

Image Quality: Resolution vs. Noise

Dr. Martin Zulliger
SCANCO Medical AG

www.scanco.ch



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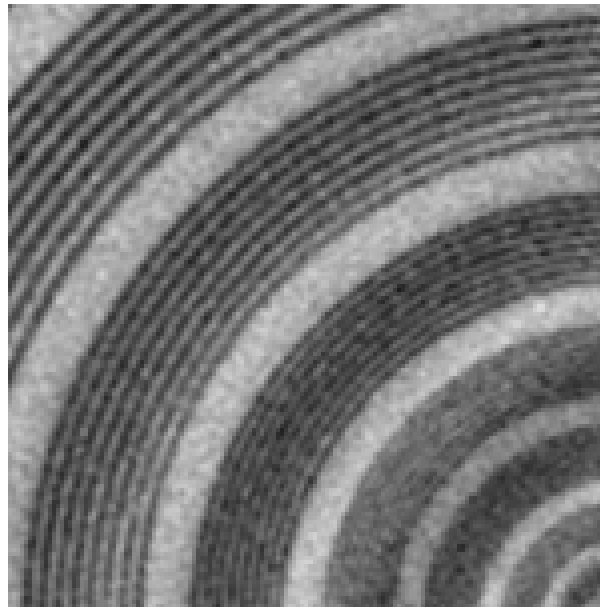
Image Quality

- Resolution
 - ✓ Detector resolution, x-ray spot, geometry
 - ✓ Projections, reconstruction, image grid
- Signal / Noise
 - ✓ Scan time, x-ray power, dose
 - ✓ Detector, scanner geometry
 - ✓ Tissue contrast
- Artifacts



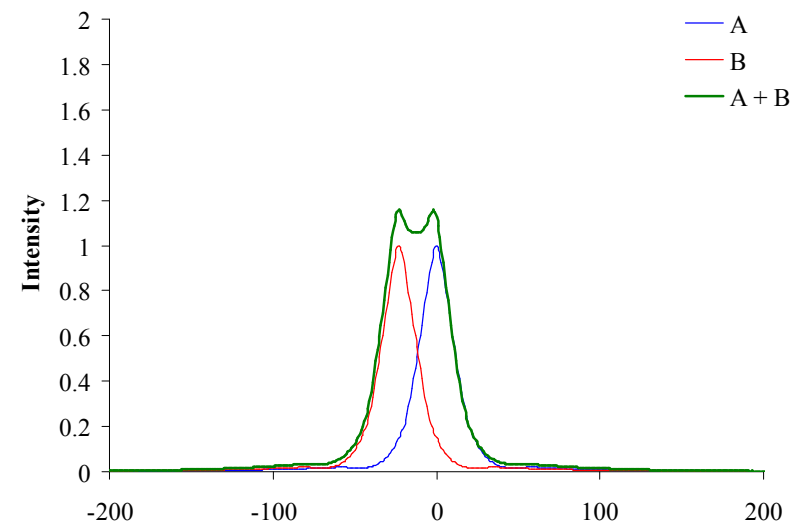
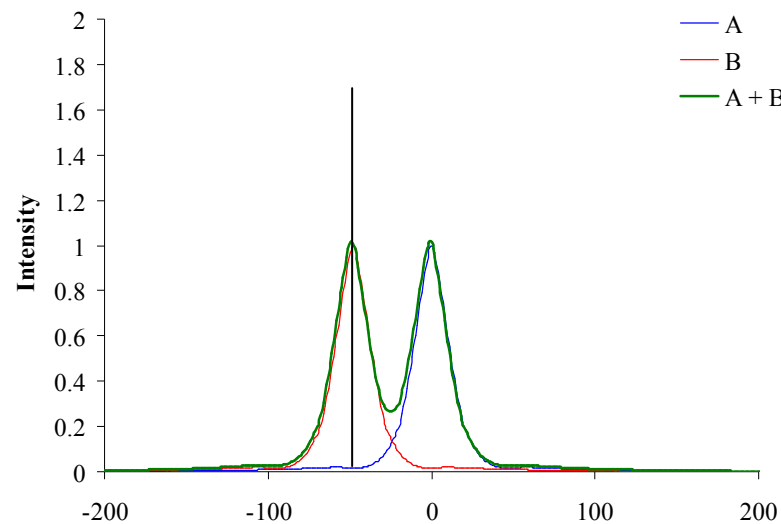
Resolution: Practical Definition

Distance between objects (or cavities) at which they can still be identified as independent from each other in an image

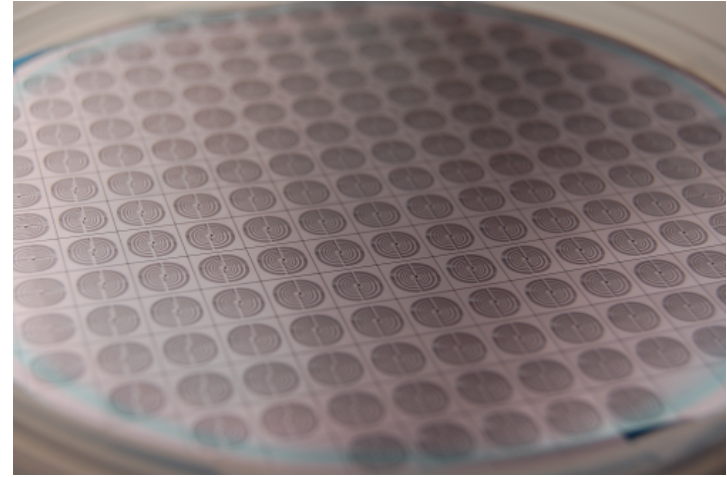


Point Spread Function (PSF)

