DICOM Correction Proposal

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Person Assigned	Christof Schadt
Submitter Name	Christof Schadt (christof.schadt@brainlab.com)
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Correction Number CP-2374
Log Summary: Improve RT equipment mapping for imaging
Name of Standard PS3.3, PS3.6, PS3.16
Rationale for Correction: CP 1205 introduced the RT Equipment Correlation Macro to the CT Image Module to be able to annotate the table position at the time of image acquisition. This existing approach has several limitations: - The parameters provided by CP 1205 are limited to patient positioning devices which only used parameters as defined by IEC 61217. To support new devices which are using non-IEC parameters, a more generic approach is needed. The approach follows the concepts of Second Generation RT Objects describing how the patient is registered in respect to the Treatment Delivery Device (the IEC fixed room system) using a matrix and a set of devices-specific parameters. - New Treatment Delivery Devices allow more flexible orientations of related image acquisition devices. Therefore, a generic description of the position of these acquisition devices is needed. The approach uses the same concept as for patient positioning devices, describing the registration of the image acquisition device to the Treatment Delivery Device (the IEC fixed room system) using a matrix and a set of devices-specific parameters. - During imaging the patient is already set up and specific parameters are recorded during various setup procedures. These procedures and parameters are already defined in the RT Treatment Preparation Module and are taken over as record of the positioning during image acquisition. - A reference to an RT Plan Instance (and potentially to a treatment beam) is required to be able to link the image acquisition to a specific treatment plan or beam to which it applies. The (Enhanced) CT, (Enhanced) MR and (Enhanced) PET Image Modules are updated accordingly. The Enhanced Image Modules also cover the Legacy Enhanced IODs.
Correction Wording:

In PS 3.3 Section 10, add the following new Macro:

C.36.2.4. RT Second Generation Imaging Macros

C.36.2.4.n RT Equipment Mapping and Plan Reference Macro

The RT Equipment Mapping and Plan Reference Macro allows to specify the geometric relationship of the imaging acquisition device and/or patient position to an RT Treatment Delivery Device.

Table C.36.2.4.n-1
RT Equipment Mapping and Plan Reference Macro Attributes Description

Attribute Name	Tag	Type	Attribute Description
Equipment Frame of Reference UID	(300A,0675)	1C	Frame of Reference identifier for the Treatment Delivery Device. Required if either Imaging Equipment to Treatment Delivery Device Relationship Sequence (gggg,eee2) or Patient to Equipment Relationship Sequence (gggg,eee1) is present. See Sections C.36.12.1 and C.36.2.4.n.1.1.
Imaging Equipment to Treatment Delivery Device Relationship Sequence	(gggg,eee2)	3	The relationship between the coordinate system of the Imaging Device and coordinate system of the Treatment Delivery Device. Only a single Item is permitted in this Sequence. See 10.39.1.1
>Device Position to Equipment Mapping Matrix	(3002,010F)	1	A rigid, homogeneous 4x4 transformation matrix that maps the coordinate system of the imaging equipment to the coordinate system of the RT treatment device as identified by Equipment Frame of Reference UID (300A,0675). Matrix elements shall be listed in row-major order.
>Device Position Parameter Sequence	(3002,0110)	2	Translational and rotational parameters for the Imaging Device. Shall be consistent with the Image to Equipment Mapping Matrix (0028,9520). Zero or more Items shall be included in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes"			DTID TNNN1 "Imaging Device Position Parameters"
Isocenter Position	(300A,012C)	3	Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.
Patient to Equipment Relationship Sequence	(gggg,eee1)	3	The relationship between the Patient Frame of Reference and the coordinate system of the Treatment Delivery Device. Only a single Item is permitted in this Sequence.
>Image to Equipment Mapping Matrix	(0028,9520)	1	A rigid, homogeneous 4x4 transformation matrix that maps the patient coordinate space in the Frame of Reference used for the patient model to the coordinate system of the RT Treatment Delivery Device as identified by Equipment Frame of Reference UID (300A,0675). Matrix elements shall be listed in row-major order. See Section 10.39.1.1, Section 10.39.1.2 and Section C.7.6.21.1.
>Patient Support Position Parameter Sequence	(300A,065B)	2	Translational and rotational parameters for the Patient Support device. Shall be consistent with the Image to Equipment Mapping Matrix (0028,9520). Zero or more Items shall be included in this Sequence.
>>Include Table 10-2 "Content Item Macro Attributes"			DTID 15302 "Patient Support Position Parameters".
>Include [CP2344] Table 10-X "RT Patient Setup Preparation Macro"			
Referenced RT Plan Sequence	(300C,0002)	3	RT Plan Instance associated with the acquisition of this Instance. Only a single Item is permitted in this Sequence.

