AAPM Computed Tomography Radiation Dose Education Slides

Hitachi Version

Many of the terms used in these slides can be found in the CT Terminology Lexicon

http://www.aapm.org/pubs/CTProtocols/documents/CTTerminologyLexicon.pdf

Last updated: 18 November 2013

Disclaimer

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Disclaimer

- Screen captures are examples of a common (or latest) software version only and all software versions are not represented
- The information contained herein is current as of the date shown on the title slide
- The master version of these slides is located at:
  - http://www.aapm.org/pubs/CTProtocols/documents/EducationSlides.pptx
- Modification of the content of these slides is not allowed.

Vendor Specific Slide Details

- The presence of a vendor name in the title of the slide indicates that the slide is vendor specific slide
- White text is used throughout to indicate vendor specific language
- An example of a vendor specific slide follows

Vendor: *Generic Parameter/Topic Name*

Vendor Specific Name

Vendor screen capture of how the acquisition parameter is set or how information on the topic is displayed

Text describing acquisition parameter or topic

Motivation

- These slides are provided to aid in understanding the factors that affect radiation dose in CT studies
- Image patients wisely and gently
  - A CT study should use as little radiation as possible, while still meeting the image quality needs of the exam
  - A CT study that is non-diagnostic because the radiation dose is too low may require rescanning the patient – increasing the total patient dose

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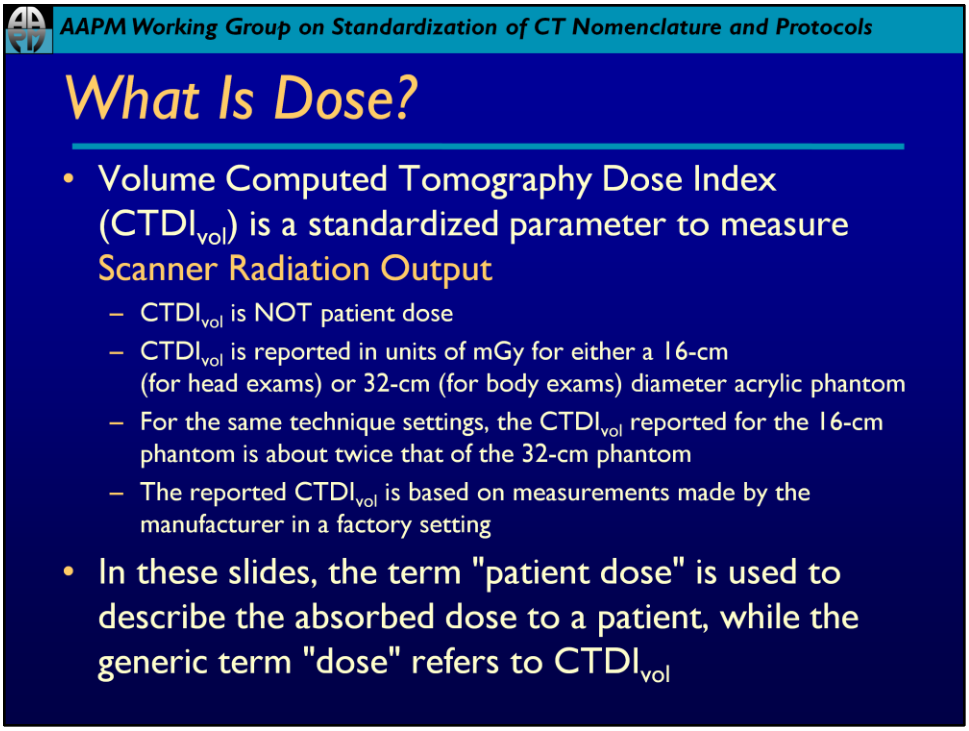
IMAGE WISELY

Outline

- What is Dose?
- Acquisition Parameter Settings
- Dose Modulation and Reduction
- Dose Display



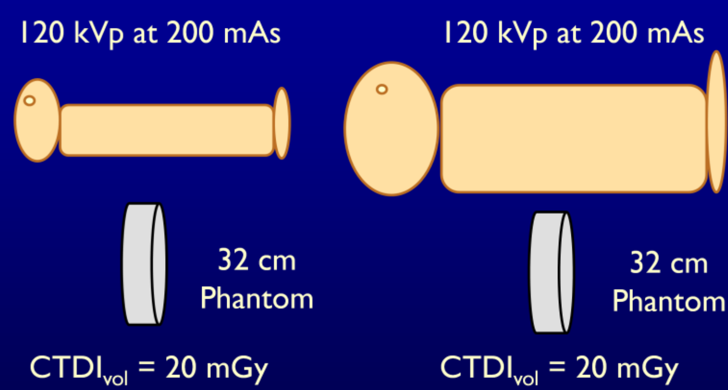
1. Bauhs, J. A., Vrieze, T. J., Primak, A. N., Bruesewitz, M. R., & McCollough, C. H. (2008). CT Dosimetry: Comparison of Measurement Techniques and Devices1. *Radiographics*, *28*(1), 245-253. doi:10.1148/rg.281075024
2. McCollough, C. H., Primak, A. N., Braun, N., Kofler, J., Yu, L., & Christner, J. (2009). Strategies for reducing radiation dose in CT. *Radiologic clinics of North America*, *47*(1), 27-40.
3. International Electrotechnical Commission. *Medical Electrical Equipment. Part 2–44: Particular requirements for the safety of x-ray equipment for computed tomography.* 2.1. International Electrotechnical Commission (IEC) Central Office; Geneva, Switzerland: 2002. IEC publication No. 60601–2–44.

How is $CTDI_{vol}$ related to patient dose?

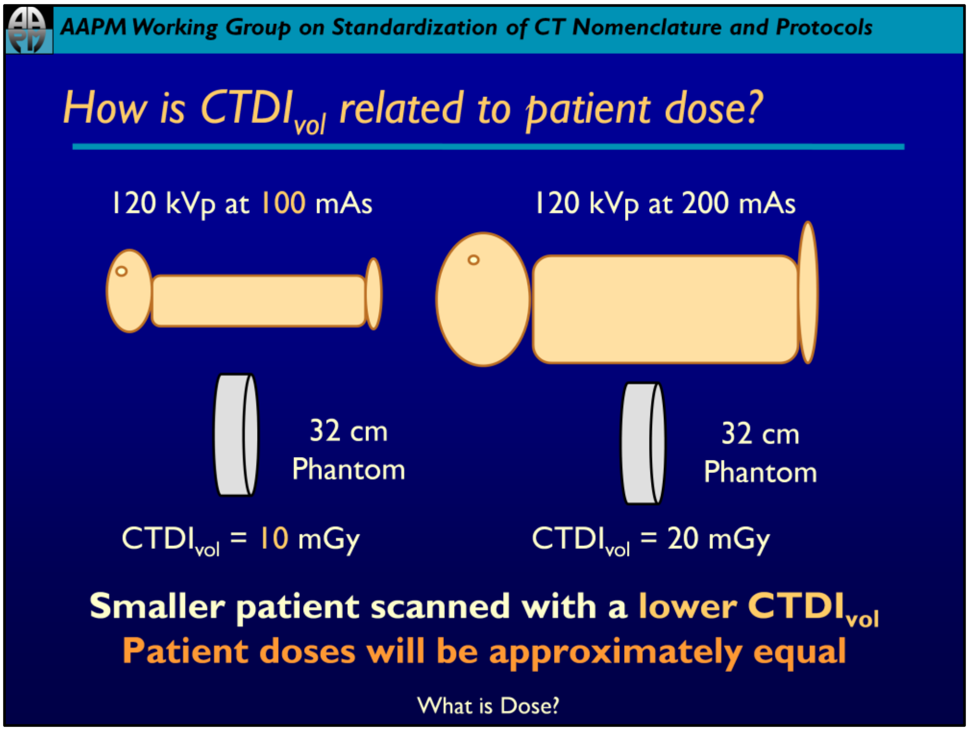
- $CTDI_{vol}$ is not patient dose
- The relationship between the two depends on many factors, including patient size and composition
- AAPM Report 204 introduces a parameter known as the Size Specific Dose Estimate (SSDE) to allow estimation of patient dose based on $CTDI_{vol}$ and patient size
- For the same $CTDI_{vol}$, a smaller patient will tend to have a higher patient dose than a larger patient

http://www.aapm.org/pubs/reports/RPT_204.pdf

How is $CTDI_{vol}$ related to patient dose?



