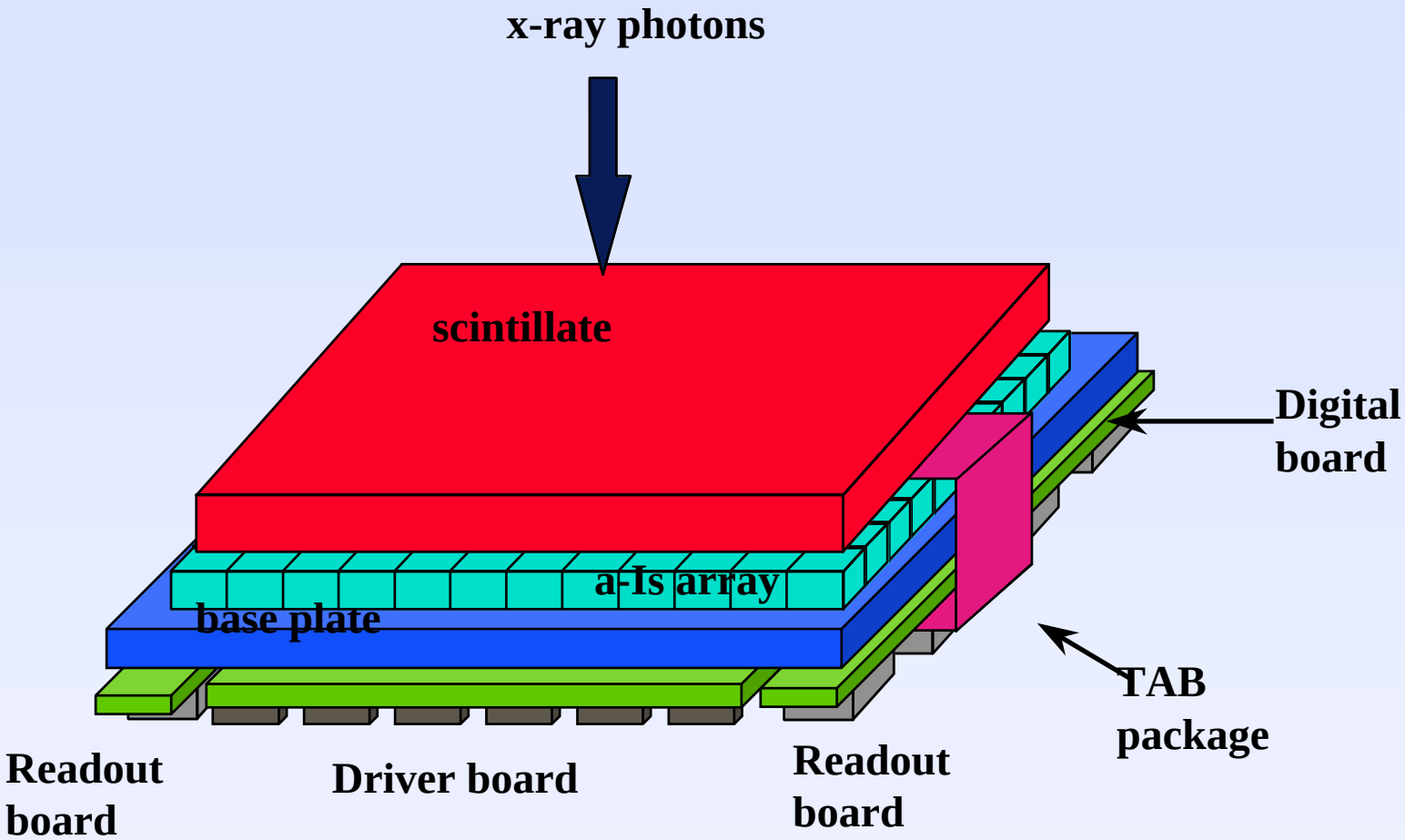
# Acuity Simulator

Acuity –CBCT dose.

# Receptor Internal Architecture

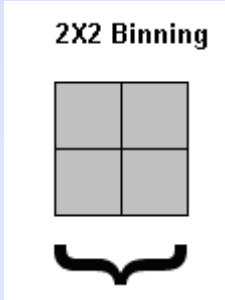


# Varian Flat Panel Imager

- Features
  - Field of View 39.1 cm X 29.2 cm
  - Pixel Pitch 194 um
  - Number of Pixels 2048 X 1536
  - Fill Factor 70%
  - Readout Landscape (Split datalines)
  - Digitization 14 bit
  - Scintillator CsI
  - Continuous Fluoroscopy or Single Image
  - Used in General R&F, Simulation, Angiography and Cone Beam CT

