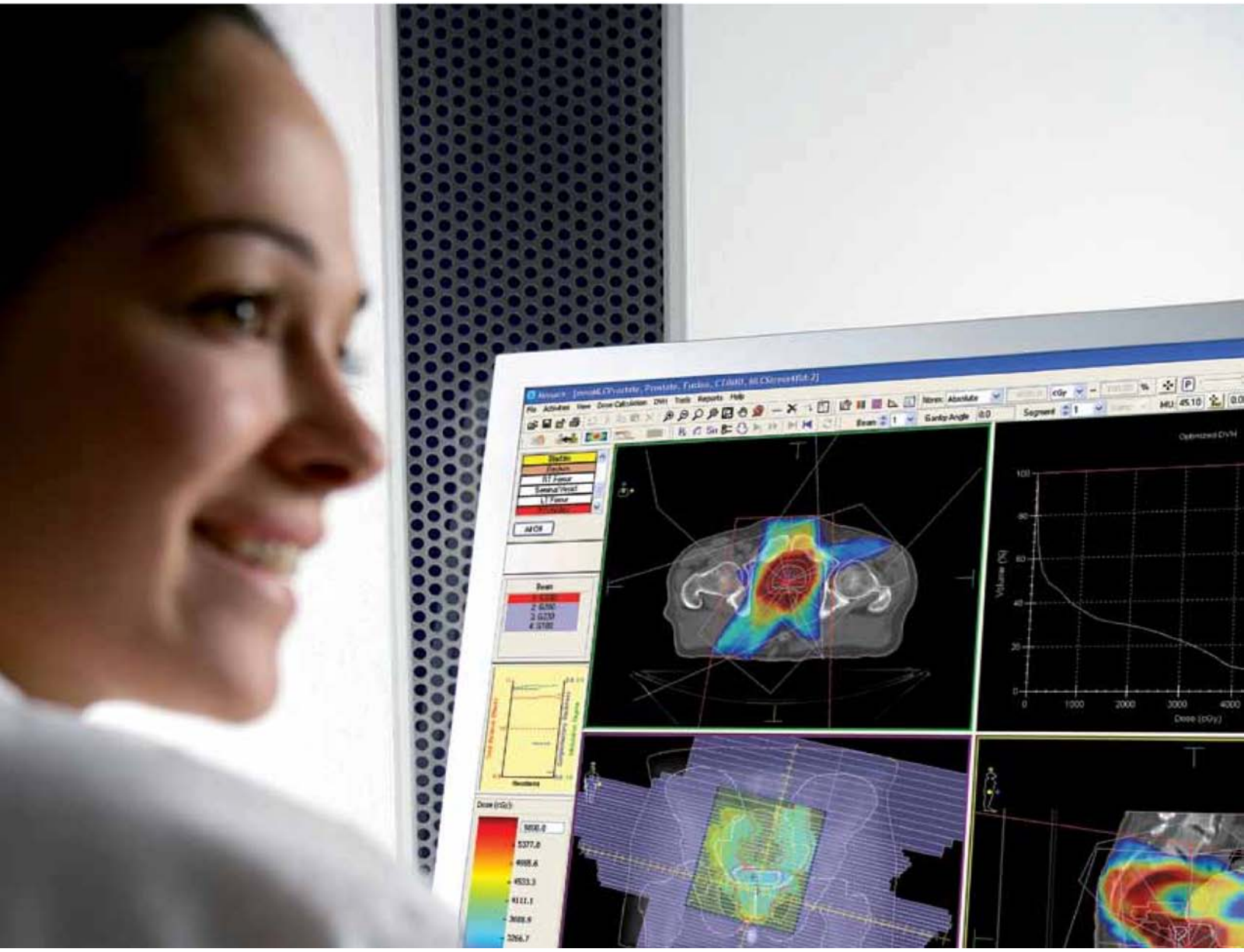
# Focal™/ Monaco® DICOM Conformance Statement

DICOM 3.0



IMPAC Medical Systems, Inc.
Document ID: LEDDCMFCLMON0001
Language: English

ELEKTA

CE 0086

**Revision History**

| Revision | Date | Purpose |
|---|---|---|
| FCL_MON_DCS_A | June 2006 | Add RTDOSE and RT IMAGE export and reformat to current DICOM compliance format. |
| LEDDCMFCLMON0001(3.0) | October 2009 | Add RT Dose Export information. |
| LEDDCMFCLMON0001(4.0) | February 2011 | Update for 4.62/3.00 changes |
| LEDDCMFCLMON0001(5.0) | October 2011 | Update for the Focal 4.64/ Monaco 3.10 releases. Adding RT Image Export for DRR, and per beam interest dose points. |
| LEDDCMFCLMON0001(6.0) | March 2012 | Update for Focal 4.70/ Monaco 3.20 releases. Adding MOSAIQ integration changes, Approval module, SETUP beams. |
| LEDDCMFCLMON0001(7.0) | December 2012 | Update for Focal 4.80/Monaco 3.30 releases:<br>• Flattening Filter Free Support in Export via Fluence Mode Sequence<br>• PET import changes to support SUV contouring |

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# 1. Conformance Statement Overview

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

Focal/Monaco is a three-dimensional, radiation therapy CT Simulation, IMRT/VMAT planning and Dose Review system that uses medical images to develop treatment plans and visualize the final planned dose results for cancer patients. Focal/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 Focal 4.80/Monaco 3.30, Focal/Monaco supports the network import of CT, MR and PET images, RT Structure Sets, RT 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. Focal/Monaco can also DICOM print DRRs to DICOM compatible printers. The user can export Images, RT Structure Sets, RT Plan, RT Dose and DRRs to multiple locations chosen at export time.