>Include Table 10-11 "SOP Instance Reference Macro Attributes"			
>Referenced Beam Sequence	(300C,0004)	3	Beams in referenced RT Plan Instance which are relevant for the acquisition of this Instance. One or more Items are permitted in this Sequence.
>>Referenced Beam Number	(300C,0006)	1	Uniquely identifies Beam specified by Beam Number (300A,00C0) in Beam Sequence (300A,00B0) within referenced RT Plan or in Ion Beam Sequence (300A,03A2) within RT Ion Plan.

C.36.2.4.n.1 RT Equipment Mapping and Plan Reference Macro Attributes Description

C.36.2.4.n.1.1 Equipment Frame of Reference UID

The Equipment Frame of Reference UID (300A,0675) identifies the Equipment Coordinate System for a Treatment Delivery Device.

If the Equipment Frame of Reference UID of a Treatment Delivery Device is not a Well-known Frame of Reference defined in C.36.12.2, it is expected that the coordinate systems and the axis parameters of the Treatment Delivery Device are documented in the Conformance Statement for that device.

In PS 3.3, extend section C.8.2.1 "CT Image Module" as follows:

C.8.2.1 CT Image Module

Table C.8-3 specifies the Attributes of the CT Image Module, which describe CT images.

Table C.8-3. CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.2.1.1.1 for specialization.
…			
CT Additional X-Ray Source Sequence	(0018,9360)	3	Acquisition parameters for X-Ray sources beyond the primary X-Ray source, which is specified in other Attributes of this Module. One or more Items are permitted in this Sequence. Note This sequence is superseded for multi-energy acquisitions by the Multi-energy CT Acquisition Sequence (0018,9362), however implementations may encounter instances that still use this sequence, in which case Multi-energy CT Acquisition (0018,9361) will be absent or will be set to NO. Shall not be present if Multi-energy CT Acquisition (0018,9361) is YES.
…			
>Energy Weighting Factor	(0018,9353)	1C	The weighting factor of the data from this additional source in a multiple energy composition image. This factor incorporates the effects of

Attribute Name	Tag	Type	Attribute Description
			• the specific X-Ray source and kV value • examination specific characteristics. Required if one Derivation Code Sequence (0008,9215) Item value is (113097, DCM, "Multi-energy proportional weighting"). May be present otherwise.
~~**Isocenter Position**~~	~~**(300A,012C)**~~	~~**3**~~	~~**Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.**~~
~~***Include Table 10-27 "RT Equipment Correlation Macro Attributes"***~~			
Include Table C.36.2.4.n-1 "RT Equipment Mapping And Plan Reference Macro Attributes"			

Note

Table 10-27 "RT Equipment Correlation Macro Attributes" was previously included in this Module but has been retired from this location. See PS3.3-yyyy

In PS 3.3, extend section C.8.3.1 "MR Image Module" as follows:

C.8.3.1 MR Image Module

Table C.8-4 specifies the Attributes of the MR Image Module, which describe MR images.

Table C.8-4. MR Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.3.1.1.1 for specialization.
…			
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
~~**Isocenter Position**~~	~~**(300A,012C)**~~	~~**3**~~	~~**Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.**~~
B1rms	(0018,1320)	3	B1+ rms value in units of microtesla (μT) for the acquisition producing the image. See [IEC 60601-2-33].
Include Table C.36.2.4.n-1 "RT Equipment Mapping And Plan Reference Macro Attributes"			

In PS 3.3, extend section C.8.9.4 "PET Image Module" as follows:

C.8.9.4 PET Image Module

Table C.8-63 specifies the Attributes of the PET Image Module, which describe PET images.

