Surgeons and surgery with the use of radioscopy and fluroscopy. Risks and Benefits

Prof. Dr. G. Dereymaeker, MD.,PhD.
Orthopedic Surgeon- Foot &Ankle surgery
Department of Biomechanics-KULeuven

Benefits of use X-ray's during surgical procedure

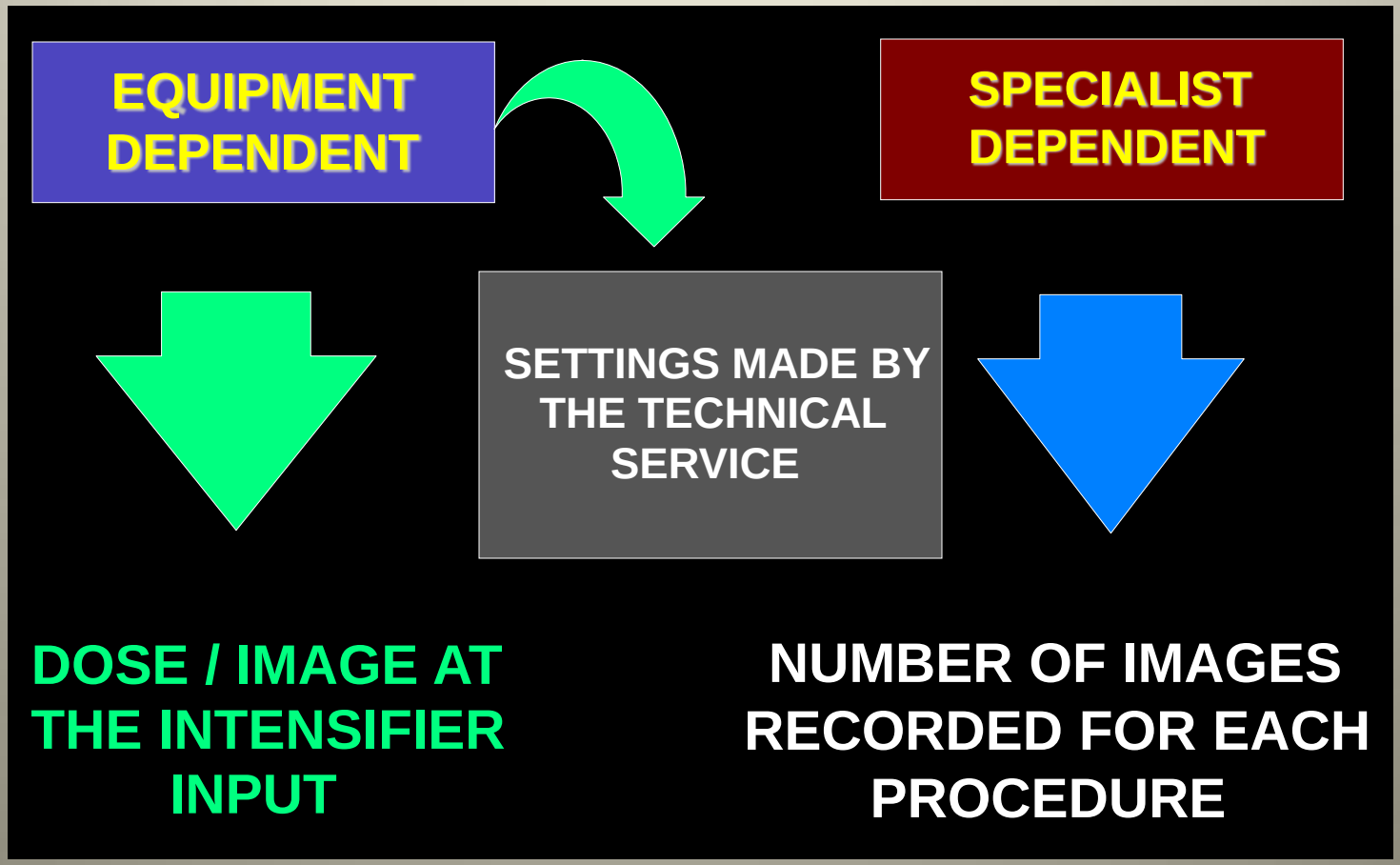
- Higher accuracy :
  - Better guidance can avoid open surgery
  - Reduction of trauma
  - Positioning of osteosynthesis or implants
  - Per operative control of the procedure
- Shorter surgery time
  - for the Patient
  - and the Surgeon
- X-ray can save lives , but can also kill at long-term

Benefits of use X-rays/Fluoroscopy during surgical procedures

- **The benefit will only be as good as the protection measurements taken for as well the patient as the operator.**
- This ➔ **Good Medical practice**
  - Tools have been improved a lot: Pulsed-intermittent radiation etc….
  - FANC together with international institutions (IAEA- Oramed) have imposed reference levels, guidelines and rules.
  - **To us** the practitioners to use these guidelines

Xrays Anno 2013 in Afrika !!!!??????

Equipment and specialist



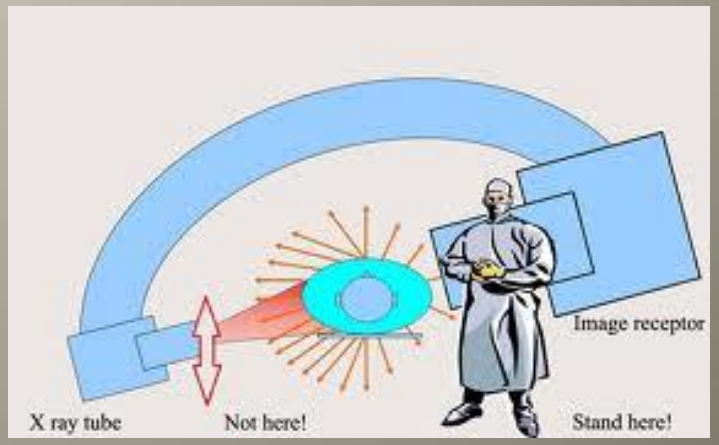
Surgeons: you are the boss in the operating room!!!!!

Surgeon: you are the boss in the operating room

But if so:

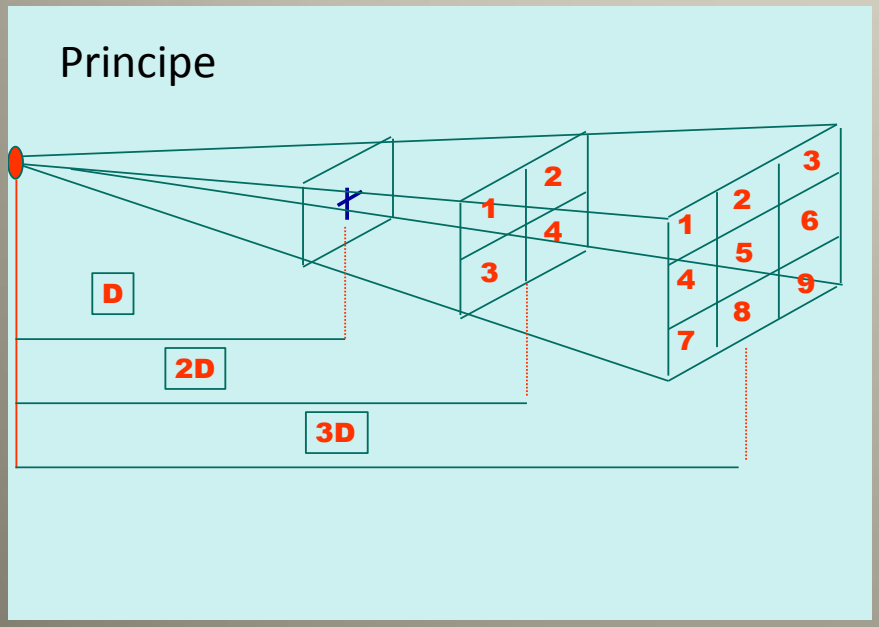
You are the responsible!!!!!!!!

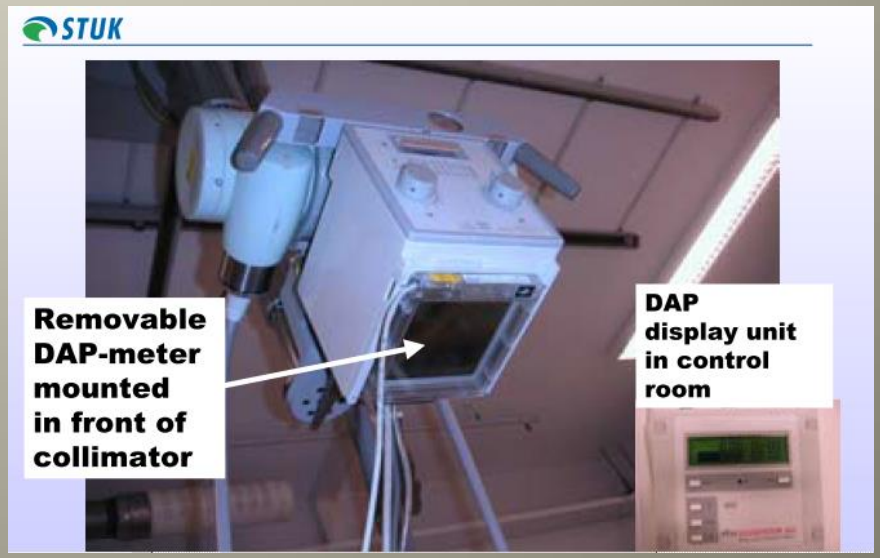
For using Fluroroscopy in the correct way



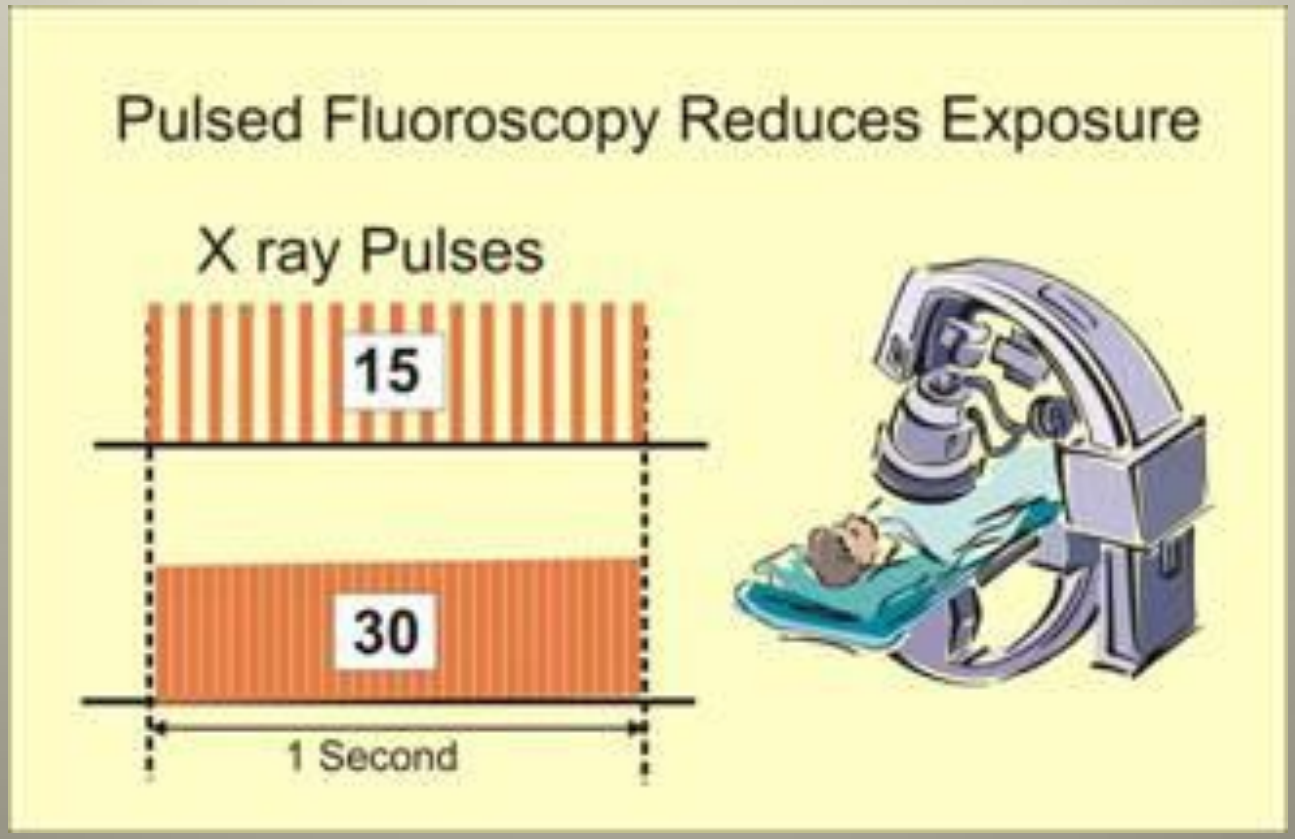
Measurement of Patients doses

- DAP = The product of irradiated surface of the patient with the dose at each point
- Display of dosimeter can be integrated in Xray device

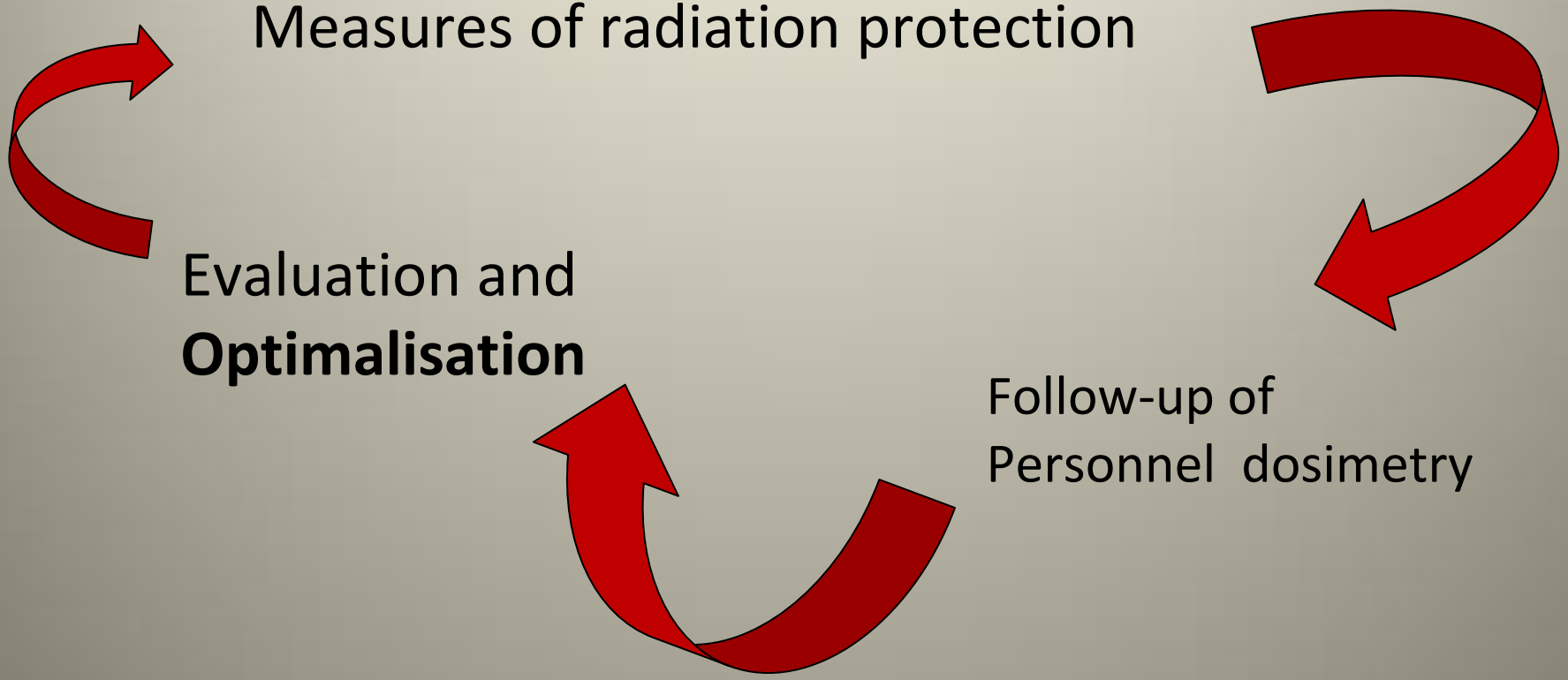




Use pulsed fluoroscopy with the lowest frame rate possible to obtain images of acceptable quality



