

Radiation Safety for the Spine Interventionalist

Dose makes headlines

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Radiation dose reduction methods gain traction

October 26, 2010

BY RICHARD M. KIRKNER

PHILADELPHIA (EGMN) – Population exposure to medical radiation increased in 2006, and nuclear cardiologists are feeling the pressure to reduce patient exposure, according to Dr. Milena J. Henzlova of Mt. Sinai School of Medicine in New York City.

"This is the first time in history that exposure to medical radiation exceeds background radiation for the general population," she reported at the annual scientific session of the American Society of Nuclear Medicine (ASNM) in Philadelphia.

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CT Algorithm Lowers Radiation Dose

By Kristina Flores, Staff Writer, MedPage Today
Published: August 23, 2010
Reviewed by Robert Janner, MD, Associate Clinical Professor of Medicine, University of California, San Francisco and
Density Caputo, BA, RH, BC-ADIT, CDE, Nurse Planner

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A new algorithm for reconstruction in coronary CT angiography (CTA) lowers radiation dose but doesn't increase image noise, researchers have found.

Adaptive statistical iterative reconstruction (ASIR) was associated with a 27% reduction in radiation dose (95% CI 21% to 32%, P=0.0001) compared with traditional filtered back projection (FBP), but there were no differences between algorithms in signal-to-noise ratio, according to Jonathan Leipsic, MD, of the University of British Columbia in Vancouver, and colleagues.

- Action Points**
- Explain to interested patients that a new algorithm for reconstruction in coronary CT angiography -- known as adaptive statistical iterative reconstruction -- lowers radiation dose but doesn't increase image noise.

... Researchers have developed an efficient method for extracting and archiving CT radiation dose information that can enable providers to keep track of estimated radiation dose delivered to each patient at a given facility, help providers make more informed health care decisions and improve patient safety, according to a study in the November issue of the *Journal of the American College of Radiology* (www.acr.org/jcr).

To facilitate access to and analysis of radiation dose information, researchers at the Hospital of the University of Pennsylvania in Philadelphia, PA, designed, implemented and validated RADANCE, an automated extraction "pipeline" to open their multi-modal Picture Archiving and Communications System (PACS) and extract radiation dose data stored in the dose report image of every CT examination performed. The "pipeline" can process both retrospective and prospective CT studies, in order to make dose information available

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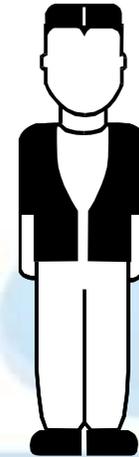
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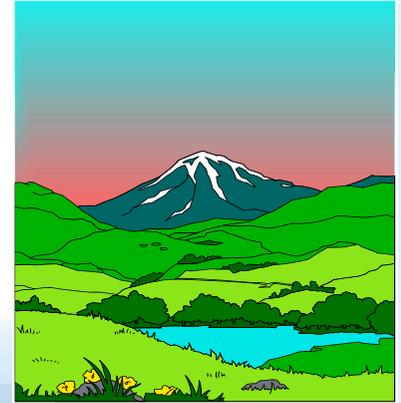
What is radiation?

Radiation is invisible energy that travels in the form of waves or high speed particles.

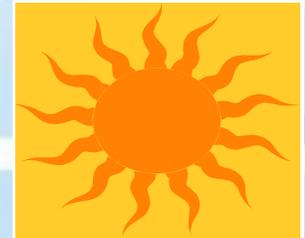
Also known as **ionizing radiation**, this has enough energy to break chemical bonds in molecules or remove tightly bound electrons from Atoms, thus creating charged molecules OR ATOMS (IONS).



