Angiography Radiation Dose – Limiting Dose to the Patient (while maintaining effective image quality)

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Presenter Disclosure Information

Name:

Within the past 12 months, the presenter or their spouse/partner have had a financial interest/arrangement or affiliation with the organization listed below.

Company Name	Relationship
Partners in Radiation Management LTD Co.	President/Treasurer

In this presentation we will review:

- ✓ The ingredients of good radiation management
- ✓ The reasons why radiation management is an essential element of fluoroscopically guided interventions
- ✓ A few technological features known to be effective at limiting radiation dose
- ✓ A few procedural issues that constitute good patient management

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Ingredients for effective dose management

- **Equipment**
  - Appropriately designed for dose limitation and image quality
  - Useful dose-monitoring devices
  - Well maintained

- **Physicians**
  - Well trained in the procedure
  - Well trained in dose management
  - Proficient in operational features of their fluoroscope

- **Support staff**
  - Well trained in radiation management

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Experiences with patient radiation exposure

1. Over two hundred cases of injury have been reported in peer-reviewed journals and public information sources, such as court records.

2. A wide severity in injuries have been identified spanning the range of mild erythema to deep tissue necrosis.

3. Impression is that injuries are increasing in frequency and in severity. (In severe cases pain is sometimes and intractable problem.)

Coronary Angioplasty

Courtesy F Mettler MD

Radiofrequency Ablation

Vañó, Br J Radiol 1998; 71, 510 - 516

TIPS placement

Nahass et al, Am J Gastroent 1998; 93: 1546-9

Uterine embolization

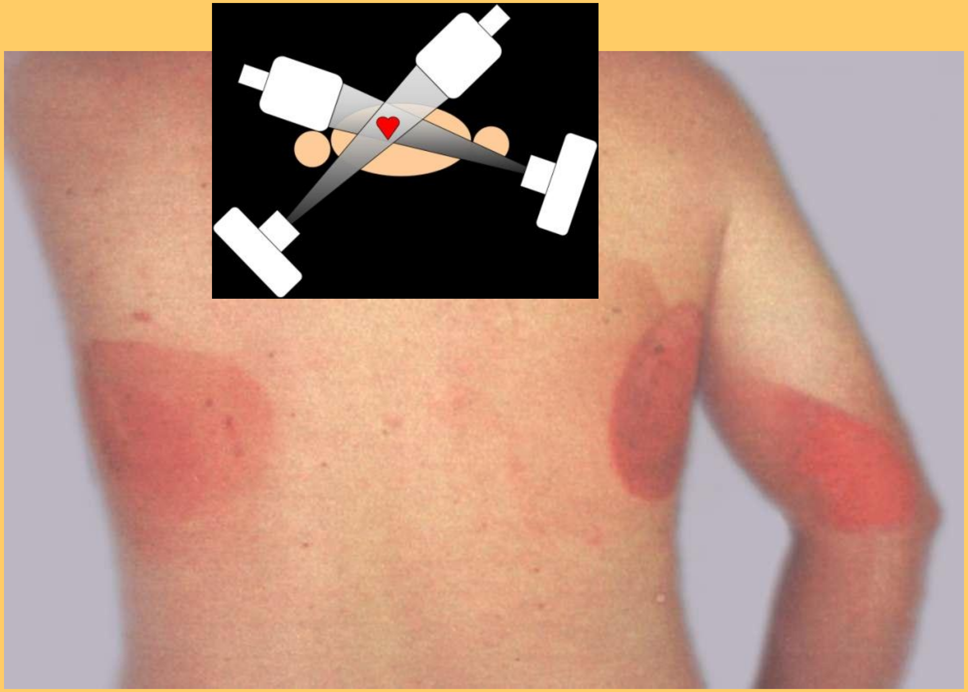
Courtesy: Shope, FDA

Renal angioplasty

Dandurand et al, Ann Derm Vener 1999; 126: 413-417

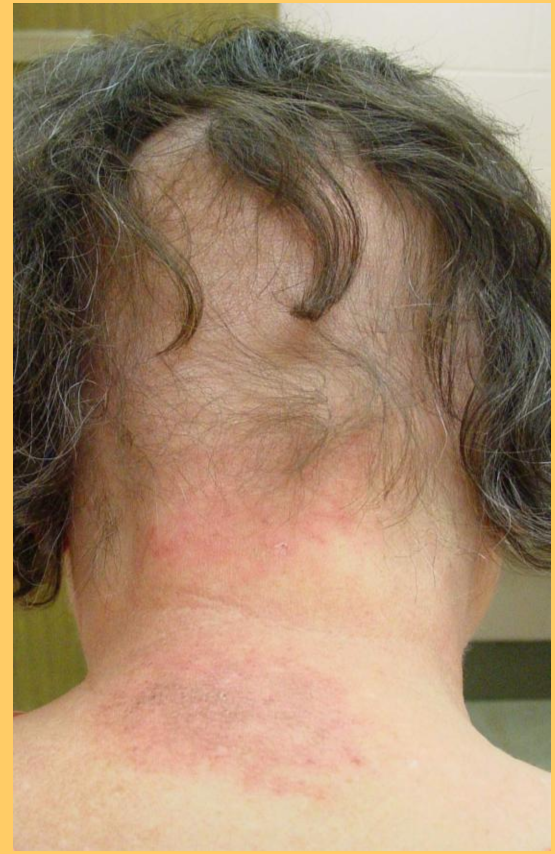
Neuroembolization

Radiation injury and anatomy



Wagner – Archer. Minimizing Risks from Fluoroscopic X Rays 2004

Granel et al, Ann Dermatol Venereol 1998; <u>125</u>; 405 - 407



Courtesy Don Miller – Original source anonymous

Five weeks after procedure

9 ½ Months after procedure

i really don't know how much more of this i can stand!!!!..do you have any idea looking at the photos, what i might be up against? it is so amazing but it seems i know more about my condition than all the doctors i have been to HOW CAN THAT BE???? do you have any stats on how many people suffer thru this????