Physical control



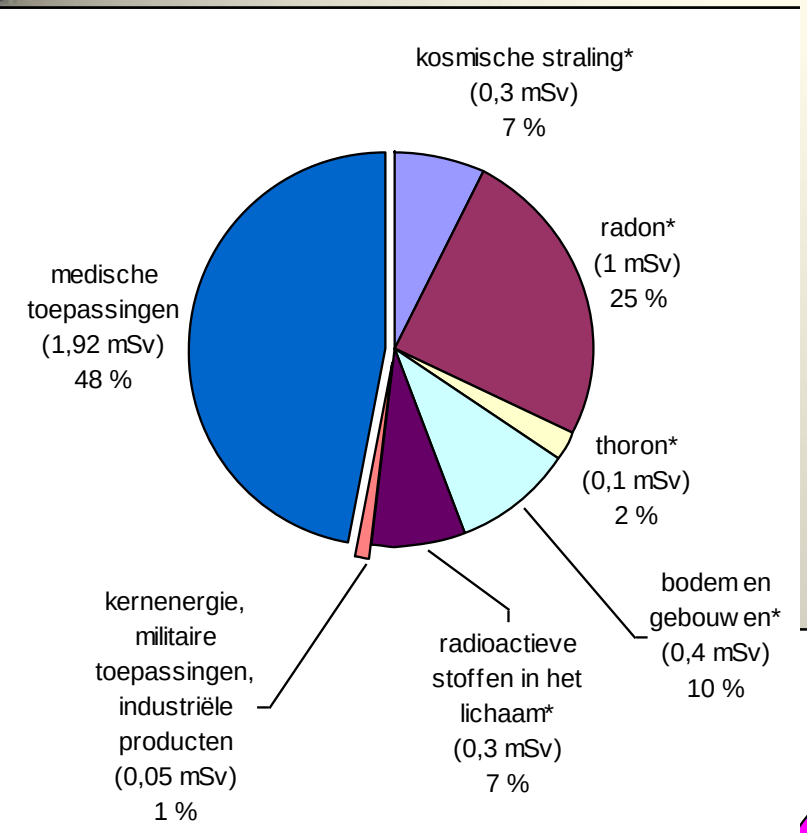
Fluoroscopy can save lives but can also kill

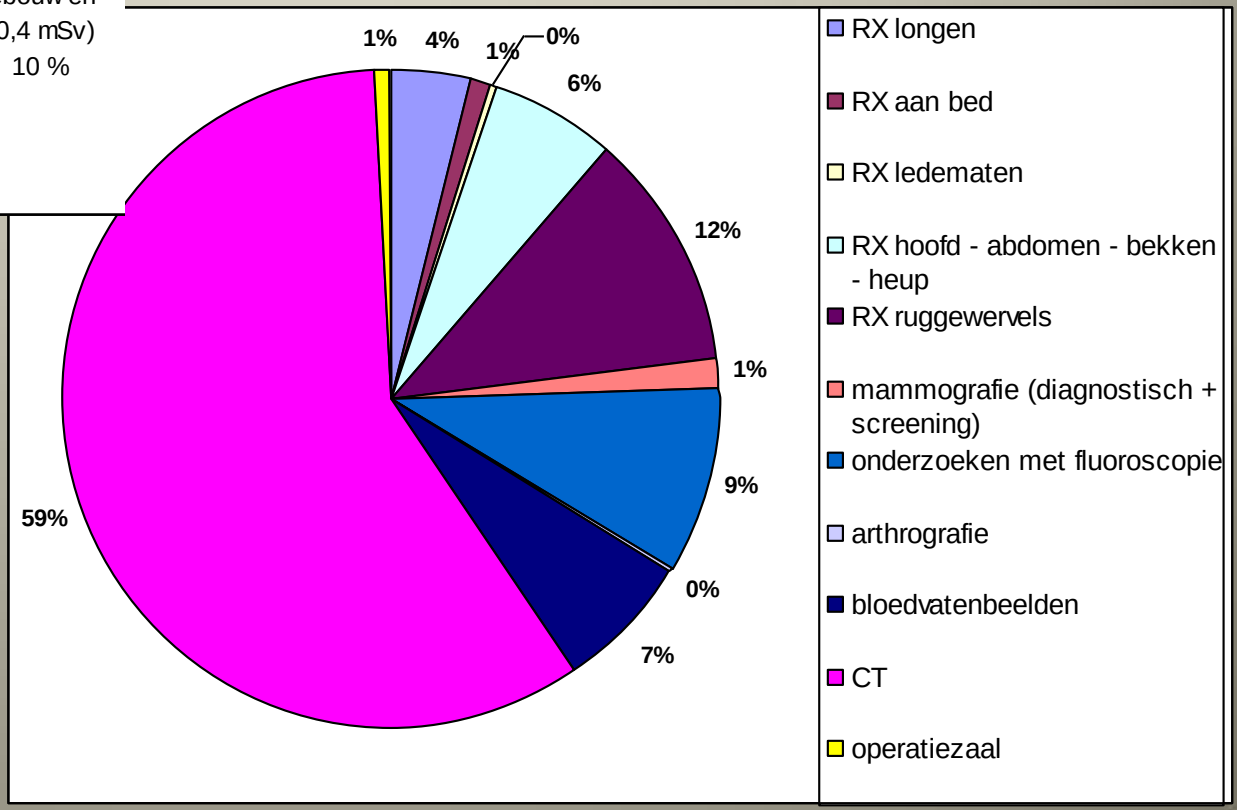
- You don’t see radiation with the eye, but you can measure it with correct tools.
- We all know there are dangerous side effects

So BASIC RULES

- Don’t use it more than necessary.
- Protect your patient and staff.
  - Avoid high dose➔ determistic effects (radiodermitis..)
  - Low dose➔ stochastic effects (tumor development)

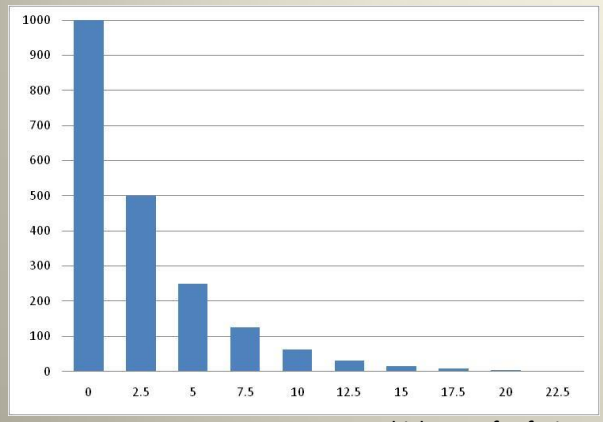
Motivation



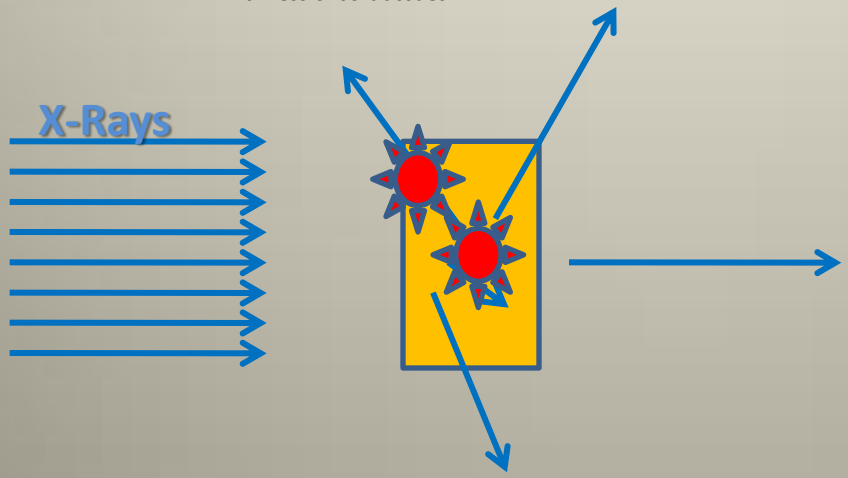


Mira-T report, 2007

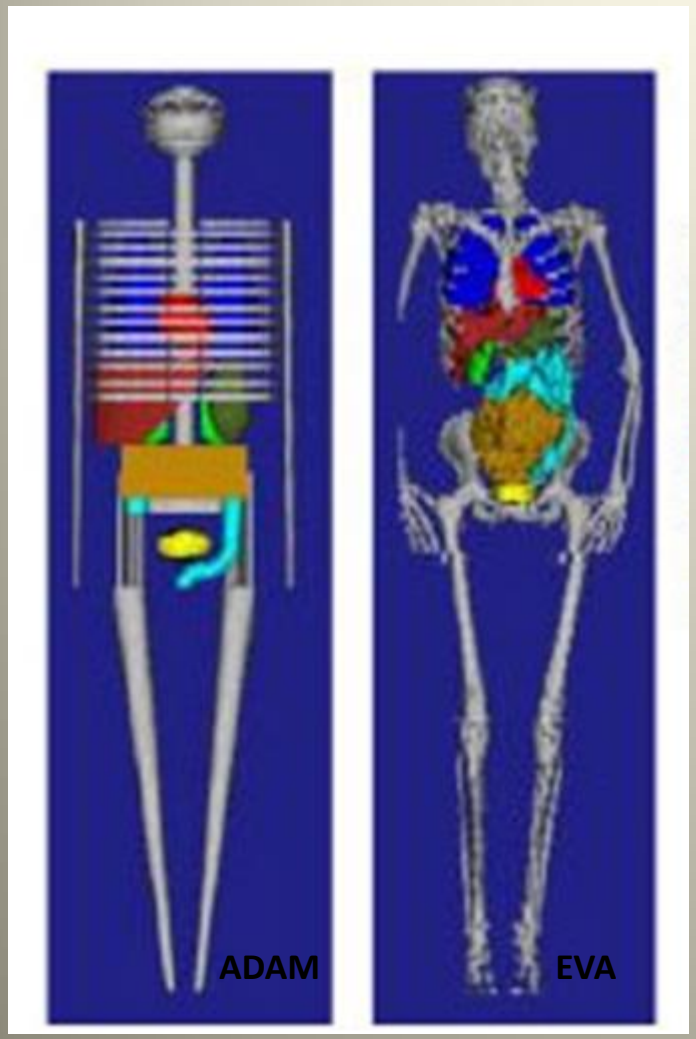
X-RAYS Exponential behavior



Thickness of soft tissues



- are massively absorbed
- are massively scattered
- most energy deposit where X-rays enter the body



Tissue or Organ	H_T per Series [mSv]
Thyroid	0.1
Breasts	5.4
Oesophagus	0.8
Lungs	6.0
Liver	16.8
Stomach	17.1
Colon	14.1
Testicles	0.0
Ovaries	14.8
Bladder	15.9
Bone marrow	7.8
Bone surface	11.9
Skin	6.5

Remainder Organs	H_T per Series [mSv]
Brain	0.0
Thymus	0.8
Spleen	17.2
Pancreas	14.4
Adrenals	14.0
Kidneys	17.5
Small intest.	15.8
Upp. large int.	16.5
Uterus	13.0

Misc.	H_T per Series [mSv]
Eye lenses	0.0

Dose Values per Examination		
DLP_w [mGy*cm]	E [mSv]	D_{uterus} [mSv]
487	**11.2**	13.0

Please note:

All organ doses H_T are based on conversion coefficients for standard patients (ADAM, EVA, CHILD, BABY) and serve for information purposes only (in particular organs outside the scan range) !

Arrêté de l'Agence Fédérale de contrôle nucléaire concernant la dosimétrie des patients // **Besluit van het Federaal Agentschap voor nucleaire controle betreffende patiëntendosimetrie**

Oct 2011

ANNEXE 9. Niveaux de référence diagnostiques belges (NRD ou DRL)

Radiologie conventionnelle chez l'adulte

Examen		NRD en DAP (cGy.cm²)	
		25e p	75e p
Abdomen		120	330
Bassin de face (AP)		170	450
Thorax PA		13	35
Thorax latéral		40	110
Thorax au lit		12	25
Colonne lombaire	totale*	7,5*	21*
	face	95	280
	profil	200	500
Crâne	total	60	150
	face	25	60
	profil	20	60

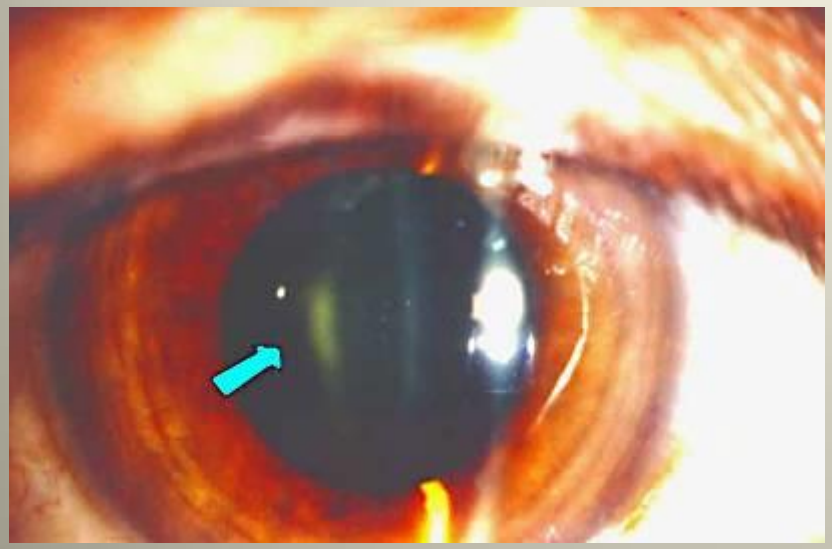
Deterministic effects of doses on the skin of the patient

A. 11 Gy:
   dry desquamation
   @ 1 month

B. 18 Gy:
   Skin necrosis

Catheterization and Cardiovascular Interventions 77:546–556 (2011)

Modern deterministic effects of the operator



DOSE LIMITS TO BE RESPECTED

	Personnel	Public
Body	20 mSv	1 mSv
Eyelens	150 mSv	15 mSv
Extremities	500 mSv	-
Skin	500 mSv	50 mSv