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

The tables below provide an overview of the network services supported by Focal/Monaco.

**Table 1-1: NETWORK SERVICES**

| SOP Classes | 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 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 |
| 1.2.840.10008.5.1.4.1.1.481.2 | 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 | Print |

| | | |
|---|---|---|
| | SOP Class | Management |

# 2. Table of Contents

## List of Tables

# 3. Introduction

## 3.2 Audience

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

## 3.3 Remarks

Focal/Monaco' s role as a CT Simulation, IMRT/VMAT planning and 3D Plan Review system means that it both imports and exports DICOM data.

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

Focal/Monaco's Contouring activity allows users to edit and add structures for later use in its CT Simulation and IMRT/VMAT Planning activities or export to another system

Focal/Monaco's CT Simulation activity allows users to 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.

Monaco's IMRT and VMAT planning activity allows users to develop intensity modulated photon MLC plans using advanced optimization and segmentation routines and export these plans and doses for example, to a treatment management system for delivery or to a secondary monitor unit calculation system.

Focal/Monaco's Plan Review activity allows users to import a completed 3D treatment plan and dose for the purposes of final plan review. The user can see images, structures, 3D dose and the textual content of the imported DICOM plan (in DICOM coordinates and conventions).

## 3.4 Definitions, Terms and Abbreviations

DRR- Digitally Reconstructed Radiograph

## 3.5 References

Digital Imaging and Communications in Medicine (DICOM), Parts 1-18 (2011), NEMA, Rosslyn, VA

