Streak-reduction Human-scale Dark-field CT with 3D Gaussian Splatting

T. Dorosti*[1,2,3], D. Frey*[1,2], J. B. Thalhammer[1,2,3], J. F. Hilmer[1,2], P. Bleuel[1,2]
S. Peterhansl[1,2], J. McGinnis[4,5], D. Rueckert[4,5], D. Pfeiffer[3], F. Pfeiffer[1,2,3], F. Schaff[1,2]

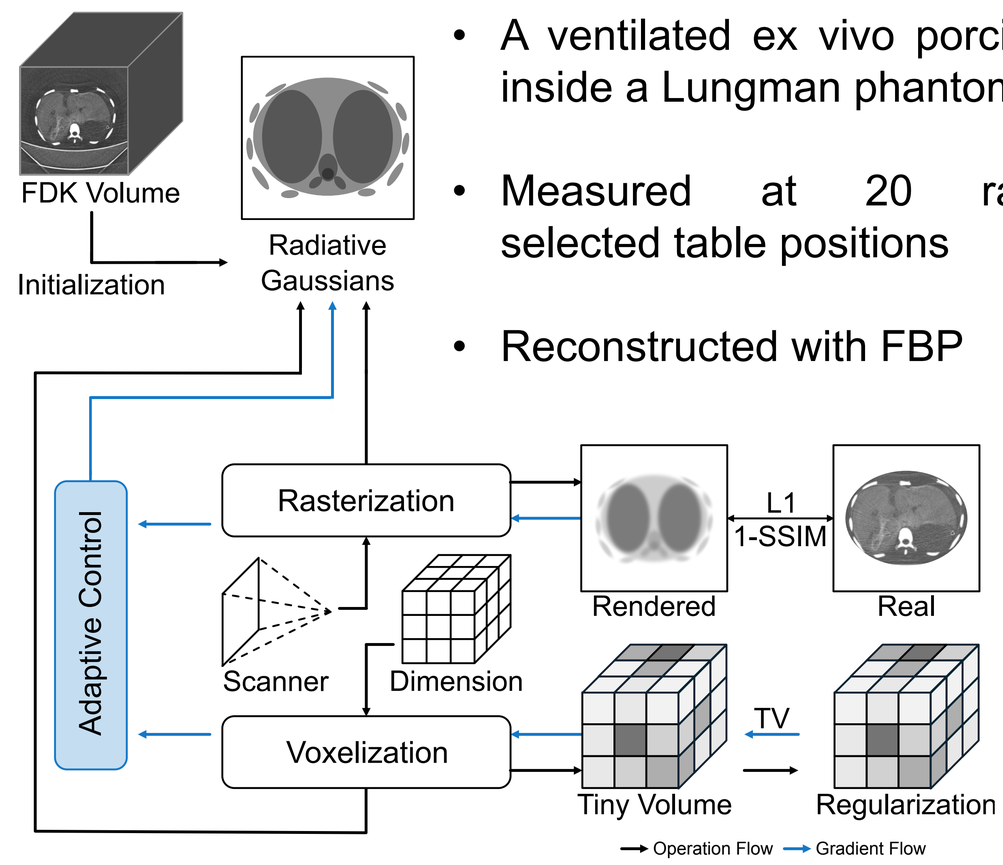
IEEE ISBI 2026

Poster No.

INTRODUCTION

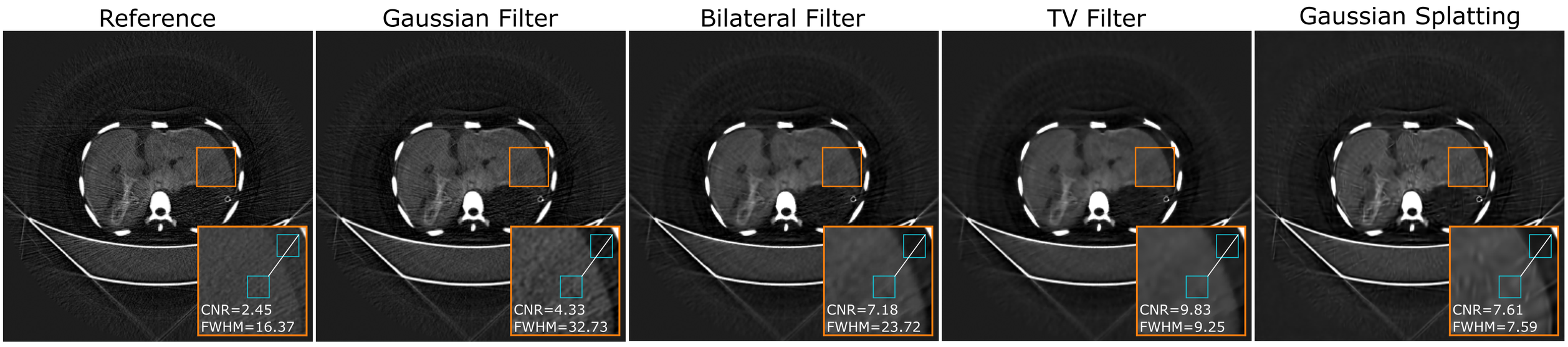
- The clinical dark-field CT scanner (DFCT) enables attenuation- and small-angle scatter-based imaging of human-scale phantoms.
- Due to the scanner's vibrating Talbot-Lau grating interferometer, images suffer from inherent streak artifacts [1].
- In this work, DFCT data is processed by re-purposing the 3D Gaussian Splatting (3DGS) method, designed for rendering sparsely sampled X-ray attenuation data [2], and is compared against conventional filtering:
  - Gaussian filter (σ = 1.00)
  - Bilateral filter ($\sigma_{Spatial}$ = 5.60)
  - Total Variation (TV) filter (λ = 0.04)