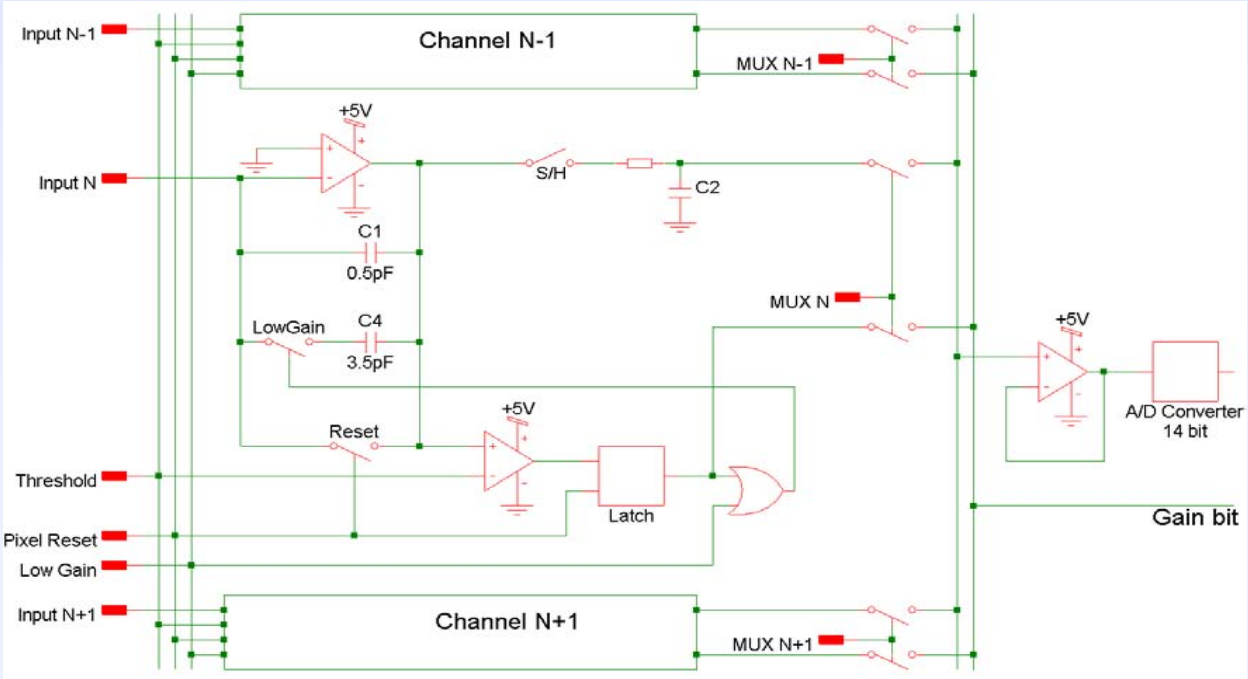
# Imaging Modes

- Full Field Fluoroscopy
  - 1024 X 768 (2X2 binned)
  - 1.3 lp/mm resolution
  - 15 fps
- Full Resolution (Single Image)
  - 2048 X 1536
  - 2.6 lp/mm resolution
- Cone Beam CT
  - 1024 X 1536
  - 15 fps

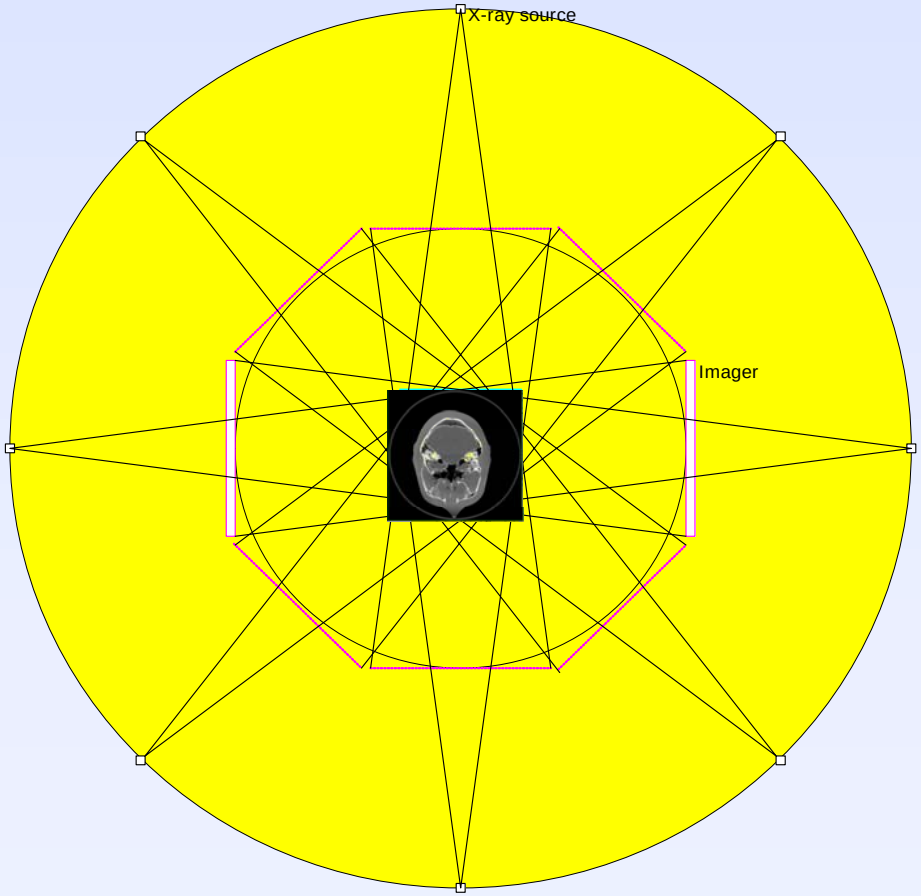


# Dual Gain Readout

- Signal accumulated by each pixel is readout twice first at high gain and then again at low gain for the same X-ray exposure pulse



