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Managing occupational dose and patient dose in an integrated manner

Prof. Hilde Bosmans, Rodrigo Trevisan Massera (PhD), prof. Nicholas Marshall

Michiel Dehairs (PhD)
(formal PhD student, now in Institut Bordet, Brussels)

UZ
Leuven

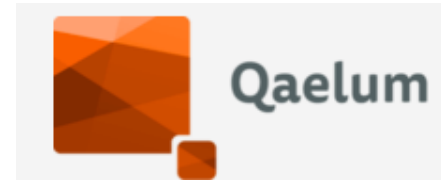
Herestraat 49
B - 3000 Leuven

www.uzleuven.be
tel. +32 16 33 22 11

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Conflicts of interest

- Co-founder and share holder of Qaelum, a spin-off company of KU Leuven

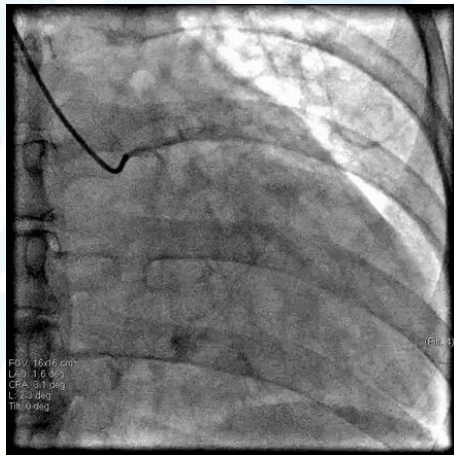


Acknowledgement

- Many graphs can be found in the PhD thesis/papers of Michiel Dehairs
- The graphs on occupational dose are the work of Rodrigo Trevisan Masera. This is unpublished work. Please don't spread.
- In part worked out with research grants of **Siemens**. Many thanks to P. Bernhardt.

Background: interventional RX and cardiology

- Fluoroscopic x-ray imaging and (higher dose) acquisitions
- Dynamic images of in the internals of a patient for guidance of catheter & tools, diagnosis and treatment



Angiogram of the heart

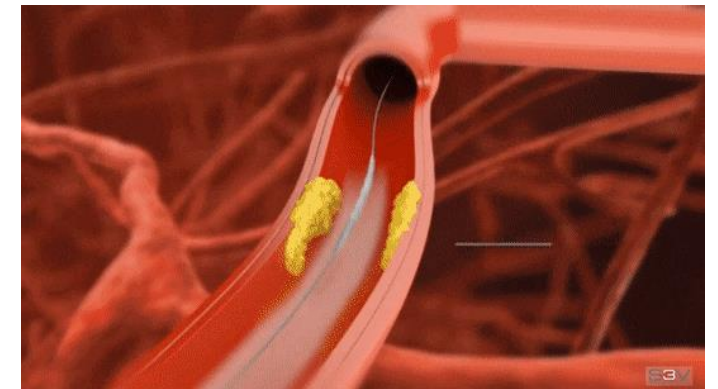
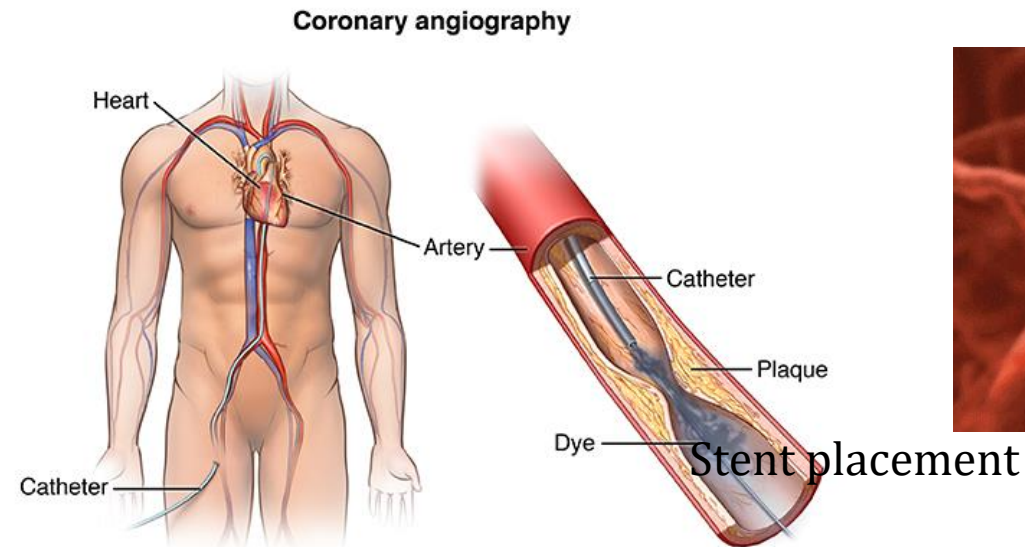
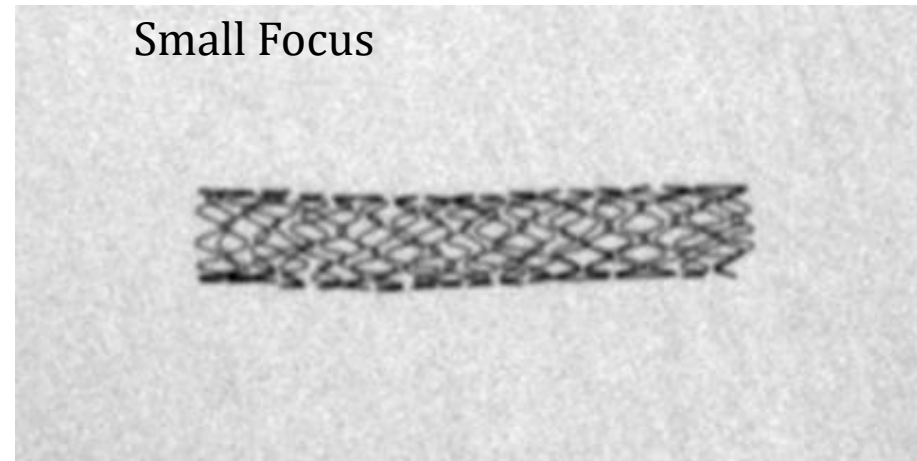
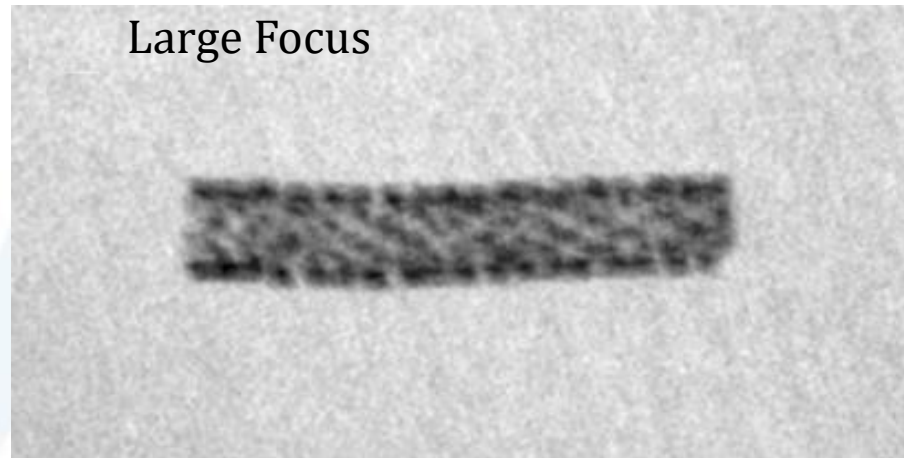


