The Digital Dilemma

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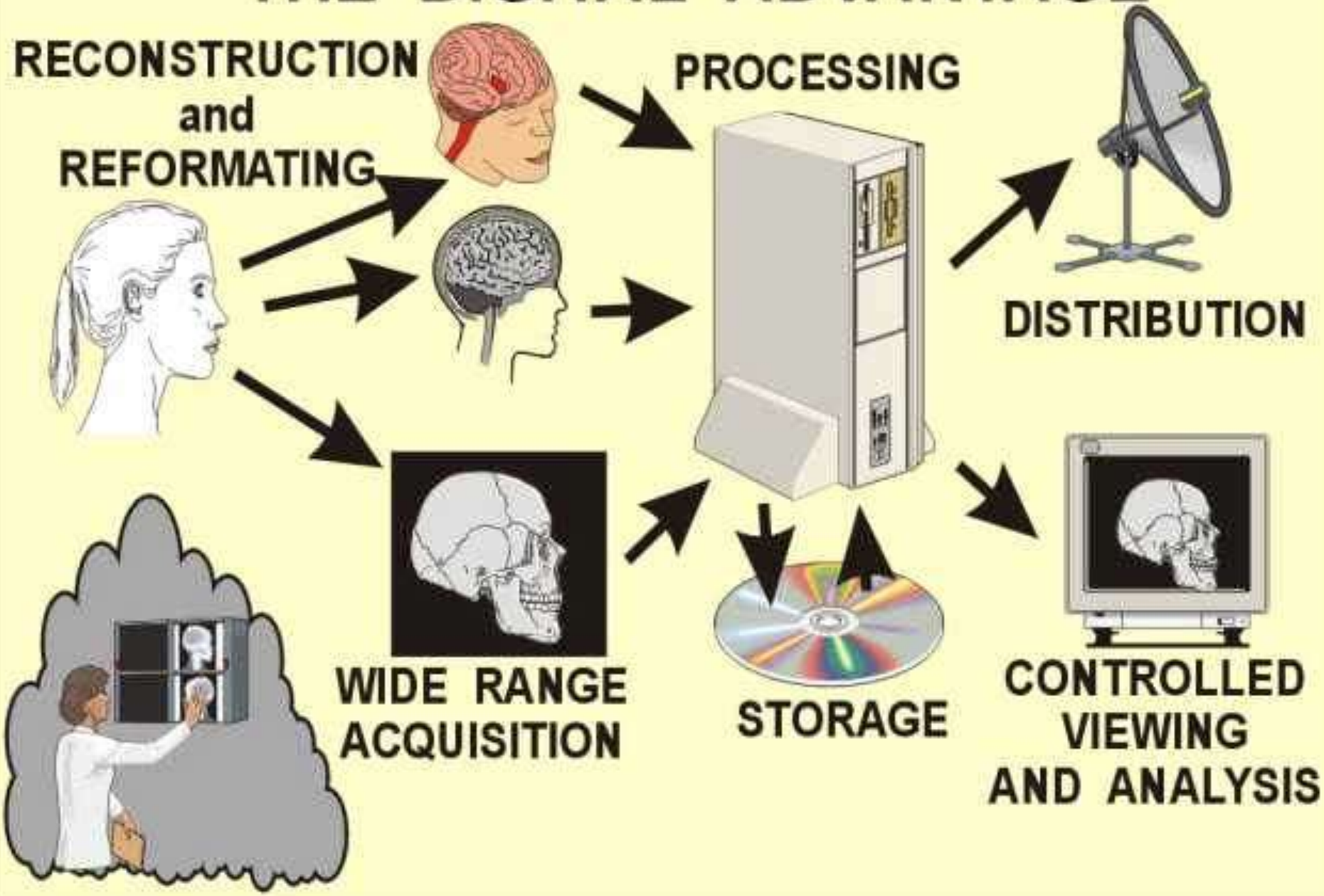
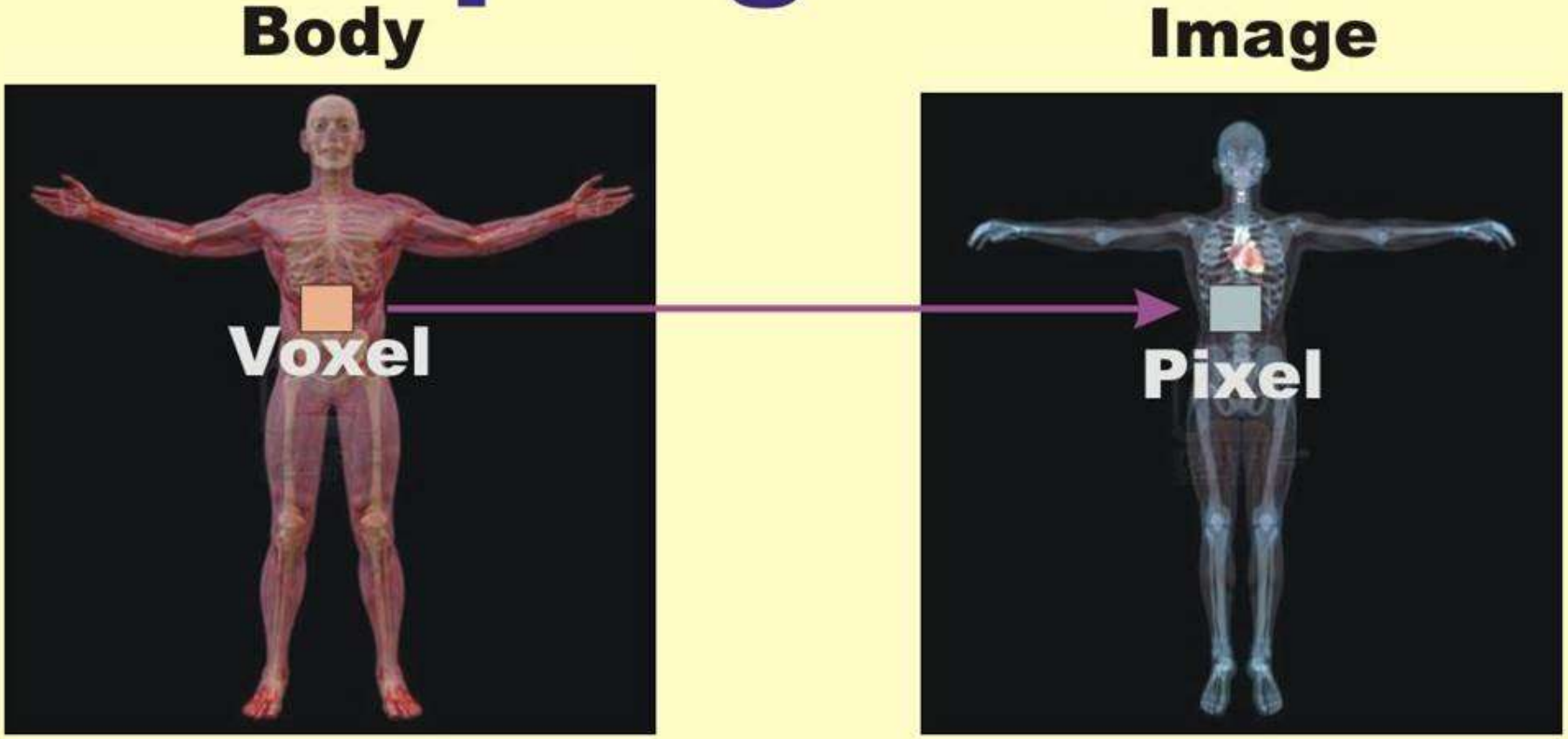
THE DIGITAL ADVANTAGE




strategy
What is the dilemma?

Digitizing is a Sampling Process



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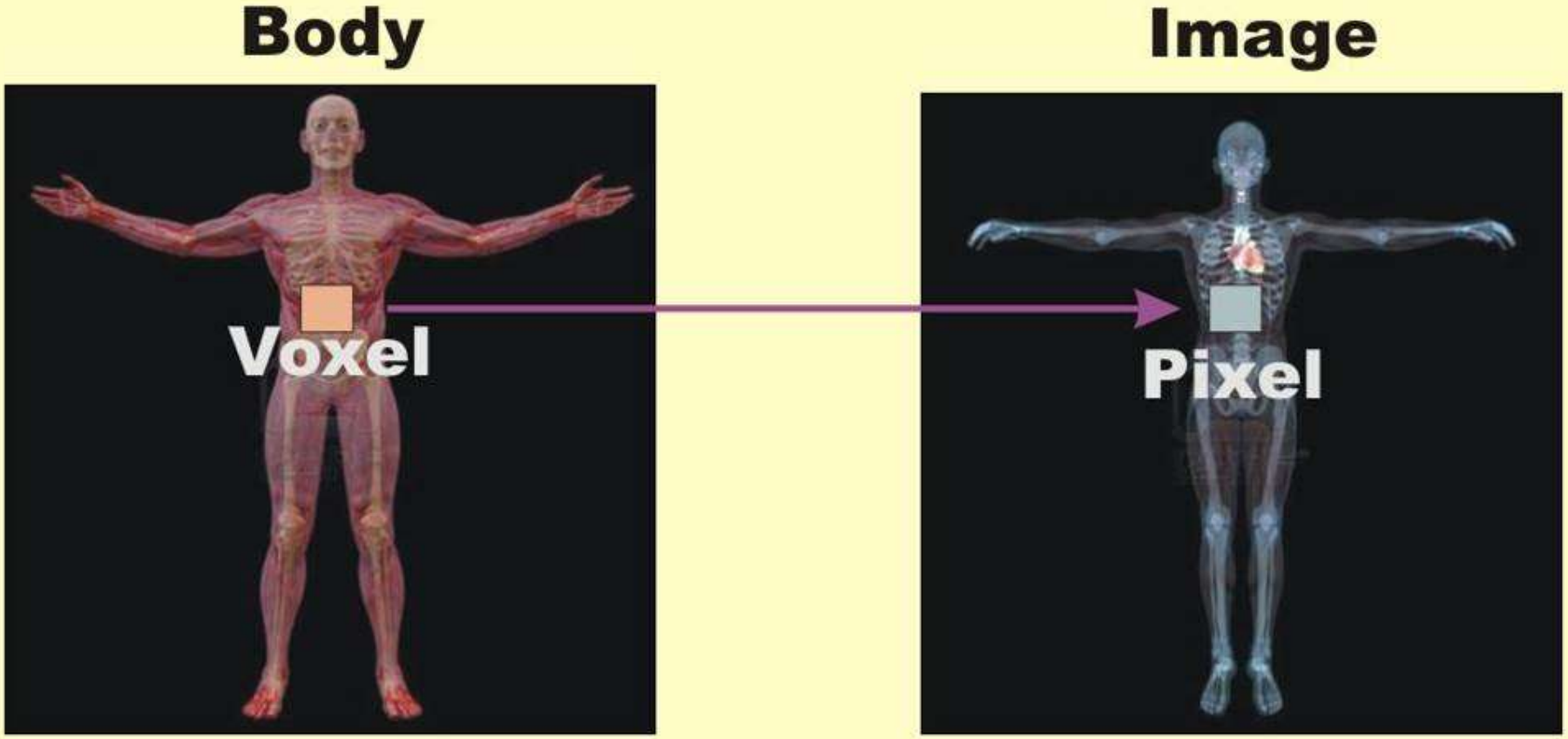
Sample Size (voxels and pixels) is a major factor in Image Quality



