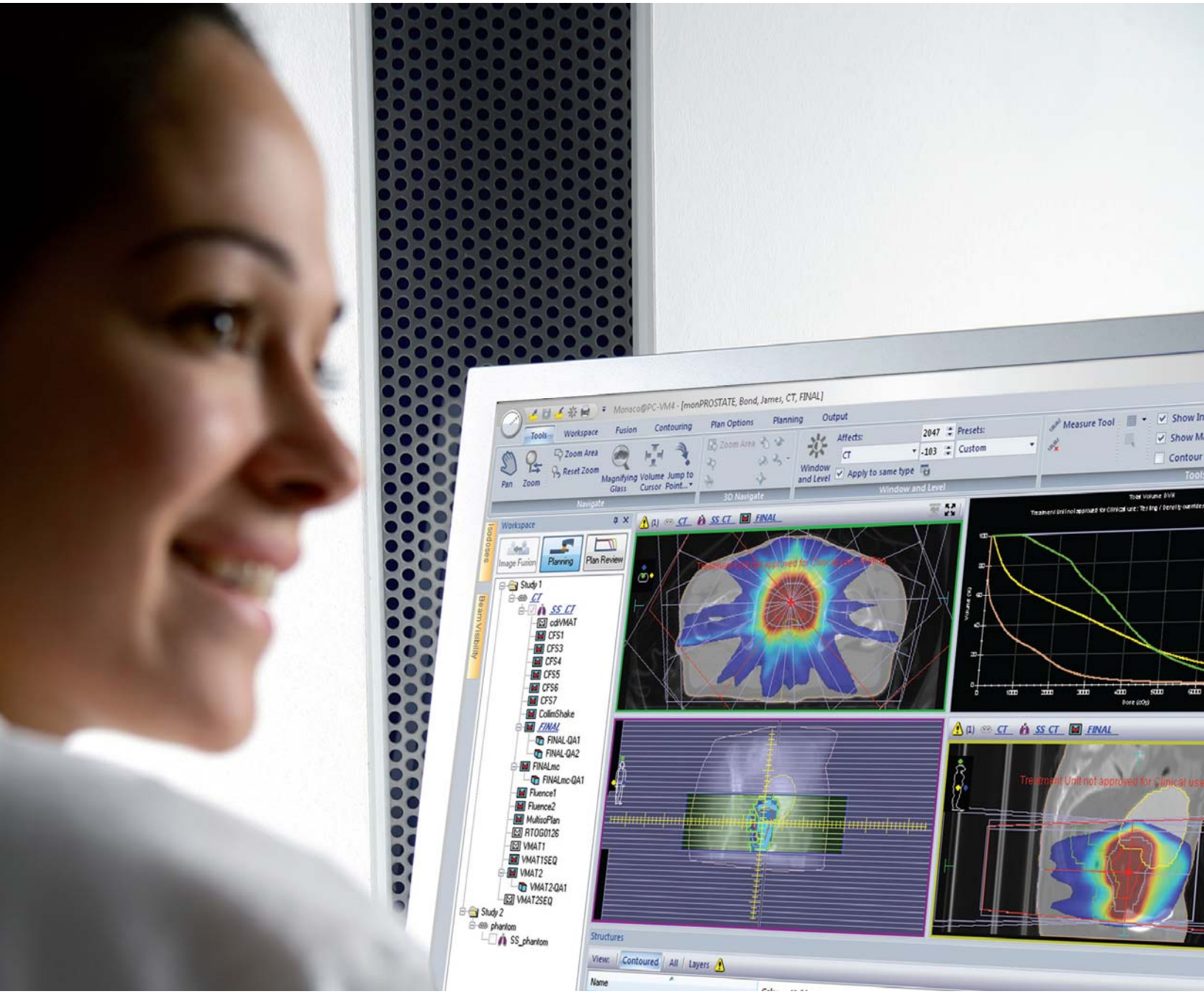
Monaco® Conformance Statement

DICOM 3.0



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ELEKTA

Referenced documents
Elekta does not supply all documents that we refer to in this document in printed forms. Elekta reserves the right to make the decision on which of the documents it supplies in printed form.

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1 Overview

1.1 Purpose

The following is the DICOM conformance statement for the IMPAC Medical Systems, Inc. Monaco product.

Monaco is a three-dimensional, radiation therapy CT Simulation, 3D/IMRT/VMAT planning system that uses medical images to develop treatment plans and visualize the final planned dose results for cancer patients. Monaco uses DICOM services to import images, structures, plan, and dose and to export images, structures, plan, and dose parameters to other vendors.

As of release 5.30, Monaco supports the network import of CT, MR and PET images, RT Structure Sets, RT Plans, RT Ion Plans and 3D RT Dose; the network export of CT Images, RT Structure Sets, RT Plans, RT Dose (Monaco Plans only) and digitally reconstructed radiographs (DRRs) as an RT Image or Secondary Capture. Monaco also DICOM prints DRRs to DICOM compatible printers. The user can export Images, RT Structure Sets, RT Plan, RT Ion Plans, RT Dose, and DRRs to multiple locations chosen at export time.

The user can edit the AE title for the Monaco workstation's export of CT IMAGES, RT STRUCTURE SETS, RT PLANS, RT Dose, and Secondary Capture DRR export.

The tables below give an overview of the network services supported by Monaco.

Table 1-1: Network Services

SOP Class	User of Service (SCU)	Provider of Service (SCP)
Transfer		
CT Image Storage	Yes	Yes
MR Image Storage	Yes	Yes
PET Image Storage	Yes	Yes
SECONDARY CAPTURE Storage	Yes	No
STRUCTURE SET Storage	Yes	Yes
RT PLAN Storage	Yes	Yes
RT ION PLAN Storage	Yes	Yes
RT Dose Storage	Yes	Yes
RT Image Storage	Yes	No
Print Management		
Basic Grayscale Print Management	Yes	No

Table 1-2: UID Values

UID Value	UID Name	Category
1.2.840.10008.1.1	Verification	Transfer
1.2.840.10008.5.1.4.1.1.2	CT Image Storage	Transfer
1.2.840.10008.5.1.4.1.1.4	MR Image Storage	Transfer
1.2.840.10008.5.1.4.1.1.128	Positron Emission Tomography (PET) Image Storage	Transfer

1.2.840.10008.5.1.4.1.1.7	Secondary Capture Image Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.3	RT Structure Set Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.5	RT Plan Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.8	RT Ion Plan Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.2	RT Dose Storage	Transfer
1.2.840.10008.5.1.4.1.1.481.1	RT Image Storage	Transfer
1.2.840.10008.5.1.1.9	Basic Grayscale Print Management Meta SOP Class	Print Management

1.2 Revisions

These items are new or were changed in this version of the document:

- Adding ion information
- Patient positioning
- RT Ion carbon planning information

1.3 Documentation conventions

This document uses these conventions:

- Menu commands, list items from a drop-down list, and control buttons are in **bold.** Vertical lines divide menu commands that are done one directly after another. Example: **File | Tools | Options.**
- Window elements, such as fields, radio buttons, check boxes, tabs and footnotes, are in *italics* or, if in a table are in **Bold Sans Serif** font. Example:

Element	Description
Patient Information Header	Shows basic patient information such as patient name, attending physician, medical record number, and date of birth.
Flowsheets	Opens the Flowsheet window, which shows treatment information for the selected patient.

- Text that you type as shown, such as commands or responses, is **bold shaded**.
- File names, file paths, databases, and database fields are printed in mixed-case `Courier` typeface.
- Words or phrases that are new and could be misunderstood are initially “in quotes.”
- Function keys and booster keys appear in upper case bold print. Example: **F2** or **Ctrl**. A plus sign divides more than one key that you press at the same time. Example: **Ctrl+ F4**.

1.4 Definitions, Acronyms and Abbreviations

Acronym/ Abbreviation	Text
3D	3 Dimension
AE	Application Entity
APEX	Apex
ATTN	Attenuation Corrected
BQML	Becquerel's/milliliter
CEI/IEC	Commission Electronique Internationale / International Electrotechnical Commission
CNTS	Counts
CT	Computed Tomography
DECY	Decay Corrected
DICOM	Digital Imaging and Communication
DRR	Digital Reconstructed Radiographs
DVH	Dose volume Histogram
GY	Gray
ID	Identifier
IMRT	Intensity Modulated Radiation Therapy
MLC	Multileaf Collimator
MR	Magnetic Resonance
NEMA	National Electrical Manufacturers' Association
PACS	Picture archiving and communication system
PET	Positron Emission Tomography
ROI	Region of Interest
RT	Radiotherapy ~~Treatment~~
SCP	Service Class Provider
SCU	Service Class User
SOP	Standard Operating Procedure

Acronym/ Abbreviation	Text
SUV	Standard Uptake Values
TCP/IP	Transmission Control Protocol/Internet Protocol
UID	Unique Identifier
VM	Value Multiplicity
VMAT	Volumetric Modulated Arc Therapy
VR	Value Representation

2 Introduction

2.1 Audience

- DICOM interface implementers
- Radiation Therapy product support personnel
- Radiation Oncology Medical Physicists
- Radiation Oncology Marketing and Sales personnel

2.2 Remarks

The role of the Monaco application for simulation/3D/IMRT/VMAT/Ion planning and 3D Plan Review means that it both imports and exports DICOM data.

The DICOM import application initially creates the existence of a patient within Monaco using images (CT, MR, and PET) and contours (RT STRUCTURE SET) “pushed” to it from an imaging source, contouring system, treatment planning, or PACS system.

The Planning activity lets users edit and add structures for later use in its simulation and 3D/IMRT/VMAT planning activities or for export to another system.

The Planning activity also lets users place beams and design ports for later export as a geometric RTPLAN to another system. The user can also export its generated DRRs as DICOM RT Image or DICOM secondary capture images or print them to a DICOM printer.

The 3D, IMRT and VMAT planning feature lets users develop 3D conformal photon and electron plans and intensity modulated photon MLC and ion plans using advanced optimization and segmentation routines Monaco exports these plans and doses to a treatment management system for delivery and quality assurance systems for any additional checks.