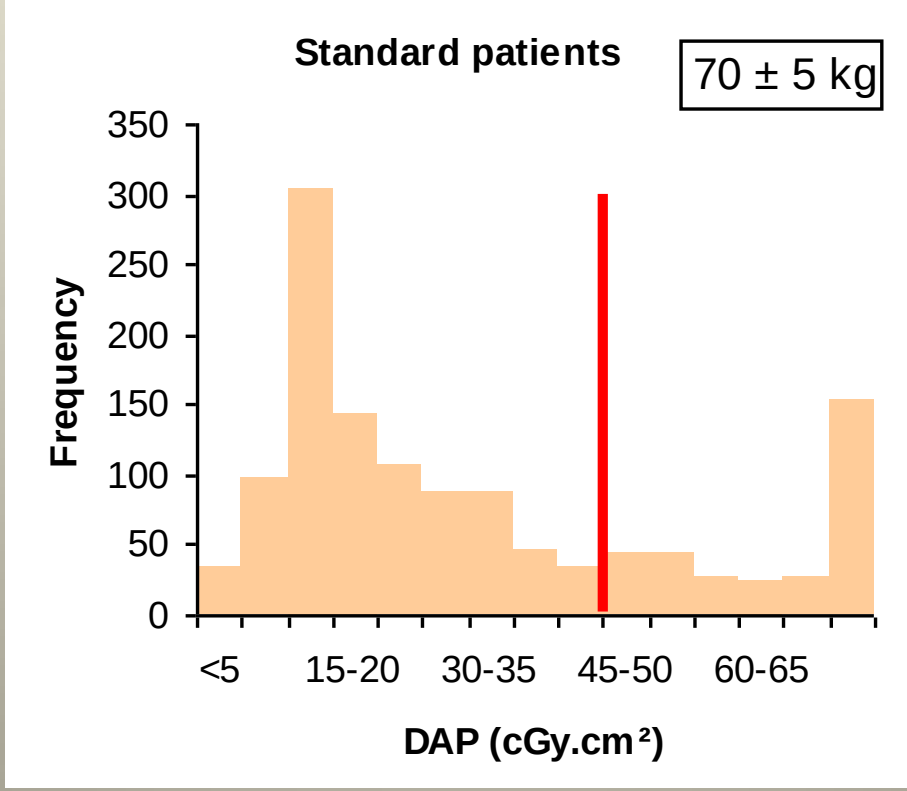
Limit will be reduced to 20mSv

During pregnancy, effective dose to the foetus < 1 mSv

Good clinical practice required;
average exposure level should be appropriate

Diagnostic Reference Levels

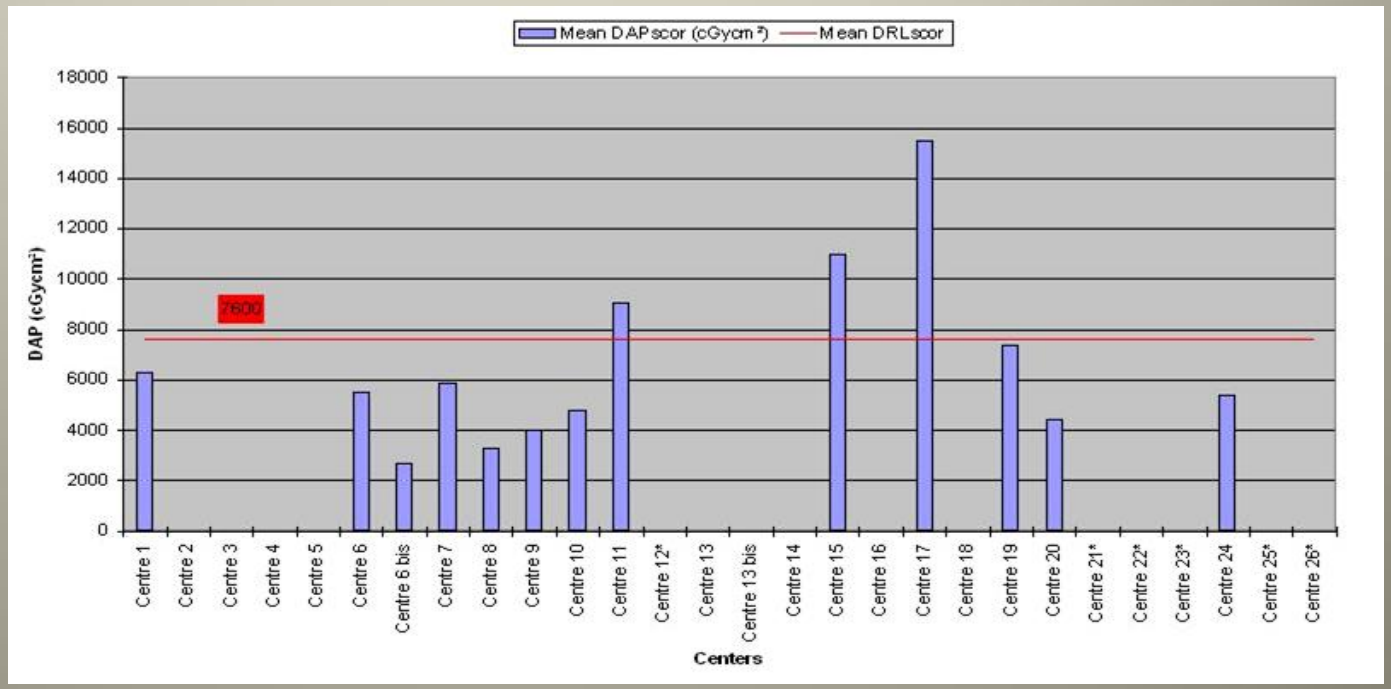
Eaxmple of ‘DRL’



M. Biernaux, FANC, Jan 2010

Follow up of patient doses

- Will be controlled by the national values of DRLs ('Diagnostic Reference Levels')



Protection of Patients and staff : Management of the X-ray doses

- Correct estimation of the scattered radiation
- How can we influence the amount of radiation and scattered radiation?
- How do we manage protection against radiation?

Based on Time--- Distance —Shielding principle

Correct estimation of scattered Radiation

Based on

Time

Distance

Lead protection

Influence of the weight of the patient:

- From 16 to 24 cm, multiply by factor 5

Influence of Xray modus:

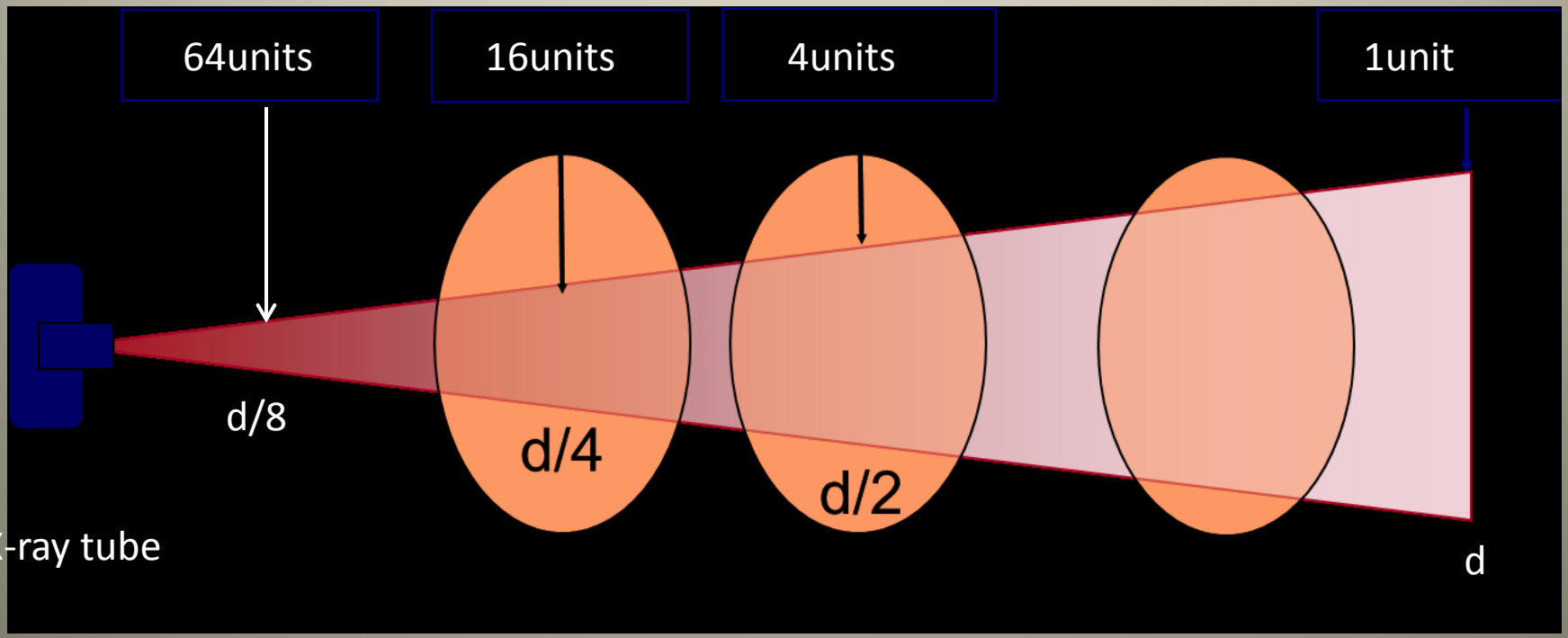
- From low dose fluoroscopy to cine➔ x factor 10

In of uit de zaal blijven (verpleegkundigen)

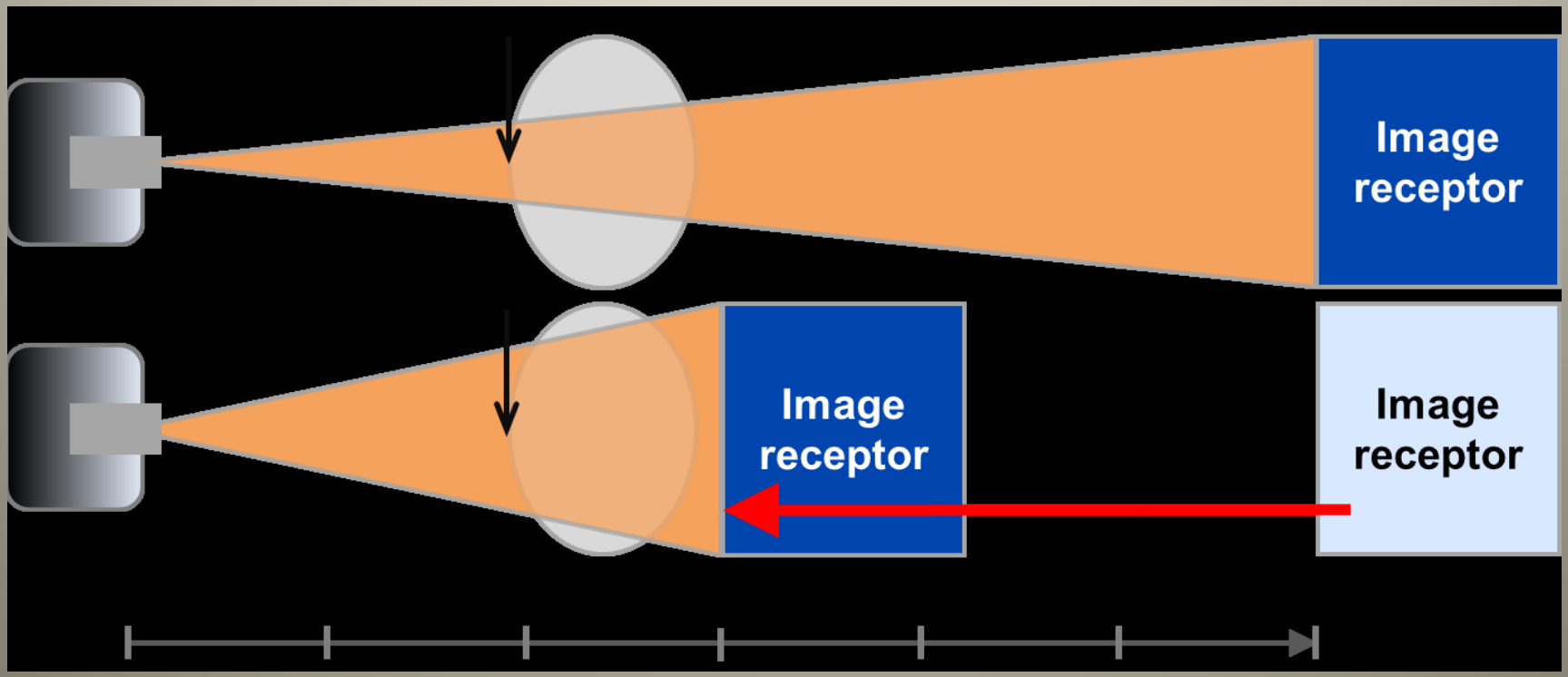
Gebruik (j/n) van afschermmiddelen

Radiation protection of patients in fluoroscopy

Maximize distance between the X ray tube and the patient to the extent possible:
The amount of beams is inversely proportional to the distance of the radiation source



Minimize distance between the patient and the image receptor: only 1-5% of the radiation on the patient exits the patient on the other side.

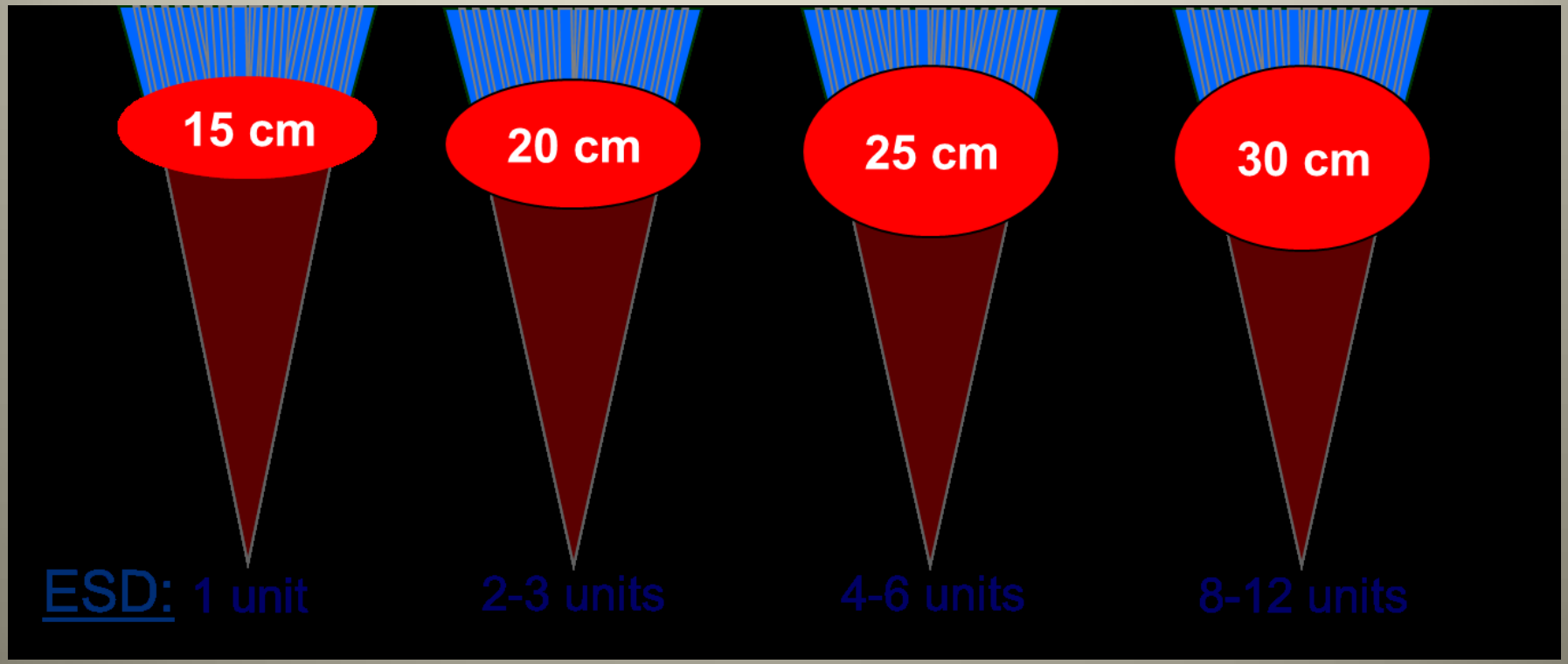


Minimize fluoroscopy time:

Keep records of fluoroscopy time and DAP/KAP (if available) for every patient

Larger patients or thicker body parts trigger an increase in entrance surface dose (ESD)

Influence of the weight of the patient:
From 16 to 24 cm, multiply by factor 5



Avoid exposing the same area of the skin in different projections
Vary the beam entrance port by rotating the tube around the patient

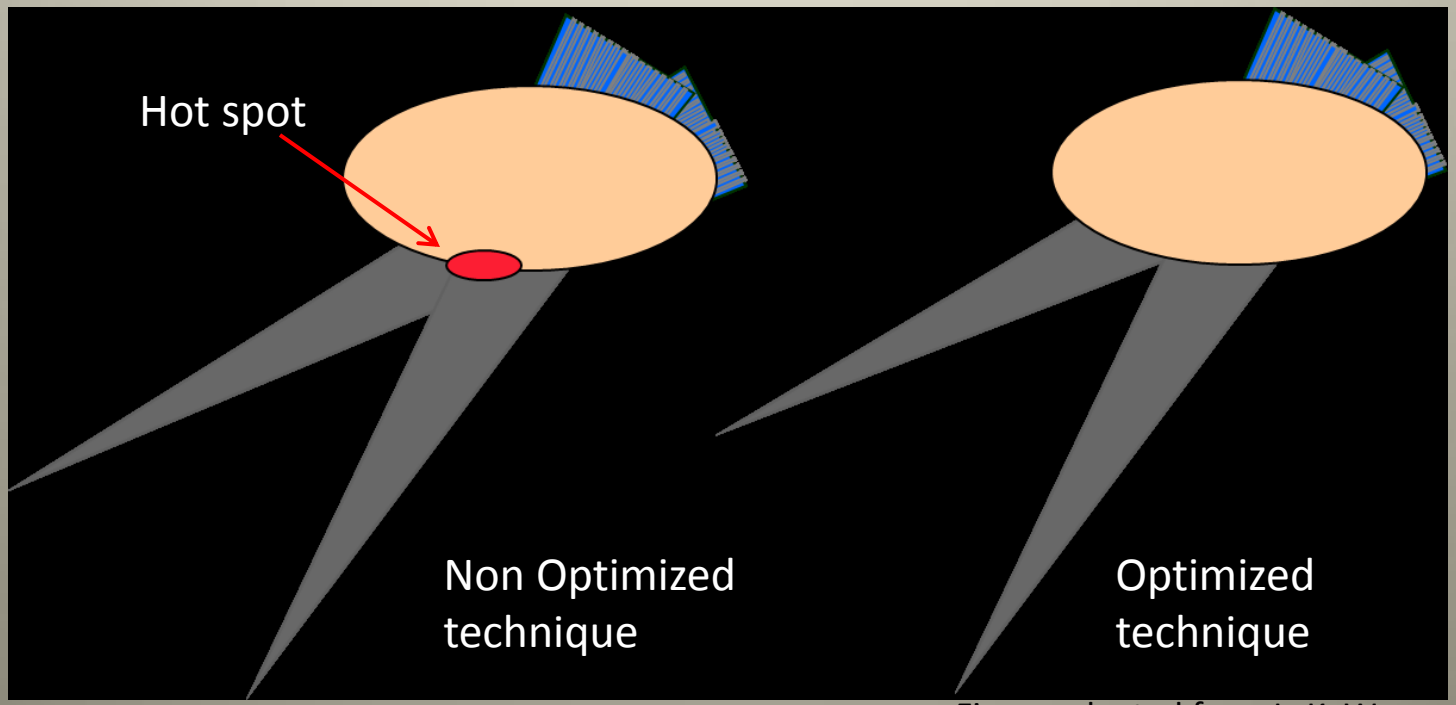
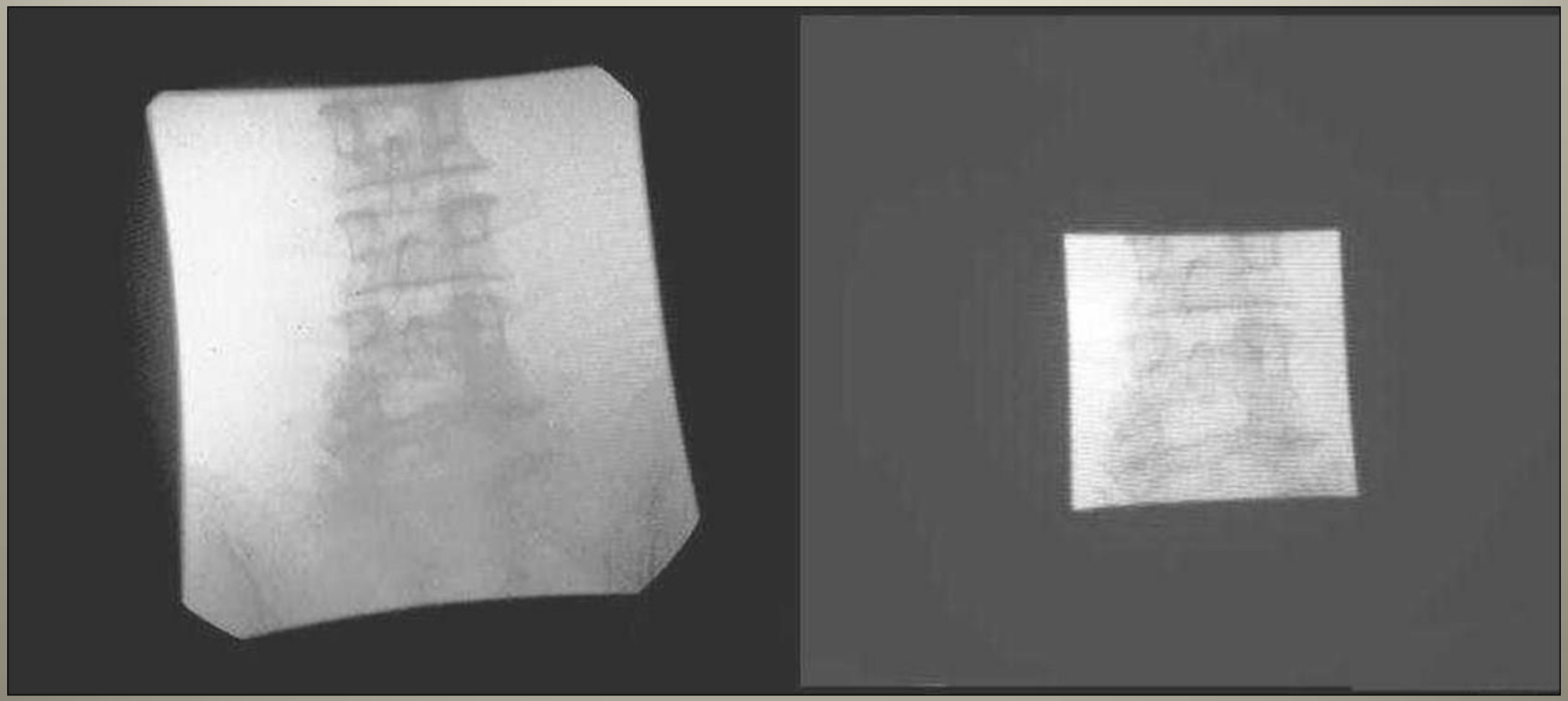


Figure adapted from L. K. Wagner

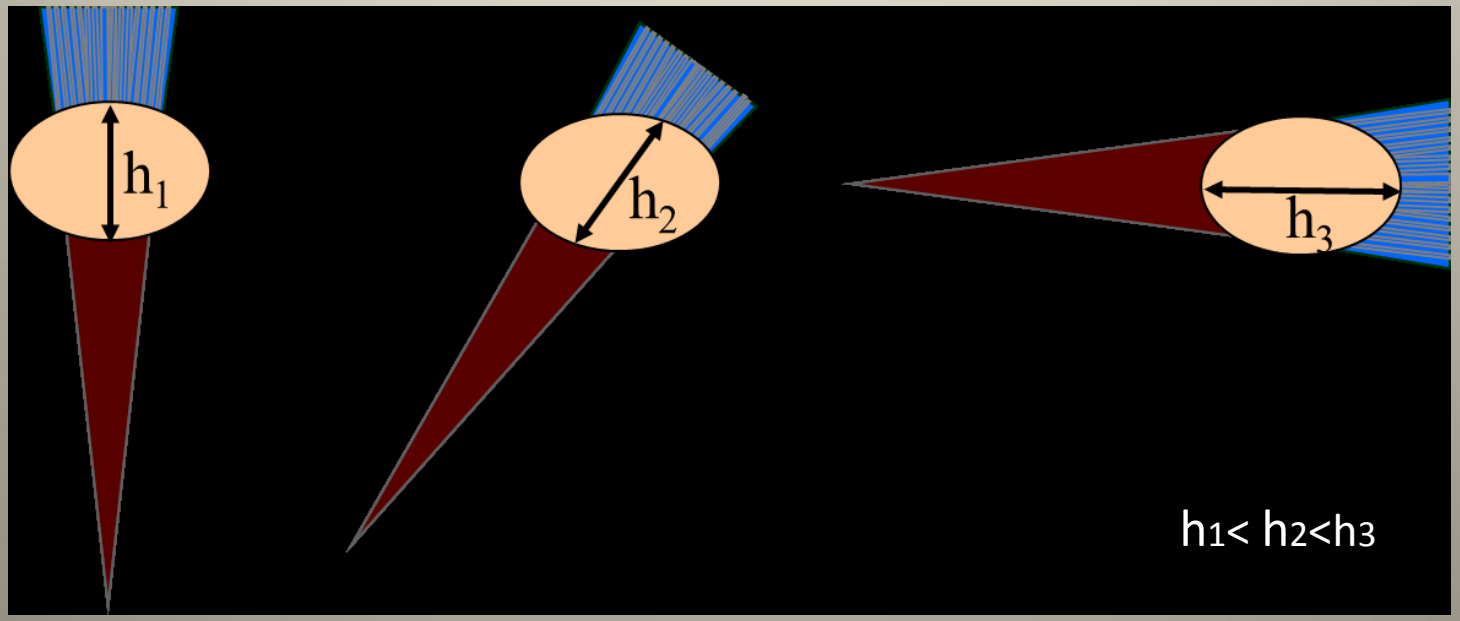
Use collimation

Collimate the X ray beam to the area of interest

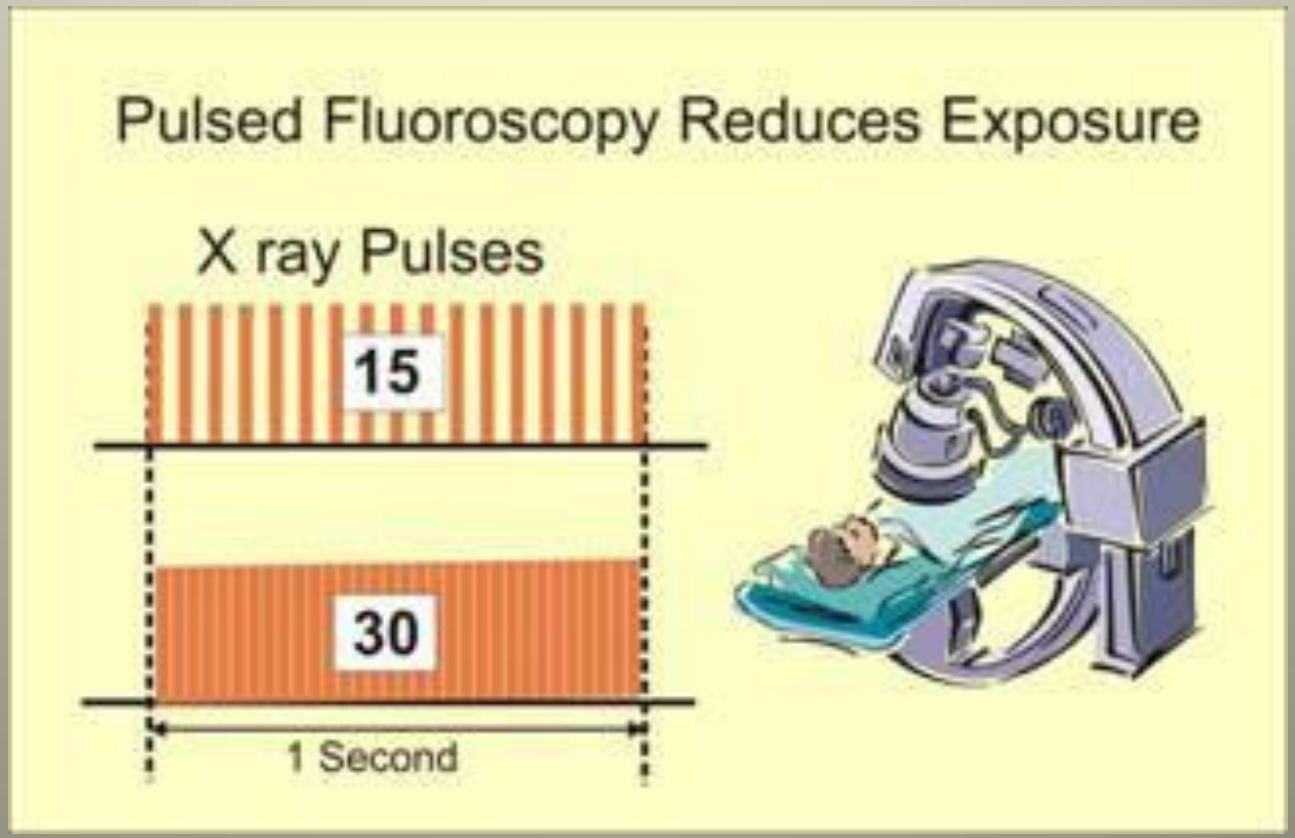


Oblique projections also increase ESD

Be aware that increased ESD increases the probability of skin injury

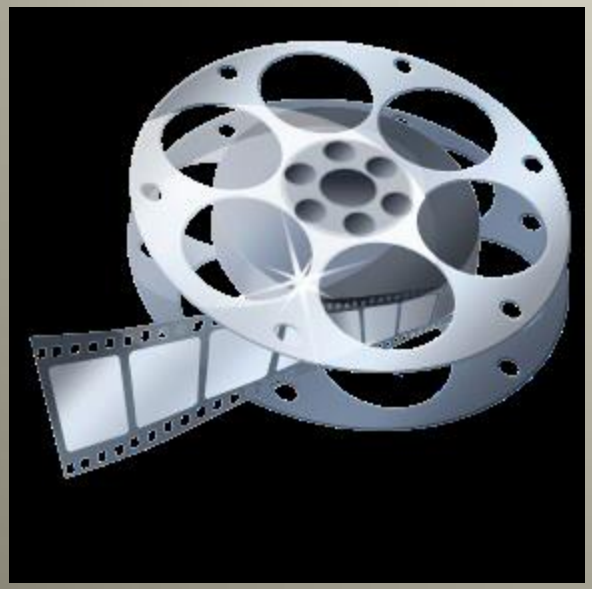


Use pulsed fluoroscopy with the lowest frame rate possible to obtain images of acceptable quality



