Digital Imaging and Communications in Medicine (DICOM)

Supplement 226: Cutaneous Confocal Microscopy [WI2020-04-A]

Prepared by:

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Scope and Field of Application

This Supplement to the DICOM Standard introduces two new IODs (Confocal Microscopy IOD, Confocal Microscopy Tiled Pyramidal Image IOD) and two corresponding SOP Classes for encoding and storing confocal microscopy images. These IODs are intended to be applicable to all application of confocal microscopy. An acquisition context module specific to cutaneous confocal microscopy has been defined. Specific modules for other applications of confocal microscopy may be added in the future.

Cutaneous confocal microscopy is a non-invasive imaging technique that allows examination of the skin at resolutions comparable to histology without performing biopsy. Cutaneous confocal microscopy may be done in-vivo or on ex-vivo tissue.

In-vivo cutaneous reflectance confocal microscopy (RCM) is used for the early diagnosis of a range of cutaneous diseases with an emphasis on melanoma and pigmented lesions. In-vivo cutaneous RCM is most often used as an adjunct to clinical and dermoscopic imaging of a skin lesion as opposed to a stand-alone imaging technique. In addition to diagnostic applications, in-vivo cutaneous RCM may be used for the pre-operative mapping of margins of ill-defined tumors, which allows more accurate surgical plan and reduces surgical morbidity.

The cutaneous RCM microscope uses a diode laser as a source of monochromatic and coherent light and scanning and focusing optical lens to penetrate the skin and illuminate a small tissue spot. Reflected light forms an image on a photodetector.

Ex-vivo cutaneous confocal microscopy allows the microscopic examination of freshly excised tissue. The ex-vivo cutaneous confocal microscopy can work in reflectance mode or fluorescence mode. When using the fluorescence mode, the entire surgical specimen is dipped in a solution of a fluorescent agent and subsequently rinsed to remove excess of fluorescent agent. In reflectance mode no staining is required.

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

Add to PS3.3

A.X Confocal Microscopy Image Information Object Definitions

The Confocal Microscopy Image Information Object Definitions specify images that are acquired by means of a confocal microscope. The confocal microscopy may be performed in-vivo or ex-vivo in reflectance or fluorescence mode.

Confocal images may be tiled or simple (non-tiled). Separate IODs have been defined for simple confocal microscopy images and tiled or tiled pyramidal images.

Simple confocal images may be encoded according the to the Confocal Microscopy Image IOD. A SOP Instance may contain one or more frames (multi-frame). A movie acquisition may be encoded as a multi-frame cine image.

A.X.1 Confocal Microscopy Image IOD

A.X.1.1 Confocal Microscopy Image IOD Description

The Confocal Microscopy Image IOD specifies the Attributes of a simple (non-tiled) Confocal Microscopy Image.

A.X.1.2 Confocal Microscopy Image IOD Description Entity-Relationship Model

The Confocal Microscopy Image IOD uses the DICOM Composite Instance IOD Entity-Relationship Information Model defined in Section A.1.2, with only the Image IE below the Series IE.

A.X.1.3 Confocal Microscopy Image IOD Module Table

Table A.X.1.3-1 specifies the Modules of the Confocal Microscopy Image IOD.

Table A.X.1.3-1

CONFOCAL MICROSCOPY IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
	Specimen	C.7.6.22	C-Required if the Imaging Subject is a Specimen
Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C-Required if time synchronization was applied
Equipment	General Equipment	C.7.5.1	M

	Enhanced General Equipment	C.7.5.2	M
Acquisition	General Acquisition	C.7.10.1	M
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	U
	Multi-frame	C.7.6.6	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Acquisition Context	C.7.6.14	M
	Confocal Microscopy Image	C.8.XX.1	M
	Cutaneous Confocal Microscopy Image Acquisition Parameters	C.8.XX.1	C – Required for cutaneous confocal microscopy
	Optical Path	C.8.12.5	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.X.1.4 Confocal Microscopy IOD Content Constraints

A.X.1.4.1 Modality

The value of Modality (0008,0060) shall be CFM.

A.X.1.4.2 Acquisition Context Module

The Defined TID for Acquisition Context Sequence (0040,0555) is TID 8300 “Skin Imaging Acquisition Context”.

Note Any lesion level attributes apply to the single lesion seen in the acquired image.

A.X.1.4.3 Referenced Image Sequence

In cutaneous confocal microscopy the Referenced Image Sequence (0008,1140) may be used to identify the SOP instance of a Dermoscopic, or Visible Light image correlated to the Confocal Microscopy acquisition. The Purpose of Reference Code Sequence (0040,A170) shall have the value (121311, DCM, Localizer).

A.X.1.4.4 Anatomic Region Sequence

For Anatomic Region Sequence (0008,2218) BCID 4029 “Dermatology Anatomic Site” may be used. For Anatomic Region Modifier Sequence (0008,2220) BCID 245 “Laterality with Median” may be used.

A.X.1.4.5 Illumination Type

For Illumination Type Code Sequence (0022,0016) BCID 8123 “Microscopy Illumination Method” may be used.

A.X.1.5 Confocal Microscopy Image Functional Group Macros

Table A.X.1.5-1 Confocal 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
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Optical Path Identification	C.8.12.6.2	C - Required if Dimension Organization Type (0020,9311) is not TILED_FULL; may be present otherwise.
Referenced Image	C.7.6.16.2.5	C – Required if the image or frame has been planned on another image or frame. May be present otherwise.
Frame Content	C.7.6.16.2.2	U – Shall not be used as a shared functional group
Real World Value Mapping	C.7.6.16.2.11	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.
Plane Position (Slide)	C.8.12.6.1	C – Required if the Frame of Reference is defined in the Slide Coordinate System.
Confocal Microscopy Image Frame Type	C.8.XX.4.1	M
Frame Anatomy	C.7.6.16.2.8	M

A.X.2 Confocal Microscopy Tiled Pyramidal IOD

A.X.2.1 Confocal Microscopy Tiled Pyramidal Image IOD Description

The Confocal Microscopy Tiled Pyramidal Image IOD specifies the Attributes of Tiled Pyramidal Confocal Microscopy Images.

A.X.2.2 Confocal Microscopy Tiled Pyramidal Image IOD Description Entity-Relationship Model

The Confocal Microscopy Tiled Pyramidal Image IOD uses the DICOM Composite Instance IOD Entity-Relationship Information Model defined in Section A.1.2, with only the Image IE below the Series IE.

A.X.2.3 Confocal Microscopy Tiled Pyramidal Image IOD Module Table

Table A.X.2.3-1 specifies the Modules of the Confocal Microscopy Tiled Pyramidal Image IOD.