Monaco’s Plan Review activity allows users to import a completed treatment plan and dose for the purposes of final plan review and possible re-calculation (if the plan is compatible with a Monaco treatment machine models). The user can see images, structures, 3D dose and the textual content of the imported DICOM plan (in DICOM coordinates and conventions) and sum or compare dose differences from these plans.

2.3 Definitions, Terms and Abbreviations

DRR- Digitally Reconstructed Radiograph.

2.4 References

Digital Imaging and Communications in Medicine (DICOM) Standard, NEMA, Rosslyn, VA

IEC Standard 61217, Radiotherapy Equipment - Coordinates, Movements and Scales (Reference CEI/IEC 61217: 1996).

3 Networking

3.1 Implementation Model

3.1.1 Application Data Flow Diagram

The diagrams below illustrate the interactions that Monaco makes with the DICOM world.

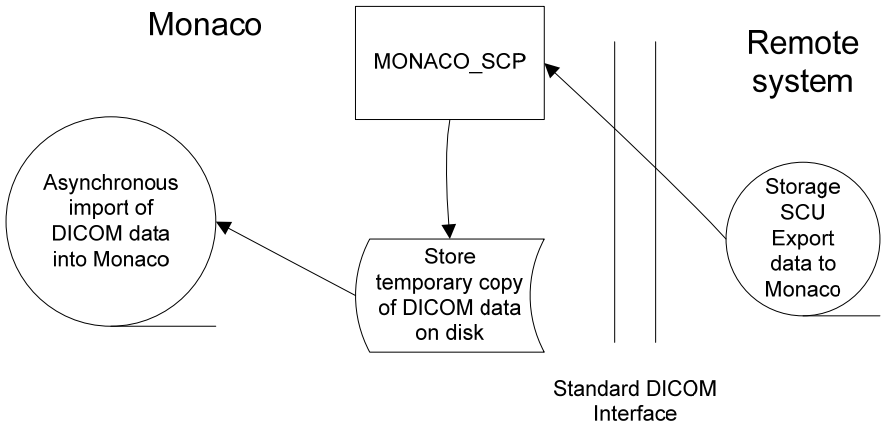

Figure 3-1: Image, Structure Set, RT Plan, RT Ion Plan, and RT Dose Import into Monaco

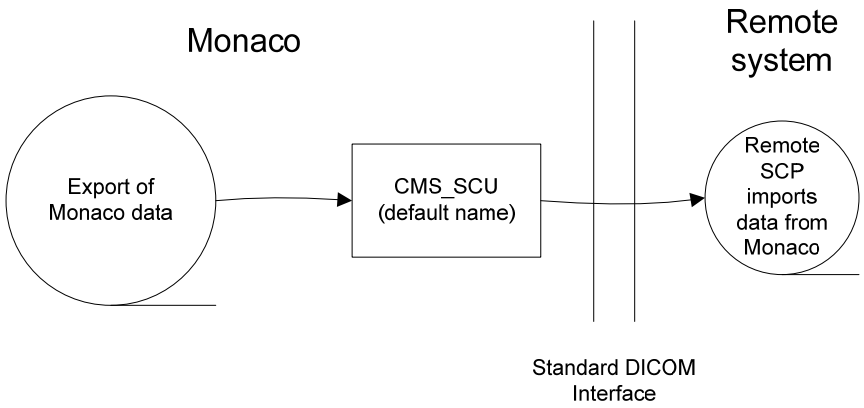

Figure 3-2: CT Image, RT Structure Set, RT Plan, RT Ion Plan, RT Dose, and DRR Export from Monaco

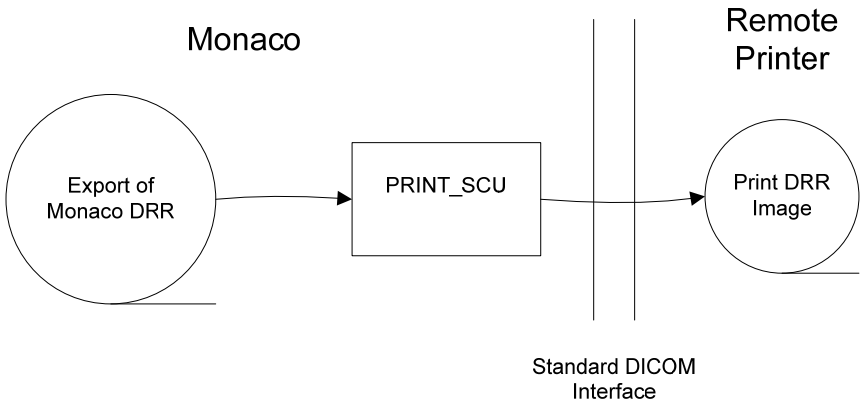

Figure 3-3: DRR Print

3.1.2 Functional Definition of AE Titles

3.1.3 Functional Definition of MONACO_SCP

CT, MR, PET, STRUCTURE SET, RTPLAN, RT ION PLAN, and RT DOSE Import into Monaco

The exporting system initiates the negotiation of an association with the Monaco DICOM server running over the network. The Monaco DICOM server merge3srv will negotiate with the client and accept the association if it can perform the requested service. If the association is accepted by the server, any DICOM objects are transferred from the client to the Monaco DICOM server over the association and stored in a temporary directory on the Monaco system. When the transfer is complete, the client application closes the association. Later, the Monaco user imports the DICOM data into the Monaco application, at which point it is converted to the internal Monaco format.

3.1.4 CT/MR/PET Image Import

If the DICOM header for a 16-bit CT image file defines a pixel padding value, Monaco will convert all CT pixels equal to that padding value to the minimum pixel value represented by the data type of that image. It is assumed that the CT manufacturer has selected a padding pixel value that is outside the range of the pixel values that make up the image. Pixel Padding values are ignored for MR and PET.

Monaco will apply the slope and intercept to the pixel values for CT and PET images before saving them in Monaco's internal format. Monaco will not apply any slope and intercept for MR images.

Monaco can import and contour on (MR) images that are sagittal, coronal or oblique and the images are parallel to each other within the series.

CT images that have a non-orthogonal IOP but do not contain a matching RT Equipment Correlation Macro value for the couch table angle, will not be imported.

3.1.5 RT Structure Set Import

The Monaco application can only import structure sets along with axial images. It cannot store structure sets by themselves.

3.1.6 RT Plan and RT Ion Plan Import

The Monaco application can only import plans along with their referenced structure set.

3.1.7 RT Dose Import

The Monaco application can only import Doses along with their referenced plan.

3.1.8 Functional Definition of CMS_SCU

3.1.9 CT, MR, PET Image, RT Structure Set, RT Plan and RT Dose Export

The Monaco client application requests Storage Services of a user-selectable DICOM server over an association. If the association is accepted by the server, the user-selected DICOM object combination is transferred from the Monaco client to the selected server. When the transfer is completed, the client application closes the association.

Axial, sagittal, and coronal images that have been imported into Monaco can be re-exported. RT Structure sets, plans, and doses can be exported for axial CT's and MR's. Oblique images cannot be exported.

The host name of the network or printing device to which the images are to be sent must be specified in Monaco's DICOM Settings.

3.1.10 DRR export via RT Image or Secondary Capture Export to SCP

The Monaco client application requests Storage Services of a DICOM server over an association. If the server accepts the association, DICOM RT Images or SC Images are then transferred from the Monaco client to the server over the association. When the transfer is completed, the client application closes the association.

The host name of the network or printing device to which the images are to be sent must be specified in Monaco's DICOM Settings.

3.1.11 Functional Definition of PRINT_SCU

3.1.12 DRR Filming

When output to "Film" is selected, the Monaco client application requests Print Services of a DICOM server over an association. If the server accepts the association, secondary capture images are then transferred from the Monaco client to the print server over the association. When the transfer is completed, the client application closes the association.

The host name of the printing device to which the images are to be sent must be specified in Monaco's DICOM Settings.

3.1.13 Sequencing of Real World Activities

3.1.14 CT/MR/PET/SC Image; RT Structure Set, RT Plan, RT Ion Plan and RT Dose Import

An operator initiates the transfer of data from a system that wants to send data to Monaco (CT, MR, PET machine, CT Simulator, or treatment planning system). The client application initiates the storage command for CT, MR, PET, RT Structure Set, RT Plan, and/or RT Dose. The Monaco DICOM server receives the data and places it in a temporary disk directory on Monaco.

Asynchronous to the DICOM transfer of this data, the user can import the DICOM data to create a new patient in Monaco or add images and associated DICOM RT objects to an existing patient.

Structure Sets can only be imported if the corresponding images are present at the same time.

RTPLAN and RT ION PLAN can only be imported if the corresponding Structure Set is present at the same time.

RTDOSE can only be imported if the corresponding RT PLAN or RT ION PLAN is present at the same time.

3.1.15 DRR as RT Image or Secondary Capture Image Export

Secondary capture image transfer is initiated by the Monaco user right clicking on the DRR image and selecting the Print option. The user can then select to output in Secondary Capture format. RT Image export is only available through the DICOM Export option.

3.1.16 CT IMAGE, STRUCTURE SET, RTPLAN, RT DOSE Export

The Monaco user initiates the export of Images, Structure Set, Plan, and Dose data via the DICOM Export option. On this dialog, the user selects the appropriate DICOM object choice, the multiple DICOM locations to which to send and makes any necessary patient or treatment machine naming edits.

Axial, sagittal, or coronal images that have been imported into Monaco can be re-exported. Derived axial image series (maximum, minimum, average pixels) from 4D datasets can also be exported with their associated structure sets and plans.

On the export dialog, the user will have the ability to export the plan and dose as a total composite of all prescriptions (multiple fraction groups) or to break up the plan and dose and export some or all of the prescriptions (fraction groups) as individual plans and doses. The DVH data is only available with the total plan RT DOSE object.

By default, without user intervention, the system will export all contours stored for the current Monaco studyset. The user can choose to reduce the contours being exported by de-selecting them on the export dialog box.

Prior to export, the user can add dose rates and tolerance tables to the RTPLAN by selecting the Additional Options button on the export dialog.

If the plan is an IMRT or VMAT for Elekta (non-microMLC) or Siemens machines, the user can select the plan to be exported as a “Composite Field Sequence”. In this mode, Monaco will combine multiple beams/arcs into a single DICOM sequence. The software will insert move-only control points into the DICOM RTPLAN object to change the gantry angle from one delivery direction to the next. As a result, the linac does not need to re-set itself for multiple new beams/arcs.

