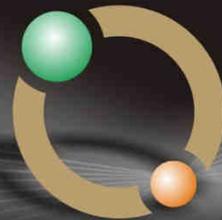


# Volúmenes & Manejo de dibujos en planificador inverso Criterios para aceptar un plan de IMRT ....y mas....

Pablo Castro Peña

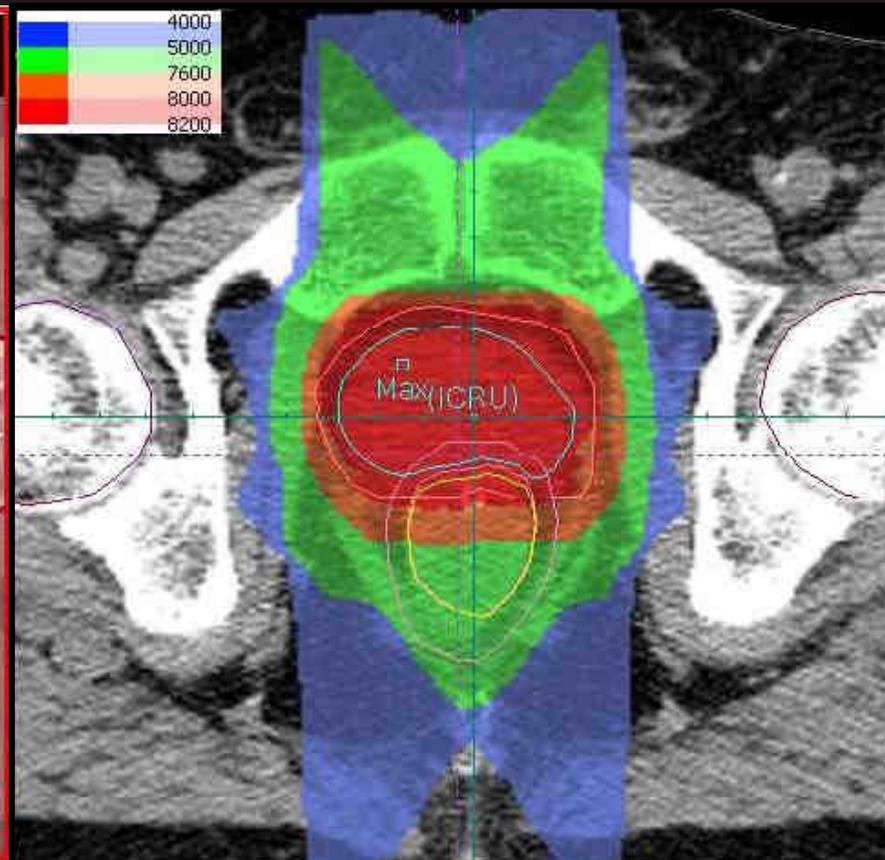
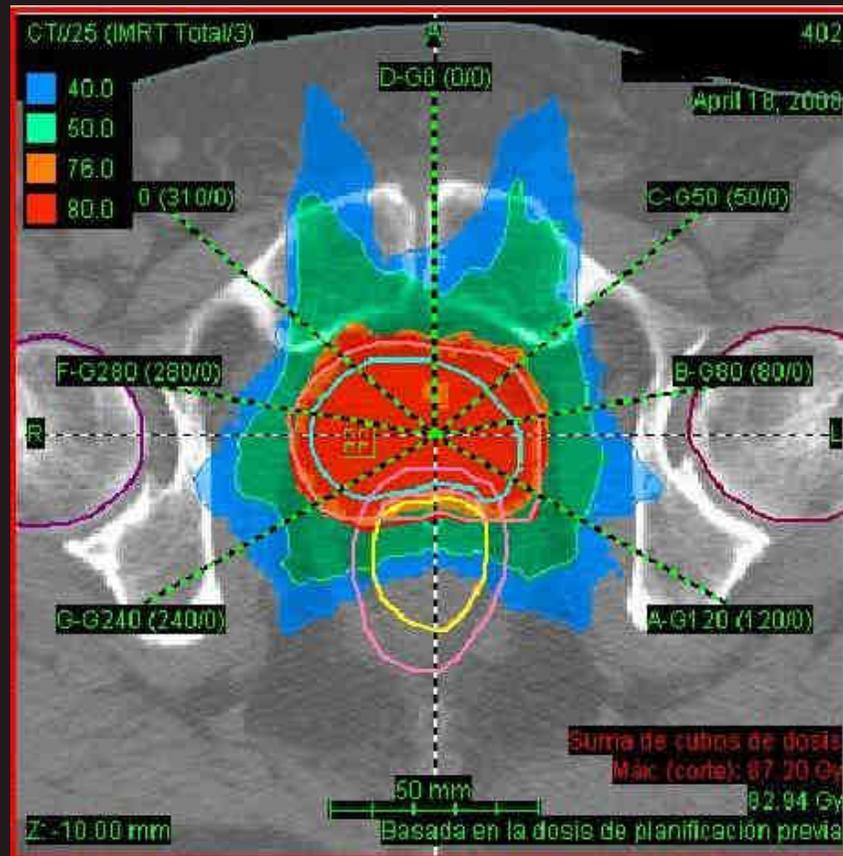
CURSO DE ACTUALIZACION EN  
PROTECCION RADIOLOGICA



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# IMRT vs 3DCRT





# IMRT

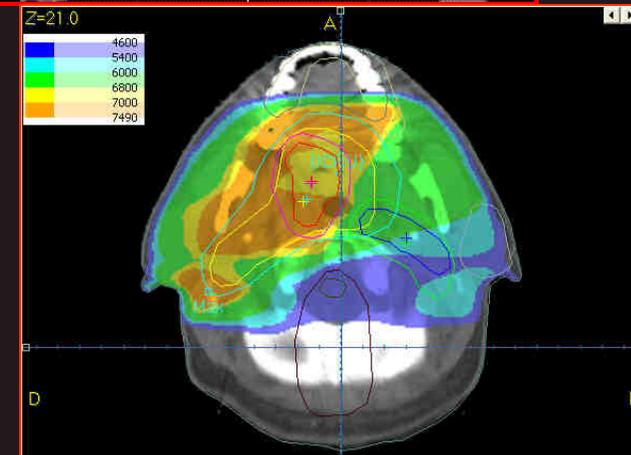
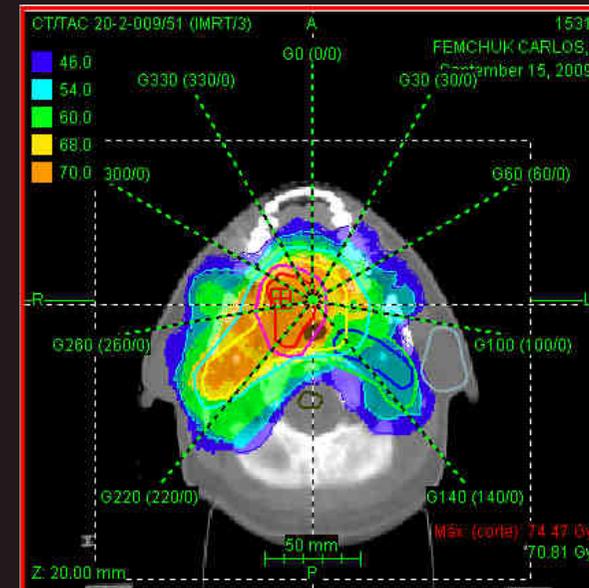
- **IMRT** disminuye toxicidad en OAR permitiendo aumentar dosis en el volumen blanco
- Importante considerar
  - Definición de volúmenes
  - Complejidad de la planificación
  - Entrega de dosis
  - Aceptación de un plan



# IMRT

## Ventajas de IMRT sobre 3D

- Mejor cobertura del volumen blanco de planificación
- Posibilidad de generar distribuciones de dosis cóncavas y gradientes de dosis muy marcados alrededor del volumen blanco



## 3DCRT

# Recomendaciones ASTRO/ACR



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## Utilización de planificación inversa

- Delimitación de volumen blanco y OAR
- Optimización de tratamiento
  - Dosis al volumen blanco
  - Límites de dosis a OAR
- Sistema de control de calidad (QA)
  - Precisión
  - Reproducibilidad diaria



# PLANIFICACION INVERSA

Planificación basada en restricción  
**dosis/volumen**

- Delineación de **volúmenes**
- Definición dosis limitante de **OAR**
- Definición de dosis de **volumen blanco**

# DELINEACION VOLUMENES



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«Less is more»

Ludwig Mies van der Rohe

Arquitecto & Diseñador Industrial (1886-1969)



-Incertidumbre

-Repercusión

/toxicidad

/control local





# Definición de Volúmenes

## ICRU 38



**Volúmenes ?**



La delimitación de volúmenes es de carácter obligatorio en un procedimiento de planificación, para que la dosis absorbida pueda ser prescripta, “grabada” y reportada.



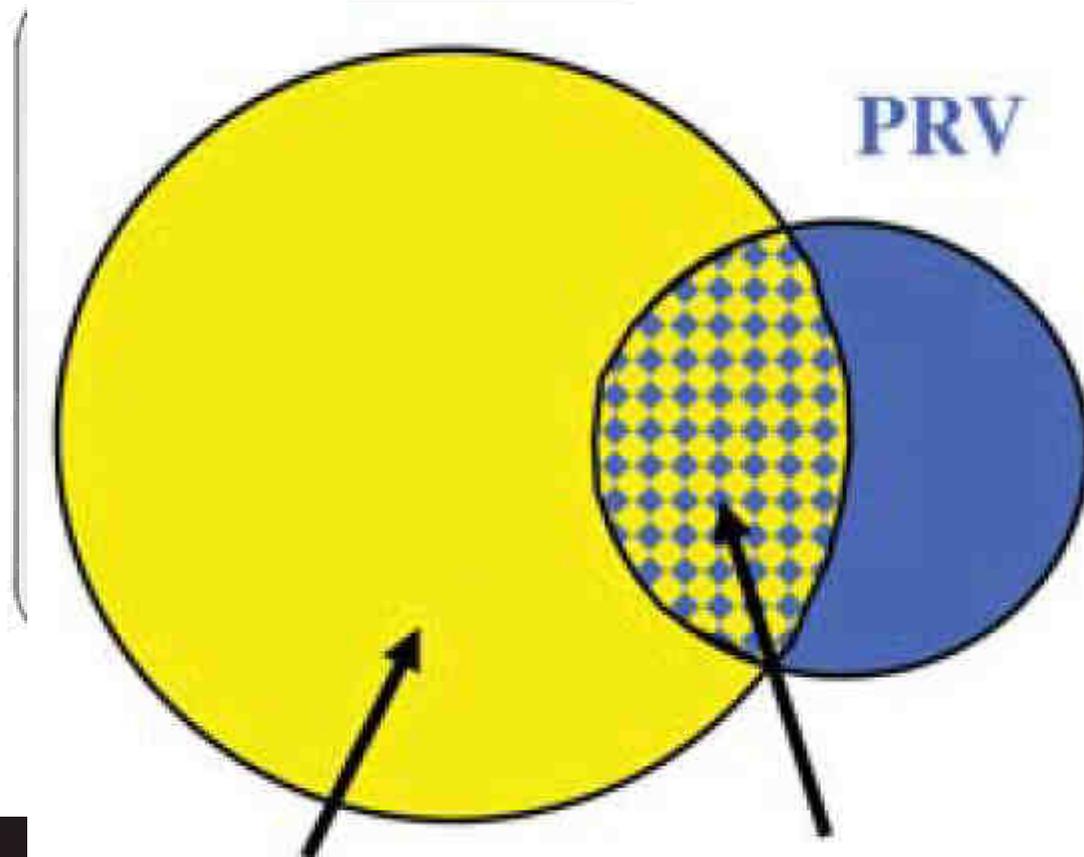


... definir:

- † Gross tumor volume or **GTV**
- † Clinical target volume or **CTV**
- † Planning target volume or **PTV**
- † Organ at risk or **OAR**
- † Planning organ-at-risk volume or **PRV**
- † Internal target volume or **ITV**
- † Treated volume or **TV**
- † Remaining volume at risk or **RVR**

