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

April 20, 2018

Computed Tomography Specialist's Factual Report

DCA17LA182

A. ACCIDENT

Location:	Denver International Airport, Denver, CO
Date:	July 02, 2017
Time:	1319 CDT
Airplane:	Bombardier, Inc. CL 600 2C10, N796SK

B. GROUP

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

C. SUMMARY

On July 02, 2017, about 1319 CDT, a BOMBARDIER INC CL 600 2C10 airplane, N796SK, experienced a left engine undercowl fire following landing and thrust reverser stow at Denver International Airport, Denver, CO. The flight crew reported that a L ENG SRG OPEN caution indicated followed by a L ENG FIRE warning. Discharge of both fire extinguishing bottles did not extinguish the fire. The cabin crew reported the smell, but not the presence of, smoke in the cabin. Fire was observed at the left engine inlet, left engine aft pylon, and on the ground below the left nacelle. The passengers were evacuated to the taxiway through the main cabin door. There were no injuries. Thermal damage to the airplane was substantial. The fire was extinguished by airport rescue and fire fighting (ARFF). The flight was conducted under the provisions of 14 Code of Federal Regulations Part 121. Visual meteorological conditions prevailed. A Federal Aviation Administration (FAA) flight plan had been filed for the flight.

The internal configurations of the left and right bleed operability valve supply ports, return ports, and drain ports were documented using radiographic images that were collected from June 14 - 21, 2017 in Chicago, Illinois. A total of 15,998 computed tomography (CT) slice images were examined, processed, and analyzed by the NTSB to evaluate the components.

Review of the images indicated that, when the scans were conducted, the following items were noted:

Left supply port:
- there were areas of distorted threads, absent threads, and missing wall material present at various locations within the left supply port;
- there was an area of raised material located on the left supply port wall between the conical seal surface and the threads;

Left return port, left drain port, right supply port, and right return port:
- there was no damage noted on the port threads, insert threads, or the lock ring teeth;

Right drain Port:
- there was no damage noted on the port threads, insert threads, or the lock ring teeth;
- there was medium density material noted between the port material and the insert collar.

D. DETAILS OF THE INVESTIGATION

1.0 General

The left and right bleed operability valve supply ports, return ports, and drain ports were subjected to x-ray radiograph and computed tomography (CT) scanning to document their internal conditions. The scanning was conducted from June 14-21, 2017. The scans were performed by Varex, Inc under the direction of the NTSB using the Actis 500/225 microfocus CT system.

For the CT scans, the components were each 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 15,998 slices, and the total size of the combined data sets was approximately 125 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	Left Supply Port	Left Return Port	Left Drain Port	Right Supply Port	Right Return Port	Right Drain Port
Number of slices	1716	3355	2392	2870	3314	2351
Voxel Size - X Direction (mm)	0.022	0.022	0.022	0.022	0.022	0.022
Voxel Size - Y Direction (mm)	0.022	0.022	0.022	0.022	0.022	0.022
Voxel Size - Z Direction (mm)	0.014	0.01	0.014	0.01	0.014	0.014
Image Projections per Revolution	2520	2520	2520	2520	2520	2520
Exposure time (ms)	285.58	285.58	285.58	285.58	285.58	285.58
Frames to Avg (frames per projection)	3	3	3	3	3	3
X-ray Source Voltage (kV)	222	222	222	222	222	222
X-ray Source Current (mA)	0.700	0.700	0.700	0.700	0.700	0.700
Source Filter Thickness (mm)	1	1	1	1	1	1
Source Filter Material	Brass	Brass	Brass	Brass	Brass	Brass
Image Matrix Size	2048 x 2048	2048 x 2048	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.

In some images, cylindrical structures were "virtually unrolled" using the 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.

The images of the components were examined for any signs of missing or damaged areas, 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 33[1]. Review of the images indicated that, when the scans were conducted, the following items were noted:

Left supply port:
- there were areas of distorted threads, absent threads, and missing wall material present at various locations within the left supply port;
- there was an area of raised material located on the left supply port wall between the conical seal surface and the threads;

Left return port, left drain port, right supply port, and right return port:
- there was no damage noted on the port threads, insert threads, or the lock ring teeth;

Right drain Port:
- there was no damage noted on the port threads, insert threads, or the lock ring teeth;
- there was medium density material noted between the port material and the insert collar.

[1] When the figures for this report were created, the NTSB accident number was ENG17IA032, and this number was used in the header for each image. Subsequent to the images being produced, the NTSB accident number was changed to DCA17LA182.

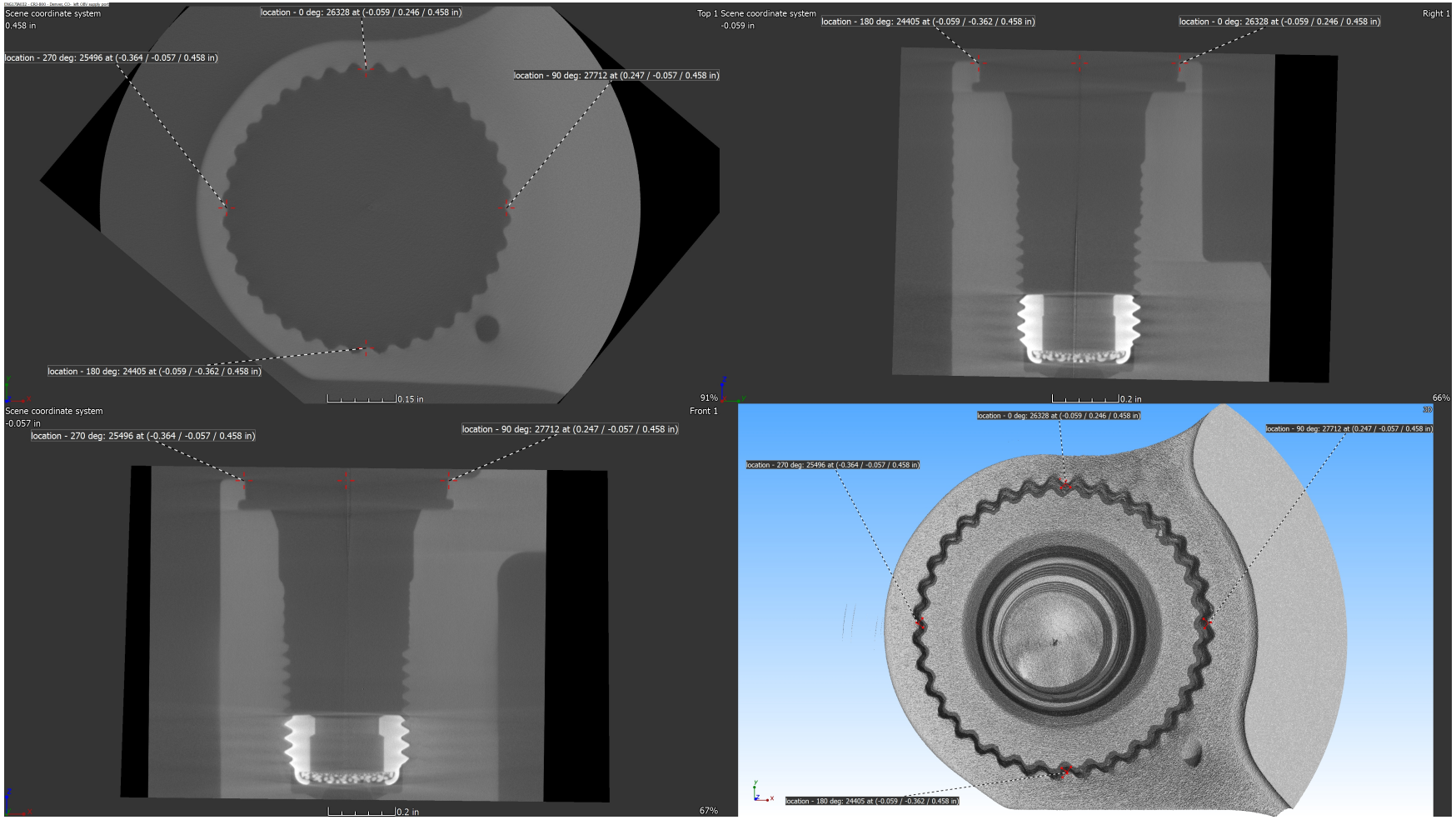


Figure 1
Left supply port – overall view

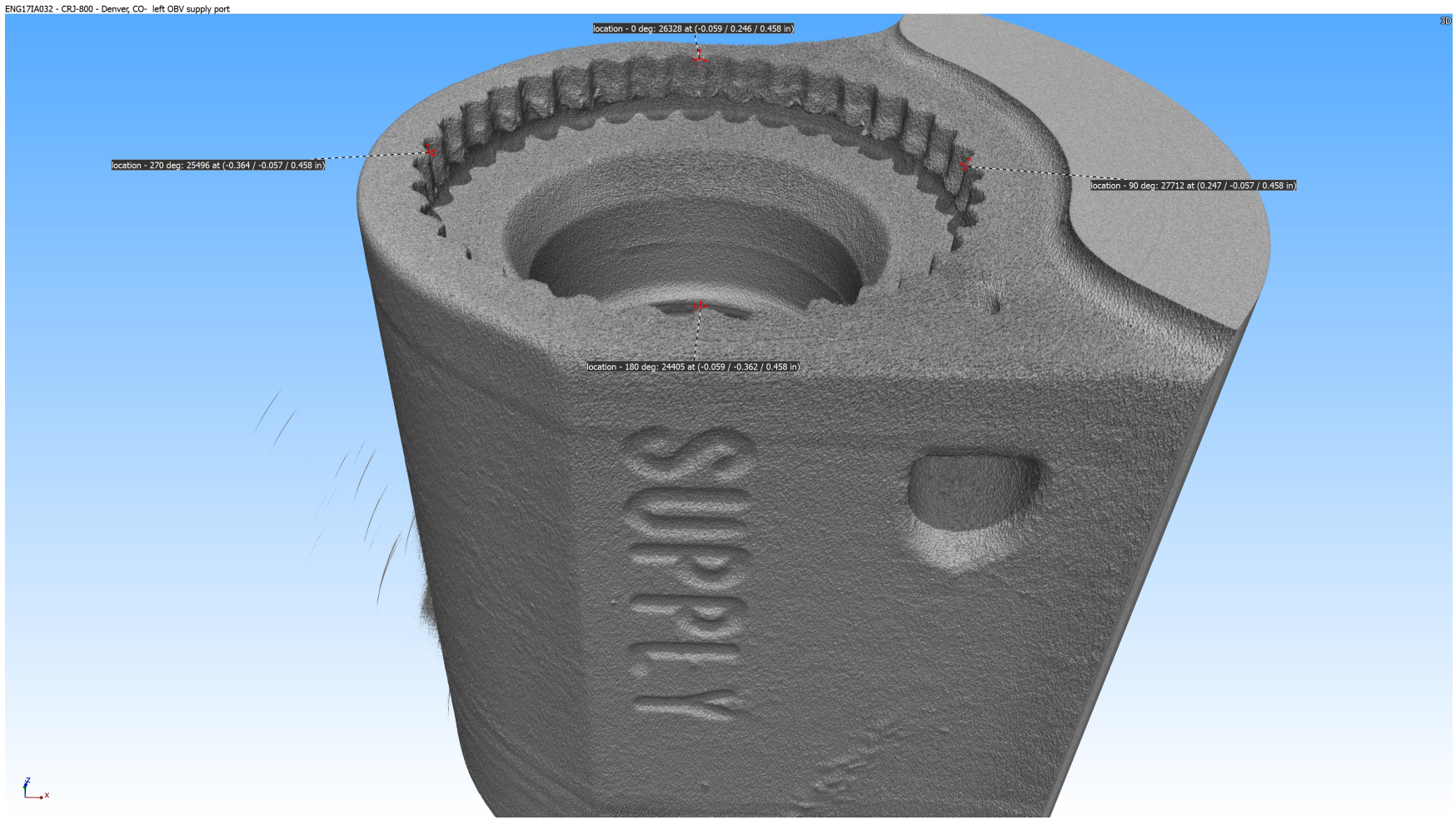


Figure 2
Left supply port – overall view showing supply imprint and orientation nomenclature

