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

May 9, 2022

Computed Tomography Specialist's Factual Report

CEN21LA259

A. ACCIDENT

Location:	Aspen-Pitkin County Airport (ASE), Aspen, Colorado
Date:	June 4, 2021
Time:	0954 mountain daylight time
Airplane:	Cessna 560XL airplane, N615RG

B. GROUP

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

C. SUMMARY

On June 4, 2021 at 0954 mountain daylight time, a Cessna 560XL airplane, N615RG, was substantially damaged when it was involved in an accident at Aspen-Pitkin County Airport (ASE), Aspen, Colorado. The pilot, co-pilot, and 3 passengers were uninjured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The internal configuration of the landing gear handle from the accident aircraft was documented using radiographic images that were collected from July 28 to August 16, 2021, in Chicago, Illinois. A total of 4,992 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 landing gear handle was in the extended position, and there were no indications of malfunctions, broken components, disconnected wiring, or other problems with the mechanisms (including the handle spring, over center track, control switches, solenoid, and lock out lever) within the landing gear handle.

D. DETAILS OF THE INVESTIGATION

1.0 General

The landing gear handle from the accident aircraft was subjected to x-ray radiograph and computed tomography (CT) scanning to document the component's internal condition. The scanning was conducted from July 28 to August 16, 2021, by Varex, Inc under the direction of the NTSB using the Actis 225/500 microfocus 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 4,992 slices, and the total size of the combined data sets was approximately 39.0 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.

For selected areas within the component, target CT techniques were used. The target CT techniques used geometric magnification[1] to provide for enhanced resolution within a component. The field of view during these scans is reduced, but the resolution within that field of view is much better than in the overall component scans.

The windings within the lockout solenoid 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] Geometric magnification is a scanning technique where the component is moved closer to the x-ray source. The x-ray beam passes through a smaller region within the component, and that smaller region's image information is spread across the x-ray detector. The resulting image is created at a higher resolution.

Table 1
Scan Protocols

Component	Landing gear handle – overall	Lock out solenoid – target CT	Lock out mechanism region of interest – target CT
Number of slices	2175	1601	1216
Voxel[2] Size - X Direction (millimeter(mm))	0.074	0.030	0.074
Voxel Size - Y Direction (mm)	0.074	0.030	0.074
Voxel Size - Z Direction (mm)	0.075	0.040	0.076
Image Projections per Revolution	1800	2160	2160
Exposure time (milliseconds)	285.6	285.6	285.6
Frames to Avg (frames per projection)	2	2	2
X-ray Source Voltage (kilovolts)	220	223	223
X-ray Source Current (mA)	0.550	0.550	0.580
Source Filter Thickness (mm)	1	1	1
Source Filter Material	brass	brass	brass
Image Matrix Size (pixels)	2048 x 2048	2048 x 2048	2048 x 2048

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 two-dimensional orthogonal slice images and three-dimensional reconstructed images of the component. As part of the evaluation, some sections of the component were digitally removed or rendered transparent in the three-dimensional images 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

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

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 images of the component 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 component are shown in figures 1 through 30. Review of the images determined that, when the scans were conducted, the landing gear handle was in the extended position, and there were no indications of malfunctions, broken components, disconnected wiring, or other problems with the mechanisms (including the handle spring, over center track, control switches, solenoid, and lock out lever) within the landing gear handle.

