Radiation Protection in Fluoroscopy

Dennis Bowman, RT(R), CRT (R)(F) - Retired
Owner/Consultant - Digital Radiography Solutions

Instructional DVD – Edition 3

FluoroRadPro

Radiation Protection in Fluoroscopy & Digital Radiography

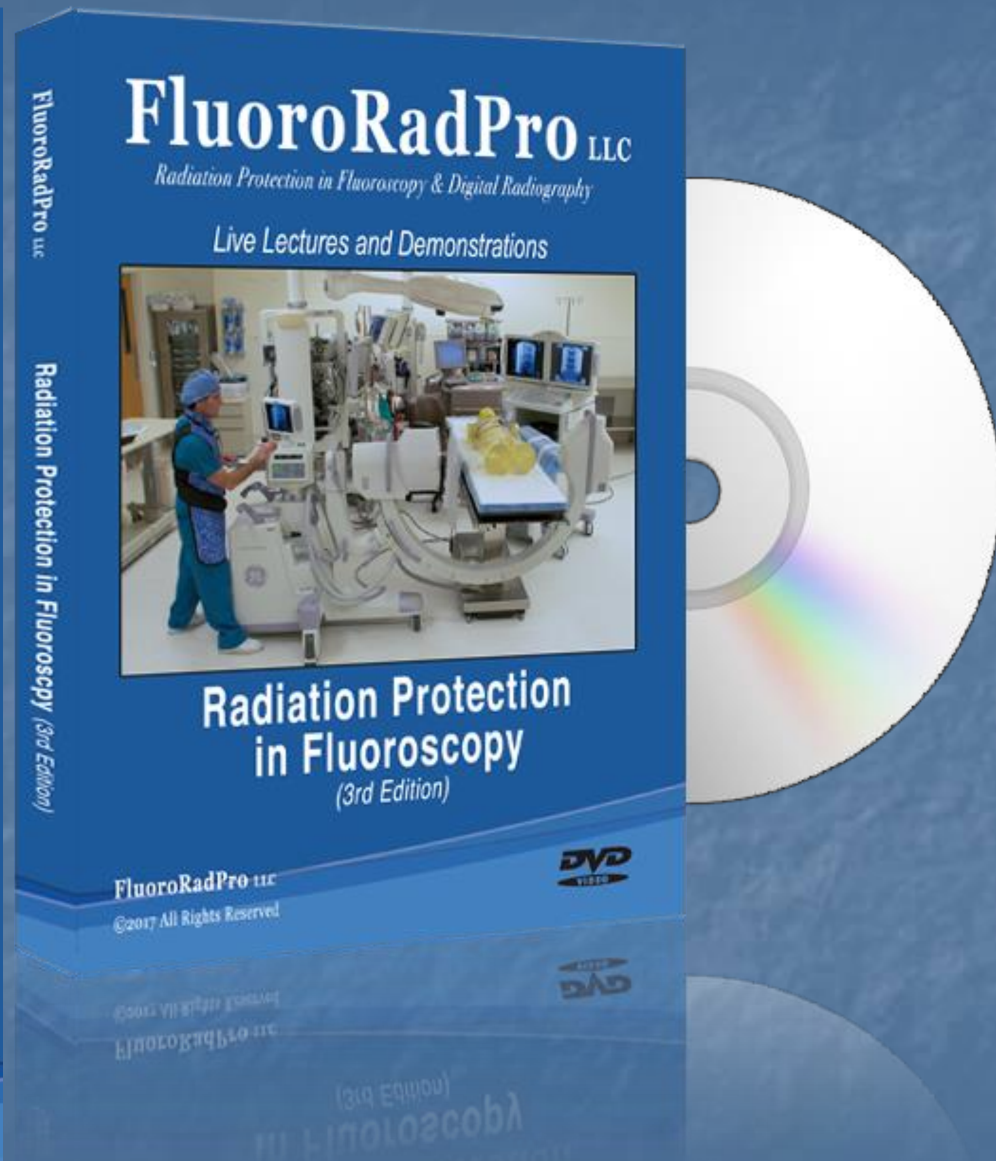
COURSE BENEFITS

- Decreased fluoroscopic dose to patients and staff
- Improved fluoroscopic and digital image quality
- Maximal efficient use of fluoroscopic and DR equipment
- Effective implementation of optimal CR and DR techniques
- Working knowledge of standardized exposure index numbers and ranges
- Heightened awareness of 'safe areas' during fluoroscopy in the OR and R&F room
- Improved understanding of radiation attenuation and scatter
- Elevated staff performance
- Enhanced digital image critique skills

COURSE HIGHLIGHTS

- Ion chamber at head, 45, and 90 degrees in OR and R&F room
- Adverse events and biologic effects
- Radiation changes with increased SID
- X-table lateral hip - location of the least amount of scatter
- CIRS pediatric phantom with pediatric versus adult settings
- Vertical collimation
- Fluoroscan - mini c-arm
- Universal CR and DR technique charts
- Dose reduction using the 15% Rule with mAs compensation

Email: frp@redshift.com **Website:** fluororadpro.com



Fluoroscopy Safety for Healthcare Workers

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Fluoroscopy Safety for Healthcare Workers

5.25 credits | 31 videos

View Course Details →

What you'll learn

- ✓ Understand how radiation scatters and in what direction during an AP chest
- ✓ Explain how to correctly use and set up a C-arm
- ✓ Discuss the difference in dose between 1fps, 2 fps, and 3 fps with digital spots
- ✓ Understand how to properly use a C-Arm to get the clearest, sharpest image
- ✓ Explain how much radiation is saved when Pulse Mode is used
- ✓ Discuss the difference in scatter between the head, 45 and 90 degrees in OR
- ✓ Explain the Inverse Square Law
- ✓ Understand ABS and how mA and kV change when using fluoroscopy
- ✓ Discuss the difference between 0.25, 0.375, and 0.5 mm lead aprons

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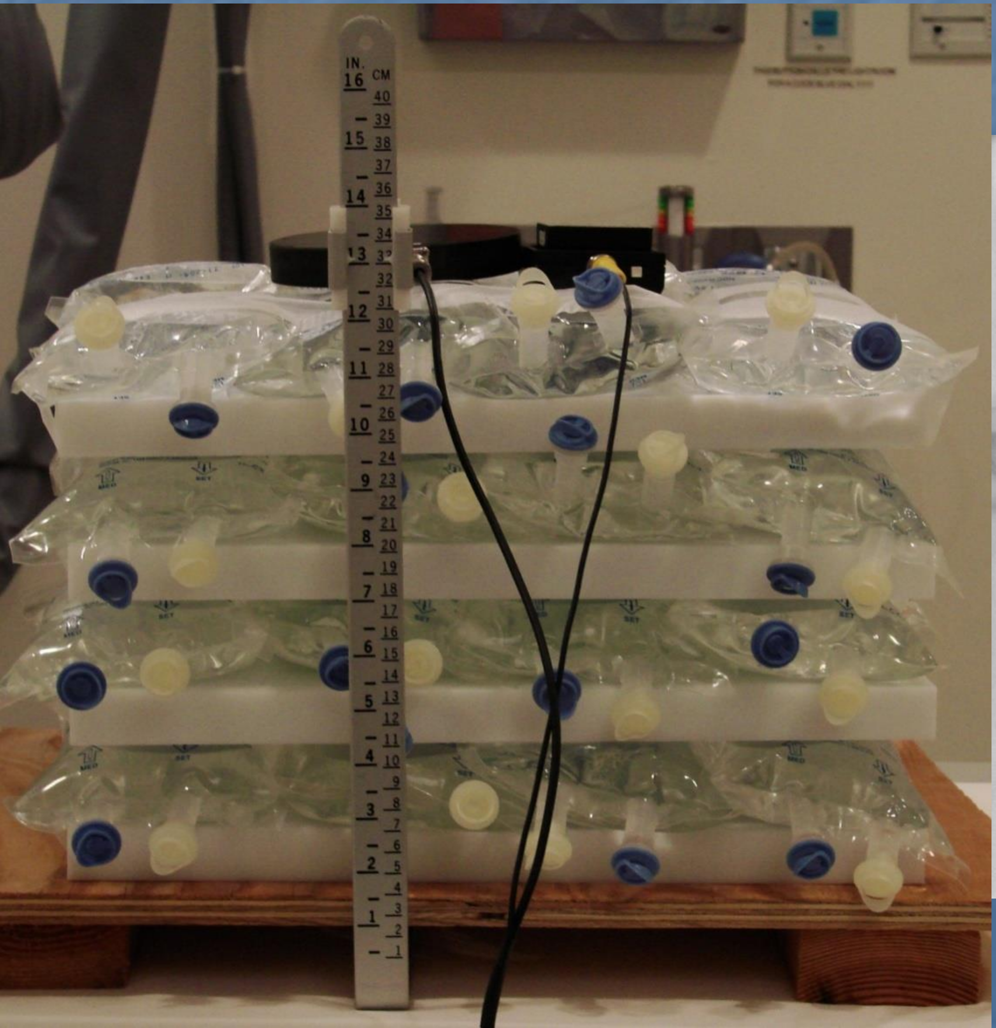
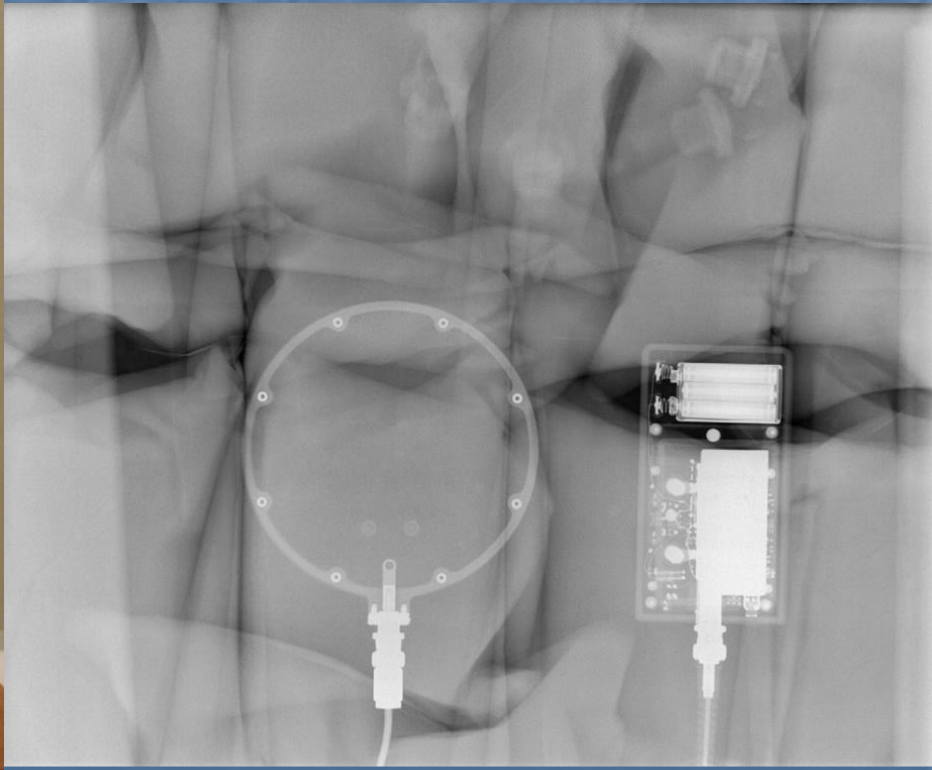
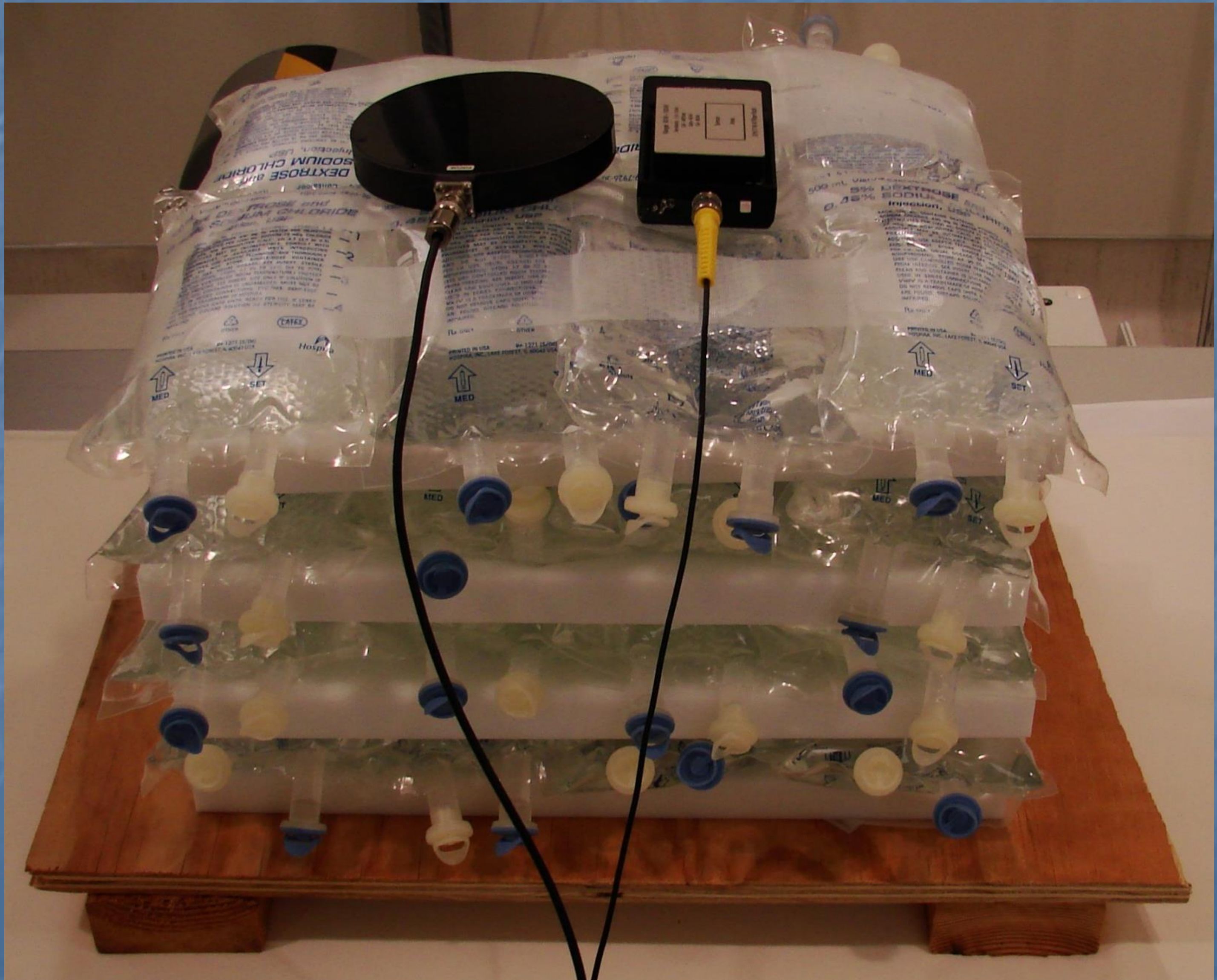
Demonstrating attenuation with my "poor man's body phantom" using polyethylene blocks and 500cc saline bags.

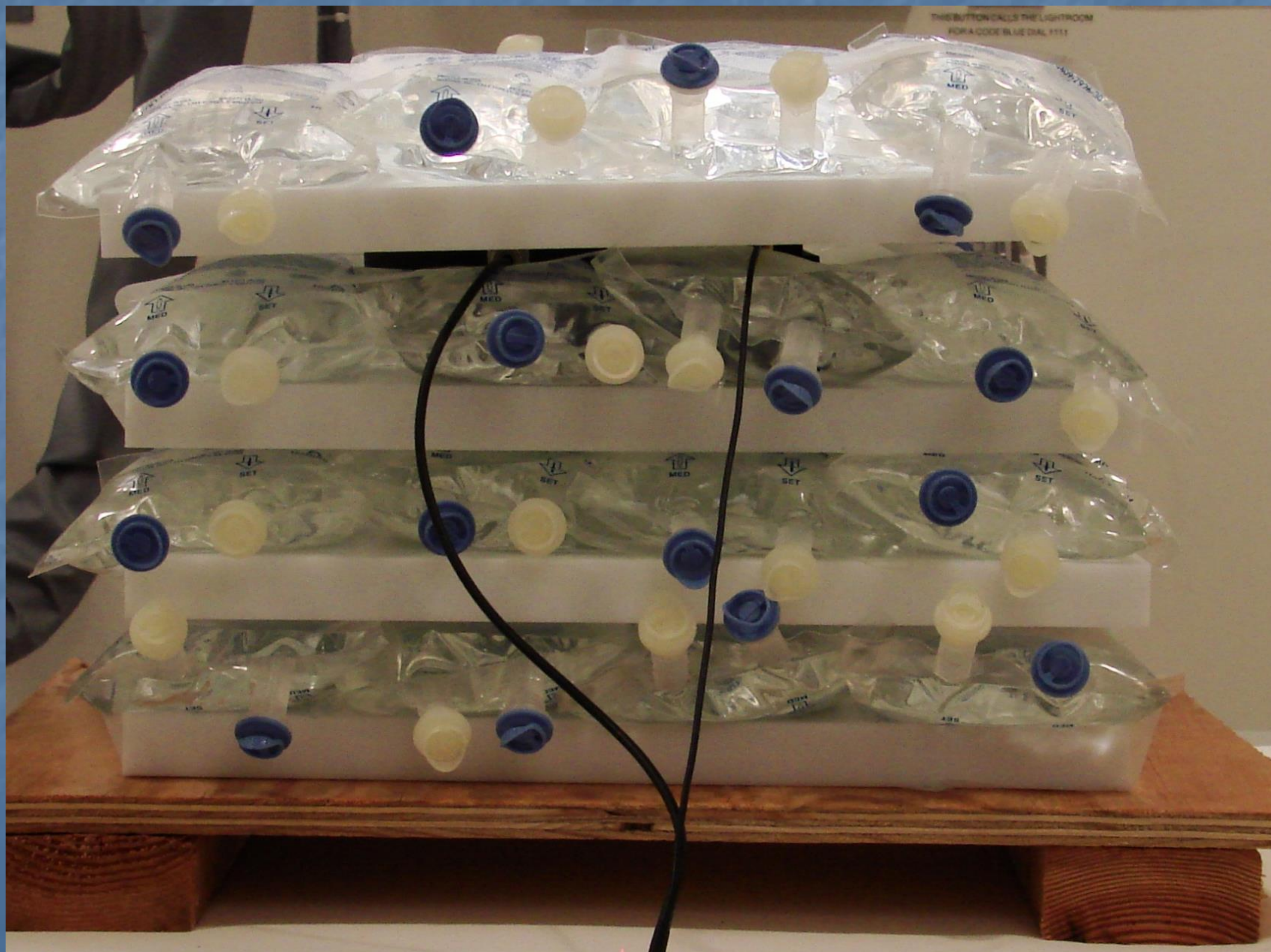




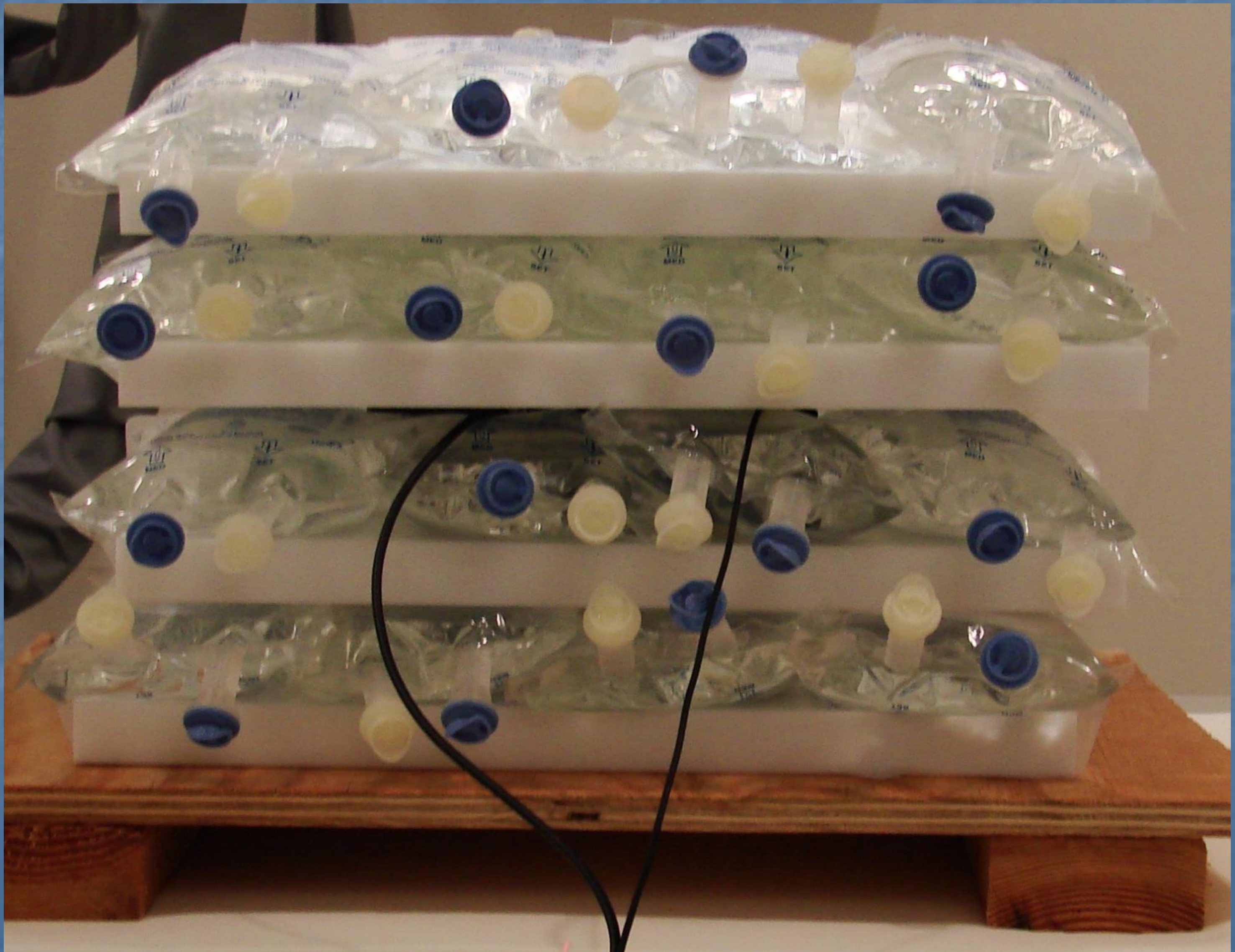
85 kV @ 14 mAs 45'' 14x17
Entrance 2.13 r 0%



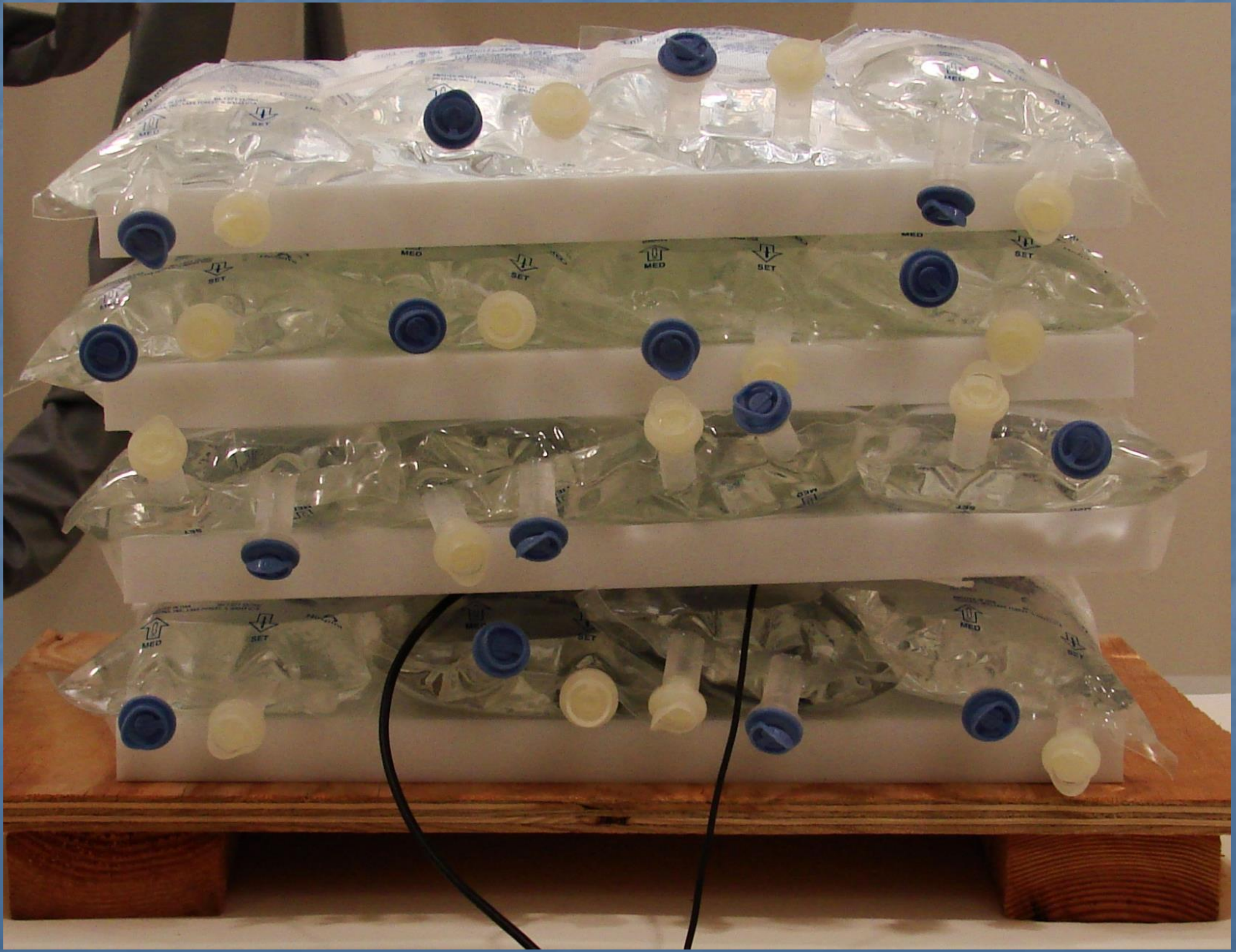
Anterior Quarter 1.05 R **+49.3%** (-50.7%)



Middle – Midline Dose (MD) 0.469 R
+22% (-78%)

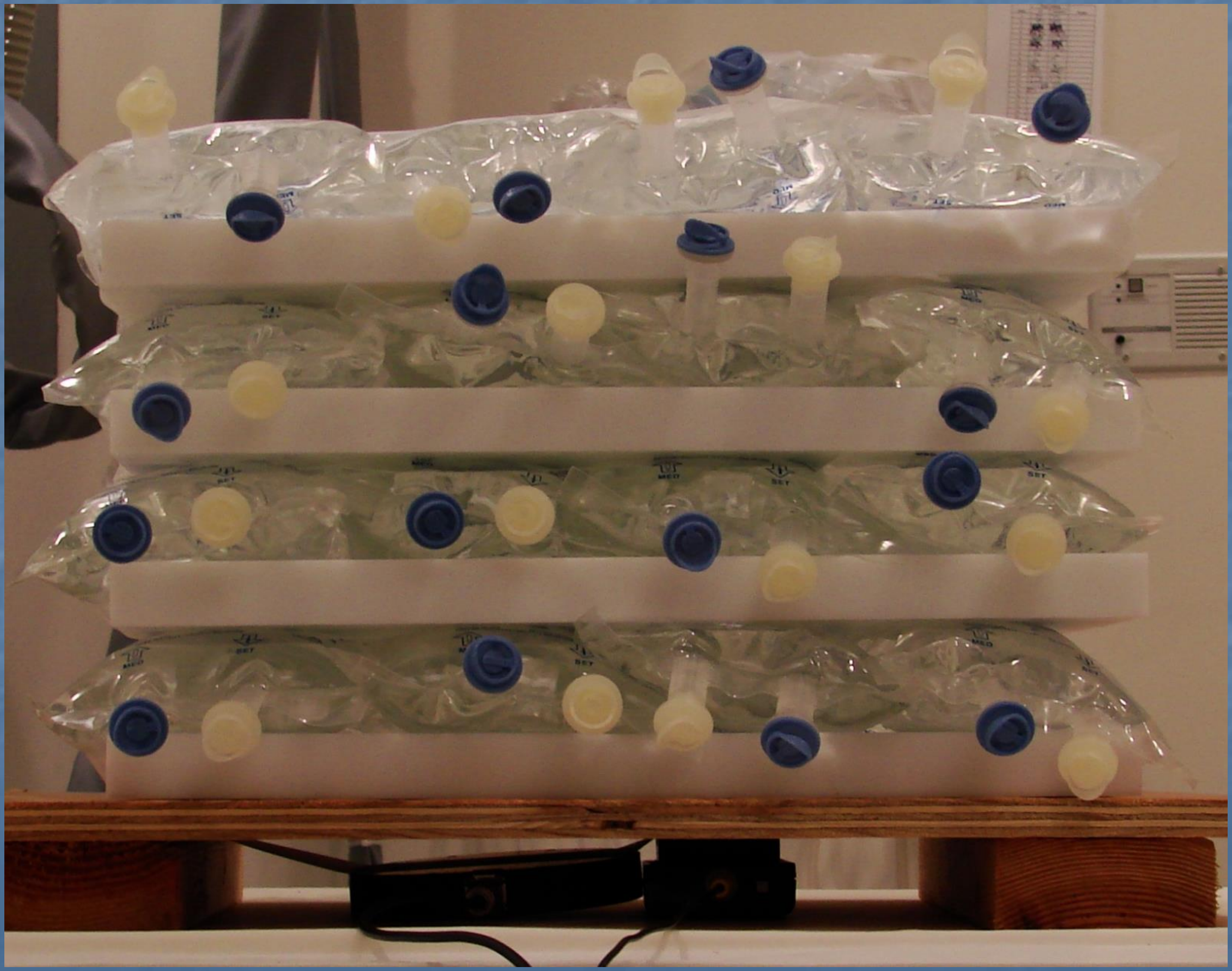


Posterior Quarter 0.195 R **+9.2%** (-90.8%)



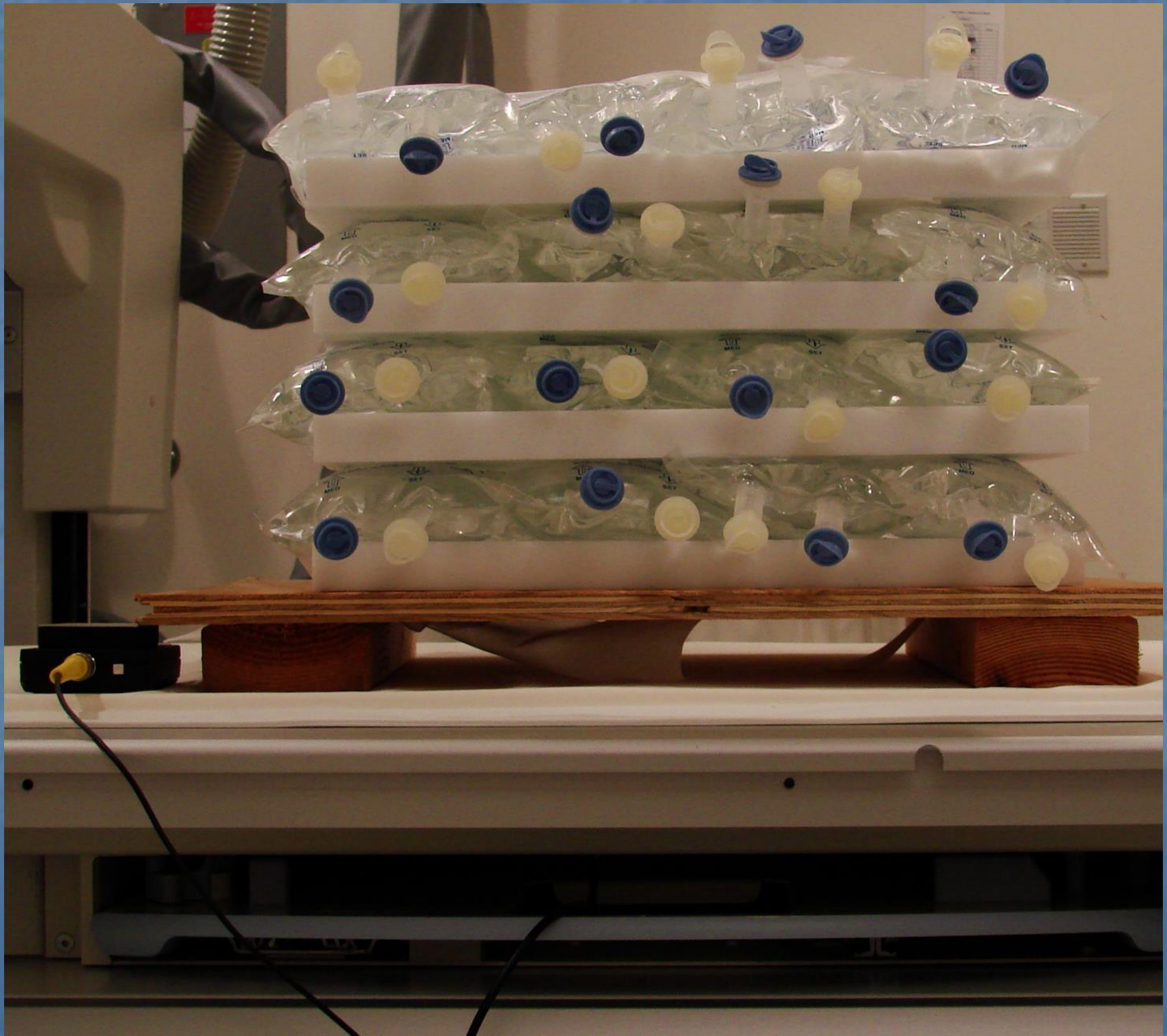
dRs

Exit 0.051 R **+2.4%** (-97.6%)



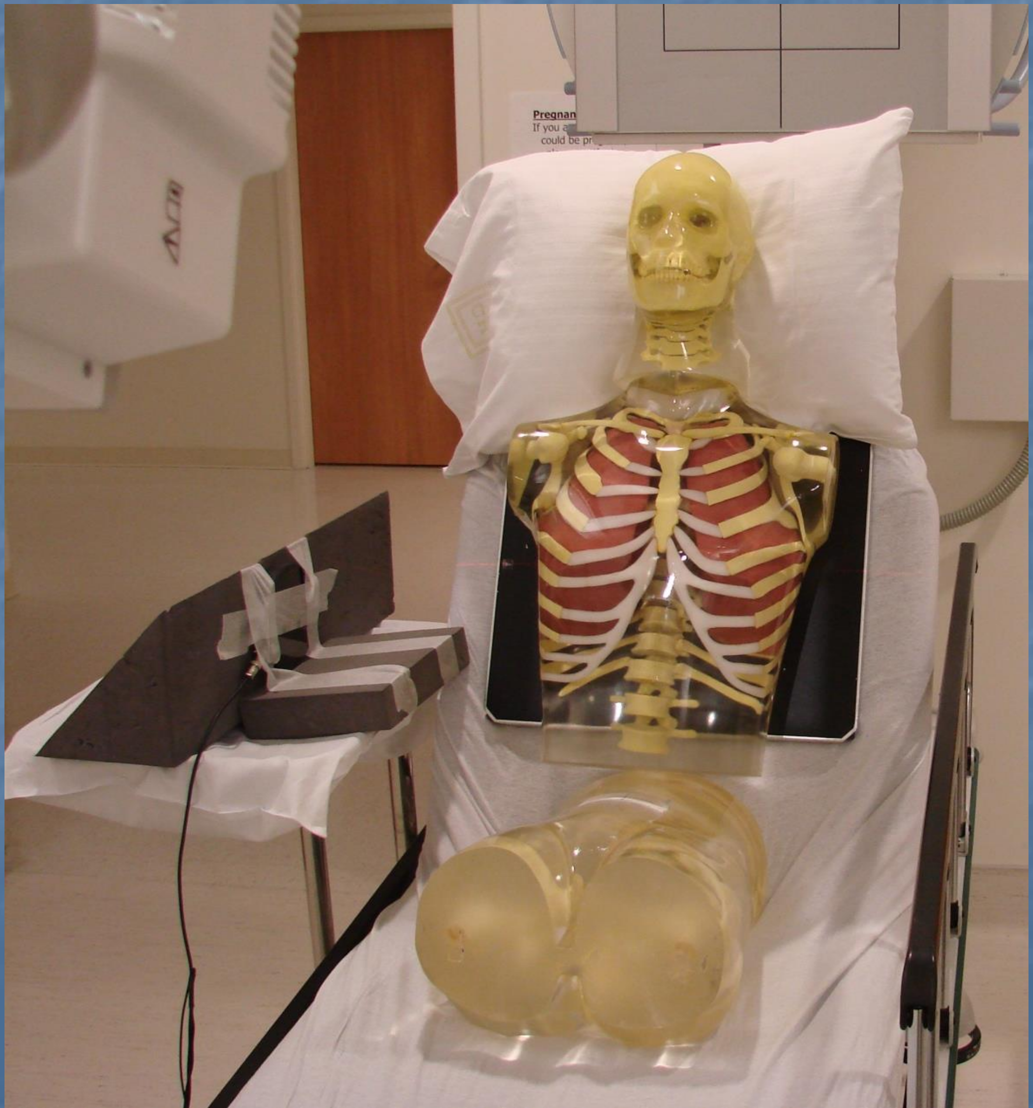
Under Grid (in bucky) 0.0075 R

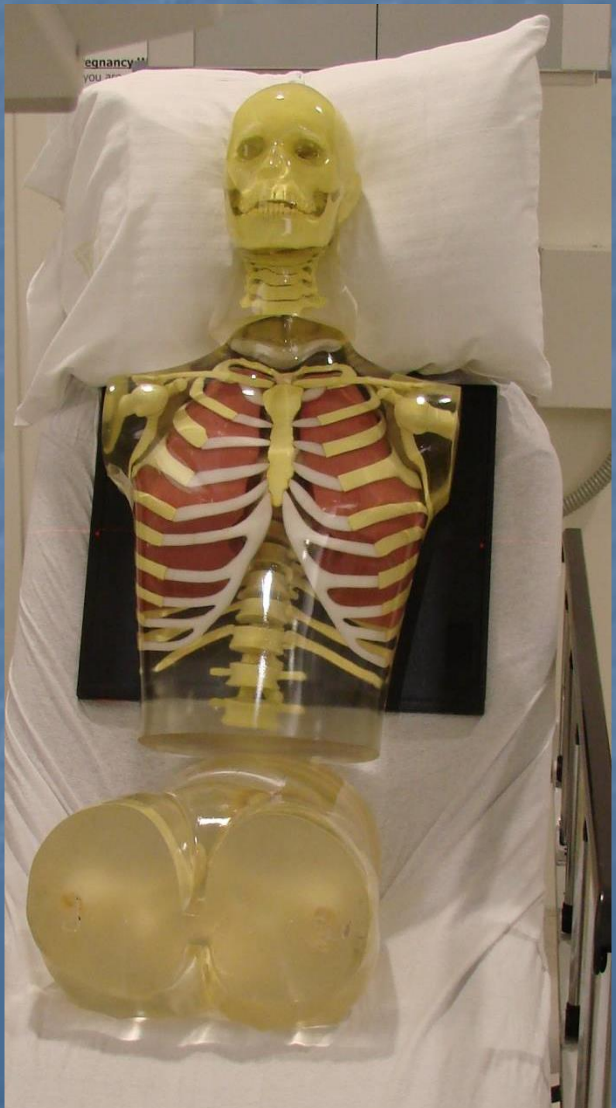
+.4% (-99.6%)



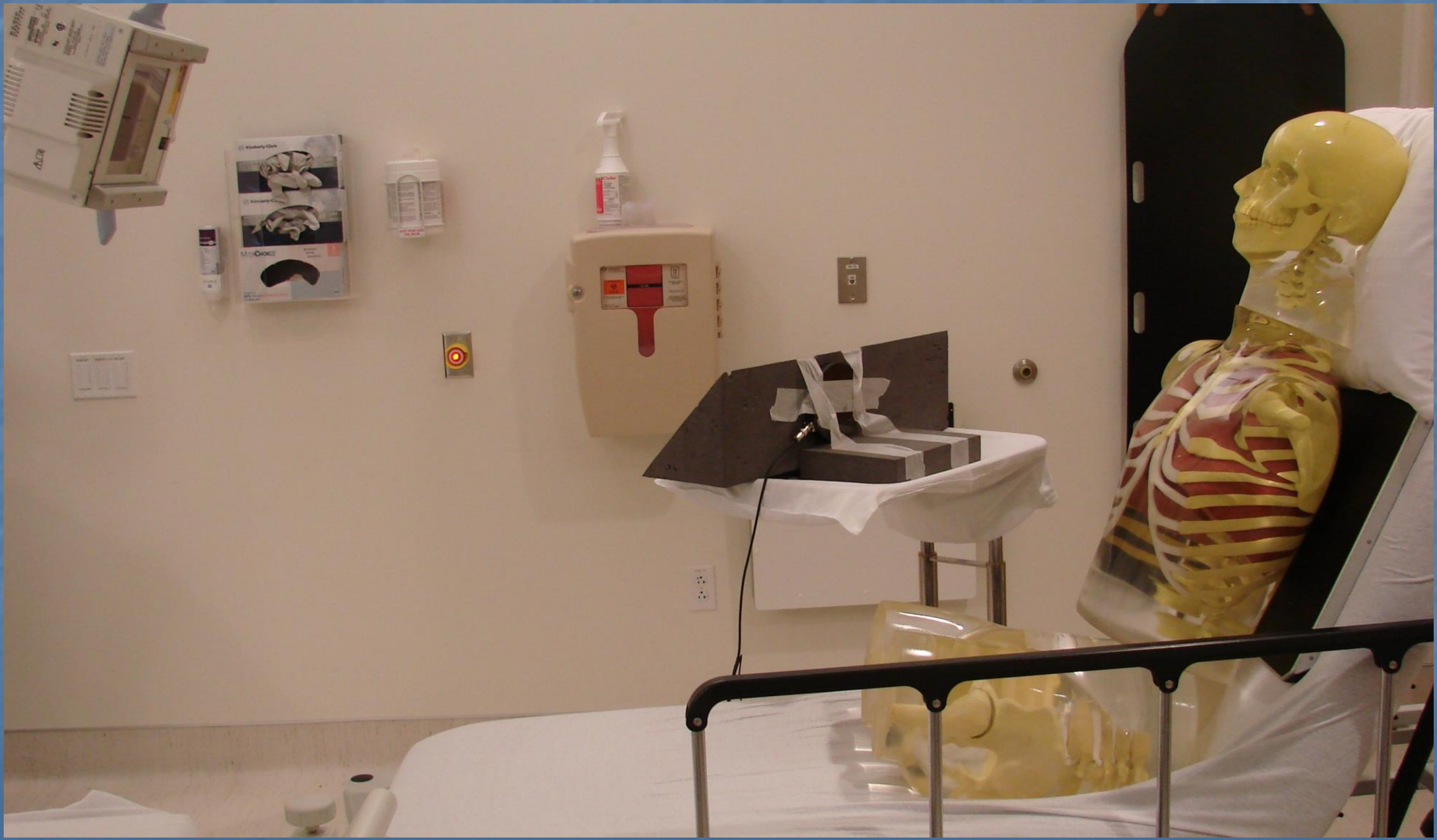
How much dose are you getting from scatter radiation coming out of your patient during an AP chest?

We did this experiment with and without grids, at 115 and 85 kV, and at 3 different angles.
This one is taken at 90 degrees to the patient.





This one is taken at 45 degrees to the patient.



And this one we are calling 0 degrees.

Natural Background Radiation – 2006
(Cosmic, Radon, Potassium 40)

- 1r = 1 rad (in air)
- 1R = 1 Roentgen (radiation has touched the body)
- 1 milliR (mR) = 1/1000 of a rad/Roentgen
- 1 microR (μR) = 1/1000 of a mR
- **Natural Radiation** = 304 milliR/year
- 304 milliR = 304,000 microR
- 304,000 microR/year = **844 microR/day**

Here are all the doses for 0, 45 and 90 degrees (arrows at 6')

85@3.2 and 115@4

Dose exposure due to scatter from Portable Chest Xrays

Angle of Chamber (Deg)	Distance (ft)	Dose #1 (microR)	Dose #2 (microR)	Average Dose (microR)
90	1	96.0	94.6	95.3
90	2	42.7	42.0	42.4
90	3	21.1	22.0	21.6
90	4	13.3	12.7	13.0
90	5	10.6	9.0	9.8
90	6	6.9	6.1	6.5
45	1	195.5	196.2	195.9
45	2	79.3	80.7	80.0
45	3	38.3	39.2	38.8
45	4	24.3	23.8	24.1
45	5	16.2	17.9	17.1
45	6	11.6	12.0	11.8
45	7	9.4	9.1	9.3
45	8	7.1	6.4	6.8
0	6	34.0	33.1	33.6
0	7	24.5	23.0	23.8
0	8	17.4	16.0	16.7
0	9	14.0	14.2	14.1
0	10	10.5	11.6	11.1
0	11	8.4	8.9	8.7
0	12	6.3	7.5	6.9
0	13	5.3	6.4	5.9
0	14	0.0	0.0	0.0
0	15	0.0	0.0	0.0
0	16	0.0	0.0	0.0

Chest technique of 85@3.2 was used for all exposures. Ionization Chamber angle is measured from mid sagittal plane.

