Smart Scanning: Practical Insights for High-Quality Veterinary CT Studies

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ANZCVS- Vet Science Week 2025

Is this CT study of good quality?

Is this CT study of good quality?

Image quality is always task dependent

Tasks

Spatial resolution

Contrast resolution

Temporal resolution

Tools

Inherent/Hardware

-Focal spot size

-Detector element size

Scanning parameters

-Reconstruction algorithm

-Field of view

-Matrix

-Slice thickness

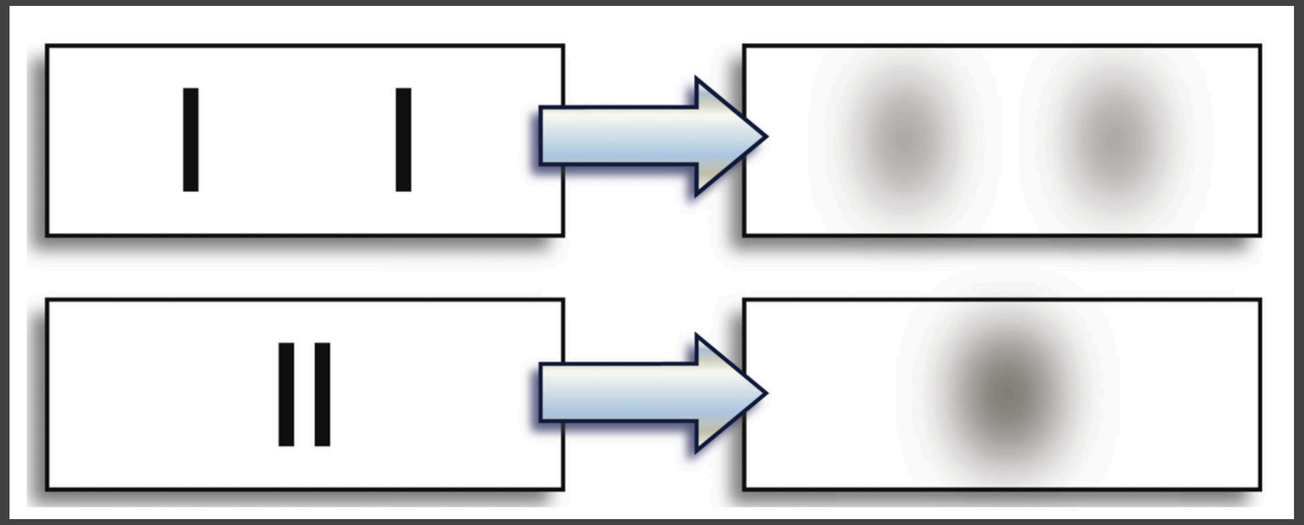
-Milliampere (mA)

-Scan time

-kilovolt-peak (kVp)

Spatial resolution

Resolution - ability to display two adjacent objects as discrete entities



Sensakovic, William. Review of Radiologic Physics (p. 40). (Function). Kindle Edition.

Factors affecting in-plane resolution

Fundamental resolution - limited control

- Focal spot size
- Detector size
- Magnification factor
- Gantry motion compensation
- Patient motion

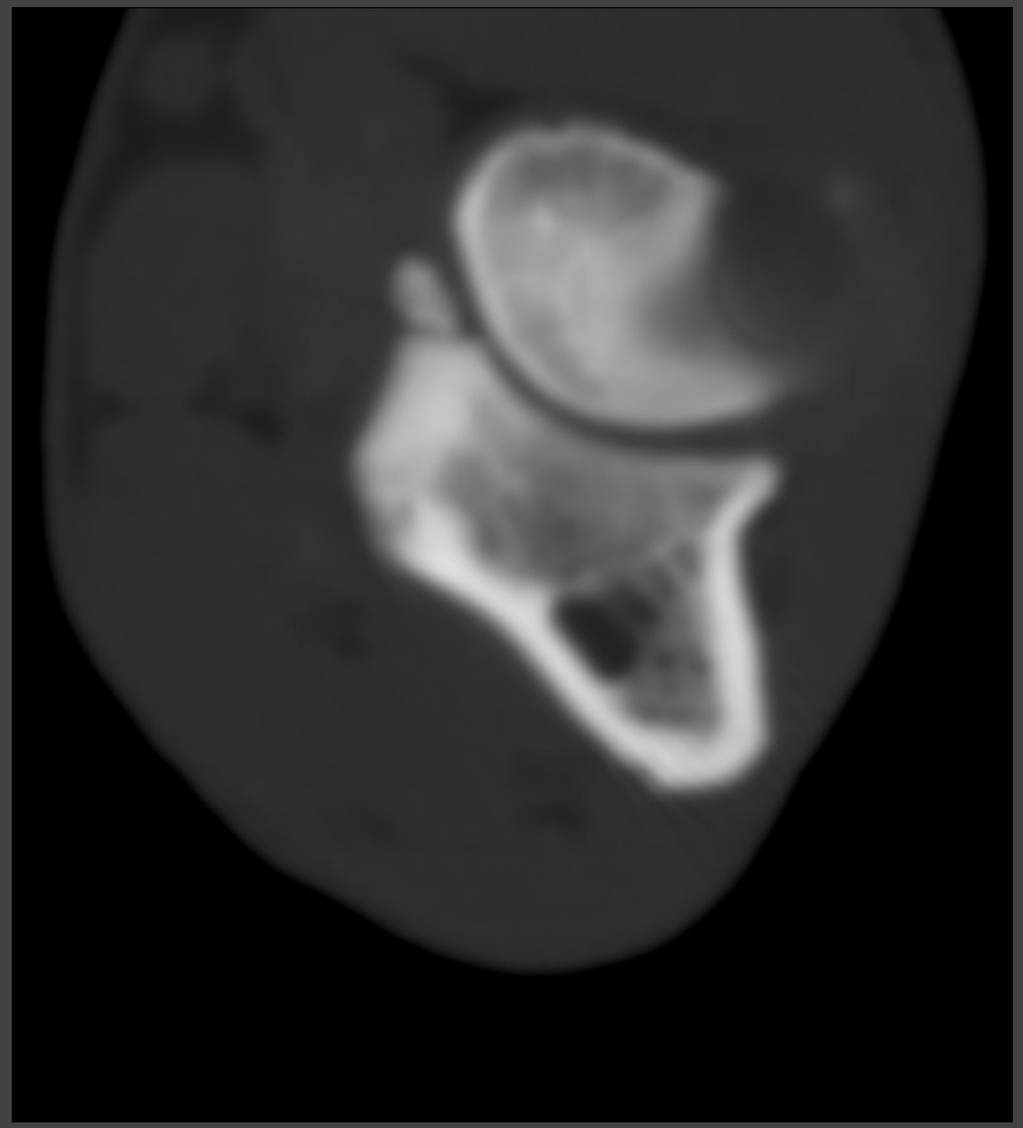
Reconstruction - can be adjusted

- Kernel or reconstruction algorithm
- FOV
- Matrix
- Slice thickness

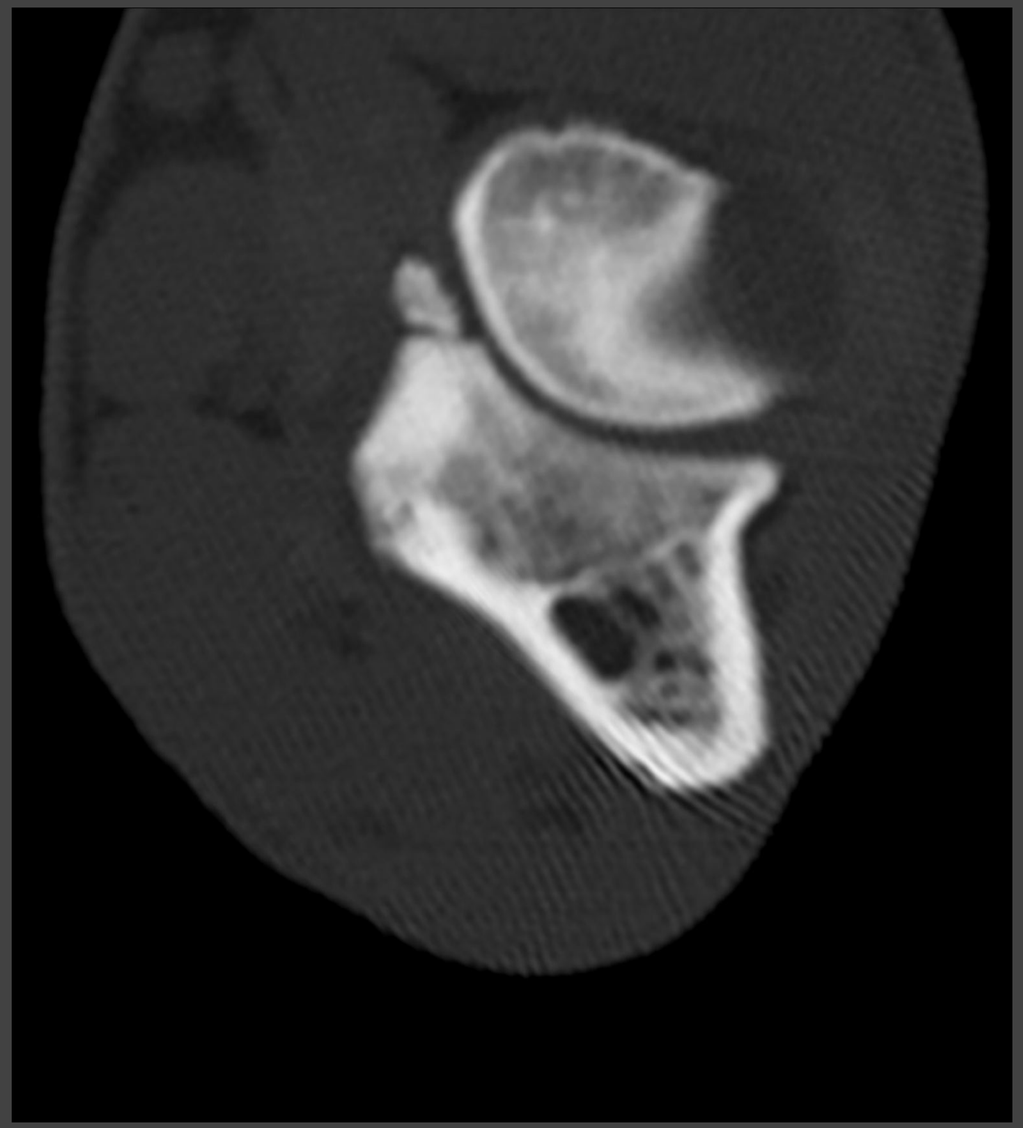
Spatial resolution

Kernel or reconstruction algorithm

Soft reconstruction



Bone reconstruction



Bone kernel - sharper image

(higher spatial resolution)

Spatial resolution

FOV

Raw data

All data acquired

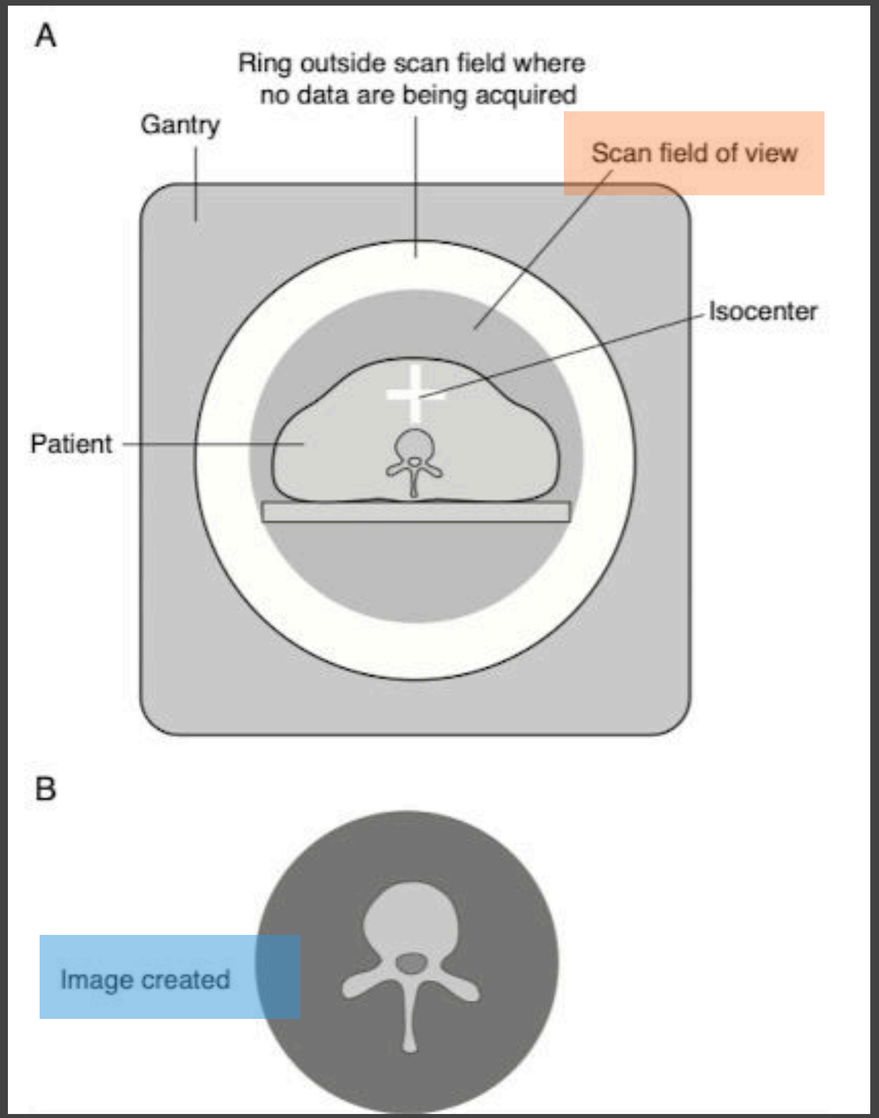
image reconstruction - raw data - create an image

Scan field of view (SFOV)

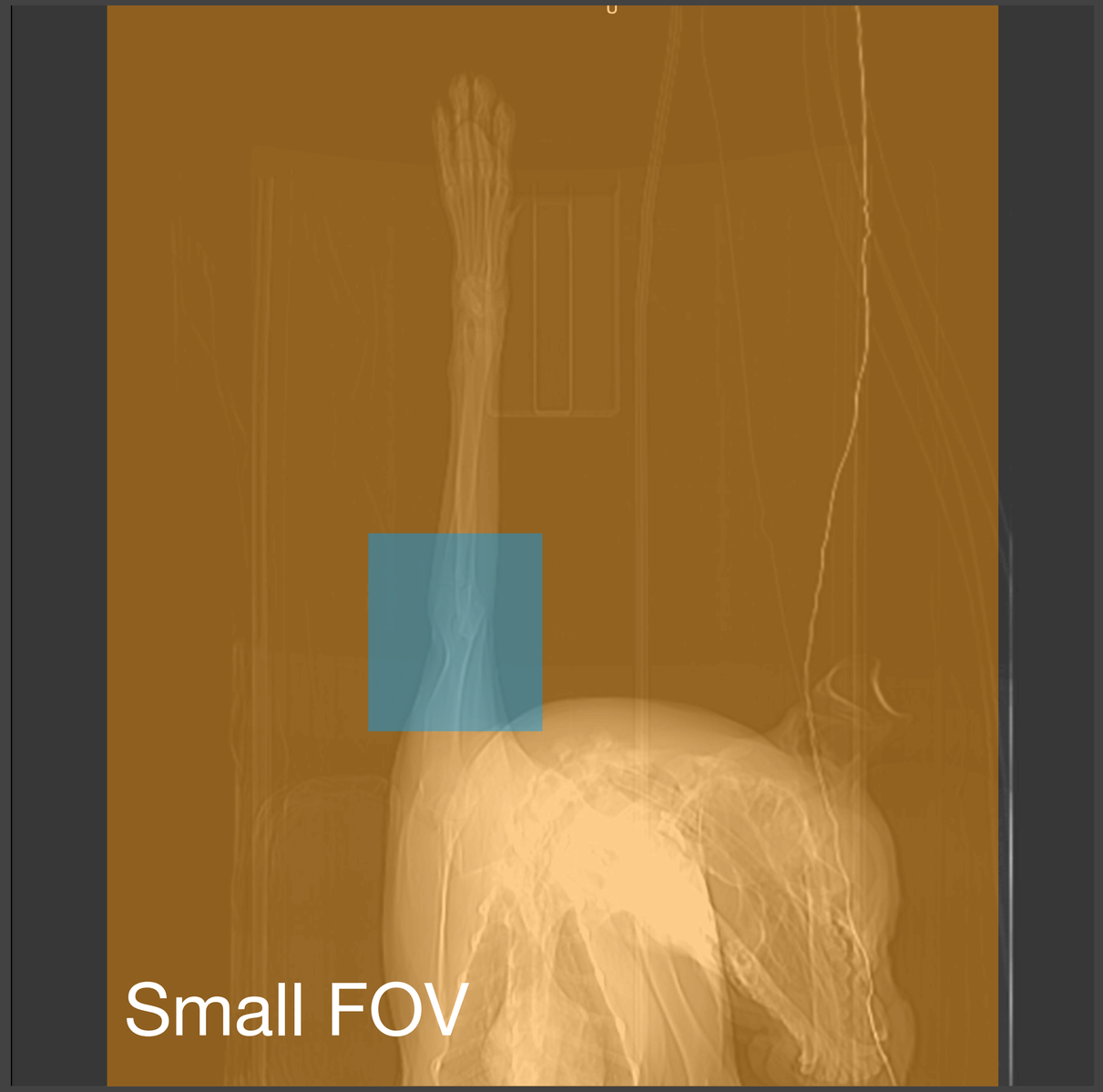
Area -raw data acquired

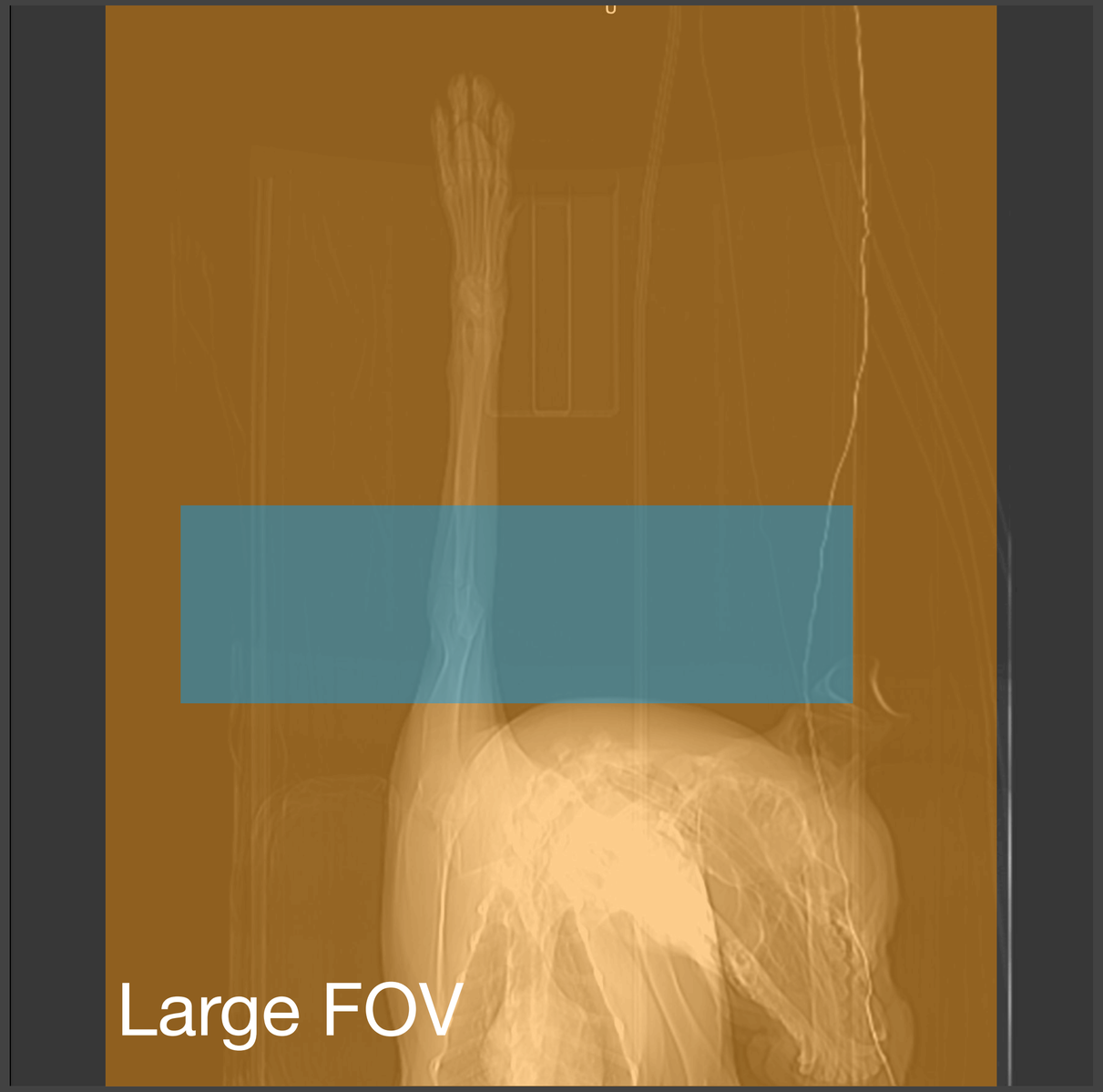
Display field of view (DFOV)

