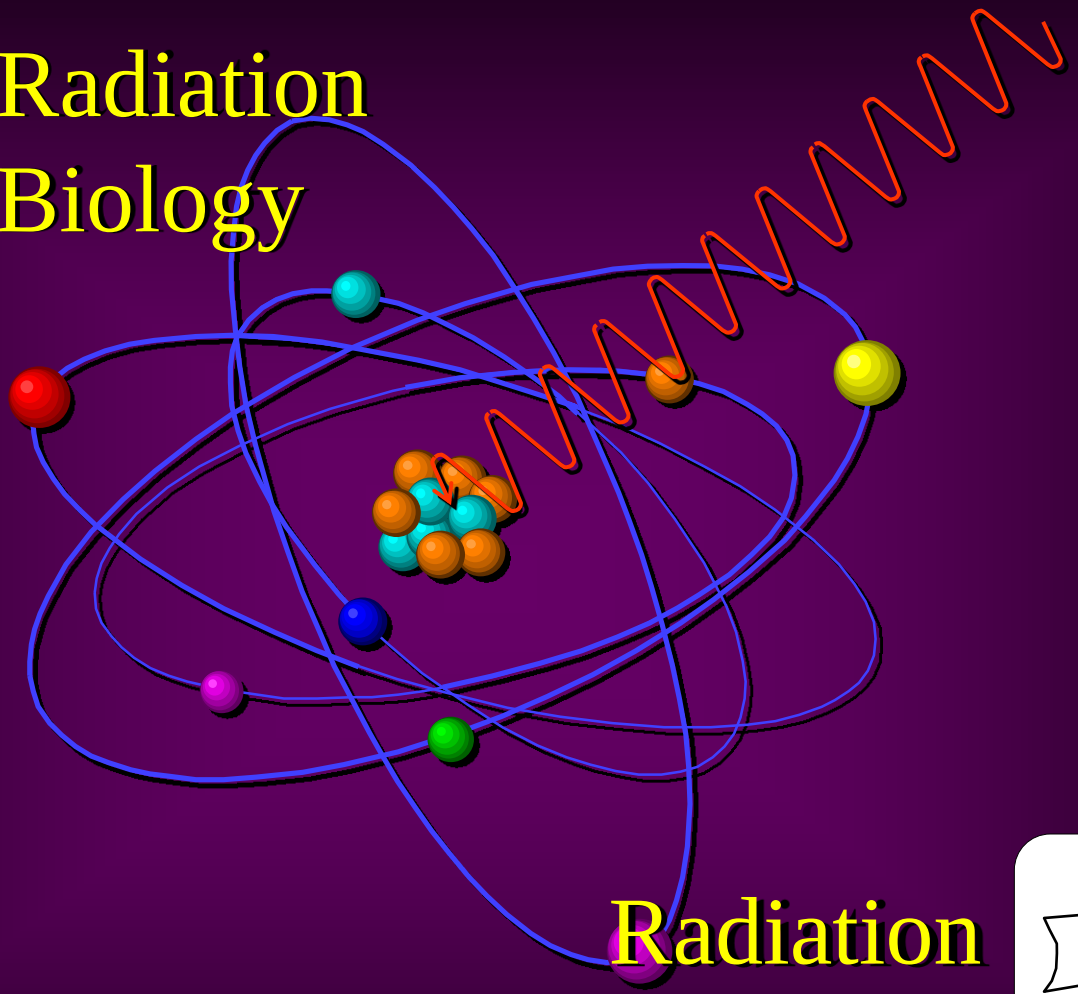
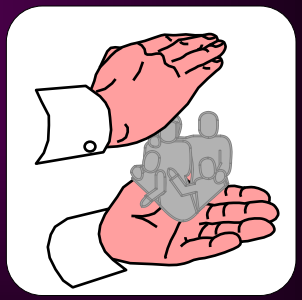
