

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

August 24, 2017

Computed Tomography Specialist's Factual Report

ANC-17-MA-001

A. ACCIDENT

Operator: Hageland Aviation Services, Inc.
Location: 12 miles northwest of Togiak, Alaska
Date: October 2, 2016
Time: 1154 Alaska daylight time
Airplane: Cessna 208B Grand Caravan airplane, N208SD

B. GROUP

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

C. SUMMARY

On October 2, 2016, about 1154 Alaska daylight time, a turbine-powered Cessna 208B Grand Caravan airplane, N208SD, sustained substantial damage after impacting steep, mountainous, rocky terrain about 12 miles northwest of Togiak, Alaska. The airplane was being operated as flight 3153 by Hageland Aviation Services, Inc., dba Ravn Connect, Anchorage, Alaska, as a scheduled commuter flight under the provisions of 14 Code of Federal Regulations (CFR) Part 135 and visual flight rules (VFR). All three people on board (two commercial pilots and one passenger) sustained fatal injuries. Visual meteorological conditions prevailed at the Togiak Airport, Togiak, and company flight following procedures were in effect. Flight 3153 departed Quinhagak, Alaska, at 1133, destined for Togiak.

The internal configurations of the terrain awareness annunciator control (TAAC) unit from the accident aircraft, along with an exemplar TAAC unit, were documented using radiographic images that were collected from May 25 – June 1, 2017 in Chicago, Illinois. A total of 8,809 computed tomography (CT) slice images were examined, processed, and analyzed by the NTSB to evaluate the components.

Review of the images indicated that, when it was scanned, the terrain inhibit button for the accident TAAC unit was in the extended position; there were no indications of mechanical damage to the terrain inhibit button that would have prevented proper operation of the button; there was low density material and a high density particle noted within the test button channel of the accident TAAC unit; and there was a high density particle noted on the exterior of the terrain inhibit button case.

D. DETAILS OF THE INVESTIGATION

1.0 General

The accident and exemplar terrain awareness annunciator control (TAAC) units were subjected to x-ray computed tomography (CT) scanning to document their internal conditions. The scanning was conducted from May 25 – June 1, 2017. The scans were performed by Varex, Inc under the direction of the NTSB using the Varex Actis 500/225 microfocus CT system.

For the CT scans, the components were each individually loaded into the imaging unit and placed on a turntable. Each 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 components were scanned using a total of 8,809 slices, and the total size of the combined data sets was 74.6 Gb. The complete scan protocols are given in table 1. The CT axial slice images were provided by Varex to the NTSB where they were examined, processed, and analyzed to evaluate the components. Target CT techniques, where the scanned field of view was narrowed to allow better resolution, were used for some of the scans to gather more detailed information on a given area of interest.

Table 1
Scan Protocols

Component	Accident TAAC unit overall scan	Exemplar TAAC unit overall scan – terrain inhibit button extended	Accident TAAC unit – button target CT	Exemplar TAAC unit – button target CT with terrain inhibit button depressed
Number of slices	1797	1936	2815	2261
Voxel Size - X Direction (mm)	0.046	0.046	0.015	0.015
Voxel Size - Y Direction (mm)	0.046	0.046	0.015	0.015
Voxel Size - Z Direction (mm)	0.049	0.049	0.015	0.015
Image Projections per Revolution	1800	1800	1800	1800
Exposure time (ms)	285.58	285.58	285.58	285.58
Frames to Avg (frames per projection)	2	1	2	2
X-ray Source Voltage (kV)	222	222	222	222
X-ray Source Current (mA)	0.590	0.590	0.590	0.590
Source Filter Thickness (mm)	1.0	1.0	1.0	1.0
Source Filter Material	Brass	Brass	Brass	Brass
Image Matrix Size	2048 x 2048	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 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 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.

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 accident and exemplar TAAC units are shown in figures 1 through 24. Review of the images indicated that, when it was scanned, the terrain inhibit button for the accident TAAC unit was in the extended position; there were no indications of mechanical damage to the terrain inhibit button that would have prevented proper operation of the button; there was low density material and a high density particle noted within the test button channel of the accident TAAC unit; and there was a high density particle noted on the exterior of the terrain inhibit button case.

