

Metal Artifact Reduction Using AI

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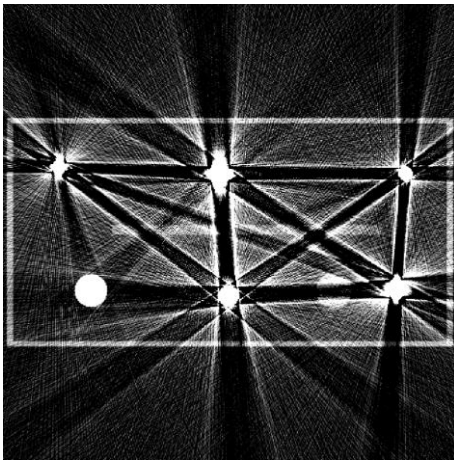
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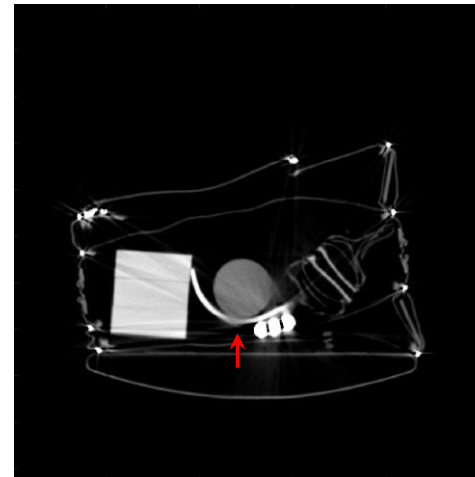
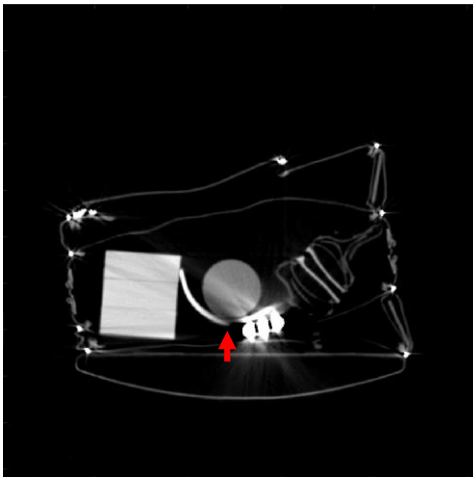
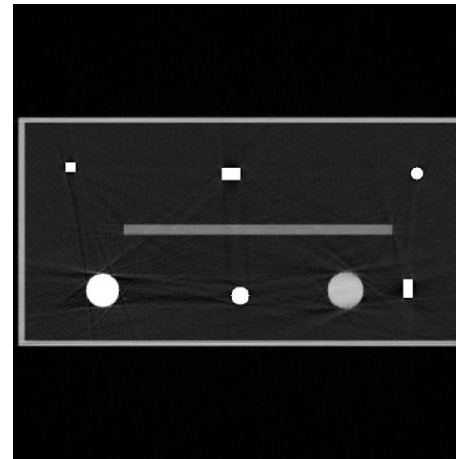
So What, who cares

- Improve detection in CT using Deep Learning to reduce metal artifacts

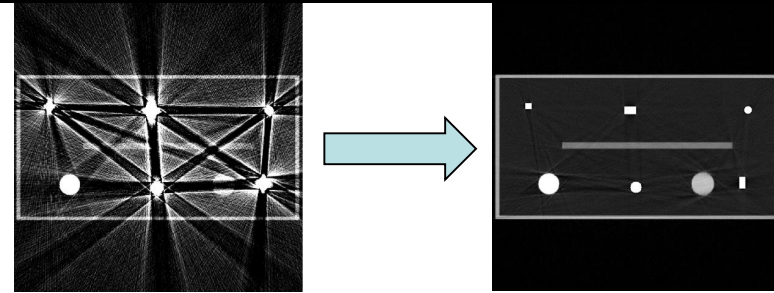
Conventional FBP



Deep Learning MAR



So What, who cares



■ Motivation

- Improve detection in X-ray CT-based scanners by reducing metal artifacts
- ALERT TO3 showed iterative reconstruction can reduce artifacts and improve detection
 - Problem: Iterative reconstruction is slow, priors can be generic, brittle

