High Performance Computing for Neutron Tomography Reconstruction

A Parallel Approach to Filtered Backprojection (FBP)

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RECSEM, 2017

Outline

Laminography & Tomography

Both:

- Image Processing
- Reconstruction of 3D volume from 2D projections (sinograms)
- Fourier/harmonic analysis (specifically Radon transform)

Tomography is special case of laminography (tilt angle $= 0^\circ$)

Inverse Radon Transform

Functional Outline

$$\text{projections} + \text{orientation information} \rightarrow \text{volume}$$

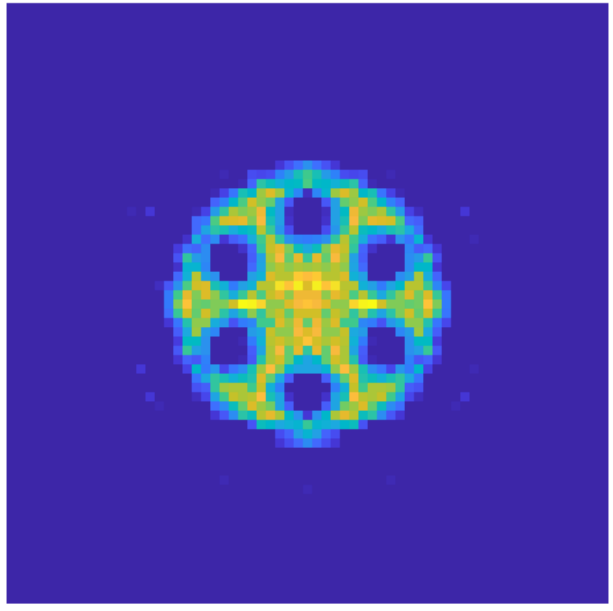
For each projection...

- clean it up (filter)
- "smear" it through the volume (interpolate)

