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Evaluation of CT Images Created Using a New Metal Artifact Reduction Reconstruction Algorithm for Radiation Therapy Treatment Planning

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Abstract

Purpose: Metal in patients creates streak artifacts in CT images. When used for radiation treatment planning, these artifacts make it difficult to identify internal structures and affects radiation dose calculations, which depend on HU numbers for inhomogeneity correction. This work quantitatively evaluates a new metal artifact reduction (MAR) CT image reconstruction algorithm (GE Healthcare CT-0521-04.13-EN-US DOC1381483) when metal is present.

Methods: A Gammex Model 467 Tissue Characterization phantom was used. CT images were taken of this phantom on a GE Optima580RT CT scanner with and without steel and titanium plugs using both the standard and MAR reconstruction algorithms. HU values were compared pixel by pixel to determine if the MAR algorithm altered the HUs of normal tissues when no metal is present, and to evaluate the effect of using the MAR algorithm when metal is present. Also, CT images of patients with internal metal objects using standard and MAR reconstruction algorithms were compared.

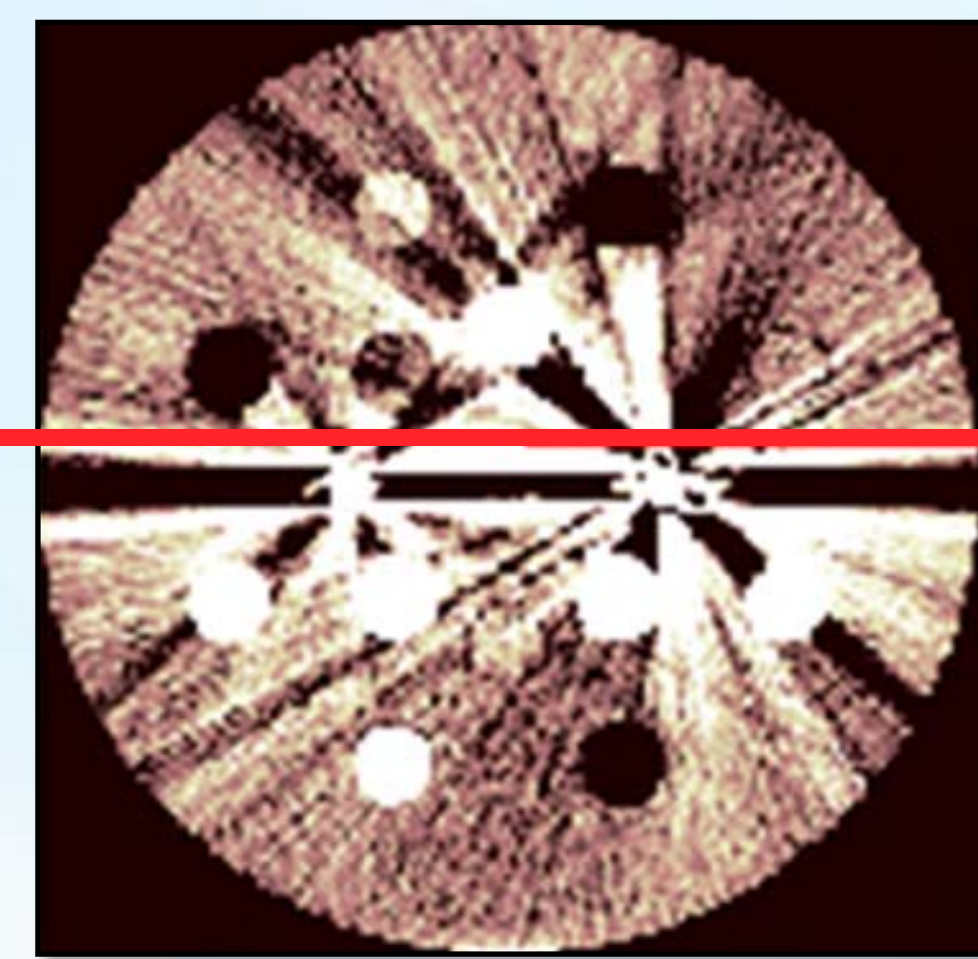
Results: Comparing the standard and MAR reconstructed images of the phantom without metal, 95.0% of pixels were within ± 35 HU and 98.0% of pixels were within ± 85 HU. Also, the MAR reconstruction algorithm showed significant improvement in maintaining HU's of non-metallic regions in the images taken of the phantom with metal. HU Gamma analysis (2%, 2mm) of metal vs. non-metal phantom imaging using standard reconstruction resulted in an 84.8% pass rate compared to 96.6% for the MAR reconstructed images. CT images of patients with metal show significant artifact reduction when reconstructed with the MAR algorithm.

