Digital Imaging and Communications in Medicine (DICOM)

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

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Document History

Open Issues

1.	Do we need to encode Detector metadata? PH commented: I don't know if DICOM needs to store information about the detectors for any reason related to the storage, transmission and display of these images. Researchers may want to know what filter was in place between the light source and the detector to understand what emitted wavelengths may have been included or excluded… Do other imaging modalities include low-level information about the electro-mechanical components involved in the imaging path? If so, these "Detector" settings are simply referencing the filter in place, and any Gain/ "High Voltage" gain and black-level offset used in order to generate the pixels. Similar, I noticed in "Open Issues" you had listed "No" as to the answer to the need to store the immersion media. I suppose this is along similar lines. Researchers may certainly care about these things while diagnosticians will not.
2.	Should we include Multi-Frame Functional Group Macros?
3.	Should we converge Table CID CCCC Colors (this supplement) with CID 6067 Fluid Color?

Closed Issues

1.	Does Confocal Microscopy require and Anatomical Regions Sequence? Yes, UI has an anatomical region avatar for users to enter the anatomical location.
2.	Do we need to encode Immersion media e.g. US Gel? No
3.	What shape (rectangle, round) is the Field of View? Square
4.	Depth (microns, mm) or anatomy (e.g. stratum spinosum, DEJ, dermis?) Depth-skin surface can be curved hence an image does not necessary contain of the anatomy in one plane
5.	Is optical magnification used? Hence can the following attribute be re-used? Optical Magnification Factor (0016,1005) 2 Optical magnification factor when the image was acquired. Optical magnification is achieved using the optics of the dermoscope **or microscope**. The number indicates the magnification factor in times (X). The size of an object (e.g., a skin lesion) would appear on the sensor n times larger than the object when imaged with a dermoscope **or microscope** using n X optical magnification. Yes, need to tweak description to add microscope
6.	Should we include specimen module in Confocal Microscopy IOD for ex vivo imaging? Does specimen come in a jar/container with a barcode. See http://dicom.nema.org/medical/dicom/current/output/chtml/part03/sect_C.7.6.22.html Ex-vivo is performed at the bedside so normally does not have container/barcode but can. Include Specimen Module as U.

7.	Pregnancy status (0010,21C0) (0001 no pregnant; 0002 possibly pregnant; 0003 pregnant; 0004 unknown) Patient Study Module. Do we make patient study module M is pregnancy is required for all confocal microscopy studies? Not mandatory
8.	Reason for confocal imaging examination include margin mapping, or diagnosis, margin status, biopsy site selection, monitoring therapy, follow up Do we use (0040, 1002) Reason for Requested Procedure (VR=LO)? Note: (0040, 1002) Reason for Requested Procedure part of General Series Module (e.g. CT Image, NM Image, MR Image, is part of the (0040, 0275) Request Attributes Sequence Add to informative context
9.	Is the distance between images for a z-stack image the equi-distance? Yes equidistant (with distance defined by the operator)
10.	Should z-stacks and mosaic stacks be encoded as multi-frame images? z-stack and mosaic stacks are currently stored as discrete images. The metadata does include a framerate indicating that a multi-frame image could potentially be used. Z-stacks should be stored as single frame images. Single frame as users prefer to mouse scroll through images at their own pace as opposed to a set frame rate.
11.	Are images always MONOCHROME? Always MONOCHROME. However, fluorescent and reflectance are displayed by specialty viewer with a pink or purple overlay. If you use a specialty viewer store reflectance and fluorescence separately. Possibly create a duplicate RGB for non-specialty viewers. See informative context.
12.	Can we use Pixel Space (0028,0030) instead of Pixels per micron? Yes (confirmed by Paul Hemmer-CaliberID)
13.	Do we use the attribute Referenced Image Sequence or Referenced Instance Sequence to reference macroscopic/dermoscopic image? Referenced Image Sequence. Referenced Instance Sequence is for non-image SOP instances.
14	How are series to be organised? Can multiple lesions be images in the one study? No Can there be multiple acquisition types (single image, z-stack etc) of each lesion? Yes A “study” has always referred to a single lesion imaged at a single time point. Each study contains 1:N series and each series contains 1:N instances. Each acquisition (stack, block, snapshot, movie) is a unique series. Current series description corresponds to acquisition mode. How to arrange series for reflectance/fluorescence simultaneous? The user acquires a mosaic in combined r/f mode, our software implementation will save this as, say, “Mosaic #1” – this is one series and the folder on disc which stores it contains two sub-folders, one for each wavelength.

