James M. Kofler, Ph.D.
Mayo Clinic Rochester

Identifying Image Artifacts, Their Causes, and How to Fix Them: Computed Tomography

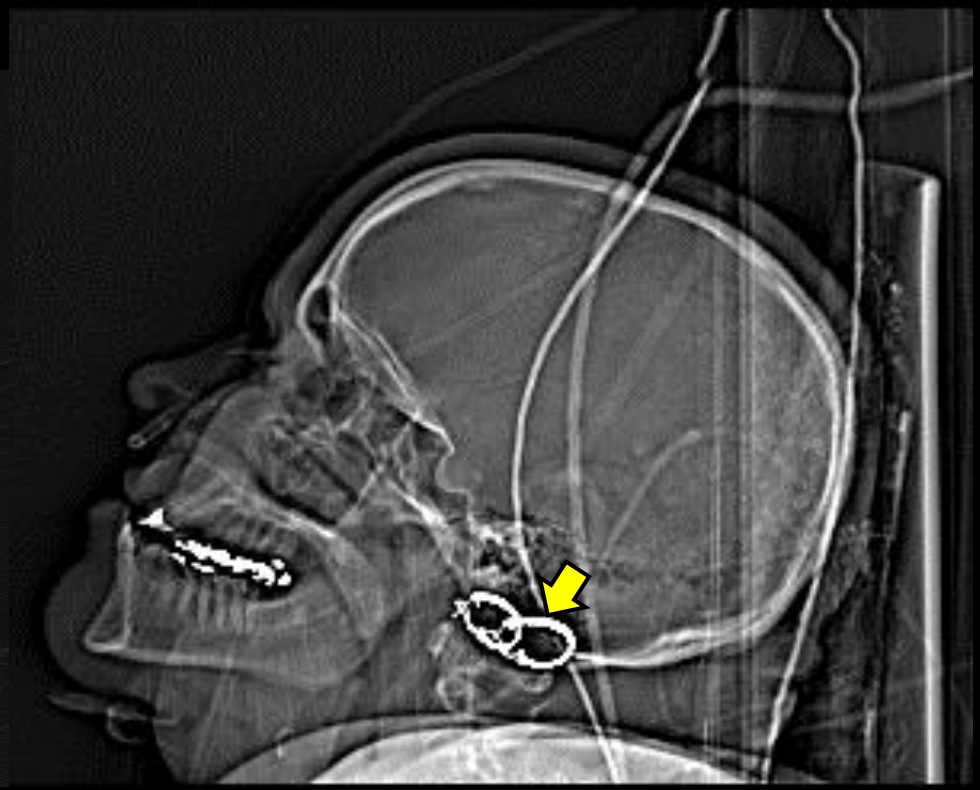
AAPM Annual Meeting 2016

Case 1

"Ring" Artifact?

(Frame from animation in presentation)

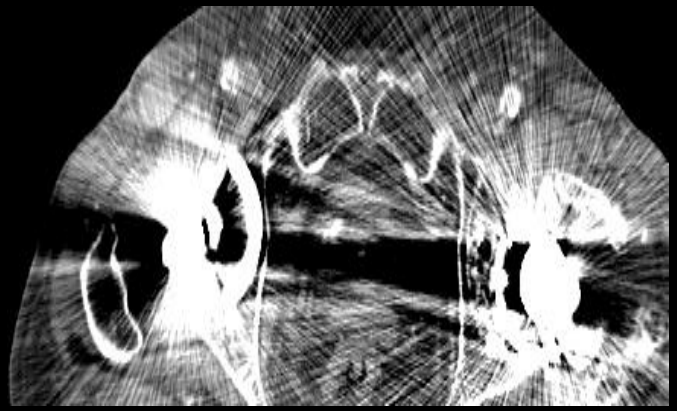
Star Pattern caused by…



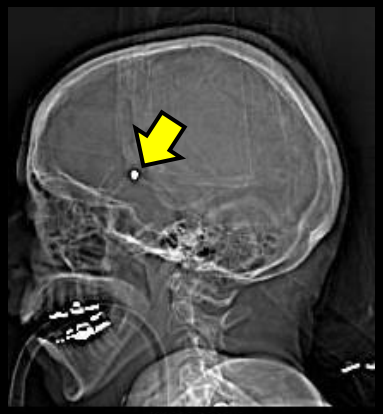
…metal earrings!

Same star artifact commonly caused by…

Dental Amalgam



Metal Implants



Metal Objects (wires, syringes, bullets, etc.)

Case 1

- Description
  - Star pattern
  - Obvious, and interferes with diagnostic content
  - Typically easy to determine cause
- Cause
  - Metal (high atten.) in FOV
- Remedy
  - Tilt gantry, avoid if possible
  - Increase kV, mAs (diminishing returns)
  - Metal Artifact Reduction algorithms

