



PINNACLE³

LUIS ÁNGEL QUIÑONES RODRÍGUEZ

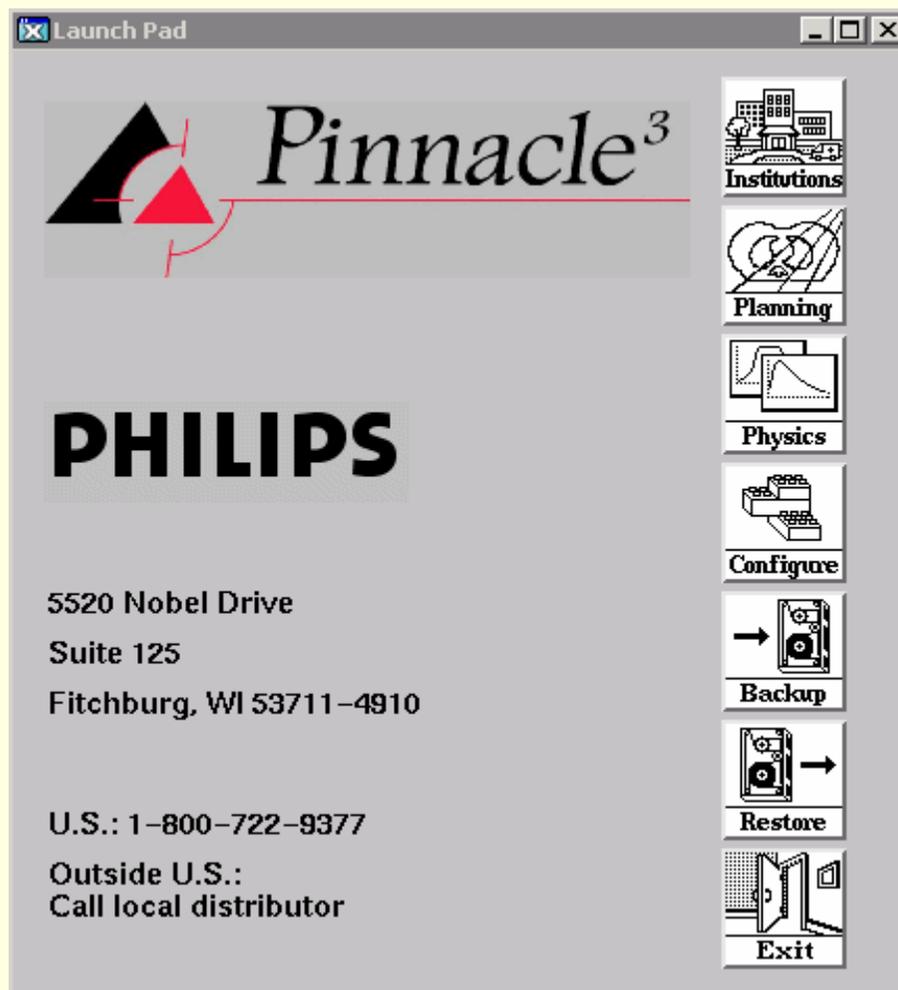
Contenido

- Módulo de Física.
 - Organización de máquinas.
 - Algoritmo de cálculo
 - Modelado
- Funcionalidades.
 - Simulación Virtual.
 - Registro de imágenes.
 - Planificación 3D.
 - IMRT , IMAT.
 - Comparación de planes.
 - Radiobiología.
- Características DICOM.
- Puntos Mejorables.
- Puntos a Destacar.

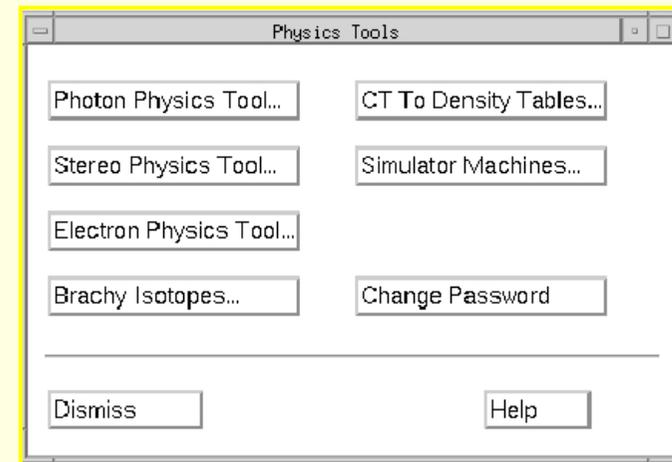
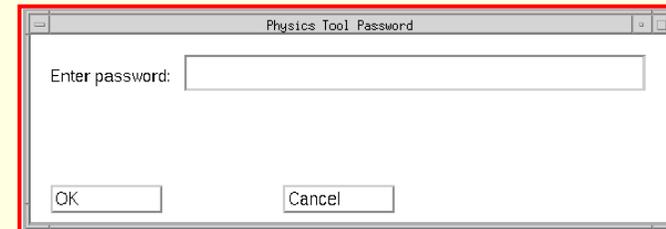
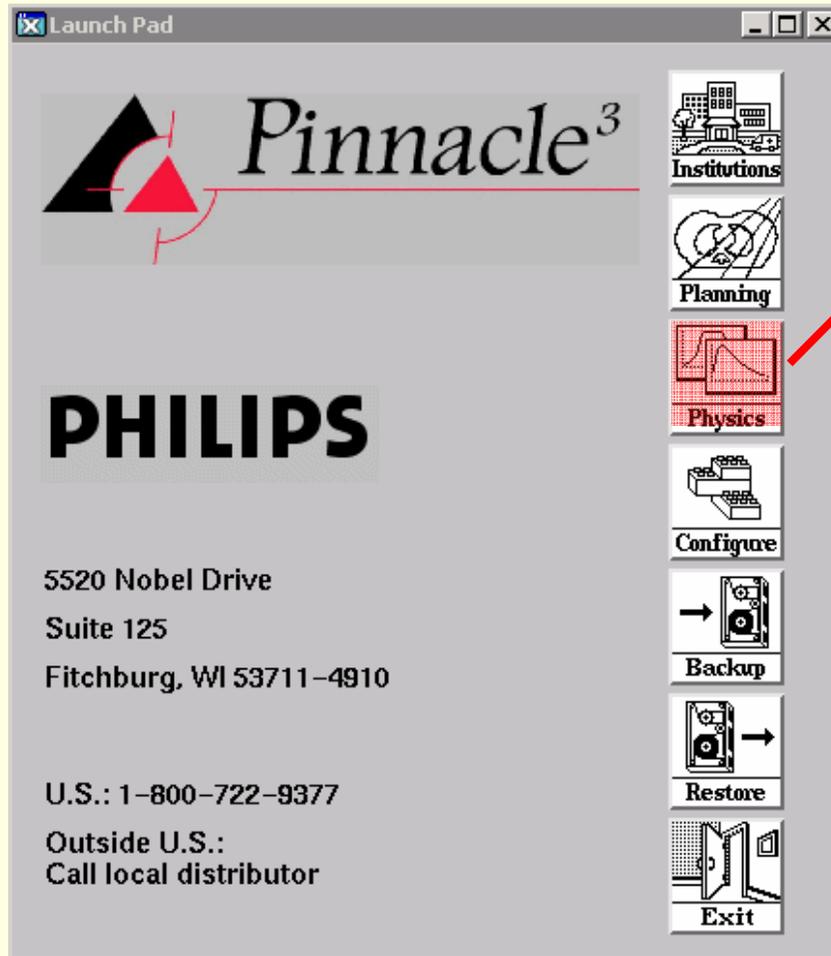
Página de Inicio

Página de inicio.

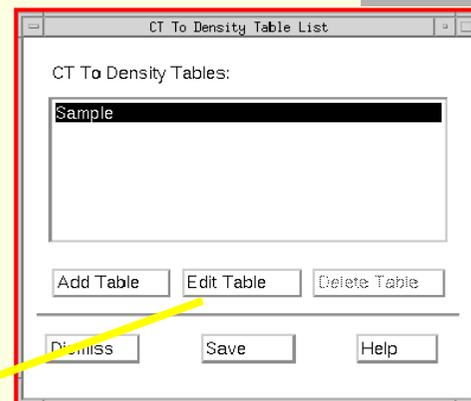
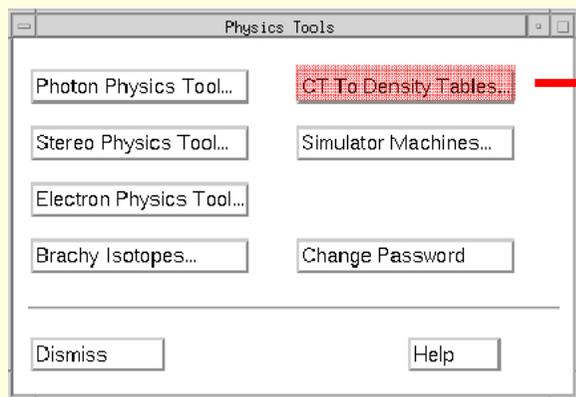
Uso.