15	Do we need a REFLECTANCE, FLUORESCENCE, and REFLECTANCE + FLUORESCENCE mode? "or" is fine since both gray channels, even if imaged simultaneously, are stored as individual images.
16	Are all stains used in ex-vivo imaging in CID8112? WG06 First Read recommended creating a CID specifically for stains used in ex-vivo confocal microscopy. Hence, have created CID DDDD Specimen Stains for Confocal Microscopy JM commented The most popular ex-vivo stain is orange acridine but is probable that additional stains will be described. Some of the single agents used in ex-vivo CM are included in the SNOMED-RT and others not (DICOM CID 8112). In some protocols of stains in ex-vivo CM a combinations of single agent stains are involved. Combination of stains is also worked in pathology frequently. Finally, no specific immunostainings are codified in the list of the table for CID 8112. I elaborated a list of these stains that appear in the literature for ex-vivo CM. However, I guess that most of them evolved or just reproduce the method described in the lab of pathology. If these immunostainings are considered for DICOM I don't know. Single agent stain 1. Aluminium chloride 2. Acetic acid 3. Citric acid 4. Methylene blue 5. Toluidine blue 6. Fluorescein (seen in SNOMED-RT as " fluorescent stain") 7. Nile blue or Patent Blue V 8. Orange acridine Combination of stainings (protocols described in the literature- I suggest to work here with individual codification of multiple single agents) 9. Methylene blue + toluidine blue 10. Fluorescence proflavine + acetic acid + toluidine blue 11. Acetic acid + acridine orange Immunostaining (in SNOMED-RT not specified) 1. FITC, fluorescein isothiocyanate -labelled S-100A10, melan-A and anti-Ber-EP4 antibodies 2. NPs10@D1_ICF_Alexa647_DOTAGA Fe3+ 3. Fluorescent-labelled IgG and C3 antibodies 4. IgG, IgM, IgA, C3 and fibrinogen
17	Should correlated reflectance and fluorescent be reference each other using referenced image sequence? Frame of reference? Use frame of reference NOT SOP Instance because the SOP Instance is not known at time of acquisition.

18	Is an ex-vivo confocal microscopy acquisition context required? The Skin Cancer Acquisition Context may be used. However, specimen preparation including staining use TID 8001 Specimen Preparation which is invoked from Specimen Preparation Step Content Item Sequence in the Specimen Module should.
19	Confocal Microscopy is correlated to a macroscopic/dermoscopic image in the x,y plane. Is this link referenced only the image? Or An X,Y co-ordinate? Linked to an x,y co-ordinate in an image. Or a "rectangle" overlay on the macroscopic/dermoscopic image? Currently vendor Takes x,y co-ordinate and then "builds" the rectangle representing the staged area based on FOV. Can we add x,y co-ordinates to Reference Image Sequence? No x,y co-ordinates should be encoded as a 3D Frame of reference used to correlate spatial information (e.g. x,y co-ordinate with potentially Z as 0). The top left-hand pixel of the confocal image needs to identify the correlated co-ordinates on the macroscopic image.
20	A single FOV on the device is square. But if we encode a Mosaic, which can be rectangular and comprises many stitched FOVs, does "Field of View" refer the image (the whole mosaic) or just the FOV of the objective lens? Redundant if using pixel spacing
22	Image Plane Module is used to contain correlation information between the macroscopic and confocal image. What is encoded in Image Orientation (Patient) (0020,0037) The direction cosines of the first row and the first column with respect to the patient? **Orientation is fixed, use existing volume co-ordinate system used US x,y are arbitrary with no reference to any real world orientation

23	Should we include Acquisition IE and General Acquisition Module in the three Confocal Microscopy IOD tables? Yes, if the image is of a conventional rather than enhanced multiframe family pattern - as yet we have not considered the necessary macro changes for the later, but will need to. Should we include the Multi-Resolution Pyramidal Image IE and Multi-resolution Pyramidal Image module in the IOD table for the Confocal Microscopy Tiled Pyramidal Image IOD? Yes. Should we include the Microscopy Slide Pyramidal Tile Organization in the Confocal Microscopy Tiled Pyramidal Image IOD? Yes. WRT to Optical Path and ICC Profile modules Is ICC Profile redundant if Optical Path module is present? If yes, is it preferable to use Optical Path? If you mean the ICCProfile in the top level dataset, when an Optical Path sequence is present that contains its own ICCProfile, then that's right - only in one of those two places, not both. WRT to Imaged Volume Depth Should we change the Attribute Description to use mm (instead of um)? No, we never change the units of an Attribute. However, rather than propagating the "microns" confusion, you could create and use a different data element, "Imaged Volume Depth in mm" or similar - ugly but safer.