Table A.X.2.3-1

CONFOCAL MICROSCOPY TILED PYRAMIDAL IMAGE IOD MODULES

IE	Module	Reference	Usage
Patient	Patient	C.7.1.1	M
	Clinical Trial Subject	C.7.1.3	U
	Specimen	C.7.6.22	C-Required if the Imaging Subject is a Specimen

Study	General Study	C.7.2.1	M
	Patient Study	C.7.2.2	U
	Clinical Trial Study	C.7.2.3	U
Series	General Series	C.7.3.1	M
	Clinical Trial Series	C.7.3.2	U
Frame of Reference	Frame of Reference	C.7.4.1	M
	Synchronization	C.7.4.2	C-Required if time synchronization was applied.
Equipment	General Equipment	C.7.5.1	M
	Enhanced General Equipment	C.7.5.2	M
Acquisition	General Acquisition	C.7.10.1	M
Multi-Resolution Pyramid	Multi-Resolution Pyramid	C.7.11.1	U – Shall be present only if Image Type Value 3 is VOLUME or THUMBNAIL
Image	General Image	C.7.6.1	M
	General Reference	C.12.4	U
	Microscope Slide Layer Tile Organization	C.8.12.14	C - Required for slide microscopy imaging. May be present otherwise
	Image Plane	C.7.6.2	M
	Image Pixel	C.7.6.3	M
	Multi-frame Functional Groups	C.7.6.16	M
	Multi-frame Dimension	C.7.6.17	M
	Acquisition Context	C.7.6.14	M
	Confocal Microscopy Image	C.8.XX.1	M
	Confocal Microscopy Tiled Pyramidal Image	C.8.XX.2	M
	Cutaneous Confocal Microscopy Image Acquisition Parameters	C.8.XX.3	C – Required for cutaneous confocal microscopy
	Optical Path	C.8.12.5	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

A.X.2.4 Confocal Microscopy Tiled Pyramidal IOD Content Constraints

A.X.2.4.1 Modality

The value of Modality (0008,0060) shall be CFM.

A.X.2.4.2 Acquisition Context Module

The Defined TID for Acquisition Context Sequence (0040,0555) is TID 8300 “Skin Imaging Acquisition Context”.

Note Any lesion level attributes apply to the single lesion seen in the acquired image.

A.X.2.4.3 Referenced Image Sequence

In cutaneous confocal microscopy the Referenced Image Sequence (0008,1140) may be used to identify the SOP instance of a Dermoscopic or Visible Light image correlated to the Confocal Microscopy acquisition. The Purpose of Reference Code Sequence (0040,A170) shall have the value (121311, DCM, Localizer).

A.X.2.4.4 Antomical Region Sequence

For Anatomic Region Sequence (0008,2218) BCID 4029 “Dermatology Anatomic Site” may be used. For Anatomic Region Modifier Sequence (0008,2220) BCID 245 “Laterality with Median” may be used.

A.X.1.4.5 Illumination Type

For Illumination Type Code Sequence (0022,0016) BCID 8123 “Microscopy Illumination Method” may be used.

A.X.2.5 Confocal Microscopy Tiled Pyramidal Image Functional Group Macros

Table A.X.2.5-1 Confocal Microscopy Tiled Pyramidal 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
Derivation Image	C.7.6.16.2.6	C - Required if the image or frame has been derived from another SOP Instance.
Optical Path Identification	C.8.12.6.2	C - Required if Dimension Organization Type (0020,9311) is not TILED_FULL; may be present otherwise.
Specimen Reference	C.8.12.6.3	U
Referenced Image	C.7.6.16.2.5	C – Required if the image or frame has been planned on another image or frame. May be present otherwise.
Frame Content	C.7.6.16.2.2	U – Shall not be used as a shared functional group
Real World Value Mapping	C.7.6.16.2.11	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.
Plane Position (Slide)	C.8.12.6.1	C – Required if the Frame of Reference is defined in the Slide Coordinate System.
Confocal Microscopy Image Frame Type	C.8.XX.4.1	M
Frame Anatomy	C.7.6.16.2.8	M

Modify A.32.11.4.3 Acquisition Context Module

A.32.11.4.3 Acquisition Context Module

The Defined TID for Acquisition Context Sequence (0040,0555) is TID 8300 “Skin ~~Cancer~~ **Imaging** Acquisition Context”.

~~It encodes patient level and lesion level information related to skin cancer.~~

Note Any lesion level attributes apply to the single lesion seen in the acquired image.

Add to PS3.3 C.7.3.1.1.1 Modality.

C.7.3.1.1 General Series Attribute Descriptions

C.7.3.1.1.1 Modality

Defined Terms:

…

CFM Confocal Microscopy

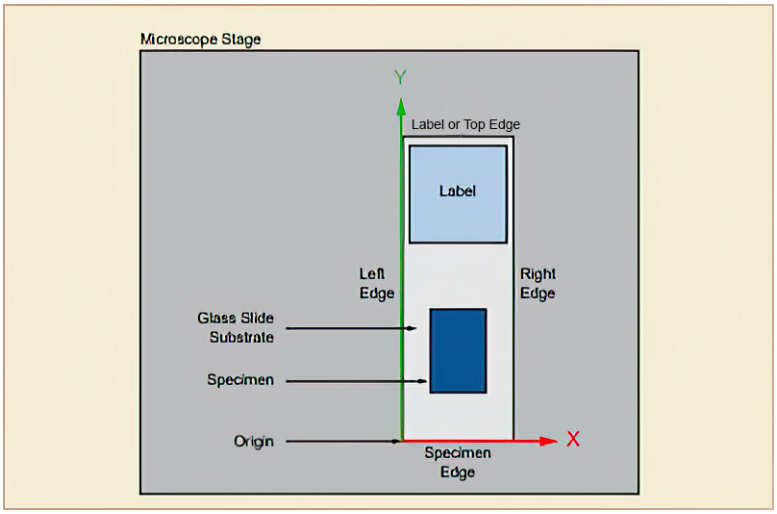
…

Add to PS3.3 C.8.12.2.1 Slide Coordinates Module Attributes Descriptions.
Note that upper diagram in Figure C8.1-16 is kept unchanged but a new subtitle is added.
The lower diagram is new with a new subtitle.
The Figure caption remains unchanged.

