Digital Imaging and Communications in Medicine (DICOM)

Supplement 176: Second Generation Radiotherapy –

Additional RT Treatment Modalities

DICOM Standards Committee, Working Group 7, Radiation Therapy

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Foreword

~~This Supplement in its current state represents the remaining sections of Supplement 147, revision 42, which is being split into several smaller attributes.~~

This document is an extension to the following parts of the published DICOM Standard:

PS 3.2	Conformance
PS 3.3	Information Object Definitions
PS 3.4	Service Class Specifications
PS 3.6	Data Dictionary
PS 3.16	Content Mapping Resource

Scope and Field of Application

Introduction

~~Existing radiotherapy IODs were designed to provide a set of containers for use in communicating radiation therapy data of all types, in a generic and flexible way.~~

Part 2 Addendum

Add new SOP Classes to PS3.2 Table A.1-2 UID Values:

UID Value	UID Name	Category
1.2.840.10008.5.1.4.1.1.481.XN.5.1	Tomotherapeutic Radiation Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.XN.5.4	Multiple Fixed Source Radiation Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.XN.5.5	Robotic Radiation Storage	Transfer

Part 3 Addendum

Add the following columns in PS3.3 Section A.1.4, Table A.1-1 COMPOSITE INFORMATION OBJECT MODULES OVERVIEW – RADIOTHERAPY

IODs Modules	Tomo Rad	Multi-Fixed Rad	Rob Rad
Patient	M	M	M
Clinical Trial Subject	U	U	U
General Study	M	M	M
Patient Study	U	U	U
Clinical Trial Study	U	U	U
General Series	M	M	M
Clinical Trial Series	U	U	U
Enhanced RT Series	M	M	M
General Equipment	M	M	M
Enhanced General Equipment	M	M	M
Frame Of Reference	M	M	M
…			
Radiotherapy Common Instance	M	M	M
RT Delivery Device Common	M	M	M
RT Radiation Common	M	M	M
Tomotherapeutic Delivery Device	M		
Tomotherapeutic Beam	M		
Multiple Fixed Source Delivery Device		M	
Fixed Orientation Collimator Group		M	
Multiple Fixed Source Beam~~s Set~~		M	
Robotic Delivery Device			M
Robotic Path			M
~~**Multi-Axial Delivery Device**~~			
~~**Multi-Axial Beam**~~			
…			
Common Instance Reference Module	M	M	M
SOP Common	M	M	M

A.VV.1.6 Tomotherapeutic Radiation Information Object Definition

A.VV.1.6.1 Tomotherapeutic Radiation IOD Description

The Tomotherapeutic Radiation IOD represents the information required to describe a radiotherapy treatment on a serial or helical tomotherapeutic delivery device.

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

A.VV.1.6.2 Tomotherapeutic Radiation IOD Entity-Relationship Model

See Figure A.VV.1.1.1-1.

A.VV.1.6.3 Tomotherapeutic Radiation IOD Module Table

Table A.VV.1.6-1
TOMOTHERAPEUTIC RADIATION IOD MODULES

IE	Module	Reference	Usage
Include 'RT Radiation IOD Modules Macro' Table A.VV.1.1.1-2			
RT Radiation	Tomotherapeutic Delivery Device	C.AA.F1	M
	Tomotherapeutic Beam	C.AA.F2	M

A.VV.1.6.3.1 RT Radiation Common Module in RT Radiation IOD Modules Macro

For the Tomotherapeutic Radiation IOD, the Code Sequence Macro in the RT Treatment Technique Code Sequence (30xx,9976) in the RT Radiation Common Module shall use Defined CID SUP147013. The Code Sequence Macro inTreatment Machine Special Mode Sequence (30xx,9C97) shall use Defined CID SUP147017. The Code Sequence Macro in Radiation Type Code Sequence (30xx,51C4) shall use Defined CID SUP147052.

A.VV.1.9 Multiple Fixed Source Radiation Information Object Definition

A.VV.1.9.1 Multiple Fixed Source Radiation IOD Description

The Multiple Fixed Source Radiation IOD represents the information required to describe a radiotherapy treatment on a multiple fixed source photon delivery device.

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

A.VV.1.9.2 Multiple Fixed Source Radiation IOD Entity-Relationship Model

See Figure A.VV.1.1.1-1.

A.VV.1.9.3 Multiple Fixed Source Radiation IOD Module Table

Table A.VV.1.9-1
MULTIPLE FIXED SOURCE RADIATION IOD MODULES

IE	Module	Reference	Usage
Include 'RT Radiation IOD Modules Macro' Table A.VV.1.1.1-2			
RT Radiation	Multiple Fixed Source Delivery Device	C.AA.H1	M
	Fixed Orientation Collimator Group	C.AA.H2	M
	Multiple Fixed Source Beams ~~Set~~	C.AA.H3~~2~~	M

A.VV.1.9.3.1 RT Radiation Common Module in RT Radiation IOD Modules Macro

For the Multiple Fixed Source Radiation IOD, the Code Sequence Macro in the RT Treatment Technique Code Sequence (30xx,9976) in the RT Radiation Common Module shall use Defined CID SUP147045. The Code Sequence Macro in Radiation Type Code Sequence (30xx,51C4) shall use Defined CID SUP147052. The Equipment Frame of Reference UID (30xx,51A0) shall be 1.2.840.10008.1.4.RRR.4.

A.VV.1.10 Robotic Radiation Information Object Definition

A.VV.1.10.1 Robotic Radiation IOD Description

The Robotic Radiation IOD represents the information required to describe a radiotherapy treatment on a robotic delivery device, such as paths, nodes, and collimation type.

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

A.VV.1.10.2 Robotic Radiation IOD Entity-Relationship Model

See Figure A.VV.1.1.1-1.

A.VV.1.10.3 Robotic Radiation IOD Module Table

Table A.VV.1.10-1
ROBOTIC RADIATION IOD MODULES

IE	Module	Reference	Usage
Include 'RT Radiation IOD Modules Macro' Table A.VV.1.1.1-2			
RT Radiation	Robotic Delivery Device	C.AA.J1	M
	Robotic Path	C.AA.J2	M

A.VV.1.10.3.1 RT Radiation Common Module in RT Radiation IOD Modules Macro

For the Robotic Radiation IOD, the Code Sequence Macro in the RT Treatment Technique Code Sequence (30xx,9976) in the RT Radiation Common Module shall use Defined CID SUP147046. The Code Sequence Macro inTreatment Machine Special Mode Sequence (30xx,9C97) shall use Defined CID SUP147017. The Code Sequence Macro in Radiation Type Code Sequence (30xx,51C4) shall use Defined CID SUP147052. The Equipment Frame of Reference UID (30xx,51A0) shall be 1.2.840.10008.1.4.RRR.3.