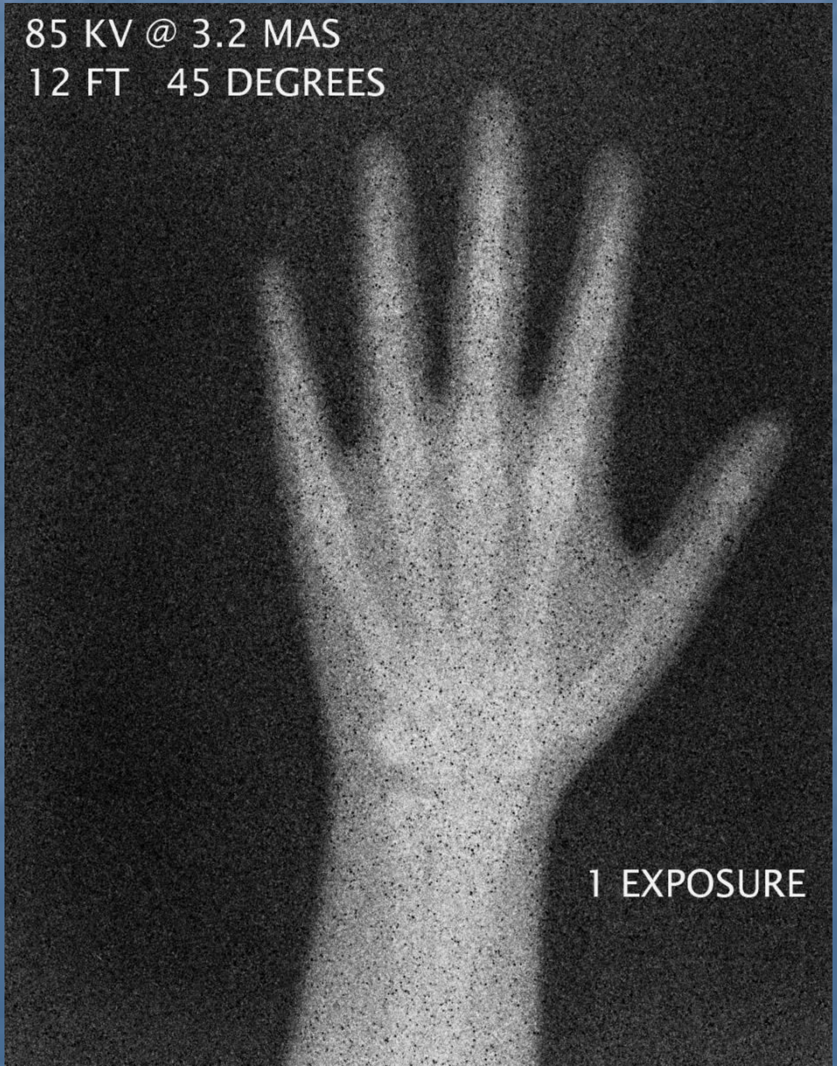
Dose exposure due to scatter from Portable Chest Xrays

Angle of Chamber (Deg)	Distance (ft)	Dose #1 (microR)	Dose #2 (microR)	Average Dose (microR)
90	1	316.0	320.0	318.0
90	2	125.8	127.2	126.5
90	3	68.3	67.6	68.0
90	4	42.2	41.0	41.6
90	5	27.1	28.3	27.7
90	6	19.7	19.7	19.7
45	1	744.0	778.0	761.0
45	2	295.0	295.0	295.0
45	3	150.7	151.2	151.0
45	4	98.3	97.6	98.0
45	5	66.2	65.2	65.7
45	6	48.6	47.4	48.0
45	7	33.6	32.7	33.2
45	8	27.6	27.5	27.6
0	6	76.0	75.1	75.6
0	7	50.5	51.8	51.2
0	8	39.3	39.8	39.6
0	9	32.3	31.9	32.1
0	10	25.4	27.0	26.2
0	11	22.4	21.8	22.1
0	12	17.0	16.9	17.0
0	13	14.3	14.4	14.4
0	14	12.6	12.5	12.6
0	15	10.2	9.9	10.1
0	16	8.3	8.2	8.3

Chest technique of 115@4 was used for all exposures. Ionization Chamber angle is measured from mid sagittal plane.

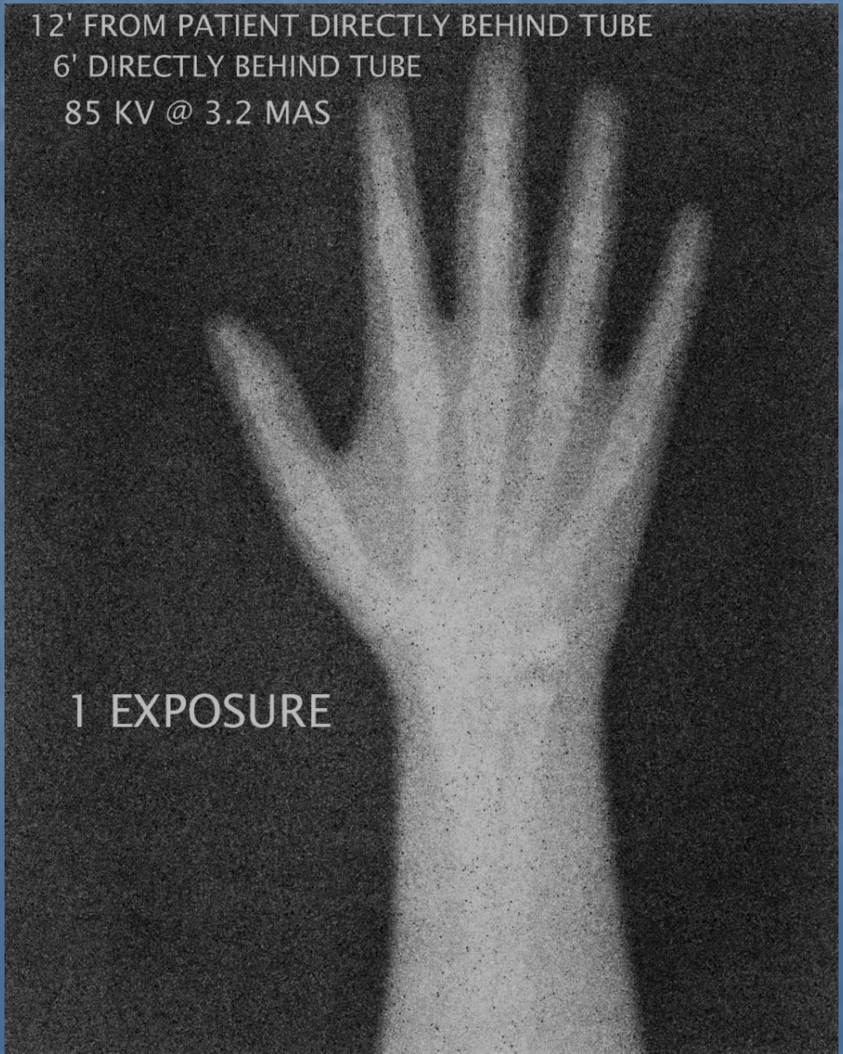
This demonstration used the arm/hand phantom and a 10x12 CR cassette. We set it up where many techs stand when making a PCXR exposure. This photo and the following image have the cassette at:
45 degrees and 12 feet from the patient.

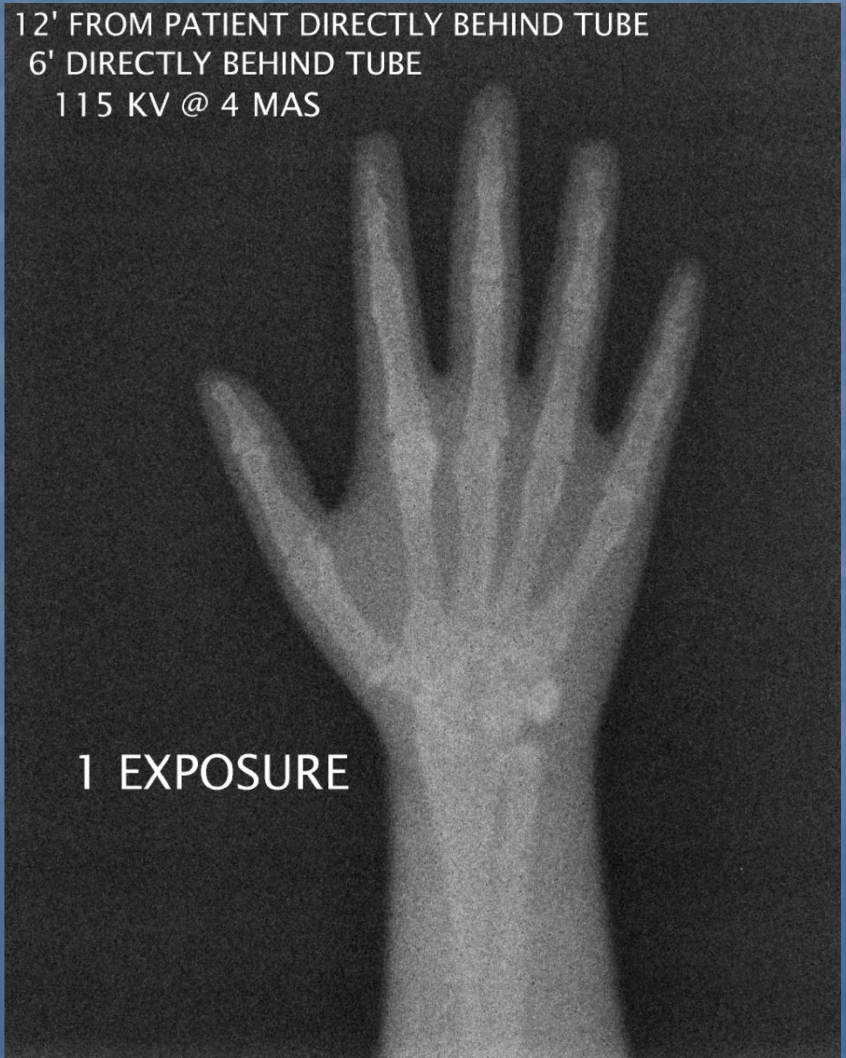
An image cannot lie!! Although the scatter dose is down in the micro R's, there's enough radiation to create this image – with 1 exposure (**read at 1200 speed**).



This photo and the following image were taken with the phantom/cassette 12 feet from the patient directly behind the tube (which is 6 feet from the patient).

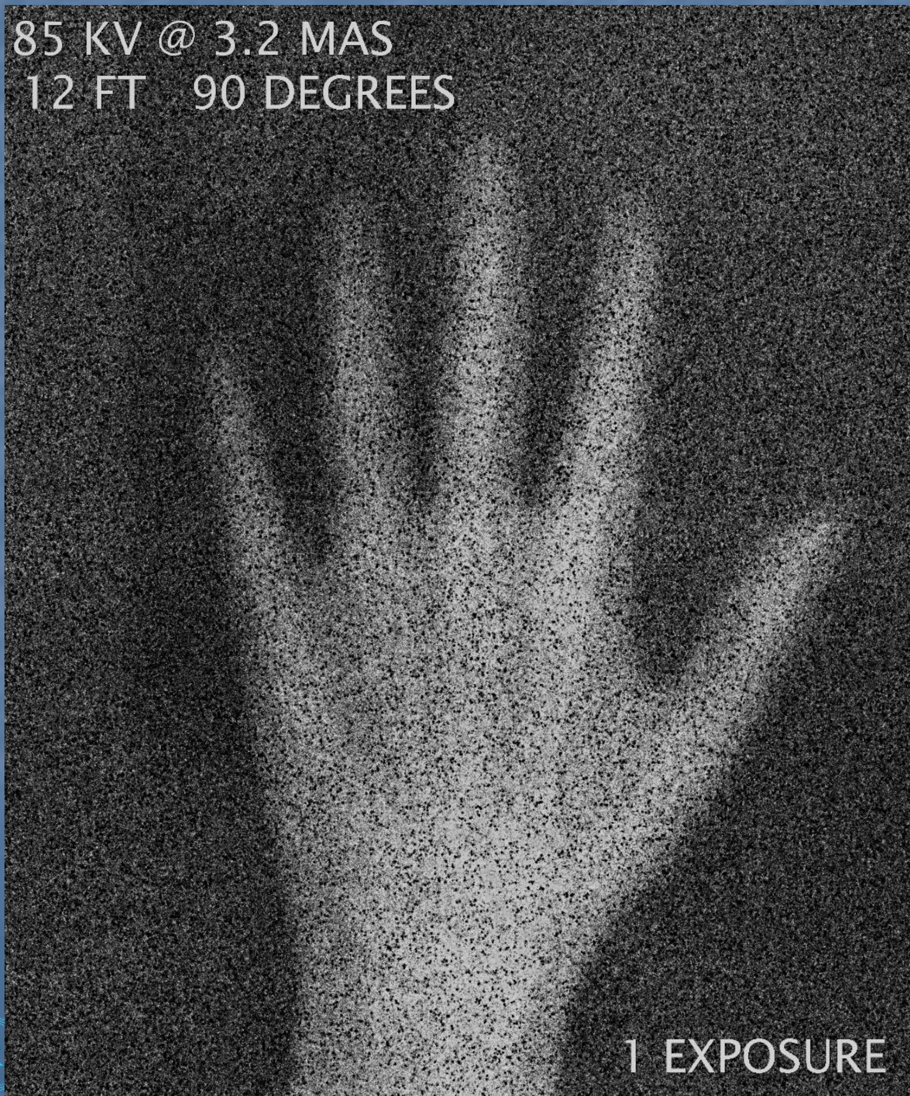
The 85 kV image had 6.0 microR and the 115kv image had 17 microR.

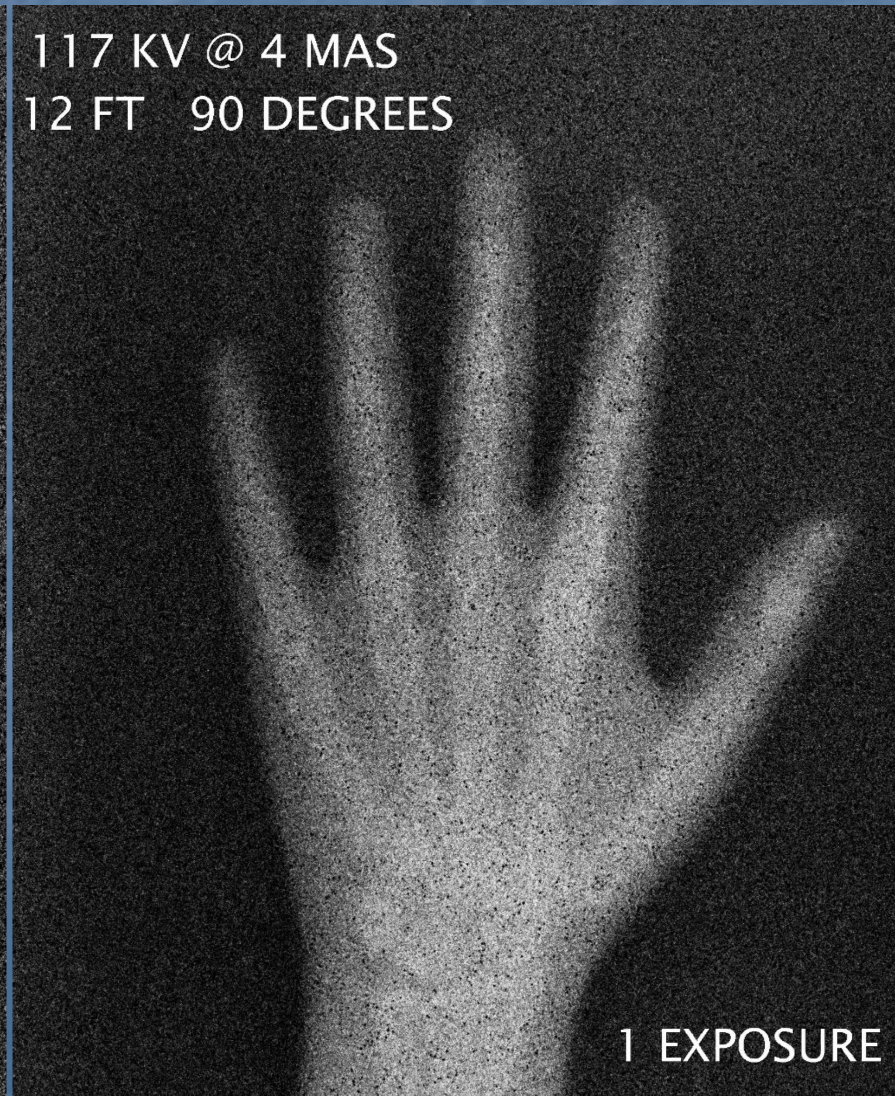




This photo and the following image were taken with the phantom/cassette 12 feet from the patient, 90 degrees from the patient.

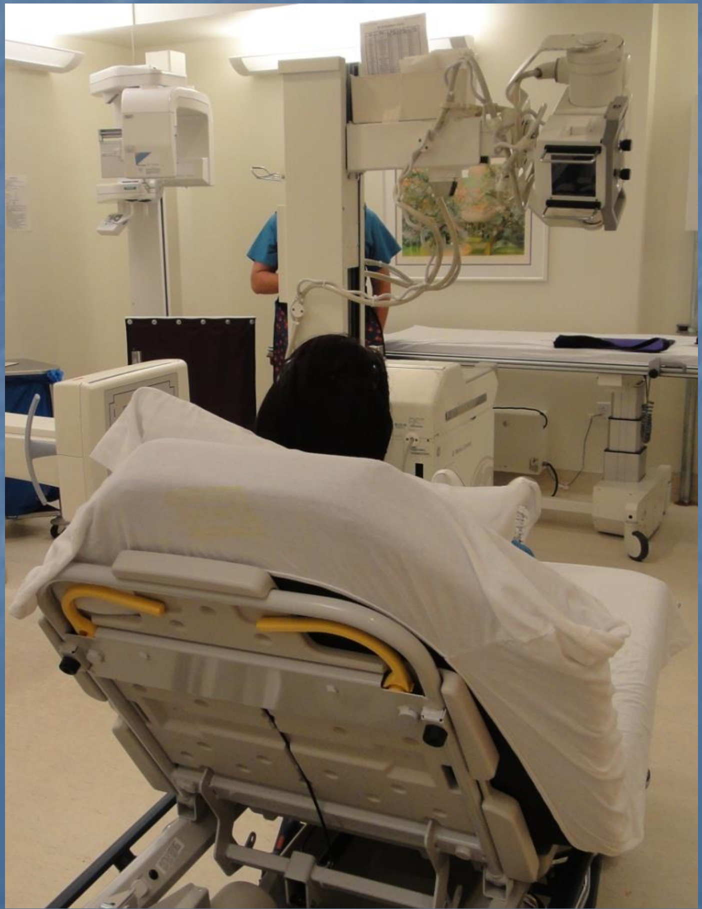
Of all the images, the one on the left shows the least amount of radiation made it to the radiographer (but it's not no radiation and it's the best place to stand).





If you're thinking like we were, then you're wondering if the scatter came from the back of the tube, not the patient? It turns out that at 12 inches from the backside of the tube the dose was so small that the dosimeter could not read it.

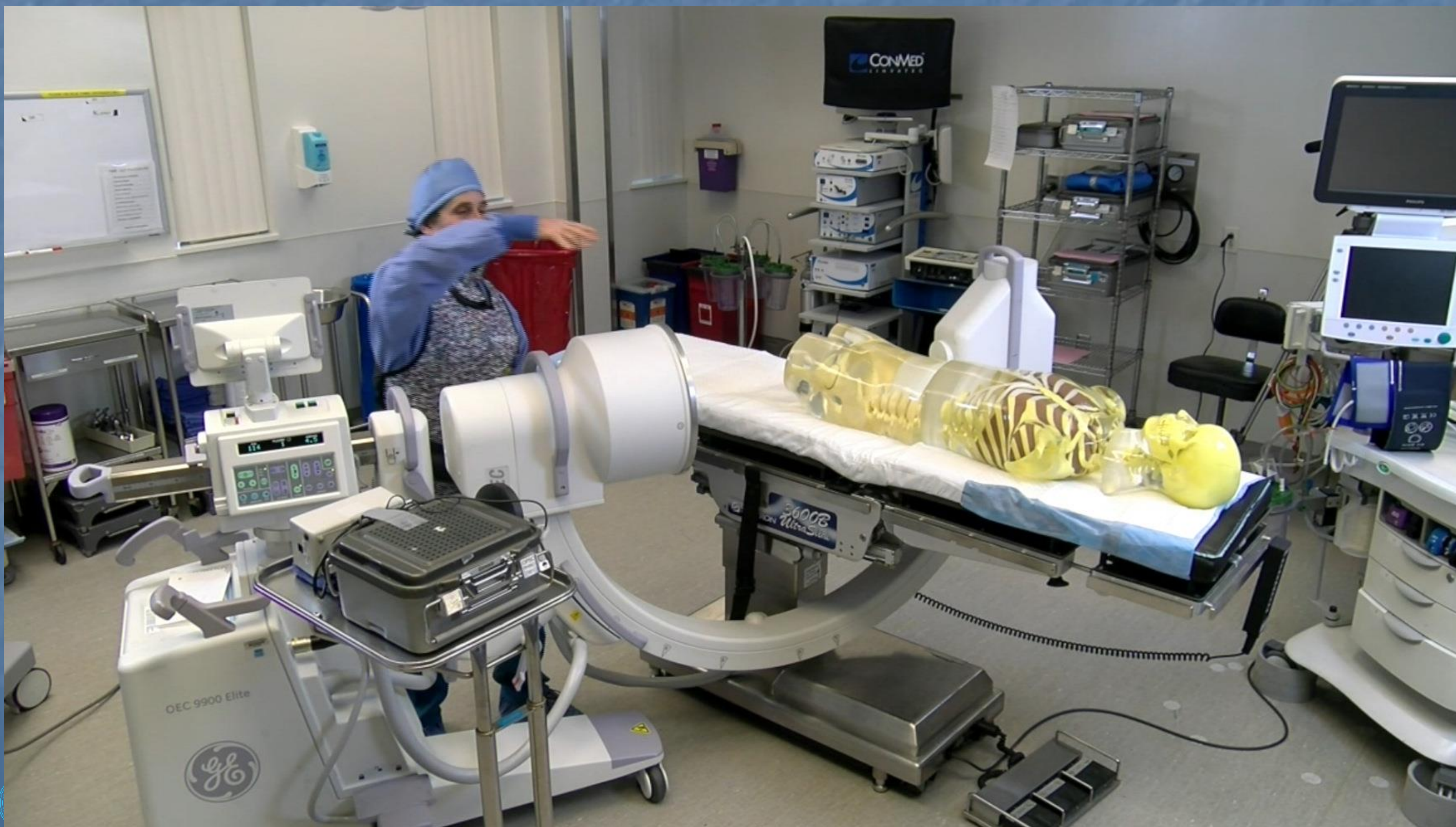
The perfect place to stand when making an exposure is directly behind the tower. You lean your head out while giving the breathing instructions, then move your head back behind the tower while making the exposure.



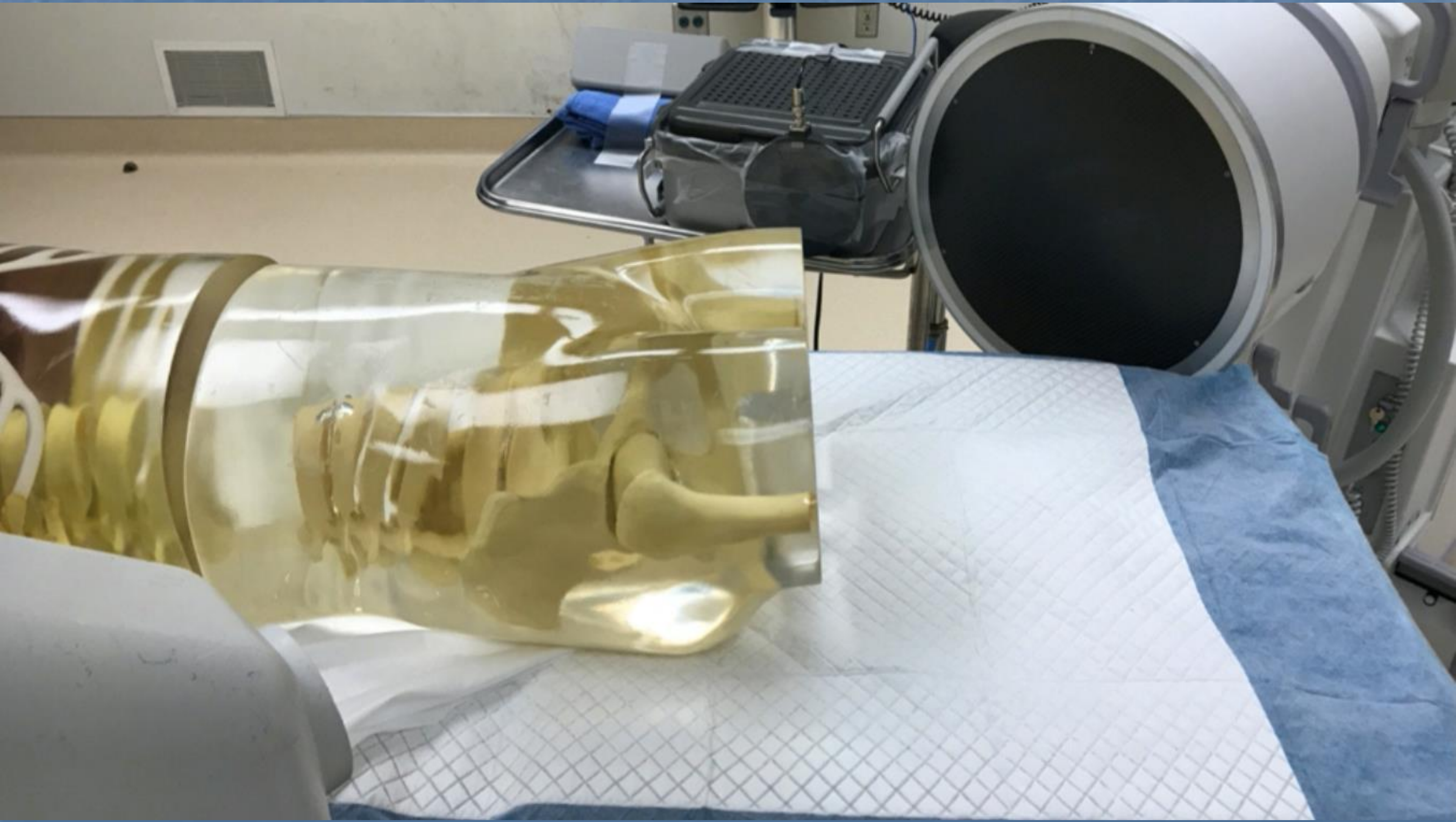
X-TABLE LATERAL HIP

LOCATION OF THE LEAST AMOUNT OF SCATTER

I always thought ours was the bad side as the exiting radiation was now larger than the II and would keep coming back towards the tech.



We are starting on the radiographers side. Ion chamber at 60 degrees toward feet at **18”**.

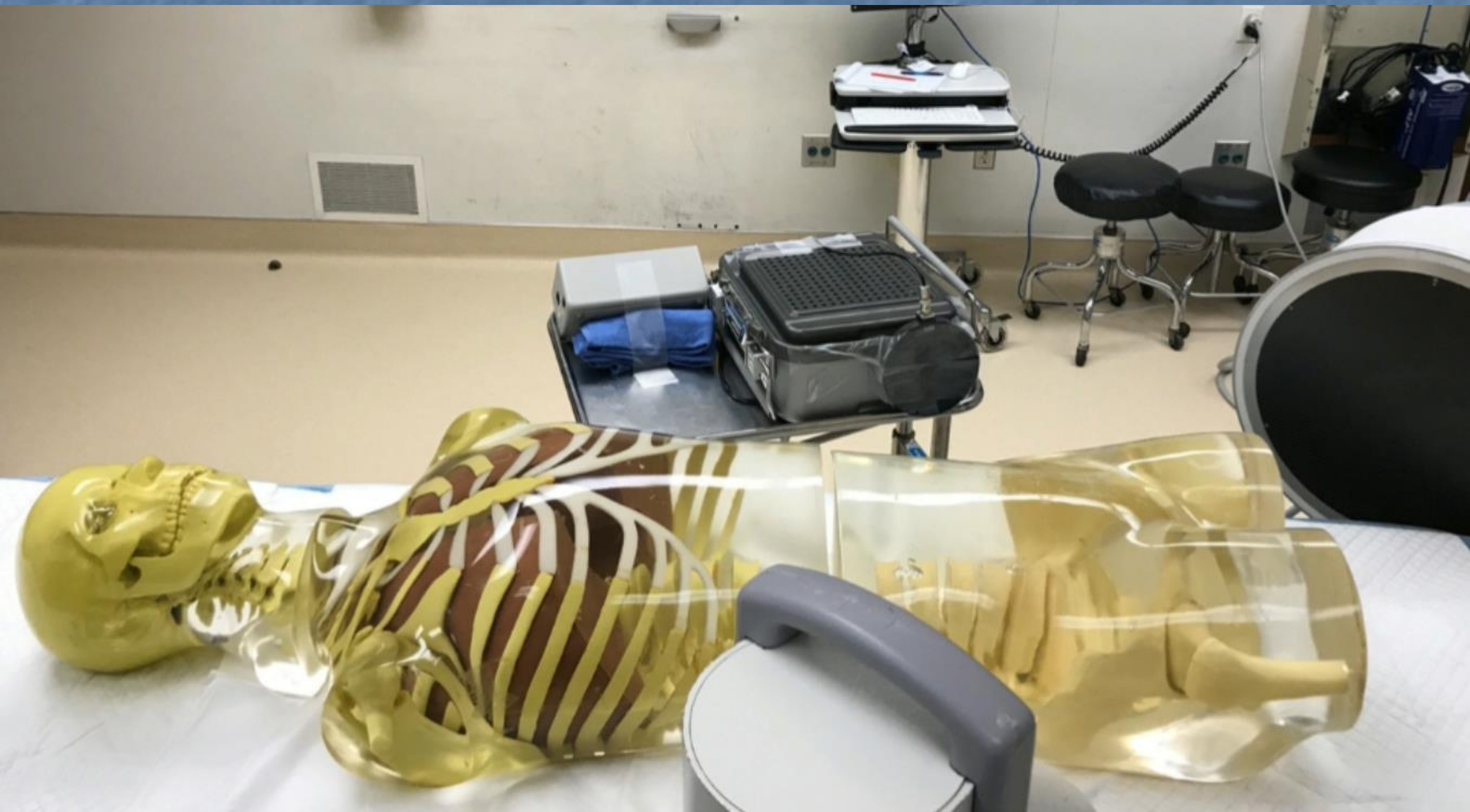


Split Second Exposure (SSE) = 9.4 μR
Spot exposure = 17.7 μR

Ion chamber on techs side at 90 degrees at 18”

SSE = 6.7 μR
Spot exposure = 15.6 μR

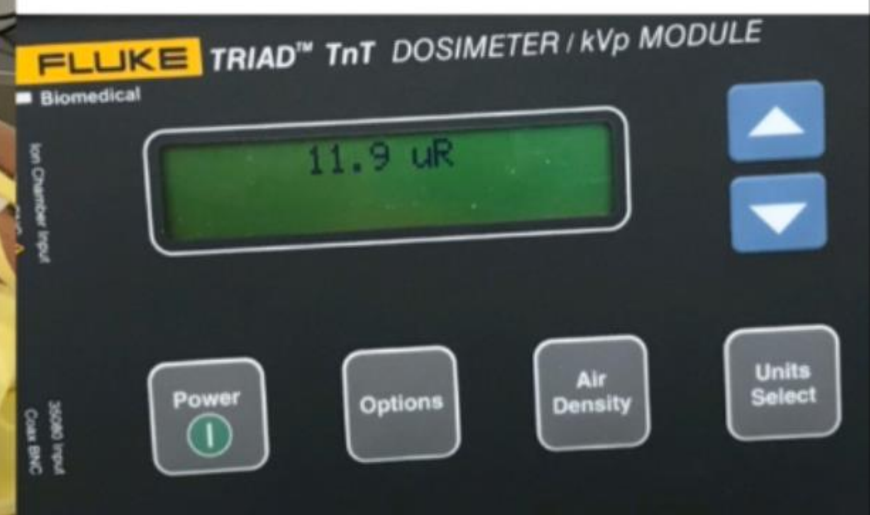
Ion chamber at 60 degrees toward head at 18".



SSE = 5.3 μR
Spot exposure = 12.8 μR

Ion chamber at 45 degrees toward head at 18".

SSE = 4.0 µR
Spot exposure = 11.9 µR



Ion chamber on MD’s side at 60 degrees towards the head at 18”.

SSE = 0.417 mR
Spot exposure = 0.969 mR

Ion chamber at 90 degrees at 18”.

SSE = 0.381 mR
Spot exposure = 0.881 mR

Ion chamber at 60 degrees towards feet at 18”.

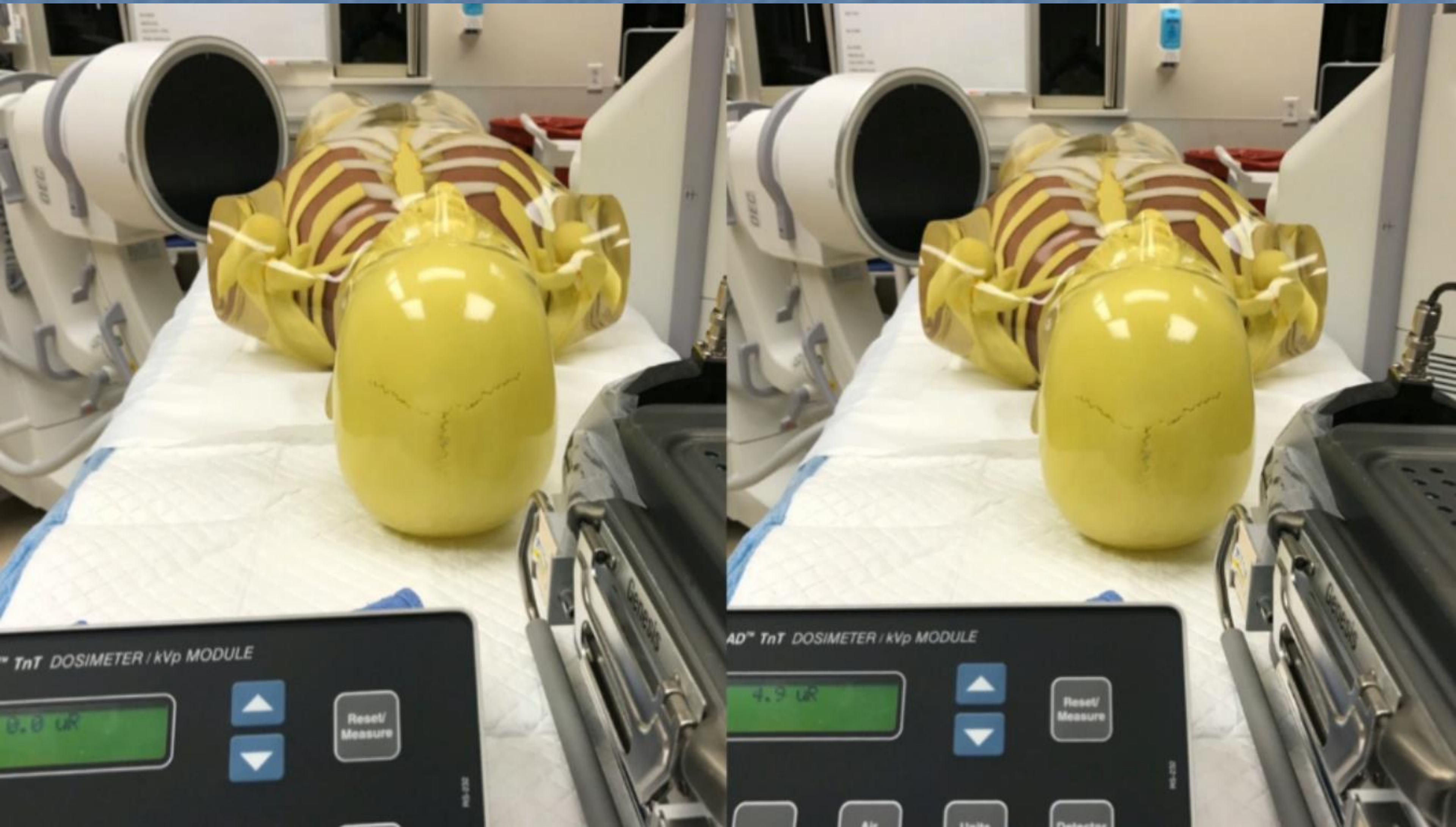
SSE = 0.273 mR
Spot exposure = 0.628 mR

Ion chamber at 45 degrees towards feet at 18”.

SSE = 0.203 mR
Spot exposure = 0.468 mR

Ion chamber on right side of head at 18”.

SSE = 0.0 μR
Spot exposure = 4.9 μR



Ion chamber on left side of head at 18".

SSE = 0.0 μR
Spot exposure = 0.0 μR

Here are the differences between the surgeon and the tech side of the table.
All of the surgeon side readouts are now in MicroR's (uR).

- 45 degrees to head - 11.9 vs 468 = 39 times more
- 60 degrees to head - 12.8 vs 628 = 49 times more
- 90 degrees to pt. - 15.6 vs 881 = 56 times more
- 60 degrees to foot - 17.7 vs 969 = 54 times more

Proving that everyone on the tube side is getting infinitely more radiation than the II side and it is your job to protect them as well as you can.

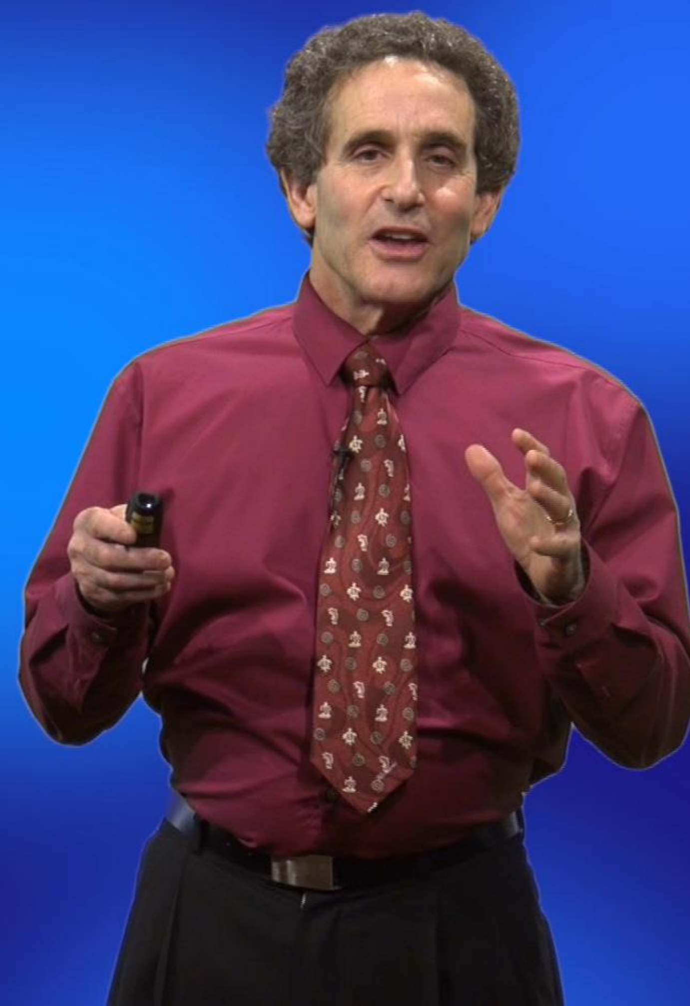
DEMONSTRATION OF THE INVERSE SQUARE LAW

We added this chart to remind you when you double the distance, you will have 1/4th of the dose, when you triple the distance you have 1/9th the dose, and when you quadruple the distance you have 1/16th the dose.

The Inverse Square Law

Distance from source	Intensity	Inverse square relationship
∞	I	I
2 ∞	$\frac{I}{4}$	$\frac{I}{2^2}$
3 ∞	$\frac{I}{9}$	$\frac{I}{3^2}$
4 ∞	$\frac{I}{16}$	$\frac{I}{4^2}$

FRP



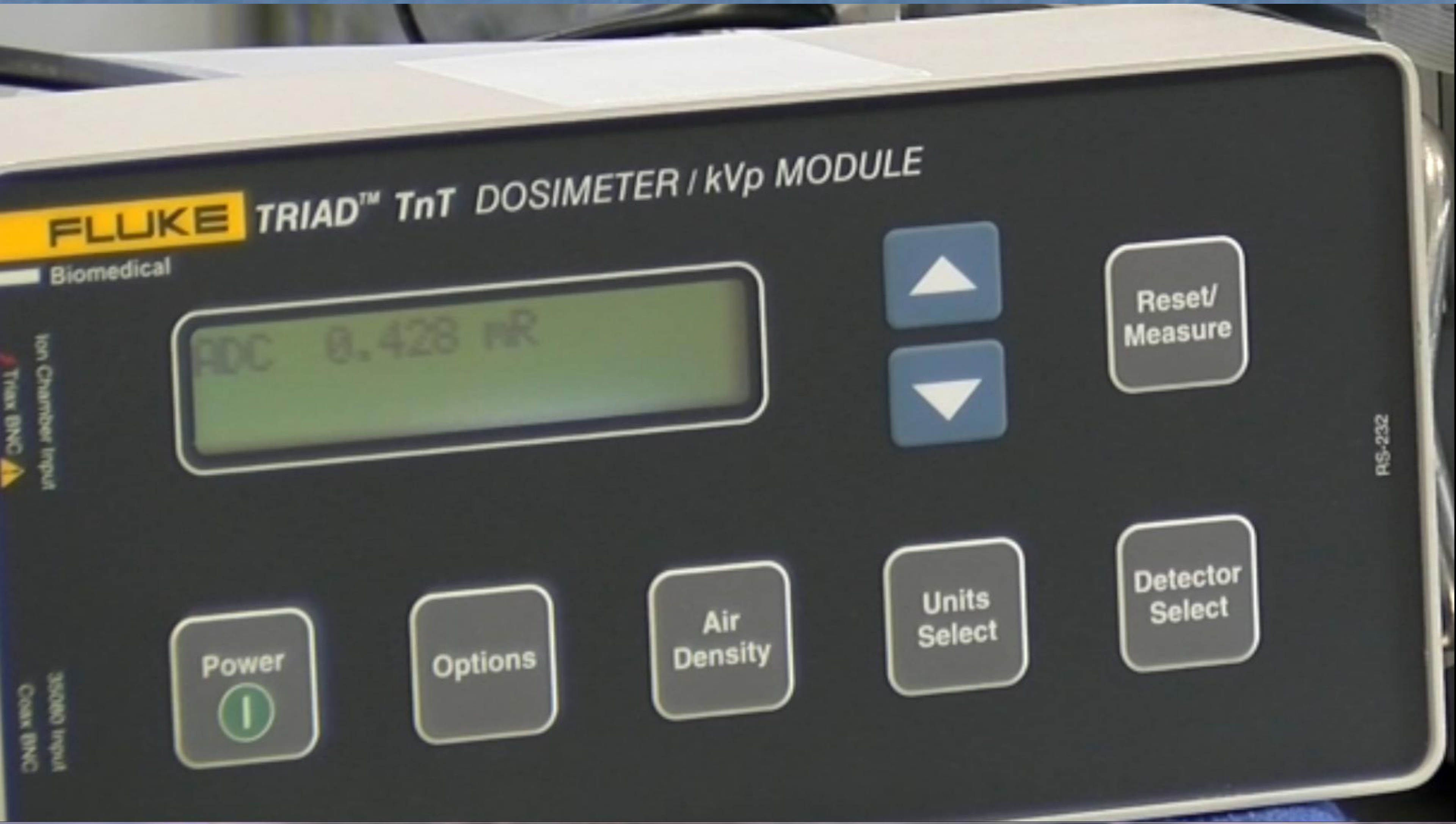
We wanted to use the C-Arm so that you can see how important it is to get distance when you can because there is no lead shield hanging to protect you.

We made exposures at 2', 4', 6' and 8'. Exposures will be with the digital spot, so they'll all be identical.

The ion chamber is at a height even with the middle of the phantom.