If the plan being exported is for Elekta’s APEX MLC, Monaco has two ways of exporting plan data depending on the version of MOSAIQ being used. The Single Plan option is offered for MOSAIQ version 2.50 or later and must be enabled on the Monaco Settings dialog under Preferences. For earlier MOSIAQ releases, the multiple plan export method needs to be used where Monaco automatically creates and exports two versions of the plan in DICOM - one to send to the Treatment management system and one to send to the MLC controller system. The content of these plans is different. They have different UIDs, but they will set up the host Elekta Linac and the MLC control system to work together.

3.2 AE Specifications

3.2.1 AE Specification for MONACO_SCP

3.2.2 SOP Classes

This Application Entity provides Standard Conformance to the following Storage SOP Classes.

Table 3-1: Number of Associations as an Association Acceptor for MONACO_SCP

SOP Class Name	SOP Class UID	SCU	SCP
Verification	1.2.840.10008.1.1	No	Yes
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	No	Yes
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	No	Yes
Positron Emission Tomography (PET) Image Storage	1.2.840.10008.5.1.4.1.1.128	No	Yes
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	No	Yes
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	No	Yes
RT Ion Plan Storage	1.2.840.10008.5.1.4.1.1.481.8	No	Yes
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	No	Yes

3.2.3 Association Policies for MONACO_SCP

3.2.4 General

The (PDU) size proposed in an association request will default to 16K bytes and is configurable in the [ASSOC_PARMS] section of the mergecom.pro file to be anything from 2K bytes to 512K bytes using the parameter PDU_MAXIMUM_LENGTH.

3.2.5 Number of Associations

Table 3-2: Number of Associations as an Association Acceptor for MONACO_SCP

Maximum number of simultaneous associations	1

3.2.6 Asynchronous Nature

Not supported

3.2.7 Association Acceptance Policies for MONACO_SCP

MONACO_SCP runs as a server in the background of the Monaco workstation listening for association requests from DICOM sources wishing to send to Monaco.

3.2.8 MONACO_SCP SOP Specific Conformance for SOP Classes

All DICOM objects are accepted by MONACO_SCP and written to a local disk are for later, asynchronous selection. Monaco users are then able to import the objects into the CT Simulation or Plan Review application.

See Appendix 1 for specific tag-by-tag data use by Monaco.

3.2.9 AE Specification for CMS_SCU

3.2.10 SOP Classes

This Application Entity provides Standard Conformance to the following SOP classes:

Table 3-3: SOP Classes for CMS_SCU

SOP Class Name	SOP Class UID	SCU	SCP
Verification	1.2.840.10008.1.1	Yes	No
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Yes	No
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Yes	No
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Yes	No
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	Yes	No
RT Ion Plan Storage	1.2.840.10008.5.1.4.1.1.481.8	Yes	No
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	Yes	No
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	Yes	No
Secondary Capture Storage	1.2.840.10008.5.1.4.1.1.7	Yes	No

3.2.11 Association Policies for CMS_SCU

3.2.12 General

The (PDU) size proposed in an association request will default to 16K bytes and is configurable in the [ASSOC_PARMS] section of the mergecom.pro file to be anything from 2K bytes to 512K bytes using the parameter PDU_MAXIMUM_LENGTH.

3.2.13 Number of Associations

Table 3-4: Number of Associations as an Association Initiator for CMS_SCU

Maximum number of simultaneous associations	1

3.2.14 Asynchronous Nature

This is not supported.

3.2.15 Association Initiation Policy for CMS_SCU

3.2.16 Store CT Image, RT Structure Set, RT Plan and RT Dose

The Monaco client application requests Storage Services of a user-selected DICOM server over an association. If the association is accepted by the server, the user-selected DICOM object combination is transferred from Monaco to the selected server over the association. When the transfer is completed, the client application closes the association.

CMS_SCU is the default name for the Monaco workstation's AE-Title. It can be edited to be unique for each workstation in the Monaco DICOM Settings dialog.

Table 3-5: Proposed Presentation Contexts for CMS_SCU

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
PET Image Storage	1.2.840.10008.5.1.4.1.1.128	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Ion Plan Storage	1.2.840.10008.5.1.4.1.1.481.8	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
Secondary Capture Storage	1.2.840.10008.5.1.4.1.1.7	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None
RT Image Storage	1.2.840.10008.5.1.4.1.1.481.1	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

3.2.17 SOP Specific Conformance for all storage SOP classes with CMS_SCU

The Patient Name (0010,0010), Patient ID (0010,0020), Patient's Birth Date (0010,0030), Patient Sex (0010,0040), Study ID (0020,0010), Study Instance UID (0020,000D) and Frame of Reference UID (0020,

0052) will be the same for all DICOM RT objects exported at the same time. Specific Character Set (0008,0005) will be ISO_IR 100 for all objects.

See Appendix 2 for tag-by-tag conversion from Monaco data of the DICOM modules common to all exported objects.

3.2.18 SOP Specific Conformance for CT Image Storage SOP Class with CMS_SCU

The original CT data will be re-exported unless the user selects the 'Use Monaco Patient ID and Patient Name' or edits the Patient ID or Patient Name at export time. If edits are made, the system exports these as the DICOM Patient ID and DICOM Patient Name. No other DICOM tags are currently updated.

If CT images for the same patient are sent as multiple series, the software can merge the series for use within the application but exports the multiple original series data.

Derived images from 4D images sets can be created and exported by Monaco. The Maximum, Minimum or average images can be exported as a new series in the same study as the first CT series used in the derivation. New series and instance UID's are generated each time the images are exported (the Instance UID's are not persistent).

For systems with a Carbon planning license, the original CT data exports as is, unless the user edits the couch roll value. If this value changes, the Image Orientation Patient (IOP) for the image, updates to show the couch roll angle updates. The RT Equipment Correlation Macro is also added to the images so that the couch table top angle is recorded. The SOP Instance UID, ownership and creation tags will be updated to reflect a new CT series in the same study.

CT images that have a non-orthogonal IOP, but do not contain a matching RT Equipment Correlation Macro value for the couch table angle, will not be imported.

3.2.19 4.2.3.3.2.2 SOP Specific Conformance for RT Structure Set Storage SOP Class with CMS_SCU

The export of RT STRUCT is not a "pass-through" of the object. The RT STRUCT will have Manufacturer set to Computerized Medical Systems† and have the Monaco UID root even if the user did not add or edit the structures with this release, the export function creates a new instance UID each time the object is exported. Object UIDs are not currently persistent.

† Computerized Medical Systems has been succeeded as a corporation by IMPAC Medical Systems Inc.; for sustained data compatibility with DICOM receivers that might use the name for specific import filtering or processing, we have refrained from changing the Manufacturer name in the DICOM export objects.

3.2.20 SOP Specific Conformance for RT Plan Storage SOP Class with CMS_SCU

Even if the RT Plan is sent without an RT Structure Set, RT Plan Geometry (300A, 000C) will be set to TREATMENT_DEVICE, otherwise the value will be PATIENT and the RT Plan will reference the RT Structure Set when it is exported at the same time.

The export function creates a new instance UID for RT Plan each time it is exported. RT Plan object UIDs are not currently persistent.

See Appendix 3 for tag-by-tag conversion from Monaco data for the RTPLAN IOD.

3.2.21 SOP Specific Conformance for RT Dose Storage SOP Class with CMS_SCU

RT Dose can be exported per BEAM or per PLAN for patient plans and QA plans that have been calculated by Monaco.

The export function creates a new instance UID each time the object is exported. Dose object UIDs are not currently persistent.

3.2.22 SOP Specific Conformance for Secondary Capture Storage SOP Class with CMS_SCU

The export function creates a new instance UID each time an image is exported. SC Image UIDs are not persistent.

3.2.23 SOP Specific Conformance for RT Image Storage SOP Class with CMS_SCU

The export function creates a new instance UID each time an image is exported. RT Image UID's are not persistent.

3.2.24 Specification for PRINT_SCU

3.2.25 SOP Classes

This Application Entity provides Standard Conformance to the following SOP classes:

Table 3-6: SOP Classes for PRINT_SCU

SOP Class Name	SOP Class UID	SCU	SCP
Verification	1.2.840.10008.1.1	Yes	No
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	Yes	No

3.2.26 Association Policies

3.2.27 General

The (PDU) size proposed in an association request will default to 16K bytes and is configurable in the [ASSOC_PARMS] section of the mergecom profile to be anything from 2K bytes to 512K bytes using the parameter PDU_MAXIMUM_LENGTH.

3.2.28 Number of Associations

Table 3-7: Number of Associations as an Association Initiator for PRINT_SCU

Maximum number of simultaneous associations	1

3.2.29 Asynchronous Nature

Not supported

3.2.30 Association Initiation Policy for PRINT_SCU

Table 3-8: Proposed Presentation Contexts for PRINT_SCU

Presentation Context Table					
Abstract Syntax		Transfer Syntax		Role	Extended Negotiation
Name	UID	Name	UID		
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	DICOM Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

3.2.31 PRINT_SCU SOP Specific Conformance for SOP Classes

When "Print to Film" is selected, the Monaco client application requests Print Services of one pre-defined DICOM server over an association. If the association is accepted by the server, secondary capture images are then transferred from the Monaco client to the print server over the association. When the transfer is completed, the client application closes the association.

4 Network Interfaces

The Monaco DICOM applications run over the TCP/IP protocol stack on any physical interconnection media supporting the TCP/IP stack

4.1 Supported Communication Stacks

Monaco provides the DICOM V3.0 TCP/IP Network Communication Support as defined in part 8 of the standard.

4.1.1 TCP/IP stack

Monaco inherits the TCP/IP capabilities of the Windows operating system that it is running on.

4.1.2 Physical Media Support

Any Ethernet network supported by the host machine is supported.

5 Support of Extended Character Sets

As an SCU, Monaco exports the extended Character Set value of ISO-IR 100 for the STRUCTURE SET and RTPLAN objects.

As an SCU for DRR export using the Secondary Capture modality, there is no extended character set defined.

As an SCP, Monaco does not accept extended character sets.

6 Security

No specific DICOM security features are applied within Monaco.