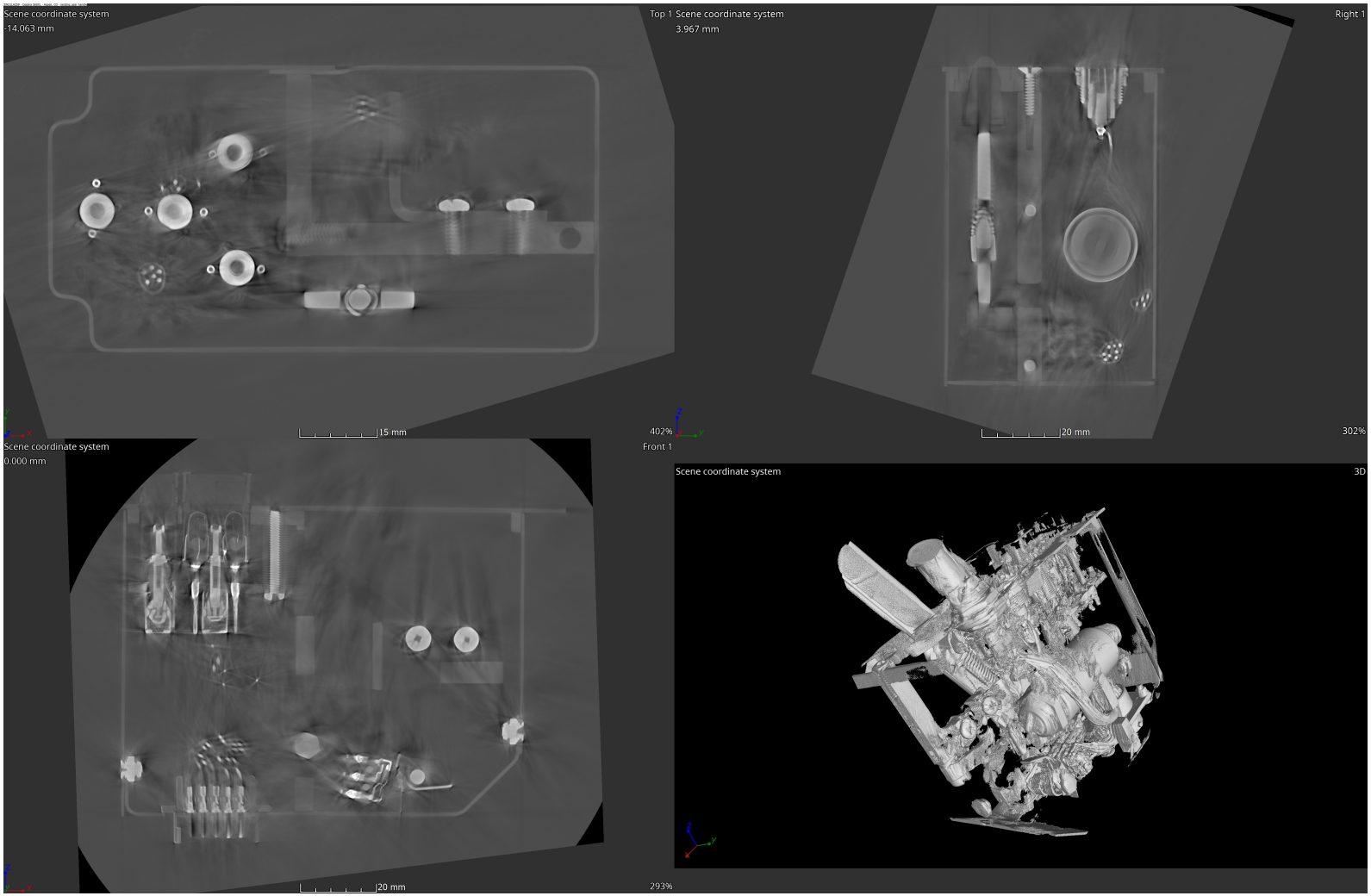

Figure 1
Landing gear handle - overview

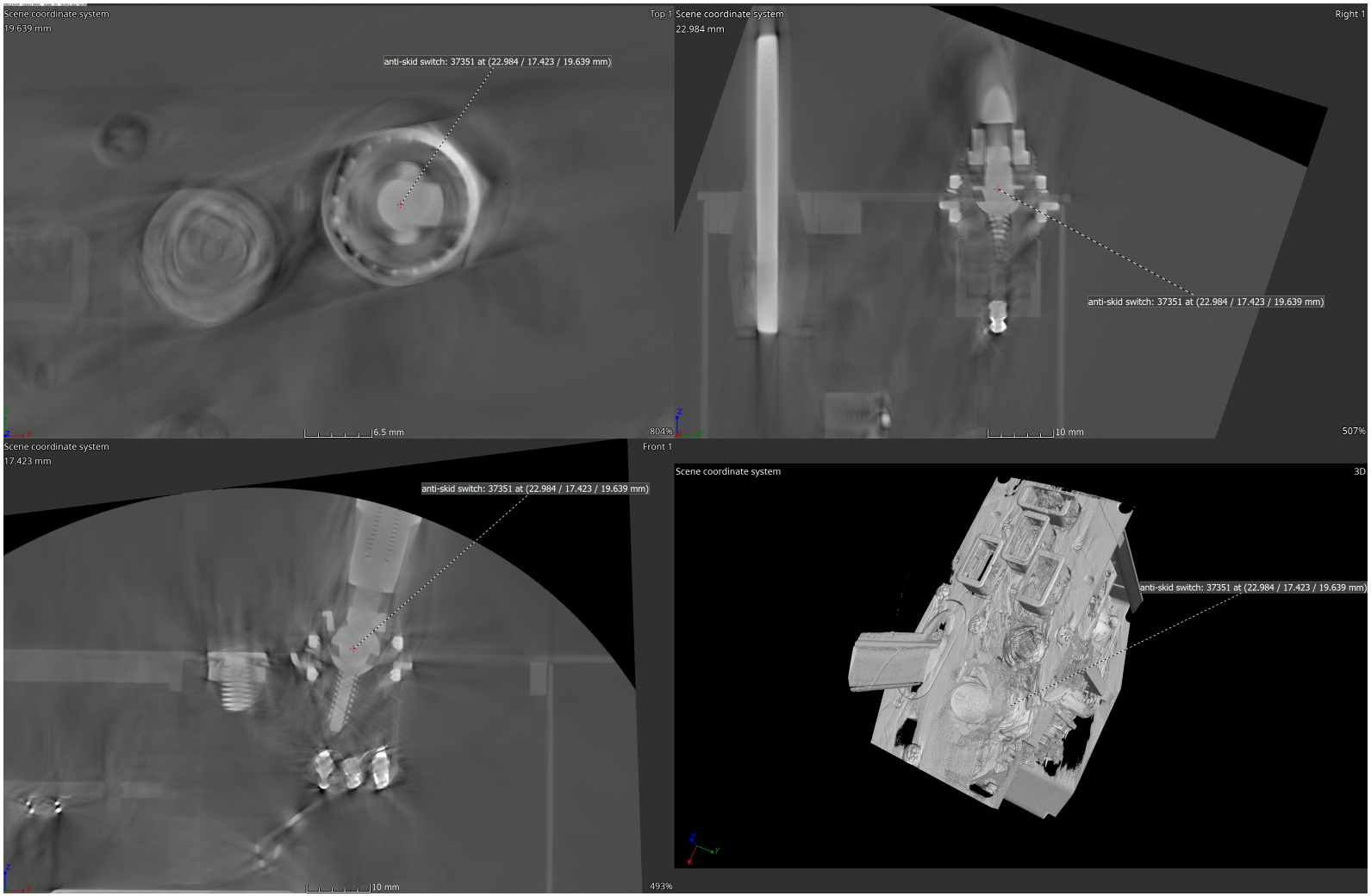

Figure 2
Landing gear handle – anti-skid switch

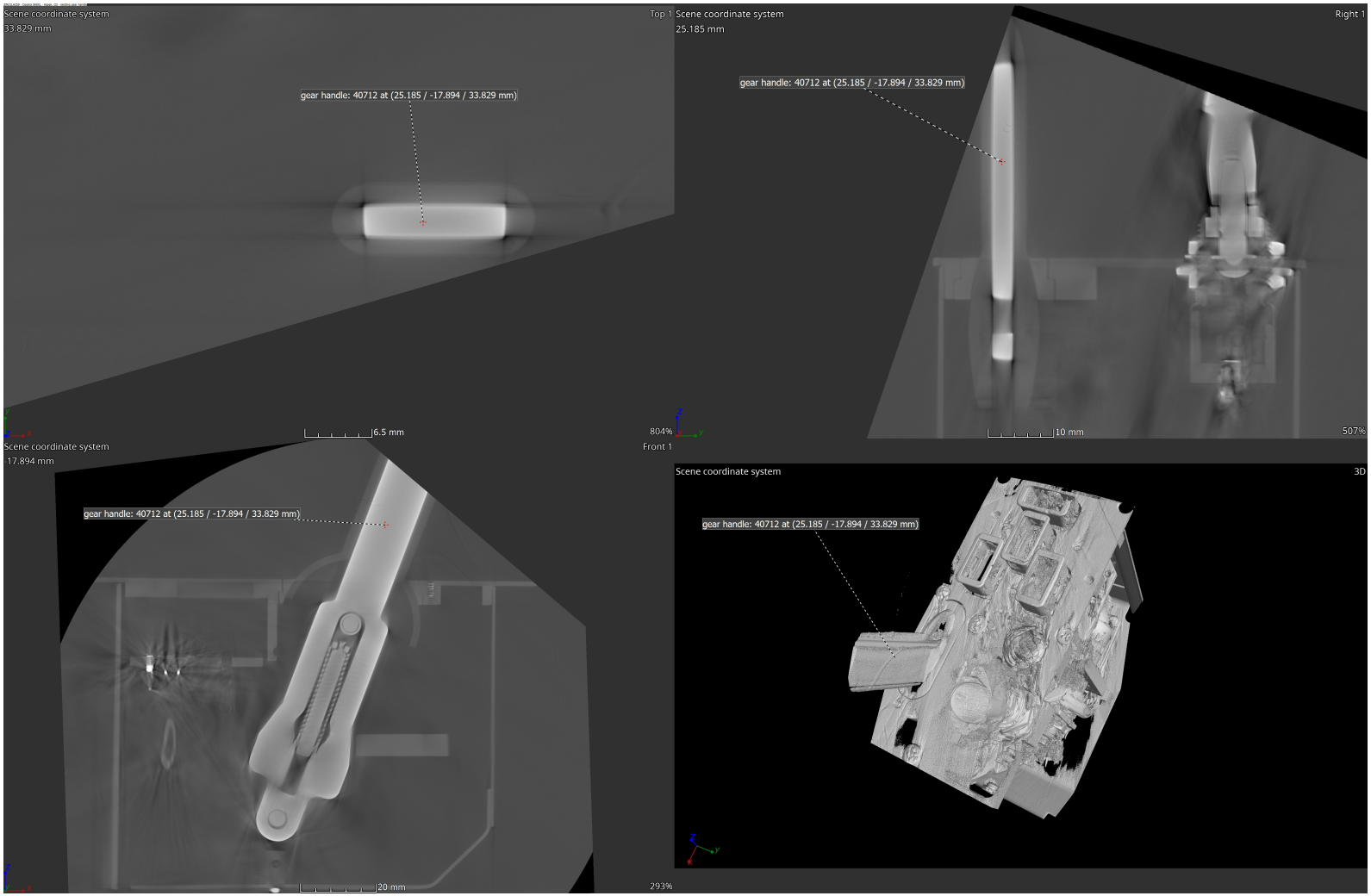

Figure 3
Landing gear handle – gear handle

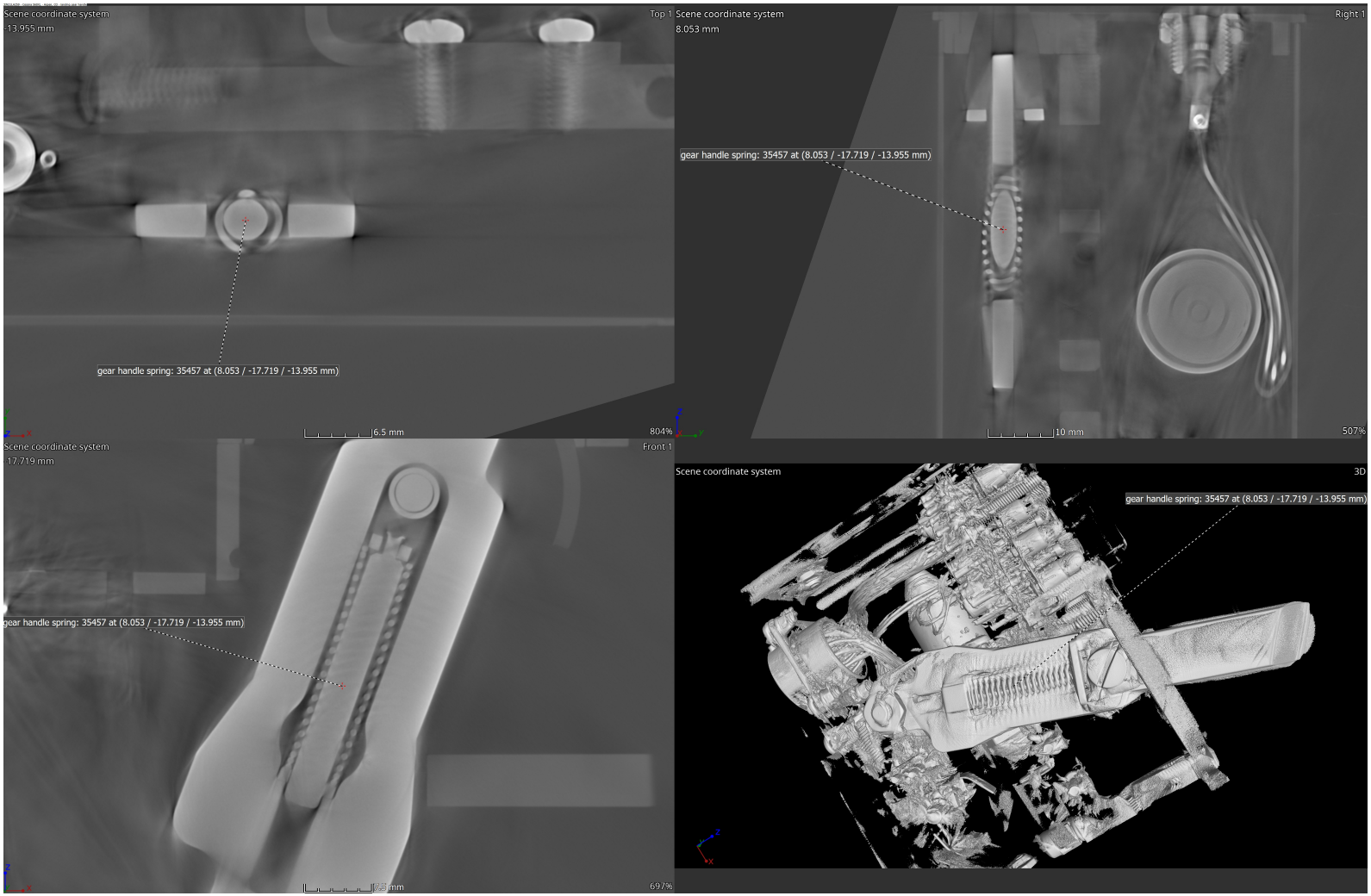

Figure 4
Landing gear handle – gear handle spring

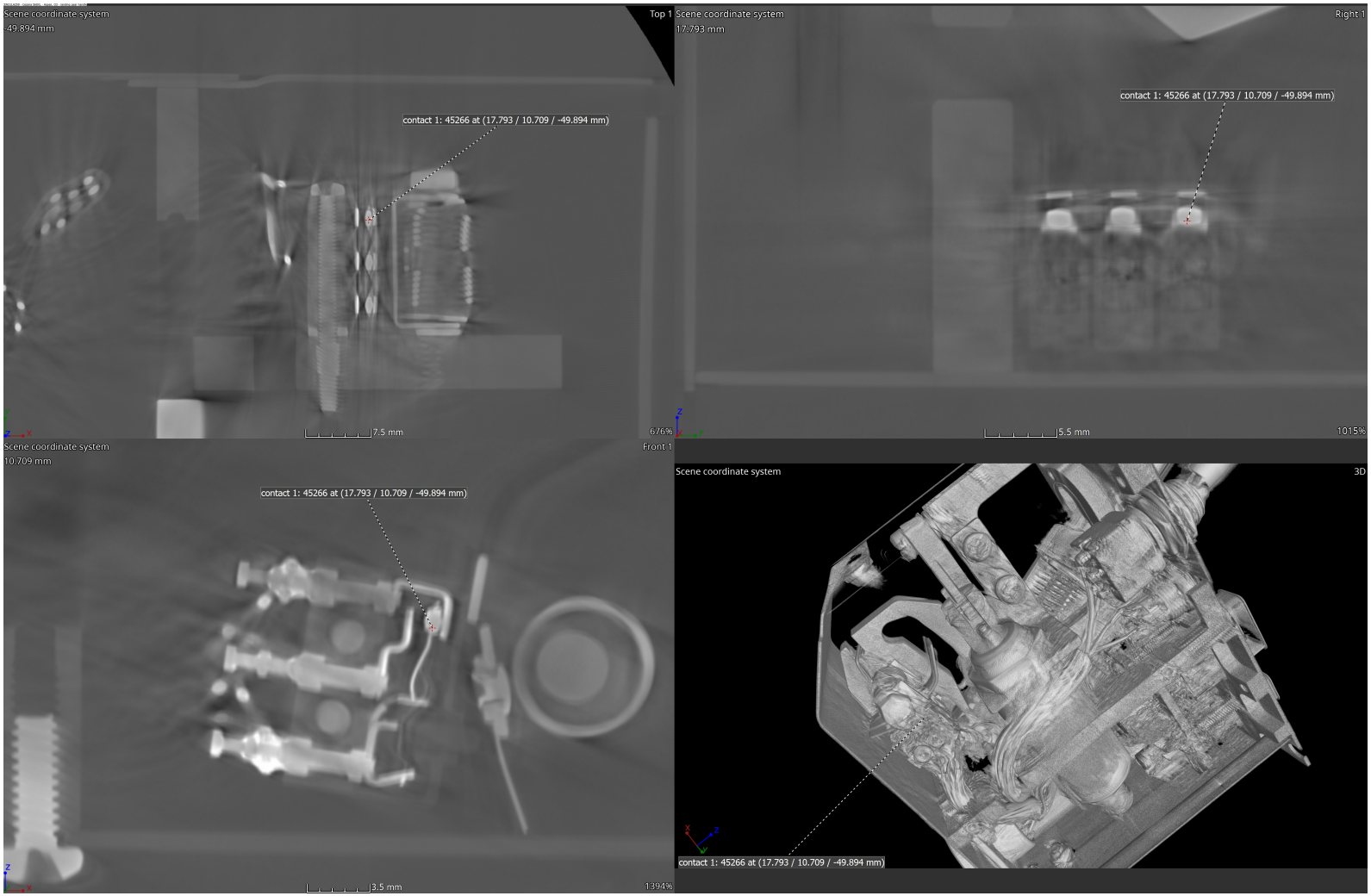

Figure 5