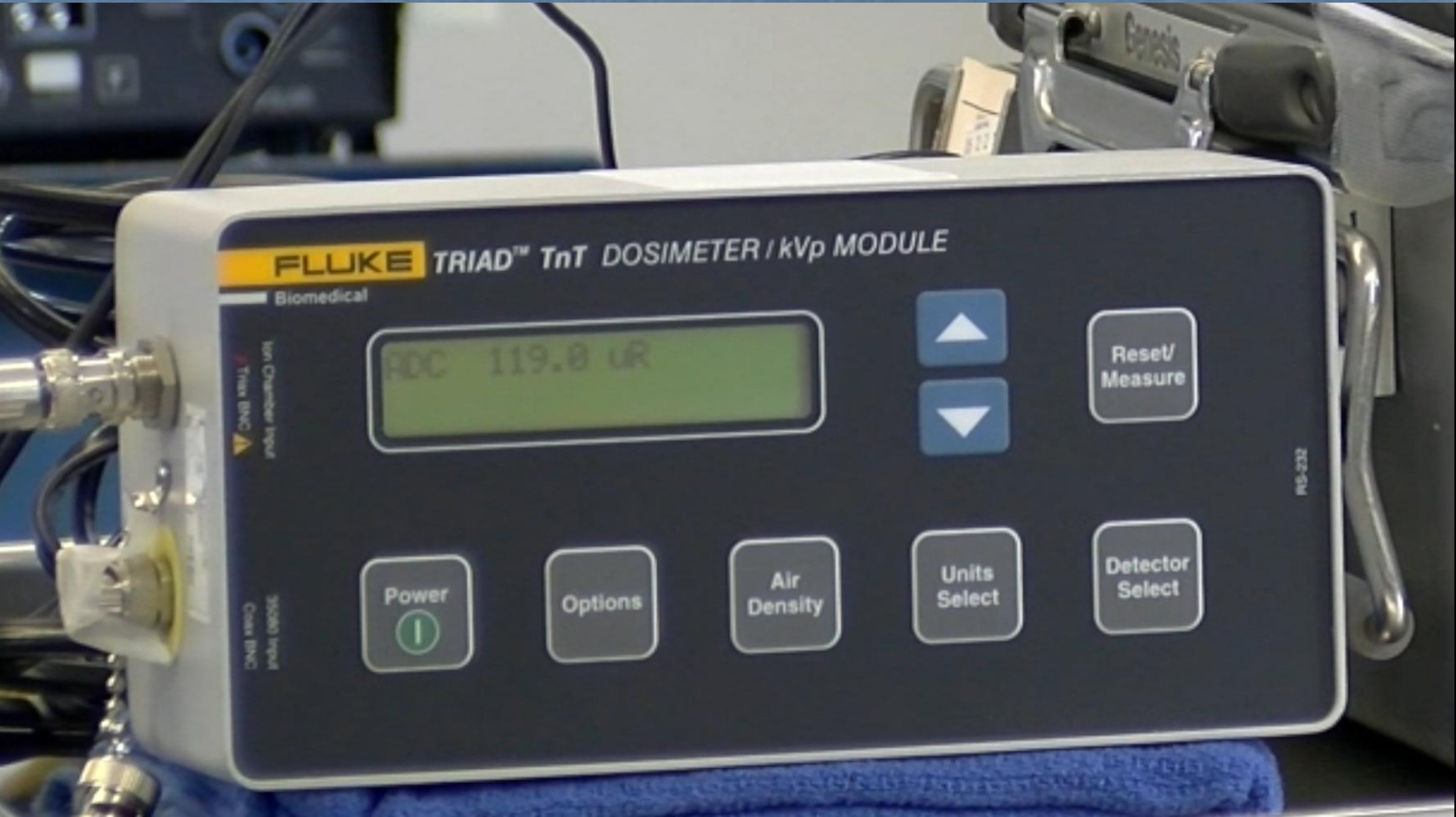
Here is the first exposure at 2'.

The readout at 2’ is 0.428 mR.



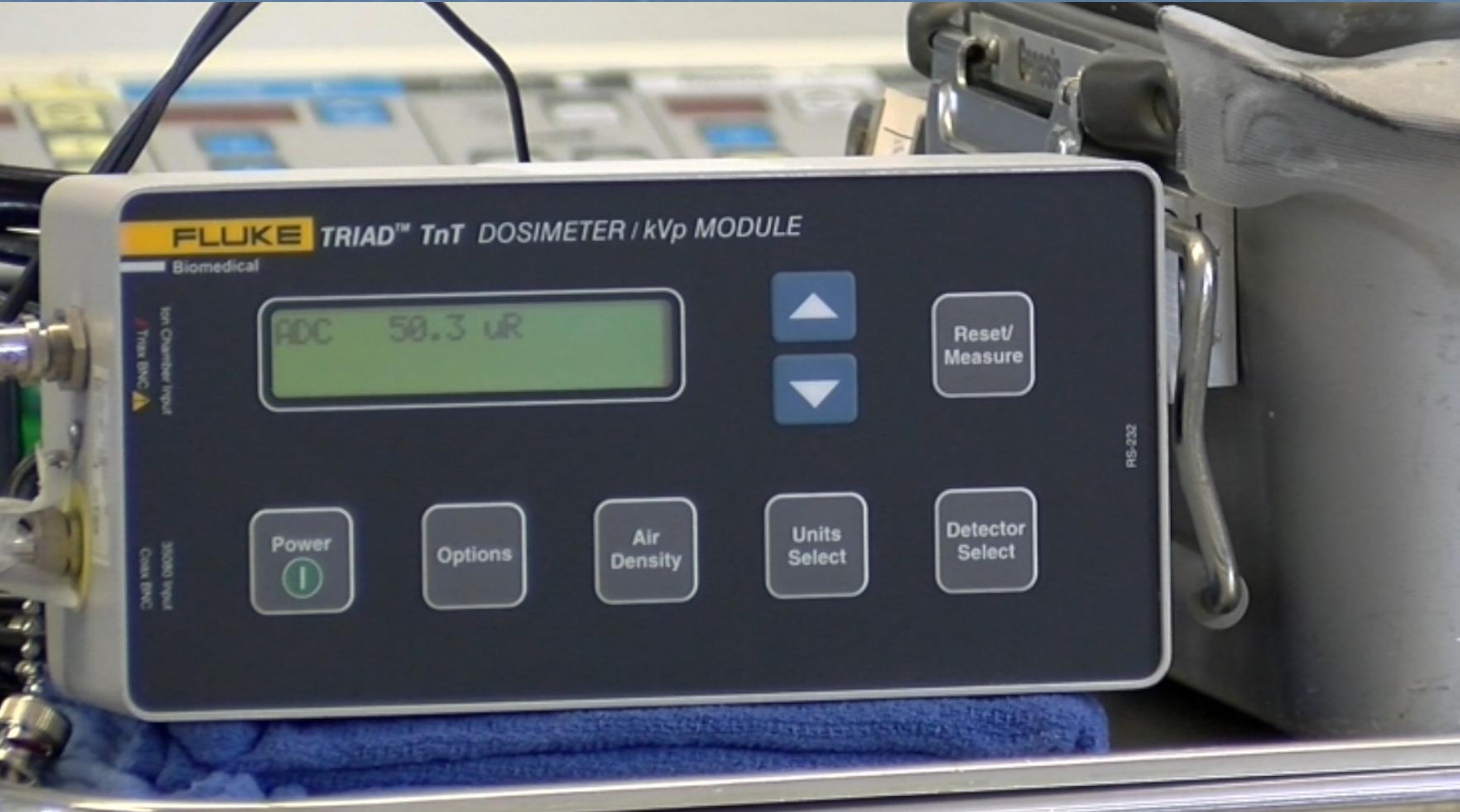
Here we are at 4 feet.

The readout at 4’ is 119.0 µR.



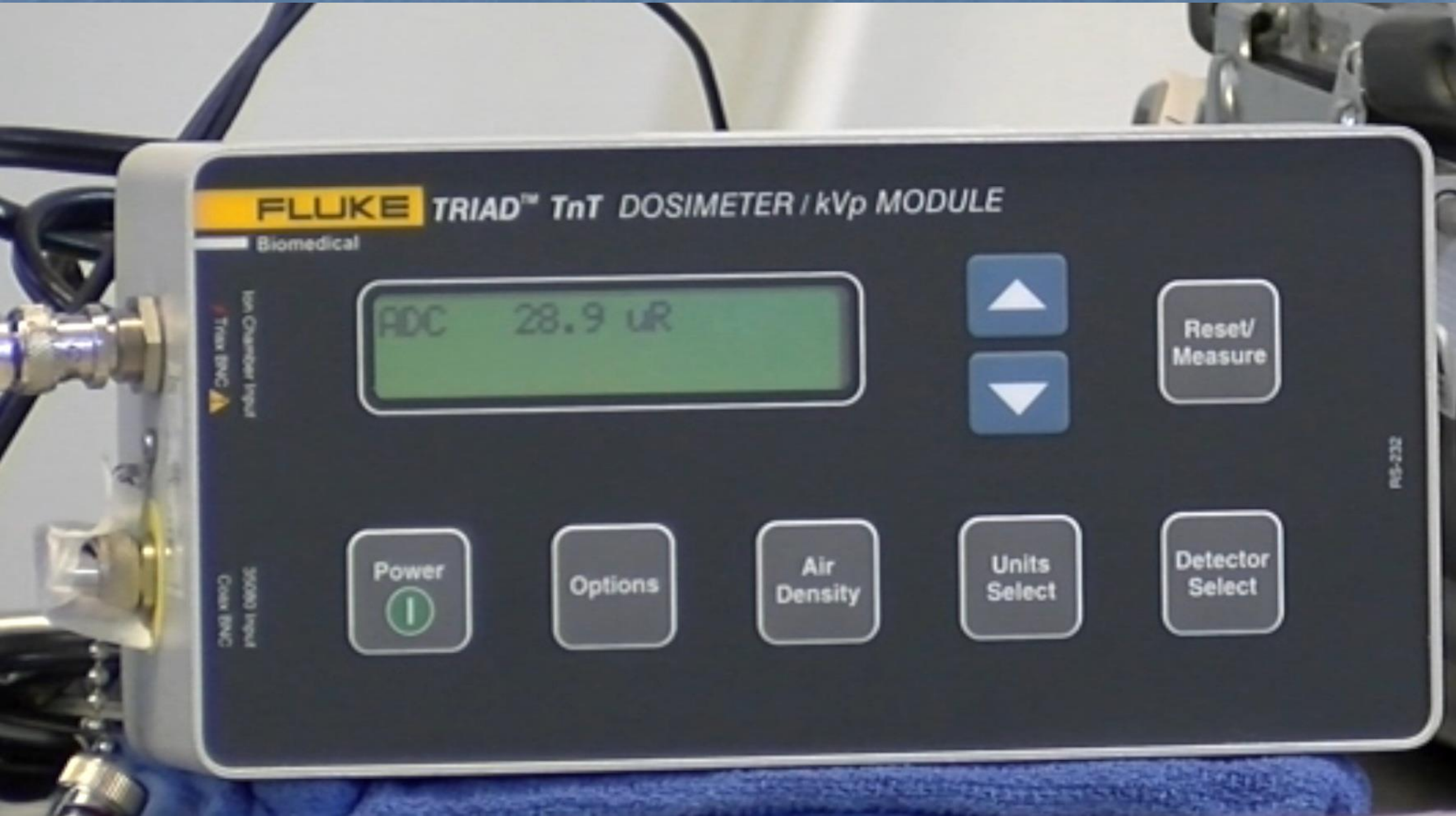
Now we have the ion chamber at 6’.

The readout at 6’ is 50.3 μR.

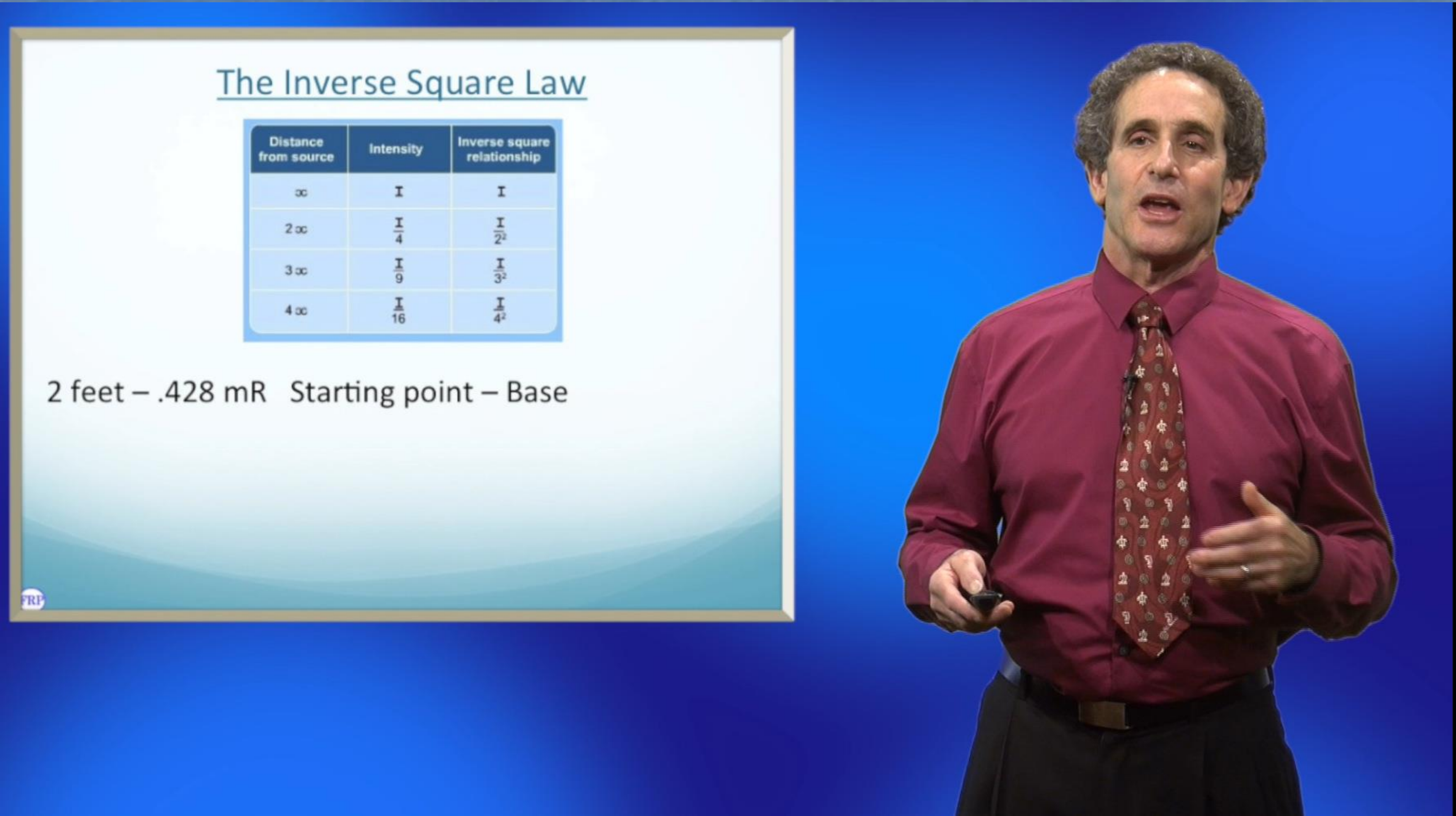


Now we're at 8'.

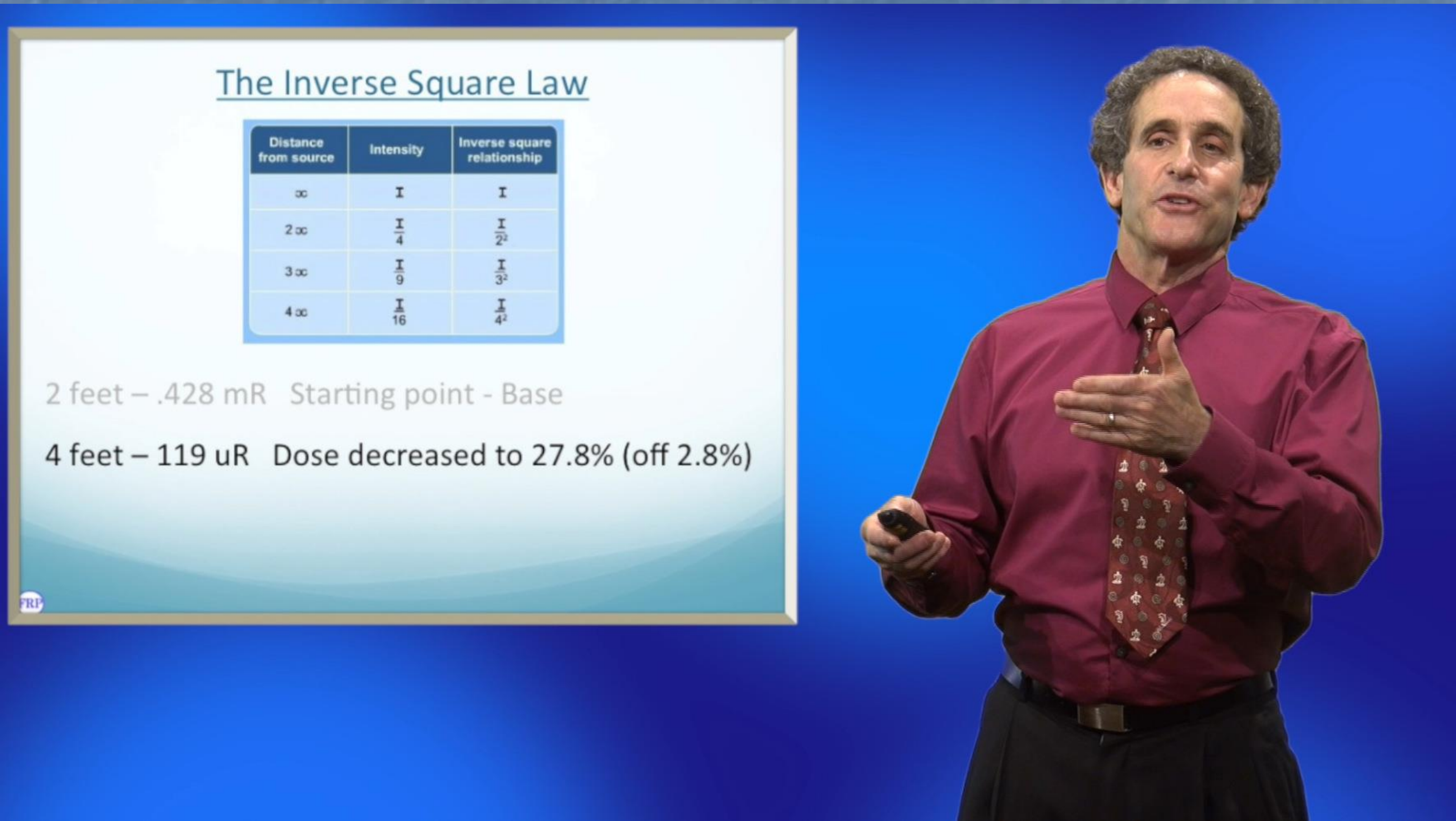
The readout at 8' is 28.9 μR.



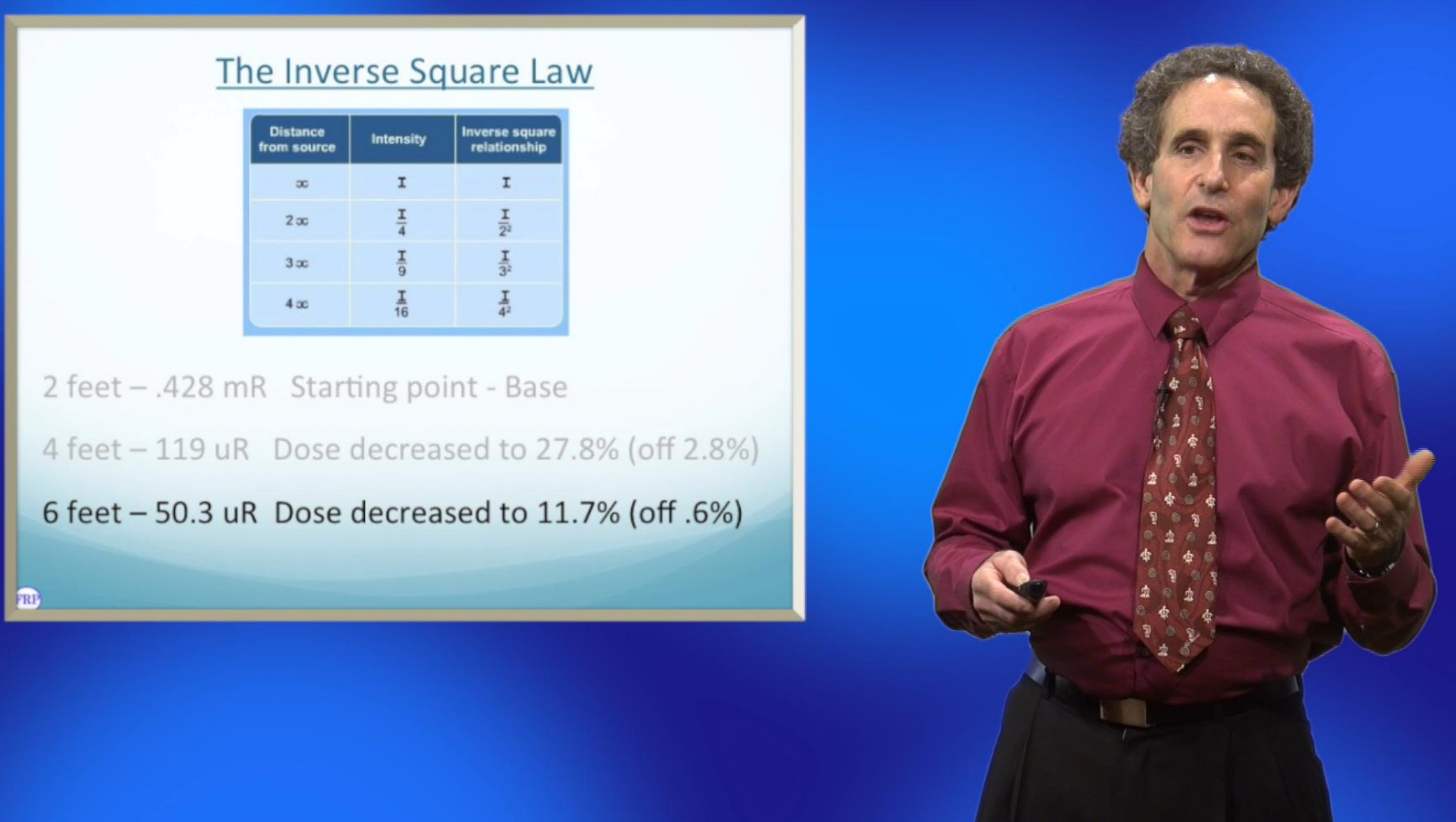
2’ was our starting point or base - .428 mR



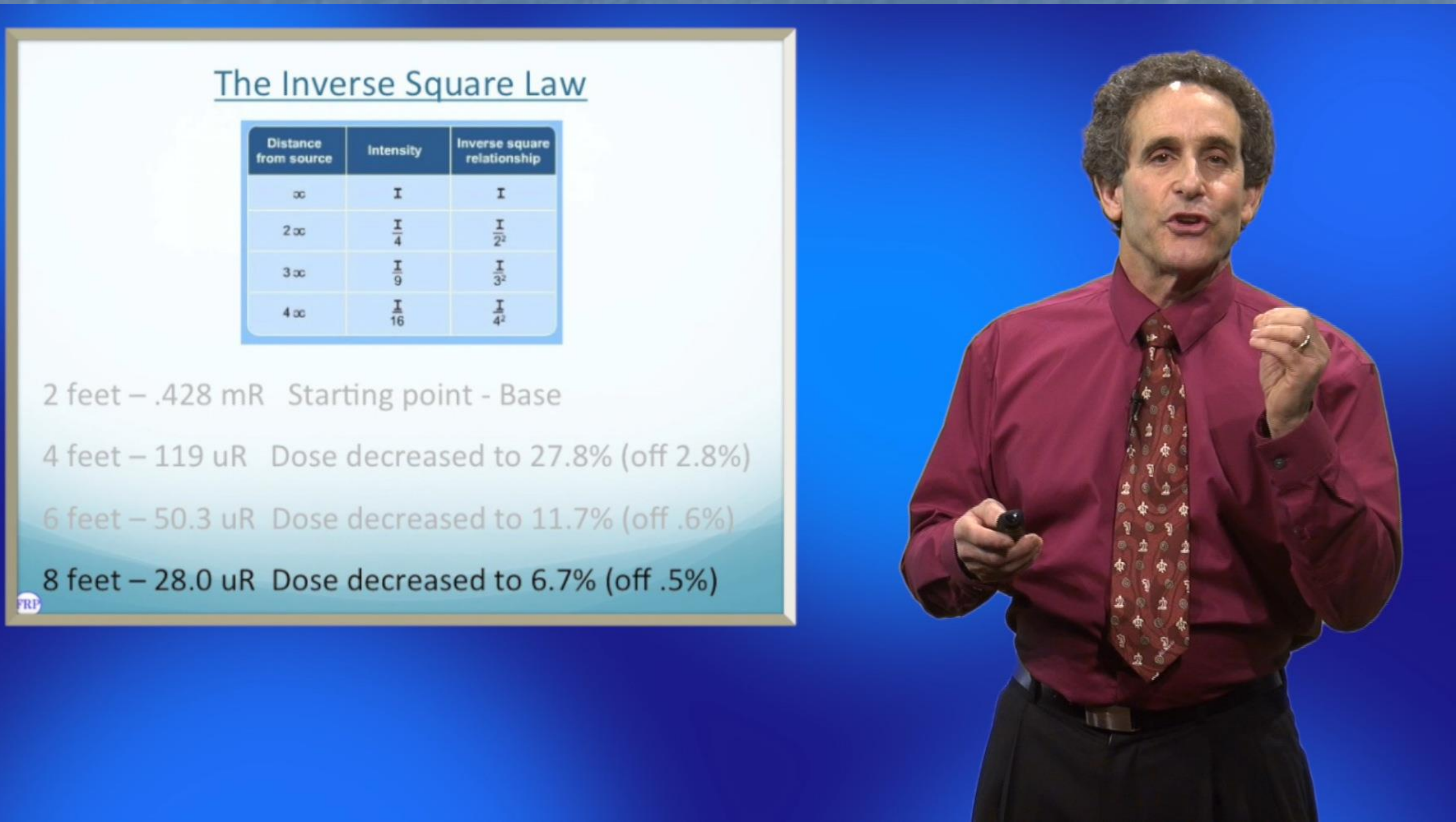
At 4’ the dose decreased to 119 μR, which is 27.8%. A perfect ¼ would have been 25%, so we were only off by 2.8%.



At 6’ the dose decreased to 50.3 µR, which is 11.7%. A perfect 1/9 would have been 11.1%, so we were only off by .6%.



At 8' the dose decreased to 28.0 µR, which is 6.7%. A perfect 1/16 would have been 6.2%, so we were only off by .5%.



This demonstration was to show you that whenever possible, don't ever be this close to your patient.

Instead, be here.

But you'd rather be here.

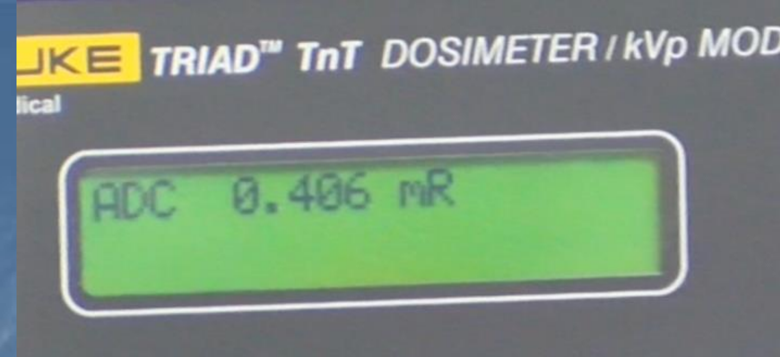
Although this is better.

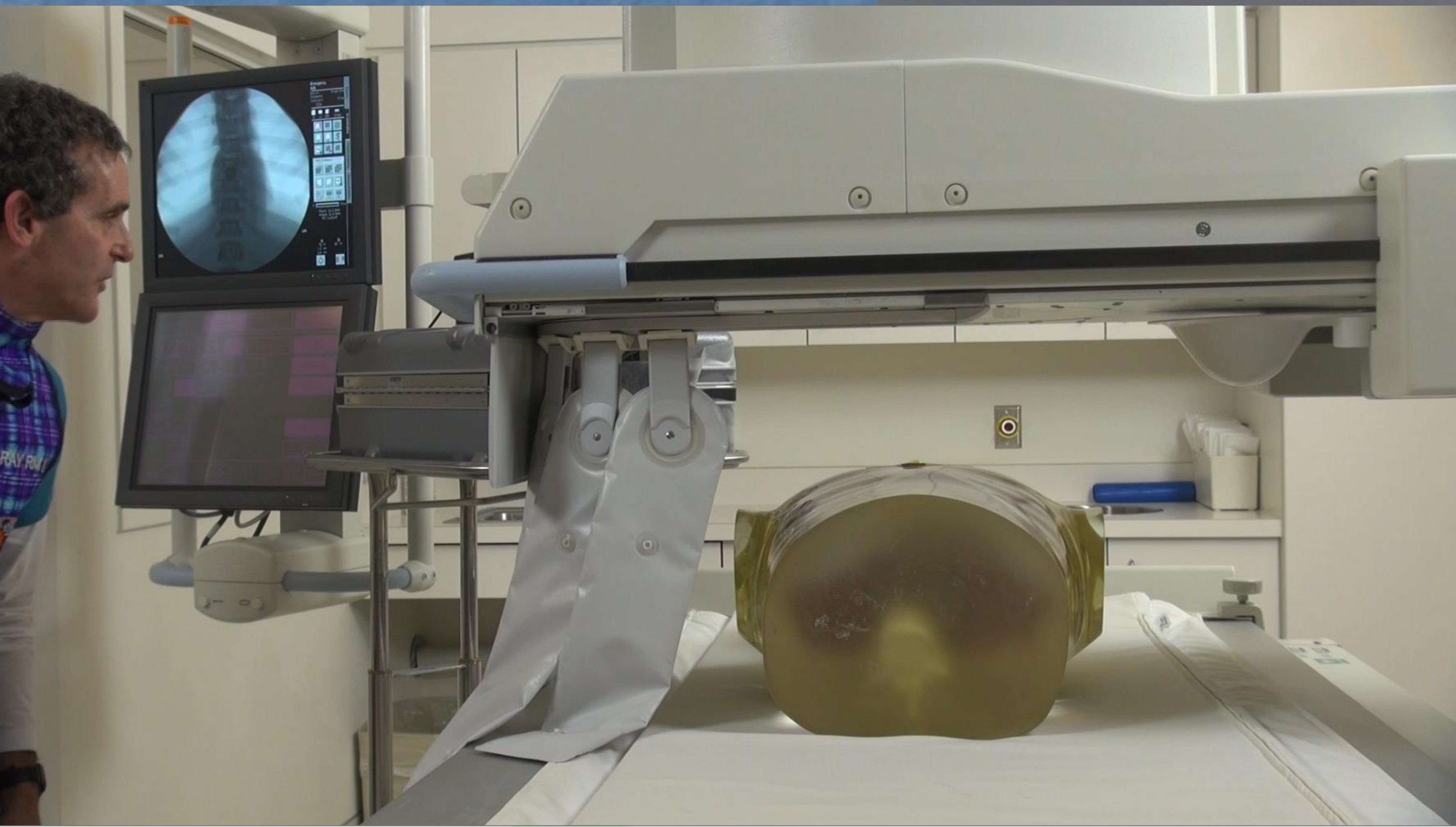
Of course, stepping back as far as the cord will allow is always the best place to stand, **because distance is your friend!!**

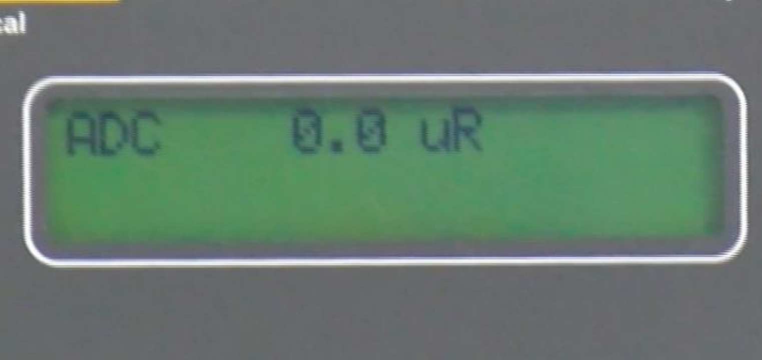
ION CHAMBER AT HEAD, 45, AND 90 DEGREES IN R/F ROOM

Ion chamber just above top of phantom, 18” away.

Ion chamber same height and distance but now at 45 degrees.







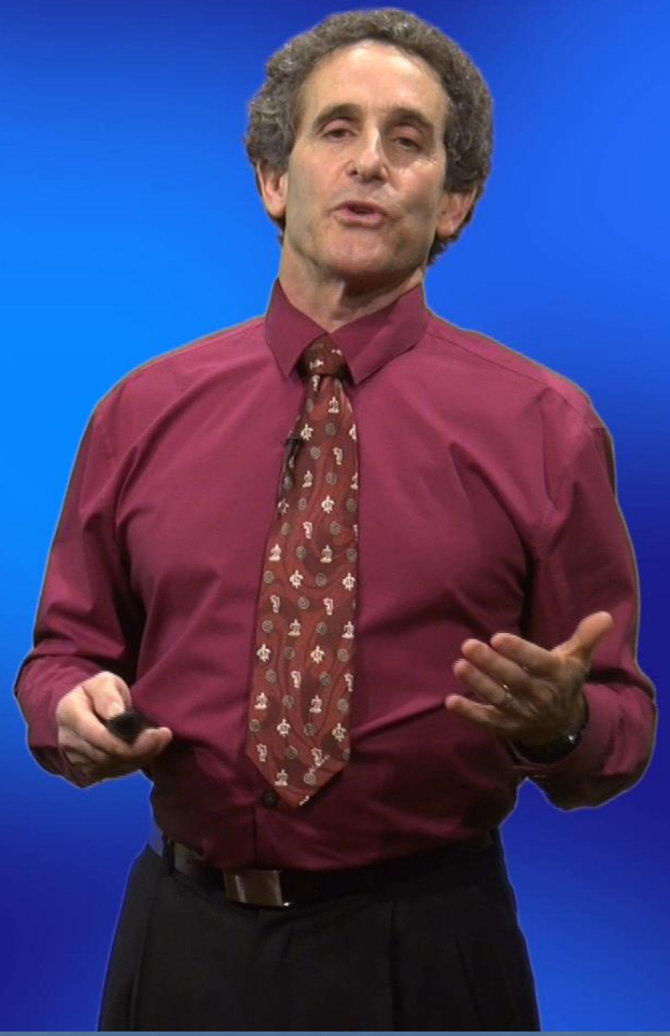
Ion chamber at 90 degrees with lead apron hanging.

Ion chamber still at 90 degrees, but with lead apron removed.

Ion chamber at foot end.

Scatter at the Head, 45, 90, Foot in R/F Room

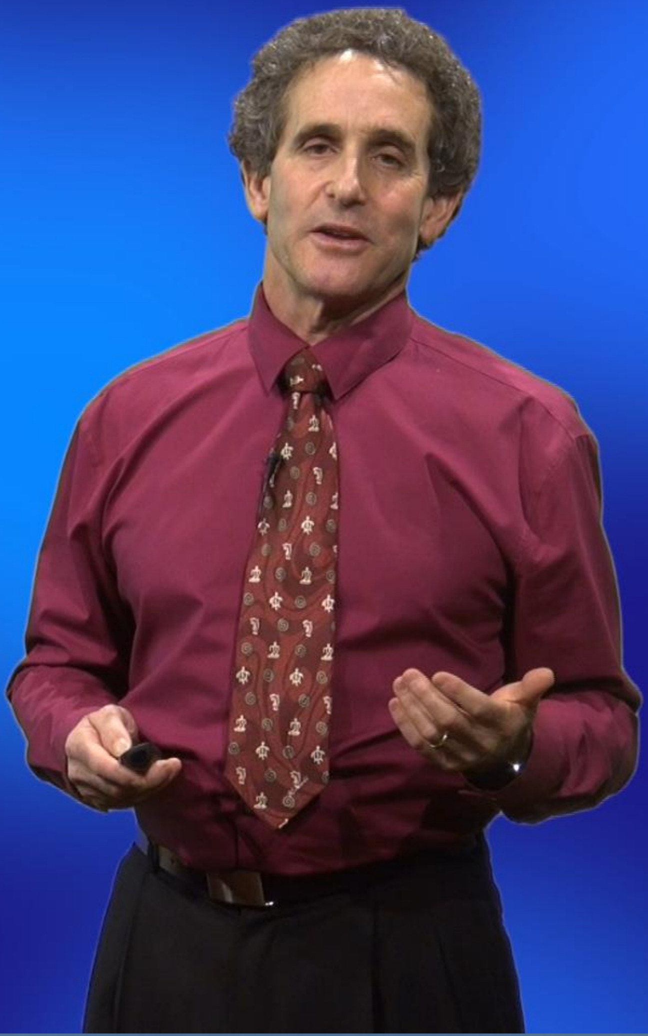
Foot	0.207 mR



Scatter at the Head, 45, 90, Foot in R/F Room

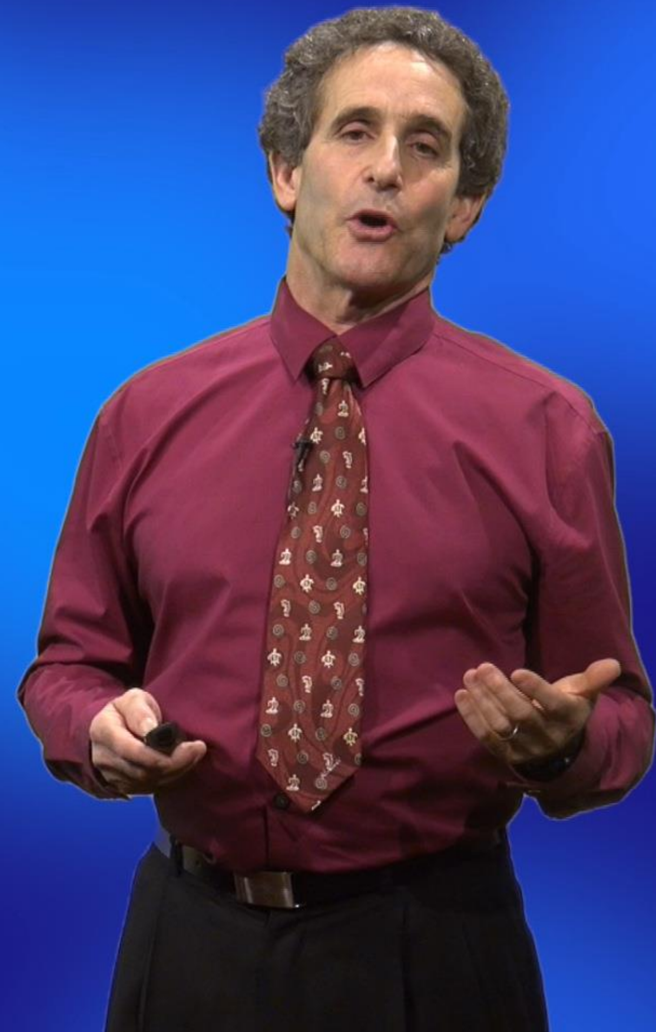
Foot 0.207 mR

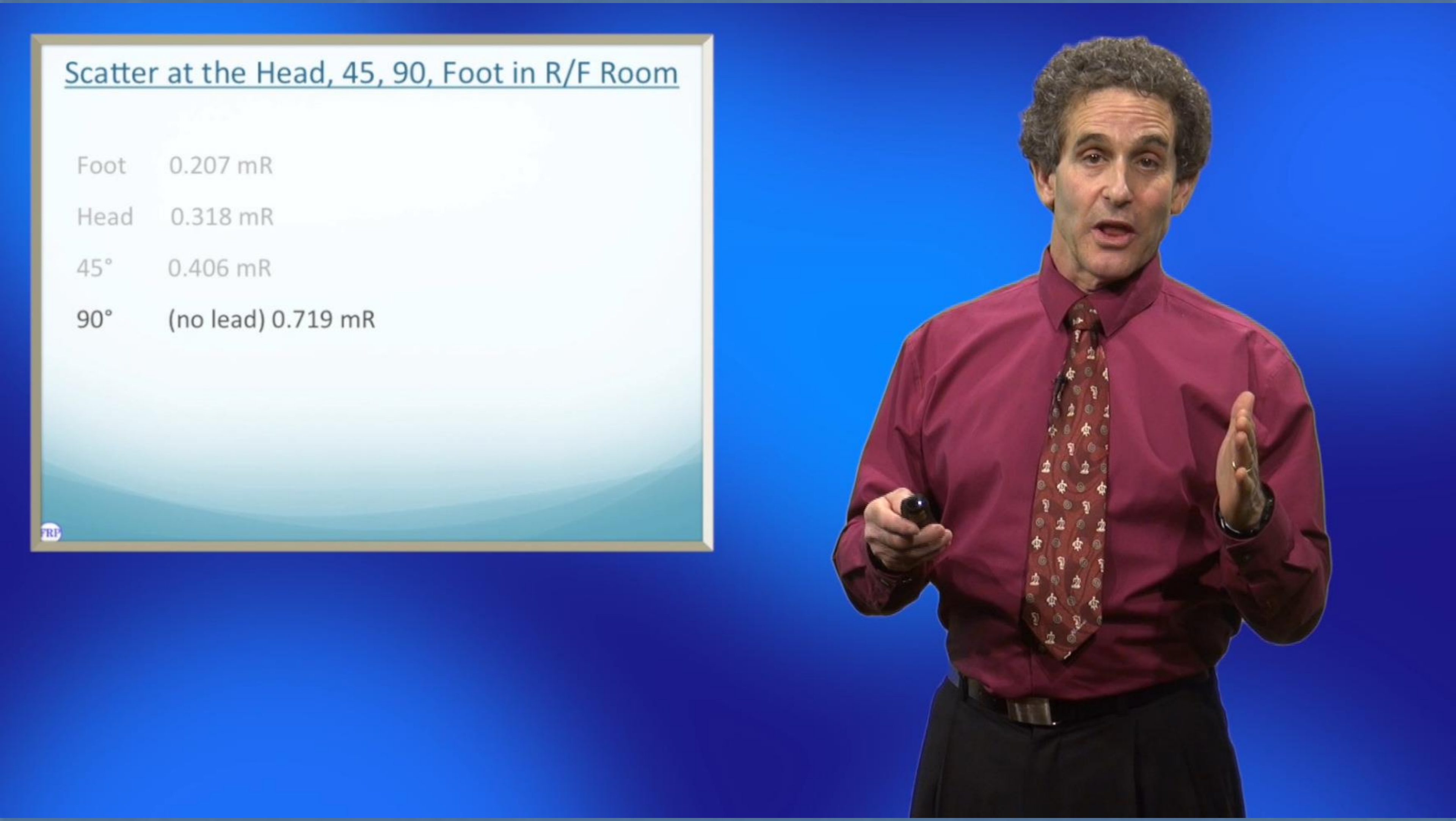
Head 0.318 mR



Scatter at the Head, 45, 90, Foot in R/F Room

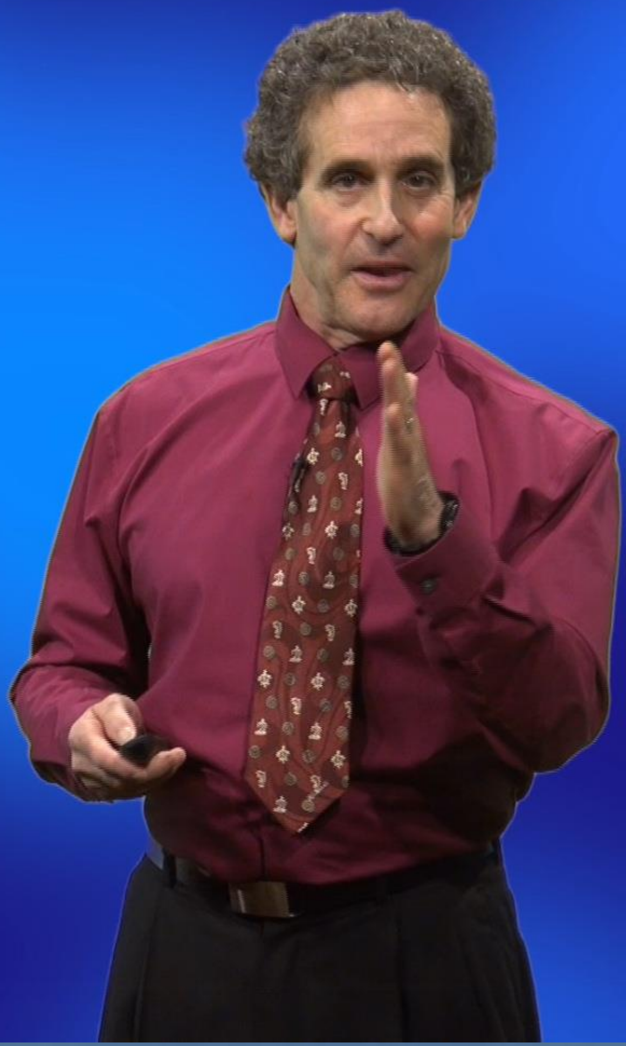
Foot	0.207 mR
Head	0.318 mR
45°	0.406 mR