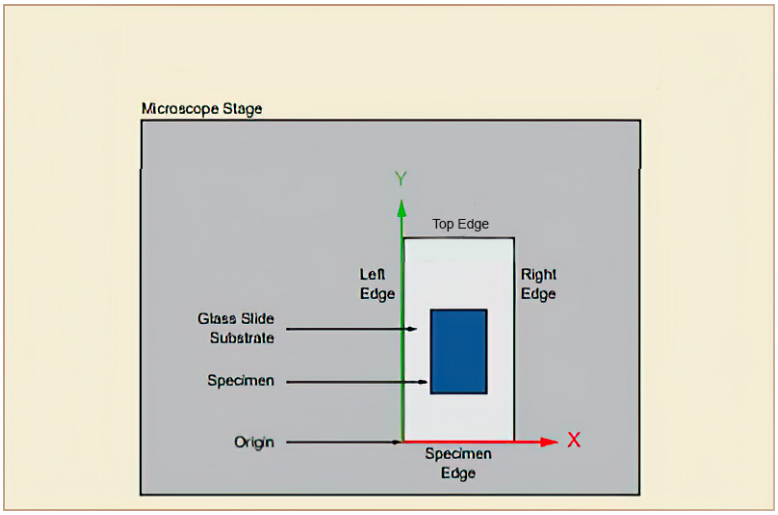
C.8.12.2.1 Slide Coordinates Module Attributes Descriptions

…

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 andnominally 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 theX, Y, and Z axes.



a) **Ex-vivo imaging - slide contains label**.



b) <u>Ex-vivo imaging - slide does not contain label.</u>

Figure C.8-16 Reference Slide Orientation

…

Figure C.8-17 depicts the Z-axis center point location. The X Offset in Slide Coordinate System (0040,072A) shall increase from theOrigin toward the Right Edge in Reference Slide Orientation. The Y Offset in Slide Coordinate System (0040,073A) shall increasefrom the Origin toward the Label Edge **or Top 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 apositive fashion coincident with increased distance from the substrate surface

….

In-vivo imaging uses a cartesian, orthogonal, right-handed coordinate system. This coordinate system is depicted in Figure C.8-18. The Y-axis is oriented from the nominal bottom of the microscope to the nominal top of the microscope. The X-axis is oriented from nominal left of the microscope to the nominal right of the microscope. The Z-axis is oriented from the subject towards the microscope.

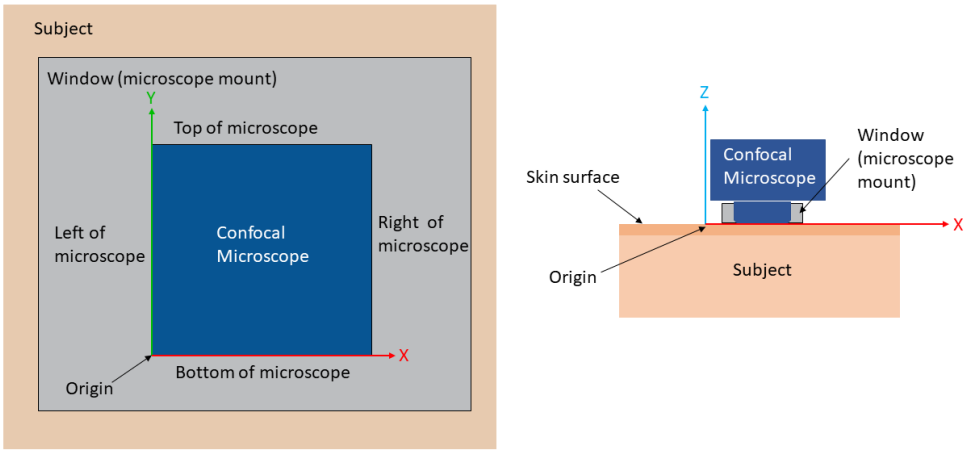


Figure C.8-18 In-vivo microscopy coordinates a) is a front on view b) is top-down view of in-vivo imaging.

…

Add the following new subsection in PS3.3 C.8 Modality Specific Modules

C.8.XX Confocal Microscopy Image Modules

This Section describes the Confocal Microscopy Image Module, the Confocal Microscopy Tiled Pyramidal Image Module, and the Cutaneous Confocal Microscopy Image Acquisition Parameters Module.

The Confocal Microscopy Image Module and the Confocal Microscopy Tiled Pyramidal Image Module contain attributes specific to Confocal Microscopy images.

The Cutaneous Confocal Microscopy Image Acquisition Parameters Module contains Attributes that are specific to Cutaneous Confocal Microscopy images.

C.8.XX.1 Confocal Microscopy Image Module

Table C.8.XX.1-1 specifies the Attributes that describe confocal microscopy images.

Table C.8.XX.1-1. Confocal Microscopy Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.XX.1.1.1 for specialization.
Photometric Interpretation	(0028,0004)	1	Specifies the intended interpretation of the pixel data. See Section C.8.12.1.1.1 for specialization of this Attribute.
Bits Allocated	(0028,0100)	1	Number of bits allocated for each pixel sample. Each sample shall have the same number of bits allocated. See Section C.8.12.1.1.2 for specialization of this Attribute. See PS3.5 for further explanation.
Bits Stored	(0028,0101)	1	Number of bits stored for each pixel sample. Each sample shall have the same number of bits stored. See Section C.8.12.1.1.2 for specialization of this Attribute. See PS3.5 for further explanation.
High Bit	(0028,0102)	1	Most significant bit for pixel sample data. Each sample shall have the same high bit. See Section C.8.12.1.1.2 for specialization of this Attribute. See PS3.5 for further explanation.
Pixel Representation	(0028,0103)	1	Data representation of the pixel samples. Each sample shall have the same pixel representation. See Section C.8.12.1.1.3 for specialization of this Attribute.
Samples per Pixel	(0028,0002)	1	Number of samples (planes) per image. See Section C.8.12.1.1.4 for specialization of this Attribute.

Planar Configuration	(0028,0006)	1C	Indicates whether the pixel data are encoded color-by-plane or color-by-pixel. Required if Samples per Pixel (0028,0002) has a value greater than 1. See Section C.8.12.1.1.5 for specialization of this Attribute.
Lossy Image Compression	(0028,2110)	1	Specifies whether an Image has undergone lossy compression (at a point in its lifetime). Enumerated Values: 00 Image has NOT been subjected to lossy compression. 01 Image has been subjected to lossy compression. Once this value has been set to 01 it shall not be reset. See Section C.7.6.1.1.5
Confocal Mode	(aaaa,aaaa)	1	Whether the images were acquired by the confocal microscope in reflectance or fluorescence mode. Enumerated Values REFLECTANCE FLUORESCENCE
Tissue Location	(bbbb,bbbb)	1	Whether the tissue that is the subject of the image is in the body (i.e., in-vivo) or an excised tissue sample (i.e., ex-vivo). Enumerated Values INVIVO EXVIVO

C.8.XX.1.1 Confocal Microscopy Image Attribute Descriptions

C.8.XX.1.1.1 Image Type

Image Type (0008,0008) is specified to be Type 1 with the following constraints:

Value 1 shall have a value of ORIGINAL or DERIVED

Value 2 shall have a value of PRIMARY

Value 3 (Image Flavor) shall have the Defined Terms specified in Table C.8.XX.1.1.1-1

Value 4 (Derived pixel) shall have the Defined Terms specified in Table C.8.XX.1.1.1-2

Table C.8.XX.1.1.1-1 Confocal Microscopy Image Flavors

VOLUME	Set of frames that define a regularly sampled volume; may be used for each layer of Multi-Resolution Pyramidal Image.
THUMBNAIL	Purpose of image is to provide an overview of the specimen; may be the apex (lowest resolution) layer of a Multi-Resolution Pyramidal Image.
NON-TILED	A non-tiled confocal microscopy image acquisition.

