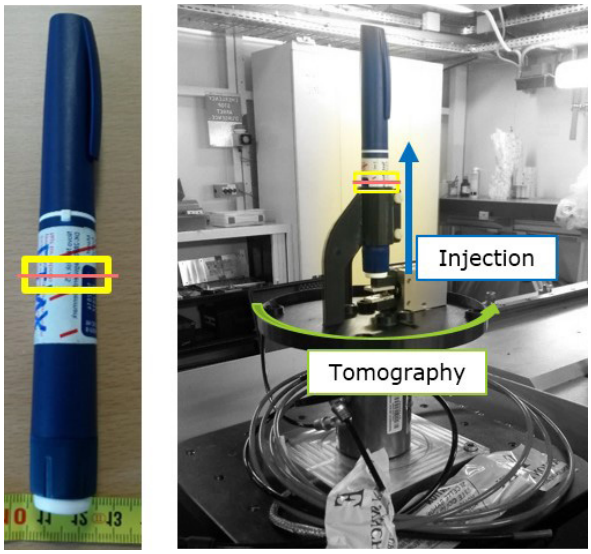
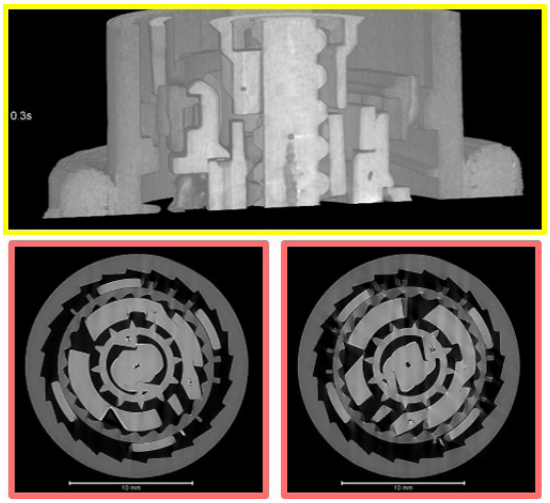
Sub-second time-resolved X-ray tomography acquisition

Novo Nordisk entered a collaboration with the 3D Imaging Center at DTU through LINX, a project funded by the Innovation Foundation in Denmark. The goal of the project was to image the movement of the internal parts of an insulin injection pen during operation using X-ray Computed Tomography (CT). To follow the fast movements of the pen, it is necessary to perform multiple CT scans per second, which required to use a synchrotron radiation facility, in this case the European Synchrotron Radiation Facility (ESRF) in France. To improve the quality of the recorded data, tools were developed at DTU to facilitate the visualization of the data. This study enabled Novo Nordisk not only to observe the internal movements of the inner parts of the pen, but also to pave the way to more advanced options for quality control.



Insulin pen set-up for CT scanning under operation.



X-ray CT scans. In yellow, a static scan of the middle region. In red, two time steps of the dynamic scans, showing the movement of the internal parts of the pen.

Challenge

Insulin injection pens consist of many moving parts that have to work in unison to deliver the exact dosis of insulin to the patient subdermally. To capture the very fast movements of the internal parts, time-resolved imaging is performed. For such fast CT acquisitions, synchrotron radiation facilities offer CT scans with sub-second time resolution, acquiring several full tomograms in one second. However, even for the acquisition of 3 tomograms per second, the real movements still had to be slowed down. In addition to the time resolution challenge, the typical field of view used at synchrotron radiation sources is small, limiting the area of the insulin pen that can be visualized.

Collaboration

Members of the 3D Imaging Center at DTU travelled together with one representative of Novo Nordisk to the European Synchrotron Radiation Facility in Grenoble, France to record high-resolution X-ray tomography scans at the microtomography beamline ID 19 on insulin injection pens during dose application. The visualization and postprocessing of the CT data was carried out by DTU. This collaboration was part of 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.

Results

The insulin pen was set up at the beamline ID 19 of ESRF to be remotely activated while 53 X-ray tomography scans were taken continuously during its operation. Different positions of the pen were studied while modifying the injection speed. At a time resolution of 3 full tomograms per second, the tomography acquisition was performed with a spatial resolution of 24 µm, which allowed to see the movements of the internal parts with decent spatial and temporal resolution.

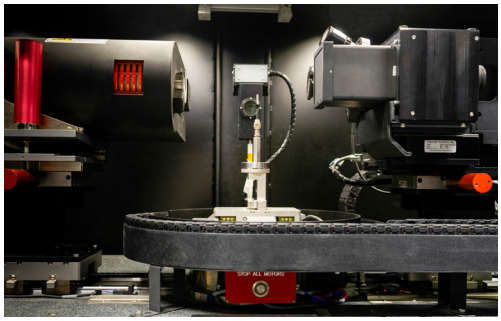
Perspectives

Further data treatment is required to improve the image quality for better visualizations. This is performed in collaboration with the QIM Center at DTU, a part of the 3D Imaging Center at DTU.

Imaging Industry Portal

The Imaging Industry Portal is a part of the 3D Imaging Center 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/english/Industry-Portal



DTU 3D Imaging Center