

Prior-based Artifact Correction (PBAC) in Computed Tomography

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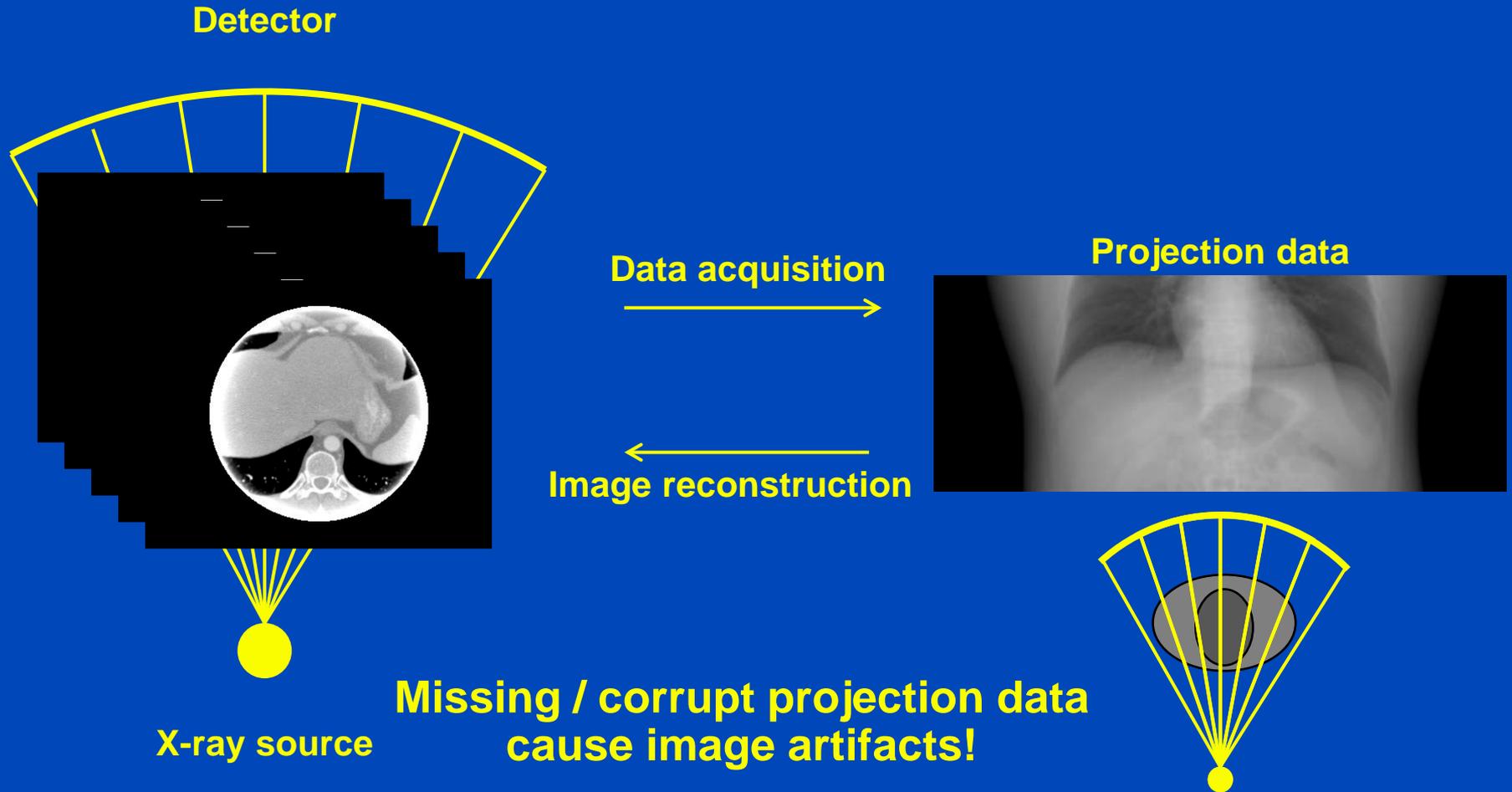