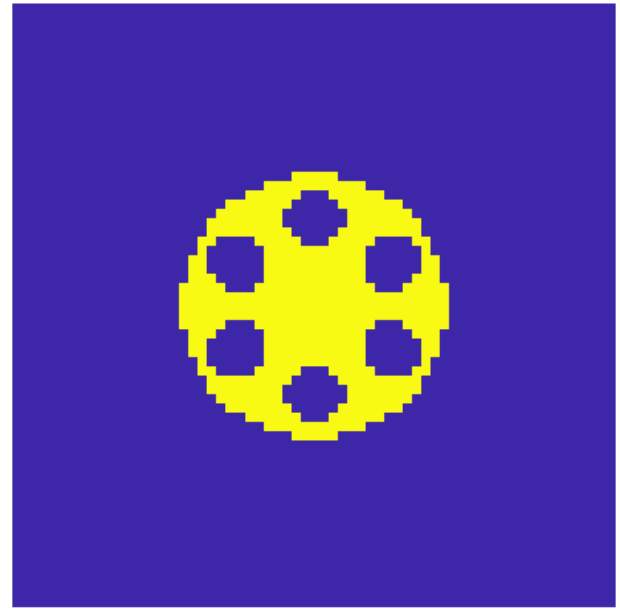
...then sum all smeared projections

Result: reconstructed 3D volume

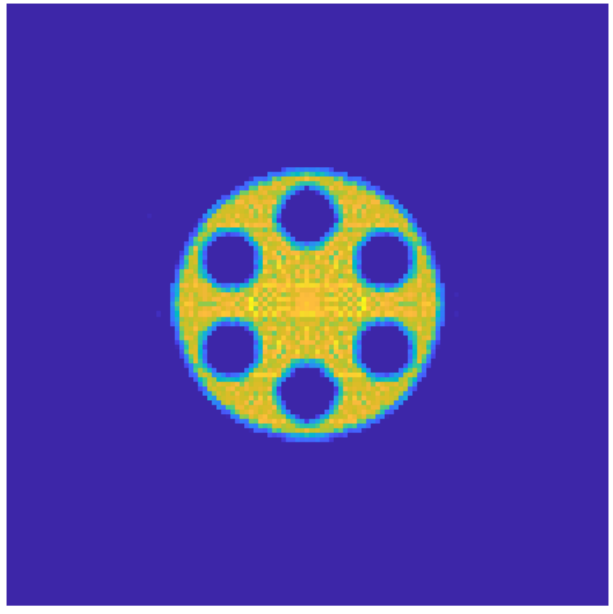
Slice: 33



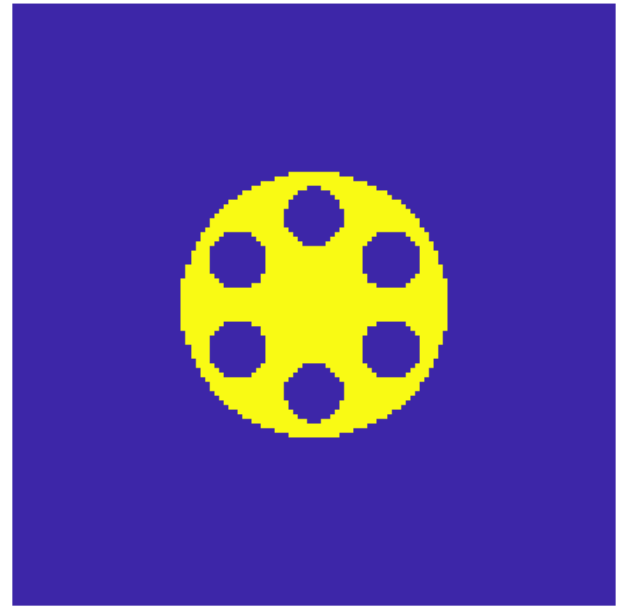
Slice: 33



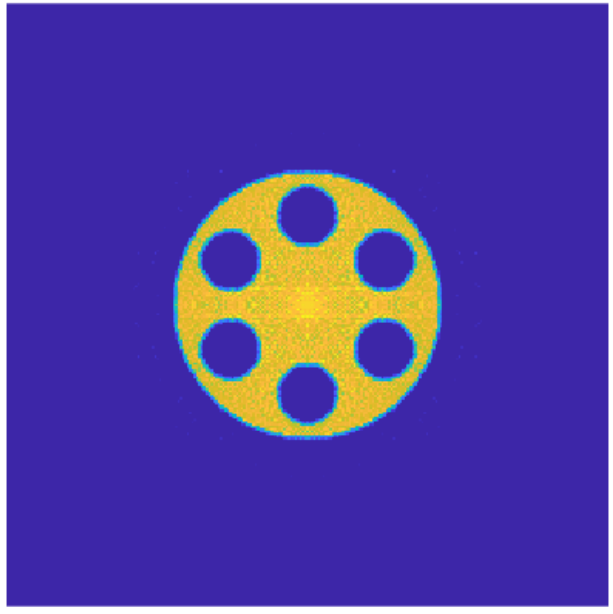
Slice: 65



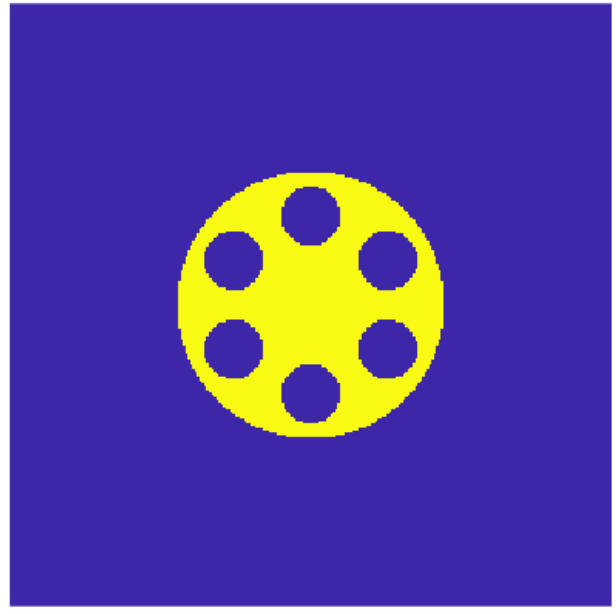
Slice: 65



Slice: 129



Slice: 129



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- to run Inverse Radon transform in parallel
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- OpenACC, MPI

