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DICOM Conformance Statement

Leksell GammaPlan®

11.1

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1 Introduction

1.1 Scope and field of application

The scope of this DICOM conformance statement is to facilitate data exchange with equipment of Elekta Neuro Sciences. This document specifies the conformance to the DICOM standard (formally called the NEMA PS3.X-1993 standards). It contains a short description of the applications involved and provides technical information about the data exchange capabilities of the equipment. The main elements describing these capabilities are the supported DICOM service object pairs (SOP) classes, Roles and Transfer Syntaxes.

1.2 Reference documents

Digital Imaging and Communications in Medicine (DICOM). Version 3.0. National Electrical Manufacturer's Association. Rosslyn, VA, United States of America. 2011.

1.3 Terminology

Term	Explanation
AE	Application Entity
AET	Application Entity Title
AP	Application Profile
FSR	File Set Reader
FSC	File Set Creator
PDU	Protocol data unit
SCP	Service Class Provider
SCU	Service Class User
SOP	Service Object Pair
UID	Unique Identifier

1.4 Important notes

This Conformance Statement by itself does not guarantee successful interoperability of Elekta equipment with non-Elekta equipment. The user (or user's agent) should be aware of the following issues:

Scope

The goal of DICOM is to facilitate inter-connectivity rather than interoperability. Interoperability refers to the ability of application functions, distributed over two or more systems, to work successfully together. The integration of medical devices into a networked environment may require application functions that are not specified within the scope of DICOM. Consequently, using only the information provided by this Conformance Statement does not guarantee

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interoperability of Elekta equipment with non-Elekta equipment. It is the user's responsibility to analyze thoroughly the application requirements and to specify a solution that integrates Elekta equipment with non-Elekta equipment.

Validation

Elekta equipment has been carefully tested to assure that the actual implementation of the DICOM interface corresponds with this Conformance Statement. Where Elekta equipment is linked to non-Elekta equipment, the first step is to compare the relevant Conformance Statements. If the Conformance Statements indicate that successful information exchange should be possible, additional validation tests will be necessary to ensure the functionality, performance, accuracy and stability of image and image related data. It is the responsibility of the user (or user's agent) to specify the appropriate test suite and to carry out the additional validation tests.

New versions of the DICOM Standard

The DICOM standard will evolve in future to meet the user's growing requirements and to incorporate new features and technologies. Elekta plans to adapt its equipment to future versions of the DICOM standard. In order to do so, Elekta reserves the right to make changes to its products or to discontinue its delivery. The user should ensure that any non-Elekta provider linking to Elekta equipment also adapts to future versions of the DICOM Standard. If not, the incorporation of DICOM enhancements into Elekta equipment may lead to loss of connectivity (in case of networking) and incompatibility (in case of media).

2 Implementation Model

The Elekta Neuro Treatment Planning system consist of one Elekta Storage Server Application Entity connected to one or more Leksell GammaPlan® Treatment Planning Workstations.

2.1 Applications data flow diagrams

The application data flows for the different services supported by the Elekta Storage Server and Leksell GammaPlan® are described below.

Verification SCU

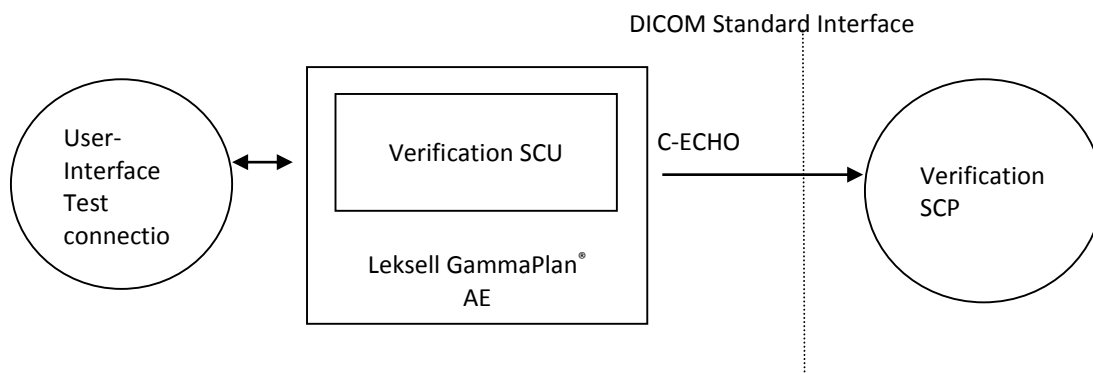


Figure 1 Application Data Flow Diagram - Verification SCU.

Verification SCP

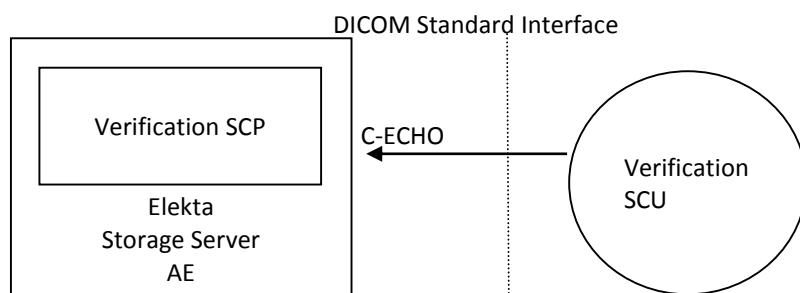


Figure 2 Application Data Flow Diagram - Verification SCP.

Storage SCP

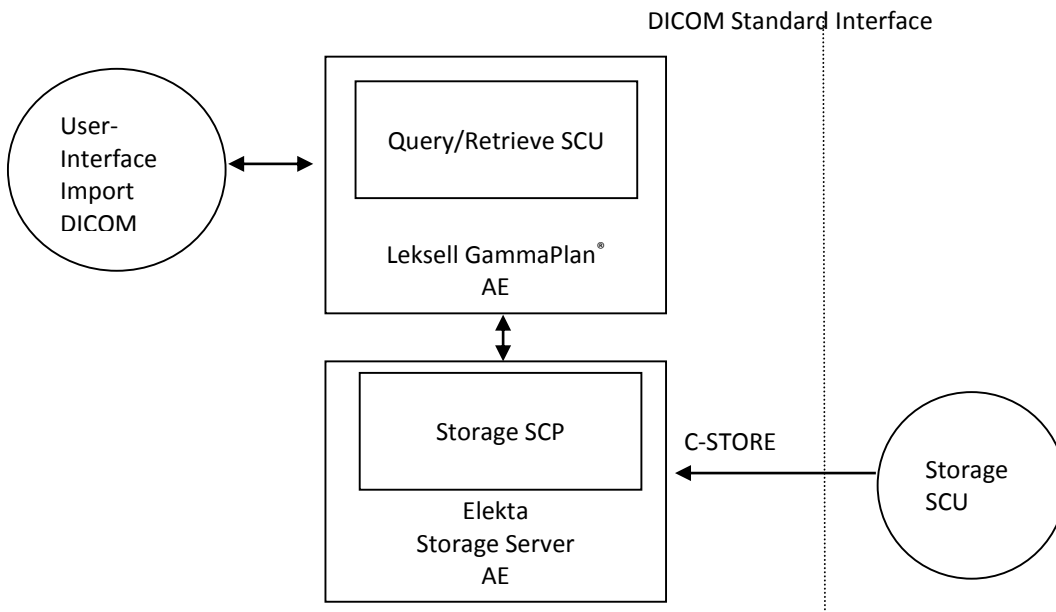


Figure 3 Application Data Flow Diagram - Storage SCP.

