Teaching Cases 1: Collimation vs. Slice Width, Dose and Scan Time

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Collimation

- Affects
  - Total scan time
  - Noise / Low contrast resolution
  - Thinnest available recons
- Note:
  - Recommend using thinnest channel widths possible for best IQ
  - Some configurations (esp. narrow collimations) are less dose efficient (vendor-specific)
  - Compare relative dose using CTDIvol on console

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Collimation vs. Slice Width

- 4, 8 and 16 detector row scanners
  - Had significant constraints in terms of what image thicknesses could be recon' d from a given configuration
- 64 and above detector row scanners
  - Many of these constraints go away
  - BUT, they may still exist, especially for very thin images

Collimation vs. Slice Width

Example: Siemens Sensation 16

- Configurations for Helical Scans:
  - 16 x 0.75mm (12 mm nominal beam width)
    - Allows 0.75, 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 10 mm thickness
    - Hence thin slices, but less coverage (12 mm beam width)
  - 16 x 1.5 mm (24 mm nominal beam width)
    - Allows 2, 3, 4, 5, 6, 7, 8, 10 mm thickness
    - (NOTE: no 1.5mm)
    - Greater coverage (24mm beam width), but thinnest is 2 mm

Collimation vs. Slice Width

Example Siemens Sensation 64

- Configurations for Helical Scans:
  - 64 x 0.6* (19.2 mm nominal beam width)
    - Allows 0.6, 0.75, 1, 1.5, 2, 3, 4, 5, 6, 7, 8, 10 mm thickness
    - Thin slices, but less coverage
  - 24 x 1.2 (28.8 mm nominal beam width)
    - Allows 1.2, 1.5, 2, 3, 4, 5, 6, 7, 8, 10 mm thickness
    - Greater coverage, but thinnest is 1.2 mm

*Z-flying focal spot: double samples along z; actual beam width is 32 x 0.6 mm

Collimation vs. Slice Width

- Significance
  - PROSPECTIVELY choose collimation that allows desired thickness(es) to be reconstructed
    - If very thin slices are needed, choose collimation setting that will allow required slice thickness(es)
    - Know that thinner collimation settings are (almost) always less dose efficient
  - Will have some impact on total scan time
    - Is that important?
    - Depends on body part, study, scanner
    - Breathhold? Timing with Contrast?

Collimation vs. Slice Width

- Example of Impact on Scan Time – Thoracic CT
  - Need to complete acquisition in single breathhold
  - NO RESPIRATORY MOTION
  - 10-15 seconds max (depending on patients Dz and severity)
  - Need approx. 30 cm (300 mm) coverage

Collimation vs. Slice Width

- Example of Impact on Scan Time – Thoracic CT
- Siemens Sensation 16
  - 16 x 0.75 mm mode yields 12 mm beam width
  - For Pitch 1 and 0.5 sec rotation time
    - Table Feed = (12 mm * 1) = 12 mm/rotation
    - Table Speed = (12 mm/rot) / 0.5 sec/rot = 24 mm/sec
    - 300 mm coverage takes (300mm / 24 mm/s) = 12.5 sec
    - Pitch 1.2 takes ~10 sec
  - Compare with 16 x 1.5 mm mode
    - Gives twice coverage (Pitch 1 scan takes < 7 sec)
    - But thinnest slice is 2 mm (is that ok?)

Collimation vs. Slice Width

- Requirements of Study Protocol
  - Are thin slices needed?
  - For Axial Reconstructions?
  - For Coronal or Sagittal (or MultiPlanar) Reformats? Or 3D?

Collimation vs. Slice Width

- Example: High Res. Chest CT for Diffuse Lung Disease
- Typically done in one of two ways:
  - Sparse Sampling
    - Full Chest, axial scans 1 mm thick, every 10 or 20 mm
  - Increased Sampling
    - Full Chest, helical scans 1 mm thick, spaced every 1 mm

- For Helical
  - Here thin section images are needed, so
  - Choose collimation that will allow 1 mm thick recons

Collimation vs. Slice Width

- Example: Abd/Pel or Chest/Abd/Pel in a Single Pass
  - Need Lots of Coverage
    - 500-600 mm in Abd/Pel
    - 800-900 mm in C/A/P
  - If possible, single breathhhold (!)
  - IV Contrast
    - so timing is important here as well

Collimation vs. Slice Width

- Example of Impact on Scan Time – A/P or C/A/P
- Siemens Sensation 16
  - 16 x 0.75 mm mode yields 12 mm beam width
  - For Pitch 1 and 0.5 sec rotation time
    - Table Feed = (12 mm * 1) = 12 mm/rotation
    - Table Speed = (12 mm/rot / 0.5 sec/rot) = 24 mm/sec
    - 500 mm coverage takes (500mm / 24 mm/s) = 21+ sec
      - Pitch 1.5 takes ~ 14 sec
    - 800 mm coverage takes (800mm / 24 mm/s) = 33+ sec
      - Pitch 1.5 takes ~ 23 sec

Collimation vs. Slice Width

- Example of Impact on Scan Time – A/P or C/A/P
- Siemens Sensation 16
  - Compare with 16 x 1.5 mm mode (Twice coverage)
    - For Pitch 1 and 0.5 sec rotation time
    - Table Feed = (24mm * 1) = 24 mm/rotation
    - Table Speed = 24 mm/rot / 0.5 sec/rot = 48 mm/s
    - 500 mm coverage takes (500mm / 48mm/s) = 10+ sec
      - Pitch 1.5 shortens this to 7-8 sec
    - 800 mm coverage takes (800mm / 48mm/s) = 17+ sec
      - Pitch 1.5 shortens this to 11-12 sec
    - But thinnest slice is 2 mm (is that ok?)

