

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

April 16, 2020

Computed Tomography Specialist's Factual Report

WPR19FA230

A. ACCIDENT

Location: Oroville Municipal Airport (OVE), Oroville, California
Date: August 21, 2019
Time: 1132 Pacific daylight time
Airplane: Cessna 560XL airplane, N91GY

B. GROUP

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

C. SUMMARY

On August 21, 2019, about 1132 Pacific daylight time, a Cessna 560XL airplane, N91GY, was destroyed when it was involved in an accident near Oroville, California. The two airline transport pilots, and eight passengers were not injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 135 on-demand charter flight.

The internal configuration of the accident parking brake valve and an exemplar parking brake valve were documented using radiographic images that were collected from September 11-23, 2019 in Chicago, Illinois. A total of 8,133 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 noted:

1. For the exemplar valve in the closed position, there was a gap between the mechanisms and shaft, and the flat side of the shaft was adjacent to the mechanisms;
2. For the exemplar valve in the open position, there was no gap between the mechanisms and shaft, and the rounded section of the shaft was adjacent to the mechanisms;
3. For the accident valve, the lever to shaft interface did not show any indications of cracks, missing material, or other abnormalities;
4. For the accident valve, the shaft flat was adjacent to the mechanisms. This position was consistent with the valve being in the closed position;
5. For the accident valve, there were indications of distorted fittings and other valve material that were consistent with thermal damage to the valve;
6. For the accident valve, the mechanism seals were not present, and there were indications of melted material at the bottom of the mechanisms in the area of the seal flanges;
7. For the exemplar valve, indications of the mechanism seals were visible. The seals appeared to be seated in the seal flanges;
8. For the exemplar valve, the mechanism seals appeared to be sealed against the valve housing when the valve was in the closed position. The mechanism seals appeared to have a gap between the seal and the valve housing when the valve was in the open position;

D. DETAILS OF THE INVESTIGATION

1.0 General

The accident parking brake valve and an exemplar parking brake valve were subjected to x-ray radiograph and computed tomography (CT) scanning to document their internal conditions. The scanning was conducted from September 11-23, 2019 by Varex, Inc under the direction of the NTSB using the Actis 500/225 micro focus system.

For the CT scans, the components were 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 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 8,133 slices, and the total size of the combined data sets was approximately 16 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	Accident parking brake valve - overall	Exemplar parking brake valve – overall – open/closed	Accident parking brake valve – target CT	Exemplar parking brake valve – target CT - open	Exemplar parking brake valve – target CT - closed
Number of slices	1573	1801/1816	981	981	981
Voxel ¹ Size - X Direction (mm)	0.148	0.148	0.044	0.044	0.044
Voxel Size - Y Direction (mm)	0.148	0.148	0.044	0.044	0.044
Voxel Size - Z Direction (mm)	0.076	0.076	0.044	0.044	0.044
Image Projections per Revolution	1800	1800	1800	1800	1800
Exposure time (ms)	285.60	285.60	285.60	285.60	285.60
Frames to Avg (frames per projection)	2	2	2	2	2
X-ray Source Voltage (kV)	222	222	223	223	223
X-ray Source Current (mA)	0.575	0.575	0.575	0.575	0.575
Source Filter Thickness (mm)	1	1	1	1	1
Source Filter Material	Brass	Brass	Brass	Brass	Brass
Image Matrix Size	1024 x 1024	1024 x 1024	1024 x 1024	1024 x 1024	1024 x 1024

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 the images, the higher density areas were shown as brighter shades of gray and lower density areas were shown as darker shades of gray. The pointers shown in some of the images denote specific areas of interest within that image.

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

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 19. Review of the images determined that, when the scans were conducted, the following indications were noted:

1. For the exemplar valve in the closed position, there was a gap between the mechanisms and shaft, and the flat side of the shaft was adjacent to the mechanisms;
2. For the exemplar valve in the open position, there was no gap between the mechanisms and shaft, and the rounded section of the shaft was adjacent to the mechanisms;
3. For the accident valve, the lever to shaft interface did not show any indications of cracks, missing material, or other abnormalities;
4. For the accident valve, the shaft flat was adjacent to the mechanisms. This position was consistent with the valve being in the closed position;
5. For the accident valve, there were indications of distorted fittings and other valve material that were consistent with thermal damage to the valve;
6. For the accident valve, the mechanism seals were not present, and there were indications of melted material at the bottom of the mechanisms in the area of the seal flanges;
7. For the exemplar valve, indications of the mechanism seals were visible. The seals appeared to be seated in the seal flanges;
8. For the exemplar valve, the mechanism seals appeared to be sealed against the valve housing when the valve was in the closed position. The mechanism seals appeared to have a gap between the seal and the valve housing when the valve was in the open position;

