KBR PART ONE **PHYSICS SYLLABUS**

FLUOROSCOPY

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- MONDAY **20 JAN 2025** — **CHAPTER TWO** — INTERVENTIONAL **ANGIOGRAPHY**
- MONDAY **27 JAN 2025** — **CHAPTER THREE** — RADIATION **SAFETY**

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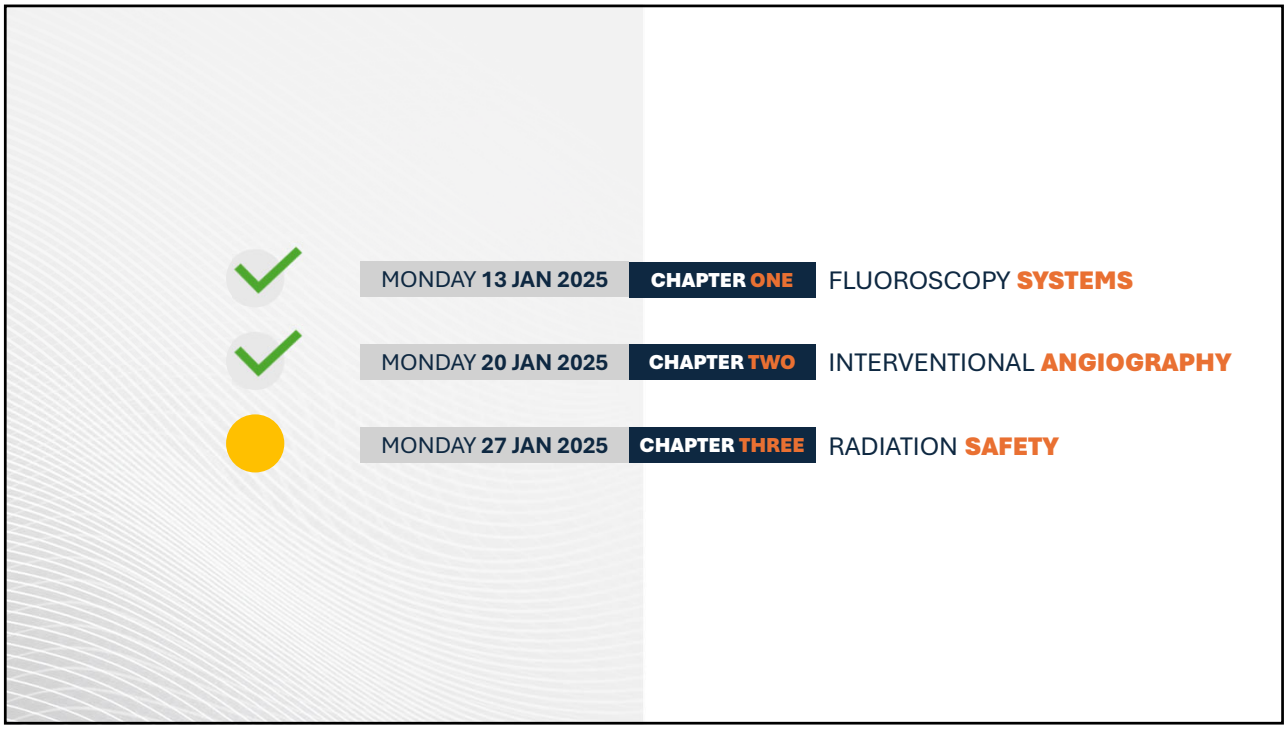
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COMPONENTS OF AN EXPOSURE

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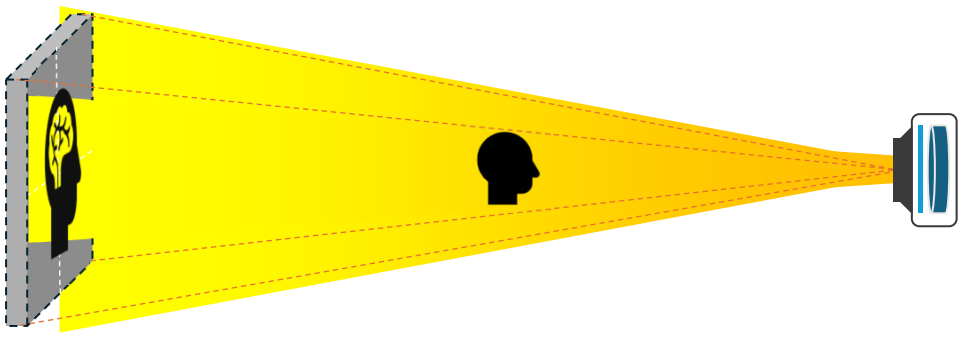

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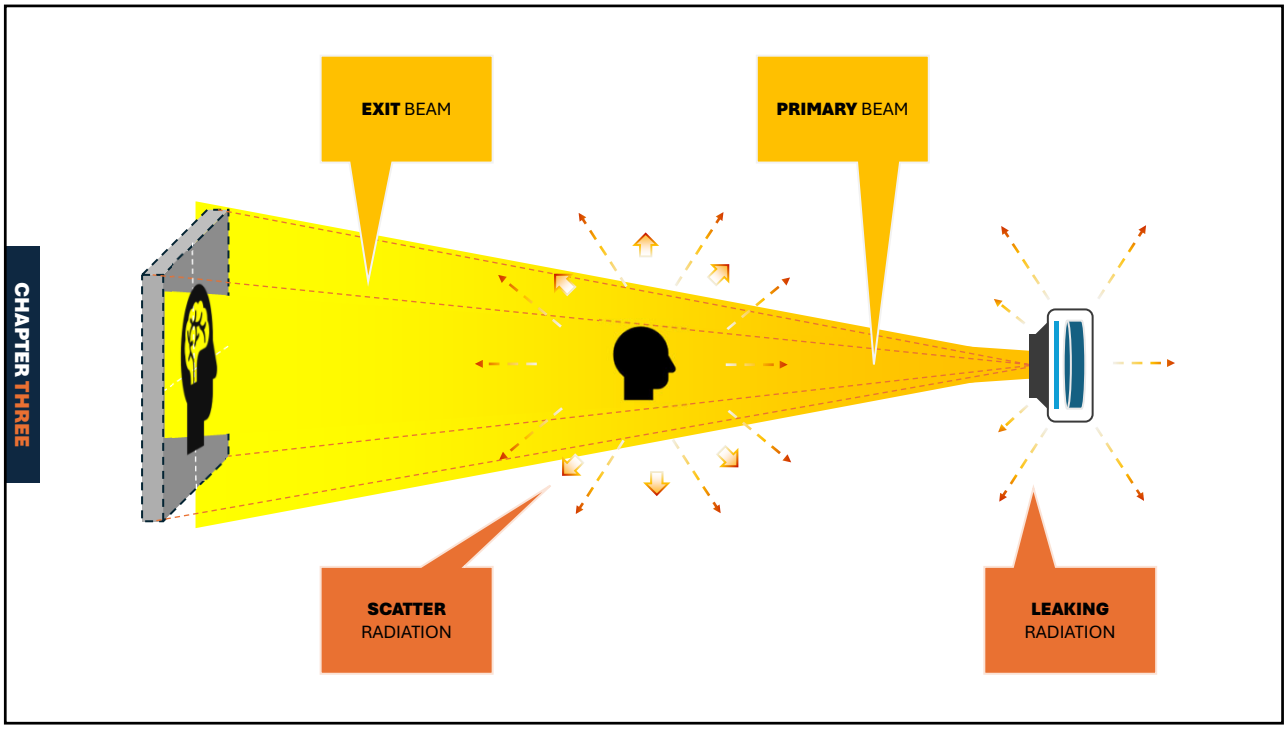
CHAPTER THREE
EXIT BEAM
PRIMARY BEAM
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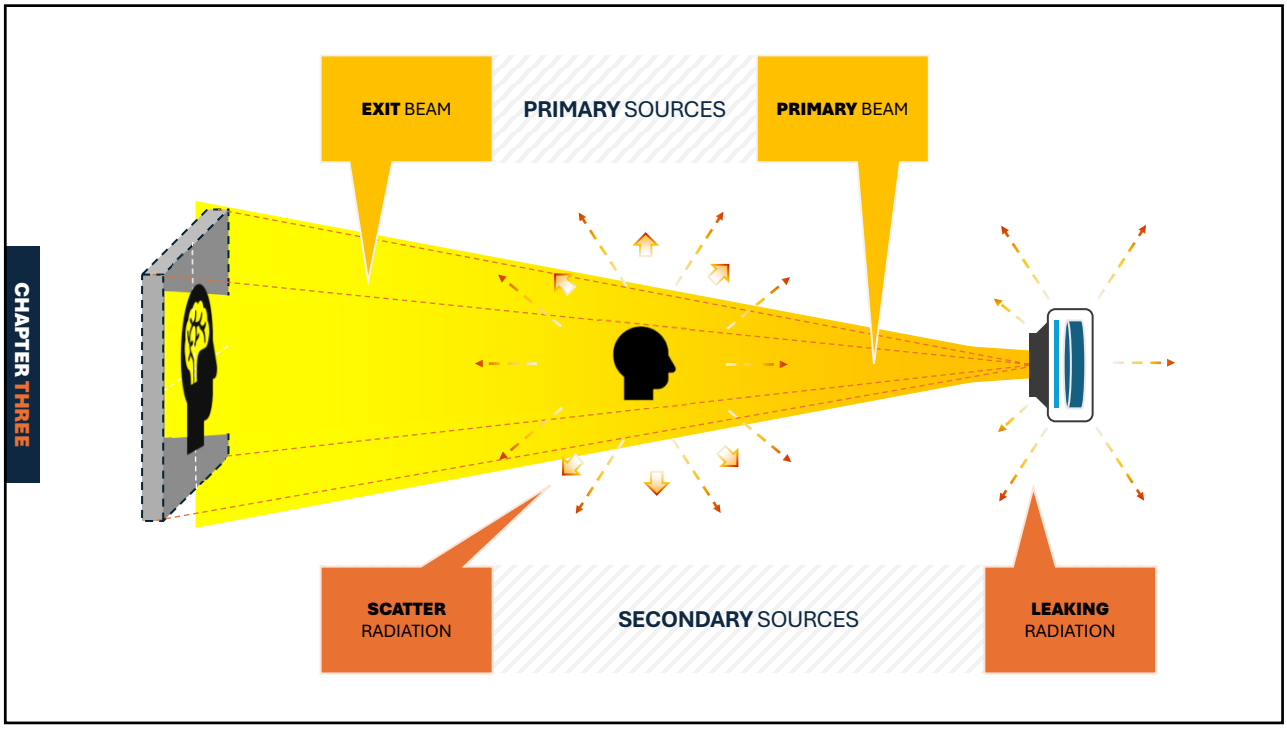
CHAPTER THREE
EXIT BEAM
PRIMARY SOURCES
PRIMARY BEAM
SCATTER RADIATION
SECONDARY SOURCES
LEAKING RADIATION

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CHAPTER THREE

1 PRIMARY SOURCES

- Primary beam
- Exit beam

Mainly **affects the patient** but can affect the medical staff in certain scenarios

SECONDARY SOURCES 2

- Scatter radiation
- Leaking radiation

Affects the patient and medical staff; especially in fluoroscopy applications

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CHAPTER THREE

EFFECTS OF RADIATION

- Probability of occurrence (not severity)
- Severity is independent of radiation dose
- No threshold
- Long delay between exposure and effect

STOCHASTIC EFFECTS

- Effects occur only after the threshold
- Severity increases with dose
- Occur within shorter time frame

DETERMINISTIC EFFECTS

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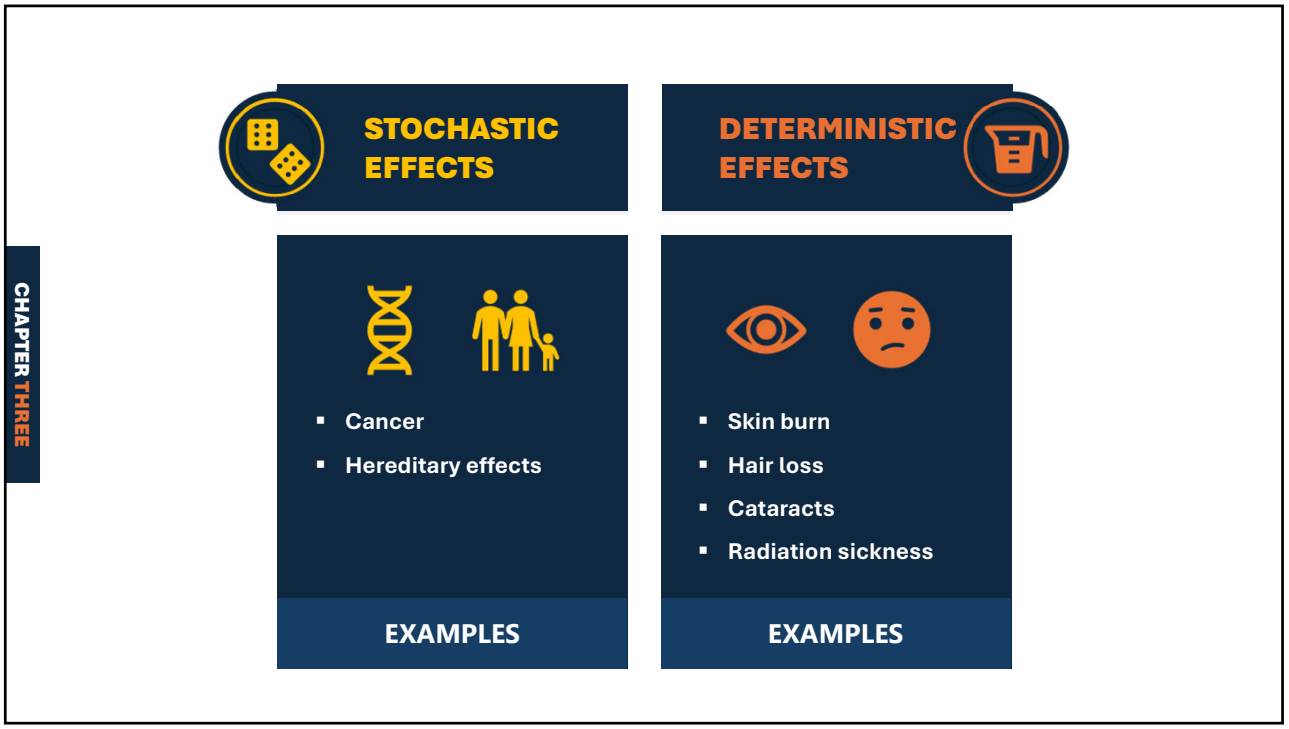
CHAPTER THREE
STOCHASTIC EFFECTS
DETERMINISTIC EFFECTS
Cancer
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EXAMPLES

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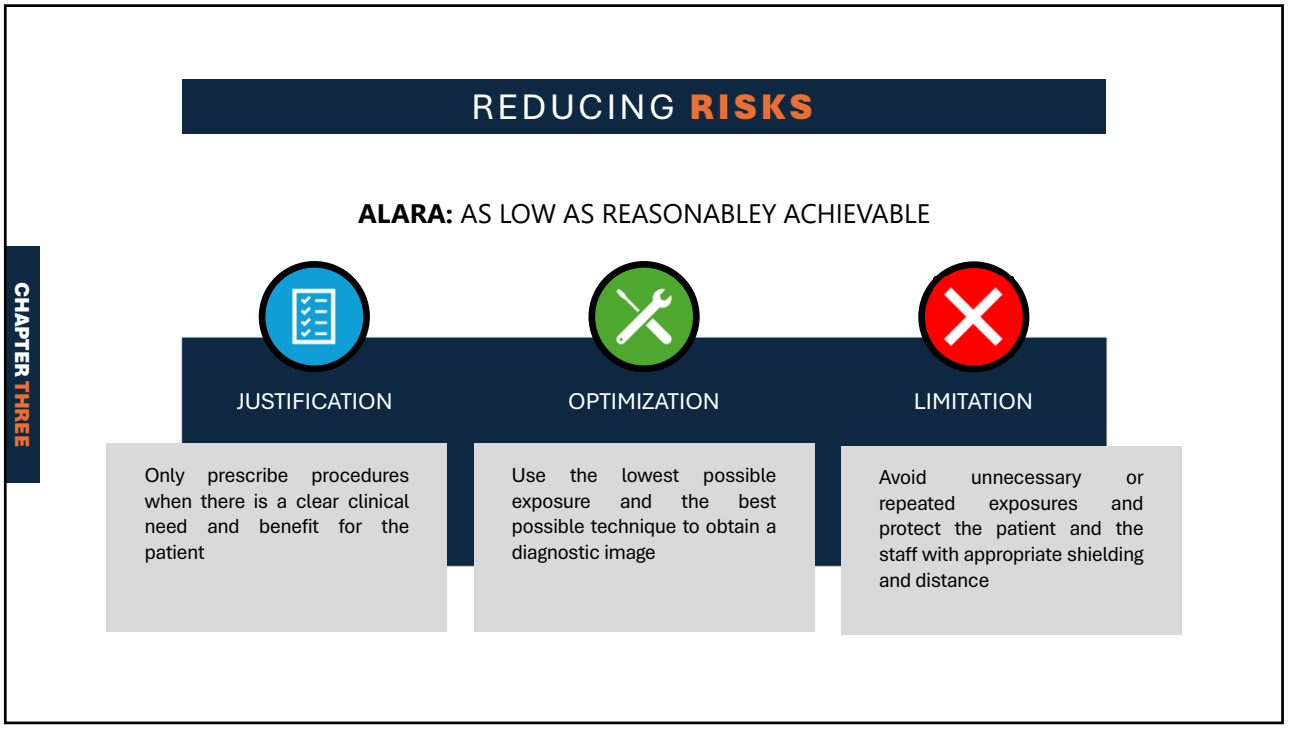
CHAPTER THREE
REDUCING RISKS
ALARA: AS LOW AS REASONABLEY ACHIEVABLE
JUSTIFICATION
OPTIMIZATION
LIMITATION
Only prescribe procedures when there is a clear clinical need and benefit for the patient
Use the lowest possible exposure and the best possible technique to obtain a diagnostic image
Avoid unnecessary or repeated exposures and protect the patient and the staff with appropriate shielding and distance

