NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

May 24, 2022

Computed Tomography Specialist's Factual Report

WPR20LA211

A. ACCIDENT

Location:	Payson, Arizona
Date:	July 7, 2020
Time:	1213 mountain standard time
Airplane:	Bell/Garlick UH-1H helicopter, N623PB

B. GROUP

Computed Tomography Specialist:	Scott Warren National Transportation Safety Board Washington, D.C.

C. SUMMARY

On July 7, 2020, about 1213 mountain standard time, a Bell/Garlick UH-1H helicopter, N623PB, was destroyed when it was involved in an accident near Payson, Arizona. The pilot was fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 133 external load flight.

The internal configurations of the left lateral actuator and right lateral actuator from the accident helicopter were documented using radiographic images that were collected from October 4, 2021 to January 25, 2022, in Chicago, Illinois. A total of 9,283 computed tomography (CT) slice images were examined, processed, and analyzed by the NTSB to evaluate the components.

Review of the images determined that, when the scans were conducted, the following indications were present:

1. There were indications of high density particles in the left lateral actuator accumulator.

2. There were indications that the cap covering the left lateral actuator irreversible valve sequence valve opening was bulging and deformed.

3. There were indications of medium density material within the piston rod of the left lateral actuator.

4. There was a crack indication noted in the mounting flange of the right lateral actuator.

D. DETAILS OF THE INVESTIGATION

1.0 General

The left lateral actuator and right lateral actuator from the accident helicopter were subjected to x-ray radiograph and computed tomography (CT) scanning to document each component's internal condition. The scanning was conducted from October 4, 2021 to January 25, 2022, by Varex, Inc under the direction of the NTSB using the Actis 225/500 microfocus CT system.

For the CT scans, the components were individually loaded into the imaging unit and placed on a turntable. The components were 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 components were scanned using a total of 9,283 slices, and the total size of the combined data sets was approximately 40.9 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 components.

Table 1
Scan Protocols

Component	Left Lateral Actuator	Right Lateral Actuator
Number of slices	4757	4526
Voxel[1] Size - X Direction (millimeter(mm))	0.098	0.082
Voxel Size - Y Direction (mm)	0.098	0.082
Voxel Size - Z Direction (mm)	0.09	0.08
Image Projections per Revolution	1800	1800
Exposure time (milliseconds)	285.6	285.6
Frames to Avg (frames per projection)	2	2
X-ray Source Voltage (kilovolts)	223	223
X-ray Source Current (mA)	0.560	0.580
Source Filter Thickness (mm)	1	1
Source Filter Material	brass	brass
Image Matrix Size (pixels)	1536 x 1536	1536 x 1536

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 of 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

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

associated with the pointer are the gray value at the pointer location and the three positional coordinates of the pointer.

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.

2.0 Computed Tomography Results

The computed tomography (CT) results for the components are shown in figures 1 through 43. Review of the images determined that, when the scans were conducted, the following indications were present:

1. There were indications of high density particles in the left lateral actuator accumulator.

2. There were indications that the cap covering the left lateral actuator irreversible valve sequence valve opening was bulging and deformed.