Table of Contents

Scope and Field of Application

This Supplement to the DICOM Standard introduces three new IODs (Confocal Microscopy Image IOD, Confocal Microscopy Tiled Pyramidal Image IOD, Confocal Microscopy Multi-Frame IOD) and three corresponding SOP Classes for encoding and storing confocal microscopy images.

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

In-vivo 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 RCM is most often used as an adjunct to clinical and dermoscopic imaging of skin lesion as opposed to a stand-alone imaging technique. In addition to diagnostic applications, in-vivo 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 confocal 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 confocal microscopy allows the microscopic examination of freshly excised tissue. The ex-vivo 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.

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

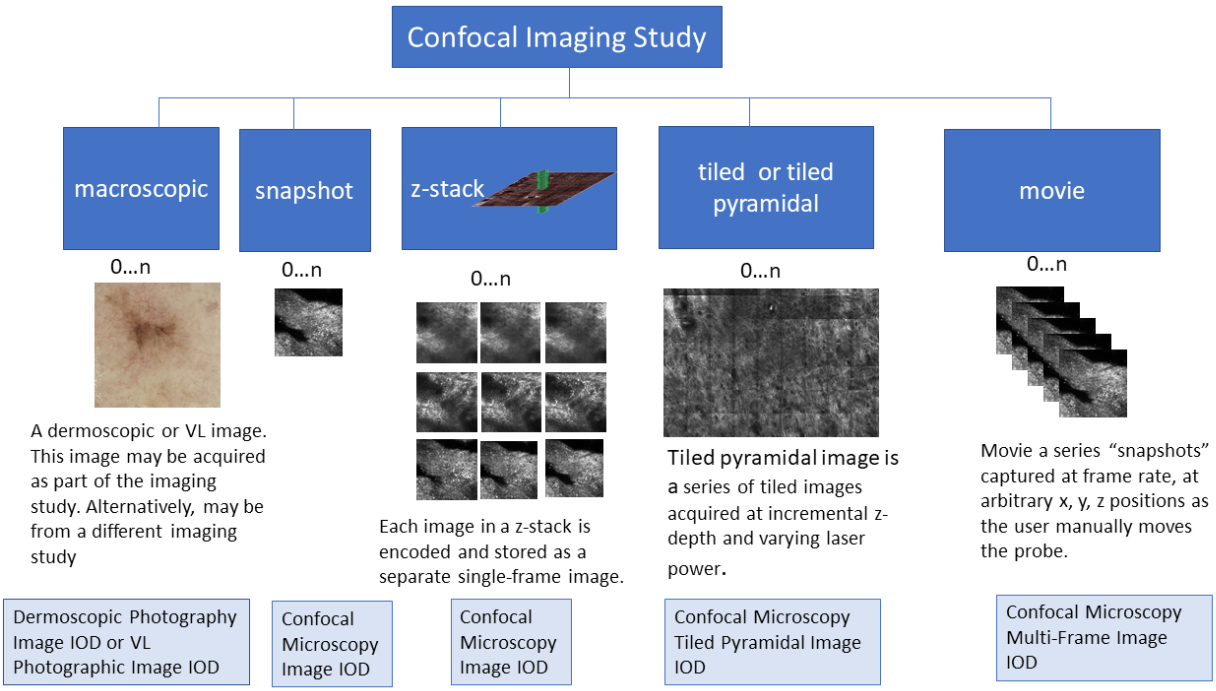

Figure 1 Capture modes for a confocal microscopy imaging study

Changes to NEMA Standards Publication PS 3.2

Digital Imaging and Communications in Medicine (DICOM)

Part 2: Conformance

Item: Add to table A.1-2 categorizing SOP Classes:

The SOP Classes are categorized as follows:

Table A.1-2
UID VALUES

UID Value	UID NAME	Category
…	…	…
1.2.840.10008.x.x.x	**Confocal Microscopy Image Storage**	**Transfer**
1.2.840.10008.y.y.y	**Confocal Microscopy Tiled Pyramidal Image Storage**	**Transfer**
1.2.840.10008.z.z.z	**Confocal Microscopy Multi-Frame Image Storage**	**Transfer**
…	…	…

Digital Imaging and Communications in Medicine (DICOM)

Part 3: Information Object Definitions

Modify 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 imaging in reflectance or fluorescence mode.