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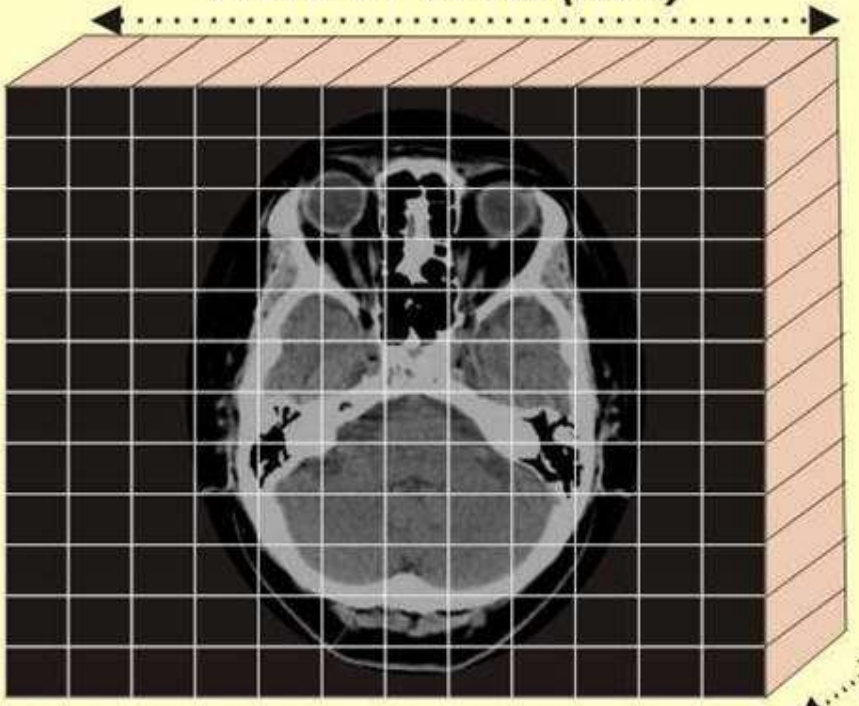
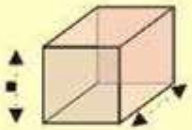
CT Slice Divided into Matrix of Voxels



FOV ÷ **Matrix** · · · · ·  **Slice Th.**

Voxel Size Controlled By

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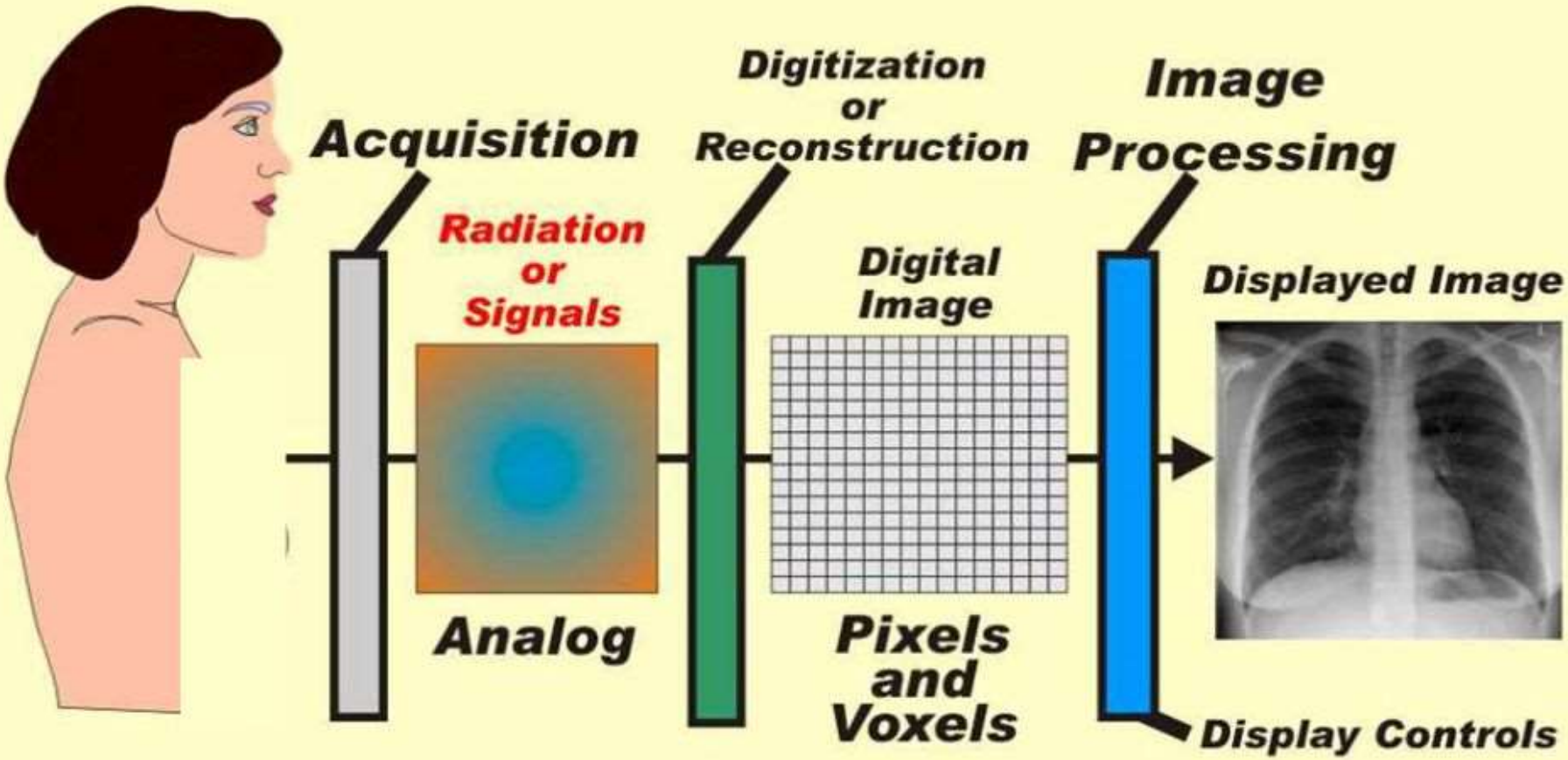
The Medical Imaging Process
All Modalities



