



GE Healthcare

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## **Technical Publications**

**Direction DOC0685777**

**Revision 1**

## **Advantage 4D RT Conformance Statement for DICOM V3.0**

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## REVISION HISTORY

REV	VER	DATE	REASON FOR CHANGE
1	1	December 4, 2009	Initial document
1	2	December 11, 2009	Document updated based on the HII findings
1	3	December 16, 2009	<p>Updated Conformance Statement overview:</p> <ul style="list-style-type: none"> <li>§ “Table 1 provides an overview of the network services supported by Advantage 4D RT Freedom.” Replaced with:</li> <li>“Table 1 provides an overview of the SOP Classes supported by Advantage 4D RT Freedom.”</li> <li>§ NETWORK SERVICES -&gt; Supported SOP Classes</li> <li>§ Removed row with “Transfer” text</li> <li>§ User of Service (SCU)   Provider of Service (SCP)</li> </ul> <p>Replaced to: SOP Class used as input   SOP Class created as output</p>

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## CONFORMANCE STATEMENT OVERVIEW

Advantage 4D RT Freedom is a diagnostic application used in the preparation of a 4D CT-scanned patient for treatment by radiotherapy on the RT Freedom CT console. This base application is a Networked Medical Imaging Console dedicated to Examination Scan, Review and Diagnosis. The workstation uses DICOM services to import acquisition images for possible further analysis or processing, and to export images and radiotherapy data to other vendors. Additionally, radiotherapy data may be imported for further processing by RT Freedom or Advantage 4D RT Freedom.

Advantage 4D RT Freedom does not have an intrinsic DICOM Network feature. It does not directly invoke the DICOM Server AE.

Table 1 provides an overview of the SOP Classes supported by Advantage 4D RT Freedom.

**Table 1**  
**Supported SOP Classes**

SOP Classes	SOP Class used as input	SOP Class created as output
CT Image Storage	Yes	Yes

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## SECTION 1 INTRODUCTION

### 1.1 OVERVIEW

This DICOM Conformance Statement is divided into sections as described below:

**SECTION 1, (Introduction)**, which describes the overall structure, intent and references for this Conformance Statement.

**SECTION 2, (Network Conformance Statement)**, which specifies the GEMS equipment compliance to the DICOM requirements for the implementation of networking features.

**SECTION 3, (CT Image Information Object Requirements)**, which specifies the GEMS equipment compliance to DICOM requirements for the implementation of a CT Image Information Object.

### 1.2 OVERALL DICOM CONFORMANCE STATEMENT DOCUMENT STRUCTURE

The Documentation Structure of the GEMS DICOM Conformance Statements is shown in the Illustration below.

### GEMS DICOM Conformance Statements

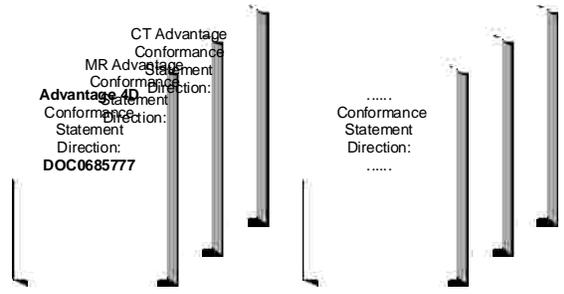
@

<http://www.ge.com/DICOM>



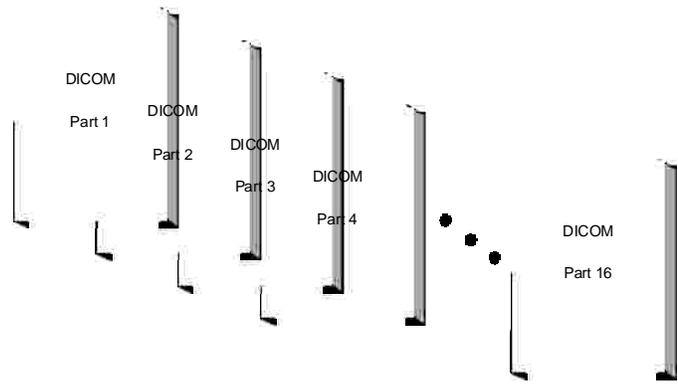
APPLICATION ENTITY SPECIFICATION  
(SERVICE CLASSES, INFORMATION OBJECTS, MESSAGE EXCHANGES, ETC.)