Confocal images may be tiled or simple (non-tiled). Simple confocal images may be encoded as single-frame image. Tiled images may use pyramidal encoding. A single pyramidal SOP Instance may contain a single tile image (single frame), or a single SOP Instance may contain multi-resolution, multi-focal depth acquisition (multiple frames). A simple movie acquisition may be encoded as multi-frame cine image.

Separate IODs have been defined for single-frame, tiled or tiled pyramidal images, and multi-frame images confocal microscopy images.

A.X.1 Confocal Microscopy Image IOD

A.X.1.1 Confocal Microscopy Image IOD Description

The Confocal Microscopy Photography Image IOD specifies the Attributes of Single-frame Confocal Microscopy Images.

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

The Confocal Microscopy Photography 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	U
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	U
	Image Pixel	C.7.6.3	M
	Acquisition Context	C.7.6.14	M
	Confocal Microscopy Image	C.X.X.X	M
	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

For Acquisition Context Sequence (0040,0555) the Defined TID is TID 8300 “Skin Imaging Acquisition Context” which encodes information related to Skin Imaging.

A.X.2 Confocal Microscopy Tiled Pyramidal Image 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	U
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	M
	Image Plane	C.7.6.2	U
	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.X.X.X	M
	Confocal Microscopy Tiled Pyramidal Image Parameters	C.Y.Y.Y	M
	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

For Acquisition Context Sequence (0040,0555) the Defined TID is TID 8300 “Skin Imaging Acquisition Context” which encodes information related to Skin Imaging.

A.X.2.3 Confocal Microscopy Tiled Pyramidal Image Functional Group Macros

Table A.X.2.3-1 Confocal Microscopy Tiled Pyramidal Image Functional Group Macros

Functional Group Macro	Section	Usage
Pixel Measures	C.7.6.16.2.1	M
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	U
Frame Content	C.7.6.16.2.2	U
Real World Value Mapping	C.7.6.16.2.11	U - May be used only if Photometric Interpretation (0028,0004) is MONOCHROME2.

A.X.3 Confocal Microscopy Multi-Frame Image IOD

A.X.3.1 Confocal Microscopy Multi-Frame Image IOD Description

The Confocal Microscopy Multi-Frame Image IOD specifies the Attributes of s simple movie acquisitions that are encoded as multi-frame cine image

A.X.3.2 Confocal Microscopy Multi-Frame Image IOD Description Entity-Relationship Model

The Confocal Microscopy Multi-Frame 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.3.3 Confocal Microscopy Multi-Frame Image IOD Module Table

Table A.X.3.3-1 specifies the Modules of the Confocal Microscopy Multi-Frame Image IOD.

Table A.X.3.3-1

CONFOCAL MICROSCOPY MULTI-FRAME 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	U
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	U
	Image Pixel	C.7.6.3	M
	Cine	C.7.6.5	M
	Multi-frame	C.7.6.6	M
	Acquisition Context	C.7.6.14	M
	Confocal Microscopy Image	C.X.X.X	M
	Optical Path	C.8.12.5	M
	SOP Common	C.12.1	M
	Common Instance Reference	C.12.2	U

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107 ## A.X.3.4 Confocal Microscopy Multi-Frame IOD Content Constraints

108 ### A.X.3.4.1 Modality
109 The value of Modality (0008,0060) shall be CFM.

110 ### A.X.3.4.2 Acquisition Context Module
111 For Acquisition Context Sequence (0040,0555) the Defined TID is TID 8300 “Skin Imaging Acquisition
112 Context” which encodes information related to Skin Imaging.

113

114 *Add to PS3.3 C.7.3.1.1.1 Modality*

115

116 ## C.7.3.1.1 General Series Attribute Descriptions

117 ### C.7.3.1.1.1 Modality
118

119 Defined Terms:

120 …

121 **CFM Confocal Microscopy**
122 …

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

124 ## C.8.XX Confocal Microscopy Image Modules

125 ### C.8.XX.1 Confocal Microscopy Image Module
126

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

128 **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.8.12.1.1.6 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.
Number of Frames	(0028,0008)	2	Number of frames in a Multi-frame Image. See Section C.7.6.6.1.1 for further explanation.
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.
Pixel Spacing	(0028,0030)	1	Physical distance in the patient between the center 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.

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)	2	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
	(0008,1140)	1C	A Sequence that references other images significantly related to this image. One or more Items are permitted in this Sequence.
>Include Table 10-3 "Image SOP Instance Reference Macro Attributes"			
>Purpose of Reference Code Sequence	(0040, A170)	1C	Describes the purpose for which the reference is made. Zero or one Item shall be included in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 7201 "Referenced Image Purposes of Reference".*
Window Center	(0028,1050)	1C	Window Center for display. See Section C.11.2.1.2 for further explanation. Required if Photometric Interpretation (0028,0004) is MONOCHROME2.
Window Width	(0028,1051)	1C	Window Width for display. See Section C.11.2.1.2 for further explanation. Required if Window Center (0028,1050) is present.

