Surgeons and **surgery** with the use of radioscopy and fluoroscopy.

Risks and Benefits

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Why me???

- I don’t know much about this subject

➔But maybe it is good to know more about it???

- We hope the effect is higher when it goes from surgeon to surgeon

➔ because surgeons are a bit “Macho” and you are one of them!!!

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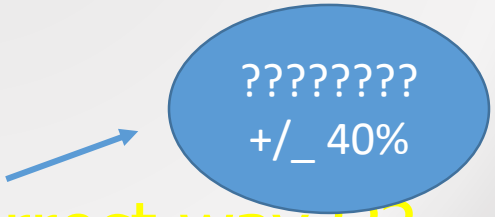
How "Macho" are we, surgeons ??

- Lead apron is worn nearly by all surgeons when using radioscopy or fluoroscopy
- Dosimeter??? ➔ surgeon dependent
  - > 50 years surgeons are worse than younger surgeons
  - Interventional cardiovascular surgeons after warning
  - Anesthesiologist in pain clinics
  - Urologist
  - Abdominal surgeons
  - Orthopedic surgeons
- Some surgeons have a big Foot!!!
- Do we use our X-ray tools in a correct way???



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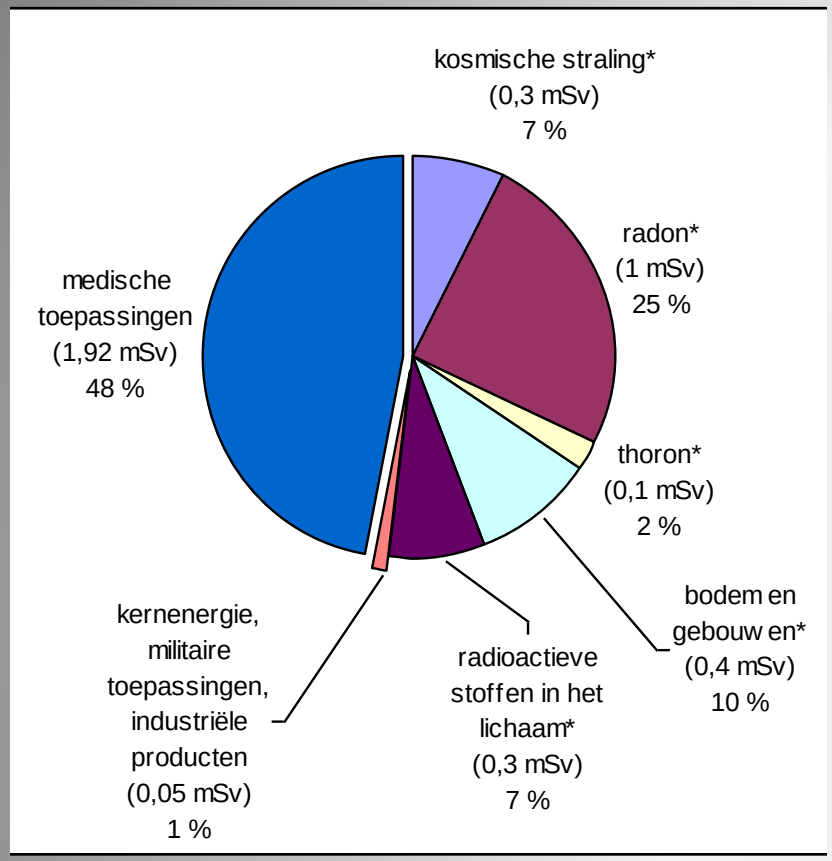
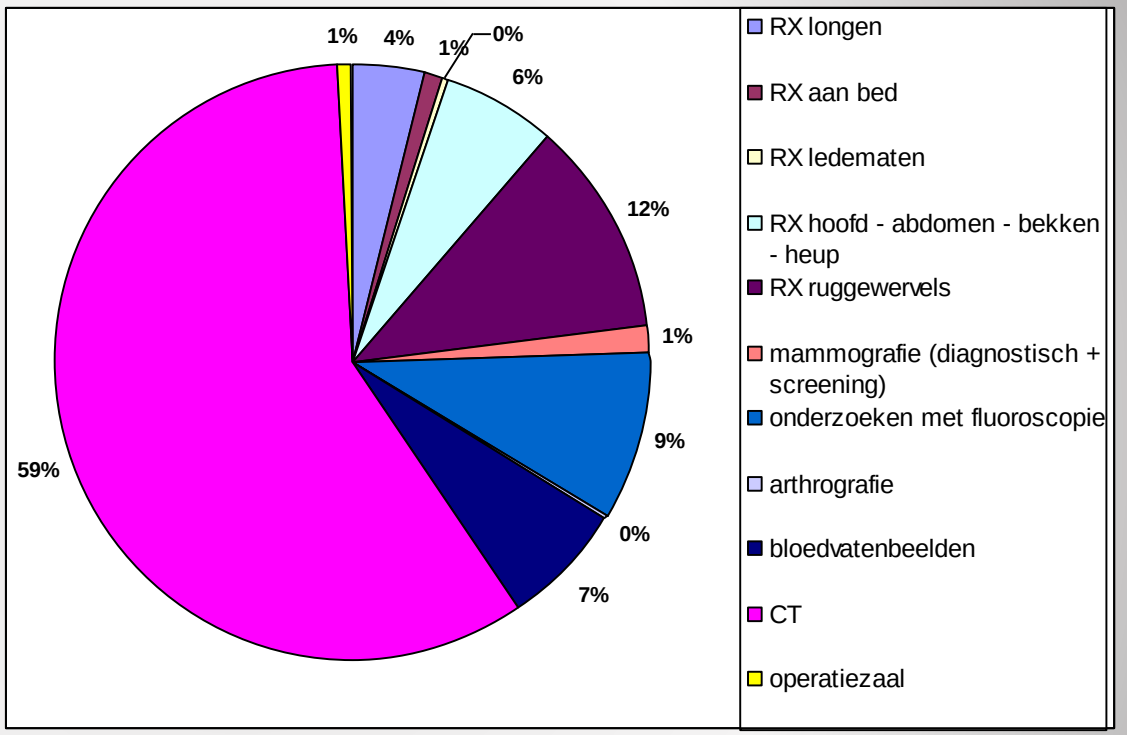
My Motivation



Mira-T report, 2007



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Benefits of using 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
  - for the Surgeon
- X-ray can save lives , but can also kill at long term

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Benefits of use Fluoroscopy during surgical procedures

- The benefit will only be as good as the protection measurements taken for
  as well the patient as the surgeon

This means ➔ **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

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X-rays Anno 2016 in Afrika !!!!??????

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BIG BROTHER IS WATCHING YOU

FANC : FEDERAAL AGENTSSCHAP VOOR NUCLEAIRE CONROLE (DRL&DAP)

ORAMED: OPTIMIZATION OF RADIATION PROTECTION FOR MEDICAL STAFF

IAEA: INTERNATIONAL ATOMIC ENERGY AGENCY

The benefit will only be as good as the protection measurements taken for as well the patient as the operator.

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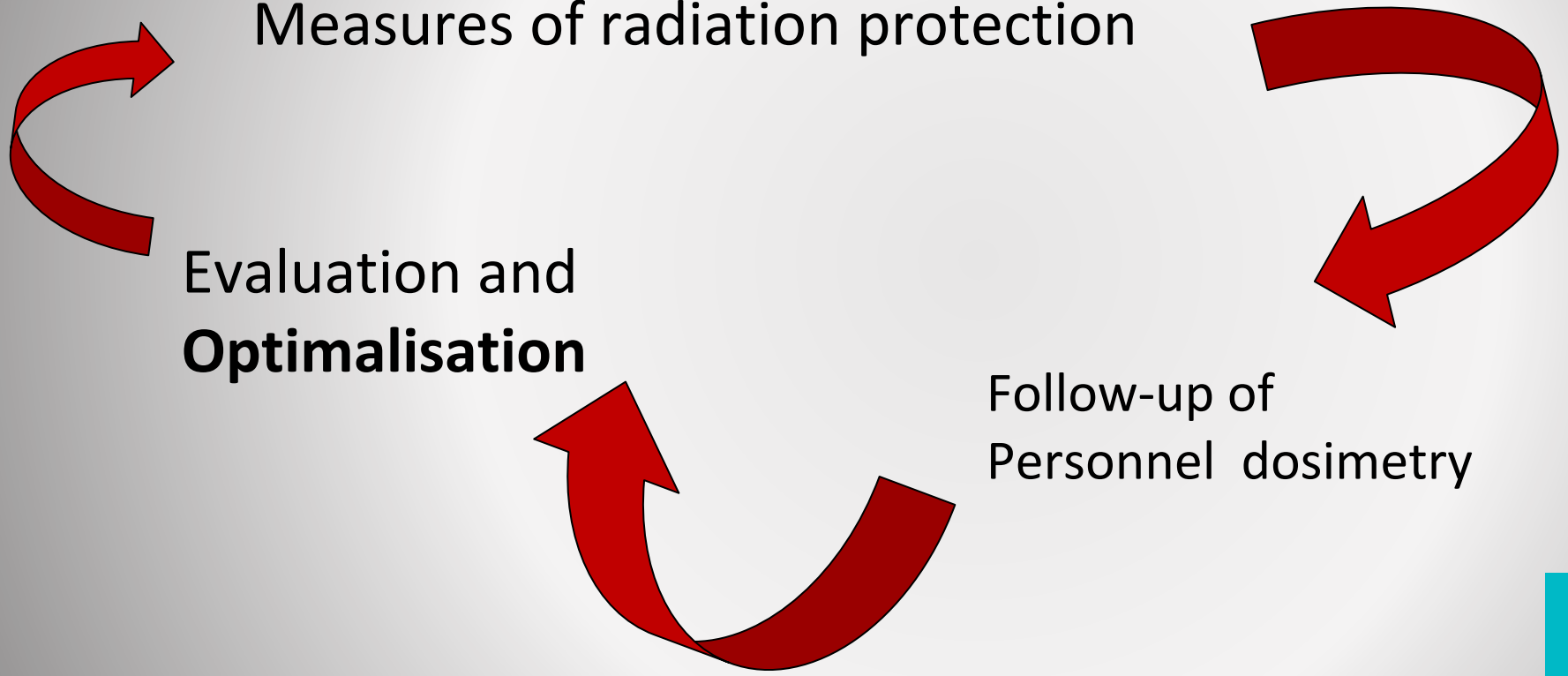
Physical control



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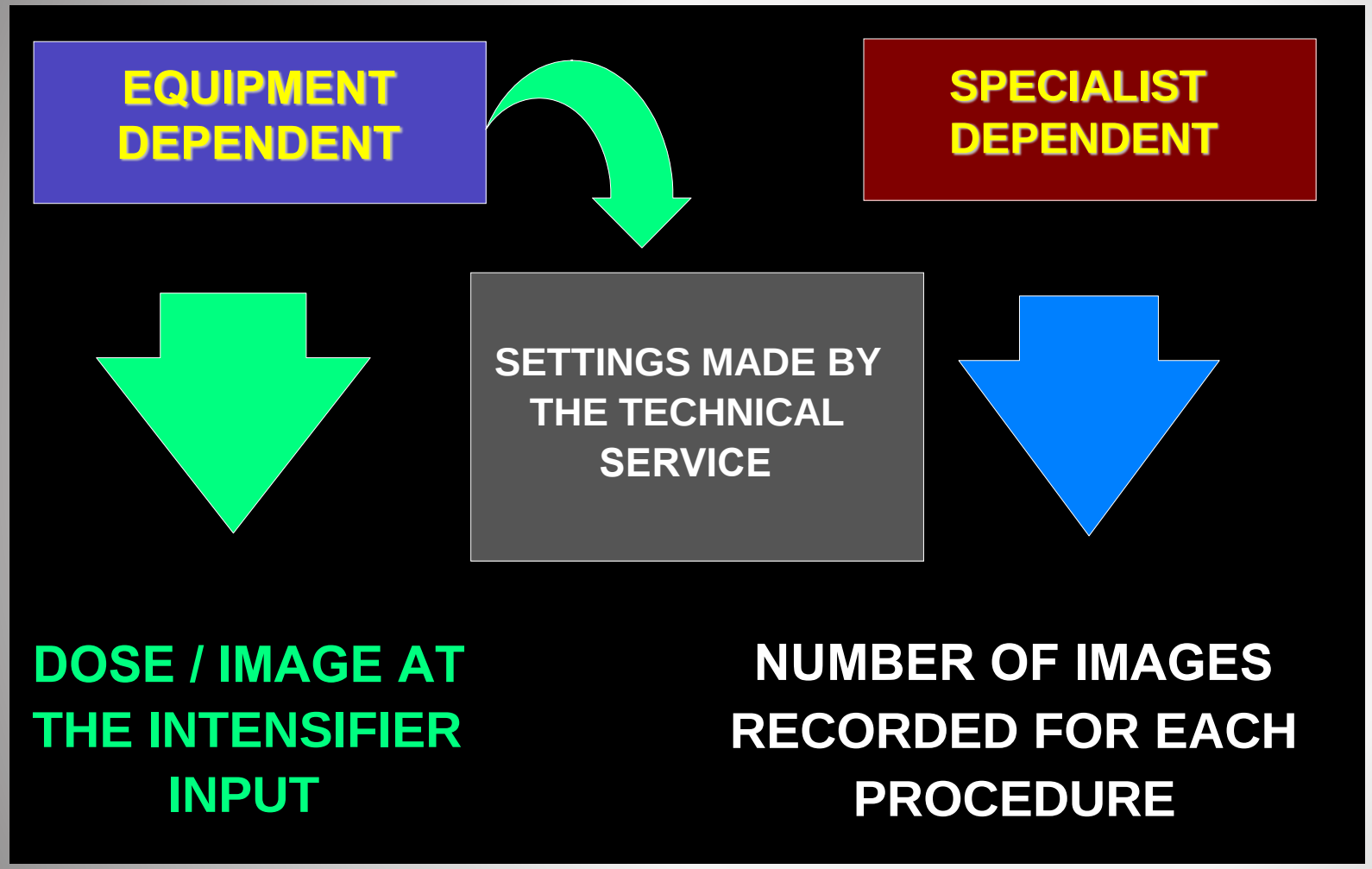
Equipment and specialist



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Different types of X-ray Machines are available for Operating theaters

Do you know yours ??