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

# 4. Networking

## 4.1 Implementation Model

### 4.1.1 Application Data Flow Diagram

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

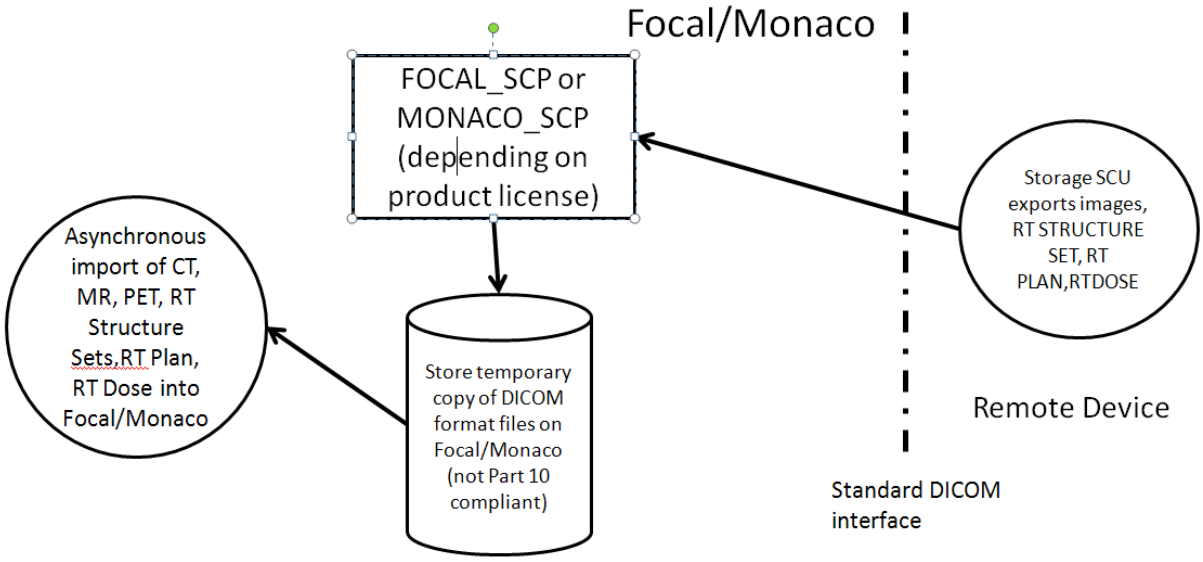


**Figure 1- Application Data Flow Diagram: Image, Structure Set, RT Plan and RT Dose Transfer to Focal/Monaco**

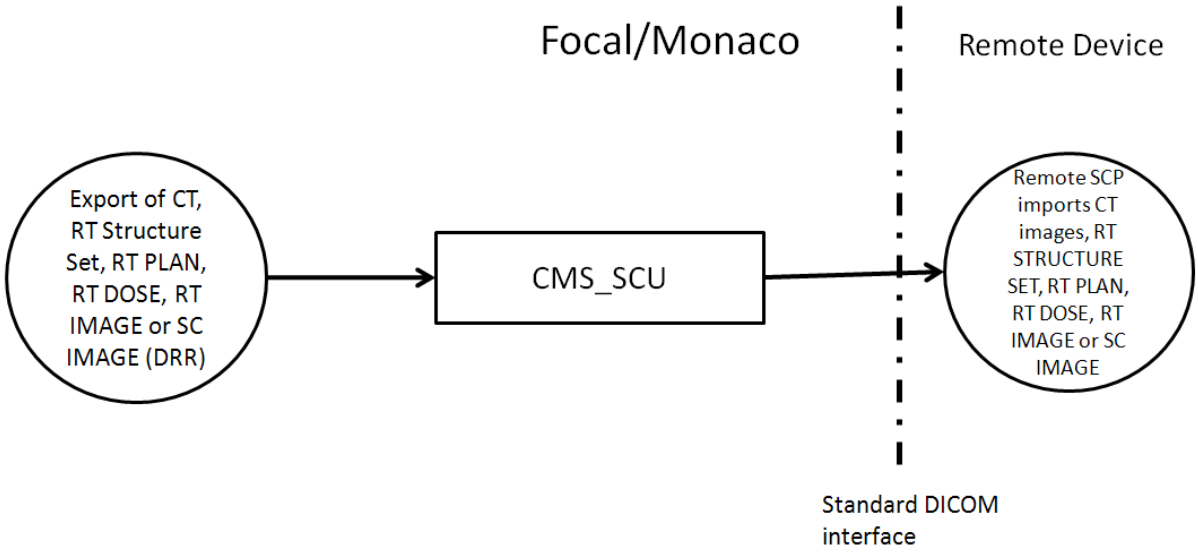


**Figure 2- Application Data Flow Diagram: CT IMAGE, RT Structure Set, RT Plan, RT Dose and DRR Export from Focal / Monaco**

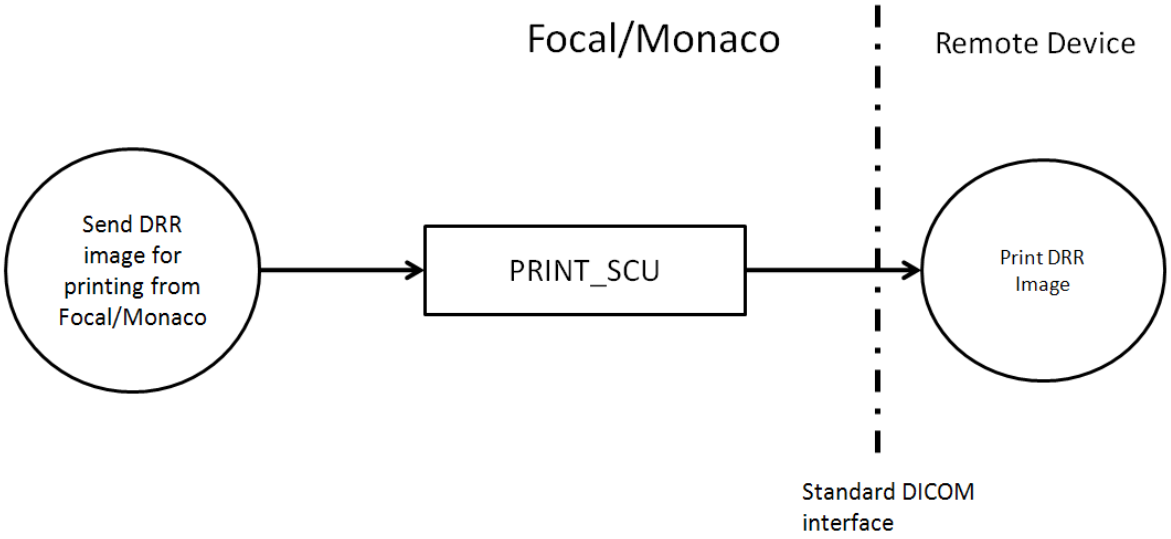


**Figure 3- Application Data Flow Diagram DRR Print**

### 4.1.2 Functional Definition of AE Titles

#### 4.1.2.1 Functional Definition of FOCAL_SCP

**CT, MR, PET, STRUCTURE SET, RTPLAN and RT DOSE Import into Focal**

The exporting system initiates the negotiation of an association with the Focal/Monaco DICOM server running over the network. The Focal/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 Focal/Monaco DICOM server over the association and stored in a temporary directory on the Focal/Monaco system. When the transfer is complete the client application closes the association. Later, the Focal/Monaco user imports the DICOM data into the Focal/Monaco application, at which point it is converted to the internal Focal/Monaco format.

##### 4.1.2.1.1 CT/MR/PET Image Import

If the DICOM header for a 16-bit CT image file defines a pixel padding value, Focal/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.

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

If CT images for the same patient are sent as multiple series, Focal/Monaco can merge the series for use within the application but will export the multiple original series data.

##### 4.1.2.1.2 RT Structure Set Import

The Focal/Monaco application can only import structure sets along with their referenced images or if the referenced images are already present in Focal/Monaco. It cannot store structure sets by themselves.

##### 4.1.2.1.3 RT Plan Import

The Focal/Monaco application can only import plans along with their referenced structure set or if the referenced structure set is already present in Focal.