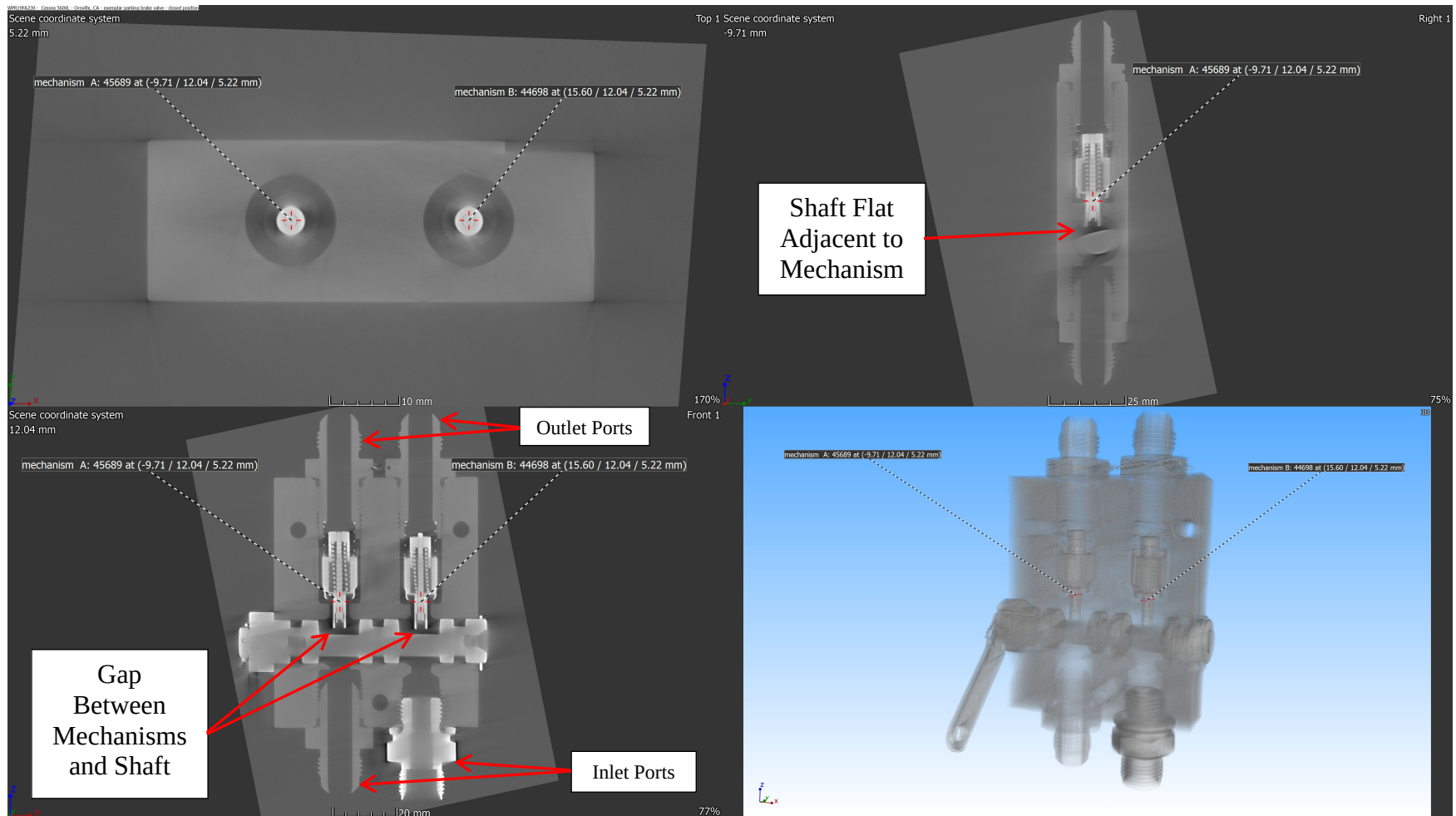


Figure 1
Exemplar parking brake valve – closed position – mechanism A

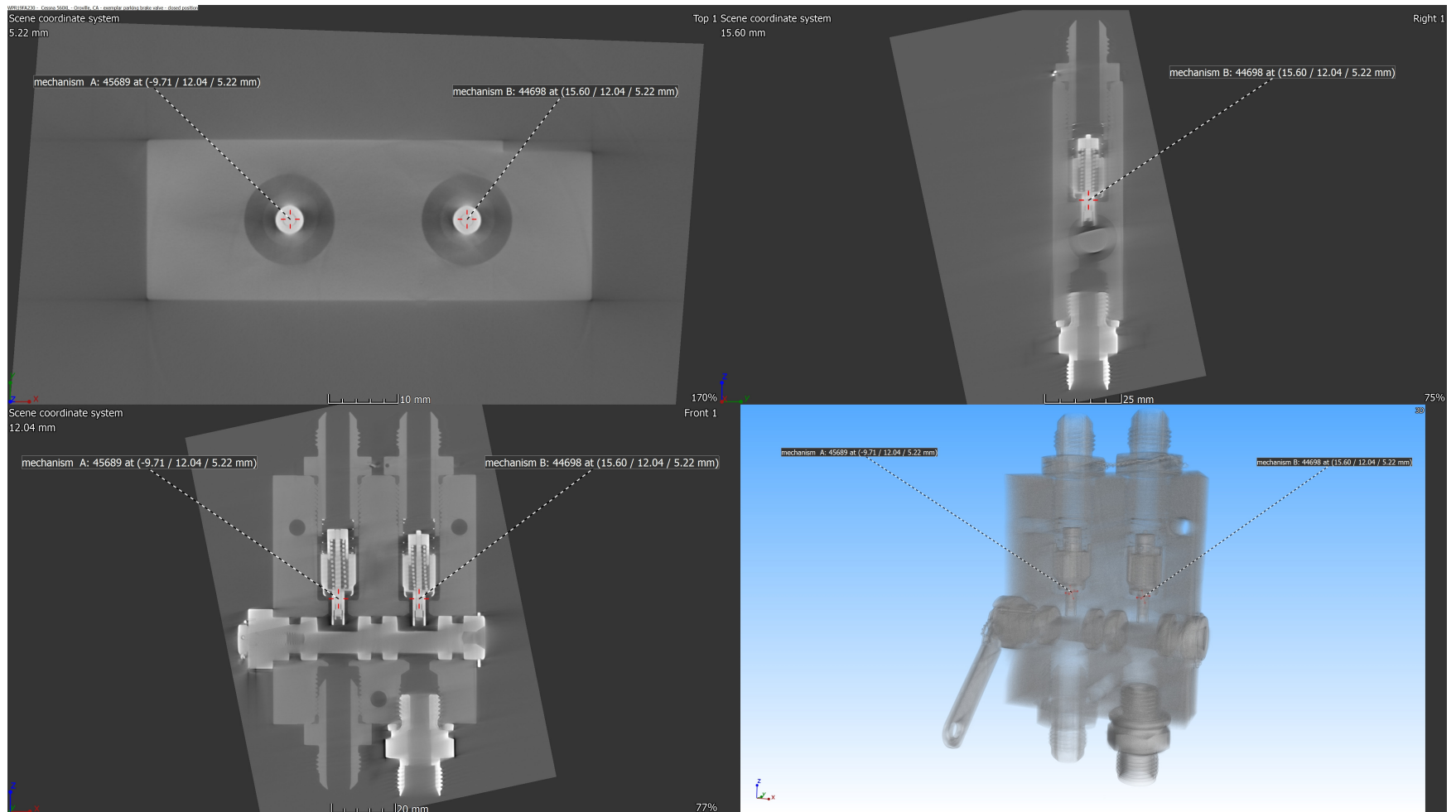


Figure 2
Exemplar parking brake valve – closed position – mechanism B

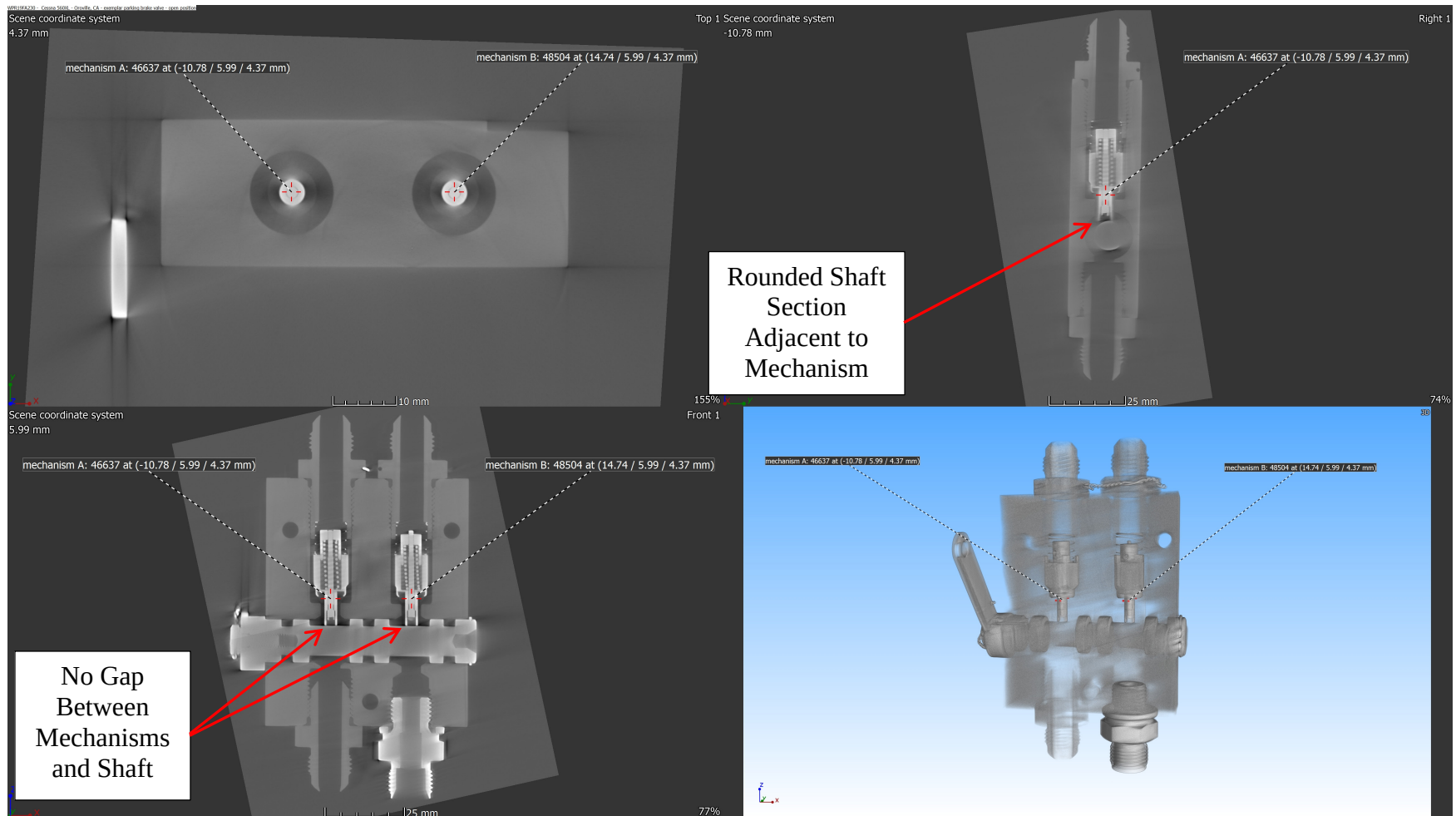


Figure 3
Exemplar parking brake valve – open position – mechanism A