Progress

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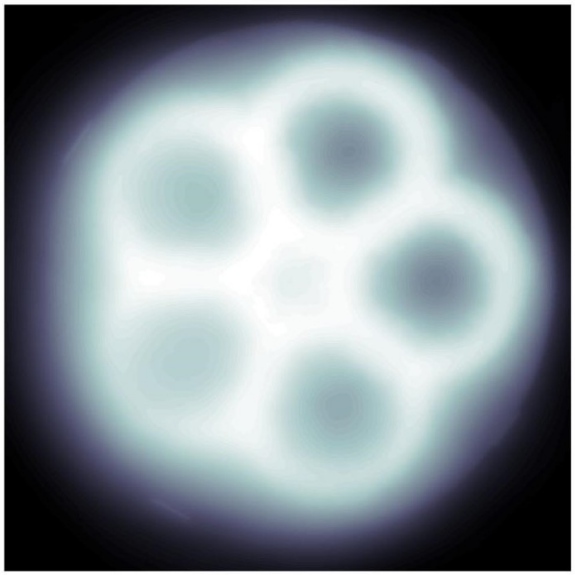
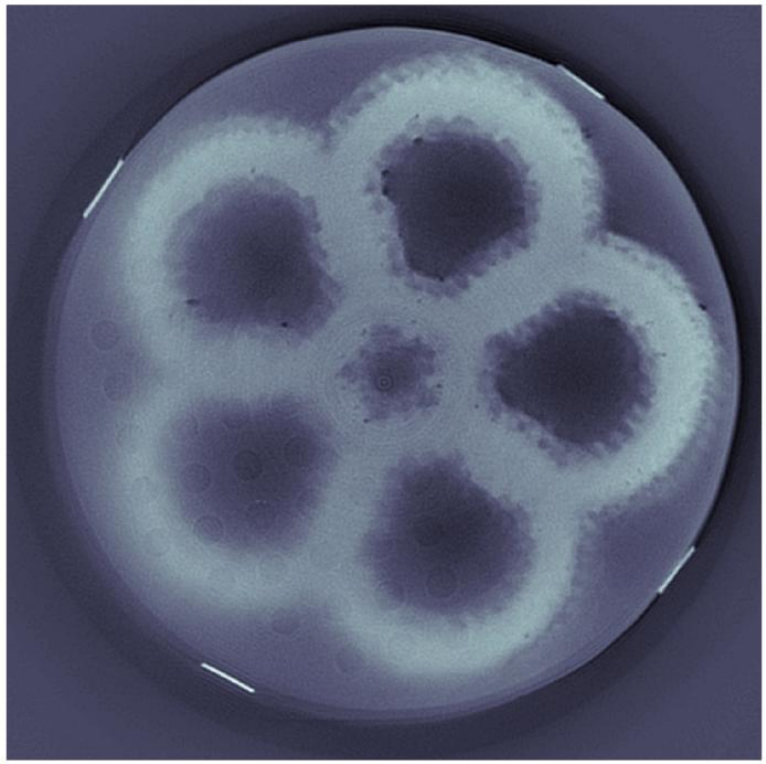
Filter necessary to reduce blurring from backprojection





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- Sinc low-pass filter ("brick wall" frequency response)
- Butterworth high- or low-pass (smoother frequency response)