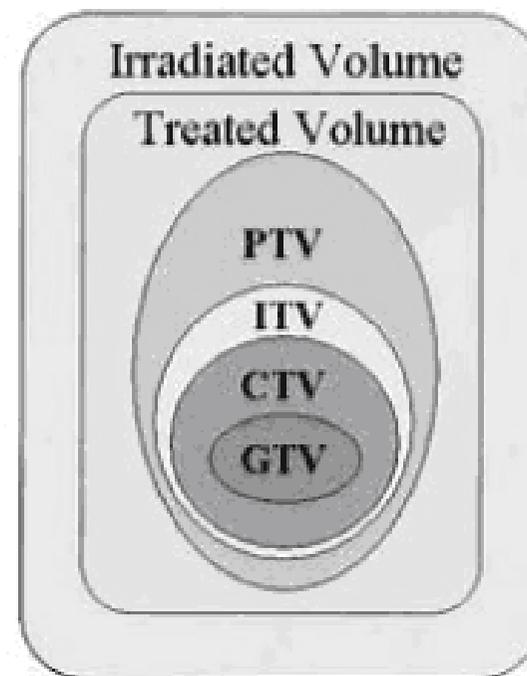


**PTV**



**PTV<sub>SV-1</sub>**

**PTV<sub>SV-2</sub>**

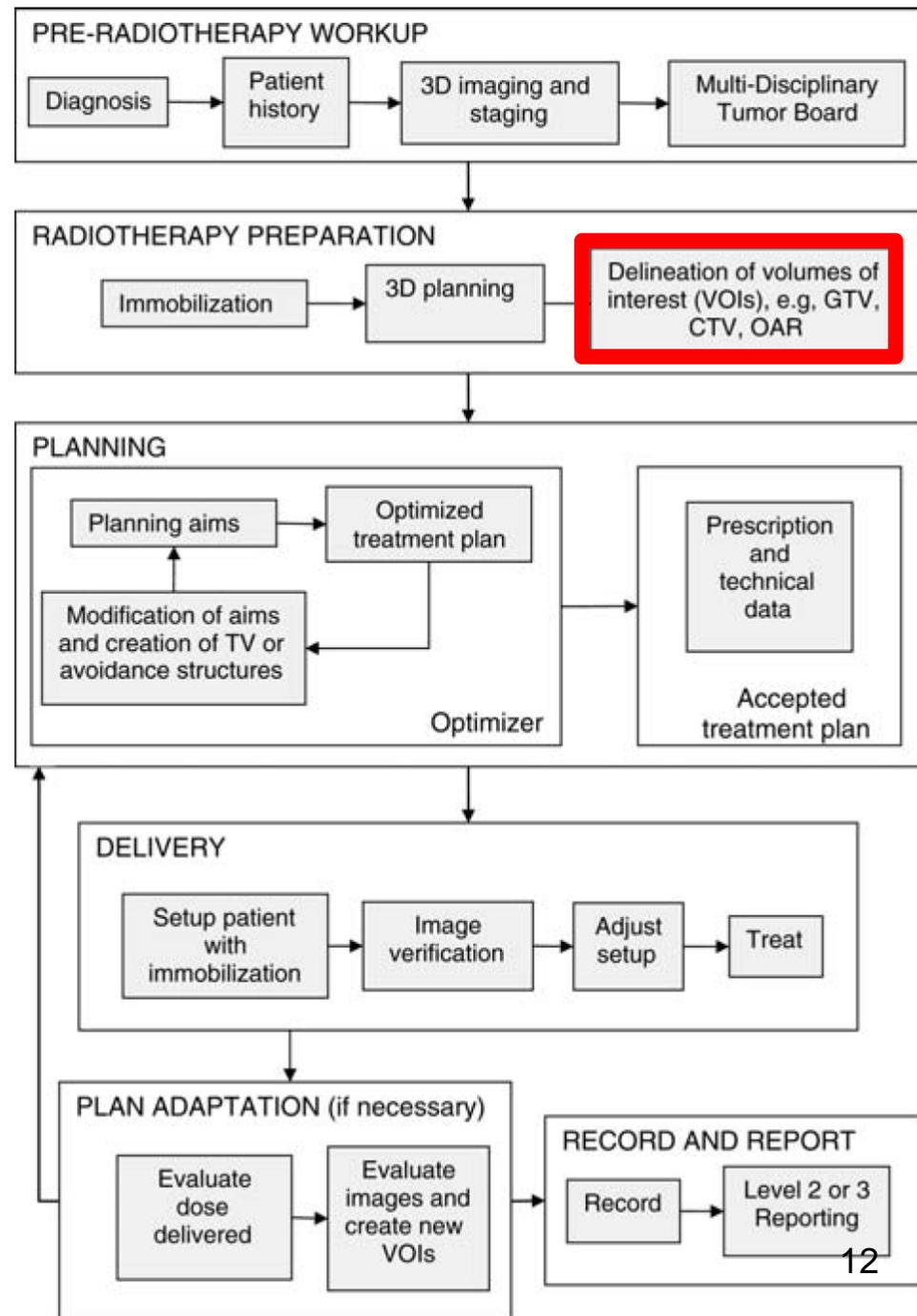


**(C) ICRU 62**

**ICRU 83**

# Secuencia de preparación para un tratamiento de RTE tridimensional

Journal of the ICRU Vol 10 No 1 (2010) Report 83  
Oxford University Press



# Simulación Virtual Definición de Volúmenes



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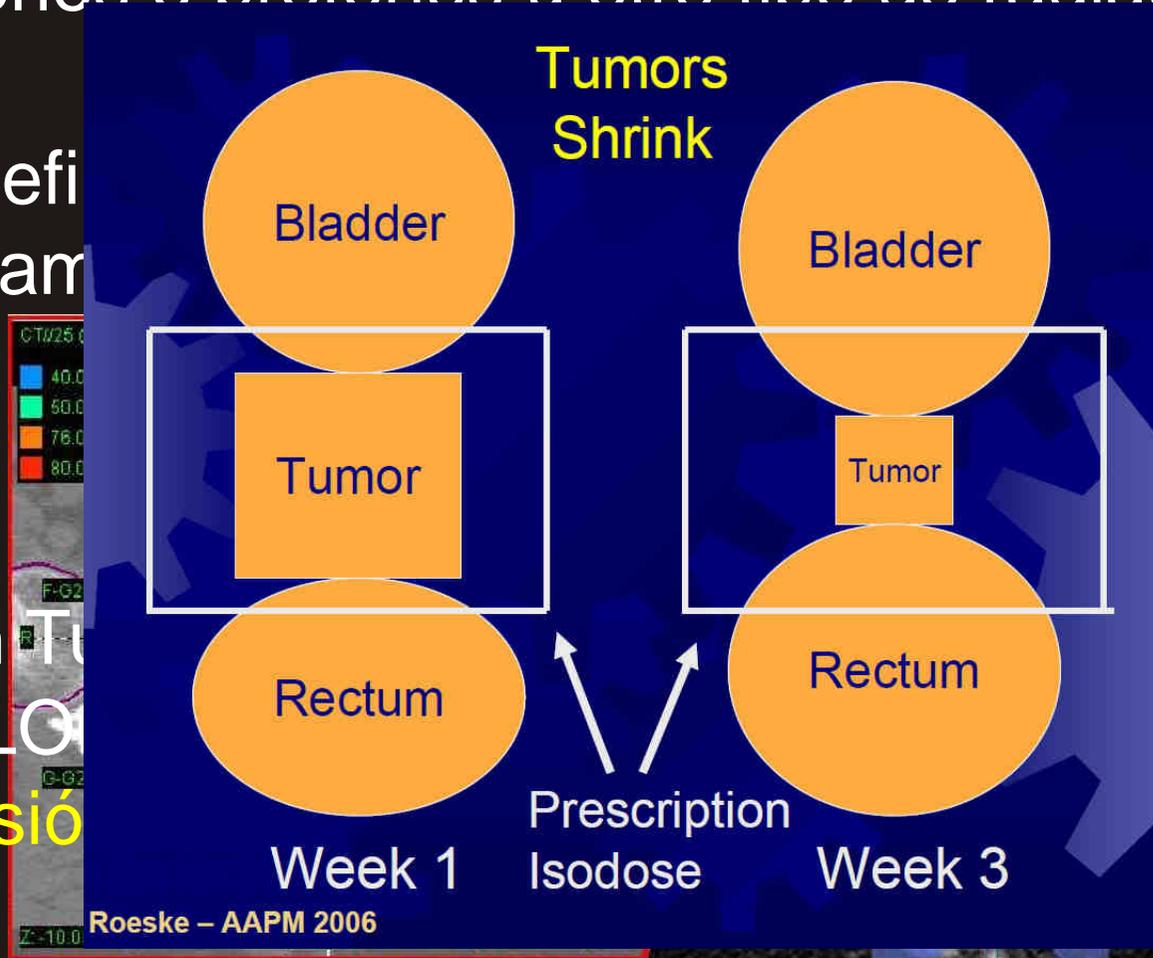


# Definición del volúmenes:

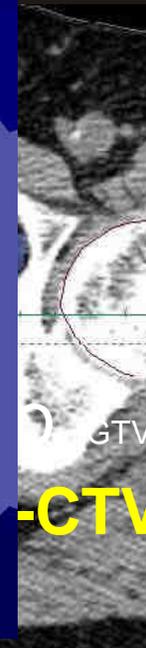
... es independiente de la utilización de fotones, electrones o protones u otro tipo de radiación.

... la definición de tratamiento

Lesión Tumoral  
PATOLÓGICA  
Regresión



la técnica



GTV-CTV, etc...)  
**-CTV-PTV)**



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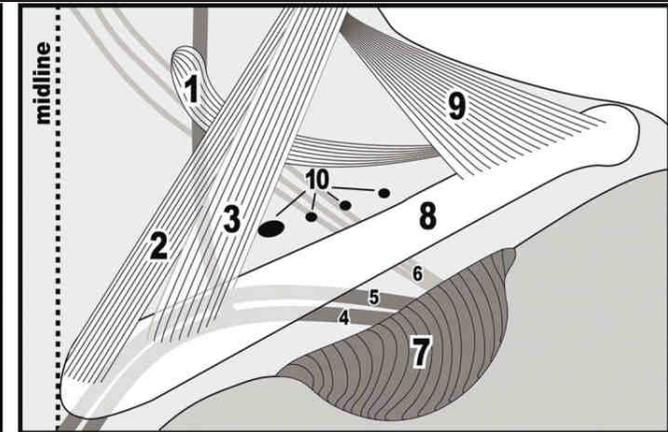
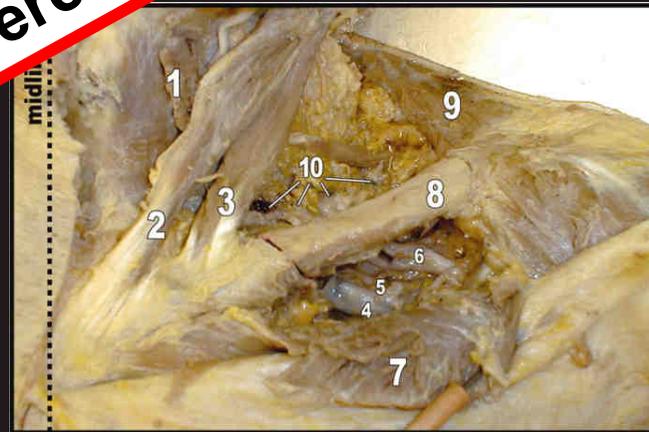
# MAMA



# Definition of the Supraclavicular and Infraclavicular Nodes: Implications for Three-dimensional CT-based Conformal Radiation Therapy<sup>1</sup>

Chika N. Madu, BS  
Douglas J. Quint, MD  
Daniel P. Normolle, PhD  
Robin B. Marsh, CMD  
Edwin Y. Wang, MD  
Lori J. Pierce, MD

**Planificación conformada 3D optimiza cobertura  
dosimétrica comparada con planificación STD.  
Repercusion sobre tamaño campos RTE.**



# Diferencias Inter-Observadores +++



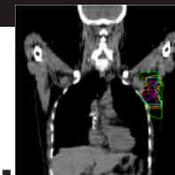
INSTITUTO DE RADIOTERAPIA  
FUNDACIÓN MARIE CURIE

*The British Journal of Radiology, 82 (2009), 595–599*

## Anatomical, clinical and radiological delineation of target volumes in breast cancer radiotherapy planning: individual variability, questions and answers

P CASTRO PENA, MD, Y M KIROVA, MD, F CAMPANA, MD, R DENDALE, MD, M A BOLLET, MD, N FOURNIER-BIDOZ, PhD and A FOURQUET, MD

*Department of Radiation Oncology, Institut Curie, Paris, France*

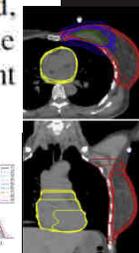
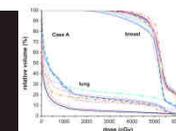


Int. J. Radiation Oncology Biol. Phys., Vol. 73, No. 3, pp. 944–951, 2009

## VARIABILITY OF TARGET AND NORMAL STRUCTURE DELINEATION FOR BREAST CANCER RADIOTHERAPY: AN RTOG MULTI-INSTITUTIONAL AND MULTIOBSERVER STUDY

X. ALLEN LI, PH.D.,\* AN TAI, PH.D.,\* DOUGLAS W. ARTHUR, M.D.,† THOMAS A. BUCHHOLZ, M.D.,‡  
SHANNON MACDONALD, M.D.,§ LAWRENCE B. MARKS, M.D.,¶ JEAN M. MORAN, PH.D.,||  
LORI J. PIERCE, M.D.,|| RACHEL RABINOVITCH, M.D.,\*\* ALPHONSE TAGHIAN, M.D., PH.D.,§  
FRANK VICINI, M.D.,†† WENDY WOODWARD, M.D., PH.D.,‡ AND JULIA R. WHITE, M.D.\*

\*Department of Radiation Oncology, Medical College of Wisconsin, Milwaukee, WI; †Virginia Commonwealth University, Richmond, VA; ‡The University of Texas M. D. Anderson Cancer Center, Houston, TX; §Massachusetts General Hospital, Boston, MA; ¶Duke University, Durham, NC; ||University of Michigan, Ann Arbor, MI; \*\*University of Colorado, Aurora, CO; and ††William Beaumont Hospital, Royal Oak, MI



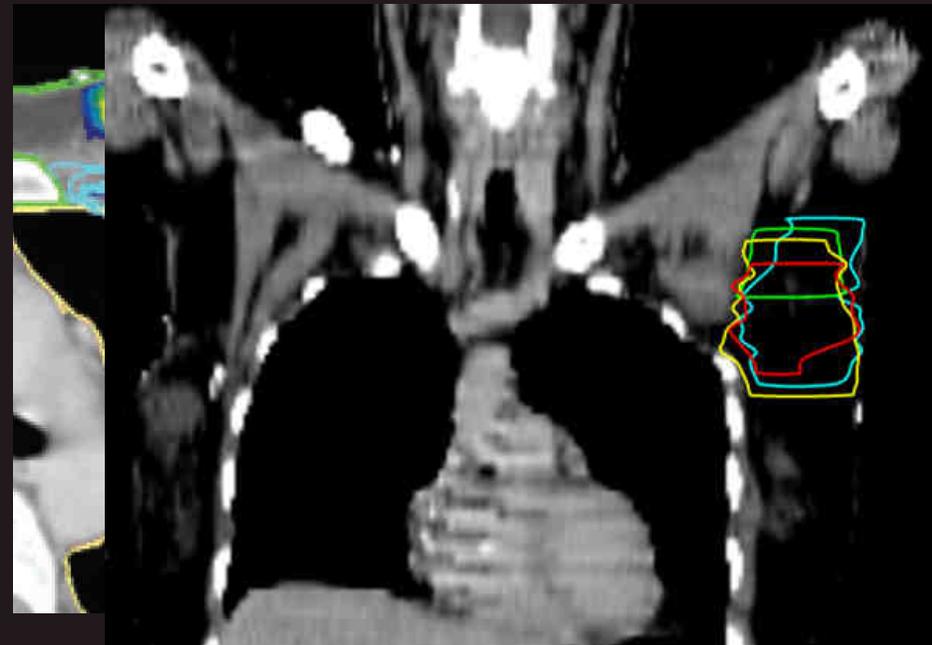
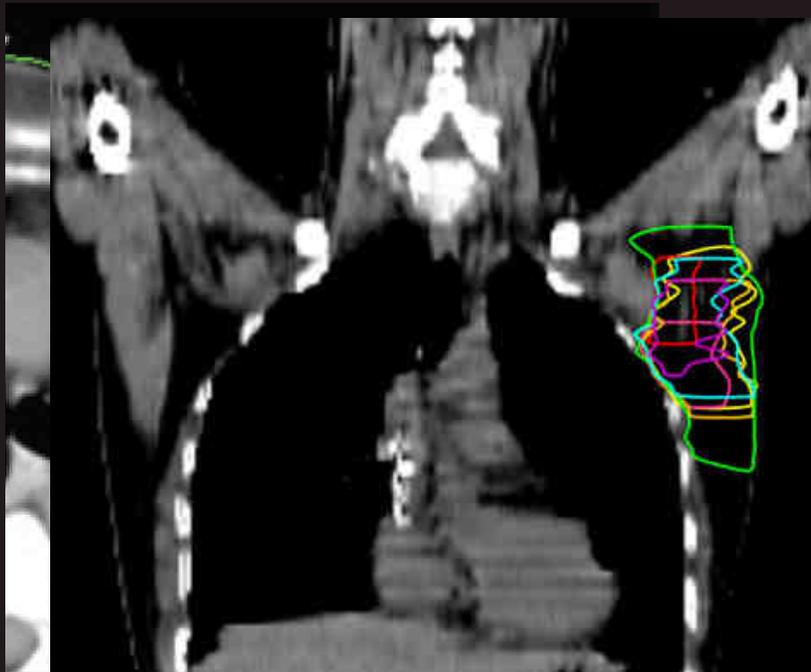
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TERAPIA  
CURIE

6 Radio-oncólogos & 5 Residentes misma institución.  
Delineación de CTV's, pre y post definición de volúmenes.

**Guía de Delimitación de Volúmenes & Entrenamiento Intensivo**



# VARIABILITY OF TARGET AND NORMAL STRUCTURE DELINEATION FOR BREAST CANCER RADIOTHERAPY: AN RTOG MULTI-INSTITUTIONAL AND MULTIOBSERVER STUDY

