



# Herramientas para Disminuir Dosis en TC

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# Introducción



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Figure XII. Annual per caput effective dose (mSv) for the United States population in 1980 [M37]

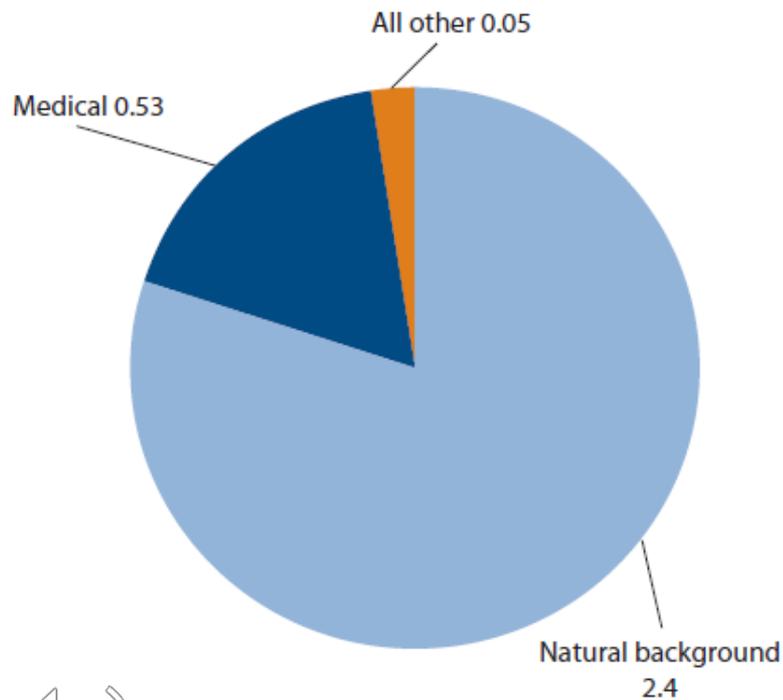
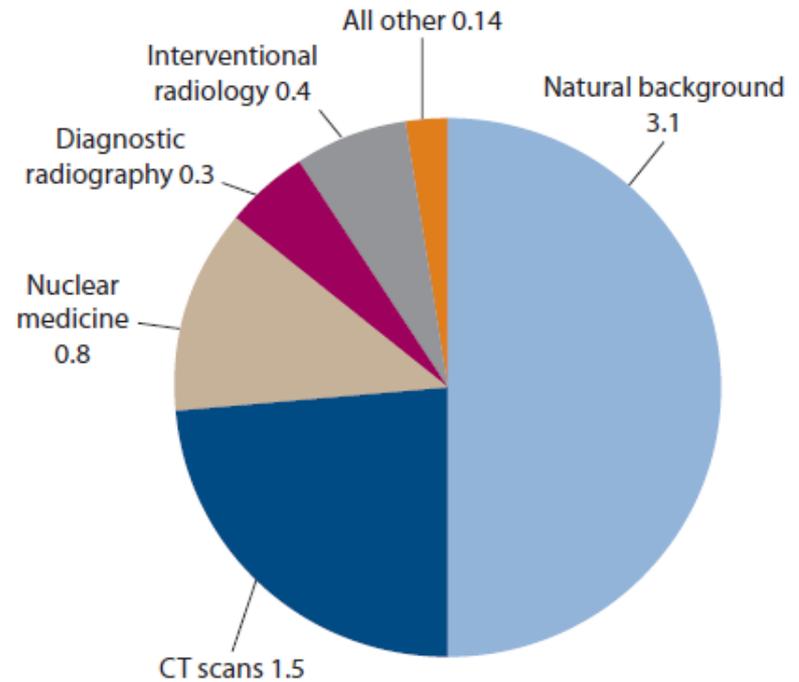


Figure XIII. Annual per caput effective dose (mSv) for the United States population in 2006 [N26]



# Introducción



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## Hospital Error Caused Radiation Overdoses

LA's Cedars-Sinai Blames Computer-Resetting Error for Exposing 206 Patients to Radiation

The Associated Press  
5 comments

LOS ANGELES October 13, 2009 (AP)



New study finds that CT scans significantly raise one's risk of cancer.

Hospital officials say a computer-resetting error caused radiation overdoses for 206 patients who underwent CT scans at Cedars-Sinai Medical Center.

In a written statement Monday, hospital officials said "a misunderstanding about an embedded default setting applied by the machine" resulted in a higher than expected amount of radiation.

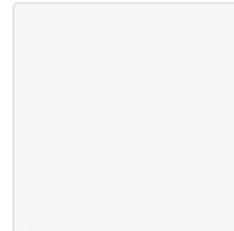
## FDA Concerned About Medical Radiation Overexposure

Local Hospitals Make Sure Patients Get Lowest, Most Effective Dose

Email Print  
Comments

POSTED: 3:23 pm EST February 16, 2010  
UPDATED: 6:32 pm EST February 16, 2010

SHARE



**BOSTON** -- CT scans are an invaluable test used to diagnose patients and save lives. But recent reports of radiation overdoses at hospitals have prompted the government to better regulate medical radiation.

NewsCenter 5's Heather Unruh reported Tuesday on steps local hospitals are taking to keep you safe.

Seventy-million CT scans are done in the U.S. every year to help diagnose patients. That's 23 times more than in the 1980s. They have saved countless lives. But the government says more needs to be done to ensure the technology is being used safely.

"Mistakes have been made," said Dr. James Thrall, the chairman of the radiology department at Massachusetts General Hospital.

[The Food and Drug Administration is investigating why more than 300 patients in four hospitals received excessive amounts of radiation.](#) The first reported overdose was at Cedars-Sinai Medical Center, where patients received up to eight times as much radiation as intended. The FDA is now taking steps to increase oversight of medical radiation.

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## California RT gives deposition in CT overdose case

By [Donna Domino, AuntMinnie.com staff writer](#)

December 10, 2009 – The California radiologic technologist accused of operating the CT scanner that delivered a massive radiation overdose to a 23-month-old boy in 2008 testified last week that she only pushed the CT scan button a few times, and she doesn't understand how the toddler received 151 scans in a single imaging session.

ADVERTISEMENT  
CT in the Emergency Department at Stony Brook University  
[Click here to view](#)

Raven Knickerbocker, who is accused of subjecting Jacoby Roth to more than an hour of continuous scanning, said she only pressed the scan button "two to four times," according to the Roth family's attorney, Don Stockett, who questioned her during a December 4 deposition in preparation for a civil trial in a lawsuit filed by the boy's parents.

Knickerbocker testified during the deposition that she performed two scout scans and then tried to start the examination, but the machine did one rotation before it stopped and displayed a fault code, said Stockett, whose practice is based in Folsom, CA. She asserted the scanning procedure lasted only about 20 minutes.

In January 2008, the boy was taken to the emergency room at Mad River Community Hospital in Arcata, a small town 290 miles north of San Francisco, after he fell out of bed and could hardly move his head.

The ER doctor ordered x-rays and CT scans to check for damage to the child's cervical spine. The boy was taken to the scanning room, where Knickerbocker performed CT scans at C-spine levels C1 through C4 in the same section of the midmaxillary sinuses, midclivus, and posterior fossa. Over the next 68 minutes, the toddler was exposed to 151 scans.



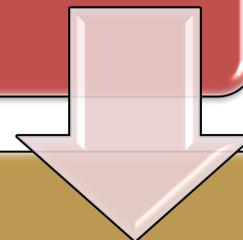
Within a few hours, the child developed a bright red ring around his head from the massive radiation

*Jacoby Roth several hours after receiving 151 CT scans in a 68-minute period. Photo courtesy of Roth family attorney Don Stockett.*

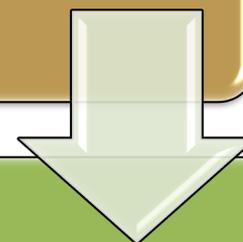




DISMINUIR LA DOSIS



OPTIMIZAR

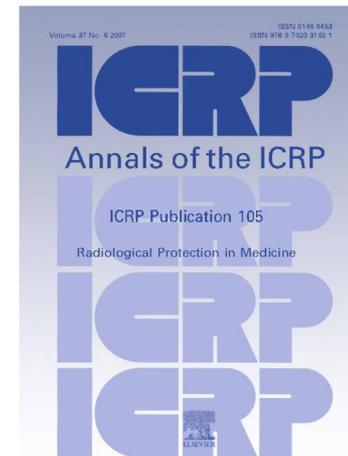


REALIZAR UN EXAMEN  
CON LA MENOR DOSIS  
REQUERIDA



# Optimización

- En exposiciones médicas se aplica en 2 niveles:
  - Diseño, selección apropiada y construcción de equipamiento e instalaciones.
  - Metodología de trabajo en el día a día.



# Optimización

- **Compromiso** entre la calidad de imagen que permite realizar un diagnóstico y la dosis de radiación entregada al paciente.

*ICRP 102. 2007*

ALARA

As Low As Reasonably Achievable



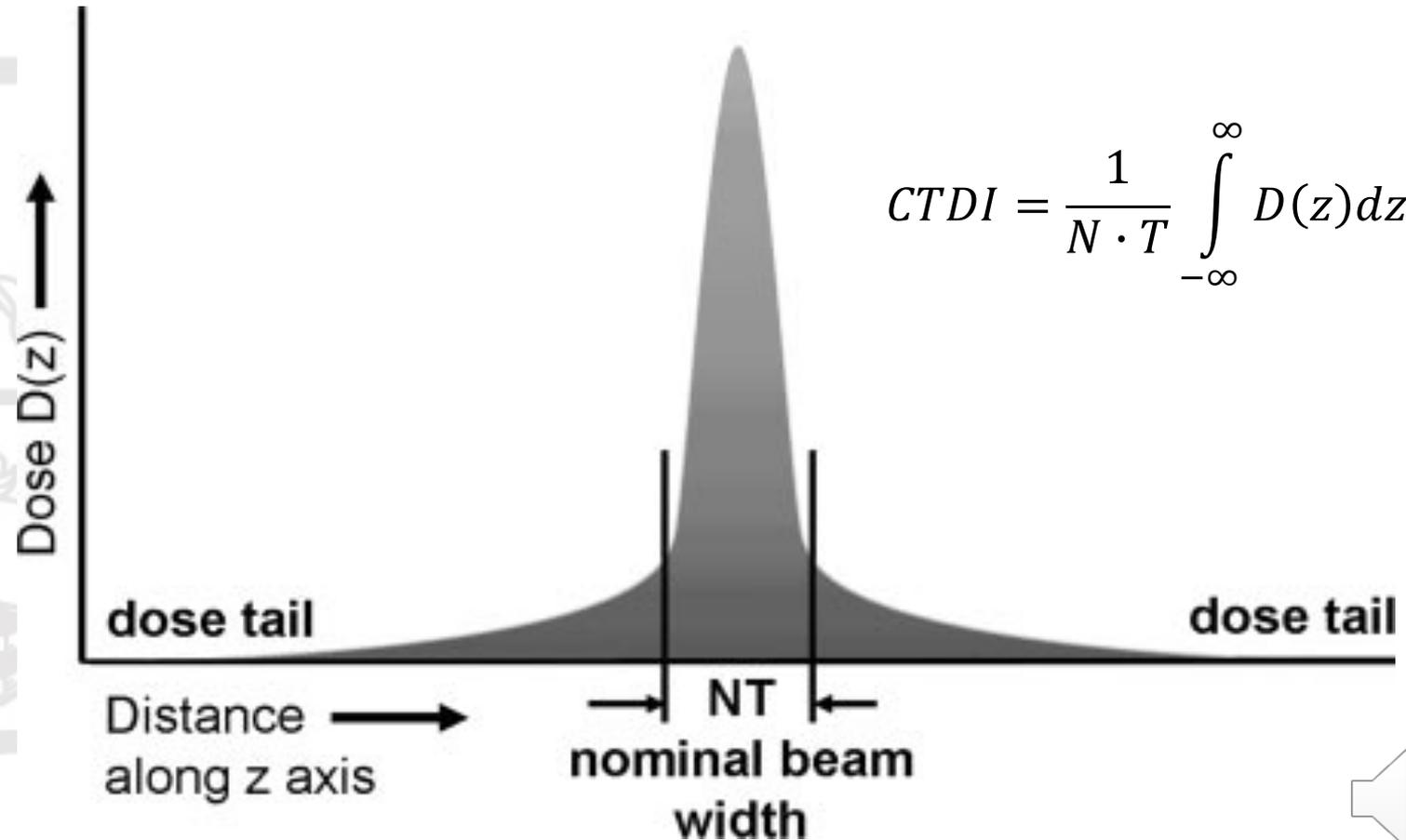


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# ¿Dosis de Radiación al Paciente?



