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

January 19, 2018

Computed Tomography Specialist's Factual Report

ENG-17-IA-005

A. ACCIDENT

Location:	San Antonio International Airport (KSAT), San Antonio, TX
Date:	December 4, 2016
Time:	1453 central daylight time
Airplane:	Embraer ERJ170 200L, N161SY

B. GROUP

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

C. SUMMARY

On December 04, 2016, about 1453 central daylight time, N161SY, an Embraer ERJ170 200L, operated by SkyWest Airlines, experienced an uncommanded retraction of the nose landing gear during rollout after landing on runway 4 at the San Antonio International Airport (KSAT), San Antonio, TX. The aircraft was originally scheduled to land at General Mariano Escobedo Int'l Airport (MMTY), Monterrey, Nuevo Leon, Mexico. However, after departure from the George Bush Intercontinental Airport (KIAH), Houston, Texas the crew heard a loud "thud/pop" just aft of the flight deck. Because no warnings or indications were displayed on the flight deck, the crew decided to proceed to MMTY. When the landing gear was extended on approach, the crew received warning indications regarding the landing gear position and a "LDG GEAR LEVER DISAGREE" message. The crew declared a missed approach, retracted the landing gear per the quick reference handbook (QRH) procedures, and elected to divert to KSAT. Upon entering US airspace, the crew declared an emergency and performed a flyby of the control tower to verify landing gear position. The tower confirmed that the gear appeared to be in the down position. After touchdown on runway 4, during the landing rollout the nose gear retracted, without command, as the aircraft slowed to a stop. The crew and passengers evacuated the aircraft from the aft cabin doors via the evacuation slides. The airplane sustained minor damage. The flight was conducted under the provisions of 14 Code of Federal Regulations Part 121. Visual meteorological conditions prevailed and a Federal Aviation Administration (FAA) flight plan had been filed for the flight.

Two spring pieces (an end segment and a ring segment) were documented using radiographic images that were collected from March 21- April 21, 2017 in Chicago, Illinois. A total of 15,546 computed tomography (CT) slice images were examined, processed, and analyzed by the NTSB to evaluate the components.

The computed tomography (CT) results for the spring end segment and ring segment are shown in figures 1 through 8. Review of the images indicated that, when they were scanned, there were cracks in multiple locations within the spring end segment; there were crack indications in the ring segment, but those indications could not be confirmed as actual cracks; there were also crack indications noted in the "air" portion of the ring segment scans which was consistent with these crack indications being a product of sensor noise or other characteristic.

D. DETAILS OF THE INVESTIGATION

1.0 General

The spring segments were subjected to x-ray radiograph and computed tomography (CT) scanning to document their internal conditions. The scanning was conducted from March 21 – April 21, 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, each component was 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 15,546 slices, and the total size of the combined data sets was approximately 128 Gb. The complete scan protocols are given in table 1[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. 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.

[1] Table 1 contains the most successful protocols used during the scanning work. Other, less successful, protocols were also used, but only the most relevant results are included in this report.

Table 1
Scan Protocols

Component	Spring end segment – target CT	Spring ring segment – target CT
Number of slices	2981	4515
Voxel Size - X Direction (mm)	0.005	0.011
Voxel Size - Y Direction (mm)	0.005	0.011
Voxel Size - Z Direction (mm)	0.005	0.011
Image Projections per Revolution	1800	1800
Exposure time (ms)	285.58	285.58
Frames to Avg (frames per projection)	1	2
X-ray Source Voltage (kV)	220	222
X-ray Source Current (mA)	0.300	0.300
Source Filter Thickness (mm)	0.5	1.0
Source Filter Material	Brass	Brass
Image Matrix Size	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. 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 cracking within the components. 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 spring end segment and ring segment are shown in figures 1 through 8. Review of the images indicated that, when they were scanned, there were cracks in multiple locations within the spring end segment; there were crack indications in the ring segment, but those indications could not be confirmed as actual cracks; there were also crack indications noted in the "air" portion of the ring segment scans which was consistent with these crack indications being a product of sensor noise or other characteristic.