Conclusions: CT imaging using the MAR reconstruction algorithm provides improved visualization of internal anatomy and more accurate HUs when metal is present compared to the standard reconstruction algorithm. MAR reconstructed CT images provide qualitative and quantitative improvements over current reconstruction algorithms, thus improving radiation treatment planning accuracy.

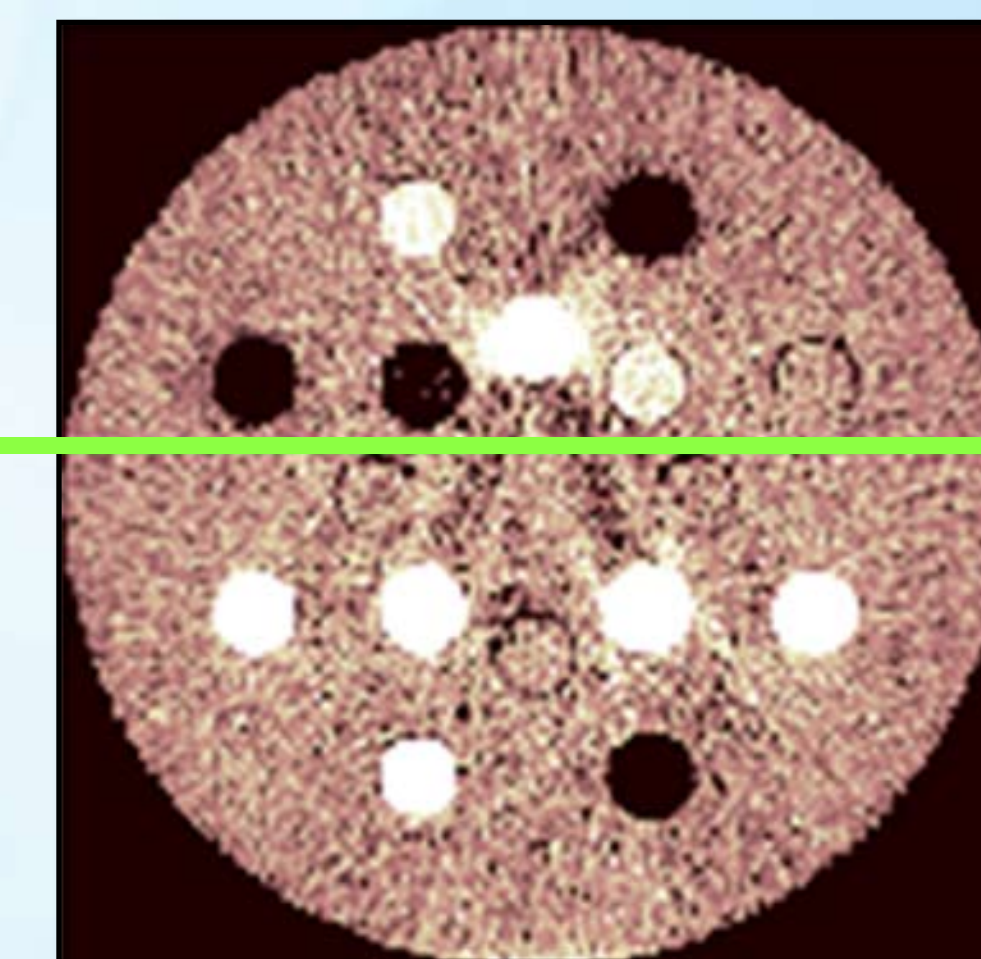
Innovation/Impact: This study quantitatively confirms that a revolutionary new CT reconstruction algorithm that reduces artifacts from metal provides improved images that can be used for radiation treatment planning. Radiation treatment planning can then be performed on patients having metal in them with better visualization of anatomy and more accurate radiation dose calculations.