Table C.8.XX.1.1.1-2 Confocal Microscopy Derived Pixels

NONE	No derivation of pixels (original)
RESAMPLED	Pixels were derived by down sampling a higher resolution image

No other values may be present.

C.8.XX.2 Confocal Microscopy Tiled Pyramidal Image Module

Table C.8.XX.2-1 specifies the Attributes that describe a confocal microscopy tiled pyramidal image.

Table C.8.XX.2-1. Confocal Microscopy Tiled Pyramidal Image Attributes

Attribute Name	Tag		Type	Attribute Description
Imaged Volume Width	(0048,0001)		1	Width of total imaged volume (distance in the direction of rows in each frame) in mm.
Imaged Volume Height	(0048,0002)		1	Height of total imaged volume (distance in the direction of columns in each frame) in mm.
Imaged Volume Depth	(0048,0003)		1	Depth of total imaged volume (distance in the z direction of focal planes) in mm.
Volumetric Properties	(0008,9206)		1	Indication if geometric manipulations are possible with frames in the SOP Instance. See C.8.16.2.1.2. Enumerated Value: VOLUME - pixels represent the volume specified for the image, and may be geometrically manipulated

C.8.XX.3 Cutaneous Confocal Microscopy Image Acquisition Parameters Module

Table C.8.XX.3-1 specifies the Attributes that describe cutaneous confocal microscopy image acquisition parameters.

Table C.8.XX.3-1. Cutaneous Confocal Microscopy Image Acquisition Parameters

Attribute Name	Tag	Type	Attribute Description

Optical Magnification Factor	(0016,1005)	2	The magnification factor achieved using the optics of the imaging device when the image was acquired. The magnification factor value represents the relative scaling of the image on the sensor e.g., for a magnification factor of 2, an object would appear on the sensor two times larger than if it was imaged with a magnification factor of 1. A magnification factor of 2 is sometimes shown in documentation as 2X. Note: The magnification factor does not, on its own, imply the ability to measure features in the image.
Image Acquisition Depth	(dddd,dddd)	2	The depth of the image acquisition from the tissue surface in millimeters (mm). See Section C.8.XX.1.1.3
Field of View Shape	(0018,1147)	1	Shape of the field of view of the confocal microscope. Defined Terms: RECTANGLE
Field of View Dimension(s)	(0018,1149)	1	Dimensions of the field of view, in mm.
Tracking ID	(0062,0020)	1C	A text label used for tracking a finding, feature or specific skin lesion, potentially across multiple reporting objects, over time. This label shall be unique within the domain in which it is used. Required if Tracking UID (0062,0021) is present. Note: This Attribute allows linkage to Content Items in SR instances with observation context (112039, DCM, "Tracking Identifier") having the same value.

Tracking UID	(0062,0021)	1C	A unique identifier used for tracking a finding, feature, or specific skin lesion, potentially across multiple reporting objects, over time. Required if Tracking ID (0062,0020) is present. Note: This Attribute allows linkage to Content Items in SR instances with observation context (112040, DCM, "Tracking Unique Identifier") having the same value.

C.8.XX.3.1 Cutaneous Confocal Microscopy Image Acquisition Attribute Descriptions

C.8.XX.3.1.1 Image Acquistion Depth

A raised skin lesion (Figure C.8.XX.3.1.1-1 A.) is flattened to the level of the skin surface for in-vivo confocal microscopy imaging. Image Acquisition Depth is measured as per the yellow arrow in Figure C.8.XX.3.1.1-1 B.

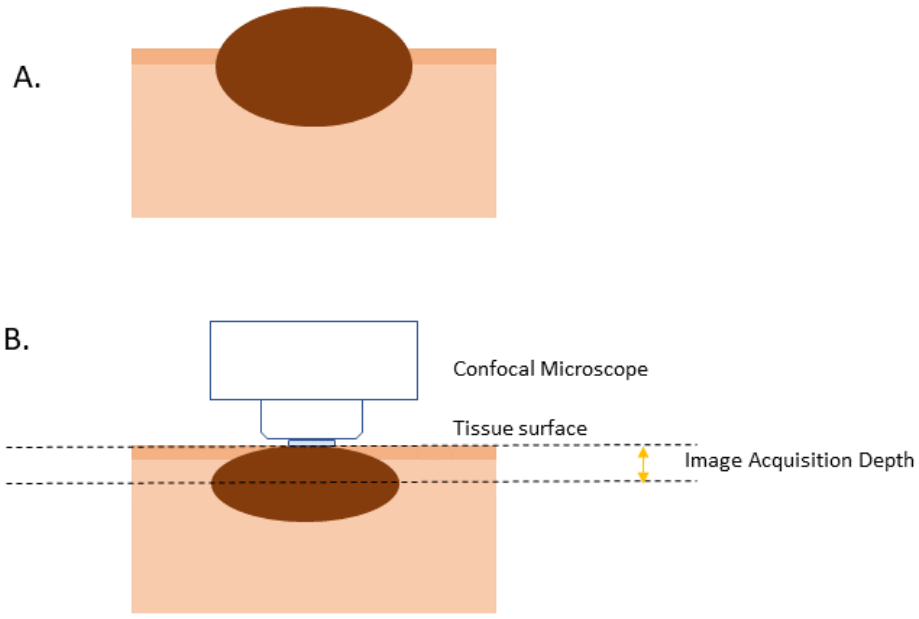


Figure C.8.XX.3.1.1-1 Acquisition depth measurement for raised skin lesions

C.8.XX.4 Confocal Microscopy Functional Group Macros

The following section contain Functional Group Macros specific to the Confocal Microscopy Image IOD and the Confocal Microscopy Tiled Pyramidal Image IOD.

C.8.XX.4.1 Confocal Microscopy Image Frame Type Macro

Table C.8.XX.4.1-1 specifies the Attributes of the Confocal Microscopy Image Frame Type Macro

Table C.8.XX.4.1-1 Confocal Microscopy Image Frame Type Macro Attributes

Attribute Name	Tag	Type	Attribute Description
Confocal Microscopy Image Frame Type Sequence	(cccc,cccc)	1	Identifies the characteristics of this Confocal Microscopy Image frame. Only a single Item shall be included in this Sequence.
>Frame Type	(0008,9007)		Type of Frame. A multi-valued Attribute analogous to Image Type (0008,0008). Enumerated Values and Defined Terms are the same as those for the four values of Image Type (0008,0008). See Section C.8.XX.1.1.1.

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Part 4: Service Class Specifications

Add to PS3.4 Annex B.5.