Collimation vs. Slice Width

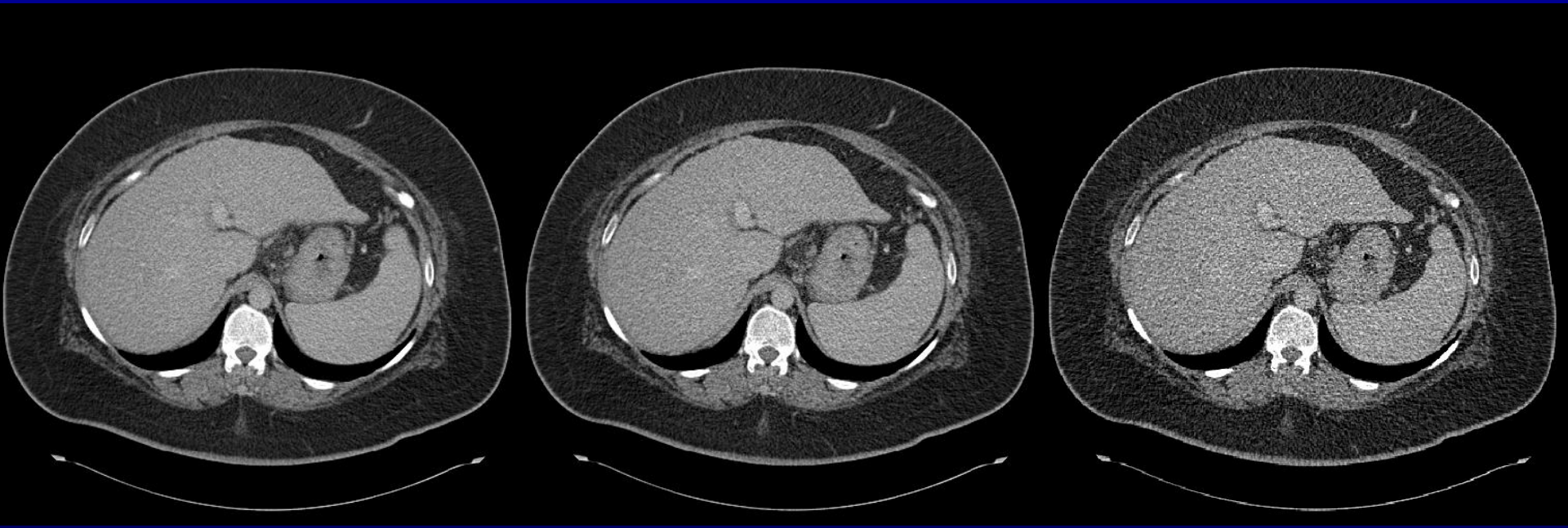
- Example of Impact on Scan Time – A/P or C/A/P
  - But thinnest slice is 2 mm (is that ok?)
  - How will images be viewed?
  - Will Coronal, Sagittal or MPR Reformats be used? 3D?

  - If only 5 mm thick slices will be viewed, then wider collimation (more dose efficient) can be used

Collimation vs. Slice Width

- Choice of mAs Level?
  - Will thin slices be used?
    - If so, will mAs level chosen provide low enough noise?
  - Will only thick slices will be used?
    - If so, a lower mAs can be used
    - As described by Jim Kofler:
      - Thicker slices, more photons, less noise
      - (Provide example images)

