

American National Standard

AAMI RT3: 2020

Radiation therapy machine
characterization

Radiation therapy machine characterization

Approved 21 February 2020 by
AAMI

Abstract: This standard defines a standard XML format for publishing and reporting the physical parameters of a C-Arm Radiation Therapy Linear Accelerator or the physical parameters in a software model of such a device.

Keywords: radiotherapy equipment, machine characteristics, XML, treatment delivery

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Committee representation

Association for the Advancement of Medical Instrumentation

Radiation Therapy Committee

This AAMI standard was developed by the **AAMI Machine Characteristics Working Group** under the auspices of the AAMI Radiation Therapy Committee. Approval of this standard does not necessarily mean that all working group members voted for its approval

At the time this document was published, the **AAMI Radiation Therapy Committee** had the following participants:

- Chair:* Jim Percy
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Robert Pekarek, Accuray Incorporated
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Colin Winfield, Elekta

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Thomas Jakob, Varian Medical Systems
Eric Schnarr, Accuray Incorporated
Colin Winfield, Elekta

NOTE Participation by federal agency representatives in the development of this standard does not constitute endorsement by the federal government or any of its agencies.

Foreword

As part of its ongoing commitment to provide safe and effective radiation therapy (RT) equipment, AdvaMed sponsored an industry-wide initiative to provide a standard way to report treatment machine and treatment machine model characteristics.

Using this document, manufacturers can publish their equipment characteristics digitally and manufacturers can digitally report these values as they are stored within a software model of this radiation treatment device.

The primary use cases for this document are anticipated to be:

- 1 Digital publication of physical equipment behavior that is needed by other manufacturers.

When a new treatment delivery system (TDS), or other radiation delivery accessory, is released into the RT industry, a machine characterization report is issued digitally by the manufacturer along with other marketing literature, technical white papers and release-for-talk documents. The digital report will be useful for users and other RT manufacturers (e.g. treatment planning systems) in assessing if the device is supported via existing implementations, models, etc. and to avoid time consuming and error prone manual entry of machine parameters into software models.

- 2 Cross system/cross machine model comparison.

A user creates an electronic report of the internal models of each system in their department and compares them to confirm a match of parameters.

Within the same system, it may be required to have variations of a machine due to optional features that it supports. The standard allows the user to easily identify these model differences.

- 3 Periodic quality assurance (QA) of machine models.

The report output can be utilized during periodic QA to confirm model consistency over time.

- 4 New software release check.

The report can be used to compare treatment machine models from one software release to the next; this is especially useful if the format of the internal treatment machine model has changed.

For use case 1, it is intended that each manufacturer create and publish a digital file in XML format as defined in the tables in this standard with the ELEMENTs and values that describe the full range of equipment parameters of their device. This file will be identified by having a value of PUBLISHED for the ELEMENT called report_type.

For use cases 2 through 4, it is intended that each manufacturer of a system that uses a software model of the treatment device provides a software routine that extracts the equipment parameters from their proprietary internal format or database and creates a report in the standard XML format as defined in the tables below. This file will be identified by having a value of MODELED for report_type. These manufacturers or third-party software developers then provide a way to compare the two reports and detail the differences.

Therefore, this standard provides the following:

- an XML based format for reporting treatment device parameters;
- a standard methodology for showing which parameters are being set, limited or fixed;
- a list of parameters to report for each device;
- the categorization of the parameters as mandatory, conditional or optional.

NOTE—This foreword does not contain provisions of the AAMI standard, *Radiation therapy machine characterization* (AAMI RT3:2020), but it does provide important information about the development and intended use of the document.

Radiation therapy machine characterization

1 Scope and purpose

1.1 Scope

This document provides specific requirements and guidance for the documentation of the physical behavior of an isocentric medical electron accelerator and other devices that are used for the purposes of a radiation treatment such as C-Arm Linear Accelerators.

Tomotherapeutic, multiple fixed source, robotic arm, light and heavy ion and other radiation treatment devices are not covered in this version.

This document does not claim full coverage of all configuration content. The scope is not intended to be comprehensive but to cover the majority of model conflict areas.

This document does not describe all the requirements and testing which might be necessary to validate that a combined system is safe and effective for use. For example, output factors are considered part of the dose calculation model and not part of the physical model. The physical model parameters are within the scope of this document.

Individual device manufacturers may have additional requirements beyond compliance to this document, including joint verification and validation of the combined system. Manufacturers are free to add additional private modules following the format described in Clause 4 for their own internal uses. These private tags are optional and shall be prefixed with "private_COMPANYNAME_" where COMPANYNAME is any self-chosen company name (that is, COMPANYNAME does not have to match the value of the tag "manufacturer_name" in the *manufacturer macro*).

This document intends that the characteristics will be published or reported in an electronic template format that is defined herein. The template will be in XML format to facilitate interchange and digital comparison of the data (see Annex A).

This document is intended to be used by medical device manufacturers and users in the field of radiation therapy.

1.2 Purpose

The purpose of this document is to provide a format for the electronic publication of Linac and treatment device specification information for participating components in the RT Machine Characterization (RT3) standard template exchange process.

The uses of this content standard are not defined in this document but may be mandated or referenced by other workflow or performance standards in the radiotherapy environment like those developed by Integrating the Healthcare Enterprise – Radiation Oncology (IHE-RO) and the International Electrotechnical Commission (IEC).

There are various potential actors in the standard template exchange process. They are:

- Treatment management system (TMS)
- Treatment planning system (TPS)
- Treatment delivery system (TDS)
- Treatment accessory manufacturers
- Quality assurance system (QAS) or secondary calculation systems
- Users (medical physicists)

In the case of an older machine that is no longer in production, the data may only be available from one of the above devices that is planning, controlling or otherwise working with the legacy machine or legacy device.

