

1	Status	Final Text
2	Date of Last Update	2019/01/24
3	Person Assigned	David Clunie
4		mailto:dclunie@dclunie.com
5	Submitter Name	David Clunie
6		mailto:dclunie@dclunie.com
7	Submission Date	2018/06/02

8	Correction Number CP-1830	
9	Log Summary: Use of Segmentation and Parametric Maps with Whole Slide Imaging	
10	Name of Standard	
11	PS3.3 2018e	
12	Rationale for Correction:	
13	Though Segmentation and Parametric Map objects can be used for WSI to encode annotations and the results of processing by	
14	using the existing Derivation Image Functional Group to reference the source WS images when there is a 1:1 relationship between	
15	segmentation and parametric map pixels and the pixels of the source images, just as for cross-sectional imaging, this may not be	
16	the case, so there is a need for coordinate information, except that this needs to be relative to the slide coordinate system.	
17	Make the cross-sectional Plane Position (Patient) and Plane Orientation (Patient) Functional Groups conditional and add the Plane	
18	Position (Slide) Functional Group when appropriate, as well as the Image Orientation (Slide) Attribute.	
19	Correction Wording:	

Amend DICOM PS3.3 as follows (changes to existing text are bold and underlined for additions and ~~struckthrough~~ for removals):

## A.32.8.4 VL Whole Slide Microscopy Image Functional Group Macros

Table A.32.8-2. VL Whole Slide Microscopy Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M - Shall be used as a Shared Functional Group.
...		
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
...		
Plane Position (Slide)	C.8.12.6.1	C - Required if Dimension Organization Type (0020,9311) is not TILED_FULL; may be present otherwise.
...		

### Note

The Plane Position (Slide) and Optical Path Identification Macros are Type C, which allows the Per-Frame Functional Group Sequence (5200,9230) to be entirely omitted in those cases in which there are no other Per-Frame Functional Group Macros with content (i.e., the Frame Content Macro is empty).

### A.32.8.4.1 VL Whole Slide Microscopy Image Functional Group Macros Content Constraints

#### A.32.8.4.1.1 Referenced Image

Defined CID for Purpose of Reference Code Sequence (0040,A170) in the Referenced Image Functional Group is CID 8120.

#### A.32.8.4.1.2 Plane Position (Slide)

Frames shall occupy plane positions in a regular tiling of the Total Image Matrix; the frames may extend beyond the edges of the Total Image Matrix. Therefore, the value of Column Position In Total Pixel Matrix (0048,021E) shall be an integer multiple of the value of Columns (0028,0011) plus a constant, and the value of Row Position In Total Pixel Matrix (0048,021F) shall be an integer multiple of the value of Rows (0028,0010) plus a (possibly different) constant.

...

## A.51.5 Segmentation Functional Groups

Table A.51-2. Segmentation Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present. May be present otherwise. See Section A.51.5.1
Plane Position (Patient)	C.7.6.16.2.3	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present <b><u>and the Frame of Reference is defined in the patient-relative Reference Coordinate System</u></b> . May be present otherwise <b><u>if the Frame of Reference is defined in the patient-relative Reference Coordinate System</u></b> . See Section A.51.5.1
Plane Orientation (Patient)	C.7.6.16.2.4	C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present <b><u>and the Frame of Reference is defined in the patient-relative Reference Coordinate System</u></b> . May be present otherwise <b><u>if the Frame of Reference is defined in the patient-relative Reference Coordinate System</u></b> . See Section A.51.5.1

Functional Group Macro	Section	Usage
<u>Plane Position (Slide)</u>	<u>C.8.12.6.1</u>	<b>C - Required if Derivation Image Functional Group (C.7.6.16.2.6) is not present and the Frame of Reference is defined in the Slide Coordinate System. May be present otherwise if the Frame of Reference is defined in the Slide Coordinate System. See Section A.51.5.1.</b>
Derivation Image	C.7.6.16.2.6	C - Required if <del>any of</del> Pixel Measures (C.7.6.16.2.1) or <u>either</u> Plane Position (Patient) (C.7.6.16.2.3) or Plane Orientation (Patient) (C.7.6.16.2.4) ( <b>if the Frame of Reference is defined in the patient-relative Reference Coordinate System</b> ), or <u>Plane Position (Slide) (if the Frame of Reference is defined in the Slide Coordinate System)</u> Functional Groups are not present. May be present otherwise. See Section A.51.5.1
...		

