GPU Implementation of FBP and GridRec

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Efficiency of GPU Implementation

- Use 32 slices of size 2048 * 2048
  - GPU OptimizedFBP
    - 1.1s for each slice with data available in GPU (40 times faster)
    - 73s for reconstruction (20 times faster)
  - CPU OptimizedFBP
    - 44.7s for each slice with data available in CPU
    - 1416s for reconstruction
  - CPU GridRec
    - 3s for each slice (6s for 2 slices)when data available in CPU using fft_nr.cpp (fft from Numerical Recipe)
    - 0.7s for each slice (1.4s for 2 slices) using fft_fftw.c
    - 99s for reconstruction (a little slower than GPU FBP)
  - GPU GridRec
    - 0.4s for each slice (0.8s for 2 slices)
      - 6 times faster than CPU using fft-nr.
      - 1.6 times faster than CPU using fftw
    - GPU for FFT and filtering only. Efficiency may be improved.

GPU GridRec

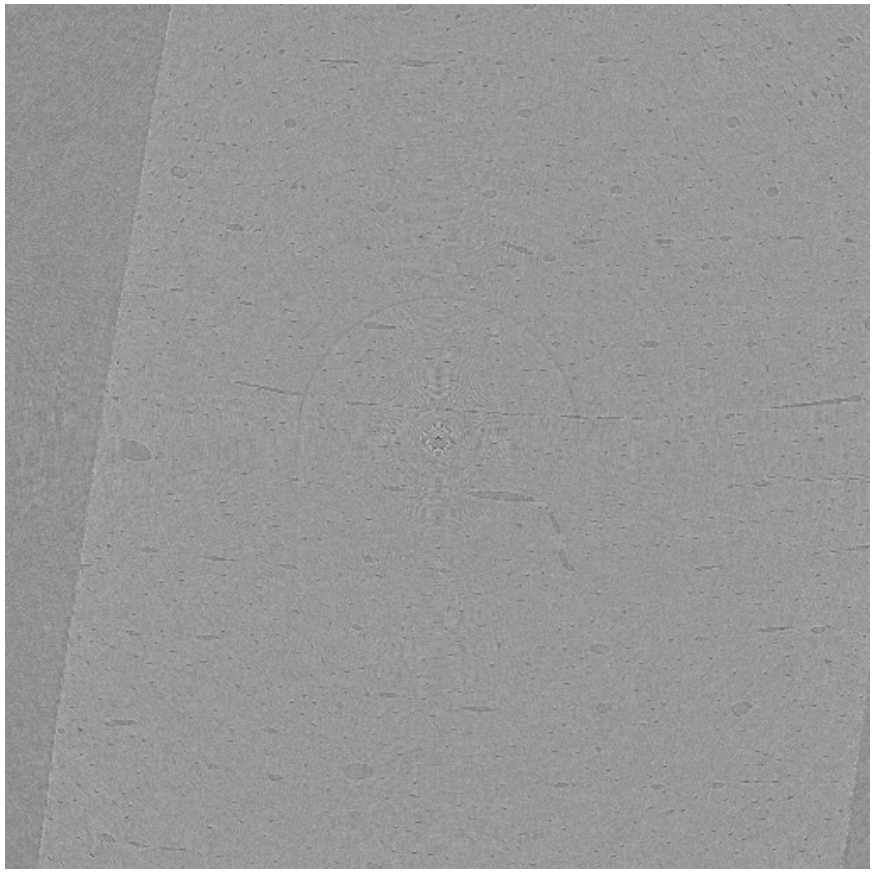
- GridRec efficiency for the reconstruction of a 2048 * 2048 slice

	CPU-NR	CPU-FFTW	GPU (ms)	Comment
Phase 1	708	550	550	
Phase 2	5314	660	160	(2D IFFT)
Phase 3	80	50	50	(post processing)
Total	6000	1260	760	

- Phase 1 can not be improved any further, because the interpolation using pswf for the filtered frequency data is inappropriate for GPU implementation
  - Hard to parallelize the computation
- Phase 1 is therefore the bottleneck.

