



Radiographic Principles and Practice

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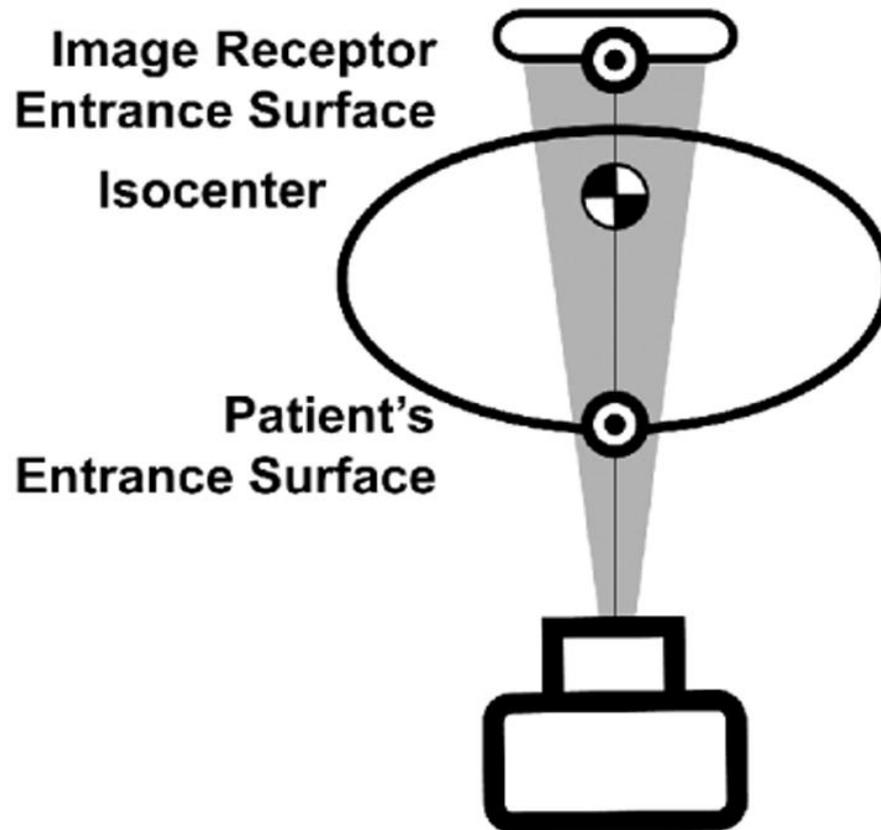


Figure 2.1 Patient and image receptor dose measuring points. Dose measurements referenced to the point at which the x-ray beam enters the patient are useful for estimating patient radiation risks. Measurements referenced to the image receptor entrance can be used to manage image quality.

The Angiographic Room

- The room should be at least 500 sq feet (47 sq meters) with a ceiling height of at least 10 feet (3 meters).
- Installation of radiologic equipment mandates that the walls of the room be shielded with lead to a minimum height of 7 feet.

X-Ray Cinematography

- The incorporation of cine pulsing systems has overcome this problem, since they permit control of the length of exposure and regulate x-ray photon flow from the radiographic tube to the image intensifier input the action t surface in synchronization with the action of the cine camera.

Radiographic Exposures

- The first is the electrical current expressed in milliamperes (mA), which determines the number of x-ray photons generated per unit time.
- The second factor is the level of kilovolt (kV), which determines the energy spectrum of the x-ray photons produced.

Automatic Exposure Control

- It is essential for cardiac angiography to incorporate an *automatic brightness stabilization* system that will compensate rapidly for changes in x-ray attenuation.

