VARIAN
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TrueBeam
Trajectory Log
File Specification

TrueBeam®
TrueBeam® STx
Edge® Radiosurgery System
VitalBeam®

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Document Title	TrueBeam Trajectory Log File Specification
Abstract	This document provides information about the file format of the trajectory logs created during treatment by the TrueBeam system. This document applies to TrueBeam® system version 2.7 and later, models TrueBeam system, TrueBeam® STx system, and Edge® radiosurgery system; and VitalBeam®.
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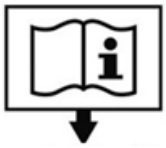	**Electronic labeling** This symbol on the label indicates that the Instructions for Use for the corresponding product are available at www.MyVarian.com. Access the Instructions for Use in electronic form by logging in with your assigned MyVarian user credentials. In compliance with EU Commission Directive No 207 / 2012, Varian will send EU customers a free printed copy of the Instructions for Use within 7 days. Use the "Paper Document Request" form provided on the Varian webpage to order your copy.

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Contents

Introduction

During treatment, the TrueBeam™ system records actual axis positions and MU delivered. After the treatment is completed, this information is stored to a trajectory log file.

This document describes the format of the TrueBeam trajectory log file so that the information can be retrieved and evaluated.

QA should be done beam by beam, because fluence is specified per beam.

Changes in the TrueBeam Trajectory Log File Specification from the Previous Release

Changes to the trajectory log file specification for TrueBeam 2.0 and releases prior to TrueBeam 2.7 MR2 are as follows:

- Added pitch and roll axes.
- Added optional tracking fields.
- Added 80-leaf MLC.
- Increased subbeam name size from 32 to 512 bytes.
- The trajectory log version is now 3.0.

Changes to the trajectory log file specification for TrueBeam 2.7 MR2 and later are as follows:

- Added MetaData structure in header reserved space.
- The trajectory log version is now 4.0.

2.7 MR2 Recorded Data in the .bin File

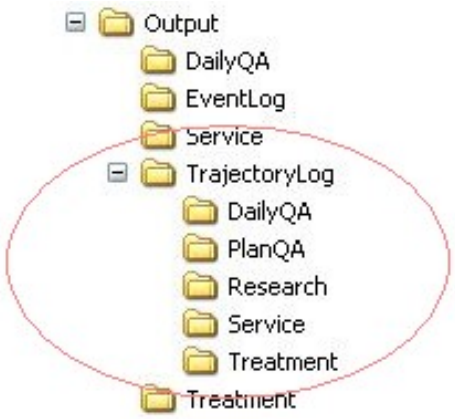
TrueBeam will capture the following “TrajectoryMetaData” after the treatment is completed. The patient name is not captured as it is part of the HIPPA information.

- Patient Id
- Plan Label (Dicom tag (300a,0002))
- Plan Instant UID
- Beam Name (Dicom tag (300a,00c2))
- Original MU
- Remaining MU
- Energy

Directory Structure for Trajectory Log Files

The directory structure is the same for TrueBeam 2.7 and later. The trajectory logs are stored at <OutputFolder> \TrajectoryLog.

Mode	Folder Location
Treatment Mode (R&V and File)	<OutputFolder> \TrajectoryLog\Treatment
Plan QA	<OutputFolder> \TrajectoryLog\PlanQA
Daily QA	<OutputFolder> \TrajectoryLog\DailyQA



Format

This section describes the trajectory log file format. The trajectory log file is divided into four sections:

- Header
- Subbeams
- Axis data
- CRC

The header has a fixed length of 1024 bytes. Not all of the 1024 bytes in the header are used. Unused bytes at the end of the header may be used for future expansion to the trajectory log file.

Integers and floats are stored in little endian (Intel) format. The system can record data from a 20-minute treatment.

For a 250 axis machine (200 leaves plus other motion axis) there are 500 values per sample, and each value is 4 bytes. Sampling at 50 Hz (every 20 ms) generates 10 KB of data per second, or 6 MB per minute. The trajectory log for a 20 minute treatment contains 120 MB of data.

Header

The following table describes the header format.

(T) Indicates values used in tracking developer mode; these are only present for tracking beams.