The consumers of published data and comparers of actual data instances are:

- Treatment management system (TMS)
- Treatment planning system (TPS)
- Treatment delivery system (TDS)
- Quality assurance system (QAS) or secondary calculation systems
- Users (medical physicists)

Some basic tenets of this document are that:

1. Values shall be unambiguous in that they will have an assigned unit.
2. Where possible, values will be enumerated to the extent that extensibility is not sacrificed. For example, if only a few values are possible then an enumeration will be used instead of free-form text.
3. All attributes shall be described sufficiently such that their meaning is not ambiguous.
4. All attribute values shall be described sufficiently such that their meaning is not ambiguous.
5. IEC 61217 shall be adhered to for coordinates and scales that are defined. Unless otherwise stated, dimensions of collimation devices are given at the machine reference distance.

NOTE This is the isocenter distance for isocentric machines.

6. The XML template will be extensible for incorporation of additional attributes and relationships in the future.

2 Normative references

The following documents are referred to in the text, a reference here implies that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61217:2011, *Radiotherapy equipment—Coordinates, movements and scales*

NEMA PS3 / ISO 12052, *Digital Imaging and Communications in Medicine (DICOM) Standard*, National Electrical Manufacturers Association, Rosslyn, VA, USA
(available for free at <https://www.dicomstandard.org/current/>)

"*Extensible Markup Language (XML) 1.0 (Fifth Edition)*", World Wide Web Consortium. 2008-11-26.
Retrieved 13 November 2019.

"*XML Schema Part 1: Structures (Second Edition)*", World Wide Web Consortium. 2004-10-28. Retrieved 13 November 2019

"*XML Schema Part 2: Datatypes (Second Edition)*", World Wide Web Consortium. 2004-10-28. Retrieved 13 November 2019

3 Terms, definitions and abbreviated items

3.1 Terms and definitions

3.1.1

beam limiting device

structure, fixed or movable, intended to block or collimate ionizing radiation, resulting in shielding the treatment region from unintended X-radiation or electron radiation

[SOURCE: IEC 60976:2007, 3.2]

3.1.2

C-Arm Linear Accelerator

single linear accelerator with optional imaging device(s) mounted on the same, single degree of rotation gantry

Note 1 to entry: The treatment head and imaging devices are physically separate; not enclosed in a continuous, closed ring structure.

3.1.3

code

real world value that is transmitted or shown as the identifier or key for the desired device or setting

3.1.4

manufacturer

natural or legal person with responsibility for the design, manufacture, packaging, or labelling of medical electrical equipment, assembling an medical electrical system, or adapting medical electrical equipment or a medical electrical system, regardless of whether these operations are performed by that person or on that person's behalf by a third party

[SOURCE: IEC 60601-1:2005 and 60601-1:2005/AMD1:2018, 3.55, modified—Replace "ME" with "medical electrical" and the NOTES are deleted.]

3.1.5

radiation aperture

aperture in the protective shielding of a radiation source or in a beam limiting device, that is intended to give passage to the radiation beam

[SOURCE: IEC 60601-1-3:2008, 3.54]

3.1.6

user

authority responsible for the use and maintenance of equipment

3.1.7

XML element

logical XML document component that either begins with a start-tag and ends with a matching end-tag or consists only of an empty-element tag

3.2 Abbreviated terms

The abbreviations used in this document are listed in Table 1.

Table 1 – Abbreviated terms

Abbreviation	Meaning
BLD	Beam Limiting Device
CC	Counterclockwise direction
CT	Computed Tomography
CW	Clockwise direction
DICOM	Digital Imaging and Communications in Medicine
EPID	Electronic Portal Imaging Device
Gy	Gray (unit)
ID	Identification
Linac	Linear Accelerator
max	Maximum
min	Minimum
MLC	Multi-leaf collimator
mm	Millimeter
MU	Monitor Unit
QA	Quality Assurance

Abbreviation	Meaning
SAD	Source Axis Distance
SDD	Source Detector Distance
SSD	Source Surface Distance
UDI	Universal Device Identifier
UID	Unique Identifier
XML	Extensible Markup Language
XSD	XML Schema Document

4 How to develop and read the Module and *Macro* tables

4.1 Overall structure

The XML format shall conform to the [Extensible Markup Language \(XML\) 1.0 \(Fifth Edition\)](#).

A published XML from a manufacturer or a generated XML from a software system that follows this standard will start with set of elements described in the REPORT table (Table 13). The XML file content of interest to this document will begin and end with:

```
<RT3report>
</RT3report>
```

The file will then contain a variable number of module entries selected from the tables of elements described below. Within several of the module tables, a call is made to include a *macro* to insert common elements used to describe an angle or an energy. How to understand and utilize these module and *macro* tables is described below.

4.2 Element column

4.2.1 Module table

A report can be created for any physical radiation therapy device, a physical accessory or a virtual, software treatment machine model.

Each XML file shall contain the mandatory REPORT module followed by any number of appropriate modules making up the manufacturer's device or the software treatment machine model.

When declaring multiple devices of the same kind, for example a set of wedges, each device (e.g. wedge) shall have its own module entry. They can share a single REPORT module if the data in the REPORT module is the same (same manufacturer, same room/machine).

Each module starts with an ELEMENT in **bold** identified by the type 'Module'. The opening and closing of the equipment module will be as follows in XML format:

```
<wedge>
  <wedge ELEMENT entries>
</wedge>
```

The ELEMENTS in a list are indented by a > symbol and the list name is in **bold**; the XML format will expand out as follows for two reference documents in the REPORT module:

```

<ref_document>
  <document_ID>document name 1</document_ID>
</ref_document>
<ref_document>
  <document_ID>document name 2</document_ID>
</ref_document>

```

When a fixed value for a parameter is needed but there are both min and max ELEMENTs required, define the max to have the same value as the min.

4.2.2 Macro table

Macros are commonly re-used blocks of ELEMENTs within modules.

For example, the *Energy macro* is part of any module where the equipment or hardware has a limited purpose; an electron cone module would only list electron energies. If the *Energy macro* is not defined, it will be assumed that there is no energy constraint for the equipment defined by that module.