Scatter at the Head, 45, 90, Foot in R/F Room
Foot 0.207 mR
Head 0.318 mR
45° 0.406 mR
90° (no lead) 0.719 mR

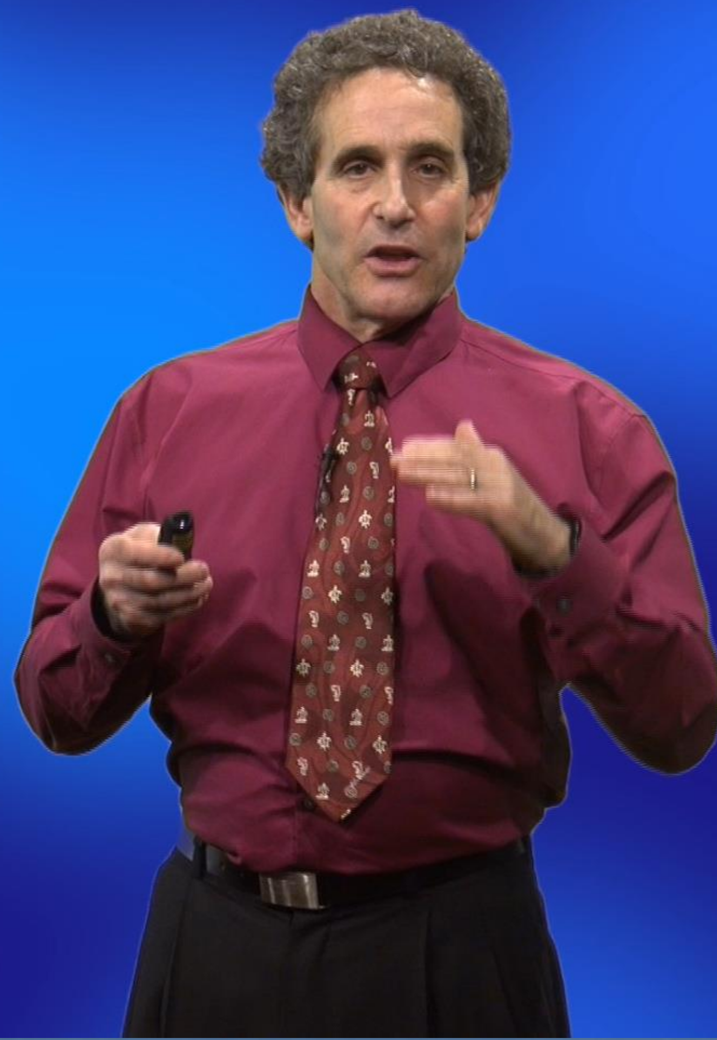
Scatter at the Head, 45, 90, Foot in R/F Room

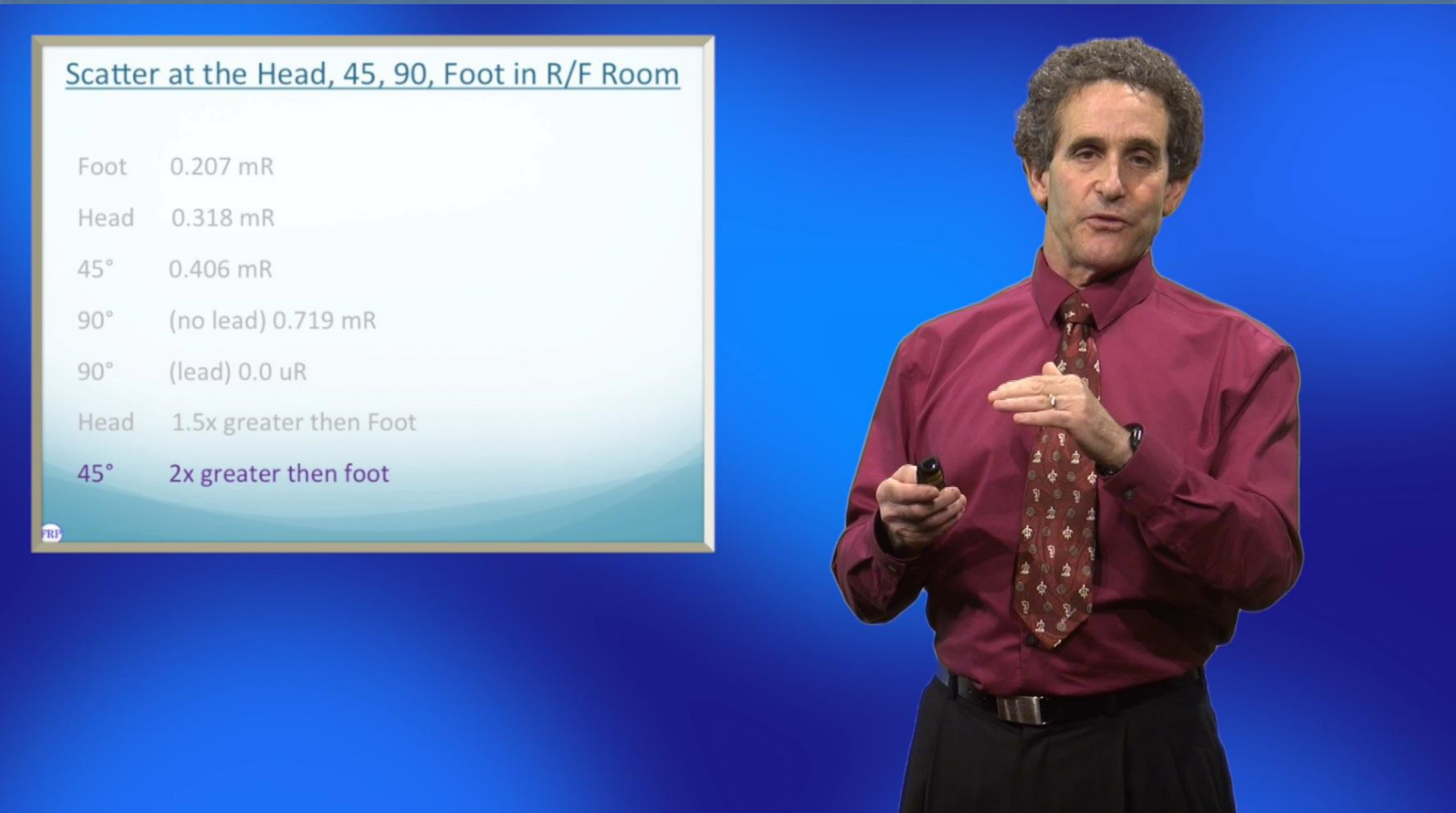
- Foot 0.207 mR
- Head 0.318 mR
- 45° 0.406 mR
- 90° (no lead) 0.719 mR
- 90° (lead) 0.0 uR



Scatter at the Head, 45, 90, Foot in R/F Room

Foot	0.207 mR
Head	0.318 mR
45°	0.406 mR
90°	(no lead) 0.719 mR
90°	(lead) 0.0 uR
Head	**1.5x greater then Foot**

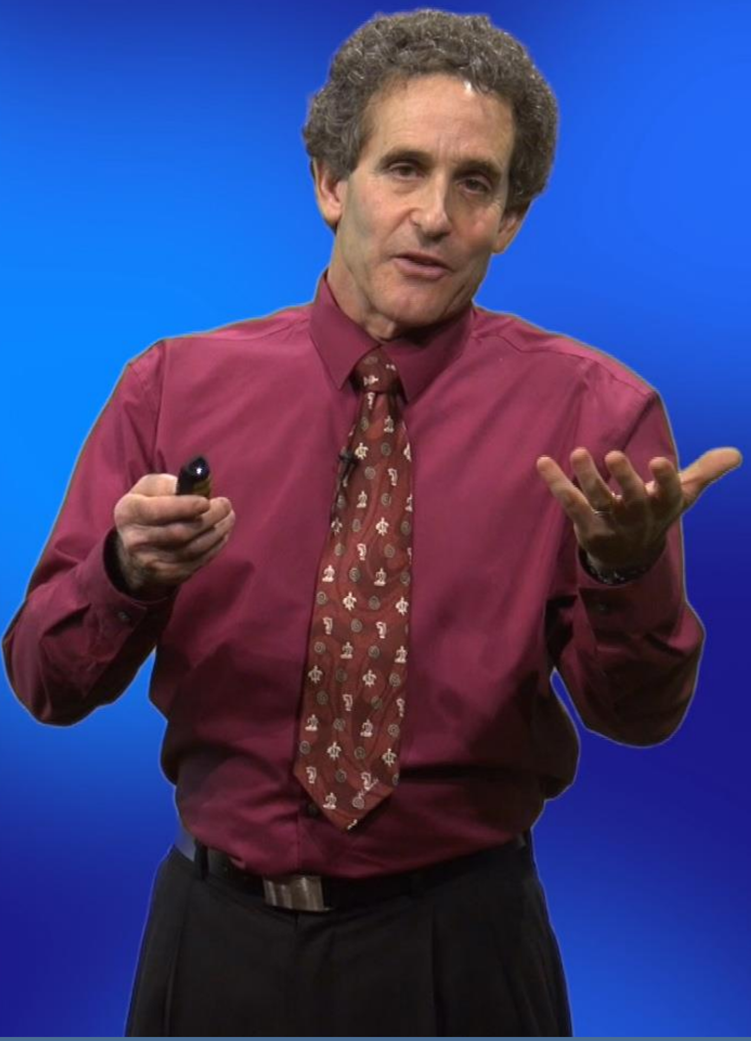



Scatter at the Head, 45, 90, Foot in R/F Room
Foot 0.207 mR
Head 0.318 mR
45° 0.406 mR
90° (no lead) 0.719 mR
90° (lead) 0.0 uR
Head 1.5x greater then Foot
45° 2x greater then foot

Perfect Isometric Curve

Scatter at the Head, 45, 90, Foot in R/F Room

Foot	0.207 mR
Head	0.318 mR
45°	0.406 mR
90°	(no lead) 0.719 mR
90°	(lead) 0.0 uR
Head	1.5x greater then Foot
45°	2x greater then foot
90°	(no lead) 3.5x greater then foot



LEAD APRONS

This experiment was to show the difference in dose getting through a .25, .375 and .5 equivalent lead shield (using the .5 as the standard). The tube is set at 40" and is collimated to a 12"x12."

The .25 and .375 aprons are letting through anywhere between 1.3 to over 22.3 times more radiation!!

Lead Apron Study, Using Abdomen Phantom w/ meter perpendicular, meter 2" away from left side. Doses are an average of three different types of lead aprons.

Lead (mm)	kV	mAs	Dose (mR)	Dose increase compared to 0.5mm lead (%)	Dose increase compared to 0.5mm lead (x)
None	81	4	0.89	29567%	296.7
0.25	81	4	0.04	1233%	13.3
0.375	81	4	0.007	133%	2.3
0.5	81	4	0.003		
None	81	8	1.84	22900%	230.0
0.25	81	8	0.08	900%	10.0
0.375	81	8	0.02	150%	2.5
0.5	81	8	0.008		
None	81	16	3.76	16248%	163.5
0.25	81	16	0.173	652%	7.5
0.375	81	16	0.043	87%	1.9
0.5	81	16	0.023		
None	102	2	0.91	9000%	91.0
0.25	102	2	0.063	530%	6.3
0.375	102	2	0.017	70%	1.7
0.5	102	2	0.01		
None	102	4	1.88	7420%	75.2
0.25	102	4	0.137	448%	5.5
0.375	102	4	0.037	48%	1.5
0.5	102	4	0.025		
None	102	8	3.81	7838%	79.4
0.25	102	8	0.283	490%	5.9
0.375	102	8	0.093	94%	1.9
0.5	102	8	0.048		
None	125	1	0.79	2533%	26.3
0.25	125	1	0.67	2133%	22.3
0.375	125	1	0.13	333%	4.3
0.5	125	1	0.03		
None	125	2	1.61	3925%	40.3
0.25	125	2	0.157	293%	3.9
0.375	125	2	0.053	33%	1.3
0.5	125	2	0.04		
None	125	4	3.29	4810%	49.1
0.25	125	4	0.34	407%	5.1
0.375	125	4	0.14	109%	2.1
0.5	125	4	0.067		

dRs

Here's an experiment to see the difference between .25mm and .5mm lead aprons at a distance of 2-6 ft. Done at 90 and 60 degrees to the patient.

The abdomen phantom is on top of 6 inches of polyethylene to simulate a 250 lb ERCP patient. The roller shield has a .5mm lead.

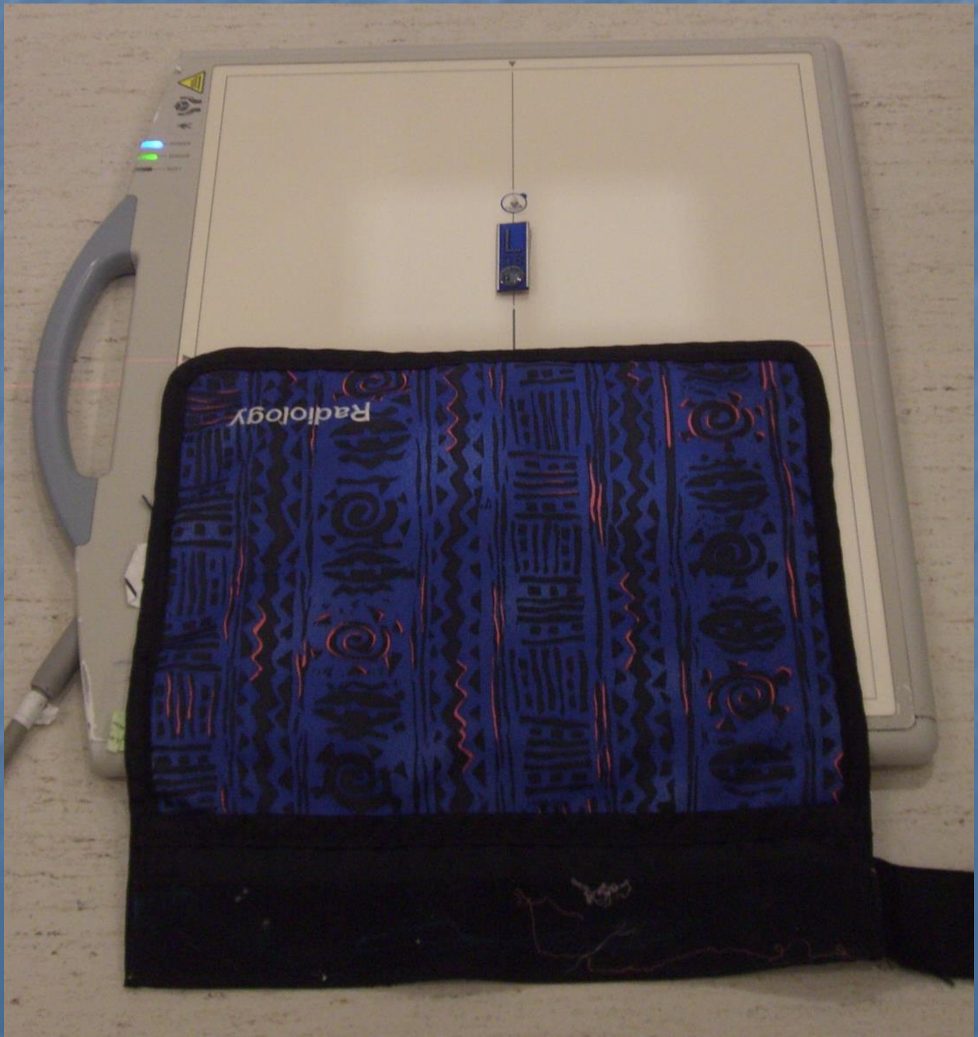
This yellow apron is .25mm.

Comparison of Lead Apron Protection

Distance (ft)	Thickness (mm)	Angle (deg)	Dose (mR)
2	0.5	90	0.012
	0.25	90	1.595
3	0.5	90	0
	0.25	90	0.834
4	0.5	90	0
	0.25	90	0.546
5	0.5	90	0
	0.25	90	0.338
6	0.5	90	0
	0.25	90	0
2	0.5	60	0
	0.25	60	1.057
3	0.5	60	0
	0.25	60	0.620
4	0.5	60	0
	0.25	60	0.389
5	0.5	60	0
	0.25	60	0

130 X's more radiation

Here’s a reminder that your lead aprons are made to protect you from scatter radiation only, **not** the primary beam.



40”   85 kV @ 16 mAs   (medium hip technique)

One .5 mm lead apron covering the R marker

40”   85 kV @ 16 mAs

Two .5 mm lead aprons covering the R marker.

dRs

40"   85 kV @ 16 mAs

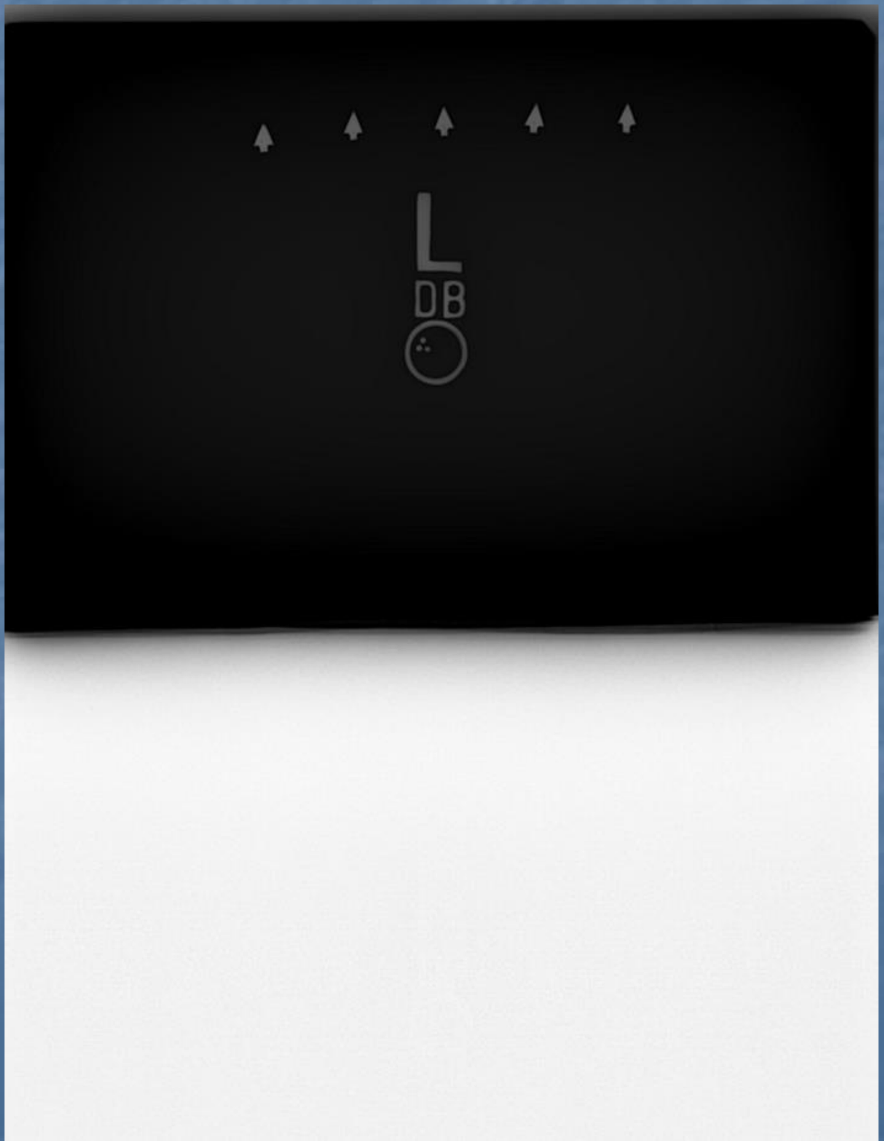
Three .5 mm lead aprons covering the R marker.

40”   85 kV @ 16 mAs

Four .5 mm lead aprons covering the R marker.

40”   85 kV @ 16 mAs

Five .5 mm lead aprons covering the R marker.



72”   113 kV @ 4 mAs   (Average gridded chest)
One .5 mm lead apron covering the R marker.

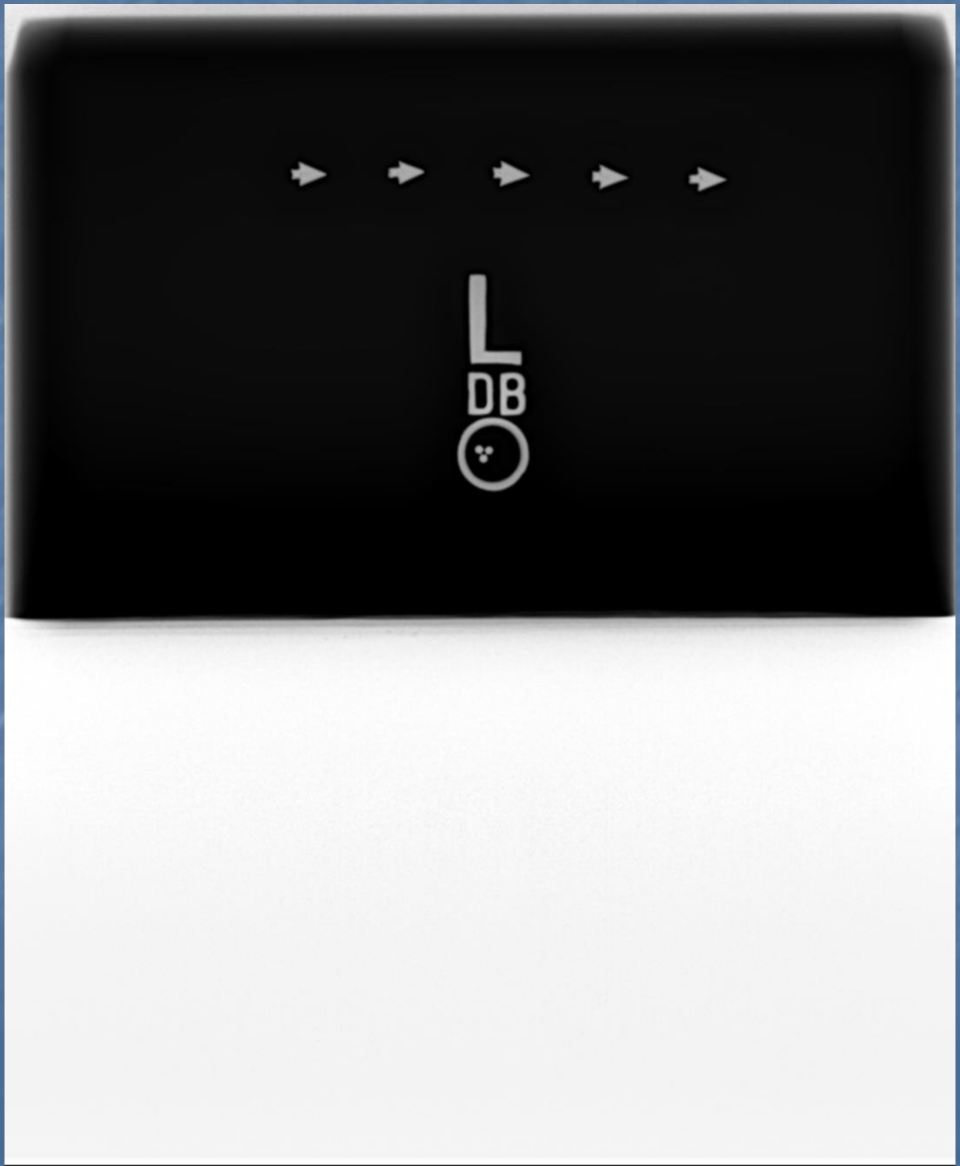
72"   113 kV @ 4 mAs
Two .5 mm lead aprons covering the R marker.

40”   113 kV @ 4 mAs
Three .5 mm lead aprons covering the R marker.

40”   113 kV @ 4 mAs

Four .5 mm lead aprons covering the R marker.

40”   113 kV @ 4 mAs
Five .5 mm lead aprons covering the R marker.



dRs

The New Shielding Debate

- In April 2019, the AAPM announced in PP 32-A "AAPM Position Statement on the Use of Patient Gonadal and Fetal Shielding" that:
- "Patient gonadal and fetal shielding during X-ray based diagnostic imaging should be discontinued as routine practice."
- "Patient shielding may jeopardize the benefits of undergoing radiological imaging. Use of these shields during X-ray based diagnostic imaging may obscure anatomic information or interfere with the automatic exposure control of the imaging system."

Continued

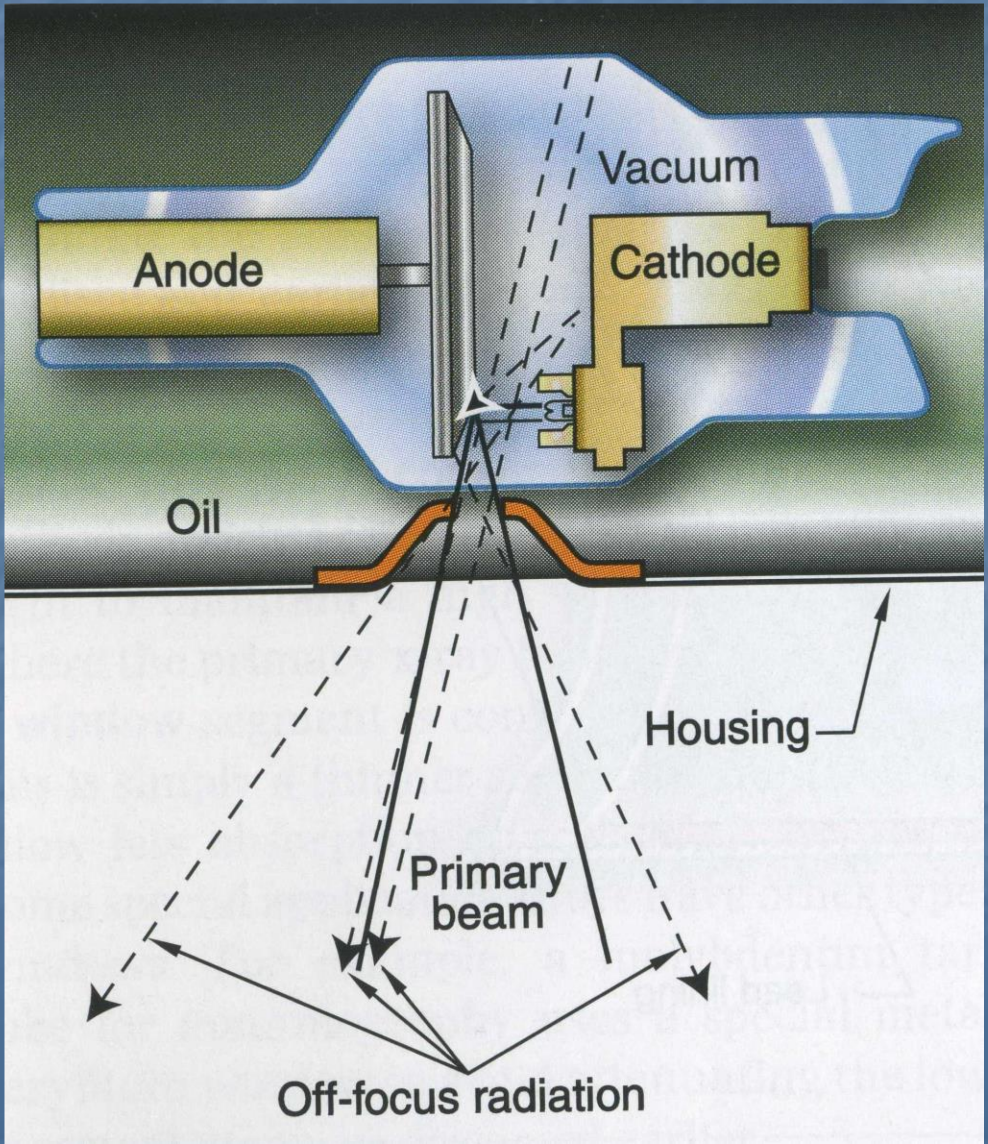
- “These effects can compromise the diagnostic efficacy of the exam, or actually result in an increase in the patient’s radiation dose.”
- “Because of these risks and the minimal to nonexistent benefit associated with fetal and gonadal shielding, AAPM recommends that the use of such shielding should be discontinued.”

The ASRT's response

- The ASRT Board of Directors immediately issued two statements in response. They were:
- The first confirmed their support to avoid contact shielding of the fetus and gonads, but only during radiographic imaging of the abdomen and pelvis.
- The second clarified that other patient shielding should continue as a best practice, if there is no risk of the shielding interfering with procedural efficacy of leading to increased patient dose.

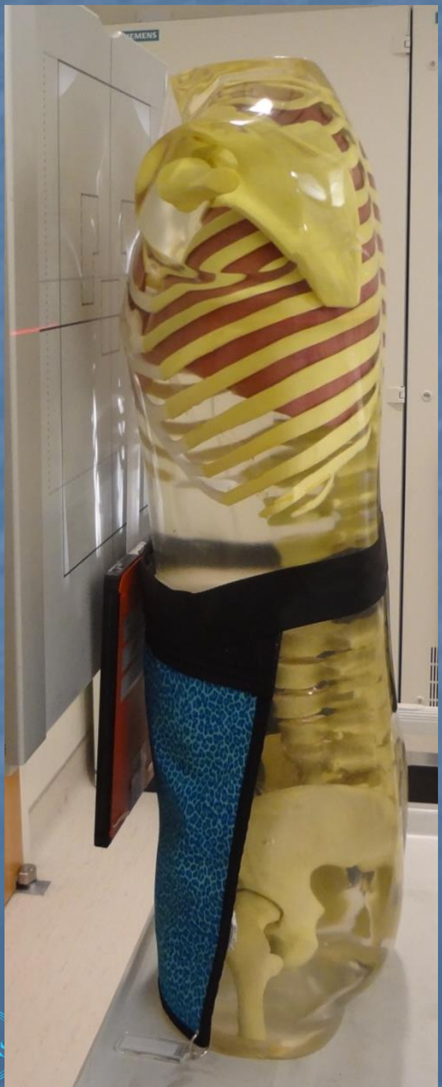
dRs

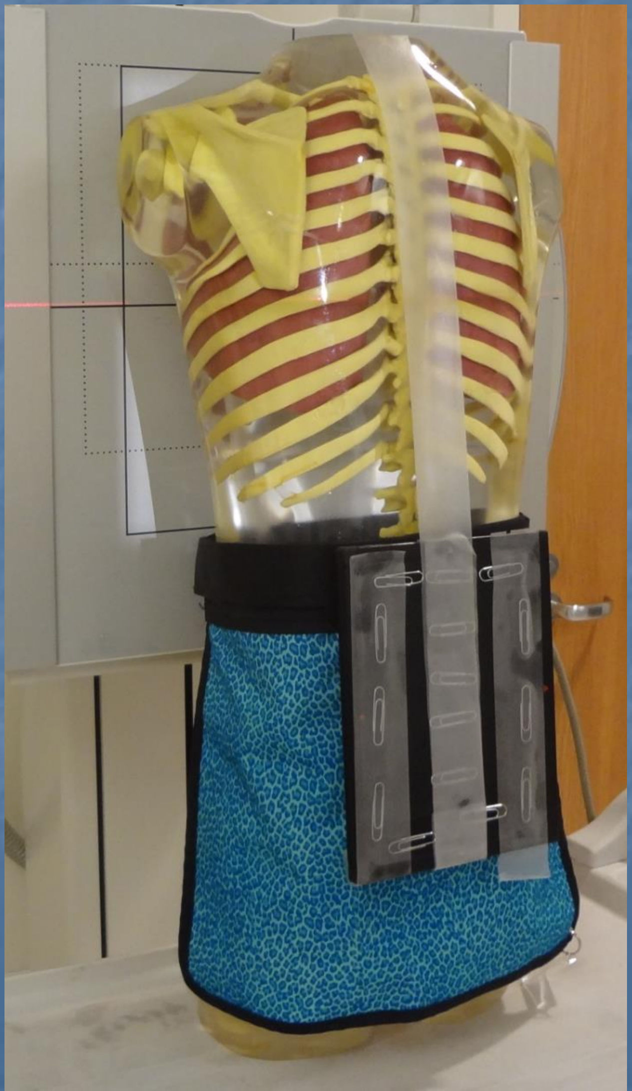
Off-Focus Radiation

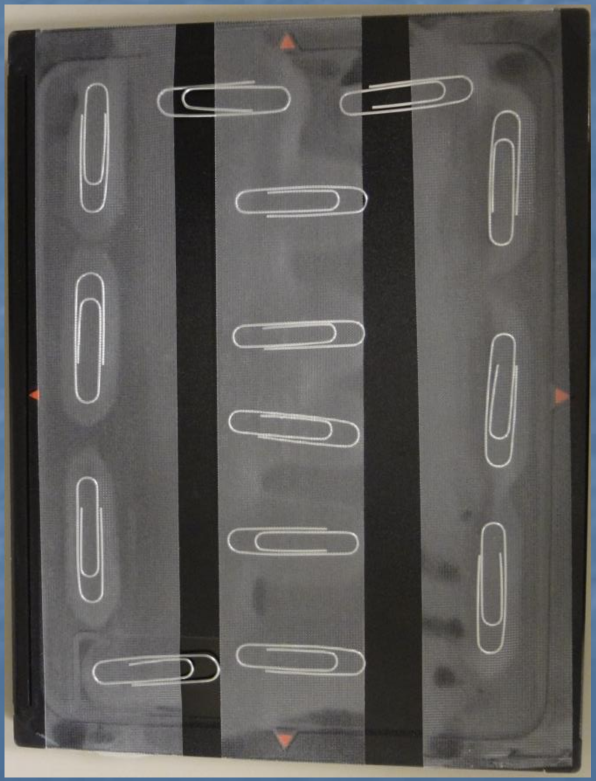


Art courtesy of "Principles of Radiographic Imaging" by Rick Carlton

Checking to see if it is wiser to shield a patient in the front or the back for a PA chest x-ray. Collimated to 14x17 with shield and cassette below primary beam.

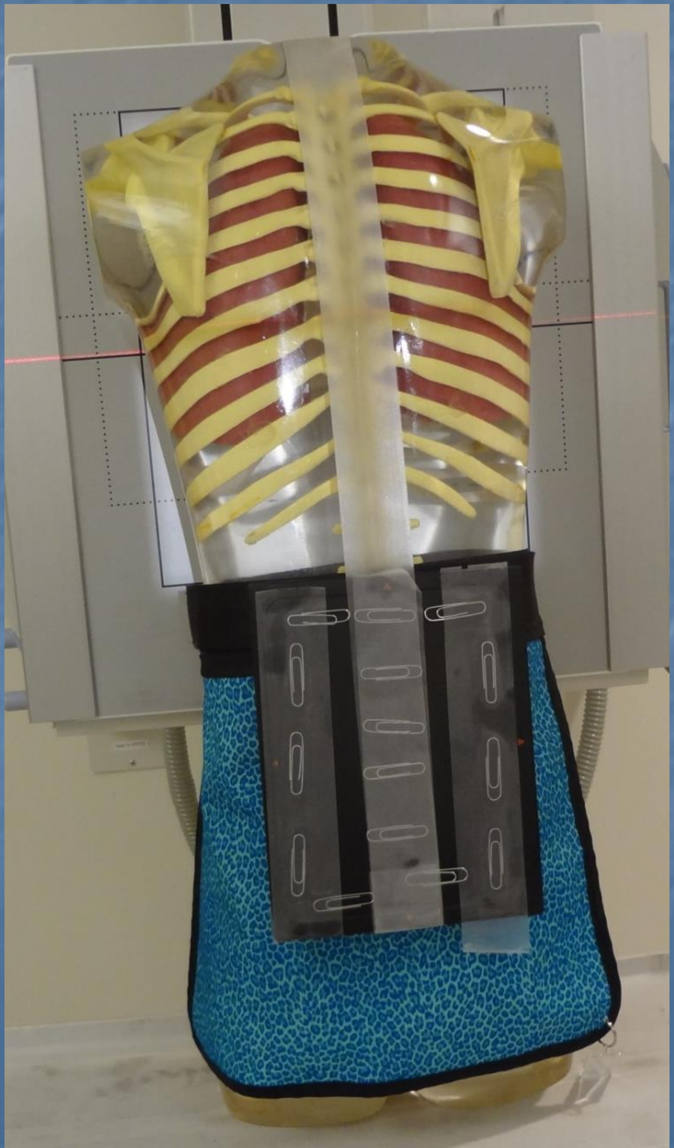


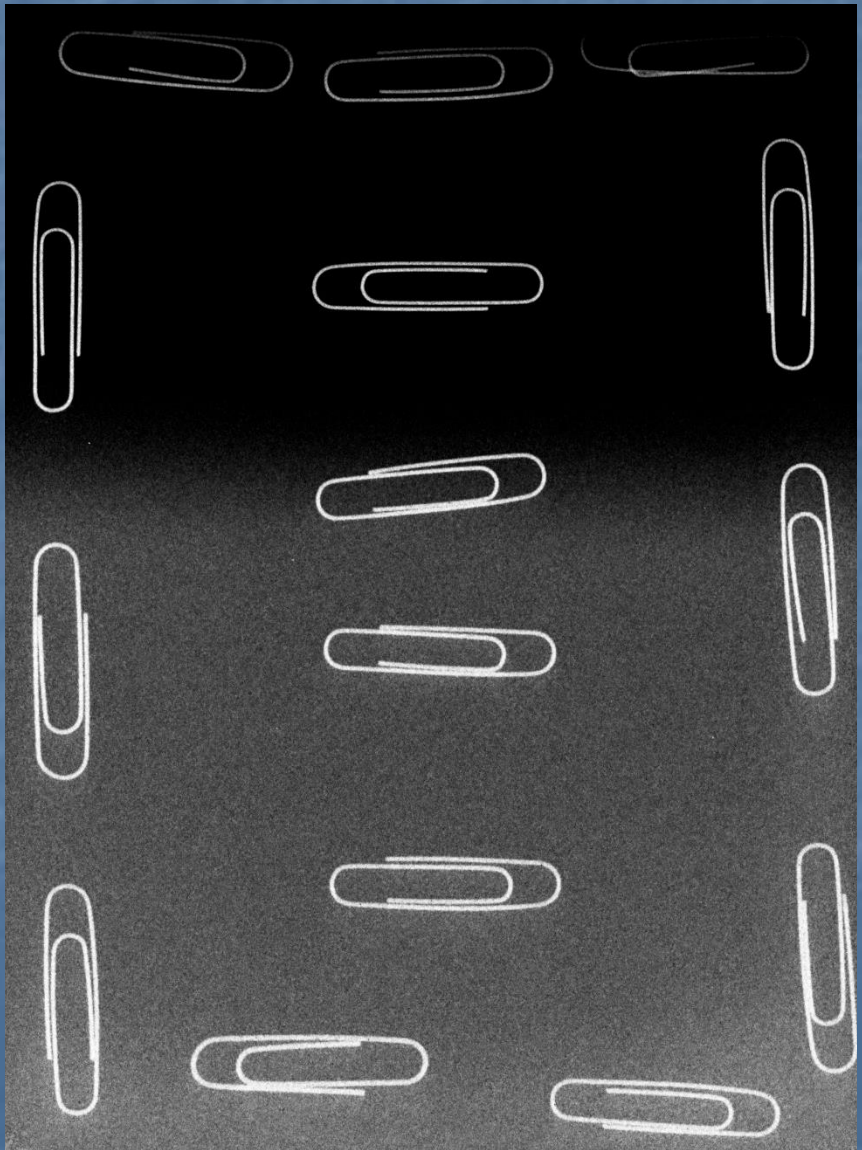




Shield and cassette in front.
117 kV @ 2.5 mAs   LgM .540

Shield and cassette in back.
117 kV @ 2.5 mAs   LgM 1.53





dRs

CR cassette with paper clips spaced every inch, bottom of 14x17 lightfield just above the cassette. None of the primary beam is exposing the cassette.

117 kV @ 2.5 mAs
LgM 1.23

(1200 Speed)

72 kV @ 20 mAs
LgM 1.69

Cassette blocked with a .5mm lead apron.

117 kV @ 2.5 mAs LgM 0.511

(Read at 1200 Speed)

Off-Focus experiment with the dosimeter. Ion chamber 36” off floor. Tube 40” and 72” SID. Collimated to 14”x17”.

Started with bottom of light field just above the top of the ion chamber.

Tube 27" higher (maxed out)

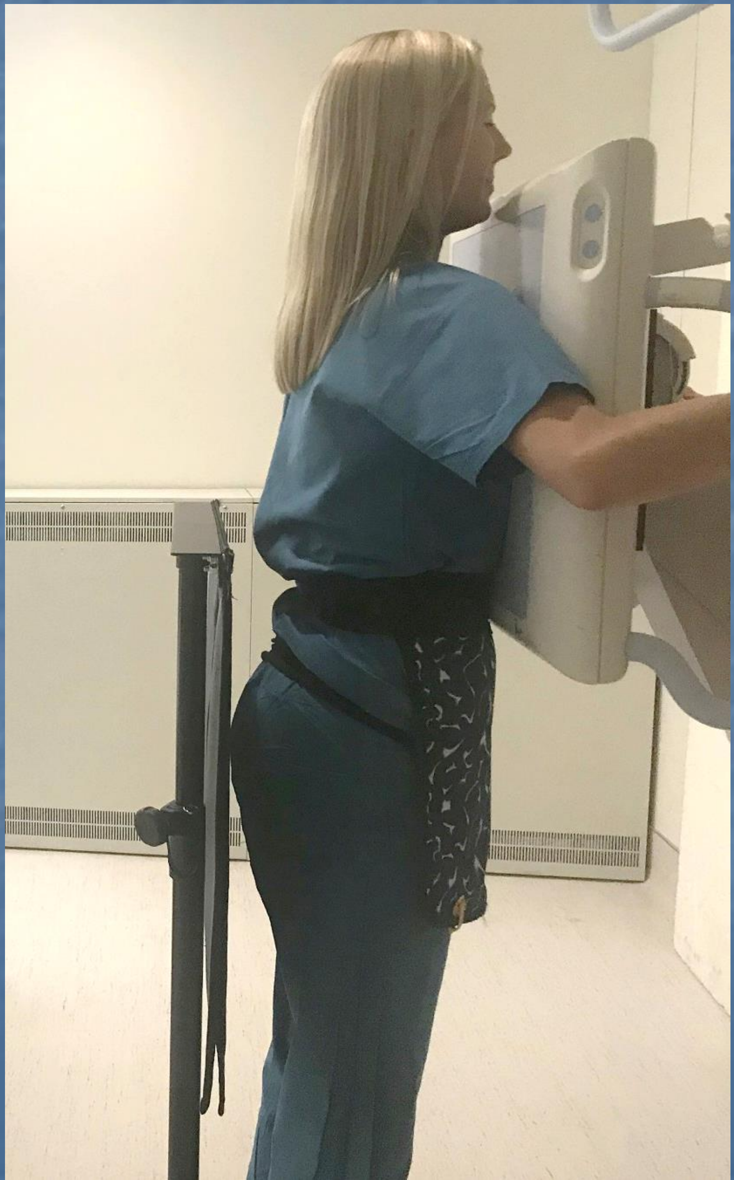
Here are the doses from all three experiments.

Off Focus Radiation			
Height above ion chamber in inches	85 kV@ 3.2 mAs 72" SID MicroR's (µR)	115 kV@ 4 mAs 72" SID MicroR's (µR)	85 kV@ 16 mAs 40" SID MicroR's (µR)
0	96.0	239.0	1035.8
1	72.0	166.1	615.4
2	52.0	117.9	432.8
3	39.3	90.5	391.6
4	31.1	71.1	321
5	27.6	59.4	296.8
6	21.8	50.9	244.6
7	18.0	42.8	218.6
8	15.6	36.7	180.6
9	13.0	31.0	164.2
10	11.2	27.1	148.5
11	9.9	23.3	133.1
12	8.6	20.8	125
13	7.4	18.7	111.7
14	0.0	17.3	105.5
15	0.0	15.8	101.1
16	0.0	14.6	97.7
17	0.0	13.8	96.2
18	0.0	12.8	95.1
19	0.0	12.6	94.1
20	0.0	12.4	90.8
21	0.0	12.4	86.9
22	0.0	12.2	82.5
23	0.0	11.6	78
24	0.0	11.5	74.2
25	0.0	11.0	72.4
26	0.0	11.2	70.3
27	0.0	10.7	66.8

Because of Off-Focus Radiation, the **<u>shield needs to be placed on the side of the tube</u>**

If your patient is pregnant, you might consider <u>double shielding on the tube side.</u>

With our new "double lead" roller shield, we only need to put on a wrap-around apron in the front.



