

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



CEN23FA071

COMPUTED TOMOGRAPHY

Specialist's Factual Report

July 21, 2023

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A. ACCIDENT

Location: Galliano, Louisiana
Date: December 29, 2022
Time: 0834 central standard time
1434 coordinated universal time (UTC)
Helicopter: Bell 407; Registration: N595RL

B. COMPUTED TOMOGRAPHY SPECIALIST

Specialist John Flynn
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C. DETAILS OF THE INVESTIGATION

1.0 General

The lateral hydraulic actuator from the accident helicopter was subjected to x-ray radiograph and computed tomography (CT) scanning to document its internal condition. The scanning was conducted on March 15 and 16, 2023, in Chicago, Illinois by Varex Imaging, Inc under the direction of the NTSB using the CST 9MV 4343 HE DRZ+ CT system.

For the CT scans, 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 (or region of interest of the part) 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 component was scanned using a total of 1,300 slices, and the total size of the combined data sets was approximately 1.75 GB. The complete scan protocols are given in table 1. The digital radiograph and CT axial slice images were provided by Varex to the NTSB where they were examined, processed, and analyzed to evaluate the component.

Table 1. Scan Protocol

	9MeV (Megavolt)
Number of slices	1300
Voxel ¹ Size - X Direction (millimeter(mm))	0.3
Voxel Size - Y Direction (mm)	0.3
Voxel Size - Z Direction (mm)	0.3
Image Projections per Revolution	2160
Exposure time (milliseconds)	1000
Frames to Avg (frames per projection)	1
X-ray Source Voltage (kilovolts)	9,000
X-ray Source Current (mA)	320 hz
Source Filter Thickness (mm)	31.5
Source Filter Material	copper
Image Matrix Size (pixels)	830 x 830

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 components 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 actuator structures 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.

The images of the components were examined for any signs of missing or damaged parts, contamination, or any other anomalies. Specific results (including example images) are presented in subsequent sections of this report.

¹ A voxel is a three-dimensional picture element (pixel).
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2.0 Computed Tomography Results

The CT results for the lateral hydraulic actuator are shown in Figures 1 through 13. Review of the images indicated that, when the scans were conducted, there were no indications of missing or broken components, blockages, or other abnormalities.

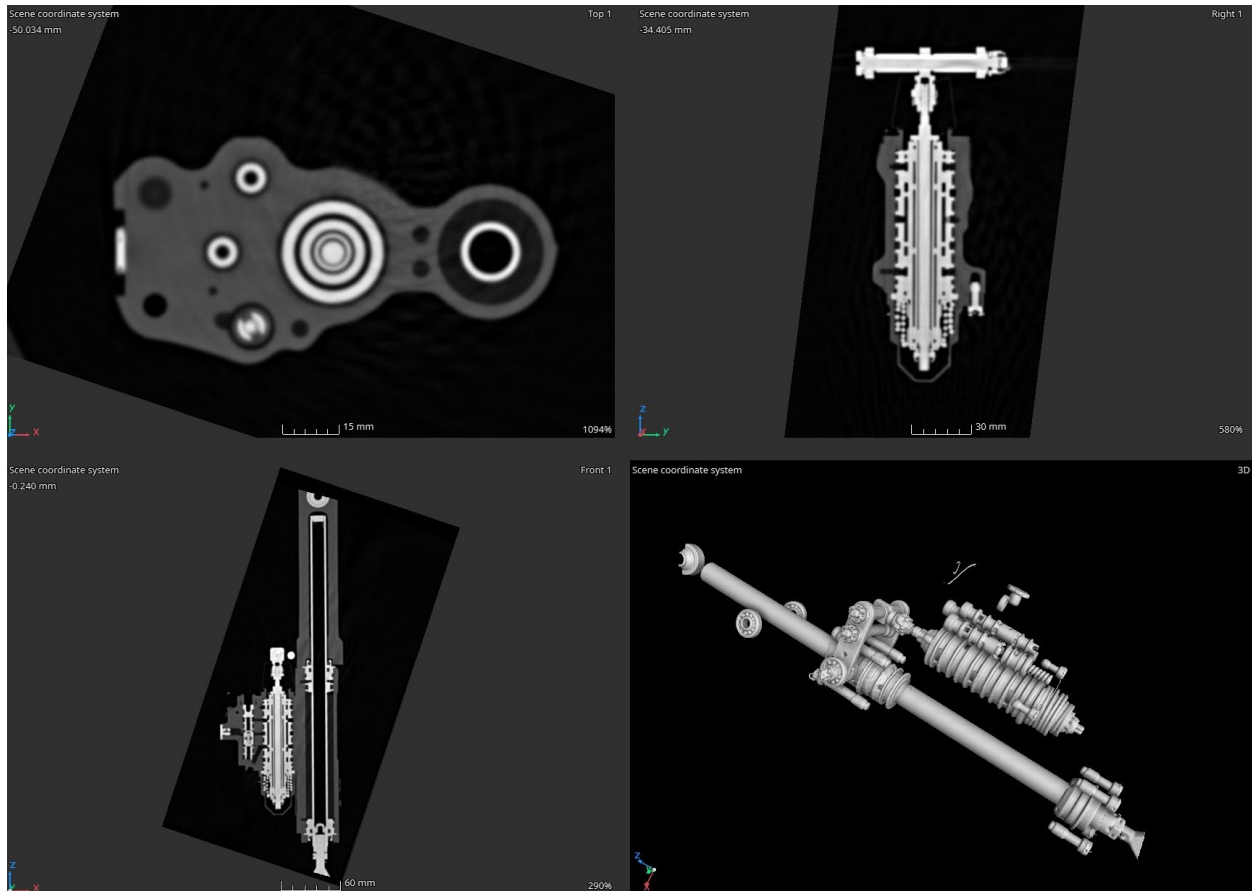


Figure 1. Lateral hydraulic actuator - overview.

