TrueBeam™ STx System

Specifications

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TrueBeam STx System 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

Table 1: X-ray Energy Configurations and Performance Specifications

X-ray Energy Configurations	Nominal Energy Description (MV) per BJR11/BJR17						
Performance Specifications	**4/4[6]**	**6/6**	**8/8**	**10/10**	**15/16**	**18/23**	**20/25**
D_{max} (cm)[1]	1.20 ± 0.20	1.60 ± 0.15	2.00 ± 0.15	2.40 ± 0.15	2.90 ± 0.15	3.30 ± 0.15	3.50 ± 0.15
% Depth dose at 10 cm Depth[1]	63.0 ± 1.0	67.2 ± 1.0	71.0 ± 1.0	74.1 ± 1.0	77.4 ± 1.0	80.2 ± 1.0	82.0 ± 1.0
Flatness							
(10 x 10 cm^2 to 20 x 20 cm^2)[2,3]	±3.0%	±3.0%	±3.0%	±3.0%	±3.0%	±3.0%	±3.0%
(20 x 20 cm^2 to 30 x 30 cm^2)[2,3]	±2.5%	±2.5%	±2.5%	±2.5%	±2.5%	±2.5%	±2.5%
(30 x 30 cm^2 to 40 x 40 cm^2)[2,3]	±2.5%	±2.5%	±2.5%	±2.5%	±2.5%	±2.5%	±3.0%
Symmetry[2,4]	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Minimum dose rate (MU/min)[5]	5	5	5	5	20	20	20
Maximum dose rate (MU/min)[5]	250	600	600	600	600	600	600
Arc dose rate range (MU/deg)[5,9]	0.1-60	0.1-60	0.1-60	0.1-60	0.1-60	0.1-60	0.1-60
Maximum field size at isoplane	40 cm x 40 cm	40 cm x 40 cm	40 cm x 40 cm	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 cm^2 field size measured at 100 cm SSD.

[2] Flatness and symmetry are measured at 100 cm SSD, at a depth of 10 cm, within the 80% Full Width at Half Maximum region along the inplane and crossplane central axes, using 10 x 10 cm^2, 20 x 20 cm^2, 30 x 30 cm^2, and 40 x 40 cm^2 field sizes.

[3] Flatness is defined as the maximum variation from the X-ray dose delivered within the central 80% FWHM region, normalized to the dose output at beam centerline.

[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.

[5] 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 cm^2 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] The 4 MV energy configuration supports the following dose rates (MU/min): 5, 10, 15, 20, 30, 40, 50, 100, 150, 200, 250.

[7] The 6-10 MV energy configurations support the following dose rates (MU/min): 5, 10, 15, 20, 40, 60, 80, 100, 200, 300, 400, 500, 600.

[8] The 15-20 MV (per BJR 11) energy configurations support the following dose rates (MU/min): 20, 40, 60, 80, 100, 200, 300, 400, 500, 600.

[9] Dose rates specified herein are in effect maximum dose rate settings. TrueBeam automatically varies actual dose rate to synchronize with axis motion for optimal treatment delivery efficiency.

Table 2: High-Intensity Energy Configurations and Performance Specifications

High-Intensity (HI) X-ray Energy Configurations								
Performance Specifications	**Energy Configuration Description[6]**							
	6HI				**10 HI**			
D_{max} (cm)[1]	1.50 ± 0.15				2.34 ± 0.15			
% Depth dose at 10 cm Depth[1]	64.3 ± 1.0				71.8 ± 1.0			
Field intensity at 10 cm depth[6,8]	Measurement point from central axis				Measurement point from central axis			
	± 2 cm	± 4 cm	± 6 cm	± 18 cm	± 2 cm	± 4 cm	± 6 cm	± 18 cm
% dose (10 cm x 10 cm)[2,3]	97.5 ± 2.0	90.5 ± 2.0	-	-	95.5 ± 2.0	85.5 ± 2.0	-	-
% dose (40 cm x 40 cm)[2,3]	-	-	90.0 ± 2.0	59.5 ± 2.0	-	-	80.0 ± 2.0	45.0 ± 2.0
Symmetry[4]	2.0%				2.0%			
Minimum dose rate (MU/min)[5,7,9]	400				400			
Maximum dose rate (MU/min)[5,7,9]	1400				2400			
Arc dose rate range (MU/deg)[5,11]	0.1-60				0.1-60			
Maximum field size at isoplane	40 cm x 40 cm				40 cm x 40 cm			

[1] Depth of ionization applies to a 10 x 10 cm^2 field size measured at 100 cm source to surface distance (SSD).