Física



Física: Tablas de densidad



CT to Density Tables Laser Settings CT Scanners

CT to Density Tables

GE Pro Speed
Phillips

Add Table Name GE Pro Speed
Delete Table Use table for DRRs only
DRRs and Dose Computation

Display Isocenter Shift As: Table

Scanner direction information for laser export
In (toward the gantry) not set
Right (toward gantry) +X

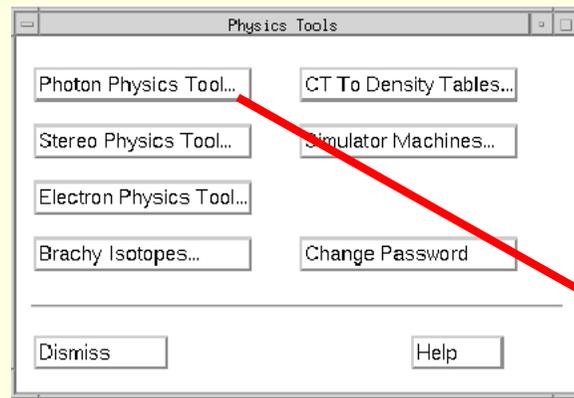
CT Number	Density
0	0.000
316	0.270
921	0.947
1000	1.000
1414	1.328
1752	1.560
2152	1.833
5000	4.000

Density

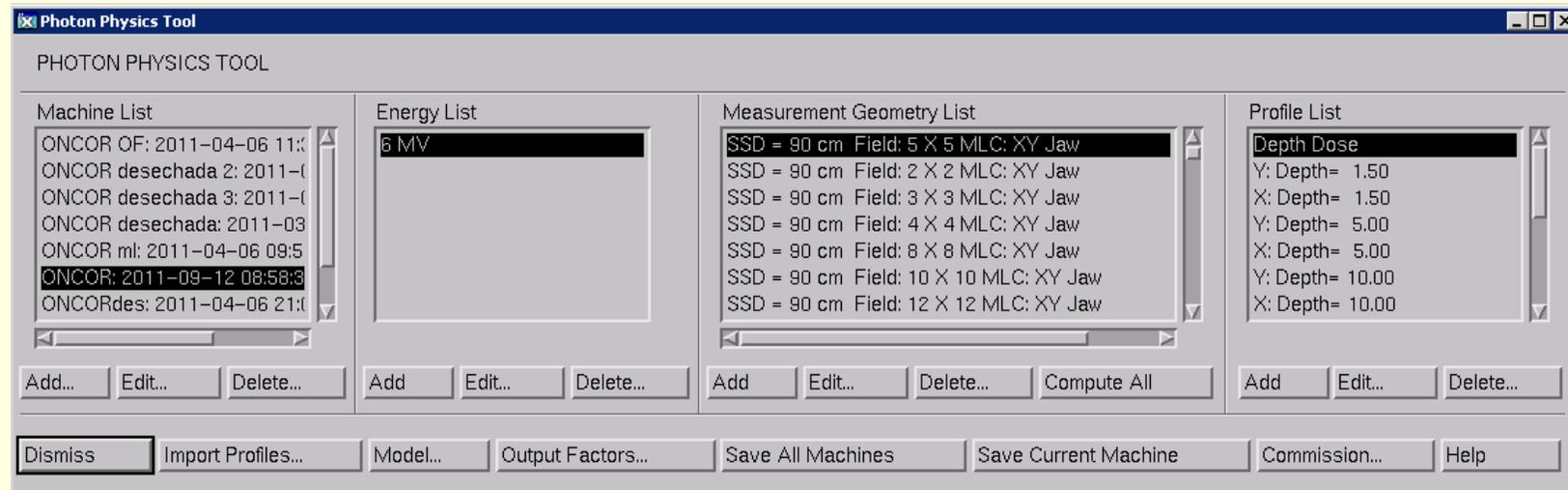
CT Number

Insert After Delete Row
Insert Before
Dismiss Save Help

Física: Organización de máquinas.

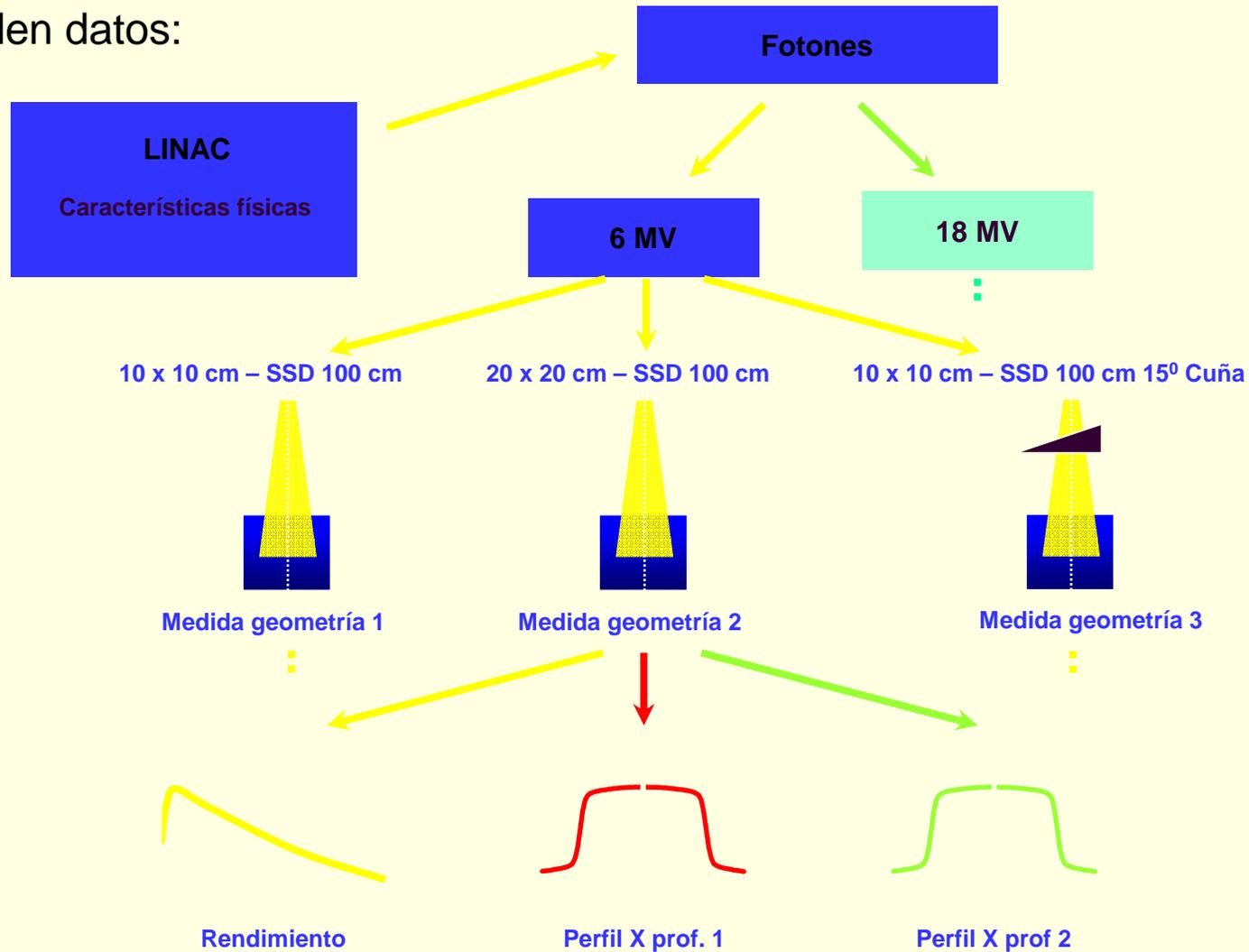


Aprobar



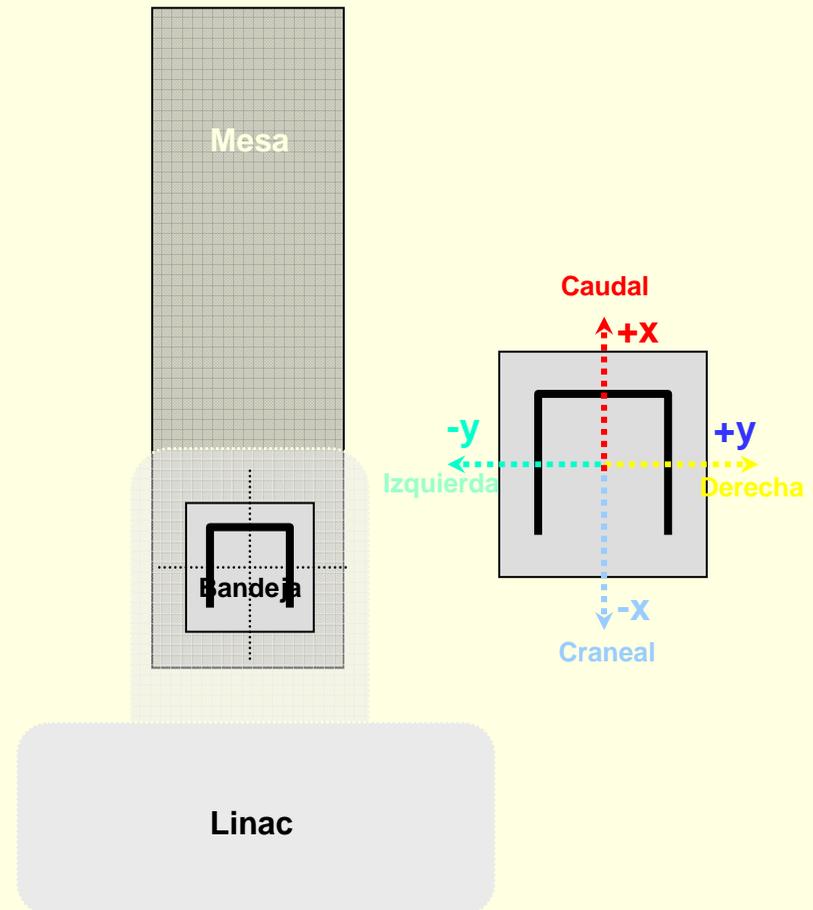
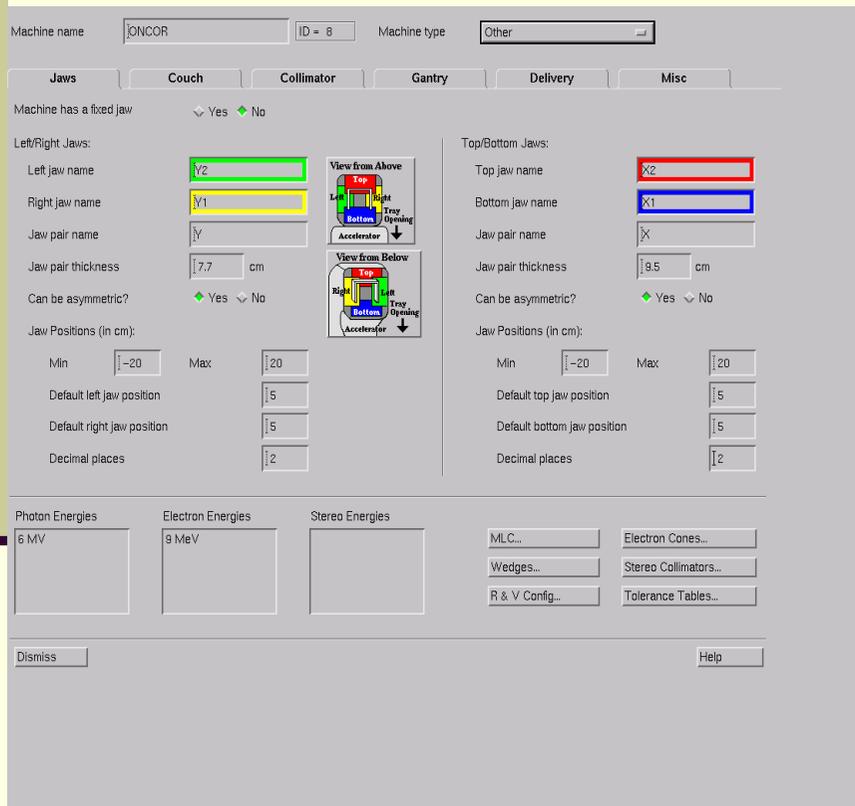
Física: Organización de máquinas

