A Selection of Fluoroscopic Imaging Hazards

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SA Radiation Pty Ltd

What this presentation covers…

- Scatter dose rates near orthopaedic procedures
- Finding the maximum entrance dose rate
- Foot pedal confusion
- Secondary radiation near O-arm systems, and
- Some intermingled random stuff with a prize (so stay awake)

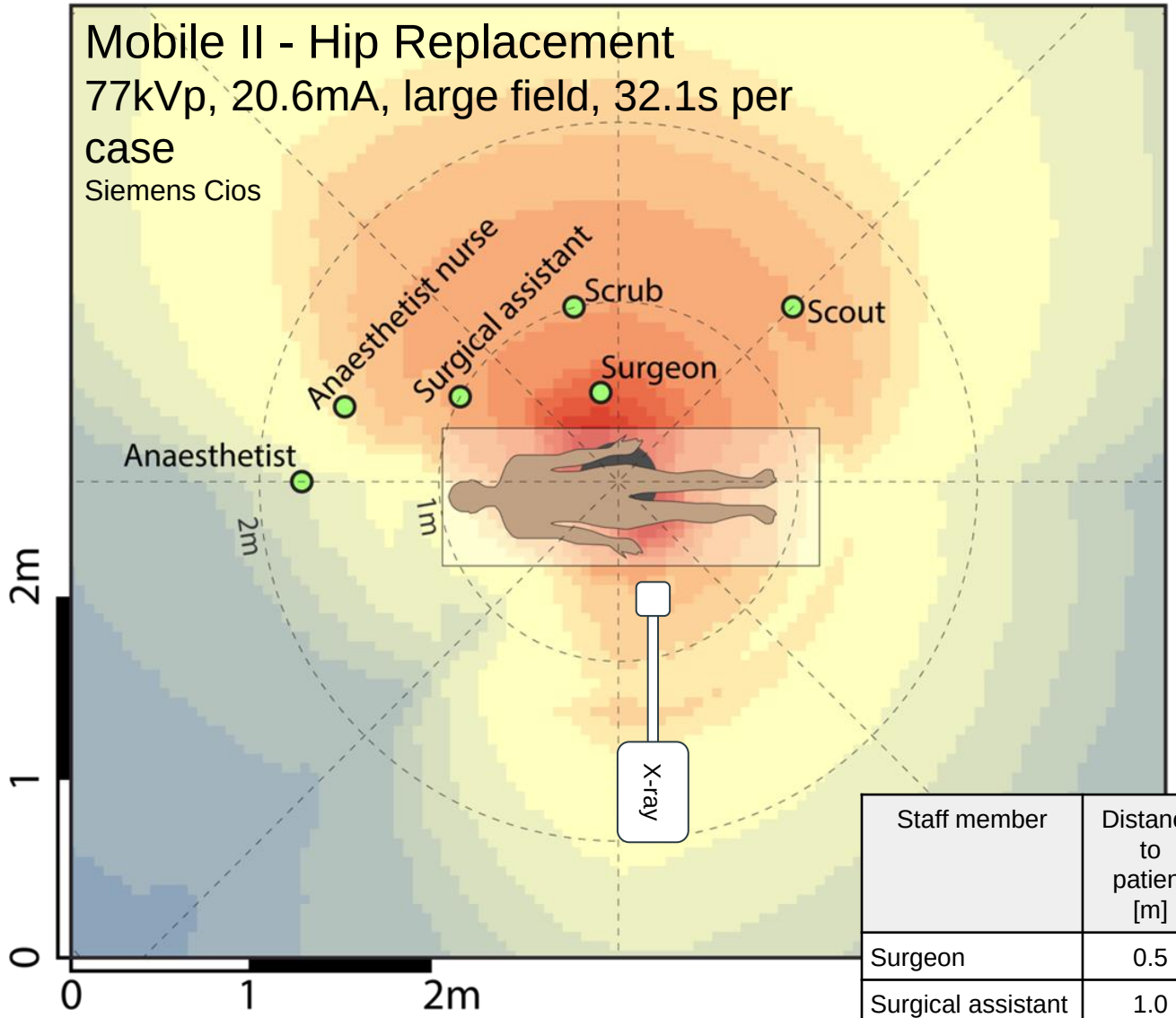
Scatter dose rates near orthopaedic procedures