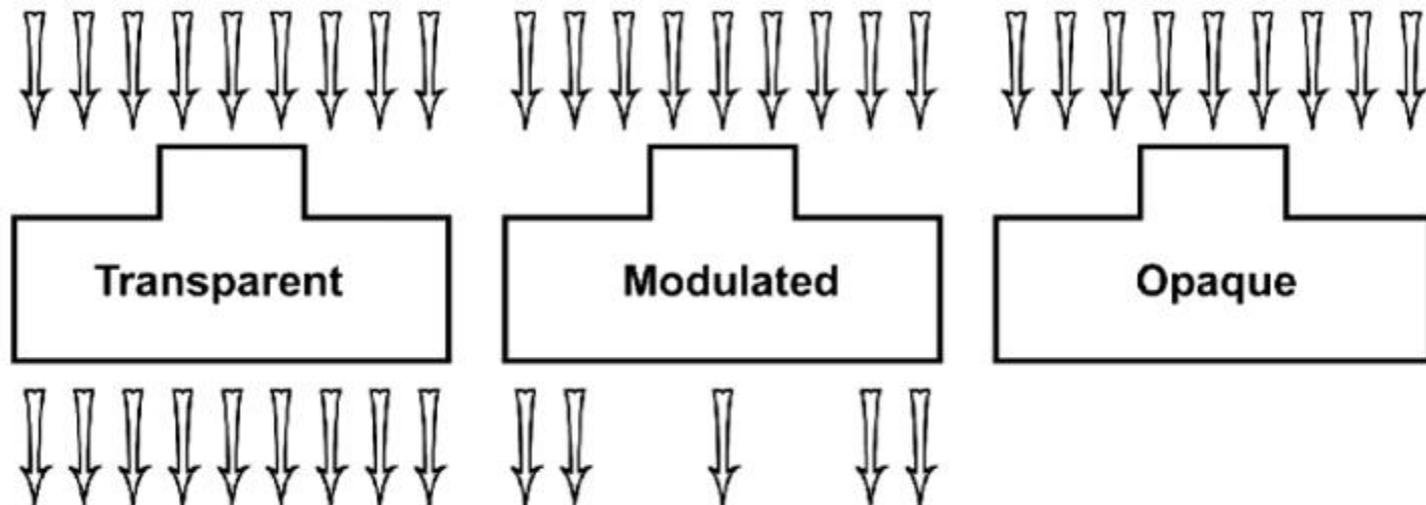


Figure 2.2 Beam modulation. Total transmission of the x-ray beam produces a uniform signal. Total attenuation produces a silhouette. Image formation requires attenuation of a portion of the x-ray beam. Thus patient dose is unavoidable (see reference 5).

Generator

- The basic construction of a generator of a consists of transformer wires that are placed in a large tank and submerged in oil for cooling and insulation. Incorporated into the system are rectifiers, which convert the alternating direct current that feeds the x-ray tube.