■ Solution

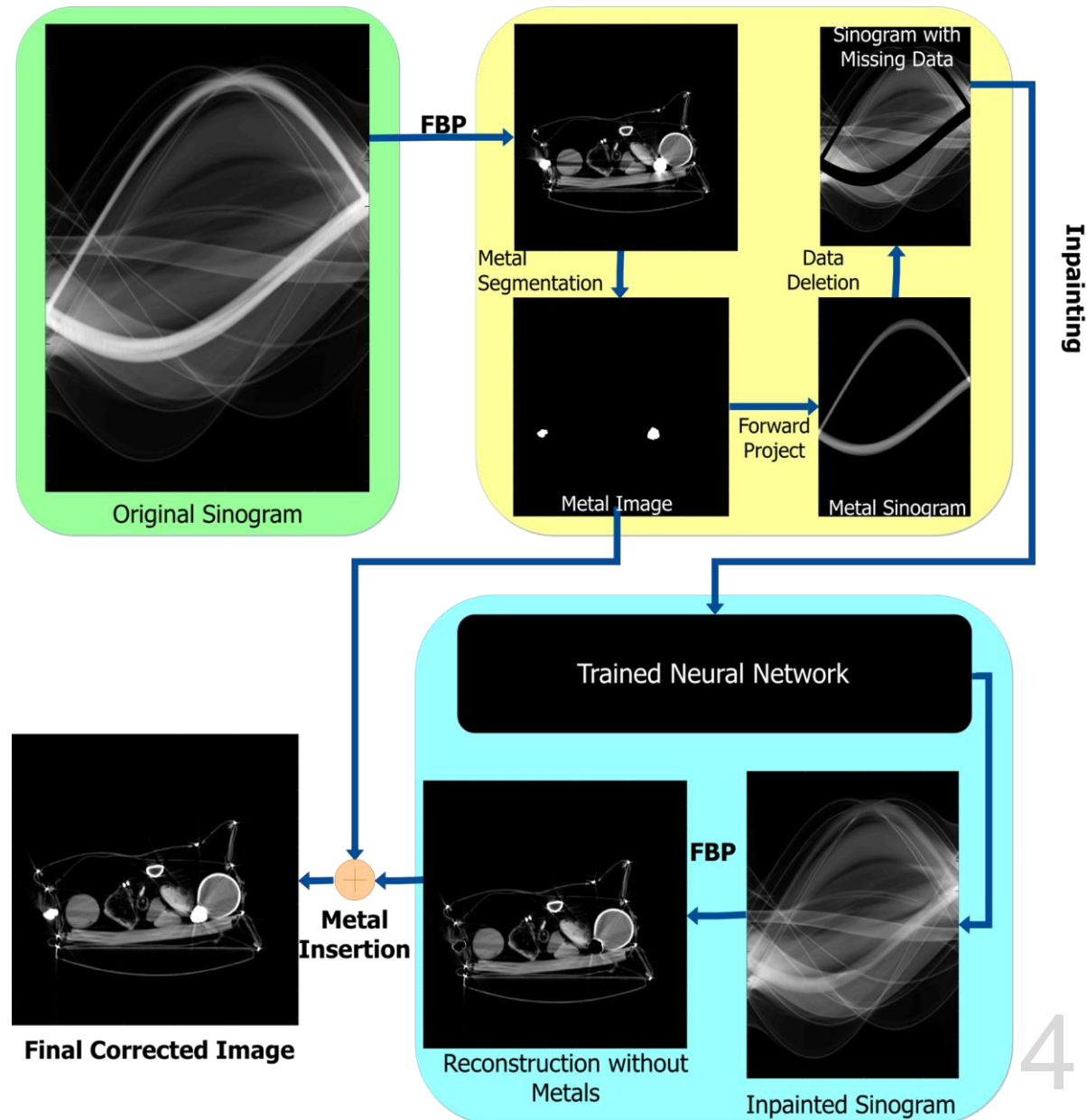
- Use Deep Learning for CT reconstruction
- Focus on **pre-reconstruction** correction of metal artifacts in X-ray CT data
- Focus on a fast method within a standard workflow
- Explore use of synthetic training data