A *macro* is called from within a module as follows;

Include list of Energy macros

Within a module, the XML format will be as follows:

```

<energy>
  <all ELEMENTs from the Energy macro>
</energy>
<energy>
  <all ELEMENTs from the Energy macro>
</energy>

```

4.3 Description column

The description column includes not only a human-readable description of the information encoded in the ELEMENT, but also when appropriate:

- Enumerated terms (These are the only allowed text values for the ELEMENT.);
- Defined terms (A list of terms that shall be used for this ELEMENT, but that list can be extended.); and
- the units associated with the ELEMENT (e.g., MU/minute).

4.4 Type column

The values in Table 2 are used in the type column of the module and *macro* tables to indicate the type of data associated with the ELEMENT.

Table 2 – Values used in the type column

Tag	Description
Module	Value that identifies the start of a module.
List	Identifies the start of a list with one or more data entries of the same kind using the same bracketing xml name—for example “appliance”: <pre><appliance> details </appliance> <appliance> details </appliance></pre>
Text	Value that identifies a text field (unconstrained). Character set is defined in the XML header.
Integer	Integer value only accepted.
Decimal[N] ^{a)}	Decimal value where N is the number of decimal places that are specified and used for publication and modeling. Where the value of N might depend on a previous, integer element value declaration, the element value type will be listed as Decimal[x] where x is that locally declared value. A value of x from 1 to 3 is allowed and the XSD schema document will check that the value is 1,2, or 3 decimal places.
Date	Complete date plus hours, minutes and seconds in local time in the form: YYYY-MM-DDThh:mm:ssTZD, where times are expressed in UTC (Coordinate Universal Time (Z)) with an offset giving the hours and minutes either ahead (+) or behind (-) UTC. (e.g., 2019-12-23T19:20:30-05:00 is December 23, 2019 at 14:20:30 Eastern Standard Time). See 5.4.2.1 of ISO 8601-1:2019.
^{a)} To avoid number comparison discrepancy, all decimal numbers should publish the exact number of characters after the decimal point stated within the [] brackets.	

4.5 Use column

The values in Table 3 are used in the use column in the module and *macro* tables to indicate when and if an ELEMENT is required to be present.

Table 3 – Values used in the use column

Value	Description
R	Mandatory module that shall be included in any report.
	Mandatory list that shall be included for this module.
	Mandatory ELEMENT that shall be provided in this module or list. Within a list, ELEMENT values are only mandatory if the list exists.
C	Conditional ELEMENT. The condition under which the list or ELEMENT value shall be provided is given in the description column.
O	Optional (user choice). Module, list or ELEMENT that may or may not be reported.

4.6 Example table

Table 4 is an extracted example of a mandatory ELEMENT within an optional list.

In the example in Table 4, it is not mandatory to provide the UDI for the device(s) that are compatible, but if provided, then the UDI number is mandatory and the equipment description is optional.

Table 4 – Example table illustrating mandatory ELEMENTs within an optional list

ELEMENT	Description	Type	Use
compatibility_UDI	Declare list of device UDI's with which this device is compatible.	List	O
>UDI_number	UDI of device for which this device's use is intended.	Text	R
>UDI_equipment_description	Description of device which is represented by above UDI.	Text	O

4.7 Reserved terms and defined names

The reserved terms used in this document are listed in Table 5.

Table 5 – Reserved terms

Term	Use
FLATTENED	The beam has been modified such that the radiation beam is relatively flat across the useful part of the beam.
UNFLATTENED	The beam has NOT been proactively modified to make the radiation beam relatively flat across the useful part of the beam.
ELEMENT	An individual line entry that formats the data or contains data.
STATIC SEGMENT	A portion of the treatment between two control points when the radiation value is changing AND the machine's physical parameters are NOT changing.
DYNAMIC SEGMENT	A portion of the treatment between two control points when the radiation value AND the machine's physical parameters are changing within the same segment.
DELIVERY SECTOR	A portion of the treatment made up of several STATIC and/or DYNAMIC SEGMENTS which can be delivered continuously (that is, they do not need to be broken up due to treatment machine delivery rules).
MOVE-ONLY SEGMENT	A portion of the treatment between two control points where no radiation is delivered.

The defined angle names used in this document are listed in Table 6.

Table 6 – Angle names

Term	Use
SOURCE	Rotation of the therapeutic radiation source. (Gantry rotation for an IEC 61217 device.)
COLLIMATOR	Rotation of the main beam limiting device collimators.
TABLE_TOP	Rotation of the table top.
PATIENT_SUPPORT	Rotation of the spindle that supports the table top.
TABLE_TOP_ECCENTRIC	Rotation of the patient support system enabled by a second rotation point that is offset from the PATIENT_SUPPORT rotation point.

Term	Use
IN_PLANE	Rotation of a virtual or real 2D surface around an axis perpendicular to that 2D surface.
OUT_OF_PLANE	Rotation of a virtual or real 2D surface around any axis that is NOT the axis perpendicular to that surface.
OTHER_ANGLE	Special case angle not covered by above names.

NOTE The *Angle macro* will describe multiple angle possibilities for any of the names in Table 6; for example, the independent pitch, roll and yaw angle ranges of a robotic table.

The defined treatment technique names used in this document are listed in Table 7.