3. There were indications of medium density material within the piston rod of the left lateral actuator.

4. There was a crack indication noted in the mounting flange of the right lateral actuator.

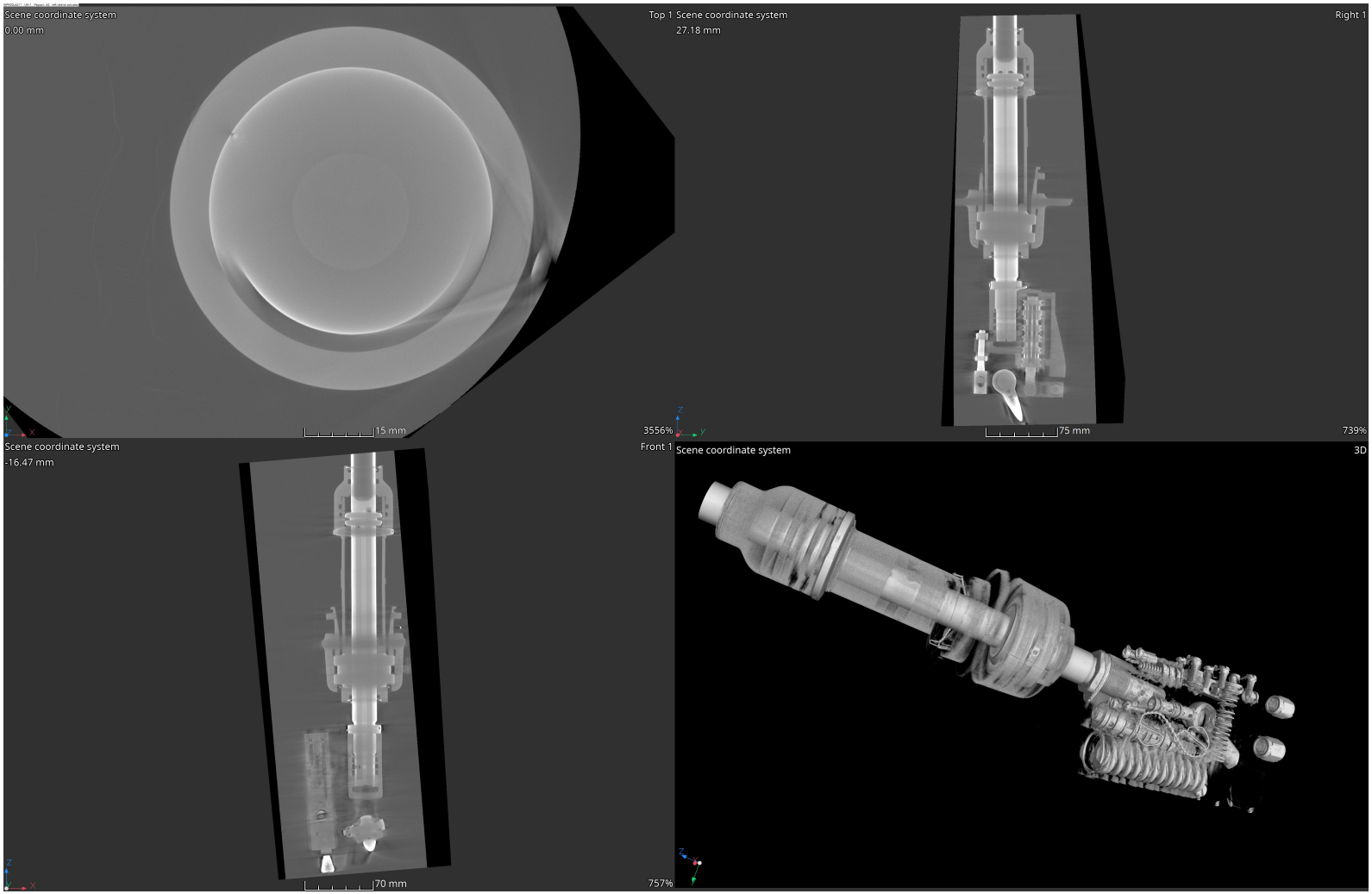


Figure 1
Left lateral actuator - overview

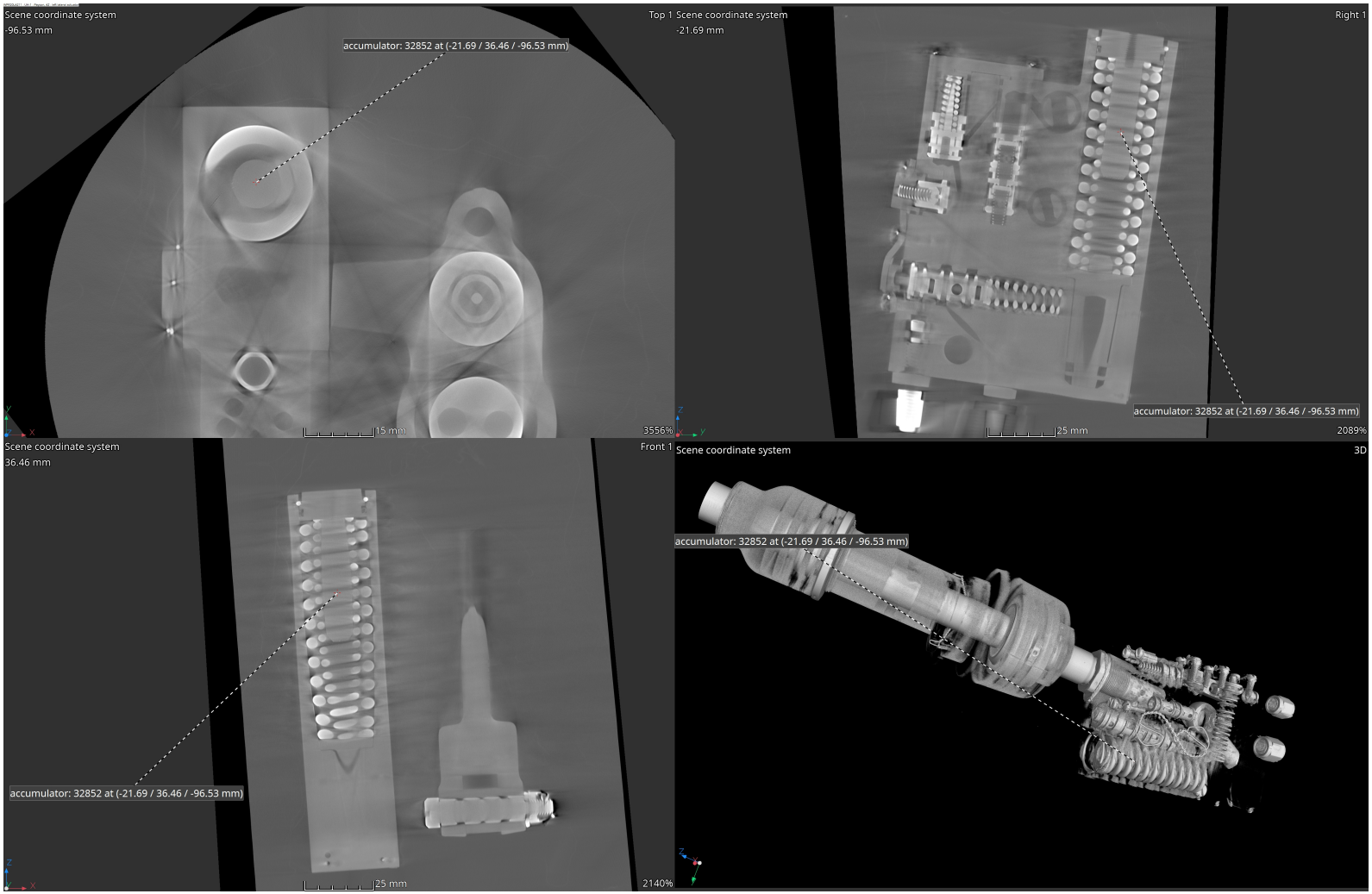


Figure 2
Left lateral actuator - accumulator

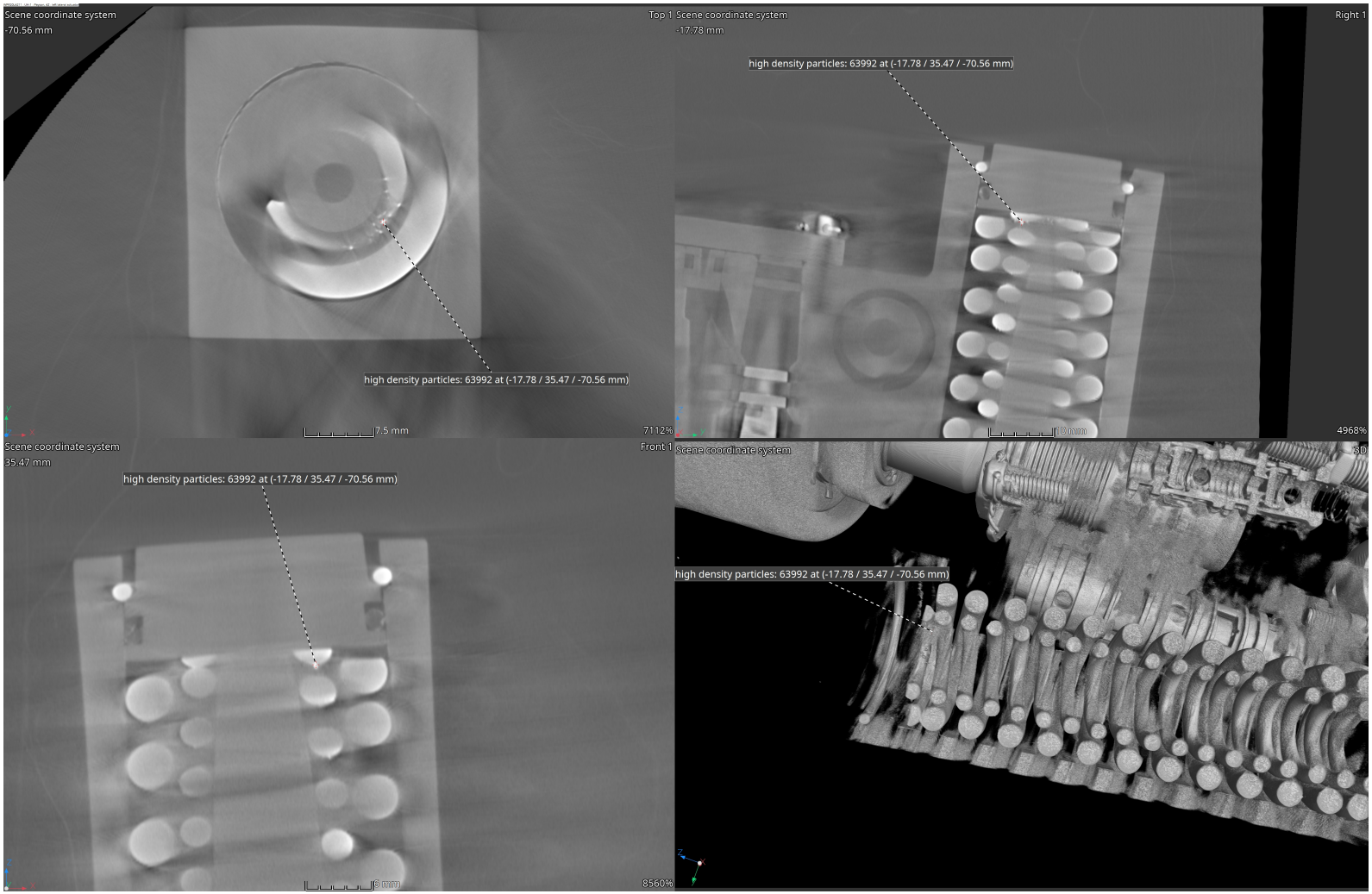


Figure 3
Left lateral actuator – high density particles

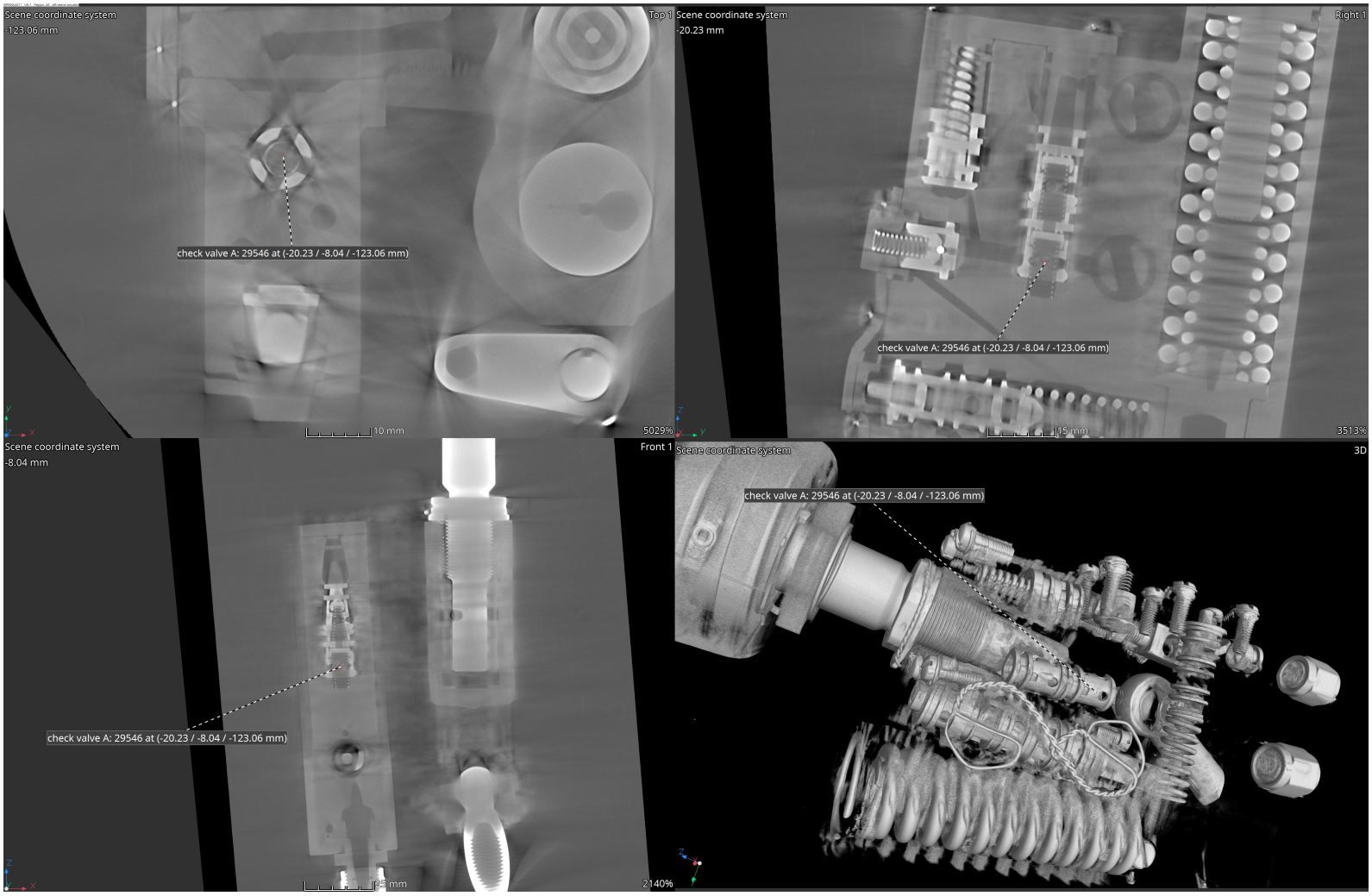


Figure 4
Left lateral actuator – check valve A

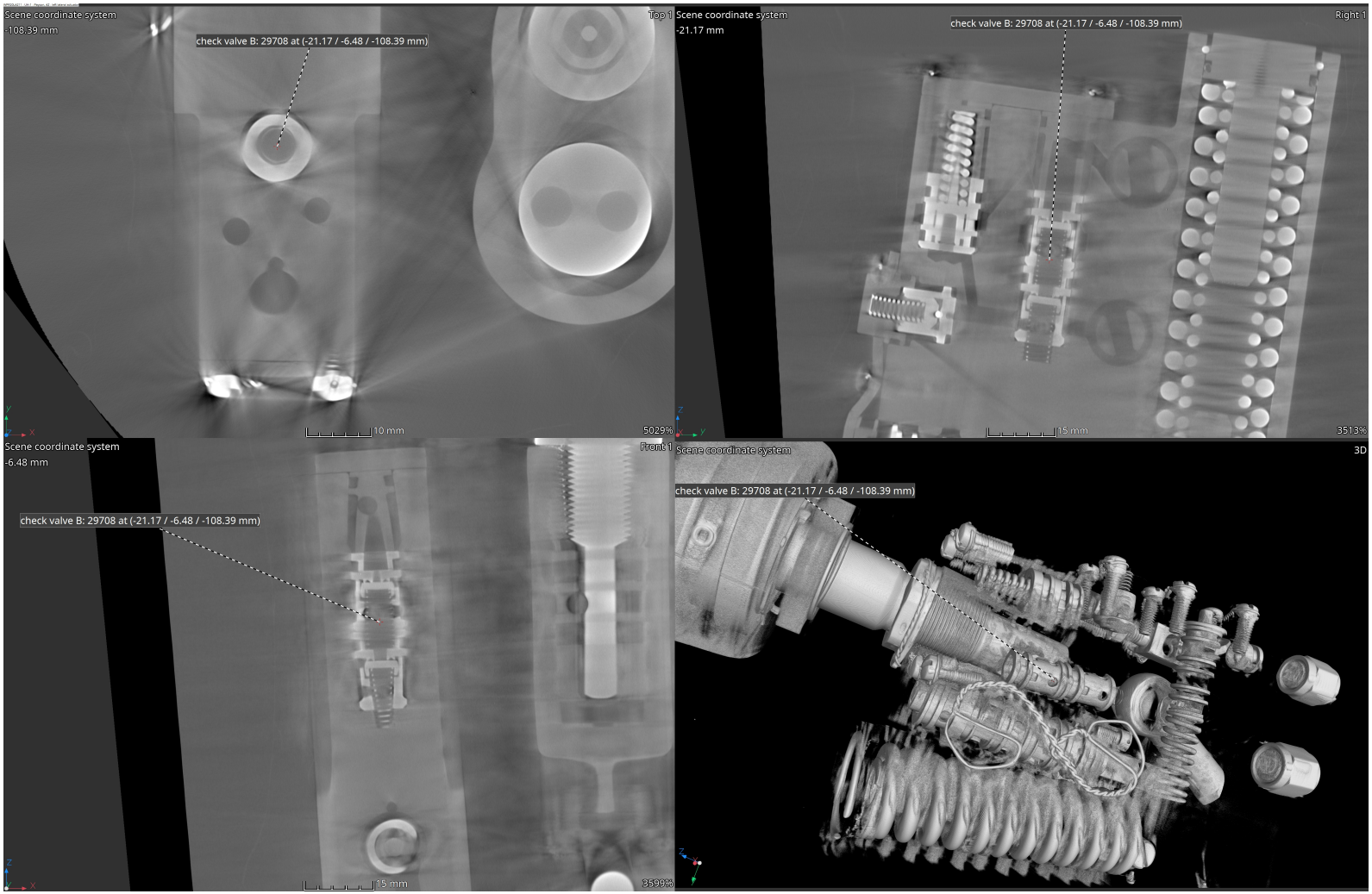


Figure 5
