Lec 4: Film Properties د.هبة عزت بيرم

➢ Film properties include density, contrast and details or definition:

- The ideal dental radiograph is not too light and not too dark. The quality of a dental radiograph is determined by its image characteristics. The image characteristics of a dental radiograph include the visual characteristics of proper density and contrast as well as the geometric characteristics of sharpness with minimal magnification and distortion.

❖ 5 Principles of shadow casting must observe during the film exposure:

1. Source of radiation should be as small as possible
2. Tube-object distance should be as great as possible
3. Object-film distance should be as small as possible
4. Film should be parallel to an easily identifiable plane of the object
5. Central ray of the beam should be perpendicular to the film

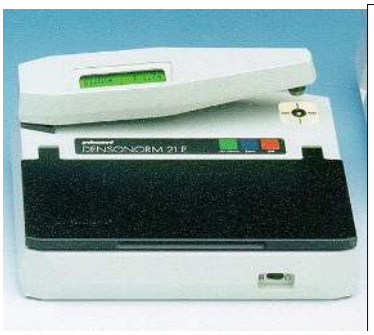
➢ The first 3 principles deal with image sharpness while the last 2 principles required during exposure as a technique.

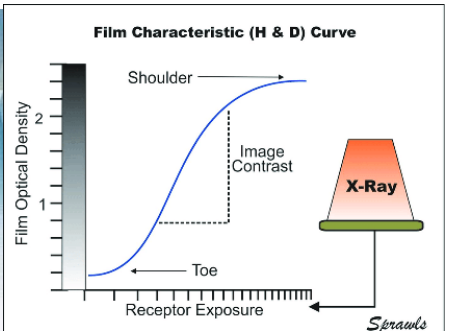
1- Density: is the degree of blackness present in the processed film. Film density used in diagnostic radiograph ranging from (0.25 to 2).

Sensitometry: is the study of the relationship between the intensity of exposure of the film and the blackness after film processing.

Film density measured by **sensitometer or densitometer**, and its relationship with radiation exposure is represented by (H & D curve) (Hurter and Driffield). The more film exposure, the blacker it becomes when processed.

The optical density OD of unexposed film are due to base density and fog density (background fog density). The base density is the OD inherent in the film base and its due to the composition of the base and the tint added to it to make the radiograph more pleasing to eye (it's about 0.1), while fog density is related to the development of silver grains that contain no useful information, it results from exposure of film during storage, undesirable chemical contamination, improper processing (should not exceed 0.2).





Factors affecting film density:

I. **Exposure time:** increase exposure time increase film density.
II. **Milliamper:** increase mA which range from (10-15mA) increase film density.
III. **Kilovoltage:** increase kV will increase density.
IV. **Developing time:** increase developing time which range from (4-5min) increase film density.
V. **Distance:** increase distance between X- ray tube and film will decrease film density.
VI. **Subject thickness:** thick patient needs more radiation than thin patient.

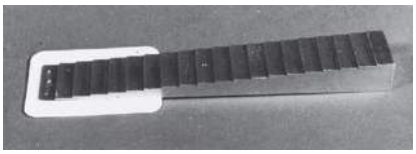
Visual Characteristic	Influencing Factors	Effect of Influencing Factors
Density	mA	↑ mA = ↑ density ↓ mA = ↓ density
	kVp	↑ kVp = ↑ density ↓ kVp = ↓ density
	Time	↑ Time = ↑ density ↓ Time = ↓ density
	Subject thickness	↑ Thickness = ↓ density ↓ Thickness = ↑ density
Contrast	kVp	↑ kVp = long-scale contrast; low contrast ↓ kVp = short-scale contrast; high contrast

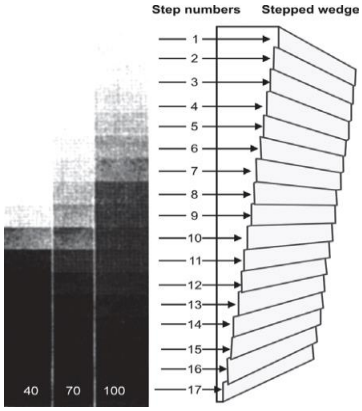
2- Contrast: means the graduation of differences in film density at different areas of a radiograph.