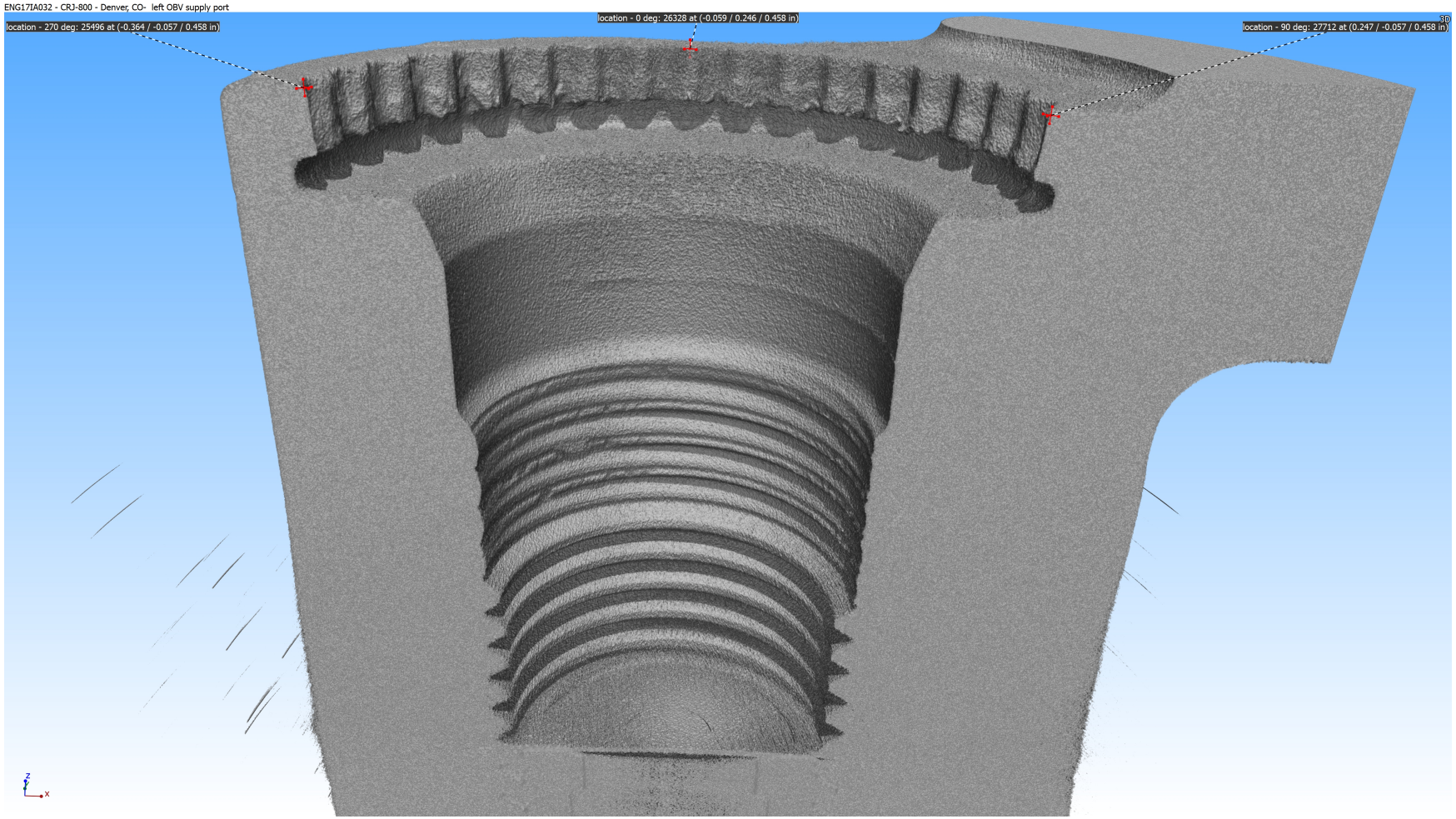


Figure 3
Left supply port – view centered on 0 deg

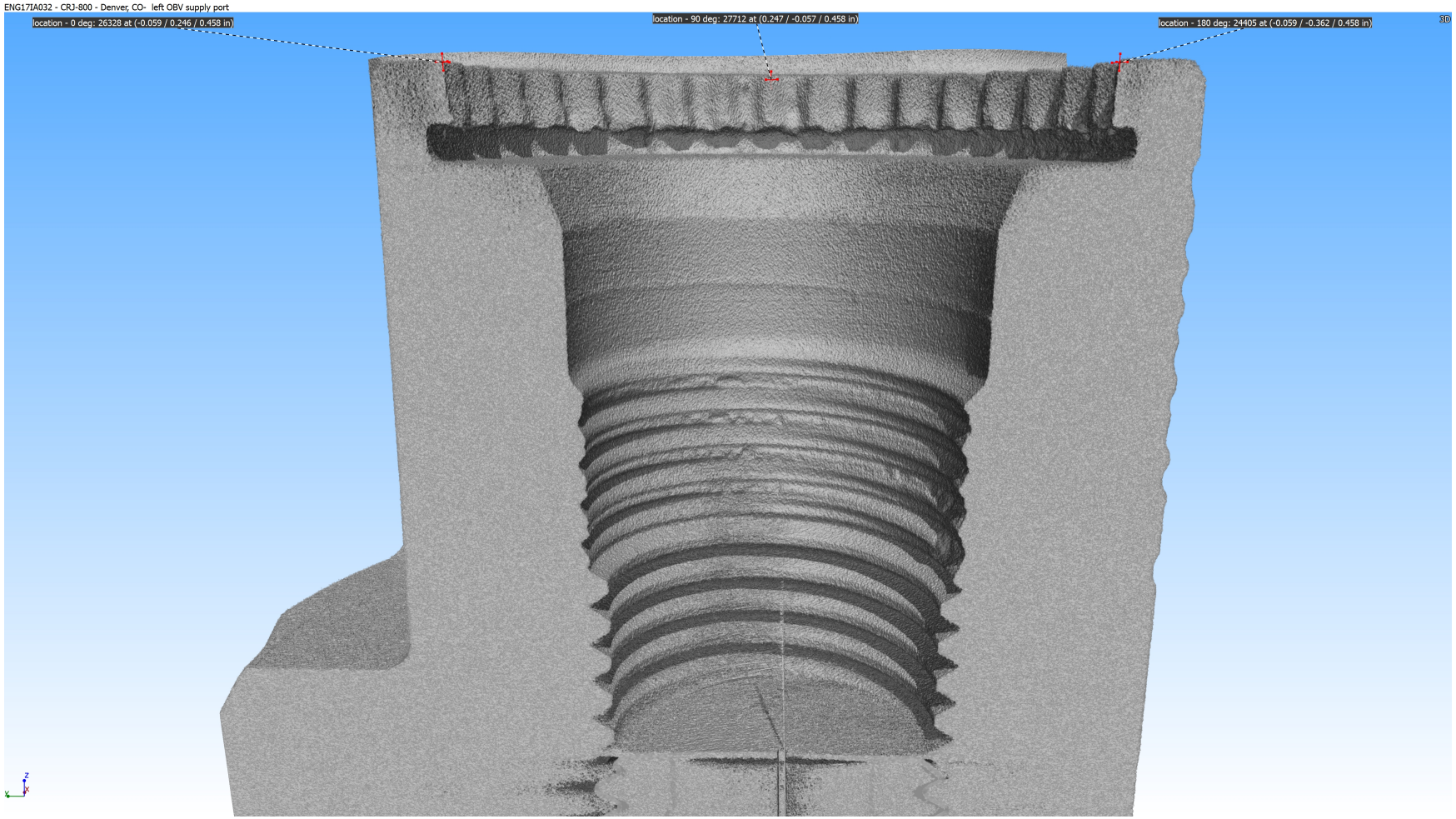


Figure 4
Left supply port – view centered on 90 deg

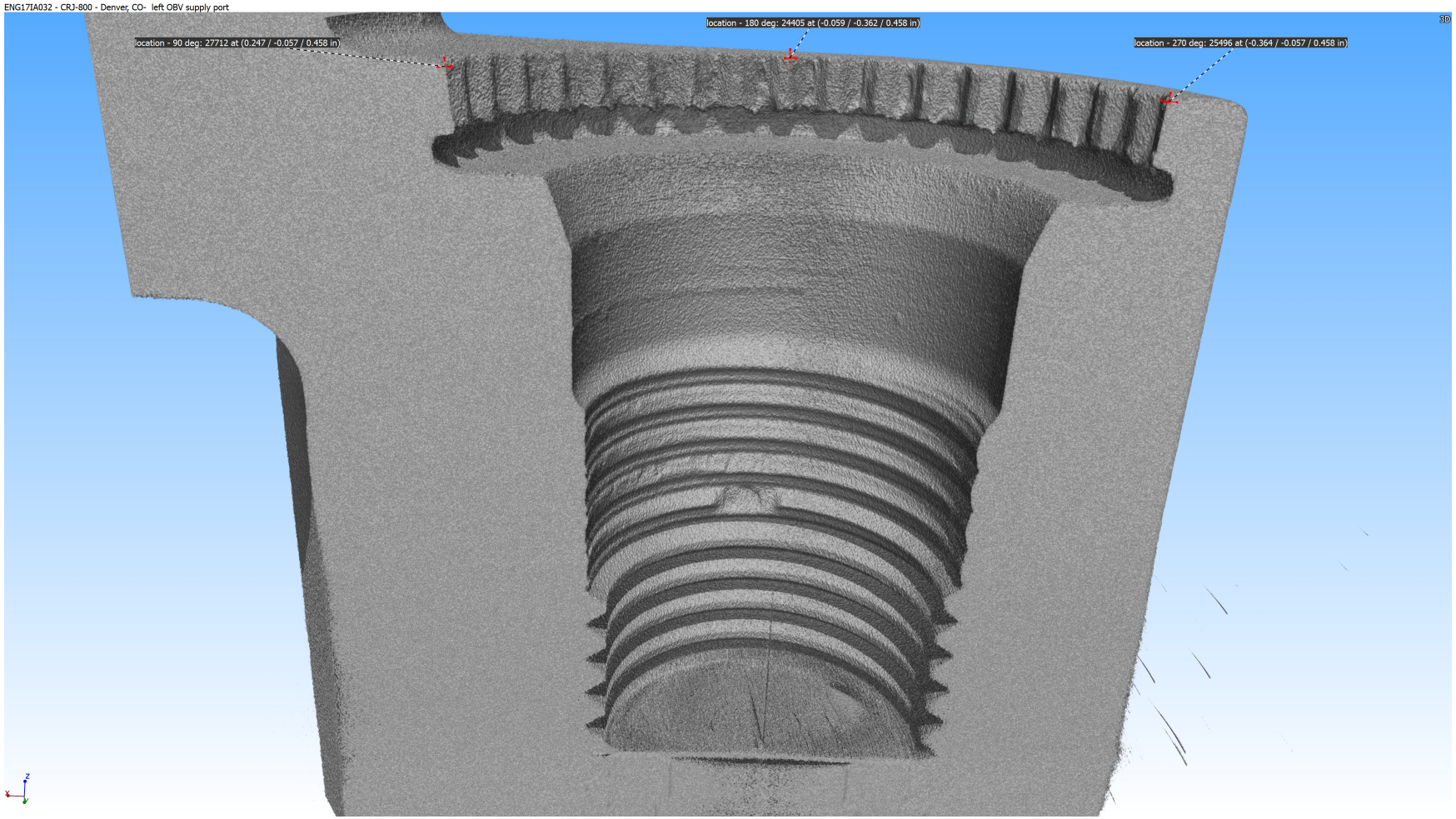


Figure 5
Left supply port – view centered on 180 deg

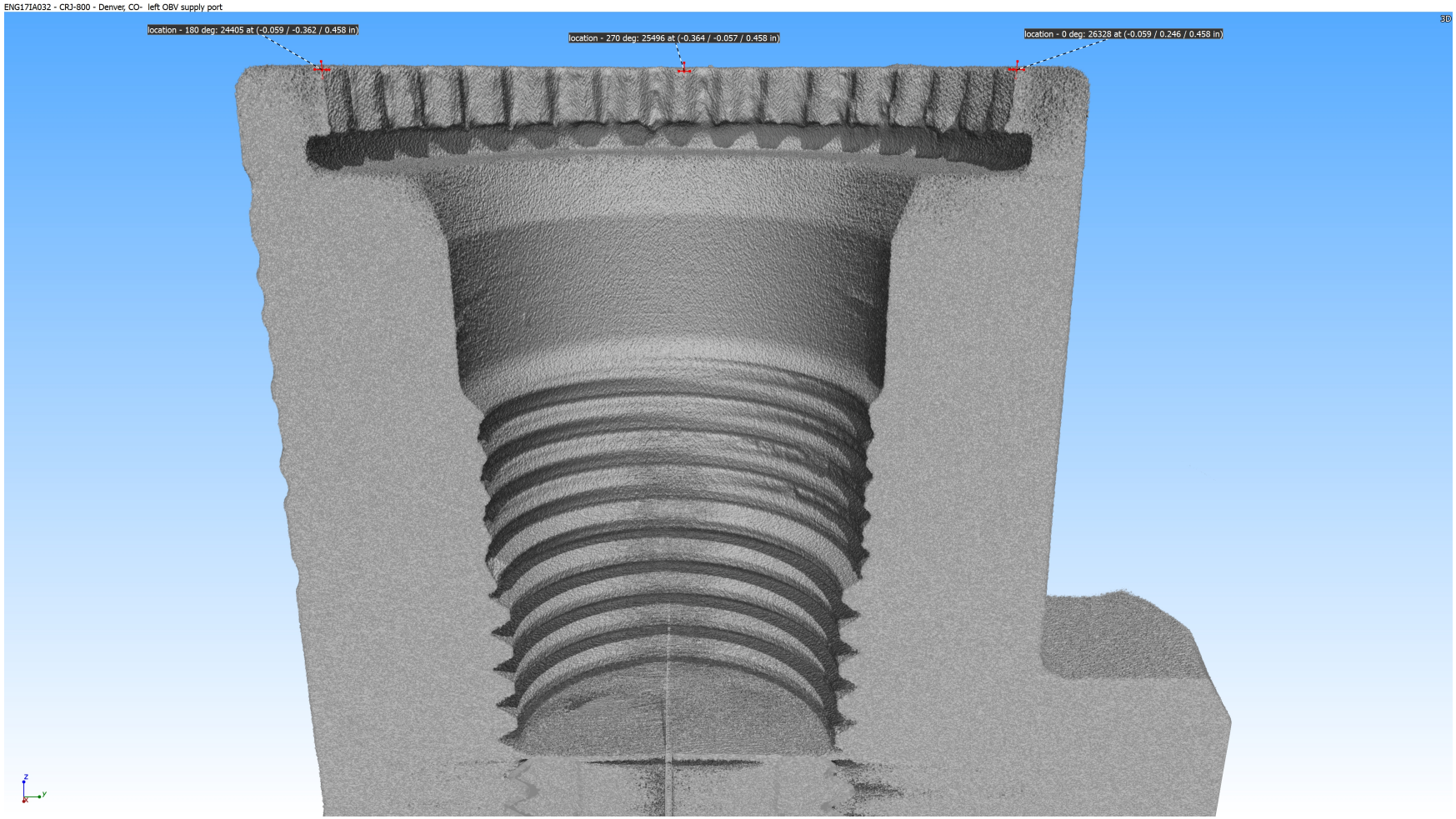


Figure 6
Left supply port – view centered on 270 deg

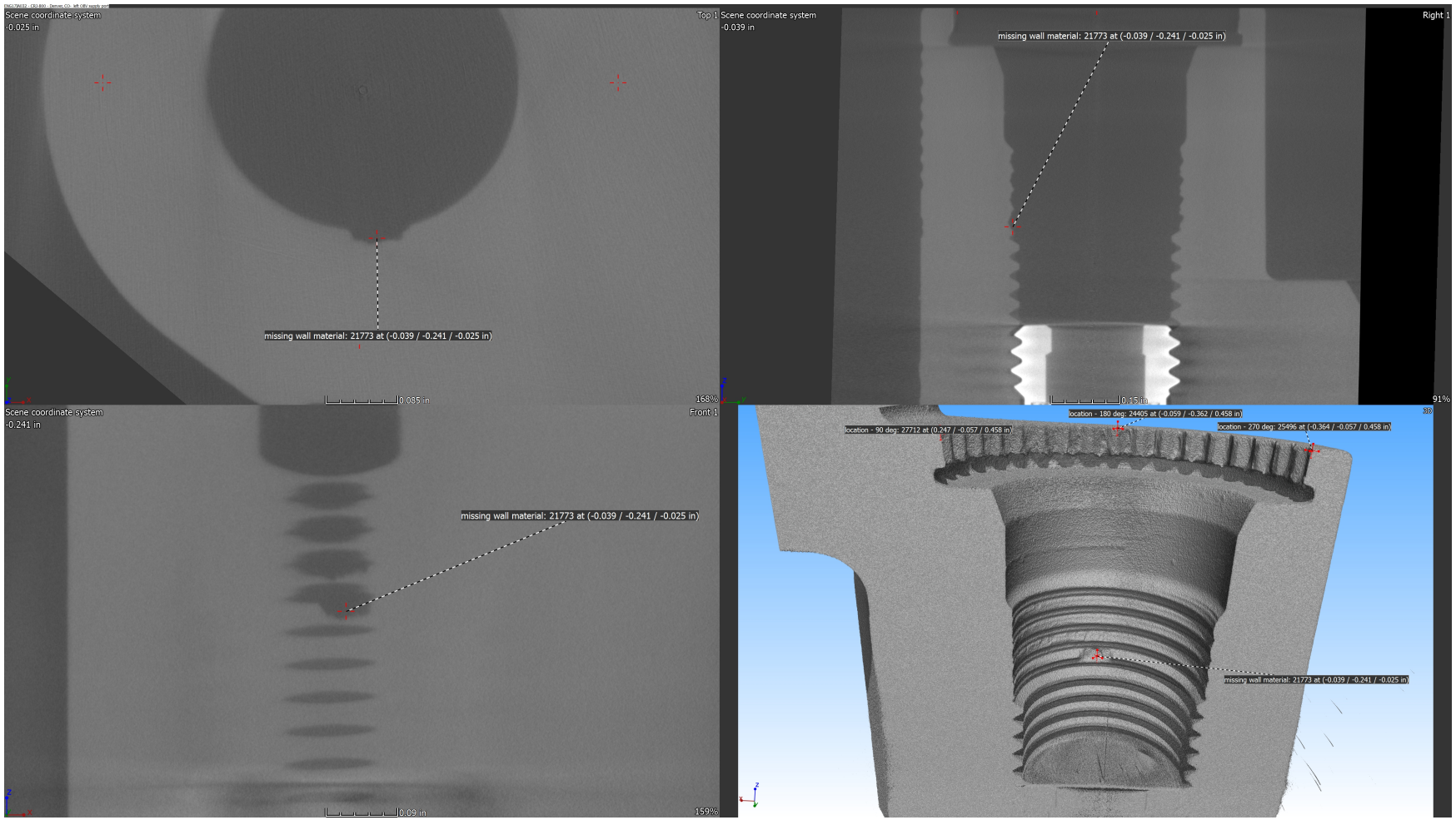