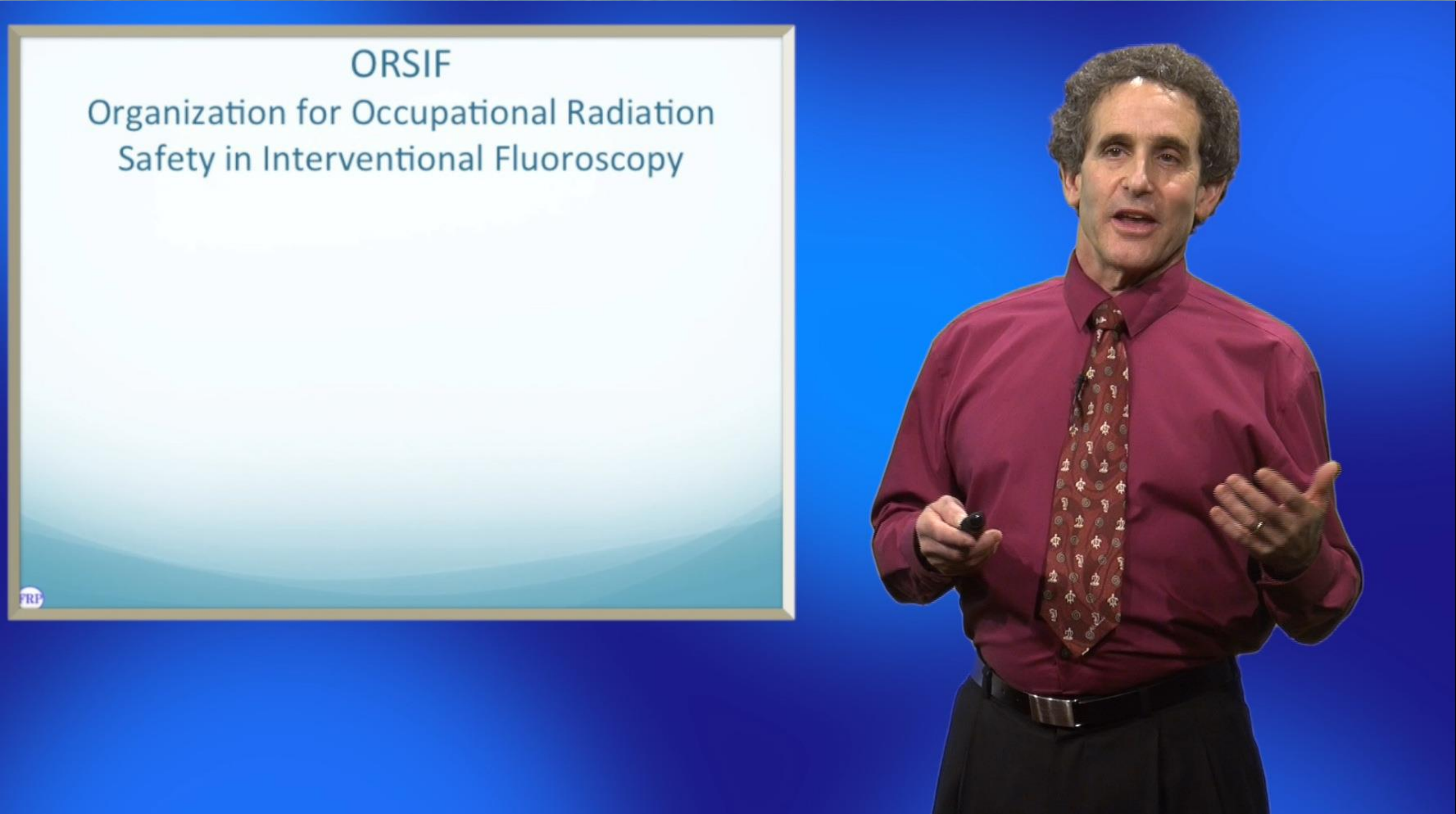
At CHOMP, because of the Off-Focus Radiation, <u>all of our upright abdomens are now taken PA.</u>

- From an Original Article in Radiologic Technology ("Reducing Pediatric Patients' Dose by Manipulating Radiographic Projections" Nov/Dec 2021), Brennan and Madigan found that during a PA lumbar projection compared with the AP projection, the **absorbed dose was reduced by 39%** .

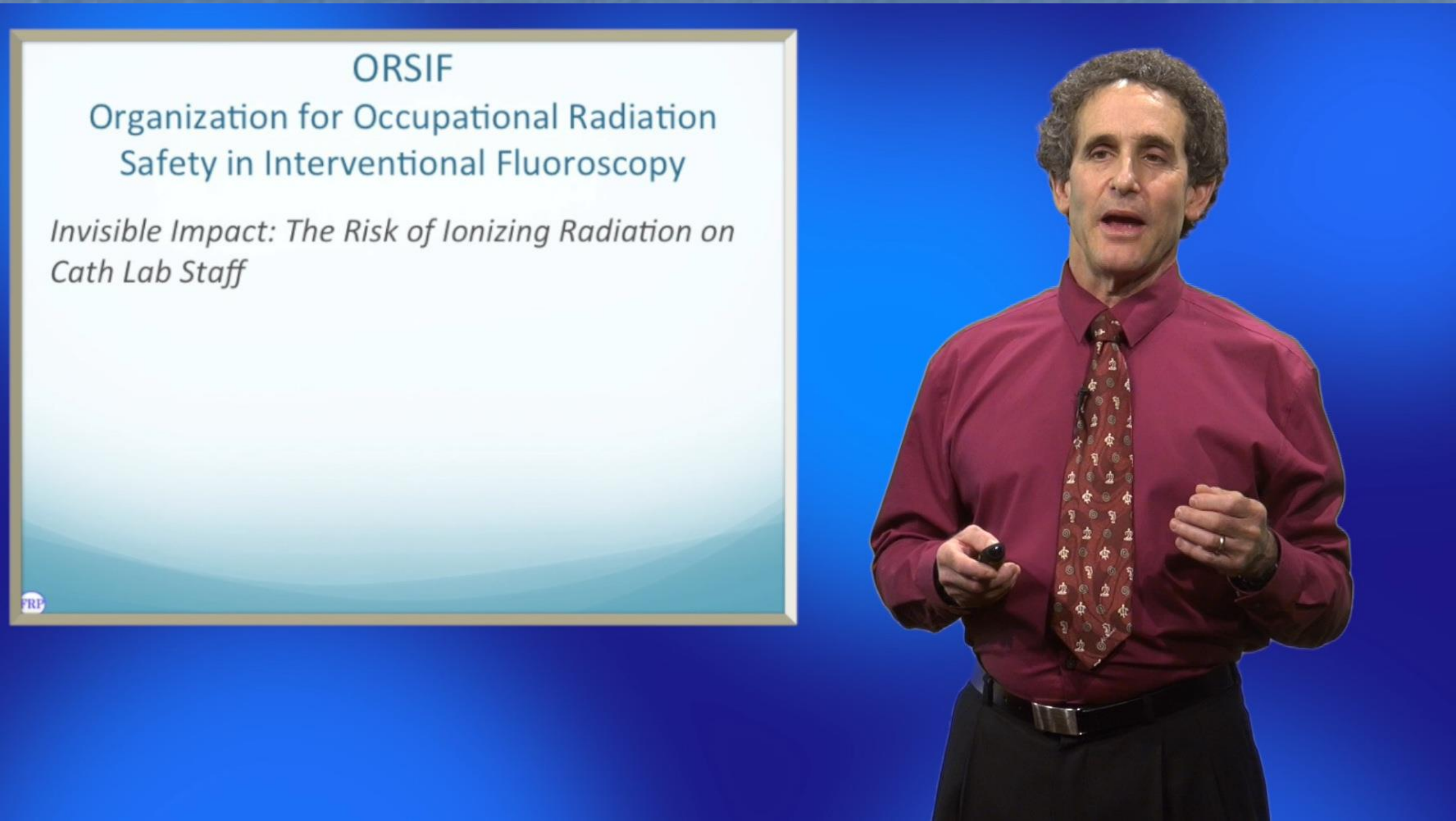
dRs

ORSIF

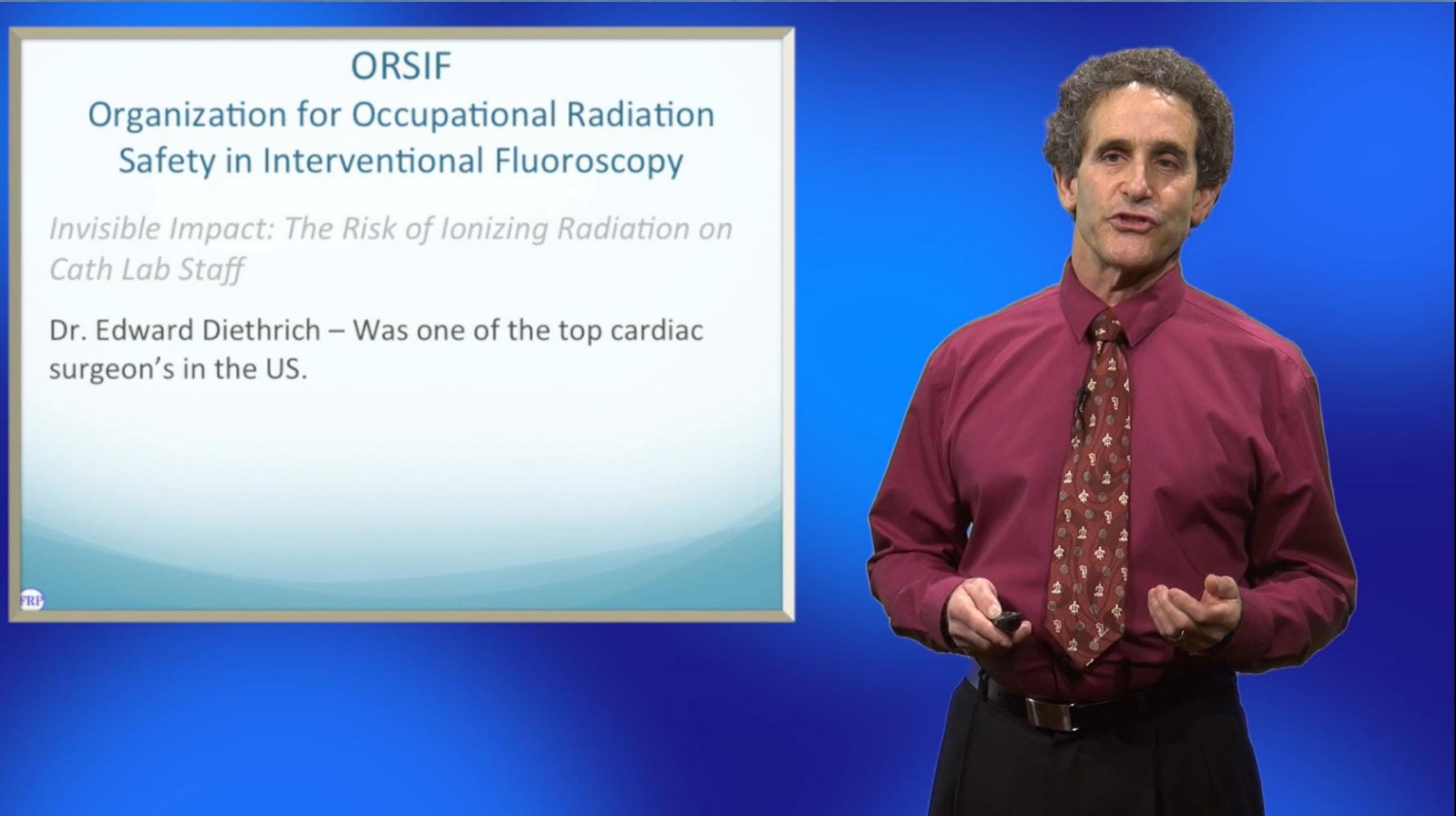
Organization for Occupational Radiation Safety in Interventional Fluoroscopy



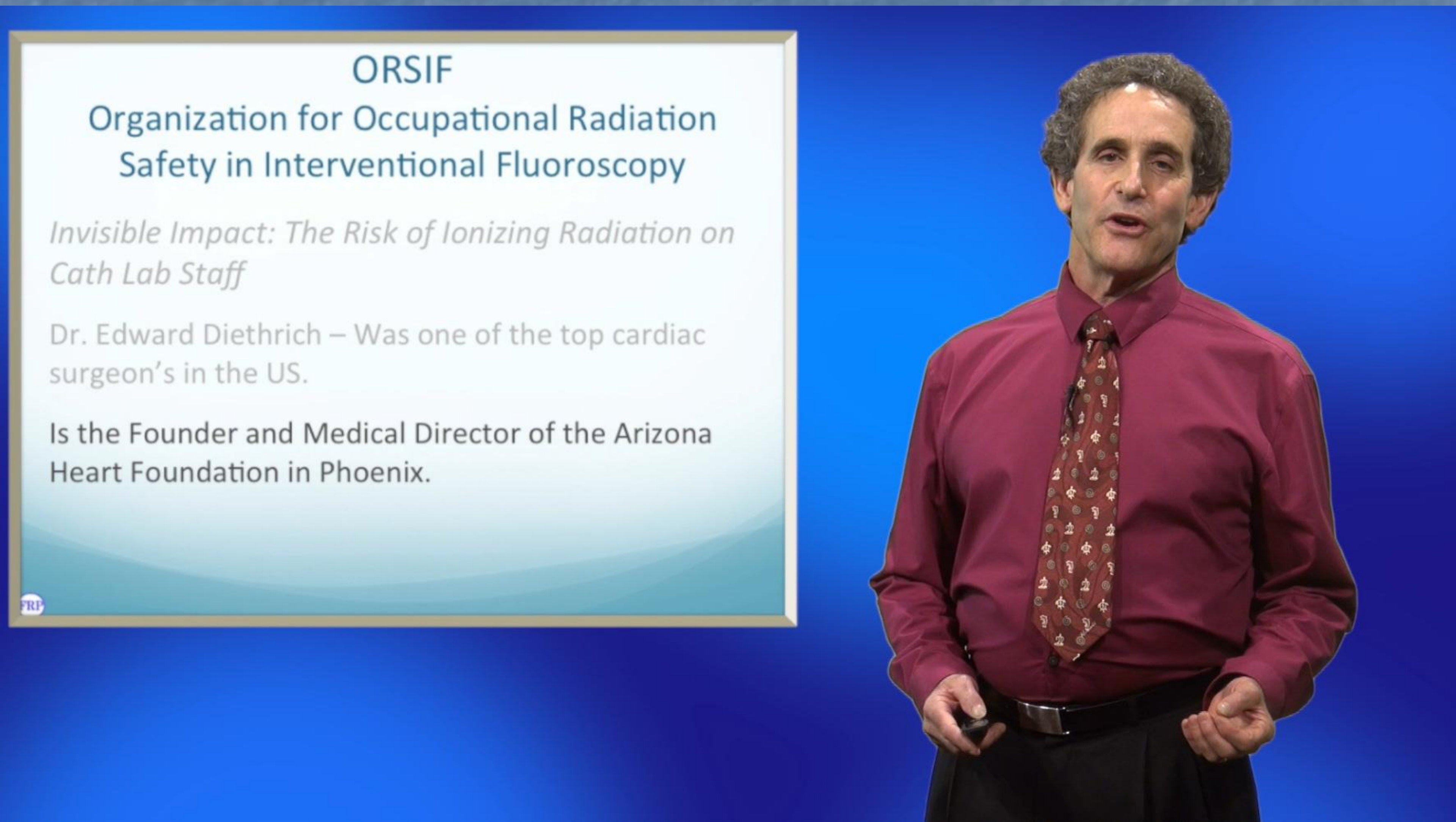
They have this incredible video called " Invisible Impact: The Risk of Ionizing Radiation on Cath Lab Staff".



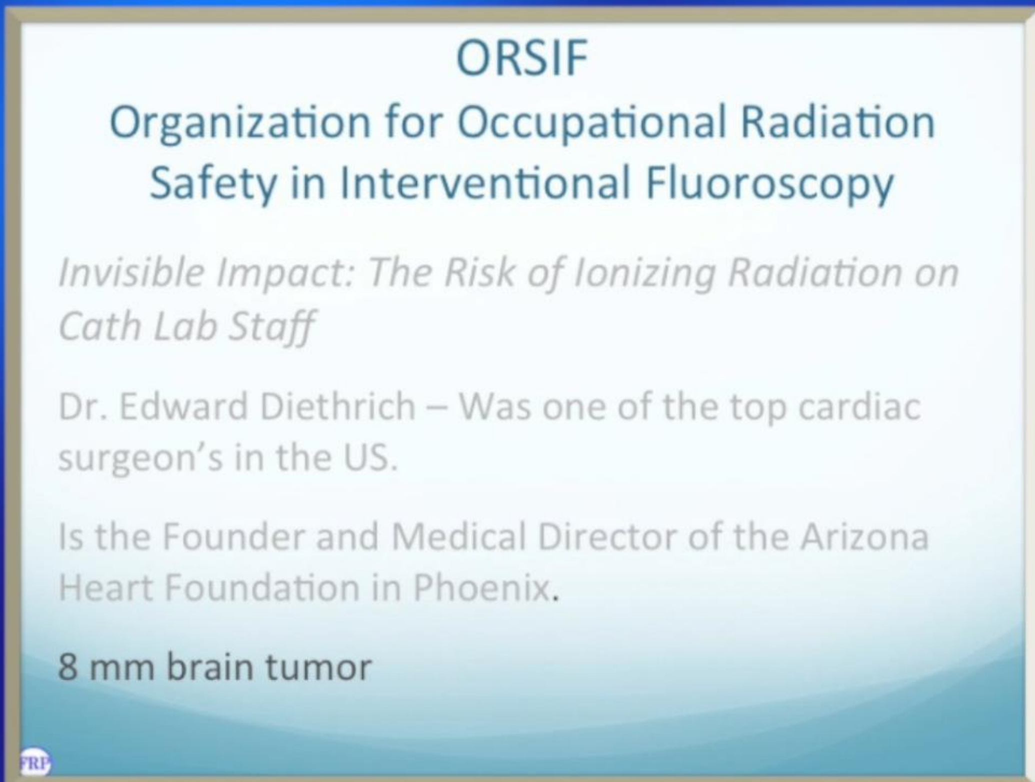
Video centers on Dr. Edward Diethrich, was one of the top cardiac surgeon’s in the US, who used a C-arm in the OR.

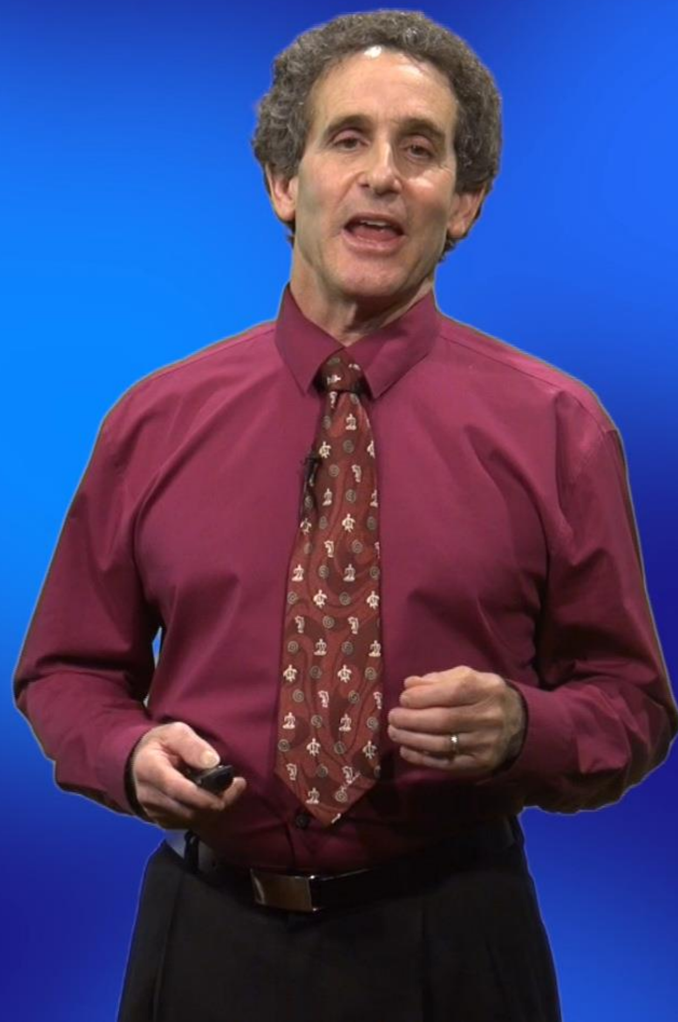


Dr. Diethrich was also the Founder and Medical Director of the Arizona Heart Foundation in Phoenix.

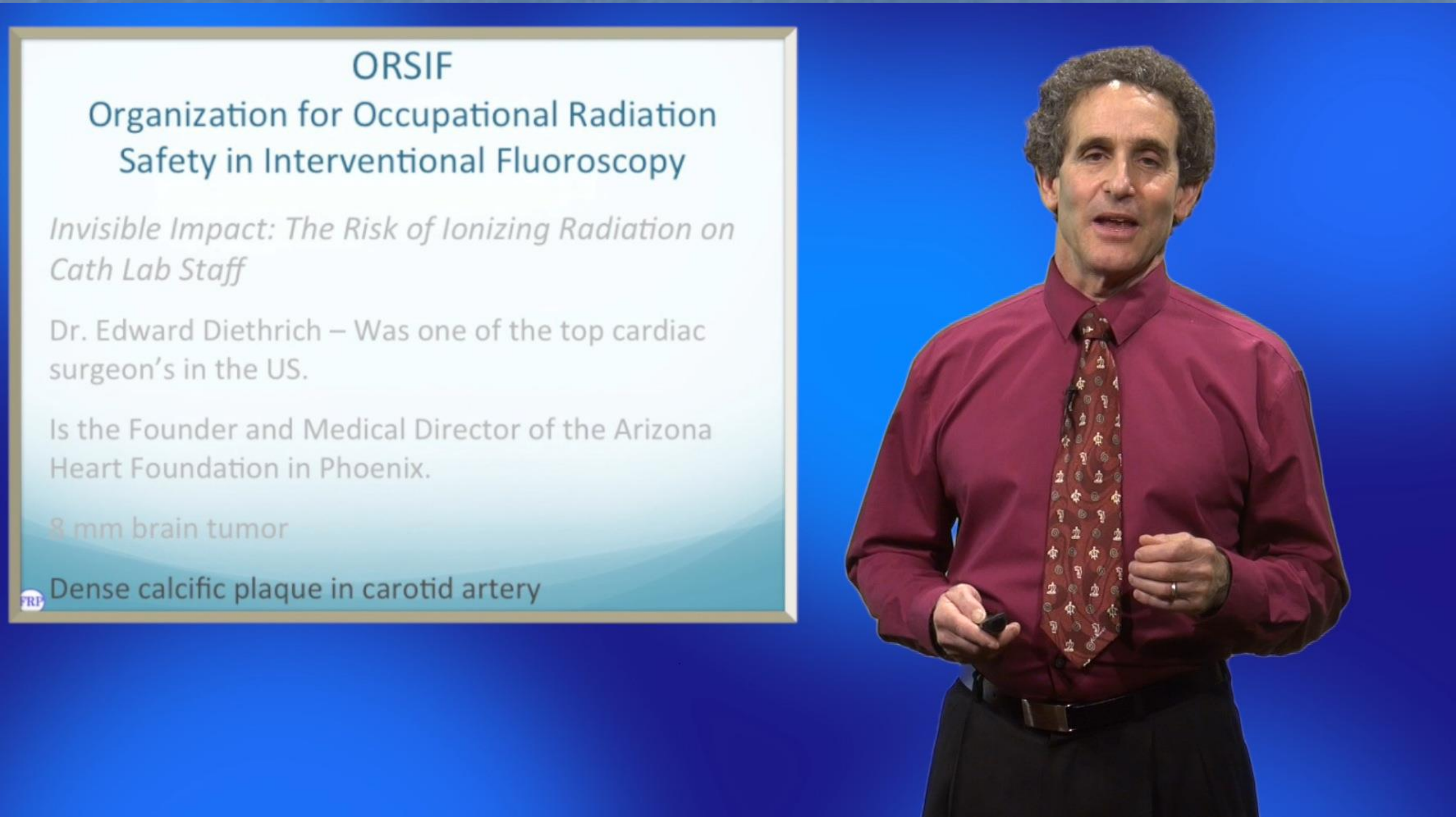


A while back, he discovered he had an 8 mm brain tumor.

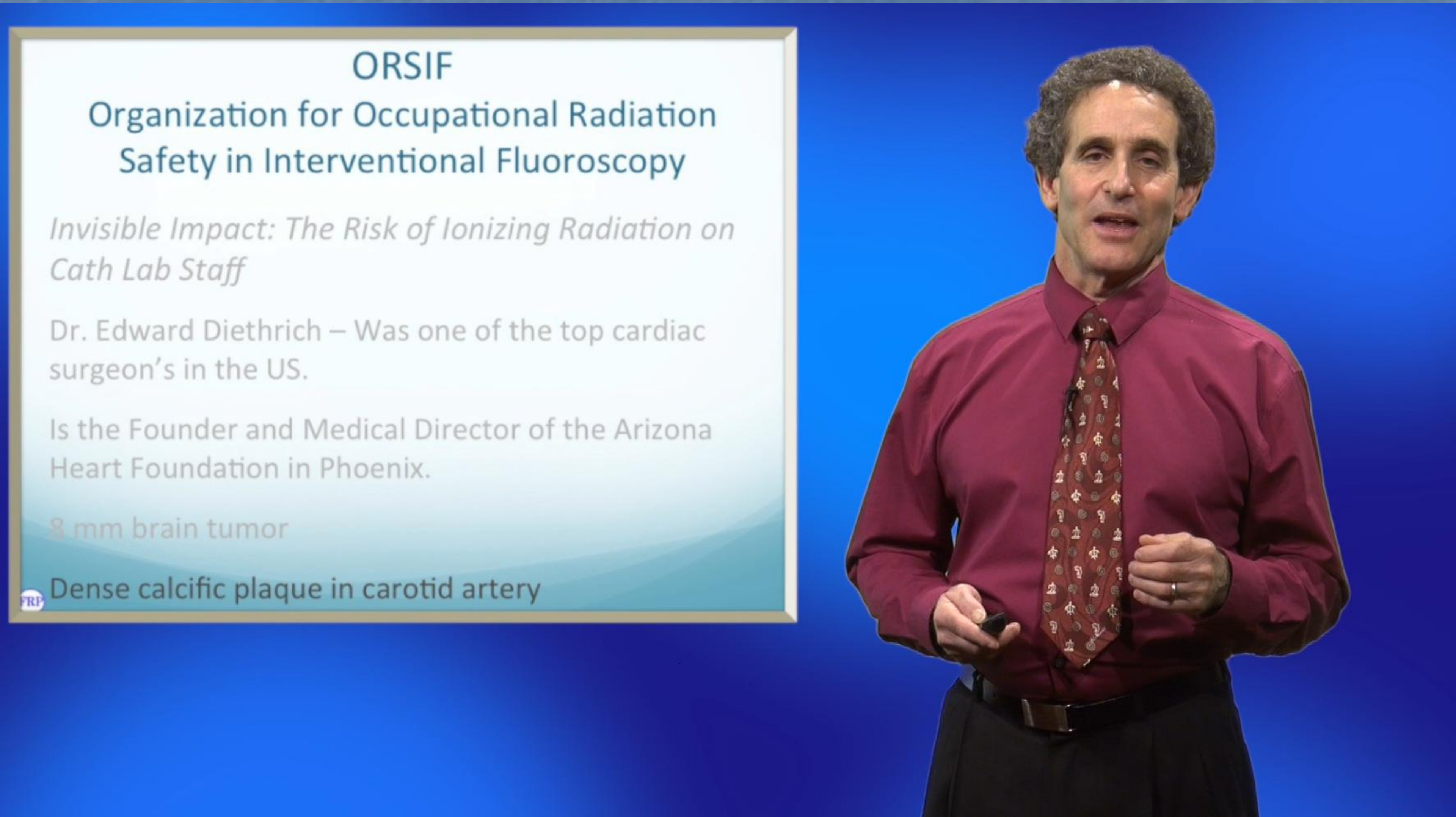




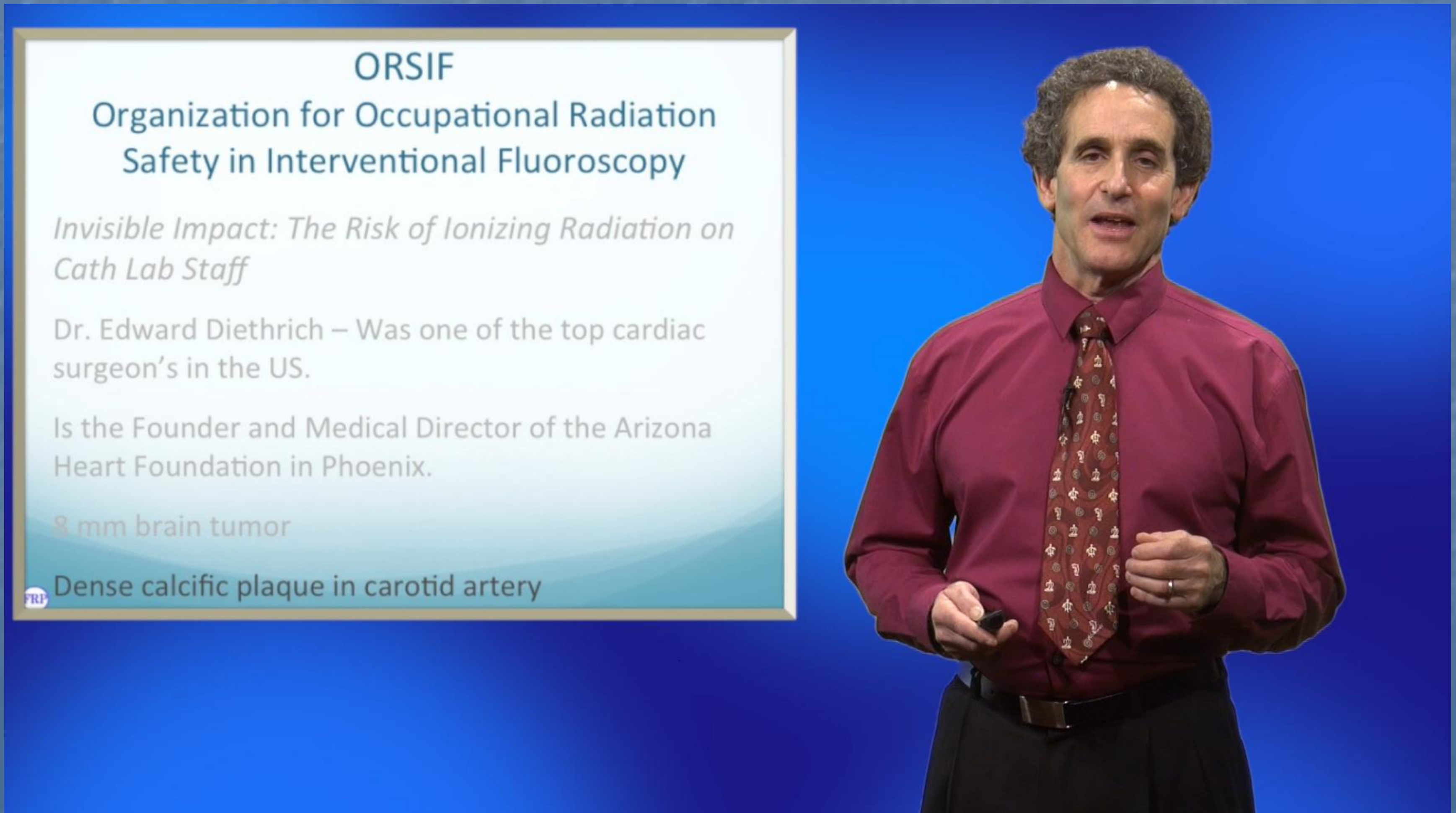
When they were diagnosing the brain tumor, they also discovered he had dense calcific plaque in his carotid artery.



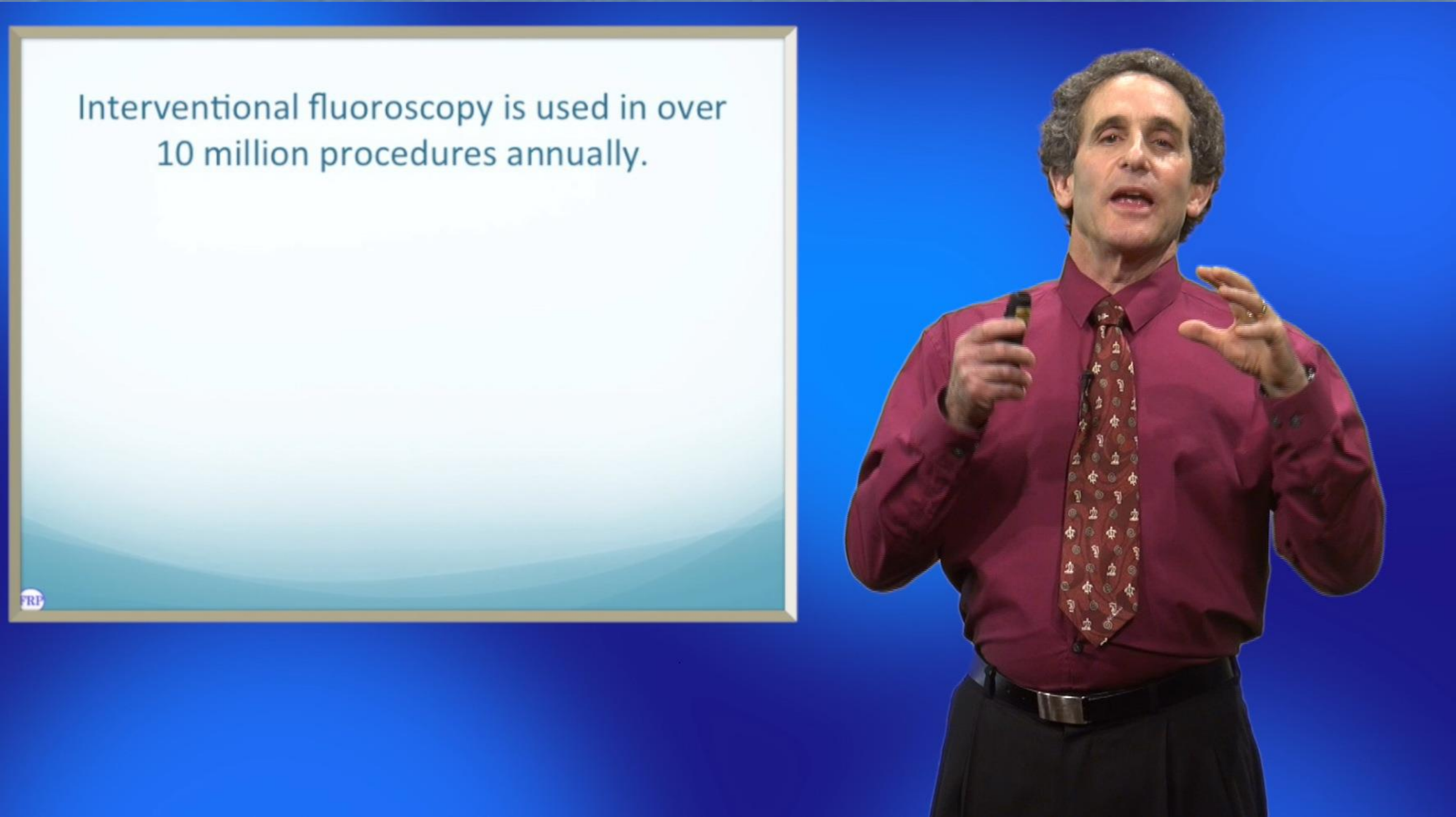
Before any of these problems, he already had bilateral lens implant surgery because of problems with his eyes.



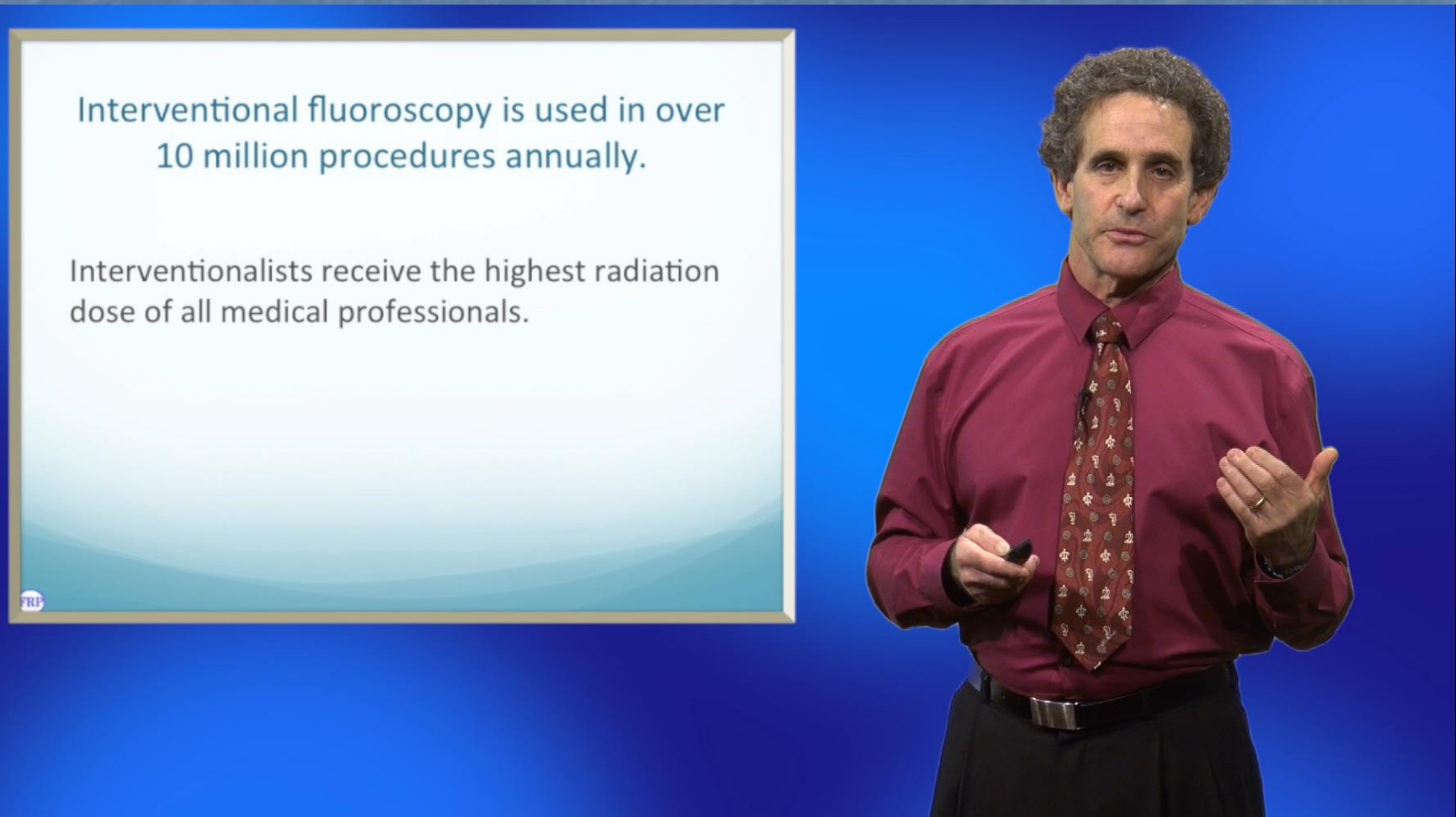
After all of the diagnosis', he became 100% convinced that the brain tumor, the carotid plaque and the eye problems were all caused by radiation!! This is why he created ORSIF and the video.



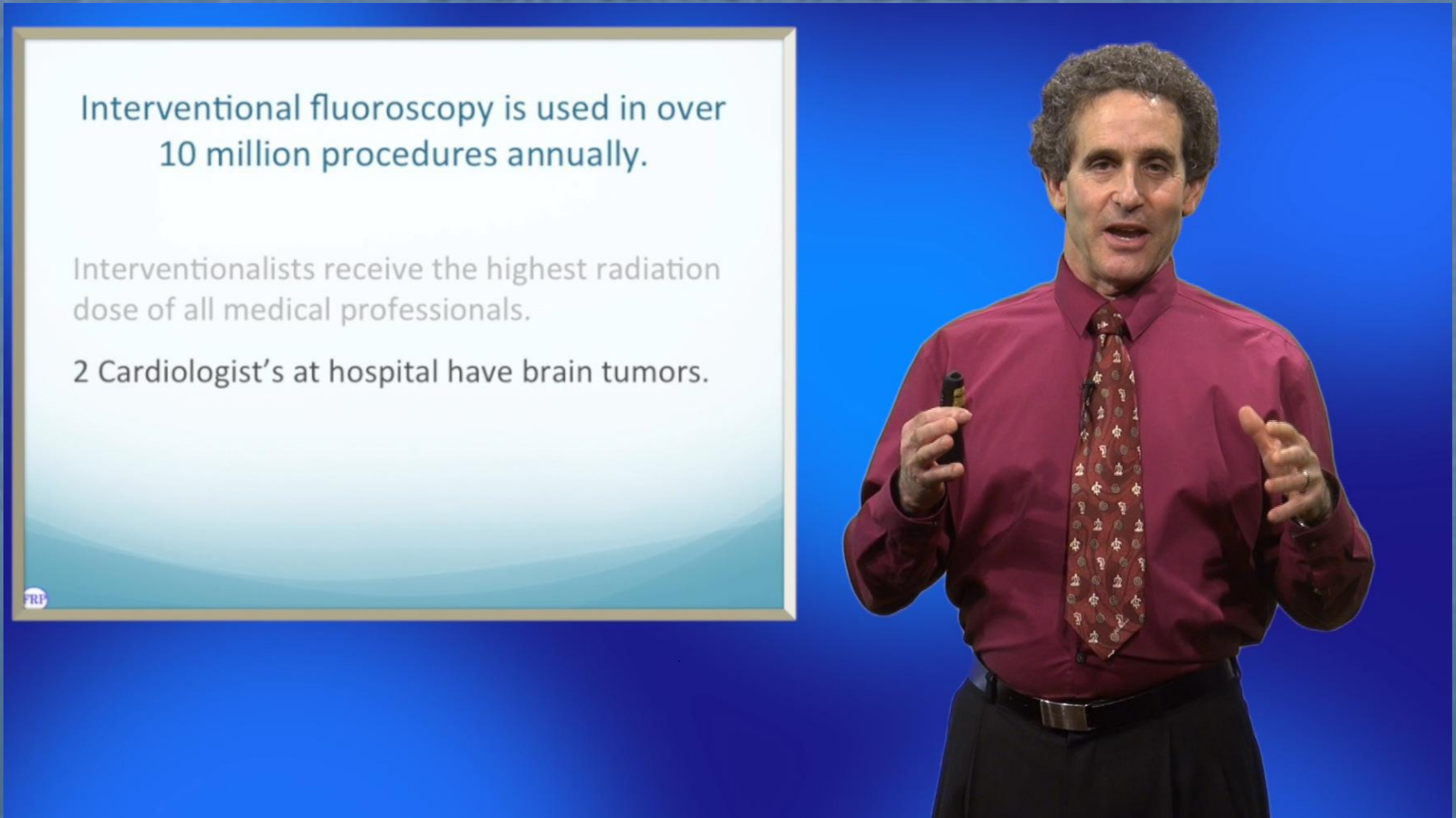
At the end of the video they close with: Interventional fluoroscopy is used in over 10 million procedures annually.



Also, Interventionalist's receive the highest radiation dose of all medical professionals.



When we were developing this course, two Cardiologist's at a leading hospital in California had brain tumors. This can't be a coincidence. Dr. Diethrich succumbed to complications of the brain tumor in 2017.