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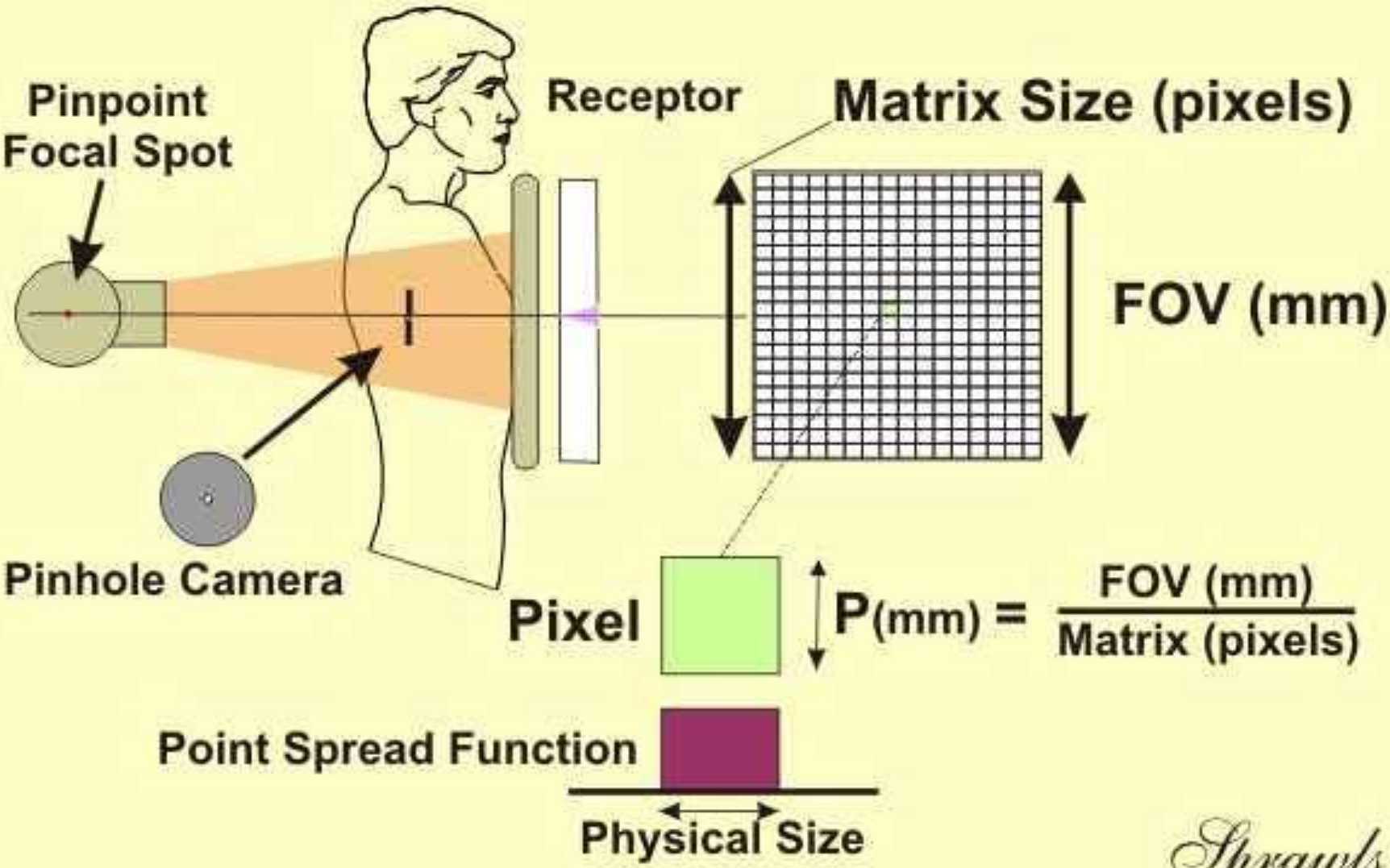
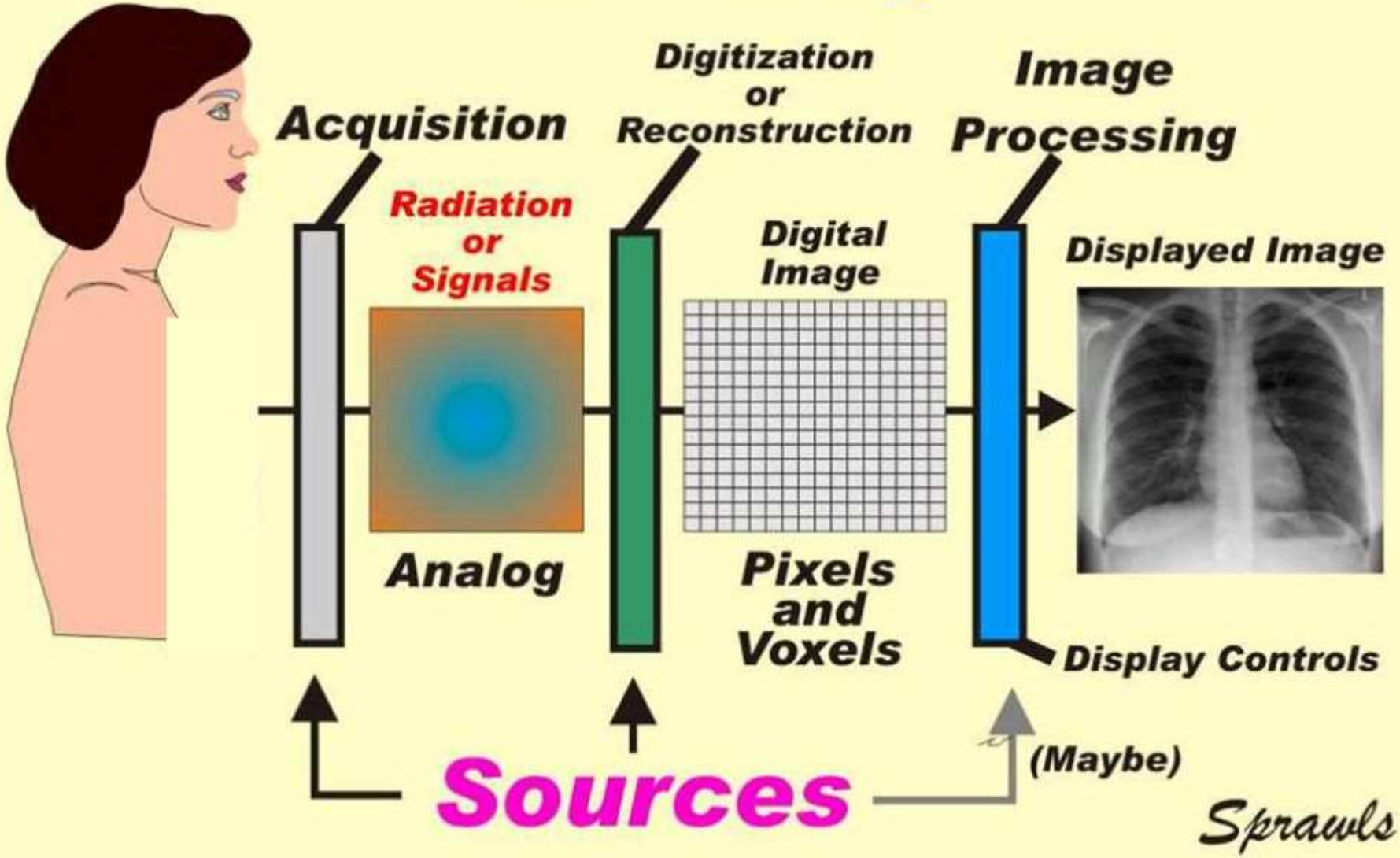
Pixel Blurring



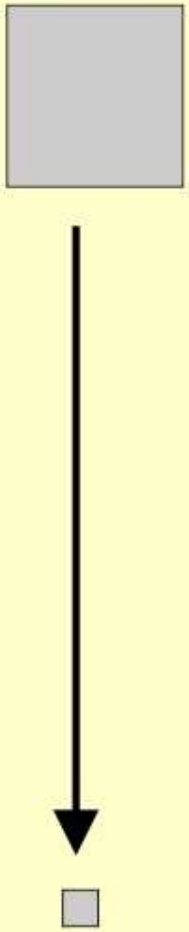
The Medical Imaging Process

Blurring

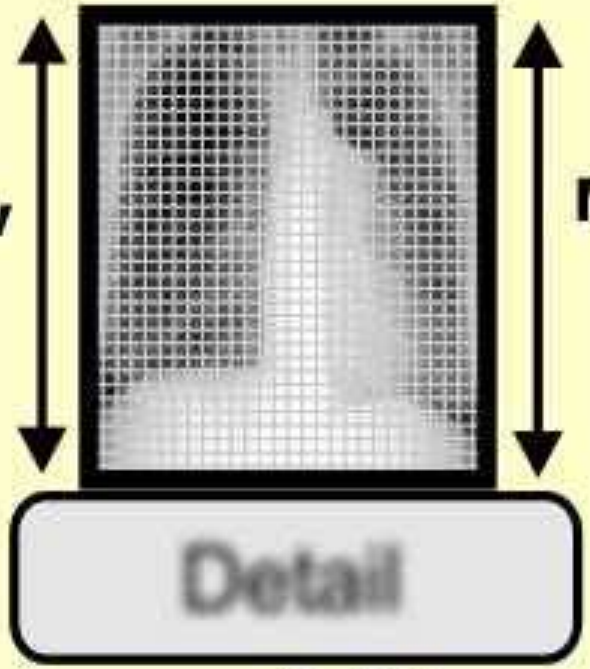


Pixel Size

Modality	Matrix
Radionuclide Imaging	128 x 128
MRI	256 x 256
Ultrasound	256 x 256
CT	512 x 512
Fluoroscopy	1024 x 1024
General Radiography	2048 x 2048
Mammography	4,096 x 5120



Digital Radiograph



Sources of Blurring

Focal Spot

Motion

Receptor

Pixel Size

Digital Image Processing

$$\frac{\text{Field of View}}{\text{Matrix Size}}$$

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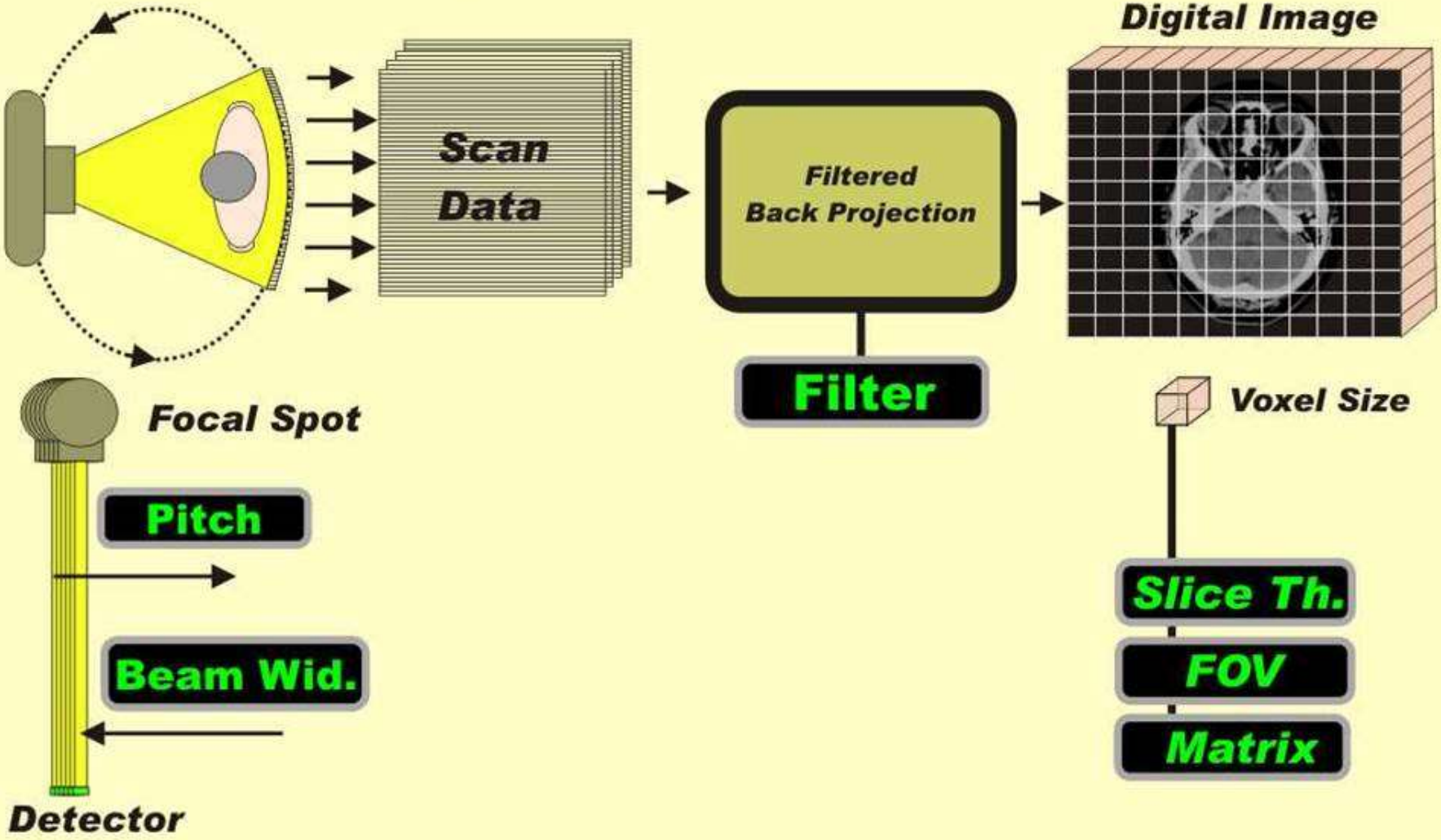
Factors That Determine Image Detail (Sources of Blurring)