# Parámetros Dosimétricos



# Parámetros Dosimétricos

- Referido a un fantoma estándar (SSDE).
- Fácilmente medible y/o calculable.
- Monitorizable y comparable.
- Relacionado con nuestros protocolos.



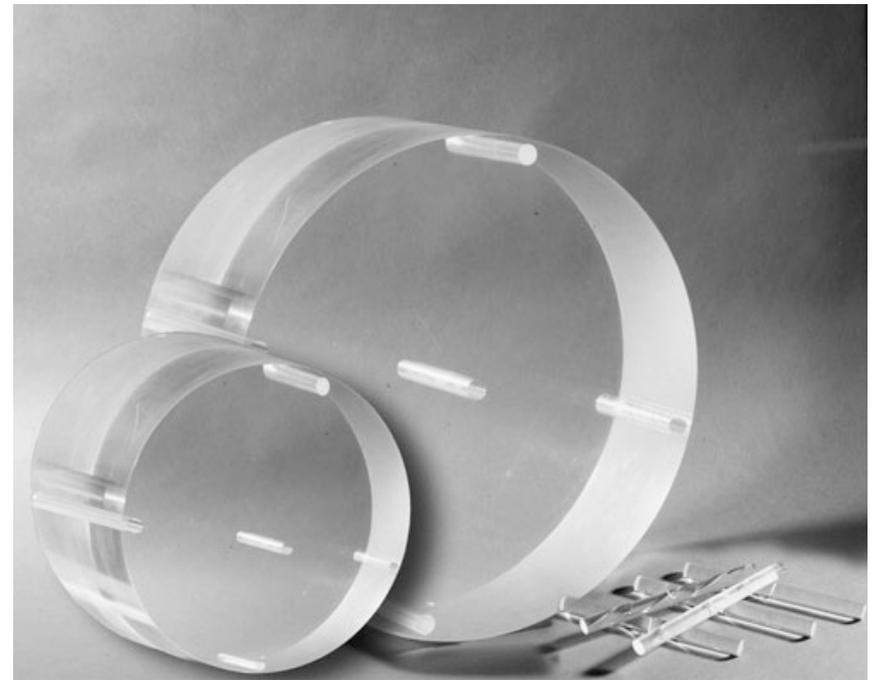
# Parámetros Dosimétricos



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Cámara de ionización  
tipo "lápiz" de 100 mm



Fantomas estándar de PMMA  
para medición de CTDI



# Parámetros Dosimétricos

- $CTDI_w = \frac{1}{3} \cdot (CTDI_{100,c} + 2 \cdot CTDI_{100,p})$

- Definido para proporcionar una estimación del CTDI promediado en todo el campo de visión

- $CTDI_{vol} = \frac{CTDI_w}{pitch}$

- Representa la dosis dentro del volumen de exploración de un protocolo de adquisición particular, para un fantoma estandarizado





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$$\text{DLP(mGycm)} = \text{CTDI}_{\text{vol}}(\text{mGy}) \cdot \text{scan length}(\text{cm})$$



# Índices de dosis en TC



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mAs efec. 201

kV 120

Duración 21.97 s

Retardo 2 s

Corte 0.6 mm Adq. 16x0.3 mm

N.º de imágenes 219

Inclinación 0.0 °

Comentario

Rango: Inicio 1187.0

Fin 1252.5

Mesa: Posición 628.0

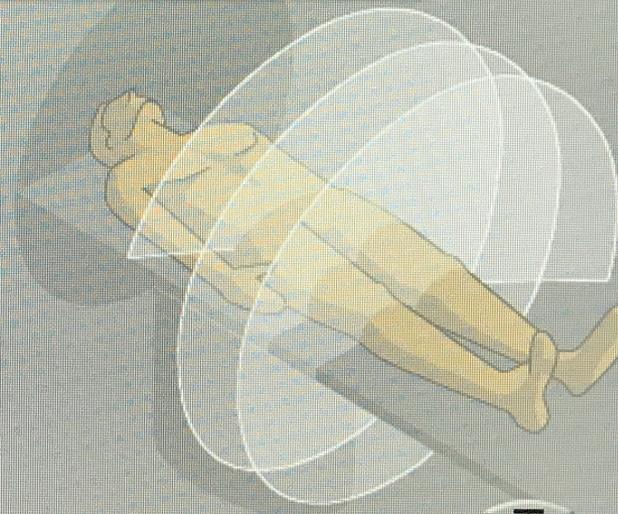
Altura 511.0

Caudocraneal

CARE Dose4D

CTDIvol (16cm): 44.93 mGy

DLP: 321.5 mGy\*cm



Rutina

Exploración

Reconstrucción

Tarea aut.



# CT Dose Index and Patient Dose: They Are *Not* the Same Thing<sup>1</sup>

Cynthia H. McCollough, PhD  
Shuai Leng, PhD  
Lifeng Yu, PhD  
Dianna D. Cody, PhD  
John M. Boone, PhD  
Michael F. McNitt-Gray, PhD

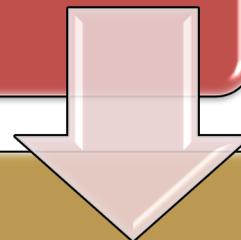
In 1981, Shope et al (1) published “A Method for Describing the Doses Delivered by Transmission X-ray Computed Tomography.” In that article, they introduced the computed tomography (CT) dose index (CTDI) as a metric to quantify the radiation output from a

tifying the radiation output of a CT scanner in a consistent and reproducibly measured fashion. This is because the primary beam emitted from the scanner (originally a relatively thin fan beam, which with current technology has expanded to cone beams of up to 16 cm

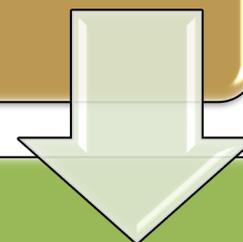


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DISMINUIR LA DOSIS



OPTIMIZAR

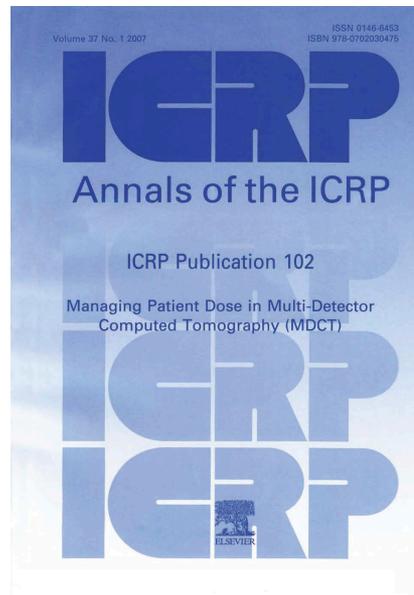


REALIZAR UN EXAMEN CON  
LOS **MENORES PARÁMETROS  
DOSIMÉTRICOS** REQUERIDOS



# Optimización

- Existe potencialidad para reducir dosis en TCMC, pero **depende de cómo usemos nuestro equipo.**



# Parámetros Dosimétricos

- Se relacionan con:
  - Índice de Dosis en TC. **CTDIvol (mGy)**
    - Diseño del tomógrafo.
    - Diámetro del fantoma (SSDE).
    - Parámetros de adquisición.
  - Producto Dosis Largo. **DLP (mGy\*cm)**
    - CTDIvol.
    - Largo de la exploración.
    - Número de fases.





**One size fits all?**



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**IMAGE WISELY™**  
Radiation Safety in  
Adult Medical Imaging

[imagewisely.org](http://imagewisely.org) |  

An awareness campaign of the American College of Radiology (ACR), the Radiological Society of North America (RSNA), the American Society of Radiologic Technologists (ASRT), and the American Association of Physicists in Medicine (AAPM).



**image  
gently®**

[imagegently.org](http://imagegently.org) |  

An awareness campaign of the Society for Pediatric Radiology, American College of Radiology (ACR) and the Radiological Society of North America for imaging.



# CTDIvol

- Parámetros de adquisición con los que se relaciona:
  - Corriente de tubo (mA).
  - Producto mAs.
  - Voltaje de tubo (kV).
  - Tiempo de rotación.
  - Pitch.
  - Configuración de detección.



# CTDIvol

■ Parámetros de adquisición con los que se relaciona:

- Corriente de tubo (mA).
- Producto mAs.
- Voltaje de tubo (kV).
- Tiempo de rotación.
- Pitch.
- Configuración de detección.



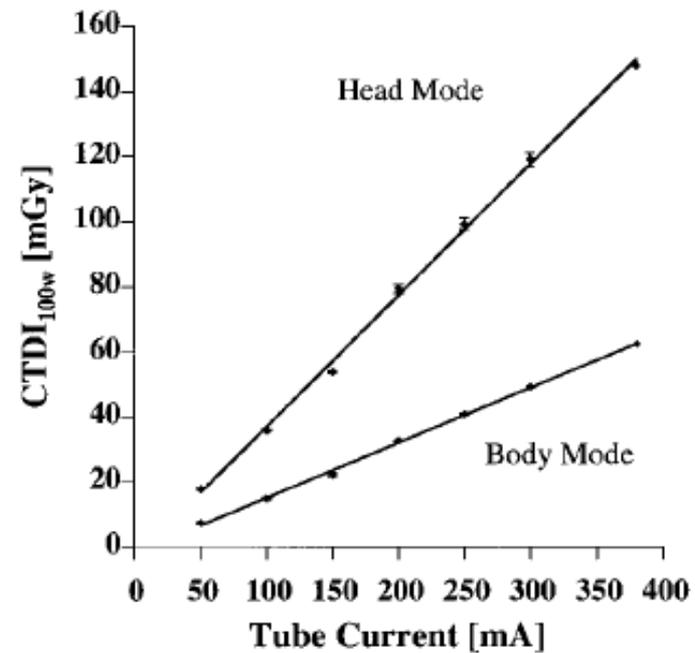
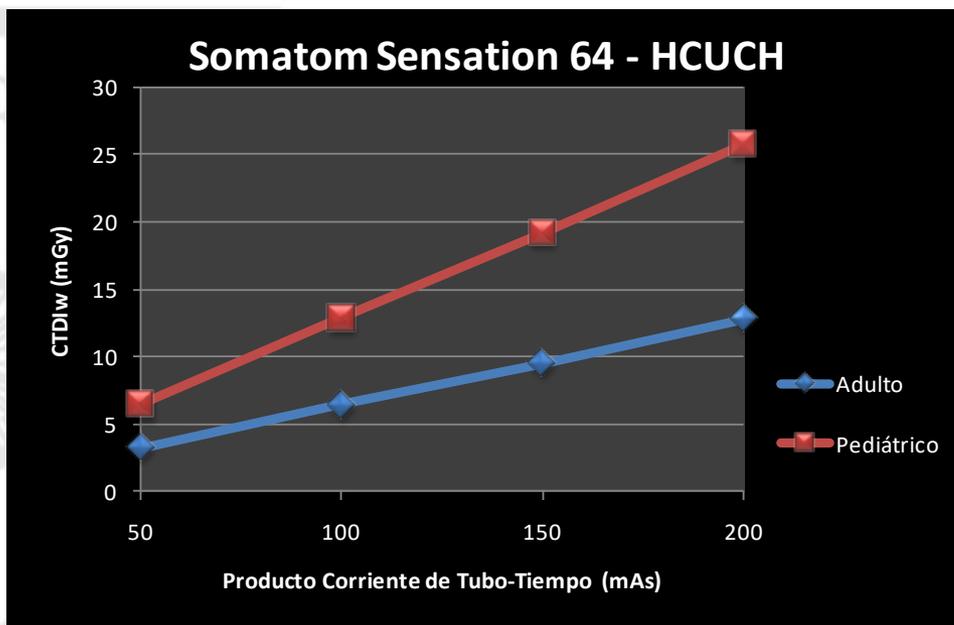
CTDIvol  $\propto$  mA y mAs