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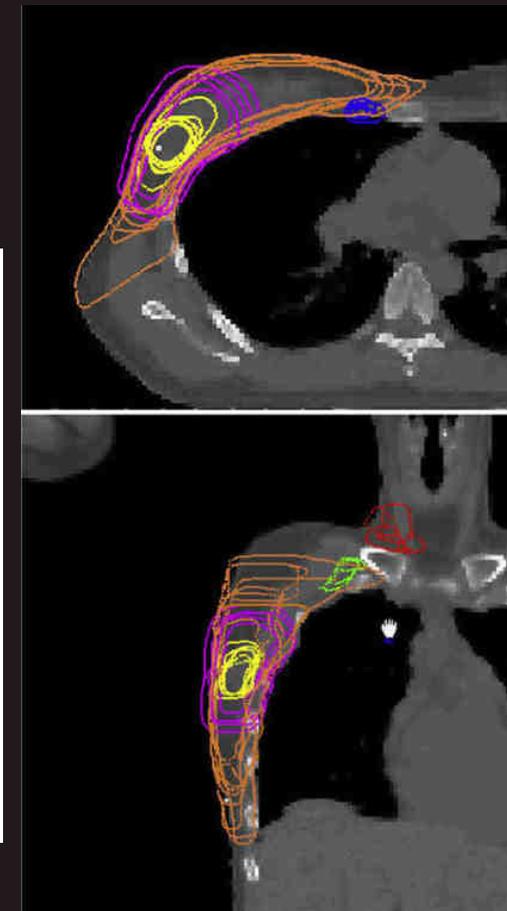
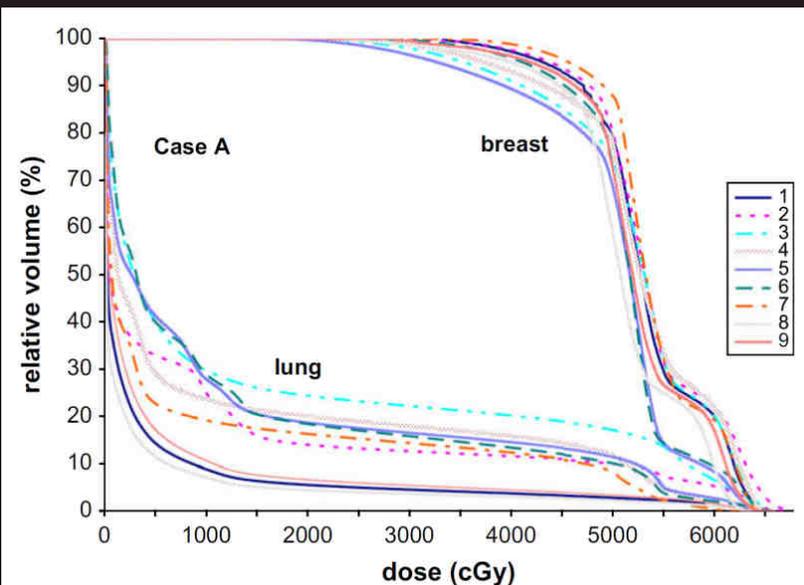
TERAPIA  
CURIE

- 9 Radio-oncólogos
- Delineación de volumen blanco y OAR
- Calculo impacto dosimétrico

Variaciones  
volumétricas  
interobservador



Impacto en  
Dosimetria



# BOOST



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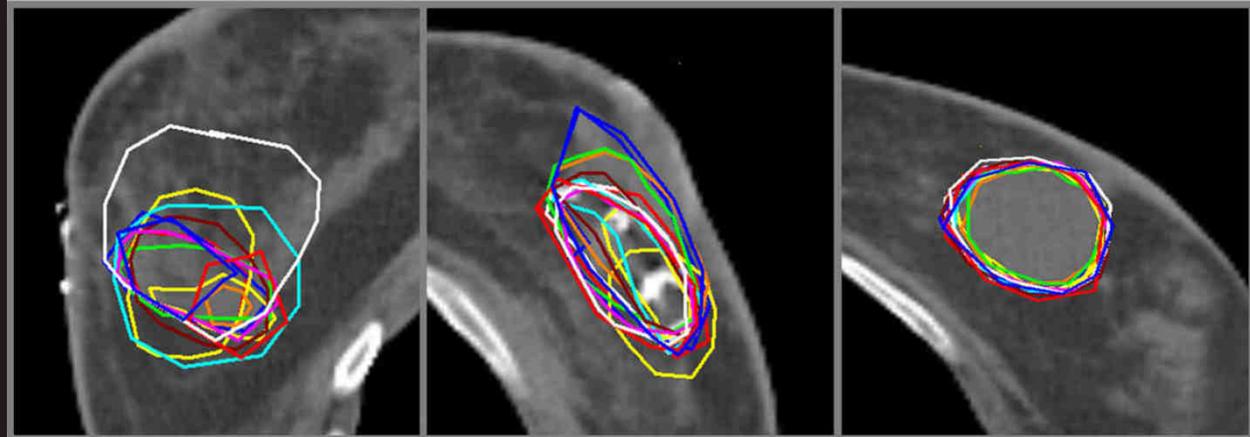
Multiinstitutional study on target volume delineation variation in breast radiotherapy in the presence of guidelines

Anke M. van Mourik, Paula H.M. Elkhuisen, Danny Minkema, Joop C. Duppen,  
On behalf of the Dutch Young Boost Study Group<sup>1</sup>, Corine van Vliet-Vroegindeweyj\*

*The Netherlands Cancer Institute, Amsterdam, The Netherlands*

*Radiotherapy and Oncology 94 (2010)*

Even in the presence of delineation guidelines considerable delineation variation is present ( $0.24 < SD < 1.22$  cm). Presence of **clips or seroma** reduced interobserver variation ( $0.24 < SD < 0.62$  cm).



Fuerte recomendación para la utilización de **CLIPS**

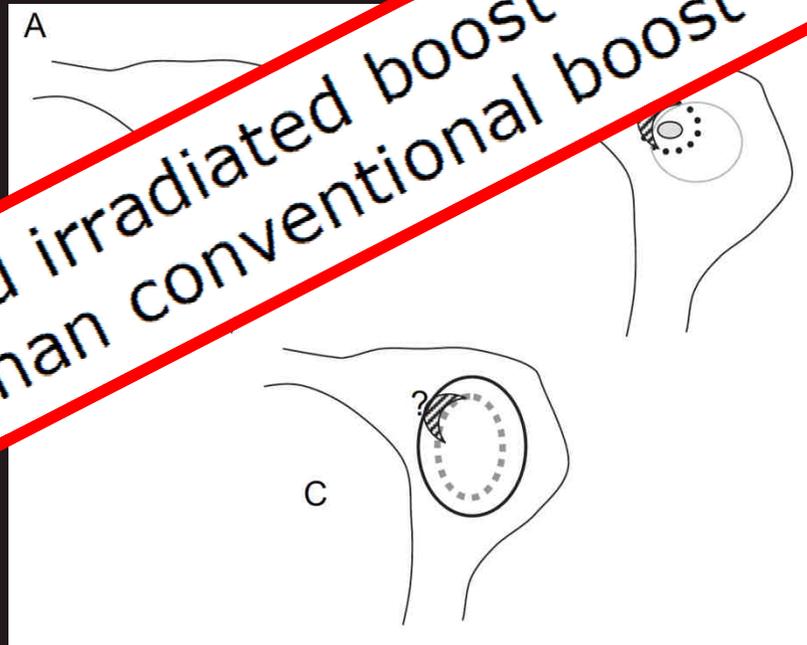


## CUSTOMIZED COMPUTED TOMOGRAPHY-BASED BOOST VOLUMES IN BREAST-CONSERVING THERAPY: USE OF THREE-DIMENSIONAL HISTOLOGIC INFORMATION FOR CLINICAL TARGET VOLUME MARGINS

BIANCA HANBEUKERS, M.A.,\* JACQUES BORGER, M.D., PH.D.,\*† PIET VAN DEN ENDE, M.D.,\*† F. VAN  
DER ENT, M.D., PH.D.,‡ RUUD HOUBEN, M.Sc.,\* JOS JAGER, M.D., PH.D.,\*† KRISTIEN KEYSERLINGK, M.D., PH.D.,\*  
LARS MURRER, PH.D.,\*† SUPRAPTO SASTROWIJOTO, M.D.,¶ KOEN VAN DE VIJVE, M.D., PH.D.,\*†  
AND LIESBETH BOERSMA, M.D., PH.D.†\*

\*Department of Radiation Oncology, MAASTRO Clinic, Maastricht, The Netherlands; †Department of Radiation Oncology,  
‡Surgery, and ¶Pathology, Maastricht University Medical Center, Maastricht, The Netherlands; †Department of Radiation Oncology,  
¶Pathology, Maasland Hospital, Sittard, The Netherlands

Int. J. Radiation Oncology Biol. Phys.



CT-based irradiated boost volumes 1.6 times larger than conventional boost volumes!

## AUTOMATIC SEGMENTATION OF WHOLE BREAST USING ATLAS APPROACH AND DEFORMABLE IMAGE REGISTRATION

VALERIE K. REED, M.D.,\* WENDY A. WOODWARD, M.D., PH.D.,\* LIFEI ZHANG, PH.D.,†  
ERIC A. STROM, M.D.,\* GEORGE H. PERKINS, M.D.,\* WELELA TEREFFE, M.D.,\* JULIA L. OH, M.D.,\*  
T. KUAN YU, M.D., PH.D.,\* ISABELLE BEDROSIAN, M.D.,‡ GARY J. WHITMAN, M.D.,§  
THOMAS A. BUCHHOLZ, M.D.,\* AND LEI DONG, PH.D.†

Departments of \*Radiation Oncology, †Radiation Physics, ‡Surgical Oncology, and §Diagnostic Radiology,  
University of Texas M. D. Anderson Cancer Center, Houston, TX



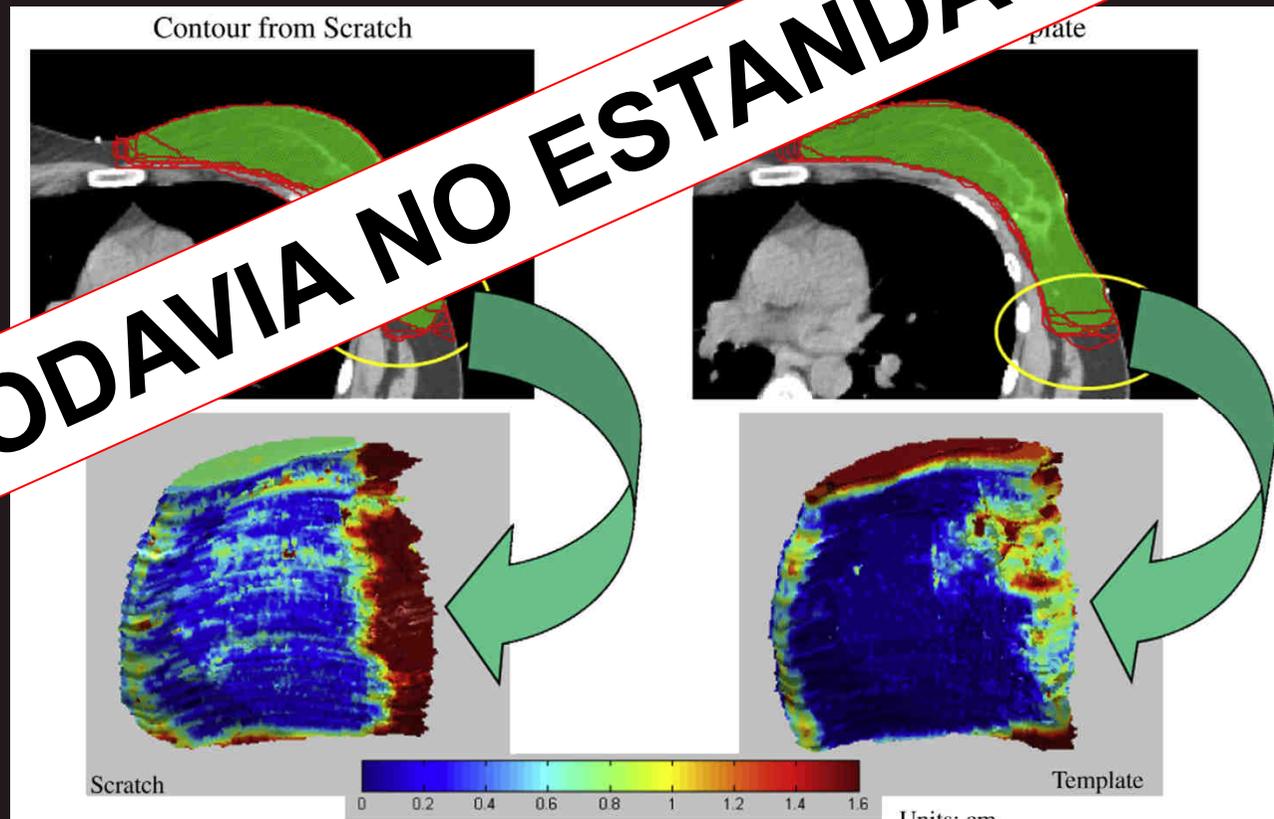
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• 30% mas rápido

• Adaptación a diferentes BMI

Verificación médica obligada

**TODAVIA NO ESTANDAR**





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# PROSTATA



CLINICAL INVESTIGATION

Prostate

## DO DIFFERENCES IN TARGET VOLUME DEFINITION IN PROSTATE CANCER LEAD TO CLINICALLY RELEVANT DIFFERENCES IN NORMAL TISSUE TOXICITY?

JACQUELINE E. LIVSEY, F.R.C.R.,\* JAMES P. WYLIE, F.R.C.R.,\* RIC SWINDELL, M.Sc.,†  
VINCENT S. KHOO, F.R.A.C.R.,‡ RICHARD A. COWAN, F.R.C.R.,\* AND JOHN P. LOGUE, F.R.C.R.\*

Departments of \*Clinical Oncology, †Medical Statistics, and ‡Academic Department of Radiation Oncology, Christie Hospital NHS Trust, Manchester, United Kingdom

**Purpose:** Many studies have described the quantitated differences between clinicians in target volume definition in prostate cancer. However, few studies have looked at the clinical effects of this. We aimed to assess the relevance and sequelae of such differences.

**Methods and Materials:** Five experienced radiation oncologists were given the clinical details of 5 patients with early-stage prostate cancer and asked to define the clinical target volume, consisting of the prostate and seminal vesicles (CTV1) and the prostate alone (CTV2), on specified planning CT scans of the pelvis. Planning target volumes (PTV1) were generated by automatic expansion of the CTV1 by a 1-cm margin. The PTV2 was defined as the CTV2. The rectum and bladder were defined by a single experienced clinician for each plan without knowledge of the involved clinician marking the CTVs. The Pinnacle planning system was used to generate the plans, using four-field conformal radiotherapy, to deliver 64 Gy in 32 fractions to the PTV1 followed by a boost of 10 Gy to the PTV2 (Medical Research Council RT01 trial protocol). Dose–volume histograms were generated for the whole bladder and rectum for each plan and the volume receiving a specific percentage of the dose (e.g.,  $V_{90}$ ) calculated for 74 Gy, followed by estimates of normal tissue complication probabilities (NTCPs) for the bladder and rectum.

