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

November 18, 2015

Computed Tomography Specialist's Factual Report

CEN15MA290

A. ACCIDENT

Operator:	Air Methods Corp
Location:	Frisco, Colorado
Date:	July 3, 2015
Time:	1339 mountain daylight time
Vehicle:	Airbus Helicopter Inc. (formerly American Eurocopter) AS350B3e helicopter, N390LG

B. GROUP

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

C. SUMMARY

On July 3, 2015, at 1339 mountain daylight time, an Airbus Helicopter Inc. (formerly American Eurocopter) AS350B3e helicopter, N390LG, impacted the upper west parking lot 360 feet southwest of the Summit Medical Center helipad (91CO), Frisco, Colorado. A post-impact fire ensued. Visual meteorological conditions prevailed at the time of the accident. The helicopter was registered to and operated by Air Methods Corp and the flight was conducted under the provisions of 14 Code of Federal Regulations Part 135 on a company flight plan. The airline transport pilot was fatally injured and two flight nurses were seriously injured. The public relations flight was en route to Gypsum, Colorado.

The internal configurations of the yaw load compensator and the tail rotor actuator were documented using radiographic images that were collected on September 15-16, 2015 in Chicago, Illinois. A total of 4,832 computed tomography (CT) slice images were examined, processed, and analyzed by the NTSB to evaluate the components.

Review of the images determined that there were indications of low density material inside the hydraulic passages of the yaw load compensator; there was an indication of a gap between the piston and piston seat within the check valve located within hydraulic line 1; there were indications of debris noted within the accumulator; there were indications of pitting noted on multiple locations of the inner accumulator wall and on the accumulator filling assembly; there were indications that some of the holes in the lower accumulator screen were blocked and some were open; there were no indications of damage noted on any of the tail rotor actuator bearings sets; the lock pin was noted to be in the engaged position; there were no indications of damage noted on the control valve port edges; no foreign material was noted inside or outside of the tail rotor actuator filter; the hydraulic passages within the actuator were distorted in a manner consistent with heat damage.

D. DETAILS OF THE INVESTIGATION

1.0 General

The yaw load compensator and the tail rotor actuator were subjected to x-ray computed tomography (CT) scanning to document their internal conditions. The scanning was conducted on September 15-16, 2015. The scans were performed by Varian Medical Systems, Inc under the direction of the NTSB using the Varian Actis 225 microfocus CT system.

For the CT scans, the components were loaded into the imaging unit and placed on a turntable. They 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 fan beam of x-rays, and the portion of the part being imaged was adjusted slightly after each scan was completed until the entire assembly was scanned. The x-ray energy levels captured by the detector were recorded at several thousand different points during each rotation, and this information was converted into axial slice images using reconstruction algorithms.

The components were scanned using a total of 4,832 axial slices. The total size of the combined data sets was 37.7 Gb. The complete scan protocol for each component is given in table 1. The CT axial slice images were provided to the NTSB where they were examined, processed, and analyzed to evaluate the components.

Table 1
Scan Protocol

Component	Yaw Load Compensator	Tail Rotor Actuator
Number of slices	2521	2311
Voxel Size - X Direction (mm)	0.097	0.097
Voxel Size - Y Direction (mm)	0.097	0.097
Voxel Size - Z Direction (mm)	0.10	0.10
Image Projections per Revolution	1800	1800
Exposure time (ms)	285.58	285.58
Frames to Avg (frames per projection)	2	2
X-ray Source Voltage (kV)	222	222
X-ray Source Current (mA)	0.45	0.45
Source Filter Material	Brass	Brass
Source Filter Thickness (mm)	2	1.5
Image Matrix Size (pixels)	2048 x 2048	2048 x 2048

Each data set of slice images was 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 high density areas are shown as brighter shades of gray and lower density areas are shown as darker shades of gray. The pointers shown in some of the images denote specific areas of interest within that 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.

2.0 Computed Tomography Results

2.1 Yaw Load Compensator

The computed tomography (CT) results for the yaw load compensator are shown in figures 1 through 14. Review of the images indicated:

1. There were indications of low density material inside the hydraulic passages of the yaw load compensator;

2. There was an indication of a gap between the piston and piston seat within the check valve located within hydraulic line 1;

3. There were indications of debris noted within the accumulator;

4. There were indications of pitting noted on multiple locations of the inner accumulator wall and on the accumulator filling assembly;

5. There were indications that some of the holes in the lower accumulator screen were blocked and some were open.

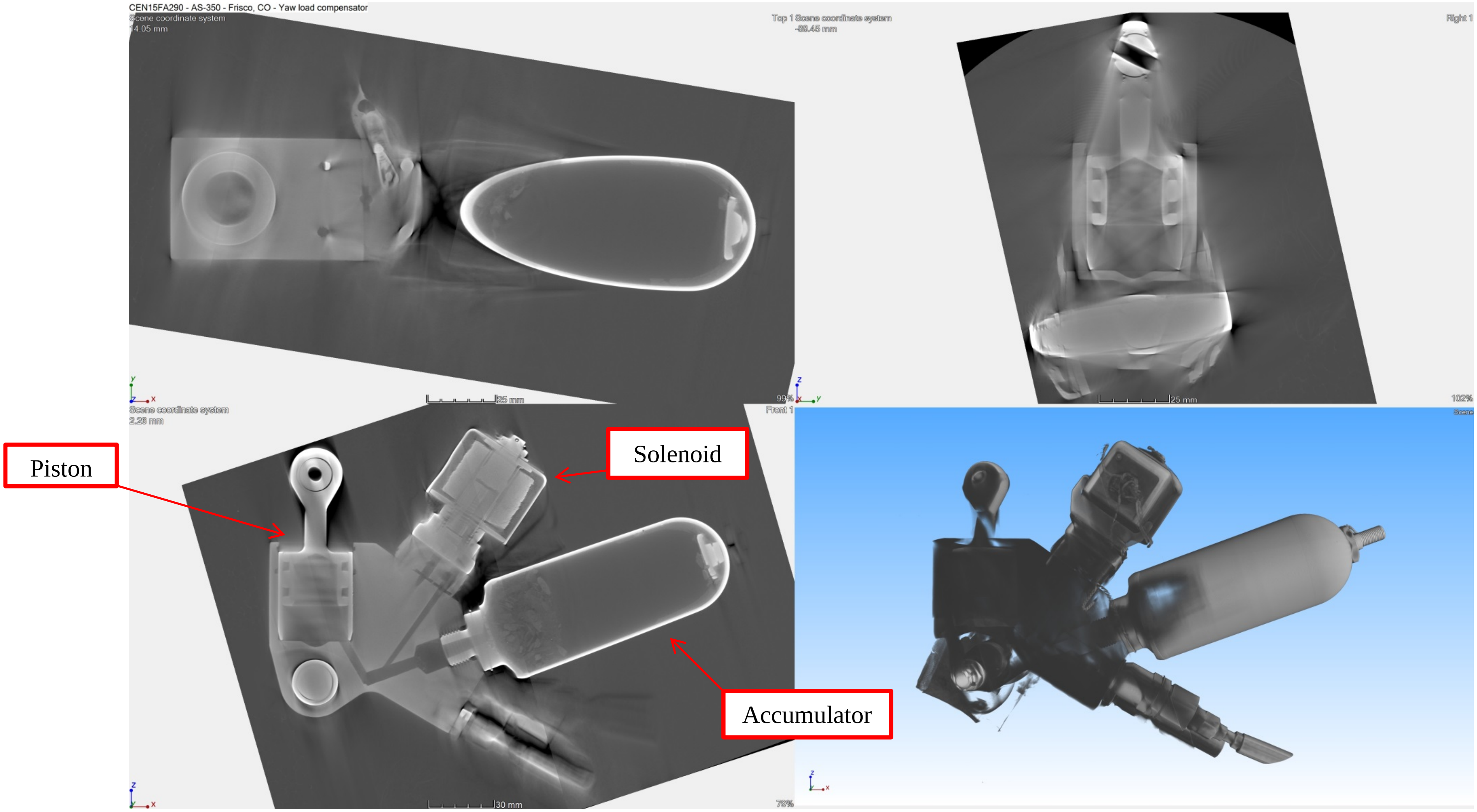

Figure 1
Yaw load compensator – Overall cross section through piston

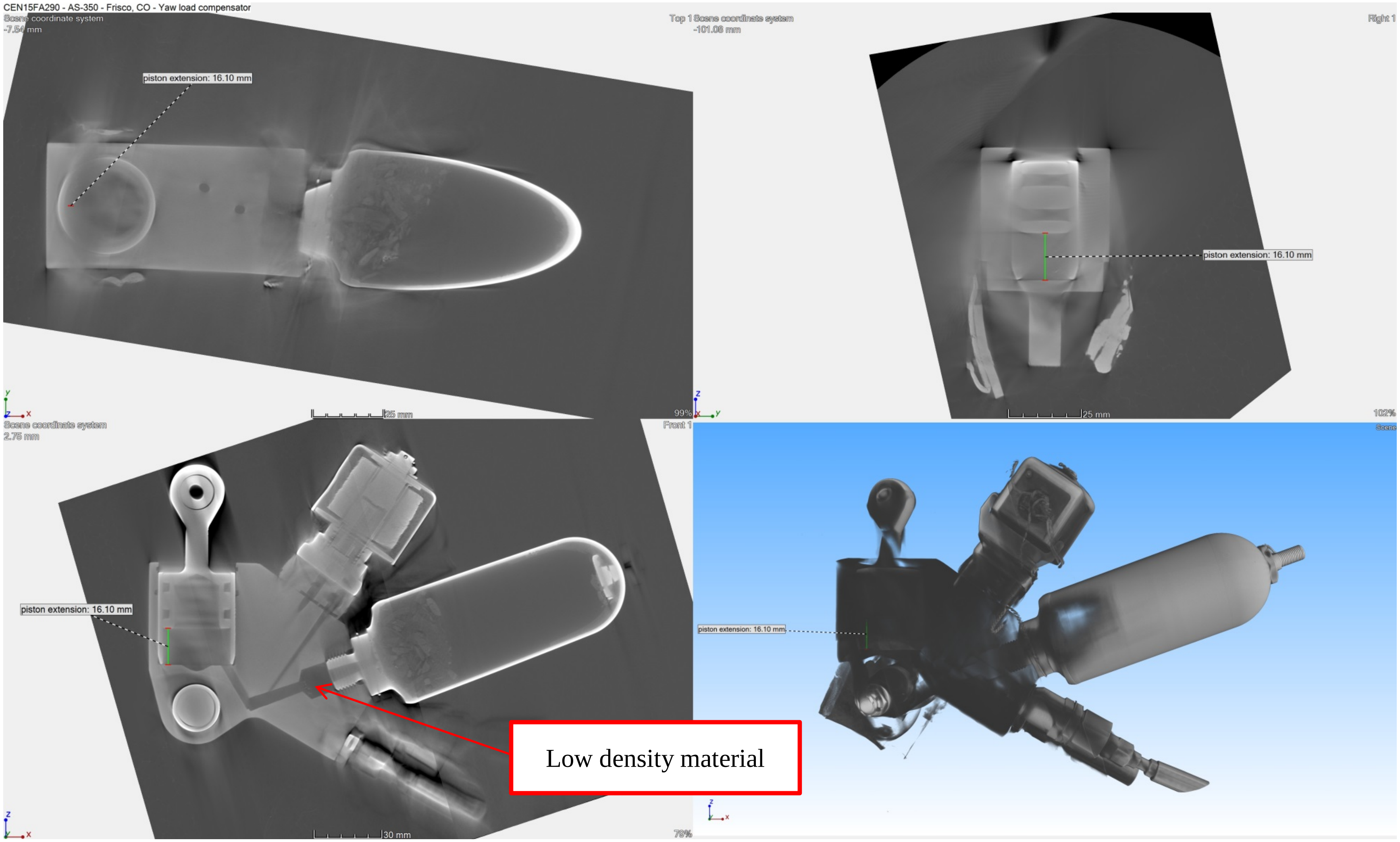

Figure 2
Yaw load compensator – Overall cross section through piston showing piston extension measurement