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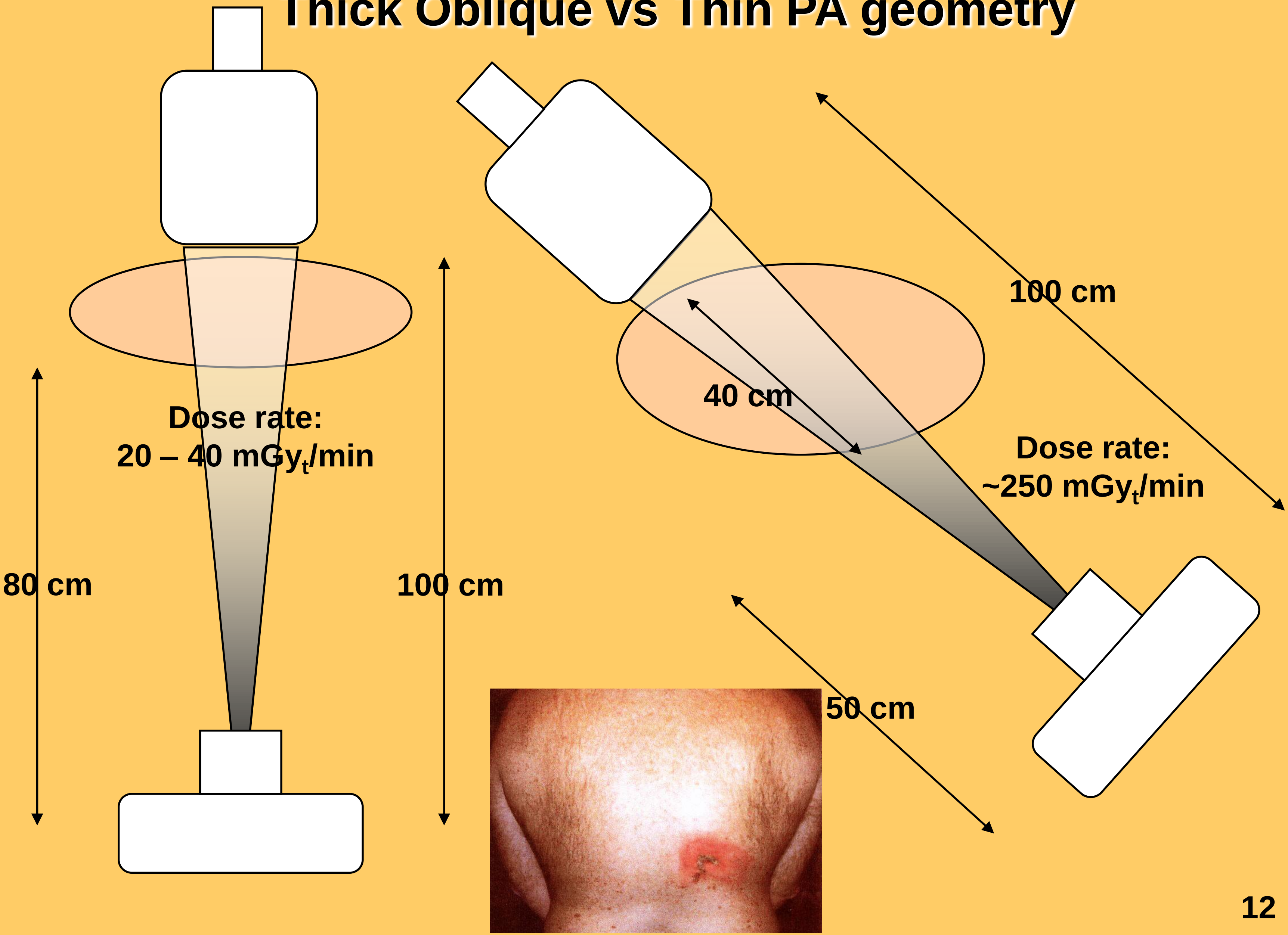