Type of Machine	Doses
Mobile X-ray machines	Low
– Intra-oral X-ray machines	Low
– C-arms machines	Medium
•vascular imaging	High
– Coronarography appliances	High
-- Mini C-arm	Low
– CT scan	High

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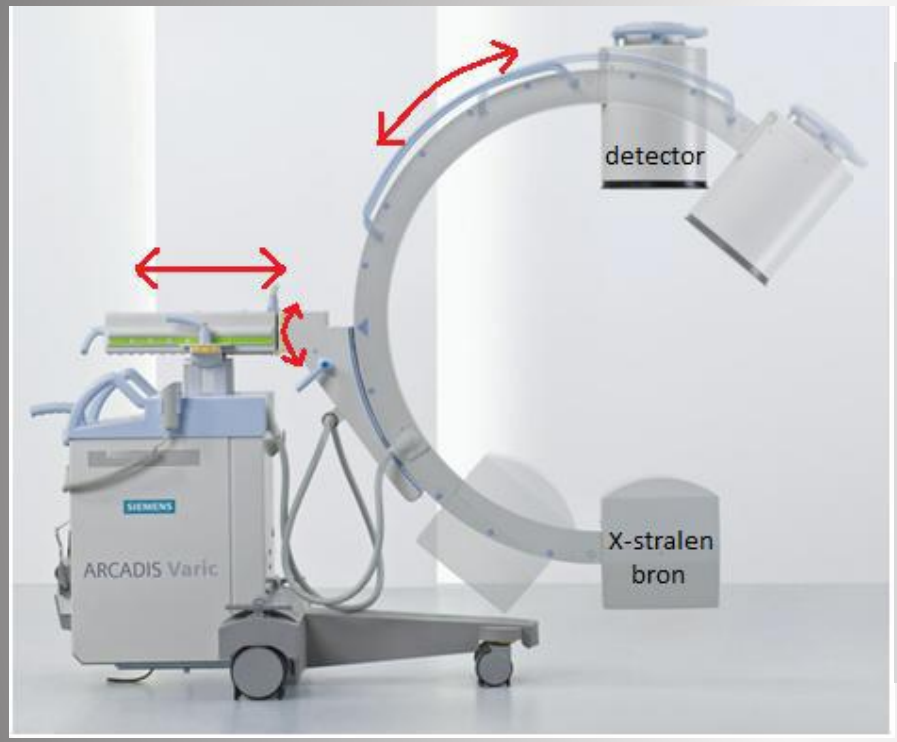
Mobile C-arms: flexible and easy to use appliances



- Good and relative cheap imaging machines
- Good efficient and performing systems
- Continuous images of moving parts (possibly with contrast media, catheters, ...)
- Possibility to record dynamic processes
- Can be use in different rooms

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

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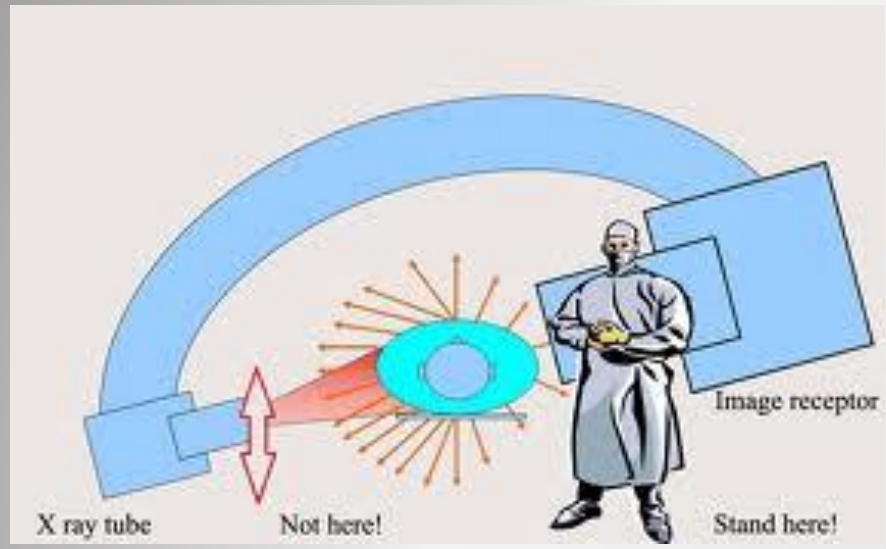
Surgeon: are you the boss in the operating room???



If so:

You are responsible !!!!

For using radio and fluoroscopy in the correct way protecting all theater staff

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Fluoroscopy can save lives but can also kill

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

So BASIC RULES

- Don’t use fluoroscopy more than necessary.
- Protect your patient and staff.

  - Avoid high dose ➔ determistic effects (radiodermitis..)
  - Low dose ➔ stochastic effects (tumor development)

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Surgeons, we are here but !!

Let other people know : In this room one is using fluoroscopy

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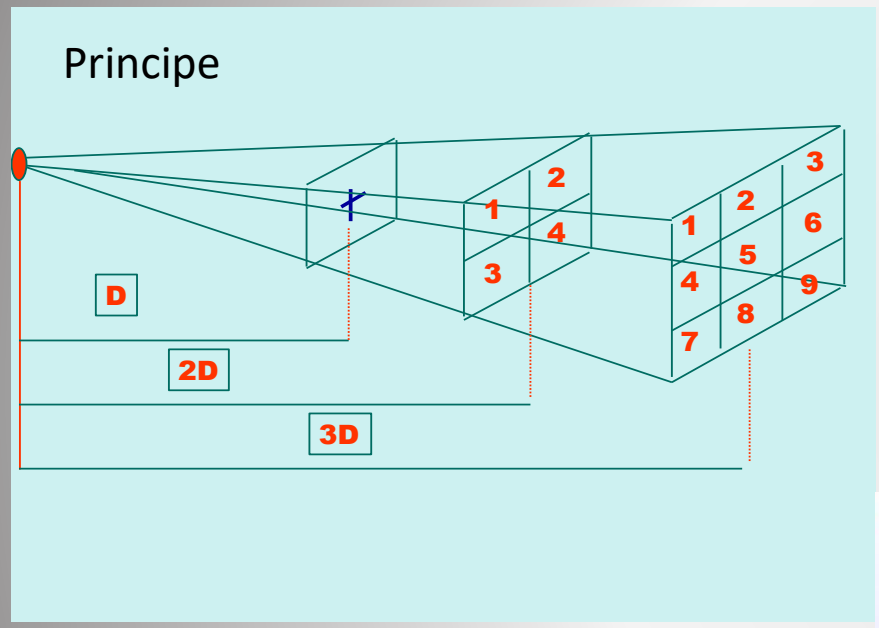
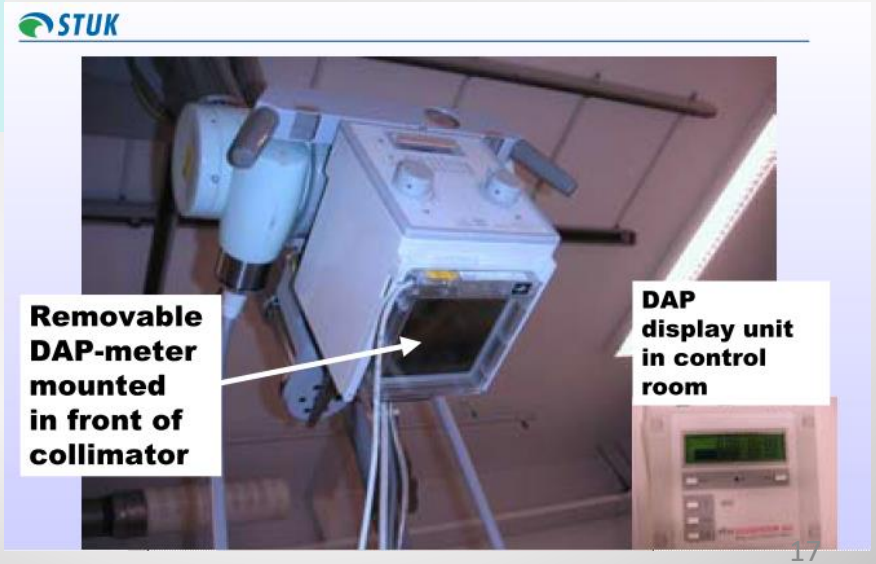
Measurement of Patient's doses



- DAP = Dose area product: The product of irradiated surface of the patient with the dose at each point
- Display of dosimeter can be integrated in X-ray device



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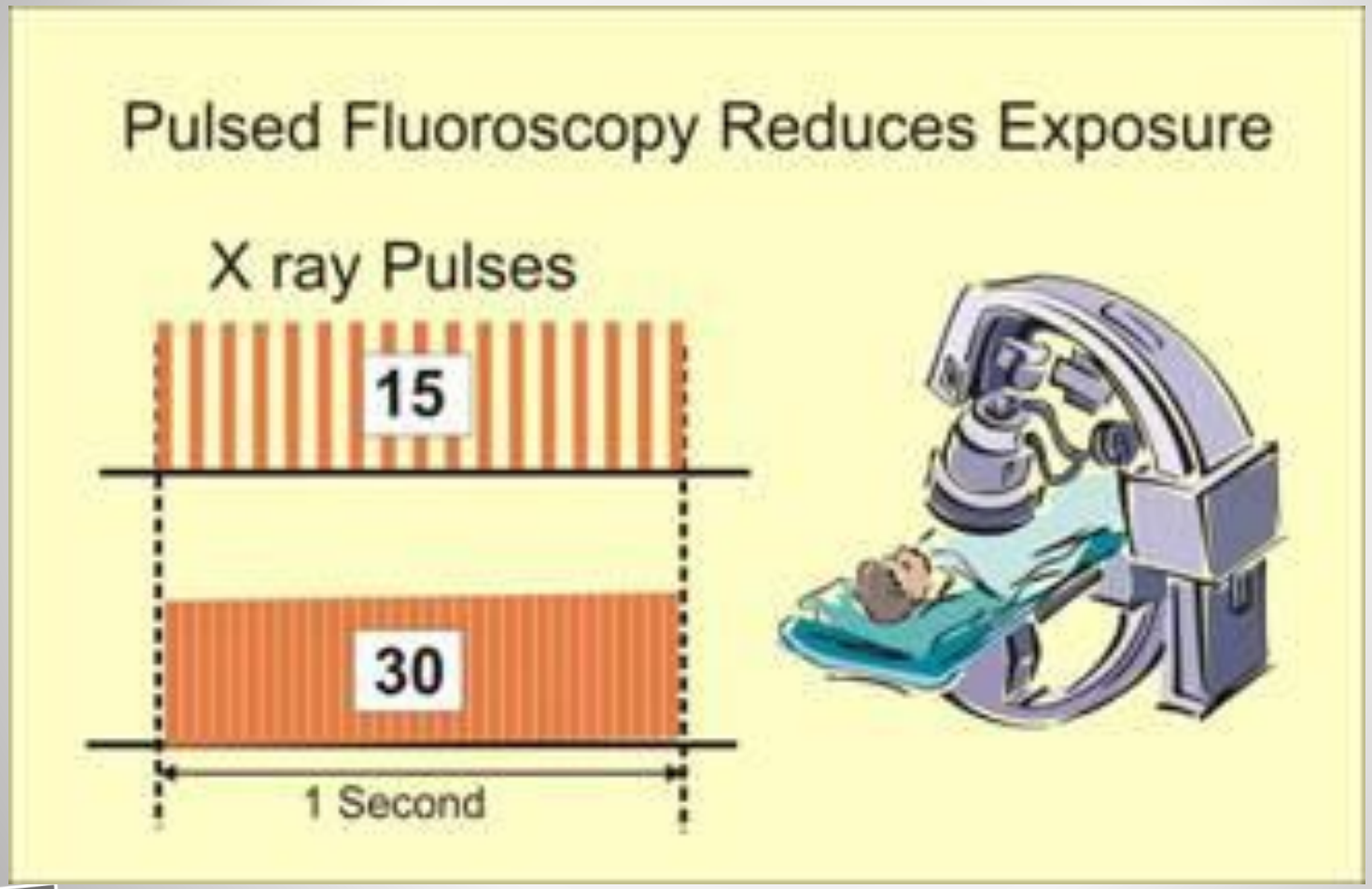
Use **pulsed fluoroscopy** with the lowest frame rate possible to obtain images of acceptable quality