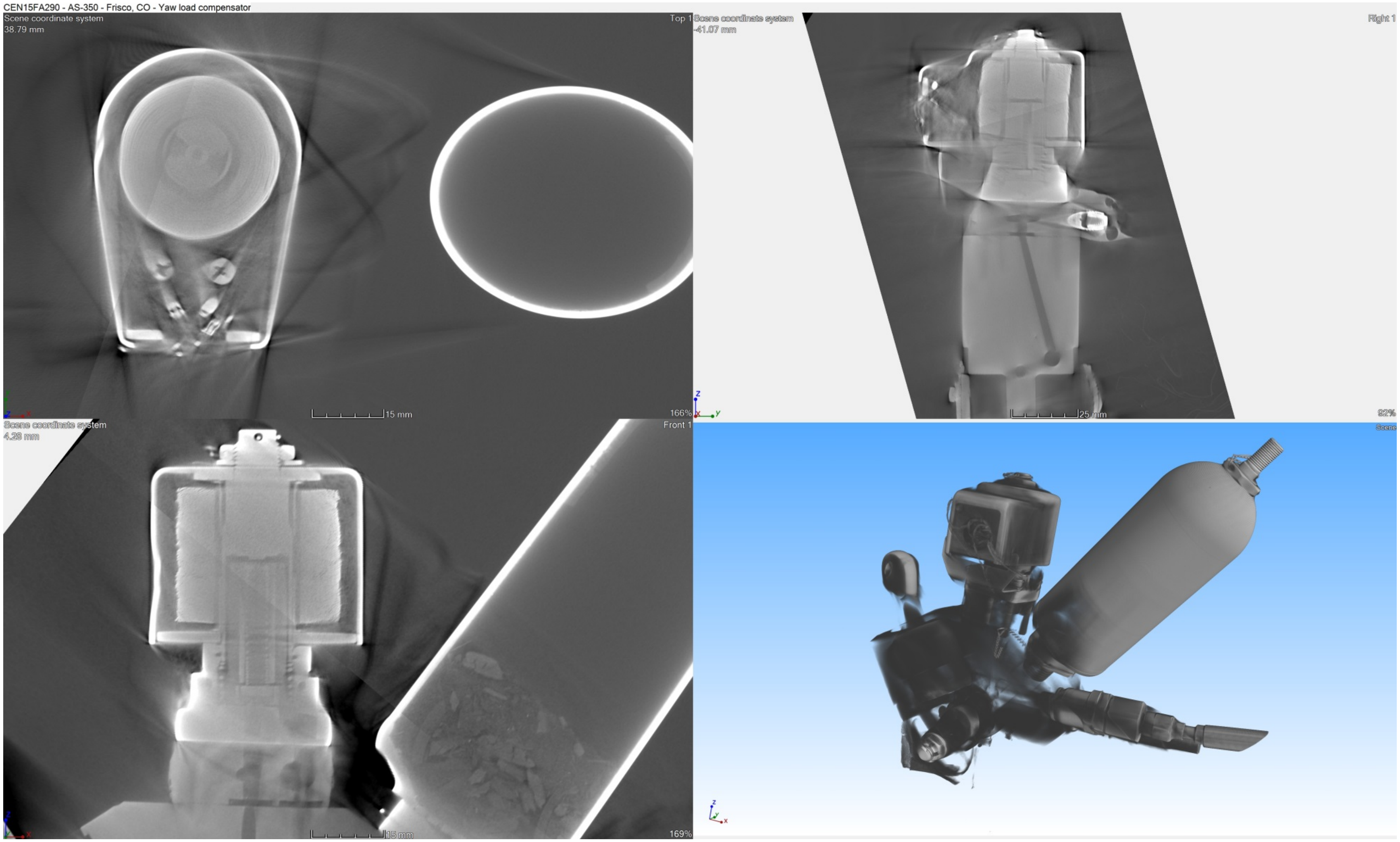

Figure 3
Yaw load compensator – Overall cross section through solenoid

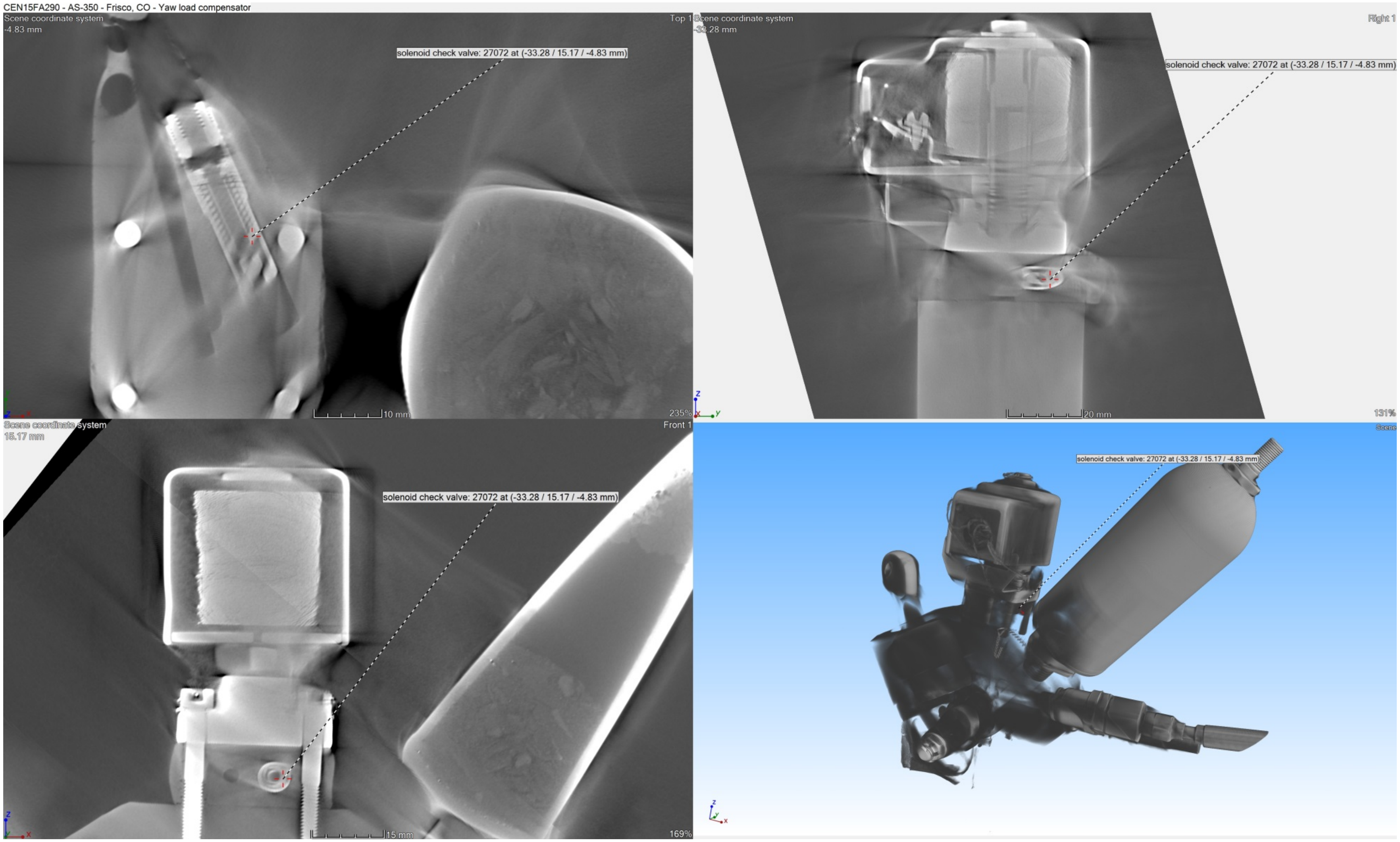

Figure 4
Yaw load compensator – Solenoid check valve

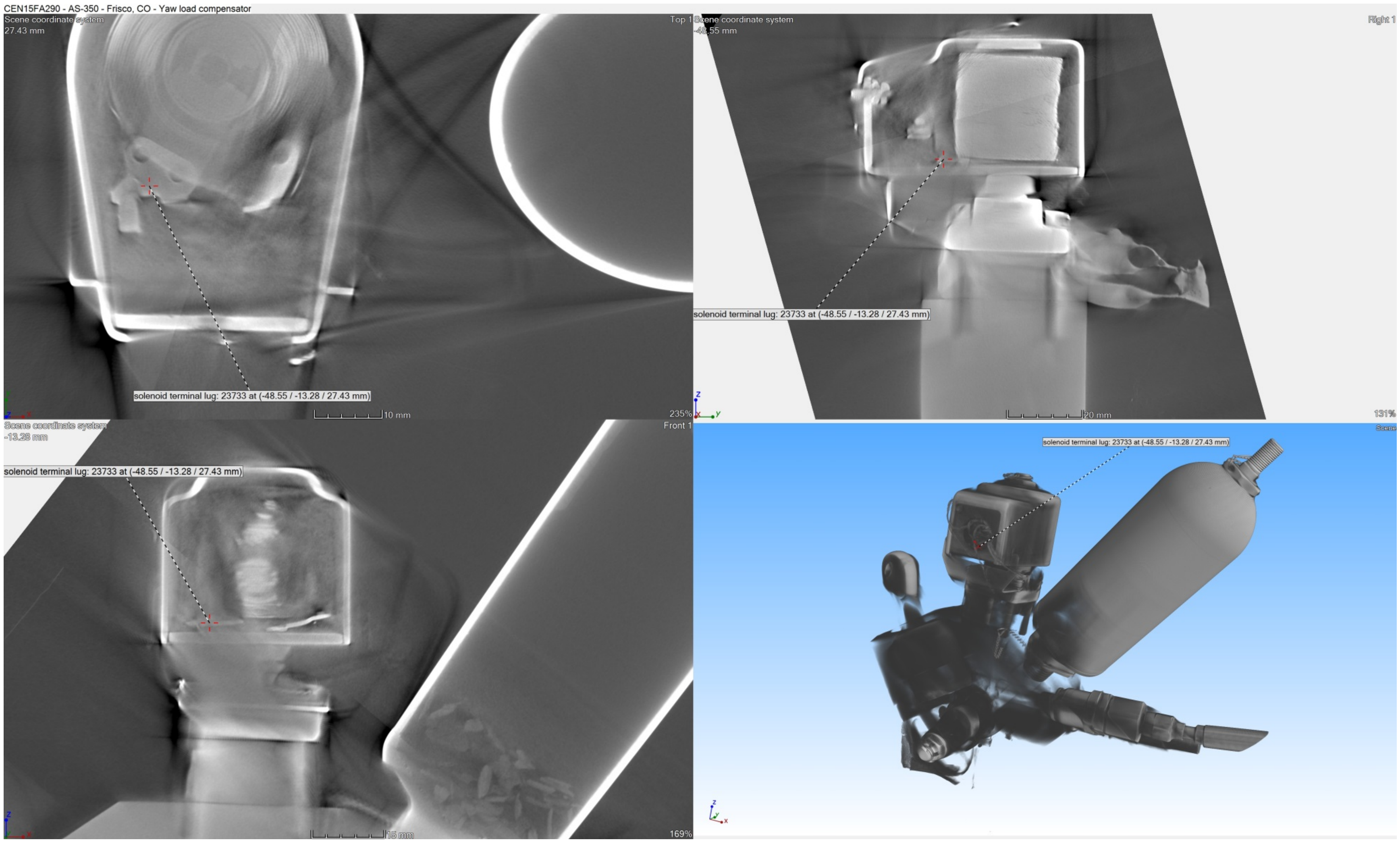

Figure 5
Yaw load compensator – Solenoid terminal lug

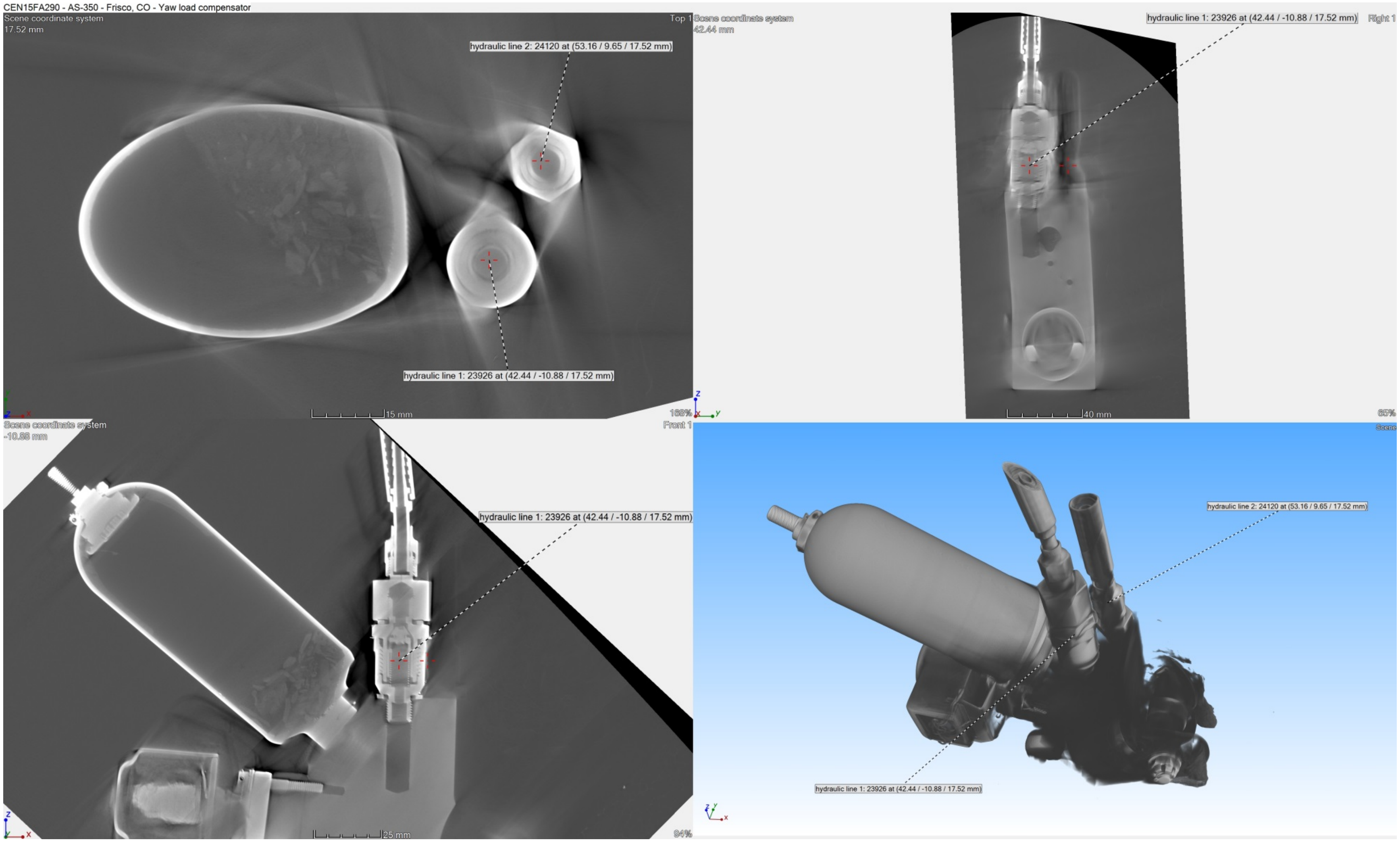

Figure 6
