

TrueBeam

Trajectory Log

File Specification

TrueBeam 2.5





P1012906-001-A

NOVEMBER 2016

Document ID P1012906-001-A

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 2.5.

Manufacturers Varian Medical Systems, Inc.

3100 Hansen Way

Palo Alto, CA 94304-1038 United States of America

European Authorized Representative

Varian Medical Systems UK Ltd.

Oncology House Gatwick Road, Crawley West Sussex RH10 9RG

United Kingdom

Notice Information in this release note is subject to change without notice and does not represent

a commitment on the part of Varian. Varian is not liable for errors contained in this release note or for incidental or consequential damages in connection with furnishing or use of this

material.

This document contains proprietary information protected by copyright. No part of this document may be reproduced, translated, or transmitted without the express written

permission of Varian Medical Systems, Inc.

FDA 21 CFR 820 Quality System Regulation

(cGMPs)

Varian Medical Systems, Oncology Systems products are designed and manufactured in

accordance with the requirements specified within this federal regulation.

ISO 13485 Varian Medical Systems, Oncology Systems products are designed and manufactured in

accordance with the requirements specified within the ISO 13485 quality standard.

CE Varian Medical Systems, Oncology Systems products meet the requirements of Council

Directive MDD 93/42/EEC.

EU REACH SVHC Disclosure The link to the current EU REACH SVHC disclosure statement is:

http://www.varian.com/us/corporate/legal/reach.html

HIPAA Varian's products and services are specifically designed to include features that help our

customers comply with the Health Insurance Portability and Accountability Act of 1996 (HIPAA). The software application uses a secure login process, requiring a user name and password that supports role-based access. Users are assigned to groups, each with certain access rights, which may include the ability to edit and add data or may limit access to data. When a user adds or modifies data within the database, a record is made that includes which data were changed, the user ID, and the date and time the changes were made. This establishes an audit trail that can be examined by authorized system

administrators.

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.



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.



 $\begin{tabular}{ll} \textbf{CAUTION} & \textbf{US Federal law restricts this device to sale by or on the order of a physician.} \end{tabular}$

Trademarks TrueBeam™ is a trademark of Varian Medical Systems, Inc. All other trademarks or

registered trademarks are the property of their respective owners.

Copyright © 2010-2016 Varian Medical Systems, Inc.

All rights reserved. Produced in the United States of America.

Contents

Introduction	.5
Changes in the TrueBeam Trajectory Log File Specification from the Previous Release	
Directory Structure for Trajectory Log Files	.5
Format	.6
Header	.6
Subbeam Structure	.9
Axis Data Structure	.9
Beam Pause1	0
Dose Servo States1	0
Tracking1	1
Contact Varian Customer Support1	2

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

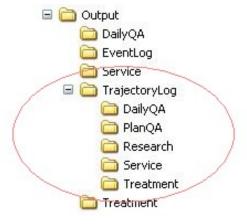
Changes to the trajectory log file specification for TrueBeam 2.0 and later are as follows:

- 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.

Directory Structure for Trajectory Log Files

The directory structure is the same for TrueBeam 2.5 and later. The trajectory logs are stored at <OutputFolder> \TrajectoryLog.

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



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	Туре
Signature 'VOSTL'	16 bytes	Zero terminated Unicode string.
Version '3.0'	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	Туре		
Axis enumeration (The MLC is enumerated as a single axis, if included, all leaves are included.)	Number of axes * 4	Integer array		
Coll Rtn – 0	bytes			
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				
MLC - 50				
TargetPosition – 60 ^(T)				
TrackingTarget – 61 (T)				
TrackingBase – 62 ^(T)				
TrackingPhase – 63 ^(T)				
TrackingConformityIndex – 64 (T)				
Samples per axis.	Number of	Integer array		
This is one for most axes. For the MLC, it is the	axes * 4			
number of leaves and carriages.	bytes			
Axis Scale.	4 bytes	Integer enumerator		
1- Machine Scale				
2- Modified IEC 61217				
Number of subbeams.	4 bytes	Integer		
Is Truncated?	4 bytes	Integer		
The system is configured to record 60000		1=truncated		
snapshots (20 minutes with a 20ms sampling		0=not		
interval). If the plan exceeds 20 minutes, the system		truncated		
stops recording data to the trajectory log and sets this flag to true (1). Otherwise the flag is false (0).				
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				

Data Description	Size	Туре
Number of snapshots	4 bytes	Integer
MLC model 0 = NDS 80 2 = NDS 120 3 = NDS 120 HD	4 bytes	Integer enumerator
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
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

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	Туре
ср	4 bytes	integer
Control Point. Internally-defined marker that defines where the plan is currently executing.		
mu	4 bytes	float
Dose delivered in units of MU.		
radTime	4 bytes	float
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.		
Seq	4 bytes	integer
Sequence number of the subbeam.		
Name	512 bytes	Zero terminated
Name of the subbeam.		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	J	MU	Gantry	Gantry	MLC	MLC	MLC	MLC	MLC	 MLC	MLC	 MLC
E		Α	E	A	Carr A	Carr A	Carr B	Carr B	Carr A Leaf 1	Carr A Leaf 60	Carr B Leaf 1	Carr B Leaf 60

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.			

Tracking

The fields used for tracking, TargetPosition, TrackingTarget, TrackingBase, are 3D vectors with x,y and z component. 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	сМU			
Beam hold	none, see table			
TrackingPhase	[0;360]			
Tracking Conformity Index	cm2			

Data Organization				
Tracking shift vectors	x			
(TargetPosition, TrackingTarget, TrackingBase)	у			
3 444,	z			
	(order = status)			
Tracking Conformity index	Overexposed (order)			
	Overexposed (status)			
	Underexposed (order)			
	Underexposed (status)			

Contact Varian Customer Support

Varian Customer Support is available on the internet, by e-mail, and by telephone. Support services are available without charge during the initial warranty period.

The MyVarian website provides contact information, product documentation, and other resources for all Varian products.

- 1. Go to www.MyVarian.com.
- 2. Choose an option:
 - If you have an account, enter your User login information (email and password).
 - If you do not have an account, click Create New Account and follow the instructions. Establishing an account may take up to two working days.
- 3. Click **Contact Us** at the top of the window to display customer support and training options, and international e-mail addresses and telephone numbers.
- 4. From the Contact Us page, choose an option:
 - Call Varian Medical Systems support using a phone support number for your geographic area.
 - Complete the form corresponding to your request for use on a call with a live Varian representative; then follow the instructions to complete the remote connect options, and click **Submit**.

You can order documents by phone, request product or applications support, and report product-related issues. Links on the MyVarian website navigate to other support resources for products, services, and education.

To find documents, click Product Documentation.
 Online documents in PDF format include customer technical bulletins (CTBs), manuals, and customer release notes (CRNs).