**Product Implementation:**



DICOM STANDARD

**Standard Specification:**



This document specifies the DICOM implementation. It is entitled:  
Advantage 4D RT Freedom

Conformance Statement for DICOM  
Direction ...# DOC0685777

This DICOM Conformance Statement documents the DICOM Conformance Statement and Technical Specification required to interoperate with the GEMS network interface.

The GEMS Conformance Statement, contained in this document, also specifies the Lower Layer communications which it supports (e.g., TCP/IP). However, the Technical Specifications are defined in the DICOM Part 8 standard.

For more information regarding DICOM, copies of the Standard may be obtained on the Internet at <http://medical.nema.org>. Comments on the Standard may be addressed to:

DICOM Secretariat  
NEMA  
1300 N. 17<sup>th</sup> Street, Suite 1847  
Rosslyn, VA 22209  
USA  
Phone: +1.703.841.3200

### 1.3 INTENDED AUDIENCE

The reader of this document is concerned with software design and/or system integration issues. It is assumed that the reader of this document is familiar with the DICOM Standard and with the terminology and concepts, which are used in that Standard.

### 1.4 SCOPE AND FIELD OF APPLICATION

It is the intent of this document to provide an unambiguous specification for GEMS implementations. This specification, called a Conformance Statement, includes a DICOM Conformance Statement and is necessary to ensure proper processing and interpretation of GEMS medical data exchanged using DICOM. The GEMS Conformance Statements are available to the public.

The reader of this DICOM Conformance Statement should be aware that different GEMS devices are capable of using different Information Object Definitions. For example, a GEMS CT Scanner may send images using the CT Information Object, MR Information Object, Secondary Capture Object, etc.

Included in this DICOM Conformance Statement are the Module Definitions, which define all data elements, used by this GEMS implementation. If the user encounters unspecified private data elements while parsing a GEMS Data Set, the user is well advised to ignore those data elements (per the DICOM standard). Unspecified private data element information is subject to change without notice. If, however, the device is acting as a "full fidelity storage device", it should retain and re-transmit all of the private data elements, which are sent by GEMS devices.

### 1.5 IMPORTANT REMARKS

The use of these DICOM Conformance Statements, in conjunction with the DICOM Standards, is intended to facilitate communication with GE imaging equipment. However, **by itself, it is not sufficient to ensure that inter-operation will be successful.** The user (or user's agent) needs to proceed with caution and address at least four issues:

- Integration** - The integration of any device into an overall system of interconnected devices goes beyond the scope of standards (DICOM v3.0), and of this introduction and associated DICOM Conformance Statements when interoperability with non-GE equipment is desired. The responsibility to analyze the integration requirements and to design a solution that integrates GE imaging equipment with non-GE systems is the **user's** responsibility and should not be underestimated. The **user** is strongly advised to ensure that such an integration analysis is correctly performed.
- Validation** - Testing the complete range of possible interactions between any GE device and non-GE devices, before the connection is declared operational, should not be overlooked. Therefore, the **user** should ensure that any non-GE provider accepts full responsibility for all validation required for their connection with GE devices. This includes the accuracy of the image data once it has crossed the interface between the GE imaging equipment and the non-GE device and the stability of the image data for the intended applications.

Such a validation is required before any clinical use (diagnosis and/or treatment) is performed. It applies when images acquired on GE imaging equipment are processed/displayed on a non-GE device, as well as when images acquired on non-GE equipment is processed/displayed on a GE console or workstation.
- Future Evolution** - GE understands that the DICOM Standard will evolve to meet the user's growing requirements. GE is actively involved in the development of the DICOM Standard. DICOM will incorporate new features and technologies and GE may follow the evolution of the Standard. The GEMS protocol is based on DICOM as specified in each DICOM Conformance Statement. Evolution of the Standard may require changes to devices, which have implemented DICOM. **In addition, GE reserves the right to discontinue or make changes to the support of communications features (on its products) described by these DICOM Conformance Statements.** The **user** should ensure that any non-GE provider, which connects with GE devices, also plans for the future evolution of the DICOM Standard. Failures to do so will likely result in the loss of function and/or connectivity as the DICOM Standard changes and GE Products are enhanced to support these changes.
- Interaction** - It is the sole responsibility of the **non-GE provider** to ensure that communication with the interfaced equipment does not cause degradation of GE imaging equipment performance and/or function.