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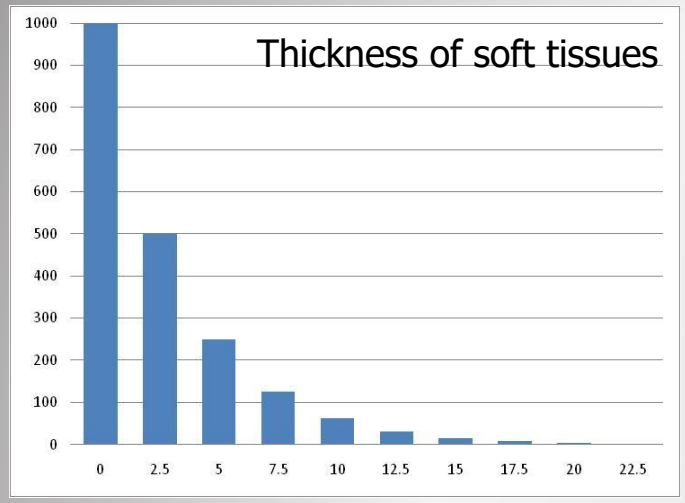
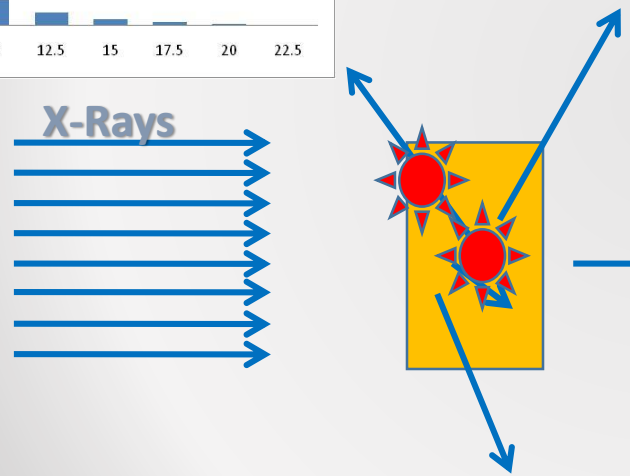
X-RAYS : Exponential behavior





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

Surgeons stand very close to the subjects irradiated

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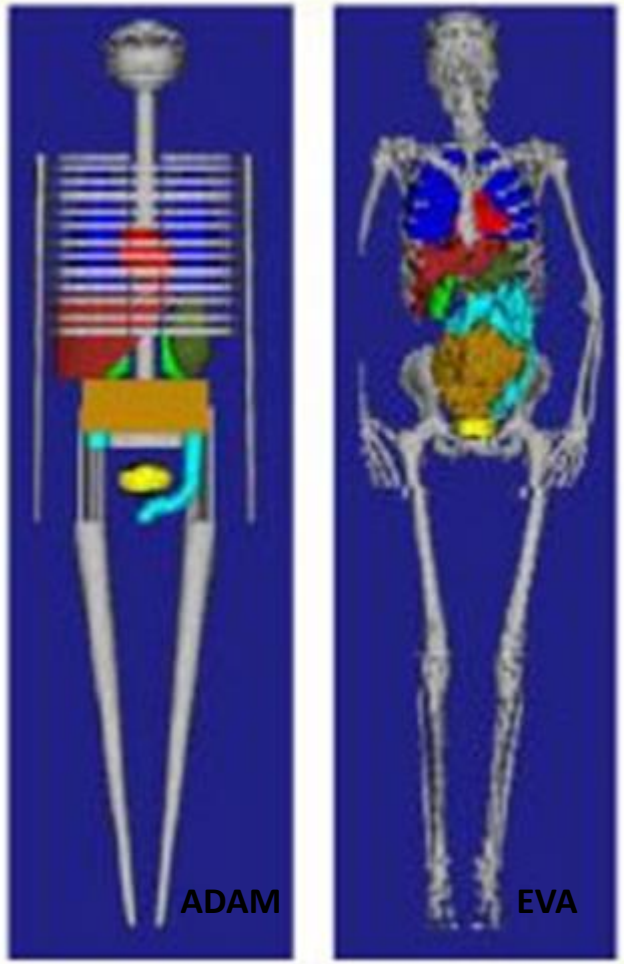
Organ sensitivity to irradiation



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)!

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Deterministic effects of doses on the skin of the patient

A. 11 Gy:
   dry desquamation
   @ 1 month

B. 18 Gy:
   Skin necrosis
   @ 6 months

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

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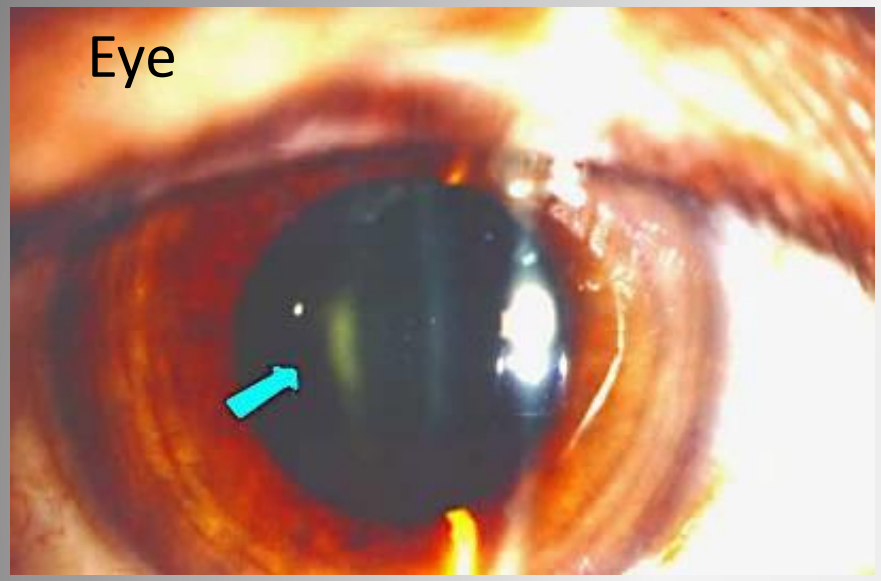
Deterministic effects to the operator



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DOSE LIMITS TO BE RESPECTED

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

Limit is reduced from 150mSv (>18y) and 50mSv (16-18y) to 20mSv in 1year

During pregnancy, effective dose to the fetus < 1 mSv

Good clinical practice required;
average exposure level should be appropriate

Diagnostic Reference Levels

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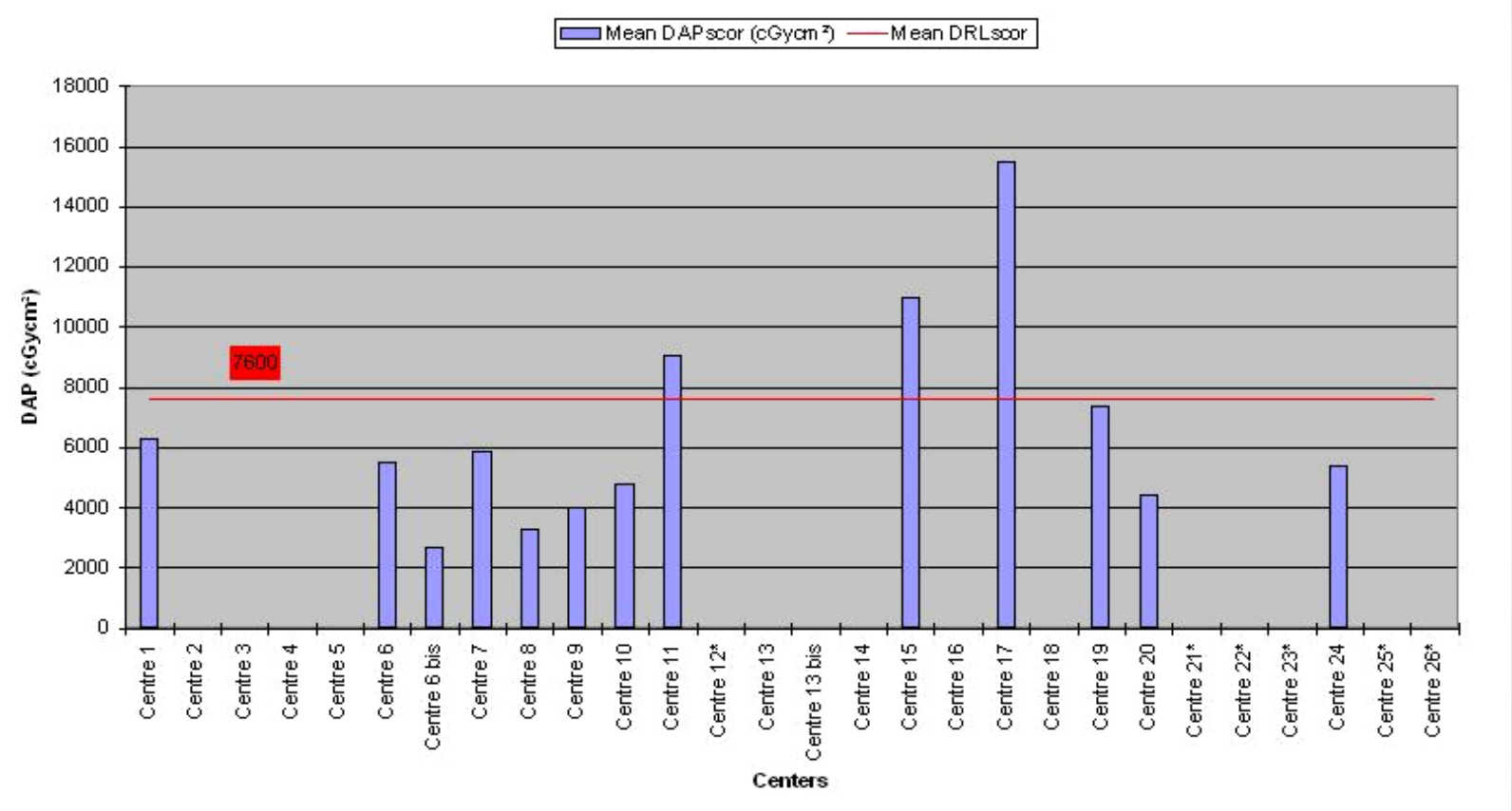
Follow up of patient doses

Will be controlled by the national values of DRL's

('Diagnostic Reference Levels')



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Besluit van het **F**ederaal **A**gentschap voor **N**ucleaire **C**ontrole betreffende patiëntendosimetrie (10/2011)

Belgische diagnostische referentieniveaus (NRD en DRL)
Conventionele radiografie

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

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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?
  - X ray modus (low dose fluoroscopy versus cine)
  - Weight of the patient
- How do we manage protection against radiation?
  - One step back
  - Lead protection

Based on Time-- Distance -- Shielding principle

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TIME

Minimize fluoroscopy time:

➢**Use whenever possible :** The Last image hold

Keep records of fluoroscopy time and DAP for every patient

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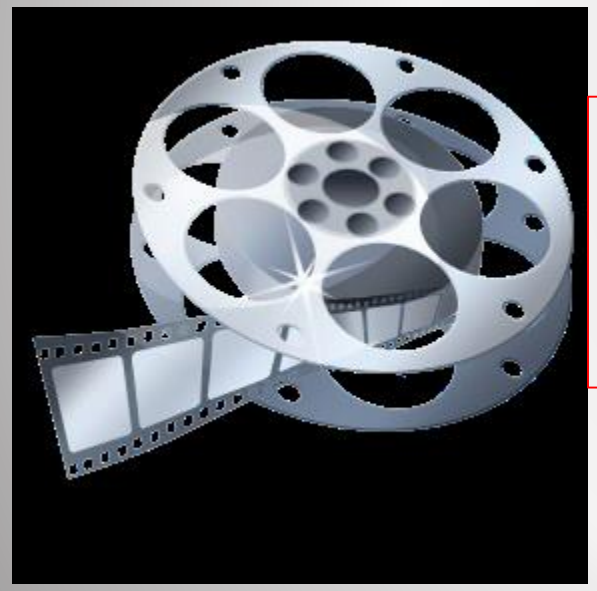
TIME