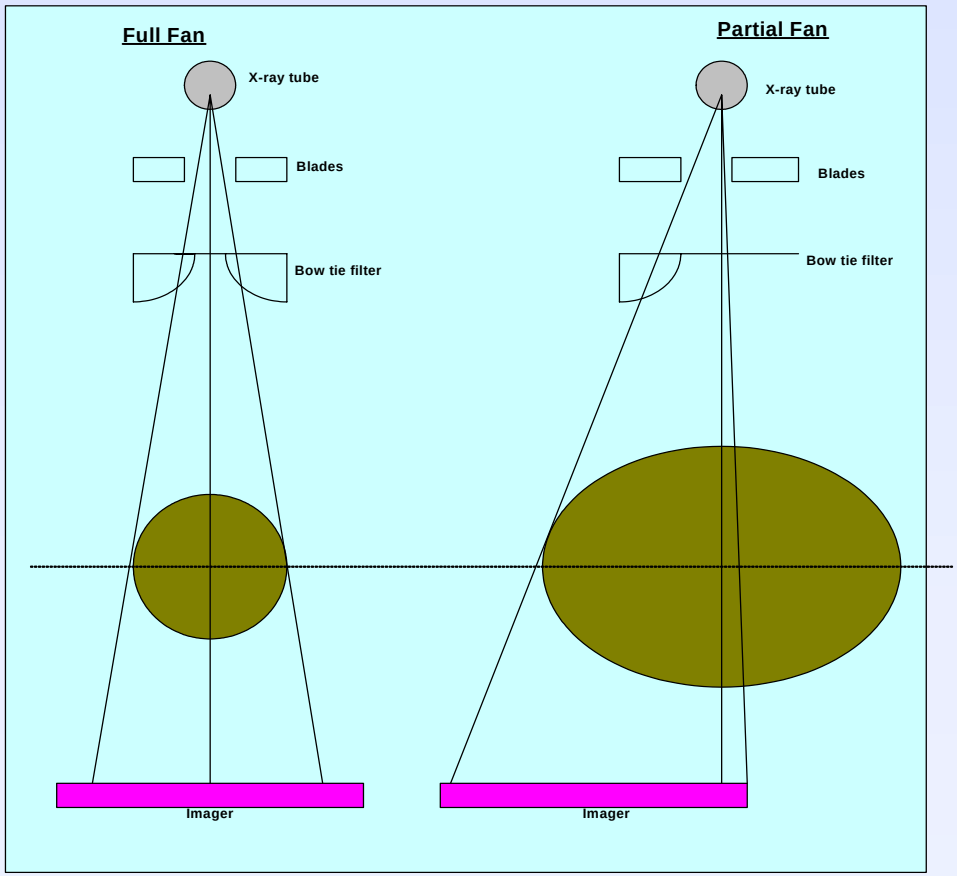
# CBCT – Data Acquisition




- Rotation 370 degrees
- Speed 8 deg/sec
- Projections 675
- Acquisition time – 45 sec

# CBCT – Modes

## Full-fan and partial fan set up

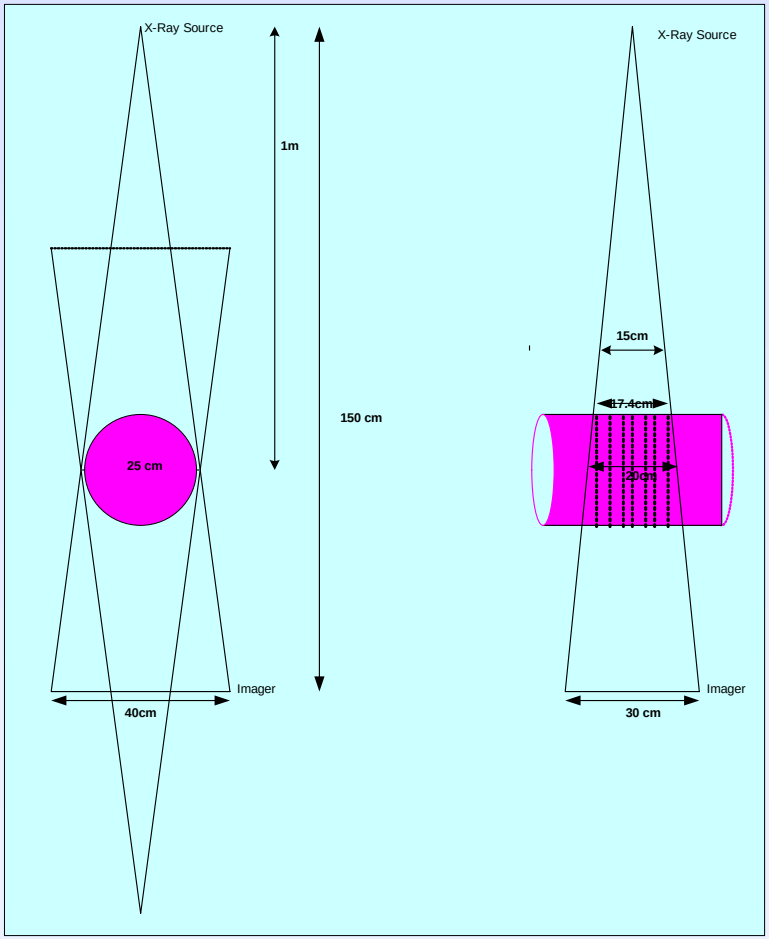


| Results (23.04.04) | | | | | | |
|---|---|---|---|---|---|---|
| Full field mode no bow tie filter but with 0.5mm Cu. Suggested factors for head mode | | | | | | |
| kV | | | | | 125 | |
| mA | | | | | 80 | |
| pulse width ms | | | | | 7 | |
| pulses/sec | | | | | 15 | |
| time 1 rotation s | | | | | 45 | |
| | | | | | | |
| mAs /rotation | | | | | 378 | |