Types of contrast:

A. **Long-scale or low contrast:** when many different film densities can be seen between totally clear and totally black areas of the radiograph.
B. **short-scale or high contrast:** when few different film densities can be seen between totally clear and totally black areas of the radiograph.

The stepwedge or penetrometer: Is an object used to show the radiographic contrast. It is made by aluminum & is constructed so that there is a constant increase in thickness of aluminum between X- ray tube and film.





Radiographs taken at 40 kVp are predominantly black and white- that is they have high contrast (a short contrast scale). Those taken at 100 kVp show many shades of gray (a long contrast scale)



Factors affecting contrast:

I. **Kilovoltage:** when increased, the contrast scale will become long and the contrast will be decreased because an X-ray beam with high energy (kVp) penetrates all tissues more evenly, giving less contrast.

II. **Processing solution temperature:** when increased, the contrast scale will be shortened and produce an image with high contrast.

Kilovoltage	Contrast	Scale of Contrast
High (>90 kVp)	Low	Long-scale
Low (<70 kVp)	High	Short-scale

kVp, kilovoltage peak.

B- Geometric Characteristics:

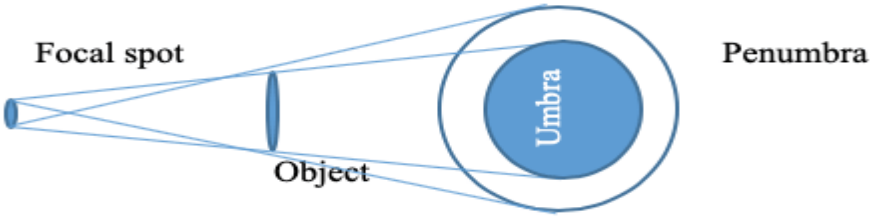
Three geometric characteristics of the radiographic image **[sharpness, magnification, and distortion]** influence the diagnostic quality of a dental radiograph. These geometric characteristics must be **minimized** to produce an accurate radiographic image.

1. Sharpness: (also known as detail, resolution, or definition)

Refers to the capability of the receptor to reproduce the distinct outlines of an object. In other words, sharpness refers to how well the smallest details of an object are reproduced on a dental radiograph.



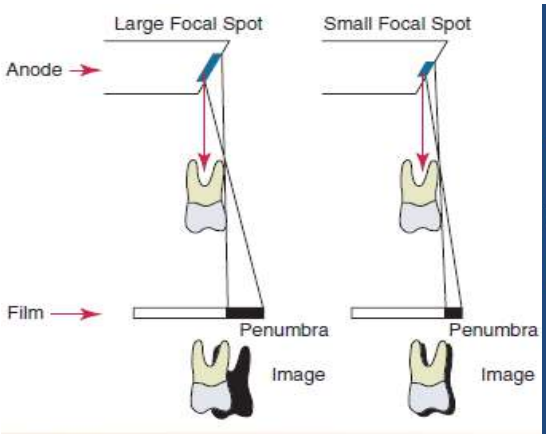
Description: A certain lack of image sharpness, or unsharpness, is present in every dental image. The unclear area that surrounds a radiographic image is termed **penumbra** (from the Latin pene, meaning "almost," and umbra, meaning "shadow"). Penumbra can be defined as the unsharpness, or blurring, of the edges of a radiographic image.