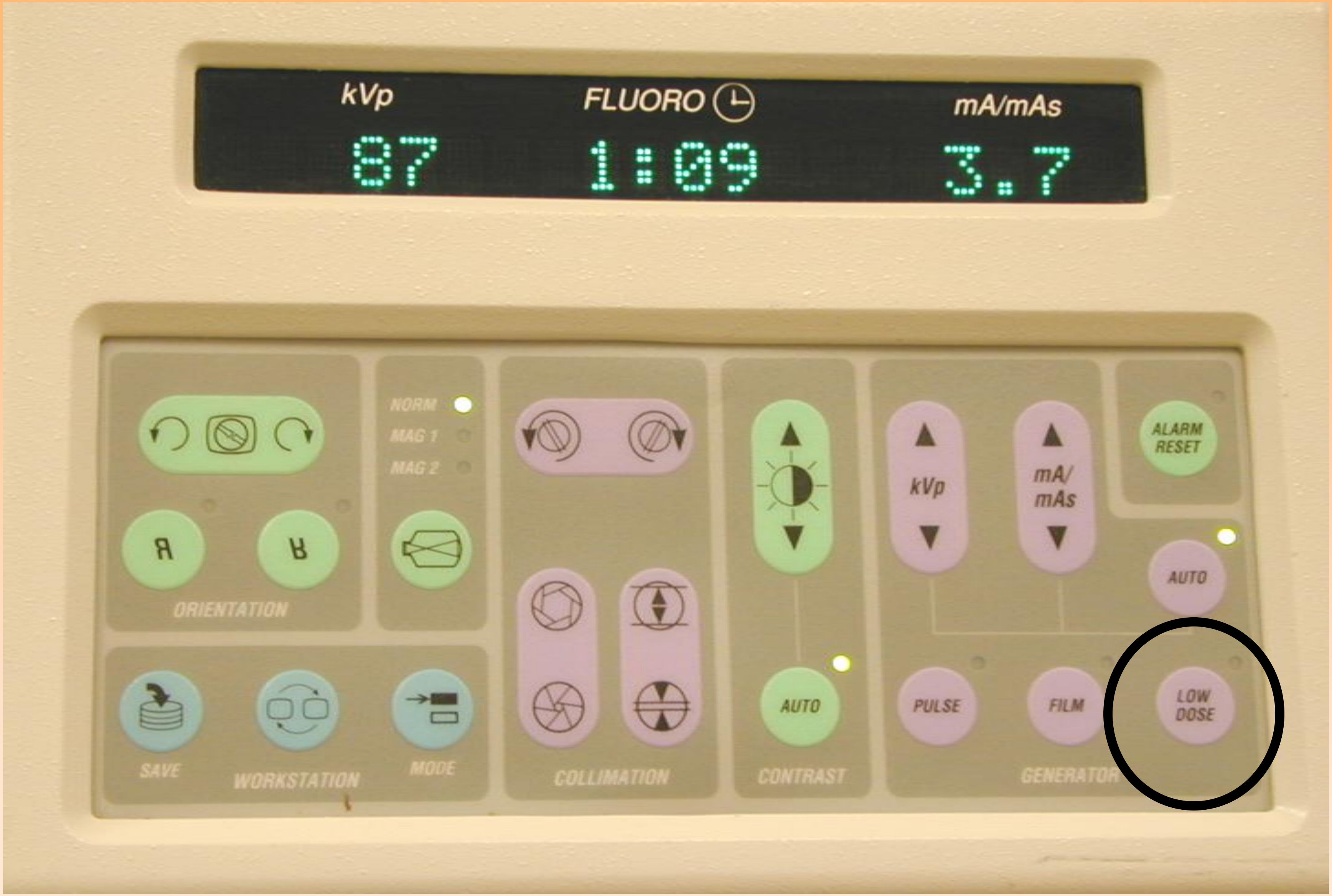
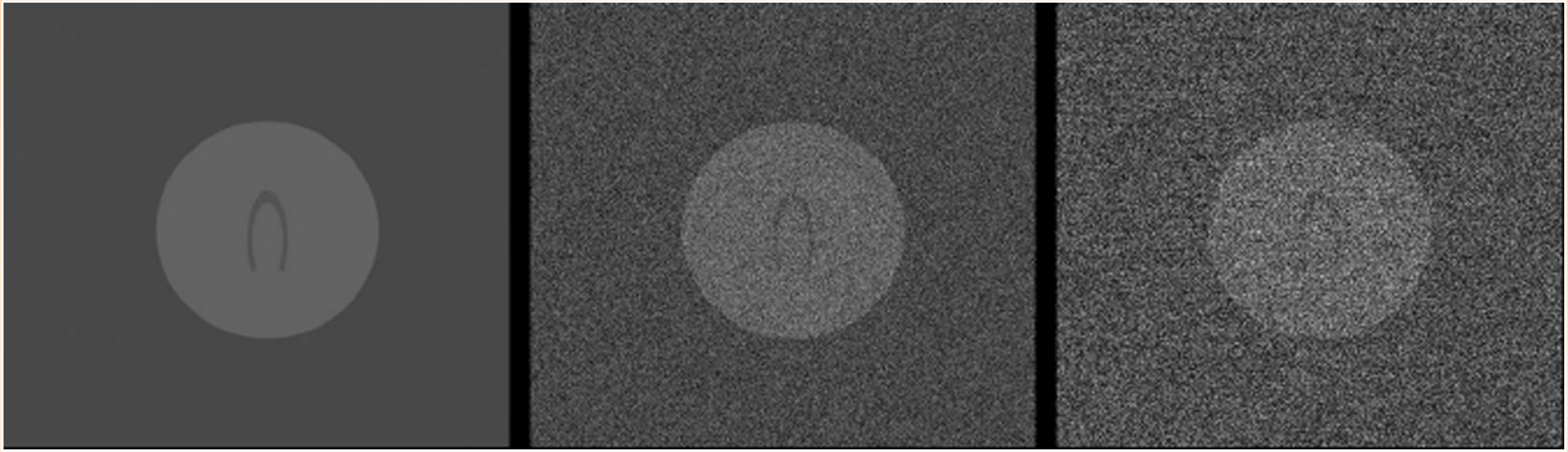
Thick Oblique vs Thin PA geometry