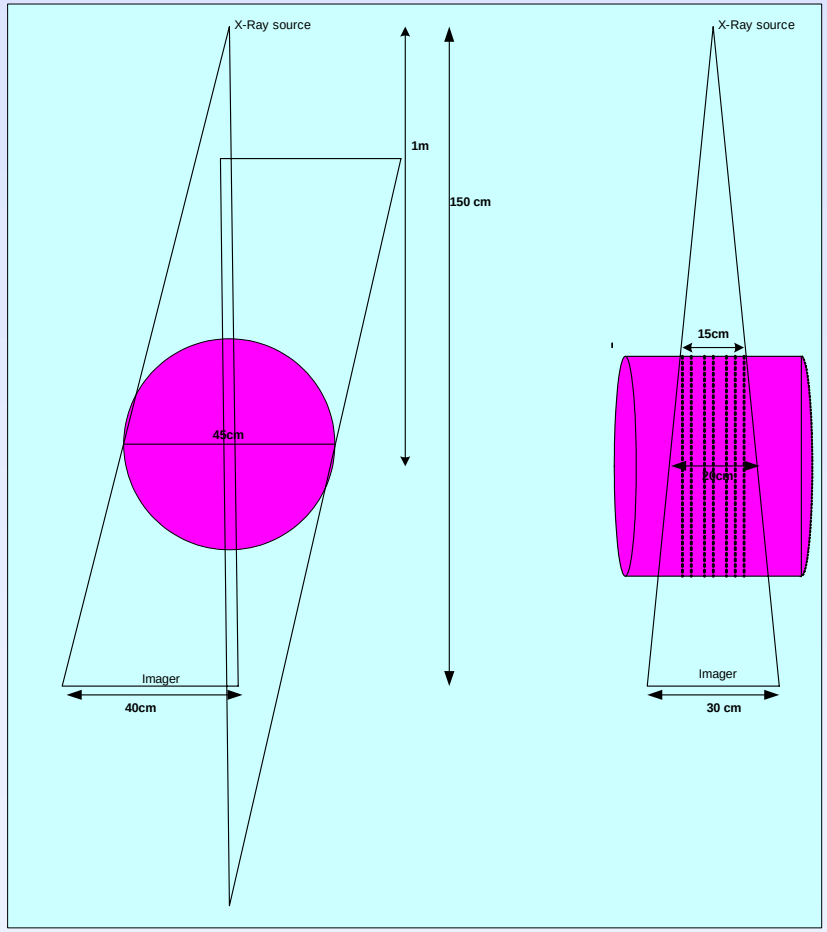
| dose profile width | imaged slice width | dose in air | image width norm CTDI | irradiated width norm CTDI | |
|---|---|---|---|---|---|
| cm | cm | mGy | mGy/mAs cm $^{-1}$ | mGy/mAs cm $^{-1}$ | |
| 1.04 | NA | 1.19 | | 0.0303 | |
| 4 | 0.2 | 4.63 | 0.612 | 0.0306 | |
| 4.8 | 1 | 5.54 | 0.147 | 0.0305 | |
| 5.2 | 1.5 | 6.04 | 0.107 | 0.0307 | |
| 6.8 | 3 | 7.78 | 0.069 | 0.0303 | |
| 10 | NA | 11.61 | | 0.0307 | |
| | | | | 0.0305 | avg |
| | | | | 0.0002 | std |