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RADIATION SAFETY

MIN EXP. TIME

MAX DISTANCE

USE BARRIERS

THE THREE KEY PRINCIPLES

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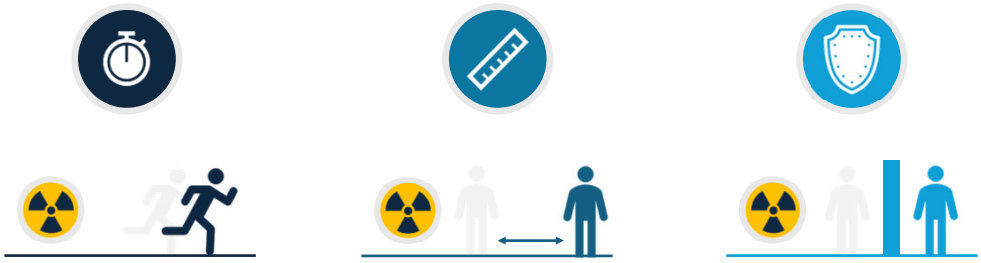
THE THREE KEY PRINCIPLES



Spend the **least amount of time** near a radiation source, **maximize your distance** from the source and **use shielding** & personal protective equipment

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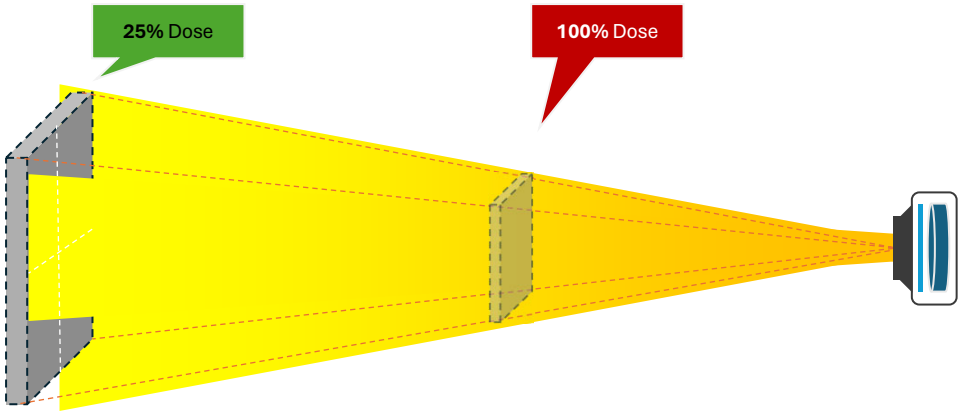
INVERSE SQUARE **LAW**



Doubling the distance from the radiation source **decreases** the intensity of the radiation by **factor of 4**

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PERSONAL PROTECTIVE EQUIPMENT & **SHIELDING**

Lead aprons and other lead-lined wearables are called **PPEs** (personal protective equipment)

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Lead barriers or **shields** can be attached to equipment, on the floor or ceiling suspended

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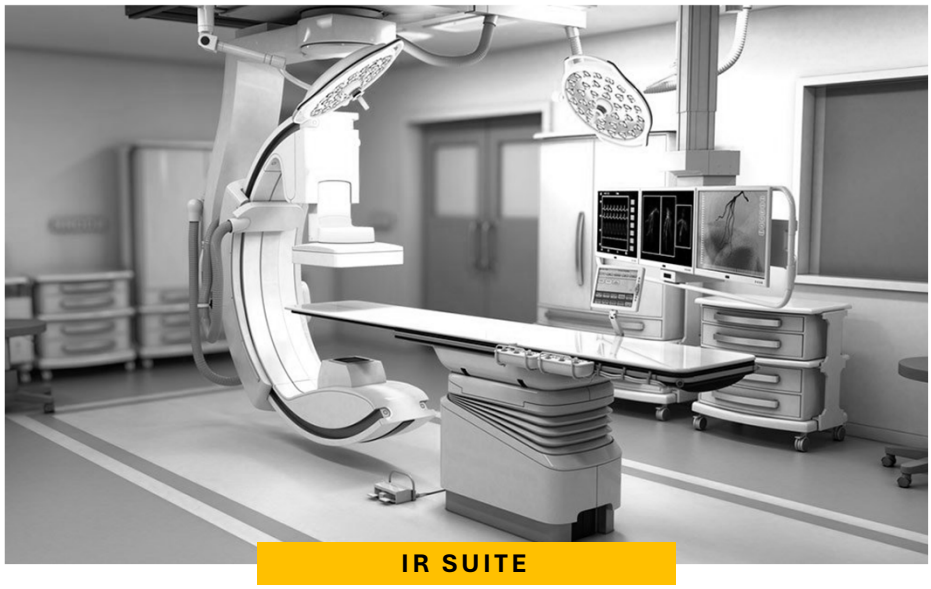

IR SUITE

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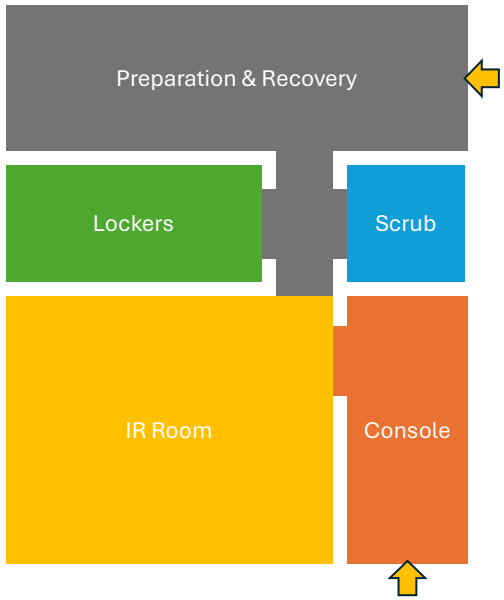
Typical layout of IR Suite and Auxiliary facilities

Equipment that are generally required in the IR suite:

- Imaging equipment
- Imaging table
- Electrophysiology systems
- Hemodynamic equipment
- Anesthesia machines
- Perfusion systems
- Surgical instrument tables
- Ultrasound equipment
- Recording equipment/computers
- Lead aprons and glasses
- Scrub area, including sinks

The IR suite should have **controlled access** and a clearly **defined and controlled workflow**; policies and procedures should be in place and strictly followed.



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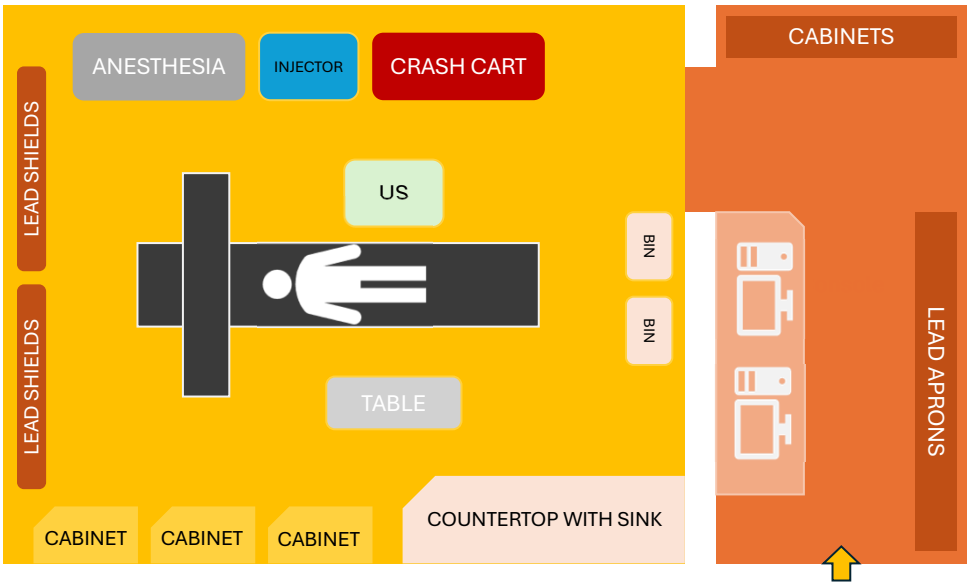

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Generally, improving **image quality** comes at the cost of increased radiation dose to the **patient and staff**.

RADIATION DOSE

IMAGE QUALITY

DIAGNOSIS

Our responsibility is to be sensible with our decisions and to "**image gently**"

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CHAPTER THREE

IMAGING WITH FLUOROSCOPY

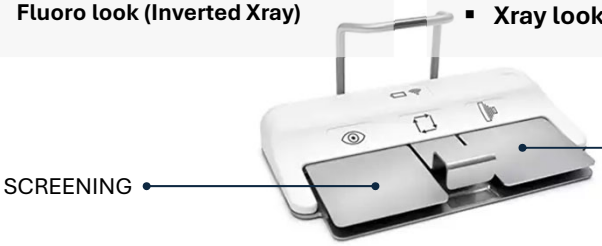
Two main modes of imaging using fluoroscopy equipment

FLUOROSCOPY SCREENING

- Low dose
- Low image quality
- Fluoro look (Inverted Xray)

DIGITAL SPOT EXPOSURE

- High dose
- High image quality
- Xray look



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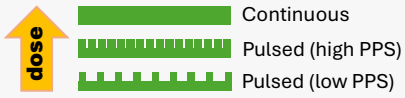
FLUOROSCOPY SCREENING

Can be **continuous** or **pulsed**

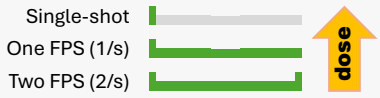


Radiologists screens the patient with this mode. If an image of interest appears, they can "screen-shot" and save it using "**Last-Image-Hold**". LIH is a **low-quality** image at **no cost of radiation**.

- **Looks like fluoroscopy image (inverted)**
- **A screen-shot (no additional radiation)**

DIGITAL SPOT EXPOSURE

Can be **single-shot** or **multi-frame**



Radiologists screens the patient with Fluoroscopy Screening mode. If an image of interest appears, they switch to this mode to take **high-quality** image(s) that are captured at **higher radiation doses**.

- **Looks like a high-quality X-Ray**
- **An additional exposure at high mA**

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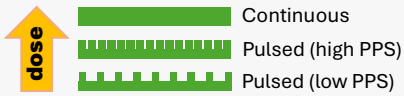
CHAPTER THREE

FLUOROSCOPY SCREENING

Can be **continuous** or **pulsed**

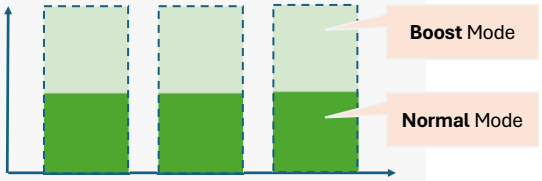


Radiologists screens the patient with this mode. If an image of interest appears, they can "screen-shot" and save it using "**Last-Image-Hold**". LIH is a **low-quality** image at **no cost of radiation**.

- **Looks like fluoroscopy image (inverted)**
- **A screen-shot (no additional radiation)**

Boost Mode

Boost mode or sometimes referred to as **High-Level-Fluoroscopy** (**HLF**) is a screening mode that uses higher mA values (taller pulses) than normal fluoroscopy screening. It is useful when imaging very large patients but of course, it comes with the cost of **higher radiation doses**.



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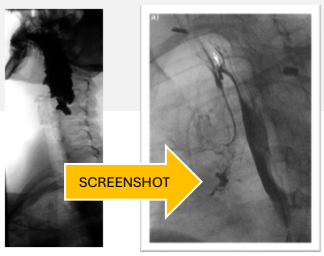
CHAPTER ONE

LAST IMAGE HOLD (LIH)

A still image captured during a fluoroscopic examination without impacting patient dose

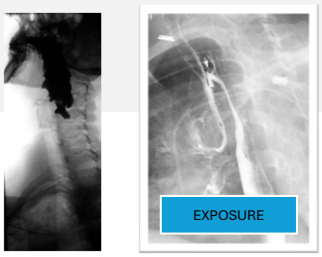
- **Meant for review** on the monitor during the procedure but can be saved.
- A screenshot of the fluoroscopy screening image (low quality)
- Always a "single-shot" – one image
- No additional dose



SPOT IMAGING

A static fluorograph made during a fluoroscopic examination to record the subject

- **Meant for recording** the procedure (images are automatically saved)
- An additional exposure at high mA
- High image quality & higher dose
- Can be a single-shot or multiple exposures at set-interval (FPS)



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SCATTER **GENERATION**

The amount of scatter radiation generated during medical exposures is directly influenced by these factors:

BEAM
ENERGY

SUBJECT
SIZE & POSITION

FIELD
SIZE

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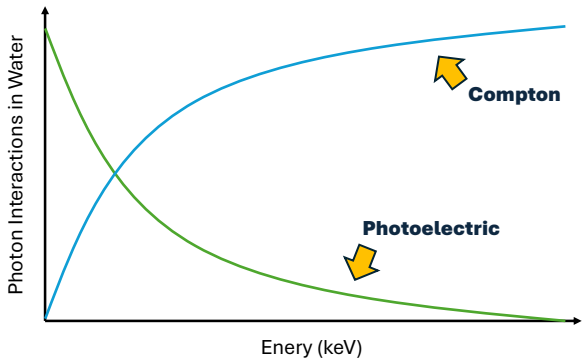

Scatter production is energy dependent; **it increases as the kVp increases.**

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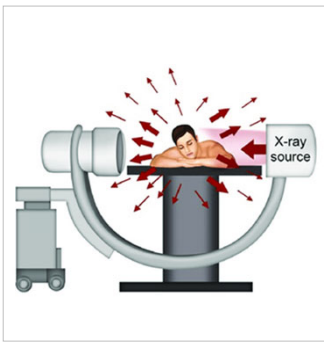
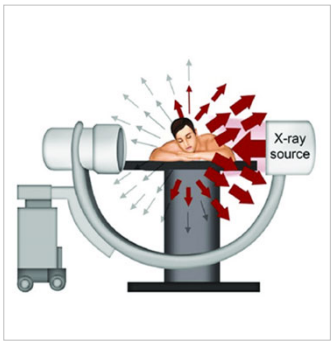
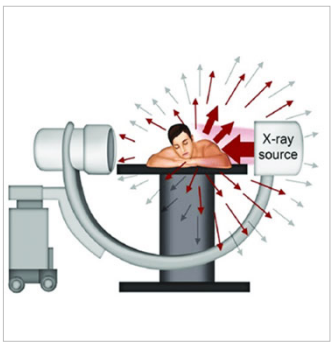


Cervical Spine



Large Patient
Lumbar Spine



Small Patient
Lumbar Spine

Scatter generation is affected by **Body Part & Size** (the bigger the part, the more scatter is generated)

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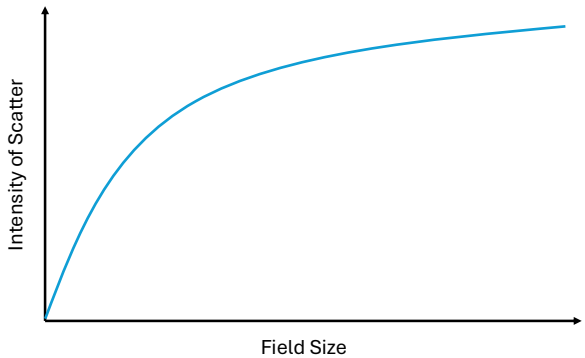

Scatter production **increases as the field size increases.** Reducing the field size with collimation limits scatter production

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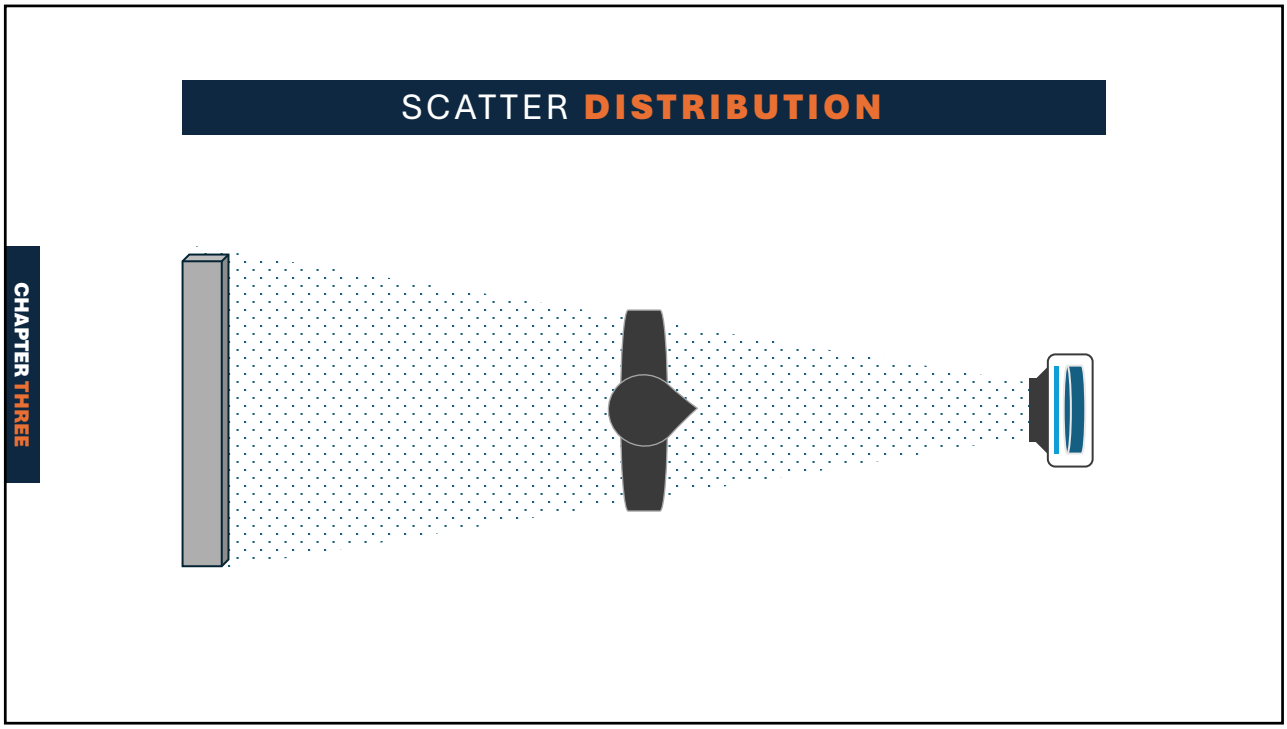

