

PET/CT Digital Reference Object Extension Analysis Sheet - Version 07/31/2014

This document describes how to perform tests for the PET/CT Digital Reference Object Extension (DROe). The DROe is a set of PET and CT DICOM image volumes designed to test functionality of medical image viewing software. The tests should take 15–20 minutes to perform.

Please fill out this form with the results of your software tests. You may record your answers directly on this form by annotating the form using your pdf viewing software. Alternatively, you may print this form, write your answers on the printed version, and scan the completed form to a pdf version for submission.

Further information on the PET/CT Digital Reference Object Project can be found at <http://depts.washington.edu/petctdro/>.

This project is sponsored by the Quantitative Imaging Biomarker Alliance (QIBA), an initiative of the Radiological Society of North America (RSNA).

1 Basic Information

Please fill out the basic information for the test on lines **1 – 10**. Include a brief description of the workstation and its hardware, the software being tested, and the makes and models of the primary scanners that supply the images viewed on the workstation used for this test.

	Item	Value
1	Name of Institution	
2	Name of person testing software	
3	Email or Phone contact	
4	Date of test	
5	Workstation used for test (Serial #)	
6	Description of hardware (Hardware Version)	
7	Make and model of monitor	
8	Software Manufacturer	
9	Name of PET/CT Analysis Software	
10	Version of software	

2 SUV-peak Tests

Using an axial view, scroll to **slice 49** in the PET image volume. You should see two circular blobs with a set of vertical dots between them as shown in Figure 1. The blob on the right should have a single off-center hot voxel.

Compute the SUV-peak value of the left blob and record the value on **Line 11**. (If your software requires an ROI to compute the SUV-peak, draw the ROI around the entire blob.)

Record the SUV-peak value and the diameter (or area/volume) of the SUV-peak ROI (not the ROI that was drawn manually).

Repeat the process for the right blob with the off-center hot voxel and record your answers on **Line 12**.

Please indicate if your SUV-peak algorithm is automated or manually drawn on **Line 13** and whether the SUV-peak ROI is 2D or 3D on **Line 14**.

	Blob	Diam or SUV-peak	Area
11	Left		
12	Right		

- 13 SUV-peak Method: ☐ Automatic
☐ Manual
- 14 SUV-peak ROI Type: ☐ 2-Dimensional
☐ 3-Dimensional

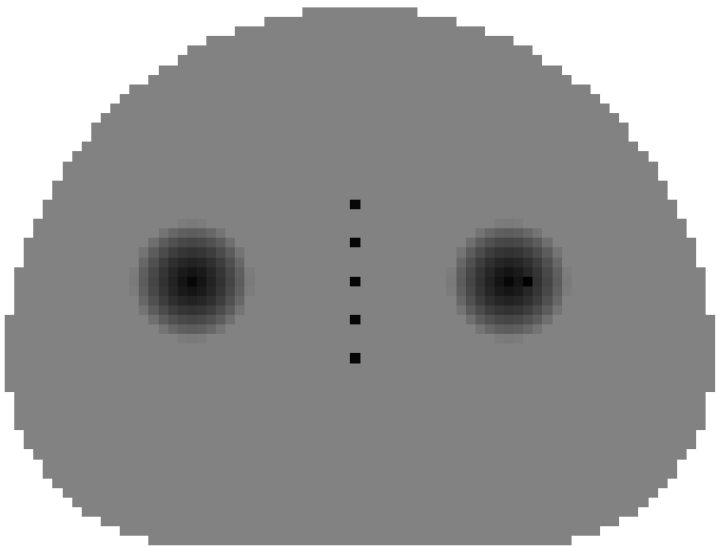


Figure 1: You should see two circular blobs and a set of vertical dots in **axial slice 49** of the PET image volume.

3 ROI Voxel Inclusion Tests

This test is to determine how much of a voxel must lie within a drawn ROI before that voxel is considered as part of the ROI calculation. This amount can vary in different directions, and we test eight directions here.

Using an axial view, scroll to **slice 63** in the PET image volume. You should see a star-like array of eight lines as shown in Figure 2. We will refer to these lines as compass points (N , NE , etc.) as illustrated in Figure 2.

Follow the steps below to perform this test.

(1) Draw a 25 mm diameter circular (or spherical) ROI in the center of the star pattern. Record the ROI-max value of the background on line **15**. A blue ROI is shown in Figure 2.