Landing gear handle – contact 1

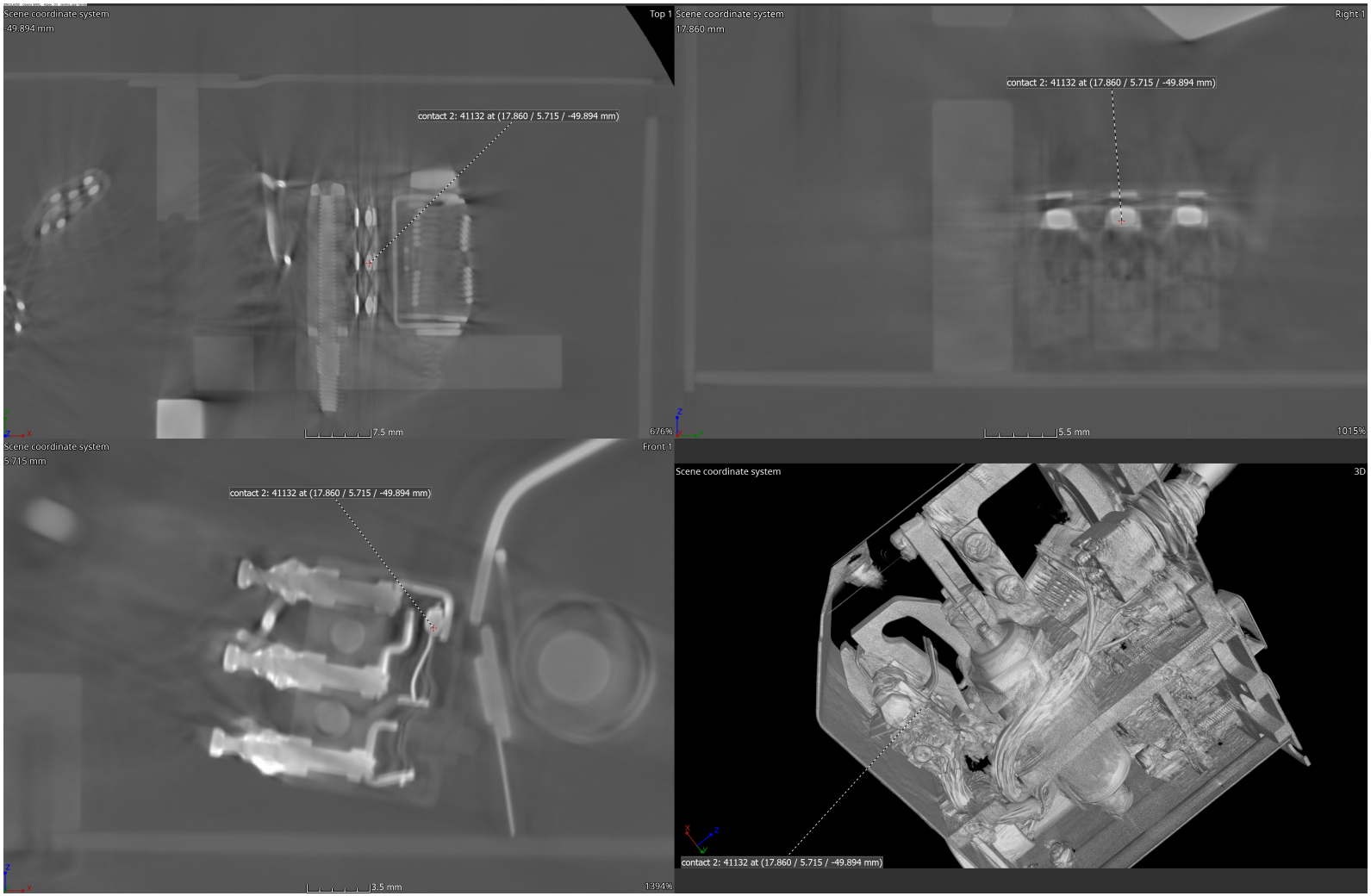

Figure 6
Landing gear handle – contact 2

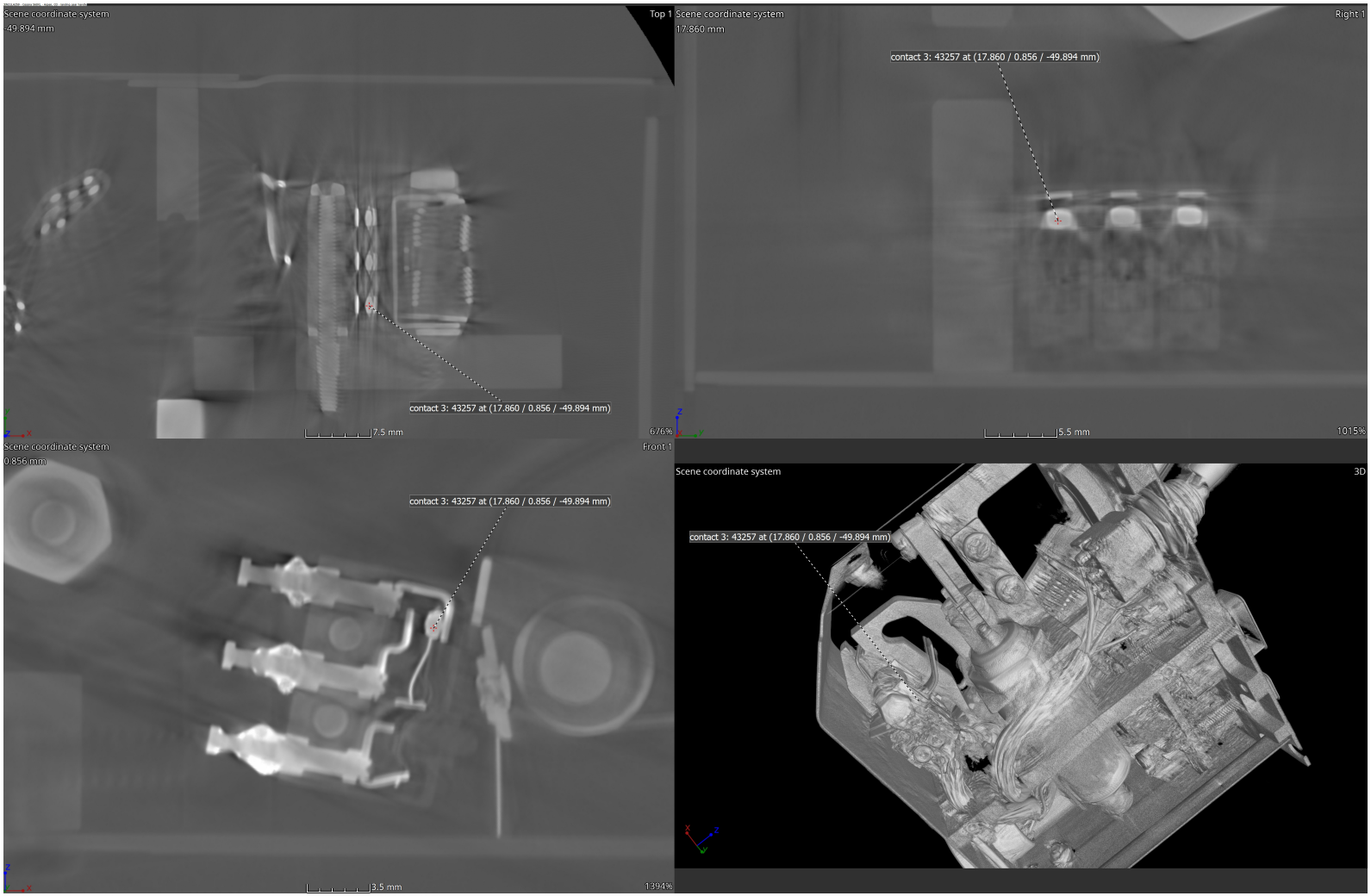

Figure 7
Landing gear handle – contact 3

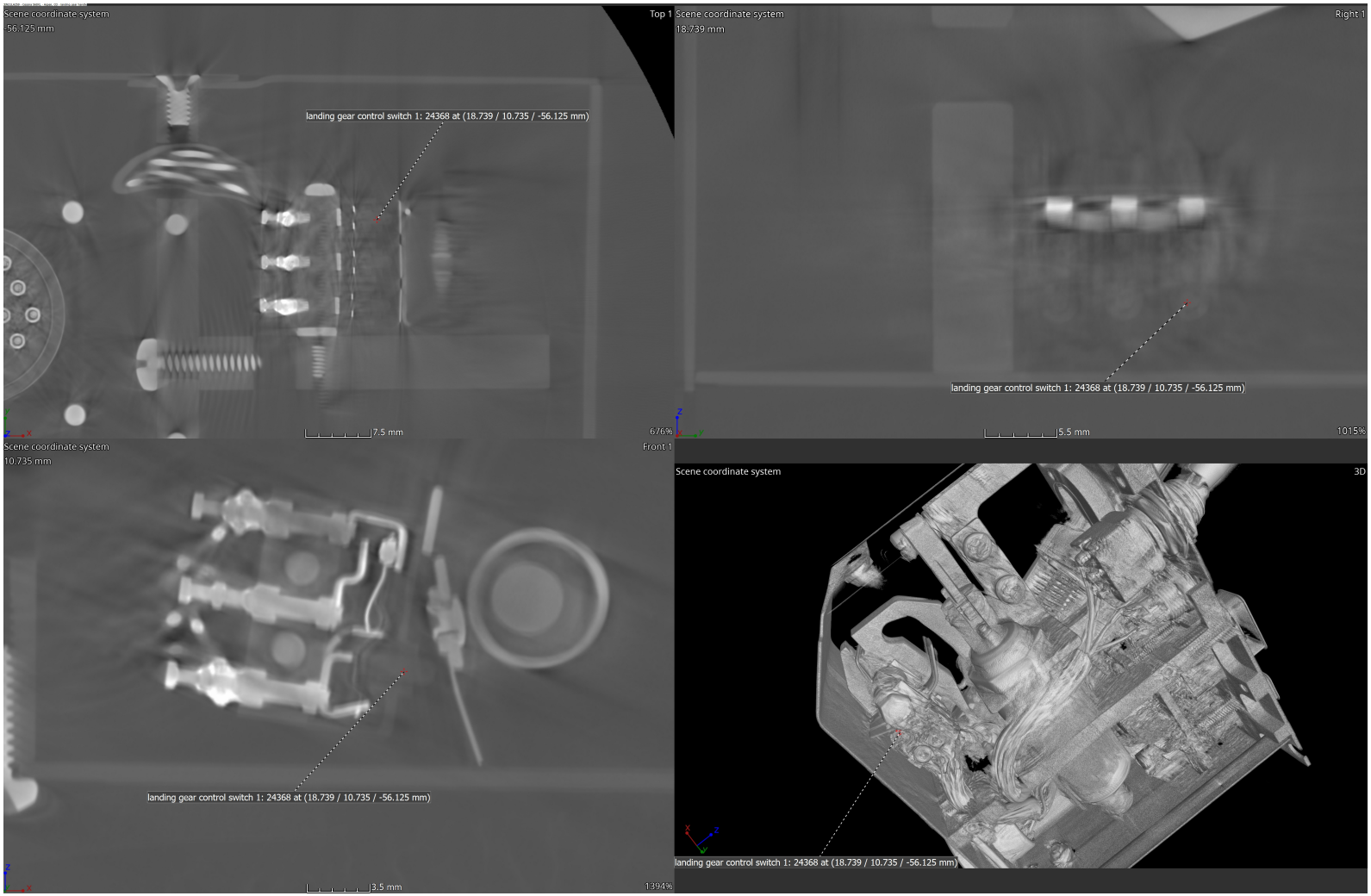

Figure 8
Landing gear handle – landing gear control switch 1

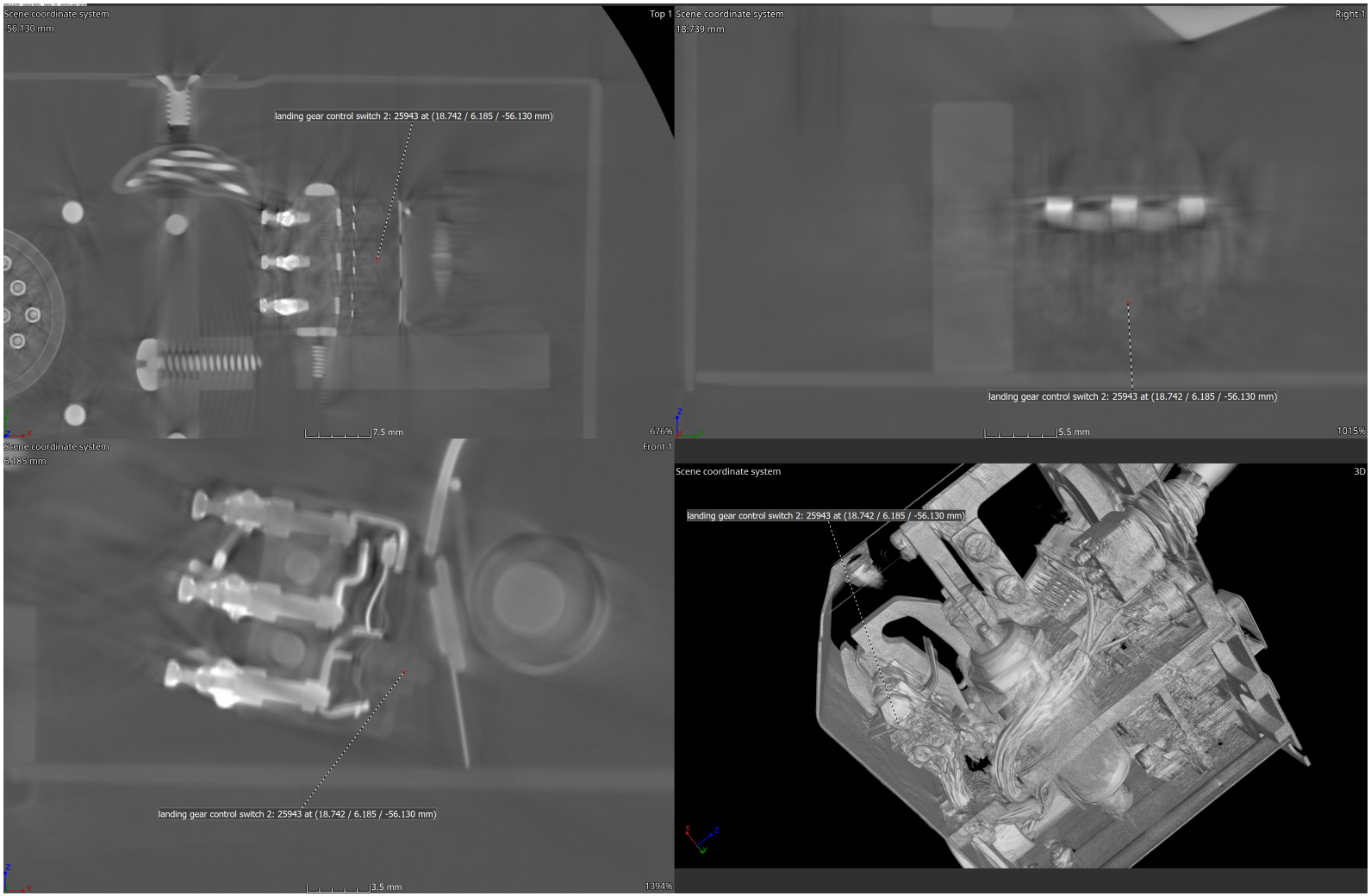

Figure 9
Landing gear handle – landing gear control switch 2

