

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

December 17, 2021

Computed Tomography Specialist's Factual Report

ERA21FA346

A. ACCIDENT

Location: Farmington, Connecticut
Date: September 2, 2021
Time: 0951 eastern daylight time
Airplane: Cessna 560XL airplane, N560AR

B. GROUP

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

C. SUMMARY

On September 2, 2021, at 0951 eastern daylight time, a Cessna 560XL airplane, N560AR, was destroyed when it was involved in an accident near Farmington, Connecticut. The two pilots and two passengers were fatally injured. One person on the ground sustained serious injuries and three people sustained minor injuries. The airplane was operated as a Title 14 Code of Federal Regulations Part 91 personal flight.

The internal configuration of the accident parking brake valve was documented using radiographic images that were collected on October 1, 2021, in Chicago, Illinois. A total of 3,051 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 shaft flat was adjacent to the mechanisms. This position was consistent with the valve being in the closed position.
4. For the accident valve, the lever to shaft interface did not show any indications of cracks, missing material, or other abnormalities.
5. For the accident valve, there were indications of high density particles and possible debris. The possible debris was consistent with burned material from outside the valve or from heated material within the valve.

D. DETAILS OF THE INVESTIGATION

1.0 General

The accident parking brake valve was subjected to x-ray radiograph and computed tomography (CT) scanning to document its internal conditions. The scanning was conducted on October 1, 2021, by Varex, Inc under the direction of the NTSB using the Actis 500/225 micro focus 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 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 3,051 slices, and the total size of the combined data sets was approximately 23.8 Gb. The complete scan protocol is 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 Protocol

Component	Accident parking brake valve
Number of slices	3051
Voxel ¹ Size - X Direction (mm)	0.041
Voxel Size - Y Direction (mm)	0.041
Voxel Size - Z Direction (mm)	0.043
Image Projections per Revolution	2160
Exposure time (ms)	285.60
Frames to Avg (frames per projection)	2
X-ray Source Voltage (kV)	222
X-ray Source Current (mA)	0.550
Source Filter Thickness (mm)	1
Source Filter Material	Brass
Image Matrix Size	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 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 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 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.

An exemplar parking brake valve was scanned as part of the NTSB's investigation into an August 21, 2019, accident involving a Cessna Citation 560XL aircraft². To provide additional context for the images from the accident parking brake valve, the exemplar images are provided in this report as well.

2.0 Computed Tomography Results

The computed tomography (CT) results for the components are shown in figures 1 through 18. 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 shaft flat was adjacent to the mechanisms. This position was consistent with the valve being in the closed position.
4. For the accident valve, the lever to shaft interface did not show any indications of cracks, missing material, or other abnormalities.
5. For the accident valve, there were indications of high density particles and possible debris. The possible debris was consistent with burned material from outside the valve or from heated material within the valve.

² See NTSB investigation WPR19FA230 for details.

