

Common Artifacts and Analysis in CT Equipment

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Abstract: *With the development of medical imaging equipment, CT has become an indispensable tool in clinical diagnosis. CT image artifacts are a common malfunction of CT machines. Many factors cause and induce ring artifacts. To eliminate this type of malfunction, it is necessary to find its cause and restore the CT image to normal. This article provides a brief analysis of several common CT artifact phenomena and their troubleshooting.*

Keywords: CT artifacts; Ring artifacts; Detector; Air calibration; Troubleshooting.

1. CT STRUCTURE AND PRINCIPLE

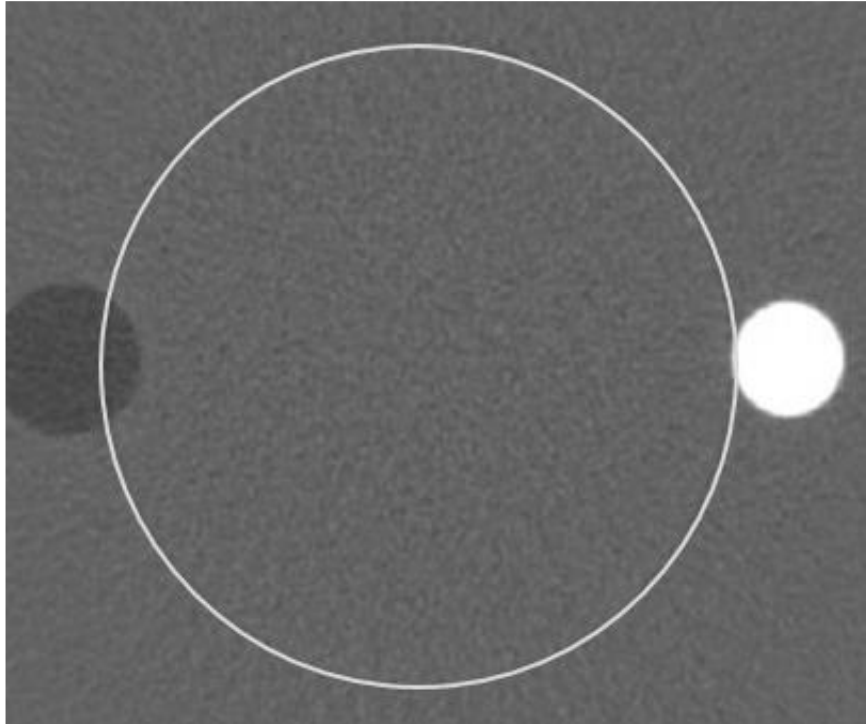
A CT imaging system consists of two parts: a hardware system and a software system. The A CT imaging system consists of two main components: hardware and software. The hardware system includes the scanning gantry, X-ray tube, collimator, filter, detector, analog-to-digital converter, high-voltage generator, and computer system. The basic function of CT software is to perform routine tasks such as scanning and image processing. Specialized software includes fault diagnosis software, special scanning software, special image processing software, and quantitative analysis software.

The working principle of CT is to use an X-ray beam to scan a specific thickness of the human body. The detector receives the remaining X-rays absorbed by a portion of that layer. The detector converts the X-ray signals of different intensities from various directions into electrical signals via an analog-to-digital converter, and then into digital signals via a digital-to-analog converter. These digital signals are then transmitted to the computer's data acquisition system. The computer processes the acquired digital information from various directions to obtain the digital values for each point on the scanned layer (the X-ray attenuation coefficient of the voxels is calculated from the scanned information), arranging them into a digital matrix. The digital matrix is then converted into pixels of different gray levels by an analog-to-digital converter.

2. SEVERAL COMMON ARTIFACT PROBLEMS IN CT SCANNERS AND THEIR SOLUTIONS

1) Artifact Phenomenon: As shown in the image below, straight line artifacts appear in the scanning positioning image, and thin single-ring artifacts appear in the transverse section. In the transverse section image, the image surrounding the ring artifacts shows no obvious anomalies, the artifact position is relatively fixed, and the ring density is uniform.