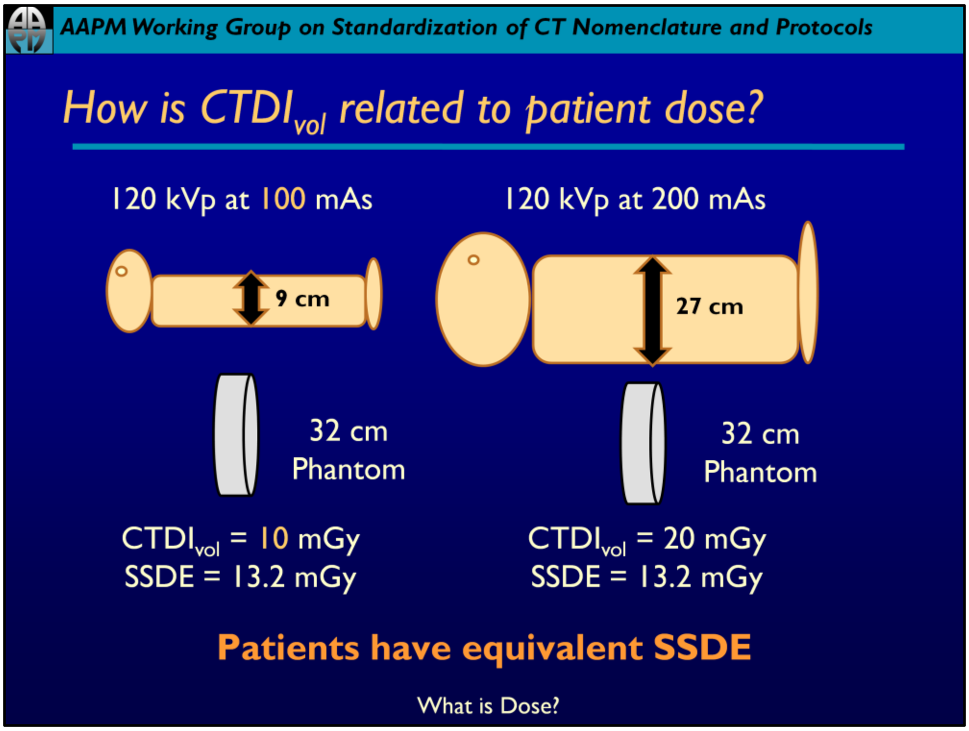
Both patients scanned with the same $CTDI_{vol}$
Patient dose will be higher for the smaller patient

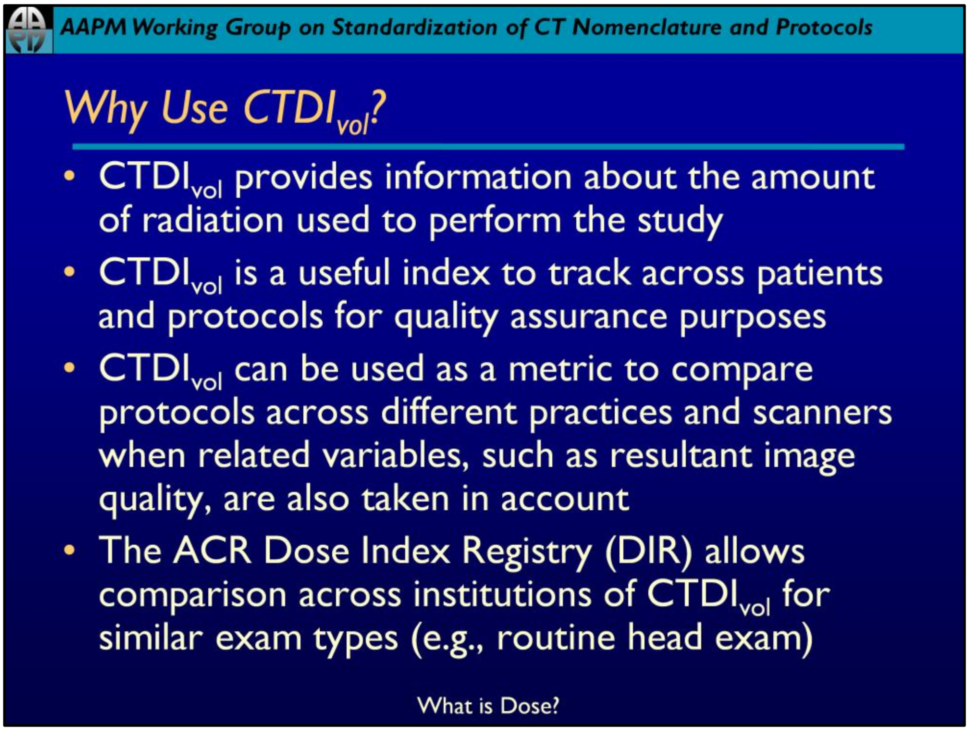


AAPM Working Group on Standardization of CT Nomenclature and Protocols
How is $CTDI_{vol}$ related to patient dose?
120 kVp at 100 mAs
120 kVp at 200 mAs
32 cm Phantom
32 cm Phantom
$CTDI_{vol}$ = 10 mGy
$CTDI_{vol}$ = 20 mGy
Smaller patient scanned with a lower $CTDI_{vol}$
Patient doses will be approximately equal
What is Dose?

Size Specific Dose Estimate (SSDE)

- AAPM report 204 describes a method to calculate SSDE using $CTDI_{vol}$
- Conversion factors based on patient size (e.g., AP or lateral width, effective diameter) are provided to estimate patient dose for a patient of that size
- However, SSDE is still not the exact patient dose, as factors such as scan length and patient composition may differ from the assumptions used to calculate SSDE
- SSDE is not dose to any specific organ, but rather the mean dose in the center of the scanned volume


AAPM Working Group on Standardization of CT Nomenclature and Protocols
How is CTDI$_{vol}$ related to patient dose?
120 kVp at 100 mAs
9 cm
32 cm Phantom
CTDI$_{vol}$ = 10 mGy
SSDE = 13.2 mGy
120 kVp at 200 mAs
27 cm
32 cm Phantom
CTDI$_{vol}$ = 20 mGy
SSDE = 13.2 mGy
Patients have equivalent SSDE
What is Dose?



1. McCollough, C. H., Leng, S., Yu, L., Cody, D. D., Boone, J. M., & McNitt-Gray, M. F. (2011). CT Dose Index and Patient Dose: They are Not the Same Thing, EDITORIAL, Radiology *259*(2), 311-316.

Dose Length Product

- The Dose Length Product (DLP) is also calculated by the scanner
- DLP is the product of the length of the irradiated scan volume and the average $CTDI_{vol}$ over that distance
- DLP has units of mGy*cm

Useful Concepts/Terms

- The relationships between acquisition parameters and $CTDI_{vol}$ described in the following slides assume all other parameters are held constant
- The relationship between a parameter and $CTDI_{vol}$ is often described as **proportional** in some way
  - The symbol $\propto$ is used to indicate "proportional to"
- Directly proportional means that a change in the parameter results in the same change in $CTDI_{vol}$
  - Example: Doubling the rotation time from 0.5 to 1.0 seconds will double the $CTDI_{vol}$
- Inversely proportional means that a change in a parameter has the opposite effect on $CTDI_{vol}$
  - Example: Doubling the pitch from 1 to 2 will reduce the $CTDI_{vol}$ by half

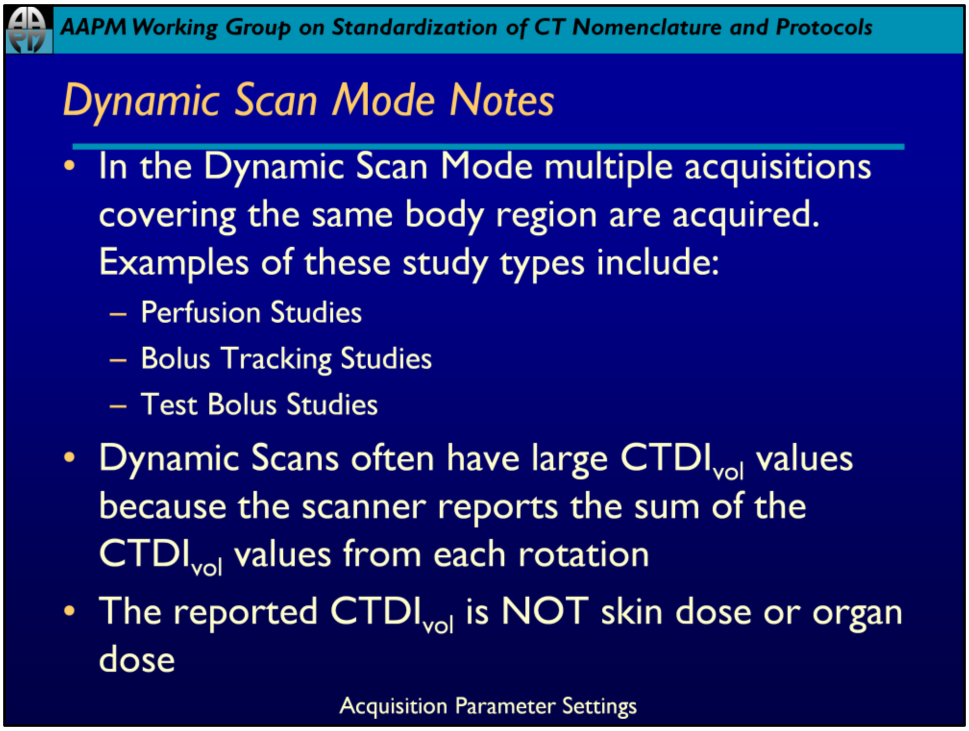
Acquisition Parameter Settings

- Acquisition Parameters define the technique that will be used and how the scan will proceed
- Acquisition Parameters are set in the user interface where scans are prescribed
- Changing a single Acquisition Parameter while holding everything else constant will typically affect the $CTDI_{vol}$ for that scan
- The following slides describe what that affect is for each parameter