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 ~ 60

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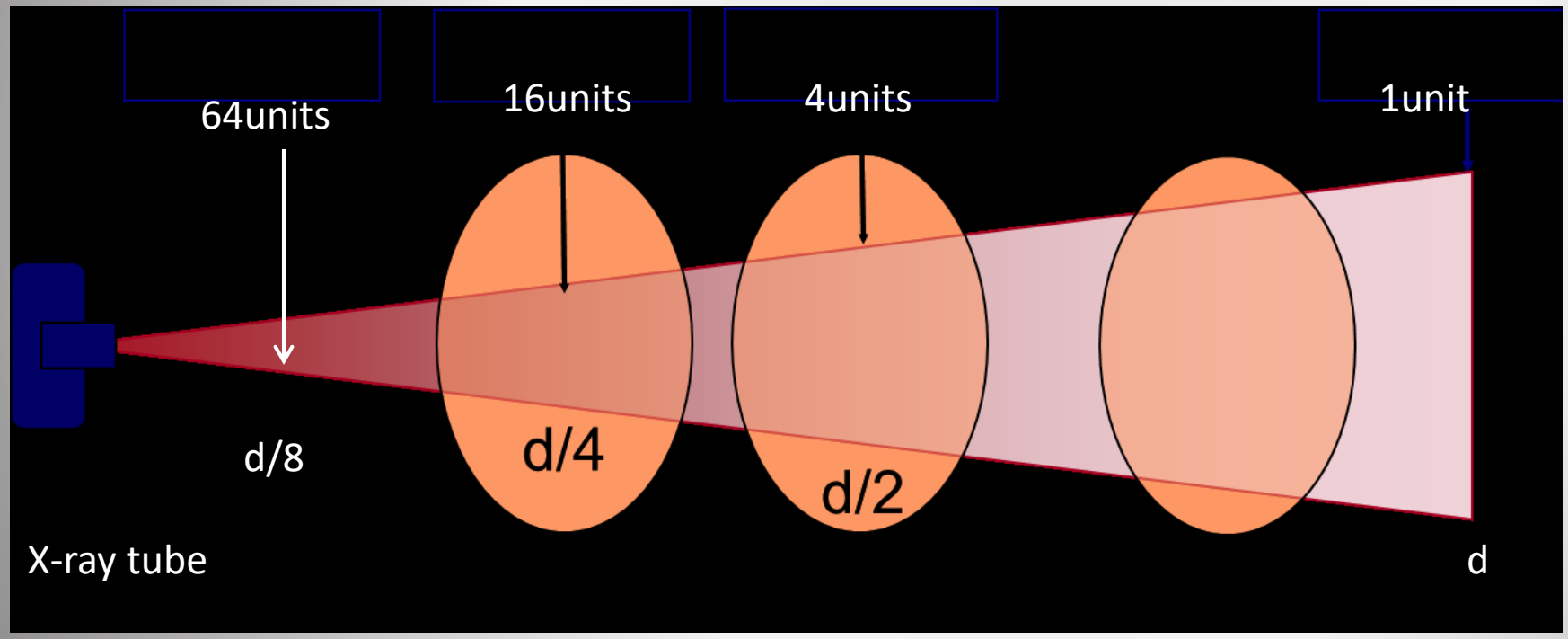
DISTANCE

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



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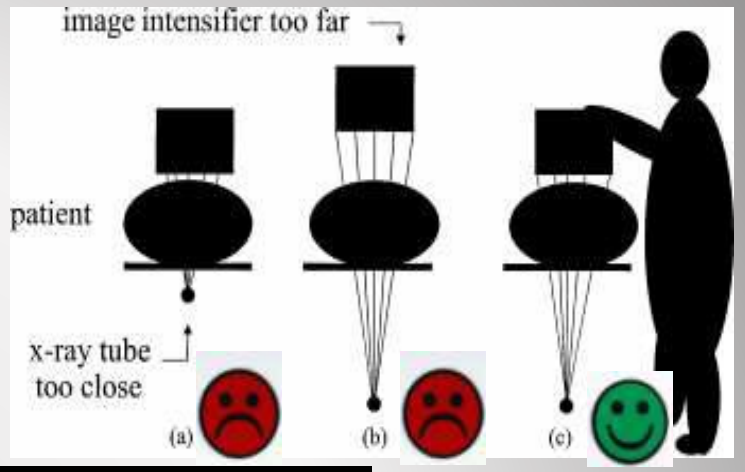
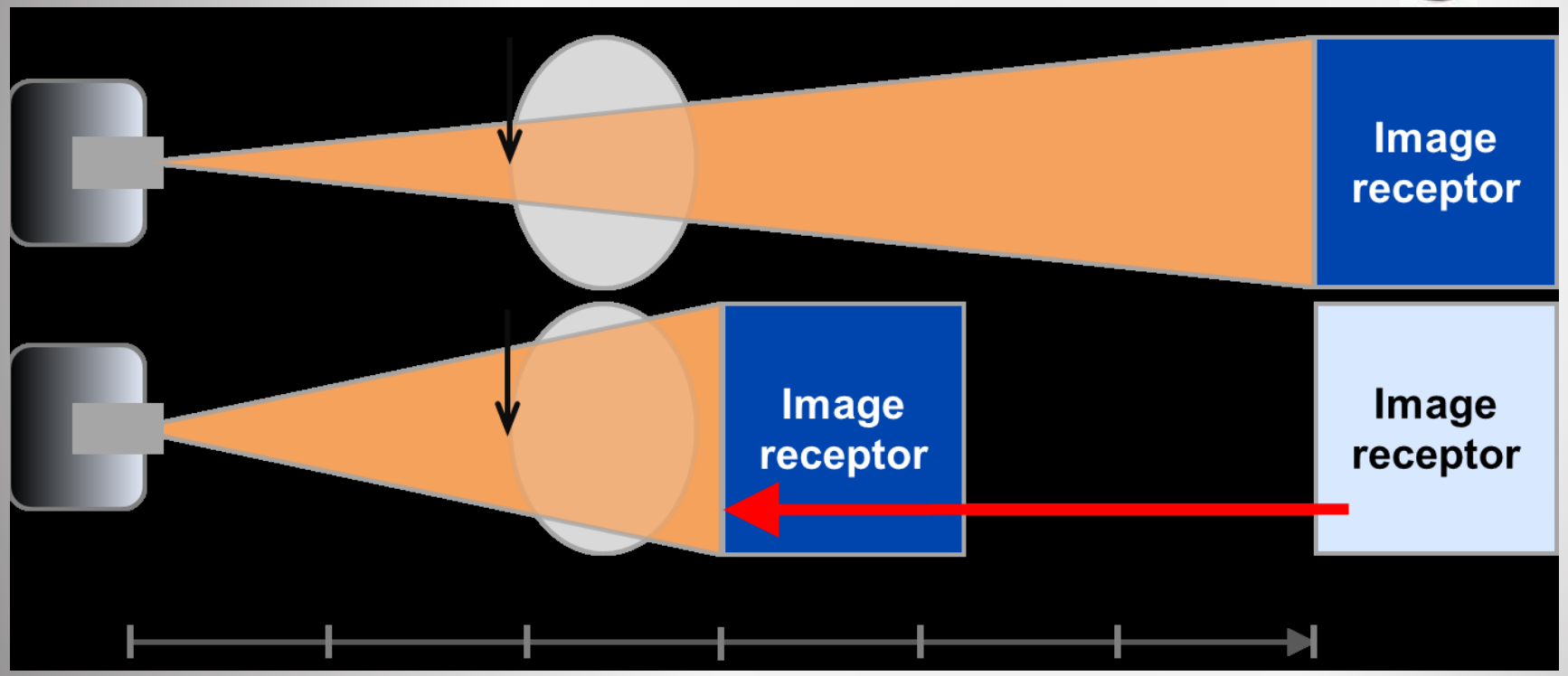
DISTANCE



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



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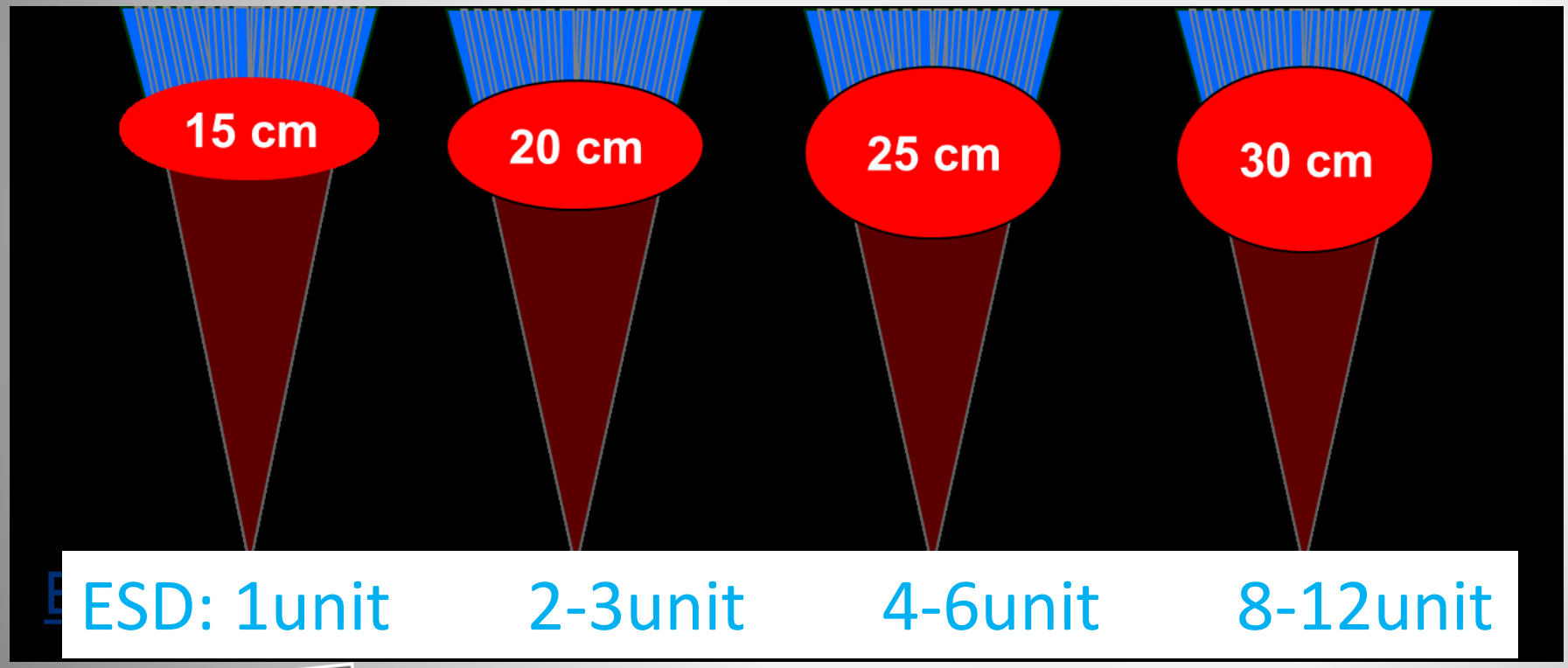
DISTANCE and ENTRANCE SURFACE

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



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DISTANCE and ENTRANCE SURFACE