Adult Abdomen Images

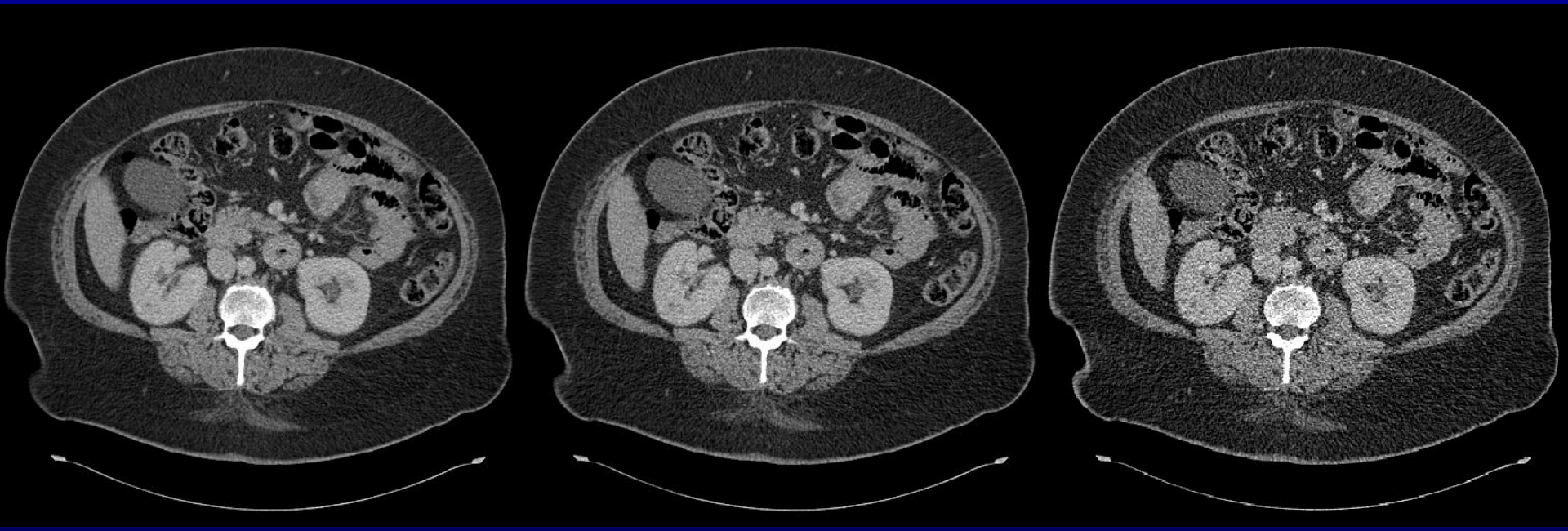


5mm 3mm 1mm

Adult Abdomen Images

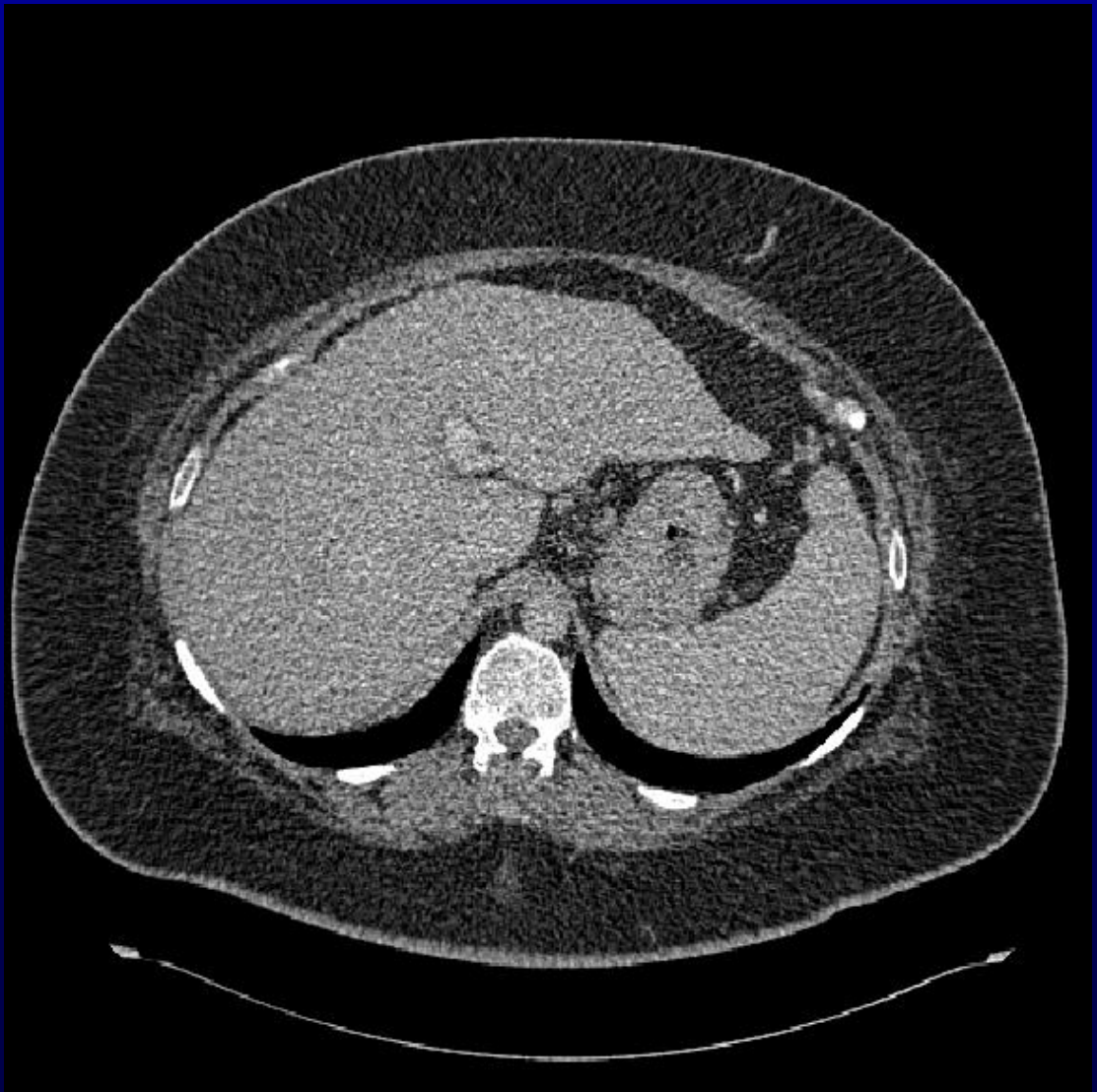