New Approach: *Deep-MAR*

Key points:

- **Sinogram-focus**
- Learn **complete** sinogram behavior
- Use fully convolutional network (FCN) for efficiency
- Use C-GAN for good performance
- **Synthetic data training**, coupled with real data tuning

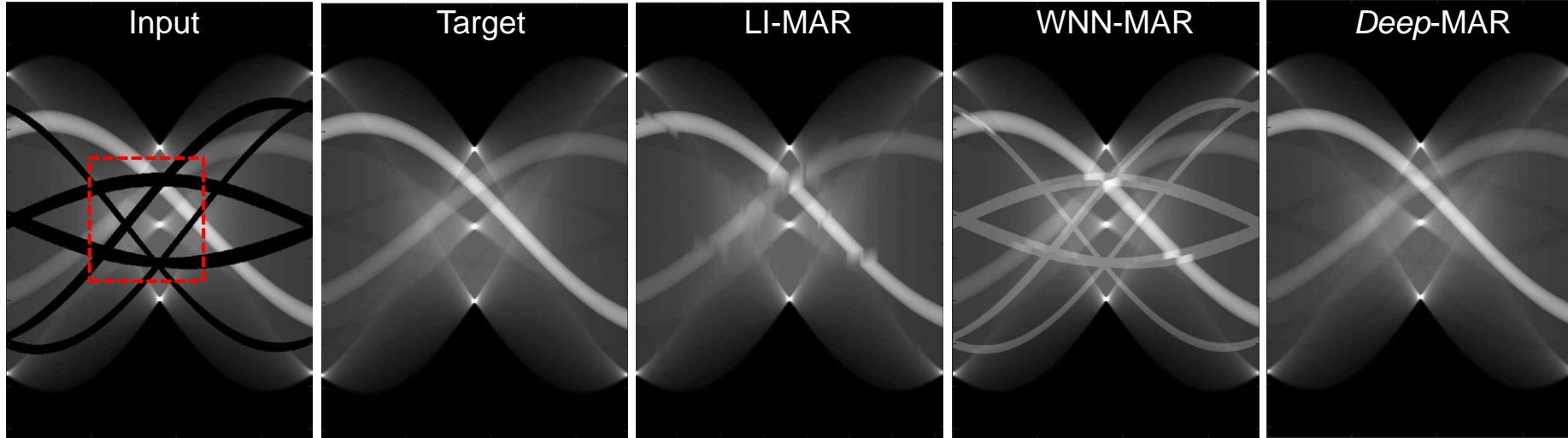
- Remove problems rather than post-hoc correction