Yaw load compensator – Overall cross section through hydraulic line 1

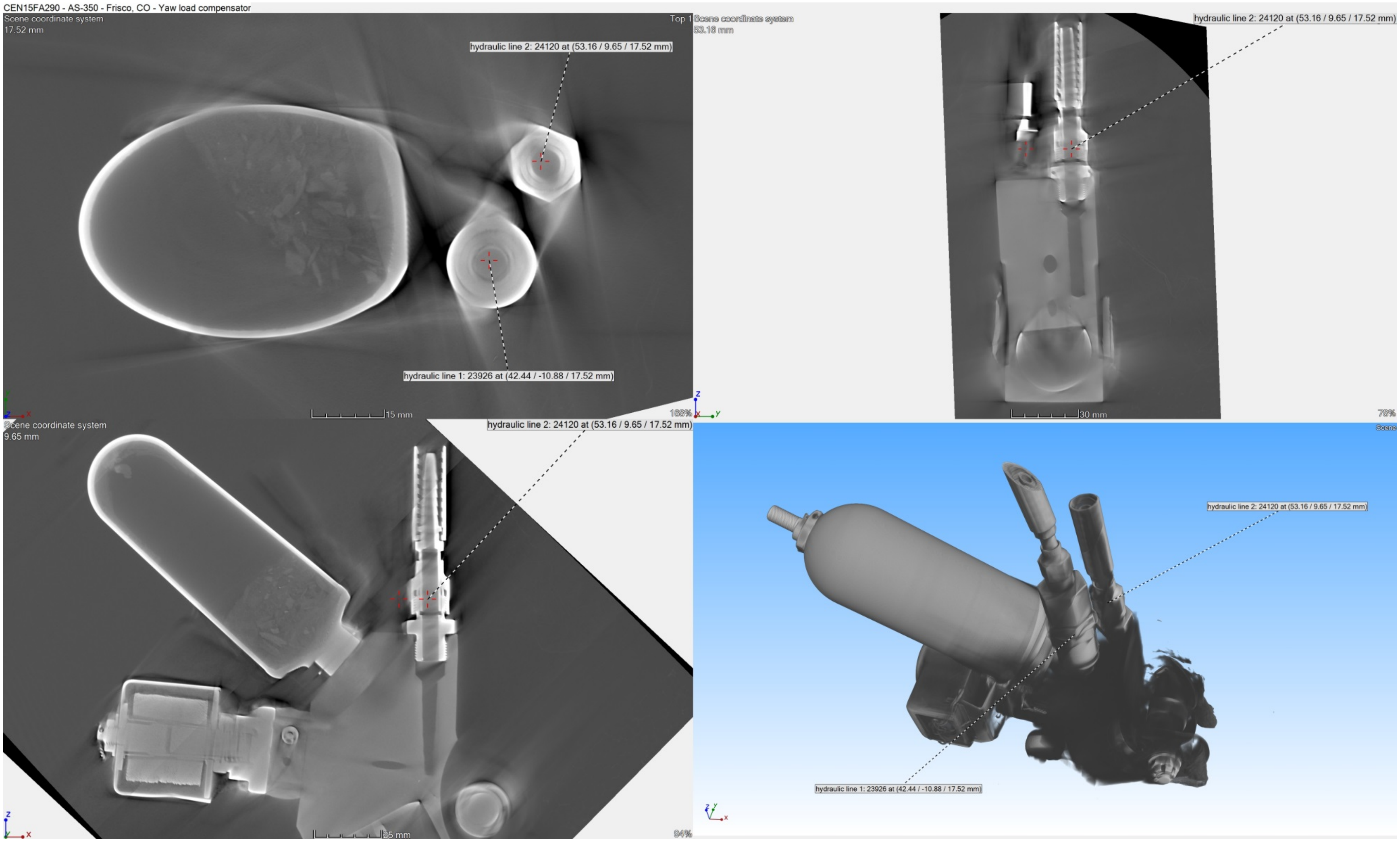

Figure 7
Yaw load compensator – Overall cross section through hydraulic line 2

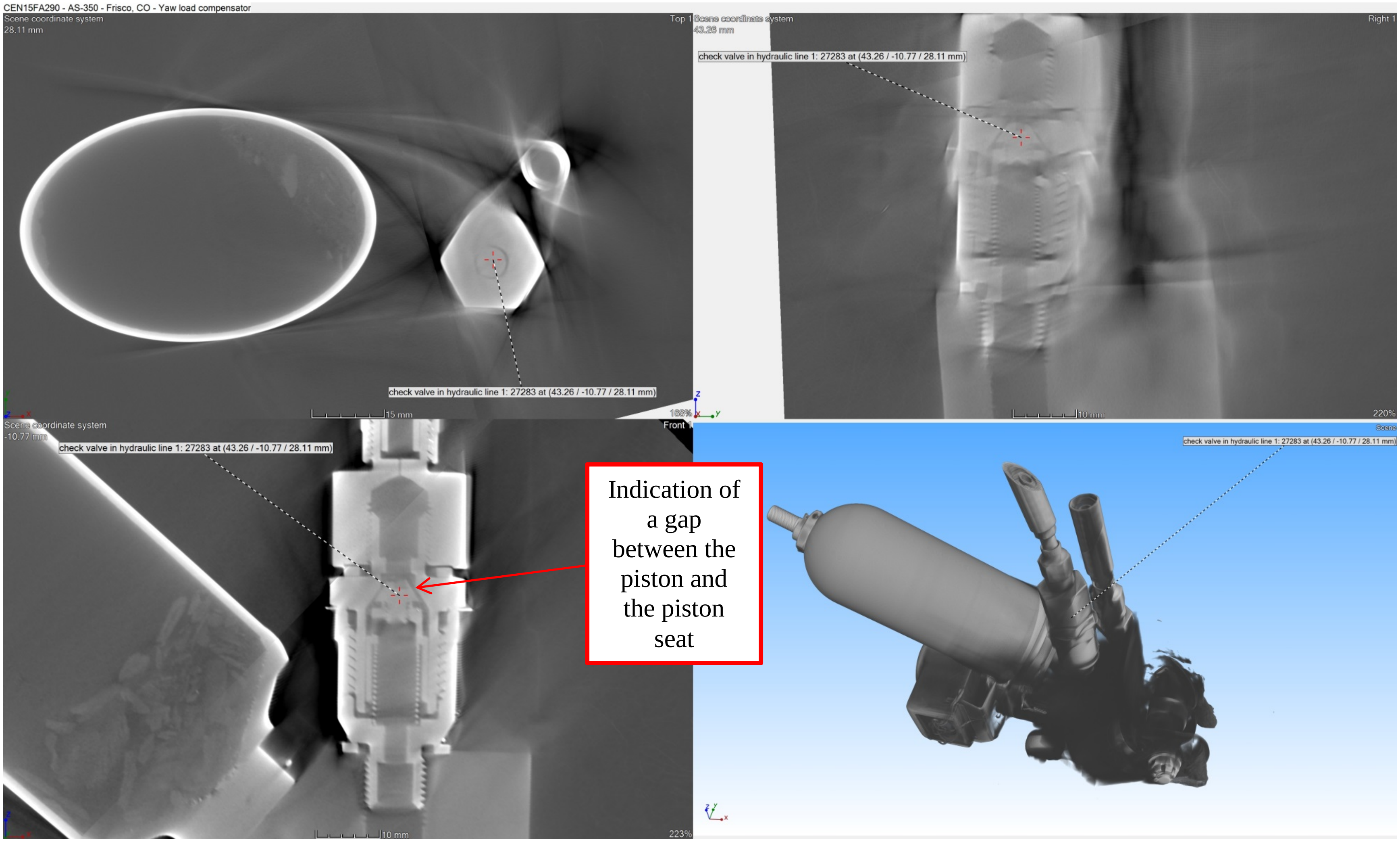

Figure 8
Yaw load compensator – hydraulic line 1 check valve

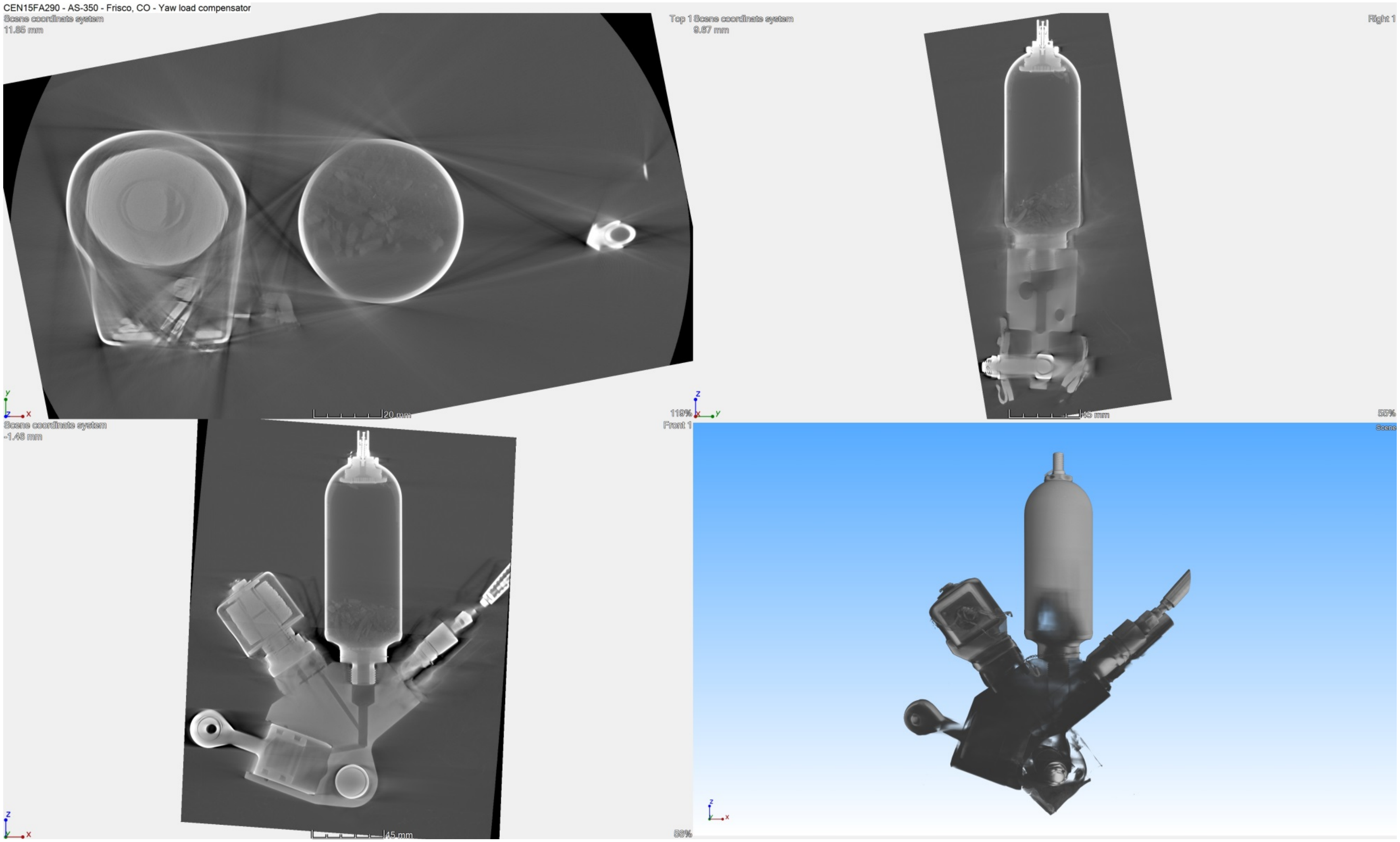

Figure 9
Yaw load compensator – Overall cross section through accumulator