# mA y mAs



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*Hamberg, L. Radiology 2003*



# CTDIvol

■ Parámetros de adquisición con los que se relaciona:

- Corriente de tubo (mA).
- Producto mAs.
- **Voltaje de tubo (kV).**
- Tiempo de rotación.
- Pitch.
- Configuración de detección.



$$\text{CTDIvol} \propto \text{kV}^n$$

$n \approx 2-3$



# kV



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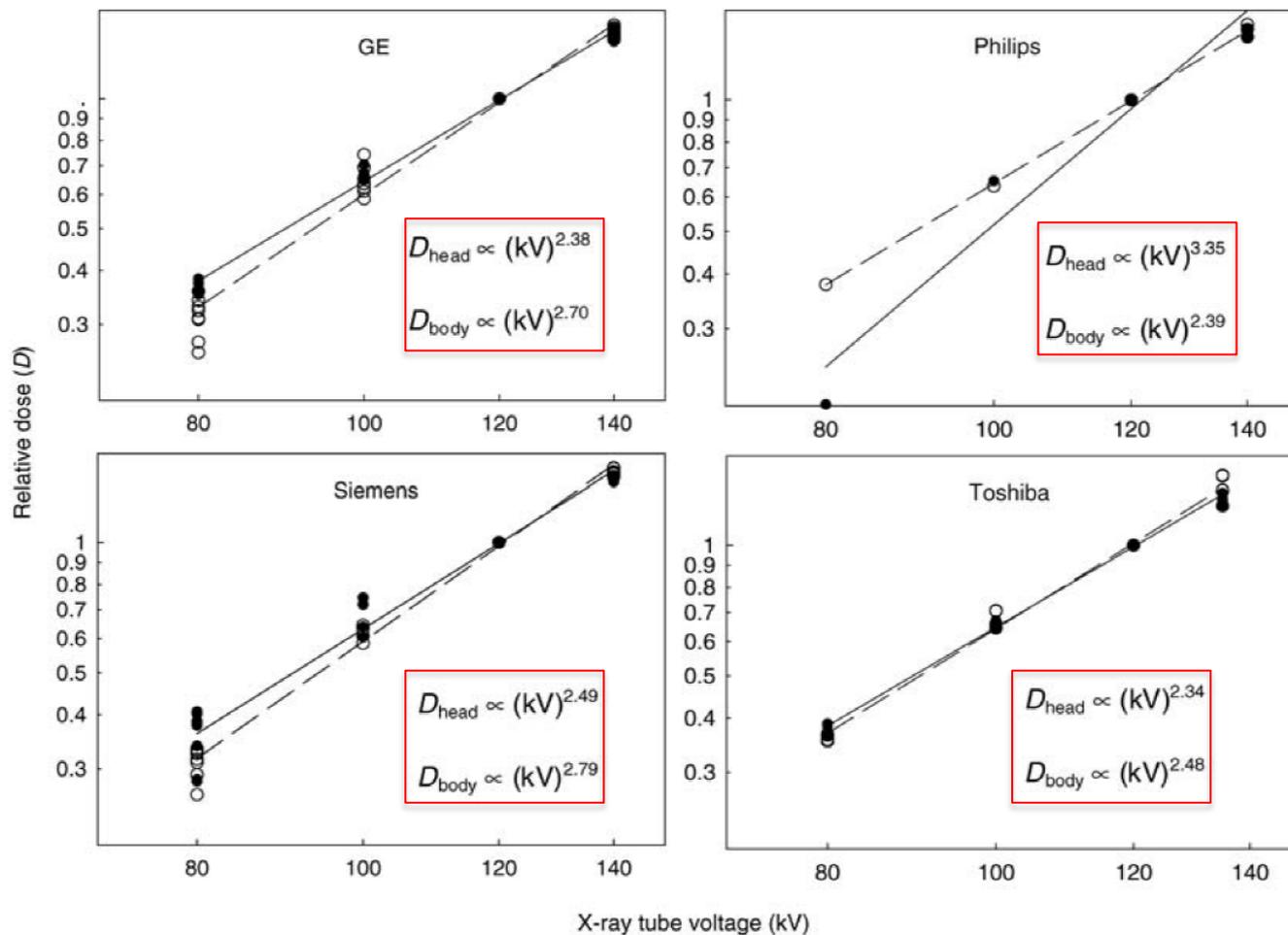


Figure 3. Relative CTDI<sub>vol</sub> as a function of X-ray tube voltage for the four vendors. Solid circles represent head and open circles body.

# CTDIvol

- Parámetros de adquisición con los que se relaciona:

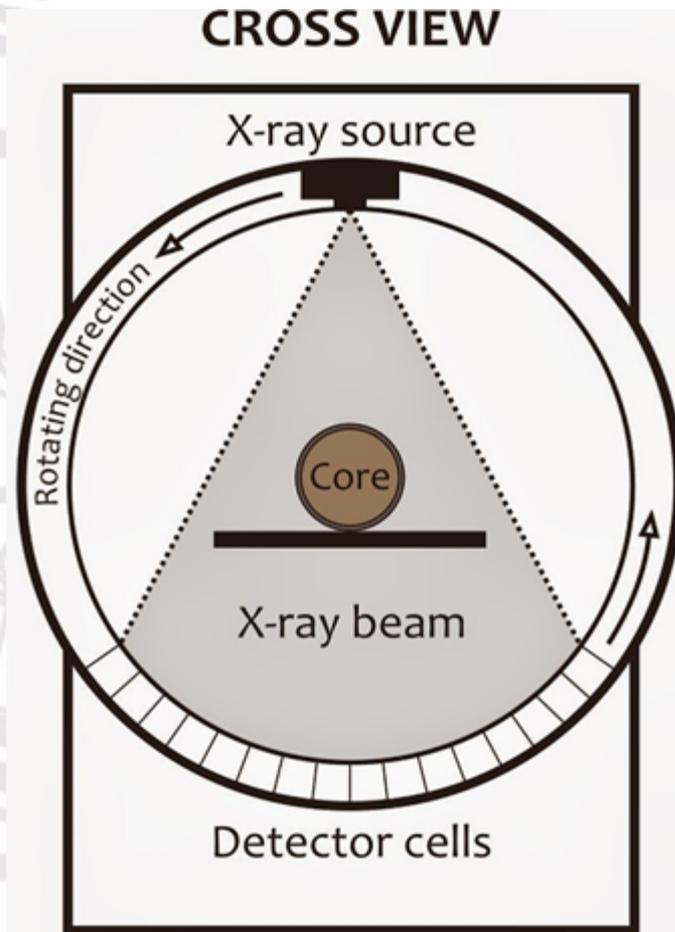
- Corriente de tubo (mA).
- Producto mAs.
- Voltaje de tubo (kV).
- **Tiempo de rotación.**
- **Pitch.**
- Configuración de detección.



Depende del fabricante



# Tiempo de rotación



- CTDI<sub>vol</sub>  $\propto$  Tiempo de rotación.
  - Hitachi, Toshiba (sin AEC)
- CTDI<sub>vol</sub> **independiente** de tiempo de rotación.
  - GE, Siemens, Philips, Toshiba (AEC)



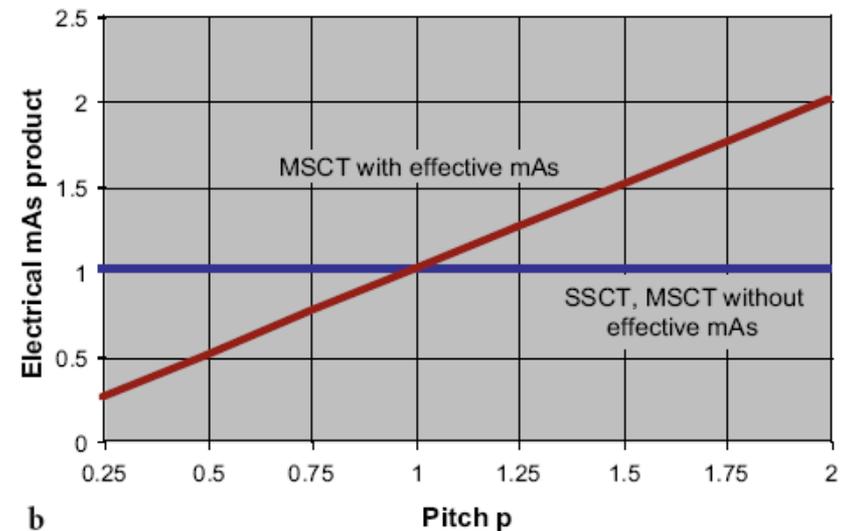
# Pitch

- $CTDI_{vol} \propto P \rightarrow$  Hitachi.
- $CTDI_{vol}$  es **independiente** al cambio de  $P \rightarrow$  GE, Philips y Siemens.
- Toshiba  $\rightarrow$  Relación depende de modelo.



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## Uso de AEC



*A.L Baert. Radiation Dose from Adult & Pediatric MDCT. 2007*



# CTDI<sub>vol</sub>



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■ Parámetros de adquisición con los que se relaciona:

- Corriente de tubo (mA).
- Producto mAs.
- Voltaje de tubo (kV).
- Tiempo de rotación.
- Pitch.