Image Quality is important



Sophisticated equipment




Wide range of radiation protection tools available



See [www, Mavig X-ray Protection](http://www.Mavig.com)

Overview

- Yes, occupational dose and patient dose are linked
 - Recent evolutions in patient dose settings
 - Research into improved patient dose settings for optimized occupational dose
- 
- A decorative graphic in the bottom-left corner consisting of several overlapping, semi-transparent blue geometric shapes, primarily triangles and quadrilaterals, arranged in a fan-like pattern pointing towards the right.

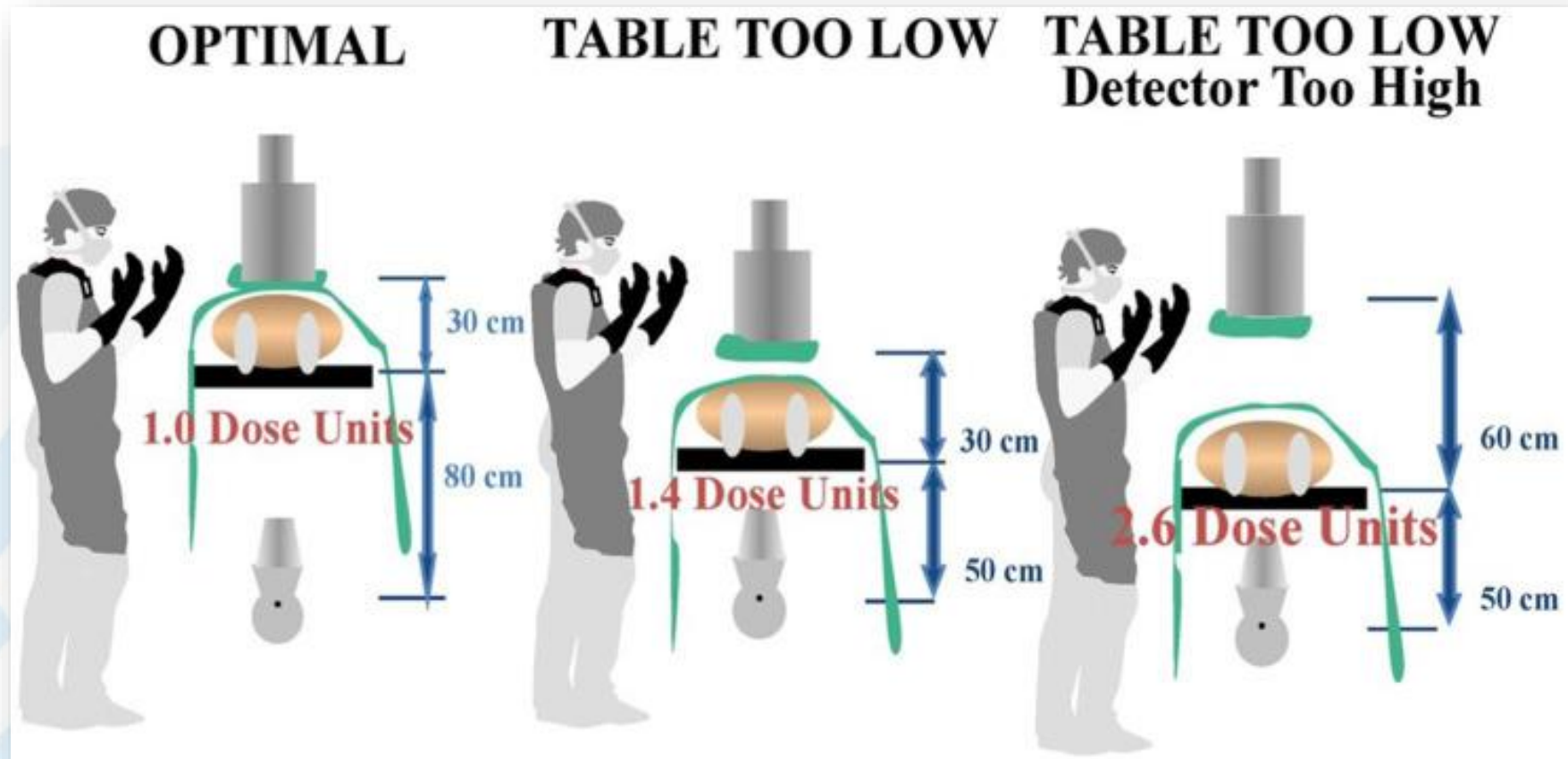
Yes, occupational dose and patient dose are linked

More dose to patients will (normally) lead to more dose to the operator

- Fluoroscopy time -> ->
- Number of ciné runs -> ->
- Length of the ciné runs -> ->
- Pulse rate -> ->
- Dose level -> ->
- Number of procedures / work load pp -> ->
- The availability and use of procedure maps -> ->
- The training of the personnel
- The application of ALARA culture

