Elekta Medical Linear Accelerator

Agility™ and Integrity™ R4.0.0 Information for Treatment Planning Systems

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Referenced documents

Elekta does not supply all the documents that we refer to in this document with the equipment. Elekta reserves the right to make the decision on which of the documents we supply with the equipment.

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TECHNICAL HELP

Contact your local Elekta representative for technical help

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List of Figures and Tables

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1 Introduction

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1.1 Introduction

This document gives additional information about Integrity™ R4.0.0. Use this document together with the related Instructions for Use.

Use this document together with the documentation for the treatment planning system to help set up the treatment planning system for Integrity™ R4.0.0.

This document gives information on all configurations of the equipment. It is possible that you do not have a license for all configurations available.

1.2 Function of this document

The function of this document is to help the User in the safe and correct operation and maintenance of the equipment.

The User is the authority who has the control of the equipment and the person or persons who operate and do work on the equipment. An Operator is the person who operates the equipment with or without help from an assistant, and who controls some or all the functions of the equipment.

1 Clinical Users

A Clinical User operates the equipment for the treatment of patients. A Clinical User is a qualified person who has the necessary knowledge and training in the safe, clinical operation of the equipment. Such treatment must be therapeutic only.

2 Service Users

A Service User operates the equipment to do maintenance tasks. A Service User is a qualified person who has the necessary knowledge and training to set different software configurations, do the necessary tests, adjustments, optimization, and calibration procedures on the equipment. Such operation must not be therapeutic.

3 All Operators

Before you operate the equipment, Elekta recommends that you read, understand, and obey all the:

– Warnings
– Cautions
– Notes
– Release notes
– Safety labels and markings
– FCOs.

Elekta recommends that you:

- Read carefully the information in the Important safety instructions section of the General safety and regulatory information chapter of this document.
- Keep this document with the equipment for easy access.

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1.3 Recommendations for training

This is information about the necessary training, regulations, and compliance that apply to the operation of the equipment.

Different countries have different regulations for training. Make sure that you have the necessary training before you operate or do work on the equipment. Make sure that your training is in compliance with the laws and regulations of the jurisdiction in which the equipment is installed.

Training is available from Elekta. Contact Elekta for more information about the applicable training courses and the persons who can work on the equipment.

1.4 Conventions for text formats in Elekta documentation

The conventions for text formats in Elekta documentation is a list of the text formats that you can find in this document.

Table 1.1 Conventions for text formats

Text format	Definition
Bold appearance	Text that shows on the screen of a VDU
	Parts of the graphical user interface
PLAIN CAPITAL LETTERS	Keyboard and keypad keys or buttons
HIGH or $\overline{\text{LOW}}$	Signal names
`Courier font`	Typed text, file names, or file paths.
	Messages displayed on the graphical user interface.

1.5 Conventions for persons who can work on the equipment

This is a table that gives the conventions for persons that can work on the equipment.

Table 1.2 Conventions for persons who can work on the equipment

Term	Definition
Authorized person	A person that is permitted to do work on the equipment by the User of the equipment.
Clinical User	A Clinical User operates the equipment for the treatment of patients. A Clinical User is a qualified person who has the necessary knowledge and training in the safe, clinical operation of the equipment. Such treatment must be therapeutic only.
Elekta approved person	A person that is approved by Elekta to have the necessary knowledge and training to do specified tasks on Elekta equipment.
Medical Physics Expert (MPE)	A person that is recognized by a competent authority to have the necessary knowledge and training in radiation physics, or radiation treatment, to give information on patient dosimetry, use of radiation procedures and equipment, on optimization, quality assurance, quality control, and other items related to medical radiation exposure and safety.

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Term	Definition
Operator	A person who operates the equipment with or without help from an assistant, and who controls some or all the functions of the equipment.
Qualified person	A person that is recognized by a competent authority to have the necessary knowledge and training to do specified tasks.
Qualified Expert (QE)	A person that is recognized by a competent authority to have the necessary knowledge and training to do the applicable tests and calculations for radiation levels and dose assessments. The person also gives information on the necessary correct radiation protection and procedures.
Service User	A Service User operates the equipment to do maintenance tasks. A Service User is a qualified person who has the necessary knowledge and training to set different software configurations, do the necessary tests, adjustments, optimization, and calibration procedures on the equipment. Such operation must not be therapeutic.
User	The organization or person responsible for the operation and maintenance of the equipment.

For more information on persons that can work on the equipment, and on training, contact your local Elekta representative.

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1.6 Conventions for the directions of the linear accelerator

The conventions for the directions of the linear accelerator are the conventions that apply when the patient is in the head first (anatomical supine) position on the treatment table.

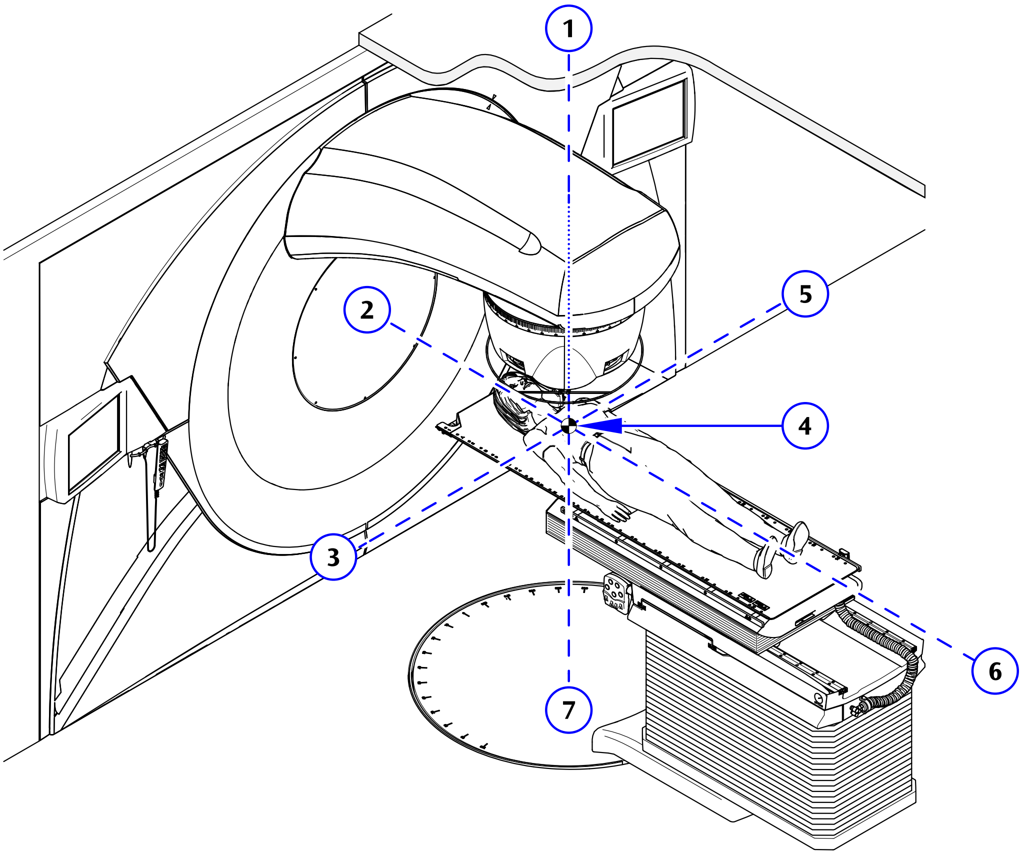

Figure 1.1 Conventions for the directions of the linear accelerator

- (1) Treatment room ceiling (top) (anatomical anterior)
- (2) Linear accelerator gun (G-end) (anatomical superior)
- (3) Linear accelerator A-side (anatomical right)
- (4) Machine isocenter
- (5) Linear accelerator B-side (anatomical left)
- (6) Linear accelerator target (T-end) (anatomical inferior)
- (7) Treatment room floor (bottom) (anatomical posterior)

Note: *The A and B positions in* **Figure 1.1** *are correct with the gantry at 0° only. The A and B positions rotate with the gantry. Therefore, with the gantry rotated 180°, A and B are opposite.*

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1.7 Abbreviations and acronyms

The abbreviations and acronyms is a list of the abbreviations and acronyms in this document with their definitions.

Abbreviation	Definition
BLD	Beam Limiting Device
DICOM	Digital Imaging and Communications in Medicine
DLG	Dynamic Leaf Guide
HVL	Half Value Layer
IEC	International Electrotechnical Commission
MeV	Mega Electron Volt
MLC	Multi-Leaf Collimator
R&V	Record and Verify
RT	Real Time
TCS	Treatment Control System
TPS	Treatment Planning System
VMAT	Volumetric Modulated Arc Therapy

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2 Hardware information

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2.1 Design description

The assembly has two leafbanks of 80 leaves. These are perpendicular to the direction of radiation and travel linearly across the beam path. Opposing banks have full interdigitation.

The nominal leaf width is 5 mm at isocenter.

Each leafbank is in a dynamic leaf guide (DLG), which can move up to 15 cm. The leaves can extend up to 20 cm from the DLG. The control system determines if the leaves and DLG move at the same time.

By combining DLG and leaf movement, the leaves can move 15 cm beyond the central axis.

The beam limiting device (BLD) incorporates two field defining diaphragms. The direction of movement is 90° with respect to the leaf axis. The diaphragms can move 12 cm beyond the central axis. The diaphragms are designed with reduced thickness in the areas where the leaves always provide additional shielding. The diaphragm motion can also be enabled to track the aperture defined by the leaves during delivery, if required by the prescription.

