حفاظت در برابر پرتو

دانش محافظت پرتونگاران و مردم در برابر پرتوهای غیر لازم

پرتوهای یونساز موجود

پرتوهای طبیعی یا زمینه ای

پرتوهای درون بدن عمدتاً K-40 منشاء خاک و مصالح ساختمانی	25 mr
پرتوهای کیهانی عمدتاً نوترون منشاء فضای بین ستارگان	50 mr
پرتوهای زمینی (وهوا) گاز رادون منشاء هوا پس از تاثیر رادیم	50 mr

پرتوهای پزشکی

رونتگن تشخیصی برای 50 درصد افراد	75 mr

پرتوهای شغلی

	1 mr
آزمایشات هسته ای و منابع دیگر	5 mr
جمع:	200 mr

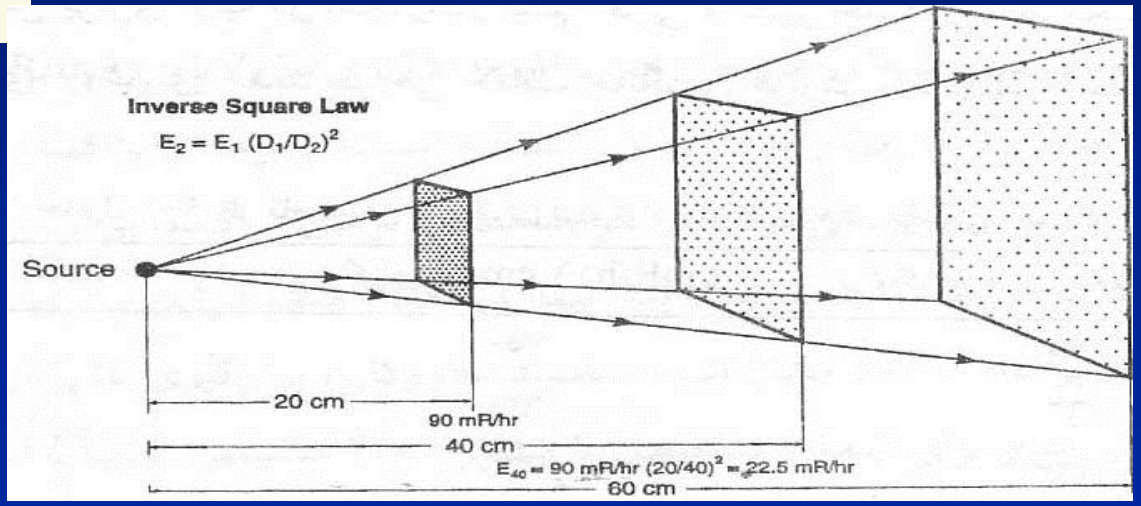
روش های کاهش تشعشع به افراد

1- عامل زمانی

آهنگ تشعشع (dose rate) کاهش یابد.

2- عامل فاصله (قانون عکس مجزور فاصله)

$$E_2 = E_1(D_1 / D_2)^2$$



اسکتر در یک متری تیوب 0.1 درصد تشعشع اولیه(لذا حداقل رعایت دو متر فاصله)

روش های کاهش تشعشع به افراد

3- حفاظ کردن پوشش سربی و دیوار سربی

ضخامت بستگی دارد به:

1) workload 2) radiation exposure
3) use factor 4) Occupancy factor 5) distance to tube

4- کنترل آلودگی

5- تکنیک مناسب

Workload (*w*)

$$W = 20\,Patients \times 5\,days/week \times 3\,film/patients \times$$
$$50\,mAs/film \times 1\,\text{min}/60\,\text{sec} = 250\,mA.\text{min}/week$$