[2] Relative dose and symmetry are specified at 100 cm SSD, using a 10 cm x 10 cm and 40 cm x 40 cm field sizes.

[3] Nominal field intensity distributions for high intensity X-ray energies are measured as shown in figures 1 and 2, on the right.

[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 cm x 10 cm field size. Measurement of dose output under conditions different than those defined herein may result in a higher or lower dose output than specified.

[6] Field intensity is relative to the central axis dose normalized to 100%.

[7] Maximum and minimum dose rates are specified at D_{max} and central axis. Dose rate will fall off lateral to the central axis in accordance with the lateral fall off of the field intensity.

[8] The %dose for a 30 cm x 30 cm field size is:
- For 6X at 4 cm (94.5 ± 2.0)%; at 14 cm (66.0 ± 2.0)%
- For 10X at 4 cm (88.5 ± 2.0)%; at 14 cm (53.0 ± 2.0)%

[9] The 6X High Intensity energy configuration supports the following dose rates (MU/min): 400, 600, 800, 1000, 1200, 1400.

[10] The 10X High Intensity energy configuration supports the following dose rates (MU/min): 400, 800, 1200, 1600, 2000, 2400.

[11] Dose rates specified herein are in effect maximum dose rate settings. TrueBeam STx automatically varies actual dose rate to synchronize with axis motion for optimal treatment delivery efficiency.

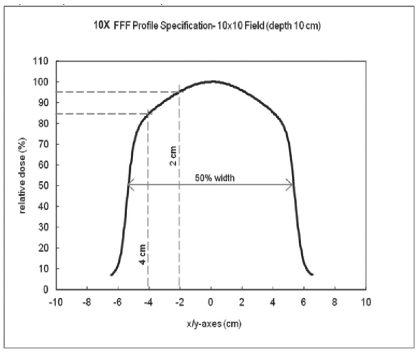

Figure 1: 10X High Intensity energy configuration field intensity profile for a 10 cm x 10 cm field size, measured at a depth of 10 cm.

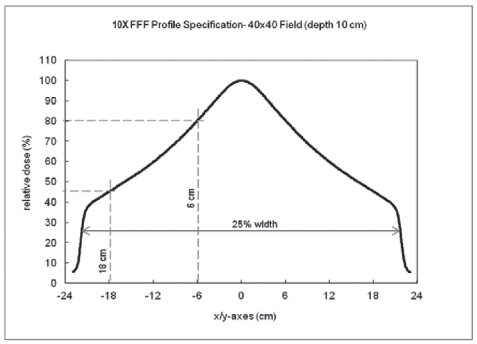

Figure 2: 10X High Intensity energy configuration field intensity profile for a 40 cm x 40 cm field size, measured at a depth of 10 cm.

Table 3: Low X-ray Imaging Energy Configuration Specification

Low X-ray imaging energy configuration is utilized for MV image acquisition only and not available for treatment delivery

Low X-ray Imaging Energy Configuration				
Descriptive Specifications				
D_{max} (cm)[1]	0.8 ± 0.2			
% Depth dose at 10 cm depth[1,2]	52.0 ± 2.0			
Field intensity at 5 cm depth	Measurement point from central axis		Field intensity[5]	
% dose (40 cm x 40 cm)[2,3]	± 6 cm	± 18 cm	96.5% ± 2.0%	74.0% ± 2.0%
Symmetry[4]	3.0%			
Maximum dose rate (MU/min)[4,6]	60			
Maximum field size at isoplane	40 cm x 40 cm			

[1] Depth of ionization applies to a 10 x 10 cm^2 field size measured at 100 cm source to surface distance (SSD).

[2] Relative dose and symmetry are specified at 100 cm SSD, using a 10 cm x 10 cm and 40 cm x 40 cm field sizes.

[3] 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 5 cm.

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

[5] Field intensity is relative to the central axis dose normalized to 100%.