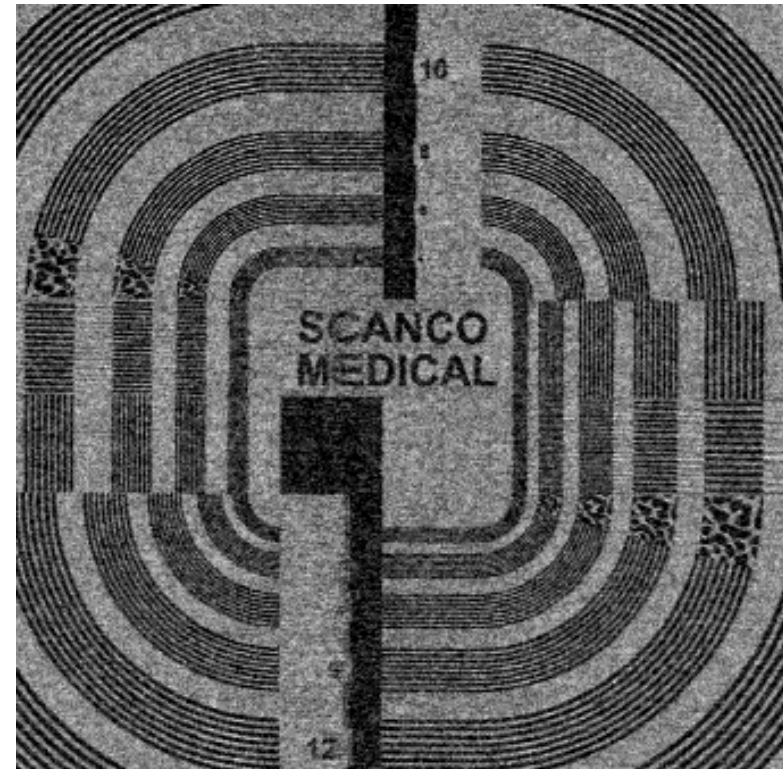
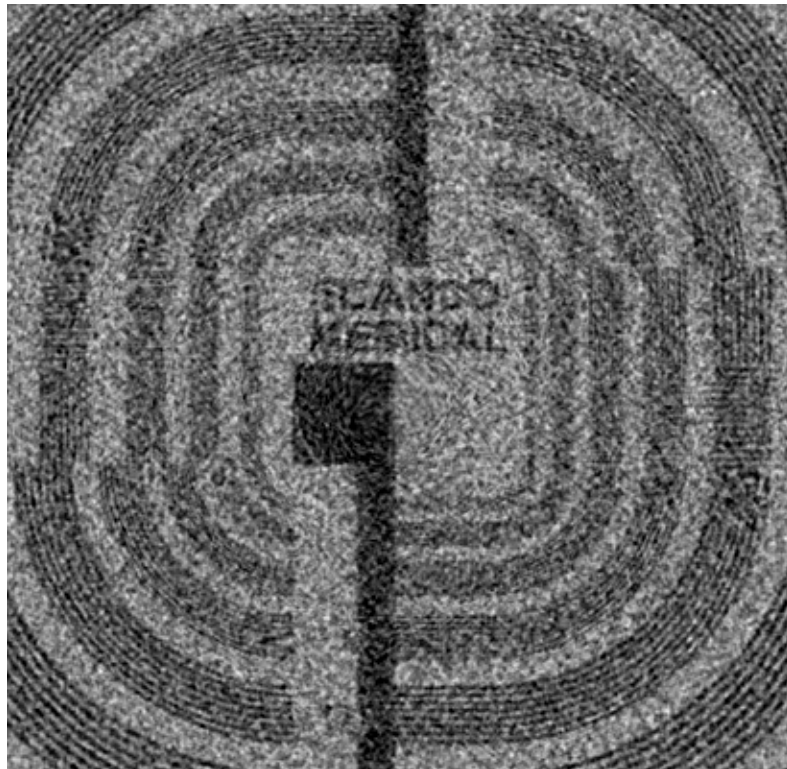
PSF: Describes how a single infinitesimally small point in the source object is spread out