1.6 REFERENCES

NEMA PS3 Digital Imaging and Communications in Medicine (DICOM) Standard, available free at <http://medical.nema.org/>

The supported RT Freedom platform DICOM conformance statements are described in the following documents:

Document title	Direction
<p><b>Discovery* and BrightSpeed* Dicom Conformance Statement for DICOM 2008 (ID/Net v3. )</b></p> <p>Note: *Refer to section 1 of the above document for a list of products in the Discovery and BrightSpeed families to which this Conformance Statement applies.</p>	<p><b>DOC0636565</b></p>

The information object implementation refers to DICOM PS3.3-1998 (Information Object Definitions).

## 1.7 DEFINITIONS

Informal definitions are provided for the following terms used in this Conformance Statement. The DICOM Standard is the authoritative source for formal definitions of these terms.

**Abstract Syntax** – the information agreed to be exchanged between applications, generally equivalent to a Service/Object Pair (SOP) Class. Examples: Verification SOP Class, Modality Worklist Information Model Find SOP Class, and Compute Radiography Image Storage SOP Class.

**Application Entity (AE)** – an end point of a DICOM information exchange, including the DICOM network or media interface software; i.e., the software that sends or receives DICOM information objects or messages. A single device may have multiple Application Entities.

**Application Entity Title** – the externally known name of an *Application Entity*, used to identify a DICOM application to other DICOM applications on the network.

**Application Context** – the specification of the type of communication used between *Application Entities*. Example: DICOM network protocol.

**Association** – a network communication channel set up between *Application Entities*.

**Attribute** – a unit of information in an object definition; a data element identified by a *tag*. The information may be a complex data structure (Sequence), itself composed of lower level data elements. Examples: Patient ID (0010,0020), Accession Number (0008,0050), Photometric Interpretation (0028,0004), Procedure Code Sequence (0008,1032).

**Information Object Definition (IOD)** – the specified set of *Attributes* that comprise a type of data object; does not represent a specific instance of the data object, but rather a class of similar data objects that have the same properties. The *Attributes* may be specified as Mandatory (Type 1), Required but possibly unknown (Type 2), or Optional (Type 3), and there may be conditions associated with the use of an Attribute (Types 1C and 2C). Examples: MR Image IOD, CT Image IOD, Print Job IOD.

**Joint Photographic Experts Group (JPEG)** – a set of standardized image compression techniques, available for use by DICOM applications.

**Media Application Profile** – the specification of DICOM information objects and encoding exchanged on removable media (e.g., CDs)

**Module** – a set of *Attributes* within an *Information Object Definition* that are logically related to each other. Example: Patient Module includes Patient Name, Patient ID, Patient Birth Date, and Patient Sex.

**Negotiation** – first phase of *Association* establishment that allows *Application Entities* to agree on the types of data to be exchanged and how that data will be encoded.

**Presentation Context** – the set of DICOM network services used over an *Association*, as negotiated between *Application Entities*; includes *Abstract Syntaxes* and *Transfer Syntaxes*.

**Protocol Data Unit (PDU)** – a packet (piece) of a DICOM message sent across the network. Devices must specify the maximum size packet they can receive for DICOM messages.

**Security Profile** – a set of mechanisms, such as encryption, user authentication, or digital signatures, used by an *Application Entity* to ensure confidentiality, integrity, and/or availability of exchanged DICOM data

**Service Class Provider (SCP)** – role of an *Application Entity* that provides a DICOM network service; typically, a server that performs operations requested by another *Application Entity*

(*Service Class User*). Examples: Picture Archiving and Communication System (image storage SCP, and image query/retrieve SCP), Radiology Information System (modality worklist SCP).

**Service Class User (SCU)** – role of an *Application Entity* that uses a DICOM network service; typically, a client. Examples: imaging modality (image storage SCU, and modality worklist SCU), imaging workstation (image query/retrieve SCU)

**Service/Object Pair (SOP) Class** – the specification of the network or media transfer (service) of a particular type of data (object); the fundamental unit of DICOM interoperability specification. Examples: Ultrasound Image Storage Service, Basic Gray scale Print Management.

**Service/Object Pair (SOP) Instance** – an information object; a specific occurrence of information exchanged in a *SOP Class*. Examples: a specific x-ray image.