Table 7 – Treatment technique names

Term	Use
TM_MLC_BASIC_STATIC	Static MLC treatment technique.
TM_MLC_FIXED_APERTURE_ARC	Arc, fixed MLC RADIATION APERTURE treatment technique.
TM_MLC_VARIABLE_APERTURE_ARC	Arc, changing MLC RADIATION APERTURE treatment technique. Also known as 'dynamic conformal'.
TM_MLC_HARD_WEDGE	Static MLC beam with wedge treatment technique.
TM_MLC_DYNAMIC_WEDGE	Static MLC beam with dynamic wedge treatment technique.
TM_MLC_MOTORIZED_WEDGE	Static MLC beam with motorized wedge treatment technique.
TM_IMRT_STEP_SHOOT_MLC	Intensity Modulated treatment at a fixed gantry angle where the beam is off while the MLC changes position to modulate the treatment beam intensity.
TM_IMRT_SLIDING_WINDOW_MLC	Intensity Modulated treatment at a fixed gantry angle where the beam is on while the MLC changes position to modulate the treatment beam intensity.
TM_MLC_IMRT_COMPENSATOR	Intensity Modulated treatment at a fixed gantry angle where the treatment part of the beam is modulated by a physical compensator. The MLC is used to conform the beam but is not used to intensity modulate it.
TM_IMAT_VMAT_MLC	Intensity Modulated Arc Treatment or Volume Modulated Arc Treatment technique.
TM_PHOTON_APPLICATOR	Static, photon cone BEAM APPLICATOR treatment technique.
TM_ELECTRON_APPLICATOR	Static, electron cone BEAM APPLICATOR treatment technique.
TM_PHOTON_APPLICATOR_ARC	Arc, photon cone BEAM APPLICATOR treatment technique.
TM_ELECTRON_APPLICATOR_ARC	Arc, electron cone BEAM APPLICATOR treatment technique.
TM_MODULATED_ELECTRON	Intensity Modulated Electron Beam treatment not using the MLC for fluence modulation.
TM_MODULATED_ELECTRON_MLC	Intensity Modulated Electron Beam treatment using the MLC for fluence modulation.

Term	Use
TM_OTHER	Special case treatment technique not covered by above values.

5 Example XML template and matching XSD schema document

The text content for an empty XML template and XSD schema for all the module elements presented below are in Annex A and Annex B.

The XSD schema conforms to the [XML Schema Part 1: Structures \(Second Edition\)](#) and [XML Schema Part 2: Datatypes \(Second Edition\)](#).

Where appropriate, for easier human readability, the template elements are marked whether they are MANDATORY, MANDATORY if they occur within an optional sequence, or CONDITIONAL upon another element's name and value. They are marked to the right of the element as follows:

<!--MANDATORY-->

<!--MANDATORY if optional sequence is defined-->

<!--CONDITIONAL- required if.....-->

6 Composite picture of the XML file (module and macro use)

Table 8 is an overall view of a PUBLISHED or MODELED report. The *macros* used in each module are listed while unique data for that module are listed as "<module name> elements".

A report shall contain the REPORT module and at least one optional module.

Table 8 – Module and macro usage in a PUBLISHED or MODELED report

Module name	Use	Reference Link Section (click to follow)
<RT3report>		
REPORT Report elements	R	8.1
LINAC CONSOLE <i>Manufacturer macro</i> Linac console elements <i>Energy macros</i>	O	8.2
CALIBRATION <i>Manufacturer macro</i> Calibration elements	O	8.3
GANTRY <i>Manufacturer macro</i> Gantry elements <i>Angle macros</i>	O	8.4
RECTANGULAR BEAM LIMITING DEVICE <i>Manufacturer macro</i> Rectangular_BLD elements <i>Angle macros</i>	O	8.5

Module name	Use	Reference Link Section (click to follow)
TABLE TOP <i>Manufacturer macro</i> Table Top elements <i>Angle macros</i>	O	8.6
TABLE <i>Manufacturer macro</i> Table elements <i>Angle macros</i>	O	8.7
MLC <i>Manufacturer macro</i> MLC elements <i>Energy macros</i>	O	8.8
WEDGE <i>Manufacturer macro</i> Wedge elements <i>Energy macros</i>	O	8.9
BEAM APPLICATOR <i>Manufacturer macro</i> Beam Applicator elements <i>Energy macros</i>	O	8.10
RADIATION APERTURE <i>Manufacturer macro</i> Radiation Aperture elements <i>Energy macros</i>	O	8.11
TREATMENT TECHNIQUE Treatment Technique elements <i>Energy macros</i>	O	8.12
ON-BOARD IMAGER <i>Manufacturer macro</i> On-Board Imager elements	O	8.13
</RT3report>		

7 Macro definitions

7.1 *Manufacturer macro*

The ELEMENTs that make up the *Manufacturer macro* are listed in Table 9.

Table 9 – Manufacturer macro

ELEMENT	Description	Type	Use
manufacturer			
manufacturer_name	Name of company for this part of the report.	Text	R
equipment_name	Marketing name of device for this part of the report.	Text	R
equipment_version	Version of the equipment being reported.	Text	O
equipment_local_name	Clinic's name for device in this part of the report.	Text	O
equipment_description	Free text description of this equipment. e.g., C-Arm Linear Accelerator MLC Micro MLC Treatment Support Wedge	Text	O
equipment_UDI	Universal Device Identifier (UDI) at the appropriate level for the device being defined.	Text	O
device_serial_number	Device serial number at the appropriate level for the device being defined.	Text	O
coordinate_system	The coordinate system in which this module (piece of equipment) is being reported. e.g., IEC_61217_2011 Mandatory if the coordinate_system is not equal to IEC_61217_2011.	Text	C
compatibility_UDI	List of devices UDI's with which this device is compatible.	List	O
>UDI_number	UDI of device for which this device's use is intended.	Text	R
>UDI_equipment_description	Description of device which is represented by above UDI.	Text	O
software_name_version	Software versions used in the equipment being described. Mandatory if equipment contains software that is user identifiable.	List	C
>software_name	Software name. e.g., AcmeTPS	Text	R
>software_version	Software version. May include letters and numbers in the manufacturer's adopted format.	Text	R

7.2 Energy macro

The ELEMENTs that make up the *Energy macro* are listed in Table 10.