Add the following to PS3.3 Annex C:

C.AA.2 Second Generation Radiotherapy General-Purpose Macros

C.AA.2.18 Decaying Radiation Source Definition Macro

The Decaying Radiation Source Definition Macro describes instances of decaying sources used for therapeutic radiation treatments. It includes information about the isotope, manufacturer and source strength.

Table C.AA.2.18-1
DECAYING RADIATION SOURCE DEFINITION ATTRIBUTES

Attribute Name	Tag	Type	Description
Number of Decaying Radiation Source Definitions	(30xx,51D0)	1	Number of decaying radiation source definitions.
Decaying Radiation Source Definition Sequence	(30xx,51D1)	1	Sequence of decaying radiation source definitions. One or more Items shall be included in this Sequence. The number of Items included in this Sequence shall equal the value of Number of Decaying Radiation Source Definitions (30xx,51D0).
>Device Index	(30xx,9112)	1	Index of the Decaying Radiation Source device. The value shall start at 1 and increase monotonically by 1.
>Include 'Device Model Macro' Table C.AA.2.11-1			
>Include 'Device Identification Macro' Table C.AA.2.14-1			*Defined CID SUP SUP147074*
>Decaying Source Isotope Code Sequence	(30xx,51D2)	1	Isotope used as decaying source. Only a single Item shall be included in this Sequence.
>>Include 'Code Sequence Macro' Table 8.8-1.			*Defined CID SUP147069*
>Decaying Source Measurement Quantity	(30xx,51D4)	1	Measurement quantity of decaying source. Enumerated Values: AIR_KERMA_RATE DOSE_RATE_WATER
>Decaying Source Reference Datetime	(30xx,51D3)	1	Reference date and time for Decaying Source Reference Air Kerma Rate (30xx,51D5) or Decaying Source Dose Rate (30xx,51D6) of Isotope.

Attribute Name	Tag	Type	Description
>Decaying Source Reference Air Kerma Rate	(30xx,51D5)	1C	Air Kerma Rate in µGy/h at 1 m in air of Isotope specified at Decaying Source Reference Datetime (30xx, 51D3). Required if Decaying Source Measurement Quantity (30xx,51D4) equals AIR_KERMA_RATE.
>Decaying Source Dose Rate	(30xx,51D6)	1C	Decaying Source Dose Rate of Isotope in Gy/sec at Decaying Source Reference Datetime (30xx,51D3). Required if Decaying Source Measurement Quantity (30xx,51D4) equals DOSE_RATE_WATER.

C.AA.F1 Tomotherapeutic Delivery Device Module

The Tomotherapeutic Delivery Device Module contains tomotherapy-specific information pertaining to the physical device used to deliver the treatment, including geometrical parameters of the collimation system. This information is constant for all ~~possible~~ beam deliveries in this Instance~~with this equipment~~.

Table C.AA.F1-1
TOMOTHERAPEUTIC DELIVERY DEVICE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Source-Axis Distance	(300A,00B4)	1	Distance in mm from the radiation source to the gantry rotation axis.~~Radiation source to Gantry rotation axis distance of the equipment that is to be used for beam delivery (mm).~~
Include ~~'Beam~~ 'Radiation Generation Mode Macro' Table C.AA.2.19-1			
Include 'RT Beam Limiting Device Definition Macro' Table C.AA.2.20-1			*Defined CID for included 'RT Accessory Device Identification Macro' is CID SUP147010.*
~~*Include 'Accessory Holder Definition Macro' Table C.AA.2.26-1*~~			
~~Tomotherapeutic Leaf Bank Definition Sequence~~	~~(30xx,1000)~~	~~1~~	~~Leaf slot positions for Leaf Banks.~~ ~~One or more Items shall be included in this sequence.~~
~~>Leaf Bank Offset~~	~~(30xx,1001)~~	~~1~~	~~Offset (in mm) of central axis of Leaf Bank in X-axis of IEC BEAM LIMITING DEVICE coordinate system, relative to the nominal central axis of the delivery machine.~~
~~>Number of Leaf Slots~~	~~(30xx,1002)~~	~~1~~	~~Number of leaf slots in the current Leaf Bank.~~ ~~See C.AA.F1.1.1.~~

Attribute Name	Tag	Type	Description
>Binary MLC Leaf Slot Boundaries	(30xx,1003)	1	Boundaries of beam limiting device (collimator) leaves (in mm) in Y-axis of IEC BEAM LIMITING DEVICE coordinate system. Contains N+1 values, where N is the Number of Binary MLC Leaf Slots.

Editorial Note: Update all existing locations of Source-Axis Distance in the Standard.

C.AA.F1.1 Tomotherapeutic Delivery Device Attribute Description

C.AA.F1.1.1 Leaf Slot Definition

A Leaf Slot is a channel perpendicular to the binary collimator long axis that can be occluded by a leaf or leaves during treatment. A Leaf Slot may be occluded by a single leaf (for example, in the case of opposing banks of interleaved leaves), or by two leaves (in the case of opposed leaf pairs). The exact nature of these leaves is not described in this module: for the purpose of beam characterization it is sufficient to model the Leaf Slot dimensions only.

C.AA.F2 Tomotherapeutic Beam Module

The Tomotherapeutic Beam Module specifies how a tomotherapeutic treatment beam is to be delivered.

Table C.8A.F2-1
TOMOTHERAPEUTIC BEAM MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Radiation Particle	(30xx,5110)	1	Particle Type of Radiation. Defined Terms: PHOTON ELECTRON PROTON
Maximum Binary MLC Jaw 1 Opening	(30xx,1005)	1	Position (in mm) of Jaw 1 (IEC Y1) edge defining the maximum extent of the opening for the current Beam, as defined by IEC BEAM LIMITING DEVICE coordinate system.
Maximum Binary MLC Jaw 2 Opening	(30xx,1006)	1	Position (in mm) of Jaw 2 (IEC Y2) edge defining the maximum extent of the opening at the current Beam, as defined by IEC BEAM LIMITING DEVICE coordinate system.
Tomotherapeutic Nominal Couch Speed	(30xx,1007)	1	Nominal Ccouch Sspeed in mm/secfor beam (mm/sec).