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Radiography
Solutions

Dennis Bowman

dennismbowman@gmail.com

(831) 601-9860

digitalradiographysolutions.com

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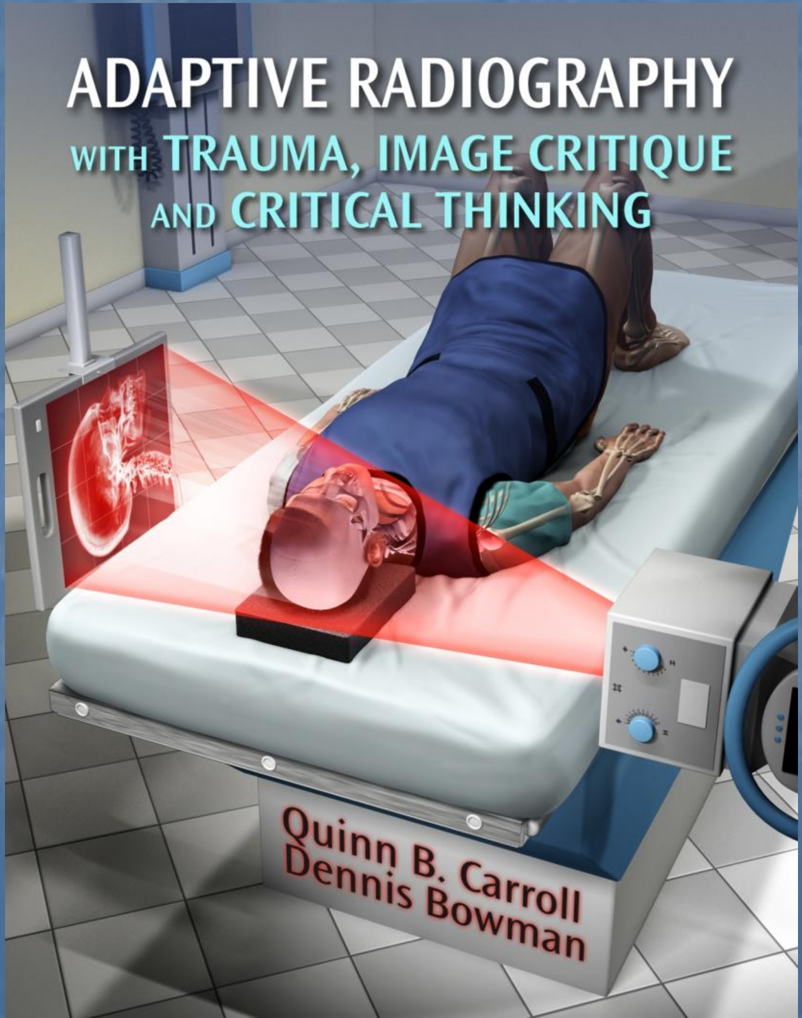
This website was created again

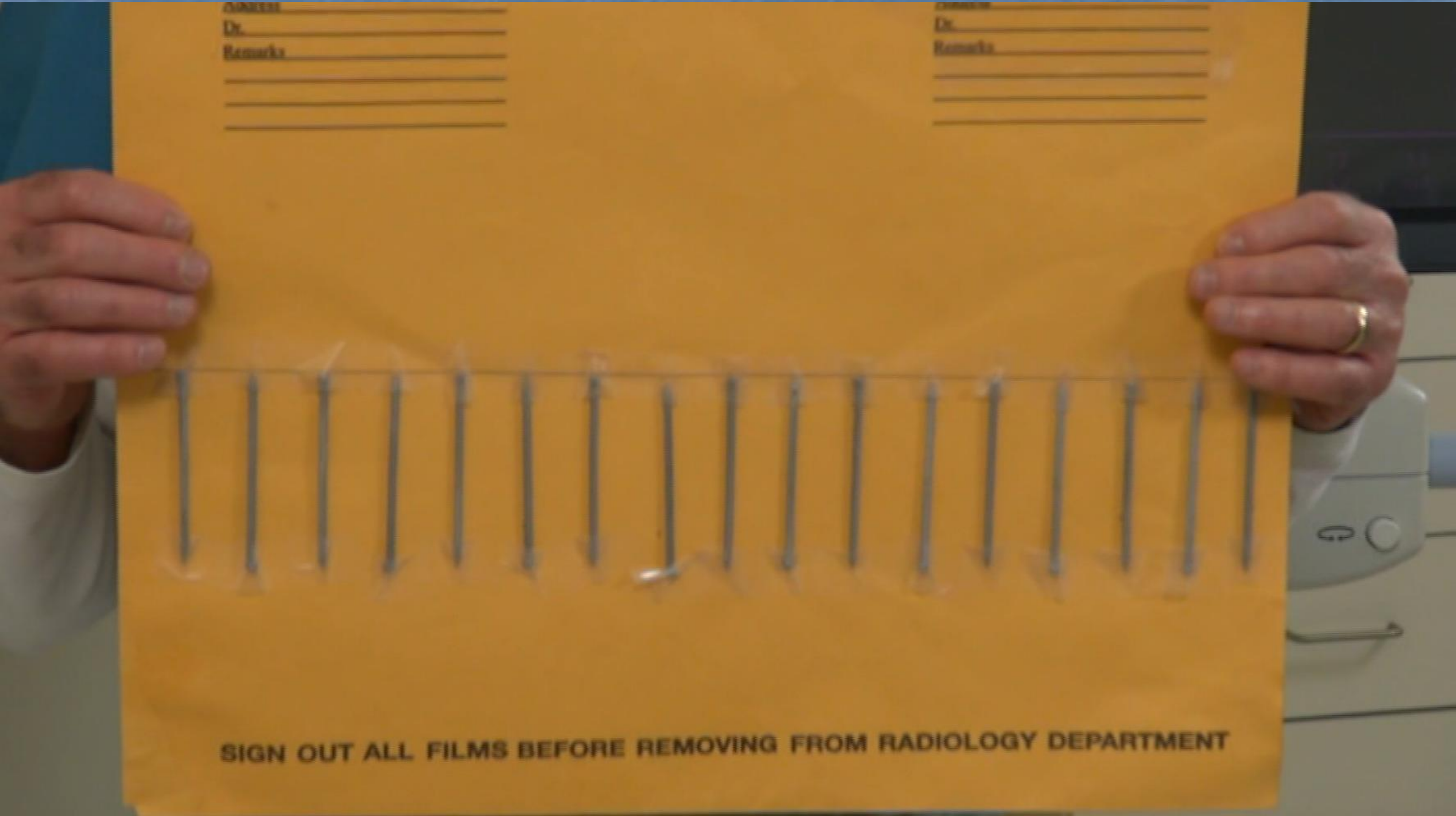
so I could continue to have all of my low dose DR and CR digital technique charts, and radiation protection experiments and demonstrations, available for free.

Adaptive Radiography: Tips and Tricks



VERTICAL COLLIMATION

This lesson is to show how much dose can be saved by using collimation.
We taped nails every inch across a film jacket.



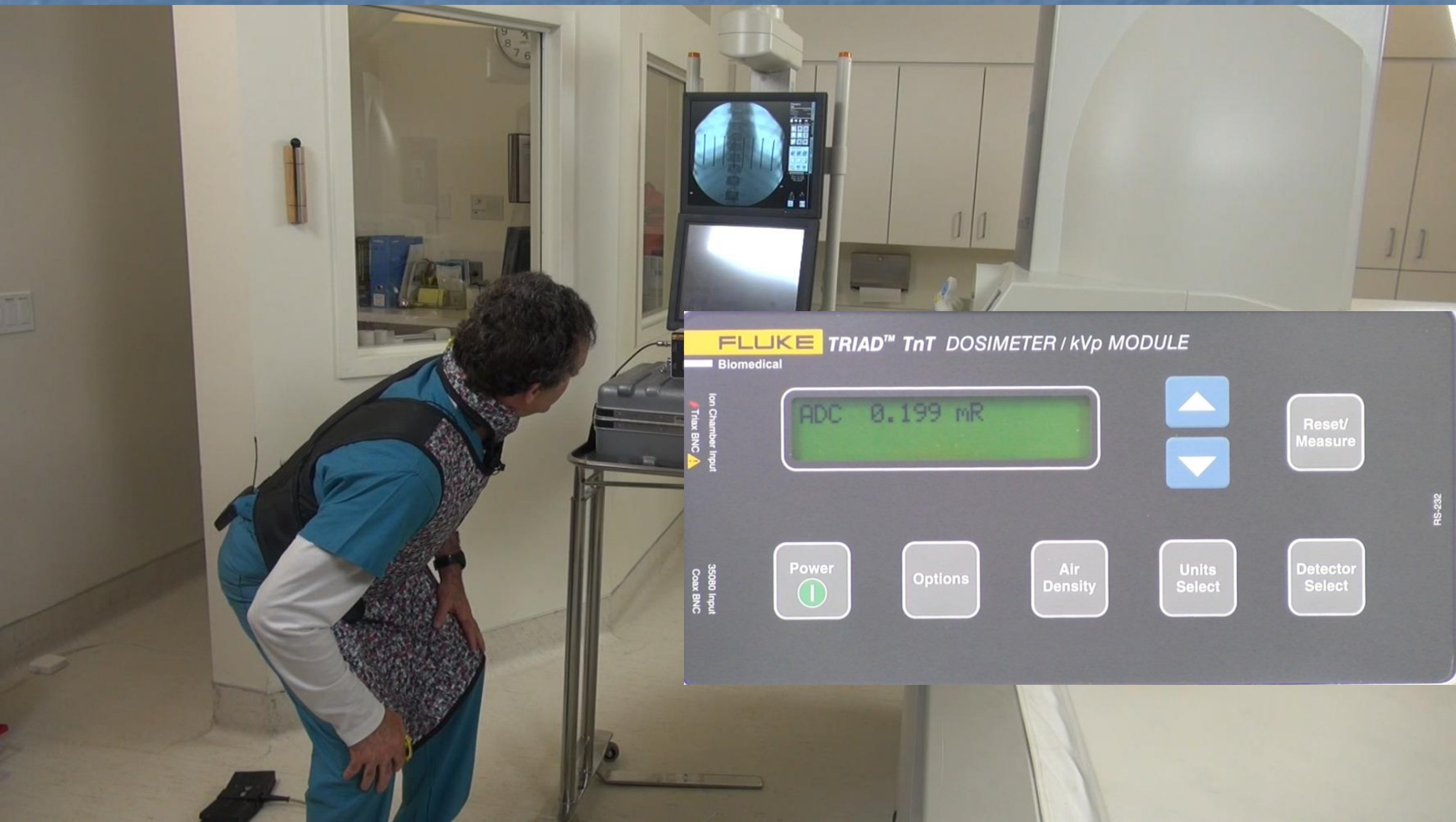
We then put the film jacket under the thorax phantom.

The ion chamber is 24” from the midline of the phantom and at mid coronal height.

We started with a little bit of collimation so that the edge of the collimated beam is just against the outer most nails.

Making a 10 second exposure. Standing as far away as possible since we had to take the hanging lead off.

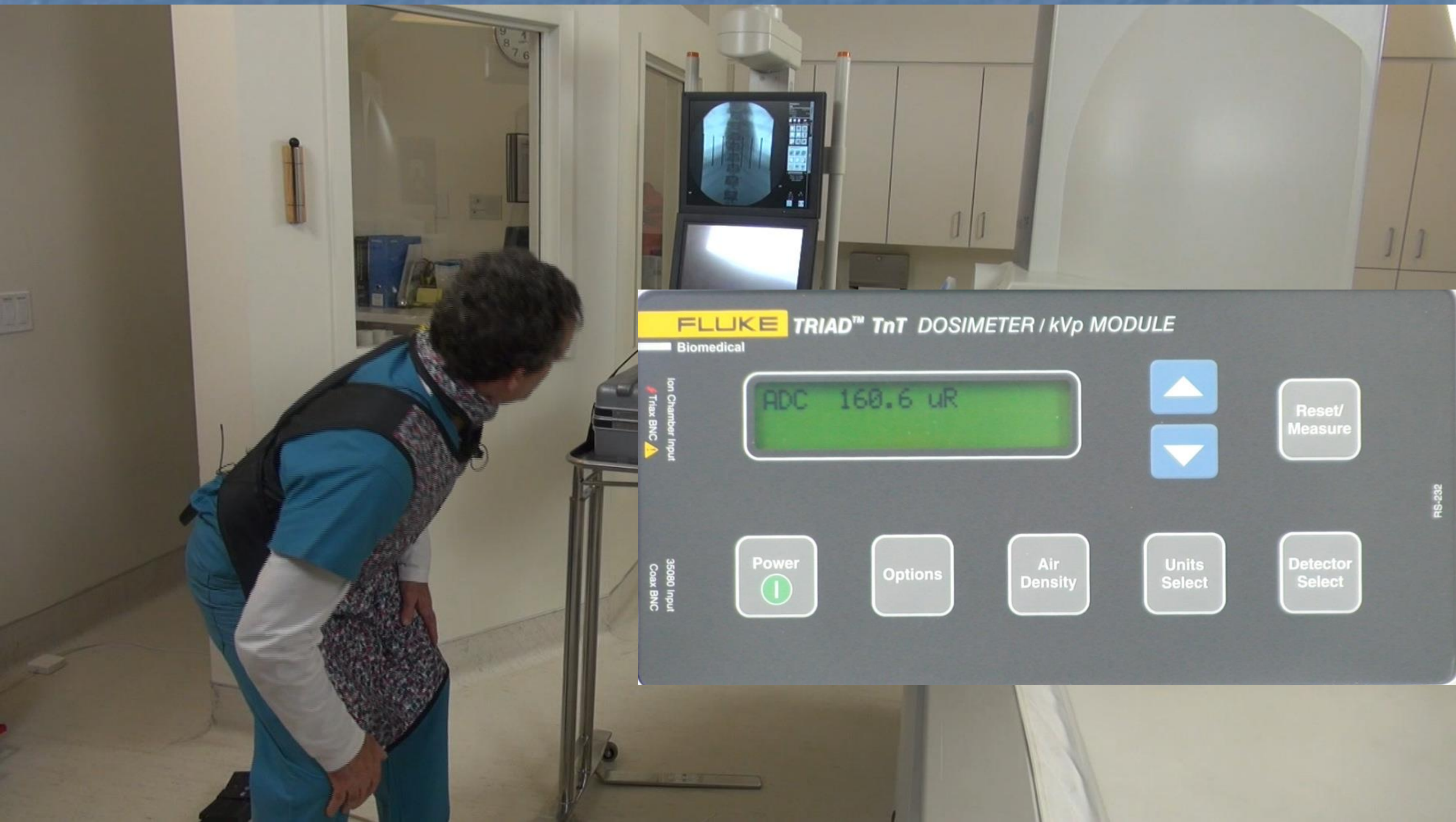
The dose was 0.199 mR.



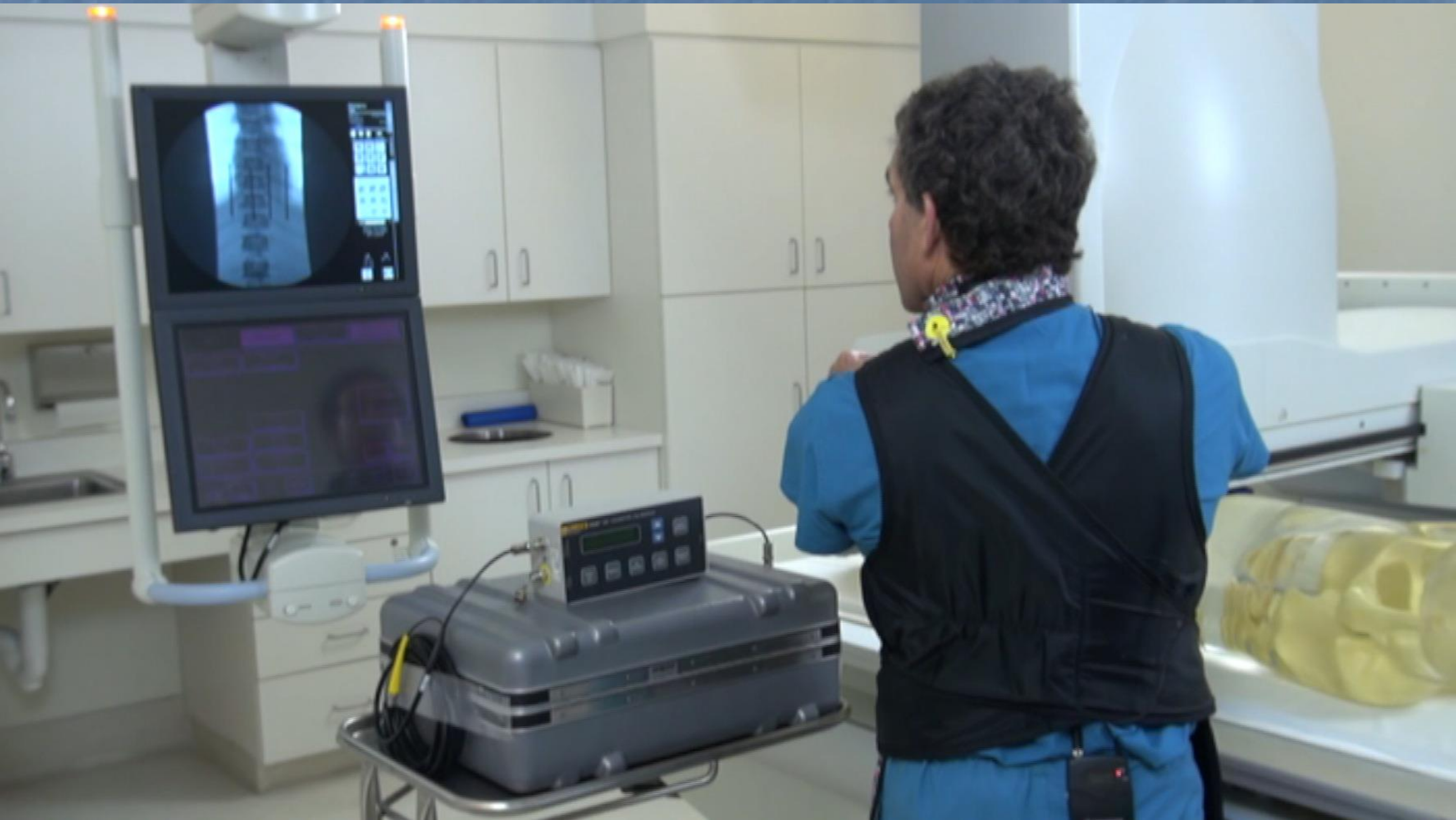
Now we have collimated one inch on each side.

Making the 10 second exposure with 1” of collimation in each side.

The dose was 160.6 µR (not mR). It would be 0.160 mR.

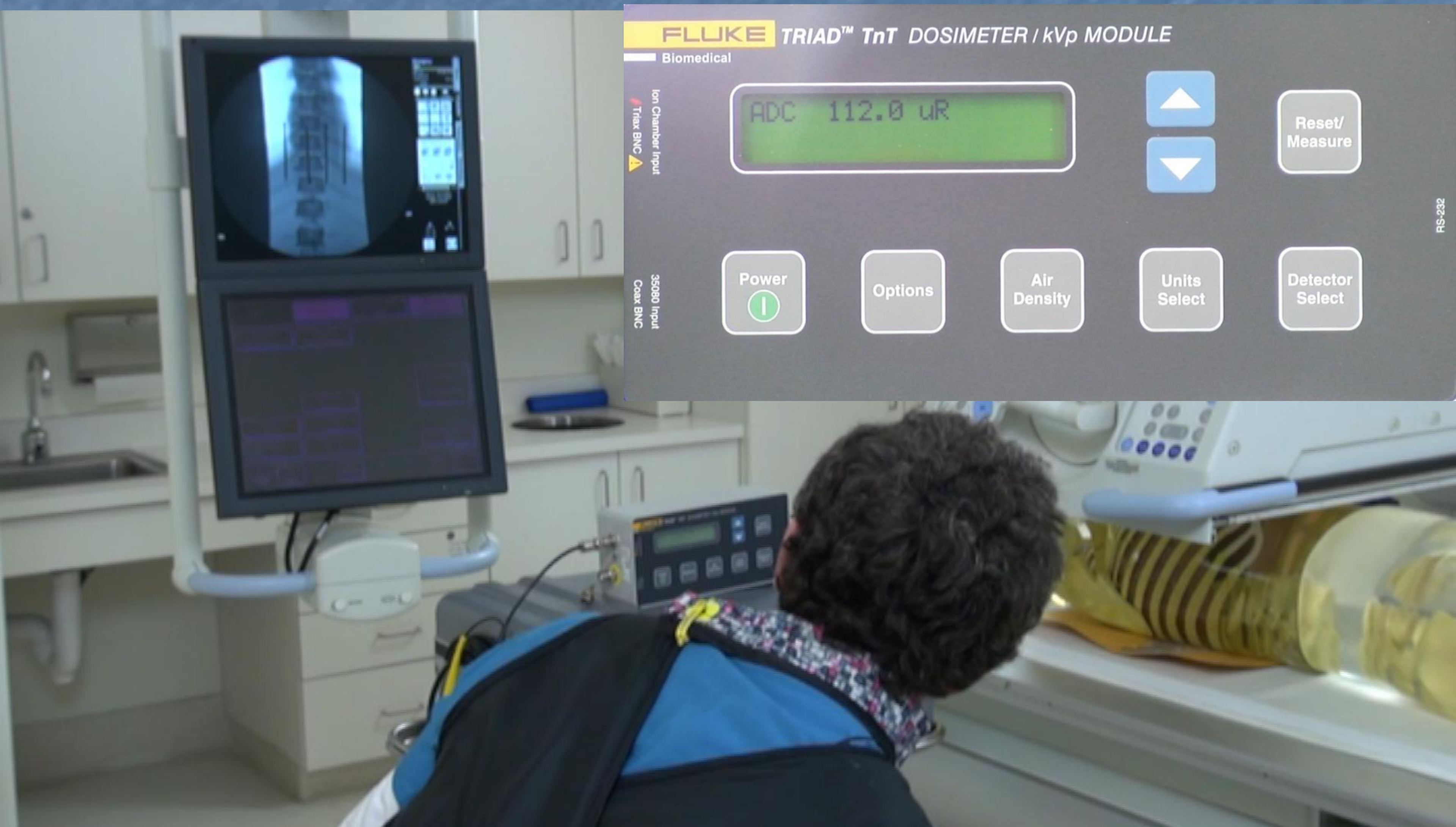


Now I have collimated 2” per side.



Making the 10 second exposure with 2” of collimation on each side.

The dose was 112.0 μR (not mR).
It would be 0.112 mR.



No one really collimates any tighter side to side, so I won't go more than that.

Vertical Collimation

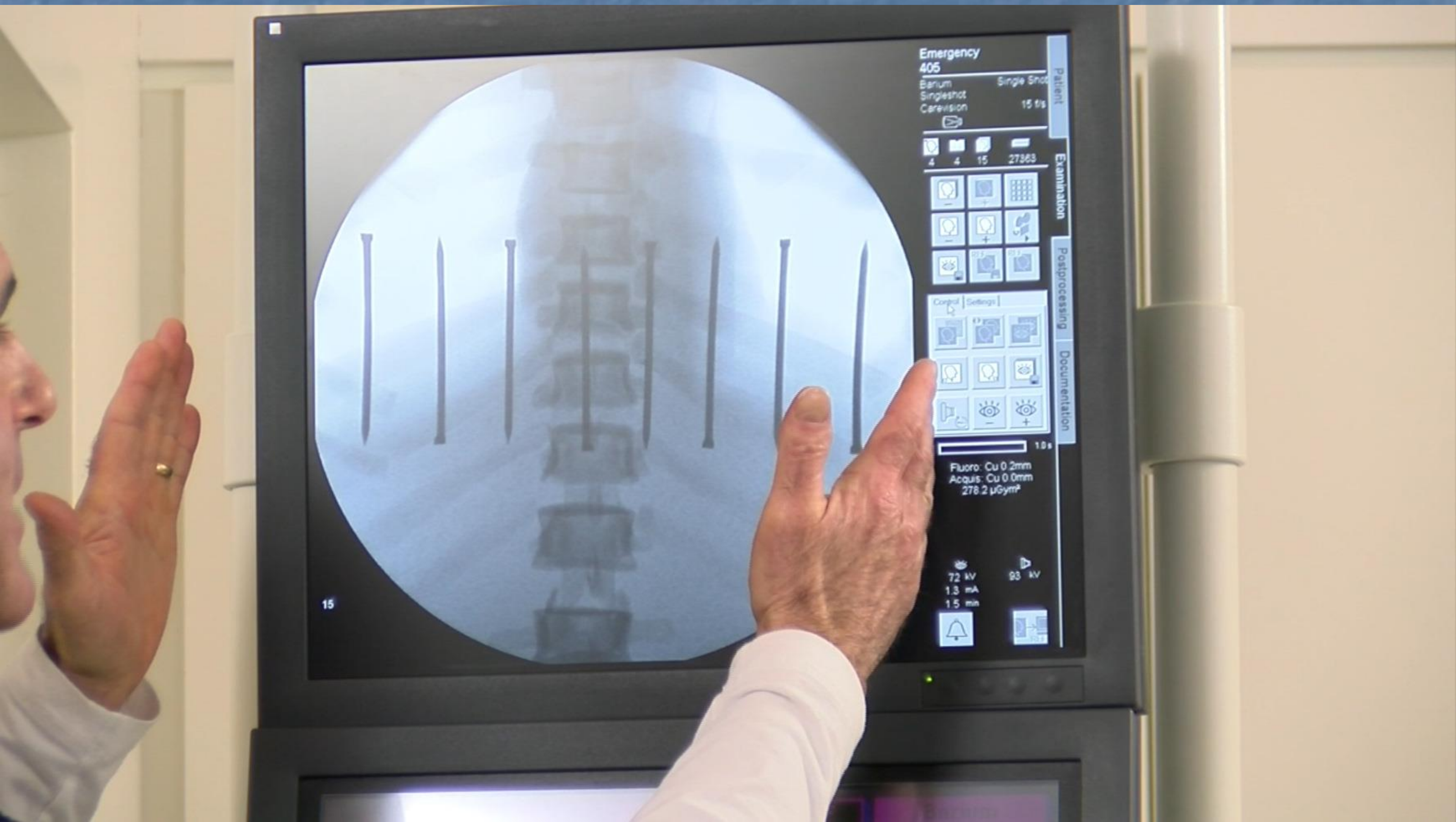
- None 0.199 mR
- 1in 0.161 mR
- 2in 0.112 mR
- 1in Decreased dose 20% of no collimation
- 2in Decreased dose 44% of no collimation

We now want to show how the image gets mag-ed up (not the good mag) and distorted when the II is higher, causing more OID.

With II just above the patient, we are seeing 10 nails with ribcage on both sides.

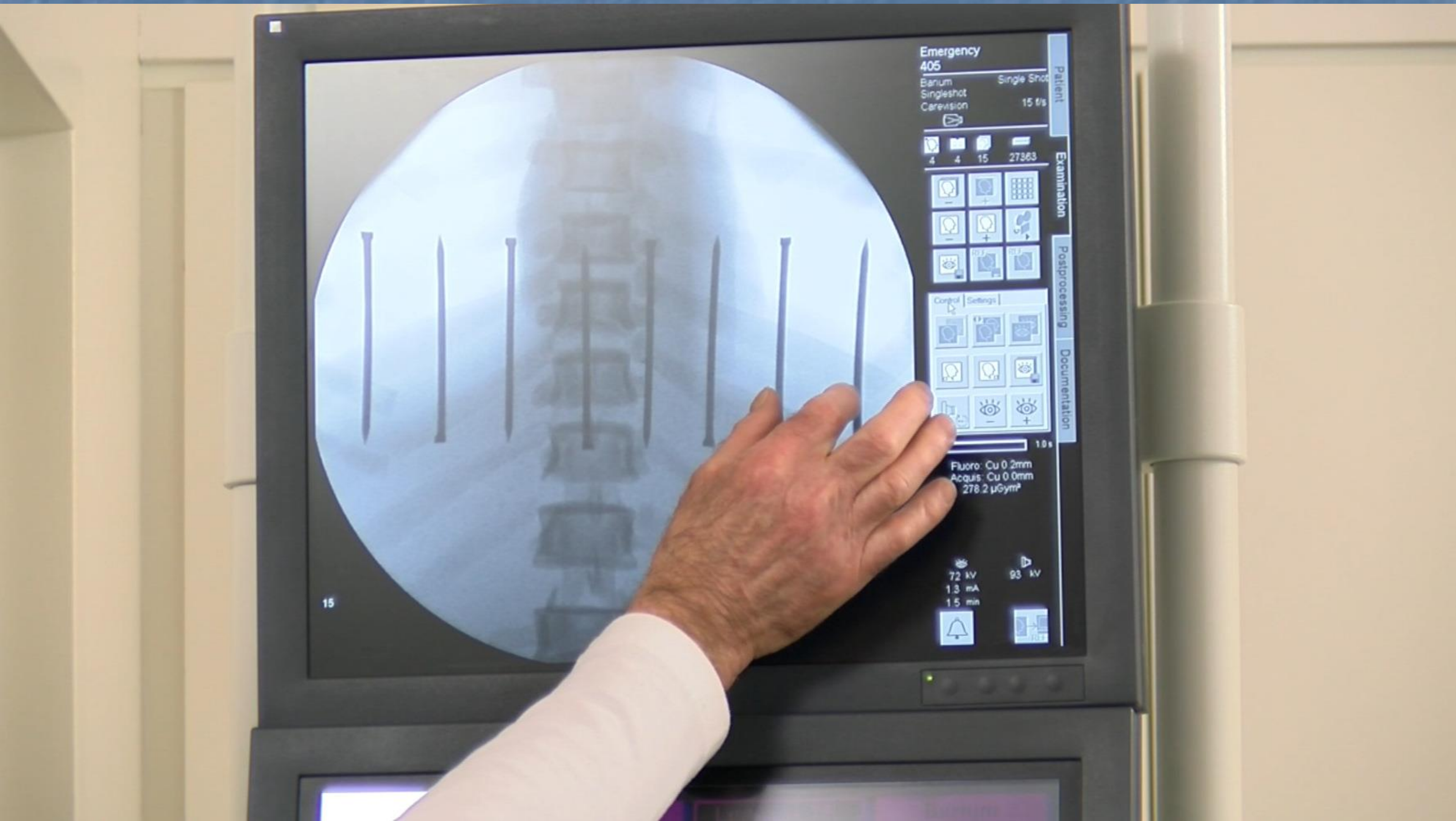
Now we have raised the II exactly 6 inches.

The ribcage and outermost nails are gone.



In addition to less anatomy, there is also distortion occuring.

You can see that the outermost nails have a slight bend to them and there is more room between the outside nail.



When the II is lifted you get more scatter which degrades the image quality, more dose to everyone in the room, and distortion on the sides of the image.

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dennismbowman@gmail.com

(831) 601-9860

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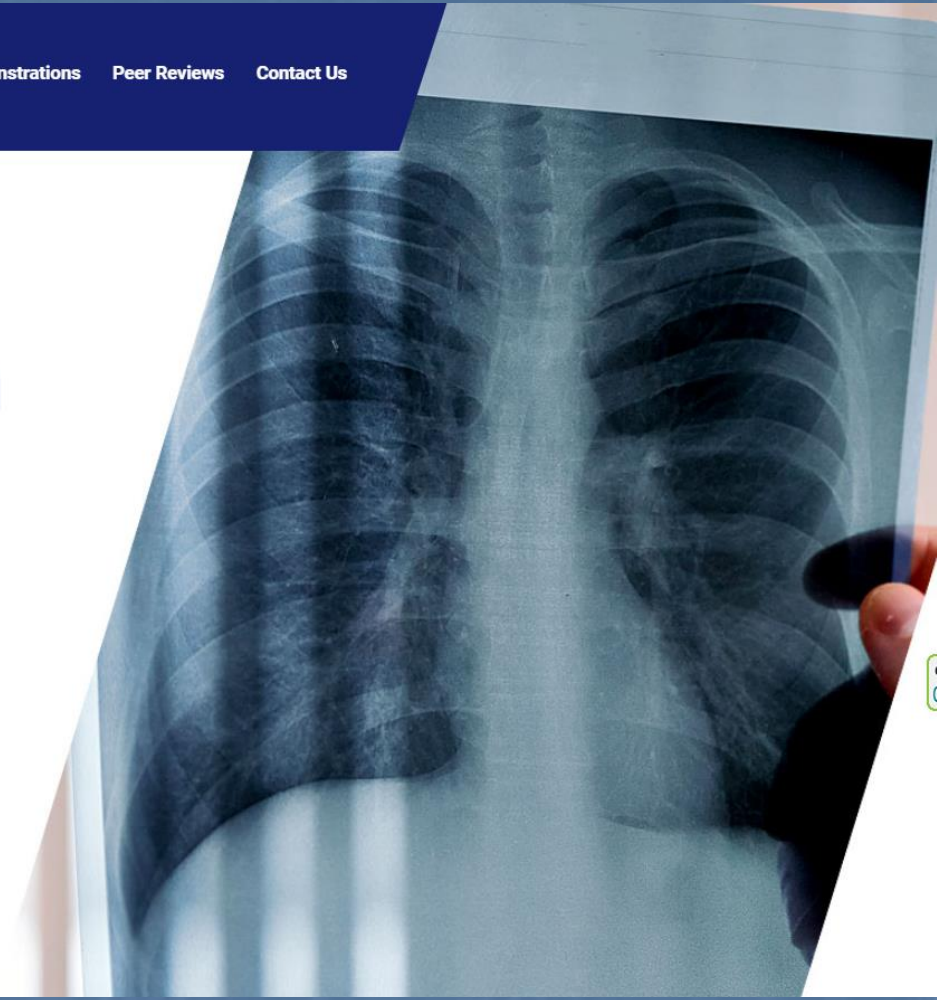
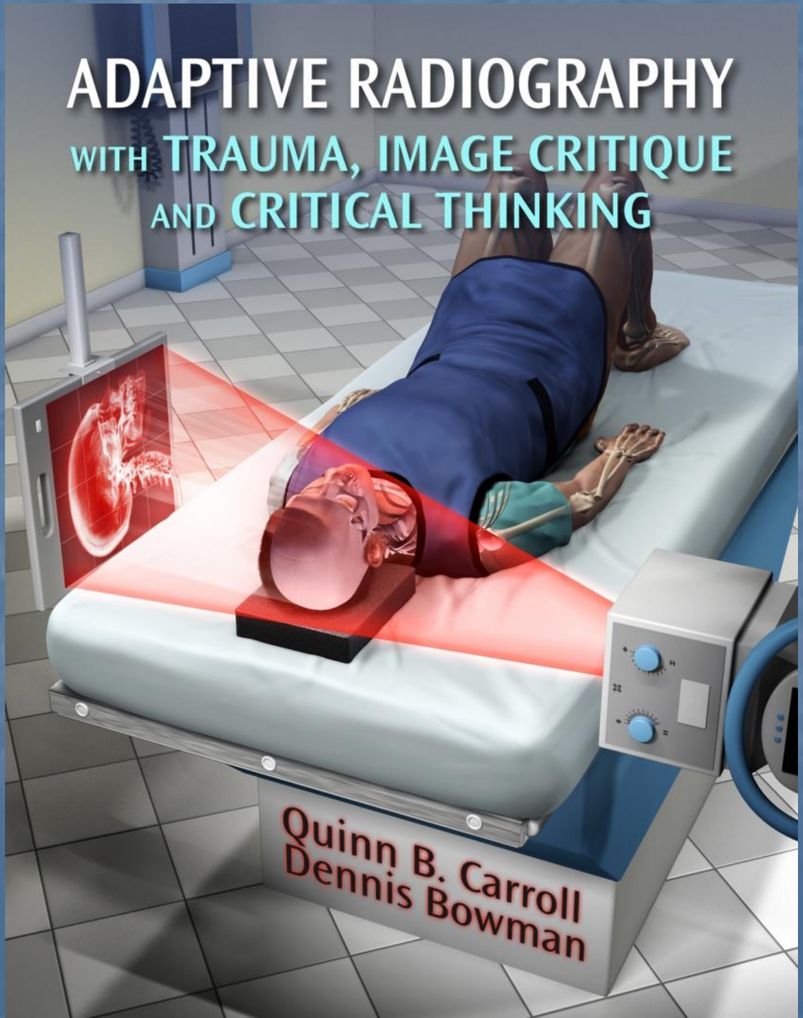


Adaptive Radiography: Tips and Tricks

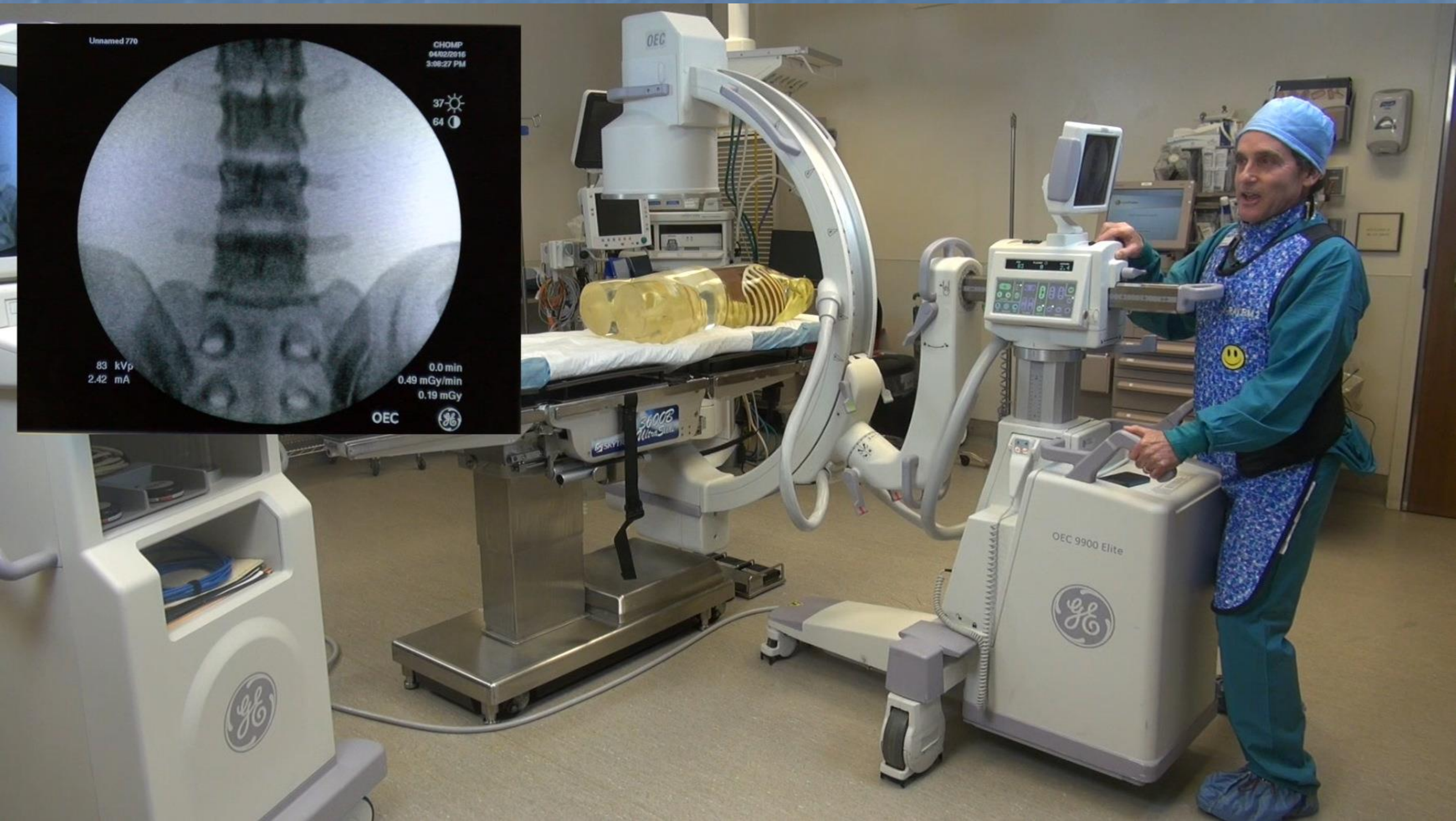


HOW MUCH RADIATION IS SAVED USING PULSE MODES?

dRs

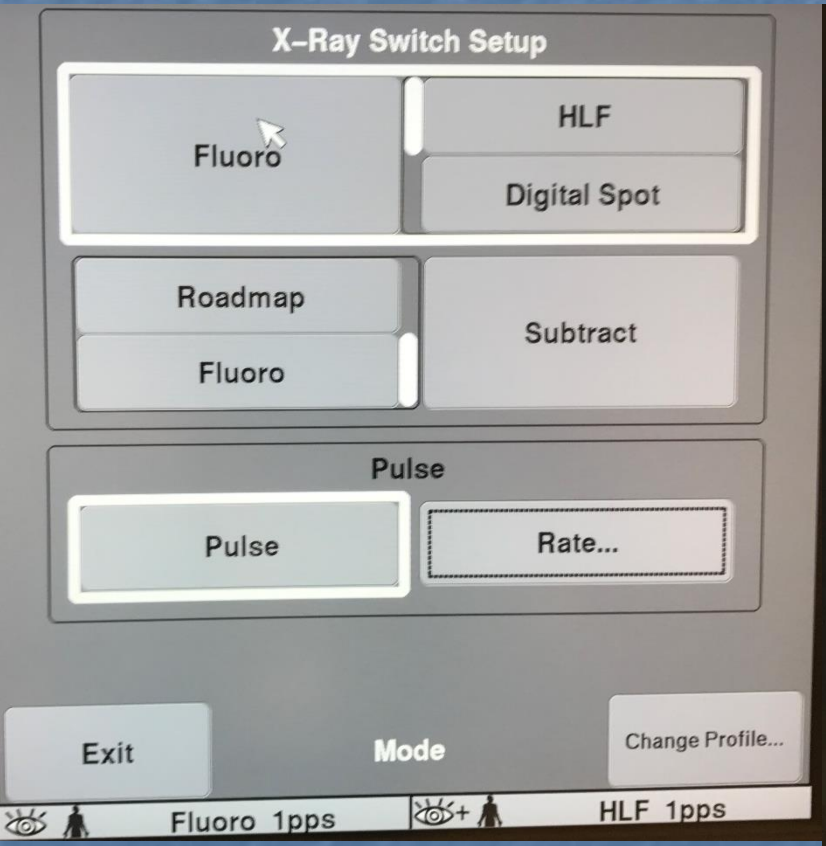
Although we are showing pulse modes in the OR with a c-arm, the same pulse mode settings are in all fluoro, interventional and cardiac cath labs.

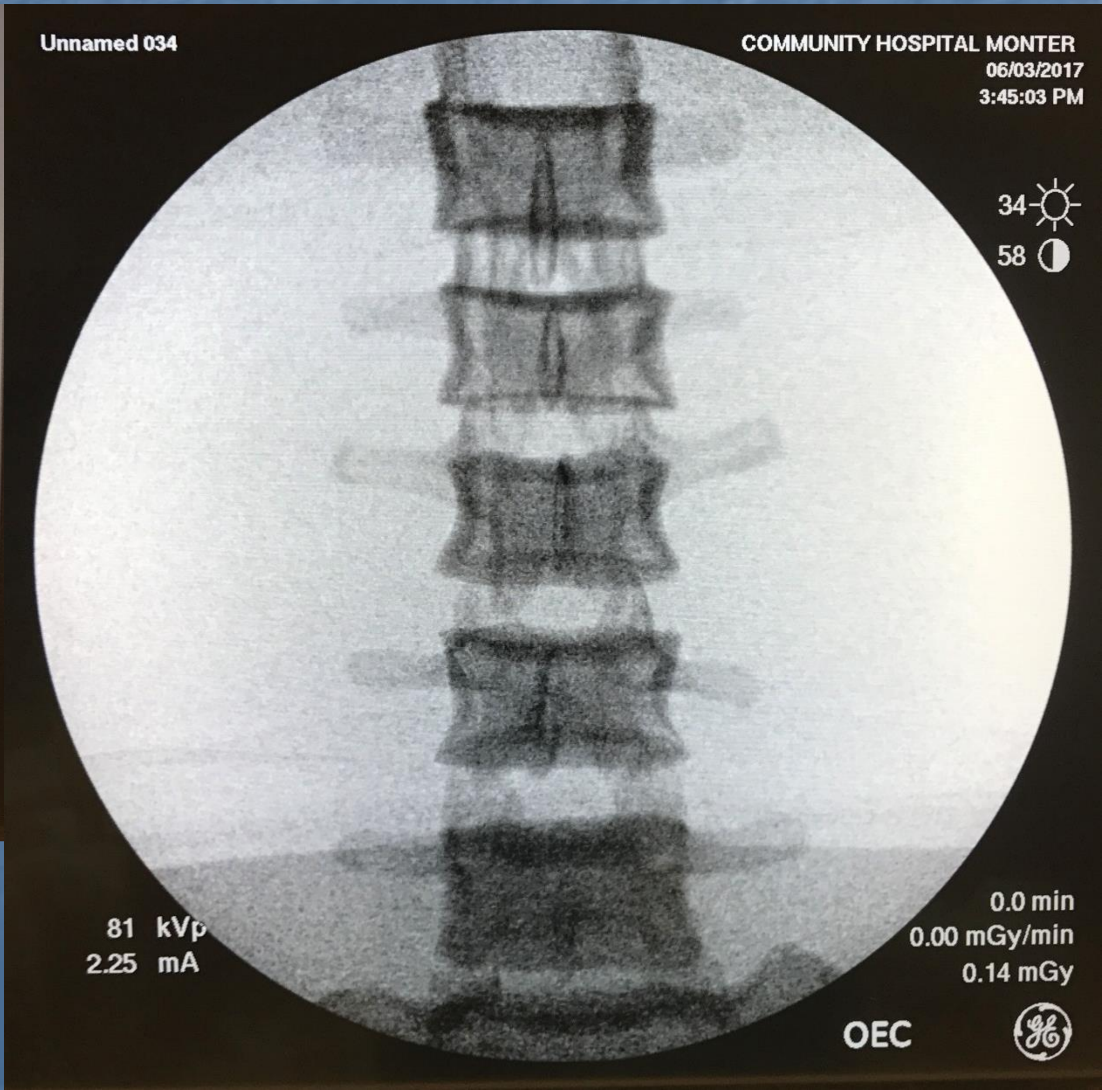
As I pan up and down the body, 1 PPS is so choppy that it is almost never used.