Image Laterality	(0020,0062)	3	Laterality of (possibly paired) body part (as described in Anatomic Region Sequence (0008,2218)) examined. Enumerated Values: R right L left U unpaired B both left and right Shall be consistent with any laterality information contained in Primary Anatomic Structure Modifier Sequence (0008,2230), Anatomic Region Modifier Sequence (0008,2220), and/or Laterality (0020,0060), if present. Note 1. Laterality (0020,0060) is a Series level Attribute and must be the same for all Images in the Series, hence it must be absent if Image Laterality (0020,0062) has different values for Images in the same Series. 2. There is no value for median, for which Primary Anatomic Structure Modifier Sequence (0008,2230) or Anatomic Region Modifier Sequence (0008,2220) may be used instead.
Anatomic Region Sequence	(0008,2218)	1C	Sequence that identifies the anatomic region of interest in this image (i.e., external anatomy, surface anatomy, or general region of the body). Only a single Item shall be included in this Sequence. Required if Number of Frames (0028,0008) is present and Specimen Description Sequence (0040,0560) is absent. May be present otherwise.

>Include Table 8.8-1 "Code Sequence Macro Attributes"			*DCID 4040 "Endoscopy Anatomic Regions" is defined for the Video Endoscopic IOD.* *BCID 4029 "Dermatology Anatomic Sites" is defined for the VL Photographic Image IOD, Dermoscopic Photography Image IOD,* ***Confocal Microscopy Image IODs, Confocal Microscopy Tiled Pyramidal Image IOD and Confocal Microscopy Multi-Frame IOD*** *for dermatology applications.* *BCID is CID 4031 "Common Anatomic Regions" for humans and CID 7483 "Common Anatomic Regions for Animals" for animals.*
>Anatomic Region Modifier Sequence	(0008,2220)	3	Sequence of Items that modifies the anatomic region of interest of this image One or more Items are permitted in this Sequence.
>>Include Table 8.8-1 "Code Sequence Macro Attributes"			*BCID 2 "Anatomic Modifier".* *BCID 245 "Laterality with Median" is defined for the VL Photographic Image IOD, Dermoscopic Photography Image IOD,* ***Confocal Microscopy Image IODs, Confocal Microscopy Tiled Pyramidal Image IOD and Confocal Microscopy Multi-Frame IOD*** *for dermatology applications*
Include Table 10-8 "Primary Anatomic Structure Macro Attributes"			*No CID is defined. These Type 3 Attributes are not appropriate when Specimen Description Sequence (0040,0560) is present, as it includes the Primary Anatomic Structure Macro for each specimen in the image.*

Optical Magnification Factor	(0016,1005)	2	Optical magnification factor when the image was acquired. Optical magnification is achieved using the optics of the dermoscope **or microscope**. The number indicates the magnification factor in times (X). The size of an object (e.g., a skin lesion) would appear on the sensor n times larger than the object when imaged with a dermoscope **or microscope** using n X optical magnification.
Slice Thickness	(0018,0050)	2	Nominal slice thickness, in mm.
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
Illumination Wave Length	(0022,0056)	1	Wavelength of the illuminator **or laser** in nm. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.
Illumination Power	(0022,0057)	1	Power of the illuminator **or laser** in microwatts. **For Optical Coherence Tomography power is at corneal plane**. Required if Acquisition Device Type Code Sequence (0022,0015) contains an Item with the value (392012008, SCT, "Optical Coherence Tomography Scanner"). May be present otherwise.

Image Acquisition Depth	(aaaa,bbbb)	2	The depth of the image acquisition from the skin surface in millimeters (mm). See Section C.8.XX.1.1.3
Spacing Between Slices	(0018,0088)	2	The spacing between z-stack images in millimeters (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.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 shall have a value of VOLUME

Value 4 (Derived pixel) shall have the Defined Terms specified in Table C.8.XX.1.1.1-1

Table C.8.XX.1.1.1-1

CONFOCAL MICROSCOPY DERIVED PIXELS

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

C.8.XX.1.1.2 Referenced Image Sequence

In in-vivo 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).

C.8.XX.1.1.3 Image Acquistion Depth

A raised skin lesion (Figure 2A.) 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 2B.

