



specifications

TrueBeam™ STx System

TrueBeam STx Specifications

The TrueBeam™ STx system specifications in this document are identified as belonging to two categories, performance specifications and descriptive specifications. Performance specifications will be demonstrated at the time of product installation, *in accordance with the purchased product configuration* and Varian’s customer acceptance testing procedures. Descriptive specifications are representative of system performance but are not demonstrated at installation.

Beam Performance Specifications

1.0 X-ray Energy Configurations and Performance Specifications

X-ray Energy Configurations				
	Nominal Energy Description (MV) per BJR11/BJR17 ⁵			
Performance Specifications	6/6	8/8	10/10	15/16
D_{max} (cm) ¹	1.60 ± 0.15	2.00 ± 0.15	2.40 ± 0.15	2.90 ± 0.15
% Depth dose at 10 cm Depth ¹	67.0 ± 1.0	71.0 ± 1.0	74.0 ± 1.0	77.0 ± 1.0
Flatness (10 x 10 cm ² to 20 x 20 cm ²) ^{2,3}	±3.0%	±3.0%	±3.0%	±3.0%
Flatness (20 x 20 cm ² to 30 x 30 cm ²) ^{2,3}	±2.5%	±2.5%	±2.5%	±2.5%
Flatness (30 x 30 cm ² to 40 x 40 cm ²) ^{2,3}	±2.5%	±2.5%	±2.5%	±2.5%
Symmetry ^{2,4}	2.0%	2.0%	2.0%	2.0%
Minimum dose rate At (MU/min) ⁶	5	5	5	20
Maximum dose rate (MU/min) ⁶	600	600	600	600
Maximum Field Size	40 cm x 40 cm	40 cm x 40 cm	40 cm x 40 cm	40 cm x 40 cm

¹ Depth of ionization applies to a 10 x 10 cm² field size measured at 100 cm SSD.

² Flatness and symmetry are specified at 100 cm SSD at a depth of 10 cm.

³ Flatness is defined as the maximum variation from the mean dose delivered within the central 80% Full Width Half Maximum (FWHM) region.

⁴ Symmetry is defined as the maximum difference between the X-ray dose delivered to any two points which are equidistant and symmetrical about the central axis and within the central 80% FWHM region, measured at a depth of 10 cm.

⁵ Nominal energy designations per BJR 11/BJR 17 provided for informational purposes only. TrueBeam supports energy designations per BJR 11.

⁶ Dose output (MU) is defined as 1 cGy delivered to a tissue-equivalent material at D_{max} and 100 cm SSD, with a 10 x 10 cm² field size. Measurement of dose output under conditions different than those defined herein may result in a higher or lower dose output than specified. Dose rate is specified at D_{max} , as described in Note 1.

High-Intensity X-ray Energy Configurations

Performance Specifications	Energy Configuration Description ⁶	
	6X	10X
D _{max} (cm) ¹	1.50 ± 0.15	2.35 ± 0.15
% Depth dose at 10 cm Depth ¹	64.2 ± 1.0	72.0 ± 1.0
Flatness (10 x 10 cm ²) ^{2,3}	±13.0%	±20.0%
Flatness (40 x 40 cm ²) ^{2,3}	±40.0%	±44.0%
Symmetry ^{2,4}	2.0%	2.0%
Minimum dose rate (MU/min) ⁵	400	400
Maximum dose rate (MU/min) ⁵	1400	2400
Maximum Field Size	40 cm x 40 cm	40 cm x 40 cm

- ¹ Depth of ionization applies to a 10 x 10 cm² field size measured at 100 cm SSD.
- ² Flatness and symmetry are specified at 100 cm SSD using 10 x 10 cm² and 40 x 40 cm² field sizes.
- ³ Flatness is defined as the maximum variation from the mean dose delivered within the central 80% FWHM region.
- ⁴ Symmetry is defined as the maximum difference between the X-ray dose delivered to any two points which are equidistant and symmetrical about the central axis and within the central 80% FWHM region, measured at a depth of 10 cm.
- ⁵ Dose output (MU) is defined as 1 cGy delivered to tissue-equivalent material at D_{max} and 100 cm SSD, with a 10 x 10 cm² field size. Measurement of dose output under conditions different than those defined herein may result in a higher or

lower dose output than specified. Dose rate is specified at D_{max}, as described in Note 1.