**Tag** – a 32-bit identifier for a data element, represented as a pair of four digit hexadecimal numbers, the “group” and the “element”. If the “group” number is odd, the tag is for a private (manufacturer-specific) data element. Examples: (0010,0020) [Patient ID], (07FE,0010) [Pixel Data], (0019,0210) [private data element]

**Transfer Syntax** – the encoding used for exchange of DICOM information objects and messages. Examples: *JPEG* compressed (images), little endian explicit value representation.

**Unique Identifier (UID)** – a globally unique “dotted decimal” string that identifies a specific object or a class of objects; an ISO-8824 Object Identifier. Examples: Study Instance UID, SOP Class UID, SOP Instance UID.

**Value Representation (VR)** – the format type of an individual DICOM data element, such as text, an integer, a person’s name, or a code. DICOM information objects can be transmitted with either explicit identification of the type of each data element (Explicit VR), or without explicit identification (Implicit VR); with Implicit VR, the receiving application must use a DICOM data dictionary to look up the format of each data element.

## 1.8 SYMBOLS AND ABBREVIATIONS

A list of symbols and abbreviations which is applicable to all DICOM v3.0 Conformance Statements is included in the *Introduction to the Integrated DICOM/Network v3.0 (ID/Net v3.0) Conformance Statement, Direction: 2118780*.

A set of symbols and abbreviations, which is applicable to radiotherapy, is available in CEI/IEC 1217: 1996 (Radiotherapy equipment – Coordinates, movements and scales).

## SECTION 2 NETWORK CONFORMANCE STATEMENT

### 2.1 INTRODUCTION

This section of the DICOM Conformance Statement (DCS) specifies the Advantage 4D RT Freedom compliance to DICOM requirements for networkin eatures.

Advantage 4D RT Freedom is a diagnostic application used in the preparation of a 4D CT-scanned patient for treatment by radiotherapy on RT Freedom CT console. This base application is a Networked Medical Imaging Console dedicated to Examination Review and Diagnosis. The workstation uses DICOM services to import acquisition es for possible further analysis or processing, and to export images and radiotherapy data to other vendors. Additionally, radiotherapy data may be imported for further processi g by RT Freedom or Advantage 4D RT Freedom.

Advantage 4D RT Freedom does not have an intrinsic DICOM Network feature. It does not directly invoke the DICOM Server AE. For some detailed information on DICOM features of RT Freedom CT console, refer to the respective Conformance Statement - Discovery\* and BrightSpeed\* where Advantage 4D RT Freedom application is running ( ee 1.6 References).

The application parses the following DICOM objects:

SOP Class Name	SOP Class UID
CT Image Storage	1.2.840.10008.5.1.4.1.1.2

The application creates the following DICOM objects:

SOP Class Name	SOP Class UID
CT Image Storage	1.2.840.10008.5.1.4.1.1.2

### 2.2 IMPLEMENTATION MODEL

#### 2.2.1 Application Data Flow Diagram

Refer to the respective Conformance Statement - Discovery\* and BrightSpeed\* where Advantage 4D RT Freedom application is running (See 1.6 References).

#### 2.2.2 Presentation Context Table

Refer to the respective Conformance Statement - Discovery\* and BrightSpeed\* where Advantage 4D RT Freedom application is running (See 1.6 References).

#### 2.2.3 Real-World Activities

The user can select CT Images (multiple phases), then rt application from CT console. Perform the phase binning and then user action needs to indicate saving of phase series. Also the Advantage 4D RT Freedom application can be started fro the Advantage 4D RT Freedom application, with the CT Images just created. After us request the 4D binned image series is

created and saved into Advantage Windows database.

The **goal of this document** is to give a detailed description of the CT IMAGE DICOM IOD (1.2.840.10008.5.1.4.1.1.2) read by the application, required to reconstruct a 3-dimensional volume

### **2.3 SUPPORT OF EXTENDED CHARACTER SETS**

The Advantage 4D RT Freedom supports ISO\_IR 100 (Latin alphabet Number 1 supplementary set) as extended character set. The product user interface will allow the user to enter characters from the console keyboard that are within ASCII or the 8-bit extended character set.

## SECTION 3 CT INFORMATION OBJECT REQUIREMENTS

### 3.1 INTRODUCTION

This section specifies the use of the DICOM CT Image IOD to represent the information included in CT Images produced and/or received by this implementation. Corresponding attributes are conveyed using the module construct.

