VARIAN
medical systems

TrueBeam™

Trajectory Log File Specification

For TrueBeam 1.5 and Higher

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Abstract This document provides information about the file format of the trajectory logs created during treatment by the TrueBeam system. Applies to TrueBeam 1.5 and later.

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WHO ICD-O codes and terms used by permission of WHO, from:

- International Classification of Diseases and for Oncology (ICD-O), 3rd edition, Geneva, World Health Organization, 2000.

ICD-10 codes and terms used by permission of WHO, from:

- International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10). Vols 1–3, Geneva, World Health Organization, 1992.

CAUTION **US Federal law restricts this device to sale by or on the order of a physician.**

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 this Version

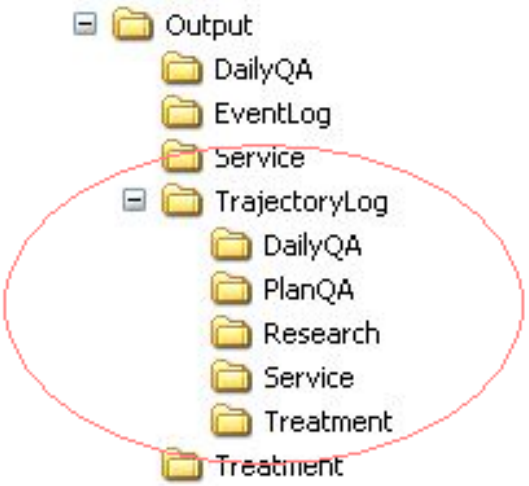
Changes to the trajectory log file specification for TrueBeam 1.5 are as follows:

- Sampling interval increased from 10ms to 20ms.
- Added 32-bit MLC model to the header.
- Added 32-bit number of samples to the header.
- Added 16-bit CRC at the end of the file.
- The trajectory log version is now 2.1.

Directory Structure for Trajectory log files in TrueBeam 1.5

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



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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 10-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.

Data Description	**Size**	**Type**
Signature ‘VOSTL’	16 bytes	Zero terminated Unicode string.
Version ‘2.1’	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, includes MU and gating if applicable. 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 MU – 40 Beam Hold – 41 Control Point - 42 MLC - 50	Number of axes * 4 bytes	Integer array
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
Number of snapshots	4 bytes	Integer
MLC model 2 = NDS 120 3 = NDS 120 HD	4 bytes	Integer enumerator
Reserved	1024 – (64 + Number of axis * 8)	N.A.
Subbeam 1	80 bytes	Subbeam structure

Data Description	Size	Type
Subbeam 2	80 bytes	Subbeam structure
	…	
Subbeam n – 1	80 bytes	Subbeam structure
Subbeam n	80 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 of the file.

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 80 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	4 bytes	float

Data Description	Size	Type
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.		
Seq Sequence number of the subbeam.	4 bytes	integer
Name Name of the subbeam.	32 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 **E**	MU **A**	Gantry **E**	Gantry **A**	MLC Carr A **E**	MLC Carr A **A**	MLC Carr B **E**	MLC Carr B **A**	MLC Carr A Leaf 1 **E**	…	MLC Carr A Leaf 60 **A**	MLC Carr B Leaf 1 **E**	…	MLC 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 iso-center) 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, say, 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.