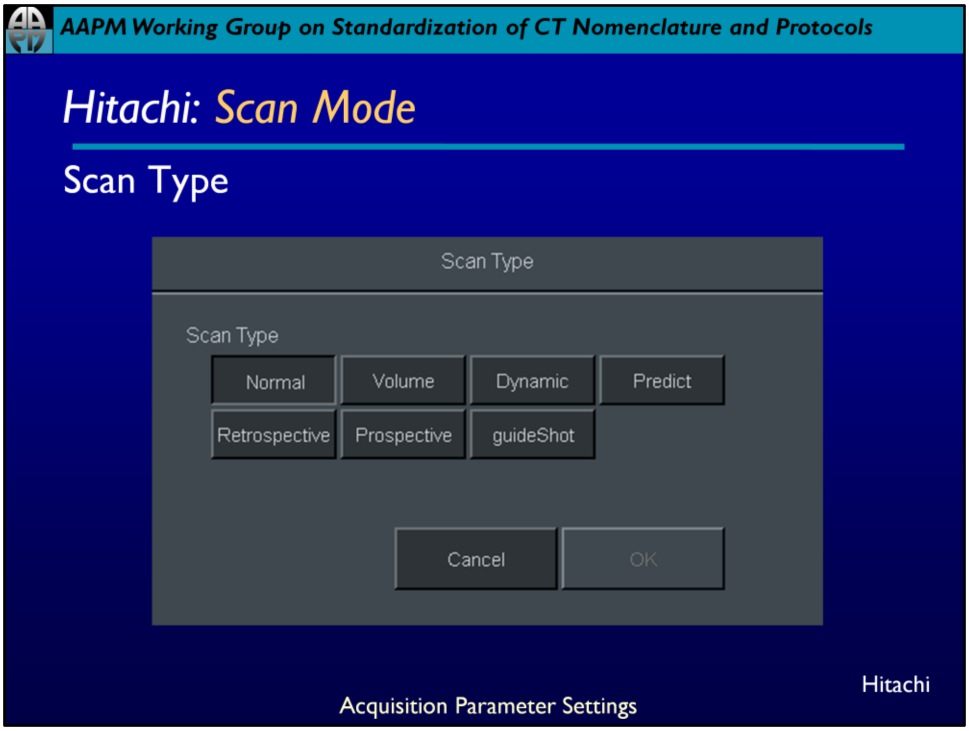
Scan Mode

- CT Scanners offer a variety of Scan Modes which describe how the table moves during an exam
- Scan Modes include
  - Axial
  - Helical or Spiral
  - Dynamic

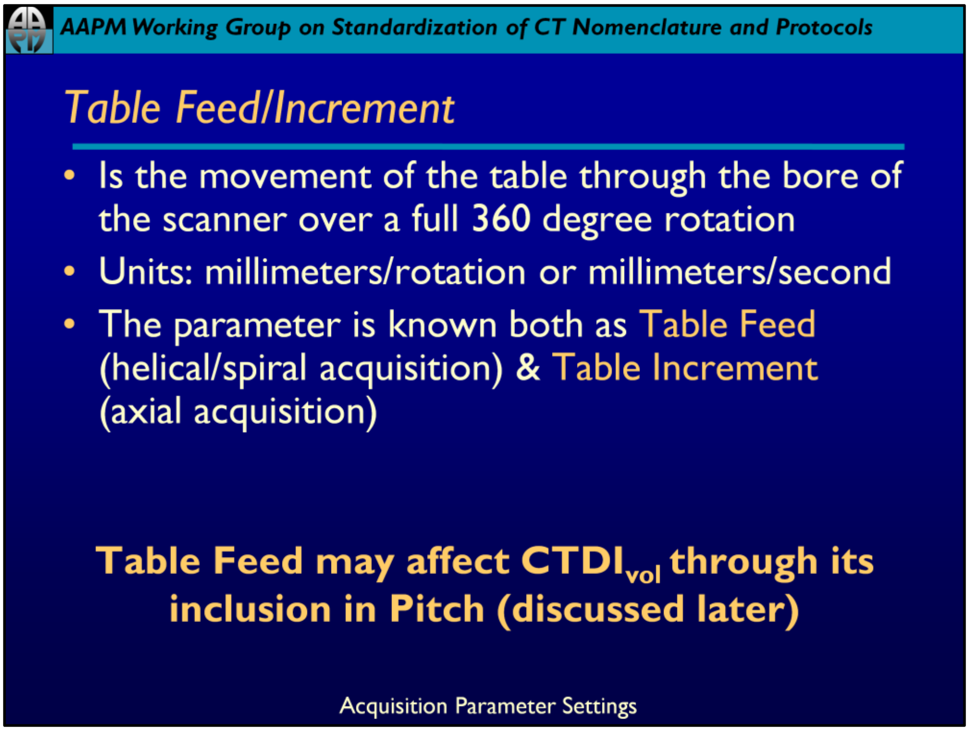
The Acquisition Parameters that affect CTDIvol may change amongst different Scan Modes



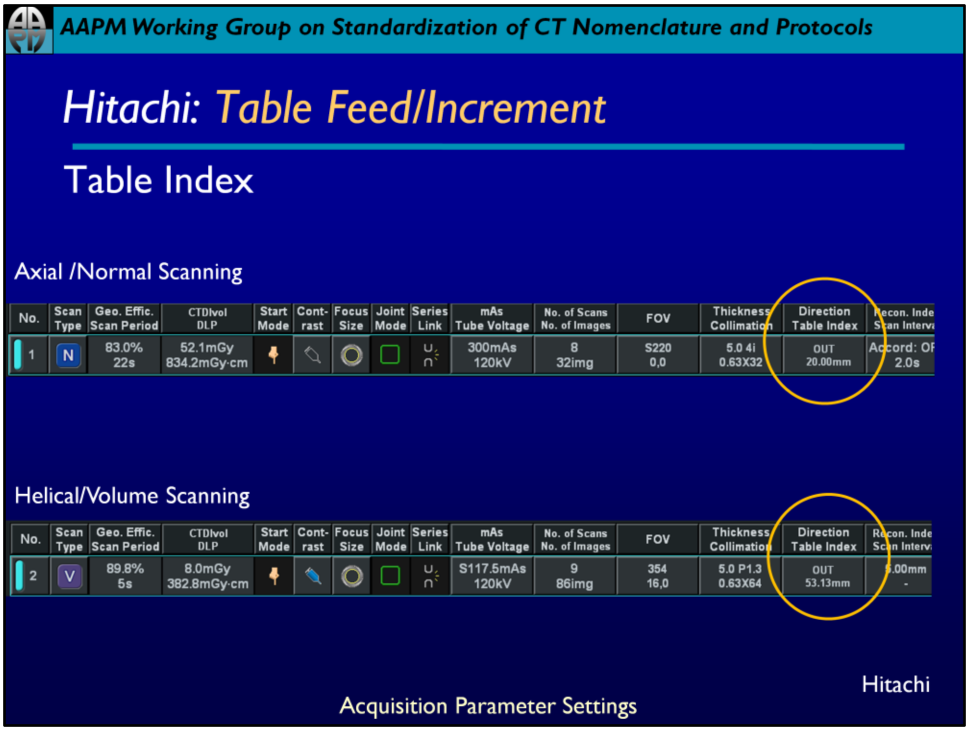
1. Bauhs, J. A., Vrieze, T. J., Primak, A. N., Bruesewitz, M. R., & Mccollough, C. H. (2008). CT Dosimetry : Comparison of Measurement Techniques and Devices. *Radiographics*, *28*(1), 245-254.
2. Zhang, D., Cagnon, C. H., Villablanca, J. P., McCollough, C. H., Cody, D. D., Stevens, D. M., Zankl, M., et al. (2012). Peak Skin and Eye Lens Radiation Dose From Brain Perfusion CT Based on Monte Carlo Simulation. *American Journal of Roentgenology*, *198*(2), 412-417.



For Hitachi users:
Normal = Axial scanning
Volume = Helical/Spiral scanning
Predict = Bolus tracking
guideShot = snap shot needle localization



Hitachi calls this feature TABLE INDEX.