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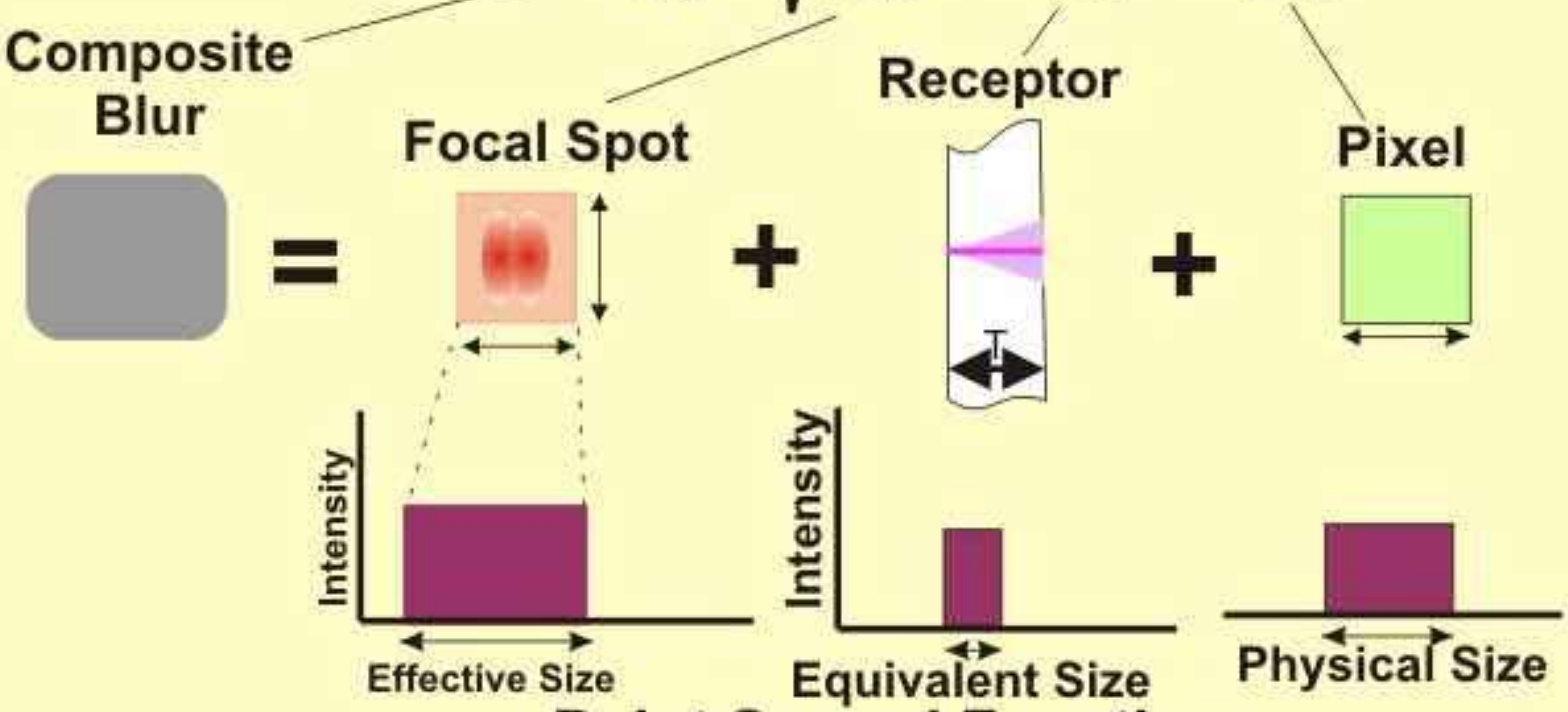
Composite Blur

Optimization

$$B_c = \sqrt{B_{fs}^2 + B_r^2 + B_p^2}$$



Point Spread Functions

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The Medical Imaging Process

Blurring

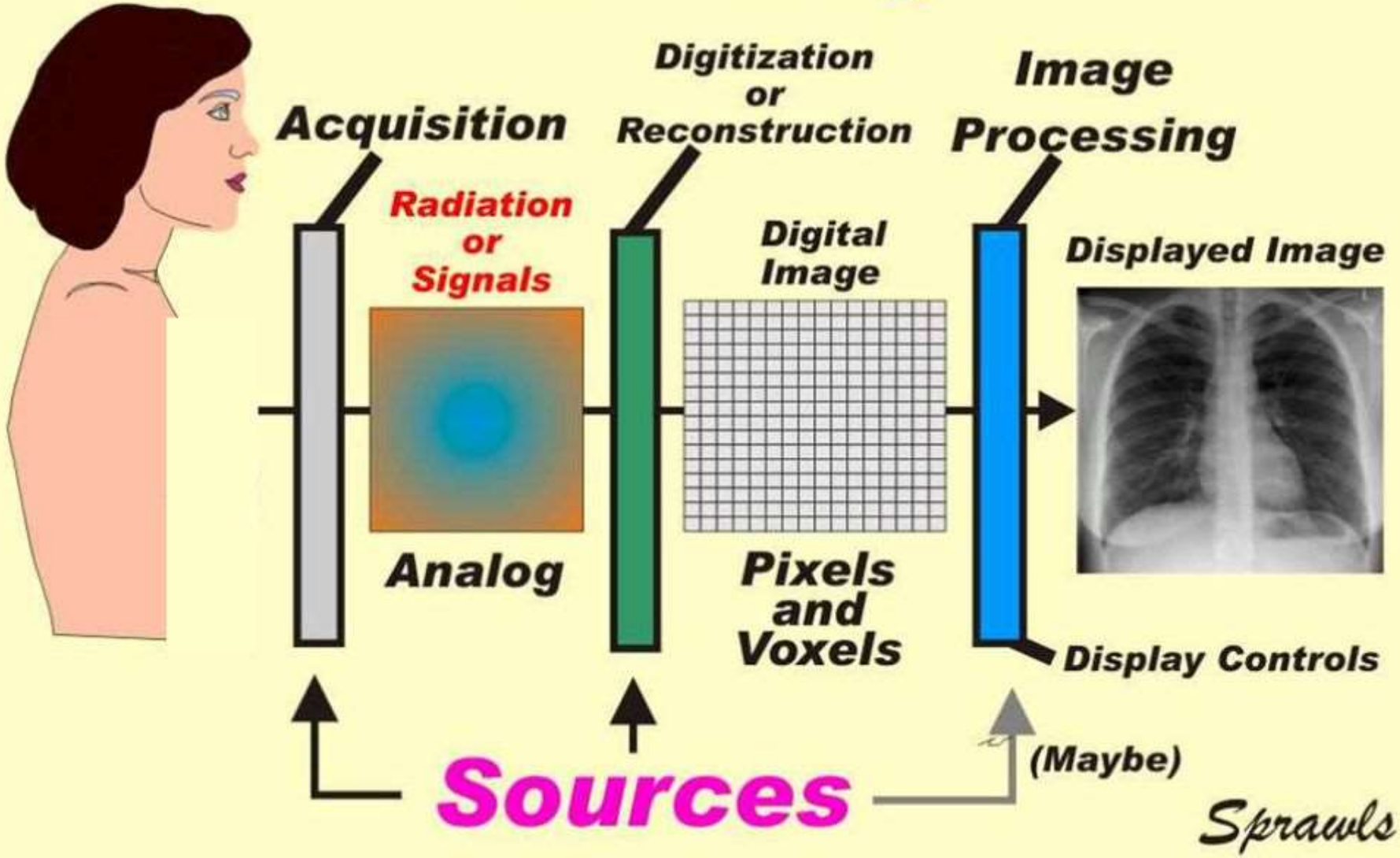

IMAGE NOISE

LOW

HIGH

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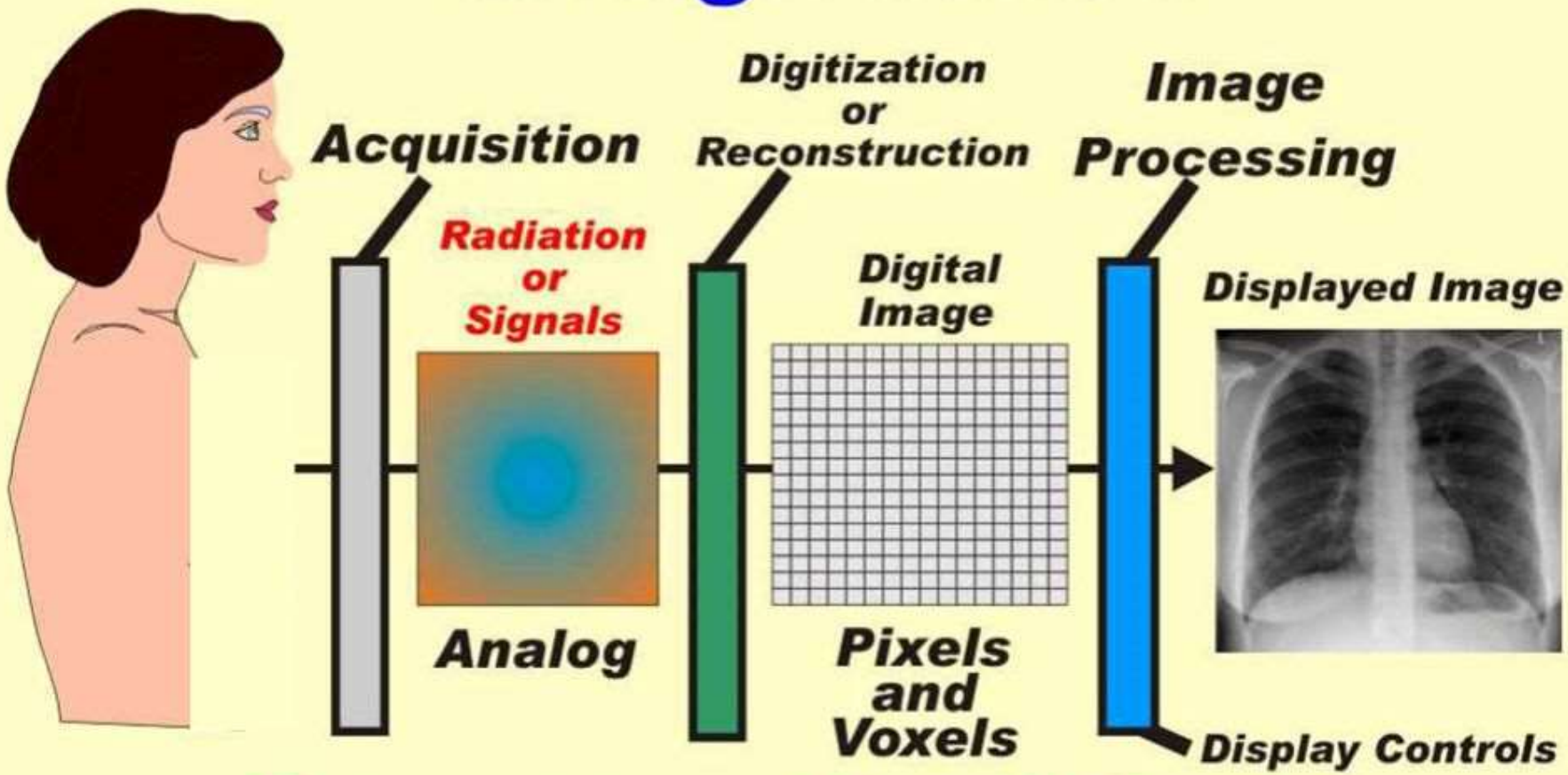
The Medical Imaging Process