■ **Configuración de detección.** →

Cambios en eficiencia de dosis  
Atentos a variaciones de CTDI<sub>vol</sub>

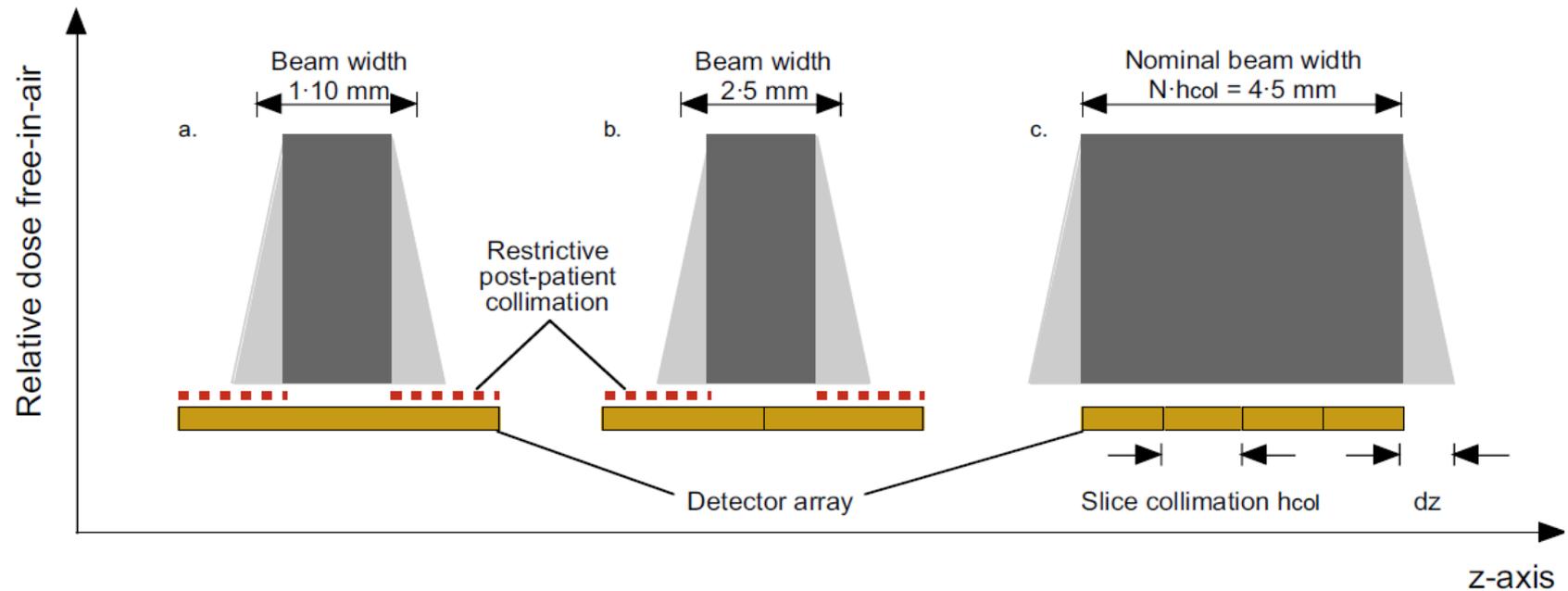


# Configuración de detección



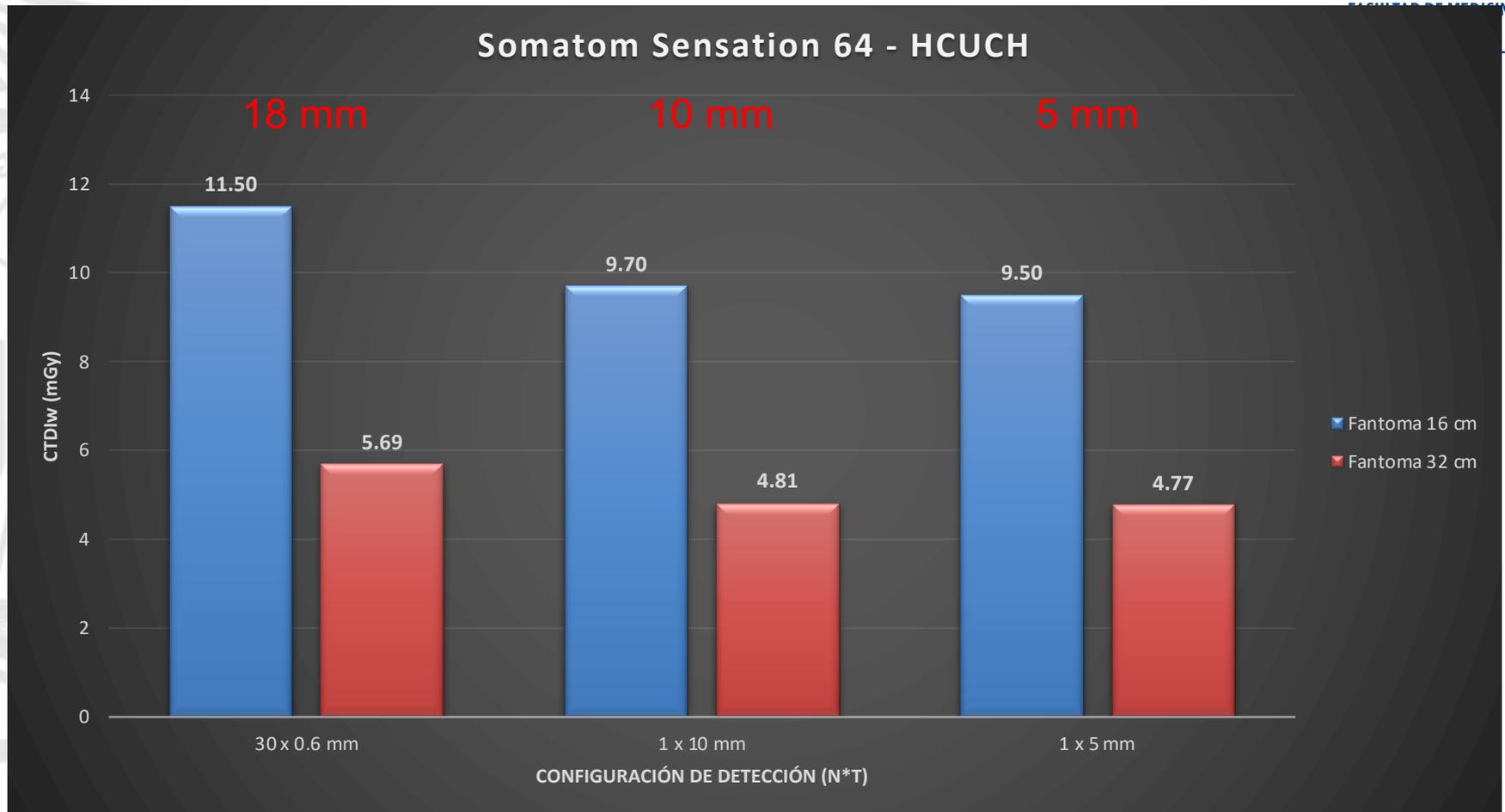
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Multicorte → > razón haz útil / penumbra



H.D Nagel. Radiation Dose from Adult & Pediatric MDCT. 2007

# Configuración de detección



# CTDIvol

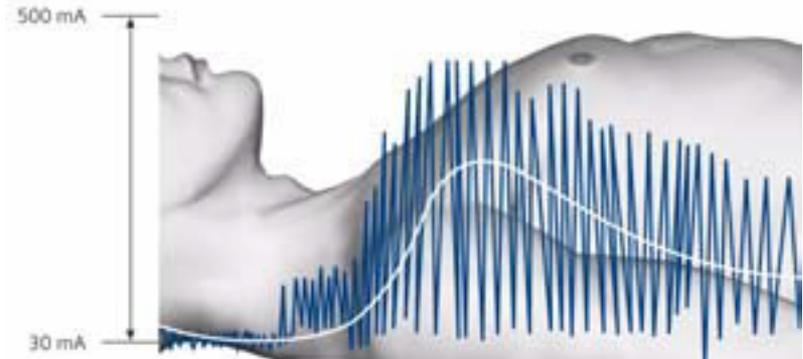
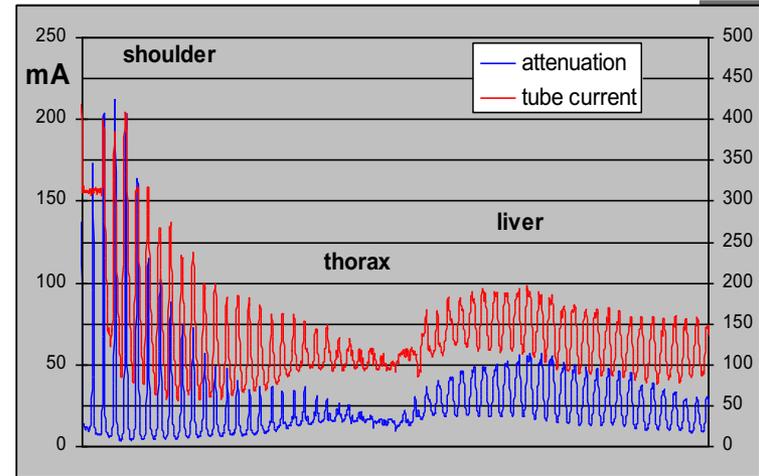
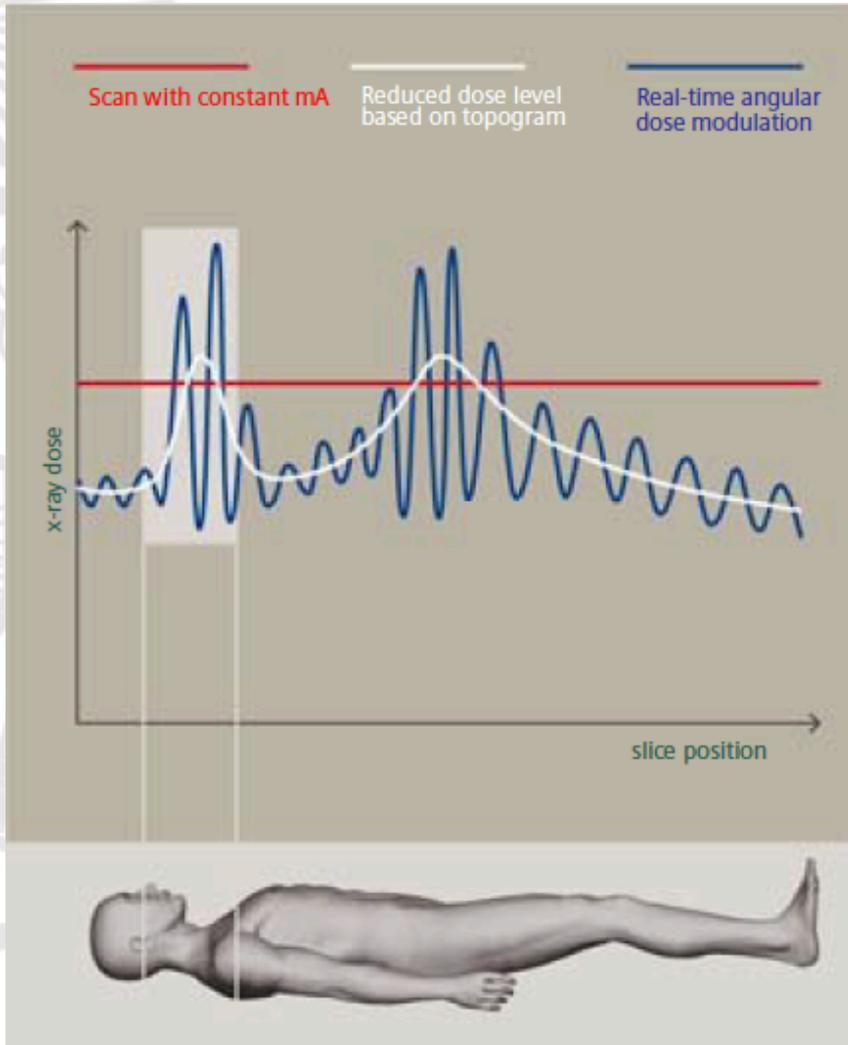
- Influencia de las herramientas del tomógrafo.
  - Modulación.
  - Proceso de reconstrucción.



# CTDIvol

- Influencia de las herramientas del tomógrafo.
  - Modulación.
    - De corriente de tubo.
    - ECG.
    - Organ-Based.
  - Proceso de reconstrucción.