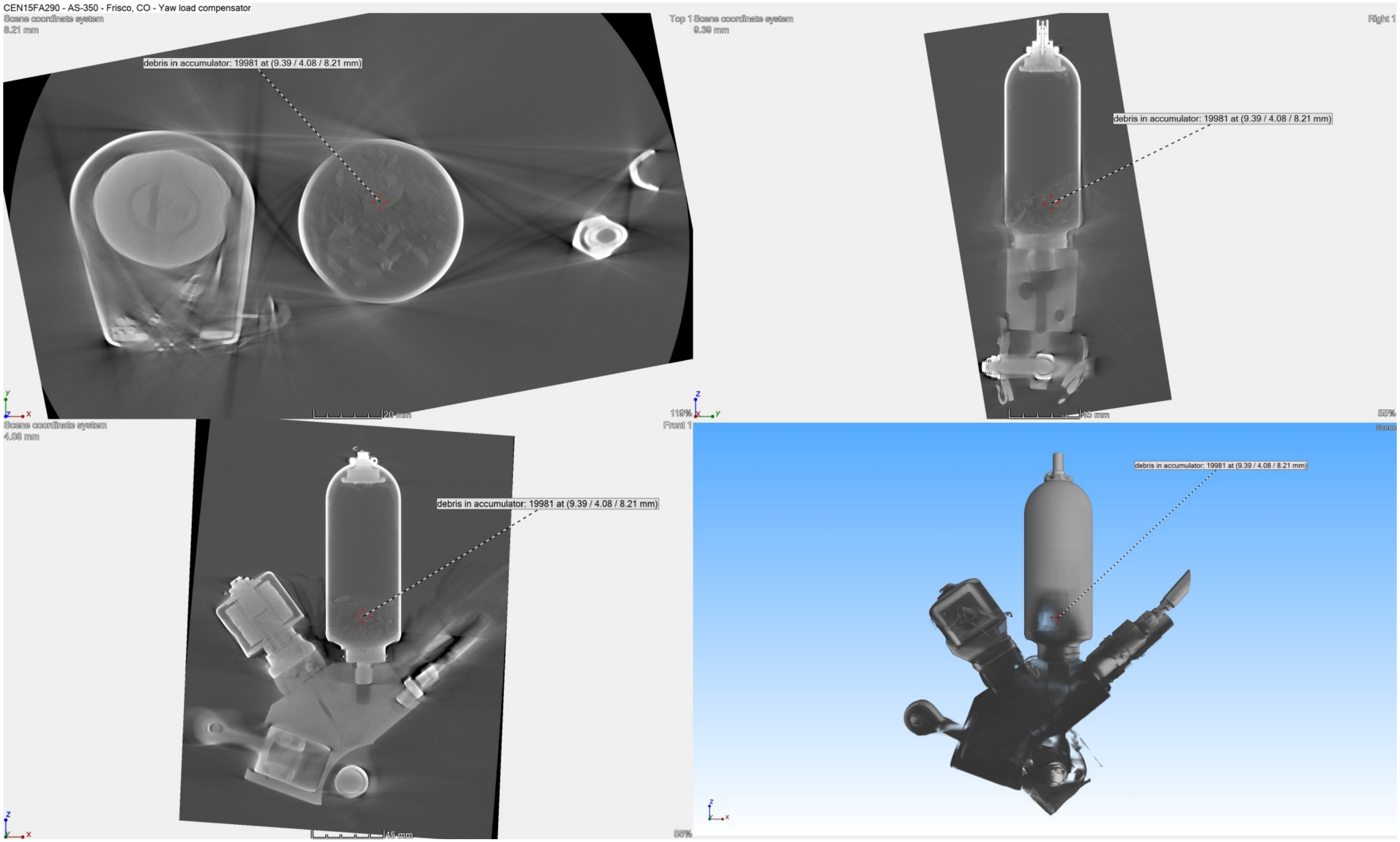

Figure 10
Yaw load compensator – Debris in accumulator

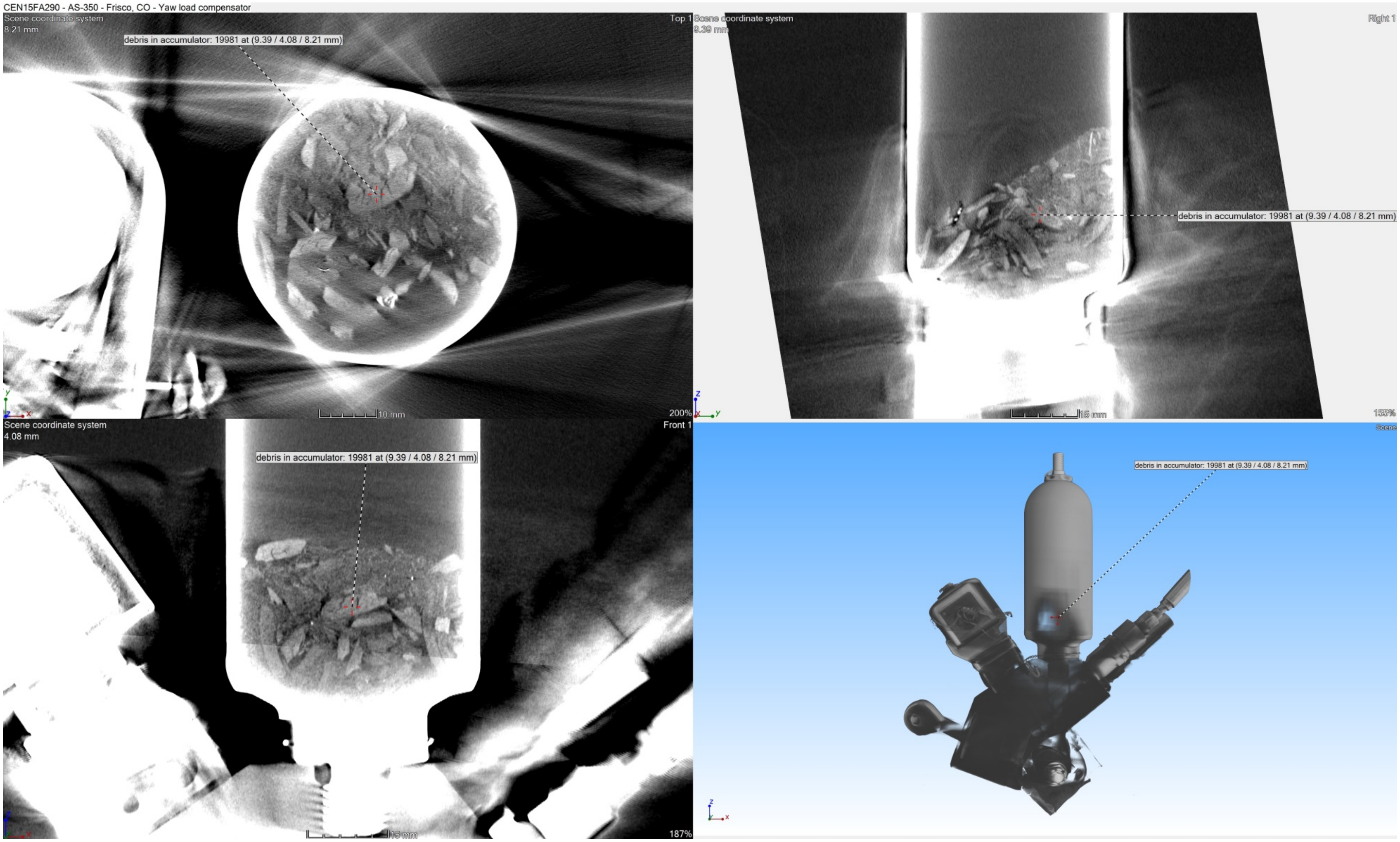

Figure 11
Yaw load compensator – Debris in accumulator – enhanced contrast

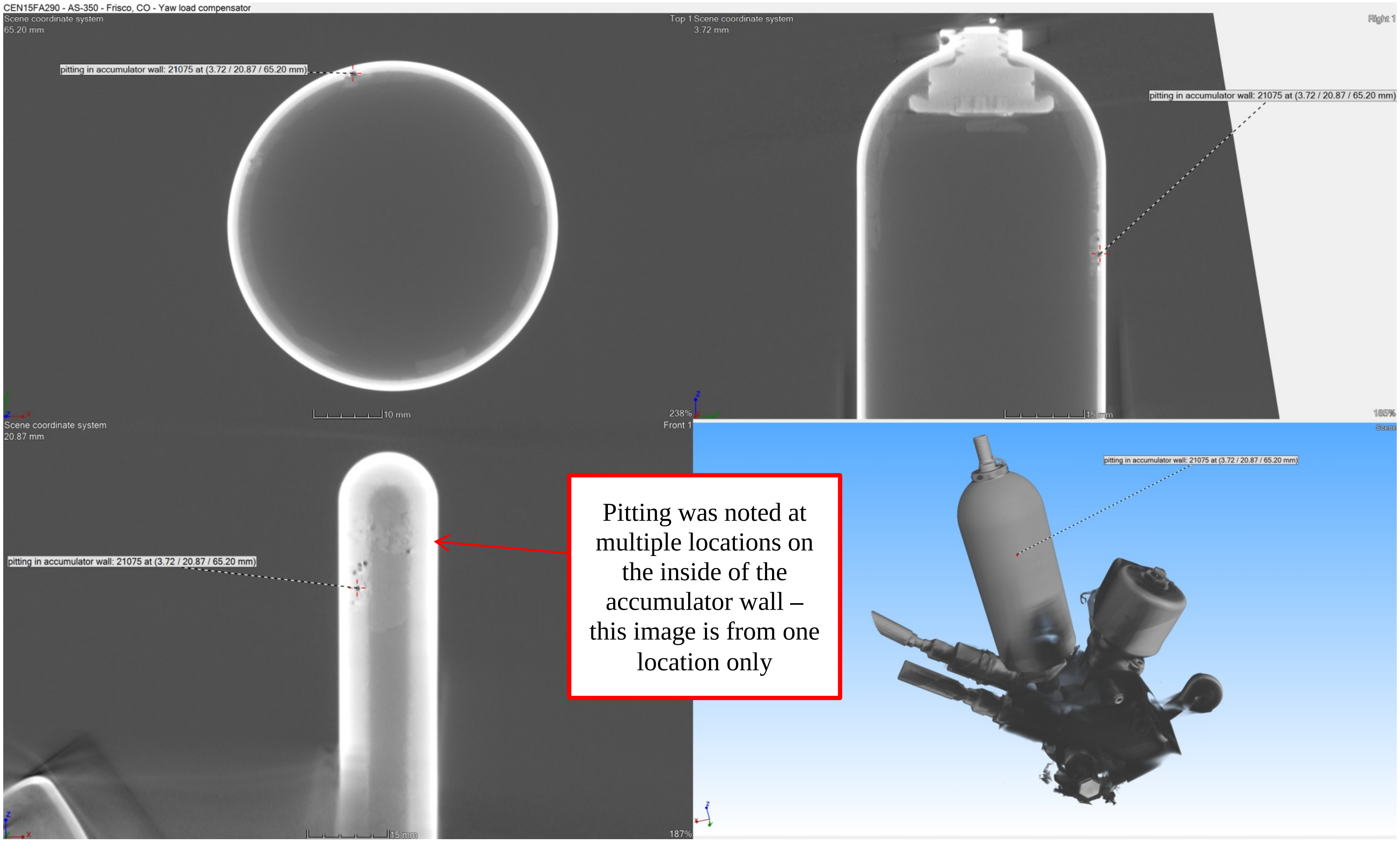

Figure 12
Yaw load compensator – Pitting in the interior accumulator wall

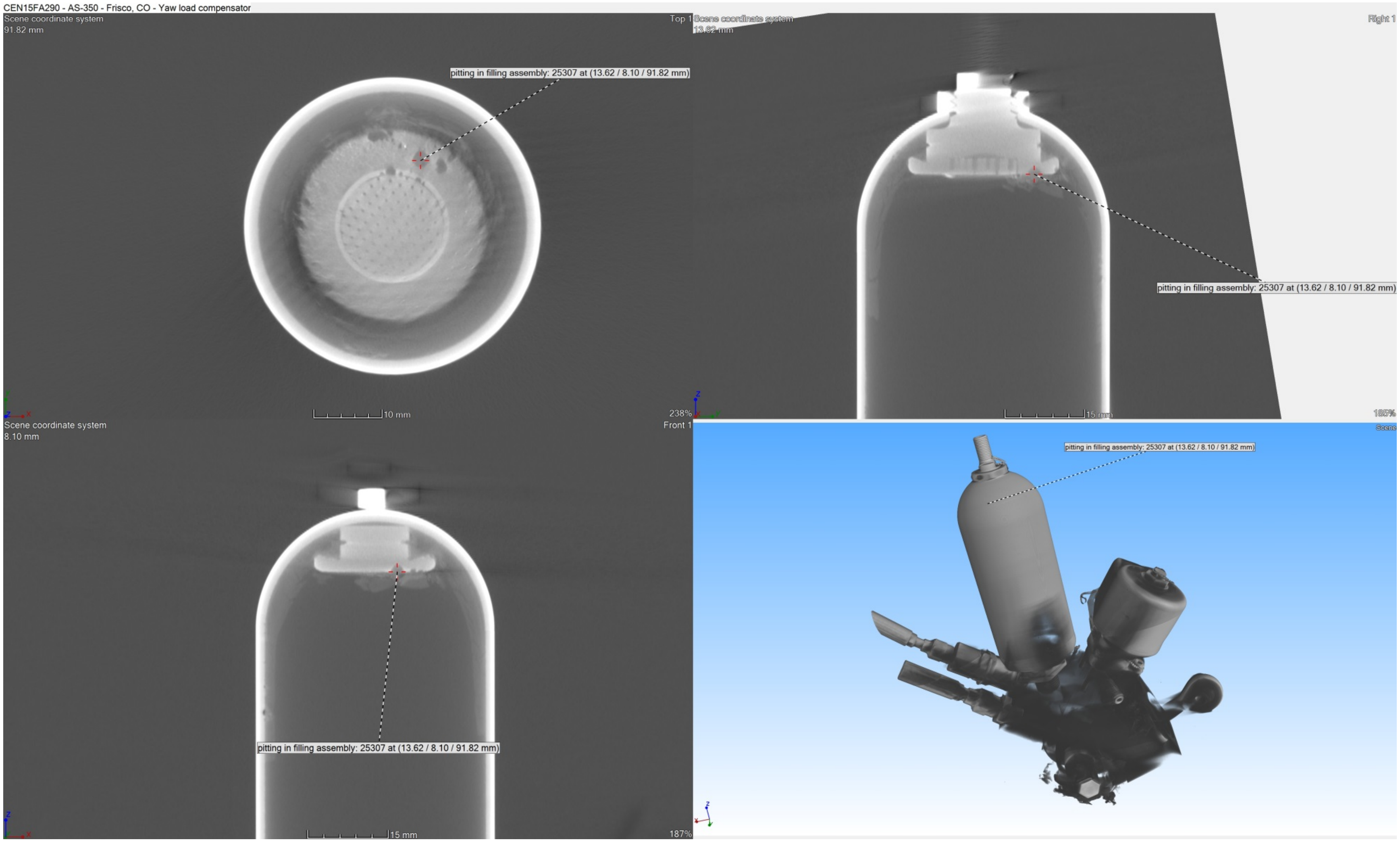