Orden datos:



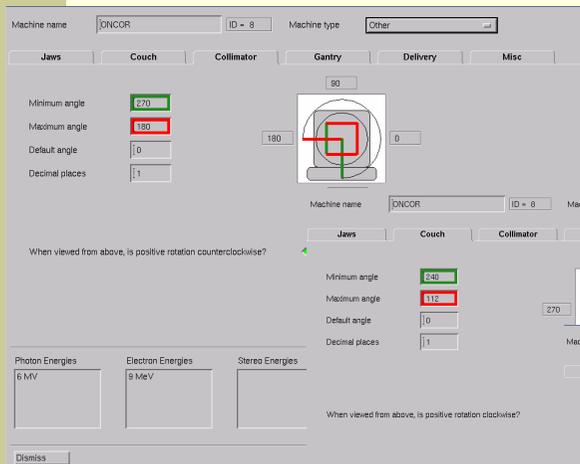
Física: Modelado-Edición

Editor de máquina:

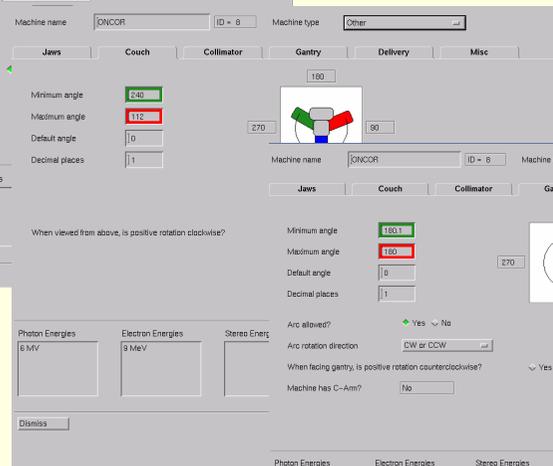


Física: Modelado-Edición.

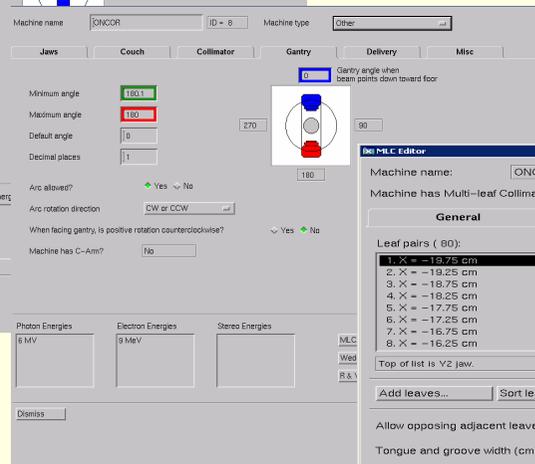
Editor de colimador:



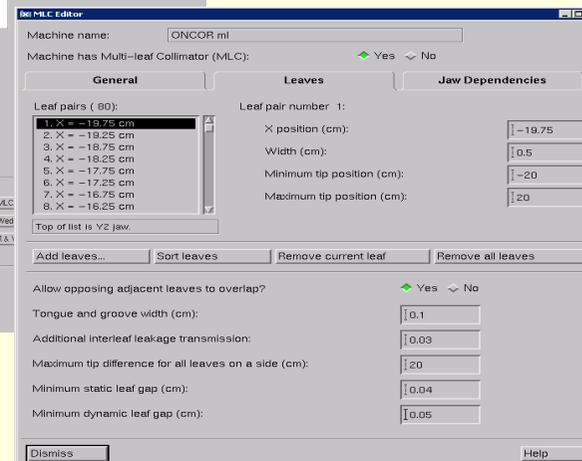
Editor de mesa:



Editor de gantry:



Editor de multilaminas:

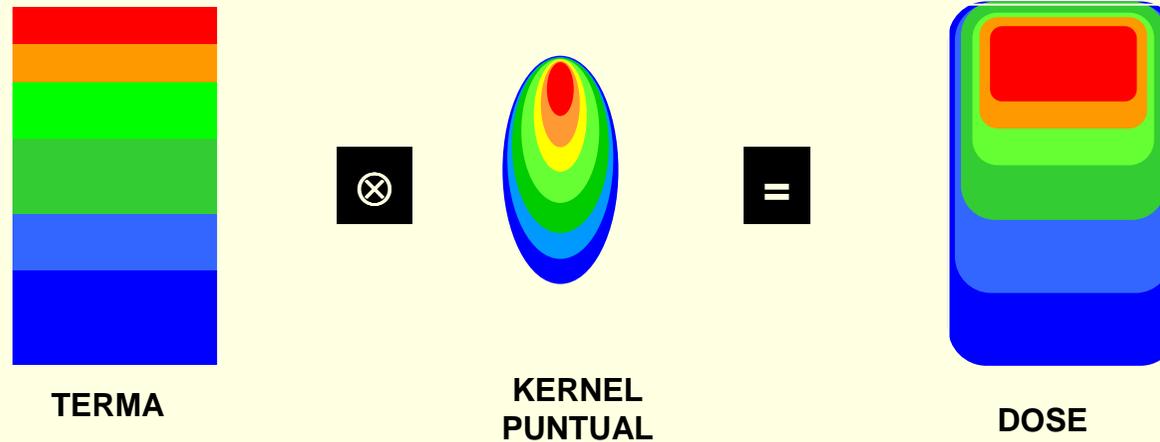


- Forma.
- Offset.
- Transmisión.
- Machihembrado.

Física: Algoritmo de cálculo

Pinnacle : Superposición Convolución de Cono Colapsado.

Haz monoenergético en un medio homogéneo:



$$D(\vec{r}) = \int_V T(\vec{r}') A(\vec{r} - \vec{r}') d^3 \vec{r}'$$

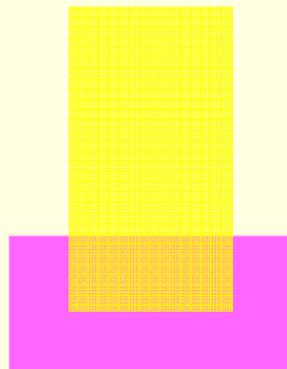
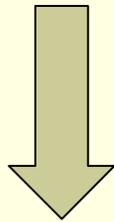
↓

$$T(\vec{r}') = \frac{\mu}{\rho} \Psi(\vec{r}')$$

Física: Algoritmo de cálculo

Kernel invariable espacialmente:

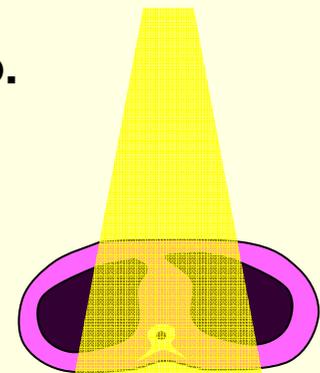
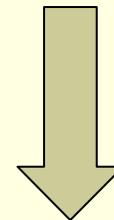
- Haz monoenergético
- No divergente
- Medio uniforme.



$$F\{D\} = F\{T\} \times F\{A\}$$

Paciente real:

- Haz polienergético
- Divergente
- Medio heterogéneo.



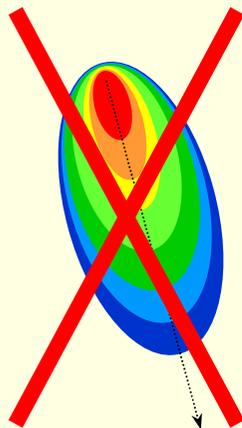
$$D(\vec{r}) = \int_V T(\vec{r}') \frac{\rho(\vec{r}')}{\tilde{\rho}} A(\tilde{\rho} \times l(\vec{r} - \vec{r}'), \vec{r} - \vec{r}') d^3\vec{r}'$$

Para cada componente polienergética
del kernel (Montecarlo)

Física: Algoritmo de cálculo

(Aproximaciones)

Divergencia



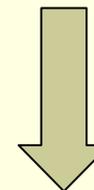
Aproximación



E 2 MV !!!

SSD 80 cm!!!

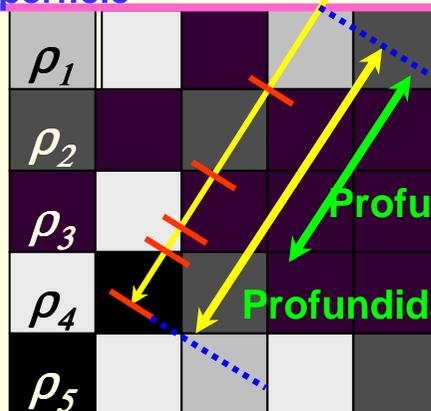
Corrige la dosis.