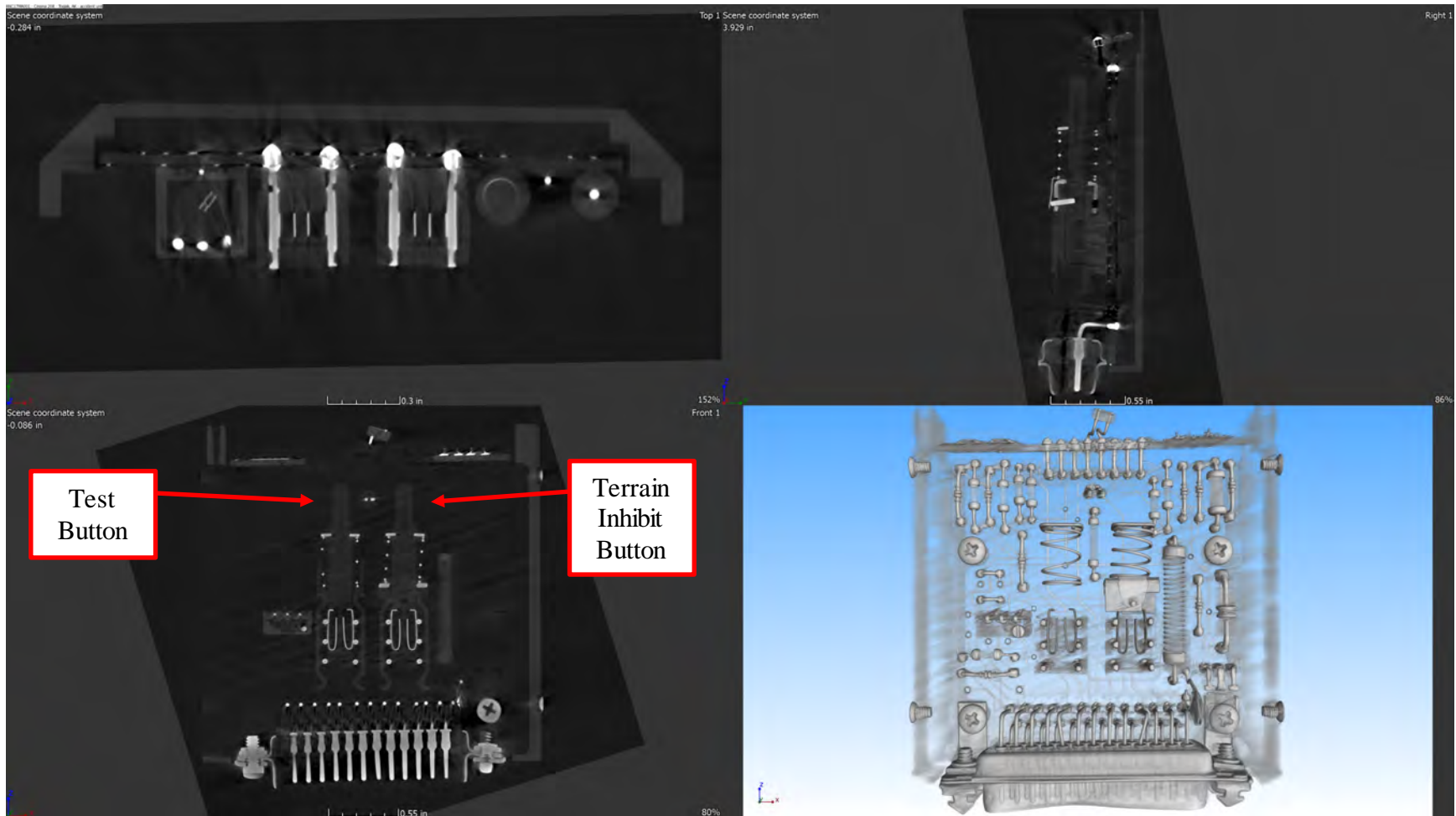


Figure 1
Accident TAAC unit - overview

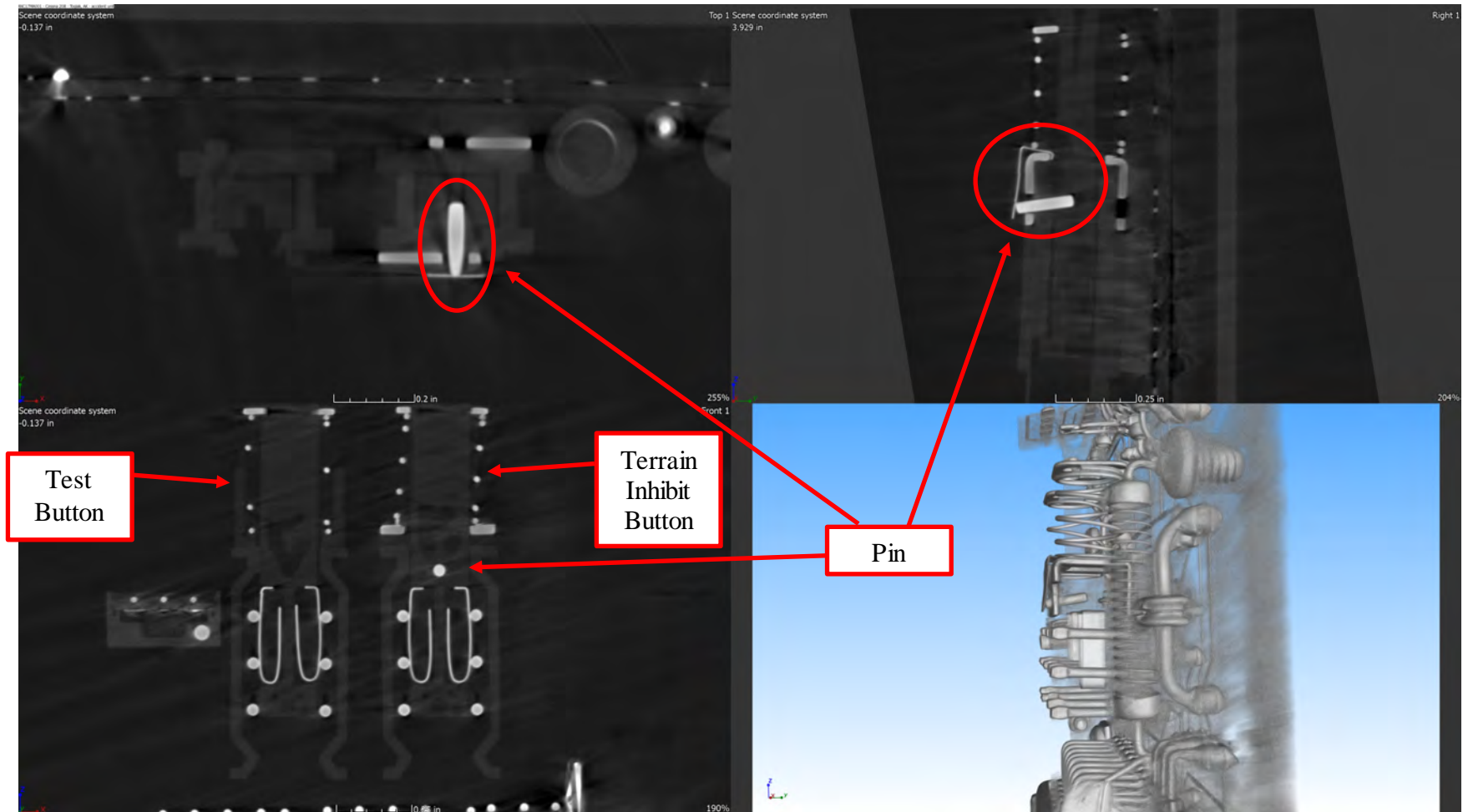


Figure 2
Accident TAAC unit – button pin

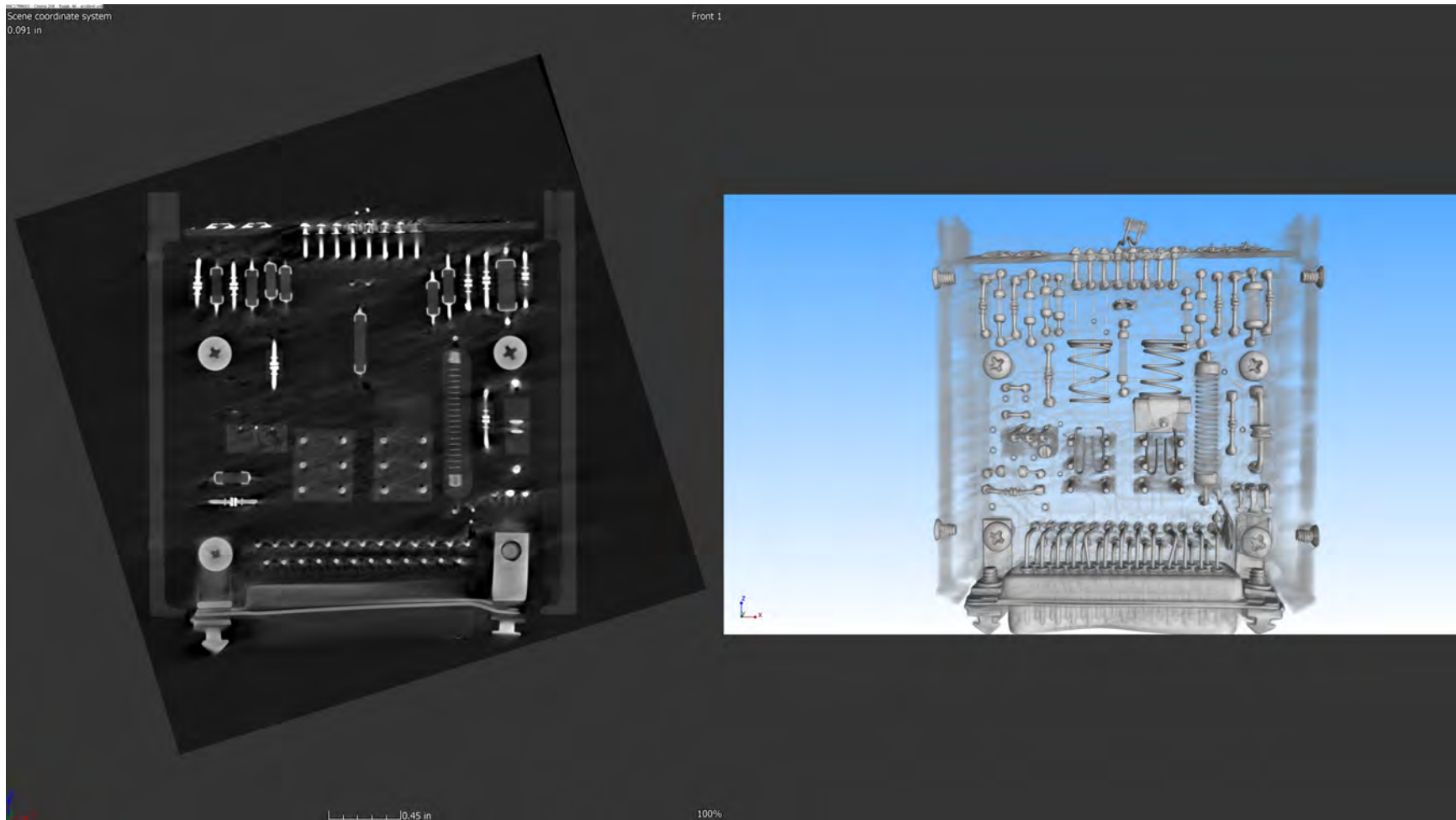


Figure 3
Accident TAAC unit – circuit board components

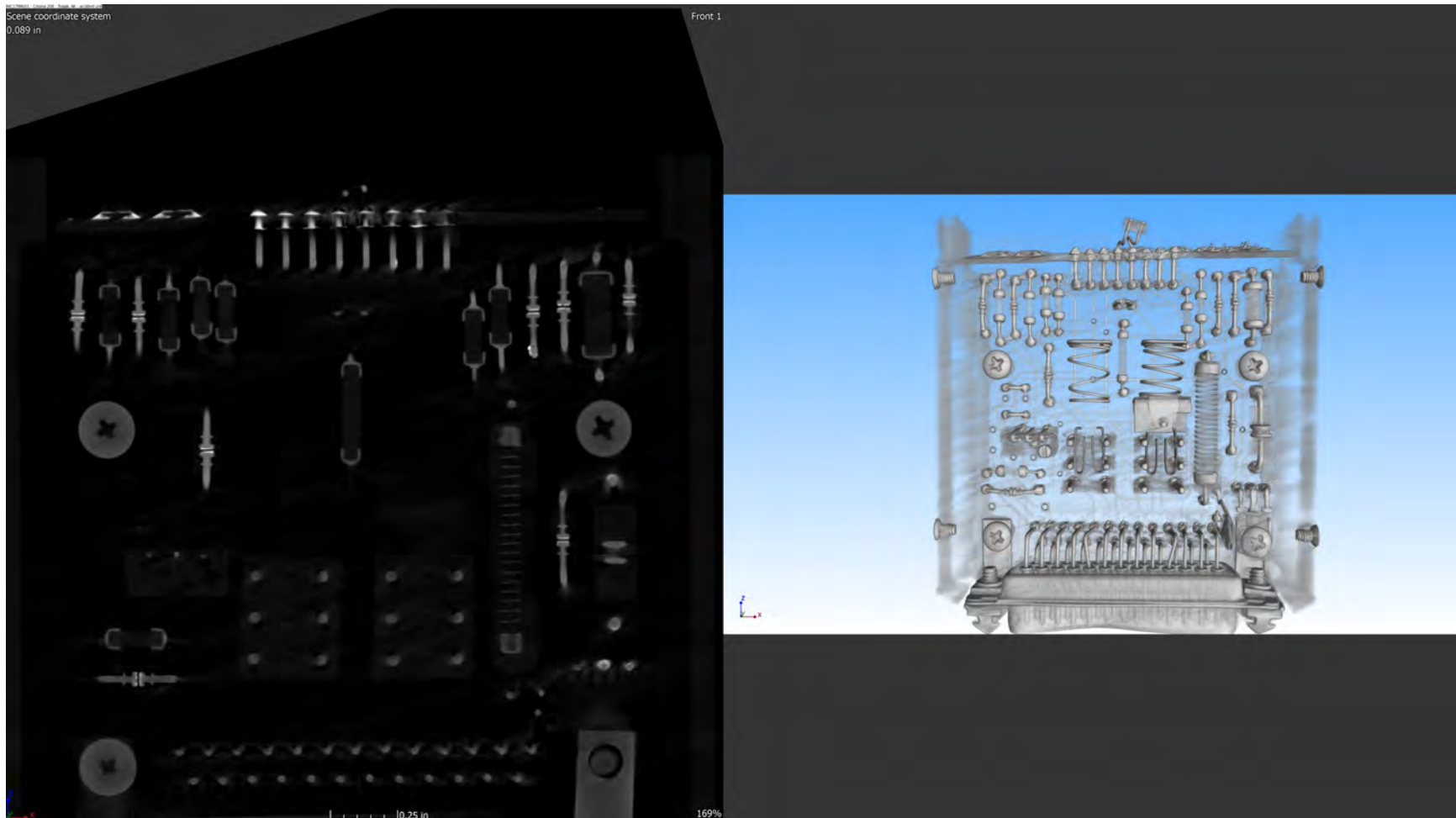


Figure 4
Accident TAAC unit – circuit board components with enhanced contrast

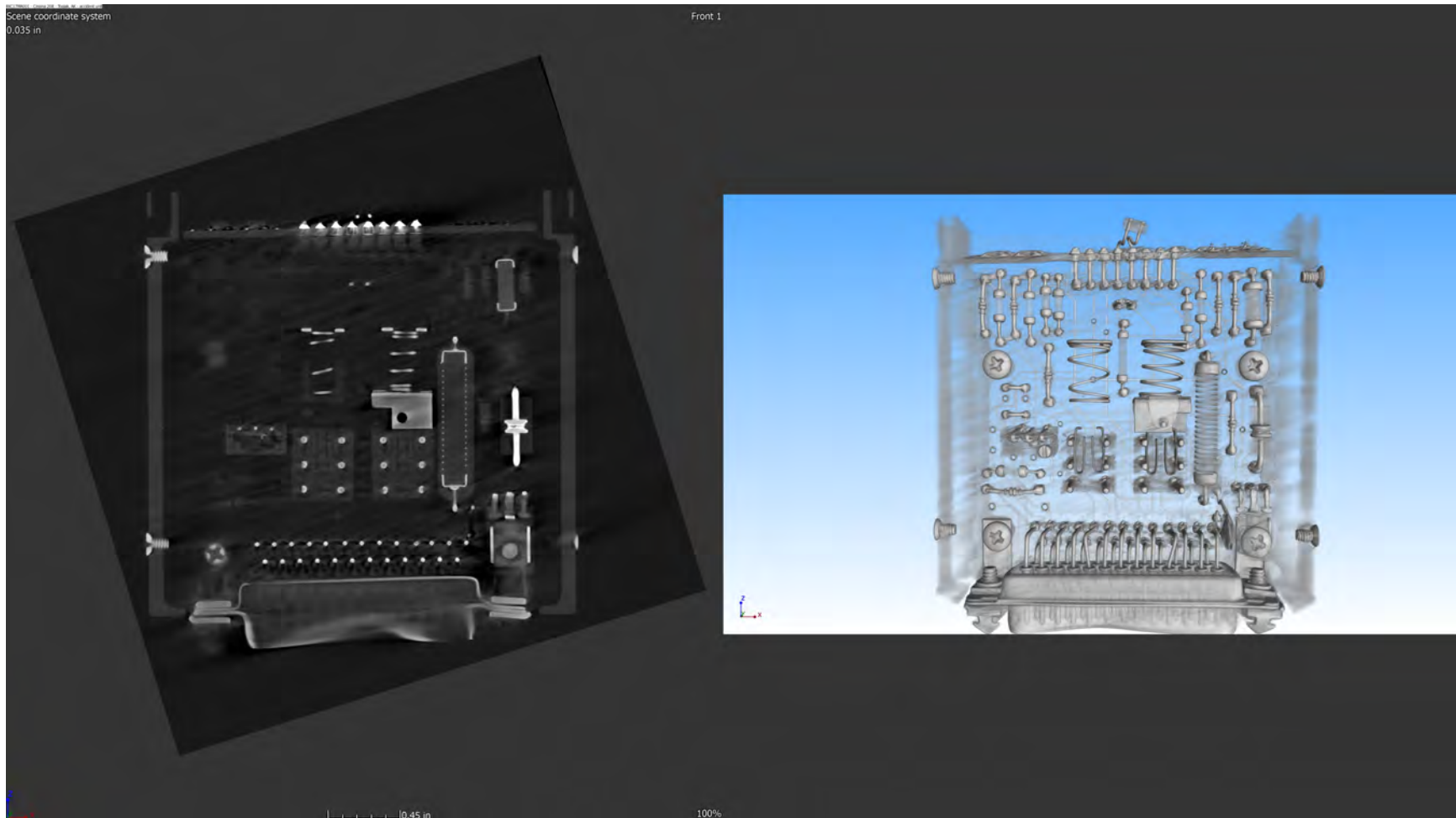