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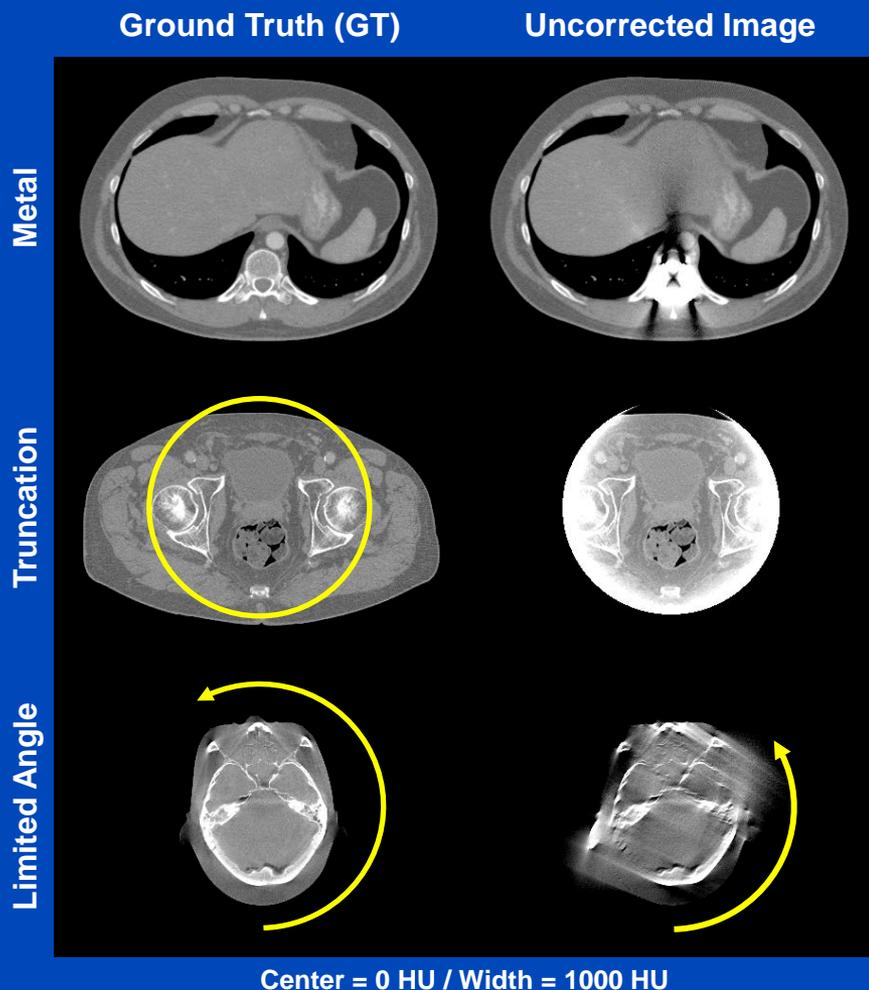
Computed Tomography (CT)