Resolution Phantom



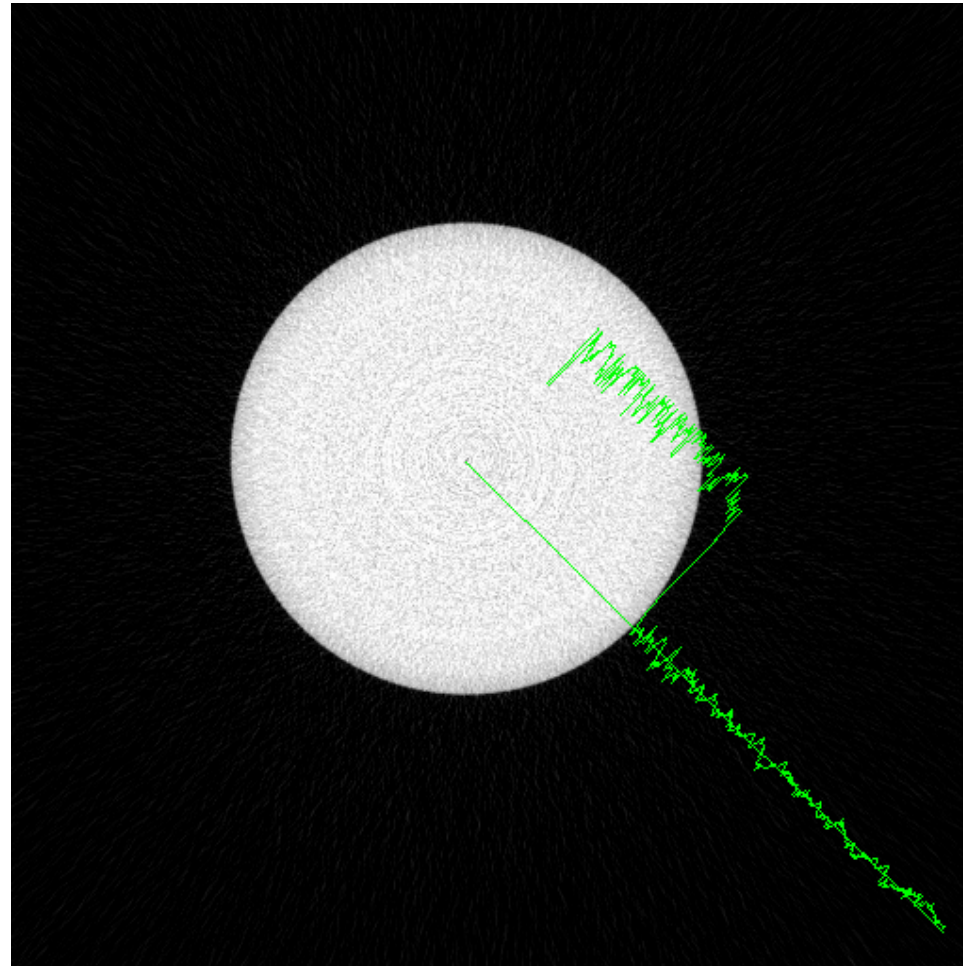
Signal-to-Noise Ratio



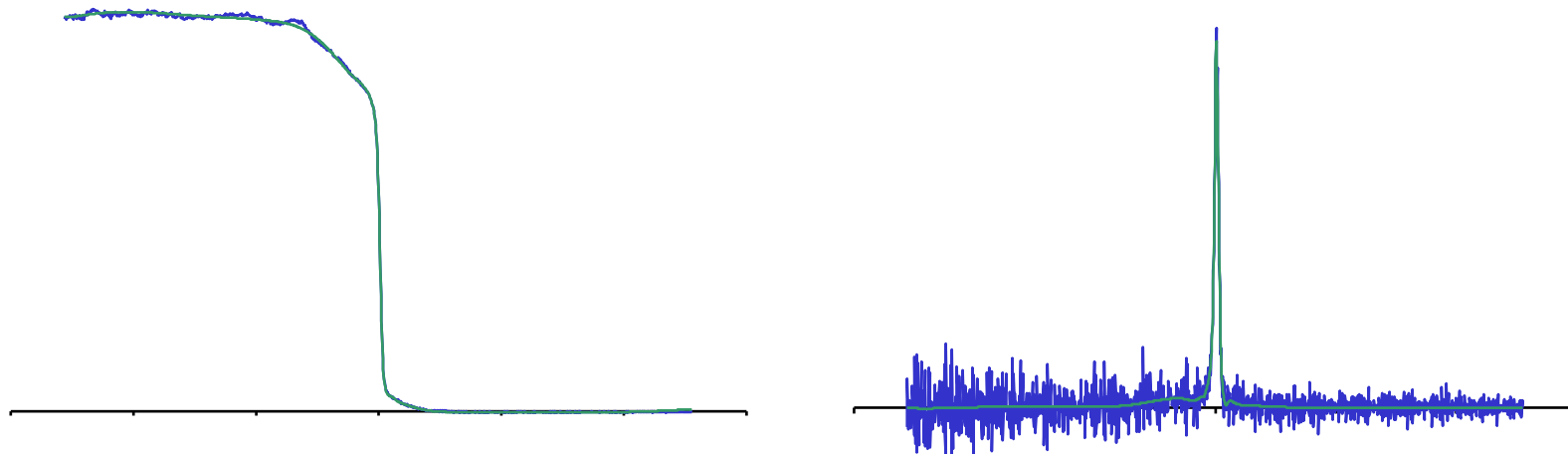
Same resolution, different scan times => different noise
X-ray source and interaction subject to Poisson-distribution



