The aim of this study is to present an exemplary application of non-destructive X-Ray CT imaging for assessing the quality of a soldered seam. When several components are being brazed together—no matter which material or in which area of use— one major issue is the stability and quality of the soldered seam.

In our present example, aluminum sheets had been welded together and the seam must be checked in the framework of comprehensive quality assurance, especially when phenomena like fracturing or delamination might occur when the part is exposed to mechanical stress. Major reasons for instability or failure are blowholes or gas inclusions within seams. This is why several techniques are regularly used to gain more information about internal unconformities.

Depending on size, geometry and material properties, various investigation techniques come into play, such as metallographic sectioning, ultrasonic and eddy-current testing or thermographic analyses. The latter three techniques are of non-destructive nature, which also holds for the modern technique presented in this case study: X-Ray computed tomography (CT), representing a very targeted method shown in the present case study.

The main principle of 3D computed tomography is to take 2D X-Ray images from a rotating object, which are subsequently transferred into a three-dimensional data set based on grayscale values. Virtual slicing of this 3D data allows to investigate every desired internal or external feature that has been collected in the single X-Ray images.

In our example, 2D slices clearly exhibit large voids, which are aligned in the seam and along the boundary between the seam and the aluminum sheet(s) (Fig. 1). This view mode enables first detection and measurements regarding number, diameter, shape or area of voids or inclusions.

However, the key point of computed tomography is the 3D aspect. Based on specific grayscale value thresholds for the different materials (see grayscale value images in Figure 1) the 3D data set can be segmented into single volumes. This is how a 3D model of the aluminum sheets and the seam is quickly reconstructed. The same holds for the voids inside the seam, which are now completely visible in 3D showing their real shape, spatial alignment and distribution as well as their volume and surface area, which are precisely determined by special software (Fig. 2, Tab. 1). Volume-based coloring helps to distinguish between smaller and larger voids.

The entire seam can be examined for potential fractures, voids or delamination by "flying though" the 2D slices.
Apart from the volumetric information, the 3D reconstruction shows that the voids are shaped more complex than expected from the 2D slices. Once the 3D volume is created it can be virtually turned, sliced and magnified in any desired way to expose maximum information about the void’s geometries.

As mentioned above, alternative inspection techniques are available, which however have been disqualified in the present case because of the following reasons. For ultrasonic testing the voids are too small. Eddy current testing is hard to use due to the complex geometry of the part. Thermography certainly shows the voids, but is limited to 2D and does not reveal the detailed spatial information about shape and volume of the voids.

This case study is one example how modern X-Ray computed tomography can be used as a very efficient, non-destructive, fast and straight-forward method, when other techniques get into difficulties. The comprehensive spatial information obtained from CT imaging helps to spot defects, material weakness or reasons for failure providing useful knowledge for reviewing and improving the manufacturing process, for instance. Most importantly, such insights gained from X-Ray CT imaging have the power to tremendously improve the quality of a product and to assure its reliability and functionality in its role on the market.