SETA Recon Lite v1.0: A Standalone Executable Tool for Automated Image Reconstruction in Cone Beam Computed Tomography

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BACKGROUND

X-ray cone-beam computed tomography (CBCT) is increasingly used in non-destructive inspection to produce high-resolution 3D images of objects and their internal features. CBCT can play a key role in quality control, damage analysis, and material characterisation across science, engineering and manufacturing sectors[1].

Problem / Motivation

For some tasks (e.g., FOV- extension, helical), contemporary CBCT systems can yield datasets that require reconstruction times that vastly exceed the acquisition time for conventional scans. This challenge is compounded by:

- Proprietary software without parallel access,
- Lack of command-line/programming expertise,
- Need for manual parameter selection

These challenges lead to:

- Workflow bottlenecks
- Potential operator bias
- High licensing/maintenance costs

Research Question

Can we develop a lightweight, user-friendly freeware tool that enables near real-time CBCT reconstruction from conventional scan data with minimal user input?

Proposed Approach

- A stand-alone tool that automates the entire CBCT reconstruction pipeline — from raw projections to 2D/3D output, with no external software needed.

✔ No licensing issues

⚡ Fast feedback

Standalone operation

Modular design

Core Imaging Library (CIL) [2]

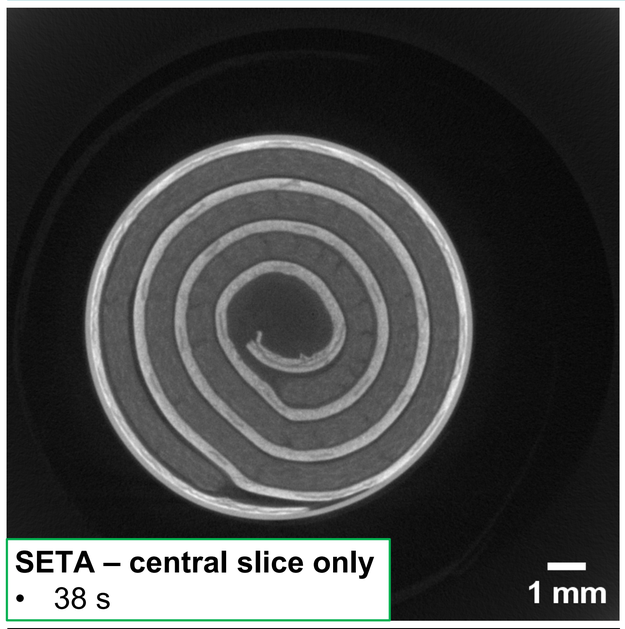
+

GPU-accelerated TIGRE[3] **backend**

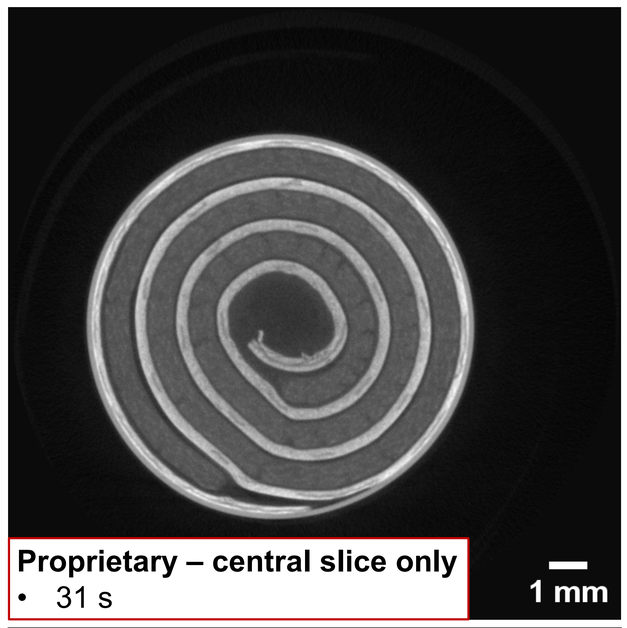
RESULTS

Recon speed benchmarking of scan of AAA battery (1250 projs; 800×3000 px):