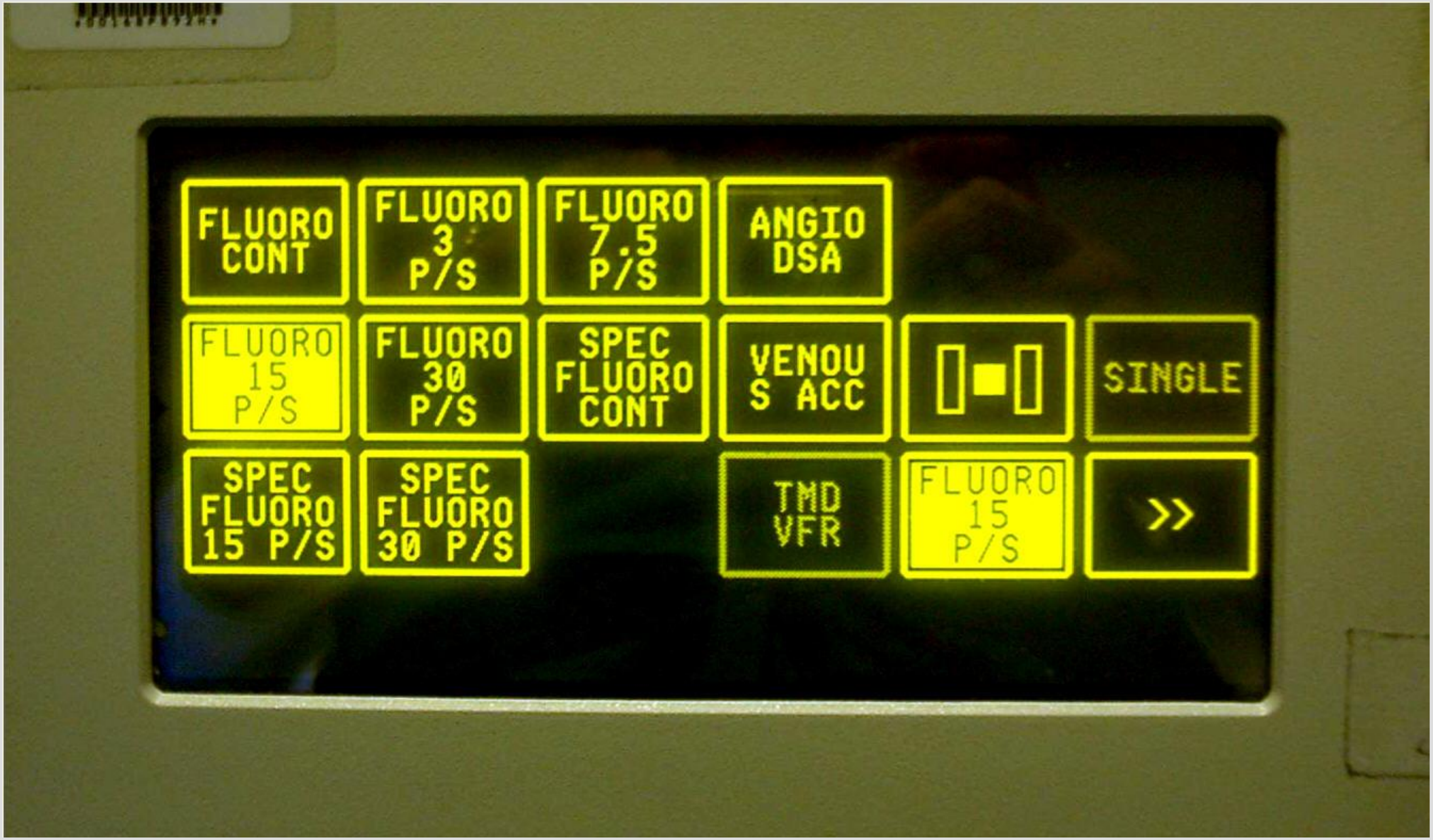



kVp
FLUORO
mA/mAs
87
1:09
3.7
NORM
MAG 1
MAG 2
ORIENTATION
ALARM RESET
kVp
mA/ mAs
AUTO
AUTO
PULSE
FILM
LOW DOSE
SAVE
WORKSTATION
MODE
COLLIMATION
CONTRAST
GENERATOR

Dose Rate (mA + kVp) Controls Visual Noise



Which Fluoro Mode?



Pulsed imaging controls:

Displaying 30 picture frames per second is usually adequate for the transition from frame to frame to appear smooth.

This is important for entertainment purposes, but not necessarily required for medical procedures.

Manipulation of frame rate can be used to produce enormous savings in dose accumulation.

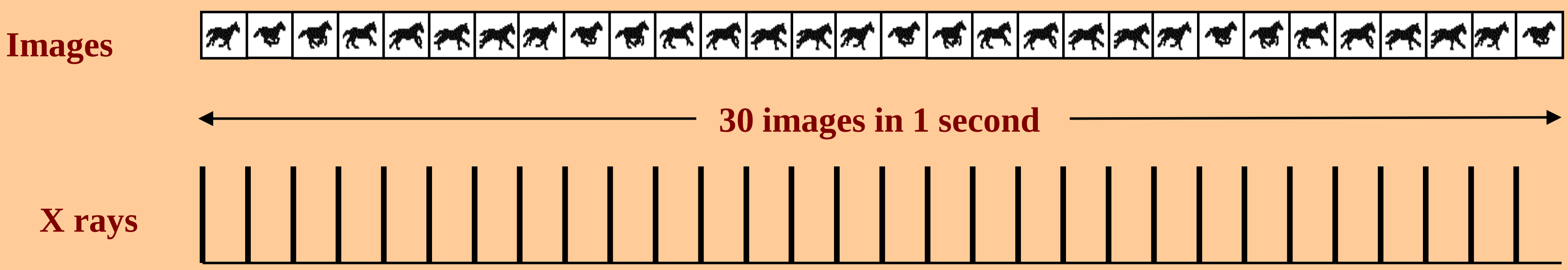
Continuous fluoroscopy

Blurred appearance of motion with continuous x-ray production because exposure time lasts the full $1/30^{th}$ of a second for each image interval

