TV or not TV? That is the Question...

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Introduction

Reconstruction of limited angle data using a fan-beam geometry:

Iterative vs. Filtered backprojection (FBP) reconstruction

- Iterative: Popular for reconstruction from few views, but high computational complexity
- FBP: Fast but challenging in case of super-short scans [1]
- Iterative methods similar to FBP plus non-linear filtering [2,3]

Materials and Methods

- Missing projections lead to low- and high-frequency artifacts (Figure 2b)
- Low-frequency artifacts due to missing mass of projection data

Compensation Weights (CW) and Regularization

- Extend Parker Weights (PW) [4] to account for missing data
- Compensate missing mass by increasing the weight of acquired rays that are spatially close to the missing data (Figure 1b)
- Enforce regularization in the reconstructed domain using a non-linear bilateral filter (BF) to remove high-frequency artifacts

Experiments

- Qualitative and quantitative evaluation using the Shepp-Logan phantom and 5 different reconstruction approaches
  - FBP with PW
  - FBP with PW → BF
  - FBP with CW
  - FBP with CW → BF
  - Iterative with total variation (TV) regularization

Detector:	640 elements
Source detector distance:	500mm
Scan range:	180°

Pixel spacing:	**0.5mm**
Fan angle $2\delta_{max}$:	**$\approx 35.5°$**
No. of projections:	**180**

Results and Discussion

- Compensation weights remove low-frequency artifacts (*Figure 2bc, Figure 3)*
- Bilateral filtering corrects high-frequency artifacts *(Figure 2cd)*
- Compensation weights with bilateral filtering yields similar results as iterative reconstruction *(Figure 2df, Figure 3)*

	rRMSE	MSE	SSIM
FBP with PW → BF	0.1271	0.0273	0.9594
FBP with CW → BF	0.0569	0.0055	0.9673
Iterative TV	0.0566	0.0054	0.9777

Conclusions

- We propose novel projection data weights that consider redundant but also missing data
- Reconstruction results are comparable to an iterative algorithm, while being a number of magnitudes faster
- The result can be used as initialization for an iterative method

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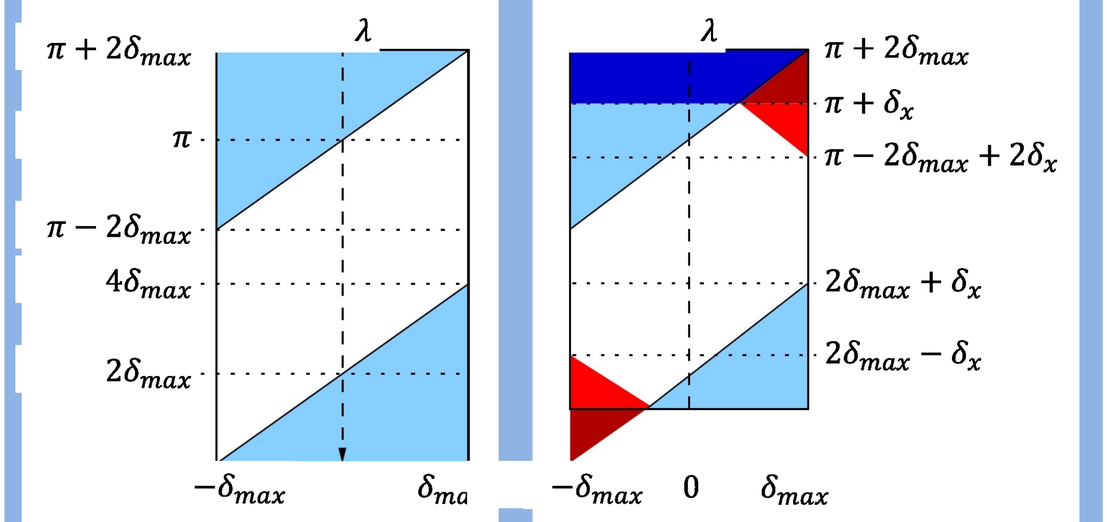

Figure 1: Sinograms of a short scan **(a)** and a super-short scan **(b)**. Light blue denotes redundancies, dark red equals missing data and light red is the area with increased weight. δ_{max} is half the fan angle and $\pi + \delta_x$ is the scan range, where $\delta_x = 2\delta_{max}$ in case of a short scan.