### 3.2 ADVANTAGE 4D RT FREEDOM MAPPING OF DICOM ENTITIES

The Advantage 4D RT Freedom maps DICOM Information Entities to local Information Entities in the product's database and user interface.

**Table 2**

MAPPING OF DICOM ENTITIES TO ADVANTAGE 4D RT FREEDOM ENTITIES

DICOM	Advantage 4D RT Freedom
Patient Entity	Patient Entity (RT Freedom CT console)
Study Entity	Examination Entity (RT Freedom CT console)
Series Entity	Series Entity (RT Freedom CT console)
Frame of Reference Entity	None
Equipment Entity	None
Image Entity	Patient model reconstruction on 3D server

### 3.3 CT IMAGE IOD MODULE TABLE

Within an entity of the DICOM CT Image Information Object Definition, attributes are grouped into a related set of attributes. A set of related attributes is termed a module. A module facilitates the understanding of the semantics concerning the attributes and how the attributes are related with each other. A module grouping does not infer any encoding of information into datasets.

Table 3 identifies the defined modules within the entities, which comprise the DICOM CT Image Information Object Definition. Module Name identifies modules.

See DICOM Part 3 for a complete definition of the entities, and attributes.

**Note: The elements that are not listed in tables are not used and will be ignored.**

**Table 3**

CT IMAGE INFORMATION OBJECT DEFINITION (IOD) MODULE TABLE

Entity Name	Module Name	Usage	Reference
Patient	Patient	M	3.4.1
Study	General Study	M	3.4.2.1
	Patient Study	U	3.4.2.2

Entity Name	Module Name	Usage	Reference
Series	General Series	M	3.4.3.1
Frame of Reference	Frame of Reference	M	3.4.4.1
Equipment	General Equipment	M	3.4.5.1
Image	General Image	M	3.4.6.1
	Image Plane	M	3.4.6.2
	Image Pixel	M	3.4.6.3
	Contrast/Bolus	C	3.4.6.4
	CT Image	M	3.4.6.5
	Overlay Plane	U	Not used
	VOI LUT SOP Common	U M	Not used 3.4.6.6

### 3.4 INFORMATION MODULE DEFINITIONS

Please refer to DICOM Standard Part 3 (Information Object Definition) for a description of each of the entities and modules contained within the SC Information Object.

**Note: The elements that are not listed in tables are not used and will be ignored.**

#### 3.4.1 Patient Entity Modules

##### 3.4.1.1 Patient Module

Attribute Name	Element Tag	TP	Notes
Patient's Name	(0010,0010)	2	SCU: Duplicated from input instances if present in those images, otherwise zero-length SCP: Used for display if provided. REQUIRED FOR SAFE PATIENT IDENTIFICATION.
Patient ID	(0010,0020)	2	SCU: Duplicated from input instances if present in those images, otherwise zero-length SCP: REQUIRED BY Advantage 4D RT Freedom FOR SAFE PATIENT IDENTIFICATION.
Patient's Birth Date	(0010,0030)	2	SCU: Duplicated from input instances if present in those images, otherwise zero-length SCP: Used for display if provided.
Patient's Sex	(0010,0040)	2	SCU: Duplicated from input instances if present in those images, otherwise zero-length SCP: Used for display if provided.

### 3.4.2 Study Entity Modules

#### 3.4.2.1 General Study

Attribute Name	Element Tag	TP	Notes
Study Instance UID	(0020,000D)	1	SCU: Duplicated from input instances SCP: Not used
Study Date	(0008,0020)	2	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom. Used for display
Study Time	(0008,0030)	2	SCU: Duplicated from input instances if provided, otherwise zero-length SCP: Used for display if provided.
Referring Physicians' Name	(0008,0090)	2	SCU: Duplicated from input instances if provided, otherwise zero-length SCP: Used for display if provided.
Study ID	(0020,0010)	2	SCU: Duplicated from input instances if provided, otherwise zero-length SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION (MUST NOT BE ZERO-LENGTH). The values of (Study ID, Series Number) pair must uniquely identify series in RT Freedom CT console database.
Accession number	(0008,0050)	2	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Study Description	(0008,1030)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Name of Physician(s) Reading Study	(0008,1060)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database

#### 3.4.2.2 Patient Study

Attribute Name	Element Tag	TP	Notes
Admitting Diagnoses Description	(0008,1080)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database
Patient's Age	(0010,1010)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database