Attribute Name	Tag	Type	Description
~~Tomotherapeutic~~ Nominal Gantry Rotation Period	(30xx,1008)	1C	Nominal ~~Gantry P~~period in seconds of one rotation of the gantry~~for beam (seconds)~~. Required if ~~Code Value in~~ RT Treatment Technique Code Sequence (30xx,9976) is (S147240, 99SUP147, "Helical Beam"). May be present otherwise.
~~Tomotherapeutic~~ Nominal ~~Delivery~~ Pitch Factor	(30xx,1009)	1C	Nominal ~~Nominal Delivery Pitch for beam~~ Pitch factor describing the treatment position motion defined by Nominal Couch Speed (30xx,1007) relative to the maximum collimator opening and the Nominal Gantry Rotation Period (30xx,1008). Required if Code Value in Radiotherapy Procedure Technique Code Sequence (30xx,0C99) is (S147240, 99SUP147, "Helical Beam"). May be present otherwise.
~~RT Treatment Technique Code Sequencexx,976~~Tomotherapeutic Control Point Sequence	(30xx,1010)	1	~~Control point~~Control Points used to model the beam delivery. Two or more Items shall be included in this ~~sequence~~Sequence.
>Include 'External Beam Control Point General Attributes Macro' Table C.AA.2.17-1			
>Include 'RT Beam Limiting Device Positions Macro' Table C.AA.2.21-1			
>Referenced ~~Beam~~ Radiation Generation Mode Index	(30xx,9124~~13~~)	1	Radiation Generation Mode Index (30xx,9113) of the Item in the Radiation Generation Mode Sequence (30xx,51C0) that corresponds to the radiation generation mode used for this delivery.~~Uniquely references the Beam Mode identified by Beam Mode Index (30xx,0113) in Beam Mode Sequence (30xx,51C0) in this IOD.~~

Attribute Name	Tag	Type	Description
>~~Gantry~~ Source Roll Continuous Angle	(30xx,51B5)	1C	Continuous gantry roll angle in degrees of the radiation source at the Control Point with respect to the Equipment Frame of Reference.~~Continuous gantry angle of radiation source at the Control Point in IEC GANTRY coordinate system with respect to IEC FIXED REFERENCE coordinate system (degrees).~~ Required if changed. See C.AA.2.16.1.1.~~Required if the Control Point Index (30xx,9111) equals 1 or attribute value changes at any Control Point.~~ See ~~C.AA.2.16.1 and~~ C.AA.G2.1.1,~~2~~ C.AA.1.8 and C.AA.E1.1.1.
~~>Binary MLC Jaw 1 Opening~~	~~(30xx,1024)~~	~~1C~~	~~Position (in mm) of Jaw 1 (IEC Y1) edge defining the extent of the opening at the current Control Point, as defined by IEC Beam Limiting Device coordinate system.~~ ~~Required if the Control Point Index (30xx,0111) equals 1 or attribute value changes at any Control Point.~~
~~>Binary MLC Jaw 2 Opening~~	~~(30xx,1025)~~	~~1C~~	~~Position (in mm) of Jaw 2 (IEC Y2) edge defining the extent of the opening at the current Control Point, as defined by IEC Beam Limiting Device coordinate system.~~ ~~Required if the Control Point Index (30xx,0111) equals 1 or attribute value changes at any Control Point.~~
>Tomotherapeutic Leaf Open Fractions	(30xx,1030)	1C	Fraction of time for each leaf between the current Control Point and the next Control Point during which the leaf is open. N values shall be provided in the order of Parallel RT Beam Delimiter Element Position Boundaries (30xx,5049) where N is the number of Parallel RT Beam Delimiters (30xx,5048). Required if changed. See C.AA.2.16.1.1.

Attribute Name	Tag	Type	Description
>Tomotherapeutic Leaf Initial Closed Fractions	(30xx,1031)	1C	Fraction of time for each leaf between the current Control Point and the next Control Point during which the leaf is closed before opening, starting at the current Control Point. N values shall be provided in the order of Parallel RT Beam Delimiter Element Position Boundaries (30xx,5049) where N is the number of Parallel RT Beam Delimiters (30xx,5048). Required if one or more leaf open times are not symmetrical about the mid-point of the Control Point interval and if changed. See C.AA.2.16.1.1. xx,91May be present otherwise.
~~>Tomotherapeutic Leaf Open Percentages~~	~~(30xx,1030)~~	~~1C~~	~~Percentage of projection time jaw leaves are open during the projection following the Control Point for the current leaf bank. Value multiplicity is equal to Number of Leaf Slots.~~ ~~Required if the Control Point Index (30xx,9111) equals 1 or attribute value changes at any Control Point.~~
~~>Tomotherapeutic Leaf Open Start Percentages~~	~~(30xx,1031)~~	~~1C~~	~~Percentage of projection time at which jaw leaves open during the projection following the Control Point for the current leaf bank. Value multiplicity is equal to Number of Leaf Slots.~~ ~~Required if one or more leaf open times are not symmetrical about the projection center~~ ~~and~~ ~~if the Control Point Index (30xx,0111) equals 1 or attribute value changes at any Control Point.~~ ~~May be present otherwise.~~

C.AA.H1 Multiple Fixed Source Delivery Device Module

The Multiple Fixed Source Delivery Device Module describes the sources in ~~contains~~ a device with multiple fixed sources ~~device-specific information pertaining to the physical device used to deliver the treatment,~~ including geometrical parameters of the collimation system. This information is constant for all beam deliveries in this Instance. ~~This information is constant for all possible beam deliveries with this equipment.~~

Table C.AA.H1-1
MULTIPLE FIXED SOURCE DELIVERY DEVICE MODULE

Attribute Name	Tag	Type	Description

Attribute Name	Tag	Type	Description
~~Radiation Source~~ Fixed Orientation Collimator Sequence	(30xx,5130)	1	The ~~radiation sources~~ fixed orientation collimators of the device that are used in this Radiation. One or more Items shall be included in this ~~sequence~~Sequence.
>Fixed Orientation Collimator Index	(30xx,5135)	1	The Index of the fixed orientation collimator.
>Fixed Orientation Collimator Opening Sequence	(30xx,5142)	1	The definition of the fixed orientation collimator opening. Only one item is permitted in this Sequence.
>>Include 'RT Beam Limiting Device Definition Macro' Table C.AA.2.20-1			Defined CID SUP147027
>Fixed Orientation Collimator Theta Angle	(30xx,5133)	1	The theta angle in degrees from the isocenter to the radiation source. See C.AA.H1.1.1.
>Fixed Orientation Collimator Phi Angle	(30xx,5134)	1C	The phi angle in degrees from the isocenter to the radiation source. See C.AA.H1.1.1.
>Radiation Source Isocenter Distance	(30xx,5132)	1	Radiation source to isocenter distance in mm.
>Referenced De~~caying Radiation Source~~vice Index	(30xx,9142~~y yy3~~)	1	The value of the Device Index (30xx,9112) in the Decaying Radiation Source Definition Sequence (30xx,~~yy~~151D1) identifying the source to be used by this ~~F~~fixed ~~O~~orientation ~~C~~collimator.
Include 'Radiation Decaying Source Definition Macro' Table C.AA.2.37			
~~*Include ' Radiation Decaying Source Definition Macro ' Table C.AA.2.37*~~			
~~>Radiation Source Label~~	~~(30xx,5131)~~	~~1~~	~~Identification label for the Radiation Source. The label shall be unique within the sequence.~~
~~>Radiation Source Collimator Size~~	~~(30xx,513B)~~	~~1~~	~~Diameter (full width at half maximum) in the machine isocenter of the beam originating from the radiation source through the collimator (mm).~~
~~>Radiation Source Distance~~	~~(30xx,5132)~~	~~2~~	~~Source to isocenter distance (mm).~~
~~>Radiation Source Theta~~	~~(30xx,5133)~~	~~1~~	~~The theta angle from the isocenter to the radiation source (degrees).~~ ~~See C.AA.H1.1.1.~~
~~>Radiation Source Phi~~	~~(30xx,5134)~~	~~1~~	~~The phi angle from the isocenter to the radiation source (degrees).~~ ~~See C.AA.H1.1.1.~~