Section- raw data - used to create an image



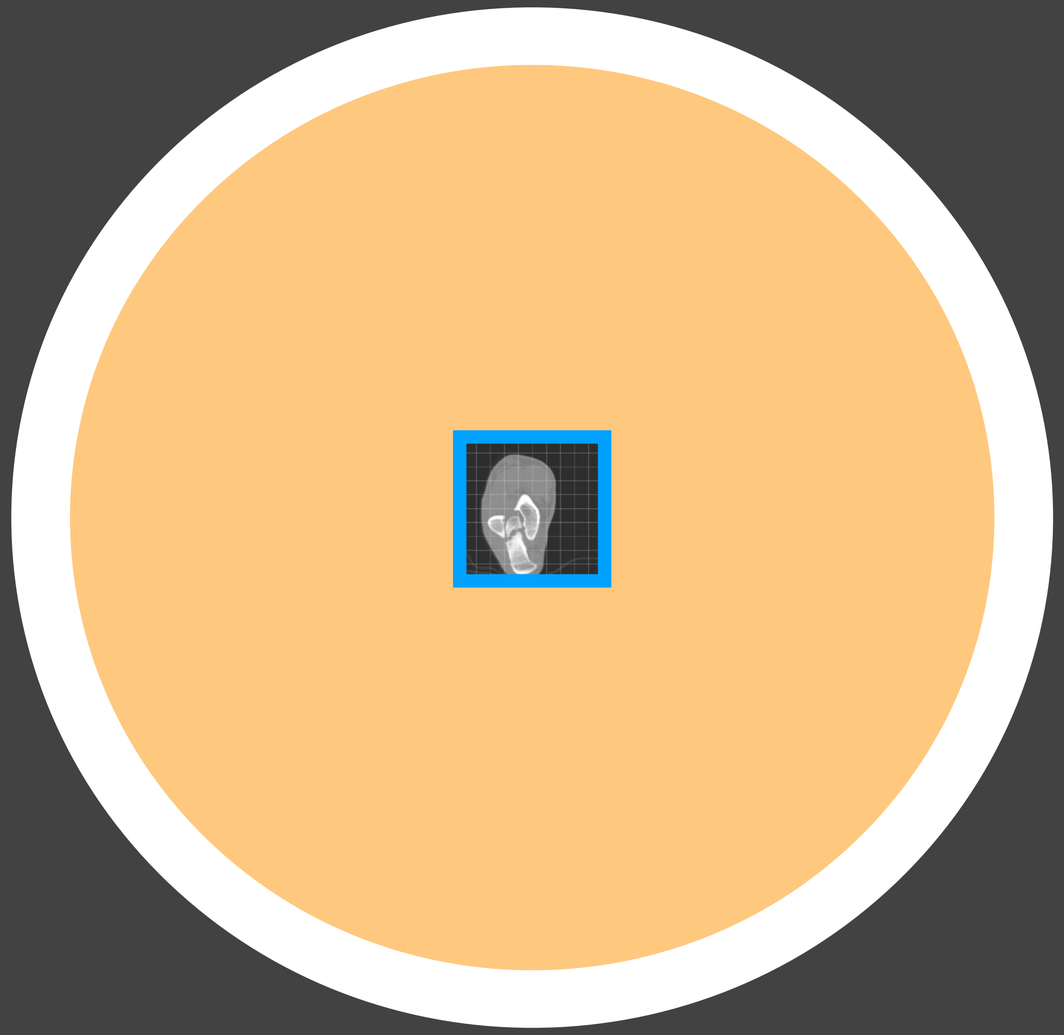
Scan field of view (SFOV)
Display field of view (DFOV)



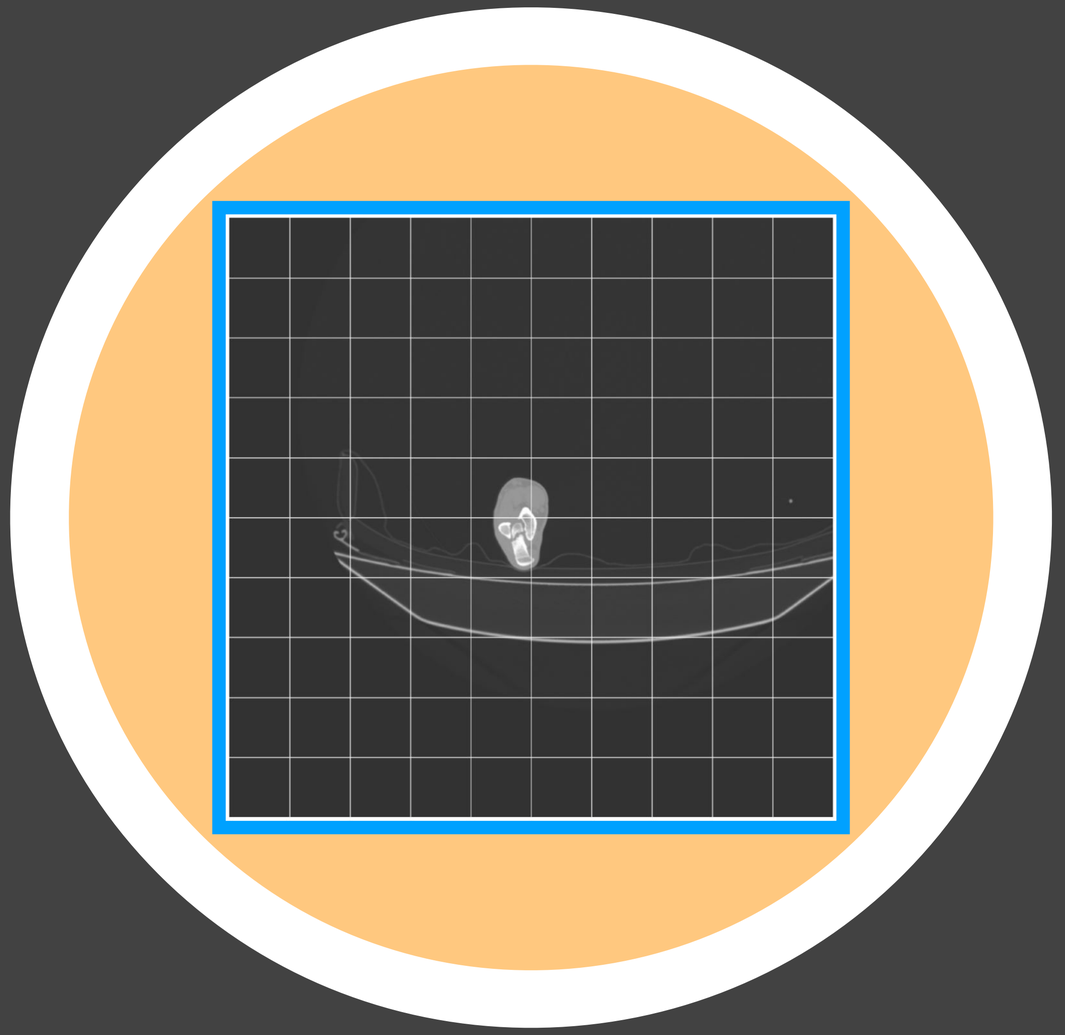


Scan field of view (SFOV)

Display field of view (DFOV)



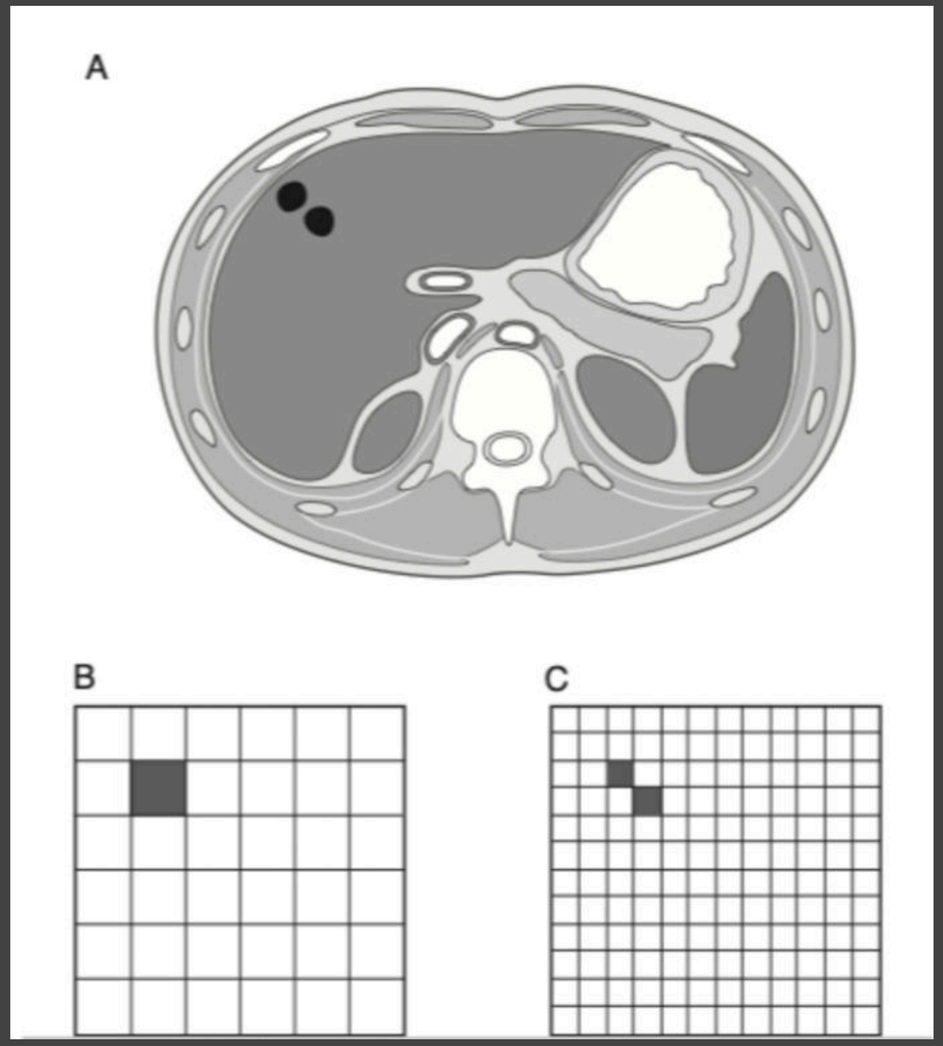
Small FOV



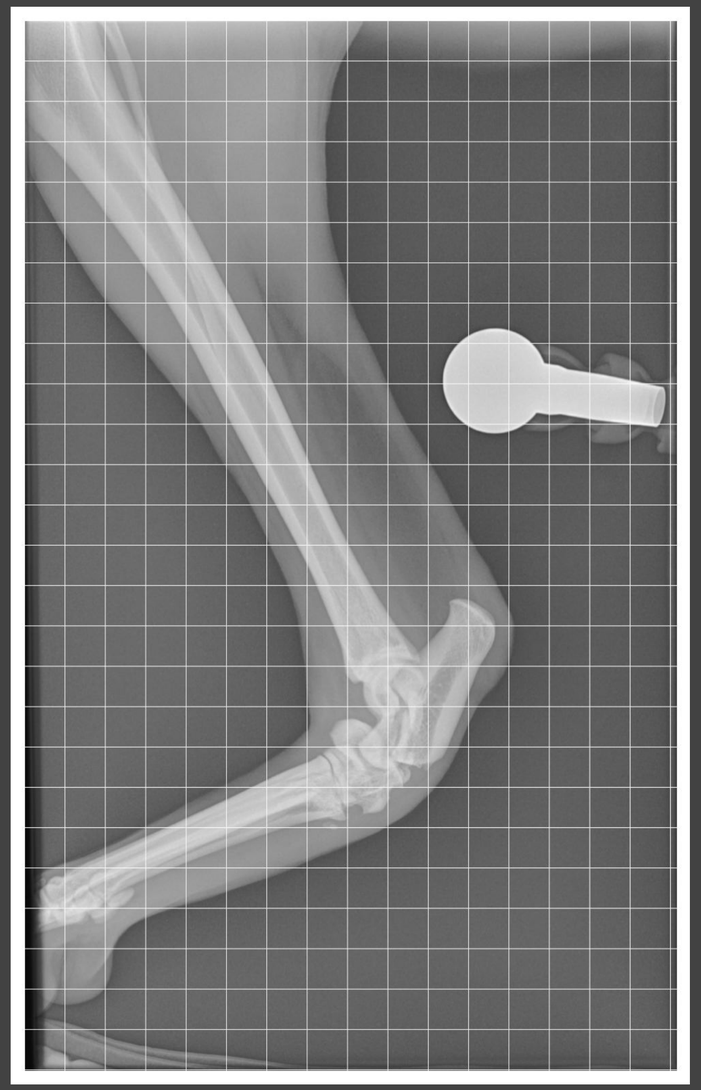
Large FOV

Each pixel - one Hounsfield unit (HU)

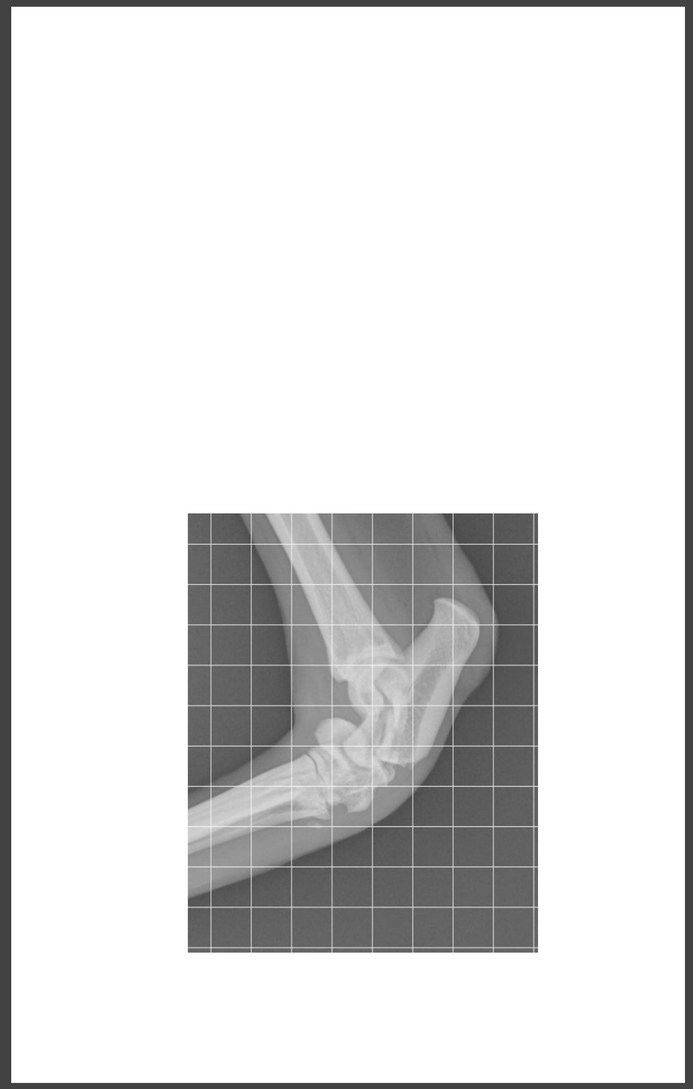
Object smaller than pixel - average - less accurate image.



Romans, Lois. Computed Tomography for Technologists: A Comprehensive Text (p. 60). (Function). Kindle Edition.