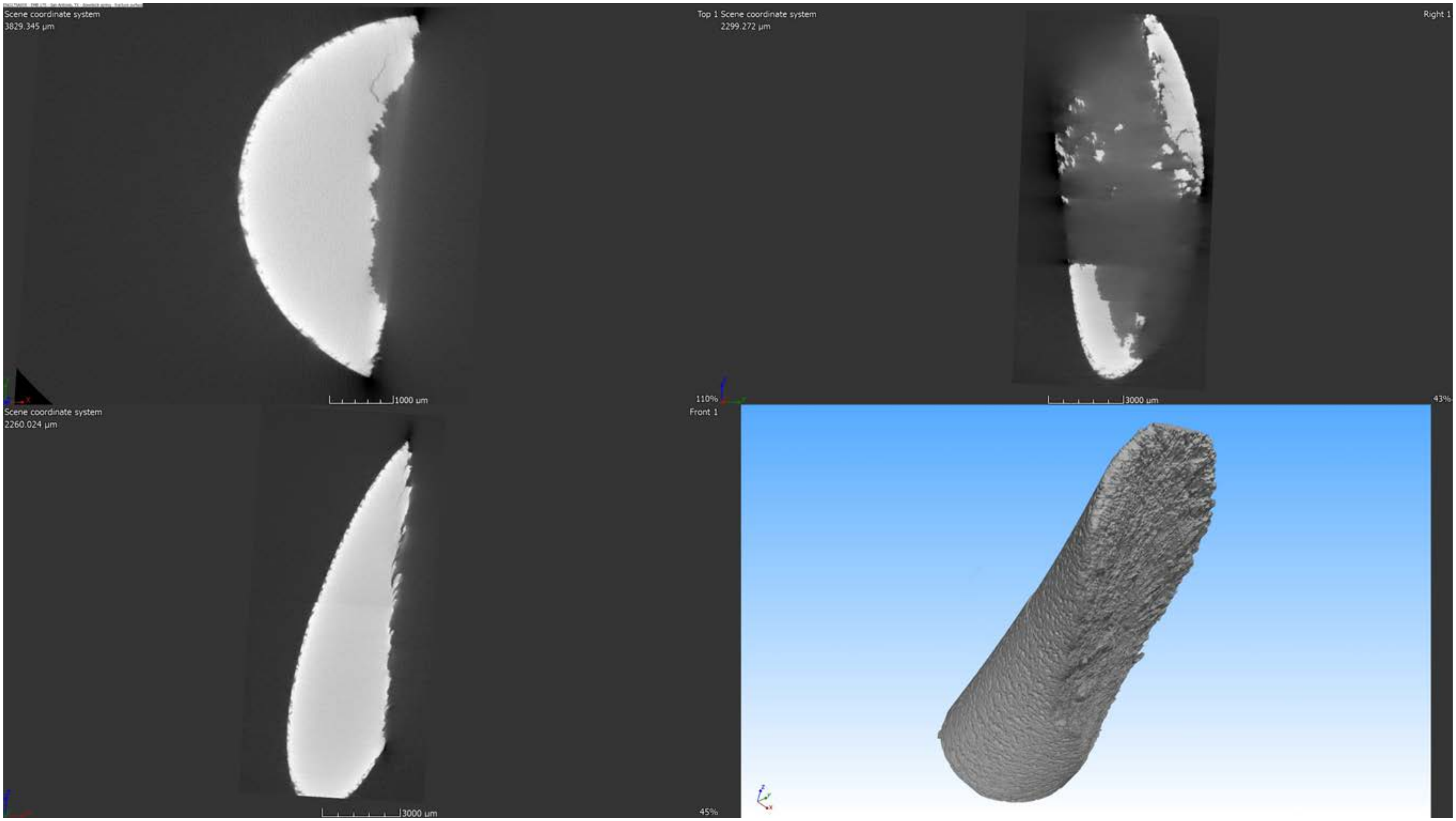

Figure 1
Spring end segment – overall view

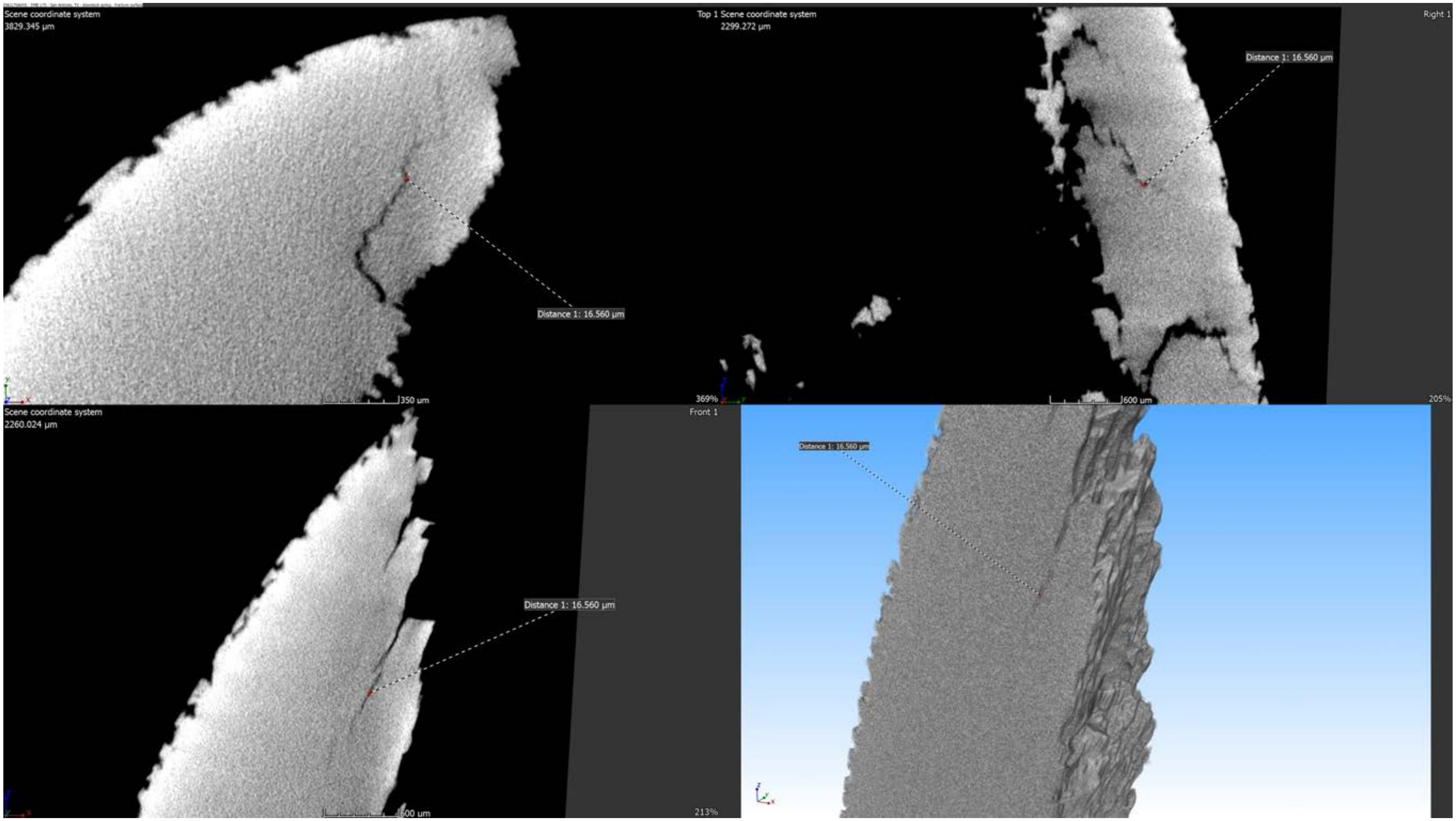