[6] Maximum and minimum dose rates are specified at D_{max} and central axis. Dose rate will fall off lateral to the central axis in accordance with the lateral fall off of the field intensity.

Table 4: 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	4.67	4.87	5.29	5.58	5.66
80% (cm, ±0.07)	1.90		2.95		4.15	5.20	5.45	6.09	6.57	6.83
50% (cm, ±0.1)	2.32		3.52		4.91	6.19	6.52	7.41	8.10	8.59
30% (cm)	≤2.70		≤3.90		≤5.40	≤6.80	≤7.30	≤8.15	≤9.30	≤10.00
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%	≤2%	≤5%	≤5%	≤5%	≤5%	≤5%

[1] Depth of ionization applies to the 15 x 15 cm^2 applicator field size, using a water phantom at 100 cm SSD, a 5 cm gap between the bottom of the open field aperture and the water surface.

[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 cm^2 through 25 x 25 cm^2 fields. See Note 4.

[3] Diagonal flatness for 6 MeV energy configuration is ±6.0% for a 10 x 10 cm^2 field, ±5.0% for 15 x 15 cm^2 through 25 x 25 cm^2 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 a depth of 85%/2 for 10 x 10 cm^2 through 25 x 25 cm^2 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 cm^2 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 cm^2 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 cm^2 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 cm^2 field size.

Table 5: General X-ray and Electron Energy Performance Specifications[5]

The following performance specifications apply to all energy configurations, except Low X-ray Imaging

Performance Specifications[2]	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	**Specification**
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.

[5] For additional IEC performance specifications, please refer to 100042130 TrueBeam, TrueBeam STx, and Edge IEC Type Tests, 100042132. TrueBeam, TrueBeam STx, and Edge IEC Site Tests and Procedures, 100043560, TrueBeam, TrueBeam STx, and Edge IEC 60976, Medical Accelerators – Fundamental Performance Characteristics.

Mechanical Performance Specifications
Supported scale conventions: IEC 601 and IEC 61217

Table 6: Isocenter Specifications[1]

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	**Specification**
Target to gantry axis distance	100 ± 0.2 cm
Isocenter height (relative to the floor)	129.5 cm + 0.5 cm/-0 cm

[1] Isocenter specifications for all X-ray energies.

Table 7: 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	**Specification**
Rotation speed	Variable from 0 to 1 RPM

Table 8: 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°
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	**Specification**
Rotational speed, no accessories	Variable from 0 to 2.5 RPM
Rotational speed, with accessories	Variable from 0 to 1 RPM
Optical range finder	70 - 156 cm range, 0.5 cm resolution, accurate to ±0.1 cm at 100 cm
Mechanical front pointer	75 - 110 cm range, 0.2 cm resolution, accurate to ±0.1 cm, at 100 cm
Independent Upper and Lower Jaws	
Performance Specifications	**Specification**
Upper jaw positional accuracy	±2 mm for static fields
Lower jaw positional accuracy	±1 mm for static fields
Descriptive Specifications	**Specification**
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.

Table 9: 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	**Specification**
Leaf side accuracy relative to the collimator axis, projected at isoplane (gantry at 0)[8]	≤ 0.2 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

Descriptive Specifications	Specification
Maximum static field size[3]	40 cm x 22 cm
Maximum static aperture field size[3]	30 cm x 22 cm
Maximum IMRT field size[3]	34 cm x 22 cm
Maximum leaf retract position	20.1 cm from centerline
Maximum leaf extend position	-20.0 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]	< 2.5%
Maximum combined collimator leakage (jaws and MLC closed), all energies[6]	< 0.02%
Mean leakage-area product per Gy delivered[7]	< 0.15 mGy-m^2
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 (leaf end to leaf end)	0.0 mm
Minimum dynamic leaf gap (leaf end to leaf end)	0.5 mm
Leaf end penumbra at D_{max}[4,5]	≤ 3.5 mm
Leaf interdigitation	Yes
Independent leaf and carriage motion	Yes

[1] Projected at the isoplane, with backup jaw coverage.