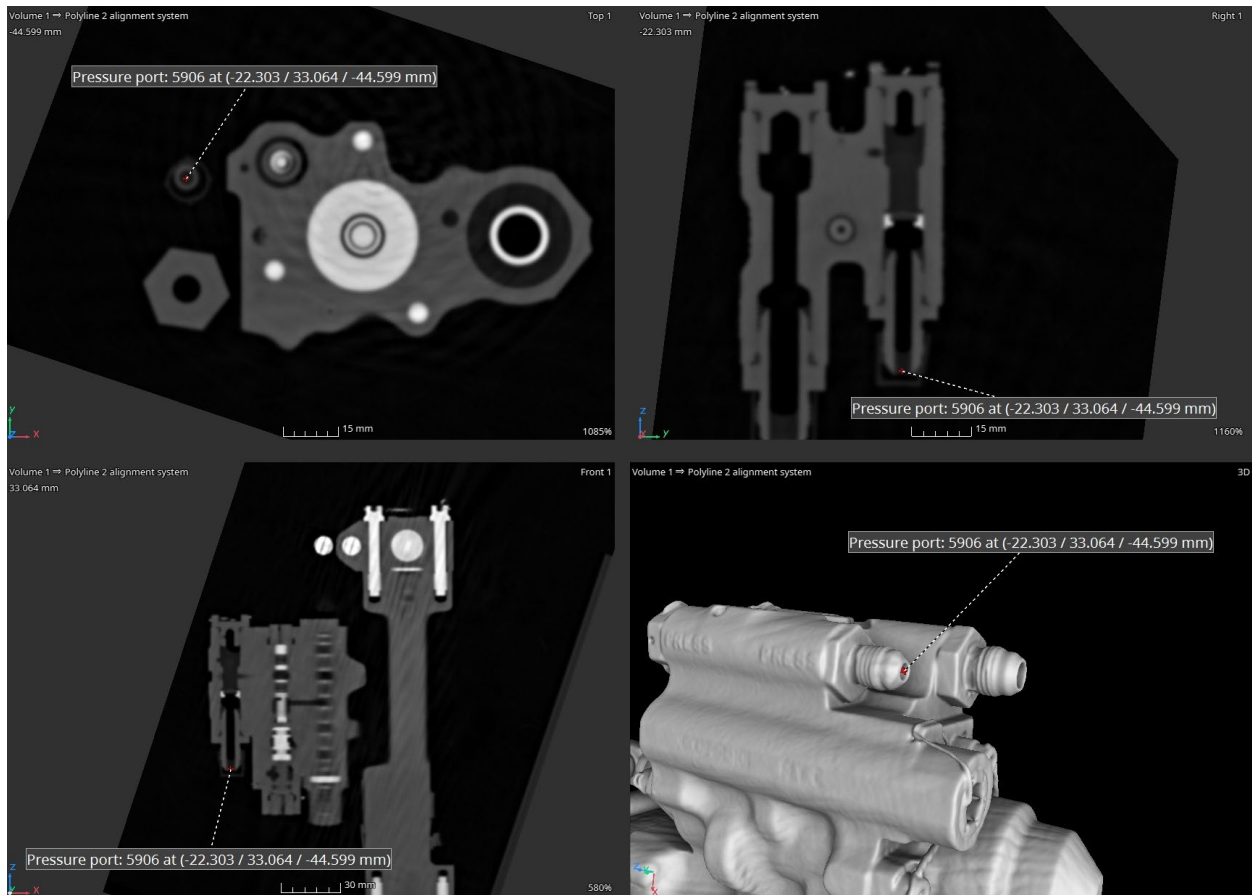


Figure 2. Lateral hydraulic actuator – pressure port.

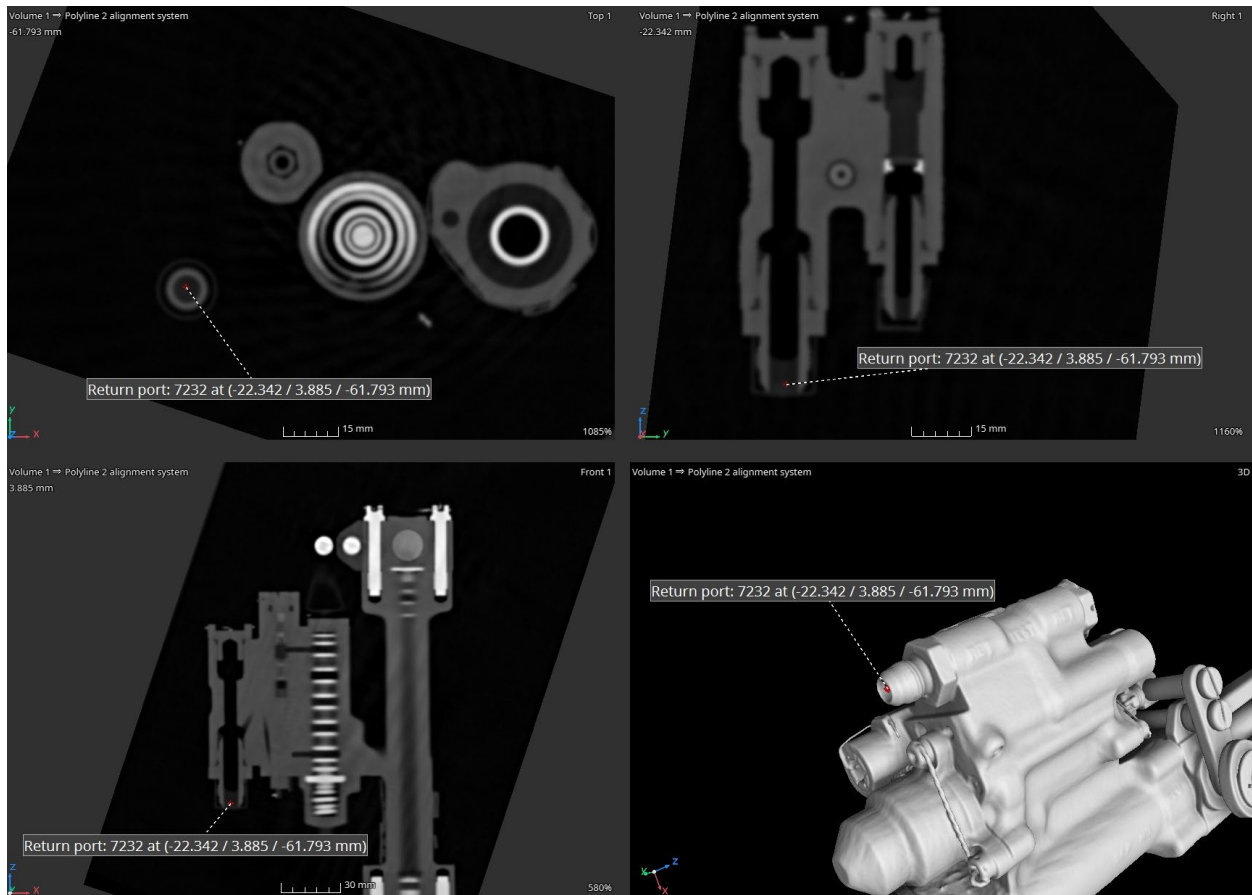


Figure 3. Lateral hydraulic actuator - return port.