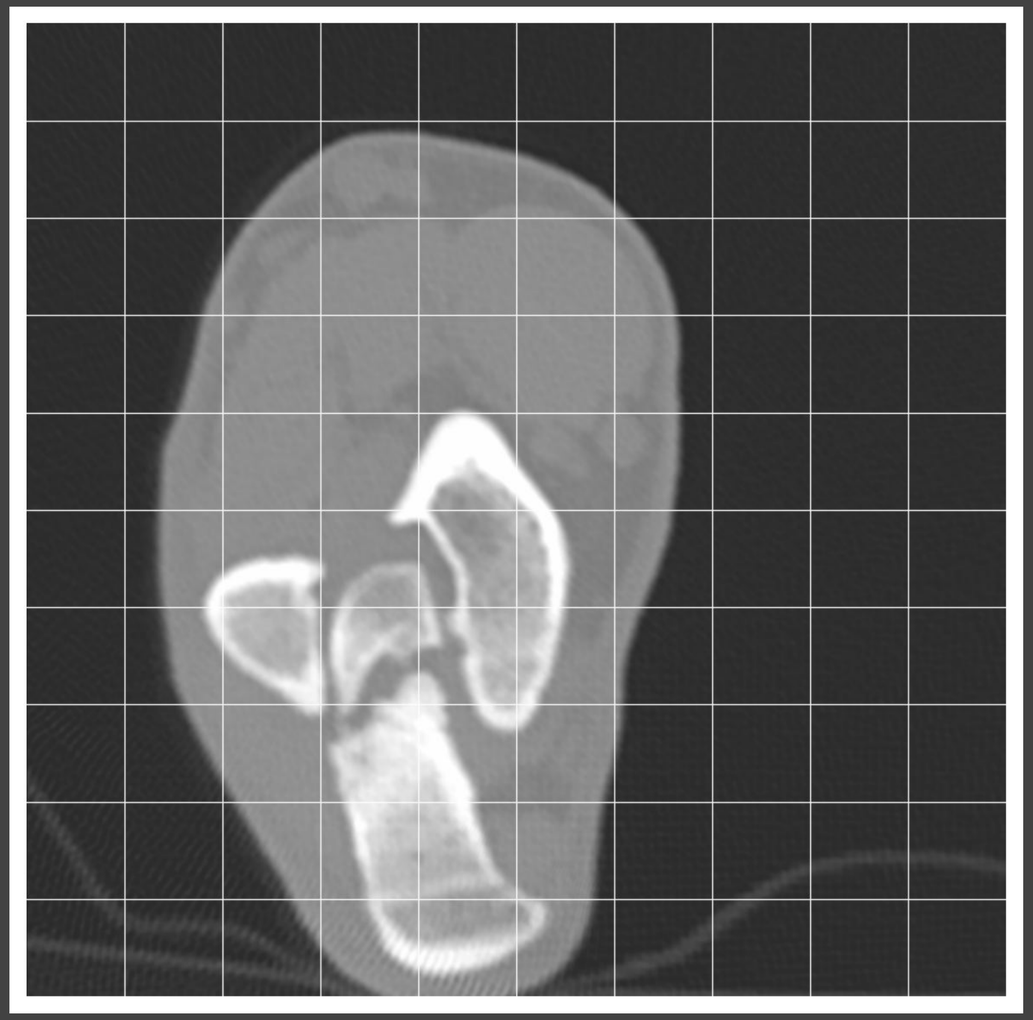


No collimation

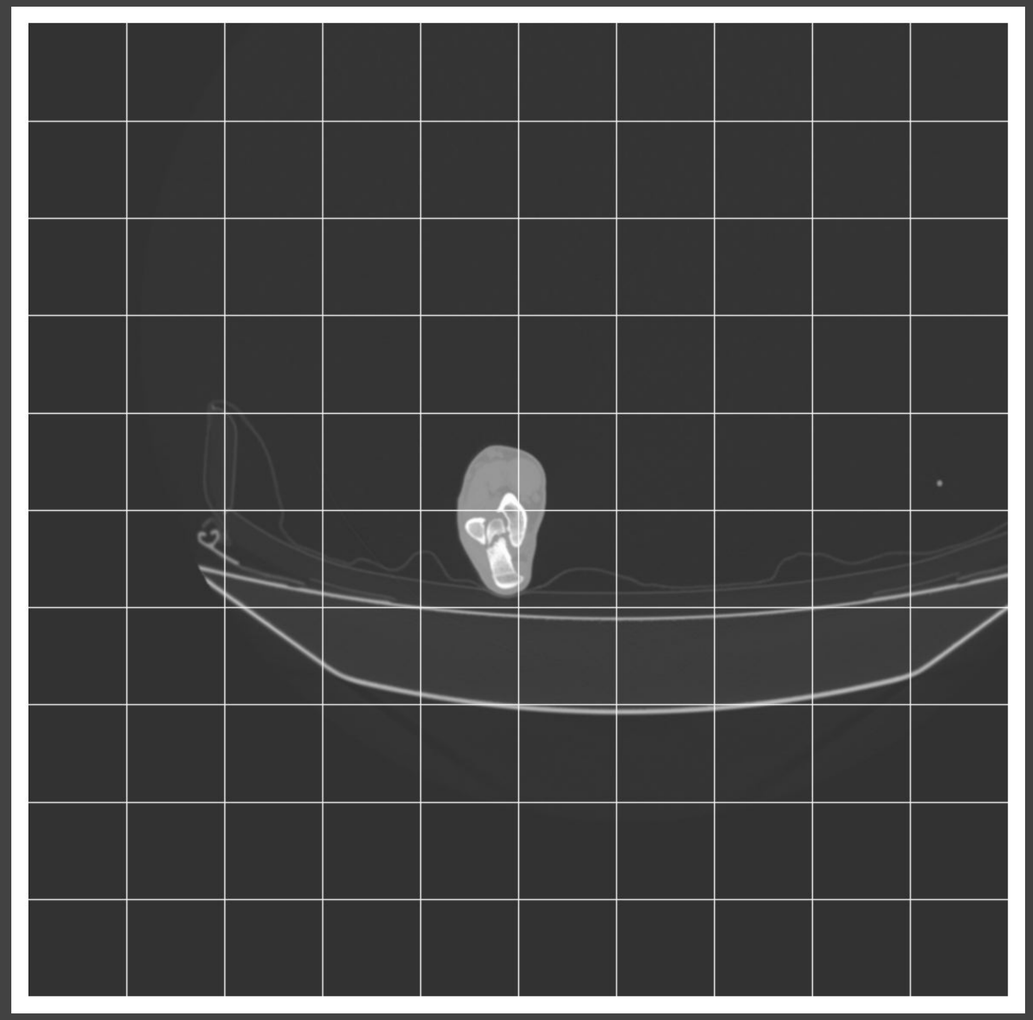


Collimation

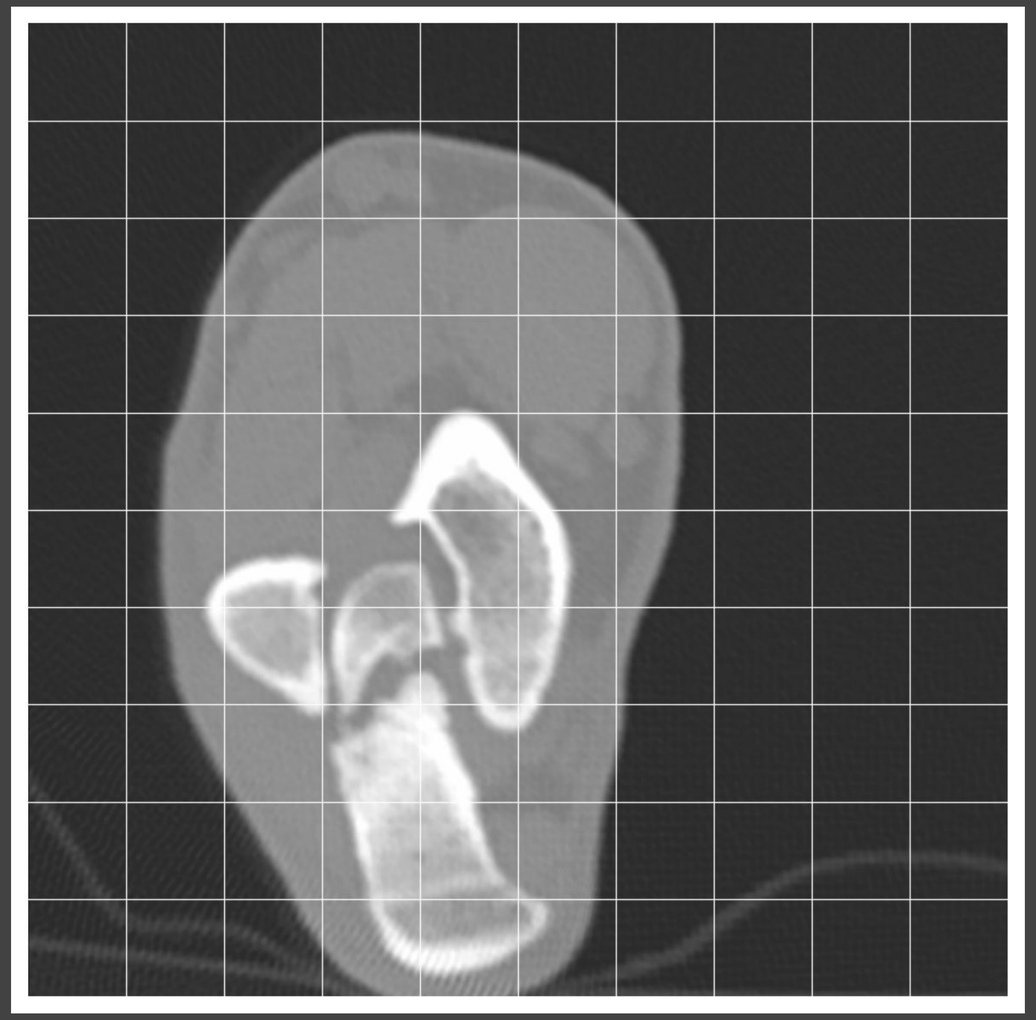
Pixel size = DFOV/matrix



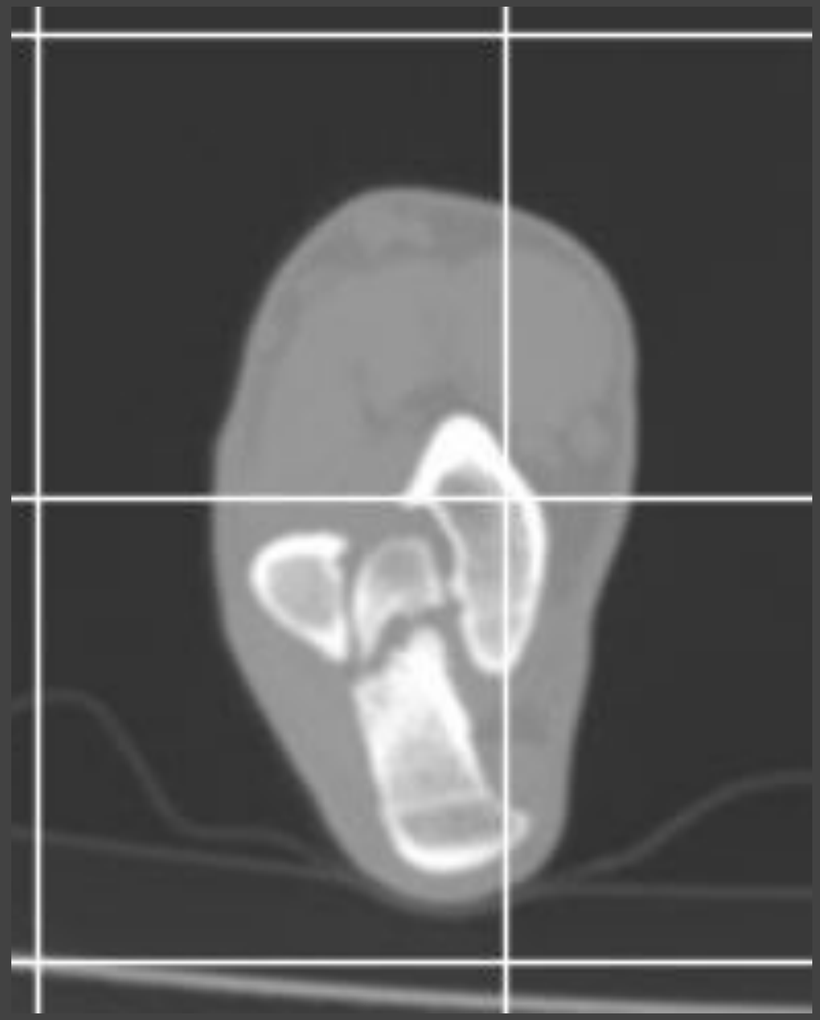
Small FOV



Large FOV

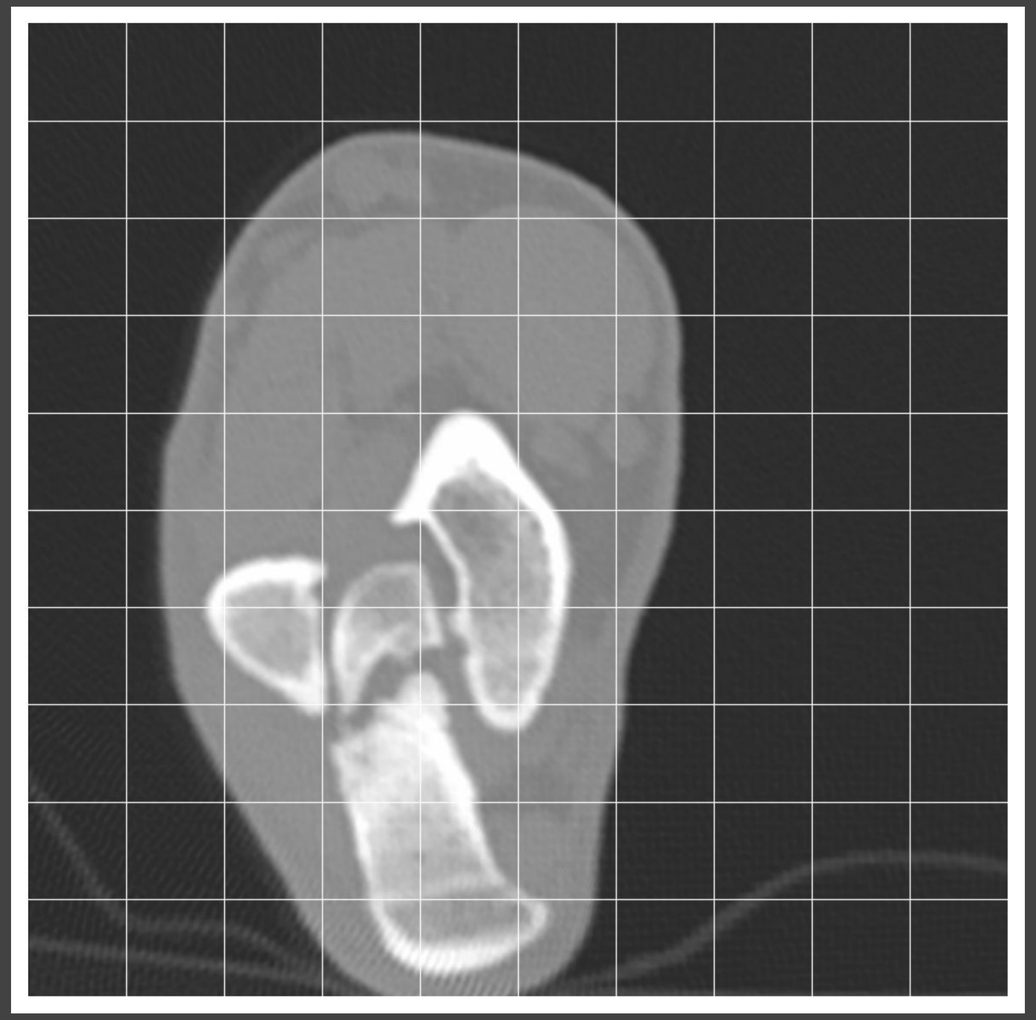


Small FOV

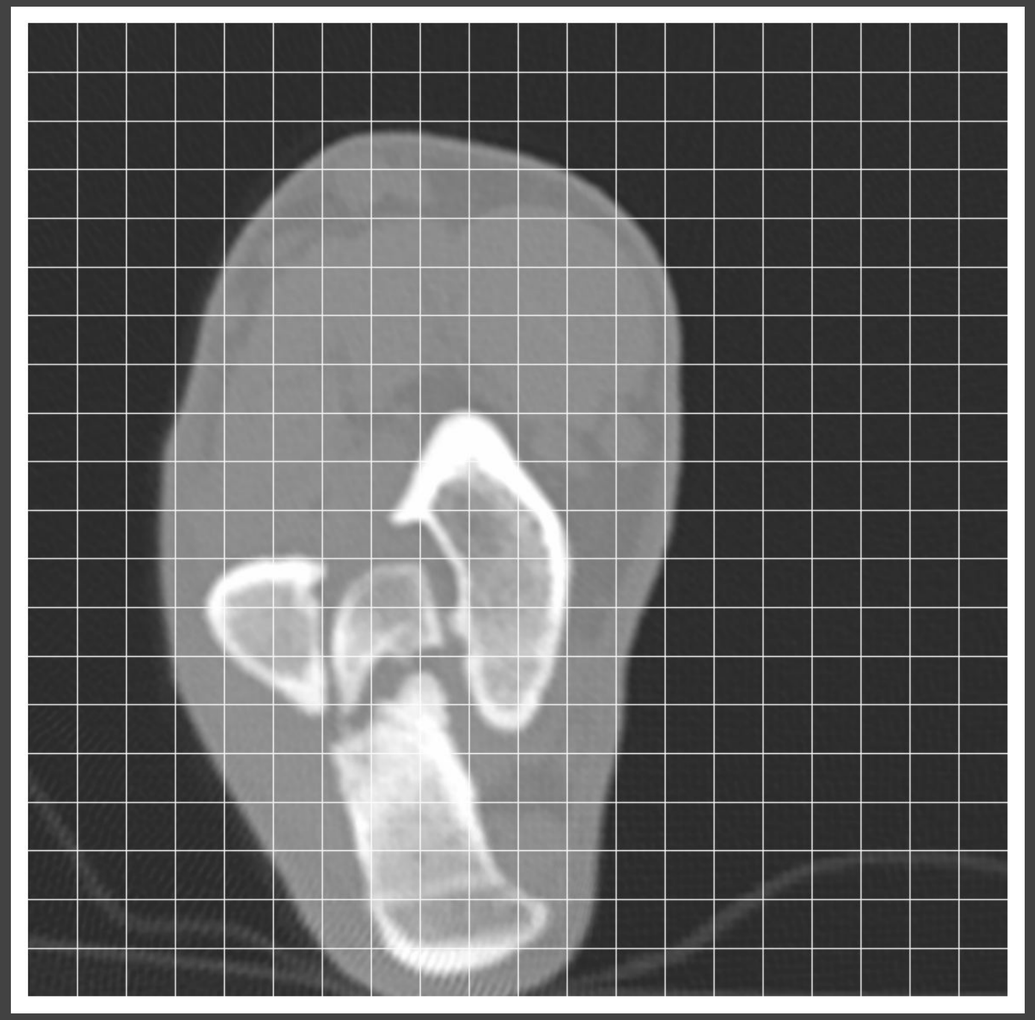


Large FOV

Pixel size = DFOV/matrix



Matrix 10 x 10



Matrix 20 x 20

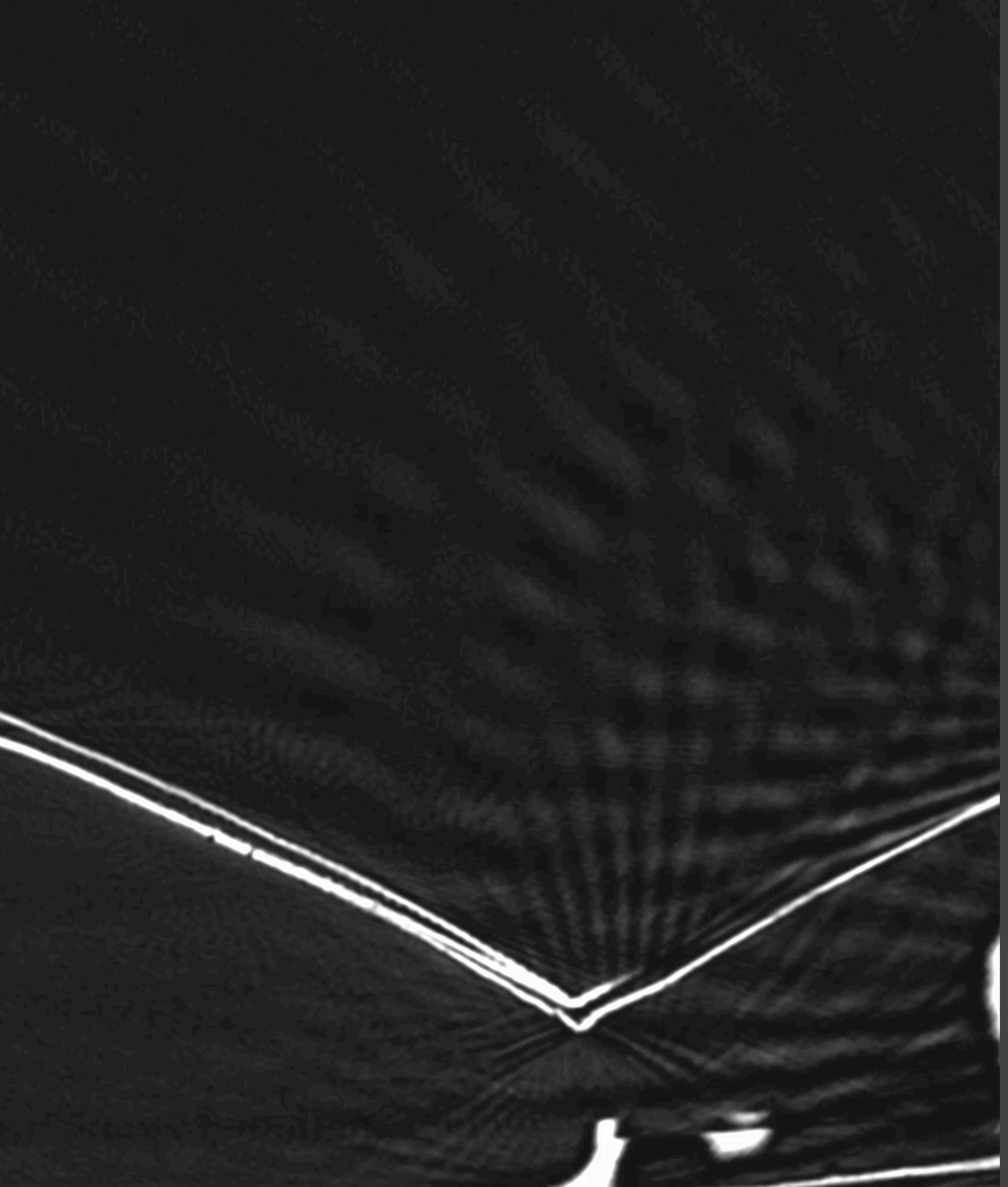
Romans, Lois. Computed Tomography for Technologists: A Comprehensive Text (p. 60). (Function). Kindle Edition.