**Results:** Statistically significant differences were found in the CTV1 and CTV2 and, consequently, the PTV1 among the 5 clinicians ( $p < 0.0005$ ). Most of the discrepancies occurred at the delineation of the prostatic apex and seminal vesicles, with the smallest variance noted at the rectum–prostate and bladder–prostate interfaces. No statistically significant differences were found among clinicians for the rectal  $V_{90}$ ,  $V_{85}$ ,  $V_{80}$ ,  $V_{70}$ , or  $V_{50}$  or for the bladder  $V_{85}$ ,  $V_{80}$ ,  $V_{70}$ , or  $V_{50}$ . A difference was noted among consultants for the bladder  $V_{90}$  ( $p = 0.015$ ), although no correlation was found between the bladder  $V_{90}$  and the size of the outlined volumes. No statistically significant differences were found between the estimates of bladder ( $p = 0.1$ ) and rectal ( $p = 0.09$ ) NTCPs.

**Conclusion:** The statistically significant difference in outlined volumes of the CTV1, CTV2, and PTV1 among the 5 clinicians is in keeping with the findings of previous studies. However, the interclinician variability did not result in clinically relevant outcomes with respect to the irradiated volume of rectum and bladder or NTCP. This may have been because the outlined areas in which interclinician differences were smallest (the rectal–prostate and prostate–bladder interfaces) are the areas that have the greatest effect on normal tissue toxicity. For the areas in which the interclinician correlation was lowest (the prostatic apex and distal seminal vesicles), the effects on normal tissue toxicity are smallest. The results of this study suggest that interclinician outlining differences in prostate cancer may have less clinical relevance than was previously thought. © 2004 Elsevier Inc.

- 3DCRT
- 4 campos
- DT: 74Gy

Sin impacto en  
estimación de  
Toxicidad  
Tisular



# DELINEACION VOLUMENES

## Ej: Cáncer de Próstata

- OAR (ICRU 50)
  - VEJIGA
  - RECTO
  - URETRA
    - TEJIDOS ERECTILES
    - CABEZAS FEMORALES
- VOLUMEN BLANCO
  - PROSTATA
  - VESICULAS SEMINALES
  - GANGLIOS LINFATICOS



# DELINEACION VOLUMENES

## Ej: Cáncer de Próstata

- OAR (ICRU 50)
  - VEJIGA
  - RECTO
  - URETRA
    - TEJIDOS ERECTILES
    - CABEZAS FEMORALES
- VOLUMEN BLANCO
  - PROSTATA
  - VESICULAS SEMINALES
  - GANGLIOS LINFATICOS



# VEJIGA

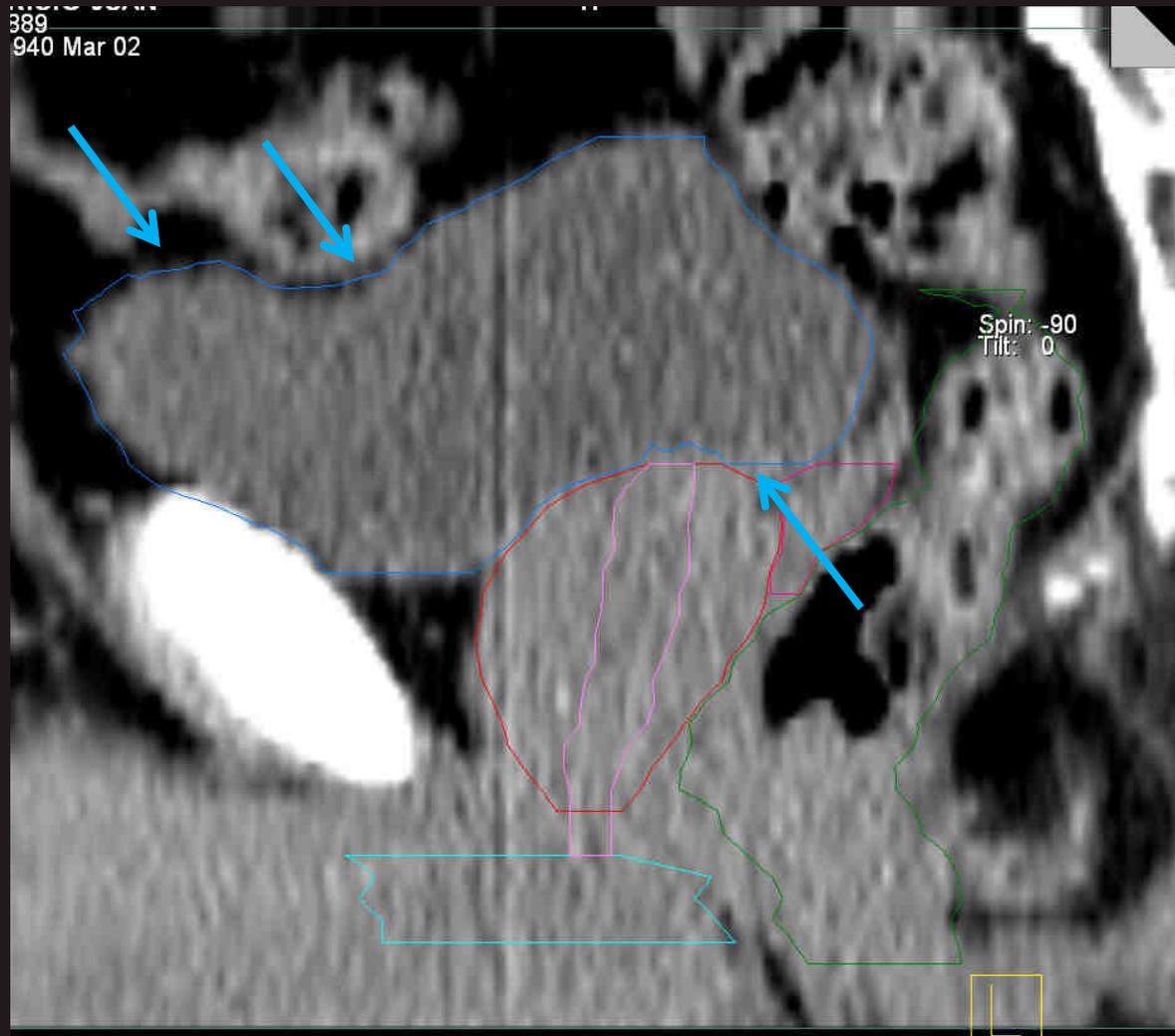
## Simulación

- Vejiga llena
  - Volumen constante & reproducible
- TAC Pelvis con y sin contraste en un tiempo
- Contraste EV
  - Mejor definición de Vejiga
    - Porción inferior, en contacto con BASE PROSTATA.....
    - Cuello vesical (Prostatectomía)

# VEJIGA Sin Contraste



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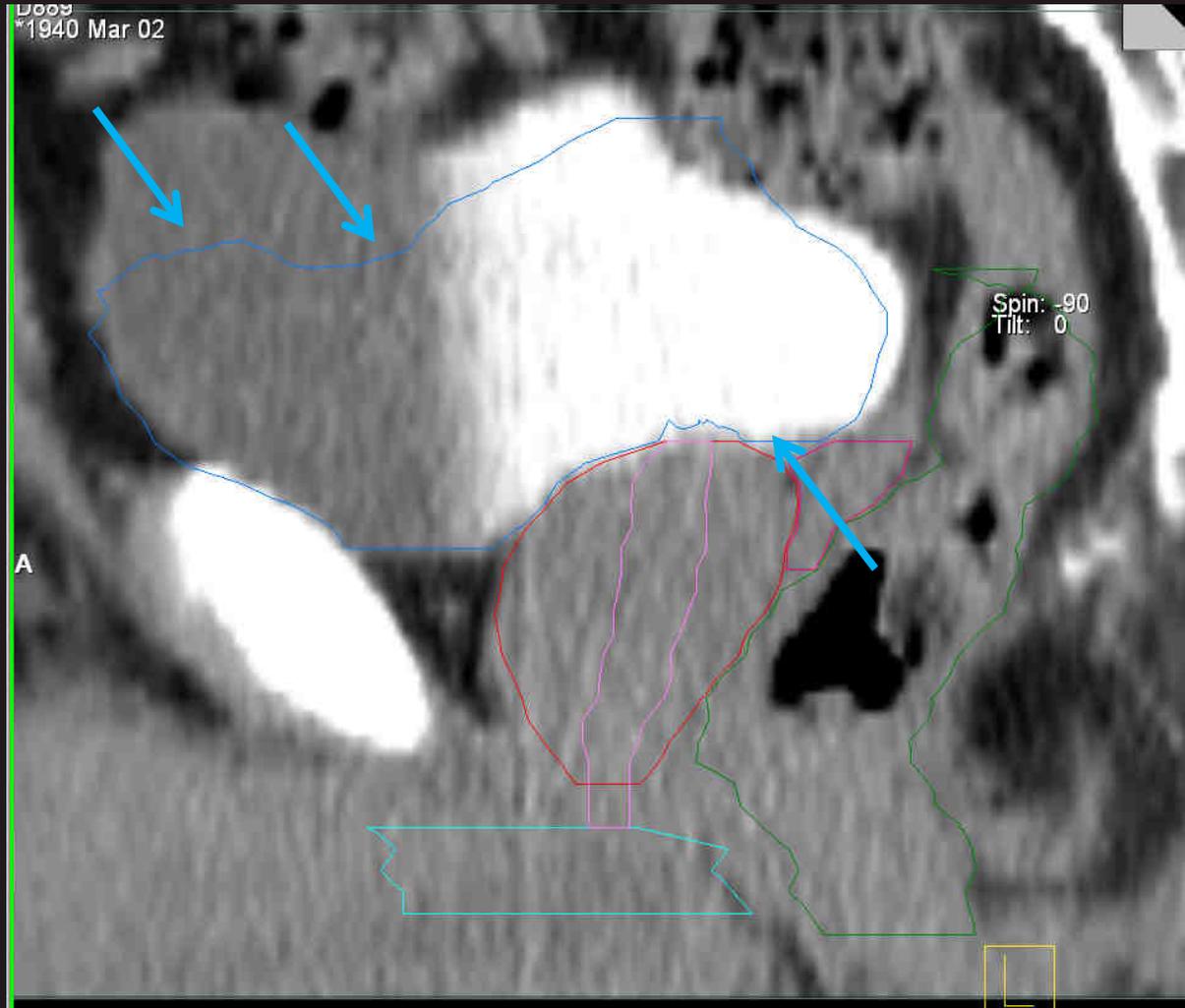


**VEJIGA**  
**PROSTATA**  
**V.SEMINALES**  
**URETRA**  
**RECTO**  
**TEJ.ERECTILES**

# VEJIGA Con Contraste



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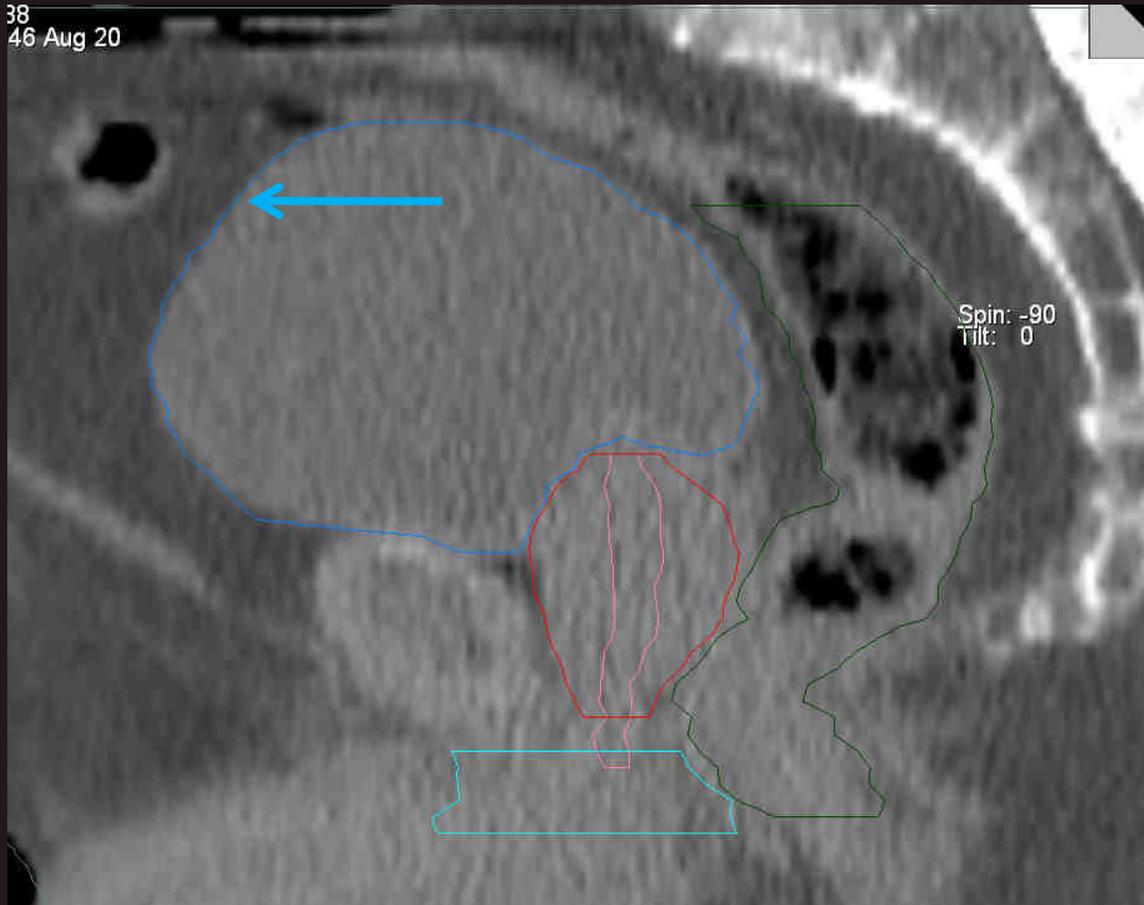
**VEJIGA**  
**PROSTATA**  
**V.SEMINALES**  
**URETRA**  
**RECTO**  
**TEJ.ERECTILES**

