Imaging Physics

Streak artifacts
Axial CT images (prior to protocol updates)
Diagnosis?

Answer and Discussion on following slides
Imaging Physics

Answer Slides
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The streak artifacts appear to emanate from the same location in both shoulders.
If we expand the field of view (FOV) slightly, we can see that the edges of the patient table have a very sharp edge, which is the source of the artifact. Any time a highly attenuating object has a sharp edge, these artifacts will result.
In this case, the artifacts originate from wires and leads that cannot be seen within the FOV.
However, if we look at the localizer, we can clearly see the lines that are the source of the artifact.
Subtle artifacts related to aliasing may also be seen when anatomy is not positioned at isocenter, as is often the case with certain combined studies, such as combined CAP + H/N lymphoma protocols.
Aliasing
Originally, the scan protocol used a gantry rotation time of 0.5 s, which led to the appearance of cardiac motion (L) but the images were without streak artifacts (R).
After updating the protocol to use a gantry rotation time of 0.28 s, cardiac motion was reduced (L) but streak artifacts were observed in the shoulders (R).

These artifacts were caused by reduced view sampling, and specifically, reduced sampling of the sharp transition of the table edge. These are class *aliasing* artifacts.

Axial CT images (after protocol updates)
These artifacts are also observed when leads or wires are positioned within the CT gantry, however, they may not be visible in the display field of view (DFOV), depending on its size.

In this case, the artifact is a combination of aliasing (fine lines) and beam hardening (dark shadows).
Head CT from combined lymphoma protocol

View sampling changes with location in the SFOV.

For this combined CAP/H+N CT for lymphoma, the head is imaged while on the patient table and not in the head holder. This often results in off center positioning of the head relative to isocenter, which can cause aliasing artifacts owing to reduced projection and view sampling away from isocenter.
Warning: Physics ahead!
The Nyquist sampling theorem tells us that the highest spatial frequency that can accurately be represented in a sampled signal is:

\[ f_{\text{max}} < \frac{f_s}{2}, \]

which implies that the sampling frequency, \( f_s \), must be greater than \( 2 \times f_{\text{max}} \), the maximum spatial frequency contained in the image.

The sampling frequency in CT is related to both the number of detector elements (projection sampling) and the number of projections acquired per rotation (view sampling).

As gantry rotation time decreases, so does the number of projections acquired, and therefore the view sampling decreases.

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<table>
<thead>
<tr>
<th>Detector (360° scan)</th>
<th>Slice configuration</th>
<th>20-slice</th>
<th>40-slice</th>
<th>64-slice</th>
<th>128-slice</th>
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Instructions For Use for the Siemens Definition CT. Note that the number of projections acquired decreases as gantry rotation time decreases.
Subtle artifacts related to aliasing may also be seen when anatomy is not positioned at isocenter, as is often the case with certain combined studies, such as combined CAP + H/N lymphoma protocols. Projection and view sampling are highest at isocenter, and meet the Nyquist sampling criteria only within a certain radius.