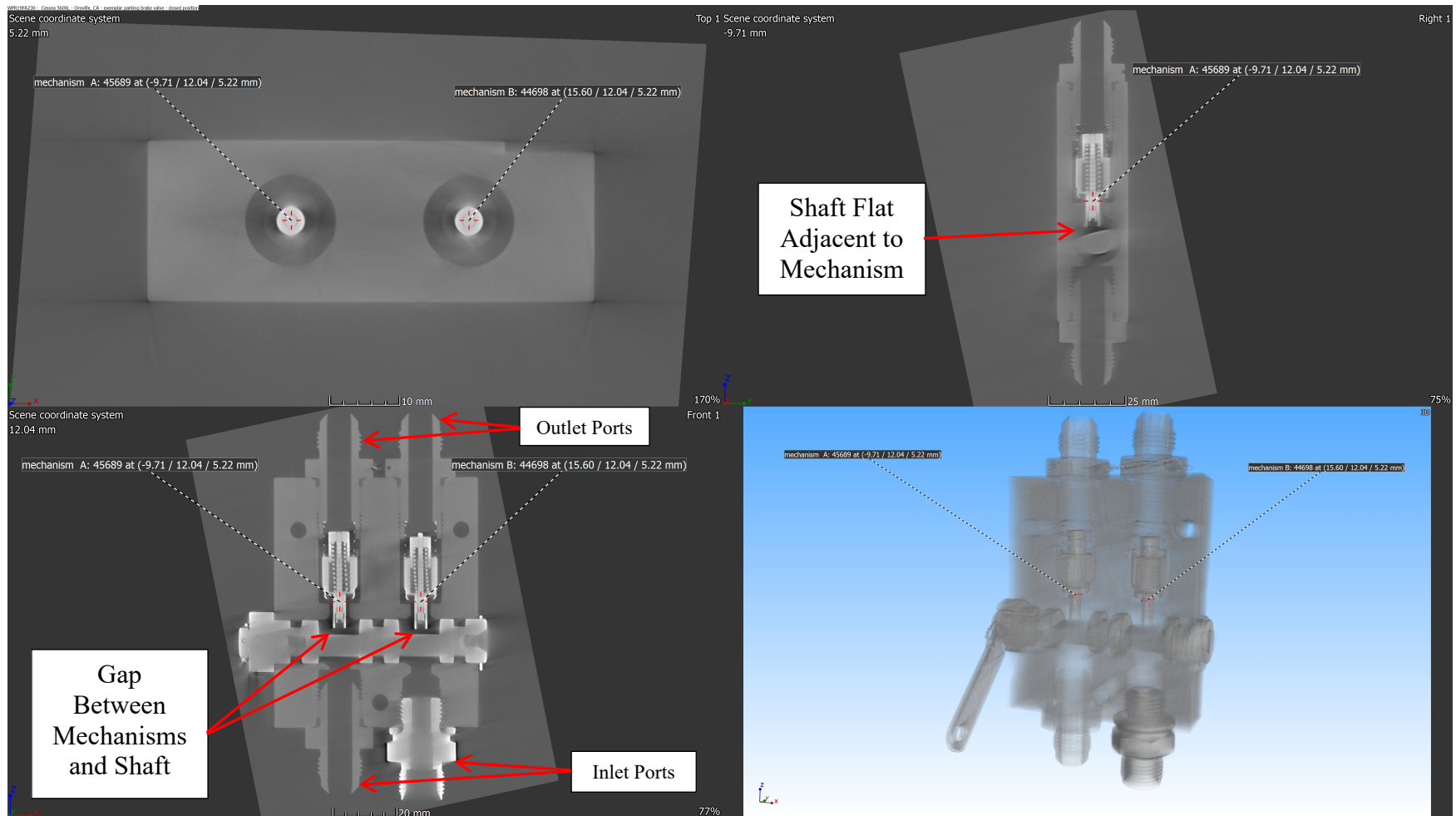


Figure 1
Exemplar parking brake valve – closed position – mechanism A

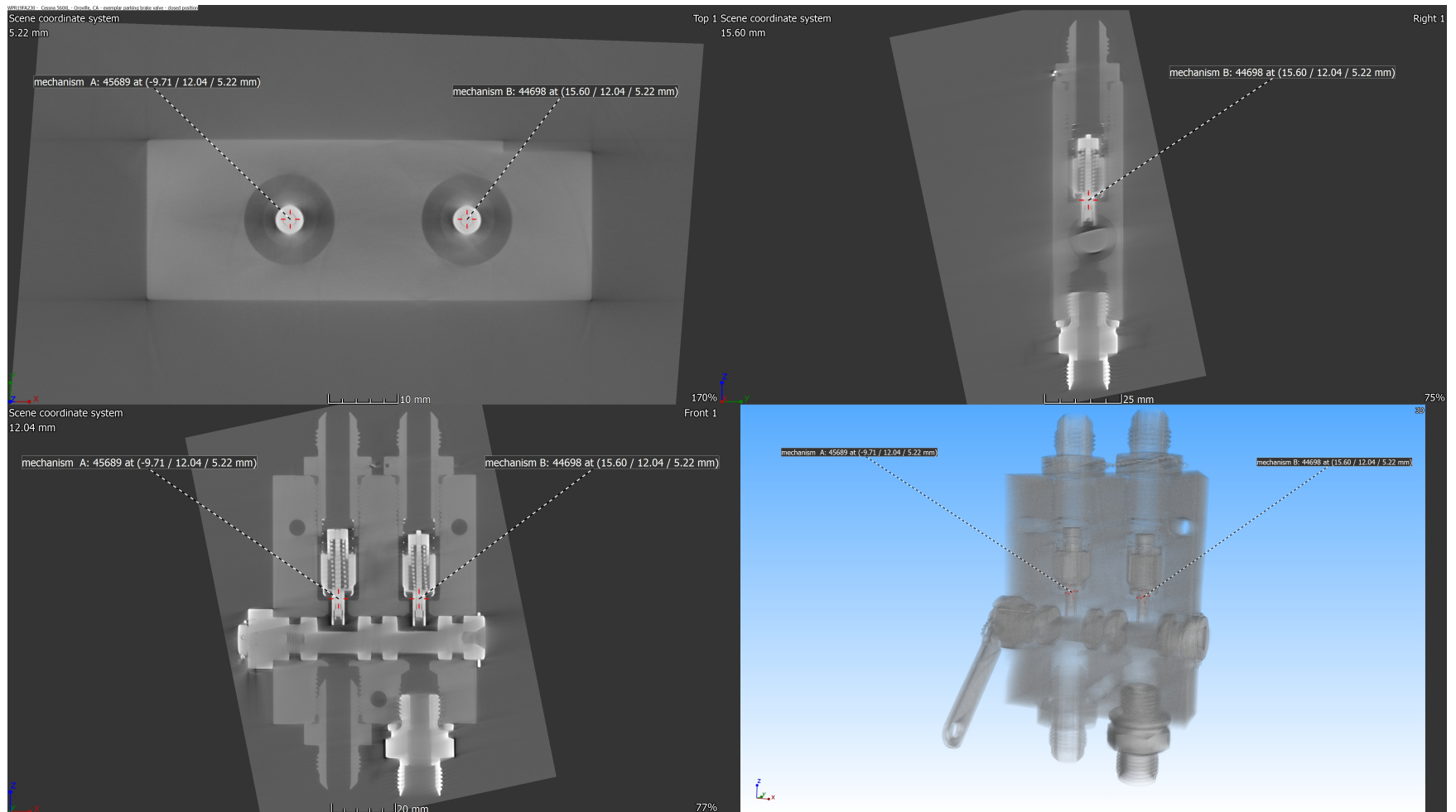


Figure 2
Exemplar parking brake valve – closed position – mechanism B

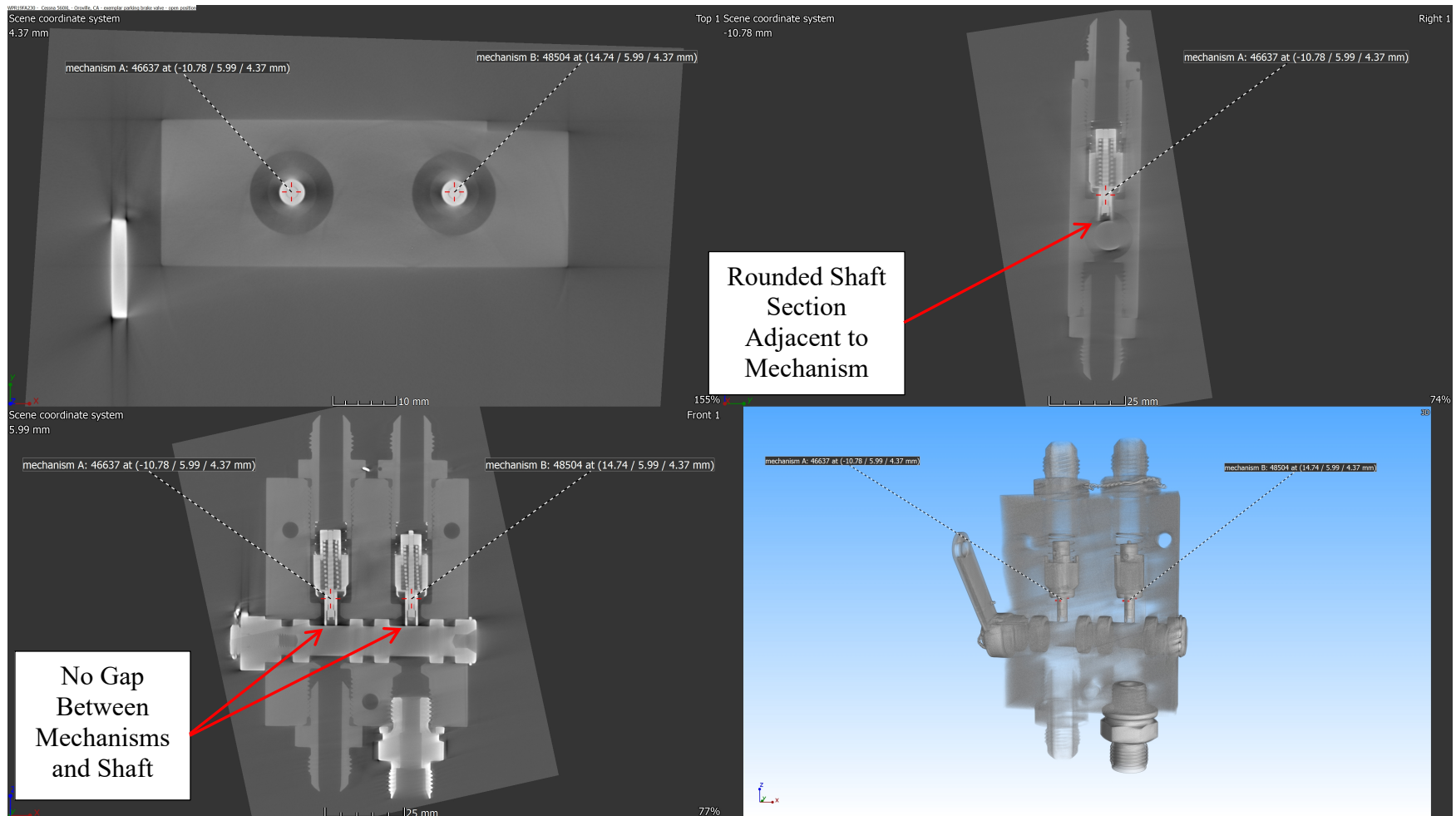


Figure 3