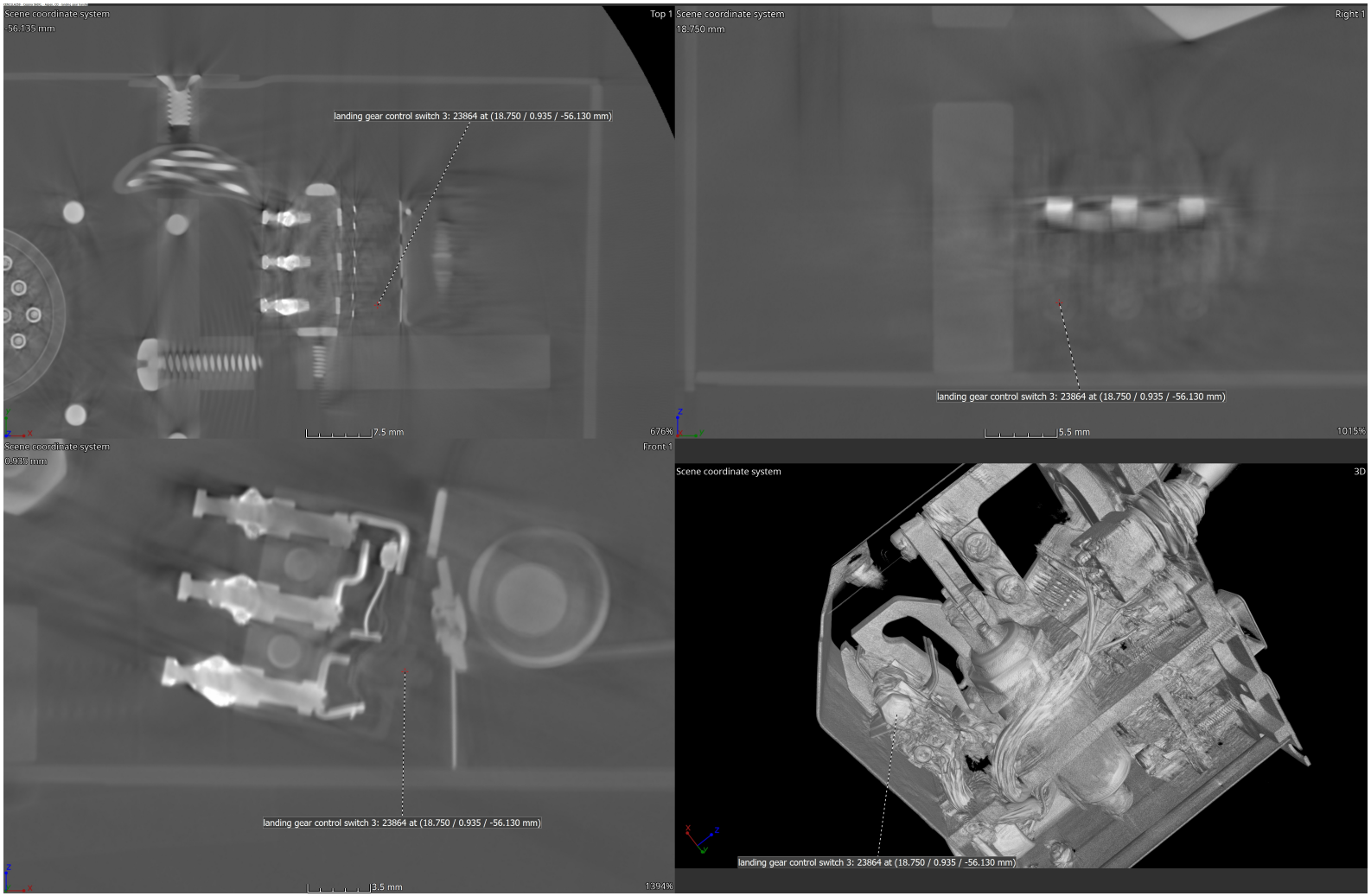

Figure 10
Landing gear handle – landing gear control switch 3

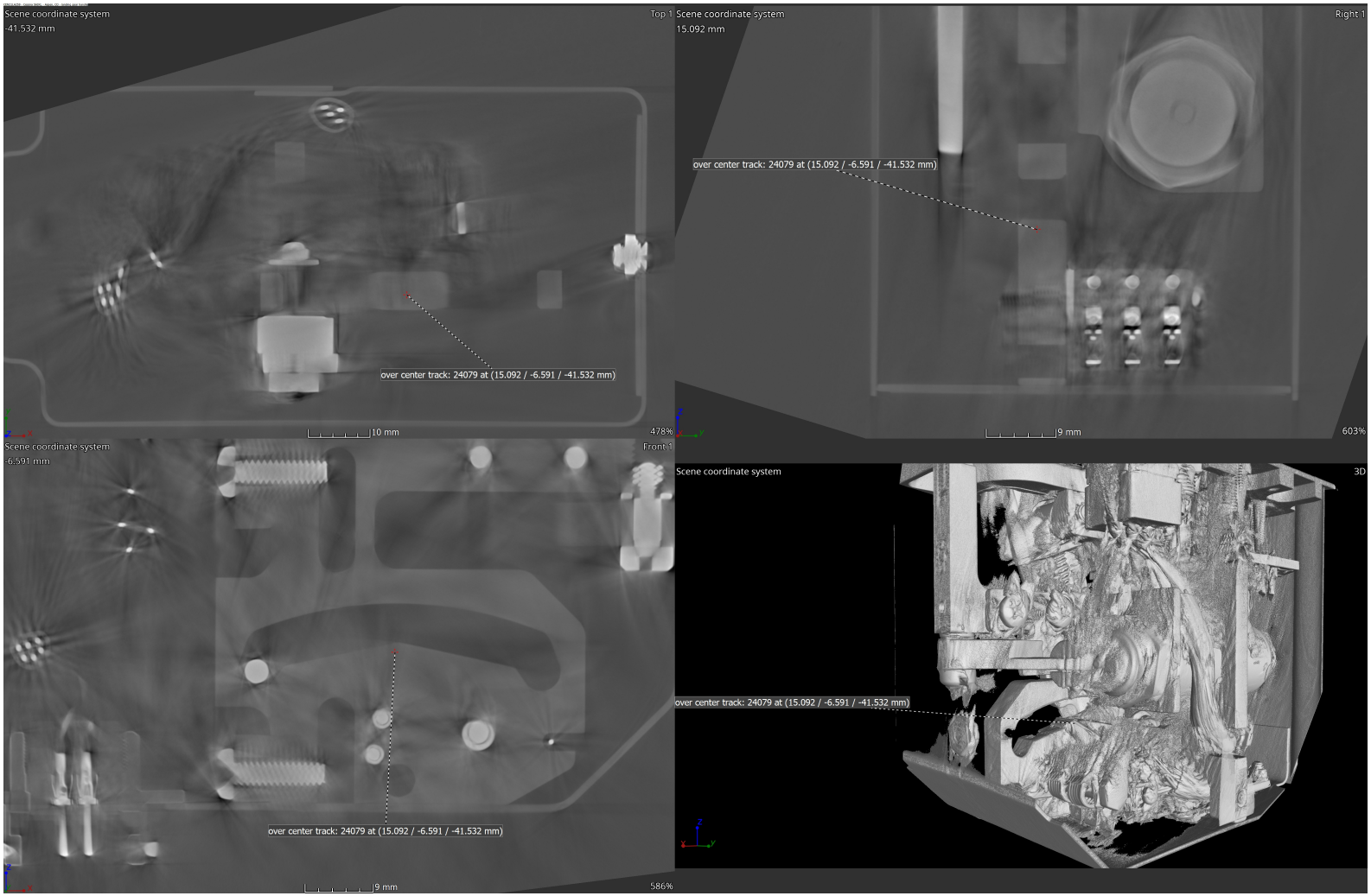

Figure 11
Landing gear handle – over center track

Figure 12
Landing gear handle – over center track bolt

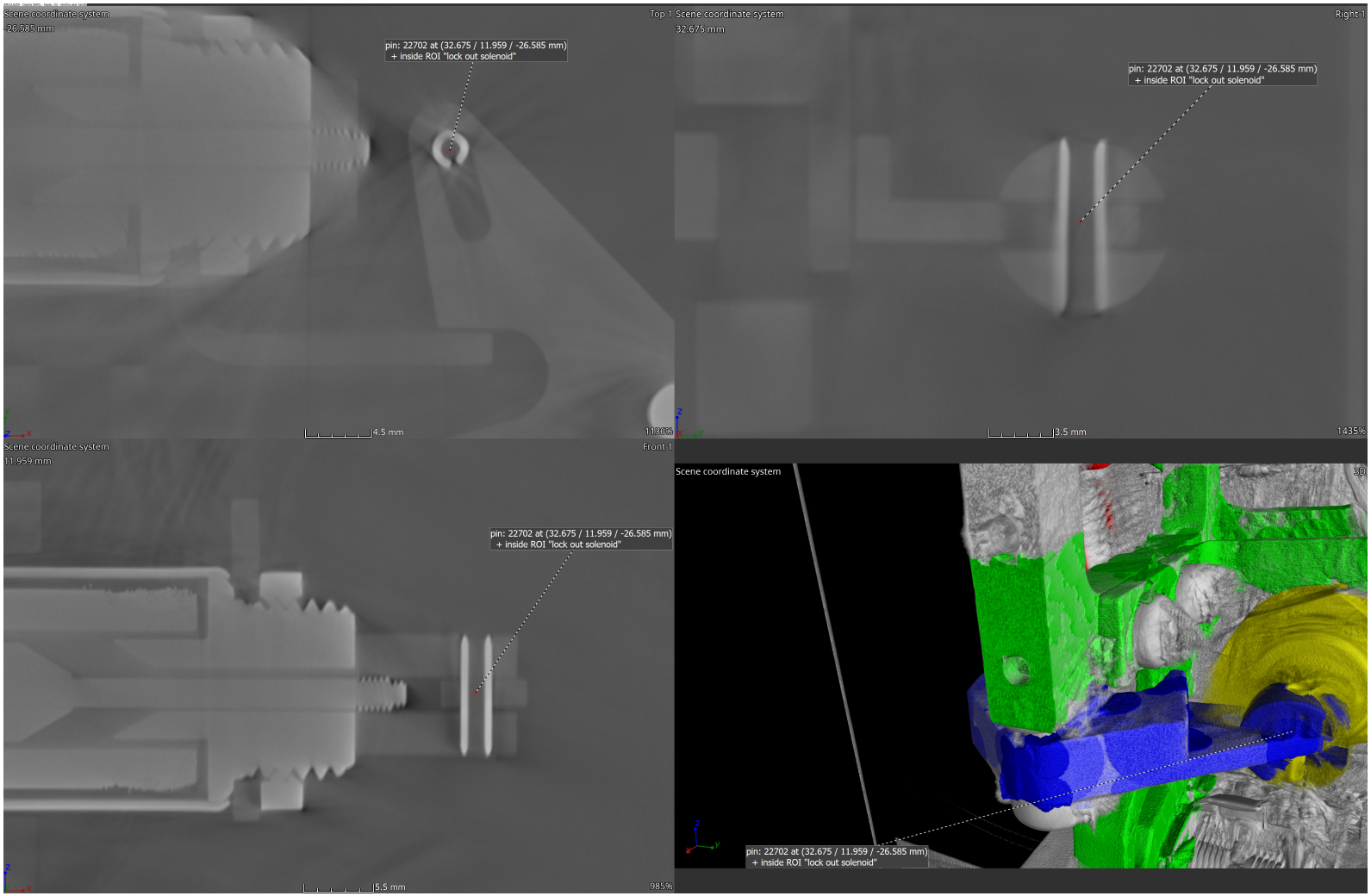

Figure 13
Landing gear handle – pin

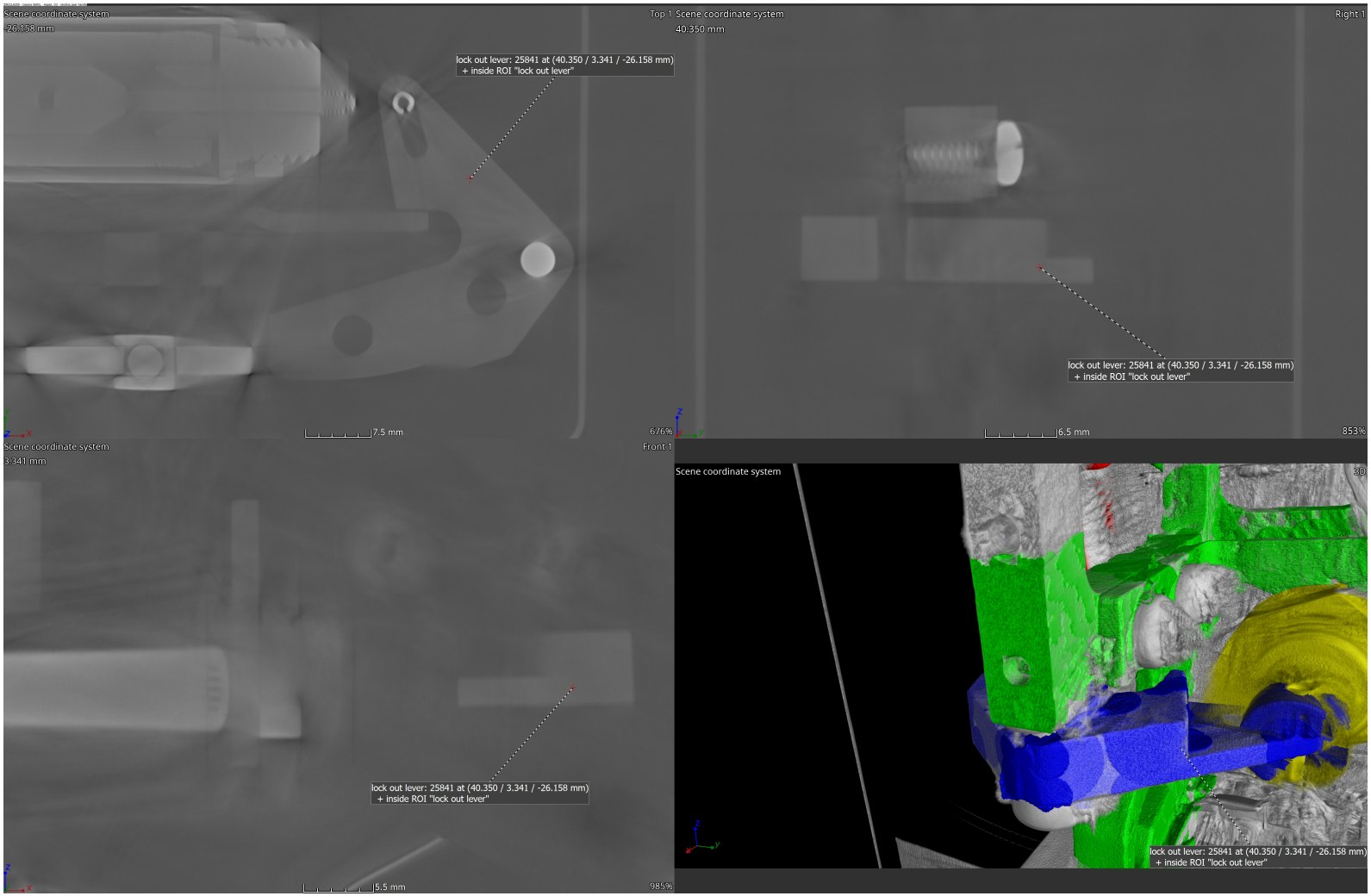

Figure 14