(2) Drag the ROI from the center of the star pattern in a line toward the NW test-line.

(3) Monitor the ROI-max value as you drag the ROI. Note the point at which the ROI-max value changes. Record the increased ROI-max value in the space on line **15**.

(4) Estimate the amount of hot voxel inclusion that was needed to increase the ROI-max value. Use the illustration in Figure 3 as a guide.

(5) Record your estimate in box **15** for the NW test line.

(6) Repeat steps 1-5 for the eight test-lines, each time moving the ROI in a line from the center of the star-pattern. Record your answers on **Lines 16 – 22**.

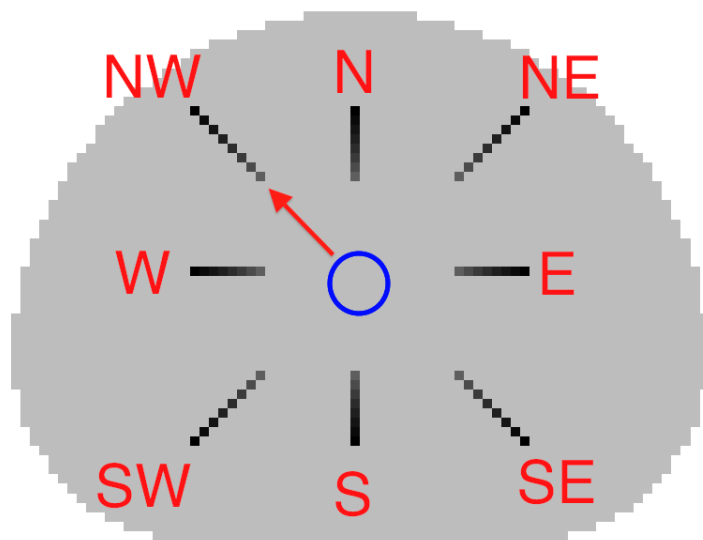


Figure 2: **Axial slice 63** of the PET image volume. Each test-line is labelled according to compass points. The circular ROI is shown in blue and the red arrow indicates the direction to drag the ROI.

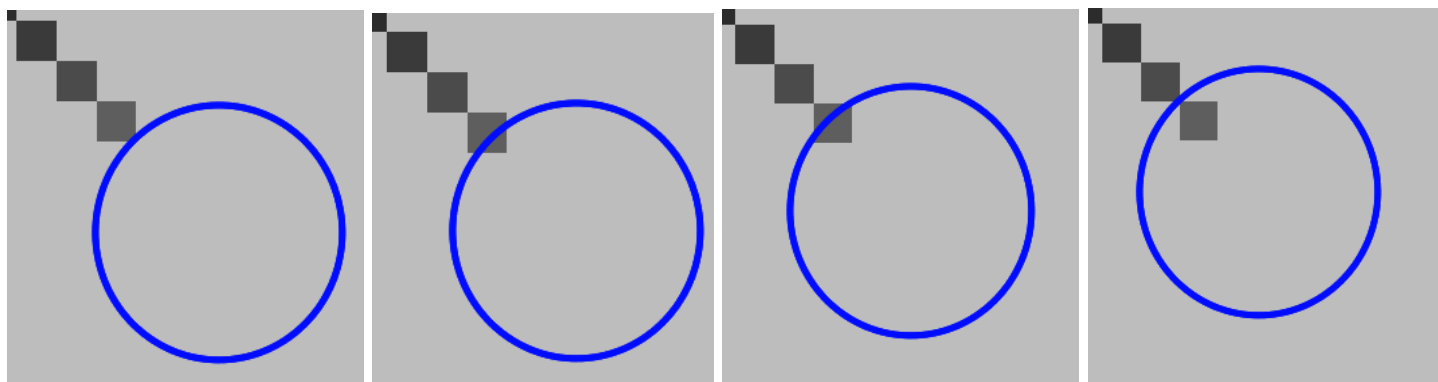


Figure 3: An illustration of different levels of hot voxel inclusion needed to increase the ROI-max value. From left to right:

- (a) **Touching:** The ROI need only touch the voxel for the ROI-max to increase
- (b) **Partial:** Some part of the voxel must be included, but not half
- (c) **Half:** At least half of the voxel must be included in the ROI
- (d) **Whole:** The entire voxel must be within the ROI for the ROI-max to increase
- (e) **Complex:** The ROI inclusion has a behavior that is not captured with descriptions (a)–(d)

ROI VOXEL INCLUSION TESTS

For each of the eight ROI inclusion test-lines, please indicate the amount of ROI inclusion needed to increase the ROI-max value by checking the appropriate box for that test-line. If the behavior of the ROI inclusion is not well-described by **(a)–(d)**, choose ‘Complex’ and provide a description of the behavior.