Appendix 1: Import Processing

Import Processing for DICOM CT, MR and PET Images, RT Structure Set, RT Plan and RT Dose

The following modules, which make up the CT, MR, and PET image IOD, are read. The elements used by Monaco are listed. Since Monaco has no use for the unlisted elements, they are not read.

Patient Module (C.7.1.1)		
Group	Element	Description
0010	0010	Patient Name
0010	0020	Patient ID
0010	1020	Patient Height Imported with PET images only for SUV calculation
0010	1030	Patient Weight Imported with PET images only for SUV calculation
0010	0040	Patient Sex

General Study Module (C.7.2.1)		
Group	Element	Description
0008	0090	Referring Physician's Name
0020	0010	Study ID
0008	0050	Accession Number
0008	1030	Study Description

Image Plane Module (C.7.6.2)		
Group	Element	Description
0028	0030	Pixel Spacing
0020	0037	Image Orientation (Patient)
0020	0032	Image Position (Patient)

Image Pixel Module (C.7.6.3)		
Group	Element	Description
0028	0010	Rows
0028	0011	Columns
0028	0100	Bits Allocated
0028	0101	Bits Stored
0028	0103	Pixel Representation
7FE0	0010	Pixel Data
0028	0106	Smallest Image Pixel Value
0028	1052	Rescale Intercept This is applied to the CT and PET pixel data before it is stored in Monaco
0028	1053	Rescale Slope This is applied to the CT and PET pixel data before it is stored in Monaco

VOI LUT Module (C.11.2)		
Group	Element	Description
0028	1050	Window Center If this value (and Window Width) is present for PET images, the system stores them and presents a PET DICOM choice for Window Width and Level. Only the first value is used.
0028	1051	Window Width

CT Image Module (C.8.2.1)		
Group	Element	Description
0008	0008	Image Type
300A	0122	Patient Support Angle If present, only a value of zero accepted.
300A	0140	Table Top Pitch Angle If present, only a value of zero accepted.
300A	0144	Table Top Roll Angle Only a value within the limits of the table top roll value will be accepted. Otherwise, the user will have to edit the value before import.
0008	0008	Image Type

MR Image Module (C.8.3.1)		
Group	Element	Description
0008	0008	Image Type

PET Series Module (C.8.9.1)		
Group	Element	Description
0054	1001	Units Only BQML or CNTS will be displayed and used for SUV calculations.
0054	1002	Count Source EMISSION will only be used for SUV calculation.
0028	0051	Corrected Image System allows SUV calculation only if ATTN and DECY values are present.
0054	1102	Decay Correction SUV option only available if value is set to START or ADMIN.

PET Isotope Module (C.8.9.2)		
Group	Element	Description
0054	0016	Radiopharmaceutical Information Sequence
>0018	1072	Radiopharmaceutical Start Time Used in SUV calculation if (0018,1078) does not exist.
>0018	1074	Radionuclide Total Dose
>0018	1075	Radionuclide Half Life
>0018	1078	Radiopharmaceutical Start DateTime Used in SUV calculation in preference to (0018,1072) if both exist.
>0018	0031	Radiopharmaceutical Imported for display only.
0054	1103	Reconstruction Method Imported for display only.

PET Image Module (C.8.9.4)		
Group	Element	Description
0008	0008	Image Type
0008	0022	Acquisition Date

		Read as start of acquisition date for SUV calculations. Value read from the first image in the image series.
0008	0032	Acquisition Time Read as start of acquisition time for SUV calculations. Value read from the first image in the image series.

GE PET Scan Module Private tags (Private Creator Identification GEMS_PETD_01)		
Group	Element	Description
0009	100D	PET scan_datetime Used for Acquisition Date/Time if the image series was post processed i.e. Series Date/Time is after Acquisition Date/Time.

Phillips PET Image Private tags (Private Creator Data Element (7053,0010)		
Group	Element	Description
7053	1000	SUV Scale Factor If exists, Monaco will allow the option: “Use Philips SUV” and apply the SUV scale factor to recalculate counts into Philips SUV.
7053	1009	Activity Concentration Scale Factor If this exists, Monaco will allow recalculation of CNTS into BQML and use BQML in SUV formulas.

6.1 Import Processing for DICOM RT Structure Set

The following modules, which make up the RT Structure Set IOD, are read. The elements used by Monaco are listed. Since Monaco has no use for the unlisted elements, they are not read.

Patient Module (C.7.1.1)		
Group	Element	Description
0010	0010	Patient Name
0010	0020	Patient ID

Structure Set Module (C.8.8.5)		
Group	Element	Description
3006	0002	Structure Set Label
0008	1155	Referenced SOP Instance UID
3006	0016	Contour Image Sequence

ROI Contour Module (C.8.8.6)		
Group	Element	Description
0008	1155	Referenced SOP Instance UID
3006	002A	ROI Display Color
3006	0016	Contour Image Sequence
3006	0039	ROI Contour Sequence
3006	0040	Contour Sequence
3006	0042	Contour Geometric Type
3006	0046	Number of Contour Points
3006	0050	Contour Data

RT ROI Observations Module (C.8.8.8)		
Group	Element	Description
3006	0080	RT ROI Observation Sequence
>3006	0080	Observation Number
>3006	0084	Referenced ROI Number
>3006	00A4	RT ROI Interpreted Type EXTERNAL

RT ROI Observations Module (C.8.8.8)		
		ORGAN BOLUS
>300C	300C	ROI Physical Properties Sequence Only imported for ROI Interpreted type of BOLUS
>>3006	00B2	ROI Physical Property If REL_ELEC_DENSITY then read the following ROI Physical Property Value as a forced density. If not REL_ELEC_DENSITY, set the forced density to null.
>>3006	00B4	ROI Physical Property Value Export Electron Density value of bolus.

6.2 Import Processing for DICOM RTPLAN

The following modules, which make up the RT Plan IOD, are read. The elements used by Monaco are listed. Since Monaco has no use for the unlisted elements, they are not read.

Patient Module (C.7.1.1)		
Group	Element	Description
0010	0010	Patient's Name
0010	0020	Patient ID

RT Series Module (C.8.8.1)		
Group	Element	Description
0008	0060	Modality

RT General Plan Module (C.8.8.9)		
Group	Element	Description
300A	0002	RT Plan Label
300A	0004	RT Plan Description

RT Fraction Scheme Module (C.8.8.13)		
Group	Element	Description
300A	0070	Fraction Group Sequence
300A	0080	Number of Beams
300A	0086	Beam Meterset
300A	00A0	Number of Brachy Application Setups

RT Beams Module (C.8.8.14)		
Group	**Element**	**Description**
300A	00C0	Beam Number
300A	00C6	Radiation Type
300A	00B2	Treatment Machine Name
300A	00B3	Primary Dosimeter Unit
300A	00B8	RT Beam Limiting Device Type
300A	00D0	Number of Wedges
300A	00F2	Total Block Tray Factor
300A	0108	Applicator ID
300A	0110	Number of Control Points
300A	0114	Nominal Beam Energy
300A	00B8	RT Beam Limiting Device Type
300A	00BC	Number of Leaf/Jaw Pairs
300A	00CE	Treatment Delivery Type
300A	00D0	Number of Wedges
300A	00E0	Number of Compensators
300A	00ED	Number of Boli
300A	00B0	Referenced Bolus Sequence
300A	00F0	Number of Blocks

6.3 Import Processing for DICOM RTDOSE

The following modules, which make up the DICOM RT DOSE IOD, are used on import. Elements that are not used for import into Monaco Plan Review are not listed.

RT Dose Module		
Group	**Element**	**Description**
0020	0013	Instance Number
0028	0002	Samples per pixel
0028	0004	Photometric Representation Accept only MONOCHROME2
0028	0100	Bits Allocated Accept 16 or 32
0028	0101	Bits Stored
0028	0102	High Bit
0028	0103	Pixel Representation Accept only 0
3004	0002	Dose Units Accept only GY
3004	0004	Dose Type Accept only PHYSICAL
3004	000A	Dose Summation Type Accept PLAN or FRACTION
300C	0002	Referenced RT Plan Sequence Accept only if Referenced RT PLAN is available at time of import
>0008	1150	Referenced SOP Class UID
>0008	1155	Referenced SOP Instance UID
3004	000C	Grid Frame Offset Vector Accept only if first value is zero and increasing with a uniform offset in the DICOM patient Z direction. The values in the vector will be assumed to be relative to the z-value of “Image Position (Patient)” (0020, 0032).
3004	000E	Dose Grid Scaling
0020	0013	Instance Number
0028	0002	Samples per pixel
0028	0004	Photometric Representation Accept only MONOCHROME2
0028	0100	Bits Allocated Accept 16 or 32
0028	0101	Bits Stored

RT Dose Module		
0028	0102	High Bit
0028	0103	Pixel Representation
0028	0103	Pixel Representation Accept only 0
3004	0002	Dose Units Accept only GY
3004	0004	Dose Type Accept only PHYSICAL
3004	000A	Dose Summation Type Accept PLAN or FRACTION
300C	0002	Referenced RT Plan Sequence Accept only if Referenced RT PLAN is available at time of import
>0008	1150	Referenced SOP Class UID
>0008	1155	Referenced SOP Instance UID
3004	000C	Grid Frame Offset Vector Accept only if first value is zero and increasing with a uniform offset in the DICOM patient Z direction. The values in the vector will be assumed to be relative to the z-value of “Image Position (Patient)” (0020, 0032).
3004	000E	Dose Grid Scaling

Appendix 2: Export -Common Module content

Patient Module (C.7.1.1)		
Group	**Element**	**Description**
0010	0010	Patient's Name Export DICOM patient name. User can also export Monaco patient name or edit this name on the Monaco export screen (up to 64 characters)
0010	**0020**	**Patient ID** **Export DICOM patient ID; user can also export Monaco patient ID or edit this value on the Monaco export screen (up to 64 characters)**
0010	**0030**	**Patient's Birth date**
0010	**0040**	**Patient's Sex** **Export M for male** **F for female** **O for unknown**
0010	**1000**	**Other Patient ID's** **For RT Structure Set and RT Plan, export Monaco's patient ID. For images, export any original value if there was one.**
0010	**1001**	**Other Patient Names** **For RT Structure Set and RT Plan, export Monaco's internal version of the Patient Name. For images, export any original value if there was one.**
0010	**0010**	**Patient's Name** **Export DICOM patient name. User can also export Monaco patient name or edit this name on the Monaco export screen (up to 64 characters)**

General Study Module (C.7.2.1)		
Group	**Element**	**Description**
0020	**000D**	**Study Instance UID** **Export unique identifier of the Study from the imported, primary image study.**
0020	**0010**	**StudyID** **For Images, RT STRUCTURE SET and RT IMAGE, Monaco's Structure Set ID is exported.** **For RTPLAN, RT ION PLAN, and RTDOSE, the original image's study ID is exported.**
0008	**0020**	**Study Date** **Export study date from the primary image study for all objects.**
0008	**0030**	**Study Time** **Export study time from the primary image study for all objects.**

General Study Module (C.7.2.1)		
0008	0050	Accession Number For Images, RT STRUCTURE SET and RT IMAGE, export 1 For RTPLAN, RT ION PLAN, and RTDOSE, the original image's number is exported.
0008	0090	Referring Physician's Name For images, export original value. For Structure Set, export Unknown. For RTPLAN, RTDOSE and RT IMAGE, export null.
0008	1030	Study Description For an image's export original CT value. For all others, not exported.