Data Acquisition and Image Reconstruction



Artifacts in CT

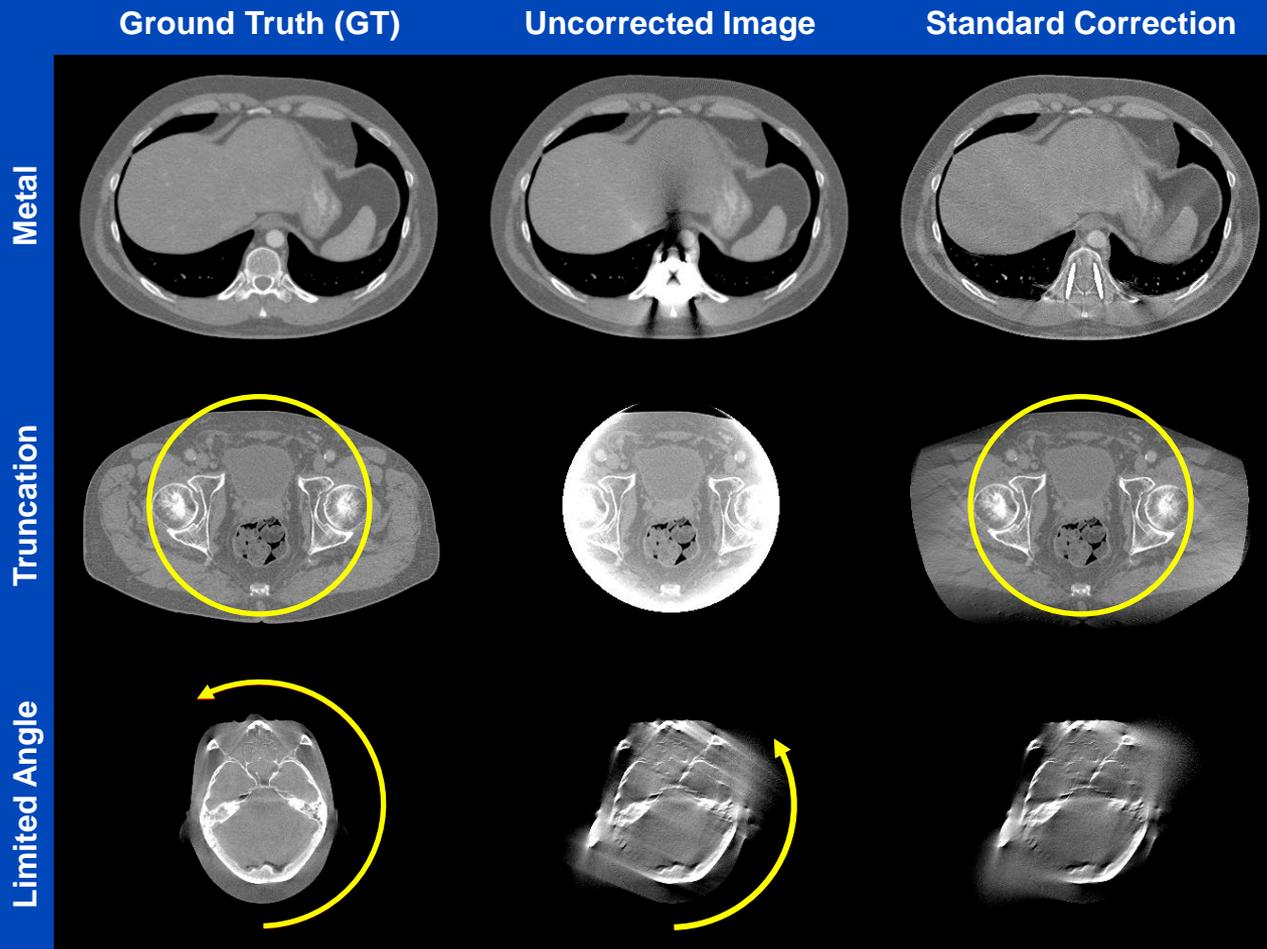
Simulation of Artifacts



- **Metal artifacts**
 - Two titanium pedicle screws
 - Beam hardening
 - Scatter and partial volume effects not considered
- **Truncation artifacts**
 - Reduced field of measurement (FOM)
 - FOM indicated by yellow circle
- **Limited angle artifacts**
 - Reduced total scan angle
 - Source trajectory indicated by yellow arc

Artifacts in CT

Standard Correction Methods



Center = 0 HU / Width = 1000 HU

- **NMAR^[1] + FSMAR^[2]**
^[1]E. Meyer, R. Raupach, M. Lell, B. Schmidt, and M. Kachelrieß. "Normalized metal artifact reduction (NMAR) in computed tomography", *Med. Phys.* 37(10), 5482-5493, 2010.
^[2]E. Meyer, R. Raupach, M. Lell, B. Schmidt, and M. Kachelrieß. "Frequency split metal artifact reduction (FSMAR) in computed tomography", *Med. Phys.* 39(9), 1904-1916, 2012.
- **Adaptive detruncation^[3]**
^[3]K. Sourbelle, M. Kachelrieß, and W. Kalender. "Reconstruction from truncated projections in CT using adaptive detruncation", *Eur. Radiol.* 15(5), 1008-1014, 2005.
- **Angular outfading**

