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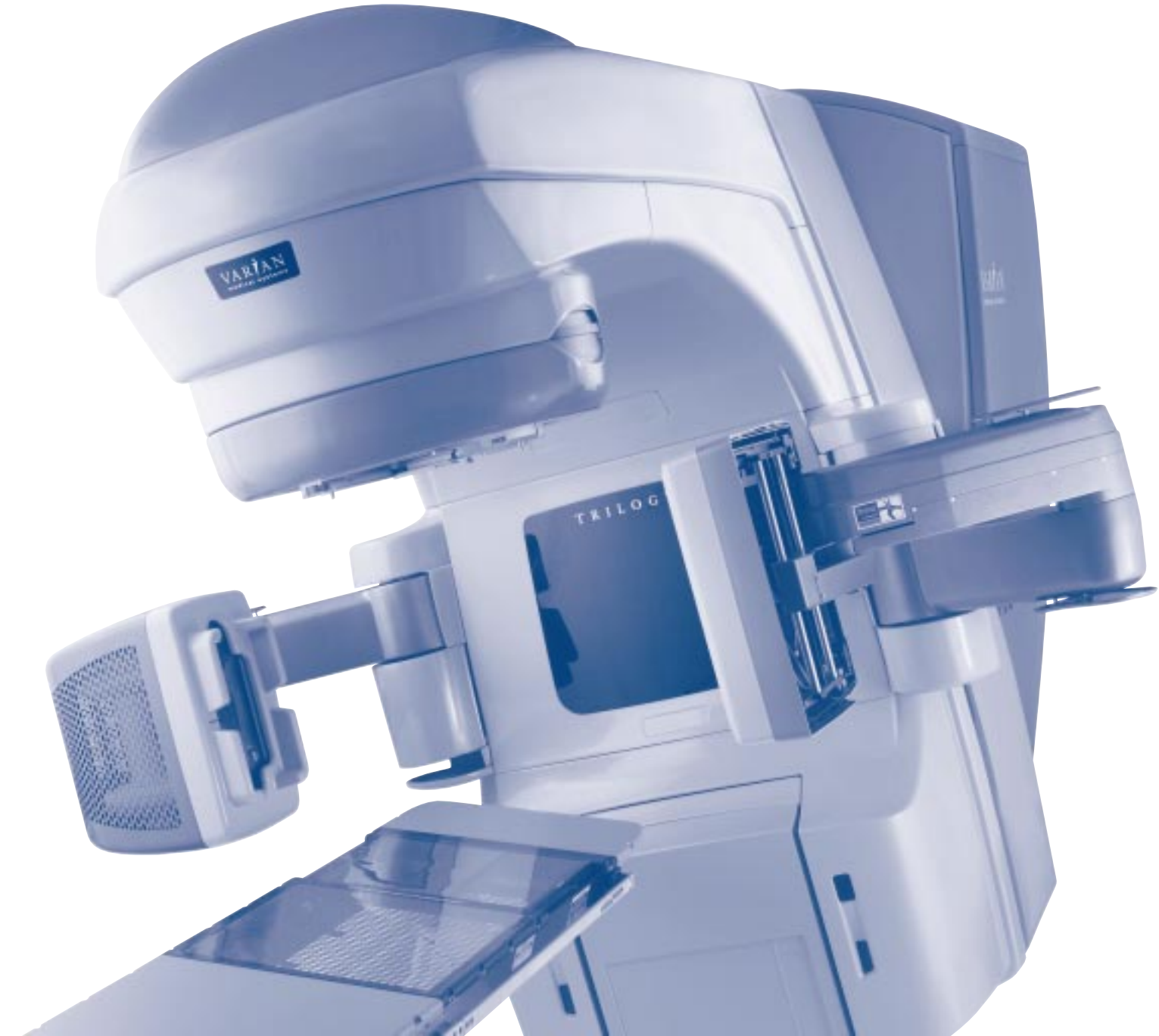
specifications

Trilogy configuration of the Clinac iX linear accelerator All in one. Best in One.



Specifications

Introduction

This specification sheet provides information for the Trilogy™ configuration of the Clinac® iX linear accelerator, referred to, hereafter, as the Trilogy configuration.

The Trilogy configuration is a component of the Trilogy Stereotactic System.

1.0 Photon Beams

1.1 Energy: Three photon beams may be selected in accordance with the specifications and combinations listed in Table 1.

Table 1: X-ray Beam Performance

X-ray Beam Energy Combinations (MV)

SRS Beam	Beam I	Beam II (BJR 17/BJR 11)
6	6	10/10
6	6	16/15
6	6	23/18
6	6	25/20

Nominal Energy (MV) BJR 17	Nominal Energy (MV) BJR 11	D_{max} (cm)[1]	%Depth Dose at 10 cm Depth[1]	Flatness[2]	Symmetry[3]
SRS6 [4]	SRS6 [4]	1.60 ± 0.15	67.0 ± 1.0	±3.0%	2.0%
6	6	1.60 ± 0.15	67.0 ± 1.0	±2.5%	2.0%
10	10	2.40 ± 0.15	74.0 ± 1.0	±2.5%	2.0%
16	15	2.90 ± 0.15	77.0 ± 1.0	±2.5%	2.0%
23	18	3.30 ± 0.15	80.0 ± 1.0	±2.5%	2.0%
25	20	3.50 ± 0.15	81.5 ± 1.0	±2.5%	2.0%

[1] Depth of ionization applies to 10 x 10 cm² field size measured at 100 cm Target-Skin Distance (TSD).

