

Optimizing Scan Protocols for Low Dose

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Dose

- Local dose
- CTDI
- Effective Dose

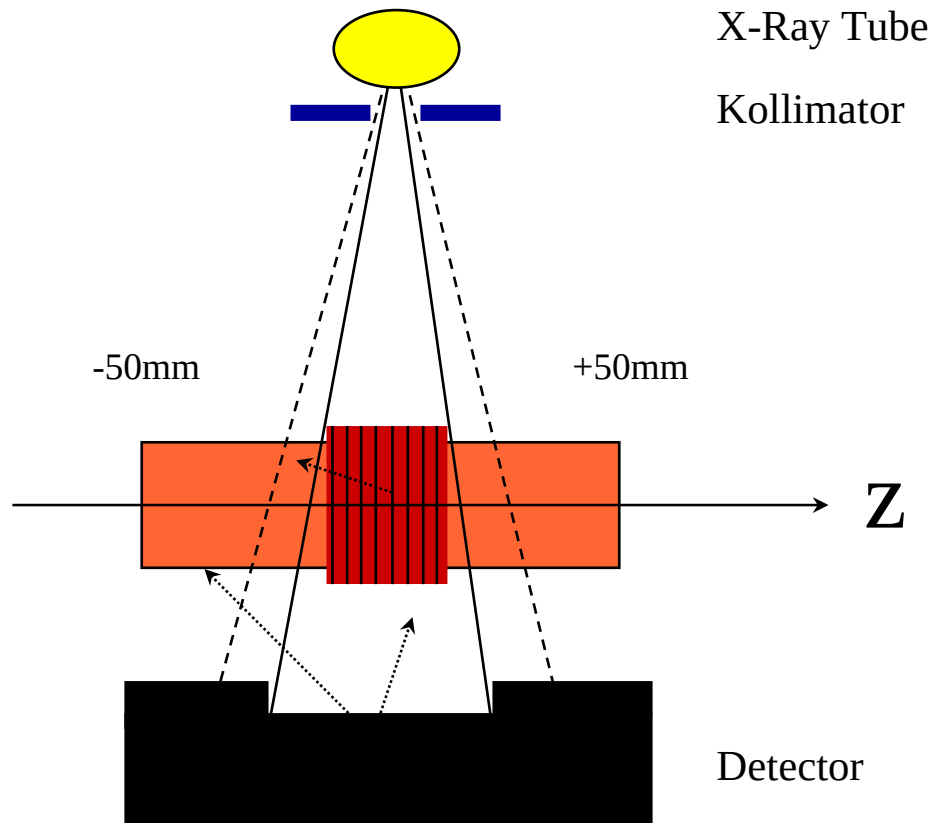
Computed Tomography Dose Index

$$CTDI = \int_{-50\text{ mm}}^{+50\text{ mm}} \frac{D(z)}{N \cdot T} dz$$

- N: Number of Sections per Rotation
- T: Nominal Tomographic Section Thickness

Definition from IEC 60601-2-44 Medical electrical equipment:
Particular requirements for the safety of X-ray equipment for
computed tomography