Heterogeneidad

Superficie

Fotón



Profundidad escalada z'

Profundidad geométrica z

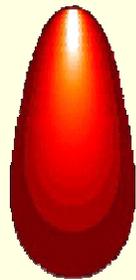


TERMA(Camino radiológico)

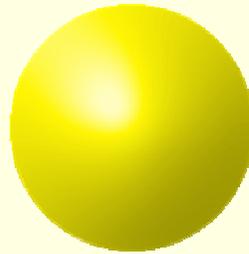
KERNEL (escalado)

Física: Algoritmo de cálculo

(Aproximaciones)



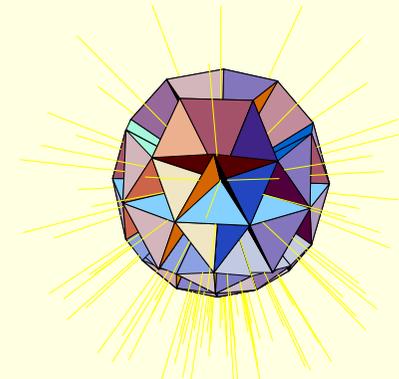
Kernel continuo



Angulo sólido continuo: 4π



Discretización en conos

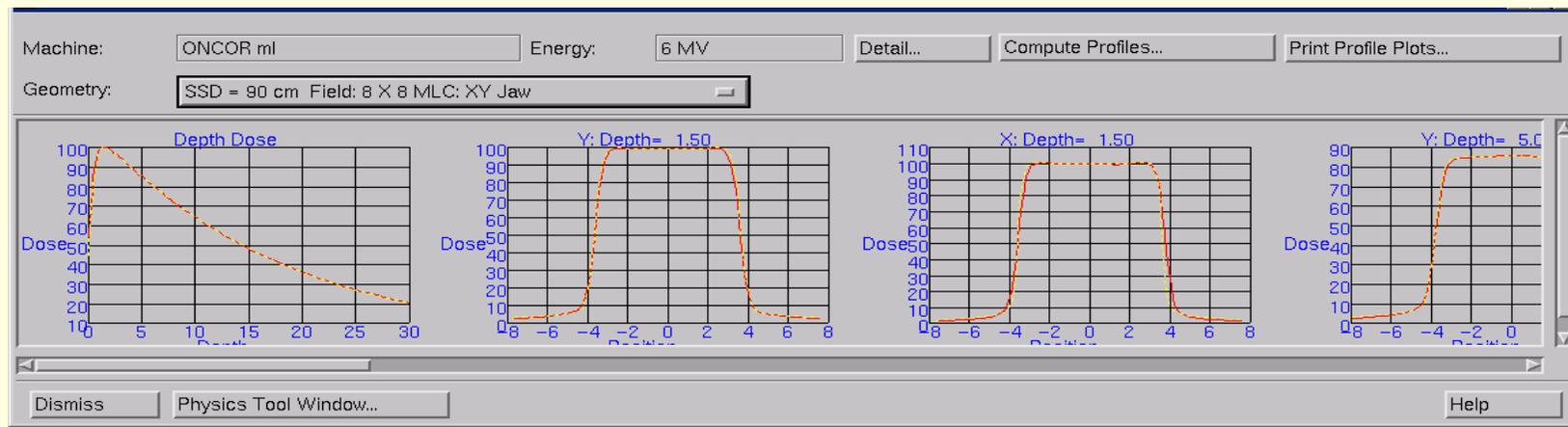


Kernel discreto con 50 direcciones

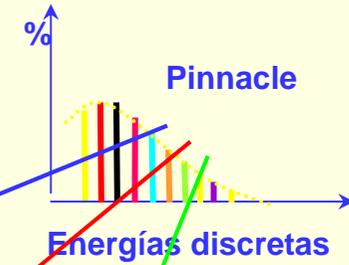
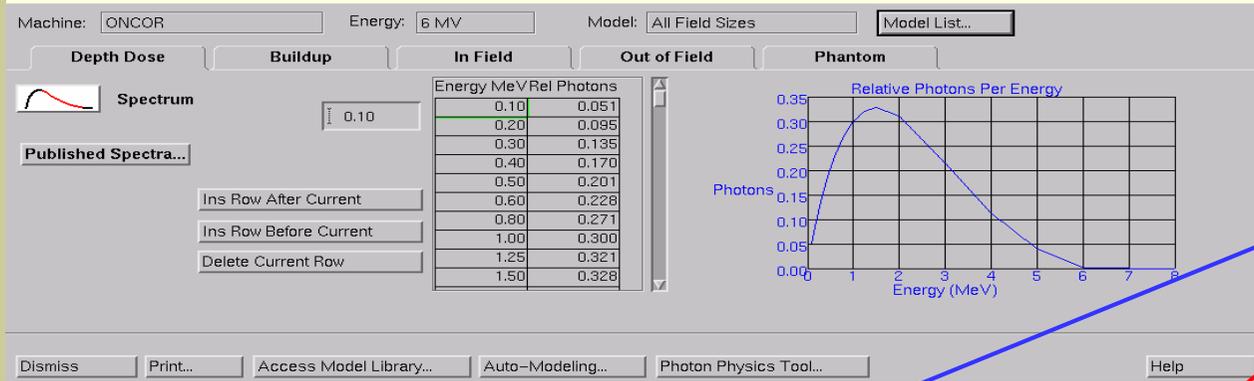
El número de operaciones pasa de ser proporcional a N^6 a serlo de MN^3 .

Física: Modelado

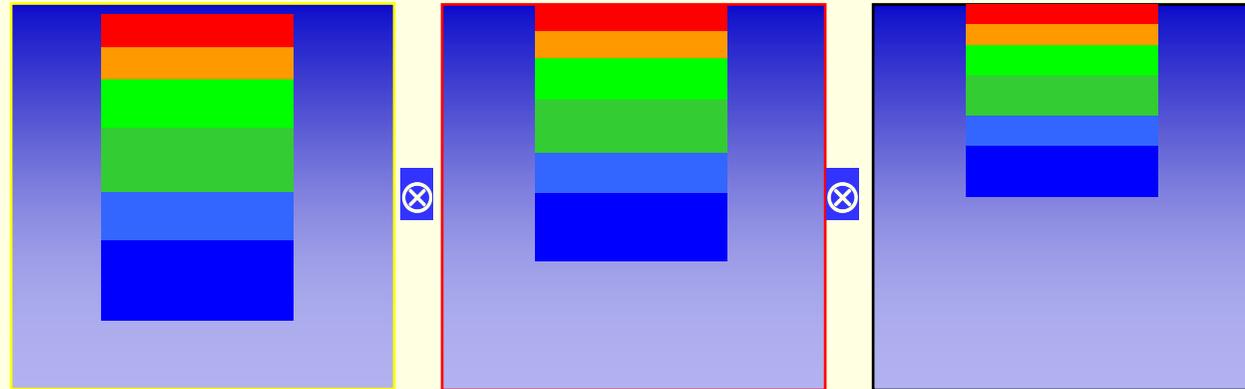
- MODELADO SEMIANALÍTICO. ([Predictivo lejos de referencia](#))
- Parámetros con sentido físico que debemos ajustar.
- Aproximaciones \longrightarrow No coincidencia exacta con la realidad.
- Herramientas de automodelado ([Scripts](#)).
- El modelado lo realiza el usuario.



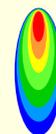
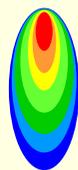
Física: Modelado-espectro



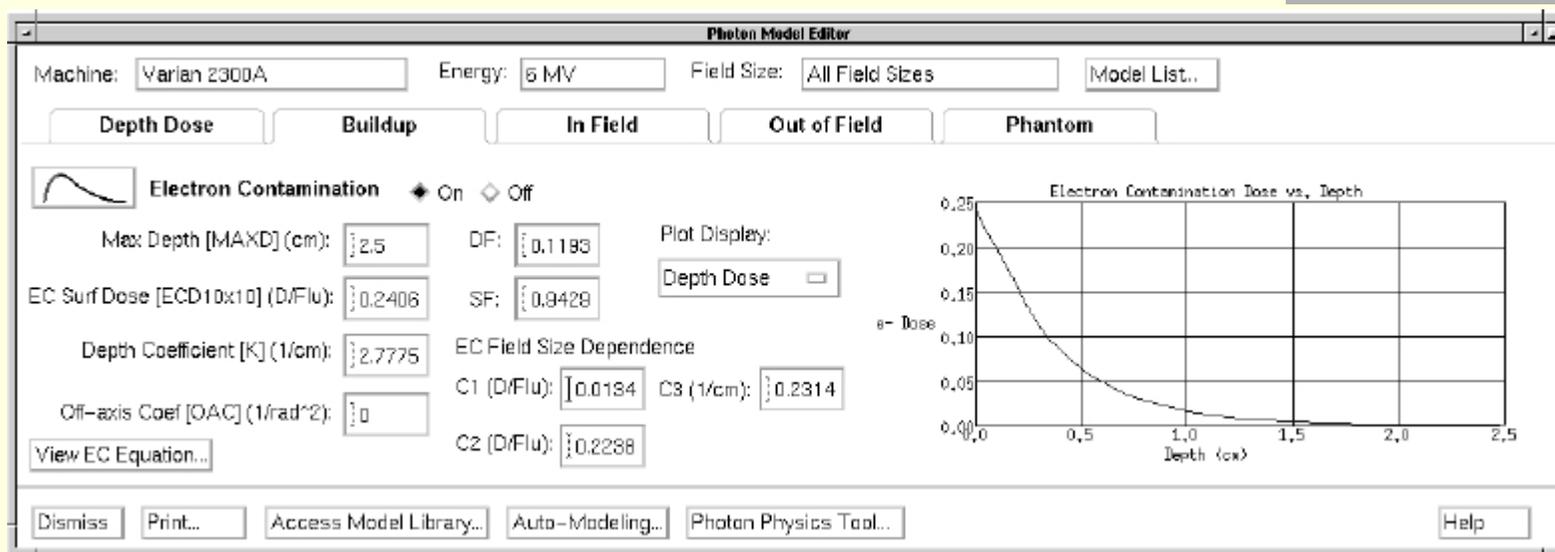
componente del TERMA



Kernels



Física: Modelado-Buildup



- Maximun depth
- Surface Dose
- Depth coefficient
- Off axis coefficient.
- Depht fraction.
- Scale fraction.
- C1, C2, C3.