Figure 7
Left supply port – missing wall material

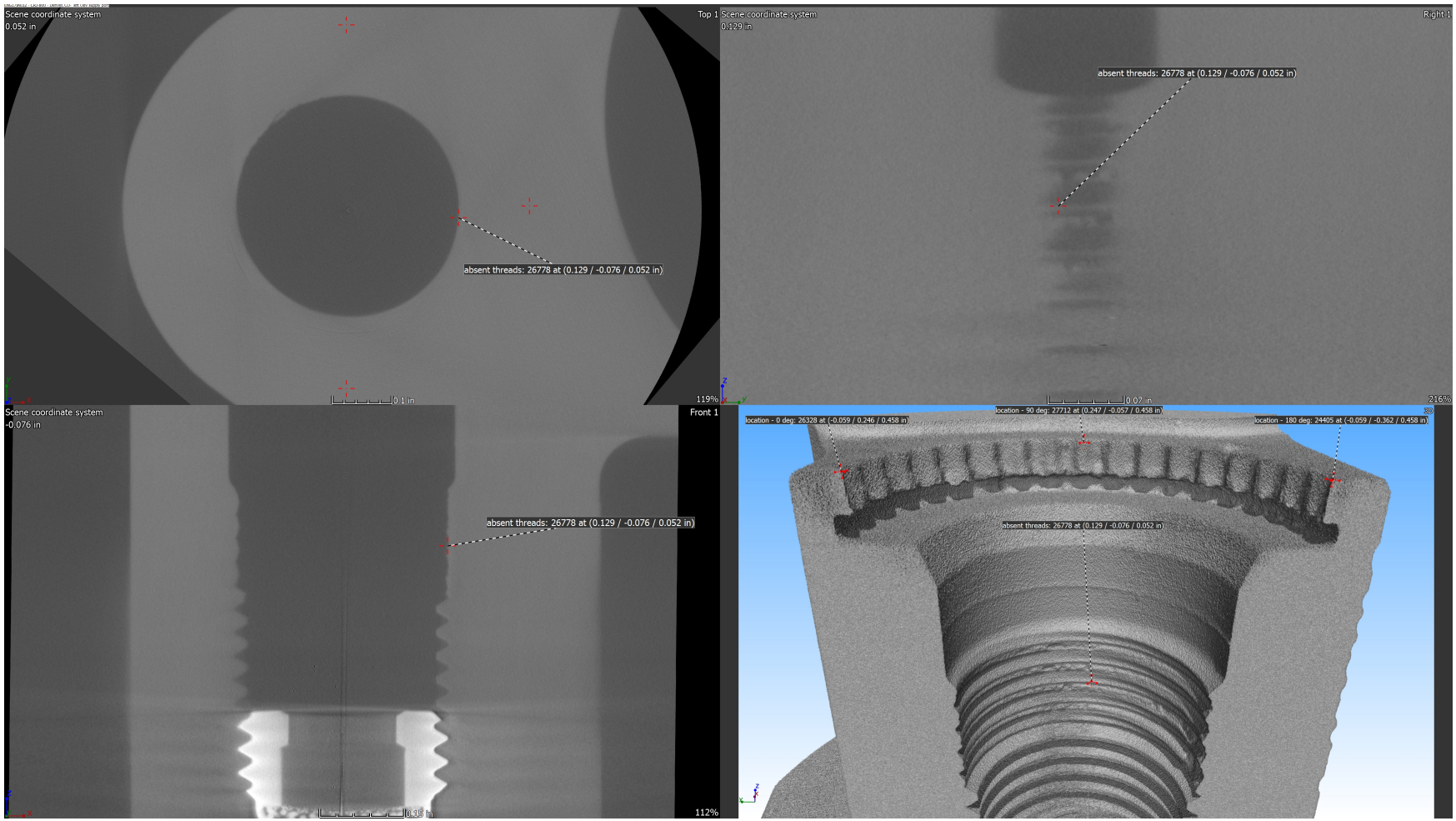


Figure 8
Left supply port – absent threads

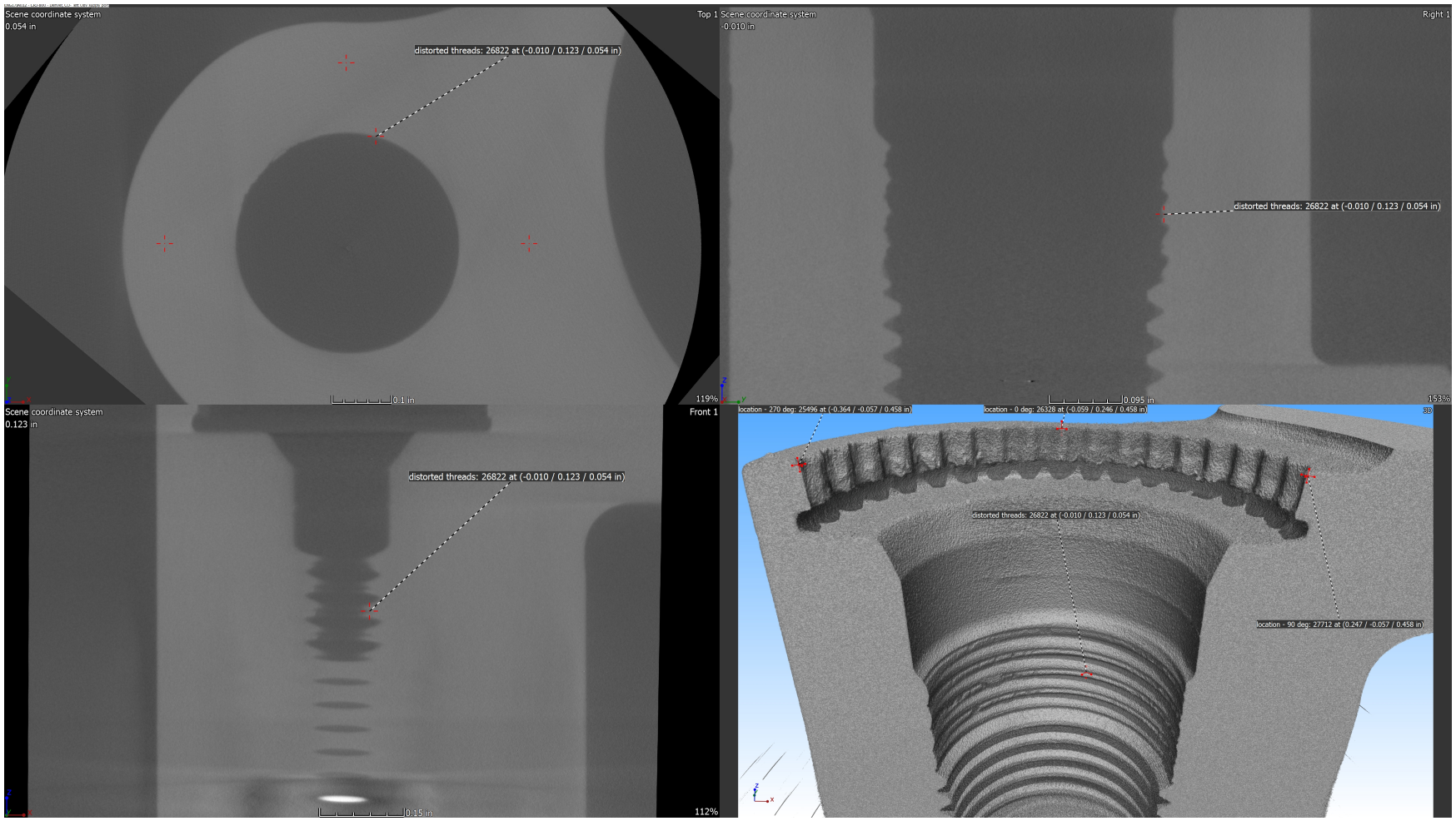


Figure 9
Left supply port – distorted threads

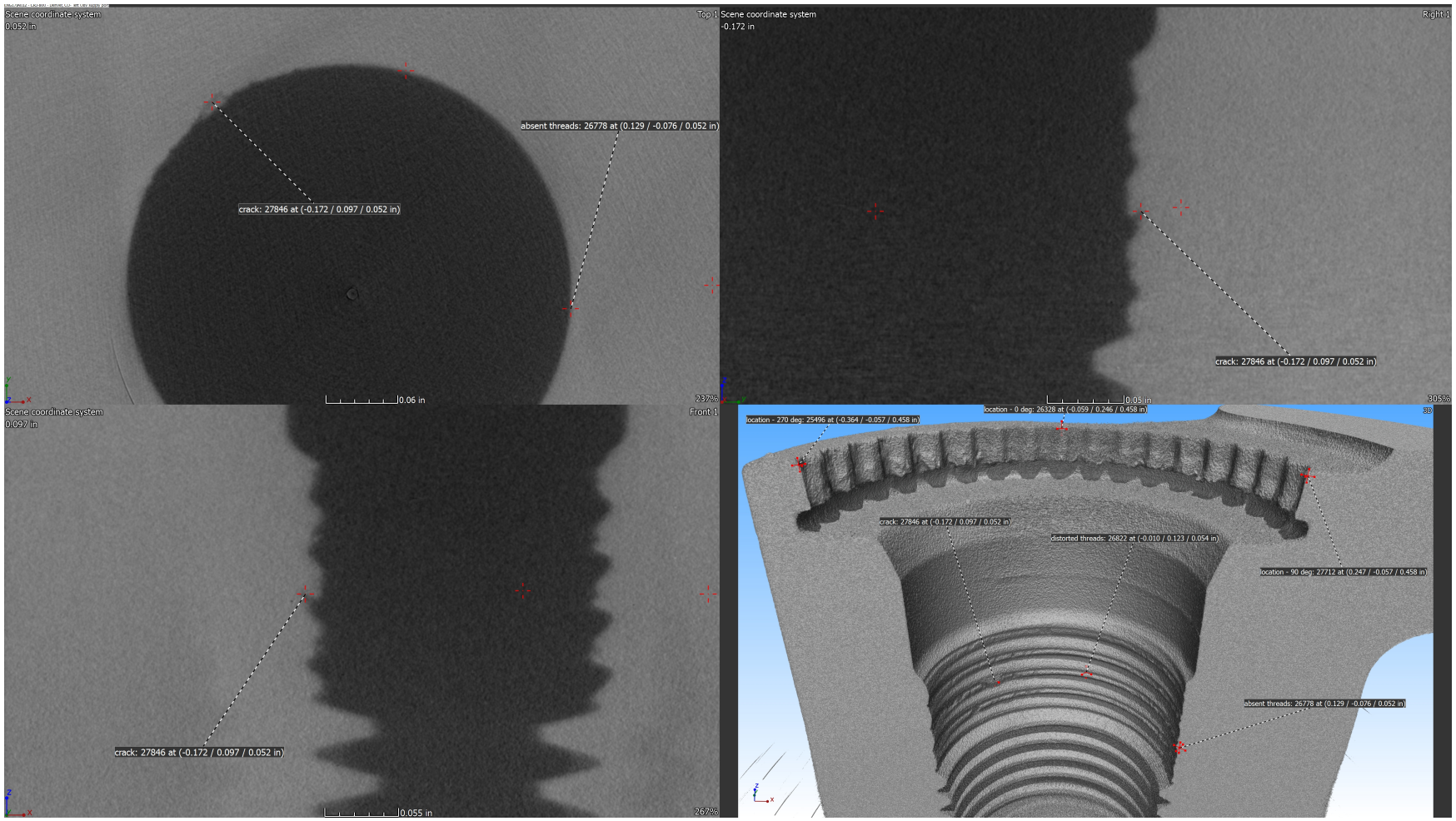


Figure 10
Left supply port – crack

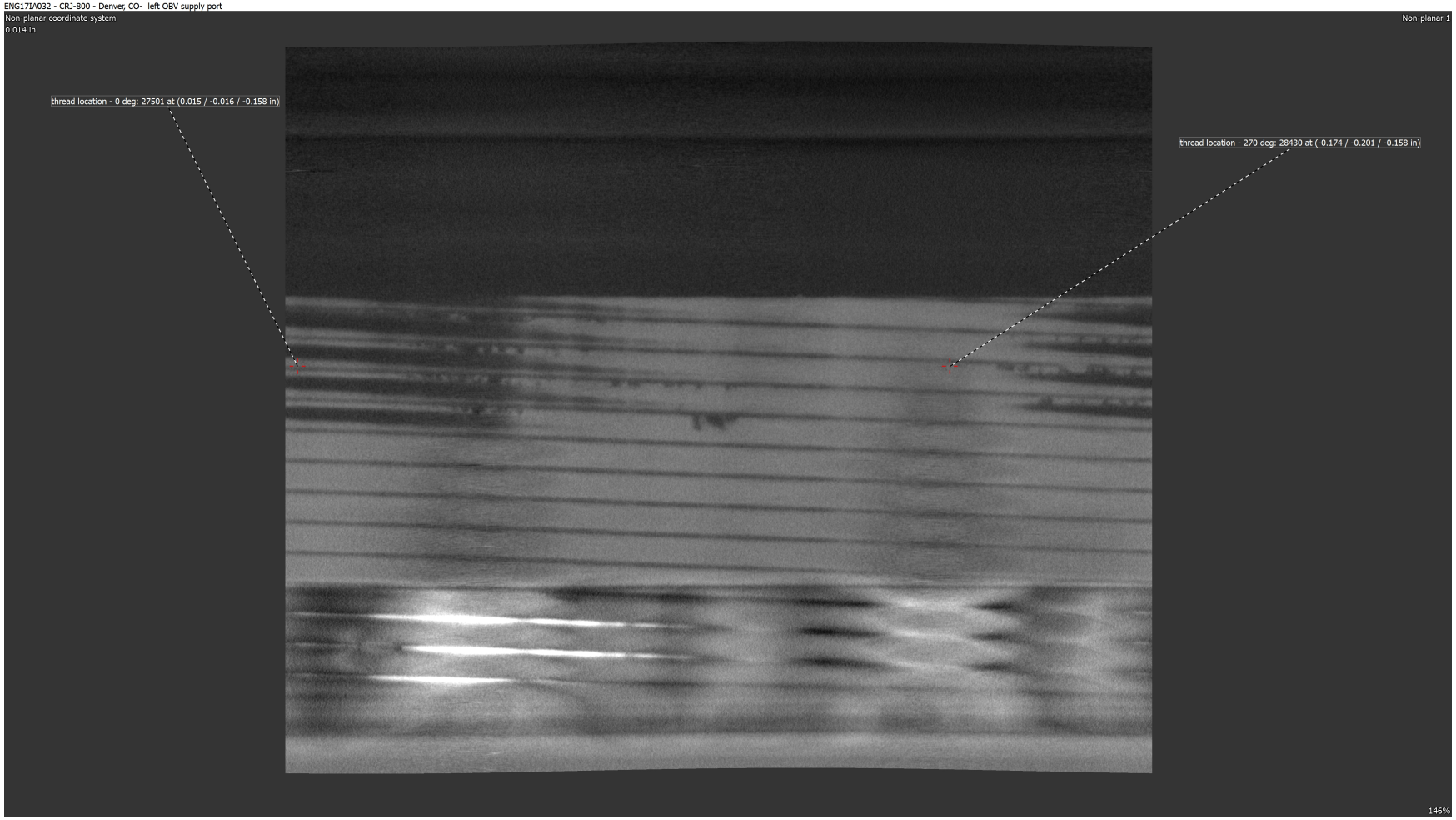


Figure 11
Left supply port – virtually unrolled threads - view 1

