

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



WPR24FA053

COMPUTED TOMOGRAPHY

Specialist's Factual Report

May 13, 2025

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A ACCIDENT

Location: Eloy, AZ
Date: December 8, 2023
Time: 1329 pacific standard time
 2129 coordinated universal time (UTC)
Airplane: Beauchamp Norm Series 5 Kitfox S9606-180, N66180

B COMPUTED TOMOGRAPHY SPECIALIST

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 Washington D.C.

C SUMMARY

On December 8, 2023, about 1329 pacific standard time, an experimental amateur-built Series 5 Kitfox, N66180, was destroyed when it was involved in an accident near Eloy, Arizona. The pilot was fatally injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 91 personal flight.

The airplane came to rest in a dirt field, 1.2 miles southwest of the departure end of runway 20. The entire structure was consumed by fire with only steel airframe and burnt aluminum, composite, and flight instrument remnants remaining.

A single intact propeller blade (see figure 1) along with assorted items of cabin contents, an iPad, and clear plexiglass fragments were located about ½ mile north of the accident site, underneath the airplanes flight path. All remaining airframe primary structure, flight control surfaces, and engine components along with the second propeller blade, which had detached on impact, were accounted for in the main wreckage. The propeller hub remained attached to the engine crankshaft.

The airplane was equipped with a 160 horsepower O-320 Lycoming engine, and a composite ground-adjustable two blade propeller, manufactured by NR Prop. The airplanes maintenance logbooks indicated that the propeller assembly was installed during the condition inspection, one month before the accident. The propeller assembly was retained for further examination.

The propeller blade found ½ miles from the accident site and an exemplar propeller (spare propeller acquired at the same time as the accident propeller blades) were sent to Varex Imaging for computed tomography scanning to document the propeller blade root area.

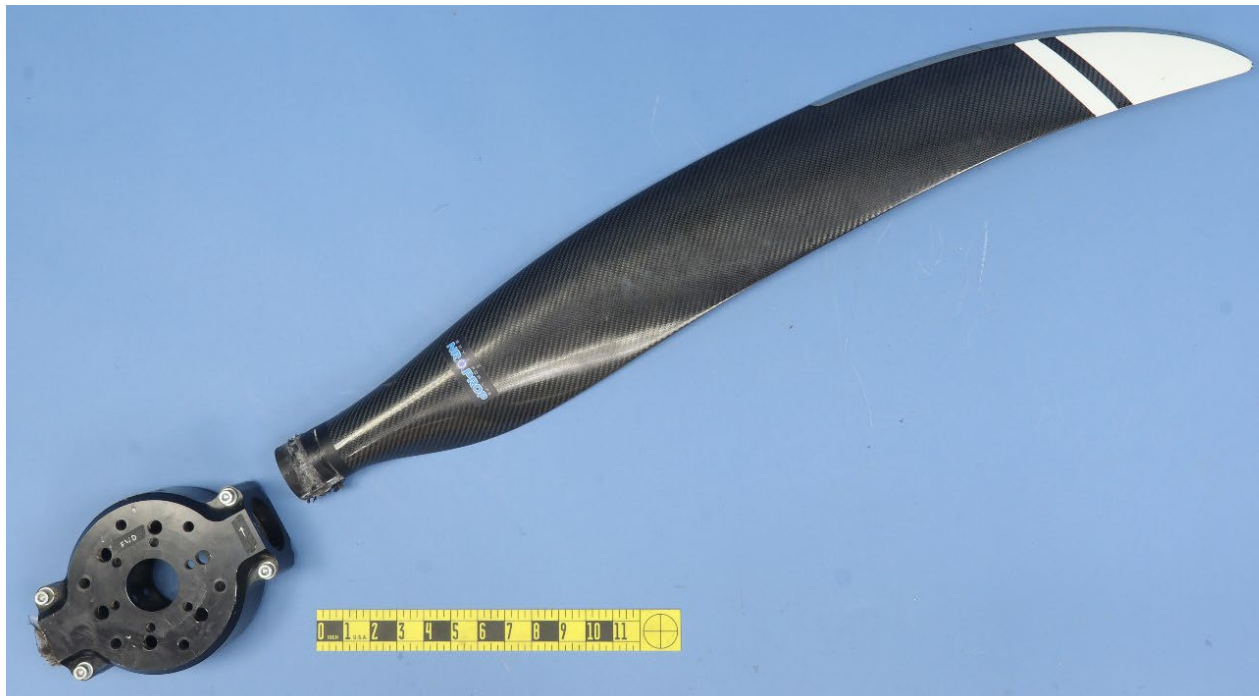


Figure 1. Photo of the accident propeller blade (one found ½ mile from accident site) and the propeller hub.

D DETAILS OF THE EXAMINATION

1.0 General

The accident propeller blade and an exemplar propeller blade were subjected to computed tomography (CT) scanning to document their internal condition and determine 1) how the internal aluminum tube is seated at the root end of both blades; 2) the fiber orientation of the root area specifically in the retention collar area; 3) if there are voids in the composite structure or between composite layers. The scanning was conducted on February 3-6, 2025, in Chicago, Illinois by Varex Imaging, Inc under the direction of the NTSB using the Actis 225/500 microfocus CT system.

For the CT scan, the component was loaded into the imaging unit and placed on a turntable. The component was then rotated in front of the x-ray source, and the x-rays were captured by a detector after they went through the part. The x-ray source produced a cone shaped beam of x-rays, and the portion of the part imaged was adjusted slightly after each scan was completed until the entire assembly was scanned. The x-ray energy levels measured by the detector were recorded at several thousand different points during each rotation, and this information was converted into slice images using reconstruction algorithms.

The root area of the two propeller blades were scanned using a total of 5300 slices, and the total size of the combined data sets was approximately 25.25 GB. The complete scan protocols are given in Table 1.

Table 1. Scan Protocol

CT System	225 kilovolts (kV)	
Component/Area	Accident propeller blade	Exemplar propeller blade
Number of Slices	2700	2600
Voxel ¹ Size - X Direction (millimeters (mm))	0.05	0.05
Voxel Size - Y Direction (mm)	0.05	0.05
Voxel Size - Z Direction (mm)	0.05	0.05
Image Projections per Revolution	2520	2520
Exposure Time (milliseconds)	285.6	285.6
Frames to Avg (frames per projection)	2	2
X-ray Source Voltage (kV)	200	200
X-ray Source Current (mA)	3.0	3.0
Source Filter Thickness (mm)	1	1
Source Filter Material	copper	copper
Image Matrix Size (pixels)	1600 x 1600	1600 x 1600
Reconstruction Software	Conebeam Software Toolkit 2.3.0.39	Conebeam Software Toolkit 2.3.0.39

The data sets of slice images were examined, processed, and analyzed by the NTSB using the VGStudioMax software package to convert the axial slice data into orthogonal slice images and a three-dimensional reconstructed image of the component. As part of the evaluation, some sections of the component were digitally removed or rendered transparent to allow closer observation of interior parts. In all the images, the higher density areas were shown as brighter shades of gray and lower density areas were shown as darker shades of gray. Each 2-D quadrant within the images shows a scale at the bottom of that quadrant - note that the scales in each quadrant may be different. The pointers shown in some of the images denote specific areas of interest within that image. The numbers associated with the pointer are the gray value at the pointer location and the three positional coordinates of the pointer.

The propeller blades were “virtually unrolled” using the CT image visualization software. This process required the identification of a path for the software to use when unrolling the data set, and it resulted in a cylindrical structure being “unrolled” to show a round surface as a flat planar image.

¹ A voxel is a three-dimensional picture element (pixel).

2.0 Computed Tomography Results

2.1 Exemplar Propeller Blade Results

The CT results for the exemplar propeller blade are shown in figures 2 through 21. Review of the images indicated that when the scans were conducted the following items were observed.

- 1) The retaining collar is present (see figures 3 and 4).
- 2) The serial number (SN) of the exemplar propeller was 6409 (see figure 5).
- 3) The root area of the exemplar propeller blade consists of the following cross section: 1) an aluminum (AL) insert; 2) layers of unidirectional carbon wrapped circularly (circ) around the insert; 3) layers of unidirectional carbon and glass oriented longitudinally (long) along the blade; 4) layers of woven glass; and 5) layers of carbon fiber. (See figure 6)
- 4) The aluminum insert starts at the root area of the propeller blade and is just under a layer of carbon fiber (see figure 7). On the exemplar blade, the top of the aluminum insert was approximately 3 - 4 mm below the cross support (see figures 8 and 9).
- 5) There was an indentation on the aluminum insert.
- 6) Several ring artifacts were observed in the CT images and an example is shown in figure 11. A ring artifact appears as a circular or arc-shaped streak or ring on the CT scan image, often near the center of the scan. The ring artifact can be due to a defective or miscalibrated detector or detector misalignment.
- 7) For the unidirectional carbon (circ) layers, there were some small voids or low density areas visible between the carbon fibers (see figures 12 thru 14).
- 8) For the unidirectional carbon and glass (long) layers, there were some small voids or low density areas visible between the carbon fibers (see figures 15 thru 17).
- 9) The woven glass layers are shown in figures 18 and 19.
- 10) The woven carbon fiber layers are shown in figures 20 and 21.

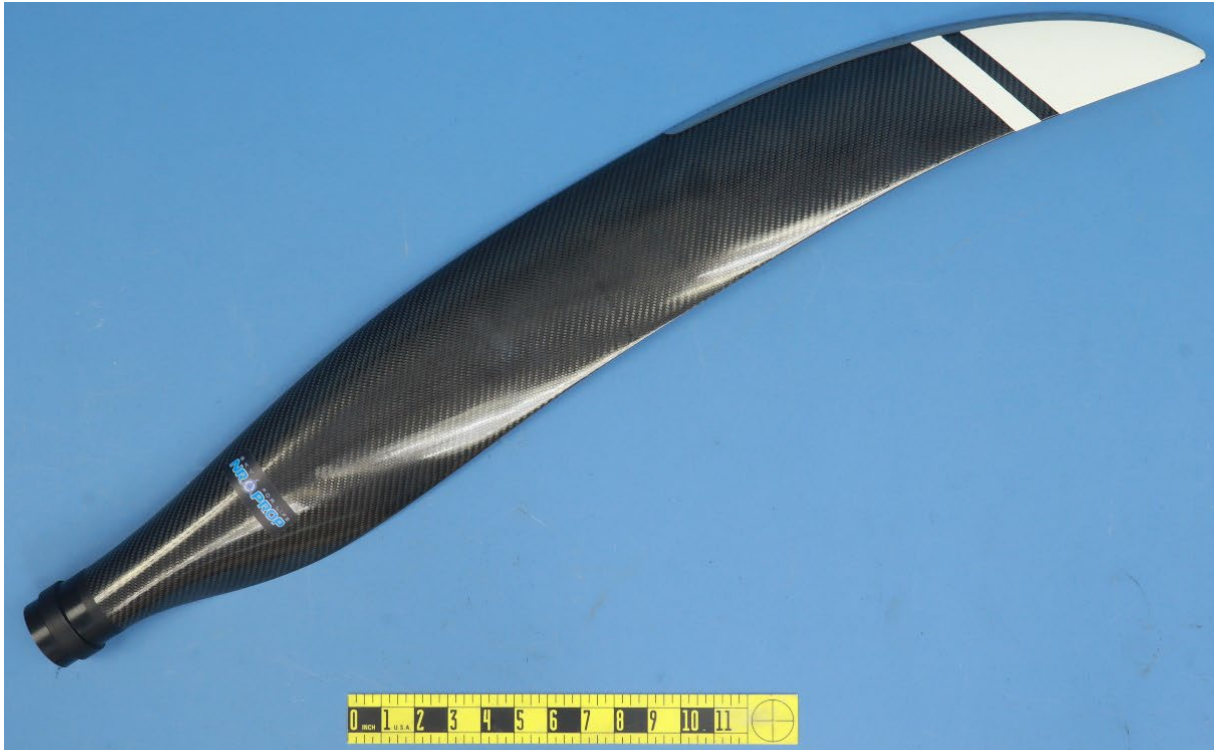


Figure 2. Photo of the exemplar propeller blade.

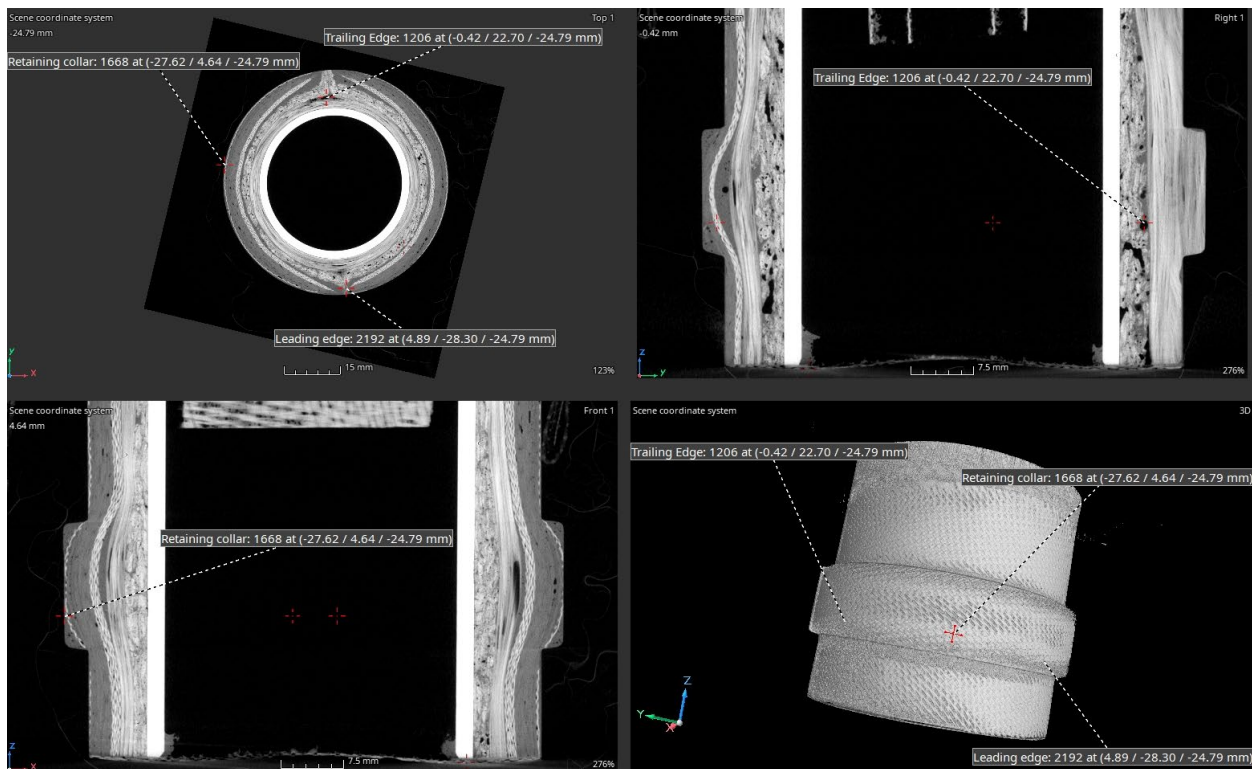


Figure 3. CT images of the exemplar propeller blade root area - overview.

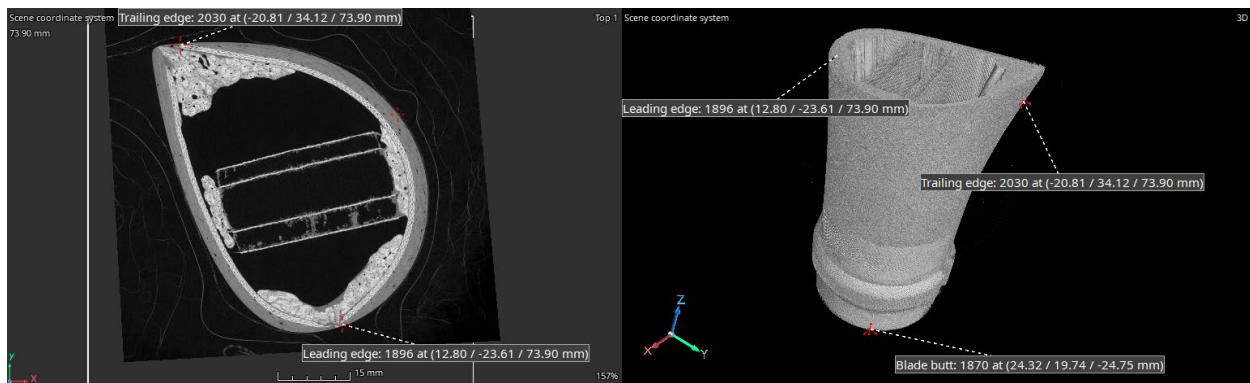


Figure 4. CT images of the exemplar propeller blade root - showing the leading and trailing edges.