Alu Cylinder



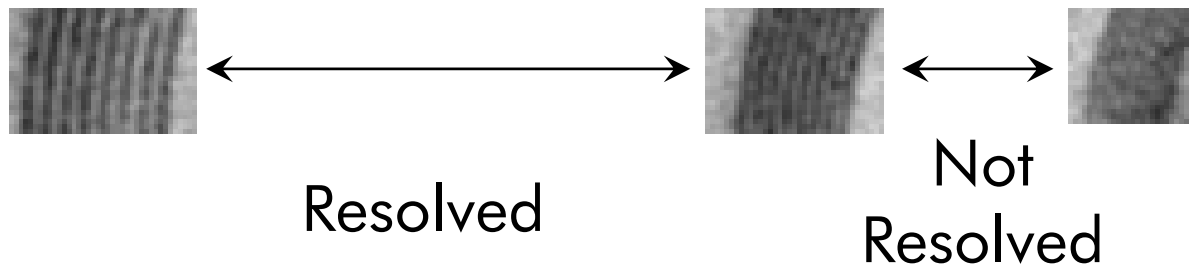
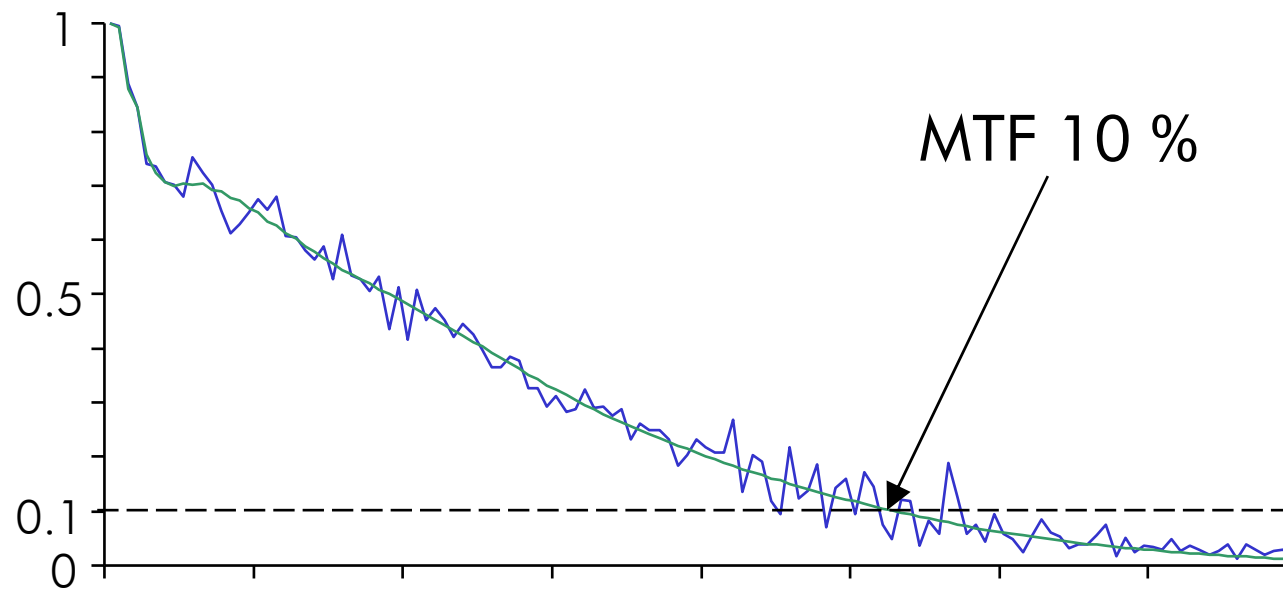
Edge and Point Spread Functions



- Derivative of ESF is PSF
- Scattering etc visible in ESF but not major determinants of PSF
- Special noise reduction makes PSF more transparent

