National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594

DCA22LA132

COMPUTED TOMOGRAPHY

Specialist's Factual Report

January 31, 2023

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A. ACCIDENT

Location: Miami, Florida
Date: June 21, 2022
Time: 17:38 eastern daylight time
21:38 universal coordinated time
Aircraft: Boeing (McDonnell Douglas) DC-9-82, HI-1064, RED Air flight 203

B. COMPUTED TOMOGRAPHY SPECIALIST

John Flynn
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C. DETAILS OF THE INVESTIGATION

The internal configuration of the left main landing gear (MLG) shimmy damper check valve P/N 2C6540 from the accident aircraft was subjected to x-ray radiograph and computed tomography (CT) scanning to document its internal condition. The scanning was conducted from September 13 - 16, 2022, by Varex, Inc under the direction of the NTSB using the Actis 225/500 microfocus CT systems.

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 shaped 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 2,006 slices, and the total size of the combined data sets was approximately 8.84 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.

Table 1 Scan Protocol

Component	shimmy damper check valve
Number of slices	2006
Voxel[1] Size - X Direction (millimeter(mm))	0.2
Voxel Size - Y Direction (mm)	0.2
Voxel Size - Z Direction (mm)	0.24
Image Projections per Revolution	2160
Exposure time (milliseconds)	285.6
Frames to Avg (frames per projection)	1
X-ray Source Voltage (kilovolts)	221
X-ray Source Current (mA) (microfocus system)	0.550
Source Filter Thickness (mm)	1
Source Filter Material	brass
Image Matrix Size (pixels)	1024 x 1024

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 all the images, the higher density areas were shown as brighter shades of gray and lower density areas were shown as darker shades of gray. Each 2-D quadrant within the images shows a scale at the bottom of that quadrant – note that the scales in each quadrant may be different. The pointers shown in some of the images denote specific areas of interest within that image. The numbers associated with the pointer are the gray value at the pointer location and the three positional coordinates of the pointer.

The valve structures were "virtually unrolled" using the CT image visualization 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 parts, contamination, or any other anomalies. Specific results (including example images) are presented in subsequent sections of this report.

[1] A voxel is a three-dimensional picture element (pixel).

D. FACTUAL INFORMATION

1.0 Shimmy Damper Check Valve Description

Figure 1 is a view of a typical in-line check valve showing the internals with the major components labeled. The shimmy damper check valve is supposed to open when 2 to 8 pounds per square (psi) pressure is applied to the inlet port. This allows fluid to flow into the shimmy damper and fill the shimmy damper reservoir. With no pressure at the inlet port, the shimmy damper check valve is supposed to remain closed and have a leakage value below 1 drop/3 minutes with 5 pounds per square inch gauge (psig) applied to the outlet port and just a trace of leakage over 3 minutes with 1000-3000 psig applied to the outlet port. The shimmy damper check valve allows fluid into the shimmy damper when it is being serviced and then retains that fluid in the shimmy damper.