Case 1: Important Points

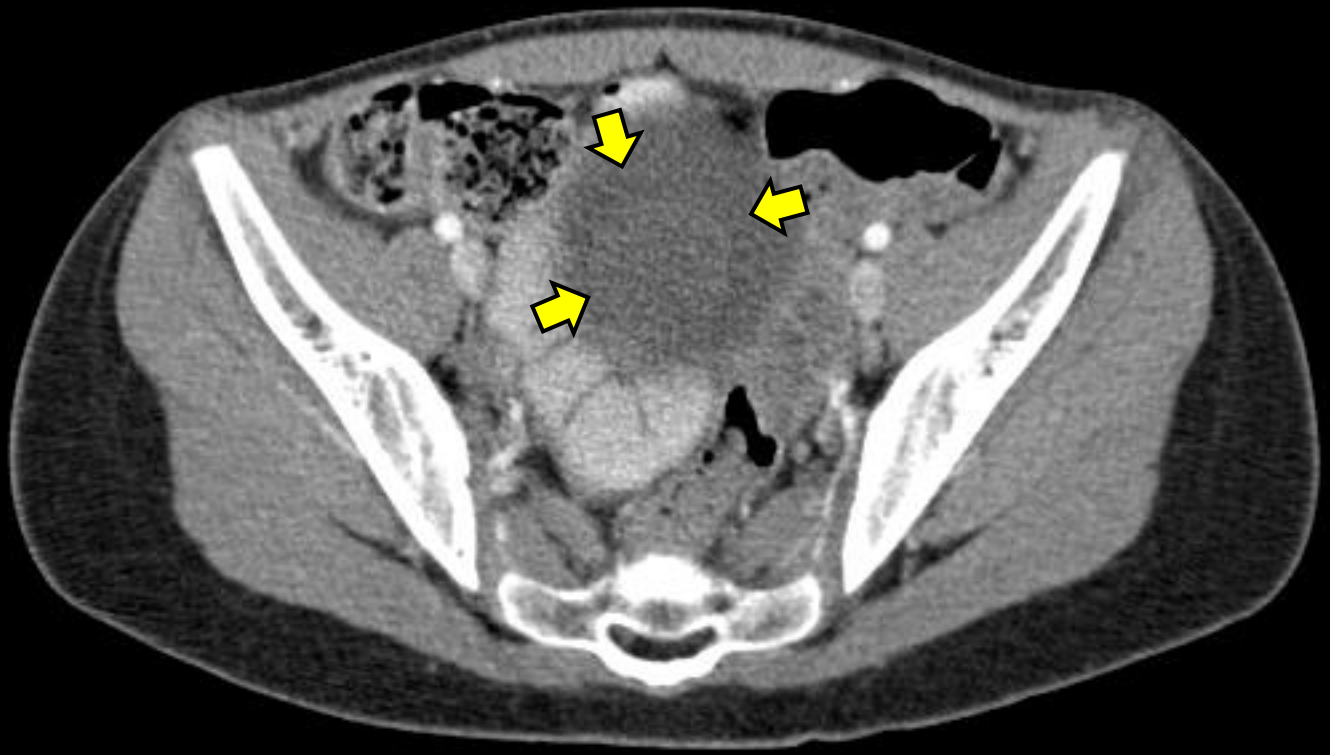
- Look at the localizer radiograph

Case 2

- Description
  - One or more concentric rings in image
  - Subtle to obvious
  - Cause typically straightfoward

Ring Artifact

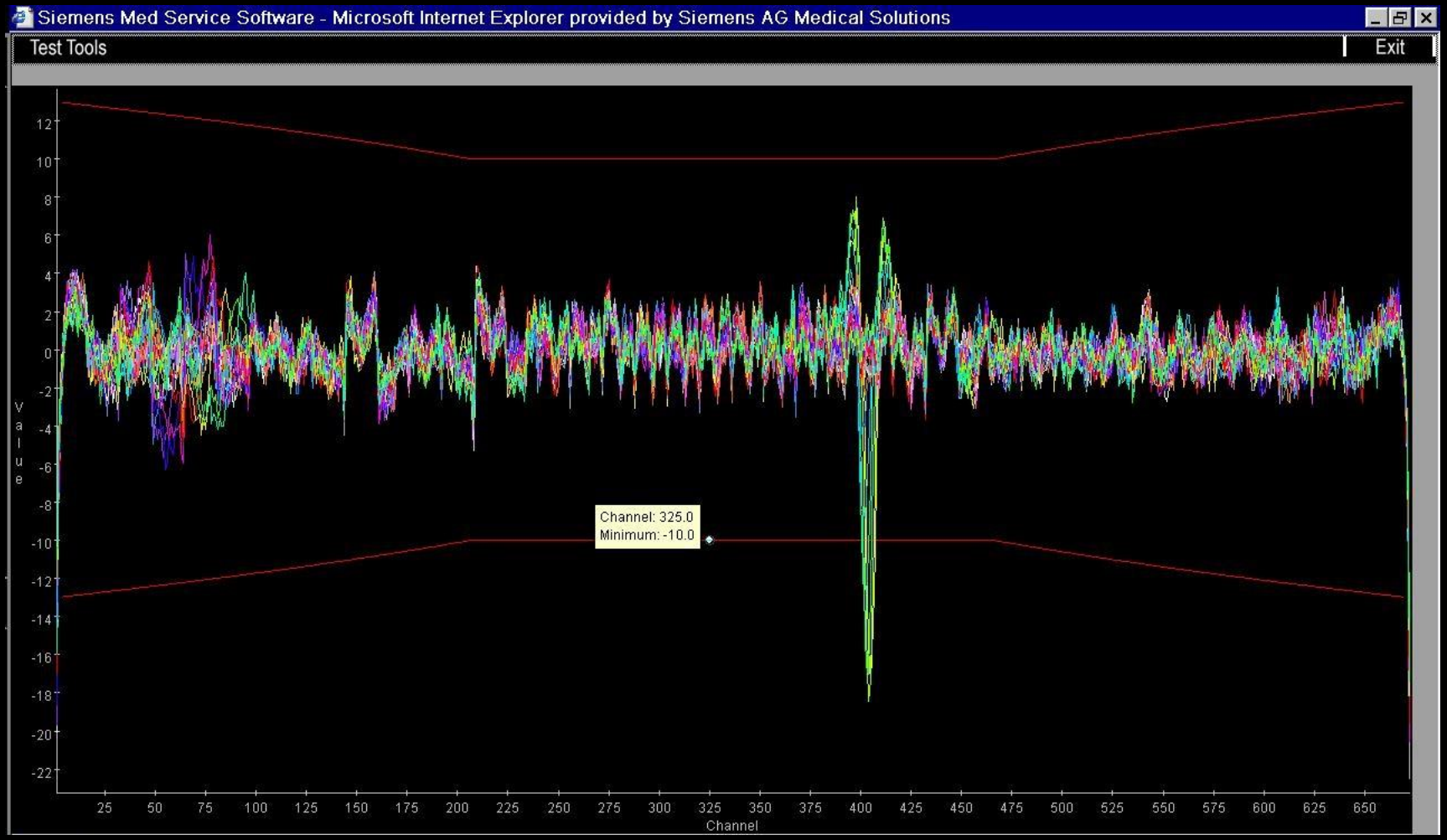
Ring Artifact



Service was called

(Frame from animation in presentation)