Accuracy of GPU Reconstruction

CPU-OptimizedFBP

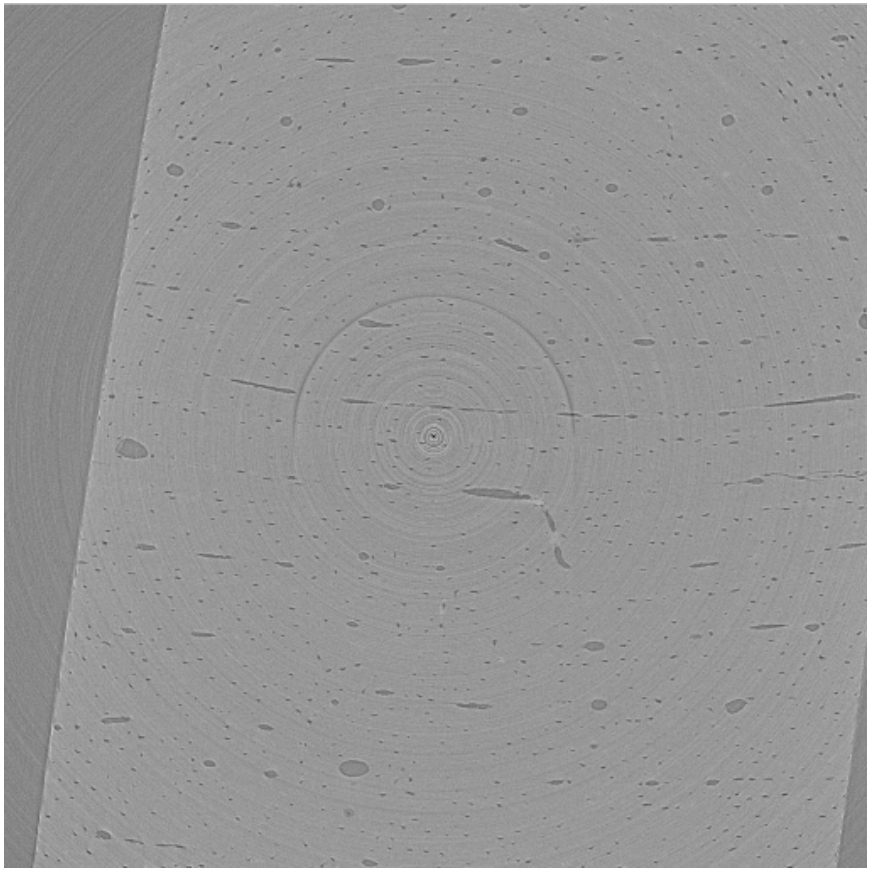