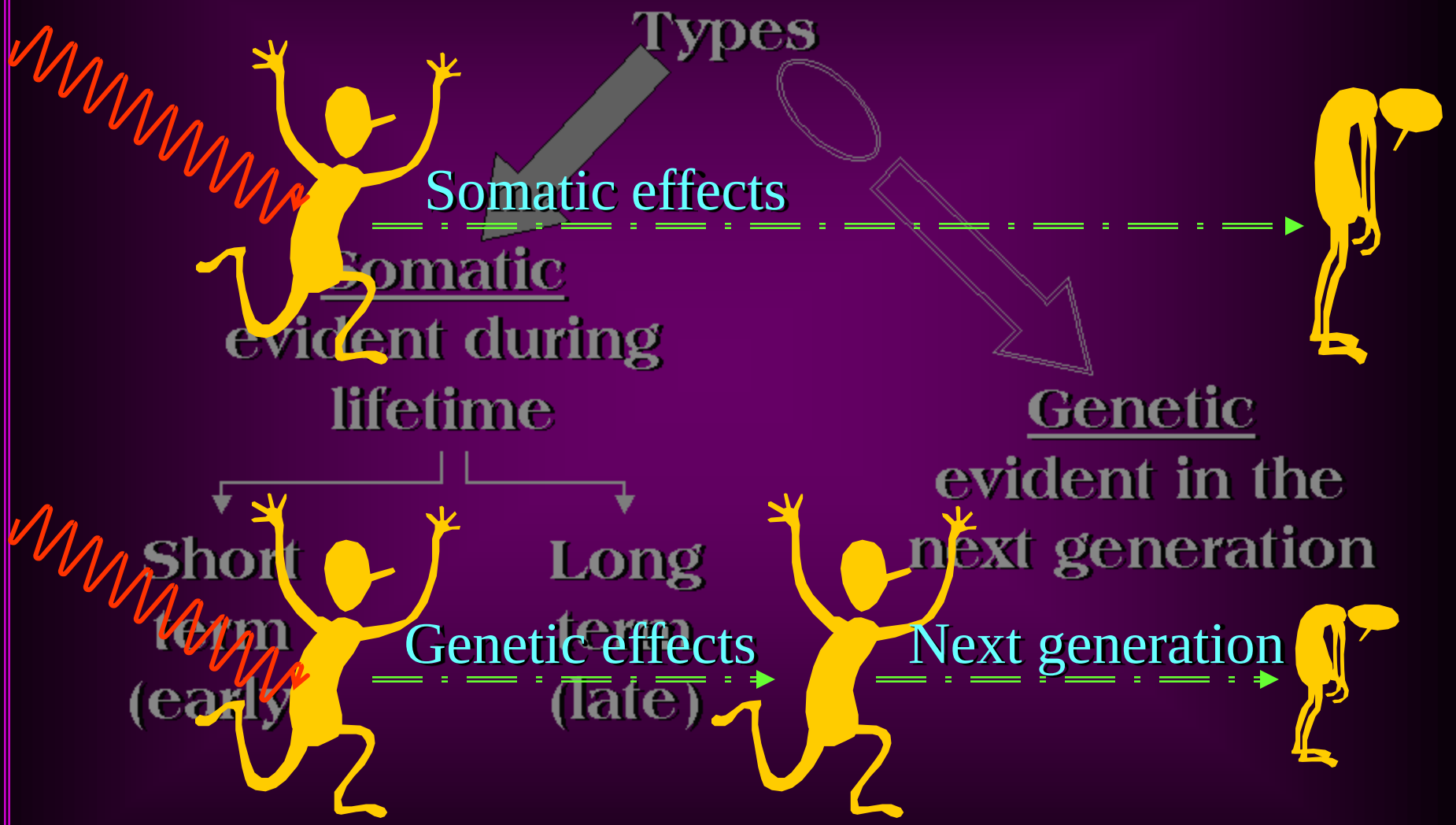
# Radiation Biology