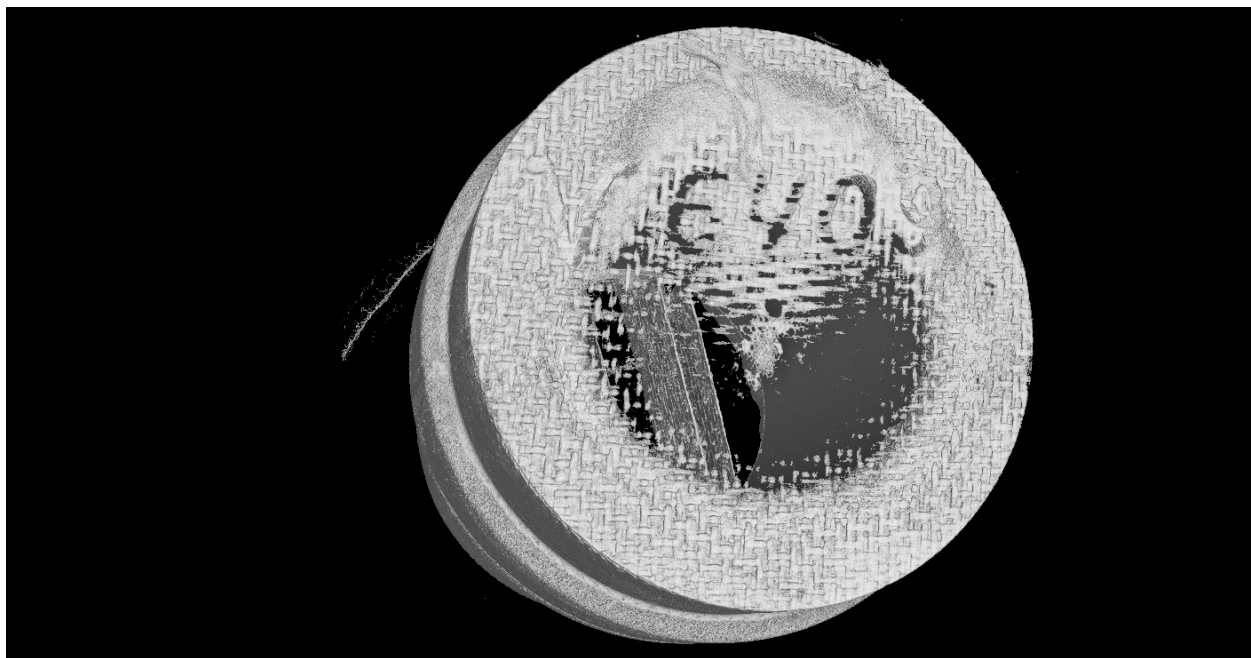


Figure 5. CT image of the exemplar propeller blade root showing SN 6409 at the blade butt.

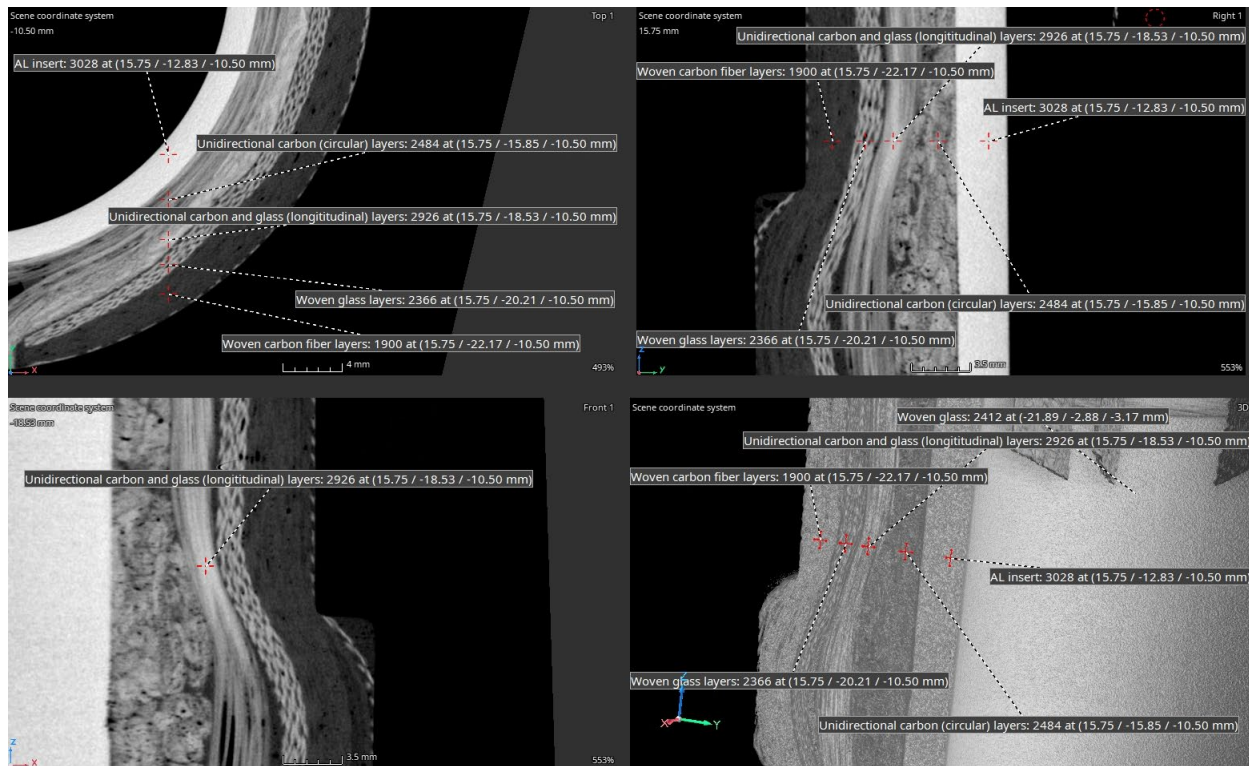


Figure 6. CT images of the exemplar propeller blade root - cross section.

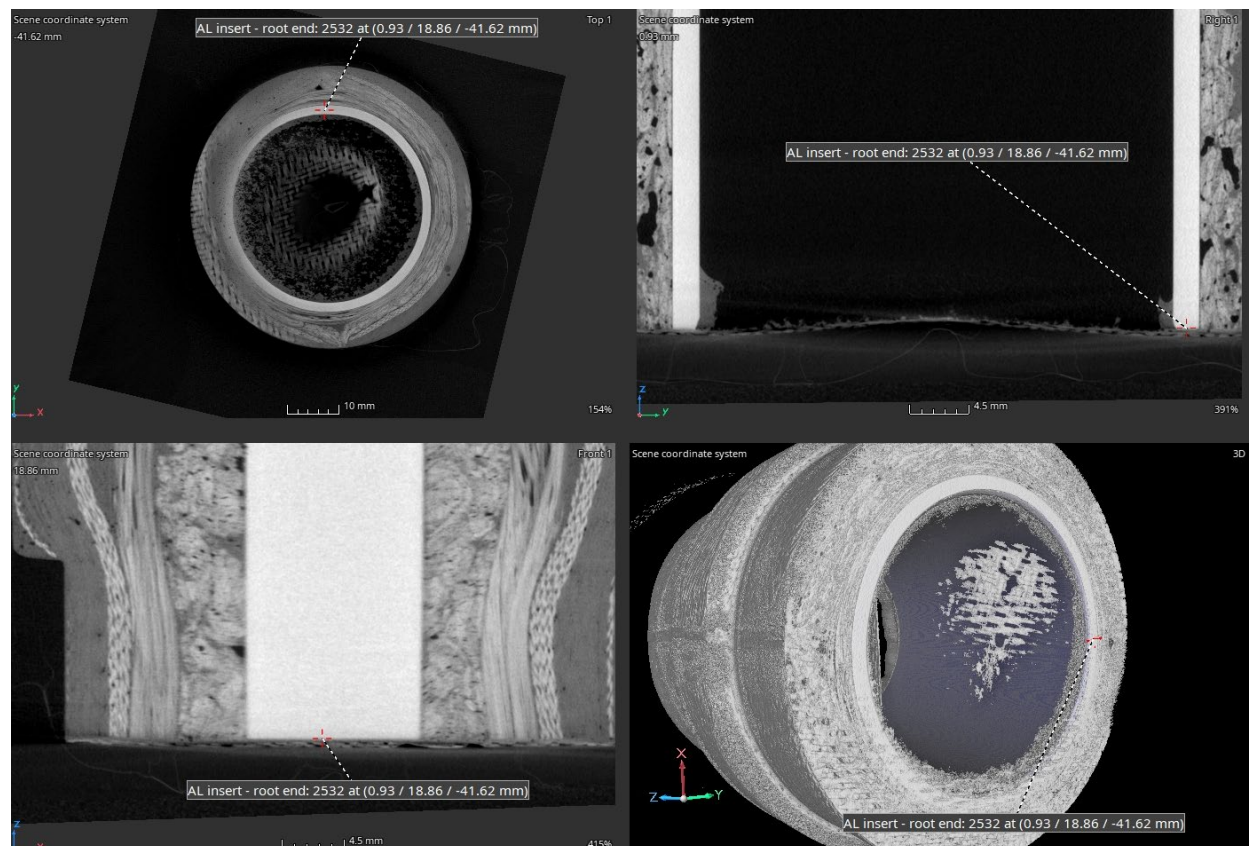


Figure 7. CT images of the exemplar propeller blade root - showing aluminum insert.

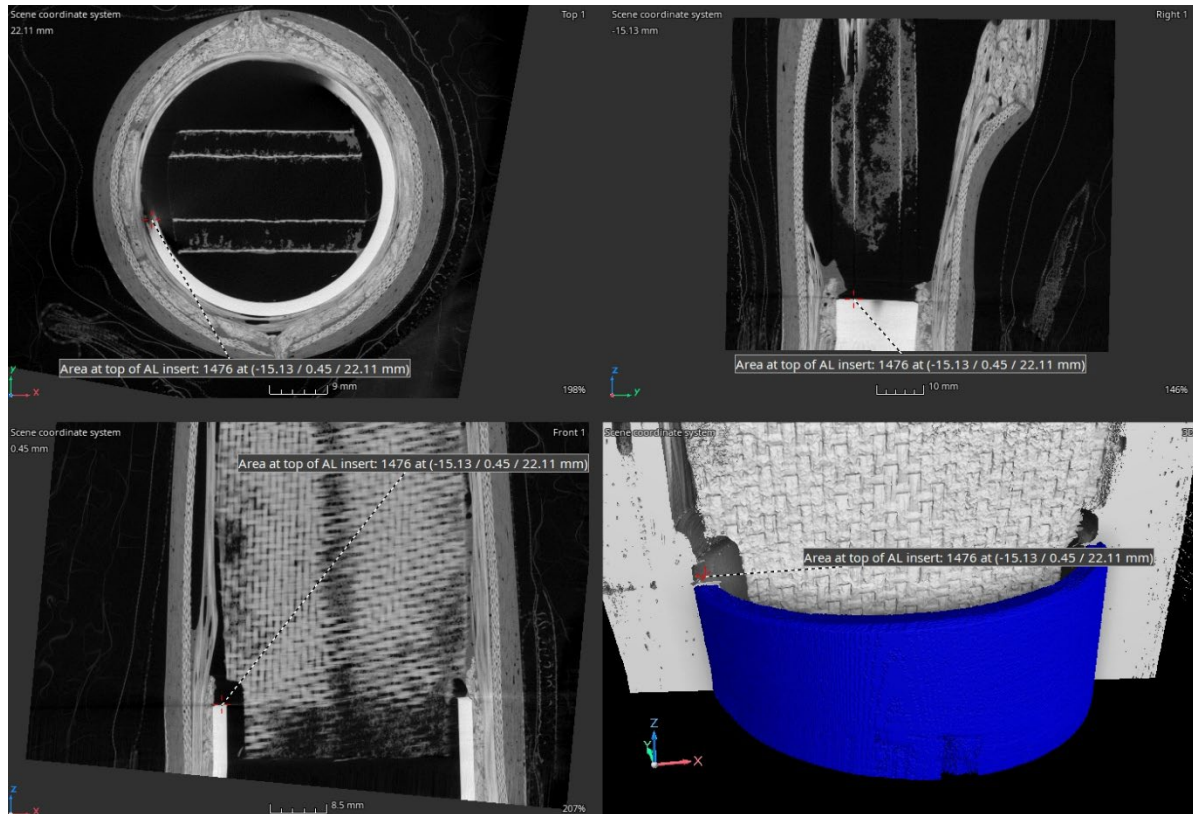


Figure 8. CT images of the exemplar propeller blade root - aluminum insert inside blade.

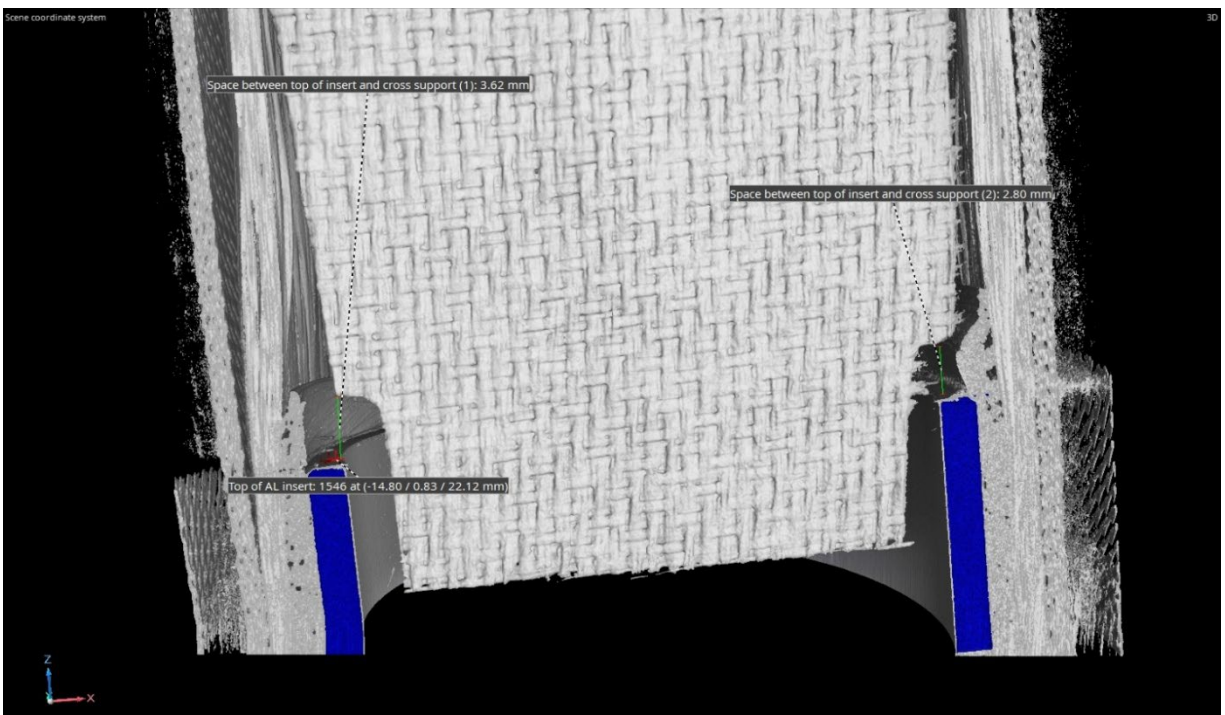


Figure 9. CT image of the exemplar propeller blade root - aluminum insert inside blade showing the gap between the cross support and the top of the insert.

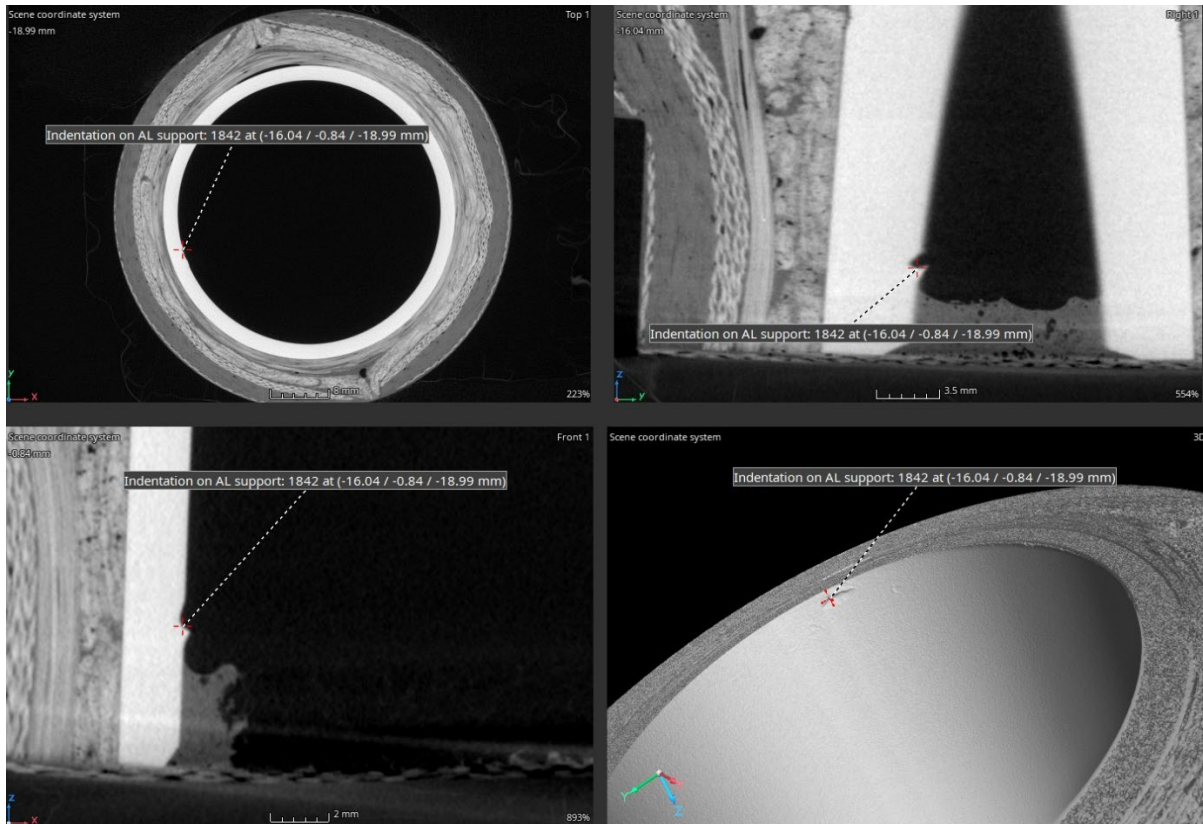


Figure 10. CT images of the exemplar propeller blade root - indentation in aluminum insert.

