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Acquisition to Visualization: New Approaches in Dynamic In-situ X-ray Imaging

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In the past few years, dynamic computed tomography (CT) approaches or uninterrupted acquisitions of deforming materials have rapidly emerged as an essential technique to understand material evolution, facilitating in situ investigations ranging from mechanical deformation to fluid flow in porous materials and beyond. Dedicated acquisition software is required to run complex time resolved experiments. Depending on the type of dynamic experiments, the user needs to implement in the acquisition software specific interval times, commands to trigger in situ stages, batch multiple scan routines and many more. The acquisition part of a dynamic experiment is an import aspect, but yet only the first step in the complete process to extract meaningful information. In this study, the authors want to explain valuable workflows from reconstruction over visualization and analysis

Dynamic acquisitions however, generate vast amounts of raw projection data, which need to be reconstructed, further post processed and eventually quantified. It is therefore essential to devise workflow strategies to quickly identify the interesting moments prior to reconstruction to optimize the amount of data that is generated, but also incorporate the added time dimension in the 3D analysis workflow to improve image quality. Challenges and possibilities in dynamic micro CT imaging in the laboratory will be demonstrated here across materials science, life science and geoscience applications.

In a next step, once the reconstructed time steps are acquired and the temporal resolution is defined, the data needs to be visualized. This can be done by loading a series of volumes, but typically there is too much information to be visually processed at the same time. To extract meaningful information in a fast and user friendly way, a smart 'flippoint' approach was implemented. Instead of analyzing the reconstructed 3D images individually, we directly incorporate the time dimension within the 3D analysis flow, by analyzing grey value changes of individual and clusters of voxels though time. Directly from this histogram deformation gradients can be calculated. Examples of this smart approach will be demonstrated in the field of soil sciences (figure1), compression of additive manufactured parts and heating/cooling experiments.