B.5 Standard SOP Classes

Table B.5-1
STANDARD SOP CLASSES

SOP Class Name	SOP Class UID	IOD Specification (defined in PS3.3)	Specialization
Confocal Microscopy Image Storage	**1.2.840.10008.Z.Z.Z**	**Confocal Microscopy Image IOD**	
Confocal Microscopy Tiled Pyramidal Image Storage	**1.2.840.10008.Y.Y.Y**	**Confocal Microscopy Tiled Pyramidal Image IOD**	

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Part 6: Data Dictionary

Add to PS3.6 Annex A Table A-1 UID Values

UID Value	UID NAME	UID Keyword	UID TYPE	Part
…				
1.2.840.10008.Z.Z.Z	**Confocal Microscopy Image Storage**	**ConfocalMicroscopyImageStorage**	**SOP Class**	**PS 3.4**
1.2.840.10008.Y.Y.Y	**Confocal Microscopy Tiled Pyramidal Image Storage**	**ConfocalMicroscopyTiledPyramidalImageStorage**	**SOP Class**	**PS 3.4**

Add the following Context Group UIDs to PS3.6 Annex A Table A-3 Context Group UID Values

Context UID	Context Identifier	Context Group Name	Comment
…			
1.2.840.10008.B.B.B	**CID BBBB**	**Topical Treatments**	
1.2.840.10008.C.C.C	**CID CCCC**	**Lesion Colors**	
1.2.840.10008.D.D.D	**CID DDDD**	**Specimen Stains for Confocal Microscopy**	

Add the following Data Elements to PS3.6 Section 6 Table 6-1 Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM
(aaaa,aaaa)	**Confocal Mode**	**ConfocalMode**	**CS**	**1**
(bbbb,bbbb)	**Tissue Location**	**TissueLocation**	**CS**	**1**
(cccc, cccc)	**Confocal Microscopy Image Frame Type Sequence**	**ConfocalMicroscopyImageFrameType Sequence**	**SQ**	**1**
(dddd,dddd)	**Image Acquisition Depth**	**ImageAcquisitionDepth**	**FD**	**1**

Changes to NEMA Standards Publication PS 3.16

Digital Imaging and Communications in Medicine (DICOM)

Part 16 Content Mapping Resource

Add to PS3.16 Annex B

Annex B DCMR Context Groups (Normative)

CID BBBB Topical Treatments

Resources: HTML| FHIR JSON|FHIR XML|IHE SVS XML

Type: Extensible
Version: 20XYMMDD
UID: 1.2.840.10008.B.B.B

Table CID BBBB Topical Treatments

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	372558009	Immunomodulator		C1527392
SCT	373219008	Antifungal		C0003308
SCT	255631004	Antibiotic		C0003232
SCT	116566001	Steroid		C0038317
SCT	373526007	Cytotoxic agent		C0304497
SCT	280906005	Keratolytic agent		C0022585
SCT	372681003	Hemostatic agent		C0019120
SCT	387305002	Tretinoin		C0040845
SCT	43706004	Ascorbic acid		C0003968
SCT	273944007	Aluminum hydroxide		C0002371

CID CCCC Lesion Colors

Resources: HTML| FHIR JSON|FHIR XML|IHE SVS XML
Type: Extensible
Version: 20XYMMDD
UID: 1.2.840.10008.C.C.C

Table CID CCCC Colors

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	371240000	Red		C1260956
SCT	371242008	Orange		C1313858
SCT	371243003	Pink		C0332585
SCT	371244009	Yellow		C0221205
SCT	371250004	Purple		C0439542
SCT	371251000	White		C0220938
SCT	371252007	Black		C0439541
SCT	371253002	Gray		C1269776

SCT	371254008	Brown		C0678579
SCT	405738005	Blue		C1260957

CID DDDD Specimen Stains for Confocal Microscopy

Resources: HTML| FHIR JSON|FHIR XML|IHE SVS XML
Type: Extensible
Version: 20XYMMDD
UID: 1.2.840.10008.D.D.D

Table CID DDDD. Specimen Stains for Confocal Microscopy

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	387372003	aluminum chloride		C0102840
SCT	85596006	fluorescein stain		C0060520
SCT	255800009	immunofluorescent stain	C-22817	C0183489
SCT	7539900	citric acid		C0055819
SCT	9010006	methyl blue stain	C-22907	C0303897
SCT	29522004	toluidine blue stain	C-22951	C0040380
SCT	77073008	nile blue stain	C-22941	C0068765
SCT	48540004	patent blue V sodium salt stain	C-22885	C0116465
SCT	29252006	acridine orange stain	C-22A08	C0001185
SCT	2869004	Acetic acid	C-21624	C0000983

Modify tables in PS3.16 Annex B

CID 29 Acquisition Modality

Resources: HTML | FHIR JSON | FHIR XML | IHE SVS XML

Type: Extensible

Version: 20YYMMDD

UID: 1.2.840.10008.6.1.19

Table CID 29. Acquisition Modality

Coding Scheme Designator	Code Value	Code Meaning
…		
DCM	CFM	Confocal Microscopy

CID 4405 Skin Disorders

Resources: HTML| FHIR JSON|FHIR XML|IHE SVS XML
Type: Extensible
Version: 20XYMMDD
UID: 1.2.840.10008.6.1.1350

Table CID 4405 Skin Disorders

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	43982006	Solar degeneration	D0-40100	C0546380
SCT	254819008	Atypical mole syndrome	D0-F1017	C0013403
SCT	782823001	Telangiectasia, cutaneous, cancer syndrome, familial		C5190630
SCT	69408002	Gorlin syndrome	D4-01046	C0004779
SCT	722859001	PTEN hamartoma tumor syndrome		C1959582
SCT	721904001	Rombo syndrome		C1867147
SCT	**398909004**	**Rosacea**		**C0035854**
SCT	**43116000**	**Eczema**		**C0013595**
SCT	**9014002**	**Psoriasis**		**C0033860**
SCT	**200936003**	**Lupus erythematosus**		**C0409974**
SCT	**24079001**	**Atopic dermatitis**		**C0011615**
SCT	**201101007**	**Actinic keratosis**		**C0022602**

CID 4406 Patient Reported Lesion Characteristics

Resources: HTML| FHIR JSON|FHIR XML|IHE SVS XML
Type: Extensible
Version: 20XYMMDD
UID: 1.2.840.10008.6.1.1351

Table CID 4406 Patient Reported Lesion Characteristics

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	418363000	Itching	F-A21A7	C0033774
SCT	247441003	Erythema	F-4410C	C4552417
SCT	162499001	Symptom has changed	R-20A12	C0436317
SCT	**271767006**	**Peeling**		**C0237849**
SCT	**297968009**	**Bleeding skin**		**C0574741**
SCT	**403598008**	**Painful skin**		**C2032737**

Note

The concept "Symptom has changed" is intended to indicate that a skin lesion has changed in size, color or shape.

