Integrating the Healthcare Enterprise

IHE Radiation Oncology
Technical Framework Supplement

Treatment Delivery Record Content for Ion (TDRC-ION)

For review and comment only.

DO NOT implement this public comment version.

Revision 1.0 – Draft for Public Comment

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Please verify you have the most recent version of this document. See here for Trial Implementation and Final Text versions and here for Public Comment versions.

Foreword

This is a supplement to the IHE Radiation Oncology Technical Framework. Each supplement undergoes a process of public comment and trial implementation before being incorporated into the volumes of the Technical Frameworks.

This supplement is published on November 10, 2023 for Public Comment. Comments are invited and can be submitted at https://www.ihe.net/Radiation_Oncology_Public_Comments. In order to be considered in development of the Trial Implementation version of the supplement, comments must be received by December 11, 2023.

This supplement describes changes to the existing technical framework documents.

"Boxed" instructions like the sample below indicate to the Volume Editor how to integrate the relevant section(s) into the relevant Technical Framework volume.

Amend Section X.X by the following:

Where the amendment adds text, make the added text **bold underline**. Where the amendment removes text, make the removed text **~~bold strikethrough~~**. When entire new sections are added, introduce with editor's instructions to "add new text" or similar, which for readability are not bolded or underlined.

General information about IHE can be found at IHE.net.

Information about the IHE Radiation Oncology domain can be found at IHE Domains.

Information about the organization of IHE Technical Frameworks and Supplements and the process used to create them can be found at Profiles and IHE Process

The current version of the Radiation Oncology Technical Framework can be found at Radiation Oncology Technical Framework.

CONTENTS

Introduction to this Supplement

This profile defines the content of the treatment record being transferred from the Treatment Delivery Device, Treatment Management System or other RT Ion Beams Treatment Record storage or producer to an interested consumer. This content can be available as soon as patient delivery is completed, and other computation and information gathering, and formatting can be performed to support the creation of the RT Ion Beams Treatment Record.

Open Issues and Questions

#	Introduced in	Owner	Description
1			Should Calculated Dose Reference Record Module be required?

Closed Issues

#	Introduced in	Owner	Description

History of Changes

Date	Rev.	Author	Change Summary
November 2023	1.0	IHE RO Technical Committee	Initial public comment publication

IHE Technical Frameworks General Introduction

The IHE Technical Frameworks General Introduction is shared by all of the IHE domain technical frameworks. Each technical framework volume contains links to this document where appropriate.

9 Copyright Licenses

IHE technical documents refer to, and make use of, a number of standards developed and published by several standards development organizations. Please refer to the IHE Technical Frameworks General Introduction, Section 9 - Copyright Licenses for copyright license information for frequently referenced base standards. Information pertaining to the use of IHE International copyrighted materials is also available there.

10 Trademark

IHE® and the IHE logo are trademarks of the Healthcare Information Management Systems Society in the United States and trademarks of IHE Europe in the European Community. Please refer to the IHE Technical Frameworks General Introduction, Section 10 - Trademark for information on their use.

IHE Technical Frameworks General Introduction Appendices

The IHE Technical Framework General Introduction Appendices are components shared by all of the IHE domain technical frameworks. Each technical framework volume contains links to these documents where appropriate.

*Update the following appendices to the General Introduction as indicated below. Note that these are **not** appendices to this domain's Technical Framework (TF-1, TF-2, TF-3 or TF-4) but rather, they are appendices to the IHE Technical Frameworks General Introduction located here.*

Appendix A – Actors

*Add the following **new or modified** actors to the IHE Technical Frameworks General Introduction Appendix A:*

No new actors

The table below lists *existing* actors that are utilized in this profile.

Complete List of Existing Actors Utilized in this Profile

Existing Actor Name	Definition
Treatment Delivery Record Producer	The actor exposing the finalized treatment record to the consumer representing a treatment delivery.
Treatment Delivery Record Consumer	A consumer of the finalized treatment record representing the treatment delivery.

Appendix B – Transactions

Add the following new or modified transactions to the IHE Technical Frameworks General Introduction Appendix B:

No new transactions.

Appendix D – Glossary

*Add the following **new or modified** glossary terms to the IHE Technical Frameworks General Introduction Appendix D:*

No new glossary terms.

Volume 1 – Profiles

Copyright Licenses

Add the following to the IHE Technical Frameworks General Introduction Copyright section:

Not applicable.

Domain-specific additions

Not applicable.

Add new Section X

X Treatment Delivery Record Content for Ion (TDRC-ION) Profile

The Treatment Delivery Record Content for Ion (TDRC-ION) Profile specifies the content of the RT Ion Beams Treatment Record being transferred from the Treatment Delivery Record Producer storage to the Treatment Record Consumer.

This profile ensures that the treatment record transferred from the Producer will contain all of the necessary information.

1. It will especially address the following:
2. This profile will make the therapists' workflow easier and faster, because it incorporates all information needed for treatment delivery record keeping.
3. This will enable therapists to concentrate more on finalizing the details of patient treatment rather than dealing with technical issues.

Fewer uncertainties will also reduce the time physicists and therapists need to gather and review treatment delivery information.

TDRC-ION contributes to patient safety, because it will standardize the content which is reviewed to assess if delivery of treatment was accurate to the plan. The profile does not specify how to validate the treatment delivery parameters, but will ensure that they are available, and well-formatted. The applications involved are Treatment Management Systems, Treatment Delivery Systems and Quality Assurance Devices.

This profile is a content profile. For further information on the context, see Section X.6 TDRC-ION Cross Profile Considerations.