# CBCT – Typical Geometry

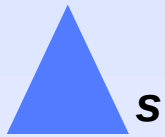
- Full Fan




Partial Fan

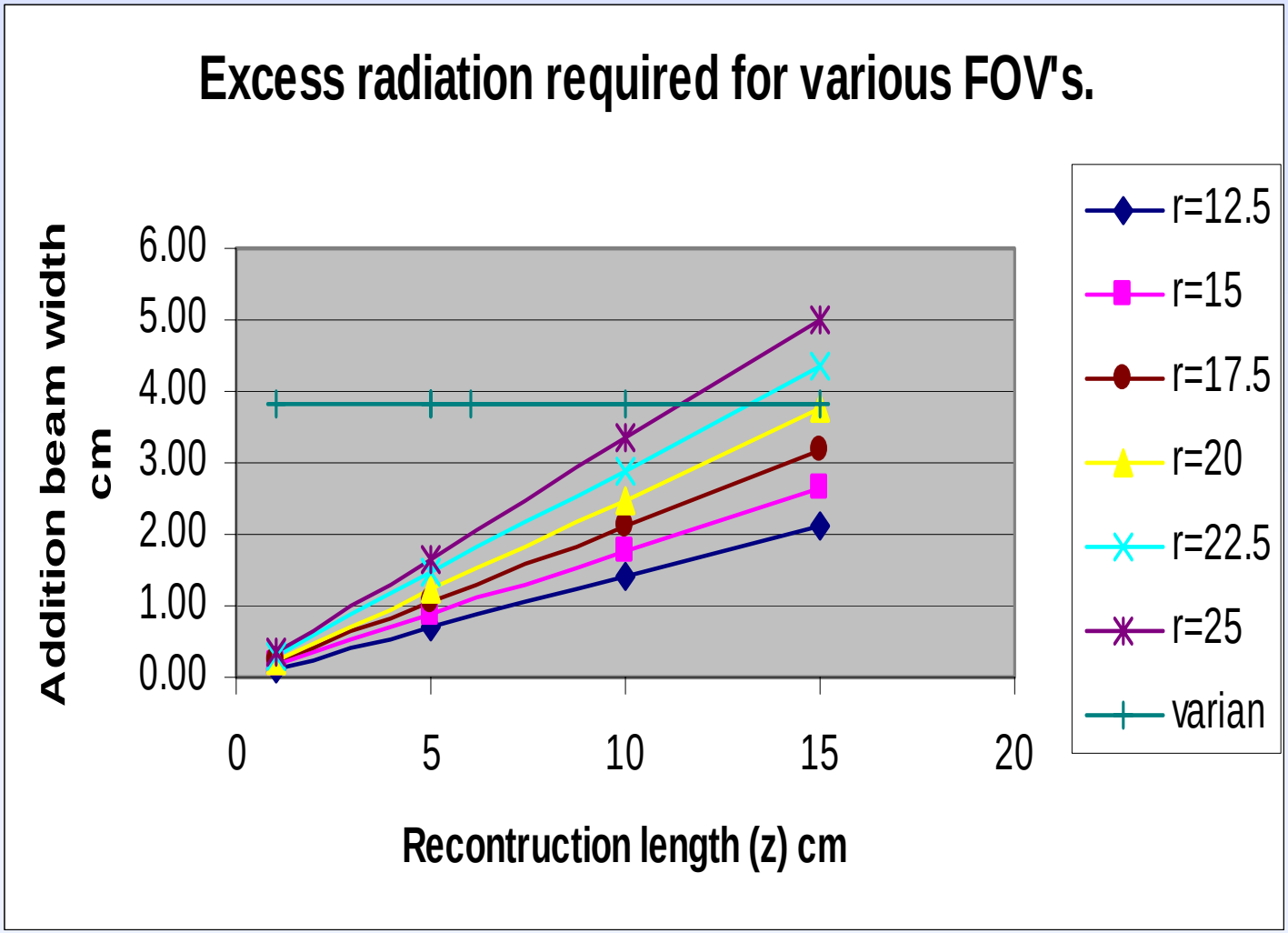


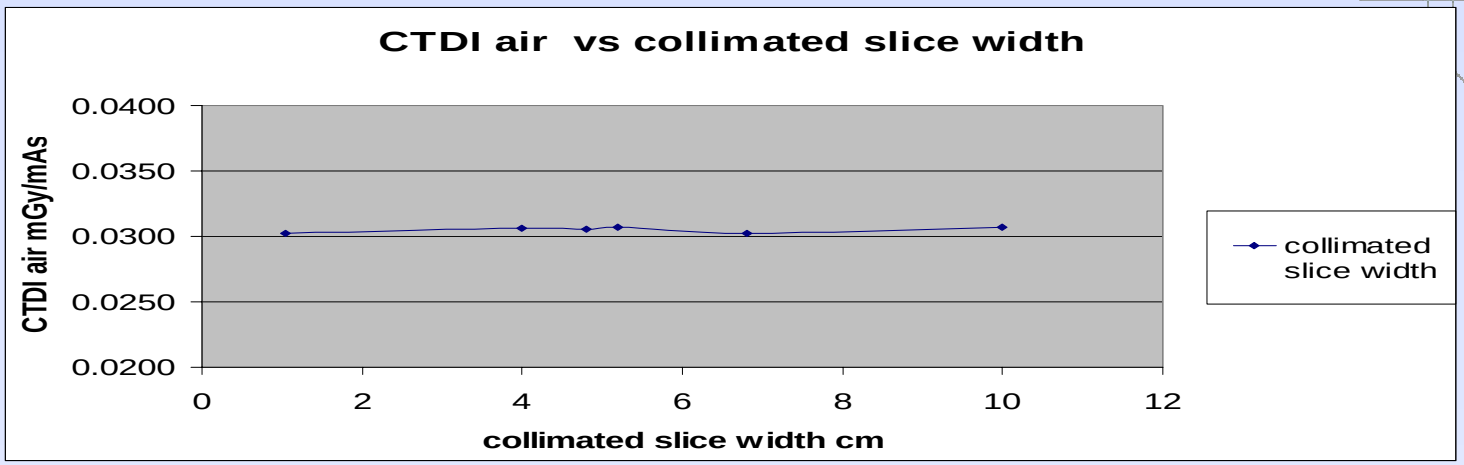
***The additional radiation required (2 x l) depends on***
***•Image reconstruction length***
***•Radius of FOV***

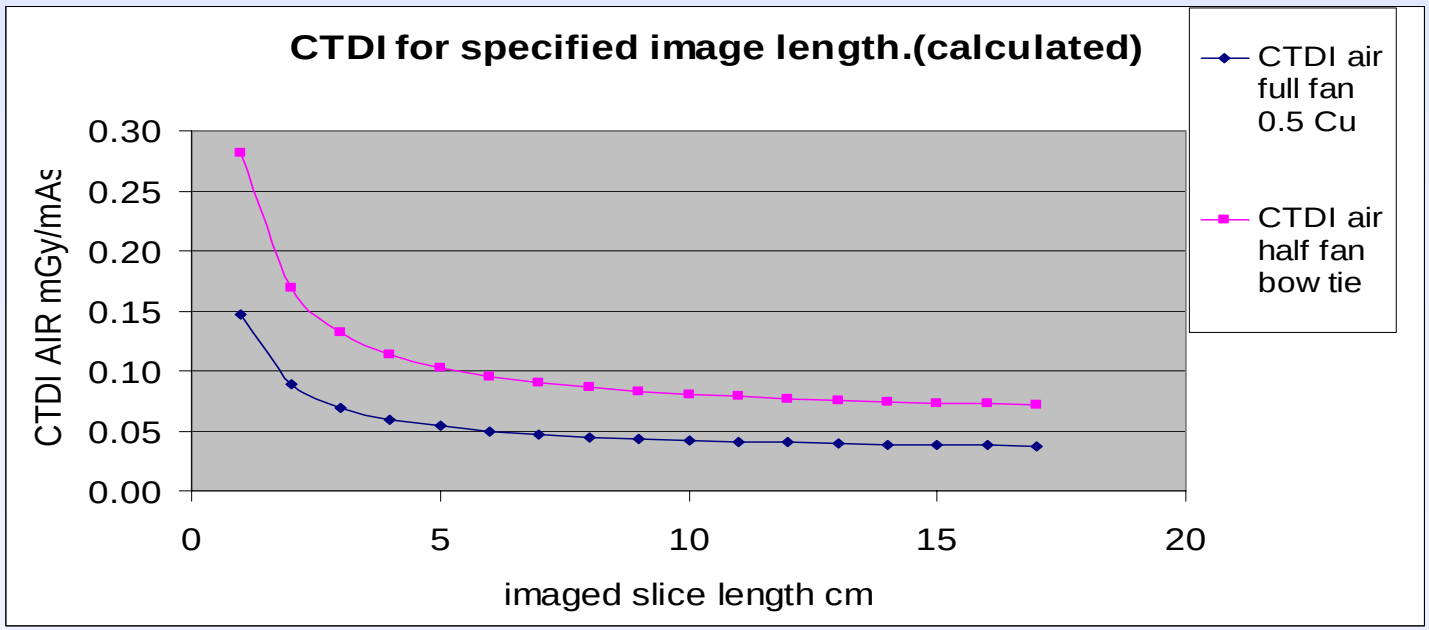
***From similar***  ***s*** ***2 x l = L ( 100 (100-r) –1)***