General Equipment Module (C.7.5.1)		
Group	Element	Description
0008	0070	Manufacturer Images will have their original value. Export Computerized Medical Systems† for RTSTRUCT and Secondary Capture DRR. Export CMS, Inc.† for RTPLAN, RT DOSE and RT IMAGE.
0008	1090	Manufacturer's Model Name Images will have their original value. For all others, export Monaco.
0018	1020	Software Version(s) Exported for edited images, RTDOSE and RT ION PLAN

† Computerized Medical Systems and CMS Inc. have been succeeded as a corporation by IMPAC Medical Systems Inc.; for sustained data compatibility with DICOM receivers that might use the name for specific import filtering or processing, we have refrained from changing the Manufacturer name in the DICOM export objects.

RT Series Module (C.8.8.1)		
Group	Element	Description
0008	0060	Modality Export CT, RTSTRUCT, RTPLAN, RT DOSE, CR (for Secondary Capture DRR) or RT IIMAGES depending on object being sent.
0020	000E	Series Instance UID Unedited Images will use their original number; for all other objects, export new, unique identifier of the series.
0020	0011	Series Number Images export original value, for RTDOSE, export null, all others export 1
0008	1070	Operator's Name

RT Series Module (C.8.8.1)		
		Unedited Images export original value; all other objects export user's log in name.

SOP Common Module (C.12.1)		
Group	Element	Description
0008	0016	SOP Class UID
0008	0018	SOP Instance UID Except for original, imported, unedited image objects, a new UID value is generated each time an export is made.
0008	0005	Specific Character Set For RT PLAN, RT ION PLAN, RT DOSE, RT IMAGE export ISO_IR 100. Not exported for RT STRUCT and Secondary Capture.
0008	0012	Instance Creation Date Except for original, imported, unedited images, export the date object is created.
0008	0013	Instance Creation Time Except for original, imported, unedited images, export the time the object is created.
0008	0014	Instance Creator UID For original, imported, unedited images, export original value. For derived or edited images, RT STRUCT, RTPLAN, RT ION PLAN and Secondary Capture DRR's, export 2.16.840.1.114337. Not exported for other objects.

Frame of Reference Module (C.7.4.1)		
Group	Element	Description
0020	0052	Frame of Reference UID For unedited images, export the value from original axial planning images (CT or MR). For images where the couch roll value has been edited, export a new Elekta based UID.
0020	1040	Patient Reference Indicator Export value from original axial planning images (CT or MR)

Appendix 3: Export of RT Structure Set

Structure Set Module (C.8.8.5)		
Group	Element	Description
3006	0002	Structure Set Label Export STRCTRLABEL
3006	0004	Structure Set Name Export STRCTRNAME
3006	0008	StructureSetDate
3006	0009	StructureSetTime
3006	0010	ReferencedFrameOfReferenceSequence
>0020	0052	Frame of Reference UID
3006	0020	StructureSetROISequence
>3006	0022	ROI Number
>3006	0022	Referenced Frame of Reference UID
>3006	0026	ROI Name
>3006	0036	ROI Generation Algorithm

ROI Contour Module (C.8.8.6)		
Group	Element	Description
3006	0039	ROI Contour Sequence
>3006	0084	Referenced ROI Number
>3006	002A	ROI Display Color
>3006	0040	Contour Sequence
>>3006	0016	Contour Image Sequence
>>3006	0042	Contour Geometric Type
>>3006	0046	Number of Contour Points
>>3006	0050	Contour Data

RT ROI Observations Module (C.8.8.8)		
Group	Element	Description
3006	0080	RT ROI Observation Sequence
>3006	0080	Observation Number

RT ROI Observations Module (C.8.8.8)		
>3006	0084	Referenced ROI Number
>3006	00A4	RT ROI Interpreted Type EXTERNAL ORGAN BOLUS SUPPORT
>3006	00A6	ROI Interpreter
>300C	300C	ROI Physical Properties Sequence Only exported for ROI Interpreted type of BOLUS
>>3006	00B2	ROI Physical Property Exported only for BOLUS. Export REL_ELEC_DENSITY
>>3006	00B4	ROI Physical Property Value Export Electron Density value of bolus.

Appendix 4: Export of RT PLAN

The following modules, which make up the DICOM RT Plan IOD, are sent. Elements that are not supported for export from a Monaco teletherapy plan are not listed. On the DICOM export page, the user can map treatment machine names to the name required at the receiving system.

RT General Plan Module (C.8.8.9)		
Group	Element	Description
300A	0002	RT Plan Label For a Total Plan, export the plan label as <2 digit Course ID >Plan ID For a single prescription, export the plan label as <2 digit Course ID ><A or, B or C, etc.>Plan ID (until 16 characters are used for the label) where A,B,C is the prescription identifier. If no course ID is entered, this course ID prefix of the format is dropped.
300A	0003	RT Plan Name Export Monaco's Plan ID
300A	0004	RT Plan Description Export Plan Description
300A	0006	RT Plan Date Export Plan saved on date
300A	0007	RT Plan Time Export Plan saved on time
300A	000A	Plan Intent Export Plan intent value if there, otherwise not exported.
300A	000C	RT Plan Geometry Export PATIENT
300C	0060	Referenced Structure Set Sequence
>0008	1150	Referenced SOP Class UID
>0008	1155	Referenced SOP Instance UID

RT Prescription Module (C.8.8.9.1)		
Group	Element	Description
300A	000E	Prescription Description Export "Plan:RxA" or "Plan:RxB" ,etc if exporting a single prescription. Export "Composite Plan: RxA, RxB, etc" if exporting Total Plan.
300A	0010	Dose Reference Sequence Export one per Monaco Prescription and one for each unique dose reference point.

RT Prescription Module (C.8.8.9.1)		
>300A	0012	Dose Reference Number
>300A	0014	Dose Reference Structure Type Export "SITE" for Prescription Site entries Export "COORDINATES" for Dose Reference Points
>300A	0016	Dose Reference Description Export Site ID If Multiple Prescriptions are being planned, Monaco automatically adds the prescription letter to the front of the Site Name (even if it is blank). This makes sure that the DICOM Dose Reference descriptions are unique for each TARGET type of Dose Reference. In the MOSAIQ application, this Dose Reference Description is translated to MOSAIQ's Site Setup name. Only the first 20 characters of this attribute are used by MOSAIQ
>300A	0018	Dose Reference Point Coordinates For Dose reference points (DRP), export X, Y, Z location of point in DICOM coordinate space.
>300A	0020	Dose Reference Type Export TARGET
>300A	0026	Target Prescription Dose For Dose Reference Structure Type = SITE, export Rx (prescription) Total Dose

Tolerance Table Module (C.8.8.11)		
Group	Element	Description
300A	0040	Tolerance Table Sequence Only export if Tolerance table name is defined for at least one fraction group.
>300A	0042	Tolerance Table Number Export number of fractions for the group.
>300A	0043	Tolerance Table Label Export Monaco's Tolerance Table Name.

RT Patient Setup Module (C.8.8.12)		
Group	Element	Description
300A	0180	Patient Setup Sequence Export: Two sequence entries if the plan uses an SSD or extended SSD beam in the plan. Otherwise one sequence.
>300A	0182	Patient Setup Number

RT Patient Setup Module (C.8.8.12)		
		Export 1 or 2
>300A	01B0	Setup Technique Export: ISOCENTRIC or FIXED_SSD depending on the beams used in the plan.
>0018	5100	If patient planning position is FOOT IN, send original CT Image Patient Position with the first character set to "F". Else if plan is head-in HEAD IN, send original CT Image Patient Position with the first character set to "H".