Continuous stream of x rays produces blurred images in each frame

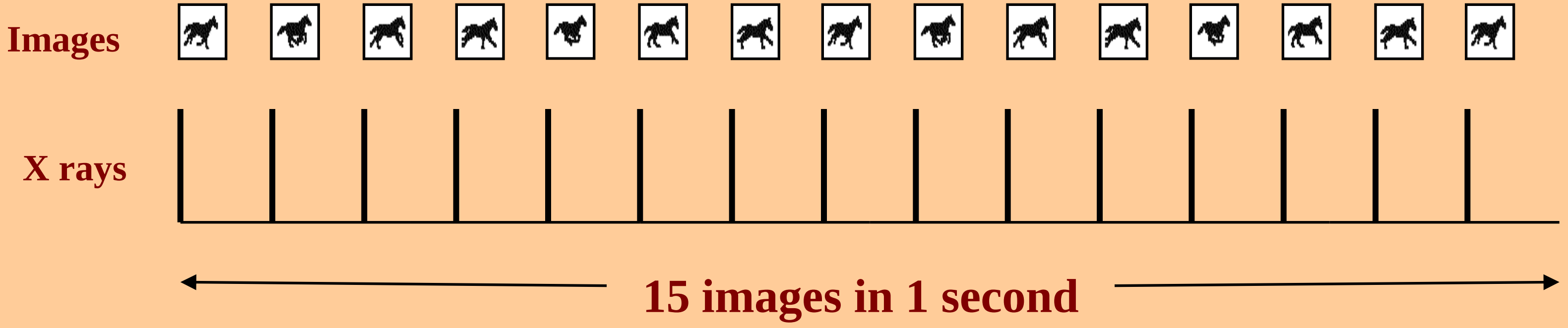
Pulsed fluoroscopy, no dose reduction

Sharp appearance of motion because each of 30 images per second is captured in a pulse (snapshot) of 1/100th of a second; exposure rate is the same as for continuous

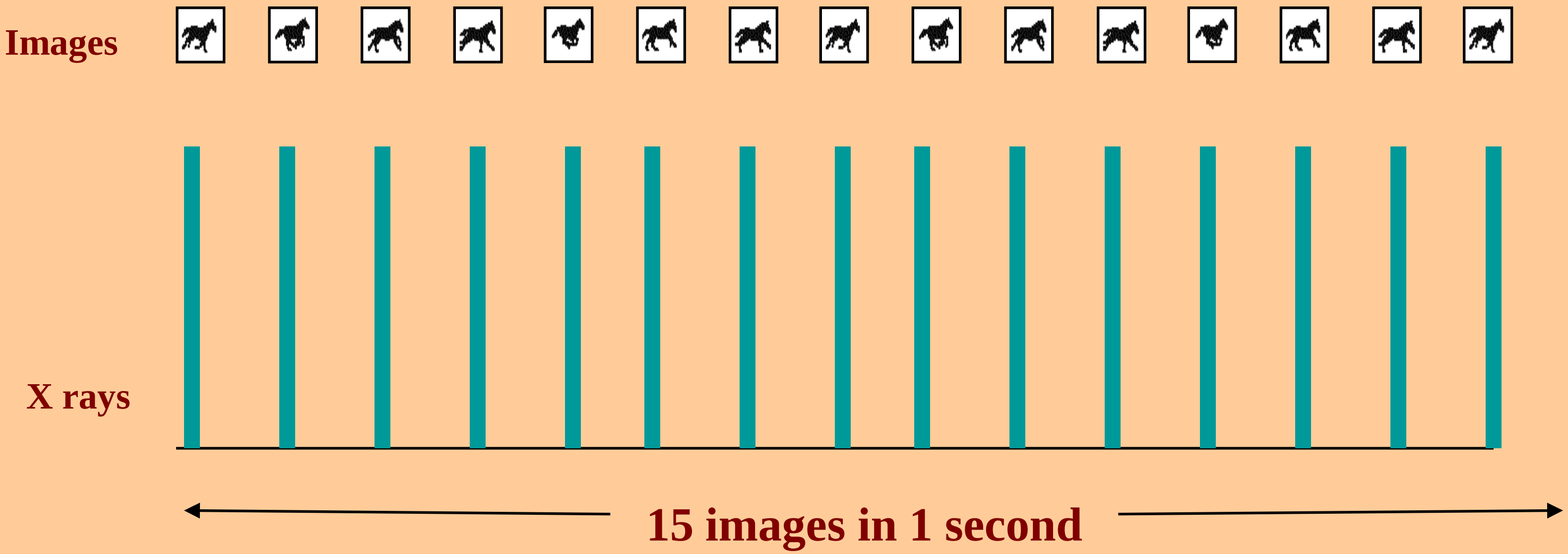


Each x-ray pulse shown above has greater intensity than continuous mode, but lasts for only 1/100th of a second; no x rays are emitted between pulses; dose to patient is same as that with continuous