Key Results: Comparison of CT images of a phantom having typical human tissue densities using the standard and the metal artifact reduction reconstruction algorithms demonstrates that the MAR algorithm maintains the accuracy of HU values. Comparison of CT images of the same phantom with metal using the same two algorithms demonstrates improved accuracy of HU values in the non-metal locations. Anatomy visualization of patients having metal is significantly improved.

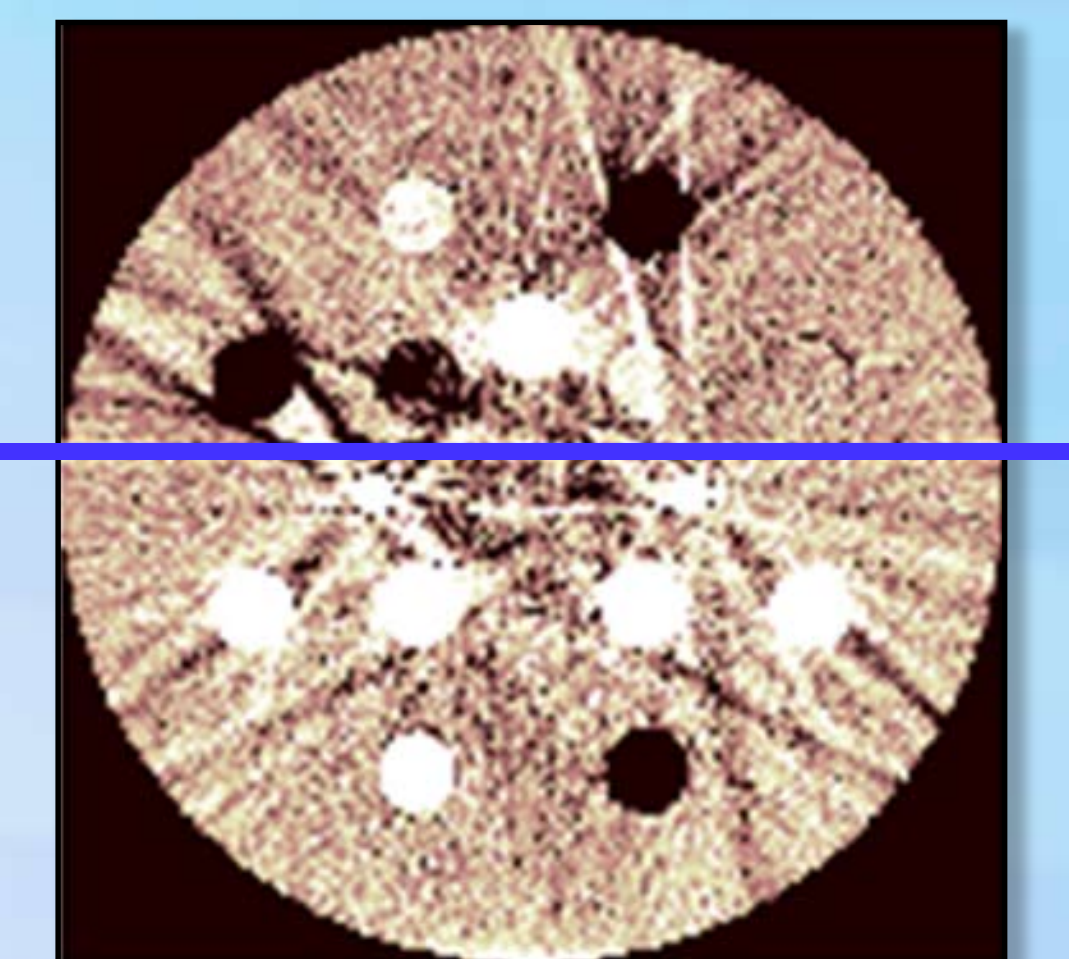
Standard Reconstruction (With Metal)