Landing gear handle – lock out lever

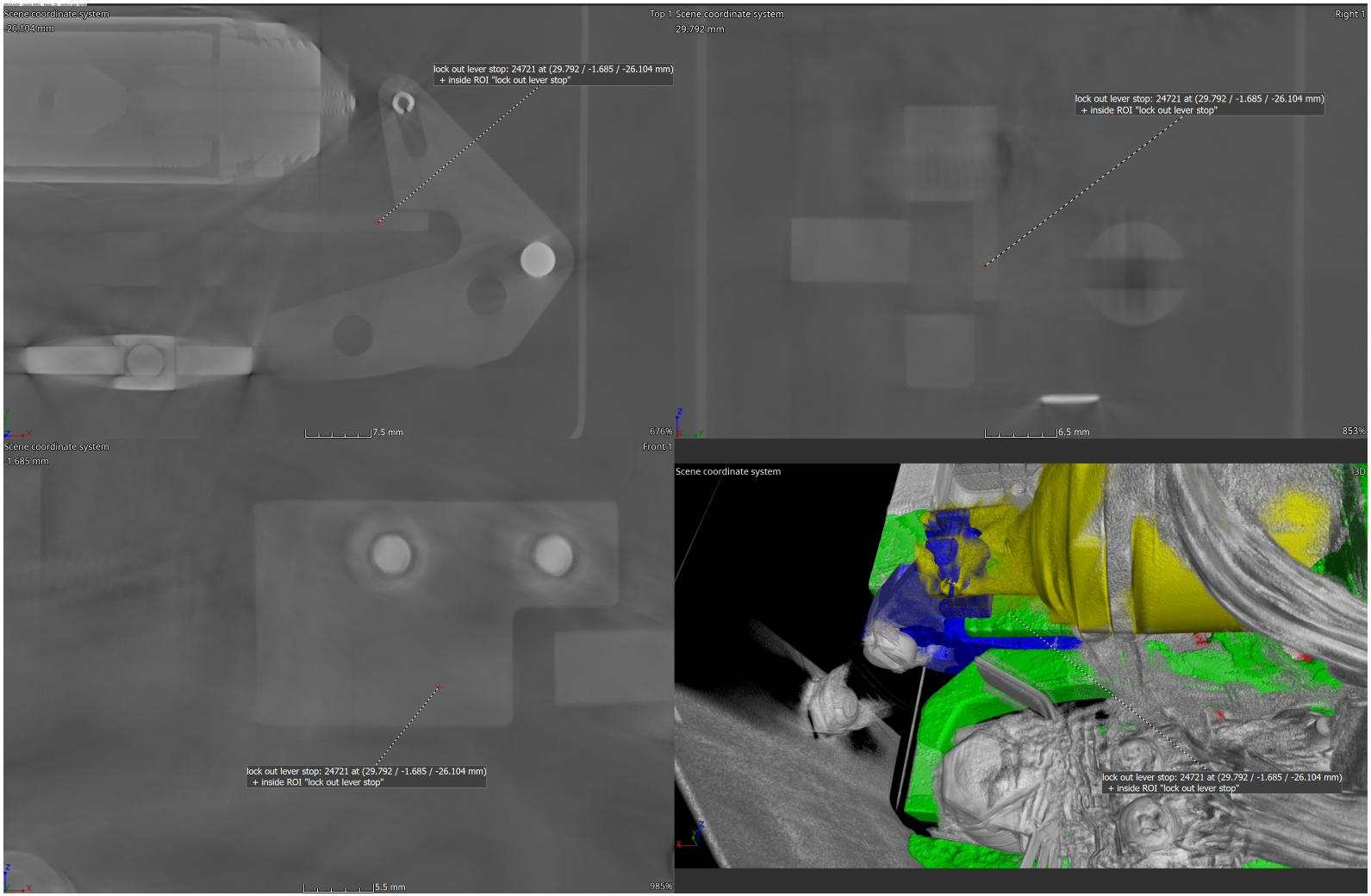

Figure 15
Landing gear handle – lock out lever stop

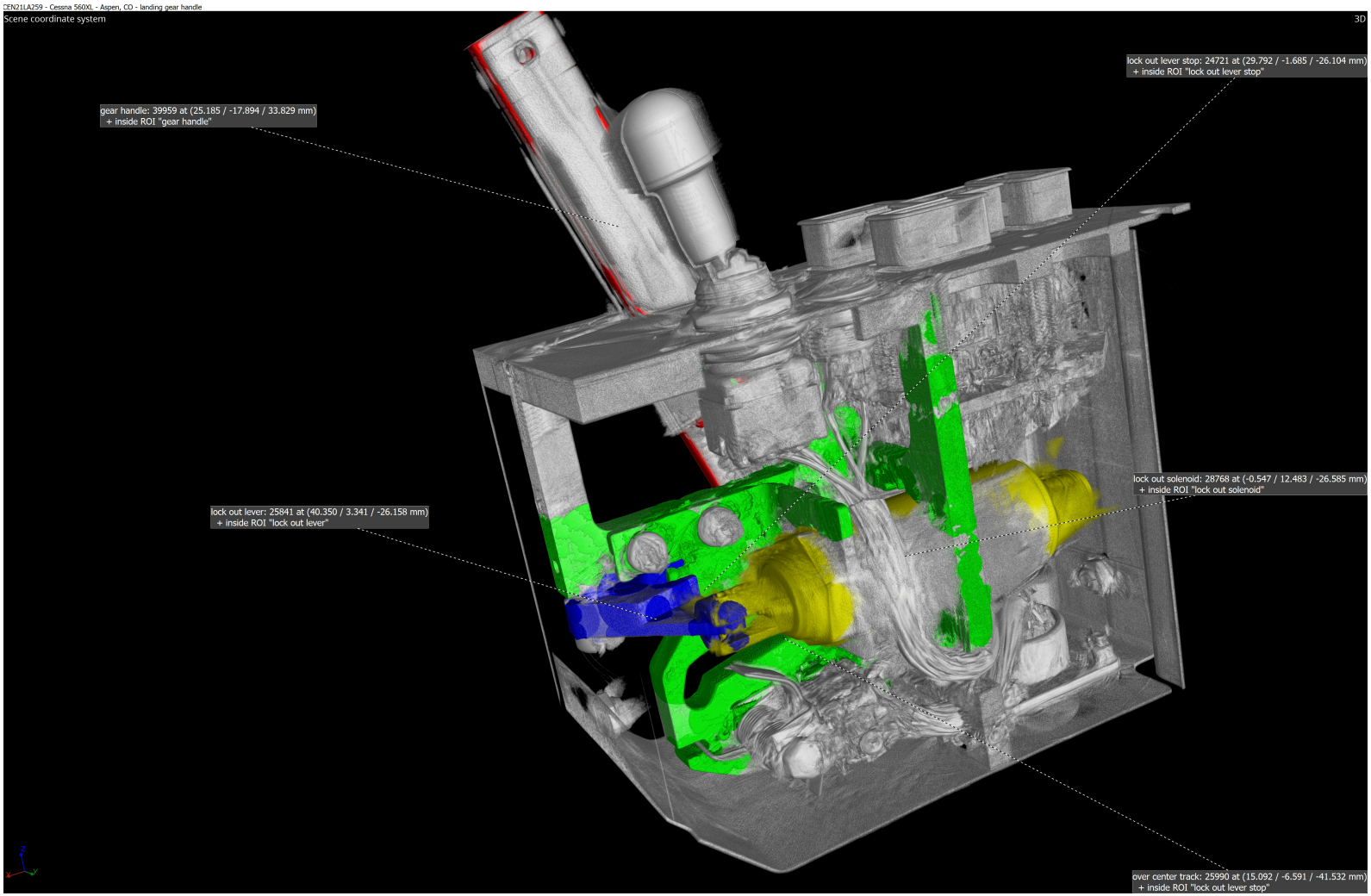

Figure 16
Landing gear handle – region of interest 1

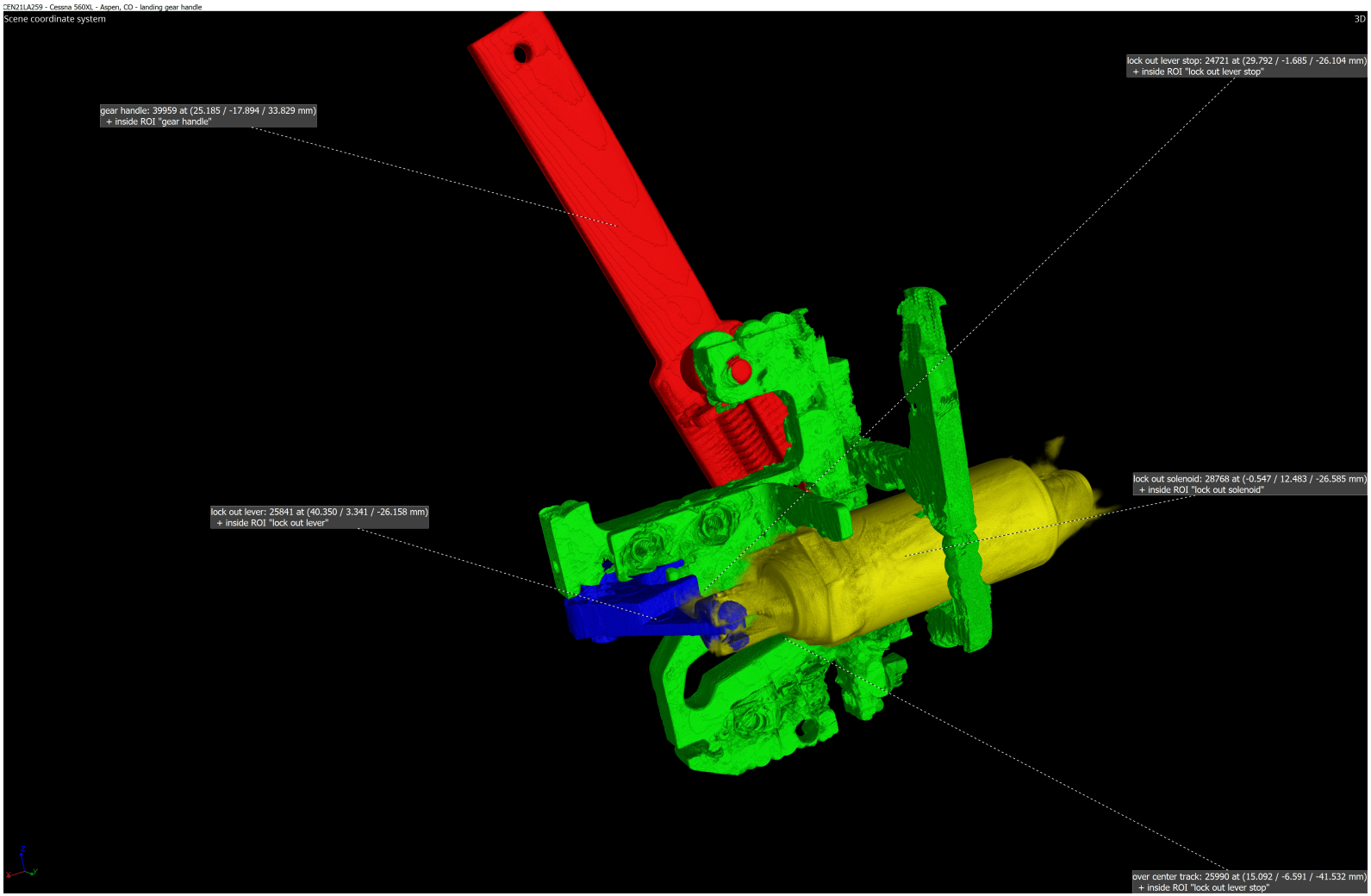

Figure 17
Landing gear handle – region of interest 2

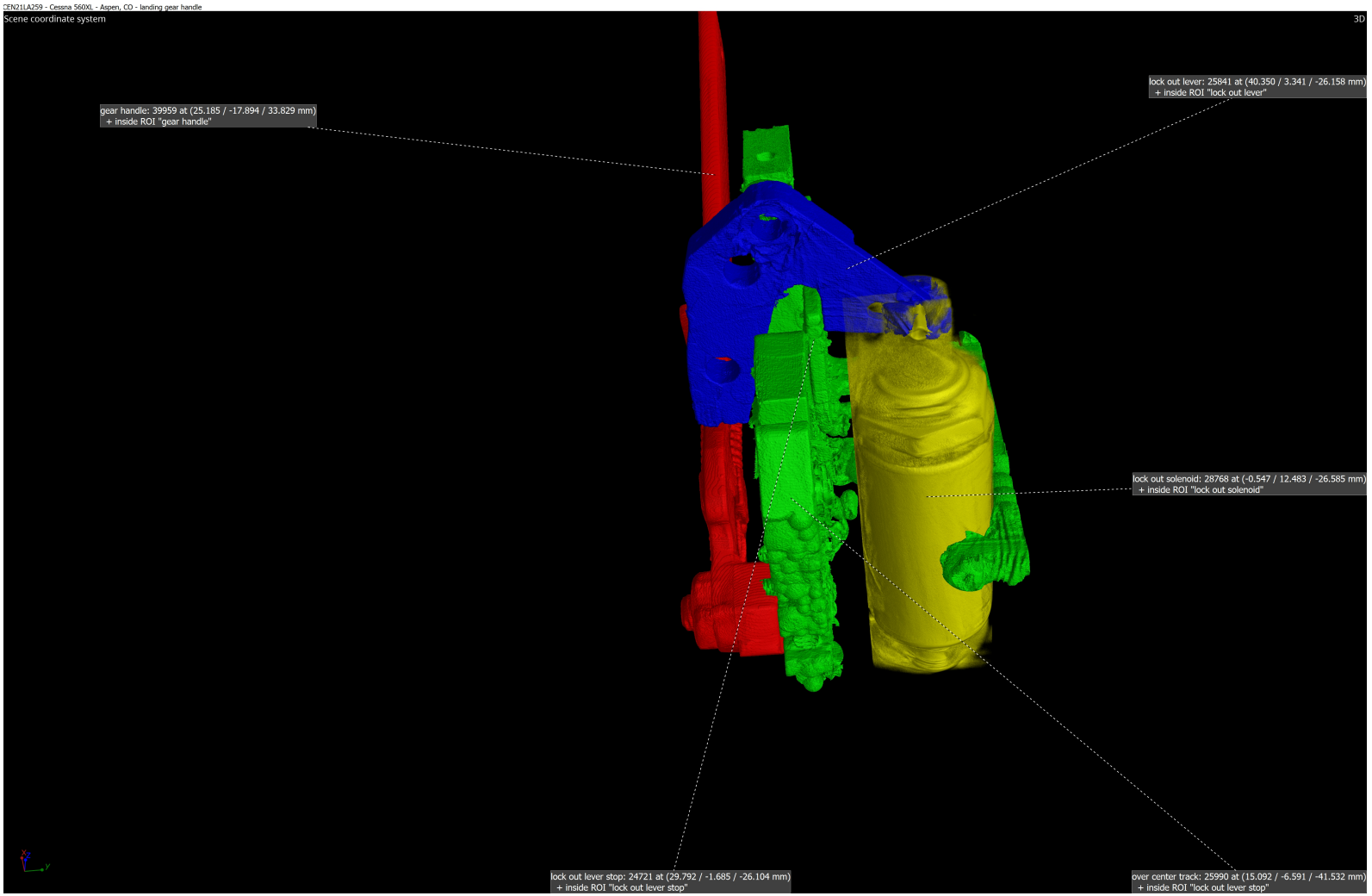

Figure 18
Landing gear handle – region of interest 3