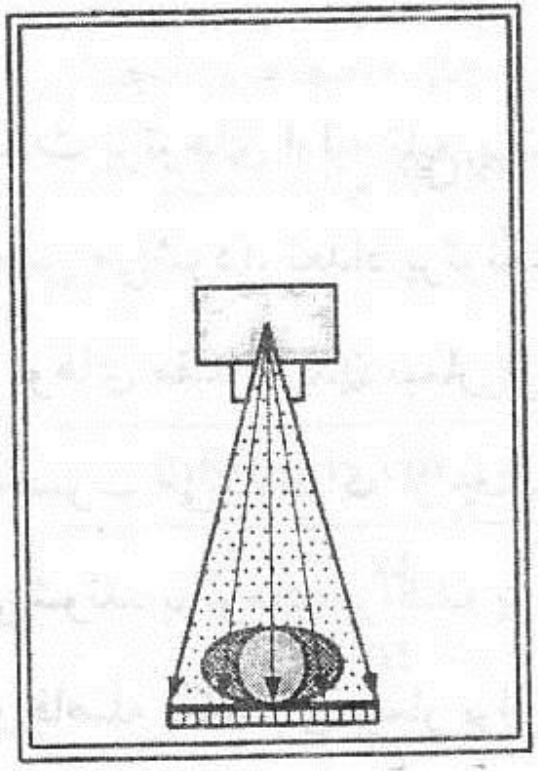
$$EX\,(mR/week)_{1m} = W\,(mA.\text{min}/week) \times Tubeoutput\,(mR/mA.\text{min})$$

پرتوهای اولیه

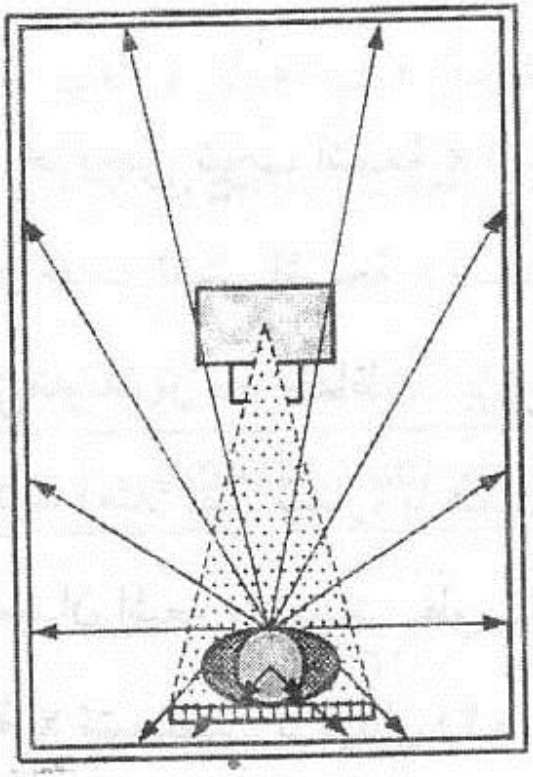
پرتوهای ثانویه

پرتوهای پراکندگی

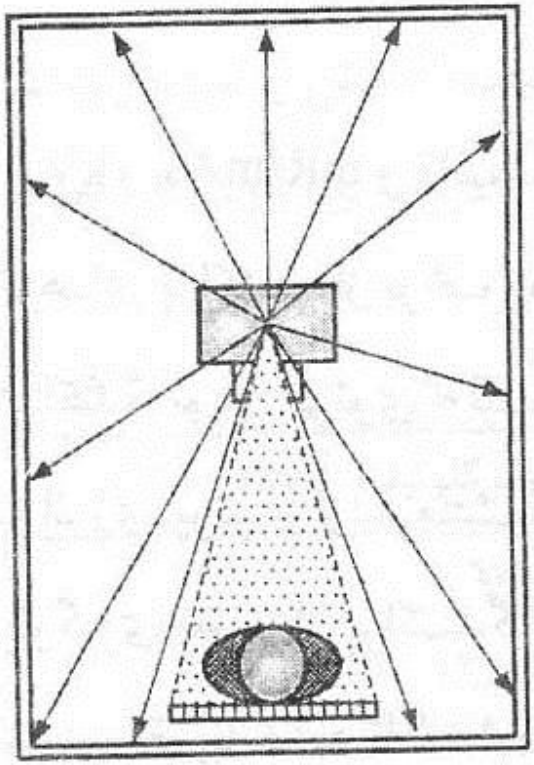
پرتوهای نشتی



A: Primary Radiation



B: Scattered Radiation



C: Leakage Radiation

Controlled and supervised area

- مناطق کنترل شده: جایی که میزان اشعه بر اساس حجم تصویربرداری محاسبه و کنترل می شود و حفاظ لازم برای محدود کردن دوز استفاده می شود (مثل اتاق X-RAY)

- مناطق تحت نظارت: جایی که تشعشع در شرایط و زمان های محدود وجود دارد (مثل جایی که دستگاه رادیولوژی موبایل استفاده می شود).