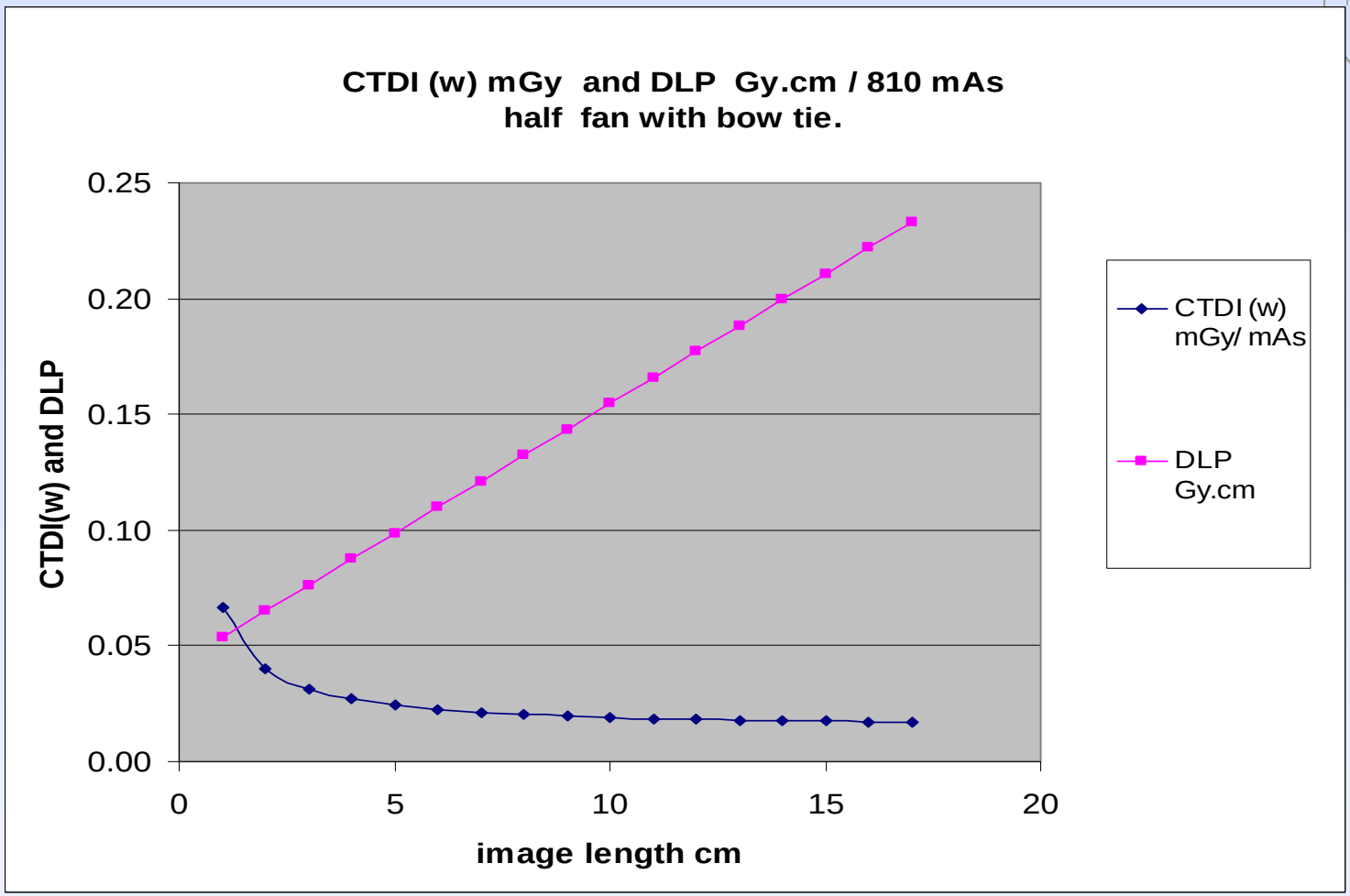
| values of 2 x *l* = additional radiation required (cm ) | | | | | | |
|---|---|---|---|---|---|---|
| Lcm / r cm | 12.5 | 15 | 17.5 | 20 | 22.5 | 25 |
| 1 | 0.14 | 0.18 | 0.21 | 0.25 | 0.29 | 0.33 |
| 5 | 0.71 | 0.88 | 1.06 | 1.25 | 1.45 | 1.67 |
| 10 | 1.43 | 1.76 | 2.12 | 2.50 | 2.90 | 3.33 |
| 15 | 2.14 | 2.65 | 3.18 | 3.75 | 4.35 | 5.00 |

| r | Lmax |
|---|---|
| 12.5 | 17.5 |
| 15 | 17 |
| 20 | 16 |
| 22.5 | 15.5 |
| 25 | 15 |


Excess radiation required for various FOV's.
Addition beam width cm
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
5
10
15
20
Recontruction length (z) cm
r=12.5
r=15
r=17.5
r=20
r=22.5
r=25
varian


CTDI air vs collimated slice width
CTDI air mGy/mAs
0.0400
0.0350
0.0300
0.0250
0.0200
0
2
4
6
8
10
12
collimated slice width cm
collimated slice width


CTDI for specified image length.(calculated)
CTDI AIR mGy/mAs
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
5
10
15
20
imaged slice length cm
CTDI air full fan 0.5 Cu
CTDI air half fan bow tie