Yes, occupational dose and patient dose are linked

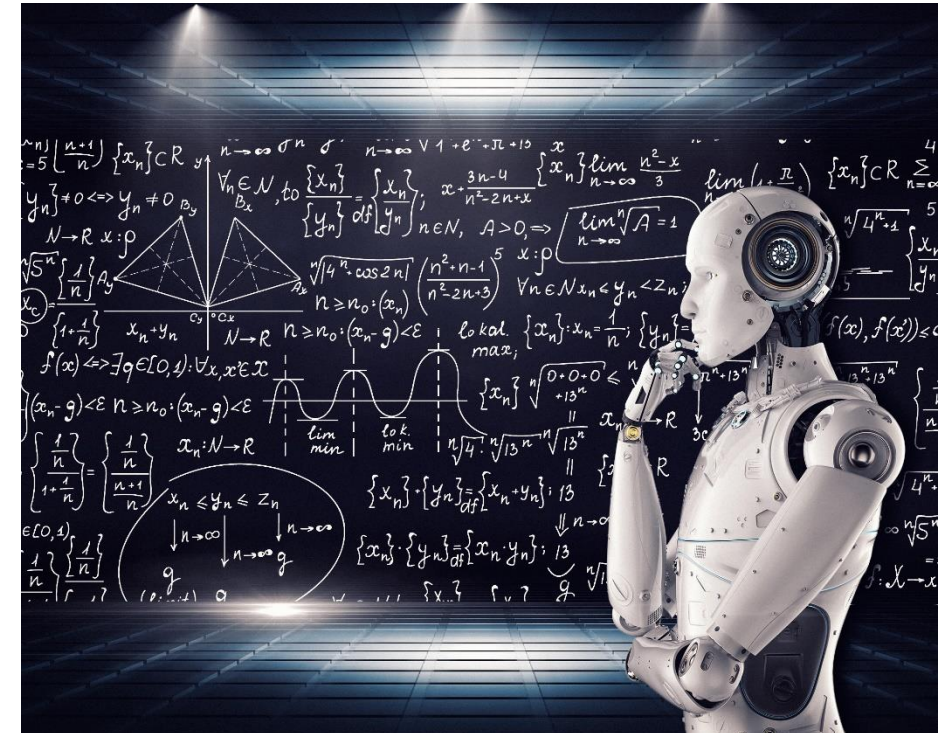
Linked, but not necessarily in a linear way



Yes, occupational dose and patient dose are linked

Linked, but not necessarily in a linear way

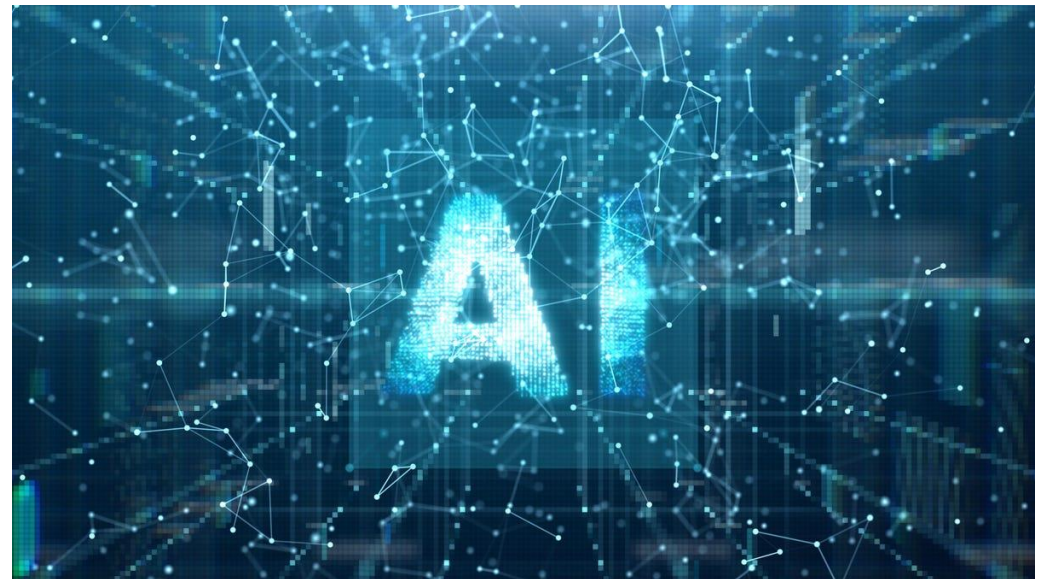
- Distance patient – detector
- The use of magnification views
- The tube voltage, filtration, collimation, ...



Yes, occupational dose and patient dose are linked

Linked, but not necessarily in a linear way

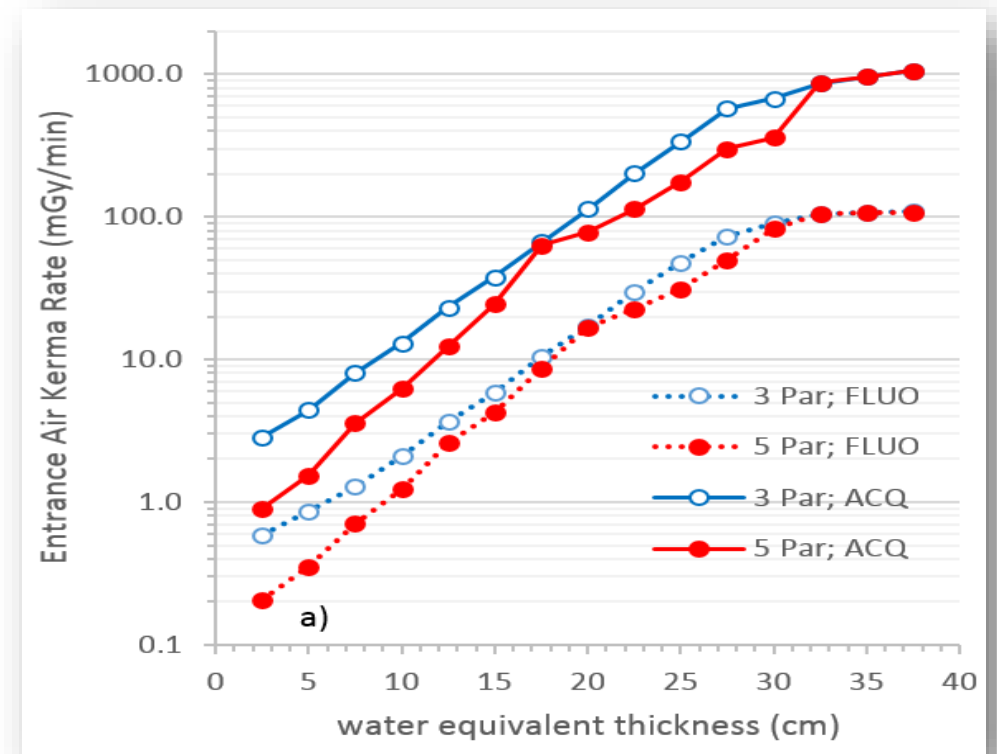
- Distance patient – detector
 - The use of magnification views
 - The tube voltage, filtration, collimation, ...
 - Image processing, with or without AI
- > impact? Should we ask ChatGPT?