Table C.8-63. PET Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image identification characteristics. See Section C.8.9.4.1.1 for specialization.
…			
include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
~~**Isocenter Position**~~	~~**(300A,012C)**~~	~~**3**~~	~~**Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.**~~
Include Table C.36.2.4.n-1 "RT Equipment Mapping And Plan Reference Macro Attributes"			

In PS 3.3, extend section C.8.15.2 "Enhanced CT Image Module" as follows:

C.8.15.2 Enhanced CT Image Module

This section describes the Enhanced CT Image Module. Table C.8-114 specifies the Attributes of the Enhanced CT Image Module.

Table C.8-114. Enhanced CT Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image characteristics. See Section C.8.16.1 and Section C.8.15.2.1.1.
…			
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
~~**Isocenter Position**~~	~~**(300A,012C)**~~	~~**3**~~	~~**Isocenter coordinates (x,y,z), in mm. Specifies the location of the machine isocenter in the Patient-Based Coordinate System associated with the Frame of Reference. It allows transformation from the Equipment-Based Coordinate System to the Patient-Based Coordinate System.**~~
~~***Include Table 10-27 "RT Equipment Correlation Macro Attributes"***~~			
Include Table C.36.2.4.n-1 "RT Equipment Mapping And Plan Reference Macro Attributes"			

Note

Table 10-27 "RT Equipment Correlation Macro Attributes" was previously included in this Module but has been retired from this location. See PS3.3-yyyy

In PS 3.3, extend section C.8.13.1 "Enhanced MR Image Module" as follows:

C.8.13.1 Enhanced MR Image Module

Table C.8-79 specifies the Attributes of the Enhanced MR Image Module.

Table C.8-79. Enhanced MR Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Include Table C.8-83 MR Image and Spectroscopy Instance Macro Attributes"			
Image Type	(0008,0008)	1	Image characteristics. See Section C.8.16.1 and Section C.8.13.1.1.1.
…			
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6.*
Include Table 10-25 "Optional View and Slice Progression Direction Macro Attributes"			
Include Table C.36.2.4.n-1 "RT Equipment Mapping And Plan Reference Macro Attributes"			

In PS 3.3, extend section C.8.22.3 "Enhanced PET Image Module" as follows:

C.8.22.3 Enhanced PET Image Module

Table C.8.22-3 specifies the Attributes of the Enhanced PET Image Module.

Table C.8.22-3. Enhanced PET Image Module Attributes

Attribute Name	Tag	Type	Attribute Description
Image Type	(0008,0008)	1	Image characteristics. See Section C.8.22.3.1.1.
…			
Icon Image Sequence	(0088,0200)	3	This icon image is representative of the Image. Only a single Item is permitted in this Sequence.
>Include Table C.7-11b "Image Pixel Macro Attributes"			*See Section C.7.6.1.1.6 for further explanation.*
Include Table C.36.2.4.n-1 "RT Equipment Mapping And Plan Reference Macro Attributes"			

In PS 3.6 Chapter 6, add the following Attributes:

Table 6-1. Registry of DICOM Data Elements

Tag	Name	Keyword	VR	VM	
(gggg,eee1)	Patient to Equipment Relationship Sequence	PatientToEquipmentRelationshipSequence	SQ	1	
(gggg,eee2)	Imaging Equipment to Treatment Delivery Device Relationship Sequence	ImagingEquipmentToTreatmentDeliveryDeviceRelationshipSequence	SQ	1	

In PS 3.16 Chapter C, add the following new TID

TID TNNN1 Imaging Device Position Parameters

Type:

Extensible

Order:

Non-Significant

Root:

No

Table TID TNNN1. Imaging Device Position Parameters

	VT	Concept Name	VM	Req Type	Condition	Value Set Constraint
1	NUMERIC	EV (126810, DCM, "IEC61217 Gantry Continuous Pitch Angle")	1	U		UNITS = EV (deg, UCUM, "deg")
2	NUMERIC	EV (126811, DCM, "IEC61217 Gantry Continuous Yaw Angle")	1	U		UNITS = EV (deg, UCUM, "deg")