Tools for the Analysis of Datasets from X-Ray Computed Tomography based on Talbot-Lau Grating Interferometry

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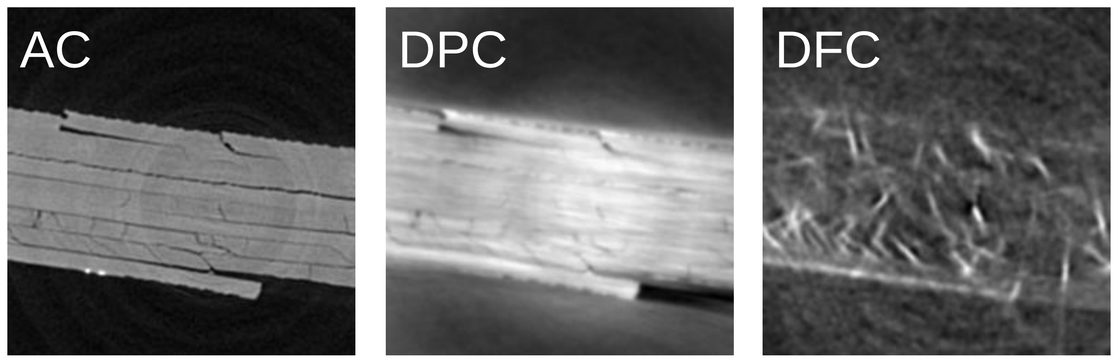
Introduction

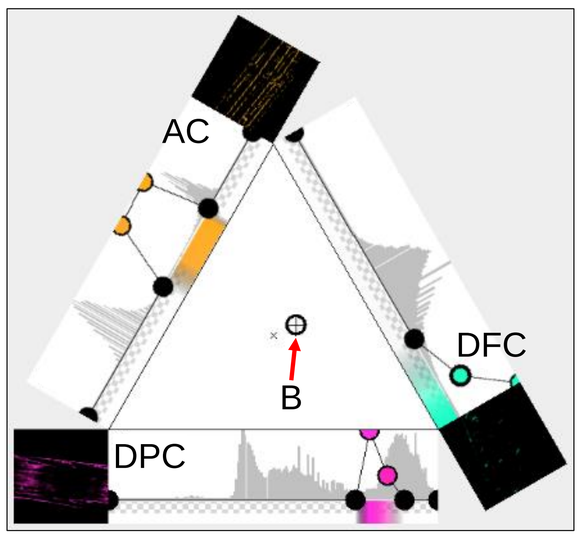
Talbot-Lau grating interferometer X-ray tomography (TLGI-XCT) devices provide three modalities in one scan:

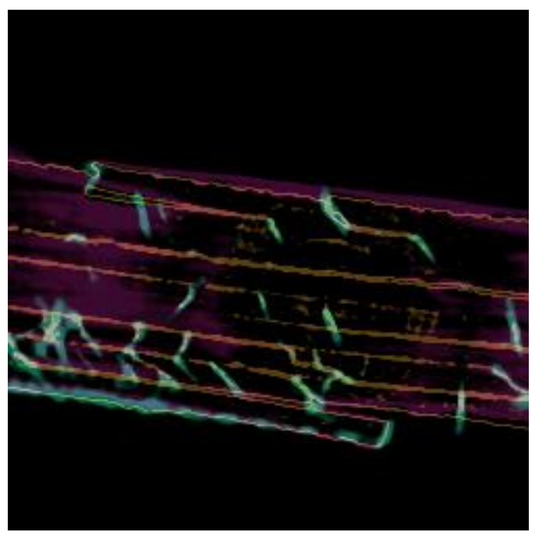
- *Attenuation contrast* (AC), as in conventional XCT devices,
- *Differential phase contrast* (DPC), which enables to resolve material interfaces through the differences in the phase shift,
- *Dark-field contrast* (DFC), which shows high responses for X-ray scattering, for example from sub-voxel-cracks or fiber bundles.