Yes, occupational dose and patient dose are linked

Linked, but not necessarily in a linear way & multi parametric

- ‘Thickness’ or ‘water equivalent density’ of the patients
- Obesity -> increases operator dose
- Children -> fine image detail needed
 - > preprogrammed in protocols
 - > specific pediatric protocols

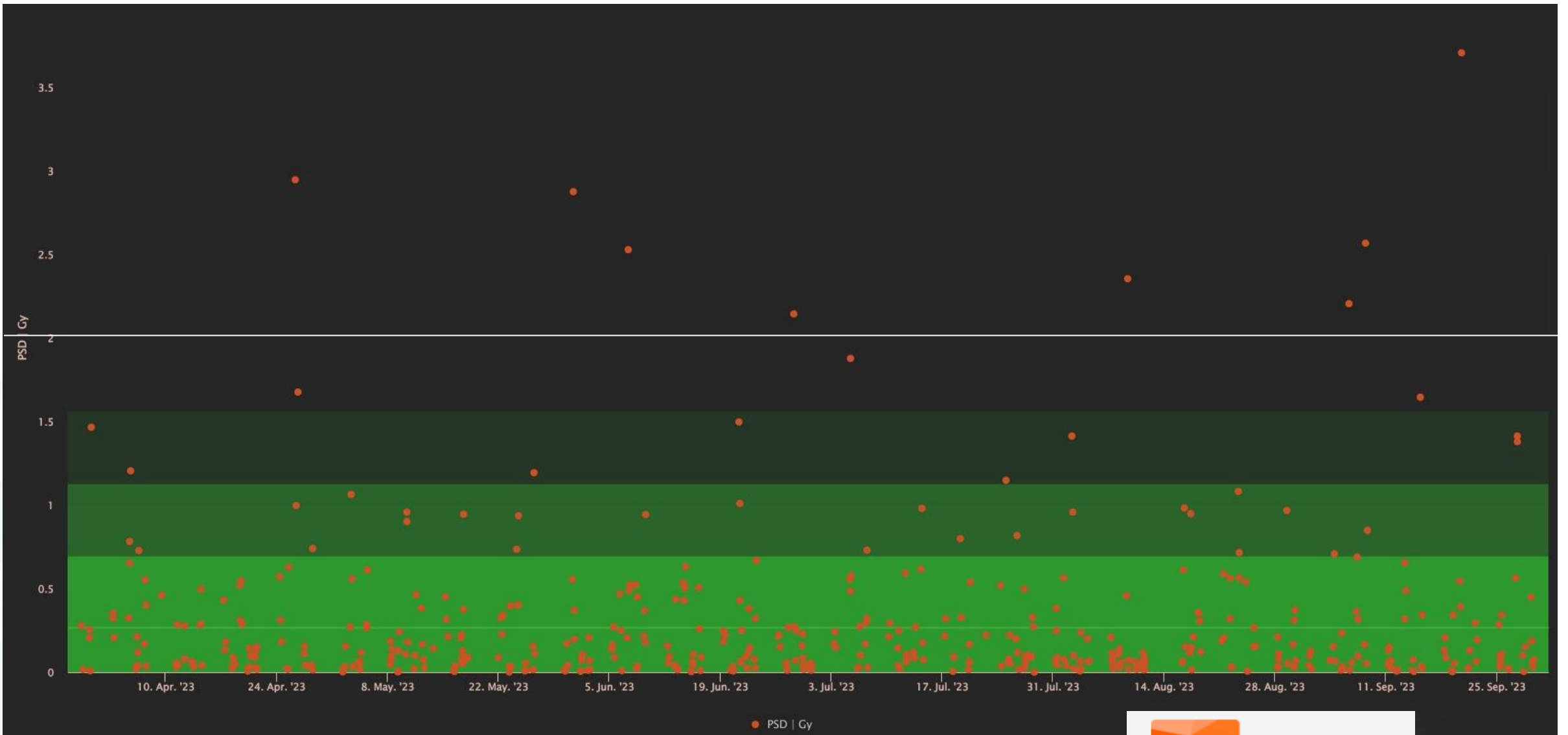


Yes, occupational dose and patient dose are linked

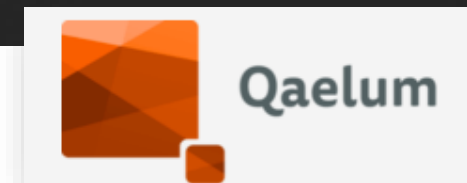
Therefore, patient dosimetry has a double role !

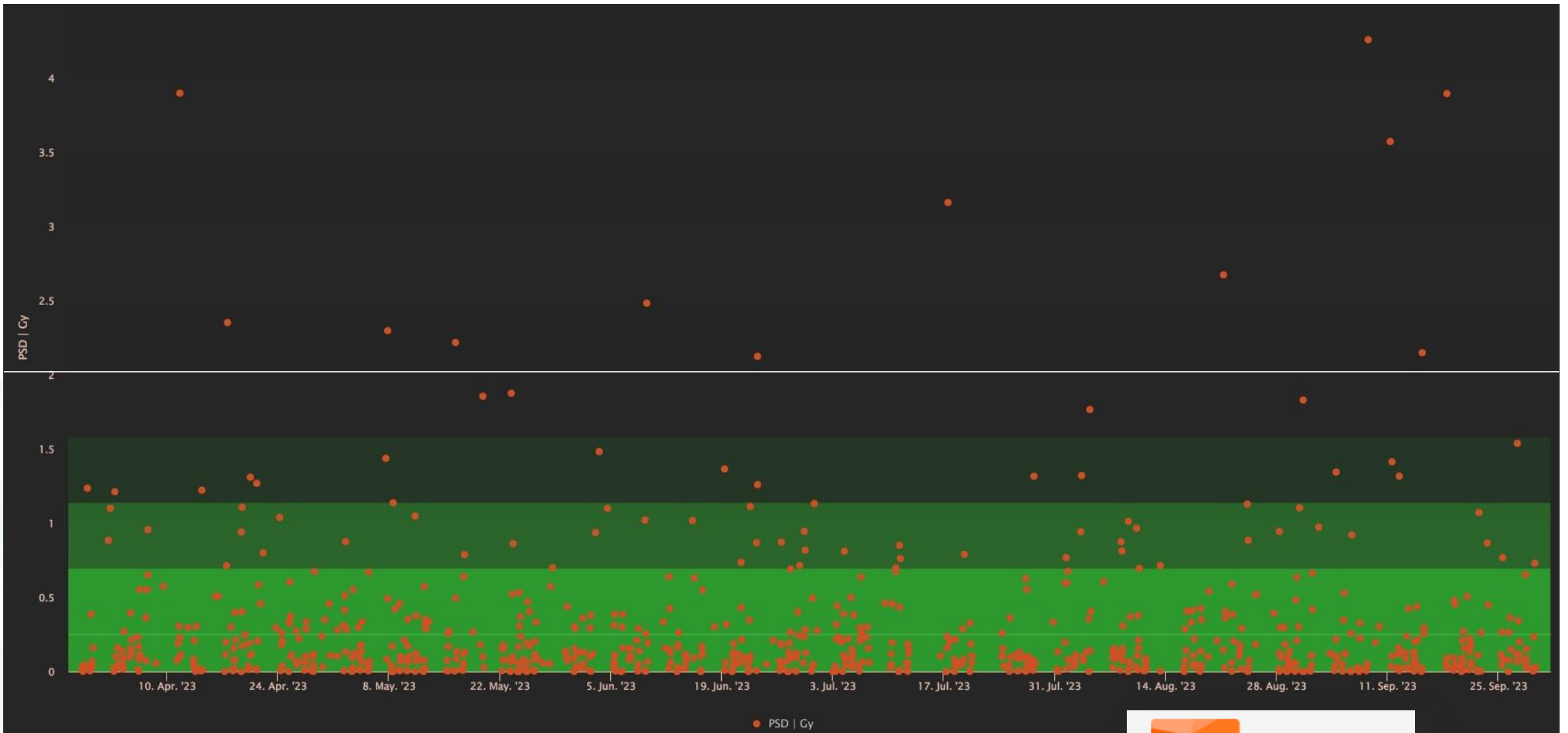
Dose management systems allow for the optimal check of patient skin dose -> find irregularities