Left lateral actuator – check valve B

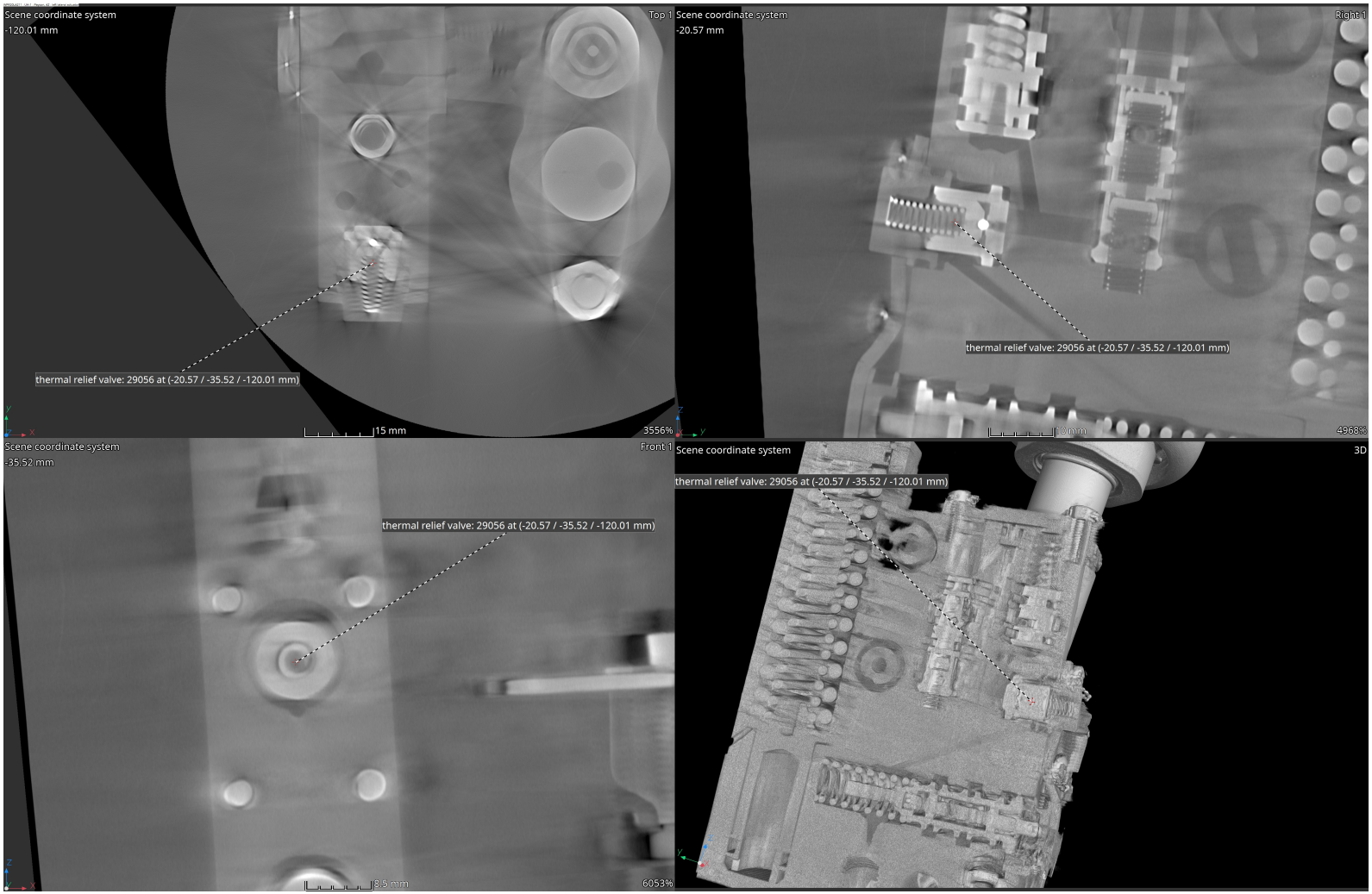


Figure 6
Left lateral actuator – thermal relief valve

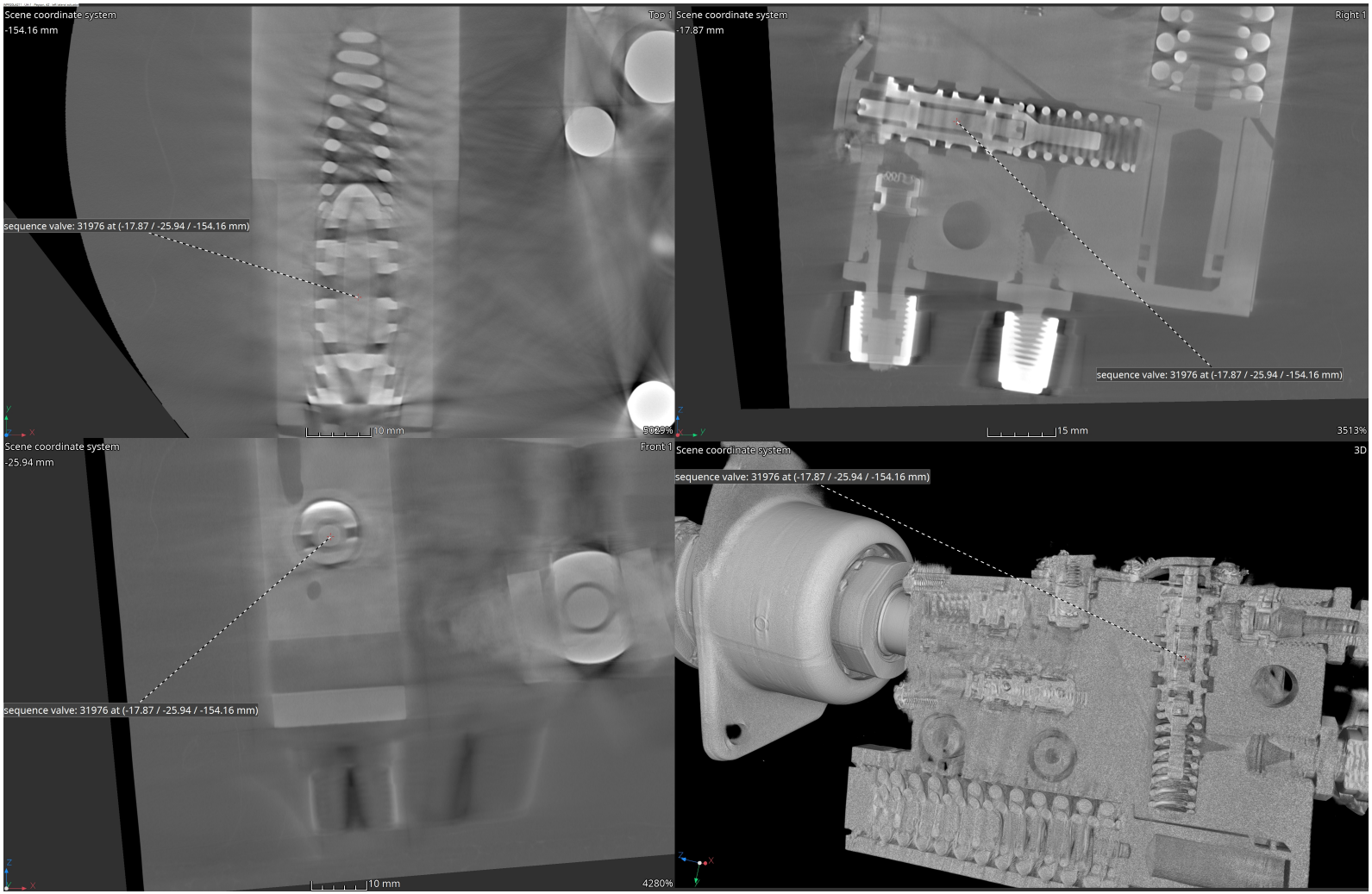


Figure 7
Left lateral actuator – sequence valve

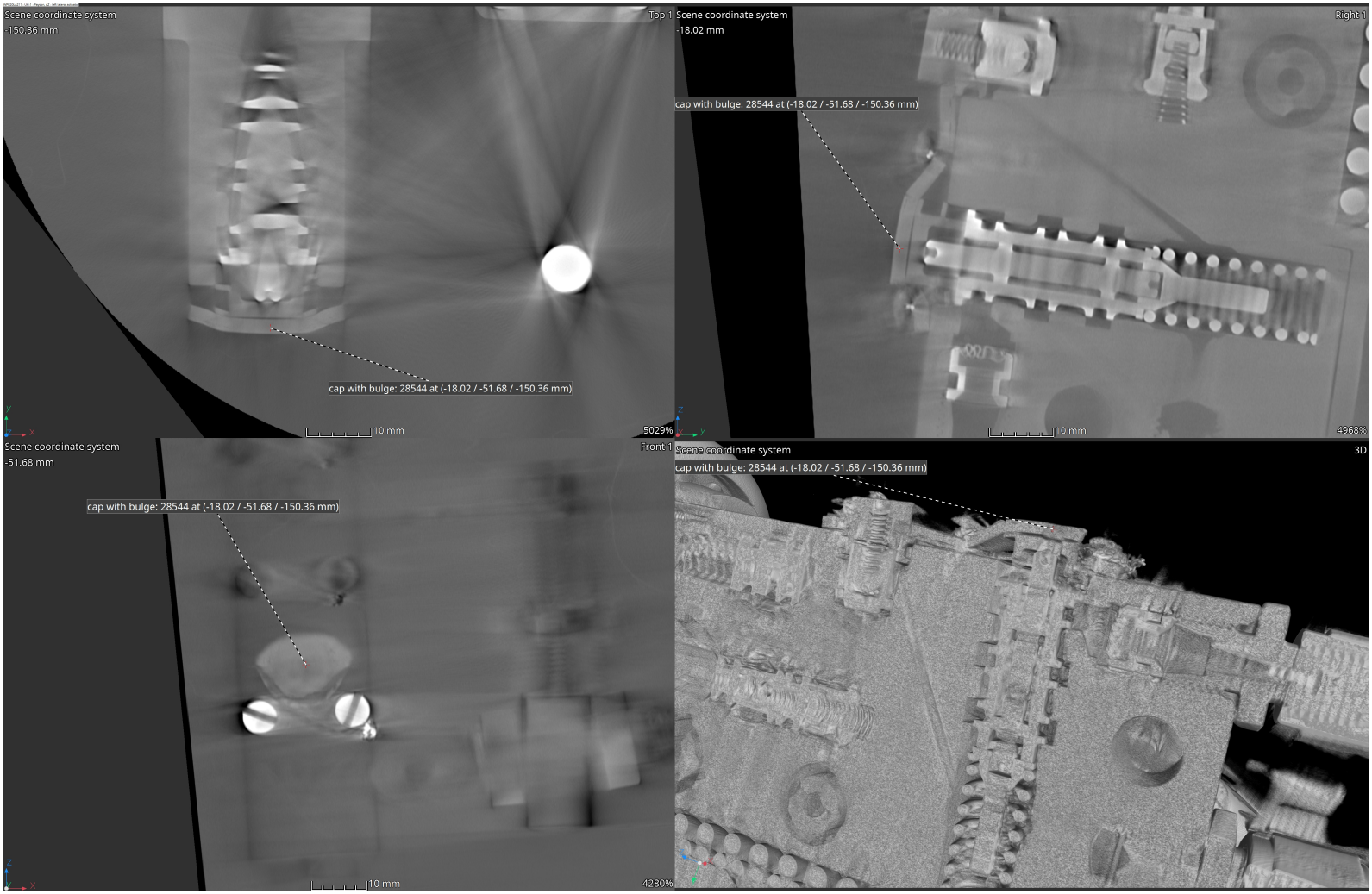


Figure 8
Left lateral actuator – cap with bulge

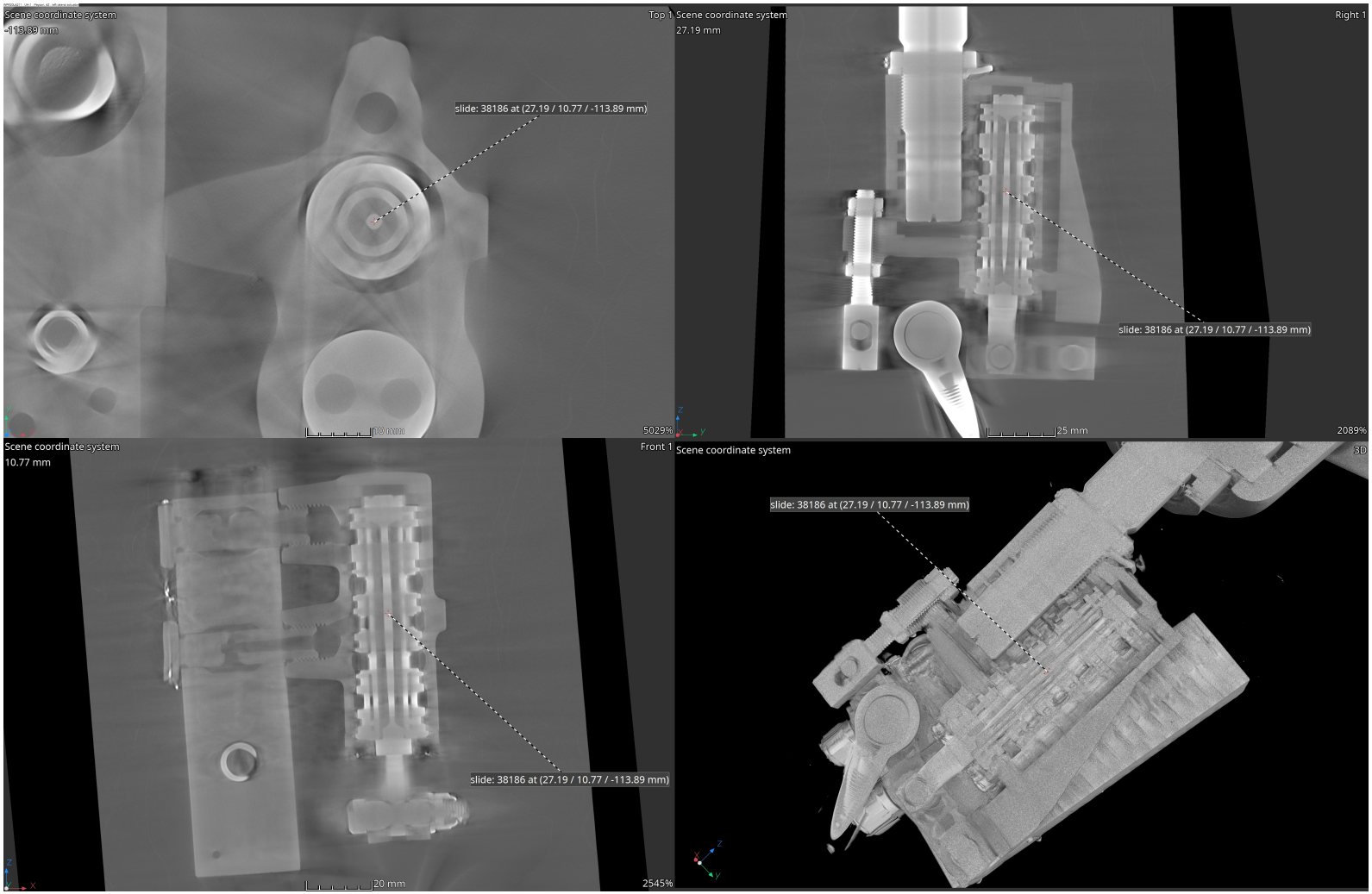


Figure 9
Left lateral actuator - slide

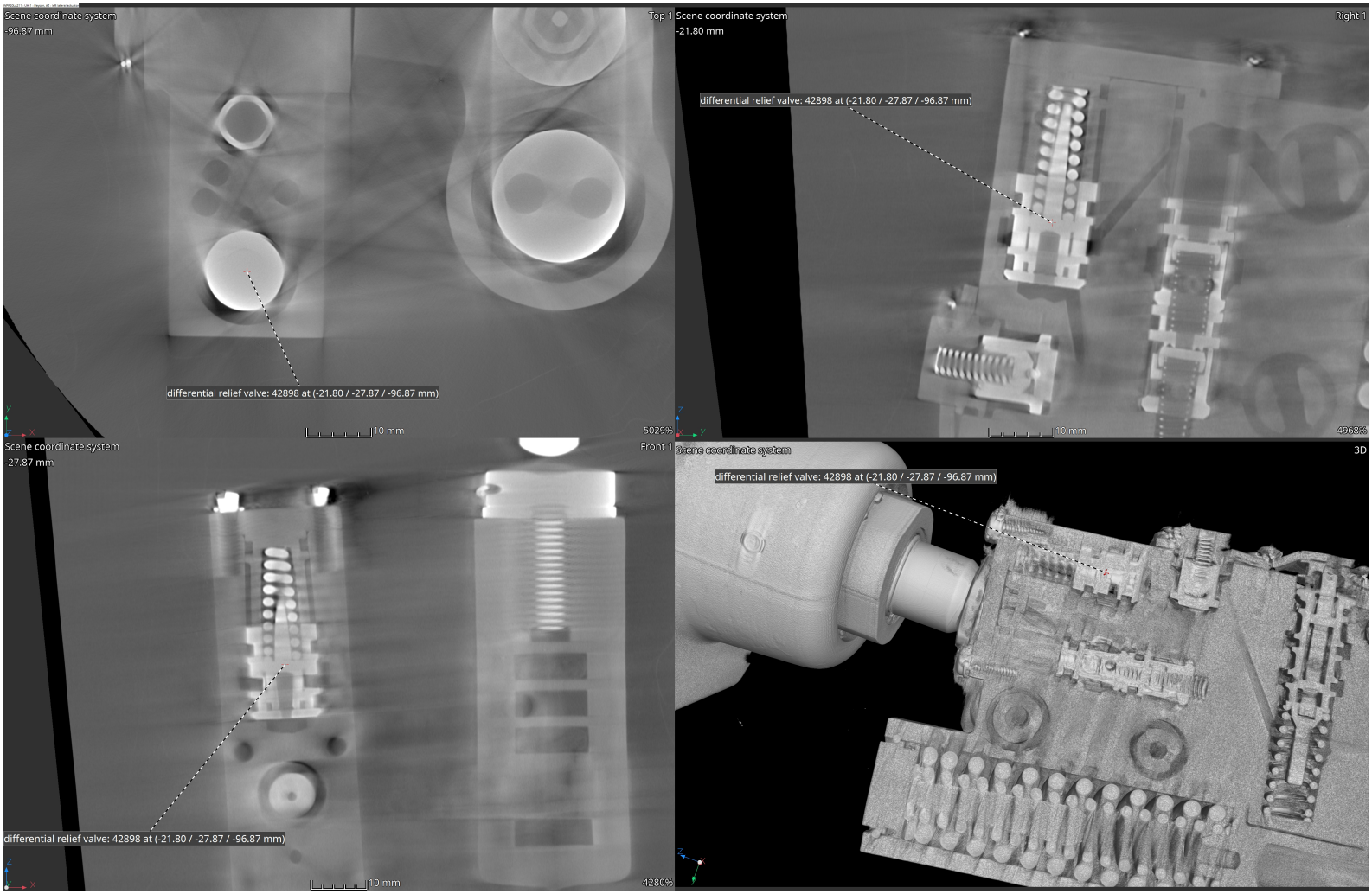


Figure 10
Left lateral actuator – differential relief valve

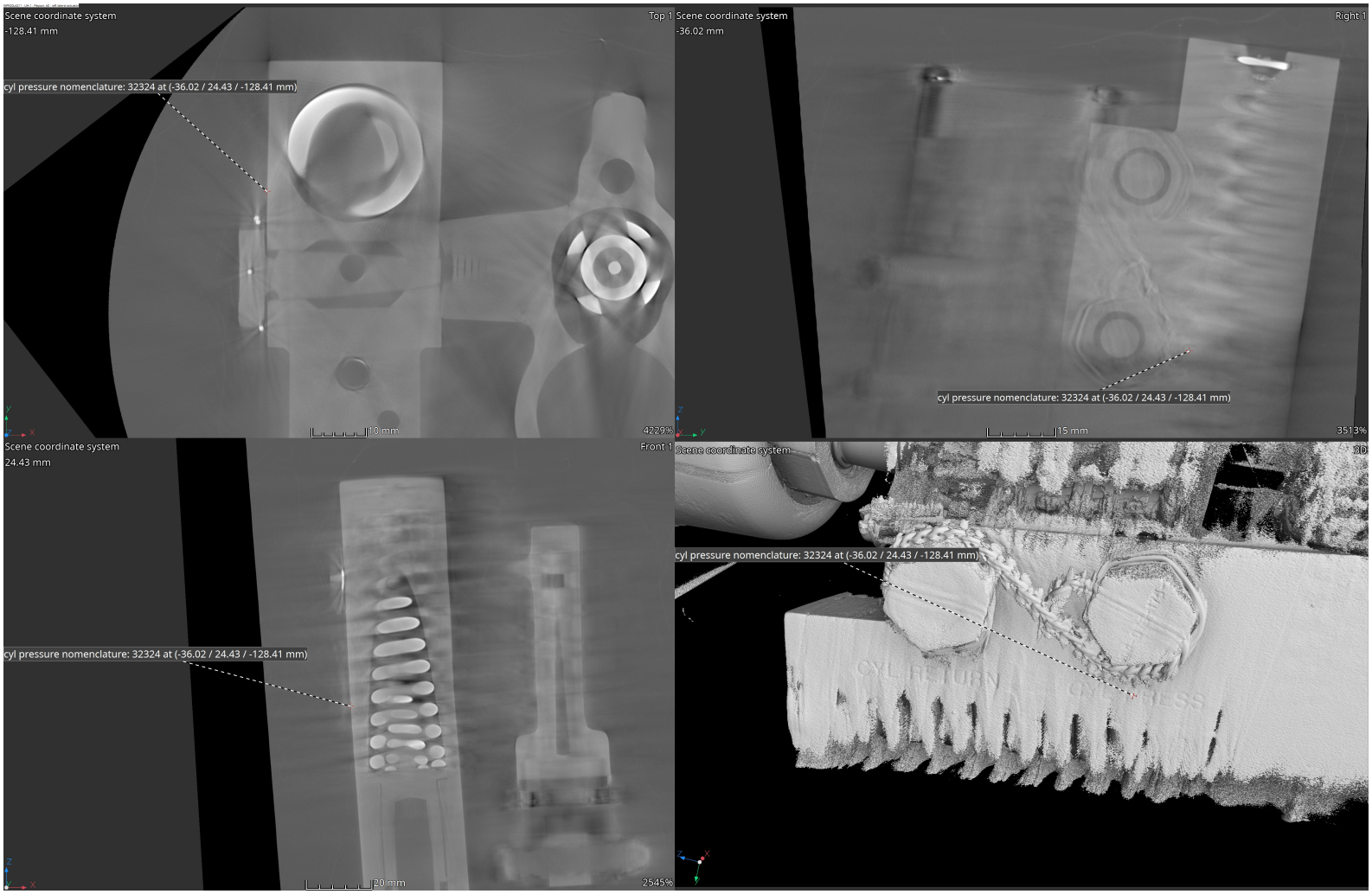


Figure 11
Left lateral actuator – cylinder pressure nomenclature