[2] Flatness is defined as the maximum variation from the mean dose delivered within the central 80% Full Width Half Maximum (FWHM) region measured at 100 cm TSD at a depth of 10 cm. The mean is the average of the maximum and minimum points within the central 80% FWHM region. The specification of ±2.5% applies to both the radial and transverse axes of all square field sizes from 20 x 20 cm² to 40 x 40 cm², inclusive. A specification of ±3.0% applies to all square field sizes between 10 x 10 cm² and 20 x 20 cm², and to 20 MV for all square field sizes larger than 30 x 30 cm². For the SRS 6MV beam, a specification of ±3.0% applies to all square field sizes between 10 x 10 cm² and 15 x 15 cm².

[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 100 cm TSD at a depth of 10 cm. This specification applies to the radial and transverse axes of all square field sizes from 10 x 10 cm² to 40 x 40 cm². For the SRS 6 MV beam, this specification applies to the radial and transverse axes of all square field sizes from 10 x 10 cm² to 15 x 15 cm².

[4] Beam matching between 6 MV Beam I and the SRS 6 MV beam is provided and defined as follows:

[4.1] The depth of D_{max} along the central axis in a water phantom at 100 cm TSD is within ±1.5 mm of the average of the two beams. The relative dose at 10 cm depth on the central axis in a water phantom at 100 cm TSD is within ±0.5% of the average of the two beams.

[4.2] The dose at any point within the central 80% of the field along the major axes, normalized to the central axis, is within ±1 percentage point of the average of the two beams. This specification applies to beams at 10 cm depth and field dimensions of 10 x 10 cm² and above.

1.2 Dose Rate: For Beams I and II, the dose rate can be selected in fixed steps of 100 MU/min up to a maximum dose rate of 600 MU/min. For the SRS 6 MV Beam, the dose rate is 1,000 MU/minute. The SRS high dose rate supports efficient delivery of stereotactic radiosurgery, stereotactic radiotherapy, and intensity-modulated radiation therapy (IMRT). Refer to section 12.0 for further information. An optional low dose rate mode is also available. Refer to page 14 for further information.

Photon Energy (BJR17)	Photon Dose Rate (MU/min)
6-25 MV	100, 200, 300, 400, 500, 600
SRS 6 MV	1000
6-25 MV (optional)	5, 10, 15, 20, 40, 60, 80

An "MU" is defined for these specifications as one cGy delivered to a tissue-equivalent material at D_{max} and 100 cm SSD, with a 10 x 10 cm^2 field size.

1.3 Maximum Field Intensity at D_{max}: The intensity at the depth of maximum buildup (D_{max}) does not exceed 109% of the central axis intensity anywhere in the measurement plane of any field size.

1.4 Leakage: The X-ray absorbed dose does not exceed 0.1% of the absorbed dose at the isocenter measured anywhere in the patient plane outside of the maximum useful beam. The neutron dose equivalent (Sievert) does not exceed 0.2% of the X-ray absorbed dose (Gray) at the isocenter.

The patient plane is defined as a circular plane with a radius of 2 m, centered on and perpendicular to the axis of the beam at isocenter. The X-ray measurements may be averaged over an area not to exceed 100 cm^2. In all other directions, the X-ray absorbed dose at 1 m from the path of the electrons between the electron gun and the target or electron window does not exceed 0.1% of the absorbed dose at isocenter.

1.5 Collimator Transmission: The X-ray transmission of the upper and lower movable collimator does not exceed 0.5%.

1.6 Spot Size: The electron spot size is less than 3 mm in diameter at the X-ray target.

1.7 Penumbra: The distance between the 20% and 80% isodose lines for a 10 x 10 cm^2 field, measured at a depth of 10 cm with a 100 cm TSD along the major axes, measures less than or equal to 9 mm.

1.8 Field Size: The field size is continuously variable from 0.5 x 0.5 cm^2 to 40 x 40 cm^2 as measured at 100 cm TSD. Field sizes larger than 35 x 35 cm^2 are limited to a 49.5 cm diagonal (the diameter of the circle defined by the primary collimator at 100 cm TSD). The field size is defined as the distance along the radial and transverse axes between the points of 50% density on an X-ray film taken at 100 cm TSD with minimum buildup. The SRS 6 MV beam field size is limited to a maximum of 15 x 15 cm^2.

1.9 Upper and Lower Independent Collimators: Asymmetrical collimation is provided for upper and lower sets of collimators.

1.9.1 Independent, asymmetrical Upper Collimator travel range: 30 cm (-10 cm to +20 cm relative to central axis)

1.9.2 Independent, asymmetrical Lower Collimator travel range: 22 cm (-2 cm to +20 cm relative to central axis)

2.0 Electron Beams

2.1 The Trilogy configuration offers a range of electron energy choices. The Trilogy configuration comes with six (6) electron beams that can be selected in accordance with the specifications and combinations listed in Table 2. The specifications apply to a 15 x 15 cm^2 electron applicator and 100 cm TSD.

2.2 Dose Rate:

Electron Dose Rate (MU/min)
100, 200, 300, 400, 500, 600, 1000
888 at 1.6 m (choose either 6 MeV or 9 MeV)

A high electron dose rate is available at 6 MeV or 9 MeV electron energy. Refer to section 8.1 for further information.

2.3 Field Sizes: A set of five electron applicators is provided, with selection from 6 sizes: 6 x 6 cm^2, 6 x 10 cm^2, 10 x 10 cm^2, 15 x 15 cm^2, 20 x 20 cm^2, and 25 x 25 cm^2. Field sizes are defined at the isocenter plane, 5 cm from the final field-defining aperture. Hardware is provided to facilitate the fabrication of custom final field defining apertures.