Image Noise



Source **Modified**

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X-Ray Image Noise

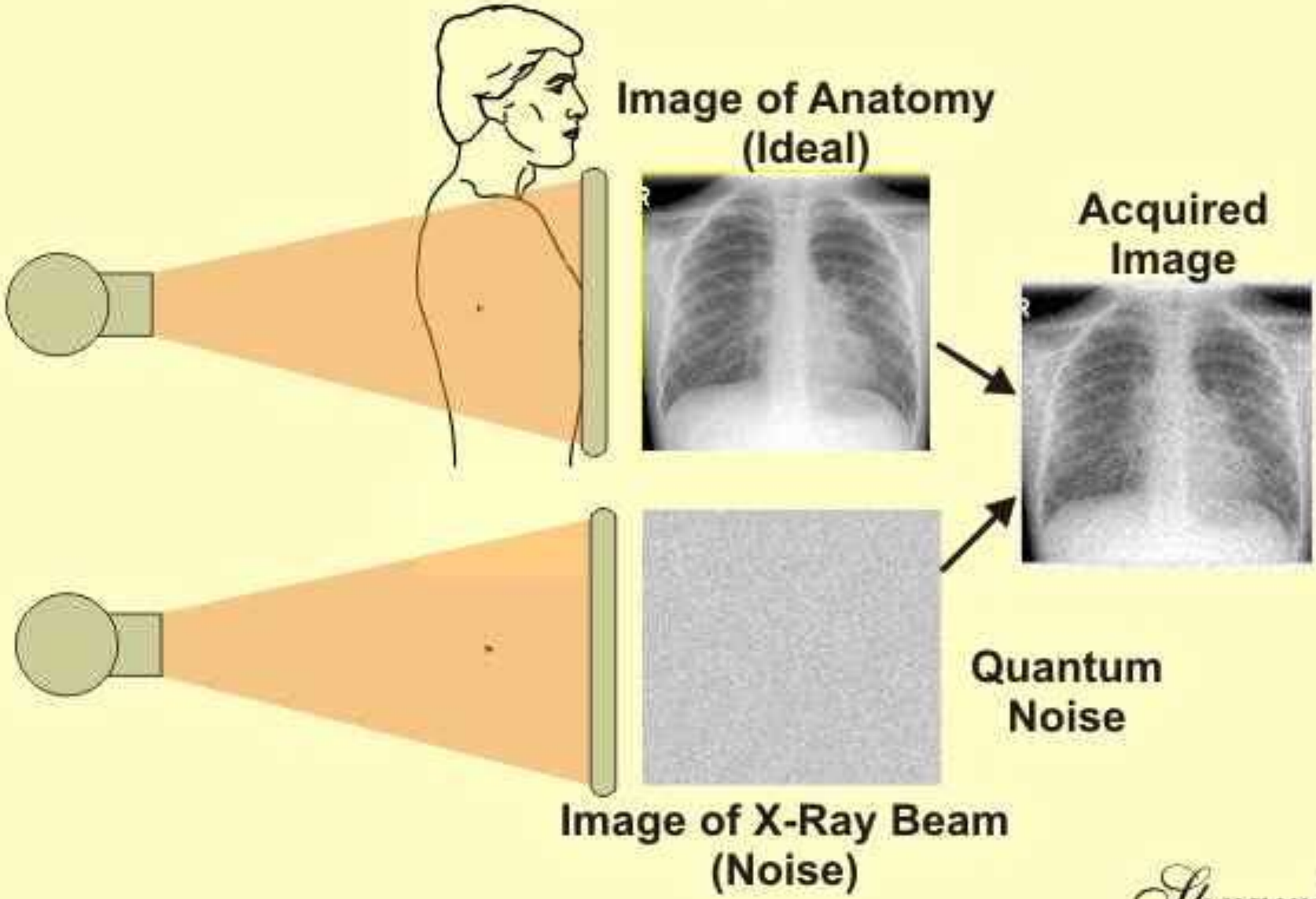

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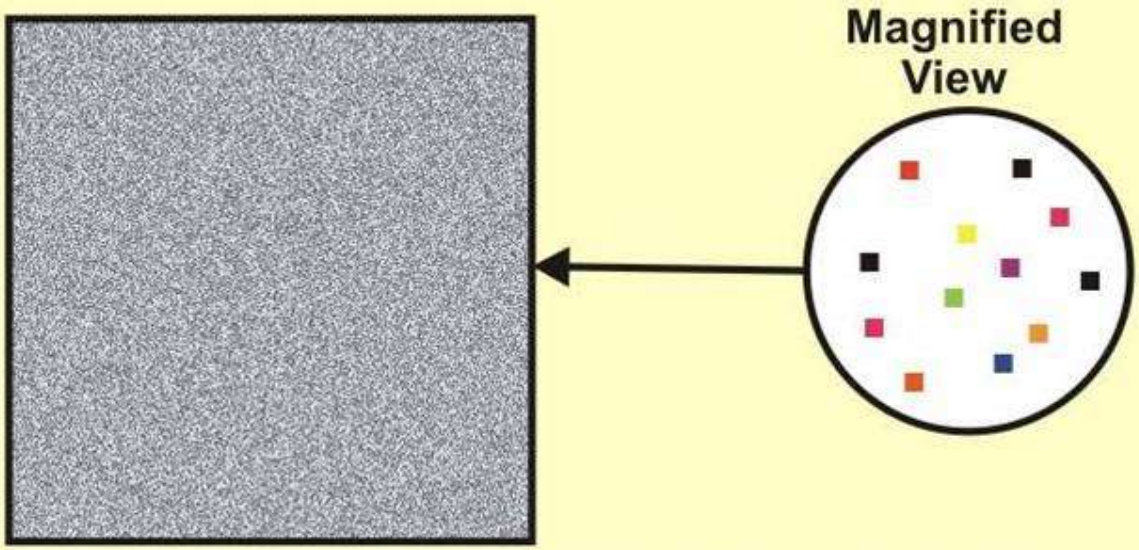
Image Of An X-ray Beam

A Random Distribution of Photons



This is visible in an x-ray image as noise (quantum noise).