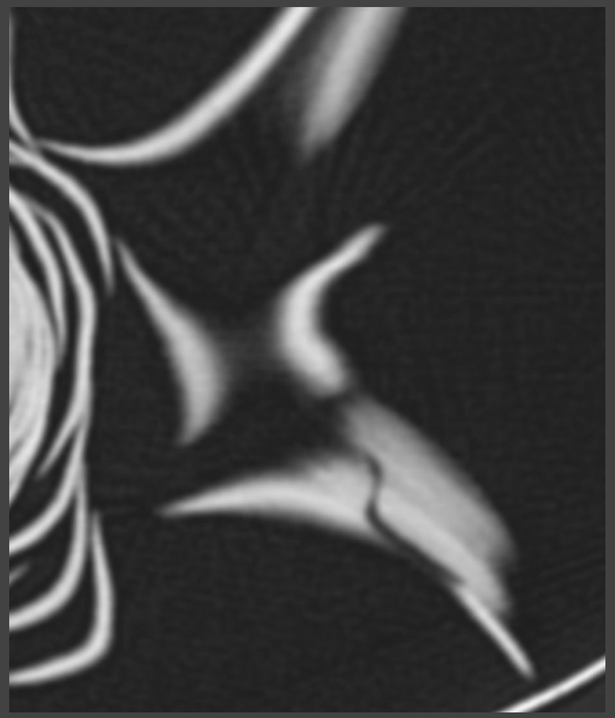
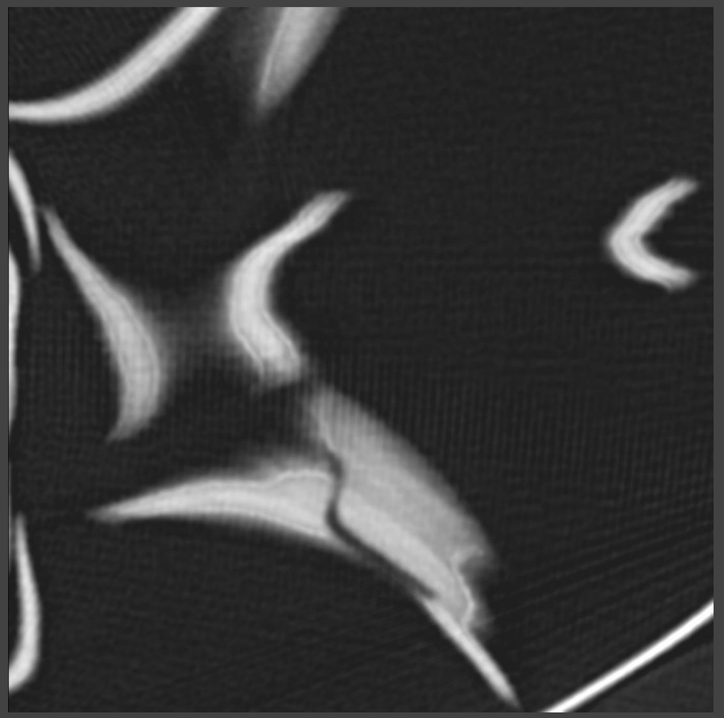
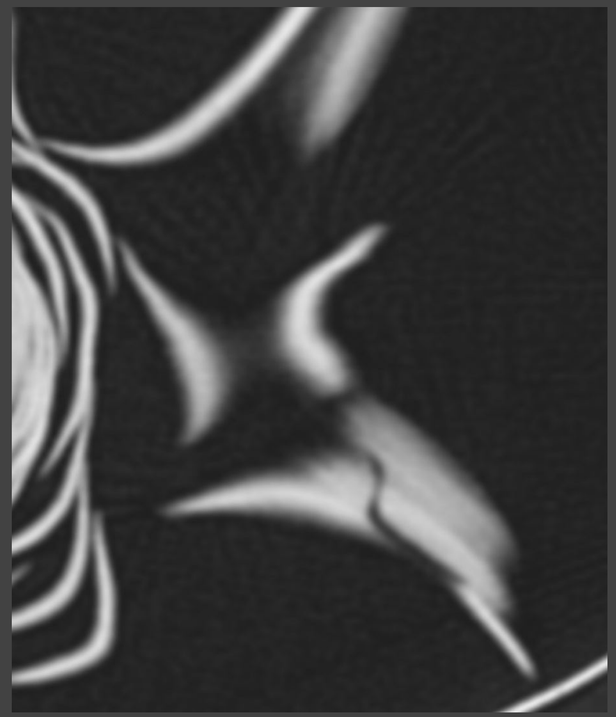
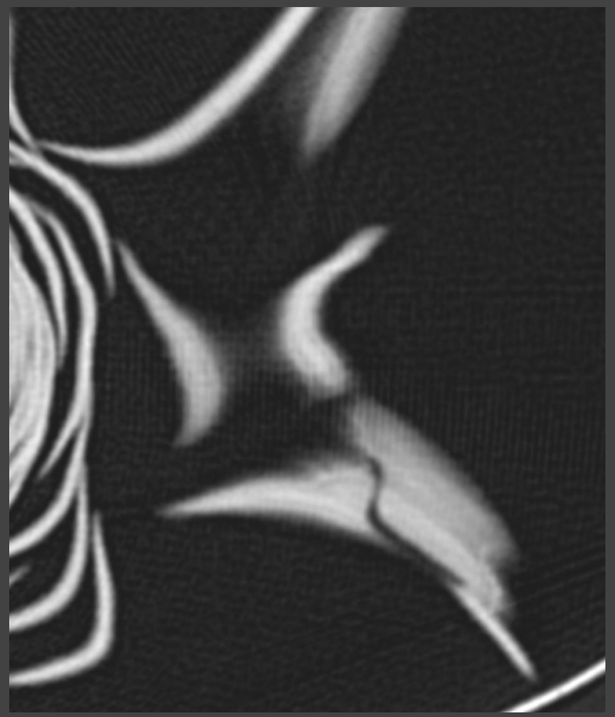
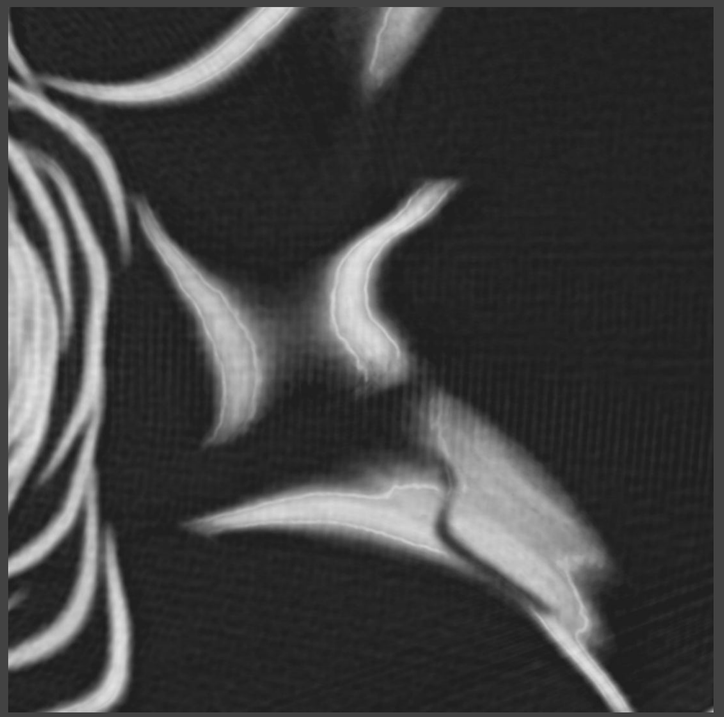
Resolution - ability to display two adjacent objects as discrete entities

Small FOV - 768 x 768

Large FOV - 768 x 768

Large FOV - 512 x 512



Factors affecting in-plane resolution

Fundamental resolution - limited control

- Focal spot size
- Detector dimensions
- Magnification factor
- Gantry motion compensation
- Patient motion

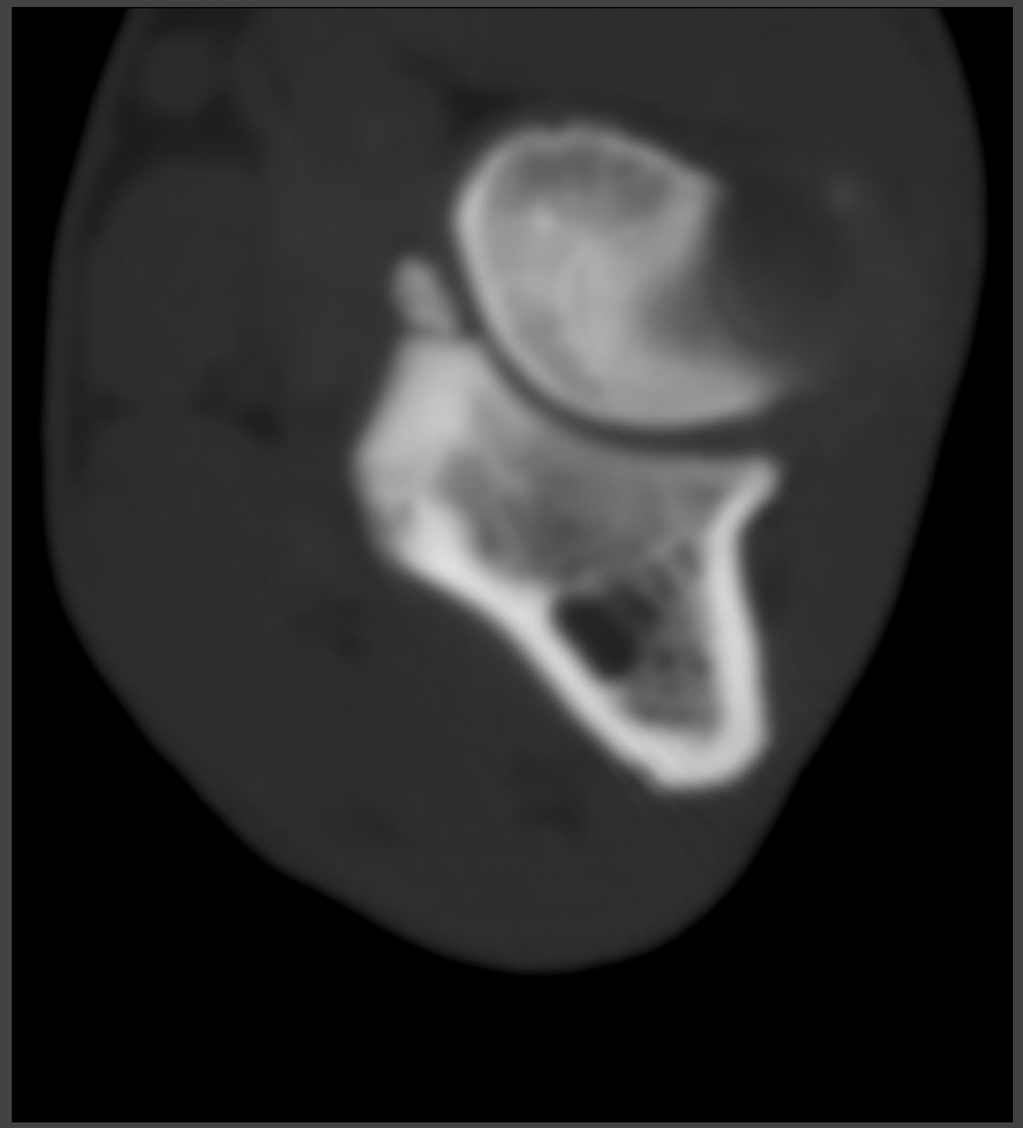
Reconstruction - can be adjusted

- Kernel or reconstruction algorithm
- FOV
- Matrix
- Slice thickness

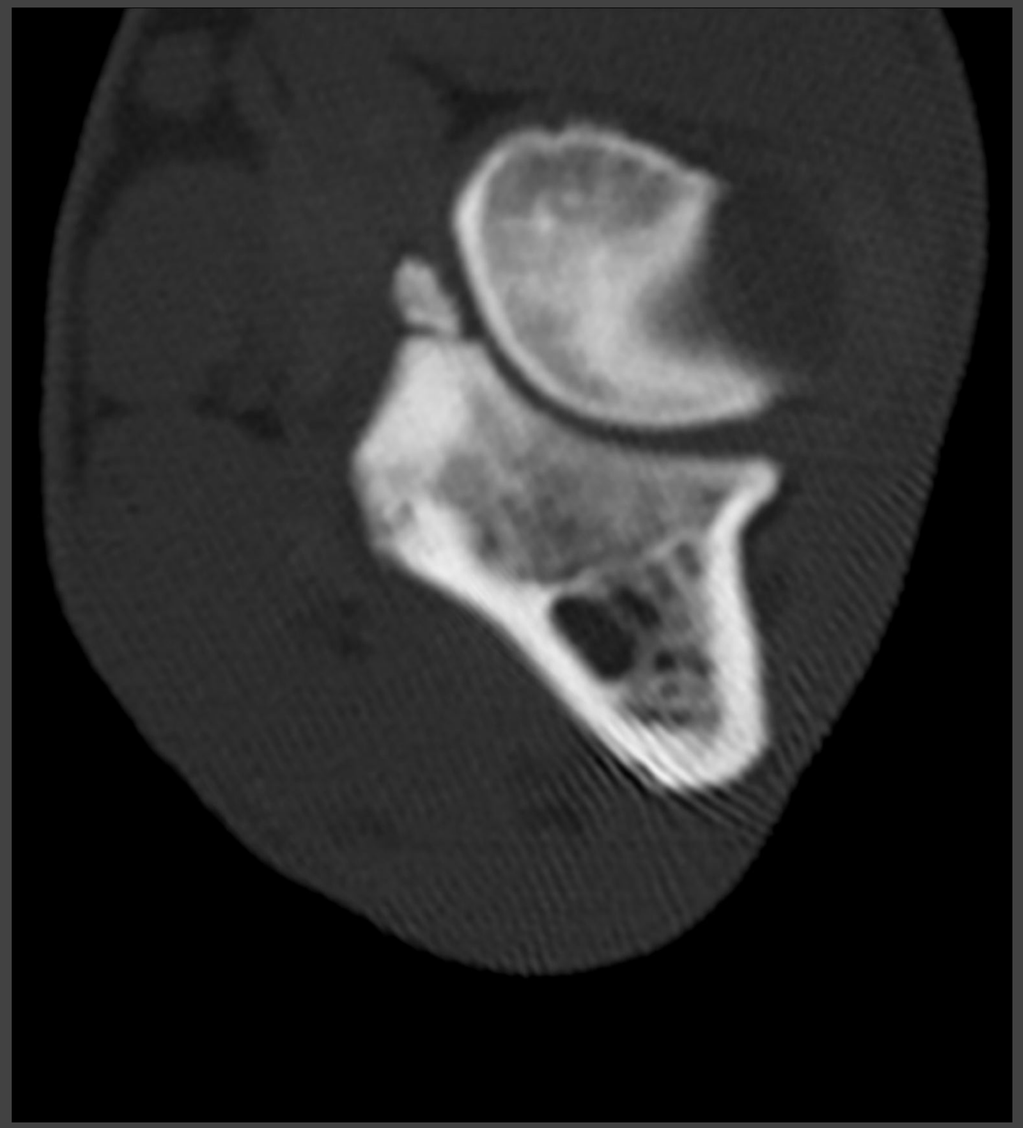
Spatial resolution

Slice thickness

Soft reconstruction



Bone reconstruction

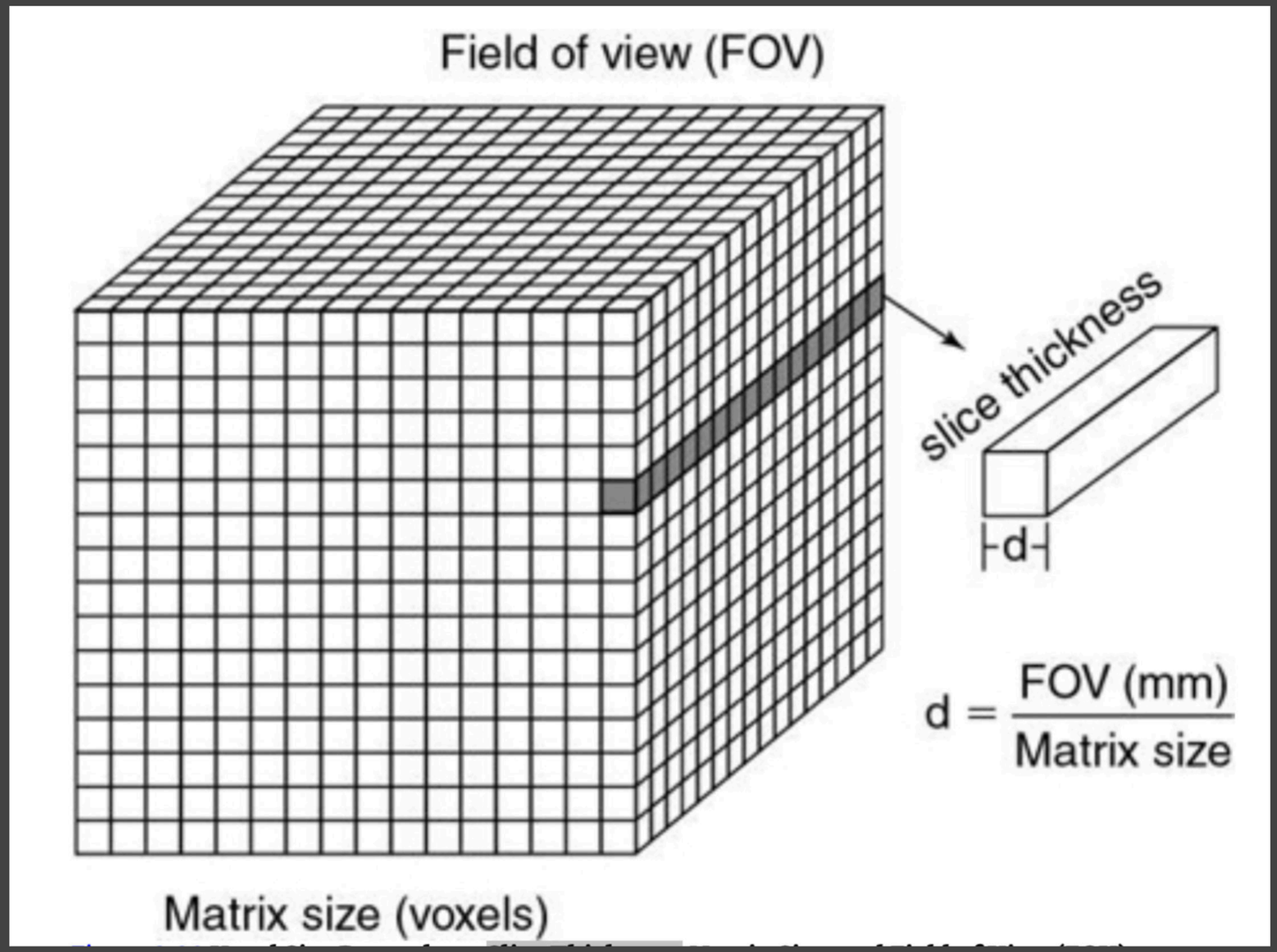


Bone kernel - sharper image

(higher spatial resolution)

Voxels

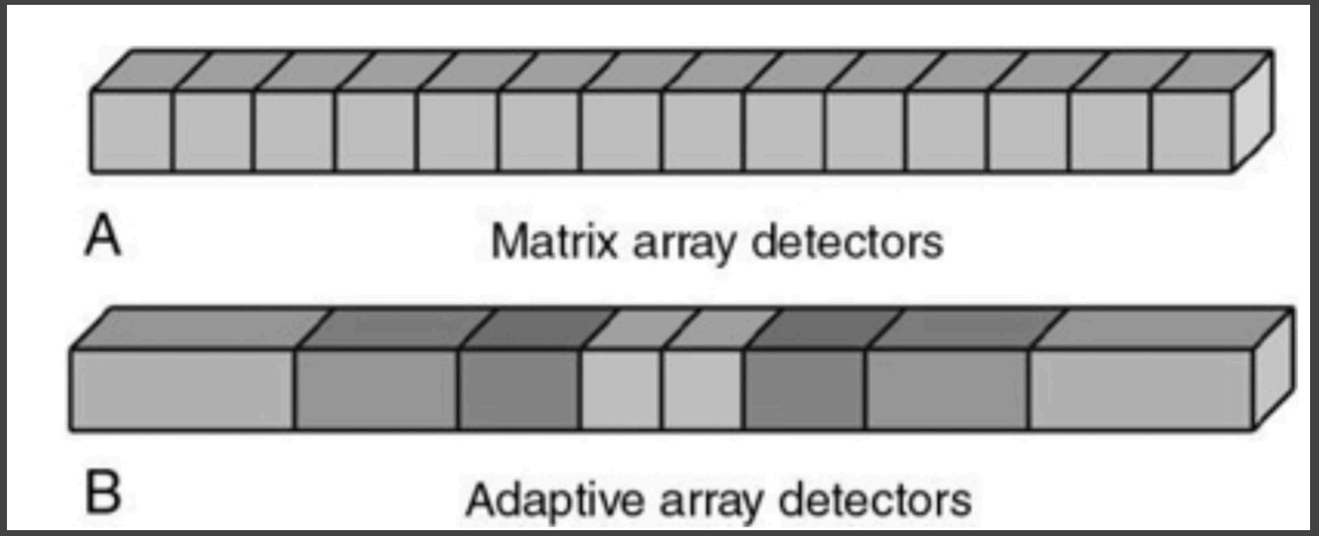
Pixels - information contained in a volume of tissue



Seeram, Euclid. Computed Tomography - E-Book (p. 265). (Function). Kindle Edition.