200-400 mRem/year

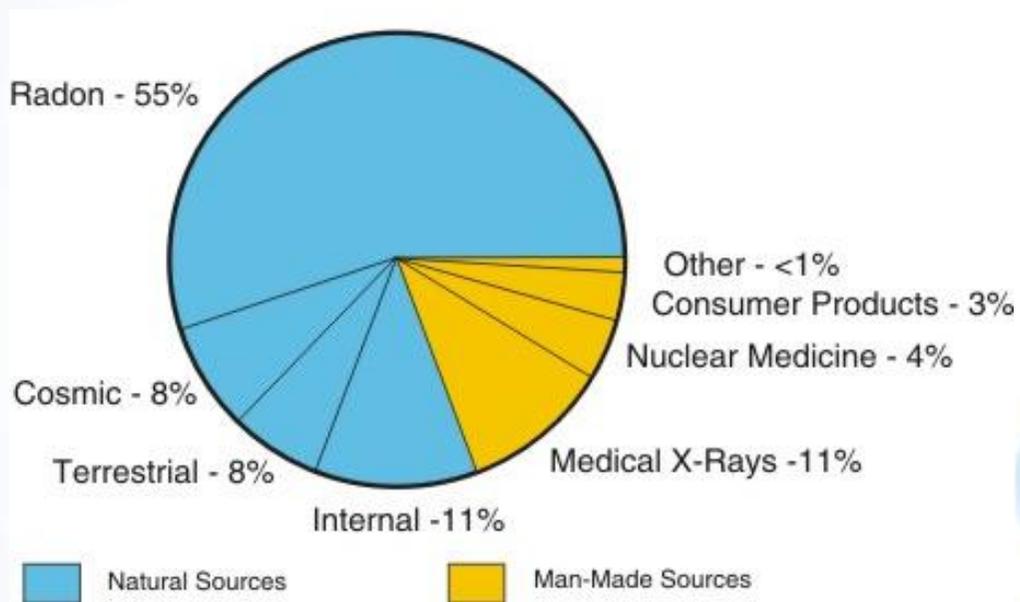


38-75 mRem/year



15-20 mRem/year

Sources of Radiation Exposure



C
A_s
Low
A_s
Reasonably
Achievable

Delivering the proper amount of radiation is critical to producing superb image quality

Why should we care about dose?

Physicians need fluoroscopy to perform Minimally Invasive Surgery (MIS)