Figure 5
Accident TAAC unit – circuit board components 2

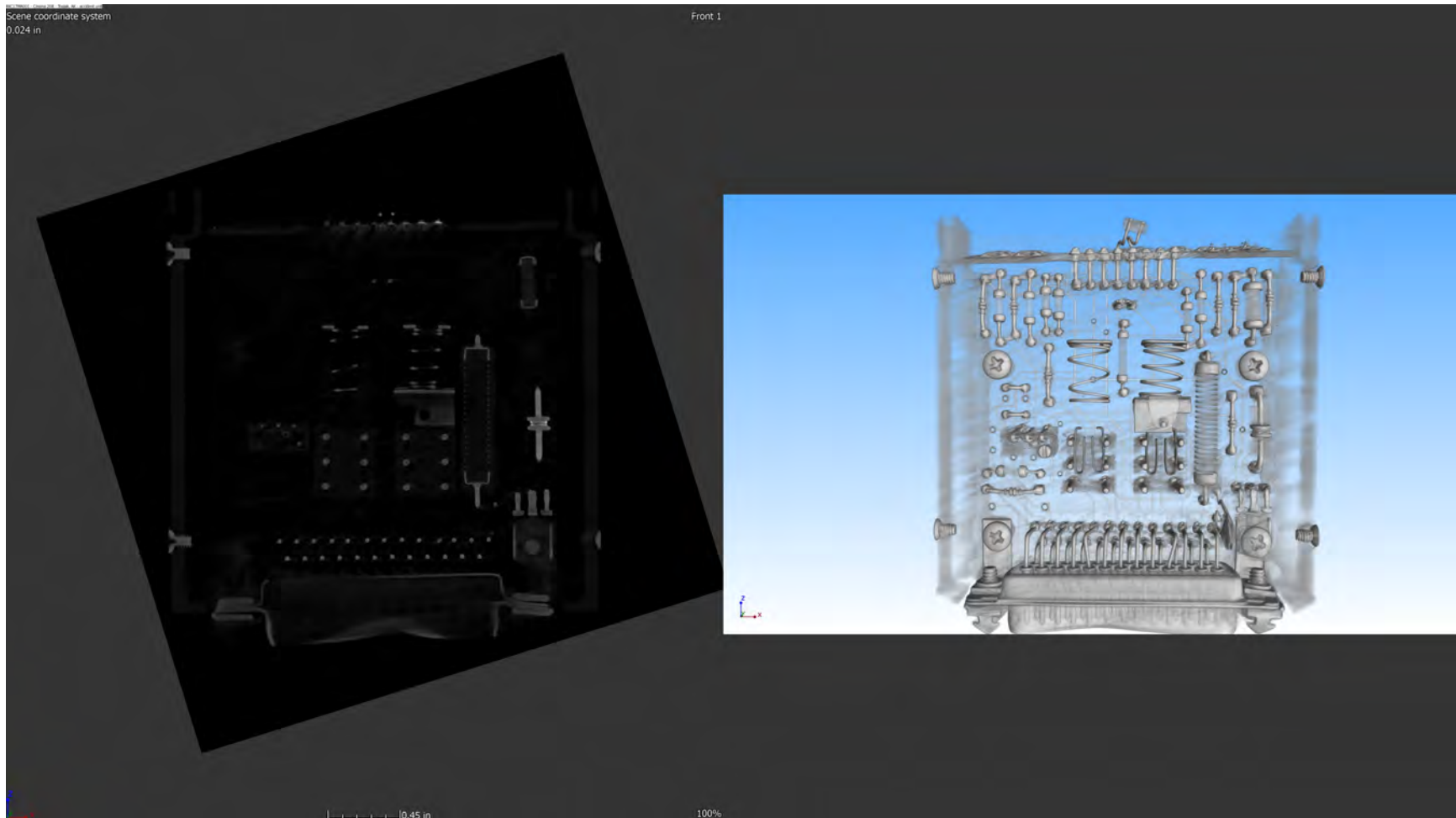


Figure 6
Accident TAAC unit – circuit board components 2 with enhanced contrast

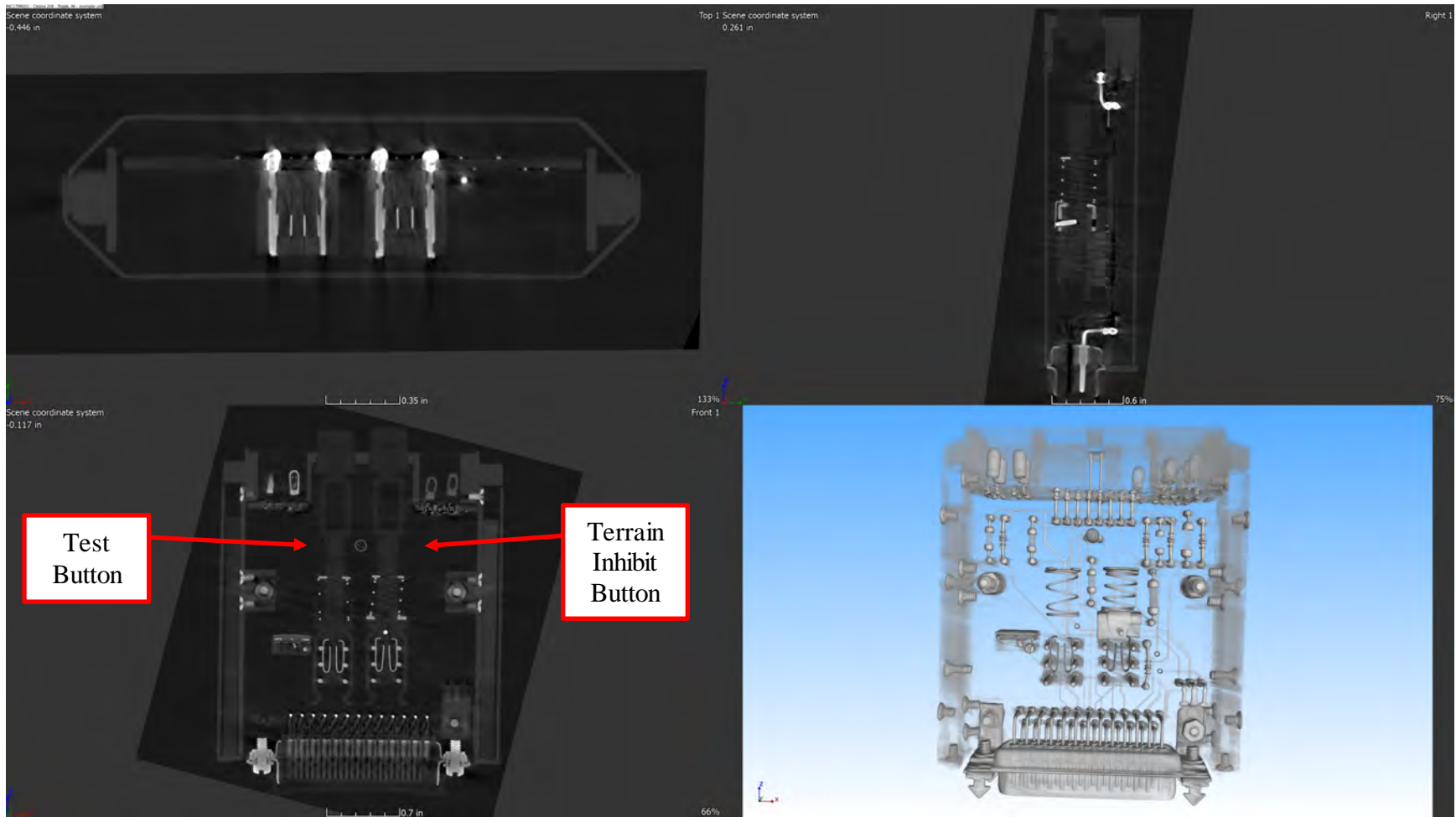


Figure 7
Exemplar TAAC unit – terrain inhibit button extended - overview

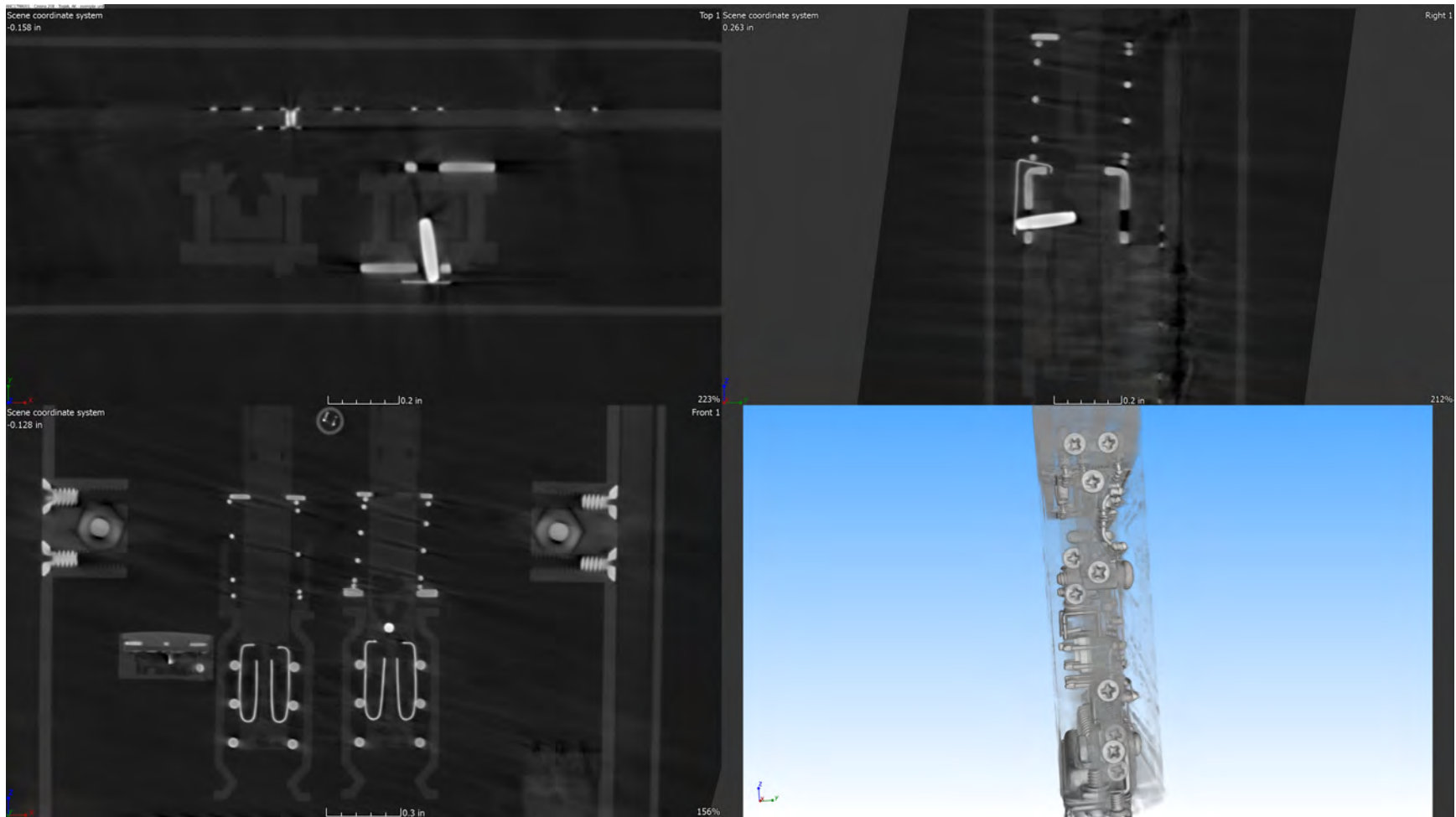


Figure 8
Exemplar TAAC unit – terrain inhibit button extended – button pin