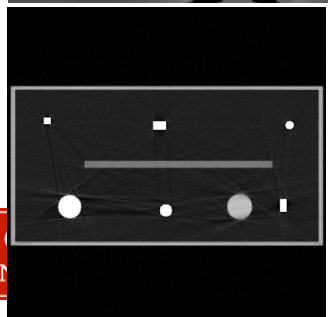
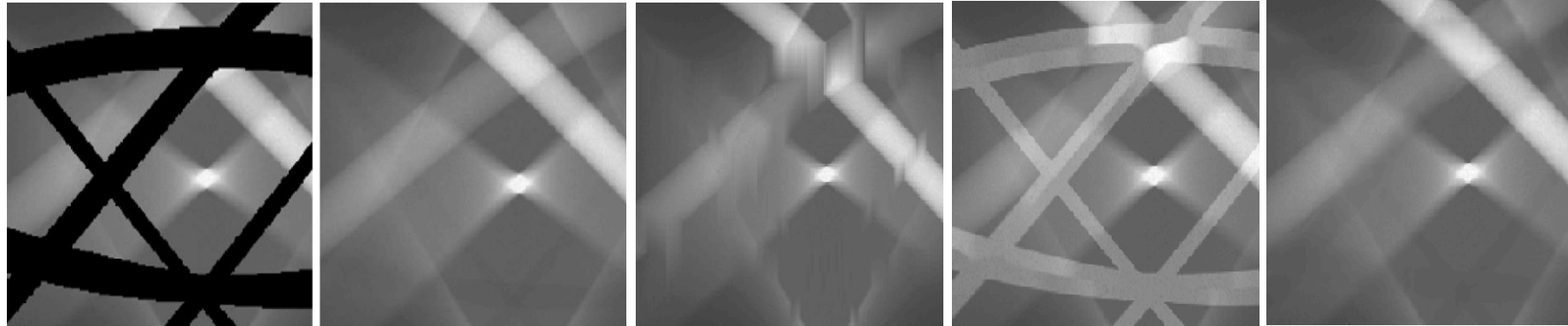
Sinogram Estimation via Deep Learning



Sinograms



Zooms



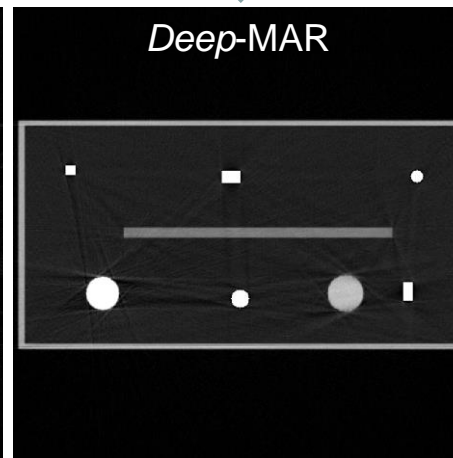
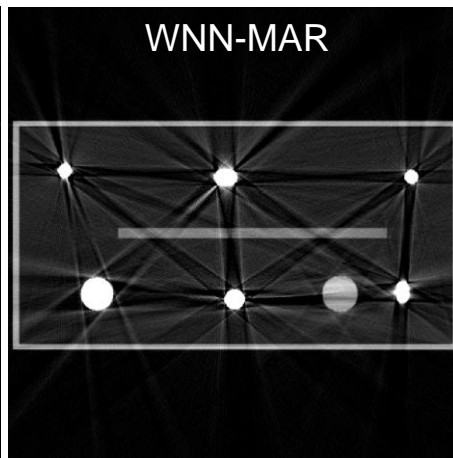
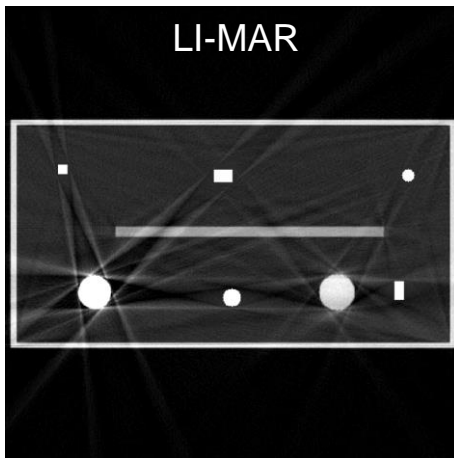
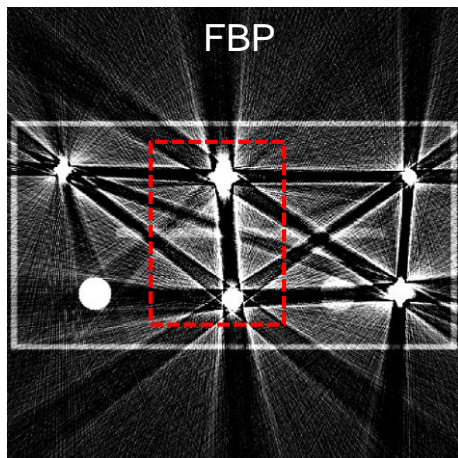
← Underlying scene