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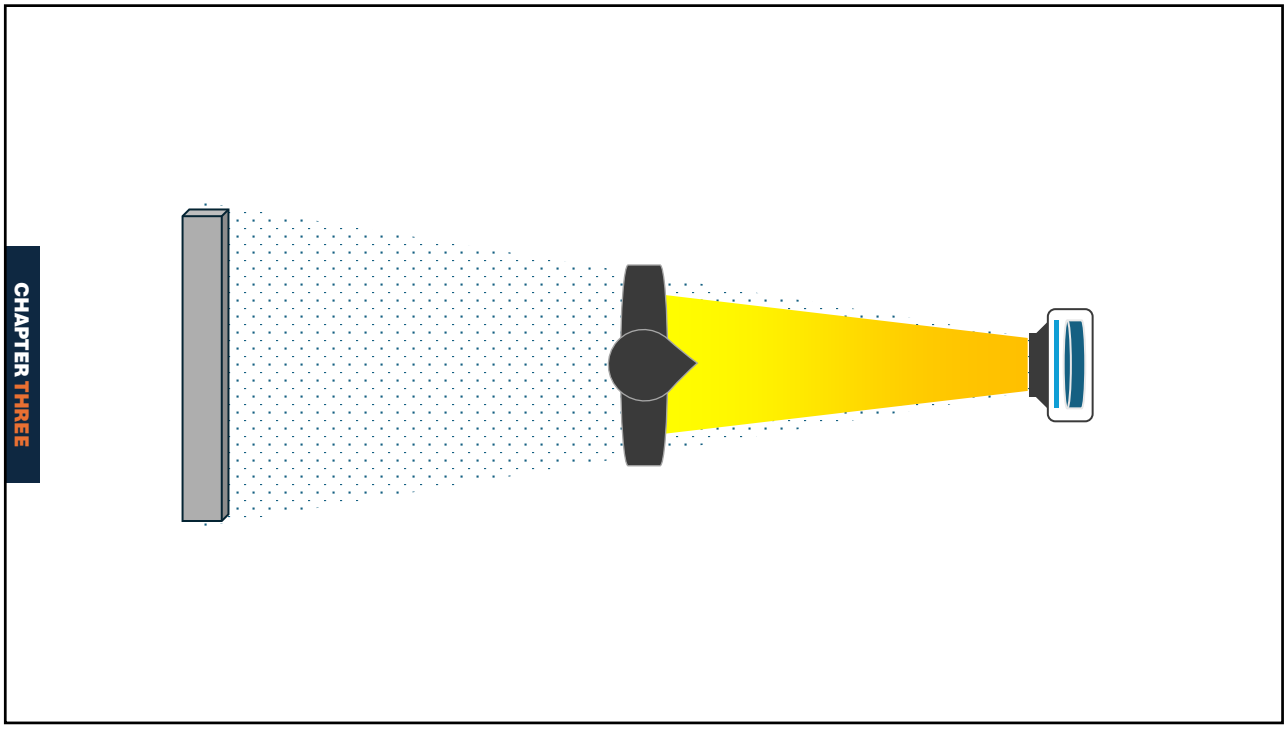

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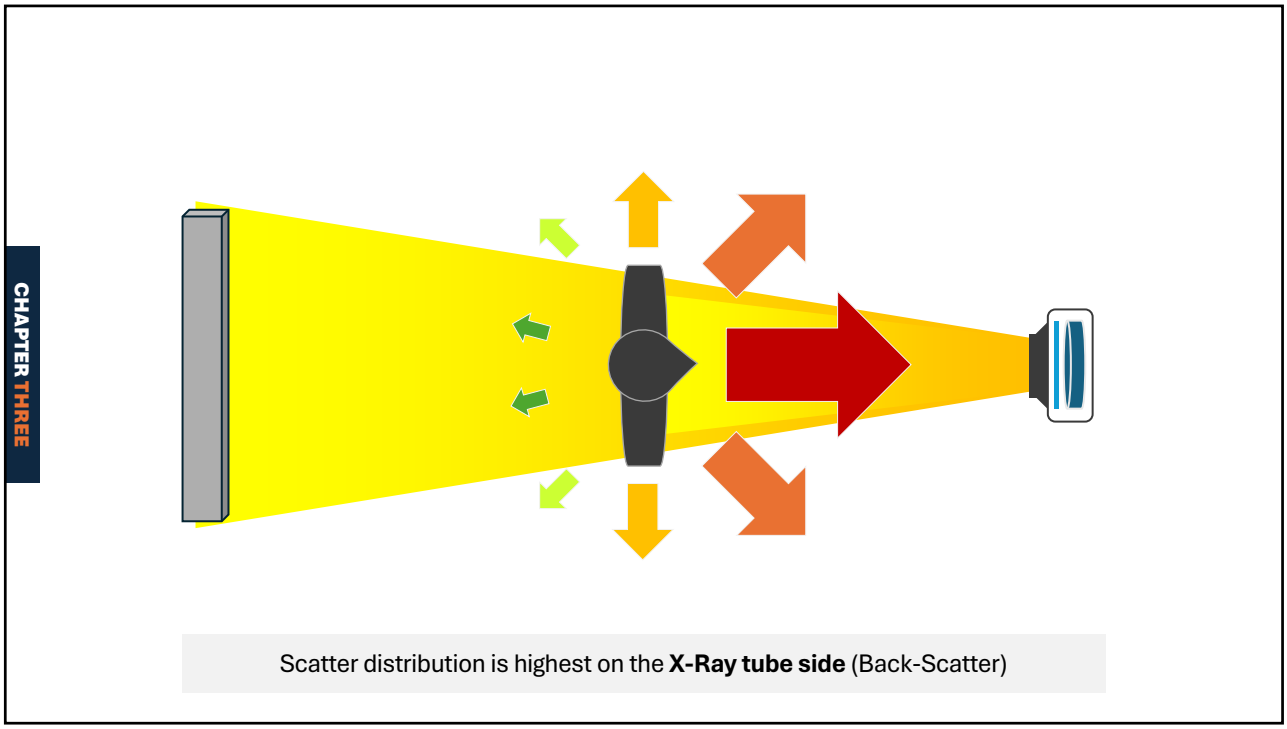
CHAPTER THREE
Scatter distribution is highest on the **X-Ray tube side** (Back-Scatter)

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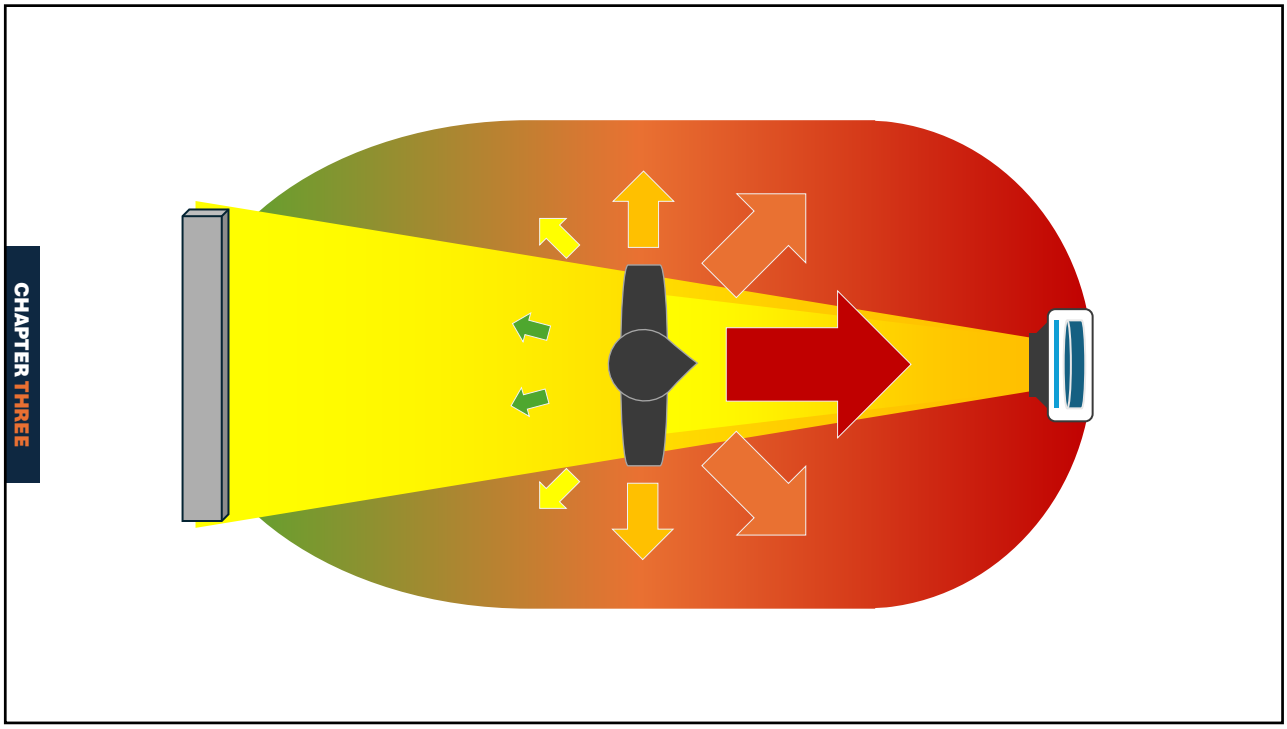
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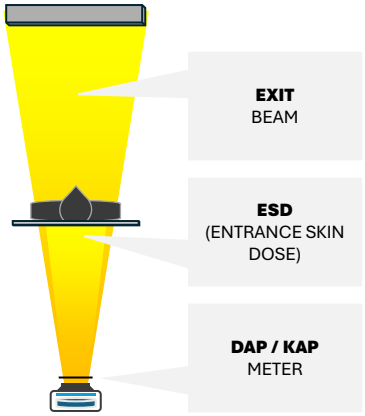
CHAPTER THREE

PATIENT RADIATION DOSE

Patient dose refers to the **amount of ionizing radiation absorbed** by a patient during a diagnostic or therapeutic procedure.

Entrance Skin Dose (ESD): The radiation dose to the patient's skin at the point where the X-ray beam enters the body. It's usually the highest dose received by the patient.

DAP / KAP Meters: Devices attached to the collimator to measure the total amount of radiation energy delivered to the patient during the procedure. It accounts for both the dose and the area exposed – **Dose or Kerma Area Product (measured in Gy.cm²)**



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CHAPTER THREE

Reducing Patient Dose in Fluoroscopy

1. REDUCE BEAM-ON TIME
2. REDUCE INTENSITY OF RADIATION

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CHAPTER THREE

Reducing Patient Dose in Fluoroscopy

1 REDUCE BEAM-ON TIME

The X-Ray beam should be ON for least amount of time possible.

2 REDUCE INTENSITY OF RADIATION

The intensity of the X-Ray beam should be minimum.

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CHAPTER THREE

Reducing Patient Dose in Fluoroscopy

1 REDUCE BEAM-ON TIME

Shorter Procedures:
Every effort should be made to keep fluoroscopy procedures as short as possible. This requires careful planning, efficient techniques, and skilled operation of the equipment.

Intermittent-Pulsed Fluoroscopy:
Instead of continuous fluoroscopy, use intermittent & pulsed fluoroscopy. This reduces the overall beam-on time and thus the radiation dose.

Last-Image Hold:
Utilize the last-image hold feature to review images without continuous exposure.

Spot Imaging:
Use the least amount of spot imaging possible, and use the least amount of frames per second.

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Reducing Patient Dose in Fluoroscopy

1 REDUCE BEAM-ON TIME

CHAPTER THREE

Roadmap Guidance:
Use roadmap guidance techniques to minimize the need for additional exposures and contrast media during interventional procedures.

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Reducing Patient Dose in Fluoroscopy

1 REDUCE BEAM-ON TIME

CHAPTER THREE

The X-Ray beam should be ON for least amount of time possible.

2 REDUCE INTENSITY OF RADIATION

The intensity of the X-Ray beam should be minimum.

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Reducing Patient Dose in Fluoroscopy

2 REDUCE INTENSITY OF RADIATION

CHAPTER THREE

Use collimation whenever possible:
Minimize the irradiated areas of the patient and improve image quality by reducing scatter production and maximizing the benefits of the ABC system.

Avoid magnification when not-needed:
Magnification increase radiation output and patient dose. This effect is more prominent in fluoroscopic systems with Image-Intensifier type receptors.

Use careful patient positioning:
Lateral and oblique positions can increase patient dose and scatter production.

Use grids only when necessary:
Grids improve image quality by absorbing scatter radiation. This results in an increase in patient dose at the ABC system attempts to compensate for the reduce signal at the detector.

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Reducing Patient Dose in Fluoroscopy

2 REDUCE INTENSITY OF RADIATION

CHAPTER THREE

Min. OID:
The Object to Image-Receptor Distance should be always kept to the absolute minimum possible. Keep the II or FPD closest to the patient to improve image quality and minimize the radiation dose.

Max SOD:
The Source to Object Distance should be always kept to the absolute maximum possible. This reduces Entrance-Skin-Dose (ESD).

Equipment Familiarity & Planning:
Being familiar with the fluoroscopy equipment and its features can help operators work more efficiently. Planning procedure can further enhance radiation safety.

Case & Performance Reviews:
Periodically review procedures and techniques to identify areas where time can be further minimized.

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Reducing Patient Dose in Fluoroscopy

1 **REDUCE BEAM-ON TIME**

The X-Ray beam should be ON for least amount of time possible.

2 **REDUCE INTENSITY OF RADIATION**

The intensity of the X-Ray beam should be minimum.

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CHAPTER THREE

PATIENT DOSE MANAGEMENT

- Substituting ultrasound for fluoroscopy guidance if it does not affect patient outcome.
- Know your equipment and use available patient-dose-reduction technologies.
- Maximize the distance of the X-ray tube from the patient to the extent possible.
- Minimize the distance of the detector from the patient.
- Minimize the fluoroscopy time (FT). Keep a record of FT for each patient.
- Use the lowest pulse rate during screening; and lowest frame rate during spot imaging.
- Use last-image-hold to review or even to capture finding if image quality is sufficient.
- Use collimation.
- Be aware that oblique projections and lateral views will result in higher patient dose.
- Vary the position where the beam enters the patient; Avoid irradiating the same part of skin by using rotation.
- Keep a record of the patient dose.
- Minimize the number frames of cine runs (DSA) or frames.
- Do not use acquisition mode for the purpose of fluoroscopy screening.
- Avoid using a large field of view or magnification.

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CHAPTER THREE

Using Shielding for Patients

Shielding:
Patient contact shielding is **not recommended** for all fluoroscopic applications. This includes adult patients, pediatrics and even pregnant women.

Shielding may interfere with the primary beam and cause the automatic-brightness-control (ABC) system to increase the exposure to compensate for the attenuation caused by the shield.