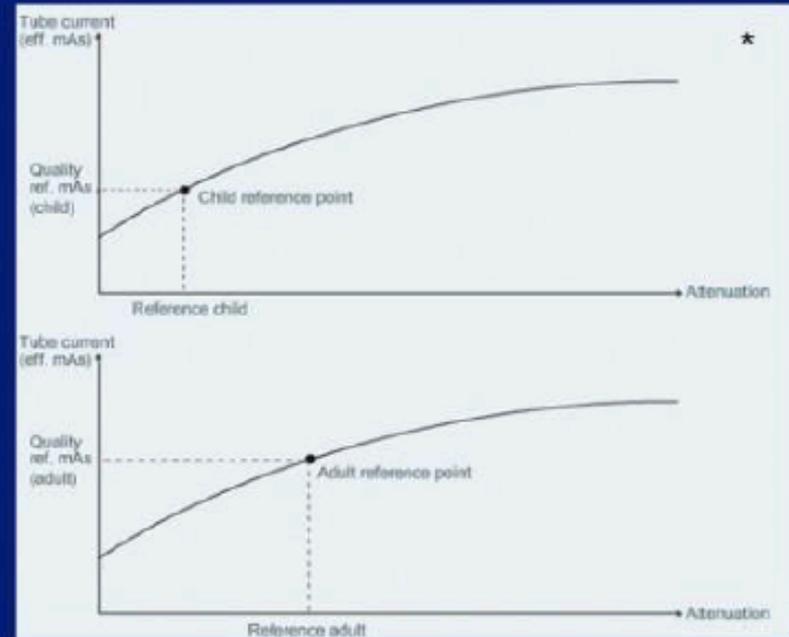


# Reference patient

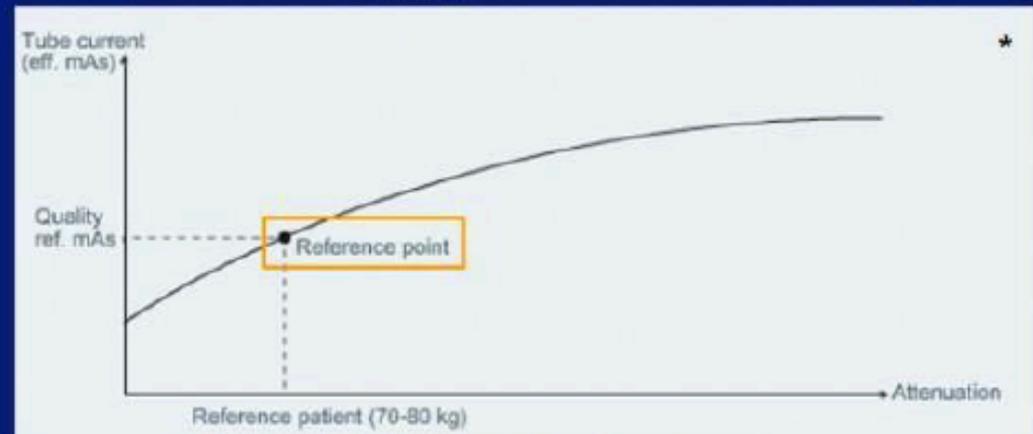


- Past (before *syngo* 2011):
  - 20-25 kg reference child
  - 70-80 kg reference adult

Each had a **separate** Quality ref. mAs value and CARE Dose4D\* curve



- Present (*syngo* 2011 and later):
  - Defined for a single reference patient, weighing 70-80 kg, also for child protocols!

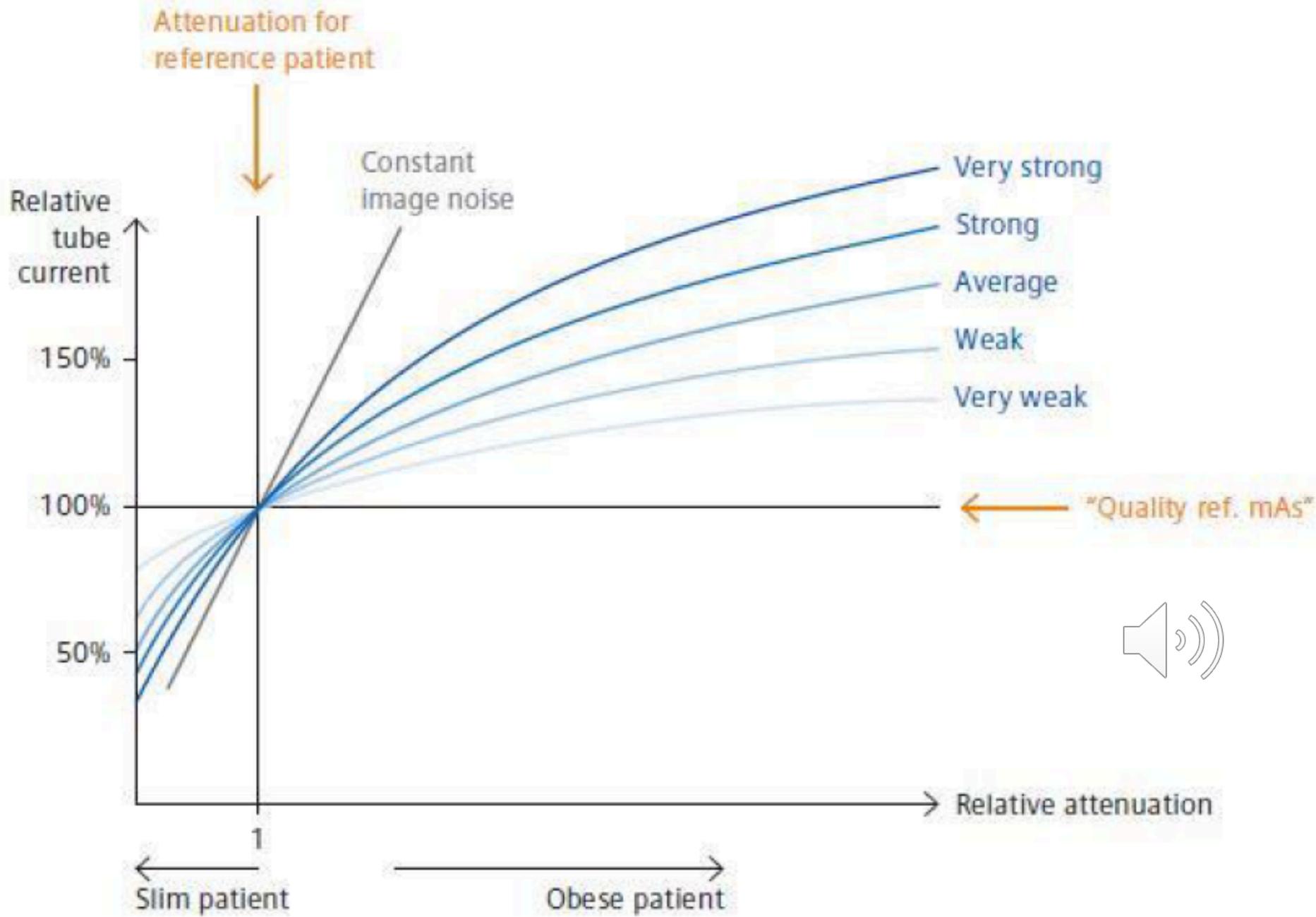


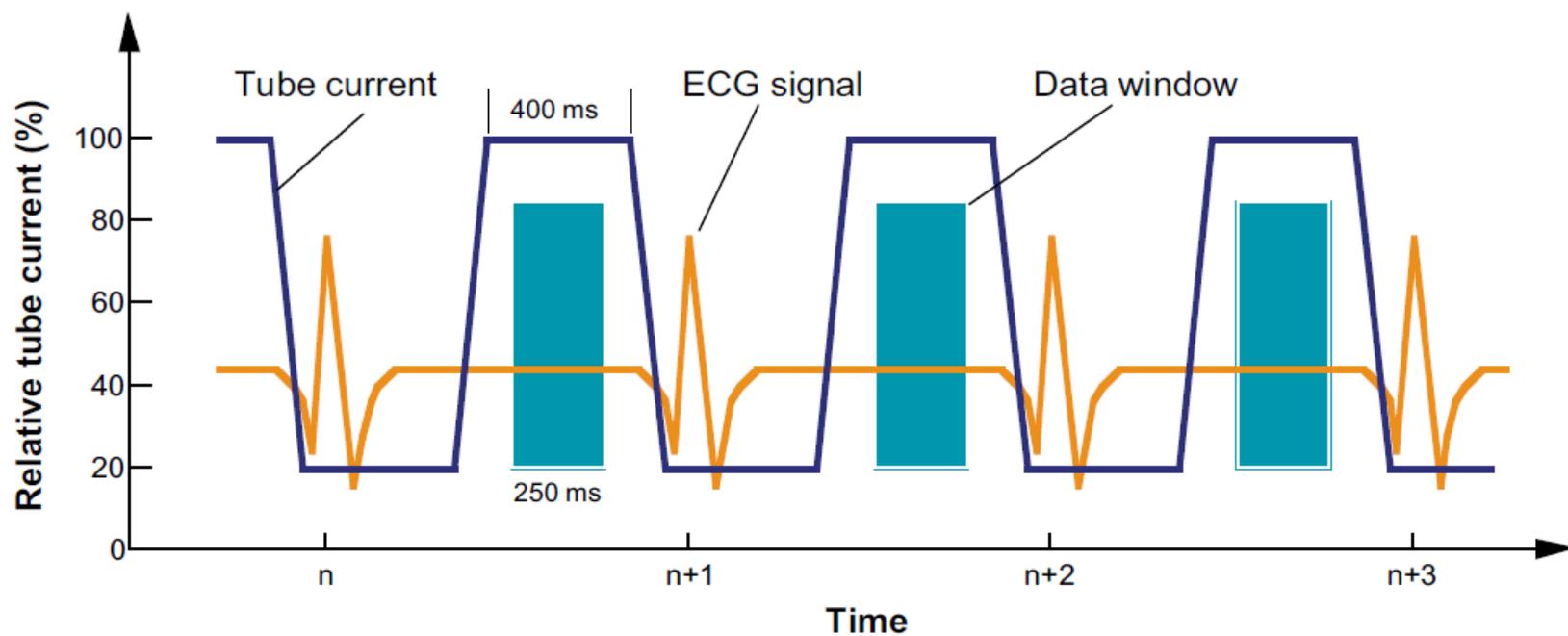
\* Siemens AG, Forchheim, Germany



Manufacturer	Method for setting exposure level
GE	'Noise Index' sets required image noise level for the 'Standard' kernel
Philips	System gives same level of image noise as a 'Reference Image' acquired earlier
Siemens	'Reference mAs' is set for standard sized patient
Toshiba	Target image standard deviation is set

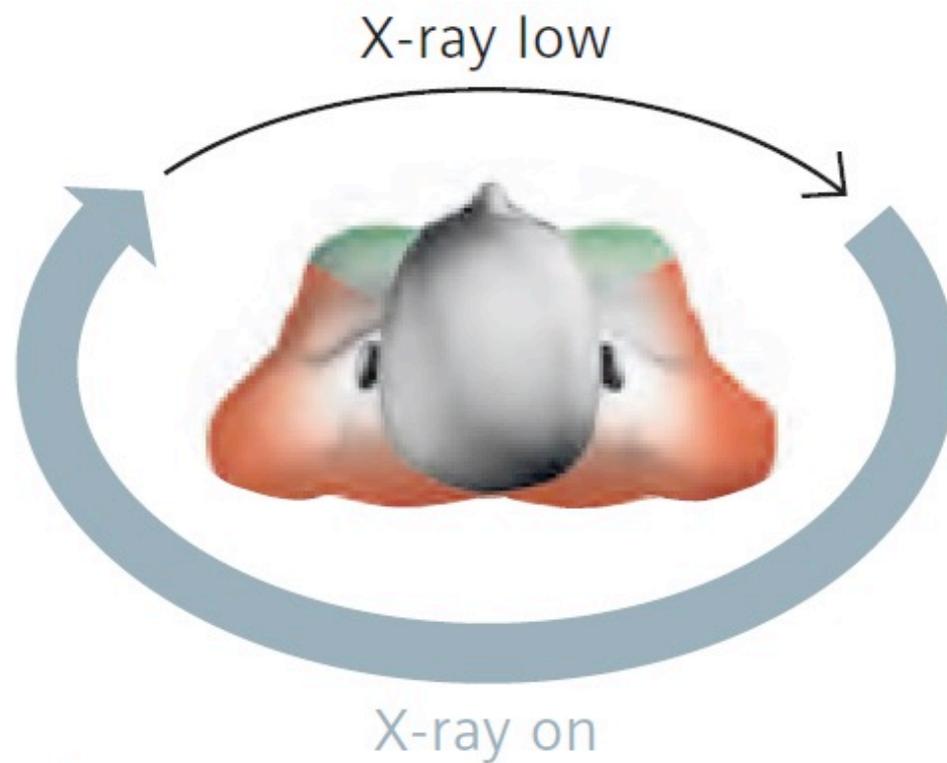








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Organ-based Modulation



# CTDIvol

- Influencia de las herramientas del tomógrafo.