Three types of exposure

- Medical Exposure (The exposure of persons as part of their diagnostic or treatment)
- Occupational Exposure (exposure incurred at work, and practically as a result of work)
- Public Exposure (including all other exposures)

Framework of radiological protection for medical exposure

- Justification
- Optimization

  - The use of doses limits for medical exposure is NOT APPLICABLE
    - **Dose constraints and guidance (or reference) levels ARE RECOMMENDED**

The justification of a practice

A review of benefits and disadvantages of the possible options

The use of radiation in medicine is accepted as doing more good than harm

E.g.: choosing between the use of X-rays or ultrasound

Justification is made on the basis of experience, professional judgement, and common sense

The optimization of protection

Optimization is usually applied at two levels:

1) The design and construction of equipment and installations
2) Day to day radiological practice (procedures)

The optimization means that doses should be:

"**as low as reasonably achievable** (ALARA)"

Guidance level for medical exposure defined by the BSS (Basic Safety Standard)

مقدار دوز یا اکتیویته قابل انتظار برای هر تکنیک که بیش از آن باید مورد توجه افراد حرفه ای قرار گیرد تا تنظیم گردد.

Guidance levels for diagnostic radiography (typical adult patient)

Examination	Entrance surface dose per radiograph (mGy)
Lumbar spine AP	10
Lumbar spine LAT	30
Lumbar spine LSJ	40
Abdomen, IVU and cholecystography AP	10

Guidance levels for diagnostic radiography (typical adult patient)

Examination	Entrance surface dose per radiograph (mGy)
Pelvis AP	10
Hip joint AP	10
Chest PA	0.4
Chest LAT	1.5

Dose guidance levels in CT (typical adult patient)

Examination	Multiple scan average dose (mGy) (a)
Head	50
Lumbar spine	35
Abdomen	25

(a) Derived from measurements on the axis of rotation in water equivalent phantoms, 15 cm in length and 16 cm (head) and 30 cm (lumbar spine and abdomen) in diameter.

Dose rate guidance levels for fluoroscopy (typical adult patient)

Operation Mode	Entrance surface dose rate (mGy/min) (a)
Normal	25
High Level (b)	100

(a) In air with backscatter

(b) For fluoroscopes that have an optional 'high level' operational mode, such as those frequently used in interventional radiology

دوز دریافت شده توسط جنین در حین تصویربرداری از مادر

Approximate fetal doses from conventional x-ray examinations

data from the UK 1998

	Mean (mGy)	Maximum (mGy)
Abdomen	1.4	4.2
Chest	<0.01	<0.01
Intravenous urogram or lumbar spine	1.7	10
Pelvis	1.1	4
Skull or thoracic spine	<0.01	<0.01

Approximate fetal doses from fluoroscopic and computed tomography procedures

data from the U.K. 1998

	Mean (mGy)	Maximum (mGy)
Barium meal (UGI)	1.1	5.8
Barium enema	6.8	24
Head CT	<0.005	<0.005
Chest CT	0.06	1.0
Abdomen CT	8.0	49
Pelvis CT	25	80

Radiation-Induced Malformations in Fetus

- Malformations have **a threshold of 100-200 mGy or higher** and are typically associated with central nervous system problems

- Fetal doses of 100 mGy are not reached even with 3 pelvic CT scans or 20 x-ray examinations
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- These levels **can** be reached with fluoroscopically guided interventional procedures of the pelvis and with radiotherapy

Termination of pregnancy

- Termination of pregnancy at fetal doses of less than 100 mGy is **NOT** justified based upon radiation risk
- At fetal doses in **excess of 100 mGy**, there can be fetal damage
- High fetal doses (100-1000 mGy) during late pregnancy **are not likely** to result in malformations
- In these cases decisions should be based upon individual circumstances

مقایسه دوز تکنیک های مختلف تصویربرداری

Typical effective doses from diagnostic medical exposures

Diagnostic procedure	Typical effective dose (mSv)	Equiv. no. of chest x-rays	Approx. equiv.period of natural background radiation
Chest (single PA film)	0.02	1	3 days
Skull	0.07	3.5	11 days
Thoracic spine	0.7	35	4 months
Lumbar spine	1.3	65	7 months

From: Referral Criteria For Imaging. CE, 2000.

Typical effective doses from diagnostic medical exposures

Diagnostic procedure	Typical effective dose (mSv)	Equiv. no. of chest x-rays	Approx. equiv.period of natural background radiation
Hip	0.3	15	7 weeks
Pelvis	0.7	35	4 months
Abdomen	1.0	50	6 months
IVU	2.5	125	14 months

From: Referral Criteria For Imaging. CE, 2000.