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

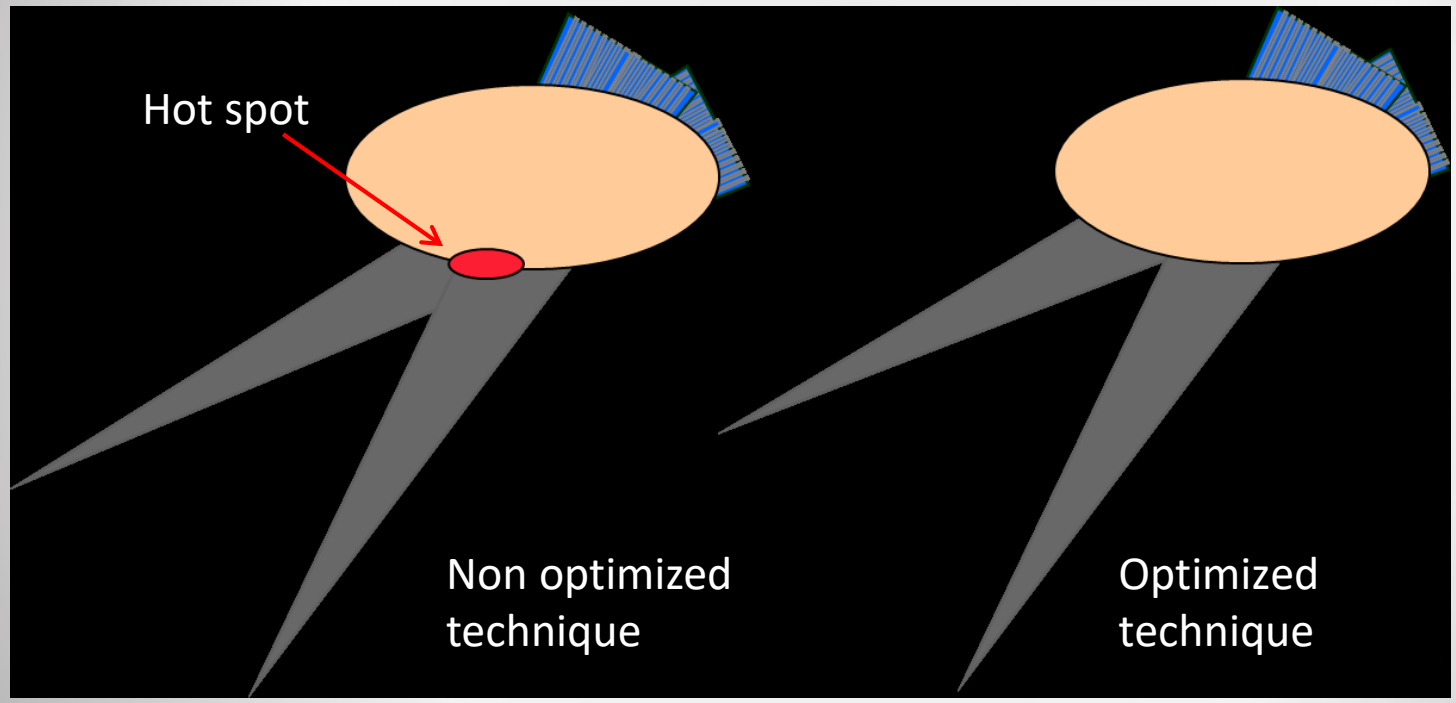

Figure adapted from L. K. Wagner

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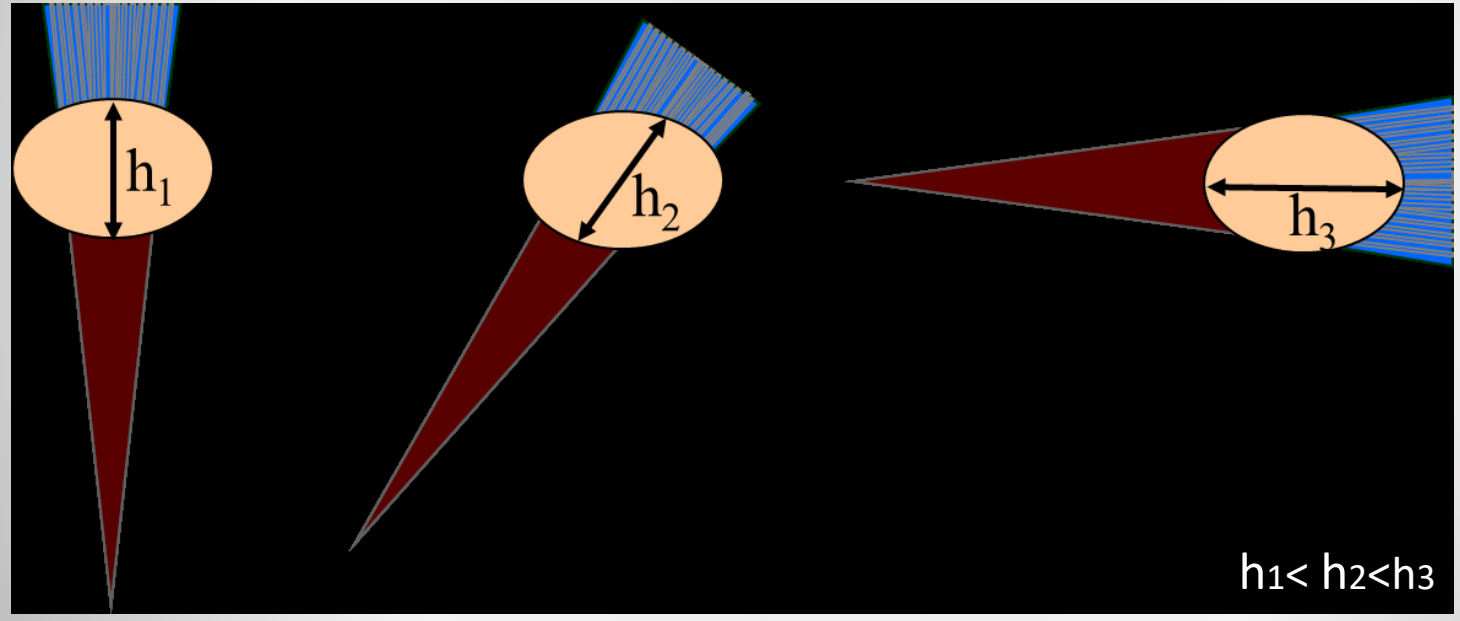
DISTANCE and ENTRANCE SURFACE

Oblique projections also increase ESD

Be aware that increased ESD increases the probability of skin injury



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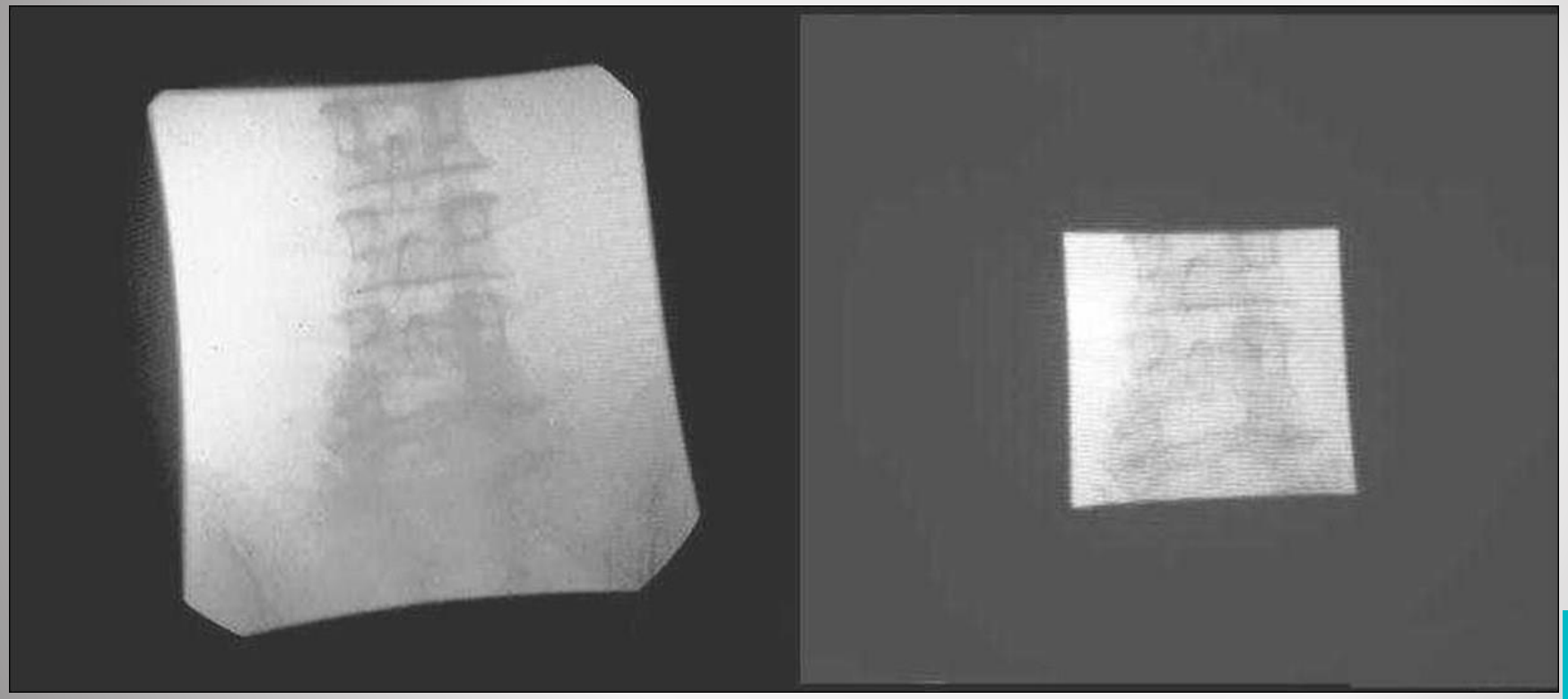
Avoid the use of magnification - Use collimation

Collimate the X-ray beam to the area of interest



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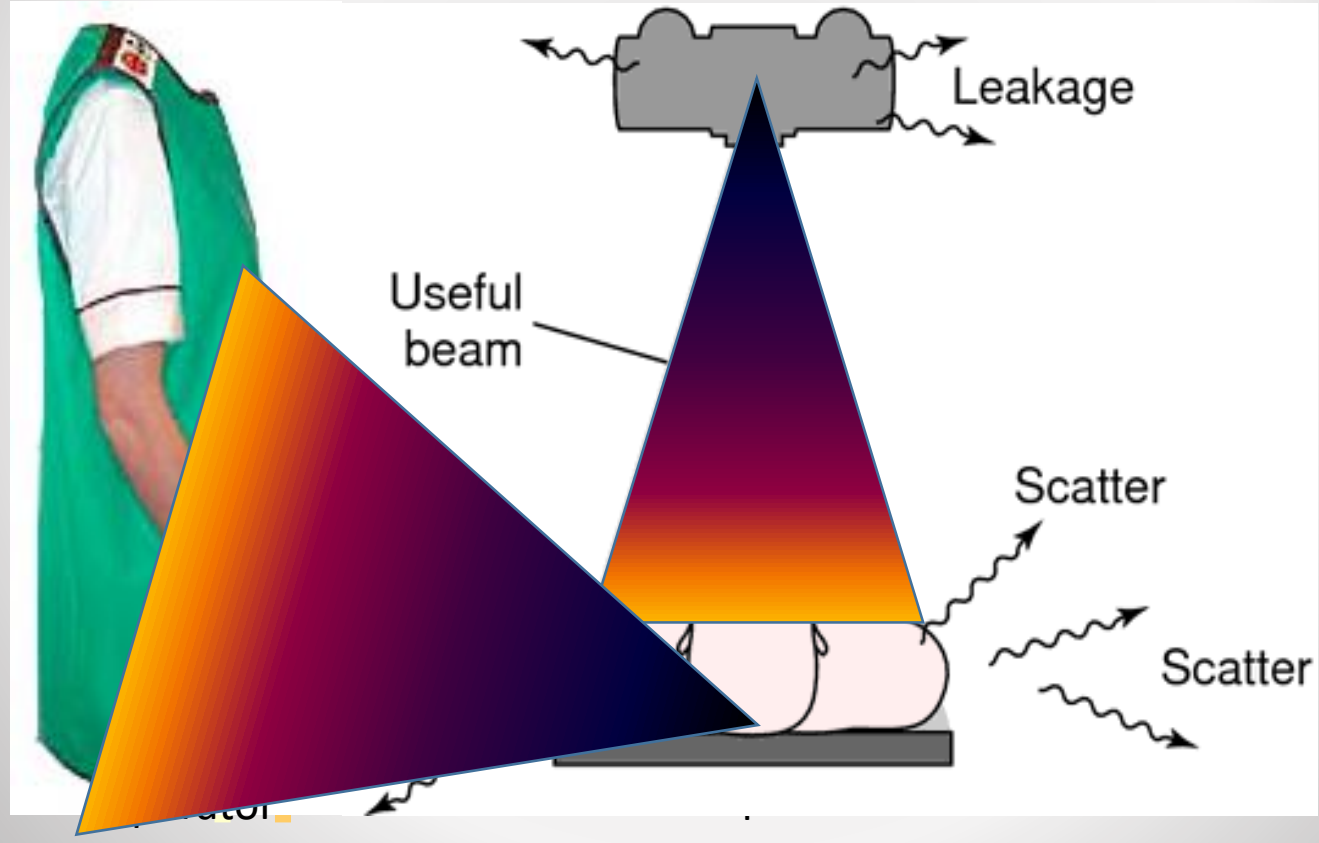
Primary X-ray beam and scatter Radiation

Xray's have an Exponential behavior & Principle of the inverse square law:
If distance from source x 2, then radiation load per unit area / 4



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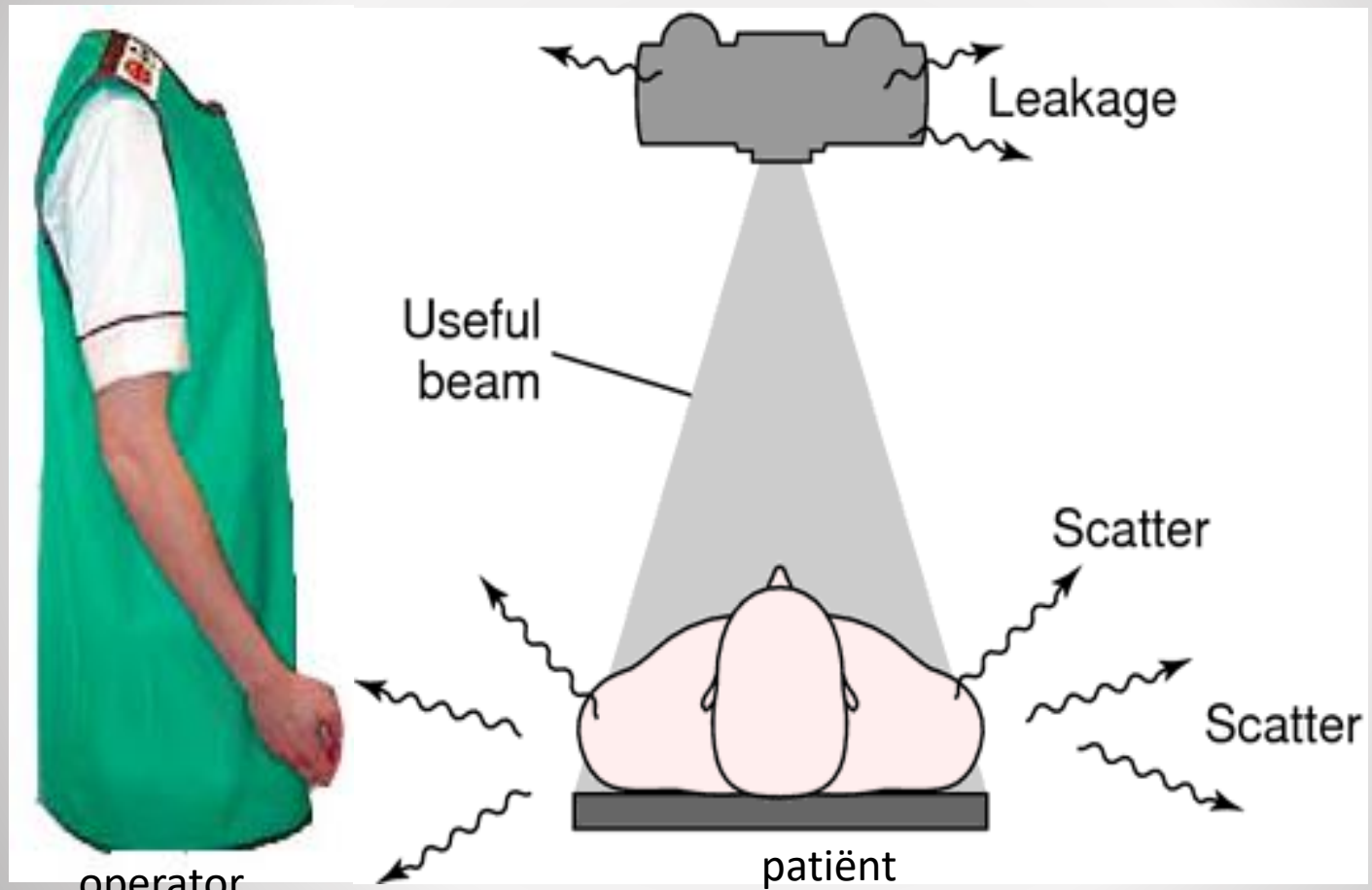
Primary X-ray beam and scatter Radiation

surgeon : close to R-xay beam !!!



