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8	Correction Number CP-1984	
9	Log Summary: Add Slide Plane Orientation information to Segmentation	
10	Name of Standard	
11	PS3.3	
12	Rationale for Correction:	
13	CP 1830 added the Plane Position (Slide) macro to segmentations, but there is no corresponding Plane Orientation information.	
14	In the Whole Slide Microscopy Image IOD, such information is communicated in the Whole Slide Microscopy Image Module rather	
15	than in a functional group.	
16	Either:	
17	<ul style="list-style-type: none"> <li>• need to explicitly state that the orientation of the segmentation image shall be the same as the referenced slide (simplest, and the approach proposed here)</li> </ul>	
18		
19	<ul style="list-style-type: none"> <li>• add conditional orientation information to the segmentation IOD, perhaps as a new macro (which would be inconsistent with the WS IOD) or in the top level data set</li> </ul>	
20		
21	Correction Wording:	

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

## A.51 Segmentation IOD

### A.51.5 Segmentation Functional Groups

Table A.51-2 specifies the use of the Functional Group Macros used in the ??? for the Segmentation IOD.

**Table A.51-2. Segmentation Functional Group Macros**

Functional Group Macro	Section	Usage
Pixel Measures	???	C - Required if Derivation Image Functional Group (???) is not present and the Frame of Reference is defined in the patient-relative Reference Coordinate System. May be present otherwise if the Frame of Reference is defined in the patient-relative Reference Coordinate System. See Section A.51.5.1
Plane Position (Patient)	???	C - Required if Derivation Image Functional Group (???) is not present and the Frame of Reference is defined in the patient-relative Reference Coordinate System. May be present otherwise if the Frame of Reference is defined in the patient-relative Reference Coordinate System. See Section A.51.5.1
Plane Orientation (Patient)	???	C - Required if Derivation Image Functional Group (???) is not present. May be present otherwise. See Section A.51.5.1
Plane Position (Slide)	C.8.12.6.1	C - Required if Derivation Image Functional Group (???) 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.
Derivation Image	???	C - Required if Pixel Measures (???) or either Plane Position (Patient) (???) or Plane Orientation (Patient) (???) (if the Frame of Reference is defined in the patient-relative Reference Coordinate System), or Plane Position (Slide) (C.8.12.6.1) (if the Frame of Reference is defined in the Slide Coordinate System) Functional Groups are not present. May be present otherwise. See Section A.51.5.1
Frame Content	???	M
Segmentation	???	M

#### 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.

The value of Purpose of Reference Sequence (0040,A170) in the Derivation Image Functional Group Macro shall be (121322, DCM, "Source Image for Image Processing Operation"). The value of Derivation Code Sequence (0008,9215) shall be (113076, DCM, "Segmentation").

#### Note

Non-image source instances used during segmentation, such as real world value maps, can be described in the top level Data Set in the Source Instance Sequence (0042,0013) of the General Reference Module and are implied to have been used for the derivation of all frames. I.e., there is no mechanism for selectively specifying on a per-frame basis which non-

image instances were used. Real World Value Map instances already contain a means of selectively applying different scale factors to different frames.

**For a segmentation with the position specified in the Slide Coordinate System, the orientation shall be that specified in the referenced image (described by the Image Orientation (Slide) (0048,0102) values in the referenced image). It is not explicitly conveyed in the segmentation instance.**

*For reference unchanged, DICOM PS3.3:*

## A.32.8 VL Whole Slide Microscopy Image IOD

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

Table A.32.8-2 specifies the use of the Functional Group Macros used in the ??? for the VL Whole Slide Microscopy Image IOD.

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

Functional Group Macro	Section	Usage
Pixel Measures	???	M - Shall be used as a Shared Functional Group.
Frame Content	???	U - Shall not be used as a Shared Functional Group.
Referenced Image	???	U
Derivation Image	???	C - Required if the image or frame has been derived from another SOP Instance.
Real World Value Mapping	???	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.
Plane Position (Slide)	C.8.12.6.1	C - Required if Dimension Organization Type (0020,9311) is TILED_FULL; may be present otherwise.
Optical Path Identification	???	C - Required if Dimension Organization Type (0020,9311) is TILED_FULL; may be present otherwise.
Specimen Reference	???	U
Whole Slide Microscopy Image Frame Type	???	M - Shall be used as a Shared Functional Group.

#### 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 or absent).

### 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 ????.

#### 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.

**Note**

Pixels beyond the edge of the Total Image Matrix may be encoded with a fixed padding value. For images with MONO-CHROME2 Photometric Interpretation, see Pixel Padding Value (0028,0120) in ???.

The encoding of tiles may be sparse; i.e., some tiles may not be encoded in frames. There are no constraints on the ordering of frames within the pixel data; each frame specifies its position in the Plane Position (Slide) Functional Group.