##### 4.1.2.1.4 RT Dose Import

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

#### 4.1.2.2 Functional Definition of CMS_SCU

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

The Focal/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 Focal client to the selected server. When the transfer is completed, the client application closes the association.

Only images that have been imported into Focal/Monaco can be exported.

The host name of the network device to which the image is to be sent must be specified in mergecom.app.

##### 4.1.2.2.2 DRR export via RT Image or Secondary Capture Export to SCP

The Focal/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 Focal/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 image is to be sent must be specified in mergecom.app.

#### 4.1.2.3 Functional Definition of PRINT_SCU

##### 4.1.2.3.1 DRR Filming

When output to "Film" is selected, the Focal/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 Focal/Monaco client to the print server over the association. When the transfer is completed, the client application closes the association.

### 4.1.3 Sequencing of Real World Activities

#### 4.1.3.1 CT/MR/PET/SC Image; RT Structure Set, RT Plan and RT Dose Import

An operator initiates the transfer of data from a system that wants to send data to Focal/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 Focal/Monaco DICOM server receives the data and places it in a temporary disk directory on Focal.

Asynchronous to the DICOM transfer of this data, the user can import the DICOM data to create a new patient in Focal/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 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 is present at the same time

#### 4.1.3.2 DRR as RT Image or Secondary Capture Image Export

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

#### 4.1.3.3 CT IMAGE, STRUCTURE SET, RTPLAN, RT DOSE Export

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

Only images that have been imported into Focal/Monaco can be re-exported.

By default, without user intervention, the system will export all contours stored for the patient. The user can choose to reduce the contours being exported by selecting the appropriate option on the export dialog box.

Prior to export, the user can add additional plan information to the RTPLAN regarding the site, prescription, dose rate and tolerance tables by selecting the appropriate option on the export dialog.

If the plan is an IMRT 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 IMRT 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 IMRT 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 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.

## 4.2 AE Specifications

### 4.2.1 AE Specification for FOCAL_SCP (or MONACO_SCP)

#### 4.2.1.1 SOP Classes

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

**Table 4.2-1 SOP CLASSES FOR FOCAL_SCP (or 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 Dose Storage | 1.2.840.10008.5.1.4.1.1.481.2 | No | Yes |

#### 4.2.1.2 Association Policies for FOCAL_SCP (or MONACO_SCP)

### 4.2.2 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.

#### 4.2.2.1 Number of Associations

**Table 4.2-2: NUMBER OF ASSOCIATIONS AS AN ASSOCIATION ACCEPTOR FOR FOCAL_SCP (or MONACO_SCP)**

| | |
|---|---|
| Maximum number of simultaneous associations | 1 |

#### 4.2.2.2 Asynchronous Nature

Not supported

#### 4.2.2.3 Association Acceptance Policies for FOCAL_SCP (or MONACO_SCP)

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

#### 4.2.2.3.1 FOCAL_SCP (or MONACO_SCP) SOP Specific Conformance for SOP Classes

All DICOM objects are accepted by FOCAL_SCP/MONACO_SCP and written to a local disk are for later, asynchronous selection. Focal 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 Focal/Monaco.

### 4.2.3 AE Specification for CMS_SCU

#### 4.2.3.1 SOP Classes

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

**Table 4.2-3: 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 |
| 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 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 |

#### 4.2.3.2 Association Policies for CMS_SCU

#### 4.2.3.2.1 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.

#### 4.2.3.2.2 Number of Associations

**Table 4.2-4: NUMBER OF ASSOCIATIONS AS AN ASSOCIATION INITIATOR FOR CMS_SCU**

| | |
|---|---|
| Maximum number of simultaneous associations | 1 |

#### 4.2.3.2.3 Asynchronous Nature

This is not supported.

#### 4.2.3.3 Association Initiation Policy for CMS_SCU

#### 4.2.3.3.1 Store CT Image, RT Structure Set, RT Plan and RT Dose

The Focal/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 Focal/Monaco to the selected server over the association. When the transfer is completed, the client application closes the association.

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

**Table 4.2-5: 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 |
| 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 |

### 4.2.3.3.2 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 Focal data of the DICOM modules common to all exported objects.

#### 4.2.3.3.2.1 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.

#### 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 CMS Inc. and have CMS Focal 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.

#### 4.2.3.3.2.3 SOP Specific Conformance for RT Plan Storage SOP Class with CMS_SCU

If 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 exported at the same time.

The export function creates a new, instance UID each time an image is exported. Object UIDs are not currently persistent.

See Appendix 3 for tag-by-tag conversion from Focal/Monaco data for the RTPLAN IO.

#### 4.2.3.3.2.4 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.

#### 4.2.3.3.2.5 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. Image UIDs are not persistent.

#### 4.2.3.3.2.6 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 UIDs are not persistent.

### 4.2.4 AE Specification for PRINT_SCU

#### 4.2.4.1 SOP Classes

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

**Table 4.2-6: 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 |

### 4.2.4.2 Association Policies

#### 4.2.4.2.1 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.

#### 4.2.4.2.2 Number of Associations

**Table 4.2-7: NUMBER OF ASSOCIATIONS AS AN ASSOCIATION INITIATOR FOR PRINT_SCU**

| | |
|---|---|
| Maximum number of simultaneous associations | 1 |

#### 4.2.4.2.3 Asynchronous Nature

Not supported

### 4.2.4.3 Association Initiation Policy for PRINT_SCU

**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 |

#### 4.2.4.3.1 PRINT_SCU SOP Specific Conformance for SOP Classes

When “Print to Film" is selected, the Focal 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 Focal client to the print server over the association. When the transfer is completed, the client application closes the association.