15 Background ROI-max: _____

	Increased ROI-max	(a) Touching	(b) Partial	(c) Half	(d) Whole	(e) Complex	(Description if Complex)
16	NW _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
17	N _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
18	NE _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
19	E _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
20	SE _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
21	S _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
22	SW _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____
23	W _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____

4 PET/CT Axial Fusion Alignment Tests

This section tests the PET and CT axial fusion alignment by examining: (1) a set of overlapped alignment stripes within the PET and CT volumes, (2) a checkerboard test pattern, and (3) the alignment of the corners of the fused images. Follow the steps below to perform this test.

NOTE: *The PET and CT alignment stripes are of different lengths to avoid a particular optical illusion.*

(1) Open the PET and CT DICOM volumes and use the Image Fusion function within your software to fuse the PET and CT volumes.

(2) Using an axial view, advance to **axial slice 64** in the transmission object (slice 32 in the emission volume), which contains PET/CT axial alignment test stripes as shown in Figure 4.

(3) Check the description in box **24** that best describes the relationship between the PET and CT vertical alignment stripes. If the relationship is not adequately described, check 'None of the above' and provide a written description of the relationship.

(4) Check the description in box **25** that best describes the relationship between the PET and CT horizontal alignment stripes. If the relationship is not adequately described, check 'None of the above' and provide a written description of the relationship.

(5) The PET and CT objects have a 2×2 checkerboard pattern that should be perfectly aligned. Please indicate the alignment of the checkerboard patterns in box **26**.

(6) In the PET and CT images, the four corners of each image are indicated by hot voxels. The corners of the PET and CT images should share an edge along the image border. Indicate the alignment of the corners of the PET and CT images in box **27**.

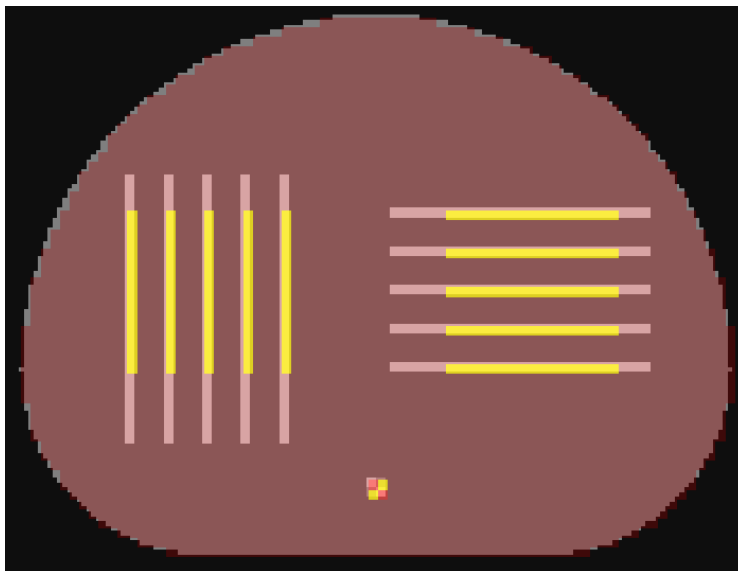


Figure 4: You should see a set of horizontal and vertical lines and a 2×2 checkerboard pattern in **axial slice 64** of the CT volume. The PET alignment bars are shorter than those of the CT and illustrated here in yellow. In this example, the vertical PET alignments stripes **APPEAR TO THE RIGHT** of the CT stripes. The horizontal PET stripes **APPEAR BELOW** the CT stripes. The PET checkerboard **APPEARS BELOW AND RIGHT** of the CT checkerboard.

AXIAL ALIGNMENT TESTS

Examine the fusion alignment between the PET and CT vertical alignment stripes (left of center) within the fused volume. Check the line in box **24** that most accurately describes the alignment between the vertical PET and CT stripes.