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Fluoroscopy Time & The 5 Minute Timer

- **Total fluoroscopy time** (total beam-on time) is commonly used as an indicator for patient dose.
- It is an indicator; however, it is far from ideal. **It doesn't take into account large contributions to patient dose, including digital spot imaging** (spot imaging is frequently the highest contributor to patient dose in fluoroscopic procedures)

- Fluoroscopic machines are equipped with timers that **sound an alarm every 5-minutes of total beam-on time**. The alarm **must be reset to continue** with the procedure.
- In fluoroscopy room the reset button is on the control panel and on the console

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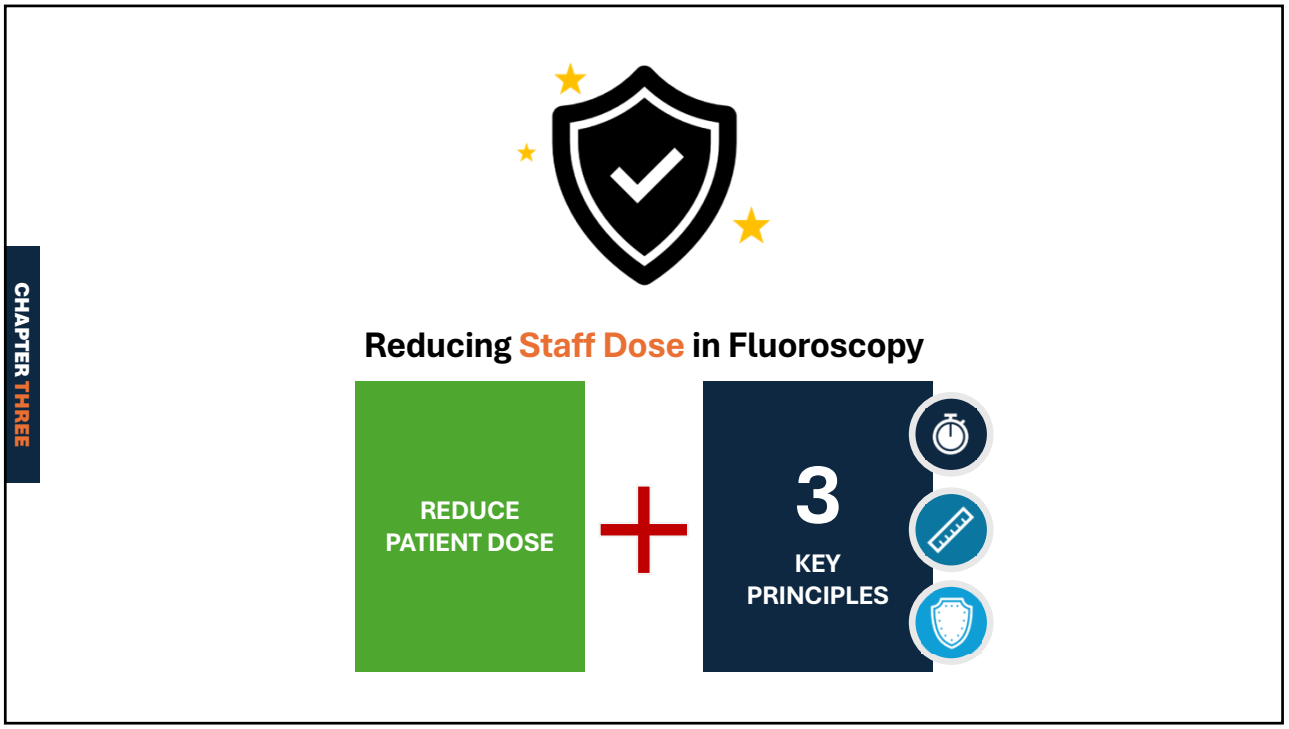
CHAPTER THREE
Reducing Staff Dose in Fluoroscopy
REDUCE PATIENT DOSE
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KEY PRINCIPLES

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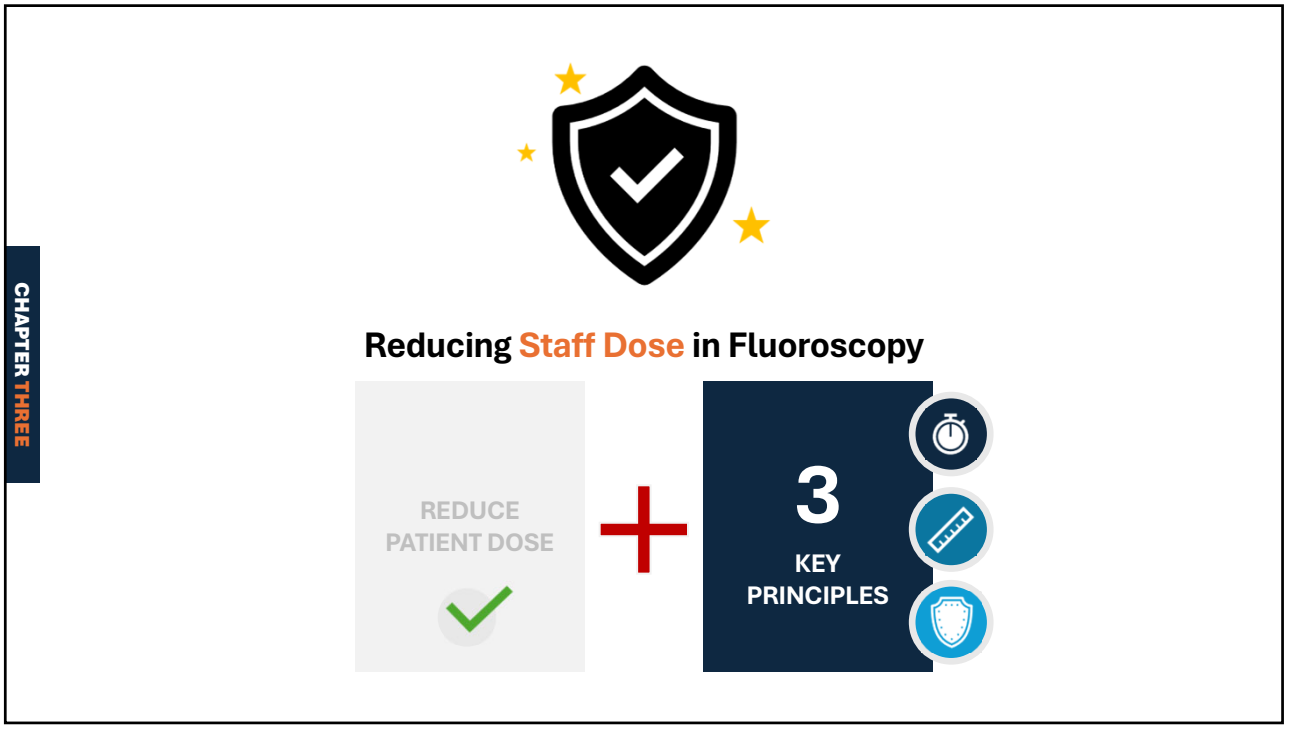
CHAPTER THREE
Reducing Staff Dose in Fluoroscopy
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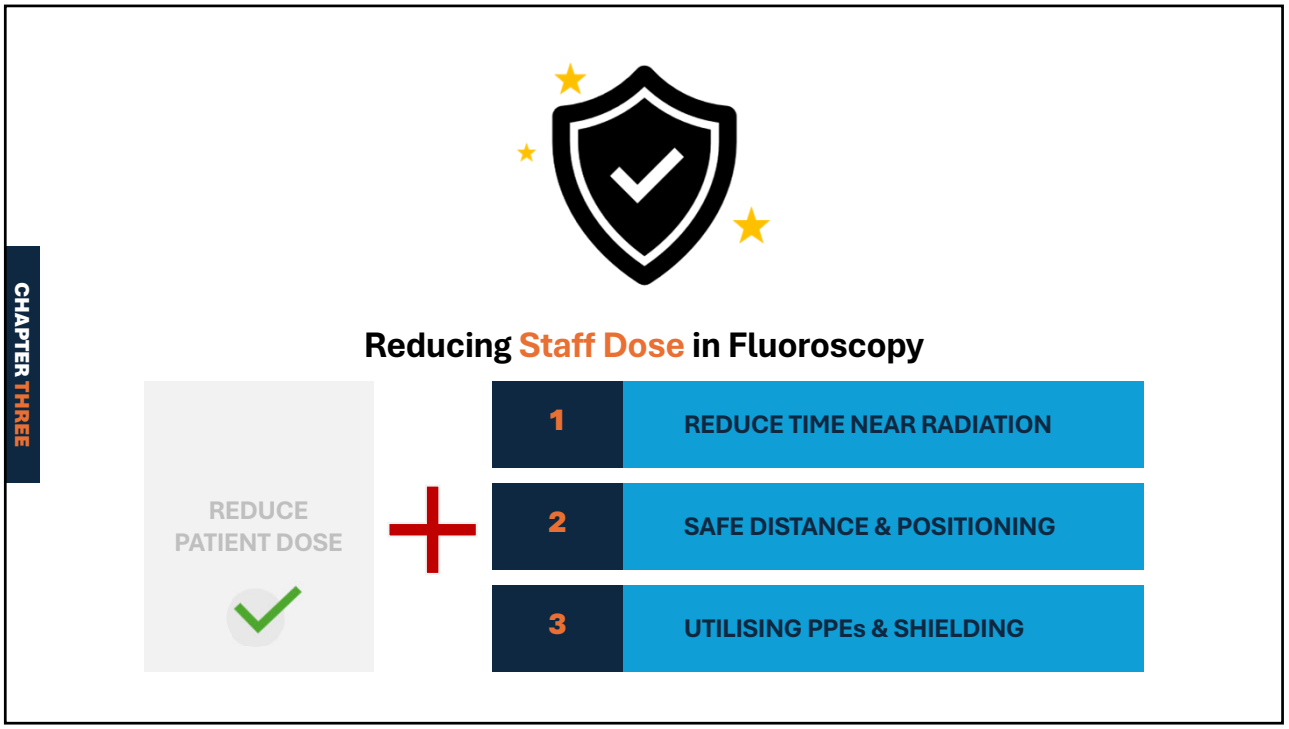
CHAPTER THREE
Reducing Staff Dose in Fluoroscopy
REDUCE PATIENT DOSE
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REDUCE TIME NEAR RADIATION
2
SAFE DISTANCE & POSITIONING
3
UTILISING PPEs & SHIELDING

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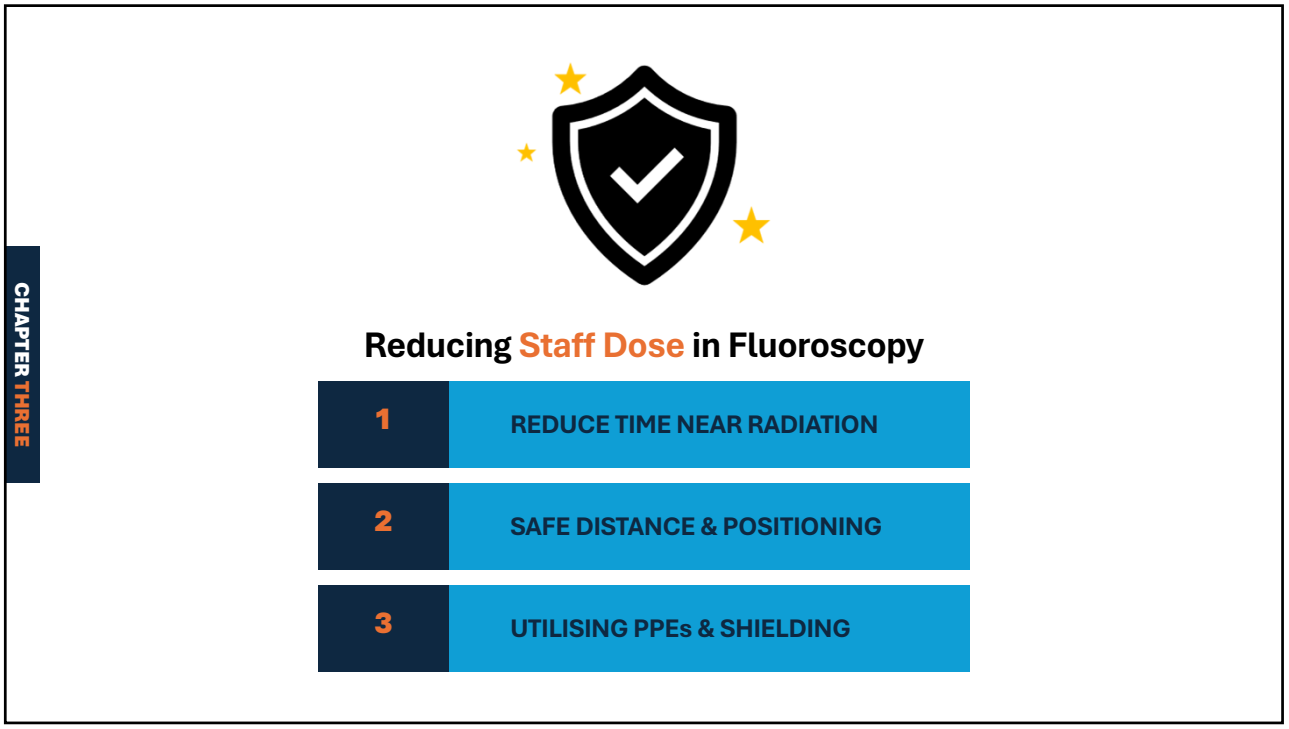
CHAPTER THREE
Reducing Staff Dose in Fluoroscopy
1
REDUCE TIME NEAR RADIATION
2
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CHAPTER THREE

Reducing Staff Dose in Fluoroscopy

1 REDUCE TIME NEAR RADIATION

Shorter Procedures:
Every effort should be made to keep fluoroscopy procedures as short as possible. This requires careful planning, efficient techniques, and skilled operation of the equipment.

Expose only when needed:
Remove your finger/foot from the exposure switch when not needed. Utilize the LIH feature to review the image on the monitor without the expense of radiation.

Reduced Number of Staff:
Number of personnel near the radiation source should be kept to the minimum required.

Reduced Beam-On Time:
This includes: intermittent fluoroscopy with low pulse rate, fewer digital spot acquisitions (and at low FPS), and utilizing features like LIH and Roadmap.

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CHAPTER THREE

Reducing Staff Dose in Fluoroscopy

1 REDUCE TIME NEAR RADIATION

2 SAFE DISTANCE & POSITIONING

3 UTILISING PPEs & SHIELDING

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CHAPTER THREE

Reducing Staff Dose in Fluoroscopy

2 SAFE DISTANCE & POSITIONING

Maximize Distance:
The distance from the radiation source should maximized. Every step counts; If you are near the patient's table, one step back (doubling the distance) will reduce your radiation dose by a factor of 4.

Remember The Inverse Square Law:
Every step counts; If you are near the patient's table, one step back (doubling the distance) will reduce your radiation dose by a factor of 4.

Safe Positioning (Personnel):
The intensity of scatter radiation is highest at the X-Ray tube side (back scatter). Medical staff should stay at the image receptor size whenever possible.

Safe Positioning (Equipment):
The intensity of scatter radiation is highest at the X-Ray tube side. The X-Ray tube should be kept under the table pointing upward toward the patient to direct back scatter away from medical staff.

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CHAPTER THREE

Reducing Staff Dose in Fluoroscopy

1 REDUCE TIME NEAR RADIATION

2 SAFE DISTANCE & POSITIONING

3 UTILISING PPEs & SHIELDING

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CHAPTER THREE

Reducing Staff Dose in Fluoroscopy

3 UTILISING PPEs & SHIELDING

Lead Aprons & Thyroid Sheilds:
Always wear lead aprons and thyroid shields (0.25mm-0.5mm). Lead aprons should be "Wrap-Around" type (front and back) to protect the medical staff during the procedure.

Shields & Barriers:
Always utilize available shielding material. Use fixed and mobile shields to protect yourself and other medical staff present in the room.

Lead Glasses: Recommended
Wearing lead glasses is optional during conventional fluoroscopic procedures but highly recommended during interventional and angiographic procedures.

Lead Gloves: Not Recommended
Wearing lead gloves is not recommended in fluoroscopic application as it may enter the primary beam and affect the ABC system leading to increased radiation dose.

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CHAPTER THREE

Reducing Staff Dose in Fluoroscopy

1 REDUCE TIME NEAR RADIATION

2 SAFE DISTANCE & POSITIONING

3 UTILISING PPEs & SHIELDING

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CHAPTER THREE

STAFF DOSE **MANAGEMENT**

- Reducing the dose to the patient means reducing the dose to all the medical staff present during the procedure.
- Minimizing fluoroscopy time (prohibiting less-experienced workers from operating the fluoroscopy controls).
- Position yourself in areas when scatter intensity is lowest.
- Always wear your PPEs
- Keep your hand out of the primary beam
- Always wear your personal dosimeter (TLD) outside the lead apron; at neck or torso height. (and know your dose)
- Monitor and keep track of beam-on time and 5-minute timer
- Record beam-on time for review
- Record cumulative dose for review
- Annual radiation dose limit for radiation workers is 20mSv per year, averaged over defined periods of 5 years. The E may not exceed 50 mSv in any one year.
- For declared pregnant staff the dose limit is 1 mSv to the fetus over the duration of the pregnancy.
- Educate and train staff on radiation protection
- Test and ensure equipment functioning safely.