X.1 TDRC-ION Actors, Transactions, and Content Modules

This section defines the actors, transactions, and/or content modules in this profile. General definitions of actors are given in the Technical Frameworks General Introduction Appendix A at https://www.ihe.net/resources/technical_frameworks/#GenIntro.

Figure X.1-1 shows the actors directly involved in the TDRC Profile and the direction that the content is exchanged.

A product implementation using this profile may group actors from this profile with actors from a workflow or transport profile to be functional. The grouping of the content module described in this profile to specific actors is described in more detail in "Section X.6" section below.

Figure X.1-1: TDRC-ION Actor Diagram

Table X.1-1 lists the content module(s) defined in the TDRC-ION Profile. To claim support with this profile, an actor shall support all required content modules (labeled "R") and may support optional content modules (labeled "O").

Table X.1-1: TDRC Profile – Actors and Content Modules

Actors	Content Modules	Optionality	Reference
Treatment Delivery Record Producer	RT Ion Treatment Record IOD for Ion External Beam	R	7.4.11.2.2
	General Beam Treatment Record Modules	R	7.4.11.2.1
Treatment Delivery Record Consumer	RT Ion Treatment Record IOD for Ion External Beam	R	7.4.11.2.2
	General Beam Treatment Record Modules	R	7.4.11.2.1

X.1.1 Actor Descriptions and Actor Profile Requirements

Most requirements are documented in Transactions (Volume 2) and Content Modules (Volume 3). This section documents any additional requirements on profile's actors.

The Treatment Delivery Record Producer is the actor exposing the content in the treatment workflow.

X.2 TDRC-ION Actor Options

Options that may be selected for each actor in this profile, if any, are listed in the Table X.2-1. Dependencies between options when applicable are specified in notes.

Table X.2-1: Treatment Delivery Record Content – Actors and Options

Actor	Option Name	Reference
Treatment Delivery Record Producer	No options defined	--
Treatment Delivery Record Consumer	No options defined	--

X.3 TDRC-ION Required Actor Groupings

An actor from this profile (Column 1) shall implement all of the required transactions and/or content modules in this profile ***in addition to all*** of the transactions required for the grouped actor (Column 2).

If this is a content profile, and actors from this profile are grouped with actors from a workflow or transport profile, the Reference column references any specifications for mapping data from the content module into data elements from the workflow or transport transactions.

In some cases, required groupings are defined as at least one of an enumerated set of possible actors; this is designated by merging column one into a single cell spanning multiple potential grouped actors. Notes are used to highlight this situation.

Section X.5 describes some optional groupings that may be of interest for security considerations and Section X.6 describes some optional groupings in other related profiles.

Table X.3-1: TDRC-ION – Required Actor Groupings

TDRC Actor	Actor to be grouped with	Reference	Content Bindings Reference
Treatment Delivery Record Producer	None		
Treatment Delivery Record Consumer	None		--

X.4 TDRC-ION Overview

X.4.1 Concepts

The Treatment Delivery Record Consumer retrieves the RT Ion Beams Treatment Record from a Treatment Delivery Record Producer, which holds the treatment record or prepares it for transmission.

X.4.2 Use Cases

X.4.2.1 Use Case #1: Transfer of Treatment Record for Recording, Evaluation and Accounting

A patient, phantom or machine test configuration has been exposed to a radiation treatment on a RT Ion Delivery System. The RT Ion Beams Treatment Record describing the treatment information needs to be available for tasks such as

- Continuing an interrupted partial treatment
- Treatment Tracking
- Adaptive Planning including Dose Reconstruction
- Trend Analysis
- Treatment Verification
- Track setup changes such as capturing Couch position/orientation for subsequent sessions and trend analysis.

X.4.2.1.1 Transfer of Treatment Record for Recording, Evaluation and Accounting Use Case Description

The user may wish to document a patient's treatment, or other machine operation procedures, hold treatment information for further analysis or to do quality assessment on the delivery. The record that represents the treatment shall contain the complete information regarding what was performed. This includes all actions that can be recorded by the equipment creating the treatment record which may include setup parameters, overrides, failed deliveries (zero MUs), etc.

X.4.2.1.2 Transfer of Treatment Record for Recording, Evaluation and Accounting Process Flow

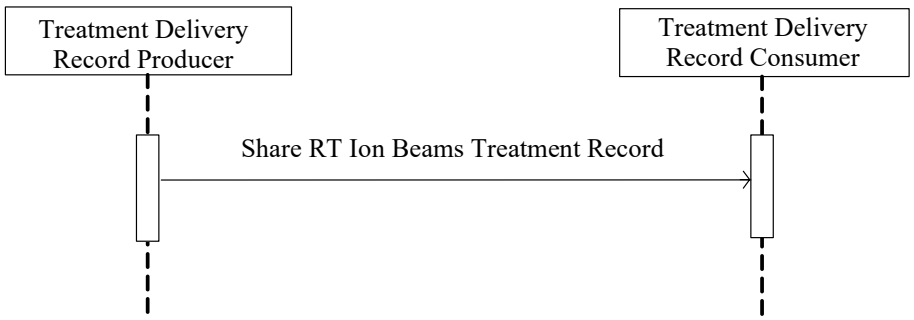

Figure X.4.2.1.2-1: Basic Process Flow in TDRC-ION Profile

Pre-conditions:

The RT Ion Beams Treatment Record is prepared at the Treatment Delivery Record Producer.

Main Flow:

The RT Ion Beams Treatment Record is stored to the Treatment Delivery Record Consumer by the Treatment Delivery Record Producer.

Post-conditions:

The RT Ion Beams Treatment Record is completely received and available at the Treatment Delivery Record Consumer.