LI-MAR = Linear interpolation MAR
 WNN-MAR = Weighted Nearest-Neighbor MAR
 Deep-MAR = Deep Learning MAR

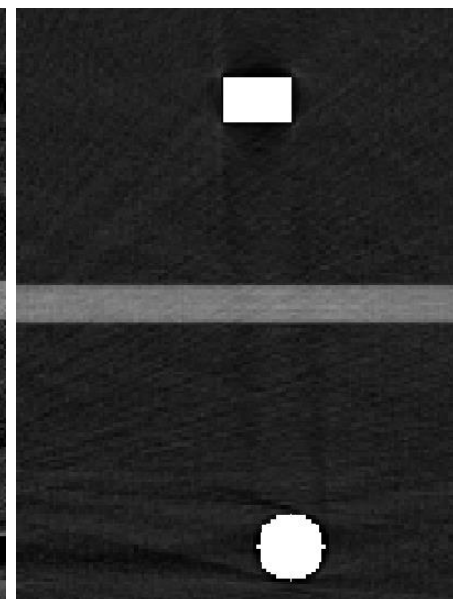
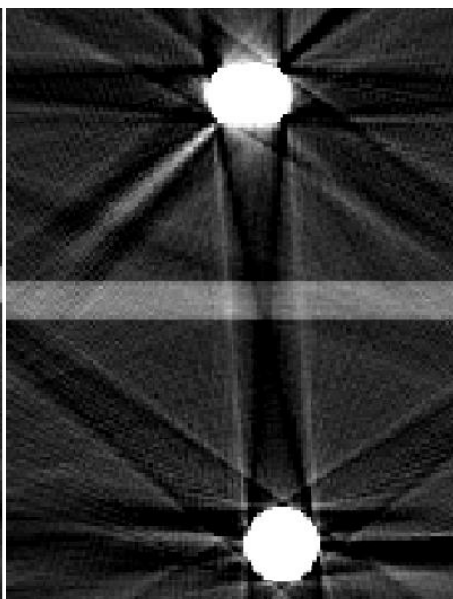
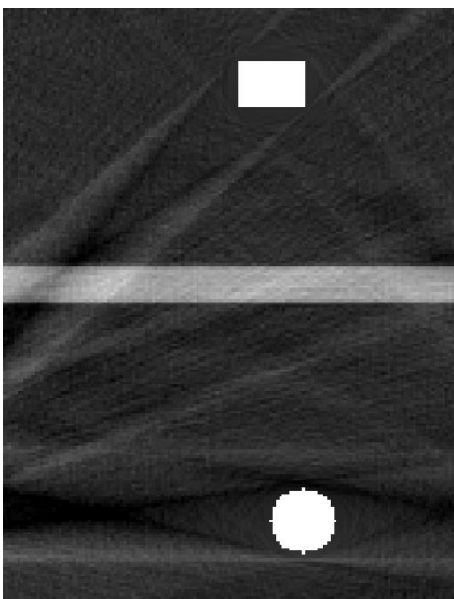
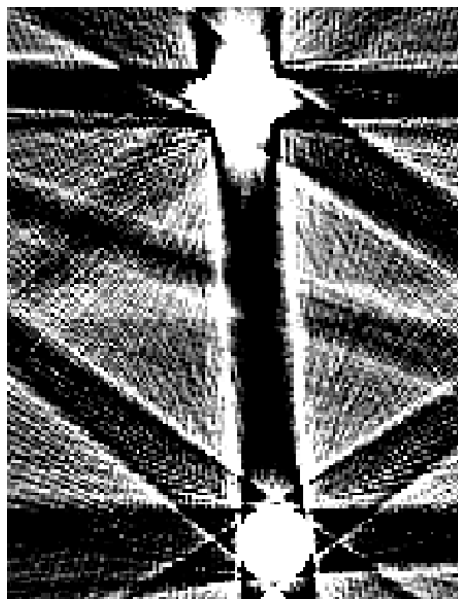
Reconstructions