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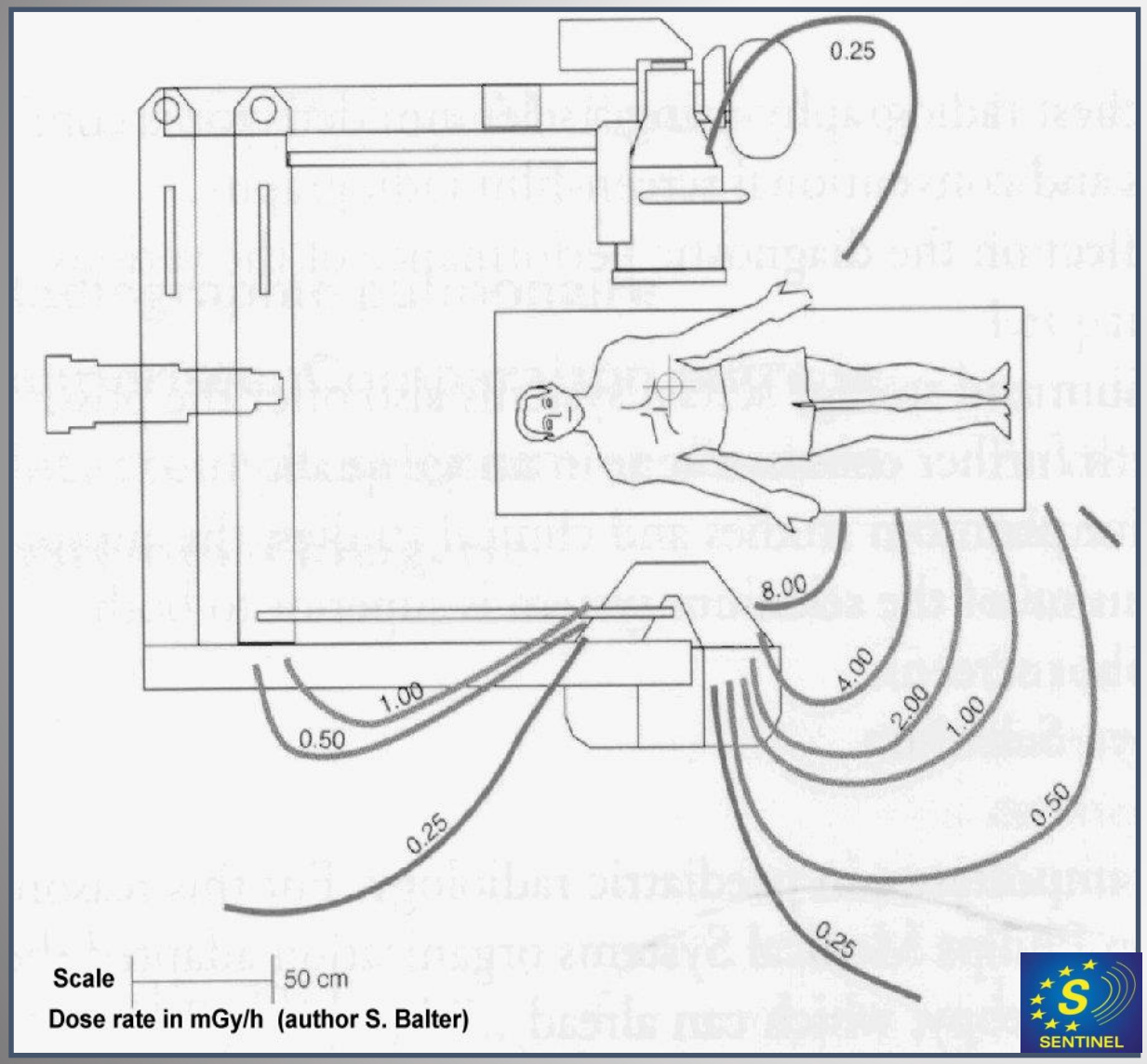
How can we correctly estimate the amount of scattered radiation???



Each device publishes his own isodoseprofile curves for the typical use of the device

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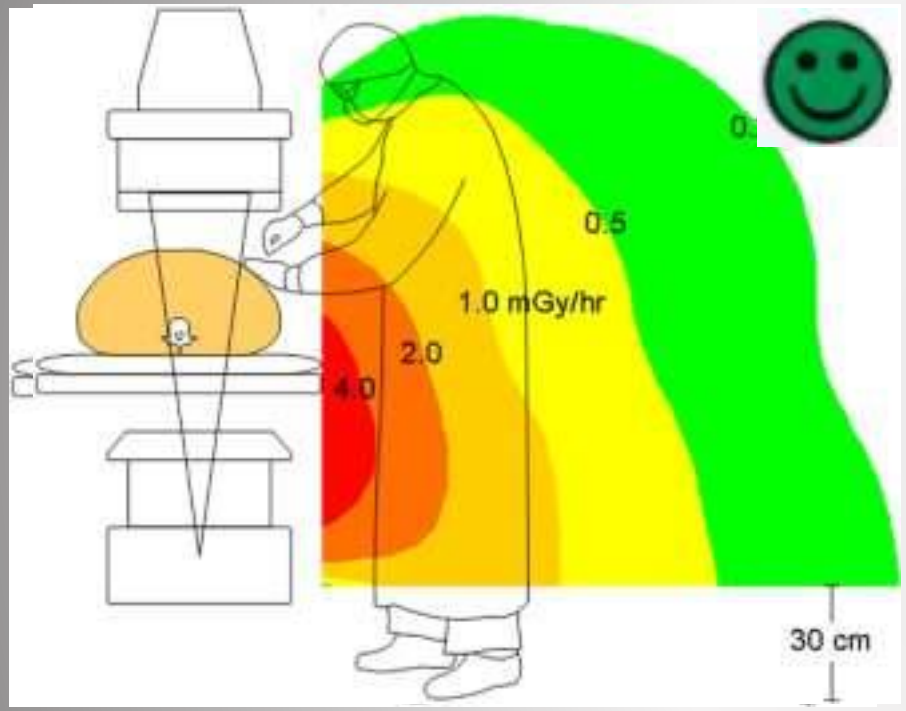
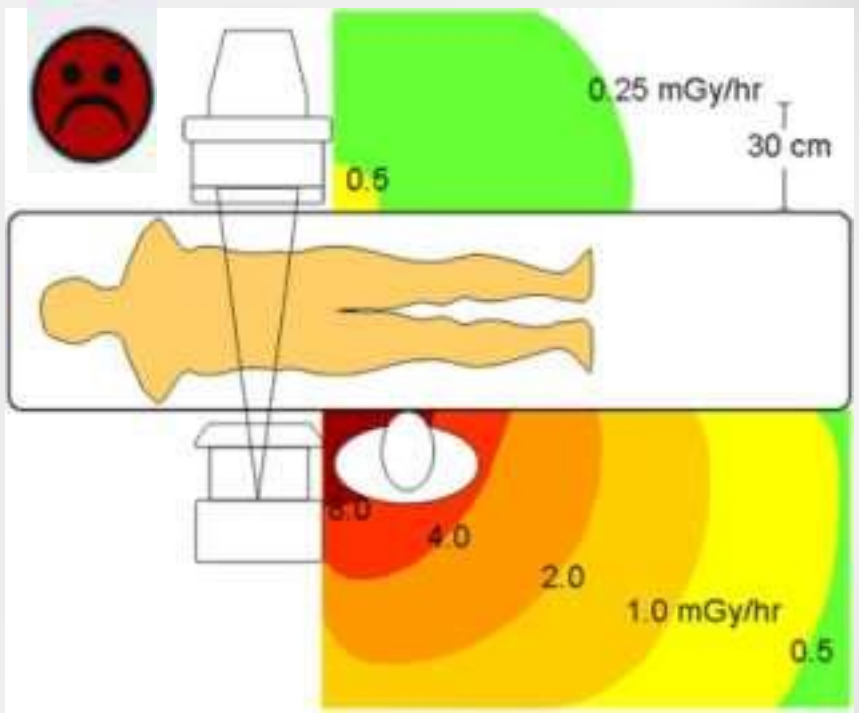
Projection mode Xray tube and image intensifier

Correct position for the surgeon in function of Isodose profiles C-arm to the RX tube position



Under –the table position of C-arm



C-arm in lateral position

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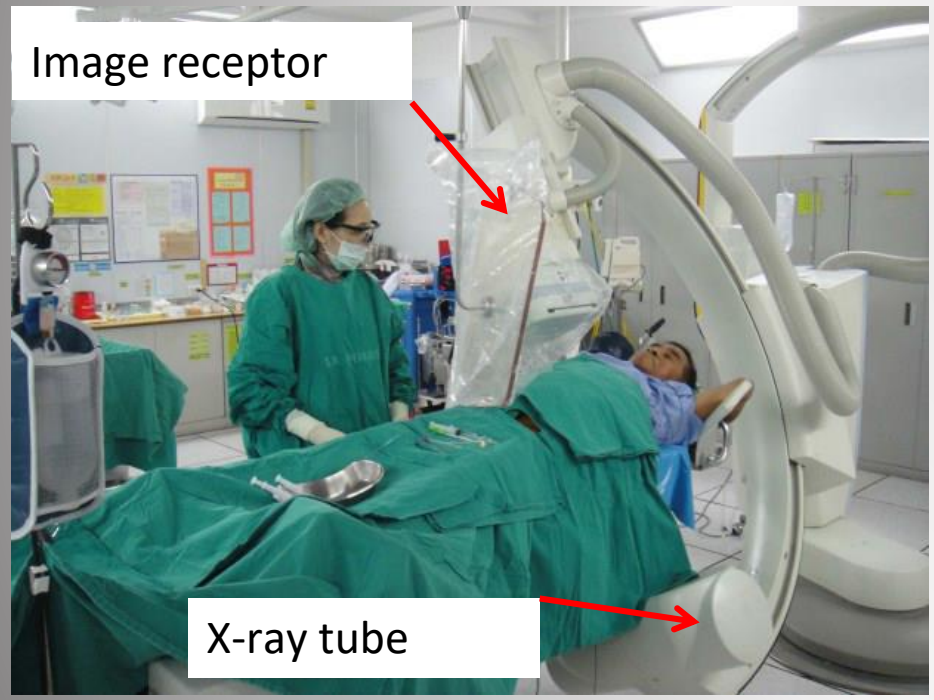
Radiation protection of staff in fluoroscopy

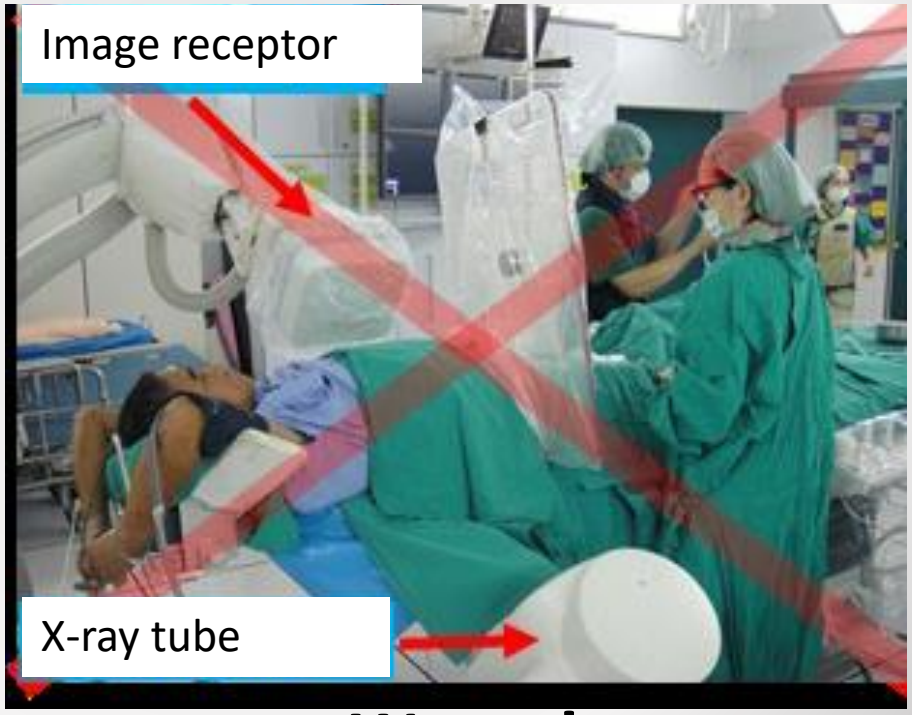
Keep X ray tube under the patient table and not over it

Under couch systems provide better protection from scattered dose and

Position of the surgeon at image reception side is safer than at X- ray tube side



Right!



Wrong!