Figure 13
Yaw load compensator – Pitting in the accumulator filling assembly

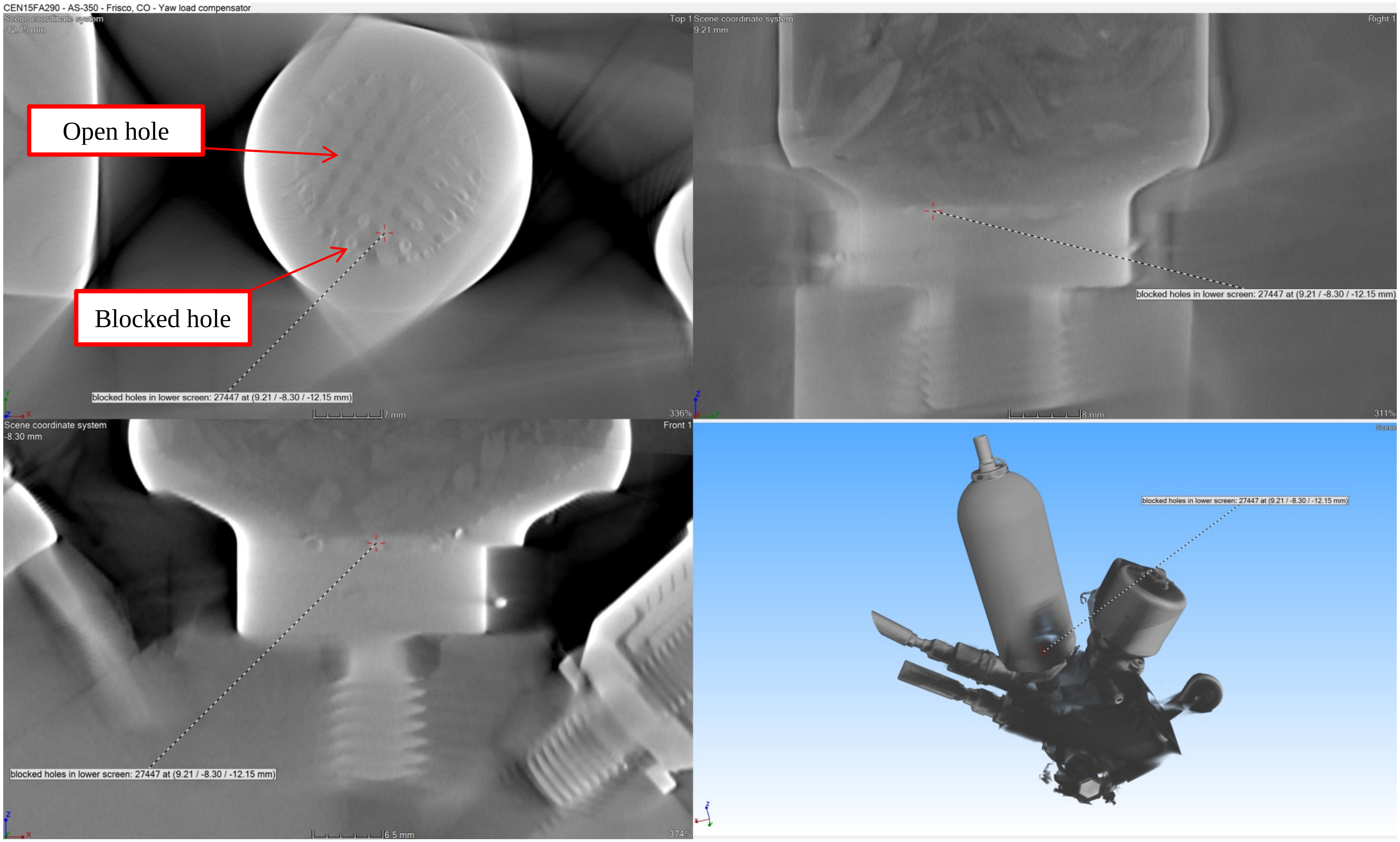

Figure 14
Yaw load compensator – Blocked holes in the lower accumulator screen

2.2 Tail Rotor Actuator

The computed tomography (CT) results for the tail rotor actuator are shown in figures 15 through 24. Review of the images indicated:

1. There were no indications of damage noted on any of the tail rotor actuator bearings sets;

2. The lock pin was noted to be in the engaged position;

3. There were no indications of damage noted on the control valve port edges;

4. No foreign material was noted inside or outside of the tail rotor actuator filter;

5. The hydraulic passages within the actuator were distorted in a manner consistent with heat damage.

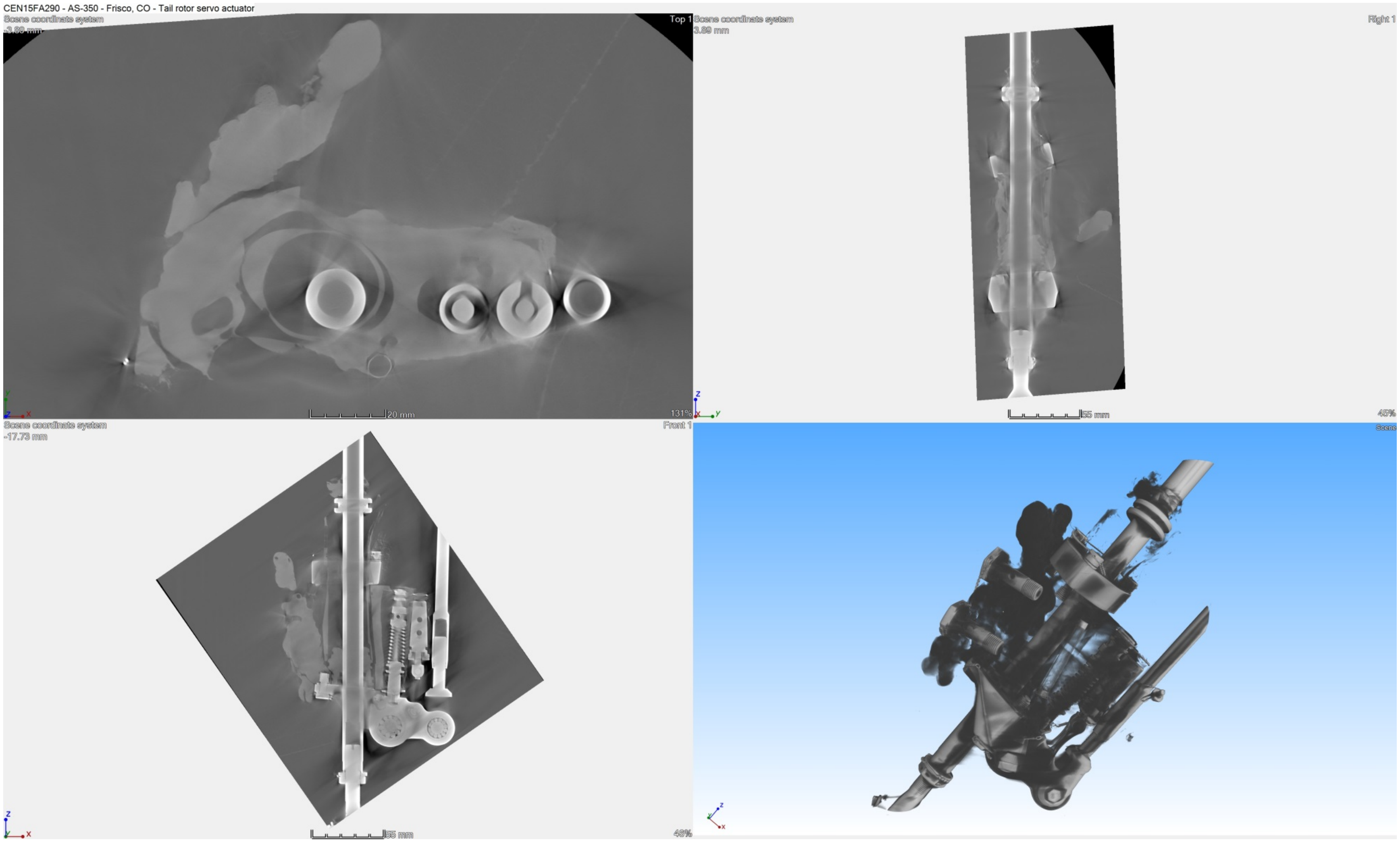

Figure 15
Tail rotor actuator – Overall cross section through piston