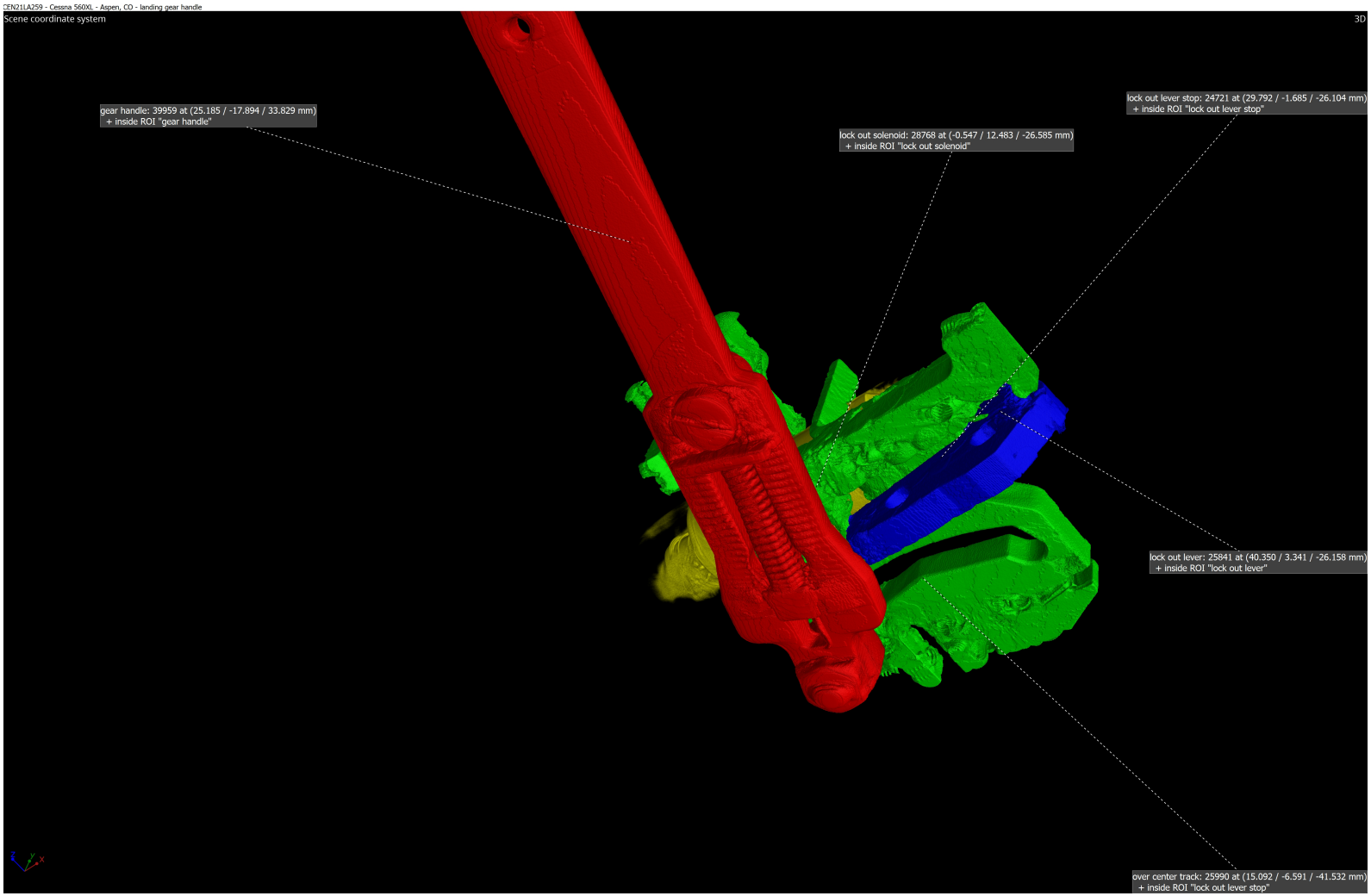

Figure 19
Landing gear handle – region of interest 4

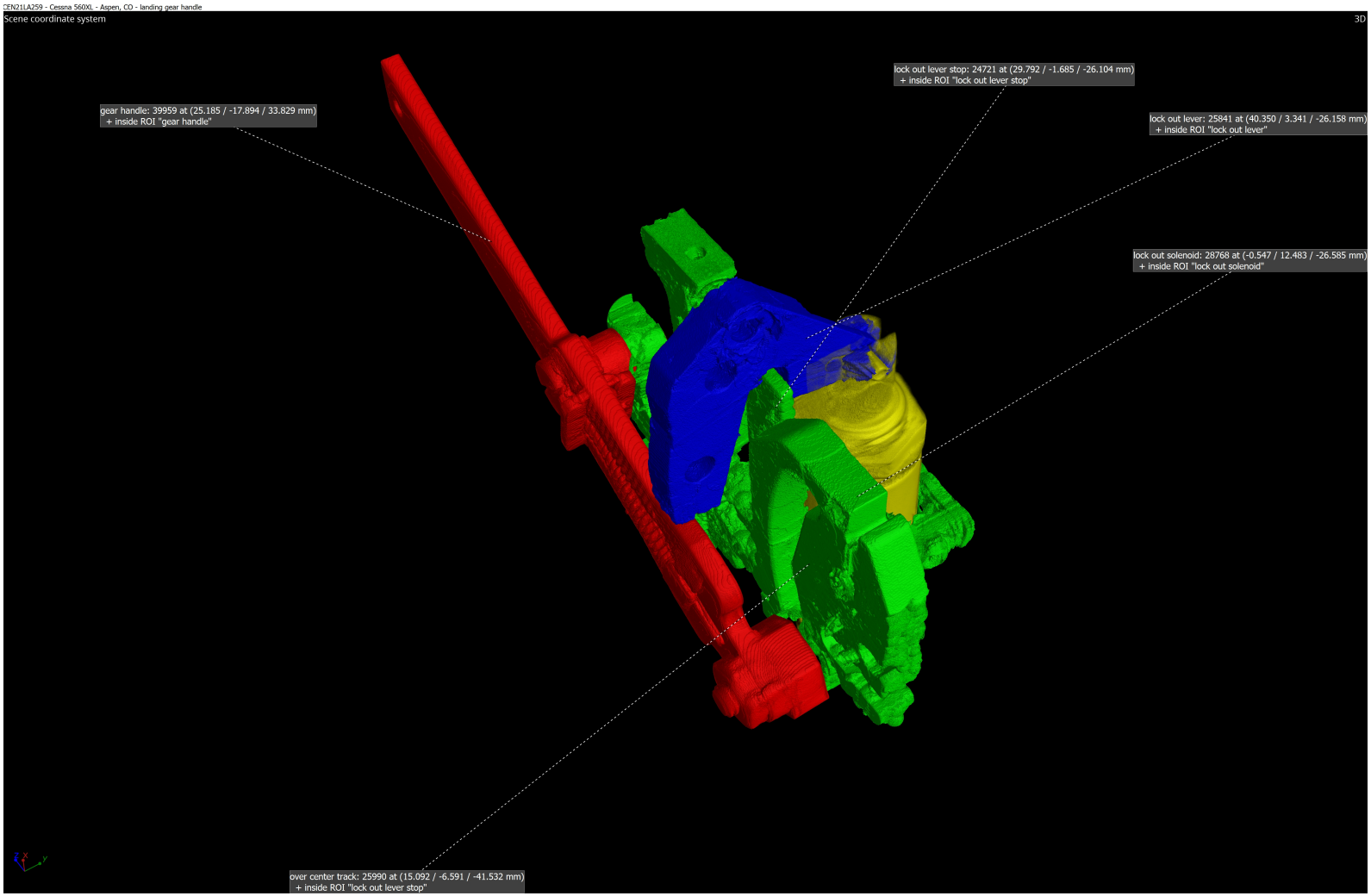

Figure 20
Landing gear handle – region of interest 5

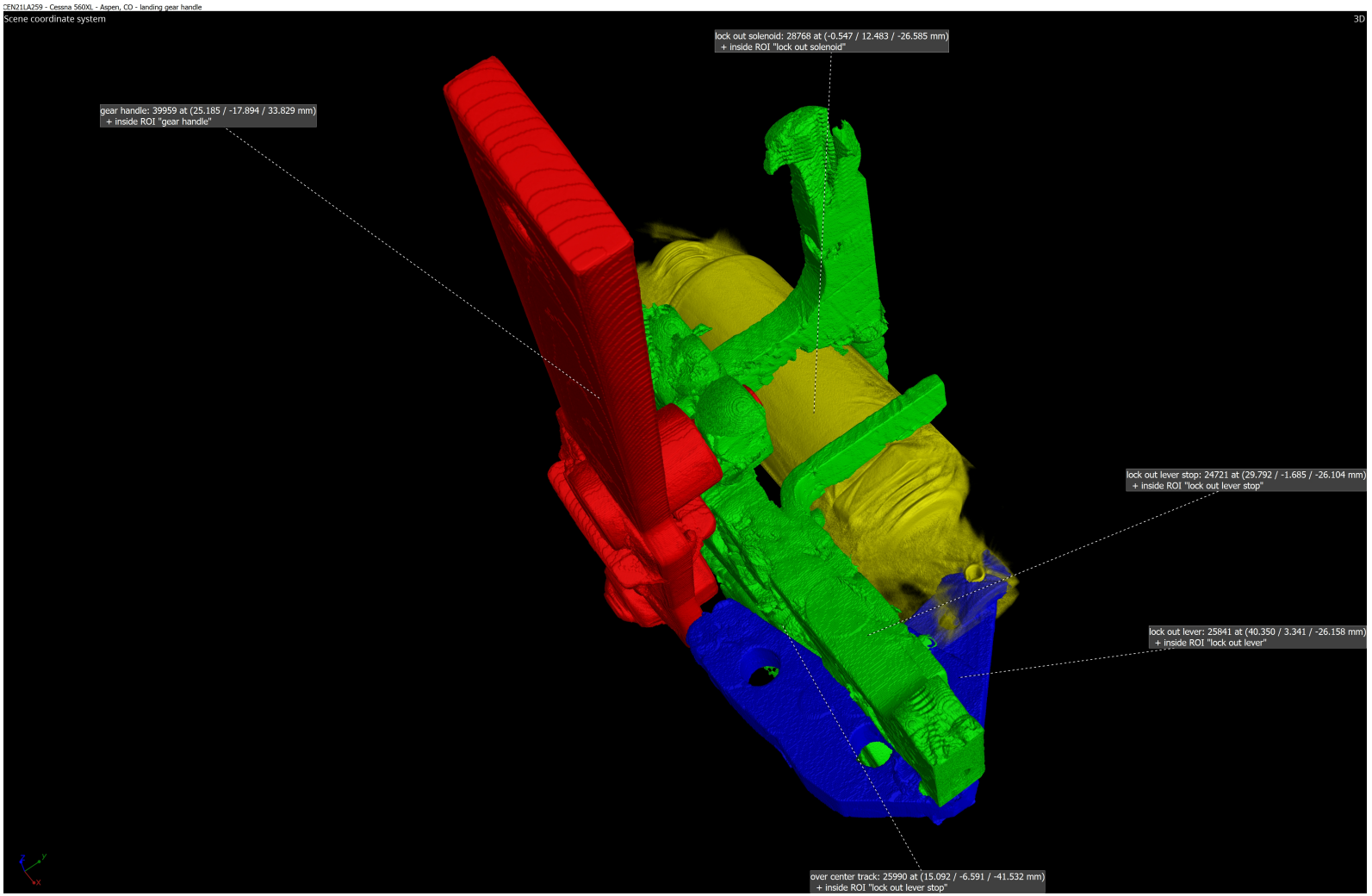

Figure 21
Landing gear handle – region of interest 6

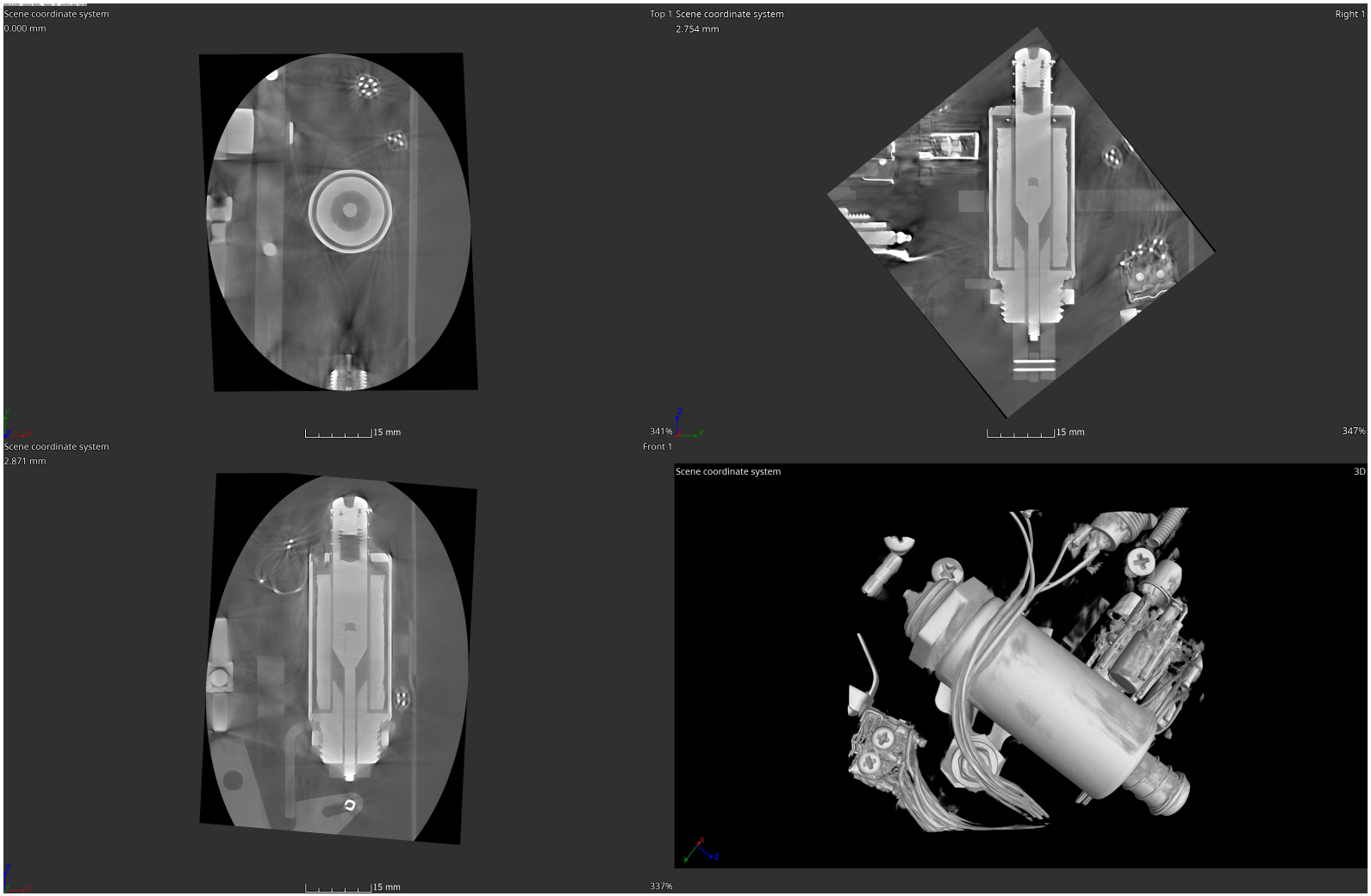

Figure 22
Landing gear handle – lock out solenoid - overview