# Radiation Protection



# Effects of Radiation



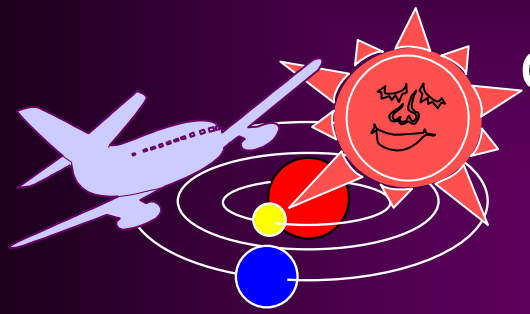
# Effects of Radiation

## *Some home truths…*

- X-rays cause damage to the tissues. Complete repair may not happen. Hence the damage is cumulative.
- We are constantly being exposed to radiation from natural sources. Hence, exposure to man-made sources of radiation should be minimized.
- Both, acute high and chronic low doses produce significant damage. Dentist, being one's own radiologist, is fully responsible for radiation protection protocols.

# Sources of Radiation

## Natural



cosmic

terrestrial

internal

## Manmade

**diagnostic & therapeutic radiation**

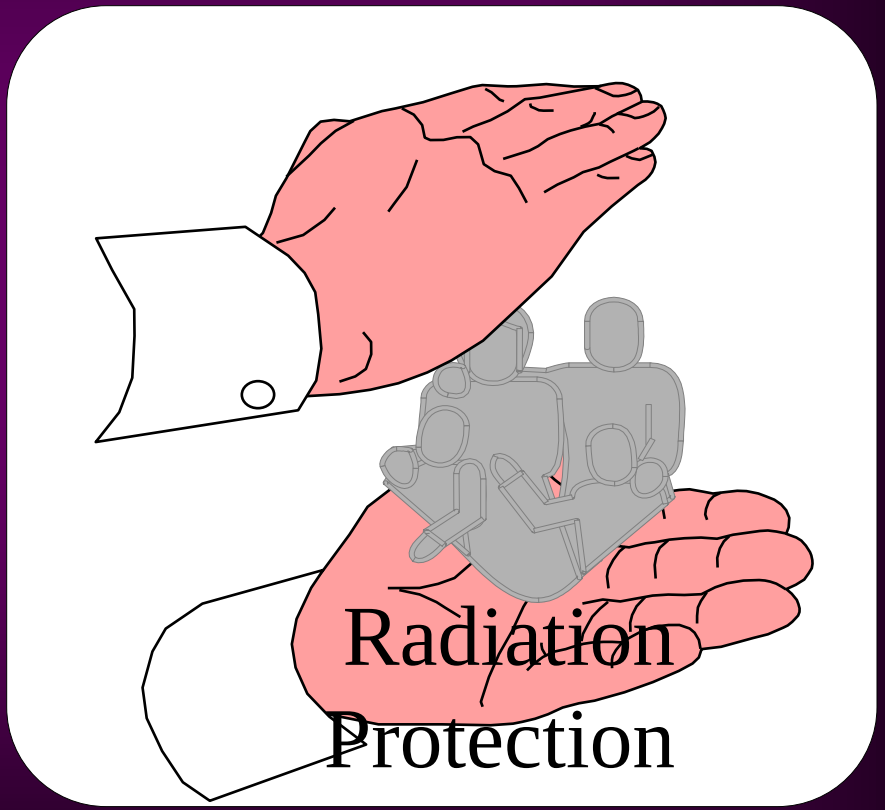
**Consumer & industrial products & sources**

Other artificial sources : nuclear weapon, nuclear power

# Moral of the Story

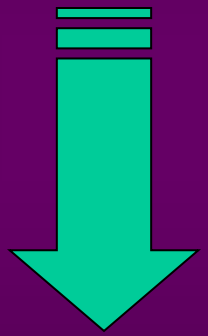
Therefore, all dental patients, irrespective of their
age and sex,
must be protected from hazards of radiation.