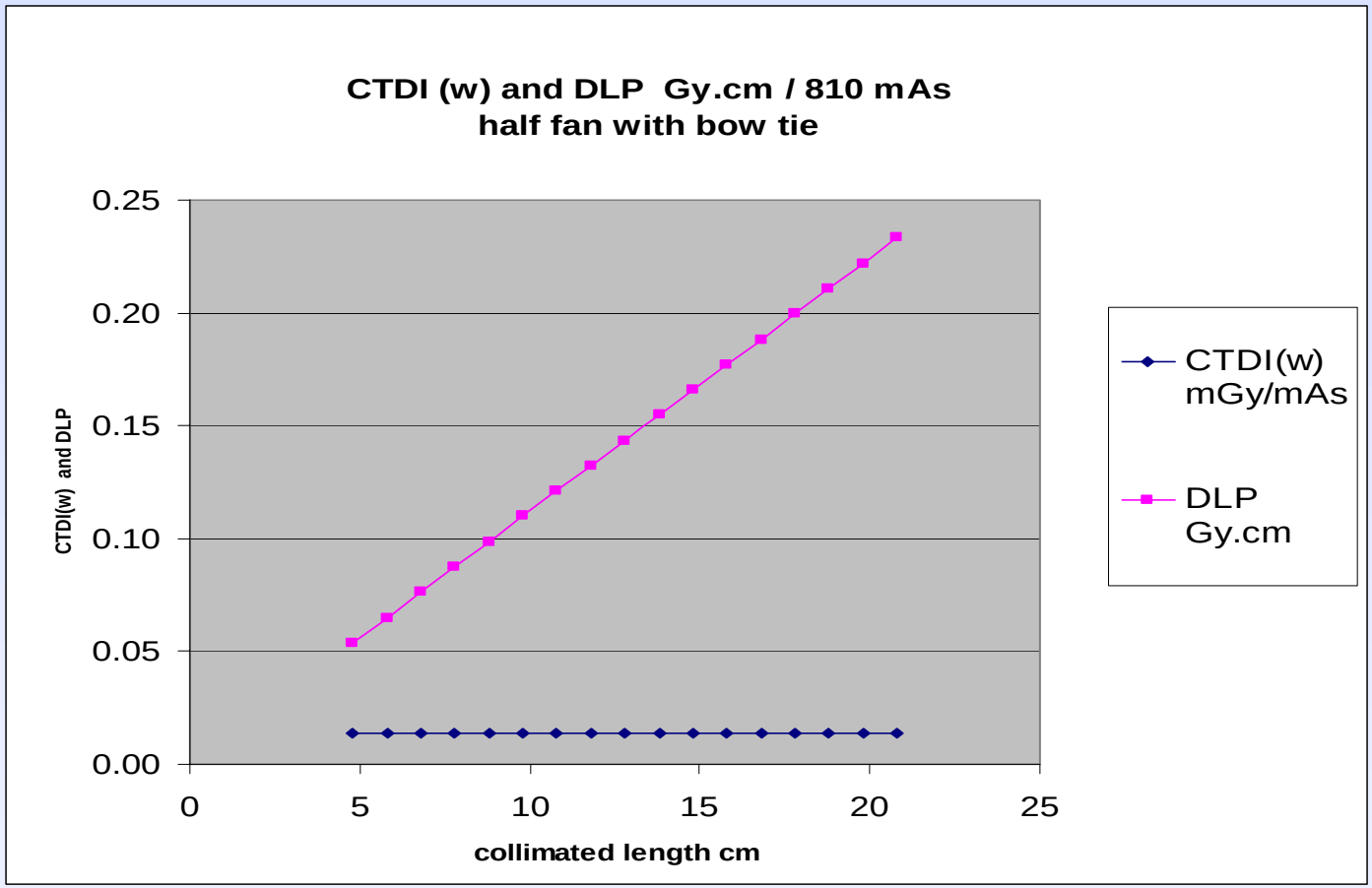

***DLP= CTDI (w) * T *A *t***

***T= nominal imaged slice width***

***CTDI (w)= CTDI for given imaged length.***

***A= mA = 80***

***t-= "on time" =15/1000 * 15 * 45 = 10.125s***




***T= collimator width slice width***

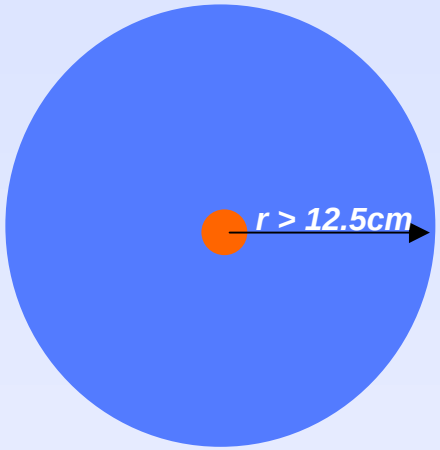
***CTDI (w)= CTDI for given collimator length.***