Examples of how Table Index is displayed for an Axial and a Volume scan

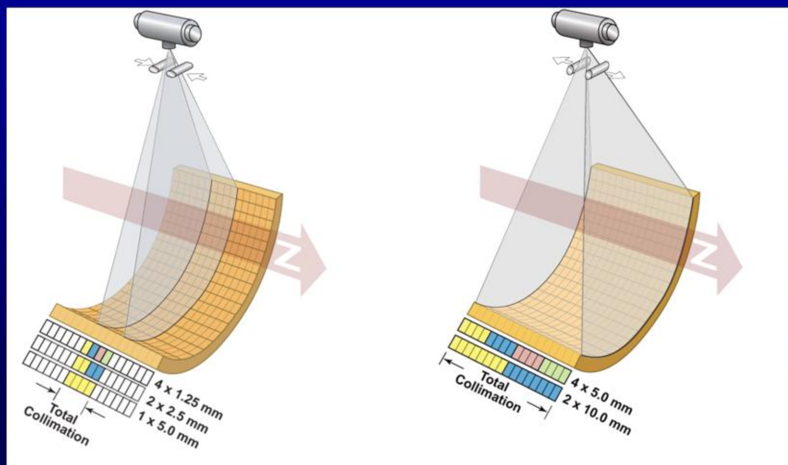
Detector Configuration

- Is the combination of the number of data channels and the width of the detector associated with each data channel
- The Detector Configuration determines the Beam Width or Beam Collimation (nT), which is the number of channels (n) times the detector width associated with each data channel (T)
- For a selected detector width per data channel, a smaller total Beam Collimation usually has a higher $CTDI_{vol}$ than a larger Beam Collimation
  - Example: On a 16 slice scanner with a detector width per channel of 1.25 mm, a collimation of 4x1.25mm is generally less dose efficient than a collimation of 16x1.25mm

Users should monitor $CTDI_{vol}$ values when changing detector configuration

AAPM Working Group on Standardization of CT Nomenclature and Protocols

Detector Configuration

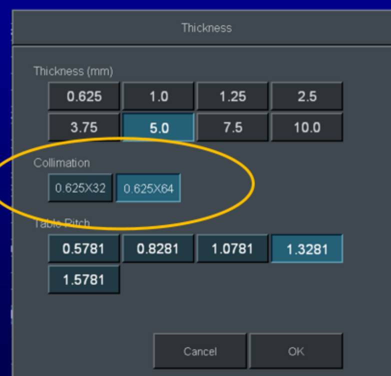


Acquisition Parameter Settings

Hitachi: Detector Configuration

Collimation

Normal (axial) mode



Volume (helical) mode

Hitachi

Acquisition Parameter Settings

Pitch

- Is the Table Feed per gantry rotation divided by the beam width/collimation
- Pitch is the ratio of two distances and therefore has no units
- Users should monitor other parameters when changing Pitch. The scanner may or may not automatically compensate for changes in Pitch (for example, by changing the tube current) to maintain the planned $CTDI_{vol}$.

$CTDI_{vol} \propto 1/\text{Pitch}$:

Hitachi, Toshiba (no AEC)

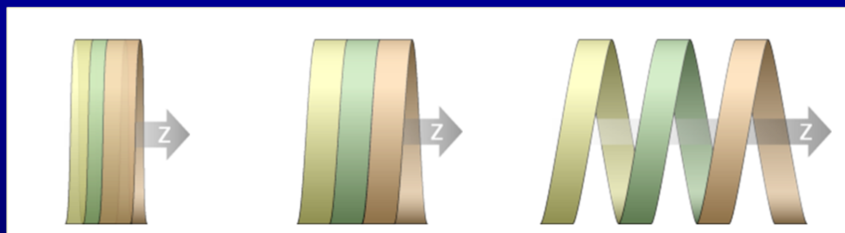
$CTDI_{vol}$ independent of Pitch:

GE, Siemens, Philips, Neusoft, Toshiba (AEC)

Pitch

- $CTDI_{vol}$ may not change in the expected manner if the scanner automatically adjust other parameters when the pitch is changed
- The relationships between CTDIvol and pitch for the different vendors are described below
  - $CTDI_{vol}$ inversely proportional to change in pitch: Hitachi, NeuroLogica
  - $CTDI_{vol}$ constant when pitch is changed due to changes to other parameters: GE, Neusoft, Philips and Siemens
  - The relationship between $CTDI_{vol}$ and pitch depends on scan mode or Software version: Toshiba

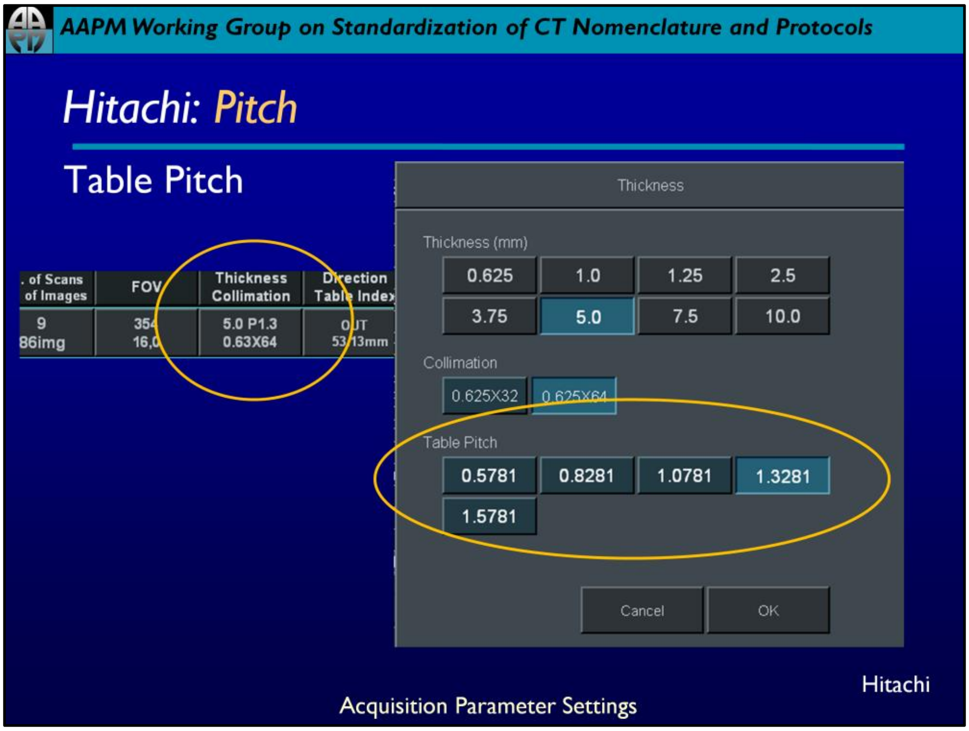
Pitch



Pitch < 1
Beam Width has some overlap at each view angle from rotation to rotation

Pitch = 1
No overlap of Beam Width at each view angle and no view angles not covered at certain table positions

Pitch > 1
Some view angles are not covered by the beam width at certain table positions



Pitch is indicated on the Thickness/Collimation parameter indicated with a "P" (i.e. P1.3)
In order to change the pitch, click on the Thickness/Collimation parameter and the Thickness window will open to give the user the ability to change the Table Pitch parameter.

Exposure Time per Rotation

- Is the length of time, in seconds, that the X-ray beam is "on" during a gantry rotation
  - It takes into account the gantry rotation time and angular acquisition range
- Units: seconds
- Users should monitor other parameters when changing Exposure Time per Rotation. The scanner may or may not automatically compensate for changes in Exposure Time per Rotation(for example, by changing the tube current)

$CTDI_{vol} \propto$ Exposure Time per Rotation

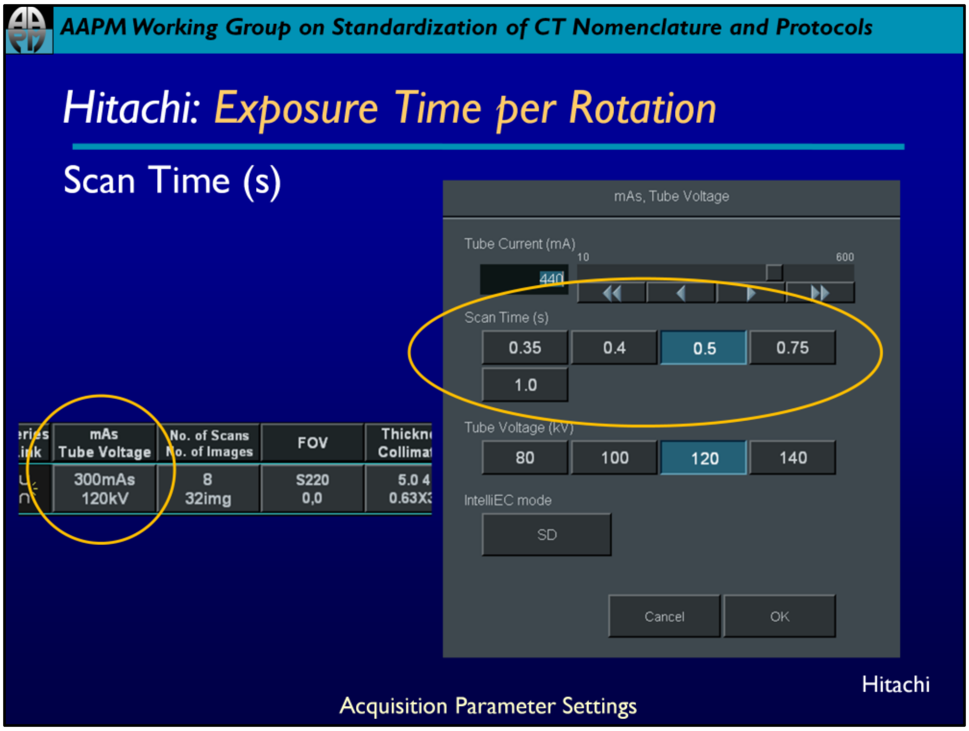
Hitachi, NeuroLogica, Toshiba (no AEC)