Storage SCU

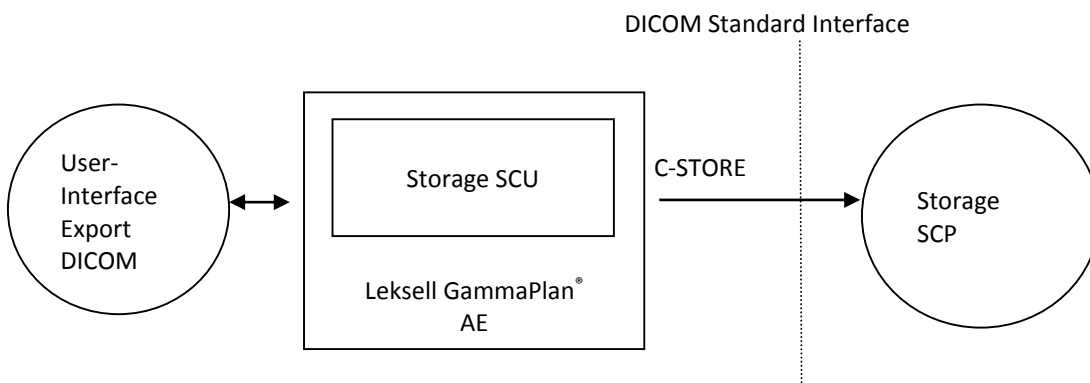


Figure 4 Application Data Flow Diagram - Storage SCU.

Query/Retrieve SCP

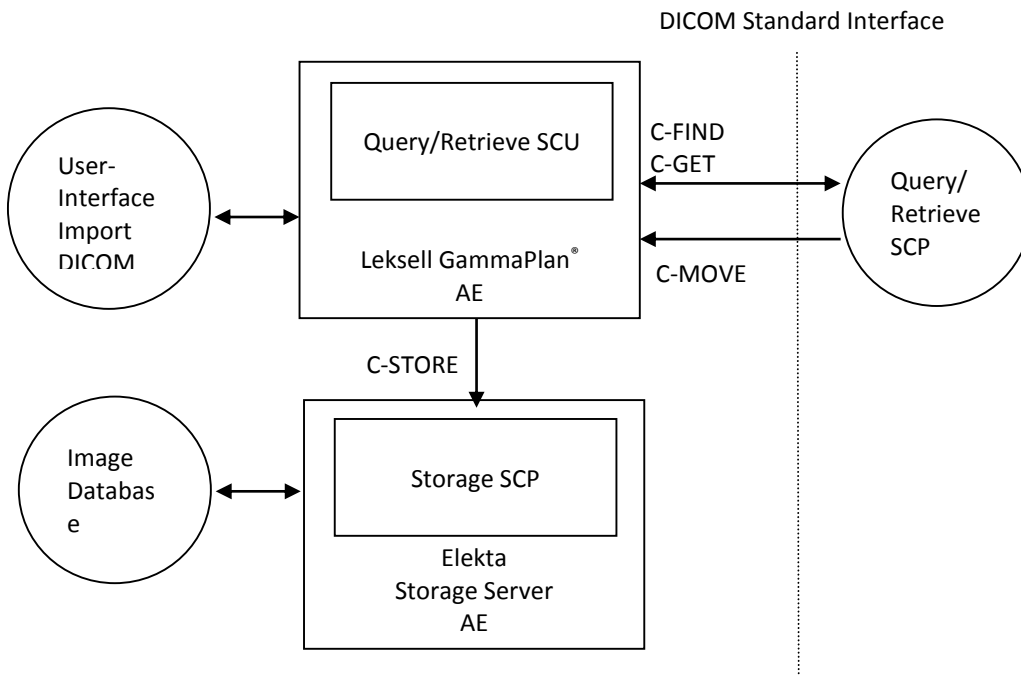


Figure 5 Application Data Flow Diagram – Query/Retrieve SCP.

File Set Reader

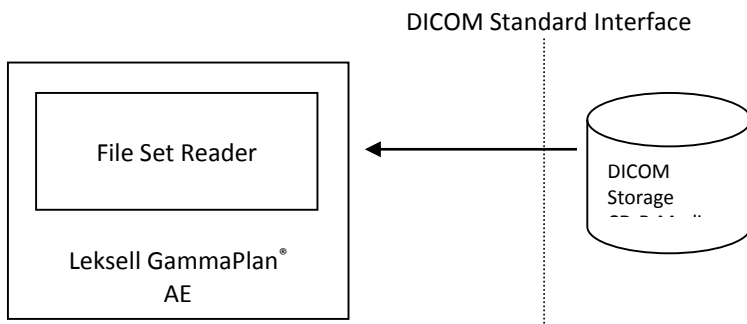


Figure 6 Application Data Flow Diagram – File Set Reader from DICOM CD-R.

Note: This is a partially conformant File Set Reader as it is able to perform M-READ but not MINQUIRE FILE Media Storage Operation.

File Set Writer

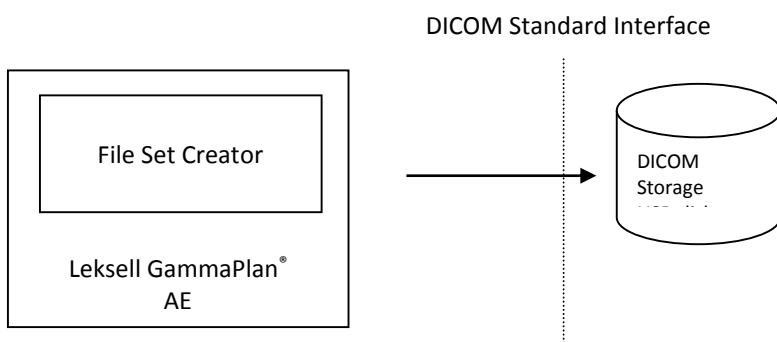


Figure 7 Application Data Flow Diagram – File Set Writer to USB medium.

Note: This is a partially conformant File Set Creator as it is able to perform M-WRITE but not M-INQUIRE FILE or MINQUIRE FILESET Media Storage Operation.

2.2 Functional definitions of Application Entity

Elekta Storage Server

The Elekta Storage Server waits for another application to connect at the TCP/IP port number 104. When another application makes a DICOM association request, the Storage Server acts as a SCP for the storage service class: It stores the DICOM objects in the inbox of the Leksell GammaPlan® Treatment Planning Workstation. The Storage Server also acts as a SCP for the verification service class: It responds to C-ECHO requests from other applications.

Leksell GammaPlan®

Leksell GammaPlan® is a DICOM Client (SCU) for the purpose of

- Importing DICOM Images and DICOM RT Structure Sets, drawn in the image planes of an already imported image series.
- Requesting a remote query/retrieve SCP to perform a search and match to the keys specified in the request in order to display the results in the Leksell GammaPlan® user interface. Depending on user action (Import) Leksell GammaPlan® sends a C-GET or a C-MOVE request to initiate a C-STORE operation on the SCP to start an image transfer from the remote query/retrieve SCP to Leksell GammaPlan®. A C-MOVE request is only sent if the query/retrieve SCP does not support the C-GET service.
- Exporting DICOM Images and DICOM Structure sets object to a remote Service Class Provider (DICOM Server). Leksell GammaPlan® also exports DICOM RT Dose and DICOM RT Plan objects. The RT objects can be exported together with an image series. Only 3D volumes can be exported. The DICOM RT Dose object contains the global dose distribution within the skull for the currently active treatment plan. A DICOM RT Plan object is created and used to connect the dose object with the structure sets and images. The DICOM RT Object can be exported together with CT, MR and PET images.
- Writing DICOM Images and DICOM Structure sets objects to a USB flash drive. Leksell GammaPlan® also writes DICOM RT Dose and DICOM RT Plan objects. This is a partially conformant File Set Creator (FSC) as it is able to perform M-WRITE but not M-INQUIRE FILE SET or M-INQUIRE FILE Media Storage Operation.
- Reading DICOM object stored on a CD-ROM. This is a partially conformant File Set Reader (FSR) as it is able to perform M-READ but not M-INQUIRE FILE Media Storage Operation.
- Echo Utility for test and validation purposes. It sends a verify request to a specified DICOM node. It acts as a SCU for the verification service class.