Table 2: Electron Beam Performance

Electron Energy Groups

Nominal Electron Energy (MeV)	
Group I	4, 6, 9, 12, 15, 18
Group II	6, 9, 12, 15, 18, 22
Group III	4, 6, 9, 12, 16, 20

	Depth of Ionization[1]			Depth of Dose Value				
Nominal Energy	90% (cm)	80% (cm)	50% (cm)	30% (cm)	85%/2 (cm)[2]	80% (cm)	Flatness[3]	Symmetry[4] (MU/min)
4	.89 ±0.1	1.00 ±0.07	1.26 ±0.1	≤2.00	0.61	1.00	±7%	2%
6	1.71 ±0.1	1.90 ±0.07	2.30 ±0.1	≤2.60	0.93	1.95	±4.5%	2%
9	2.68 ±0.1	2.95 ±0.07	3.50 ±0.1	≤3.90	1.45	3.00	±4.5%	2%
12	3.77 ±0.1	4.15 ±0.07	4.89 ±0.1	≤5.40	2.02	4.25	±4.5%	2%
15	4.68 ±0.1	5.20 ±0.07	6.17 ±0.1	≤6.80	2.57	5.35	±4.5%	2%
16	4.87 ±0.1	5.45 ±0.07	6.49 ±0.1	≤7.30	2.67	5.60	±4.5%	2%
18	5.31 ±0.1	6.10 ±0.07	7.41 ±0.1	≤8.15	3.04	6.40	±4.5%	2%
20	5.52 ±0.1	6.55 ±0.07	8.13 ±0.1	≤9.30	3.26	6.90	±4.5%	2%
22	5.59 ±0.1	6.80 ±0.07	8.64 ±0.1	≤10.00	3.37	7.20	±4.5%	2%

[1] Depth of Ionization values apply to 15 x 15 cm^2 applicator field size. Electron measurements are made at 100 cm TSD and a nominal 5 cm gap between the bottom of the open field aperture and the water surface. Measurements are defined with a 0.1 cm^3 PTW ionization chamber, or equivalent.

[2] D85%/2 is the depth at which flatness and symmetry are specified. Values are defined at 100 cm TSD using a 15 x 15 cm^2 electron applicator field size. No inverse square corrections are assumed.

[3] Flatness is defined as the maximum variation from the mean electron ionization within the central 80% FWHM region. The mean is the average of the maximum and minimum points within the central 80% FWHM region. This specification applies to square electron applicator field sizes from 10 x 10 cm^2 to 25 x 25 cm^2 measured on the radial and transverse axes. A specification of ±5% is applied to 6 MeV for 10 x 10 cm^2 applicator field size. The diagonal flatness specification for the above applicator field sizes is ±5%, except 4 MeV. The 4 MeV flatness specification applies only to the radial and transverse axes.

[4] Symmetry is defined as the maximum difference between the ionization delivered to any two points that are equidistant and symmetrical about the central axis and within the central 80% FWHM region. This specification applies to the plane normal to the central axis and to square electron applicator field sizes from 10 x 10 cm^2 to 25 x 25 cm^2, except 4 MeV. The 4 MeV specification applies only to the radial and transverse axes.

2.4 X-ray Contamination: For nominal energies up to 10 MeV, the X-ray contamination is less than or equal to 2%. For nominal energies greater than 10 MeV, the X-ray contamination is less than or equal to 5%. This specification is defined in water with a 100 cm TSD, at a depth of 10 cm beyond the depth of the 10% isodose line, with a 15 x 15 cm^2 electron applicator.

2.5 Patient Plane Leakage: Electron leakage is less than or equal to 2% of the absorbed dose on central axis. This specification is defined in air, at 100 cm TSD with 1 cm buildup, in an area 4 cm outside the 50% isodose line.

2.6 Applicator Side Plane Leakage: The leakage does not exceed 9% of central axis ionization at D_{max}. This specification is defined along a plane coincident to the side of the electron applicator, measuring 10 cm up from the bottom of an applicator.

3.0 Accelerator System Features

3.1 RF Power Source: Varian's high-efficiency klystron is operated in linear amplifier mode and driven by a solid-state oscillator, with power and frequency automatically locked to required operating levels.

3.2 Electron Gun: The unique triode design of the electron gun allows exact and safe control of electron beam levels in the accelerator. It provides the ability to rapidly and precisely vary output dose rate and turn the beam on or off. This capability is especially important in dynamic dose delivery, where high-speed beam gating and elimination of dark current during beam-off time periods is important. The gun is demountable, resulting in minimum system downtime during replacement.

3.3 Standing Wave Accelerator: The Varian side-coupled cavity accelerator structure has been developed for optimum use of RF power and narrow output spectrum at the design energy for the guide. Spectrum characteristics, with and without use of an energy switch, have been matched to the transport requirements of the downstream bend magnet to ensure high dose rate capability.

3.4 Patented Non-Contacting Energy Switch: In each of the X-ray treatment modes where this is utilized, the switch functions to change the ratio of electric fields between two sections of the accelerator guide. This is done in such a way as to ensure a tight energy spectrum over a wide range of photon energies, with consequent high output capability and stable operation.

3.5 Solenoid: A full-length magnetic solenoid assures high electron beam transmission through the accelerator structure, resulting in reduced stray-radiation and efficient use of RF power.

3.6 Bend Magnet: This patented 270° bend magnet is fully achromatic, with one-to-one imaging for superior transport and control of the beam from the accelerator. The magnet is also equipped with energy slits fixed at ±3%, enabling output beams of consistently high quality and precise dosimetry.

3.7 Radial and Transverse Steering Systems: These systems ensure basic beam alignment in all modes, as well as gantry orientation. Ion chamber sensors, in conjunction with the steering coils and servo electronics, maintain beam symmetry changes to within 2% under all foreseeable conditions.

4.0 Dosimetry System

The following specifications apply for both independent dosimetry channels:

4.1 Reproducibility with Energy: Precision of the dosimetry measurement system for each energy is ±1% or ±1 MU, whichever is greater, at a fixed dose rate.