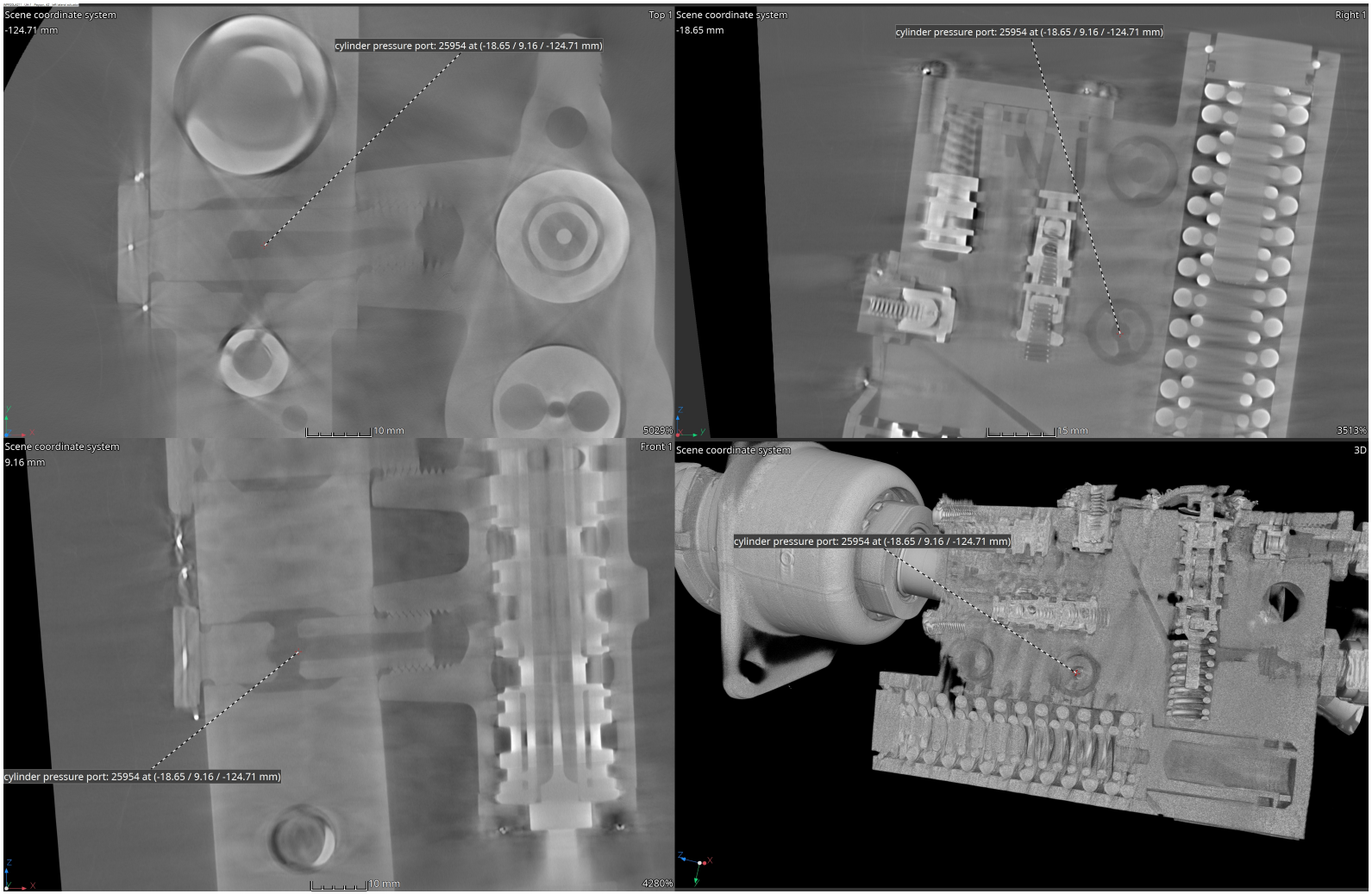


Figure 12
Left lateral actuator – cylinder pressure port

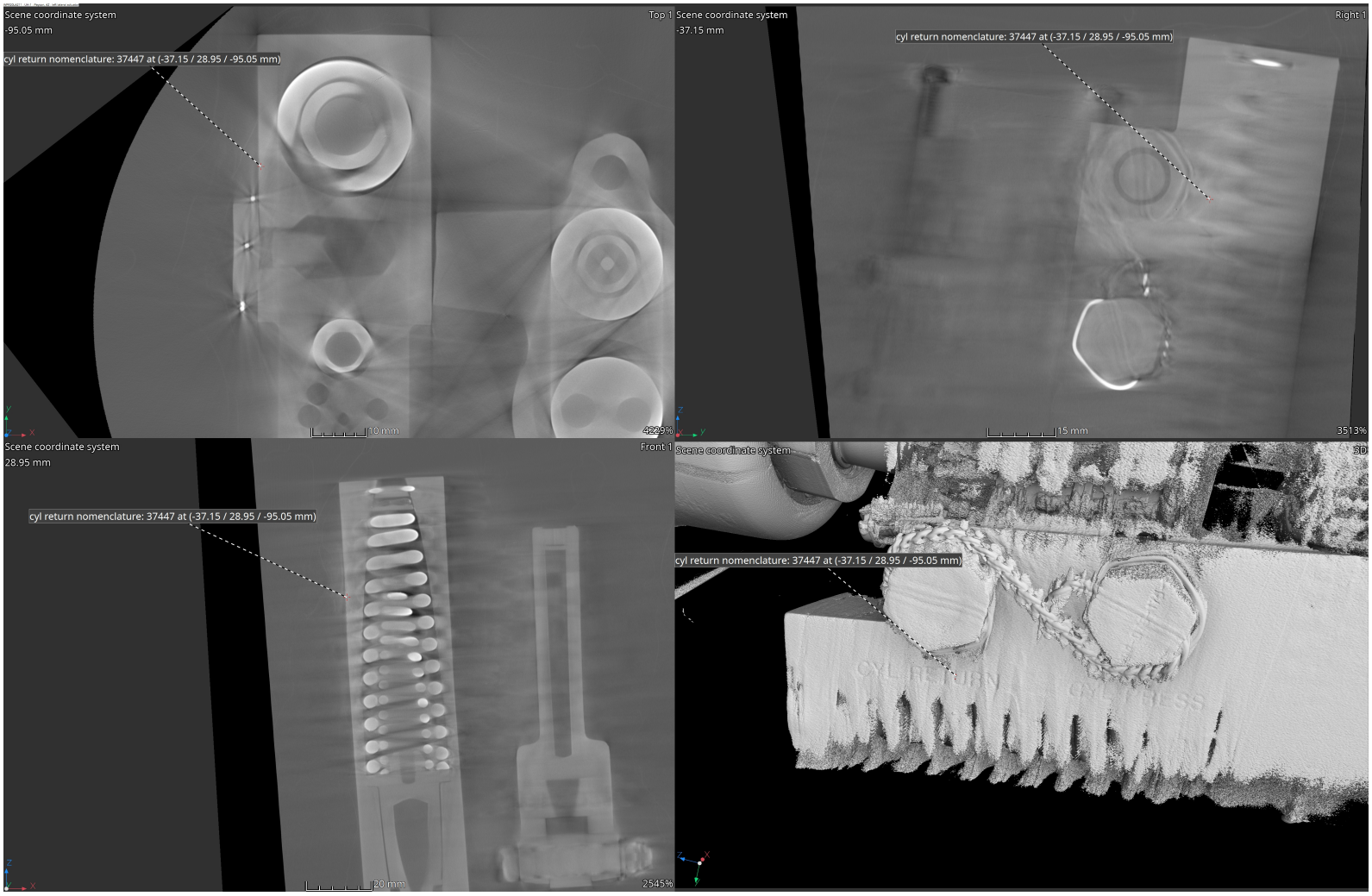


Figure 13
Collective actuator – cylinder return nomenclature

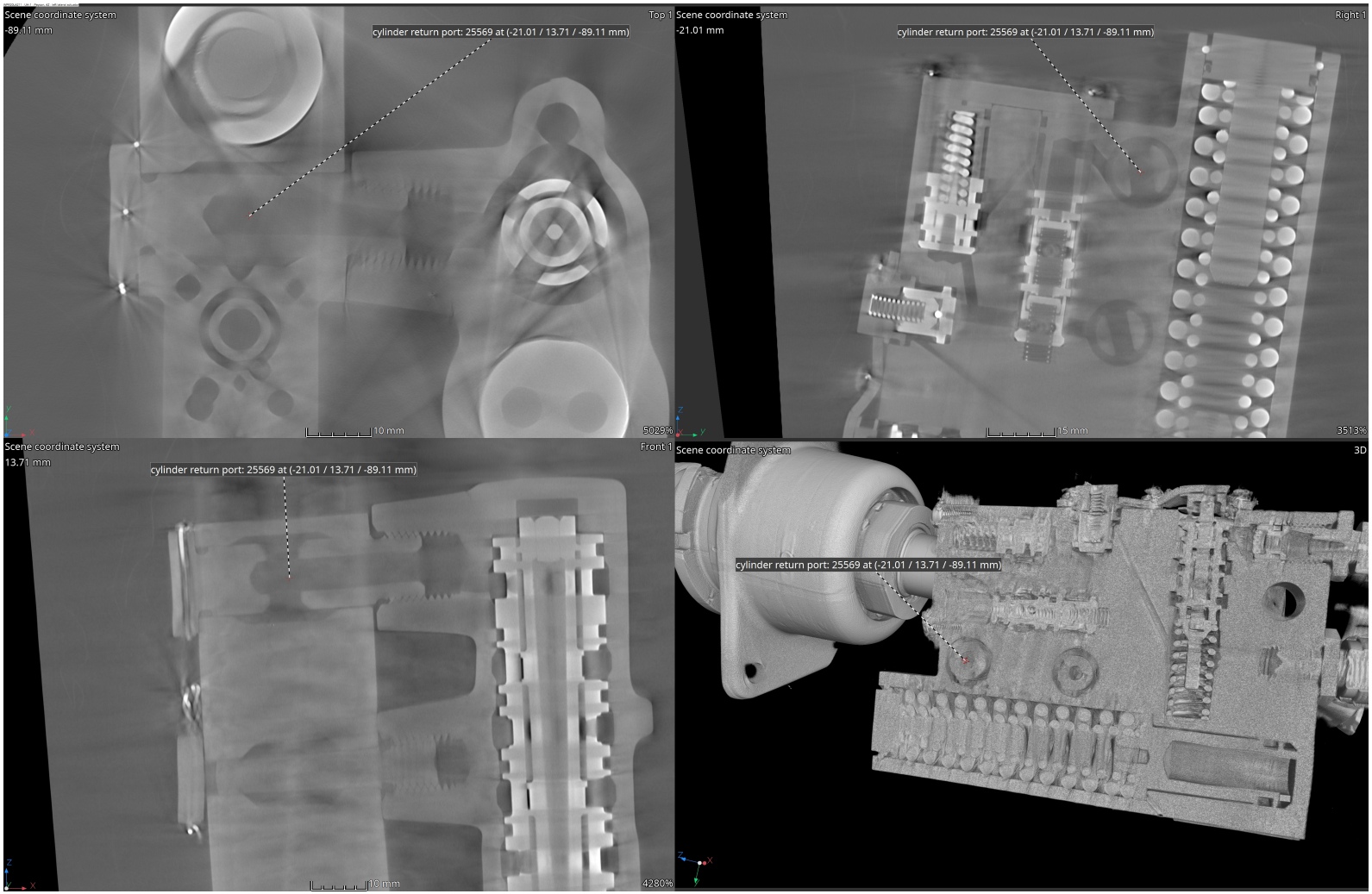


Figure 14
Left lateral actuator – cylinder return port

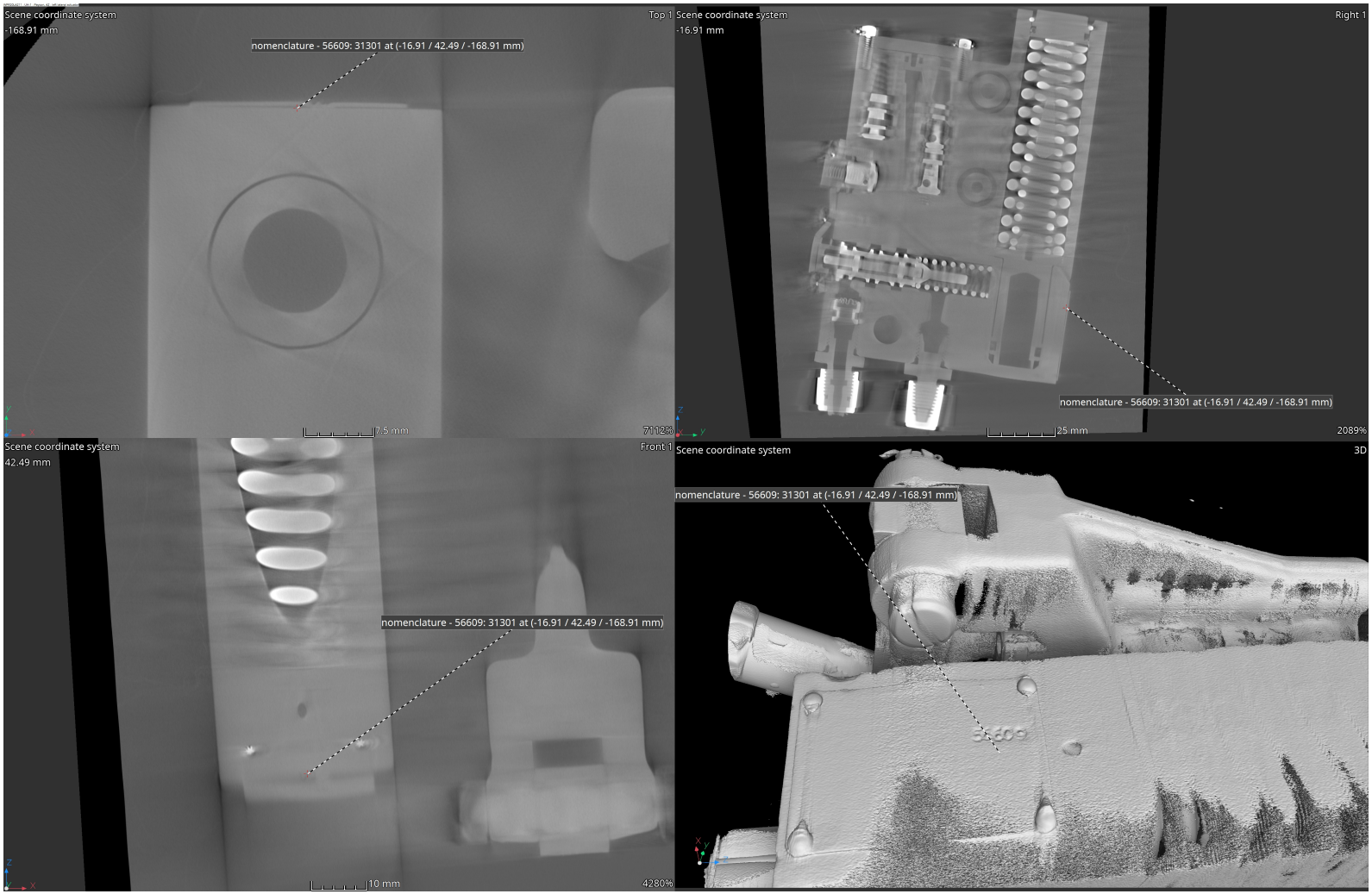


Figure 15
Left lateral actuator – nomenclature - 56609

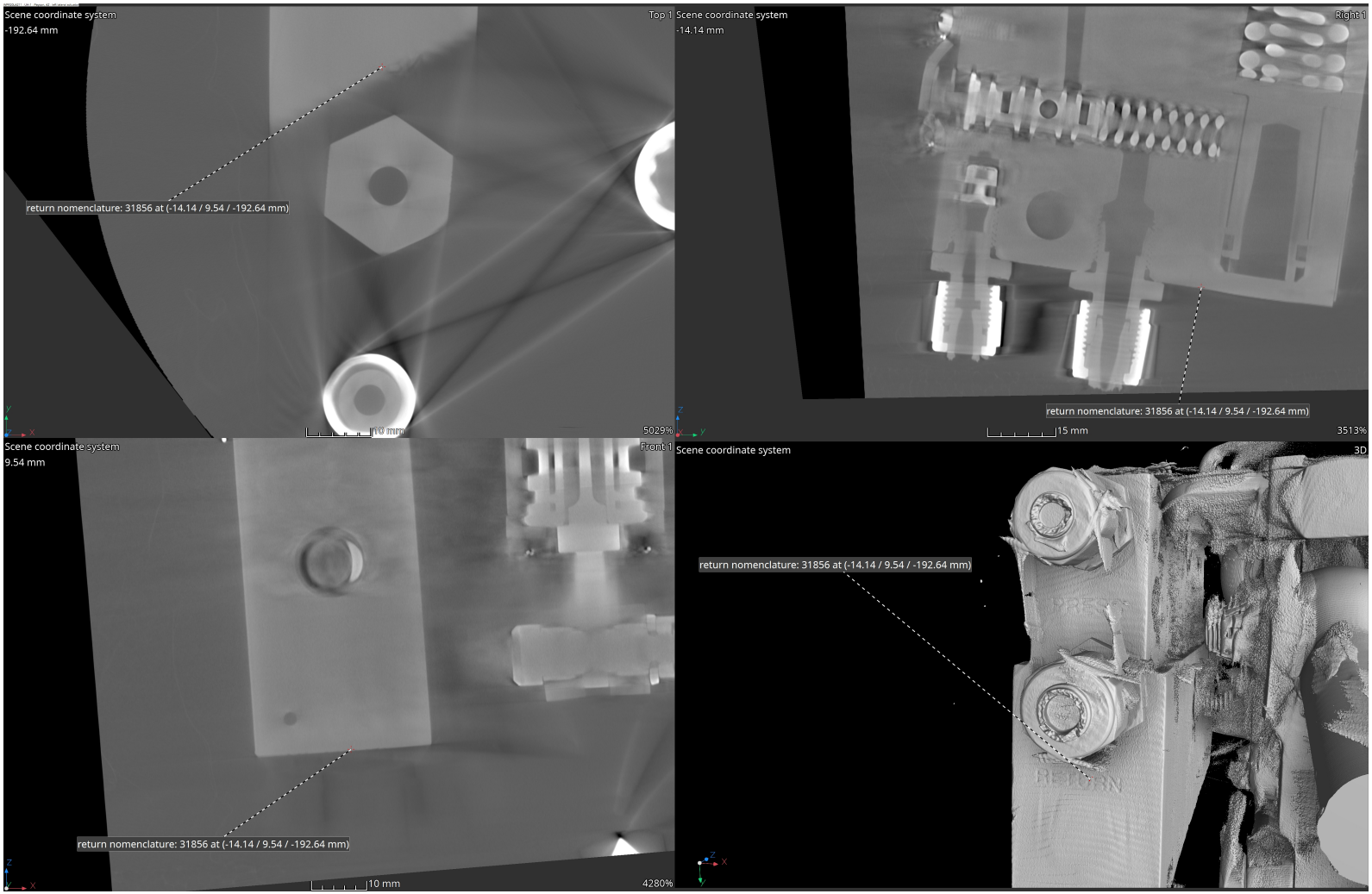


Figure 16
Left lateral actuator – return nomenclature

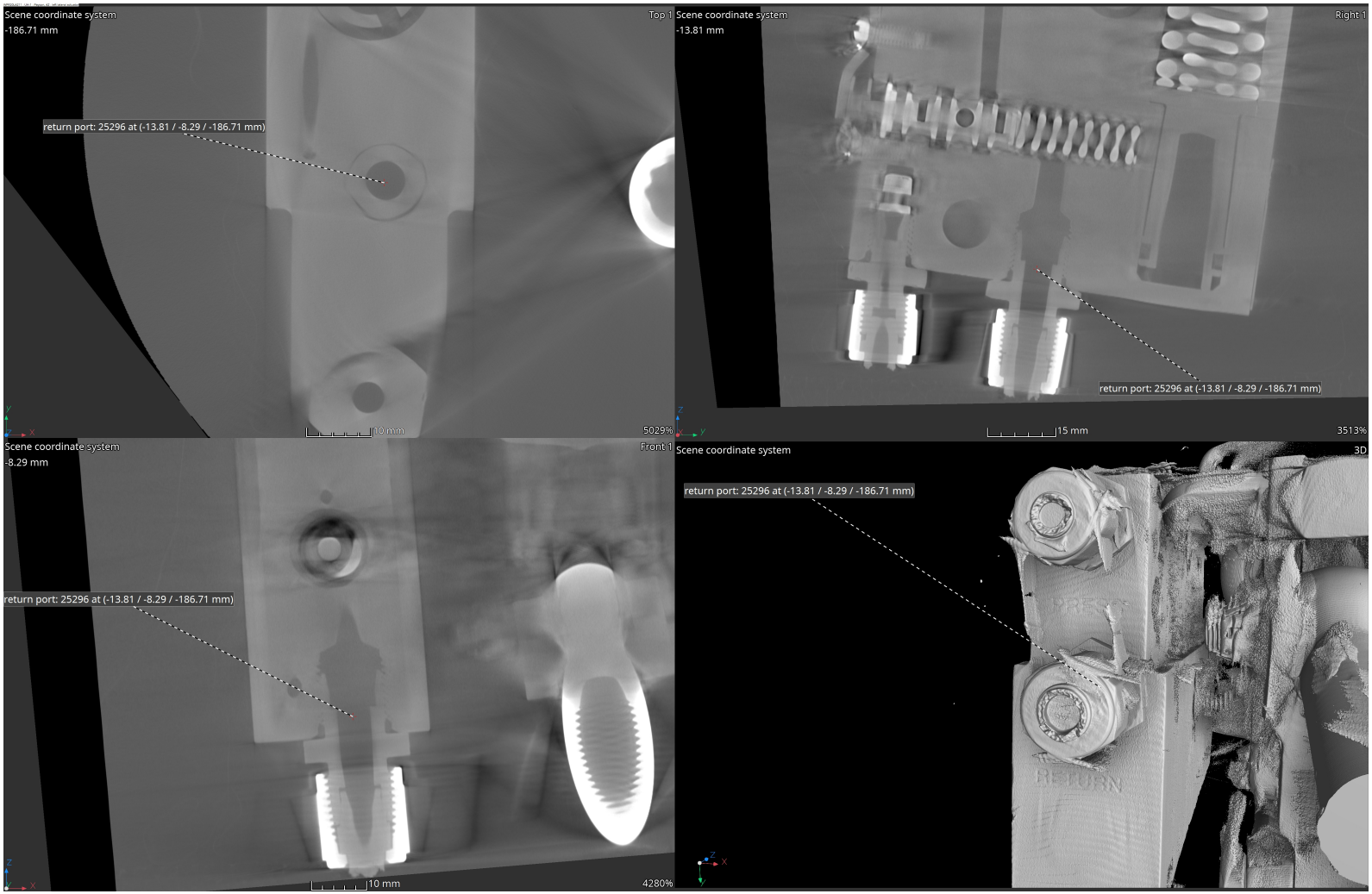


Figure 17
Left lateral actuator – return port