ALARA Principle



# ALARA Principle

As Low As Reasonably Achievable: "every effort should be made to keep the dose to all individuals as low as practical and all unnecessary radiation exposure should be avoided"



The goal of radiation protection procedures is to minimize radiation exposure of patients, personnel and operator during radiographic procedures.

# Units of Radiation Measurement

Roent… …unt of
x- or g… …ter (at
STP) 2…

1 rad … …00 ergs/gm

1 Gra…

1 rem … …nals)

1 Sievert (Sv) = …ms = 1000 millieSievert (mSv)

Maximum Permissible Dose (MPD)

**"the maximum dose that a person or specified parts thereof shall be allowed to receive in a stated period of time"**

**MPD for occupationally exposed individuals = 20 mSv per year**

**MPD for general population = 1 mSv per year**

The goal of radiation protection procedures is to minimize radiation exposure of patients, personnel and operator during radiographic procedures.

Methods of Radiation Protection

- Protection of the Patient
- Protection of the Operator
- Protection of other Personnel

# Protection of the Patient

1. **Patient Selection:** Type, frequency and extent of examination

2. **Conduct of Examination:**
   a. Choice of equipment
   b. Choice of technique
   c. Operation of equipment- kVp, mA, S
   d. Processing of the film
   e. Interpretation of image

# Protection of the Patient

1. **Patient Selection:** Type, frequency and extent of examination

**The guiding principle:** Only those patients, in whom diagnosis, treatment and prognosis will be significantly affected by radiographic examination, should be subjected to it.

# Protection of the Patient

**1. Patient Selection:** Type, frequency and extent of examination

**Depends on:**

Age (presence/absence of teeth, type of dentition)

New/recall patient

Disease status and susceptibility

Patient motivation

Availability of dental care

# Protection of the Patient

2. Conduct of Examination: a. Choice of equipment
   - Image receptor selection
   - Focal spot to image receptor distance
   - Collimation
   - Filtration
   - Leaded aprons and collars

# Protection of the Patient

2. Conduct of Examination: a. Choice of equipment

Image receptor selection

Non-screen film (E-speed films, using double film packets)
Screen film (fastest screen-film combination, rare earth intensifying screens)
Xeroradiography
Digital radiography

"a balance between the speed and the image quality should be attempted as faster films affect the quality adversely"

# Protection of the Patient

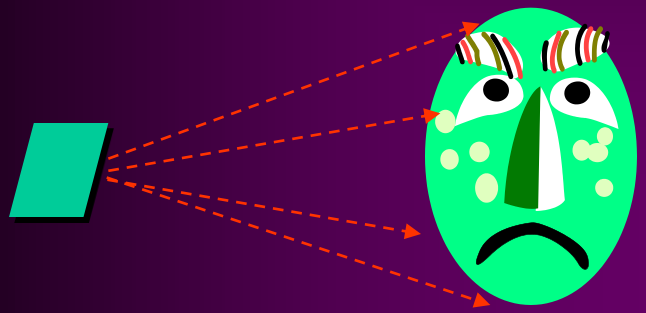
2. Conduct of Examination: a. Choice of equipment
   Focal spot to image receptor distance