GPU-OptimizedFBP

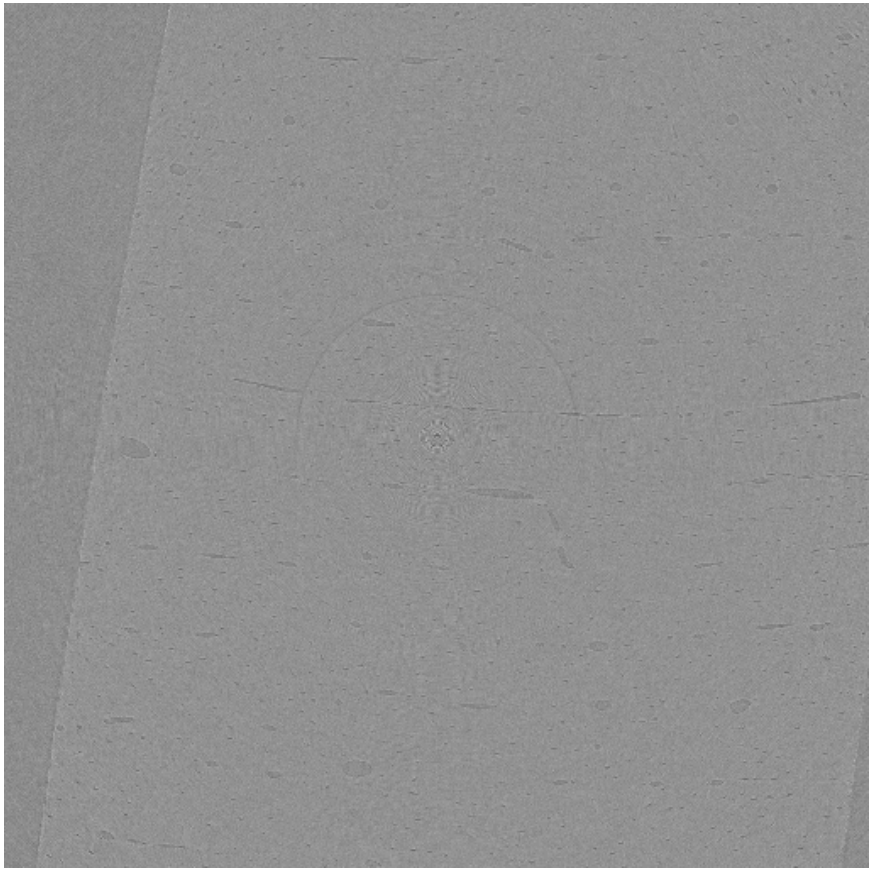
GPU FBP results are very close to CPU FBP results