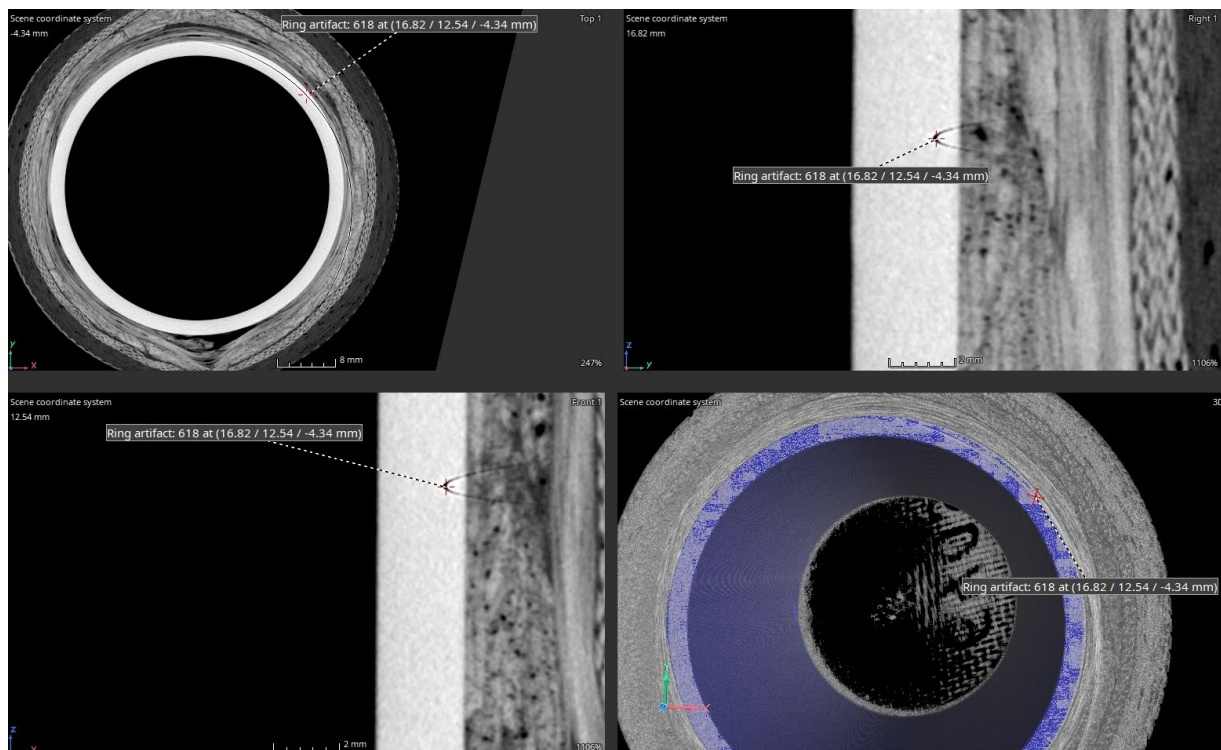


Figure 11. CT images of the exemplar propeller blade root - ring artifact.

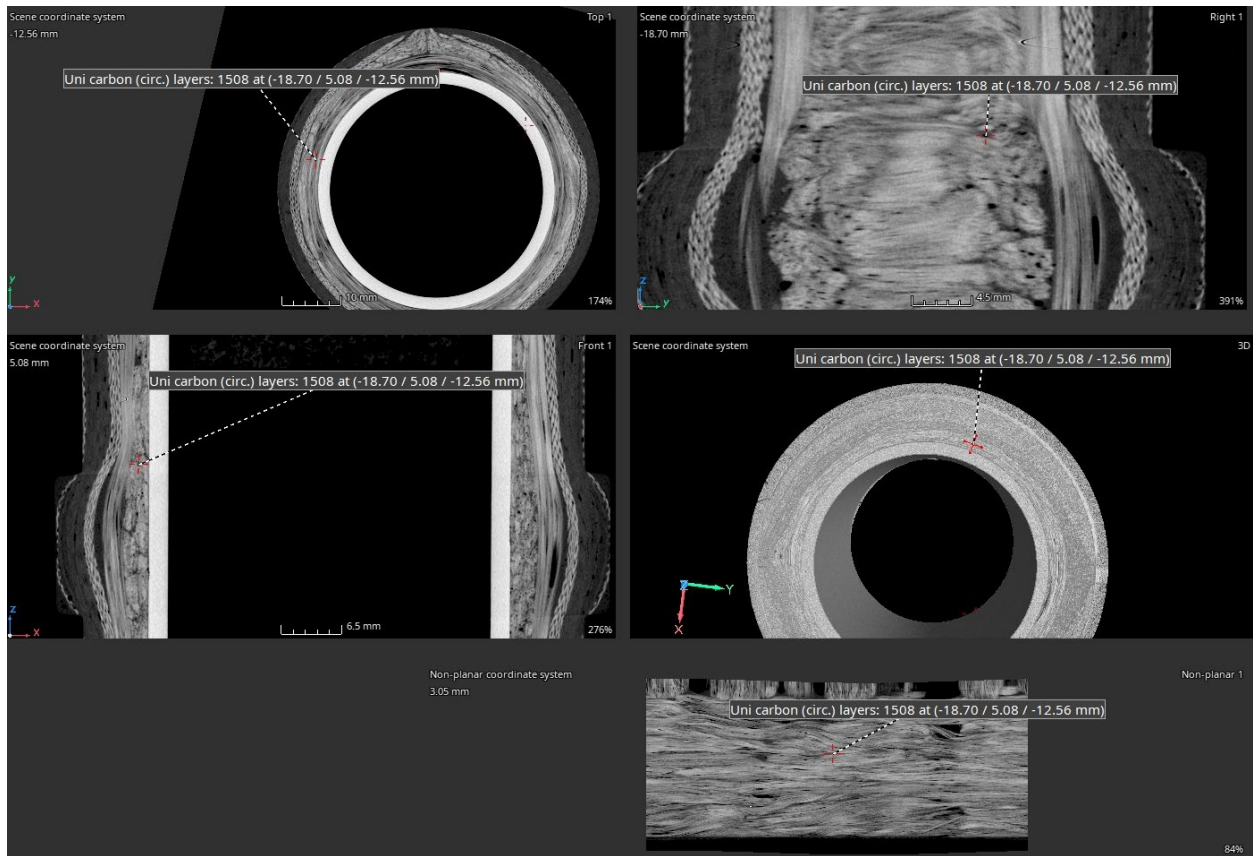


Figure 12. CT images of the exemplar propeller blade root- unidirectional carbon (circ) layers.

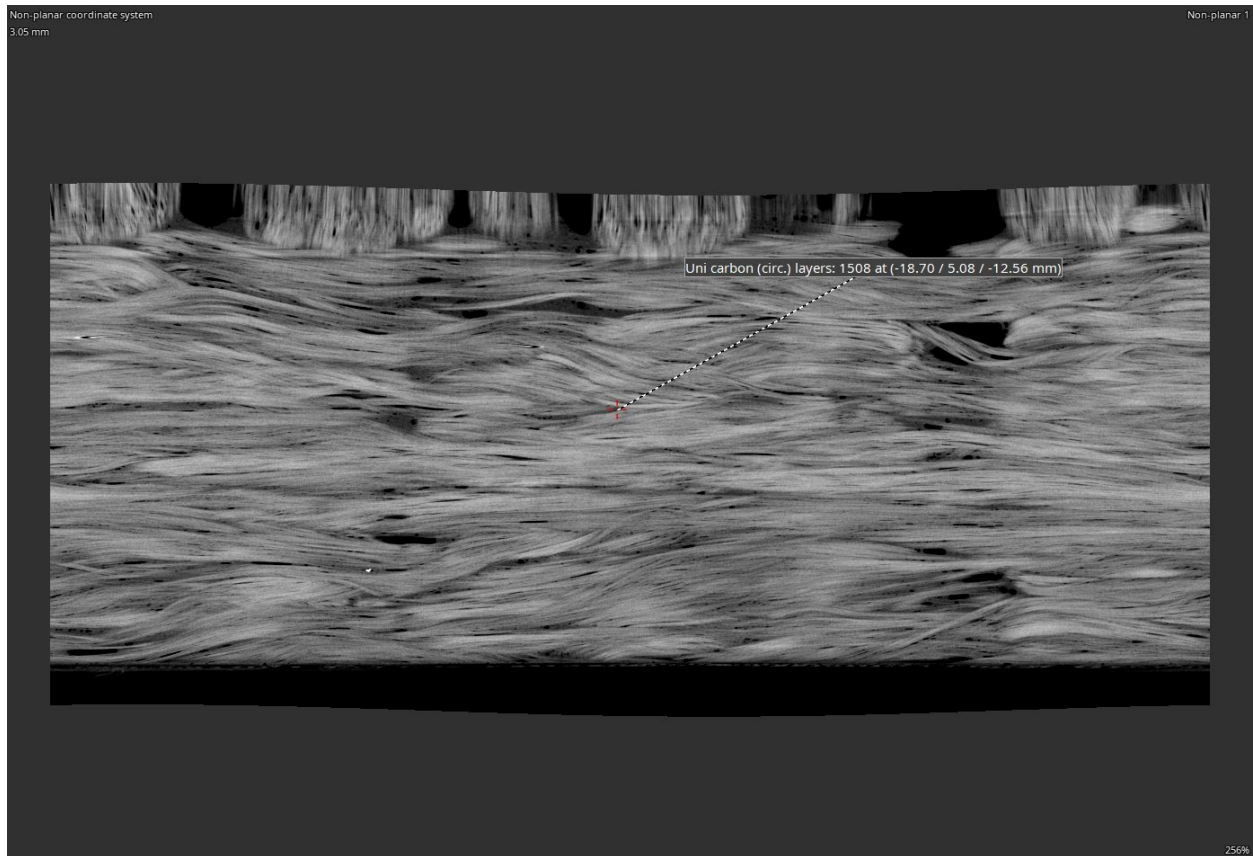


Figure 13. CT image of the exemplar propeller blade root - unidirectional carbon (circ) layers unrolled.

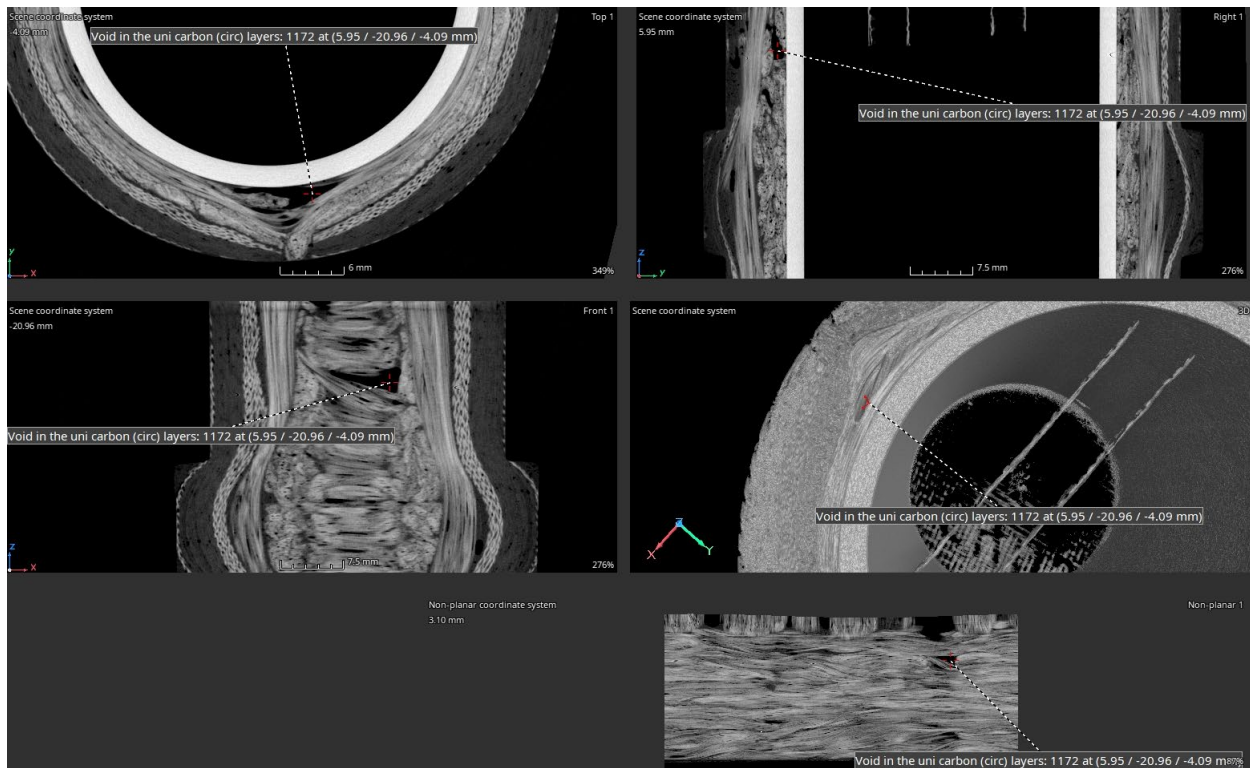


Figure 14. CT images of the exemplar propeller blade root - void in the unidirectional carbon (circ) layers.

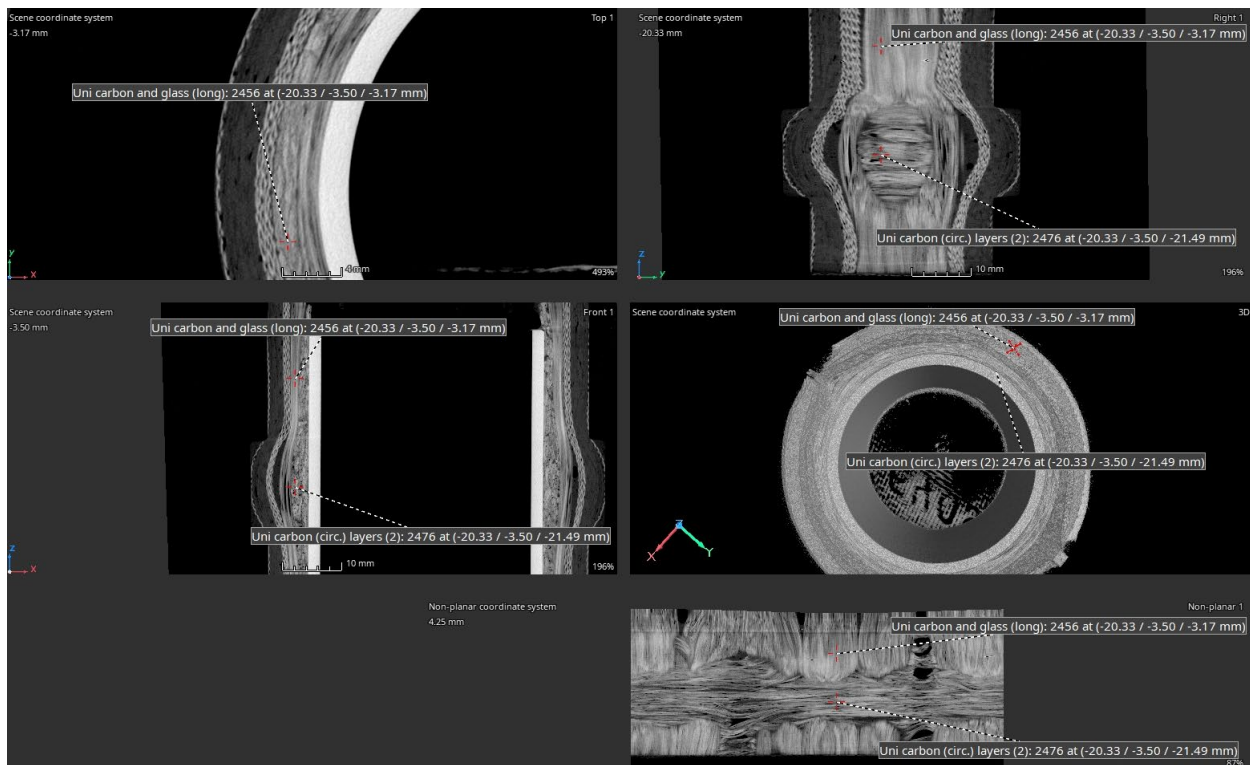


Figure 15. CT images of the exemplar propeller blade root - unidirectional carbon and glass (long) layers.