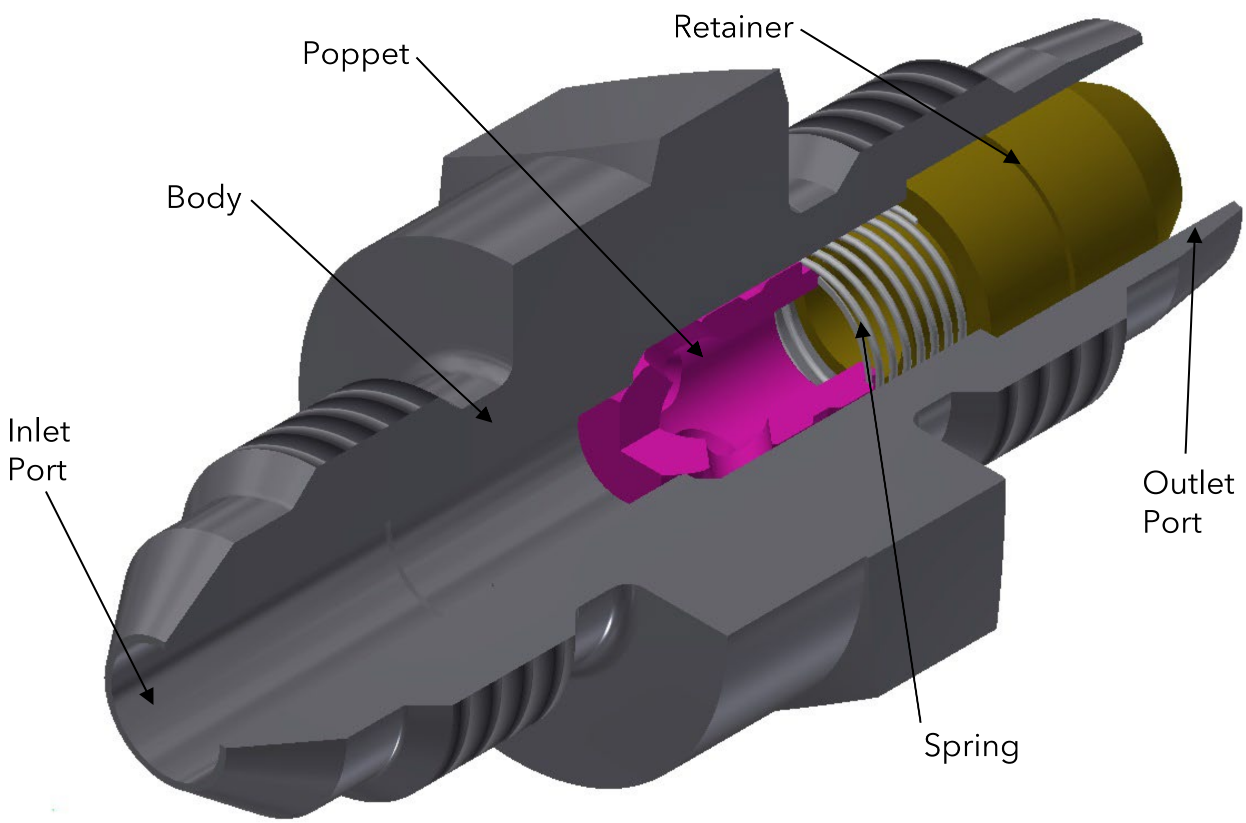

Figure 1. Shimmy damper check valve internal view. (Courtesy of Crissair, Inc.)

2.0 Computed Tomography Results

The CT results for the component are shown in Figures 2 through 6. Review of the images determined that, when the scans were conducted, the following indications were noted:

1. Poppet was not centered. (**Figure 2**)
2. Spring was not centered, and spring coils overlapped[2] at top of spring near the retainer end. (**Figures 3-6**)
3. Spring was intact. (**Figure 6**)
4. There were no indications of foreign objects or debris in the check valve.