- 24:** ☐ Vertical PET stripes **APPEAR TO THE LEFT** of the CT stripes
☐ Vertical PET stripes **APPEAR TO THE RIGHT** of the CT stripes
☐ Vertical PET stripes **ARE ALIGNED** with the CT stripes
☐ None of the above (describe below)

Examine the fusion alignment between the PET and CT horizontal alignment stripes (right of center) within the fused volume. Check the line in box **25** that most accurately describes the alignment between the horizontal PET and CT stripes.

- 25:** ☐ Horizontal PET stripes **APPEAR ABOVE** the CT stripes
☐ Horizontal PET stripes **APPEAR BELOW** the CT stripes
☐ Horizontal PET stripes **ARE ALIGNED** with the CT stripes
☐ None of the above (describe below)

Examine the fusion alignment between the PET and CT 2×2 checkerboard (near the center of the body) within the fused volume. Check the line in box **26** that most accurately describes the alignment. If there is a misalignment, please describe the misalignment in the space provided.

- 26:** ☐ The PET and CT 2×2 checkerboard patterns **ARE ALIGNED**
☐ The PET and CT 2×2 checkerboard patterns **ARE NOT ALIGNED** (describe below)

The four corners of the PET and CT contain marker pixels that indicate the 'Bounding Box' around the image. The outermost corners of the PET and CT volumes should be perfectly overlaid. Check the line in box **27** that most accurately describes the alignment. If there is a misalignment, please describe the misalignment in the space provided.

- 27:** ☐ The PET and CT corners **ARE ALIGNED**
☐ The PET and CT corners **ARE NOT ALIGNED** (describe below)
-

5 PET/CT Sagittal Fusion Alignment Tests

This section tests the PET and CT fusion alignment in the sagittal view. The steps to perform the sagittal fusion alignment tests are the same as those for the axial alignment tests.

NOTE: The PET and CT alignment stripes are of different lengths to avoid a particular optical illusion.

NOTE: The PET and CT checkerboard patterns have a 4:3 aspect ratio in the sagittal view due to non-cubic voxels.

(1) Open the PET and CT DICOM volumes and use the Image Fusion function within your software to fuse the PET and CT volumes.

(2) Using a sagittal view, scroll to **sagittal slice 128** in the transmission object (slice 64 in the emission volume), which contains the PET/CT sagittal alignment test stripes as shown in Figure 5.

(3) Check the description in box **28** that best describes the relationship between the PET and CT vertical alignment stripes. If the relationship is not adequately described, check 'None of the above' and provide a written description of the relationship.

(4) Check the description in box **29** that best describes the relationship between the PET and CT horizontal alignment stripes. If the relationship is not adequately described, check 'None of the above' and provide a written description of the relationship.

(5) The PET and CT objects have a 2×2 checkerboard pattern that should be perfectly aligned. Please indicate the alignment of the checkerboard patterns in box **30**.

(6) In the PET and CT images, the four corners of each image are indicated by hot voxels. The corners of the PET and CT images should share an edge along the image border. Indicate the alignment of the corners of the PET and CT images in box **31**.