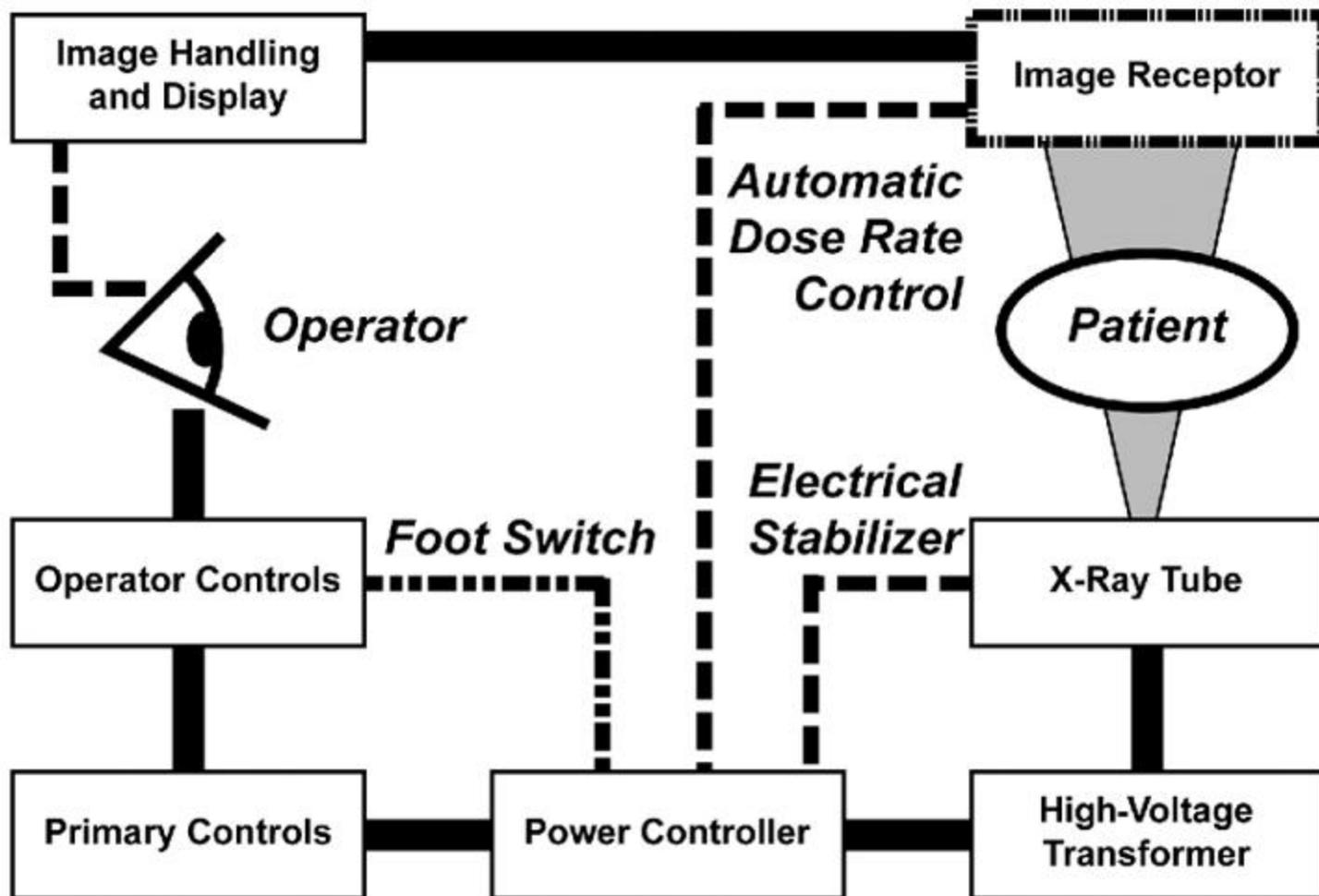


Figure 2.4 Generator and feedback schematic. Modern generators rely on a large number of feedback loops to manage radiation dose and stabilize image quality. The operator provides the final control loop by managing system resources.

X-Ray Tubes

- Electrons liberated from the heated filament of cathode are accelerated toward the slanted surface of the rapidly rotating anode. On impact with the target material, the electron flow generates x-ray photons leaving the x-ray tube in the direction of the tube window.
- Given the optimal values for tube tension (70 to 80 kV) and exposure time (3 to 6 msec) for cardiac angiography, x-ray tubes capable of high current (600 to 1000 mA) are desirable.