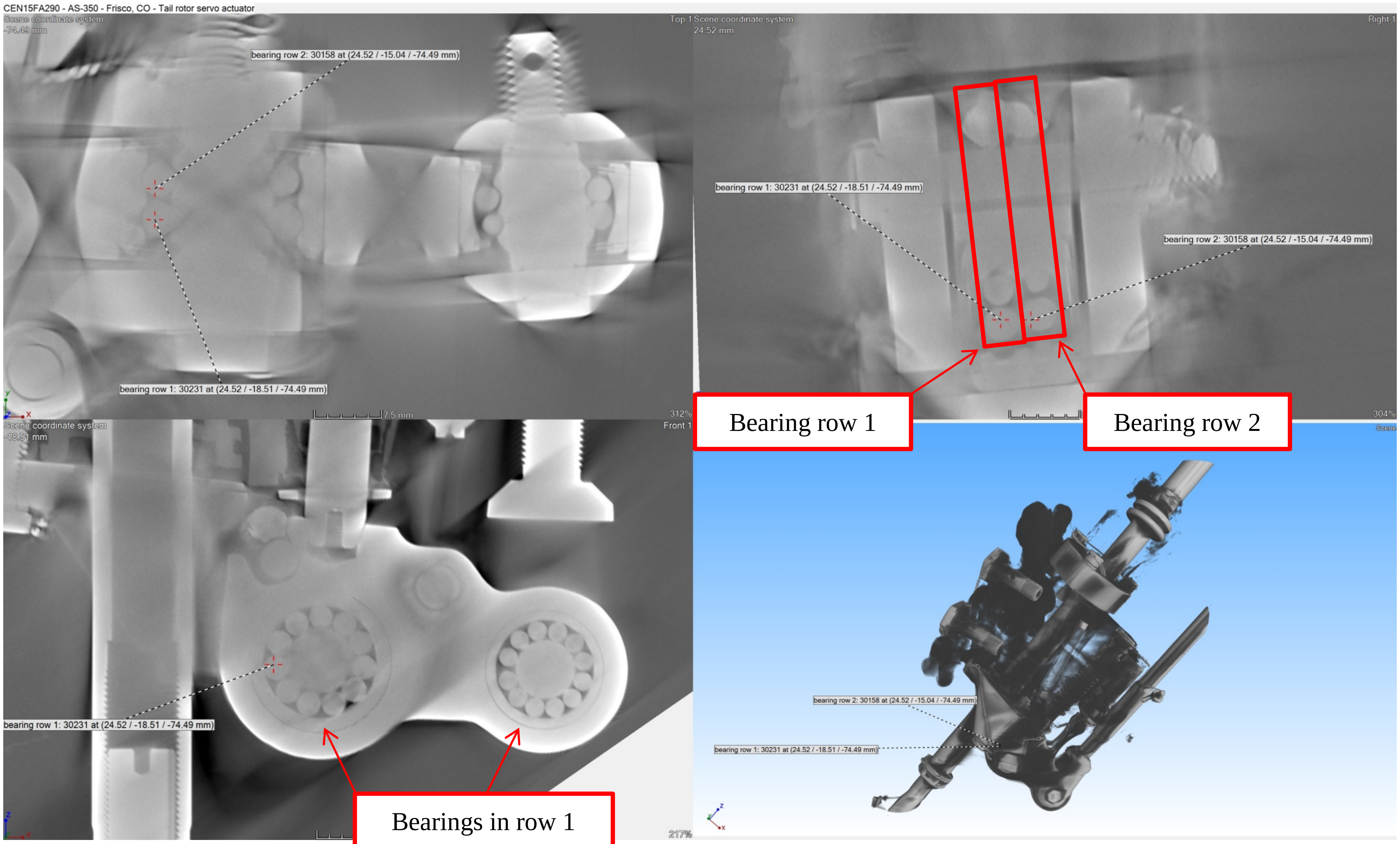

Figure 16
Tail rotor actuator – Bearings in row 1

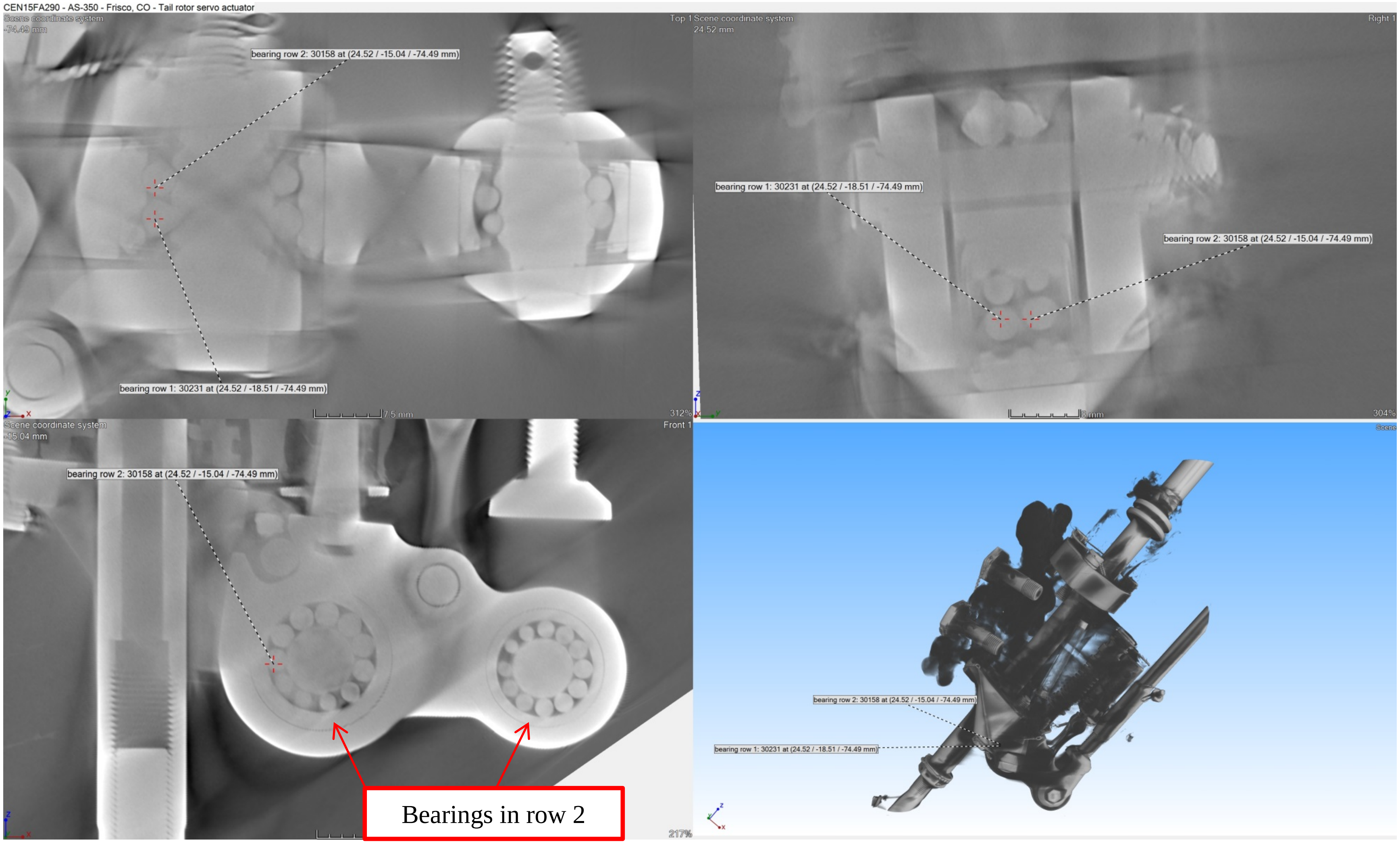

Figure 17
Tail rotor actuator – Bearings in row 2

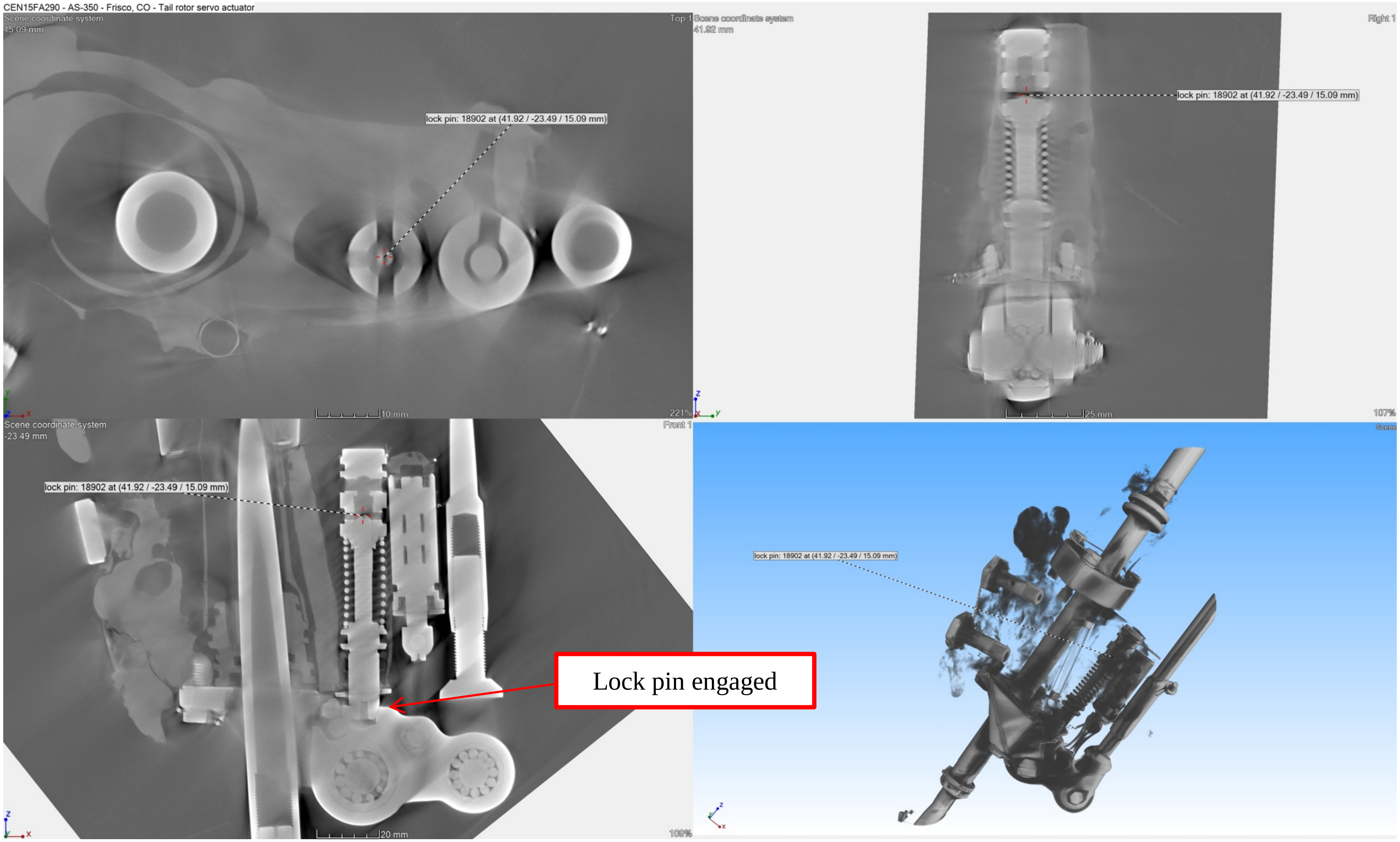

Figure 18
Tail rotor actuator – Overall cross section through lock pin

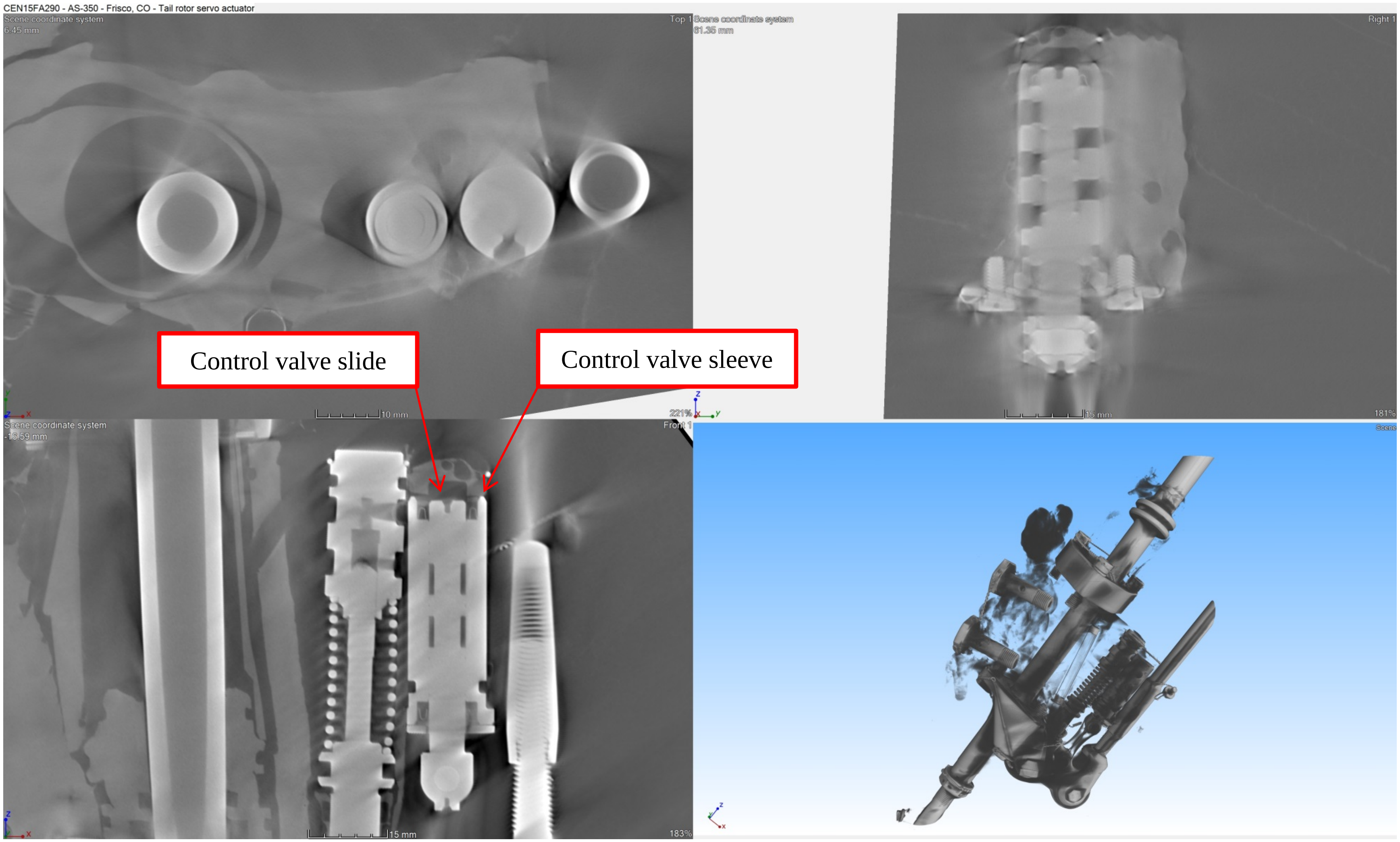

Figure 19
Tail rotor actuator – Overall cross section through control valve

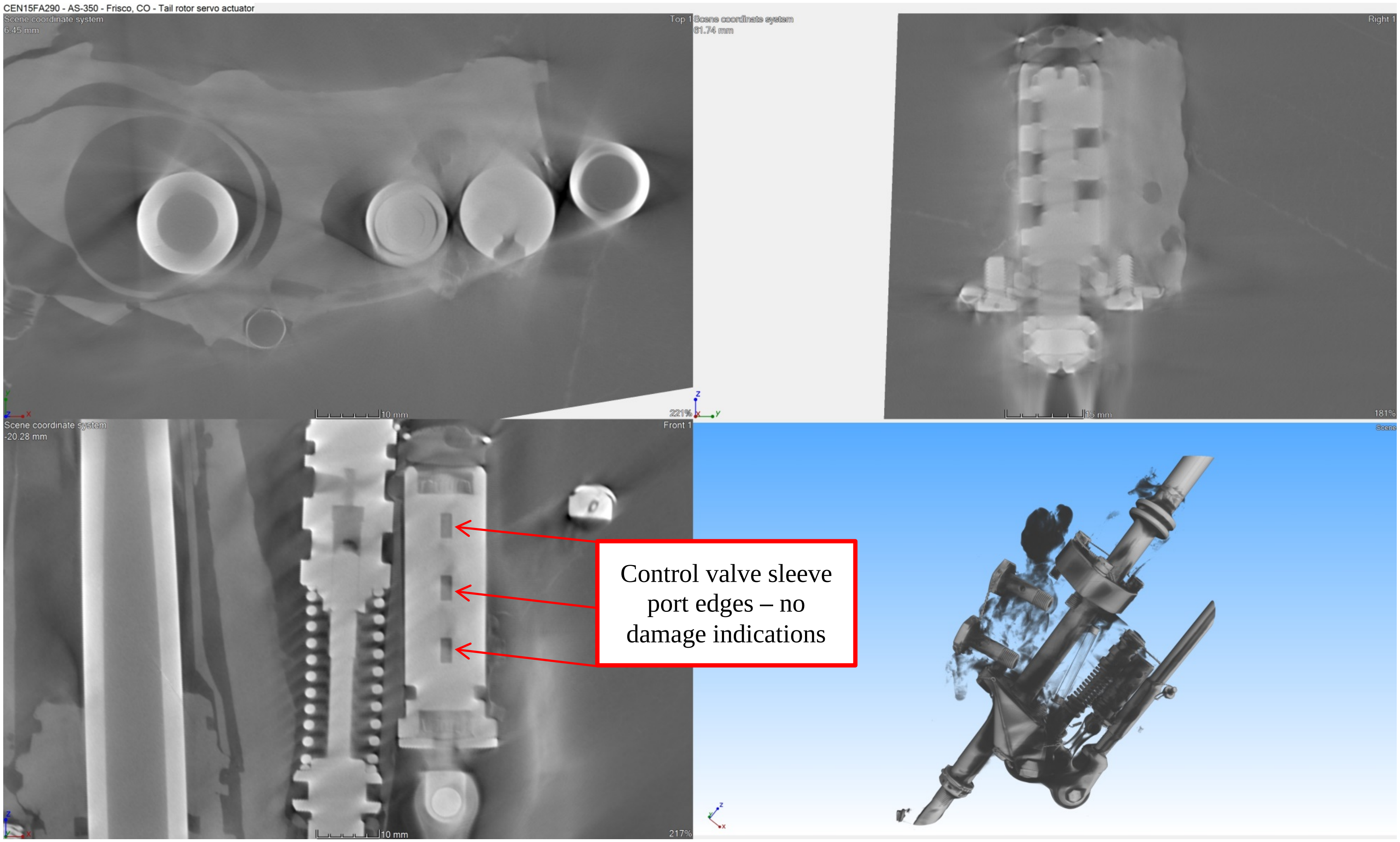

Figure 20
Tail rotor actuator – Overall cross section through control valve – port edges