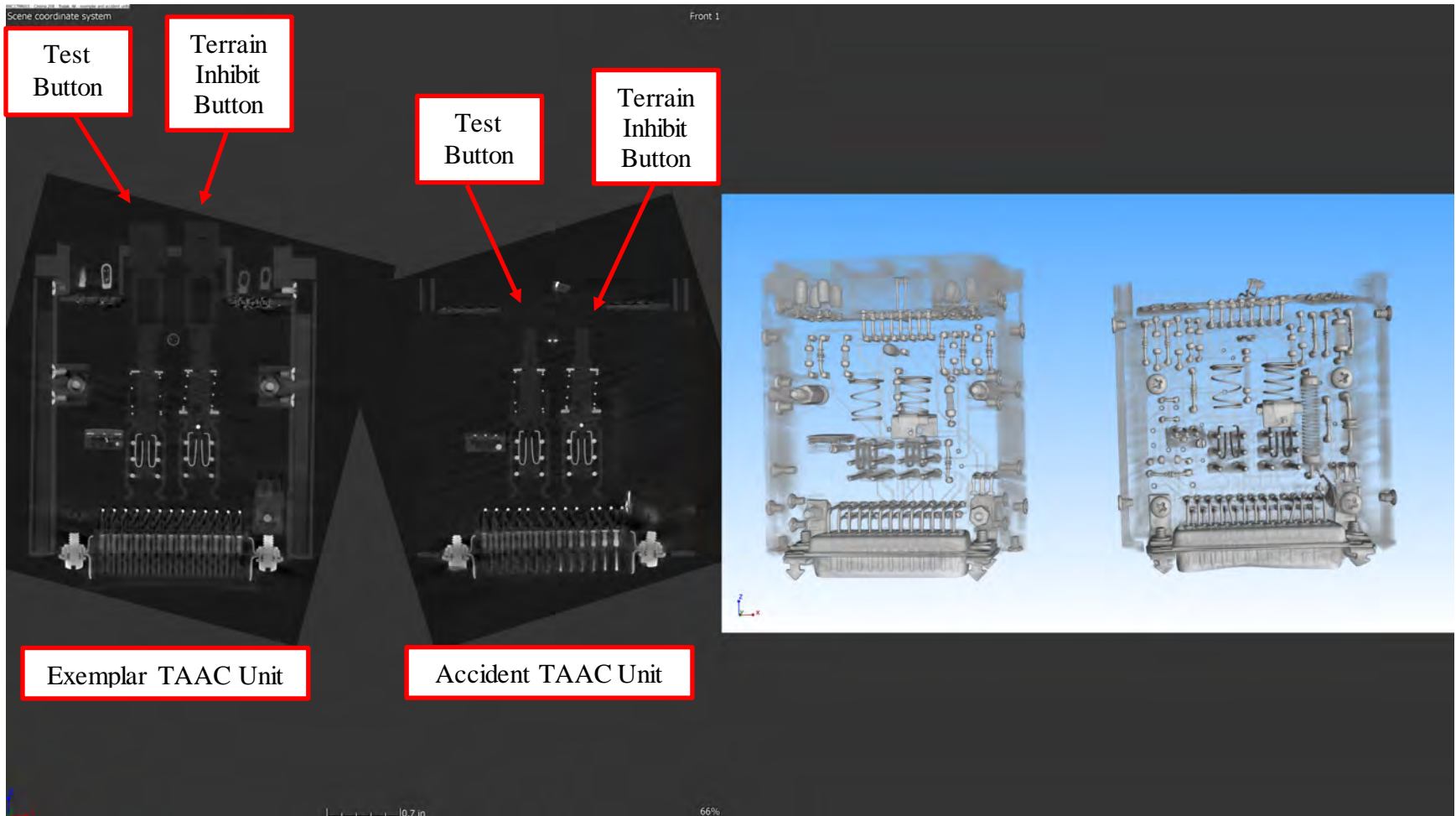


Figure 9
Exemplar and Accident TAAC units – terrain inhibit button extended on exemplar unit - overview

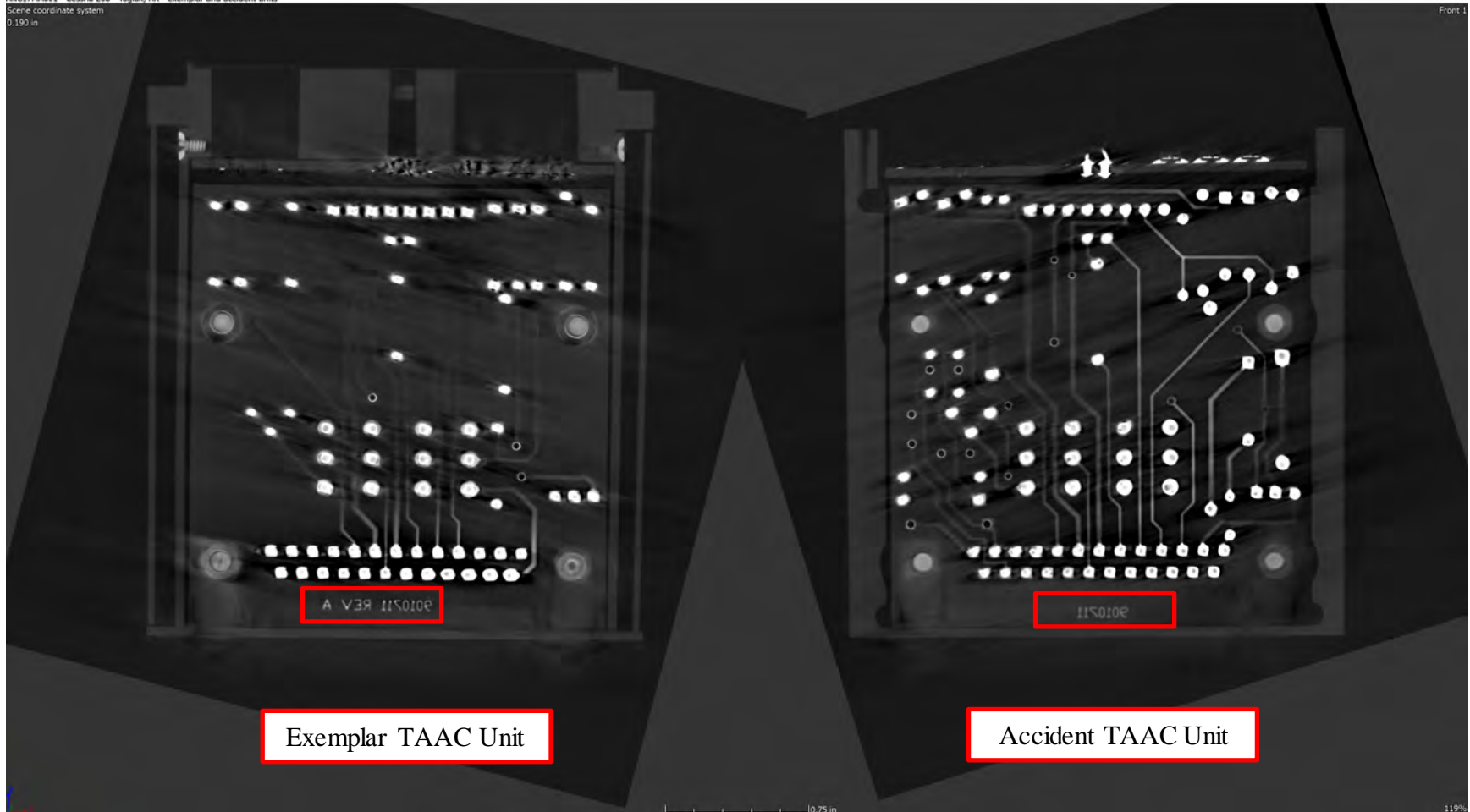


Figure 10
Exemplar and Accident TAAC units –circuit board nomenclature

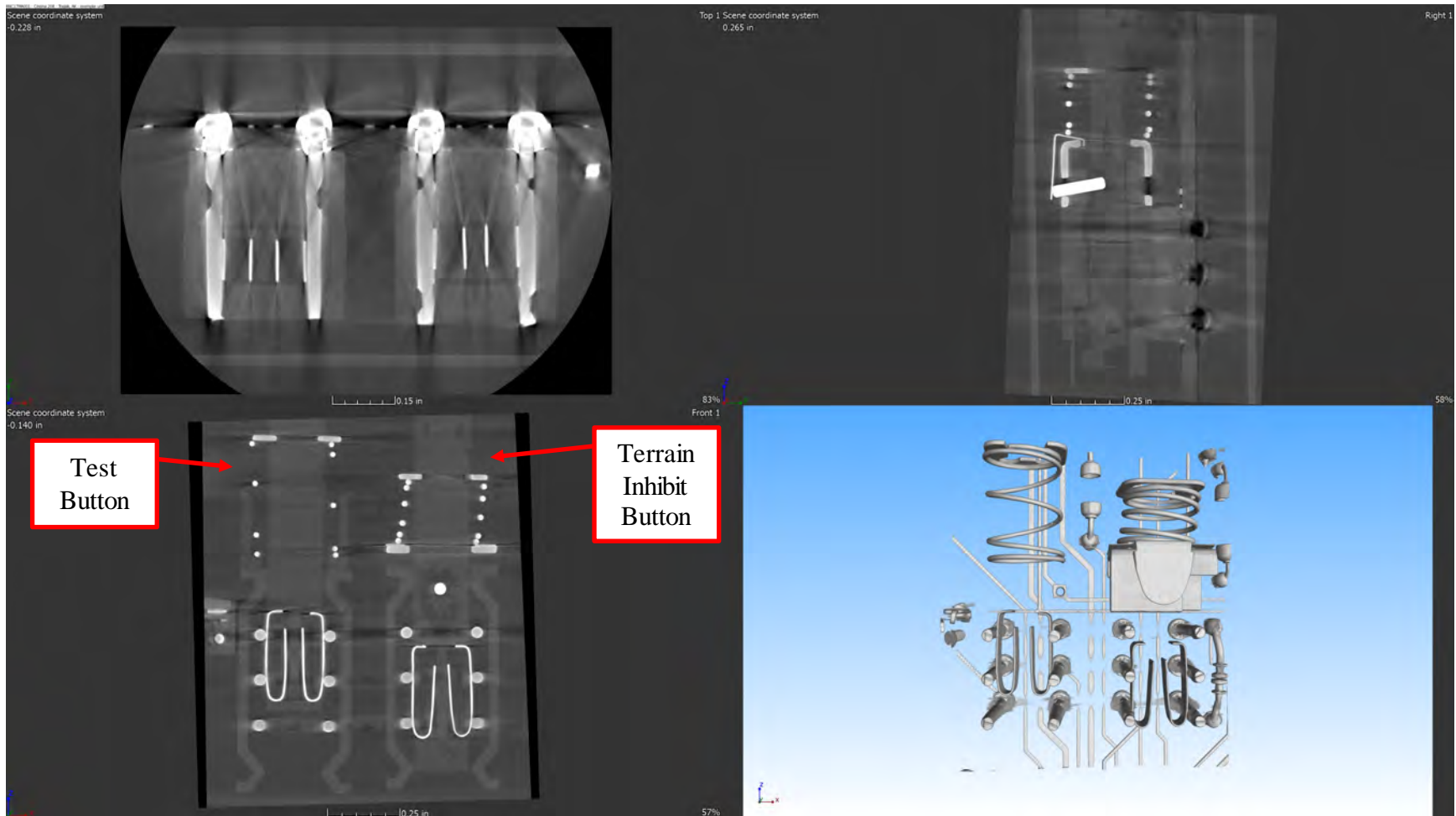


Figure 11
Exemplar TAAC unit target CT – terrain inhibit button depressed - overview