# VEJIGA Sin Contraste



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38  
46 Aug 20

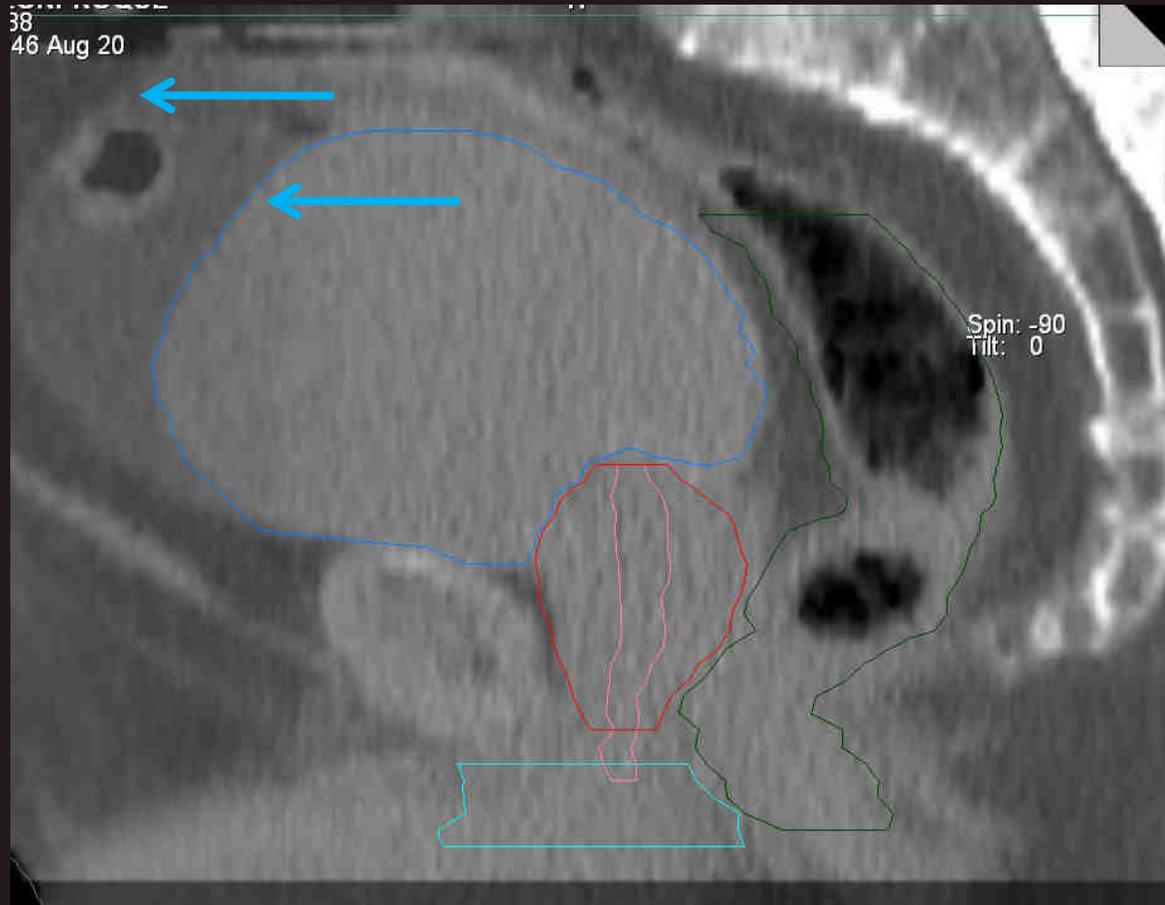


**VEJIGA**  
**PROSTATA**  
**URETRA**  
**RECTO**  
**TEJ.ERECTILES**

# VEJIGA Transición



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**VEJIGA**  
**PROSTATA**  
**URETRA**  
**RECTO**  
**TEJ.ERECTILES**

# VEJIGA Con Contraste



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**VEJIGA**  
**PROSTATA**  
**URETRA**  
**RECTO**  
**TEJ.ERECTILES**

**Definir que volumen referencia  
(reproductible)**



# RECTO

Simulación en condiciones fisiológicas  
reproducibles

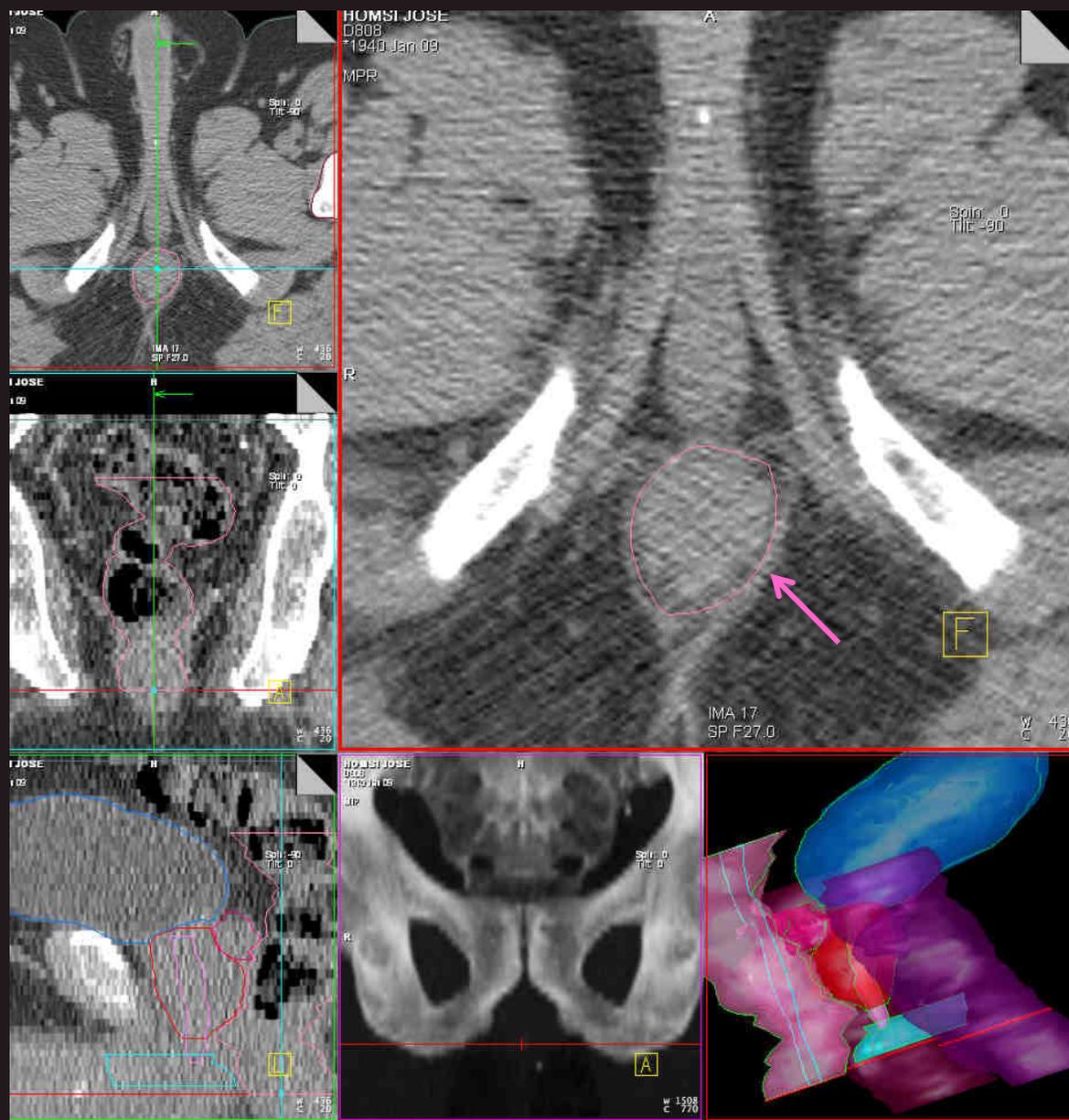
-Dibujo:

- Limite INF.: Ano (Tuberosidad Isquiática) ó 1 cm debajo de PTV
- Limite SUP.: Unión recto-Sigma ó 1 cm superior al PTV



**RECTO**

**Límite**  
**INFERIOR**



# TEJIDOS ERECTILES



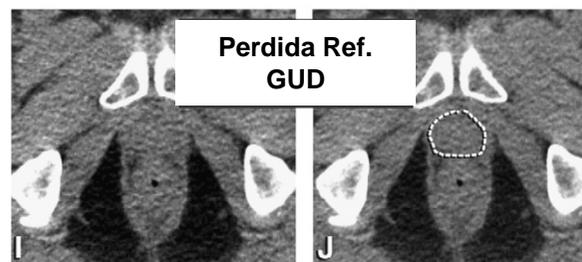
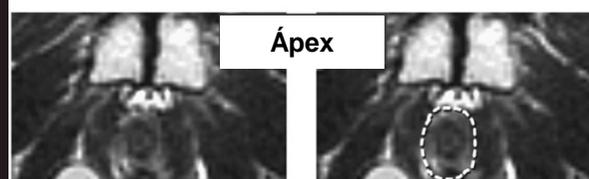
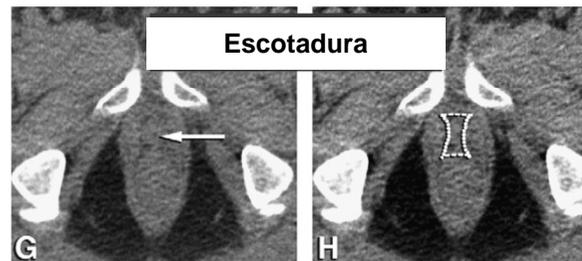
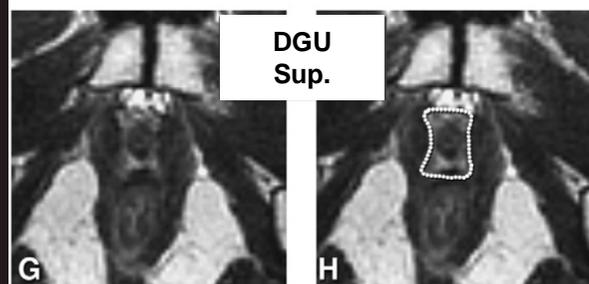
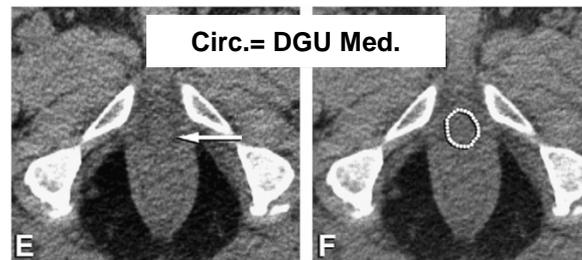
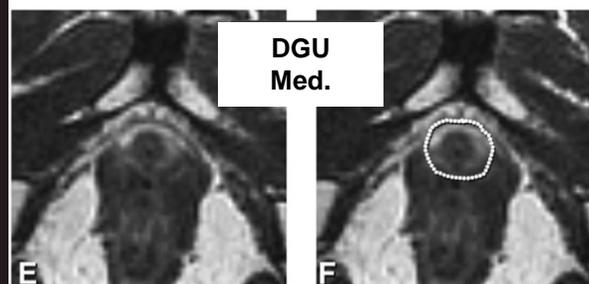
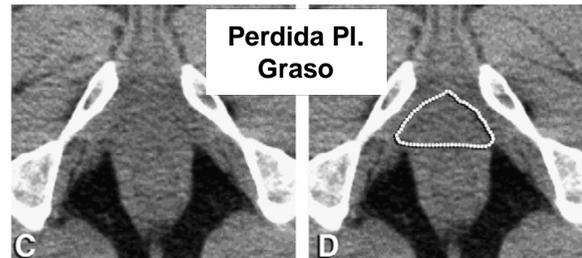
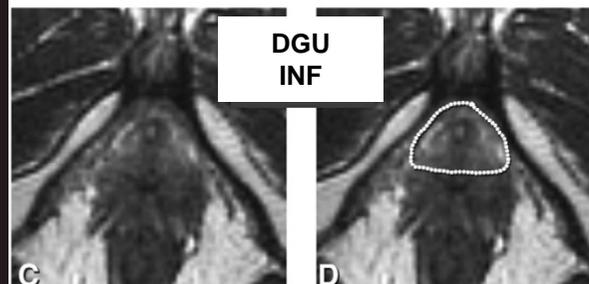
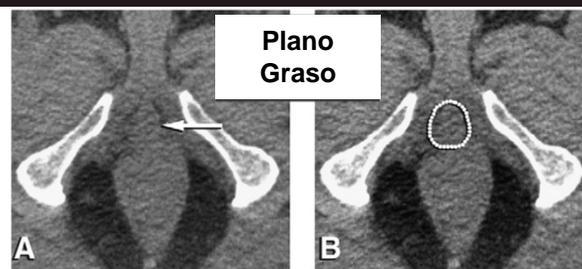
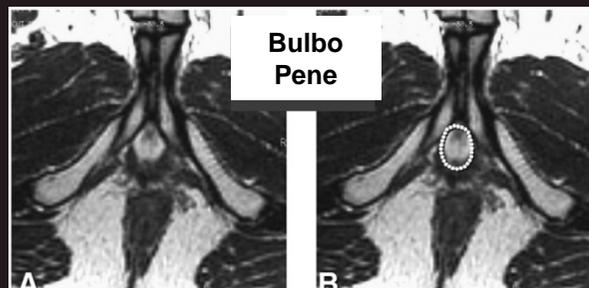
INSTITUTO DE RADIOTERAPIA  
FUNDACIÓN MARIE CURIE

## Bulbo Peneano & Cuerpo Cavernoso

- Aumento del riesgo de Impotencia
  - Pickett:  $D_{95} > 14\text{Gy}$
- **Reducir márgenes en APEX próstata**
  - Probable aumento de falla local o >  
**Disfunción eréctil ? !!!**
- Delimitación sistemática
  - Mejor visualización con RM
  - Sin Límites Dosis bien definidos
  - Estudios randomizados en curso



# RM & TAC

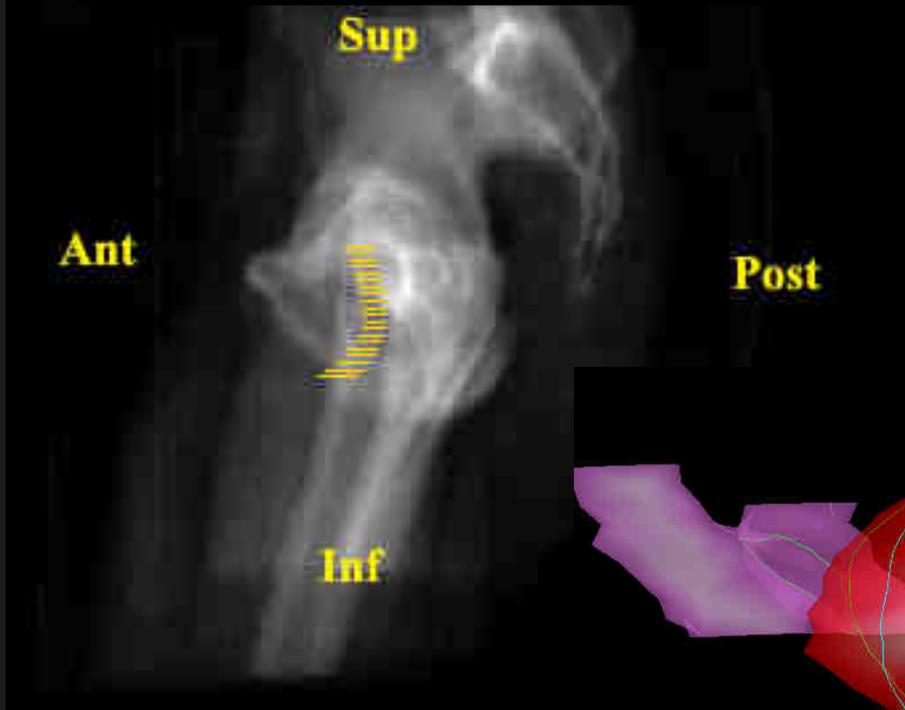


# URETRA

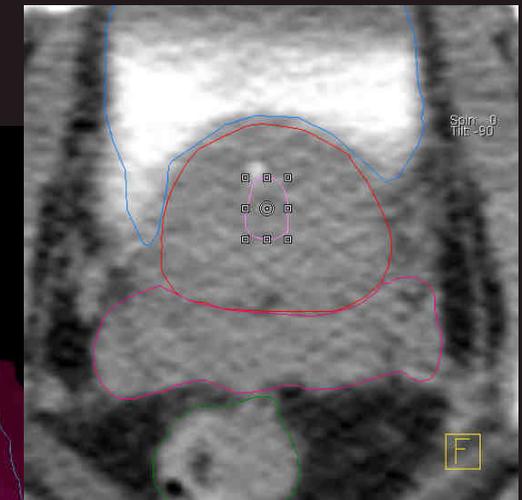


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## URETRA PROYECCION LATERAL