CID 4407 Lesion Palpation Findings

Resources: HTML| FHIR JSON|FHIR XML|IHE SVS XML
Type: Extensible
Version: 20XYMMDD

UID: **1.2.840.10008.6.1.1352**

Table CID 4407 Lesion Palpation Findings

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
DCM	130485	Firm skin lesion		
DCM	130486	Raised skin lesion		C0748816
DCM	**EEEE**	**Mobile skin lesion**		**C2071496**

CID 4409 Skin Procedures

Resources: **HTML| FHIR JSON|FHIR XML|IHE SVS XML**
Type: **Extensible**
Version: **20XYMMDD**
UID: **1.2.840.10008.6.1.1354**

Table CID 4409 Skin Procedures

Coding Scheme Designator	Code Value	Code Meaning	SNOMED-RT ID	UMLS Concept Unique ID
SCT	302396003	Cryotherapy to skin lesion	P1-40C19	C0411410
SCT	240977001	Biopsy of skin	P1-031C8	C0150866
SCT	428604001	Photodynamic therapy of skin	P0-05E3D	C1998192
SCT	24977001	Topical chemotherapy for malignant neoplasm	P2-67017	C0199946
SCT	**440258006**	**Excision of skin**		**C0191322**
SCT	**445907001**	**Laser procedure on skin**		**C1955835**
SCT	**879916008**	**Radiofrequency ablation**		**C0850292**

Add tables in PS3.16 Annex C

TID FFFF Specimen Staining for Cutaneous Confocal Microscopy

Type: **Extensible**
Order: **Significant**
Root: **No**

Table TID FFFF Specimen Staining for Cutaneous Confocal Microscopy

	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1	CODE	DT (424361007, SCT, "Using substance")	1-n	MC	IF Row 2 not present	DCID DDDD "Specimen Stains for Confocal Microscopy"
2	TEXT	DT (424361007, SCT, "Using substance")	1	MC	IF Row 1 not present	

TID 8300 Skin ~~Cancer~~ Imaging Acquisition Context

This Template provides defines an Acquisition Context Template for Skin **Imaging** ~~Cancer~~. The attributes in this template represent values known at the time of image acquisition. Hence, these values may subsequently change.

Type: **Extensible**
Order: **Non-Significant**
Root: **No**

Table TID 8300. Skin ~~Cancer~~ Imaging Acquisition Context

Row Number	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
…						
13	CODE	DT (418799008, SCT, "Findings reported by patient/informant")	1-n	U		BCID 4406 "Patient Reported Lesion Characteristics"
…						
17	CODE	EV (DDDD, DCM, "Skin lesion color")	1-n	U		BCID CCCC "Lesion Colors"
18	CODE	EV (386439008, SCT, "Skin care topical treatments")	1-n	U		BCID BBBB "Topical treatments"
19	CODE	EV (C4684549, NCIt, "New Lesion Indicator")	1-n	U		DCID 230 "Yes-No"

Content Item Descriptions

Row 13	Finding reported by patient/informant prior to imaging.
Row 18	Recent topical treatments relevant to this confocal imaging acquisition.

Add the following definitions to Part 16 Annex D DICOM Controlled Terminology Definitions (Normative) – Modify Table D-1

Annex D DICOM Controlled Terminology Definitions (Normative)

Table D-1. DICOM Controlled Terminology Definitions (Coding Scheme Designator "DCM" Coding Scheme Version "01")

Code Value	Code meaning	Definition	Notes
130485	Firm skin lesion	A skin lesion that is firm on palpation.	
130486	Raised skin lesion	A lesion that is raised from the skin surface on palpation.	
DMS	Dermoscopy	An acquisition device, process or method that performs imaging of the surface of the skin using epiluminescence microscopy	
…			
CFM	**Confocal Microscopy**	**An acquisition device, process or method that performs imaging using a confocal microscope.**	
DDDD	**Lesion color**	**A visual assessment of the coloration of a lesion.**	
EEEE	**Mobile skin lesion**	**A skin lesion that moves on palpation.**	

Digital Imaging and Communications in Medicine (DICOM)

Part 17: Explanatory Information

Add to PS3.17 Annex XXXX

Annex XXXX Cutaneous Confocal Microscopy (Informative)

XXXX.1 Cutaneous Confocal Microscopy Imaging Study

A cutaneous confocal microscopy imaging study consists of different capture modes outlined in Figure XXXX.1-1XXXX.1-1. A cutaneous confocal microscopy imaging study always images a single lesion.

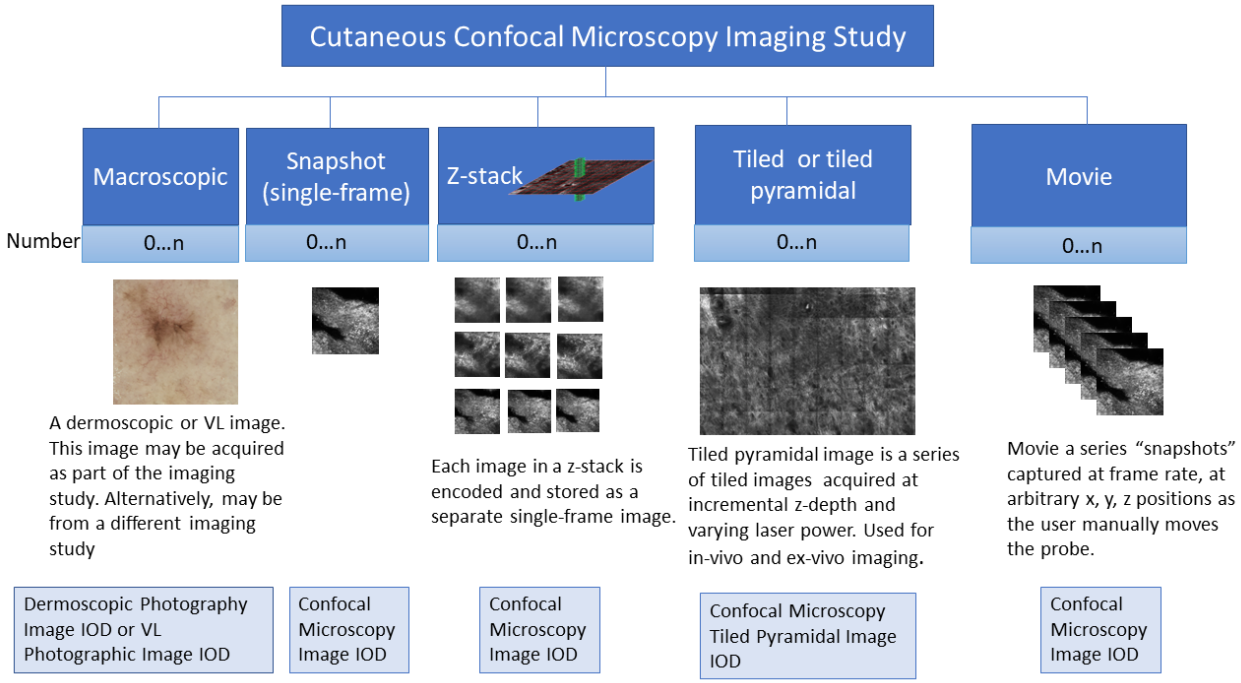


Figure XXXX.1-1 Capture modes for a confocal microscopy imaging study

XXXX.2 Cutaneous Confocal Microscopy Raw Data

Cutaneous Confocal Microscopy Tiled Pyramidal Images are an amalgamation of image tiles, ribbons or strips. Individual tiles, ribbons or strips are not for display and may be encoded using the Raw Data IOD.