Reconstructions



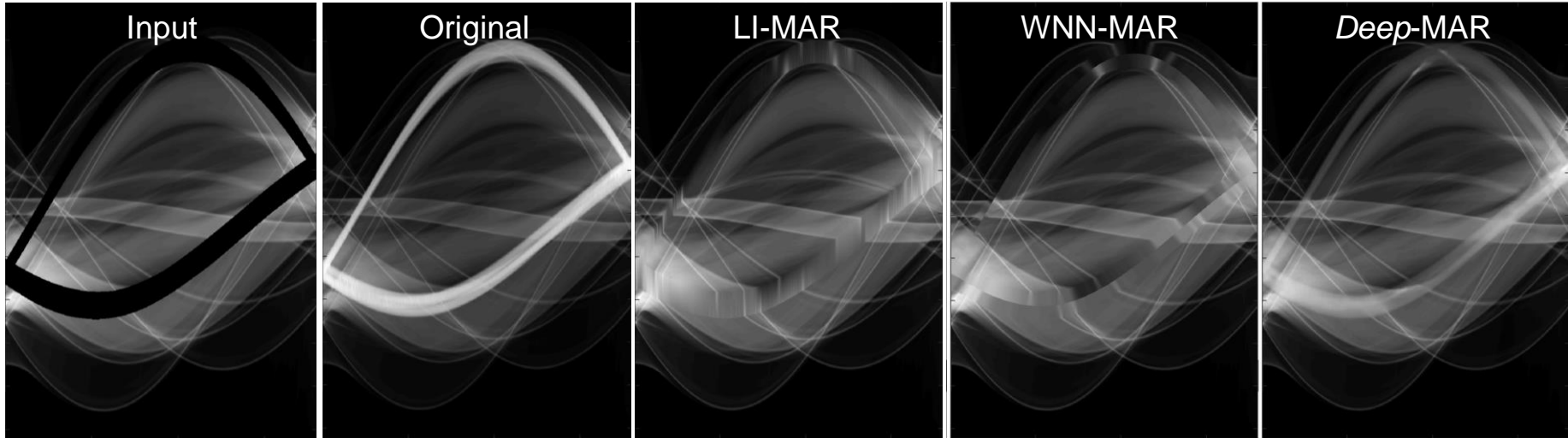
Residuals



Example based on TO3 simulations

LI-MAR = Linear interpolation MAR
 WNN-MAR = Weighted Nearest-Neighbor MAR
 Deep-MAR = Deep Learning MAR

Real Examples: Sinogram Estimation



← Underlying scene

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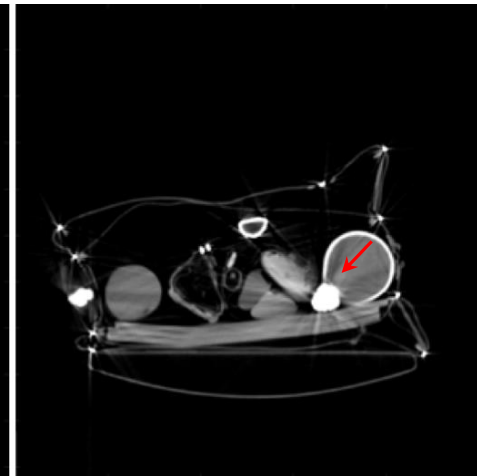
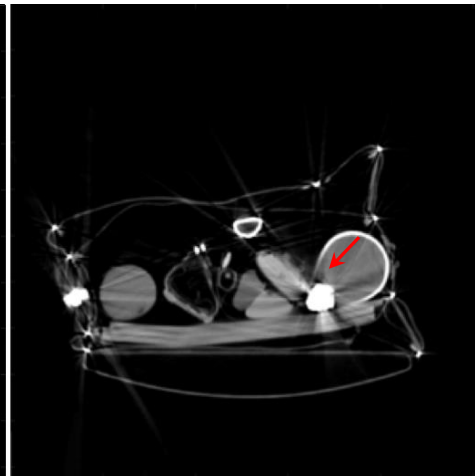
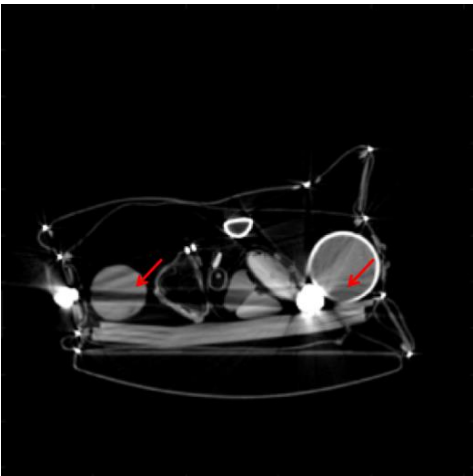
Real Examples: Reconstructions



