

## DICOM Correction Item

Correction Number	CP-1044						
Log Summary: FOV clarifications for XA Derived images.							
Type of Modification	Name of Standard						
Addition	PS 3.3, PS 3.6 – 2009						
<p>Rationale for Correction:</p> <p>Based on the discussions of Field Of View Origin in Supplement 139 (Enhanced XA Informative Annex), the Figure C.8-15 of PS3.3 is confusing because the FOV Origin seems to be related to the center of the TLHC Pixel Data instead of the center of the TLHC Detector Element. This figure should be modified, and a clarifying note should be added.</p> <p>The phrasing of the FOV Area definition of PS3.3 may let think that the FOV is exactly the area encoded in the Pixel Data, which prevents any implementation of a DICOM XA derived image where the Pixel Data is a region smaller than the FOV. The PS3.3 should be enhanced to:</p> <ul style="list-style-type: none"> <li>- Clarify that the FOV is usually the area encoded in the Pixel Data (but may be different)</li> <li>- In order to enable the encoding in the Pixel Data a region smaller than the FOV, and rotated from the FOV, two new attributes should be defined: 1) to relate the origin of the Pixel Data Area to the FOV Area and 2) to define a float rotation angle. These attributes (type 3) would allow to continue relating the Pixel Data to the geometry of the acquisition system (in particular, the relationship to the Isocenter Projection).</li> </ul> <p>The FOV Origin attribute is used in the following modules and macros of the PS3.3:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 20%;">Table C.8-71</td> <td>DX DETECTOR MODULE ATTRIBUTES</td> </tr> <tr> <td>Table C.8.19.6-2</td> <td>X-RAY FIELD OF VIEW MACRO ATTRIBUTES</td> </tr> <tr> <td>Table C.8.21.3.1.1-1</td> <td>X-RAY 3D GENERAL SHARED ACQUISITION MACRO</td> </tr> </table>		Table C.8-71	DX DETECTOR MODULE ATTRIBUTES	Table C.8.19.6-2	X-RAY FIELD OF VIEW MACRO ATTRIBUTES	Table C.8.21.3.1.1-1	X-RAY 3D GENERAL SHARED ACQUISITION MACRO
Table C.8-71	DX DETECTOR MODULE ATTRIBUTES						
Table C.8.19.6-2	X-RAY FIELD OF VIEW MACRO ATTRIBUTES						
Table C.8.21.3.1.1-1	X-RAY 3D GENERAL SHARED ACQUISITION MACRO						
<p>Sections of documents affected</p> <p>PS 3.3 C.8.7.2.1.2, C.8.11.4.1.1, C.8.19.6 and C.8.19.6.4.1.3</p> <p>PS 3.6</p>							
Correction Wording:							

**Amend PS 3.3 as follows:**

**Extend the definition of Field of View in C.8.7.2.1.2 to Digital Detector**

**C.8.7.2.1.2 Field of View**

The Field of View Attribute describes the shape and dimensions of the Image **Receptor Intensifier** Field of View (~~zoom mode~~), **applicable to both Image Intensifier and Digital Detector**. This could be further restricted by the Collimator. See Section C.8.7.3.

**Clarify that the Field of View has usually the same size as the Pixel Data area (but not always). Add note to clarify that the Field of View Origin is from the center of the detector element at the TLHC of the Field of View .**

#### **C.8.11.4.1.1 Physical, Active, Field of View, Exposed and Displayed Areas**

The relationship between the Physical Detector Area, the Active Detector Area, the Field of View (what is stored in the Pixel Data (7FE0,0010)), the Exposed Area (after X-Ray Collimation) and the Displayed Area is illustrated in the following diagrams.

Note: Some of these Attributes relate the image data to manufacturer specific characteristics of the detector that may be used for quality control purposes, e.g. correlation of image artifacts with a detector defect map, analysis of noise performance, etc.

The Displayed Area is defined in pixel coordinates relative to the stored image pixel values by the Attributes of the Display Shutter Module (see section C.7.6.11). If this Module is not present or supported, then the Displayed Area is equal to the Field of View.

The Exposed Area is defined in pixel coordinates relative to the stored image pixel values by the Attributes of the X-Ray Collimator Module (see section C.8.7.3).