Exemplar parking brake valve – open position – mechanism A

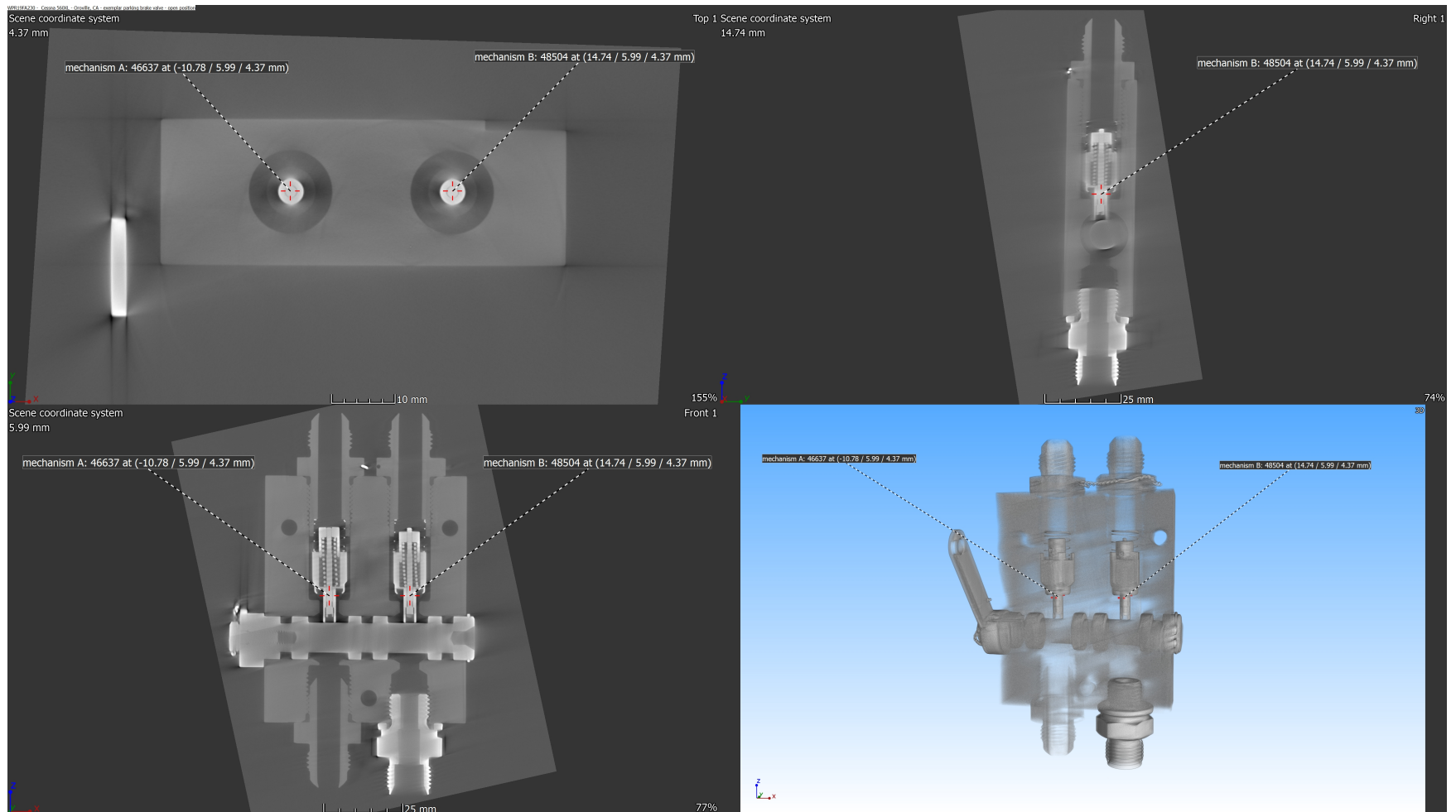


Figure 4
Exemplar parking brake valve – open position – mechanism B

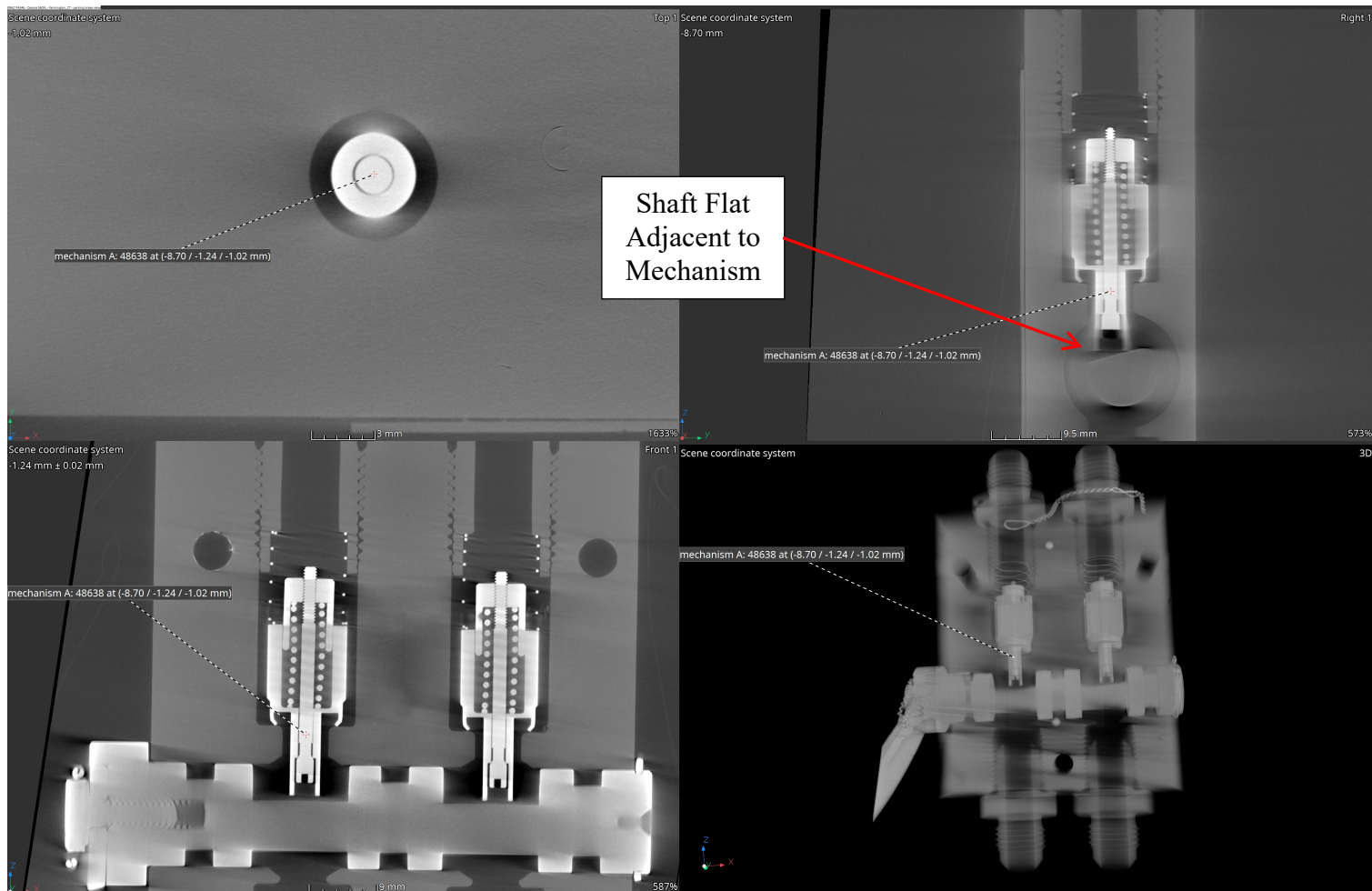


Figure 5
Accident parking brake valve – mechanism A