X.5 TDRC-ION Security Considerations

Not applicable.

X.6 TDRC-ION Cross Profile Considerations

X.6.1 Workflow Aspects

It is likely that the TDRC-ION Profile content will be transferred using a DICOM C-STORE DIMSE Service. This operation may be configured on the adhering Producer device to be attempted after every radiation delivery.

Alternatively, the C-STORE can be embedded in the DICOM Query-Retrieve Service, following a C-MOVE request by the Treatment Delivery Record Consumer based, for example, on a timeframe query. This communication is anticipated to follow the workflow specification in the following profiles:

Table X.6-1: TDRC – Cross Profile Actor Mappings

TDRC Actor	Workflow Profile	Adhering Actor in Workflow Profile
Treatment Delivery Record Producer	Treatment Delivery Workflow II (TDW II)	Treatment Delivery Device
Treatment Delivery Record Consumer	Treatment Delivery Workflow II (TDW II)	Object Storage

Appendices to Volume 1

None.

Volume 2 – Transactions

Not applicable.

Appendices to Volume 2

No appendices.

Volume 2 Namespace Additions

The RO domain does not have a namespace registry for OIDs, etc. They have not had to define any specifically for the domain. Any UIDs, OIDs, etc. come from DICOM so far.

Additions to the Radiation Oncology OID Registry are:

NA

Volume 3 – Content Modules

5 IHE Namespaces, Concept Domains and Vocabularies

Add to Section 5 IHE Namespaces, Concept Domains and Vocabularies

NA

5.1 IHE Namespaces

The Radiation Oncology registry of OIDs is located at:

The Radiation Oncology domain does not have a namespace registry for OIDs, etc. They have not had to define any specifically for the domain. Any UIDs, OIDs, etc. come from DICOM so far.

Additions to the Radiation Oncology OID Registry are:

codeSystem	codeSystemName	Description
NA	NA	NA

5.2 IHE Concept Domains

For a listing of the Radiation Oncology Concept Domains see:

NA

conceptDomain	conceptDomainName	Description
NA	NA	NA

5.3 IHE Format Codes and Vocabularies

5.3.1 IHE Format Codes

*List in the table below any **new** format codes to be added to the IHE Format Codes wiki page at http://wiki.ihe.net/index.php/IHE_Format_Codes. For public comment, the additions must be listed in the table below. The domain technical committee must ensure any new codes are also added to the wiki page prior to publication for trial implementation.*

Profile	Format Code	Media Type	Template ID
NA	NA	NA	NA

5.3.2 IHEActCode Vocabulary

*List in the table below, any **new** additions to the IHEActCode Vocabulary wiki page at http://wiki.ihe.net/index.php/IHEActCode_Vocabulary. For public comment, the additions must be listed in the table below. The domain technical committee must ensure any new codes are also added to the wiki page prior to publication for trial implementation.*

Code	Description
NA	NA

5.3.3 IHERoleCode Vocabulary

*List in the table below any **new** additions to the IHERoleCode Vocabulary wiki page at http://wiki.ihe.net/index.php/IHERoleCode_Vocabulary. For public comment, the additions must be listed in the table below. The domain technical committee must ensure any new codes are also added to the wiki page prior to publication for trial implementation.*

Code	Description
NA	NA

6 HL7 V3 CDA Content Modules

No HL7 V3 CDA Content Modules defined.

7 DICOM Content Definition

DICOM Content Definitions constrain the use of instances of specific DICOM IODs (also referred to as DICOM objects). This typically means placing requirements on the creators of those instances, although requirements may also be placed on the receivers and users.

The most common such requirements are to:

- Make a module that is optional (U) in a DICOM IOD be required or conditional
- Make an attribute that is optional (Type 3) in a DICOM Module be required or conditional
- Require that an attribute that is optional (Type 3) in a DICOM Module be absent
- Constrain the content of an attribute to be empty
- Constrain the content of an attribute to be populated in a certain way, such as:
  - Constraining the value to be taken from a specific table
  - Constraining the value to be copied from a specific source
  - Constraining the value to encode certain information
- Require that an attribute be displayed/accessible to the operator

Reiterating DICOM requirements is kept to a minimum sufficient to provide context for the IHE requirements. Implementers are still required to be familiar with, and conform to, the underlying DICOM specification.

Content Definitions may be referenced from a Profile independent of transactions to constrain content without specifying the transport. Content Definitions may also be referenced from within a Transaction specification to constrain the content without duplicating the same constraint text across multiple related transactions.

For attributes that are optional, the creator is permitted but not required to include them, and the receiver is permitted but not required to ignore them.

7.1 Conventions

DICOM Conventions are defined in Appendix E to the *IHE Technical Frameworks General Introduction*.

Table 7.1-1: Usage of DICOM Modules in IHE

M / C / U	As defined in DICOM PS 3.3
R	The Module is defined as Conditional (C) or User Option (U) in DICOM. The Requirement is an IHE extension of the DICOM requirements, and the module shall be present.

RC	The Module is defined as Conditional (C) or User Option (U) in DICOM. The Requirement is an IHE extension of the DICOM requirements, and the module shall be present when the specified conditions apply.