***DLP= CTDI (w) * T *A *t***

***A= mA = 80***

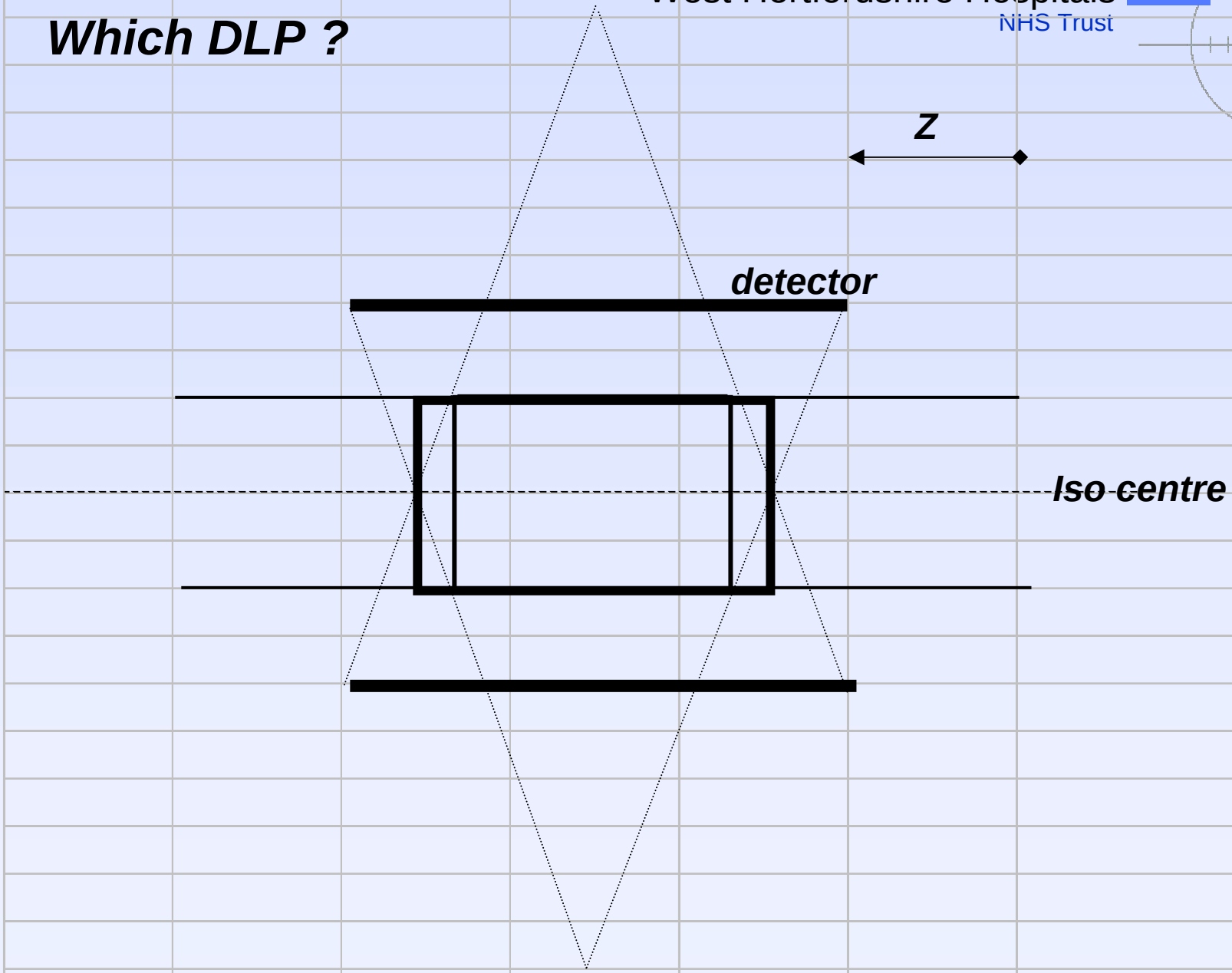
***t-=time =15/1000 *15*45=10.125s***

## *CTDI (w) and half fan geometry*




***CTDI = 1/3 CDTI ( c ) + 2/3 CDTI ( p )***

# *Which DLP ?*



**For comparison purposes.**

| exam | CTDI(w) mGy | DRL CTDI(w) mGy | DRL DLP mGycm | E mSv | Varian * CTDI(w) mGy | Varian * DLP mGy cm. | Varian * E mSv | conversion factor mSv/ mGycm |
|---|---|---|---|---|---|---|---|---|
| post fossa | 50 | 60 | 1050 | | | | | |
| helical head | 43 | | | 2 | | | | |
| std brain | 50 | | | 2 | | | | |
| high res head | 43 | | | | | | | |
| inner ear | 80 | | | | | | | |
| mean head | 50 | | | | 22 | 381 | 0.9 | 0.0023 |
| ref | 1 | 2 | 3 | 4 | | | | 5 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ref 1 | IPEM report 32 part 111 APX 111 | | | | Varian* Full fan 0.5 Cu 810 mAs. 1 rotation collimtor length =(13.8 +3.8) cm | | | |
| ref 2 | ICRP 87 | | | | | | | |
| ref 3 | ICRP 87 | | | | | | | |
| ref 4 | making the best use of the department of radiology | | | | | | | |
| ref 5 | European Guidelines on Quality Criteria for CT EUR 16262 en | | | | | | | |

**For comparison purposes.**

| exam | | DRL's | DRL | E | Varian * | Varian * | Varian * | conversion |
|---|---|---|---|---|---|---|---|---|
| | CTDI(w) | CTDI(w) | DLP | | CTDI(w) | DLP | E | factor |
| | mGy | mGy | mGycm | mSv. | mGy | mGy cm. | mSv | mSv/ mGycm |
| Abdomen | 20 | 35 | 780 | 10 | 11 | 395 | 5.9 | 0.015 |
| Helical body | 15 | | | | | | | |
| low noise spine | 41 | | | | | | | |
| high res spine | 34 | | | | | | | |
| pelvis | | | | 10 | 11 | 395 | 7.5 | 0.019 |
| chest | | | | 8 | 11 | 395 | 6.7 | 0.017 |
| mean body | 20 | | | | 11 | 395 | | |
| ref | 1 | 2 | 3 | 4 | | | | 5 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ref 1 | IPEM report 32 part 111 APX 111 | | | | Varian* Half fan 810 mAs. 2 rotations, collimated length = 2*(13.8 +3.8) cm | | | | |
| ref 2 | ICRP 87 | | | | | | | | |
| ref 3 | ICRP 87 | | | | | | | | |
| ref 4 | making the best use of the department of radiology | | | | | | | | |
| ref 5 | European Guidelines on Quality Criteria for CT EUR 16262 en | | | | | | | | |