C.AA.H1.1 Equipment Frame of Reference ~~Multiple Fixed Source Delivery Device Attribute Description~~

~~C.AA.H1.1.1 Radiation Source Angles~~

The ~~equipment~~ coordinate system axes are oriented as follows (when viewed from the patient support device pedestal to the front of the delivery device):

- the x-Axis points horizontally to the right~~When viewed from the patient support device towards the front of the equipment, the x-Axis points to the viewers Right~~
- ~~,~~ the y-Axis points towards the delivery device ~~and~~
- the z-Axis ~~points up~~is the cross-product of the x and y axes.

The origin of the coordinate system is the point where the beam lines of all multiple fixed collimators intersect.

For each source,

- the Fixed Orientation Collimator Theta Angle ~~Radiation Source Theta~~ (30xx,5133) is the angle from the ~~Z~~ Z-axis ~~of the equipment coordinate system~~ to the vector (v) from the isocenter to the source
- the ~~,~~ ~~Fixed Orientation Collimator Phi Angle Radiation Source Phi~~ (30xx,5134) is the angle from the ~~X~~ X-axis ~~of the device coordinate system~~ to the projection (v_{xy}) of the vector (v) ~~from the isocenter to the source~~ on the XY plane ~~of the device coordinate system~~.

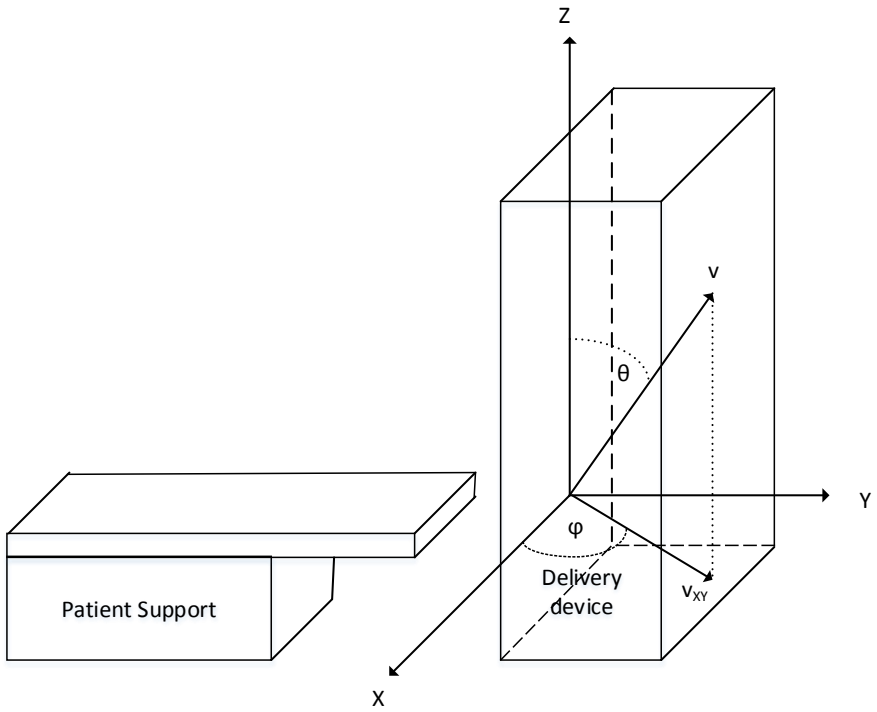

Figure C.AA.H1.1-1
Fixed Orientation Coordinate System

C.AA.H2 Fixed Orientation Collimator Group Module

The fixed orientation collimators grouped within this Module represent fixed orientation collimators that are used together during treatment delivery. All the collimators may be in a single holder (often referred to as a "helmet") or may be in a set of holders each containing a subset of the collimators.

Table C.AA.H2-1
FIXED ORIENTATION COLLIMATOR GROUP MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
Fixed Orientation Collimator Group Sequence	(30xx,5131)	1	Groups of fixed orientation collimators. One or more Items shall be included in this Sequence.
>Fixed Orientation Collimator Group Index	(30xx,5139)	1	Index of the fixed orientation collimator group. The value shall start at 1 and increase monotonically by 1.
>Include 'RT Accessory Device Identification Macro'			*Defined CID SUP147021*

Attribute Name	Tag	Type	Description
Table C.AA.2.15-1			
>Fixed Orientation Collimator References Sequence	(30xx,513F)	1	Fixed orientation collimators that are contained in this group. One or more Items shall be included in this Sequence. See C.AA.H3.1.1-1.
>>Referenced Fixed Orientation Collimator Index	(30xx,513A)	1	The value of Fixed Orientation Collimator Index (30xx,5135) from the Fixed Orientation Collimator Sequence (30xx,5130) identifying the fixed orientation collimator. Each fixed orientation collimator shall only be referenced once in the Fixed Orientation Collimator Group Sequence (30xx,5131).

C.AA.H32 Multiple Fixed Source Beams ~~Set~~ Module

The Multiple Fixed Source Beams ~~Set~~ Module specifies how ~~a~~ multiple fixed source treatment beams ~~is~~ are to be delivered. A pattern is a collection of fixed orientation collimators that are simultaneously used for radiation delivery. A treatment may be specified by a sequence of one or more patterns. In this context, a pair of Control Points may be referred to as a "shot".