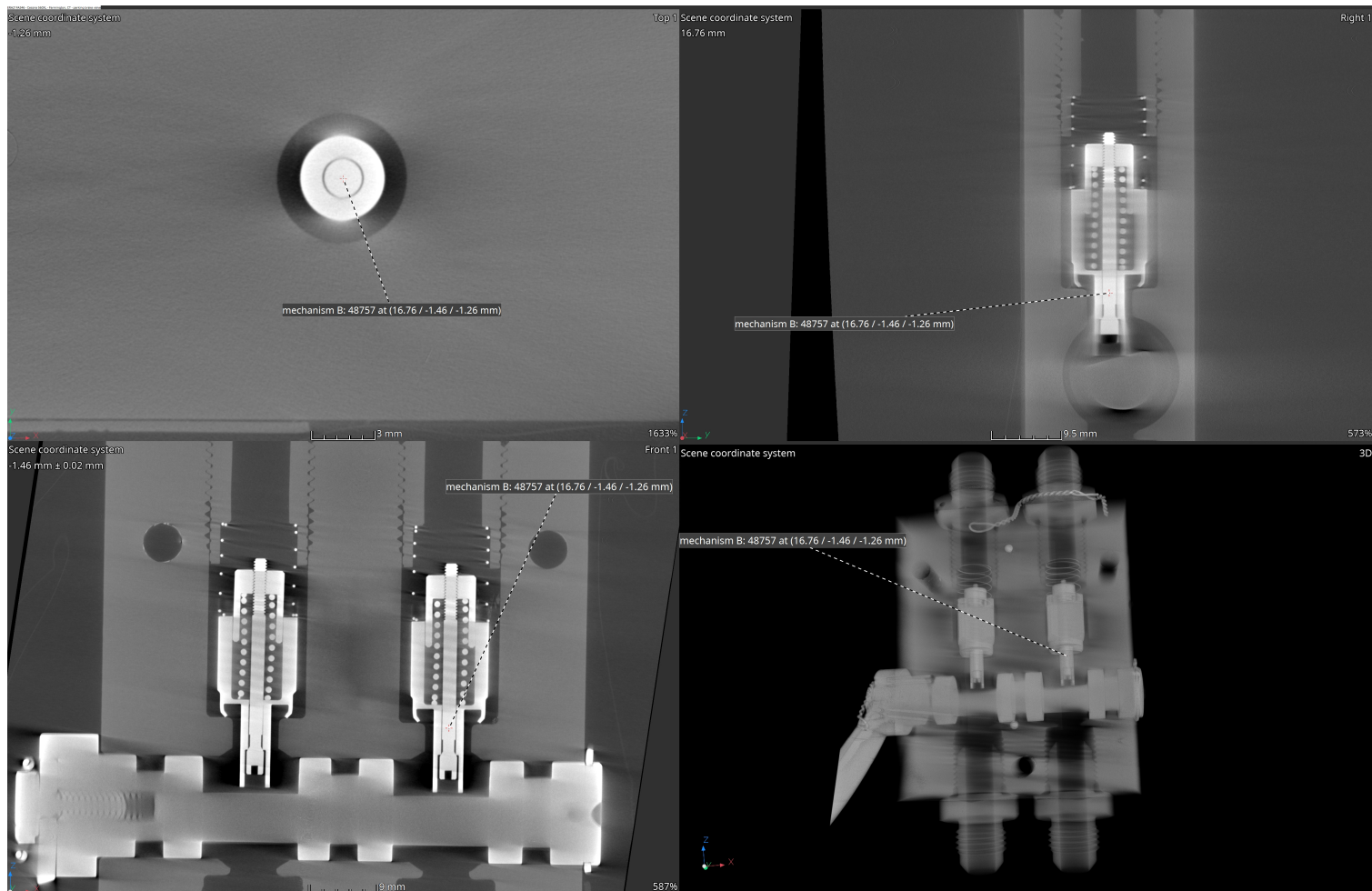


Figure 6
Accident parking brake valve – mechanism B

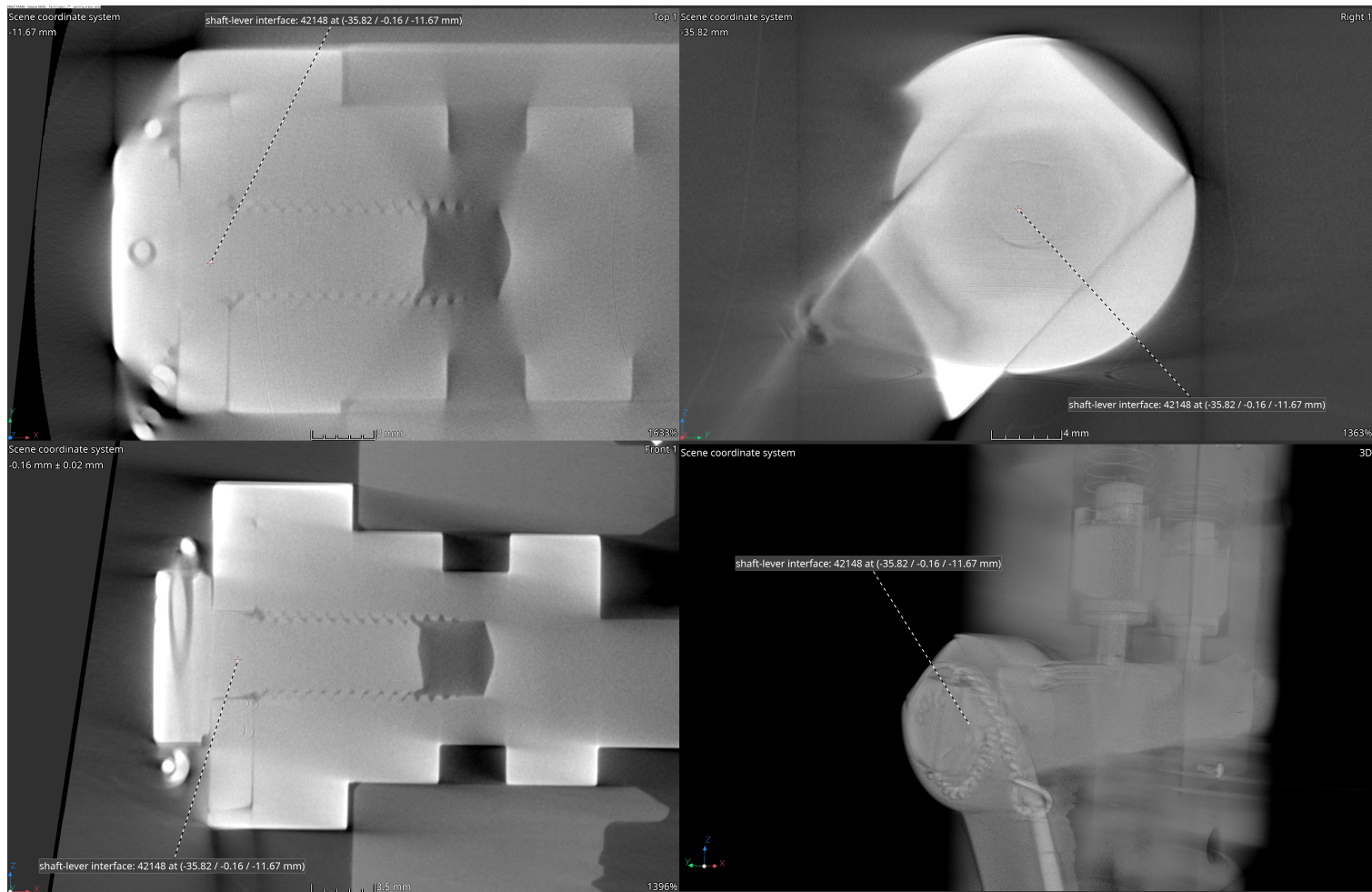


Figure 7
Accident parking brake valve – lever to shaft interface

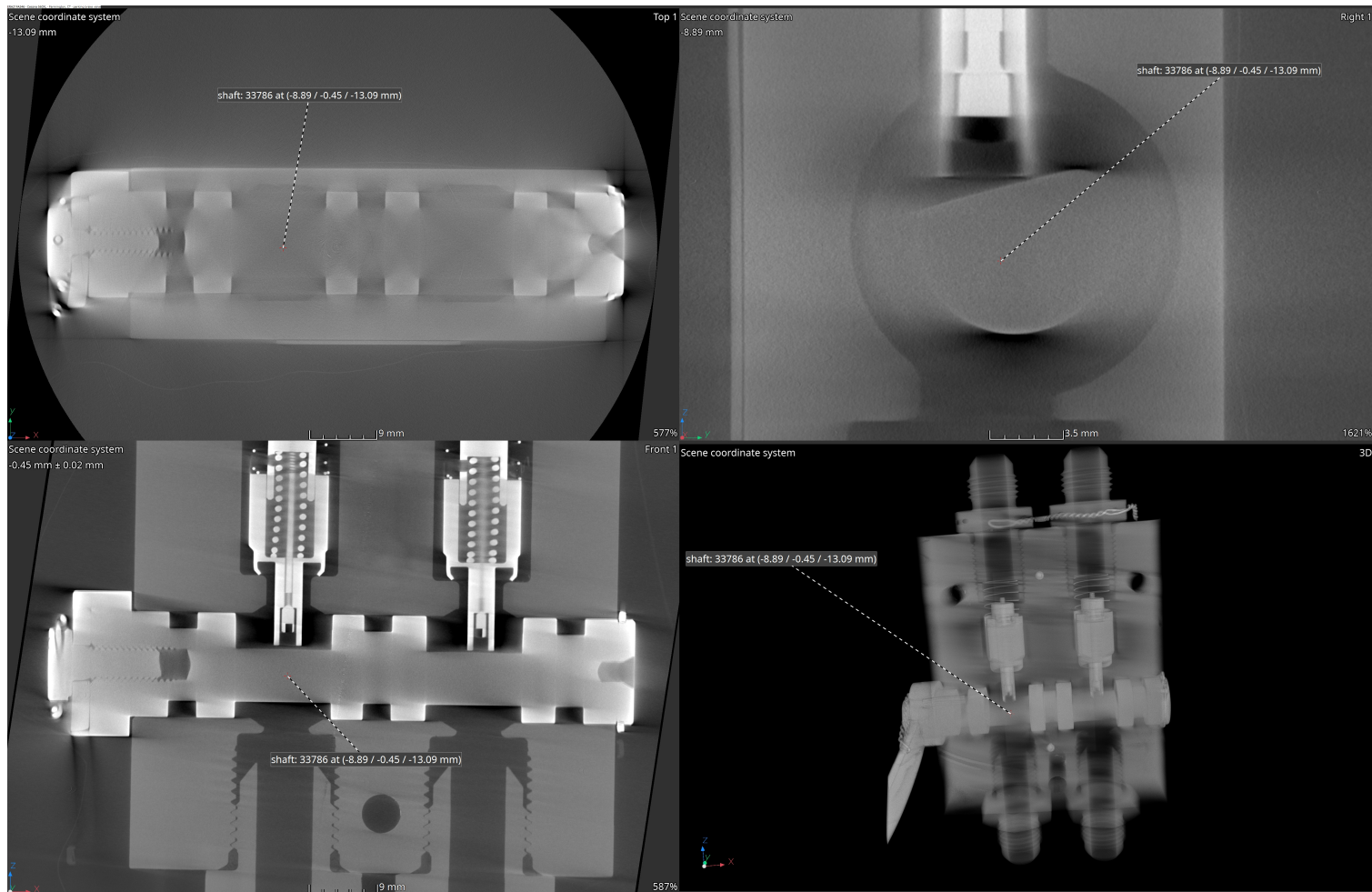


Figure 8
Accident parking brake valve – shaft