4.2 Dose Calibration Linearity versus Total Dose: The linearity is as follows:

- 1% for 20-999 MU
- 2% for 10-20 MU
- 3% for 5-10 MU

4.3 For photon Beams I and II, doses up to 999 MU per field can be delivered. For the SRS 6 MV Beam, doses up to 6,000 MU can be delivered. For all electron beams, doses up to 4,000 MU can be delivered.

4.4 Reproducibility of Dose vs. Gantry Angle: The precision of the dosimetry system is ±1.5% at any gantry angle from 0 to 360 degrees.

4.5 Reproducibility with Dose vs. Dose Rate: The dose rate dependence of the dosimetry system with variations in dose rate from minimum to maximum is less than ±1% or ±1 MU, whichever is greater.

4.6 Beam-Off Interlocks: The radiation beam automatically terminates in the event of any of the following:

- Monitor Units 1 complete
- Monitor Units 2 complete
- Treatment time complete
- Radial symmetry exceeds 2%
- Transverse symmetry exceeds 2%
- Excess dose rate
- Excess dose per pulse
- Excess dose per degree
- Loss of ion chamber bias voltage
- Under dose rate

5.0 Beam Matching Specifications

Beam matching of a new high energy Clinac iX accelerator (including the Trilogy configuration) to existing high-energy Clinac iX accelerators, Trilogy configurations of the Clinac iX accelerator, and low- and high-energy Clinac EX accelerators that meet the serial number requirements shown below is available as a purchasable option. If purchased, this option includes on-site demonstration of the matched beams as described below.

Basic or Fine Beam Matching to existing accelerator systems installed outside a 1-year time frame may be available as a purchasable option (refer to section 5.3).

5.1 Restrictions and Definitions

5.1.1 All specifications apply to fields measured in water with the surface 100 cm from the target of the accelerator system.

5.1.2 D_{max} is the depth at which the maximum dose occurs along the central axis of the beam for a 10 x 10 cm^2 X-ray field.

5.1.3 R85/2 is one-half the depth where 85% relative ionization occurs on the central axis of an electron field using the 15 x 15 cm^2 applicator.

5.1.4 Major axes lines orthogonal to the central axis of the beam and perpendicular to the sides of rectangular fields.

5.1.5 The term “average” is defined as the average value for the referenced performance specification, calculated using measurements obtained from the new high energy Clinac iX accelerator and the existing accelerator systems(s) to which it is matched.

5.2 On-Site Demonstration of Matched Beams

5.2.1 Basic Photon Beam Matching, per beam

5.2.1.1 Basic Matching of Photon X-Ray Beam Energy: For each X-ray beam of the same nominal energy, the depth of D_{max} along the central axis in a water phantom at 100 cm TSD is within ±1.5 mm of the average. For each X-ray beam of the same nominal energy, the relative dose at 10 cm depth on the central axis in a water phantom at 100 cm TSD (normalized to the dose at $D_{max)}$ is within ±1.0% of the average.

5.2.1.2 Basic Matching of Photon X-Ray Beam Flatness: For X-ray beams of the same nominal energy, the maximum dose in the plane normal to the beam axis at a depth of D_{max} in water at 100 cm TSD is within ±1% of the average. For each beam of the same nominal energy, the dose at any point within the central 80% of the in-plane and cross-plane axes, normalized to the central axis, measured at a depth of 10 cm in water at a TSD of 100 cm is within ±2% of the average for the measured values at that point. This specification applies to X-rays at 10 cm depth and field dimensions greater than 10 x 10 cm^2.

5.2.2 Basic Electron Beam Matching, per beam

5.2.2.1 Basic Matching of Electron Beam Energy: For each electron beam of the same nominal energy, the relative ionization at 100 cm TSD, the depth of 90%, 80%, and 50%, is within ±1.0 mm of the average. This specification applies to the 15 x 15 cm^2 applicator.

5.2.2.2 Basic Matching of Electron Beam Flatness: Basic matching of electron beams does not include flatness.

5.2.3 Fine Photon Beam Matching, per beam

5.2.3.1 Fine Matching of Photon X-Ray Beam Energy: For each X-ray beam of the same nominal energy, the depth of D_{max} along the central axis in water phantom at 100 cm TSD is within ±1.5 mm of the average. For each X-ray beam of the same nominal energy, the relative dose at 10 cm depth on the central axis in a water phantom at 100 cm TSD (normalized to the dose at D_{max}) is within ±0.5% of the average.

5.2.3.2 Fine Matching of Photon X-Ray Beam Flatness: For X-ray beams of the same nominal energy, the maximum dose in the plane normal to the beam axis at a depth of D_{max} in water at 100 cm TSD is within ±1% of the average. For each beam of the same nominal energy, the dose at any point within the central 80% of the in-plane and cross-plane axes, normalized to the central axis, measured at a depth of 10 cm in water at a TSD of 100 cm is within ±2% of the average. This specification applies to X-rays at 10 cm depth and field dimensions greater than 10 x 10 cm^2.

5.2.4 Fine Electron Beam Matching, per beam

5.2.4.1 Fine Matching of Electron Beam Energy: For each electron beam of the same nominal energy, the relative ionization values of 90%, 80%, and 50% at 100 cm TSD, are within ±1.0 mm of the average. This specification applies to the 15 x 15 cm^2 applicator.

5.2.4.2 Fine Matching of Electron Beam Flatness: For each beam of the same nominal energy, the ionization at any point within the central 80% of the in-plane and cross-plane scans, normalized to the central axis, measured at the depth of D_{max} in water at a TSD of 100 cm is within ± 2% of the average of the measured values at that point. This specification applies to the 25 x 25 cm^2 and 10 x 10 cm^2 applicators.