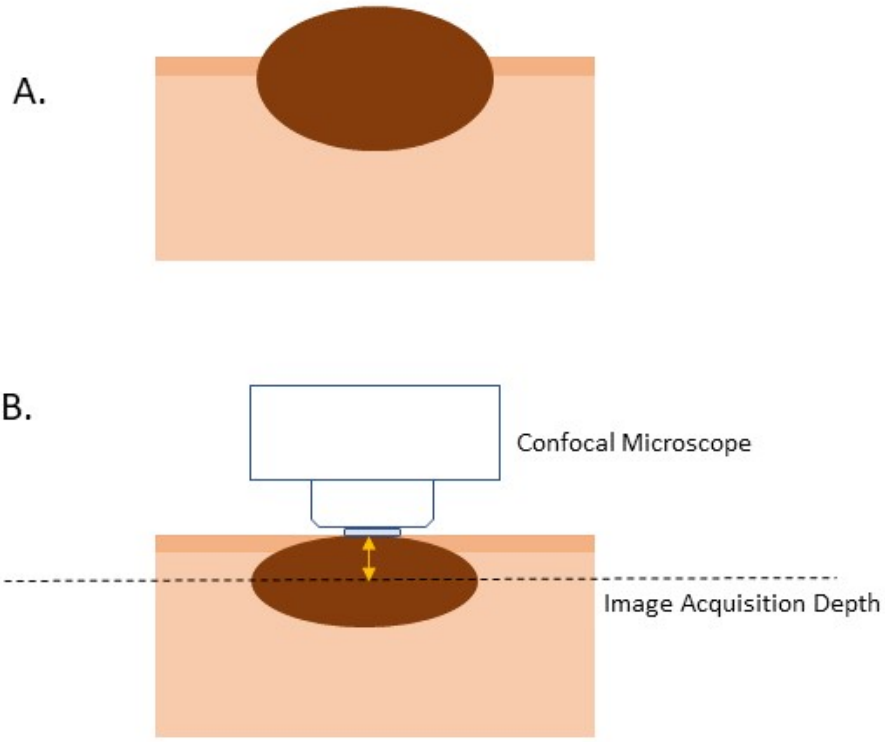

Figure 2 Acquisition depth measurement for raised skin lesions

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

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

Table C.8.XX.2-1. Confocal Microscopy Tiled Pyramidal Image 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
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.
Total Pixel Matrix Columns	(0048,0006)	1	Total number of columns in pixel matrix; i.e., width of total imaged volume in pixels.
Total Pixel Matrix Rows	(0048,0007)	1	Total number of rows in pixel matrix; i.e., height of total imaged volume in pixels.
Total Pixel Matrix Focal Planes	(0048,0303)	1C	Total number of focal planes (z locations) in the pixel matrix; i.e., depth of total imaged volume in pixels. See Section C.8.12.4.1.3 Required if Dimension Organization Type (0020,9311) is present with a value of TILED_FULL. May be present otherwise.
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

Digital Imaging and Communications in Medicine (DICOM)

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 (See PS 3.3)
Confocal Microscopy Image Storage	**1.2.840.10008.X.X.X**	**Confocal Microscopy Image IOD**
Confocal Microscopy Tiled Pyramidal Image Storage	**1.2.840.10008.Y.Y.Y**	**Confocal Microscopy Tiled Pyramidal Image IOD**
Confocal Microscopy Multi-Frame Image Storage	**1.2.840.10008.Z.Z.Z**	**Confocal Microscopy Multi-Frame Image IOD**

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Part 6: Data Dictionary

Add to PS3.6 Annex A

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.X.X.X	Confocal Microscopy Image Storage	SOP Class	PS 3.4
1.2.840.10008.Y.Y.Y	Confocal Microscopy Tiled Pyramidal Image Storage	SOP Class	PS 3.4
1.2.840.10008.Z.Z.Z	Confocal Microscopy Multi-Frame Image Storage	SOP Class	PS 3.4

Add to PS3.6 the following Context Group UIDs:

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 to PS3.6 the following Data Elements to Section 6, Registry of DICOM data elements:

Tag	Name	Keyword	VR	VM
(aaaa,aaaa)	Confocal Mode	ConfocalMode	CS	1
(bbbb,bbbb)	Tissue Location	TissueLocation	CS	1
(aaaa,bbbb)	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 ~~History of Non-Melanoma Skin Cancer~~ 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 ~~History on Non-Melanoma Skin Cancer~~ 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
NCIt	**C94522**	**New lesion**		**C2986548**
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.