$CTDI_{vol}$ independent of Exposure Time per Rotation:

GE, Siemens, Philips, Neusoft, Toshiba (AEC)

Exposure Time per Rotation

- $CTDI_{vol}$ may not change in the expected manner if the scanner automatically adjust other parameters when the exposure time per rotation is changed
- The relationships between CTDIvol and exposure time per rotation for the different vendors are described below
  - $CTDI_{vol}$ proportional to change in parameter: Hitachi and NeuroLogica
  - $CTDI_{vol}$ constant when the parameter is changed due to changes to other parameters: GE, Neusoft, Philips and Siemens
  - The relationship between $CTDI_{vol}$ and the parameter depends on scan mode or Software version: Toshiba

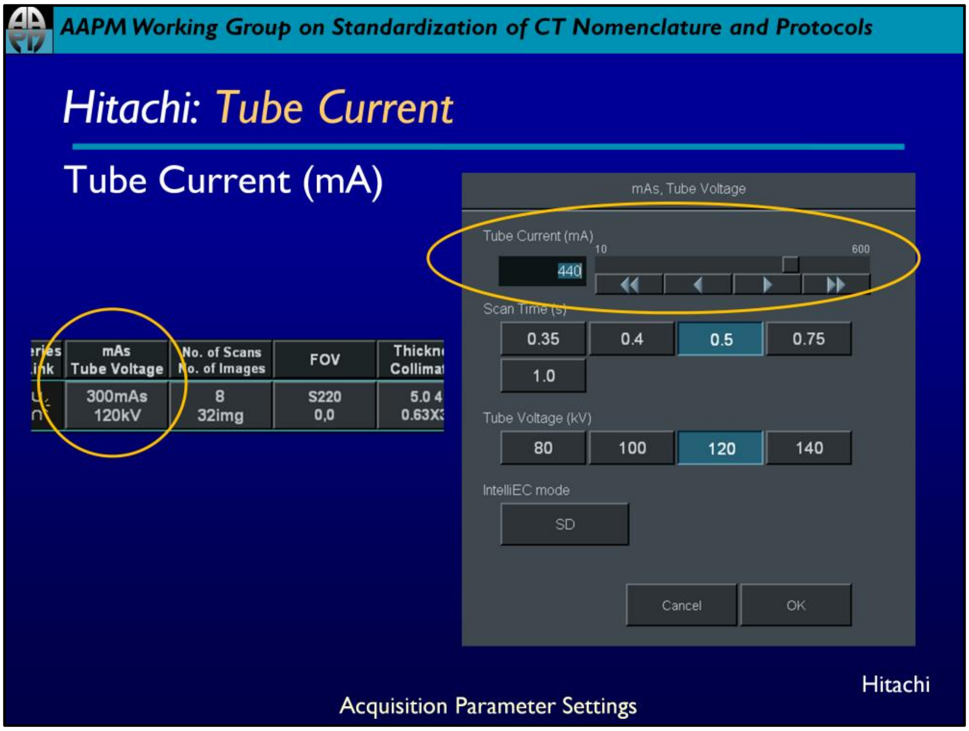


Scan Time (s) is located under the mAs/Tube Voltage parameter
In order to change the scan time, click on the mAs/Tube Voltage parameter and the mAs,Tube Voltage window will open to give the user the ability to change the Scan Time (s) parameter.

Tube Current

- Determines the number of electrons accelerated across the x-ray tube per unit time
- Units: milliAmperes (mA)
- $CTDI_{vol}$ is directly proportional to Tube Current

$$\mathbf{CTDI_{vol} \propto Tube\ Current}$$



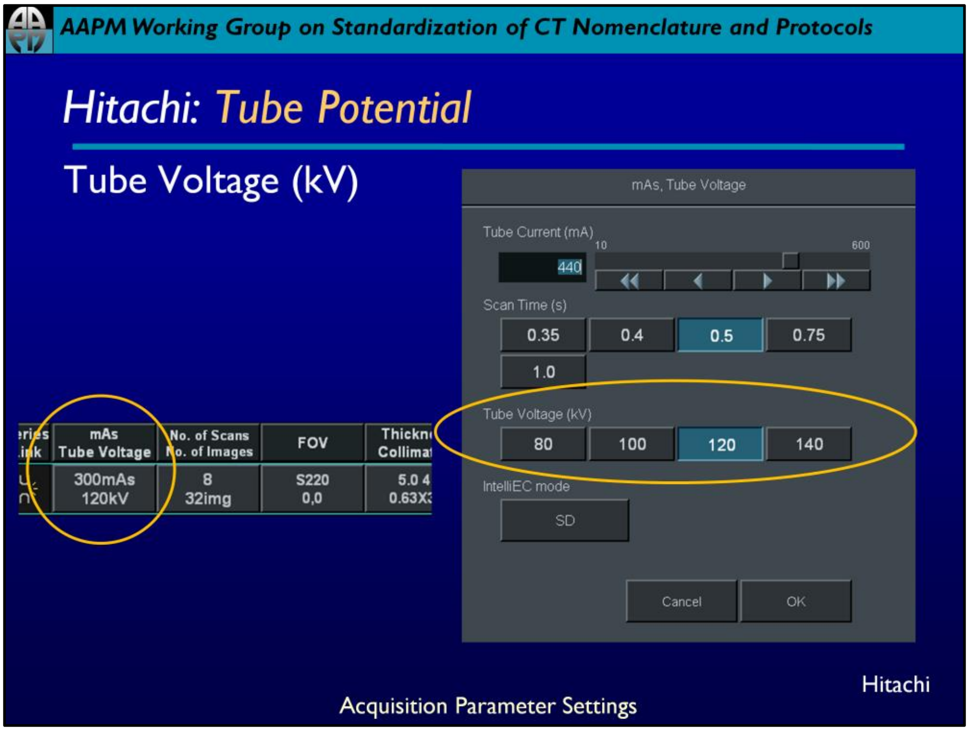
Tube Current (mA) is located under the mAs/Tube Voltage parameter
In order to change the Tube Current (mA), click on the mAs/Tube Voltage parameter and the mAs,Tube Voltage window will open to give the user the ability to change the Tube Current (mA) parameter.

Tube Potential

- Is the electrical potential applied across the x-ray tube to accelerate electrons toward the target material
- Units: kiloVolts (kV or kVp)
- $CTDI_{vol}$ is **approximately** proportional to the square of the percentage change in Tube Potential

$$CTDI_{vol} \propto \left(\frac{kV_{new}}{kV_{old}} \right)^n$$

n ≈ 2 to 3



Tube Voltage (kV) is located under the mAs/Tube Voltage parameter
In order to change the Tube Voltage (kV), click on the mAs/Tube Voltage parameter and the mAs,Tube Voltage window will open to give the user the ability to change the Tube Voltage (kV) parameter.

Tube Current Time Product

- Is the product of Tube Current and the Exposure Time per Rotation
- Units: milliAmpere-seconds (mAs)
- $CTDI_{vol}$ is directly proportional to Tube Current Time Product

$CTDI_{vol}$ ∝
Tube Current Time Product

Hitachi: Tube Current Time Product

mAs

No.	Scan Type	Geo. Effic. Scan Period	CTDIvol DLP	Start Mode	Cont-rast	Focus Size	Joint Mode	Series Link	mAs Tube Voltage	No. of Scans No. of Images	FOV
1	N	83.0% 22s	52.1mGy 834.2mGy·cm						300mAs 120kV	8 32img	S220 0,0

Acquisition Parameter Settings

Hitachi

Field Of Measurement

- Is the diameter of the primary beam in the axial plane at the gantry iso-center
- Units: millimeters (mm)
- $CTDI_{vol}$ may decrease with a decrease in the Field of Measurement
  - The relationship is vendor specific

Users should monitor the $CTDI_{vol}$ values when changing the Field of Measurement

Hitachi: Field of Measurement

FOV (Field of View)