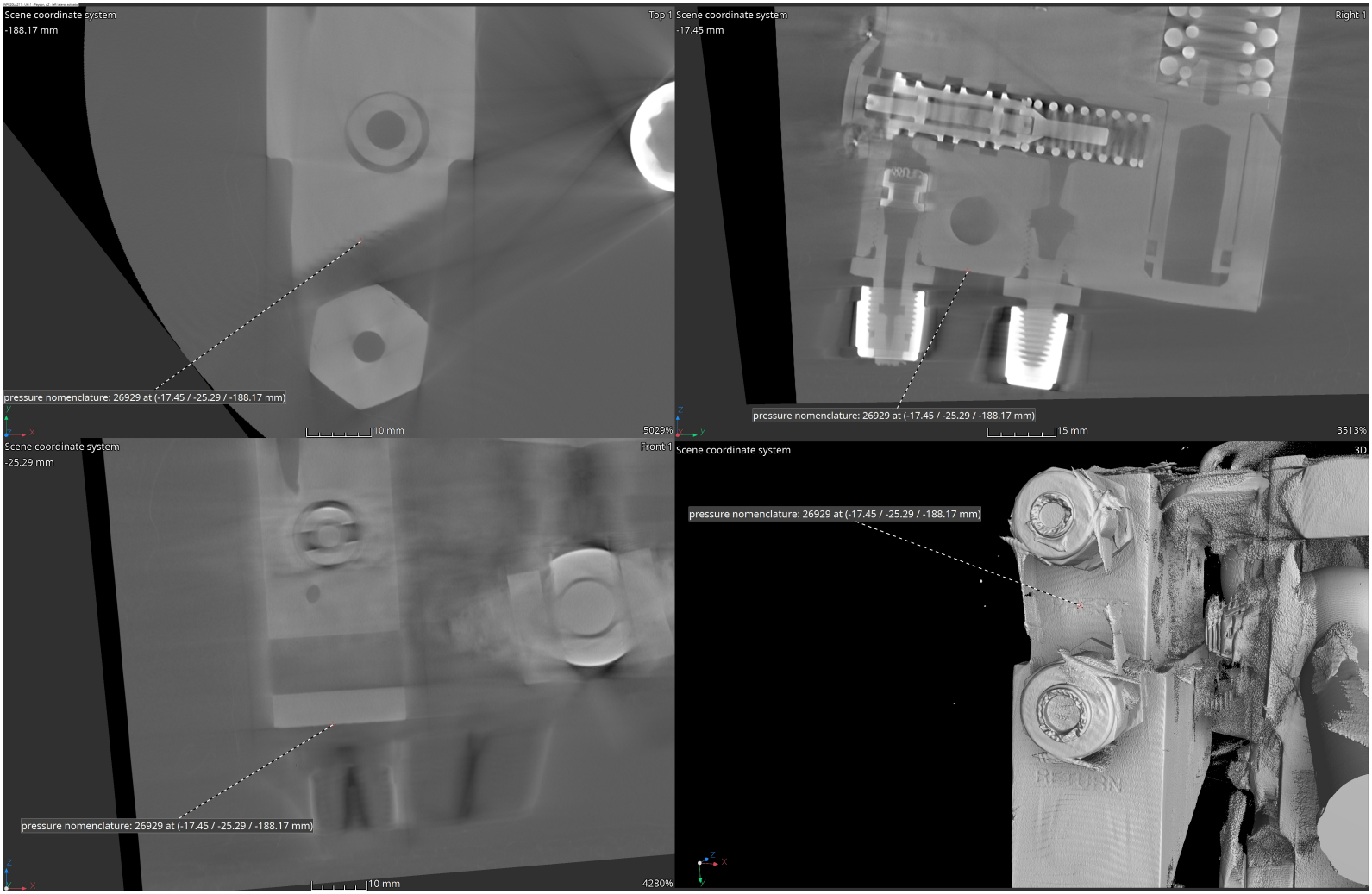


Figure 18
Left lateral actuator – pressure nomenclature

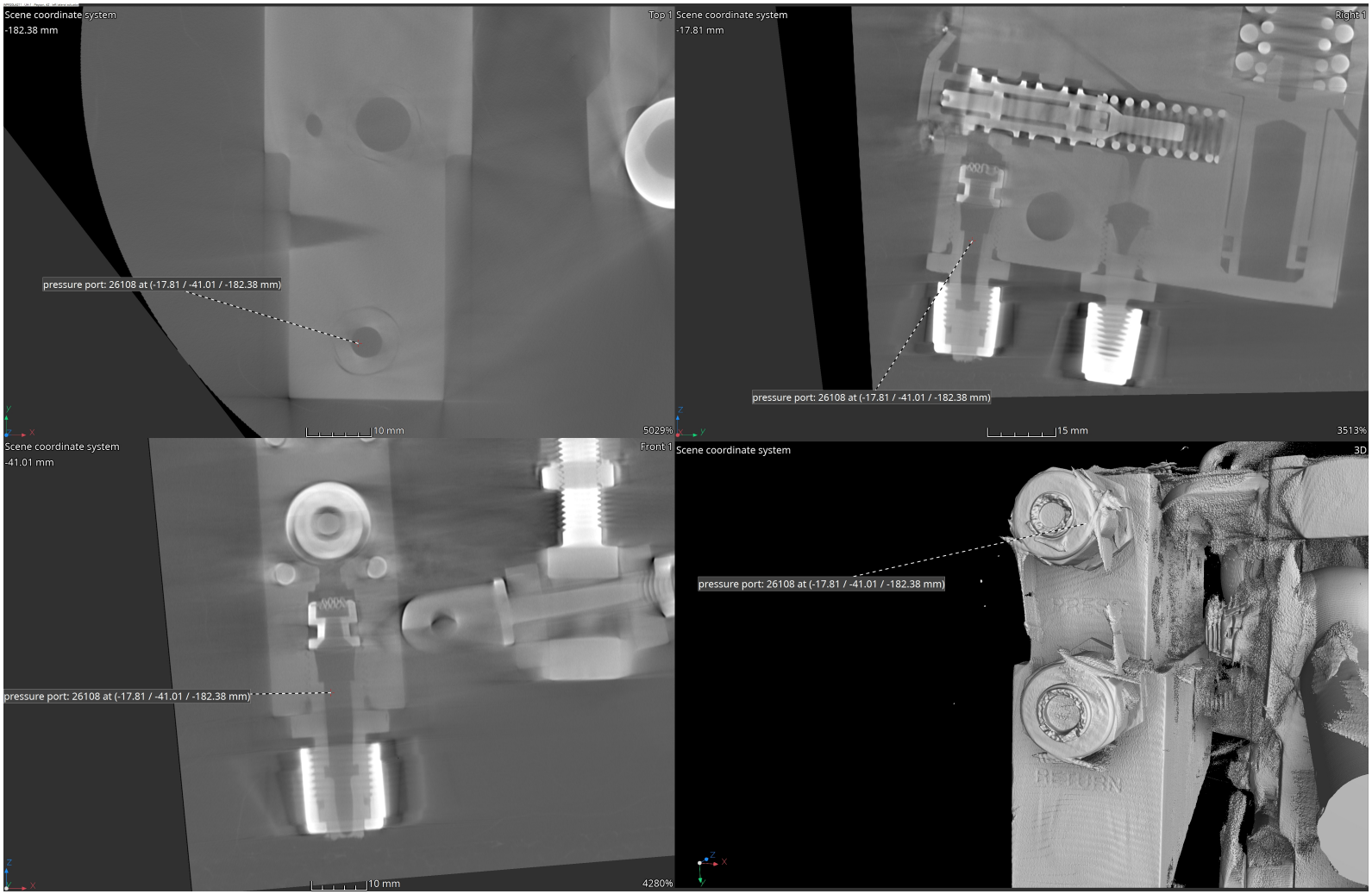


Figure 19
Left lateral actuator – pressure port

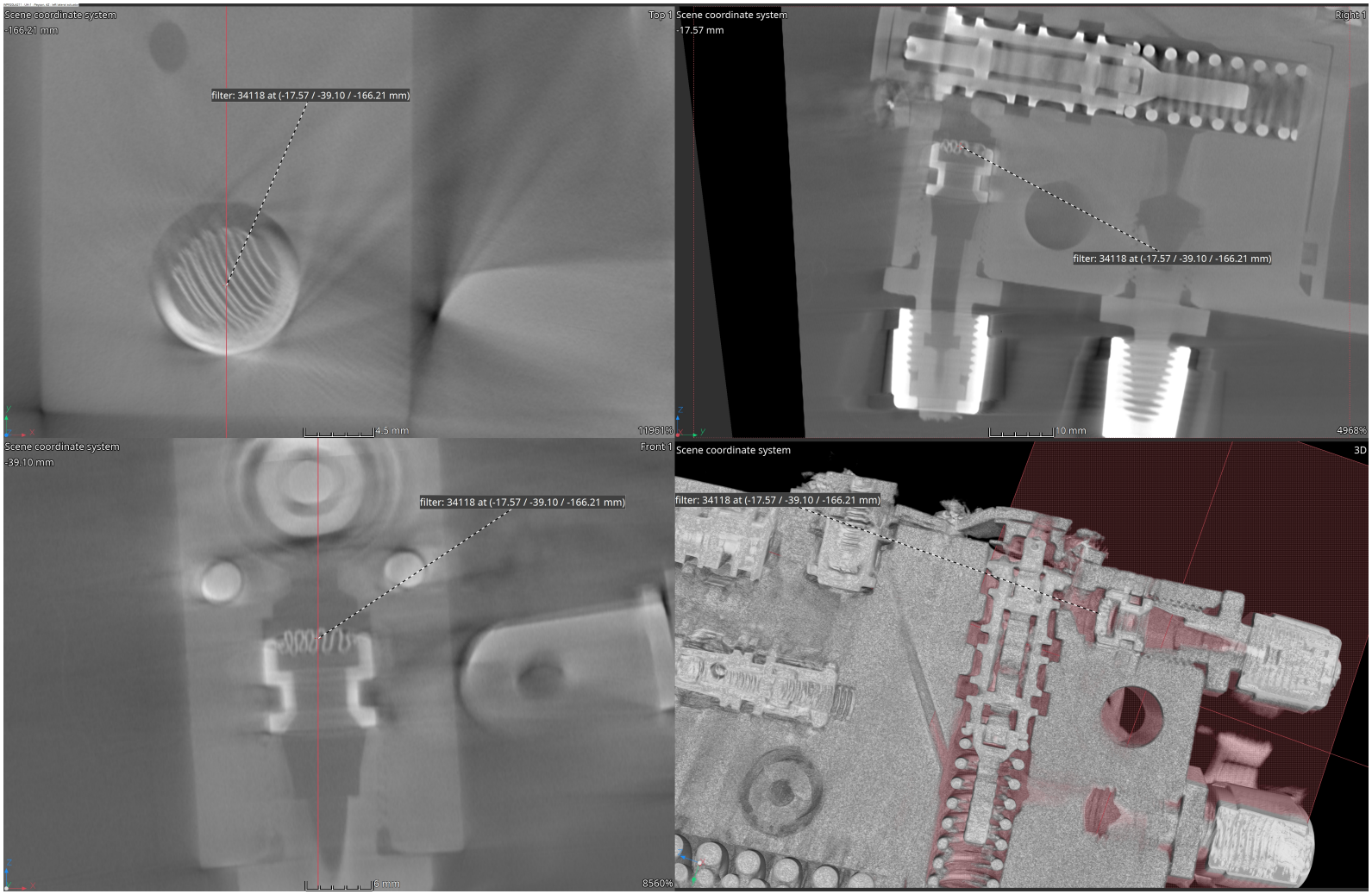


Figure 20
Left lateral actuator - filter

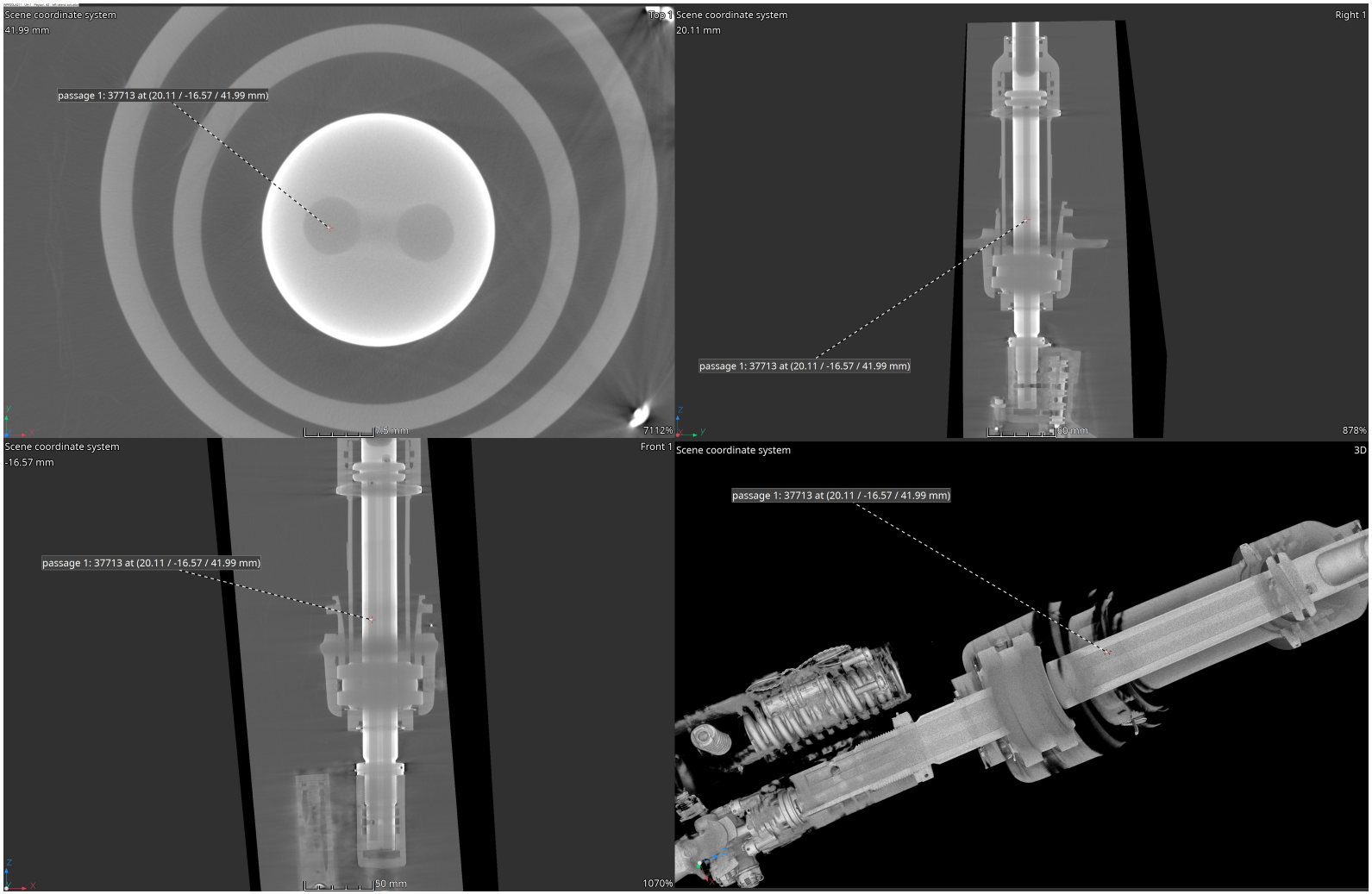


Figure 21
Left lateral actuator – passage 1

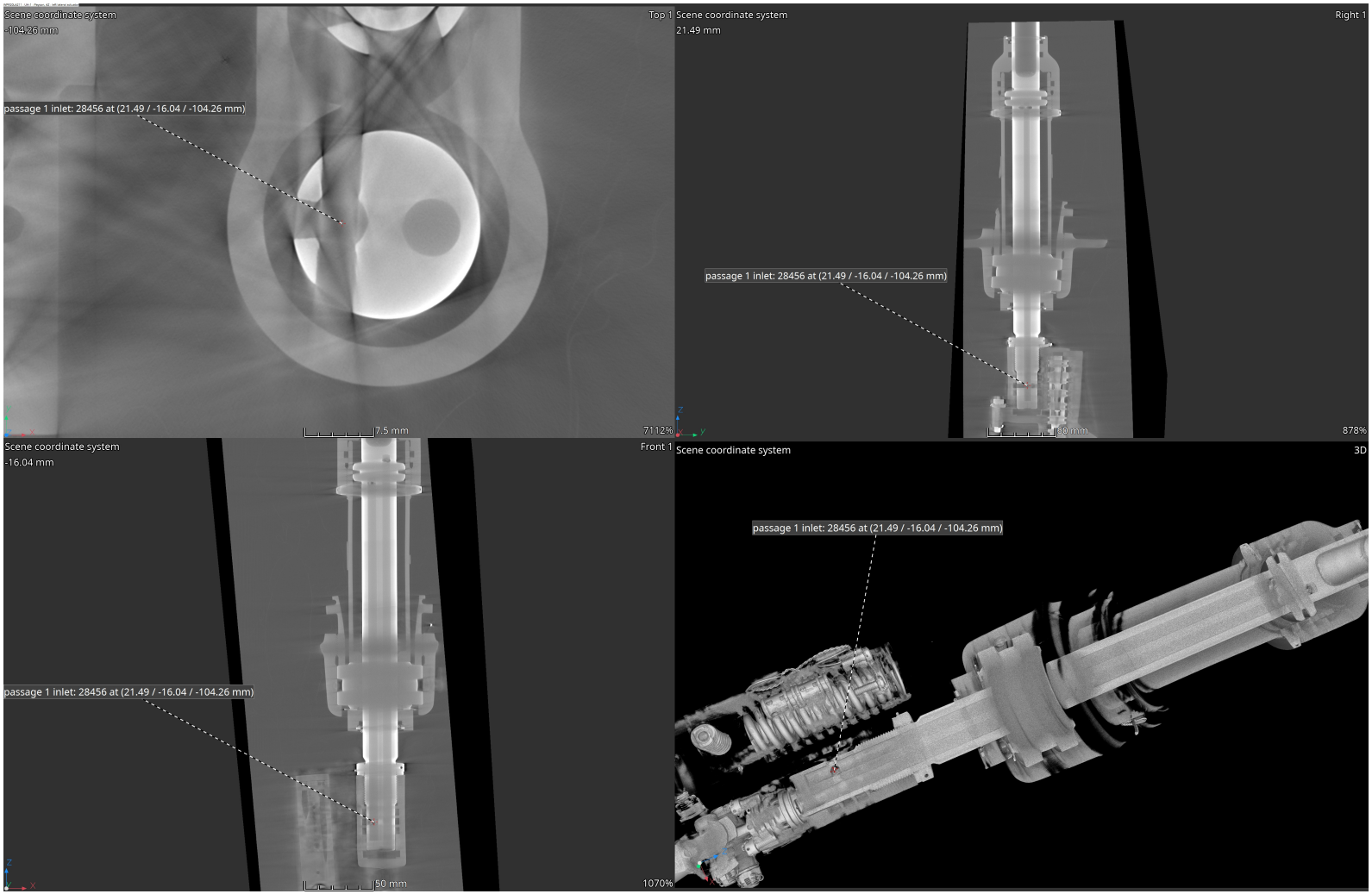


Figure 22
Left lateral actuator – passage 1 inlet

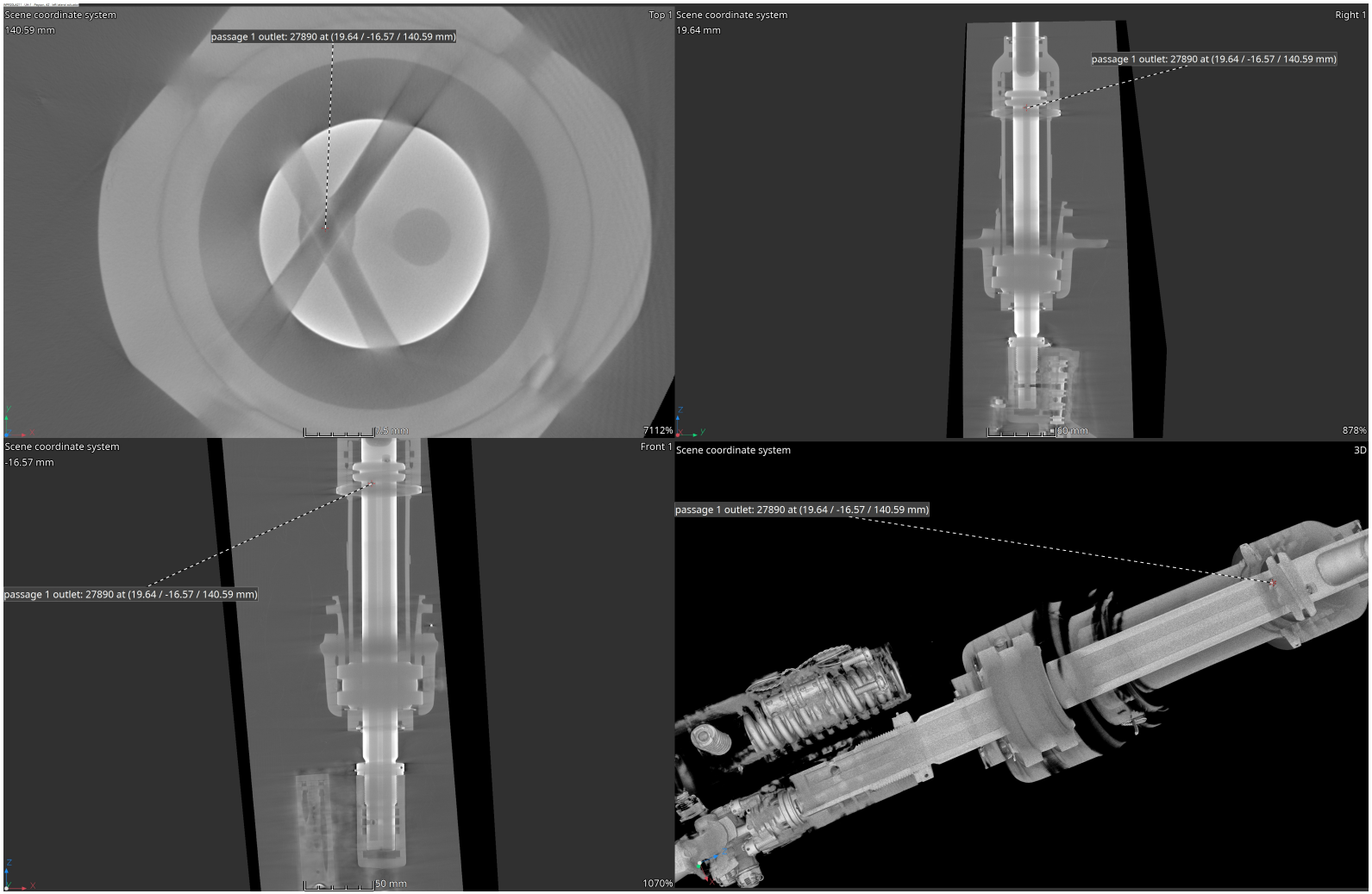


Figure 23
Left lateral actuator – passage 1 outlet

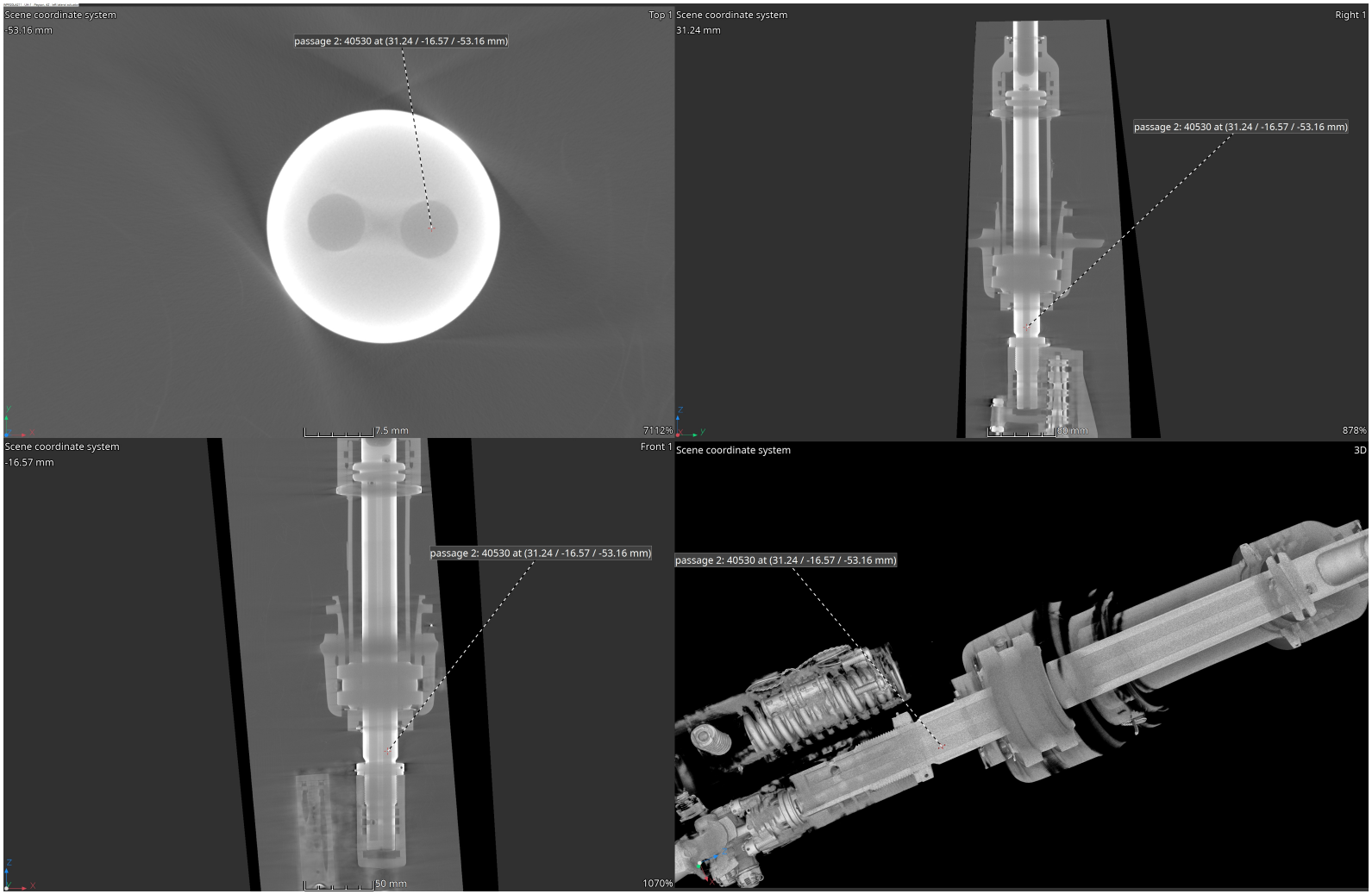


Figure 24
Left lateral actuator – passage 2