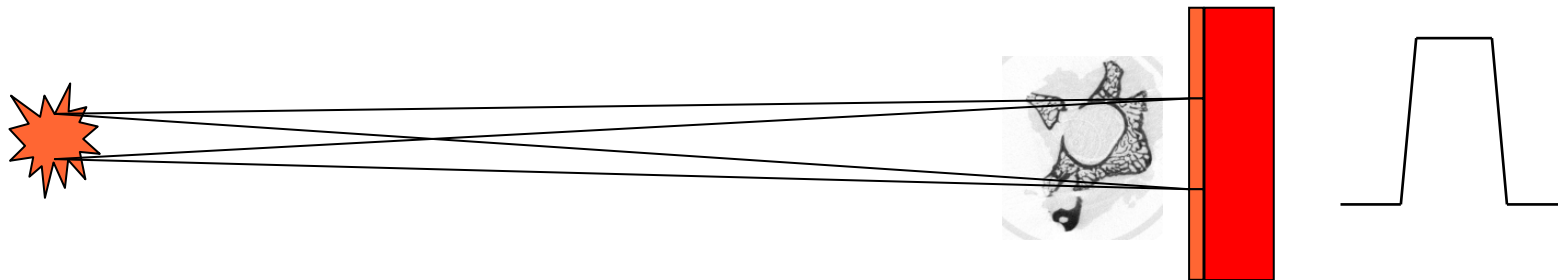


MTF



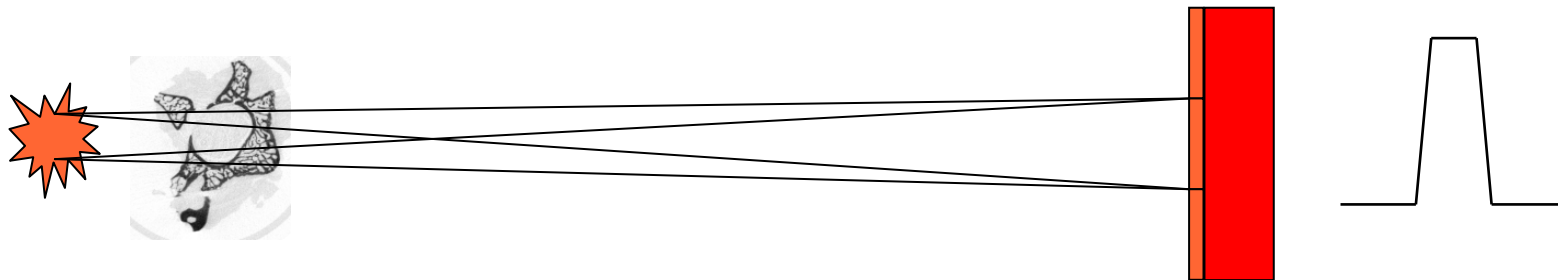
Scanner Geometry: The Sweet Spot

- Source Width and Detector Element Width are major determinants of overall PSF
- Convolution of the two at object position gives a geometry component estimate



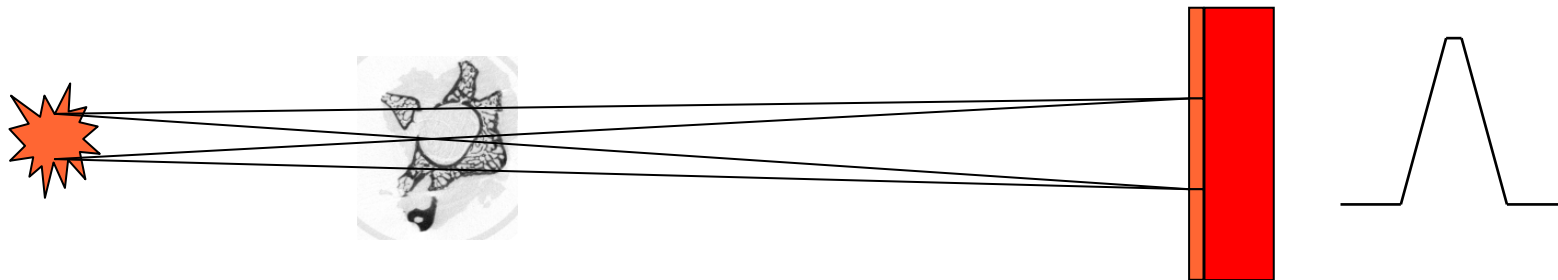
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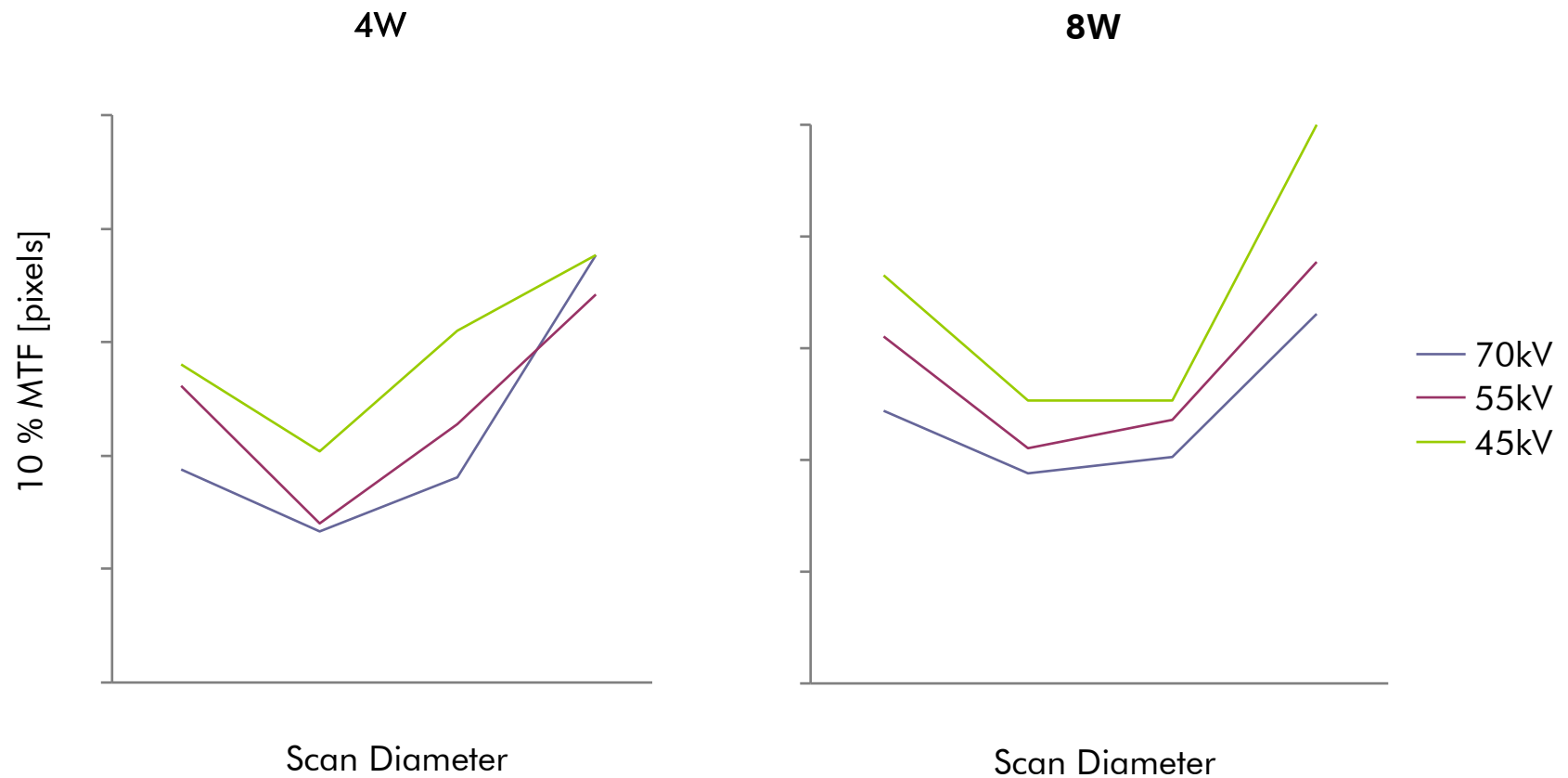