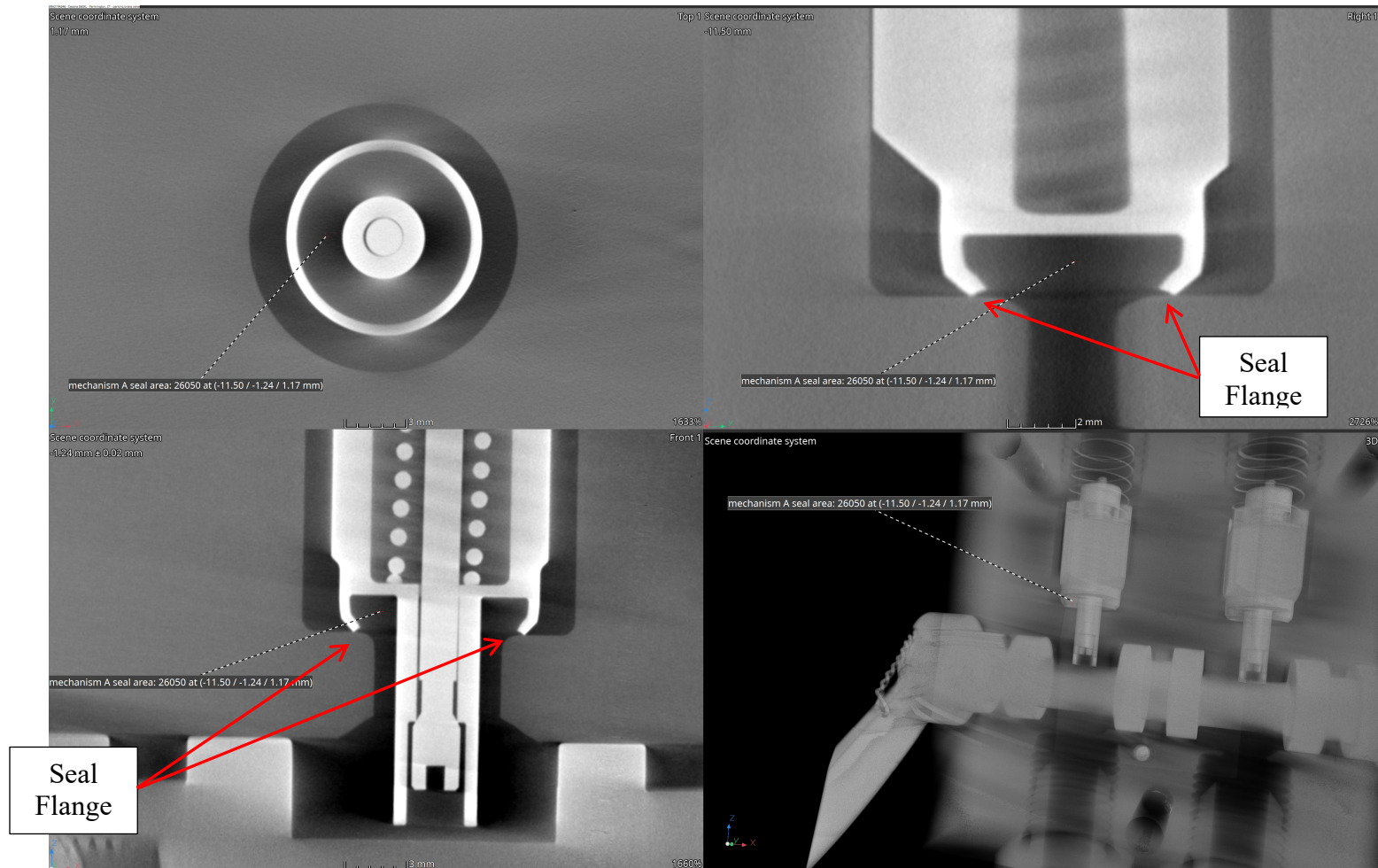


Figure 9
Accident parking brake valve – mechanism A – seal flange

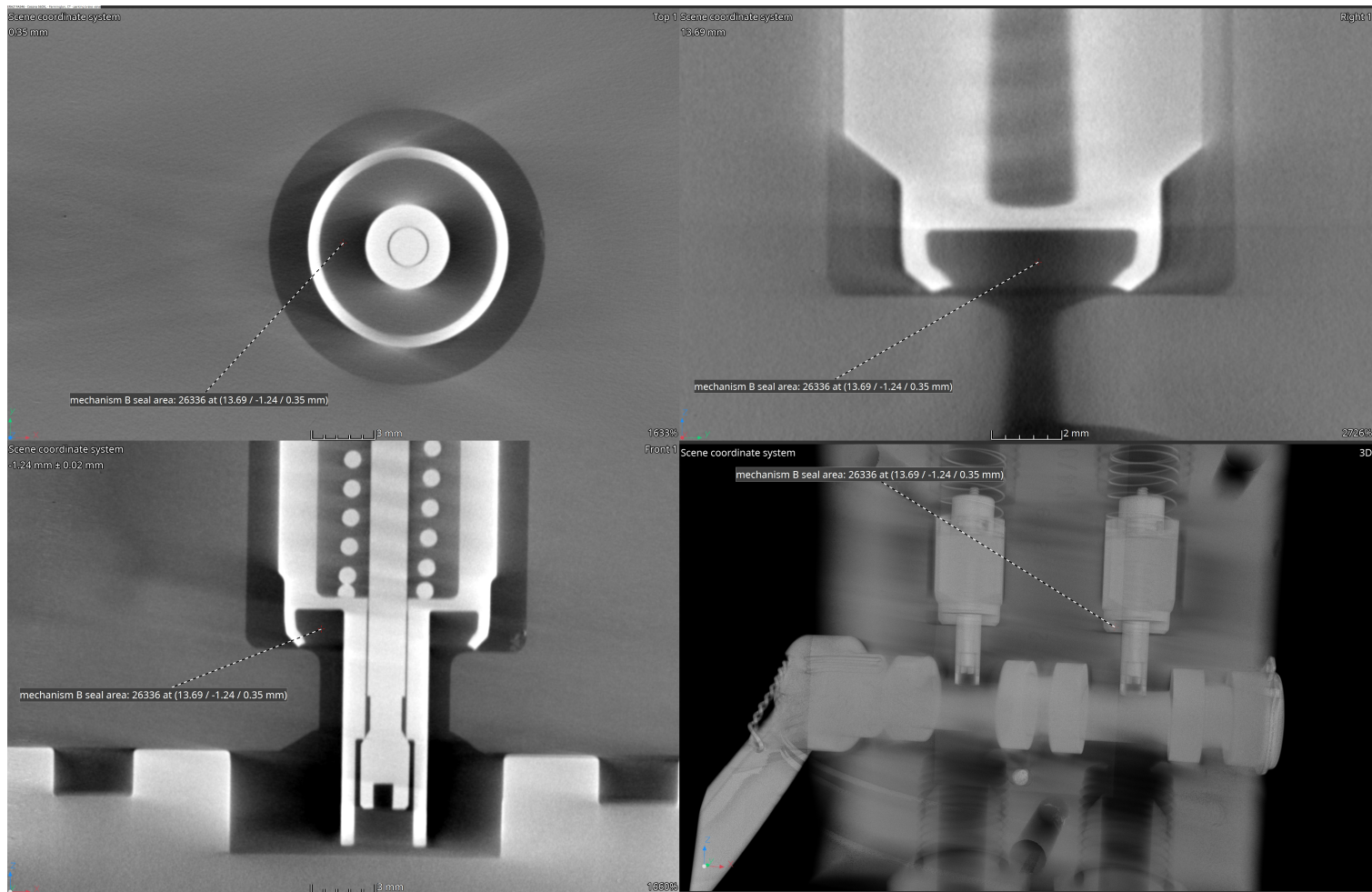


Figure 10
Accident parking brake valve – mechanism B – seal flange

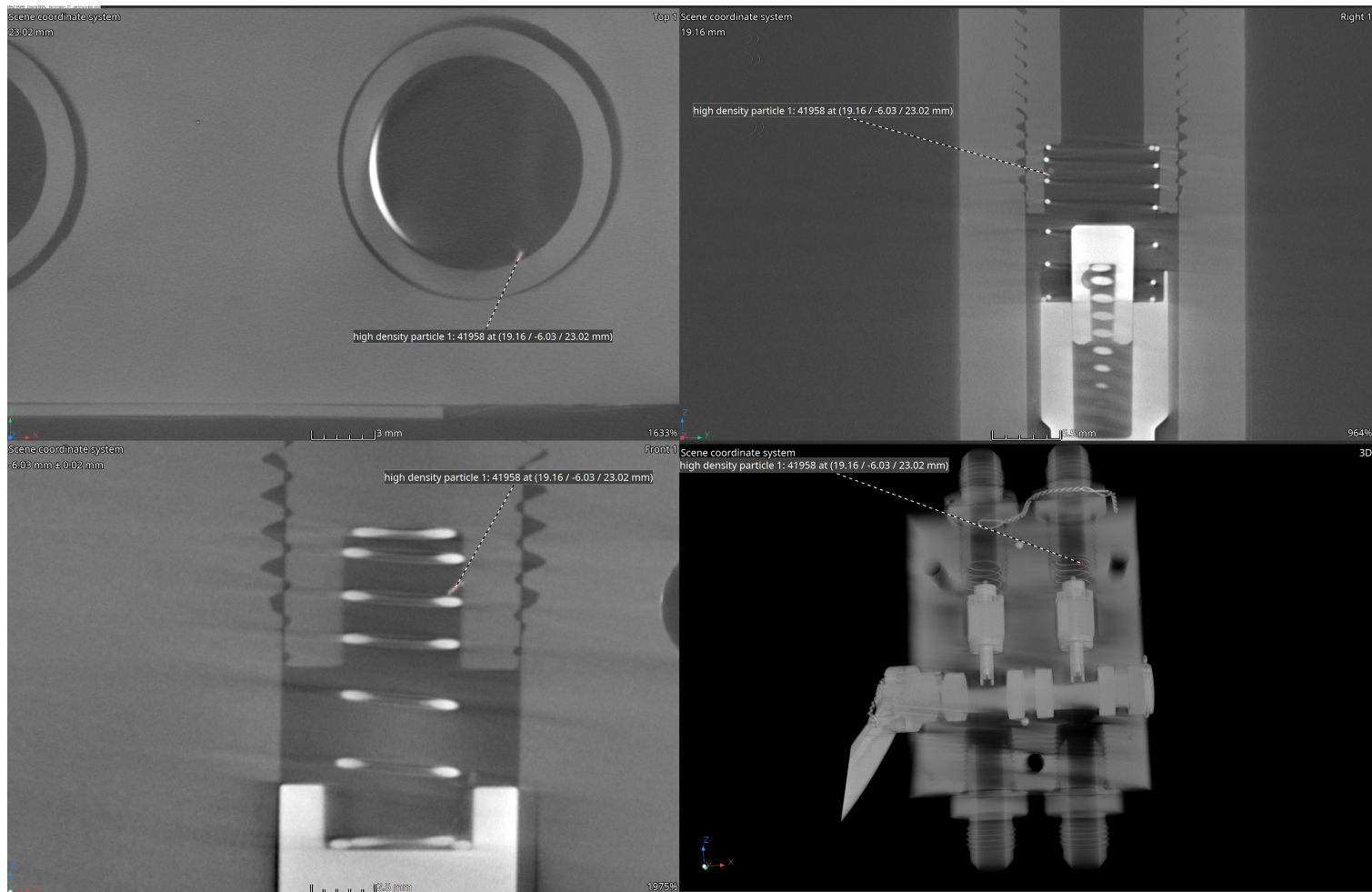