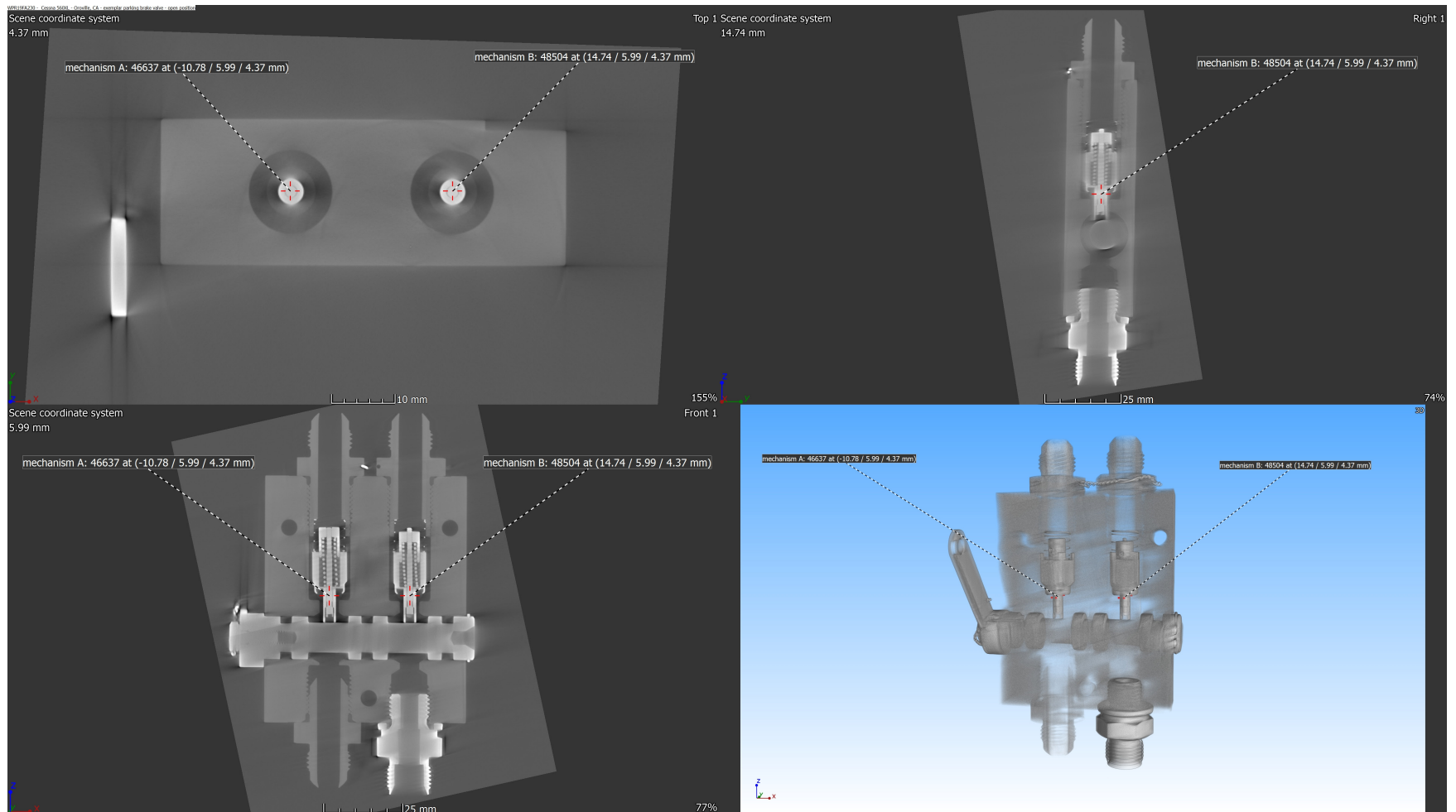


Figure 4
Exemplar parking brake valve – open position – mechanism B

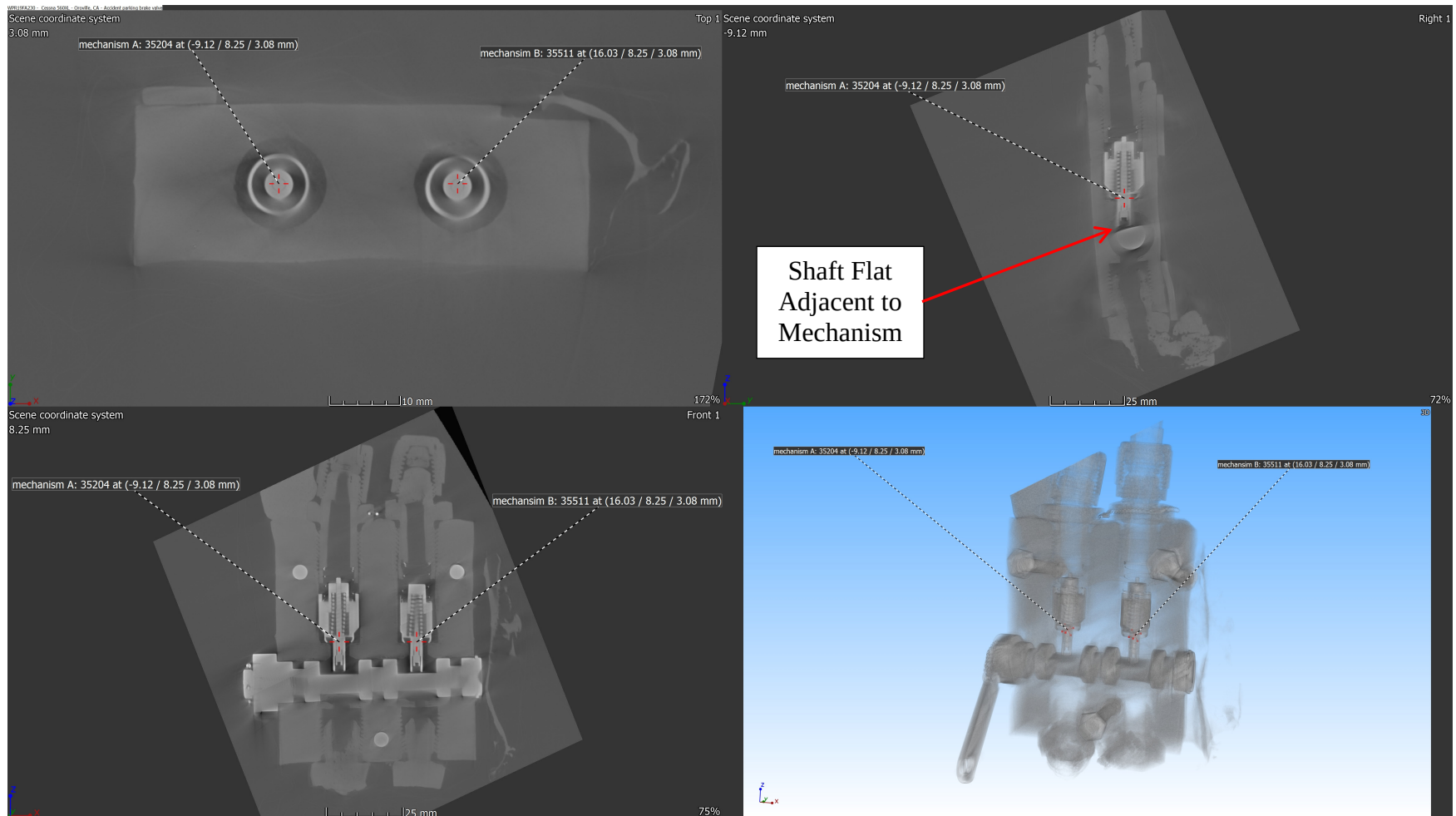


Figure 5
Accident parking brake valve – mechanism A

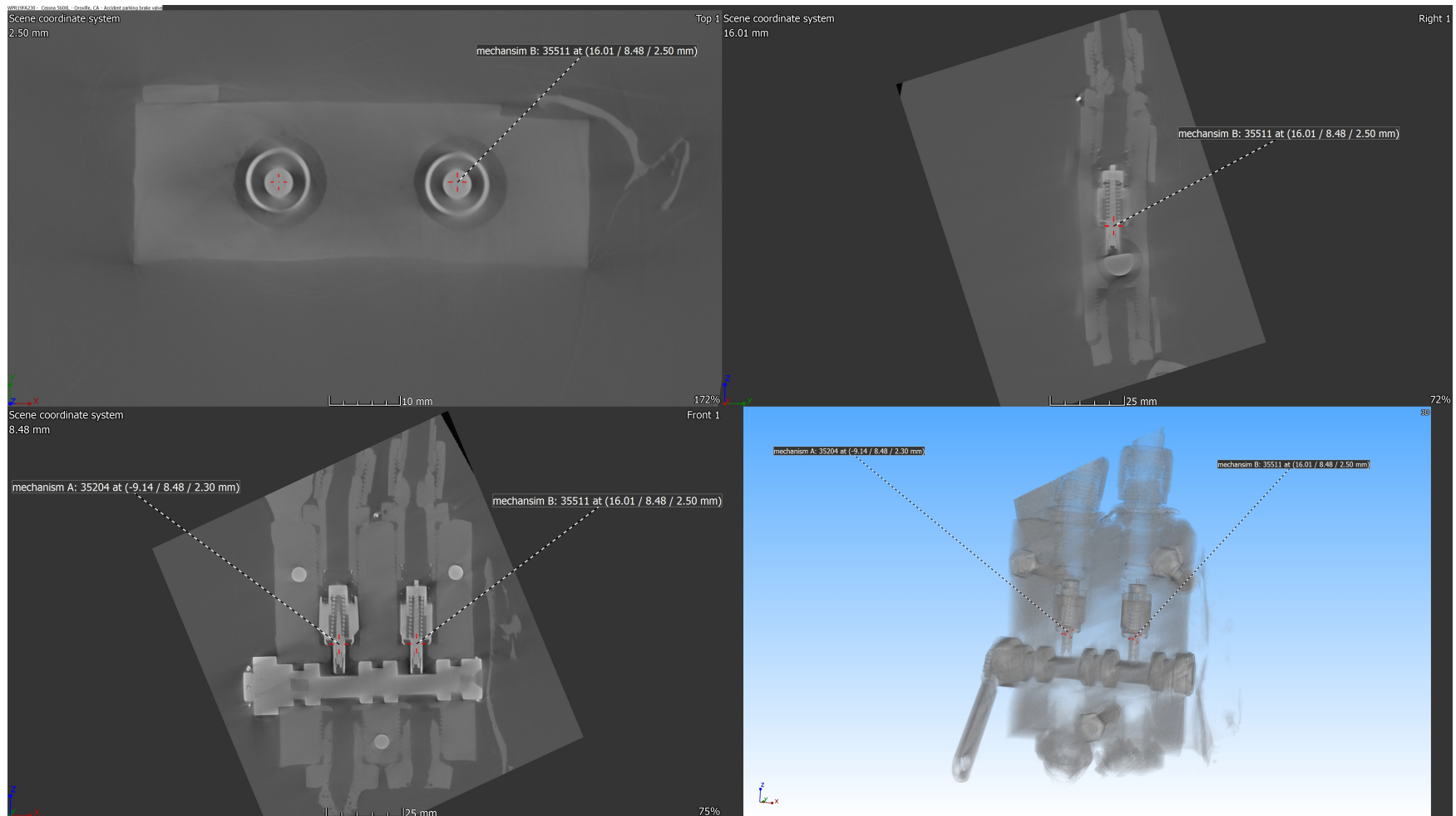


Figure 6
Accident parking brake valve – mechanism B