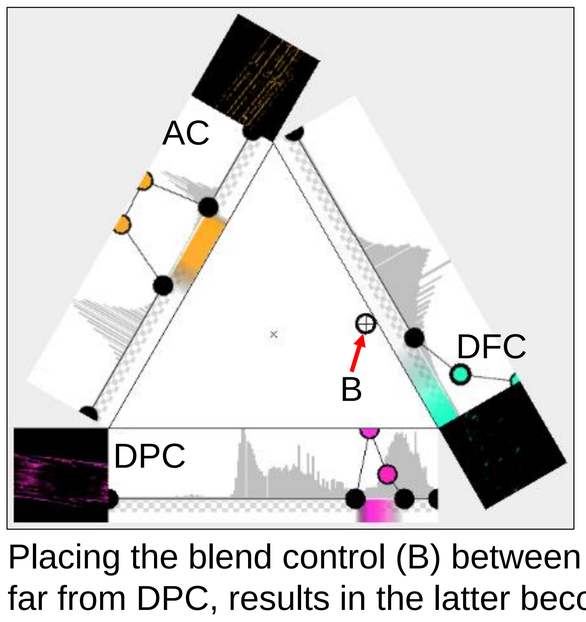
Tri-Modal Transfer Function Widget

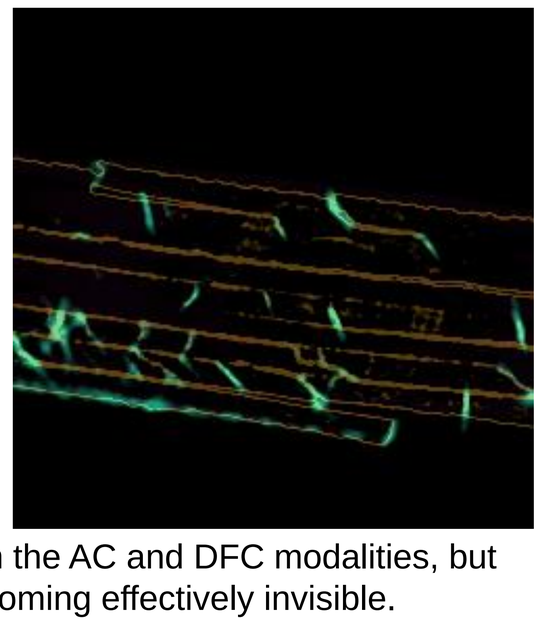
We propose a triangular tri-modal transfer function widget: Transfer function widgets and histograms for each modality are arranged along the edges. A slice image of the respective modality is placed next to its transfer function. The barycentric coordinates of a blend control (B) within the triangle define the weight of a modality through the distance from it slice image. The blended image is shown in a larger slice view.





The blend control (B) is near the barycenter, all three modalities are nearly equally weighted and can be seen in the result.





Placing the blend control (B) between the AC and DFC modalities, but far from DPC, results in the latter becoming effectively invisible.

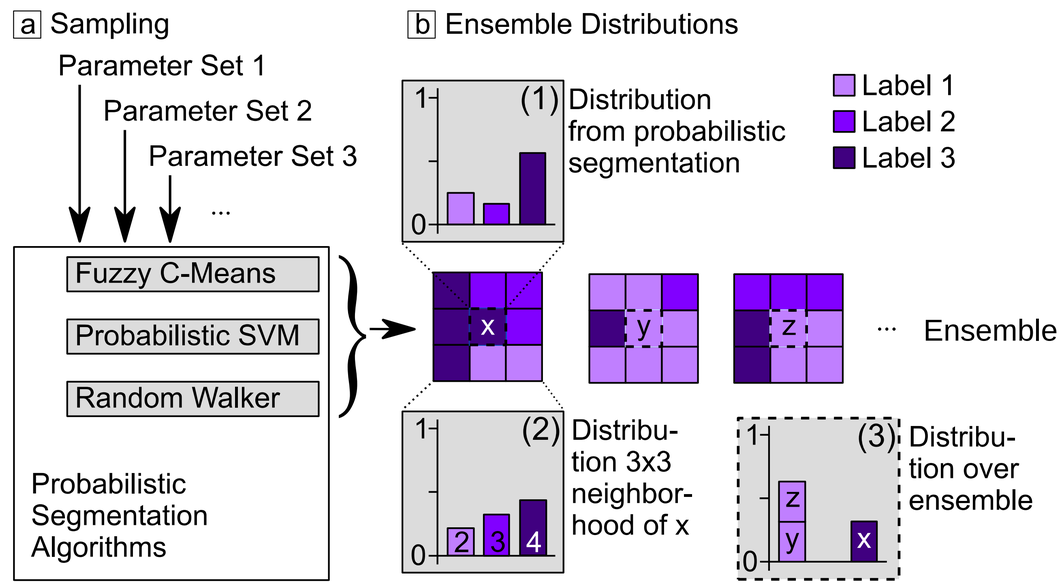
In material testing, domain experts often want to utilize the full information, i.e. use all three modalities simultaneously. We propose a widget design for the combined manipulation of all transfer functions, leading to a blended visualization of the three modalities.

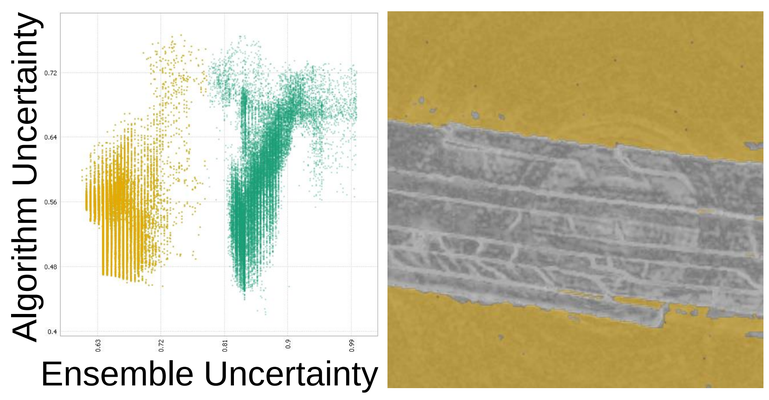
Segmenting the combined information of the three modalities requires specialized algorithms. Understanding their outcome and improving them is a challenge. We therefore have analyzed types of uncertainty in multi-modal segmentation algorithms, and present methods for the investigation of segmentation results and their uncertainty.

Analyzing Segmentation Uncertainty

Running multiple parametrizations of probabilistic, multi-modal segmentation algorithms yields three types of uncertainty, resulting from:

- the probabilistic character of (some) segmentation algorithms,
- the neighborhood variability, and
- the ensemble variability





Selecting pixels with low ensemble uncertainty selects the background. The algorithm uncertainty for these pixels varies over the whole intensity range, indicating that even though the single algorithms are about as uncertain about the background as about the rest, the whole ensemble still agrees very much on the segmentation of the background.

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