Table 10 – Energy macro

ELEMENT	Description	Type	Use
energy			
energy_code	Code which identifies this energy combination.	Text	O
energy_description	Description of this energy code or ID.	Text	O
radiation_type	Enumerated terms: PHOTON or ELECTRON.	Text	R
energy_unit	Energy unit. Enumerated terms: kV, MV or MeV.	Text	R
nominal_energy	Nominal energy value unit specified above.	Decimal[1]	R
fluence_mode	Type of fluence mode for this energy. Enumerated terms: FLATTENED or UNFLATTENED.	Text	R
fluence_mode_code	Code that defines FLATTENED or UNFLATTENED fluence mode.	Text	O
dose_rate_range	List of continuous, nominal dose rate ranges.	List	O
>min_dose_rate	Nominal minimum dose rate in this range in MU/minute. This is the minimal prescribable or usable dose rate for the energy.	Decimal[1]	R
>max_dose_rate	Nominal maximum dose rate in this range in MU/minute.	Decimal[1]	R
discrete_dose_rate	List of discrete nominal dose rates available for this equipment for this energy.	List	O
>dose_rate	Nominal dose rate value in MU/minute.	Decimal[1]	R
NOTE If a specific combination of energy, fluence mode and dose rate is commissioned for a specific purpose, it is recommended that this is defined as its own energy entry into the list of energies. This will differentiate it from the full range for the machine. An energy code can be used to differentiate the “energy” specification, e.g., High Dose Rate Electron (HDRE).			

7.3 Angle macro

The ELEMENTs that make up the *Angle macro* are listed in Table 11.

Table 11 – Angle macro

ELEMENT	Description	Type	Use
angle			
angle_name	Defined angle name from Table 6.	Text	R
axis_rotation	Enumerated terms: ROLL, PITCH or YAW.	Text	R

ELEMENT	Description	Type	Use
angle_display_resolution	Display resolution of angle. Number of decimal places displayed for this parameter.	Integer	R
angle_precision	Measurable repeatability of this angle in degrees. Where x is the integer value declared for this angle's_display_resolution.	Decimal[x+1]	R
eccentric_rotation_offset	Distance from isocenter to eccentric point of rotation in mm. See Figure 1.	Decimal[1]	R
angle_range	Define angle direction and limits during irradiation. List separate ranges for CW and CC if they are different.	List	R
>rotation_direction	Enumerated terms: CW or CC or BOTH.	Text	R
>continuous_rotation	Is this angle capable of continuous rotation? Enumerated terms: YES or NO	Text	R
>min_angle	Minimum angle value in degrees Where x is the integer value declared for this angle's_display_resolution. Mandatory if continuous_rotation is NO.	Decimal[x]	C
>max_angle	Maximum angle value in degrees Where x is the integer value declared for this angle's_display_resolution. Mandatory if continuous_rotation is NO.	Decimal[x]	C
min_rotation_speed	Minimum rotation speed during irradiation in degrees/second.	Decimal[2]	O
max_rotation_speed	Maximum rotation speed during irradiation in degrees/second.	Decimal[2]	O
rotation_speed_resolution	Number of decimal places used to display in degree/second.	Integer	O
max_angle_acceleration	Maximum rotation acceleration during irradiation in degrees/second ² .	Decimal[2]	O
min_mu_per_deg	Minimum allowed MU per degree of rotation (number ≥ 0).	Decimal[2]	O
max_mu_per_deg	Maximum allowed MU per degree of rotation (number ≥ 0).	Decimal[2]	O

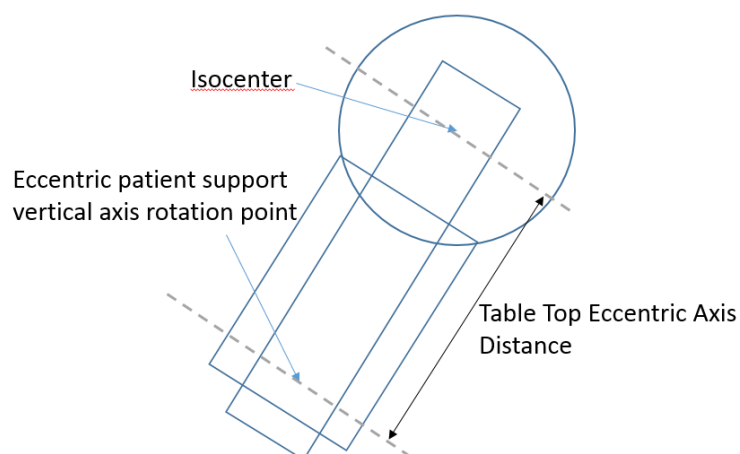


Figure 1 – Relation of eccentric axis of rotation to the isocenter

7.4 Beam Limiting Device (BLD) macro

The ELEMENTs that make up the *Beam Limiting Device macro* are listed in Table 12.

Table 12 – Beam Limiting Device macro

ELEMENT	Description	Type	Use
BLD_name	Enumerated terms: X1, X2, Y1, Y2, MLCX1, MLCX2, MLCY1, MLCY2.	Text	R
BLD_direction	Enumerated terms: X or Y.	Text	R
BLD_display_resolution	Display resolution of translation parameter Number of decimal places displayed for this parameter.	Integer	R
BLD_precision	Measurable repeatability of this translation parameter in mm. Where x is the integer value declared for BLD_display_resolution.	Decimal[x+1]	R
min_translation	Minimum available translation value in mm. Where x is the integer value declared for this distance's_display_resolution.	Decimal[x]	R
max_translation	Maximum available translation value in mm. For a fixed value, set to the same as min. Where x is the integer value declared for this distance's_display_resolution.	Decimal[x]	R

8 Module definitions

8.1 REPORT MODULE

The ELEMENTs that make up the REPORT section of the XML file are listed in Table 13.