Typical effective doses from diagnostic medical exposures

Diagnostic procedure	Typical effective dose (mSv)	Equiv. no. of chest x-rays	Approx. equiv. period of natural background radiation
CT head	2.3	115	1 year
CT chest	8	400	3.6 years
CT abdomen or pelvis	10	500	4.5 years

From: Referral Criteria For Imaging. CE, 2000.

Occupational Dose Limit

for medical research purposes and for individuals helping in care of patients, and visitors:

5 mSv during the period of the examination

20 mSv per years (averaged over 5 years)

1 mSv for children visiting

1100 MBq activity in patients discharged from hospitals for Iodine 131

Responsibilities (BSS I.10)

کارکنان با اشعه باید:

1. قوانین تشعشع را بدانند و رعایت کنند.
2. مقدار تشعشع دریافت شده در آنها با وسایل مونیتورینگ محاسبه و کنترل شود.
3. هنگام تصویرگیری، لباس و پوشش های محافظتی پرتو را بپوشند.
4. مجور کار را اشعه را از مراکز ملی مربوطه دریافت کنند.

Personal protective equipment

- Workers should be provided with suitable and adequate personal protective equipment
- Protective equipment includes **lead aprons, thyroid protectors, protective eye-wear and gloves**.

Personal protective equipment

- Additional protective devices should be available in **fluoroscopy and interventional radiology rooms** which include:
  - Protective lead curtains mounted on the patient table.

SCREEN AND GOGLES

لوازم مونیتورینگ (دوزیمتری) شخصی

- Individual external doses should be determined by:
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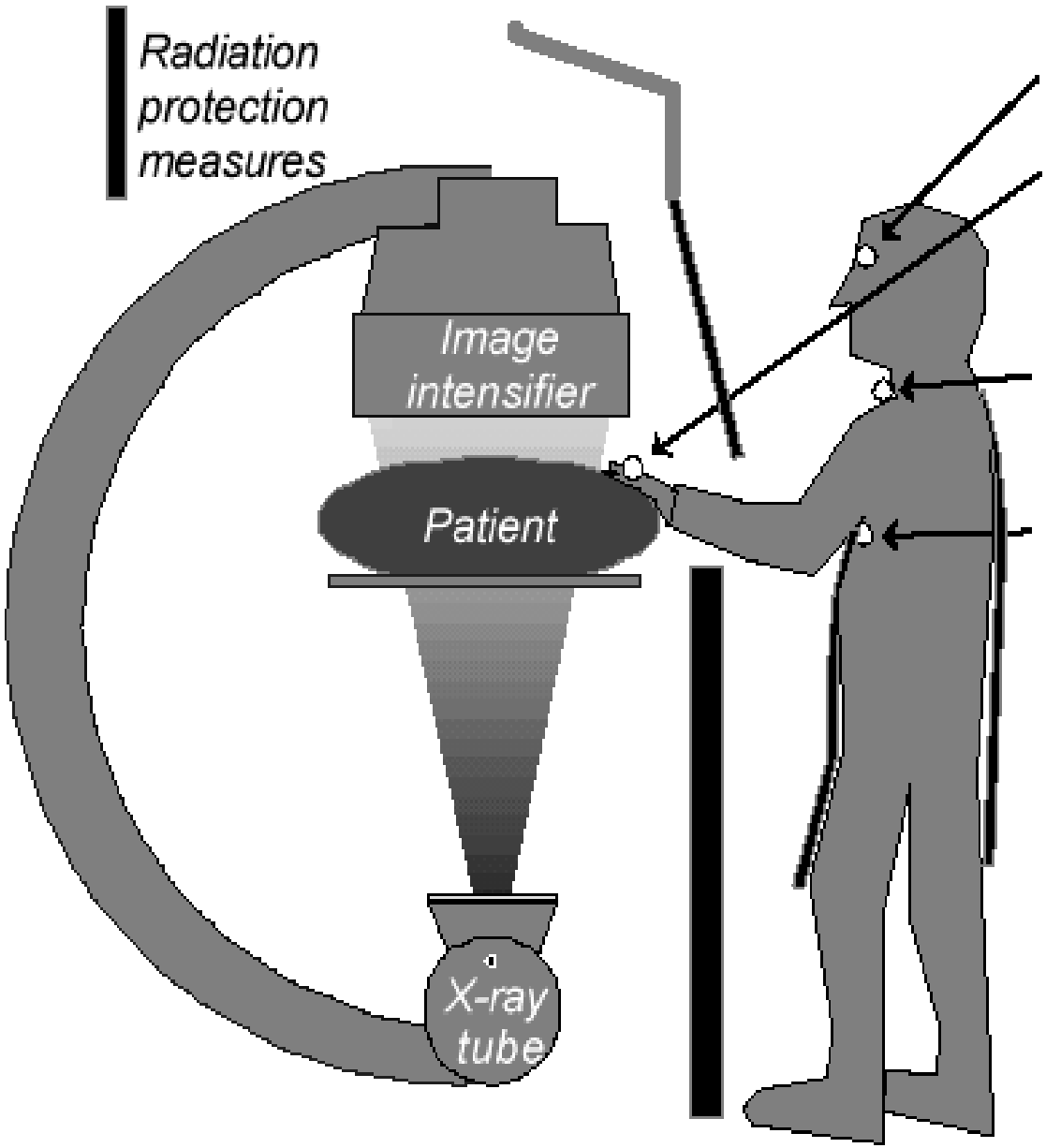
  - **Thermoluminescent**
  - **Film badges**
  - **Electronic dosimeters**
- Worn at breast level, between the shoulders and the waist
- The exchange of dosimeters and report receipt **should not exceed** three months