Minimize number of frames and cine runs to clinically acceptable level

Documentation should be performed with **last image hold** whenever possible and not with cine images



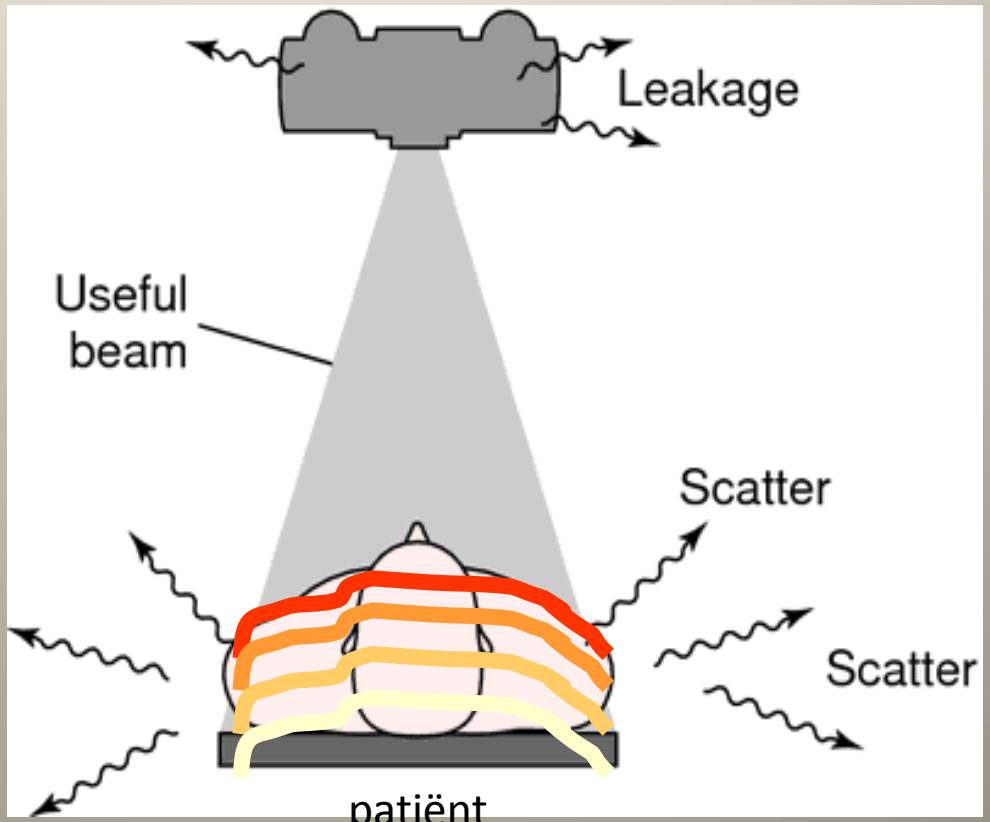
Influence of X-ray modus:

From low dose fluoroscopy to cine➔ x factor 10

Primary X-ray beam and scatter Radiation

R- RAY'S : Exponential behavior

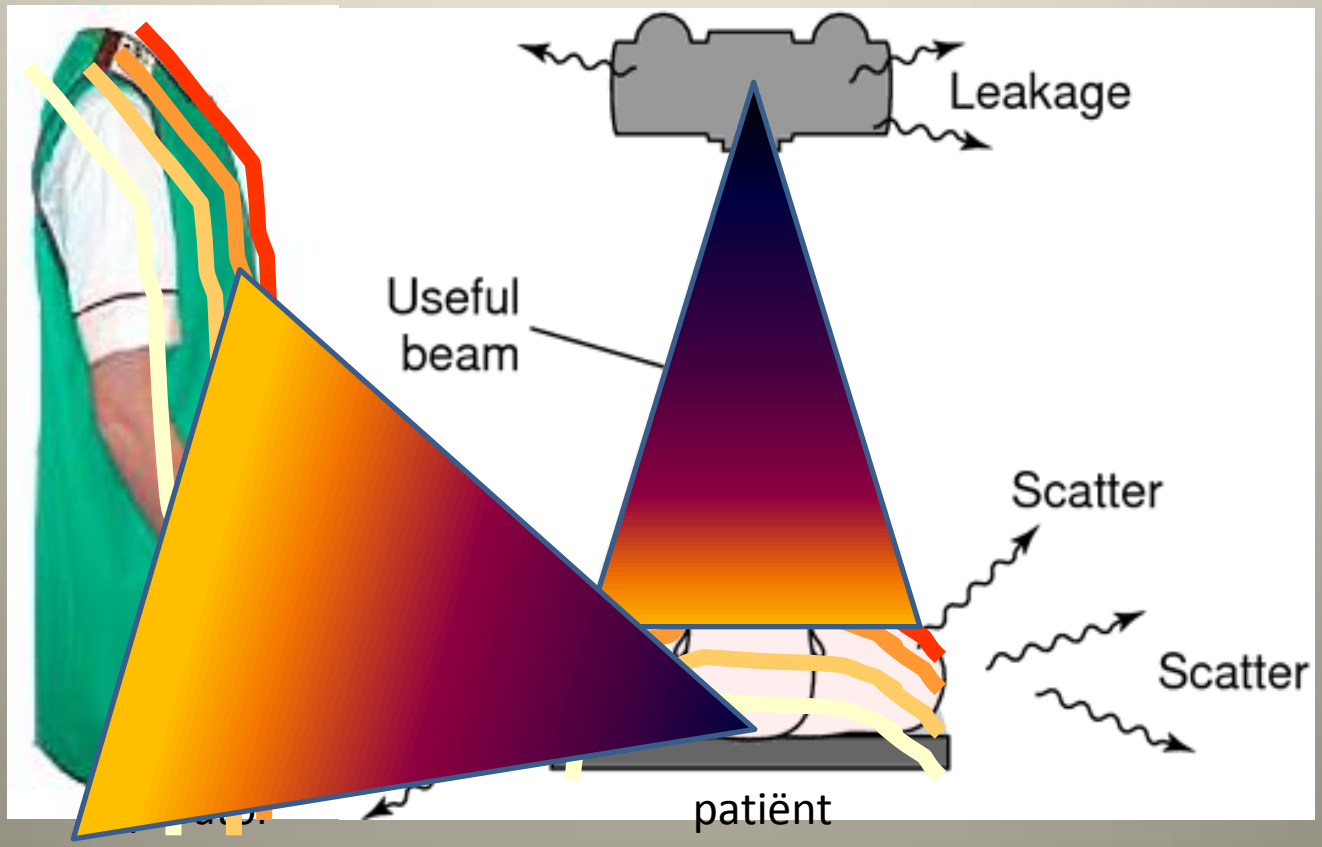
operator



patiënt

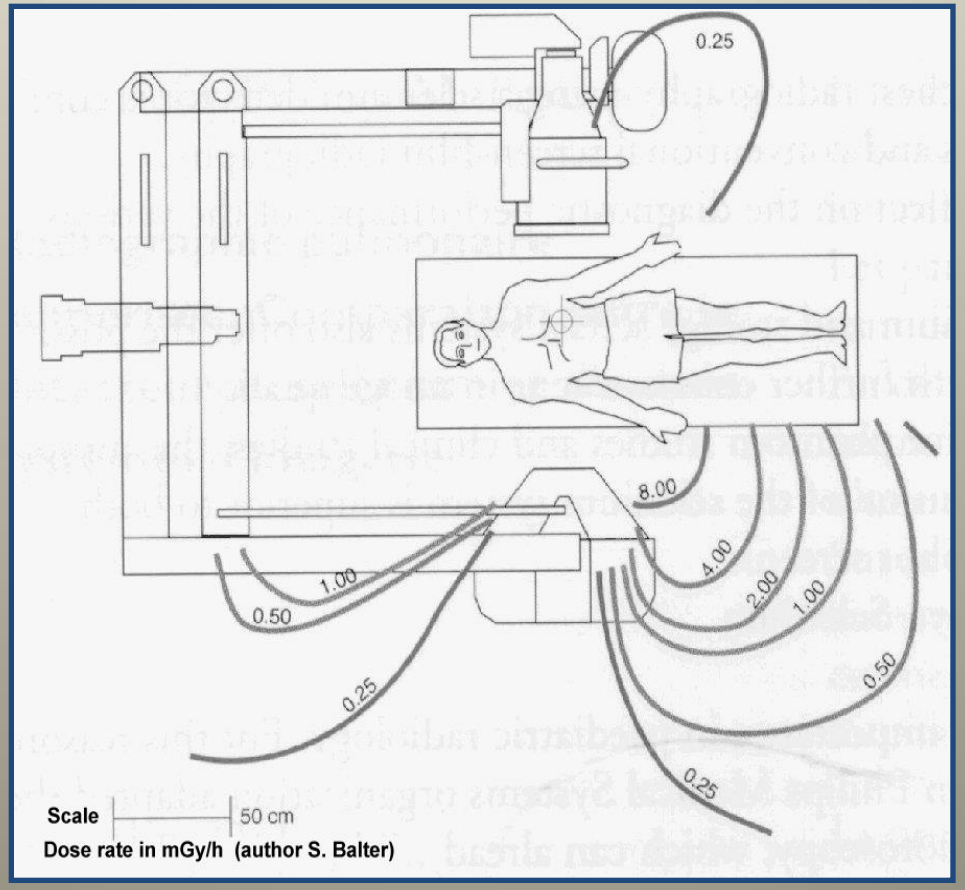
Primary X-ray beam and scatter Radiation

Exponential behavior & inverse square law

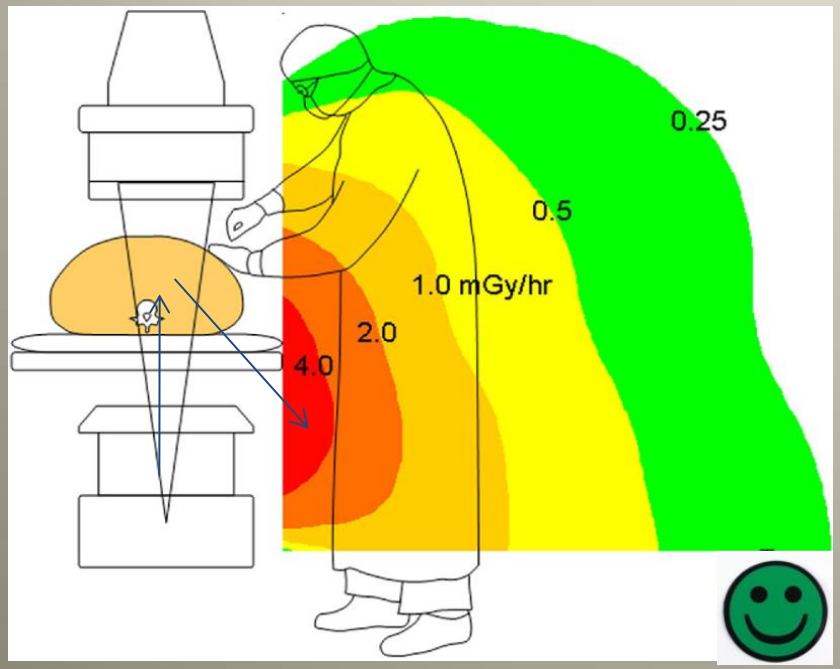


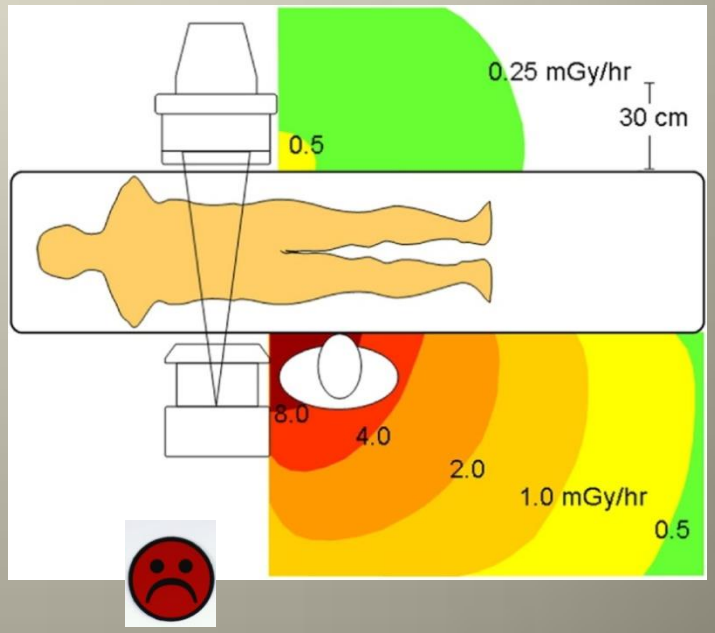
How can we correctly estimate the amount of scattered radiation???

- Each device publishes his own isodose curves for the typical use of the device



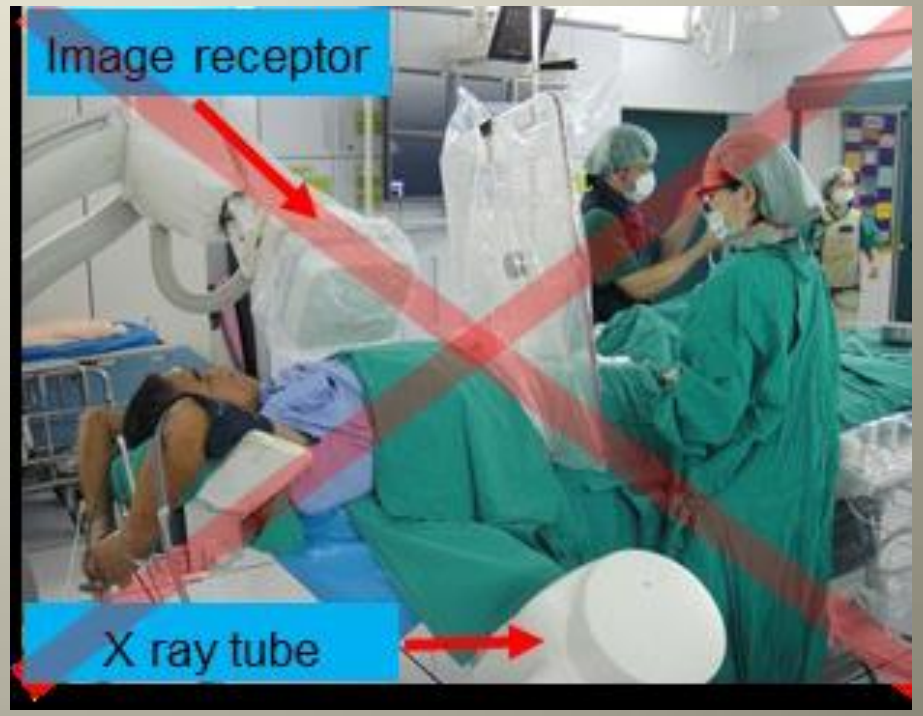
Practical application:
make a good choice for your position !