Accuracy of GPU Reconstruction

CPU-GridRec



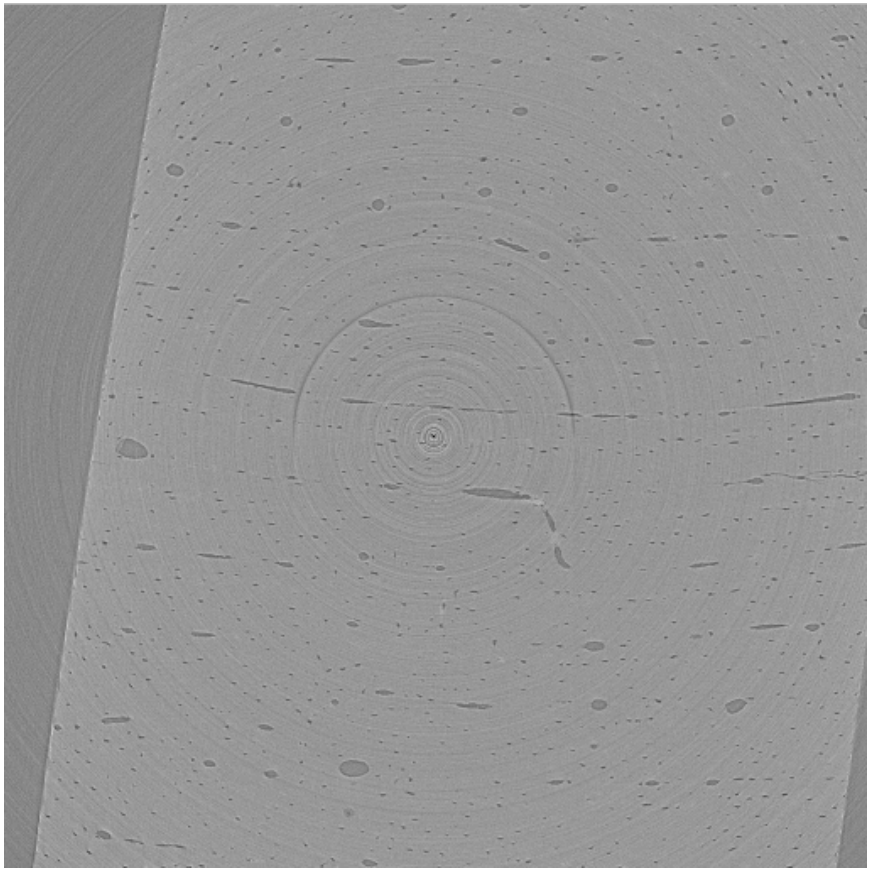
GPU-OptimizedFBP



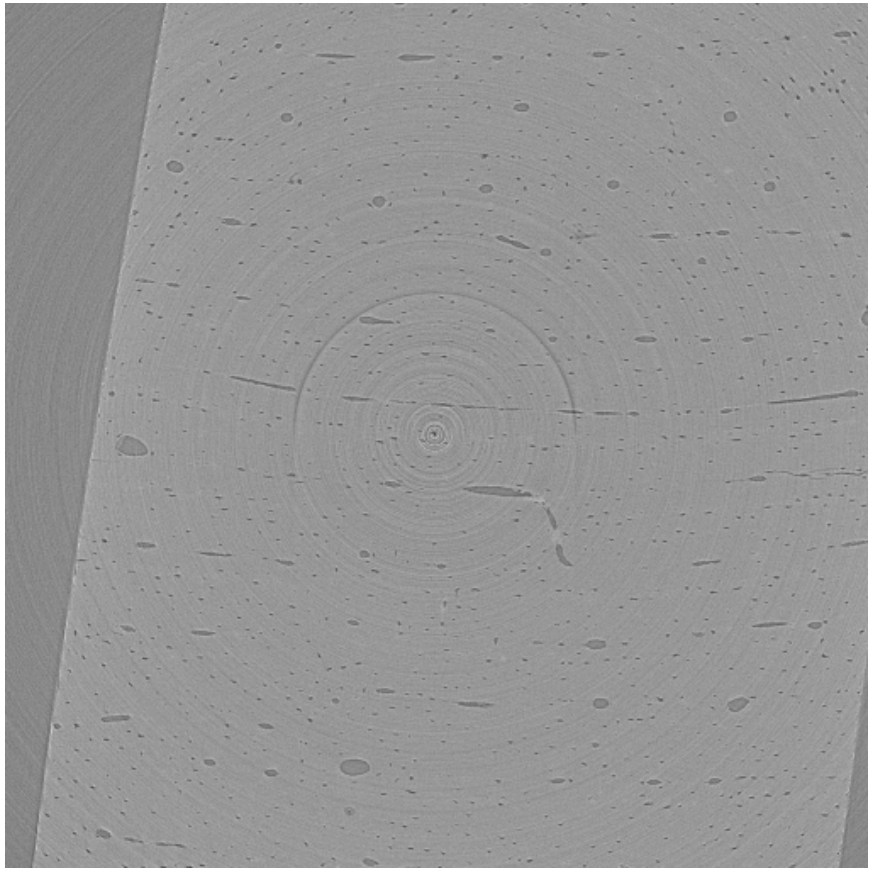
GPU FBP results have lower contrast than CPU GridRec