Personal dosimetry



Lens dose, *optional*

Finger dose, *optional*

Second dosemeter
outside and above the apron at the neck, optional

Personal dose
dosemeter behind the lead apron

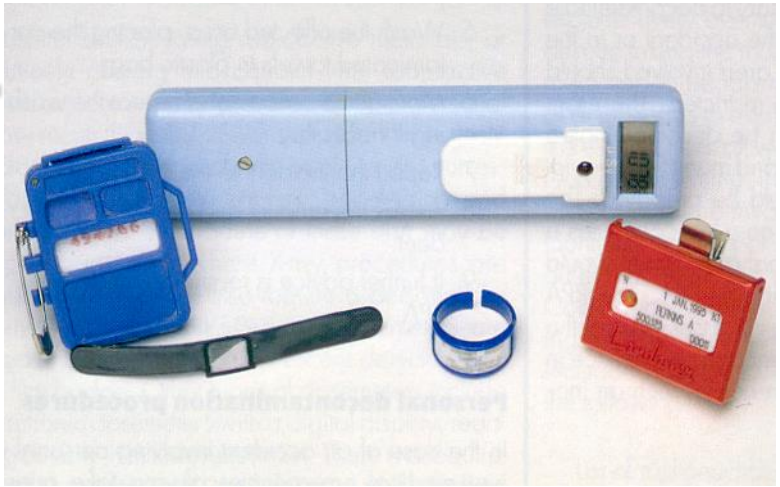
Dose limits of occupational exposure
(ICRP 60)