Table 7.1-2: Usage of DICOM Attributes in IHE

O	The attribute or its value is optional, i.e., in DICOM it is Type 2 or 3.
O+*	The attribute is optional, but additional constraints have been added. Note: The specification approach does not force a Type 2 or Type 3 value to become a Type 1 by stating O+.
R	The attribute is required, and is not an IHE extension of the DICOM requirements; i.e., it is already Type 1 in DICOM, but additional constraints are placed by IHE, for example on the value set that may be used for the attribute.
R+	The Requirement is an IHE extension of the DICOM requirements, and the attribute shall be present, i.e., is Type 1, whereas the DICOM requirement may be Type 2 or 3.
RC+	The Requirement is an IHE extension of the DICOM requirements, and the attribute shall be present when the condition is satisfied, i.e., is Type 1C, whereas the DICOM requirement may be Type 2 or 3. If the condition is not fulfilled, the DICOM definitions apply. Note, that this means that the attribute may be present / have a value also in case the condition does not apply.
D	The requirements of DICOM apply unchanged, but the attribute needs to be displayed.
-	No IHE extension of the DICOM requirements is defined. The attribute is listed for better readability or similar purpose.
X+	The attribute information is required to be absent. DICOM Type 2 attributes shall be present with no value. DICOM Type 3 attributes shall be absent.

7.1.1 DICOM Structured Report

Conventions for constraining instances of DICOM Structured Reports as IHE Content Definitions are not yet worked out. In many cases, requiring the use of a specific DICOM SR Template may be sufficient.

7.1.2 Display Requirements

If a requirement lists *, then that attribute is not required to be displayed.

7.2 General Definitions

No change to framework.

7.3 IOD Definitions

This section defines each DICOM IOD used in the IHE Radiation Oncology domain in detail, specifying the standards used and the information defined.

7.3.1 Prescription IODs

7.3.2 Plan IODs

7.3.3 Image IODs

7.3.4 RT Structure Set IODs

7.3.5 RT Dose IODs

7.3.6 Treatment Record IODs

7.3.6.1 Technique Specific RT Treatment Record

7.3.6.1.1 RT Ion Treatment Record IOD for Ion External Beam

7.3.6.1.1.1 Referenced Standards

Edition PS 3.3 2022e

7.3.6.1.1.2 IOD Definition

Table 7.3.6.1.1.2-1: IOD Definition

IE	Module	Reference	Usage	IHE-RO Usage
Patient	Patient	C.7.1.1	M	M See RO TF-3: 7.4.1.1.1
	Clinical Trial Subject	C.7.1.3	U	U
Study	General Study	C.7.2.1	M	M See RO TF-3: 7.4.1.2.1
	Patient Study	C.7.2.2	U	U
	Clinical Trial Study	C.7.2.3	U	U
Series	RT Series	C.8.8.1	M	M See RO TF-3: 7.4.1.4.1
	Clinical Trial Series	C.7.3.2	U	U
Equipment	General Equipment	C.7.5.1	M	M See RO TF-3: 7.4.1.5.1
Treatment Record	RT General Treatment Record	C.8.8.17	M	M See Section 7.4.11.2.1

IE	Module	Reference	Usage	IHE-RO Usage
	RT Patient Setup	C.8.8.12	U	R
	RT Treatment Machine Record	C.8.8,18	M	-
	Measured Dose Reference Record	C.8.8.19	U	-
	Calculated Dose Reference Record	C.8.8.20	U	R See Section 7.4.11.5.1 Calculated Dose Reference Record Module for Consistent Dose
	RT Ion Beams Session Record	C.8.8.26	M	M See Section 7.4.11.2.2
	RT Treatment Summary Record	C.8.8.23	U	-
	General Reference	C.12.4	U	-
	SOP Common	C.12.1	M	M See RO TF-3: 7.4.1.6.1
	Common Instance Reference	C.12.2	U	-

7.4 Module Definitions

This section defines each DICOM Module used in the IHE Radiation Oncology domain in detail, specifying the standards used and the information defined.

7.4.1 General Modules

7.4.1.1 Patient Module

7.4.1.1.1 Patient Module Base Content

7.4.1.2 Study Module

7.4.1.2.1 Study Module Base Content

7.4.1.3 General Series Module

7.4.1.4 RT Series Module

7.4.1.4.1 RT Series Module Base Content

7.4.1.4.2 RT Series Module with Treatment Session UID

Table 7.4.1.4.2-1: Module Definition

Attribute	Tag	Type	Attribute Note
Series Date	(0008,0021)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Series Time	(0008,0031)	RC+	Must be used and preserved, if present. If the producer creates a new series must be defined.
Treatment Session UID	(300A,0700)	R+	Value shall be present

7.4.1.5 Equipment Module

7.4.1.5.1 Equipment Module Base Content

7.4.1.6 SOP Common Module

7.4.1.6.1 SOP Common Module Base Content

7.4.2 Workflow-Related Modules

7.4.3 General Plan-Related Modules

7.4.4 Plan-Related Modules in Planning

7.4.5 Plan-Related Modules in Delivery

7.4.6 Image-related Modules in Planning

7.4.7 Image-related Modules from Delivery

7.4.8 Segment Modules in Planning

7.4.9 Segment Modules in Delivery

7.4.10 Registration Modules in Planning

7.4.11 Treatment Record Modules

7.4.11.1 Specific RT Beam Type Specifications

7.4.11.2 General Beam Attribute Specifications

7.4.11.2.1 RT General Treatment Record Module

7.4.11.2.1.1 Referenced Standards

DICOM 2022e Edition PS 3.3

7.4.11.2.1.2 Module Definition

Table 7.4.11.2.1.2-1: Module Definition

Attribute	Tag	Type	Attribute Note
Instance Number	(0020,0013)	-	
Treatment Date	(3008,0250)	R+	Value shall be present
Treatment Time	(3008,0251)	R+	Value shall be present
Referenced RT Plan Sequence	(300C,0002)	R+	Sequence shall be present and shall contain 1 item (See Note 1.)
>Referenced SOP Class UID	(0008,1150)	-	
>Referenced SOP Instance UID	(0008,1155)	-	
Referenced Treatment Record Sequence	(3008,0030)	RC+	Required if the referenced treatment record(s) participated in the generation of this treatment. (See Note 2.)
>Referenced SOP Class UID	(0008,1150)	-	
>Referenced SOP Instance UID	(0008,1155)	-	

Note 1: RT Ion Plan and RT Ion Beams Treatment Record display parameters and requirements should be fully detailed in the workflow profiles that make use of this content.