Accuracy of GPU Reconstruction

CPU-GridRec



GPU-GridRec

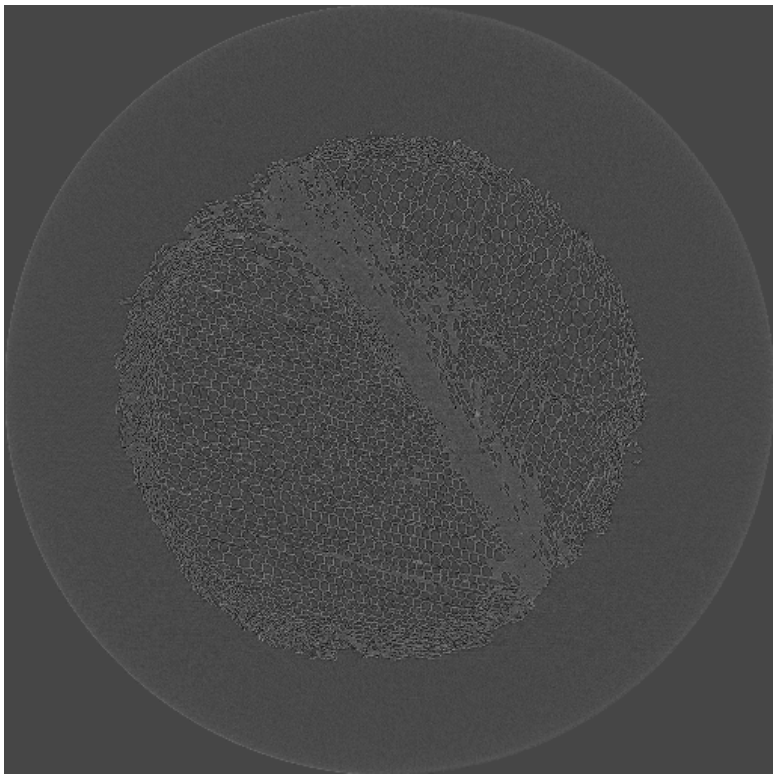


GPU GridRec results are very close to CPU GridRec

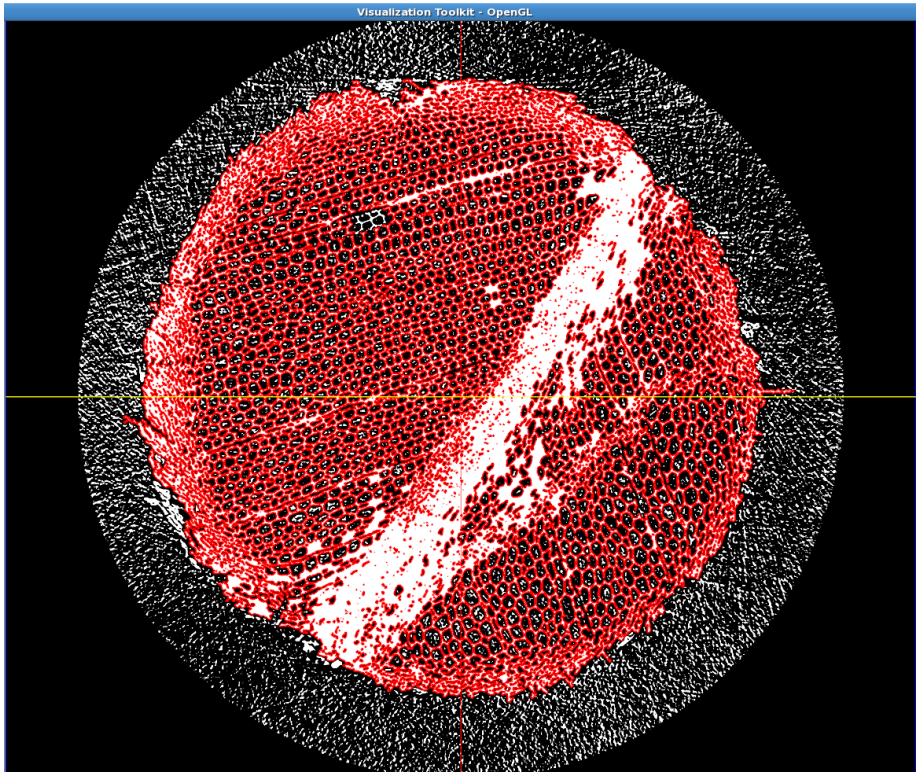
Conclusion

- GPU FBP is about 40 times faster than CPU FBP
- GPU FBP is about 3 times faster than CPU GridRec (when GridRec uses fft_nr.cpp)
- GPU GridRec is about 6 times faster than CPU GridRec when GridRec uses fft_nr.cpp
- GPU GridRec is about 1.6 times faster than CPU GridRec when GridRec uses fft_fftw.cpp
- GPU FBP results contain lower contrast than CPU GridRec
- Benefits of GPU FBP are therefore limited, when compared with GPU GridRec.
- Combine GPU GridRec with MPI cluster codes for higher efficiency