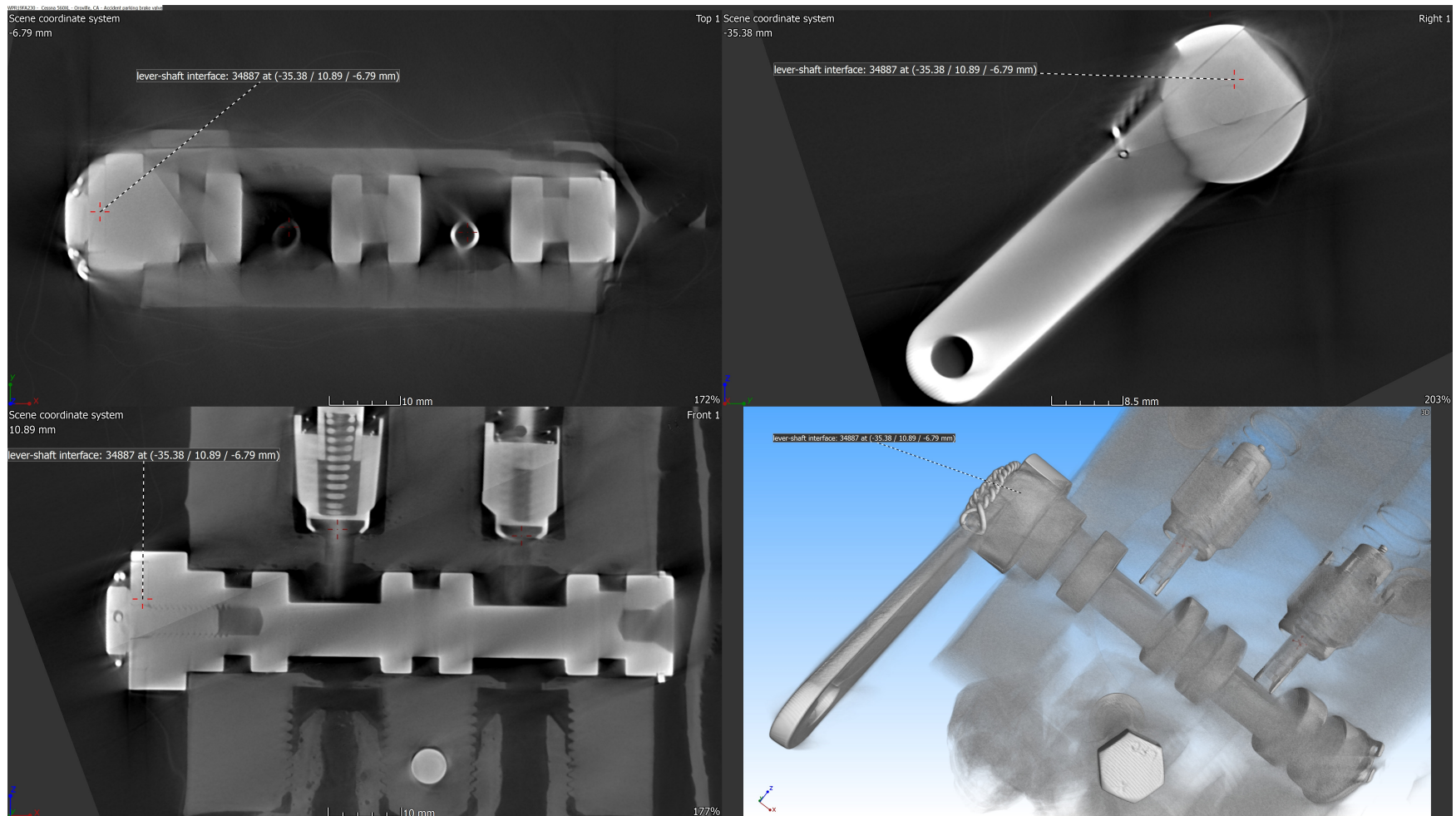


Figure 7
Accident parking brake valve – lever to shaft interface

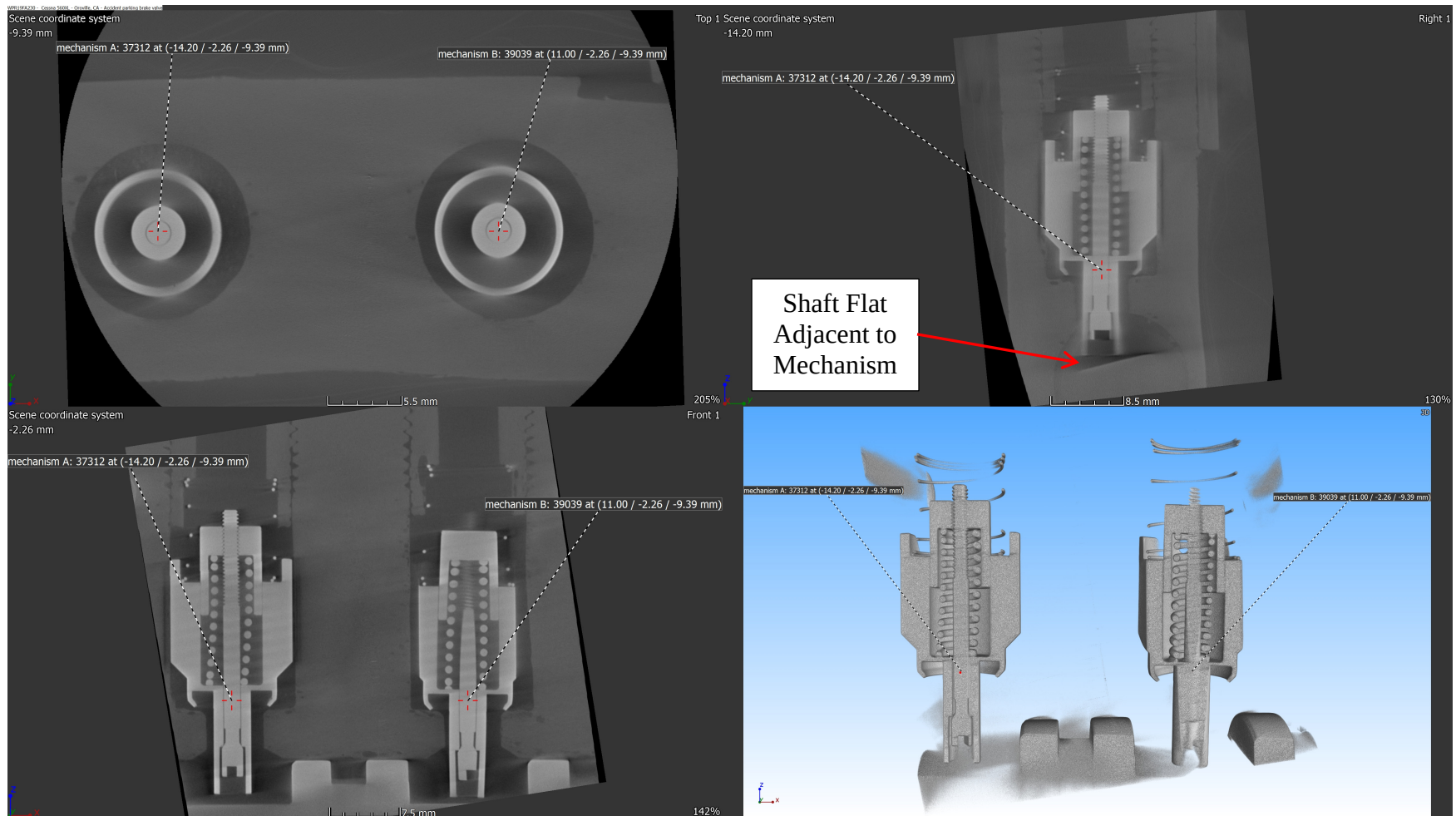


Figure 8
Accident parking brake valve – target CT - mechanism A

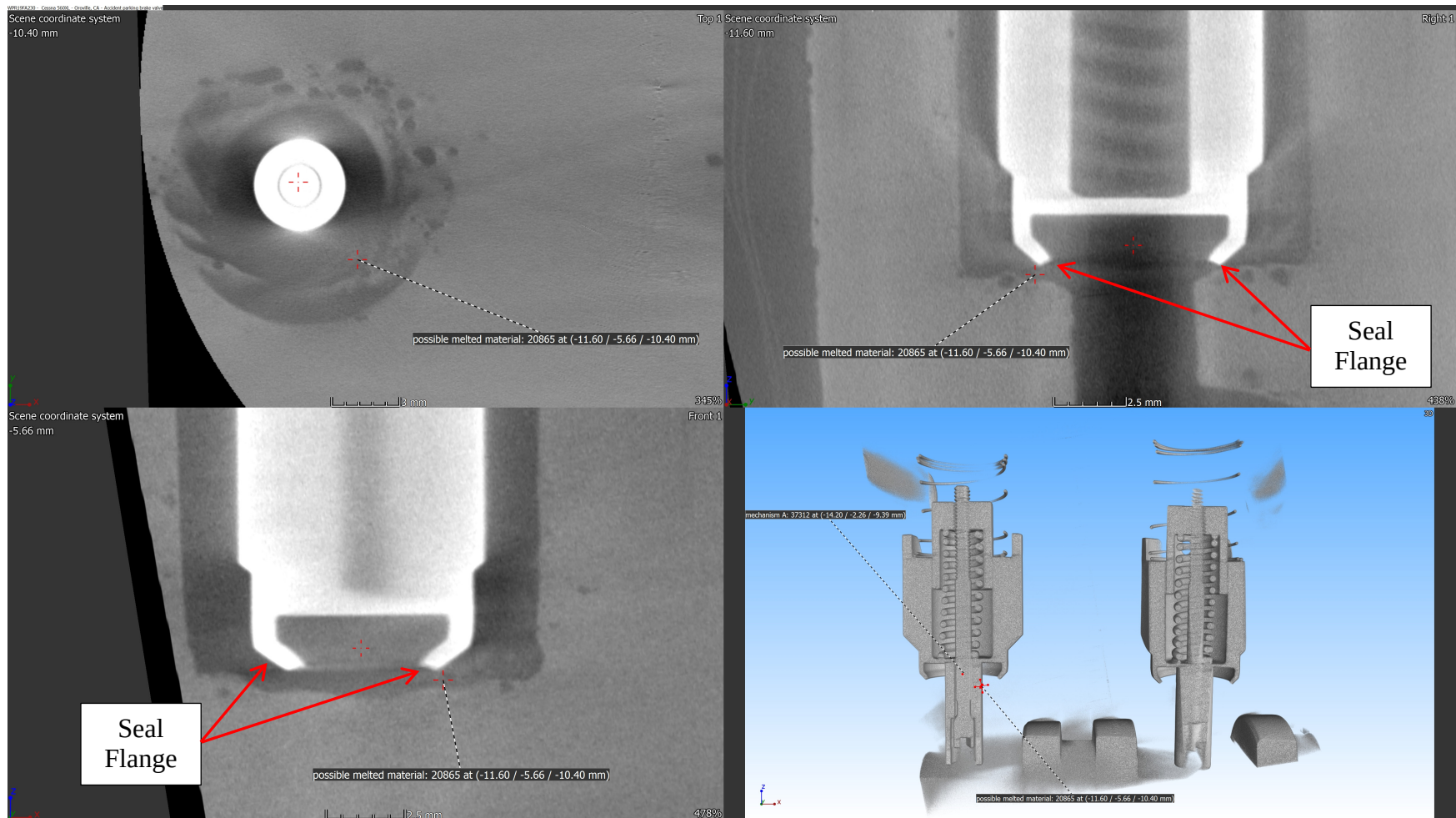


Figure 9
Accident parking brake valve – target CT – mechanism A - possible melted material