XXXX.3 Pre-rendered Pseudo Color Images

An Ex-vivo Confocal Microscopy imaging examination may be acquired in both reflectance and fluorescence mode. The reflectance and fluorescent images are acquired simultaneously and are exactly spatially correlated. Both the reflectance and fluorescent images are encoded and stored as grey scale images. Speciality Confocal Microscopy image viewers display reflectance and fluorescent images using different color overlays and allow the user to toggle between reflectance and fluorescence images. A vendor may choose to also encode a duplicate of the reflectance and fluorescence images as RGB images to allow for non-specialty viewers to display the reflectance and fluorescent confocal microscopy images in a similar way to speciality viewers. The color images would be encoded as a Visible Light Image

IOD or a Secondary Capture Image IOD, as they are designed only for non-specialty viewers (e.g., EMR Universal Viewers).

XXXX.4 Correlation of Macroscopic and Confocal Images

XXXX.4.1 In-Vivo confocal microscopy imaging acquisition method

An adhesive window is attached to the patient's skin centered over the lesion. Initially, the macroscopic camera is clipped into the adhesive window and a macroscopic image acquired. The macroscopic camera is then unclipped from the adhesive tissue window. The adhesive tissue window remains in place.

The confocal microscope is positioned, orientated, and clipped into the same adhesive tissue window, thus centering the two otherwise unrelated images which have different fields of view (FOV). The FOV of each image is encoded in Field of View Dimension(s) (0018,1149).

Using the confocal microscope user interface, the user "draws" a region of interest over the macroscopic image where they wish to acquire a confocal microscopy mosaic image. The rectangle will be converted to stage co-ordinates which are used to direct the confocal microscope. The confocal microscopy can image up to an 8mm square area.

The macroscopic and the confocal image need to be correlated at both image level and spatial co-ordinate level.

The macroscopic image and the confocal microscopy image have a common frame of reference which is encoded by the Frame of Reference UID (0020,0052)

The Referenced Image Functional Group Macro should present to encode the spatial correlation between a macroscopic image (used as a localizer) and a confocal microscopy image.

At image level, Referenced Image Sequence (0008,1140) is used to identify the SOP instance of the macroscopic image correlated to the confocal microscopy image. The macroscopic image will be acquired first. Hence, the Referenced Image Sequence (0008,1140) needs to be encoded in confocal microscopy image. The Purpose of Reference Code Sequence (0040, A170) will have the value (121311, DCM, Localizer).

Spatial information is encoded in the Image Plane module via the Image Position (Patient) (0020,0032) attribute which encodes the x, y, and z coordinates of the upper left-hand corner of staged area (Figure XXX.4-1) The z coordinate encodes depth which may be 0.

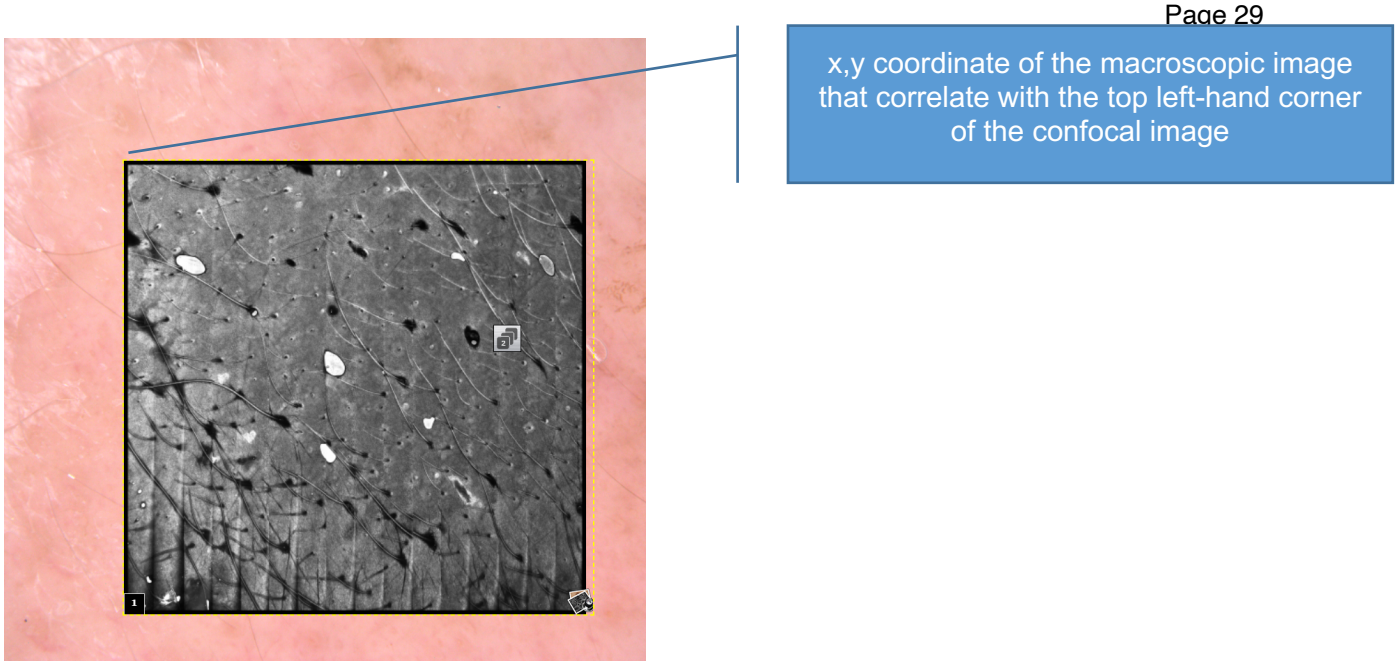


Figure XXX.4-1 Thumbnail of confocal microscopy image overlay on macroscopic image (not for diagnostic purposes)

XXXX.4.2 Ex-Vivo confocal microscopy imaging acquisition method

Ex-Vivo image acquisition is conceptually the same. Both macroscopic camera and confocal microscope are mounted inside the same housing. The excised tissue is placed on a glass microscope slide, then the slide is placed on the ex-vivo confocal microscope. The stage positions the slide firstly centered over the macroscopic camera and then centered over the confocal microscope. Once the imaging is done, the tissue is either processed or stored, and the slide is discarded.

XXXX.5 Specimen Preparation

To encode specimen preparation including staining, TID 8001 Specimen Preparation may be used and is invoked from Specimen Preparation Step Content Item Sequence in the Specimen Module.