5.3 Beam Matching to Accelerator Systems Installed Outside a 1-Year Time Frame

5.3.1 Basic or Fine Beam Matching, including on-site demonstration, of a new high energy Clinac iX accelerator to existing accelerator systems installed outside a 1-year time frame is available as a purchasable option for accelerator systems that meet the following requirements:

- Clinac iX, all serial numbers
- Trilogy configuration, all serial numbers
- Low-energy Clinacs, serial number 244 and higher
- Clinac 21 series, serial number 865 and higher
- Clinac 23 series, serial number 144 and higher
- Silhouette edition Clinacs, all serial numbers

5.3.2 Basic or Fine Beam Matching, including on-site demonstration, of a new high energy Clinac iX accelerator to existing accelerator systems that do not meet the serial number requirements above may be available as a purchasable option.

6.0 Mechanical Features

6.1 Gantry

6.1.1 Rotation Range: ±185° from the vertical

6.1.2 Target to Axis Distance: 100 ±0.2 cm

6.1.3 Mechanical and radiation isocenter accuracy

6.1.3.1 The Trilogy configuration not available with Retractable Beam Stopper

6.1.3.2 Requires 52-inch Exact™ Couch base frame

6.1.3.3 ≤0.5 mm radius sphere for gantry and collimator axes

6.1.3.4 ≤0.75 mm radius sphere for gantry, collimator, and couch axes

6.1.4 Position Indicators (gantry and console)

6.1.4.1 IEC Scale convention (IEC 601 or 1217 compliant) or Varian Scale may be used for position readouts.

6.1.4.2 Digital Readouts:

- Accuracy: ±0.5°
- Resolution: 0.1°

6.1.4.3 Mechanical Scales:

- Accuracy: ±1.0°
- Resolution: 1.0°

6.1.4.4 Gantry Display Only: Enhanced Dynamic Wedge™ (EDW) graphic indicator shows that EDW is enabled in either Y1 or Y2 direction.

6.1.5 Target to Surface Distance Indicators

6.1.5.1 Optical Distance Indicator:

- Accuracy: ±0.1 cm at 100 cm, and ±0.5 cm at 70 cm and 156 cm
- Resolution: 0.5 cm

6.1.5.2 Mechanical Front Pointer:

- Range: 70-110 cm
- Accuracy: ±0.1 cm at 100 cm
- Resolution: 0.2 cm

6.1.6 Isocenter Height (nominal): 129.5 cm

6.2 Collimator

6.2.1 Extended Rotation Range: ±165°

6.2.2 Mechanical Isocenter Accuracy: ≤0.05 cm radius from isocenter

Trilogy System Dimensions

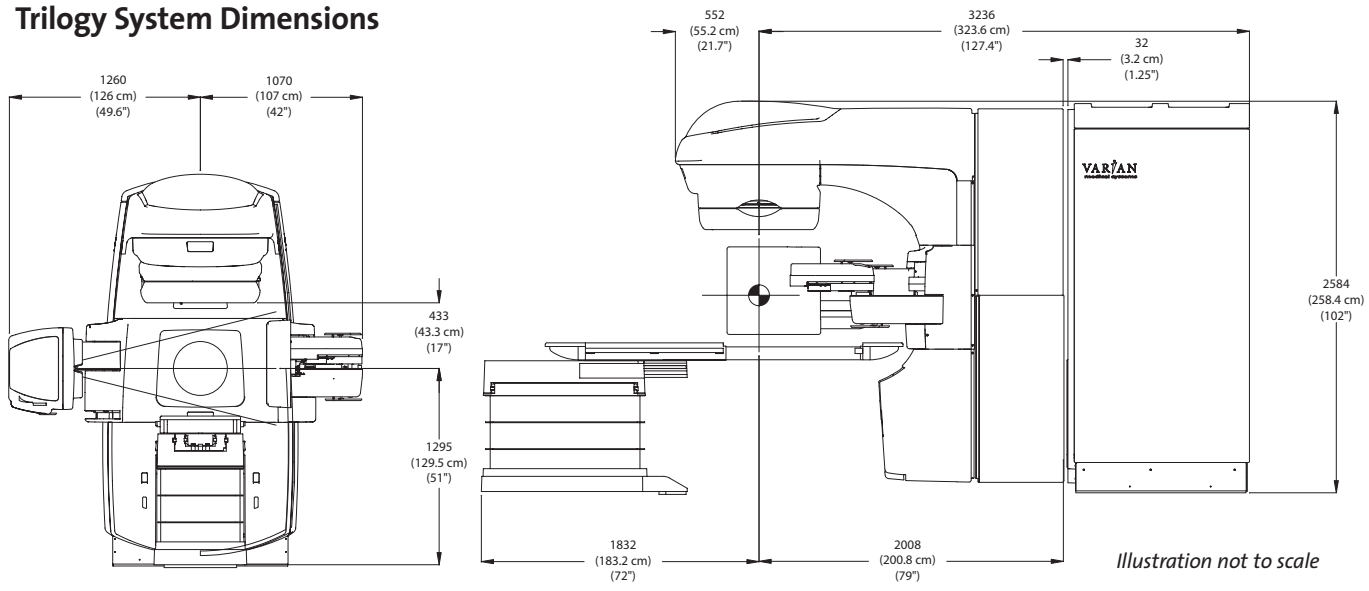


Illustration not to scale

6.2.3 Position Indicators (gantry and console)

6.2.3.1 Digital Readouts:

- Accuracy: ±0.5°
- Resolution: 0.1°

6.2.3.2 Mechanical Scales:

- Accuracy: ±1.0°
- Resolution: 1.0°

6.3 Field Size Collimation

6.3.1 Range: The field size is continuously variable from 0.5 x 0.5 cm^2 to 40 x 40 cm^2 as measured at 100 cm TSD. Field sizes larger than 35 x 35 cm^2 are limited to a 49.5 cm diagonal (the diameter of the circle defined by the primary collimator at 100 cm TSD). The field size is defined as the distance along the radial and transverse axes between the points of 50% density on an X-ray film taken at 100 cm TSD with minimum buildup. The SRS 6 MV beam field size is limited to a maximum of 15 x 15 cm^2.