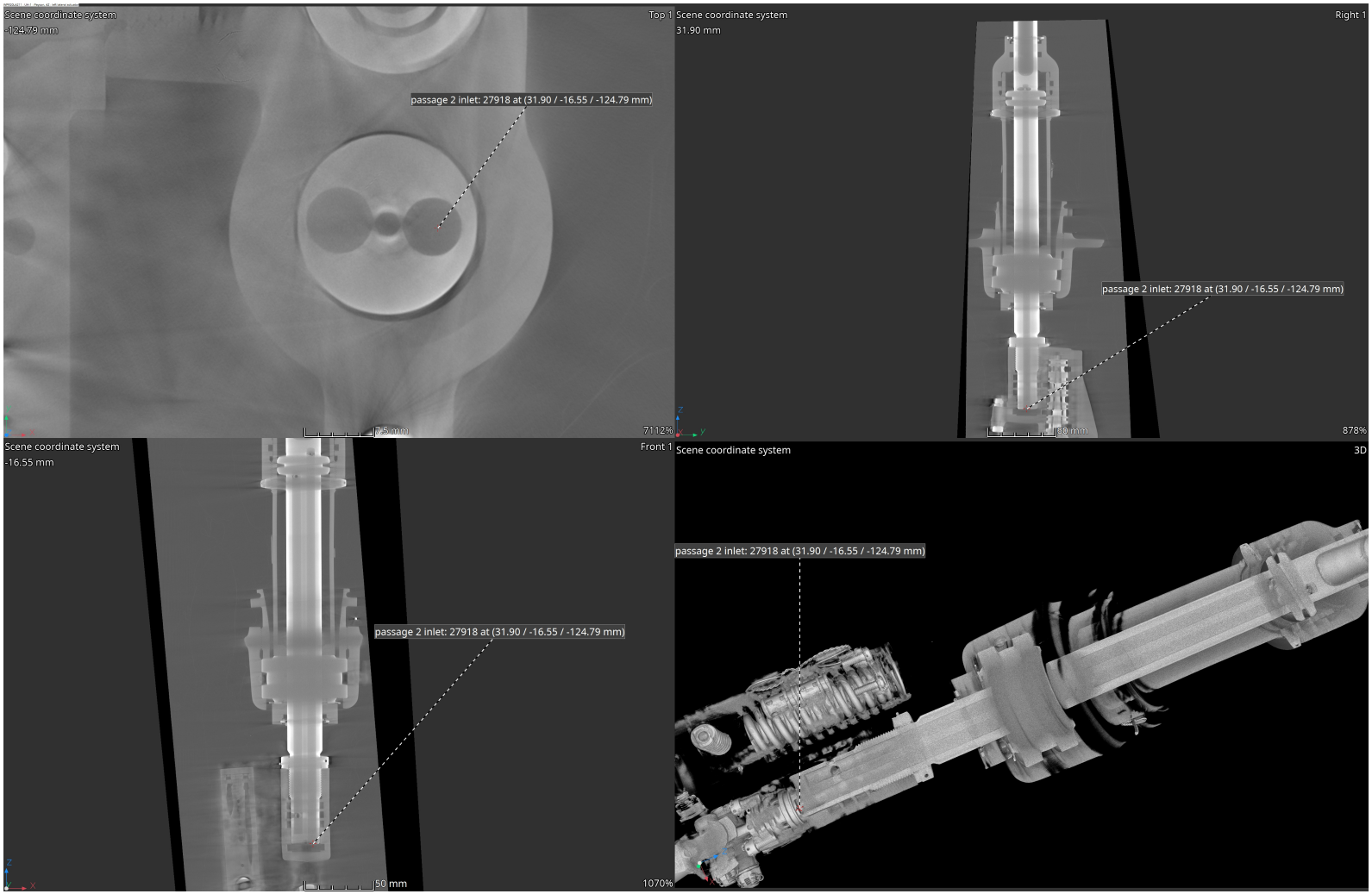


Figure 25
Left lateral actuator – passage 2 inlet

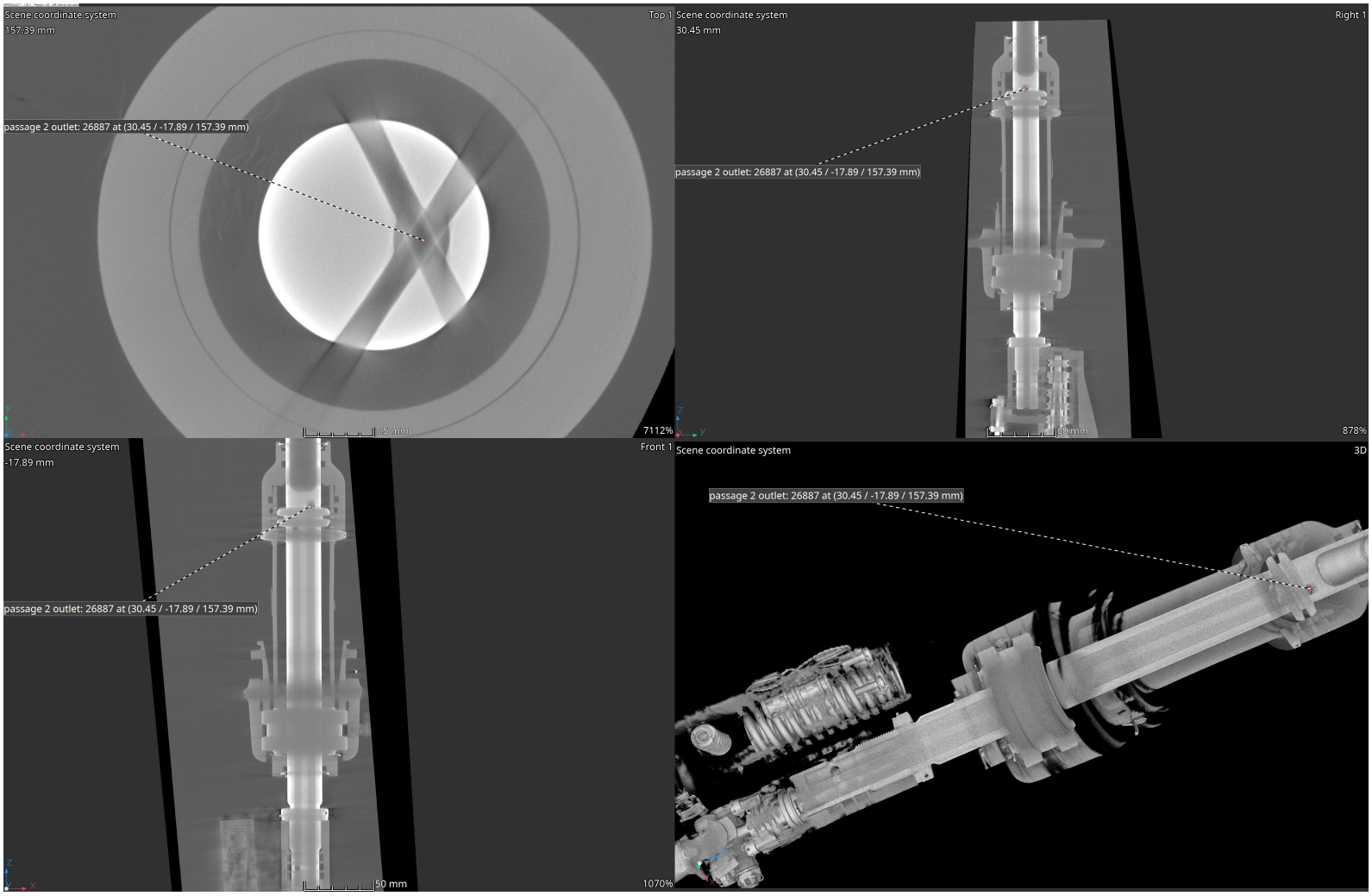


Figure 26
Left lateral actuator – passage 2 outlet

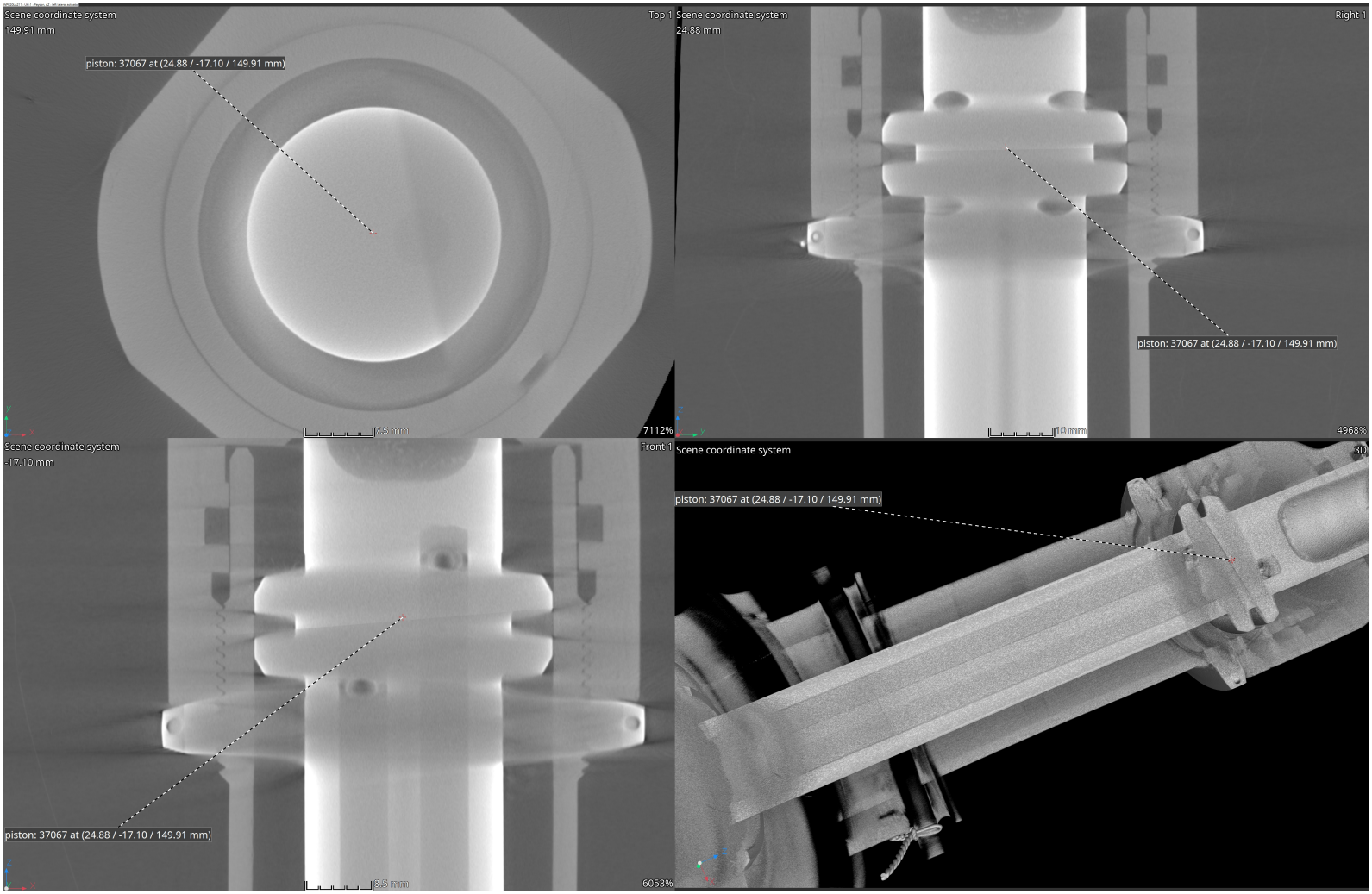


Figure 27
Left lateral actuator - piston

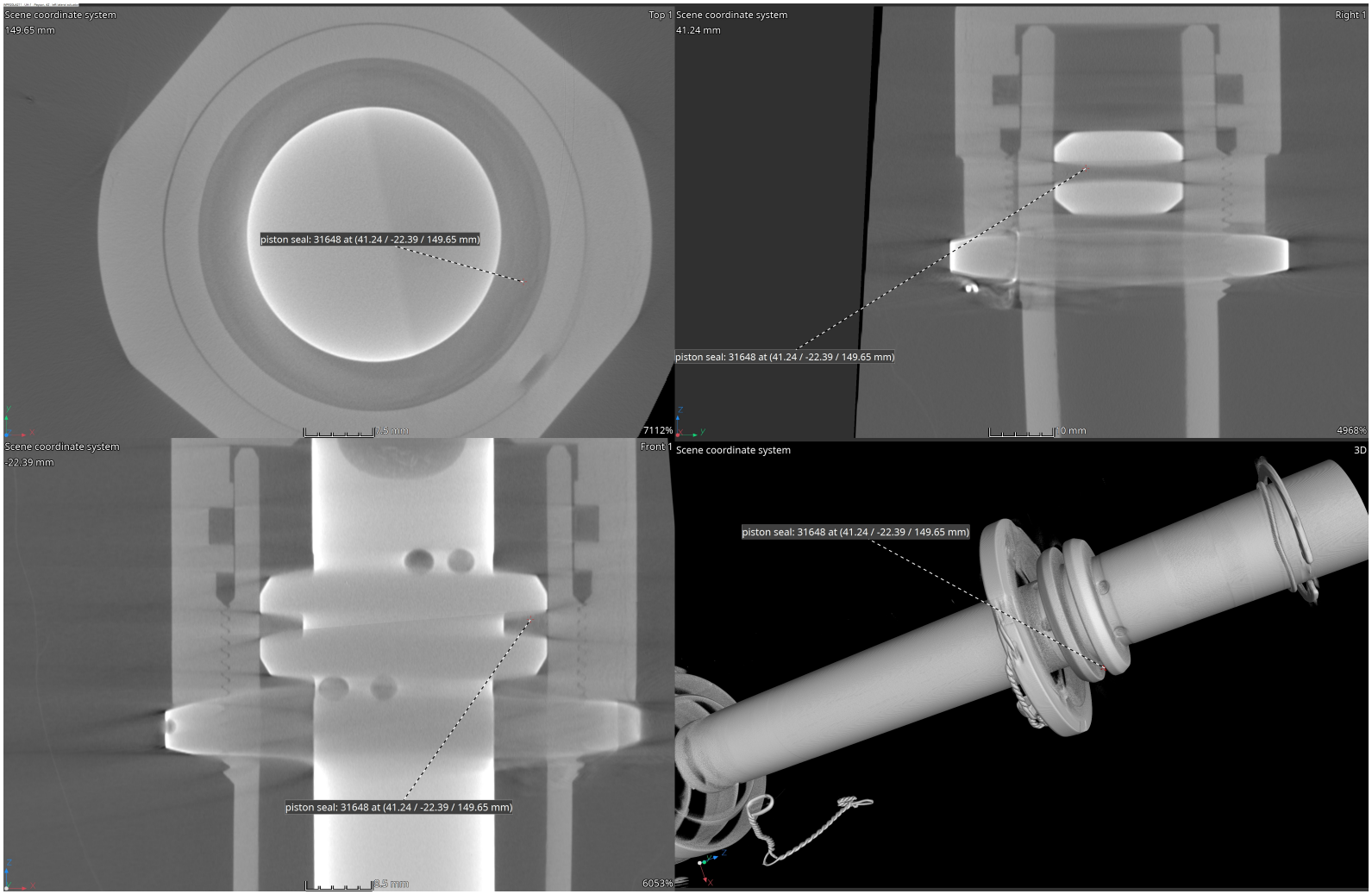


Figure 28
Left lateral actuator – piston seal

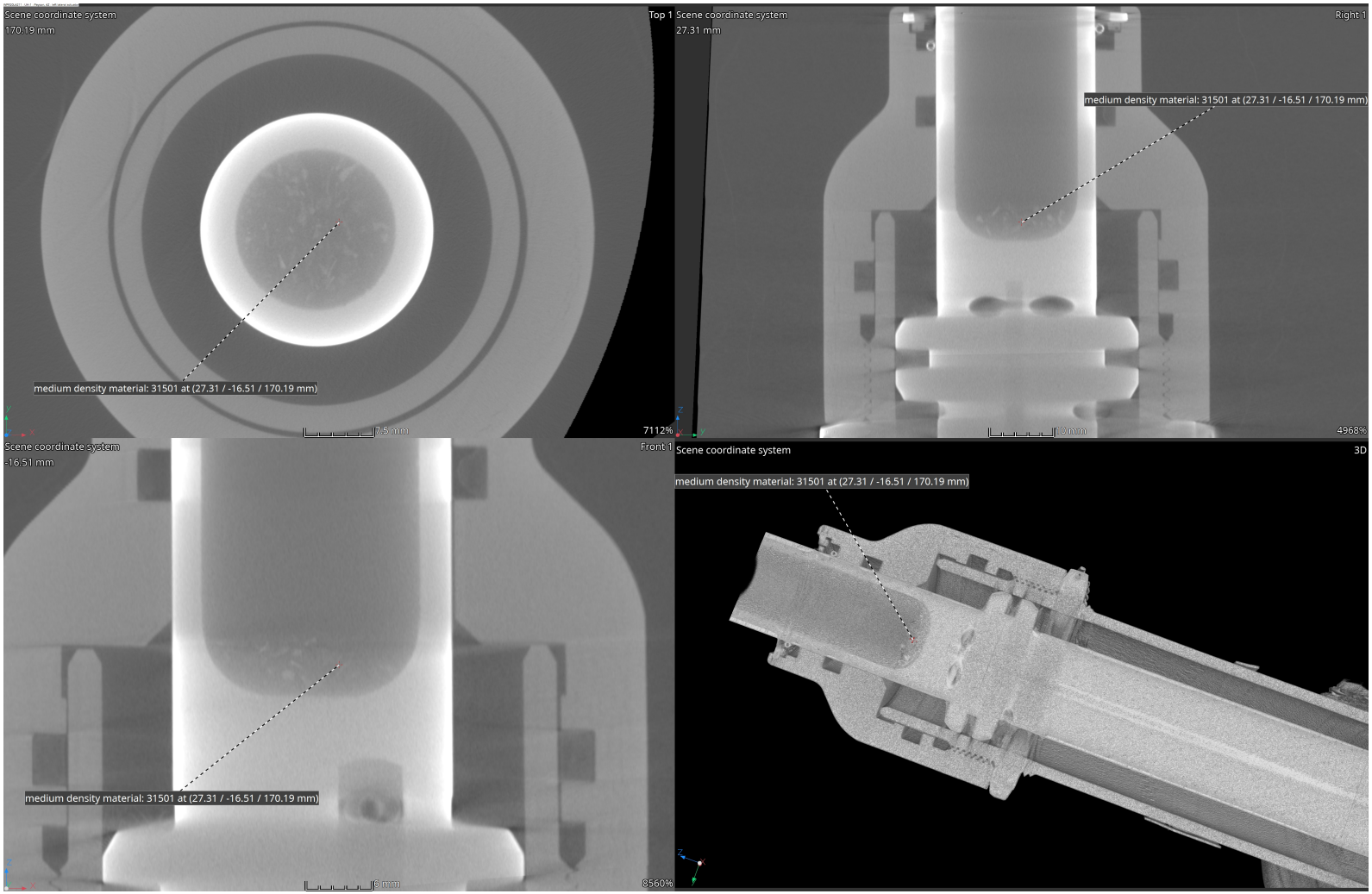


Figure 29
Left lateral actuator – medium density material

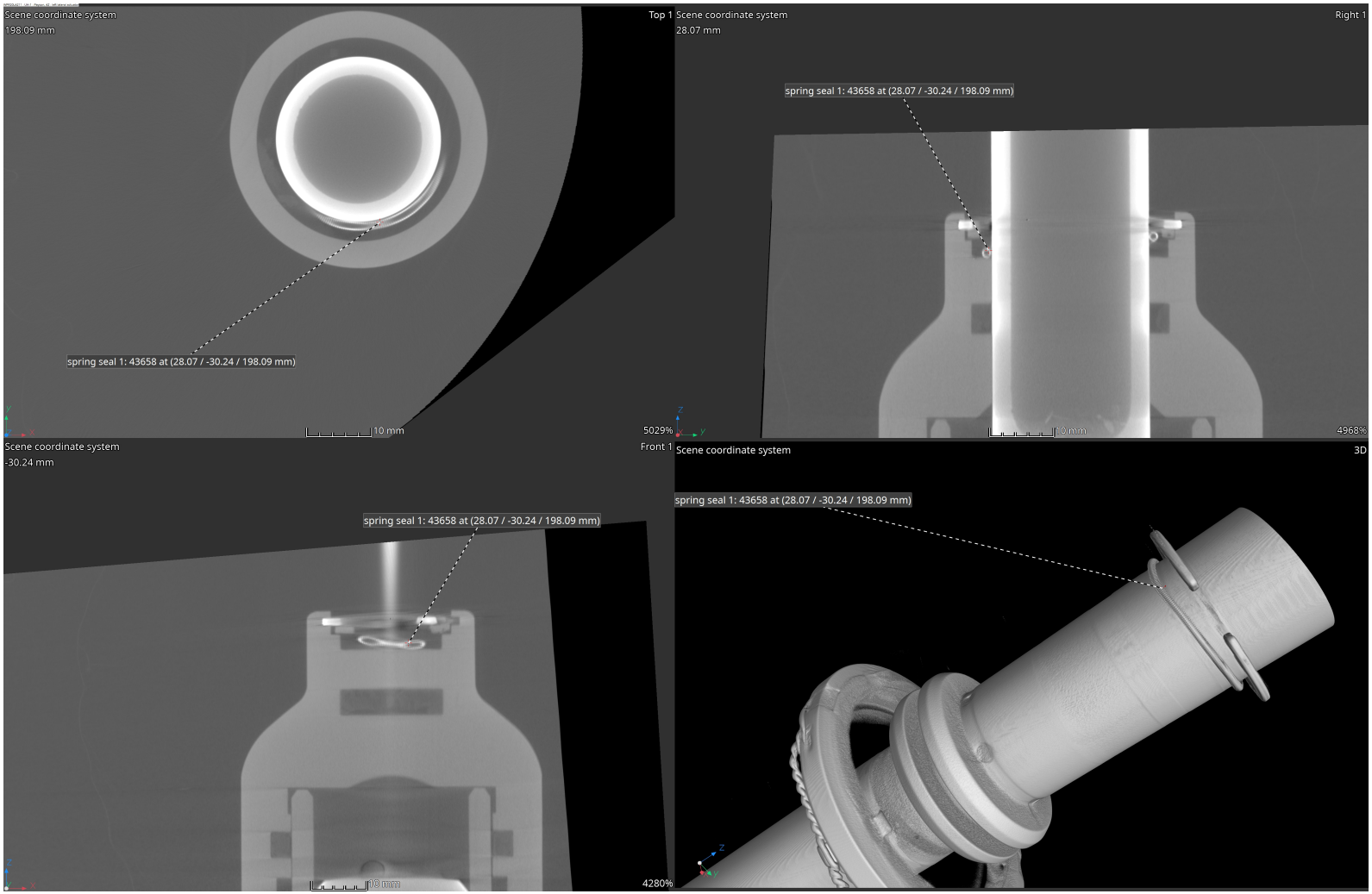


Figure 30
Left lateral actuator – spring seal 1

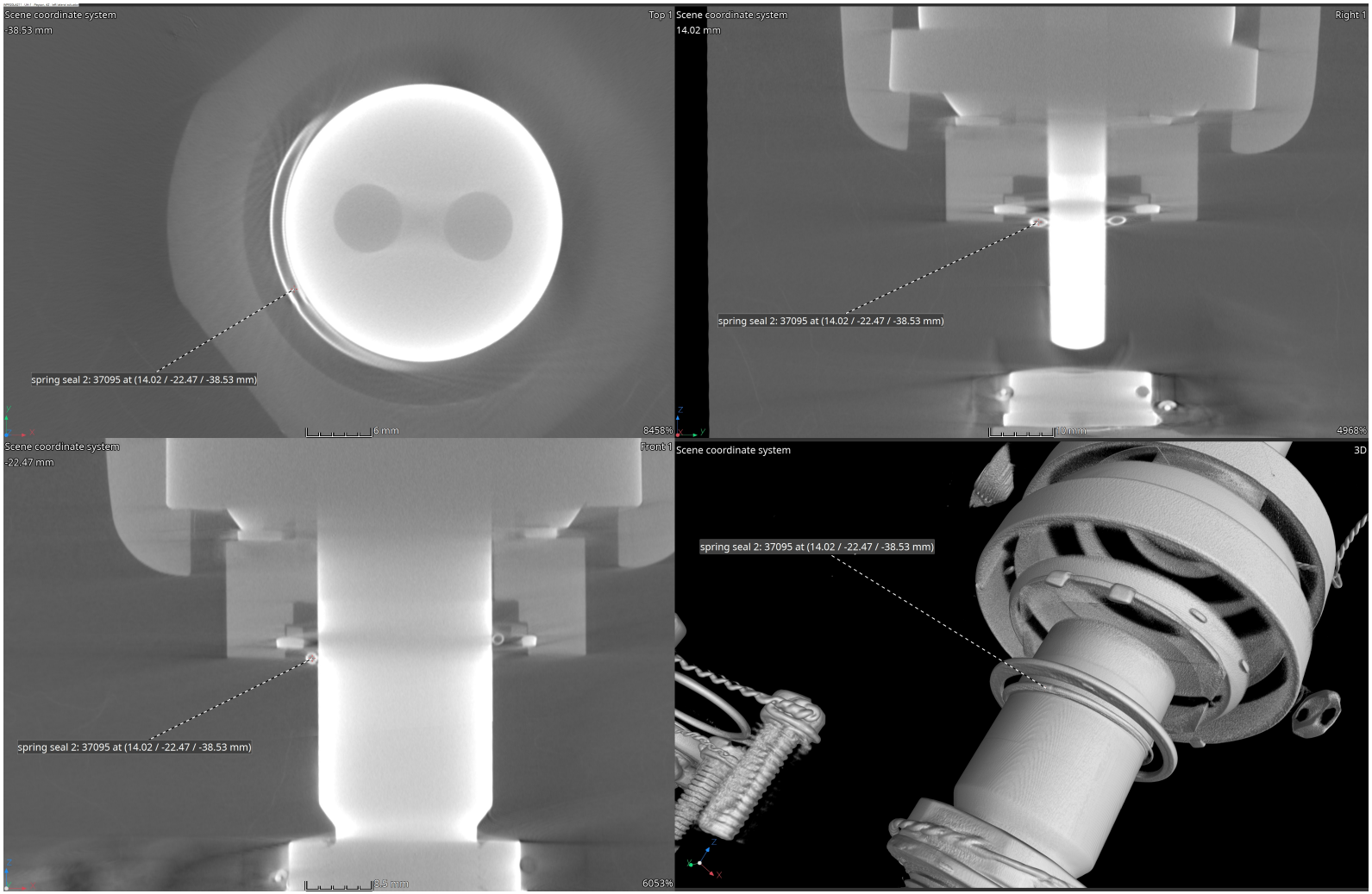