253 **CID 4407 Lesion Palpation Findings**
254 **Resources:** **HTML| FHIR JSON|FHIR XML|IHE SVS XML**
255 **Type:** **Extensible**
256 **Version:** **20XYMMDD**
257 **UID:** **1.2.840.10008.6.1.1352**
258
259 **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**

260

261 **CID 4409 Skin Procedures**
262 **Resources:** **HTML| FHIR JSON|FHIR XML|IHE SVS XML**
263 **Type:** **Extensible**
264 **Version:** **20XYMMDD**
265 **UID:** **1.2.840.10008.6.1.1354**
266
267 **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**

268
269

270 *Modify tables in PS3.16 Annex C*
271

272 **TID 8003 Specimen Staining**
273 **Type: Extensible**
274 **Order: Significant**
275 **Root: No**

276 **Table TID 8003. Specimen Staining**
277

	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1	**CODE**	**EV (121139, DCM, "Modality")**	**1**	**U**		**DCID 29 "Acquisition Modality"**
~~1~~ 2	CODE	DT (424361007, SCT, "Using substance")	1-n	MC	IF Row **~~23~~** not present	**IF Row 1 = "CFM"** **DCID DDDD "Specimen Stains for Confocal Microscopy"** **ELSE** DCID 8112 "Specimen Stains"
~~2~~ 3	TEXT	DT (424361007, SCT, "Using substance")	1	MC	IF Row **~~12~~** 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
…						
17	**CODE**	**DT (DDDD, DCM, "Skin lesion color")**	**1-n**	**U**		**DCID CCCC "Lesion Colors"**
18	**CODE**	**DT (386439008, SCT, "Skin care topical treatments")**	**1-n**	**U**		**DCID BBBB "Topical treatments"**

Content Item Descriptions

Row 18	**Topical treatments used in the two weeks prior to imaging.**

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 of the surface of the skin using a confocal microscope.**	
DDDD	**Lesion color**	**The 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 Confocal Microscopy (Informative)

XXXX.1 Confocal Microscopy Raw Data

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.2 Pre-rendered Pseudo Color Images

An Ex-vivo Confocal Microscopy imaging examination may be acquired in both reflectance and fluorescent 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. EMRs

XXXX.3 Correlation of Macroscopic and Confocal Images

In-Vivo confocal microscopy imaging acquisition method

An adhesive tissue window is attached to the patient's skin centered over the lesion. Initially, the macroscopic camera is clipped into the adhesive tissue 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 Dimensions (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 and Frame of Reference UID (0020,0052)

The image plane module may be 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 Position (Patient) (0020,0032) which encodes the x, y, and z coordinates of the upper left-hand corner of staged area (Figure 3) The z co-ordinate encodes depth which may be 0.