2.3 Sequencing of Real World Activities

The user “verification” of a remote application can be made during a configuration session of the remote applications. Retrieve of images is only possible if results from a previous “Search...”

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operation exists and those entities can be selected for "Import".

3 AE specifications

3.1 Elekta Storage Server AE Specification - Storage

The Elekta Storage Server Application Entity provides Standard Conformance to the following DICOM V3.0 SOP classes for storage as a SCP:

SOP Class Name	UID
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
XA Image Storage	1.2.840.10008.5.1.4.1.1.12.1
PET Image Storage	1.2.840.10008.5.1.4.1.1.128
RT Structure Set	1.2.840.10008.5.1.4.1.1.481.3
SC Image Storage	1.2.840.10008.5.1.4.1.1.7

Table 1: SOP Classes for storage supported by the Elekta Storage Server.

Association Establishment Policies

General

The Elekta Storage Server accepts association in response to C-STORE requests from other Applications Entities. It will accept C-STORE requests for CT, MR, XA, PET, RT Structure Set and SC SOP classes and in this case will act as storage service class provider. The Storage Server is a LINUX daemon, waits for C-STORE requests, and performs the necessary operations upon it receiving such requests.

Number of Associations

The number of simultaneous associations that will be accepted by the Elekta Storage Server is limited to 5.

Asynchronous Nature

The Elekta Storage Server does not perform asynchronous operations window negotiation.

Implementation Identifying Information

The Elekta Storage Server does not export any DICOM object. The only occasion where an Implementation Identifier may be used is during the establishment of the association with a DICOM peer. For this reason the implementation identifying information of the OFFIS DCMTK DICOM toolkit has been kept unchanged:

IMPLEMENTATION_CLASS_UID = 1.22276.0.7230010.3.0.3.5.4

IMPLEMENTATION_VERSION = OFFIS_DCMTK_354

Association Initiation by Real World Activity

The Elekta Storage Server never initiates an association.

Association Acceptance Policy

Remote System Requests Image Storage on the Elekta Storage Server

Associated Real World Activity – Storage Provider

A DICOM AE sends a storage request to the Elekta Storage Server. If the request is accepted the images and objects are stored on the Elekta Storage Server.

Presentation context table - storage

Presentation Context Table					
Abstract Syntax		Transfer Syntax List		Role	Extended Negotiation
Name	UID	Name	UID		
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
PET Image Storage	1.2.840.10008.5.1.4.1.1.12.8	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.48.1.3	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

Secondary Capture	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
Image Storage		Explicit VR Little Endian	1.2.840.10008.1.2.1		
		Explicit VR Big Endian	1.2.840.10008.1.2.2		

Table 2: Presentation context table: C-STORE service

C-STORE SCP conformance

The Elekta Storage Server is Conformance Level 0 Storage SCP. The stored attributes may be accessed only through Leksell GammaPlan® and only for display. The duration of storage of these attributes is at the user discretion.

Presentation context acceptance criterion

The Elekta Storage Server will accept any context listed in Table 2. There is no check for duplicate contexts.

Transfer syntax selection policies

The preference in acceptance of Transfer Syntaxes is:

Implicit Little Endian above Explicit Little Endian above Explicit Big Endian

3.2 Elekta Storage Server AE Specification - Verification

The Elekta Storage Server Application Entity provides Standard Conformance to the Verification DICOM V3.0 SOP class as a SCP:

SOP Class Name	UID
Verification	1.2.840.10008.1.1

Table 3: SOP Classes for verification supported by the Elekta Storage Server.

General

The Elekta Storage Server accepts association in response to C-ECHO requests and act as verification service class provider. The Storage Server is a LINUX daemon, waits for C-ECHO requests, and performs the necessary operations upon it receiving such requests.

Number of Associations

The number of simultaneous associations that will be accepted by the Elekta Storage Server is limited to 5.

Asynchronous Nature

The Elekta Storage Server does not perform asynchronous operations window negotiation.

Implementation Identifying Information

The Elekta Storage Server does not export any DICOM object. The only occasion where an

Implementation Identifier may be used is during the establishment of the association with a DICOM peer. For this reason the implementation identifying information of the OFFIS DCMTK DICOM toolkit has been kept unchanged:

IMPLEMENTATION_CLASS_UID = 1.22276.0.7230010.3.0.3.5.4

IMPLEMENTATION_VERSION = OFFIS_DCMTK_354

Association Initiation by Real World Activity

The Elekta Storage Server never initiates an association.

Association Acceptance Policy

Remote system requests verification

Associated real world activity – Verification Provider

A remote DICOM AE wish to verify the application level communication using the C-ECHO command.

Presentation context table - verification

Presentation Context Table					
Abstract Syntax		Transfer Syntax List		Role	Extended Negotiation
Name	UID	Name	UID		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCP	None
		Explicit VR Little Endian	1.2.840.10008.1.2.1	SCP	None
		Explicit VR Big Endian	1.2.840.10008.1.2.2	SCP	None

Table 4: Presentation context table: C-ECHO service

C-ECHO SCP conformance

The Elekta Storage Server provides standard conformance to the C-ECHO service as a Service Class Provider.

Presentation context acceptance criterion

The only accepted presentation context is defined in Table 4.

Transfer syntax selection policies

The preference in acceptance of Transfer Syntaxes is:

Implicit Little Endian above Explicit Little Endian above Explicit Big Endian

3.3 Leksell GammaPlan® AE - Storage

Leksell GammaPlan® Application Entity provides Standard Conformance the following DICOM V3.0 SOP classes for storage as a SCU:

SOP Class Name	UID
CT Image Storage	1.2.840.10008.5.1.4.1.1.2
MR Image Storage	1.2.840.10008.5.1.4.1.1.4
PET Image Storage	1.2.840.10008.5.1.4.1.1.128
¹ SC Image Storage	1.2.840.10008.5.1.4.1.1.7
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5

Table 5: SOP Classes for storage supported by Leksell GammaPlan®.

Association Establishment Policies

General

The maximum PDU size for Leksell GammaPlan® can be configurable from a minimum of 4 Kbytes. There is no upper limit. It is limited by the available system resources. The default value is 64 Kbytes.

Number of Associations

Leksell GammaPlan® supports one active association at a time as a Service Class User.

Asynchronous Nature

Leksell GammaPlan® does not support asynchronous operations and will not perform asynchronous window negotiation.

Implementation Identifying Information

IMPLEMENTATION_CLASS_UID = 1.2.840.113854.88

IMPLEMENTATION_VERSION = ELEKTA_NTPS_11.1

Association Initiation by Real World Activity

Leksell GammaPlan® sends a C-STORE request to a remote Applications Entities.

Association Initiation Policy

Leksell GammaPlan® initiates associations for the purpose of

- Export DICOM objects to PACS, Linac or other similar systems

¹ Only Secondary Capture of tomographic images can be sent to a remote Application Entity.