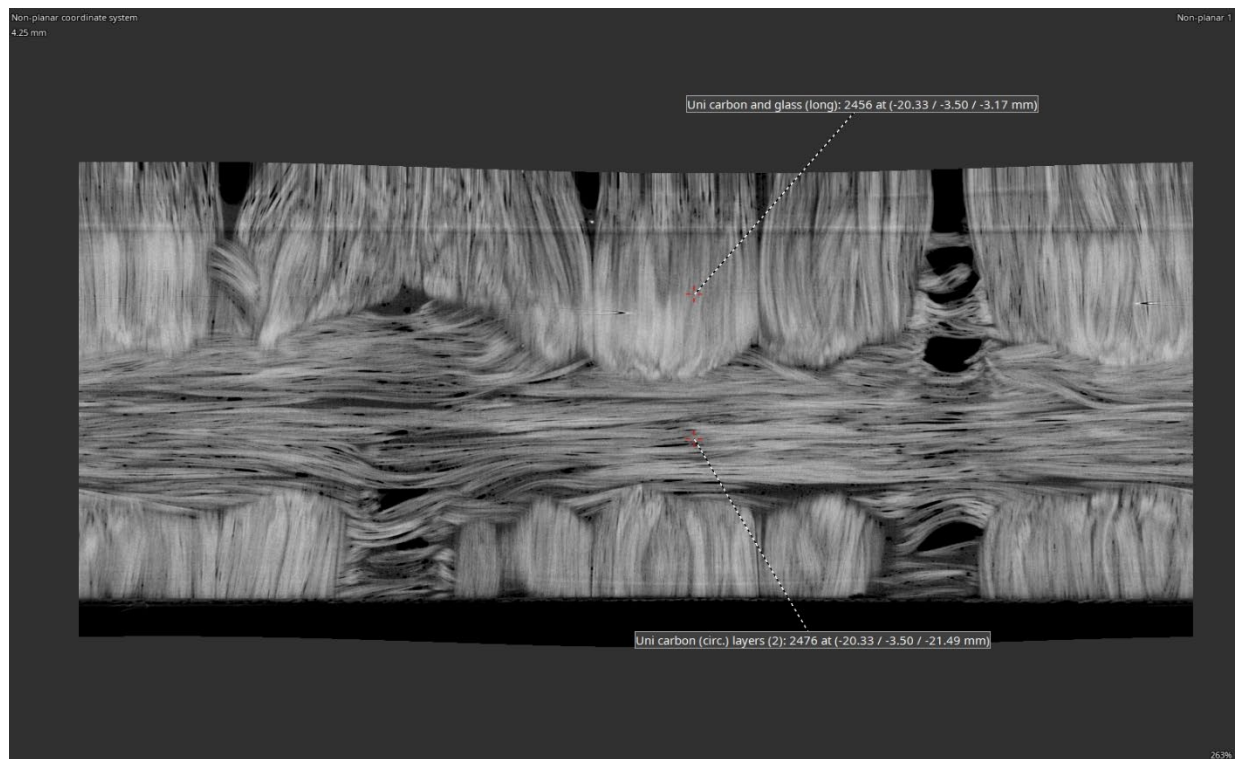


Figure 16. CT image of the exemplar propeller blade root - unidirectional carbon and glass (long) layers unrolled.

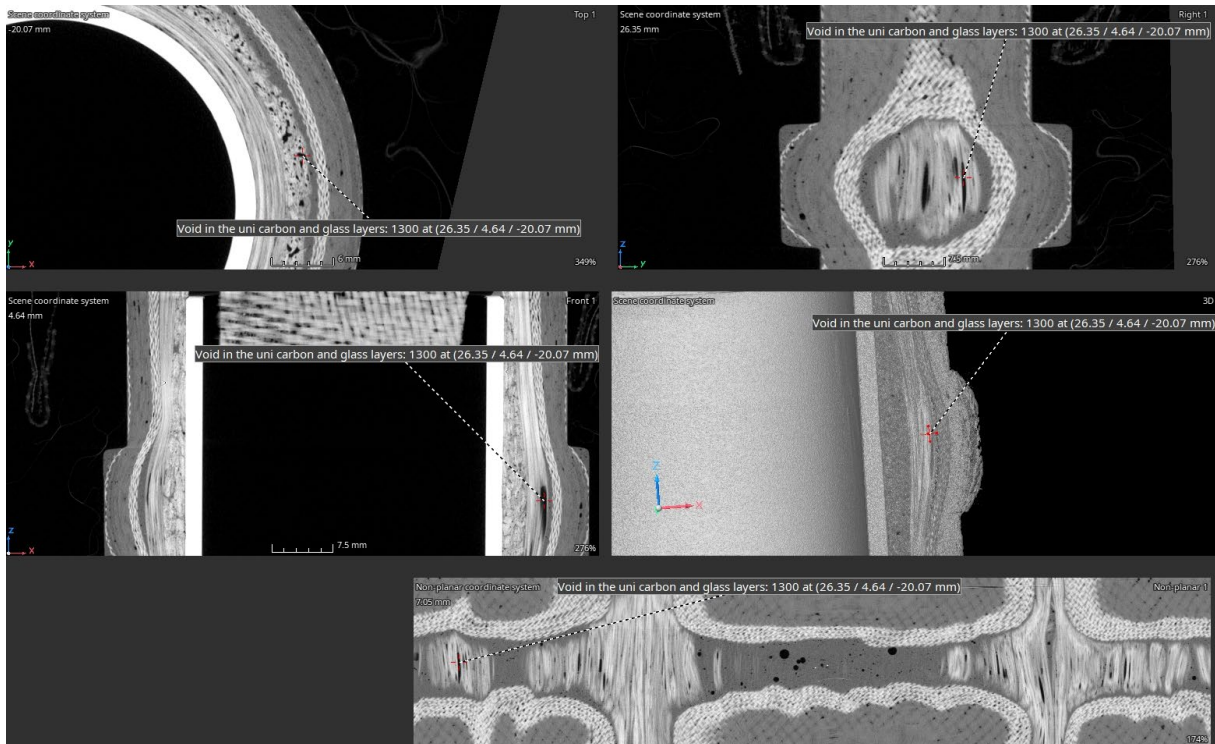


Figure 17. CT images of the exemplar propeller blade root - void in unidirectional carbon and glass (long) layers.

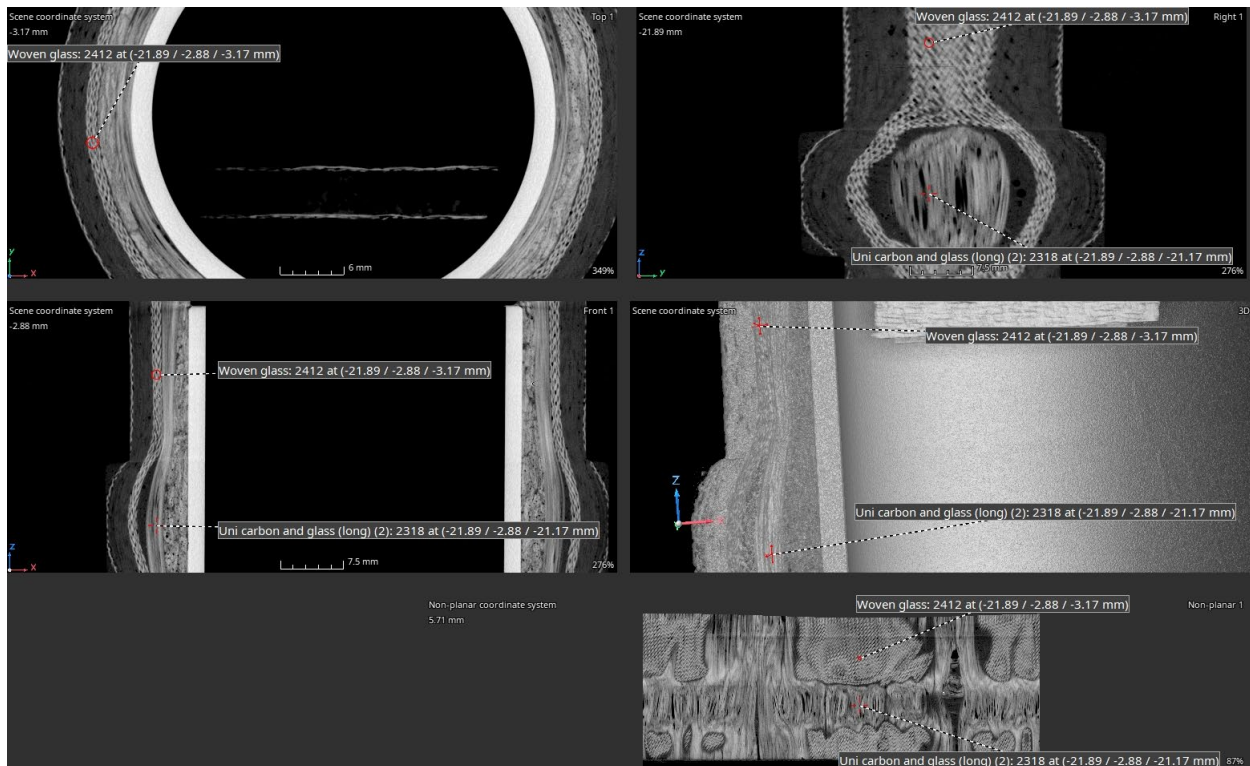


Figure 18. CT images of the exemplar propeller blade root - woven glass layers.



Figure 19. CT image of the exemplar propeller blade root - woven glass layers unrolled.

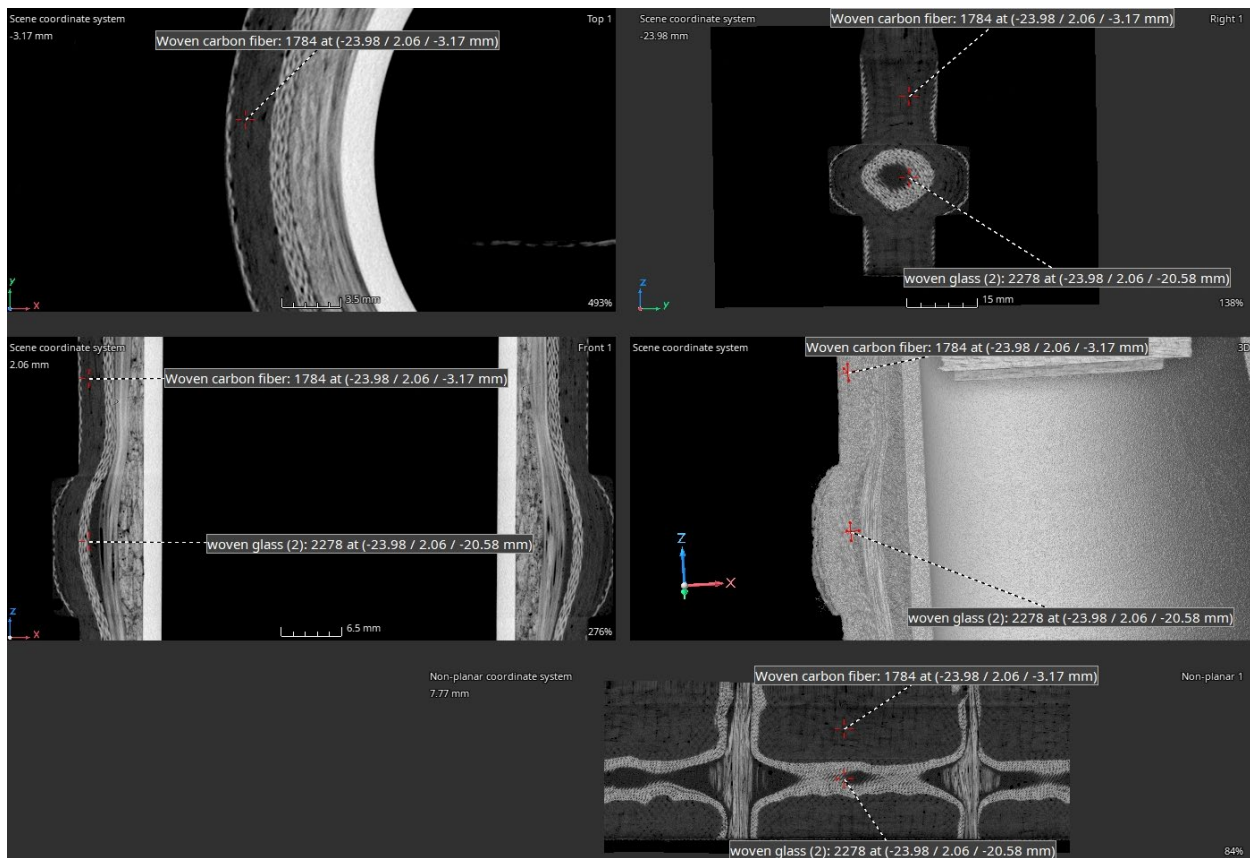


Figure 20. CT images of the exemplar propeller blade root - woven carbon fiber layers.

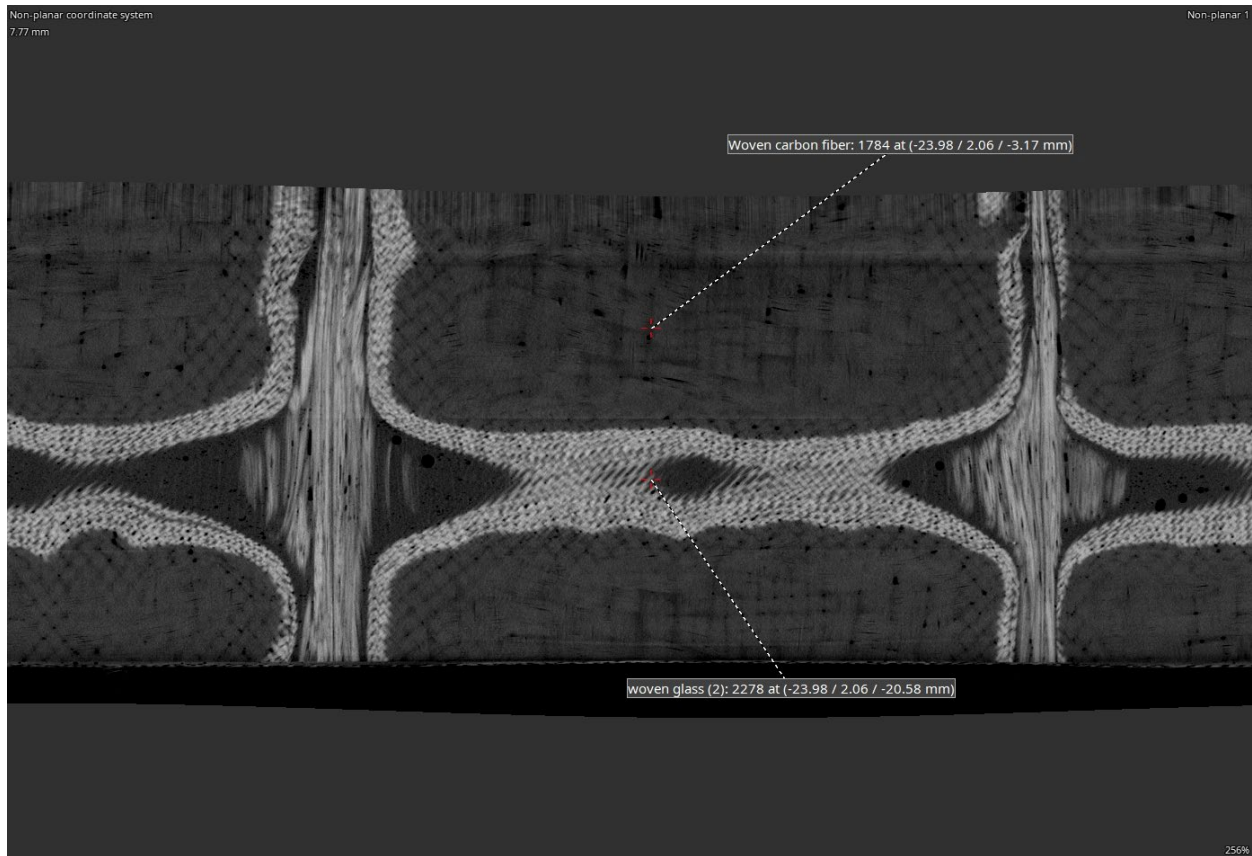


Figure 21. CT image of the exemplar propeller blade root - woven carbon fiber layers unrolled.

2.2 Accident Propeller Blade Results

The CT results for the accident propeller blade are shown in figures 22 through 44. Review of the images indicated that when the scans were conducted the following items were observed.

- 1) The retaining collar is not present on the accident propeller blade (see figures 22, 23 and 24). (The retaining collar is shown on the exemplar propeller blade in figure 3.)
- 2) The accident propeller blade was SN 6410 (see figure 24).
- 3) The root area of the accident propeller blade consists of the following cross section: 1) an AL insert; 2) layers of unidirectional carbon wrapped circularly around the insert; 3) layers of unidirectional carbon and glass oriented longitudinally along the blade; 4) layers of woven glass; and 5) layers of carbon fiber. (See figure 25)
- 4) For the accident propeller, the AL insert was recessed approximately 3.69 to 3.82 millimeters into the blade (see figure 26). On the accident blade,

- the top of the AL insert was approximately 1-1.5 mm below the cross support (see figure 27). The AL insert was bowed inward (see figure 28).
- 5) There was a gap between the AL insert and the unidirectional carbon (circ) layers (see figures 28 and 29). There was an anomaly between the AL insert and the unidirectional carbon (circ) layers (see figure 29). There appear to be tears in the unidirectional carbon (circ) material (see figures 30 and 31). The unidirectional carbon (circ) layers do not go all the way to the blade root (see figure 31).
 - 6) There are three large areas of voids in and between the unidirectional carbon (circ) layers and unidirectional carbon and glass (long) layers. Void area 1 is approximately 4.44 mm by 18.49 mm (see figures 32 and 35). Void area 2 is approximately 2.95 mm by 23.62 mm (see figures 33 and 35). Void area 3 consists of several voids of varying size (1.50 mm by 7.82 mm to 2.09 mm by 1.58 mm and mostly occupy the unidirectional carbon and glass (long) layers (see figures 34 and 35).
 - 7) For the unidirectional carbon and glass (long) layers, there were some voids or low density areas visible between the carbon fibers (see figures 36 and 37).
 - 8) There were two significant voids noted between the unidirectional carbon and glass (long) layers and the woven glass layers (see figures 38 thru 40).
 - 9) The woven glass layers are broken and portions missing on opposite sides of the propeller (see figures 41 and 42).
 - 10) The woven carbon fiber layers are broken and portions missing on opposite sides of the propeller. (see figures 43 and 44).