Figure 2
Spring end segment – crack width measurement of 16.560 microns

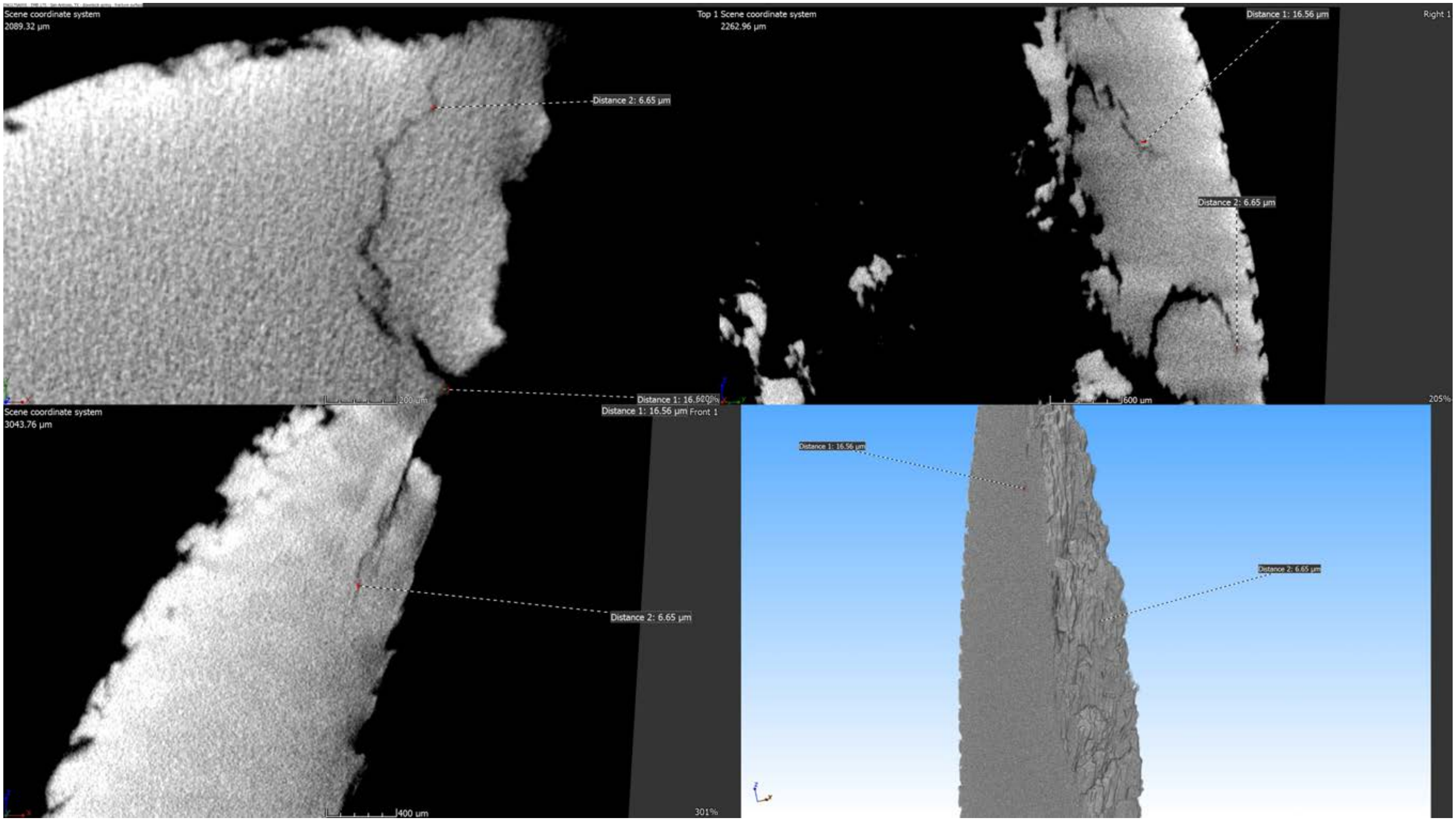

Figure 3