- ⁶ Nominal field intensity distribution for High Intensity X-ray Energies can also be described as follows:

	6X	10X
Beam intensity 5 cm from central axis	91%	80%
Beam intensity 10 cm from central axis	77%	60%
Distance from central axis to 90% relative intensity	±5 cm	±3 cm
Distance from central axis to 80% relative intensity	±9 cm	±5 cm

2.0 Electron Energy Configurations and Performance Specifications

Energy Configurations (MeV)										
	6	6 HDTSE ⁶	9	9 HDTSE ⁶	12	15	16	18	20	22
Performance Specifications										
Depth of ionization ¹										
90% (cm, ±0.1)	1.71		2.68		3.77	4.68	4.87	5.31	5.55	5.65
80% (cm, ±0.07)	1.90		2.95		4.15	5.20	5.45	6.10	6.55	6.80
50% (cm, ±0.1)	2.30		3.50		4.89	6.17	6.49	7.41	8.13	8.64
30% (cm)	≤2.70		≤3.90		≤5.40	≤6.80	≤7.30	≤8.15	≤9.30	≤10.00
85%/2 (cm)	0.93		1.45		2.02	2.57	2.67	3.04	3.26	3.37
Radial and transverse flatness ² measured at 85%/2	±5.0%		±4.5%		±4.5%	±4.5%	±4.5%	±4.5%	±4.5%	±4.5%
Symmetry ⁴ measured at 85%/2 (plane normal to CAX)	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Maximum dose rate (MU/min) ⁶	1000	2500	1000	2500	1000	1000	1000	1000	1000	1000
Descriptive Specifications										
Diagonal flatness ^{2,3} measured at 85%/2	±5.0% ³		±5.0%		±5.0%	±5.0%	±5.0%	±5.0%	±5.0%	±5.0%
X-ray contamination ⁵	≤2%	≤2%	≤2%	≤2%	≤5%	≤5%	≤5%	≤5%	≤5%	≤5%

¹ Depth of ionization applies to the 15 x 15 cm² applicator, water phantom at 100 cm SSD, no inverse square correction.

² Flatness is defined as the maximum variation from the mean electron ionization delivered within the central 80% FWHM region, measured for 10 x 10 cm² through 25 x 25 cm² fields.

³ Diagonal flatness for 6 MeV energy configuration is ±6.0% for a 10 x 10 cm² field, ±5.0% for 15 x 15 cm² through 25 x 25 cm² fields.

⁴ Symmetry is defined as the maximum difference between the ionization delivered to any two points which are equidistant and symmetrical about the central axis and within the central 80% FWHM region measured at 100 cm SSD at a depth of 10 cm for 10 x 10 cm² through 25 x 25 cm² fields.

⁵ X-ray contamination is specified in water at a 100 cm SSD, a depth of 10 cm beyond the depth of the 10% isodose line, using a 15 x 15 cm² electron applicator.

⁶ Dose output (MU) is defined as 1 cGy delivered to a tissue-equivalent material at D_{max} and 100 cm SSD using a 15 x 15 cm² electron applicator for all energies with the exception of the HDTSE energies. Dose rate is specified at D_{max}, measured using 100 cm SSD, using a 15 x 15 cm² electron applicator for all electron energies with the exception of the HDTSE energies. HDTSE (High Dose Total skin Electron) energy specifications apply to a 36 x 36 cm² field size.

3.0 General X-ray and Electron Energy Performance Specifications

<i>The following performance specifications apply to all energy configurations, unless noted otherwise</i>	
Performance Specifications²	Specification
Dose output per monitor unit vs. dose rate ¹	±1% or ±1 MU
Dose output per monitor unit vs. total dose ^{1,3,4}	1% or 0.5 MU at a fixed gantry angle
Dose output per monitor unit repeatability ¹	±1% or ±1 MU
Dose rate linearity ¹	±1% or ±1 MU/min
Dose output per monitor unit vs. gantry angle	±1.5% or ±1.5 MU
Descriptive Specifications	
X-ray beam symmetry deviation vs. gantry and collimator angles	±1.5%

¹ Measured with gantry at 0 per IEC 61217.

² Whichever is greater.

³ Total Dose linearity for X-ray energy configurations is specified based on a minimum total dose of 5 MU.

⁴ Total Dose linearity for High Intensity X-ray energy configurations is specified based on a minimum total dose of 50 MU.

Mechanical Performance Specifications

Supported scale conventions: IEC 601 and IEC 61217

4.0 Isocenter Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Gantry and collimator isocenter accuracy	≤ 0.5 mm radius
Gantry, collimator, and couch isocenter accuracy	≤ 0.75 mm radius
Descriptive Specifications	
Target to Gantry Axis Distance	100 ± 0.2 cm
Isocenter Height	129.5 cm + 0.5 cm/-0 cm

5.0 Gantry Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Rotational accuracy	≤ 0.3 degrees
Rotation range	±185° from the vertical
Descriptive Specifications	
Rotation speed	Variable from 0 to 1 RPM