Detector Array Arrangement

Fixed and Adaptive arrays

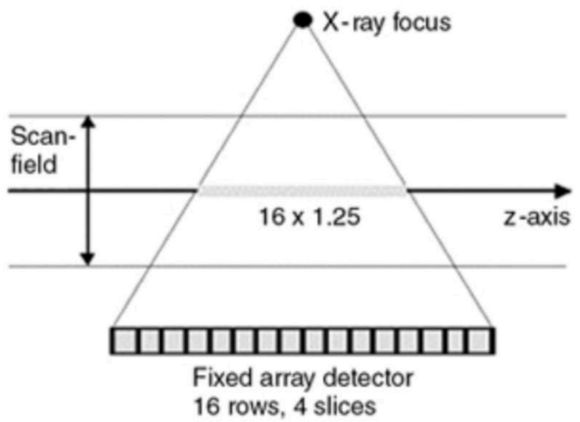


Seeram, Euclid. Computed Tomography - E-Book (p. 265). (Function). Kindle Edition.

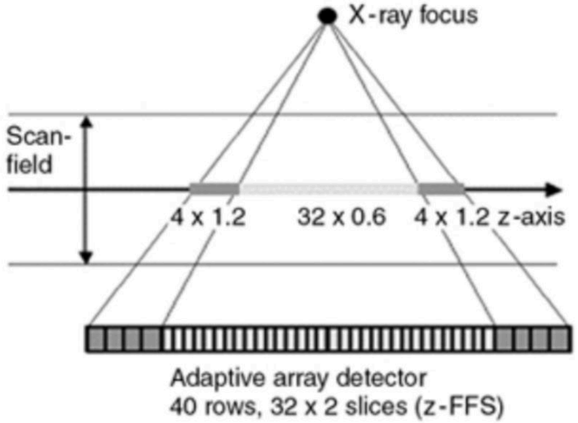
Rows, slices and data channels

Slice width - number of detector elements grouped into each data channel

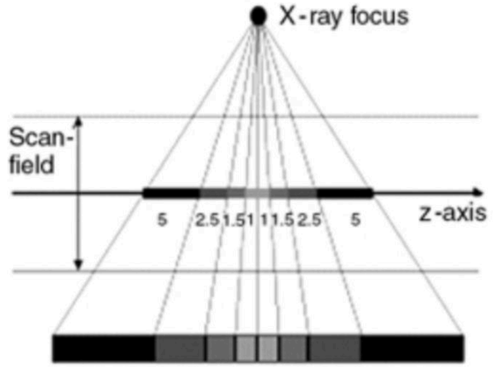
Thinner slice - smallest single detector element.



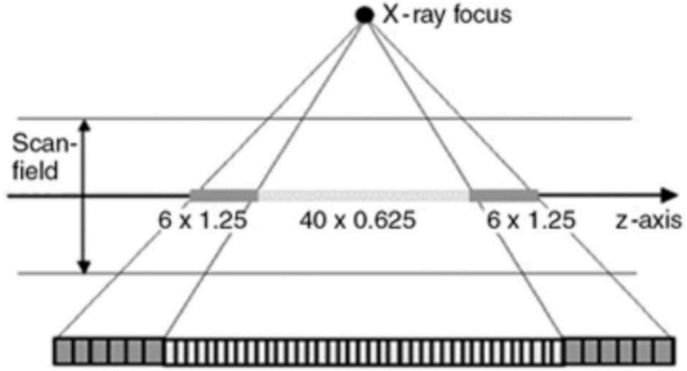
Fixed array detector
16 rows, 4 slices



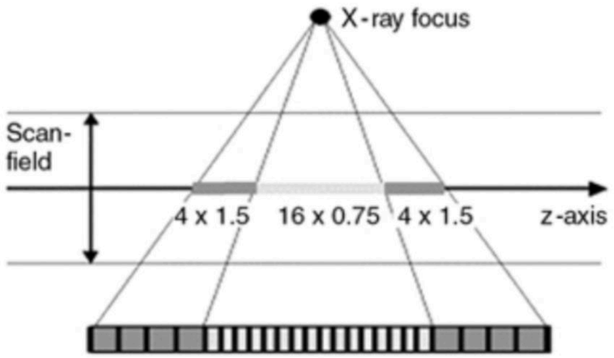
Adaptive array detector
40 rows, 32 x 2 slices (z-FFS)



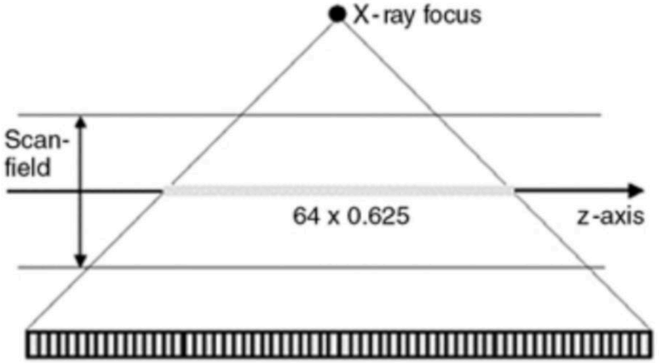
Adaptive array detector
8 rows, 4 slices



Adaptive array detector
52 rows, 32 / 40 slices



Adaptive array detector
24 rows, 16 slices



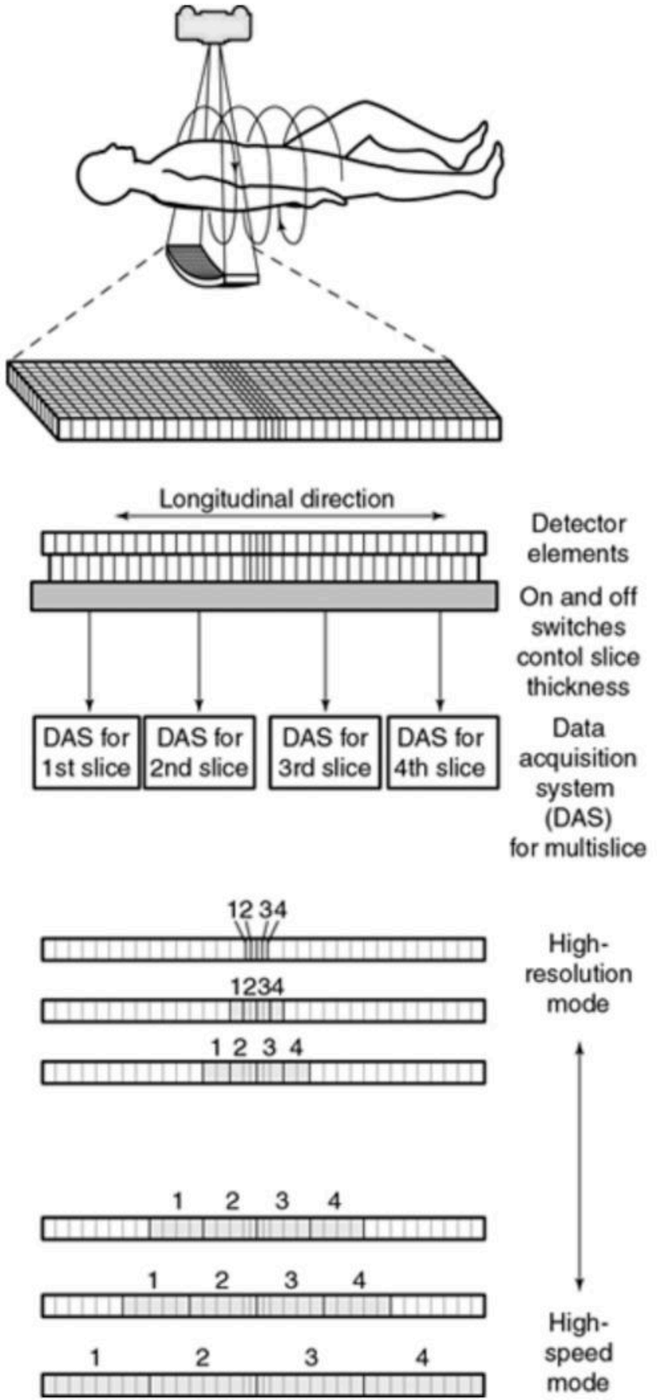
Fixed array detector
64 rows, 64 slices

Seeram, Euclid. Computed Tomography - E-Book (p. 265). (Function). Kindle Edition.

Rows, slices and data channels

Slice width - number of detector elements grouped into each data channel

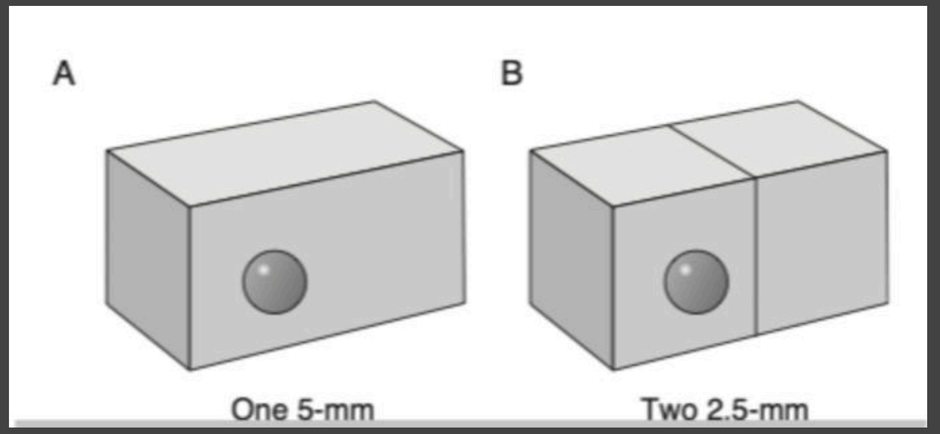
Thinner slice - smallest single detector element.



Seeram, Euclid. Computed Tomography - E-Book (p. 265). (Function). Kindle Edition.

Slice thickness/Image thickness

A- 2-mm object - 5-mm slice - volume averaging



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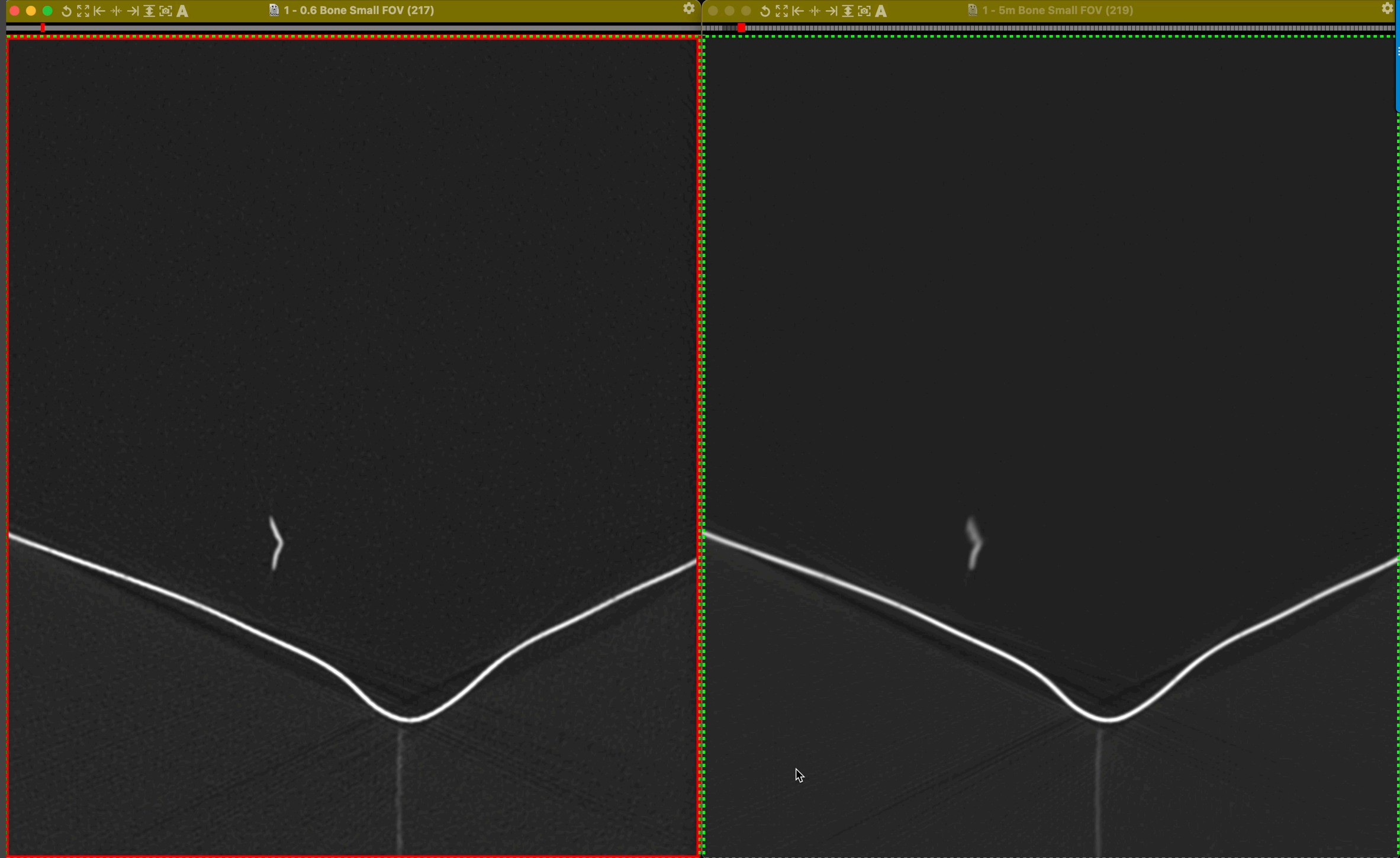

1 - 0.6 Bone Small FOV (217)
1 - 5m Bone Small FOV (219)

Tasks

Spatial resolution

Contrast resolution

Temporal resolution

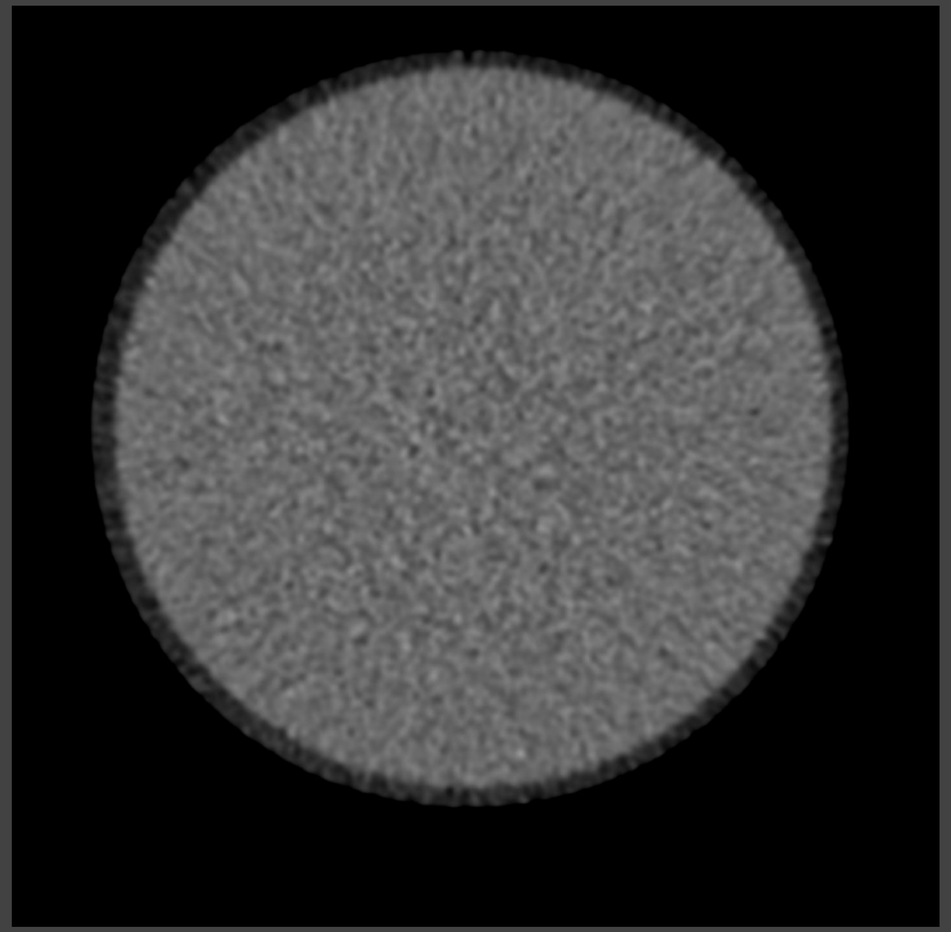
Tasks

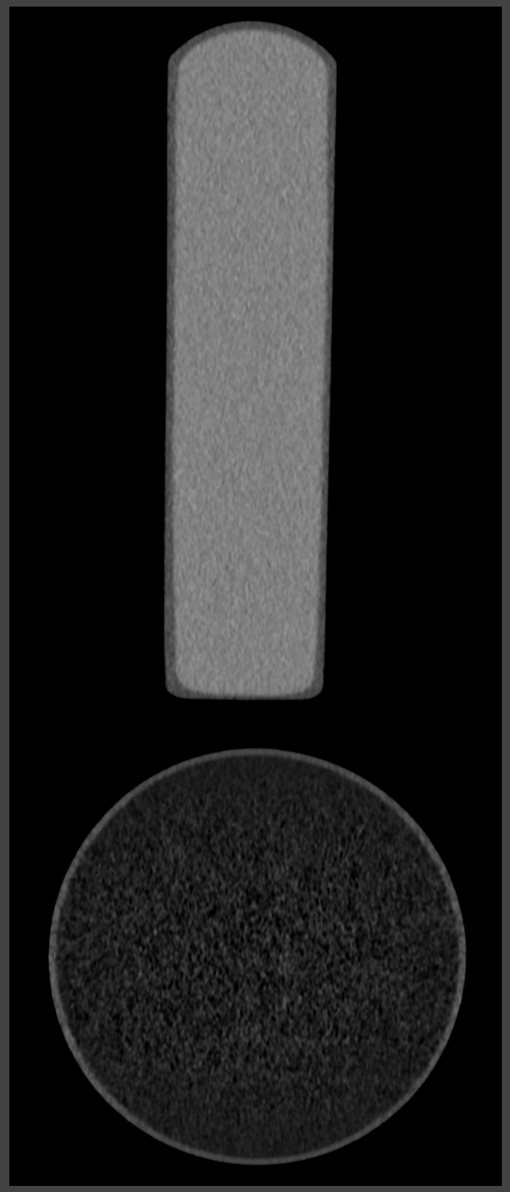
Contrast resolution

Contrast resolution - ability to detect very subtle changes in gray scale and distinguish them from the noise in the image.