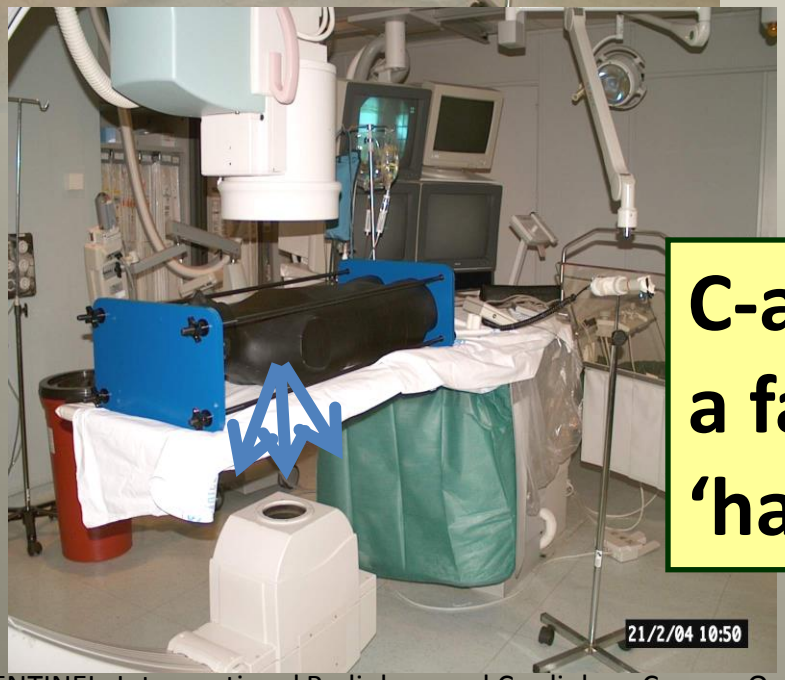


Radiation protection of staff in fluoroscopy

Right!



Wrong!

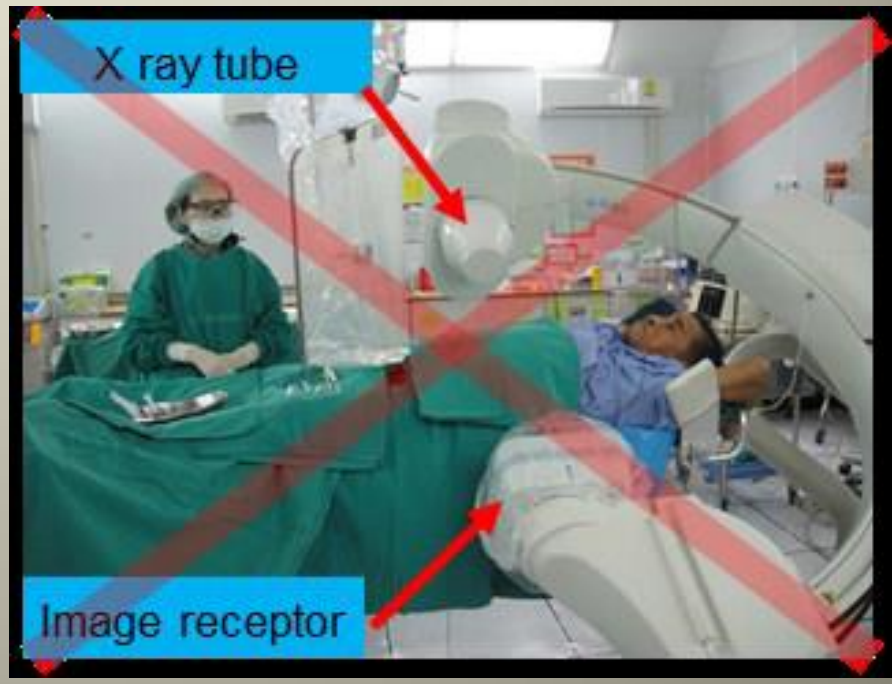


C-arm angulation can make a factor 5 of difference of 'harmful scattering'

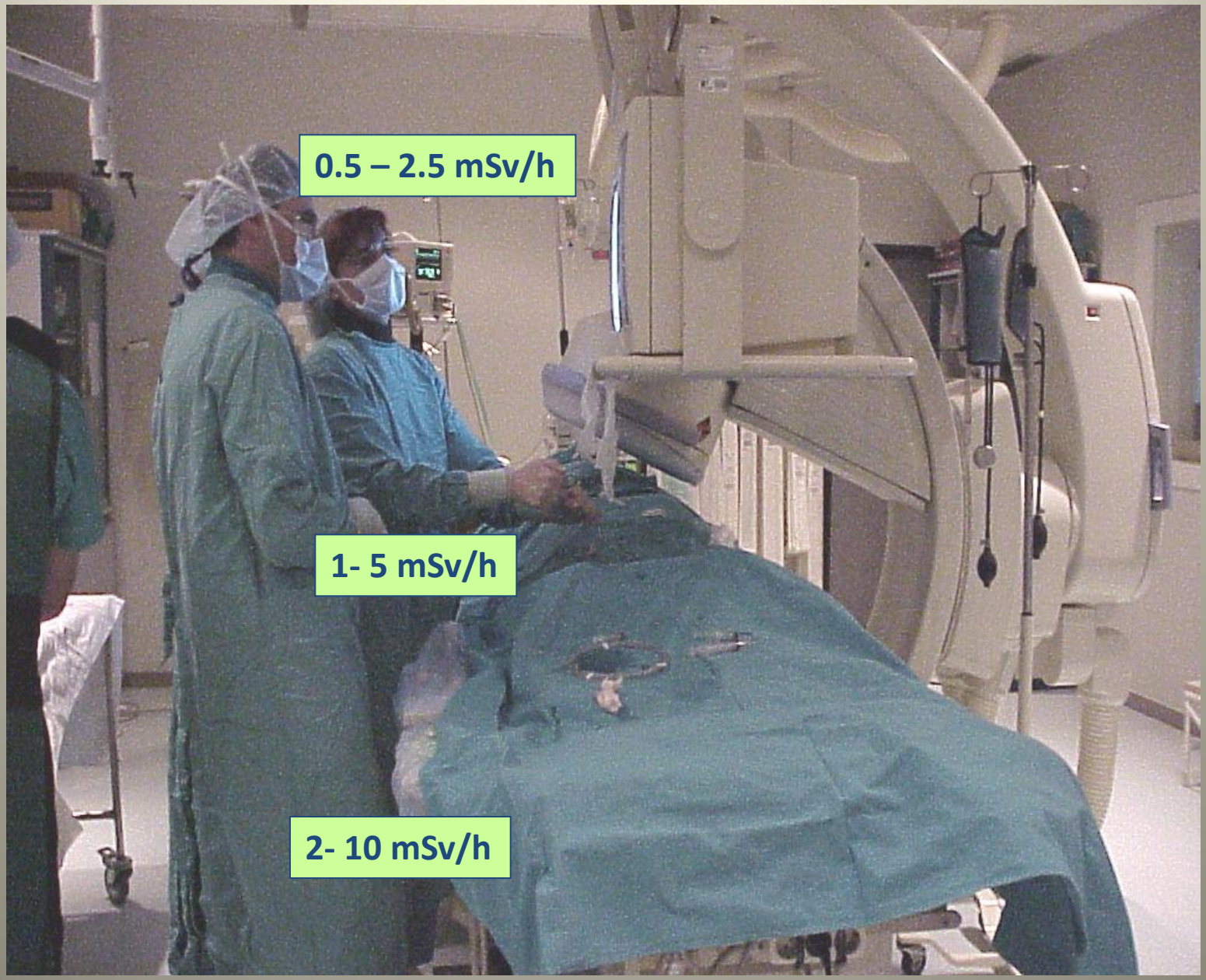
Keep X ray tube under the patient table and not over it

Undercouch systems provide better protection from scattered dose

Correct

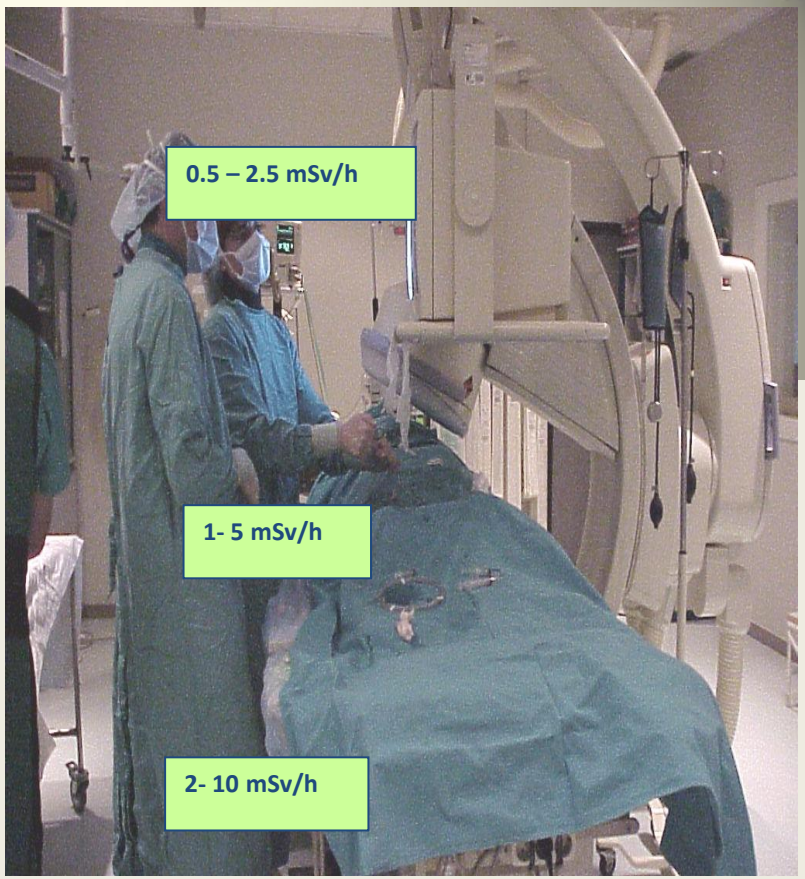


Wrong!


0.5 – 2.5 mSv/h
1- 5 mSv/h
2- 10 mSv/h

Example:

- **Interventional radiologist/cardiologist**
  - **300 procedures/year**
  - **15 min fluoroscopy/ procedure**
    + 1000 images (~10 min fluoro) ≈ 25 min fluoro



→ Eyelens:
Eq. dose = 300*25/60*(0.5 , 2.5)= 65 - 325 mSv/year
(limit 150 mSv/year)

→ Lead glasses advised

→ Feet:
Eq. Dose = 300*25/60*(2, 10)= 260 - 1300 mSv/year
(limit 500 mSv/year)

→ Whole body:
Effective doses=300*25/60*(1 , 5)= 125 - 625 mSv/year
(limit 20 mSv/year)

→ Whole body (lead apron)
Effective dose = 625 mSv/y *0.07 = 9 - 44 mSv/year

→ Whole body (lead apron + Thyroid protection)
Effective dose = 625 mSv/y *003 = 4- 20mSv/year

Protection is a must!!!!

preferrable with lead glasses and 2 dosimeters certainly if eyelens level will be reduced to 20mSv

Make correct use of Fluoroscopy

With a foto camera
at the X-ray display
this picture is ….

X-rays are on ……

Nobody looks to the display

This is unallowed use of X-ray radiation!!!!!!

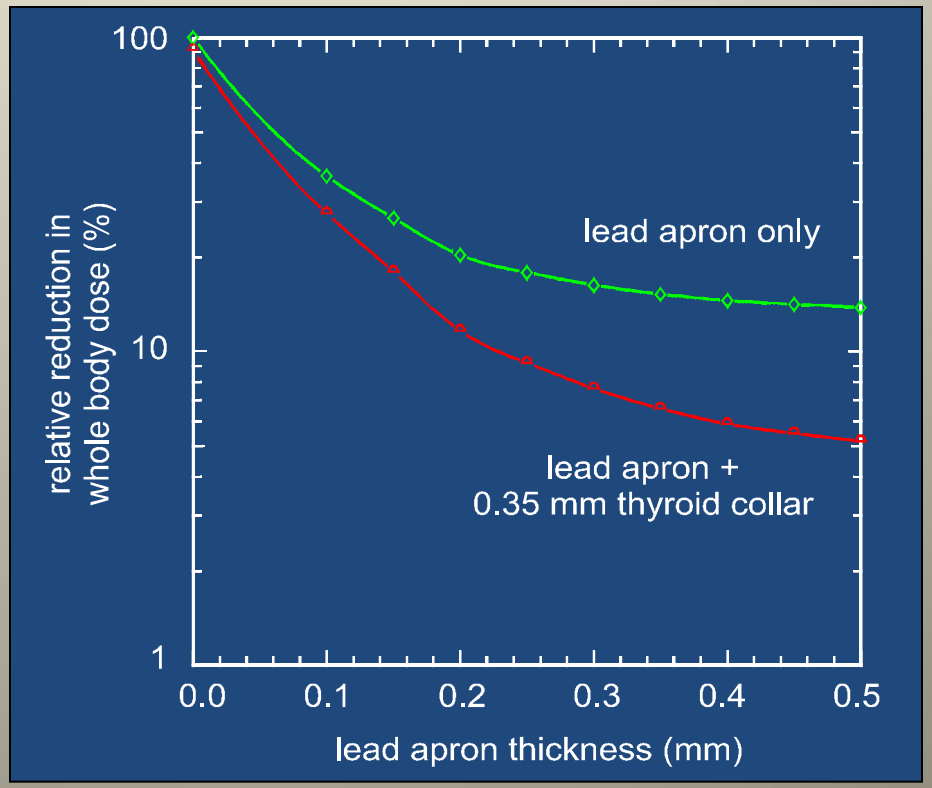
http://rpop.iaea.org/RPOP/RPoP/

http://rpop.iaea.org Content/Documents/ Whitepapers/poster-staff-radiation-protection.pdf

IAEA

Protection tools:

Apron and Thyroid Protection



Protection tools

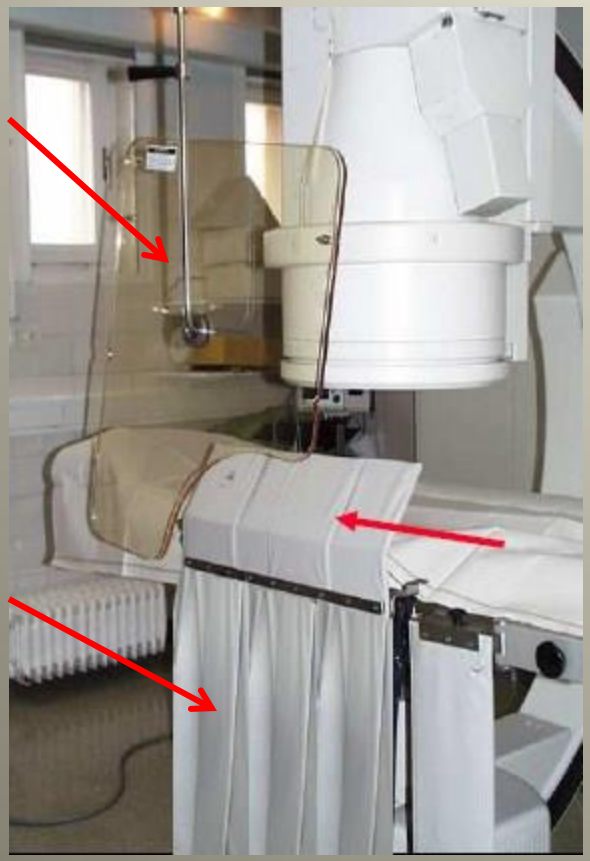
SCREEN AND GOGLES

- Adjustable like normal glasses
- +/- side sheets

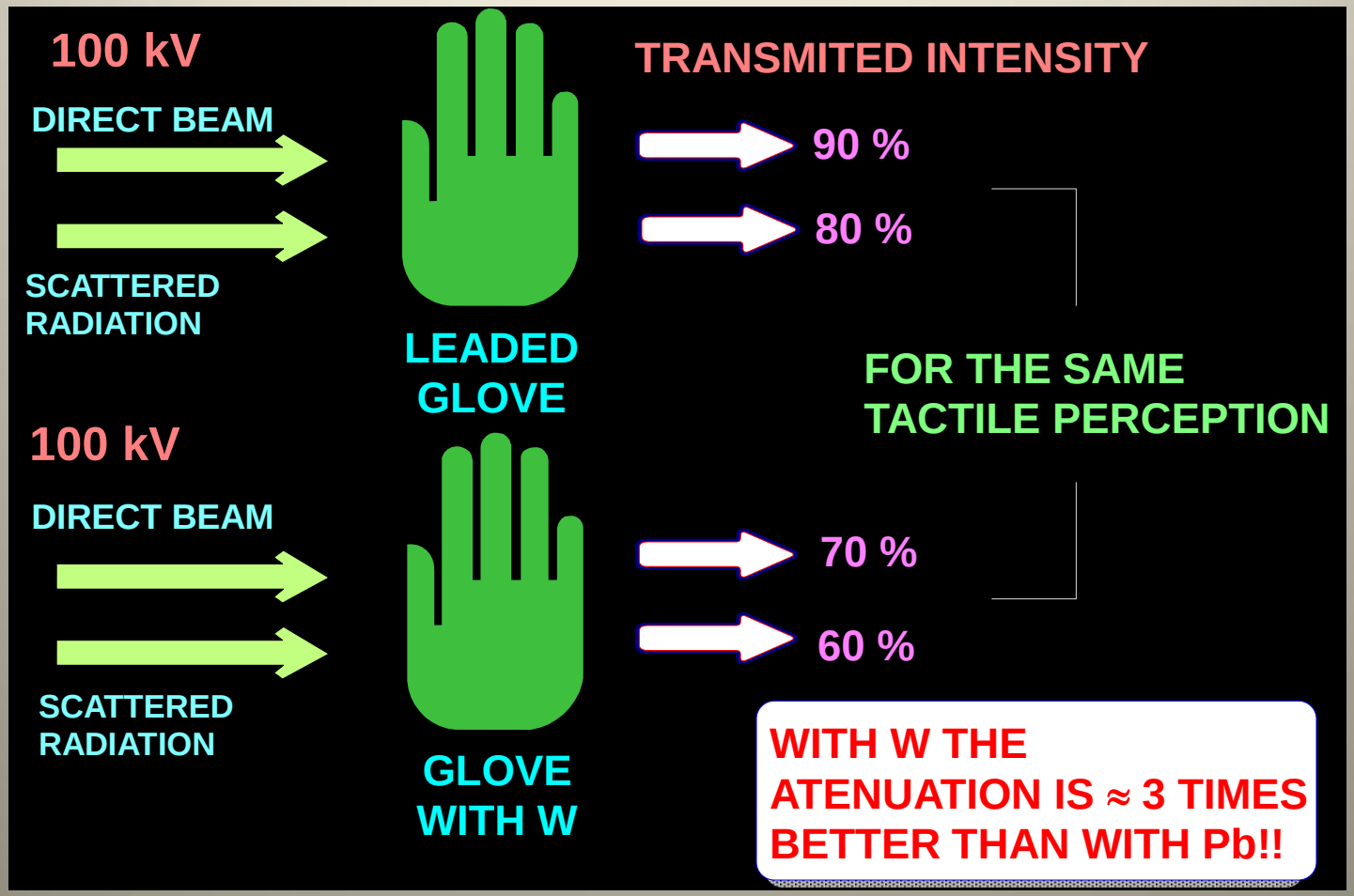
Protection tools

CURTAINS and MOBILE SHIELDS

Use ceiling suspended screens, lateral shields and table curtains
They provide more than 90% protection from scattered radiation in fluoroscopy
Mobile floor shielding is advisable when using cine acquisition

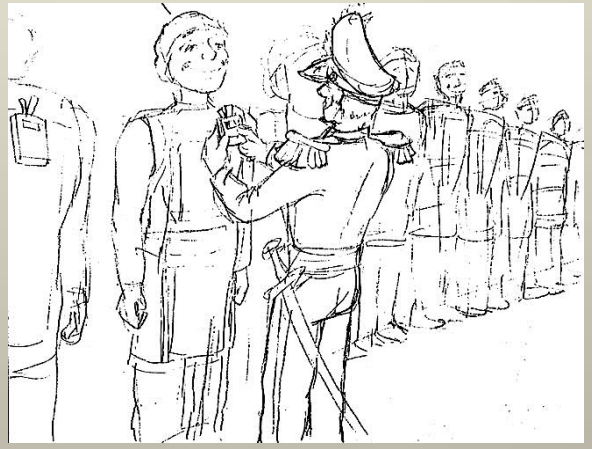


Protection tools (II)

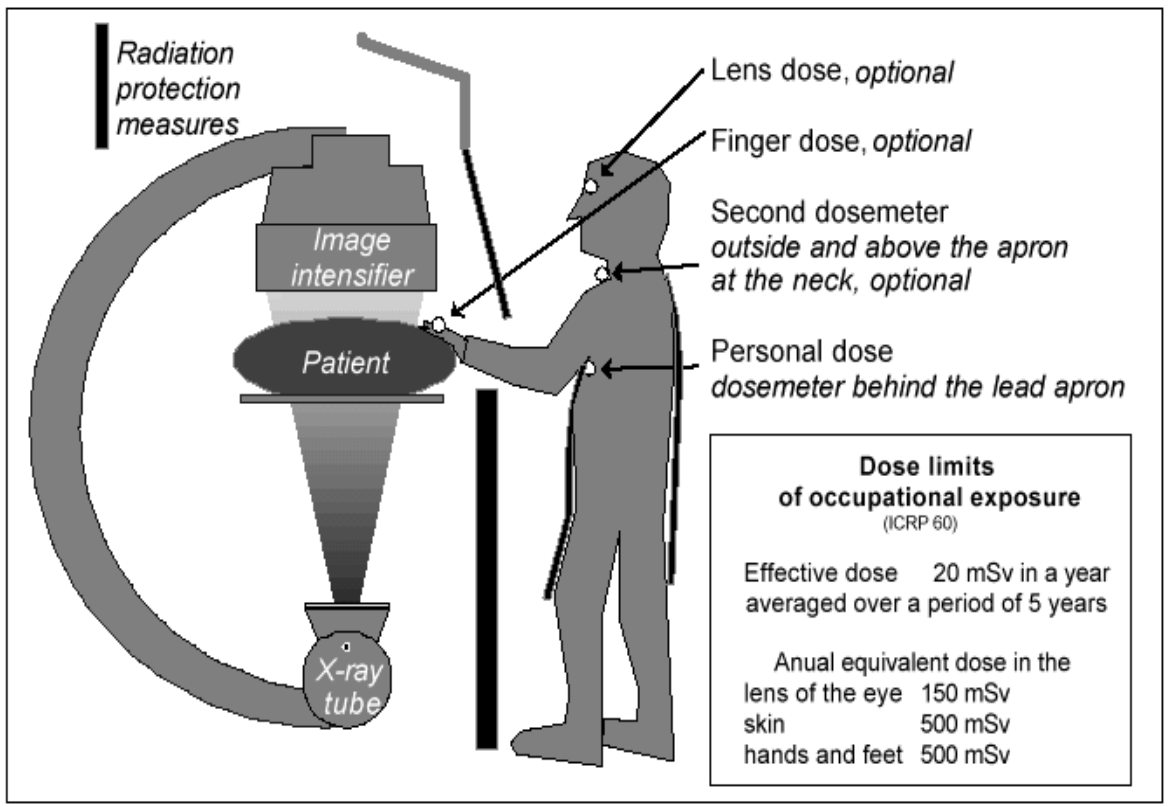


Optimize the staff doses

Dose monitoring: required !



Personal dosimetry



Several personal dosimeters maybe recommended

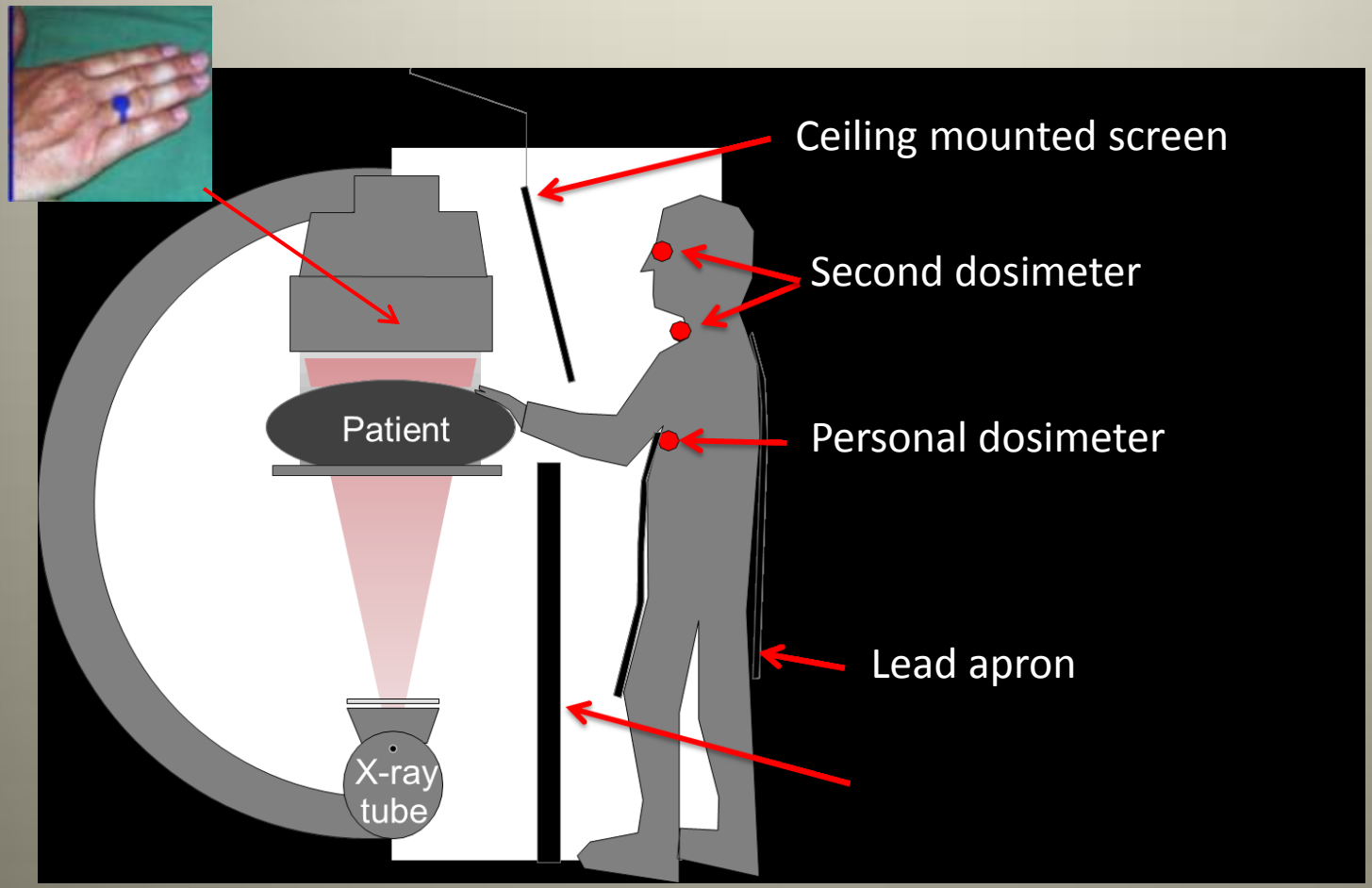
From: Avoidance of radiation injuries from interventional procedures. ICRP draft 2000

When double dosimetry?

If it is probable that you reach 3/10 of annual dose limit on your personal dosimeter and if exposed to high dose radiation/ interventional X-ray procedures

If Necessary use two dosimeters

1. One inside the apron at chest level (personal dosimeter)
2. One outside the apron at neck or eye level (second dosimeter)
3. Additional finger ring dosimeter for procedures requiring hands close
4. to primary beam



Take home points: some extra basic principles for radiation protection

- Time
- Distance: step one step back
- Leadshielding

- Monitoring of the doses of all staff en all patients undergoing interventional RX procedures
- Bewustwording *(Awareness)* voor deze heel specifieke toepassingen
- Zaal / ergonomie & Toestel: afregeling & selectie van dosis modus en dosis tempo; gebruik van dosisreducerende opties (bv filters); controle van dosis en beeldkwaliteit

Discussie
Wat moet er nog gebeuren opdat

- U uw patiënten goed kunt opvolgen
  - Niet AL uw patiënten, wel de patiënten met verhoogd risico
  - Niet enkel ‘morgen’ maar gedurende voldoend lange tijd
- U er zeker van kunt zijn dat u uw X-stralentoestel optimaal gebruikt?