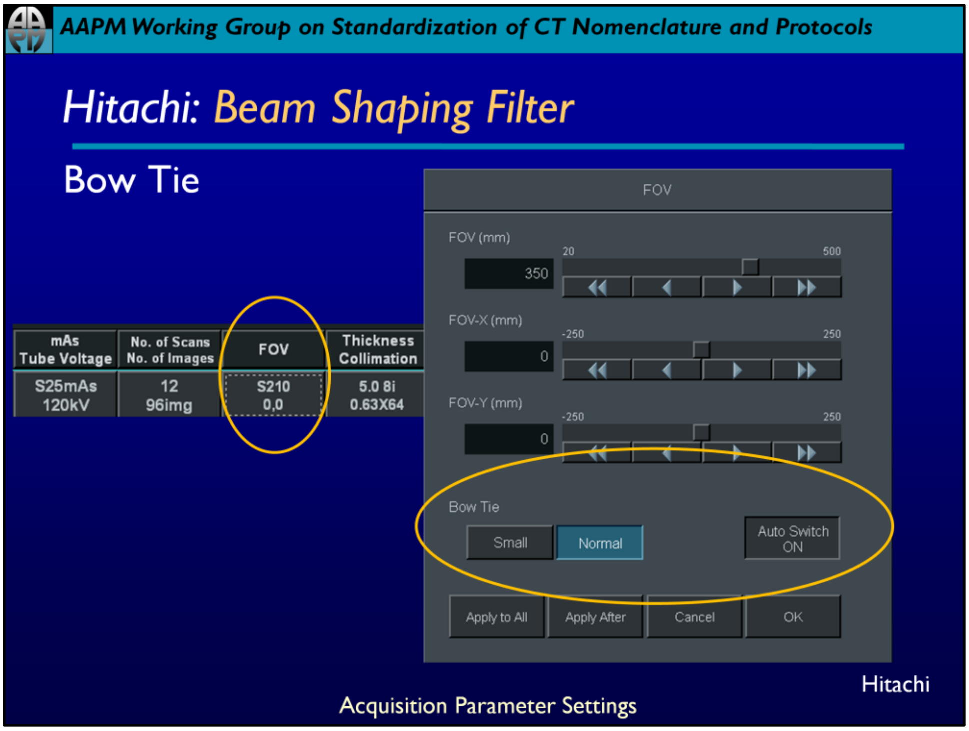
Hitachi

Acquisition Parameter Settings

Beam Shaping Filter

- Is the scanner component that modifies the energy spectrum and spatial distribution of the primary beam
- Beam Shaping may include a bow tie filter and/or flat filters
- CTDI_{vol} is affected by a change in Beam Shaping Filters
  - The relationship is vendor and filter specific

Users should monitor CTDI_{vol} values when changing the Beam Shaping Filter



The “S” in front of the FOV value indicates the Small Bow Tie filter is in use.
The Small Bow Tie filter can be used when the FOV is below 240mm.

The Small Bow Tie filter can be automatically turned on when the Auto Switch button is depressed in Scan Protocol Settings and saved permanently within the protocol.

Acquisition Parameter Settings Summary

Parameter	Relationship to $CTDI_{vol}$
Scan Mode	Changes in the Scan Mode may affect $CTDI_{vol}$
Table Feed/Increment	Table Feed affects $CTDI_{vol}$ through its inclusion in Pitch
Detector Configuration	Decreasing the Beam Collimation typically, but not always, increases the $CTDI_{vol}$
Pitch	$CTDI_{vol}$ relationship to pitch is vendor dependent
Exposure Time Per Rotation	$CTDI_{vol}$ relationship to exposure time per rotation is vendor dependent
Tube Current	$CTDI_{vol} \propto$ Tube Current
Tube Potential	$CTDI_{vol} \propto (kVp_1/kVp_2)^n$ n ~ 2 to 3
Tube Current Time Product	$CTDI_{vol} \propto$ Tube Current Time Product
Effective Tube Current Time Product	$CTDI_{vol} \propto$ Effective Tube Current Time Product
Field of Measurement	Changes in the Field of Measurement may affect $CTDI_{vol}$
Beam Shaping Filter	Changes in the Beam Shaping Filter may affect $CTDI_{vol}$

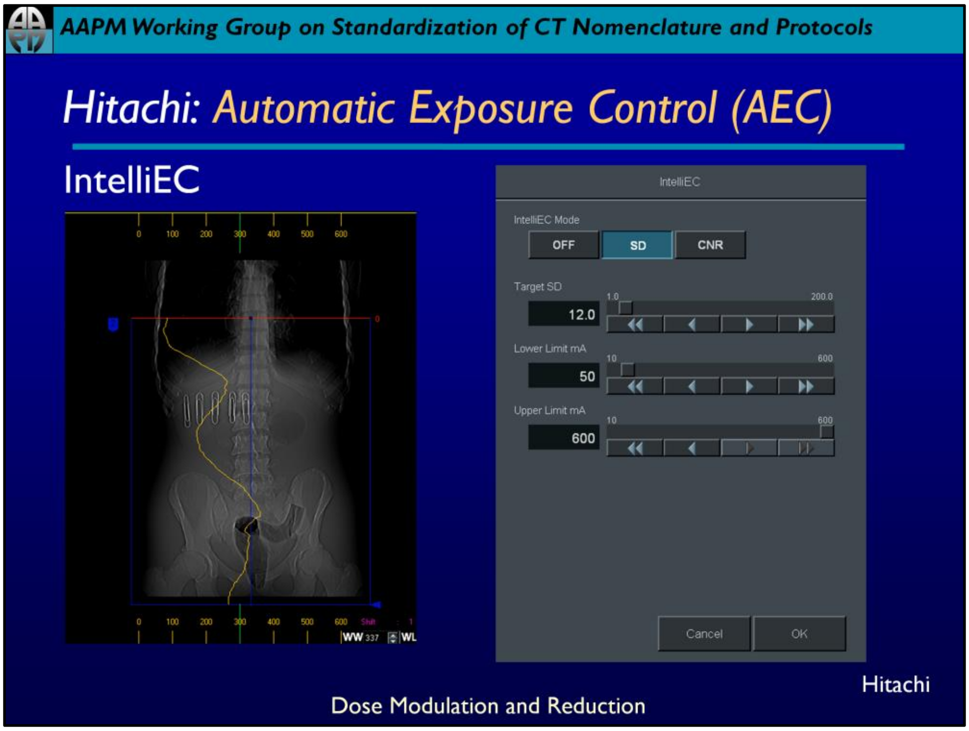
Dose Modulation and Reduction

- Many CT scanners automatically adjust the technique parameters (and as a result the $CTDI_{vol}$) to achieve a desired level of image quality and/or to reduce dose
- Dose Modulation and Reduction techniques vary by scanner manufacturer, model and software version

Automatic Exposure Control (AEC)

- Automatically adapts the Tube Current or Tube Potential according to patient attenuation to achieve a specified image quality
  - Automatic adjustment of Tube Current may not occur when Tube Potential is changed
  - **Centering the patient in the gantry is VITAL for most AEC systems**
- AEC aims to deliver a specified image quality across a range of patient sizes. It tends to increase $CTDI_{vol}$ for large patients and decrease it for small patients relative to a reference patient size

The use of Automatic Exposure Control may decrease or increase $CTDI_{vol}$ depending on the patient size and body area imaged and image quality requested

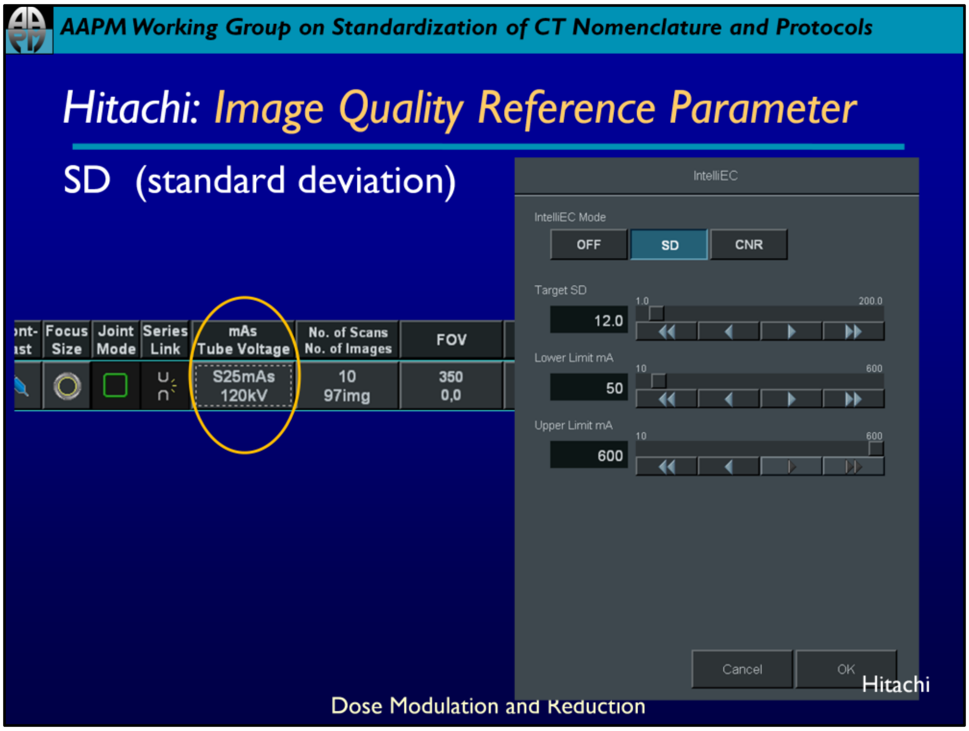


For the Hitachi Scenaria scanner, IntelliEC is based on one PA scanogram

Image Quality Reference Parameter

- Is the AEC parameter that is set by the user to define the desired level of image quality
- Changing the Image Quality Reference Parameter will affect the $CTDI_{vol}$

The effect on $CTDI_{vol}$ when changing the Image Quality Reference Parameter is vendor dependent



Inversely proportional
Increasing SD will decrease the dose but increase the noise
Decreasing the SD will increase the dose but decrease the noise

The user will be able to determine SD is turned “ON” by the indication of the “S” in front of the mAs value.