RT Fraction Scheme Module (C.8.8.13)		
Group	Element	Description
300A	0070	Fraction Group Sequence Export one per Monaco prescription
>300A	0071	Fraction Group Number
>300A	0078	Number of Fractions Planned
>300A	0080	Number of Beams
>300A	00A0	Number of Brachy Application Setups Export 0
>300C	0004	Referenced Beam Sequence
>>300A	0082	Beam Dose Specification Point Export Weight Point Coordinates in (millimeter coordinates to first decimal place)
>>300A	0084	Beam Dose Export Dose to the Dose Reference Point (DRP); for CT Simulation Beams, this is a default of 10 Gy.
>>300A	0086	Beam Meterset For Monaco plans, export total meter set value for the beam (MU or time)
>>300C	0006	Referenced Beam Number Export Beam number (an integer value between 1 and 99).
>>300C	0050	Referenced Dose Reference Sequence Exported only if Rx Site and Rx Total Dose are present in Monaco for this beam's fraction group.
>>300C	0051	Referenced Dose Reference Number

RT Beams Module (C.8.8.14)		
Group	Element	Description

RT Beams Module (C.8.8.14)		
300A	00B0	Beam Sequence
>0008	1040	Institutional Department Name Export Monaco Clinic Name
>300A	00B2	Treatment Machine Name Export Treatment Unit ID from Monaco's export page. This may be a different machine name than is used within Monaco.
>300A	00B3	Primary Dosimeter Unit Export dosimetry units identified in Monaco for this machine
>300A	00B4	Source-Axis Distance Export machine reference distance defined in Monaco for this machine
>300A	00B6	Beam Limiting Device Sequence
>>300A	00B8	RT Beam Limiting Device Type Export X, Y, ASYMX, ASYMY, or MLCX as appropriate.
>>300A	00BA	Source to Beam Limiting Device Distance Export beam's source to collimator distance for the X, Y or MLC collimator as appropriate
>>300A	00BC	Number of Leaf/Jaw Pairs Export 1 if not MLC, if MLC, export value from MLC configuration file
>>300A	00BE	Leaf Position Boundaries Export values from MLC configuration file
>300A	00C0	Beam Number Export Monaco's Beam number (an integer between 1 and 99)
>300A	00C2	Beam Name Export Field ID
>300A	00C3	Beam Description Export beam description
>300A	00C4	Beam Type
>300A	00C6	Radiation Type
>300A	00CE	Treatment Delivery Type Export "TREATMENT" for regular treatment beams Export "SETUP" for such beams as designated by the user.
>3002	0050	Primary Fluence Mode Sequence Sequence only sent if the energy in the machine model has been explicitly updated to indicate that its fluence is STANDARD or NON_STANDARD. Otherwise, sequence is not exported.
>>3002	0051	Fluence Mode If sequence is sent, export STANDARD or NON_STANDARD as stored in the

RT Beams Module (C.8.8.14)		
		Monaco machine model for this energy.
>>3002	0052	Fluence Mode ID If Fluence Mode is NON_STANDARD, export value stored in machine model for this energy- SRS or FFF.
>300A	00D0	Number of Wedges
>300A	00D1	Wedge Sequence
>>300A	00D2	Wedge Number
>>300A	00D3	Wedge Type
>>300A	00D4	Wedge ID
>>300A	00D5	Wedge Angle
>>300A	00D6	Wedge Factor
>>300A	00D8	Wedge Orientation
>>300A	00da	Source to Wedge Tray Distance
>300A	00E0	Number of Compensators
>300A	00ED	Number of Boli
>300C	00ED	Referenced Bolus Sequence
>>300C	0084	Referenced ROI Number
>>300A	00DC	Bolus ID Export system's bolus structure name
>>300A	00DD	Bolus Description User-defined description for the Bolus
>300A	00F0	Number of Blocks Export total ports and blocks in beam (Monaco's maximum is 20)
>300A	00F2	Total Block Tray Factor No value exported for electrons
>300A	00F4	Block Sequence
>>300A	00E1	Material ID
>>300A	00F5	Block Tray ID No value exported for electrons
>>300A	00F6	Source to Block Tray Distance Export source to block tray distance from Monaco's treatment machine parameters (for electrons this corresponds to the insert distance).
>>300A	00F8	Block Type If Monaco polygon flag says port, then export APERTURE otherwise SHIELDING

RT Beams Module (C.8.8.14)		
>>300A	00FA	Block Divergence Export PRESENT
>>300A	00FB	Block Mounting Position Export SOURCE_SIDE
>>300A	00FC	Block Number Export Monaco's polygon number (1-20)
>>300A	00FE	Block Name
>>300A	00E1	Material ID
>>300A	0100	Block Thickness
>>300A	0102	Block Transmission
>>300A	0104	Block Number of Points
>>300A	0106	Block Data
>300A	0107	Applicator Sequence Sequence only sent for an electron beam, photon beam with a stereotactic cone or photon beam with an add-on MLC.
300A	00F9	Accessory Code Export user defined value from Map Machines configuration file for Stereotactic cone or add-on MLC.
>>300A	0108	Applicator ID For Stereotactic cone or add-on MLC, export user defined value from Map Machines configuration file.
>>300A	0109	Applicator Type For Stereotactic cone or add-on MLC, export user defined value from Map Machines configuration file
>>300A	010A	Applicator Description For Stereotactic cone or add-on MLC, export user defined value from Map Machines configuration file
>300A	010E	Final Cumulative Meterset Weight
>300A	0110	Number of Control Points
>300A	0111	Control Point Sequence
>>300A	0112	Control Point Index
>>300A	0134	Cumulative Meterset Weight
>>300C	0050	Reference Dose Reference Sequence Export two values- the first one for the SITE prescription that is being treated and the second for the COORDINATE type of Dose Reference Point for this beam.

RT Beams Module (C.8.8.14)		
>>>300C	0051	Reference Dose Reference Number
>>>300A	010C	Cumulative Dose Reference Coefficient Export null
>>>300A	0088	Beam Dose Point Depth
>>>300A	0089	Beam Dose Point Equivalent Depth
>>>300A	008A	Beam Dose Point SSD
>>300A	0114	Nominal Beam Energy
>>300A	0115	Dose Rate Set Dose Rate Set is exported for all treatment modalities if Dose Rate is defined for the fraction group. For arc plans (i.e., VMAT and DCA) that use add-on micro-MLCs, the dose rate used for segmentation is exported. In all cases, the dose rate is encoded for every control point.
>>300A	0116	Wedge Position Sequence
>>>300C	00C0	Referenced Wedge Number
>>>300A	0118	Wedge Position
>>300A	011A	Beam Limiting Device Position Sequence
>>>300A	00B8	RT Beam Limiting Device Type
>>>300A	011C	Leaf/Jaw Positions
>>300A	011E	Gantry Angle
>>300A	011F	Gantry Rotation Direction
>>300A	0120	Beam Limiting Device Angle
>>300A	0121	Beam Limiting Device Rotation Direction Export: NONE
>>300A	0122	Patient Support Angle
>>300A	0123	Patient Support Rotation Direction Export: NONE
>>300A	0125	Table Top Eccentric Angle Export 0
>>300A	0126	Table Top Eccentric Rotation Direction Export NONE
>>300A	012C	Isocenter Position
>>300A	012E	Surface Entry Point
>>300A	0130	Source to Surface Distance

Approval Module (C.8.8.16)		
Group	**Element**	**Description**
300E	0002	Approval Status Export: Send APPROVED (if plan is approved); otherwise send UNAPPROVED.
300E	0004	Review Date Export: If Approval Status (300E,0002) is APPROVED, send the plan's approval date.
300E	0005	Review Time Export: If Approval Status (300E,0002) is APPROVED, send the plan's approval time.
300E	0008	Reviewer Name Export: If Approval Status (300E,0002) is APPROVED, send stored approver's name.

Appendix 5: Secondary Capture and RT Image Export for DRR

The following modules, which make up the Secondary Capture and RT image IOD, are exported. The elements used by Monaco are listed.

General Image Module (C.7.6.1)		
Group	Element	Description
0020	0013	Instance Number Export 1
0008	0008	Image Type For Secondary Capture, not exported. For RT IMAGE, export DERIVED\SECONDARY\DRR
0008	2111	Derivation Description Export: “Monaco\<patientID>\<saved plan ID>\beam number\BEV”
0020	0020	Patient Orientation See Appendix 6 for reported values algorithm

Image Pixel Module (C.7.6.3)		
Group	Element	Description
0028	0010	Rows For Secondary Capture export= 512 For RT IMAGE export =1024
0028	0011	Columns For Secondary Capture export= 512 For RT IMAGE export =1024
0028	0004	Photometric Interpretation MONOCHROME2
0028	0100	Bits Allocated 8
0028	0101	Bits Stored 8
0028	0102	High Bit 7
0028	0103	Pixel Representation 0
0028	0106	Smallest Image Pixel Value For Secondary Capture, not reported. For RT IMAGE, export 0

Image Pixel Module (C.7.6.3)		
0028	0106	Largest Image Pixel Value For Secondary Capture, not reported. For RT IMAGE, export 255
7FE0	0010	Pixel Data

SC Equipment Module (C.8.6.1)		
Group	Element	Description
0008	0064	Conversion Type Export WSD
0008	0060	Modality For Secondary Capture, export CR

RT Image Module (C.8.8.2)		
Group	Element	Description
3002	0002	RT Image Label Export the Beam Description if available otherwise, export BeamN (where N is the beam number from XiO's current plan) (MOSAIQ uses the first 5 characters of this tag to try to match the DRR automatically with a Field ID.)
0008	0008	Image Type For Secondary Capture, not exported. For RT IMAGE, export DERIVED\SECONDARY\DRR
0008	0064	Conversion Type Export WSD
3002	000c	RT Image Plane Export NORMAL
3002	000d	X-Ray Image Receptor Translation Export X, Y shift of the center of the DRR from the beam isocenter. Value of Z will be zero (i.e. at the isocenter plane)
3002	000e	X-Ray Image Receptor Angle
	0011	Image Plane Pixel Spacing
3002	0012	RT Image Position Export the top left corner of the image where the center of the image is 0,0
3002	0020	Radiation Machine Name Export Monaco's DICOM export treatment unit name from the DICOM export

RT Image Module (C.8.8.2)		
		page mapping.
300A	00B3	Primary Dosimeter Unit Export MU
3002	0022	Radiation Machine SAD Export SAD for the beam whose DRR is being generated.
3002	0026	RT Image SID Export SAD value of the treatment machine for this beam.
300C	0002	Referenced RT Plan Sequence Only exported if RTPLAN or RTION PLAN is being exported with the RT IMAGE.
0008	1150	Referenced SOP Class UID If plan is for Carbon beams, export 1.2.840.10008.5.1.4.1.1.481.8. (RT ION PLAN), else export 1.2.840.10008.5.1.4.1.1.481.5 (RT PLAN).
0008	1155	Referenced SOP Instance UID Export instance UID of Plan object (RT or RTION)
300C	0006	Referenced Beam Number Export the beam number
300A	011E	Gantry Angle Export gantry angle of the beam whose DRR is being generated.
300A	0120	Beam Limiting Device Angle Export gantry angle of the beam whose DRR is being generated.
300A	0122	Patient Support Angle Export couch angle of the beam whose DRR is being generated.
300A	0125	Table Top Eccentric Angle Export 0
300A	0140	Table Top Pitch Angle Exported for Carbon Plans Export: pitch angle from plan.
300A	0142	Table Top Pitch Rotation Direction Exported for Carbon Plans Export: NONE.
300A	0144	Table Top Roll Angle Exported for Carbon Plans Export: value of table roll Note: For head-first plans, Monaco Positive Roll Angle is in the opposite direction as the IEC. For feet-first plans, the Monaco positive roll angle is in the same direction as the IEC.