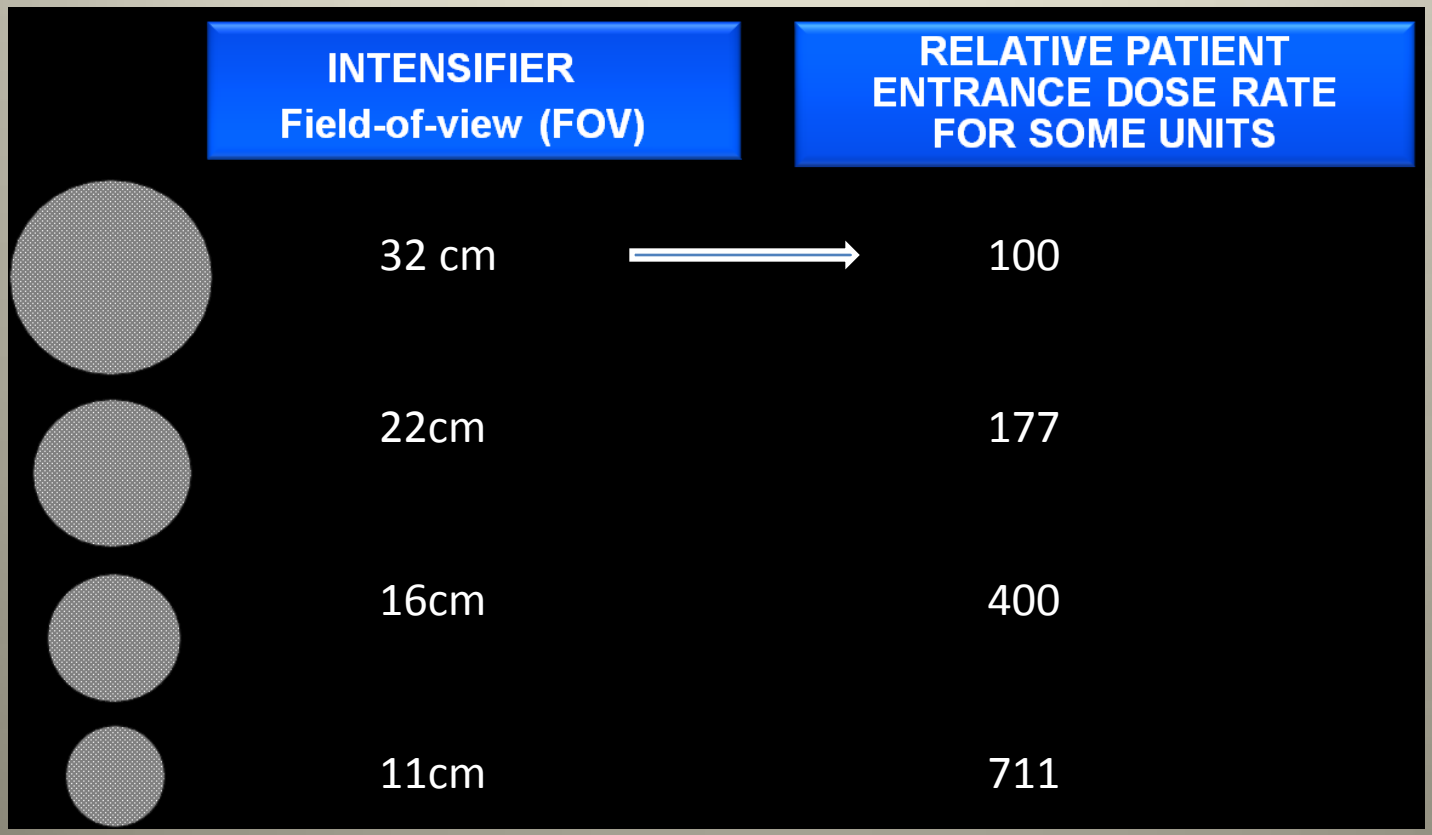
Discussie
Hoe optimaliseert u uw dosis?

- Hoe vergelijkt uw dosis met de NORM?
- Welke beschermingsmiddelen heeft U? gebruikt U ze correct?
- Welke dosisreducerende ‘toetsen’ op uw toestel heeft U ? … kent U?

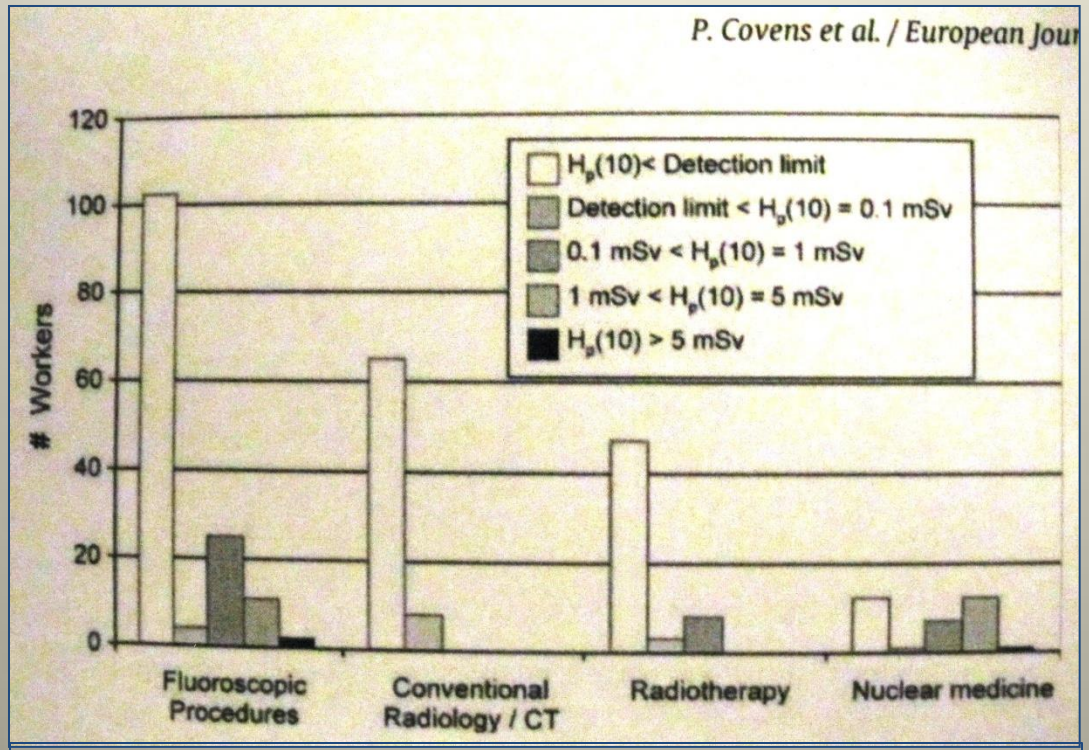
- Of was u totnogtoe TE bang?

Avoid the use of magnification

Decreasing the field of view by a factor of two increases dose rate by a factor of four



Address your concerns about radiation protection to radiation protection specialists (medical physicists)



Distribution of annual dosimeter readings Hp(10) in a typical university hospital

4. PEOPLE TO HELP YOU

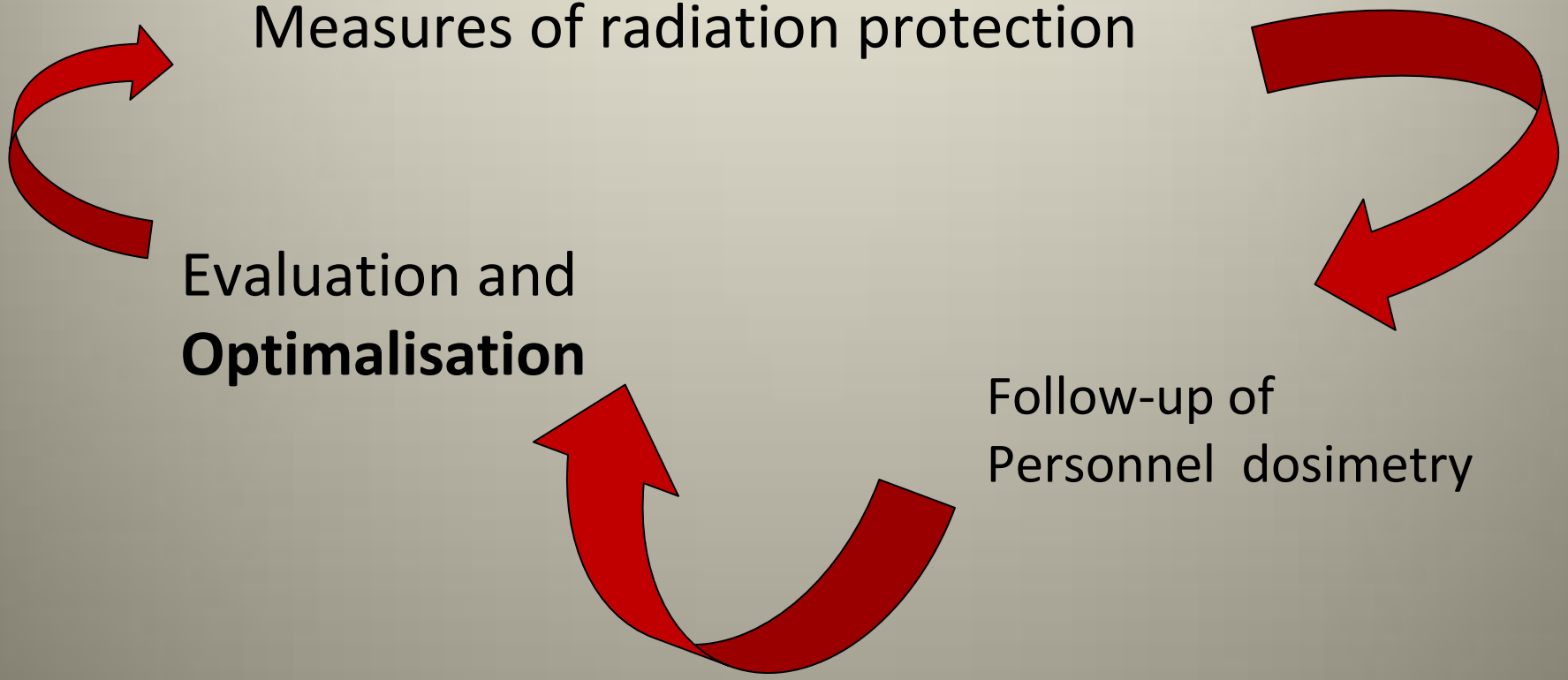
Physical control vs Medical Physics

- Radiation protection of the personnel

(dosimetry; lead apron; rooms & radiation leakage)

- Acceptable image quality at acceptable patient dose via well adjusted and properly used equipment

Physical control

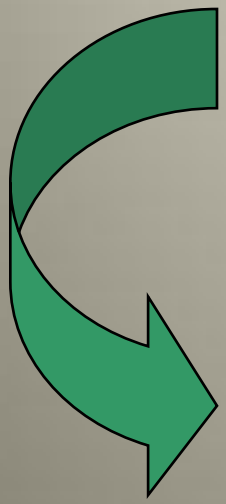


Medical Physics

- Make you work with your patients at least below the DRL
- Ensure acceptable image quality
- This will also limit your personnel dose

Practical radiation protection rules (I)

ARTICULATED SHIELDING, LEADED APRONS, GLOVES, THYROID PROTECTORS, ETC, MUST BE USUALLY AVAILABLE IN THE X-RAY ROOMS



BUT THEY MUST BE USED ALWAYS AND PROPERLY

Practical radiation protection rules (II)

REGULAR QUALITY CONTROL CHECKS MUST BE PROGRAMMED

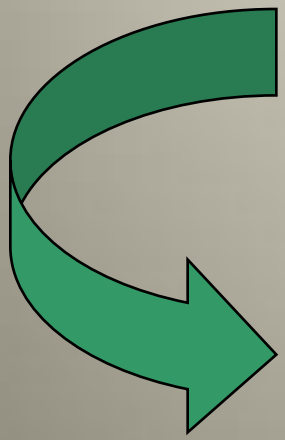
BUT

STAFF MUST ASK FOR THESE CHECKS AND FORECAST SUFFICIENT ROOM AVAILABILITY FOR DOING IT

Practical radiation protection rules (IV)

IMPORTANT PARAMETERS:

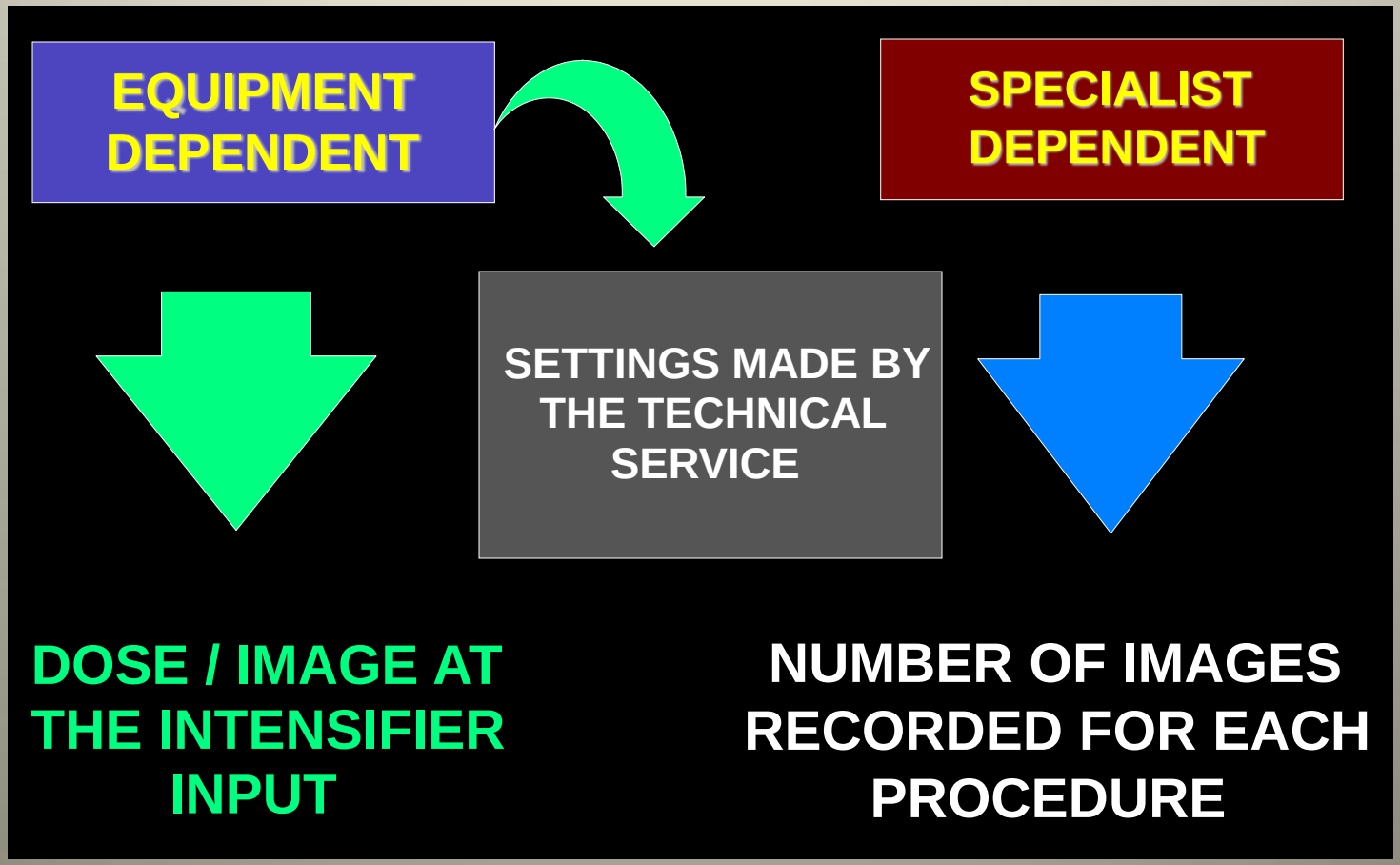
- **FOCUS-PATIENT SKIN DISTANCE**
- **PATIENT-IMAGE INTENSIFIER DISTANCE**



PATIENT DOSE WILL INCREASE IF :

- **THE FOCUS-SKIN DISTANCE IS SHORT**
- **THE PATIENT-IMAGE INTENSIFIER DISTANCE IS LARGE**

Equipment and specialist



Radiation risk for staff

EQUIPMENT CHARACTERISTICS

 # ROOM DIMENSIONS
 # SHIELDING THICKNESS
 # X-RAY SYSTEM POSITION

THE ROLE OF THE SPECIALIST

DISTANCE AND RELATIVE POSITION OF THE STAFF WITH RESPECT TO THE PATIENT

Take home points: Safety Axioms

- Vermijd verrassingen! Volg dosissen op, ook tijdens de procedures

- Beheer straling zoals u medicatie, kontraststoffen, …, beheert

- U bent als arts bent verantwoordelijk.
  - voor
  - Tijdens de ingreep
  - na

Take home points:

Ask yourself these questions:

Is your facility prepared?

How knowledgeable is your staff?

How do you compare?

How much dose am I delivering to my patients?

Are my staff properly protected?

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