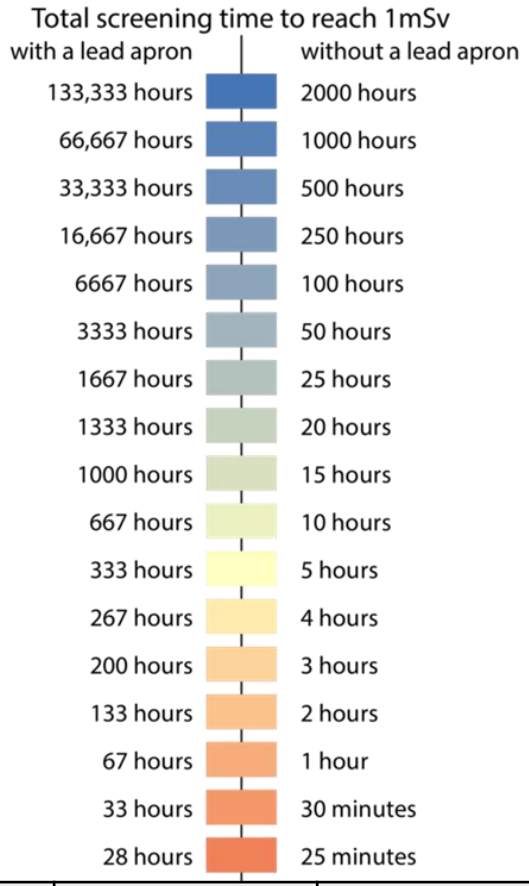
- Purpose was for theatre staff education
- Conducted in partnership with radiographers and theatre staff to ensure clinical relevance
- Body phantom and X-ray units setup for typical operating conditions
- Heatmaps generated from theatre scatter measurements and interpolating/extrapolating using inverse-square-law

Mobile II - Hip Replacement

77kVp, 20.6mA, large field, 32.1s per case

Siemens Cios





Staff member	Distance to patient [m]	Cases per year to reach 1mSv* **WITH** lead apron	Cases per year to reach 1mSv* **NO** lead apron
Surgeon	0.5	2392	36
Surgical assistant	1.0	> 10000	164
Anaesthetist	1.8	> 10000	2472
Anaesthetist nurse	1.6	> 10000	890
Scrub	1.0	8226	123
Scout	1.4	> 10000	160

* 1mSv = Annual dose limit for member of public

(Average annual dose from background radiation in Australia = 1.5mSv)