Scanner Geometry: The Sweet Spot

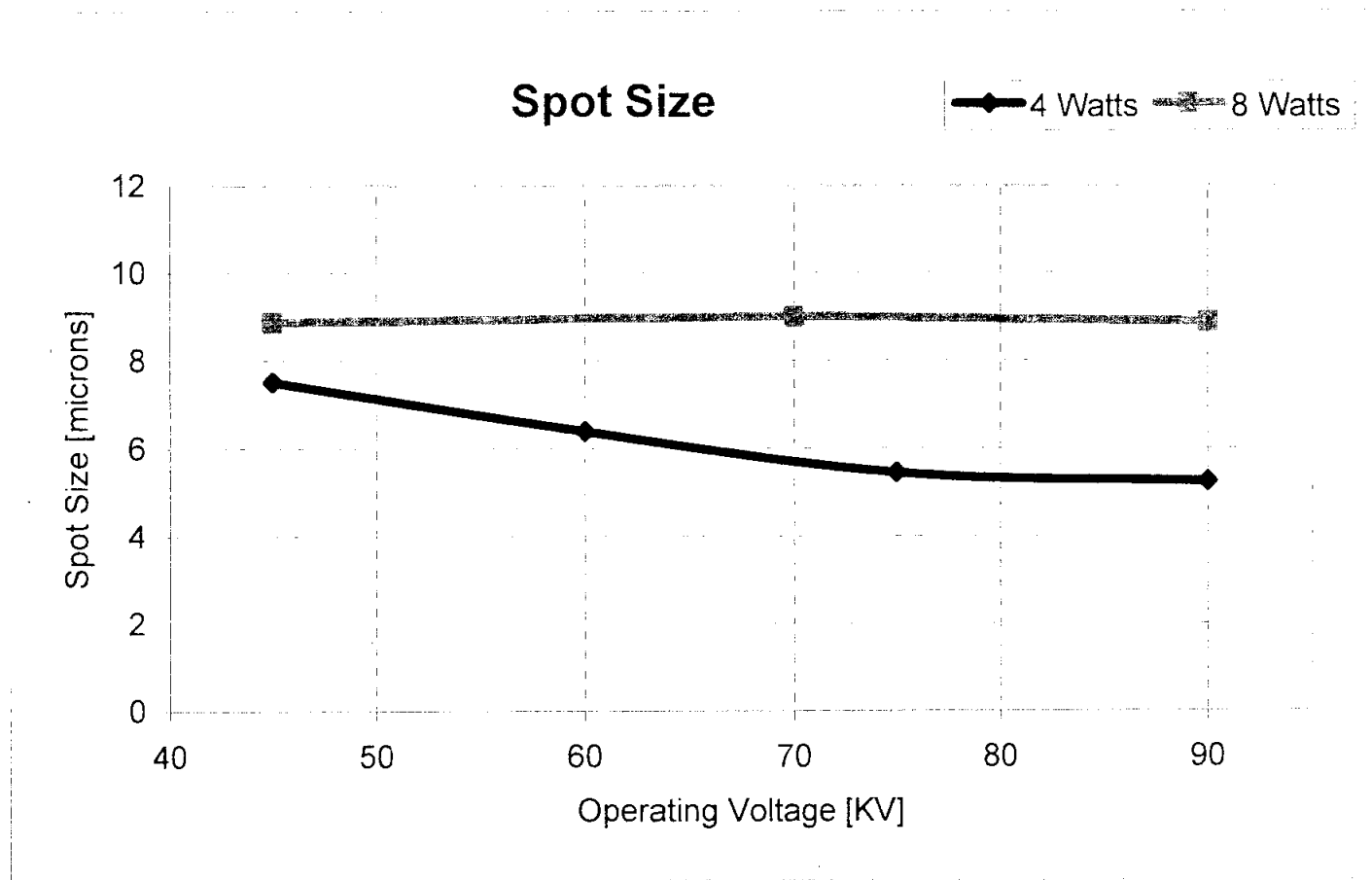
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Best Resolution Per Pixel