Table 13 – REPORT MODULE ELEMENTS

ELEMENT	Description	Units/values	Use
RT3report		Module	R
report_UID	Globally unique identifier (UID). For referencing from outside this standard. e.g., from DICOM Mandatory if report_type value is MODELED.	Text	C
report_creation_date_time	Date and time of creation of this content.	Date	R
report_issuer	Name of the company or entity (for example, medical center) issuing the report.	Text	R
report_type	Enumerated terms: PUBLISHED or MODELED. PUBLISHED is issued by the manufacturer or entity modifying the design. Use the ref_document list to report the original product being modified. MODELED is generated by a system containing a software model.	Text	R
modeled_type	Enumerated terms: CLINICAL, NON_CLINICAL or UNKNOWN CLINICAL—Machine model is signed off and ready for clinical use as a reference model. NON_CLINICAL—Machine model is still in preparation and is not complete and signed off. UNKNOWN—The status of the Machine model is not known. Mandatory if report_type value is MODELED.	Text	C
room_code	Identifier where the main equipment is located ("PORTABLE" is a possible term for a device that is not limited to one location).	Text	O
reporting_software_manufacturer	Name of the company whose software is creating this report. Mandatory if report_type value is MODELED.	Text	C
reporting_software_name	Name of the software that is creating this report. Mandatory if report_type value is MODELED.	Text	C
reporting_software_version	Version number of the software that is creating this report. Mandatory if report_type value is MODELED.	Text	C
standard_version	Version of this RT3 standard being used.	Text	R

ELEMENT	Description	Units/values	Use
ref_document	List of internal document ID(s) from which this published data is drawn.	List	O
>document_ID	Document identifier.	Text	R
changes_made	Textual summary of changes made with this version.	Text	O
authors	Names of authors making the changes or updates in this version.	Text	O
report_note	Human readable comment with special notes or information about this report.	Text	O

8.2 LINAC CONSOLE MODULE

The ELEMENTs that make up the LINAC CONSOLE MODULE are listed in Table 14.

Table 14 – LINAC CONSOLE MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
linac_console		Module	O
<i>Include Manufacturer macro</i>			R
min_mu_per_beam	Minimum programmed MU required by the system at the beam level.	Decimal[2]	O
max_mu_per_beam	Maximum programmed MU required by the system at the beam level.	Decimal[2]	O
min_mu_per_delivery_sector	Minimum MU required between continuous radiation-on control points (a "DELIVERY SECTOR").	Decimal[3]	O
max_mu_per_delivery_sector	Max allowed MU between continuous radiation-on control points (a "DELIVERY SECTOR").	Decimal[3]	O
min_mu_per_cp_pair	Minimum MU required between two control points.	Decimal[3]	O
max_mu_per_cp_pair	Max allowed MU between two control points.	Decimal[3]	O
beam_mu_resolution	Decimal places allowed for total beam monitor units.	Integer	R
delivery_sector_mu_resolution	Decimal places allowed between continuous radiation-on control points (a "DELIVERY SECTOR").	Integer	O
cp_mu_resolution	Control Point resolution. Number of decimal places allowed between 2 control points.	Integer	O
special_check	List of special control console codes. For example: A code for port film electron mode. A code for high dose rate electron. Licenses that control modes or techniques.	List	O

ELEMENT	Description	Units/values	Use
>special_check_code	Manufacturer's defined code.	Text	R
>special_check_description	Description of special check code.	Text	O
<i>Include list of Energy macros</i>	List of energies for the Linac console.	List	R
linac_console_note	Module specific, human readable comment with special notes or information about this module's content.	Text	O

8.3 CALIBRATION MODULE

The ELEMENTs that make up the CALIBRATION MODULE are listed in Table 15.

This module describes the calibration conditions for an energy and includes identifiers of the energy, the calibration conditions that were used and the calibration value. Multiple instances of this module may be present.

A user can therefore be sure that the equipment monitor units (MU) in different models mean the same thing in terms of dose.

Table 15 – CALIBRATION MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
calibration		Module	O
<i>Include Manufacturer macro</i>			R
radiation_type	Enumerated terms: PHOTON or ELECTRON.	Text	R
nominal_energy	Nominal energy value in MV or MeV.	Integer	R
source_surface_distance	Distance from radiation source to material surface in mm.	Decimal[2]	R
calibration_medium	Name of calibration material. e.g., WATER, GEL, TEFLON	Text	R
depth_in_medium	Depth in medium to calibration point in mm.	Decimal[2]	R
water_equiv_depth	Equivalent depth in water in mm.	Decimal[2]	O
calib_field_size	Declare calibration field size. Shall have four entries of this element in list to fully define the dimension of the calibration field size.	List	R
<i>>Include list of Beam Limiting Device macros</i>			R
calibration_value	Enter calibration value for the above defined conditions in Gy/MU.	Decimal[4]	R
calibration_date_time	Date and time of calibration. Mandatory if report_type value is MODELED.	Date	C
calibration_key	DICOM calibration UID key that will be exported.	Text	O
calibration_detector	Detector used for calibration.	Text	O
calibration_protocol	Calibration protocol name.	Text	C

ELEMENT	Description	Units/values	Use
calibration_note	Module specific, human readable comment with special notes or information about this module's content.	Text	O

8.4 GANTRY MODULE

The ELEMENTs that make up the GANTRY MODULE are listed in Table 16.

Table 16 – GANTRY MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
gantry		Module	O
<i>Include Manufacturer macro</i>			R
source_axis_distance	Gantry source to axis distance in mm.	Decimal[1]	R
<i>Include list of Angle macros</i>			R
gantry_note	Module specific, human readable comment with special notes or information about this module's content.	Text	O

8.5 RECTANGULAR BEAM LIMITING DEVICE MODULE

The ELEMENTs that make up the RECTANGULAR BEAM LIMITING DEVICE MODULE are listed in Table 17.

Table 17 – RECTANGULAR BEAM LIMITING DEVICE MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
rectangular_BLD		Module	O
<i>Include Manufacturer macro</i>			R
beam_limiting_device	Define travel limits for each rectangular beam limiting device. Shall have four entries of this element in list to fully define the travel dimensions of the rectangular collimator.	List	R
<i>>Include list of Beam Limiting Device macros</i>			R
>source_BLD_proximal_distance	Physical distance on central axis from source to "top" of BLD (surface closest to radiation source) in mm.	Decimal[2]	O
>source_BLD_distal_distance	Physical distance on central axis from source to "base" of BLD (surface closest to patient) in mm.	Decimal[2]	O
>max_speed	Maximum speed of BLD translation during treatment in mm/second.	Decimal[2]	O
>min_mu_per_mm	Minimum MU per mm in MU/mm.	Decimal[2]	O
<i>Include list of Angle macros</i>			R
rectangular_BLD_note	Module specific, human readable comment with special notes or information about this modules content.	Text	O

8.6 TABLE TOP MODULE

The ELEMENTs that make up the TABLE TOP MODULE are listed in Table 18.