6.3.2 Position Indicators

- Accuracy: ±0.2 cm
- Resolution: 0.1 cm

6.3.3 Light and X-ray Field Coincidence: The field-defining light coincides to within 1.5 mm of the 50% isodensity line on an X-ray film. This is defined at 100 cm TSD with minimum buildup for any field size.

6.4 Exact Couch with Indexed Immobilization™

6.4.1 The Exact Couch is standard with the Trilogy configuration. (Specifications and standard vs. optional accessories for the Exact Couch are provided on Exact Couch specification sheet, RAD 1951A.)

6.4.2 Motion Controls

- Two Hand Pendants that control the accelerator and Exact Couch
- Two Couch Side Panels
- Remote Couch Control

6.4.3 Position Indicators

- Corrective motions: small translations (in x, y, and z) and small rotation of the couch to fine tune patient setups
- Planned motions: large rotations of the couch to sequence between non-coplanar fields and arcs

6.4.3.1 Translation

- Accuracy: ±0.1 cm
- Resolution: 0.1 cm

6.4.3.2 Rotation

- Accuracy: ±0.5°
- Resolution: 0.1°

6.5 Compact stand assembly

6.5.1 Single access and through-door viewing of all gas and water system status indicators

6.5.2 Imager electronics (PortalVision™ MV imaging system and On-Board Imager™ kV imaging system) incorporated in reduced height stand

7.0 Accessories

The following accessories are included as standard with the Trilogy configuration and the Exact Couch:

7.1 Collimator Accessories:

- Interface Mount
- Accessory Mount
- Port Film Graticule
- 4-Way Wedge Set (four wedges 15°, 30°, 45°, 60°)
- Five Electron Applicators: A set of five electron applicators is provided, with selection from 6 sizes: 6 x 6 cm^2, 6 x 10 cm^2, 10 x 10 cm^2, 15 x 15 cm^2, 20 x 20 cm^2, and 25 x 25 cm^2.
- Custom Aperture Fabrication Hardware
- Mechanical Front Pointer (holder and 4 rods)
- Drilled Star trays (Qty 10 - 0.635 cm thickness)
- Slotted Block trays (Qty 2 - 0.635 cm thickness)

7.2 Accessory Spare Parts Kit

7.3 Stereotactic Motion Disable Kit included for the gantry and Exact Couch

8.0 Basic Static Procedures Mode

8.1 High Dose Total Skin Electron Mode: The Trilogy configuration is capable of delivering electron treatments at high dose rates for the purpose of total skin irradiation. The dose rate at 1.6 m is 888 MU/min, corresponding to nominally 2,500 MU at isocenter. This mode is available in 6 MeV or 9 MeV.

8.1.1 X-ray contamination at calibration point is <1%.

8.1.2 Symmetry at isocenter is ±2%.

8.1.3 Integrated dose monitor: 1 to 9,000 MU.

8.1.4 Exposure time: 0.1 to 99.9 min.

8.2 Total Body Electron Mode: Delivers 9,000 MU at isocenter with all normal machine safety and dosimetry interlocks operational, and delivers standard energies at standard dose rate ranges.

8.2.1 Special TBE accessory tray is provided.

8.2.2 All beams are calibrated at machine isocenter.

8.2.3 Integrated dose: 1 to 9,000 MU.

8.2.4 Exposure time: 0.1 to 99.9 min.

8.3 Total Body Photon X-ray Mode: Delivers 9,000 MU at isocenter with all normal machine safety and dosimetry interlocks operational, and delivers standard energies at standard dose rate ranges.

8.3.1. Special TBI accessory tray is provided.

8.3.2 All beams are calibrated at machine isocenter.

8.3.3 Integrated dose: 1 to 9,000 MU.

8.3.4 Exposure time: 0.1 to 99.9 min.

9.0 Advanced Static Procedures Mode

Auto Field Sequencing (AFS), for use with the 4D Integrated Treatment Console (refer to 4D Integrated Treatment Console Product Brief, RAD 2768 for information and specifications), provides automated delivery of multiple coplanar and non-coplanar fields. With this time saving feature, the accelerator automatically acquires the mode up signal and machine setup information from the 4D Integrated Treatment Console, and then allows the operator to remotely move the gantry, jaws, collimator, and Exact Couch axes between coplanar and non-coplanar treatment fields. This feature eliminates the need to go into the treatment room to alter the machine setup between treatment fields. AFS works in concert with the Millennium™ multileaf collimator (MLC) to deliver both static and dynamic plans efficiently and smoothly. (Refer to Auto Field Sequencing Specification, RAD 6045.)

10.0 Basic Dynamic Procedures Modes

10.1 Photon Arc Mode and Electron Arc Mode: The Trilogy configuration is capable of delivering the following dose over a preset gantry rotation of up to 360 degrees or any fraction thereof. MU per degree (MU/DG) is automatically computed based on the preset total dose and the preset arc segment.

Photon Beams I and II	0.30 MU to 20 MU per degree
SRS 6 MV Beam	0.30 MU to 60 MU per degree
All electron beams	0.30 MU to 20 MU per degree

10.1.1 Precision: During Arc treatment, the position of the gantry deviates no more than 0.5 degrees from the desired instantaneous gantry angle, and the dose deviates no more than 0.20 MU from the desired instantaneous total dose, as specified by the user-preset total dose and arc segment.