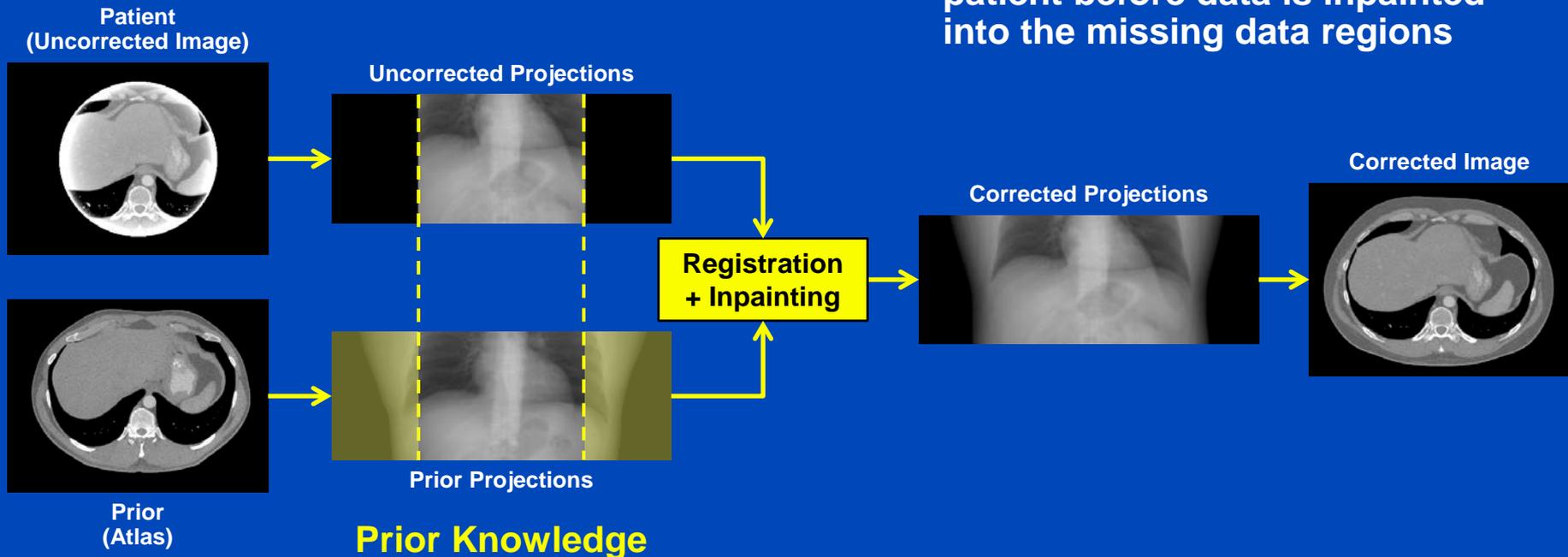
Prior-based Artifact Correction^[1] (PBAC)