Troubleshooting: System error messages were reviewed, but no obvious issues were found. Air calibration was performed, but the problem persisted. Research indicated the artifacts were likely caused by a detector unit malfunction, a detector channel board malfunction, or dust or foreign objects on the detector surface. The equipment was cleaned and maintained to remove any foreign objects causing the artifacts. The faulty channel was located using the system's built-in data detection. The corresponding channel was moved to an edge position, and the equipment was calibrated and scanned again. If the artifact position corresponded to the channel adjustment, the channel was confirmed to be damaged. Software settings could be used to temporarily disable the faulty channel and ensure short-term departmental use. If the artifact position did not change after channel replacement, a detector unit malfunction was suspected and replacement was necessary.



2) Artifact phenomenon: As shown in Figure 1, a faint ring artifact appears during scanning. Air calibration can eliminate it, but it will reappear after a short period of operation.

Troubleshooting: Common artifacts can be eliminated through phantom calibration and air calibration. However, this problem recurred shortly after being resolved. The artifact images showed largely consistent shapes and positions, and image processing revealed the problem persisted. Therefore, a hardware system fault was suspected. The maintenance interface indicated that the detector temperature was too high. Upon disassembly and inspection of the detector, it was found that one of the cooling fans (Figure 2) was blowing air outwards instead of drawing in air for cooling. Replacing the fan resolved the problem.