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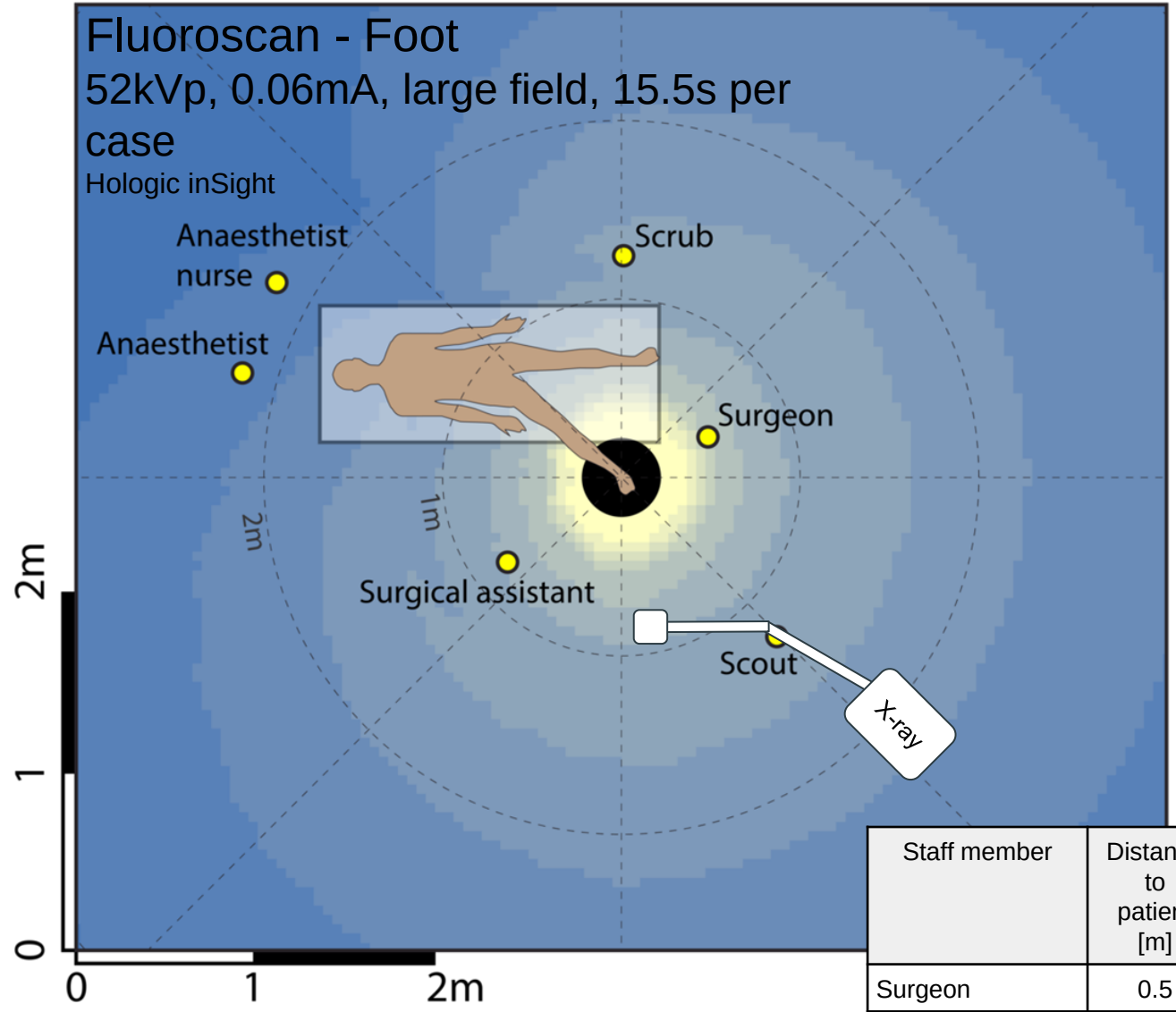
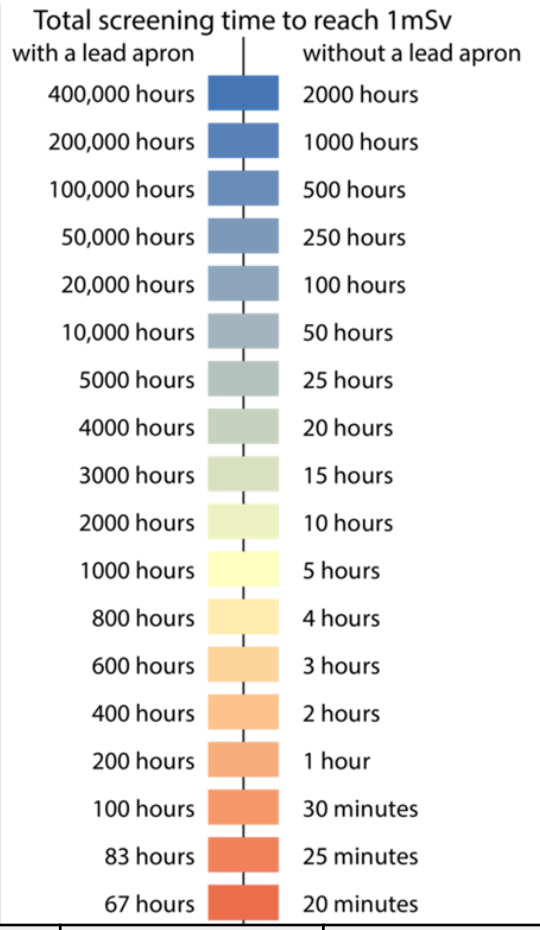
Fluoroscan - Foot

52kVp, 0.06mA, large field, 15.5s per case

Hologic inSight





Staff member	Distance to patient [m]	Cases per year to reach 1mSv* **WITH** lead apron	Cases per year to reach 1mSv* **NO** lead apron
Surgeon	0.5	> 10000	5033
Surgical assistant	0.7	> 10000	> 10000
Anaesthetist	2.2	> 10000	> 10000
Anaesthetist nurse	2.2	> 10000	> 10000
Scrub	1.2	> 10000	> 10000
Scout	1.2	> 10000	> 10000

* 1mSv = Annual dose limit for member of public

(Average annual dose from background radiation in Australia = 1.5mSv)