They want the best I.Q. at lowest possible dose

Radiation dose is cumulative

High doses of radiation can be harmful to the body

Physicians and techs are in a radiation environment every day



Imaging challenges in the OR or procedures room

Equipment & instrument crowding

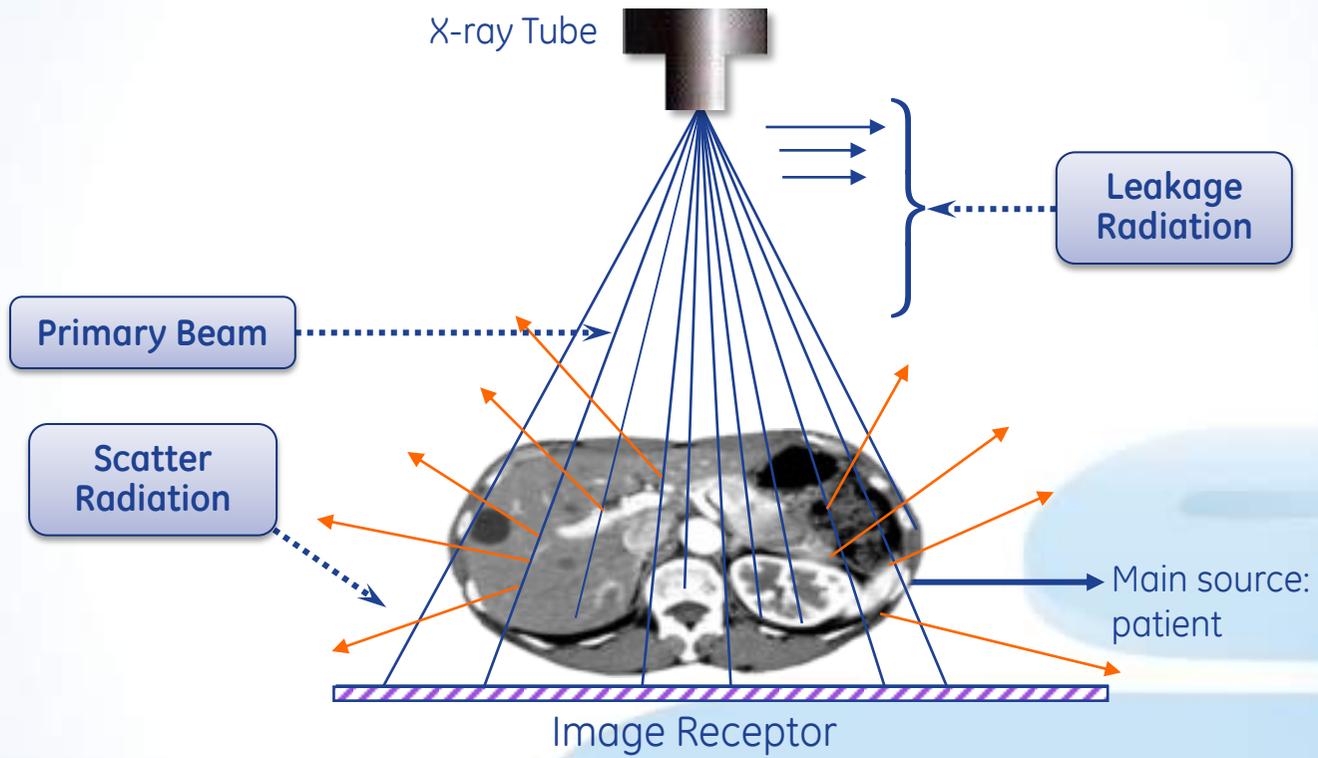
Exposure to patient, surgeons and staff

Patient draping

Limited options for patient positioning



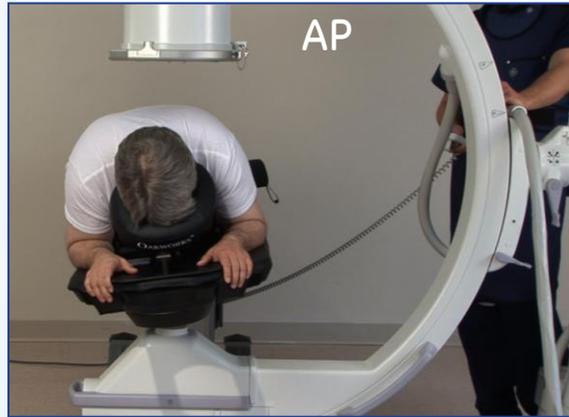
The Right Image at the Right Dose



Patient receives primary radiation

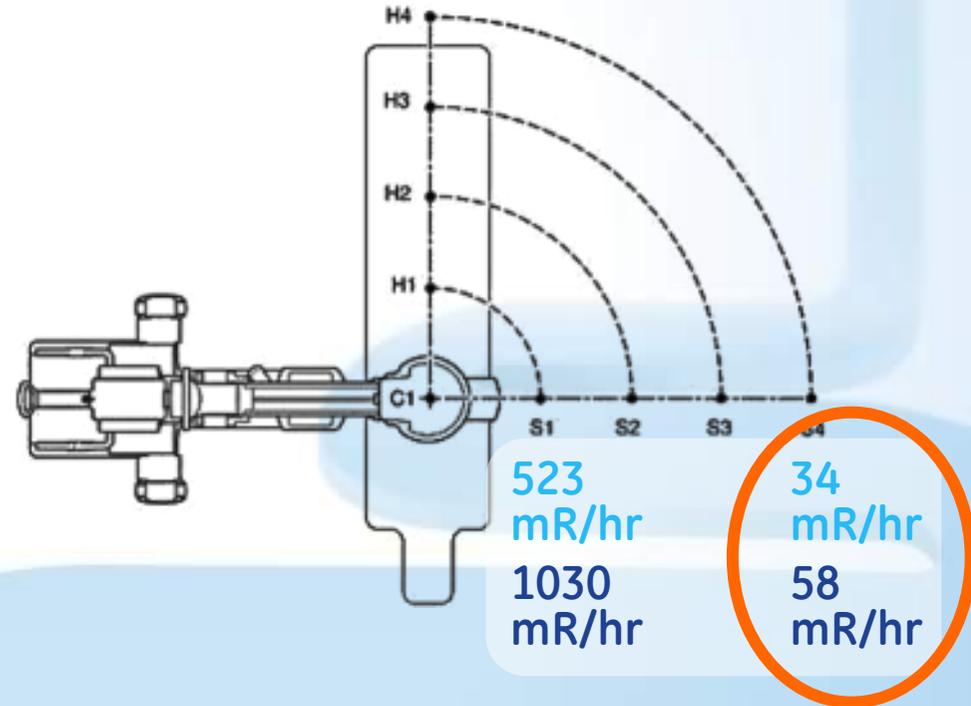
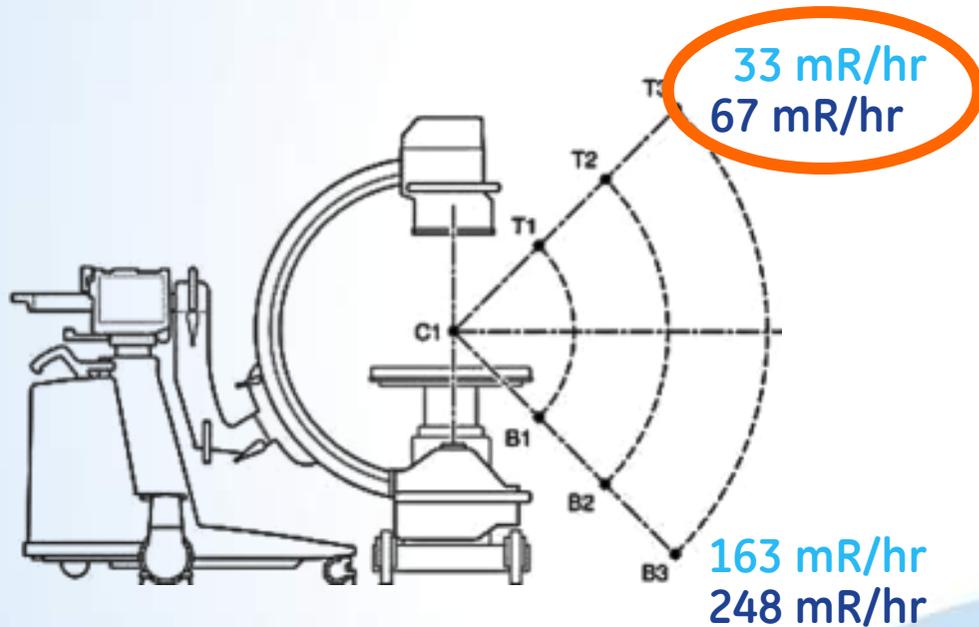