- Central a la Próstata
- Se sitúa ANT hacia el BP & Vejiga
- 1-1,5 cm diámetro
- Se extiende pocos cm SUP & INF del PTV



**Evitar PUNTOS  
CALIENTES !!!**

# PROSTATA



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- Áreas de mayor complejidad
  - Apex & Base
- Definir un volumen geoméricamente coherente con la estructura anatómicas (bordes romos ....)
- Utilizar todas las incidencias TAC
- Conocimiento de dimensiones



- **BASE**

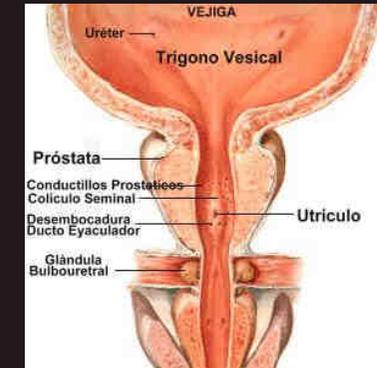
- Fusión Contraste (impronta ...)
- Limite posterior con VS
- Superficie plana

- **MEDIA**

- Fascias musculares peri-prostáticas
  - Banda plana, oscura y anterior
- Plexo venoso dorsal
  - Al largo del borde anterior prostático

- **APEX**

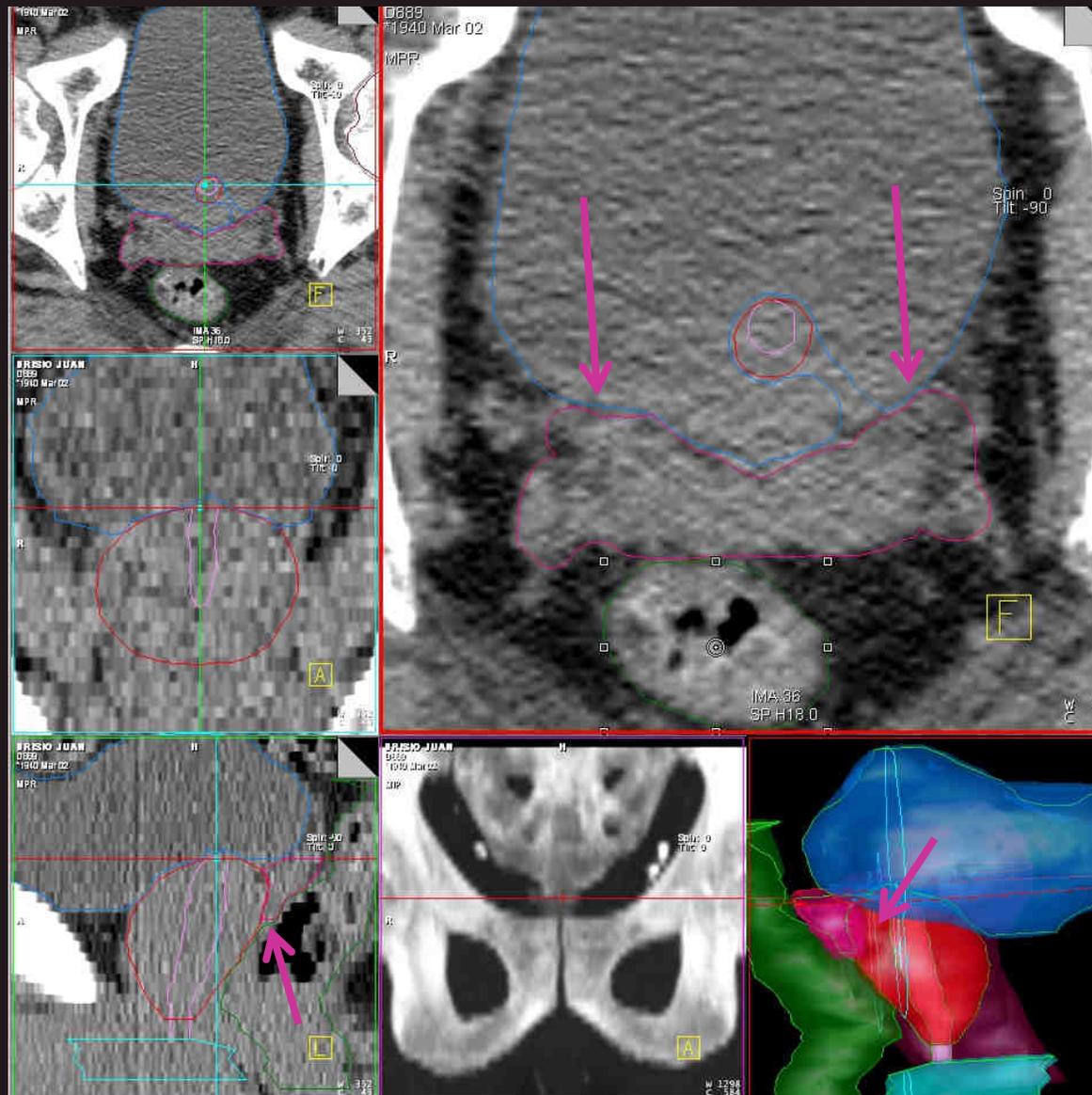
- Relación con estructura ósea inespecífica
- Limite posterior referencia es el RECTO
- Aprox. a 1-1,5 cm de limite sup. BP



# VESICULAS SEMINALES



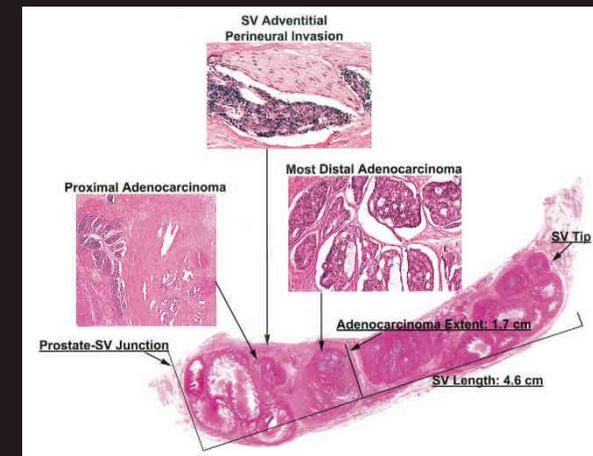
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Una porción de las VS debería ser incluida en CTV solo para pacientes:

- PSA 10ng/mL
- Gleason 7
- T2b

Al trata las VS, solo los primeros **2-2,5cm** deberían ser incluidos en el CVT

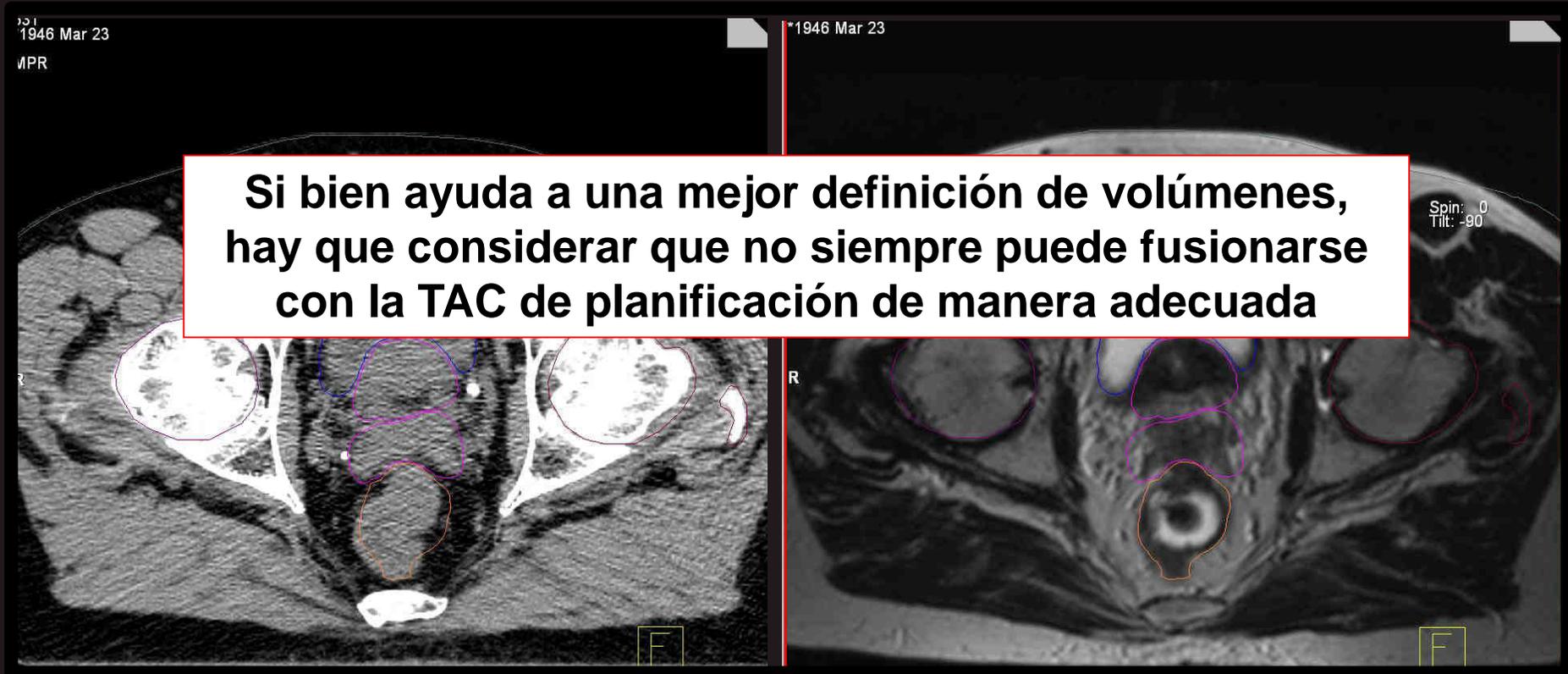


KESTIN L., MARTINEZ A.;  
IJROBP Vol. 54, No. 3, pp.  
686-697, 2002

# FUSION TAC/RM



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STEENBAKKERS R, et al.; IJROBP Vol. 57, No. 5, pp. 1269–1279, 2003  
BUYOUNOUSKI M. et al.; IJROBP Vol. 58, No. 3, pp. 743–749, 2004  
JACKSON A. et al. ; BJR 80 (2007), 926–933



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# Criterios para aceptar un plan de tratamiento

# ACEPTACION PLAN IMRT



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- Limites Dosis del PTV
  - Absolutos: HDV, **PTV Min (98%) & PTV Max (2%)**
  - Efectivos: Prescripción Isodosis
- Limite Dosis Tejidos Normales (HDV)
- Limite Gradiente Dosis Tejidos normales
  - Controlar cortes axiales
    - Limites: 100%, 90% y 50%

# MODIFICACION DEL PTV



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- En casos especiales se pueden realizar modificaciones del PTV..

Ej:

- 8 mm excepto posterior
  - **PTV Efectivo: 6-13 mm**
- 5 mm posterior
  - **PTV Efectivo: 3-8 mm**



- Guías para aceptación de plan de tratamiento
- Definidas según patología & técnica y/o esquema de tratamiento
- Basadas en bibliografía internacional y/o experiencia institucional
  - Deben ser respetadas a nivel institucional (salvo excepciones)

# Guías Aceptación Plan Tratamiento O Protocolos de tratamiento



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The screenshot shows a Windows XP file explorer window titled "fisicosymedicos en cofre3 (Cofre3)". The address bar shows the path "Dirección \\Cofre3\fisicosymedicos". The left sidebar contains "Tareas de archivo y carpeta" and "Otros sitios". The main area displays a list of files and folders:

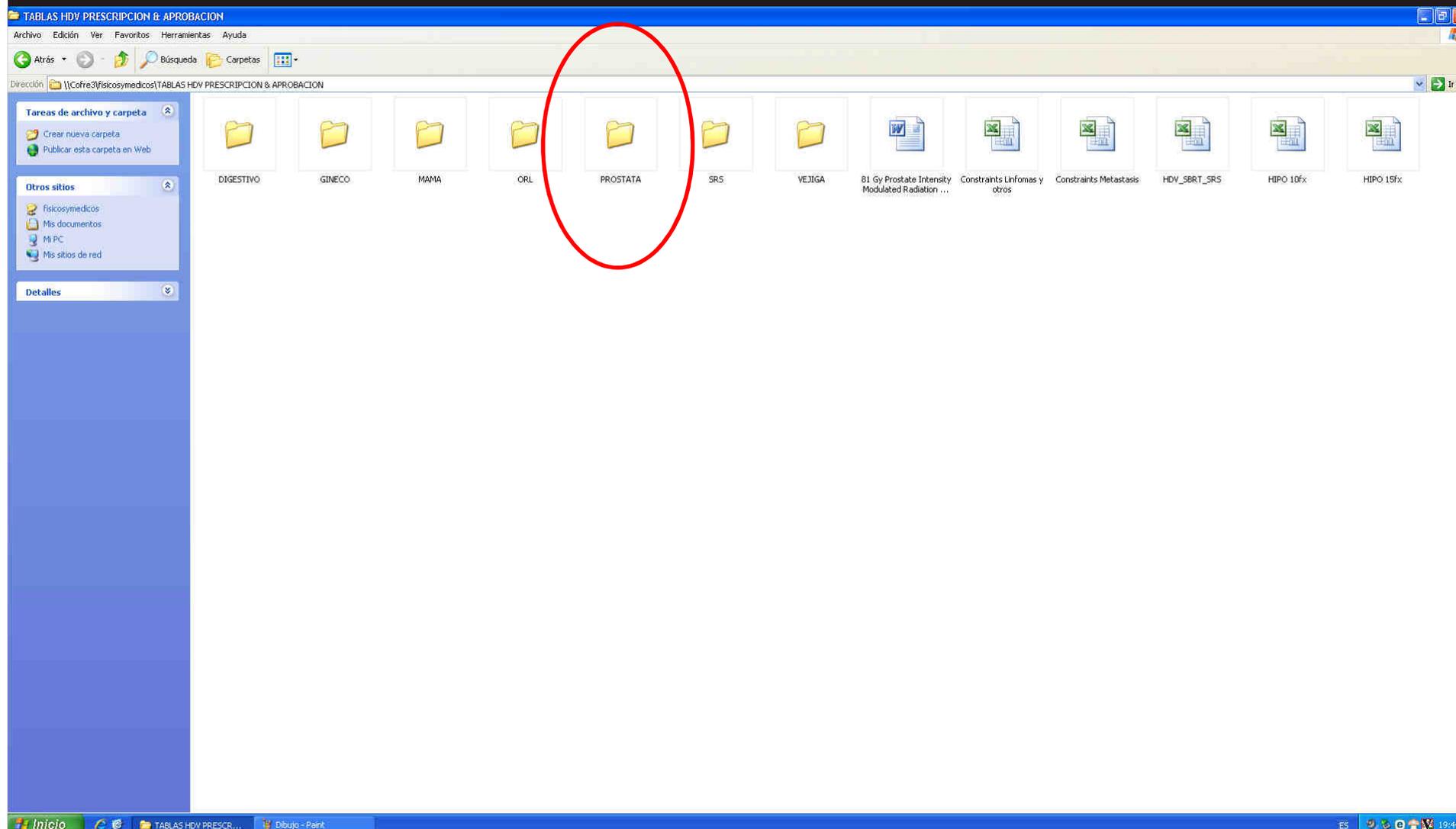
- Auxilio
- TABLAS HDV PRESCRIPCIÓN & APROBACIÓN
- trashbox
- Breast ESTRO guideline state 2013-05
- ecuacion
- HDMLC-PDIP-configur...
- MORENO BLAS MACROADENOMA
- MORENO BLASS -10 FINAL
- rodriguez
- TAC de hoy

The taskbar at the bottom shows the "Inicio" button, the system clock at 19:43, and the date 08/08/2013.