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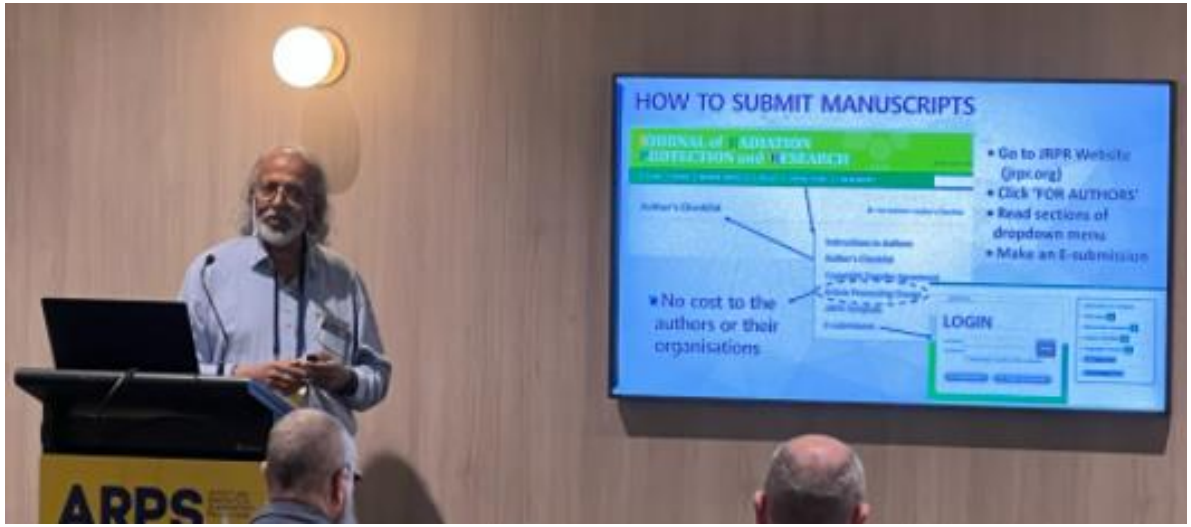
Summary

- Full paper to be submitted to JRPR
- Use of lead aprons for normal fluoro X-ray units are justified
- Use of lead aprons for low-power fluoro X-ray units are not justified (but required by current SA legislation)



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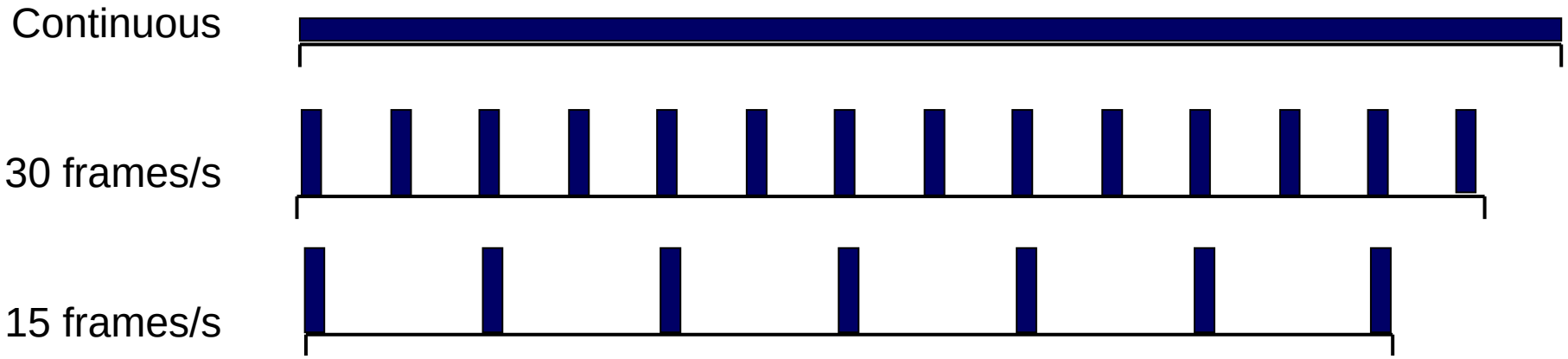
Finding the maximum entrance dose rate



- Fluoroscopic compliance tests require a measurement of the maximum skin entrance dose rate
- Performed at a specific distance from the tube
- Does the highest dose rate occur at the highest frame rate?

Entrance dose rates and frame rates

- Software on modern systems allows the dose per frame to be set for each frame rate
- This means the highest dose rate may not be at the highest frame rate
- Some examples…

25 – Equivalent dose rate

All measurements made at 300mm from the FPD entrance & 600mm from the focal spot, Abdomen protocol.