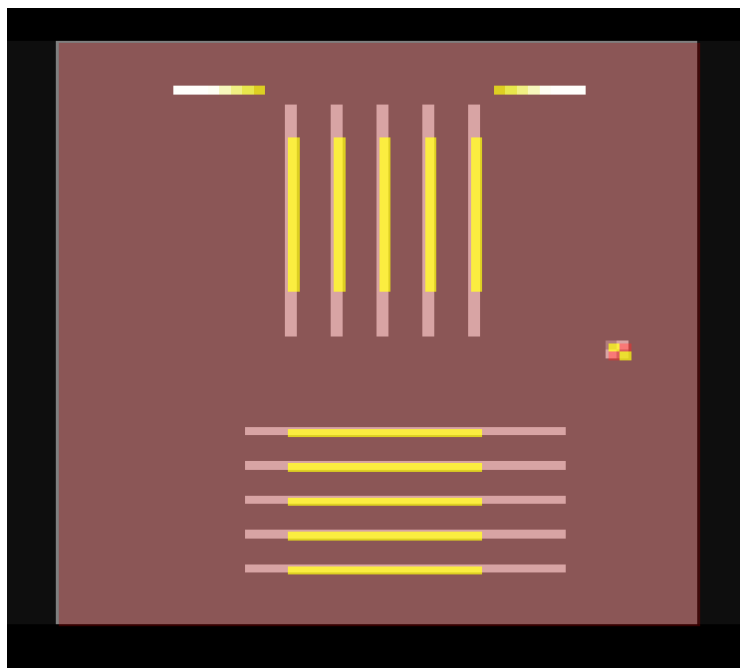


Figure 5: You should see a set of horizontal and vertical lines and a 2×2 checkerboard pattern in **sagittal slice 128** of the CT volume. The PET alignment bars are shorter than those of the CT and illustrated here in yellow. In this example, the vertical PET alignments stripes **APPEAR TO THE RIGHT** of the CT stripes. The horizontal PET stripes **APPEAR BELOW** the CT stripes. The PET checkerboard **APPEARS BELOW AND RIGHT** of the CT checkerboard.

SAGITTAL ALIGNMENT TESTS

Examine the fusion alignment between the PET and CT vertical alignment stripes (above center) within the fused volume. Check the line in box **28** that most accurately describes the alignment between the vertical PET and CT stripes.

- 28:** ☐ Vertical PET stripes **APPEAR TO THE LEFT** of the CT stripes
☐ Vertical PET stripes **APPEAR TO THE RIGHT** of the CT stripes
☐ Vertical PET stripes **ARE ALIGNED** with the CT stripes
☐ None of the above (describe below)

Examine the fusion alignment between the PET and CT horizontal alignment stripes (below center) within the fused volume. Check the line in box **29** that most accurately describes the alignment between the horizontal PET and CT stripes.

- 29:** ☐ Horizontal PET stripes **APPEAR ABOVE** the CT stripes
☐ Horizontal PET stripes **APPEAR BELOW** the CT stripes
☐ Horizontal PET stripes **ARE ALIGNED** with the CT stripes
☐ None of the above (describe below)

Examine the fusion alignment between the PET and CT 2×2 checkerboard (right of center in the body) within the fused volume. Check the line in box **30** that most accurately describes the alignment. If there is a misalignment, please describe the misalignment in the space provided.

- 30:** ☐ The PET and CT 2×2 checkerboard patterns **ARE ALIGNED**
☐ The PET and CT 2×2 checkerboard patterns **ARE NOT ALIGNED** (describe below)

The four corners of the PET and CT contain marker pixels that indicate the 'Bounding Box' around the image. The outermost corners of the PET and CT volumes should be perfectly overlaid. Check the line in box **31** that most accurately describes the alignment. If there is a misalignment, please describe the misalignment in the space provided.

- 31:** ☐ The PET and CT corners **ARE ALIGNED**
☐ The PET and CT corners **ARE NOT ALIGNED** (describe below)
-

6 PET/CT Coronal Fusion Alignment Tests

This section tests the PET and CT fusion alignment in the coronal view. The steps to perform the coronal fusion alignment tests are the same as those for the axial and sagittal alignment tests.

NOTE: The PET and CT alignment stripes are of different lengths to avoid a particular optical illusion.

NOTE: The PET and CT checkerboard patterns have a 4:3 aspect ratio in the coronal view due to non-cubic voxels.

(1) Open the PET and CT DICOM volumes and use the Image Fusion function within your software to fuse the PET and CT volumes.

(2) Using a coronal view, scroll to **coronal slice 170** in the transmission object (slice 85 in the emission volume), which contains PET/CT axial alignment test pattern as shown in Figure 6.

(3) Check the description in box **32** that best describes the relationship between the PET and CT vertical alignment stripes. If the relationship is not adequately described, check 'None of the above' and provide a written description of the relationship.

(4) Check the description in box **33** that best describes the relationship between the PET and CT horizontal alignment stripes. If the relationship is not adequately described, check 'None of the above' and provide a written description of the relationship.

(5) The PET and CT objects have a 2×2 checkerboard pattern that should be perfectly aligned. Please indicate the alignment of the checkerboard patterns in box **34**.

(6) In the PET and CT images, the four corners of each image are indicated by hot voxels. The corners of the PET and CT images should share an edge along the image border. Indicate the alignment of the corners of the PET and CT images in box **35**.