RT Image Module (C.8.8.2)		
300A	**0146**	**Table Top Roll Rotation Direction** **Exported for Carbon Plans** **Export: NONE.**

Appendix 6: Export of RT DOSE

The following are notes on the tags that make up the DICOM RT DOSE IOD for which the meaning is not obvious or well defined elsewhere.

RT Dose Module (C.8.8.3)		
Group	**Element**	**Description**
0028	0002	Samples Per Pixel Export 1
0020	0013	Instance Number Export 1
0028	0004	Photometric Interpretation Export MONOCHROME2
0028	0100	Bits Allocated Export 16
0028	0101	Bits Stored Export 16
0028	0102	High Bit Export 15
0028	0103	Pixel Representation Export 0
3004	0002	Dose Units Export GY
3004	0004	Dose Type Export PHYSICAL or EFFECTIVE
3004	000A	Dose Summation Type Export BEAM or PLAN depending on the user selection
300C	0002	Referenced RT Plan Sequence
>0008	1150	Referenced SOP Class UID Export 1.2.840.10008.5.1.4.1.1.481.5 for photon and electron plans Export 1.2.840.10008.5.1.4.1.1.481.8 for RTION PLANs.
>0008	1155	Referenced SOP Instance UID Export the SOP Instance UID for the RTPLAN or RT ION PLAN object that was exported at the same time as this dose object
>300C	0020	Referenced Fraction Group Sequence Exported if Dose Summation type is BEAM
>>300C	0022	Referenced Fraction Group Number Export 1

RT Dose Module (C.8.8.3)		
>>300C	0004	Referenced Beam Sequence Exported if Dose Summation type is BEAM
>>>300C	0006	Referenced Beam Number Exported if Dose Summation type is BEAM
3004	000C	Grid Frame Offset Vector

RT DVH Module (C.8.8.4)		
Group	Element	Description
300C	0060	Referenced Structure Set Sequence
>0008	1150	Referenced SOP Class UID
>0008	1155	Referenced SOP Instance UID
3004	0040	DVH Normalization Point DV
3004	0042	DVH Normalization Dose Value
3004	0050	DVH Sequence
>3004	0060	DVH Referenced ROI Sequence
>>3006	0084	Referenced ROI Number
>>3006	0062	DVH ROI Contribution Type
>3004	0001	DVH Type
>3004	0002	Dose units
>3004	0004	Dose Type Export PHYSICAL or EFFECTIVE
>3004	0052	DVH Dose Scaling
>3004	0054	DVH Volume Units
>3004	0056	DVH Number of Bins
>3004	0058	DVH Data
>3004	0070	DVH Maximum Dose
>3004	0072	DVH Maximum Dose
>3004	0074	DVH Mean Dose

Appendix 7: DRR and Intensity Map Patient Orientation tag (0020,0020) Reported Values

Head First plan, patient is supine:
Beam at IEC 0 = L\F Beam angle 0 < angle < 45 (beam gantry angle between zero and forty five degrees) = LP\F Beam angle 45 <= angle < 90 (beam gantry angle from 45 degrees up to ninety degrees) = PL\F
Beam at IEC 90 = P\F Beam angle 90 < angle < 135 (beam gantry angle between 90 and 135 degrees) = PR\F Beam angle 135 <= angle < 180 (beam gantry angle from 136 degrees up to 180 degrees) = RP\F
Beam at IEC 180 = R\F Beam angle 180 < angle < 225 (beam gantry angle between 180 and 225 degrees) = RA\F Beam angle 225 <= angle < 270 (beam gantry angle from 226 degrees up to 270 degrees) = AR\F
Beam at IEC 270 = A\F Beam angle 270 < angle < 315 (beam gantry angle between 270 and 315 degrees) = AL\F Beam angle 315 <= angle < 360 (beam gantry angle from 316 degrees up to 360 degrees) = LA\F

Feet First plan, patient is supine:
Beam at IEC 0 = R\H Beam angle 0 < angle < 45 (beam gantry angle between zero and forty five degrees) = RP\H Beam angle 45 <= angle < 90 (beam gantry angle from 45 degrees up to ninety degrees) = PR\H
Beam at IEC 90 = P\H Beam angle 90 < angle < 135 (beam gantry angle between 90 and 135 degrees) = PL\H Beam angle 135 <= angle < 180 (beam gantry angle from 136 degrees up to 180 degrees) = LP\H
Beam at IEC 180 = L\H Beam angle 180 < angle < 225 (beam gantry angle between 180 and 225 degrees) = LA\H Beam angle 225 <= angle < 270 (beam gantry angle from 226 degrees up to 270 degrees) = AL\H
Beam at IEC 270 = A\H Beam angle 270 < angle < 315 (beam gantry angle between 270 and 315 degrees) = AR\H Beam angle 315 <= angle < 360 (beam gantry angle from 316 degrees up to 360 degrees) = RA\H

Head First plan, patient is prone:
Beam at IEC 0 = R\F Beam angle 0 < angle < 45 (beam gantry angle between zero and forty five degrees) = RA\F Beam angle 45 <= angle < 90 (beam gantry angle from 45 degrees up to ninety degrees) = AR\F
Beam at IEC 90 = A\F Beam angle 90 < angle < 135 (beam gantry angle between 90 and 135 degrees) = AL\F Beam angle 135 <= angle < 180 (beam gantry angle from 136 degrees up to 180 degrees) = LA\F
Beam at IEC 180 = L\F Beam angle 180 < angle < 225 (beam gantry angle between 180 and 225 degrees) = LP\F Beam angle 225 <= angle < 270 (beam gantry angle from 226 degrees up to 270 degrees) = PL\F
Beam at IEC 270 = P\F Beam angle 270 < angle < 315 (beam gantry angle between 270 and 315 degrees) = PR\F Beam angle 315 <= angle < 360 (beam gantry angle from 316 degrees up to 360 degrees) = RP\F

Feet first plan, patient is prone:
Beam at IEC 0 = L\H Beam angle 0 < angle < 45 (beam gantry angle between zero and forty five degrees) = LA\H Beam angle 45 <= angle < 90 (beam gantry angle from 45 degrees up to ninety degrees) = AL\H
Beam at IEC 90 = A\H Beam angle 90 < angle < 135 (beam gantry angle between 90 and 135 degrees) = AR\H Beam angle 135 <= angle < 180 (beam gantry angle from 136 degrees up to 180 degrees) = RA\H
Beam at IEC 180 = R\H Beam angle 180 angle < 225 (beam gantry angle between 180 and 225 degrees) = RP\H Beam angle 225 <= angle < 270 (beam gantry angle from 226 degrees up to 270 degrees) = PR\H
Beam at IEC 270 = P\H Beam angle 270 < angle < 315 (beam gantry angle between 270 and 315 degrees) = PL\H Beam angle 315 <= angle < 360 (beam gantry angle from 316 degrees up to 360 degrees) = LP\H

Appendix 8: RT Ion Plan Import

RT Ion Beams Module (C.8.8.25)		
Group	Element	Description
300A	03A2	Ion Beam Sequence
>300A	00B2	Treatment Machine Name Import: Assign to IEC Machine for plan review.
>300A	00B3	Primary Dosimeter Unit Read and add to DICOM Report
>300A	00C0	Beam Number Read and add to DICOM Report
>300A	00C3	Beam Description Read and add to DICOM Report
>300A	00E0	Number of Compensators Read and add to DICOM Report
>300A	00ED	Number of Boli Read and add to DICOM Report
>300A	00F0	Number of Blocks Read and add to DICOM Report
>300A	010E	Final Cumulative Meterset Weight Read and add to DICOM Report Reject Plan if no monitor units for beam(s)
>>300A	0110	Number of Control Points Read, divide by two and add to DICOM Report as number of segments
>>300A	011E	Gantry Angle Read and add to DICOM Report
>>300A	0120	Beam Limiting Device Angle Read and add to DICOM Report
>>300A	0121	Beam Limiting Device Rotation Direction Read and add to DICOM Report
>>300A	0122	Patient Support Angle Read and add to DICOM Report
>>300A	0140	Table Top Pitch Angle Must be zero
>>300A	0142	Table Top Roll Angle
>>300A	0144	Table Top Roll Angle Must be zero

RT Ion Beams Module (C.8.8.25)		
>>300A	0146	Table Top Roll Rotation Direction Must be NONE
>>300A	014C	Gantry Pitch Rotation Direction Must be NONE

Appendix 9: RT Ion Plan Export

RT Prescription Module (C.8.8.9.1) in RT Ion Plan		
Group	Element	Description
300A	0010	Dose Reference Sequence
>300A	0012	Dose Reference Number
>300A	0014	Dose Reference Structure Type Export “SITE” for Prescription Site entries Export “COORDINATES” for Dose Reference Points
>300A	0018	Dose Reference Point Coordinates Export Dose reference points (DRP); export X, Y, Z location of point in DICOM coordinate space.
>300A	0020	Dose Reference Type Export TARGET
>300A	0026	Target Prescription Dose For SITE type Dose Reference Structure Type entries, export Rx (prescription) Total Dose
>300B	0010	MOSAIQ Private creator
>300B	0032	Target Prescription Effective Dose
>2111	0010	NIRS_MELCO Private Creator
>2111	103B	Effective Dose to DRP

RT Patient Setup Module (C.8.8.12) for RT ION PLAN		
Group	Element	Description
300A	0180	Patient Setup Sequence
300A	0182	Patient Setup Number Export 1
300A	01B0	Setup Technique Export: ISOCENTRIC
0018	5100	Patient Position If patient planning position is FOOT IN, send original CT Image Patient Position with the first character set to "F". Else if plan is HEAD IN, send original CT Image Patient Position with the first character set to "H".