Figure 31
Left lateral actuator – spring seal 2

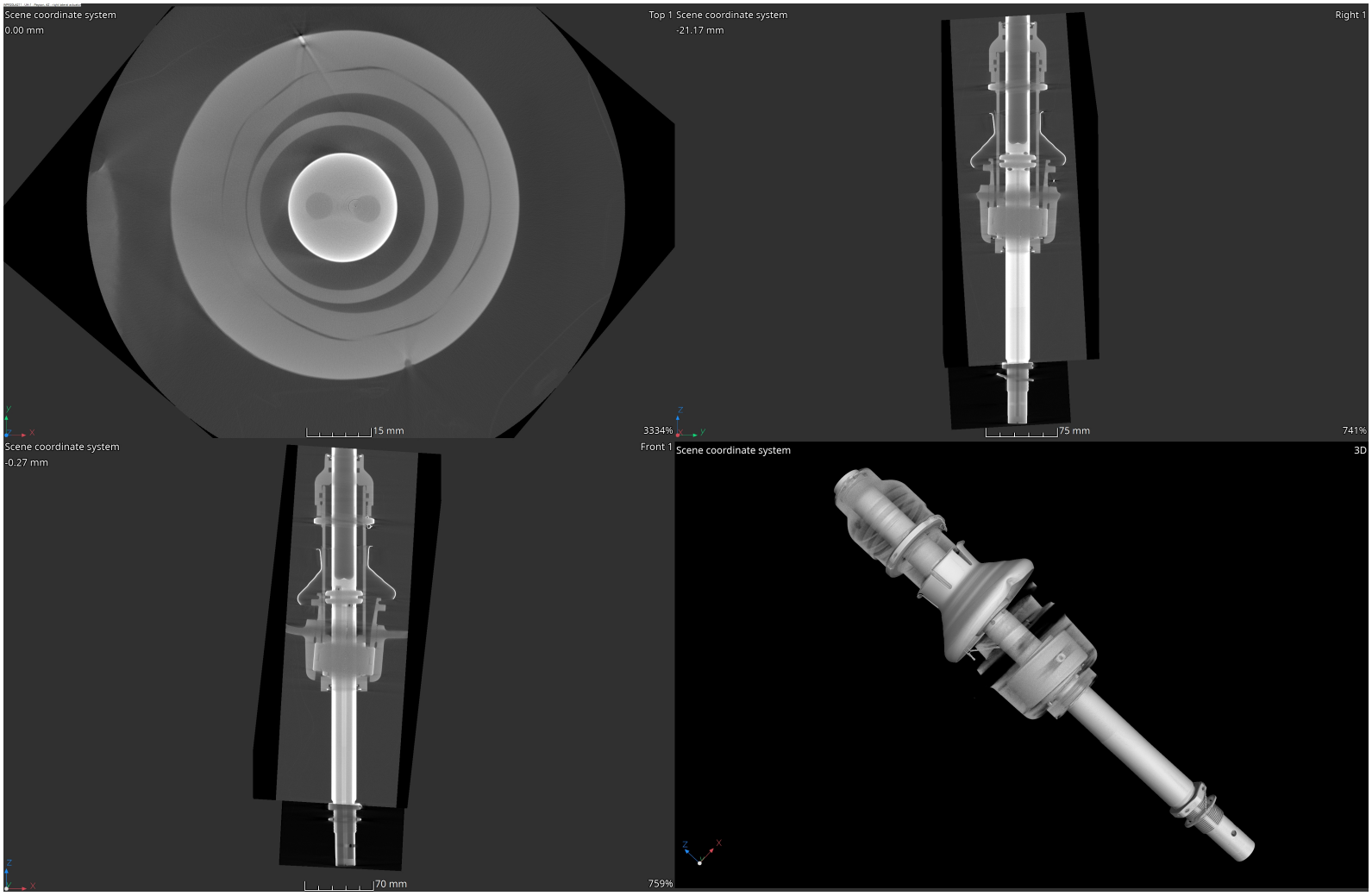


Figure 32
Right lateral actuator - overview

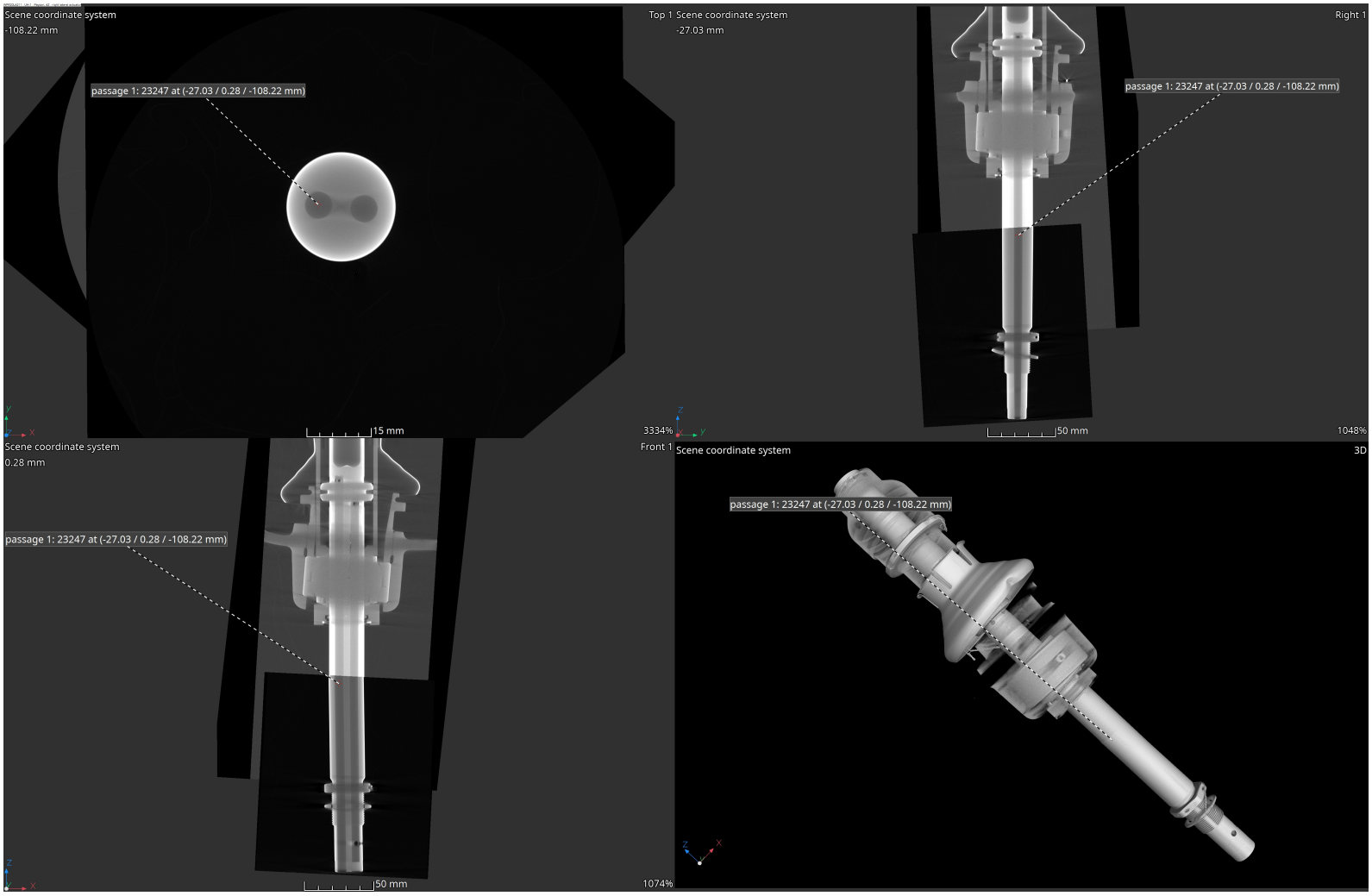


Figure 33
Right lateral actuator – passage 1

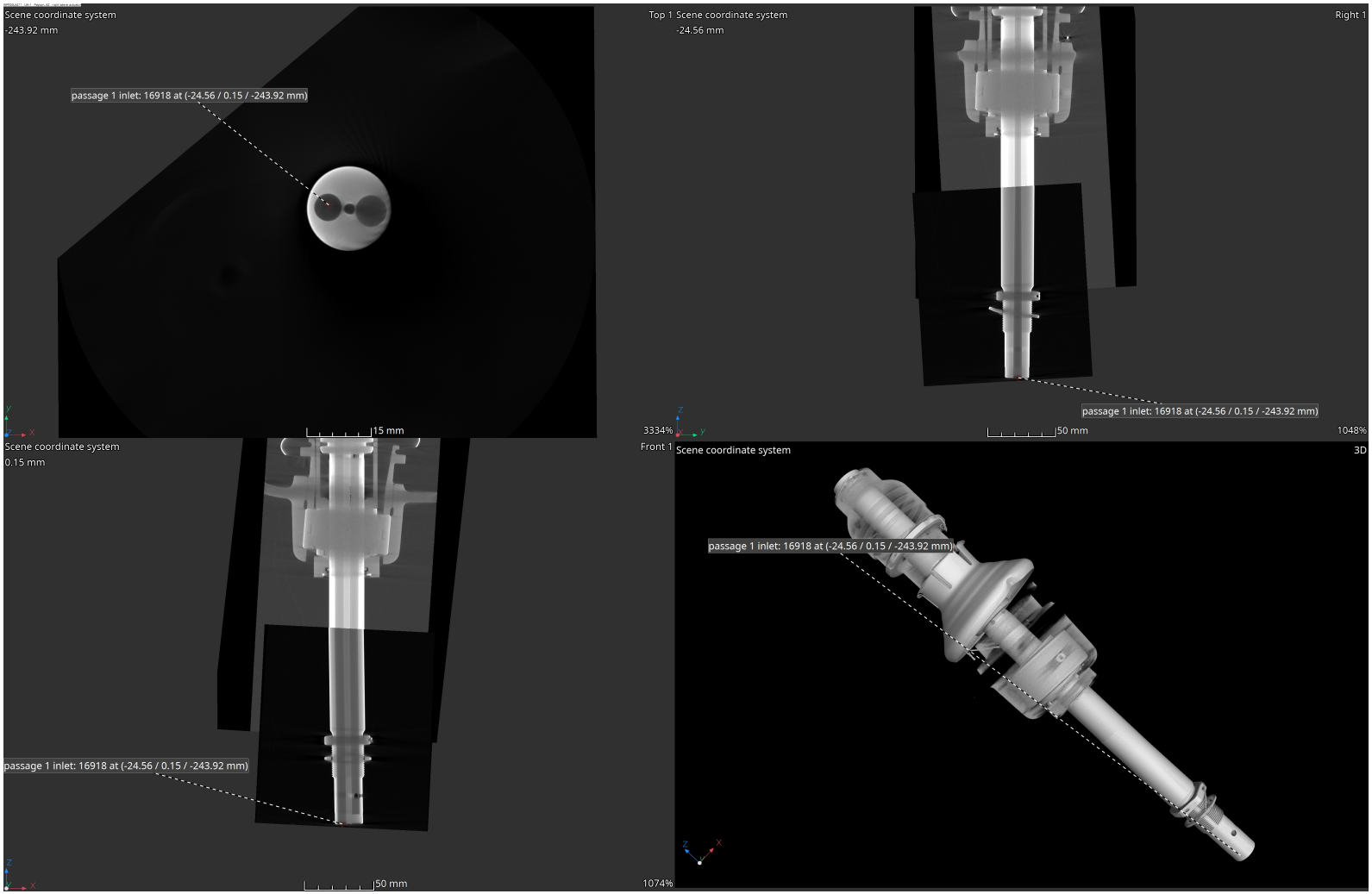


Figure 34
Right lateral actuator – passage 1 inlet

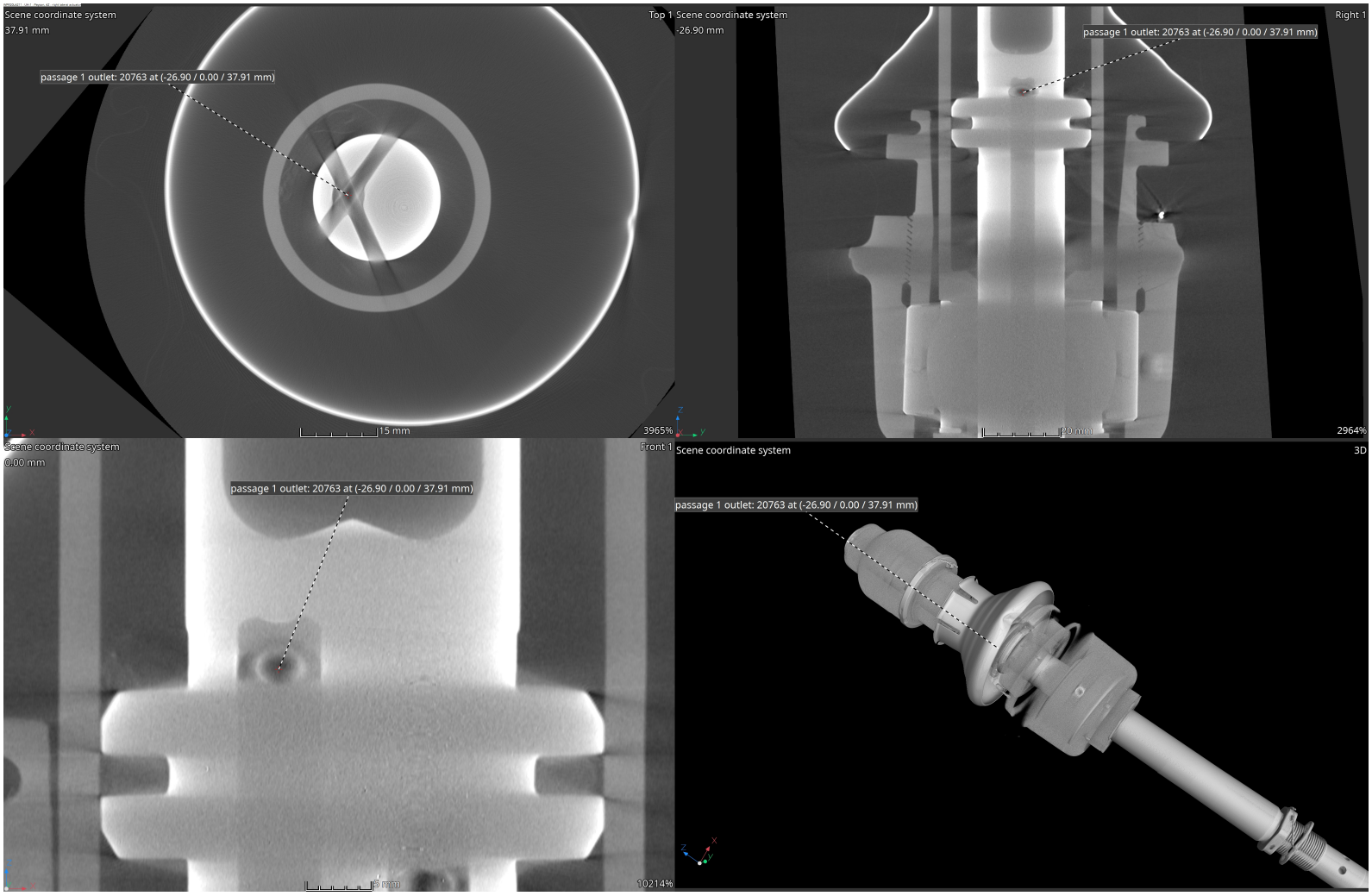


Figure 35
Right lateral actuator – passage 1 outlet

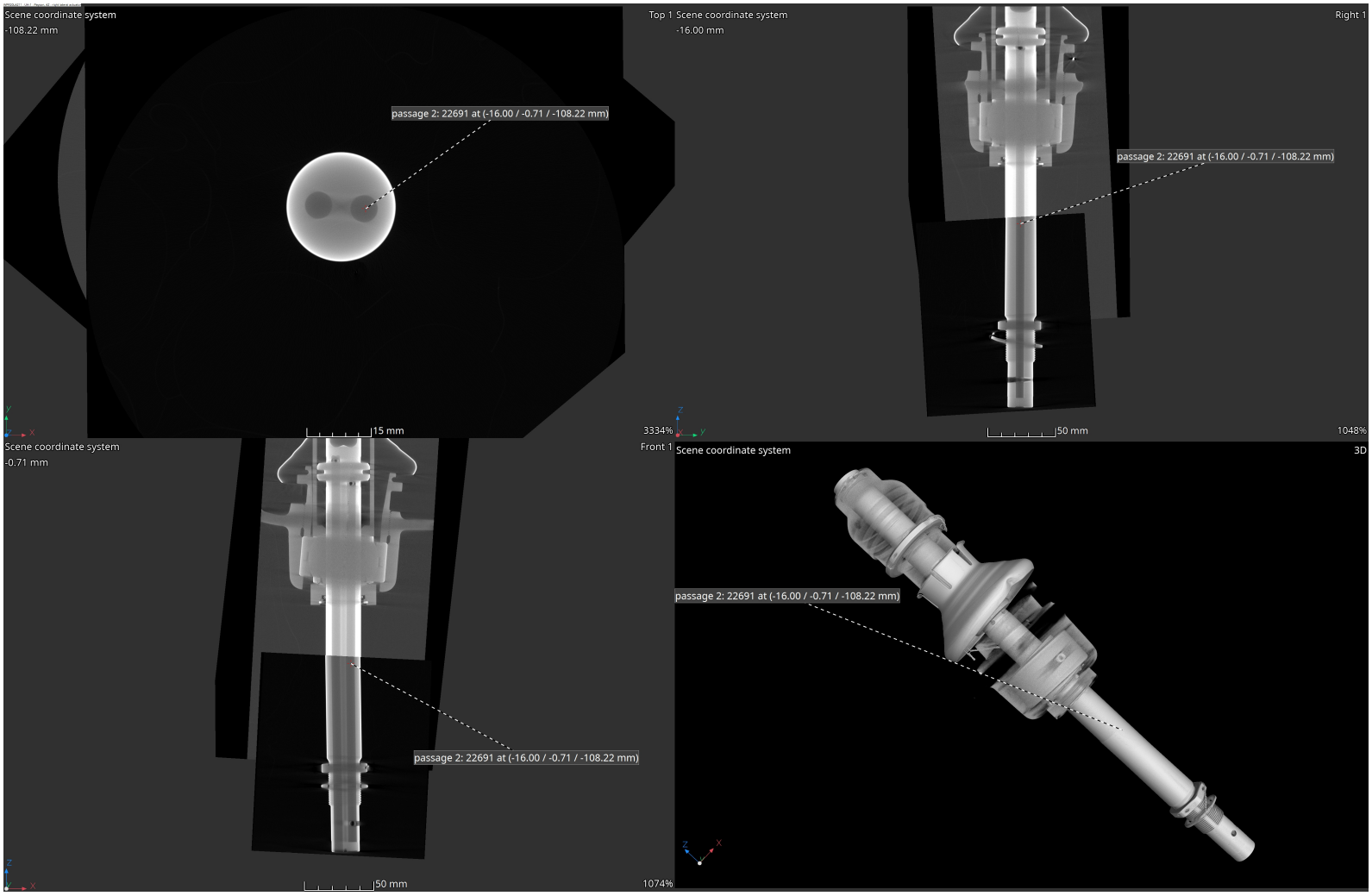


Figure 36
Right lateral actuator – passage 2

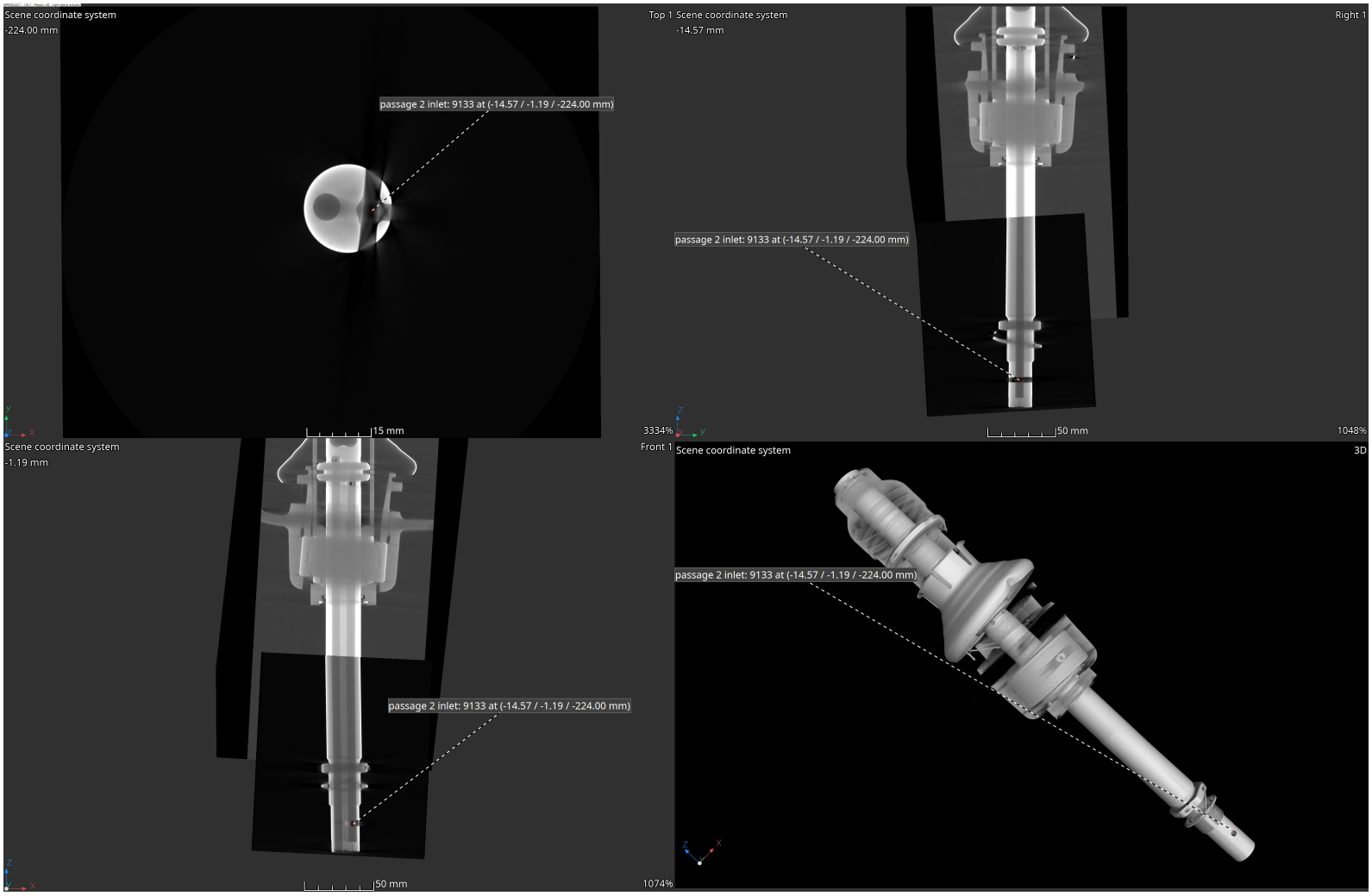


Figure 37
Right lateral actuator – passage 2 inlet