Attribute Name	Element Tag	TP	Notes
Patient's Weight	(0010,1030)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database
Additional Patient's History	(0010,21B0)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database

### 3.4.3 Series Entity Modules

#### 3.4.3.1 General Series

Attribute Name	Element Tag	TP	Notes
Modality	(0008,0060)	1	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION. MUST NOT BE ZERO LENGTH. MUST be CT modality.
Series Instance UID	(0020,000E)	1	SCU: Duplicated from input instances SCP: Used internally for series identification
Series Number	(0020,0011)	2	SCU: Generated, or provided by user. SCP: REQUIRED BY Advantage 4D RT Freedom AND USED FOR IDENTIFICATION. REQUIRED IF MULTIPLE CT SERIES ARE TO BE REFERENCED FOR THE SAME STUDY. The values of (Study ID, Series Number) pair must uniquely identify series in RT Freedom CT console database.
Series Date	(0020,0021)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database
Series Time	(0020,0031)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database
Performing Physician's Name	(0008,1050)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database
Series Description	(0008,103E)	3	SCU: Generated from Adv4D RT Freedom SCP: Used if provided.
Operators' Name	(0008,1070)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Body Part Examined	(0018,0015)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.

Attribute Name	Element Tag	TP	Notes
Patient Position	(0018,5100)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.

### 3.4.4 Common Frame Of Reference Entity Modules

#### 3.4.4.1 Frame Of Reference

Attribute Name	Element Tag	TP	Notes
Frame of Reference UID	(0020,0052)	1	SCU: Duplicated from input instances SCP: not used directly, but used only to declare/store in the Image Database.
Position Reference Indicator	(0020,1040)	2	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.

### 3.4.5 Equipment Entity Modules

#### 3.4.5.1 General Equipment

Attribute Name	Element Tag	TP	Notes
Manufacturer	(0008,0070)	2	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION. MUST BE "GE MEDICAL SYSTEMS".
Institution Name	(0008,0080)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Station Name	(0008,1010)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Manufacturer's Model Name	(0008,1090)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Pixel Padding Value	(0028,0120)	3	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION. MUST NOT BE ZERO LENGTH.

### 3.4.6 Image Entity Modules

#### 3.4.6.1 General Image

Attribute Name	Element Tag	TP	Notes
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Attribute Name	Element Tag	TP	Notes
Image Number	(0020,0013)	2	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION. MUST NOT BE ZERO LENGTH.
Image Date	(0008,0023)	2C	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Image Time	(0008,0033)	2C	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Image Type	(0008,0008)	3	See CT Image Module.
Acquisition Number	(0020,0012)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Acquisition Date	(0008,0022)	3	SCU: Duplicated from input instances if provided SCP: not used directly, but used only to declare/store in the Image Database.
Acquisition Time	(0008,0032)	3	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION. Must not be zero length.

#### 3.4.6.2 Image Plane

Attribute Name	Element Tag	TP	Notes
Pixel Spacing	(0028,0030)	1	SCU: Duplicated from input instances Scp: Used for patient model reconstruction. PIXELS MUST BE SQUARE (i.e. X and Y values must be equal).
Image Orientation (Patient)	(0020,0037)	1	SCU: Duplicated from input instances SCP: Used for patient model reconstruction. IMAGES MUST NOT HAVE GANTRY TILT OR SWIVEL (i.e. only one of each (x, y ,z) cosine triplet can be non-zero).
Image Position (Patient)	(0020,0032)	1	SCU: Duplicated from input instances SCP: Used for patient model reconstruction.
Slice Thickness	(0018,0050)	2	SCU: Duplicated from input instances SCP: Used for patient model reconstruction.
Slice Location	(0020,1041)	3	SCU: Duplicated from input instances SCP: Required by Advantage 4D RT Freedom. Used by 4D RT Freedom to identify z coordinate.