Bad Detector Module



Ring Artifacts from Photon Starvation

Case 2

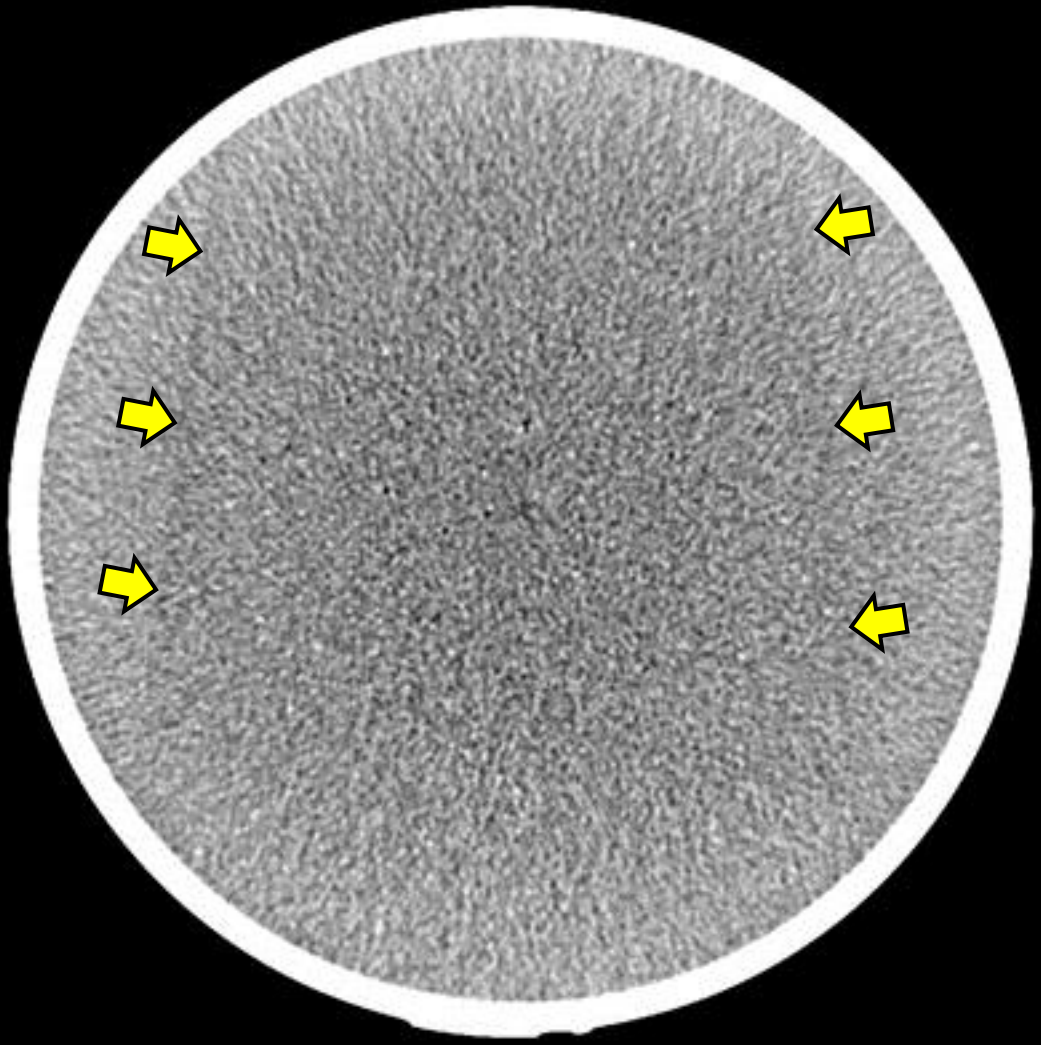
- Description
  - One or more concentric rings in image
  - Subtle to obvious
  - Cause typically straightforward
- Cause
  - Detector(s) imbalance/malfunction or blocked
  - Photon starvation
- Remedy
  - Service
  - Increase technique, if possible

Case 2: Important Points

- Ring artifacts common
- Usually requires Service
- Scrolling can help visualize
- Check centering
  - Patient not always centered but rings are

Case 3

- Description
  - Some shape superimposed on images
  - Can be subtle but usually obvious
    - Usually doesn’t mimic pathology
  - Not intermittent



Cushion in FOV during morning calibration

Case 3

- Description
  - Some shape superimposed on images
  - Can be subtle but usually obvious
    - Usually doesn’t mimic pathology
  - Not intermittent
- Cause
  - Object scanned during calibrations
- Remedy
  - Re-calibrate