Association Acceptance Policy

Leksell GammaPlan® does not accept associations.

Requests for DICOM Object Storage on Remote Systems

Associated Real World Activity – Storage User

Leksell GammaPlan® requests associations with remote systems that it wishes to send DICOM objects to.

Presentation context table - storage

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

Table 6: Presentation context table: C-STORE service for Leksell GammaPlan®.

C-STORE SCU conformance

Leksell GammaPlan® provides standard conformance for Storage as a SCU. The systems performs a Conformance Level 0 for Storage, i.e., not all DICOM Type 1 and 2 attributes received earlier by another module may have been stored for re-export.

Presentation context acceptance criterion

Not applicable.

Transfer syntax selection policies

Not applicable.

3.4 Leksell GammaPlan® AE – Verification

Leksell GammaPlan® Application Entity provides Standard Conformance the following DICOM V3.0 SOP classes for verification as a SCU for :

SOP Class Name	UID
Verification	1.2.840.10008.1.1

Table 7: SOP Classes for verification supported by Leksell GammaPlan®.

Association Establishment Policies

General

The maximum PDU size for Leksell GammaPlan® can be configurable from a minimum of 4 Kbytes. There is no upper limit. It is limited by the available system resources. The default value is 64 Kbytes.

Number of Associations

Leksell GammaPlan® supports one active association at a time as a Service Class User.

Asynchronous Nature

Leksell GammaPlan® does not support asynchronous operations and will not perform asynchronous window negotiation.

Implementation Identifying Information

IMPLEMENTATION_CLASS_UID = 1.2.840.113854.88

IMPLEMENTATION_VERSION = ELEKTA_NTPS_11.1

Association Initiation by Real World Activity

Leksell GammaPlan® sends a C-ECHO request to a remote Applications Entities.

Association Initiation Policy

Leksell GammaPlan® initiates associations for the purpose of

- Verify the application level communication to another system

Association Acceptance Policy

Leksell GammaPlan® does not accept associations.

Remote system requests verification

Associated real world activity – Verification User

Leksell GammaPlan® requests associations from remote systems to verify the application level communication using the C-ECHO command.

Presentation context table - Verification

Presentation Context Table					
Abstract Syntax		Transfer Syntax List		Role	Extended Negotiation
Name	UID	Name	UID		
Verification	1.2.840.10008.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	SCU	None

Table 8: Presentation context table: C-ECHO service

C-ECHO SCU conformance

Leksell GammaPlan® provides standard conformance for Verification as SCU.

Presentation context acceptance criterion

Not applicable.

Transfer syntax selection policies

Not applicable.

3.5 Leksell GammaPlan® AE Specification – Query/Retrieve

Leksell GammaPlan® Application Entity provides Standard Conformance the following DICOM V3.0 SOP classes for Query/Retrieve as a SCU²:

SOP Class Name	UID
Patient Root Query/Retrieve Information Model - FIND	1.2.840.10008.5.1.4.1.2.1.1
Study Root Query/Retrieve Information Model - FIND	1.2.840.10008.5.1.4.1.2.2.1
Patient Root Query/Retrieve Information Model - GET	1.2.840.10008.5.1.4.1.2.1.3
Patient Root Query/Retrieve Information Model - MOVE	1.2.840.10008.5.1.4.1.2.1.2

Table 9: SOP Classes for Query/Retrieve supported by Leksell GammaPlan®.

Association Establishment Policies

General

The maximum PDU size for Leksell GammaPlan® can be configurable from a minimum of 4 Kbytes. There is no upper limit. It is limited by the available system resources. The default value is 64 Kbytes.

² A license is required for the Query/Retrieve functionality.

Number of Associations

Leksell GammaPlan® supports one active association at a time as a Service Class User.

Asynchronous Nature

Leksell GammaPlan® does not support asynchronous operations and will not perform asynchronous window negotiation.

Implementation Identifying Information

IMPLEMENTATION_CLASS_UID = 1.2.840.113854.88

IMPLEMENTATION_VERSION = ELEKTA_NTPS_11.1

Association Initiation by Real World Activity

Leksell GammaPlan® sends a C-FIND request to a remote Applications Entity followed by a C-GET request if the Entity supports a C-MOVE request is sent otherwise.

Association Initiation Policy

Leksell GammaPlan® initiates associations for the purpose of

- Finding DICOM objects on remote Application Entities
- Retrieve DICOM objects from remote Application Entities

Requests for finding DICOM Object on Remote Systems

Associated Real World Activity - Find

Leksell GammaPlan® sends a C-FIND request when the user queries a remote Query/Retrieve SCP for patients, studies, series or objects. The search on the STUDY level is performed using the Study Root Query Retrieve Information Model with the following tags:

Description	Tag	Value
Patient's Name	(0010,0010)	The value is entered in the GUI. Non ascii letters included in the entered value will be replaced by a question mark (?).
Patient ID	(0010,0020)	The value is entered in the GUI
Study Date	(0008,0020)	A date range is entered in the GUI.
Query/Retrieve level	(0008,0052)	STUDY
Study Time	(0008,0030)	Empty
Study ID	(0020,0010)	Empty
Study Instance UID	(0020,000d)	Empty

The search on the SERIES level is performed using the Patient Root Query Retrieve Information Model with the following tags:

Description	Tag	Value
Patient ID	(0010,0020)	From the STUDY level query.
Study Instance UID	(0020,000d)	From the STUDY level query
Query/Retrieve level	(0008,0052)	SERIES
Modality	(0008,0060)	Empty
Series Instance UID	(0020,000e)	Empty
Series Number	(0020,0011)	Empty

The search on the IMAGE level is performed using the Patient Root Query Retrieve Information Model with the following tags:

Description	Tag	Value
Patient ID	(0010,0020)	From the STUDY level query.
Study Instance UID	(0020,000d)	From the STUDY level query
Series Instance UID	(0020,000e)	From the SERIES level query
Query/Retrieve level	(0008,0052)	IMAGE
SOP Instance UID	(0008,0018)	Empty
Instance Number	(0020,0013)	Empty

The attributes with empty values or with wild cards “*” or “?” above are retrieved from the Query/Retrieve SCP. Leksell GammaPlan® does not support code extension techniques multiple values of Specific Character Sets are not supported.

Presentation context table - Find

Presentation Context Table					
Abstract Syntax		Transfer Syntax List		Role	Extended Negotiation
Name	UID	Name	UID		
Patient Root Query/Retrieve Information Model – FIND	1.2.840.10008.5.1.4.1.2.1.1	Implicit VR Little Endian	1.2.840.10008.1.2	BOTH	None
Study Root Query/Retrieve Information	1.2.840.10008.5.1.4.1.2.2.1	Implicit VR Little Endian	1.2.840.10008.1.2	BOTH	None

Model – FIND					
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Table 10: Presentation context table: C-FIND service for Leksell GammaPlan®.

C-FIND SCU conformance

Leksell GammaPlan® provides standard conformance for the C-FIND service as SCU.

Presentation context acceptance criterion

Not applicable.

Transfer syntax selection policies

Not applicable.

Requests for retrieving DICOM Object on Remote Systems

Associated Real World Activity – Move/Get

Leksell GammaPlan® requests associations for retrieving DICOM objects on remote DICOM AE. On user selection of a specific DICOM series or a DICOM object, a C-GET request is sent to systems supporting the C-GET service if this service is not supported a C_MOVE request is sent. When retrieving a selected DICOM series a C-FIND request on the IMAGE level is sent before the C-GET/C-MOVE request. The C-GET/C-MOVE request will include the following tags:

Description	Tag	Value
Patient ID	0010,0020	From the previous C-FIND query
Study Instance UID	0020,000d	From the previous C-FIND query
Series Instance UID	0020,000e	From the previous C-FIND query
SOP Instance UID	0008,0018	A vector of values from the preceding C-FIND query when retrieving DICOM series. One value when retrieving a DICOM object.