Image Quality Reference Parameter

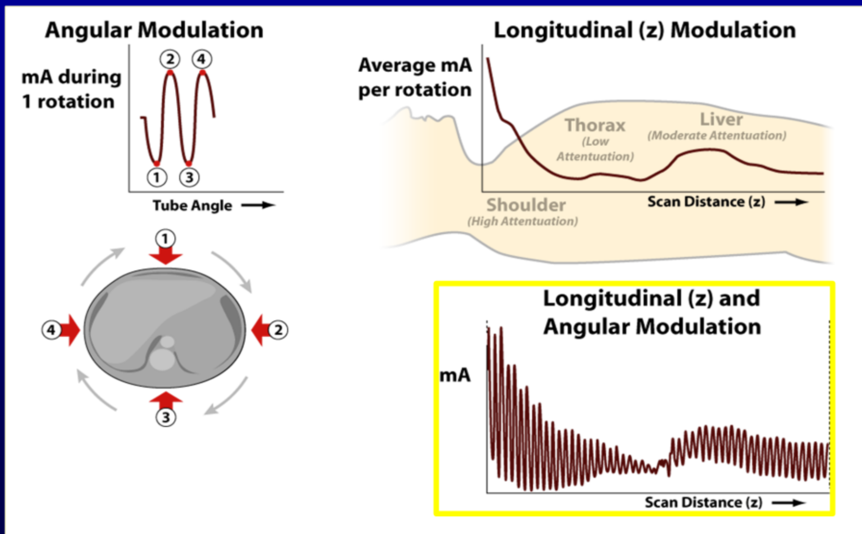
- A change in the Image Quality Reference Parameter will affect the $CTDI_{vol}$
- Setting the parameter for "increased" image quality (e.g., lower noise) will result in more dose
  - Decreasing the SD# (standard deviation) will result in an increase in the $CTDI_{vol}$
- Setting the parameter for "decreased" image quality (e.g., more noise) will result in less dose
  - Increasing the SD# (standard deviation) will result in a decrease in the $CTDI_{vol}$

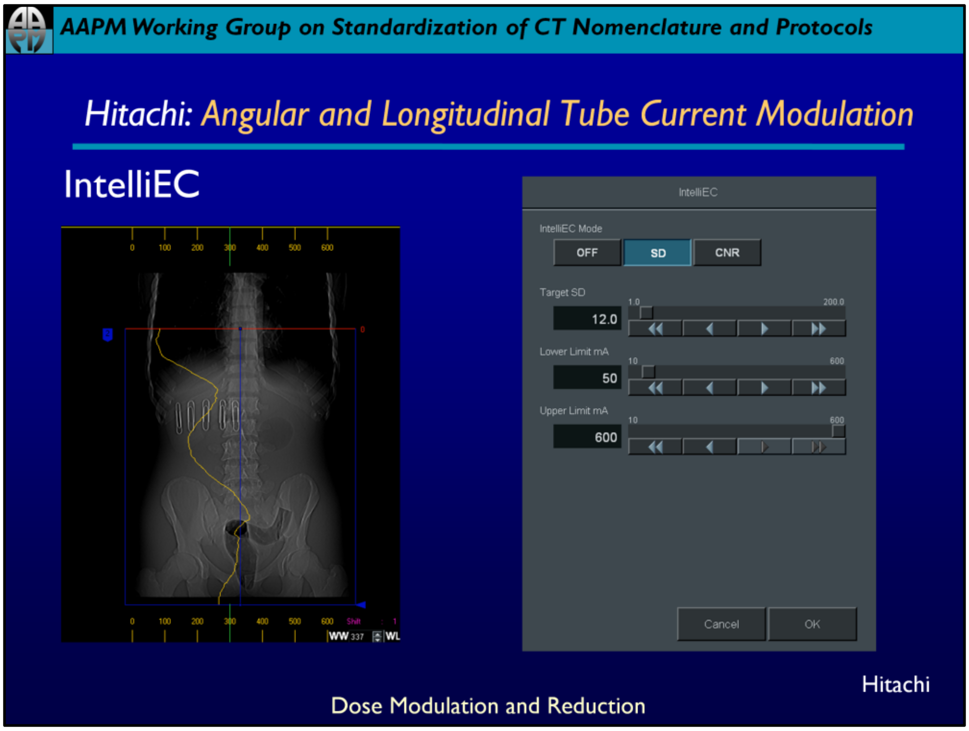
Angular and Longitudinal Tube Current Modulation

- Is an AEC feature that incorporates the properties of both Angular and Longitudinal Tube Current Modulation to
  - Adjust the Tube Current based on the patient's overall attenuation
  - Modulate the Tube Current in the angular (X-Y) and longitudinal (Z) dimensions to adapt to the patient's shape

The use of Angular and Longitudinal Tube Current Modulation may decrease or increase $CTDI_{vol}$ depending on the patient size and body area imaged and image quality requested

Angular and Longitudinal Tube Current Modulation





For the Hitachi Scenaria scanner, IntelliEC is based on one PA scanogram

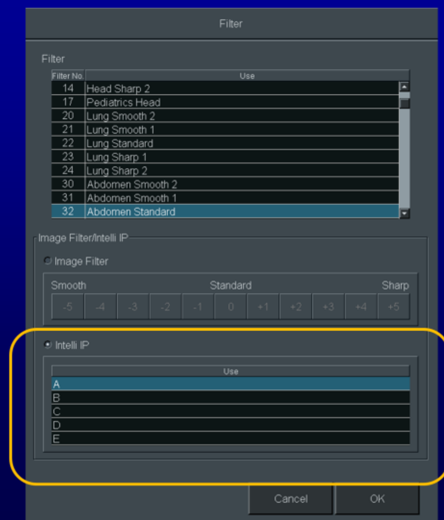
Iterative Reconstruction

- Is a feature that uses the information acquired during the scan and repeated reconstruction steps to produce an image with less "noise" or better image quality (e.g., higher spatial resolution or decreased artifacts) than is achievable using standard reconstruction techniques

The use of Iterative Reconstruction by itself may not decrease $CTDI_{vol}$; with use of Iterative Reconstruction, image quality will change and this may allow a reduction in the $CTDI_{vol}$ by adjusting the acquisition parameters used for the exam

Hitachi: *Iterative Reconstruction*

Intelli IP



Hitachi

Iterative Reconstruction

- Iterative Reconstruction using Intelli IP is completed using Image and Projection Data
- Changing the Letter of Intelli IP will affect the resultant image quality; it WILL NOT affect the $CTDI_{vol}$ of the scan
- In consultation, the radiologists and medical physicists may adjust the acquisition parameters for studies reconstructed using Intelli IP based on the imaging task and patient population, dose concerns, and the needs of the interpreting radiologist(s)

Dose Display

- Information about the $CTDI_{vol}$ planned for each scan is typically displayed before the exam on the user console
- Information about the $CTDI_{vol}$ delivered by each scan is typically reported in a data page or DICOM structured dose report
- Dose information provided after the exam typically also includes the DLP and the CTDI phantom size. These may also be included in information displayed before the scan.