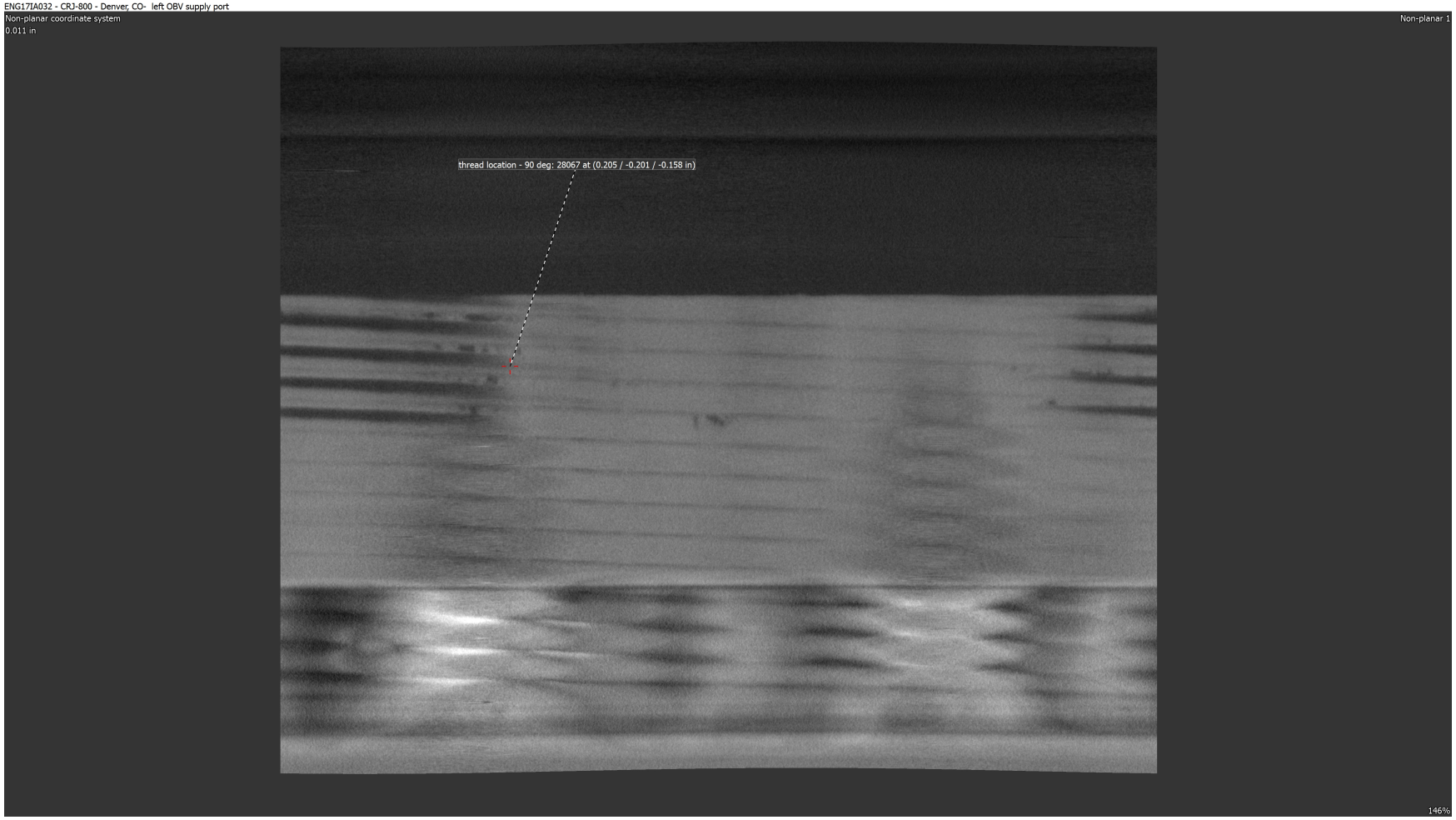


Figure 12
Left supply port – virtually unrolled threads - view 2

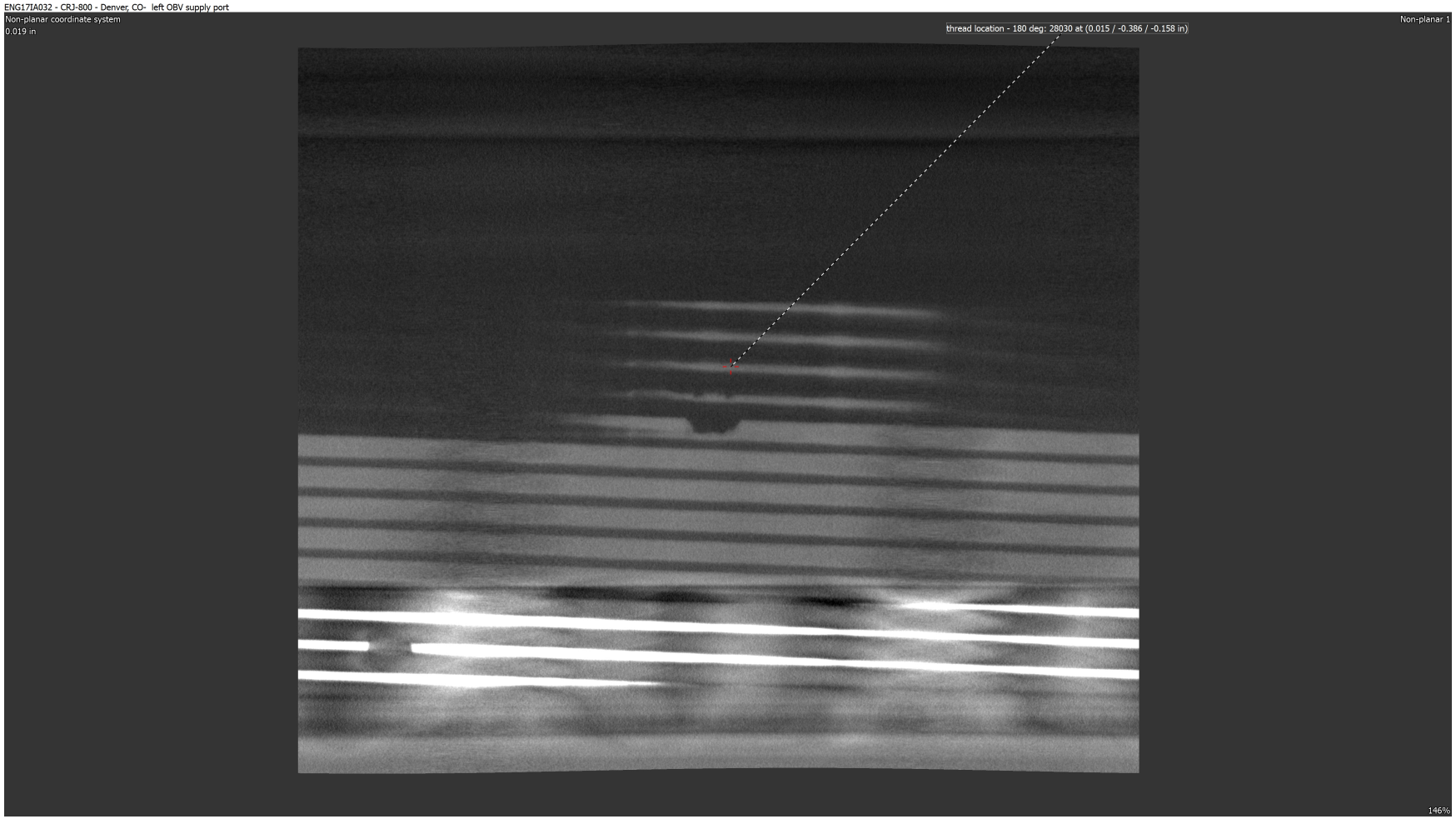


Figure 13
Left supply port – virtually unrolled threads - view 3

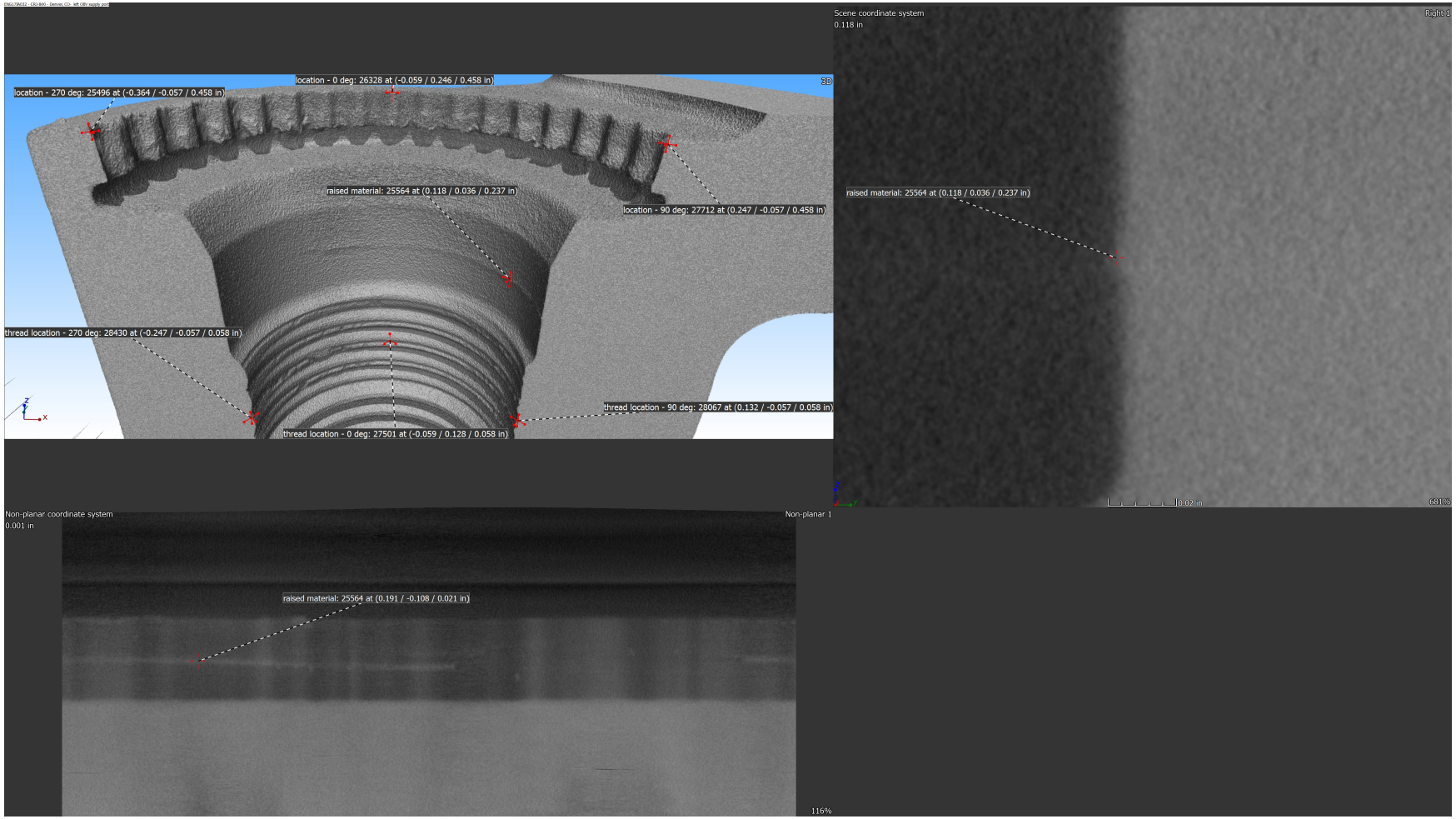


Figure 14
Left supply port – raised material

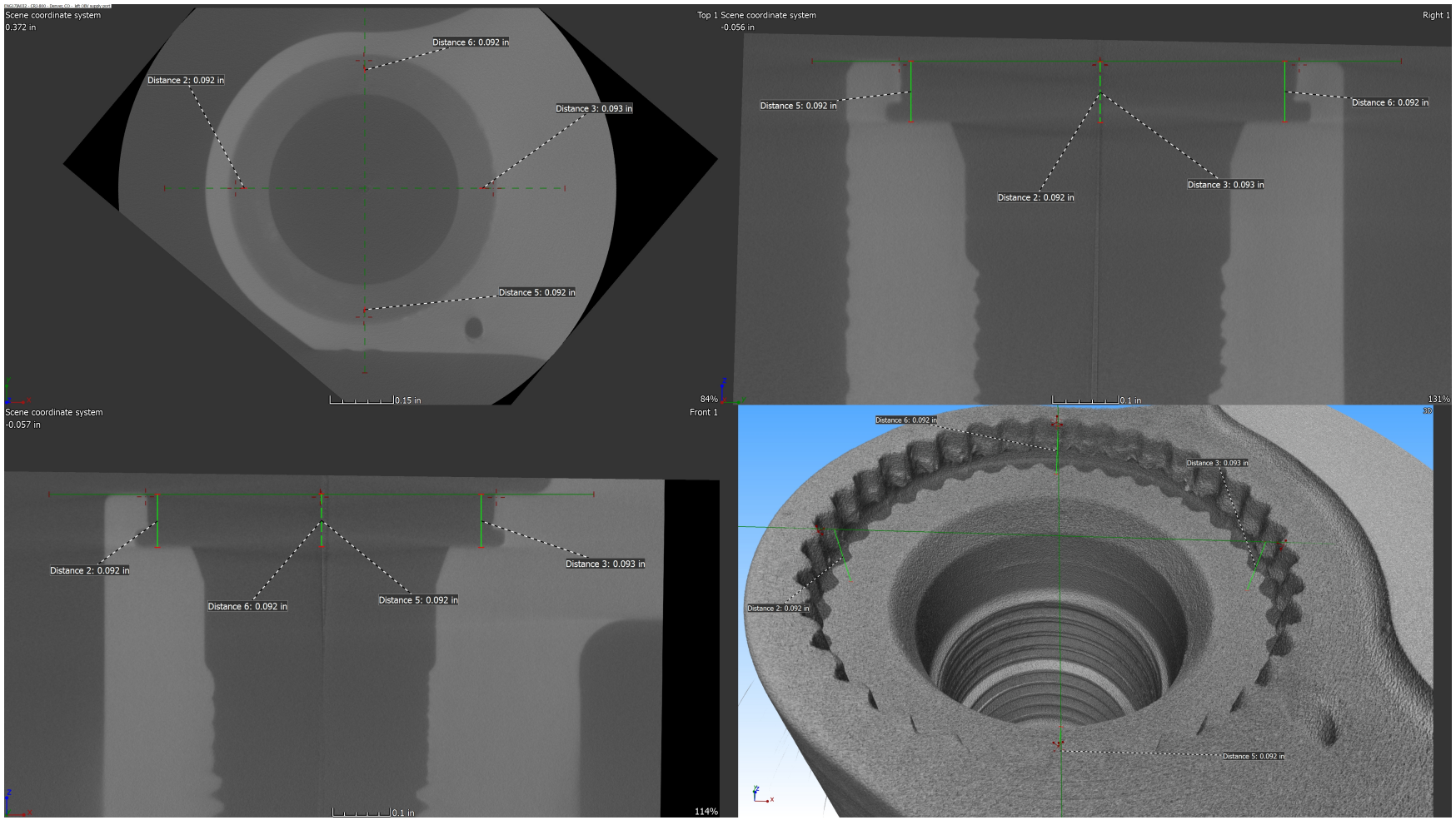


Figure 15
Left supply port – counter bore to port edge dimensions

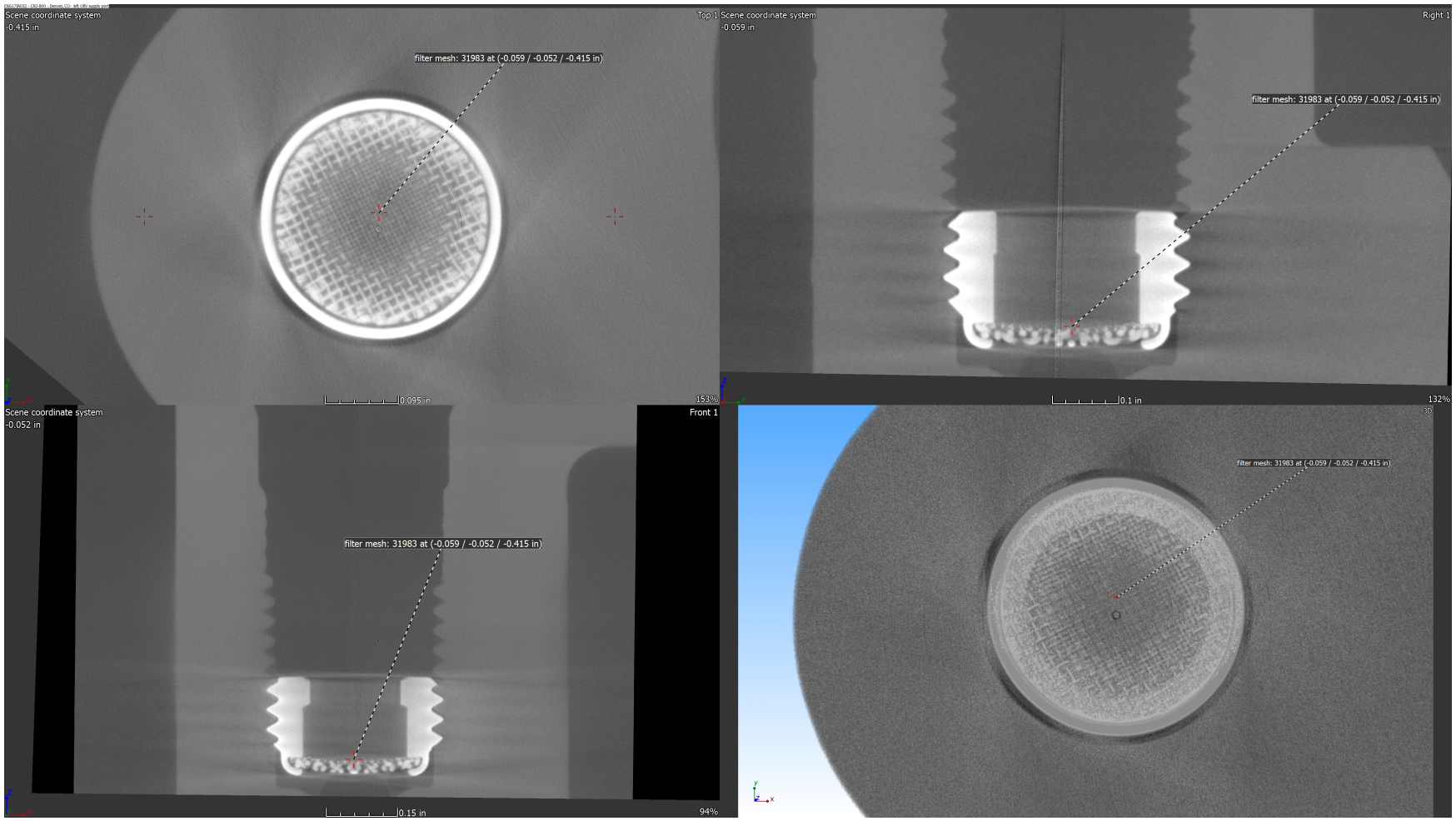