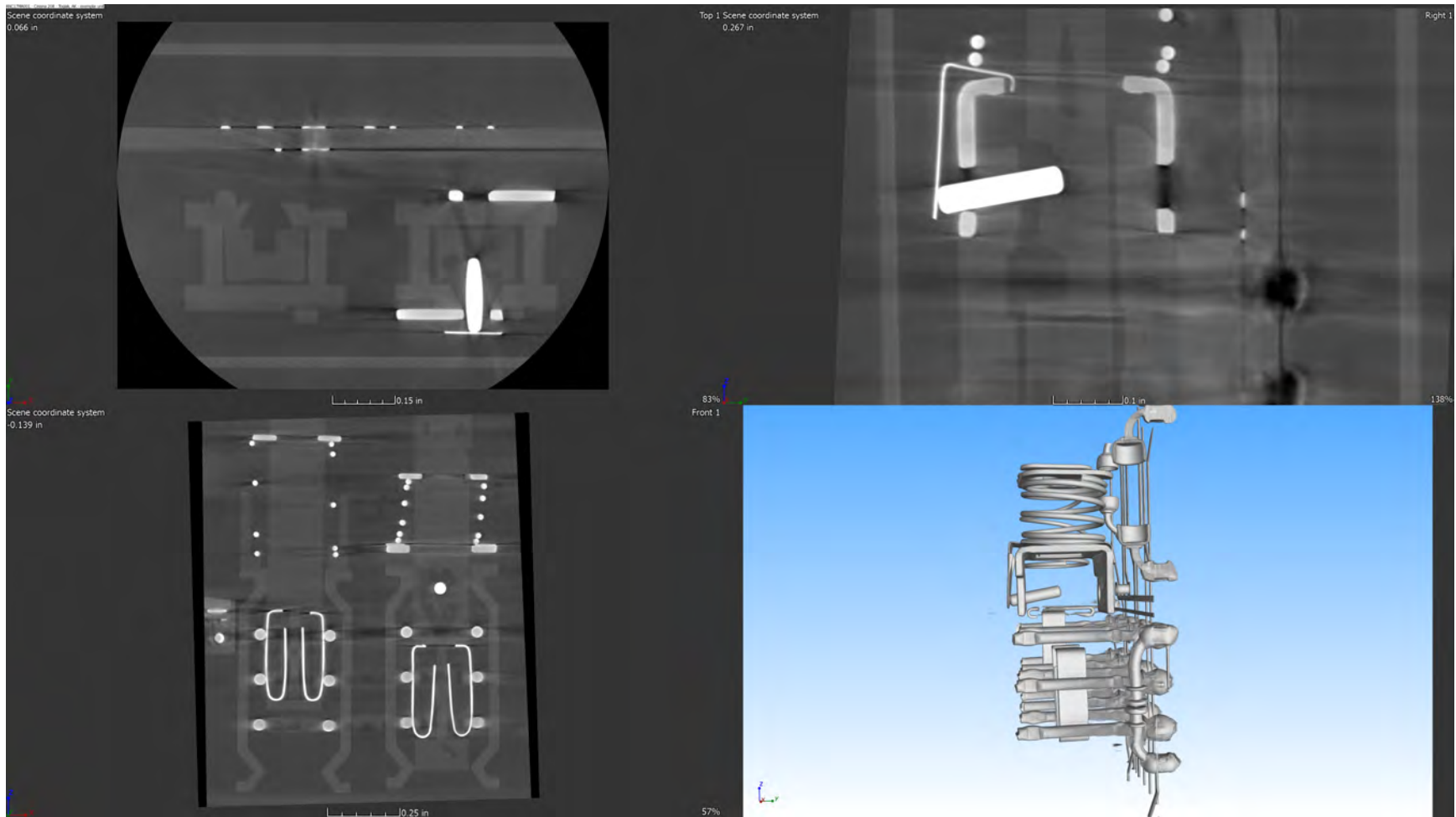


Figure 12
Exemplar TAAC unit target CT – terrain inhibit button depressed – button pin

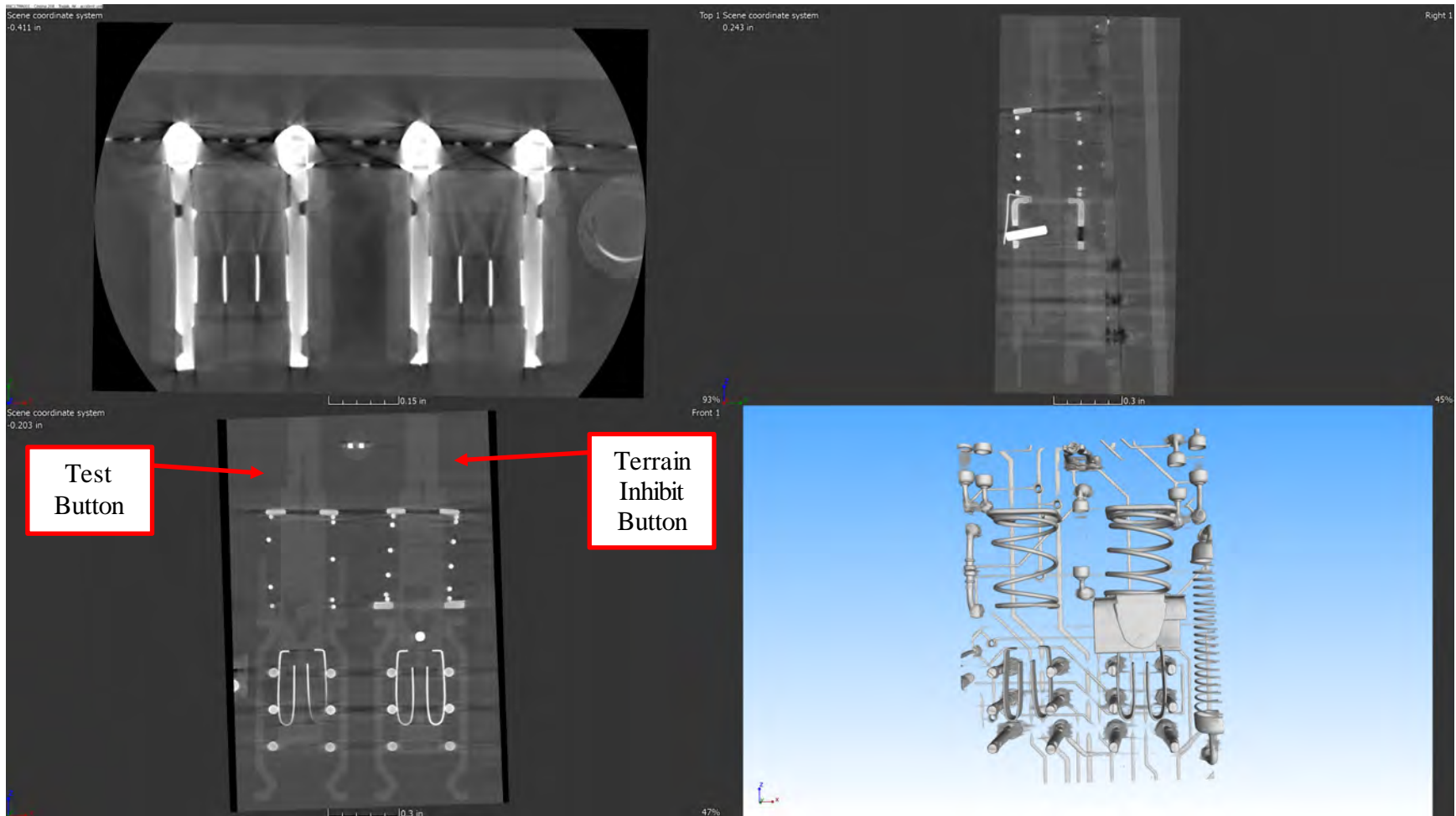


Figure 13
Accident TAAC unit target CT –overview

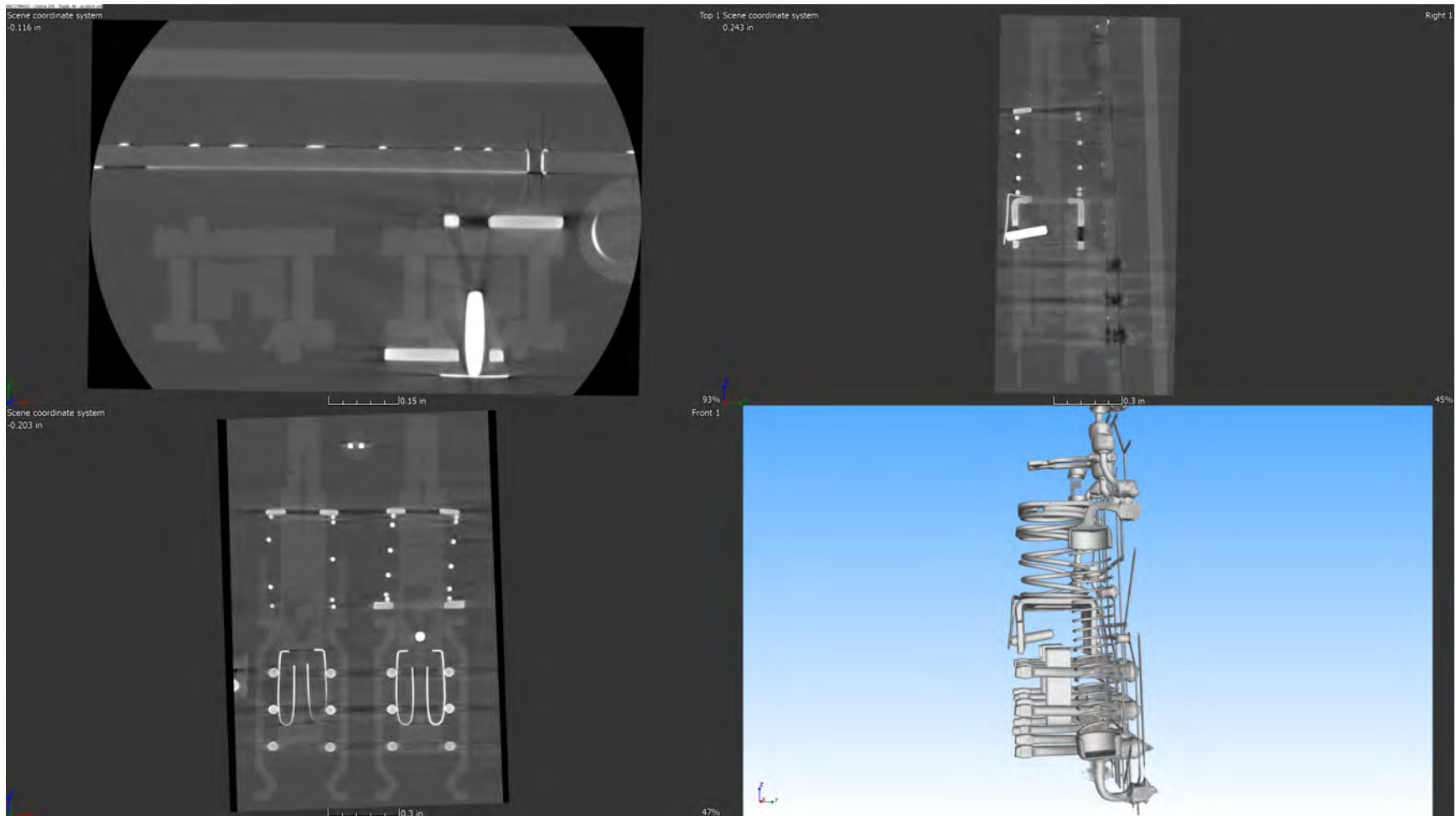


Figure 14
Accident TAAC unit target CT –button pin

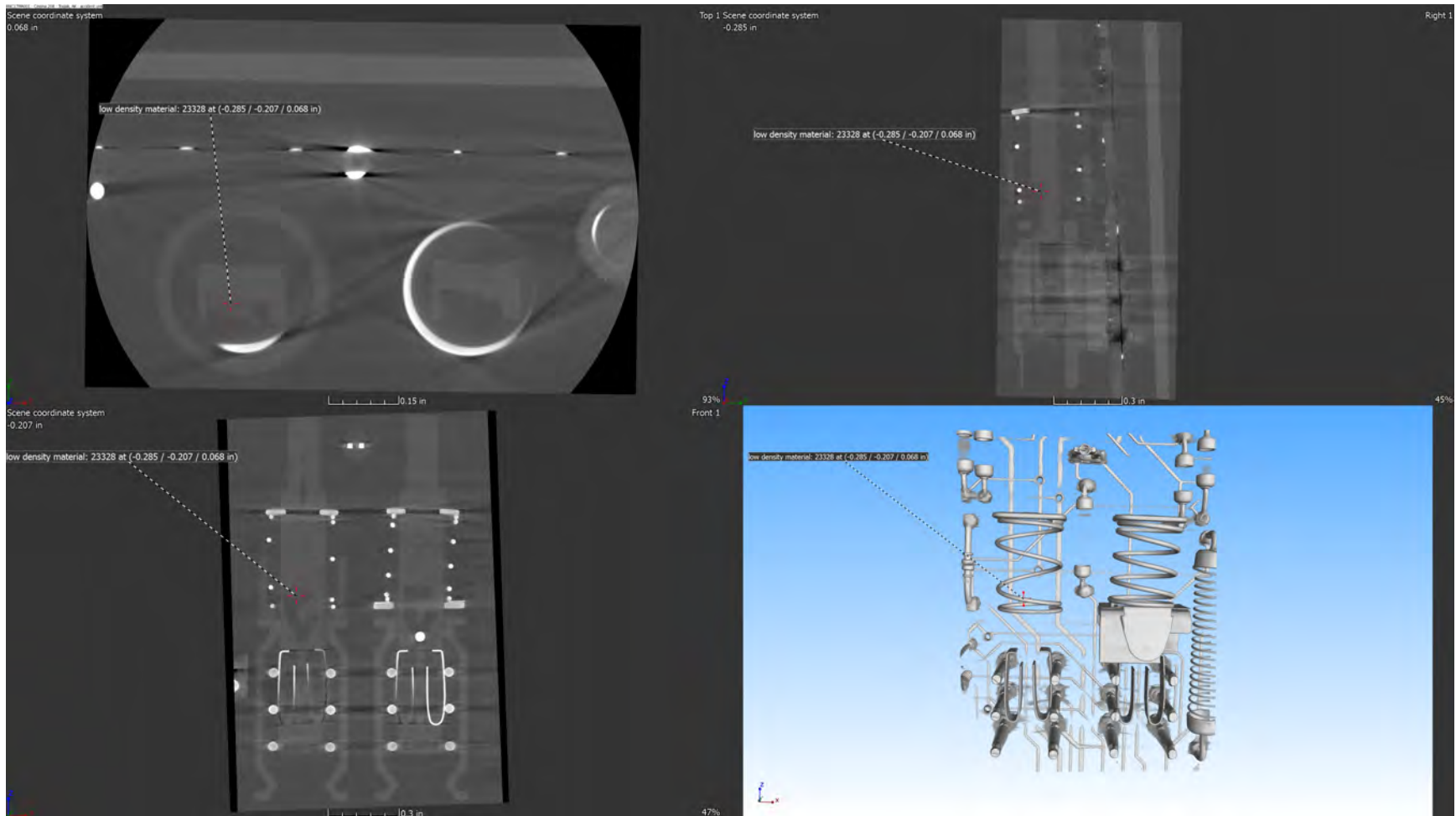


Figure 15
Accident TAAC unit target CT – low density material in test button channel