Surgeon and staff normally receive scatter radiation

Positioning & Set-up for Pain

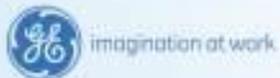


Air Kerma Scatter Rates

9 Inch Image Intensifier
12 Inch Image Intensifier



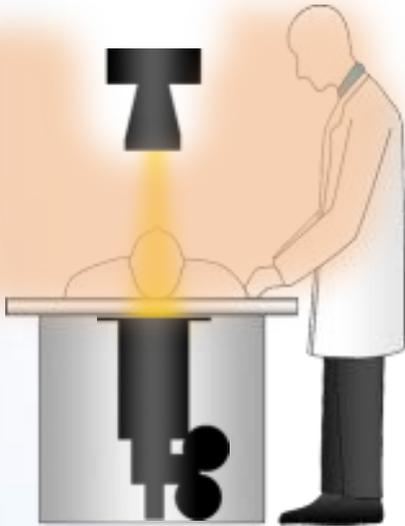
Technique: Fluoroscopic 73kVp @ 2.4 ma
Phantom: ANSI Abdomen Phantom



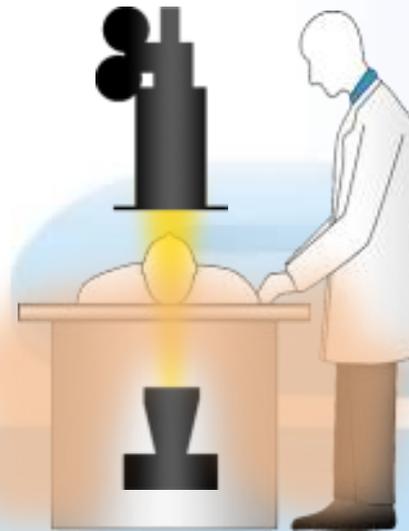
Inverse Square Principle – Distance reduces dose

Scatter radiation

Scatter radiation with
X-ray tube on top



Scatter radiation with
I.I. on top



Good radiation protection
practices

$$\text{Dose} = \text{Exposure Rate} \times \text{Time}$$

What impacts dose?