Figure 16
Left supply port – filter mesh

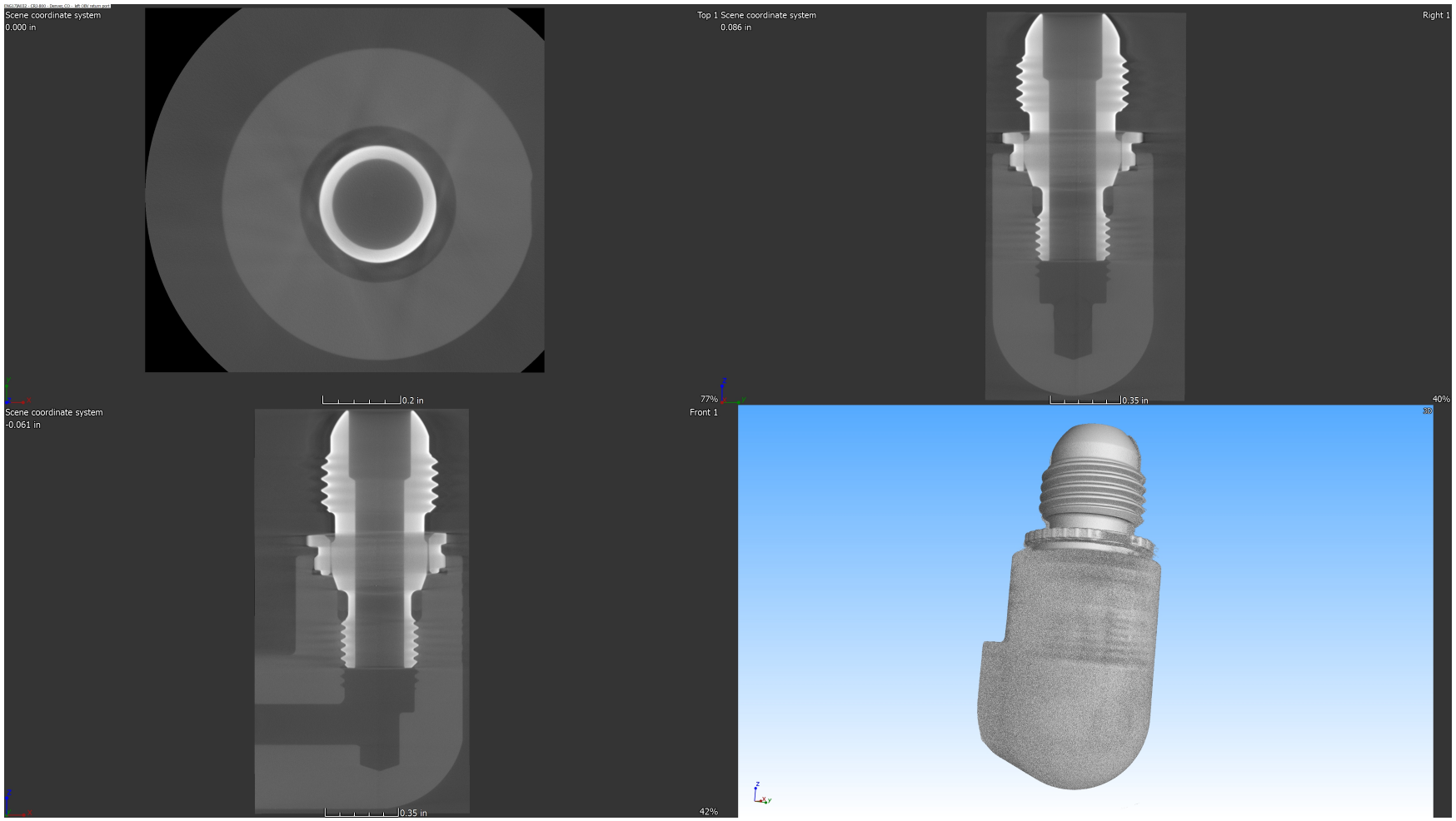


Figure 17
Left return port – overall view

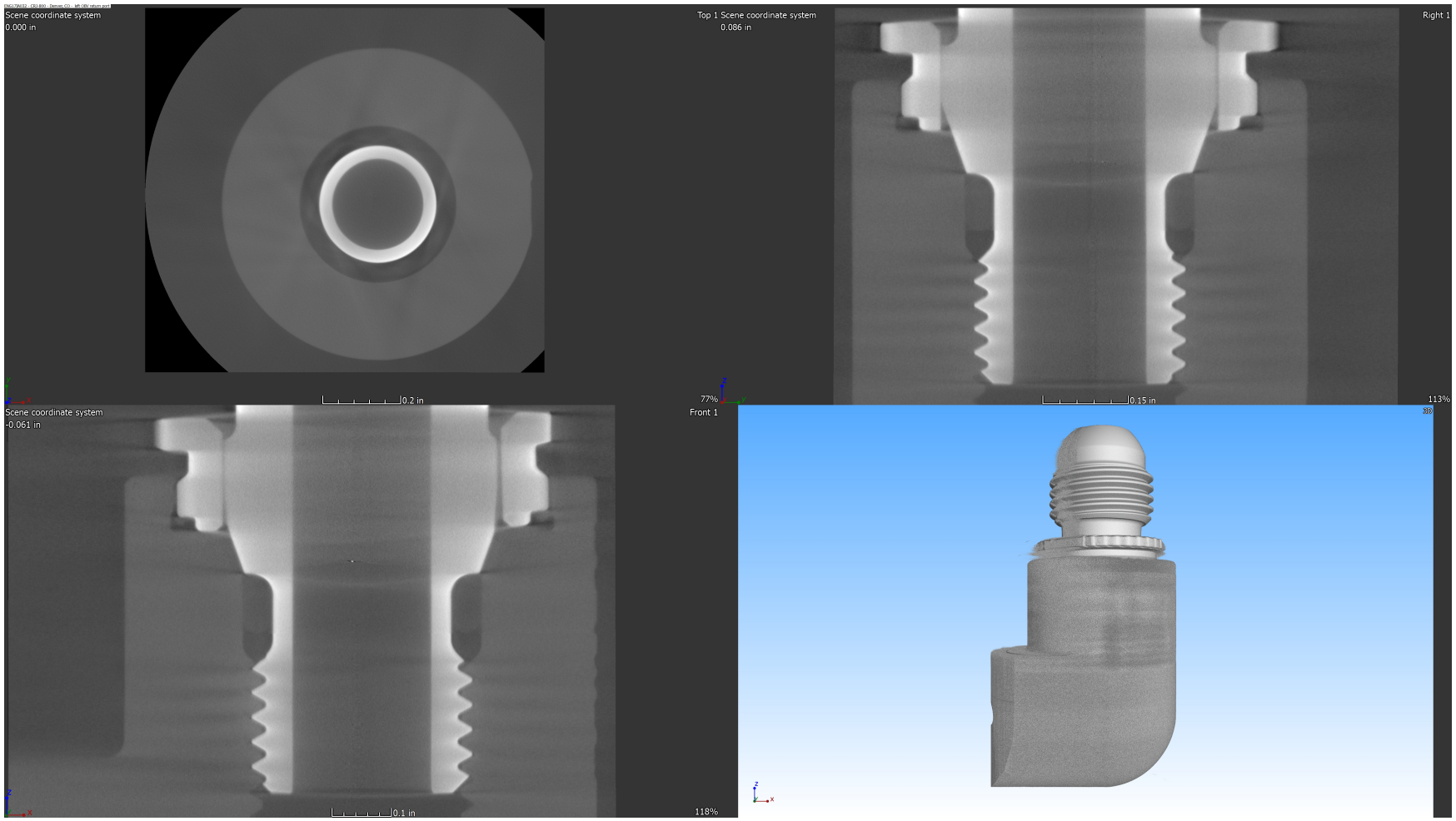


Figure 18
Left return port – threads

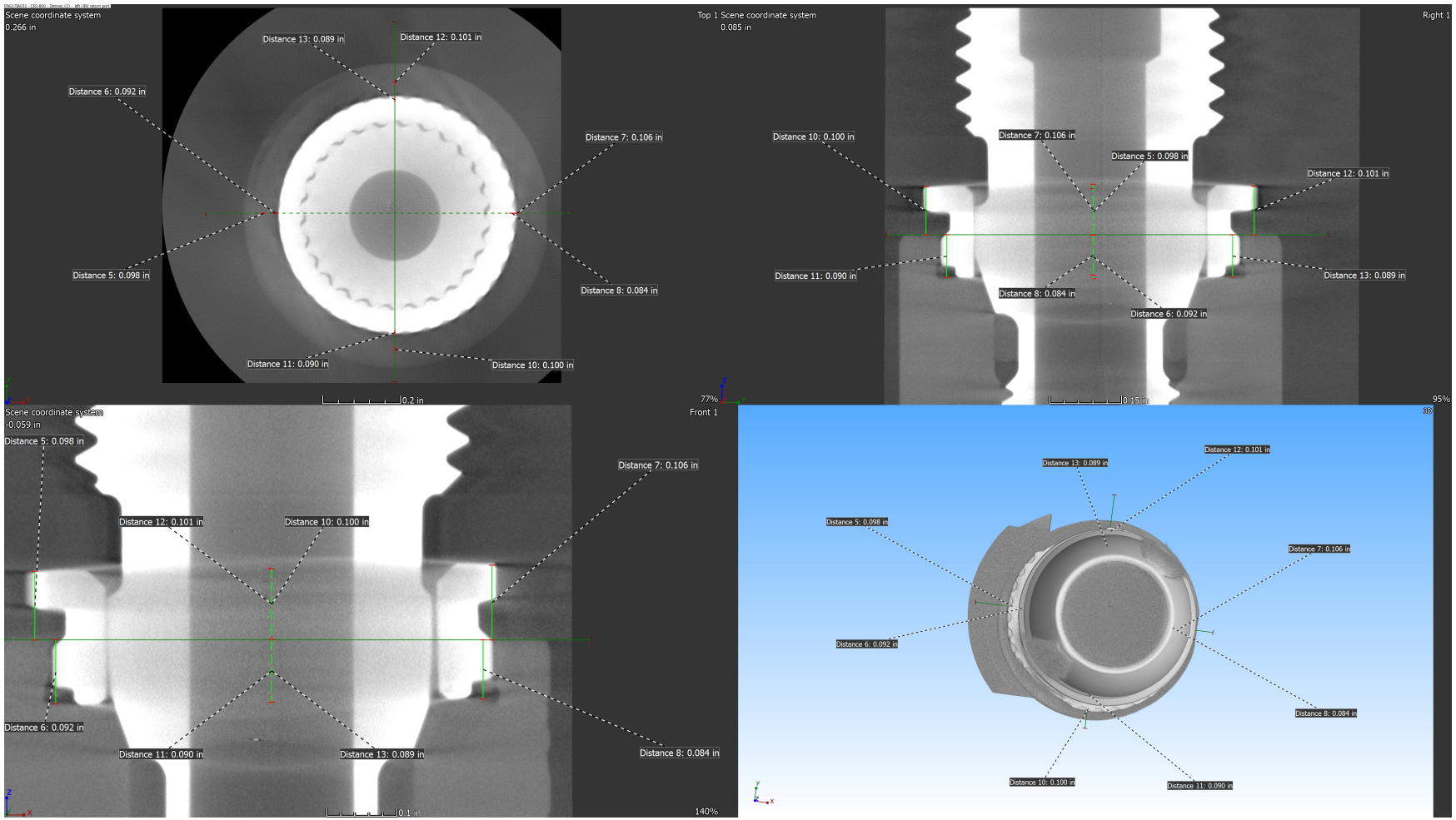


Figure 19
Left return port – collar and counter bore dimensions

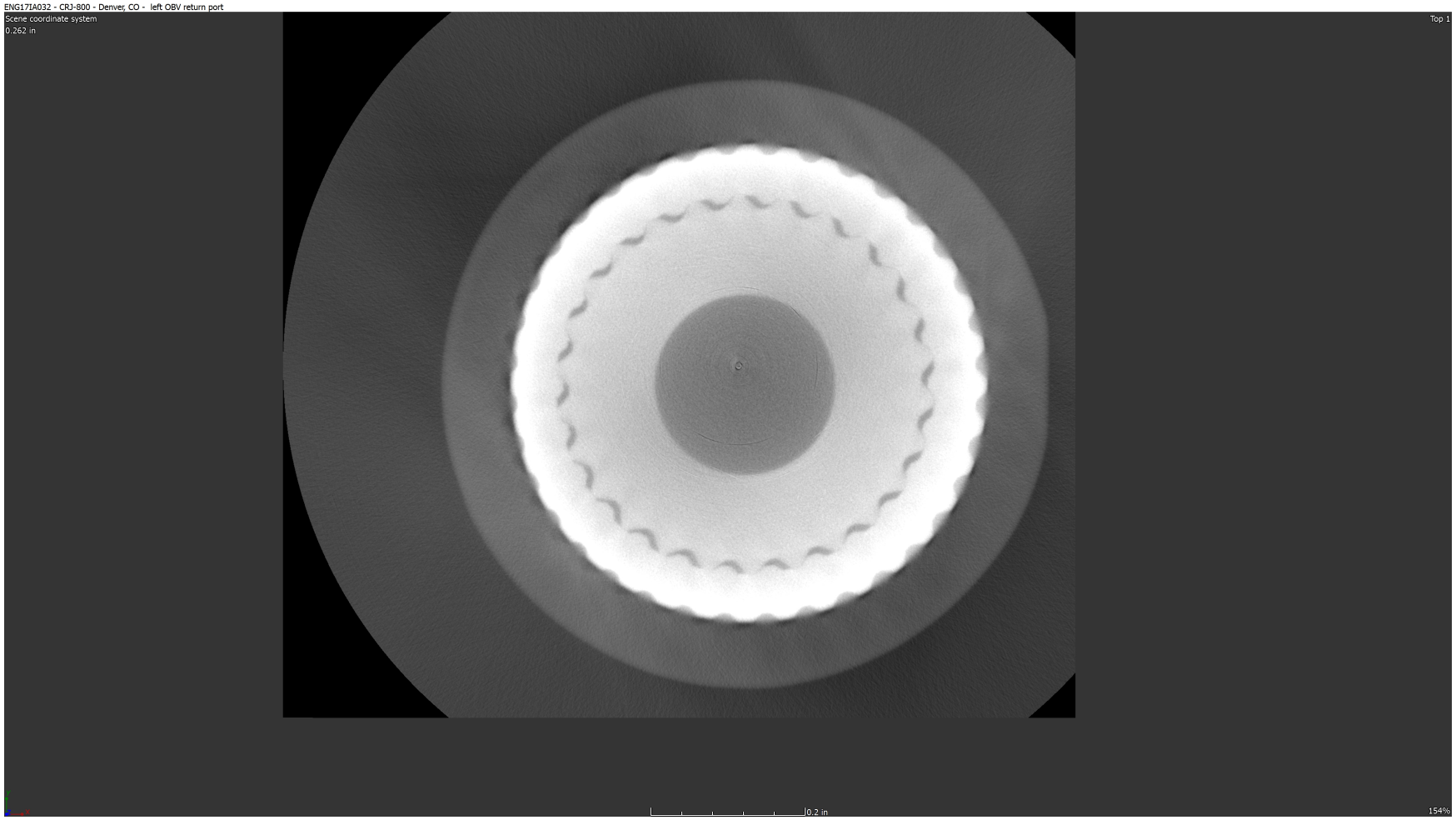


Figure 20
Left return port – spline-collar interaction