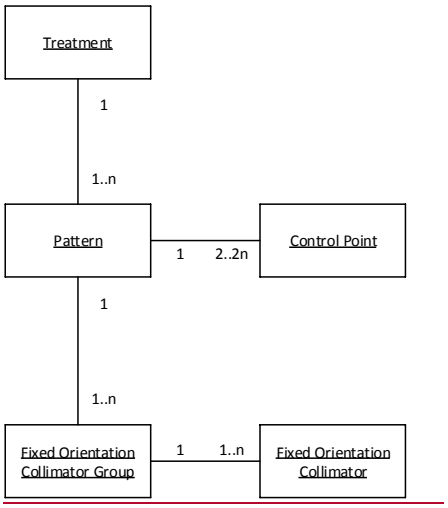

Figure C.AA.H3-1

Model of a Multiple Fixed Source Beams Treatment~~In this context "beam" refers to a radiation for a period of time from multiple radiation sources.~~

Table C.A8A.H23-1
MULTIPLE FIXED SOURCE BEAM SET MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
~~Radiation Particle~~	~~(30xx,5110)~~	~~1~~	~~Particle Type of Radiation.~~ ~~Defined Terms:~~ ~~PHOTON~~
Fixed Orientation Collimator ~~Radiation Source~~ Pattern Sequence	(30xx,513C)	1	~~Radiation source~~Fixed orientation collimator patterns. One or more Items shall be included in this Sequence.
>Fixed Orientation Collimator Pattern Index	(30xx,5136)	1	Index of the fixed orientation collimator pattern. The value shall start at 1 and increase monotonically by 1.
>Fixed Orientation Collimator ~~Radiation Source~~ Pattern Label	(30xx,513D)	1	Identification label for the fixed orientation collimator ~~Radiation Source P~~pattern. The label shall be unique within this Sequence.
~~>Radiation Source Pattern Source Sequence~~	~~(30xx,513F)~~	~~1~~	~~Radiation sources used for the enclosing pattern.~~ ~~One or more Items shall be included in this Sequence.~~
~~>>Referenced Radiation Source Label~~	~~(30xx,513A)~~	~~1~~	~~Uniquely identifies the Radiation Source described in the Radiation Source Sequence (30xx,5130) by a reference to the Radiation Source Label (30xx,5131).~~
>Fixed Orientation Collimator Group References Sequence	(30xx,5138)	1	The fixed orientation collimator groups used in this fixed orientation collimator pattern. One or more Items shall be included in this Sequence.
>>Referenced Fixed Orientation Collimator Group Index	(30xx,5140)	1	The value of Fixed Orientation Collimator Group Index (30xx, 5139) from the Fixed Orientation Collimator Group Sequence (30xx,5131) identifying a fixed orientation collimator group used.

Attribute Name	Tag	Type	Description
~~Radiation~~ Multiple Fixed Source Control Point Sequence	(30xx,5137)	1	~~Control point~~Control Points used to model the radiation delivery. The Sequence shall contain an even number of Items. ~~, where each pair marks the start and end of a radiation.~~ Two or more Items shall be included in this Sequence.
>*Include 'RT Control Point General Attributes Macro' Table C.AA.1.16-1~~Include 'External Beam Control Point General Attributes Macro' Table C.AA.2.17-1~~*			
>Referenced Fixed Orientation Collimator~~Radiation Source~~ Pattern Index	(30xx,513E)	1C	The value of Fixed Orientation Collimator Pattern Index (30xx,5136) from the Fixed Orientation Collimator Pattern Sequence (30xx,513C) identifying patterns of fixed orientation collimators. Required if value differs from preceding populated Item. This attribute shall follow the requirements defined in C.AA.2.16.1.1.~~Uniquely identifies the Radiation Source Pattern described in the Radiation Source Pattern Sequence (30xx,513C) by a reference to the Radiation Source Pattern Label (30xx,513D).~~ ~~Required if the Control Point Index (30xx,9111) equals 1 or attribute value changes at any Control Point.~~ ~~See C.AA.2.16.1.~~

C.AA.J1 Robotic Delivery Device Module

The Robotic Delivery Device Module contains robot-specific information pertaining to the physical device used to deliver the treatment, including geometrical parameters of the collimation system. This information is constant for all possible beam deliveries with this equipment.

Commented [CSH1]: End of WG-06 Marchc 2017. Continue here in June 2017.

Table C.AA.J1-1
ROBOTIC DELIVERY DEVICE MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description

Attribute Name	Tag	Type	Description
Robotic Base Position ~~Device~~ Geometry	(30xx,9F03)	1	~~Imaging g~~Geometry of the Robotic Base Position.~~with which this path is associated.~~ Defined Terms: ~~NORMAL~~FLOOR_LEFT – Looking from the foot of the table towards the robot, the robot is floor-mounted to the viewer's left ~~MIRROR~~FLOOR_RIGHT – Looking from the foot of the table towards the robot, the robot is floor-mounted to the viewer's right FLOOR_CENTER - Looking from the foot of the table towards the robot, the robot is floor-mounted straight ahead
Include ~~'Beam~~ 'Radiation Generation Mode Macro' Table C.AA.2.19-1			
Include 'RT Beam Limiting Device Definition Macro' Table C.AA.2.20-1			
Include 'Accessory Holder Definition Macro' Table C.AA.2.26-1			

C.AA.J1.1 Equipment Frame of Reference UID

The Equipment Frame of Reference UID (30xx,51A0) 1.2.840.10008.1.4.RRR.3 defines a coordinate system as follows:

The equipment coordinate system axes are oriented as follows~~:~~ (when viewed from the foot of the table towards the robot and the robot is floor-mounted straight ahead~~When viewed from the patient support device towards the front of the equipment,~~):

- the x-Axis points to the viewer's ~~R~~right,
- the y-Axis points to the ~~device~~robot ~~and~~
- the z-Axis ~~points up~~is the cross-product of the x- and y-axis, ~~,~~ irrespective of the actual mounting position of the robot.