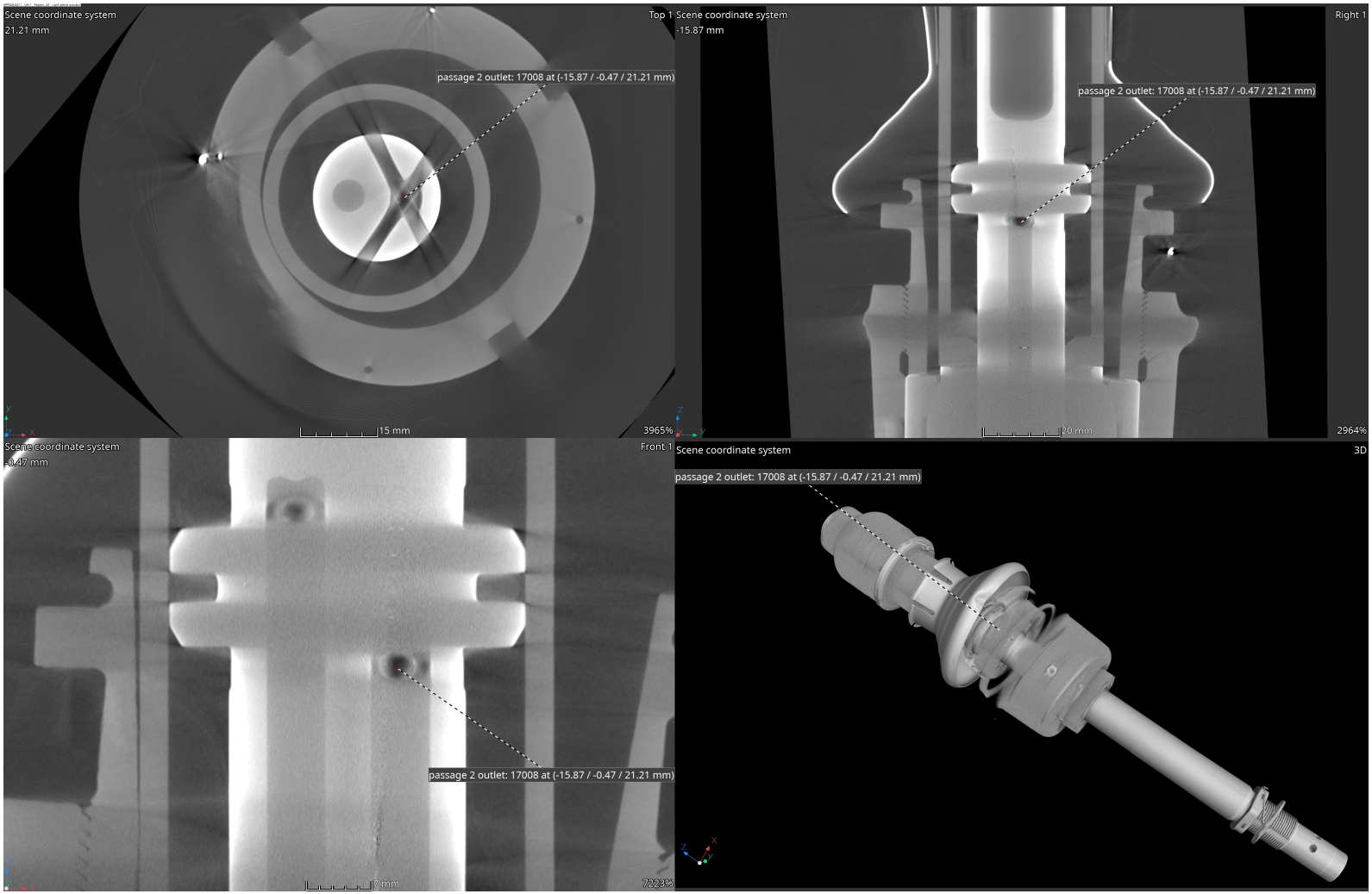


Figure 38
Right lateral actuator – passage 2 outlet

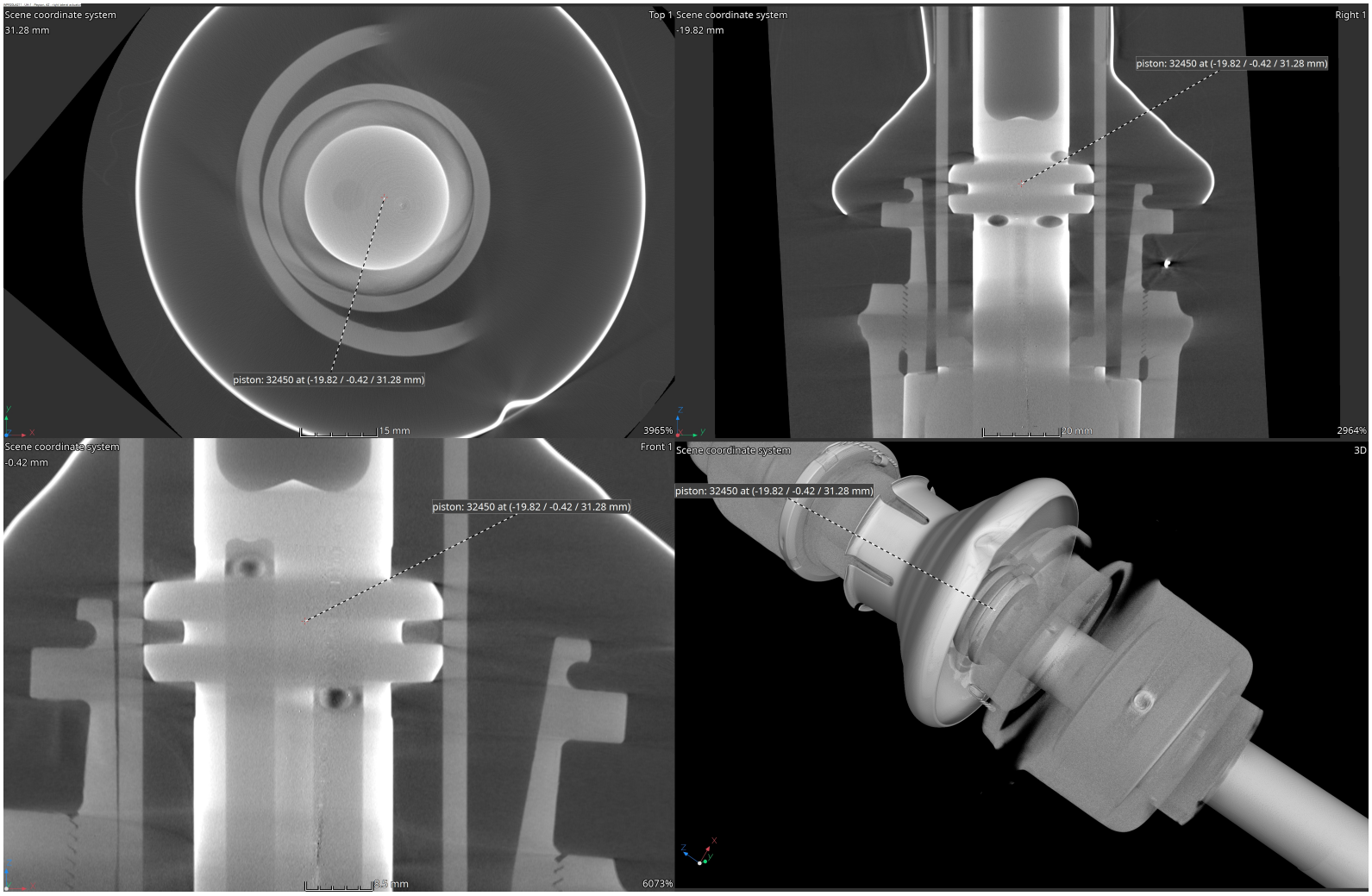


Figure 39
Right lateral actuator - piston

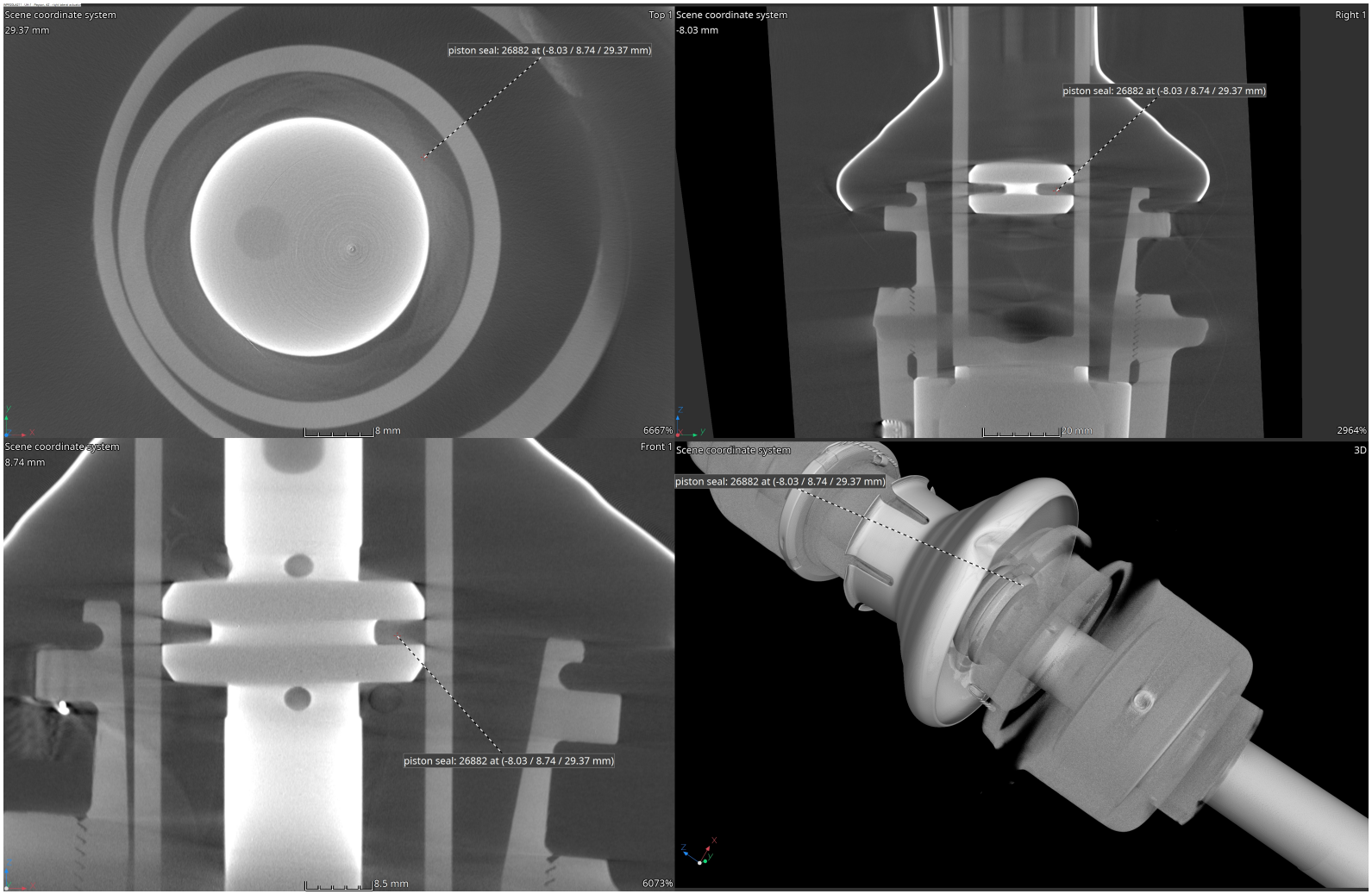


Figure 40
Right lateral actuator – piston seal

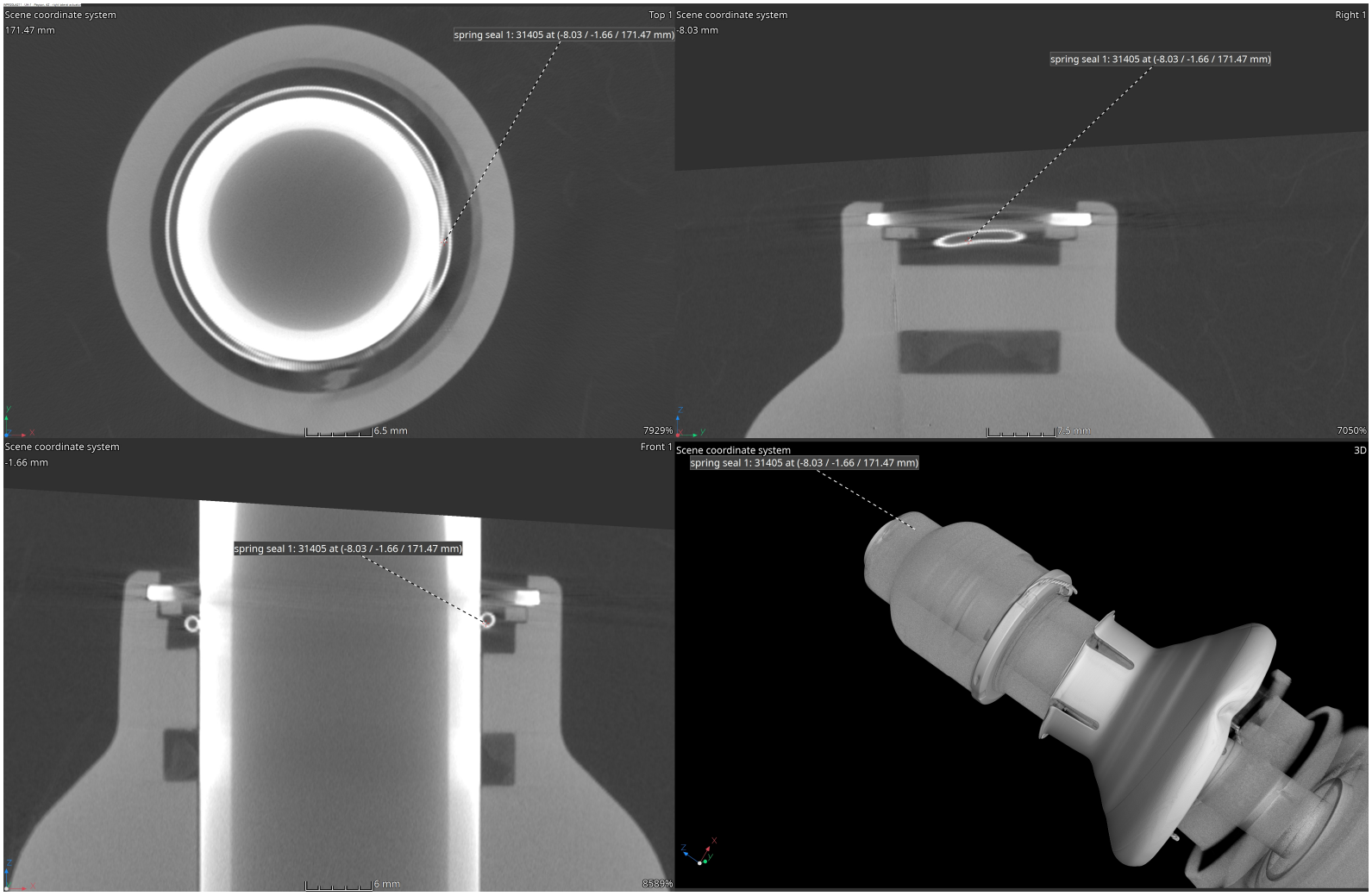


Figure 41
Right lateral actuator – spring seal 1

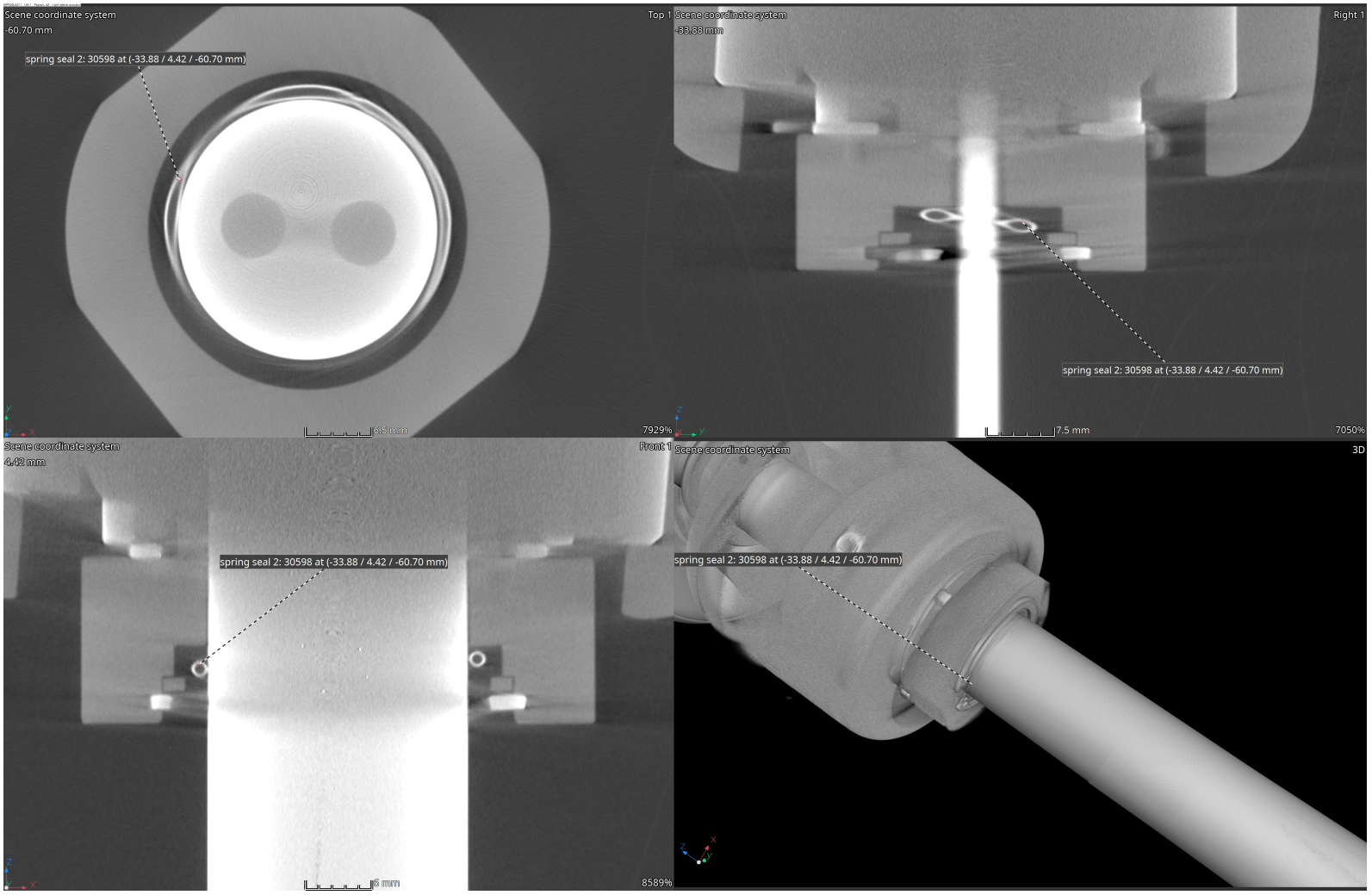


Figure 42
Right lateral actuator – spring seal 2

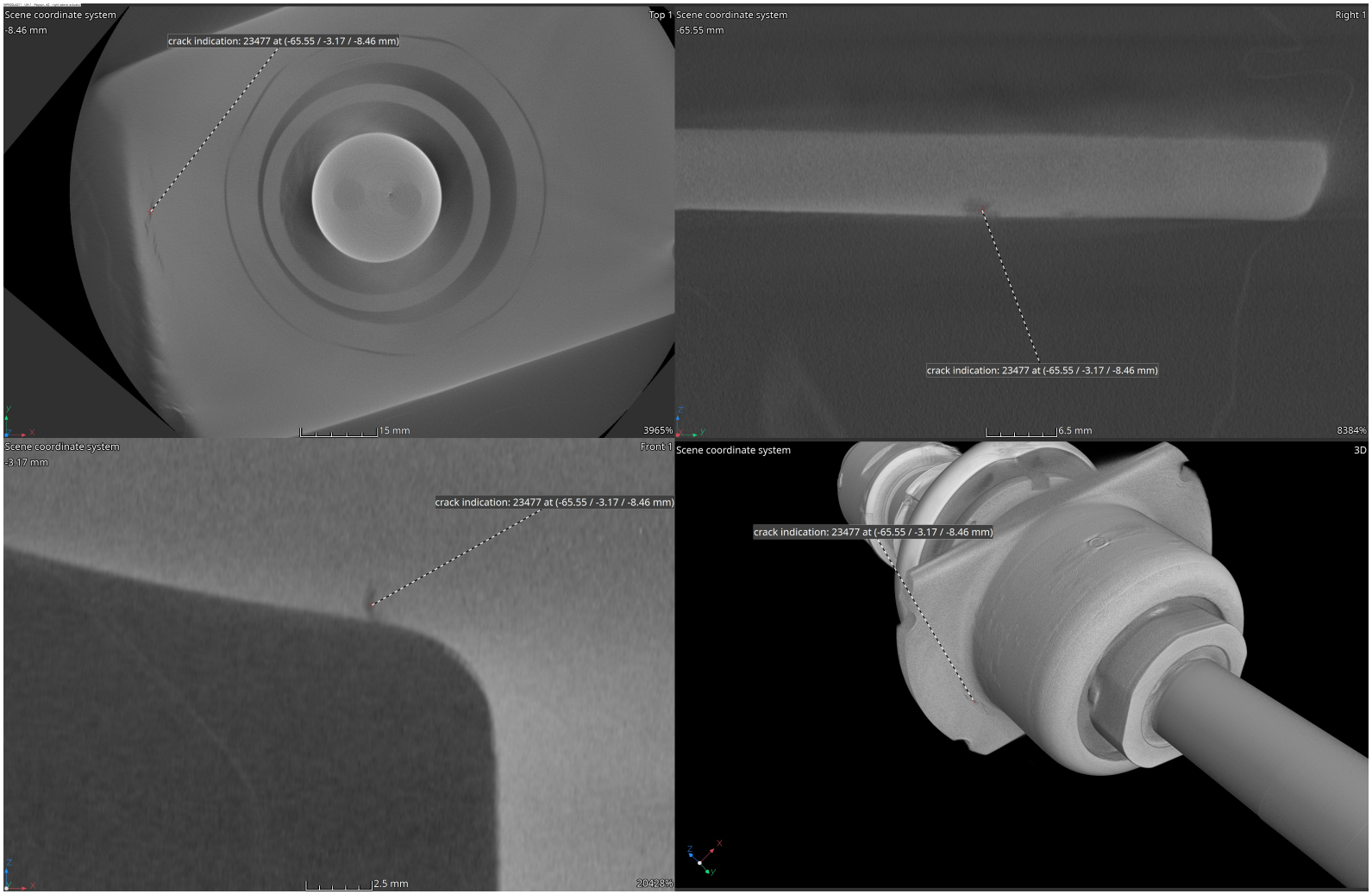


Figure 43
Right lateral actuator – crack indication

Scott Warren
Lead Aerospace Engineer
(Computed Tomography Specialist)