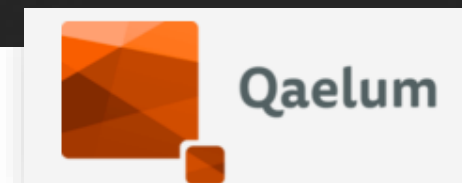


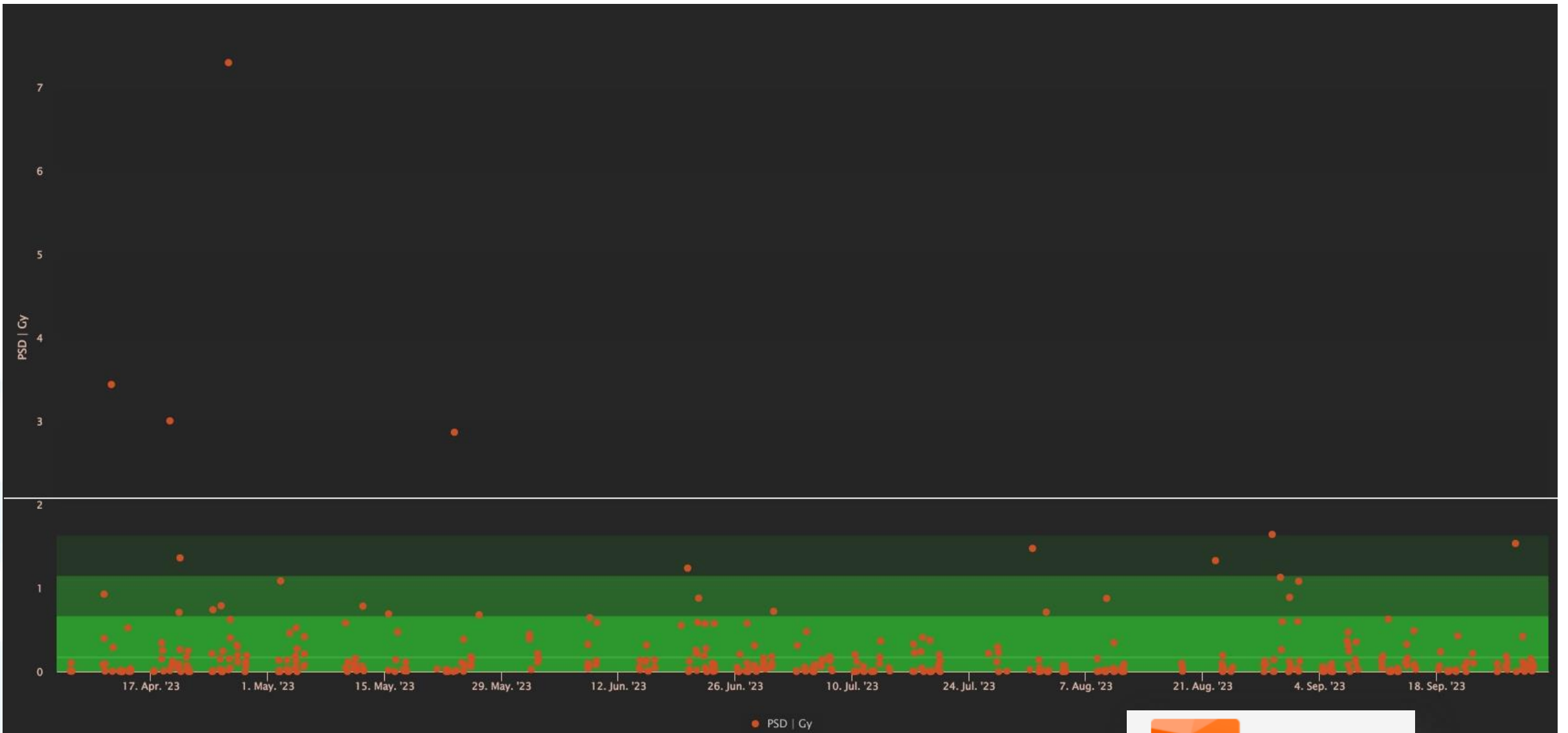
Peak skin dose in Room 2 (Gy). Period: last 6 months (around 500 exams)



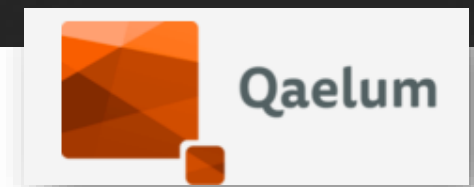


Peak skin dose in Room 3 (Gy). Period: last 6 months (around 860 exams)