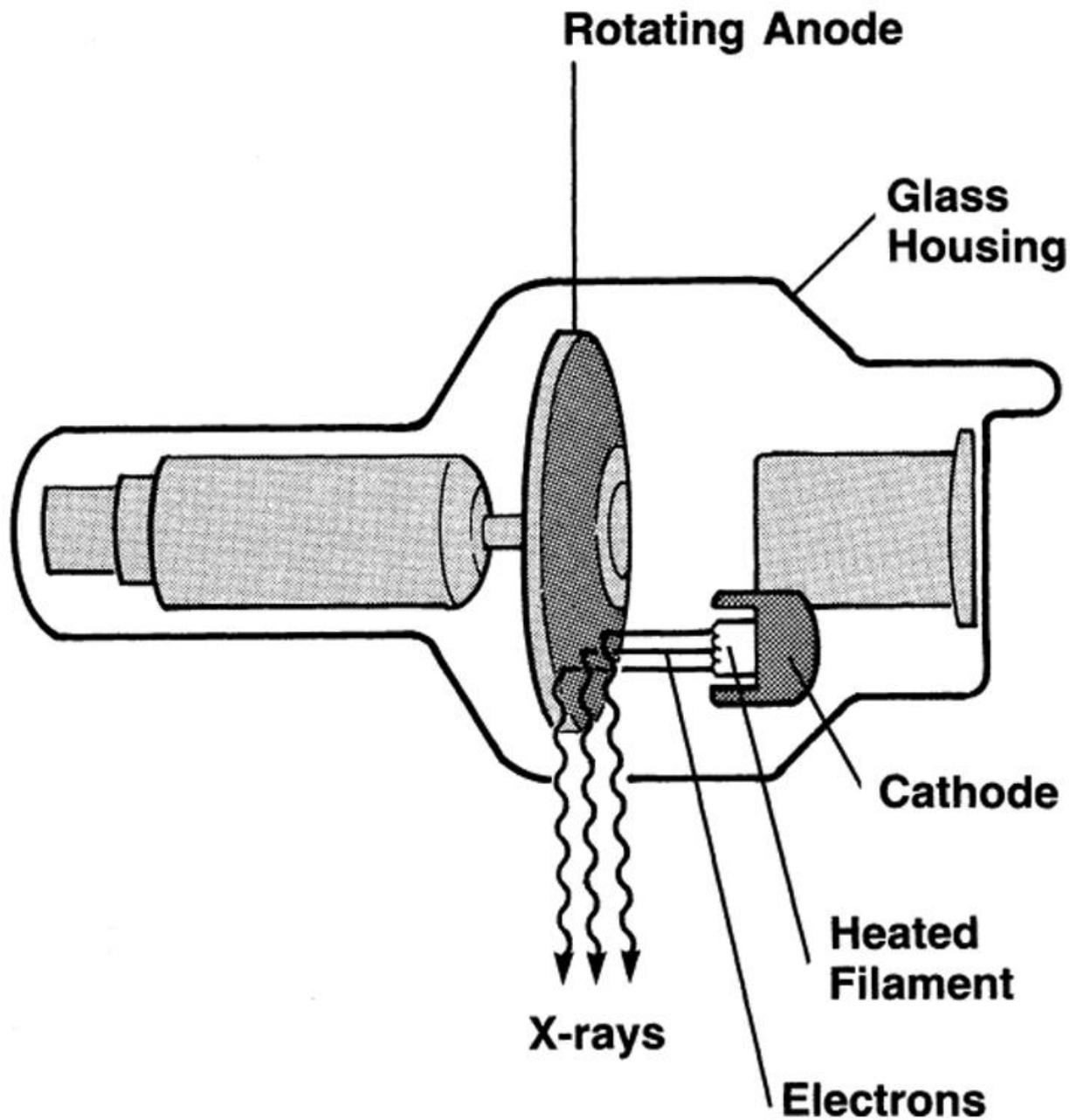


Figure 2.5 Rotating anode x-ray tube. See text for discussion.

Image Intensifiers

- The image intensifier reduces the radiation level at which a rapid sequence of images can be obtained, it is perhaps the most important component of radiographic systems that aim to produce motion pictures of biologic events.
- The smaller ones have an input diameter of 12 to 17 cm (5 to 7 in) and are preferred for selective coronary angiography because of their better resolution power.

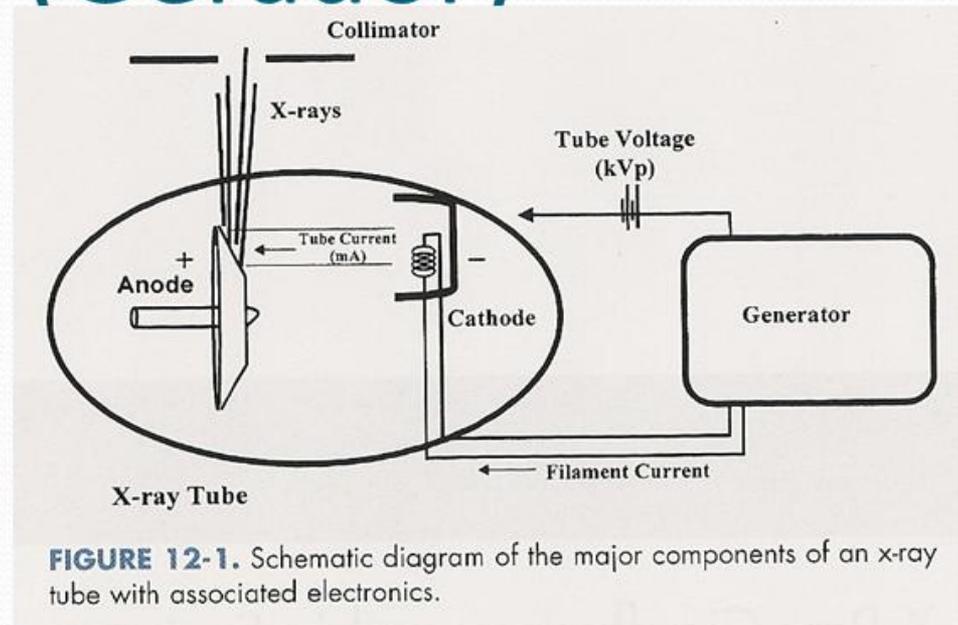
Princípio físico (Gerador)

- Cátodo:

- Fio de tungstênio;
- Acelerador de elétrons;
- 80 KV e 800 mA.

- Ânodo:

- Placa de tungstênio rotatória;
- Desaceleração abrupta:
 - Geração de Rx (1%);
 - Geração de calor (99%).
- 60-120 KW.