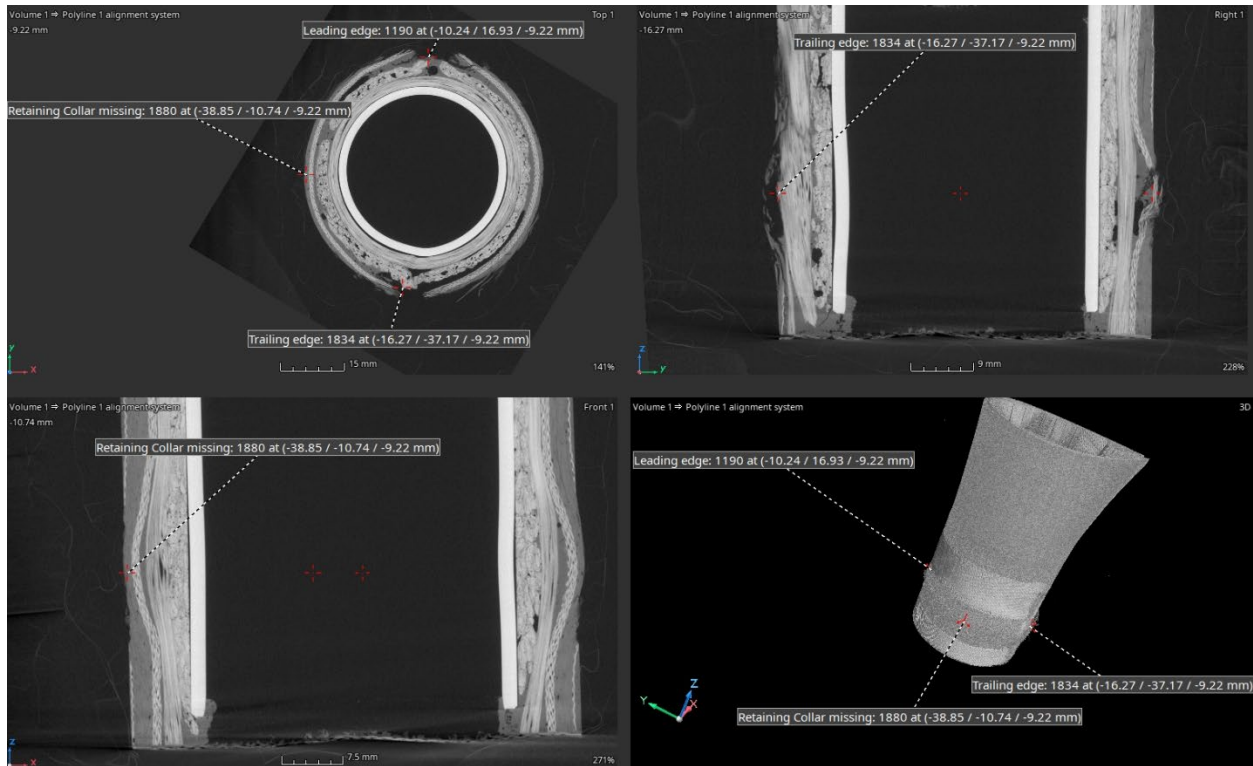


Figure 22. CT images of the accident propeller blade root - overview.

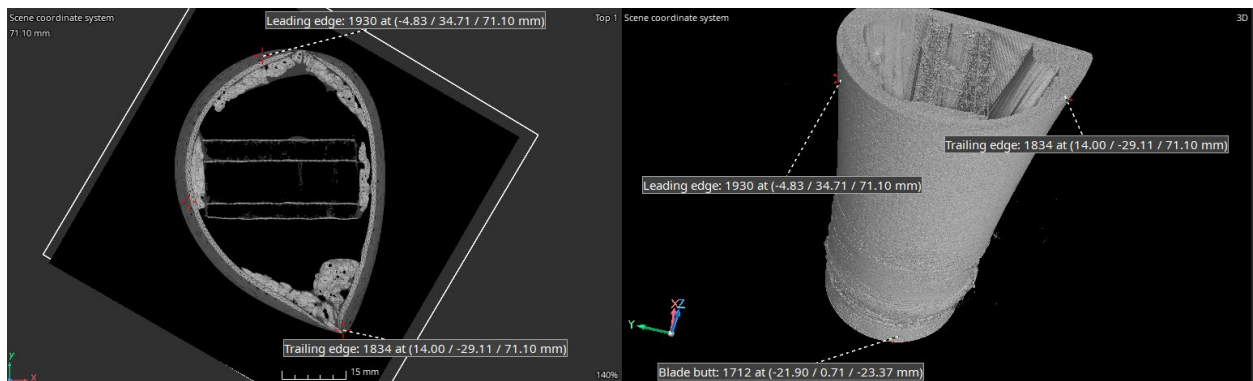


Figure 23. CT images of the accident propeller blade root - showing the leading and trailing edges.



Figure 24. CT images of the accident propeller blade root showing SN 6410 at the blade butt.

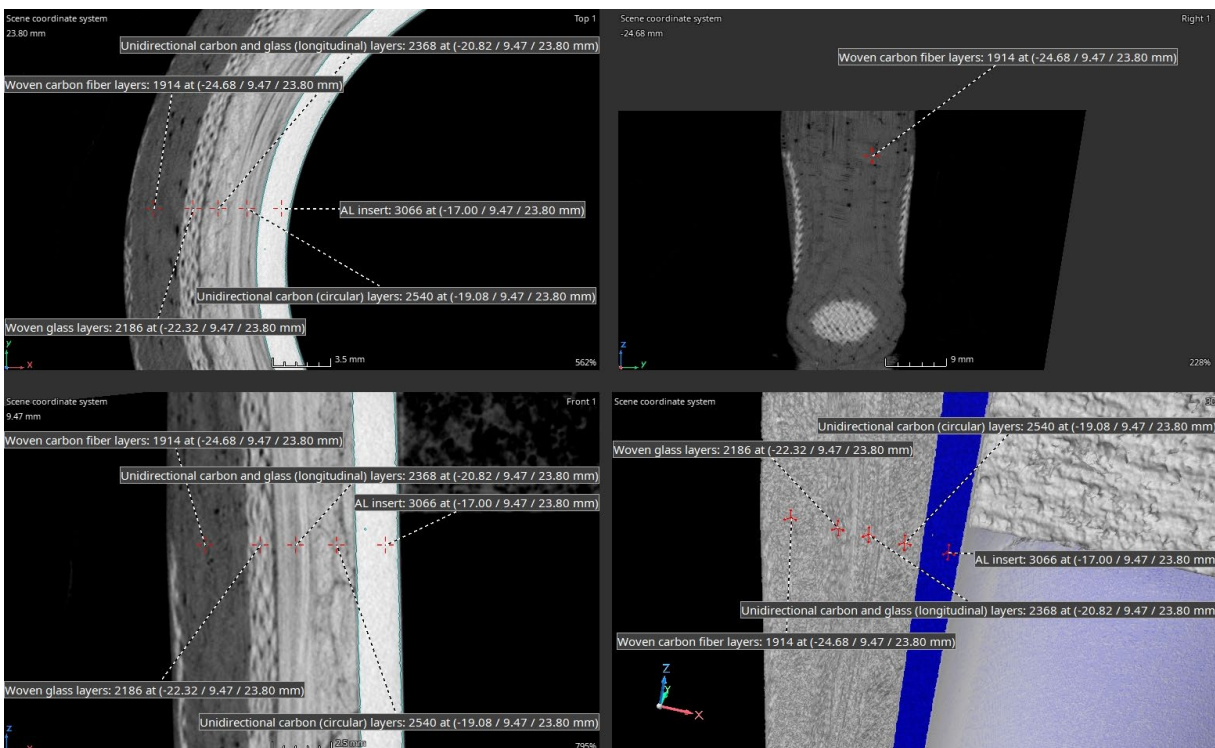


Figure 25. CT images of the accident propeller blade root showing the cross section.

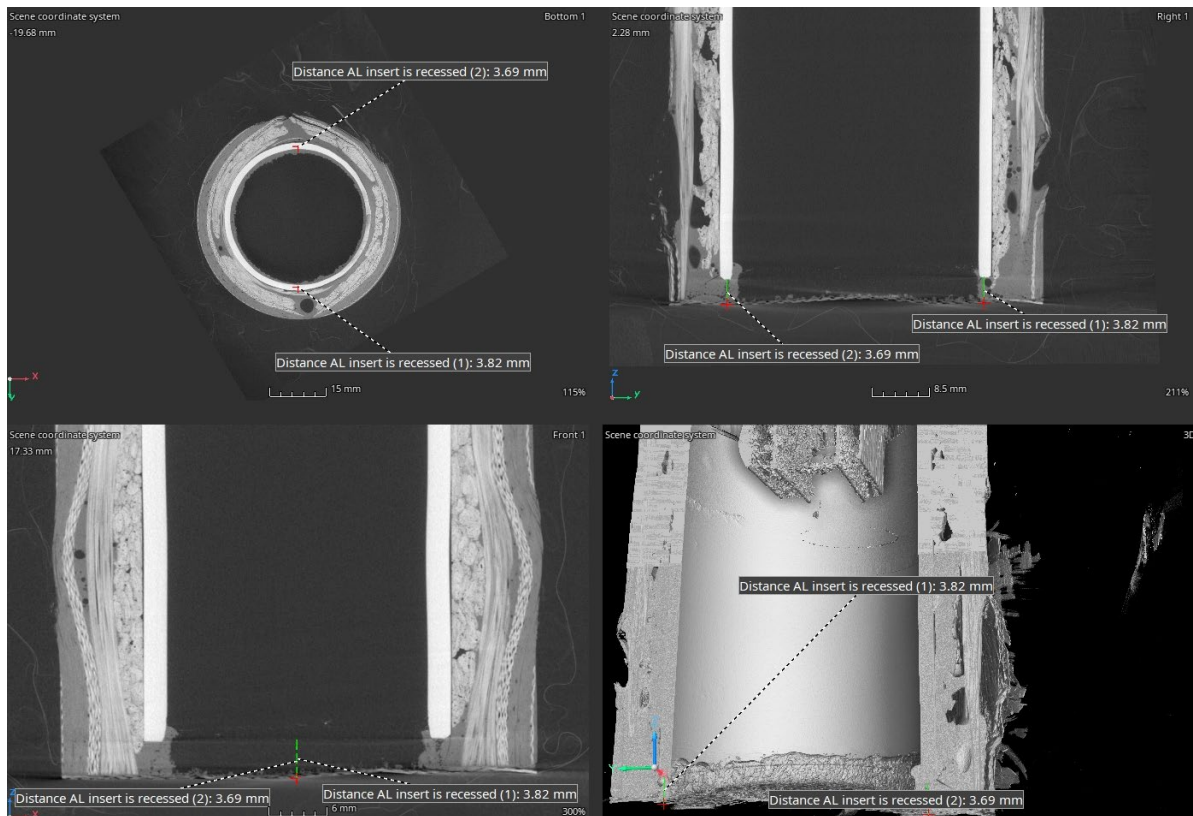


Figure 26. CT images of the accident propeller blade root - aluminum insert at blade butt.

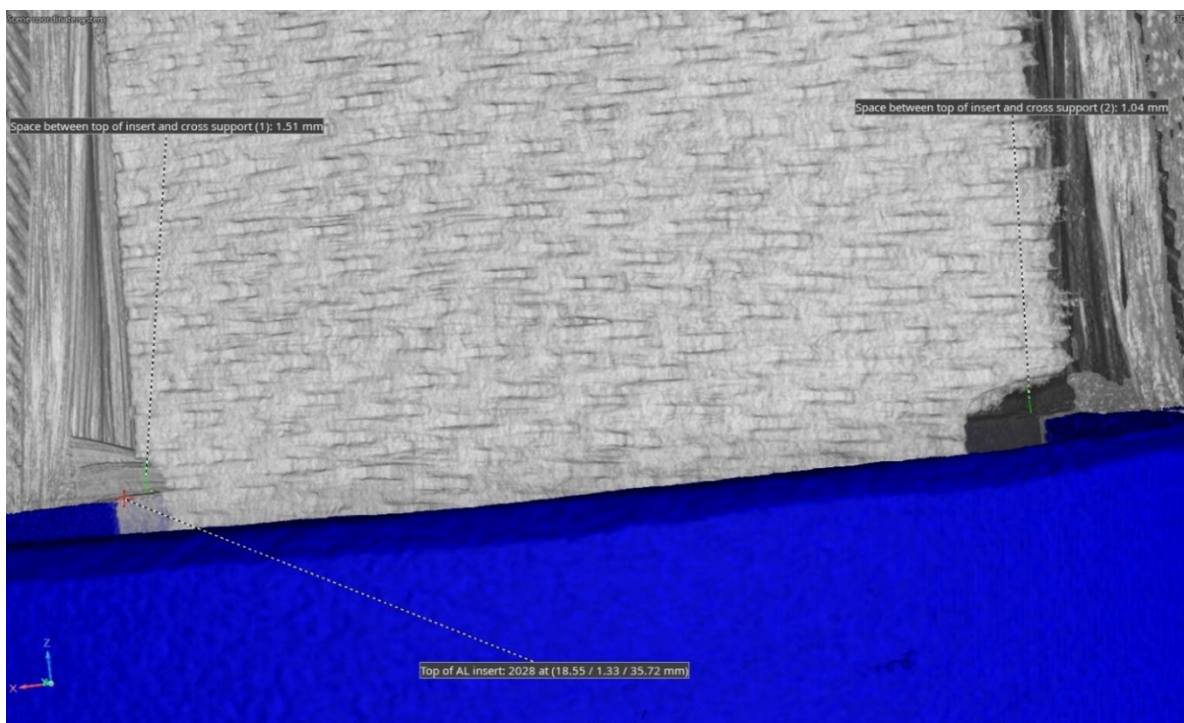


Figure 27. CT image of the accident propeller blade root - aluminum insert inside blade showing the gap between the cross support and the top of the insert.

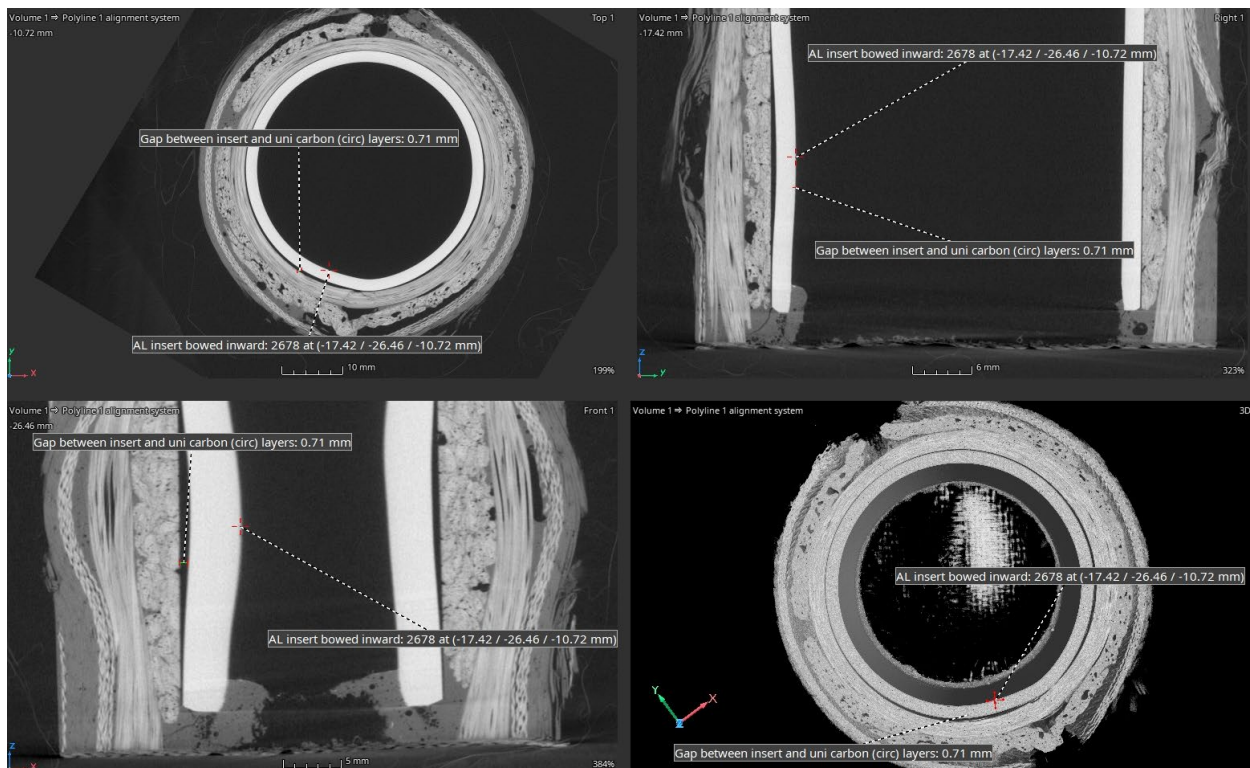


Figure 28. CT images of the exemplar propeller blade root - aluminum insert bowed inward.