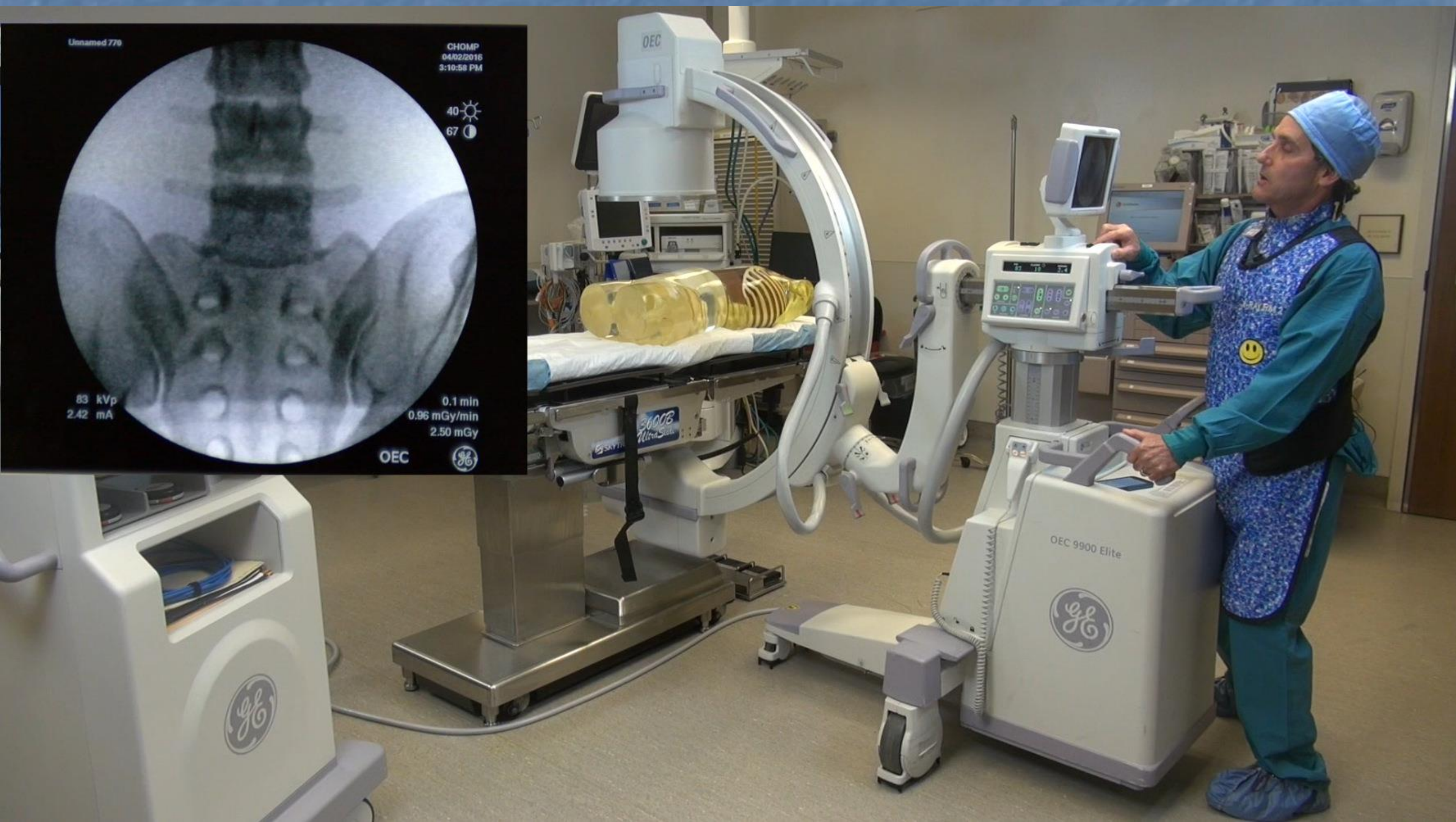
Fluoro-ing for 10 seconds at 1 PPS and not moving the II.

The dose using 1 PPS for 10 seconds is: 0.14 mGy



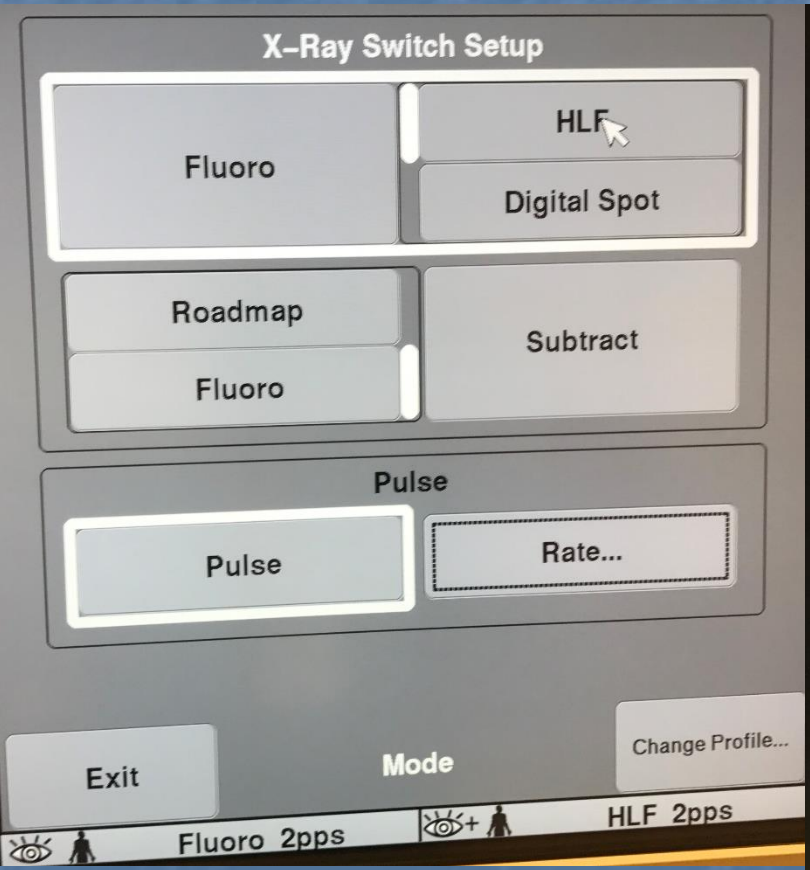


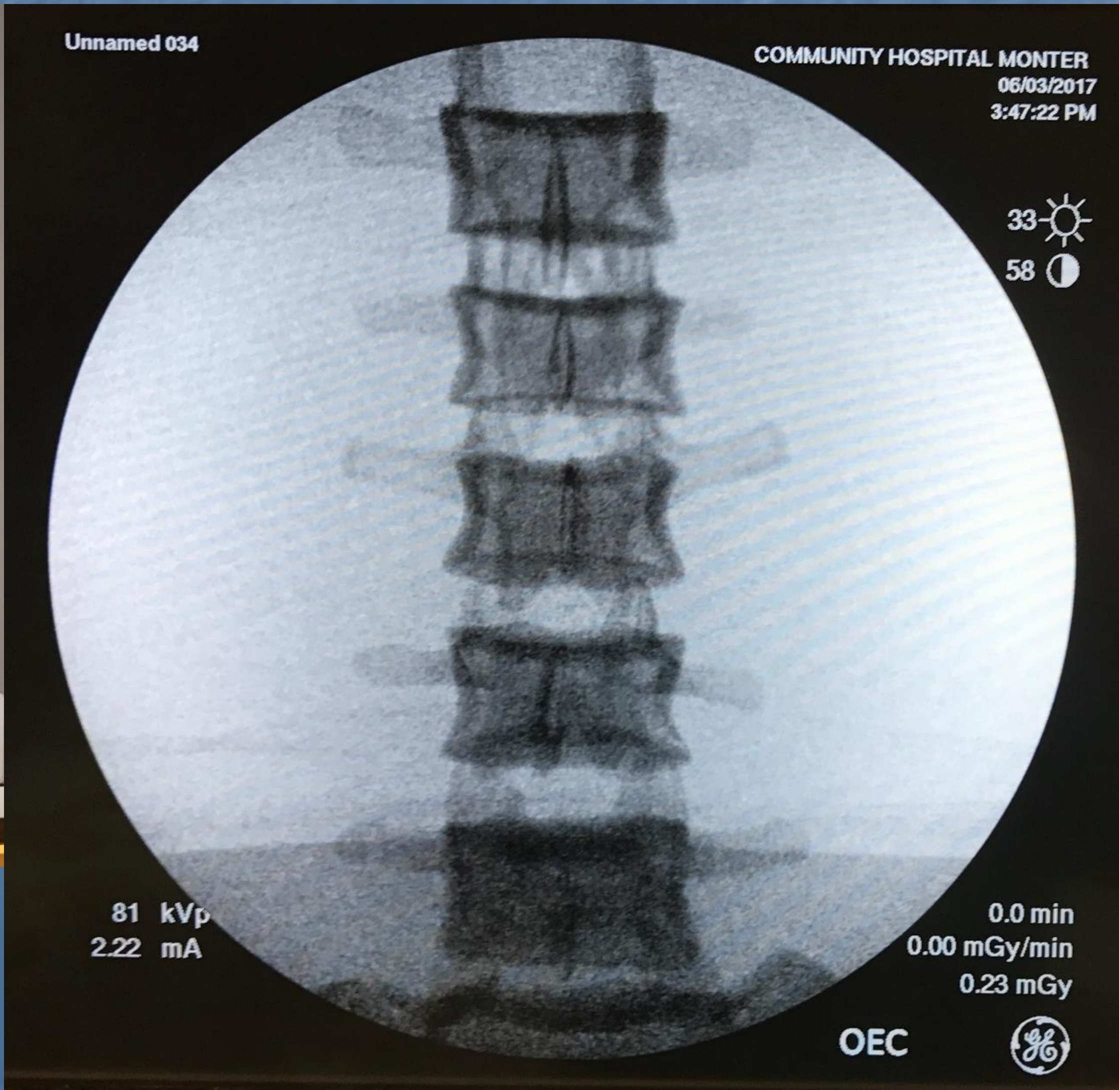
As I pan up and down the body, 2 PPS is still too choppy. Again, it is barely ever used.



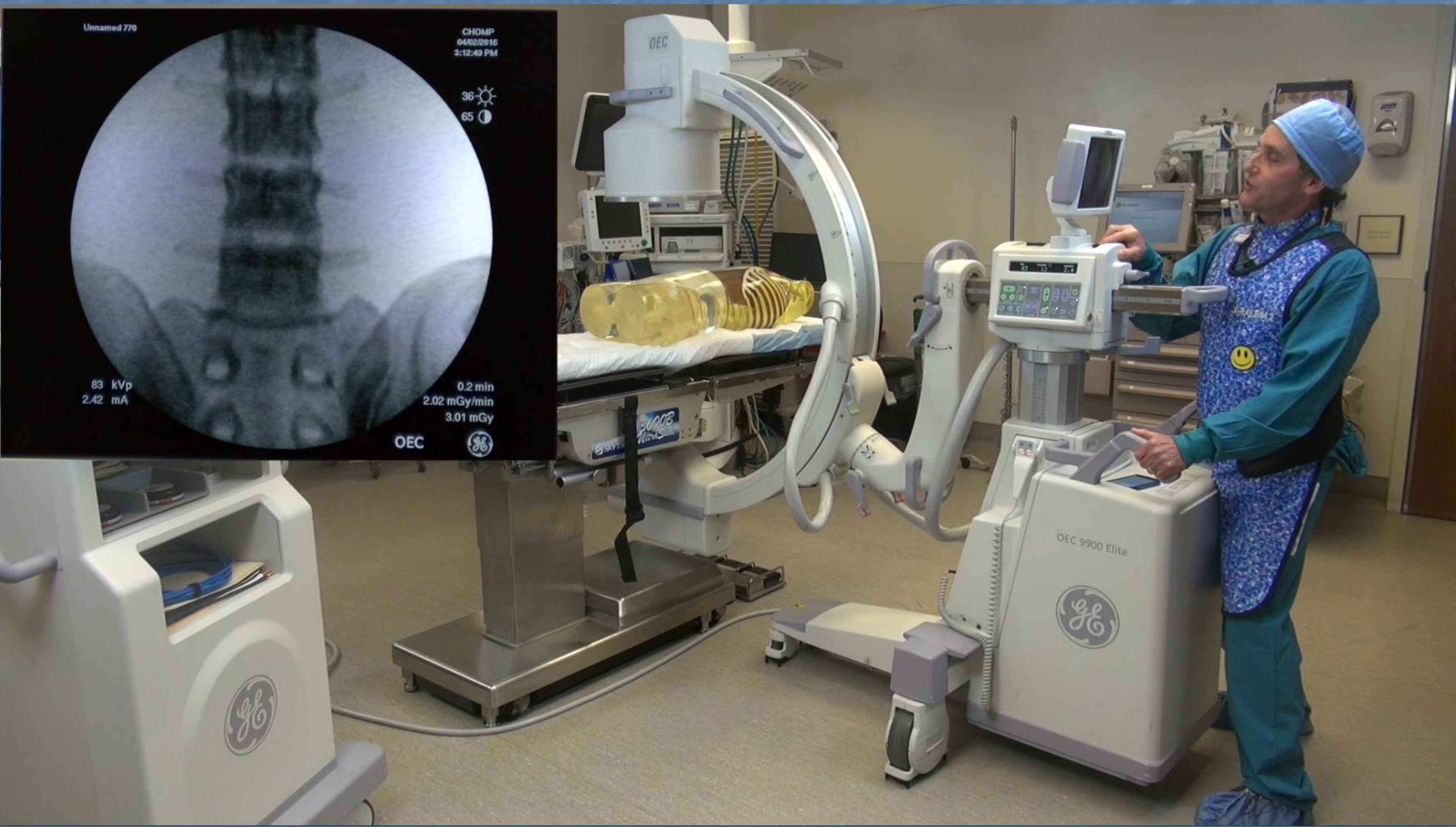
Fluoro-ing for 10 seconds at 2 PPS.

The dose using 2 PPS for 10 seconds is: 0.23 mGy



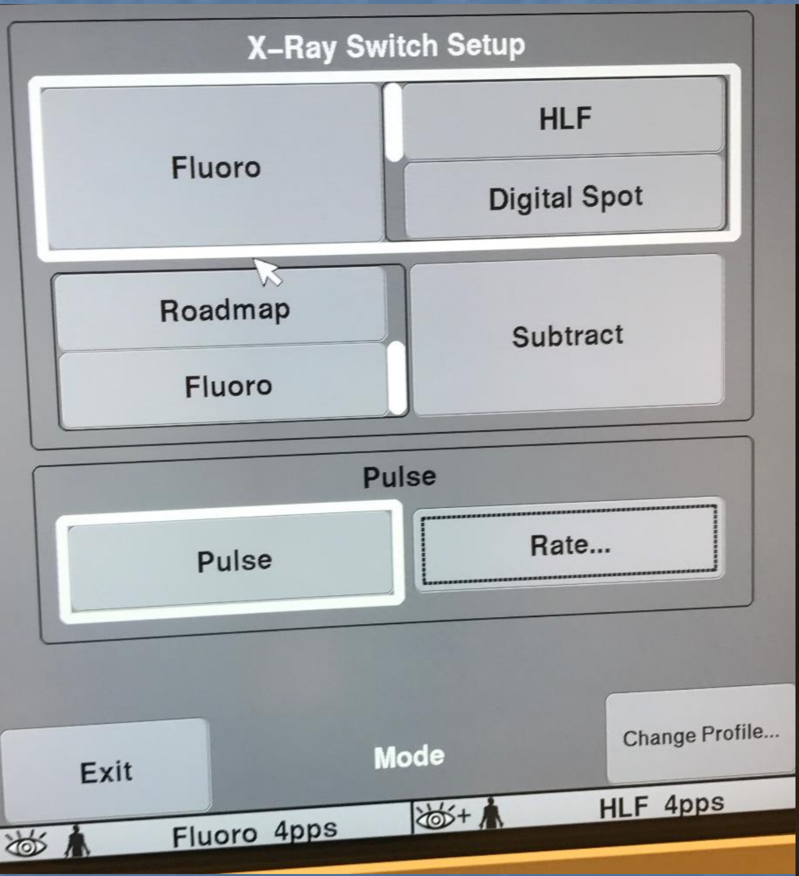


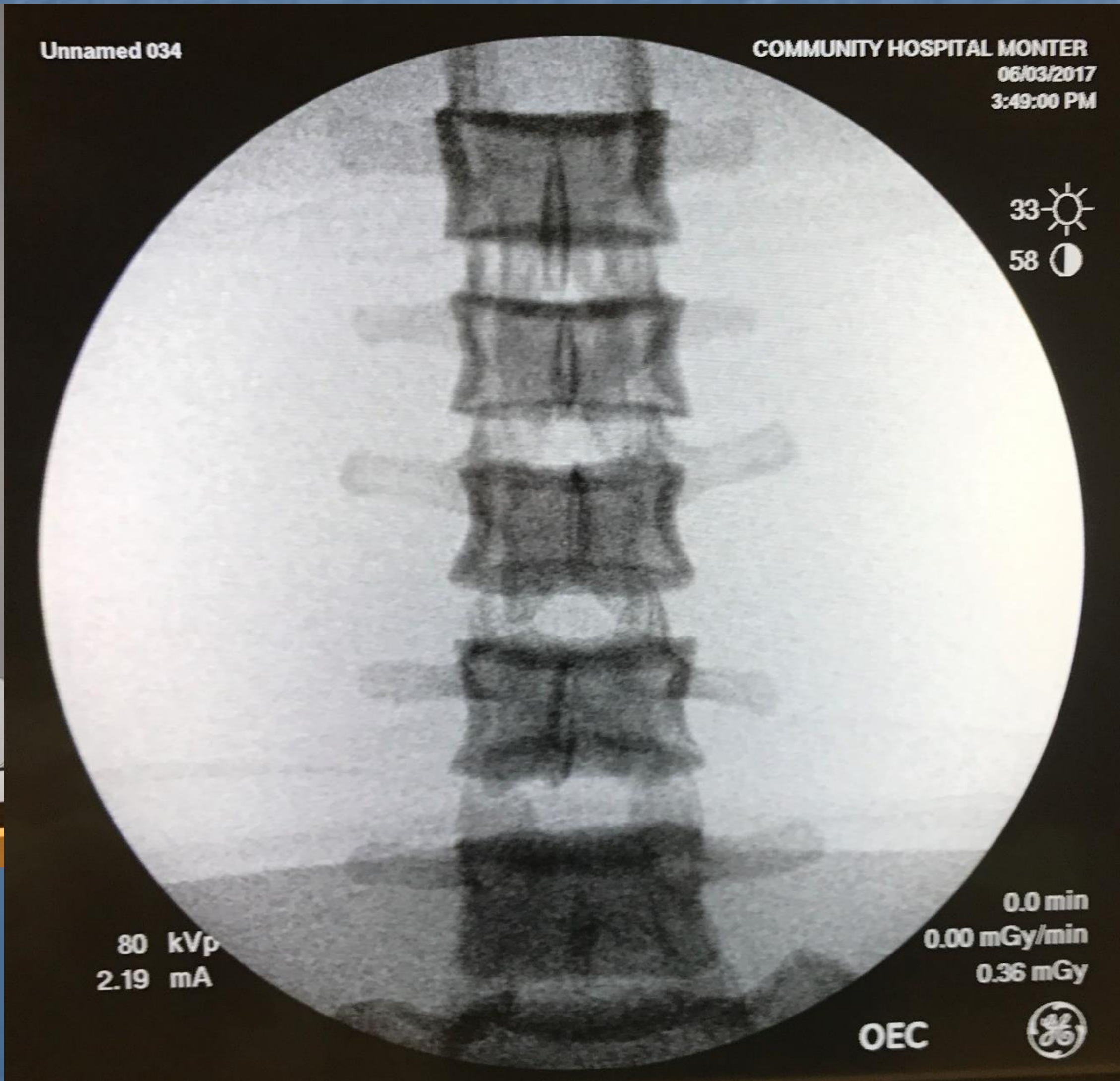
4 PPS is the best yet, but it is still pretty choppy. Usually a physician will only use it if missing chunks of anatomy/pathology is not a big deal.



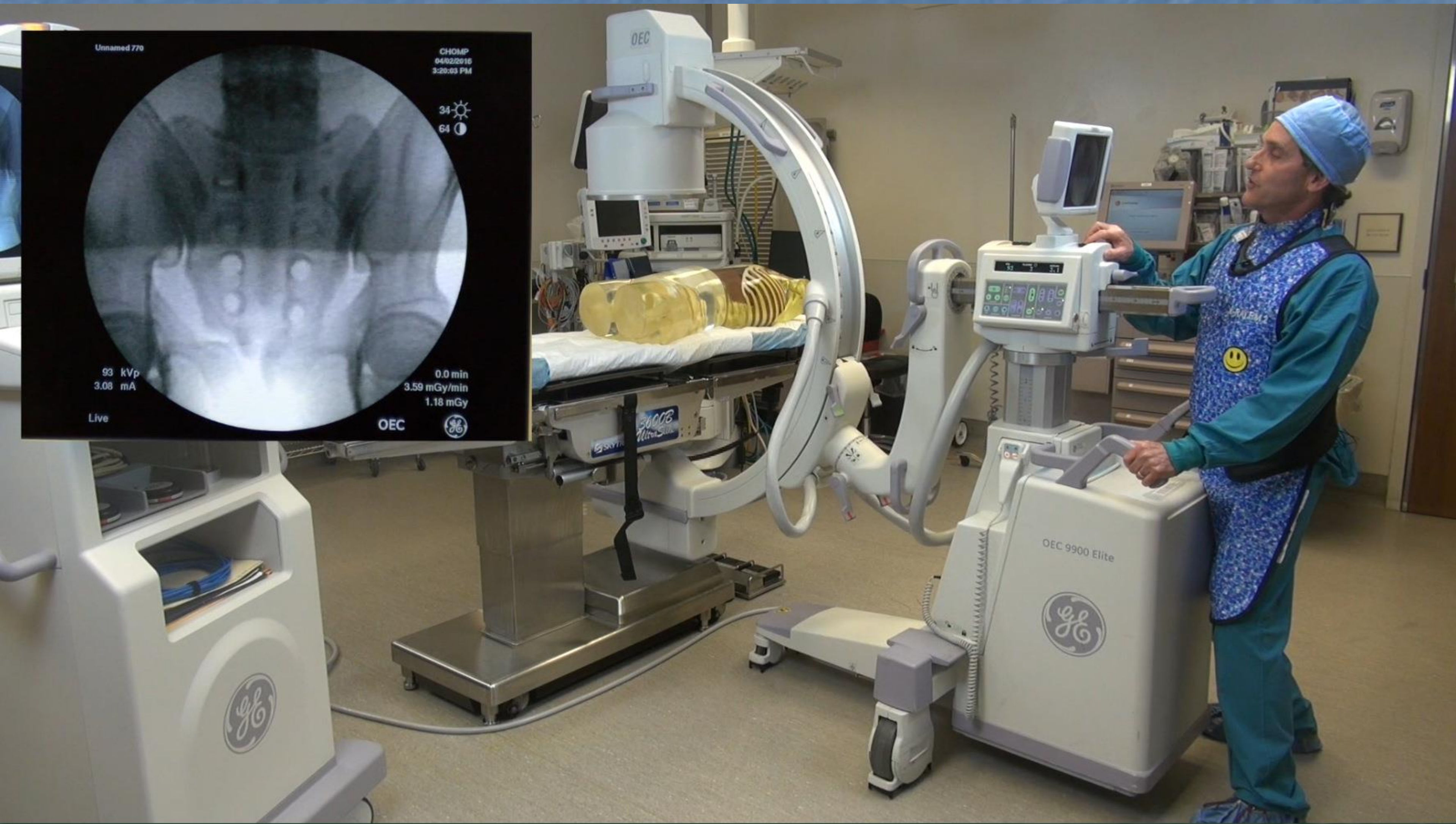
Fluoro-ing for 10 seconds at 4 PPS

The dose using 4 PPS for 10 seconds is: 0.36 mGy



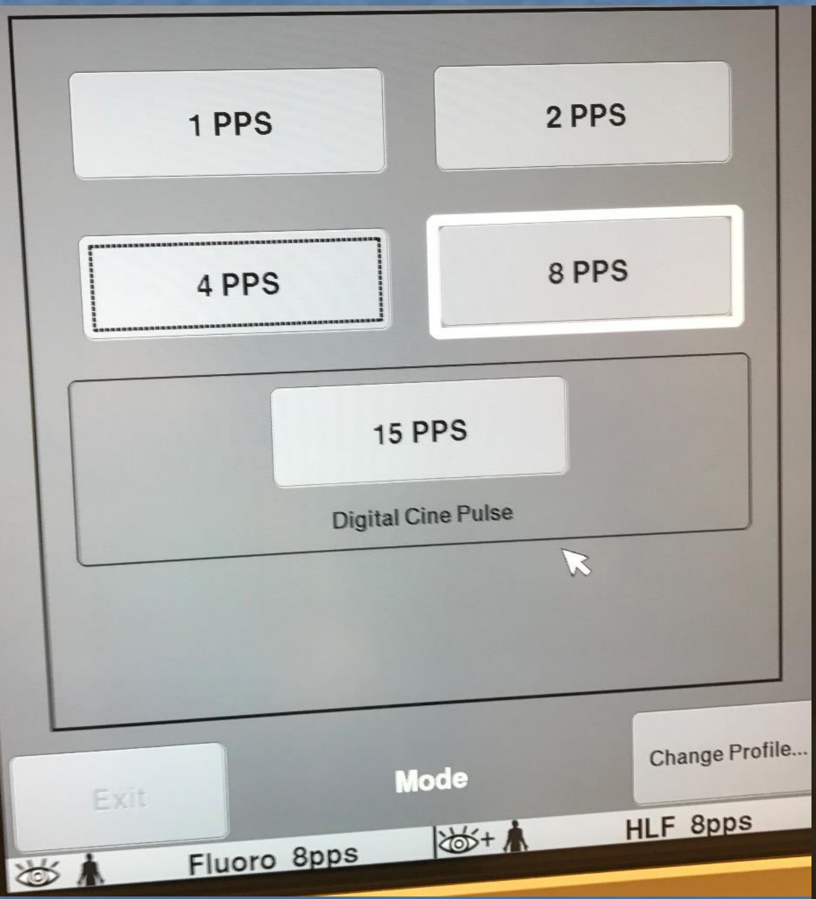


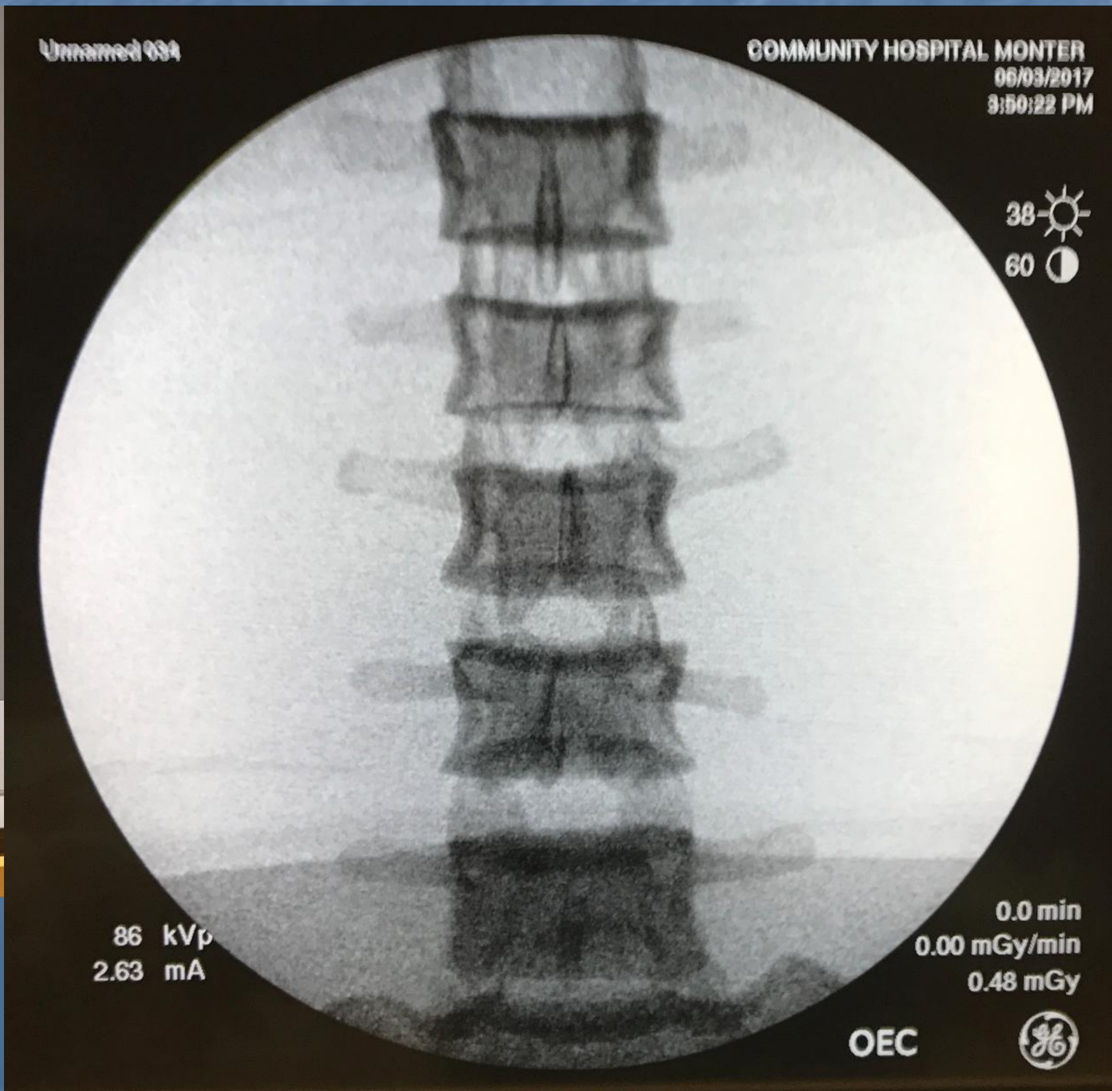
As I fluoro at 8 PPS the image is barely choppy at all. This is why 8 PPS is used almost all the time.



Fluoroing for 10 seconds at 8 PPS

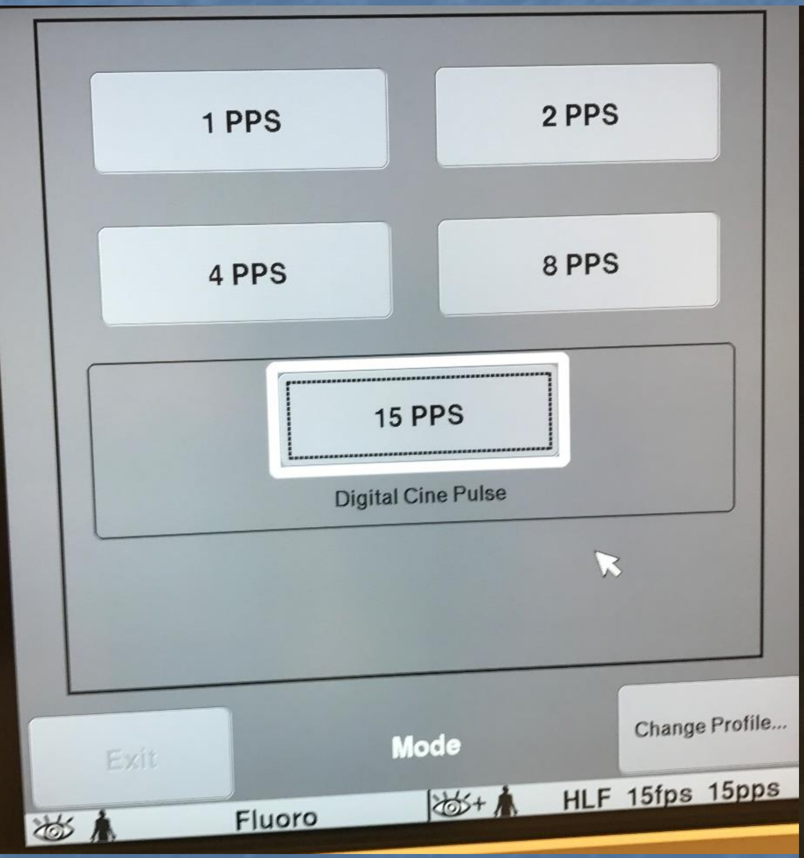
The dose using 8 PPS for 10 seconds is: 0.48 mGy

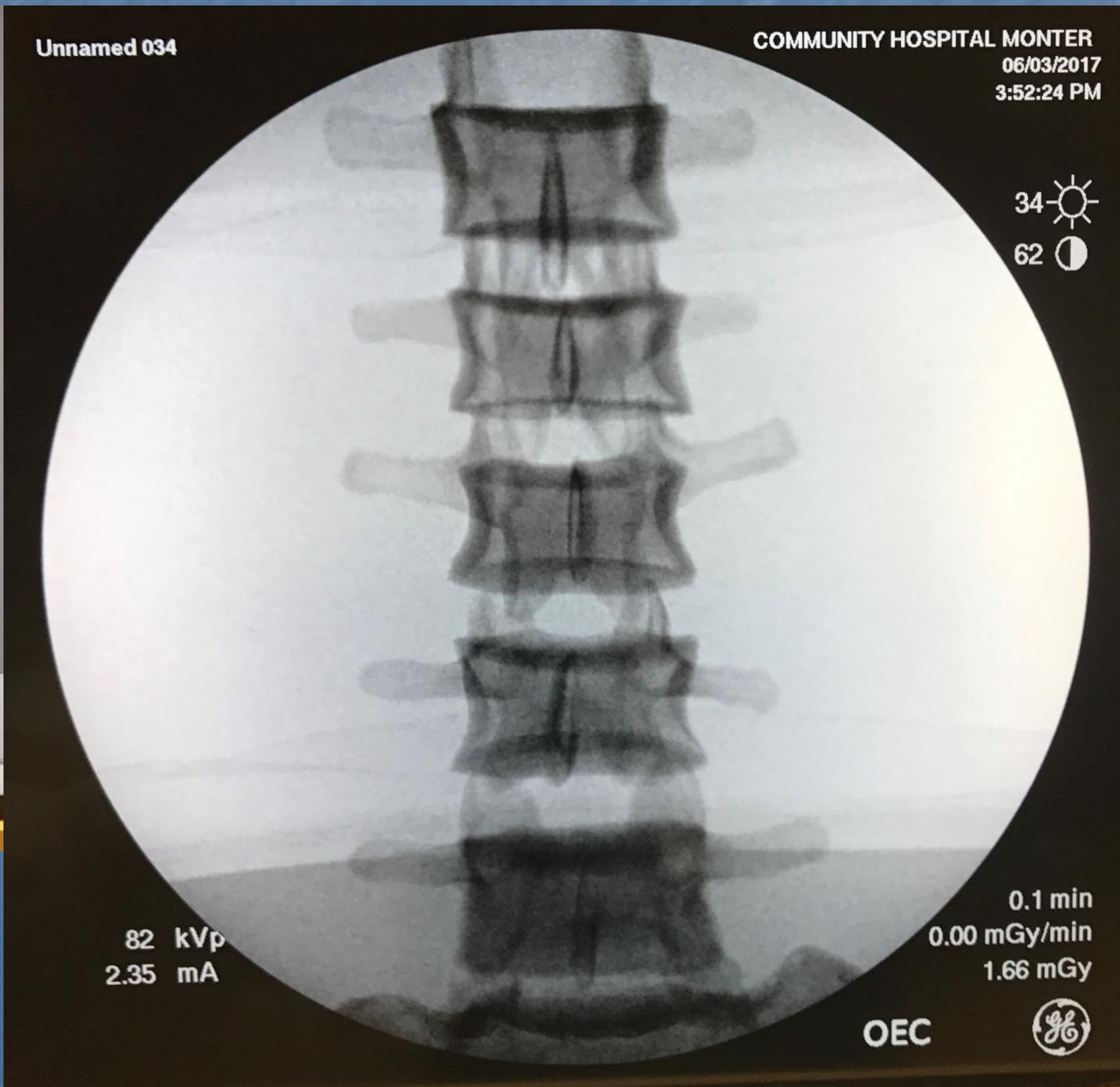




We wanted to show what the dose will be with 10 seconds of fluoro using the 15 PPS.

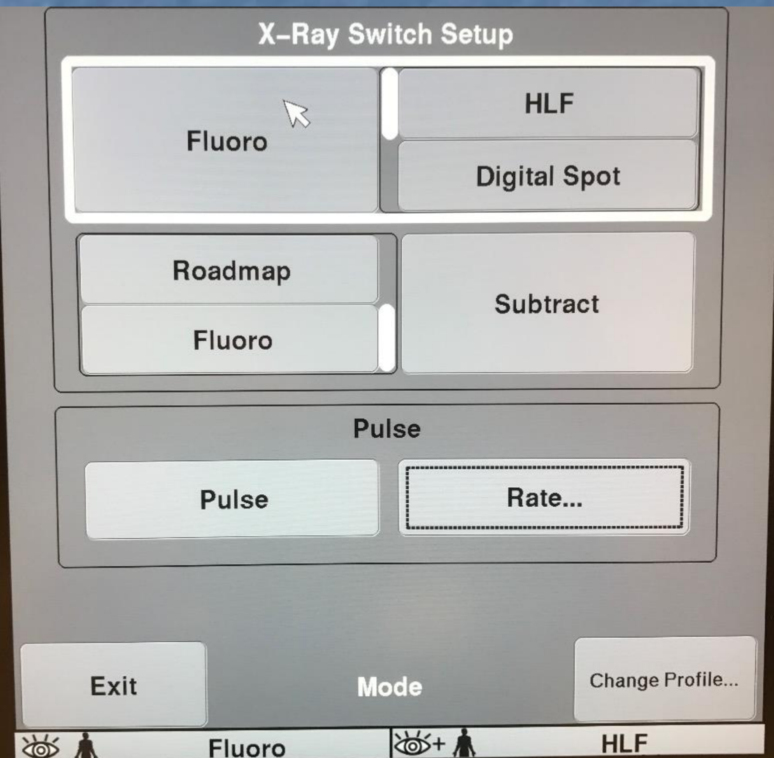
The dose using 15 PPS for 10 seconds is: 1.66 mGy

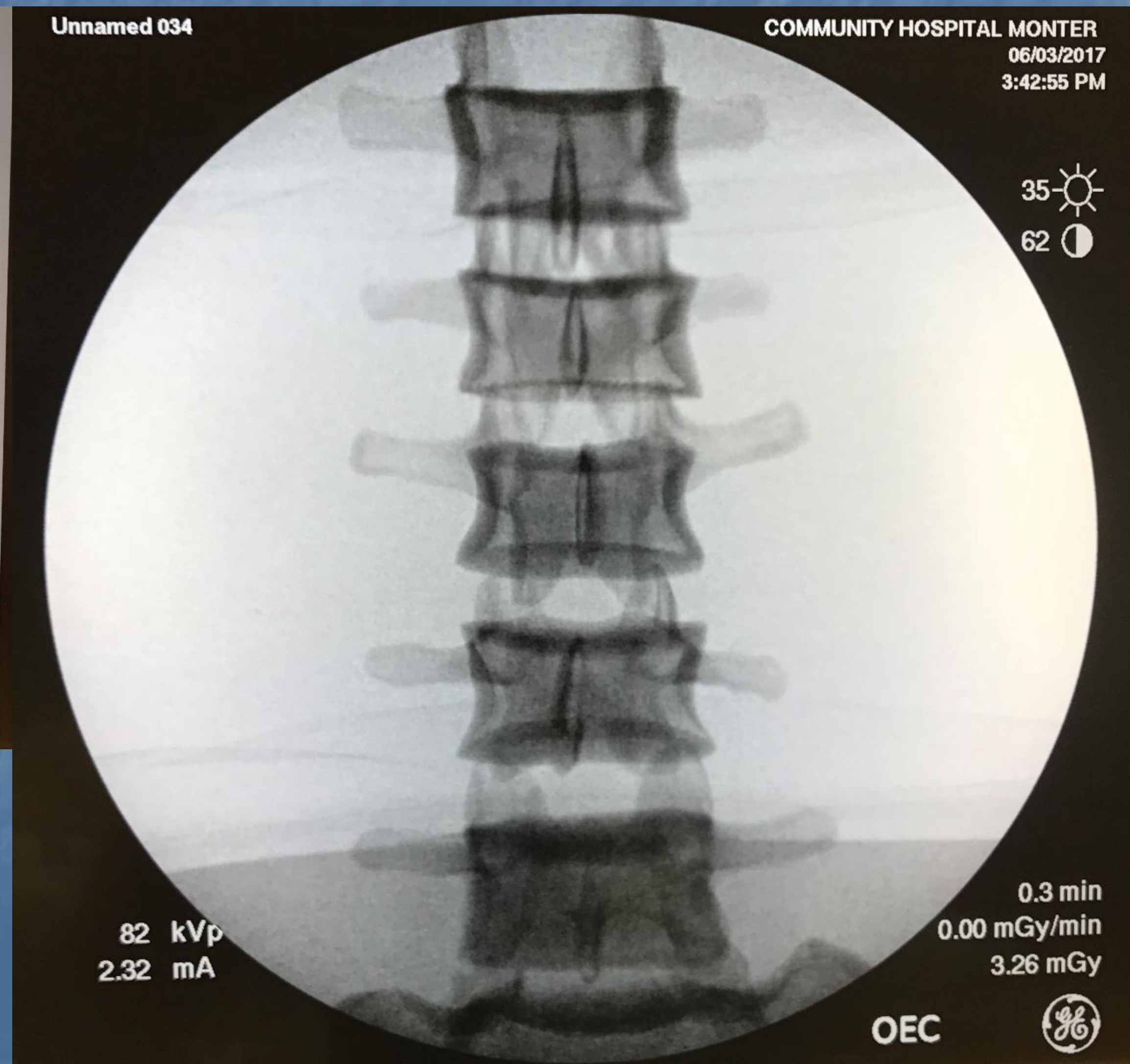




Now we want to show you how much more dose there is using the regular default setting (no PPS set).

The dose using no PPS for 10 seconds is: 3.26 mGy





Here are the compared doses for the Pulse Modes. They are all compared to the No Pulse.

- No Pulse – 3.26 mGy =
- 15 PPS – 1.66 mGy = **49.1% less**
- 8 PPS – 0.48 mGy = **85.3% less**
- 4 PPS – 0.36 mGy = **89.0% less**
- 2 PPS – 0.23 mGy = **92.9% less**
- 1 PPS – 0.14 mGy = **95.7% less**

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I have 4 PPS set to show that a second of fluoro is not really a second of fluoro. It took 9 seconds of actual time for the c-arm to record 2 seconds.

dRs Digital Radiography Solutions

Dennis Bowman

dennismbowman@gmail.com

(831) 601-9860

digitalradiographysolutions.com

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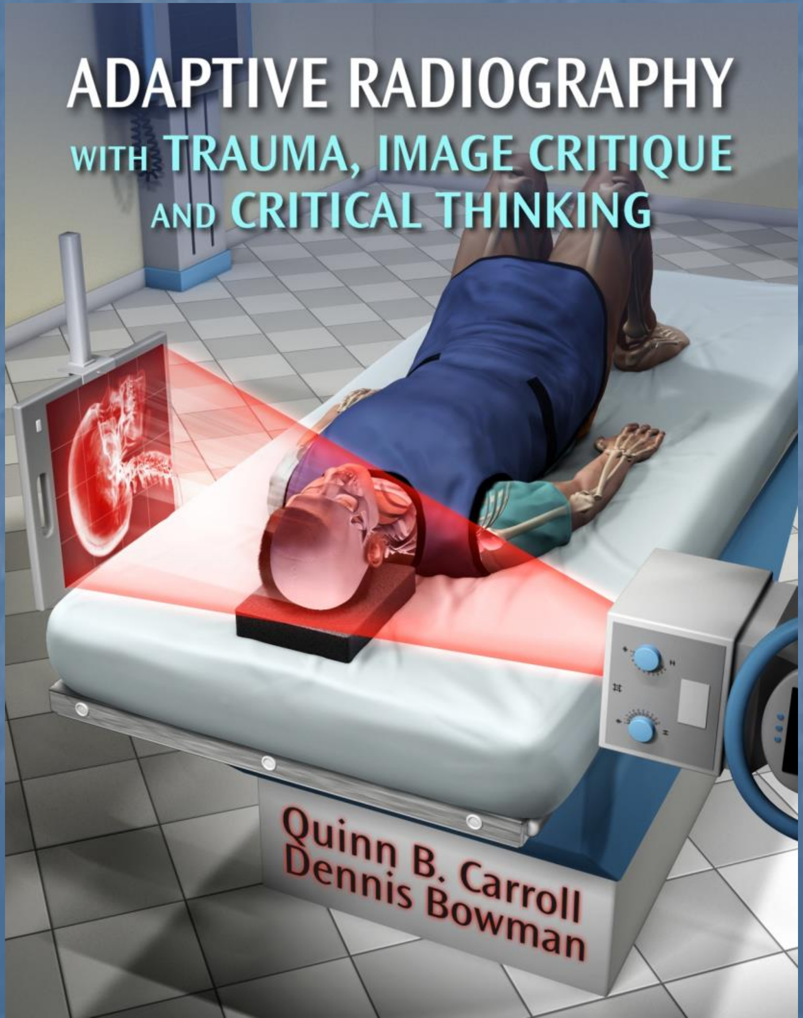
so I could continue to have all of my low dose DR and CR digital technique charts, and radiation protection experiments and demonstrations, available for free.