For the Digital X-Ray IODs, the Field of View is usually rectangular in shape and **usually has** the same size as the stored Pixel Data (7FE0,0010). The shape and size of the Field of View and the spacing of the pixels are defined by the following Attributes:

- Field of View Shape (0018,1147),
- Field of View Dimensions (0018,1149),
- Imager Pixel Spacing (0018,1164),
- Rows (0028,0010),
- Columns (0028,0011)

**In the case where the Field of View has the same size as the stored Pixel Data (7FE0,0010) the following relationships are verified:**

**If the Field of View Shape (0018,1147) attribute equals RECTANGLE:**

- Field of View Dimensions<sub>row dimension</sub> = Imager Pixel Spacing<sub>row spacing</sub> \* Rows
- Field of View Dimensions<sub>column dimension</sub> = Imager Pixel Spacing<sub>column spacing</sub> \* Columns

**If the Field of View Shape (0018,1147) attribute equals ROUND or HEXAGONAL:**

- Field of View Dimensions<sub>diameter</sub> = Imager Pixel Spacing<sub>row spacing</sub> \* Rows
- Field of View Dimensions<sub>diameter</sub> = Imager Pixel Spacing<sub>column spacing</sub> \* Columns

The following Attributes define the relationship of the Field of View to the Physical Detector Area:

- Field of View Origin (0018,7030),
- Field of View Rotation (0018,7032),
- Field of View Horizontal Flip (0018,7034).

For the Digital X-Ray IODs, the Active Area, i.e. that part of the detector matrix that was activated for this exposure, is usually rectangular in shape. The shape and size of the Active Area and the size and spacing of the detectors are defined by the following Attributes:

- Detector Active Shape (0018,7024),
- Detector Active Dimensions (0018,7026),
- Detector Element Physical Size (0018,7020),
- Detector Element Spacing (0018,7022).

Notes: 1. The Detector Element Physical Size (0018,7020) and Detector Element Spacing (0018,7022) may be different if there are insensitive regions between each detector.  
2. This model of description is not able to accurately describe multiple matrices of detectors that are "tiled" to produce a single image.

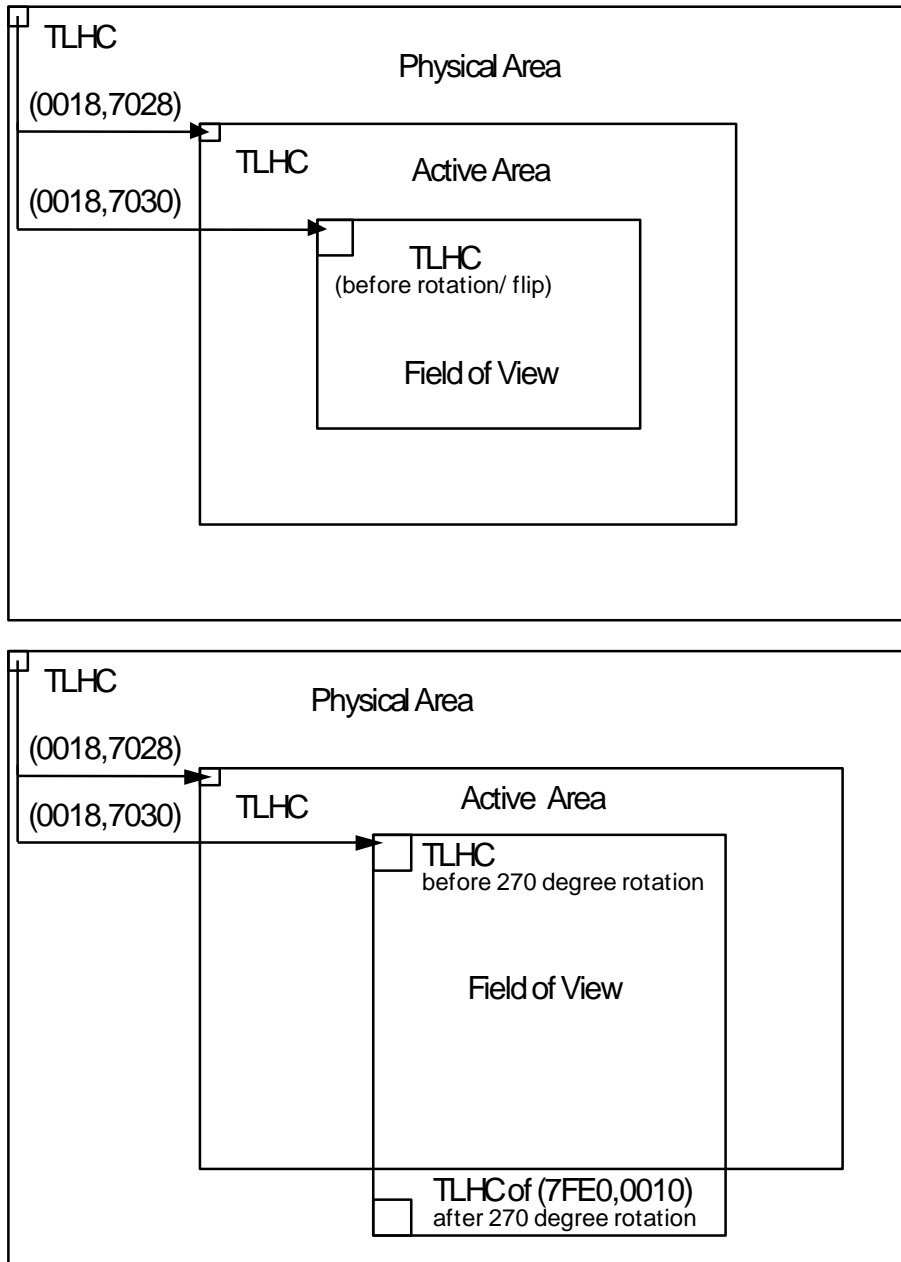
The following optional Attribute defines the relationship of the Active Area to the Physical Detector Area:

- Detector Active Origin (0018,7028).

**In the case where the Field of View has the same size as the stored Pixel Data (7FE0,0010),**

**t** The relationship between detectors and stored image pixels is defined by Detector Binning (0018,701A) which specifies how many detectors, in each of the row and column directions, contribute to (are pooled or averaged to form) a single stored image pixel.

- Notes:
- 1. Detector Binning (0018,701A) may have values less than one if sub-sampling is used to derive an image with higher spatial resolution than the detector matrix.**
  - 2. The detector binning results in the size of a stored image pixel being different from the contributing physical detector pixels. In this case it is important to notice that the Field Of View Origin (0018,7030) is defined with respect to the center of the detector element located at the TLHC of the Field of View.**
  - 3. For images where the Field of View describes an area not equal to the size (rows and columns) of the stored Pixel Data (7FE0,0010), the Detector Binning (0018,701A) does not fully specify the relationship between the contributing physical detector pixels and the stored image pixels.**



**Figure C.8-15**  
**Explanation of ~~DX~~ Digital Detector Attributes**

**Add Pixel Data Area Related to FOV attributes to Frame Pixel Data Properties Sequence, to allow to relate the Pixel Data to the geometry of the acquisition system (in particular, the relationship to the Isocenter Projection) in case of cropping, rotation, padding and/or resizing of the FOV area.**

**C.8.19.6.4 XA/XRF Frame Pixel Data Properties Macro**

Table C.8.19.6-4 specifies the attributes of the Frame Pixel Data Properties Functional Group macro.

**Table C.8.19.6-4  
 XA/XRF FRAME PIXEL DATA PROPERTIES MACRO ATTRIBUTES**

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
Frame Pixel Data Properties Sequence	(0028,9443)	1	Sequence containing the pixel data properties for this frame. Only a single Item shall be permitted in this sequence.
>Pixel Intensity Relationship	(0028,1040)	1	The relationship between the Pixel and the X-Ray beam intensity. See C.8.19.6.4.1.1.
>Pixel Intensity Relationship Sign	(0028,1041)	1	The sign of the relationship between the Pixel sample values stored in Pixel Data (7FE0,0010) and the X-Ray beam intensity. Enumerated Values: 1 = Lower pixel values correspond to less X-Ray beam intensity -1 = Higher pixel values correspond to less X-Ray beam intensity See C.8.11.3.1.2 for further explanation.
>Imager Pixel Spacing	(0018,1164)	1C	Physical distance measured at the receptor plane of the detector between the centers of each pixel specified by a numeric pair – row spacing value (delimiter) column spacing value in mm. See 10.7.1.3 for further explanation of the value order. The value of this attribute shall never be adjusted to account for calibration against an object of known size; Pixel Spacing (0028,0030) is specified for that purpose. It is only allowed to be adjusted to compensate for the change of the Field of View Dimension(s) in Float (0018,9461) attribute. See C.8.19.6.4.1.2 Required if Image Type (0008,0008) Value