Display of Planned $CTDI_{vol}$

- $CTDI_{vol}$ is displayed before a study is performed based on the selected technique parameters
- It is important to check $CTDI_{vol}$ before a study is performed to ensure that the output of the scanner is appropriate for the specific patient and diagnostic task

$CTDI_{vol}$ is displayed for each planned acquisition

Hitachi: Display of Planned $CTDI_{vol}$

$CTDI_{vol}$

No.	Scan Type	Geo. Effic. Scan Period	CTDIvol DLP	Start Mode	Cont-rast	Focus Size	Joint Mode	Series Link	mAs Tube Voltage	No. of Scans No. of Images	FOV	Thickn Collimat
1	N	83.0% 22s	52.1mGy 834.2mGy·cm						300mAs 120kV	8 32img	S220 0,0	5.0 4 0.63X3

Hitachi

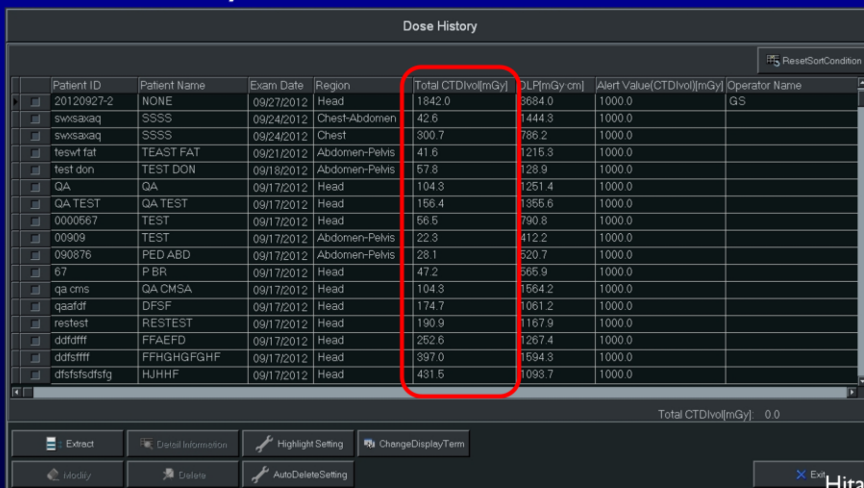
Dose Display

Post Study Data Page

- Following the completion of a study, a Post Study Data Page is created that includes information on the delivered $CTDI_{vol}$ and DLP and the phantom size used to calculate these values
- Information is displayed for each series

Hitachi: Post Study Data Page

Dose History


Dose History

ResetSortCondition

Patient ID	Patient Name	Exam Date	Region	Total CTDIvol[mGy]	DLP[mGy·cm]	Alert Value(CTDIvol)[mGy]	Operator Name
20120927-2	NONE	09/27/2012	Head	1842.0	3684.0	1000.0	GS
swxsaxaq	SSSS	09/24/2012	Chest-Abdomen	42.6	1444.3	1000.0	
swxsaxaq	SSSS	09/24/2012	Chest	300.7	786.2	1000.0	
teswt fat	TEAST FAT	09/21/2012	Abdomen-Pelvis	41.6	1215.3	1000.0	
test don	TEST DON	09/18/2012	Abdomen-Pelvis	57.8	128.9	1000.0	
QA	QA	09/17/2012	Head	104.3	1251.4	1000.0	
QA TEST	QA TEST	09/17/2012	Head	156.4	1355.6	1000.0	
0000567	TEST	09/17/2012	Head	56.5	790.8	1000.0	
00909	TEST	09/17/2012	Abdomen-Pelvis	22.3	412.2	1000.0	
090876	PED ABD	09/17/2012	Abdomen-Pelvis	28.1	520.7	1000.0	
67	P BR	09/17/2012	Head	47.2	565.9	1000.0	
qa cms	QA CMSA	09/17/2012	Head	104.3	1564.2	1000.0	
qaafdf	DFSF	09/17/2012	Head	174.7	1061.2	1000.0	
restest	RESTEST	09/17/2012	Head	190.9	1167.9	1000.0	
ddfdfff	FFAEFD	09/17/2012	Head	252.6	1267.4	1000.0	
ddfsffff	FFHGHGFGHF	09/17/2012	Head	397.0	1594.3	1000.0	
dfsfsfsdfsfg	HJHHF	09/17/2012	Head	431.5	1093.7	1000.0	

Total CTDIvol[mGy]: 0.0

Extract | Detail Information | Highlight Setting | ChangeDisplayTerm

Modify | Delete | AutoDeleteSetting | Exit

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Dose Display

Post Study Data Page - $CTDI_{vol}$

- $CTDI_{vol}$ is displayed for each series after a study is performed and is calculated based on the technique factors used to acquire the data
- It is useful to check $CTDI_{vol}$ after a study is performed to ensure that the output of the scanner was as expected

$CTDI_{vol}$ is displayed for each completed acquisition

Post Study Data Page - DLP

- DLP is displayed for each series after a study is performed and is calculated based on the technique factors and scan length used

DLP is displayed for each completed acquisition and is typically summed for all of the acquisitions

Hitachi: Post Study Data Page

Detail Information

Detail Information

Detail Information per Sequence

Region	CTDIvol[mGy]	DLP[mGy*cm]	Tube Current[mA]	Tube Voltage[kV]	IntelliEC ON/OFF	Scan Time[s]	Scan Count	Exposure Time[s]	Dose Validation Phantom
Head	52.1	1147.1	300	120	OFF	1.00	11	11.00	Head Phantom
Head	138.8	20.8	300	120	OFF	1.00	1	1.00	Head Phantom

OK

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Dose Display

Post Study Data Page – CTDI Phantom

- The CTDI Phantom used for each acquisition in the study is typically displayed
- Different phantoms may be used to calculate the $CTDI_{vol}$ for different acquisitions in the same study (and may vary by vendor)
  - Head and C-Spine Example
    - Body Phantom used to report $CTDI_{vol}$ for C-Spine portion of exam
    - Head Phantom used to report $CTDI_{vol}$ for Head portion of exam

Hitachi: Post Study Data Page – CTDI Phantom

Detail Information

Detail Information per Sequence

Region	CTDIvol[mGy]	DLP[mGy*cm]	Tube Current[mA]	Tube Voltage[kV]	IntelliEC ON/OFF	Scan Time[s]	Scan Count	Exposure Time[s]	Dose Validation Phantom
Head	52.1	1147.1	300	120	OFF	1.00	11	11.00	Head Phantom
Head	138.8	20.8	300	120	OFF	1.00	1	1.00	Head Phantom

OK

Detail Information

Detail Information per Sequence

Region	CTDIvol[mGy]	DLP[mGy*cm]	Tube Current[mA]	Tube Voltage[kV]	IntelliEC ON/OFF	Scan Time[s]	Scan Count	Exposure Time[s]	Dose Validation Phantom
Abdomen-Pelvis	17.0	314.6	145	120	OFF	0.75	8	6.00	Body Phantom
Abdomen-Pelvis	11.1	206.1	95	120	OFF	0.75	8	6.00	Body Phantom

OK

Dose Display

Summing Dose Report Values

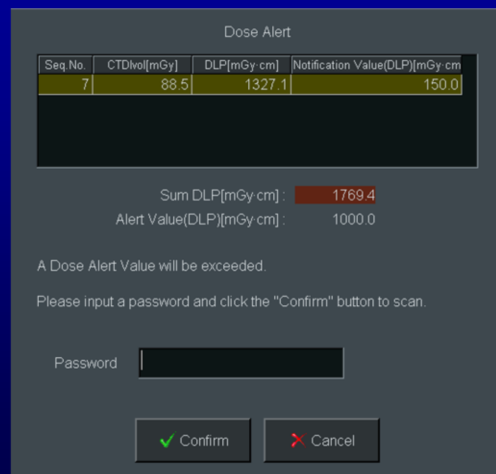
- $CTDI_{vol}$ values for separate series are NOT to be summed to give a "total" $CTDI_{vol}$ for a study
  - This is especially true if the series cover different anatomic regions
- DLP is typically summed over all series in the Post Study Data Page to provide an estimate of the total patient exposure
  - Extreme care should be taken when considering summed DLPs because different phantoms may have been used to calculate the $CTDI_{vol}$ values used to determine DLP
- A medical physicist should be contacted if patient specific dose estimates are required

Dose Alert Levels

- Dose Alert Levels require specific action by the operator to continue scanning
- Dose Alert Levels are typically much higher than Notification Levels and take into account all series within the exam
- Triggering a Dose Alert requires that the operator confirm the protocol and settings are correct by entering in his or her name. Optionally, sites may require that the operator provide a brief explanation in the provided field

Hitachi: *Dose Alert Levels*

Dose Alert



The Dose Alert feature complies with the NEMA XR-25 standard.

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Dose Display

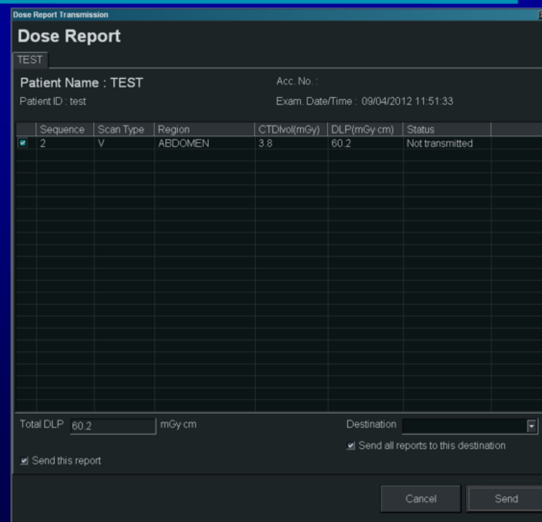
Radiation Dose Structured Reports

- Radiation Dose Structured Reports (RDSRs) are provided in newer software versions in a defined DICOM format
- They provide the most complete set of information regarding the irradiating events
- The reports are very detailed and require an RDSR viewer for easy visualization of relevant information

AAPM Working Group on Standardization of CT Nomenclature and Protocols

Hitachi: Radiation Dose Structured Reports

DICOM Dose Structured Report



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Dose Display

Questions

- Please contact the medical physicist providing support for your CT practice, your lead technologist, supervising radiologist or manufacturer's application specialist with questions regarding these important topics and concepts.

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