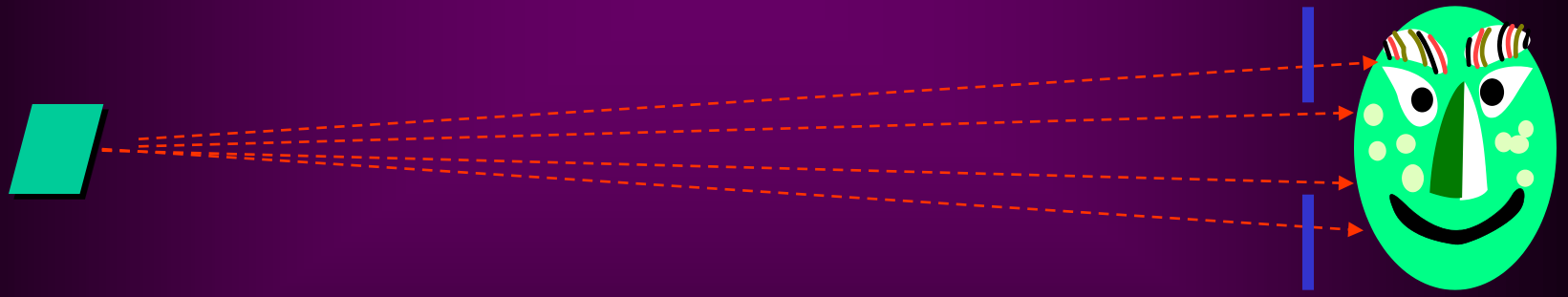
Maximum possible distance, consistent with tube voltage and use of collimator, reduces the area and amount of exposure ('inverse square law') considerably. Longer distance also has the added benefit of giving better image quality.

# Protection of the Patient

## 2. Conduct of Examination: a. Choice of equipment

### Focal spot to image receptor distance





"in intra-oral radiography a minimum distance of 20 cms and a maximum distance of 40 cms is optimum"

# Protection of the Patient

2. Conduct of Examination: a. Choice of equipment
   Collimation

Rectangular collimation reduces radiation exposure by 60%, when compared to cylindrical collimation.

Cylindrical collimation: radiation beam of 7 cms diameter at skin
Rectangular collimation: 3.5 x 4.5 cms size radiation beam at skin

## 2. Conduct of Examination: a. Choice of equipment Filtration

Adequate total filtration, corresponding to the tube voltage, should be provided to reduce radiation exposure of soft tissues.

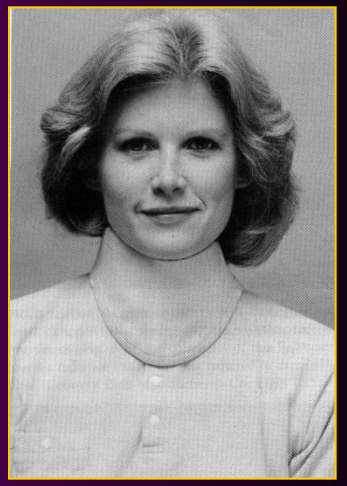
Tube voltage up to 70 kVp: 1.5 mm of Al

Tube voltage > 70 kVp: 2.5 mm of Al

## 2. Conduct of Examination: a. Choice of equipment

### Leaded aprons and collars

Must be used to minimize any unnecessary radiation. Pregnancy, per se, is not a contra-indication for intra-oral radiographic examination.



# Protection of the Patient

1. **Patient Selection:** Type, frequency and extent of examination

2. **Conduct of Examination:**
   a. Choice of equipment
   b. Choice of technique
   c. Operation of equipment- kVp, mA, S
   d. Processing of the film
   e. Interpretation of image

# Protection of the Patient

2. Conduct of Examination: a. Choice of equipment
   - Image receptor selection
   - Focal spot to image receptor distance
   - Collimation
   - Filtration
   - Leaded aprons and collars

# Protection of the Patient

## 2. Conduct of Examination: b. Choice of technique

Intra-oral projection: use of film holders
Periapical (paralleling cone technique significantly reduces patient exposure compared to bisecting-the angle technique)
Bitewing, Occlusal
Extra-oral projection:

- Use of intensifying screens
- Use of higher tube voltage
- Use of longer focal spot to image receptor

**The most appropriate technique consistent with the clinical requirements should be employed.**

# Protection of the Patient

## 2. Conduct of Examination: c. Operation of equipment

Tube voltage: appropriate to clinical requirement

Low voltage (65 kVp) > high contrast > for detection of dental caries

High voltage (80 kVp) > low contrast > for detection of periodontal disease

Tube current & exposure time: appropriate to voltage & focal spot to image receptor distance

**Optimum exposure factors for intra-oral radiography**

**65 to 80 kVp, 10 mA, 20-40 cms TID**

# Protection of the Patient

## 2. Conduct of Examination: d. Processing of the film

"time-temperature processing in an adequately equipped and maintained dark-room, is the best way to assure optimum film quality" and avoid retakes.