**Note**

Different SOP Instances within a Series may have different tiling boundaries and sizes.

Frames associated with different optical paths may coincide in any spatial dimension.

## 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
...			
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.8.12.4.1 Whole Slide Microscopy Image Attribute Descriptions

#### C.8.12.4.1.4 Total Pixel Matrix Origin Sequence and Image Orientation (Slide)

Total Pixel Matrix Origin Sequence (0048,0008) specifies the location of the top leftmost pixel of the pixel matrix, and Image Orientation (Slide) (0048,0102) specifies the direction cosines of the first row and the first column of the pixel matrix, both with respect to the Slide Coordinate System Frame of Reference (see Section C.8.12.2). Although the image acquisition may vary the true row and column orientation at the pixel scale to account for local variation in the physical specimen, this Attribute describes the orientation as if the Pixel Matrix were flat.

**Note**

Typically, Image Orientation (Slide) will describe only a planar rotation, as the image plane is usually nominally parallel to the slide surface.

## C.8.12.6 Whole Slide Microscopy Image Functional Group Macros

The following sections contain Functional Group Macros specific to the VL Whole Slide Microscopy Image IOD.

**Note**

The Attribute descriptions in the Functional Group Macros are written as if they were applicable to a single frame (i.e., the Macro is part of the Per-frame Functional Groups Sequence). If an Attribute is applicable to all frames (i.e., the Macro is part of the Shared Functional Groups Sequence) the phrase "this frame" in the Attribute description shall be interpreted to mean "for all frames".

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

Table C.8.12.6.1-1 specifies the Attributes of the Plane Position (Slide) Functional Group 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	Describes position of frame in the Total Pixel Matrix and in the Slide Coordinate System Frame of Reference.  Only a single Item shall be included in this Sequence.
>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 ???). 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 ???). 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.
>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.

## C.8.12.2 Slide Coordinates Module

The table in this Section contains Attributes that describe Slide Coordinates. Slide Coordinates provide a means to locate an image within a given Frame of Reference.

### Note

1. A Frame of Reference (identified by a Frame of Reference UID) typically only applies to a single mounting of a slide on a particular microscope stage; there is no guarantee that a subsequent mounting of the slide, even on the same equipment, will allow reproducible positioning to the exact same location. These Attributes allow consistent location of multiple images within the Series of a single Frame of Reference.
2. There is no a priori correspondence of pixels to Slide Coordinates. Therefore, the geometrical symmetry point through the pixel plane of the digital microscope may not correspond to the center of a pixel. The geometrical symmetry point could be between pixels.
3. This Module formerly included a Type 3 Attribute Pixel Spacing Sequence (0040,08D8), and subsidiary Attributes; see PS3.3-2009. Pixel Spacing is an Attribute of the image acquisition, not the slide coordinates, and is inappropriate for this Module. It is now conveyed by Pixel Spacing (0028,0030) in the ??? or the Pixel Measures Functional Group (see ???).

**Table C.8-78. Slide Coordinates Module Attributes**

Attribute Name	Tag	Type	Attribute Description
Image Center Point Coordinates Sequence	(0040,071A)	2	The coordinates of the center point of the Image in the Slide Coordinate System Frame of Reference.  Zero or one Item shall be included in this Sequence.  See Section C.8.12.2.1.1 for further explanation.
>X Offset in Slide Coordinate System	(0040,072A)	1	The X offset in millimeters from the Origin of the Slide Coordinate System. See Figure C.8-16.

Attribute Name	Tag	Type	Attribute Description
>Y Offset in Slide Coordinate System	(0040,073A)	1	The Y offset in millimeters from the Origin of the Slide Coordinate System. See Figure C.8-16.
>Z Offset in Slide Coordinate System	(0040,074A)	2	The Z offset in microns from the image substrate reference plane (i.e., utilized surface of a glass slide).

### C.8.12.2.1 Slide Coordinates Attribute Descriptions

#### C.8.12.2.1.1 Image Center Point Coordinates Sequence

This Section defines the Slide Coordinate System and specifies the Attributes that shall be used to describe the location of the center point of the Image pixel plane (as captured through a microscope) in the Slide Coordinate System Frame of Reference.

#### Note

In Slide Microscopy (SM), the Microscope is equipped with a moveable Stage and position sensors that enable storage of the location of the center point of the displayed image with respect to the examined Specimen.

The Stage is the part of the Microscope to which the Slide is attached for viewing. The Objective Lens is the lens that is closest to the Specimen. The Top Surface of the Slide is the surface of the Slide on which the Specimen is mounted. The Bottom Surface of the Slide is the opposite surface. This Specification presumes that: 1) the Slide is rectangular; 2) the Top Surface of the Slide is oriented toward the Objective Lens of the Microscope; and 3) the Bottom Surface of the Slide is in perfect contact with the Microscope Stage when the Slide is attached to the Stage for viewing.