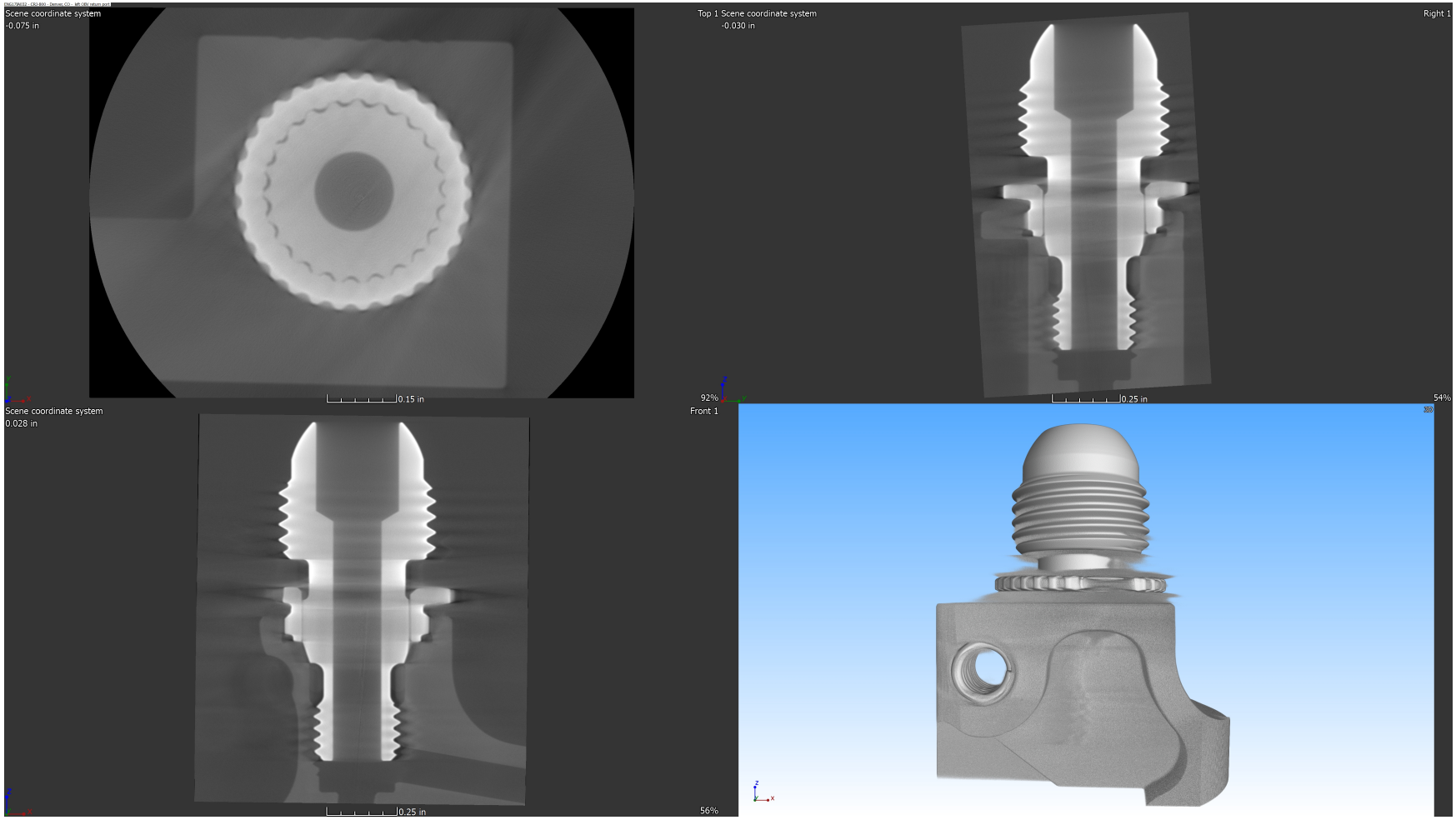


Figure 21
Left drain port – overall view

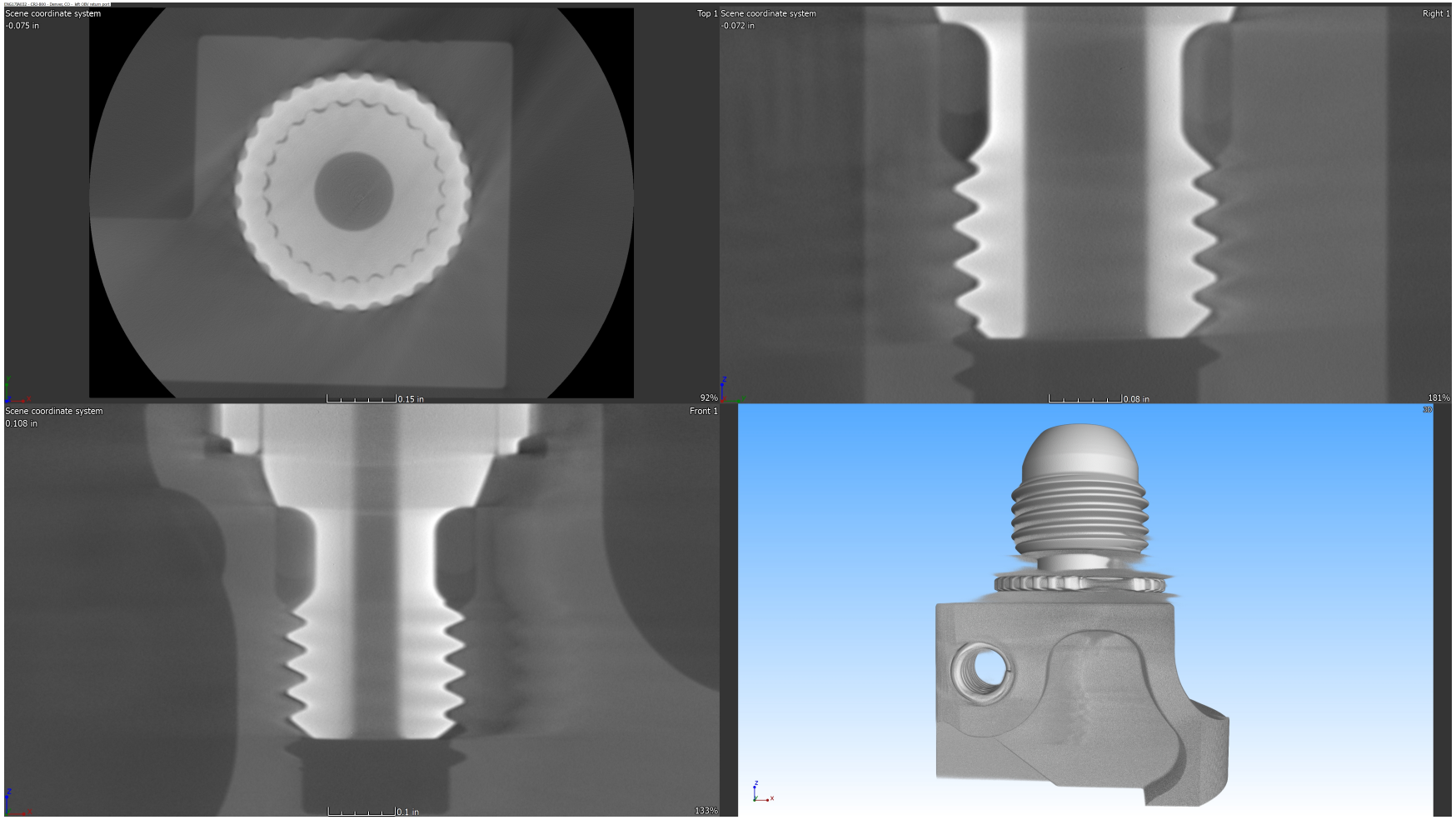


Figure 22
Left drain port – threads

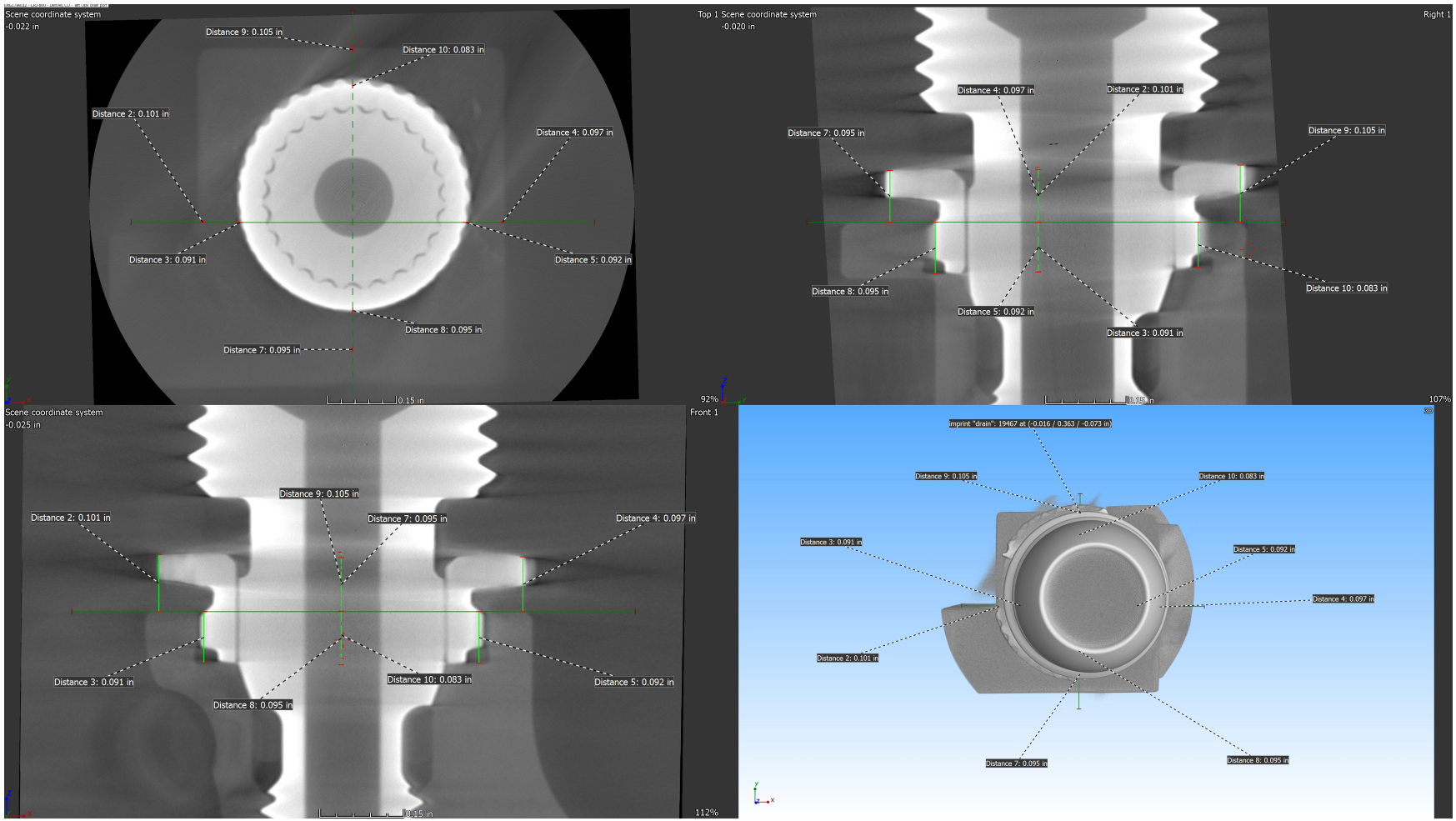


Figure 23
Left drain port – collar and counter bore dimensions

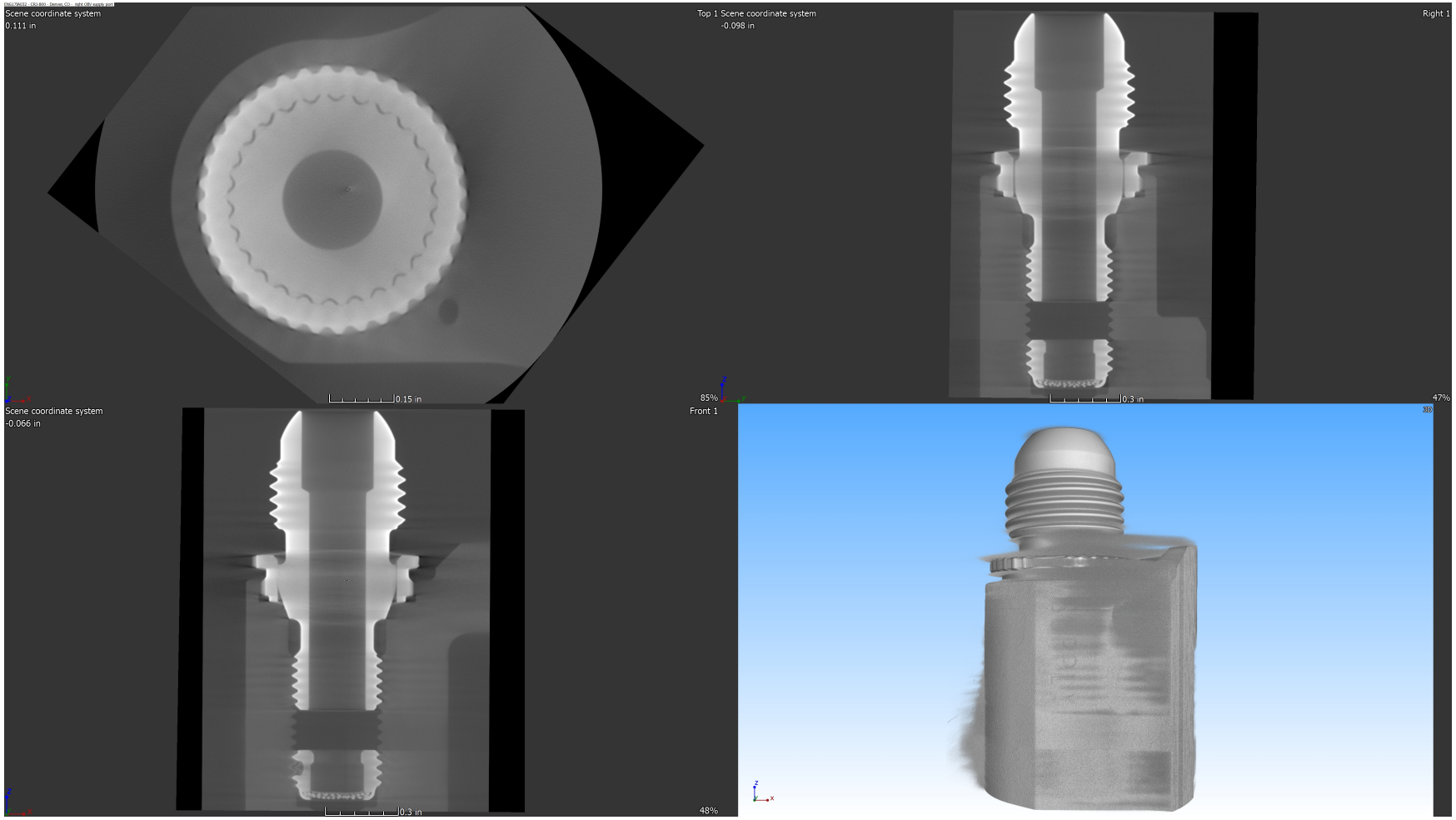


Figure 24
Right supply port – overall view

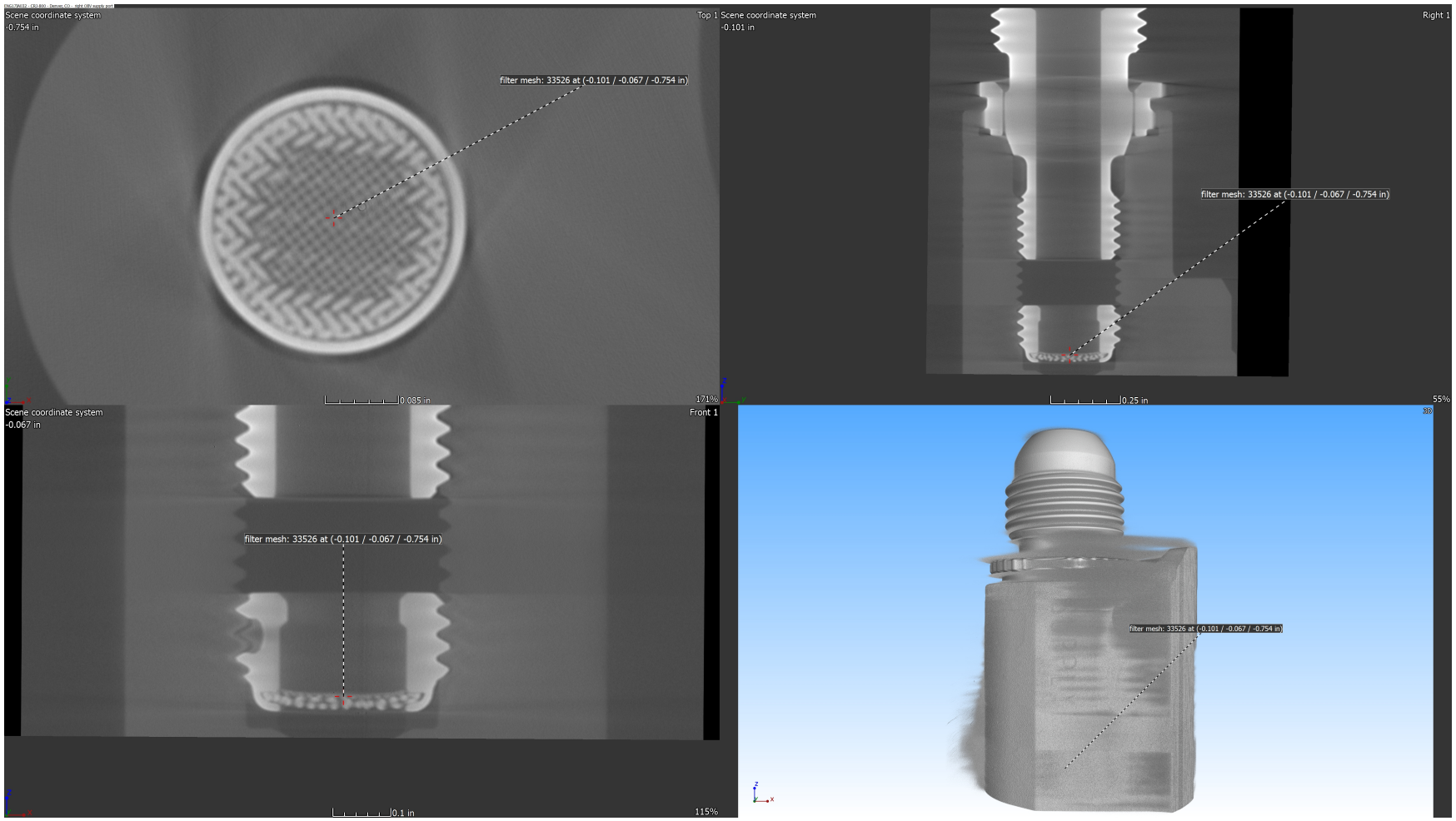


Figure 25