If these tolerances are exceeded, the dose delivery is suspended and the gantry position is targeted to the position dictated by the actual dose delivered. When the gantry is again within 0.5 degrees of the desired position, the treatment will resume. The Dose Position Interlock (DPSN) is asserted if the gantry is not positioned within 0.5 cm of the desired position within 3 seconds.

The DPSN will terminate the beam immediately if the position deviates 3.0 degrees or more from the desired position, or the dose delivered exceeds 0.45 MU.

10.1.2 Arc Dose Rate: The dose rate during a dynamic arc treatment is automatically modulated between zero and the ceiling dose rate selected in Physics Mode.

10.1.3 Arc Direction: The Trilogy configuration may be programmed to perform arc therapy in either a clockwise or counterclockwise direction.

10.2 Enhanced Dynamic Wedge™ (EDW) Mode: EDW can be used with either Beam I or Beam II. EDW utilizes Y-jaws to create wedge shaped dose distributions. Enhanced Dynamic Wedges of 10, 15, 20, 25, 30, 45, and 60 degrees are included, with up to 30 cm (wedge direction) by 40 cm field sizes. (Refer to Enhanced Dynamic Wedge Specification, RAD 1880C.)

11.0 Advanced Dynamic Techniques

Intensity-modulated radiation therapy (IMRT) and conformal arc therapy are advanced dynamic techniques in which the leaves of the Millennium MLC move during treatment. Refer to dMLC Specification, RAD 5610 for additional information and specifications.

11.1 Arc Dynamic MLC allows delivery of MLC fields as a function of gantry arc angle, also known as conformal arc therapy. An MLC shape change every 2° is supported.

11.2 Dose Dynamic MLC allows delivery of MLC fields as a function of percent dose delivered, also known as IMRT. Both dynamic IMRT (i.e., sliding window) and segmental IMRT (i.e., step-and-shoot) techniques are supported. Combinations of the two IMRT techniques also are supported. In addition, Dose Dynamic MLC enables treatment delivery with electronic compensation, in which MLC leaf motion simulates the dosimetric effect of a physical compensator.

12.0 Stereotactic Mode

The Trilogy configuration is capable of delivering stereotactic treatments at high dose rates and with remote couch motion. This mode is available with 6 MV photons. Both cone- and MLC-based treatment delivery are supported. Beam flatness, symmetry, and other specifications can be found in Table 1.

12.1 Dose Rate: 1,000 MU per minute at D_{max} at 100 cm TSD

12.2 Maximum dose per field: 6,000 MU

12.3 Maximum field size: 15 x 15 cm^2

12.4 Maximum dose per degree for arc treatments: 60 MU per degree

12.5 Stereotactic Motion Disable

12.5.1 Mechanical couch locks

12.5.2 Electrical disable for gantry and couch

13.0 Treatment Command Center

Ergonomic command center configuration places all control modules, monitors, and user interaction devices within easy reach of the operator. Direct access application selection simplifies the workspace by reducing the number of input devices (e.g., keyboard and mouse), while allowing continuous viewing of all applications.

14.0 In-Room Display

A high-resolution, flat screen, color display monitor is included for in-room display of accelerator parameters and patient-specific information.

15.0 Typical Facility Requirements

15.1 Electrical Requirements

15.1.1 Typical 60Hz: 200-240 VAC, line-to-line, 3-phase, 4-wire plus ground, 45 KVA load.

15.1.2 Typical 50Hz: 360-440 VAC, line-to-line, 3-phase, 4-wire plus ground, 45 KVA load.

15.2 Cooling Water Requirements: The cooling water requirements can be satisfied with a one-pass system (domestic supply and waste return) or a closed loop system.

15.3 Ventilation must be sufficient to remove 8 kW from treatment room and 1 kW from control console.

15.4 Compressed Air Requirements: Instrument quality air is required.

15.5 For facilities requirements refer to the Trilogy configuration Installation Data Package.

15.6 On-Board Imager Power Requirements

15.6.1 Input voltage: 400 to 480 Vac (±10%), 3-phase, 4-wire plus ground

15.6.2 Input frequency: 50 or 60 Hz (±1%)

15.6.3 For comprehensive facilities requirements refer to the On-Board Imager Installation Data Package.

Included in the Trilogy Stereotactic System

4D Integrated Treatment Console

The 4D Integrated Treatment Console provides a streamlined front end to the Trilogy Stereotactic System. The console integrates use of the accelerator, Millennium MLC, and MV imager into one application on a single workstation. For image-guided radiotherapy using kV images, the console is used in combination with the On-Board Imager workstation. The 4D Integrated Treatment Console uses a DICOM RT interface to communicate with the VARiS Vision™ oncology information system and other information system databases.

Millennium 120-Leaf Multileaf Collimator

The Millennium 120-leaf MLC offers 0.5 cm leaf resolution at isocenter for the central 20 cm of the 40 cm x 40 cm field. The Millennium MLC operates in static, dynamic, and conformal arc modes. The static mode provides efficient beam shaping for 3D conformal radiation therapy. The dynamic mode enables IMRT with both step-and-shoot and sliding window delivery. The conformal arc mode enables conformal arc therapy in which the leaves always conform to the outer boundary of the target as the gantry rotates around the patient.

Refer to MLC RAD 5609 for additional MLC information and specifications.

Stereotactic Components

Choose either the Varian or BrainLAB package of stereotactic components. Each package includes:

- Conical collimators for circular arc treatments and collimator mount
- Stereotactic headring and couch mount
- Frameless stereotactic intracranial immobilization
- Stereotactic treatment planning capability for cones and the Millennium 120-leaf MLC
- Optical positioning system (available only with the Varian package)

PortalVision aS1000 MV Imaging System

The PortalVision aS1000 is an MV imaging system that allows for verification of patient setups, treatment portals, and pre-treatment QA.