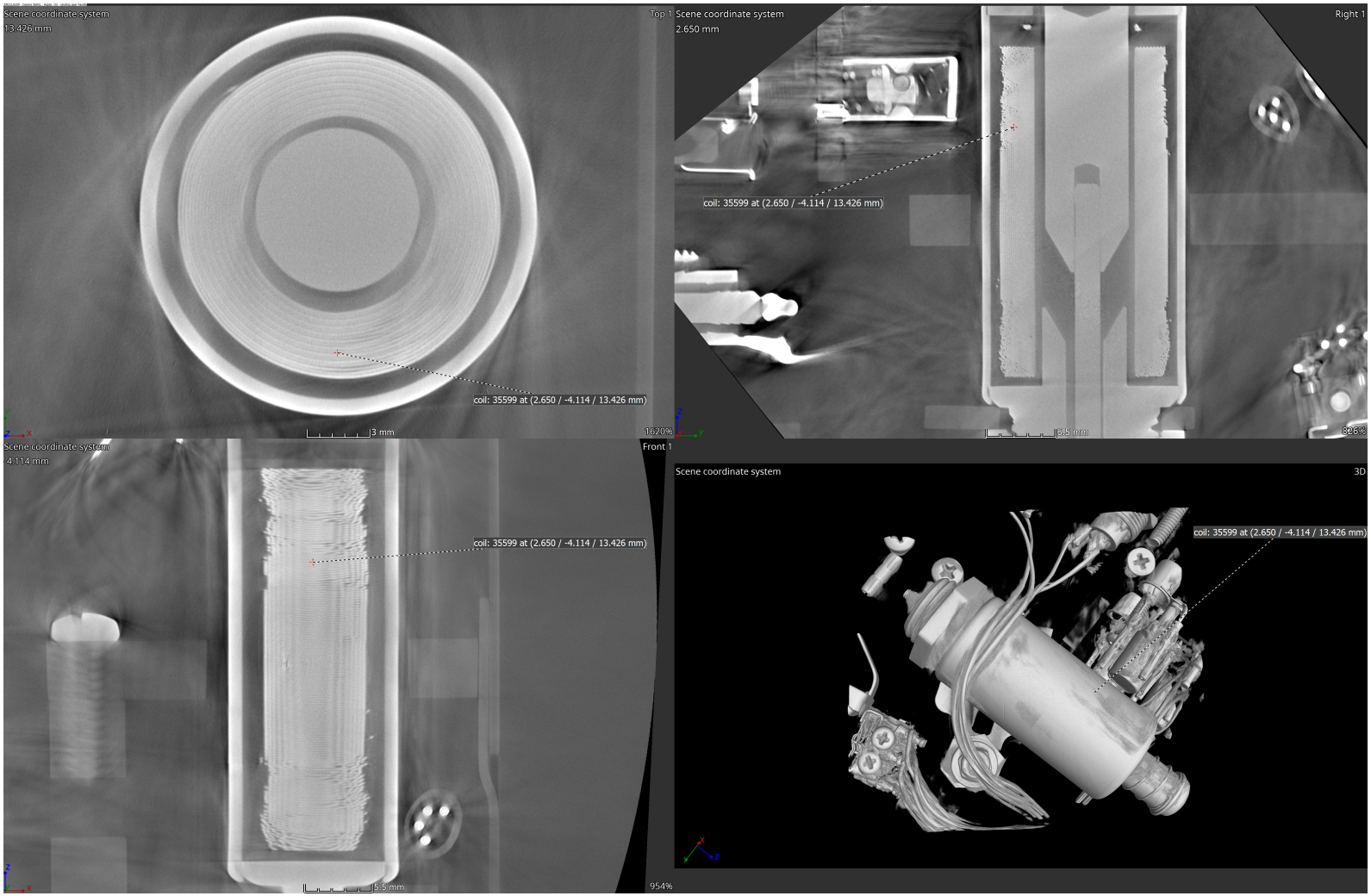

Figure 23
Landing gear handle – lock out solenoid - coil

Figure 24
Landing gear handle – lock out solenoid – coil connection 1

Figure 25
Landing gear handle – lock out solenoid – coil connection 2

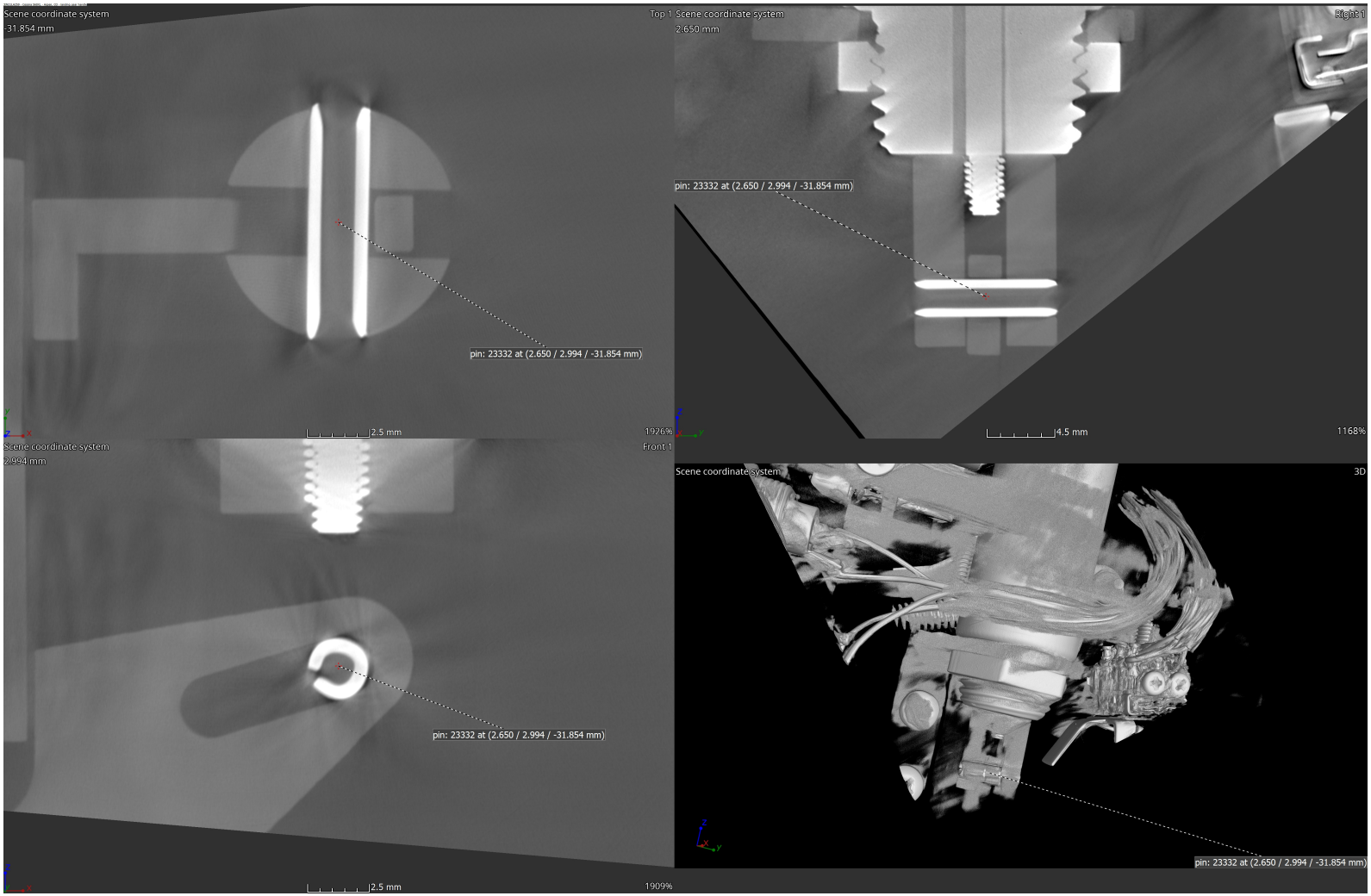

Figure 26
Landing gear handle – lock out solenoid - pin

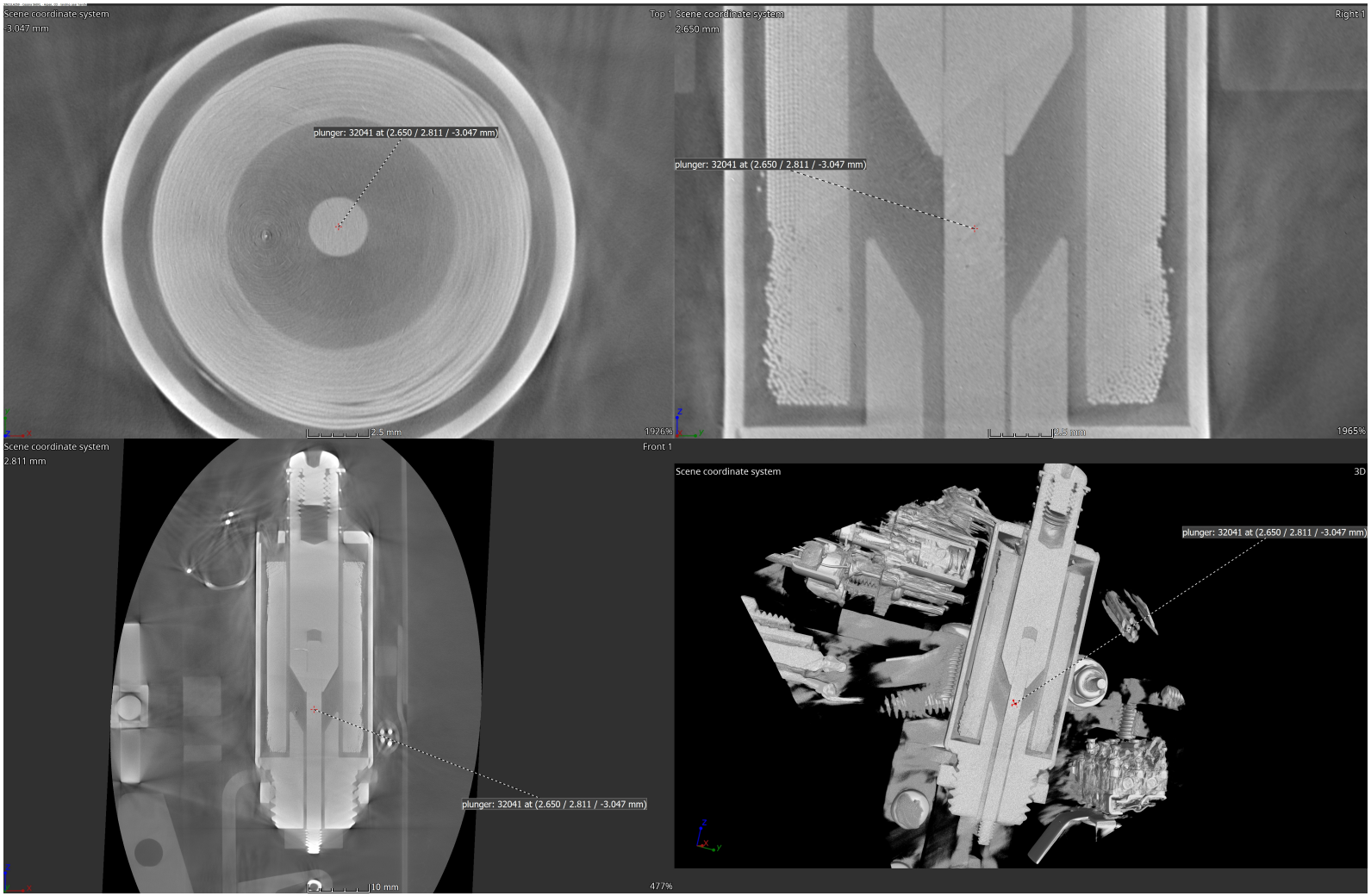

Figure 27
