Connecting the time dimension

Dynamic μCT reconstruction using piecewise linear fitting

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The problems of dynamic μCT

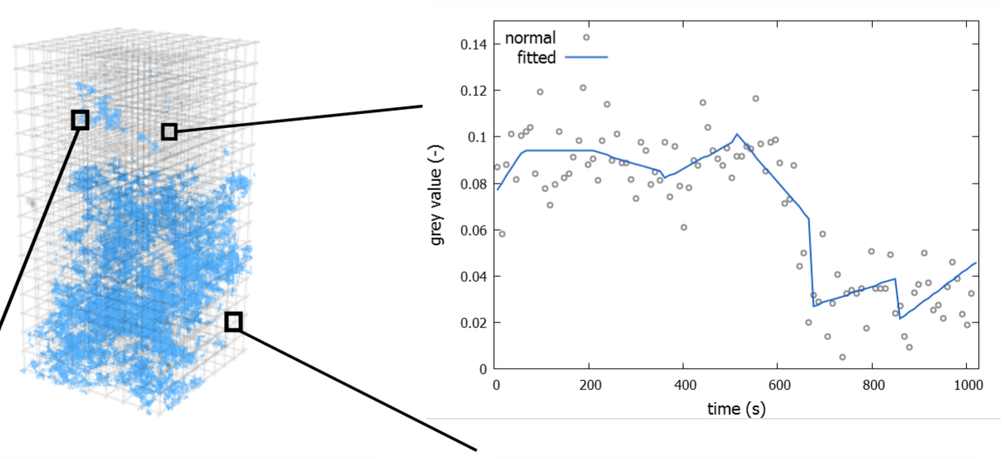
Dynamic μCT or 4D μCT is the CT scanning of samples that undergo a dynamic process during the scan. An example is fluid flow through rock. This typically involves very fast imaging to analyse fast processes. The acquisition covers multiple rotations. The main problems in reconstructing dynamic μCT scans are:

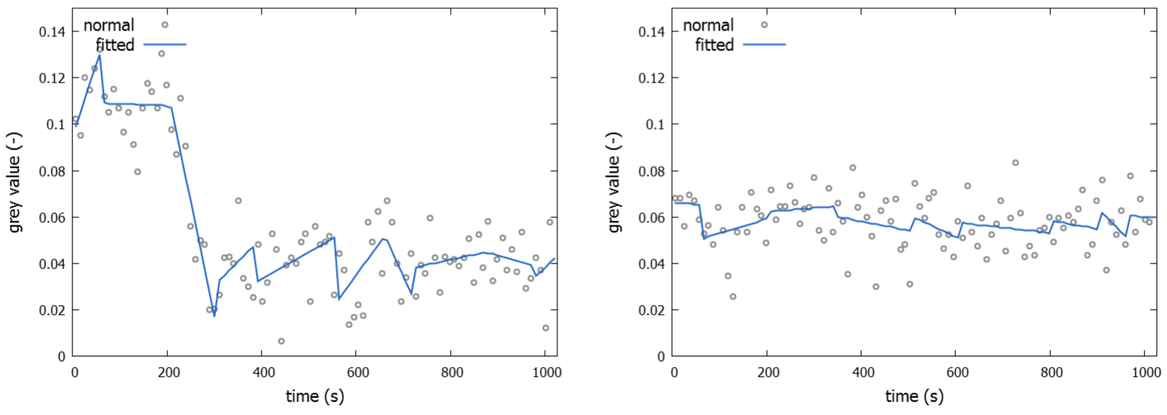
- High noise
- Movement artefacts

Can piecewise linear fitting solve these?

How does this work?

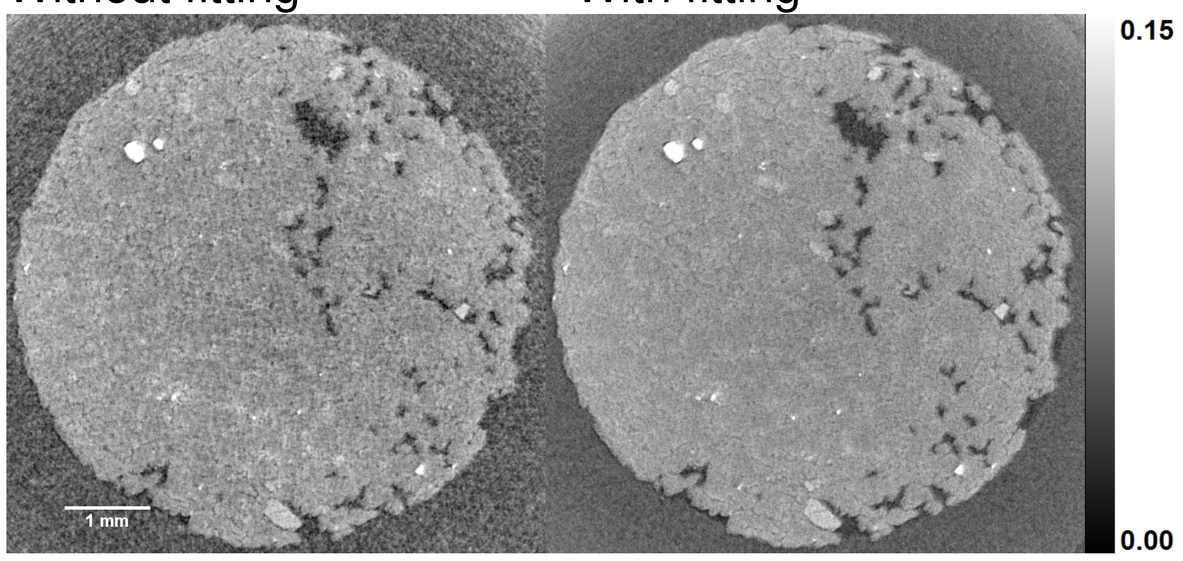
1. Scan the sample
2. Divide the scan into ”time steps”. Perform a 3D reconstruction for each time step.
3. Plot the grey value of one voxel in function of time
4. Fit a piecewise linear function to this plot
5. Repeat for every voxel





Results

Without fitting | With fitting



This is a slice of the 4D volume representing one time moment of fluid (black) flow through porous rock (light grey), both without (left) and with (right) piecewise linear fitting.

Advantages and disadvantages

\+ Significant noise reduction
\+ Sudden changes are captured (breakpoints)
\+ Improves temporal resolution
\+ Very general (almost any sample)
\+ Any 3D reconstruction method can be used
— No small peaks in time evolution ($\approx$ noise)
— Can cross logical boundaries (i.e. $\mu < 0$)

Conclusion

Piecewise linear fitting can improve the result of a dynamic μCT scan. The main advantage is the noise reduction. Even though it operates in the temporal dimension, noise in the spatial dimensions is also reduced.

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