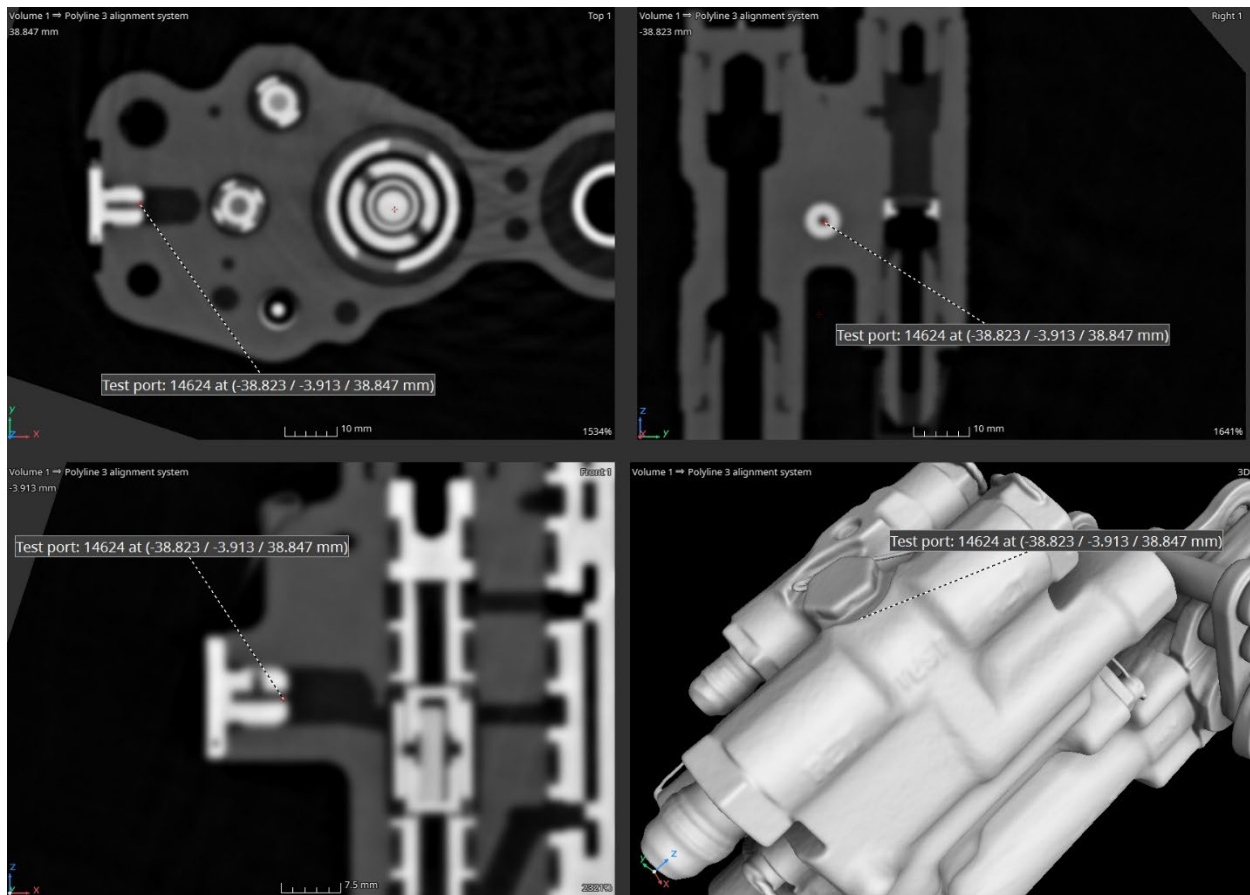


Figure 4. Lateral hydraulic actuator - test port.