Data Description	Size	Type
Signature 'VOSTL'	16 bytes	Zero terminated Unicode string.
Version '4.0'	16 bytes	x.y formatted as a zero terminated Unicode string.
Header Size (fixed for now at 1024).	4 bytes	integer
Sampling Interval in milliseconds. The sampling interval must be an integral multiple of the system heartbeat of 20ms.	4 bytes	integer
Number of axes sampled. Indicates the length of the next field, Axis enumeration.	4 bytes	integer

Data Description	Size	Type
Axis enumeration (The MLC is enumerated as a single axis, if included, all leaves are included.) Coll Rtn – 0 Gantry Rtn – 1 Y1 – 2 Y2 – 3 X1 – 4 X2 – 5 Couch Vrt – 6 Couch Lng – 7 Couch Lat – 8 Couch Rtn – 9 Couch Pit – 10 Couch Rol - 11 MU – 40 Beam Hold – 41 Control Point - 42	Number of axes * 4 bytes	Integer array

Data Description	Size	Type
MLC – 50 TargetPosition – 60 (T) TrackingTarget – 61 (T) TrackingBase – 62 (T) TrackingPhase – 63 (T) TrackingConformityIndex – 64 (T)		
Samples per axis. This is one for most axes. For the MLC, it is the number of leaves and carriages.	Number of axes * 4 bytes	Integer array
Axis Scale. 1- Machine Scale 2- Modified IEC 61217	4 bytes	Integer enumerator
Number of subbeams.	4 bytes	Integer
Is Truncated? The system is configured to record 60000 snapshots (20 minutes with a 20ms sampling interval). If the plan exceeds 20 minutes, the system stops recording data to the trajectory log and sets this flag to true (1). Otherwise the flag is false (0).	4 bytes	Integer 1=truncated 0=not truncated

Data Description	Size	Type
Number of snapshots	4 bytes	Integer
MLC model 0 = NDS 80 2 = NDS 120 3 = NDS 120 HD	4 bytes	Integer enumerator
MetaData	745	MetaData structure
Reserved	1024 – (64 + Number of axis * 8)	N.A.
Subbeam 1	560 bytes	Subbeam structure
Subbeam 2	560 bytes	Subbeam structure
Subbeam n – 1	560 bytes	Subbeam structure

Data Description	Size	Type
Subbeam n	560 bytes	Subbeam structure
Axis data Snapshot 1	2 * 4 * number of samples	Float array
Axis data Snapshot 2	2 * 4 * number of samples	Float array
…	…	…
Axis data Snapshot N – 1	2 * 4 * number of samples	Float array
Axis data Snapshot N	2 * 4 * number of samples	Float array
CRC	2 bytes	Unsigned short standard 16-bit CCITT CRC with seed OxFFFF. The CRC is calculated on all the preceding contents

MetaData Structure

The MetaData structure includes the following field names: PatientID, PlanName, SOPInstanceUID, MUPlanned, MURemaining, Energy, and BeamName where the maximum allocated size for all field names is 78 bytes. The following table specifies the field names and their corresponding data types and sizes. Field names are excluded from the field data size.

Field Name	Field Data Max Size	Field Data Max Characters	Type/Format (Regular Expression)
PatientID	256 bytes	64	Unicode UTF8
PlanName	64 bytes	16	Unicode UTF8
SOPInstanceUID	64 bytes	64	DICOM_REQ_LO

Field Name	Field Data Max Size	Field Data Max Characters	Type/Format (Regular Expression)
MUPlanned	10 bytes	10	ASCII (^\d{1,5}([.]\d{1,4})?$)
MURemaining	10 bytes	10	ASCII (^\d{1,5}([.]\d{1,4})?$)
Energy	7 bytes	7	ASCII
BeamName	256 bytes	64	Unicode UTF8

Subbeam Structure

A subbeam is created when a series of treatment fields are made automatic. Each previously independent field is now handled as a subbeam.