## 2. Conduct of Examination: e. Interpretation of image

"ideal viewing conditions to obtain maximum available information"

The goal of radiation protection procedures is to minimize radiation exposure of patients, personnel and operator during radiographic procedures.

Methods of Radiation Protection

- Protection of the Patient
- Protection of the Operator
- Protection of other Personnel

# Protection of the Operator

"unless protective shielding is provided for the operator, the installation should be so arranged that the operator can stand at least 6 feet from the patient during exposure"

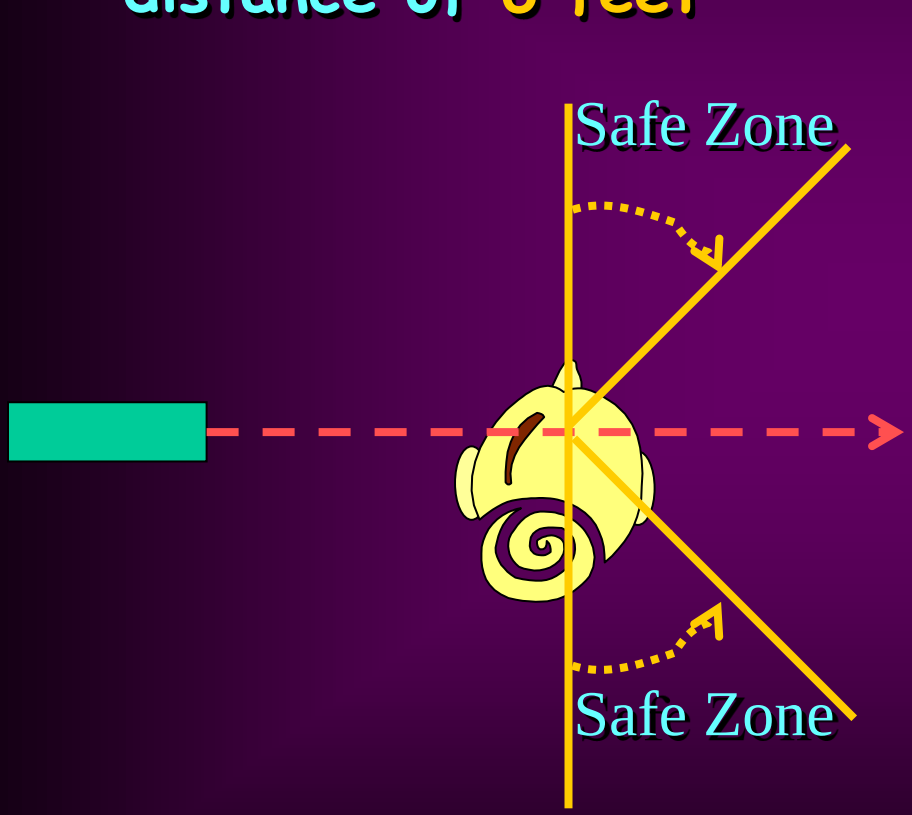
# Protection of the Operator

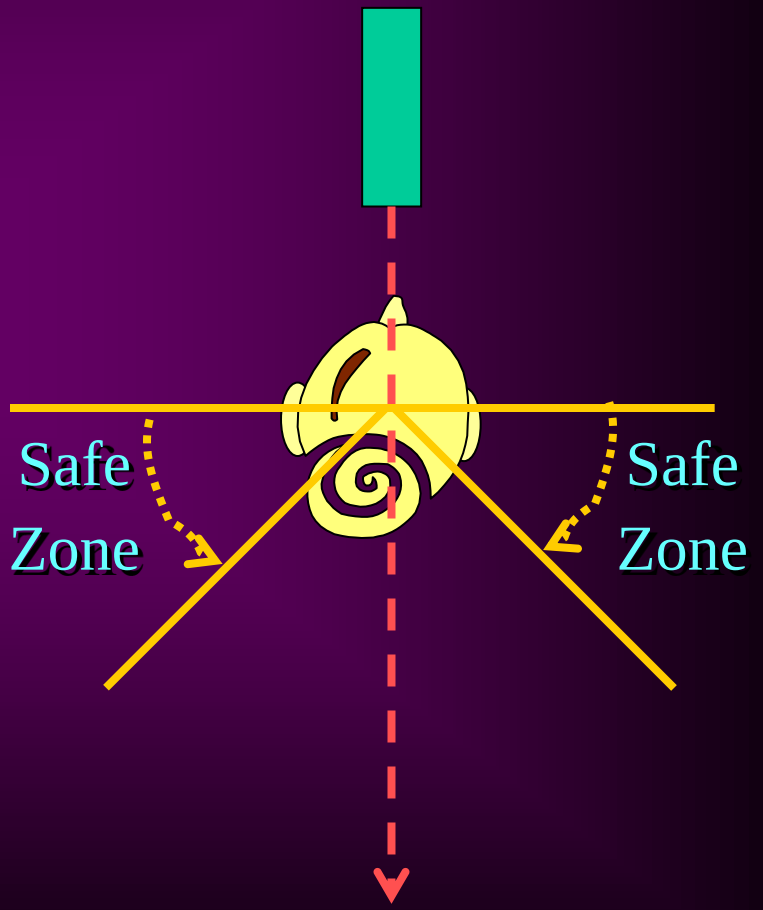
**Methods of protection:**

1. Use of barrier (0.25 mm of lead, 9-inch brick wall)
2. Use of lead apron
3. Position-and-distance rule: Safe Zone > space between $90^0$ to $135^0$ to the primary beam, at a distance of 6 feet.

# Protection of the Operator

3. Position-and-distance rule: **Safe Zone** > space between $90^0$ to $135^0$ to the primary beam, at a distance of 6 feet



# Protection of the Operator

Methods of protection:

1. Use of barrier (0.25 mm of lead, BEST, brick wall)
2. Use of leaded apron
3. Position-and-distance rule
4. Use of film-holding devices
5. Operator should not stabilize film, tube or patient during exposure.
6. Use of personnel monitoring devices