Presentation context table – Move/Get

Presentation Context Table					
Abstract Syntax		Transfer Syntax List		Role	Extended Negotiation
Name	UID	Name	UID		
Patient Root Query/Retrieve Information Model - GET	1.2.840.10008.5.1.4.1.2.1.3	Implicit VR Little Endian	1.2.840.10008.1.2	BOTH	None
Patient Root Query/Retrieve	1.2.840.10008.5.1.4.1.2.1.2	Implicit VR Little Endian	1.2.840.10008.1.2	BOTH	None

Information Model - MOVE					
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Table 11: Presentation context table: C-GET and C-MOVE service for Leksell GammaPlan®.

C-GET conformance

Leksell GammaPlan® provides standard conformance for the C-GET service as SCU.

C-MOVE SCU conformance

Leksell GammaPlan® provides standard conformance for the C-MOVE service as SCU.

4 Communication profiles

4.1 Supported Communication Stacks

The Elekta Storage Server and Leksell GammaPlan® provides DICOM V3.0 TCP/IP Network Communication Support as defined in part 8 of the DICOM standard.

4.2 TCP/IP Stack

Elekta Storage Server inherits the TCP/IP stack from the LINUX operating system upon which they execute.

4.3 OSI Stack

Not supported.

4.4 Physical Media Support

Reading DICOM Object stored on CD-ROM

Specification

Leksell GammaPlan® can read DICOM part 10 formatted Objects stored on CD-R with the ISO/IEC 9660 Media Format. All DICOM objects on the CD-R will be sent to the Elekta Storage Server. I.e. the DICOM Directory File (DICOMDIR) is not used and it is not possible to select separate files to be stored. The Leksell GammaPlan® is then not conformant to any application profiles defined in the DICOM standard. DICOM objects without Meta information will also be sent to the Elekta Storage Server.

Leksell GammaPlan® is partially conformant as FSR because it supports the M-READ service but does not the M-INQUIRE FILE service. The following table defines which objects are read by the application and which transfer syntaxes are supported:

Information Object Definition	Service Object Pair Class UID	Transfer Syntax	UID
CT Image	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
		JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
		JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
MR Image	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1

		Explicit VR Big Endian	1.2.840.10008.1.2.2
		JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
		JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
X-Ray Angiographic Image	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
		JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
		JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
PET Image	1.2.840.10008.5.1.4.1.1.128	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
		JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
		JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
Secondary Capture Image	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1
		Explicit VR Big Endian	1.2.840.10008.1.2.2
		JPEG Lossless, Non-Hierarchical, First-Order Prediction (Process 14 [Selection Value 1])	1.2.840.10008.1.2.4.70
		JPEG Lossless, Non-Hierarchical (Process 14)	1.2.840.10008.1.2.4.57
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Implicit VR Little Endian	1.2.840.10008.1.2
		Explicit VR Little Endian	1.2.840.10008.1.2.1

	Explicit VR Big Endian	1.2.840.10008.1.2.2
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Table 12: Media Storage: Objects and Transfer

Writing DICOM Object to USB flash drives

Specification

Leksell GammaPlan® can write DICOM part 10 formatted objects to USB flash drives. It is partially conformant as FSC as it is able to perform M-WRITE but not M-INQUIRE FILE SET or M-INQUIRE FILE Media Storage Operation. It is not conformant to any application profiles defined in the DICOM standard. The following table defines which objects are written by the applications and which transfer syntaxes are supported:

Information Object Definition	Service Object Pair Class UID	Transfer Syntax	UID
CT Image	1.2.840.10008.5.1.4.1.1.2	Implicit VR Little Endian	1.2.840.10008.1.2
MR Image	1.2.840.10008.5.1.4.1.1.4	Implicit VR Little Endian	1.2.840.10008.1.2
X-Ray Angiographic Image	1.2.840.10008.5.1.4.1.1.12.1	Implicit VR Little Endian	1.2.840.10008.1.2
PET Image	1.2.840.10008.5.1.4.1.1.128	Implicit VR Little Endian	1.2.840.10008.1.2
Secondary Capture Image	1.2.840.10008.5.1.4.1.1.7	Implicit VR Little Endian	1.2.840.10008.1.2
RT Dose Storage	1.2.840.10008.5.1.4.1.1.481.2	Implicit VR Little Endian	1.2.840.10008.1.2
RT Structure Set Storage	1.2.840.10008.5.1.4.1.1.481.3	Implicit VR Little Endian	1.2.840.10008.1.2
RT Plan Storage	1.2.840.10008.5.1.4.1.1.481.5	Implicit VR Little Endian	1.2.840.10008.1.2

Table 13: Media Storage: Objects and Transfer supported by Leksell GammaPlan®

5 Extensions, Specialization, Privatization

5.1 Private Data Elements

Private Attributes are added to the RT Plan exported by Leksell GammaPlan® if the Dose Reference Type (300A,0020) is TARGET. The used group is 0009 and the private identification code is added to element 0010. Thereby we have reserved the block 0009,1000 – 0009,10FF.

Attribute Name	Tag	Type	Value Type	Value Multiplicity	Attribute Description	Value
> Implementor Identification Code	(0009,0010)	1	LO	1	Identifier for the implementor reserving the private elements.	ELEKTA GAMMAPLAN
> Target Bounding Box Size	(0009,1020)	3	DS	3	A vector defining the size in the X, Y and Z directions of the Patient Coordinate System, the values given in mm of a bounding box containing the target.	
> Target Volume Size	(0009,1021)	3	DS	1	The size in cubic centimeters of the target volume (TV). ³	
> Prescription Isodose Volume Size	(0009,1022)	3	DS	1	The size in cubic centimeters of the the prescription isodose volume (PIV) ³ .	
> Prescription Isodose Volume in Target	(0009,1023)	3	DS	1	The size in cubic centimeters of the part of the prescription isodose volume (PIV) that is inside the target volume (TV), i.e. $\text{Volume}(\text{PIV} \cap \text{TV})$. ³	
> Paddick Conformity Index	(0009,1024)	3	DS	1	The conformity index defined by Paddick: $\text{Volume}(\text{PIV} \cap \text{TV})^2 / (\text{Volume}(\text{TV}) * \text{Volume}(\text{PIV}))$ ⁴	
> Dose Gradient Index	(0009,1025)	3	DS	1	The quotient between the half-prescription isodose volume size and the prescription isodose volume size. ⁴	
> 12 Gy Volume	(0009,1026)	3	DS	1	The size in cubic centimeters of the the volume receiving more than 12 Gy. ³	
> Target Prescription Isodose	(0009,1027)	3	DS	1	The isodose in percent to which the dose (300A,0026) is prescribed. ⁵	

Table 14: Private Data Elements included in the RT Plan exported by Leksell GammaPlan®.

³ Will be set to zero if no target is defined.

⁴ Will be set to NULL if no target is defined.

⁵ Will not be included if no target is defined.

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6 Configuration

6.1 Elekta Storage Server

The Application Entity Title for the Storage Server and the port is defined in a configuration file. The default AET (as generated when the application is installed) is ELEKTA_STORAGE and the port is 104. This configuration is intended to be performed by Elekta service engineers only.