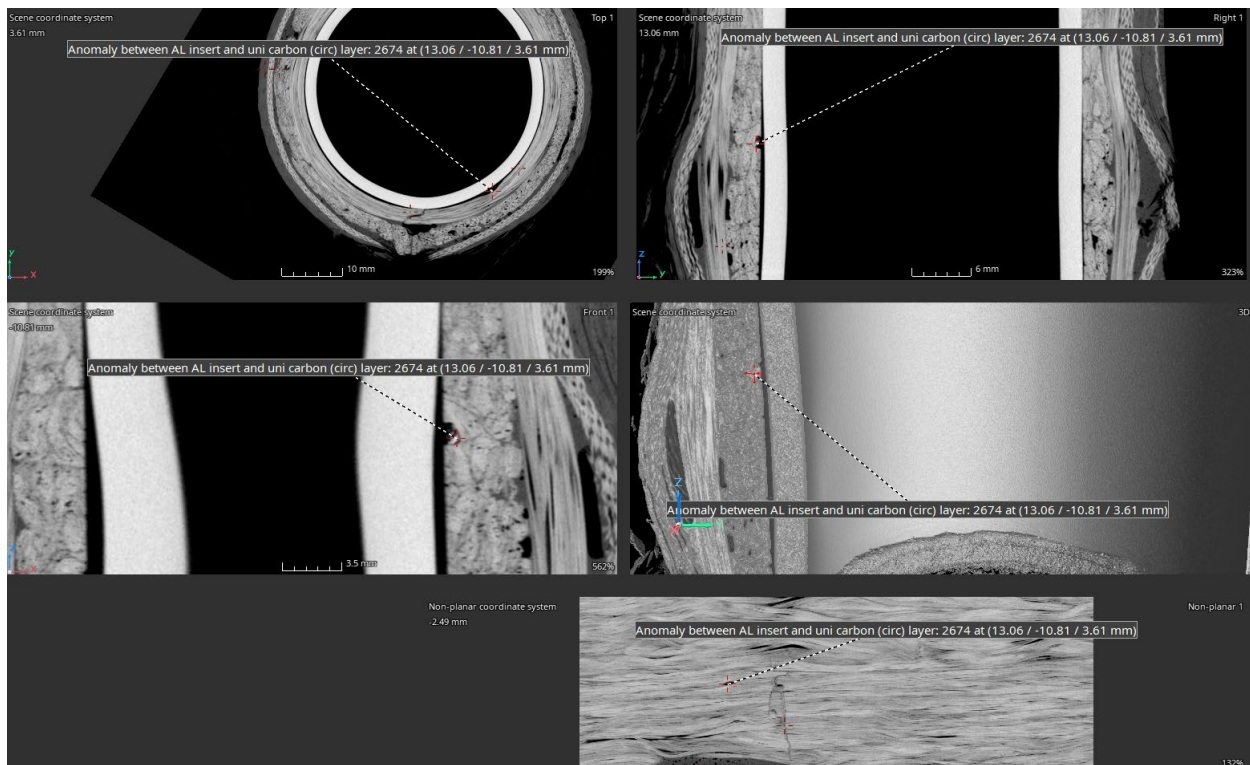


Figure 29. CT images of the accident propeller blade root - anomaly between unidirectional carbon layers (circ) and aluminum insert.

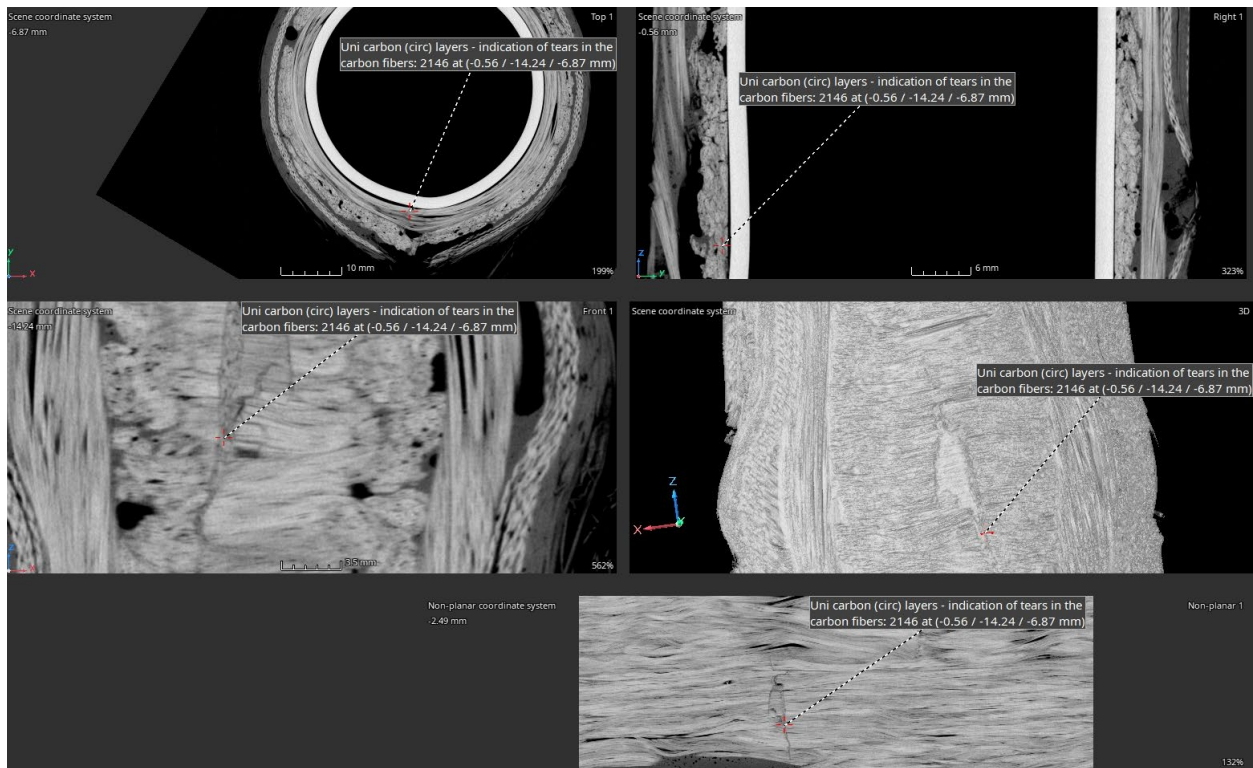


Figure 30. CT images of the accident propeller blade root - indications of tears in the unidirectional carbon (circ) material.

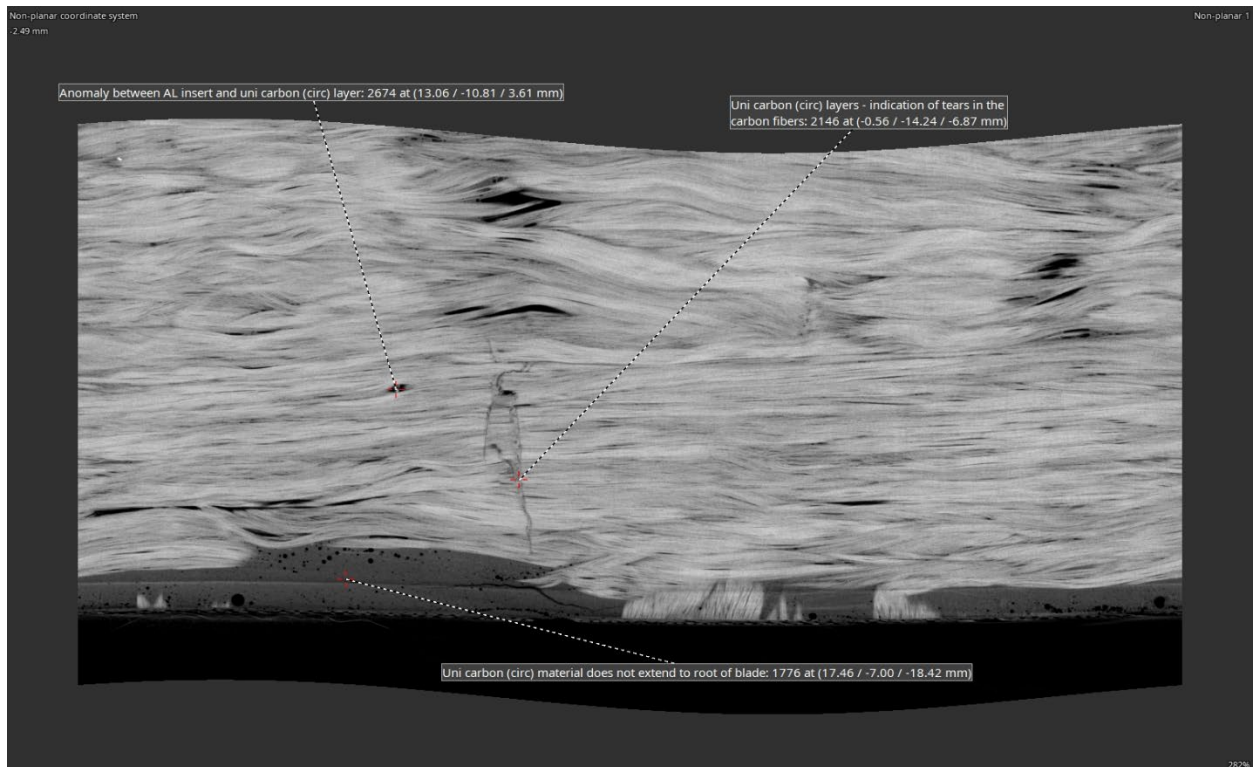


Figure 31. CT image of the accident propeller blade root -unidirectional carbon (circ) layers unrolled.

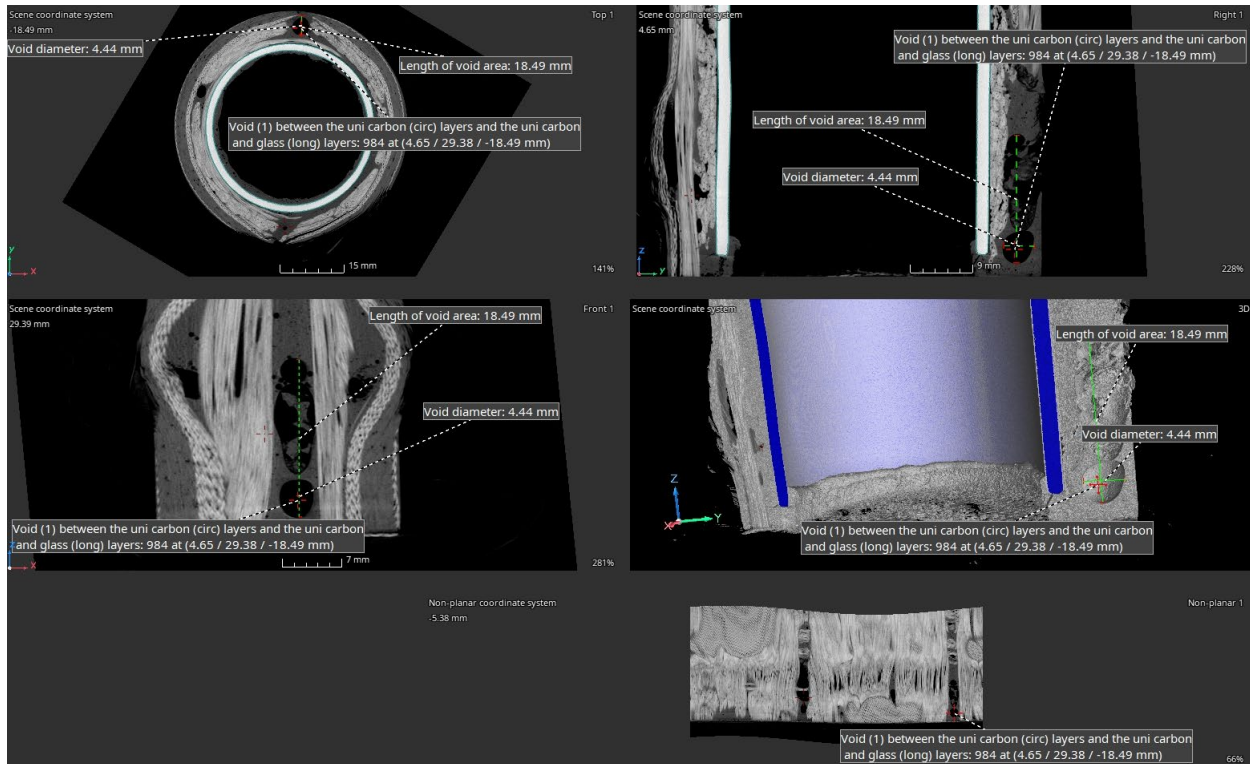


Figure 32. CT images of the accident propeller blade root - void area 1 in unidirectional carbon (circ) layers and unidirectional carbon and glass (long) layers.

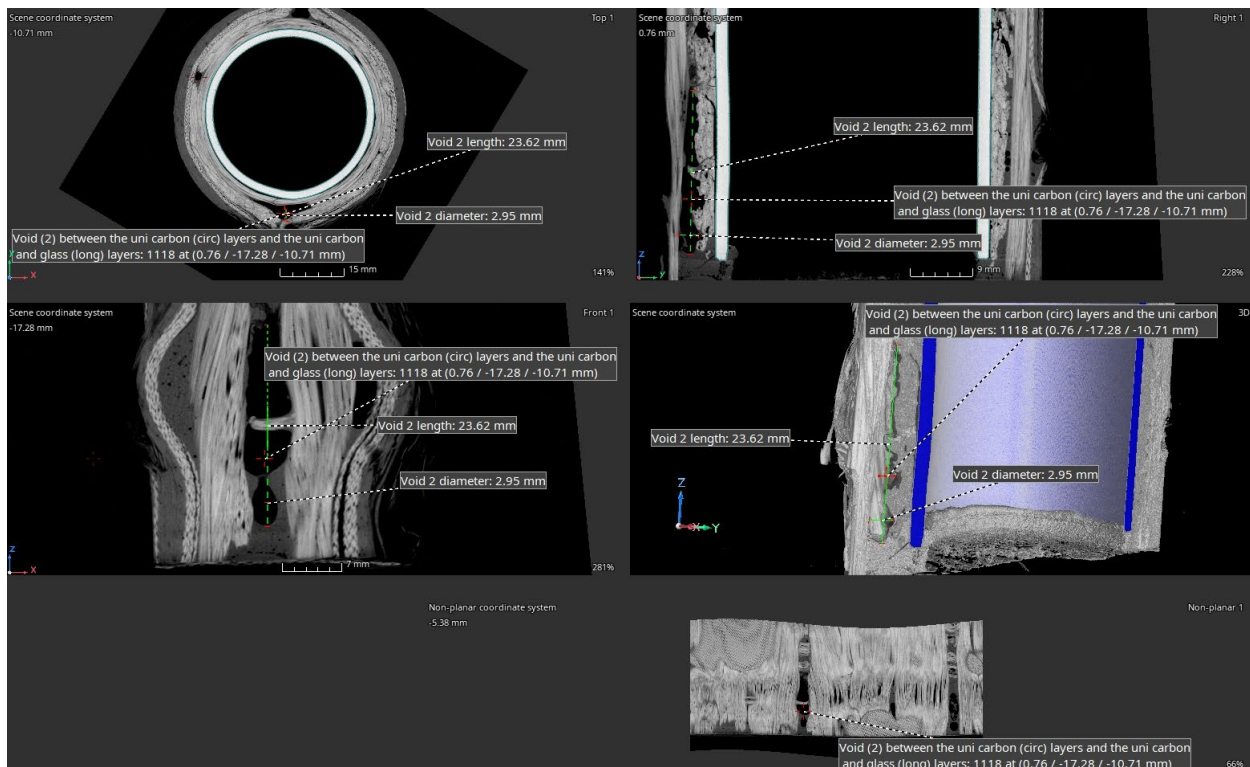


Figure 33. CT images of the accident propeller blade root - void area 2 in unidirectional carbon (circ) layers and unidirectional carbon and glass (long) layers.

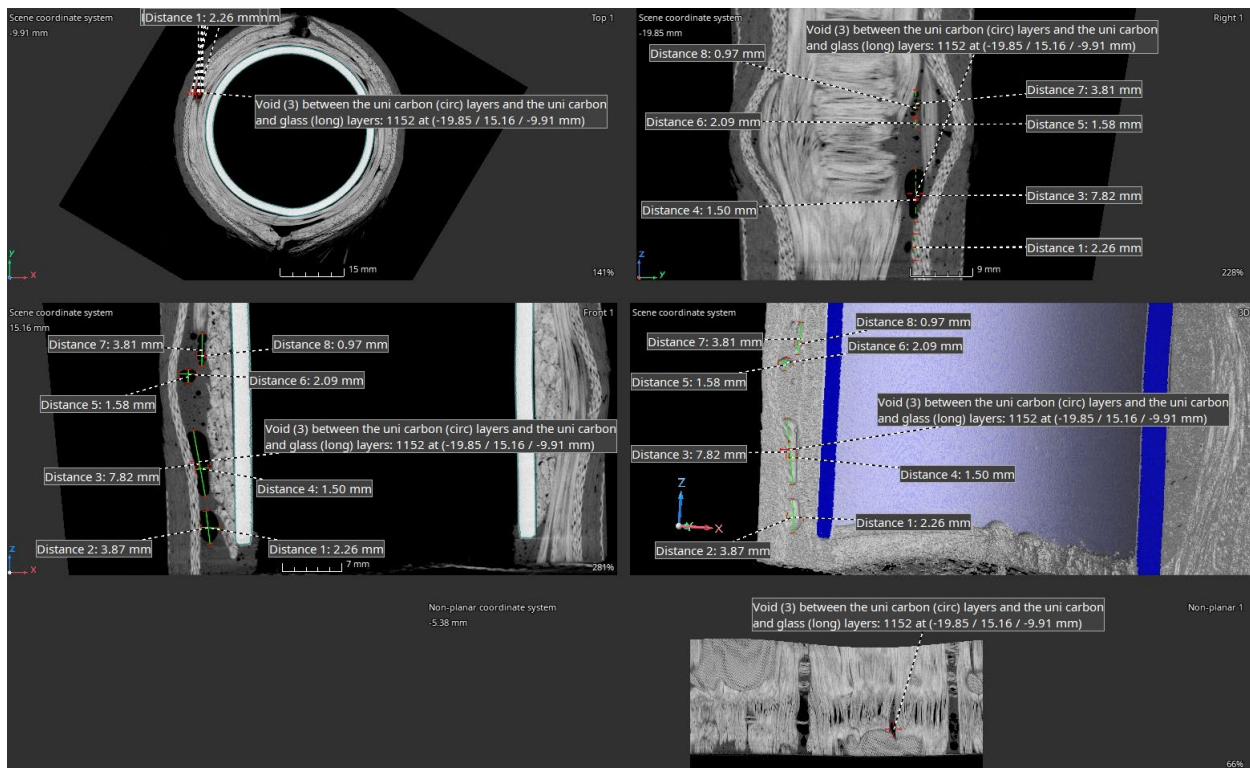


Figure 34. CT images of the accident propeller blade root - void area 3 in unidirectional carbon (circ) layers and unidirectional carbon and glass (long) layers.