Bushberg, Jerrold T.; Seibert, J. A.; Leidholdt, Edwin M.; Boone, John M.. The Essential Physics of Medical Imaging (p. 160). (Function)

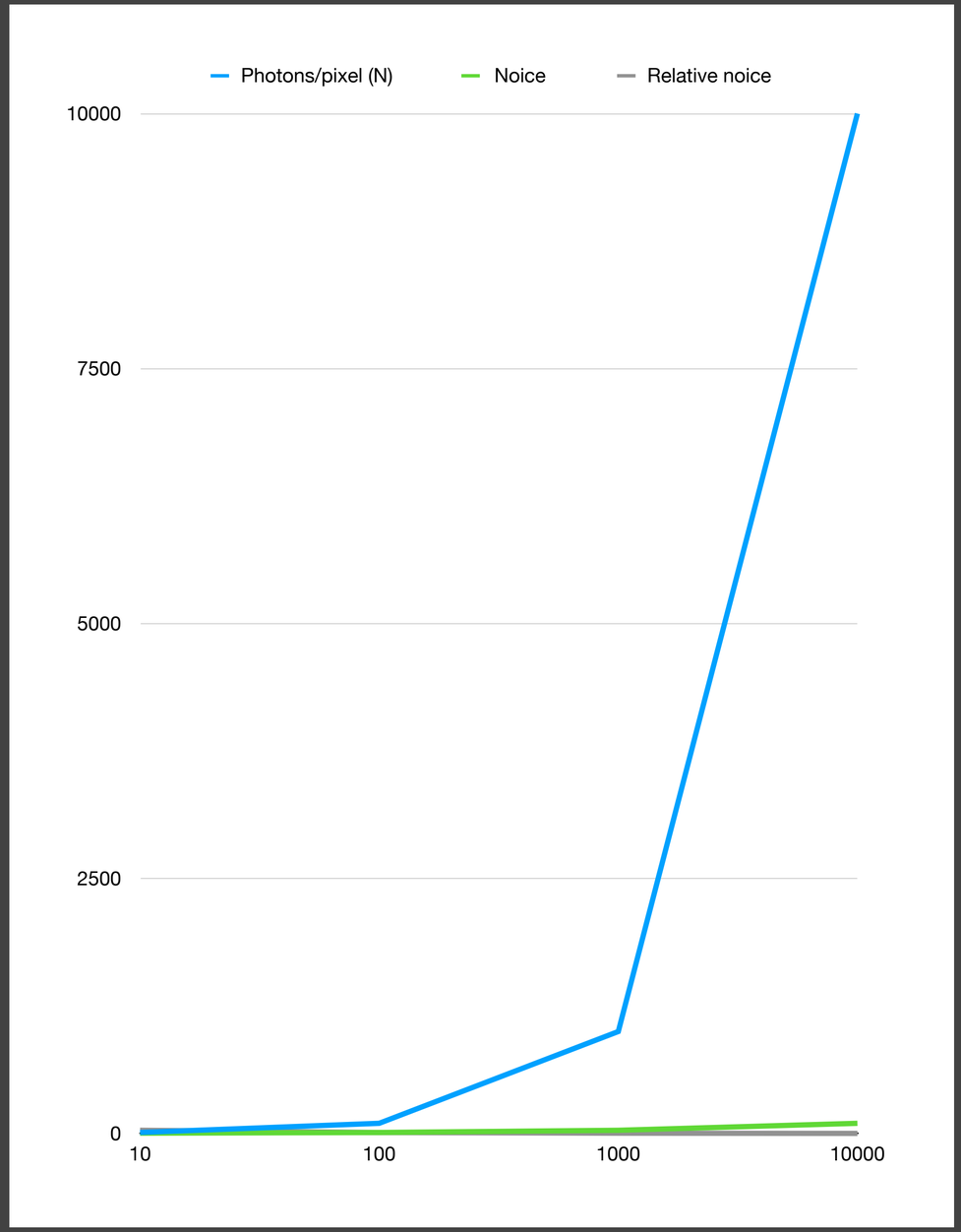
Mottle in CT represents random fluctuations in attenuation



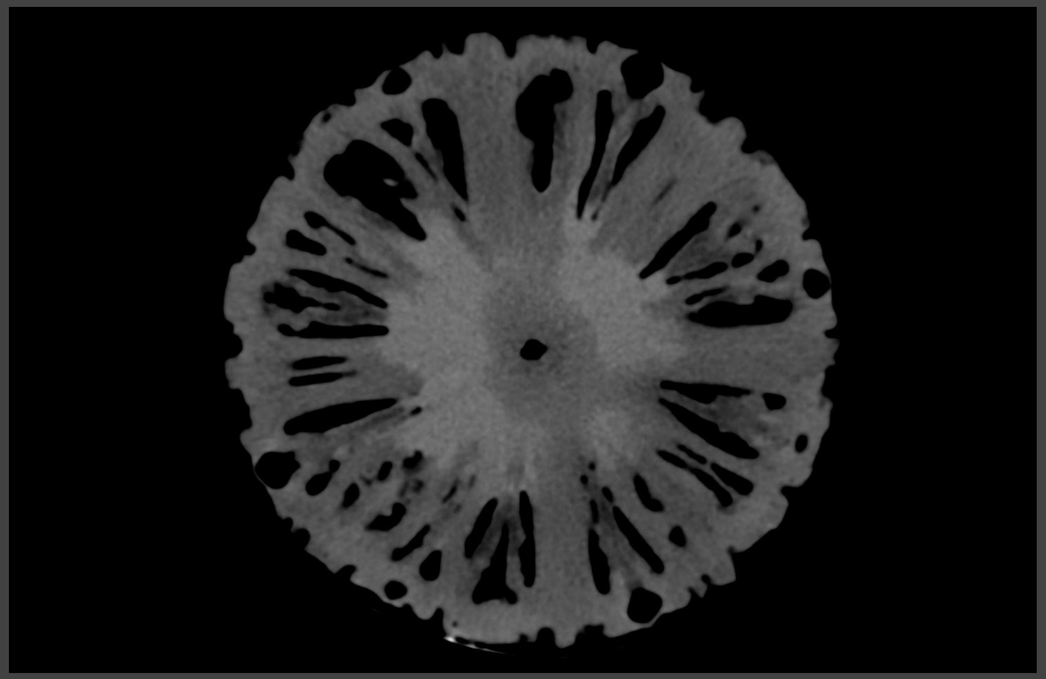


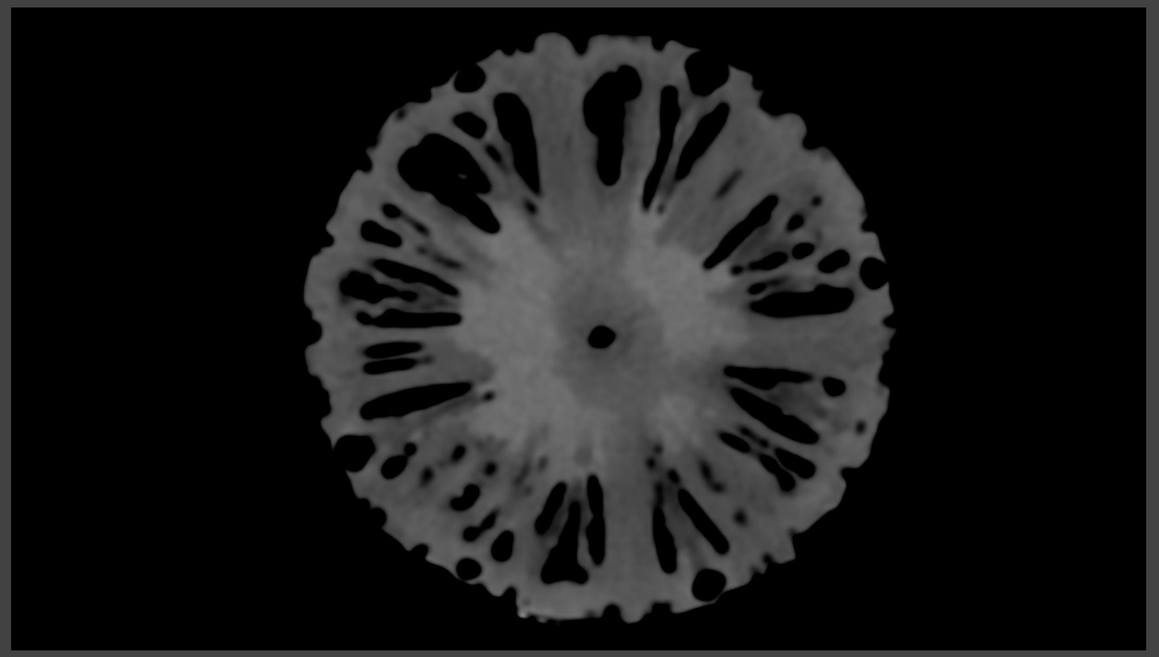
CT mottle depends primarily on the number of x-ray photons used to make the image.

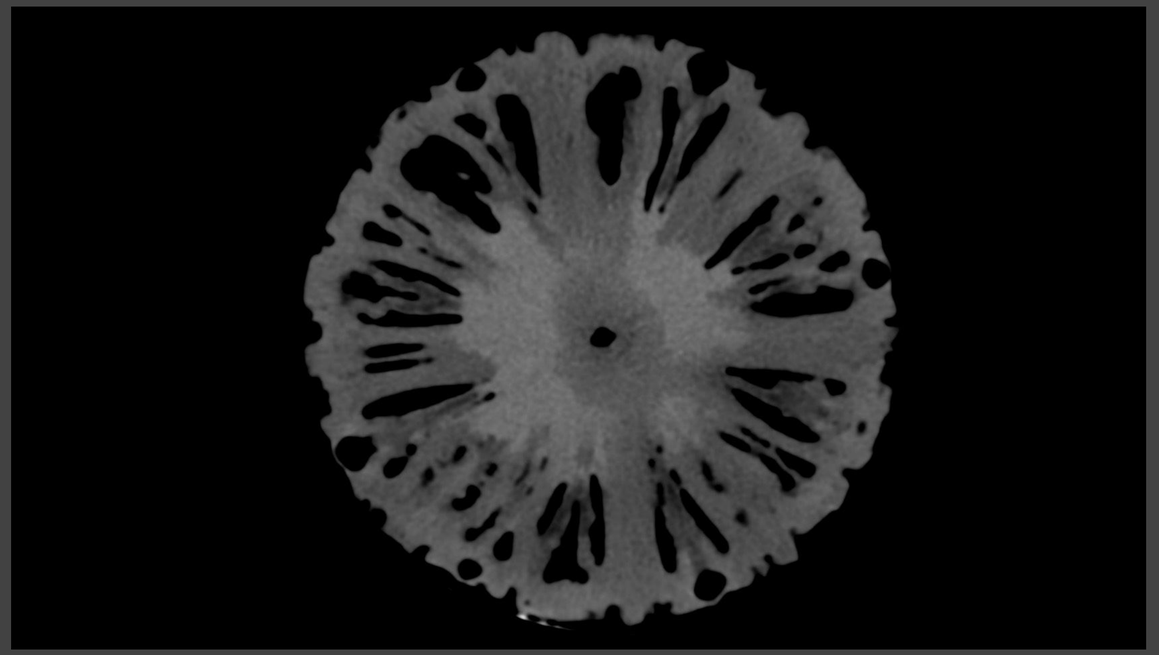
PHOTONS/PIXEL (N)	NOISE (σ) ($\sigma = \sqrt{N}$)	RELATIVE NOISE (σ/N) (%)	SNR (N/σ)
10	3.2	32	3.2
100	10	10	10
1,000	31.6	3.2	32
10,000	100	1.0	100
100,000	316.2	0.3	316



Sensakovic, William. Review of Radiologic Physics (p. 40). (Function). Kindle Edition.







Contrast resolution

Average number of photons per pixel

-Effective mA

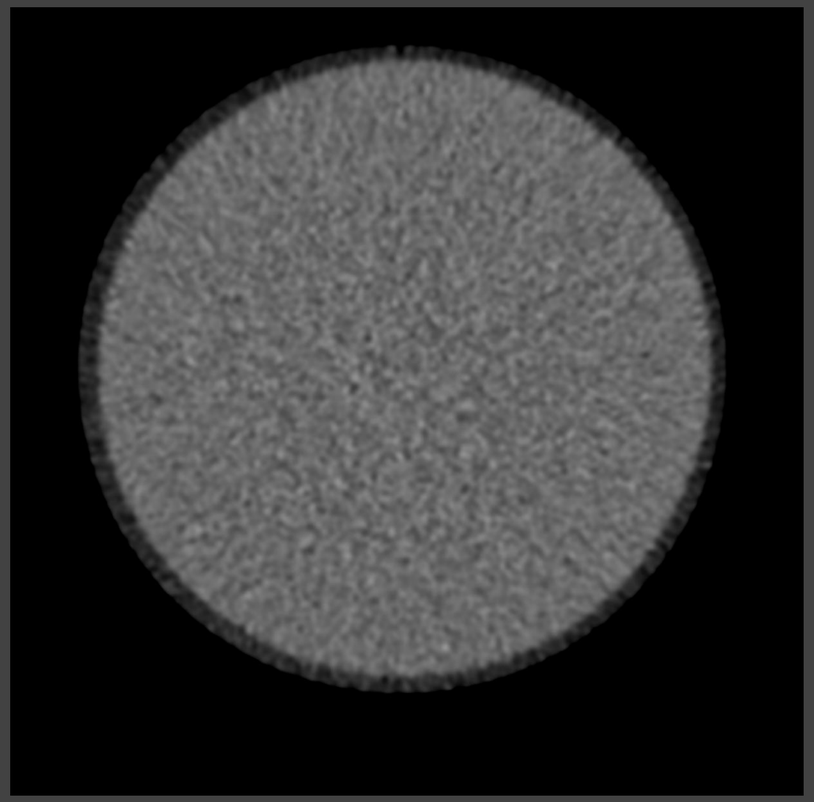
-Voxel size

-Pixel size

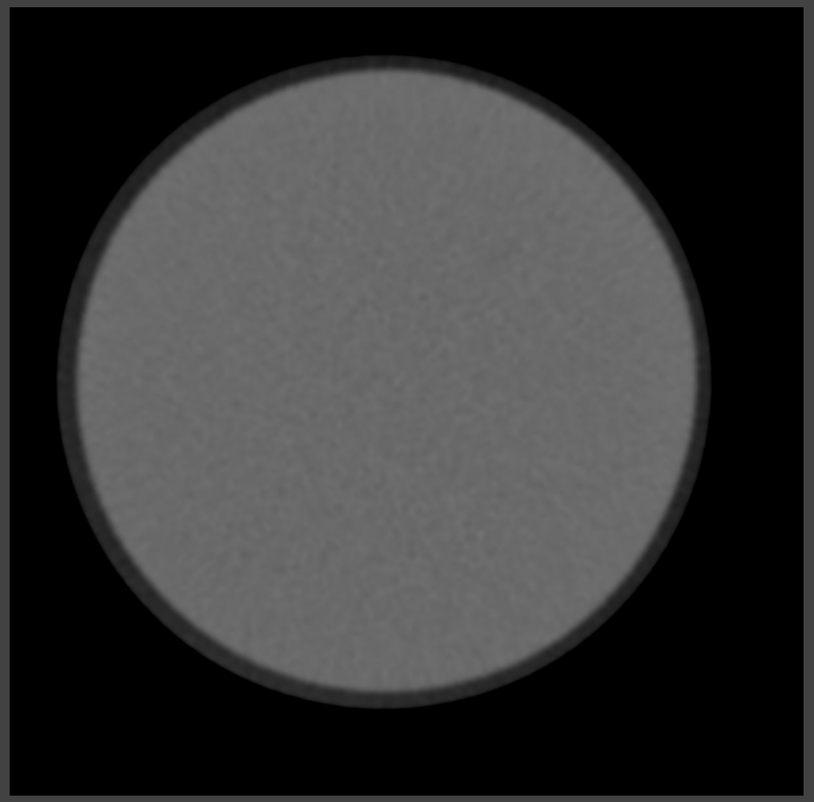
-Slice thickness

Sensakovic, William. Review of Radiologic Physics (p. 40). (Function). Kindle Edition.