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

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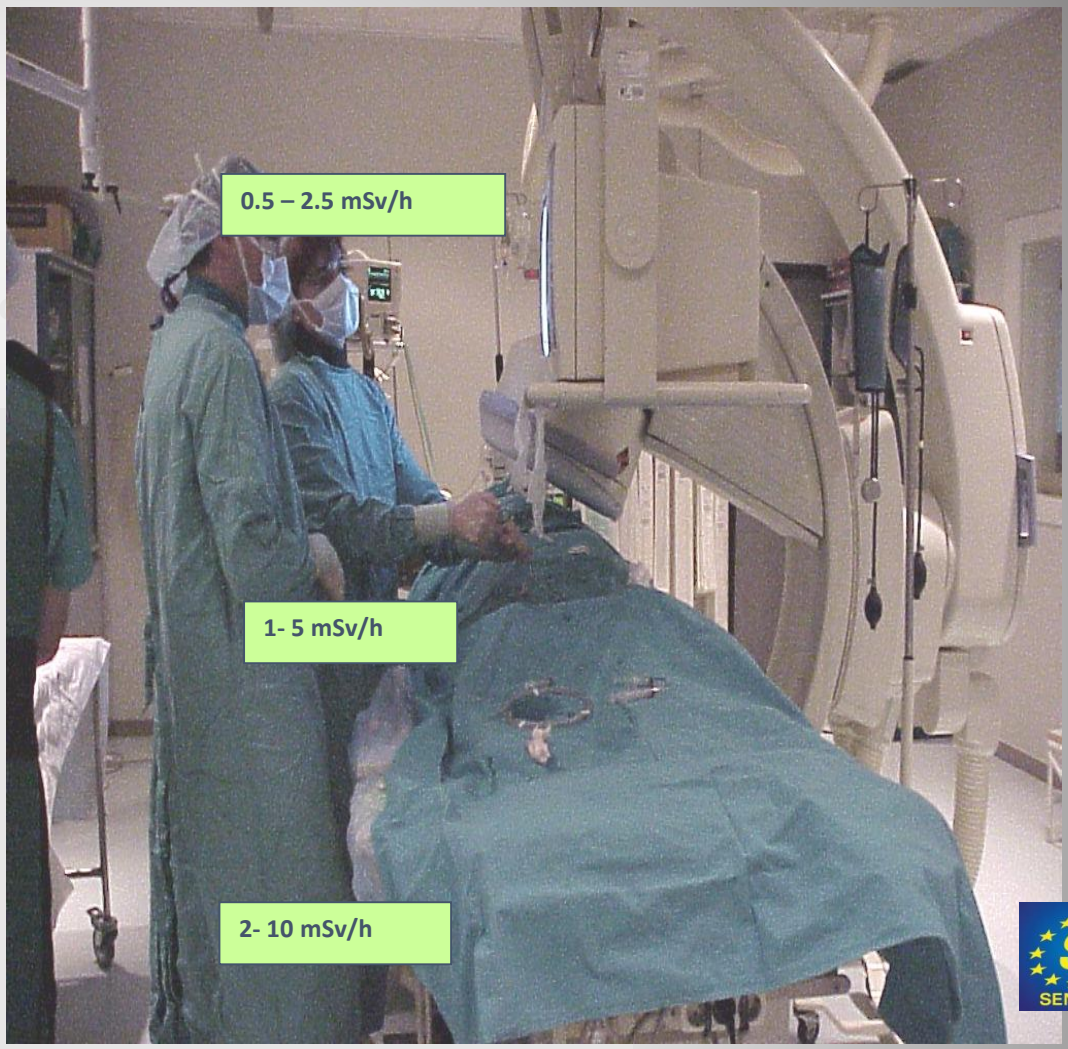
Example:

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

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Advisable skirt type lead apron to distribute weight

Lead glass eyewear with side protection

Thyroid protection

IAEA

http://rpop.iaea.org

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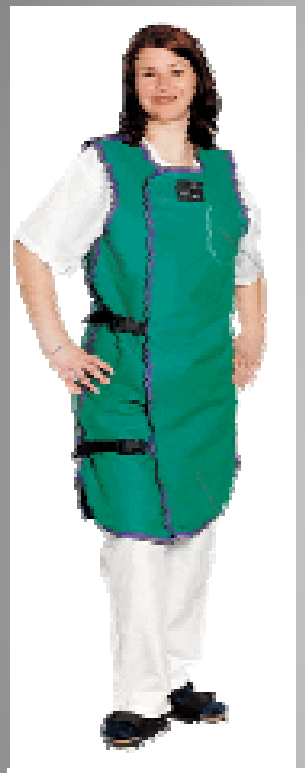
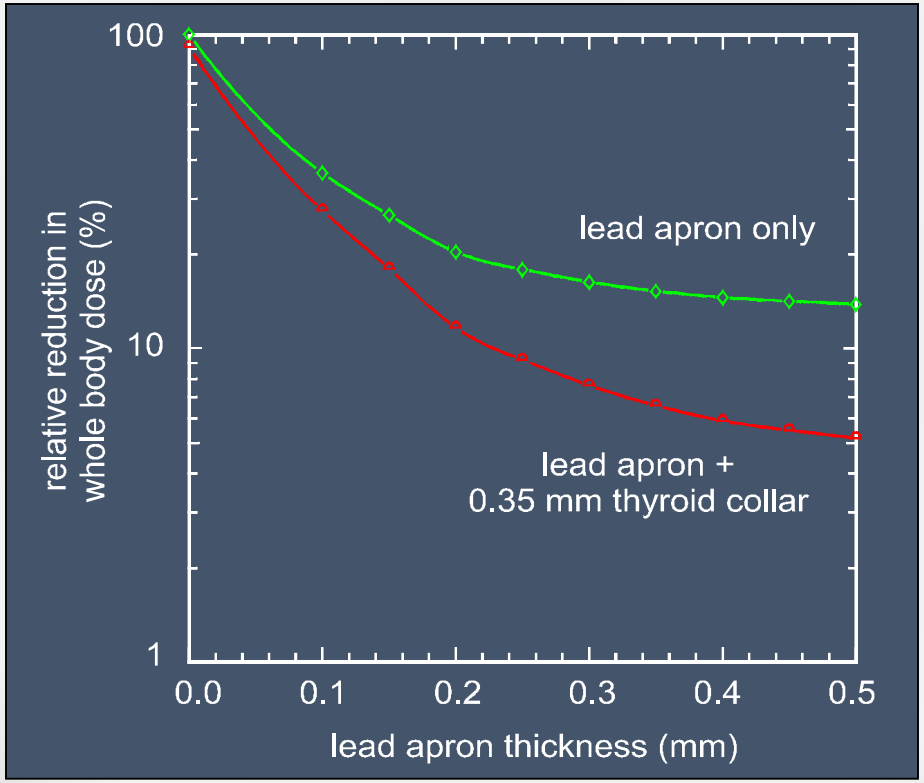
Protection tools:

Apron and Thyroid Protection



skirt type lead apron to distribute weight → 0.25 mm lead equivalence but with overlap on front to make it 0.5 mm on the front and 0.25 mm on the back



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Protection tools

SCREEN AND GOGLES

- Adjustable like normal glasses
- +/- side sheets

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Protection tools

CURTAINS and MOBILE SHIELDS

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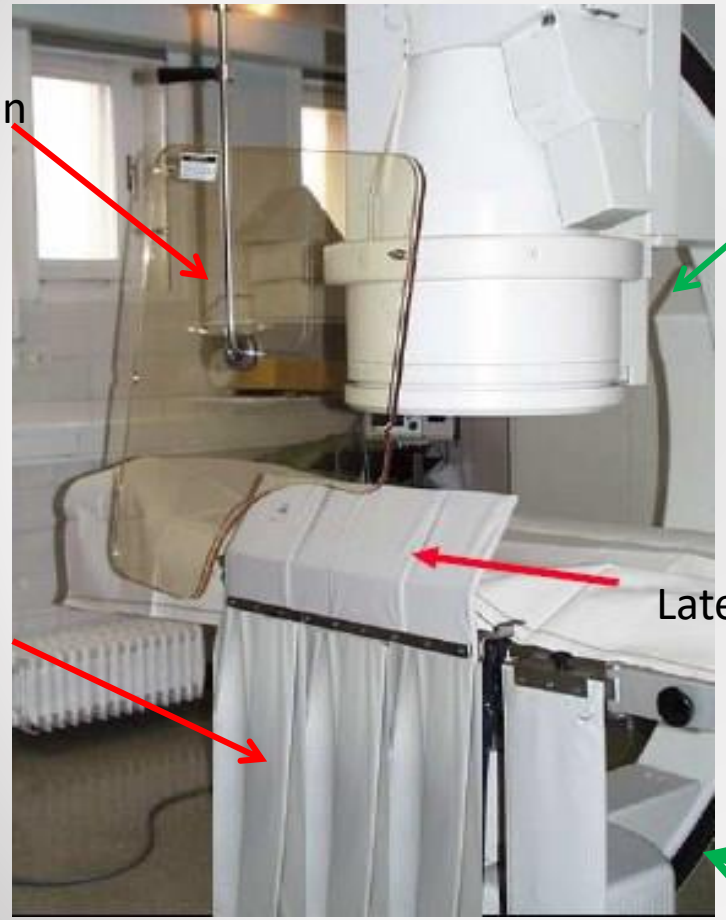
Use ceiling suspended screens, lateral shields and table curtains
They provide more than 90% protection from scattered radiation in fluoroscopy
Mobile floor shielding is advisable when using cine acquisition



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Keep hands outside the primary beam unless totally unavoidable

Hands inside the central area of the primary beam will increase exposure factors (kV, mA) and doses to patient and staff

Use special equipment , needle holders or tweezers to protect your hands

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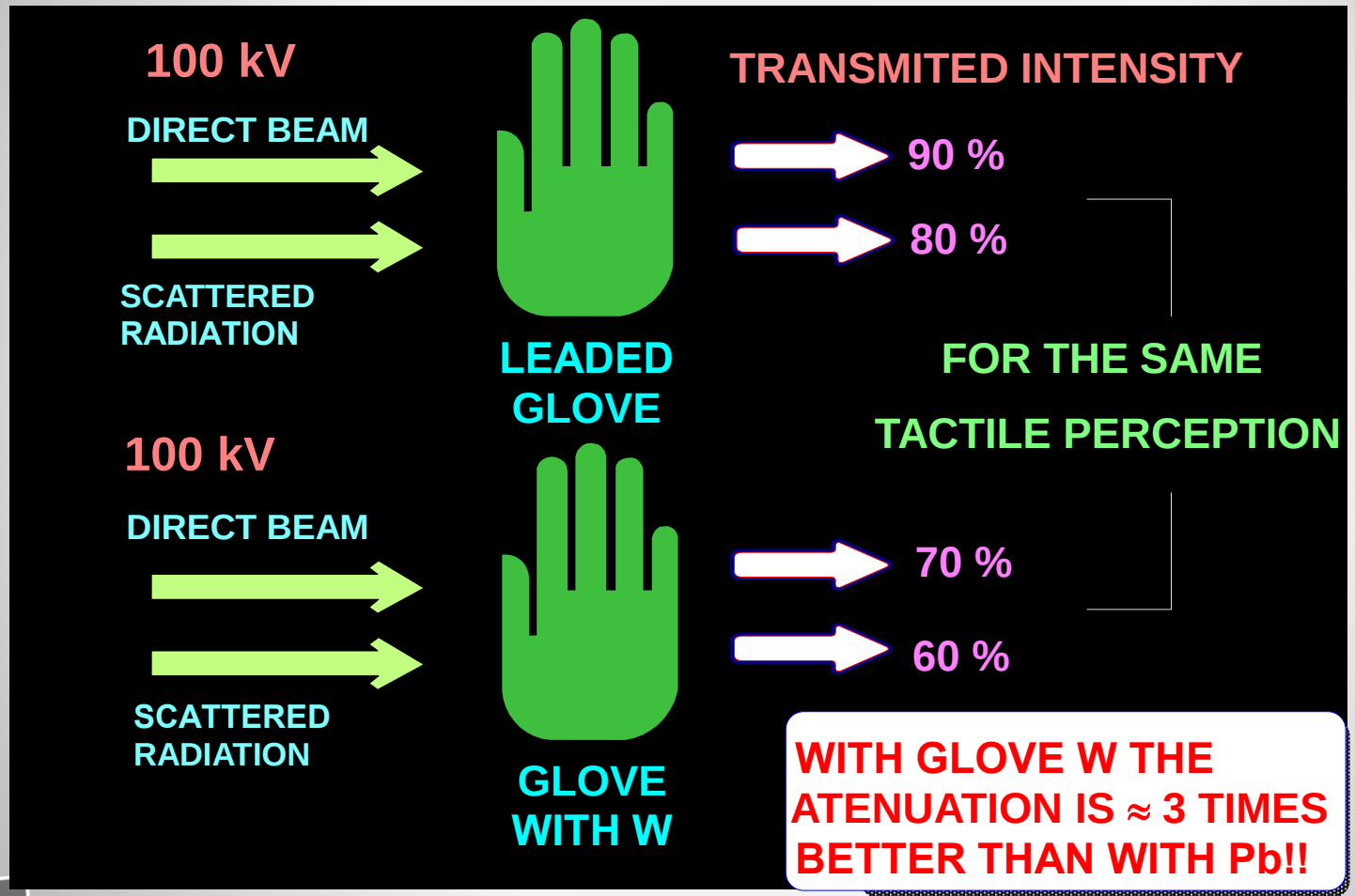
Protection tools



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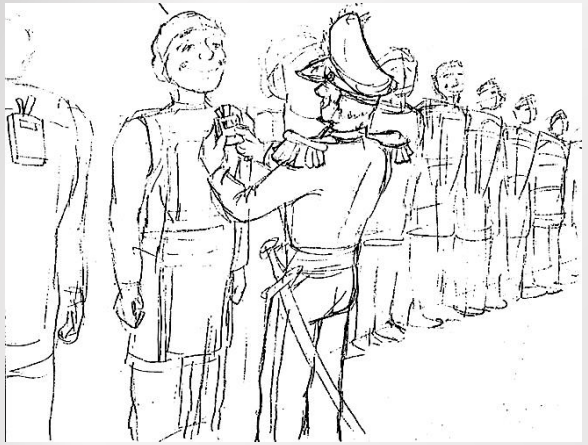
Optimize the staff doses



Dose monitoring: required !