Case 3: Important Points

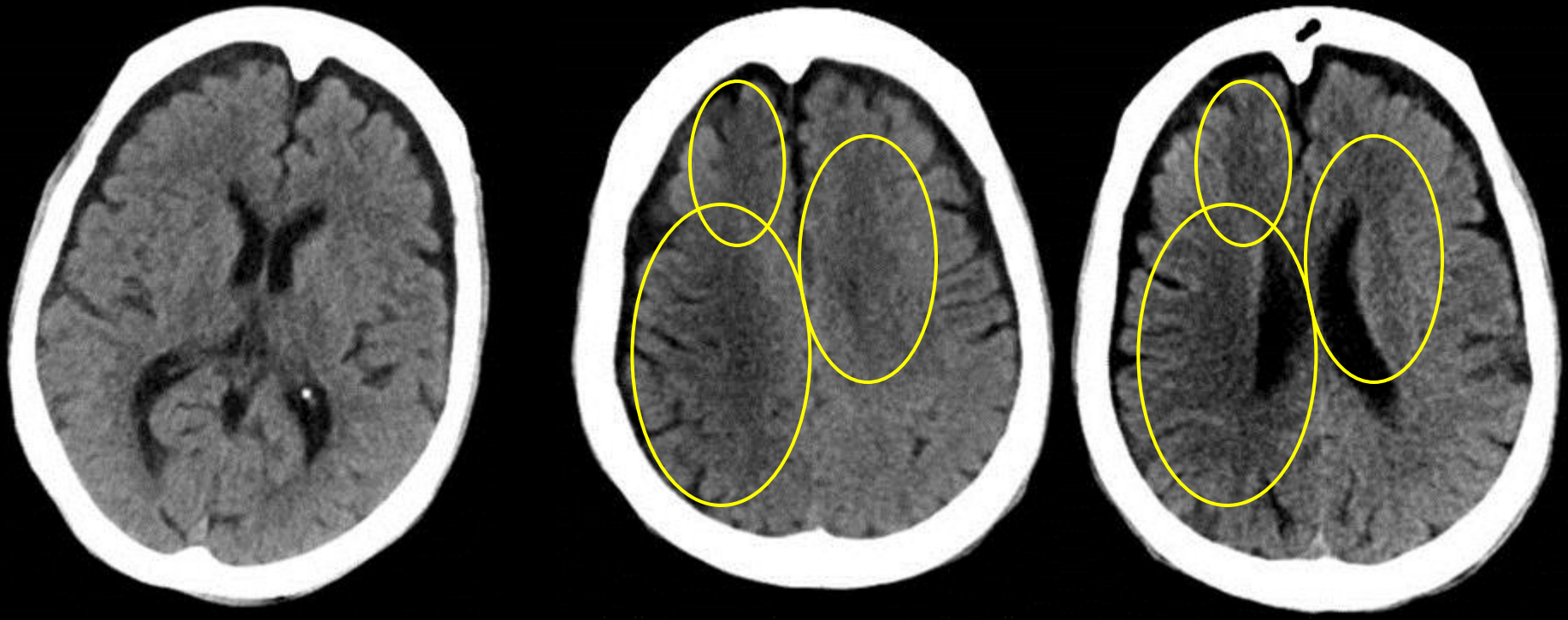
- Don’t overlook the simple things
  - “Object” could be cushion, pillow, phantom, etc.

Case 4

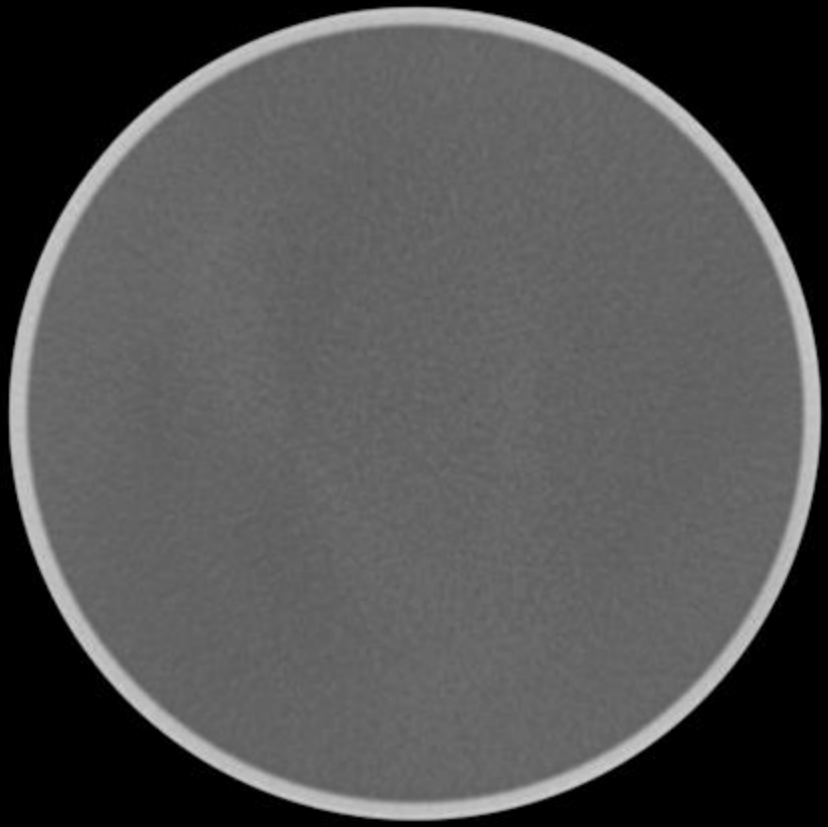
- Description
  - Dark “blotches” on head scan
  - Not too subtle but mimic critical pathology
  - Not intermittent

Normal (prior from previous day)