Pulsed fluoroscopy, dose reduction at 15 pulses per second

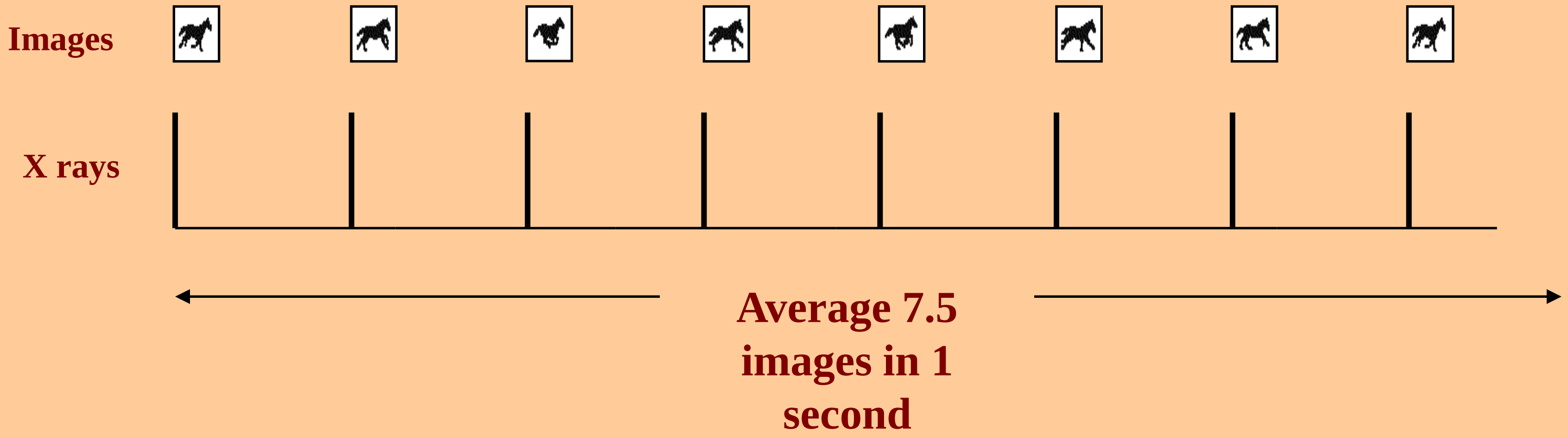


Pulsed fluoroscopy, dose <u>enhancement</u> at 15 pulses per second



Reproduced with permission from Wagner LK, Houston, TX 2004.

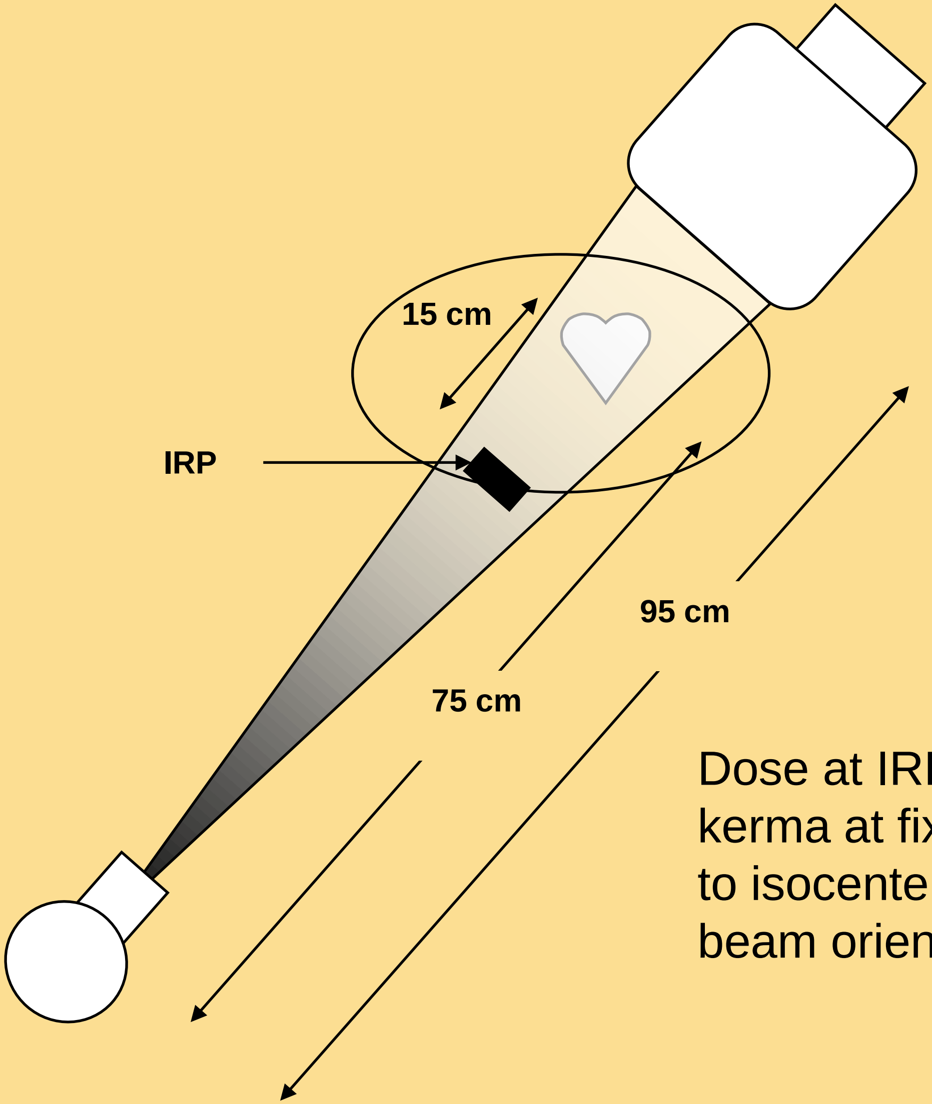
Pulsed fluoroscopy, dose reduction at 7.5 pulses per second



Is this realistic?