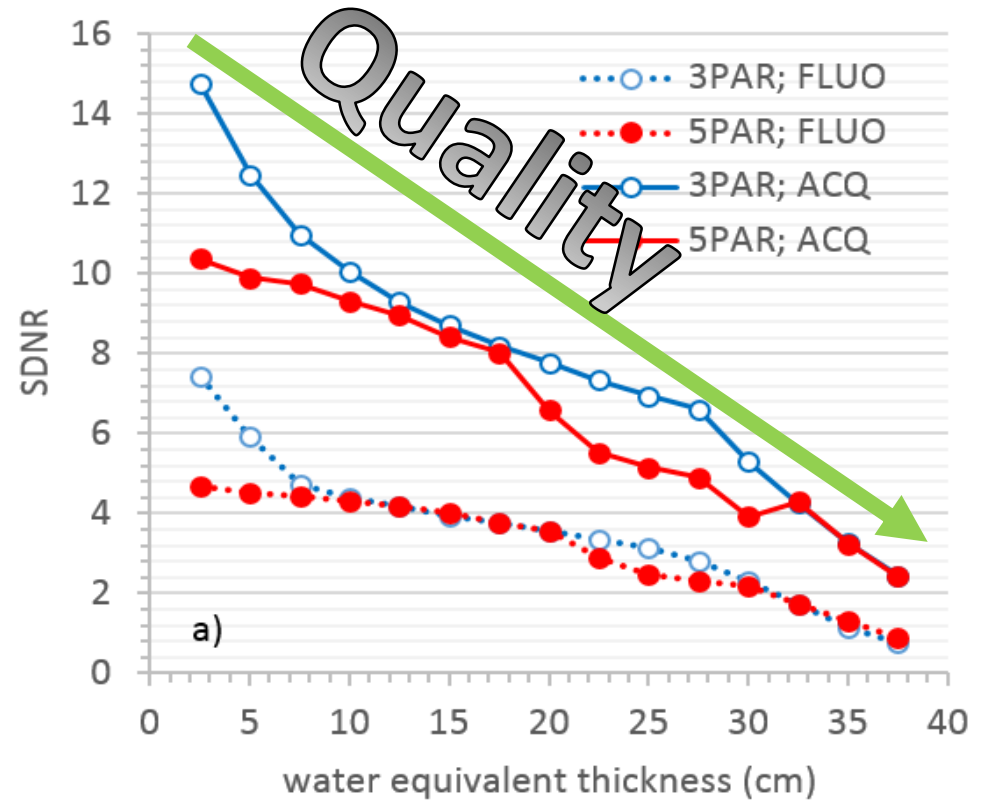
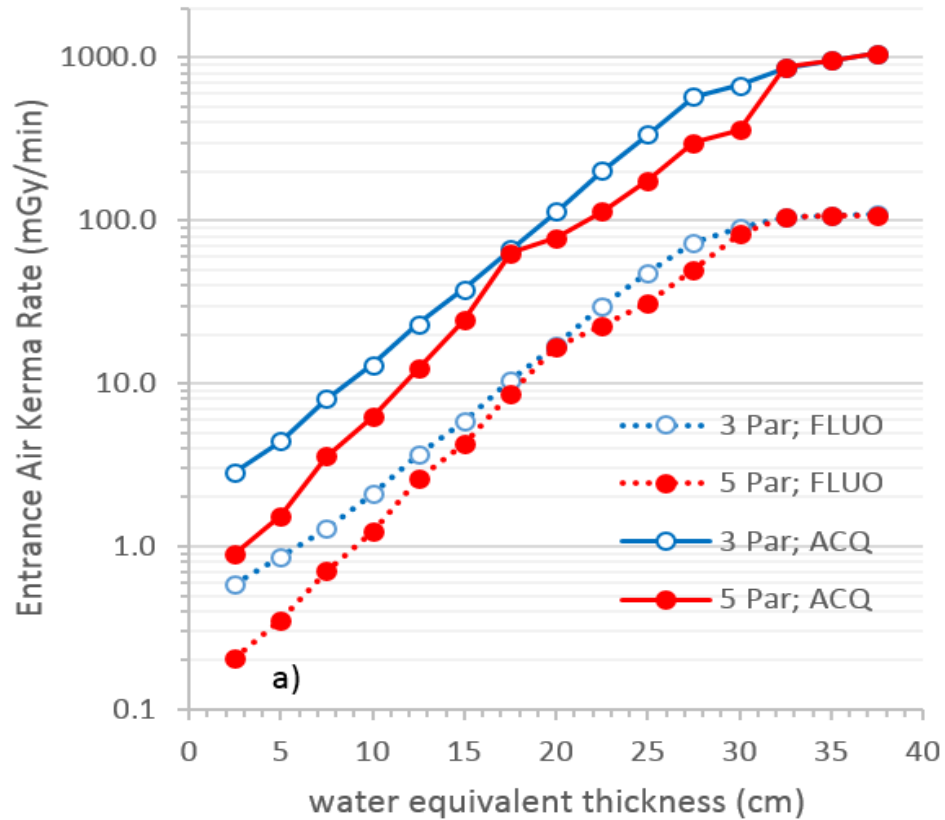




Peak skin dose in Room 4 (Gy). Period: last 6 months (around 450 exams)



Recent evolutions in patient dose settings



Published by M. Dehairs



Recent evolutions in patient dose settings

Quality



Recent evolutions in patient dose settings

-> tuning towards constant quality (up to a certain obesity)

Impact on occupational dose?

Wait for studies on Siemens OPTIQ or equivalent approaches.