Set							Measured	Limit
Mode	Field size (cm)	fps	kVp	mA	ms	mAs	mGy/min	mGy/min
Auto	42	30	124.7	77.6	5.1	11.9	87.71	100
Auto	42	15	124.7	124.4	6.9	12.9	88.11	100
Auto	42	10	124.7	167.7	7.8	13.1	87.47	100
Auto	32	30	124.7	77.7	5.1	11.9	87.21	100
Boost	42	30	125.0	75.9	5.1	11.6	135.3	150

Set							Measured	Limit mGy/min
Mode	Protocol	Field size (cm)	fps	kVp	mA	ms/f	mGy/min	mGy/min
Auto	FL Card +	20	15	125	237.0	4.0	92.52	100
Auto	FL Card +	20	30	125	160.0	3.7	91.20	100
Auto	FL Card	20	15	125	240.4	4.9	93.12	100
Auto	FL Card	16	15	125	240.1	4.9	93.24	100

Section 9.1 PATIENT SKIN DOSE SUMMARY

Patient Skin Dose Rate in mGy/min							
	DOSE SETTING (pulse rate if known)						
Field Size (cm)	Dose Setting:	Auto	Auto	Auto	Boost	Boost	Boost
	Frame Rate:	30	15	7.5	30	15	7.5
20		82.56	86.34	87.72	121.8	130.14	132.12
15.9		81.36	87.78	88.98	120.84	129.36	
12.8		80.7	87.18	88.62	121.38	128.88	130.74
8		80.46	86.58	87.84	120.66	128.04	129.78

Summary

- Unless you have access to the service engineers, you need to test all available frame rates to ensure compliance
- This will result in a lot of tests (= a lot of time, = a lot of down time, = a lot of extra cost)
- Requires some thought when setting test protocols

Revival of workplace nicknames

Wicket keeper (puts gloves on and stands back)

Harvey Norman (3 years with no interest)

Sensor light (only works if someone walks past)

Lantern (not very bright, has to be carried)

Deck chair (always folds under pressure)

2-stroke (hard to get started, always smokes)

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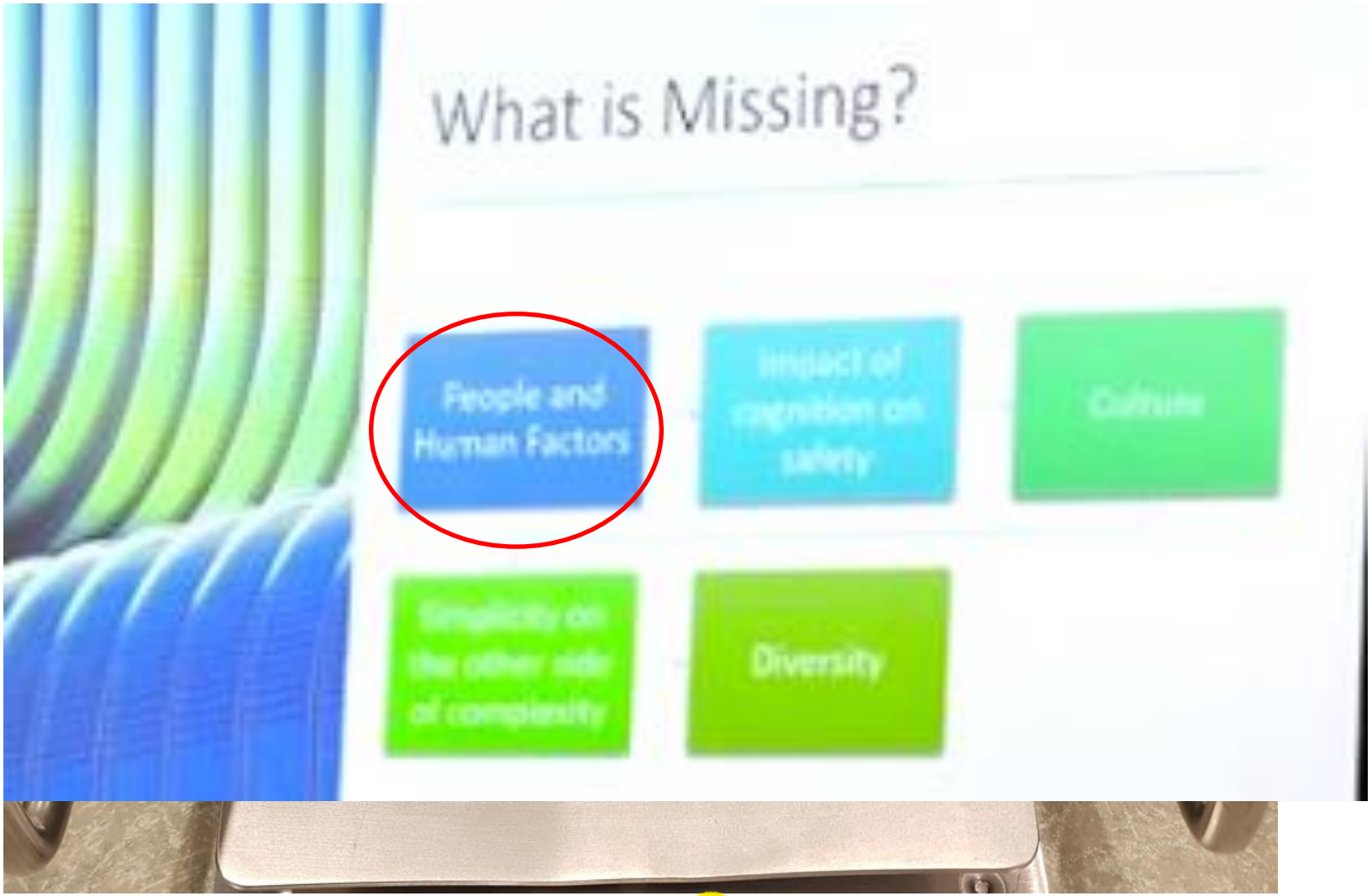
Foot pedal confusion