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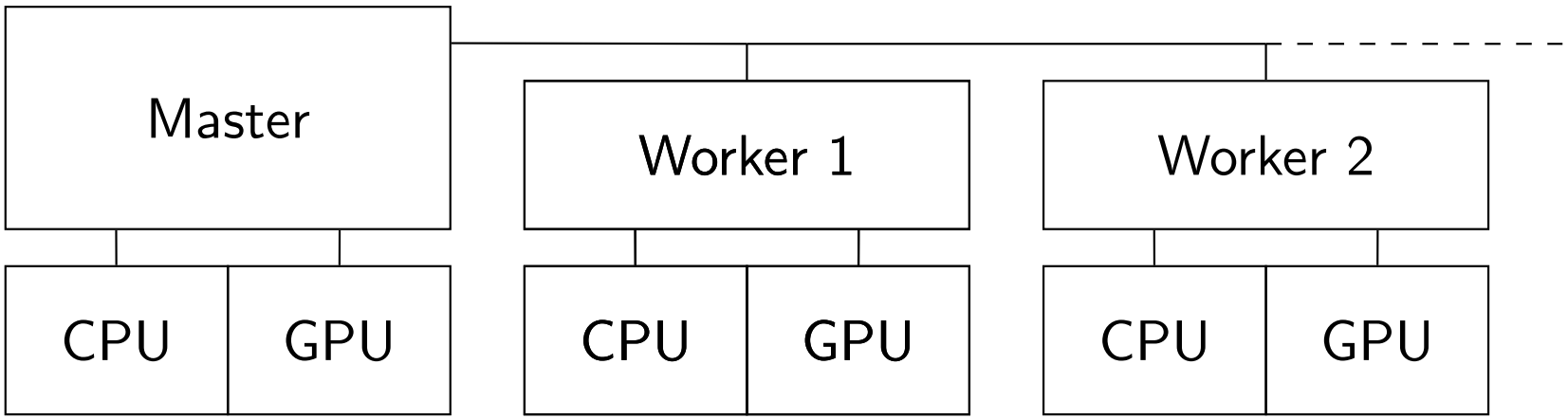
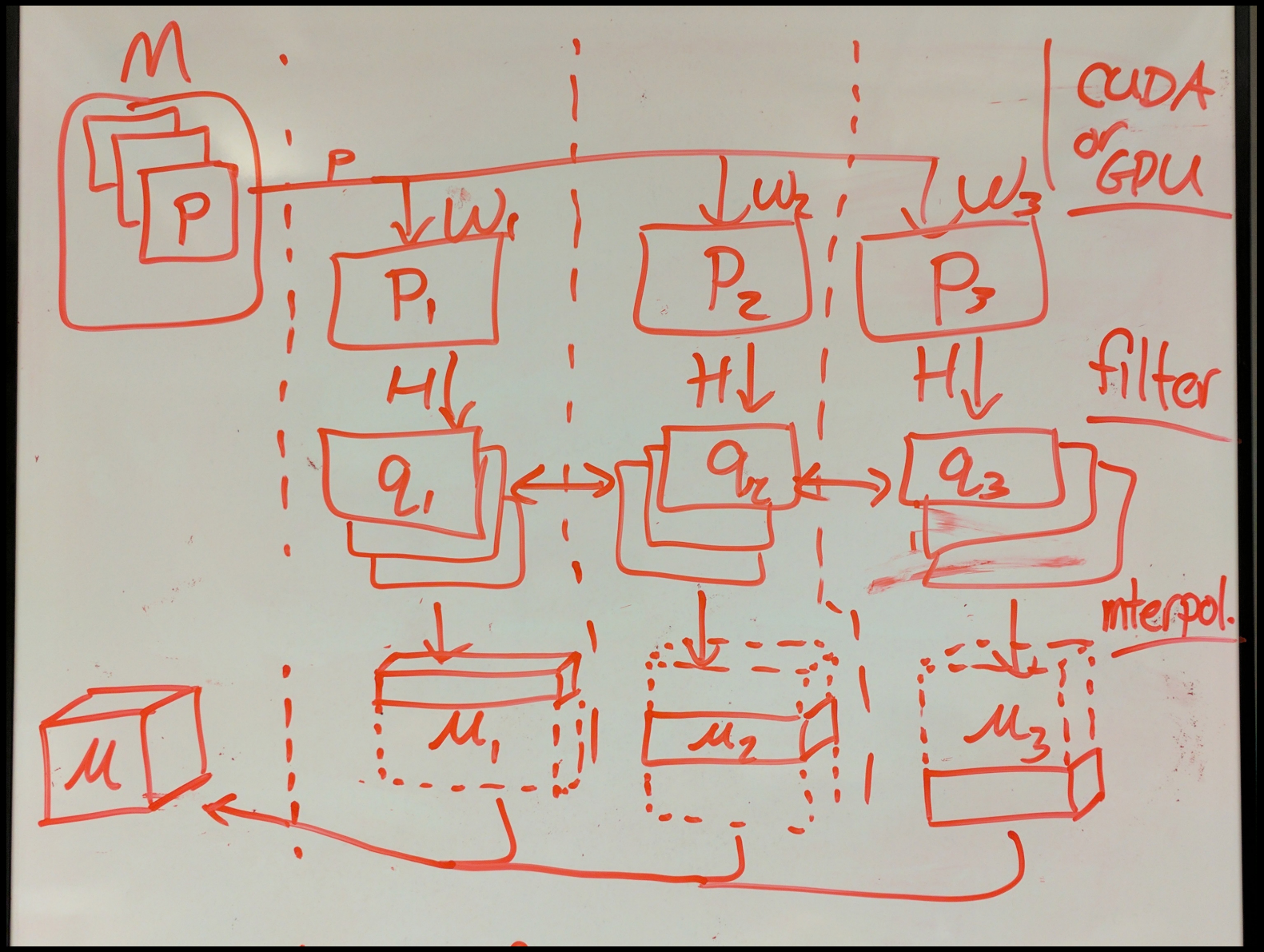
Implementing scaled ramp filter for code efficiency

Toolset:

- C: foundation of code
- MPI: communication between nodes
- OpenACC: communication with devices (GPU)




M
P
P
CUDA or GPU
w_1
w_2
w_3
P_1
P_2
P_3
H
H
H
filter
q_1
q_2
q_3
interpol.
u_1
u_2
u_3
u

References

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IEEE Trans Nucl Sci., 62(1):131–136, 2015.

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