#### Note

1. The Label of the Slide is presumed to be mounted-on or written-on the Top Surface of the Slide.
2. Specification of the mechanical form, function, or tolerances of the Microscope are outside the scope of this Standard.

Figure C.8-16 depicts the Top Surface of the Slide on the Microscope Stage from the perspective of the Objective Lens. This is Reference Slide Orientation. The X, Y, and Z axes of the Slide Coordinate System in Reference Slide Orientation are defined as follows. The Y-axis is a line that nominally represents the Left Edge of the Slide. The X-axis is a line that is orthogonal to the Y-axis and nominally represents the Specimen Edge of the Slide. The Z-axis is a line that passes through the intersection of the X-axis and Y-axis and is orthogonal to the Microscope Stage. The Origin (0,0,0) of the Slide Coordinate System is the point of intersection of the X, Y, and Z axes.

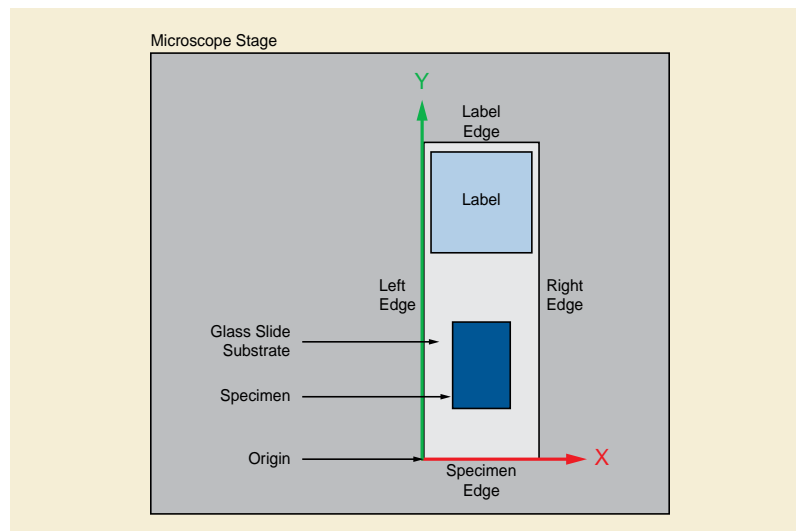
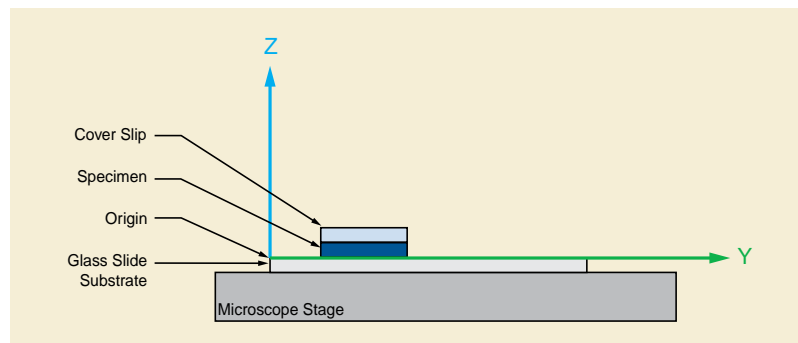


Figure C.8-16. Reference Slide Orientation

**Note**

1. An improperly-placed coverslip or Specimen that overlaps an Edge of a Slide is not considered part of the Edge a Slide for purposes of defining the Slide Coordinate System. However, such objects may cause inaccurate positioning of the Slide on the Stage.
2. If the Left Edge and Specimen Edge of the Slide are not orthogonal (e.g., the Slide is damaged or defective or the Specimen Edge is curvilinear), then the lower left-hand corner of the Slide may not be located at the Origin.
3. The definitions of X, Y, and Z axes are the same for inverted microscopes, with the Top Surface of the slide (i.e., Specimen side of the Slide) still being closest to the Objective Lens.
4. The origin of a Frame of Reference is arbitrary (see ???), but its nominal location for consistency of slide coordinates is defined in this section.

Figure C.8-17 depicts the Z-axis center point location. The X Offset in Slide Coordinate System (0040,072A) shall increase from the Origin toward the Right Edge in Reference Slide Orientation. The Y Offset in Slide Coordinate System (0040,073A) shall increase from the Origin toward the Label Edge in Reference Slide Orientation. The Z Offset in Slide Coordinate System (0040,074A) shall be nominally referenced as zero at the image substrate reference plane (i.e., the top surface of a glass slide) and shall increase in a positive fashion coincident with increased distance from the substrate surface.



**Figure C.8-17. Z-Axis Center Point Location, View From Right Edge of Slide**