ROBUST SPARSE-VIEW DARK-FIELD CT WITH 3D GAUSSIAN SPLATTING

*D. Frey[*1,2], T. Dorosti[*1,2,3], J. McGinnis[4,5], T. Hiu[1,2], F. I. Ozlugedik[1,2], J. B. Thalhammer[1,2,3], S. Peterhansl[1,2], D. Rückert[4,5], F. Pfeiffer[1,2,3], F. Schaff[1,2]*

[1]Chair of Biomedical Physics, [2]Munich Institute of Biomedical Engineering, [3]Institute for Diagnostic and Interventional Radiology, [4]Chair for AI in Healthcare and Medicine, and [5]Munich Center for Machine Learning (MCML); Technical University of Munich (TUM), Germany

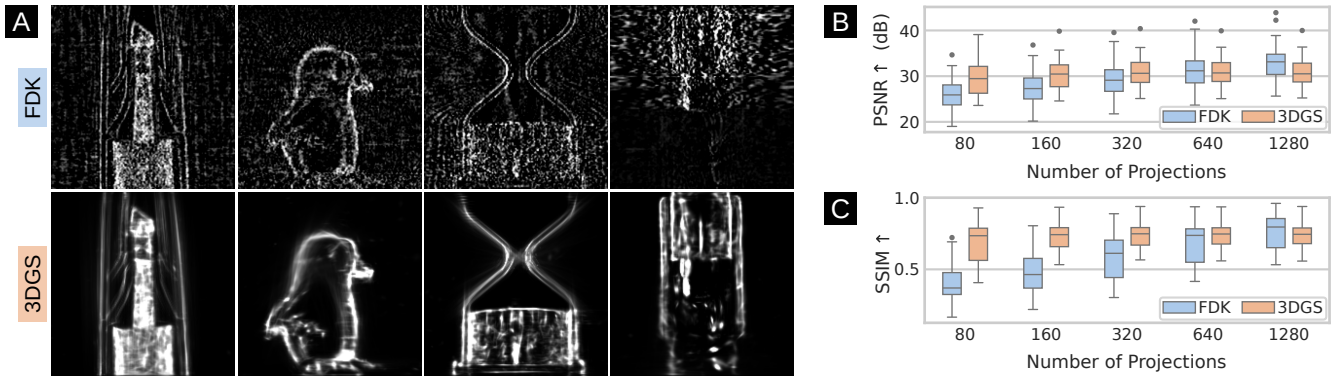

Fig. 1. Lateral slices from 80-view reconstructions (A) demonstrate the robustness of 3DGS to sparse inputs, while FDK suffers from high-frequency noise and streak artifacts. 3DGS consistently recovers smooth, continuous structures and maintains geometric integrity across 17 different samples evaluated with PSNR (B) and SSIM (C) on isotropic reconstruction volumes.

1. INTRODUCTION

Streak artifacts constitute a major challenge in X-ray dark-field computed tomography (DFCT). Convolutional neural networks have shown promising results for streak reduction, but they rely on dedicated ground truth data with limited availability [1]. In contrast to post-processing approaches, this work aims to prevent streak formation at the reconstruction stage using 3D Gaussian splatting (3DGS) [2].

2. METHODS

3DGS was implemented using R^2-Gaussian, as described in [2], and sparsely acquired dark-field projections reconstructed in comparison to Feldkamp–Davis–Kress (FDK). Reconstruction quality was assessed based on peak signal-to-noise ratio (PSNR) and structural similarity index measure (SSIM) in reference to full-view FDK (2324 projections).

3. RESULTS AND CONCLUSION

Visual and quantitative evaluation highlight the superior performance of 3DGS compared to FDK, as illustrated in Fig. 1. Due to imperfections in the full-view FDK reference, metrics can deviate from the visual impression. SSIM provides a more reliable assessment owing to its larger noise resilience compared to PSNR. Our findings underscore the potential of 3DGS to enable streak-free DFCT reconstruction.

4. REFERENCES

[1] T. Kumschier et al., "Streak artefact removal in x-ray dark-field computed tomography using a convolutional neural network," *Medical Physics*, vol. 51, no. 10, 2024.

[2] R. Zha et al., "R²-gaussian: Rectifying radiative gaussian splatting for tomographic reconstruction," *Advances in Neural Information Processing Systems*, vol. 37, 2024.

*Equal contribution. No live experiments were performed. Ethical approval was not required. The authors declare no conflicts of interest. Financial support through the European Research Council (ERC Synergy Grant SmartX, 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 – Institute for Advanced Study.