Landing gear handle – lock out solenoid - plunger

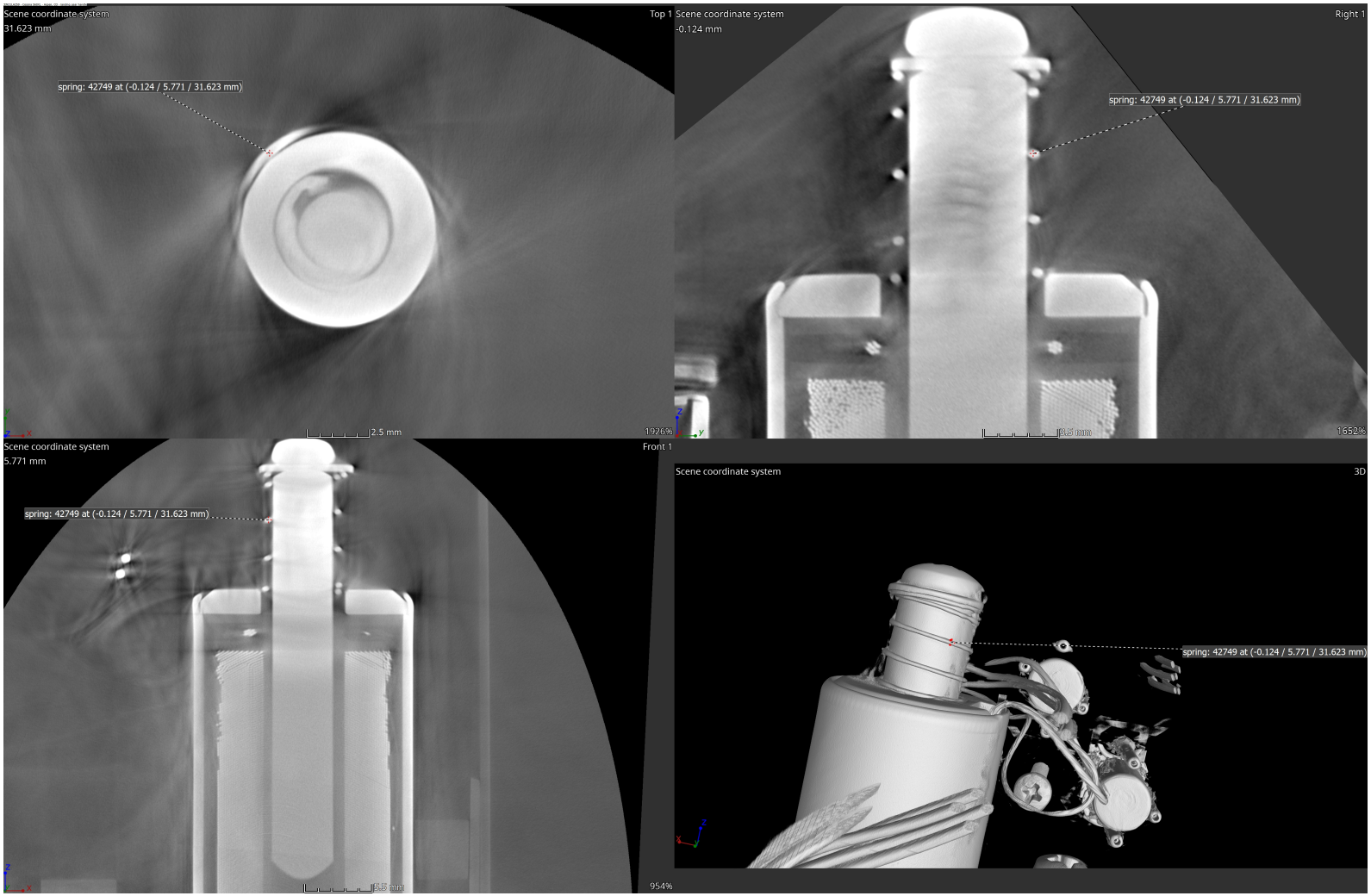

Figure 28
Landing gear handle – lock out solenoid - spring

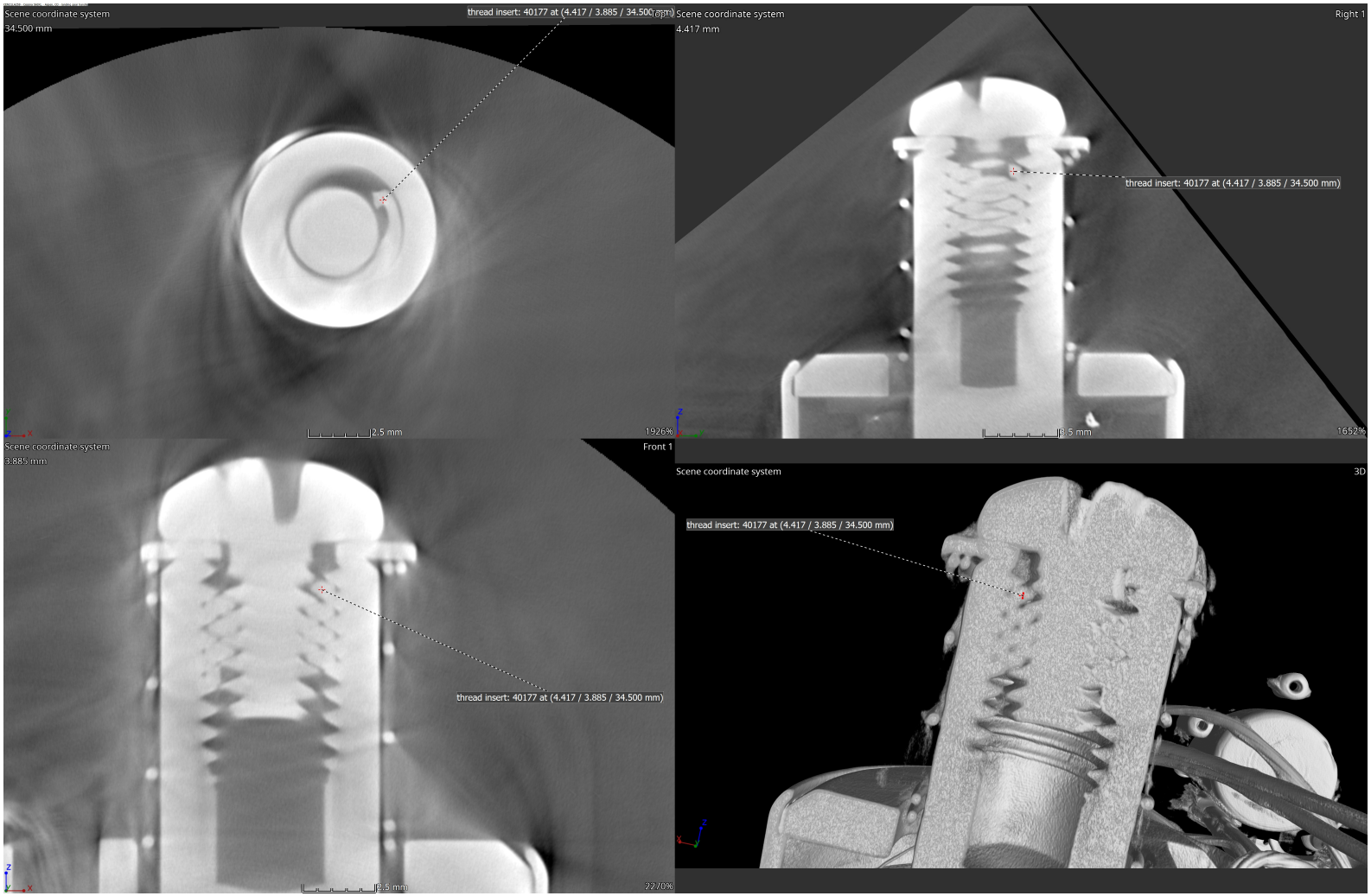

Figure 29
Landing gear handle – lock out solenoid – thread insert

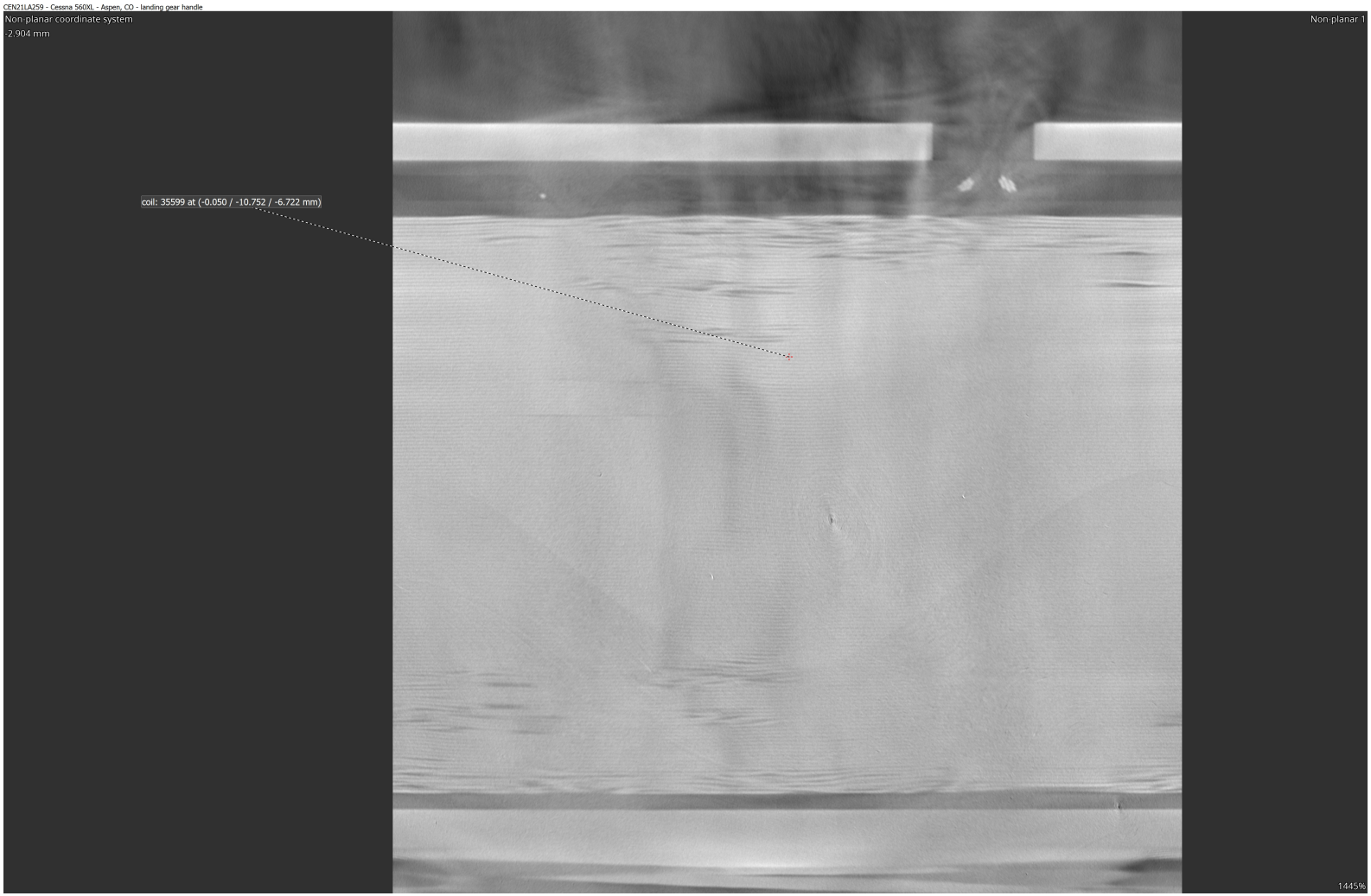

Figure 30
Landing gear handle – lock out solenoid – coil - unrolled

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