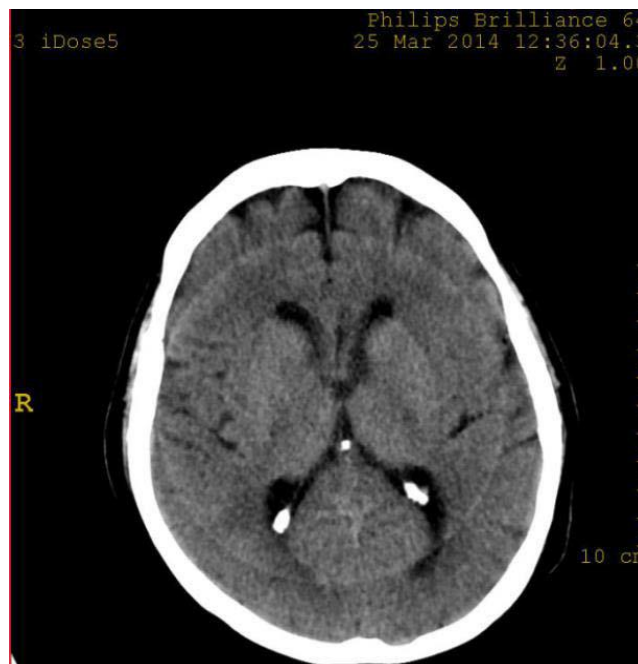


Figure 1

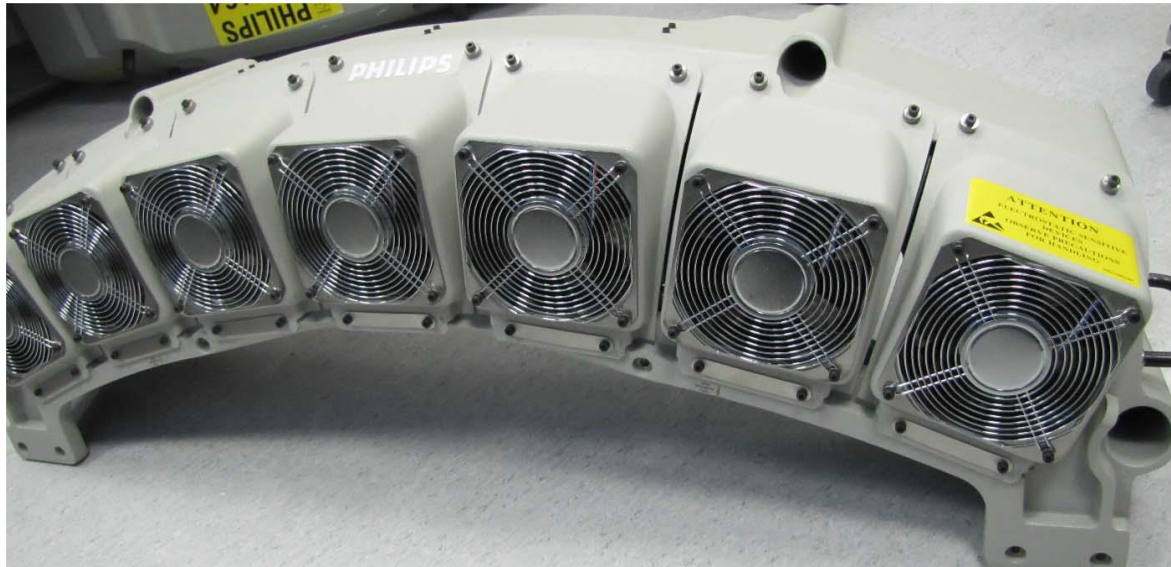
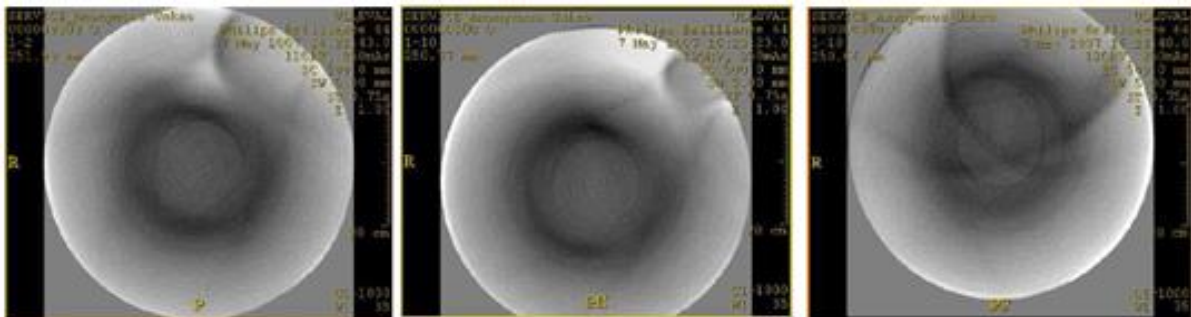


Figure 2

3) Artifact phenomenon: As shown in the figure below, the artifact is blurred and its shape is variable. After multiple exposures, the artifact position moves frequently, and air calibration and phantom calibration are ineffective.

Troubleshooting: The fault persisted after image reconstruction. Furthermore, the artifact positions changed continuously with each scan, forming irregular shapes, suggesting the presence of air bubbles in the cooling oil inside the X-ray tube. During scanning, the tube rotated, causing these air bubbles to move and resulting in the continuous change in image artifact positions. The fault was repaired and eliminated by adding oil and purging the tube. After calibration, the fault was resolved.



3. EQUIPMENT MAINTENANCE AND UPKEEP

In addition to ensuring a suitable operating environment, preheating the X-ray tube before use, and frequent calibration during operation, it is also necessary to periodically calibrate the mechanical performance of the equipment and perform dust removal and lubrication of the machine body. For air-cooled models, the fan and its filter should be cleaned regularly; compressed air can be used to blow away dust from areas such as the data optical path. Clean and lubricate the brushes and slip rings, and check the wear of the carbon brushes. Maintain and lubricate the mechanical components of the scanning bed. Different parts of the bed frame have different functions and effects; when lubricating, ensure that the correct type of lubricant is used to avoid accelerating equipment wear due to using the wrong oil.

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