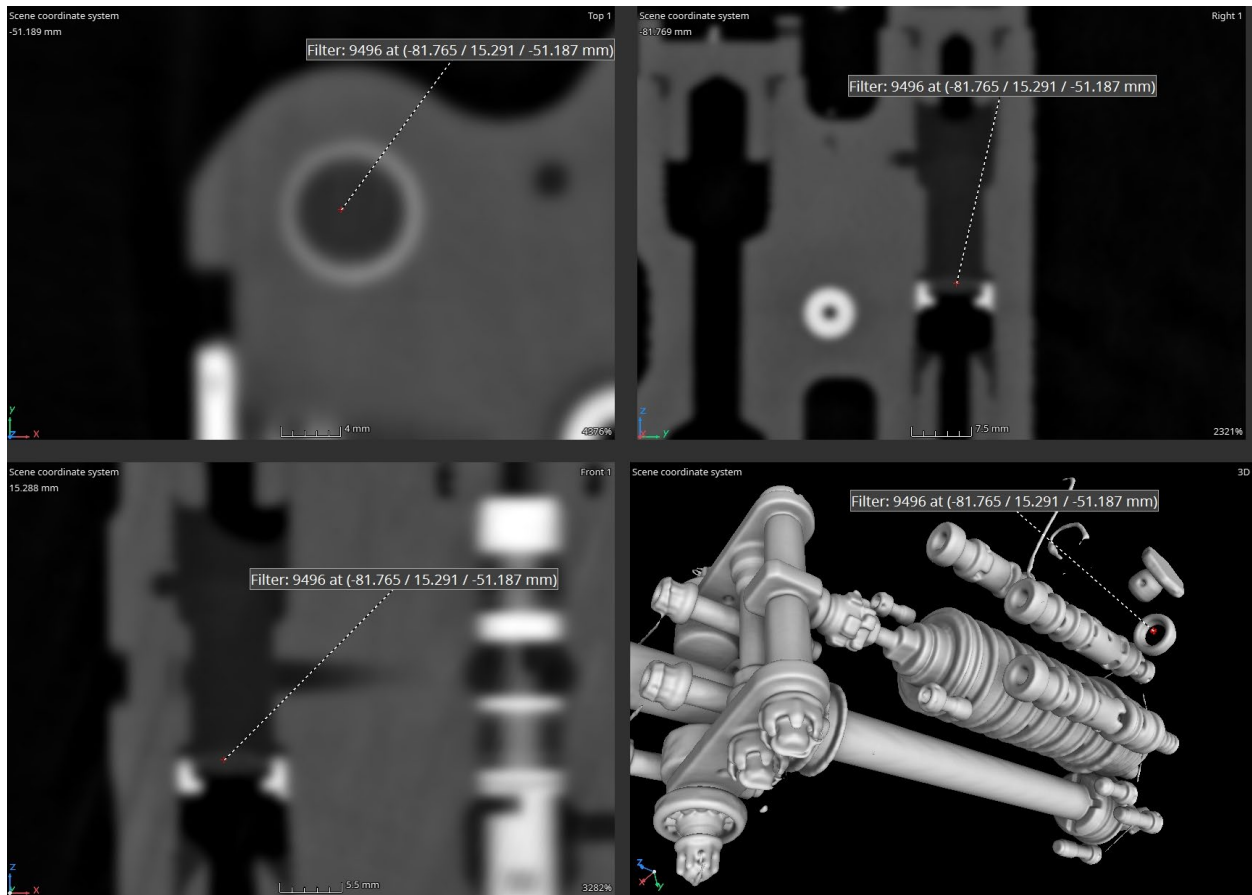


Figure 5. Lateral hydraulic actuator – pressure port filter screen.

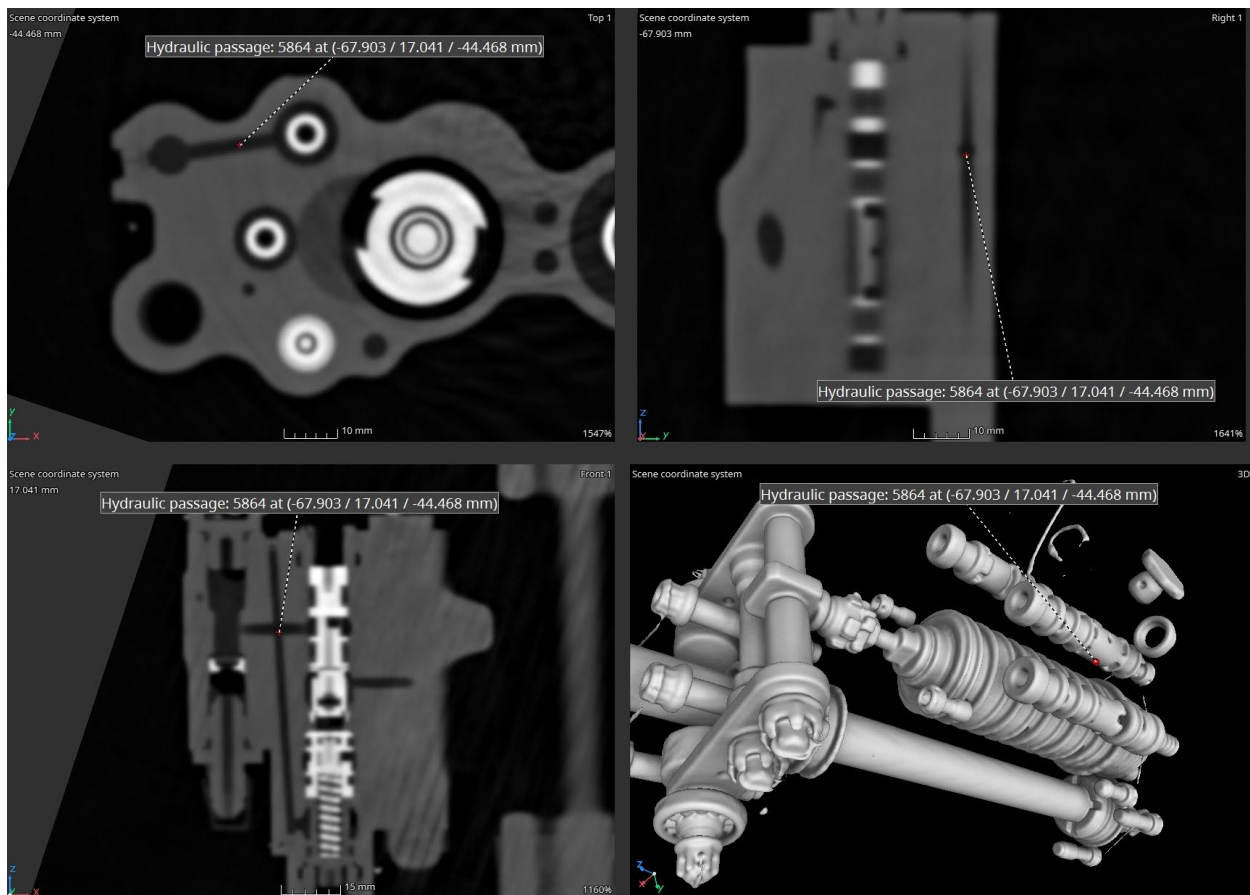


Figure 6. Lateral hydraulic actuator - hydraulic passage.