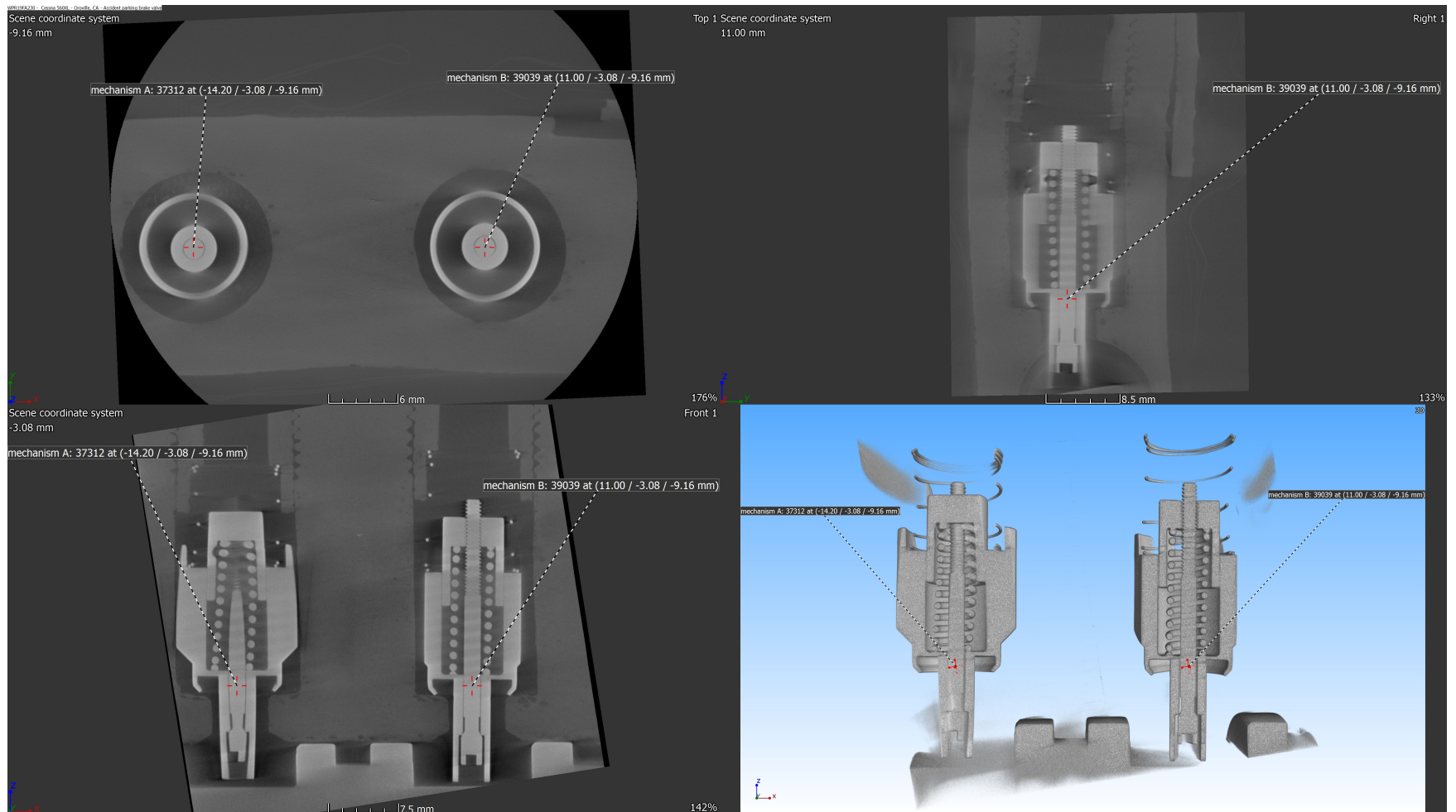


Figure 10
Accident parking brake valve – target CT - mechanism B

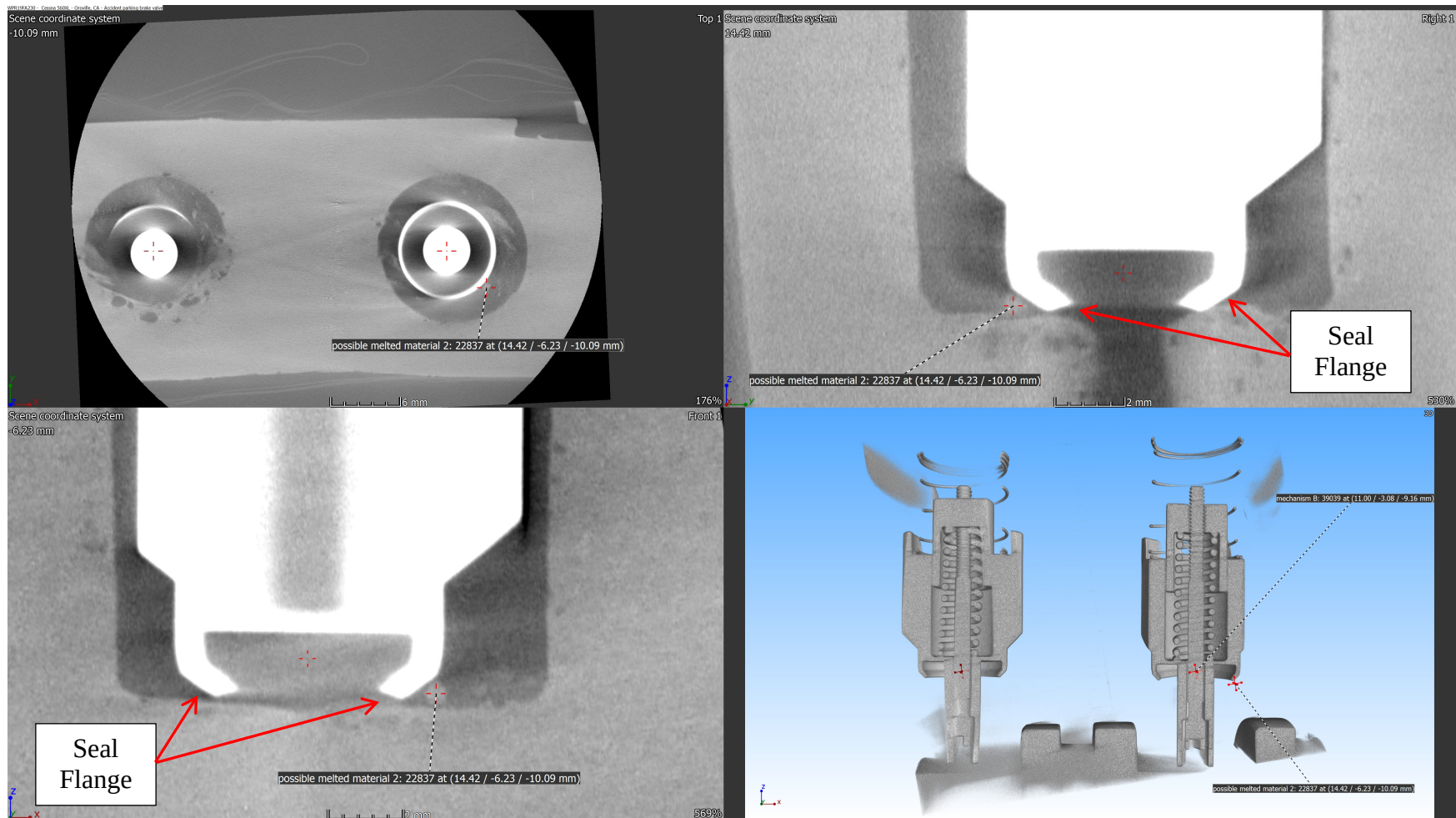


Figure 11
Accident parking brake valve – target CT - mechanism B – possible melted material