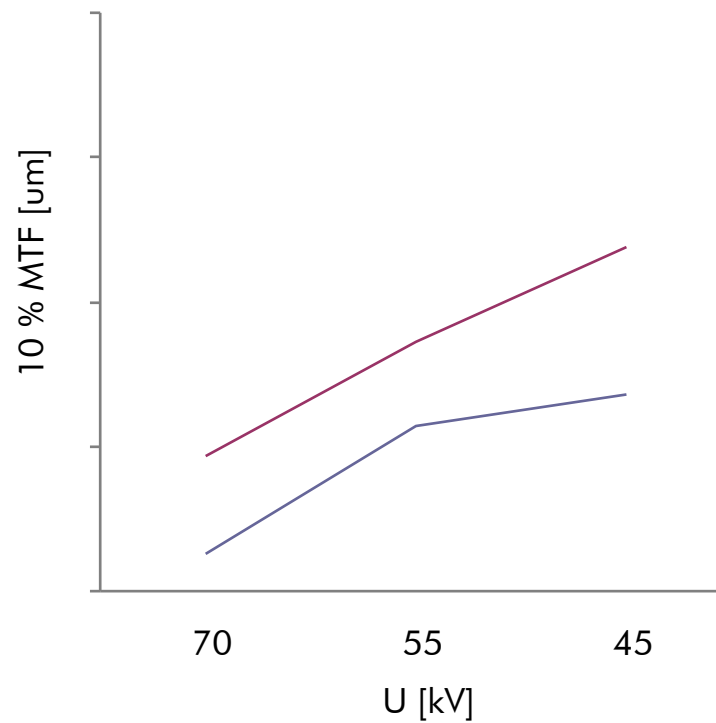


Resolution: X-ray Source

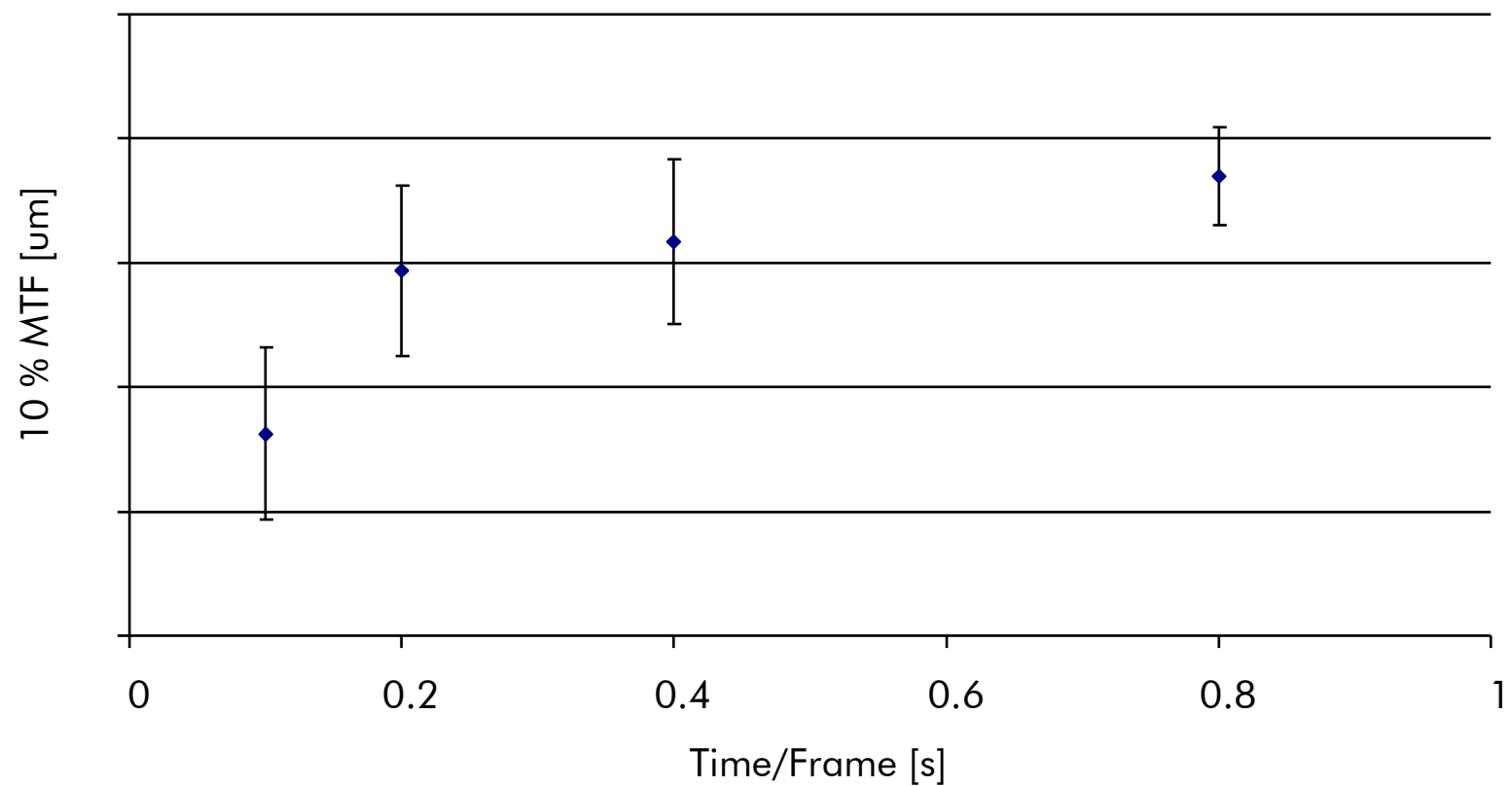


Resolution: X-ray Source

Near Source, 8W vs 4W



Integration Time



Conclusions

Best Resolution

- Smallest Diameter
- Shortest Integration Time