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CHAPTER THREE

RADIATION **SAFETY**

- OVERVIEW
- KEY PRINCIPLES
- PATIENT DOSE
- STAFF DOSE
- BEST PRACTICES

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CHAPTER THREE

RADIATION SAFETY

- OVERVIEW
- KEY PRINCIPLES
- PATIENT DOSE
- STAFF DOSE
- BEST PRACTICES

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CHAPTER THREE

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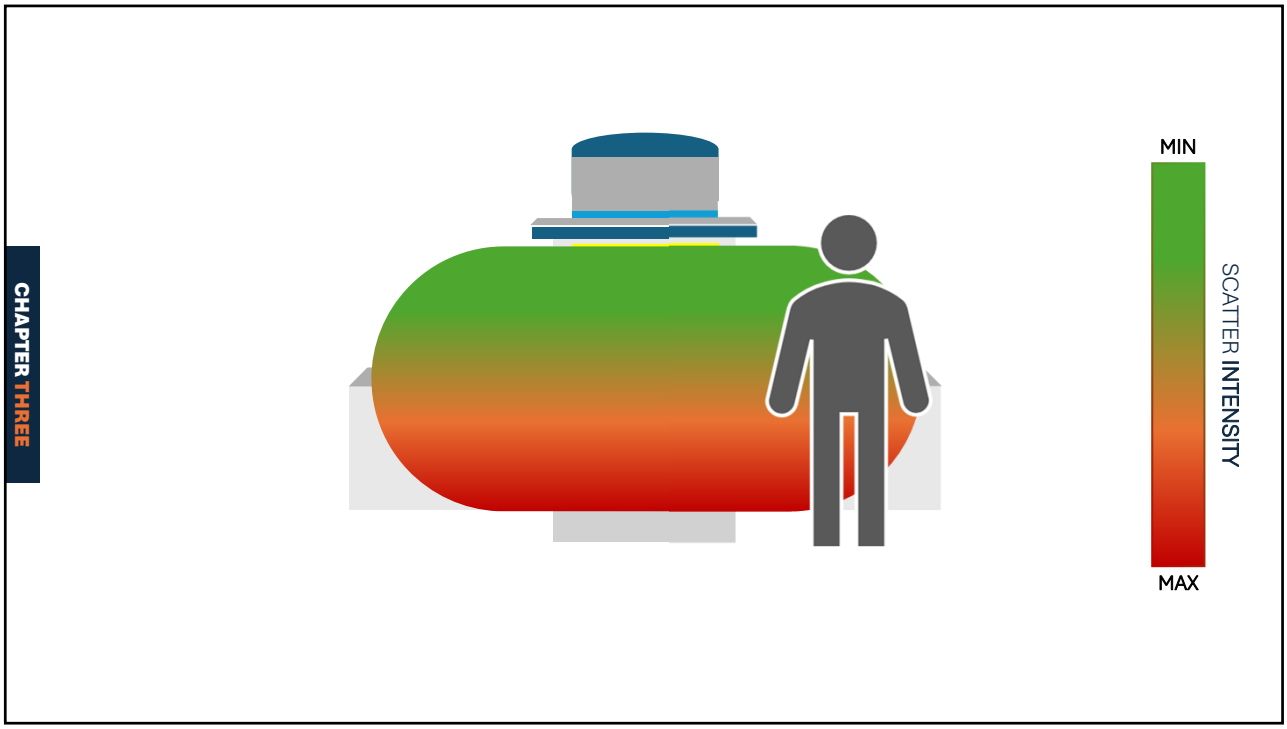

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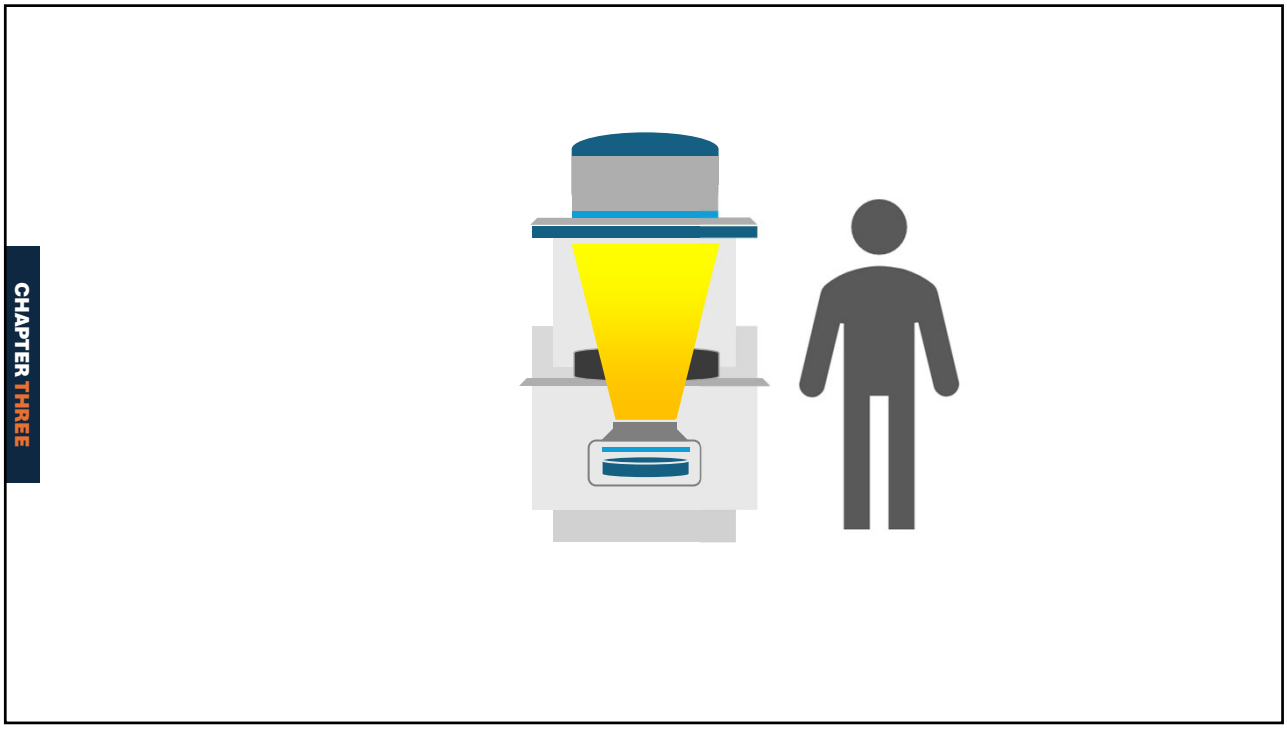

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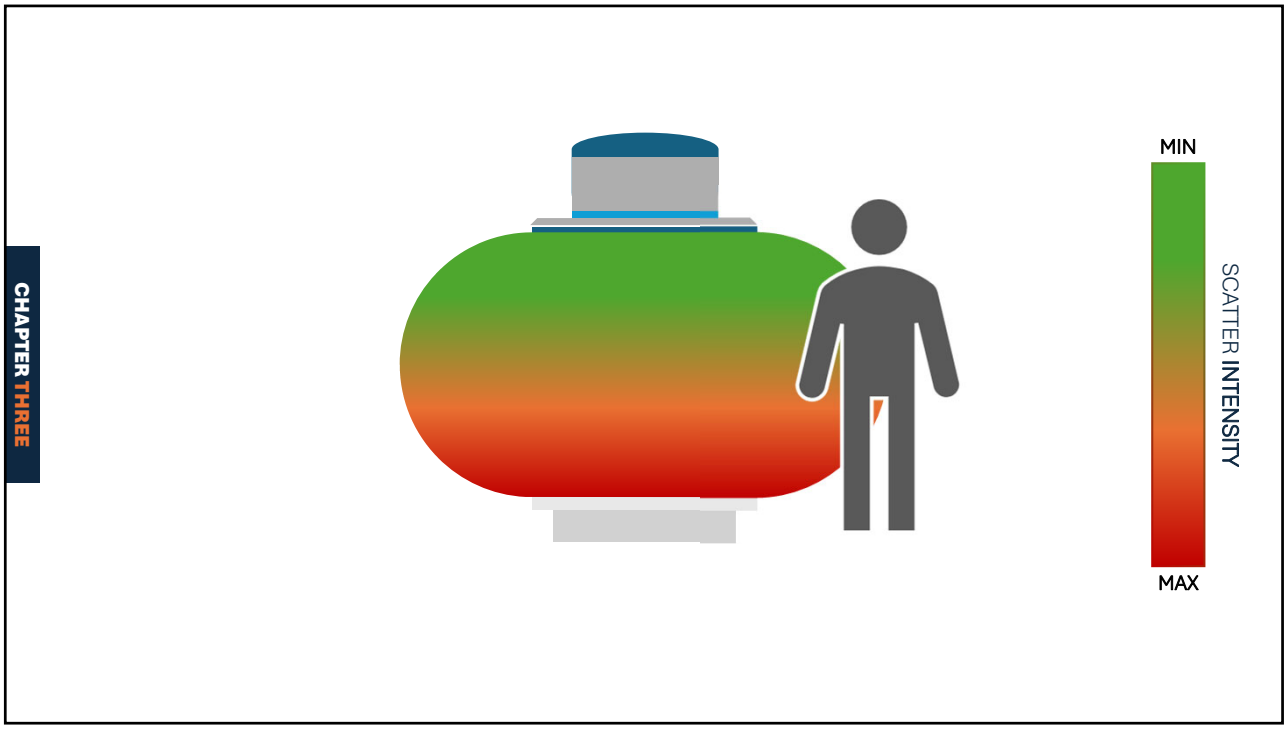

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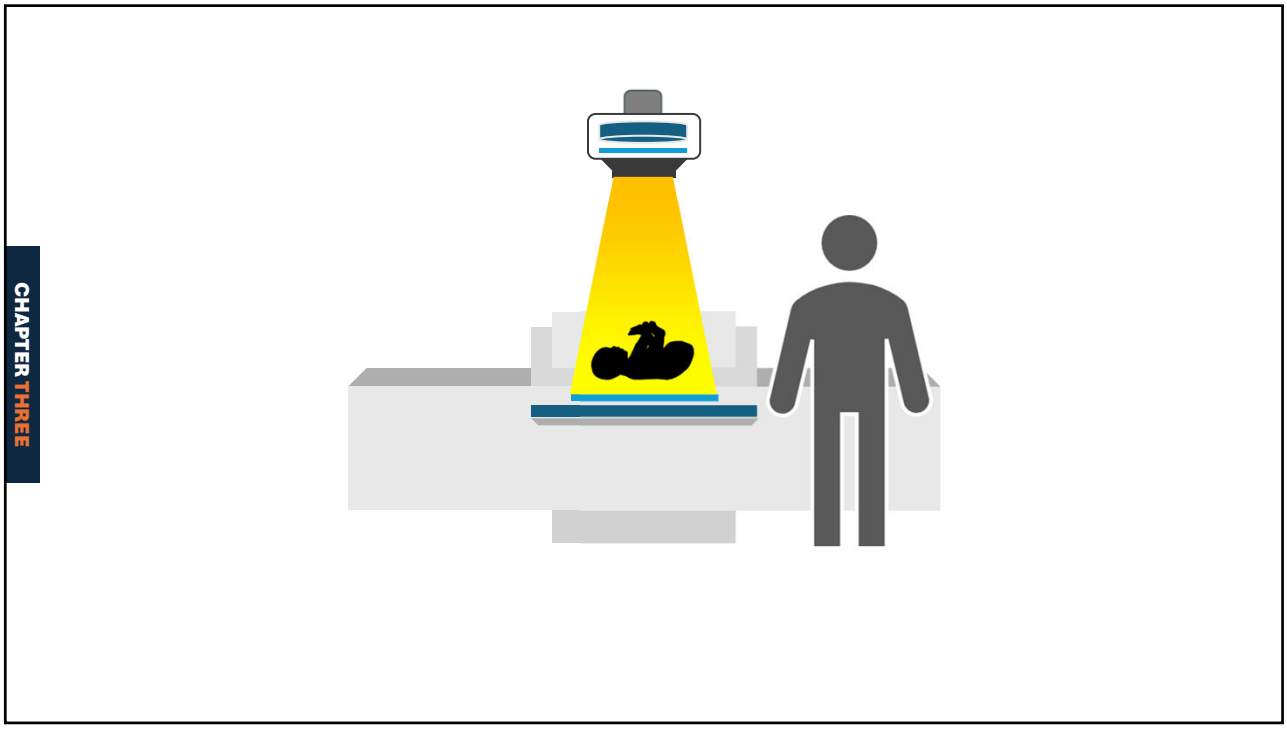

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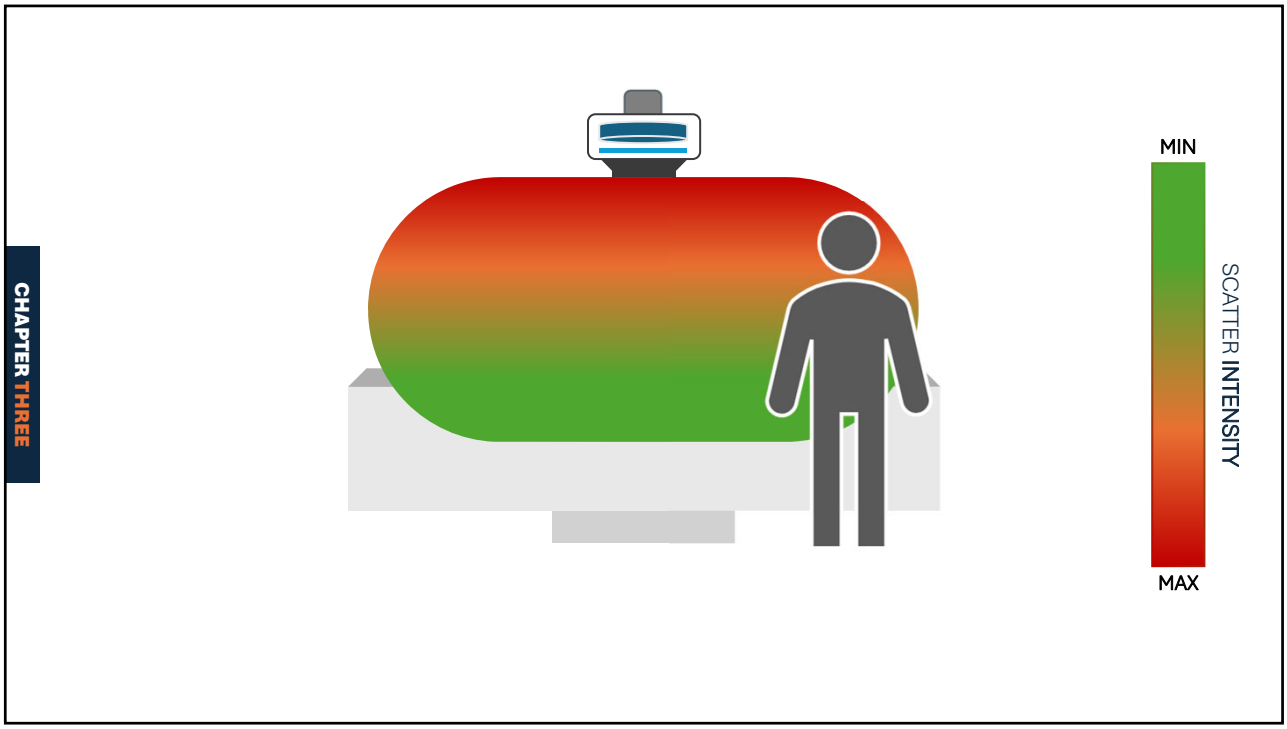
CHAPTER THREE
MIN
SCATTER INTENSITY
MAX

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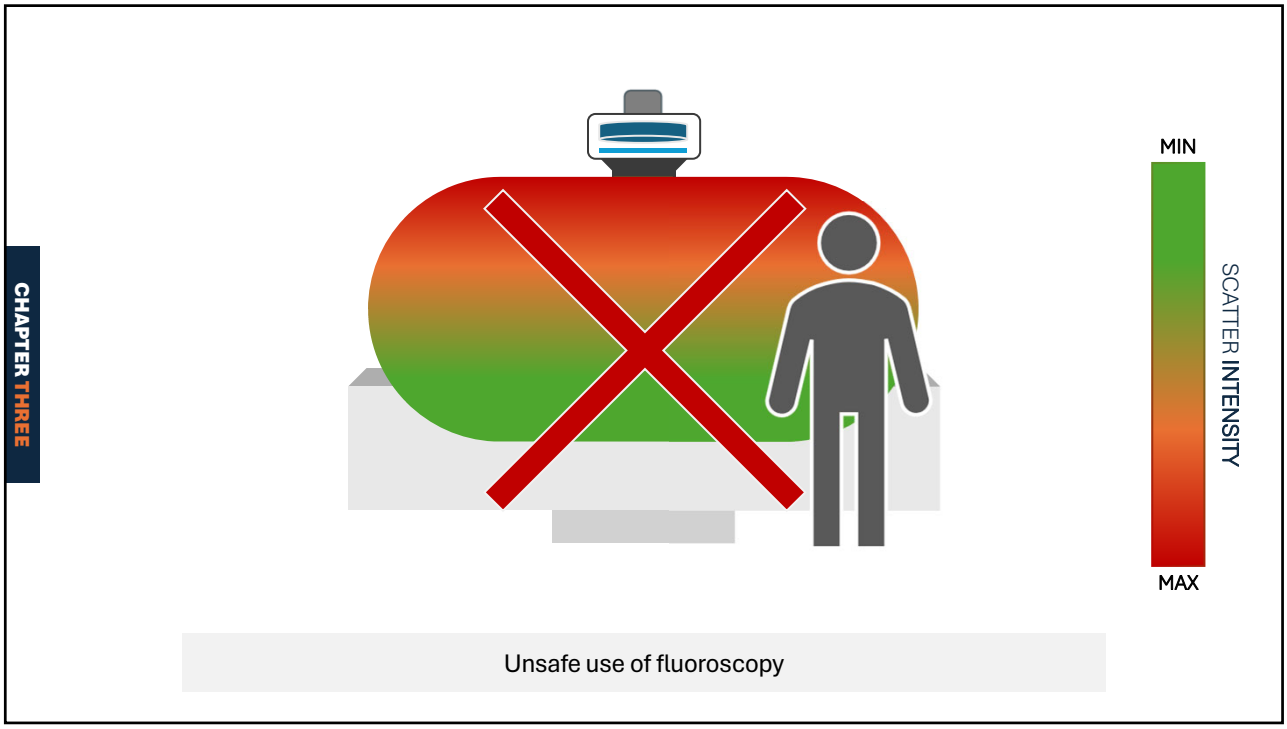
CHAPTER THREE
MIN
SCATTER INTENSITY
MAX
Unsafe use of fluoroscopy

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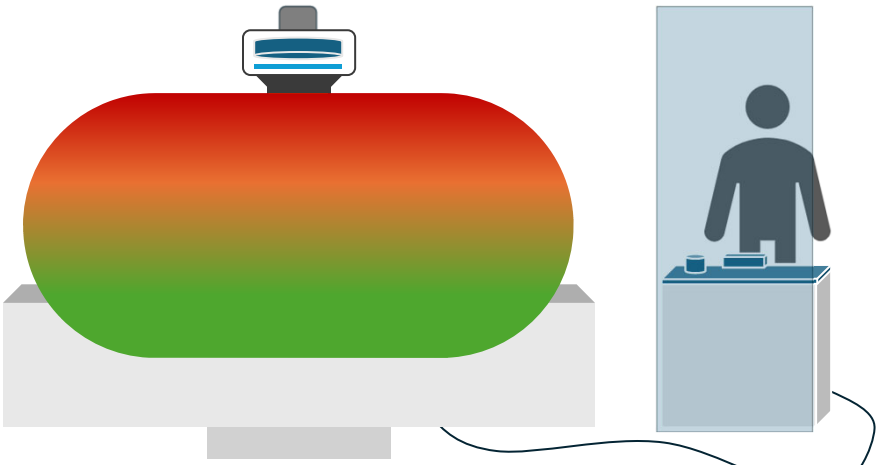