A aquisição de imagem utiliza 10 vezes mais energia e radiação que a fluoroscopia

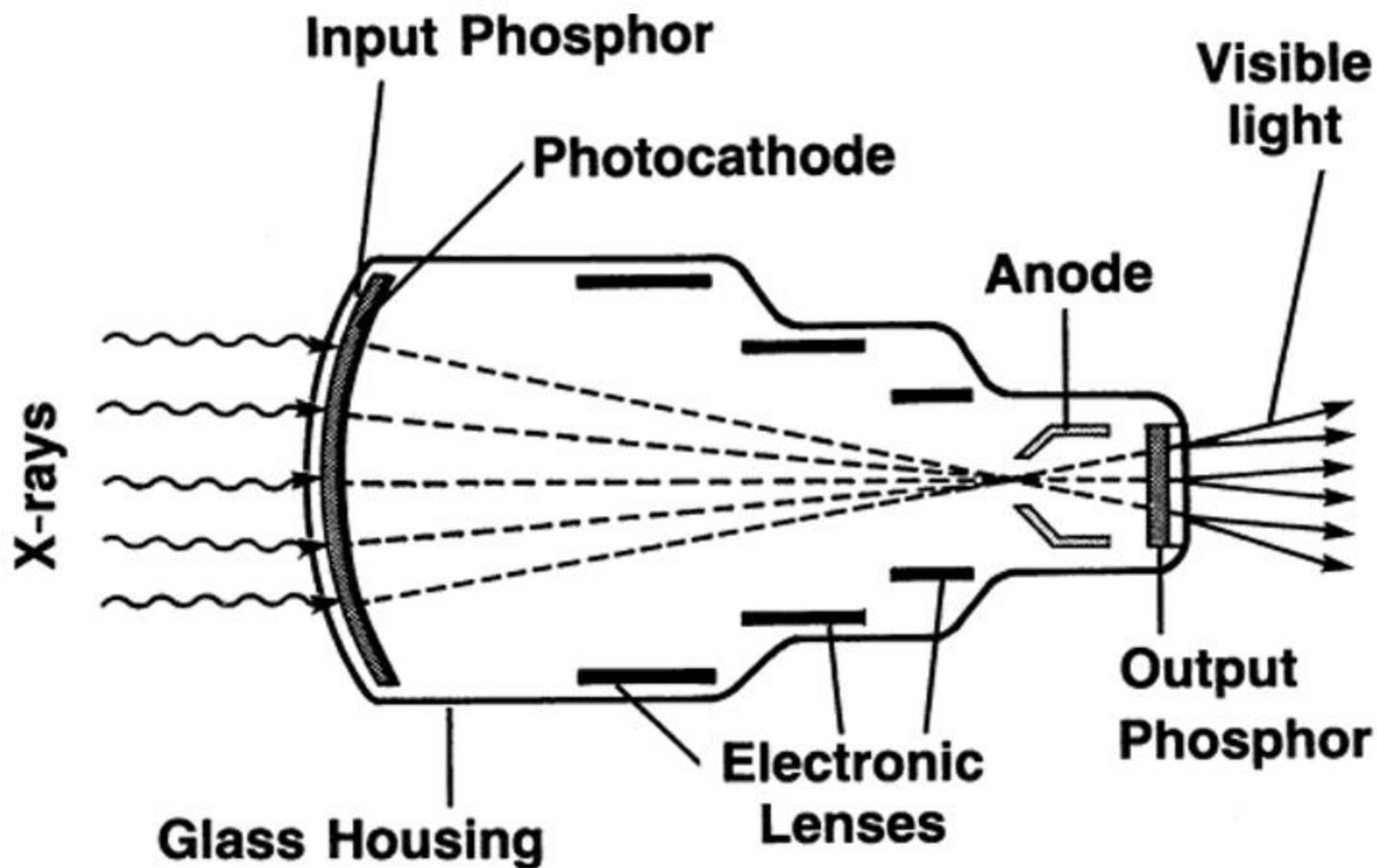


Figure 2.7 X-ray image intensifier. See text for discussion.

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Figure 2.8 Image framing. The focal length of the lens between the image intensifier and the video camera determines the visualized fraction of the output screen. Full overframing is shown on the left, partial in the center, and exact framing on the right. The choice determines the relative use of the image intensifier's physical field of view.