Spring end segment – crack width measurement of 6.65 microns

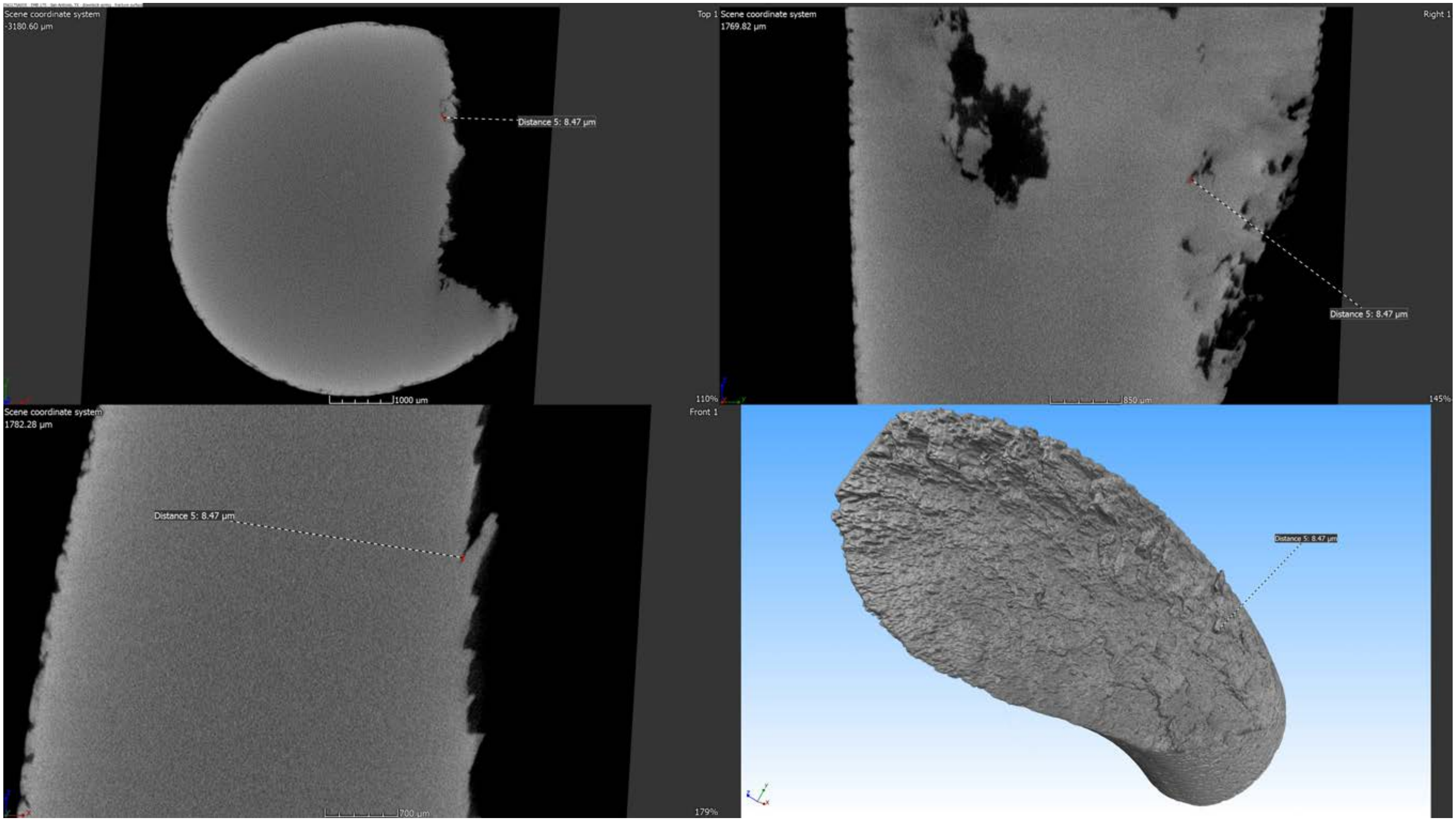

Figure 4
Spring end segment – crack