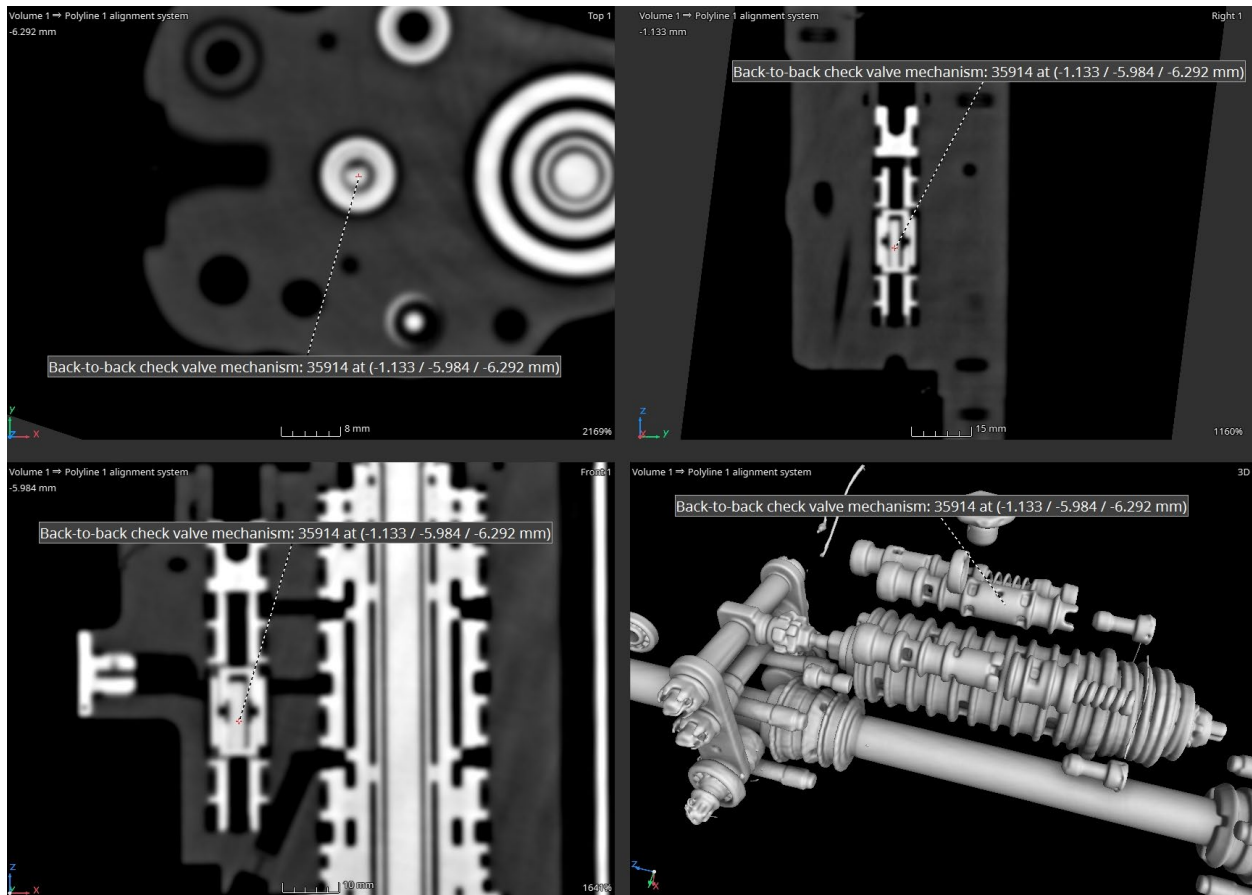


Figure 7. Lateral hydraulic actuator – back-to-back check valve.

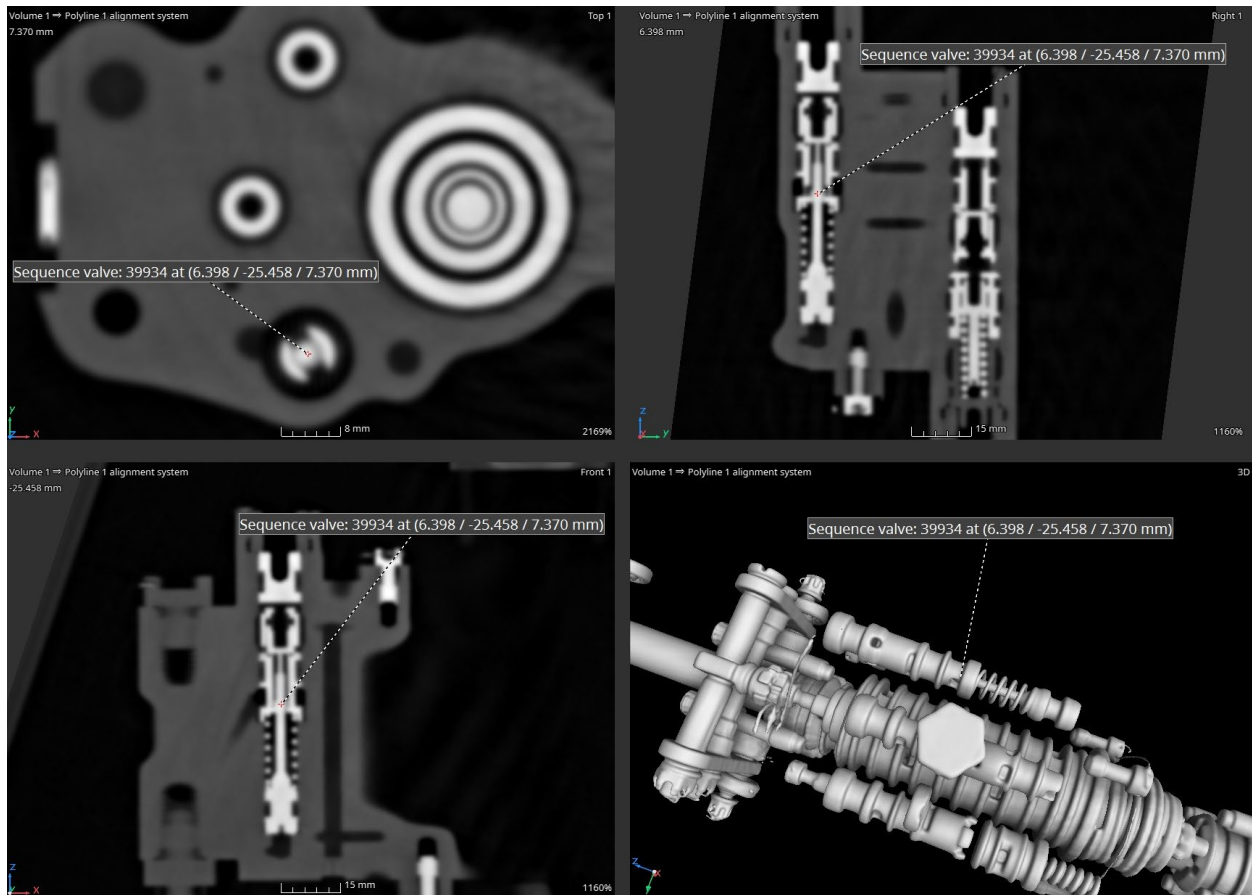


Figure 8. Lateral hydraulic actuator – sequence valve.