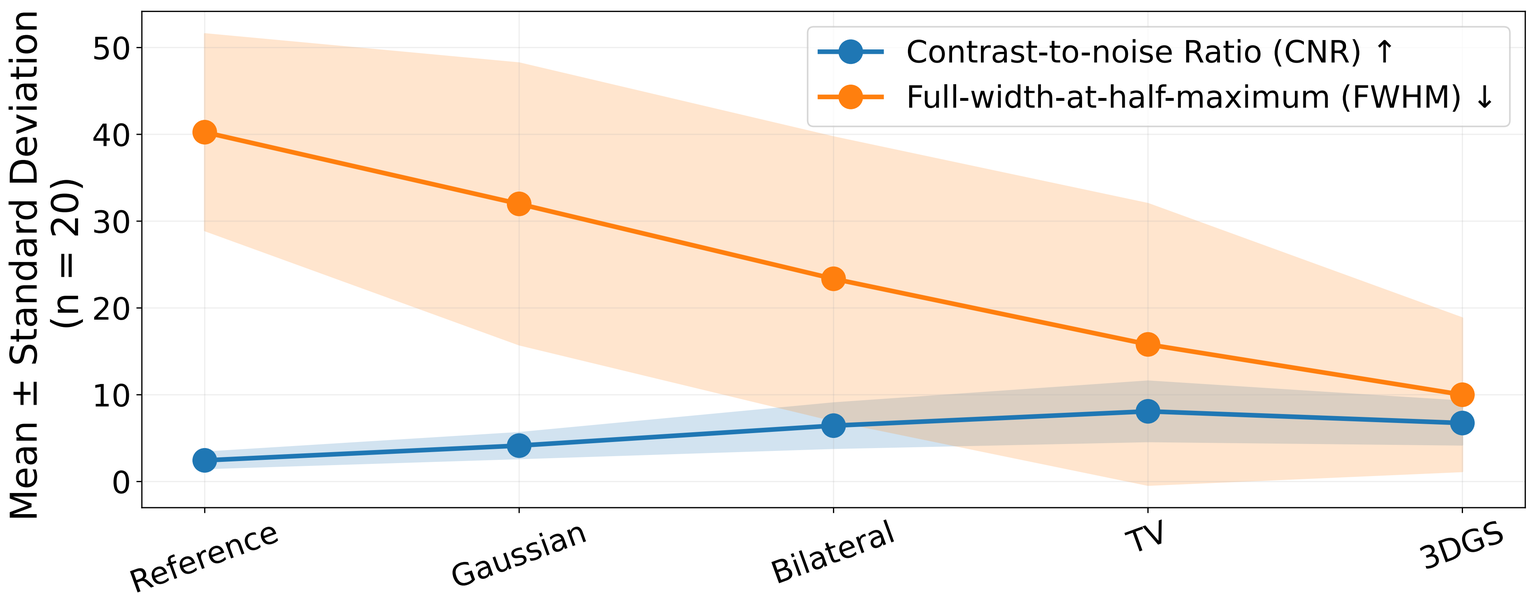
METHODS



- A ventilated ex vivo porcine lung inside a Lungman phantom
- Measured at 20 randomly selected table positions
- Reconstructed with FBP

RESULTS





- The TV filter yields a higher CNR than the 3DGS method (CNR_{TV} = 8.09 ± 3.47, CNR_{3DGS} = 6.74 ± 2.51).
- The sharpness preserved with the 3DGS method is noticeable ($FWHM_{TV}$ = 15.80 ± 16.21, $FWHM_{3DGS}$ = 10.06 ± 8.83).
- 3DGS post-processing results in the best balance between contrast and sharpness.

CONCLUSION

These findings indicate that 3DGS outperforms conventional filtering in DFCT streak-reduction, preserving edge sharpness and a high CNR, a necessity for diagnostic accuracy in future clinical trials.

REFERENCES

[1] M. Viermetz et al., "Dark-field computed tomography reaches the human scale," *PNAS*, vol. 119, 2022.

[2] R. Zha et al., "R^2-gaussian: Rectifying radiative gaussian splatting for tomographic reconstruction," Advances in Neural Information Processing Systems, vol. 37, 2024.

Acknowledgements

[1] Chair of Biomedical Physics, Department of Physics, School of Natural Sciences, TUM
[2] Munich Institute of Biomedical Engineering (MIBE), TUM
[3] Institute for Diagnostic and Interventional Radiology, TUM University Hospital
[4] Chair for AI in Healthcare and Medicine, Institute for AI and Informatics, TUM University Hospital
[5] Munich Center for Machine Learning (MCML), TUM

Financial support through the European Research Council (ERC Smart Detectors for Darkfield X-ray Imaging, SyG 101167328), and the Free State of Bavaria under the Excellence Strategy of the Federal Government and the States, as well as by the Technical University of Munich (TUM) – Institute for Advanced Study (IAS).

* Equal contribution; tina.dorosti@tum.de

Technical University of Munich

MIBE IAS

Bayerisches Staatsministerium für Wissenschaft und Kunst

Federal Ministry of Education and Research