6.0 Collimator Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Rotational accuracy	≤ 0.5 degrees
Rotational reproducibility	≤ 0.3 degrees
Rotation range	±175°
Optical range finder	70 – 156 cm range, 0.5 cm resolution, accurate to ±0.1 cm at 100 cm
Mechanical front pointer	70 – 110 cm range, 0.2 cm resolution, accurate to ±0.1 cm, at 100 cm
Coincidence of light field and radiation field (50% isodensity line) ¹	1.5 mm
Cross hair intersection alignment to collimator	±0.5 mm
Descriptive Specifications	
Rotational speed, no accessories	Variable from 0 to 2.5 RPM
Rotational Speed, with accessories	Variable from 0 to 1 RPM
Independent Upper and Lower Jaws	
Performance Specifications	
Positional accuracy	±1 mm for static fields
Descriptive Specifications	
Travel range – lower jaws	-2 cm to +20 cm
Travel range – upper jaws	-10 cm to +20 cm
Jaw speed	Variable from 0 cm/sec to a maximum speed of 2.5 cm/sec

¹ Measured at 100 cm SSD with minimum buildup for any field size.

7.0 HD120™ Multileaf Collimator (MLC) Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
MLC leaf end position accuracy at all leaf positions relative to the collimator axis ¹	±1 mm
MLC leaf end position reproducibility at all leaf positions relative to the collimator axis ¹	±0.5 mm
Descriptive Specifications	
MLC leaf side position accuracy at all leaf positions relative to the collimator axis ¹	±1 mm
MLC leaf side position reproducibility at all leaf positions relative to the collimator axis ¹	±0.5 mm
Number of leaves	120
Central high resolution leaf width (central 8 cm, leaf width projected at isocenter)	2.5 mm
Outboard leaf width (outer 14 cm, leaf width projected at isocenter)	5 mm

Maximum static field size	22 cm x 40 cm
Maximum static aperture field size	22 cm x 30 cm
Maximum IMRT field size	22 cm x 32 cm
Maximum leaf retract position	20.1 cm from centerline
Maximum leaf extend position	-20.1 cm over beam centerline
Maximum displacement between adjacent leaf ends at a single carriage position	15 cm
Average leaf transmission ²	< 2.0%
Maximum interleaf leakage ²	< 3.0%
Maximum carriage speed	Variable from 0 to 1.2 cm/sec
Maximum leaf speed	Variable from 0 to 2.5 cm/sec
Relative leaf accuracy, leaf end to leaf end	0.25 mm
Minimum static leaf gap (end to end)	0.0 mm
Minimum dynamic leaf gap (end to end)	0.25 mm

¹ Projected at the isoplane.

² Leakage specified as percentage of total dose per field or dose segment, measured with jaws fully retracted. Significant reduction in interleaf transmission is provided with static jaw shielding outside the treatment aperture or dynamic jaw tracking of aperture.

8.0 Treatment Couch Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Rotational accuracy for fine patient positioning, 0° to ±6°	≤ 0.3°
Rotational accuracy for large rotations, greater than ±6°	≤ 0.4°
Spatial translational accuracy for fine patient positioning (±5 cm about mechanical isocenter) ^{1,2}	≤ 0.5 mm
Translational patient positioning accuracy over entire couch travel range	≤ 2 mm
Travel Range	
Lateral (cm from centerline)	±24.5 cm
Vertical	Couch top placement from 63 cm to 170 cm above the turntable
Longitudinal	Position of the front edge of the couch top, relative to isocenter, ranges from -51.5 cm retracted to +93.5 cm extended beyond isocenter
Rotational about isocenter	±95°
Couch weight limit with IGRT couch top	227 kG (500 lbs)

¹ Performance specified for a patient weight of 30-135 kg, within a vertical travel range extending from couch top positioned at isocenter to -20 cm below isocenter.

² For patients over the entire weight range (up 228 kg) the spatial translational accuracy performance specification for small patient shifts (±5 cm) is 0.7 mm and for large patient shifts (±20 cm) is 1.2 mm.

9.0 MV Imager Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Imager alignment to mechanical isocenter	≤ 0.5 mm
Imager travel range	
Vertical (along the beam axis)	80 cm
Lateral	31 cm
Longitudinal (140 cm SID)	31 cm
Treatment energy imaging performance specifications	
Minimal settable exposure	0.1 MU (6 MV)
Dose rates for portal image acquisition (140 cm SID)	50 – 1000 MU/min
Dose rates for portal dosimetry (100 cm SID)	50 – 800 MU/min
Contrast resolution (6 MV, 0.8 MU/frame, 10 frames averaged)	0.20%
Maximum image acquisition rate, limited by image protocol selected	20 fps
Small object detection (lead, tungsten, or tantalum wire)	0.5 mm
Detector Descriptive Specifications	
Receptor type	Amorphous silicon
Active imaging area	30.1 x 40.1 cm ²
Pixel matrix	1024 x 768 or 512 x 384
A/D conversion	14 bit
Typical radiographic image exposure	1.5 MU
Maximum exposure (dosimetry mode)	Any supported irradiation protocol
Lifetime	> 4 year under normal use
MTF (f50) measured with slit (typical)	0.43 cycles/min
Linearity	
30 MU	3%
50 MU	2%
100 MU	1%
Lag	1st frame (@7.5 fps)
	4%