Figure 11
Accident parking brake valve – high density particle 1

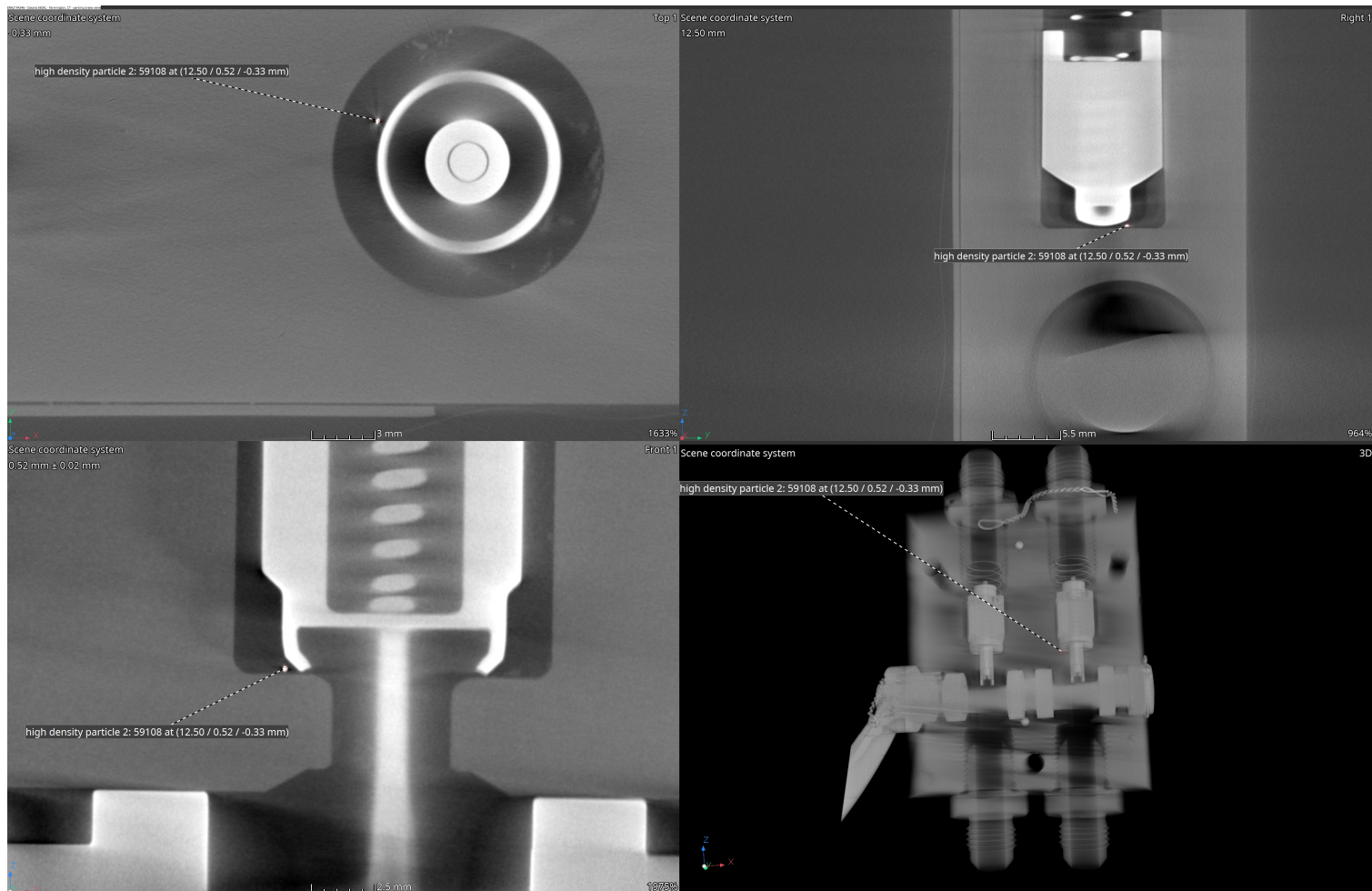


Figure 12
Accident parking brake valve – high density particle 2

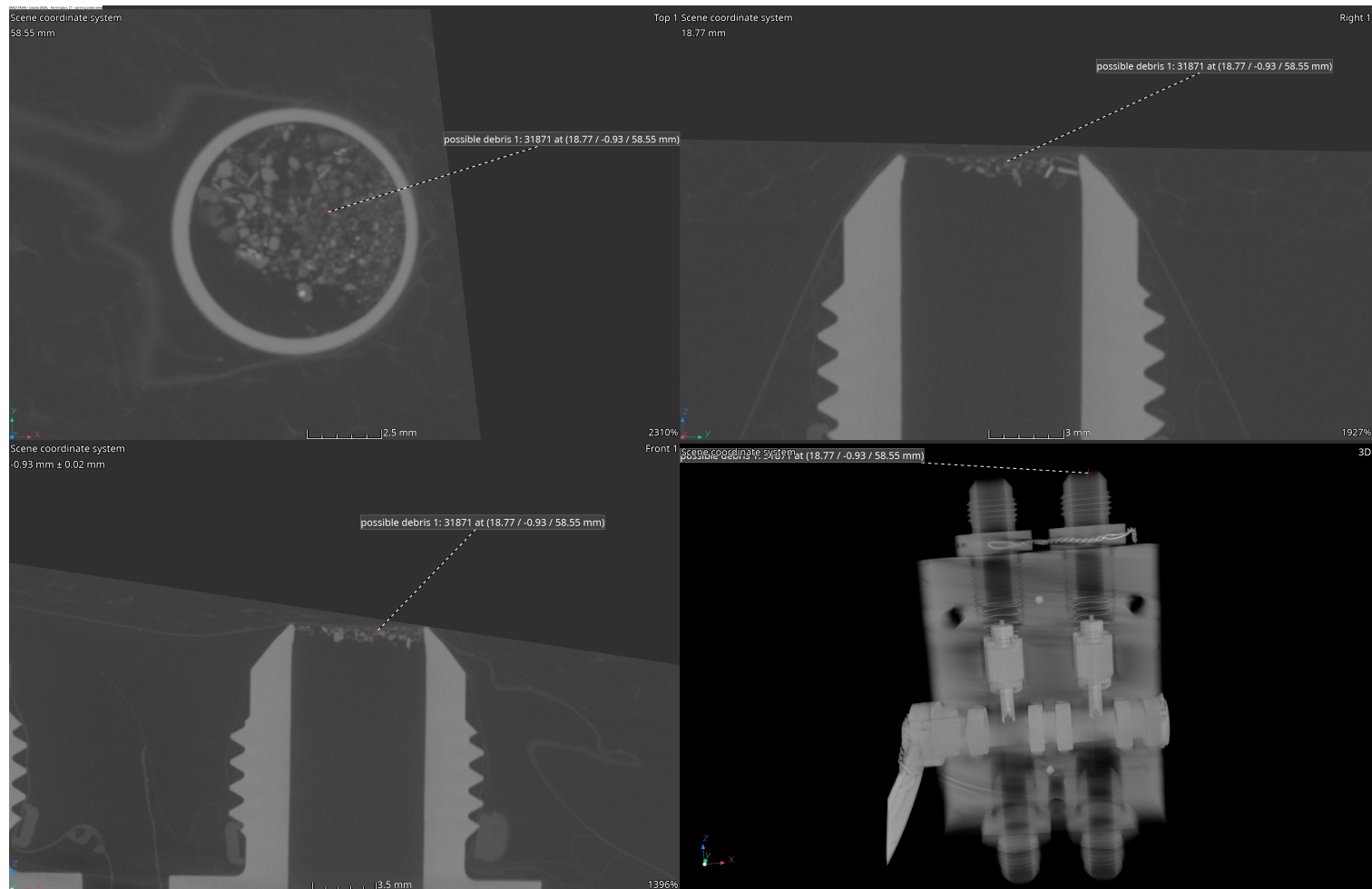


Figure 13
Accident parking brake valve – possible debris 1