A standard accessory ring is an integral part of the BLD. This makes the BLD compatible with accessories used on other Elekta BLDs.

A summary of the design characteristics is reported in the following table. All values are at isocenter unless stated otherwise.

Note: *No design changes have been made to the treatment system above the interface ring, which is nominally positioned at 137.1 mm from the target reference.*

Table 2.1 Summary of technical design characteristics for Agility™

Item	Value	Unit
Physical properties		
Maximum field size	400 × 400	mm²
Nominal leaf pitch	5	mm
Leaf individual travel range with respect to the DLG	200	mm
Leaf interdigitation range	200	mm
Leaf and DLG combined range	350	mm
Diaphragm range	320	mm
Maximum leaf speed	35	mm/s
Maximum DLG speed	30	mm/s
Maximum diaphragm speed	90	mm/s
Clearance between the accessory ring and isocenter	450	mm
Host digital accelerator photon energies	4 - 25	MV
Host digital accelerator electron energies	4 - 20	MeV
Transmission specifications		
Maximum leaf transmission	< 0.5	%
Average leafbank transmission	< 0.375	%
Maximum transmission through leaves and thicker section of diaphragm	< 0.12	%

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Item	Value	Unit
Maximum transmission through leaves and thinner section of diaphragm	< 0.12	%
Maximum transmission through thicker section of diaphragm only	< 0.5	%

The corners of the 40 cm × 40 cm field are rounded due to the primary collimator. A number of the corner leaves therefore cannot extend to the 20 cm distance from the central axis.

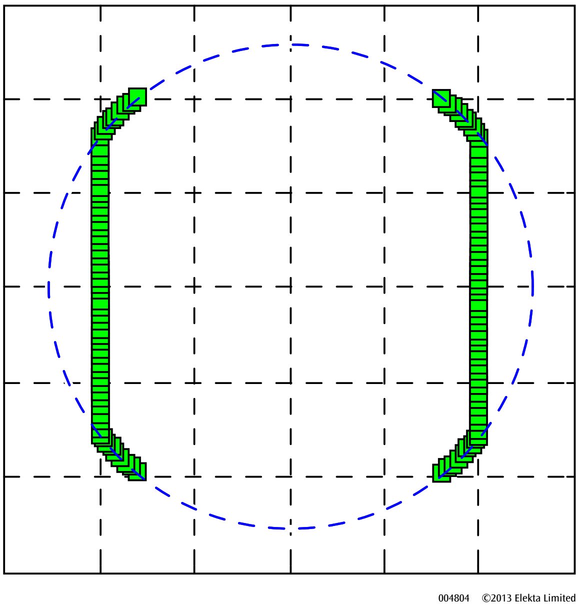

Figure 2.1 Maximum legal leaf positions

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2.2 Technical data

This section has the technical data that is necessary for a physics model.

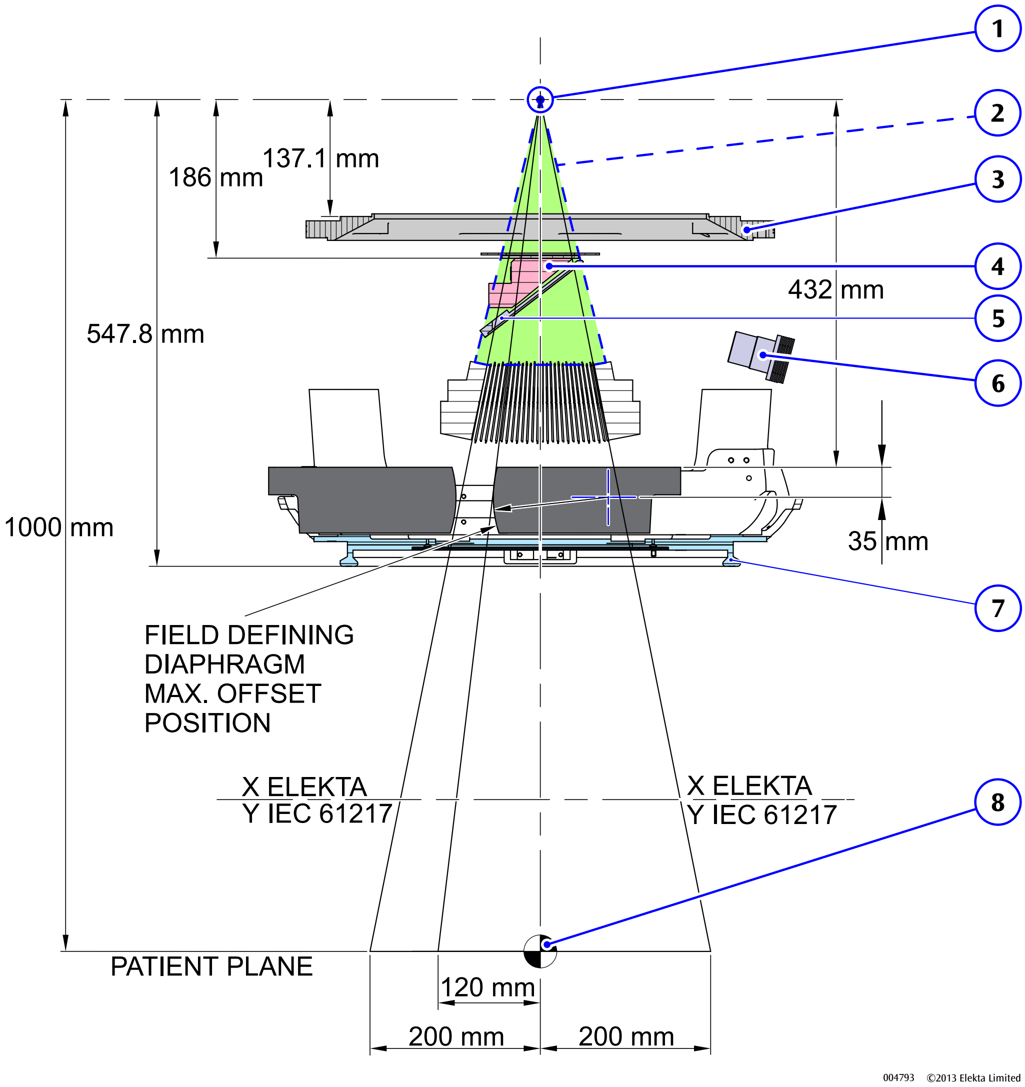

Figure 2.2 Section through head on IEC 'Y' plane (direction perpendicular to leaf travel).

(1)	Target	(5)	Mirror
(2)	27° 48' cone	(6)	Optical system
(3)	Interface ring	(7)	Accessory ring
(4)	Wedge	(8)	Isocenter

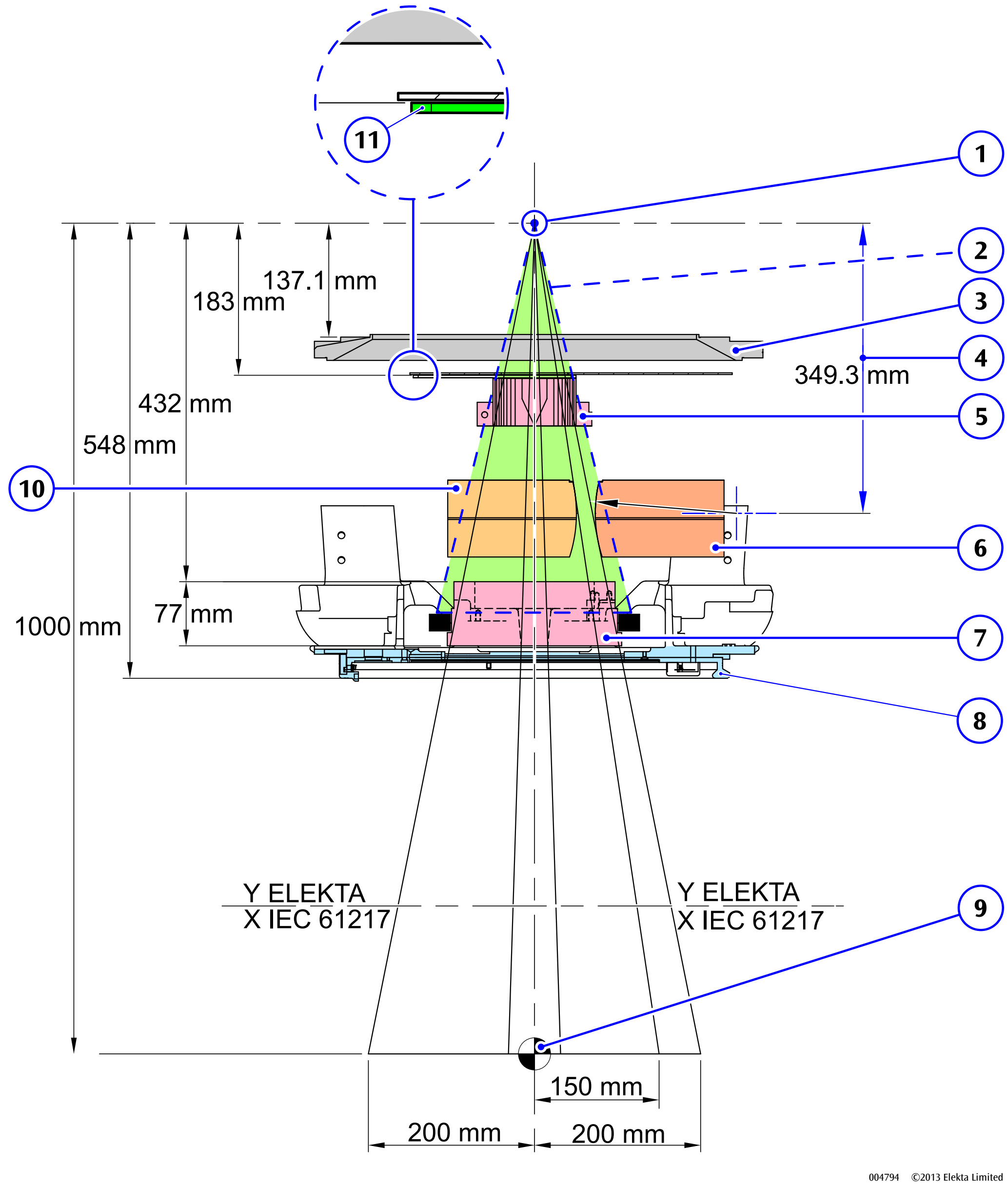

Figure 2.3 Section through head on IEC 'X' plane (direction in line with leaf travel)

(1)	Target	(7)	Diaphragm
(2)	27° 48' cone	(8)	Accessory ring
(3)	Interface ring	(9)	Isocenter
(4)	Distance to center of leaf radius	(10)	Leaf (extended)
(5)	Wedge	(11)	Anti-backscatter plate
(6)	Leaf (retracted)		

Figure 2.4 shows the difference for the X-axis and Y-axis between the Elekta and IEC 61217 co-ordinate systems.