Original

LI-MAR

WNN-MAR

Deep-MAR

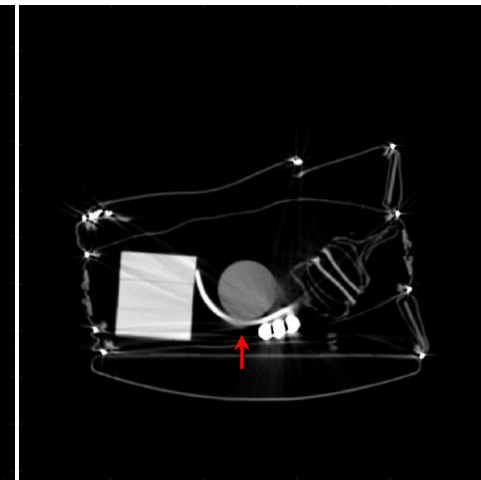
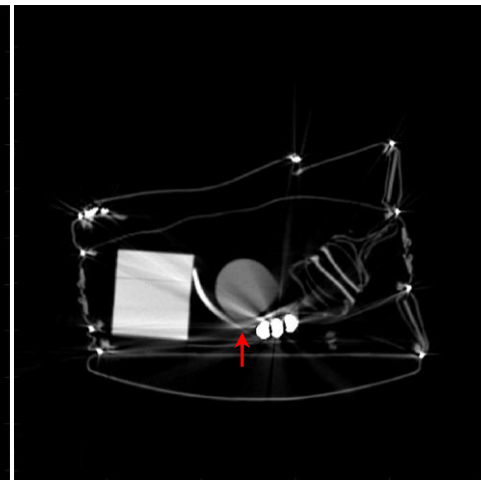
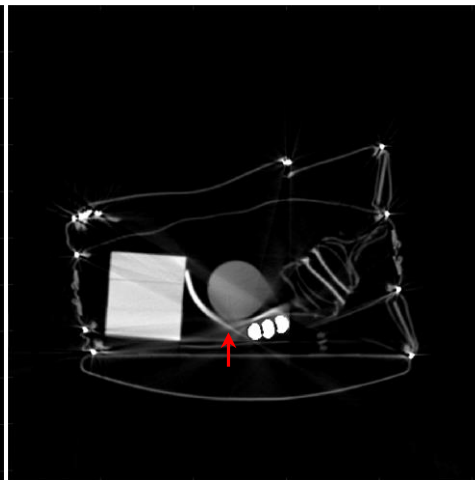
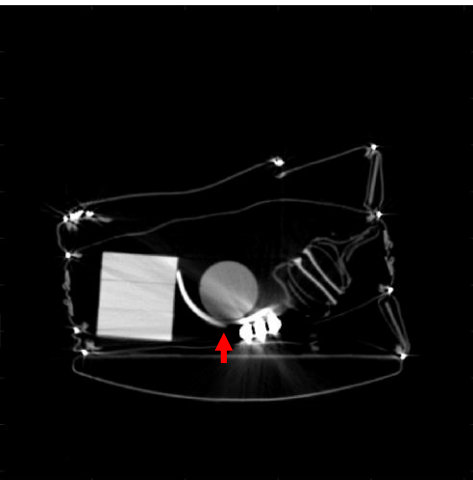
Real Examples: Reconstructions