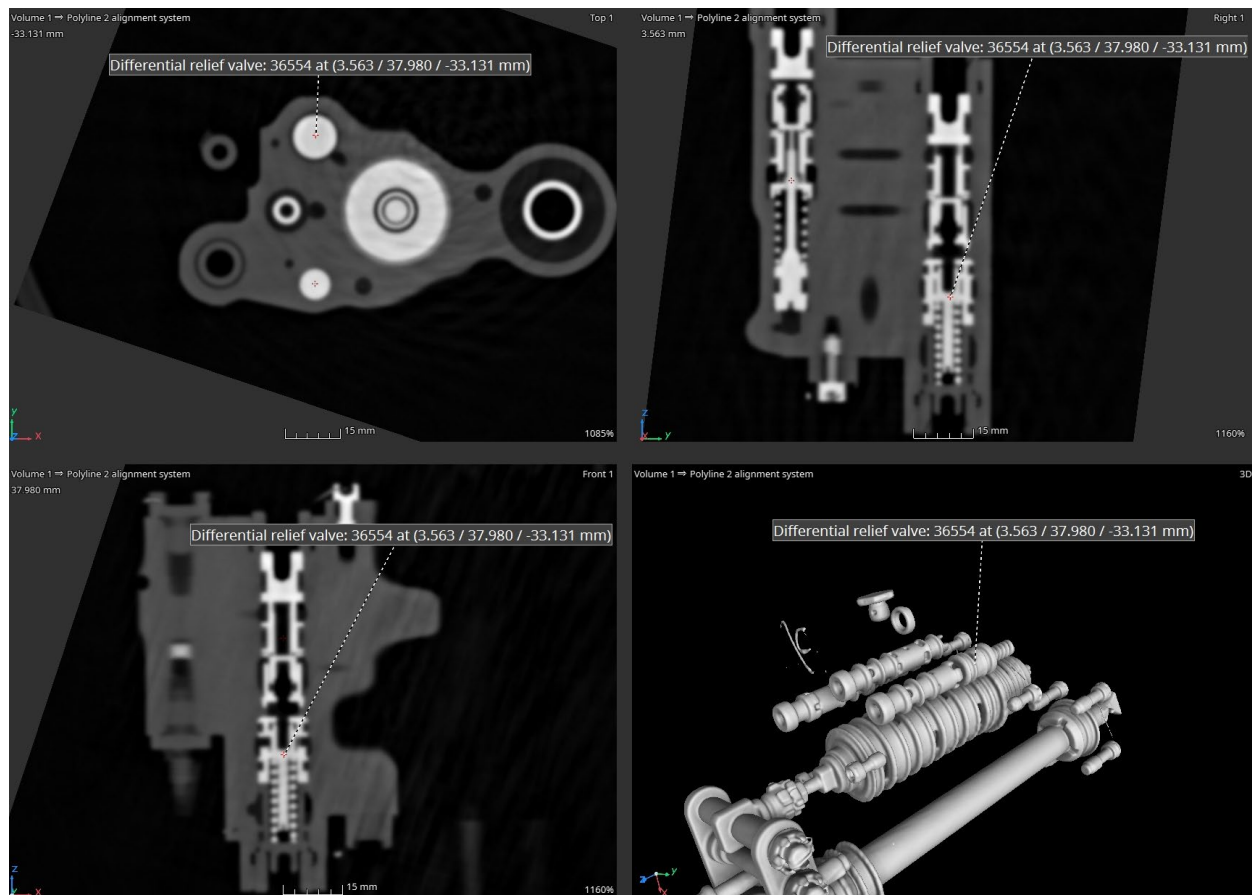


Figure 9. Lateral hydraulic actuator – differential relief valve.