How can we reduce it?

Exposure time



Minimize exposure time

Exposure amount



Minimize exposure amount

Take precautions!

Maximum dosimeter readings

MONTHLY	420 mrems
QUARTERLY	1250 mrems
YEARLY	5000 mrems
LIFETIME	5 rems x (n-18) where "n" is your age

These levels are the standards set by the federal government for radiation exposure to occupational personnel

Dose = Amount of radiation received - mrem

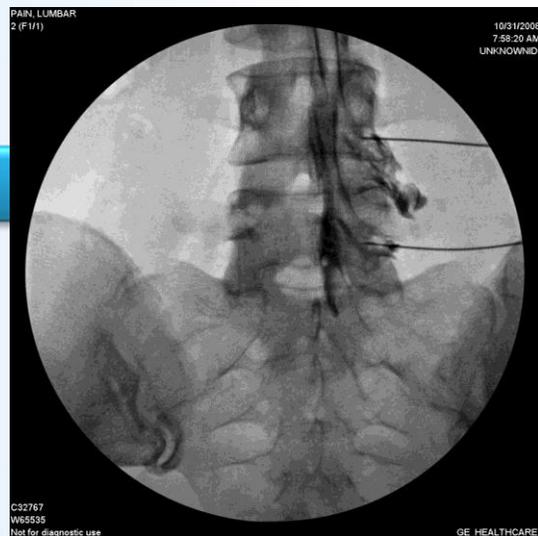
Dose Rate = How fast you receive the dose - mrem/hr.

Annual radiation exposure limits

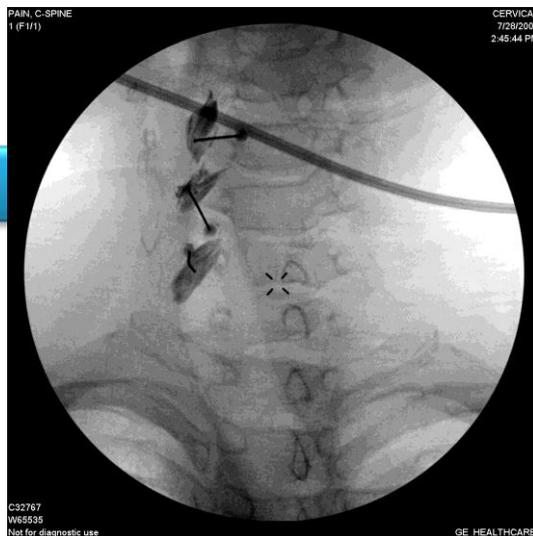
Whole body (organs & gonads)	5,000 mrem/yr
Lens of eyes	15,000 mrem/yr
Extremities & skin	50,000 mrem/yr
Fetal	500 mrem/gestation period

Minimize exposure time.

Better image quality means less exposure time



Lumbar



Cervical



Biacuplasty

Power efficiency is a balancing act

Providing a superb image with each exposure can reduce exposure time.