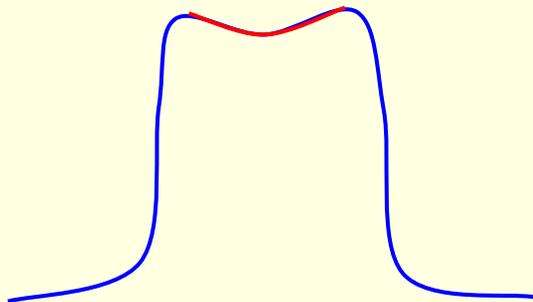
Física: Modelado-fluencia

Machine: Energy: Model:

 **Flattening Filter Attenuation**

Modeled As: Spectral Off-Axis Softening Factor:

Limit Profile Edge for Auto-Modeling by: cm Wedge/Compensator Scatter Factor:



- Cone angle.
- Cone radius.
- Spectral off axis softening.
- Modifier scatter factor.

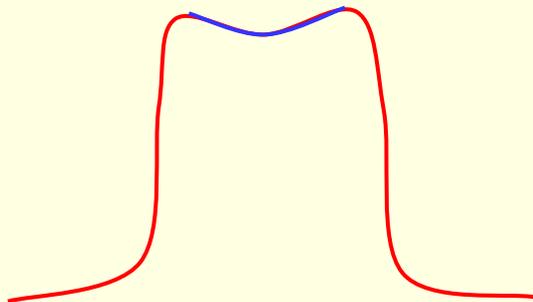
Física: Modelado-fluencia

Machine: Energy: Model:

Effective Source Size **Flattening Filter Scatter Source** **Transmission Factors**

Perpendicular to gantry axis: cm Gaussian Height: Jaw Transmission: MLC Transmission:

Parallel to gantry axis: cm Gaussian Width:



- Source size X,Y.
- Gaussian height.
- Gaussian width.
- Jaw transmission.

Física: Modelado- Factores de Campo

iii

$$OF_c = (OF)(OF_p)$$

iii

¿ Hemos modelado bien el cabezal ?

- No es necesario medir los factores de campo del cabezal.
- ¿ Efecto intercambio ?



Machine: ONCOR Energy: 6 MV

The 'calibration point' is the point at which absolute dose is measured for Pinnacle. A depth of 10 cm is recommended. In general, this is NOT the same as the machine calibration point, which is typically measured at Dmax.

Calibration Point Depth (cm): 10

Source To Calibration Point Distance (cm): 100

Dose/MU at Calibration Point (cGy/MU): 0.81

Measurement Field Sizes: Sort

- 2 X 2 MLC: XY Jaw
- 3 X 3 MLC: XY Jaw
- 4 X 4 MLC: XY Jaw
- 5 X 5 MLC: XY Jaw

Add Edit... Delete Compute...

Dismiss Help

Clínica: Funcionalidades

Launch Pad



PHILIPS

5520 Nobel Drive
Suite 125
Fitchburg, WI 53711-4910

U.S.: 1-800-722-9377
Outside U.S.:
Call local distributor

- Institutions
- Planning
- Physics
- Configure
- Backup
- Restore
- Exit

Site:
Institution: Hospital Universitario Puerta del Mar, Avda. Ana de Villa, 21,, Cadiz, Cadiz, 11009.

Patients

Last Name	First Name	Middle Name	MRN	Radiation Oncologist	Last Modified
OCTAVIUS	RF		00011		2012-05-18 08:10:57
OCTAVIUS	RF	GE	00011		2011-04-14 12:29:33
OCTAVIUS	PHILLIPS2DARRAY		00072		2012-06-06 17:19:24
OCTAVIUS	PHILLIPSSEMIFLEX		00071		2012-05-03 12:58:57
PINNACLE		CONTROL DE CAL.	123456789		2011-09-20 09:09:02
prueba pulmon	PABL		20110423		2011-07-07 17:24:32
CC TPS DM-5					2011-08-30 12:54:41
CC TPS DM-4					2011-07-26 09:15:59
CC TPS DM-10					2011-09-30 11:34:58
CC REJILLA DE CALCULO					2011-07-26 12:59:56
CC TPS DM-10 - 2					2011-08-12 20:41:39

Add... Edit... Delete... Transfer... Images... Concat Images... Sort by Patient Lastname

Plans

- IMRT_HIPOFAR,,
- QAIMRTSF,,
- TTOIMRTSF,,
- QAIMRT2DARRAY,,
- TTOIMRT2DARRAY,,
- IMRT_TTO,,

Primary Image Set
SANZ GARCIA*CARMEN, CT, 660647, 1, 147, 2012-04-30 07:33:57,

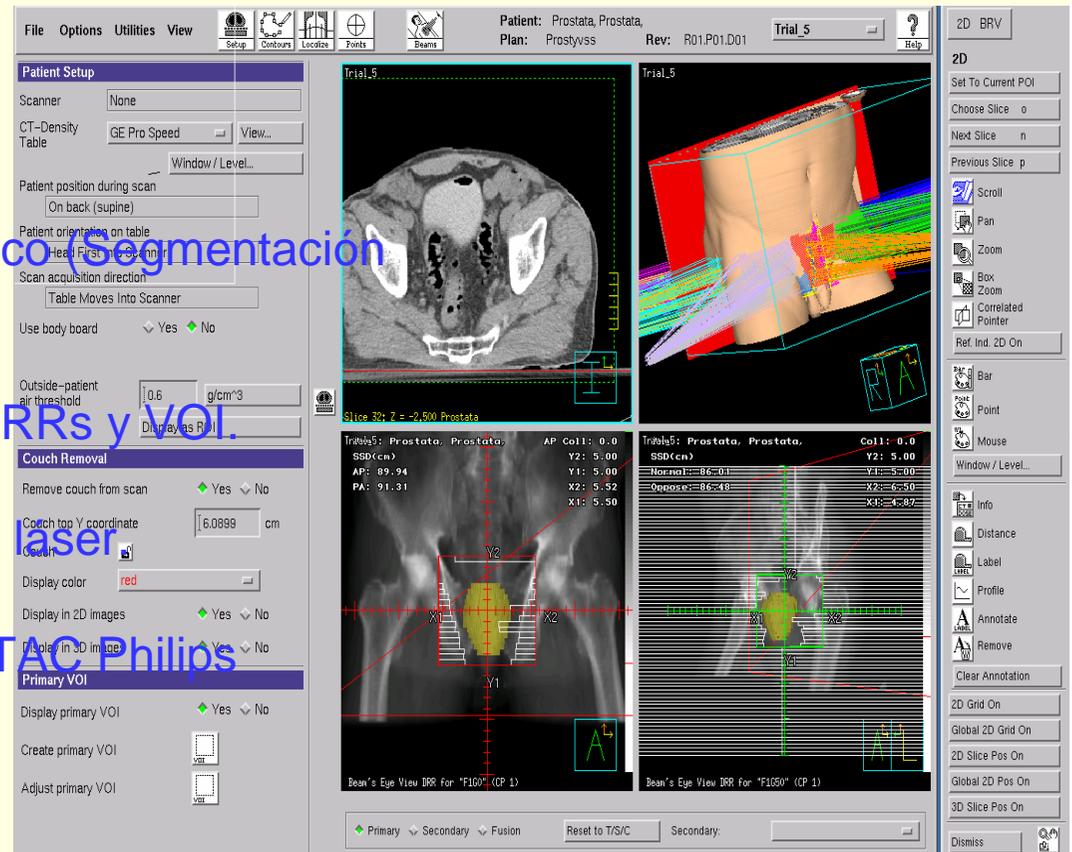
Fusion Image Sets

Add... Edit... Copy Copy Without Dose Delete... AcQSim... Fusion... Planning... P3MD... QA Tools...

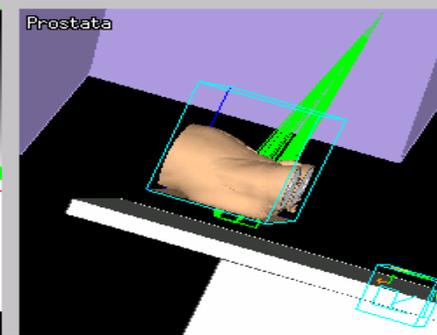
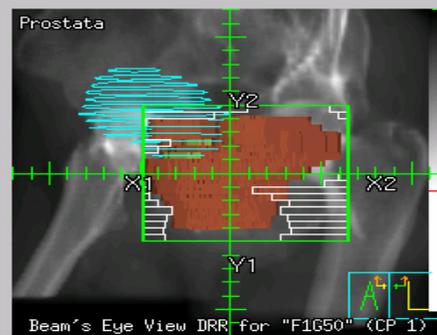
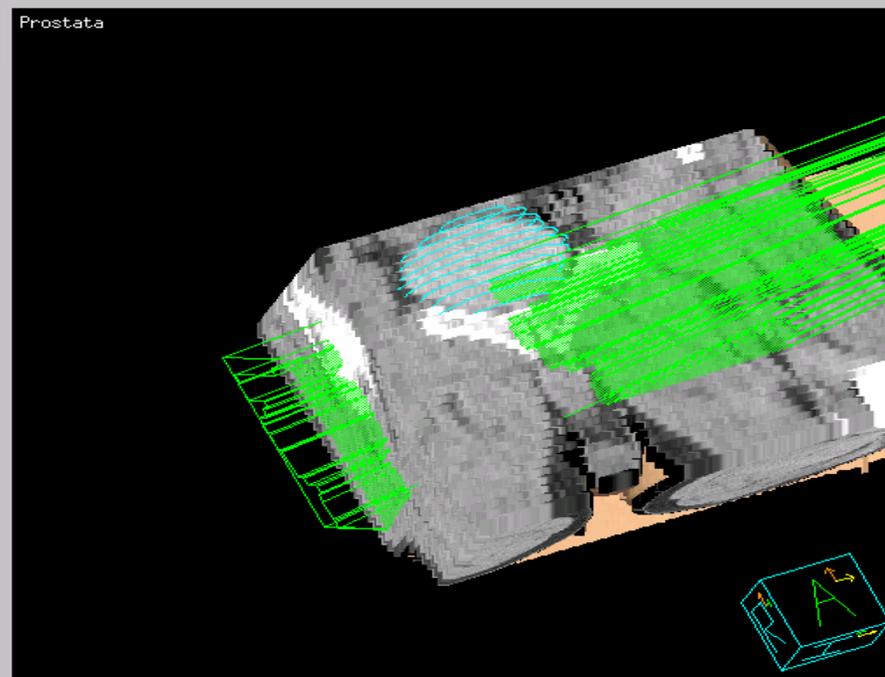
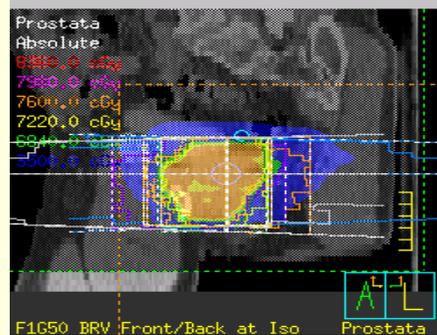
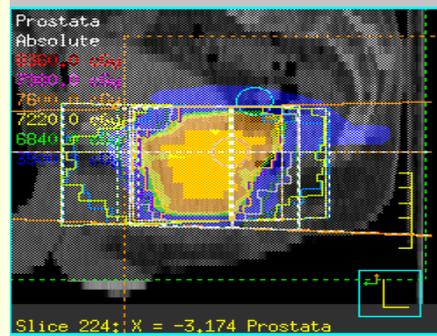
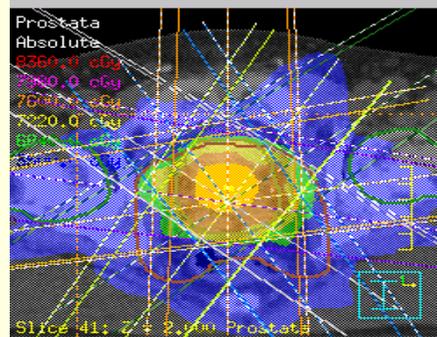
Dismiss Help