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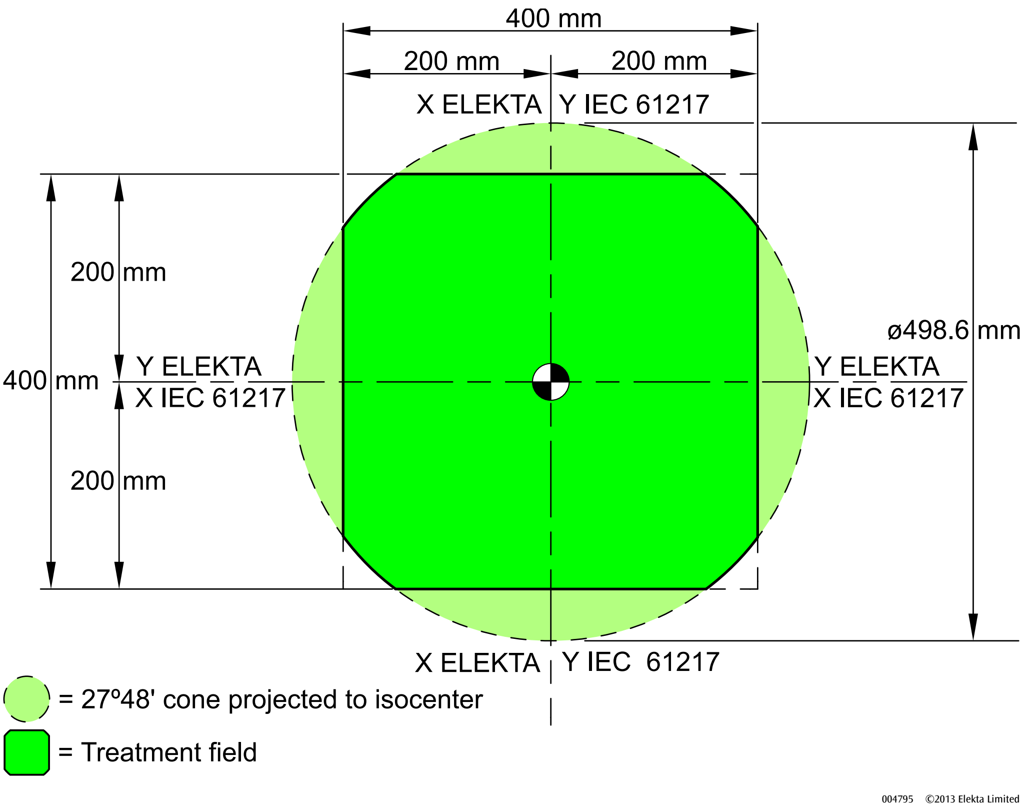

Figure 2.4 Plan view of treatment field

The 27° 48' cone projection is associated with the primary collimator. This is above the interface ring, which is the same for all BLDs.

2.3 Information for add-on BLDs

You must design your TPS so that when a plan is made that uses an add-on beam limiting device (BLD), the correct field size for the integrated beam limiting device (BLD) on the digital accelerator is automatically set by the TPS. This is to limit leakage outside the treatment area.

2.4 Geometry

2.4.1 Geometry of the leaves

The physical height of the leaf is 92.5 mm, however only a part of this is associated with the curvature of the leaf. In addition, the leaf height corresponding to the curved tip is different, depending on which cross-section of the leaf is considered, because of the presence of shaped cut-outs for the guide and the optical marker.

For physics modelling, a leaf height of approximately 90 mm can be assumed, for which other applicable dimensions are shown in **Figure 2.5**. For example, the position of the centre of curvature within the leaf.

The leaf sides are flat and the resulting gaps are de-focussed from the X-ray source. This is to reduce overall transmission. There is a constant leaf gap of 90 µm between the leaves.

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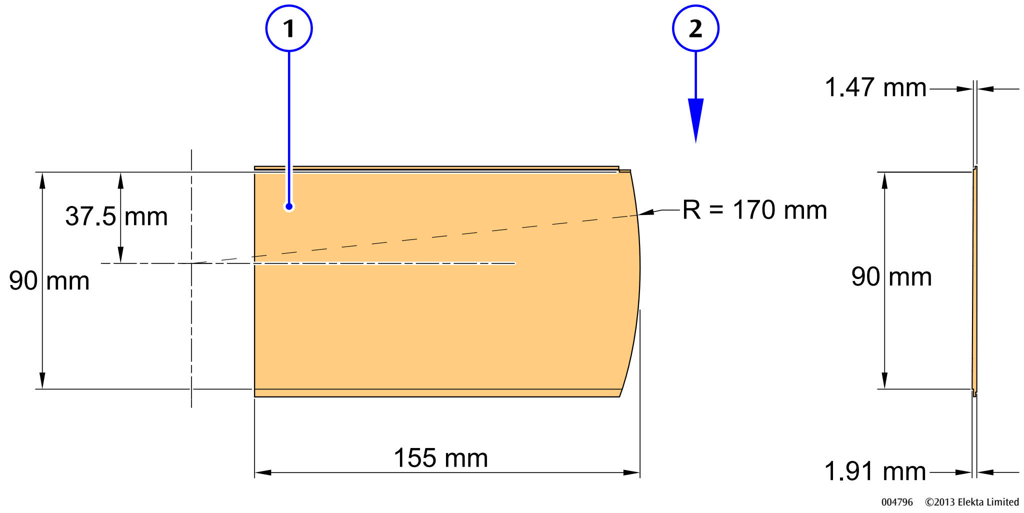

Figure 2.5 Leaf dimensions used for physics calculations

(1) Tungsten leaf (2) Direction of beam

2.4.2 Geometry of the diaphragms

The diaphragms give continuous adjustment of the field size in the Y direction. Without these diaphragms, the adjustments will be in 5 mm steps.

During treatment setup, the diaphragms automatically move to a position specified by the prescription sent from the record and verify (R&V) system. The field is specified by the BLD (see Section through head on IEC 'Y' plane (direction perpendicular to leaf travel)).

The maximum speed for the diaphragms is 9 cm/s when positioning without radiation. When used in a dynamic treatment with the radiation ON, the speed is restricted to 3.5 cm/s.

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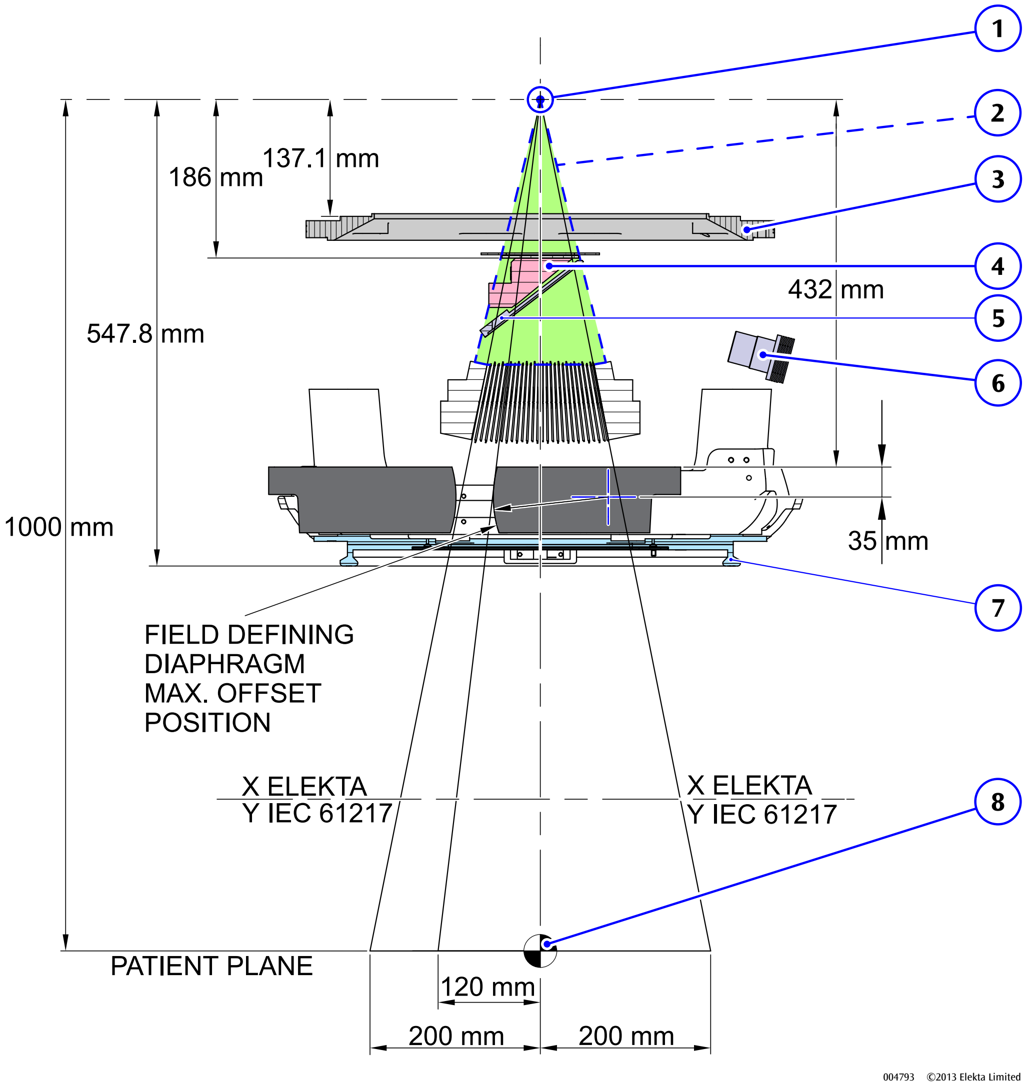