- Modulación.

- Proceso de reconstrucción.

- Algoritmos iterativos.



Reducción de ruido → disminución de CTDIvol



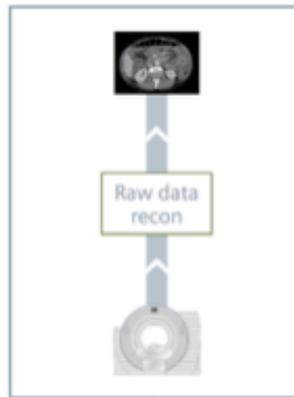


SIEMENS

# History of Iterative Reconstruction

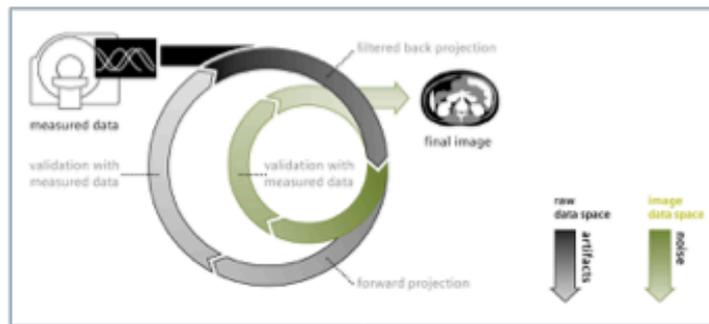
## Continuous development

### WFBP\*



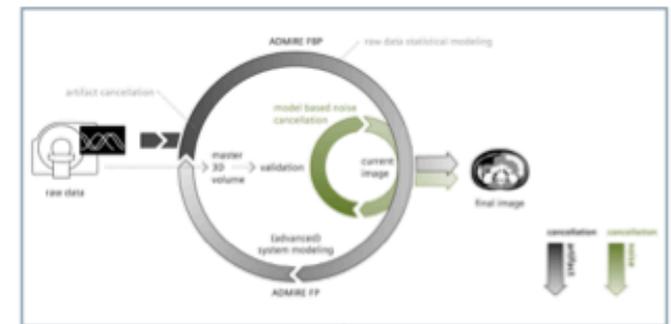
### SAFIRE (2010)

**Sinogram Affirmed (raw-data based) Iterative Reconstruction**



### ADMIRE (2013)

**Advanced Modeled Iterative Reconstruction**



# Proceso de reconstrucción

Willemink et al. Eur Radiol. 2013



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**Table 2** Summary of the included abdominal studies

CT examination	Publication	In/ex vivo	Subjects (n)	Reconstruction technique (level)	Objective quality			Subjective quality			Achieved dose reduction (%)	
					Noise	CNR	SNR	Quality	Noise	Diagnostic utility		Artefacts
Contrast-enhanced and unenhanced abdominal CT	Hara 2009 [17]	In/ex vivo	12	ASIR (40 %)	+	-	-	+	+	-	-	32-65 % <sup>c</sup>
	Marin 2010 [23]	In/ex vivo	10	ASIR (NA)	+	+	-	-	-	-	-	71 % <sup>a</sup>
	Prakash 2010 [31]	In vivo	222	ASIR (20, 40 %)	+	-	-	+	+	+	+	25 % <sup>c</sup>
	Sagara 2010 [27]	In vivo	53	ASIR (40 %)	+	-	-	-	+	+	+	23-66 % <sup>c</sup>
	Singh 2010 [52]								+	+	+	50-75 % <sup>c</sup>
	May 2011 [36]								+	+	+	50 % <sup>c</sup>
	Schindera 2011 [18]								+	+	-	40 % <sup>c</sup>
	Martinsen 2012 [53]								-	+	-	61 % <sup>c</sup>
	Vorona 2011 [30]								+	+	-	37 % <sup>c</sup>
	Noël 2011 [59]								-	-	-	NA
Mueck 2011 [14]	In/ex vivo	42	ASIR (30, 50, 70, 100 %)	+	-	-	+	-	+	-	38 % <sup>c</sup>	
CT enterography	Kambadakone 2011 [16]	In vivo	48	ASIR (30 %)	+	-	-	+	+	+	-	35 % <sup>c</sup>
	Lee 2011 [28]	In/ex vivo	92	IRIS (I30)	+	-	-	+	-	-	-	50 % <sup>c</sup>
CT colonography	Flicek 2010 [32]	In/ex vivo	18	ASIR (40 %)	+	-	-	+	+	-	-	50 % <sup>b</sup>
Liver CT	Mitsumori 2012 [25]	In vivo	19	ASIR (50 %)	+	-	-	+	-	+	-	40 % <sup>c</sup>
Volume-rendered CT portovenography	Matsuda 2010 [54]	In vivo	19	ASIR (100 %)	+	+	-	+	-	-	-	NA

**Reducción de dosis  
30-70%**

<sup>a</sup>Based on the effective dose, <sup>b</sup>based on the dose-length product (DLP), <sup>c</sup>based on the volume CT dose index (CTDI<sub>vol</sub>), <sup>d</sup>dose reduction simulated based on discarding parts of the raw data, <sup>e</sup>based on using one of two tubes, <sup>f</sup>animal study

+ Reported, -not reported, NA not available, CNR contrast-to-noise ratio, SNR signal-to-noise ratio, CCTA coronary computed tomographic angiography, FBP filtered back-projection, IRIS Iterative Reconstruction in Image Space, Siemens Medical Solutions, AIDR 3D Adaptive Iterative Dose Reduction 3D, Toshiba Medical Systems, ASIR Adaptive Statistical Iterative Reconstruction, GE Healthcare, iDose<sup>f</sup> Philips Healthcare, SAFIRE Sinogram-Affirmed Iterative Reconstruction, Siemens Medical Solutions, MBIR Model-Based Iterative Reconstruction, GE Healthcare

# DLP



■ Parámetros de adquisición con los que se relaciona:

- CTDIvol.
- Largo de la exploración.
- Número de fases.



# DLP

■ Parámetros de adquisición con los que se relaciona:

■ CTDI<sub>vol</sub>.

■ Largo de la exploración.



$$DLP = CTDI_{vol} * L$$

■ Número de fases.



$$DLP_{total} = \sum DLP_i$$



# DLP



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*IAEA. 10 Pearls: Radiation protection of patients in CT*

**PE protocol**  
Apices to adrenal  
PE=Pulmonary embolism

**PE protocol**  
Apices to lung bases

Shorter scan length:  
20-30% dose reduction

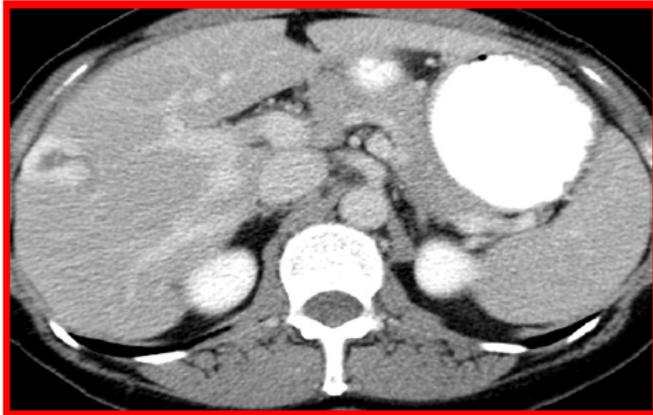
*Images courtesy of: MK Kalra, S. Singh, MGH Webster Center for Advanced Research and Education in Radiation*



Disponible en <https://rpop.iaea.org/RPOP/RPoP/Content/index.htm>

# DLP

IAEA. 10 Pearls: Radiation protection of patients in CT



**6. Multiple pass or phase CT should NOT be performed routinely**

**Multiphase CT can increase the dose by as much as 2-3 folds over single phase CT**

*Images courtesy of: MK Kalra, S. Singh, MGH Webster Center for Advanced Research and Education in Radiation*

Disponibile en <https://rpop.iaea.org/RPOP/RPoP/Content/index.htm>





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¿Y qué pasa con la calidad de imagen?



# Calidad de Imagen

- En TC el parámetro de imagen que mayormente se relaciona con la dosis es el **RUIDO**.
- Reducir el ruido en muchas oportunidades genera **aumento del CTDI<sub>vol</sub>**.

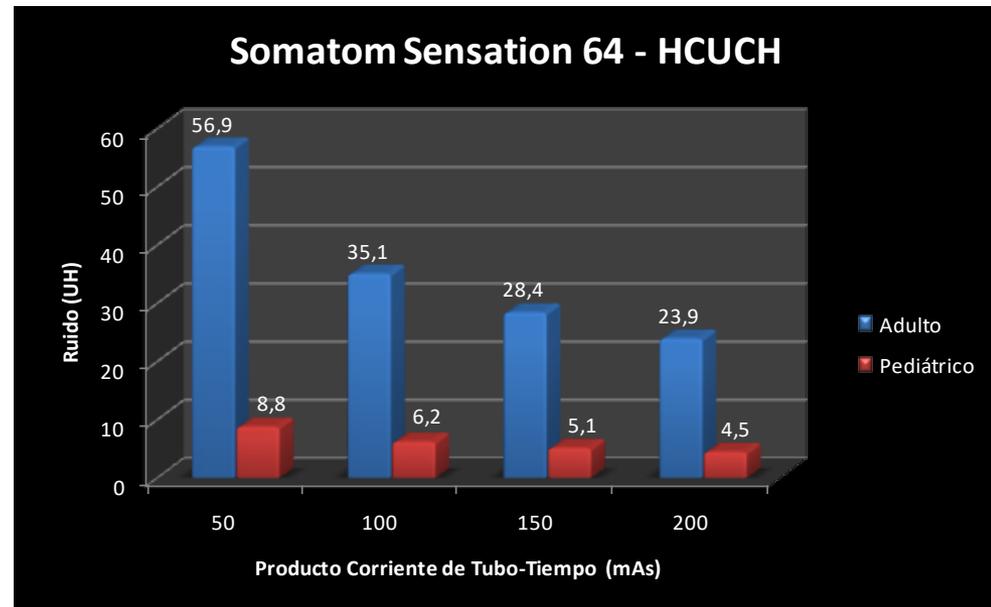
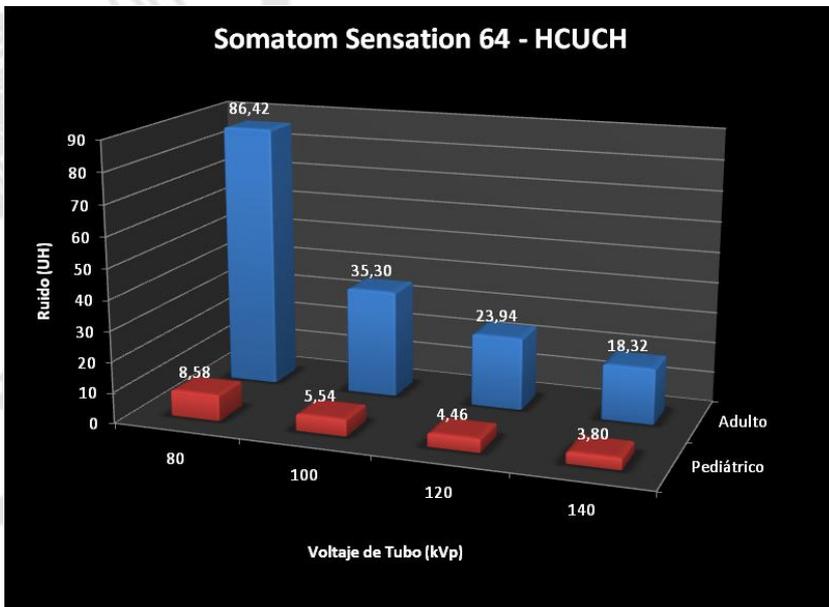