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Examination Table and Equipament Support

- The patient is placed in a recumbent position on an examination table, the top of should be as radiolucent as possible. Carbon-fiber tops combine adequate strenght with little radiation absorption.
- That major degrees of angulation in relation to the patient's long axis unavoidably increase the object thickness.

Cine film and Processing

- Sensitometer: consists of an accurately calibrated light source that delivers constant exposures.
- Densitometer: permits accurate measurement of the optical densities at different steps on the processed film strip.

Imaging Equipment Quality Assurance

- The *cine on-frame density* is determined densitometrically on a test film that has been exposed under conditions that simulate the examination of the average patient, using a phantom (copper plate) as patient equivalent.
- The determination of the *cine on-frame resolution* measures the spatial resolution power of the x-ray tube/image intensifier/camera/ film system.

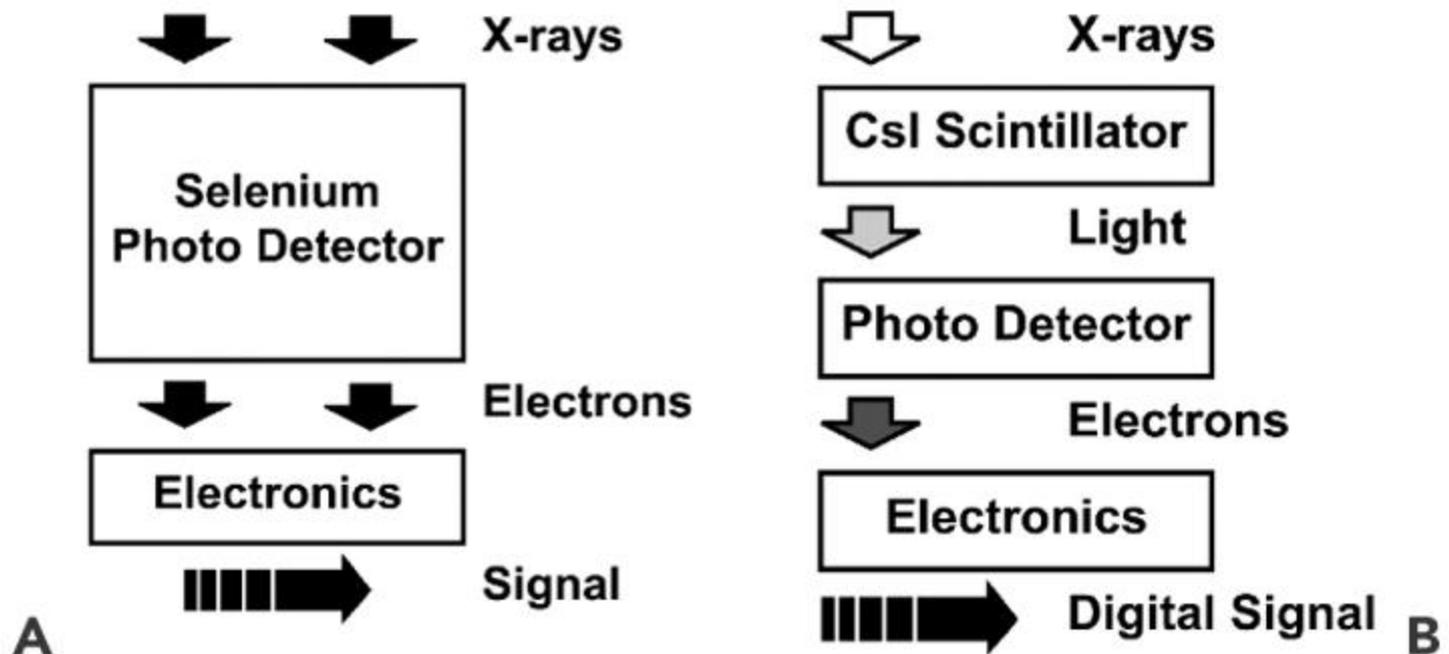


Figure 2.9 Indirect and direct digital (flat-panel) image receptors. The indirect (left) detector uses a CsI scintillator, virtually identical to that in an image intensifier, to convert the x-ray signal into light. A photodetector converts the light into an electron signal. This signal is then digitized. The direct detector (right) uses a selenium layer to directly convert the x-ray signal into an electrical charge distribution. This signal is then digitized.

