CTPOW 2026 LAB

Exploring the Limits of Scanner Capabilities

Learning objectives

- Compare the effects of different CT reconstruction methods on overall image quality (e.g., focal spot, matrix, field-of-view, dose, reconstruction kernel, denoising)
- Measure quantitative image quality metrics
- Explain the trade-off between noise and resolution in CT reconstruction algorithms
- Analyze why many specifications cannot be achieved simultaneously in real-world use

Demonstration/Hands-On Activity with Mobile CT

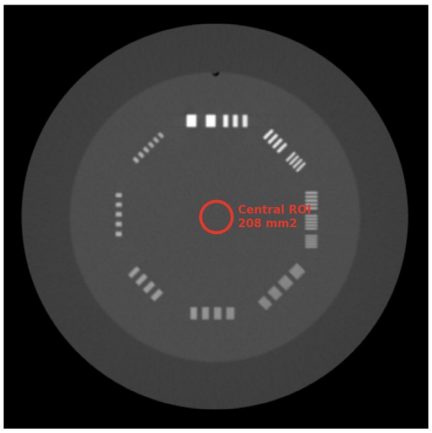
Gather around the mobile CT lab and investigate how the mobile CT differs from an MDCT.

Scan 1: Scan the CATPHAN phantom with the nominal focal spot size and the low-resolution matrix.
Scan 2: Reconstruct the CATPHAN phantom with the nominal focal spot size and the high-resolution matrix.
Scan 3: Scan the CATPHAN phantom with the small focal spot size and the high-resolution matrix.

Discussions	
1	Compare scans 1-3, which scan has the highest spatial resolution? Answer: _____
2	What kind of scans would we need high resolution imaging for? Answer: _____
Take-home: Several factors affect spatial resolution (e.g., matrix size, focal spot size, field-of-view, etc.) and these options will differ between different CT systems	

Activity 1 - Dose versus noise

Open the Resolution images reconstructed with Standard kernel and no ASiR. Place one circular ROI at image center. Rotation time is fixed at 0.3 s, so mA is proportional to mAs and dose.



Index	Image Type	Mean (HU)	SD (HU)
A1	**100 mA, Standard, FBP**		
A2	**400 mA, Standard, FBP**		
B1	**100 mA, Standard, ASiR**		
B2	**400 mA, Standard, ASiR**		

Discussions	
1	Comparing A1 and A2, what do you conclude? Answer:
2	Comparing A1 and B1, what do you conclude? Answer:

Take-home: At fixed scan and reconstruction settings, noise SD varies approximately as $\frac{1}{\sqrt{dose}}$

Activity 2 - Noise texture

Open the Resolution or Contrast images, focus on the central ROI. Score texture from 1 (fine-grained) to 5 (coarse/blotchy or plastic-like).

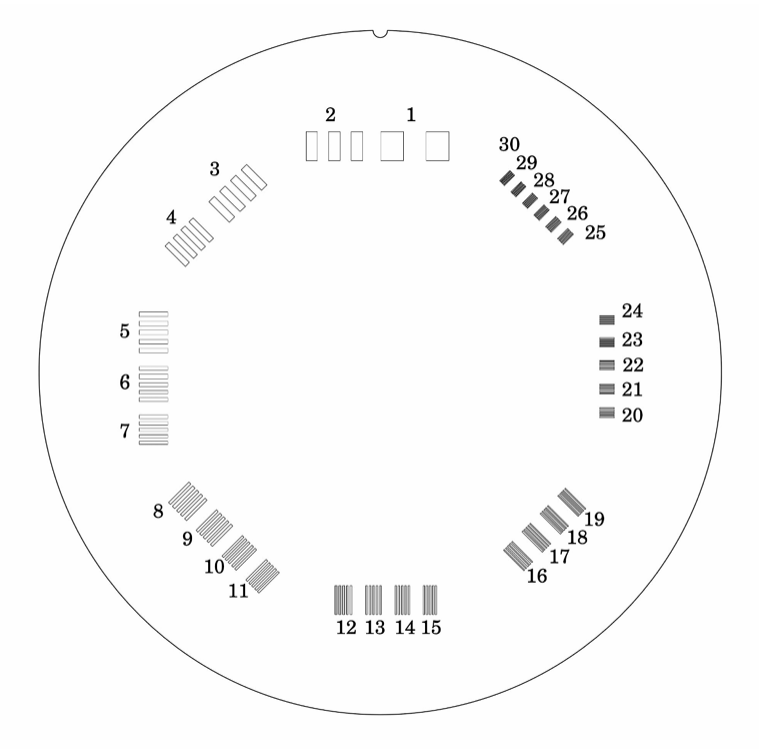
Index	Dose	Kernel	Recon	Central mean (HU)	Central SD (HU)	Texture 1-5
A1	**100mA**	Standard	FBP			
B1	**100mA**	Standard	ASiR			
C1	**800mA**	Standard	FBP			
D1	**100mA**	Bone	FBP			