[2] Leakage specified as percentage of total dose per field or dose segment, measured with jaws fully retracted, using 4 MV through 10 MV energy configurations and 6X and 10X High Intensity energy configurations. Significant reduction in interleaf transmission is provided with static jaw shielding outside the treatment aperture or dynamic jaw tracking of aperture.

[3] Maximum physical field size, projected at the isoplane.

[4] Penumbra defined as 20-80% leaf end, measured using 10 cm x 10 cm field size, 6 MV at D_{max}, 100 cm SAD.

[5] For additional IEC performance specifications for the MLC, please refer to 100042130 TrueBeam, TrueBeam STx, and Edge IEC Type Tests, 100042132. TrueBeam, TrueBeam STx, and Edge IEC Site Tests and Procedures, 100043560, TrueBeam, TrueBeam STx, and Edge IEC 60976, Medical
Accelerators – Fundamental Performance Characteristics.

[6] Maximum combined collimator leakage includes MLC and jaws and is measured for all energies. Mean leakage is 0.01%.

[7] Mean leakage-area product represents integral leakage dose over the combined aperture area defined by the MLC and jaws. Leakage area product is calculated based on using 1 Gy dose output, a 5 cm radial MLC aperture and a jaw aperture of 10.4 cm x 11.6 cm.

[8] Represents alignment of MLC to collimator Y-axis, based on center leaf edge position under static conditions, gantry at 0°.

Table 10: 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)[1-6]	≤ 0.5 mm
Couch weight limit with IGRT couch top[6]	227 kG (500 lbs)
Couch weight limit with Calypso® system kVue couchtop, using Calypso compatible insert, universal tip or insert for Pivotal™ treatment solution for prone breast care [4,6]	200 kG (440 lbs)
Descriptive Specifications	**Specification**
Travel range (nominal)	
Lateral (cm from centerline)	≥ ±24.5 cm
Vertical (+1/-0 cm)	106 cm
Longitudinal	≥ 145 cm
Rotational (yaw) about isocenter	±95°

[1] Performance for the specified couch top, with 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 weight below 30 kg or over 200 kg (KVue couch) or 227 kg (IGRT couch top) the spatial translational accuracy performance specification for small patient shifts (±5 cm) is 0.7 mm and for large patient shifts (±20 cm) is 1.9 mm.

[3] Addition of immobilization devices on to the couch tops specified above defines a new couch system configuration. Quality assurance testing of each new couch system configuration should be performed under patient weight conditions as performance may be affected by mechanical tolerances and patient weight distribution changes introduced by the immobilization device.

[4] Substitution of kVue couch inserts other than the inserts specified above defines a new couch system configuration. Quality assurance testing of each new couch system configuration should be performed under patient weight conditions as performance may be affected by the size, weight, and longitudinal extension of the couch insert.

[5] Addition of immobilization devices to the front edge of the couch tops specified above defines a new couch system configuration that has a weight distribution shifted forward on the couch top and not in accordance with the specifications above. Quality assurance testing of each new extended couch top system configuration should be performed under representative forward patient weight distribution conditions as performance may be affected by mechanical tolerances and weight distribution shifts introduced by the immobilization device.

[6] Measured using weight distributed according to IEC 60601-2-46:2011: Particular requirements for the basic safety and essential performance of operating tables..

Table 11: PerfectPitch™ 6 Degrees of Freedom (6DoF) Couch Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Rotational (yaw) accuracy for fine patient positioning, 0° to ±6°	≤ 0.3°
Rotational (yaw) accuracy for large rotations, greater than ±6°	≤ 0.4°
Accuracy for fine patient positioning (±5 cm about mechanical isocenter with 6DoF)[1-6]	≤ 0.5 mm
Couch weight limit with IGRT couch top	200 kG (440 lbs)[6]
Couch weight limit with Calypso kVue couchtop, using Calypso compatible insert, universal tip or Pivotal prone breast insert [4,6]	150 kG (330 lbs)[6]
Descriptive Specifications	**Specification**
Travel range (nominal)	
Lateral (cm from centerline)	≥ ±24.5 cm
Vertical (+1/-0 cm)	94 cm
Longitudinal	≥ 145 cm
Pitch and roll about isocenter	±3°
Rotational about isocenter (yaw)	±95°

[1] Performance for the specified couch top, with 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 weight below 30 kg or over 200 kg (KVue couch) or 227 kg (IGRT couch top) the spatial translational accuracy performance specification for small patient shifts (±5 cm) is 0.7 mm and for large patient shifts (±20 cm) is 1.9 mm.