Table 18 – TABLE TOP MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
table_top		Module	O
<i>Include Manufacturer macro</i>			R
table_top_code	Label, code or ID for recognizing the table top.	Text	O
<i>Include list of Angle macros</i>			O
table_top_note	Module specific, human readable comment with special notes or information about this module's content.	Text	O

8.7 TABLE MODULE

The ELEMENTs that make up the TABLE MODULE are listed in Table 19.

Table 19 – TABLE MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
table		Module	O
<i>Include Manufacturer macro</i>			R
table_code	Code used to identify the table.	Text	O
table_translation	Declare all travel direction travel limits.	List	R
>trans_direction	Enumerated terms: VERTICAL, LONGITUDINAL or LATERAL.	Text	R
>min_translation	Minimum available translation value in mm.	Decimal[2]	R
>max_translation	Maximum available translation value in mm. For a fixed value, set to the same as min.	Decimal[2]	R
>table_display_resolution	Display resolution of translation parameter Number of decimal places displayed for this parameter.	Integer	O
>table_precision	Measurable repeatability of this translation parameter in mm. Where x is the integer value declared for table_display_resolution.	Decimal[x+1]	O
<i>Include list of Angle macros</i>	Use two entries to indicate any eccentric angle rotation parameters.		R
table_note	Module specific, human readable comment with special notes or information about this module's content.	Text	O

8.8 MLC MODULE

This module describes opposing paired leaves that are positionally controlled.

The ELEMENTs that make up the MLC MODULE are listed in Table 20. For multiple MLC tiers, declare the MLC tier closest to the radiation source first.

NOTE The shape of an MLC face (or leaf tip) is deliberately left out of this version of the document.

Table 20 – MLC MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
MLC		Module	O
<i>Include Manufacturer macro</i>			R
MLC_type	Enumerated terms: BUILT-IN or ADD-ON. Report the MLC closest to source first.	Text	R
MLC_code	Code that is recognized by a receiving system as defining this device.	Text	O
MLC_tier	List of stacked MLCs.	List	R
>tier_code	Code that identifies this tier of the MLC.	Text	O
>MLC_orientation	How the MLC is oriented in the system's coordinate system (X or Y).	Text	R
>source_MLC_proximal_distance	Physical distance to "top" of MLC leaf in mm. Physical distance on central axis from source to "top" of MLC leaf (surface closest to radiation source) in mm.	Decimal[2]	O
>source_MLC_distal_distance	Physical distance to "base" of MLC leaf in mm. Physical distance on central axis from source to "base" of MLC leaf (surface closest to patient) in mm.	Decimal[2]	O
>MLC_display_resolution	Number of integers after the decimal point for display of MLC leaf position.	Integer	R
>MLC_precision	Measurable repeatability of the MLC position in mm. Where x is the integer value declared for MLC_display_resolution.	Decimal[x+1]	R
>supports_interdigitation	Tips of the neighboring leaves on opposing MLC support frames can pass one another. Enumerated terms: YES or NO.	Text	R
>moveable_leaf_support_frame	Specifies whether the MLC leaves are mounted on a moveable support frame. Enumerated terms: YES or NO.	Text	R

ELEMENT	Description	Units/values	Use
>dynamic_leaf_support_frame	Can the MLC leaf support frame move during irradiation? Enumerated terms: YES or NO. Mandatory if moveable_leaf_support_frame value equals YES.	Text	C
>max_leaf_speed	Maximum MLC leaf speed in mm/second.	Decimal[2]	R
>leaf_speed_resolution	Number of integers after the decimal point for speed display in mm/second.	Integer	O
>guard_leaf_pairs	Number of guard MLC leaf pairs (typically 0, 1 or 2). Number of non-prescribed MLC leaf pairs outside the treatment field that will be automatically opened under the (non-MLC) field defining diaphragm to improve the penumbra edge.	Integer	R
>guard_leaf_trigger_distance	The trigger distance (in mm) to the perpendicular field defining diaphragm below which a leaf pair of this MLC is open and becomes a "guard pair". This distance is defined from the leading edge of the other field defining diaphragm and the closest physical edge of a leaf pair of this MLC.	Decimal[2]	R
>MLC_physical_parameters	Optional list of physical MLC parameters at the real leaf position and not reference distance.	List	O
>>leafset_number	MLC leaf set number. A number from 1 to N where number 1 is the leaf set at the most negative X or Y position in IEC 61217 coordinates; N is the most positively positioned MLC leaf set. See Figure 2.	Integer	R
>>MLC_physical_boundary_neg	Most negative position of MLC leaf edge (side) in mm.	Decimal[2]	R
>>MLC_physical_boundary_pos	Most positive position of MLC leaf edge (side) in mm.	Decimal[2]	R
>>physical_leaf_travel_limit		List	R
>>>leaf_code	Code to identify the MLC being specified. The code shall follow the geometry and naming scheme specified in IEC 61217 section 6.4.1.3 Multi-element edges. Values are X101 through X2NN and follow the diagram shown in Figure 2.	Text	R
>>>machine_leaf_code	Alternative Code recognized by the treatment machine to identify this MLC leaf.	Text	O
>>>min_physical_translation	Minimum available translation value in mm.	Decimal[2]	R