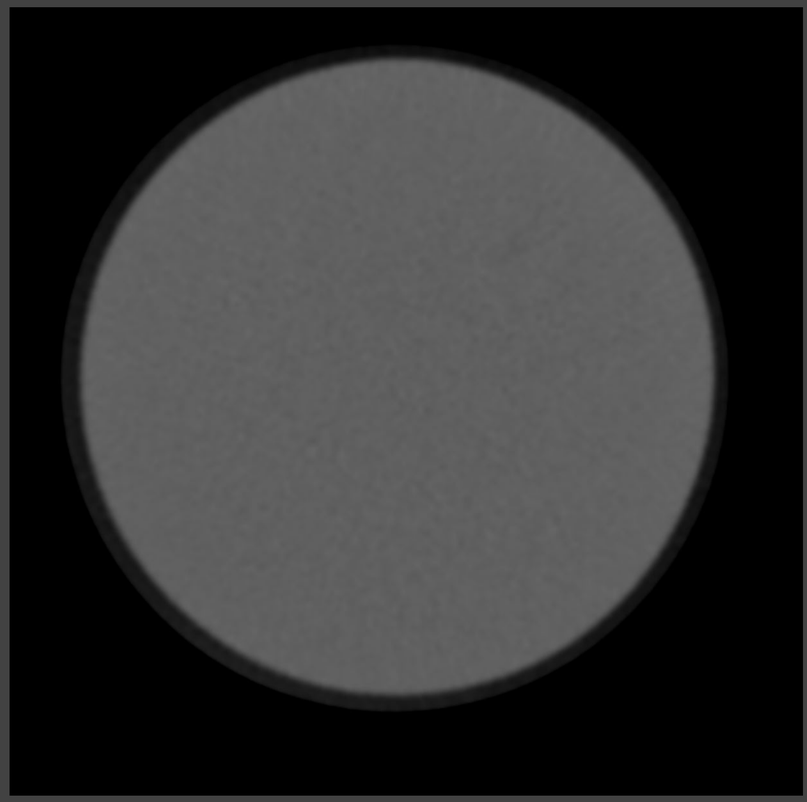
effective mA



6

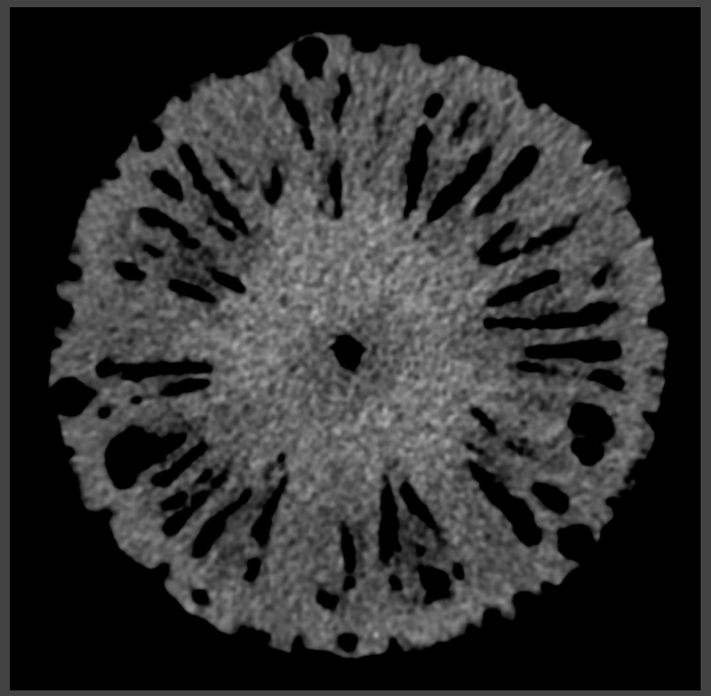


200



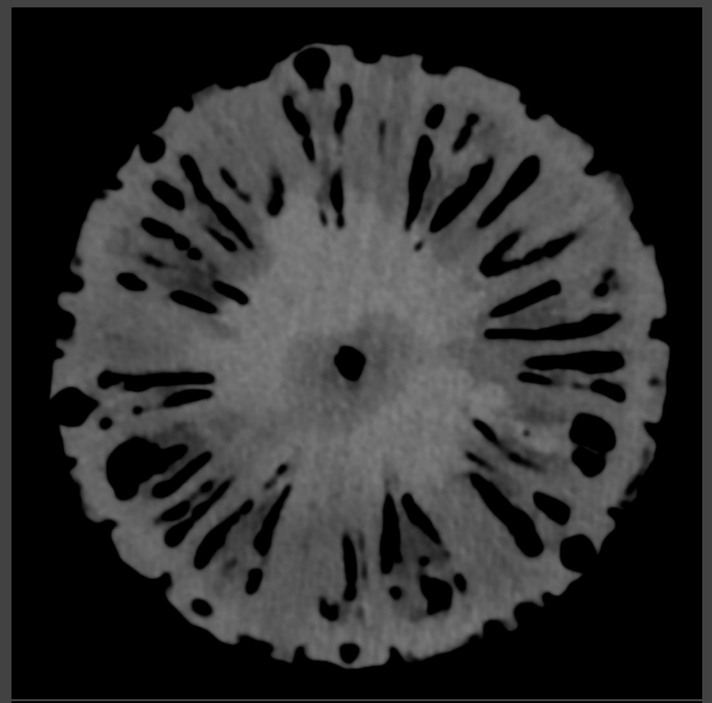
400

effective mA

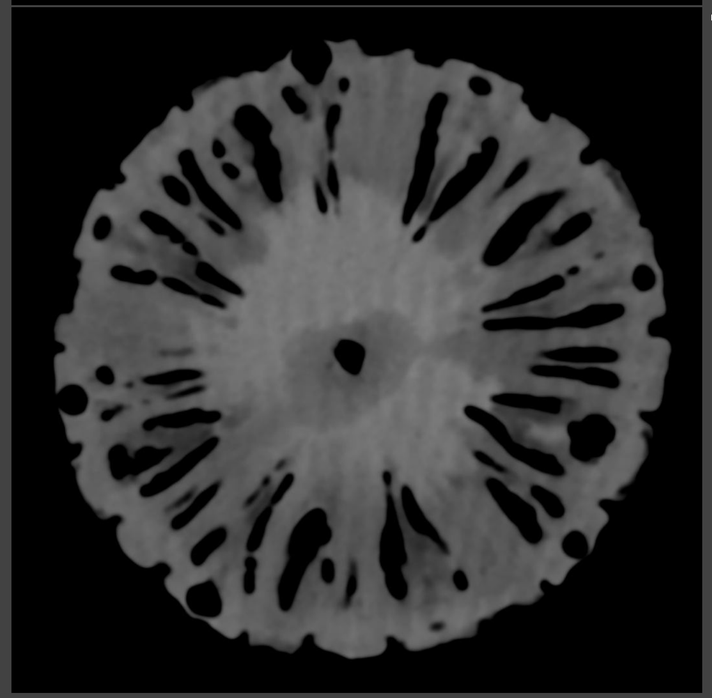


5

300

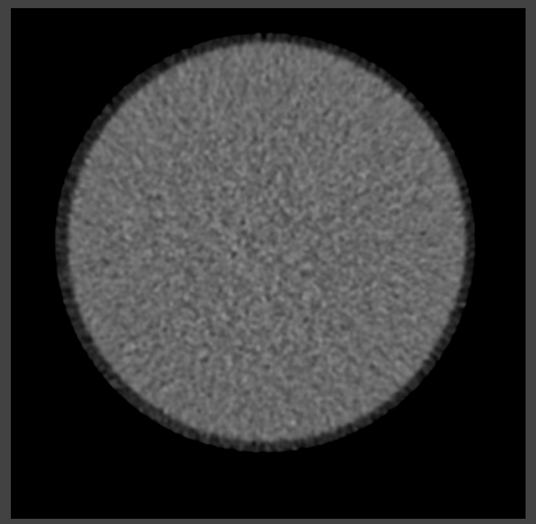


100

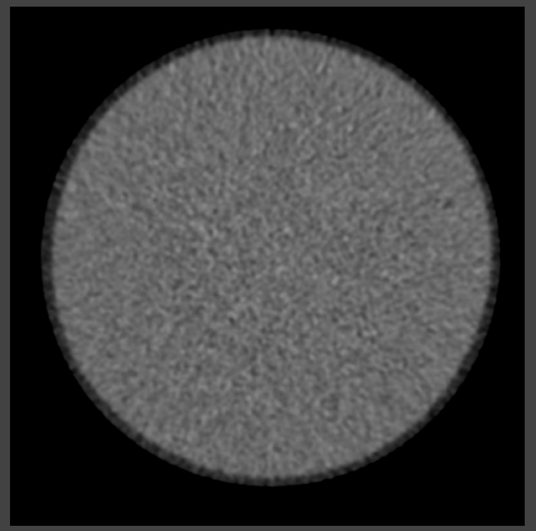


450

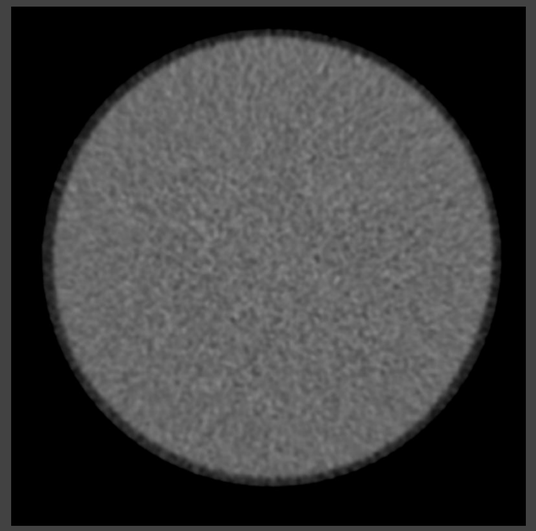
effective mA 6



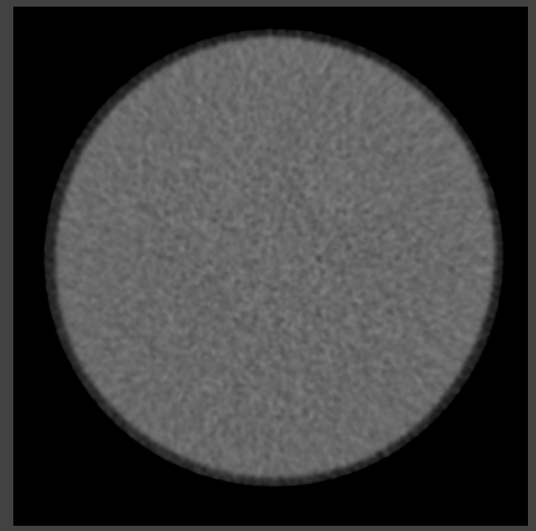
1 mm



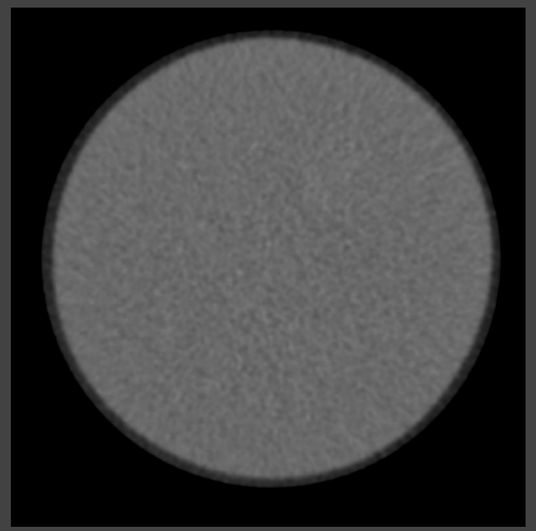
2 mm



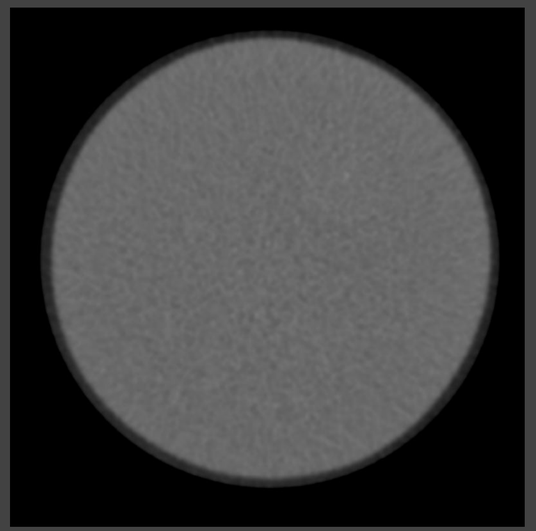
4 mm



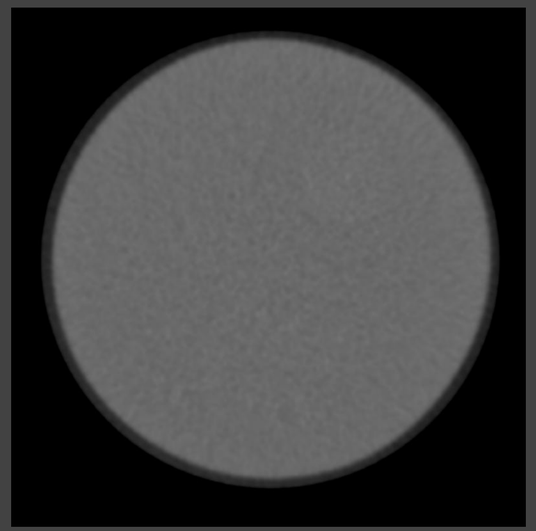
8 mm



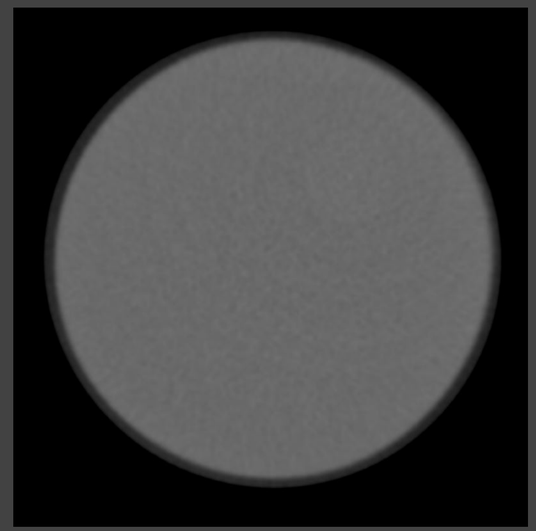
16 mm



32 mm



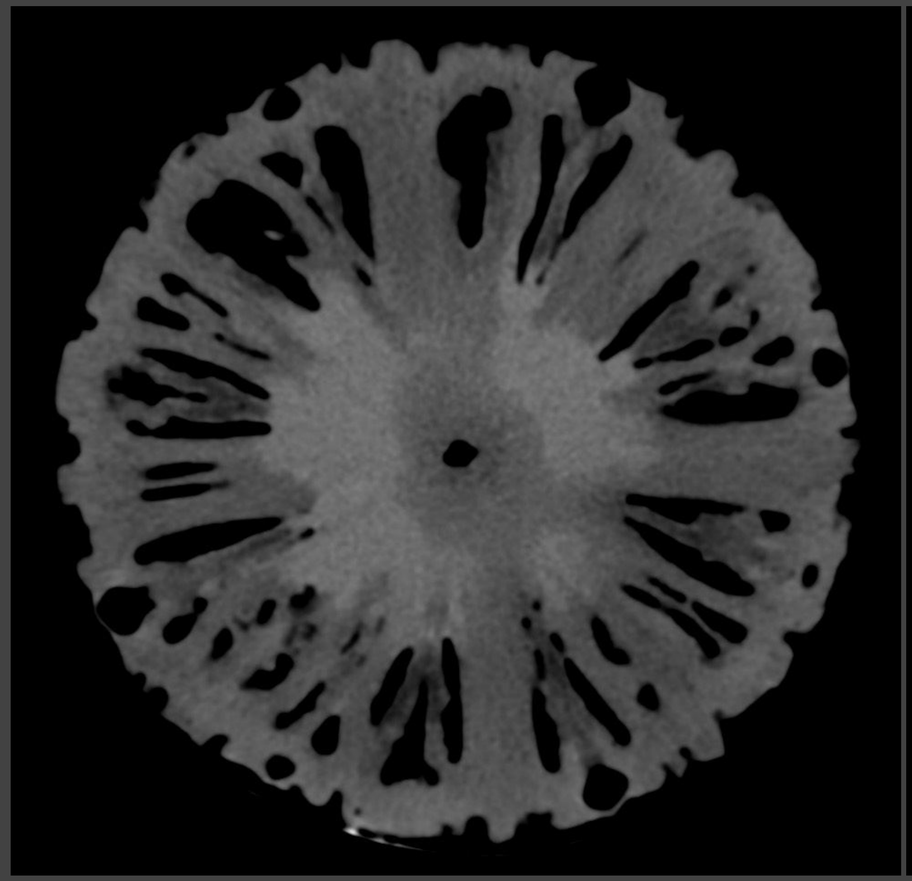
64 mm



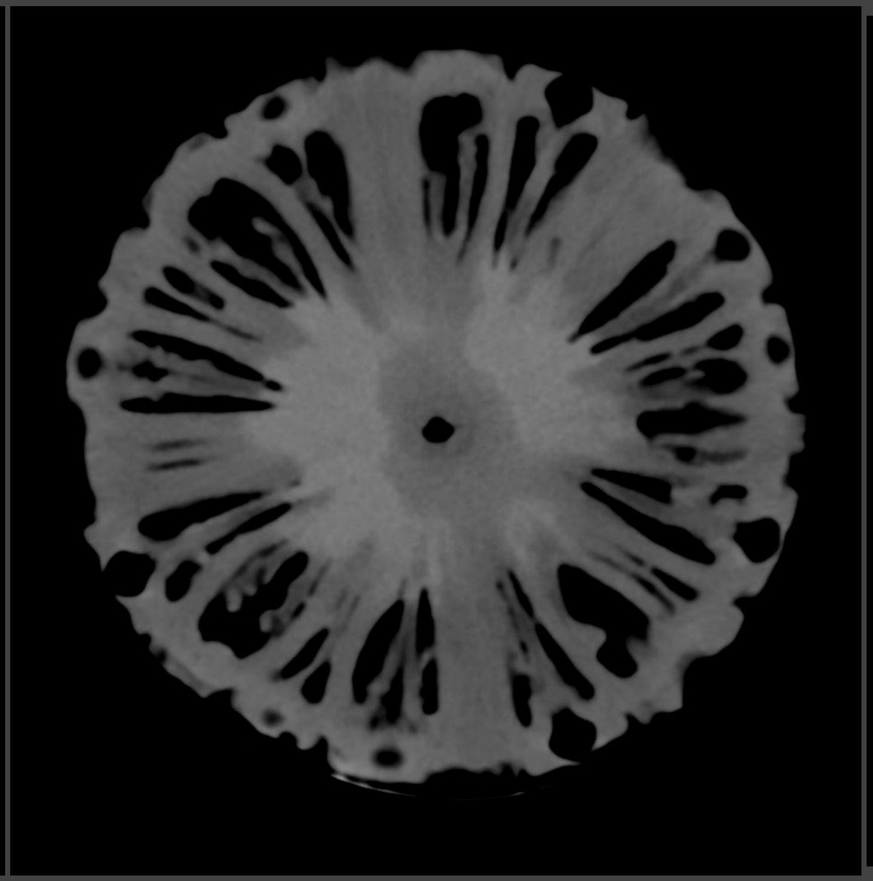
128 mm

reconstructed slice thickness

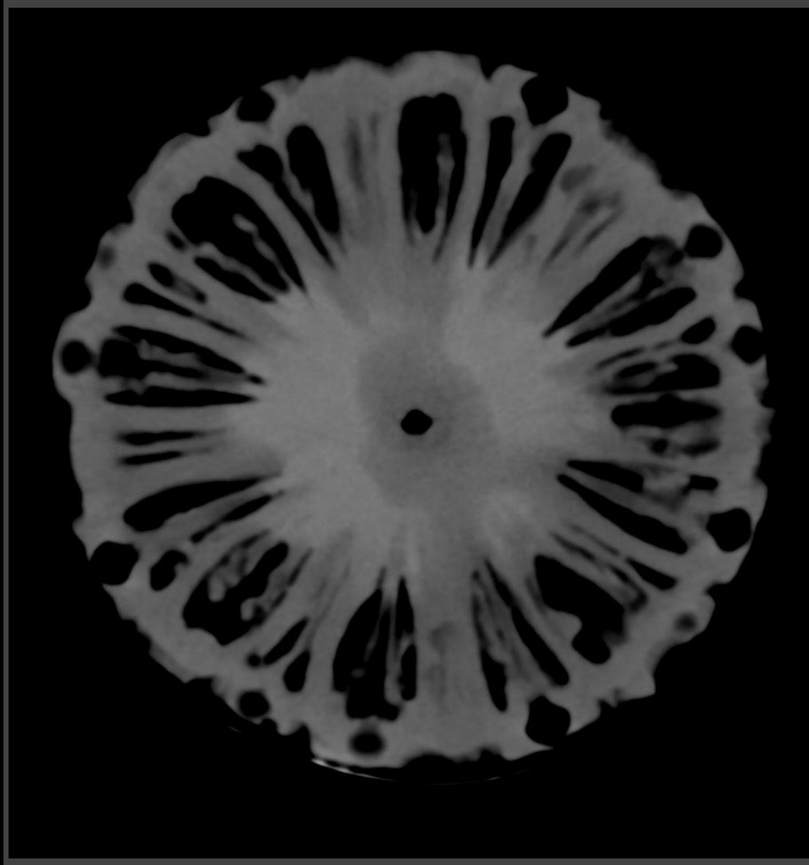
1 mm



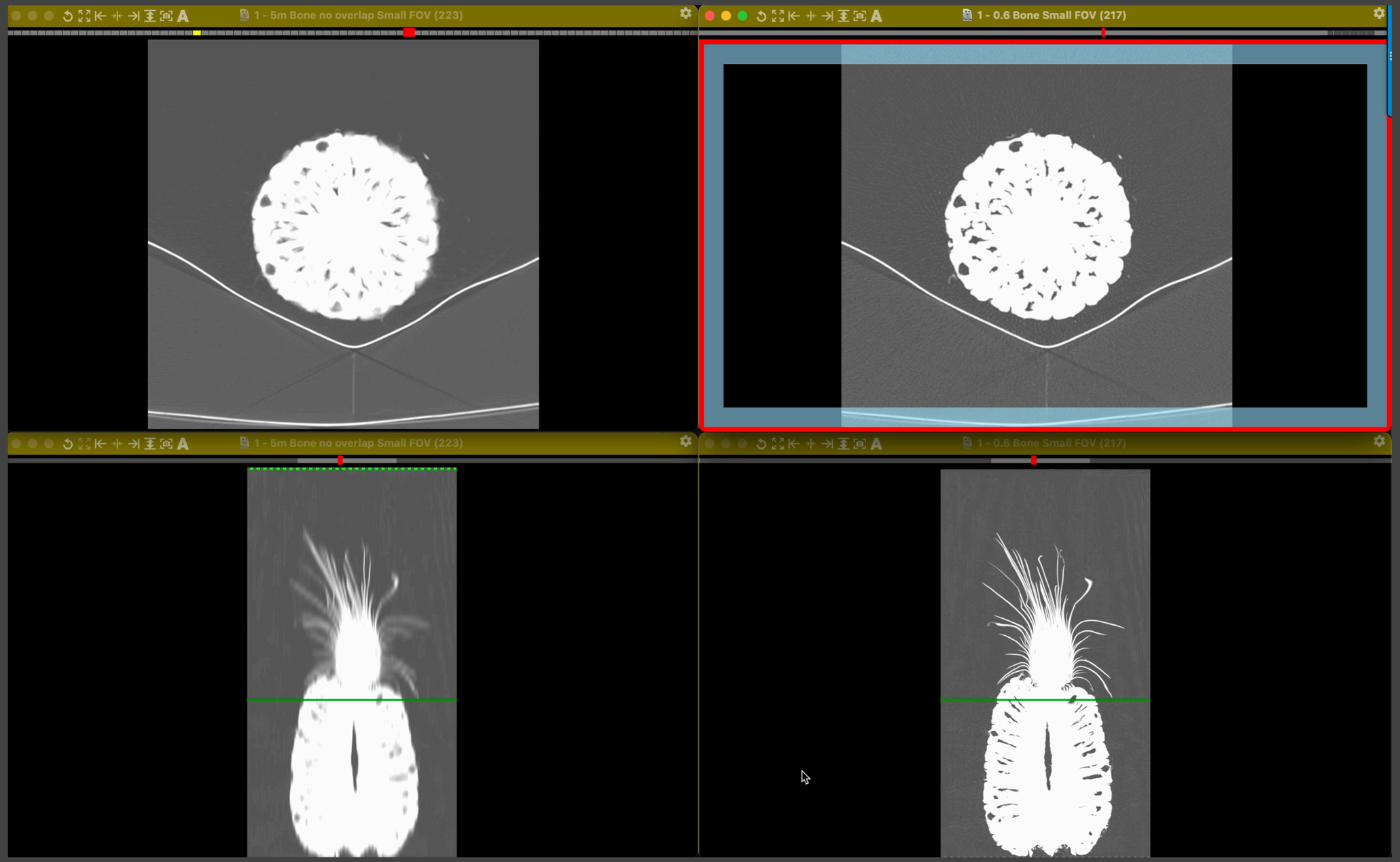
3 mm



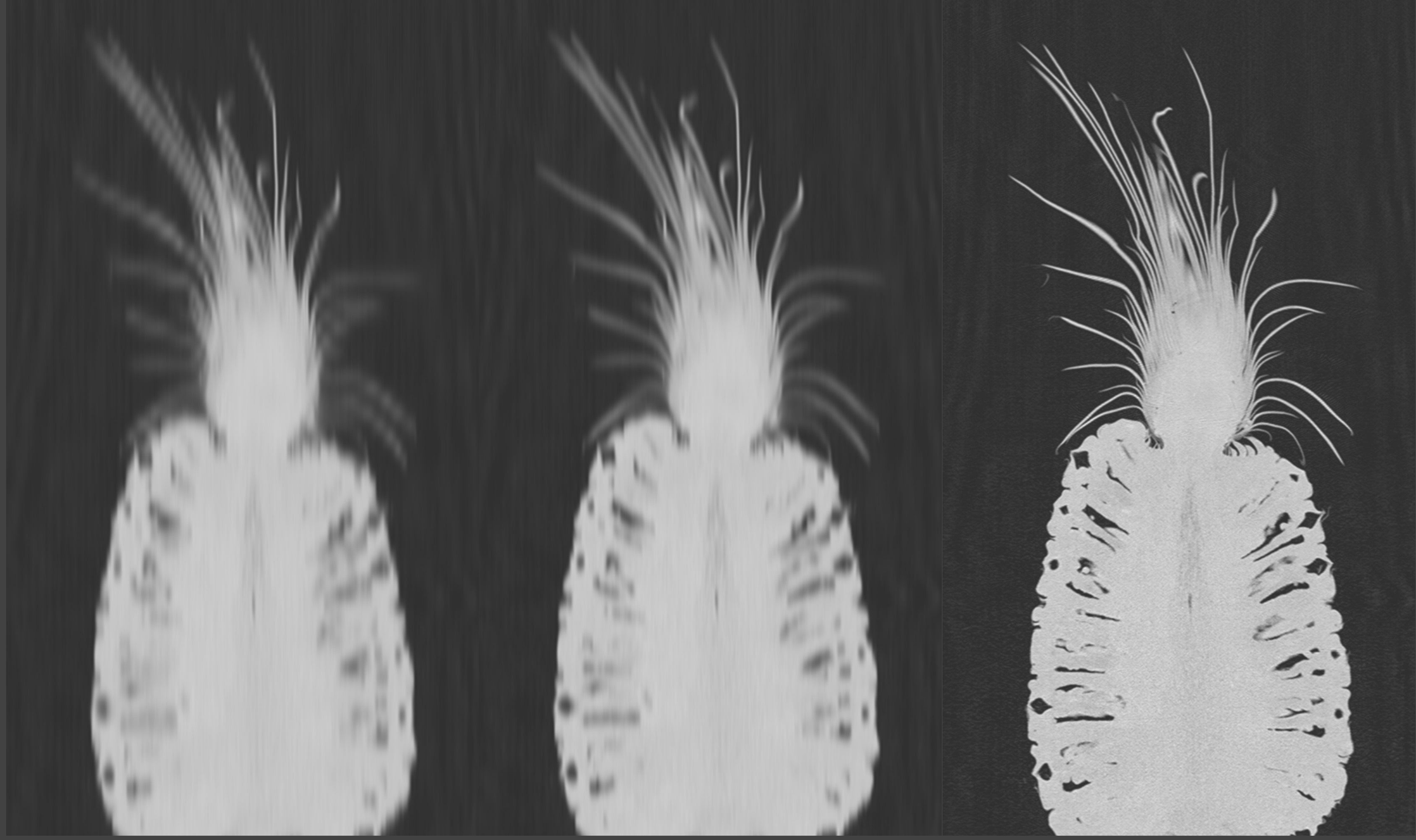
5 mm



Slice thickness



Overlap



5 mm no overlap

5 mm overlap

0.6 mm overlap

Tasks

Spatial resolution

Contrast resolution

Temporal resolution

Temporal resolution

Pitch

Constant mAs

Effective mAs

Rotation time

Pitch

Pitch = distance the table travels per rotation / total collimated x-ray beam width.

Constant milliamperage-seconds

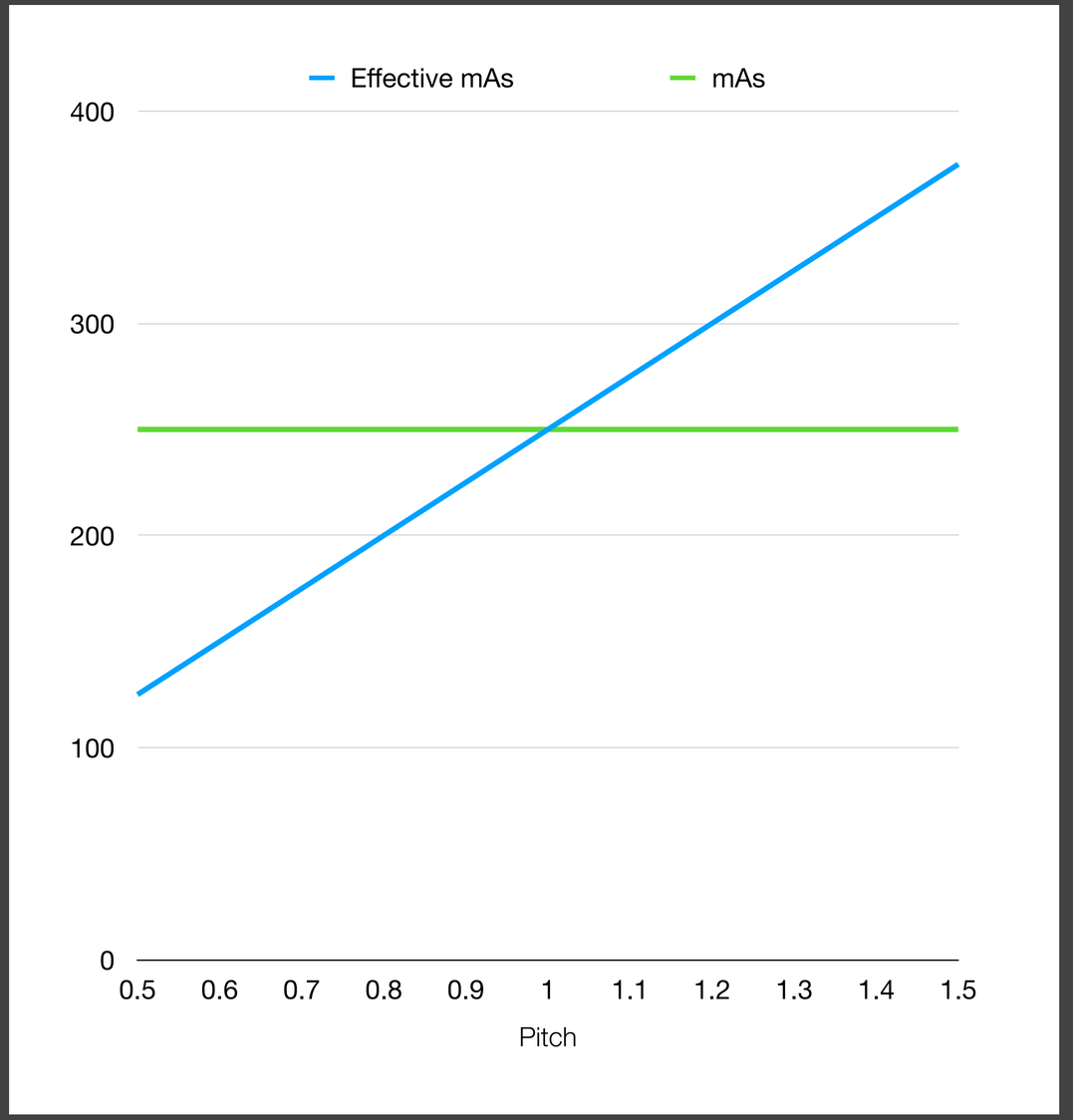