High **Medium** **Low**

— Photon Concentration (Exposure)→

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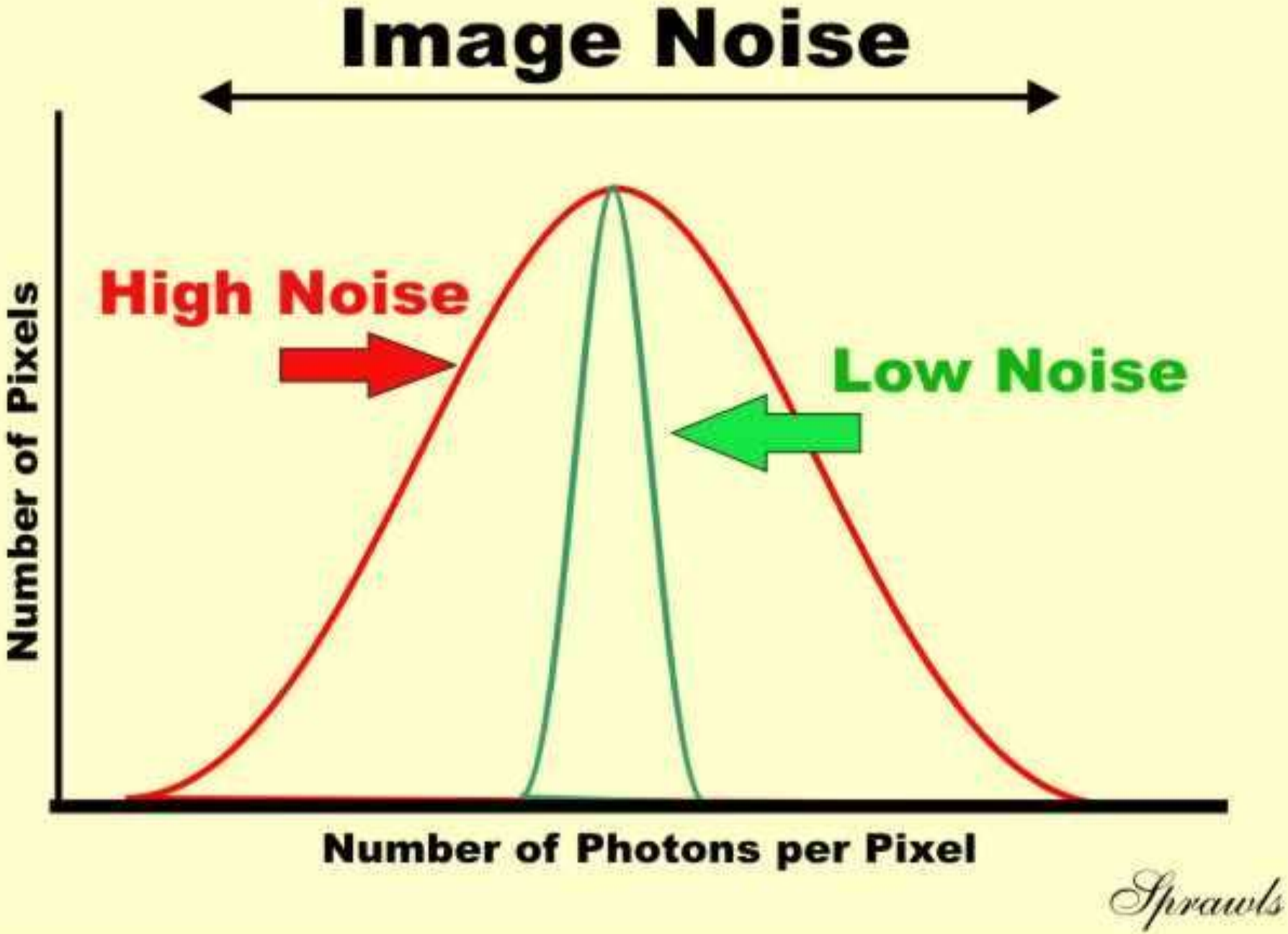
Image Noise
High Noise
Low Noise
Number of Pixels
Number of Photons per Pixel
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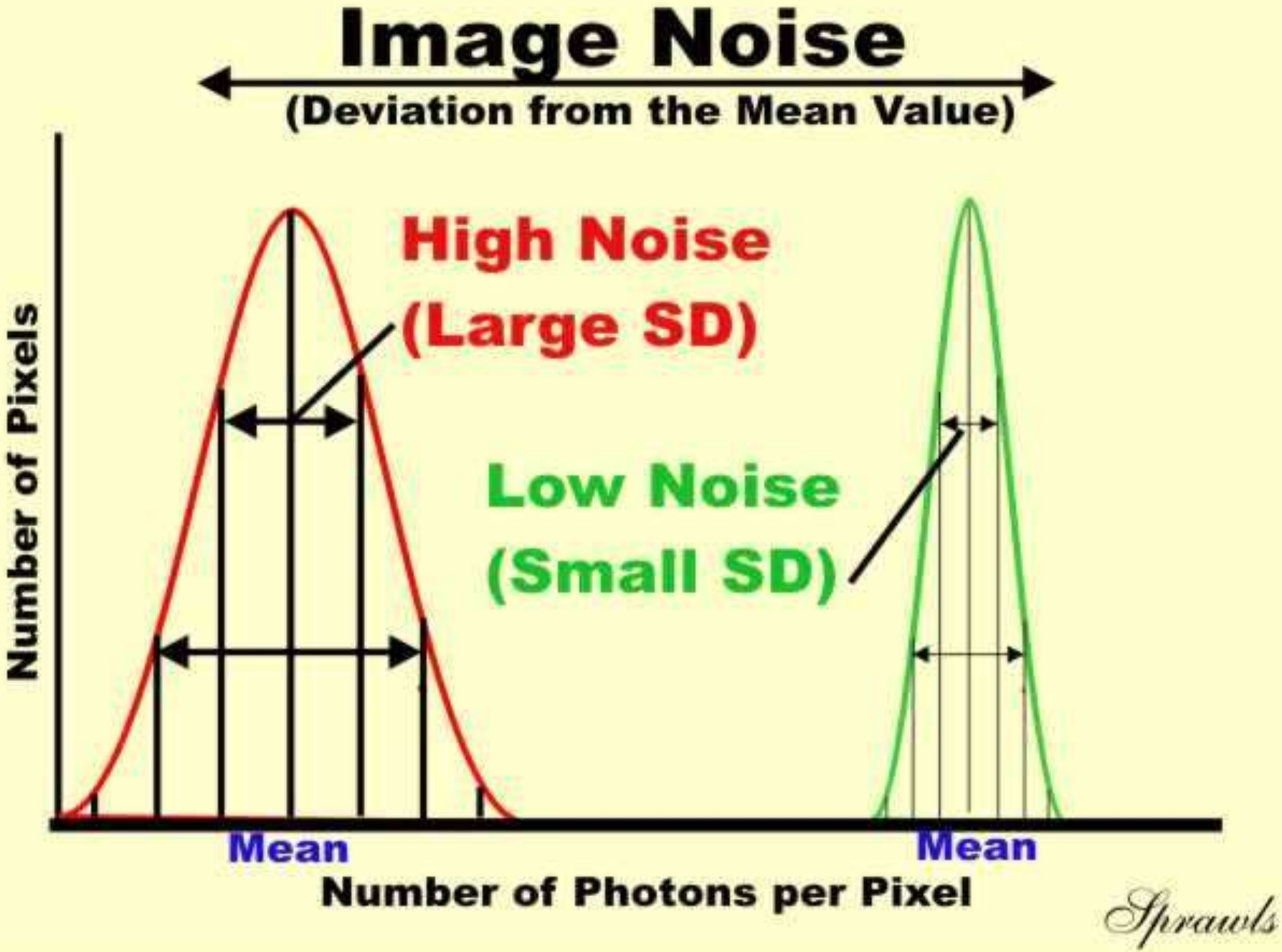
Image Noise
(Deviation from the Mean Value)
High Noise
(Large SD)
Low Noise
(Small SD)
Number of Pixels
Mean
Mean
Number of Photons per Pixel
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Digital X-ray Imaging

Pixel Size

Small	Medium	Large
High	Medium	Low

Image Noise

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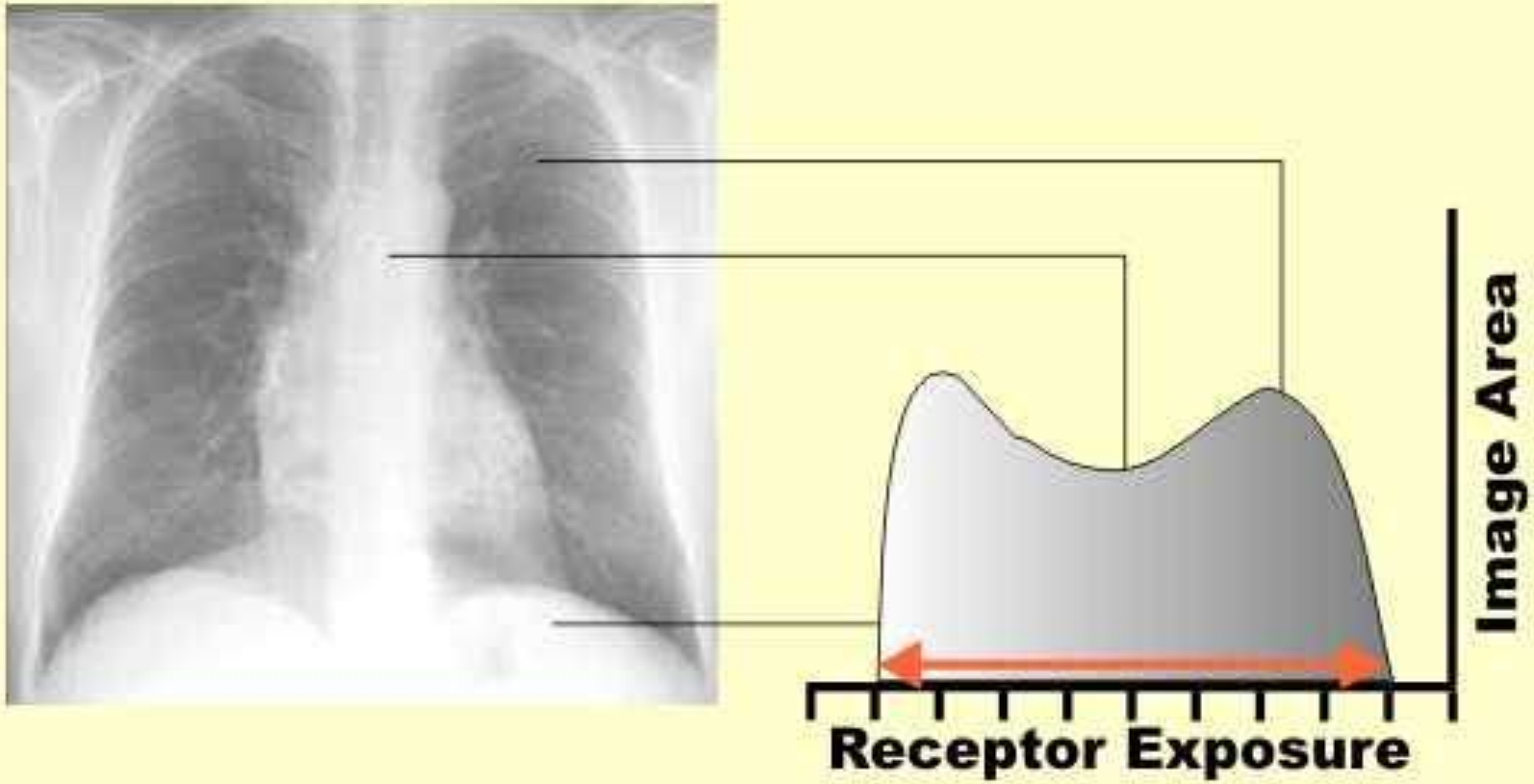
Range of Exposure to the Receptor Histogram