5mm 3mm 1mm

Adult Abdomen Images



5mm 3mm 1mm

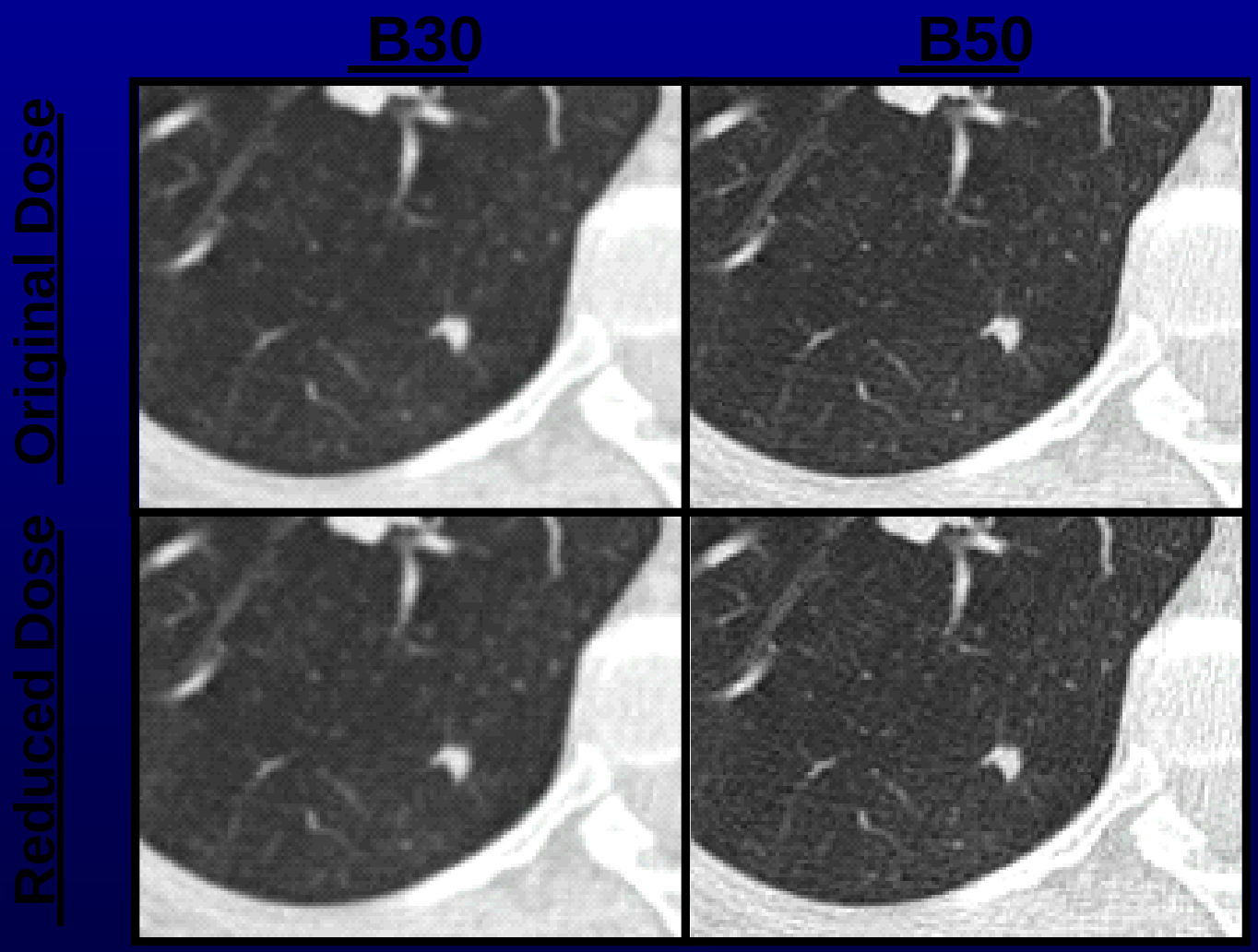
Adult Abdomen Images



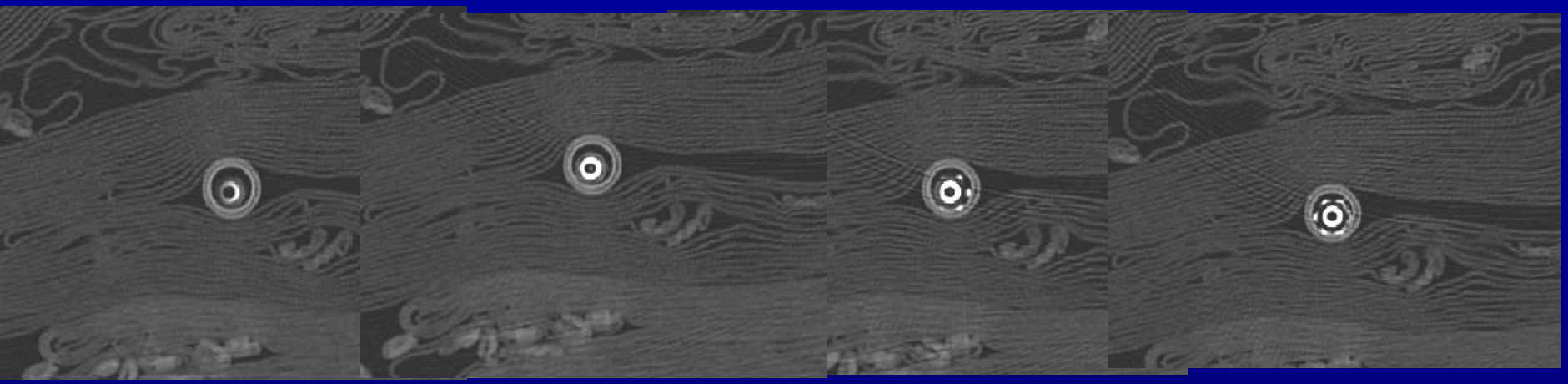
