Correction Number CP-2178

Log Summary: Clarify Microscopy Bulk Simple Annotations Coordinate Units

Name of Standard
PS3.3 2022b

Rationale for Correction:
Units for 3D point coordinates in annotations are explicitly specified in mm for X, Y and Z, as well as when the Z coordinate is factored out.

However, for Z, this is inconsistent with the Z Offset in Slide Coordinate System, used in WS images, which is specified in microns. The units are specified by the Attributes and their descriptions, and not an inherent feature of the defined Coordinate System. Emphasize the discrepancy and clarify what units are required.

Correction Wording:
Amend DICOM PS3.3 as follows:

C.37.1.2 Microscopy Bulk Simple Annotations Module

Table C.37.1-2. Microscopy Bulk Simple Annotations Module Attributes

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Pixel Origin Interpretation</strong> (0048,0301) 1C For image-relative coordinates, specifies whether coordinates are to be interpreted relative to the individual frame pixel origins, or relative to the Total Pixel Matrix origin (see Section C.8.12.4.1.4). Required if Annotation Coordinate Type (006A,0001) is 2D. <strong>Enumerated Values:</strong> FRAME relative to individual frame VOLUME relative to Total Image Matrix  <strong>Note</strong> The use of the term &quot;VOLUME&quot; to refer to the Total Image Matrix is historical and inherited from Presentation States, and does not refer to 3D coordinates.</td>
</tr>
<tr>
<td>&gt;Common Z Coordinate Value</td>
<td>(006A,0010)</td>
<td>1C</td>
<td>The Z coordinate(s) common to all points in Point Coordinates Data (0066,0016) or Double Point Coordinates Data (0066,0022), in mm in the Slide Coordinate System (Section C.8.12.2.1.1) associated with the Frame of Reference. More than one value may be present if the Annotations apply to more than one (but not all) Z planes. Required if Annotation Coordinate Type (006A,0001) is 3D, and all points in Point Coordinates Data (0066,0016) or Double Point Coordinates Data (0066,0022) are in the same Z plane(s).  <strong>Note</strong> This requirement means that it is mandatory to factor out the commonality, i.e., it is not permitted to send Point Coordinates Data (0066,0016) or Double Point Coordinates Data (0066,0022) with (X, Y, Z) triplets where all the Z values are the same. For Annotations of images that only have a single Z plane, or where all the points in an Annotation Group are coplanar and in the same Z plane, this condition will always be satisfied. Annotations in different Z planes can be separated into separate Annotation Groups in order to allow this condition to be satisfied, but using separate Annotation Groups is not required. See Section C.37.1.2.1.1.</td>
</tr>
<tr>
<td>&gt;Point Coordinates Data</td>
<td>(0066,0016)</td>
<td>1C</td>
<td>The coordinates of one or more points that define the Annotations (whether single points or polygons), encoded in (X, Y) or (X, Y, Z) order. Required if Double Point Coordinates Data (0066,0022) is not present. For each point, two coordinates (X, Y) shall be encoded if Common Z Coordinate Value (006A,0010) is present, otherwise three coordinates (X, Y, Z) shall be encoded. See Section C.37.1.2.1.1.</td>
</tr>
<tr>
<td>Attribute Name</td>
<td>Tag</td>
<td>Type</td>
<td>Attribute Description</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------</td>
<td>------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>&gt;Double Point Coordinates Data</td>
<td>(0066,0022)</td>
<td>1C</td>
<td>The coordinates of one or more points that define the Annotations (whether single points or polygons), encoded in (X, Y) or (X, Y, Z) order.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Required if Point Coordinates Data (0066,0016) is not present.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For each point, two coordinates (X, Y) shall be encoded if Common Z Coordinate Value (006A,0010) is present, otherwise three coordinates (X, Y, Z) shall be encoded.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>See Section C.37.1.2.1.1.</td>
</tr>
</tbody>
</table>