width measurement of 8.47 microns

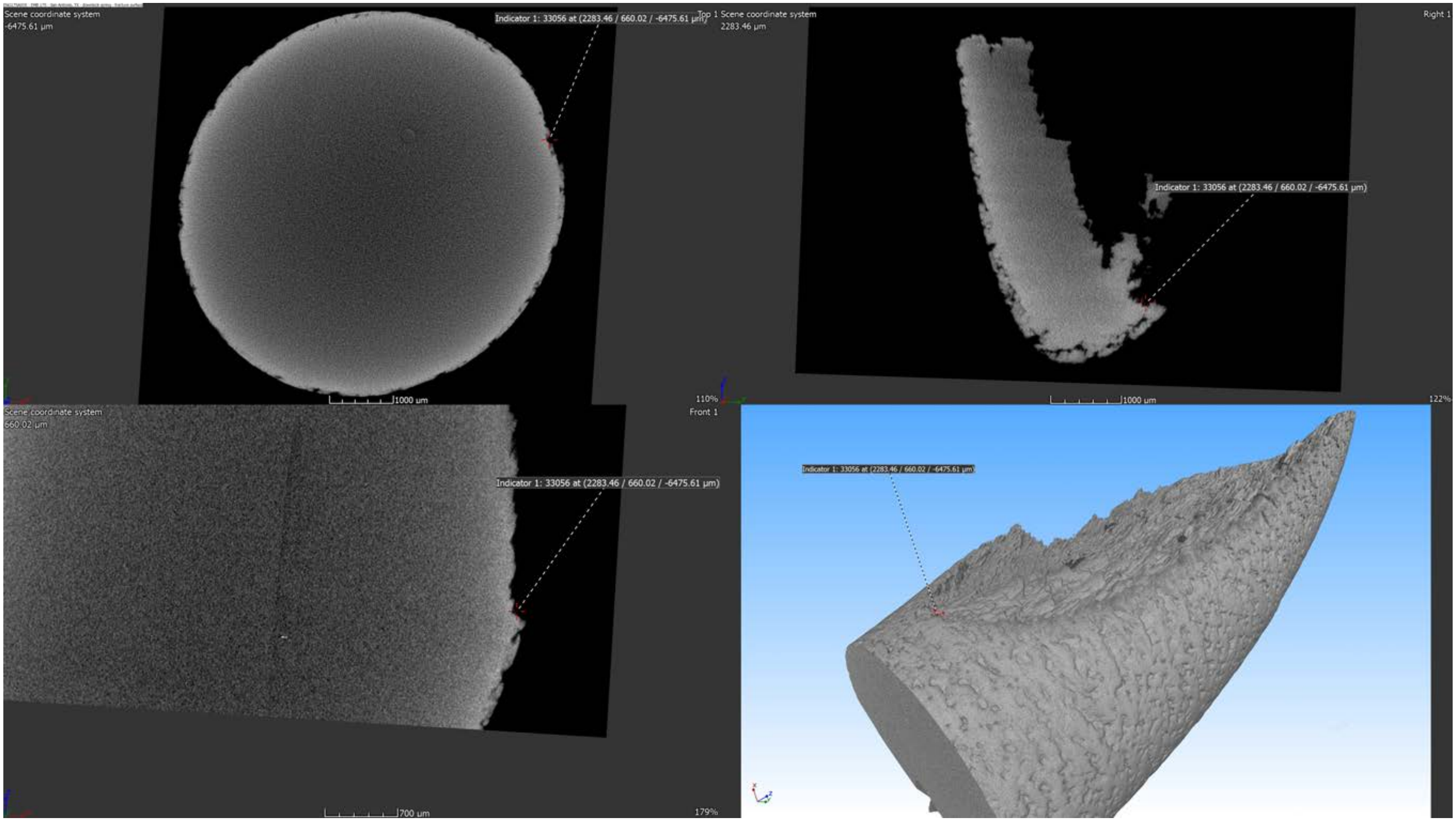

Figure 5
Spring end segment – surface pitting