			1 equals ORIGINAL. May be present otherwise. Note: These values are the actual pixel spacing distances of the stored pixel values of an image.
<u>&gt;Pixel Data Area Origin Relative To FOV</u>	<u>(0018,7036)</u>	<u>3</u>	<u>Offset of the TLHC of the image stored in Pixel Data (7FE0,0010) from the TLHC of the Field Of View Area after FOV rotation and Flip. It is measured in image stored pixels as a row offset followed by a column offset.</u> Note: <u>Due to the differences in image stored pixel and detector element spacing, one may expect this attribute to have non-integer values.</u> <u>See C.8.19.6.4.1.3.</u>
<u>&gt;Pixel Data Area Rotation Angle Relative To FOV</u>	<u>(0018,7038)</u>	<u>3</u>	<u>Angle clockwise of the row direction of the image stored in Pixel Data (7FE0,0010) relative to the row direction of the Field Of View Area after FOV rotation and Flip. It is measured in degrees.</u> <u>See C.8.19.6.4.1.3.</u>
...			

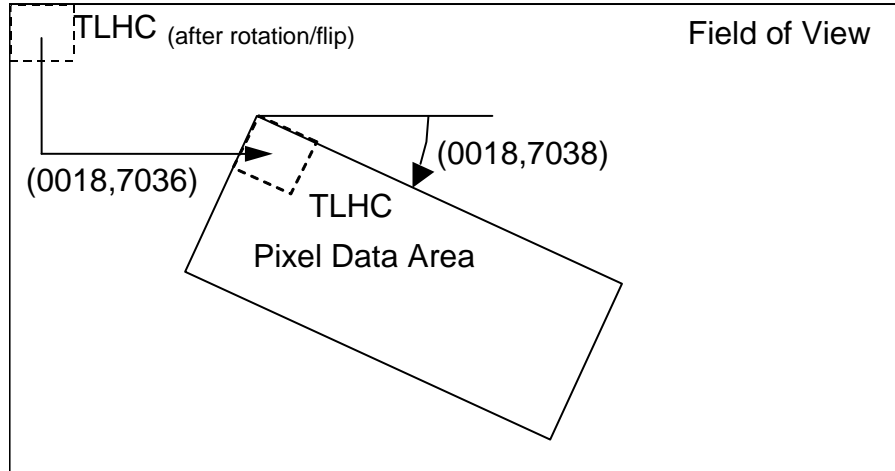
...

**C.8.19.6.4.1.3 Pixel Data Area Relative to FOV**

**In the case where the Field of View does not have the same size as the stored Pixel Data (7FE0,0010), the stored Pixel Data (7FE0,0010) may be the result of cropping, rotation, resizing and/or padding of the Field of View. The following Attributes specify the relationship of the Pixel Data area to the Field Of View Area:**

- **Pixel Data Area Origin Relative to FOV (0018,7036)**
- **Pixel Data Area Rotation Angle Relative to FOV (0018,7038)**

**Note: In order to make use of the Pixel Data Area Origin Relative to FOV (0018,7036), the Imager Pixel Spacing (0018,1164) is needed.**



**Figure C.8-xx**  
**Explanation of Pixel Data Area Attributes**

Amend PS 3.6 as follows:

**6 Registry of DICOM data elements**

<b>Tag</b>	<b>Name</b>	<b>Keyword</b>	<b>VR</b>	<b>VM</b>
(0018,7036)	Pixel Data Area Origin Relative To FOV	PixelDataAreaOriginRelativeToFOV	FL	2
(0018,7038)	Pixel Data Area Rotation Angle Relative To FOV	PixelDataAreaRotationAngleRelativeToFOV	FL	1