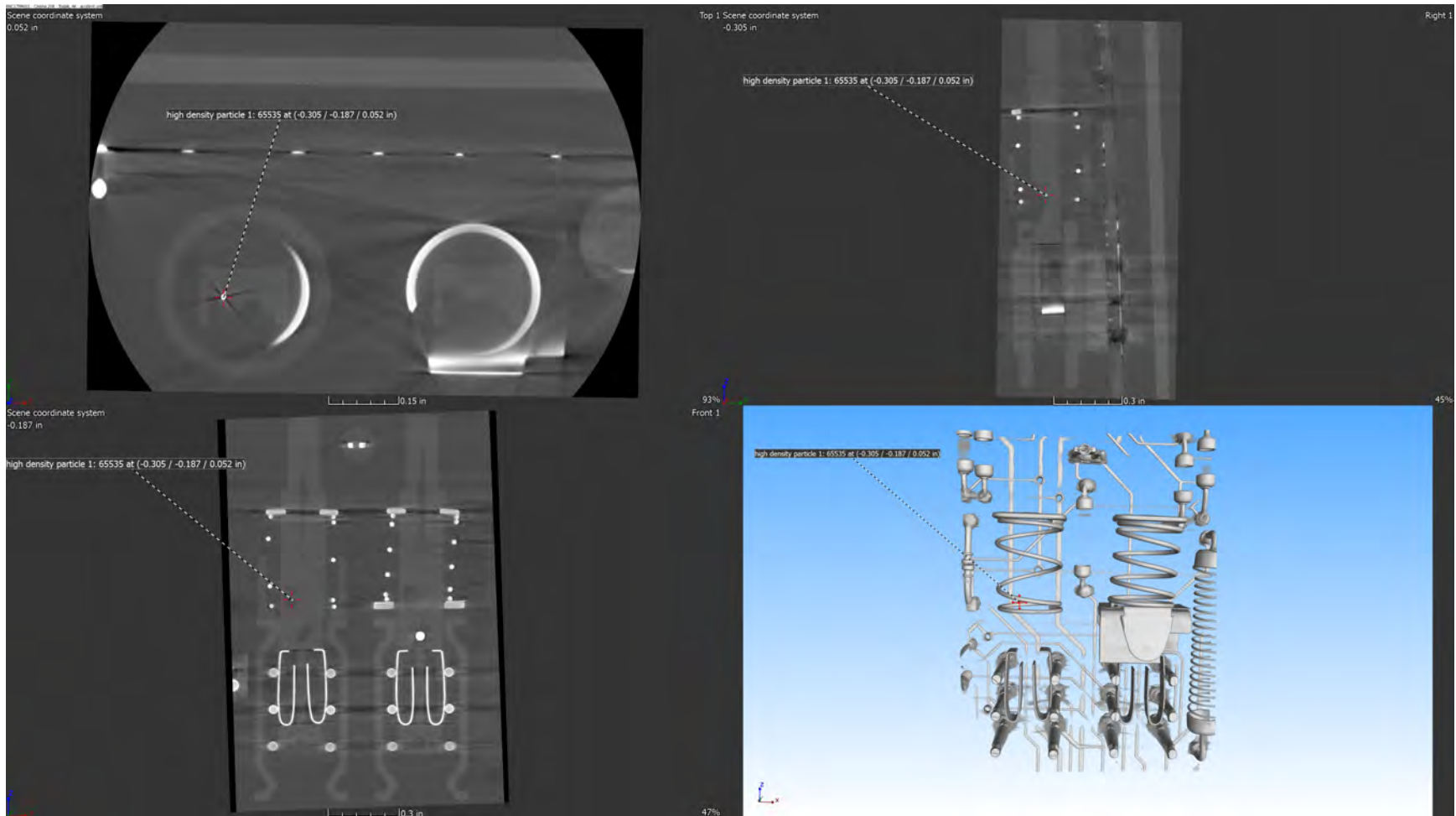


Figure 16
Accident TAAC unit target CT – high density particle in test button channel

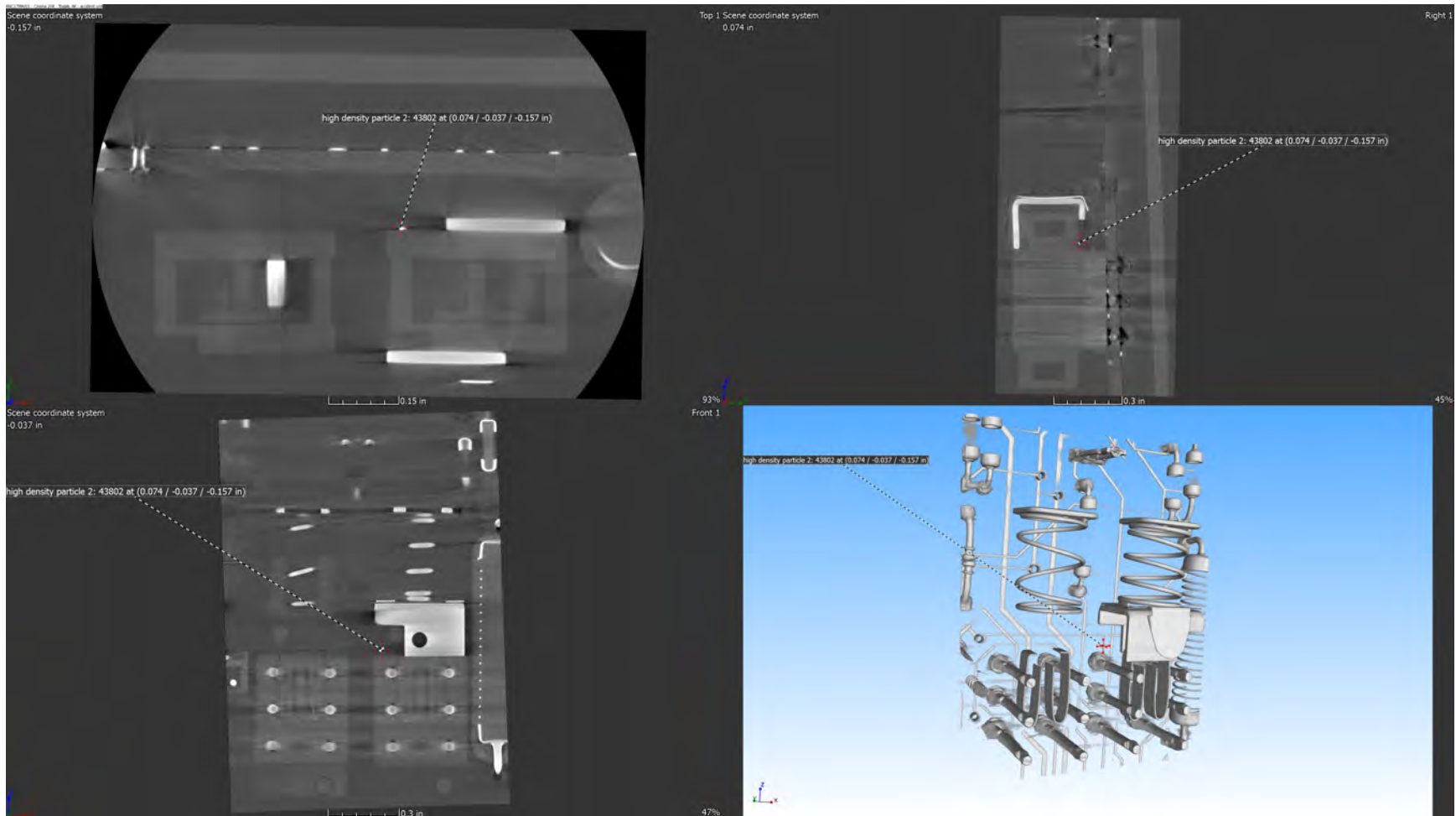


Figure 17
Accident TAAC unit target CT – high density particle on terrain inhibit button exterior