Adult Abdomen Images

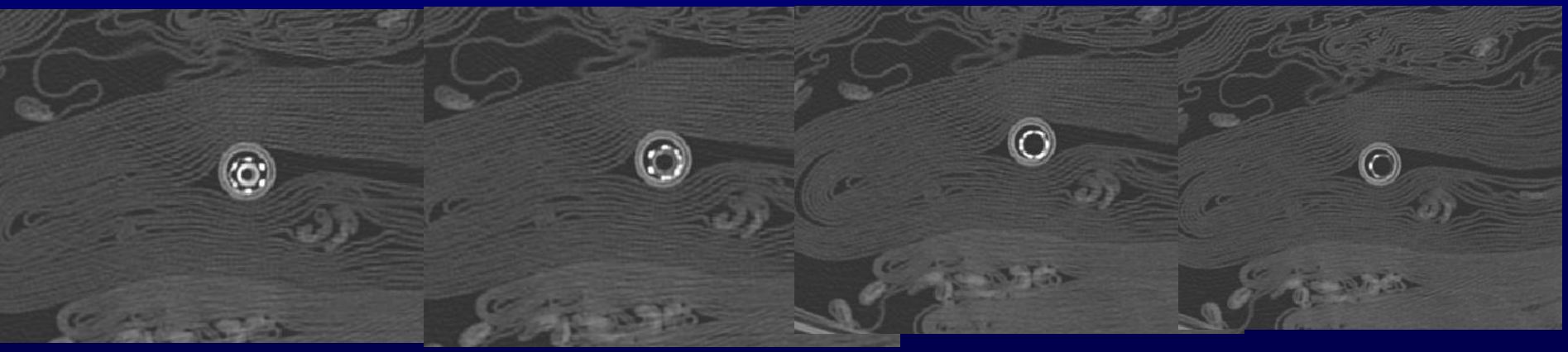
Diffuse Lung Disease (Peds)

Lung Nodule Detection (or F/U)