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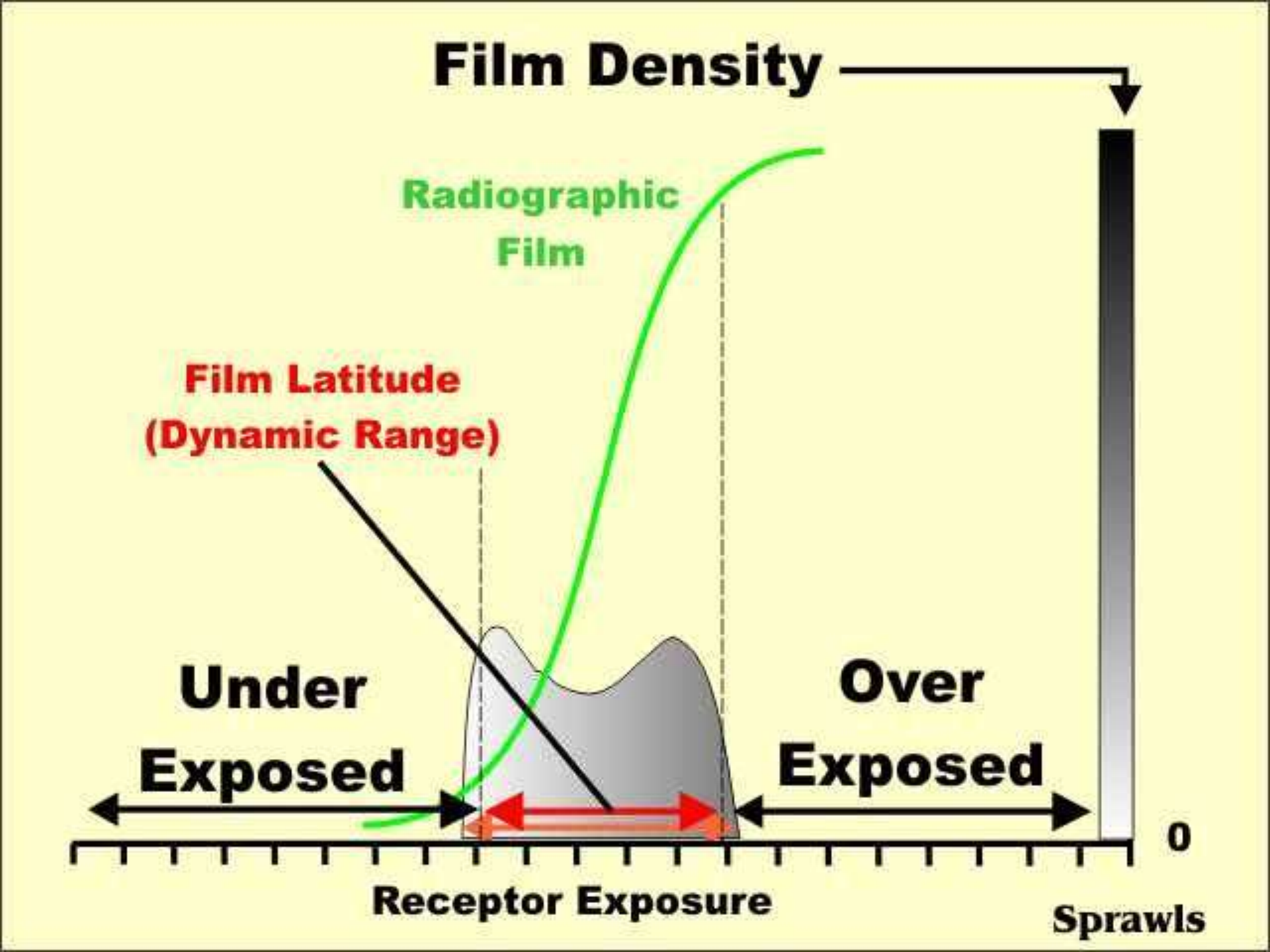
Film Density
Radiographic Film
Film Latitude (Dynamic Range)
Under Exposed
Over Exposed
0
Receptor Exposure
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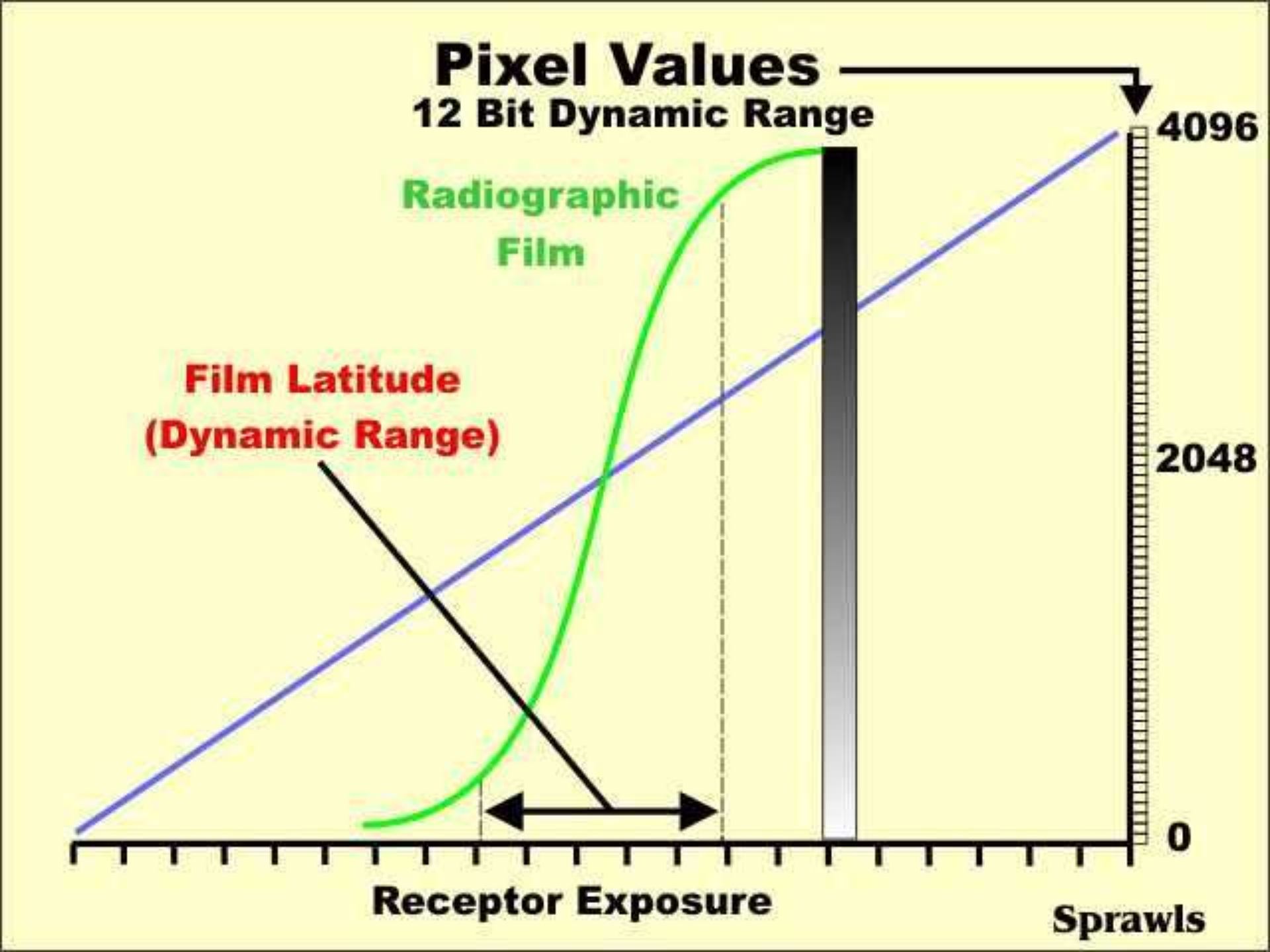
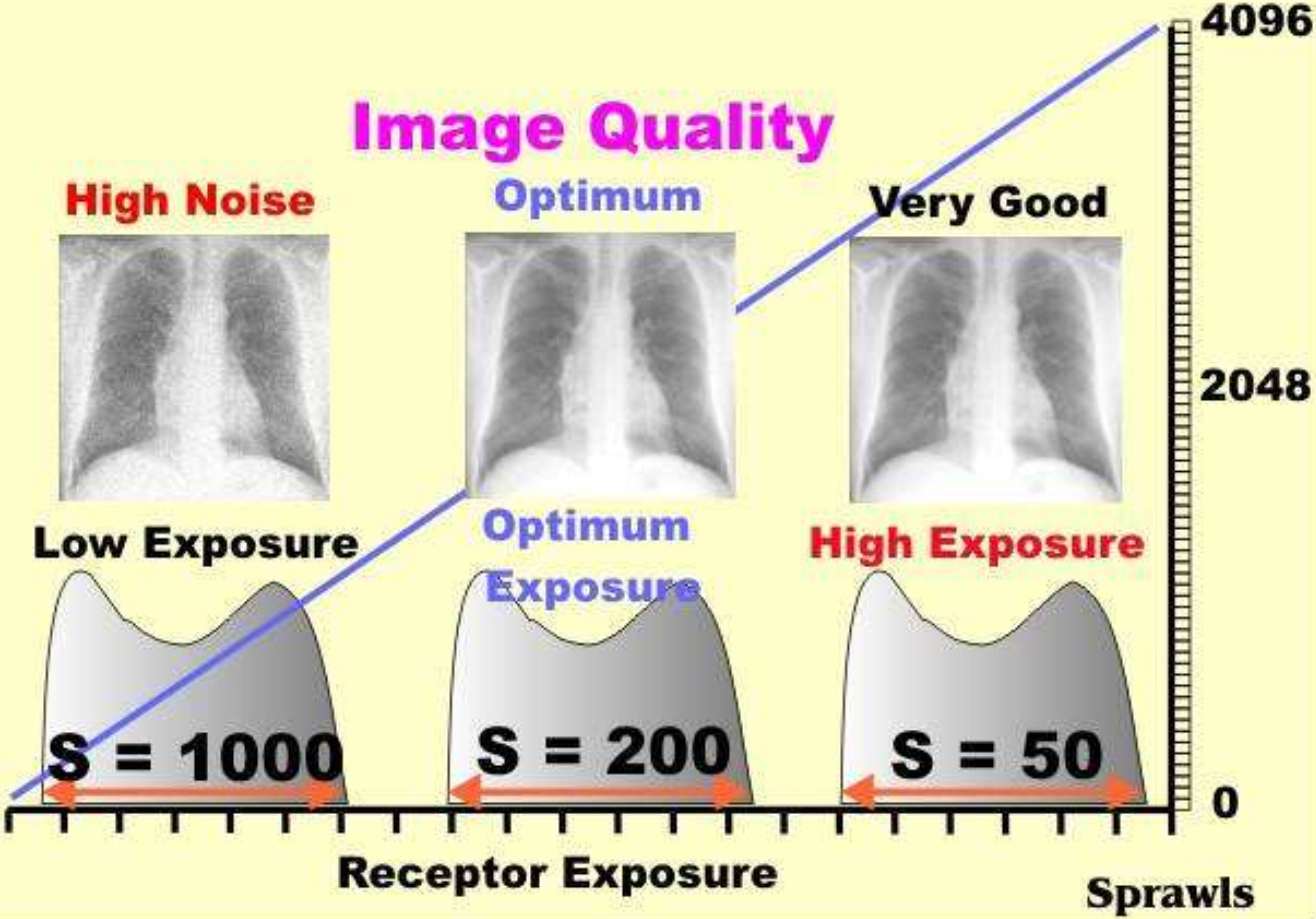
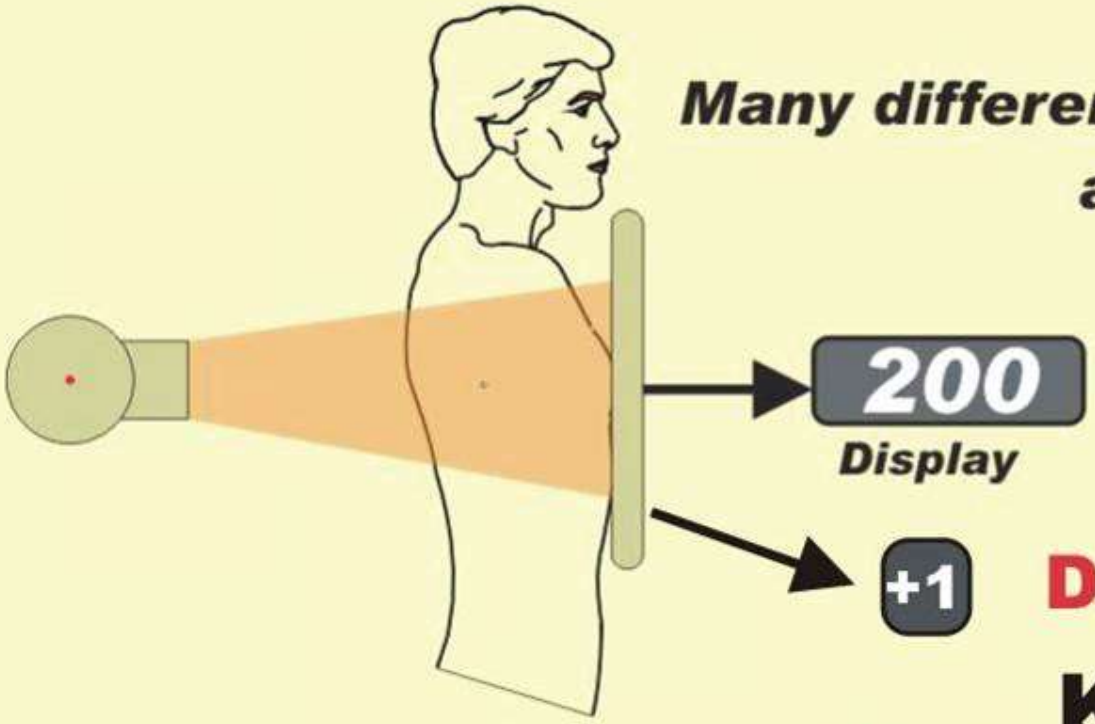