"Diffuse right hemispheric abnormalities" -Very serious



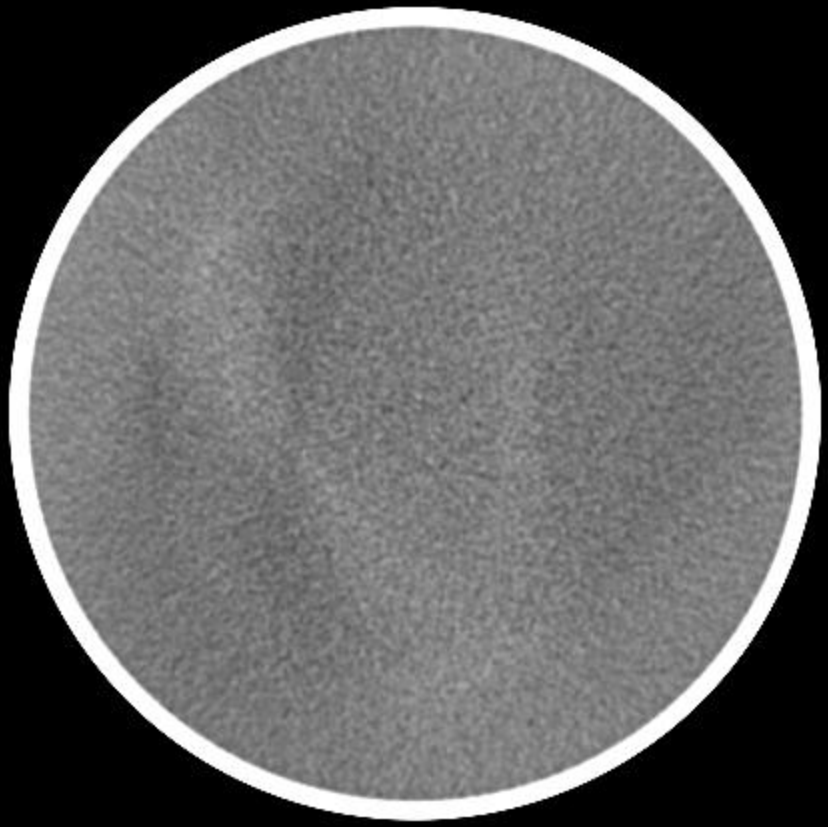
QA Phantom from Morning QC



WW: 400, WL: 0

Typical abd settings

QA Phantom from Morning QC



WW: 100, WL: 0

ACR settings

QA Phantom from Morning QC

WW: 40, WL: 0

Better settings?

Case 4

- Description
  - Dark “blotches” on head scan
  - Not too subtle but mimic critical pathology
  - Not random
- Cause
  - Contrast material on gantry window
- Remedy
  - Wipe off gantry
  - Note: Make sure not calibrated into system

Case 4: Important Points

- Morning QAs must be reviewed carefully using appropriate ww/wl
- Suspected artifacts must be reported
- Inspect gantry between every patient for contrast spillage, if needed. Clean with water and tissue/cloth (no soap/disinfectants)
- Known spills should be cleaned immediately

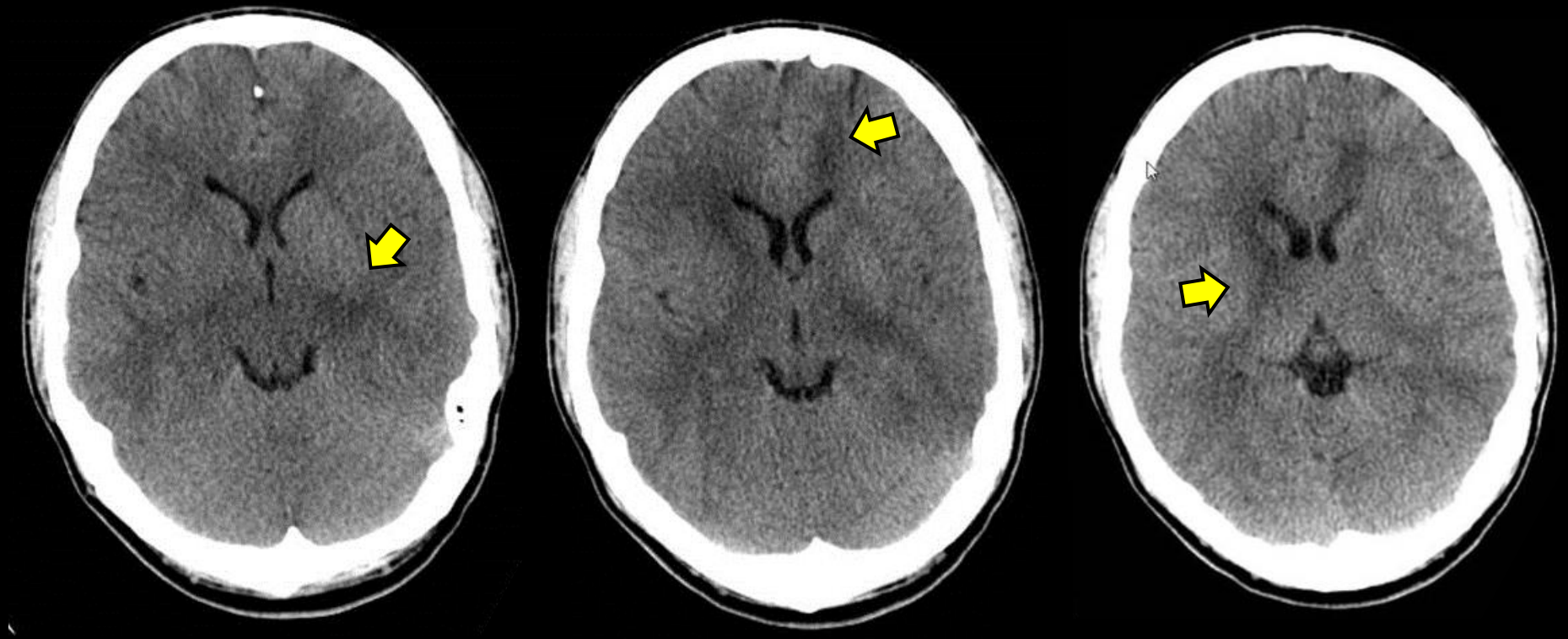
Case 5

- Description
  - Irregular dark bands
  - Very subtle (2-3 HU) and mimics pathology
  - Intermittent, very infrequent