The amorphous silicon detector has an active imaging area of 40 cm x 30 cm with a pixel resolution of 1024 x 768. Image acquisition is supported before, during, and after treatment.

Match and Review software is included for image analysis.

A motorized, retractable arm is used to position and hold the detector.

Refer to PortalVision aS500 Specification, RAD 2552A, for information and specifications.

On-Board Imager Patient Positioning and Target Localization System

The On-Board Imager provides high-quality kV images in the treatment room for target localization, patient positioning, and motion management. Refer to On-Board Imager Specification, RAD 9502B, for information and specifications. The following clinical capabilities are supported:

- Online setup correction based on either a kV-kV or kV-MV pair of radiographs
- Automated and manual alignment of a pair of radiographs to their reference images
- Acquisition of gated radiographs
- Online setup correction based on radiopaque markers
- Pretreatment verification of gated treatment portals using kV fluoroscopy
- Remote couch motion to correct patient setups
- Acquisition of Cone-beam CT scans

RPM™ Respiratory Gating System

The RPM respiratory gating system enables passive, real-time monitoring of patient respiration for the purpose of intrafraction motion management. Two gating systems are provided. Each system includes an infrared tracking camera, external marker block, and RPM respiratory gating system workstation. The RPM respiratory gating system supports gated treatment delivery and image acquisition on the accelerator, gated simulation on compatible simulators (not all simulators are supported), and gated CT acquisition on compatible third-party CT scanners (not all CT scanners are compatible). Depending on the capabilities of the CT scanner, the RPM respiratory gating system supports both retrospective and prospective gating of CT scans. Refer to RPM Respiratory Gating System Specification, RAD 5616 for additional information.

LaserGuard™ Collision Detection System

LaserGuard monitors the MLC collimator face with a plane of infrared light that emanates from a device located within the gantry. Any object that intrudes into this area, called the protection zone, triggers an emergency stop of all accelerator motion. Refer to Auto Field Sequencing with LaserGuard Specification, RAD 6046 for information and specifications.

Argus™ QA Software

Argus provides powerful software tools for automation of quality assurance data acquisition, data analysis, visual display of data, and reporting. Argus also provides a centralized database for digital storage of data.

The Argus QA software provides quality assurance modules for linear accelerators, including static and dynamic MLC using DynaLog™ file analysis, CT simulators, standard simulators, film processors, and HDR brachytherapy systems.

Portal Dosimetry

Portal Dosimetry enables use of the MV imager to record the intensity patterns of IMRT fields for pretreatment quality assurance of IMRT planning and delivery.

Portal Dosimetry includes integrated image acquisition mode for recording of IMRT fields and image viewing and analysis software. (*Use of the image analysis software is optimized when the reference dose image is calculated as dose to amorphous silicon. Currently, only the Eclipse™ integrated treatment planning system offers this capability.)

Factory Beam Data Set

The Factory Beam Data Set is provided in hard copy and ASCII file formats. The data include physical wedge profiles, machine mechanical parameters, and representative beam data. The data set is not a substitute for the commissioning process but an aid to speed that process as well as data entry to treatment planning systems. The factory data are representative of the Trilogy configuration manufacturing standard, not the specific machine delivered.

SmartConnect™ Remote Access Technology

SmartConnect remote access technology connects the Trilogy system with Varian Customer Support for expert assistance and online remote analysis. Diagnostic and Morning Checkout Logs can be viewed remotely and transferred to Varian for report generation and trend analysis.

Options

Silhouette™ Edition

The Trilogy configuration is available in a Silhouette Edition that fits into an existing vault with a minimum room size of 16 feet (4.9 m) width by 19 feet (5.8 m) length. A variety of configuration and artistic panel options are available for creation of a customized radiation therapy treatment environment.

Treatment Console Area Packaging

Compact packaging and cable management of Varian-provided workstations, control modules, and other ancillary devices for easy site preparation and enhanced treatment console area space management. A variety of packaging configurations are available for optimal utilization of the available space.

Laser Alignment System

- Wall and ceiling lasers
- Diode back pointer line laser

CCTV Camera System

This two-camera CCTV system is used for monitoring patient activity inside of the treatment room and patient activity from outside the room at the treatment console.

Patient Intercom System

The Patient Intercom System is used for audio communication with the patient in the treatment room from the treatment console area.

Collimator Accessories

- Electron Arc Applicators and Mold Frames
- Additional Block Tray sets
  - Solid or Slotted
  - 0.635 cm or 1 cm thickness
- Compensator Mount
- Upper and Lower Compensator Trays
- Extended Spare Parts Kit

Custom Coding

Custom Coding provides recognition of the presence of one or more beam-shaping accessories. Accessory recognition includes confirmation of the presence of a beam-shaping accessory in one of four possible accessory positions and identification of the type of accessory. Standard Varian beam-shaping accessories (e.g., 30-degree wedges) are identified by name. Custom beam-shaping accessories (e.g., blocks in Varian-provided block trays or custom final field defining apertures for electron applicator systems) are identified by a custom code for that accessory.

Low Dose Rate (LDR)

The Low Dose Rate option allows dose rate selection of 5, 10, 15, 20, 40, 60, 80 MU per minute in addition to the standard dose rate set of 100-600 MU per minute. The option is available for Beams I and II.

Reproducibility vs. Dose Rate

- ≤10 MU/min: ±10%
- 15-20 MU/min: ±5%
- ≥40 MU/min: ±2%

Reproducibility vs. MU

- ≤10 MU: ±3%
- 15-20 MU: ±2%
- ≥20 MU: ±1%

Specifications subject to change without notice.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