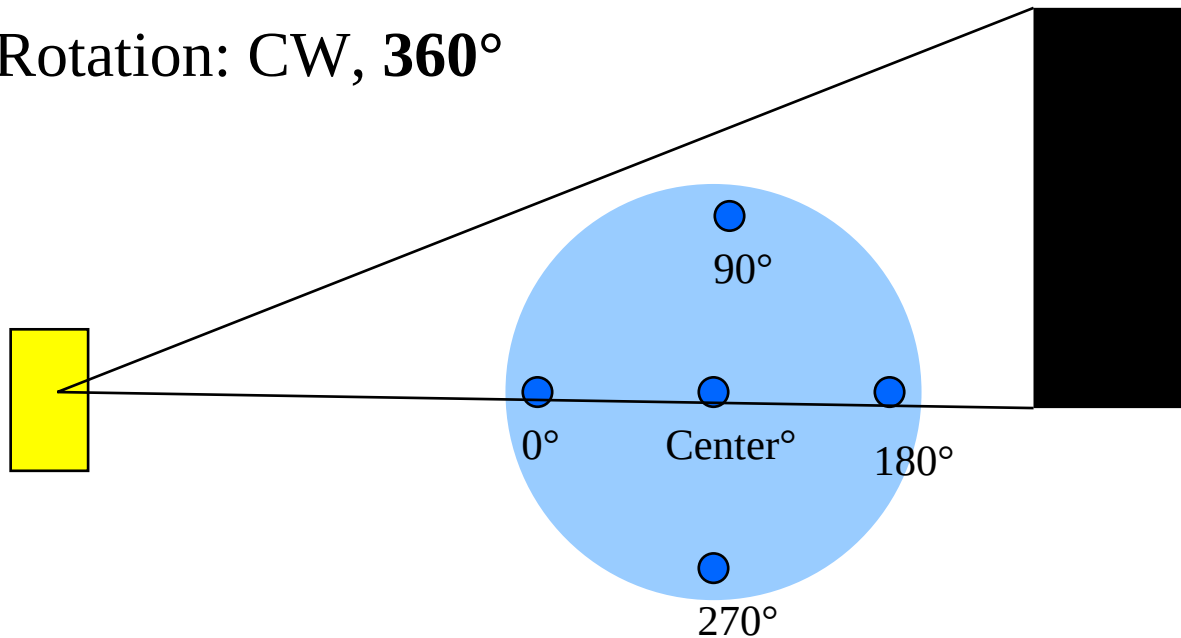
Computed Tomography Dose Index



Computed Tomography Dose Index

- CTDI vivaCT 40 (PMMA Phantom, 35 mm)

Rotation: CW, 360°



$CTDI_{(0^\circ, 90^\circ, 180^\circ, 270^\circ)}$ are equal

$$CTDI_w = 1/3 CTDI_{center} + 2/3 CTDI_{peripheral}$$

Computed Tomography Dose Index

CTDI vivaCT 40

E	Time Current Product HR / MR / SR	FOV	CTDI _w High Res	CTDI _w Med. Res	CTDI _w Stand. Res
70 kV	53 / 27 / 13 mAs	38.9 mm	260 mGy	130 mGy	65 mGy
55 kV	68 / 34 / 17 mAs	38.9 mm	220 mGy	110 mGy	55 mGy
45 kV	83 / 42 / 21 mAs	38.9 mm	190 mGy	95 mGy	48 mGy
70 kV	53 / 27 / 13 mAs	30.7 mm	420 mGy	210 mGy	105 mGy
55 kV	53 / 27 / 13 mAs	30.7 mm	350 mGy	175 mGy	88 mGy
45 kV	53 / 27 / 13 mAs	30.7 mm	305 mGy	153 mGy	77 mGy
70 kV	53 / 27 / 13 mAs	21.5 mm	850 mGy	425 mGy	213 mGy
55 kV	53 / 27 / 13 mAs	21.5 mm	720 mGy	360 mGy	180 mGy
45 kV	53 / 27 / 13 mAs	21.5 mm	620 mGy	310 mGy	155 mGy

- Above Table with Integration time of 300 ms (at 6 W)
- CTDI_w is proportional to mAs at a given FOV and E
- CTDI_{air}: Multiply CTDI_w with a factor of ~ 2

Optimization for Dose

- Use lowest possible resolution
- Use shortest integration time
 - mAs (= tube current x integration time x # projections)
- ✓ Check image quality! Is it still sufficient for your purpose?

Computed Tomography Dose Index

CTDI VivaCT 40

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Optimization for Dose

- Which Energy?
- Higher energy settings will lead to shorter integration time.



Optimization for Dose

- CTDI is the same if you have a one stack measurement or a multi-stack measurement. The CTDI is something like a local dose.

Effective Dose

- To compare the risk for the patient of different Systems/Technologies
 - ✓ Which kind of radiation
 - ✓ What is exposed
 - ✓ How big is the exposed volume

Effective Dose

ICRP, 1990
Tissue Weighting Factors

Gonads	0.2
Bone Marrow	0.12
Colon	0.12
Lung	0.12
Stomach	0.12
Bladder	0.05
Brest	0.05
Liver	0.05
Esophagus	0.05
Thyroid	0.05
Skin	0.01
Bone Surface	0.01
Others	0.05
Total	1.00

Effective Dose

- Half of the lung gets a local dose of 1mGy

Effective Dose:= $0.5 * 1\text{mGy} * 0.12\text{TWF} = 0.06\text{mSv}$

Optimization for Dose

- Irradiate only the volume of interest.



Summary

- Use lowest possible resolution setting
- Irradiate not more than you need to
- Use shortest integration time (mAs)
- “Choose high KV setting”

Keep an eye on image quality