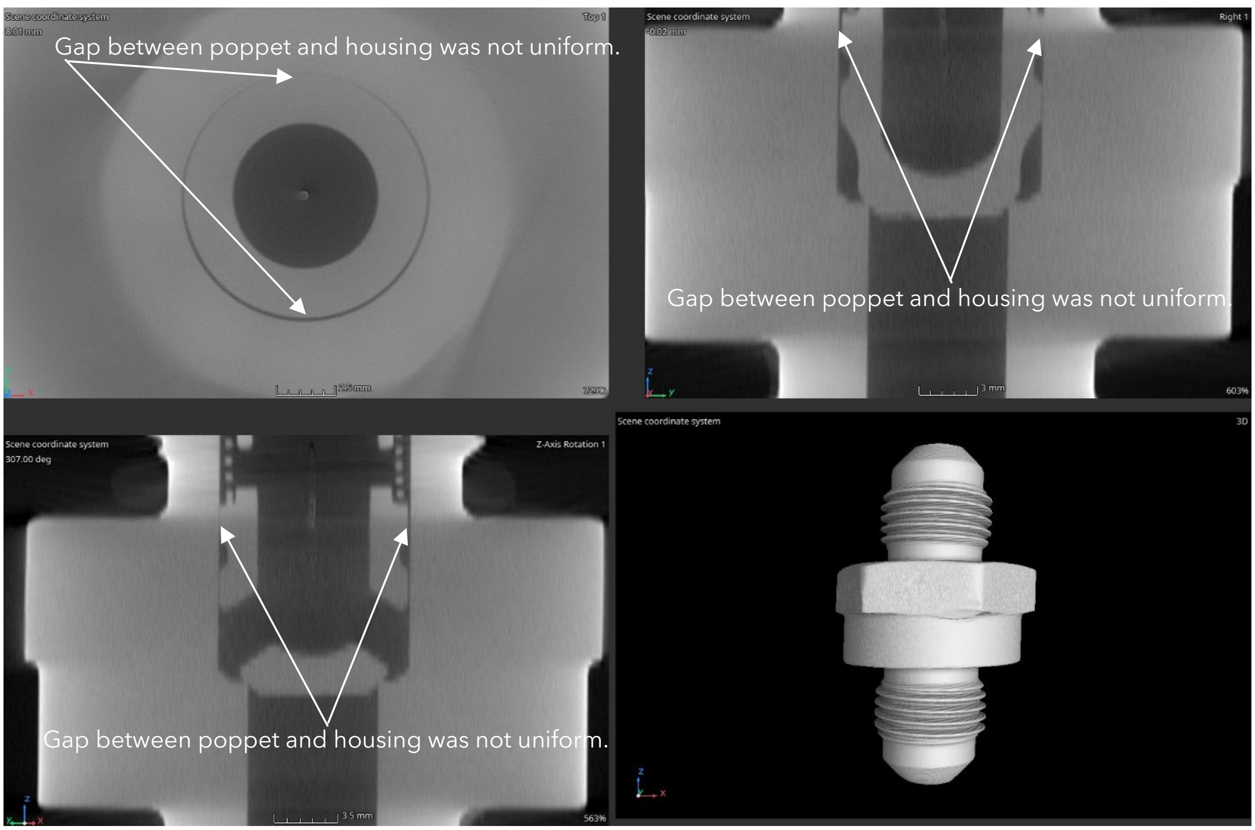

Figure 2. CT images illustrating the poppet is not centered in check valve.

[2] For the check valve, the spring coils are "overlapped" when the outside diameter of the coil is alongside the inner diameter of another portion of the coil.