Figure 2.6 *Section through head on IEC 'Y' plane (direction perpendicular to leaf travel).*

(1)	Target	(5)	Mirror
(2)	27° 48' cone	(6)	Optical system
(3)	Interface ring	(7)	Accessory ring
(4)	Wedge	(8)	Isocenter

The diaphragm tip curve (with a radius of 135 mm) does not align with the central axis of the diaphragm height. This optimizes the penumbra across the full range of field sizes and offsets.

The diaphragm dimensions are shown in **Figure 2.7**.

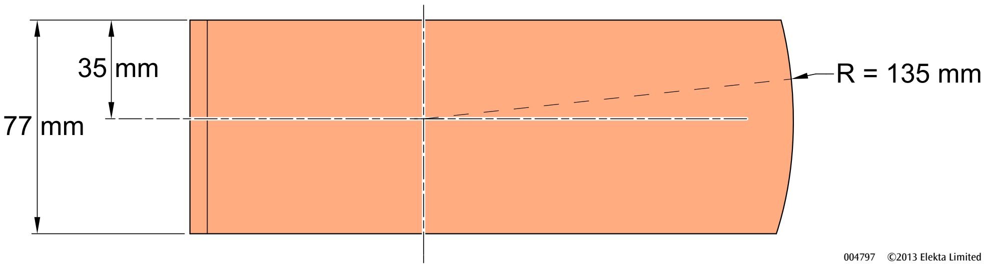

Figure 2.7 *Diaphragm dimensions used for physics calculations*

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2.5 Composition

The composition of the leaf, diaphragms, and wedge are in **Table 2.2**.

Table 2.2 Material composition

Item	Material	Composition	Density
Leaf	Tungsten	W95%, Ni 3.75%, Fe 1.25%	18 g/cm^3
Diaphragm	Tungsten	W95%, Ni 3.75%, Fe 1.25%	18 g/cm^3
Wedge Block	Lead	Pb 96%, Sb 4%	11 g/cm^3

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3 Software Information

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3.1 Leaf behavior

3.1.1 Leaf behavior behind diaphragms

The control system automatically constrains the out of field leaves (the leaves behind the diaphragms) to values that make sure they are put behind the thickest section of the diaphragms. In the **Figure 3.1**, The constraint boundary, (1), is calculated to be within the diaphragm outline projected from the patient side, (2).

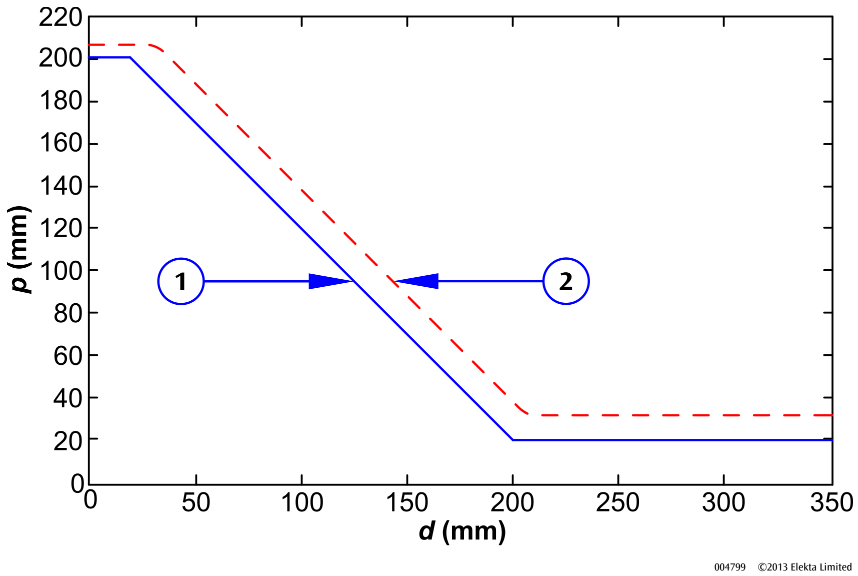

Figure 3.1 Plot of constraint line and physical projection of diaphragm shape

3.1.2 Constant and variable definitions

The constants and variables used to define the constraints are provided in this topic.

Table 3.1 Constants and variables used for constraint definition

Variable\ Constant	Description	Value
d	The positional differential between isocentric leaf side position and the isocentric diaphragm radiation position (in the IEC Y direction) at which you are evaluating the constraint.	N/A
p	The constrained leaf position at isocenter in IEC X direction.	N/A
D_g	The Guard Constraint Distance constant specified at isocenter. The positional differential between isocentric leaf side position and the isocentric diaphragm radiation position (in the IEC Y direction) at which the control system starts to modify the constraint to match the diaphragm shape.	10 mm
D_s	The Out Field Spine Distance constant specified at isocenter.	20 mm
D_{sg}	The Out Field Spine Gap constant specified at isocenter. D_{sg}= 2. D_s	40 mm
D_{clg}	The Closed Leaf Gap constant specified at leaf bank.	1 mm

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These parameters are shown in **Figure 3.2**.

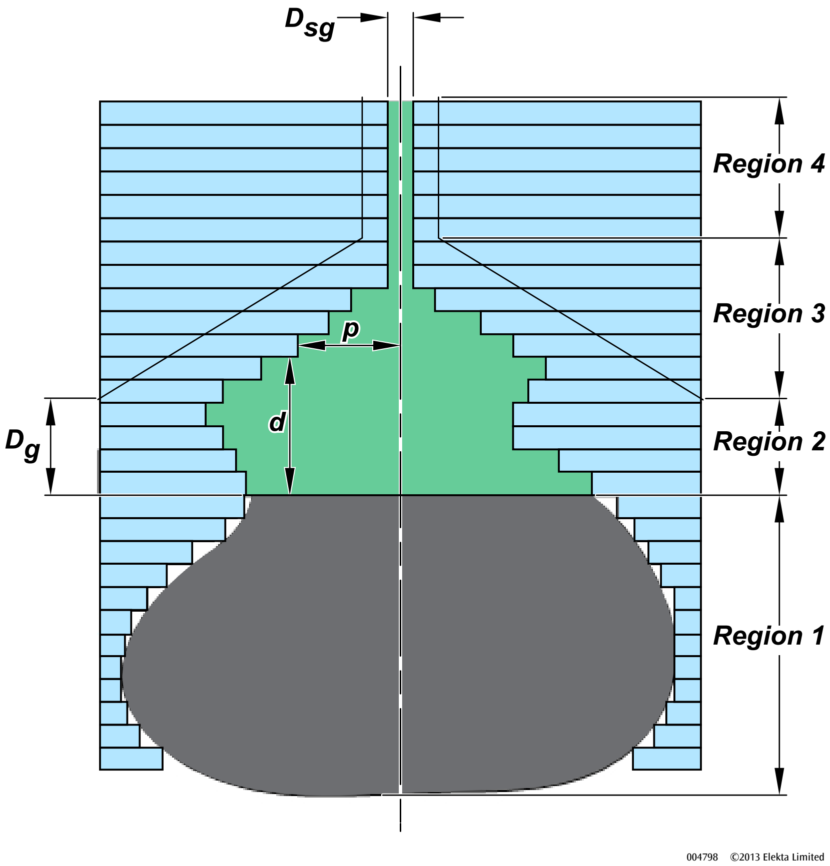

Figure 3.2 Constants and variables used for constraint definition

3.1.3 Order of constraints

The constraints are applied as follows:

1. Leaves in bank IEC X+ constrained by diaphragm Y+
2. Leaves in bank IEC X- constrained by diaphragm Y+
3. Leaves in bank IEC X+ constrained by diaphragm Y-
4. Leaves in bank IEC X- constrained by diaphragm Y-
5. Opposing leaves constrained by Dsg or Dclg

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3.1.4 Leaf position constraints with respect to diaphragms

This information is about the leaf position constraints with respect to diaphragms.