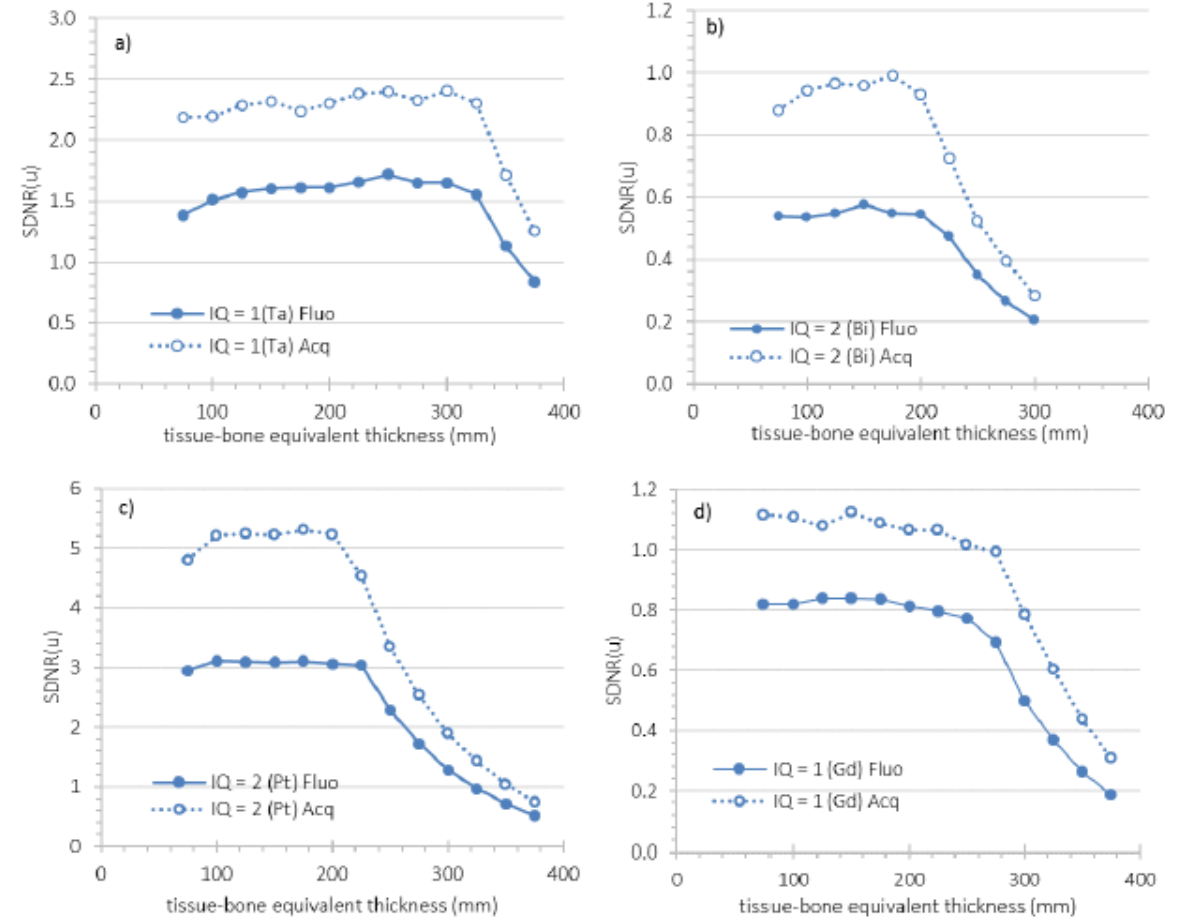


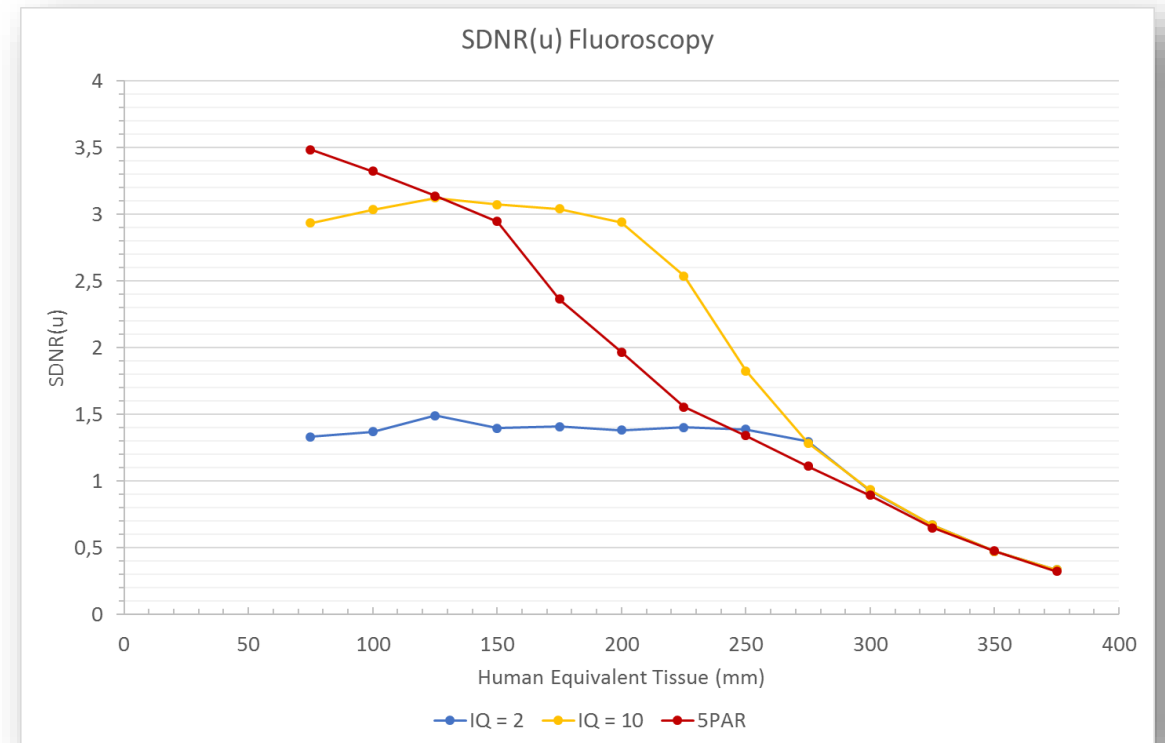
Figure 3. SDNR(u) plotted against tissue-bone equivalent thickness for fluoroscopy and acquisition modes, for four different materials a) tantalum b) bismuth c) platinum d) gadolinium

Recent evolutions in patient dose settings

-> tuning towards constant quality
(up to a certain obesity)

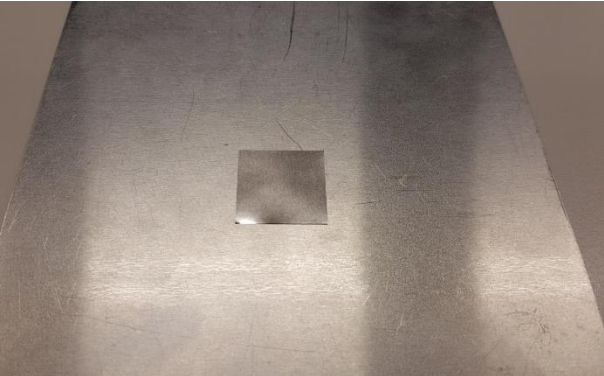
Impact on occupational dose?

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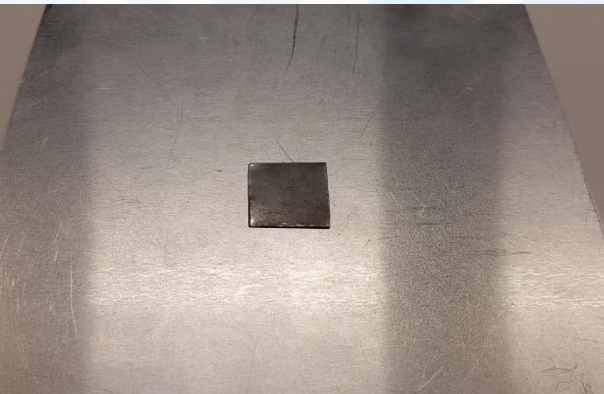