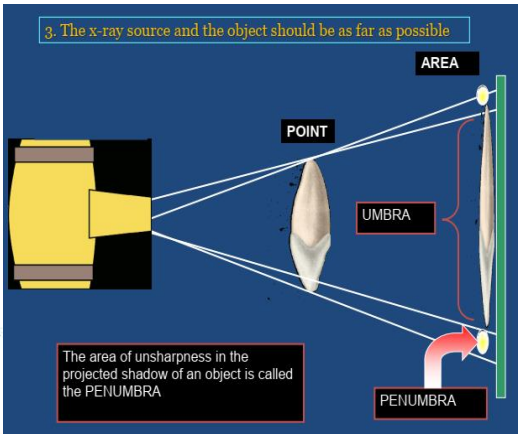


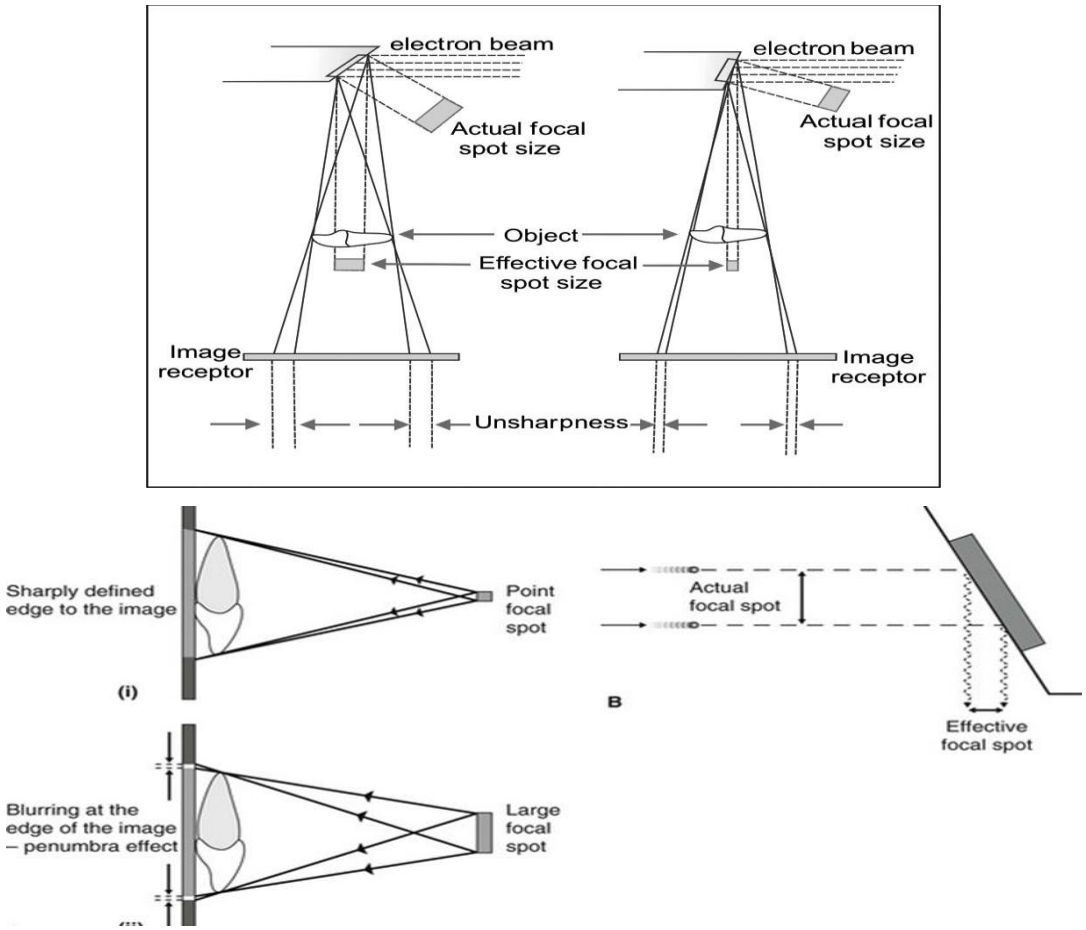
Influencing Factors: The sharpness of an image is influenced by the following three factors:

- Focal spot size
- Film composition
- Movement

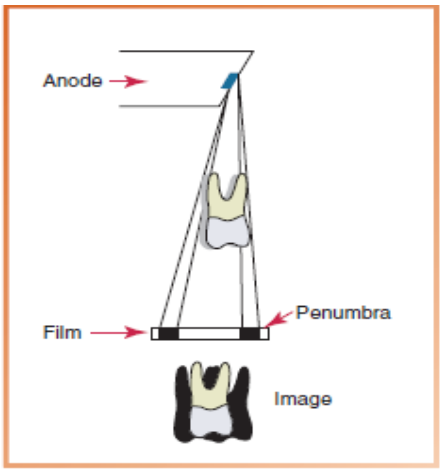
❖ **<u>Focal Spot Size:</u>** the tungsten target of the anode serves as a **focal spot**. The size of the focal spot ranges from 0.6 to 1.0 mm^2. Sharper the image appears; the smaller the focal spot area.

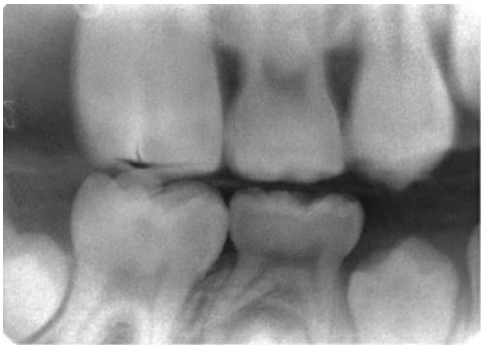






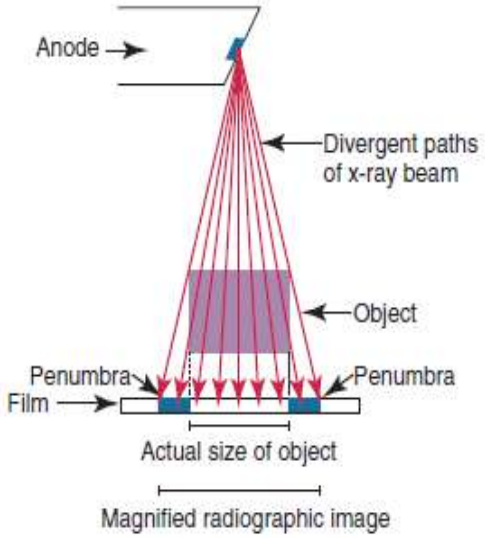
- **<u>Film Composition:</u>** The composition of the film emulsion influences sharpness. Sharpness is relative to the size of the crystals found in the film emulsion. The emulsion of *faster film* contains larger crystals that produce <u>less image sharpness</u>, whereas *slower film* contains smaller crystals that produce <u>more image sharpness</u>. <u>Unsharpness occurs because the larger crystals do not produce object outlines as well as smaller do</u>.
- **<u>Movement:</u>** Movement influences image sharpness. A loss of image sharpness occurs if the tube-head, the receptor, or the patient moves during x-ray exposure. Even slight amounts of movement result in Unsharpness.





2. Magnification:

Image **magnification** or enlargement of a radiographic image refers to a radiographic image that appears larger than the actual size of the object. Magnification, results from the divergent paths of the x-ray beam. X-rays travel in diverging straight lines as they radiate from the focal spot. Because of these diverging paths, some degree of image magnification is present in every dental radiograph.