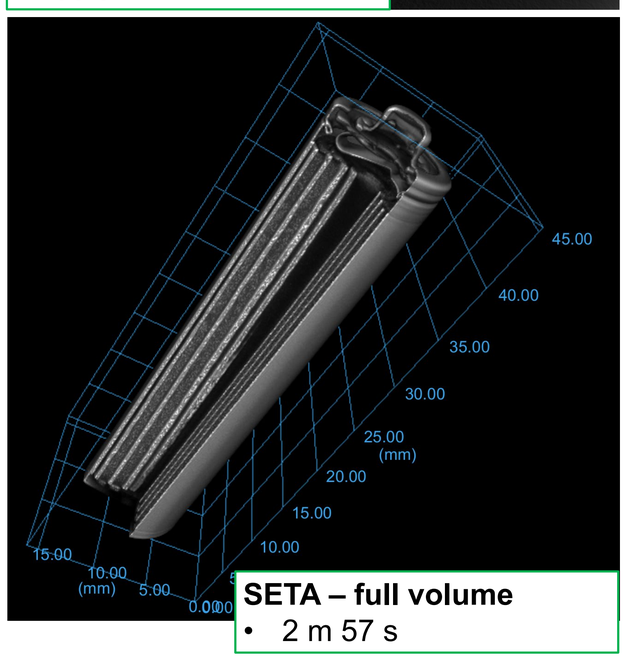
- NVIDIA RTX A6000 (48 GB)
- AMD EPYC 7252 8-core (3.1 GHz base)
- 128 GB RAM