3.4.6.3 Image Pixel

Attribute Name	Element Tag	TP	Notes
Samples per Pixel	(0028,0002)	1	See CT Image Module.
Photometric Interpretation	(0028,0004)	1	See CT Image Module.
Rows	(0028,0010)	1	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom. Must be 512.
Columns	(0028,0011)	1	SCU: Duplicated from input instances SCP: Required by Advantage 4D RT Freedom. Must be 512.
Bits Allocated	(0028,0100)	1	See CT Image Module.
Bits Stored	(0028,0101)	1	See CT Image Module.
High Bit	(0028,0102)	1	See CT Image Module.
Pixel Representation	(0028,0103)	1	SCU: Duplicated from input instances SCP: Used for image display
Pixel Data	(7FE0,0010)	1	SCU: Duplicated from input instances SCP: Used for image display
Smallest Image Pixel Value	(0028,0106)	3	SCU: Duplicated from input instances if present SCP: Not used
Largest Image Pixel Value	(0028,0107)	3	SCU: Duplicated from input instances if present SCP: Not used

3.4.6.4 Contrast/Bolus (not mandatory)

Attribute Name	Element Tag	TP	Notes
Contrast/Bolus Agent	(0018,0020)	1	SCU: Duplicated from input instances SCP: Not used
Contrast/Bolus Route	(0018,1040)	1	SCU: Duplicated from input instances SCP: Not used

3.4.6.5 CT Image

Attribute Name	Element Tag	TP	Notes
Image Type	(0008,0008)	1	SCU: Duplicated from input instances SCP: Must be provided
Samples per Pixel	(0028,0002)	1	SCU: Value 1 is stored SCP: Not used.
Photometric Interpretation	(0028,0004)	1	SCU: Duplicated from input instances SCP: not used directly, but used only to declare/store in the Image Database.

Attribute Name	Element Tag	TP	Notes
Bits Allocated	(0028,0100)	1	SCU: Value 16 is stored SCP: Not used.
Bits Stored	(0028,0101)	1	SCU: Value 16 is stored SCP: Not used.
High Bit	(0028,0102)	1	SCU: Value 15 is stored SCP: Not used.
Rescale Intercept	(0028,1052)	1	SCU: Duplicated from input instances SCP: Used for display
Rescale Slope	(0028,1053)	1	SCU: Value "1" is stored SCP: Used for display.
KVP	(0018,0060)	2	SCU: Duplicated from input instances if provided SCP: Not used.
Acquisition Number	(0020,0012)	2	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION.
Scan Options	(0018,0022)	3	SCU: Duplicated from input instances SCP: REQUIRED BY Advantage 4D RT Freedom FOR IMAGE IDENTIFICATION. Must contain the word "CINE".
Data Collection Diameter	(0018,0090)	3	SCU: Duplicated from input instances if provided SCP: Not used.
Reconstruction Diameter	(0018,1100)	3	SCU: Duplicated from input instances if provided SCP: Not used.
Gantry/Detector Tilt	(0018,1120)	3	SCU: Duplicated from input instances if provided SCP: Not used.
Exposure Time	(0018,1150)	3	SCU: Duplicated from input instances if provided SCP: REQUIRED BY Advantage 4D RT Freedom.
X-ray Tube Current	(0018,1151)	3	SCU: Duplicated from input instances if provided SCP: REQUIRED BY Advantage 4D RT Freedom.
Convolution Kernel	(0018,1210)	3	SCU: Duplicated from input instances if provided SCP: Not used.

3.4.6.6 SOP Common

Attribute Name	Element Tag	TP	Notes
SOP Class UID	(0008,0016)	1	SCU: Duplicated from input instances SCP: Used by Advantage 4D RT Freedom to confirm image is CT Image.

Attribute Name	Element Tag	TP	Notes
SOP Instance UID	(0008,0018)	1	SCU: Generated from Advantage 4D RT Freedom SCP: Used by Advantage 4D RT Freedom for image identification.
Specific Character Set	(0008,0005)	1C	SCU: Duplicated from input instances SCP: Advantage 4D RT Freedom supports only the ISO_IR 100 extended character set.

### 3.5 PRIVATE DATA DICTIONARY

Attribute Name	Element Tag	Private Creator Identification	VR	Notes
Cardiac Phase	(0045, 1033)	GEMS_HELIOS_01	CS	SCU: Generated, the phase information for the image is stored. SCP: Not used
Gating type	(0015,101A)	GEMS_PETD_01	SL	SCU: filled as Respiratory (=2). SCP: Not used.
Total Number of Bins	(0015,101B)	GEMS_PETD_01	SL	SCU: filled with total number of bins (phases). SCP: Not used.
% Phase Value	(0015, 101C)	GEMS_PETD_01	SL	SCU: filled with target respiratory phase number. This tag, therefore, contains the same information as the Cardiac Phase (0045, 1033). SCP: Not used.