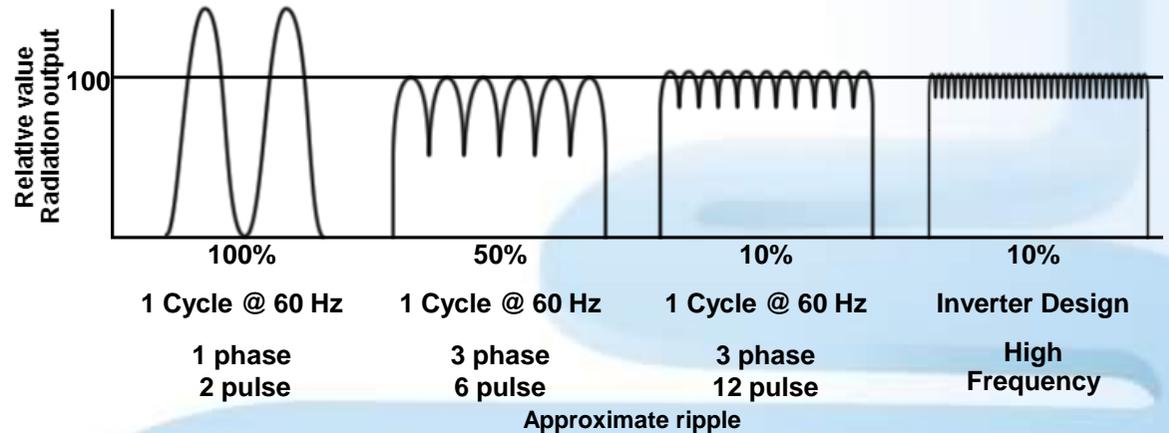
If you can't see, you tend to fluoro longer.



Choose power so you have it when you need it



15 kW high frequency, generator delivers constant peak power



High Penetrating Power to Image Large Patients and do more applications

Rotating anode drives high I.Q.

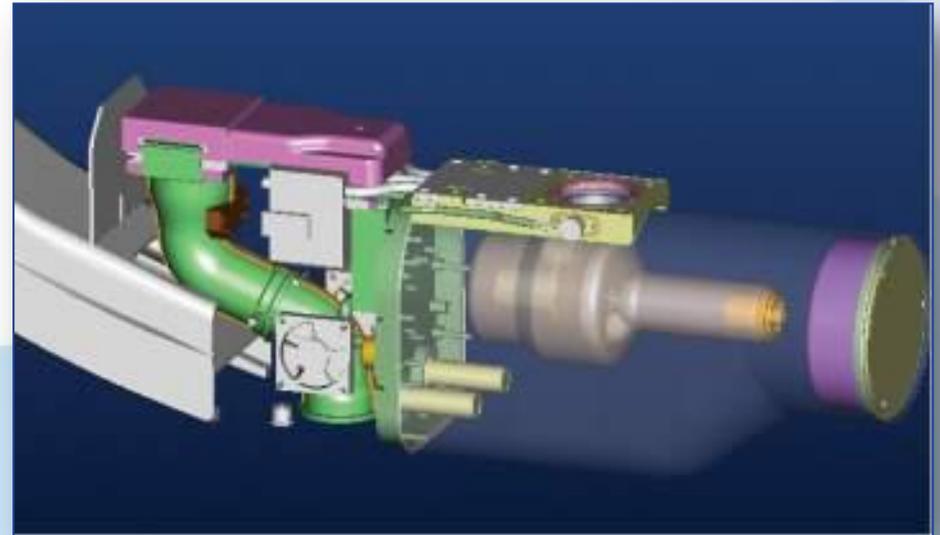
Allows for a higher peak power capacity

Offers smaller focal spot for better resolution

Anode target rotates 3,560 RPM

Larger target area gives higher heat dissipation making it capable of high power pulse mode

- 300,000 H.U. Heat Storage
- 85,000 H.U./min. Heat Dissipation rate
- Small Focal spots – 0.3mm/0.6mm



Auto features make dose optimization easy

Automatic brightness & contrast features optimize imaging

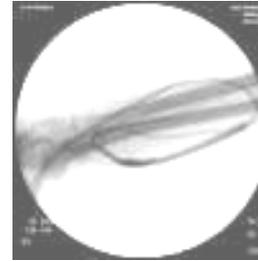
Point & shoot capability reduces errors and unnecessary dose

Auto features can optimize technique factors for anatomical density:

- KVp
- mA
- Camera gain

Auto metal detection features prevent blooming or burnout and prevent retakes

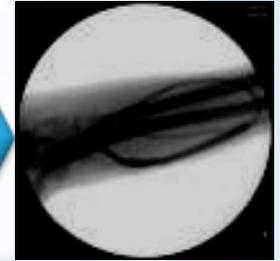
Brightness



High



Auto setting



Low

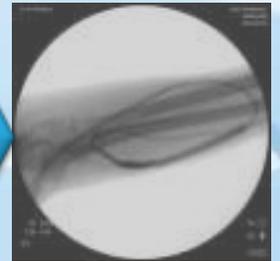
Contrast



High



Auto setting



Low

Fewer shots required with laser aimer

Removable targeting device
pinpoints anatomy of interest

Crosshairs on the image help
ensure alignment

Fewer shots, less dose



Minimize exposure amount.

Reduce dose by up to 90%

Low Dose Mode

One half the milliamperage
Up to 50% dose reduction

Pulse Fluoro Mode

1, 2, 4, 8 PPS
75-90% reduction in dose vs.
standard fluoro



Digital Cine

Dig. Spot

HLF/DSA

Standard Fluoro Mode

Low Dose

Pulse Mode

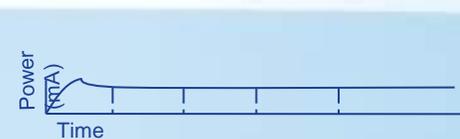
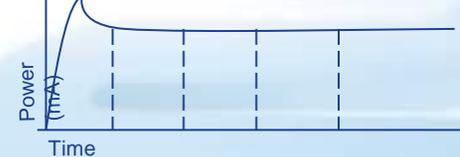
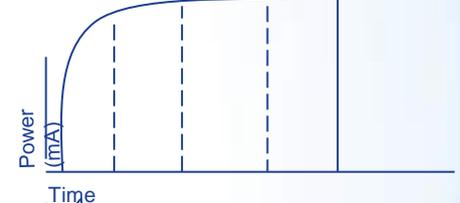
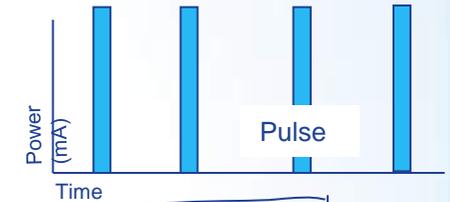
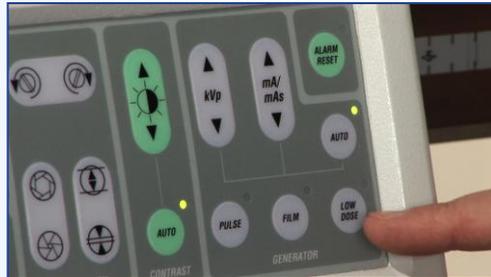
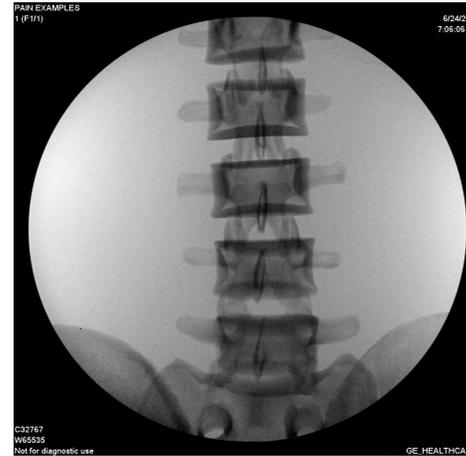