Note 2: Resumption of a partial modulated treatment may require all the spot maps previously treated for this fraction.

7.4.11.2.2 RT Ion Beams Session Record Module

7.4.11.2.2.1 Referenced Standards

DICOM 2022e Edition PS 3.3

7.4.11.2.2.2 Module Definition

Note that all attribute values shall be the actual values used in the treatment and not copied from the Plan unless explicitly noted in the Module Definition Table. The record should reflect as close as possible, what is actually displayed to the user or selected at the machine.

Setup beams where Treatment Delivery Type (300A,00CE) is SETUP are widely used in Ion treatments as a general place holder for performing all imaging and setup activities. To differentiate from TREATMENT beams, a separate module definition module definition table is included to differentiate the requirements.

Table 7.4.11.2.2.2-1: Module Definition – Treatment Beams

Attribute	Tag	DCM Type	Type	Attribute Note
Referenced Fraction Group Number	(300C,0022)	3	R+*	Shall be the same value as this attribute in the referenced RT Ion Plan
Number of Fractions Planned	(300A,0078)	2	R+	Value shall be present and greater than or equal to 1.
Primary Dosimeter Unit	(300A,00B3)	1	R+*	Shall be the same value as this attribute in the referenced RT Ion Plan
Treatment Session Ion Beam Sequence	(3008,0021)	1	R+*	Shall have one item included in this sequence for each beam item that has one or more recordable attributes. (See Note 2.)
>Referenced Beam Number	(300C,0006)	1	R+*	Value shall be present. This value may be repeated in multiple beam items. (See Note 2.)
>Beam Name	(300A,00C2)	1	R+	Value shall be present and equal to matching beam in plan
>Beam Description	(3002,00C3)	3	RC+	Required if the Beam Description (3002,00C3) is present in the plan. Original plan value must be maintained, but additional information may be appended. May be present otherwise.
>Beam Type	(300A,00C4)	1	-	
>Radiation Type	(300A,00C6)	1	R*	Value shall be either PROTON or ION.
>Radiation Mass Number	(300A,0302)	1C	-	
>Radiation Atomic Number	(300A,0304)	1C	-	
>Radiation Charge State	(300A,0306)	1C	-	
>Scan Mode	(300A,0308)	1	-	
>Modulated Scan Mode Type	(300A,0309)	1C	-	
>Referenced Tolerance Table Number	(300C,00A0)	3	RC+	Shall be present if present in the plan and used during treatment.
>Beam Limiting Device Leaf Pairs Sequence	(300A,0309)	3	RC+	Shall be present if a BLD was used during treatment.
>Referenced Patient Setup Number	(300C,006A)	1	R+	Value shall be present.
>Referenced Verification Image Sequence	(300C,0040)	1	RC+*	If known, the sequence shall be present when images were acquired during performance of this beam item which can include setup, delivery, and post-delivery verification.
>Referenced Measured Dose Reference Sequence	(3008,0080)	3	RC+*	Sequence shall be present if measured dose information is available. (See Note 1.)
>Referenced Calculated Dose Reference Sequence	(3008,0090)	3	RC+*	Sequence shall be present if calculated dose information is available. (See Note 1.)
>Number of Wedges	(300A,00D0)	1	-	
>Wedge Sequence	(300A,00D1)	1C	-	

Attribute	Tag	DCM Type	Type	Attribute Note
>Number of Compensators	(300A,00E0)	1	-	
>Recorded Compensator Sequence	(3008,00C0)	1C	-	
>Number of Boli	(300A,00ED)	1	-	
>Referenced Bolus Sequence	(300C,00B0)	1C		
>Number of Blocks	(300A,00F0)	1	-	
>Recorded Block Sequence	(3008,00D0)	1C	RC+*	Sequence shall be present if Blocks were used during current beam delivery
>>Block Tray ID	(300A,00F5)	3	-	
>>Accessory Code	(300A,00F9)	3	RC+*	Shall be present if actual value known
>>Referenced Block Number	(300C,00E0)	1	-	
>>Block Name	(300A,00FE)	3	RC+*	Value shall be present if displayed to the user.
>>Number of Block Slab Items	(300A,0440)	3	-	
>>Recorded Block Slab Sequence	(3008,00D1)	1C	-	
>Recorded Snout Sequence	(3008,00F0)	1C	RC+*	Sequence shall be present if Snout was used during current beam delivery
>>Snout ID	(300A,030F)	1	-	
>>Accessory Code	(300A,00F9)	3	RC+	Shall be present if actual value known
>Applicator Sequence	(300A,0108)	1C	-	
>General Accessory Sequence	(300A,0420)	3	-	
>Number of Range Shifters	(300A,0312)	1	-	
>Recorded Range Shifter Sequence	(3008,00F2)	1C	RC+*	Sequence shall be present if Range Shifters were used during current beam delivery
>Number of Lateral Spreading Devices	(300A,0330)	1	-	
>Recorded Lateral Spreading Device Sequence	(3008,00F4)	1C	-	
>Number of Range Modulators	(300A,0340)	1	-	-
>Recorded Range Modulator Sequence	(3008,00F6)	1C	RC+*	Sequence shall be present if Range Modulators were used during current beam delivery
>Patient Support Type	(300A,0350)	1	-	
>Current Fraction Number	(3008,0022)	2	R+	Value shall be present and must be identical for all beam items in this sequence.
>Treatment Delivery Type	(300A,00CE)	2	R+	Value shall be present and be either TREATMENT or CONTINUATION. (See Note 3.)
>Treatment Termination Status	(3008,002A)	1	R+*	Value of NORMAL indicates that the beam item has been completed for this session. Any other value is an abnormal termination.