Radiation Safety

- The *rad* (radiation absorbed dose) is a unit of absorbed dose and is defined as the amount of energy deposited per unit mass of irradiated material.
- No maximum permissible dose limit has been established for the patient; it is therefore the responsibility of the physician to determine the balance between the potential

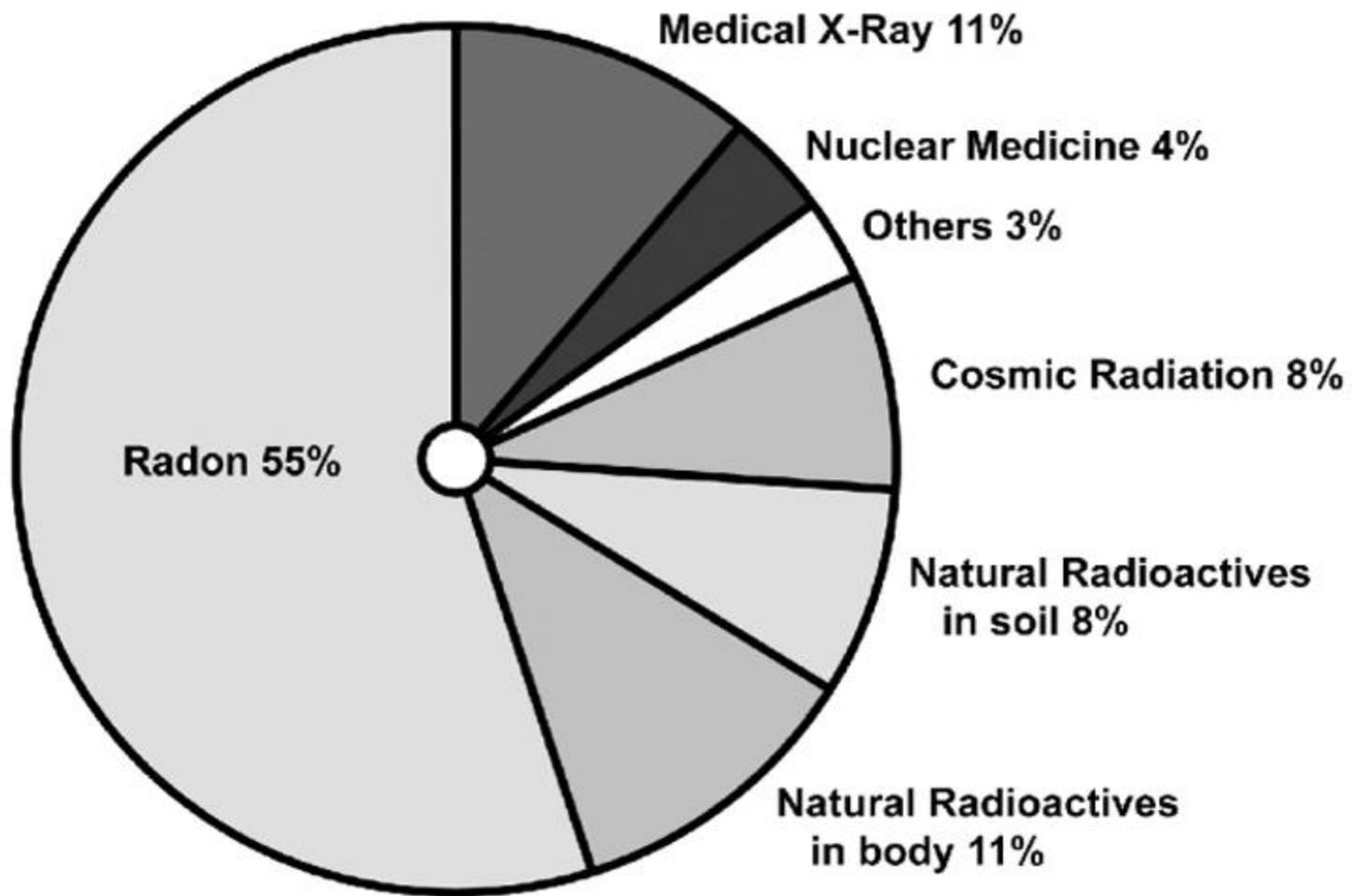


Figure 2.11 Average annual effective dose in the United States. More than 80% of the effective dose is delivered by natural sources. Medical use of radiation supplies most of the remaining amount.