# 5. Network Interfaces

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

## 5.1 Supported Communication Stacks

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

### 5.1.1 TCP/IP stack

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

#### 5.1.1.1 Physical Media Support

Any Ethernet network supported by the host machine is supported.

# 6. Support of Extended Character Sets

As an SCU, Focal/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, Focal/Monaco does not accept extended character sets.

# 7. Security

No specific DICOM security features are applied within Focal/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 Focal are listed. Since Focal/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***<br>Imported with PET images only for SUV calculation |
| 0010 | 1030 | ***Patient Weight***<br>Imported with PET images only for SUV calculation |
| 0010 | 0040 | ***Patient Sex***<br>Imported with PET images only for SUV calculation |

| General Study Module (C.7.2.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0020 | 0010 | ***Study ID*** |

| Image Plane Module (C.7.6.2) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0028 | 0030 | ***Pixel Spacing*** |
| 0020 | 0037 | ***Image Orientation (Patient)***<br>Only accept Axial images |
| 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 Val*** |
| 0028 | 1052 | ***Rescale Intercept***<br>This is applied to the CT and PET pixel data before it is stored in Focal |
| 0028 | 1053 | ***Rescale Slope***<br>This is applied to the CT and PET pixel data before it is stored in Focal |

| **VOI LUT Module (C.11.2)** | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0028 | 1050 | ***Window Center***<br>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*** |

| **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***<br>Only BQML or CNTS will be displayed and used for SUV calculations. |
| 0054 | 1002 | ***Count Source***<br>EMISSION will only be used for SUV calculation. |
| 0028 | 0051 | ***Corrected Image***<br>System allows SUV calculation only if **ATTN** and **DECY** values are present. |
| 0054 | 1102 | ***Decay Correction***<br>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***<br>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***<br>Used in SUV calculation in preference to 0018,1072 if both exist. |
| >0018 | 0031 | ***Radiopharmaceutical***<br>Imported for display only |
| 0054 | 1103 | ***Reconstruction Method***<br>Imported for display only. |

| PET Image Module (C.8.9.4) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0008 | 0008 | ***Image Type*** |
| 0008 | 0022 | ***Acquisition Date***<br>Read as start of acquisition date for SUV calculations . Value read from the first image in the image series. |
| 0008 | 0032 | ***Acquisition Time***<br>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***<br>Used for Acqusition 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/Focal 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/Focal will allow recalculation of CNTS into BQML and use BQML in SUV formulas. |

### Import Processing for DICOM RT Structure Set

The following modules, which make up the RT Structure Set IOD, are read. The elements used by Focal/Monaco are listed. Since Focal/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*** |

| General Study Module (C.7.2.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0020 | 0010 | ***Study 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*** |

| ROI Contour Module (C.8.8.6) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 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 Observations Sequence*** |
| 3006 | 0084 | ***Referenced ROI Number*** |
| 3006 | 0085 | ***ROI Observation Label*** |
| 3006 | 00A4 | ***ROI Interpreted Type*** |

### Import Processing for DICOM RTPLAN

The following modules, which make up the RT Plan IOD, are read. The elements used by Focal/Monaco are listed. Since Focal/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*** |

### 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 Focal/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***<br>Accept only MONOCHROME2 |
| 0028 | 0100 | ***Bits Allocated***<br>Accept 16 or 32 |
| 0028 | 0101 | ***Bits Stored*** |
| 0028 | 0102 | ***High Bit*** |
| 0028 | 0103 | ***Pixel Representation***<br>Accept only 0 |
| 3004 | 0002 | ***Dose Units***<br>Accept only GY |
| 3004 | 0004 | ***Dose Type***<br>Accept only PHYSICAL |
| 3004 | 000A | ***Dose Summation Type***<br>Accept PLAN or FRACTION |
| 300C | 0002 | ***Referenced RT Plan Sequence***<br>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***<br>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 RT STRUCT, RT PLAN, RT DOSE Secondary Capture and RT Image Export (common module content)

| Patient Module (C.7.1.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0010 | 0010 | ***Patient's Name***<br>Export DICOM patient name. User can also export Focal/Monaco patient name or edit this name on the Focal/Monaco export screen (up to 64 characters) |
| 0010 | 0020 | ***Patient ID.***<br>Export DICOM patient ID; user can also export Focal/Monaco patient ID or edit this value on the Focal/Monaco export screen (up to 64 characters) |
| 0010 | 0040 | ***Patient Sex***<br>Export M for male<br>F for female<br>O for unknown |