Attribute	Tag	DCM Type	Type	Attribute Note
				There shall not be more than one NORMAL termination per unique Referenced Beam Number (300C,0006).
>Treatment Termination Code	(3008,002B)	3	-	
>Treatment Verification Status	(3008,002C)	2	R+	Value shall be present.
>Specified Primary Meterset	(3008,0032)	3	R+	See Note 4.
>Specified Secondary Meterset	(3008,0033)	3	R+*	Required if a secondary meterset was used by the device.
>Delivered Primary Meterset	(3008,0036)	3	R+	This value can be 0 if no radiation was actually delivered.
>Delivered Secondary Meterset	(3008,0037)	3	R+*	Required if a secondary meterset was used by the device.
>Specified Treatment Time	(3008,003A)	3	R+*	Required if a set point for beam on time was set.
>Delivered Treatment Time	(3008,003B)	3	R+*	
>Delivered Depth Dose Parameters Sequence	(300A,0506)	3	RC+*	Required if the Depth Dose Parameters Sequence (300A,0505) was present in the plan.
>Number of Control Points	(300A,0110)	1	R+*	Value must be greater than 0 and is equivalent to the number of items in the reported Ion Control Point Delivery Sequence (3008,0041). If the Beam Type (300A,00C4) is STATIC, the value will be an even number.
>Ion Control Point Delivery Sequence	(3008,0041)	1	-	Since the treatment delivery may not completely align with the plan directives, it is expected that this sequence will report on the delivery only, and that the control points reported may not agree with the plan.
>>Referenced Control Point Index	(300C,00F0)	1	-	
>>Treatment Control Point Date	(3008,0024)	1	-	
>>Treatment Control Point Time	(3008,0025)	1	-	
>>Specified Meterset	(3008,0042)	2	R+*	
>>Delivered Meterset	(3008,0044)	1	-	
>>Meterset Rate Set	(3008,0045)	3	-	
>>Meterset Rate Delivered	(3008,0046)	3	-	
>>Nominal Beam Energy	(300A,0014)	1C	-	
>>KVP	(0018,0060)	1C	-	
>>Ion Wedge Position Sequence	(300A,03AC)	1C	-	
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	-	
>>Range Shifter Settings Sequence	(300A,0360)	1C	-	
>>Lateral Spreading Device Settings Sequence	(300A,0370)	1C	-	

Attribute	Tag	DCM Type	Type	Attribute Note
>>Range Modulator Settings Sequence	(300A,0380)	1C	-	
>>Gantry Angle	(300A,011E)	1C	-	
>>Gantry Rotation Direction	(300A,011F)	1C	-	
>>Gantry Pitch Angle	(300A,014A)	2C	-	
>>Gantry Pitch Rotation Direction	(300A,014C)	2C	-	
>>Beam Limiting Device Angle	(300A,0120)	1C	-	
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	-	
>>Scan Spot Tune ID	(300A,0390)	1C	-	
>>Number of Scan Spot Positions	(300A,0392)	1C	-	
>>Scan Spot Position Map	(300A,0394)	1C	RC+*	Measured (x,y) positions.
>>Scan Spot Metersets Delivered	(3008,0047)	1C	-	
>>Scan Spot Time Offset	(300A,038F)	3	RC+*	Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC
>>Scanning Spot Size	(300A,0398)	3	X	
>>Scanning Spot Sizes Delivered	(300A,0399)	3	RC+*	Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC
>>Number of Paintings	(300A,0391)	1C	RC+*	The value shall be 1. If repaints occur, they shall be recorded as separate Spots. See C.8.8.26.2
>>Scan Spot Reordered	(300A,0393)	3	RC+	Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC
>>Scan Spot Prescribed Indices	(300A,0391)	1C	-	
>>Patient Support Angle	(300A,0122)	1C	-	
>>Patient Support Rotation Direction	(300A,0123)	1C	-	
>>Table Top Pitch Angle	(300A,0140)	2C	RC+*	Value shall be present for the first item of the Control Point Sequence or if the Table Top Pitch Angle changes during Beam.
>>Table Top Pitch Rotation Direction	(300A,0144)	2C	RC+*	Value shall be present for the first item of the Control Point Sequence or if the Table Top Pitch Angle changes during Beam.
>>Table Top Roll Angle	(300A,0144)	2C	RC+*	Value shall be present for the first item of the Control Point Sequence or if the Table Top Roll Angle changes during Beam.
>>Table Top Roll Rotation Direction	(300A,0146)	2C	RC+*	Value shall be present for the first item of the Control Point Sequence or if the Table Top Roll Angle changes during Beam.
>>Head Fixation Angle	(300A,0148)	3	RC+*	Required if the Patient Support Type (300A,0350) is CHAIR.
>>Chair Head Frame Position	(300A,0151)	3	RC+*	Required if the Patient Support Type (300A,0350) is CHAIR.