6.2 Leksell GammaPlan®

The AET of Leksell GammaPlan® can be configured in the user interface. Leksell GammaPlan® listens to port 50 001. The IP-address is configured when installing the Leksell GammaPlan® workstation. The AET, IP-address and port of the remote Storage and Query/Retrieve SCP can be configured in the user interface. The maximum PDU size for Leksell GammaPlan® is configurable from a minimum of 4 Kbytes. There is no upper limit. It is limited by the available system resources. The default value is 64 Kbytes.

7 Support of Extended Character Sets

Leksell GammaPlan® supports the following character sets in addition to the default when handling DICOM objects:

- ISO_IR 100
- ISO_IR 101
- ISO_IR 109
- ISO_IR 110
- ISO_IR 144
- ISO_IR 127
- ISO_IR 126
- ISO_IR 138
- ISO_IR 148
- ISO_IR 192

Code extension techniques are currently not supported.

DICOM Image Attributes handled by Leksell GammaPlan®

The tables below list the DICOM attributes handled by Leksell GammaPlan® when handling DICOM image objects.

Name	TAG	Usage/Comment
Patient Name	(0010, 0010)	Identification
Patient ID	(0010, 0020)	Identification
Study Date	(0008,0020)	Identification
Study Time	(0008,0030)	Identification
Instance Number	(0020,0013)	User information
Patient Orientation	(0020, 0020)	3D reconstruction
Modality	(0008, 0060)	Identification/Validation See Note 1
Image Orientation Patient	(0020, 0037)	3D reconstruction
Bits Allocated	(0028, 0100)	Pixel data interpretation and display
Bits stored	(0028, 0101)	Pixel data interpretation and display
Samples per pixel	(0028, 0002)	Pixel data interpretation and display
Photometric Interpretation	(0028, 0004)	Pixel data interpretation
High Bit	(0028, 0102)	Pixel data interpretation and display
Pixel Representation	(0028, 0103)	Pixel data interpretation and display
Columns	(0028, 0011)	Pixel data interpretation and display
Rows	(0028, 0010)	Pixel data interpretation and display
Pixel Data	(7FE0, 0010)	Pixel data interpretation and display
Pixel Data Group Length	(7FE0,0000)	Must match length of Pixel Data attribute
Transfer Syntax UID	(0002, 0010)	Criteria to perform byte swapping
Pixel spacing	(0028, 0030)	3D reconstruction
Pixel Aspect Ratio	(0028,0034)	Pixel data interpretation and display
Series Number	(0020, 0011)	Separation of a stack in several series
Instance Number	(0020, 0013)	User information

Slice Location	(0020, 1041)	Separation of a stack in several series
Study Instance UID	(0020, 000D)	Separation of a stack in several series
Image Position Patient	(0020, 0032)	3D reconstruction
Slice Thickness	(0018, 0050)	3D reconstruction/validation. See Note 2
Spacing between Slices	(0018, 0088)	3D reconstruction/validation See Note 2
CT rescale slope	(0028, 1053)	Pixel data interpretation and display
CT rescale intercept	(0028, 1052)	Pixel data interpretation and display
KVP	(0020,0012)	Used during electron density calculations.
Pixel Padding Value	(0028, 0120)	Pixel data interpretation and display
Window Center	(0028, 1050)	Pixel data interpretation and display
Window Width	(0028, 1051)	Pixel data interpretation and display
Manufacturer	(0008, 0070)	Used during electron density calculations.
Manufacturer's Model Name	(0008,1090)	Used during electron density calculations.
Station Name	(0008,1010)	Used during electron density calculations.
Frame of Reference	(0020,0052)	Reference to other DICOM objects
Series Instance UID	(0020, 000E)	Separation of a stack in several series
SOP Instance UID	(0008, 0018)	Image object identification
Specific Character Set	(0008,0005)	The exported DICOM RT objects will have the same Specific Character Set as the referring DICOM images.
SOP Class UID	(0008,0016)	Used to determine if the application support this DICOM object.
Series Type	(0054,1000)	For rejection of dynamic PET studies.
Number Of Frames	(0028,0008)	For rejection of multi frame angio studies.

Table 15: Image DICOM Attributes handled by Leksell GammaPlan®.

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Note 1

The accepted values for "modality" are: CT, MR, XA, PT, RTSTRUCT, OT and DS. Note DS is a retired enumerated value for modality since the introduction of XA, but it can still be found in some image headers.

Note 2

For a valid 3D reconstruction, it is required that "slice thickness" and "spacing between slices" do not differ more than an application-configured tolerance.

DICOM RT Attributes exported by Leksell GammaPlan®

GENERAL IMAGE MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Instance Number	(0020,0013)	2	<null>
Image Type	(0008,0008)	3	DERIVED\SECONDARY\DOSE
IMAGE PLANE MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Pixel Spacing	(0028,0030)	1	<value depending on data – grid size>
Image Orientation (Patient)	(0020,0037)	1	<value depending on data>
Image Position (Patient)	(0020,0032)	1	<value depending on data >
Slice Thickness	(0018,0050)	2	<null>
IMAGE PIXEL MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Include 'Image Pixel Macro' Table C.7-11b			See IMAGE PIXEL MACRO ATTRIBUTES
IMAGE PIXEL MACRO ATTRIBUTES			
Attribute Name	Tag	Type	Value
Samples per Pixel	(0028,0002)	1	1
Photometric Interpretation	(0028,0004)	1	MONOCHROME2
Rows	(0028,0010)	1	<value depending on data – pixels covering the selected object>
Columns	(0028,0011)	1	<value depending on data – pixels covering the selected object >
Bits Allocated	(0028,0100)	1	16
Bits Stored	(0028,0101)	1	16
High Bit	(0028,0102)	1	15
Pixel Representation	(0028,0103)	1	0

Pixel Data	(7FE0,0010)	1C	<value depending on data – dose values>
MULTI-FRAME MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Number of Frames	(0028,0008)	1	<value depending on data – frames covering the selected object>
Frame Increment Pointer	(0028,0009)	1	(3004,000C)
RT DOSE MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Samples per Pixel	(0028,0002)	1C	1
Photometric Interpretation	(0028,0004)	1C	MONOCHROME2
Bits Allocated	(0028,0100)	1C	16
Bits Stored	(0028,0101)	1C	16
High Bit	(0028,0102)	1C	15
Pixel Representation	(0028,0103)	1C	0
Dose Units	(3004,0002)	1	GY
Dose Type	(3004,0004)	1	PHYSICAL
Instance Number	(0020,0013)	3	<null>
Dose Summation Type	(3004,000A)	1	PLAN
Referenced RT Plan Sequence	(300C,0002)	1C	<One item>
>Include 'SOP Instance Reference Macro' Table 10-11			<Reference to RT Plan object>
Grid Frame Offset Vector	(3004,000C)	1C	<value depending on data>
Dose Grid Scaling	(3004,000E)	1C	<value depending on data>
STRUCTURE SET MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Structure Set Label	(3006,0002)	1	ROIs in <Image study name>