This is the most challenging, and most dangerous, type of artifact

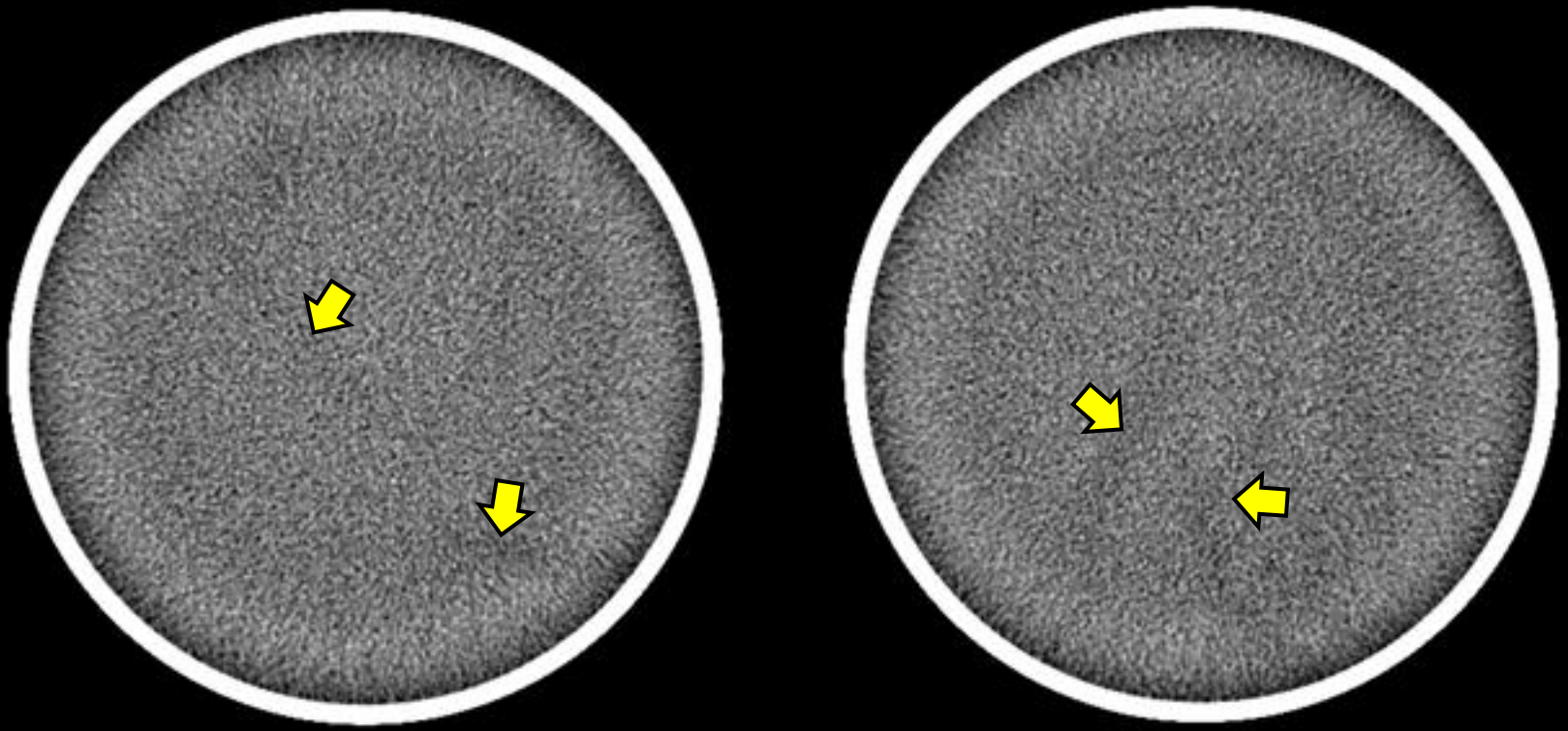
Suspected cerebral edema

- Very serious
- Patient transferred by ambulance 45 miles from remote site



Happened with 2 different patients within 24 hours

Morning QA images
- 2 of 12 showed very subtle artifact



Both at WW: 40, WL: 0

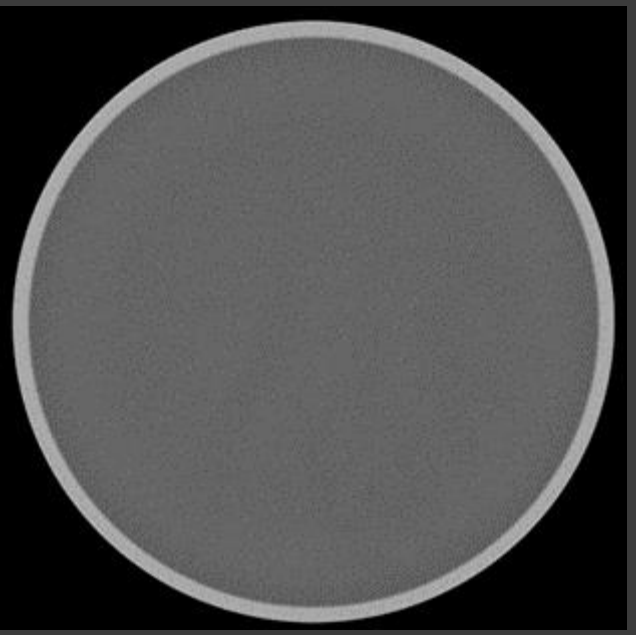
Service was called

Case 5

- Description
  - Irregular dark bands
  - Very subtle (2-3 HU) and mimics pathology
  - Intermittent, very infrequent
- Cause
  - Air bubbles in tube cooling system
- Remedy
  - Repair by Service