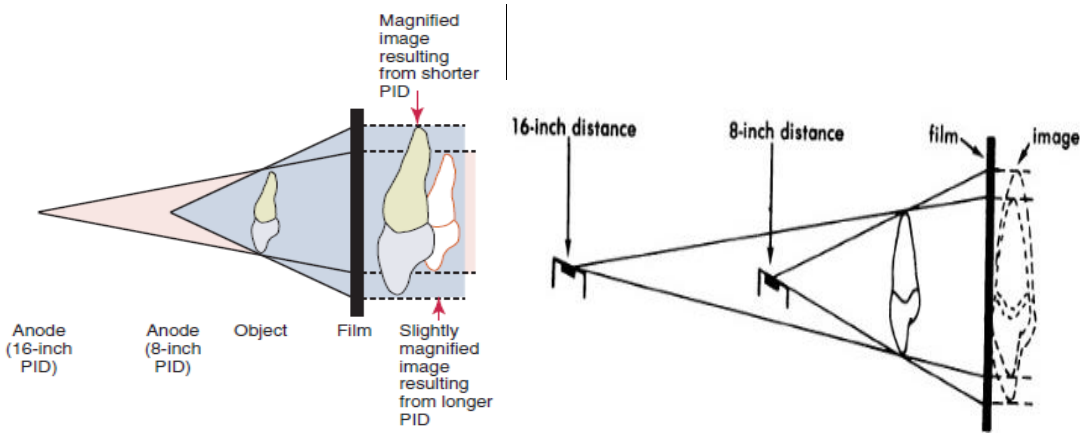


Influencing Factors: The image magnification on a dental radiograph is influenced by the following:

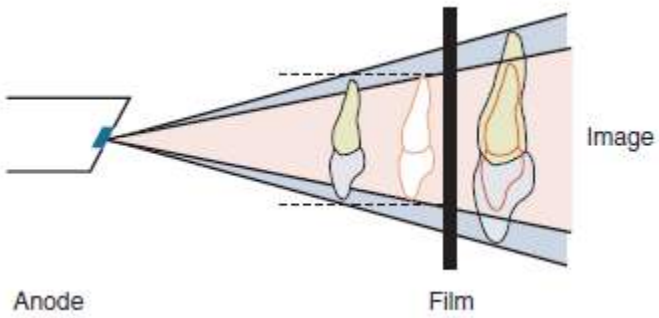
- Target–receptor distance
- Object–receptor distance

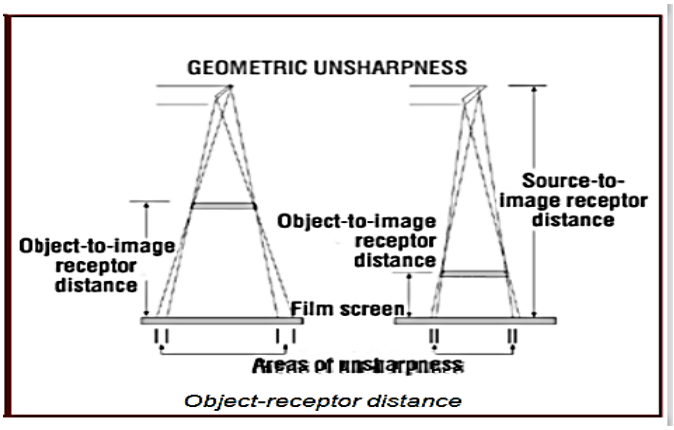
❖ **Target-Receptor Distance:** (also known as the source-to-receptor distance) is the distance between the source of x-rays (focal spot on the tungsten target) and the image receptor.

The target–receptor distance is determined by **length of the position-indicating device (PID)**. When a longer PID is used, more parallel rays from the middle of the x-ray beam strike the object rather than the diverging x-rays from the periphery of the beam. As a result, a longer PID and target– receptor distance result in less image magnification, and a shorter PID and target–receptor distance result in more image magnification.