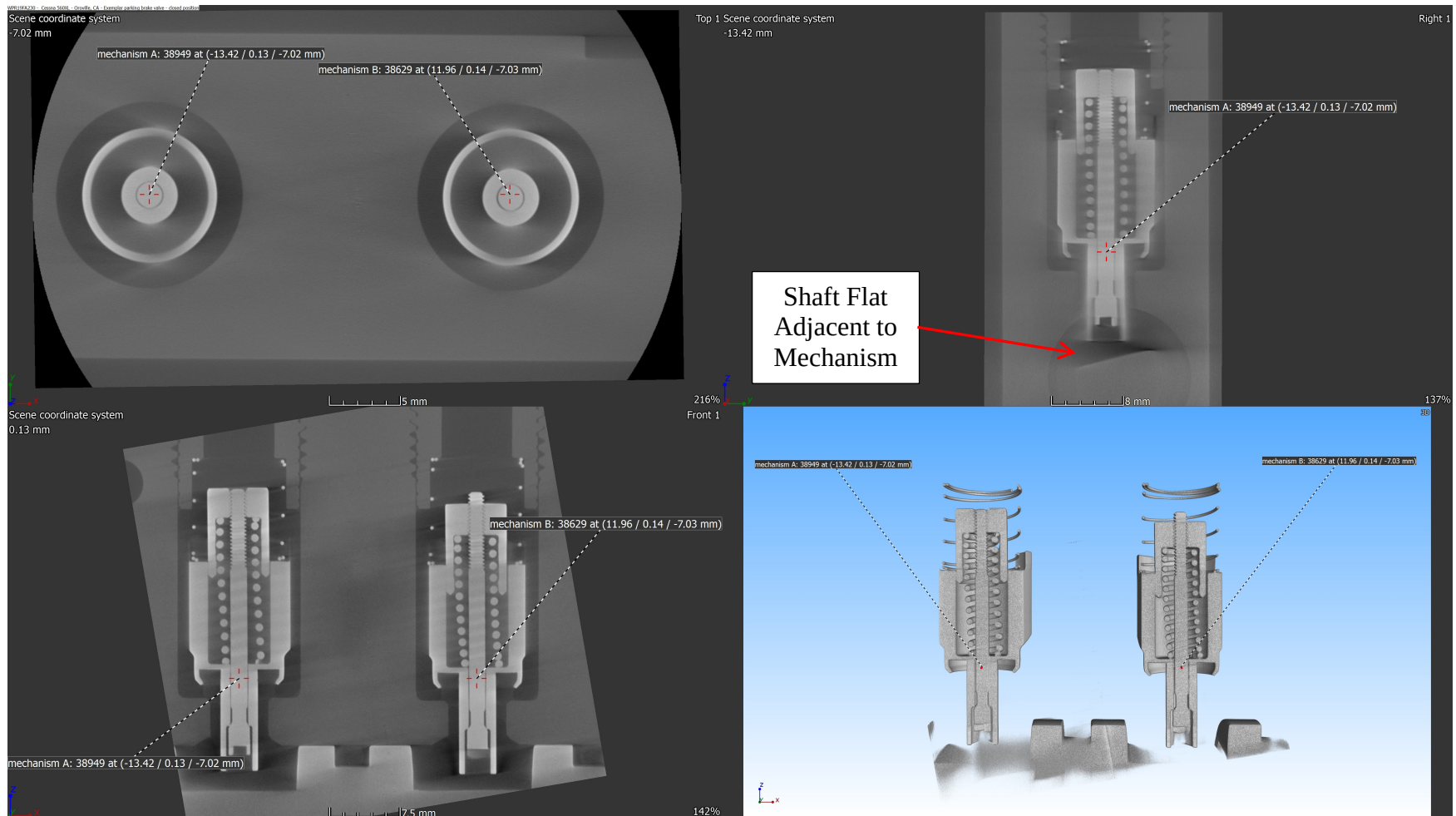


Figure 12
Exemplar parking brake valve – target CT - closed position - mechanism A

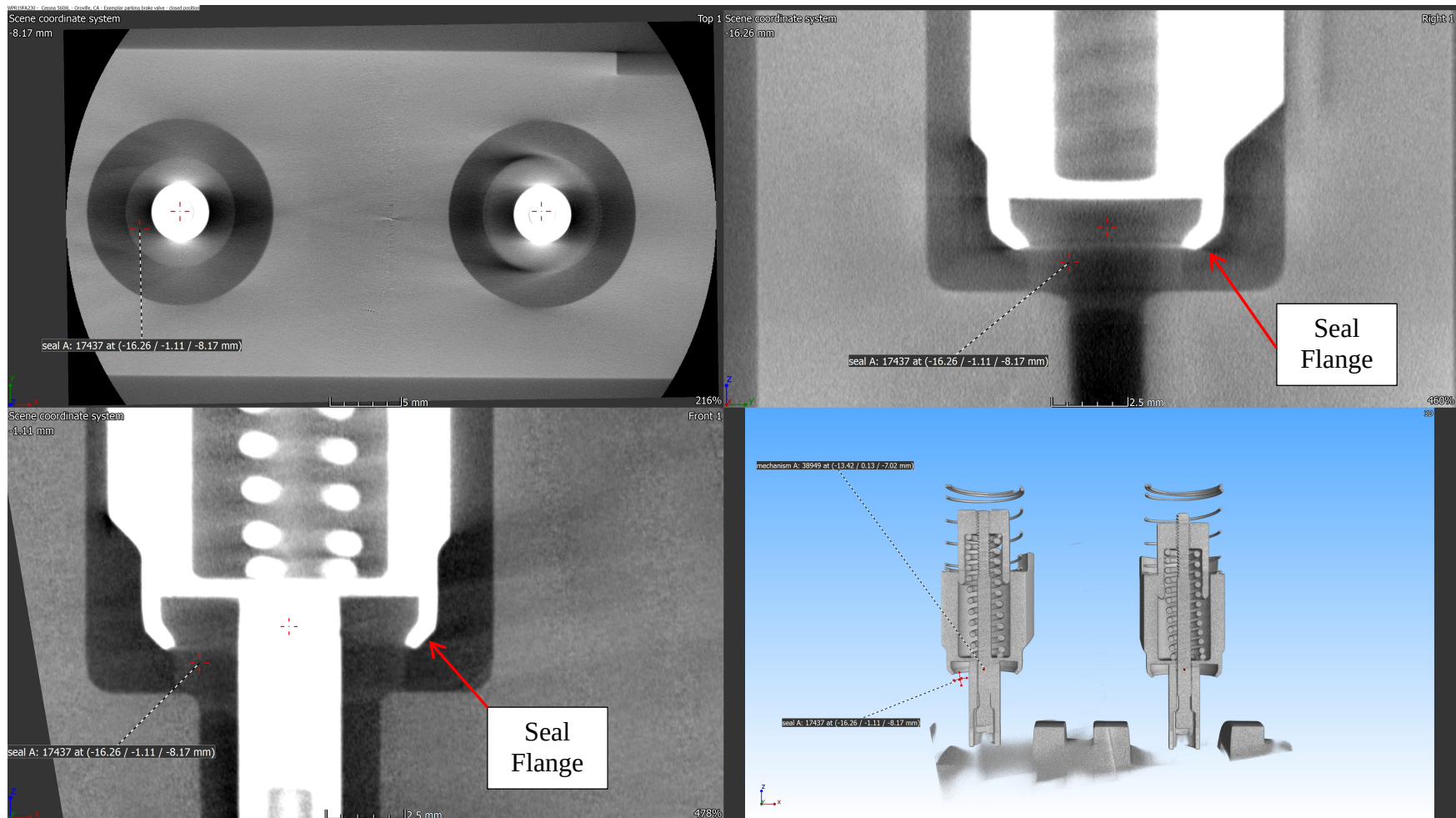


Figure 13
Exemplar parking brake valve – target CT - closed position - mechanism A – seal

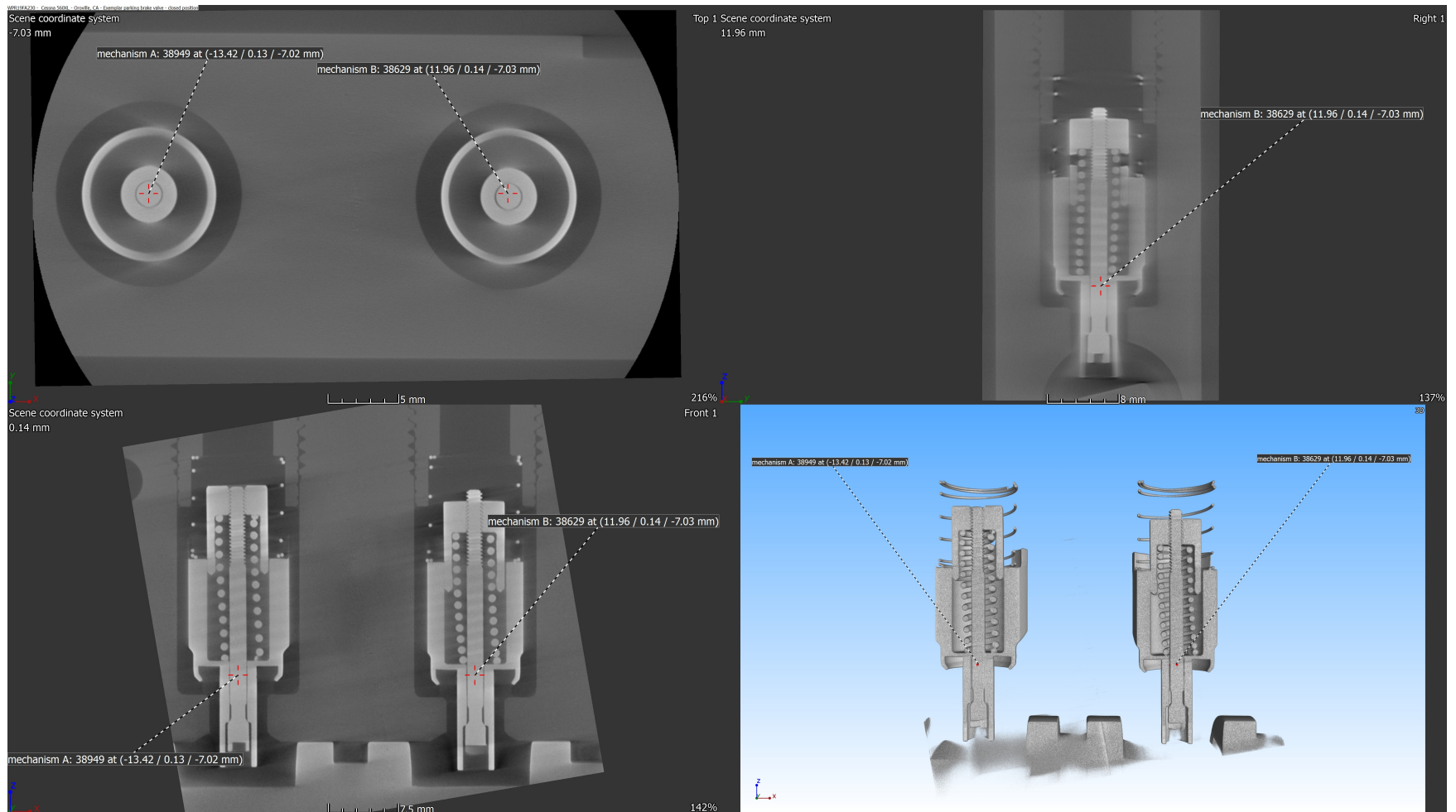


Figure 14
Exemplar parking brake valve – target CT - closed position - mechanism B