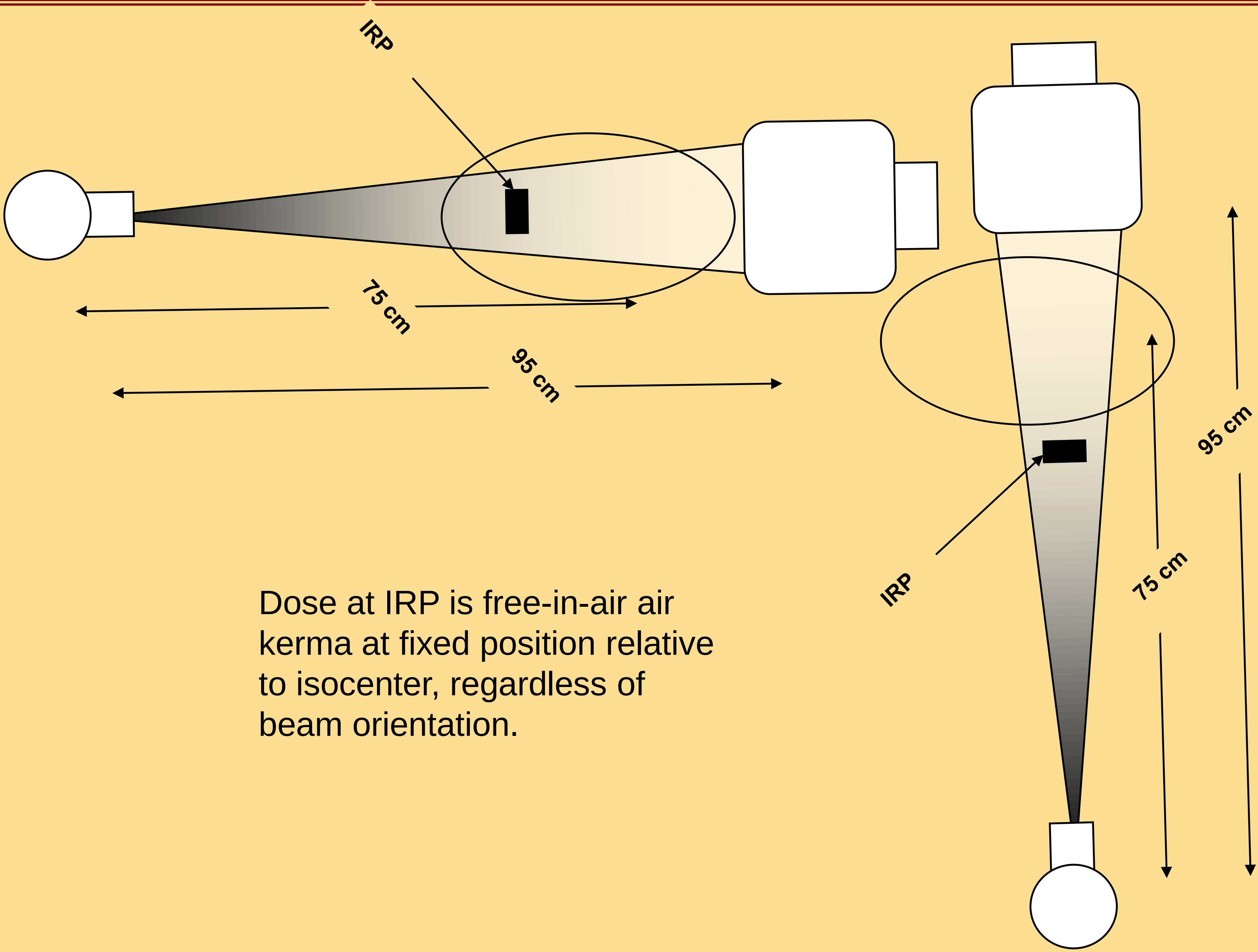
How much radiation exists at some position?

The concept of [Air Kerma]() at a reference position



Dose at IRP is free-in-air air kerma at fixed position relative to isocenter, regardless of beam orientation.