[3] Addition of immobilization devices on to the couch tops specified above defines a new couch system configuration. Quality assurance testing of each new couch system configuration should be performed under patient weight conditions as performance may be affected by mechanical tolerances and patient weight distribution changes introduced by the immobilization device.

[4] Substitution of kVue couch inserts other than the inserts specified above defines a new couch system configuration. Quality assurance testing of each new couch system configuration should be performed under patient weight conditions as performance may be affected by the size, weight, and longitudinal extension of the couch insert.

[5] Addition of immobilization devices to the front edge of the couch tops specified above defines a new couch system configuration that has a weight distribution shifted forward on the couch top and not in accordance with the specifications above. Quality assurance testing of each new extended couch top system configuration should be performed under representative forward patient weight distribution conditions as performance may be affected by mechanical tolerances and weight distribution shifts introduced by the immobilization device.

[6] Measured using weight distributed according to IEC 60601-2-46:2011: Particular requirements for the basic safety and essential performance of operating tables.

Table 12: MV Imager Specifications

All scale references below are per IEC 61217

Performance Specifications	Specification
Imager alignment to MV radiation isocenter (imager at 150 cm SID)	≤ 0.5 mm
Imager travel range (applications may further limit travel ranges)	
Vertical (along the beam axis)	-80.0 cm to +0.0 cm
Lateral	-16.0 cm to +15.5 cm
Longitudinal (at 150 cm SID)	-13.5 cm to +30.5 cm
Treatment Energy Imaging Performance Specifications	**Specification**
Minimal settable exposure	0.1 MU (Low X imaging, 6 MV)
Dose rates for portal image acquisition (150 cm SID, full resolution)	50 – 2400 MU/min[1]
Dose rates for portal dosimetry (100 cm SID, full resolution)	50 – 2400 MU/min[2]
Contrast resolution (full resolution, 6 MV, 1.5 MU/frame, 2 frames, hole diameter 15 mm)	0.15%
Maximum image acquisition rate, limited by image protocol selected	20 fps
Small object detection (lead, tungsten, or tantalum wire)	0.5 mm
MV Imaging Descriptive Specifications	**Specification**
MV imager deployment (x,y,z = 0, 0, 50 for image receptor target)	
Retracted to mid position	21 s
Mid to deployed position	19 s
Receptor model	aS1200
Active imaging area	43.0 x 43.0 cm^2
Pixel matrix	1280 x 1280 640 x 640
A/D conversion	16 bit
Imager lifetime	> 4 year under normal use
MTF (f50) measured with slit (typical)	0.35 cycles/mm (6MV typical) 0.55 cycles/mm (Low X, typical)
Portal dosimetry linearity (6 MV, full resolution, 5MU – 100 MU range)	0.5%
Lag 1st frame (@7.5 fps)	1.5%
MV beam energy range (per BJR11)	2-20 MV
Portal imaging using High Intensity energies	Yes
Typical radiographic image exposure	1.5 MU[3]
Maximum exposure (dosimetry mode)	Any permissible irradiation

[1] Saturation at 12 MU/frame; equivalent to 7200 MU/min.

[2] Saturation at 5.3 MU/frame; equivalent to 3200 MU/min.

[3] 1.0 MU when using Low X imaging.

Table 13: kV Imager Specifications

All scale references below are per IEC 61217

kV Imager Performance Specifications	Specification
kV imager alignment to MV radiation isocenter (imager at 150 cm SID)	≤ 0.5 mm
kV imager travel range (applications may further limit travel ranges)	
Vertical (along the beam axis)	-80.0 to +0.0 cm
Lateral	-18.5 cm to +15.5 cm
Longitudinal (150 cm SID)	-22.0 cm to +24.0 cm
kV Imager Descriptive Specifications	**Specification**
Receptor Model	4030CB
Active imaging area	39.7 x 29.8 cm^2
Pixel matrix	2048 x 1536 1024 x 768
A/D conversion	
Single gain	14 bit
Dynamic gain	>16 bit (effective)
Operating modes	
Single Gain (fluoroscopy mode)	1024 x 768, 15 fps
Single Gain (full resolution image mode)	2048 x 1536 Readout time: 66 ms
Dynamic Gain mode	1024 x 768, 15 fps Readout time: 66 ms
Maximum exposure	4000 µRad at gain = 1
MTF @ 1 lp/mm	> 45%
DQE(0) (using RQA5 kV beam quality)	> 60%
Non-uniformity	< 1%
Grid	10:1 with >70% transmission (as measured per IEC 60627)
Dynamic range	
Fluoroscopy mode	1,500:1
Single full resolution image mode	3,000:1
Dynamic gain mode	18,000:1
Lag, 1st frame (@7.5 fps, 1 x 1 binning)	< 5%