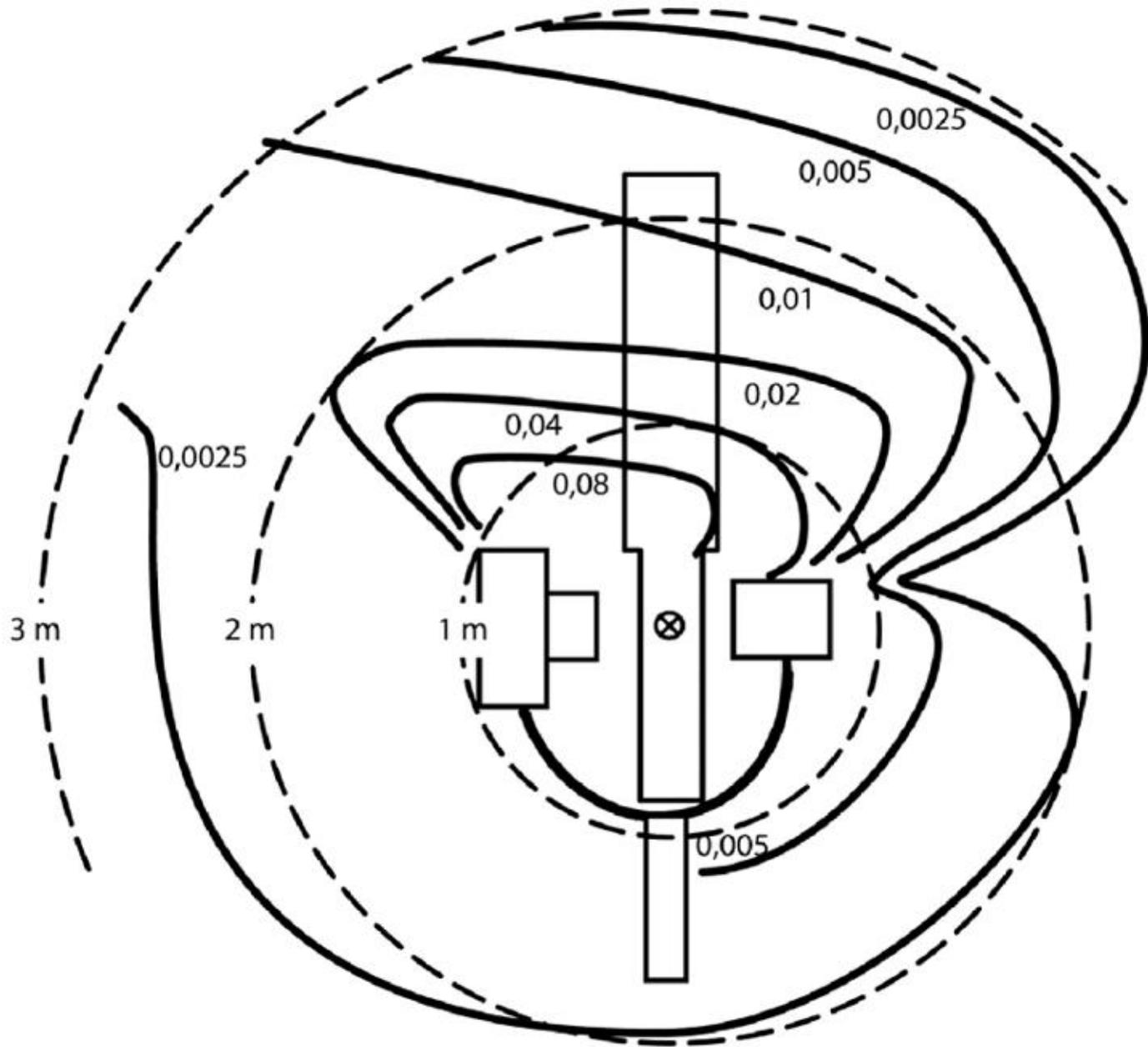


Figure 2.13 Scatter isodose curves around an interventional fluoroscope. This figure illustrates the radiation scatter levels 1 m above the floor from a full lateral beam. The asymmetry is caused by backscatter from the patient coupled with attenuation by the patient and equipment. (Figure courtesy of Philips Medical Systems.)



Figure 2.12C Time line of a major radiation injury (Reference 1). Early erythema and blistering at approximately 8 weeks is seen in (A). This has resolved by approximately 20 weeks (B); however the tissue is necrotic. The tissue has broken down by 20 months (C). A skin graft was required (D). A fuller explanation of this sequence is available in a 1995 publication at <http://www.fda.gov/cdrh/rsnaii.html> (last accessed 17 Mar 05)