For example:

```
(0040,0612)      SpecimenPreparationStepContentItemSequence
   (0040,A040)   ValueType     TEXT
   (0040,A043)   ConceptNameCodeSequence
    >(0008,0100) CodeValue     121041
    >(0008,0102) CodingSchemeDesignator     DCM
    >(0008,0104) CodeMeaning   Specimen Identifier
   (0040,A160)   TextValue     TCGA-GR-7351-01Z

   (0040,A040)   ValueType     CODE
   (0040,A043)   ConceptNameCodeSequence
   >(0008,0100)  CodeValue     111701
   >(0008,0102)  CodingSchemeDesignator     DCM
   >(0008,0104)  CodeMeaning   Processing type
   (0040,A168)   ConceptCodeSequence
   >(0008,0100)  CodeValue     127790008
   >(0008,0102)  CodingSchemeDesignator     SCT
   >(0008,0104)  CodeMeaning   Staining

   (0040,A040)   ValueType     CODE
```

```
 (0040,A043)   ConceptNameCodeSequence
>(0008,0100)   CodeValue     121139
>(0008,0102)   CodingSchemeDesignator     DCM
>(0008,0104)   CodeMeaning   Modality
 (0040,A168)   ConceptCodeSequence
>(0008,0100)   CodeValue     XXXX
>(0008,0102)   CodingSchemeDesignator     DCM
>(0008,0104)   CodeMeaning   CFM

(0040,A040)    ValueType     CODE
(0040,A043)    ConceptNameCodeSequence
>(0008,0100)   CodeValue     424361007
>(0008,0102)   CodingSchemeDesignator     SCT
>(0008,0104)   CodeMeaning   Using substance
(0040,A168)    ConceptCodeSequence
>(0008,0100)   CodeValue     9010006
>(0008,0102)   CodingSchemeDesignator     SCT
>(0008,0104)   CodeMeaning   methyl blue stain

0040,A040)     ValueType     CODE
(0040,A043)    ConceptNameCodeSequence
>(0008,0100)   CodeValue     424361007
>(0008,0102)   CodingSchemeDesignator     SCT
>(0008,0104)   CodeMeaning   Using substance
(0040,A168)    ConceptCodeSequence
>(0008,0100)   CodeValue     29522004
>(0008,0102)   CodingSchemeDesignator     SCT
>(0008,0104)   CodeMeaning   toluidine blue stain
```

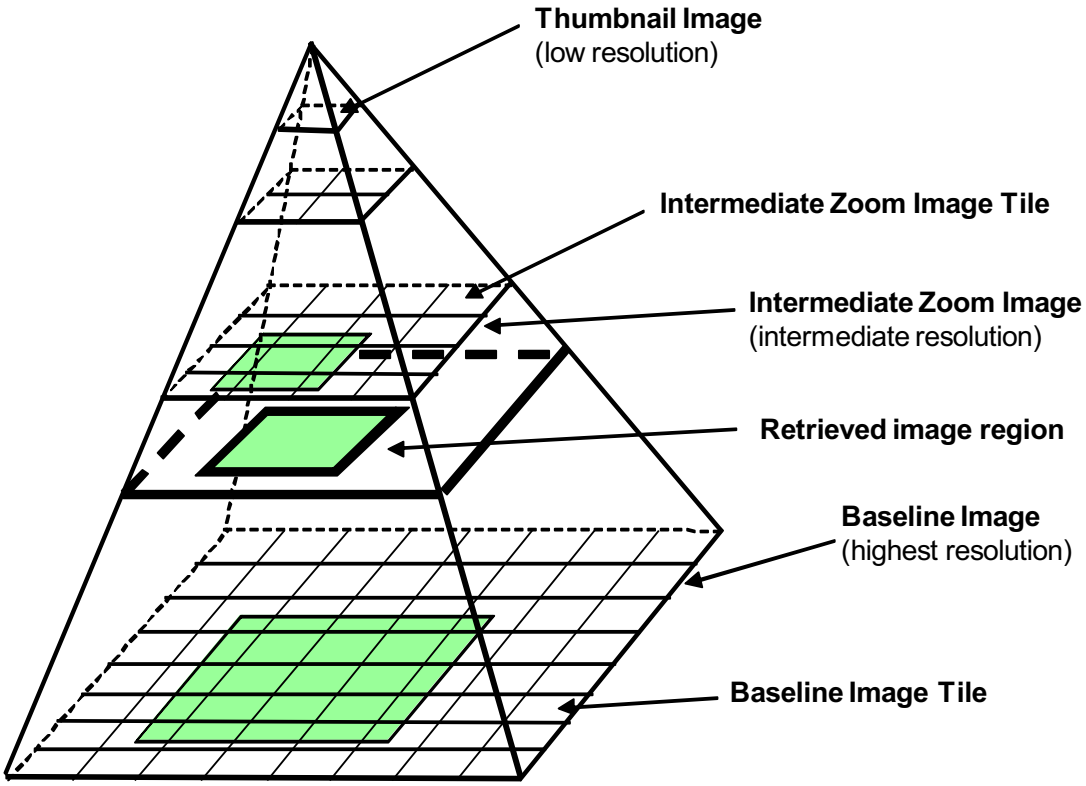
XXXX.6 Series Organization

It is recommended that:

- Each acquisition mode (e.g., z-stack, snapshot, tiled pyramidal) is encoded as a separate series.
- Dermoscopic or Visible Light Photography images within an imaging study are in a different series to the Confocal Microscopy images.

XXXX.7 Encoding of Confocal Microscopsy Tiled Pyramidal Images

The encoding of Confocal Microscopy Tiled Pyramidal Images replicates the method used for Whole Slide Imaging. The following description of the encoding is reproduced from the Scope and Forward of Supplement 145.



492

493 **Figure XXX.7-1 Whole-slide Image as a "Pyramid" of Image Data**

494 As shown in this figure, the WSI consists of multiple images at different resolutions (the "altitude" of the
495 pyramid corresponds to the "zoom level"). The base of the pyramid is the highest resolution image data as
496 captured by the instrument. A thumbnail image may be created which is a low resolution version of the
497 image to facilitate viewing the entire image at once. One or more intermediate levels of the pyramid may
498 be created, at intermediate resolutions, to facilitate retrieval of image data at arbitrary resolution.

499 Each image in the pyramid may be stored as a series of tiles, to facilitate rapid retrieval or arbitrary
500 subregions of the image.

501 Figure XXX.7-1 shows a retrieved image region at an arbitrary resolution level, between the base level and
502 the first intermediate level. The base image and the intermediate level image are "tiled". The shaded
503 areas indicate the image data which must be retrieved from the images to synthesize the desired
504 subregion at the desired resolution.

505 **XXXX.8 Frame of Reference Module**

506 The frame of reference module may be used if multiple successive images are acquired during a single
507 acquisition. For cutaneous confocal microscopy, the same frame of reference identifier should be used for:

508 • The macroscopic and confocal microscopy images acquired during the same imaging study using
509 the same window.
510 • All images in a z-stack.
511 • Ex-vivo imaging in reflectance and fluorescent mode.

512

513

514