Right supply port – filter mesh

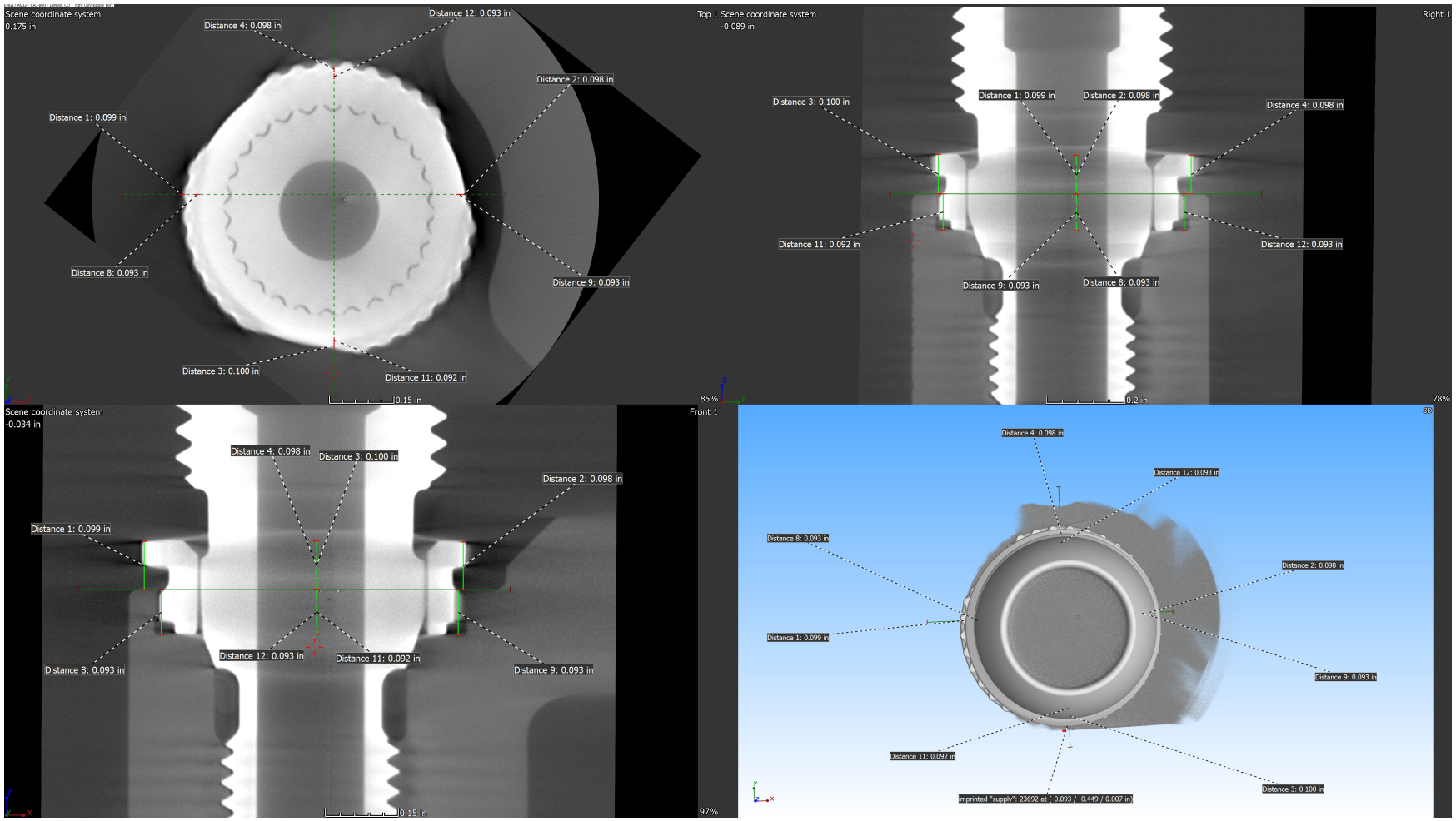


Figure 26
Right supply port – collar and counter bore dimensions

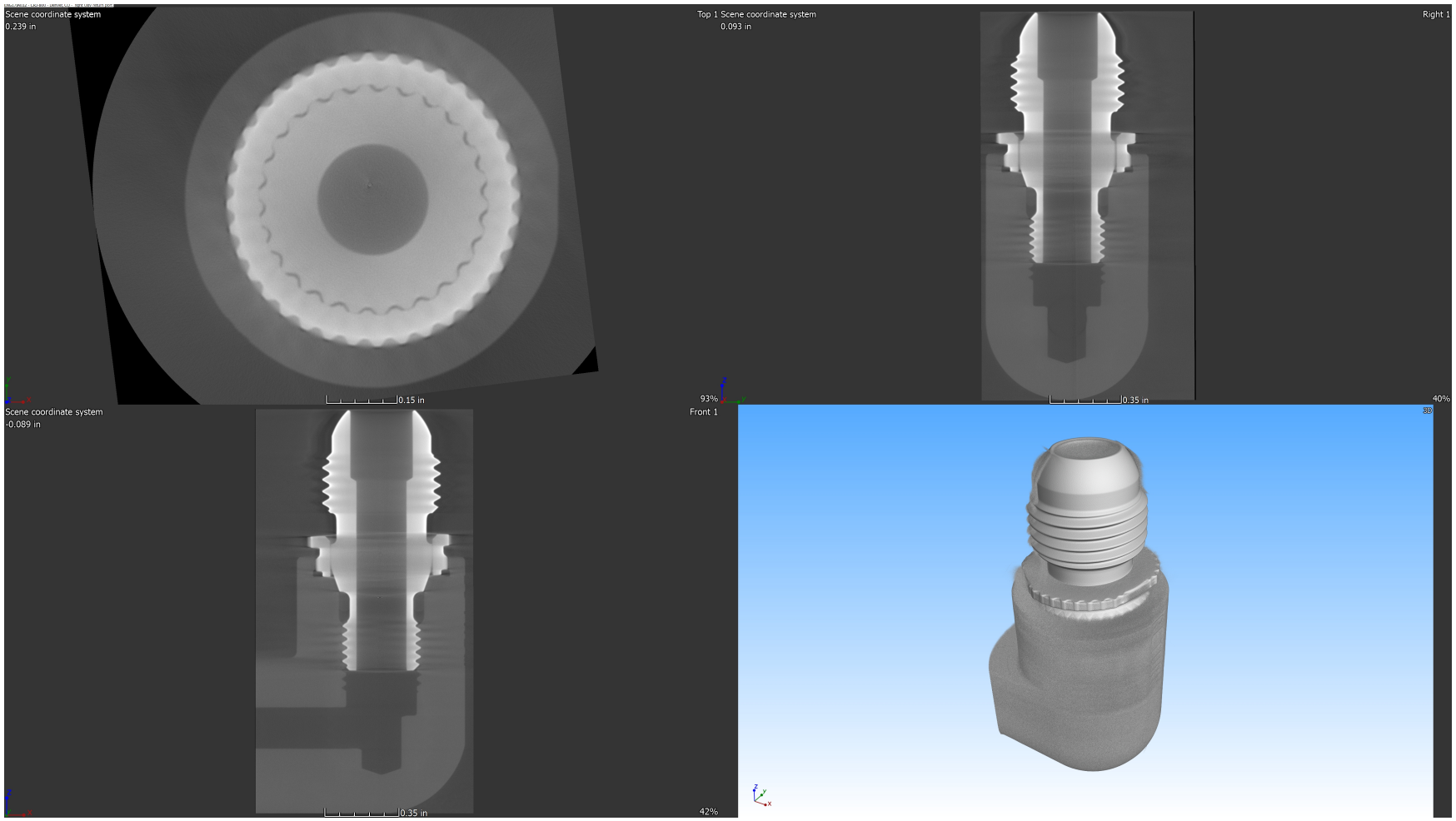


Figure 27
Right return port – overall view

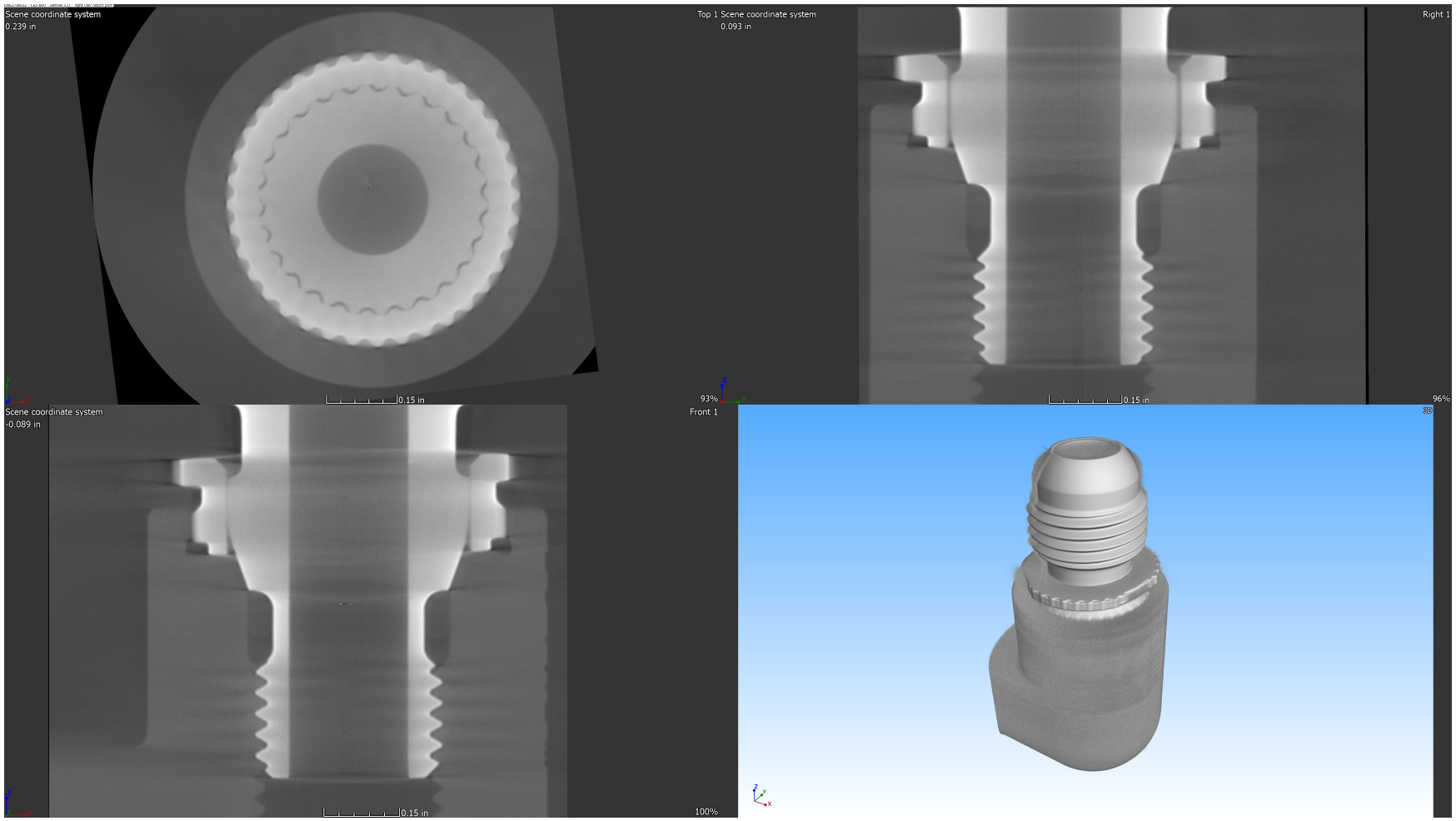


Figure 28
Right return port – threads

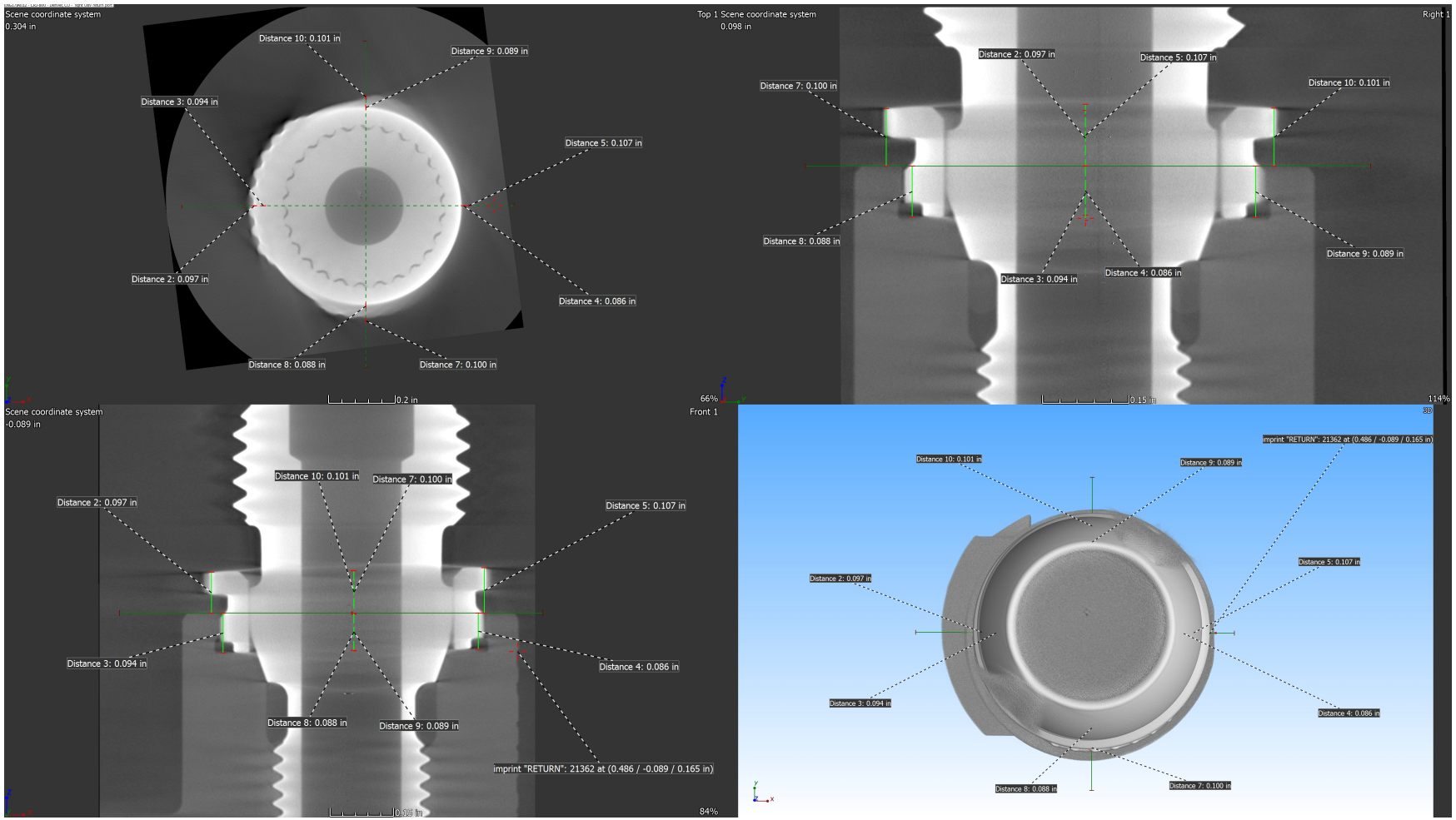


Figure 29
Right return port – collar and counter bore dimensions