kV Imager Source/X-ray Tube Descriptive Specifications	Specification
X-ray Tube Model	Varian GS 1542
Target angle	14°
Target diameter	133 mm
Heat capacity	
Anode	1,500,000 HU (1110 kJ)
Housing	2,000,000 HU (1480 kJ)
Anode cooling	
Maximum Anode heat dissipation	3950 HU/s (2800 W)
Usable Anode heat dissipation	2960 HU/s (2100 W)
Source spot	
Small (nominal 0.4 mm)	0.4 mm - 0.6 mm x 0.6 mm - 0.85 mm
Large (nominal 1.0 mm)	1.0 mm - 1.4 mm x 1.4 mm - 2.0 mm
Focal spot superposition	
X-axis; Y-axis	0.1 mm
Z-axis	0.15 mm
X-ray Collimation Descriptive Specifications	**Specification**
Field size at isocenter (X-ray tube at 100 cm)	
Minimum	2.0 cm x 2.0 cm
Maximum	50 cm x 50 cm
Asymmetric blade motions at isocenter (X-ray source at 100 cm), minimal size recommended	
X1	+3.5 cm to -25 cm
X2	-3.5 cm to +25 cm
Y1	+3.5 cm to -25 cm
Y2	-3.5 cm to +25 cm
Blade motions at isocenter (with no gantry motion, X-ray source at 100 cm)	
Accuracy	± 2 mm
Reproducibility	± 0.5 mm
Automated bow-tie deployment	
No bow-tie to full fan bow-tie	<10 s (8 s typical)
No bow-tie to half fan bow-tie	<20 s (13 s typical)
Half fan bow-tie to full fan bow-tie	<10 s (8 s typical)
Full fan bow-tie to half fan bow-tie	<10 s (8 s typical)
Automated Ti filter deployment	
None to Pos1	<10 s (8 s typical)
None to Pos2	<20 s (13 s typical)
Pos1 to Pos2	<10 s (8 s typical)
Pos2 to Pos1	<10 s (8 s typical)
Field opening follows the imager	Yes, configurable On/Off

X-ray Generator Descriptive Specifications	Specification
Generator type	200 kHz, 50 kW
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
kV Imaging Mechanical Specifications	**Specification**
Deployment of kV imaging arms [x,y,z = 0, 0, 50 for image receptor target]	
Retracted to mid position	28 s
Mid to deployed position	19 s
kV Dosimetric Descriptive Specifications	**Specification**
Radiographic exposures	
@75kVp; @100cm	75 µGy/mAs
@100kVp; @100cm	131 µGy/mAs
@125kVp; @100cm	196 µGy/mAs
kV Imaging Storage Descriptive Specifications	**Specification**
Maximum length of fluoroscopy sequence that can be saved to the information system (excludes sequences with excessive noise)	5 minutes
Maximum number of triggered images—in one sequence—that can be saved to the information system	100