The constraint line is a piecewise linear function shown in **Figure 3.3** and is as follows:

For $d < 0$ p = Refer to maximum legal leaf positions (see Table 3.2) Opposing leaves constrained by Dclg	(Region 1)
For $0 < d \leq Dg$ p = Refer to maximum legal leaf positions (see Table 3.2) Opposing leaves constrained by Dclg	(Region 2)
For $Dg < d$ For $200 - d + Dg \geq 0$ $p = 200 - d + Dg + Ds$ For $200 - d + Dg < 0$ $p = Ds$ Opposing leaves constrained by Dsg	(Region 3) (Region 4)

There are references to **Table 3.2**, which has the maximum legal leaf positions as a function of leaf number.

Table 3.2 Maximum legal leaf positions (in cm)

IEC X Leaf Numbers	Maximum Legal Position (cm)
1	16.10
2	16.70
3	17.30
4	17.80
5	18.30
6	18.80
7	19.20
8	19.70
9 to 72	20.00
73	19.70
74	19.20
75	18.80
76	18.30
77	17.80
78	17.30
79	16.70
80	16.10

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If the opposing leaves constraint is violated, each leaf in the pair is moved outward by an equal amount to form the specified minimum separation unless this would violate the constraint p. In this case the outer leaf is constrained to the position p, and the inner leaf moved to form the minimum required separation.

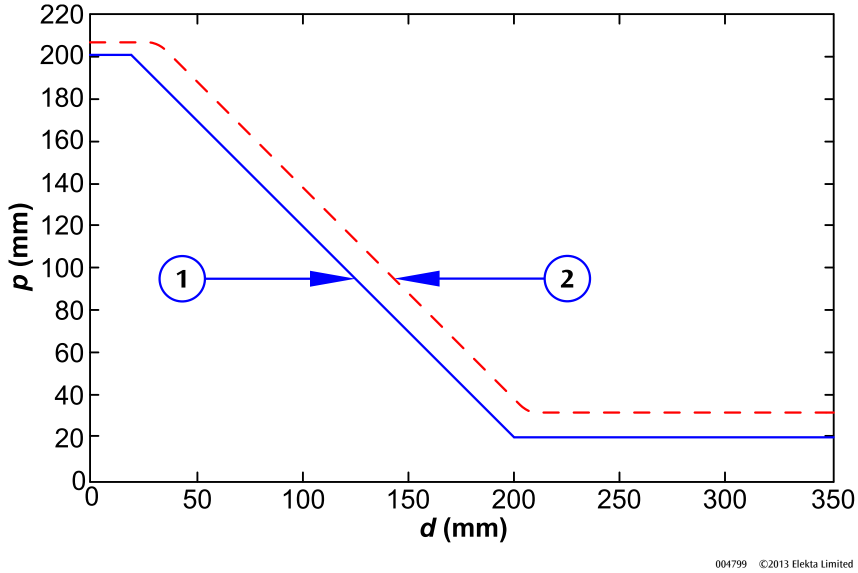

Figure 3.3 *Plot of constraint line and physical projection of diaphragm shape*

(1) Constraint line

(2) Projection of thick section of diaphragm to isocenter

3.1.5 Leaf behavior behind the diaphragms in static mode

This information is about the leaf behavior behind the diaphragms in static mode.

All leaves that are greater than or equal to Dg behind the diaphragm are controlled by the control system.

This is shown as (1) in **Figure 3.4**. This is not a usual prescription from the TPS.

In static mode these leaves are positioned so that there is a gap (Dsg) between opposing leaves, irrespective of their prescribed positions (2).

(3) shows the leaf positions that are sent to the TCS from the TPS or the R&V system. (3) also shows that the first two leaves behind the diaphragm are deliberately offset to show the system behavior.

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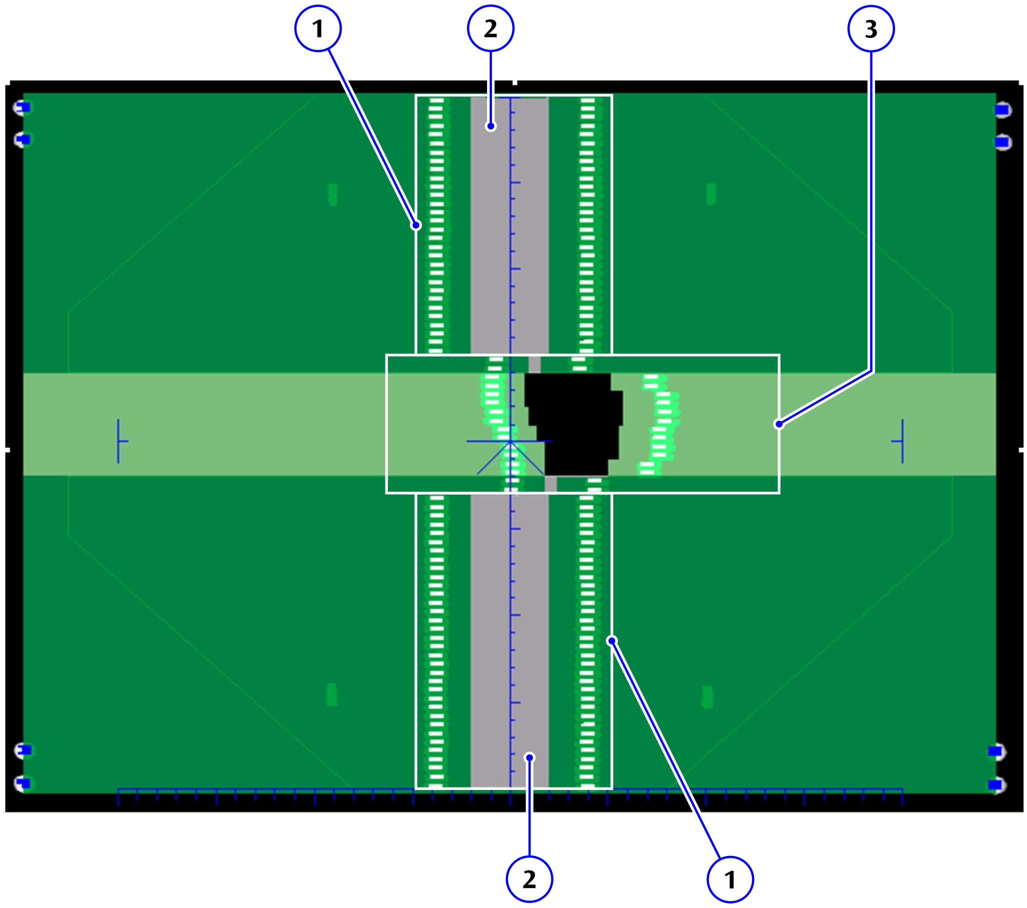

Figure 3.4 Behavior of leaves behind the diaphragms in static mode

3.1.6 Leaf behavior behind diaphragms in dynamic photon mode

This information is about leaf behavior behind diaphragms in dynamic photon mode.

In dynamic mode, the leaves that are greater than or equal to Dg behind the diaphragm, are set to a position dependant on their prescribed position and the distance from the leading edge of the diaphragm. Their actual position (AP) is defined below:

AP = P - [P (x/y)]

Where P is the prescribed position, x is the distance from the Out Field Spine Distance (Ds) and y is the distance to the diaphragm edge minus the Guard Constraint Distance (Dg). If all prescribed leaf positions behind the diaphragm are less than Ds, this causes a fan shape.

Leaf positions are constrained by the rules in **Leaf behavior behind diaphragms** (see Related links).

Figure 3.5 shows that the first two leaves outside of the field are determined by the TPS and R&V system (1). This is not a usual prescription from the TPS. (1) also shows that the first two leaves behind the diaphragm are deliberately offset to show the system behavior.

In (2) the first out of field leaf has been offset but the next is prescribed as closed along the central axis. The other leaves behind the diaphragm (those greater than Dg behind the diaphragm) have been set to closed along the central axis. So the whole fan shape is also symmetrical.

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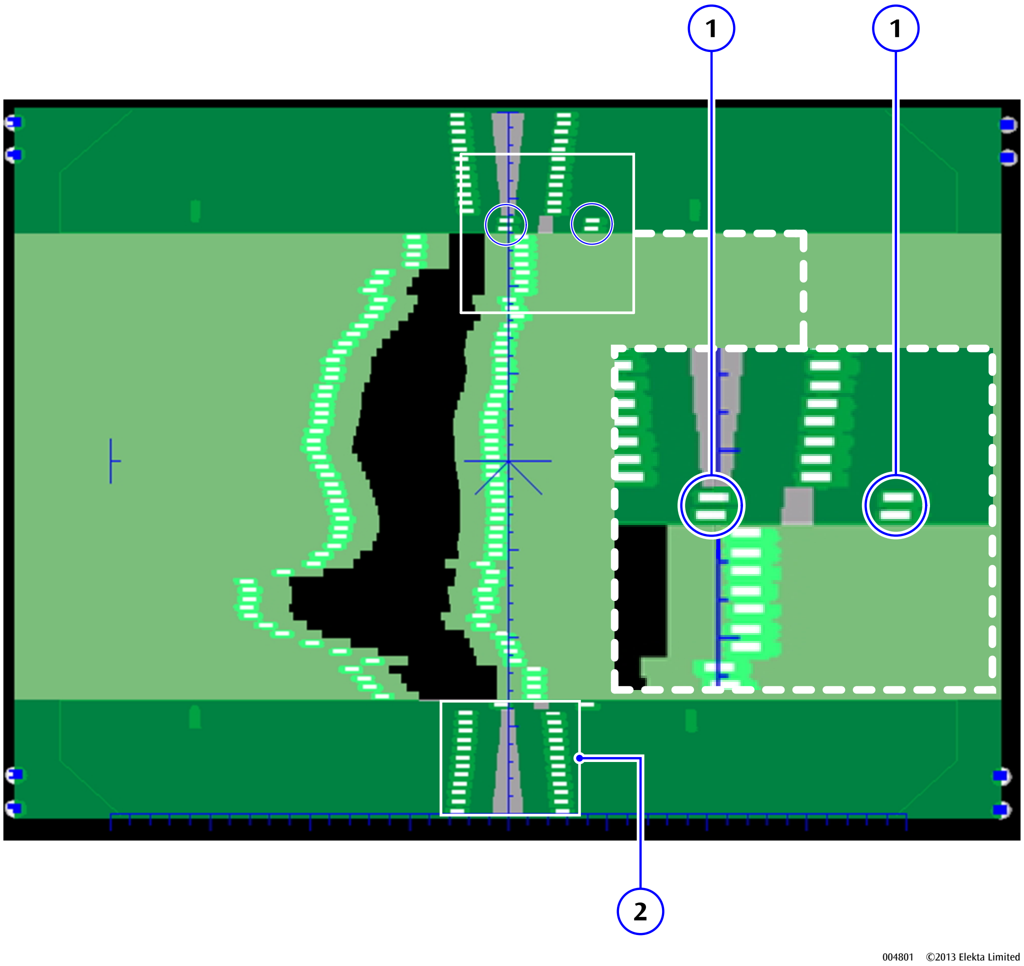

Figure 3.5 Behavior of leaves behind diaphragms in dynamic mode

In **Figure 3.6** the leaf positions (1) are automatically set by the TCS in dynamic mode.