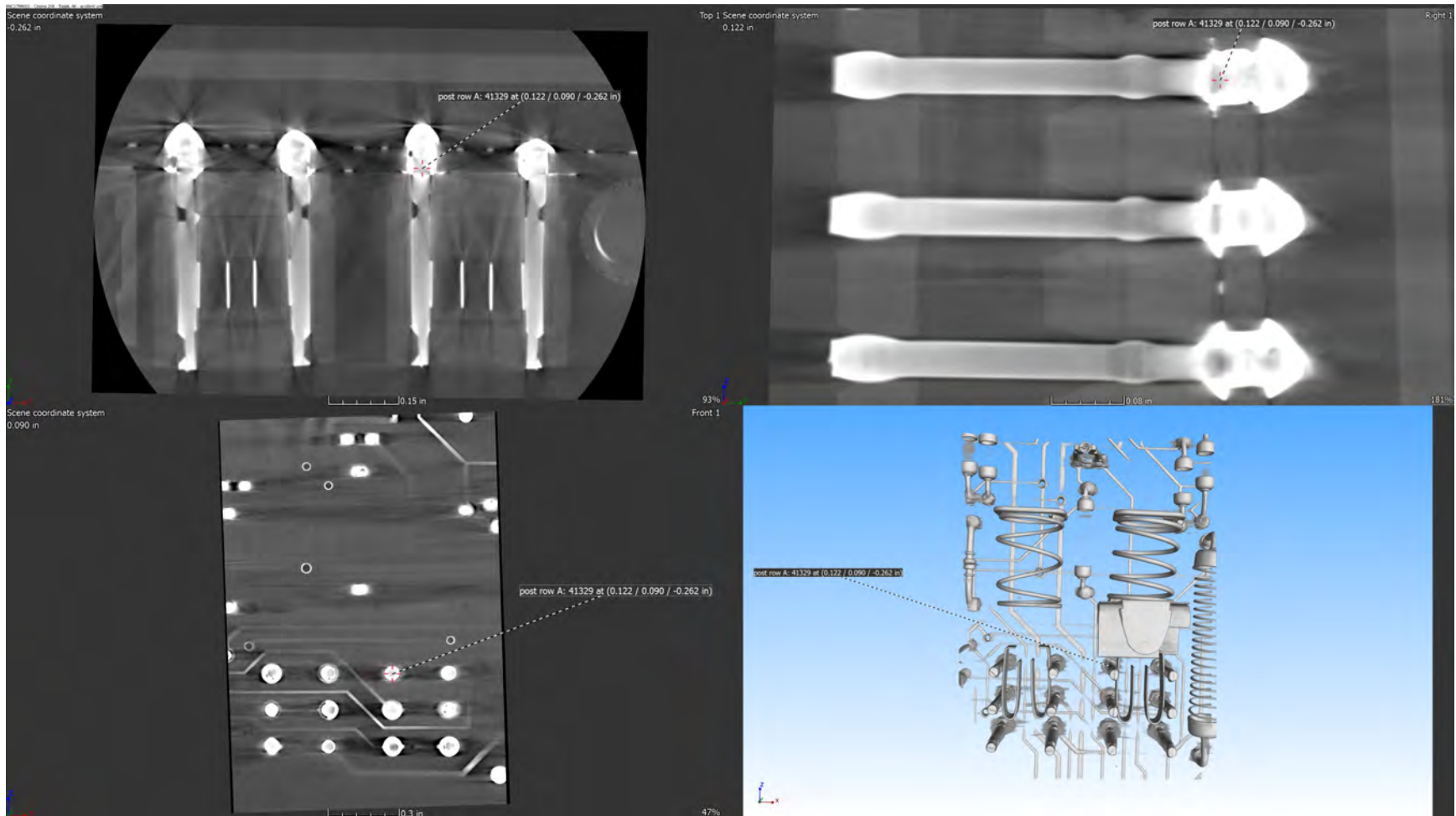


Figure 18
 Accident TAAC unit target CT – connection posts – row A

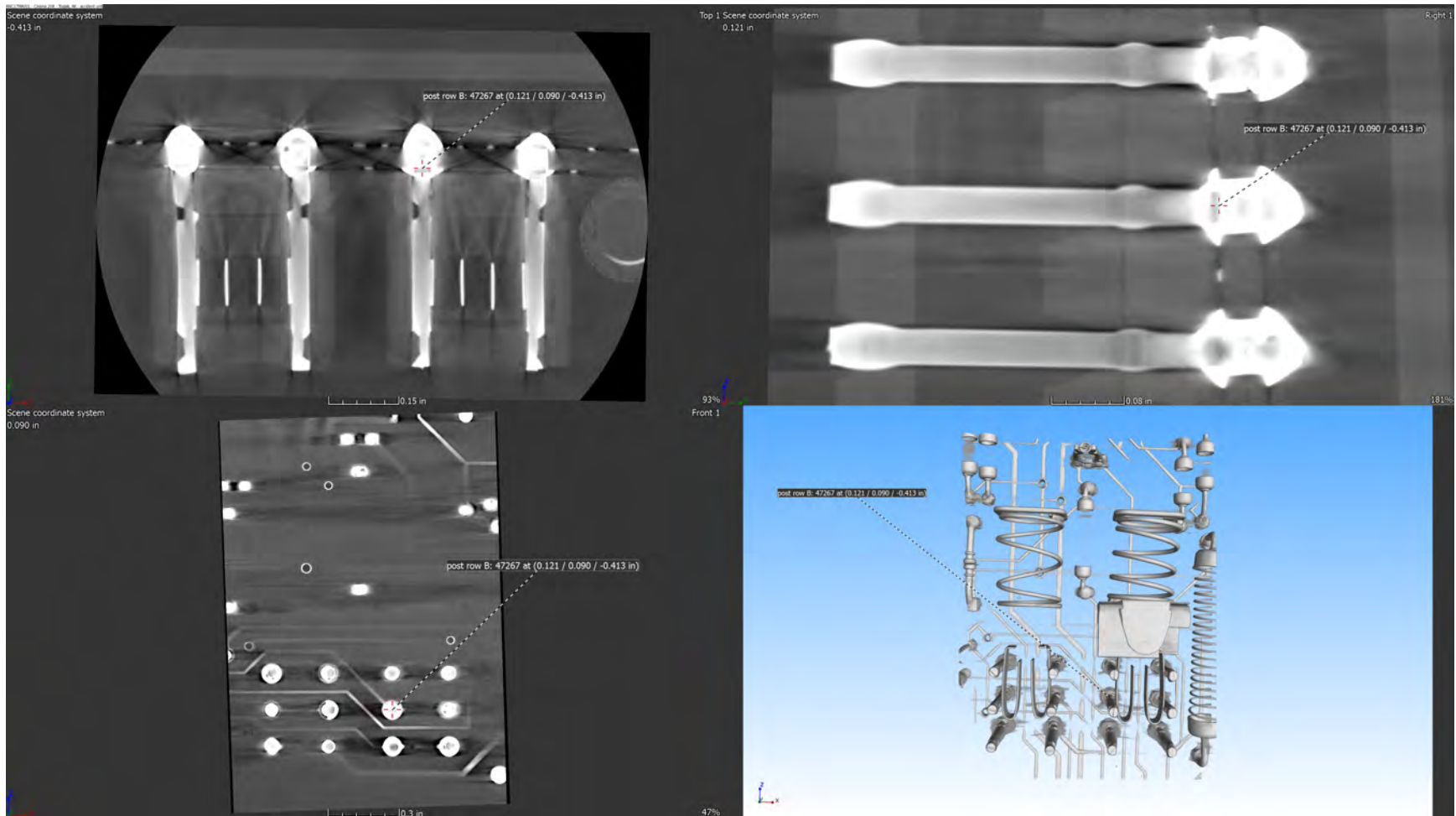


Figure 19
Accident TAAC unit target CT – connection posts – row B

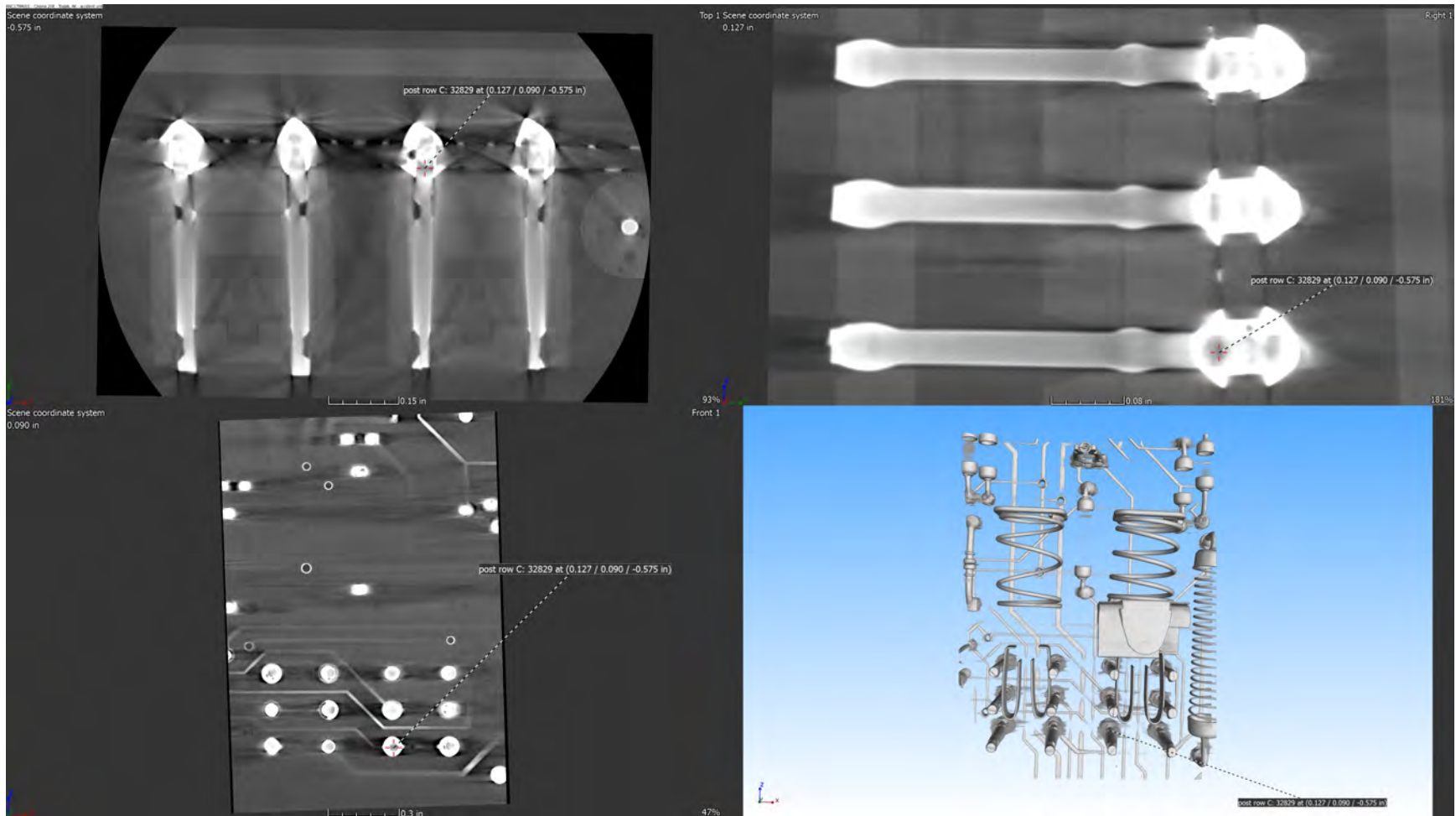


Figure 20
 Accident TAAC unit target CT – connection posts – row C

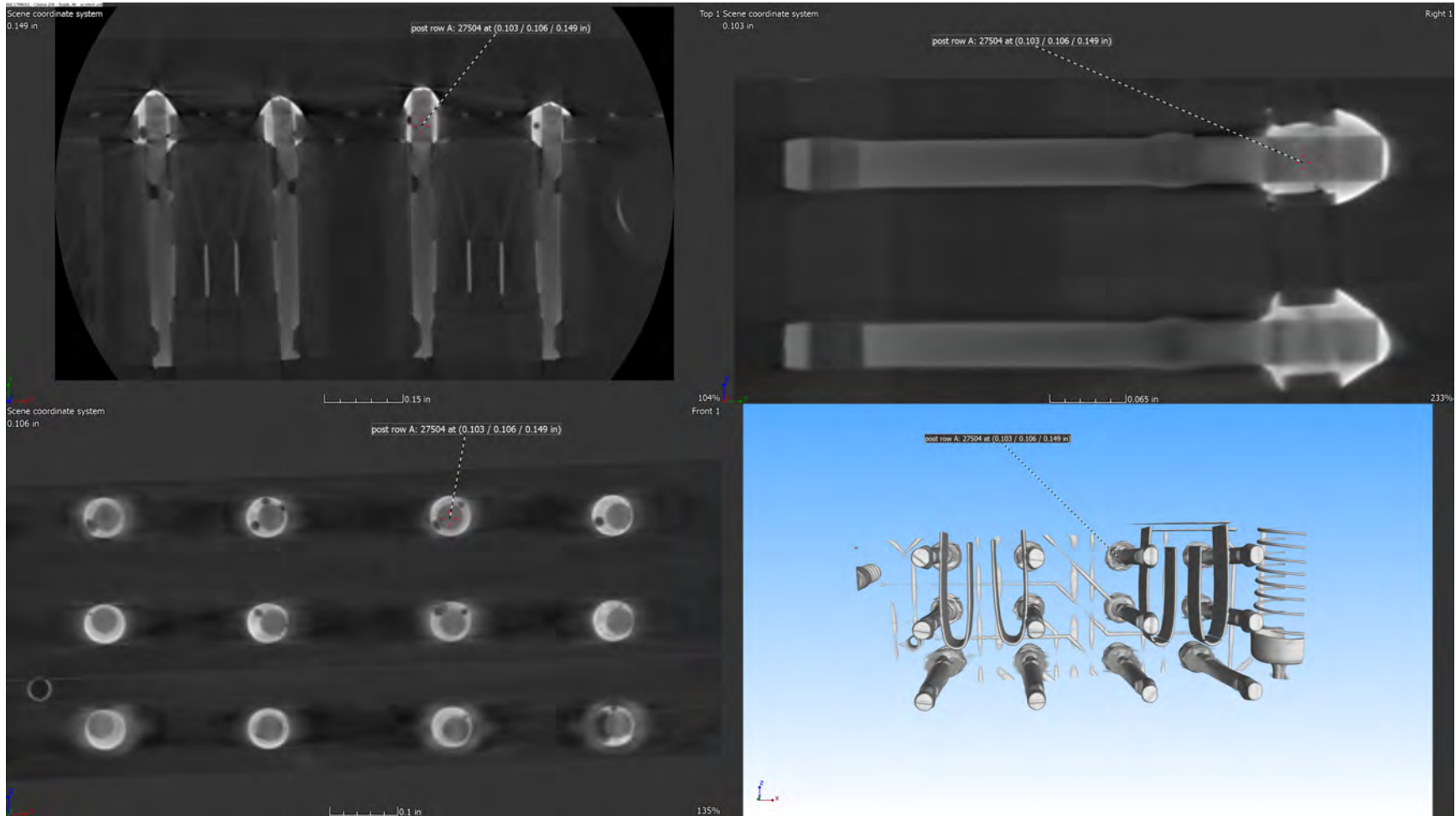


Figure 21
 Accident TAAC unit target CT – connection posts – row A with contrast enhanced to show solder joint