Selection of milliamperage and time (in seconds) separately

If pitch is increased, scan time is shorter and total mAs is reduced.

If pitch is decreased, scan time is longer and total mAs is increased.

Effective mAs

To keep the effective mAs constant, increasing the pitch from 1 to 2 requires doubling the mAs per rotation.



Rotation time

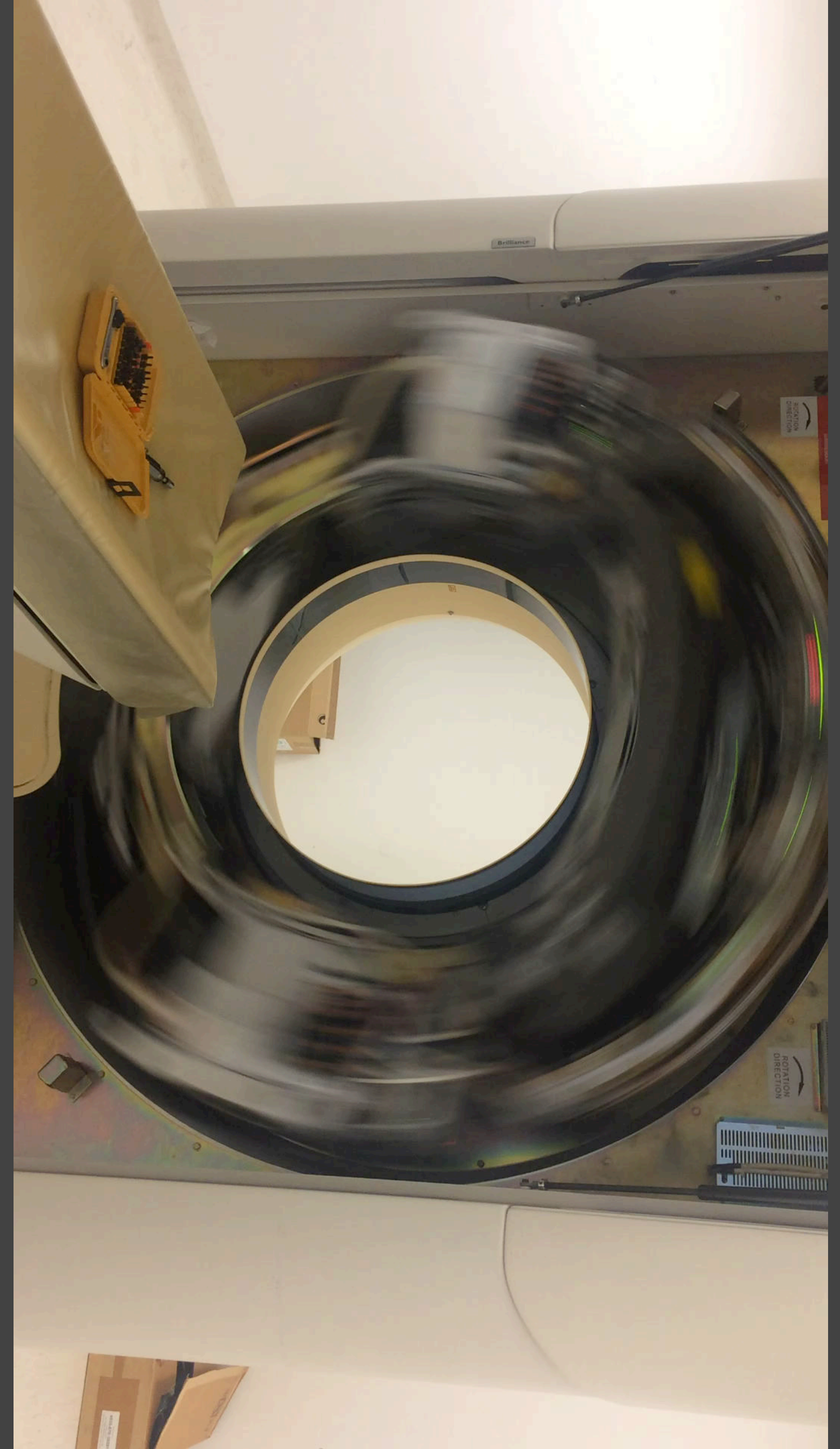
Short rotation times limit the maximum mA available due to heating concerns.

x-ray output = tube current (mA) x x-ray tube rotation time (s)

CT scanners -

large focal spot (1.2 mm)

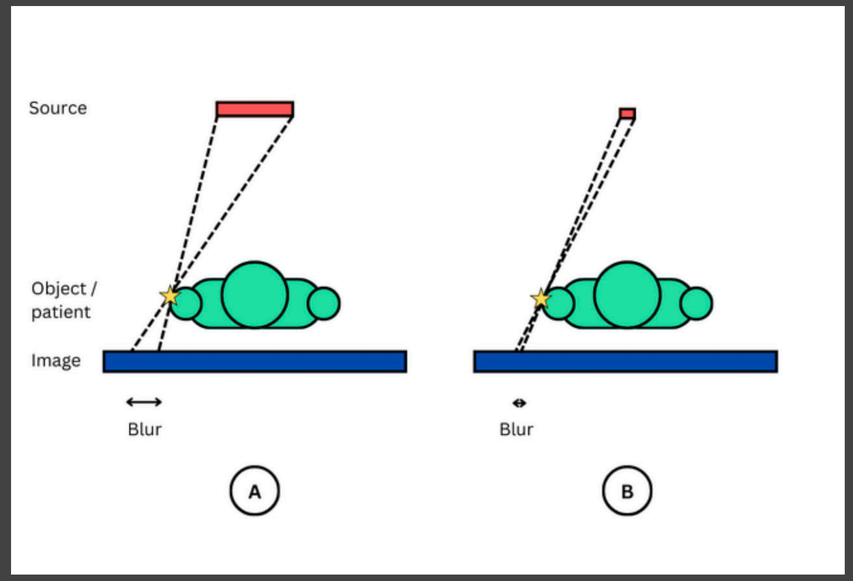
small focal spot (0.6 mm)

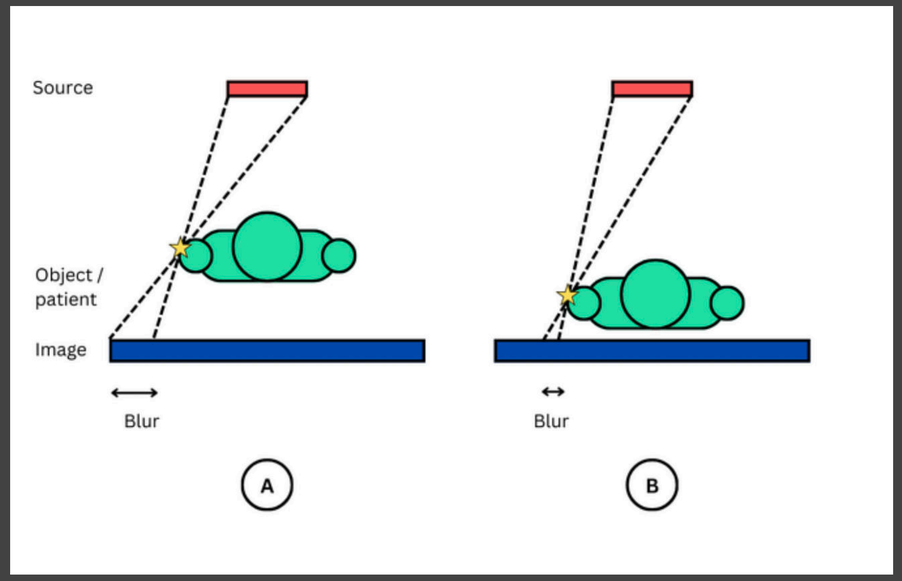


Fast scans (high pitch and short rotation times) -

-High x-ray output (heating) large focal spot

-Gantry Motion- reduced resolution





https://radiopaedia.org/cases/geometric-blur-illustrations#:~:text=Geometric blur is a type,and detector (image) 1.&text=where f = focal spot size,SOD = source to object distance.

High Spacial Resolution

Structures with high inherent contrast

Small voxel

- Small pixel (FOV and matrix)
- Thin slices

High Contrast Resolution

Structures with low inherent contrast

Reduce noice

Large voxel

- Large pixel (FOV and matrix)
- Thick slices

Fin!

Thanks for your attention