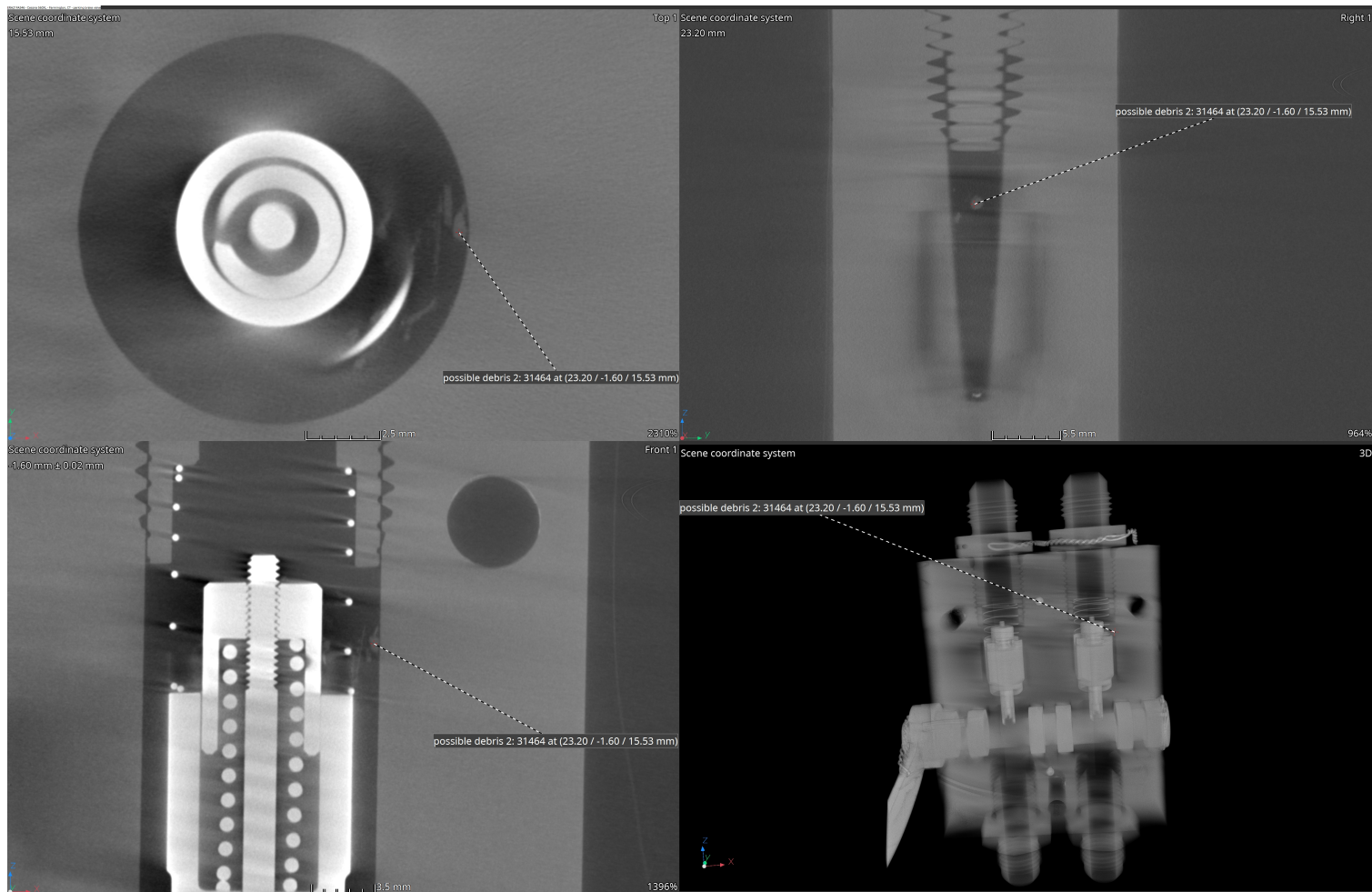


Figure 14
Accident parking brake valve – possible debris 2

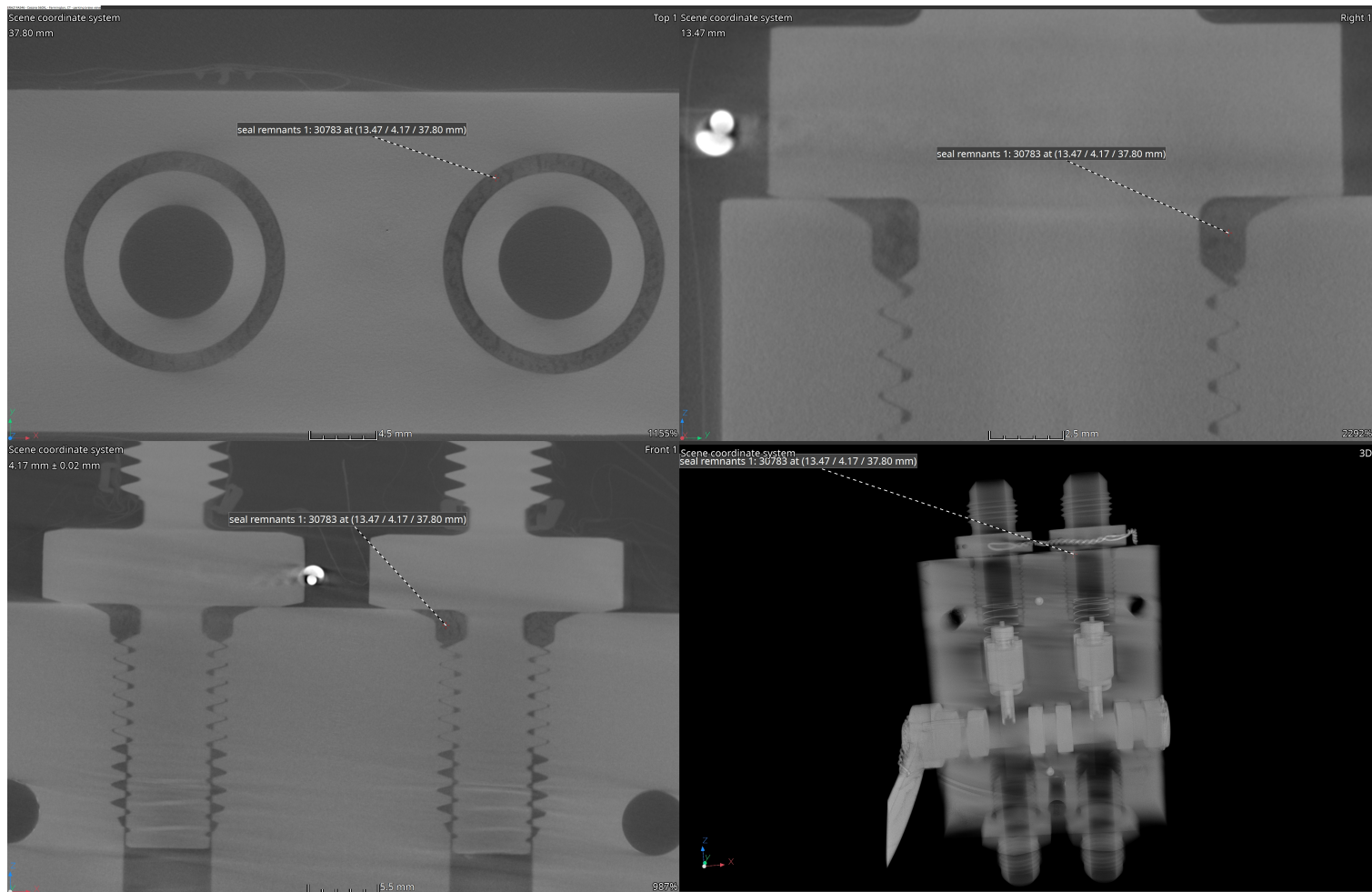


Figure 15
Accident parking brake valve – seal remnants 1

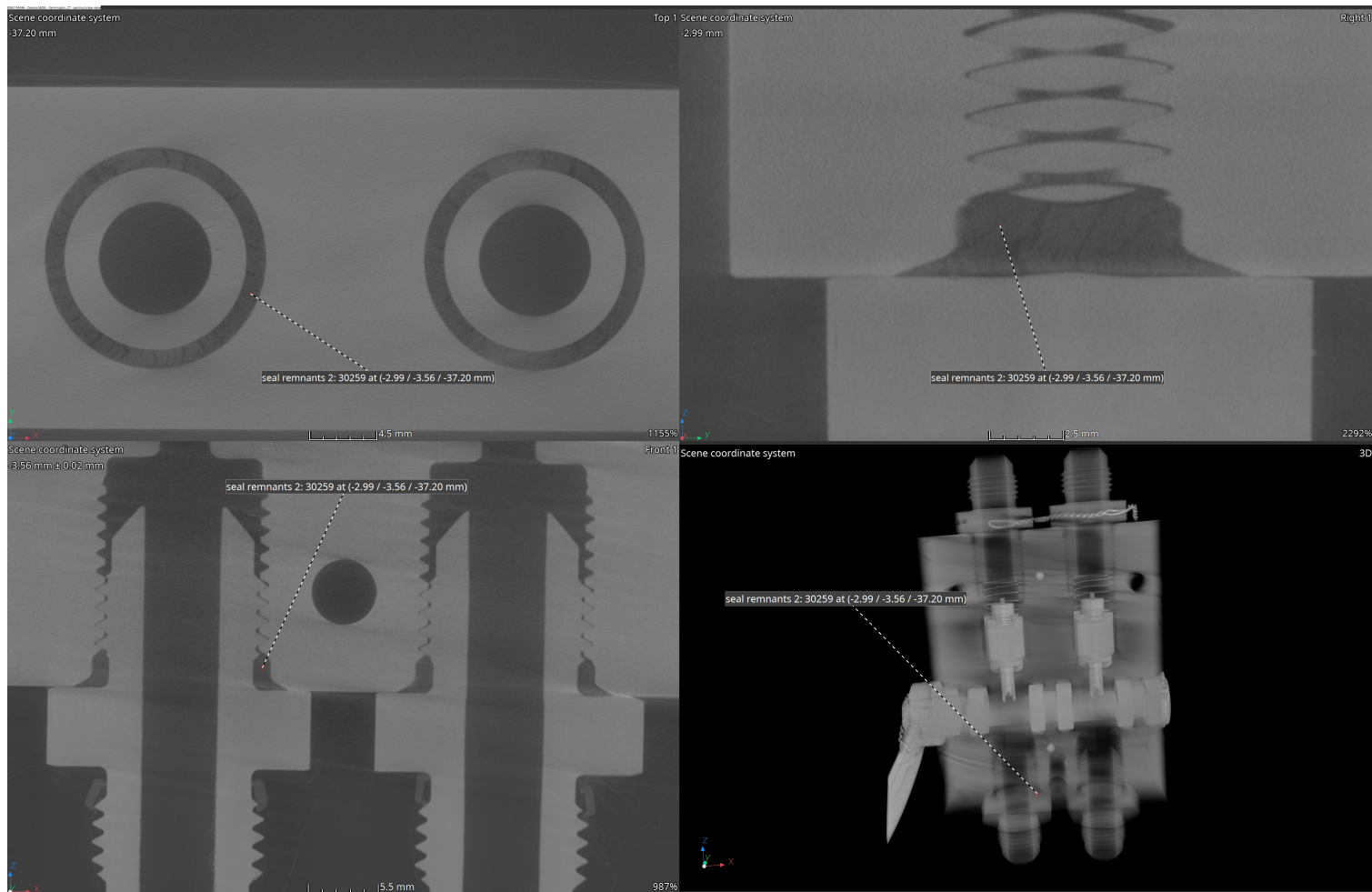


Figure 16