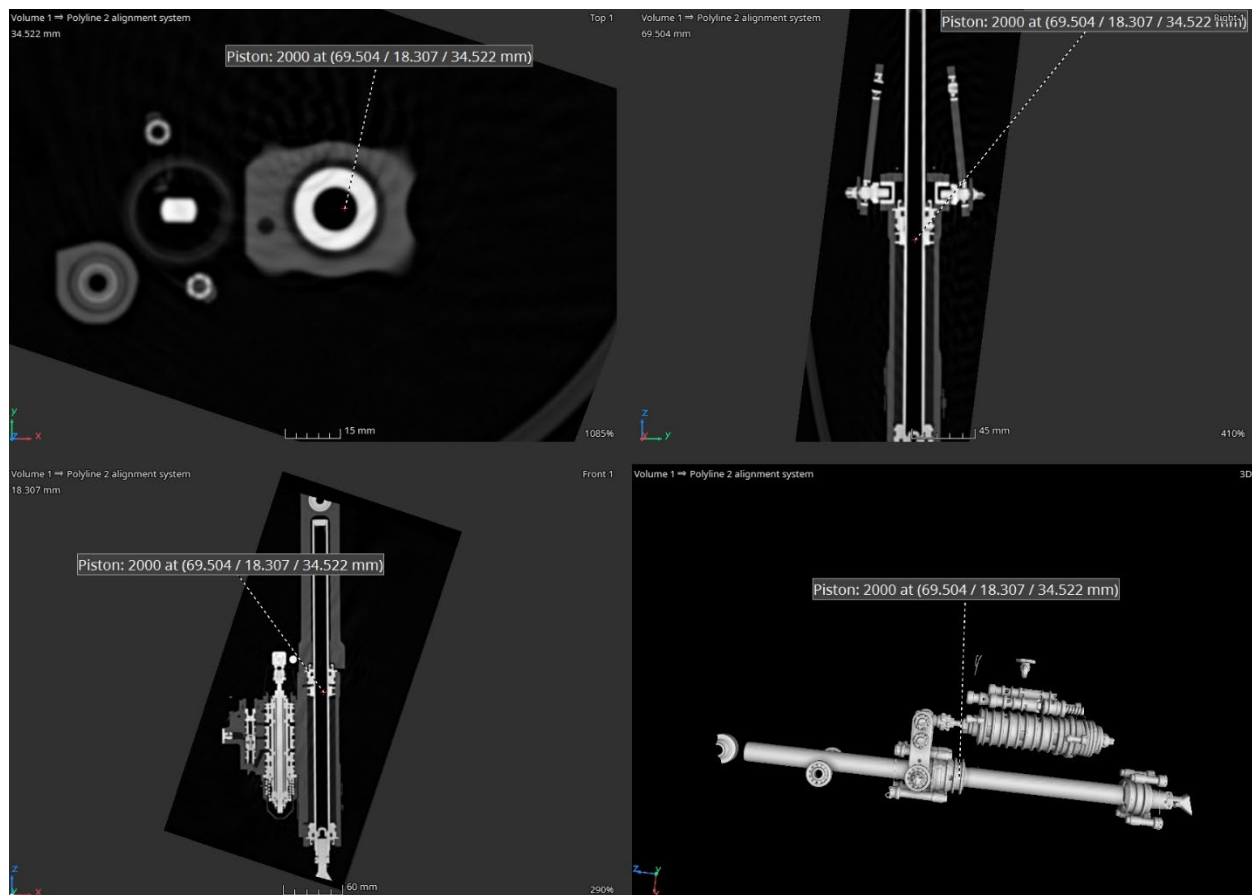


Figure 10. Lateral hydraulic actuator – piston.

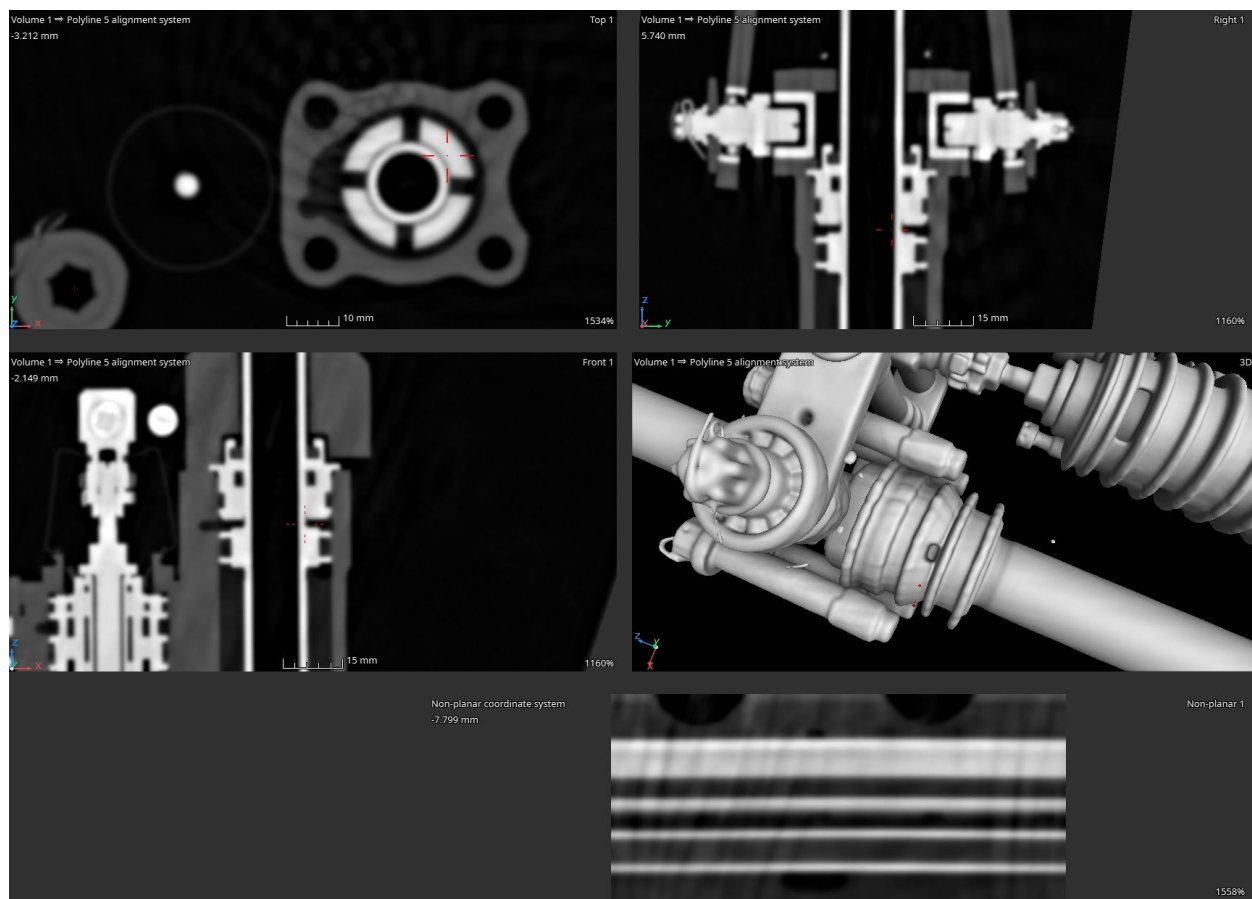


Figure 11. Lateral hydraulic actuator – piston and gland.