Structure Set Date	(3006,0008)	2	<null>
Structure Set Time	(3006,0009)	2	<null>
Referenced Frame of Reference Sequence	(3006,0010)	3	<one item>
>Frame of Reference UID	(0020,0052)	1	<frame of reference in image study>
>RT Referenced Study Sequence	(3006,0012)	3	<one item>
>>Include 'SOP Instance Reference Macro' Table 10-11			<study instance UID of image study>
>>RT Referenced Series Sequence	(3006,0014)	1	<one item>
>>>Series Instance UID	(0020,000E)	1	<series instance UID of image study>
>>>Contour Image Sequence	(3006,0016)	1	<one item per image in the study >
>>>>Include 'Image SOP Instance Reference Macro' Table 10-3			<SOP instance UID of image>
Structure Set ROI Sequence	(3006,0020)	3	<one item per Volume>
>ROI Number	(3006,0022)	1	<sequence number starting at 1>
>Referenced Frame of Reference UID	(3006,0024)	1	<frame of reference UID>
>ROI Name	(3006,0026)	2	<User defined Volume name>
>ROI Generation Algorithm	(3006,0036)	2	MANUAL
ROI CONTOUR MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
ROI Contour Sequence	(3006,0039)	1	<one item per Volume>
>Referenced ROI Number	(3006,0084)	1	<reference to ROI number>
>ROI Display Color	(3006,002A)	3	<user defined Volume color>
>Contour Sequence	(3006,0040)	3	<one item per Region in Volume>

>>Contour Image Sequence	(3006,0016)	3	<one item>
>>>Include 'Image SOP Instance Reference Macro' Table 10-3			<reference to image containing the contour>
>>Contour Geometric Type	(3006,0042)	1	CLOSED_PLANAR
>>Number of Contour Points	(3006,0046)	1	<number of Vertices in Region>
>>Contour Data	(3006,0050)	1	<vertex coordinates in DICOM patient coordinates>
RT ROI OBSERVATIONS MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
RT ROI Observations Sequence	(3006,0080)	1	<One item per Volume>
>Observation Number	(3006,0082)	1	<Index starting at 0>
>Referenced ROI Number	(3006,0084)	1	<Reference to ROI Item>
>ROI Observation Label	(3006,0085)	3	<User defined Volume name>
>RT ROI Interpreted Type	(3006,00A4)	2	If volume type target: PTV If volume type risk: AVOIDANCE If skull volume: EXTERNAL Otherwise: <null>
>ROI Interpreter	(3006,00A6)	2	<null>
RT GENERAL PLAN MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
RT Plan Label	(300A,0002)	1	<User defined plan name>1
RT Plan Name	(300A,0003)	3	<user defined plan name>
RT Plan Description	(300A,0004)	3	<user defined plan comment>
RT Plan Date	(300A,0006)	2	<Treatment plan date, date of approval>
RT Plan Time	(300A,0007)	2	<empty>
RT Plan Geometry	(300A,000C)	1	PATIENT

RT PRESCRIPTION MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Dose Reference Sequence	(300A,0010)	3	<One item per target>
>Dose Reference Number	(300A,0012)	1	<Number matching the target ID: 1 for target A, 2 for target B etc.>
>Dose Reference Structure Type	(300A,0014)	1	SITE
>Dose Reference Description	(300A,0016)	3	<User defined treatment prefix><User defined target name>
>Dose Reference Type	(300A,0020)	1	TARGET
>Target Prescription Dose	(300A,0026)	3	<Target prescription dose [Gy]>
RT PATIENT SETUP MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Patient Setup Sequence	(300A,0180)	1	<One item per shot run>
>Patient Setup Number	(300A,0182)	1	<Sequence number starting at 1>
>Patient Position	(0018,5100)	1C	HFS/HFP
>Fixation Device Sequence	(300A,0190)	3	<Zero or one item>
>>Fixation Device Type	(300A,0192)	1	HEADFRAME/BITEBLOCK
>>Fixation Device Label	(300A,0194)	2	<null>
>>Fixation Device Pitch Angle	(300A,0199)	3	<Shot run gamma angle>
>Setup Technique	(300A,01B0)	3	ISOCENTRIC
RT FRACTION SCHEME MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Fraction Group Sequence	(300A,0070)	1	<One item per target>
>Fraction Group Number	(300A,0071)	1	<Sequence number starting at 1>

>Referenced Dose Reference Sequence	(300C,0050)	3	<One item for each dose reference/target with the primary target first in the sequence>
>>Referenced Dose Reference Number	(300C,0051)	1	<Reference to dose reference number>
>>Target Prescription Dose	(300A,0026)	3	<Target prescription dose [Gy]>
>Number of Fractions Planned	(300A,0078)	2	<Number of fractions>
>Number of Beams	(300A,0080)	1	<Number of shots>
>Referenced Beam Sequence	(300C,0004)	1C	<One item per shot>
>>Referenced Beam Number	(300C,0006)	1	<Reference to beam number>
>>Beam Dose Specification Point	(300A,0082)	3	<Dose reference point of the target in DICOM patient coordinates >
>>Beam Dose	(300A,0084)	3	<Dose [Gy] delivered by the shot in the Beam Dose Specification Point>
>>Beam Meterset	(300A,0086)	3	<Shot time>
>Number of Brachy Application Setups	(300A,00A0)	1	0
RT BEAMS MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Beam Sequence	(300A,00B0)	1	<One item per shot>
>Beam Number	(300A,00C0)	1	<Sequence number starting at 1>
>Beam Name	(300A,00C2)	3	<User defined treatment prefix><Shot name/ID>
>Beam Type	(300A,00C4)	1	STATIC
>Radiation Type	(300A,00C6)	2	PHOTON
>Treatment Machine Name	(300A,00B2)	2	<User defined radiation unit name>
>Institutional Department Name	(0008,1040)	3	<User defined clinic name>
>Primary Dosimeter Unit	(300A,00B3)	3	MINUTE
>Beam Limiting Device Sequence	(300A,00B6)	1	<One item>

>>RT Beam Limiting Device Type	(300A,00B8)	1	X
>>Number of Leaf/Jaw Pairs	(300A,00BC)	1	0
>>Leaf Position Boundaries	(300A,00BE)	2C	NULL
>Referenced Patient Setup Number	(300C,006A)	3	<Reference to Patient Setup item>
>Treatment Delivery Type	(300A,00CE)	3	TREATMENT
>Number of Wedges	(300A,00D0)	1	0
>Number of Compensators	(300A,00E0)	1	0
>Number of Boli	(300A,00ED)	1	0
>Number of Blocks	(300A,00F0)	1	0
>Final Cumulative Meterset Weight	(300A,010E)	1C	<Same as meterset for last (2nd) control point.>
>Number of Control Points	(300A,0110)	1	2
>Control Point Sequence	(300A,0111)	1	<2 items>
>>Control Point Index	(300A,0112)	1	0/1
>>Cumulative Meterset Weight	(300A,0134)	2	0/<Shot time>
>>Referenced Dose Reference Sequence	(300C,0050)	3	<One item for each dose reference/target with the primary target first in the sequence>
>>>Referenced Dose Reference Number	(300C,0051)	1	<Reference to dose reference number>
>>>Cumulative Dose Reference Coefficient	(300A,010C)	2	For control point 0: 0 For control point 1 if the dose reference represents the target to which the shot belongs: 1 For control point 1 if the dose reference represents another target: beam dose to the dose reference point of the referenced target divided by the beam dose to the reference point of the target to which the

			shot belongs.0/1
>>Nominal Beam Energy	(300A,0114)	3	<1.25>
>>Dose Rate Set	(300A,0115)	3	<Shot dose rate [Gy/minutes] corresponding to the calculated meterset>
>>Beam Limiting Device Position Sequence	(300A,011A)	1C	<Two items. One in the X- and one in the Y-direction>
>>>RT Beam Limiting Device Type	(300A,00B8)	1	X and Y
>>>Leaf/Jaw Positions	(300A,011C)	1	Hard coded to -10 and 10 for the X- and Y-direction.
>>Gantry Angle	(300A,011E)	1C	0
>>Gantry Rotation Direction	(300A,011F)	1C	NONE
>>Beam Limiting Device Angle	(300A,0120)	1C	0
>>Beam Limiting Device Rotation Direction	(300A,0121)	1C	NONE
>>Patient Support Rotation Direction	(300A,0123)	1C	NONE
>>Patient Support Angle	(300A,0122)	1C	0
>>Table Top Eccentric Angle	(300A,0125)	1C	0
>>Table Top Eccentric Rotation Direction	(300A,0126)	1C	NONE
>>Table Top Pitch Angle	(300A,0140)	1C	0
>>Table Top Pitch Rotation Direction	(300A,0142)	1c	NONE
>>Table Top Roll Angle	(300A,0144)	1C	0
>>Table Top Roll Rotation Direction	(300A,0146)	1C	NONE
>>Table Top Vertical Position	(300A,0128)	2C	0