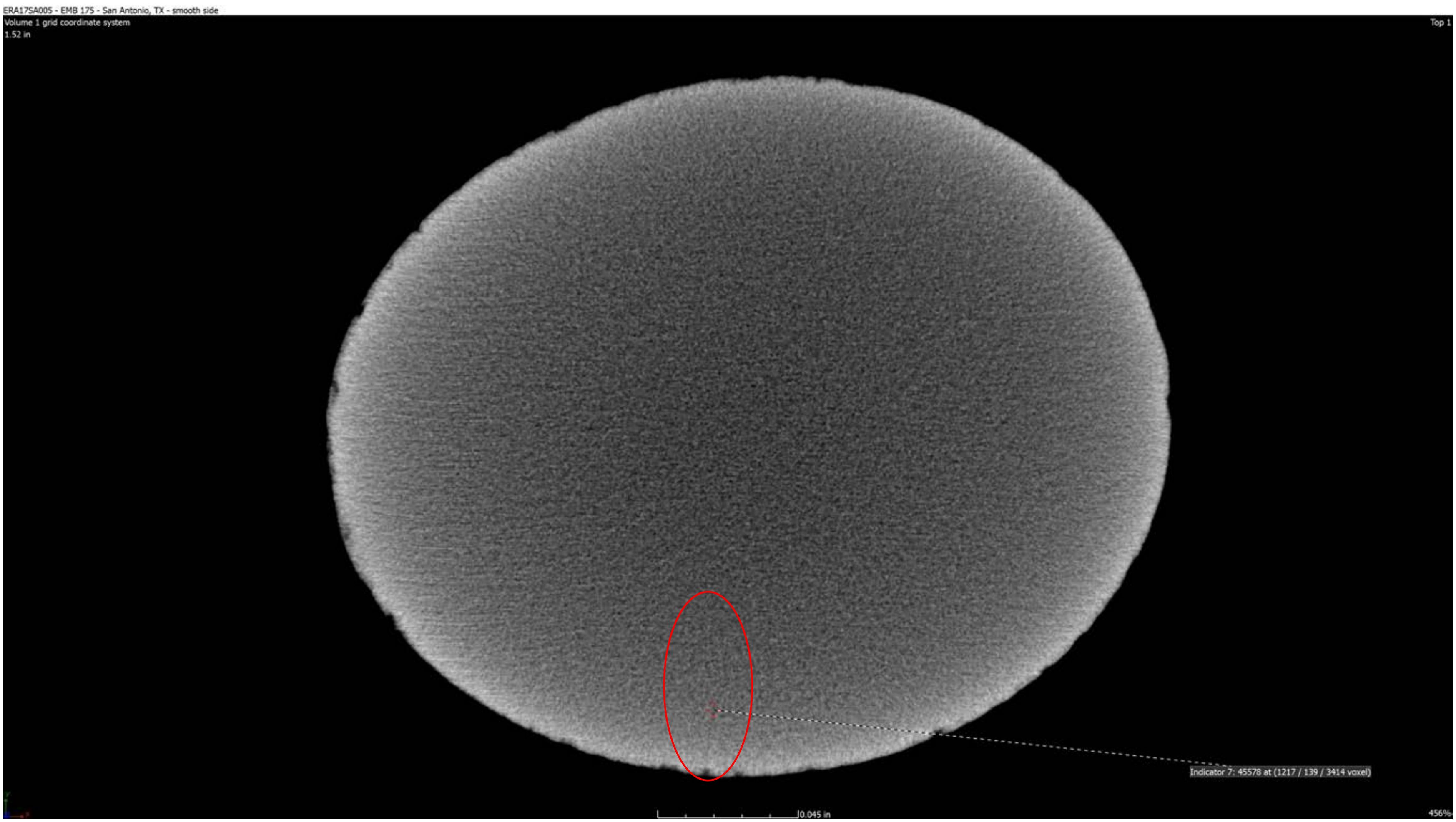

Figure 6
Spring ring segment – apparent crack indication 1

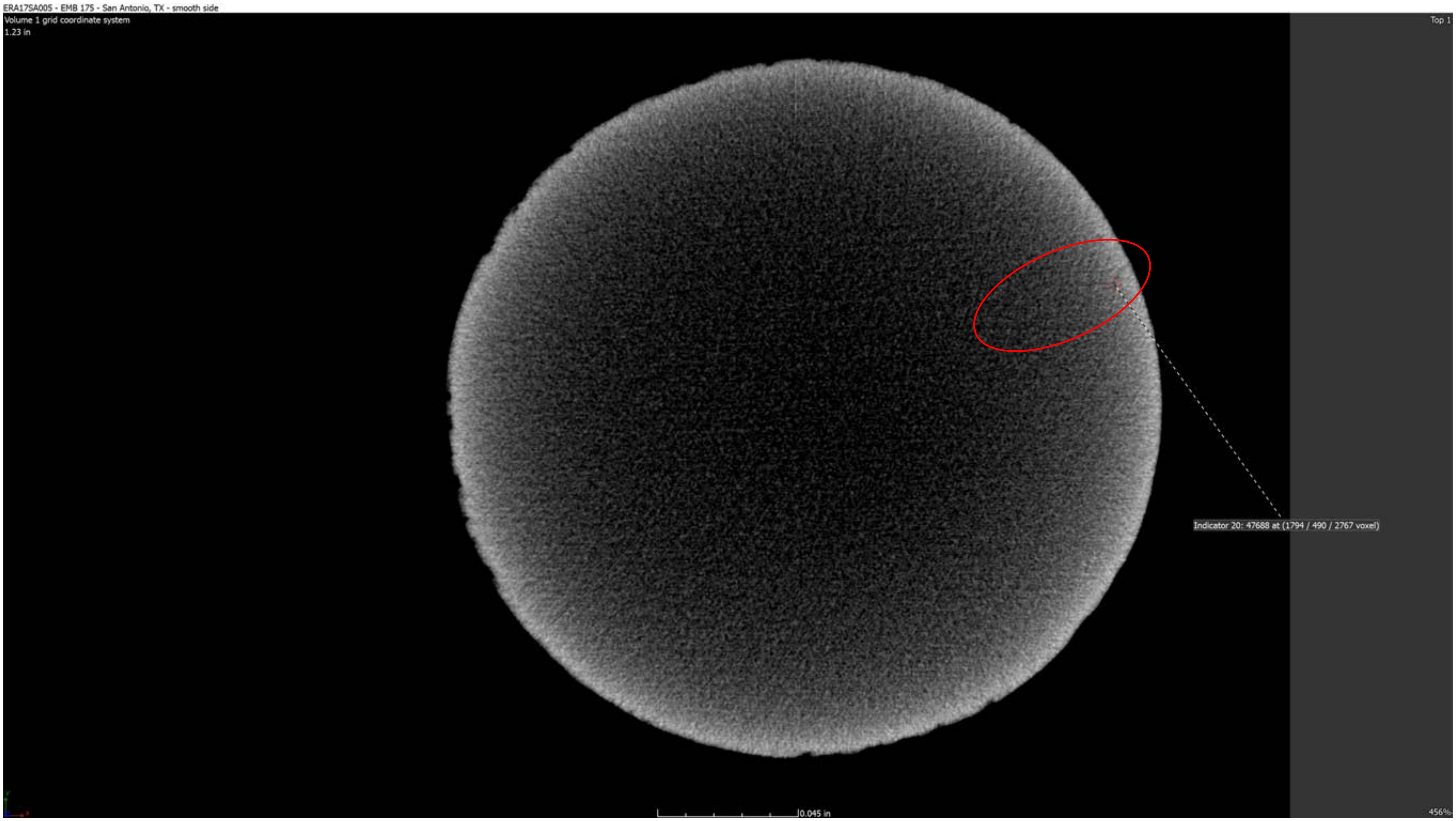

Figure 7
Spring ring segment – apparent crack indication 2 (note: other apparent crack indications are present in this image)