DOSIMETRY

# Protection of the Operator

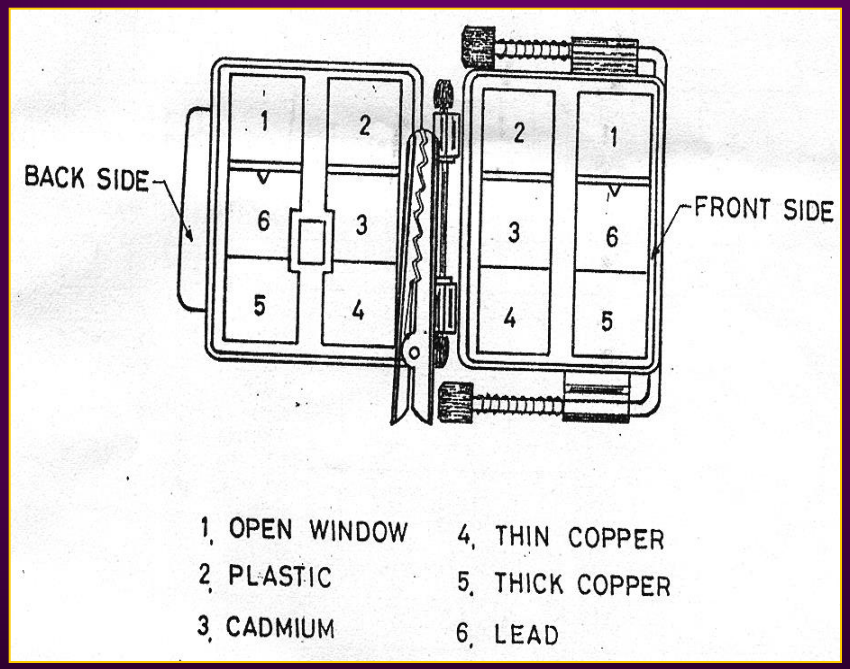
## DOSIMETRY

"determination of quantity of radiation exposure or dose"

Use of Personnel Monitoring Devices:

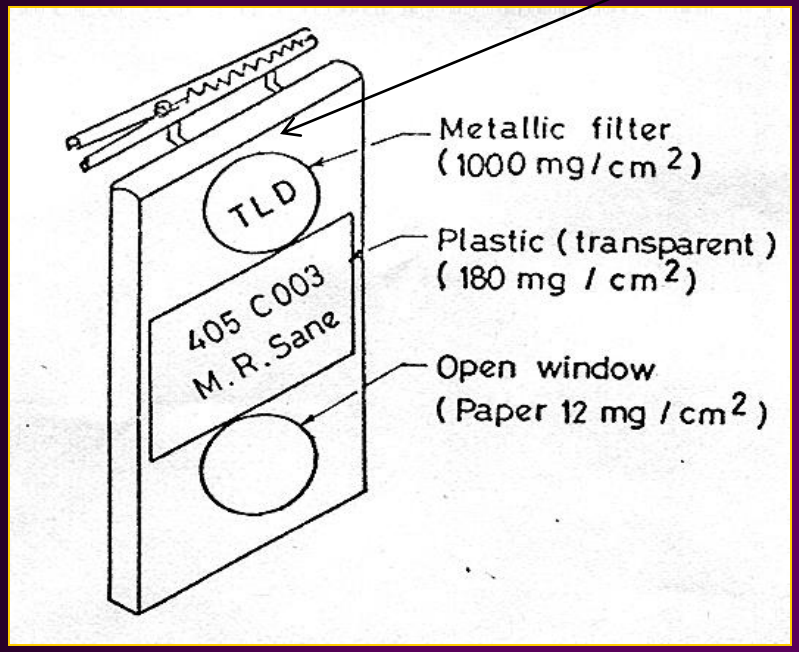
# Use of Personnel Monitoring Devices:

## Film badge




- Uses a dental film enclosed in a light tight cover in a metal framework.
- 6 quadrants.
- Ratio of blackening of the open part to that produced in regions of filters gives an indication of quality of the radiation.

# Thermo luminescent Dosimeter 'TLD'




- Nickel plated aluminium plate with 3 symmetrical holes (12mm)
- 3 filters
  1. Open region
  2. Copper
  3. Aluminium

- Principle of thermoluminiscence from LiF2
- Light energy measured by photomultiplier tube

# Protection of the Operator

Methods of protection:

1. Use of barrier (0.25 mm of lead, 9-inch brick wall)
2. Use of leaded apron
3. Position-and-distance rule
4. Use of film-holding devices
5. Operator should not stabilize film, tube or patient during exposure.
6. Use of personnel monitoring devices
7. Quality assurance
8. Continuing education

BEST

The goal of radiation protection procedures is to minimize radiation exposure of patients, personnel and operator during radiographic procedures.

Methods of Radiation Protection

- Protection of the Patient
- Protection of the Operator
- Protection of other Personnel

# Protection of other Personnel

1. During the exposure, dental auxiliary staff should either leave the room, or stand behind a leaded barrier, or wear a leaded apron.

2. Patients in the waiting area or persons in adjacent rooms can be protected by gypsum bonded walls for the operatory.