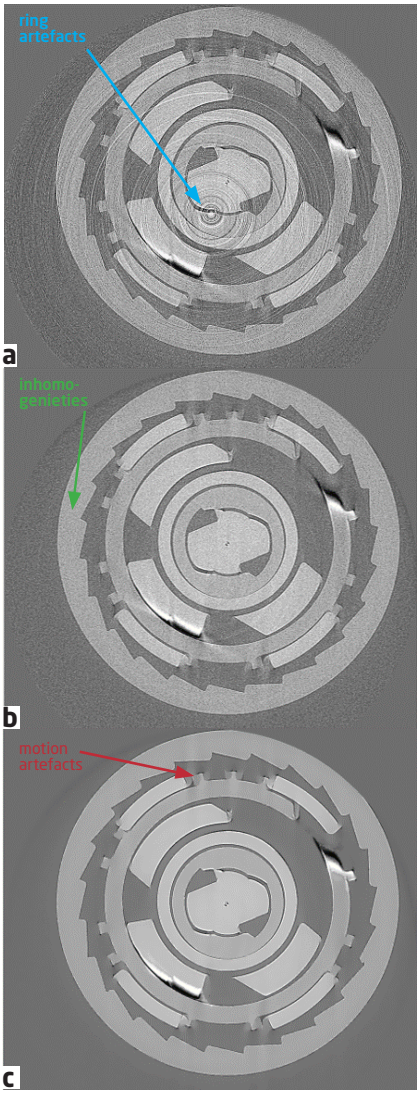
# Improving the image quality of high-speed data

Novo Nordisk produces insulin to treat people suffering from diabetis, a world-wide increasing disease. The patients need to inject the insulin themselves several times a day, which is why the injection is made as easy as possible for the patients. Therefore, the insulin is kept in a "pen" where it can be dosed and injected in a safe and standardised way. In order to get better at developing new product designs, Novo Nordisk was interested in studying the movements of the internal components of the insulin pen during operation. For this pupose, X-ray Computed Tomography (CT) was carried out at very high speeds at a synchrotron. However, when performing very fast studies, the image quality often suffers. In this part of the project, the purpose was to improve the original image quality to facilitate further image analysis performed in another step in the project.




*2D images showing a cross-section of the 3D image a) after the immediate reconstruction at the synchrotron, b) after repeated reconstruction and correction for ring artifacts and c) after an iterative filtering of the data.*

## Challenge

The 3D images obtained from the X-ray experiment at the synchrotron contained noise and artefacts, which made visualization challenging. To facilitate image analysis, we decided to repeat the reconstructions of the 3D images and perform a subsequent filtering to obtain a better quality of the 3D images.

## Collaboration

Novo Nordisk got in contact with the 3D Imaging Centre at DTU through the LINX project, in which researchers at leading Danish universities collaborate with scientists in industry to solve industry relevant problems using advanced neutron and X-ray techniques.
In this part of the project, the researchers at the 3D Imaging Centre at DTU made use of tools which were developed in the "P$^3$- Predicting Petrophysical Parameters for evaluating oil reservoirs" project. The project was previously conducted at University of Copenhagen and Mærsk Oil & Gas and funded by the Innovation Fund Denmark as grant number 5184-00034B.

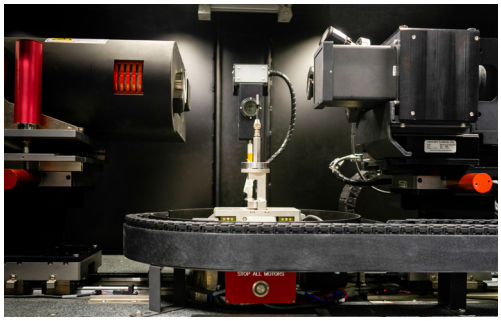
## Results

As the internal parts of the insulin pen move with a higher speed than the image acquisition took place, artefacts due to movement were expected and cannot be corrected for. These motion artefacts can e.g. be seen by smirred edges as indicated on the bottom figure on the left. Besides these motion artefacts, the immediately at the synchrotron reconstructed images also contained a huge amount of noise appearing in the form of so-called "ring artefacts", which are visible as a number of rings around a center, as indicated in the top part of the figure on the left. When re-reconstructing and correcting for these artefacts, an image without those ring artefacts is obtained, as it can be seen in the middle image on the left. After correction for these artefacts, the image was filtered such that inhomogenieties in grey values were reduced and the edges of the individual parts became more obvious, as it can be seen in the bottom image. The different corrections made a more precise identification of the individual components possible. The 3D images with improved image quality were then used as input for further analysis and visualization steps in this project.

## Imaging Industry Portal

The Imaging Industry Portal is a part of the 3D Imaging Centre at DTU and assists companies in using and implementing 3D Imaging in research, development and production. The portal offers research-based 3D Imaging services and provides companies with the latest equipment and the most advanced knowledge within 3D Imaging and data analysis. The Imaging Industry Portal works as a gateway to ESS and MAX IV, as well as other large scale facilities.

www.imaging.dtu.dk/Industry-Portal



## DTU 3D Imaging Centre