Table 14 : kV CBCT Specifications

All scale references below are per IEC 61217 – Deployed CBCT modes

	Head	Pelvis	Spotlight	Thorax	Image Gently	Pelvis Obese	4D Thorax	4D Spotlight
Voltage [kVp]	100	125	125	125	80	140	125	125
Tube current [mA]	15	60	60	15	20	75	40	40
Pulse duration [ms]	20	20	25	20	10	25	20	20
Frame rate [fps]	15	15	15	15	15	15	7	7
Scan arc [deg]	200	360	200	360	200	360	360	200
Gantry rotation speed [deg/s]	6	6	6	6	6	6	3	3
Scan duration [s]	33	60	33	60	33	60	120	67
Number of projections	500	900	500	900	500	900	840	467
Exposure (mAs)	150	1080	750	270	100	1688	672	373
CTDIw, norm [mGy / 100 mAs]	1.95	1.32	1.34	1.32	0.84	1.64	1.32	1.34
CTDIw (mGy)	2.93	14.3	10.1	3.56	0.84	27.7	8.87	5.00
Fan type	Full fan	Half fan	Full fan	Half fan	Full fan	Half fan	Half fan	Full fan
Default pixel matrix	512 x 512	512 x 512	512 x 512	512 x 512	512 x 512	512 x 512	512 x 512	512 x 512
Slice thickness [mm]	2	2	2	2	2	2	2	2
Ring suppression algorithm	Medium	Medium	Medium	Medium	Medium	Medium	Disabled	Disabled

CBCT Image Acquisition and Reconstruction	
Descriptive Specifications	**Specification**
HU accuracy* (Measured using CTP404 sensitometry insert of the Catphan 504. Applies to full fan and half-fan modes.)	±50 HU
HU uniformity§ (Measured in CTP486 uniformity insert of the Catphan 504. Applies to full-fan and half-fan modes.)	±40 HU (±30 HU typical)
Spatial resolution – full-fan (Measured using CTP528 high resolution insert of the Catphan 504. Reconstructed with 0.5 mm pixel size and slice thickness of 2 mm.)	≥6 lp/cm (7 lp/cm typical)
Spatial resolution – half-fan (Measured using CTP528 high resolution insert of the Catphan 504. Reconstructed with 0.9 mm pixel size and slice thickness of 2 mm.)	≥4 lp/cm (5 lp/cm typical)
Spatial resolution – limiting (Measured using CTP528 high resolution insert of the Catphan 504. Reconstructed with 0.2 mm pixel size and slice thickness of 2 mm.)	≥12 lp/cm (14 - 15 lp/cm typical)
Low contrast detectability (Measured using CTP515 low contrast insert of the Catphan 504. Dose of 13.94 mGy CTDIw – Pelvis mode – with 1.0 mm pixel size and 2 mm slice thickness.)	1.0%; 15, 9 mm diameter objects visible

Performance Specifications	Specification
Reconstruction field of view	Head Scans: 0 - 25.0 cm Body scans : 0 - 46.0 cm
Reconstruction length	Head Scans: 17.0 cm Body scans : 15.5 cm
Available reconstruction matrices	128x128, 256x256, 384x384, 512x512
Slice Thickness (mm)	1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 10
Acquisition and reconstruction times (From instant when start button is pressed until the reconstructed result is displayed in the imaging application.)	200 degree scan: 50 s 360 degree scan: 75 s
CBCT workload (thermal considerations only)	> 50 Pelvis scans/hr

* Valid only if HU calibration has been performed.
§ Valid only if HU and blade calibrations have been performed.

Table 16: Optical System Specifications

All scale references below are per IEC 61217

Optical System Descriptive Specifications	Specification
Autocalibration	Yes
Acquisition rate	30 fps
Reflector type	Passive – 4 spheres
Angular range of reflectors	± 60 degrees
Beam hold rise/fall time (nominal)	15 msec
Tracking volume when placed at 2.0 - 2.5 m from isocenter	0.5 m^3

Specifications subject to change without notice.

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Specifications subject to change without notice. Not all features and options listed in this document are available in all markets.

Intended Use Summary

Varian Medical Systems' linear accelerators are intended to provide stereotactic radiosurgery and precision radiotherapy for lesions, tumors, and conditions anywhere in the body where radiation treatment is indicated.

Important Safety Information

Radiation treatments may cause side effects that can vary depending on the part of the body being treated. The most frequent ones are typically temporary and may include, but are not limited to, irritation to the respiratory, digestive, urinary or reproductive systems, fatigue, nausea, skin irritation, and hair loss. In some patients, they can be severe. Treatment sessions may vary in complexity and time. Radiation treatment is not appropriate for all cancers.

Medical Advice Disclaimer

Varian as a medical device manufacturer cannot and does not recommend specific treatment approaches. Individual treatment results may vary.

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