### A.51.5.1 Segmentation Functional Groups Description

When a Frame of Reference UID is present the segment shall be specified within that coordinate system, using the Pixel Measures, **and either the** Plane Position (Patient) and Plane Orientation (Patient) **or the Plane Position (Slide)** Functional Groups. Since this defines the spatial relationship of the segment, the size of the segmentation frames need not be the same size, or resolution, as the image data used to generate the segment data. The Derivation Image Functional Group may also be present, to specify on which images the segmentation was actually performed (since there may be others in the same Frame of Reference that are spatially co-located, but were not used to perform the segmentation).

If the Frame of Reference UID is not present, each pixel of the segmentation shall correspond to a pixel in a referenced image, using the Derivation Image Functional Group. Hence, the rows and columns of each referenced image will match the segmentation image. If both the Frame of Reference UID and the Derivation Image Functional Group are present, the segmentation and referenced image pixels need not correspond.

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### A.75.5 Parametric Map Functional Groups

Table A.75-2. Parametric Map Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
Plane Position (Patient)	C.7.6.16.2.3	<b>MC – Required if the Frame of Reference is defined in the patient-relative Reference Coordinate System.</b>
Plane Orientation (Patient)	C.7.6.16.2.4	<b>MC – Required if the Frame of Reference is defined in the patient-relative Reference Coordinate System.</b>
<u>Plane Position (Slide)</u>	<u>C.8.12.6.1</u>	<b>C - Required if the Frame of Reference is defined in the Slide Coordinate System.</b>
Referenced Image	C.7.6.16.2.5	U
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
...		

### C.8.12.4 Whole Slide Microscopy Image Module

Table C.8.12.4-1. Whole Slide Microscopy Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			

Attribute Name	Tag	Type	Attribute Description
Image Orientation (Slide)	(0048,0102)	1	The direction cosines of the first row and the first column of the total pixel matrix with respect to the Slide Coordinate System Frame of Reference. See Section C.8.12.4.1.4
...			

## C.8.20.2 Segmentation Image Module

Table C.8.20-2. Segmentation Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			
<u>Image Orientation (Slide)</u>	<u>(0048,0102)</u>	<u>1C</u>	<u>The direction cosines of the first row and the first column of the total pixel matrix with respect to the Slide Coordinate System Frame of Reference. See Section C.8.12.4.1.4.</u> <u>Required if Plane Position (Slide) Sequence (0048.021A) is present within a Functional Group Sequence.</u>

## C.8.32.2 Parametric Map Image Module

Table C.8.32-2. Parametric Map Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
...			
<u>Image Orientation (Slide)</u>	<u>(0048,0102)</u>	<u>1C</u>	<u>The direction cosines of the first row and the first column of the total pixel matrix with respect to the Slide Coordinate System Frame of Reference. See Section C.8.12.4.1.4.</u> <u>Required if Plane Position (Slide) Sequence (0048.021A) is present within a Functional Group Sequence.</u>

## C.7.6.16.2.1 Pixel Measures Macro

Table C.7.6.16-2. Pixel Measures Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Pixel Measures Sequence	(0028,9110)	1	Identifies the physical characteristics of the pixels of this frame. Only a single Item shall be included in this Sequence.

Attribute Name	Tag	Type	Attribute Description
>Pixel Spacing	(0028,0030)	1C	<p>Physical distance in the imaging target (patient, specimen, or phantom) between the centers of each pixel, specified by a numeric pair - adjacent row spacing (delimiter) adjacent column spacing in mm. See Section 10.7.1.3 for further explanation of the value order.</p> <p><b>Note</b></p> <p>In the case of CT images with an Acquisition Type (0018,9302) of CONSTANT_ANGLE, the pixel spacing is that in a plane normal to the central ray of the diverging X-Ray beam as it passes through the data collection center.</p> <p>Required if:</p> <ul style="list-style-type: none"> <li>• Volumetric Properties (0008,9206) is other than DISTORTED or SAMPLED, or</li> <li>• SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or</li> <li>• SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or</li> <li>• SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8").</li> </ul> <p>May be present otherwise.</p>
>Slice Thickness	(0018,0050)	1C	<p>Nominal reconstructed slice thickness (for tomographic imaging) or depth of field (for optical non-tomographic imaging), in mm.</p> <p>See Section C.7.6.16.2.3.1 for further explanation.</p> <p><b>Note</b></p> <p>Depth of field may be an extended depth of field created by focus stacking (see Section C.8.12.4).</p> <p>Required if:</p> <ul style="list-style-type: none"> <li>• Volumetric Properties (0008,9206) is VOLUME or SAMPLED, or</li> <li>• SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or</li> <li>• SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or</li> <li>• SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8").</li> </ul> <p>May be present otherwise.</p>