Pixel Values
12 Bit Dynamic Range
4096
2048
0
Radiographic
Film
Film Latitude
(Dynamic Range)
Receptor Exposure
Sprawls

Effect of Exposure on Image Quality



Receptor Exposure Indicator



Many different names, quantities, and units

Exposure Index

Deviation Index

$$DI = \frac{K\ (\text{Indicated})}{K\ (\text{target})}$$

Set for specific procedure

Ref: AAPM Report 116

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Sample Size (voxels and pixels) is a major factor in Image Quality

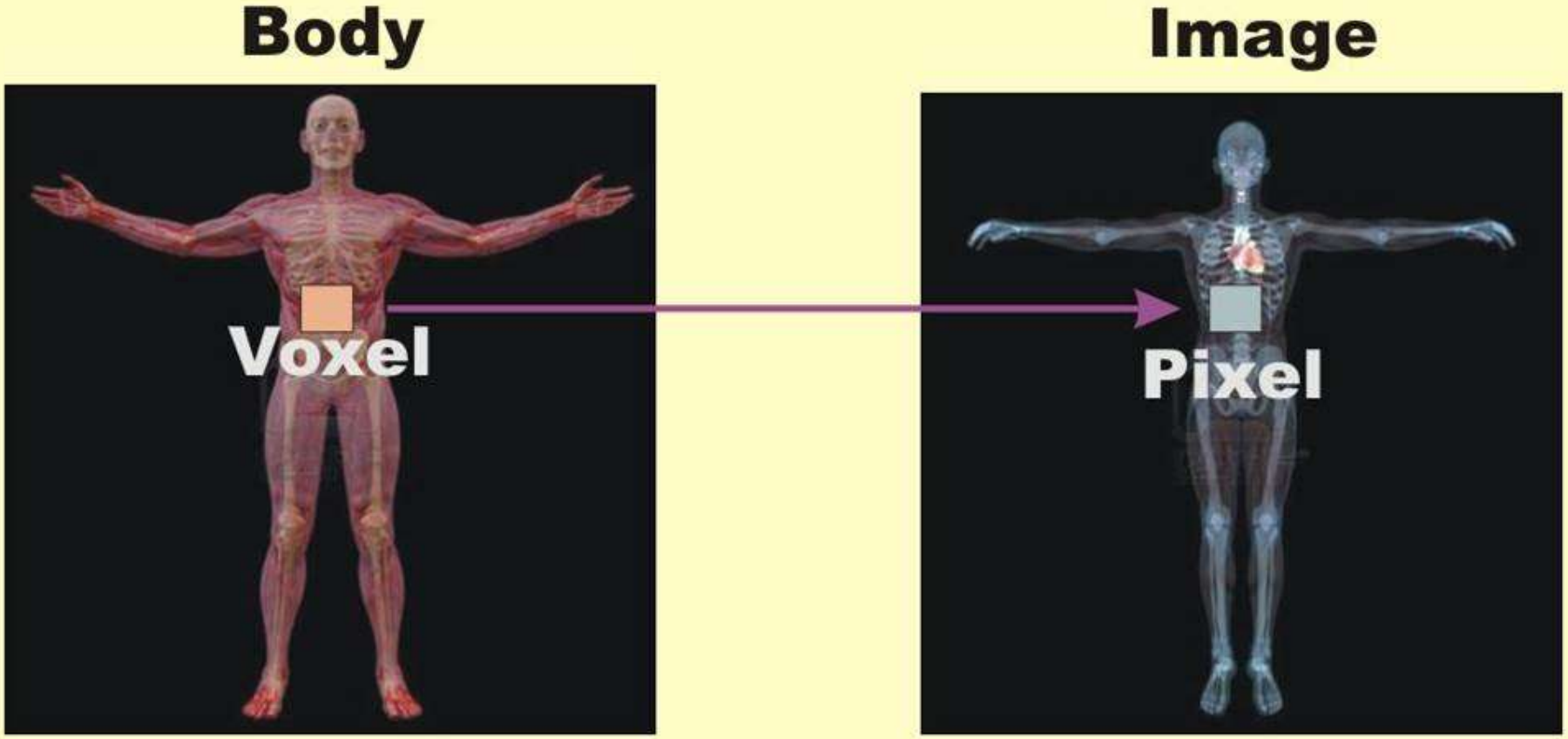

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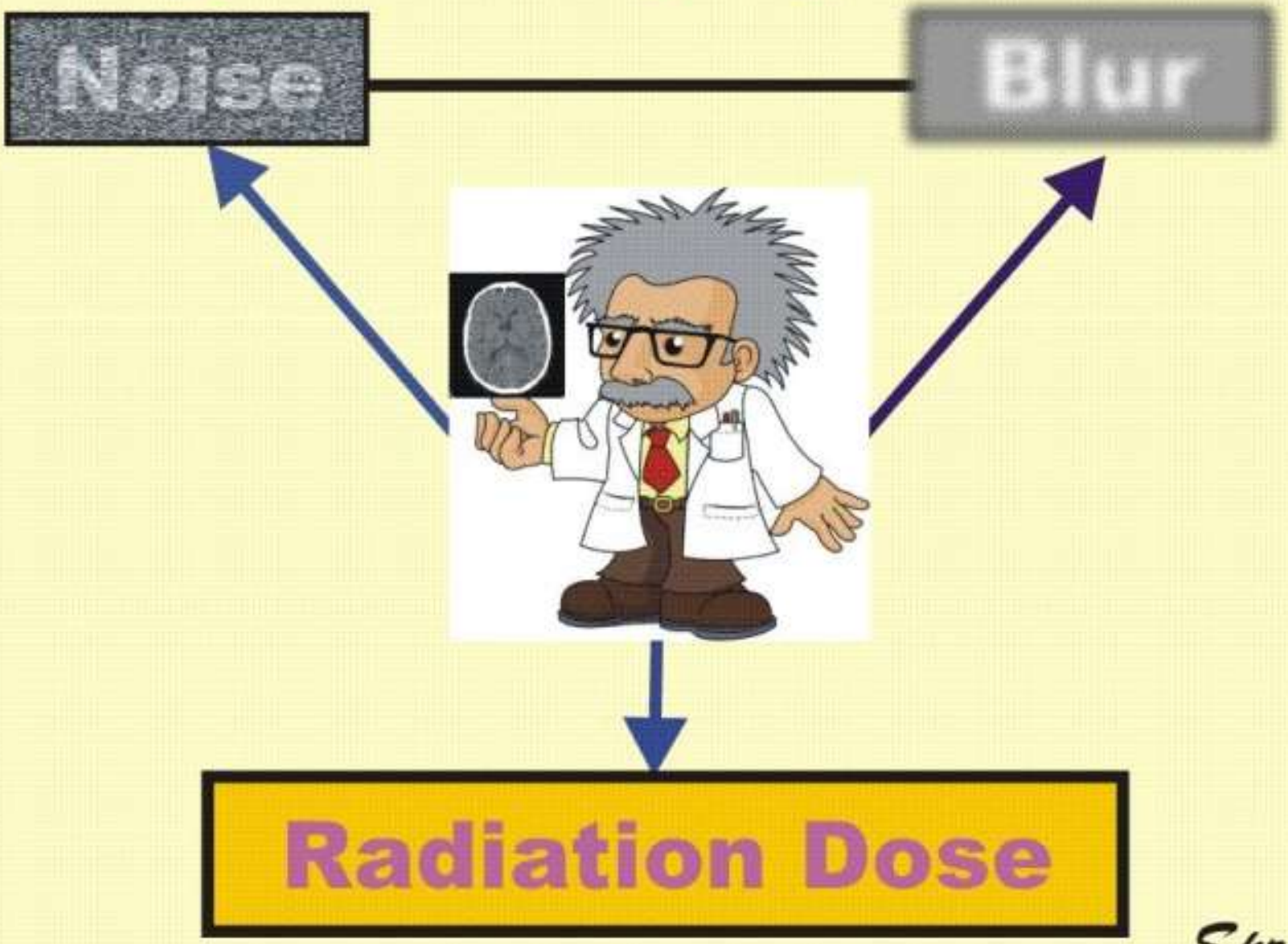
Image Quality Optimization



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