# Guías Aceptación Plan Tratamiento O Protocolos de tratamiento



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# Guías Aceptación Plan Tratamiento O Protocolos de tratamiento



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The screenshot shows a Windows Explorer window titled 'PROSTATA'. The address bar displays the path: \\Cofre3\fisicosymedicos\TABLAS HDV PRESCRIPCION & APROBACION\PROSTATA. The main pane lists the following files:

- PROSTATA IMRT + IGRT x 28 fracciones
- PROSTATA IMRT x 36 fracciones
- PROSTATA POS-PROSTATECTOMIA IMRT x 36 fracciones
- PROSTATA RTC3D x 38 fracciones
- PROSTATA SBRT x 5 fracciones
- Tabla HDV PROSTATA SBRT x 5 fracciones

The left sidebar contains the following sections:

- Tareas de archivo y carpeta**:
  - Crear nueva carpeta
  - Publicar esta carpeta en Web
- Otros sitios**:
  - TABLAS HDV PRESCRIPCION & APROBACION
  - Mis documentos
  - MI PC
  - Mis sitios de red
- Detalles**: (collapsed)

Tabla HDV PROSTATA SBRT x 5 fracciones

	HDV Objetivos	HDV Logrado
<b>PTV- PROSTATA</b>		
D95%	40,0 Gy	Gy
D98%	≥ 39,2 Gy	Gy
V50/ VPTV	≤ 4,0	
Dmedia		
Dmax (2%)		
	HDV Objetivos	HDV Logrado
<b>RECTO</b>		
V50 (V20Gy)	≤ 50,0 %	%
V80 (V32Gy)	≤ 20,0 %	%
V90 (V36Gy)	≤ 10,0 %	%
V100 (V40Gy)	≤ 5,0 %	%
<b>RECTO ANTERIOR</b>		
Vmax	< 42 Gy	Gy
<b>RECTO POSTERIOR</b>		
Vmax	< 16 Gy	Gy
<b>VEJIGA</b>		
V50% (V20Gy)	≤ 40 Gy	Gy
V100 (V40Gy)	≤ 10 %	%
<b>FEMUR: Cabeza/Cuello</b>		
Izq V40(V16Gy)	≤ 5 %	%
Izq 25 Gy	≤ 10 cc	cc
Der V40(V16Gy)	< 5 %	%
Der 25 Gy	< 10 cc	cc
<b>BULBO PENEANO</b>		
Vmax	< 40 Gy	Gy
V25Gy	< 3 cc	cc
<b>URETRA</b>		
Vmax	< 42 Gy	Gy

Microsoft Excel - Tabla HDV PROSTATA SBRT x 5 fracciones [Modo de compatibilid]

# Control corte por corte



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The screenshot displays the Brainlab iPlan RT 4.5 Dose software interface. The main window shows an axial CT scan of a pelvis with two target volumes outlined in red and orange. The interface includes a top navigation bar with 'Overview', 'Slices', 'Irradiation Plan', and 'Plan Content' tabs. The right sidebar contains a 'Navigator' panel with 'Plan 1' and 'Treatment Planning' buttons, a 'Functions' panel with 'The RTPlan' and 'IMRT Beam 1-6' list, and a 'Prescription' panel with 'Refresh MU', 'Add Beam', 'Find', 'Reset IMRT', and 'Beam' options. The bottom status bar shows 'CT #1 (Axial) Slice 70 / 156' and 'CT #1 (Axial) Sagittal View' and 'CT #1 (Axial) Coronal View'.

CT #1 (Axial)  
Slice 70 / 156

CT #1 (Axial)  
Sagittal View

CT #1 (Axial)  
Coronal View

Overview Slices Irradiation Plan Plan Content

BRAINLAB  
iPlan RT 4.5 Dose

# Control corte por corte



INSTITUTO DE RADIOTERAPIA  
FUNDACIÓN MARIE CURIE

The screenshot displays the Brainlab iPlan RT 4.5 Dose software interface. The main window shows an axial CT scan of the pelvis with a prostate target volume outlined in orange and a penile beam (PB) target volume outlined in yellow. The dose distribution is shown as a color gradient from red (high dose) to blue (low dose). The interface includes a Navigator panel on the right with buttons for 'Treatment Planning', 'Physician's Review', 'Go to...', and 'Next'. Below the Navigator is the 'Functions' and 'Prescription' panel, which shows a tree view of the treatment plan with 'IMRT Beam 1' through 'IMRT Beam 6' listed. The 'Properties' panel for the selected beam shows parameters: Table: 0, Gantry: 210, Collimator: 0, Margin: 3.0 mm, and MU: 1515 (5 x 303). The bottom of the interface has a navigation bar with 'Overview', 'Slices', 'Irradiation Plan', and 'Plan Content' tabs. The bottom right corner displays the 'BRAINLAB iPlan RT 4.5 Dose' logo.

# Control HDV



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CT #1 (Axial)  
Slice 95 / 103

Navigator  
PLAN FINAL  
Physicist's Verification  
Load Plan  
Go to... Next

Functions  
The RTPlan  
Group 1  
G226  
G280  
G300  
G0  
G60  
G100  
Beams / Arcs  
Properties  
Table: 8 °  
Gantry: 225 °  
Collimator: 10 °  
Margin: 6 mm  
MI: 2548 (28 x 91)  
Plan Approval  
Export  
Dose Fluence Dose  
Export Wizard

**DVH**

Min. Dose : 2.4 % = 1.67 Gy  
Mean Dose : 41.5 % = 29.87 Gy  
Max. Dose : 102.1 % = 71.49 Gy

Volume [%] ▾

Violated DVH constraint

Dose [Gy]	Volume [%]
0	100
5	95
10	75
20	65
30	55
40	40
50	25
60	10
70	0

100.0 % = 130.888 cm  
Gridsize : 2.00 mm  
Dose [Gy] ▾  
Pencil Beam  
100.0 % = 70.00 Gy  
Guardian : 50%:20%

Objects

Select single / multiple Item(s) or Group ▾

PTV Prostate	PTV
PTV Prostate-Boost	PTV
Prostate	Boost
PTV - Recto EXT	Boost
Reg. uretra	Boost
Bladder	OAR 2
Bladder-PTV	OAR 2
Recto EXT	OAR 2
Recto EXT-PTV	OAR 2
Rectum	OAR 2
Rectum-PTV	OAR 2
Hip Joint, Left	OAR 3

Display Options

- Normal Tissue Graph
- Differential DVH
- Interpolate Graph
- Show Constraints

Calculation

Grid Size: 2.0 mm

- Finer for Small Objects

Recalc  
Export to Clipboard

Close

Overview Slices Field Reconstructions Setup DRRs Plan Content

BRAINLAB  
Plan RL 4.5 Dose

# Double Chek (campos, fraccionamiento, etc)



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**Overview** | **Slices** | **Irradiation Plan** | **Plan Content**

**Navigator**  
Prostata SBRT 2  
ID: SIMPOSIO Prost2  
PLAN IMRT  
Treatment Planning  
Physician's Review  
Go to... Next

**Functions** | **Prescription**

The RTPlan  
Group 1  
G210  
G235  
G260  
G300  
G0  
G60  
Refresh MU Prescription

Treatment Group  
Add Beam Find  
Reset IMRT

Beam  
Properties Delete

Table: 0  
Gantry: 210  
Collimator: 20  
Margin: 3.0 mm  
MU: 1160 (5 x 232)

Pencil Beam Display: 2.0mm

40.00  
38.00  
36.00  
30.00  
20.00  
Gy

Group: Group 1  
Name: G210

Dose frac.: 0.0000, 5 x 8.0 MU (1 of 30)

CT #1 (Axial)  
Sagittal View Slice 04 / 171

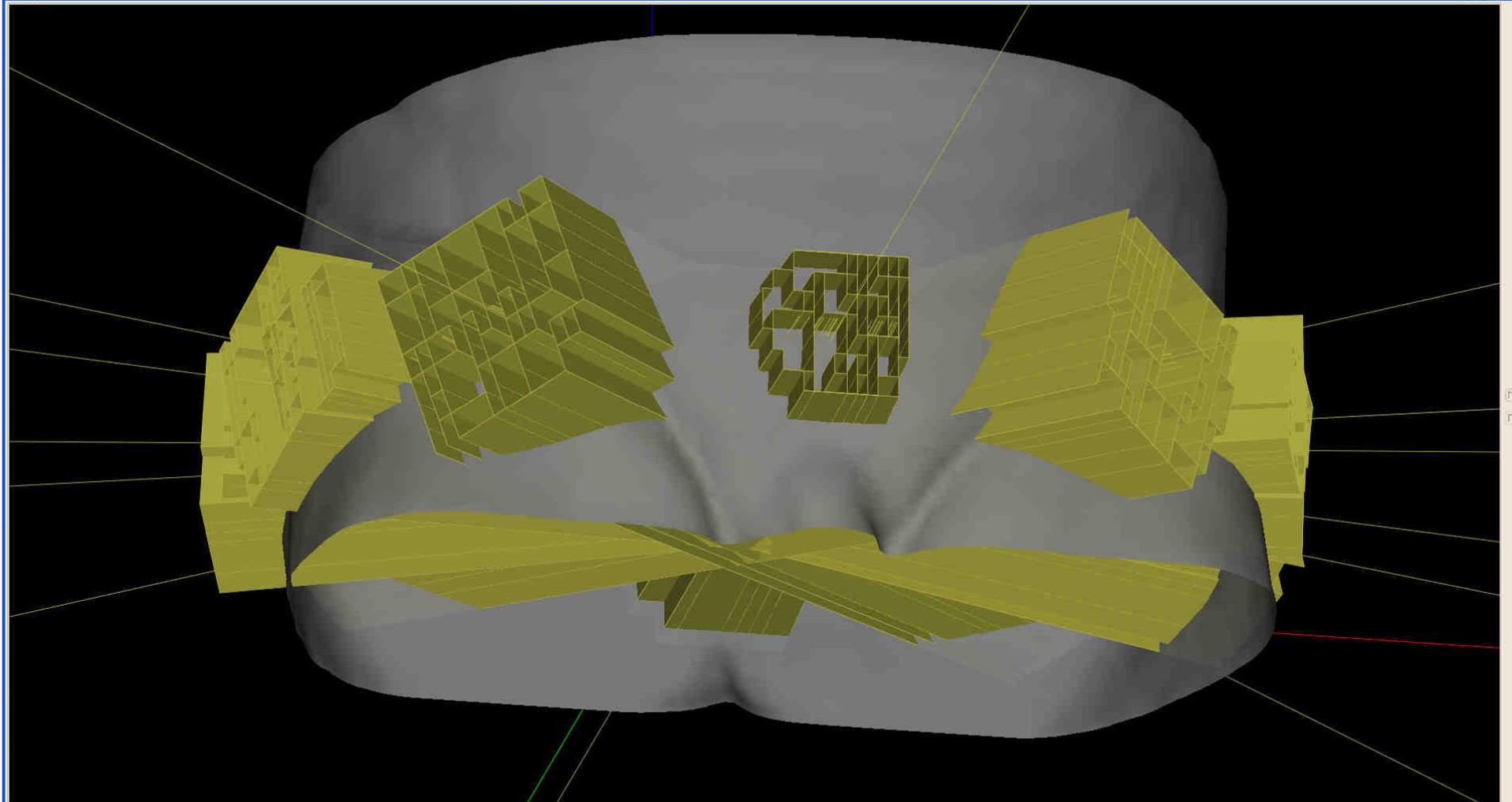
BRAINLAB  
about iPlan in RT 4.5 Dose

# Double Chek (campos, fraccionamiento, etc)



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Representación 3D



Inicio



PCRT 3D v6.021 -

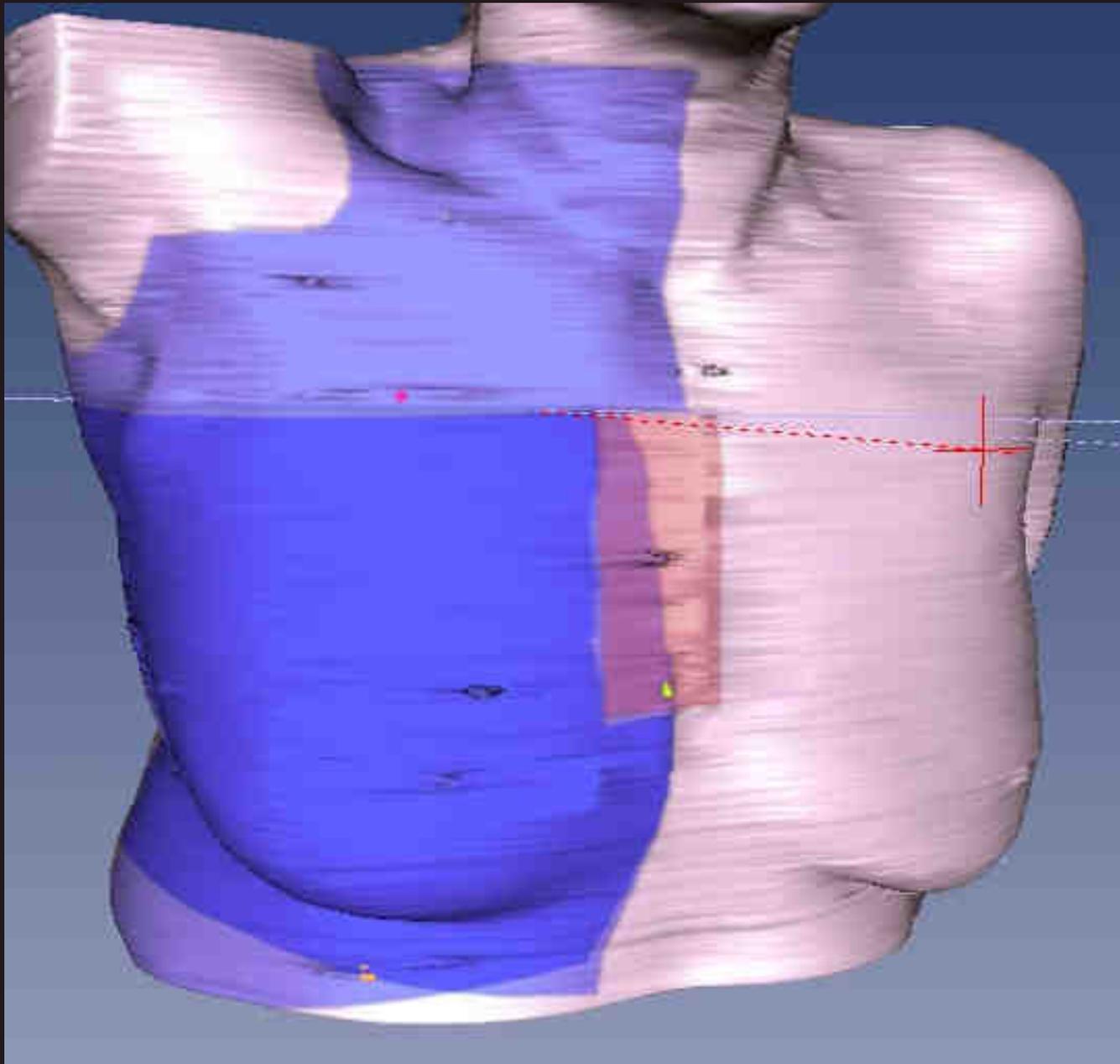
Dibujo - Paint

12:57 p.m.