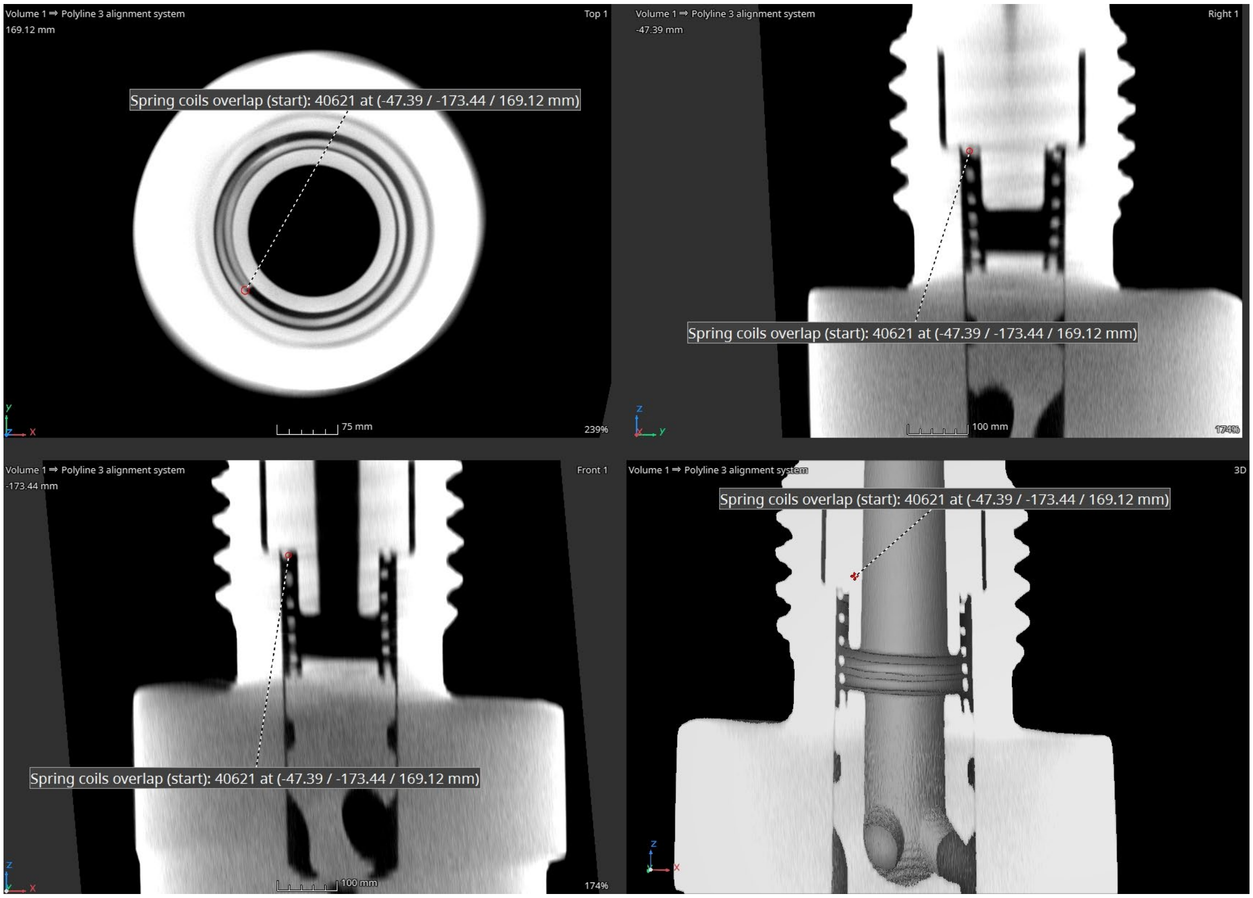

Figure 3. CT images illustrating the start of the overlap of spring coils near the retainer.