- Idea

- Use prior data to replace missing or corrupt patient projection data

- Prior data

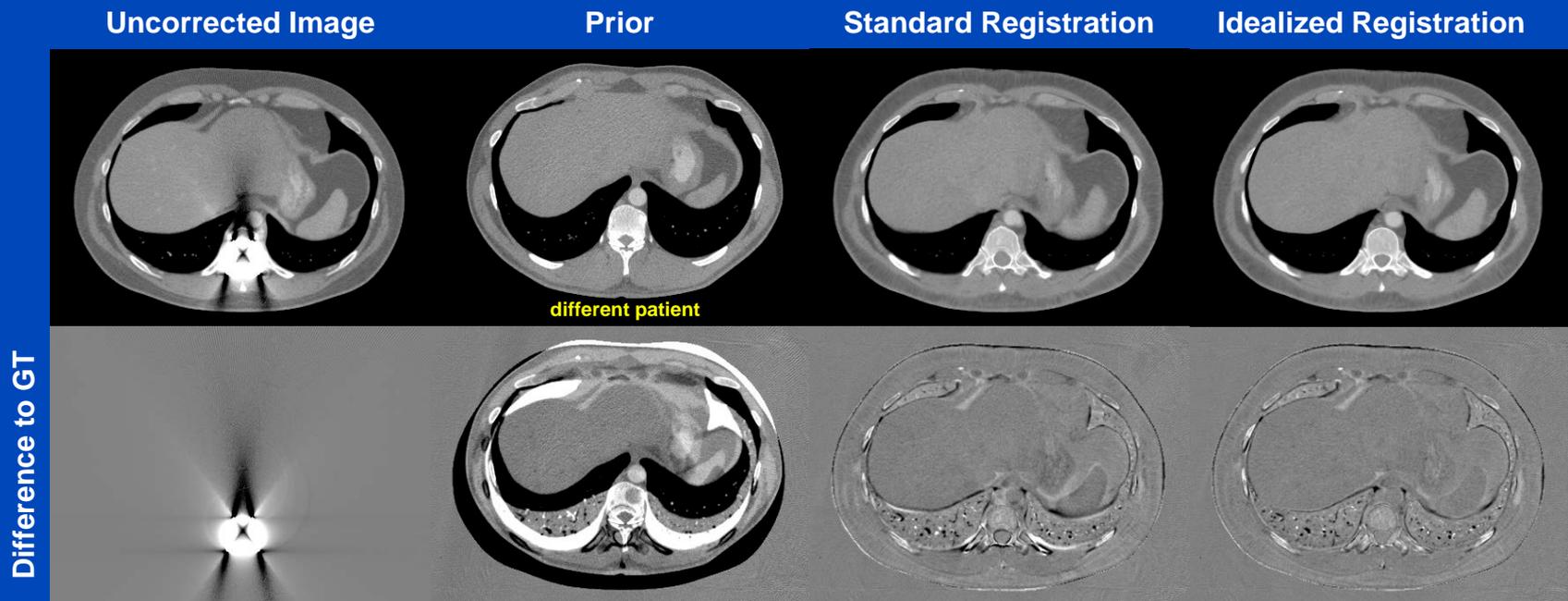
- Different scan of the same patient or scan of a different patient
- Needs to be registered to the patient before data is inpainted into the missing data regions



Registration

Compensate for Differences between Patient and Prior

- Deformable registration
 - Based on the Demons algorithm
 - Local, voxel-specific deformation
 - Sensitive to image artifacts
- Two approaches
 - Standard registration: Registration onto std. correction
 - Idealized registration: Registration onto GT



Center = 0 HU / Width = 1000 HU (reconstructions and difference images)