- Highest Tube Voltage
- Lowest Tube Current

Cost

- Much Data
- Lower Signal-to-Noise Ratio



Take Home Message

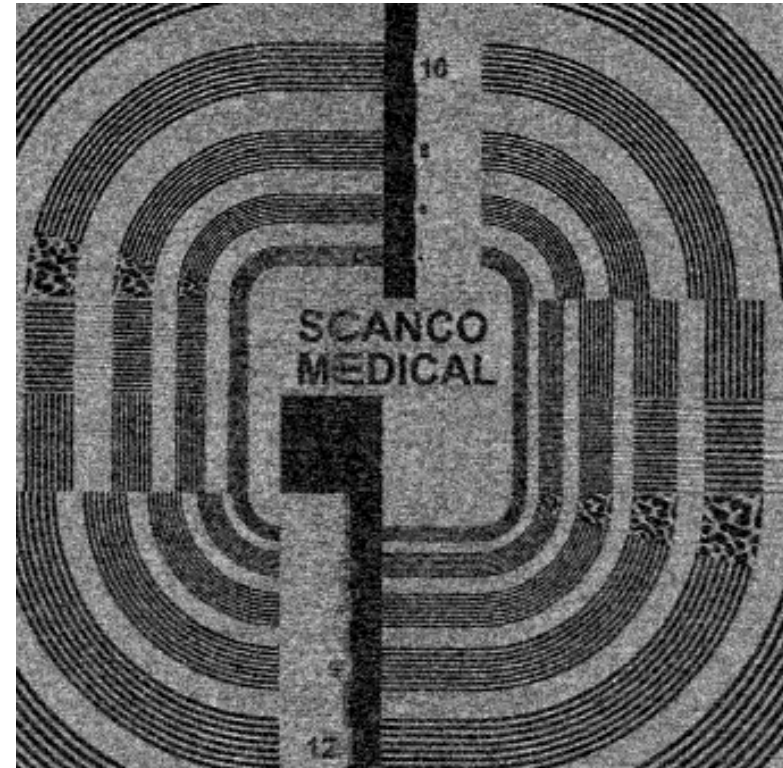
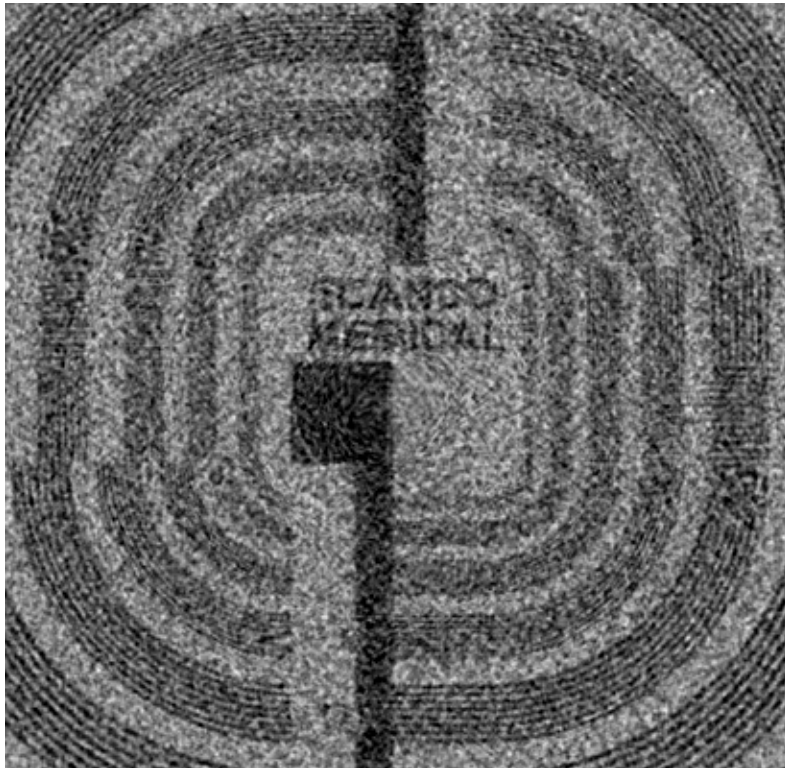


**Image Quality is more than Resolution.
Do not forget Signal & Noise!**