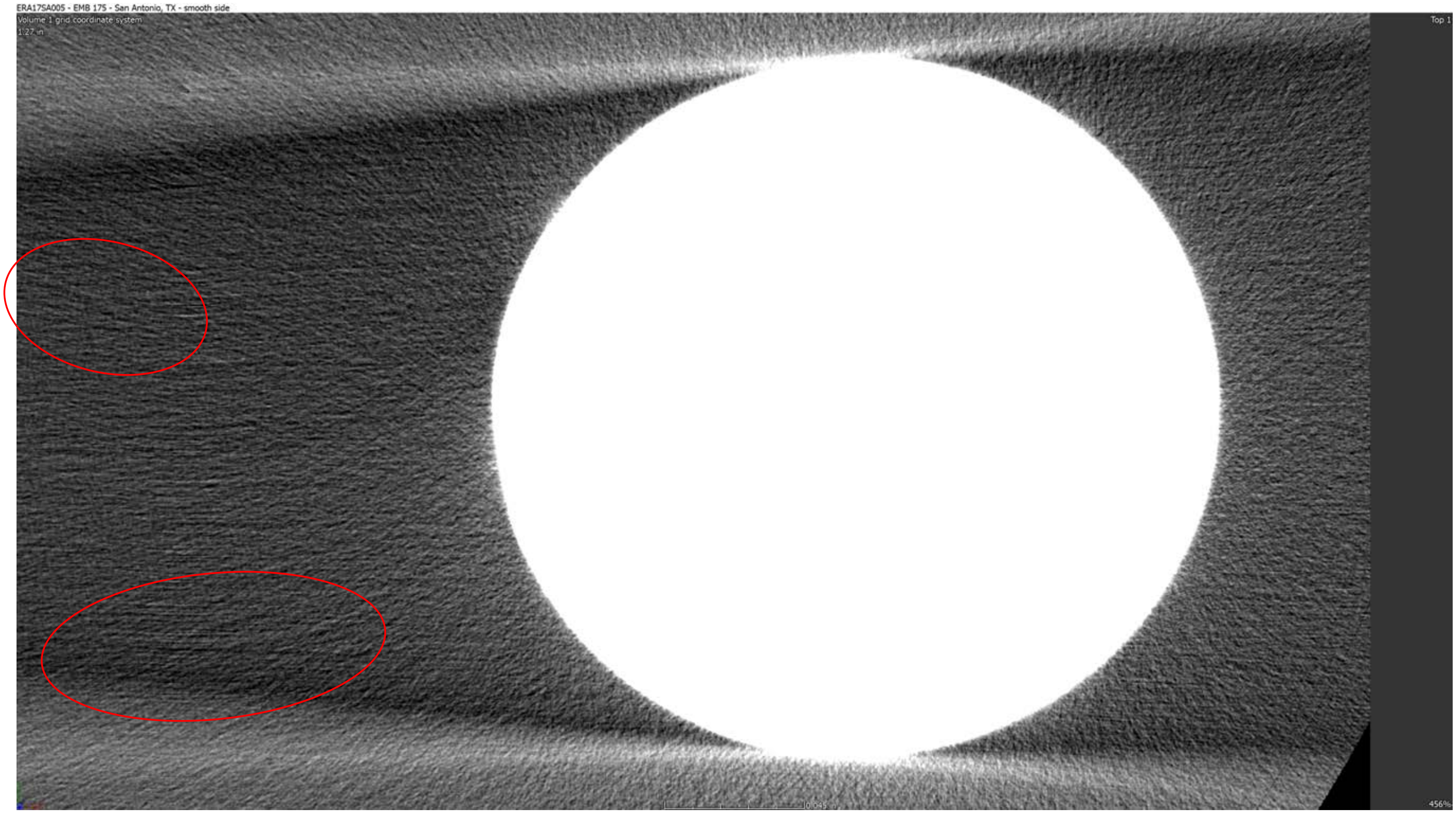

Figure 8
Spring ring segment – apparent crack indications in the air surrounding the ring segment (note: the contrast in this image has been modified to enhance the visibility of fine details in the air surrounding the ring segment)

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