Attribute Name	Tag	Type	Attribute Description
>Spacing Between Slices	(0018,0088)	1C	<p>Spacing between adjacent slices, in mm. The spacing is measured from the center-to-center of each slice, and if present shall not be negative.</p> <p>Required if Dimension Organization Type (0020,9311) is TILED_FULL and Total Pixel Matrix Focal Planes (0048,0303) is greater than 1. May be present otherwise.</p> <p><b>Note</b></p> <p>In the case of Whole Slide Images, Spacing Between Slices (0018,0088) describes the spacing of focal planes separately encoded, and is distinct from Distance Between Focal Planes (0048,0014), which describes in what manner different focal planes were combined into a single encoded plane (focus stacking).</p>

### C.7.6.16.2.3 Plane Position (Patient) Macro

**Table C.7.6.16-4. Plane Position (Patient) Macro Attributes**

Attribute Name	Tag	Type	Attribute Description
Plane Position Sequence	(0020,9113)	1	<p>Identifies the position of the plane of this frame.</p> <p>Only a single Item shall be included in this Sequence.</p>
>Image Position (Patient)	(0020,0032)	1C	<p>The x, y, and z coordinates of the upper left hand corner (center of the first voxel transmitted) of the frame, in mm. See Section C.7.6.2.1.1 and Section C.7.6.16.2.3.1 for further explanation.</p> <p><b>Note</b></p> <p>In the case of CT images with an Acquisition Type (0018,9302) of CONSTANT_ANGLE the image plane is defined to pass through the data collection center and be normal to the central ray of the diverging X-Ray beam.</p> <p>Required if:</p> <ul style="list-style-type: none"> <li>Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Volumetric Properties (0008,9206) of this frame is other than DISTORTED, or</li> <li>SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or</li> <li>SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or</li> <li>SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8").</li> </ul> <p>May be present otherwise.</p>

#### C.7.6.16.2.3.1 Position and Orientation for SAMPLED Frames

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## C.7.6.16.2.4 Plane Orientation (Patient) Macro

Table C.7.6.16-5. Plane Orientation (Patient) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Orientation Sequence	(0020,9116)	1	Identifies orientation of the plane of this frame. Only a single Item shall be included in this Sequence.
>Image Orientation (Patient)	(0020,0037)	1C	The direction cosines of the first row and the first column with respect to the patient. See Section C.7.6.2.1.1 and Section C.7.6.16.2.3.1 for further explanation.  Required if: <ul style="list-style-type: none"> <li>• Frame Type (0008,9007) Value 1 of this frame is ORIGINAL and Volumetric Properties (0008,9206) of this frame is other than DISTORTED, or</li> <li>• SOP Class UID is Segmentation Storage ("1.2.840.10008.5.1.4.1.1.66.4") and Frame of Reference UID (0020,0052) is present, or</li> <li>• SOP Class UID is Ophthalmic Tomography Image Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.4") and Ophthalmic Volumetric Properties Flag (0022,1622) is YES, or</li> <li>• SOP Class UID is Ophthalmic Optical Coherence Tomography B-scan Volume Analysis Storage ("1.2.840.10008.5.1.4.1.1.77.1.5.8").</li> </ul> May be present otherwise.

## C.7.6.16.2.5 Referenced Image Macro

Table C.7.6.16-6. Referenced Image Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Referenced Image Sequence	(0008,1140)	2	The set of images or other composite SOP Instances used to plan the acquisition, if any, and other significant related images. See Section C.7.6.16.2.5.1 for further explanation. Zero or more Items shall be included in this Sequence.
<i>&gt;Include Table 10-3</i>			
>Purpose of Reference Code Sequence	(0040,A170)	1C	Describes the purpose for which the reference is made.  Only a single Item shall be included in this Sequence.  Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted Enhanced CT Image Storage) and not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted Enhanced MR Image Storage) and not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted Enhanced PET Image Storage), may be present otherwise.  See Section C.7.6.16.2.5.1 for further explanation.
<i>&gt;&gt;Include Table 8.8-1</i>			Defined CID 7201, or as specified in the IOD invocation of this Functional Group.