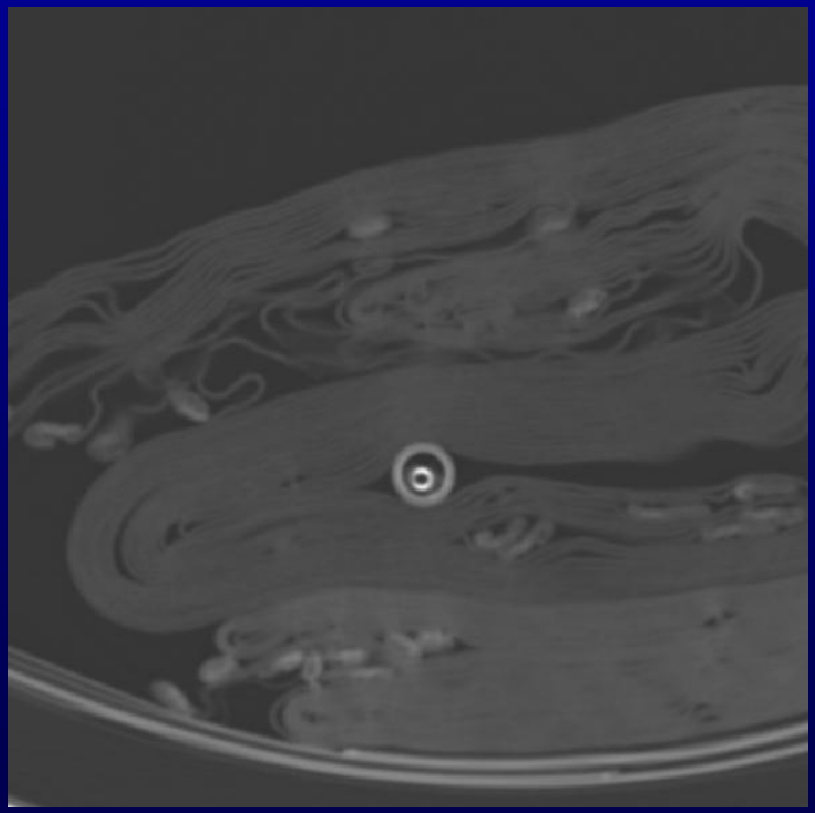


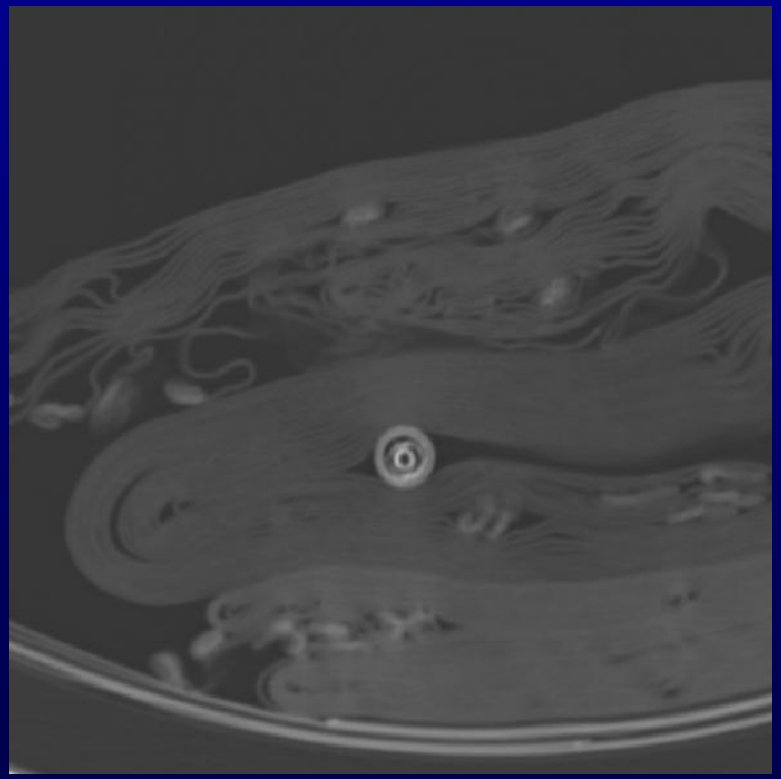
1.5mm slice thickness – Axial images



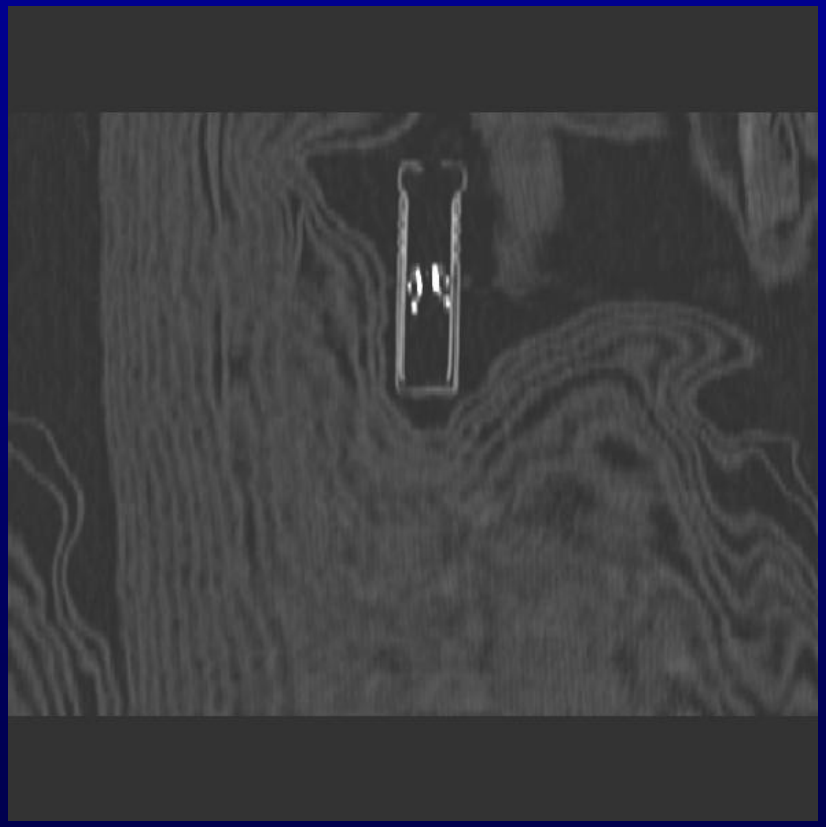


Large, 10mm slices

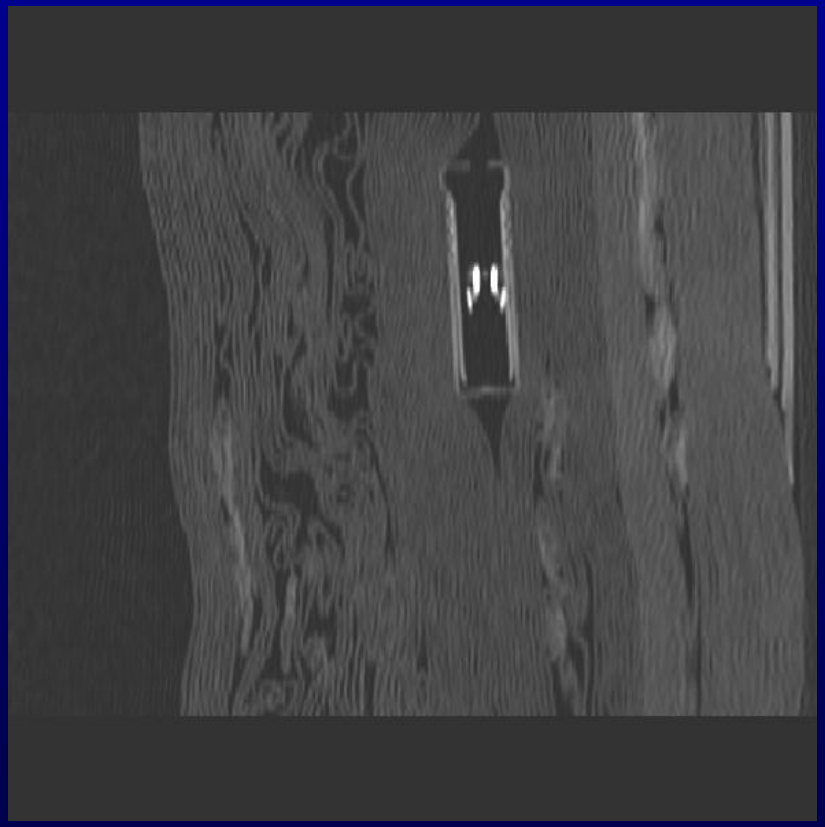




MPR sag & coron, 1.5mm

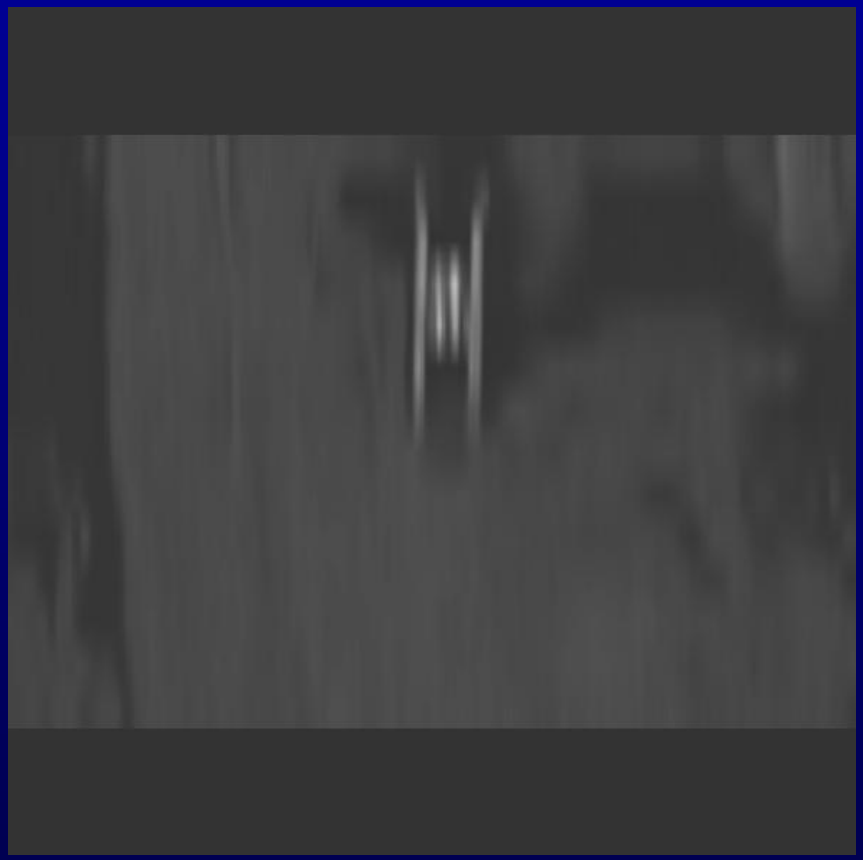


Coronal

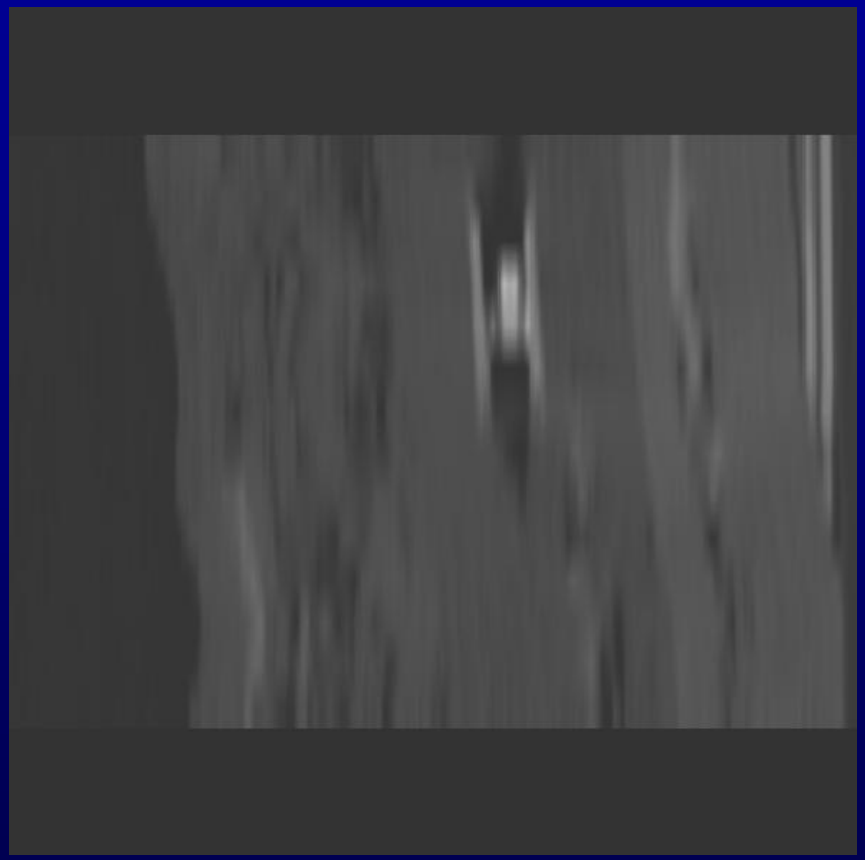


Saggital