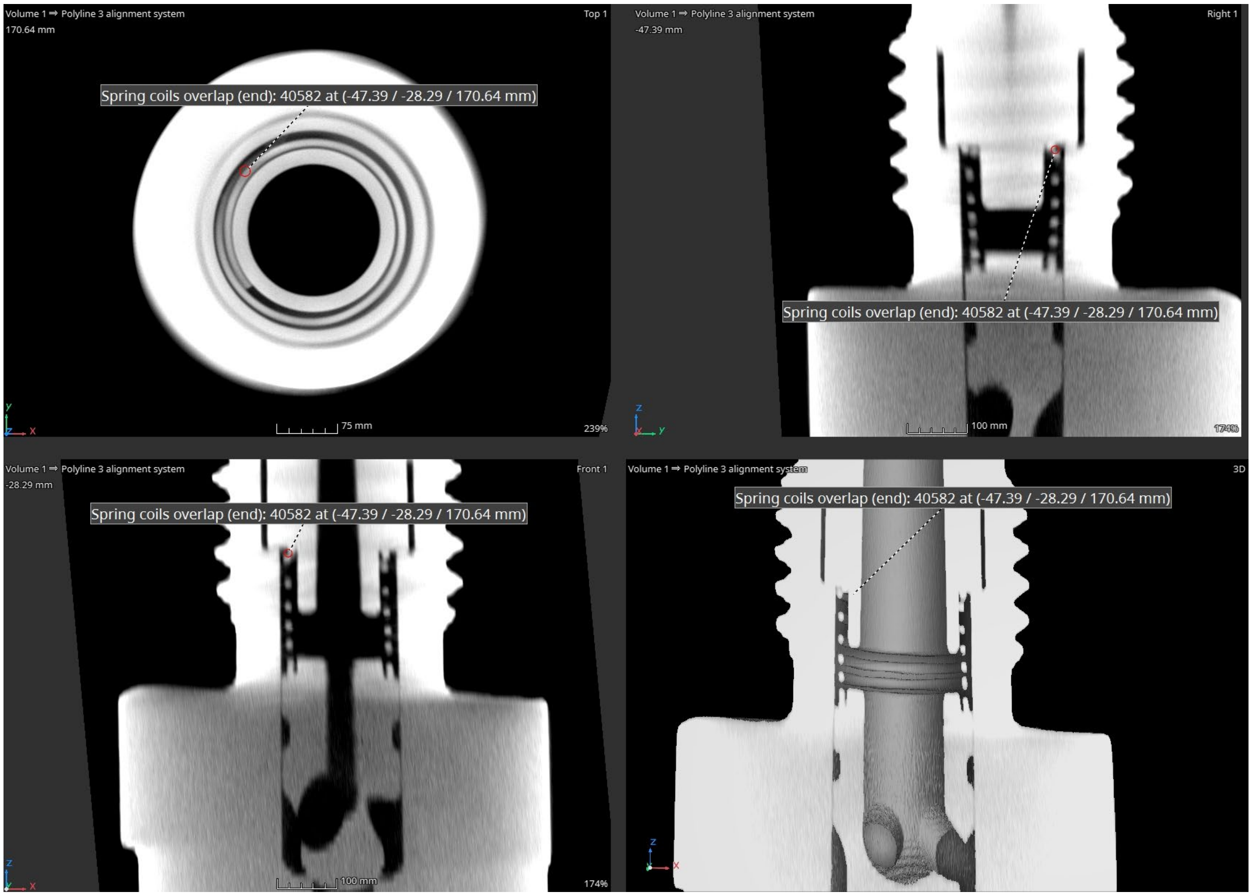

Figure 4. CT images illustrating the end of the overlap of spring coils near the retainer.

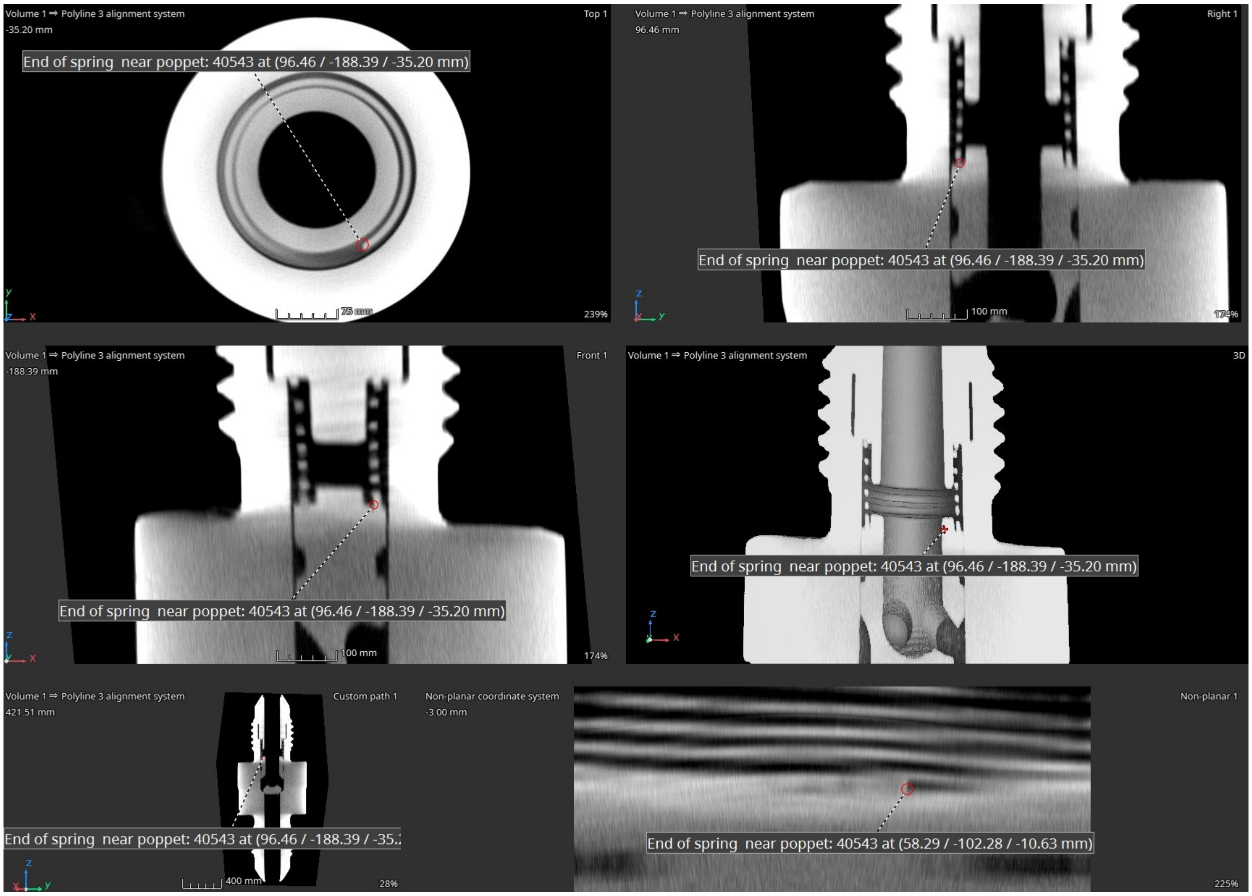

Figure 5. CT images illustrating the end of the spring coil near the poppet.