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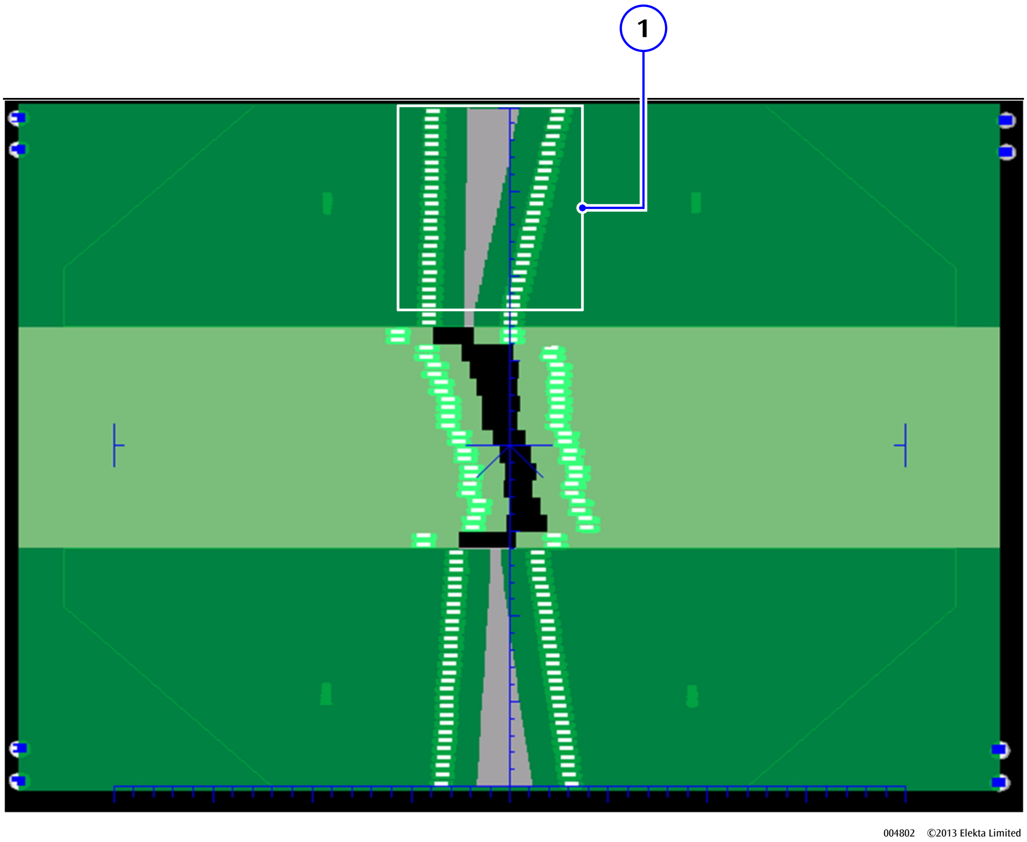

Figure 3.6 Behavior of leaves behind diaphragms in dynamic mode

These prescribed leaf positions are offset from the central axis, so the whole fan shape is offset. This behaviour allows optimal movement of the leaves between the control points.

3.1.7 Guard leaf behavior

This is the description of the behavior of guard leaves on the diaphragms.

Guard leaves are the first leaves behind that diaphragm which are moved to the same position as the last leaf in the field. **Figure 3.7** shows different types of guard leaf behavior, and also when a leaf is not a guard leaf.

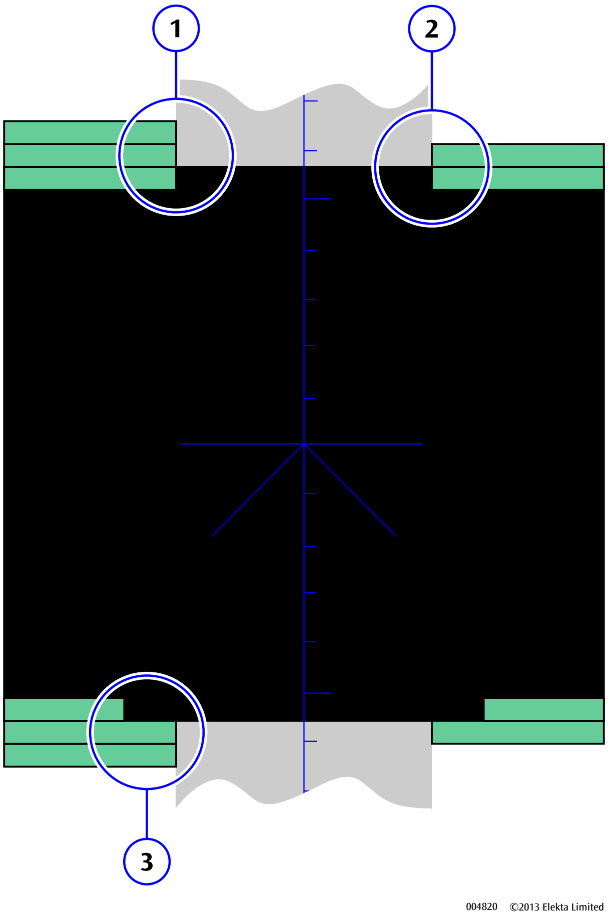

Figure 3.7 Guard leaf behavior

(1) Two guard leaves

(2) One guard leaf

(3) No guard leaf

All leaf positions must be fully specified in the prescription. Because of this, guard leaves are set by the Treatment Planning System (TPS).

The treatment control system has standard beams in Quick Beam that have two guard leaves on each side of the field.

3.1.8 Closed leaf constraint

This information is on the constraints of closed leaves.

When the opposing leaf positions are equal, the leaf pair is considered closed.

There is a minimum leaf separation gap between opposite leaves when prescribed as closed.

When defining a closed position, leaves are constrained by a minimum closed leaf gap parameter. This gap is 1 mm for both static and dynamic shapes.

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This is the distance measured between the leaf tips as measured at the leaf bank.

Equality is established at a precision of 0.1 mm by truncation. For example, 12.77 => 12.7 and 12.71 => 12.7.

This fixed separation is used in all conditions, regardless of offset or gantry angle, to prevent leaf collisions.

This gap parameter is specified at leaf tip level, not at isocenter. Because of the rounded leaf tip design, radiation transmission reduces as the leaf gap is moved away from isocenter. This also causes behavior where isocentric leaf positions will appear to overlap at the isocentric plane (see negative isocentric leaf gap values in **Figure 3.8** and **Figure 3.9**).

The minimum leaf gap measurement at isocenter is dependent on the treatment planning system implementation of closed leaf behavior. Since planning systems have to specify their BLD position through DICOM at the isocenter plane, there are two choices in how to plan for this effect:

1 Apply a constant leaf gap at isocenter, regardless of the leaf position relative to isocenter (recommended minimum isocentric gap of 5 mm)

2 Apply a continuously reducing isocentric leaf gap with distance from isocenter, according to the blue curve in **Figure 3.8**.

Figure 3.8 and **Figure 3.9** show the measured transmission with gap distance from isocenter. Once you reach the transmission you consider closed by the control system, specify the opposing IEC X1 and X2 leaf positions at the same IEC X location ("zero" gap) and leave them at this zero isocentric gap for any positions further off axis. Even though the DICOM reported leaf position will define the leaves as closed, the TCS will automatically set the minimum gap. Under this condition the leakage will be lower than if the leaves were at the same IEC X location, but higher than the bulk transmission through the leaves. The TPS must correctly model this. The center of the leaf gap will be set as the average of the (non-radiation) tip positions if the leaves were in the closed leaf prescribed position.

Note: *Leaf positions are directly calibrated to the radiation field edge (the 50% transmission level) and not the light field edge.*

For more information refer to the documentation of your TPS.