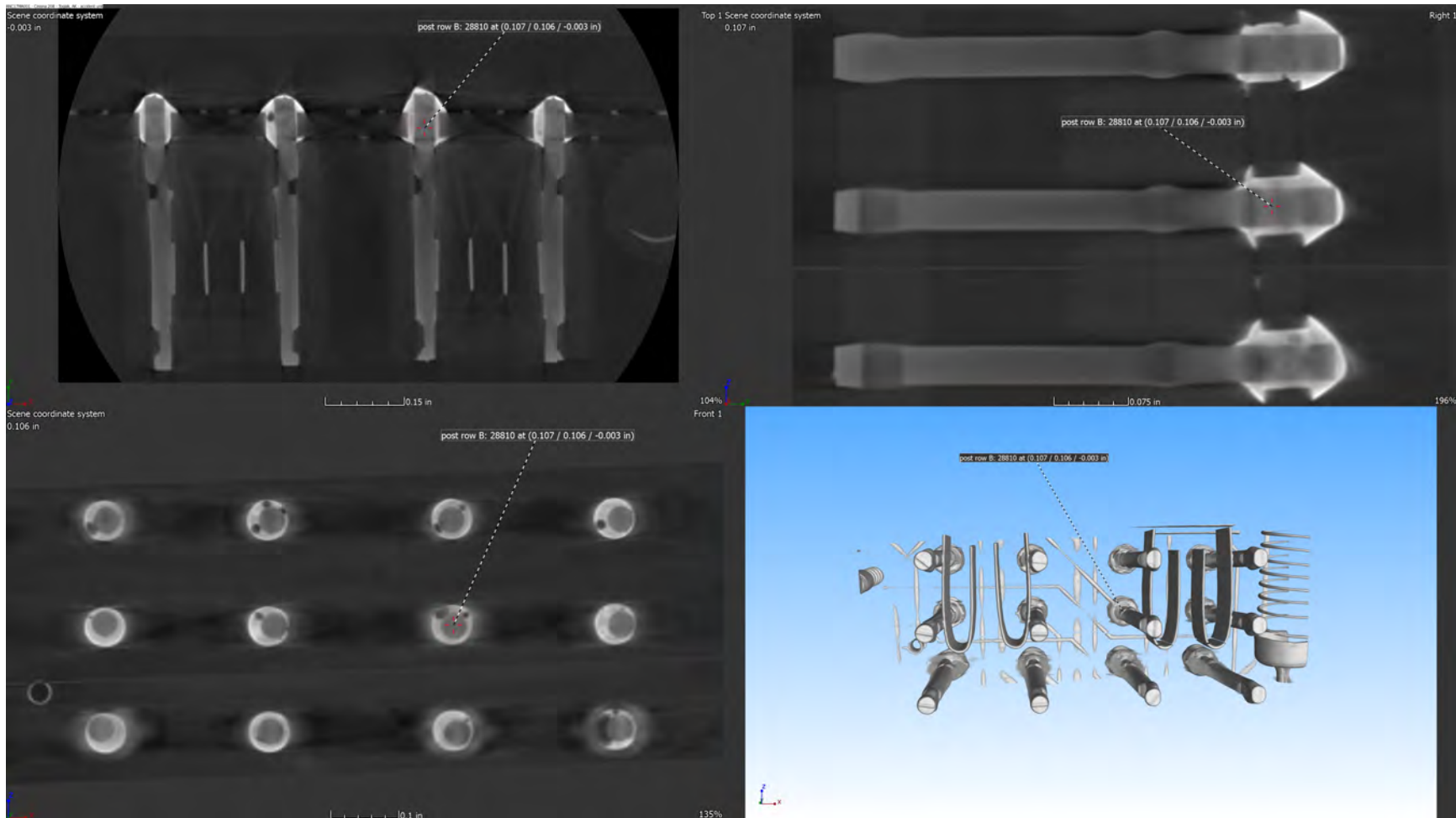


Figure 22
Accident TAAC unit target CT – connection posts – row B with contrast enhanced to show solder joint

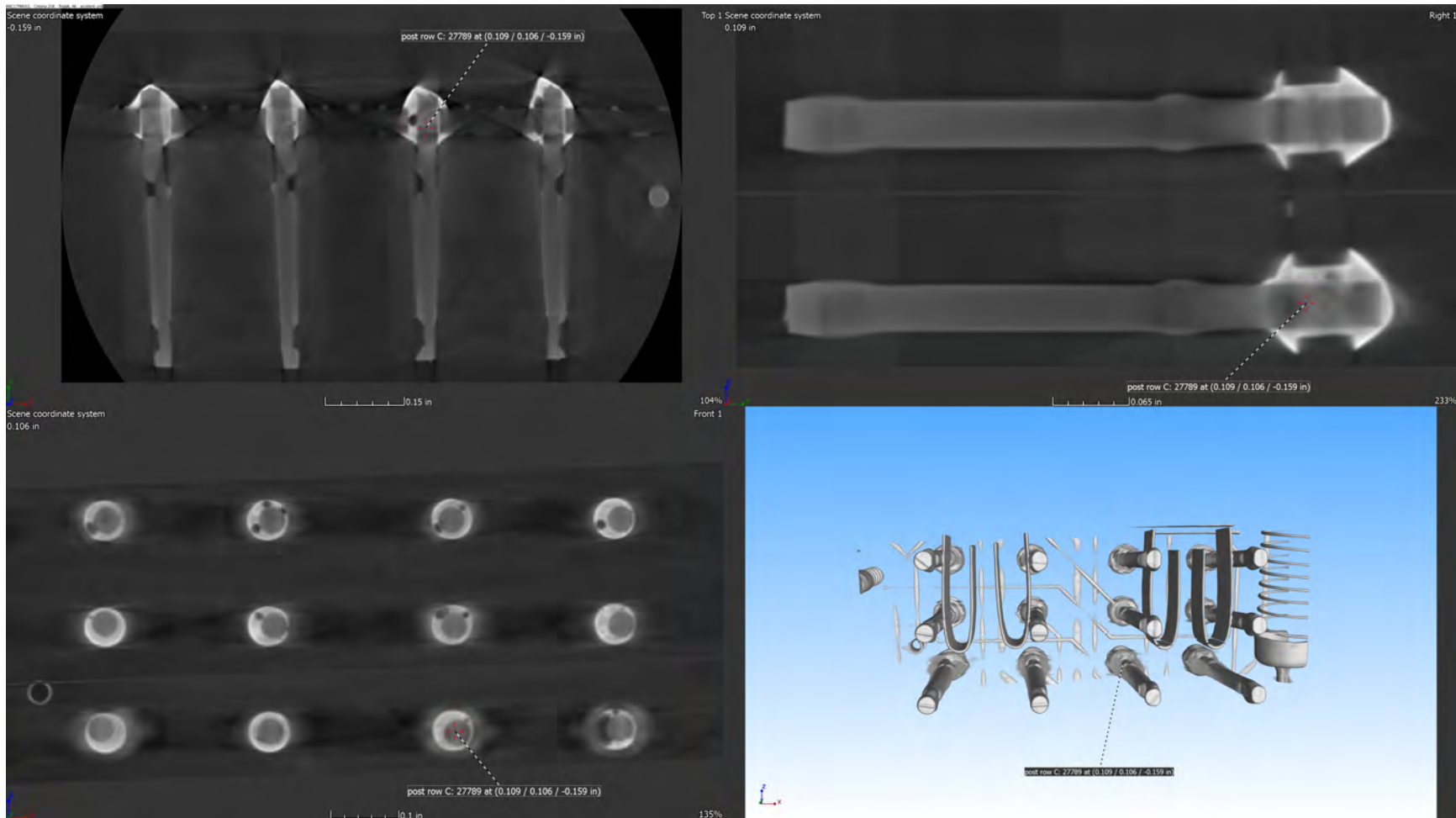


Figure 23
Accident TAAC unit target CT – connection posts – row C with contrast enhanced to show solder joint

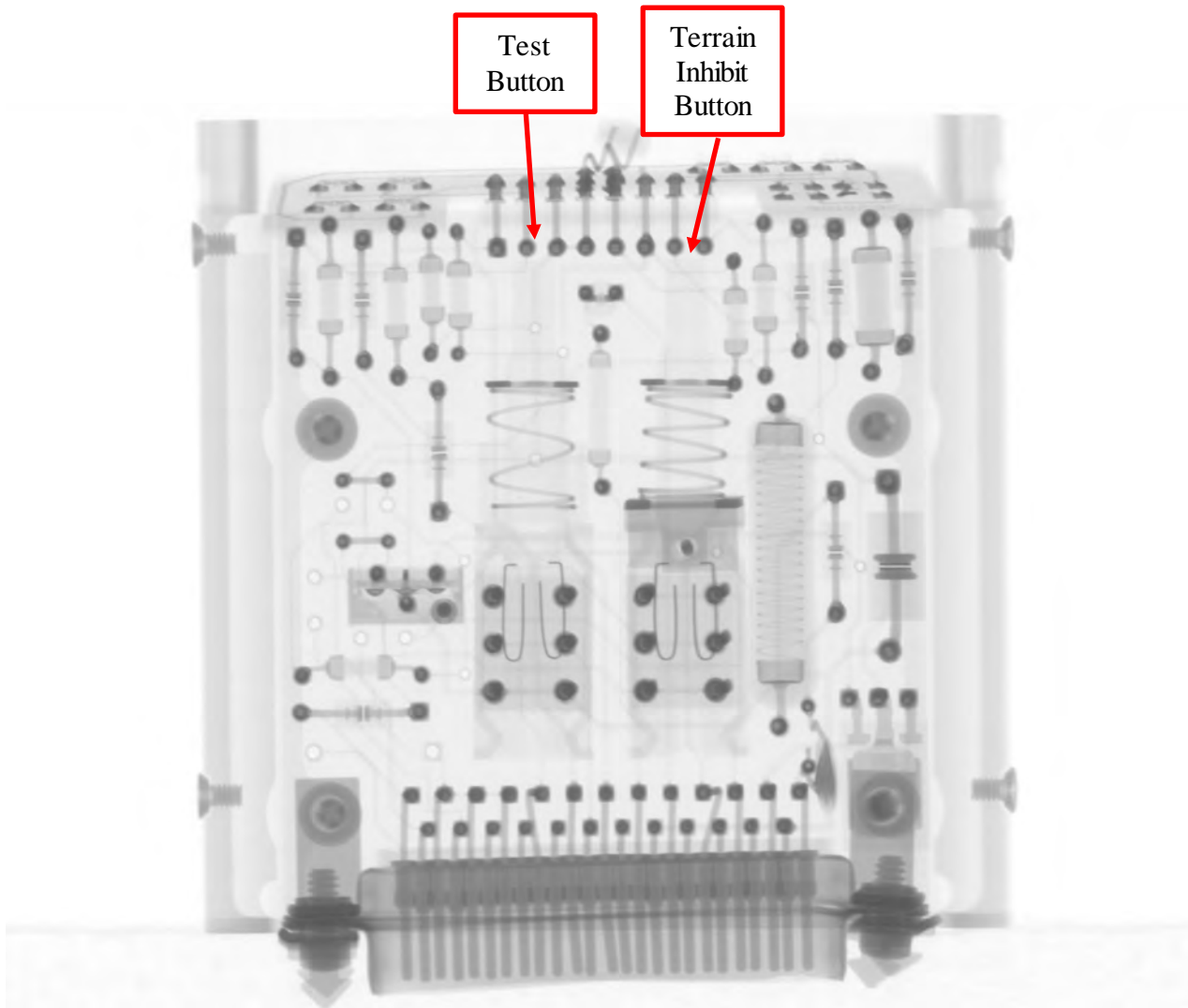


Figure 24
Accident TAAC unit digital radiograph – overview

Scott Warren
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