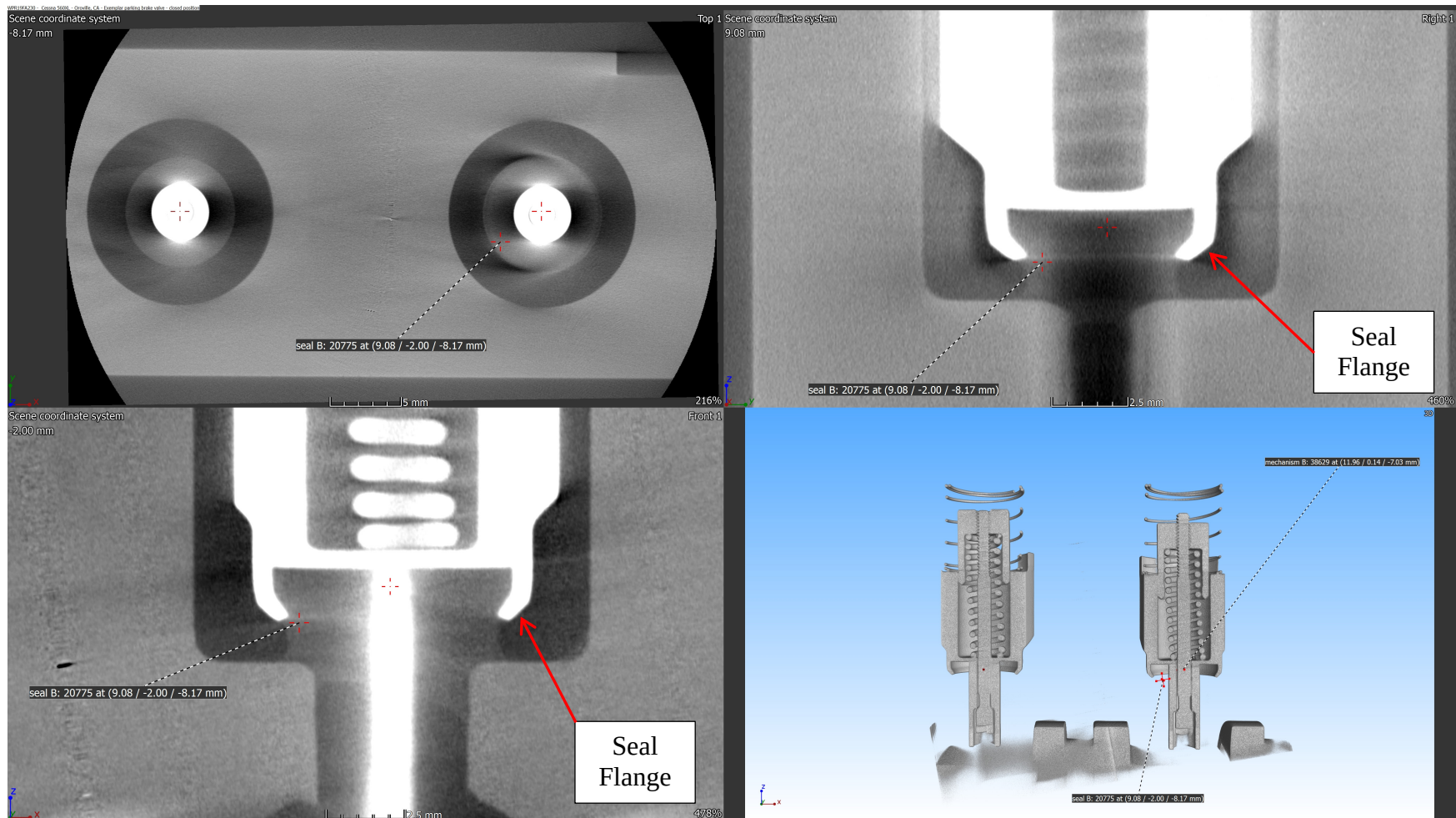


Figure 15
Exemplar parking brake valve – target CT - closed position - mechanism B – seal