Adaptive Radiography: Tips and Tricks

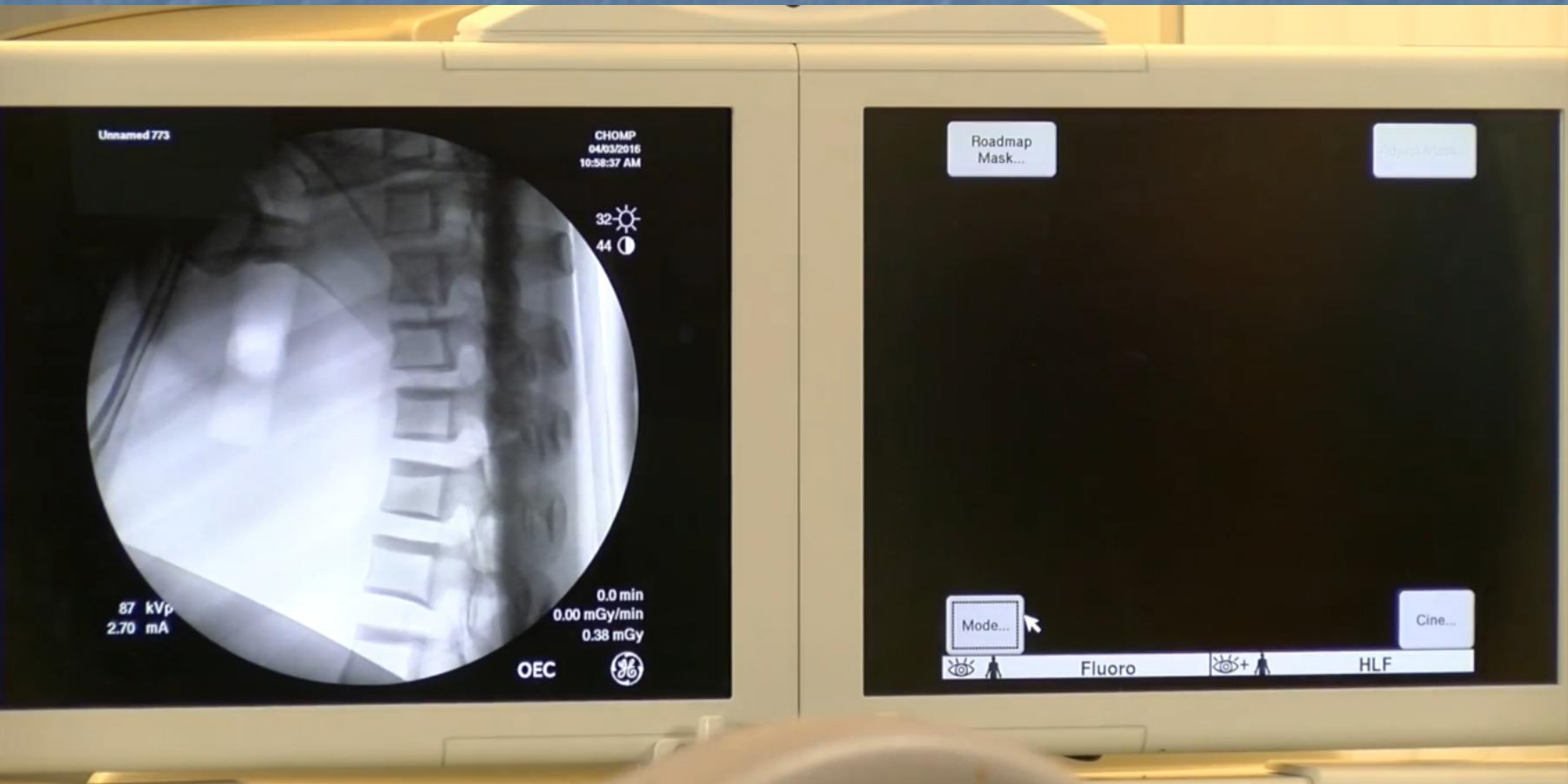


DOSE DIFFERENCE BETWEEN MAGNIFICATION MODES

Most c-arms have 2 mag modes while most R/F rooms have a third setting.

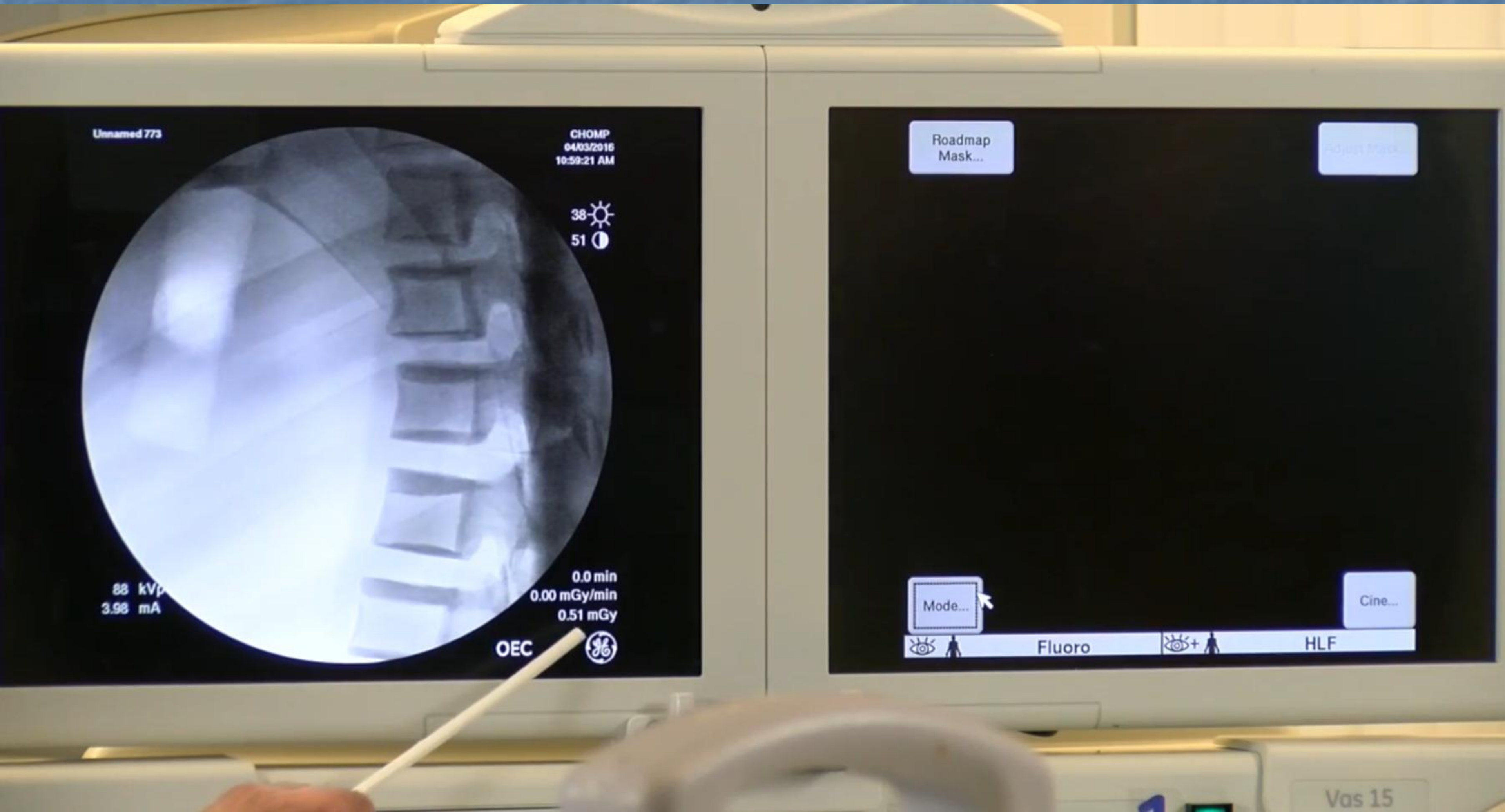
We're using the thoracic phantom in a lateral projection. All exposures will be for 2 seconds.

This is the default/no mag setting.
You can count almost 8 vertebrae.
This is the full 12” image.
Note that the readout was 0.38 mGy.

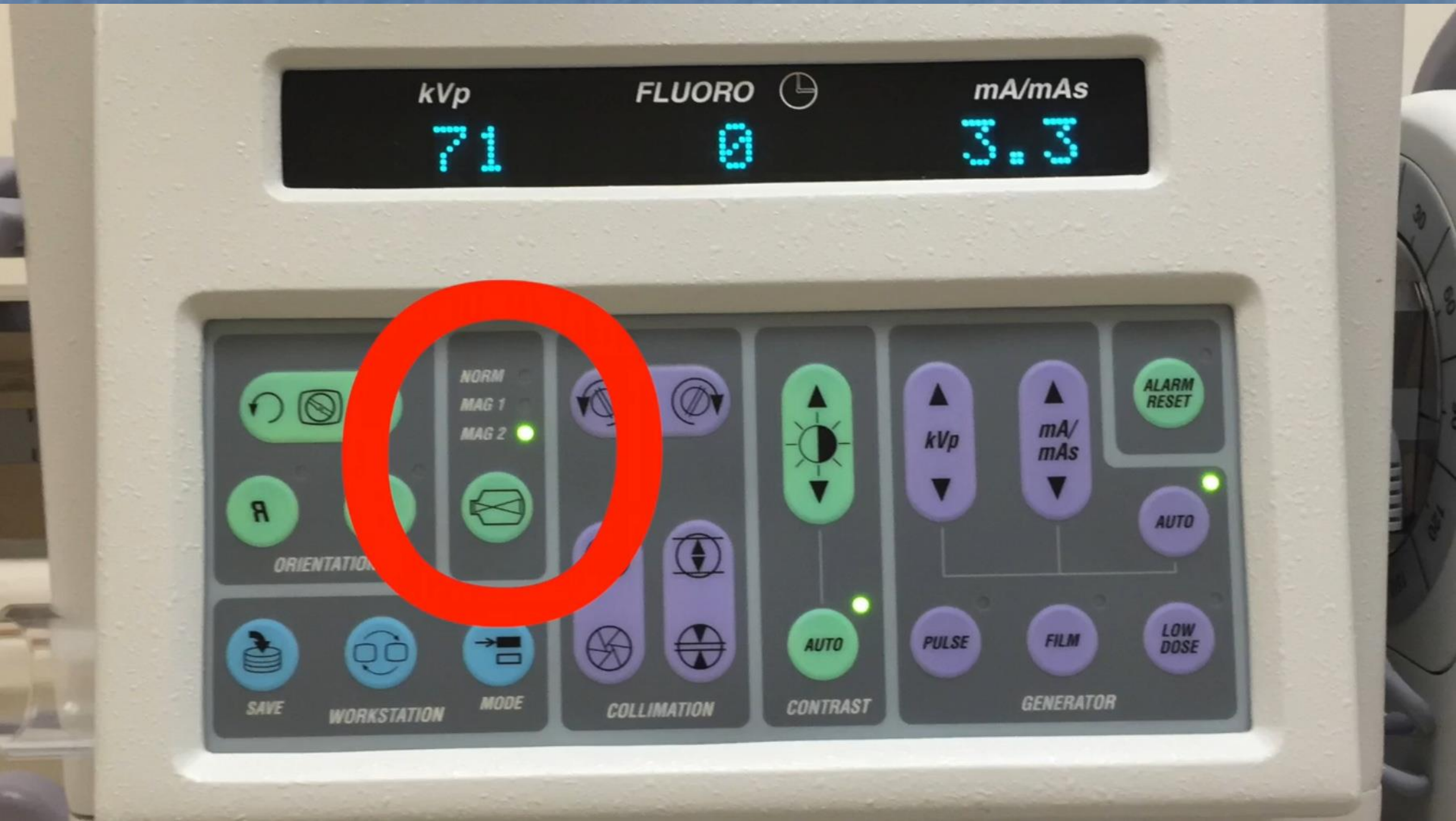


Now we'll make the exposure on Mag 1.

Mag 1 takes the 12” to a 9” image.
You can now see just over 5 vertebrae.
The dose at Mag 1 is now 0.51 mGy.



Now we’re set up on Mag 2.



Mag 2 takes the image from 12” to 6”. You can now see just under 4 vertebrae. The dose readout at Mag 2 is 0.84 mGy

This is the good way to mag.
You never want to mag by moving the II further away from your patient, which just increases the OID.

Dose Differences with Mag Modes

- Regular – .38 mGy   Starting point - Base
- Mag 1 – .51 mGy   Dose increased by 34%
- Mag 2 – .84 mGy   Dose increased by 121%

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Always be willing and ready to suggest to the surgeon that mag-ing an image could be very helpful.

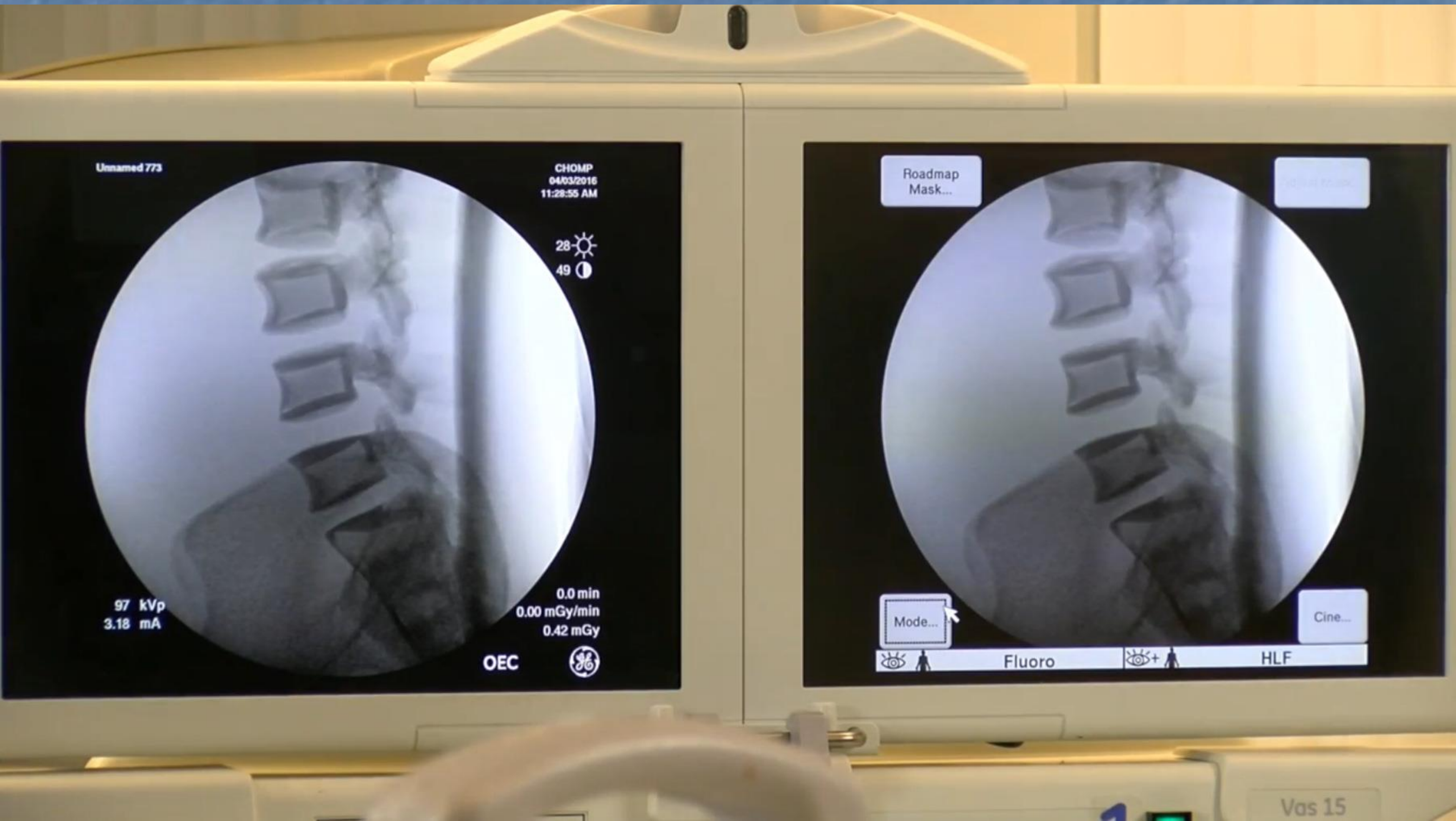
There will be more dose, but it is worth it.

LOW DOSE
VERSUS
DEFAULT SETTINGS

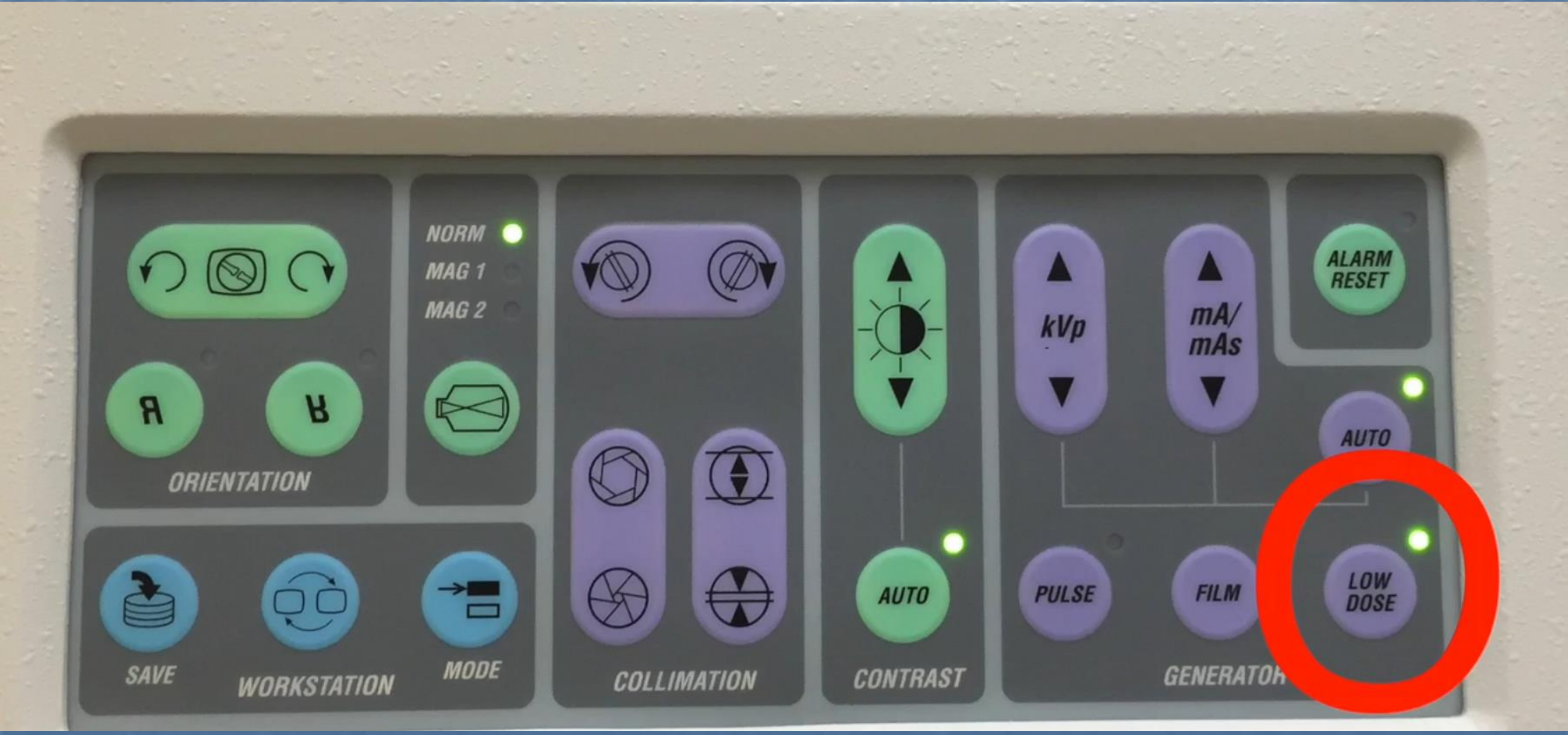
Also might be called pediatric settings.
It cuts the mA in half and gives a higher kV.
It has a much lower dose, but a nosier image.

Making the first exposure.

First exposure made and sent to the right screen. It was 97 kV @ 3.18 mA.



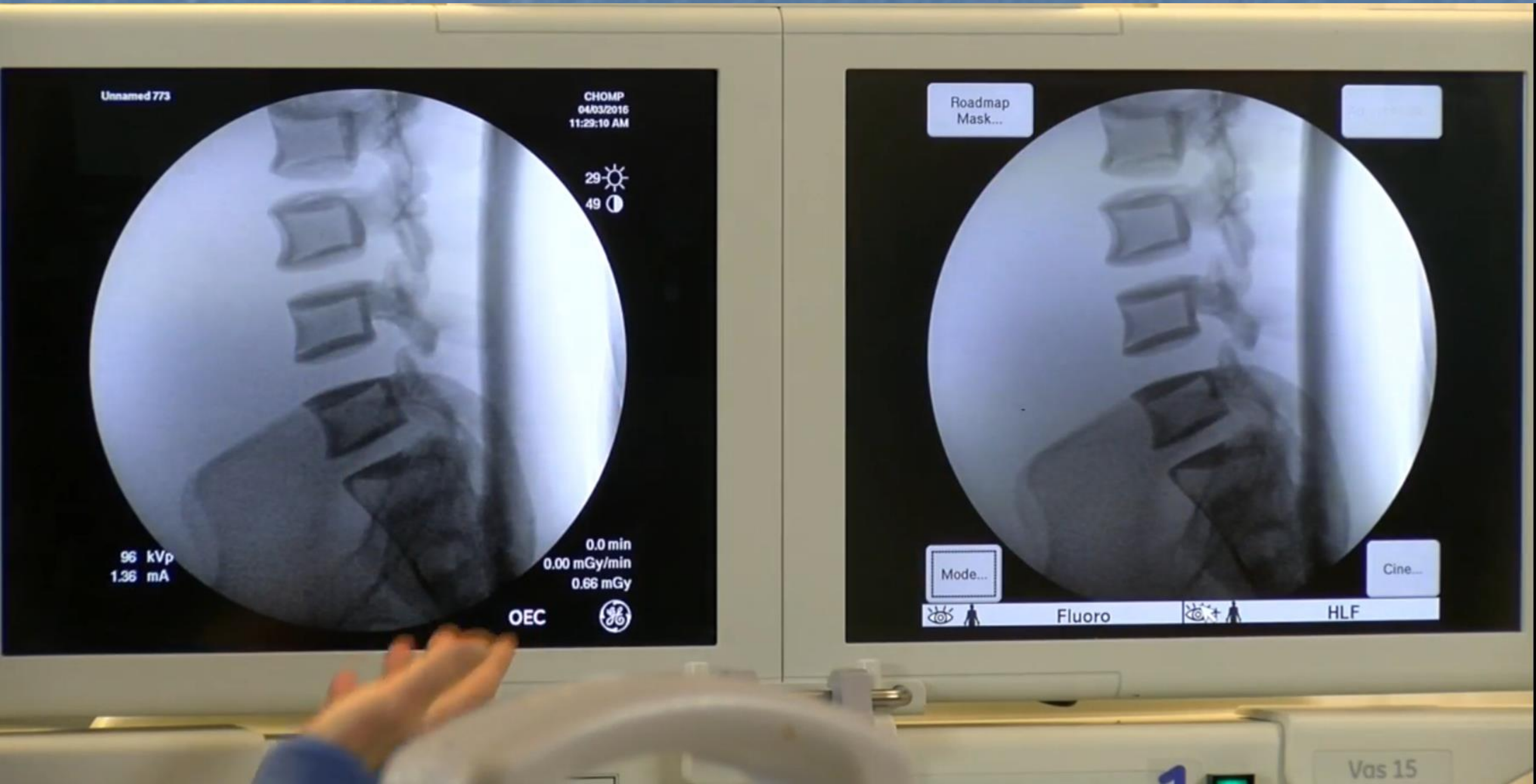
Now set on Low Dose button. This will cut the mA to half and usually increase 3-4 more kV.



Second exposure made with Low Dose.

Image on left is Low Dose and on right is regular default setting.

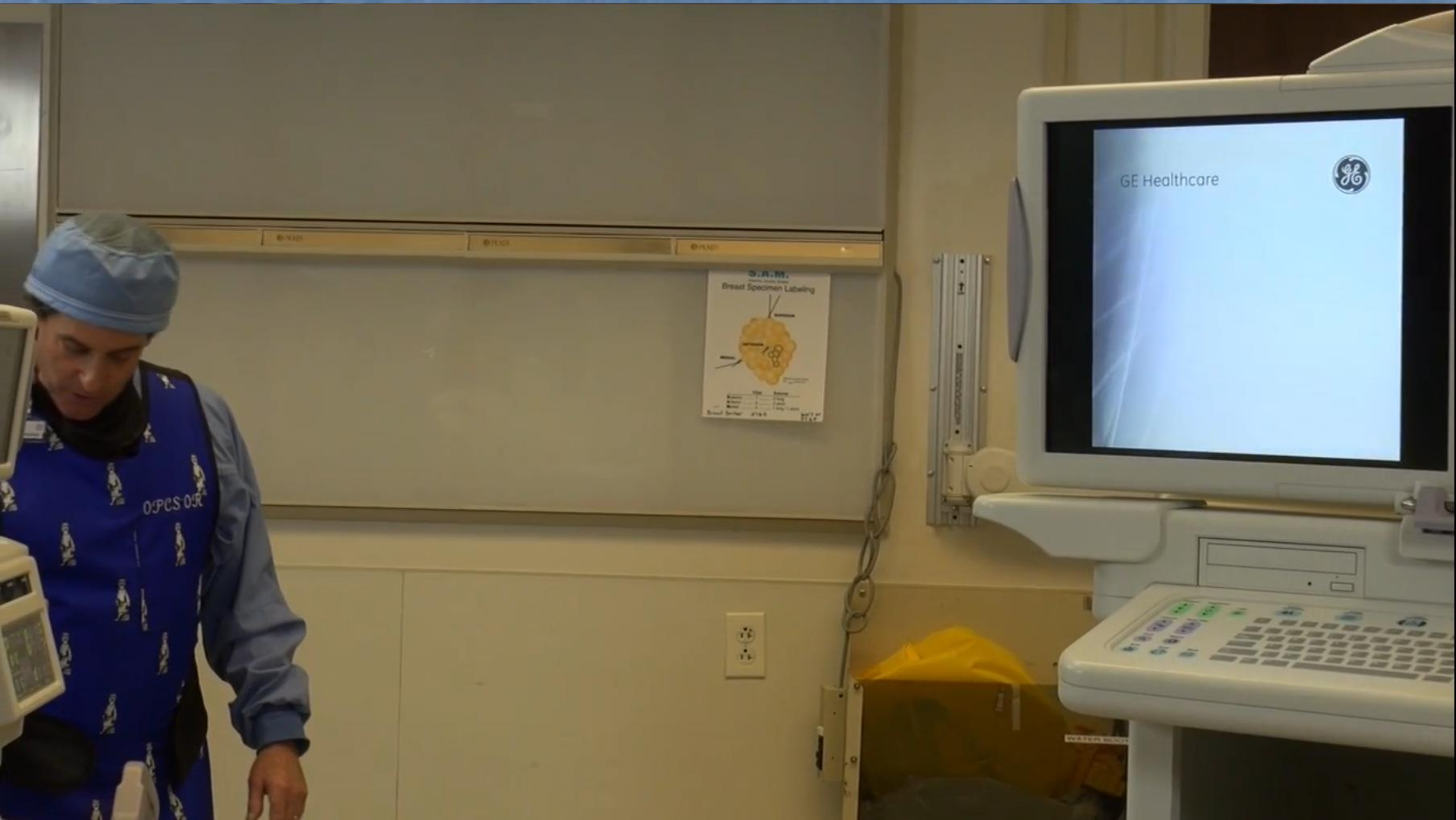
You can see that the image on the left has more noise, but it also used less than half the dose. 97 kV to 96 kV and 3.18 mA to 1.36 mA.



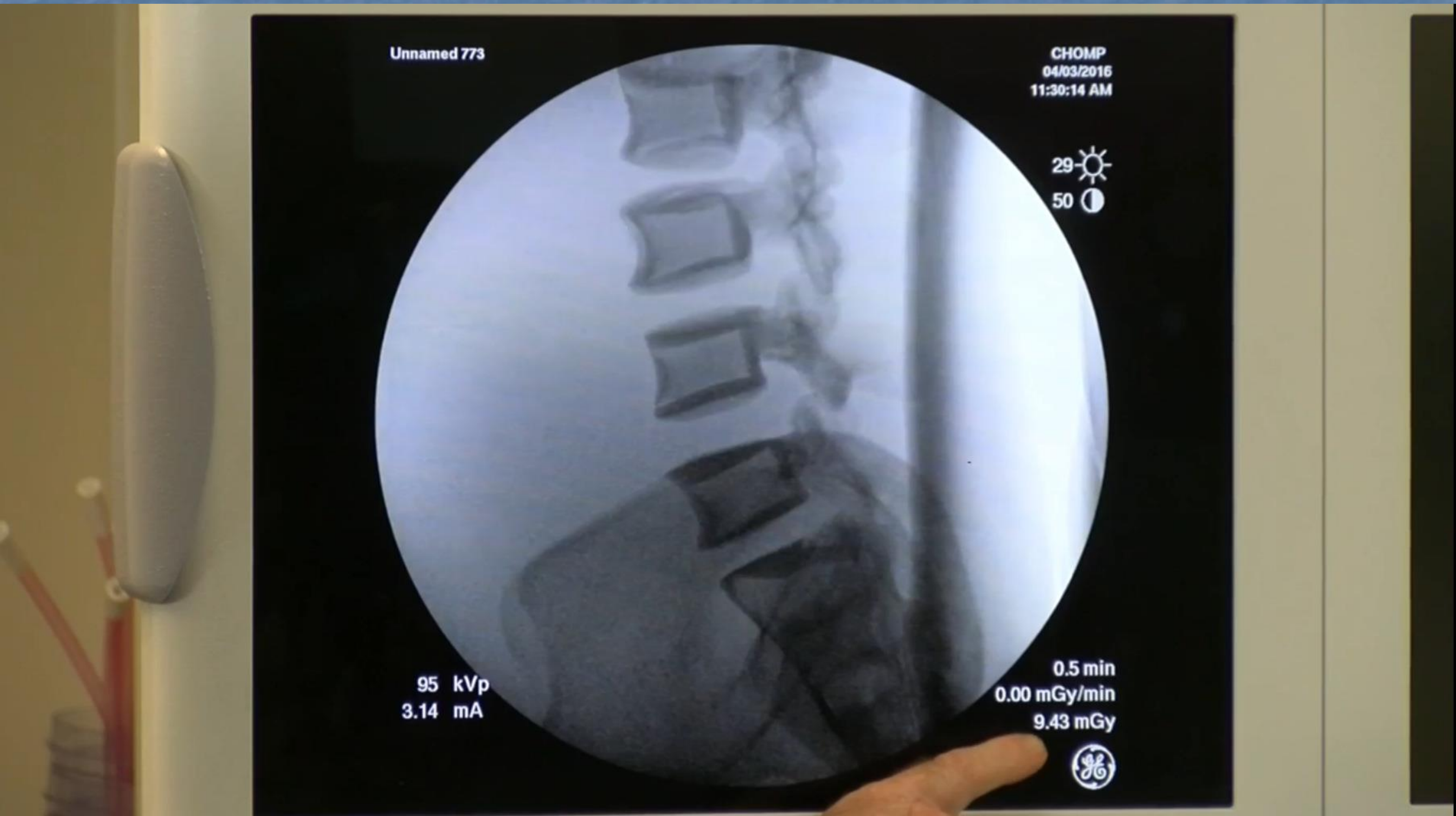
Any time you think that the image does not have to be perfect, ask the physician if Low Dose can be used, as it utilizes ½ the mA.

We will reset everything and make 30 second exposures so we can compare the dose.

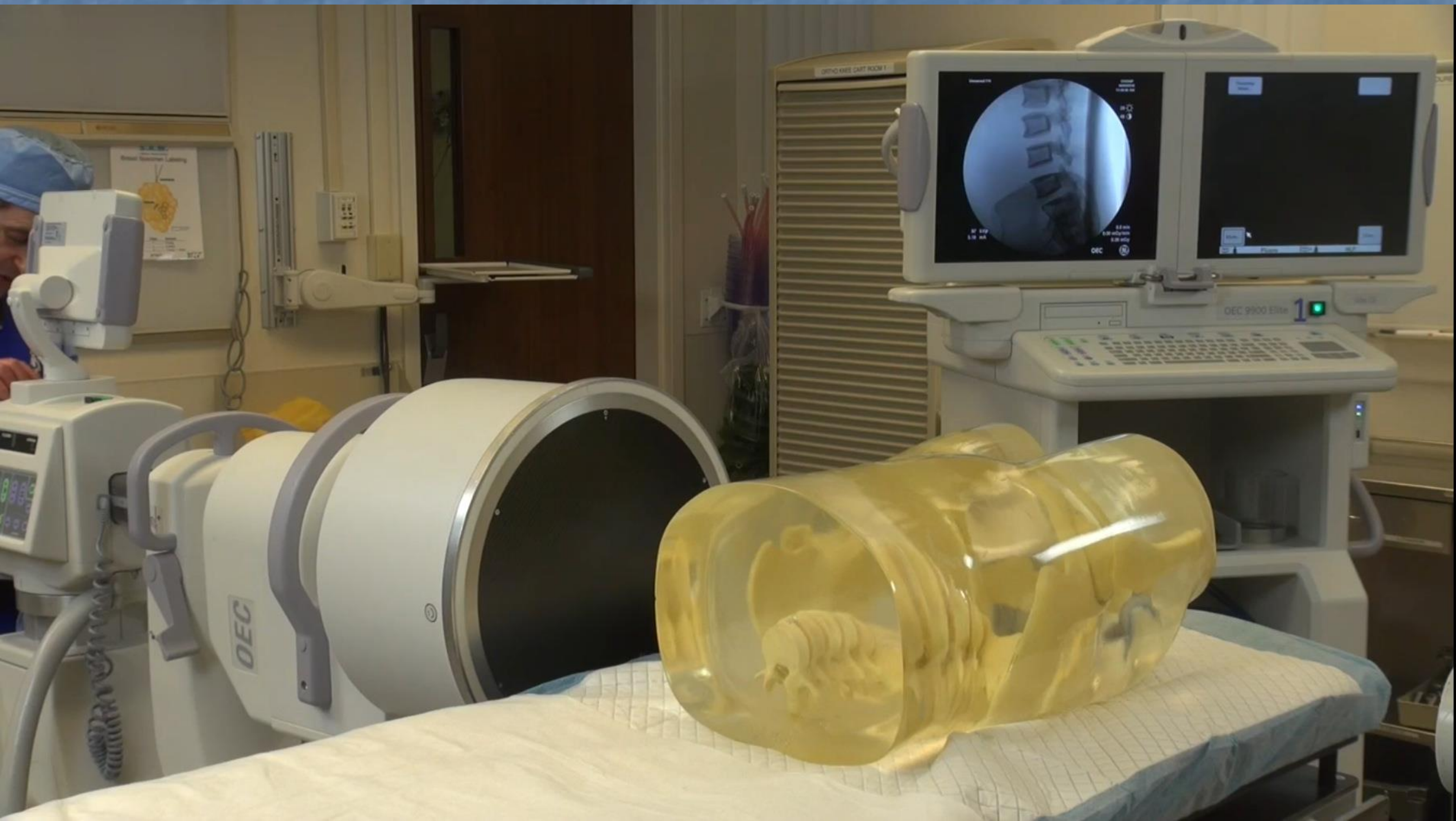
30 Second exposure made on default/regular setting.



It was 9.43 mGy.

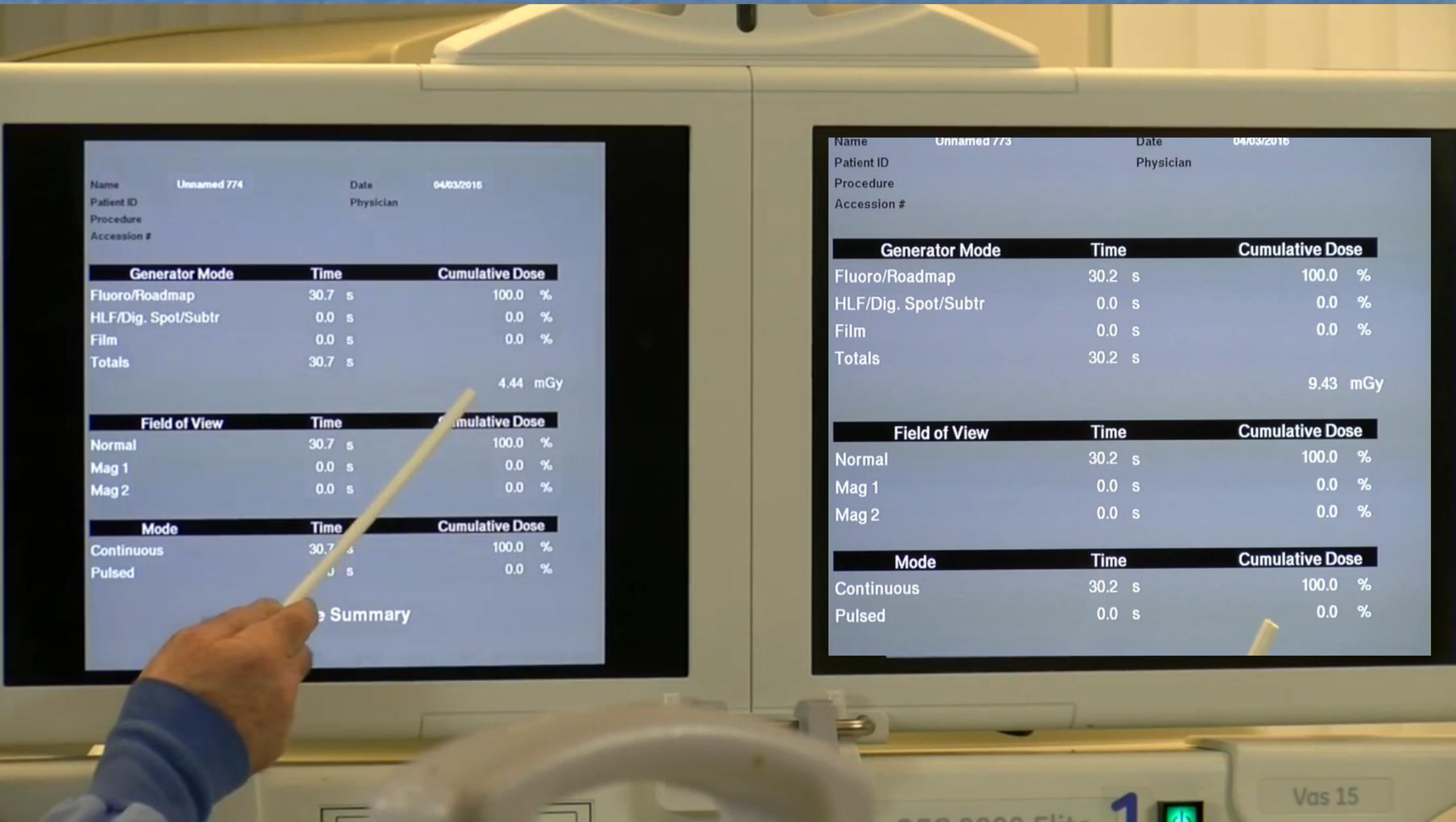


Now we are making a 30 second exposure on the Low Dose setting.

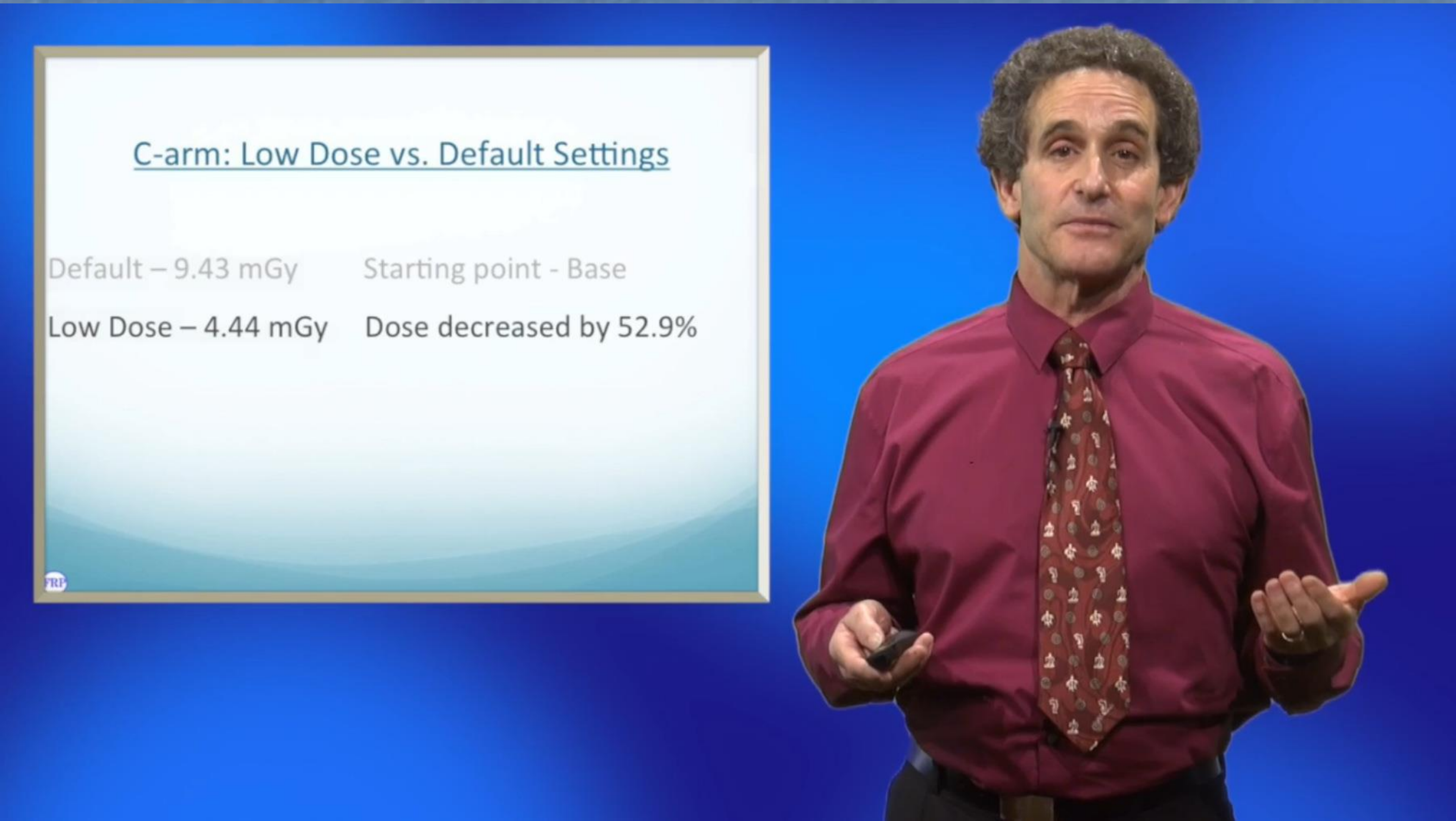


The dose was 4.44 mGy.

The Low Dose was 4.44 mGy and the regular setting was 9.43 mGy.



Dose is decreased by 52.9% when Low Dose is used. This is why it should always be suggested to the physician whenever you can.



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Digital Radiography Solutions

Dennis Bowman

dennismbowman@gmail.com

(831) 601-9860

digitalradiographysolutions.com