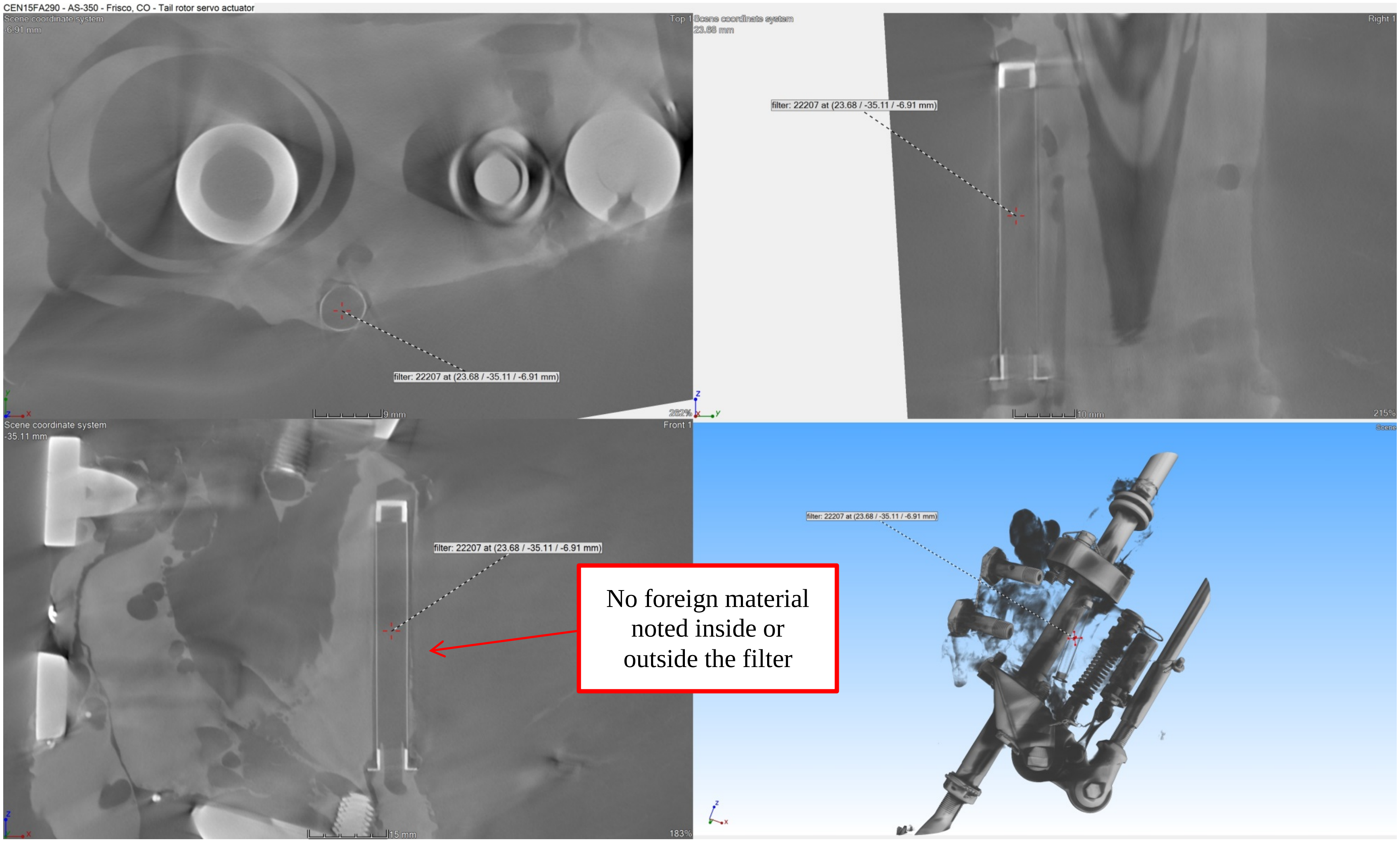

Figure 21
Tail rotor actuator – filter

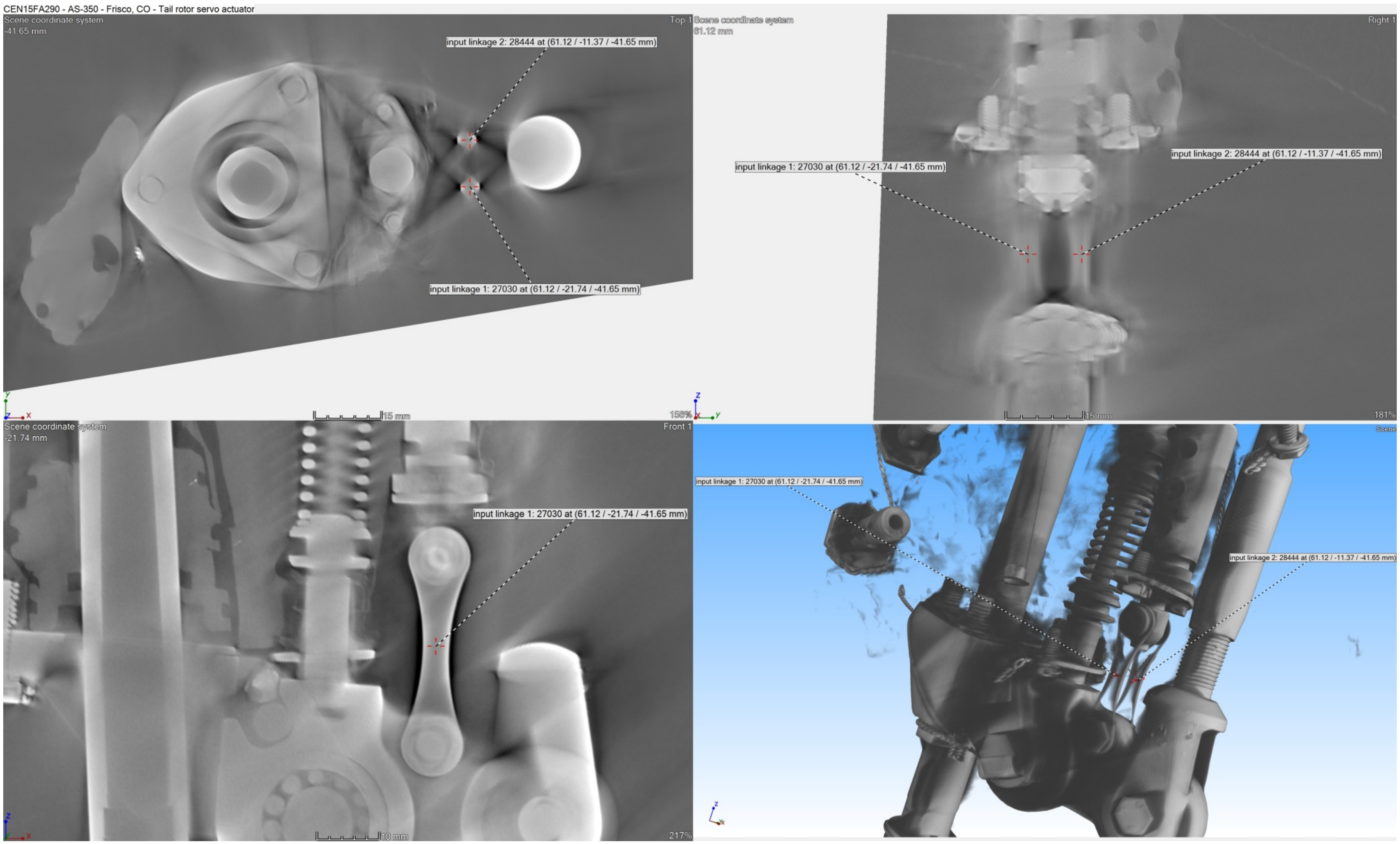

Figure 22
Tail rotor actuator – Input linkage 1

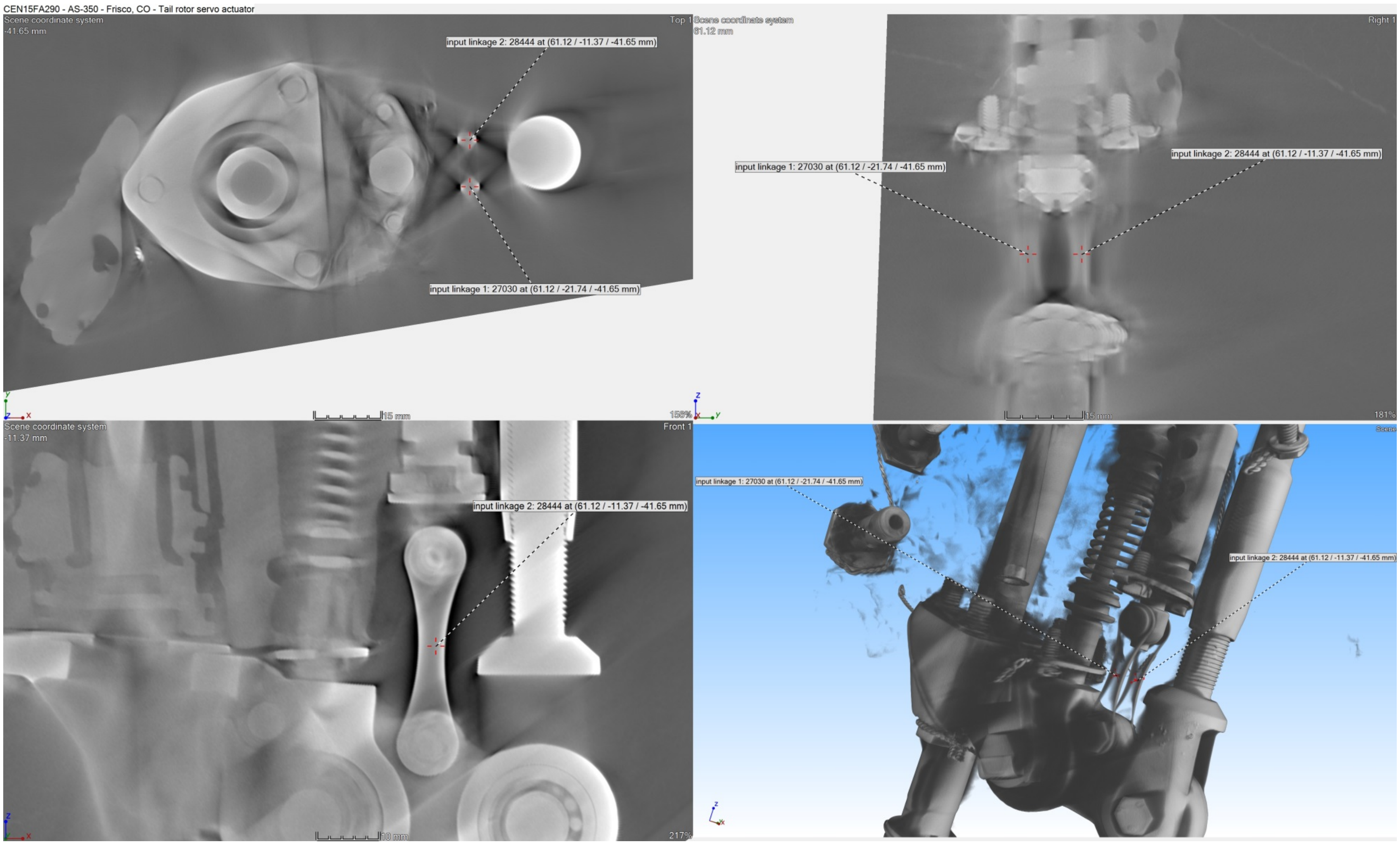

Figure 23
Tail rotor actuator – Input linkage 2

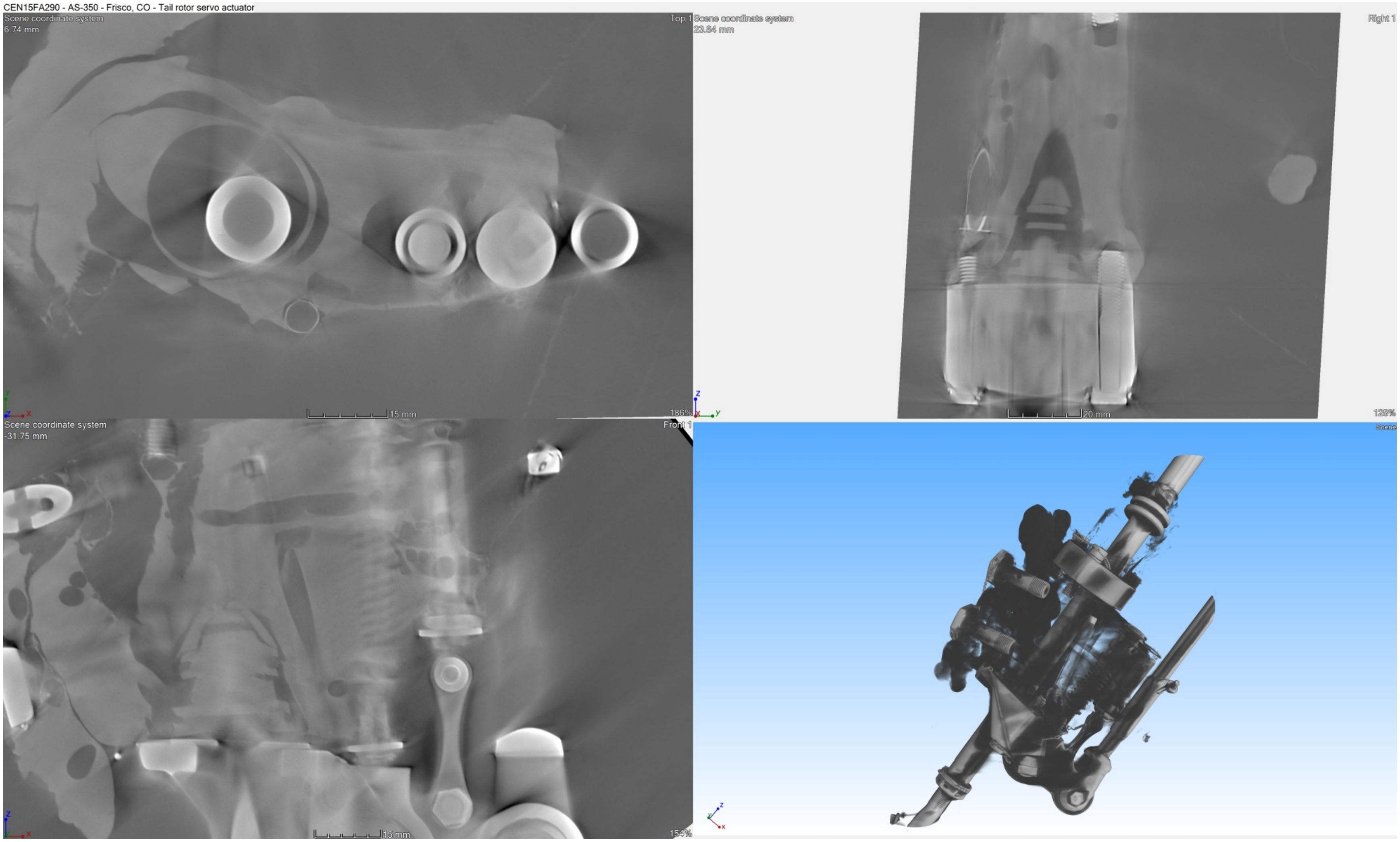

Figure 24
Tail rotor actuator – Distorted hydraulic passages

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