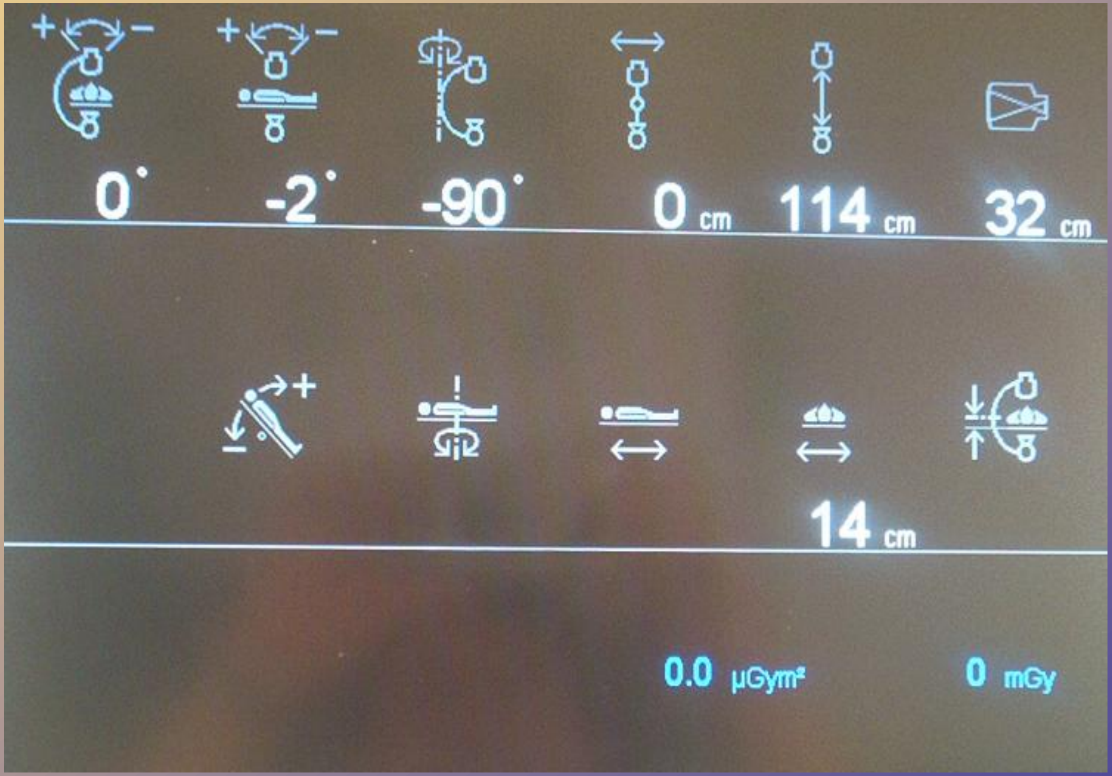
The IRP is shown relative to isocentric cardiac geometry. In this example the isocenter is 75 cm from the focal spot and the SID is 95 cm.



Dose at IRP is free-in-air air kerma at fixed position relative to isocenter, regardless of beam orientation.

Dose management

Physicians must have the tools to measure dose and the training to know how to use them.



Air kerma at reference (AK)	Alert level	Alert interpretation
3000 mGy	1	FYI – to assist physician in projecting how much radiation might be required to complete procedure.
6000 mGy	2	Alert – to assist physician in projecting how much radiation might be required to complete procedure.
9000 mGy	3	Warning – benefit/risk decision must be dictated in report; doses are nearing level that requires mandatory review by medical staff and radiation safety.
12000 mGy	4	Warning – dose level is at level requiring mandatory review by medical staff and radiation safety.
15000 mGy	5	Dose is at level defined by JCAHO as a reviewable sentinel event
All additional +3000 mGy		For the information of the physician

Average (Maximum) Absorbed doses to Skin from Interventional Procedures

	Fluoroscopy on-time (minutes) Average (Max)	Highest Localized Absorbed Dose in Skin (Gy) Average (Max)
Neuro Embolization	**30 (140)**	**A: 1.0 (3.2)** **B: 2.0 (~7)**
Hepatic Embolization	**20 (63)**	**0.7 (3.0)**
Percutaneous Transluminal Coronary Angioplasty	**20 (85)**	**1.0 (7.0)**
Radiofrequency Ablation (Cardiologic)	**25 (100)**	**0.7 (5.5)**

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Before the Procedure: Radiation Consent?

- Risk factors in medical history?
- Previous radiation to same area?
- Big patient?
- “High dose” procedure?
- Complex/difficult anatomy or lesion?
- *Consider consent for radiation effects*

Thanks to Don Miller, MD

Consent Topics

- *Hair loss*
  - Usually temporary; regrowth of hair may be incomplete.
- *Skin rashes*
  - Infrequent, on very rare occasions they may result in tissue breakdown and possibly severe ulcers.
- *Slightly elevated risk for cancer*
  - Later in life. This risk is typically low compared to the normal incidence of human cancer.
- *Cataracts* occur rarely.

Based on Wagner, L. (AAPM SS 02)

During Procedure

- Active dose management
- When do you stop the procedure?
  - A good question without a good answer
  - Presupposes you can measure dose in real time (Example:3,6,9 rule for IRP!)
  - Consider rotating the beam
  - Clinical risk / benefit evaluation
  - Radiation = iodine **(Thanks to S. Balter)**

Thanks to Don Miller, MD

Post-Procedure

- Record the dose in the medical record
- If the dose exceeded deterministic thresholds:
  - Discuss possible effects and their management with the patient.
  - Have patient or family member notify you if deterministic effects occur.
  - Institute a clinical follow-up plan for the patient

Thanks to Don Miller, MD

Follow-Up Plan

- Necessary when large radiation doses are used
- Self-exam at 2 –3 weeks
  - May not cause symptoms
  - The patient can’t see his/her own back
  - Patient needs to know location of the radiation field
- May need follow-up for > 1 yr
- Useful for operator QI

Thanks to Don Miller, MD

Without a Plan…

- Patient goes to dermatologist, not you
- Neither dermatologist nor patient may consider fluoroscopy as the etiology
  - Patient doesn't think it is relevant
  - Dermatologist thinks dose is too low
- Unnecessary skin biopsy performed
  - Biopsy not pathognomonic
  - May result in non-healing ulcer
  - Diagnosis can be made from a careful history and the appearance of the lesion
- Diagnosis likely to be delayed

Thanks to Don Miller, MD