>>Table Top Longitudinal Position	(300A,0129)	2C	0
>>Table Top Lateral Position	(300A,012A)	2C	0
>>Isocenter Position	(300A,012C)	2C	<Shot position in DICOM patient coordinates >
PATIENT MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Patient's Name	(0010,0010)	2	<copied from the images>
Patient ID	(0010,0020)	2	<copied from the images>
Patient's Birth Date	(0010,0030)	2	<copied from the images>
Patient's Sex	(0010,0040)	2	<copied from the images>
GENERAL STUDY MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Study Instance UID	(0020,000D)	1	<copied from the images>
Study Date	(0008,0020)	2	<copied from the images>
Study Time	(0008,0030)	2	<copied from the images>
Referring Physician's Name	(0008,0090)	2	<copied from the images>
Study ID	(0020,0010)	2	<copied from the images>
Accession Number	(0008,0050)	2	<copied from the images>
Study Description	(0008,1030)	3	<copied from the images>
PATIENT STUDY MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Admitting Diagnoses Description	(0008,1080)	3	<Diagnosis string for the examination>6
Admitting Diagnoses Code Sequence	(0008,1084)	3	<One item per diagnosis>
>Code Value	(0008,0100)	1	
>Coding Scheme Designator	(0008,0102)	1	ELEKTA GAMMAPLAN

>Coding Scheme Version	(0008,0103)	1C	1.0
>Code Meaning	(0008,0104)	1	
RT SERIES MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Modality	(0008,0060)	1	RTDOSE/RTSTRUCT/RTPLAN
Series Instance UID	(0020,000E)	1	<generated UID>
Series Number	(0020,0011)	2	<null>
FRAME OF REFERENCE MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Frame of Reference UID	(0020,0052)	1	<copied from the images>
Position Reference Indicator	(0020,1040)	2	<copied from the images>
GENERAL EQUIPMENT MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Manufacturer	(0008,0070)	2	Elekta
Manufacturer's Model Name	(0008,1090)	3	GammaPlan
Software Versions	(0018,1020)	3	<GammaPlan version number>
APPROVAL MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
Approval Status	(300E,0002)	1	UNAPPROVED/APPROVED/REJECTED
Review Date	(300E,0004)	2C	<null>
Review Time	(300E,0005)	2C	<null>
Reviewer Name	(300E,0008)	2C	<User entered approver name>
SOP COMMON MODULE ATTRIBUTES			
Attribute Name	Tag	Type	Value
SOP Class UID	(0008,0016)	1	<SOP Class UID>
SOP Instance UID	(0008,0018)	1	<generated UID>

Specific Character Set	(0008,0005)	1C	<copied from the images>
Instance Creation Date	(0008,0012)	3	<date of creation>
Instance Creation Time	(0008,0013)	3	<time of creation>

Table 16: DICOM RT Attributes exported by Leksell GammaPlan®.

DICOM attributes set in CBCT images generated by Leksell Gamma Knife®

Coordinates

The transformation between the Leksell coordinate system and the DICOM patient coordinate system that the images are expressed in is a mirroring of the y- and z-axis and can be expressed as:

$$T_{Leksell \rightarrow DICOM \text{ patient}} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Attributes

Module	Attribute Name	Tag	Value/Comment
CT Image	Image Type	(0008,0008)	ORIGINAL\PRIMARY\AXIAL
CT Image	Samples Per Pixel	(0028,0002)	1
CT Image	Photometric Interpretation	(0028,0004)	MONOCHROME2
CT Image	Bits Allocated	(0028,0100)	16
CT Image	Bits Stored	(0028,0101)	16
CT Image	High Bit	(0028,0102)	15
CT Image	Rescale Intercept	(0028,1052)	-1024
CT Image	Rescale Slope	(0028,1053)	1
CT Image	Kvp	(0018,0060)	According to the selected CBCT pre-set
CT Image	Acquisition Number	(0020,0012)	NULL
Frame Of Reference	Frame Of Reference Uid	(0020,0052)	The SOP Instance UID of the first slice of the scan
Frame Of Reference	Position Reference Indicator	(0020,1040)	NULL
General Equipment	Manufacturer	(0008,0070)	Elekta
General Equipment	Manufacturers Model Name	(0008,1090)	LGK Perfexion PLUS
General Equipment	Software Versions	(0018,1020)	CS-Software\<version>\ DICOM-Interface\<version>
General Image	Instance Number	(0020,0013)	The instance number will be 1 for the first image in a series.
General Image	Acquisition Date	(0008,0022)	Date the CBCT scan started
General Image	Acquisition Time	(0008,0032)	Time the CBCT scan started

General Series	Modality	(0008,0060)	CT
General Series	Series Instance Uid	(0020,000E)	UID generated by Leksell Gamma Knife®
General Series	Series Number	(0020,0011)	1
General Series	Series Date	(0008,0021)	Date of creation of the series
General Series	Series Time	(0008,0031)	Time of creation of the series
General Series	Body Part Examined	(0018,0015)	HEADNECK
General Series	Patient Position	(0018,5100)	HFS
General Study	Study Instance UID	(0020,000D)	UID generated by Leksell Gamma Knife®
General Study	Study Date	(0008,0020)	Date of creation of the study
General Study	Study Time	(0008,0030)	Time of creation of the study
General Study	Referring Physicians Name	(0008,0090)	NULL
General Study	Study Id	(0020,0010)	NULL
General Study	Accession Number	(0008,0050)	NULL
Image Pixel	Pixel Representation	(0028,0103)	1
Image Pixel	Pixel Data	(7FE0,0010)	The pixel data of the image
Image Plane	Pixel Spacing	(0028,0030)	The pixel spacing of the image
Image Plane	Image Orientation Patient	(0020,0037)	See explanation about coordinates above.
Image Plane	Image Position Patient	(0020,0032)	See explanation about coordinates above.
Image Plane	Slice Thickness	(0018,0050)	The slice thickness of the image
Patient	Patients Name	(0010,0010)	Last name^First name Value entered in Leksell GammaPlan®
Patient	Patient Id	(0010,0020)	Value entered in Leksell GammaPlan®
Patient	Patients Birth Date	(0010,0030)	Value entered in Leksell GammaPlan®
Patient	Patients Sex	(0010,0040)	Value entered in Leksell GammaPlan®
Sop Common	Sop Class Uid	(0008,0016)	1.2.840.10008.5.1.4.1.1.2
Sop Common	Sop Instance Uid	(0008,0018)	UID generated by Leksell Gamma Knife®
Sop Common	Specific Character Set	(0008,0005)	ISO_IR 192 (UTF-8 encoding)

Table 17: DICOM attributes set in CBCT images generated by Leksell Gamma Knife®.