### C.37.1.2.1 Microscopy Bulk Simple Annotations Module Attributes

#### C.37.1.2.1.1 Type, Points, Polygons, Parameterized and Rotated Shapes and Indices

If Annotation Coordinate Type (006A,0001) is 2D, then the coordinates are interpreted as image-relative, either relative to an individual frame or the Total Pixel Matrix, with units of pixels, as defined in ???. If Pixel Origin Interpretation (0048,0301) is FRAME, then a single frame of a single image shall be specified in Referenced Image Sequence (0008,1140). If Pixel Origin Interpretation (0048,0301) is VOLUME, then a single image shall be specified in Referenced Image Sequence (0008,1140) without a subset of frames designated, and the coordinates are relative to the Total Image Matrix of that image. The referenced image shall not be an instance of a Concatenation; i.e., in the case of Concatenations, references shall be relative to the SOP Instance UID of Concatenation Source (0020,0242).

**Note**
1. The referenced image need not be any particular resolution layer of a WSI pyramid. I.e., it may or may not be the highest resolution layer. The user may annotate images that are not at the highest resolution, but such Annotations may be projected onto any resolution layer that is available (or computed). If the referenced image is no longer stored or accessible, the ability to project the Annotations onto other layers may be lost.
2. A reference to a single frame means that all Annotations in this instance are on that frame; no mechanism is provided to span frames, or to specify more than one frame.

If Annotation Coordinate Type (006A,0001) is 3D, then the X, Y and Z coordinates are interpreted as volume relative, with units of mm, in the Cartesian space defined by the Frame of Reference UID.

**Note**
- A single referenced image may be specified even if Annotation Coordinate Type (006A,0001) is 3D. It need not be any particular resolution layer of a WSI pyramid, but may be interpreted as a suitable layer on which to render, select from or otherwise apply the Annotation. In particular, it may not be the highest resolution layer. Regardless, the Annotations are applicable to any image in the same Frame of Reference.
- **The use of millimeters as the unit for the Z coordinates is inconsistent with the use of microns for the Z Offset in Slide Coordinate System (0040,074A) in the Section C.8.12.2 Slide Coordinates Module.**

Open polylines and implicitly closed polygons shall have their vertices encoded in Point Coordinates Data (0066,0016) or Double Point Coordinates Data (0066,0022) in clockwise winding order when viewed from the top surface of the slide towards the bottom, per Section C.8.12.2.1 Slide Coordinates Attribute Descriptions. The line segments shall not cross (i.e., shall be simple polygons, not complex polygons), and shall not contain holes (i.e., the keyhole technique described for RT Structure Sets (???), shall not be used).

The plane of the coplanar points is not required to correspond to an image plane or be parallel to the slide surface; the points are only required to be coplanar in a geometric sense (i.e., they need not all have the same Z coordinate value).
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**

<table>
<thead>
<tr>
<th>Attribute Name</th>
<th>Tag</th>
<th>Type</th>
<th>Attribute Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Center Point Coordinates Sequence</td>
<td>(0040,071A)</td>
<td>2</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>See Section C.8.12.2.1.1 for further explanation.</td>
</tr>
<tr>
<td>&gt;X Offset in Slide Coordinate System</td>
<td>(0040,072A)</td>
<td>1</td>
<td>The X offset in millimeters from the Origin of the Slide Coordinate System. See Figure C.8-16.</td>
</tr>
<tr>
<td>&gt;Y Offset in Slide Coordinate System</td>
<td>(0040,073A)</td>
<td>1</td>
<td>The Y offset in millimeters from the Origin of the Slide Coordinate System. See Figure C.8-16.</td>
</tr>
<tr>
<td>&gt;Z Offset in Slide Coordinate System</td>
<td>(0040,074A)</td>
<td>2</td>
<td>The Z offset in microns from the image substrate reference plane (i.e., utilized surface of a glass slide).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Note</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The use of units of microns is inconsistent with the use of millimeters for Point Coordinates Data (0066,0016), Double Point Coordinates Data (0066,0022) and Common Z Coordinate Value (006A,0010) in the Section C.37.1.2 Microscopy Bulk Simple Annotations Module.</td>
</tr>
</tbody>
</table>

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