| General Study Module (C.7.2.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0020 | 000D | ***Study Instance UID***<br>Export unique identifier of the Study from the imported, primary image study. |
| 0020 | 0010 | ***Study ID***<br>Focal/Monaco study ID is exported for all except RT Dose. For RT Dose, DICOM study ID is exported. |
| 0008 | 0020 | ***Study Date***<br>Export study date from the primary image study for all objects except RT Structure, for which we export the date of export. |
| 0008 | 0030 | ***Study Time***<br>Export study time from the primary image study for all objects except RT Structure, for which we export the time of export. |
| 0008 | 0050 | ***Accession Number***<br>Export 1 |

| General Equipment Module (C.7.5.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0008 | 0070 | ***Manufacturer***<br>Export Computerized Medical Systems for Secondary Capture DRR. Export CMS, Inc. for RTSTRUCT, RTPLAN and RT DOSE and RT IMAGE. |
| 0008 | 1090 | ***Manufacturer's Model Name***<br>Export Focal if system is licensed as a Focal system, Monaco if system is licensed as a Monaco system. |

| RT Series Module (C.8.8.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0008 | 0060 | ***Modality***<br>Export CT, RTSTRUCT, RTPLAN, RT DOSE, CR (for Secondary Capture DRR) or RT Image depending on object being sent. |
| 0020 | 000E | ***Series Instance UID***<br>Export unique identifier of the series generated from CMS Focal/Monaco's root number |
| 0020 | 0011 | ***Series Number***<br>Export 1 |
| 0008 | 1070 | ***Operator's Name***<br>Export user's name |

| SOP Common Module (C.12.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0008 | 0016 | ***SOP Class UID*** |
| 0008 | 0018 | ***SOP Instance UID***<br>Except for CT image objects, new UID value is generated each time an export is made. |
| 0008 | 0005 | ***Specific Character Set***<br>For RT PLAN, RT DOSE, RT IMAGE export ISO_IR 100. Not exported for RT STRUCT and Secondary Capture. |
| 0008 | 0012 | ***Instance Creation Date***<br>Except for CT image, export date object created. |
| 0008 | 0013 | ***Instance Creation Time***<br>Except for CT image, export date object created. |
| 0008 | 0014 | ***Creator UID***<br>For RT STRUCT and Secondary Capture, export 2.16.840.1.114337. Not exported for other objects. |

# Appendix 3 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 Focal/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. The user can also map a general block ID (like “custom”) for all blocks in the plan.

| RT General Plan Module (C.8.8.9) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 300A | 0002 | ***RT Plan Label***<br>Export Plan ID based on combination of Course ID (if present) plus saved plan ID. |
| 300A | 0003 | ***RT Plan Name***<br>Export Plan ID in full |
| 300A | 0004 | ***RT Plan Description***<br>Export Plan Description |
| 0008 | 1070 | ***Operator's Name***<br>Export null |
| 300A | 0006 | ***RT Plan Date***<br>Export Plan saved on date |
| 300A | 0007 | ***RT Plan Time***<br>Export Plan saved on time |
| 300A | 000A | ***Plan Intent***<br>Export Plan intent value if there, otherwise not exported. |
| 300A | 000C | ***RT Plan Geometry***<br>Export PATIENT unless no RT SRUCTURE SET is being exported at the same time; for that case, export TREATMENT_DEVICE |
| 300C | 000C | ***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 | 0010 | ***Dose Reference Sequence*** |
| >300A | 0012 | ***Dose Reference Number*** |
| >300A | 0014 | ***Dose Reference Structure Type***<br>Export “SITE” for Prescription Site entries<br>Export “COORDINATES” for Dose Reference Points |
| >300A | 0018 | ***Dose Reference Point Coordinates*** |

| RT Prescription Module (C.8.8.9.1) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| | | For Dose reference points (DRP), export X, Y, Z location of point in DICOM coordinate space. |
| >300A | 0020 | ***Dose Reference Type***<br>Export TARGET |
| >300A | 0026 | ***Target Prescription Dose***<br>For SITE type Dose Reference Structure Type entries, export Rx (prescription) Total Dose |

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

| RT Fraction Scheme Module (C.8.8.13) | | |
|---|---|---|
| **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***<br>Export 0 |
| >300C | 0004 | ***Referenced Beam Sequence*** |
| >>300C | 0006 | ***Referenced Beam Number***<br>Export Beam number (an integer value between 1 and 99) |
| >>300A | 0082 | ***Beam Dose Specification Point***<br>Export Weight Point Coordinates in (millimeter coordinates to first decimal place) |
| >>300A | 0084 | ***Beam Dose***<br>Export Dose to the Dose Reference Point (DRP); for CT Simulation Beams, this is a default of 10 Gy. |