Discussions	
1	Compare A1 and C1 (dose): Dose changes eightfold. How much does SD change? Does the texture score change substantially? Answer: _____
2	Compare A1 and D1 (kernel): How does Standard to Bone change SD and grain appearance? Does the noise become finer or coarser? Answer: _____
3	Compare A1 and B1 (ASiR): How does ASiR change SD and texture? Does it simply scale the FBP grain, or create a smoother/coarser/plastic appearance? Answer: _____
Take-home: Dose mainly changes noise amplitude when the kernel is fixed. Kernel and iterative reconstruction can change both amplitude and spatial texture.	

Texture: 1 = very fine grain; 3 = intermediate; 5 = distinctly coarse, blotchy, or plastic-like.

Activity 3 - High-contrast resolution

Use fixed window/level and zoom. Record the highest-frequency group in which all five bars and spaces are separable. Copy central SD from Activities 1-2.



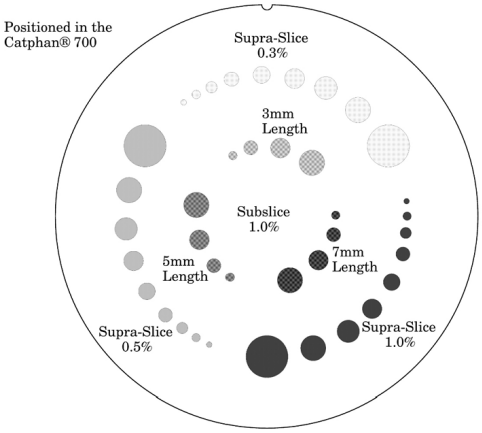
Index	Dose	Kernel	Recon	Highest visible (lp/cm)	Central SD (HU)
A1	**100mA**	Standard	FBP		
D1	**100mA**	Bone	FBP		
C1	**800mA**	Standard	FBP		
D2	**800mA**	Bone	FBP		
B3	**100mA**	Bone	ASiR		

Discussions	
1	Convert lp/cm to # bars/cm Answer:
2	Compare A1 and D1 or C1 and D2, how does the noise and spatial resolution change? What is the trade-off between noise and spatial resolution? Answer:
3	Compare A1 and C1, does increasing dose increase spatial resolution? Answer:
4	Compare D1 and B3, does turning on ASiR change the spatial resolution? Answer:
Take-home: Kernel is usually the dominant control of high-contrast resolution. Sharper resolution is not free: the principal penalty is increased noise SD.	

Activity 4 - Low-contrast detectability

Use fixed window/level and zoom. Score the smallest confidently visible disk in the supra-slice 1% contrast group: 15, 9, 8, 7, 6, 5, 4, 3, and 2 mm. Record low confidence rather than guessing.

CTP515 Low Contrast Module with Supra-slice and Subslice Contrast Targets



Index	Dose	Kernel	Recon	Smallest visible disk (mm)
F1	**100mA**	Standard	FBP	
F2	**100mA**	Standard	ASiR	
F3	**100mA**	Bone	FBP	
F4	**100mA**	Bone	ASiR	
G1	**800mA**	Standard	FBP	
G2	**800mA**	Standard	ASiR	
G3	**800mA**	Bone	FBP	
G4	**800mA**	Bone	ASiR	

Discussions	
1	Compare F1 and F3 or G1 and G3, does the kernel affect which disk you can see? Answer:
2	Compare F1 and F2 or F1 and F2, does ASiR affect which disk you can see? Answer:
3	Compare F1 and G1 or F3 and G3, does the dose affect which disk you can see? Answer:
4	Look at images G1-G4, can you see some of the lower (<1.0%) contrast disks? Answer:
5	Compare F1 with G1 and G4, how does the noise texture affect which disks you can see? Answer:
Take-home: Low-contrast detection is photon-limited and observer-dependent. At very low dose, changing kernel or adding ASiR cannot fully replace adequate signal. Noise texture can affect detectability low-contrast small objects.	