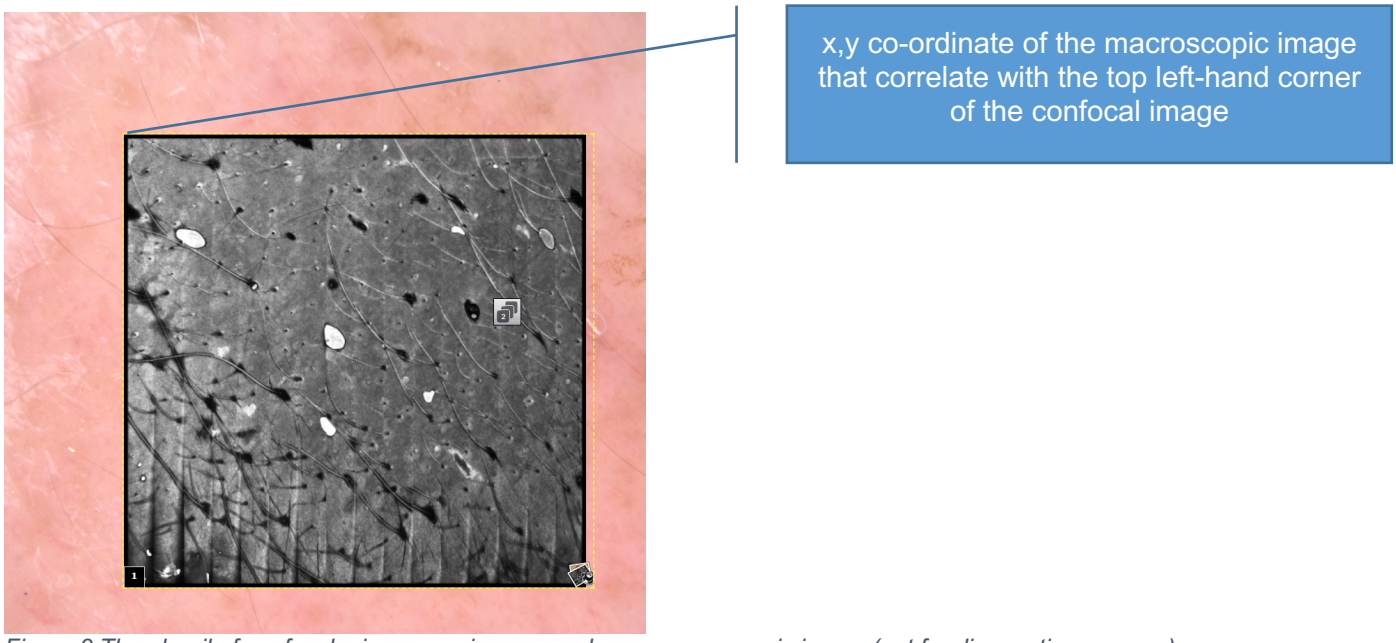

Figure 3 Thumbnail of confocal microscopy image overlay on macroscopic image (not for diagnostic purposes)

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 stage positions the slide firstly centered over the macroscopic camera and then centered over the confocal microscope.

XXXX.4 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.

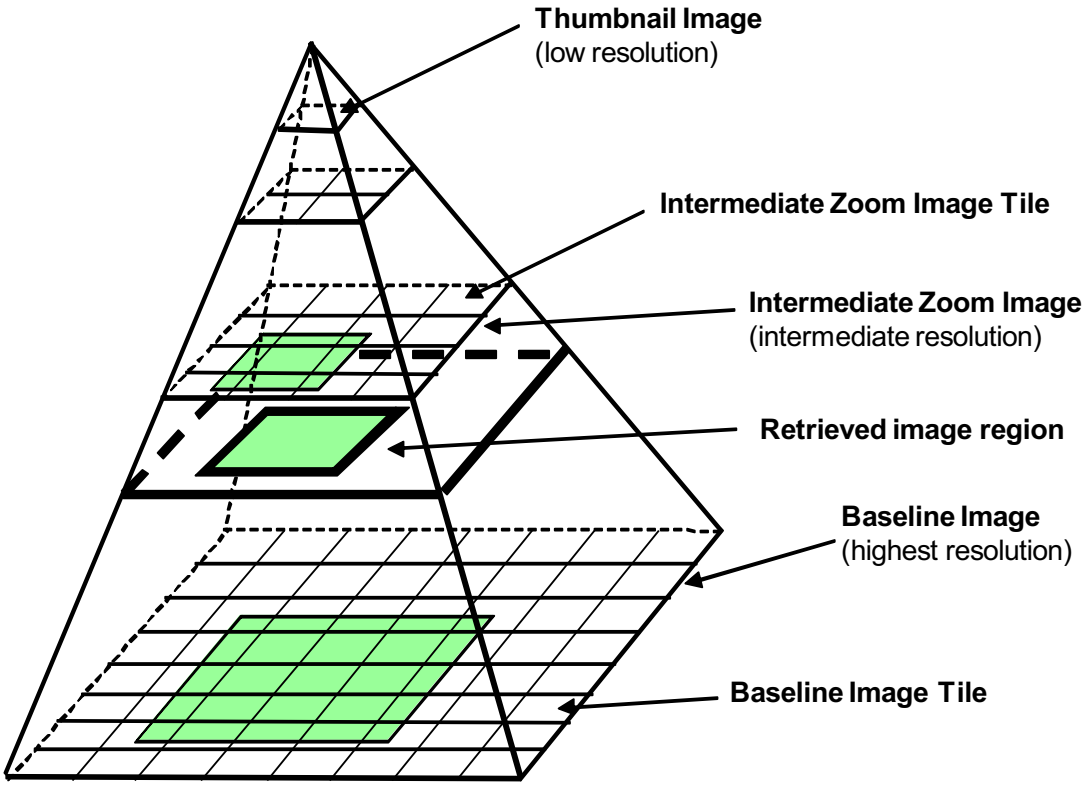

Figure 4 Whole-slide Image as a "Pyramid" of Image Data

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

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

Figure 4 shows a retrieved image region at an arbitrary resolution level, between the base level and the first intermediate level. The base image and the intermediate level image are "tiled". The shaded areas indicate the image data which must be retrieved from the images to synthesize the desired subregion at the desired resolution.

XXXX.8 Frame of Reference Module

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

- All images in a z-stack.
- Ex-vivo imaging in reflectance and fluorescent mode.