The orientation of ~~x and y coordinate of the~~ beam ~~limiting device~~ modifier coordinate system coincides with the equipment coordinate ~~system~~system ~~-~~under the following conditions:

- Robot Head Yaw Angle (30xx,9F46) is zero
- The ~~B~~beam direction (from the source point to the target point) ~~is parallel~~is in line with ~~to~~ the negative z-axis of the equipment coordinate system

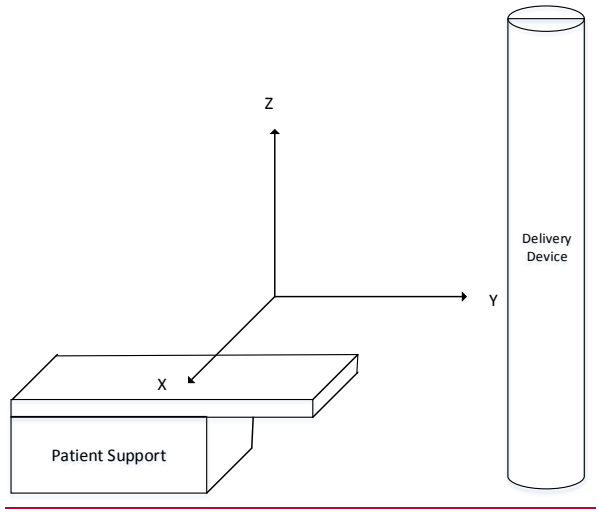

Figure C.AA.J1.1-1
Robotic Coordinate System

~~(x and y coordinates of source and target are equal)~~

C.AA.J2 Robotic Path Module

The Robotic Path Module specifies how a robotic path is to be delivered. Each SOP Instance corresponds to a single robotic ~~"~~path~~"~~. Multiple paths are encoded as separate RT Radiation instances defined by reference in the RT Radiation Set IOD.

Table C.AA.J2-1
ROBOTIC PATH MODULE ATTRIBUTES

Attribute Name	Tag	Type	Description
~~Radiation Particle~~	~~(30xx,5110)~~	~~1~~	~~Particle Type of Radiation.~~ ~~Defined Terms:~~ ~~PHOTON~~ ~~ELECTRON~~ ~~PROTON~~
Robotic Path Identifier Code Sequence	(30xx,9F15)	1	~~Path Set i~~Identifier of the template path from which the nodes referenced in the Robotic Path Control Point Sequence (30xx,9F50) were selected. Only a single Item shall be included in this ~~sequence~~Sequence.
>Include 'Code Sequence Macro' Table 8.8-1.			*Defined CID SUP147011~~.~~*

Attribute Name	Tag	Type	Description
Robotic Path Control Point Sequence	(30xx,9F50)	1	~~Control point~~Control Points used to model the beam delivery. Two or more Items shall be included in this ~~sequence~~Sequence.
>Include 'External Beam Control Point General Attributes Macro' Table C.AA.2.17-1			
>Referenced ~~Beam~~ Radiation Generation Mode Index	(30xx,9124~~1 3~~)	1	Beam Radiation Generation Index (30xx,9113) in the Radiation Generation Mode Sequence (30xx,51C0) in this IOD.~~Uniquely references the Beam Mode identified by Beam Mode Index (30xx,0113) in Beam Mode Sequence (30xx,51C0).~~
>Robotic ~~Path~~ Node Number	(30xx,9F33)	1	A unique number that ~~determines~~ identifies ~~the sequence of delivery of~~ an individual node~~s~~ within the path. ~~The value of node numbers increases monotonically, but may be non-contiguous.~~ See Note 1.
>RT Treatment Source Coordinate	(30xx,9F40)	1	Coordinates (x,y,z) in mm of the source of the beam with respect to the Equipment Frame of Reference~~in the equipment defined original (device) coordinate system~~.
>RT Treatment Target Coordinate	(30xx,9F44)	1C	~~Cartesian values~~Coordinates (x,y,z) in mm of the target of the beam along the central axis of the beam with respect to the Equipment Frame of Reference~~in the equipment defined original (device) coordinate system~~. Required if changed. See C.AA.2.16.1.1.~~if Robotic Beam Sub-Control Point Sequence (30xx,0F42) is not present~~ ~~and~~ ~~the Control Point Index (30xx,9111) equals 1 or attribute value changes at any Control Point.~~ ~~See C.AA.2.16.1.1.~~

Attribute Name	Tag	Type	Description
>Robot Head Yaw Angle	(30xx,9F46)	1C	Robot Head Yaw Angle in degrees, i.e. the rotation of ROBOTIC COLLIMATORthe beam-limiting device coordinate system about the Z-beam axis of the ROBOTIC HEAD coordinate system (degrees)with respect to the Equipment Frame of Reference. Required if changed. See C.AA.2.16.1.1.Required if Robotic Beam Sub-Control Point Sequence (30xx,0F42) is not present and if the Control Point Index (30xx,9111) equals 1 or attribute value changes at any Control Point. See C.AA.2.16.1.1.
>Include 'RT Beam Limiting Device Positions Macro' Table C.AA.2.21-1			
>Robotic Beam Sub-Control Point Sequence	(30xx,0F42)	1C	Specification of beam parameter changes within a Control Point. Required at all Control Points but the last. C.AA. Two or more Items shall be included in this sequence.
>>Include 'External Beam Sub-Control Point General Attributes Macro' Table C.AA.2.18-1			
>>RT Treatment Target Coordinate	(30xx,0F44)	1C	Cartesian values (x,y,z) of the target of the beam in the equipment defined original (device) coordinate system. Required if the Sub-Control Point Index (30xx,0115) equals 1 or attribute value changes at any Sub-Control Point. See C.AA.2.18.1.1.
>>Robot Head Yaw Angle	(30xx,0F46)	1C	Robot Head Yaw Angle, i.e. the rotation of ROBOTIC COLLIMATOR coordinate system about the Z-axis of the ROBOTIC HEAD coordinate system (degrees). Required if the Sub-Control Point Index (30xx,0115) equals 1 or attribute value changes at any Sub-Control Point. See C.AA.2.18.1.1.

Note 1: The values of Robotic Path Node Number (30xx,9F33) within the Robotic Path Control Point Sequence (30xx,9F50) may reference node positions being pre-defined in the device configuration. This attribute is distinct from the RT Control Point Index (30xx,9111), which simply indexes items within the Robotic Path Control Point Sequence (30xx,9F50).

C.AA.

Part 4 Addendum

2 **Add the following to PS3.4, Appendix B.5, Table B.5-1**

SOP Class Name	SOP Class UID	IOD Spec (defined in PS 3.3)
Tomotherapeutic Radiation Storage	**1.2.840.10008.5.1.4.1.1.481.XN.5.1**	**Tomotherapeutic Radiation IODA.VV.1.6**
Multiple Fixed Source Radiation Storage	**1.2.840.10008.5.1.4.1.1.481.XN.5.4**	**Multiple Fixed Source Radiation IODA.VV.1.9**
Robotic Radiation Storage	**1.2.840.10008.5.1.4.1.1.481.XN.5.5**	**Robotic Radiation IODA.VV.1.10**

4

Add the following to PS3.4, Table I.4-1

Table I.4-1 Media Storage Standard SOP Classes

SOP Class Name	SOP Class UID	IOD Specification
Tomotherapeutic Radiation Storage	1.2.840.10008.5.1.4.1.1.481.XN.5.1	Tomotherapeutic Radiation IOD
Multiple Fixed Source Radiation Storage	1.2.840.10008.5.1.4.1.1.481.XN.5.4	Multiple Fixed Source Radiation IOD
Robotic Radiation Storage	1.2.840.10008.5.1.4.1.1.481.XN.5.5	Robotic Radiation IOD