Attribute	Tag	DCM Type	Type	Attribute Note
>>Table Top Vertical Position	(300A,0128)	2C	RC+*	Value shall be present in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Table Top Longitudinal Position	(300A,0129)	2C	RC+*	Value shall be present in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Table Top Lateral Position	(300A,012A)	2C	RC+*	Value shall be present in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Snout Position	(300A,030D)	2C	RC+*	Value shall be present in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Corrected Parameter Sequence	(3008,0068)	3	RC+*-	Value shall be present if corrected parameters were used.
>>Override Sequence	(3008,0060)	3	RC+*	Value shall be present if override parameters were used.

Note 1: Treatment Records with 0 Gy delivered are expected and are assumed that they represent that no dose was delivered to the patient.

Note 2: A new item of the Treatment Session Ion Beams Sequence (3008,0021) shall be created whenever the Referenced Beam Number (300C,0006) changes. This is to ensure that everything possible about the treatment is recorded including any registration or verification imaging, table movement, overrides, failed delivery, etc. The Referenced Beam number may be repeated in new Treatment Session Beam items if the beam delivery had not been completed previously.

Note 3: A value of CONTINUATION in the Treatment Delivery Type (300A,00CE) shall be used if the Delivered Meterset (3008,0044) is greater than 0 in the first control point in the Ion Control Point Delivery Sequence (3008,0041).

Note 4: Per the DICOM standard DICOM PS3.3 C.8.8.26.1, the Specified metersets outside the Control Point Sequence are for this beam item only unlike the metersets inside the Control Point sequence which are cumulative over the entire fraction. For example, Specified Meterset = Last Control Point Meterset – First Control Point Meterset.

Table 7.4.11.2.2.2-2: Module Definition – Setup Beams

Attribute	Tag	DCM Type	Type	Attribute Note
Referenced Fraction Group Number	(300C,0022)	3	R+*	Shall be the same value as this attribute in the referenced RT Ion Plan
Number of Fractions Planned	(300A,0078)	2	R+	Value shall be present and greater than or equal to 1.
Primary Dosimeter Unit	(300A,00B3)	1	-	Primary Dosimeter Unit of the treatment beam delivery machine. It does not apply to distinct imaging radiation sources.
Treatment Session Ion Beam Sequence	(3008,0021)	1	R+*	Shall include an item if Radiation Type (300A,00C6) value is PROTON or ION. May include an item otherwise.

Attribute	Tag	DCM Type	Type	Attribute Note
>Referenced Beam Number	(300C,0006)	1	R+*	Value shall be present and shall reference a beam with Treatment Delivery Type (300A,00CE) equal to SETUP. This value may be repeated in multiple beam items.
>Beam Name	(300A,00C2)	1	R+	Value shall be present and equal to matching beam in plan
>Beam Description	(3002,00C3)	3	RC+	Required if the Beam Description (3002,00C3) is present in the plan. Original plan value must be maintained, but additional information may be appended. May be present otherwise.
>Beam Type	(300A,00C4)	1	-	
>Radiation Type	(300A,00C6)	1	R+*	Shall be PROTON or ION only if proton or ion beam was delivered.
>Radiation Mass Number	(300A,0302)	1C	-	
>Radiation Atomic Number	(300A,0304)	1C	-	
>Radiation Charge State	(300A,0306)	1C	-	
>Scan Mode	(300A,0308)	1	-	
>Modulated Scan Mode Type	(300A,0309)	1C	-	
>Referenced Tolerance Table Number	(300C,00A0)	3	-	
>Beam Limiting Device Leaf Pairs Sequence	(300A,0309)	3	-	
>Referenced Patient Setup Number	(300C,006A)	1	R+*	Value shall be present.
>Referenced Verification Image Sequence	(300C,0040)	1	-	
>Referenced Measured Dose Reference Sequence	(3008,0080)	3	-	
>Referenced Calculated Dose Reference Sequence	(3008,0090)	3	-	
>Number of Wedges	(300A,00D0)	1	-	
>Wedge Sequence	(300A,00D1)	1C	-	
>Number of Compensators	(300A,00E0)	1	-	-
>Recorded Compensator Sequence	(3008,00C0)	1C	-	
>Number of Boli	(300A,00ED)	1	-	-
>Referenced Bolus Sequence	(300C,00B0)	1C	-	
>Number of Blocks	(300A,00F0)	1	-	-
>Recorded Block Sequence	(3008,00D0)	1C	-	
>>Block Tray ID	(300A,00F5)	3	-	
>>Accessory Code	(300A,00F9)	3	RC+	Shall be present if actual value known
>>Referenced Block Number	(300C,00E0)	1	-	