Results

Simulations

PBAC

Ground Truth

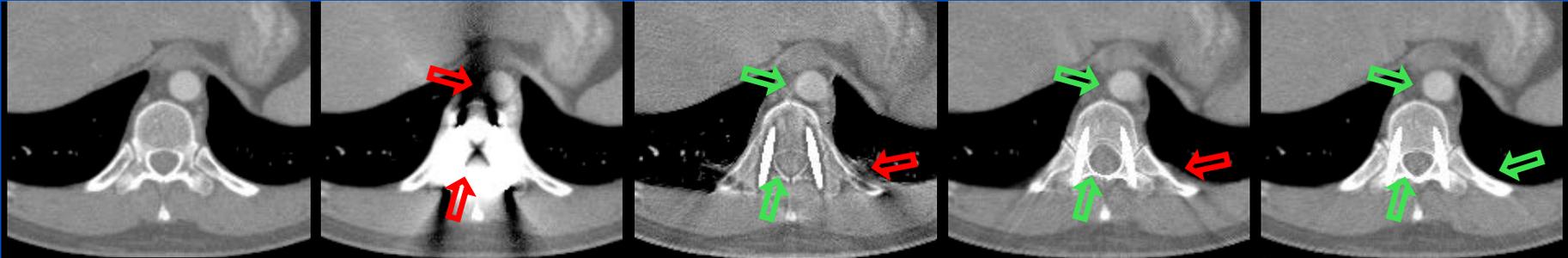
Uncorrected Image

Standard Correction

Standard Registration

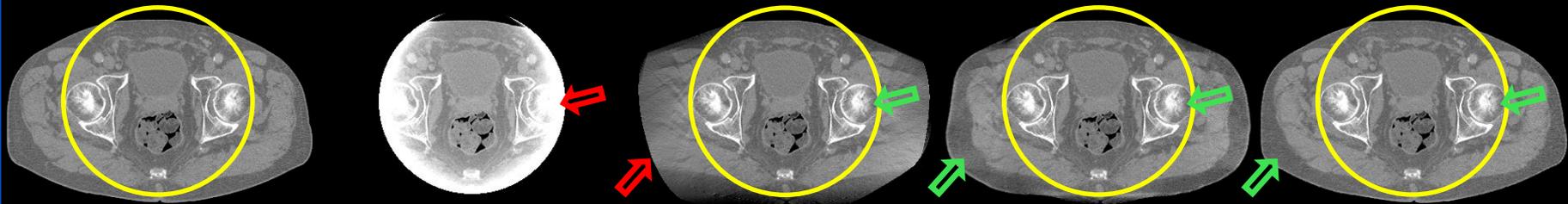
Idealized Registration

Metal



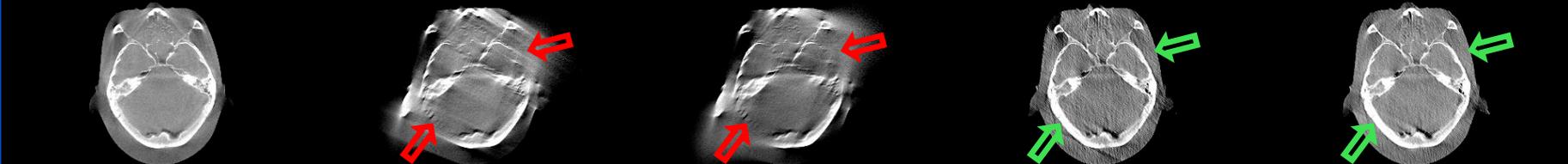
different patient as prior

Truncation



different patient as prior

Limited Angle



same phantom as prior

Center = 0 HU / Width = 1000 HU

Results

Patient Data

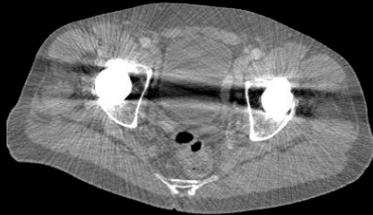
PBAC

Uncorrected Image

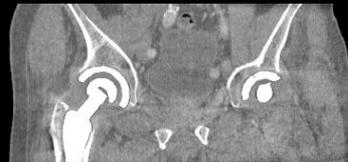
Standard Correction

Standard Registration

Transaxial



Coronal



Sagittal



Center = 0 HU / Width = 1000 HU

Conclusions and Outlook

- **Conclusions**
 - PBAC effectively corrects for common CT artifacts.
 - PBAC appears to be superior or at least comparable to standard CT artifact correction methods.
- **Outlook and future plans**
 - Develop and implement artifact-insensitive deformable registration (e.g. rawdata-based)
 - Generalize PBAC to be applicable to other modalities (e.g. MRI and PET/MRI)

Thank You!

This presentation will soon be available at www.dkfz.de/ct.

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