# Double Chek (campos, fraccionamiento, etc)



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HDV Objetivos HDV Logrado

PTV- PROSTATA

D95%	40,0 Gy	40 Gy
D98%	≥ 39,2 Gy	39 Gy
V50/ VPTV	≤ 4,0	

Dmedia

Dmax (2%)

HDV Objetivos HDV Logrado

RECTO

V50 (V20Gy)	≤ 50,0 %	40 %
V80 (V32Gy)	≤ 20,0 %	21 %
V90 (V36Gy)	≤ 10,0 %	8 %
V100 (V40Gy)	≤ 5,0 %	2 %

RECTO ANTERIOR

Vmax	< 42 Gy	41 Gy
------	---------	-------

RECTO POSTERIOR

Vmax	< 16 Gy	15 Gy
------	---------	-------

VEJIGA

V50% (V20Gy)	≤ 40 Gy	30 Gy
V100 (V40Gy)	≤ 10 %	5 %

FEMUR: Cabeza/Cuello

Izq V40(V16Gy)	≤ 5 %	2 %
Izq 25 Gy	≤ 10 cc	0 cc
Der V40(V16Gy)	< 5 %	3 %
Der 25 Gy	< 10 cc	1 cc

BULBO PENEANO

Vmax	< 40 Gy	20 Gy
V25Gy	< 3 cc	0 cc

URETRA

Vmax	< 42 Gy	41 Gy
------	---------	-------

OK



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# TRATAMIENTO

## IMRT & IGRT

### Control volumétrico intra-tamiento

# Próstata & Desplazamiento

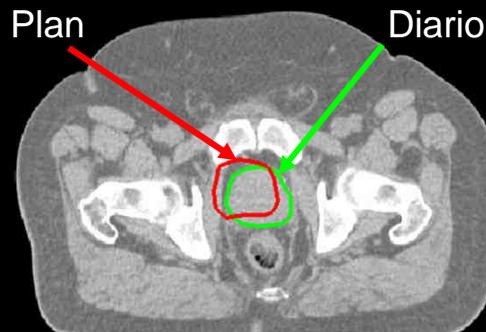


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Posicionamiento  
& Marcas Piel

Posicionamiento &  
Estructuras Oseas

Posicionamiento &  
(Fiduciales & C. Beam)



**I-D= 0.7 cm; S-I= 0.7 cm; A-P= 1.1 cm**

Foskey, et al. 2005  
Chandra et al, IJBOBP, 2004

Desplazamiento &  
Deformación

Gentileza P. KUPELIAN

Inter-fracción  
(día a día)

Intra-fracción  
(durante RTE)

# IGRT (Inter-Intra Fracción)



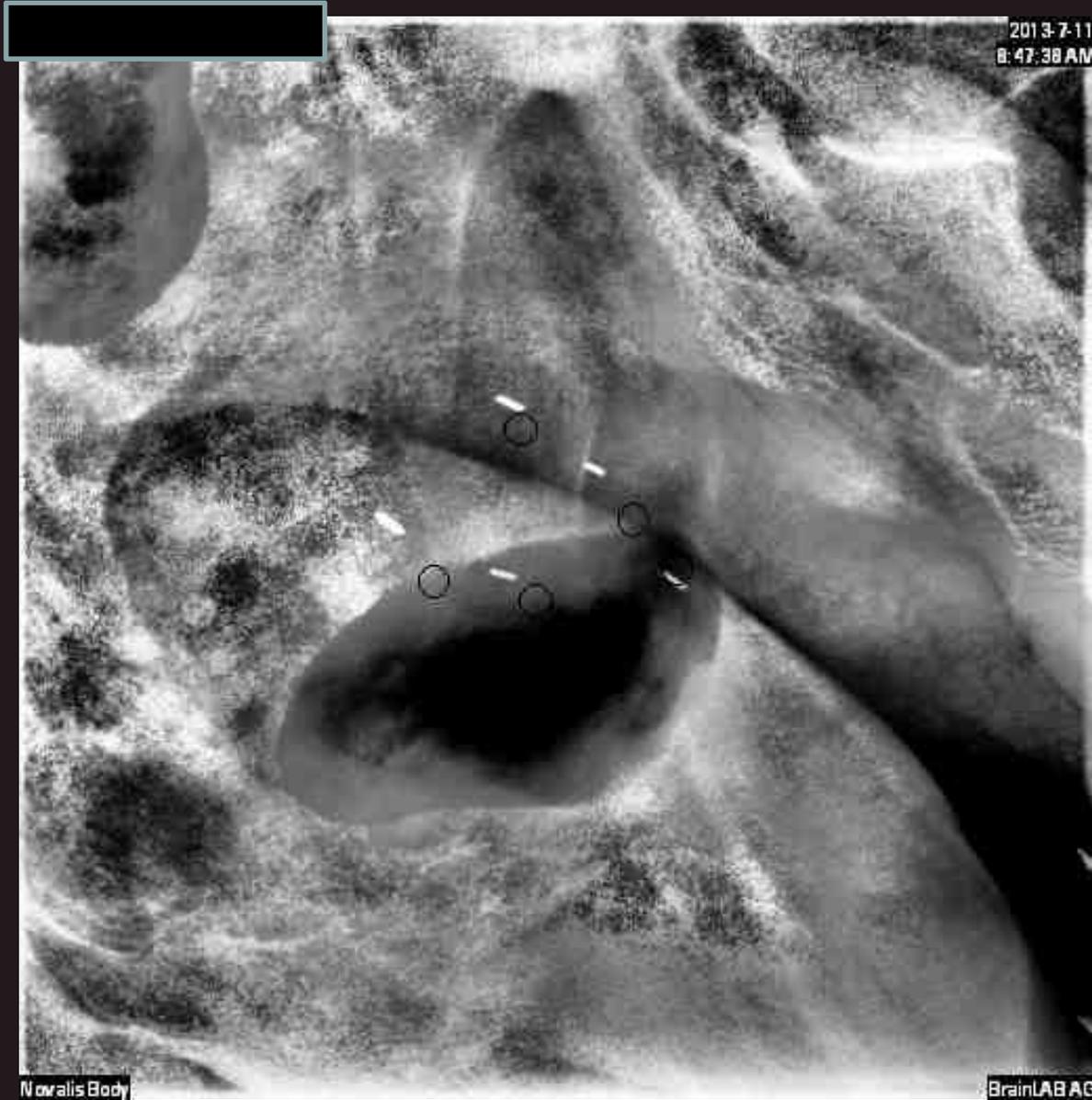
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# INTRA - Fracción



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# INTRA - Fracción



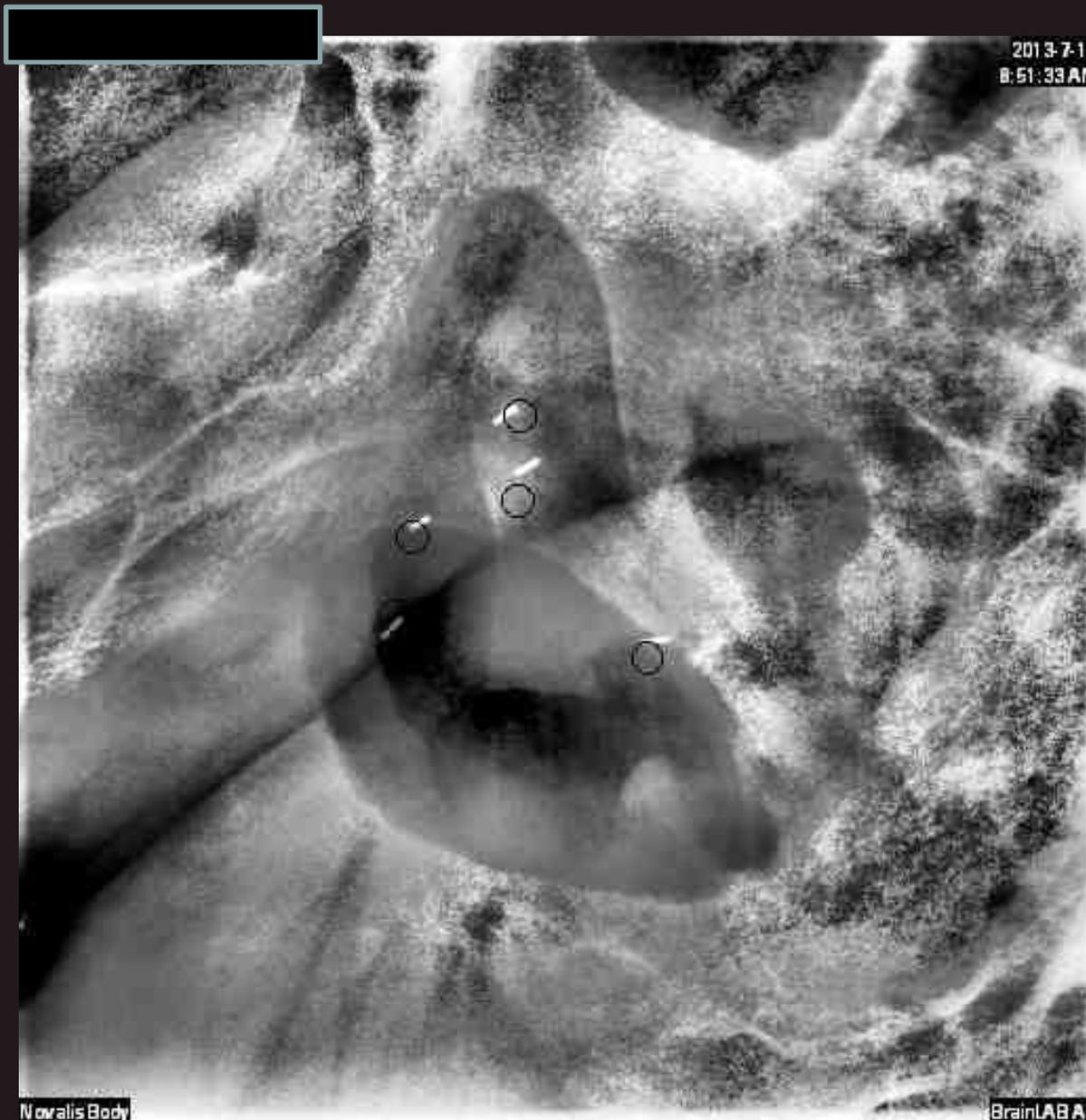
INSTITUTO DE RADIOTERAPIA  
FUNDACIÓN MARIE CURIE



# INTRA - Fracción



INSTITUTO DE RADIOTERAPIA  
FUNDACIÓN MARIE CURIE



Novalis Body

BrainLAB AG

# INTRA - Fracción



INSTITUTO DE RADIOTERAPIA  
FUNDACIÓN MARIE CURIE



Novalis Body

BrainLAB AG

# Desplazamiento & deformación



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FUNDACIÓN MARIE CURIE

The screenshot displays the Brainlab iPlan RT 4.5 Dose software interface. The main window shows an axial CT scan of a head and neck region. Two target volumes are outlined: a red one superiorly and an orange one inferiorly. The interface includes a Navigator panel on the right with buttons for 'Treatment Planning', 'Physician's Review', 'Go to...', and 'Next'. Below this is a 'Functions' panel with a tree view showing 'The RTPlan' containing 'Group 1' and six 'IMRT Beam' entries. A 'Properties' panel at the bottom right shows parameters for the selected beam: Table (0), Gantry (210), Collimator (0), Margin (3.0 mm), and MU (1515 (5 x 303)). At the bottom, there are three smaller view windows: 'Sagittal View', 'Coronal View', and 'Overview'. The 'Overview' window shows the patient's position on a treatment couch. The bottom navigation bar includes 'Overview', 'Slices', 'Irradiation Plan', and 'Plan Content'.

CT #1 (Axial)  
Slice 70 / 156

CT #1 (Axial)  
Sagittal View

CT #1 (Axial)  
Coronal View

Overview Slices Irradiation Plan Plan Content

BRAINLAB  
iPlan RT 4.5 Dose

# Desplazamiento & deformación



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The screenshot displays a medical software interface for radiation therapy planning. The main window shows an axial CT scan of a prostate with several segmented contours: a purple inner contour, a blue outer contour, and a brown contour below. The interface includes a top navigation bar with patient information (ELORZA HUGO, ID: D04862, Plan 1) and buttons for 'Object Creation' and 'Treatment Planning'. A right-hand sidebar contains an 'Object' list with items like 'Bladder', 'CAB FEMOR DER', 'CAB FEMOR IZQ', 'Enlarged Prostate', 'Outer Contour', 'Penile Bulb', and 'Prostata 2'. Below this are tools for 'Brush Size', 'Outlining' (Brush, Eraser, SmartBrush, Draw Sphere, SmartShaper), and 'Auto Fill' and 'Interpolation' checkboxes. At the bottom, there are buttons for 'Advanced Manipulation...', 'Role Reassignment...', and 'Create Dose Object...'. The bottom status bar shows 'Overview', 'Slices', 'Multiple Sets', and 'Plan Content' tabs. The bottom right corner features the 'BRAINLAB' logo and 'About Plan' and 'Dose' buttons.

# Desplazamiento & deformación



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The screenshot displays the iPlan RT 4.5 Dose software interface. The main window shows an axial CT scan of a prostate with several contours overlaid. A color-coded dose distribution is visible, with a color scale on the right ranging from 38.95 Gy (yellow) to 62.97 Gy (magenta). Blue arrows point to specific contour regions. The interface includes a Navigator panel on the right with patient information (ELORZA HUGO, ID: D04062, Plan 1) and buttons for Object Creation, Treatment Planning, Go to..., and Next. Below the Navigator is an Object list with items like Bladder, CAB FEMOR DER, CAB FEMOR IZQ, Enlarged Prostate, Outer Contour, Penile Bulb, and Prostata 2. The interface also features a Brush Size slider, Contours checkbox, and various tool buttons like Brush, Eraser, SmartBrush, Draw Sphere, SmartShaper..., Auto Fill, and Interpolation. At the bottom, there are tabs for Overview, Slices, Multiple Sets, and Plan Content. The bottom right corner shows the BRAINLAB iPlan RT 4.5 Dose logo.



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Gracias