Attribute	Tag	DCM Type	Type	Attribute Note
>>Block Name	(300A,00FE)	3	RC+*	Value shall be present if displayed to the user.
>>Number of Block Slab Items	(300A,0440)	3	-	
>>Recorded Block Slab Sequence	(3008,00D1)	1C	-	
>Recorded Snout Sequence	(3008,00F0)		-	
>>Snout ID	(300A,030F)	1	-	
>>Accessory Code	(300A,00F9)	3	RC+	Shall be present if actual value known
>Applicator Sequence	(300A,0108)	1C	-	
>General Accessory Sequence	(300A,0420)	3	-	
>Number of Range Shifters	(300A,0312)	1	-	-
>Recorded Range Shifter Sequence	(3008,00F2)	1C	-	
>Number of Lateral Spreading Devices	(300A,0330)	1	-	-
>Recorded Lateral Spreading Device Sequence	(3008,00F4)	1C	-	
>Number of Range Modulators	(300A,0340)	1	-	-
>Recorded Range Modulator Sequence	(3008,00F6)	1C	-	
>Patient Support Type	(300A,0350)	1	-	
>Current Fraction Number	(3008,0022)	2	R+	Value shall be present.
>Treatment Delivery Type	(300A,00CE)	2	R+	Value shall be SETUP.
>Treatment Termination Status	(3008,002A)	1	R+*	If the setup actions were successfully completed, the value shall be NORMAL.
>Treatment Termination Code	(3008,002B)	3	-	
>Treatment Verification Status	(3008,002C)	2	R+	Value shall be present.
>Specified Primary Meterset	(3008,0032)	3	RC+*	Shall be present if Radiation Type (300A,00C6) is PROTON or ION
>Specified Secondary Meterset	(3008,0033)	3	-	
>Delivered Primary Meterset	(3008,0036)	3	-	
>Delivered Secondary Meterset	(3008,0037)	3	-	
>Specified Treatment Time	(3008,003A)	3	-	
>Delivered Treatment Time	(3008,003B)	3	-	
>Delivered Depth Dose Parameters Sequence	(300A,0506)	3	-	
>Number of Control Points	(300A,0110)	1	-	
>Ion Control Point Delivery Sequence	(3008,0041)	1	-	
>>Referenced Control Point Index	(300C,00F0)	1	-	
>>Treatment Control Point Date	(3008,0024)	1	-	
>>Treatment Control Point Time	(3008,0025)	1	-	
>>Specified Meterset	(3008,0042)	2	R+*	Value shall be empty if Radiation Type (300A,00C6) is not PROTON or ION.

Attribute	Tag	DCM Type	Type	Attribute Note
>>Delivered Meterset	(3008,0044)	1	R+*	Value shall be 0 if Radiation Type (300A,00C6) is not PROTON or ION..
>>Meterset Rate Set	(3008,0045)	3	-	
>>Meterset Rate Delivered	(3008,0046)	3	-	
>>Nominal Beam Energy	(300A,0014)	1C	-	
>>KVP	(0018,0060)	1C	X	
>>Ion Wedge Position Sequence	(300A,03AC)	1C	-	
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	-	
>>Range Shifter Settings Sequence	(300A,0360)	1C	-	
>>Lateral Spreading Device Settings Sequence	(300A,0370)	1C	-	
>>Range Modulator Settings Sequence	(300A,0380)	1C	-	
>>Gantry Angle	(300A,011E)	1C	R+*	Shall be equal to the position of the ion source even in the case of X-Ray imaging action. Note: An X-Ray source gantry angle will be specified in any associated imaging objects such as RT Image or CT.
>>Gantry Rotation Direction	(300A,011F)	1C	-	
>>Gantry Pitch Angle	(300A,014A)	2C	-	
>>Gantry Pitch Rotation Direction	(300A,014C)	2C	-	
>>Beam Limiting Device Angle	(300A,0120)	1C	-	
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	-	
>>Scan Spot Tune ID	(300A,0390)	1C	-	
>>Number of Scan Spot Positions	(300A,0392)	1C	-	
>>Scan Spot Position Map	(300A,0394)	1C	-	
>>Scan Spot Metersets Delivered	(3008,0047)	1C	-	
>>Scan Spot Time Offset	(300A,038F)	3	-	
>>Scanning Spot Size	(300A,0398)	3	X	
>>Scanning Spot Sizes Delivered	(300A,0399)	3	RC+*	Required if Scan Mode (300A,0308) is MODULATED or MODULATED_SPEC
>>Number of Paintings	(300A,0391)	1C	-	
>>Scan Spot Reordered	(300A,0393)	3	-	
>>Scan Spot Prescribed Indices	(300A,0391)	1C	-	
>>Patient Support Angle	(300A,0122)	1C	-	
>>Patient Support Rotation Direction	(300A,0123)	1C	-	

Attribute	Tag	DCM Type	Type	Attribute Note
>>Table Top Pitch Angle	(300A,0140)	2C	RC+*	Value shall not be empty for the first item of the Control Point Sequence or if the Table Top Pitch Angle changes during Beam.
>>Table Top Pitch Rotation Direction	(300A,0144)	2C	RC+*	Value shall not be empty for the first item of the Control Point Sequence or if the Table Top Pitch Angle changes during Beam.
>>Table Top Roll Angle	(300A,0144)	2C	RC+*	Value shall not be empty for the first item of the Control Point Sequence or if the Table Top Roll Angle changes during Beam.
>>Table Top Roll Rotation Direction	(300A,0146)	2C	RC+*	Value shall not be empty for the first item of the Control Point Sequence or if the Table Top Roll Angle changes during Beam.
>>Head Fixation Angle	(300A,0148)	3	RC+*	Required if the Patient Support Type (300A,0350) is CHAIR.
>>Chair Head Frame Position	(300A,0151)	3	RC+*	Required if the Patient Support Type (300A,0350) is CHAIR.
>>Table Top Vertical Position	(300A,0128)	2C	R+*	Value shall not be empty in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Table Top Longitudinal Position	(300A,0129)	2C	R+*	Value shall not be empty in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Table Top Lateral Position	(300A,012A)	2C	R+*	Value shall not be empty in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Snout Position	(300A,030D)	2C	R+*	Value shall not be empty in Control Point 0 of Ion Control Point Delivery Sequence (3008,0041) and for further control points if value changes during beam administration.
>>Corrected Parameter Sequence	(3008,0068)	3	-	
>>Override Sequence	(3008,0060)	3	RC+*	Value shall be present if override parameters were used.

7.4.11.3 Beam Option Specifications

7.4.11.4 Measured Dose Reference Record

7.4.11.5 Calculated Dose Reference Record

7.4.11.5.1 Calculated Dose Reference Record Module for Consistent Dose

Appendices to Volume 3

None.

Volume 4 – National Extensions

4 National Extensions

Not applicable.