Part 6 Addendum

2 **Add the following data elements to PS3.6:**

6 REGISTRY OF DICOM DATA ELEMENTS

(30xx,9F03)	Robotic Base Position Device Geometry	RoboticBasePositionDeviceGeometry	CS	1
~~(30xx,0F10)~~	~~Robotic Collimation Type~~	~~RoboticCollimationType~~	~~CS~~	~~1~~
(30xx,9F15)	Robotic Path Identifier Code Sequence	RoboticPathIdentifierCodeSequence	SQ	1
(30xx,9F33)	Robotic ~~Path~~ Node Number	Robotic~~Path~~NodeSequenceNumber	UL	1
(30xx,9F40)	RT Treatment Source Coordinates	RTTreatmentSourceCoordinates	FL	3
~~(30xx,9F42)~~	~~Robotic Beam Sub-Control Point Sequence~~	~~RoboticBeamSubControlPointSequence~~	~~SQ~~	~~1~~
(30xx,9F44)	RT Treatment Target Coordinates	RTTreatmentTargetCoordinates	FL	3
(30xx,9F46)	Robot Head Yaw Angle	RobotHeadYawAngle	FL	1
(30xx,9F50)	Robotic Path Control Point Sequence	RoboticPathControlPointSequence	SQ	1
~~(30xx,1000)~~	~~Tomotherapeutic Leaf Bank Definition Sequence~~	~~TomotherapeuticLeafBankDefinitionSequence~~	~~SQ~~	~~1~~
~~(30xx,1001)~~	~~Leaf Bank Offset~~	~~LeafBankOffset~~	~~FD~~	~~1~~
~~(30xx,1002)~~	~~Number of Leaf Slots~~	~~NumberOfLeafSlots~~	~~US~~	~~1~~
~~(30xx,1003)~~	~~Binary MLC Leaf Slot Boundaries~~	~~BinaryMLCLeafSlotBoundaries~~	~~FD~~	~~2-n~~
~~(30xx,1005)~~	~~Maximum Binary MLC Jaw 1 Opening~~	~~MaximumBinaryMLCJaw1Opening~~	~~FD~~	~~1~~
~~(30xx,1006)~~	~~Maximum Binary MLC Jaw 2 Opening~~	~~MaximumBinaryMLCJaw2Opening~~	~~FD~~	~~1~~
(30xx,1007)	~~Tomotherapeutic~~ Nominal Couch Speed	~~Tomotherapeutic~~NominalCouchSpeed	FD	1
(30xx,1008)	~~Tomotherapeutic~~ Nominal Gantry Period	~~Tomotherapeutic~~NominalGantryPeriod	FD	1
(30xx,1009)	Nominal Pitch Factor	NominalPitchFactor	FD	1
~~(30xx,1009)~~	~~Tomotherapeutic Nominal Delivery Pitch~~	~~TomotherapeuticNominalDeliveryPitch~~	~~FD~~	~~1~~
(30xx,1010)	Tomotherapeutic Control Point Sequence	TomotherapeuticControlPointSequence	SQ	1
~~(30xx,1024)~~	~~Binary MLC Jaw 1 Opening~~	~~BinaryMLCJaw1Opening~~	~~FL~~	~~1~~

~~(30xx,1025)~~	~~Binary MLC Jaw 2 Opening~~	~~BinaryMLCJaw2Opening~~	~~FL~~	~~1~~
(30xx,1030)	Tomotherapeutic Leaf Open ~~Percentages~~Fractions	~~TomotherapeuticLeafOpenPercentages~~ TomotherapeuticLeafOpenFractions	FL	1-n
(30xx,1031)	Tomotherapeutic Leaf ~~Open Start~~ Initial Closed ~~Percentages~~Fractions	~~TomotherapeuticLeafOpenStartPercentages~~TomotherapeuticLeafInitialClosedFractions	FL	1-n
(30xx,5130)	Fixed Orientation Collimator ~~Radiation Source~~ Sequence	FixedOrientationCollimator~~RadiationSource~~Sequence	SQ	1
(30xx,5131)	Fixed Orientation Collimator Group Sequence ~~Radiation Source Label~~	FixedOrientationCollimatorGroupSequence~~RadiationSourceLabel~~	~~LO~~ SQ	1
(30xx,5132)	Radiation Source Isocenter Distance	RadiationSourceIsocenterDistance	~~FD~~	1
(30xx,5133)	Fixed Orientation Collimator Theta Angle~~Radiation Source Theta~~	FixedOrientationCollimatorThetaAngle~~RadiationSourceTheta~~	FD	1
(30xx,5134)	Fixed Orientation Collimator Phi Angle~~Radiation Source Phi~~	FixedOrientationCollimatorPhiAngle~~RadiationSourcePhi~~	FD	1
(30xx,5135)	Fixed Orientation Collimator Index	FixedOrientationCollimatorIndex	US	1
(30xx,5136)	Fixed Orientation Collimator Pattern Index	FixedOrientationCollimatorPatternIndex	US	1
(30xx,5137)	~~Radiation~~ Multiple Fixed Source Control Point Sequence	~~RadiationSourceControlPointSequence~~ MultipleFixedSourceControlPointSequence	SQ	1
(30xx,5138)	Fixed Orientation Collimator Group References Sequence	FixedOrientationCollimatorGroupReferencesSequence	SQ	1
(30xx,5139)	Fixed Orientation Collimator Group Index	FixedOrientationCollimatorGroupIndex	US	1
(30xx,513A)	Referenced Fixed Orientation Collimator ~~Radiation Source Label~~Index	~~ReferencedRadiationSourceLabel~~ReferencedFixedOrientationCollimatorIndex	~~LO~~ US	1
~~(30xx,513B)~~	~~Radiation Source Collimator Size~~	~~RadiationSourceCollimatorSize~~	~~FD~~	~~1~~
(30xx,513C)	Fixed Orientation Collimator Pattern Sequence ~~Radiation Source Pattern Sequence~~	FixedOrientationCollimatorPatternSequence~~RadiationSourcePatternSequence~~	SQ	1