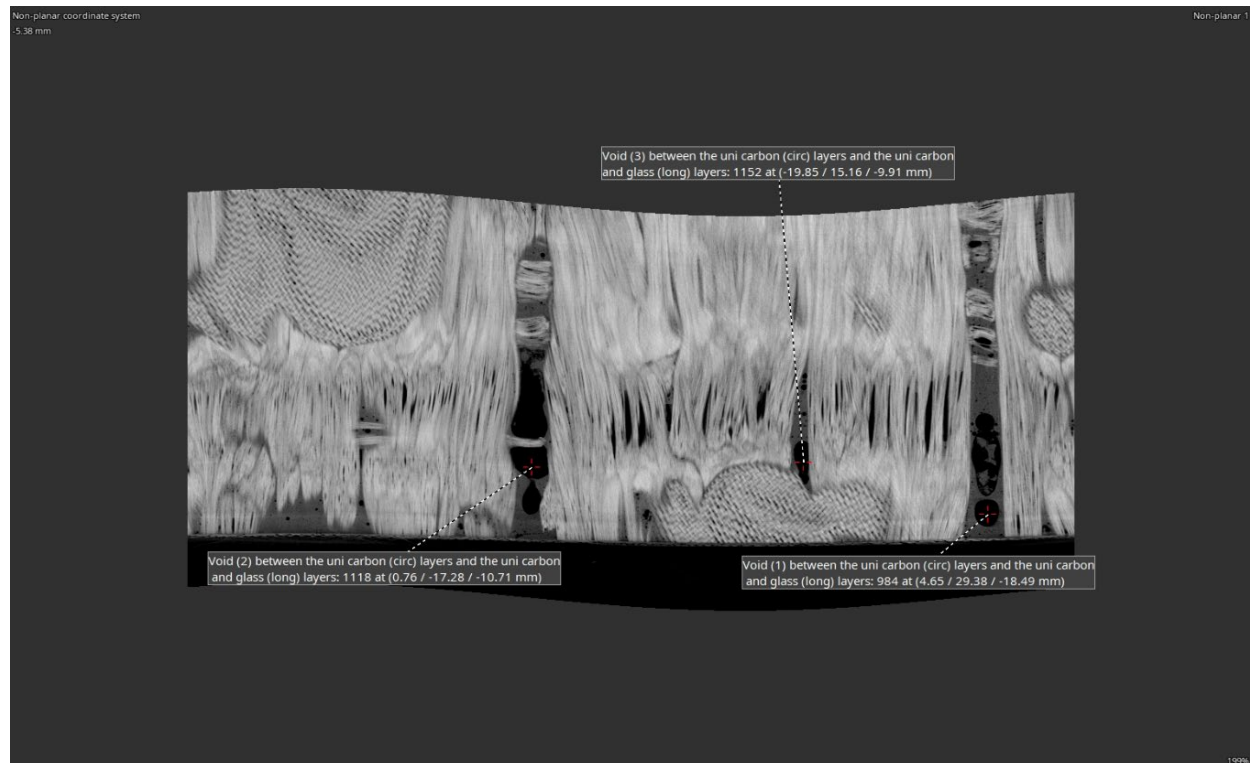


Figure 35. CT image of the accident propeller blade root - unidirectional carbon (circ) layers and unidirectional carbon and glass (long) layers unrolled.

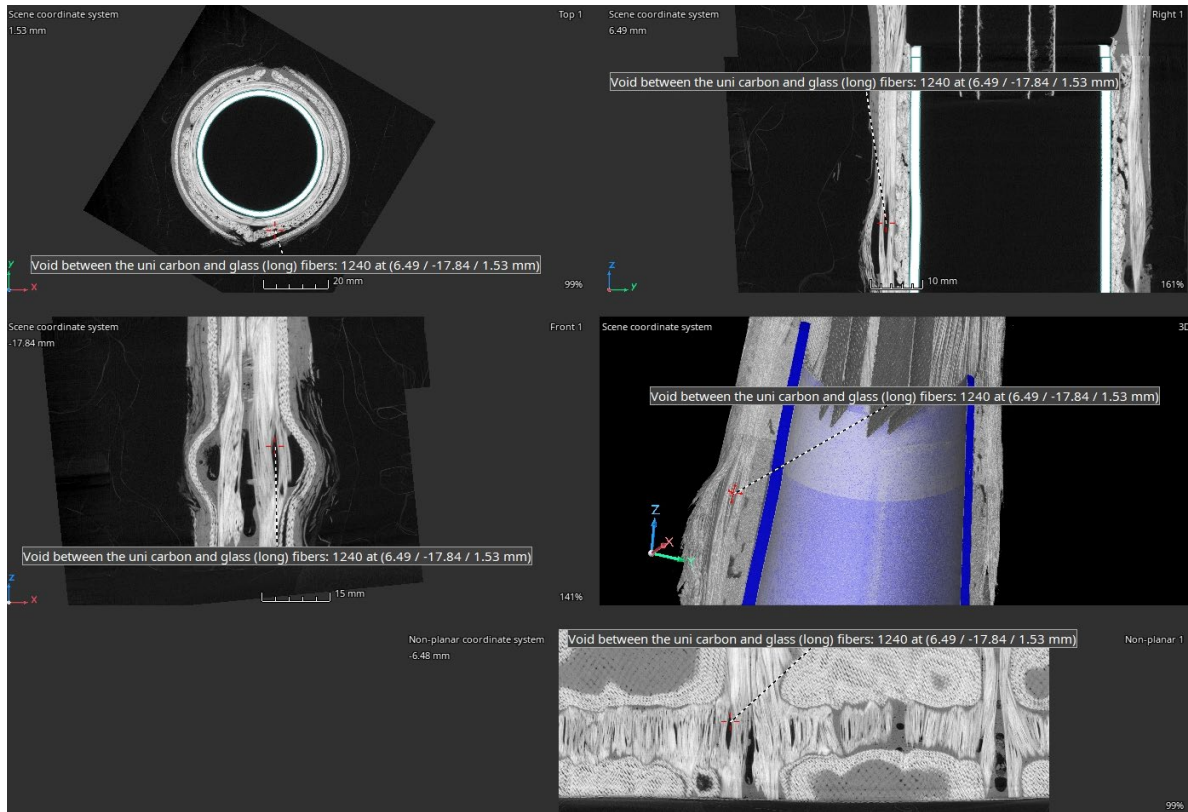


Figure 36. CT images of the accident propeller blade root - void between unidirectional carbon and glass (long) layers.

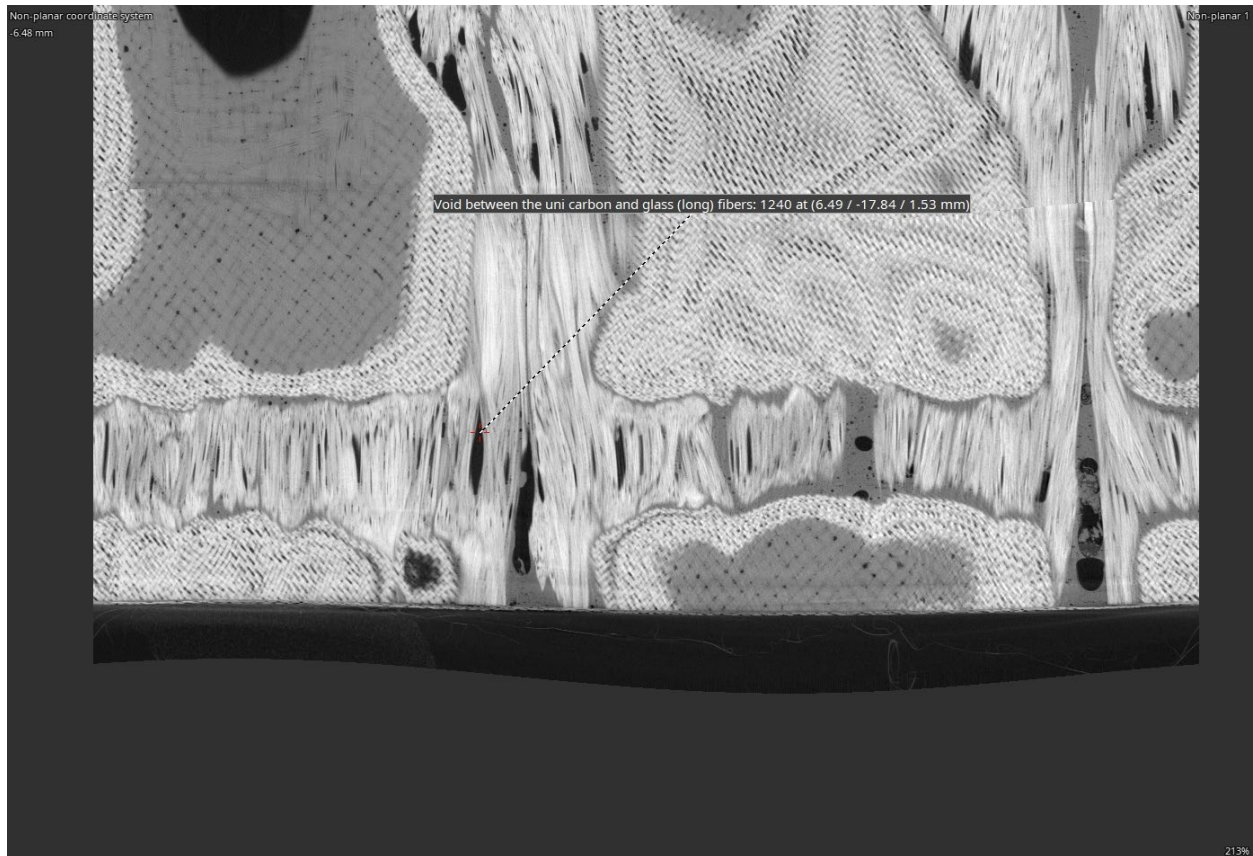


Figure 37. CT image of the accident propeller blade root - void between the unidirectional carbon and glass (long) layers unrolled.

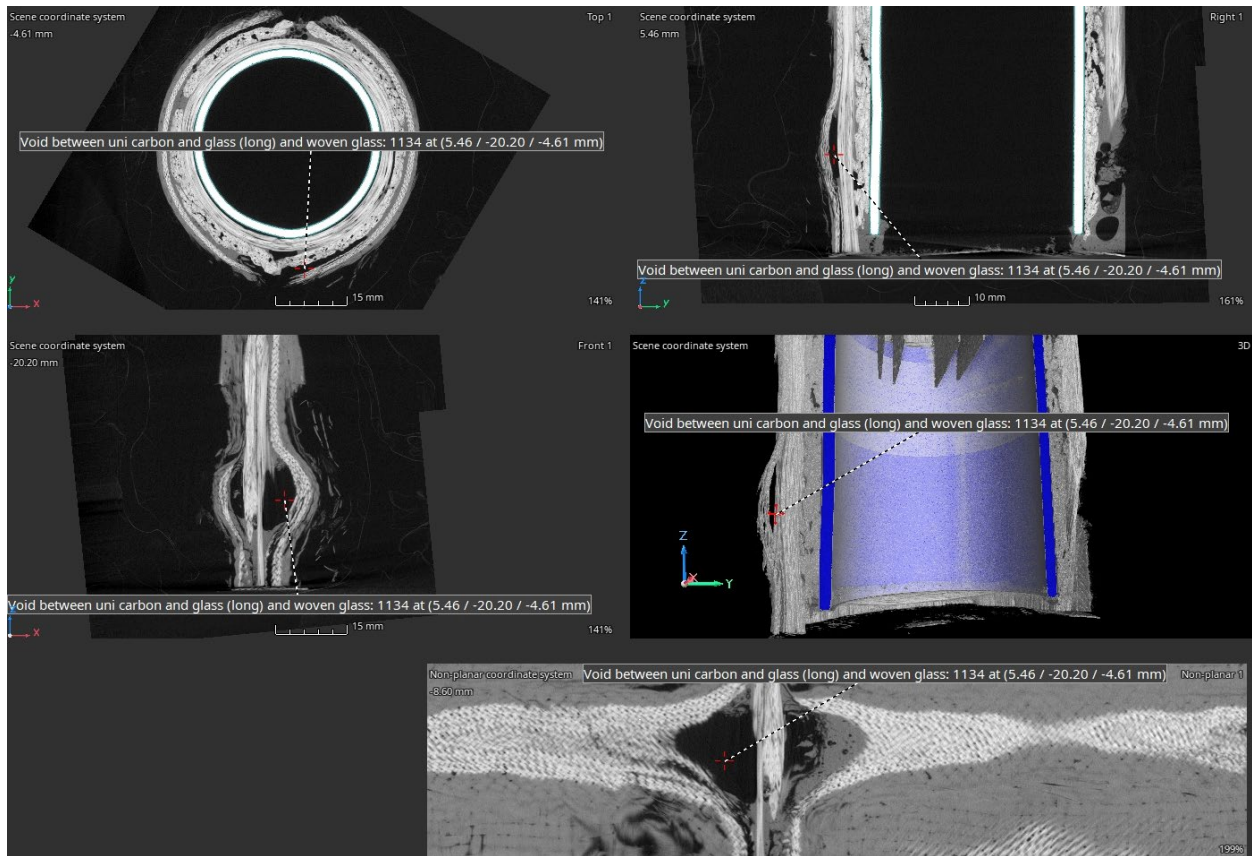


Figure 38. CT images of the accident propeller blade root - void 1 between unidirectional carbon and glass (long) layers and the woven glass layers.

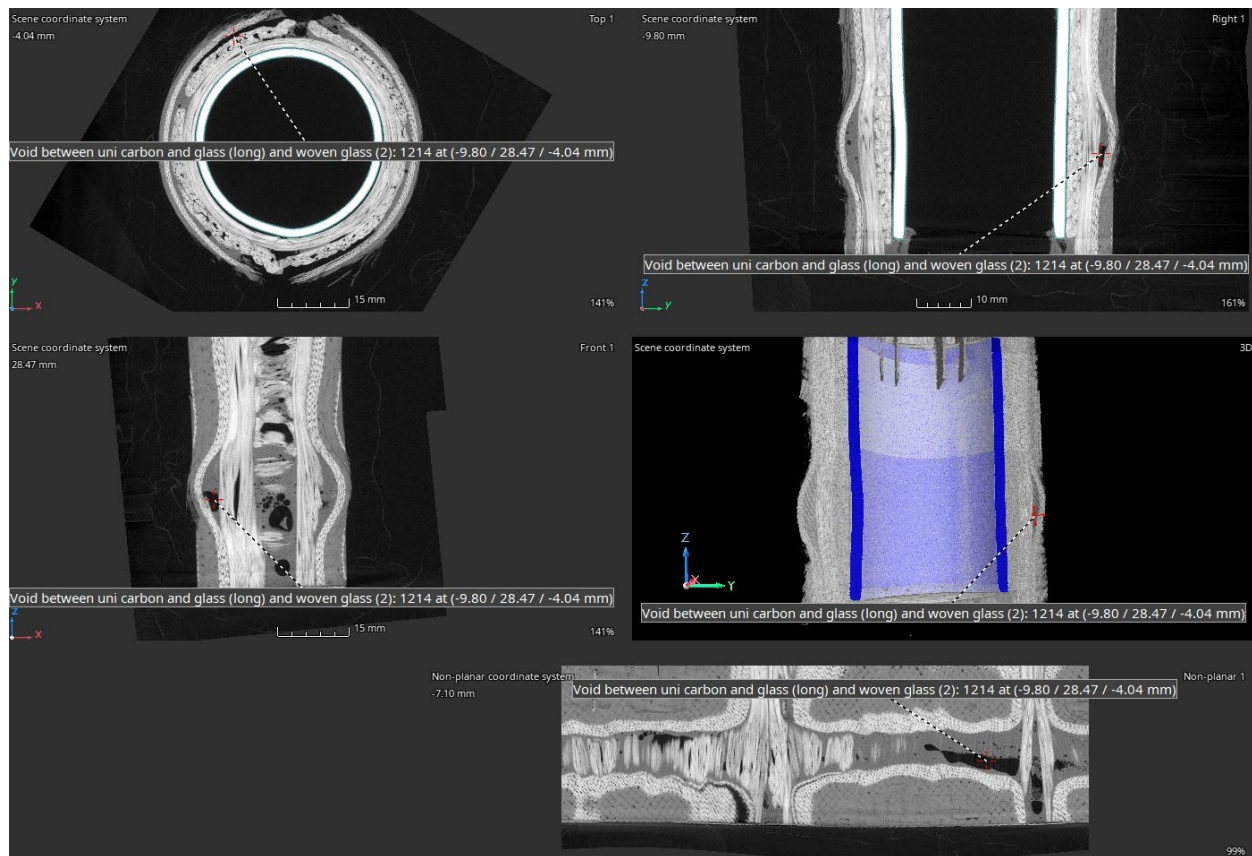


Figure 39. CT images of the accident propeller blade root - void 2 between unidirectional carbon and glass (long) layers and woven glass layers.