| RT Fraction Scheme Module (C.8.8.13) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| >>300A | 0086 | ***Beam Meterset***<br>Monaco only: export total meter set value for this beam (MU or time) |
| >>300C | 0006 | ***Referenced Beam Number***<br>Export Beam number (an integer value between 1 and 99). |
| >>300C | 0050 | ***Referenced Dose Reference Sequence***<br>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** |
| 300A | 00B0 | ***Beam Sequence*** |
| >0008 | 1040 | ***Institutional Department Name***<br>Export Focal/Monaco Clinic Name |
| >300A | 00B2 | ***Treatment Machine Name***<br>Export machine ID from Focal/Monaco's export customization page. This may be a different machine name than is used within Focal/Monaco. |
| >300A | 00B3 | ***Primary Dosimeter Unit***<br>Export dosimetry units identified in Focal for this machine |
| >300A | 00B4 | ***Source-Axis Distance***<br>Export machine reference distance defined in Focal/Monaco for this machine |
| >300A | 00B6 | ***Beam Limiting Device Sequence*** |
| >>300A | 00B8 | ***RT Beam Limiting Device Type***<br>Export X, Y, ASYMX, ASYMY or MLCX as appropriate. |
| >>300A | 00BA | ***Source to Beam Limiting Device Distance***<br>Export beam's source to collimator distance for the X, Y or MLC collimator as appropriate |
| >>300A | 00BC | ***Number of Leaf/Jaw Pairs***<br>Export 1 if not MLC, if MLC, export value from MLC configuration file |
| >>300A | 00BE | ***Leaf Position Boundaries***<br>Export values from MLC configuration file |
| >300A | 00C0 | ***Beam Number***<br>Export Focal/Monaco's Beam number (an integer between 1 and 99) |

| RT Beams Module (C.8.8.14) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| >300A | 00C2 | ***Beam Name***<br>Export Field ID |
| >300A | 00C3 | ***Beam Description***<br>Export Beam Description |
| >300A | 00C4 | ***Beam Type*** |
| >300A | 00C6 | ***Radiation Type*** |
| >300A | 00CE | ***Treatment Delivery Type***<br>Export “TREATMENT” for regular treatment beams<br>Export “SETUP” for such beams as designated by the user. |
| >3002 | 0050 | ***Primary Fluence Mode Sequence***<br>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***<br>If sequence is sent, export STANDARD or NON_STANDARD as stored in the Monaco machine model for this energy. |
| >>3002 | 0052 | ***Fluence Mode ID***<br>If Fluence Mode is NON_STANDARD, export value stored in machine model for this energy- SRS or FFF. |
| >300A | 00D0 | ***Number of Wedges***<br>Export zero; Focal/ Monaco currently do not use wedge information. |
| >300A | 00D1 | ***Wedge Sequence***<br>Export if plan from XiO has a regular, EDW or Virtual wedge |
| >>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***<br>Export 0: Focal/Monaco does not currently export compensator data |
| >300A | 00ED | ***Number of Boli*** |
| >300A | 00F0 | ***Number of Blocks***<br>Export total ports and blocks in beam (Focal maximum is 20) |
| >300A | 00F2 | ***Total Block Tray Factor*** |

| RT Beams Module (C.8.8.14) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| >300A | 00F4 | ***Block Sequence*** |
| >>300A | 00E1 | ***Material ID*** |
| >>300A | 00F5 | ***Block Tray ID*** |
| >>300A | 00F6 | ***Source to Block Tray Distance***<br>Export source to block tray distance from Focal/Monaco's treatment machine parameters |
| >>300A | 00F8 | ***Block Type***<br>If Focal polygon flag says port, then export APERTURE otherwise SHIELDING |
| >>300A | 00FA | ***Block Divergence***<br>Export PRESENT |
| >>300A | 00FC | ***Block Number***<br>Export Focal's polygon number (1-20) |
| >>300A | 00FE | ***Block Name*** |
| >>300A | 0102 | ***Block Transmission*** |
| >>300A | 0104 | ***Block Number of Points*** |
| >>300A | 0106 | ***Block Data*** |
| >300A | 0107 | ***Applicator Sequence***<br>Sequence only sent if beam is electron or contains an add-on MLC |
| 300A | 00F9 | ***Accessory Code***<br>Export value from Map Machines configuration file if the single export option for Apex is enabled and a value is selected. |
| >>300A | 0108 | ***Applicator ID*** |
| >>300A | 0109 | ***Applicator Type*** |
| >>300A | 010A | ***Applicator Description.***<br>Export Cone description |
| >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*** |
| >>>300C | 0051 | ***Reference Dose Reference Number*** |

| RT Beams Module (C.8.8.14) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| >>>300A | 010C | ***Cumulative Dose Reference Coefficient***<br>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***<br>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***<br>Export: NONE |
| >>300A | 0122 | ***Patient Support Angle*** |
| >>300A | 0123 | ***Patient Support Rotation Direction***<br>Export: NONE |
| >>300A | 0125 | ***Table Top Eccentric Angle***<br>Export 0 |
| >>300A | 0126 | ***Table Top Eccentric Rotation Direction***<br>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***<br>Export: Send APPROVED (if plan is approved); otherwise send UNAPPROVED. |
| 300E | 0004 | ***Review Date***<br>Export: If Approval Status (300E,0002) is APPROVED, send the plan's approval date. |
| 300E | 0005 | ***Review Time***<br>Export: If Approval Status (300E,0002) is APPROVED, send the plan's approval time. |
| 300E | 0008 | ***Reviewer Name***<br>Export: If Approval Status (300E,0002) is APPROVED, send stored approver's name. |