Effective dose 20 mSv in a year averaged over a period of 5 years

Anual equivalent dose in the

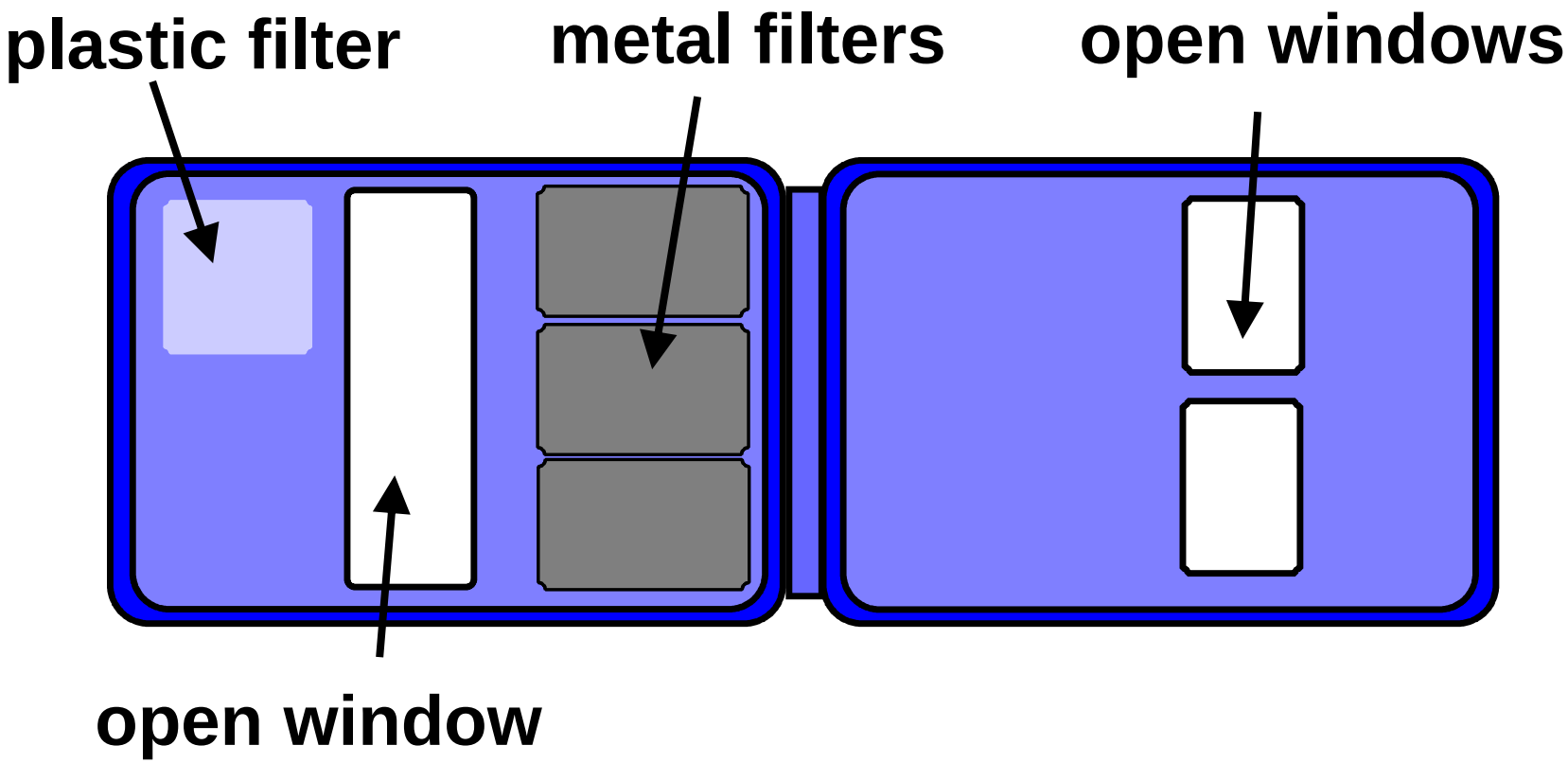
lens of the eye	150 mSv
skin	500 mSv
hands and feet	500 mSv

Different types of personal dosemeters…



- **film**
- **termoluminescence dosemeters (TLD)**
- **”electronic” dosemeters**

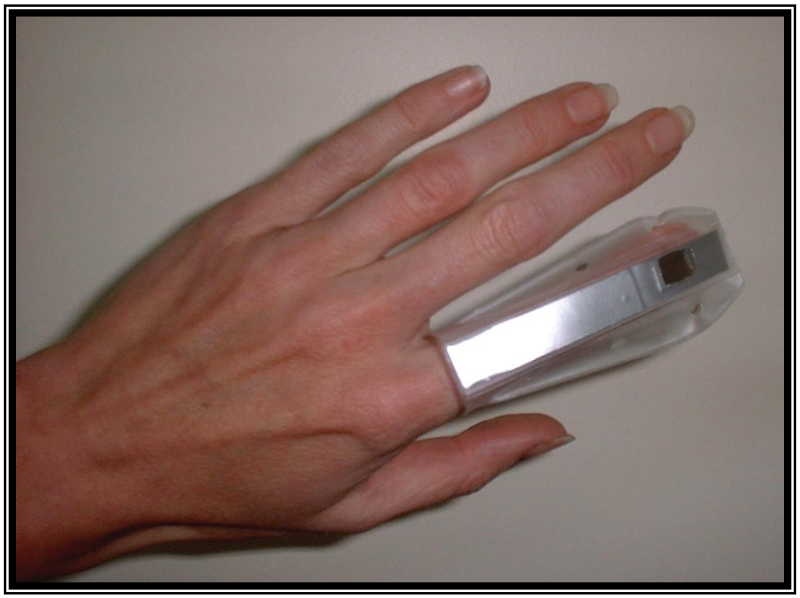
Film badge



detects beta, gamma, X-ray

TLDs

whole body



extremity