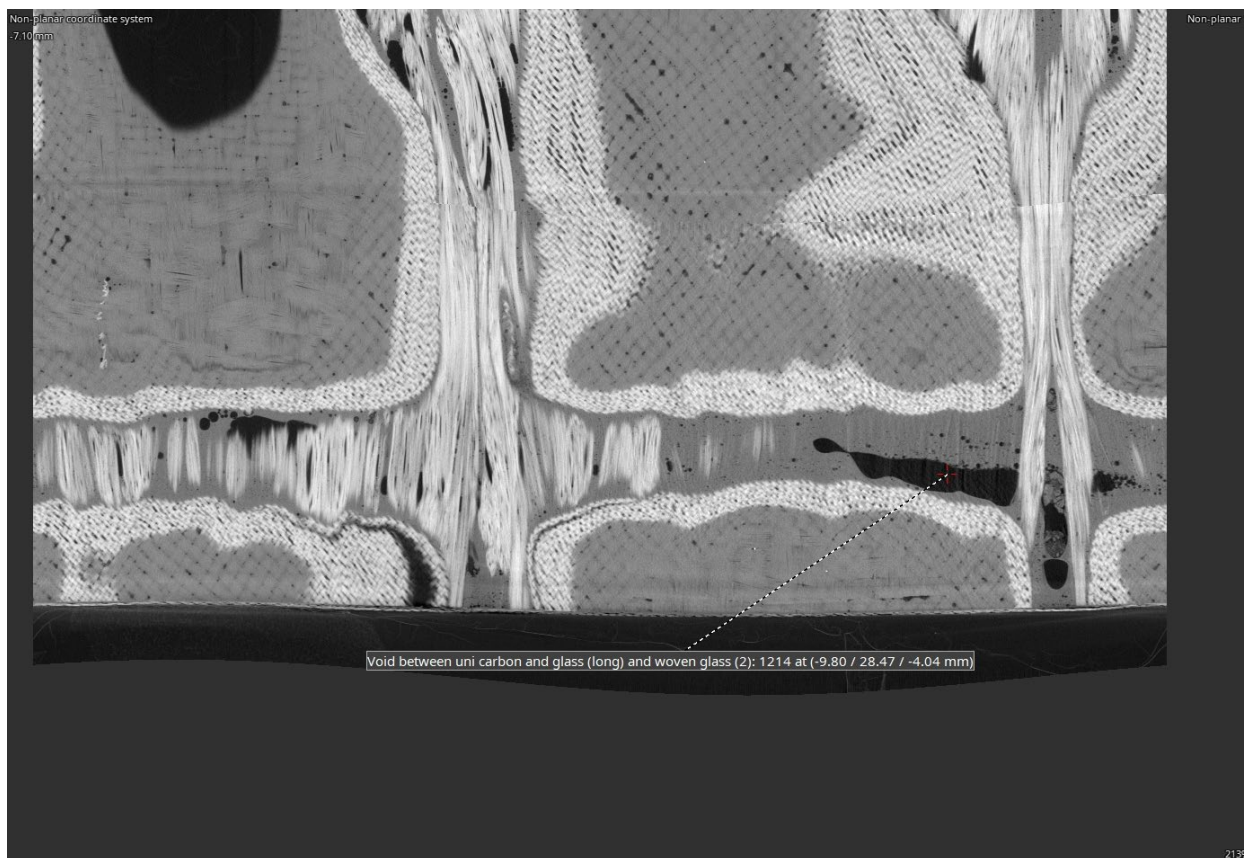


Figure 40. CT image of the accident propeller blade root - void 2 between unidirectional carbon and glass (long) layers and woven glass layers unrolled.

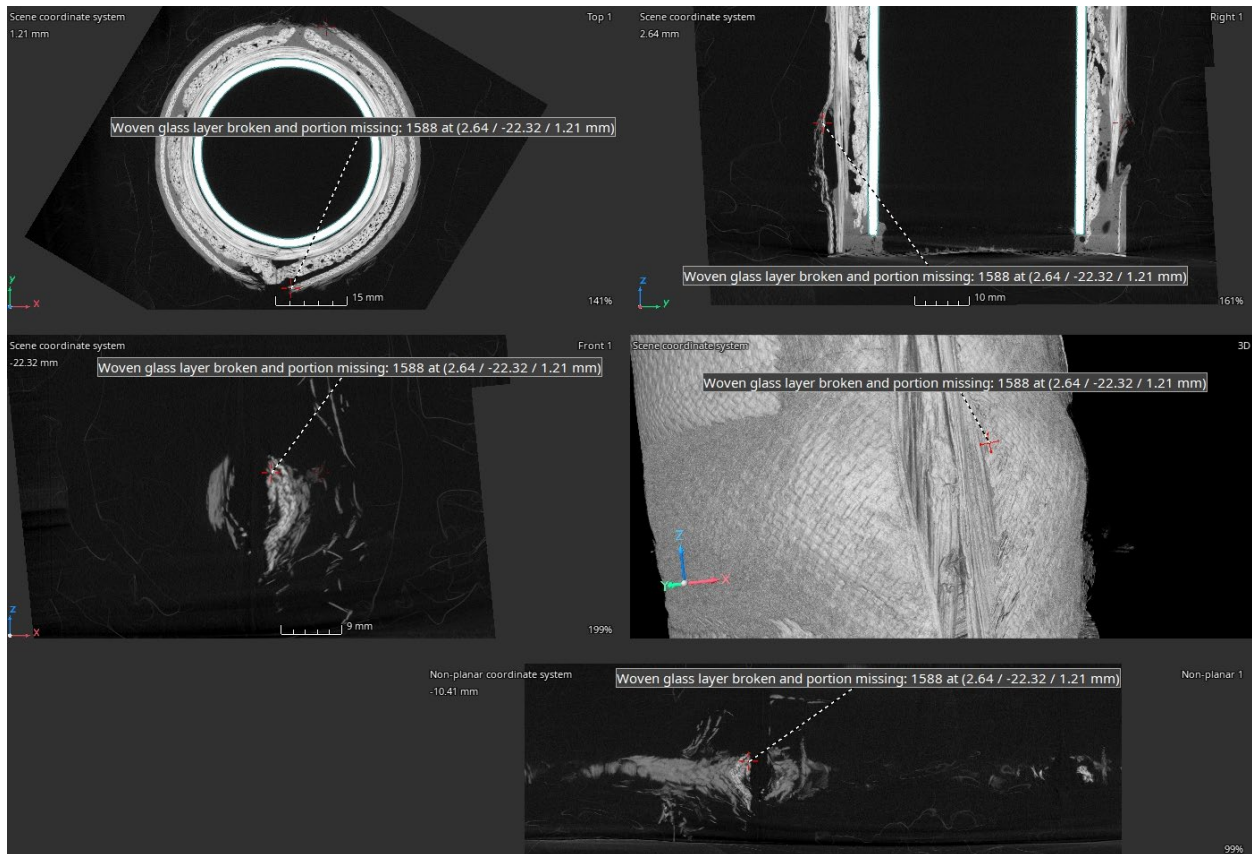


Figure 41. CT images of the accident propeller blade root - area 1 of broken woven glass layers.

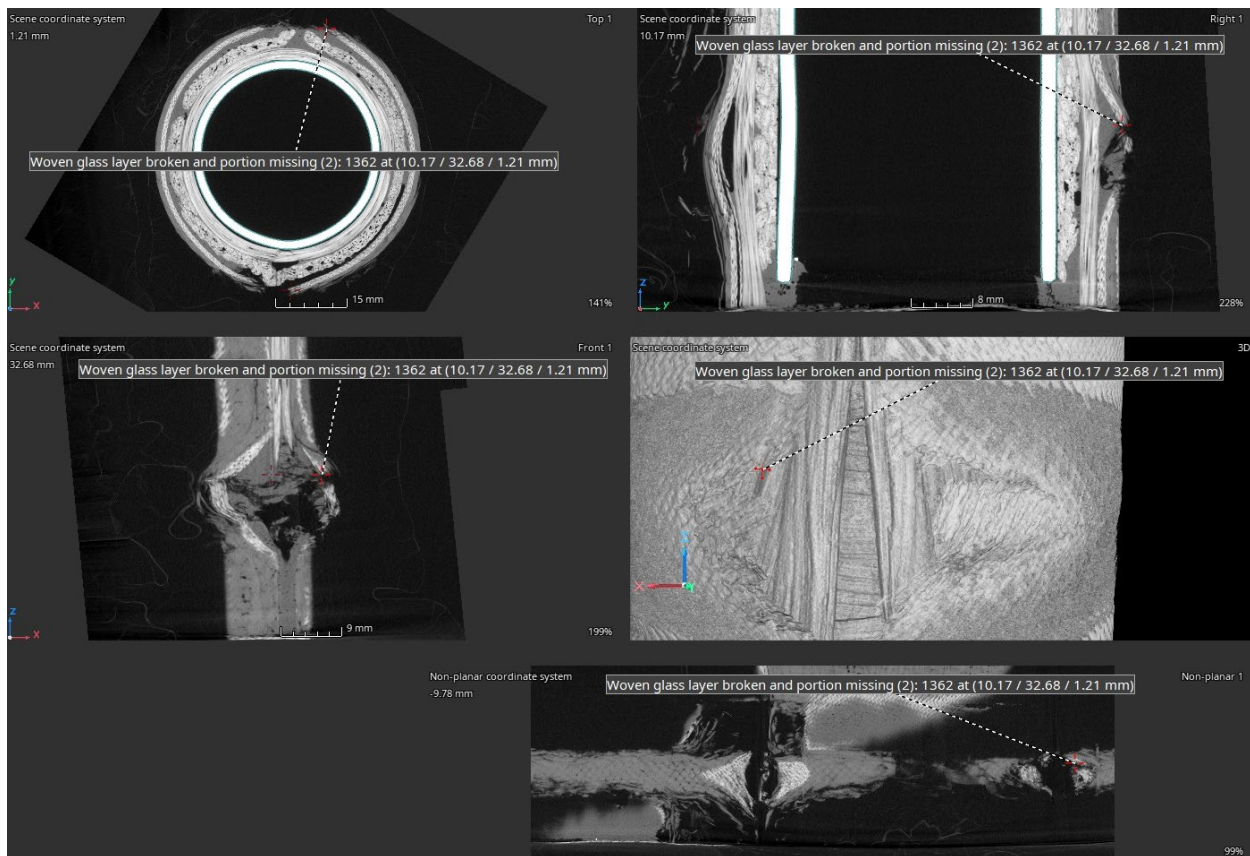


Figure 42. CT images of the accident propeller blade root - area 2 of broken woven glass layers.

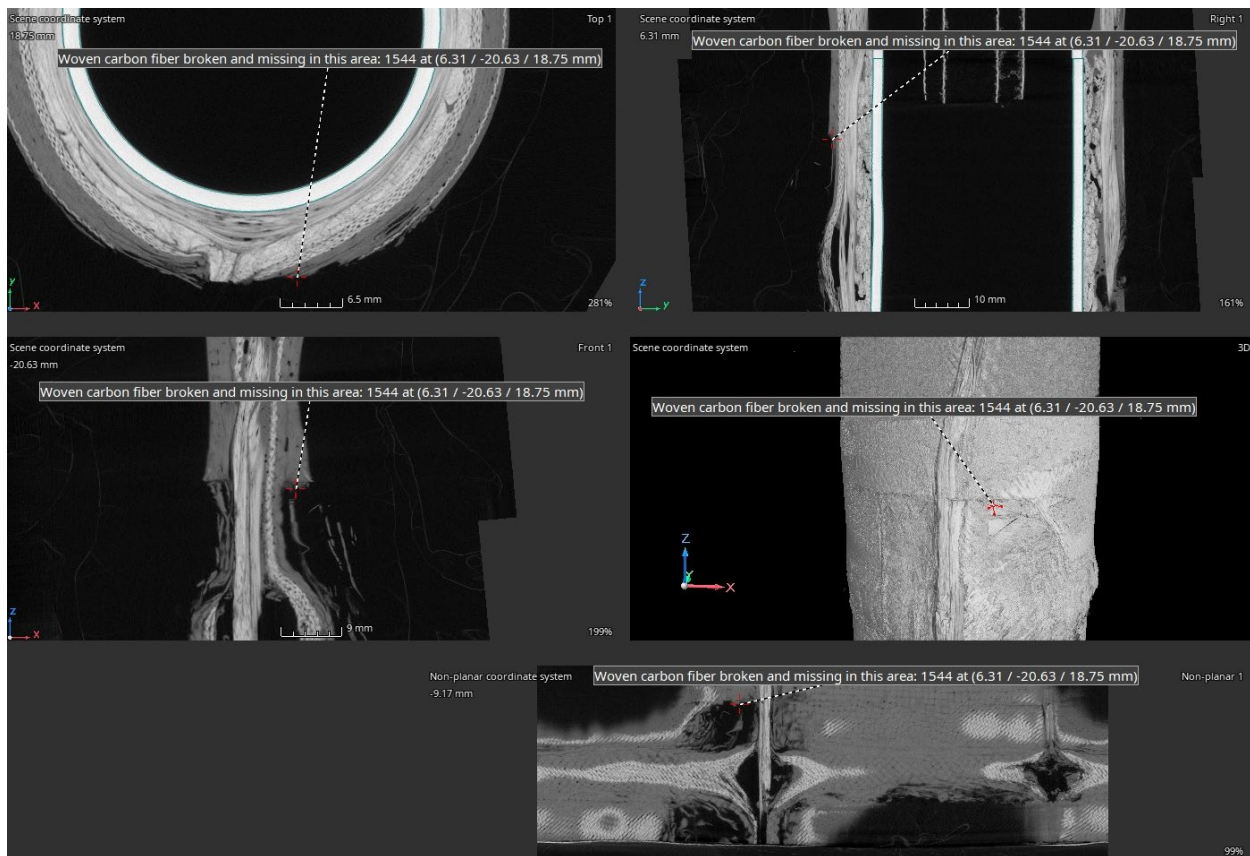


Figure 43. CT images of the accident propeller blade root - area 1 of broken and missing woven carbon fiber layers.

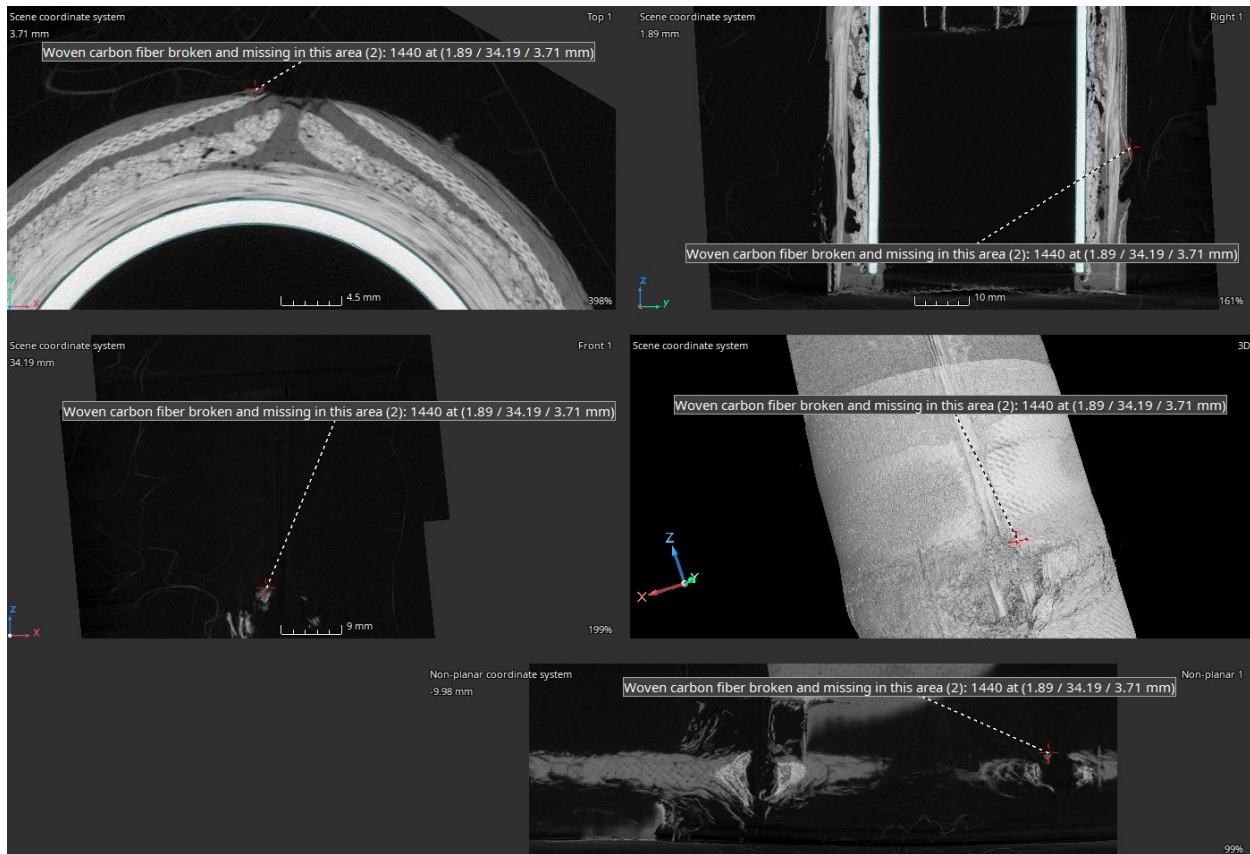


Figure 44. CT images of the accident propeller blade root - area 2 of broken and missing woven carbon fiber layers.

Submitted by:

John Flynn
Computed Tomography Specialist