Over-table conventional fluoroscopy systems are **remotely-operated**

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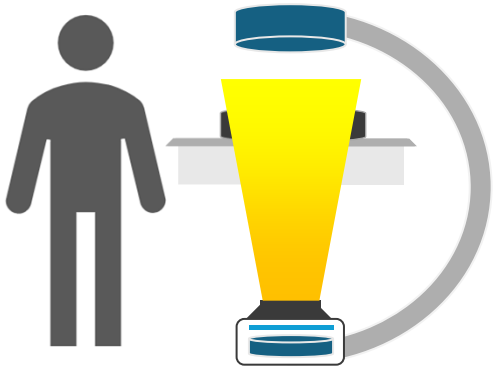
CHAPTER THREE



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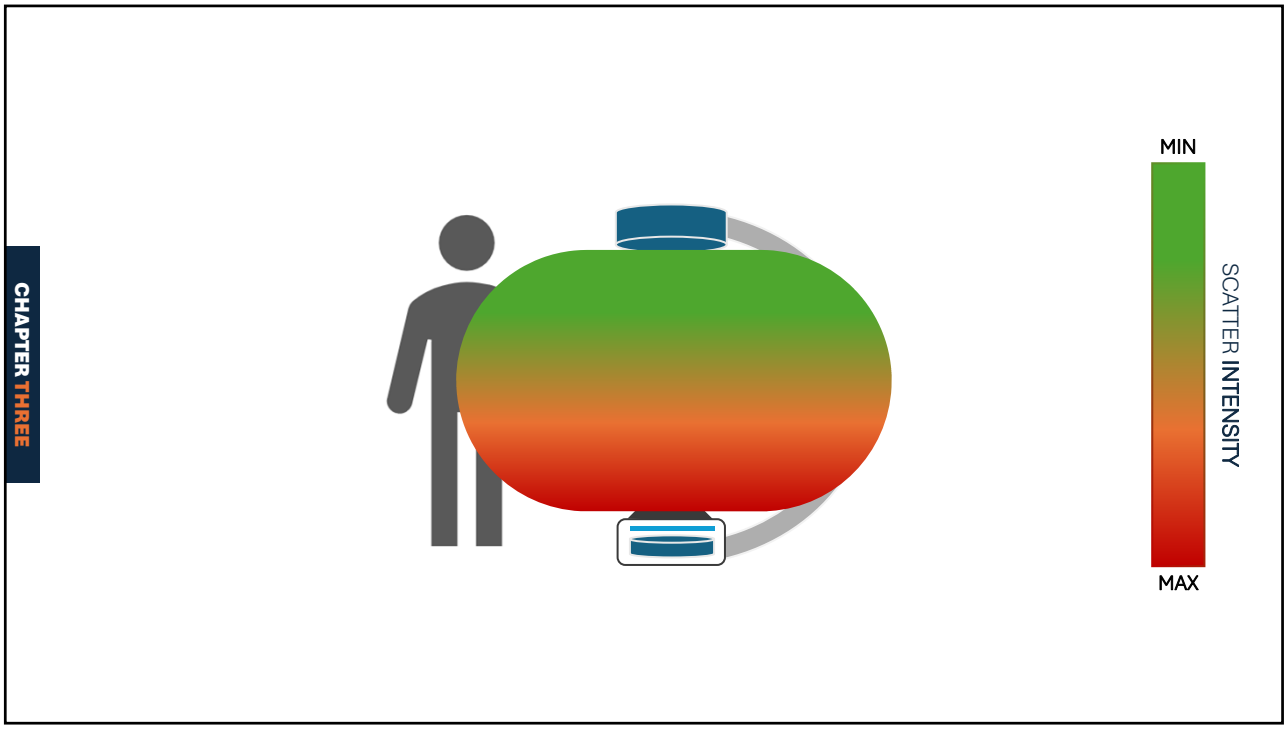

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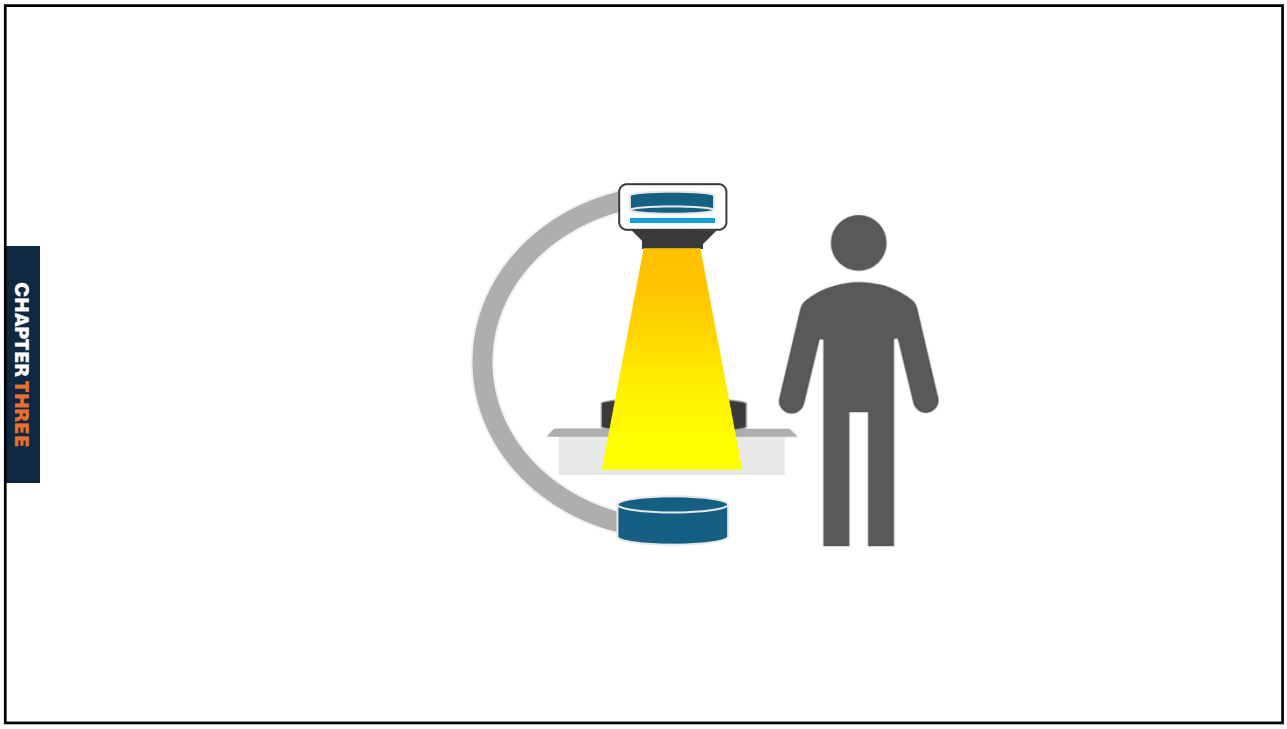

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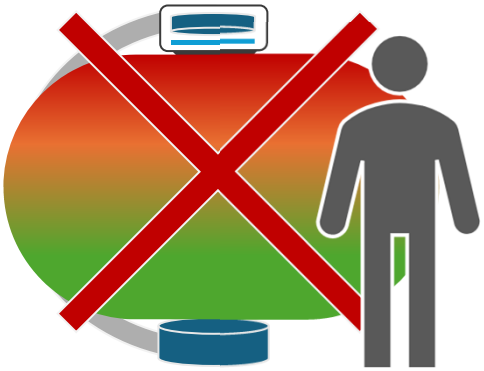

Unsafe use of fluoroscopy

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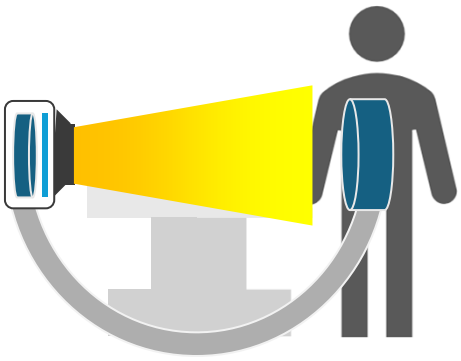

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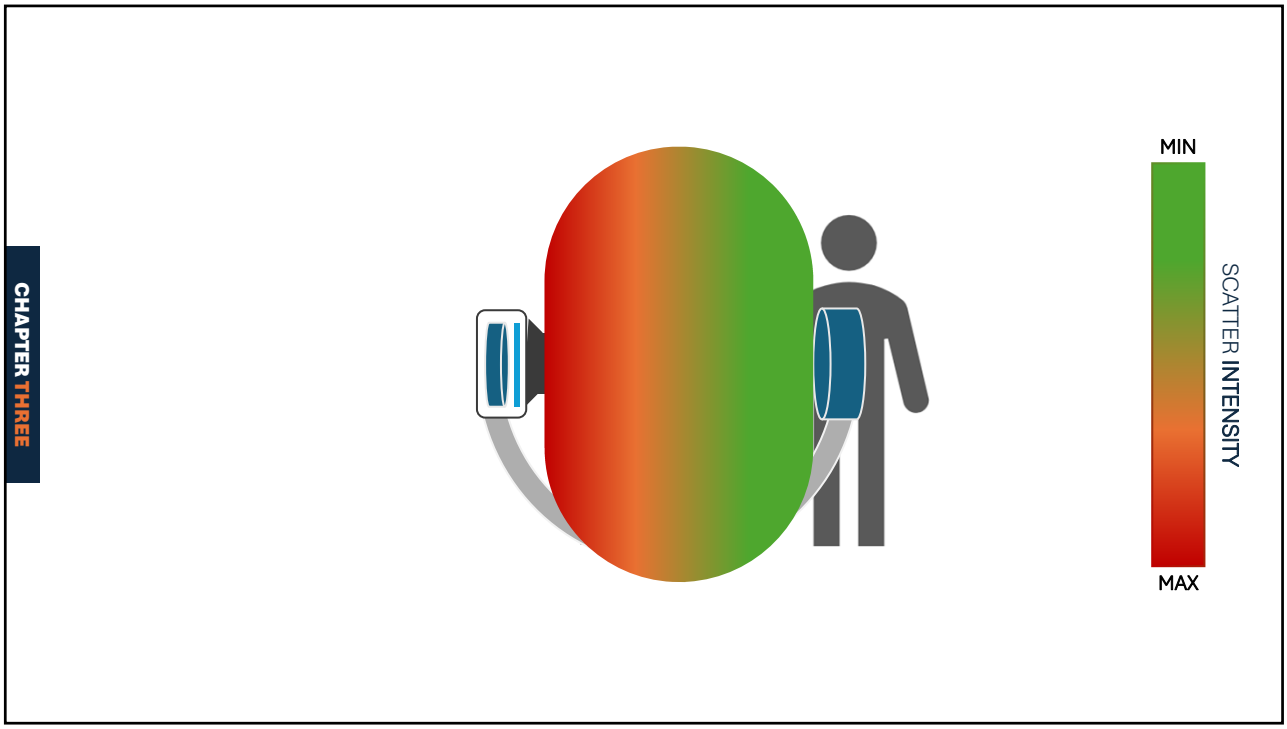

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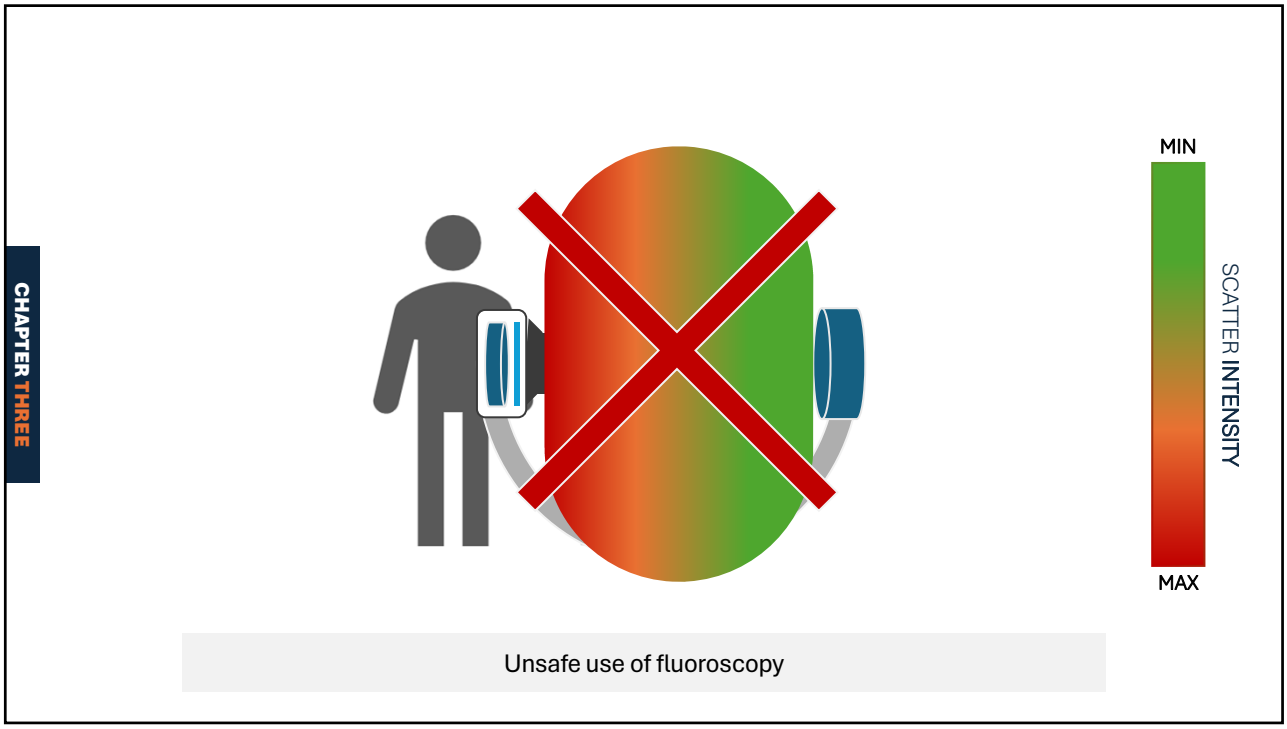

Unsafe use of fluoroscopy

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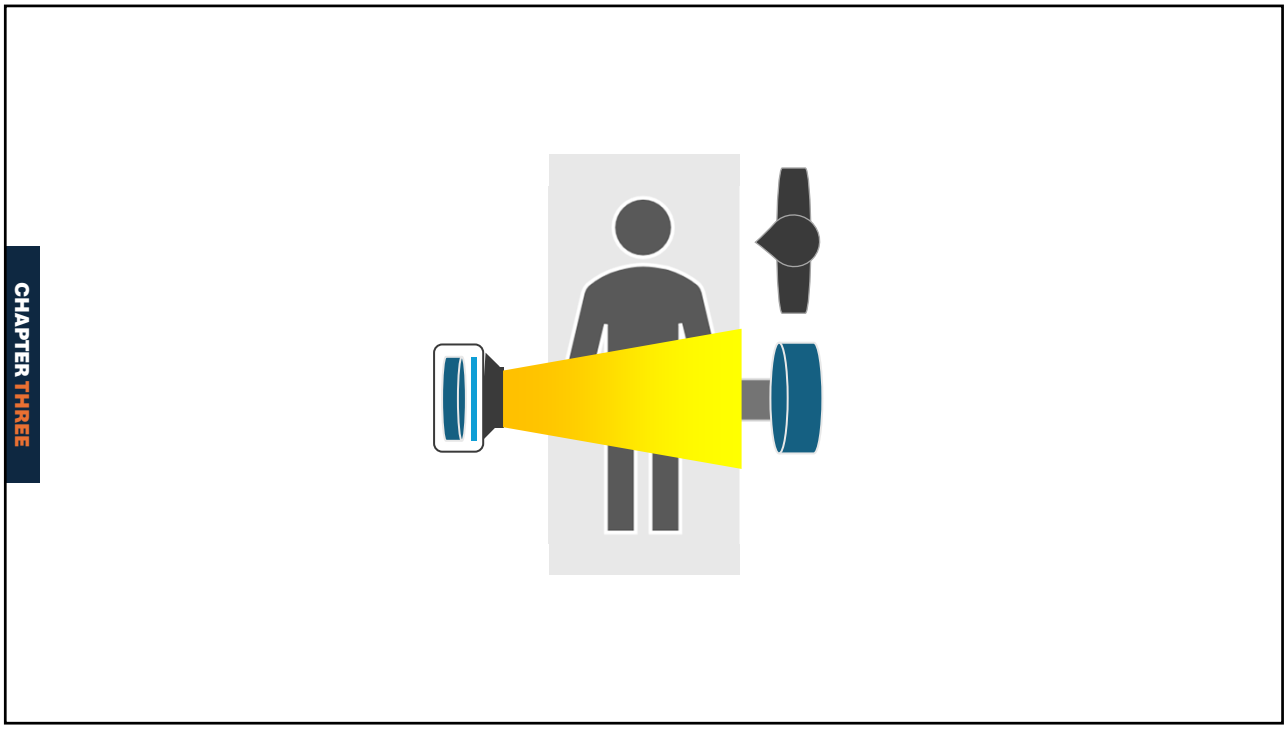