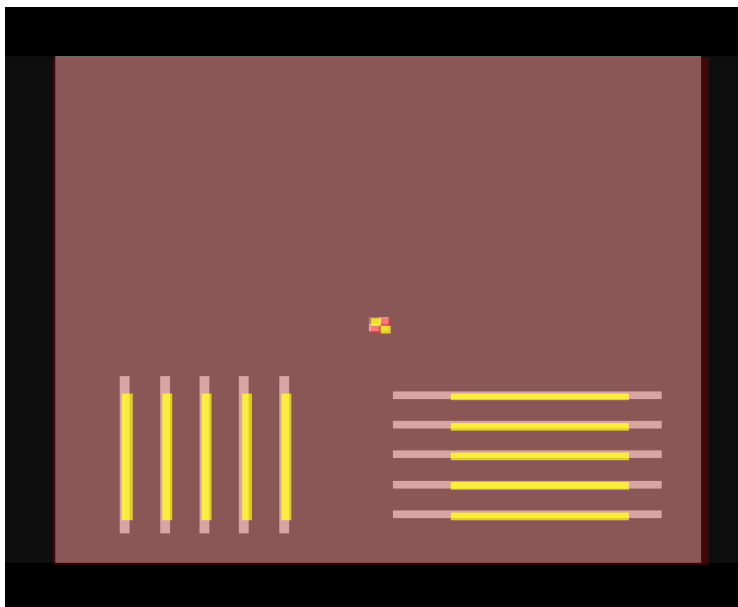


Figure 6: You should see a set of horizontal and vertical lines and a 2×2 checkerboard pattern in **coronal slice 170** of the CT volume. The PET alignment bars are shorter than those of the CT and illustrated here in yellow. In this example, the vertical PET alignments stripes **APPEAR TO THE RIGHT** of the CT stripes. The horizontal PET stripes **APPEAR BELOW** the CT stripes. The PET checkerboard **APPEARS BELOW AND RIGHT** of the CT checkerboard.

CORONAL ALIGNMENT TESTS

Examine the fusion alignment between the PET and CT vertical alignment stripes (left of center) within the fused volume. Check the line in box **32** that most accurately describes the alignment between the vertical PET and CT stripes.

- 32:** ☐ Vertical PET stripes **APPEAR TO THE LEFT** of the CT stripes
☐ Vertical PET stripes **APPEAR TO THE RIGHT** of the CT stripes
☐ Vertical PET stripes **ARE ALIGNED** with the CT stripes
☐ None of the above (describe below)

Examine the fusion alignment between the PET and CT horizontal alignment stripes (right of center) within the fused volume. Check the line in box **33** that most accurately describes the alignment between the horizontal PET and CT stripes.

- 33:** ☐ Horizontal PET stripes **APPEAR ABOVE** the CT stripes
☐ Horizontal PET stripes **APPEAR BELOW** the CT stripes
☐ Horizontal PET stripes **ARE ALIGNED** with the CT stripes
☐ None of the above (describe below)

Examine the fusion alignment between the PET and CT 2×2 checkerboard (near the center of the body) within the fused volume. Check the line in box **34** that most accurately describes the alignment. If there is a misalignment, please describe the misalignment in the space provided.

- 34:** ☐ The PET and CT 2×2 checkerboard patterns **ARE ALIGNED**
☐ The PET and CT 2×2 checkerboard patterns **ARE NOT ALIGNED** (describe below)

The four corners of the PET and CT contain marker pixels that indicate the 'Bounding Box' around the image. The outermost corners of the PET and CT volumes should be perfectly overlaid. Check the line in box **35** that most accurately describes the alignment. If there is a misalignment, please describe the misalignment in the space provided.

- 35:** ☐ The PET and CT corners **ARE ALIGNED**
☐ The PET and CT corners **ARE NOT ALIGNED** (describe below)
-

7 User Feedback

We appreciate any feedback that you have to offer in improving these tests. If you have any comments or suggestions about the design of the test, the layout, submission process, etc., please let us know or write 'None'.

36 Feedback:

8 Submit the Report

If you chose to print this form and write in your answers, please scan the completed form to a pdf in order to submit.

Email the completed pdf document and any screenshots taken to **jkoudelik@rsna.org** with subject line **DROe report**. Include your name and the name of your institution in the body of the email.

Contact the Imaging Research Laboratory at the University of Washington with any questions or comments:

email: petctdro@uw.edu
Phone: 206-543-0517
Fax: 206-543-8356