Funcionalidades: Simulación virtual- ACQSYM3

- Necesaria Licencia.
- Reconstrucción Volumétrica.
- Contorneo manual y automático (Segmentación de volúmenes, interpolación)
- Visualización avanzada de DRRs y VOI.
- Localización de isocentro con laser
- Explotación de recursos con TAC Philips que lo incorpore.



Funcionalidades: Sim Virtual- Vistas

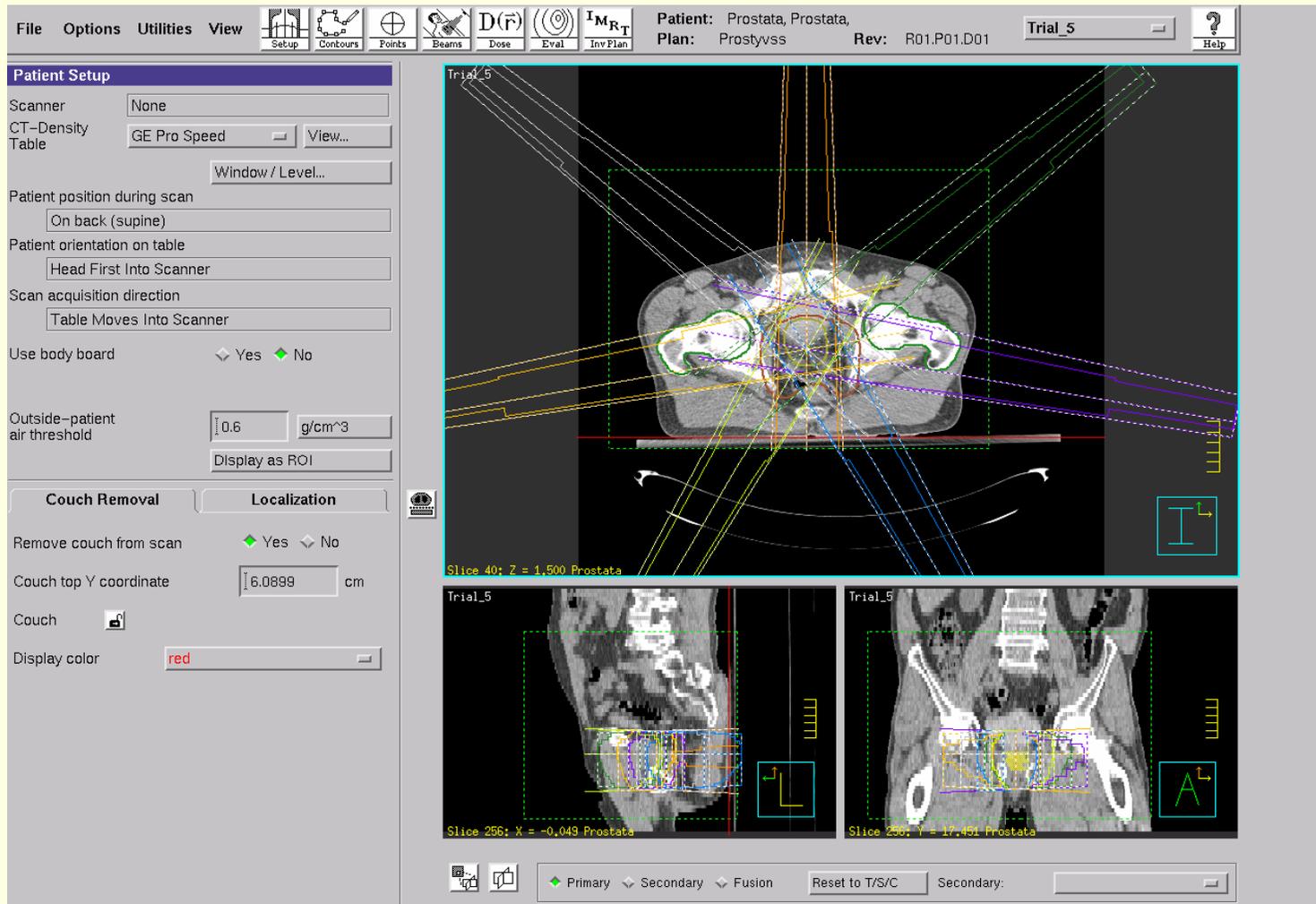


Funcionalidades: Registro-Syntegra

- Necesaria Licencia.
- Fusión multimodal de dos o más juegos de imagen (TAC, RM, PET).
- Fusión manual o automática:
 - Información mutua.
 - Cross Correlation.
 - Local Correlation.
- Fusión en tumores de SNC.



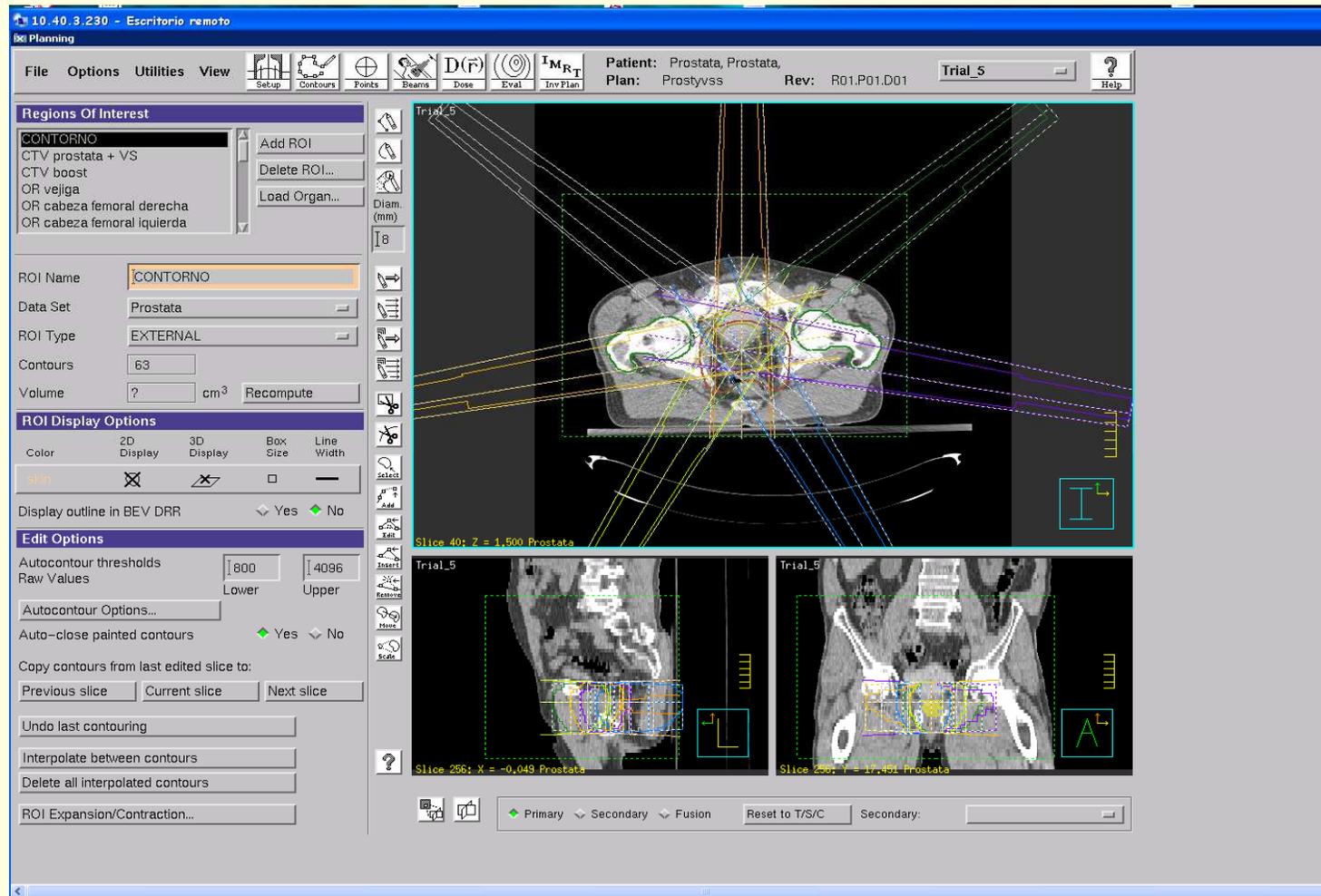
Funcionalidades: Planificación-3D Set-Up