Postprocessing for Wood Adhesive Data



Org



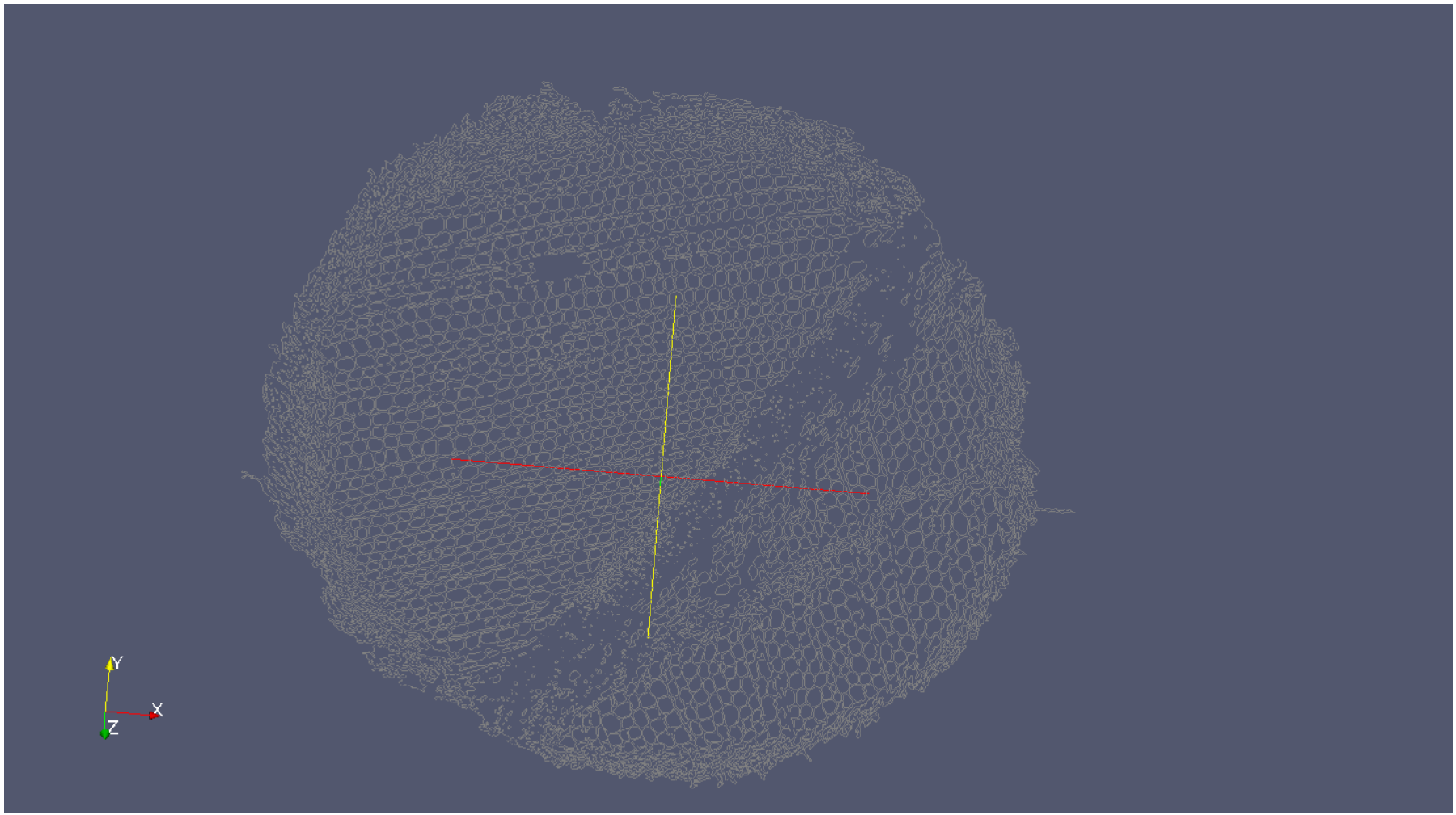
Post-processing

(1) Thresholding

(2) Itk::ConfidenceConnectedImageFilter

(3) vtk visualization

Postprocessing for Wood Adhesive Data



Boundaries