❖ **Object–Receptor Distance:** Is the distance between the object being radiographed (tooth) and the image receptor. The tooth and the receptor should always be placed as close together as possible. The closer the tooth is to the receptor, the less is the enlargement of the image. A decrease in object–receptor distance results in a decrease in magnification, and an increase in object– receptor distance results in an increase in image magnification**.**





3. Distortion

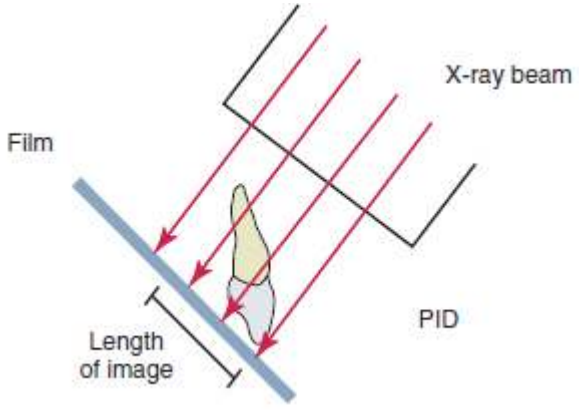
Dimensional **distortion** of a radiographic image is a variation in the true size and shape of the object being radiographed. A distorted image does not have the same size and shape as the object being radiographed.

Description: A distorted image results from the unequal magnification of different parts of the same object. Distortion results from improper receptor alignment or beam angulation.

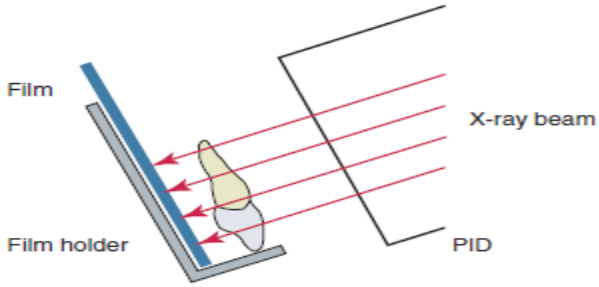
Influencing Factors: The dimensional distortion of a radiographic image is influenced by the following:

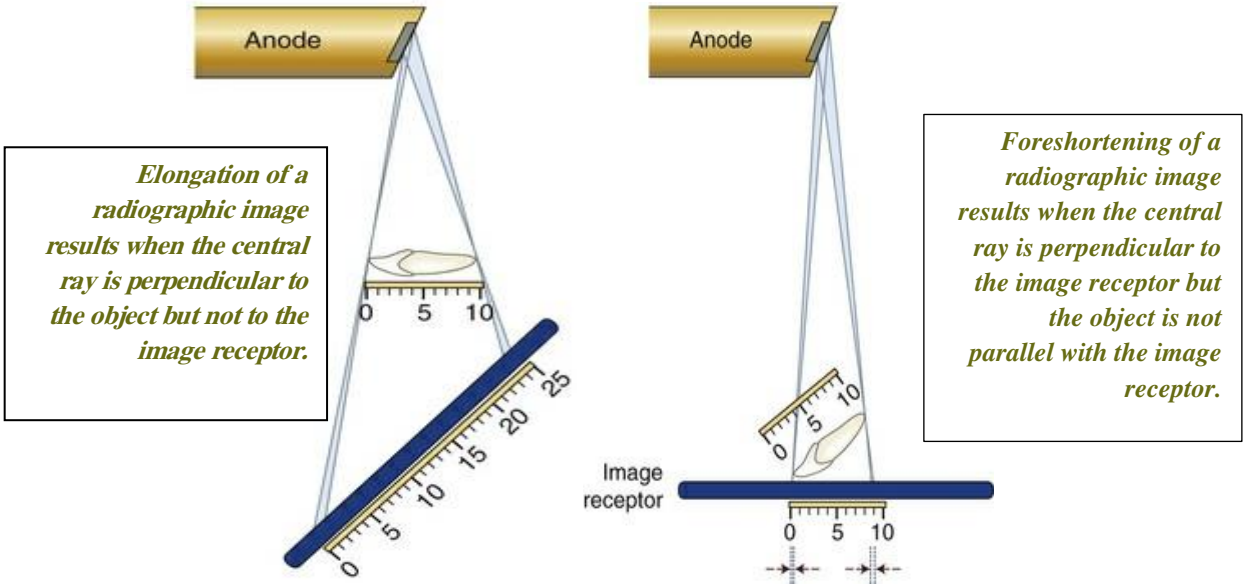
- Object–receptor alignment
- X-ray beam angulation

❖ **Object–Film Alignment:** To minimize dimensional distortion, the object and receptor must be parallel to each other. If the object (tooth) and receptor are not parallel, an angular relationship results. An angular relationship produces a variation of distances between the tooth and the receptor that result in a distorted image. A distorted image may appear too long or too short.