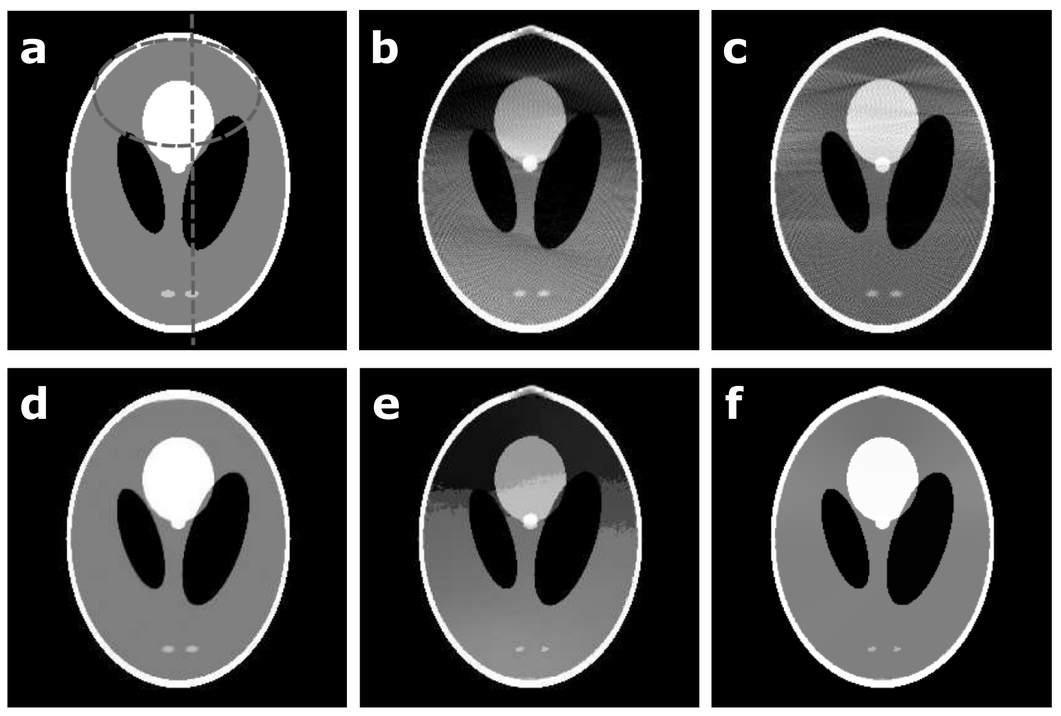

Figure 2: Ground truth phantom **(a)** and reconstruction results using PW only **(b)**, novel CW **(c)**, iterative TV regularized **(d)**, PW with BF **(e)** and CW with BF **(f)**. The window for the visualization was chosen as [1.0, 1.4].

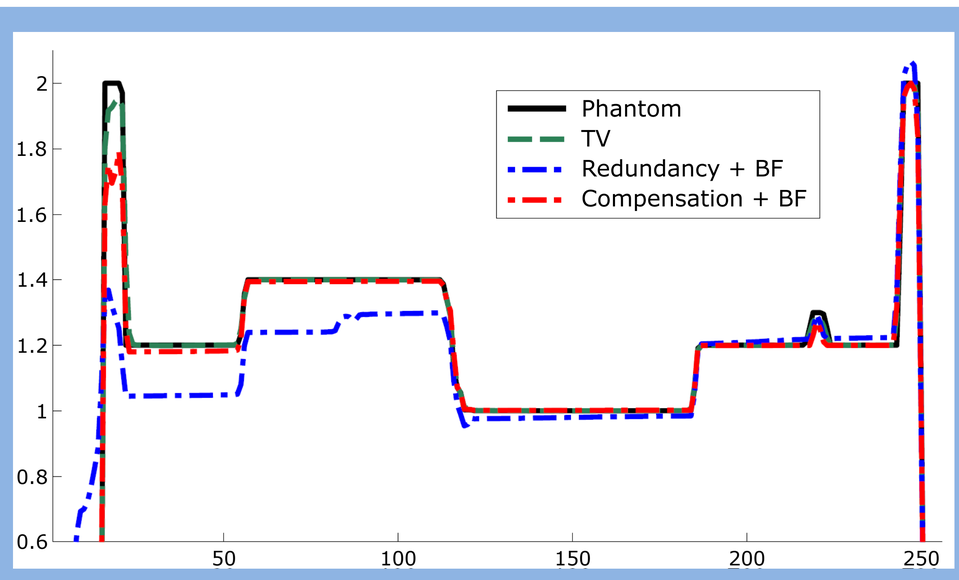

Figure 3: Profiles along the line indicated in Figure 2a. Note the correction of the low-frequency bias.

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