# Appendix 4 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 Focal/Monaco are listed.

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

| Image Pixel Module (C.7.6.3) | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0028 | 0010 | ***Rows***<br>For Secondary Capture export= 512<br>For RT IMAGE export =1024 |
| 0028 | 0011 | ***Columns***<br>For Secondary Capture export= 512<br>For RT IMAGE export =1024 |
| 0028 | 0004 | ***Photometric Interpretation***<br>MONOCHROME2 |
| 0028 | 0100 | ***Bits Allocated***<br>8 |
| 0028 | 0101 | ***Bits Stored***<br>8 |
| 0028 | 0102 | ***High Bit***<br>7 |
| 0028 | 0103 | ***Pixel Representation***<br>0 |

| | | |
|---|---|---|
| 0028 | 0106 | ***Smallest Image Pixel Value***<br>For Secondary Capture, not reported.<br>For RT IMAGE, export 0 |
| 0028 | 0106 | ***Largest Image Pixel Value***<br>For Secondary Capture, not reported.<br>For RT IMAGE, export 255 |
| 7FE0 | 0010 | ***Pixel Data*** |

| **RT Image Module (C.8.8.2)** | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 3002 | 0002 | ***RT Image Label***<br>Export beam description |
| 0008 | 0008 | ***Image Type***<br>For Secondary Capture, not exported.<br>For RT IMAGE, export DERIVED\SECONDARY\DRR |
| 0008 | 0064 | ***Conversion Type***<br>Export WSD |
| 3002 | 000c | ***RT Image Plane***<br>Export NORMAL |
| 3002 | 000d | ***X-Ray Image Receptor Translation***<br>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***<br>Export 0,0 |
| 3002 | 0011 | ***Image Plane Pixel Spacing***<br>Export pair of values that are the same (square pixels). Calculated as image width at isocenter divided by the number of columns |
| 3002 | 0012 | ***RT Image Position***<br>Export the top left corner of the image where the center of the image is 0,0 |
| 3002 | 0020 | ***Radiation Machine Name***<br>Export Monaco's DICOM export treatment machine name from the DICOM export page mapping. |
| 300A | 00B3 | ***Primary Dosimeter Unit***<br>Export MU |
| 3002 | 0022 | ***Radiation Machine SAD***<br>Export SAD for the beam whose DRR is being generated. |
| 3002 | 0026 | ***RT Image SID***<br>Export SAD value of the treatment machine for this beam. |
| 300C | 0002 | ***Referenced RT Plan Sequence***<br>Only exported if RTPLAN or RTIONPLAN is being exported with the RT IMAGE. |

| | | |
|---|---|---|
| 0008 | 1150 | ***Referenced SOP Class UID***<br>If beam is Proton beam, 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***<br>Export instance of Plan object (RT or RT ION) |
| 300C | 0006 | ***Referenced Beam Number***<br>Export the beam number |
| 300A | 011E | ***Gantry Angle***<br>Export gantry angle of the beam whose DRR is being generated. |
| 300A | 0120 | ***Beam Limiting Device Angle***<br>Export gantry angle of the beam whose DRR is being generated. |
| 300A | 0122 | ***Patient Support Angle***<br>Export couch angle of the beam whose DRR is being generated. |
| 300A | 0125 | ***Table Top Eccentric Angle***<br>Export 0 |

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

# Appendix 5 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 | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 0028 | 0002 | ***Samples Per Pixel***<br>Export 1 |
| 0020 | 0013 | ***Instance Number***<br>Export 1 |
| 0028 | 0004 | ***Photometric Interpretation***<br>Export MONOCHROME2 |
| 0028 | 0100 | ***Bits Allocated***<br>Export 16 |
| 0028 | 0101 | ***Bits Stored***<br>Export 16 |
| 0028 | 0102 | ***High Bit***<br>Export 15 |
| 0028 | 0103 | ***Pixel Representation***<br>Export 0 |
| 3004 | 0002 | ***Dose Units***<br>Export GY |
| 3004 | 0004 | ***Dose Type***<br>Export PHYSICAL |
| 3004 | 000A | ***Dose Summation Type***<br>Export BEAM or PLAN depending on the user selection |
| 300C | 0002 | ***Referenced RT Plan Sequence*** |
| >0008 | 1150 | ***Referenced SOP Class UID***<br>Export 1.2.840.10008.5.1.4.1.1.481.5 |
| >0008 | 1155 | ***Referenced SOP Instance UID***<br>Export the SOP Instance UID for the RTPLAN object that was exported at the same time as this dose object |
| >300C | 0020 | ***Referenced Fraction Group Sequence***<br>Exported if Dose Summation type is BEAM |
| >>300C | 0022 | ***Referenced Fraction Group Number***<br>Export 1 |
| >>300C | 0004 | ***Referenced Beam Sequence***<br>Exported if Dose Summation type is BEAM |
| >>>300C | 0006 | ***Referenced Beam Number***<br>Exported if Dose Summation type is BEAM |
| 3004 | 000C | ***Grid Frame Offset Vector***<br>First value is zero and monotonically increasing in the DICOM patient Z direction. The values in the vector are relative to the z-value of “Image Position (Patient)” (0020,0032). |

| RT Dose Module | | |
|---|---|---|
| **Group** | **Element** | **Description** |
| 3004 | 000E | ***Dose Grid Scaling***<br>Export value that converts Monaco's internal dose representation to GY. |

# Appendix 6 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

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