Case 5: Important Points

- WW / WL very important



400 / 40

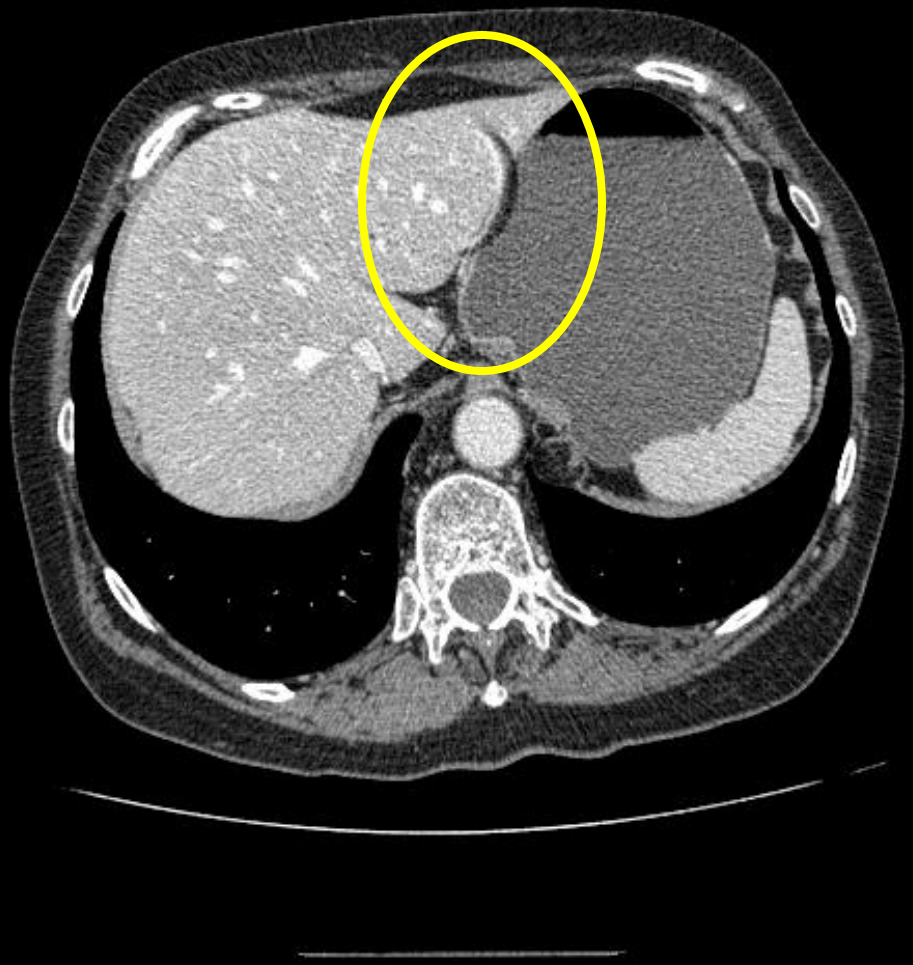
100 / 0

40 / 0

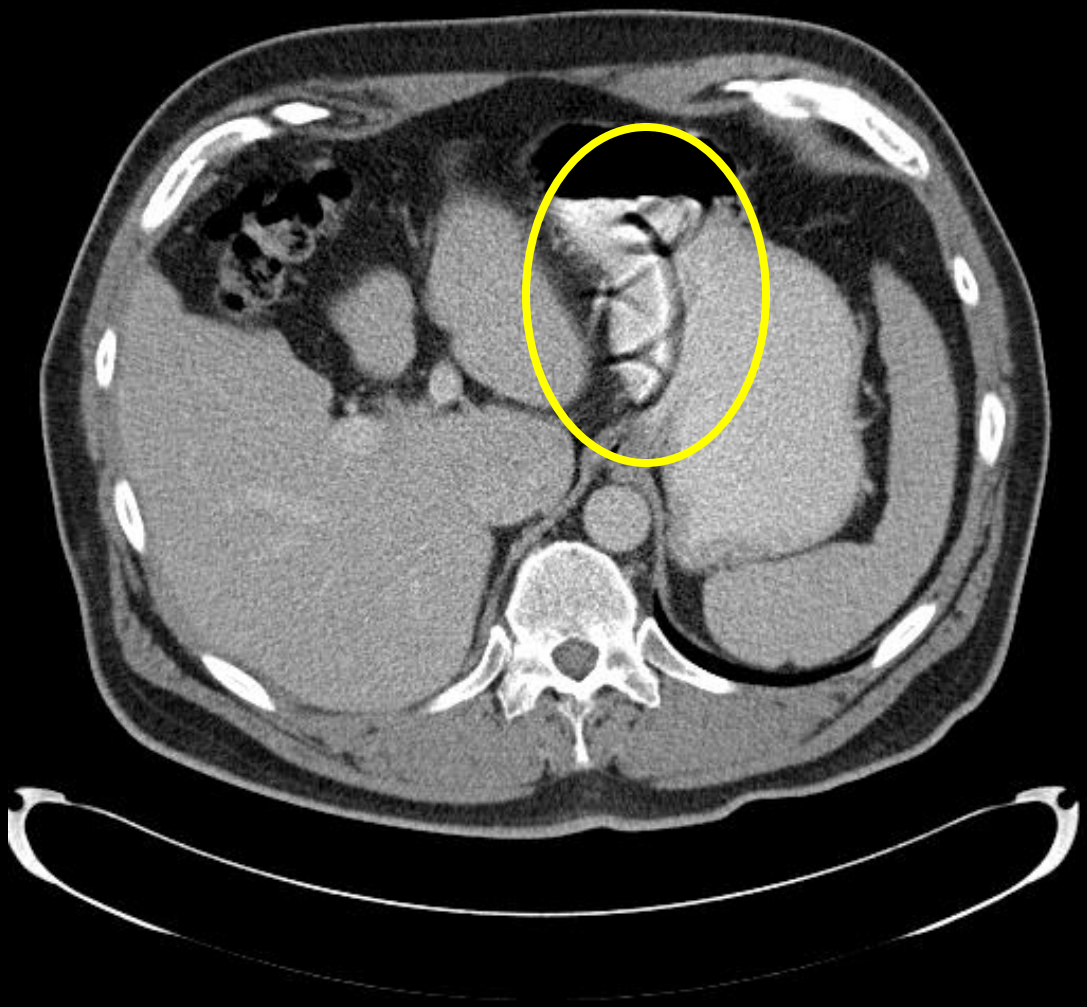
- Alert staff of intermittent issue

Case 6 (last one!)