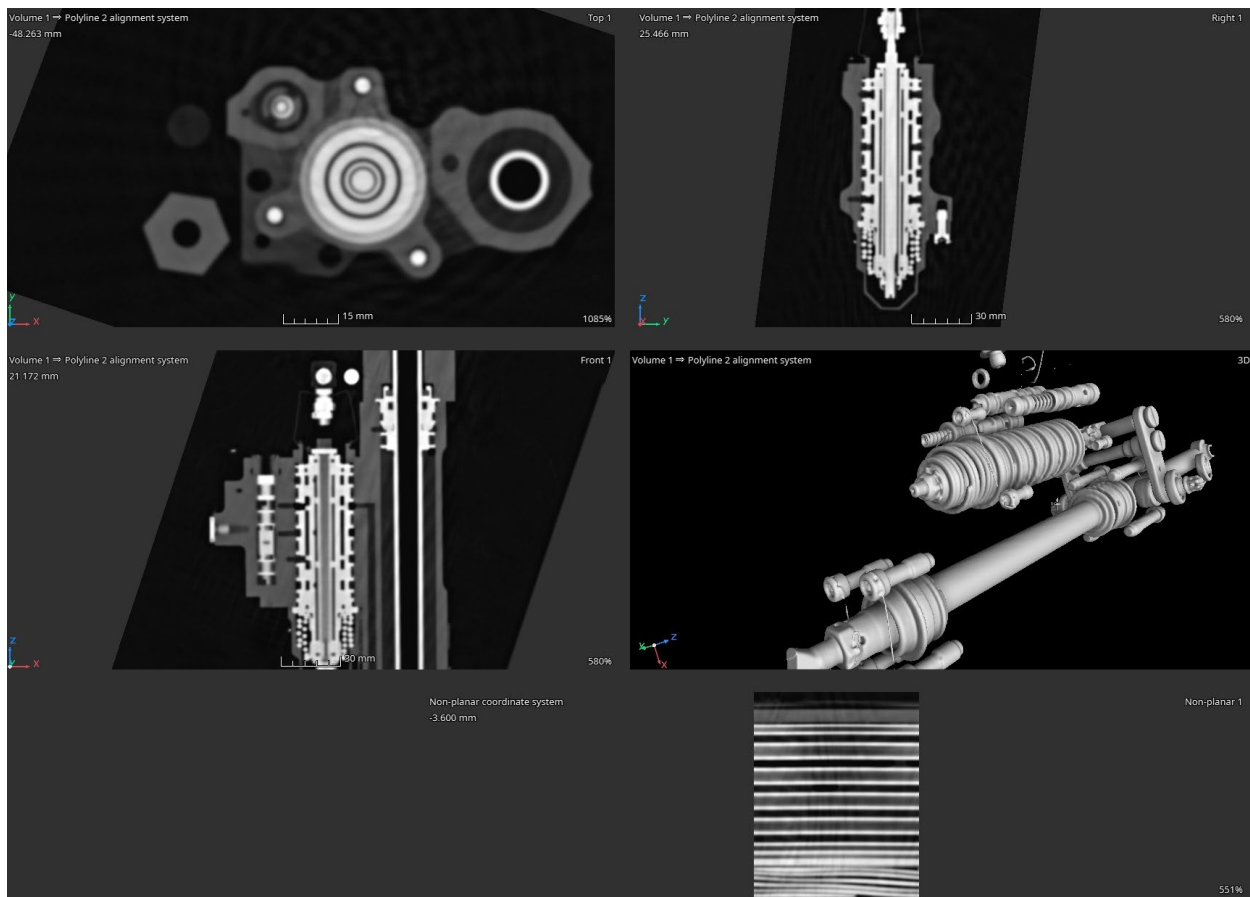


Figure 12. Lateral hydraulic actuator – spool.

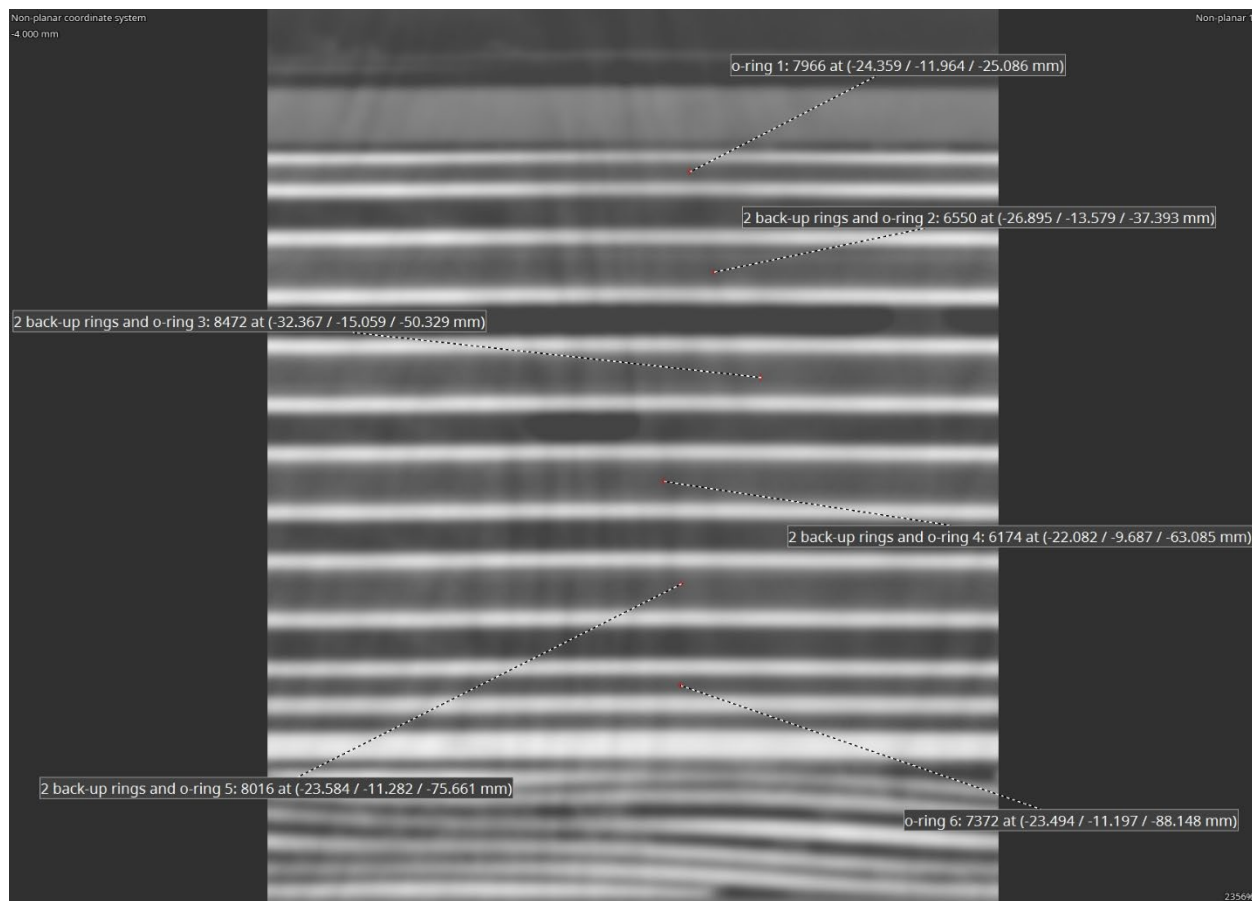


Figure 13. Lateral hydraulic actuator - spool unrolled.

Submitted by:

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