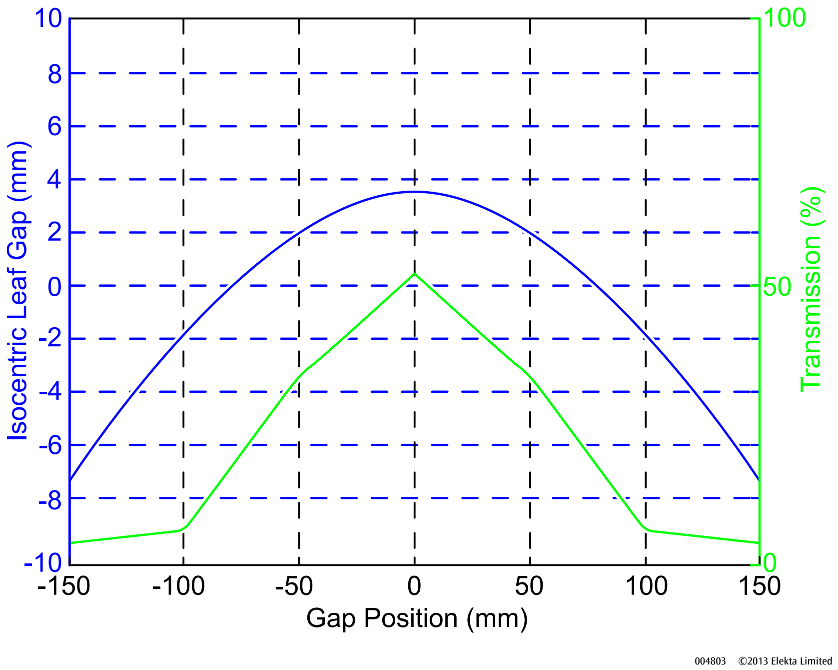

Figure 3.8 Isocentric Leaf Gap and Transmission against Gap Position for a 1 mm gap at leaf tip

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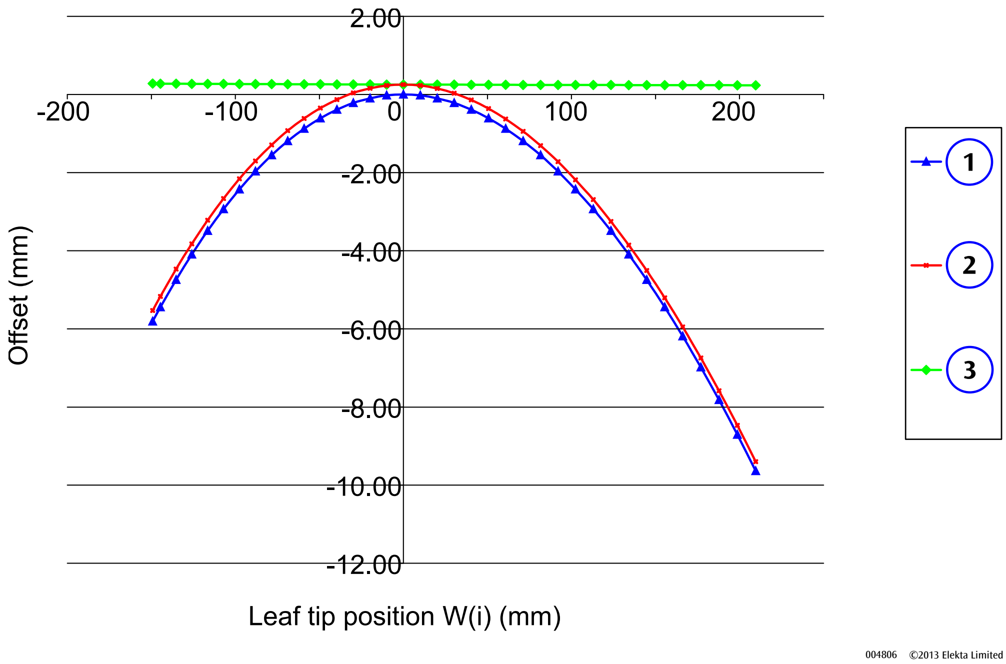

Figure 3.9 *Relationship between the light field, the radiation field, and the leaf tip position*

(1) Light field vs Leaf tip XL(i) - W(i)

(2) Radiation field vs leaf tip XR(i) - W(i)

(3) Radiation field vs Light field XR(i) - XL(i)

3.1.9 Validation rules for photon beams

This is a description of the validation rules for photon beams.

1 All leaf positions must be defined for all control points.

2 The IEC Y diaphragm pair positions must be defined for all control points.

3 The IEC X diaphragm pair positions, if defined, must be specified as fixed at 200 mm.

Note: *It is not necessary to specify these parameters.*

4 The DLG positions must not be specified.

5 The leaf positions must not be more than the maximum legal position. See **Table 3.3**.

6 The differential in leaf positions on a DLG must not exceed the maximum leaf travel range with respect to DLG position (200 mm).

7 The maximum prescribable extended position for any leaf is 150 mm across the field centre.

8 Opposing leaves must have a separation of greater than or equal to 0 mm. Leaf pairs can be prescribed as touching by sending both leaf positions with the same prescribed position anywhere within the normal range of leaf travel (-150 mm to +200 mm).

9 Interdigitation of adjacent opposing leaves is allowed.

10 The IEC Y diaphragm positions must not exceed the maximum field size (200 mm) and the maximum over-travel specification (120 mm).

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11 The IEC Y diaphragm pair positions must be constrained according to the following conditions:

– For wedge IN condition the range is from +150 mm to -120 mm
– For wedge OUT condition the range is from +200 mm to -120 mm

The IEC Y diaphragm pair must have a gap greater than or equal to 5 mm at isocenter.

12 No leaf positions or diaphragm positions shall be specified for electron treatments.

13 The wedge can be specified as out or undefined for electron treatments.

14 Failure to conform to rules 1 to 13 can result in a prescription being rejected.

Table 3.3 Maximum legal leaf positions (in cm)

IEC X Leaf Numbers	Maximum Legal Position (cm)
1	16.10
2	16.70
3	17.30
4	17.80
5	18.30
6	18.80
7	19.20
8	19.70
9 to 72	20.00
73	19.70
74	19.20
75	18.80
76	18.30
77	17.80
78	17.30
79	16.70
80	16.10

3.1.10 Tolerance checking

Leaves behind the diaphragms are not tolerance checked by the R&V system. The reported value may deviate from the prescribed value because of the automatic repositioning of out of field leaves.

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3.1.11 Offsets for leaf and diaphragm tip positions

This section gives the information about differences between the leaf positions from the TCS and the leaf position used for treatment planning. It can be necessary for your TPS system to use a conversion table.

The TCS always uses and displays the radiation field edge for the leaf position. This is calculated during the BLD calibration and uses the 50% transmission level.

If your TPS calculates the plan using the leaf tip or the light field edge (leaf tangent) then you must use the values in **Table 3.4**, and **Table 3.5** to calculate the necessary parameters for your TPS.

To know if this conversion is necessary and which conversions you need to use, refer to the information for your TPS.

The values in **Table 3.4**, and **Table 3.5** represent the offset between the projection of the radiation field and light field edges with respect to the leaf and diaphragm tip projection in the isocenter plane at the i-th position, XR(i)-W(i), and XL(i)-W(i). The offset of the radiation field edge with respect to the light field edge [XR(i)-XL(i)] is also tabulated for the i-th position of the leaf or diaphragm tip W(i).

Figure 3.10 shows the projection in the isocentric plane of:

- XL(i), the light field edge
- XR(i), radiation field edge
- W(i), the leaf tip position

XR(i) is defined by the projection of the beam for which the transverse path is equal to one half-value layer (HVL) in the tungsten leaf or diaphragm.

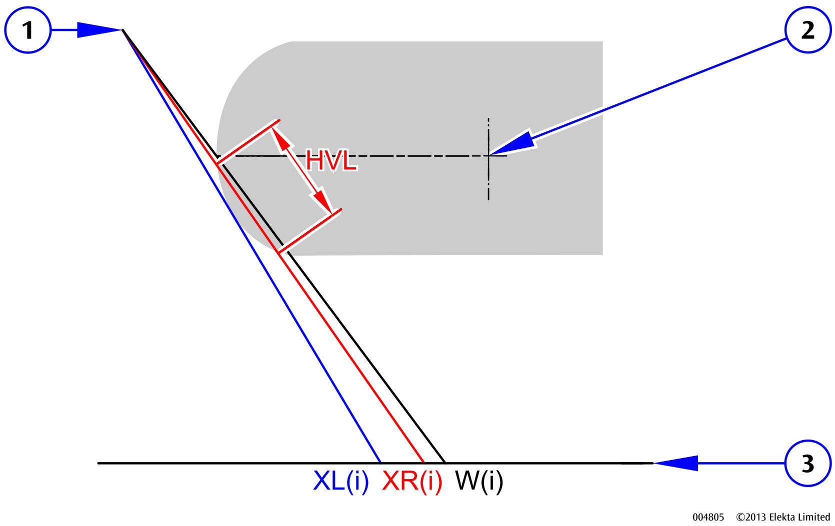

Figure 3.10 Leaf tip position diagram

(1) Radiation source
(2) Center of curvature
(3) Isocenter plane

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Table 3.4 Offsets for leaf tip positions