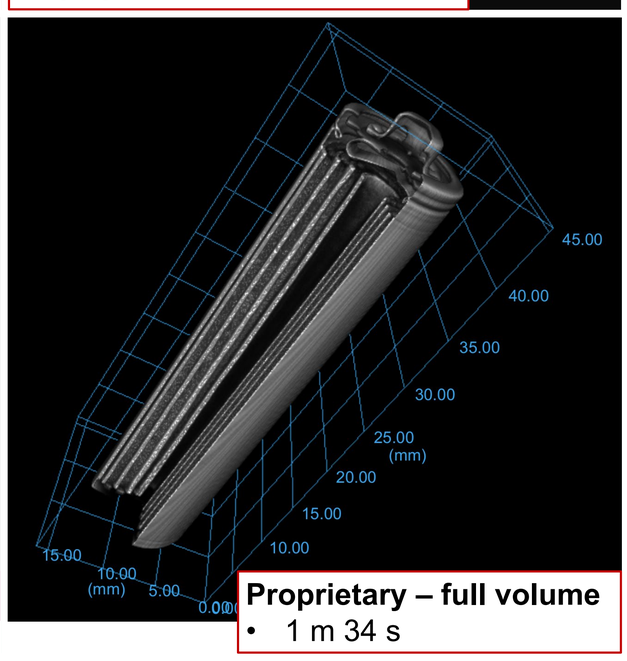
SETA – central slice only
- 38 s



Proprietary – central slice only
- 31 s

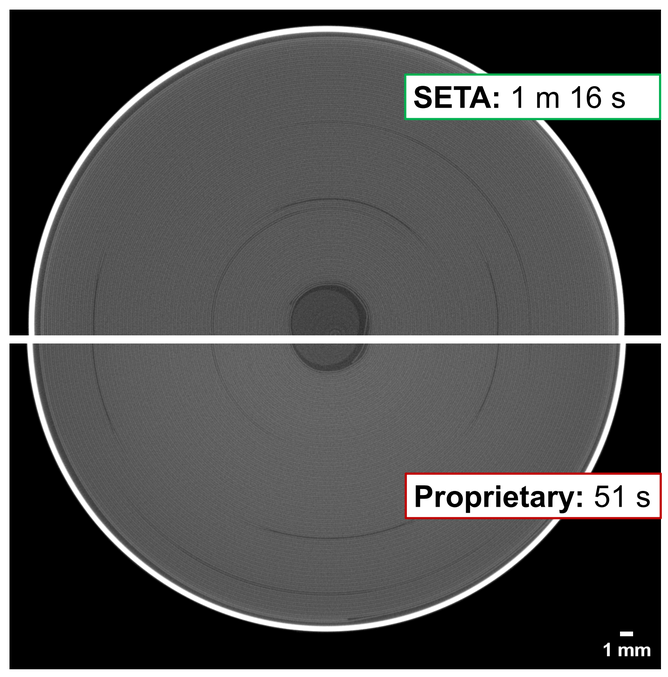


SETA – full volume
- 2 m 57 s



Proprietary – full volume
- 1 m 34 s

Central slice recon speed for scan of large battery (2200 projs; 1400 × 3000 px)



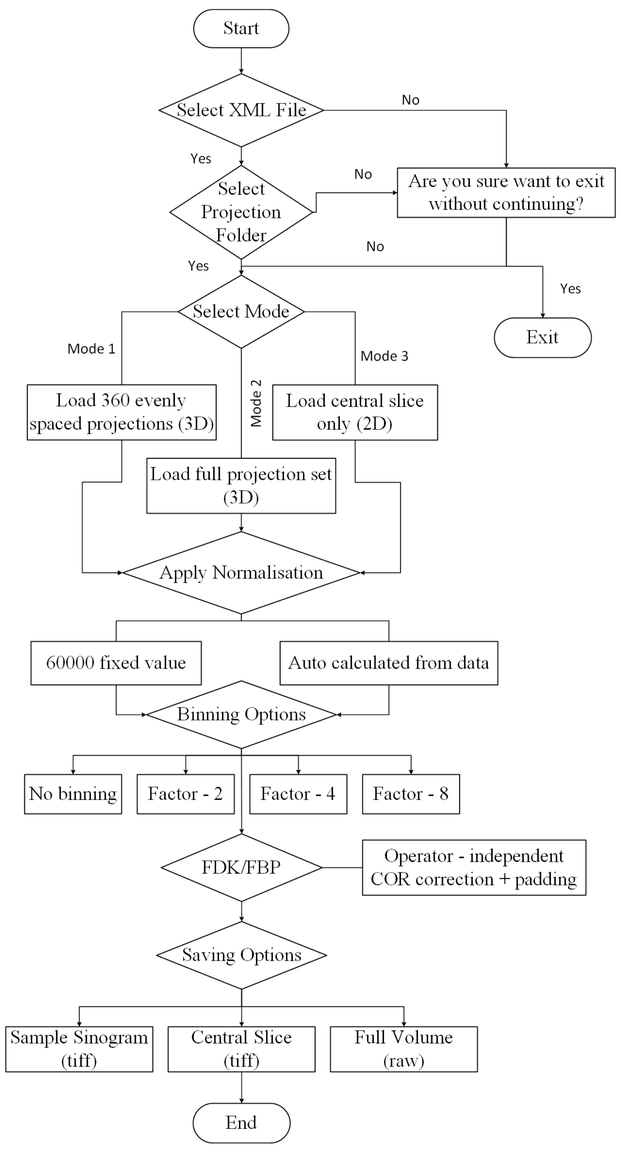
SETA:
- Image-based auto centre-of-rotation calc.
- Single .raw/tiff output
- Binaries-based portable .exe file
- RAM-intensive
- Slightly slower
- **FREE**

Proprietary:
- Manual or manipulator-based centre-of-rotation calc.
- Stack of .raw/.flt output
- Installation required; node-locked
- RAM-efficient
- Paid-for licence