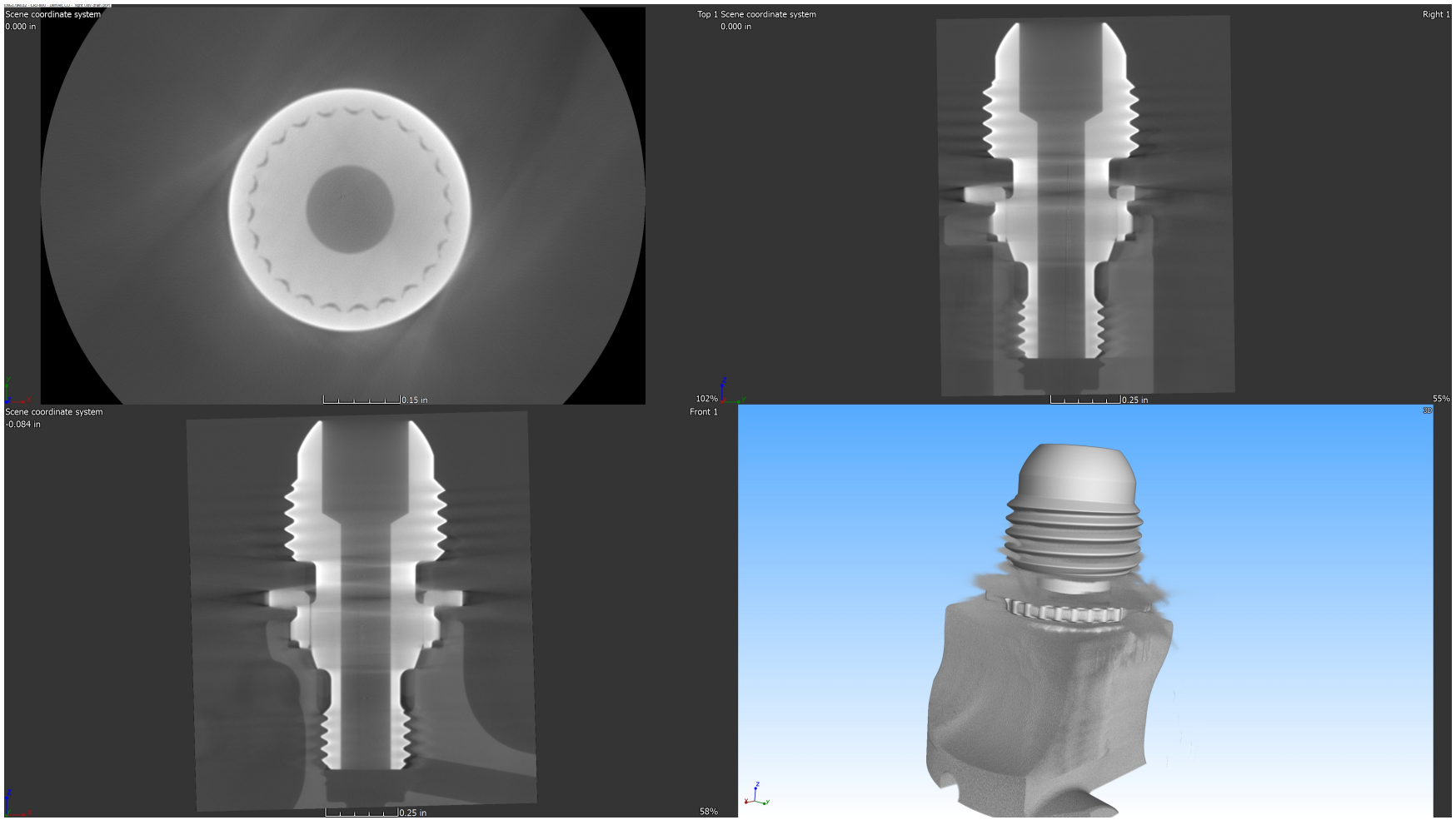


Figure 30
Right drain port – overall view

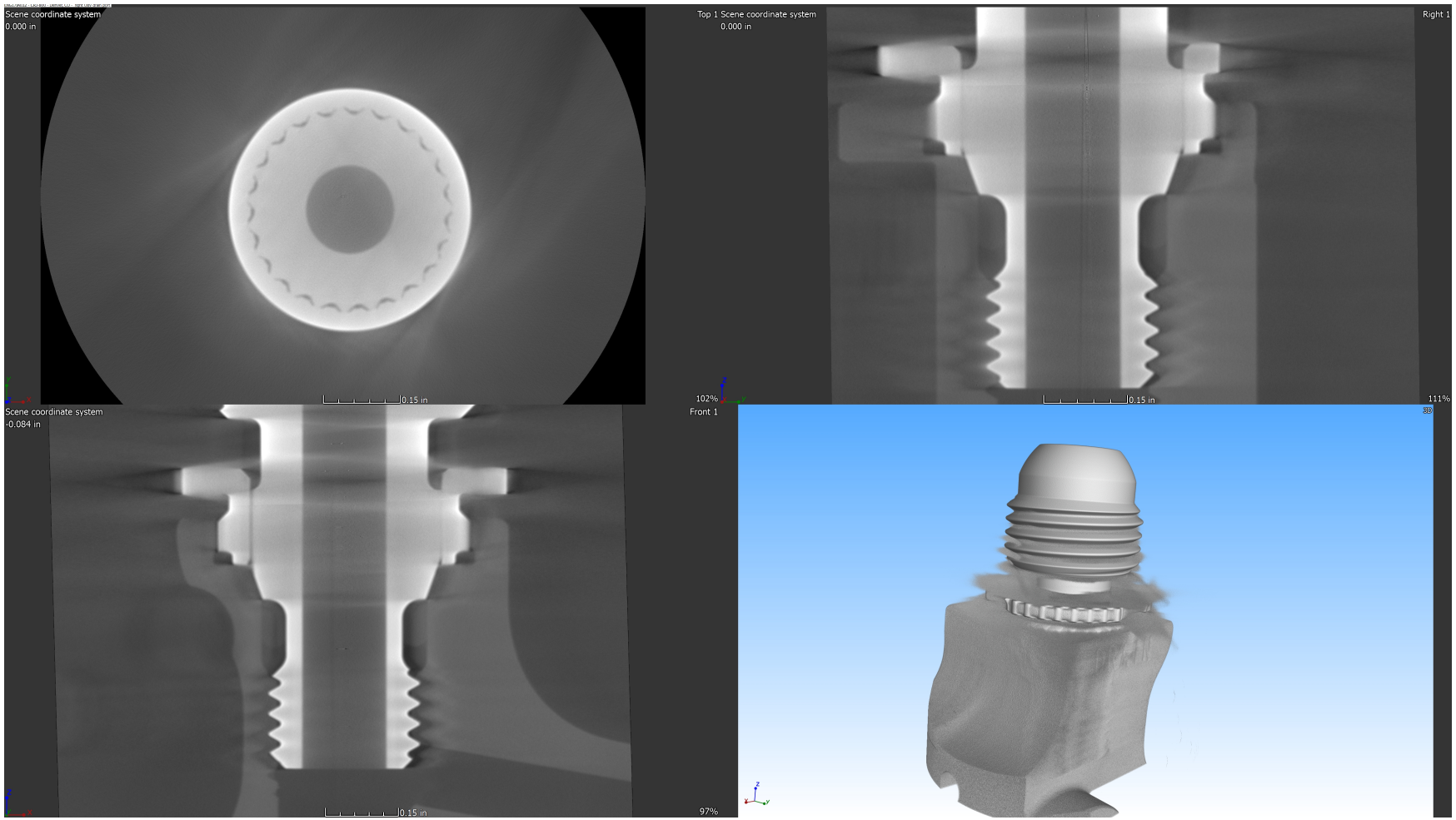


Figure 31
Right drain port – threads

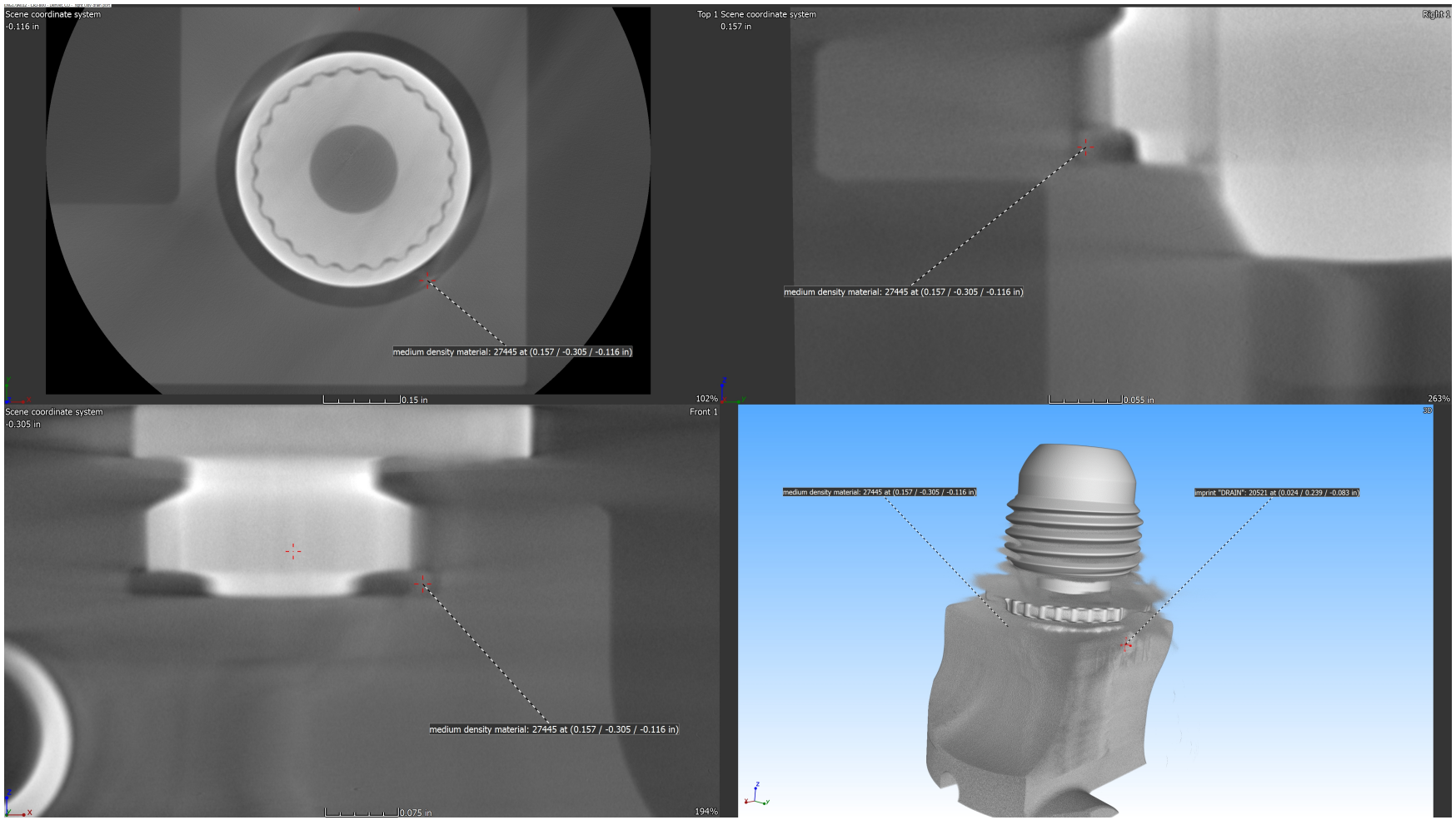


Figure 32
Right drain port – medium density material

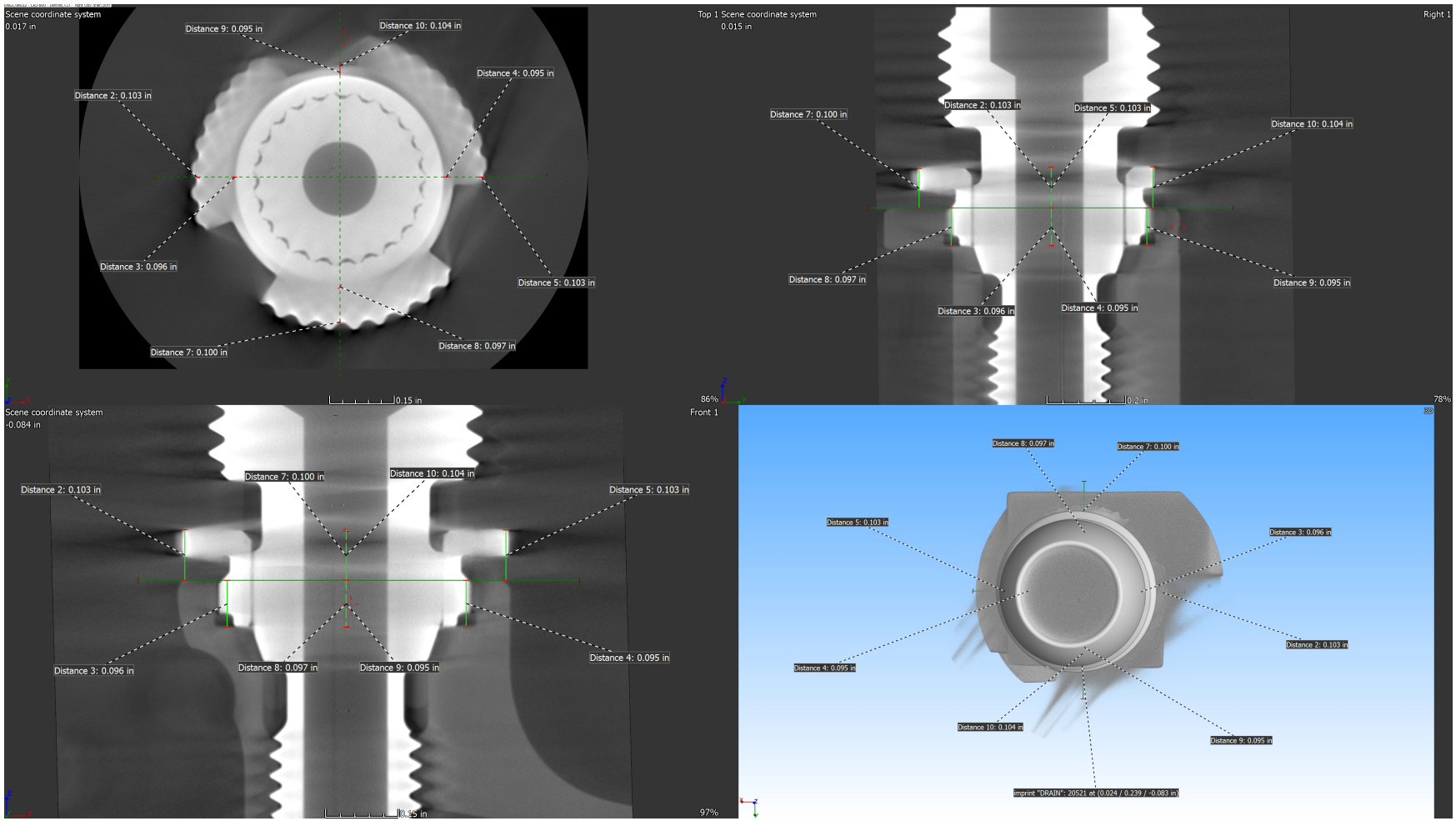


Figure 33
Right drain port – collar and counter bore dimensions

Scott Warren
Lead Aerospace Engineer
(Computed Tomography Specialist)