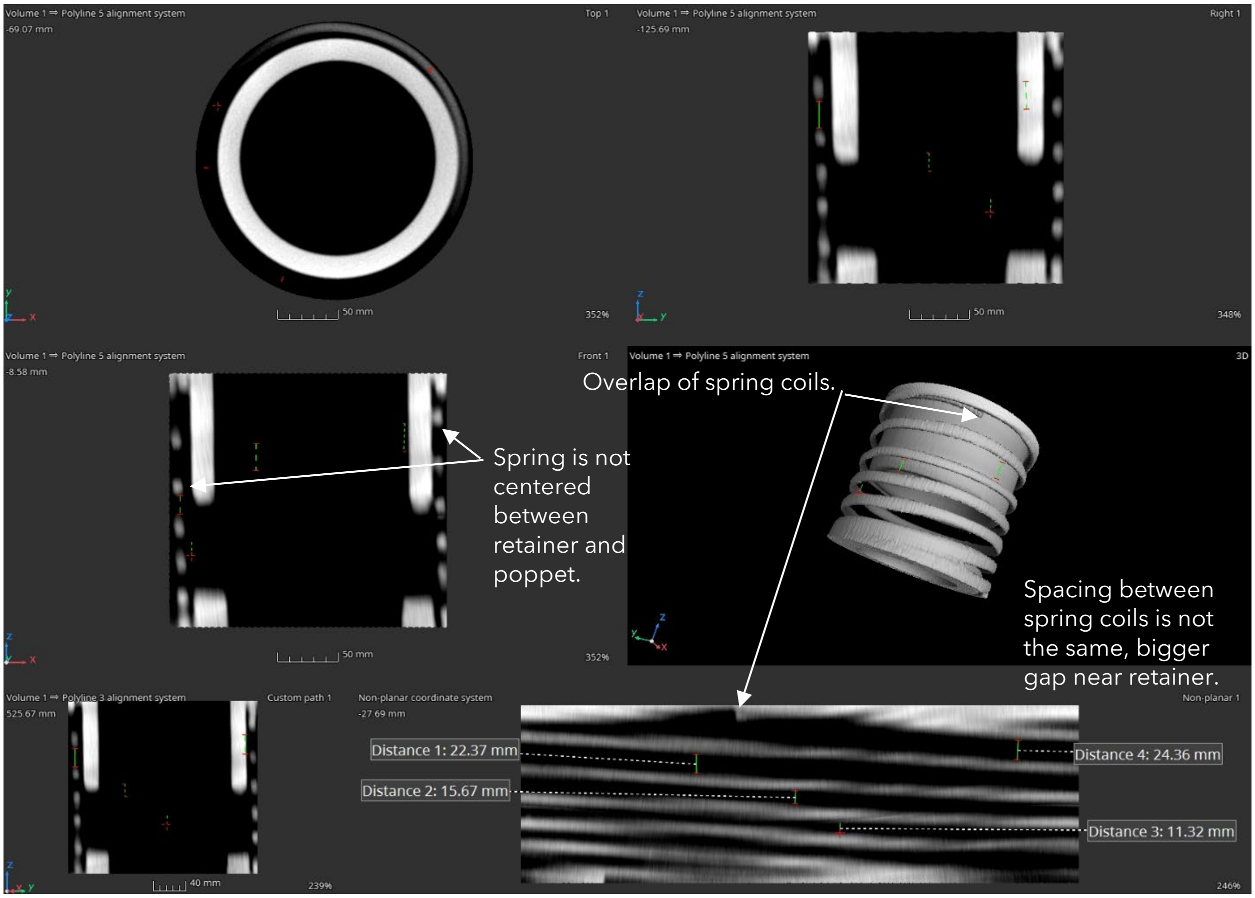

Figure 6. CT images of the shimmy damper check valve spring with remaining check valve digitally removed.

Submitted by:

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