Image quality versus dose reduction

Low dose example on average size patient



Pulse fluoro example on average size patient



On-screen collimation limits exposure

Limit radiation with iris, dual leaf, and curved collimator

Collimators shield exposure using lead and tungsten shutters

Collimate & rotate from last image for fewer shots

Improved I.Q. through smaller focus area

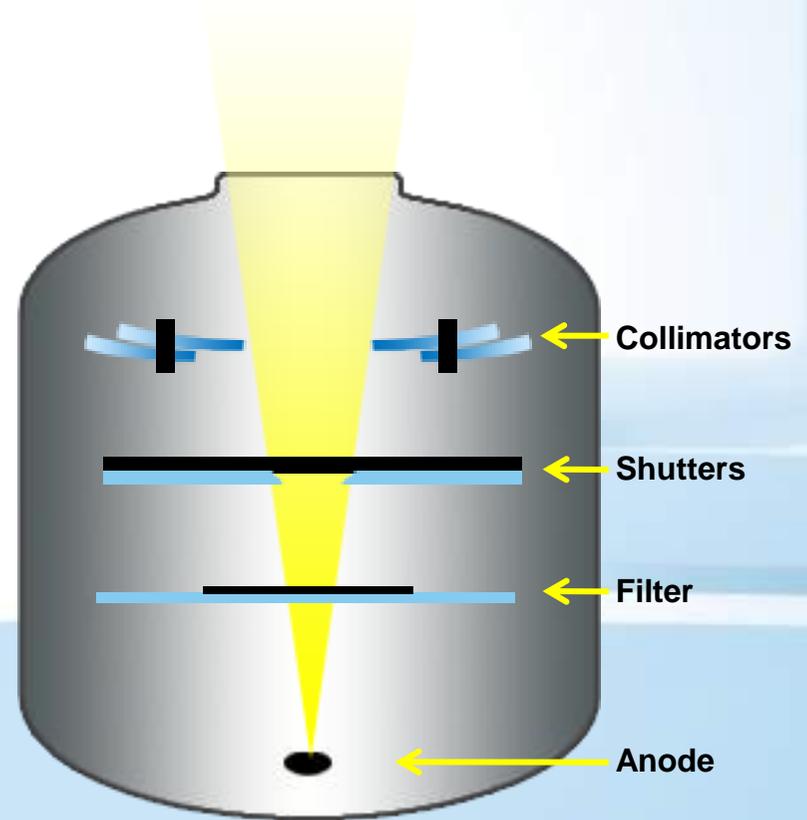


Beam filtration reduces patient skin dose

Beam filters absorb low-energy photons that would be absorbed by the patient

Filtering the X-ray removes harmful and unnecessary radiation at lower energy and lower frequency levels

Hardens the beam for better I.Q.



Know your field of view



Size counts when it comes to dose

Larger field of view, more scatter radiation, but lower primary dose

Each magnification increases technique by 50%
- - higher technique, higher dose

Magnification is a trade-off between image quality and dose levels

Normal

- Largest Coverage
- Lowest Dose



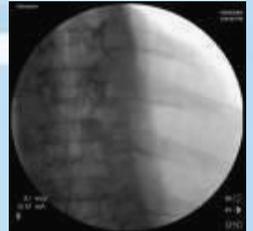
Mag.1

- Zoomed image
- Higher-res.
- Higher dose



Mag.2

- Largest display
- Highest Res.
- Highest Dose



Magnification means higher dose



Protecting personnel

Distance: Stand as far from the radiation source as possible and use leaded shielding

Shielding: Lead aprons, screens, thyroid shields minimize exposure

0.5 mm of lead or its equivalent

Monitoring: Should be worn by all personnel who are in the room anytime fluoroscopy is taking place.



Radiation monitoring

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OEC Radiation Safety Quick-Guide

Radiation Concepts
Fluoroscopic guidance is used routinely for many surgical and interventional procedures to obtain a more precise localization of anatomic target areas and to verify the positions of instruments relative to the surrounding anatomy. This Quick-Guide reviews the basic concepts of radiation nomenclature, safety and the practical technique methods in the fluoroscopy suite to minimize exposure risks for the patient and staff.

Mobile C-arm Fluoroscopy: Basic Radiation Terms

- **kVp** - (kilovolts) - Primarily influences the quality and penetrability of the X-ray beam and is the main controller of image contrast (shades of gray).
- **mA** - (milliamperes) - Affects the quantity of radiation and controls image density (blacks and whites).
- **MAS (mAs X time)** - Calculation that determines the amount of dose received over a period of time.
- **MAGNIFICATION** - Increases the displayed size of an image during real time fluoroscopy. Selecting Mag mode will also result in an increase in dose. Note that you can increase magnification by positioning the patient closer to the X-ray source; however, this will result in a greater increase in dose as compared to selecting the Mag mode.



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