- The button has unlimited dose rates

(but the pics are amazing!)

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Lesson

- RSO’s – please check that all operators of fluoroscopic equipment understand what the buttons are for

A radon chamber specifically designed for environmentally relevant exposures of small animals

McEvoy-May JH[1,2], Puukila S[1,3], Haigh P[4], Johnston A[4], Boreham DR[3], Hooker AM[1,2], Dixon DL[1,3]

1 Flinders Health and Medical Research Institute, Flinders University, Adelaide, SA, Australia. 2 Centre for Radiation Research Education and Innovation, University of Adelaide, Adelaide, SA, Australia. 3 Northern Ontario School of Medicine, Sudbury, ON, Canada. 4 Environment Protection Authority – Retired, Adelaide, SA, Australia.

Northern Ontario School of Medicine

Flinders UNIVERSITY

Scatter near O-arm systems

- Useful for in-theatre CT imaging
- Scatter measured at normal operator position (2 m from patient)
- 3 measurements
  A. in front of operator (no lead)
  B. In front of operator (under lead)
  C. Behind operator (no lead)

Location	3D dose (nGy)	3D peak dose rate (uGy/h)	2D peak dose rate (uGy/h)
A	431	167	66
B	12	2.8	0.2
C	101	28	12.3

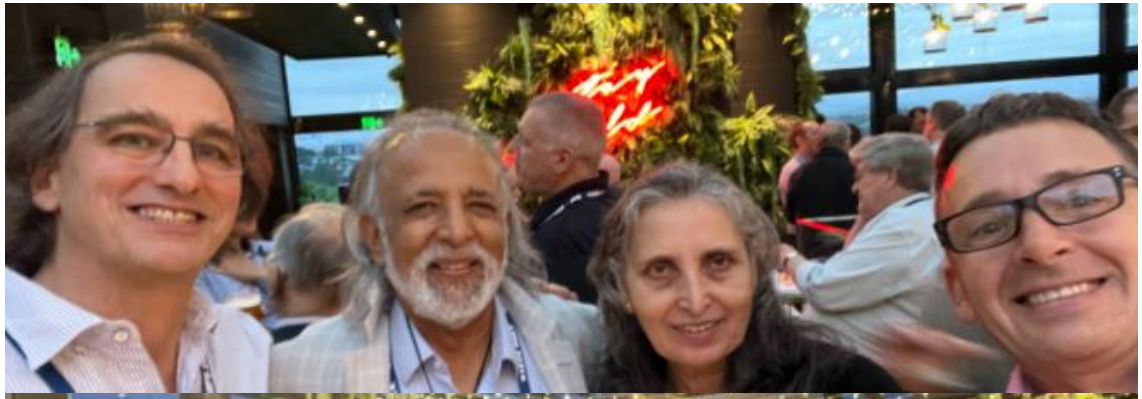
Scan parameters:
3D exposure parameters: 120kVp, 100mAs, 20cm scan width
2D exposure parameters: 100kVp, 6.9mA, 30 p/s pulse rate

Lesson

- O-arms produce much larger scatter dose rates than regular fluoroscopic systems
- Data strongly supports only full wrap **lead** aprons are used in O-arm procedures
- Check shielding requirements

Thanks for listening.

Any questions?



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