Standard Reconstruction (Without Metal)



MAR Reconstruction (With Metal)



HU Profile Comparison

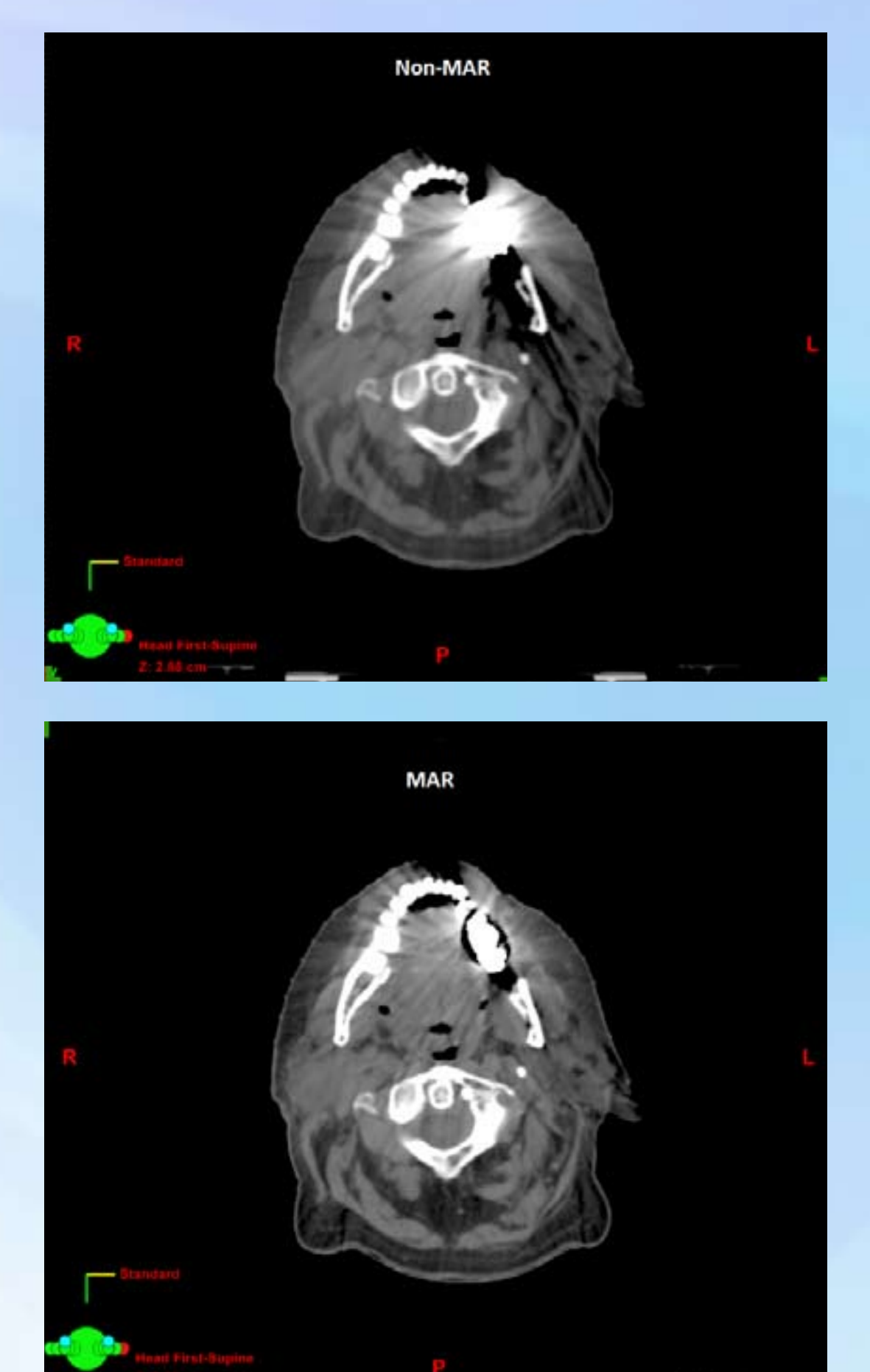