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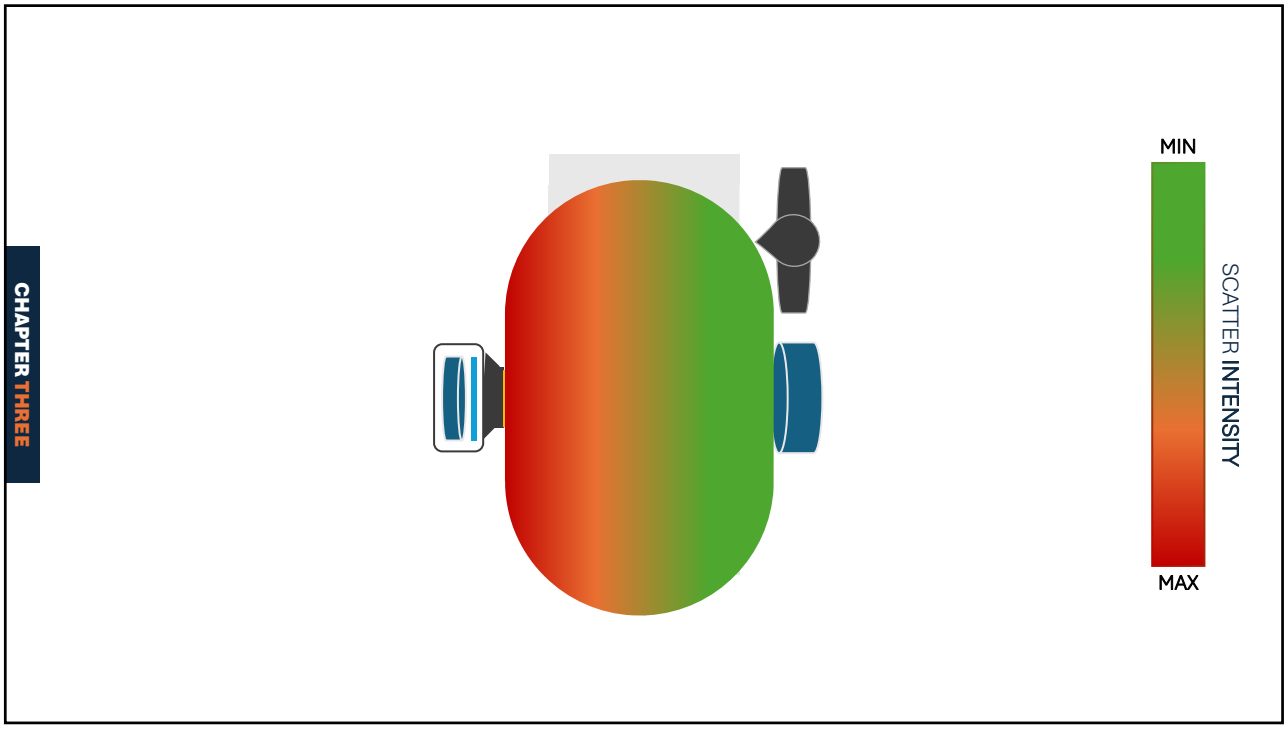

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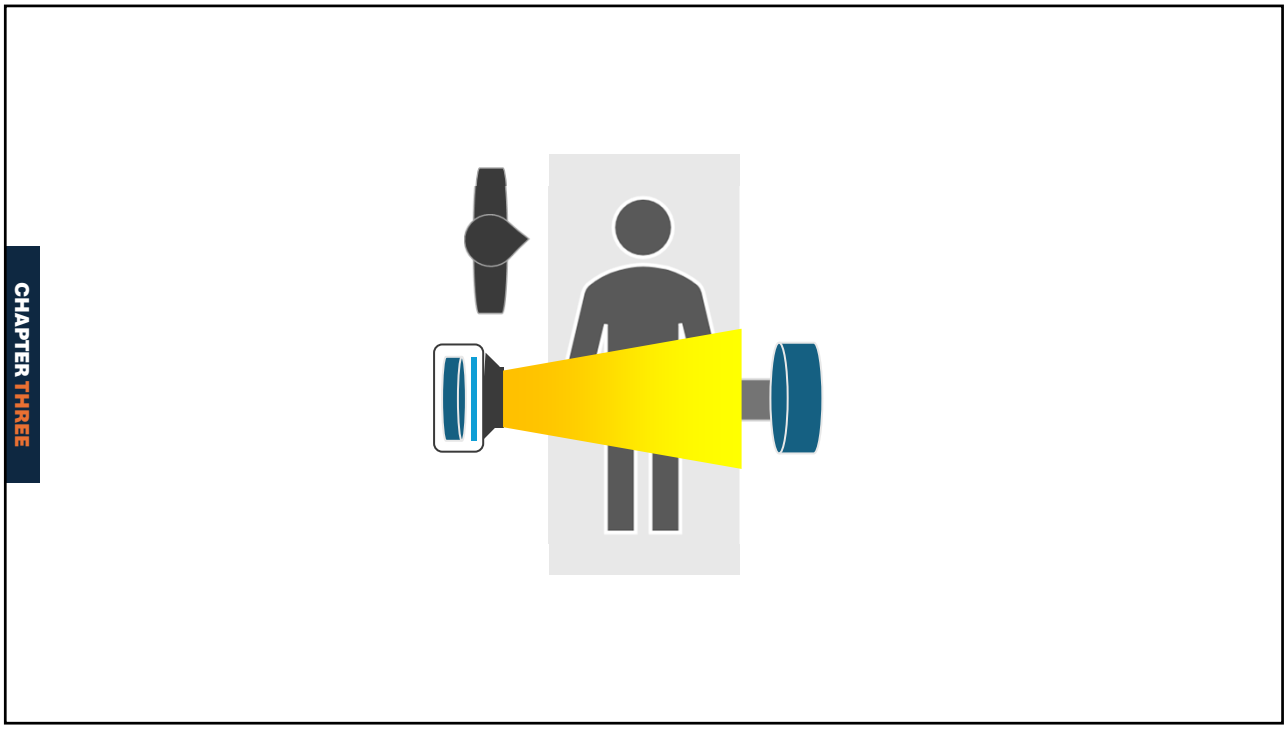
CHAPTER THREE

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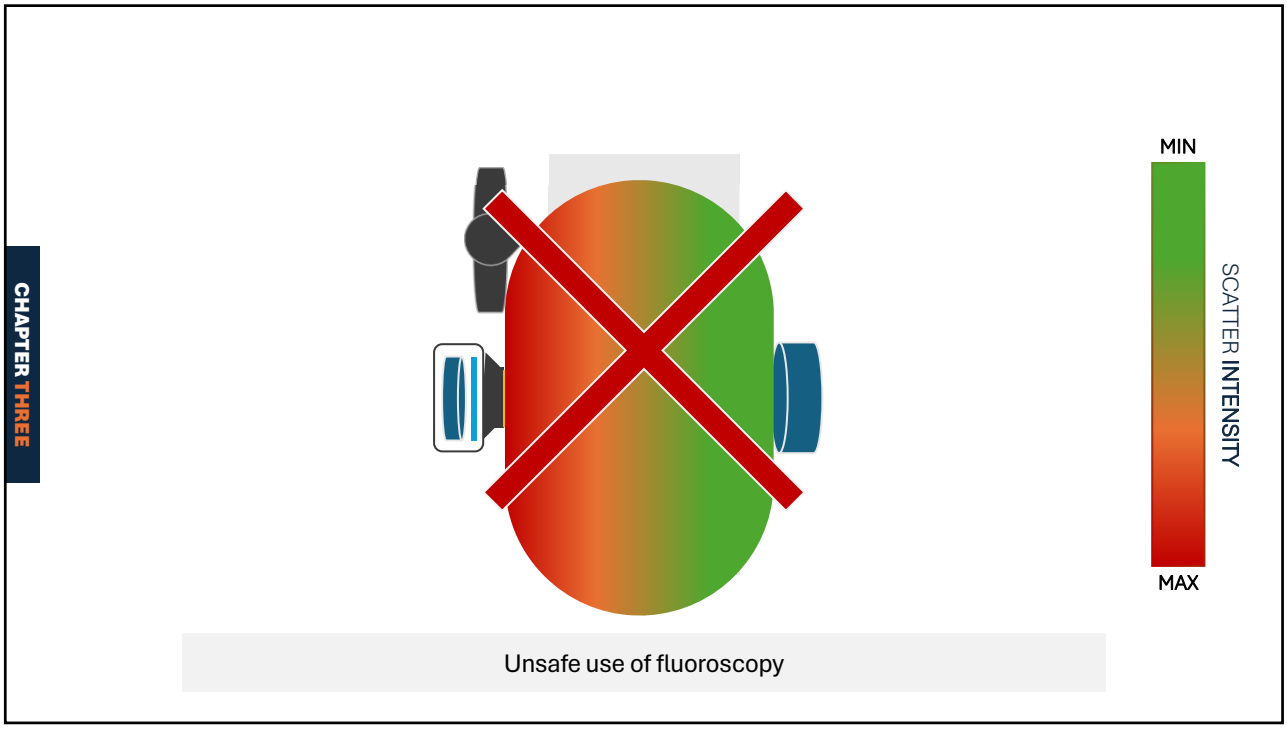
CHAPTER THREE
MIN
SCATTER INTENSITY
MAX
Unsafe use of fluoroscopy

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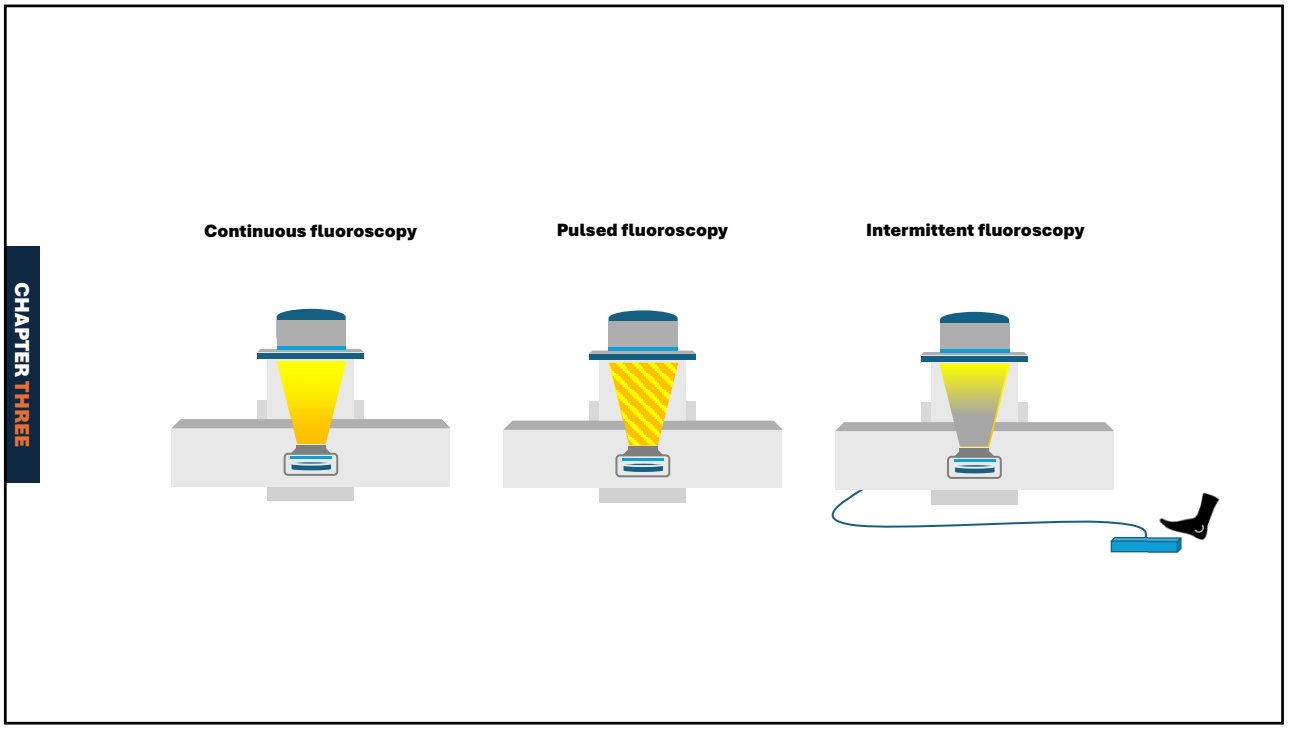
CHAPTER THREE
Continuous fluoroscopy
Pulsed fluoroscopy
Intermittent fluoroscopy

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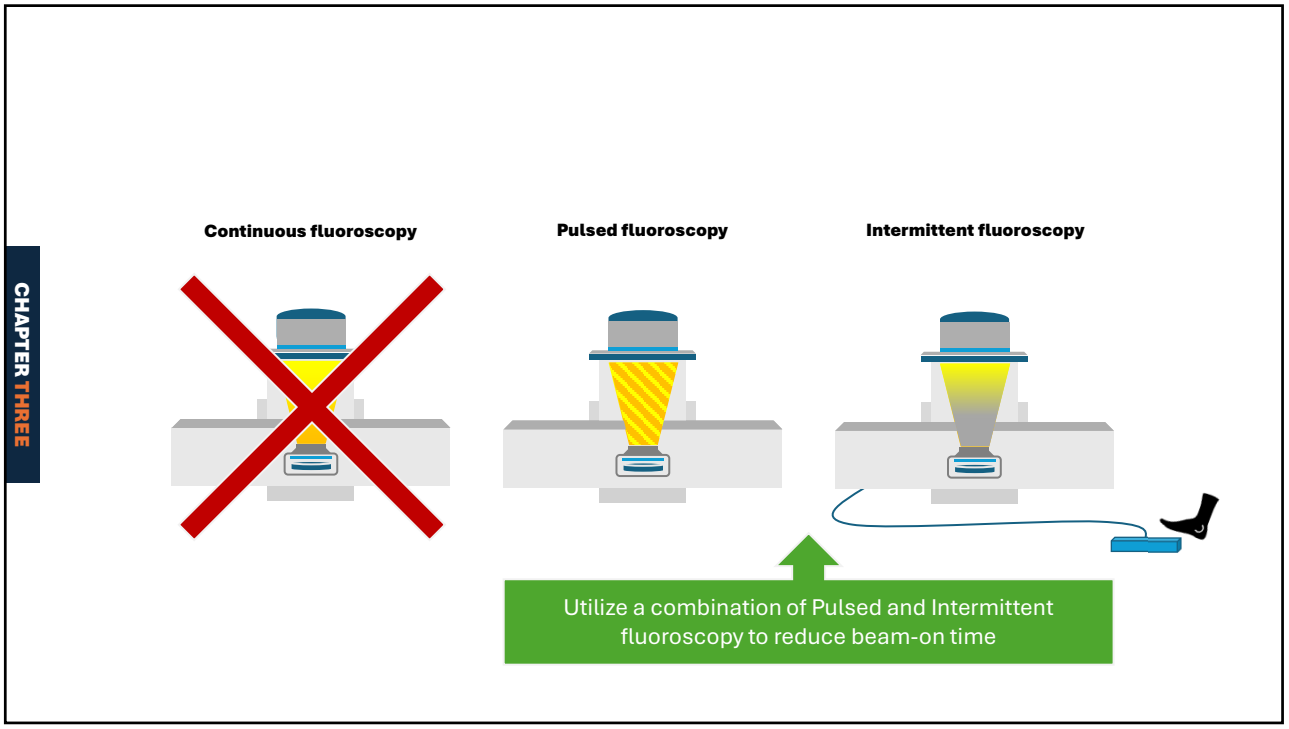
CHAPTER THREE
Continuous fluoroscopy
Pulsed fluoroscopy
Intermittent fluoroscopy
Utilize a combination of Pulsed and Intermittent fluoroscopy to reduce beam-on time