METHODS

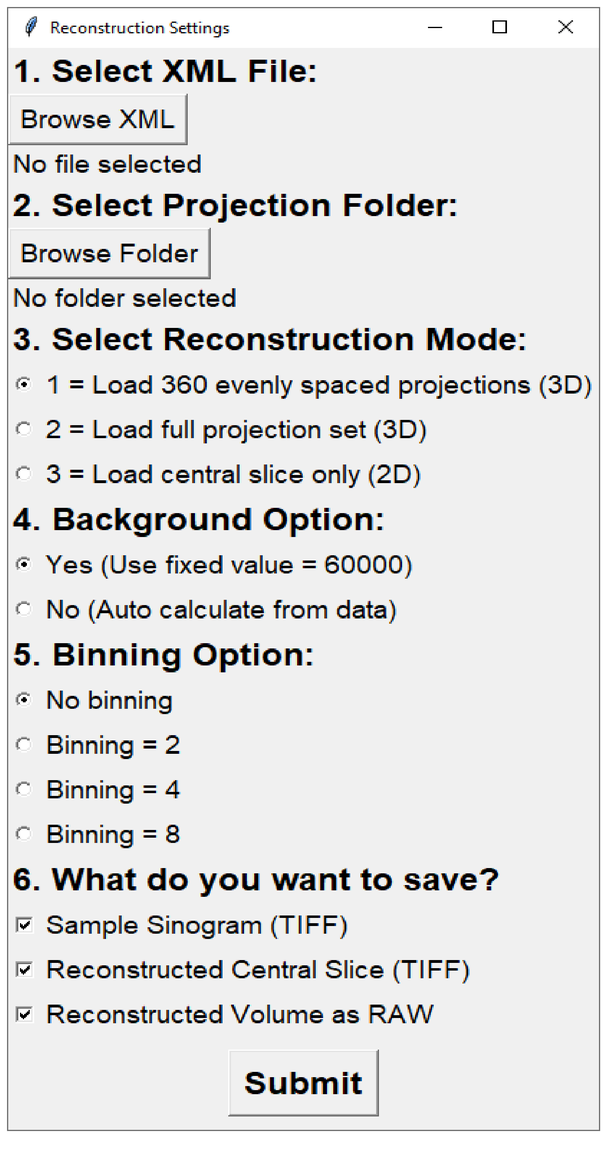
Tomographic Reconstruction Workflow

Overview of the main steps from data selection to reconstruction and saving.



Reconstruction Settings User Interface

This interface guides users through file selection, reconstruction, and saving steps.



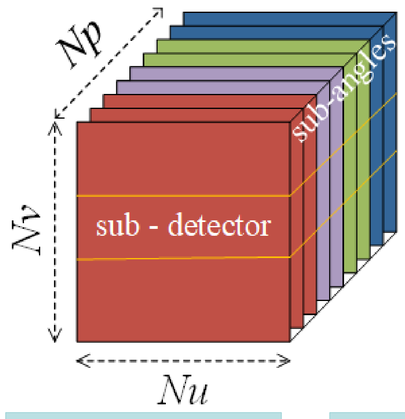
OUTLOOK

Conclusion

We developed and tested a stand-alone tool that reconstructs CBCT data efficiently, without relying on external software.

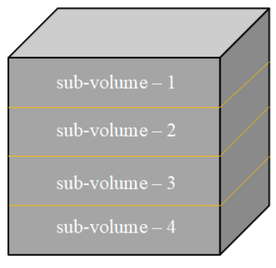
Future Work

The current implementation is constrained by memory when processing large data. Future work will focus on a hybrid decomposition method[4] that splits projections and volumes for stable, scalable reconstruction.

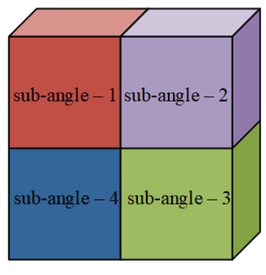


- *Np*: Number of projection.
- *Nv* : Detector height
- *Nu* : Detector weight

Volume Decomposition



Projection Decomposition



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[1] Zwanenburg, et al. (2021). Meas. Sci. Technol. 33(2022), 012003. https://doi.org/10.1088/1361-6501/ac354a
[2] Jørgensen, J.S., et al. (2021). Philos. Trans. R. Soc. A, 379(2204), 20200192. https://doi.org/10.1098/rsta.2020.0192
[3] Biguri, A., et al. (2025). Eng. Res. Express 7 015011. https://doi.org/10.1088/2631-8695/adbb3a
[4] Chen, P. et al. (2021). Proc. SC '21. https://doi.org/10.1145/ 3458817.3476139

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