(30xx,513D)	Fixed Orientation Collimator Group Label ~~Radiation Source Pattern Label~~	FixedOrientationCollimatorGroupLabel~~RadiationSourcePatternLabel~~	LO	1
(30xx,513E)	Referenced Fixed Orientation Collimator~~Radiation Source~~ Pattern Index	Referenced~~FixedOrientationCollimatorRadiationSource~~PatternIndex	~~SH~~ US	1
(30xx,513F)	Fixed Orientation Collimator References ~~Radiation Source Pattern Source~~ Sequence	FixedOrientationCollimatorReferences~~RadiationSourcePatternSource~~Sequence	SQ	1
(30xx,5140)	Referenced Fixed Orientation Collimator Group Index	ReferencedFixedOrientationCollimatorGroupIndex	US	1
(30xx,5142)	Fixed Orientation Collimator Opening Sequence	FixedOrientationCollimatorOpeningSequence	SQ	1
(30xx,5143)	Fixed Orientation Collimator Groups Used Flag	FixedOrientationCollimatorGroupsUsedFlag	CS	1
(30xx,51D0)	Number of Decaying Radiation Source Definitions	NumberofDecayingRadiationSourceDefinitions	US	1
(30xx,51D1)	Decaying Radiation Source Definition Sequence	DecayingRadiationSourceDefinitionSequence	SQ	1
(30xx,51D2)	Decaying Source Isotope Code Sequence	DecayingSourceIsotopeCodeSequence	SQ	1
(30xx,51D3)	Decaying Source Reference Datetime	DecayingSourceReferenceDatetime	DT	1
(30xx,51D4)	Decaying Source Measurement Quantity	DecayingSourceMeasurementQuantity	FD	1
(30xx,51D5)	Decaying Source Reference Air Kerma Rate	DecayingSourceReferenceAirKermaRate	FD	1
(30xx,51D6)	Decaying Source Dose Rate	DecayingSourceDoseRate	FD	1

Add the following to PS3.6 Annex A:

ANNEX A REGISTRY OF DICOM UNIQUE IDENTIFIERS (UID) (NORMATIVE)

Table A-1
UID VALUES

UID Value	UID NAME	UID TYPE	Part
1.2.840.10008.5.1.4.1.1.481.XN.5.1	Tomotherapeutic Radiation Storage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.481.XN.5.4	Multiple Fixed Source Radiation Storage	SOP Class	PS 3.4
1.2.840.10008.5.1.4.1.1.481.XN.5.5	Robotic Radiation Storage	SOP Class	PS 3.4

Add the following Well-known Frames of References to PS3.6, Annex A:

UID Value	UID Name	Normative Reference
1.2.840.10008.1.4.RRR.3	Robotic System	TBDSee C.AA.J1.1
1.2.840.10008.1.4.RRR.4	Multiple Fixed Source System	TBDSee C.AA.H1.1

Add the following data elements to PS3.6, Annex A:

Table A-3
CONTEXT GROUP UID VALUES

Context UID	Context Identifier	Context Group Name
1.2.840.10008.6.1.FFF.11	SUP147011	Radiotherapy Robotic Paths
1.2.840.10008.6.1.FFF.21	SUP147021	Multiple Fixed Source Collimator Holders
1.2.840.10008.6.1.FFF.69	SUP147069	Isotopes for Radiotherapy
1.2.840.10008.6.1.FFF.74	SUP147074	Decaying Radiation Source

Part 16 Addendum

Add the following new CIDs to PS3.16, Annex B:

CID SUP147011 RADIOTHERAPY ROBOTIC PATHS

Context ID SUP147011

Radiotherapy Robotic Paths

Type: Extensible Version: yyyymmdd

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
99SUP147	S147200	One Path Head
99SUP147	S147201	One Path Body
99SUP147	S147202	Even Paths Head
99SUP147	S147203	Even Paths Body
99SUP147	S147204	Short Paths Head
99SUP147	S147205	Short Path Body
99SUP147	S147206	Prostate
99SUP147	S147207	Prostate Short
~~99SUP147~~	~~S147208~~	~~Trigeminal~~

CID SUP147021 MULTIPLE FIXED SOURCE COLLIMATOR HOLDERS

Context ID SUP147021

Multiple Fixed Source Collimator Holders

Type: NoExtensible Version: yyyymmdd

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
99SUP147	S147XX1	Helmet
99SUP147	S147XX2	Sector

CID SUP147069 ISOTOPES FOR RADIOTHERAPY

Context ID SUP147070

Isotopes for Radiotherapy

Type: Extensible Version: yyyymmdd

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
Include CID SUP147057 Brachytherapy Isotope		

CID SUP147074 DECAYING RADIATION SOURCE

Context ID SUP147074

Decaying Radiation Source

Type: NoExtensible Version: yyyymmdd

Coding Scheme Designator (0008,0102)	Code Value (0008,0100)	Code Meaning (0008,0104)
99SUP147	S147960	General Radiotherapeutic Decaying Source
99SUP147	S147961	Brachytherapy Decaying Source

Add the following to the table in PS3.16, Annex D:

ANNEX D DICOM CONTROLLED TERMINOLOGY DEFINITIONS (NORMATIVE)

Code Value	Code Meaning	Definition	Notes
S147200	One Path Head	The robotic path that includes the full set of nodes available with the patient in a head-first position and the target being associated with the patient's head.~~one path head~~	
S147201	One Path Body	The robotic path that includes the full set of nodes available with a target being within the body, excluding the head.~~one path body~~	
S147202	~~Even~~ Three Paths Head	A set of robotic paths that include the same set of nodes as defined by One Path Head, divided into three paths for use with up to 3 collimators.~~The robotic path even paths head~~	
S147203	~~Even~~ Three Paths Body	A set of robotic paths that include the same set of nodes as defined by One Path Body, divided into three paths for use with up to 3 collimators.~~The robotic path one path body~~	
S147204	Short Paths Head	The robotic path with a reduced set of nodes from One Path Head that limits the number of possible nodes but covers the whole area.~~short paths head~~	
S147205	Short Path Body	The robotic path with a reduced set of nodes from One Path Body that limits the number of possible nodes but covers the whole area.~~short path body~~	
S147206	Prostate	The robotic path which supports increased corrections primarily related to prostate treatments.~~prostate~~	
S147207	Prostate Short	The robotic path with a reduced set of nodes from Prostrate that limits the number of possible nodes but covers the whole area.~~prostate short~~	
~~S147208~~	~~Trigeminal~~	~~The robotic path trigeminal~~	
S147960	General Radiotherapeutic Decaying Source	A general decaying source used for radiotherapeutic treatments	

Code Value	Code Meaning	Definition	Notes
S147961	Brachytherapy Decaying Source	A decaying source used for brachytherapy treatments	
S147XX1	Helmet	A collimator holder for the whole set of collimators of a multiple fixed sources device used for delivery.	
S147XX2	Sector	A collimator holder for a defined subset out of all available collimator openings for a delivery of a Control Point.	

2