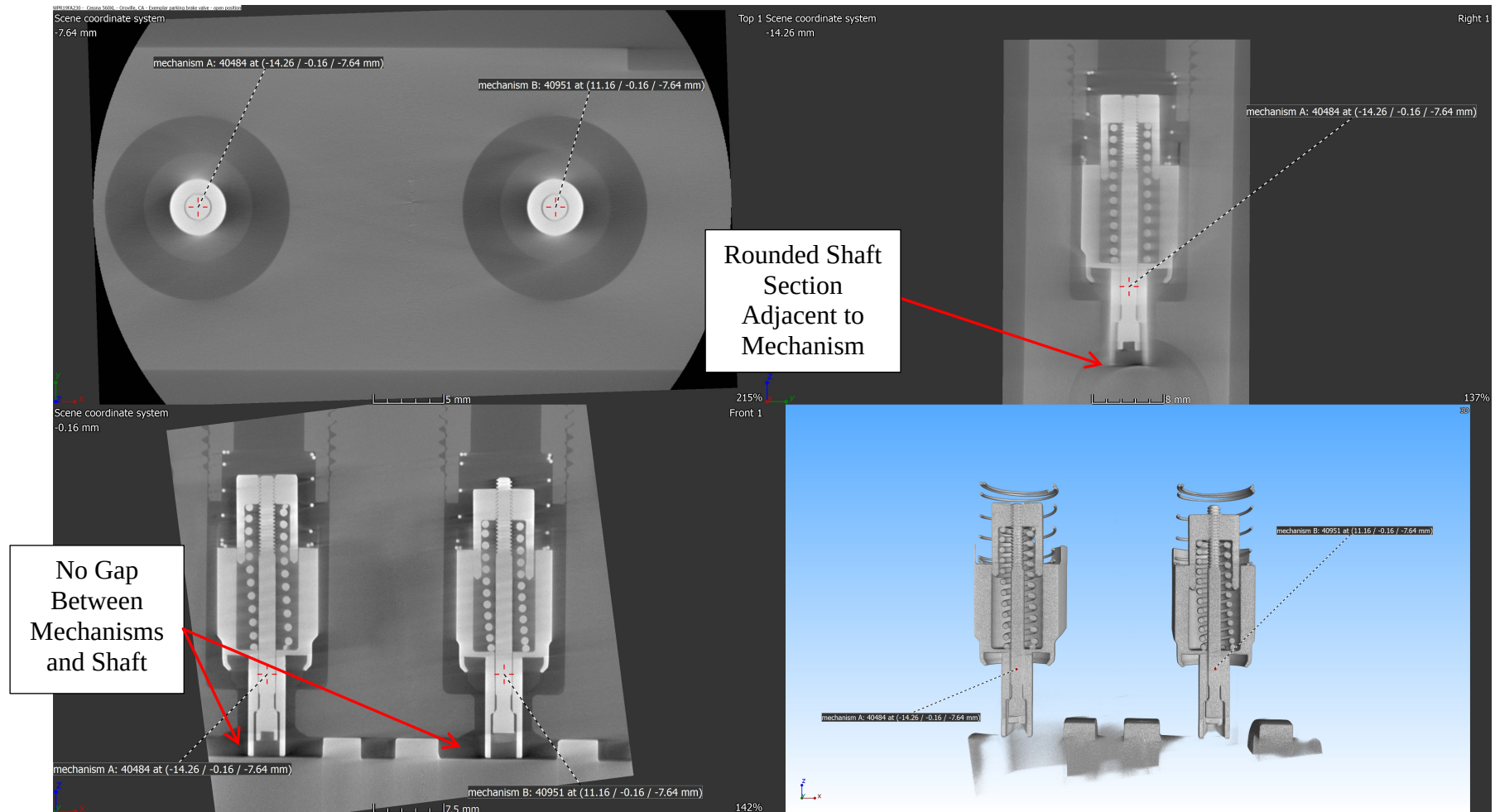


Figure 16
Exemplar parking brake valve – target CT - open position - mechanism A

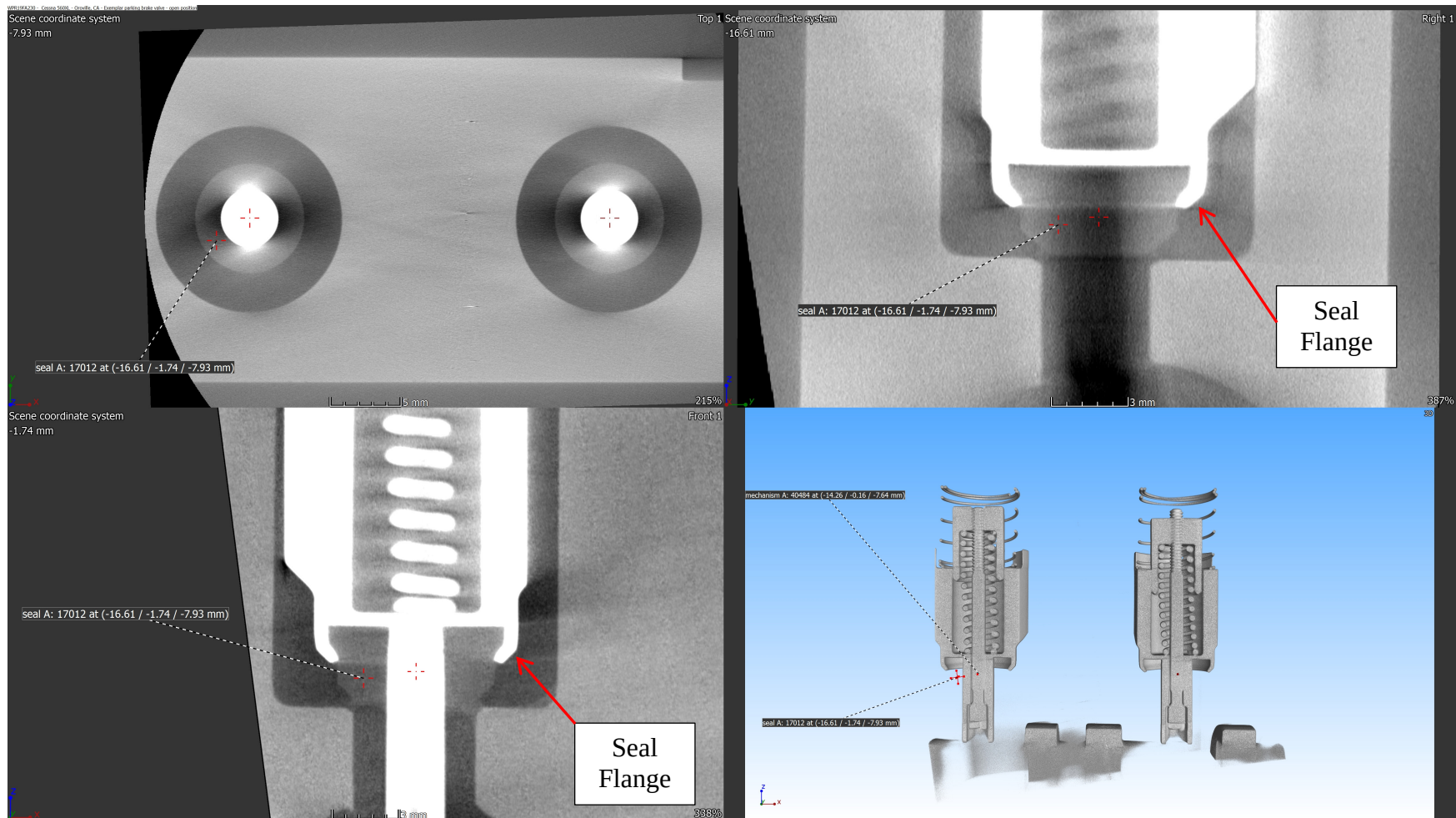


Figure 17
Exemplar parking brake valve – target CT - open position - mechanism A – seal

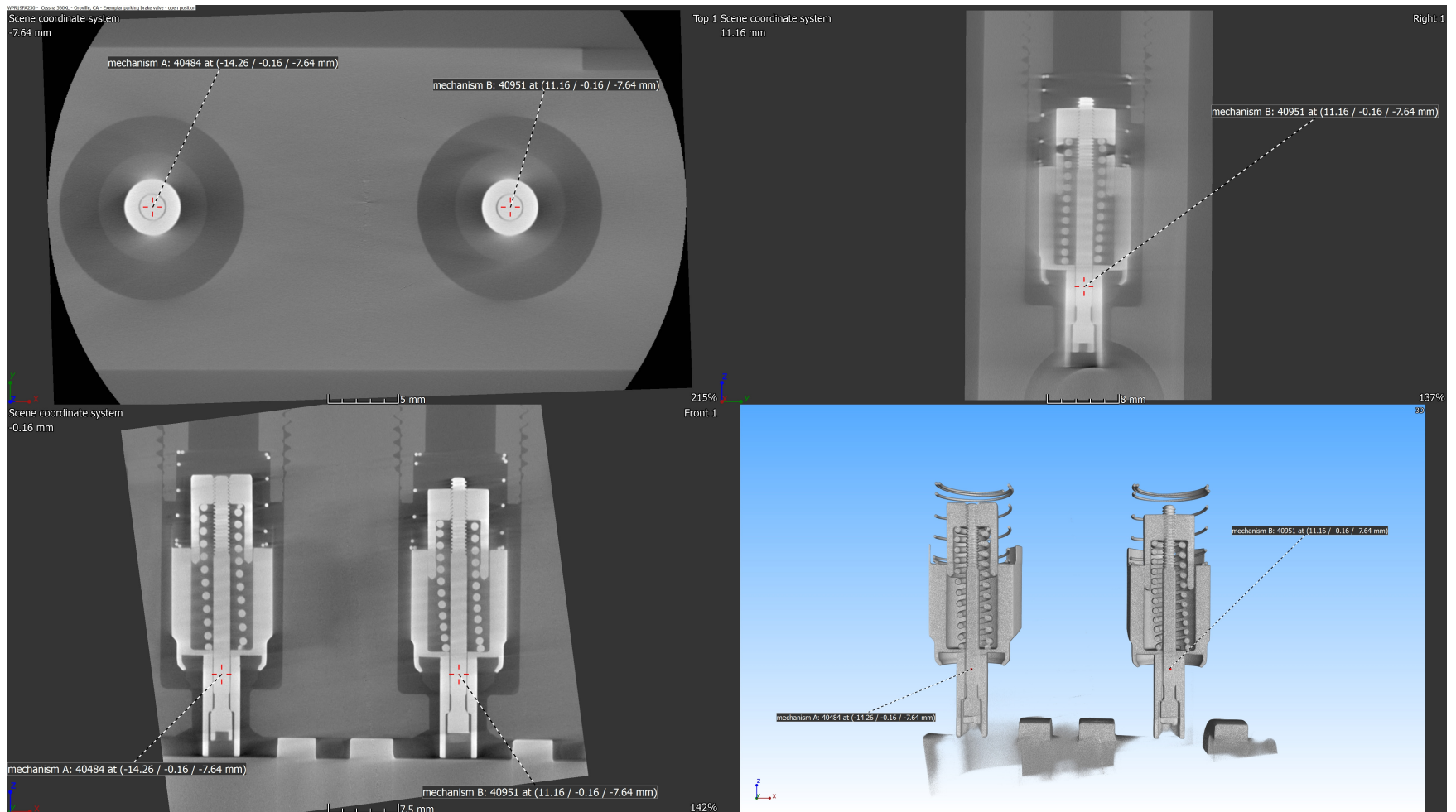


Figure 18
Exemplar parking brake valve – target CT - open position - mechanism B

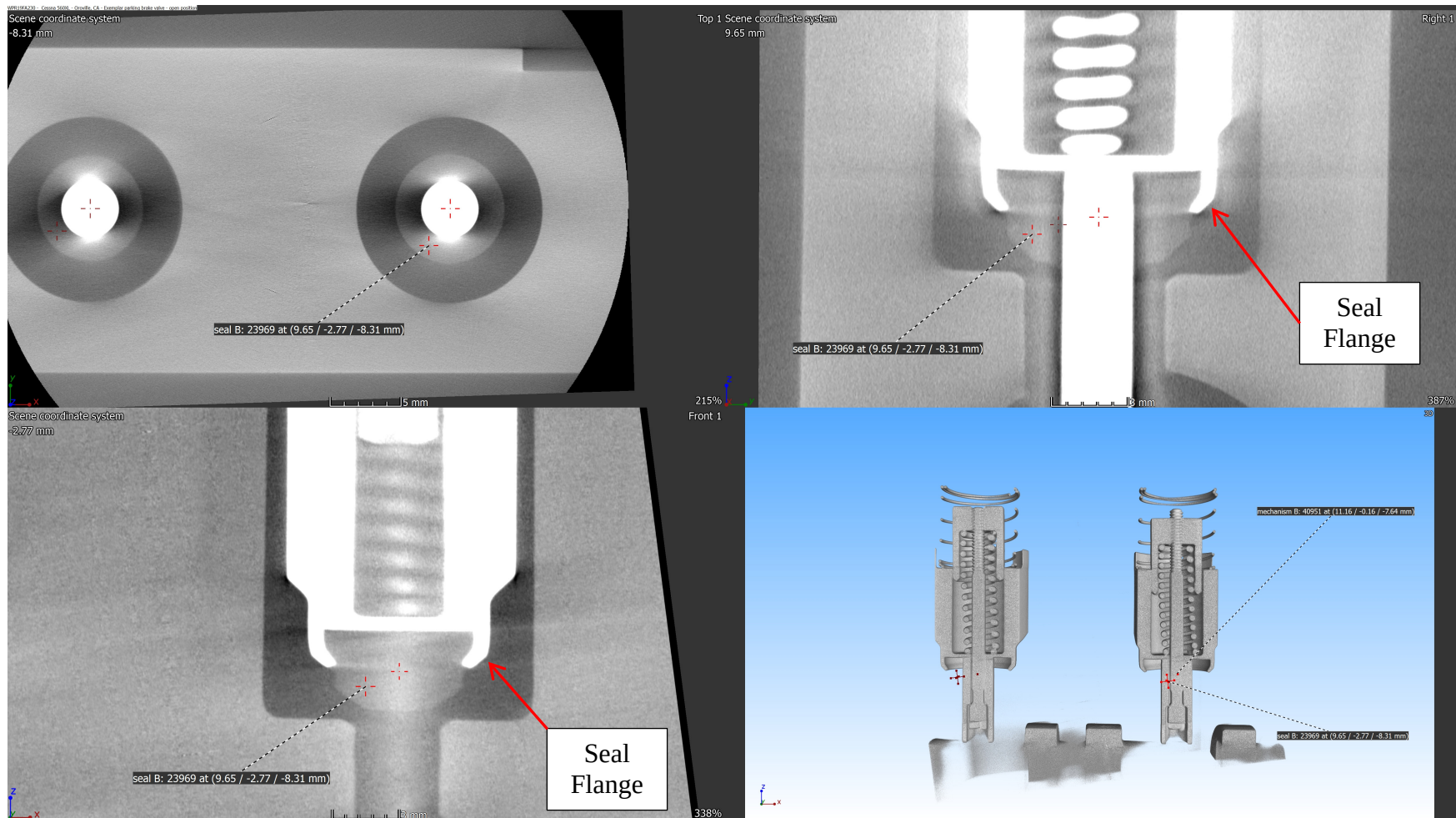


Figure 19
Exemplar parking brake valve – target CT - open position - mechanism B – seal

Scott Warren
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