10.0 kV Imager Specifications

All scale references below are per IEC 61217

Performance Specifications		Specification
Imager alignment to mechanical isocenter		≤ 0.5 mm
Imager travel range		
	Vertical (along the beam axis)	80 cm
	Lateral	31 cm
	Longitudinal (140 cm SID)	31 cm
Minimal exposure		4 μRad
Maximum image acquisition rate (1024 x 768), limited by image protocol selected		15 fps
Detector Descriptive Specifications		
Receptor type		Amorphous silicon
Active imaging area		39.7 x 29.8 cm ²
Pixel matrix		2048 x 1536 or 1024 x 768
A/D conversion		14 bit
Effective A/D conversion in dynamic gain mode		> 16 bit
Maximum Exposure		4000 μRad at gain = 1
MTF 1 lp/mm		> 45%
DQE(0) (using RQA5 kV beam quality)		> 60%, quantum limited
Lag, 1st frame (@7.5 fps, 1 x 1 binning)		< 5%
Typical radiographic image exposure		
	@75 kVp; @100 cm	75 μGy/mAs
	@100 kVp; @100 cm	131 μGy/mAs
	@125 kVp; @100 cm	196 μGy/mAs
Source Descriptive Specifications		
Tube travel range Vertical (along kV beam axis)		20 cm
Generator type		200 kHz, 50 kW
Heat Storage Capacity		1.5 MHU
kV range		40 – 140 kV
kV accuracy		
	Entire kV Range	±5%
	70 – 85 kV	±2%
mA Range		10 – 630 mA
mA Accuracy		±5%
mAs Range		0.1 – 1000 mAs
mAs accuracy		±10%
Exposure time		1 – 6300 ms
Exposure time accuracy		
	5 ms – 6300 ms	2%
	1 ms, 4 ms	10%
Auto tube calibration		Yes
Anatomical programs		Yes
Dose area product readout		Yes

11.0 kV CBCT Specifications

All scale references below are per IEC 61217

Image Acquisition Descriptive Specifications	Standard Dose Head	Pelvis	Pelvis Spot light	Low-dose Thorax
X-ray voltage (kVp)	100	125	125	125
X-ray current (mA)	20	80	80	20
X-ray millisecond (ms)	20	13	25	20
Gantry rotation range (degrees)	200	360	200	360
Number of projections	360	660	360	660
Exposure (mAs)	145	680	720	262
CTDI _w , norm (mGy/100 mAs)	1.94	1.32	2.1	1.32
CTDI _w (mGy)	2.8	9.0	15.12	3.48
Fan type	Full fan	Half fan	Full fan	Half fan
Default pixel matrix	512 x 512	512 x 512	512 x 512	512 x 512
Slice thickness (mm)	2.0	2.0	2.0	2.0
Ring suppression algorithm	Medium	Medium	Medium	Medium

CBCT Image Acquisition and Reconstruction	
Performance Specifications	Specification
HU accuracy	±50 HU
HU uniformity	±20 HU
Spatial resolution – full-fan (512 x 512 reconstruction matrix)	7 lp/cm
Spatial resolution – half-fan (512 x 512 reconstruction matrix)	5 lp/cm
Spatial resolution – half-fan (1024 x 1024 reconstruction matrix)	9 lp/cm
Spatial resolution – limiting	12 lp/cm
Reconstruction field of view	Head Scans: 0 – 250 mm Body scans: 0 – 460 mm
Reconstruction length	Head Scans: 17.0 cm Body scans: 15.5 cm
Reconstruction matrices	128 x 128, 256 x 256, 384 x 384, 512 x 512
Slice thickness	1 mm, 1.5 mm, 2 mm, 2.5 mm, 3 mm, 3.5 mm, 4 mm, 4.5 mm, 5.0 mm, 10 mm
CBCT workload	12 Head scans/hr 12 Pelvis scans/hr

12.0 Optical Imager Specifications

All scale references below are per IEC 61217

Descriptive Specifications	Specification
Autocalibration	Yes
Image acquisition rate	30 fps
Marker type	Passive
Stereocamera dimensions	613 x 104 x 86 mm
Tracking view when placed at 2.0 – 2.5 m from isocenter	0.5 m ³

Specifications subject to change without notice.

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