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LI-MAR

WNN-MAR

Deep-MAR

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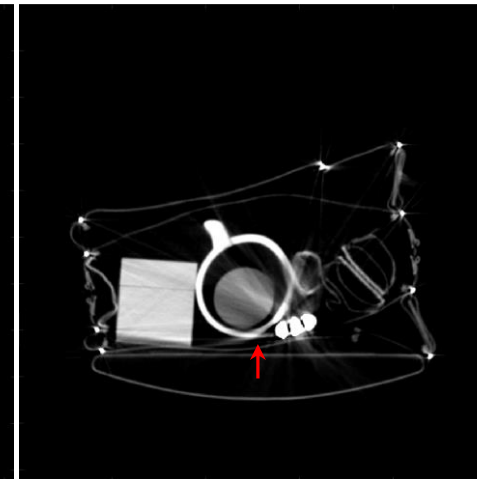
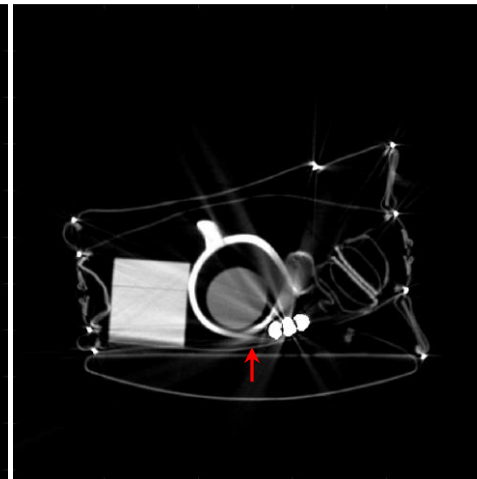
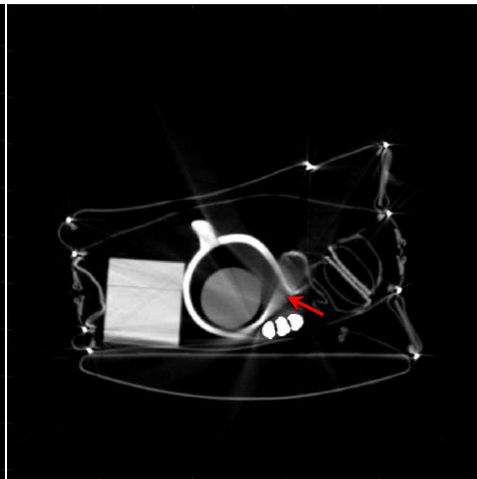
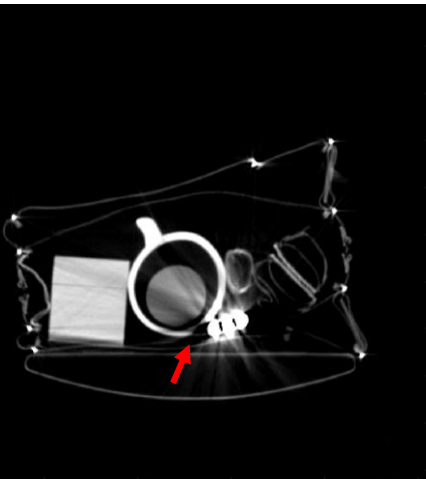
Real Examples: Reconstructions



Original

LI-MAR

WNN-MAR

Deep-MAR

Conclusions

- A new deep-learning-based MAR technique
 - Correct sinogram, not artifact image
 - Focus learning on complete sinograms (vs patches)
 - GANs to avoid over-smoothing
 - Implementation is fast
- CNN trained on a large dataset learns to correct sinograms.
- Initial results show promise!
- Efficient and fully automated solution