Leaf tip W(i) (mm)	Light field XL(i) (mm)	Radiation field XR(i) (mm)	Light - Tip XL(i)-W(i) (mm)	Rad - Tip XR(i)-W(i) (mm)	Rad - Light XR(i)-WL(i) (mm)
-149.19	-155	-154.72	-5.81	-5.53	0.28
-144.56	-150	-149.72	-5.44	-5.17	0.28
-135.25	-140	-139.73	-4.75	-4.47	0.28
-125.9	-130	-129.73	-4.1	-3.82	0.27
-116.51	-120	-119.73	-3.49	-3.22	0.27
-107.06	-110	-109.73	-2.94	-2.67	0.27
-97.57	-100	-99.73	-2.43	-2.16	0.27
-88.03	-90	-89.73	-1.97	-1.7	0.27
-78.45	-80	-79.73	-1.55	-1.29	0.27
-68.81	-70	-69.74	-1.19	-0.93	0.26
-59.12	-60	-59.74	-0.88	-0.61	0.26
-49.39	-50	-49.74	-0.61	-0.35	0.26
-39.61	-40	-39.74	-0.39	-0.13	0.26
-29.78	-30	-29.74	-0.22	0.04	0.26
-19.9	-20	-19.74	-0.1	0.16	0.26
-9.98	-10	-9.75	-0.02	0.23	0.25
0	0	0.25	0	0.25	0.25
10.02	10	10.25	-0.02	0.23	0.25
20.1	20	20.25	-0.1	0.15	0.25
30.22	30	30.25	-0.22	0.03	0.25
40.39	40	40.25	-0.39	-0.14	0.25
50.61	50	50.25	-0.61	-0.36	0.25
60.88	60	60.25	-0.88	-0.63	0.25
71.19	70	70.25	-1.19	-0.94	0.25
81.55	80	80.25	-1.55	-1.31	0.25
91.97	90	90.25	-1.97	-1.72	0.25
102.43	100	100.24	-2.43	-2.18	0.24
112.94	110	110.24	-2.94	-2.69	0.24
123.49	120	120.24	-3.49	-3.25	0.24
134.1	130	130.24	-4.1	-3.85	0.24
144.75	140	140.24	-4.75	-4.51	0.24
155.44	150	150.24	-5.44	-5.2	0.24
166.19	160	160.24	-6.19	-5.95	0.24
176.98	170	170.24	-6.98	-6.74	0.24

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Leaf tip W(i) (mm)	Light field XL(i) (mm)	Radiation field XR(i) (mm)	Light - Tip XL(i)-W(i) (mm)	Rad - Tip XR(i)-W(i) (mm)	Rad - Light XR(i)-WL(i) (mm)
187.82	180	180.24	-7.82	-7.58	0.24
198.71	190	190.24	-8.71	-8.47	0.24
209.64	200	200.24	-9.64	-9.4	0.24

Figure 3.11 shows curves for the different types of offset in **Table 3.4**.

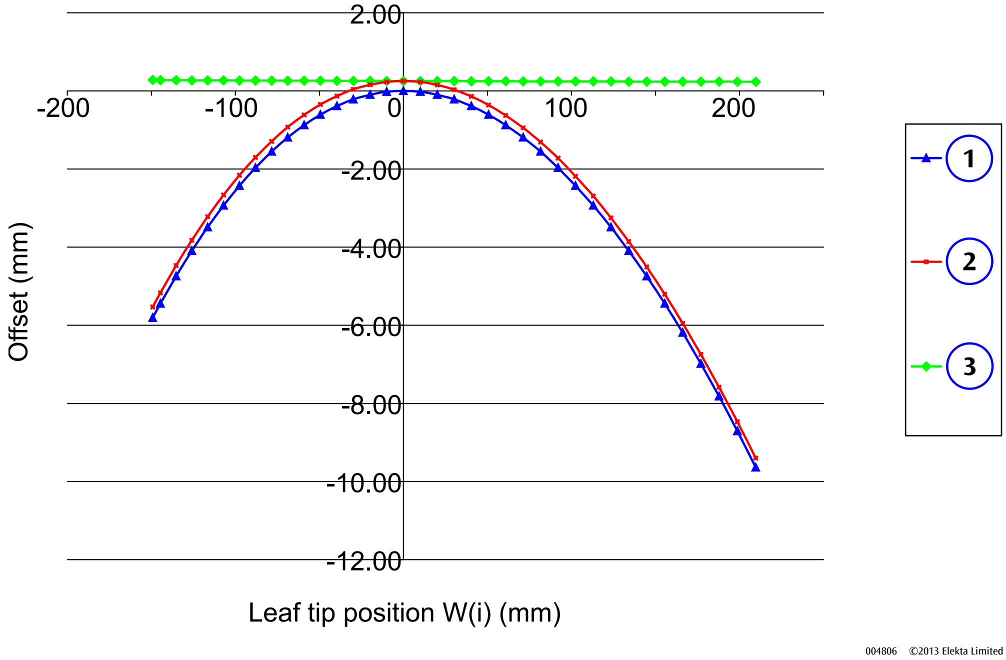

Figure 3.11 Relationship between the light field, the radiation field, and the leaf tip position

(1) Light field vs Leaf tip XL(i) - W(i)

(2) Radiation field vs leaf tip XR(i) - W(i)

(3) Radiation field vs Light field XR(i) - XL(i)

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Table 3.5 Offsets for diaphragm tip positions

Diaphragm Tip position W(i) (mm)	Light Field edge XL(i) (mm)	Radiation Field edge XR(i) (mm)	XL(i)-W(i) (mm)	XR(i)-W(i) (mm)	XR(i)-XL(i) (mm)
-127.57	-130.00	-129.75	-2.43	-2.18	0.25
-117.93	-120.00	-119.75	-2.07	-1.82	0.25
-108.26	-110.00	-109.75	-1.74	-1.49	0.25
-98.56	-100.00	-99.75	-1.44	-1.19	0.25
-88.83	-90.00	-89.75	-1.17	-0.92	0.25
-79.08	-80.00	-79.75	-0.92	-0.68	0.25
-69.29	-70.00	-69.75	-0.71	-0.46	0.25
-59.48	-60.00	-59.76	-0.52	-0.28	0.24
-49.64	-50.00	-49.76	-0.36	-0.12	0.24
-39.77	-40.00	-39.76	-0.23	0.01	0.24
-29.87	-30.00	-29.76	-0.13	0.11	0.24
-19.94	-20.00	-19.76	-0.06	0.18	0.24
-9.99	-10.00	-9.76	-0.01	0.23	0.24
0.00	0.00	0.24	0.00	0.24	0.24
10.01	10.00	10.24	-0.01	0.22	0.24
20.06	20.00	20.24	-0.06	0.18	0.24
30.13	30.00	30.24	-0.13	0.11	0.24
40.23	40.00	40.24	-0.23	0.01	0.24
50.36	50.00	50.24	-0.36	-0.13	0.24
60.52	60.00	60.24	-0.52	-0.28	0.24
70.71	70.00	70.24	-0.71	-0.47	0.24
80.92	80.00	80.24	-0.92	-0.69	0.24
91.17	90.00	90.23	-1.17	-0.93	0.23
101.44	100.00	100.23	-1.44	-1.21	0.23
111.74	110.00	110.23	-1.74	-1.51	0.23
122.07	120.00	120.23	-2.07	-1.84	0.23
132.43	130.00	130.23	-2.43	-2.20	0.23
142.82	140.00	140.23	-2.82	-2.59	0.23
153.23	150.00	150.23	-3.23	-3.00	0.23
163.68	160.00	160.23	-3.68	-3.44	0.23
174.15	170.00	170.23	-4.15	-3.91	0.23
184.64	180.00	180.23	-4.64	-4.41	0.23
195.17	190.00	190.23	-5.17	-4.94	0.23
205.72	200.00	200.23	5.72	-5.49	0.23

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Figure 3.12 shows curves for the different types of offset in **Table 3.5**.

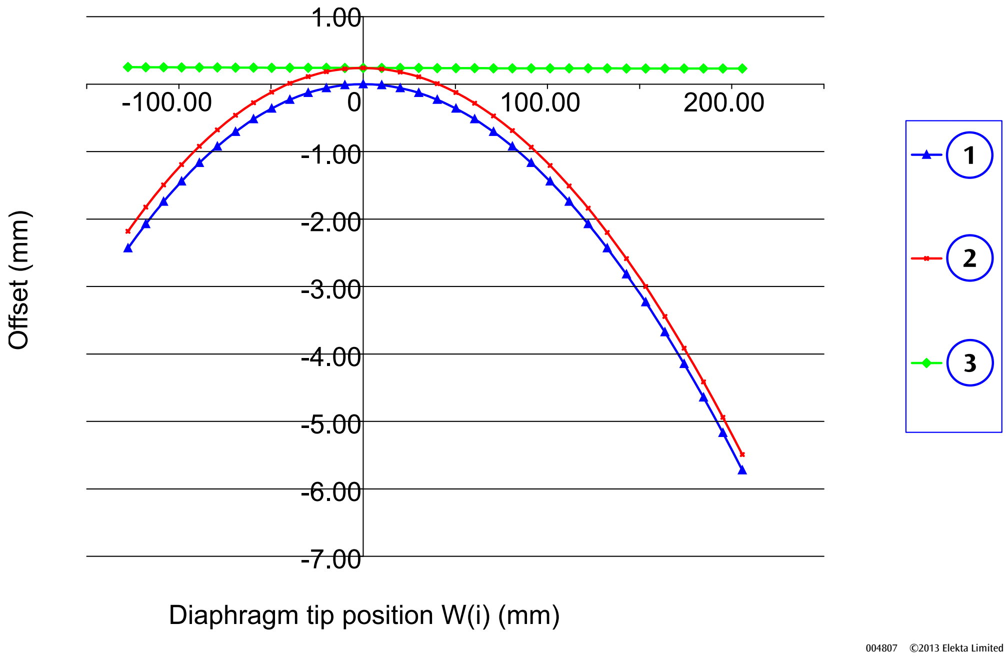

Figure 3.12 Relationship between the light field, the radiation field, and the diaphragm tip position

(1) Light field vs diaphragm tip XL(i) - W(i))

(2) Radiation field vs diaphragm tip XR(i) - W(i)

(3) Radiation field vs Light field XR(i) - XL(i)

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