### C.7.6.16.2.5.1 Use of Referenced Image Macro

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## C.7.6.16.2.6 Derivation Image Macro

**Table C.7.6.16-7. Derivation Image Macro Attributes**

Attribute Name	Tag	Type	Attribute Description
Derivation Image Sequence	(0008,9124)	2	The set of Images or other composite SOP Instances that were used to derive this frame.  Zero or more Items shall be included in this Sequence.
>Derivation Description	(0008,2111)	3	A text description of how this frame data was derived. See Section C.12.4.1.1 for further explanation.
>Derivation Code Sequence	(0008,9215)	1C	A coded description of how this frame was derived. See Section C.12.4.1.1 for further explanation.  One or more Items shall be included in this Sequence. More than one Item indicates that successive derivation steps have been applied.  Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted Enhanced CT Image Storage) and not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted Enhanced MR Image Storage) and not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted Enhanced PET Image Storage), may be present otherwise.
>>Include Table 8.8-1			Defined CID 7203.
>Source Image Sequence	(0008,2112)	2	The set of Images or other Composite SOP Instances that were used to derive this frame.  Zero or more Items shall be included in this Sequence. See Section C.12.4.1.2 for further explanation.
>>Include Table 10-3			
>>Purpose of Reference Code Sequence	(0040,A170)	1C	Describes the purpose for which the reference is made, that is what role the source image or frame played in the derivation of this image or frame.  Only a single Item shall be included in this Sequence.  Required if SOP Class UID is not "1.2.840.10008.5.1.4.1.1.2.2" (Legacy Converted Enhanced CT Image Storage) and not "1.2.840.10008.5.1.4.1.1.4.4" (Legacy Converted Enhanced MR Image Storage) and not "1.2.840.10008.5.1.4.1.1.128.1" (Legacy Converted Enhanced PET Image Storage), may be present otherwise.
>>>Include Table 8.8-1			Defined CID 7202.

Attribute Name	Tag	Type	Attribute Description
>>Spatial Locations Preserved	(0028,135A)	3	<p>The extent to which the spatial locations of all pixels are preserved during the processing of the source image that resulted in the current image or frame.</p> <p><b>Enumerated Values:</b></p> <p><b>YES</b>  <b>NO</b>  <b>REORIENTED_ONLY</b> A projection radiograph that has been flipped, and/or rotated by a multiple of 90 degrees</p> <p><b>Note</b></p> <ol style="list-style-type: none"> <li>This applies not only to images with a known relationship to a 3D space, but also to projection images. For example, a projection radiograph such as a mammogram that is processed by a point image processing operation such as contrast enhancement, or a smoothing or edge enhancing convolution, would have a value of YES for this Attribute. A projection radiograph that had been magnified or warped geometrically would have a value of NO for this Attribute. A projection radiograph that has been flipped, and/or rotated by a multiple of 90 degrees, such that transformation of pixel locations is possible by comparison of the values of Patient Orientation (0020,0020) would have a value of REORIENTED_ONLY. This Attribute is typically of importance in relating images with Presentation Intent Type (0008,0068) values of FOR PROCESSING and FOR PRESENTATION.</li> <li>When the value of this Attribute is NO, it is not possible to locate on the current image any pixel coordinates that are referenced relative to the source image, such as for example, might be required for rendering CAD findings derived from a referenced FOR PROCESSING image on the current FOR PRESENTATION image.</li> </ol>
>>Patient Orientation	(0020,0020)	1C	<p>The Patient Orientation values of the source image.</p> <p>Required if the value of Spatial Locations Preserved (0028,135A) is REORIENTED_ONLY.</p>

### C.8.12.6.1 Plane Position (Slide) Macro

Table C.8.12.6.1-1. Plane Position (Slide) Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Plane Position (Slide) Sequence	(0048,021A)	1	<p>Describes position of frame in the Total Pixel Matrix and in the Slide Coordinate System Frame of Reference.</p> <p>Only a single Item shall be included in this Sequence.</p>
>Column Position In Total Image Pixel Matrix	(0048,021E)	1	The column position of the top left hand pixel of the frame in the Total Pixel Matrix (see Section C.8.12.4.1.1). The column position of the top left pixel of the Total Pixel Matrix is 1.
>Row Position In Total Image Pixel Matrix	(0048,021F)	1	The row position of the top left hand pixel of the frame in the Total Pixel Matrix (see Section C.8.12.4.1.1). The row position of the top left pixel of the Total Pixel Matrix is 1.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in mm from the Origin of the Slide Coordinate System. See Figure C.8-16.

<b>Attribute Name</b>	<b>Tag</b>	<b>Type</b>	<b>Attribute Description</b>
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in mm from the Origin of the Slide Coordinate System. See Figure C.8-16.
>Z Offset in Slide Coordinate System	(0040,074A)	1	The Z offset in $\mu\text{m}$ from the Origin of the Slide Coordinate System, nominally the surface of the glass slide substrate. See Figure C.8-17  <b>Note</b>  Required even if only a single focal plane was acquired.