NO USA CONTORNO EXTERNO

Funcionalidades: Planificación-3D

Contornos



Funcionalidades: Planificación-3D

Puntos de interes

The screenshot displays a medical planning software interface for 3D prostate planning. The main window shows a transverse CT slice of a prostate with a yellow target volume and blue organs at risk. A point of interest (POI) is marked with a red dot and labeled 'O-TAC'. The interface includes a menu bar (File, Options, Utilities, View), a toolbar with icons for Setup, Contours, Points, Beams, Dose, Eval, and Inv Plan, and a patient information panel (Patient: Prostata, Prostata; Plan: Prostyvss; Rev: R01.P01.D01; Trial_5). The 'Points of Interest' panel on the left shows a list of points (O-TAC, ISO) and a detailed configuration for the selected 'O-TAC' point, including its name, data set (Prostata), type (MARKER), local coordinates (Lateral: -3.28, Ant-Post: 13.48, Sup-Inf: 0.00 cm), and DICOM coordinates (Lateral: -32.79, Ant-Post: -134.84, Sup-Inf: 0.00 mm). The 'Display Options' panel shows the color set to 'skyblue', 2D display turned 'On', and 3D display turned 'Off'. The main view area shows the 3D prostate model with a red dot for the POI and a list of coordinates for other points: 8280,0 cGy, 7880,0 cGy, 7600,0 cGy, 7220,0 cGy, 6840,0 cGy, and 3500,0 cGy. The view is set to 'Transverse' and 'Slice 44: Z = 2,500 Prostata'.

File Options Utilities View Setup Contours Points Beams Dose Eval Inv Plan Patient: Prostata, Prostata Plan: Prostyvss Rev: R01.P01.D01 Trial_5 Help

Points of Interest

O-TAC Add Point
ISO Delete Point...

POI Name: O-TAC
Data Set: Prostata
POI Type: MARKER

Local Coordinates
Lateral: -3.28 Ant-Post: 13.48 Sup-Inf: 0.00 cm

DICOM Coordinates
Lateral: -32.79 Ant-Post: -134.84 Sup-Inf: 0.00 mm

Diameter: 2 cm

Autoplace POI...
Set Reference Point
Set Inside Multiple Regions

Display Options

Color: skyblue
2D Display: On
3D Display: Off

Transverse
Primary Secondary Fusion Reset to T/S/C Secondary:

Trial_5
Absolute
8280,0 cGy
7880,0 cGy
7600,0 cGy
7220,0 cGy
6840,0 cGy
3500,0 cGy

Slice 44: Z = 2,500 Prostata

Funcionalidades: Planificación-3D

Haces

File Options Utilities View Setup Contours Points Beams $D(\vec{r})$ Eval I_{MRT} Inv Plan Patient: Prostata, Prostata, Plan: Prostyvss Rev: R01.P01.D01 Trial_5 Help

Beams
F1G0
F1G50
F1G100
F1G150
Add Beam
Delete Beam...
Control Point 1

Setup Geometry Modifiers
Name: F1G0 Field ID
Machine: ONCOR
Version: 2011-09-12 08:58:33
Modality: Photons
Energy: 6 MV
Beam Type: Step & Shoot MLC
Dose Rate: 600 MU/min

Display Options
Color: red
2D Display: Yes No
3D Display: Yes No
Note: Affects REV.

Isocenter
Isocenter: ISO Details...
SAD (cm): 100.0
SSD (cm): 89.94
Localization System: Laser Valid
Add New Isocenter Laser Export...

3D Visualization
Trial_5
Absolute
3380.0 cGy
7380.0 cGy
7600.0 cGy
7220.0 cGy
6600.0 cGy
3500.0 cGy
Slice 44: Z = 7,500 Prostata
Transverse
Primary Secondary Fusion Reset to T/S/C Secondary:

Funcionalidades: Planificación-3D

Dosis

File Options Utilities View Patient: Prostata, Prostata, Prostata Plan: Prostyvss Rev: R01.P01.D01 Prostata ? Help

Dose Grid

	Lateral	Ant-Post	Sup-Inf
Resolution (cm)	0.300	0.300	0.300
Dimension (pixels)	121	91	82
Origin (cm)	-21.990	5.079	-12.652

Extend top slice of CT: 5 cm
Extend bottom slice of CT: 5 cm

Density/Fluence Grid Resolution
 Match Dose Grid Specify

2D Display Yes No

Cover range of slices...
Cover selected ROIs...

Dose Computation

Status of: F1G0 Computed

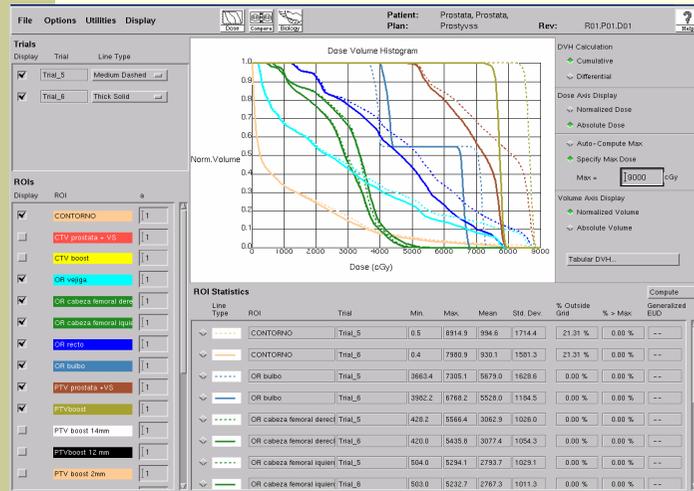
F1G0	Adaptive Convolve	Done
F1G50	Adaptive Convolve	Done
F1G100	Adaptive Convolve	Done
F1G150	Adaptive Convolve	Done
F1G210	Adaptive Convolve	Done

Edit Prescriptions... Beam Weighting...

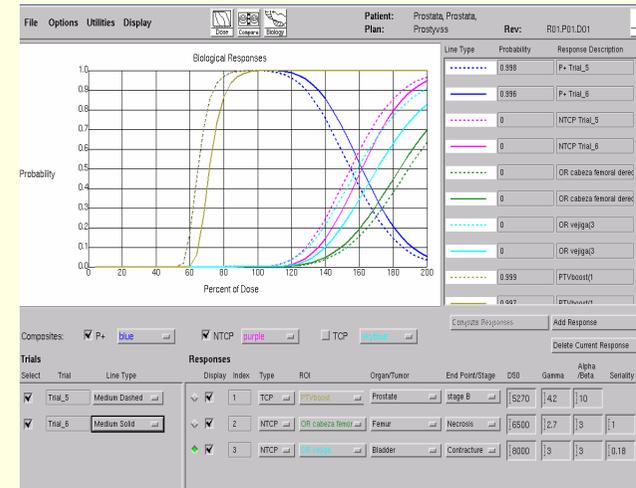
Prostata
Absolute
8360.0 cGy
7380.0 cGy
7600.0 cGy
7220.0 cGy
6880.0 cGy
3500.0 cGy

Transverse
 Primary Secondary Fusion
Reset to T/S/C Secondary:

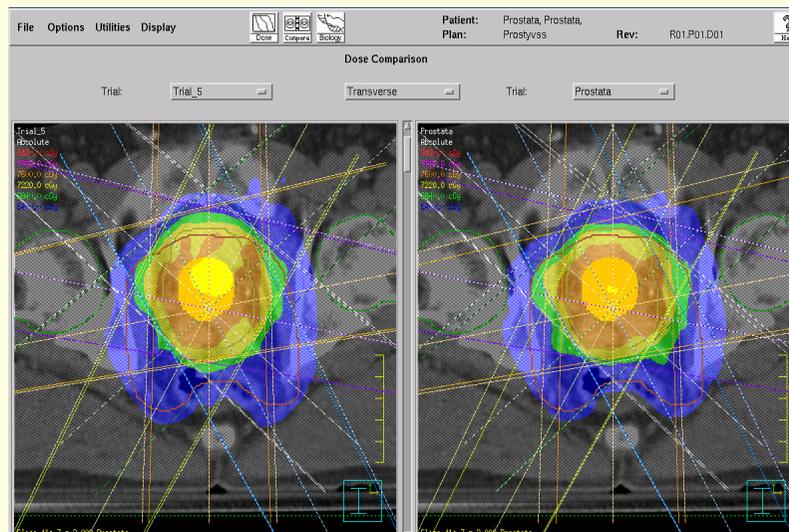
Funcionalidades: Evaluación y comparación de planes.



Histograma DV



Radiobiología



Isodosis

Funcionalidades: IMRT -Inversa

Necesaria Licencia.

