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**Dosimetry for CT 3: Practical Experiences**

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# Dosimetry for CT (3)
# Practical Experiences

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# Practical issues

- Dosemeter calibration & correction coefficients

- Setting scanner up

- Collecting data – interpreting parameters

- Scan projection radiography

- Worked examples for patient dosimetry

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# CT chamber calibration factors

- CoP assumes CT chambers calibrated in terms of dose length product (mGy cm / digit) eg at SSDL

- Many are calibrated in terms of mGy /digit

- If this is the case, the chamber length (10cm) needs to be included – extra factor of 10 in equations, or in cal coeff

# Beam quality correction coefficient

- Factor $k_Q$ may not be available

- Should know the beam quality at calibration

- If calibration quality inappropriate for CT, user determination of $k_Q$ may be necessary

- Ensure correct uncertainty scenario used

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# Setting scanner up for measurements

- Single axial slices required
  - may need to be in 'engineer' mode – password usually required
  - look for axial / sequential protocol and change number of slices

- May need to adapt chamber support for in air measurements

- Overscan needs to be switched off (if possible)

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# Effect of overscan

- Distribution of air kerma in peripheral slots may not be uniform
  - voltage ramping
  - overscan

- If position of maximum air kerma constant, position phantom with 1 peripheral slot in this position

- If variable, either fix start angle or take multiple measurements

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# Correction for helical overscan

- Correction factor can be measured using the CT ionization chamber as described by IPEM
- Obtained by scanning slightly more than the entire length of the chamber in axial and then helical mode
  - same collimated beam width is used for both scans
  - axial scans should be contiguous and the helical scan should have a pitch of 1
  - measurement is made with the chamber positioned along the scanner axis and free-in-air

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# Collecting patient data

- For multi-slice (multi-detector) CT, care should be taken to correctly interpret parameters

- $N$, the number of simultaneously acquired slices per rotation (also referred to as the number of data channels used during the acquisition)

- $T$ the nominal thickness of each acquired slice (which is not necessarily the same as the nominal width of the reconstructed slice).

- Product $NT$ should reflect the total nominal width of the X ray beam.

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# Nominal slice width in multi-slice scanning

- Multiple narrow 'beams' eg

| | |
|---|---|
| 4 x 1mm | 4 mm |
| 4 x 2mm | 8 mm |
| 4 x 5mm | 20 mm |
| 4 x 10mm | 40 mm |

- Nominal slice width is total beam width for 1 rotation

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# Tube current modulation

- Many scanners now use tube current modulation techniques to reduce patient dose so that the tube current may vary continuously as the scanner rotates or may change for each successive rotation.

- When calculating the air kerma length product, $P_{KL,CT}$, it is important to use the actual values of the tube loading for the complete helical scan or for each axial scan as appropriate.

- Alternatively, for helical scans, the product of the average tube current and total scan time can be used.

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# Effective mAs ($P_{IT}$)

- Care should be taken when recording values of tube current as some scanners give values of an 'effective tube current' which varies with pitch rather than the actual tube current.

- $P_{ITeff} = P_{ITrot} / pitch$

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# Calculation of $P_{KL,CT}$

$$P_{KL,CT} = C_{VOL} \text{ x scan length}$$

$$= nl \; C_{VOL}$$

$$= nl \; {}_nC_w \; P_{ITeff}$$

$$= nl \; {}_nC_w \; P_{IT} \; NT/l$$

$$= NT \; {}_nC_w \; nP_{IT}$$

$$= NT \; {}_nC_w \; P_{ITtot}$$

$$= l \; {}_nC_{VOL} \; P_{ITtot}$$

$l$ is the distance moved by the couch per scanner rotation

$n$ number of rotations

$P_{ITeff}$ effective mAs/slice

$P_{IT}$ mAs/rotation

$P_{ITtot}$ total mAs/scan
   (= mA x total scan time)

NT nominal slice width

**NB Units mGy cm**

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# Extra Note (just to complicate things..)

Siemens Sensation 64 uses dual focus technology for all 0.6mm detector settings

This produces 2 sets of overlapping data using same detector bank

Thus, 64 x 0.6mm corresponds to a nominal slice width of 32 x 0.6mm (extra slices are from second focal spot not additional detectors)

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# Dosimetry for Scan Projection Radiograph

- Typically 3% total dose

- Use the CT ionisation chamber to measure the incident air kerma for the SPR

- Done in absence of patient or phantom using the CT ionisation chamber supported at the appropriate height above the couch top and aligned parallel to the axis of rotation of the scanner

- Scanner settings should be those for the SPR and the scan length should exceed the length of the ionization chamber (100 mm)

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# Example 1 : Single slice scanner

Abdomen CT

10mm slice width, 15mm increment

200 mAs / rotation, 25 slices

$_nC_W$  0.008 mGy/mAs

$$C_{VOL} = {_n}C_{VOL}\, P_{IT} \qquad\qquad {_n}C_{VOL} = {_n}C_W \frac{NT}{l}$$

$$C_{vol} = 0.008 \times 200 \times \frac{1 \times 10}{15} = 1.07 \text{ mGy}$$

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# Example 1 : Single slice scanner

Abdomen CT

10mm slice width, 15mm increment

200 mAs / rotation, 25 slices

$_nC_w$  0.008 mGy/mAs   $C_{vol}$ = 1.07 mGy

$$P_{KL,CT} = nl\ C_{VOL}$$

$P_{KL,CT}$ = 1.07 x 25 x1.5 = 40 mGycm

$$P_{KL,CT} = NT\ _nC_w\ P_{ITtot}$$

$P_{KL,CT}$ = 1.0 x 0.008 x 200 x 25 = 40 mGycm

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# Example 2 : Siemens Multislice Scanner

Abdomen CT

4x5mm slices, Pitch 1.2

220 effective mAs , total mAs 9240

$_nC_w$  0.008 mGy/mAs

$$C_{VOL} = {_nC_w}\, P_{ITeff}$$

$C_{vol}$ = 0.008 x 220 = 1.76 mGy

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# Example 2 :Siemens Multislice Scanner

Abdomen CT

4x5mm slices,  Pitch 1.2

220 effective mAs , total mAs 4240

$_nC_w$  0.008 mGy/mAs   $C_{vol}$ = 1.76 mGy

$$P_{KL,CT} = NT\ _nC_w\ P_{ITtot}$$

$P_{KL,CT}$ = $\dfrac{4 \times 5}{10}$ x 0.008 x 4240= 68 mGycm

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# Example 3 :Philips Multislice Scanner

Abdomen CT

4x5mm slices, Pitch 1.2

220 effective mAs , Scan length 400mm

$_nC_w$  0.008 mGy/mAs


$$C_{VOL} = {_nC_w} \, P_{ITeff}$$


$C_{vol}$ = 0.008 x 220 = 1.76 mGy

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# Example 3 :Philips Multislice Scanner

Abdomen CT

4x5mm slices,  Pitch 1.2

220 effective mAs , Scan length 400mm

$_nC_w$  0.008 mGy/mAs   $C_{vol}$ = 1.76 mGy

$$P_{KL,CT} = C_{VOL} \text{ x scan length}$$

$P_{KL,CT}$ = $\dfrac{400}{10}$ x 1.76= 70 mGycm

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# Final tips

- Know your scanner…!

- Collect scanner displayed values of DLP, but check/calibrate them

- Adjust data collection forms for scanner type (so radiographers understand clearly which parameters to record)

- Total mAs / DLP likely to be most accurate for helical multi-slice scanners (includes extra slices & hopefully mA modulation)

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