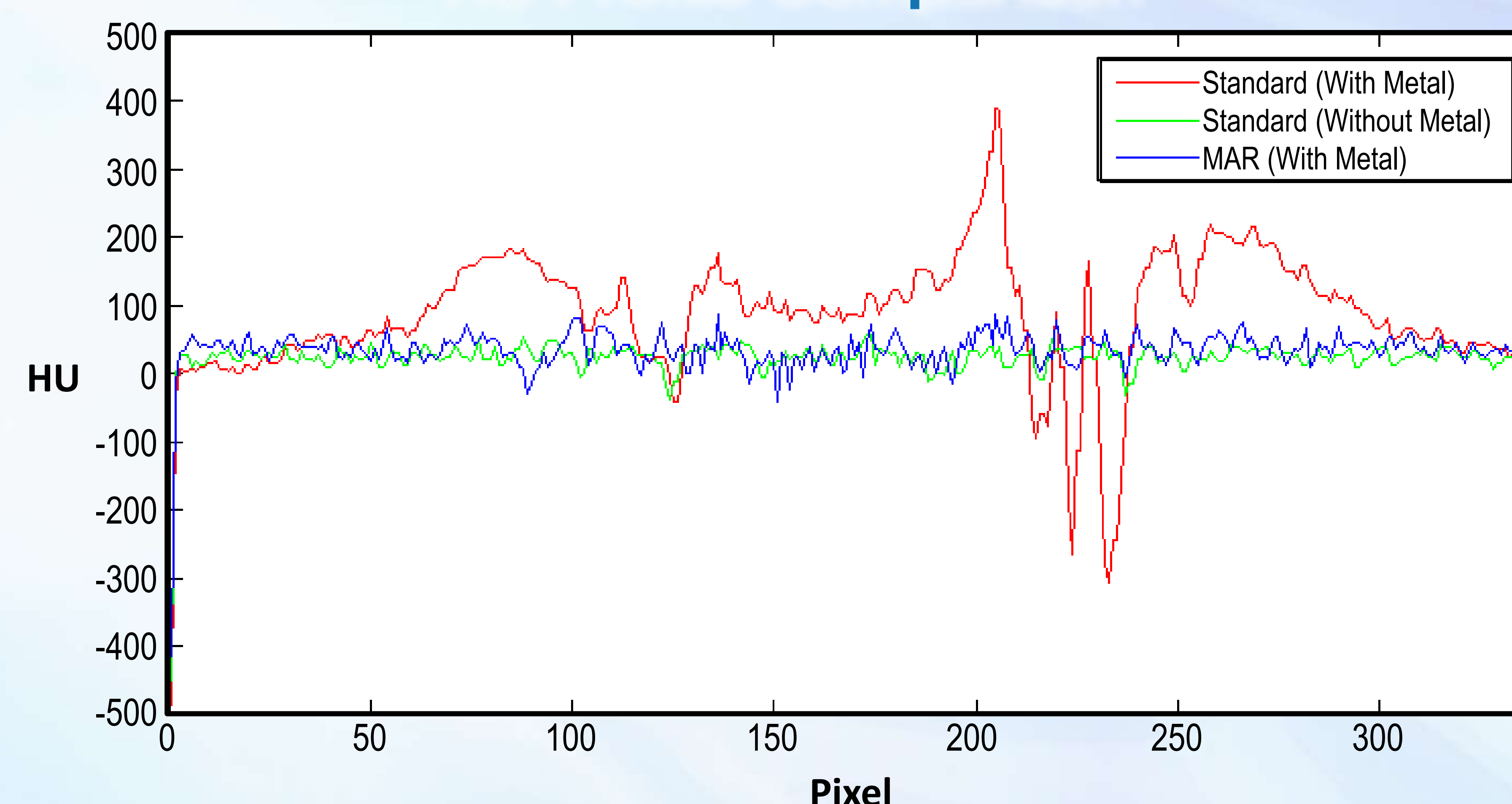
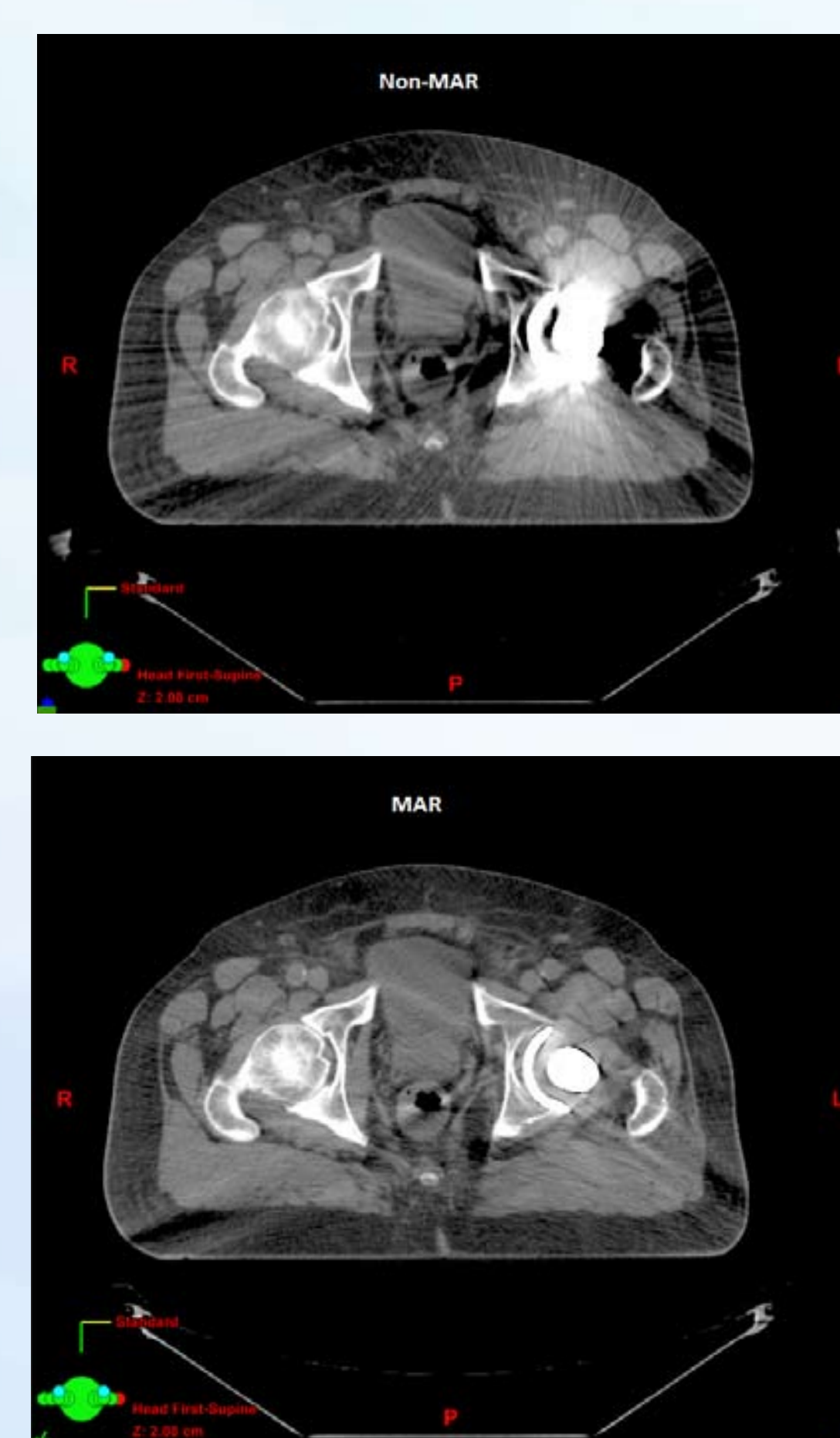
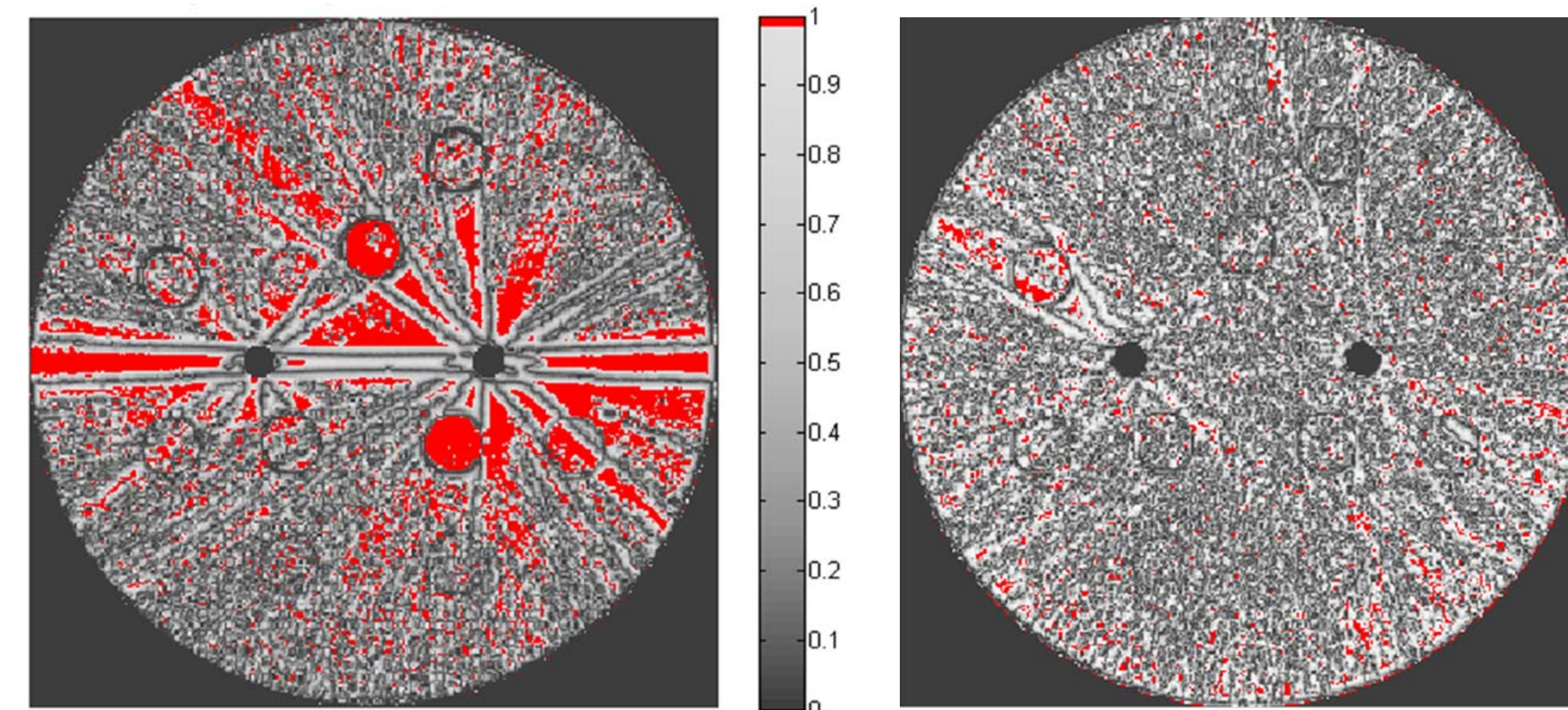


Figure 1: HU profile comparison between the reconstruction algorithms, with and without metal.

HU Gamma Map:
Standard (Without Metal) vs
Standard (With Metal)
(2%, 2mm) 84.8% Pass Rate



HU Gamma Map:
Standard (Without Metal) vs
MAR (With Metal)
(2%, 2mm) 96.6% Pass Rate

Figure 2: HU gamma analysis between the reconstruction algorithms, with and without metal.