ELEMENT	Description	Units/values	Use
>>>max_physical_translation	Maximum available translation value in mm. For a fixed value, set to the same as min.	Decimal[2]	R
>>>physical_park_position	Physical “parked” leaf position of MLC leaf when not being used in treatment in mm.	Decimal[2]	O
>>min_physical_static_leaf_gap	Minimum physical distance between opposing MLC leaves if MLC leaf does not move during treatment in mm.	Decimal[2]	O
>>min_physical_dynamic_leaf_gap	Minimum distance between opposing MLC leaves if leaf moves during irradiation in mm.	Decimal[2]	O
>>max_physical_leaf_support_diff	Maximum physical distance an MLC leaf can be extended beyond another on the same MLC leaf support or MLC leaf support frame in mm.	Decimal[2]	O
>>max_physical_leaf_extension_from_leaf_support_frame	Maximum physical distance that an MLC leaf can extend beyond the MLC leaf support frame in mm. Mandatory if moveable_leaf_support_frame value is YES.	Decimal[2]	C
>>max_physical_leaf_retraction_from_leaf_support_frame	Maximum physical distance that an MLC leaf can be retracted from the MLC leaf support frame in mm. Mandatory if moveable_leaf_support_frame is YES.	Decimal[2]	C
>>min_physical_adjacent_leaf_gap	Minimum leaf gap that shall be maintained between adjacent leaves from opposing leaf support frames in mm.	Decimal[2]	O
>MLC_ref_dist_parameters	Declare individual leaf pair parameters at reference position (for example, isocenter).	List	R
>>leafset_number	MLC leaf set number. A number from 1 to N where number 1 is the leaf set at the most negative X or Y position in IEC 61217 coordinates; N is the most positively positioned MLC leaf set. See Figure 2.	Integer	R
>>MLC_boundary_neg	Most negative position of leaf edge (side) in mm.	Decimal[2]	R
>>MLC_boundary_pos	Most positive position of leaf edge (side) in mm.	Decimal[2]	R
>>leaf_travel_limit		List	R
>>>leaf_code	Code to identify the MLC being specified. The code shall follow the geometry and naming scheme specified in IEC 61217:2011, 6.4.1.3, <i>Multi-element edges</i> . Values are X101 through X20N and follow the diagram shown in Figure 2.	Text	R
>>>machine_leaf_code	Alternative Code recognized by the treatment machine to identify this MLC leaf.	Text	O

ELEMENT	Description	Units/values	Use
>>>min_translation	Minimum available translation value in mm.	Decimal[2]	R
>>>max_translation	Maximum available translation value in mm. For a fixed value, set to the same as min.	Decimal[2]	R
>>>park_position	"Parked" leaf position of leaf when not being used in treatment in mm.	Decimal[2]	O
>>min_static_leaf_gap	Minimum distance between opposing MLC leaves if leaf does not move during treatment in mm.	Decimal[2]	R
>>min_dynamic_leaf_gap	Minimum distance between opposing MLC leaves if leaf moves during irradiation in mm. NOTE If dynamic delivery is not supported, enter same value as static.	Decimal[2]	O
>>max_leaf_support_diff	Maximum distance an MLC leaf can be extended beyond another on the same MLC bank or MLC leaf support frame at reference distance in mm.	Decimal[2]	R
>>max_leaf_extension_from_leaf_support_frame	Maximum distance that a leaf can extend beyond the MLC leaf support frame at reference distance in mm. Mandatory if moveable_leaf_support_frame value is YES.	Decimal[2]	C
>>max_leaf_retraction_from_leaf_support_frame	Maximum distance that a leaf can be retracted from the MLC leaf support frame at reference distance in mm. Mandatory if moveable_leaf_support_frame value is YES.	Decimal[2]	C
>>min_adjacent_leaf_gap	Minimum leaf gap that shall be maintained between adjacent leaves from opposing leaf support frames in mm.	Decimal[2]	O
<i>Include Energy macros</i>			R
MLC_note	Module specific, human readable comment with special notes or information about this module's content.	Text	O

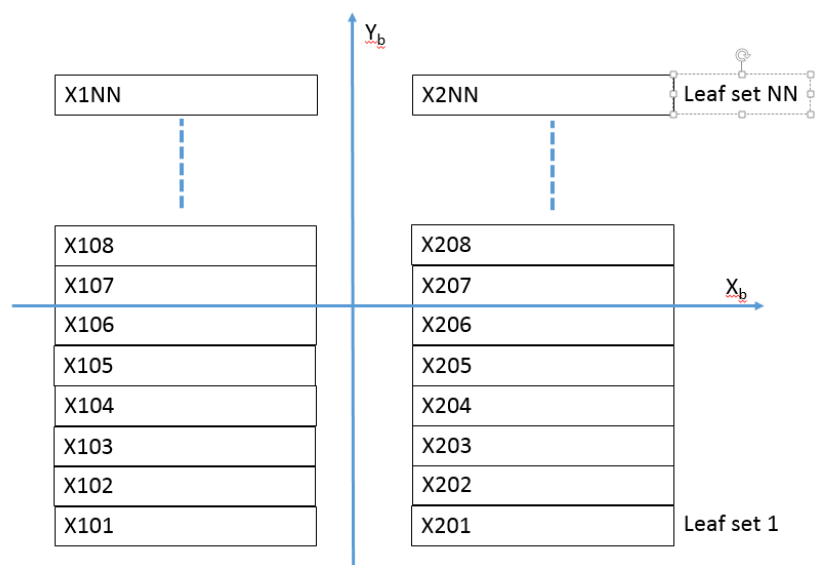


Figure 2 – MLC leaf set numbering and leaf codes

8.9 WEDGE MODULE

The ELEMENTs that make up the WEDGE MODULE are listed in Table 21.

Table 21 – WEDGE MODULE ELEMENTs

ELEMENT	Description	Units/values	Use
wedge		Module	O
<i>Include Manufacturer macro</i>			R
wedge_code	Code recognized for this wedge.	Text	O
wedge_type	One of the following values: Enumerated terms: FIXED, DYNAMIC or MOTORIZED.	Text	R
wedge_angle	Nominal wedge angle	Integer	R
wedge_defining_BLD	Enumerated terms: X, Y or NONE. Mandatory if virtual wedge uses a collimator to create a wedge effect.	Text	C
wedge_direction	List of available wedge directions.	List	R
>wedge_orientation	Define position of wedge per the IEC standard – 0, 90, 180, 270 degrees.	Integer	R
>wedge_orientation_code	Code that is recognized for this wedge orientation.	Text	O
> wedge_field_size_limits	Enter field size limits for wedge in this orientation. Shall have four entries of this element in list to fully define the dimension of the wedge field size limits.	List	R