BRUKER MICRO-CT ACADEMY

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Welcome

In this issue of the Bruker microCT Academy newsletter, we focus on scanning trajectories and the associated topic of reconstruction algorithms. The differences between circular and helical scanning are high-lighted. You will see how the quality of reconstruction and reconstruction speed are affected by using different scanning trajectories and reconstruction algorithms.

To get suitable tomographical reconstruction data, movement of the object or source-detector pair can be done in different ways. In the simplest case, the object or source-detector pair is just rotating during the scan, creating a circular trajectory for acquisition geometry. Using more complicated movements with simultaneous or sequential rotation and translation create non-circular acquisition geometries. With special reconstruction algorithms appropriate for a particular acquisition geometry, one can significantly improve accuracy of the reconstructed results and suppress different artifacts, which may appear on reconstructions from circular scanning. In the SkyScan system range, solutions for both circular as non-circular (helical) scanning trajectories exists.

Circular trajectories

In most situations, the simplest trajectory with fast, but approximate reconstruction is a circular one. With a relatively small opening angle of the cone beam along the rotation axis, it produces reconstruction results very close to the internal structure of scanned objects. Necessity to scan long objects, which cannot fit in one vertical camera field of view, or to increase the scanning speed by using a short source-detector distance with a big opening angle of the beam, may increase differences of the reconstructed results from the real object structure.

Filtered back-projection, the Feldkamp algorithm

The most popular reconstruction algorithm for cone-beam tomographical systems is a filtered back-projection algorithm originally developed by Feldkamp, Davis and Kress, published in 1984 and later named according to the first letters of the developer names as an FDK algorithm. NRecon is utilizing the FDK algorithm as a standard and performs such reconstruction using CPU with multithreading (NReconServer engine) or acceleration with GPU on graphical cards. (GPUReconServer engine). Typically, graphical cards will outperform CPU as can be seen from the table with reconstruction speeds on the website.

Hierarchical reconstruction

Besides hardware acceleration for reconstruction (by using graphical cards or clusters), another option is to use a more efficient algorithm. The fast, hierarchical back-projection algorithm does precisely this. By dividing the reconstruction volume into smaller ones, requiring fewer projections for reconstruction, significant speed-ups can be achieved. This is especially true for larger datasets, as can be observed from the table. The InstaRecon® engine for NRecon uses a hierarchical reconstruction algorithm and was developed together with our partner InstaRecon® Inc. For more information on InstaRecon® and interesting further reading, we kindly refer to their website.

Additional information can also be found in '*MN109 - Reconstruction algorithms and engines for NRecon*'.

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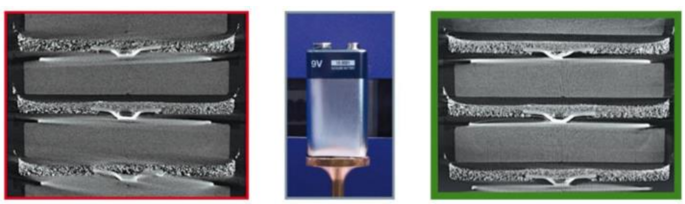
- Helical trajectory and exact reconstruction

A helical scanning trajectory involves simultaneous object rotation and translation along the rotation axis during data acquisition. In contrary to circular scanning, it respects the Tuy's data sufficiency condition, which defines possibilities for exact rather than approximate tomographical reconstruction. This implies that in a number of cases, especially in scanners with wide opening of the X-ray beam, certain reconstruction artefacts, such as blurring at surfaces perpendicular to the rotation axis at high cone angles, can be eliminated (as illustrated in the images of the battery) and long objects can be investigated without stitching of multiple partial scans. To unlock the full potential of helical scanning, an exact reconstruction is required. SkyScan recently added this functionality to the NRecon software together with our partner iTomography™ (https://www.itomography.com). For more information on this fascinating topic, we refer to '*MN106_Spiral Scanning*'.



Two vertical slices through a 9 V battery are shown from scans made with the SkyScan 1275. For the image on the left, a circular trajectory was used, for the one on the right a helical scanning trajectory. An exact reconstruction algorithm was used for the reconstruction of the helical scan data.

- Bruker microCT news

- It is with joy we announce that the next annual Bruker microCT User Meeting will take place in the lovely city of Ghent from April 16th to 19th, 2018. We look forward to learning from each other's research and the possibility of networking. More details to follow. Save the date and hope to see you there!
- Bruker microCT will host a free entry level on-line webinar on Bone imaging from the SkyScan microCT systems on December 5th, 2017. If you would like to learn more, please feel free to register.

- Image of the month

The images show a round courgette scanned using the SkyScan 1275. The two-part oversize scan has an image pixel of 50 µm and took 42 minutes to acquire. The greyscale images are two orthogonal slices, the colour picture was generated using the volume rendering program CTVox.