# Calidad de Imagen



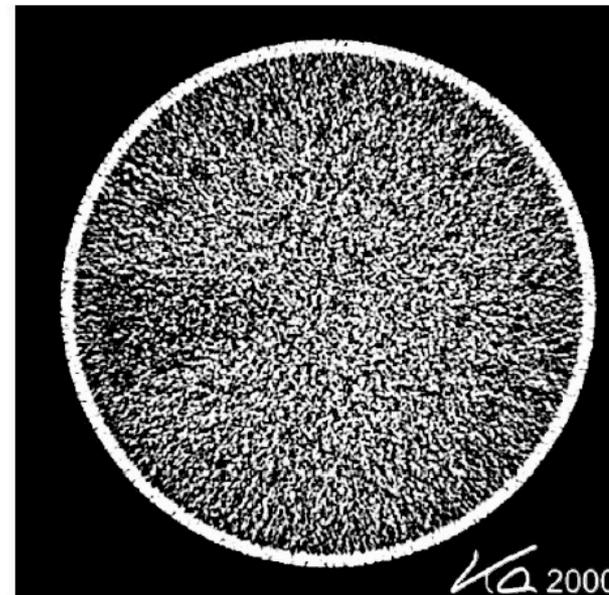
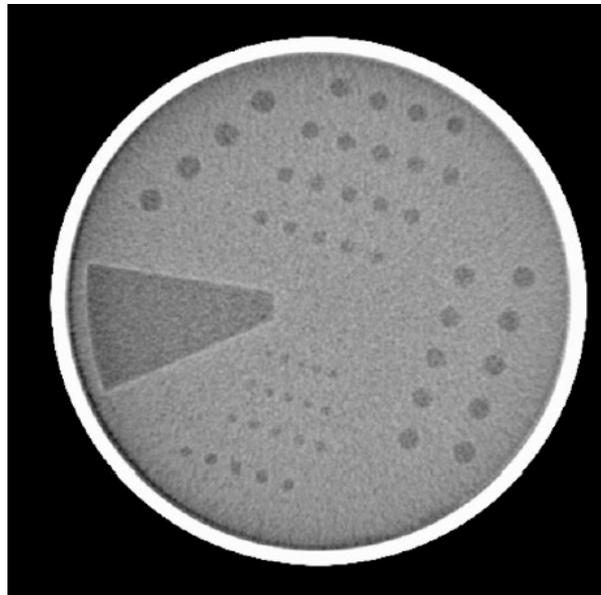
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- El ruido es **más evidente** en pacientes de mayores dimensiones.



# Calidad de Imagen

- Al incrementarse el ruido lo primero afectado es la visualización de **estructuras pequeñas** y de **bajo contraste**.



# Calidad de Imagen

- Sin embargo, si en la región anatómica o la patología es de **alto contraste intrínseco**.
  - Tórax, estudios osteo-articulares, evaluación de litiasis renal.
- Son aceptables por lo general niveles de ruido mayores.

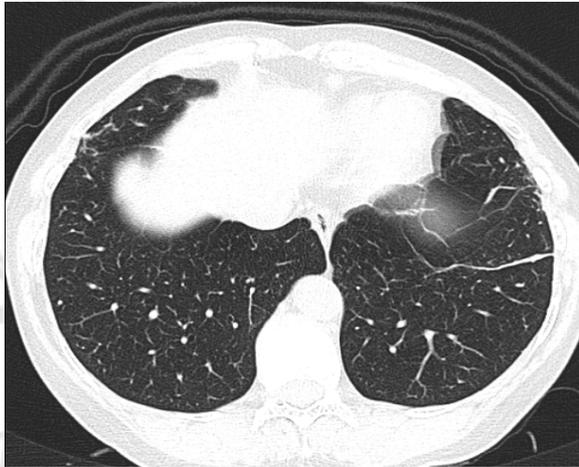


# Calidad de Imagen

Ambas pacientes de sexo femenino

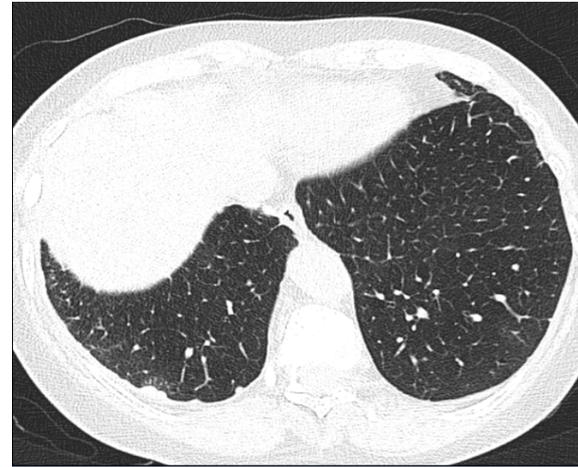
Diámetro AP es de 22,5 cm

A



Protocolo Estándar

B



Protocolo Baja Dosis

Variable de Interés	Protocolo Estándar	Protocolo de Baja Dosis
CTDIvol (mGy)	10,1	6,9
DLP (mGy*cm)	358	239

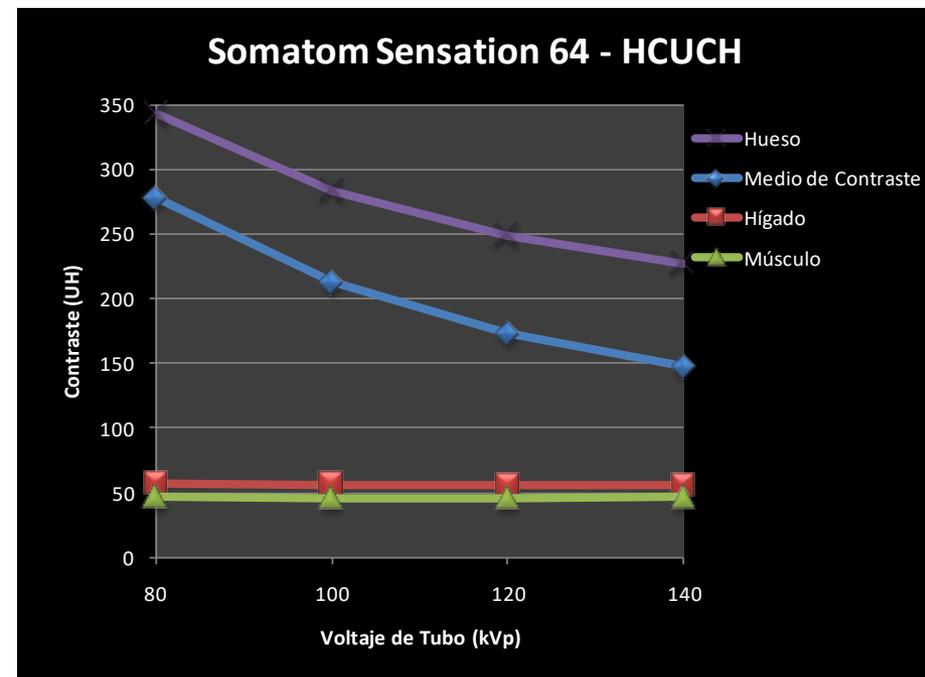


# Calidad de Imagen



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- El contraste de **estructuras óseas** y con **medio yodado** pueden favorecerse con reducción del kV.



# Calidad de Imagen

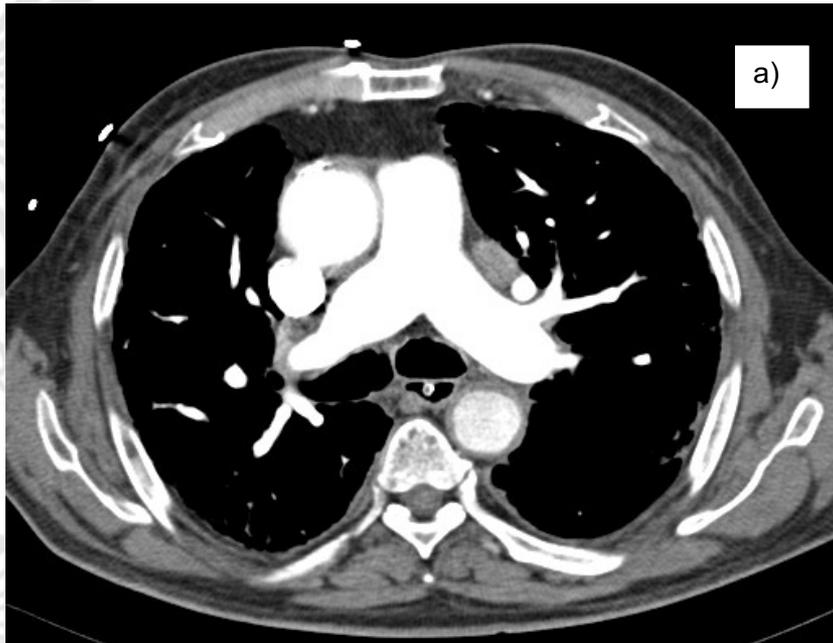


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## ■ Caso

- Paciente de sexo masculino
- 79 años de edad
- 58 Kg
- 1,58 m
- IMC: 23,23 Kg/m<sup>2</sup>
- Ingresa en **marzo** para realizarse un AngioTC por TEP (Protocolo Estándar).
- Regresa en **mayo** para efectuarse nuevamente este examen (Protocolo de Baja Dosis) .





Variables de Interés	Protocolo Estándar	Protocolo de Baja Dosis
CTDIvol (mGy)	19,18	11,84
DLP (mGy * cm)	638	363

