plot on Reference image.

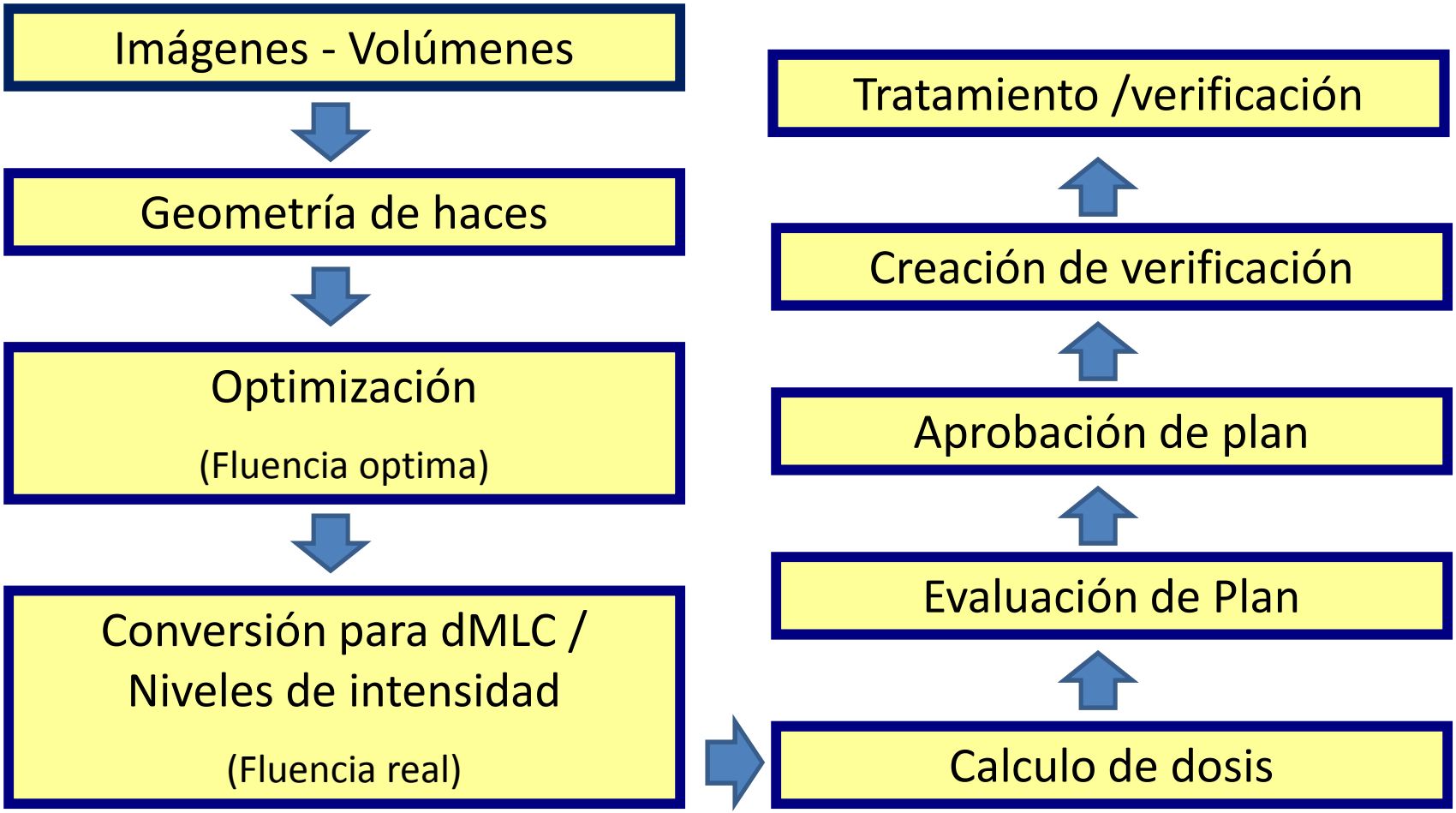


Gamma > Histog... | Report Options

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 especifico 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 calculo 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