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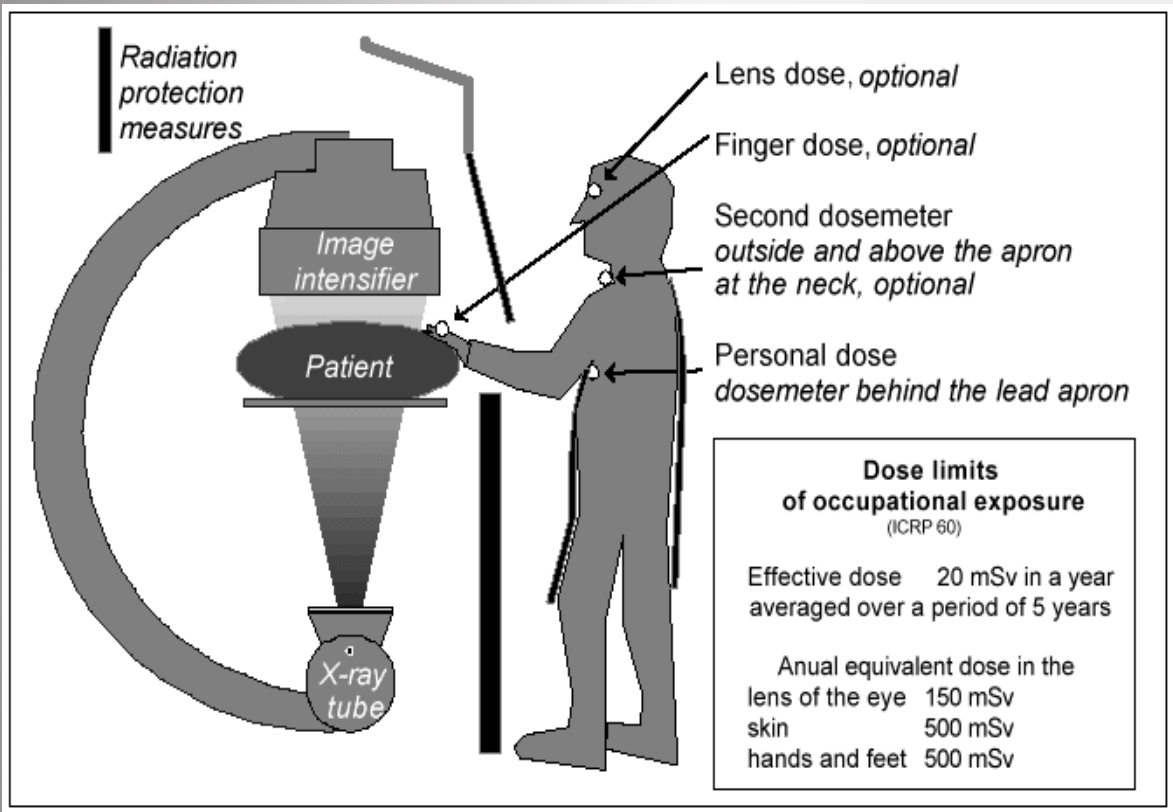
Personal dosimetry



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

Several personal dosimeters maybe recommended

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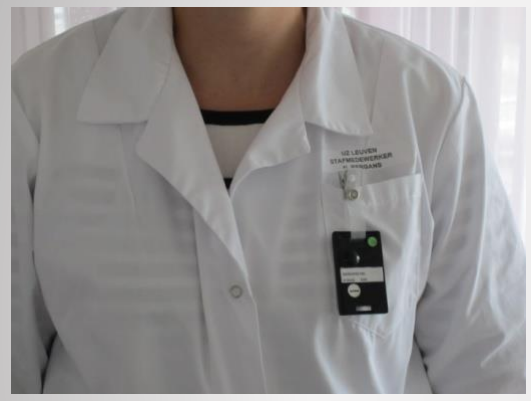
When double dosimetry?



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

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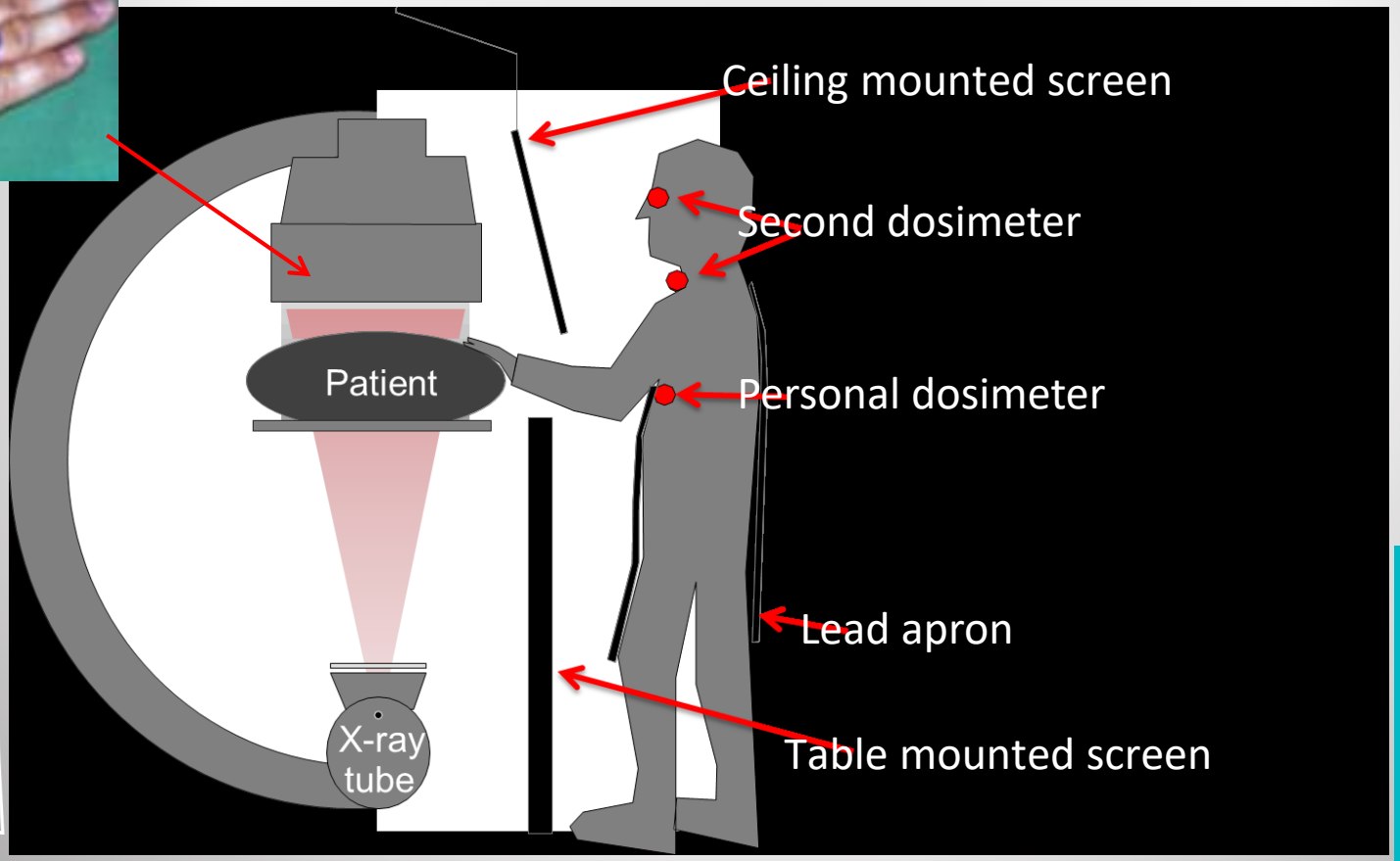
If Necessary use two dosimeters

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 to the beam



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Discussion (I)
What needs to be done in the future for your patients?

- Can you follow up your patients?
  - Not all of them, but those with high risks
  - Not only 'tomorrow' but for a long term
- Are you sure you use your device in the optimal way?

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Discussion (II)
How do you optimize your dose?

- How does your dose compare with the NORM (DRL)?
- Which protection do you have?
- Do you use them always: especially your personal dosimeter?
- Which dose reducing 'keys' or 'touches' do you have on your device? … Do you know them?
- Or are you to **anxious** to use them?.....

Then address your concerns about radiation protection to radiation protection specialists (medical physicists)

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PEOPLE TO HELP YOU

Physical control vs Medical Physics

- Radiation protection of the staff:

✓Dosimetry

✓lead apron

✓Rooms &

✓radiation leakage

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

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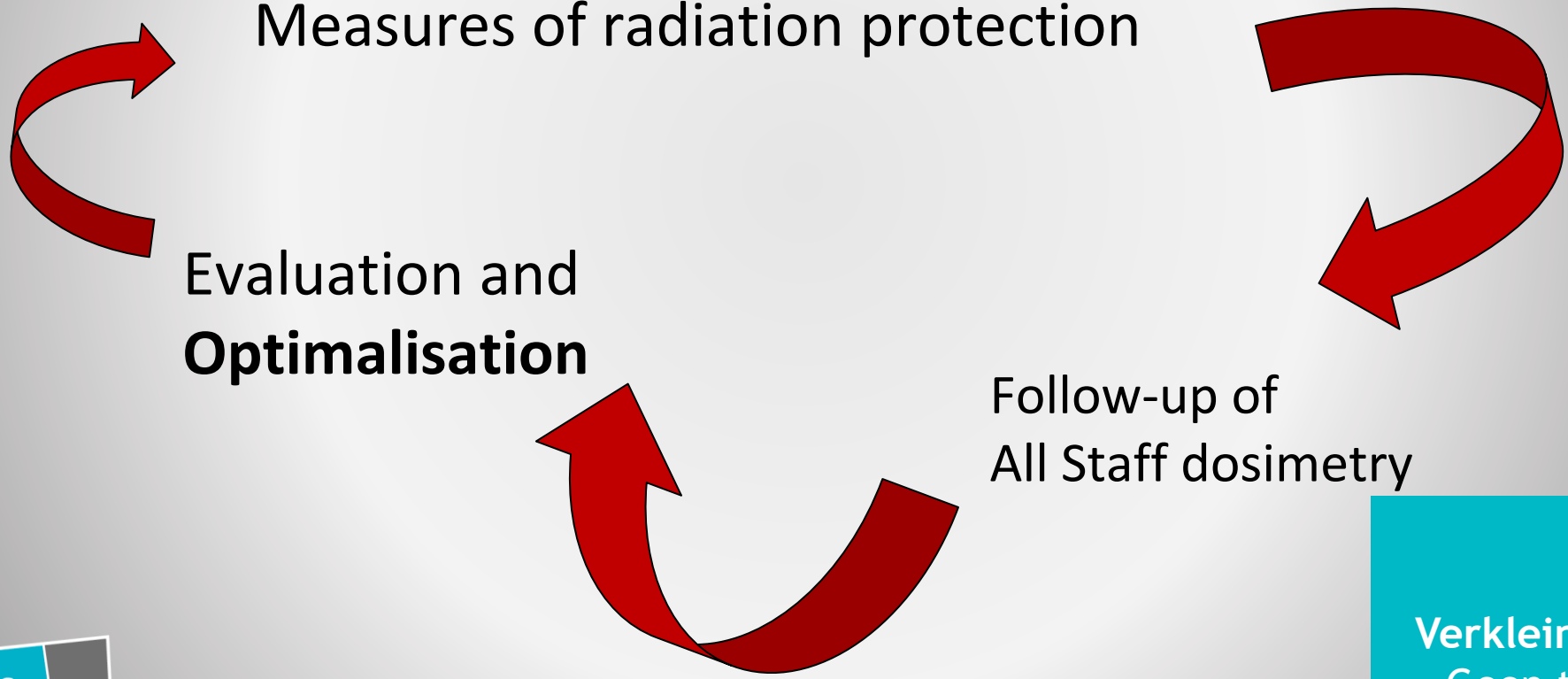
Physical control



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Medical Physics

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

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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

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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

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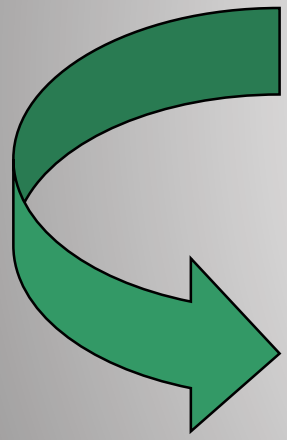
Practical radiation protection rules (III)

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**

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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

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Take home points: Safety axioms

- **Time**
- **Distance:** step one step back
- **Lead shielding**

- Monitoring of the doses of all staff and all patients undergoing interventional RX procedures
- Keep **Awareness** for those very specific applications and devices
- You are the **surgeon**
  - **➔ the responsible operator :**
    - PRE
    - PER
    - POST

→ **procedure**

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- Oramed and Sentinel
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Thank

You

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