RT Fraction Scheme Module (C.8.8.13) in RT Ion Plan		
Group	Element	Description
300A	0070	Fraction Group Sequence
>300A	0071	Fraction Group Number
>300A	0078	Number of Fractions Planned
>300A	0080	Number of Beams
>300A	00A0	Number of Brachy Application Setups Export 0
>300C	0004	Referenced Beam Sequence
>>300C	0006	Referenced Beam Number Export Beam number (an integer value between 1 and 99)
>>300A	0082	Beam Dose Specification Point Export Dose Reference Point (DRP) Coordinates in (millimeter coordinates to first decimal place)
>>300A	0084	Beam Dose Export Dose to the Dose Reference Point (DRP)
>>2111	0010	NIRS_Melco Private Creator
>>2111	103B	Effective Dose to DRP
>>300A	0086	Beam Meterset For Monaco plans, export total meter set value for the beam
>>300C	0006	Referenced Beam Number Export Beam number (an integer value between 1 and 99).
>>300C	0050	Referenced Dose Reference Sequence Exported only if Rx Site and Rx Total Dose are present in Monaco for this beam's fraction group.
>>>300A	0026	Target Prescription Dose
>>>300B	0032	Target Prescription Effective Dose
>>>300C	0051	Referenced Dose Reference Number

RT Ion Beams Module (Part 3 C.8.8.25)		
Group	Element	Description
300A	03A2	Ion Beam Sequence Export: Send for each proton or carbon beam that is active and calculable.
>300A	00C0	Beam Number Export: Beam number
>300A	00C2	Beam Name Export Field ID if present in the beam, or if present, export Monaco's beam description (up to 24 characters), else export Beam Number.
>300A	00C3	Beam Description Export: Beam description (up to 24 characters).
>300A	00C4	Beam Type Export: STATIC
>300A	00C6	Radiation Type Export: ION
>300A	0302	Radiation Mass Number For ION radiation type, export 12
>300A	0304	Radiation Atomic Number For ION radiation type, export 6
>300A	0306	Radiation Charge State For ION radiation type, export 6
>300A	0308	Scan Mode Export: MODULATED
>300A	00B2	Treatment Machine Name Export: Monaco's mapped machine ID from the export dialog.
>0008	1040	Institutional Department Name Export: Monaco Clinic Name
>300A	00B3	Primary Dosimeter Unit Export: NP
>300A	030A	Virtual Source-Axis Distances Export: Vertical and Horizontal scan reference distances.
>300C	006A	Referenced Patient Setup Number
>300A	00CE	Treatment Delivery Type Export: TREATMENT
>300A	00D0	Number of Wedges Export: 0.
>300A	00E0	Number of Compensators Export: 0

RT Ion Beams Module (Part 3 C.8.8.25)		
>300A	00ED	Number of Boli Export: 0
		Number of Blocks Export: 0
>300A	0312	Number of Range Shifters Export: Number of unique range shifters in current beam.
>300A	0314	Range Shifter Sequence Export: Send if Number of Range Shifters (300A,0312) > 0.
>>300A	0316	Range Shifter Number Export: range shifter number
>>300A	0318	Range Shifter ID Export: Send proton or carbon range shifter ID.
>>300A	0320	Range Shifter Type Export: BINARY
>300A	0330	Number of Lateral Spreading Devices Export: Number of Lateral Spreading Devices
>300A	0332	Lateral Spreading Device Sequence
>>300A	0334	Lateral Spreading Device Number Export: 1 for SCANNING_X, 2 for SCANNING_Y
>>300A	0336	Lateral Spreading Device ID Export: SCANNING_X or SCANNING_Y
>>300A	0338	Lateral Spreading Device Type Export MAGNET
>300A	0340	Number of Range Modulators Export: Number of range Modulators
>300A	0342	Range Modulator Sequence
>>300A	0344	Range Modulator Number
>>300A	0346	RangeModulator ID Export:Ridge Filter ID from Monaco's Spot Scan Parameters
>>300A	0348	Range Modulator Type Export: FIXED
>300A	010E	Final Cumulative Meterset Weight Export: NP calculation result.
>300A	0110	Number of Control Points Export: See Ion Control Point Sequence (300A,03A8)
>300A	03A8	Ion Control Point Sequence

RT Ion Beams Module (Part 3 C.8.8.25)		
>>300A	0112	Control Point Index Export: Start at 0 and increment by 1 for each subsequent control point.
>>300A	0134	Cumulative Meterset Weight Export: Sum of all spot weights (Scan Spot Meterset Weights (300A,0396)) sent thus far (before current control point). For example: CP#0) 0 CP#1) sum of 1st layer CP#2) sum of 1st and 2nd layers CP#3) sum of 1st, 2nd and 3rd layers CP#N) sum of all (1st through Nth) layers
>>300C	0050	Reference Dose Reference Sequence Export two values- the first one for the SITE prescription that is being treated and the second for the COORDINATE type for the Dose Reference Point for this beam.
>>>300C	0051	Reference Dose Reference Number
>>>300A	010C	Cumulative Dose Reference Coefficient Export null.
>>300A	0015	Nominal Beam Energy Unit Export: MEV
>>300A	0114	Nominal Beam Energy Export: Export maximum nominal energy in the beam.
>>300A	035A	Meterset Rate
>>300A	0360	Range Shifter Settings Sequence Export: Send in first control point if Number of Range Shifters (300A,0312) > 0.
>>>300A	0100	Referenced Range Shifter Number
>>>300A	0362	Range Shifter Setting Export: IN or OUT
>300A	0366	Range Shifter Water Equivalent Thickness Export: If beam is spot scanning, send the range shifter water equivalent thickness.
>>300A	0370	Lateral Spreading Device Settings Sequence
>>>300C	0102	Referenced Lateral Spreading Device Number
>>>300A	0372	Lateral Spreading Device Setting Export: IN
>>300A	0380	Range Modulator Settings Sequence

RT Ion Beams Module (Part 3 C.8.8.25)		
>>>300C	0104	Referenced Range Modulator Number Export: 1 or 2
>>300A	011E	Gantry Angle Export: In first control point send the gantry angle converted from Monaco to IEC coordinate system.
>>300A	011F	Gantry Rotation Direction Export: In first control point, send NONE.
>>300A	0120	Beam Limiting Device Angle Export: In first control point, send 0.
>>300A	0121	Beam Limiting Device Rotation Direction Export: In first control point, send NONE.
>>300A	0122	Patient Support Angle
>>300A	0123	Patient Support Angle Rotation Export: In first control point, send NONE.
>>300A	0390	Scan Spot Tune ID Export: Exportthe tune ID
>>300A	0392	Number of Scan Spot Positions Export: Export number of spots with non-zero weight.
>>300A	0394	Scan Spot Position Map Export: Export the x/y position in beam coordinates of each spot with non-zero weight.
>>300A	0396	Scan Spot Meterset Weights Export: For the control point that specifies the beginning of an energy layer, send the spot weights that correspond to the spots in Scan Spot Position Map (300A,0394). For the control point that specifies the end of an energy layer, send spot weights of “0” for each spot on Scan Spot Position Map (300A,0394).
>>300A	0398	Scanning Spot Size Export: Export tune ID value times 2
>>300A	039A	Number of Paintings Export: Export number of paintings.
>>300A	0122	Patient Support Angle Export: In first control point, send the couch angle converted from Monaco to IEC coordinate system.
>>300A	0123	Patient Support Rotation Direction Export: In first control point, send NONE.
>>300A	0140	Table Top Pitch Angle Export: pitch angle from plan Import: accept only a value of zero degrees

RT Ion Beams Module (Part 3 C.8.8.25)		
>>300A	0142	Table Top Pitch Rotation Direction Export: In first control point, send NONE.
>>300A	0144	Table Top Roll Angle Export: value of table roll Note: For head-first plans, Monaco Positive Roll Angle is in the opposite direction as the IEC. For feet-first plans, the Monaco positive roll angle is in the same direction as the IEC.
>>300A	0146	Table Top Roll Rotation Direction Export: In first control point, send NONE.
>>300A	014A	Gantry Pitch Angle Export: 0
>>300A	014C	Gantry Pitch Angle Rotation Direction Export: NONE
>>300A	0128	Table Top Vertical Position Export: In first control point, if set, send the couch position z coordinate (Monaco's Z value) transformed to the original Frame of Reference; otherwise send NULL.
>>300A	0129	Table Top Longitudinal Position Export: In first control point, send NULL.
>>300A	012A	Table Top Lateral Position Export: In first control point, if set, send the couch position x-coordinate transformed to original Frame of Reference; otherwise send NULL.
>>300A	030D	Snout Position Export: In first control point, send the nozzle tip to isocenter distance
>>300A	012C	Isocenter Position Export: In first control point, send the beam isocenter transformed to original Frame of Reference.
>300B	0010	MOSAIQ Private Creator Export: "IMPAC"
>300B	1002	Maximum Collimated Field Diameter Export: If it is not a spot-scan beam, or if it is Spot Scanning and manufacturer is "IBA" then send the maximum field diameter.
>300B	1004	Planned Distal Target Distance Export: If Beam Spreading type is "Spot Scanning" and manufacturer is IBA, send distal layer prescribed range. Else, if it is not a spot-scan beam, send prescribed range. Spreading type is "Spot Scanning" and manufacturer is IBA, send difference between the prescribed ranges for the first and last layers.
>300B	100E	Nominal SOBP Width Export: If Beam

RT Ion Beams Module (Part 3 C.8.8.25)		
>300A	0350	Patient Support Type Export: TABLE.

Appendix 10: Private Data Elements

Below is a list of the private tags for ValueRepresentation and ValueMultiplicity found in Appendix 7 for RTIONPLAN.

Private Creator Identification (IMPAC)				
Tags		Attribute Name	VR	VM
300B	0010	MOSAIQ Private creator	LO	1
300B	1002	Maximum Collimated Field Diameter Monaco calculates this as: snout.diameter * mach_ref_dist / (mach_ref_dist - iso_to_aperture_dist)	FL	1
300B	1004	Planned Distal Target Distance Deepest planned layer Range	FL	1
300B	100E	Nominal SOBP Width For multiple layer beam- calculated difference between the most distal layer Range and most proximal layer Range	FL	1
300B	0032	Target Prescription Effective Dose	DS	1

Private Creator Identification (NIRS Melco)				
Tags		Attribute Name	VR	VM
2111	0010	NIRS_Melco Private Creator	LO	1
2111	103B	Effective Dose to DRP	DS	1

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