MPR sag & coron, 10mm



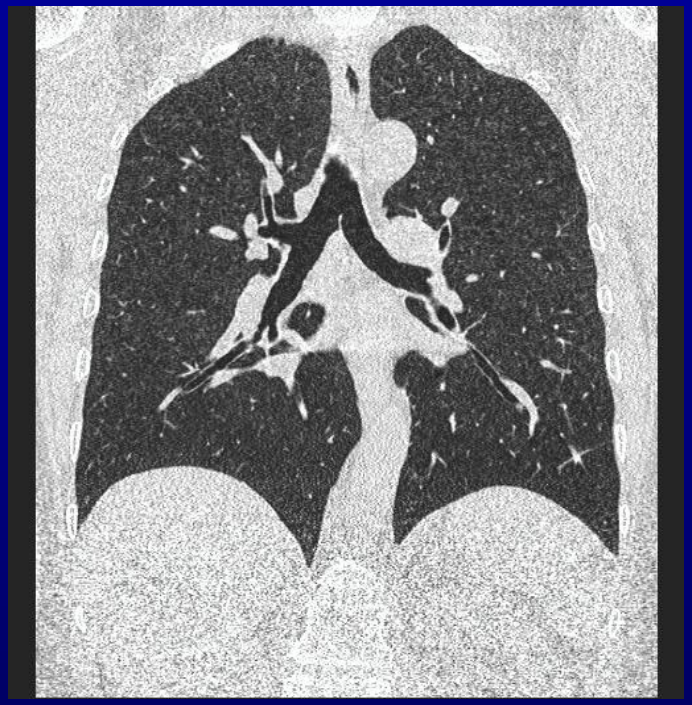
Coronal



Saggital

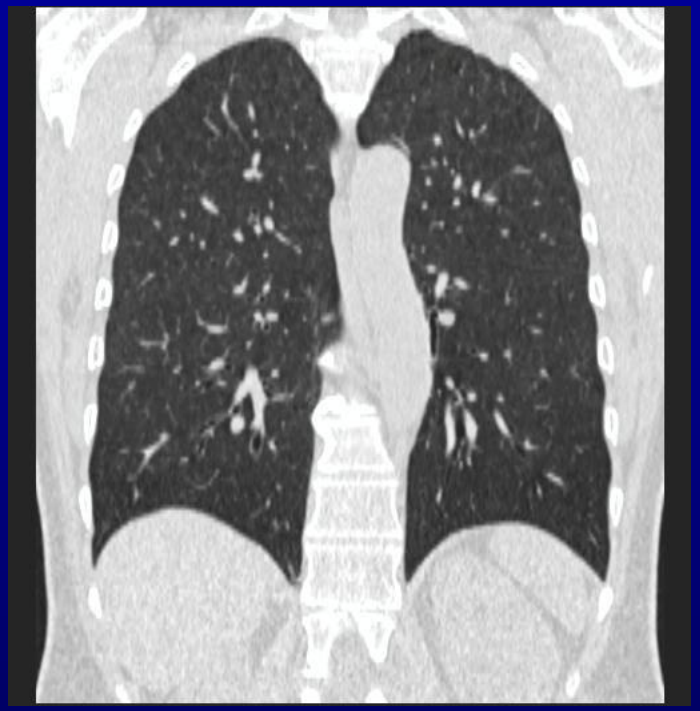
Coronal Views

Reconstructed from 2mm Thick slices



Reconstructed from 0.6 mm Thick slices

Coronal Views



Reconstructed from 2mm Thick slices

Reconstructed from 0.6 mm Thick slices

Collimation and Recon Image Thickness

- Affects
  - Total scan time
  - Thinnest available recons
  - Noise / Low contrast resolution
  - Affect quality of coronals and other reformats
- Implications for Dose
  - If thin slices are used, temptation is to increase mAs to compensate and reduce noise
  - Are thin slices needed? For Dx? For Reformats?
  - Is proper reconstruction filter being used?