Métodos:

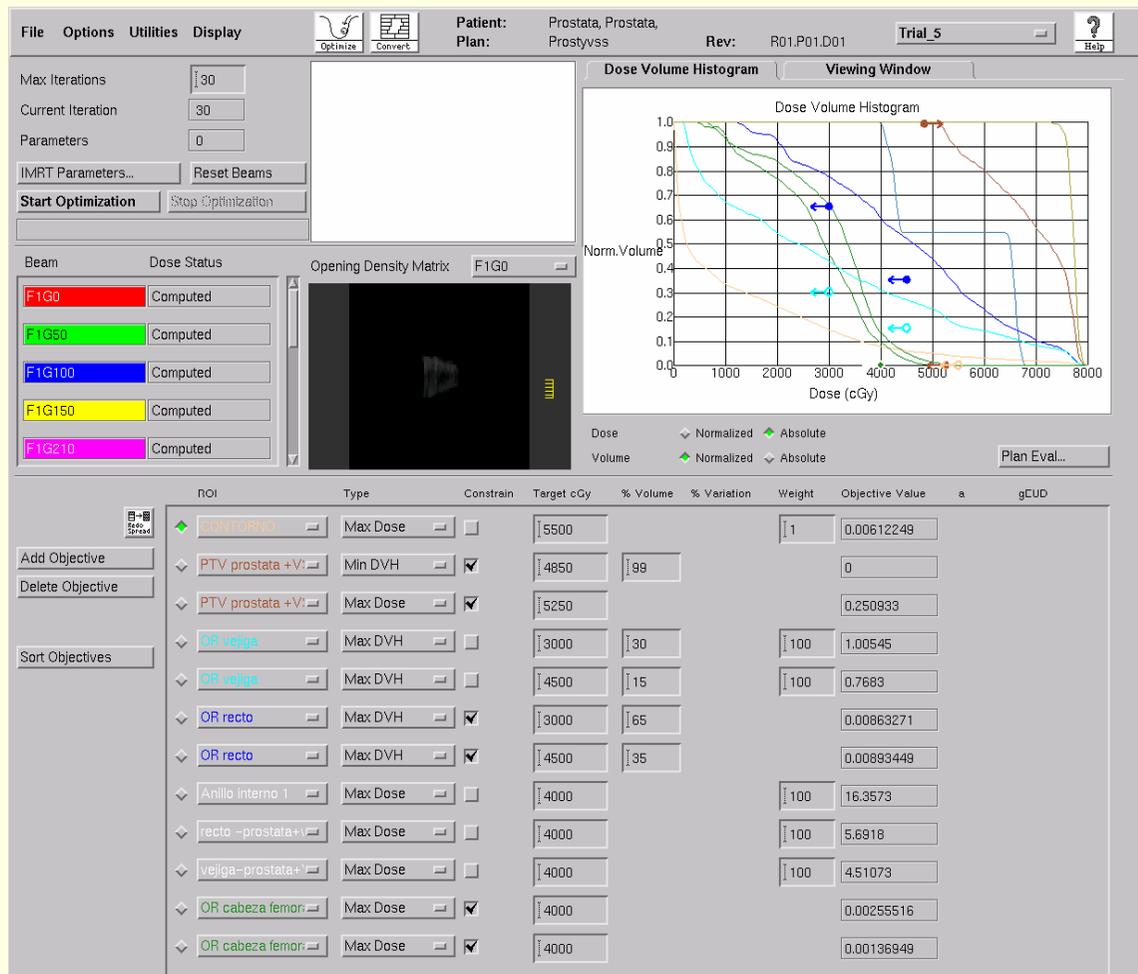
- Modulación de Intensidad. (Optimización - Conversión).
- DMPO. (DAO en Step and Shoot).
- Smart ArC (DAO en IMAT).(Para VMAT y rapid-Arc)

O.D.M

Ajustes:

- Pesos de segmento.
- Pesos de haces.

Funcionalidades: IMRT-Optimización



Creación de función Objetivo

- Dosis mín (O,C)
- Dosis máx (O,C)
- Dosis Uniforme (O)
- DVH mín (O,C)
- DVH máx (O,C)
- Uniformidad (C)

Método de gradiente

Funcionalidades: IMRT - Parámetros

Optimization Conversion Trial **Trial_5**

Max iterations Stopping tolerance
Convolution dose iteration Apply tumor overlap fraction

Beam	Optimization Type	 Radio Spread	Allow jaw motion	Split if necessary
F2G0	DMPO	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F2G50	DMPO	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F2G100	DMPO	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F2G150	DMPO	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
F2G210	DMPO	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

DMPO Intensity Modulation SmartArc Segment Weight

Maximum number of segments Minimum number of leaf pairs
Minimum segment area cm² Minimum leaf end separation cm
Minimum segment MUs
 Compute final dose **Beam Splitting**
Use SVD for dose calculation Yes No Minimum overlap distance cm
Maximum overlap distance cm

Funcionalidades: IMRT -Conversión

Conversión de modulación de intensidad:

- k-medias. (Step and Shoot, todos los equipos)
- Imfast (Step and Shoot, equipos Siemens)
- Sliding Window.

Filtrado (MI, DMPO) :

- Área mínima del segmento.
- UM mínimas.
- Cuadrado equivalente mínimo.

Funcionalidades: Radiobiología.

- Con Licencia.

TCP , NTCP, P+ (S-Kallman)

- D50
- α/β
- γ
- Serialidad.

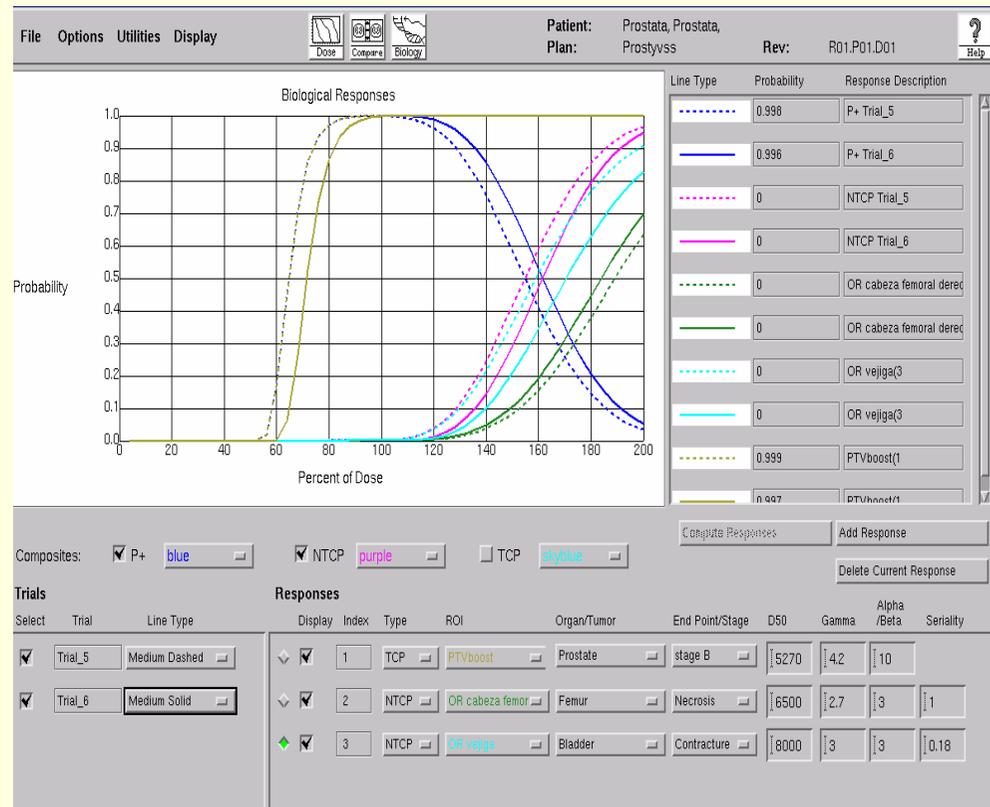
Editables

- Sin Licencia

¿TCP?, NTCP (L.K.B)

- D50
- α/β
- γ
- N (Factor de volumen)

Editables



Funcionalidades: Radiobiología-IMRT

- Necesaria Licencia.
- Función objetivo con las gEUD de las ROIs(Niemerko generalizado)
 - $a < 0$ (Tumor).
 - $a=0$ (OAR en paralelo puros).
 - $a>0$ (OAR).
- Objetivos y Restricciones
 - EUD Objetivo (O,C)
 - EUD mín. (O,C)
 - EUD máx. (O,C)
- Junto con otros objetivos y restricciones dosimétricos, o a posteriori.
- ¡ Incertidumbres respecto al parámetro a y respecto al modelo !

por ROI

Funcionalidades: DICOM

Table 1: Supported SOP Classes as SCP by ADAC RTP_SCP AE

SOP Class Name	UID
Verification	1.2.840.10008.1.1
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
PET Image Storage	1.2.840.10008.5.1.4.1.1.128
NM Image Storage	1.2.840.10008.5.1.4.1.1.120
US Image Storage	1.2.840.10008.5.1.4.1.1.6.1
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.6
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1

Table 37: Supported SOP Classes as SCU by ADAC RTP_SCU

SOP Class Name	UID
Verification	1.2.840.10008.1.1
Basic Grayscale Print Management (META)	1.2.840.10008.5.1.1.9
Basic Film Session	1.2.840.10008.5.1.1.1
Basic Film Box	1.2.840.10008.5.1.1.2
Basic Grayscale Image Box	1.2.840.10008.5.1.1.4
Printer	1.2.840.10008.5.1.1.16
Basic Color Print Management (META)	1.2.840.10008.5.1.1.18
Basic Film Session	1.2.840.10008.5.1.1.1
Basic Film Box	1.2.840.10008.5.1.1.2
Basic Color Image Box	1.2.840.10008.5.1.1.4.1
Printer	1.2.840.10008.5.1.1.16
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5
Computed Radiography Image Storage	1.2.840.10008.5.1.4.1.1.1
Secondary Capture Image Storage	1.2.840.10008.5.1.4.1.1.7
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
PET Image Storage	1.2.840.10008.5.1.4.1.1.128
NM Image Storage	1.2.840.10008.5.1.4.1.1.120
Spatial Registration Storage	1.2.840.10008.5.1.4.1.1.66.1

Puntos Débiles

- Importación, exportación:
 - Importación de perfiles PTW. Necesaria conversión a ASCII.
 - Ausencia de Query and Retrieve.
- Cálculo variable de dosis con elección de rejilla. Para rejilla de 5mm ($\pm 3\%$).
- Problemas con el refrescado de imágenes.
- Comparación de planes con Histogramas incompleta. Precisión variable.
- Necesidad de Scripts para operaciones básicas (Informes, exportación HDV)
- Interfaz gráfica “dura”.
- ¿Sistema Operativo ? (Entorno UNIX)

Puntos Destacables.

- Algoritmo de cálculo muy preciso. Modelado concienzudo de todos los aspectos físicos.
- Scripting. Personalización y automatización de tareas.
 - Todo y más es programable.
 - HotScripts, programación manual.
- Innumerables visualizaciones 2D y 3D.
- Herramientas de contorneo y expansión de ROIs, MBO.
- Módulo de registro completo y eficiente.
- Comparación dosimétrica de planes simple y útil.
- Herramientas de optimización de planes, tanto directas como inversas (DMPO).
- ¿Sistema Operativo ?
- Herramienta precisa, completa, depurada y adaptable a las necesidades del usuario.