- Description
  - Partial “rings” not centered over isocenter
  - Very obvious, does not mimic pathology
  - Intermittent, very infrequent



(Frame from animation in presentation)



(Frame from animation in presentation)

Case 6 (last one!)

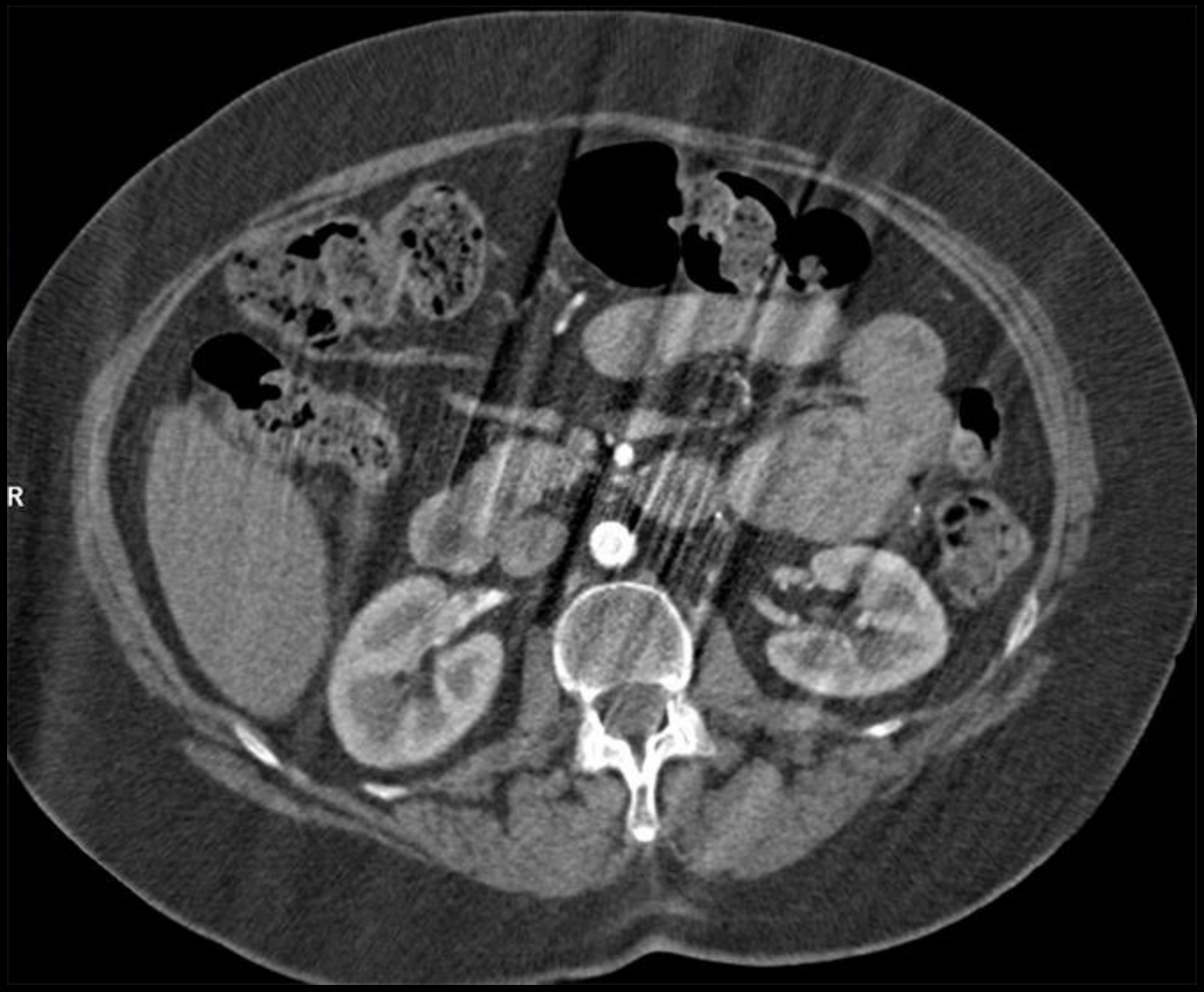
- Description
  - Partial “rings” not centered over isocenter
  - Very obvious, does not mimic pathology
  - Intermittent, very infrequent
- Cause
  - Moving air bubbles in patient
- Remedy
  - No remedy—just identify
  - See it once and recognize forever!

Clinical Image Artifacts

- Be familiar with common artifacts
  - How to recognize
  - How to address
- Trouble shooting
  - Start with the simple sources
- Communicate concerns
  - Call Service when necessary
  - Provide sample cases, if possible
  - Let staff know of any potential problems
- Technologists should be diligent

References:

- Hsieh J., Computed Tomography: Principles, Design, Artifacts, and Recent Advances (Chapter 7), SPIE Press, Bellingham, WA, ISBN 0-8194-4425-1.
- Computed Tomography Quality Control Manual, 2012, American College of Radiology. http://www.acr.org/Education/Education-Catalog/Products/8336734
- Barrett JF, Keat N, Artifactis in CT: Recognition and Avoidance, Radiographics 2004; 24:1679-1691.
- Hedrick WR, Markovic MA, Short JA, Vera CD, Computed Tomography Artifact Created by Air in the X-ray Tube Oil, JCAT, 40(1) 2016.
- Liu F, Cuevas C, Moss AA, Kolokythas O, Dubinsky TJ, Kinahan PE, Gas Bubble Motion Artifact in MDCT, AJR: 190, Feb 2008.



Artifact from Tube Arcing

(Frame from animation in presentation)