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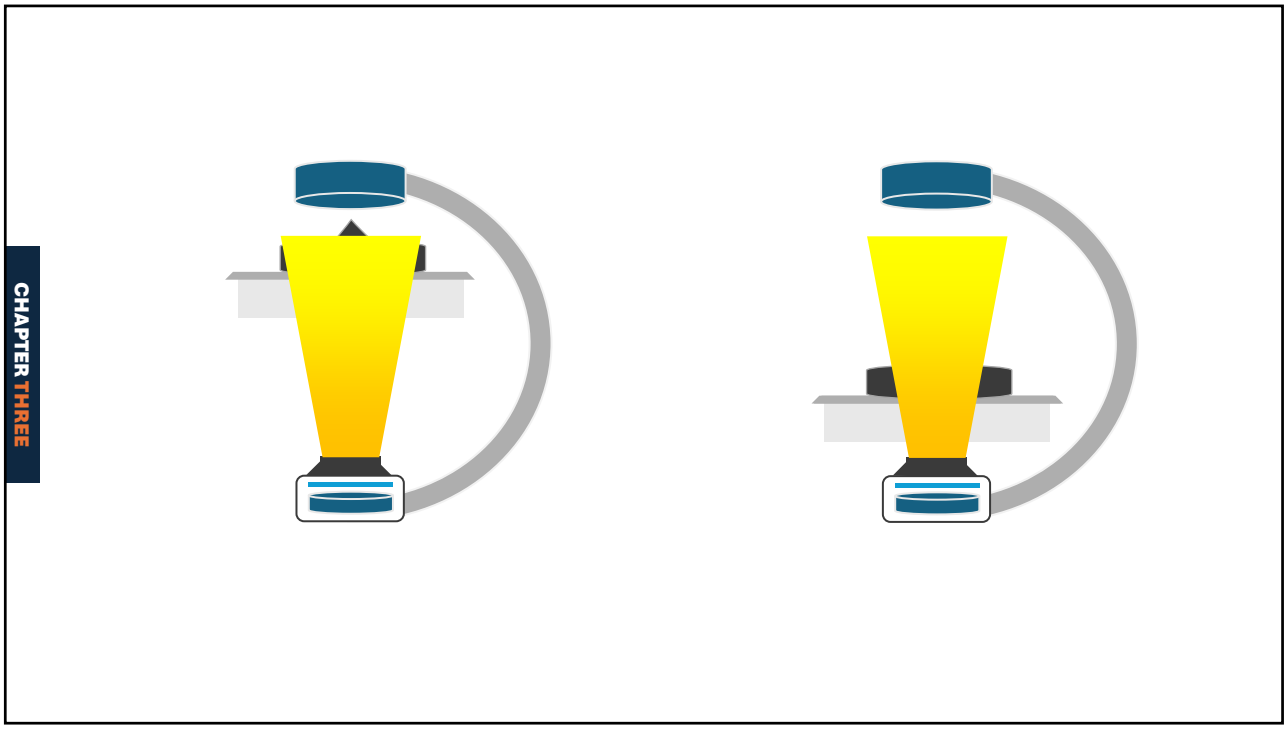
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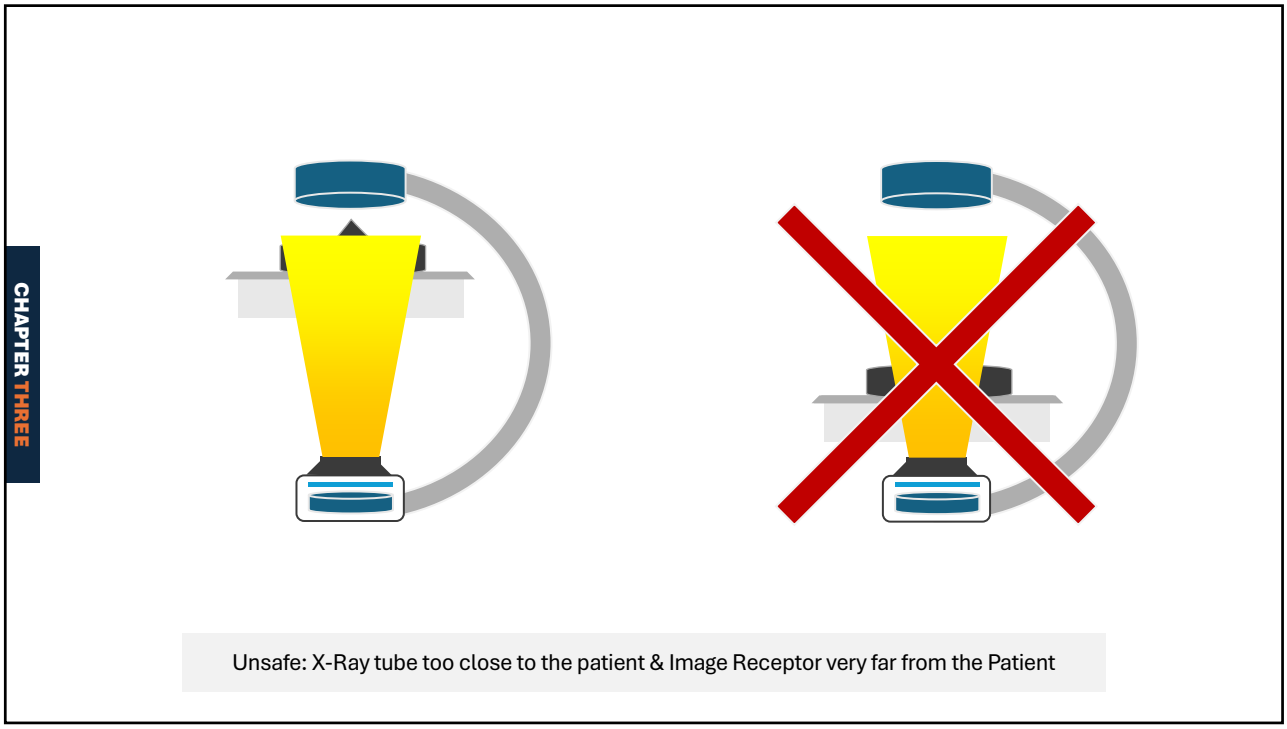
CHAPTER THREE
Unsafe: X-Ray tube too close to the patient & Image Receptor very far from the Patient

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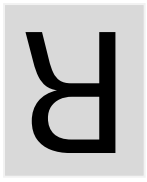
CHAPTER THREE

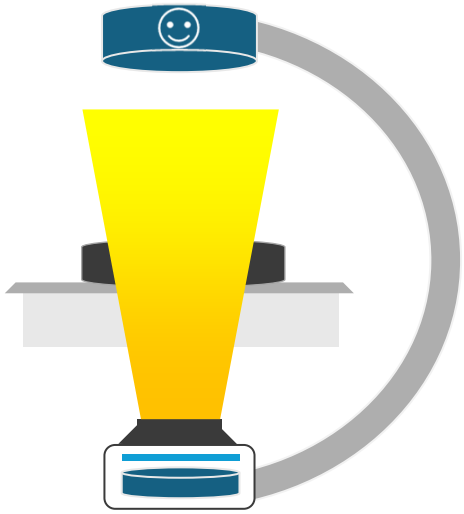
C-ARM IMAGE ORIENTATION CHEAT SHEET



VERTICAL FLIP

HORIZONTAL FLIP

Patient supine – happy face toward head	No RR
Patient Prone – happy face toward head	Backwards R
Patient Supine – happy face toward feet	Both RR
Patient Prone – happy face toward feet	Upside Down R



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CHAPTER THREE

BONUS!

COMMON SAFETY QUESTIONS, ANSWERED.

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CHAPTER THREE

Does a patient's physique have an effect on radiation dose to the patient and staff?

Yes. All fluoroscopy systems which operate in automatic exposure control (AEC) mode require that a certain amount of radiation reaches the detector in order to produce clinically useful images. Most units are equipped with automatic exposure (or brightness) control (ABC) systems. When a thicker patient is positioned in the path of the X-ray beam, the AEC system increases the exposure factors (kV, mA) in order to compensate for the increased attenuation in the patient's body and conversely the exposure factors decrease when a slim patient or thinner body part is in the beam. This could result in higher radiation dose and elevated risk of radiation injury to the skin of thicker patients. Dose to the staff would also increase as a result of an increase in exposure factors.

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CHAPTER THREE

Is there a relationship between staff dose and patient dose in fluoroscopy?

Yes. Reducing patient dose will lower staff doses too. However, the opposite is not true as staff dose can be reduced by the use of personal protective devices such as lead aprons, which will not reduce patient dose. There are a large number of factors that can reduce patient and staff dose.

Remember: Not attempting to minimize patient dose is equivalent to neglecting your own radiation protection.

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CHAPTER THREE

How effective is a reduction in fluoroscopy time in reducing dose to the patient and staff?

Very effective. Fluoroscopy time is the easiest parameter to perceive and control. Minimization of fluoroscopy time has been proven to be one of the most effective ways of reducing radiation dose to the patient and staff during fluoroscopy. Experience has shown that a substantial reduction in patient dose may be achieved by limiting the fluoroscopy time. However, it is important to note that fluoroscopy time is not the only parameter which reduces the dose to the patient. Dose also depends on other factors such as thickness of the imaged body part, field of view, pulse frequency and dose level of fluoroscopy employed. The radiation exposure of the patient and staff are also dependent on cine images or frame acquisitions.

In some instances the contribution from fluoroscopy and from frame acquisitions may be almost equal. Reducing patient dose can also lead directly to a reduction in staff dose.

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CHAPTER THREE

How should I select the pulse rate in pulsed fluoroscopy?

In contrast to continuous fluoroscopy, pulsed fluoroscopy aims to reduce the dose to patients and staff by using short pulses of radiation. The pulse frequency should be as low as possible provided that it is adequate to achieve the clinically desired results. Typically, for most non cardiac procedures, a pulse rate of 10 pulses/s or less should be adequate.

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CHAPTER THREE

Where should I stand in relation to the X-ray tube during a fluoroscopic procedure?

The scattered radiation from the patient comprises the main source of radiation dose to staff. Measurements have shown that scattered radiation from a patient's body is more intense at the entrance side of X-ray beam, Therefore, on the side where the X-ray tube is located. Therefore, it is better to stand on the side of the detector, that is the exit side, and not on the X-ray tube side during a fluoroscopic procedure. Typically, only around 1% to 5 % of the radiation falling on the patient body comes out on the exit side. So if you stand on the side of transmitted beam you encounter scattered radiation corresponding to only 1% to 5% of the incident beam intensity, whereas you encounter scattered radiation corresponding to 100% of the entrance beam intensity on other side.

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CHAPTER THREE

How effective are lead aprons in fluoroscopic work?

Lead aprons are the most effective personal radiation protection means and should be worn by everyone in a fluoroscopy room (except the patient). Lead aprons may reduce the dose received by over 90% (85%-99%) depending on the energy of the X-rays (kV setting) and the lead equivalent thickness of the apron. The thickness of a patient's body part in the beam determines the kV that the machine uses. The system will select a higher kV than for a thinner one and thus staff will be exposed to more scattered radiation. The same lead apron will provide less protection when the beam is of higher energy (or higher kV). A lead apron with 0.35 mm lead thickness equivalence should be sufficient for most fluoroscopic procedures. For high workload, a wrap-around lead apron with 0.25 mm lead equivalence that overlaps on the front and provides 0.25+0.25=0.5 mm lead equivalence on the front and 0.25 mm on the back would be ideal. For a low work load a 0.25 mm lead equivalence apron should do well.

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CHAPTER THREE

Should I use lead gloves in fluoroscopic work?

Generally not. Leaded gloves may reduce the dose to the hands by 15%-30% as long as the hands remain outside the primary X-ray beam. In contrast, if gloves are worn and the hand is in primary beam, the automatic exposure control system will trigger an increase in exposure (kV) which increases the dose to the hands, as well as patient and staff dose. Furthermore, a false sense of security might increase the time the hands remain inside the primary beam, nullifying the potential of the gloves to protect against radiation.

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CHAPTER THREE

Should I use a protective screen, as I am not used to it and I find it a hindrance in my work?

Yes. A protective screen is a very effective means of radiation protection. It can attenuate the scattered radiation used in fluoroscopy settings by more than 90%. The benefits regarding personal eye protection (e.g. to the eyes) is much more than the small inconvenience at the initial stage. Most interventionists now find it acceptable to use the screen keeping in mind the associated benefits. Cooperation with the manufacturers of such systems may improve the usability of protective devices by tailoring them to the needs of practitioners.

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CHAPTER THREE

Where might skin injury occur in fluoroscopic procedures?

On the skin surface at the entry port of the X-ray beam. The highest radiation dose to the skin occurs at the point of entry of the X-ray beam and that becomes the likely area for skin injury. If the beam is entering through the posterior surface (back of the patient), the entry port on the back will become the most likely area for radiation injury when the radiation dose to skin exceeds the dose threshold for skin injury.

The radiation intensity is typically 2 to 3 times higher for lateral and oblique views as compared to anteroposterior (AP) and posteroanterior (PA) views. Breast tissue in the beam will increase the thickness of the imaged part of the patient's body and will lead to an increase in exposure parameters (kV, mA) and beam intensity. Thus one should avoid breast as the point of entry for the X-ray beam. On the other hand, the intensity of the exit beam is only about 1% of the intensity of the entrance beam. Directing the beam from the posterior surface rather than the anterior, whenever feasible and if it does not interfere with clinical purposes, will reduce the chances of breast skin injury during interventions in the chest region.

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CHAPTER THREE

RADIATION SAFETY

CHAPTER
COMPLETED

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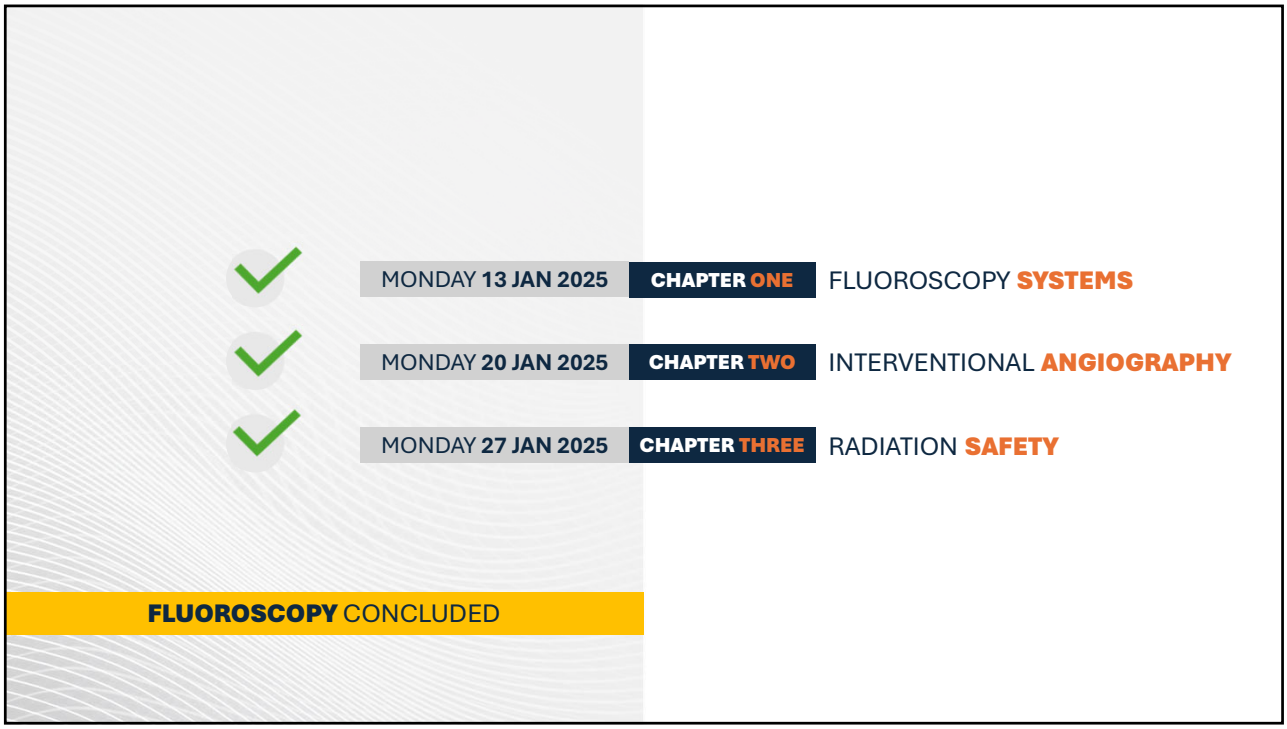
MONDAY 13 JAN 2025
CHAPTER ONE
FLUOROSCOPY SYSTEMS
MONDAY 20 JAN 2025
CHAPTER TWO
INTERVENTIONAL ANGIOGRAPHY
MONDAY 27 JAN 2025
CHAPTER THREE
RADIATION SAFETY
FLUOROSCOPY CONCLUDED

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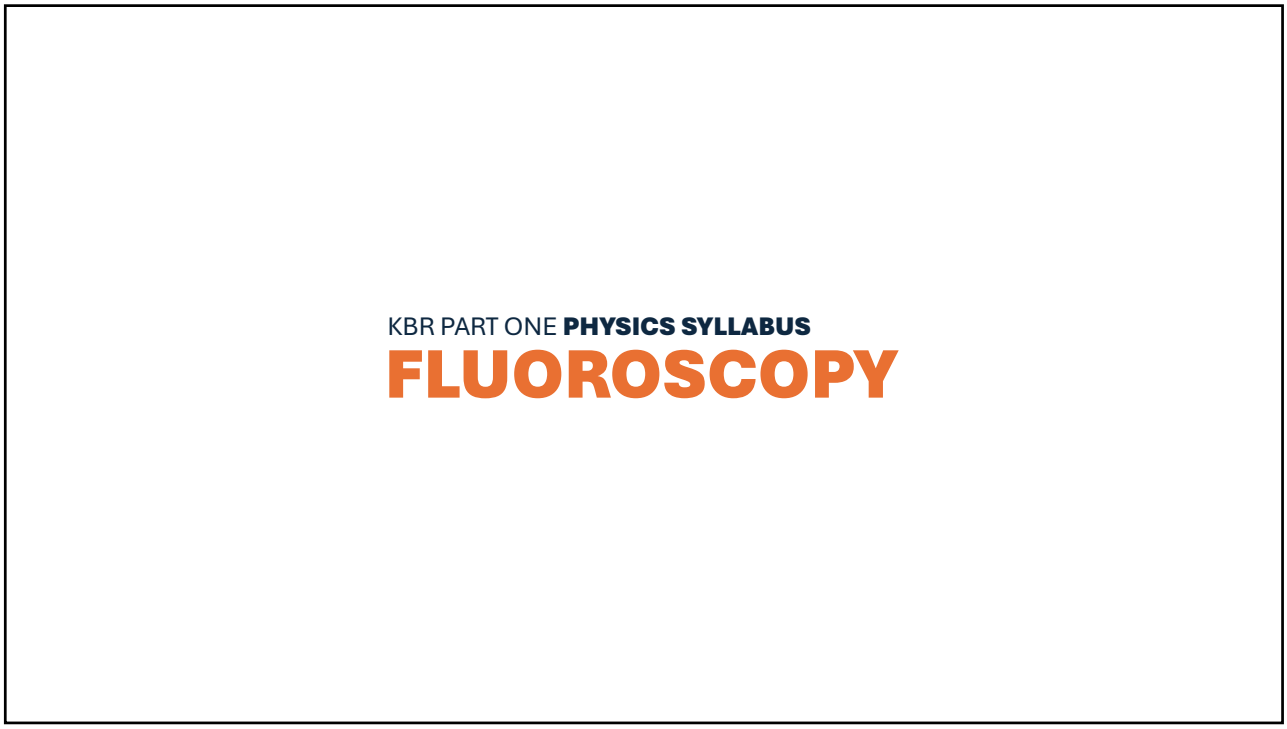
KBR PART ONE PHYSICS SYLLABUS
FLUOROSCOPY

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