Each subbeam is 560 bytes long and has the following structure:

Data Description	Size	Type
cp Control Point. Internally-defined marker that defines where the plan is currently executing.	4 bytes	integer
mu Dose delivered in units of MU.	4 bytes	float
radTime In units of seconds. Expected (calculated) irradiation time of the subbeam. When the actual irradiation time exceeds the expected radiation time, the system terminates the plan. If the expected irradiation time is zero, then the system does not terminate the plan due to actual irradiation time.	4 bytes	float
Seq Sequence number of the subbeam.	4 bytes	integer
Name Name of the subbeam.	512 bytes	Zero terminated Unicode string
Reserved	32 bytes	Zero terminated Unicode string

Axis Data Structure

The axis data is stored immediately after the subbeam data. The data is stored as a series of snapshots. Each snapshot is a sequence of arrays in the following order:

Values[Axis1], Values[Axis2], …, Values[AxisN].

Each array contains the number of values needed for that axis. SamplesPerAxis[AxisJ] values. Each value has two fields, expected and actual.

Values are stored in Varian scale.

Here is an example in which MU, Gantry Rotation and the 120-leaf standard definition MLC are sampled. Note that this example excludes the information for the other axes, concentrating on the MU, Gantry rotation, and the MLC.

MU	MU	Gantry	Gantry	MLC	MLC	MLC	MLC	MLC	…	MLC	MLC	…	MLC
E	**A**	**E**	**A**	Carr A **E**	Carr A **A**	Carr B **E**	Carr B **A**	Carr A Leaf 1 **E**		Carr A Leaf 60 **A**	Carr B Leaf 1 **E**		Carr B Leaf 60 **A**

E = expected

A = actual

Samples are stored in the scale specified in the header (which for collimation implies values at isocenter) in float precision format. The units are cm for linear axes, degrees for rotational axes, MU for dose.

The control point is a float. The fractional part of the control point indicates percentage of the segment that is complete at that sample. For example, a control point value of 1.5 indicates the treatment is halfway between control point 1 and control point 2. Successive control points may be identical during beam holds. Note that there is no concept of separate expected and actual values for the control point. The control point is duplicated in the expected and actual fields to maintain consistency.

Beam Pause

The beam may be paused as a result of a minor fault being raised during treatment. The user can also pause the beam by pressing the Beam Off button. In this case, the system does not keep any beam records during the beam pause. When the beam is resumed, the trajectory log starts recording again.

Consequently, there are no trajectory log records during such a pause.

The trajectory log does not directly display such a beam pause. The trajectory log shows an axis ramp down and subsequent axis ramp up around the point where the beam is paused.

Dose Servo States

If the beam is held, for example, as a result of gating, the system continues to keep beam records. The trajectory log indicates a dose servo hold asserted for the duration of the beam hold.

The dose servo disabled state is possible only when the Service application is running. The service technician can disable the dose servo through the Service application. The dose servo is always enabled when the Treatment application is running. When the dose servo is disabled, the MV beam can still be delivered, but the dose output is not adjusted to achieve planned beam delivery.

The dose servo field is an enumeration:

Dose Servo States		
State	**Value**	**Explanation**
NORMAL	0	MV beam is being delivered, and dose servo is enabled.
FREEZE	1	MV beam is being delivered, but dose servo is temporarily turned off, so the dose rate is kept constant. Only occurs during
HOLD	2	MV beam is not being delivered, because dose servo is holding the MV beam. Occurs during gating, field-to-field transitions, some control point transitions, or beam pause.
DISABLED	3	MV beam is being delivered, but the dose servo is disabled by the user through the Service application. The dose is always enabled while the treatment application is running.

Tracking

The fields used for tracking, TargetPosition, TrackingTarget, and TrackingBase are 3D vectors with x,y and z components. TrackingPhase is a phase in degree between [0 and 360]. Since the order and status concept does not apply here, the values are duplicated in the order and status fields.

The conformity index quantifies the difference area between the planned aperture, shifted by the TargetPosition, and the order respectively actual aperture, outlined by the MLC and the jaws. Its unit is cm2, and it lists first the overexposed, then the underexposed area.

Units	
linear axes, shift vectors	cm
rotational axes	degrees / 100
Dose	cMU
Beam hold	none, see table
TrackingPhase	[0;360]
Tracking Conformity Index	cm2

Data Organization	
Tracking shift vectors (TargetPosition, TrackingTarget, TrackingBase)	x y z (order = status)
Tracking Conformity index	Overexposed (order) Overexposed (status) Underexposed (order) Underexposed (status)

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