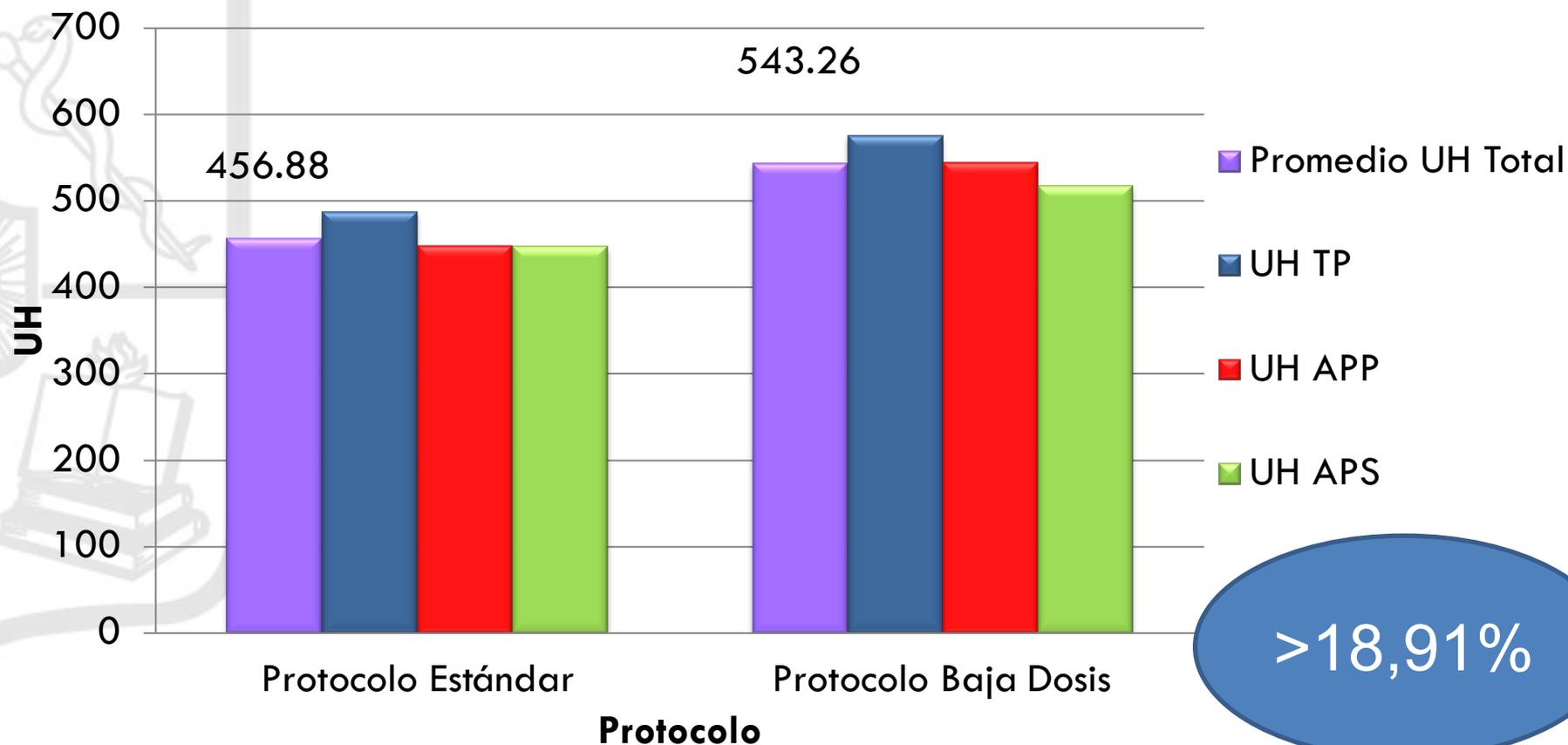


# Promedio UH Total



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## Promedio UH

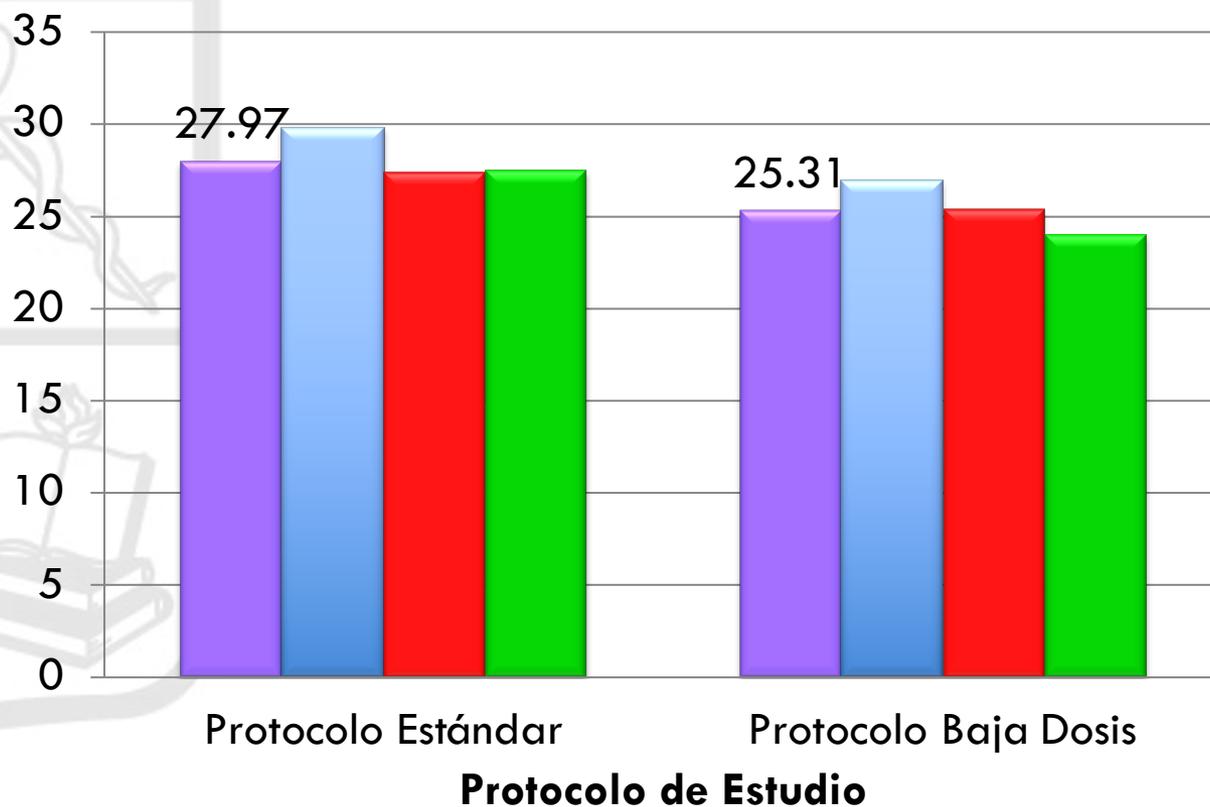


# CNR



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## CNR Promedio



- CNR total
- CNR TP
- CNR APP
- CNR APS

<9,5 %

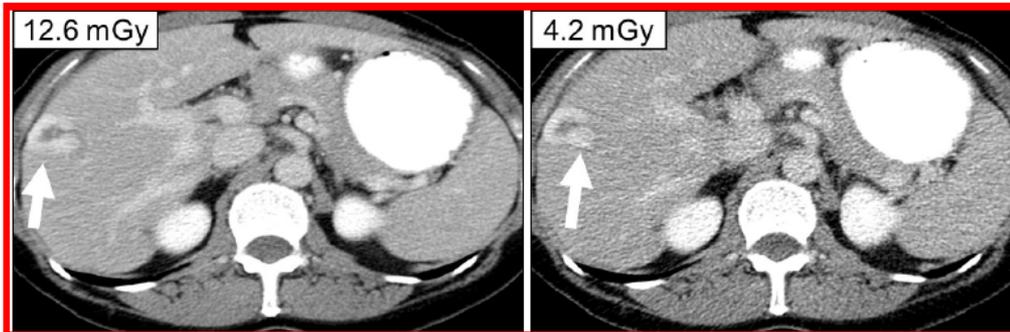
# Calidad de Imagen



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IAEA. 10 Pearls: Radiation protection of patients in CT



Calidad de imagen mejor que la necesaria

Calidad de imagen adecuada para diagnosticar

4. Las imágenes de elevada calidad pueden ser agradables a la vista pero requieren mayores dosis de radiación a los pacientes.

Comience a utilizar imágenes que contengan algo de ruido sin que esto suponga perder información necesaria para diagnosticar

Las imágenes son cortesía de MK Kalra, S. Singh, del Centro MGH Webster para investigación avanzada y formación en materia de radiaciones

Disponible en <https://rpop.iaea.org/RPOP/RPoP/Content/index.htm>



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¿Qué tan altos/bajos son mis valores de  $CTDI_{vol}$  y DLP?



# NDRs

- Por el momento la comparación se puede realizar con **Niveles Diagnósticos de Referencia** de organismos internacionales.
- Valores que provienen de encuestas nacionales sobre práctica clínica.



# NDRs

- Útil para identificar situaciones en la práctica diaria en las que los parámetros dosimétricos están **inusualmente** y/o **excesivamente** altos o bajos.
- No tienen validez como **LÍMITE**.



# NDRs para TC



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Table A..1. Initial diagnostic reference levels for CT examinations on adult patients (European Commission, 1999)

Examination	Diagnostic reference level*	
	CTDI <sub>w</sub> (mGy)	DLP (mGy cm)
Routine head	60	1050
Face and sinuses	35	360
Vertebral trauma	70	460
Routine chest	30	650
HRCT of lung	35	280
Routine abdomen	35	780
Liver and spleen	35	900
Routine pelvis	35	570
Osseous pelvis	25	520

- same as ICRP reference levels



# NDRs para TC



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Table A.2. Initial reference dose values for CT examinations on paediatric patients (Shrimpton and Wall, 2000).

Examination	Patient age (years)	CTDI <sub>w</sub> per slice or rotation (mGy)	DLP per examination (mGy cm)
Brain	< 1	40	300
	5	60	600
	10	70	750
Chest (general)	< 1	20	200
	5	30	400
	10	30	600
Chest (HRCT)	< 1	30	50
	5	40	75
	10	50	100
Upper abdomen	< 1	20	330
	5	25	360
	10	30	800
Lower abdomen & pelvis	< 1	20	170
	5	25	250
	10	30	500

The International Commission on Radiological Protection. Publication 87



# NDRs para TC

NRPB-W67



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## Doses from Computed Tomography (CT) Examinations in the UK – 2003 Review

**P C Shrimpton, M C Hillier**

NATIONAL RADIOLOGICAL PROTECTION BOARD, CHILTON

**M A Lewis**

*ImPACT* (IMAGING PERFORMANCE ASSESSMENT OF CT SCANNERS)  
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& PAST CHAIR OF CT USERS GROUP



Public Health  
England

## Doses from Computed Tomography (CT) Examinations in the UK – 2011 Review

**TABLE 12 Trends in national reference doses for common CT examinations on adults**

Examination (clinical indication)	Region/ technique	National reference doses for the UK					
		CTDI <sub>vol</sub> per sequence (mGy)			DLP per exam (mGy cm)		
		1999 <sup>a</sup>	2003 <sup>b</sup>	2011 <sup>c</sup>	1999 <sup>a</sup>	2003 <sup>b</sup>	2011 <sup>c</sup>
Head <sup>d</sup> (acute stroke)	Post fossa	–	65/100	80	–	–	–
	Cerebrum	–	55/65	60	–	–	–
	Brain (whole)	–	–	60	–	–	–
	Whole exam	(60 <sup>e,f</sup> )	–	–	1050 <sup>f</sup>	760/930	970
Chest <sup>g</sup> (lung cancer)	Lung	(30 <sup>e,f</sup> )	10/13	–	–	–	–
	Liver	(35 <sup>e,h</sup> )	11/14	–	–	–	–
	Whole exam	–	–	12	650 <sup>f</sup>	430/580	610
Chest – high resolution <sup>g</sup> (interstitial lung disease)	Axial only	–	–	4	–	–	140
	Helical only	–	–	12	–	–	350
	Whole exam	(35 <sup>e,h</sup> )	3/7	–	280 <sup>h</sup>	80/170	–
Abdomen <sup>g</sup> (liver metastases)	Whole exam	(35 <sup>e,h</sup> )	13/14	14	900 <sup>h</sup>	460/470	910
Abdomen and pelvis <sup>g</sup> (abscess)	Whole exam	(35 <sup>e,f</sup> )	13/14	15	780 <sup>f</sup>	510/560	745
Chest-abdomen-pelvis <sup>g</sup> (cancer)	Whole exam	–	12/14	–	–	760/940	1000



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TABLE 6.11—*NCRP recommended DRLs and achievable doses ( $CTDI_{vol}$ ) for adult and pediatric CT (in milligray).*

Procedure	DRLs	Achievable Doses
Adult head <sup>a</sup>	75	57
Adult chest <sup>b</sup>	21	14
Adult abdomen-pelvis <sup>a</sup>	25	17
Pediatric head <sup>b</sup> (5 y old)	40	31
Pediatric abdomen-pelvis <sup>a</sup> (5 y old)	20	14

<sup>a</sup>Based on ACR (2011b) data.

<sup>b</sup>Based on preliminary results of 2005 to 2006 NEXT CT survey.



# Take home points



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- Reducción de dosis → optimización de CTDIvol y DLP.
- Nuestros protocolos de examen tienen impacto directo sobre CTDIvol y DLP.
- Optimizar está a nuestro alcance → apropiado uso de las herramientas que entrega nuestro equipo de TC (básicas y avanzadas).
- Al optimizar → compromiso entre dosis y calidad de imagen.
- NDR internacionales pueden orientarnos al monitorear nuestros propios valores CTDIvol y DLP.
- **Necesitamos NDRs nacionales.**



# Literatura recomendada

- Bauhs, J et al. RadioGraphics 2008; 28:245–253
- McNitt-Gray, M. RadioGraphics 2002; 22:1541–1553
- IAEA . 10 Pearls: Radiation protection of patients in CT