Accident parking brake valve – seal remnants 2

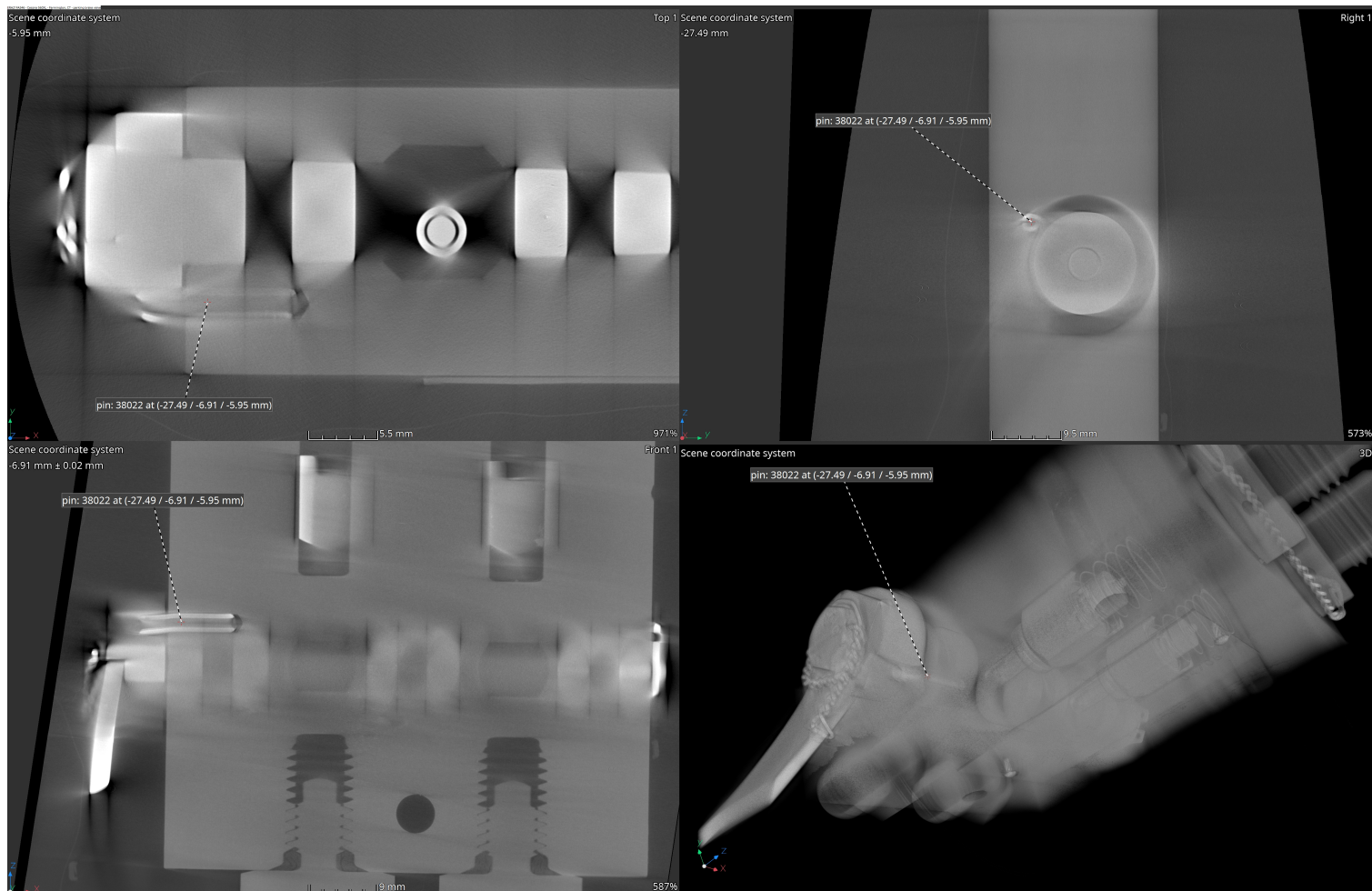


Figure 17
Accident parking brake valve – pin

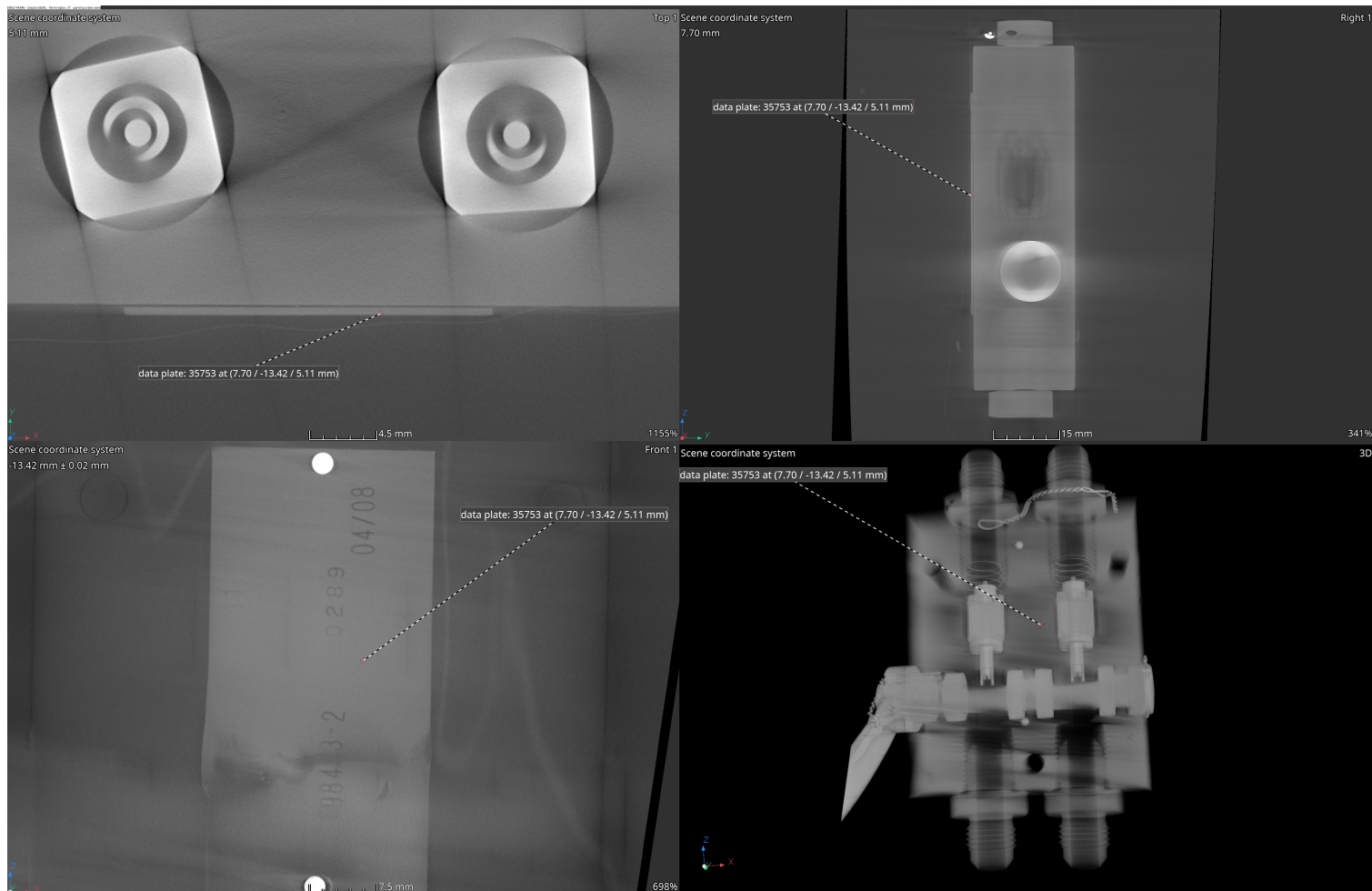


Figure 18
Accident parking brake valve – data plate

Scott Warren
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