❖ **X-Ray Beam Angulation:** To minimize dimensional distortion, the x-ray beam must be directed perpendicular to the tooth and the receptor. The central ray of the x-ray beam must be as nearly perpendicular to the tooth and receptor as possible to record the adjacent structures in their true spatial relationships.





Elongation of a radiographic image results when the central ray is perpendicular to the object but not to the image receptor.

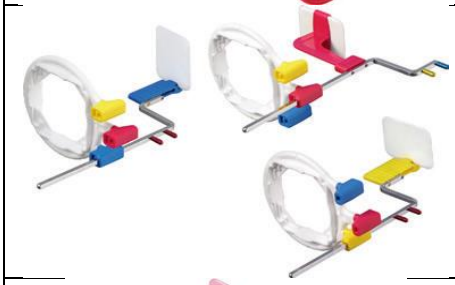
Foreshortening of a radiographic image results when the central ray is perpendicular to the image receptor but the object is not parallel with the image receptor.

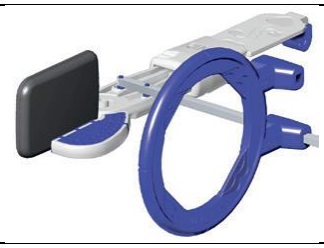
Dental X-Ray Film Holders and Beam Alignment Devices:

A **film holder** is a device used to hold and align intraoral dental x-ray films in the mouth. Film holders eliminate the need for the patient to stabilize the film. The use of receptor holders is strongly recommended for a variety of reasons, including avoiding the use of the patient's (or operator's) finger to hold the receptor. In the paralleling technique, the receptor must be held in its proper position by one of a variety of receptor-holding devices all serving one purpose to position the receptor parallel to the long axis of the tooth.

The **localizing rings** on paralleling receptor-holding devices align the PID with the receptor in both the horizontal and vertical planes, helping reduce the incidence of **collimator cutoff** (known as *cone cutting*).

For use in conjunction with a beam alignment device, a **collimating device**, which is a metal plate with an opening, can be used to restrict the size of the beam.

	Rinn XCP conventional instruments (blue: anterior; yellow: posterior; red: bite-wing; green: endodontics).
	Rinn XCP-ORA devices.
	Rinn Flip-Ray eliminates the need for multiple devices.
	Rinn Snap-A-Ray is color coded.
	Disposable Stabe bite block.

	Snap-a-Ray Bisecting option for sensor with arm and ring kit attached.

Geometric Characteristic	Influencing Factors	Effects of Influencing Factors
Sharpness	Focal spot size	↓ Focal spot size = ↑ sharpness
		↑ Focal spot size = ↓ sharpness
	Film composition	↓ Crystal size = ↑ sharpness
		↑ Crystal size = ↓ sharpness
	Movement	↓ Movement = ↑ sharpness
		↑ Movement = ↓ sharpness
Magnification	Target–receptor distance	↑ Target–receptor distance = ↓ magnification
		↓ Target–receptor distance = ↑ magnification
	Object–receptor distance	↑ Object–receptor distance= ↑ magnification
		↓ Object–receptor distance = ↓ magnification
Distortion	Object–receptor alignment	Object and receptor parallel = ↓ distortion
		Object and receptor not parallel = ↑ distortion
	X-ray beam angulation	Beam perpendicular to object and receptor = ↓ distortion
		Beam not perpendicular to object and receptor = ↑ distortion