Recent evolutions in patient dose settings

Platinum



Iron



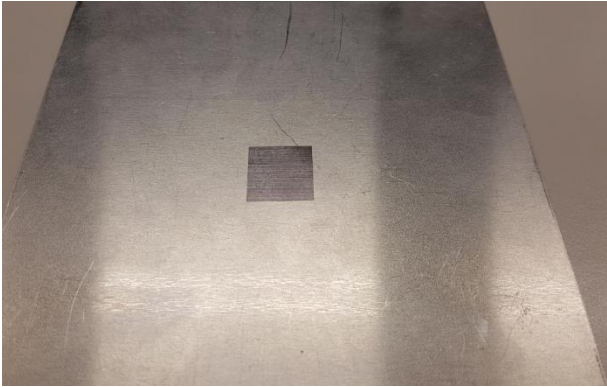
Bismuth



Gadolinium



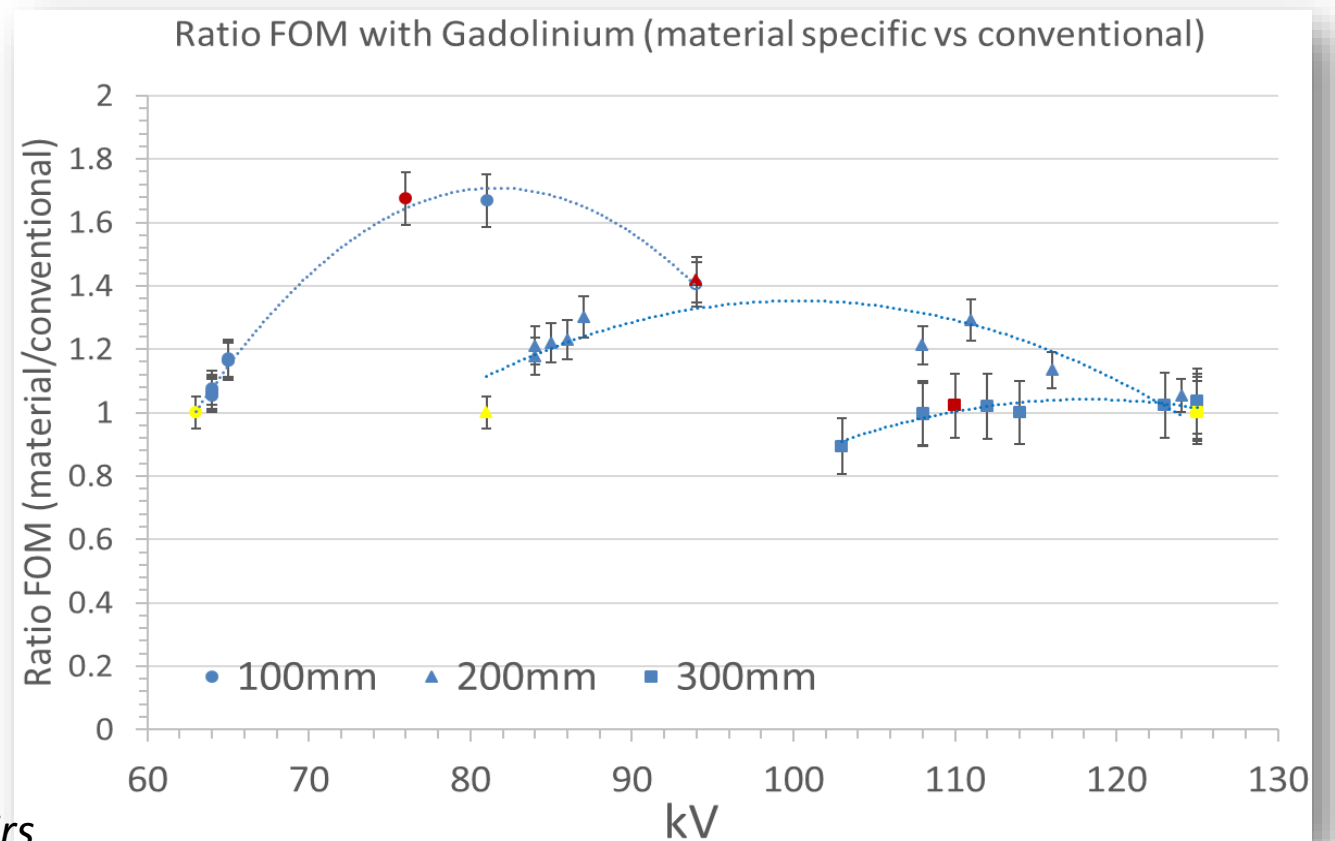
Tantalum



Recent evolutions in patient dose settings

-> tuning towards best visibility of critical task

Expected to lead to lower occupational dose, right?
Wait for studies !



Research into improved patient dose settings for optimized occupational dose



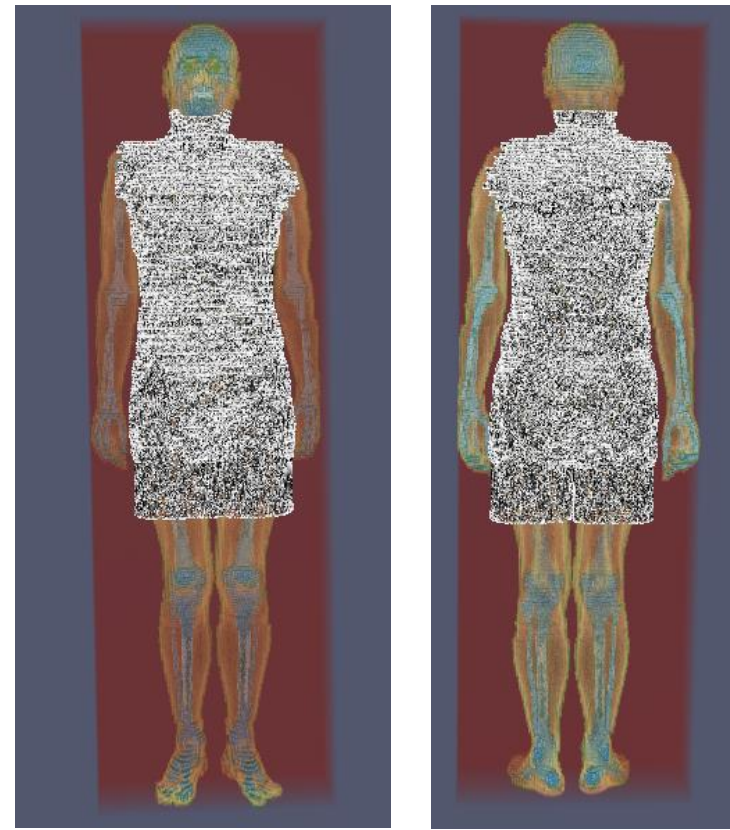
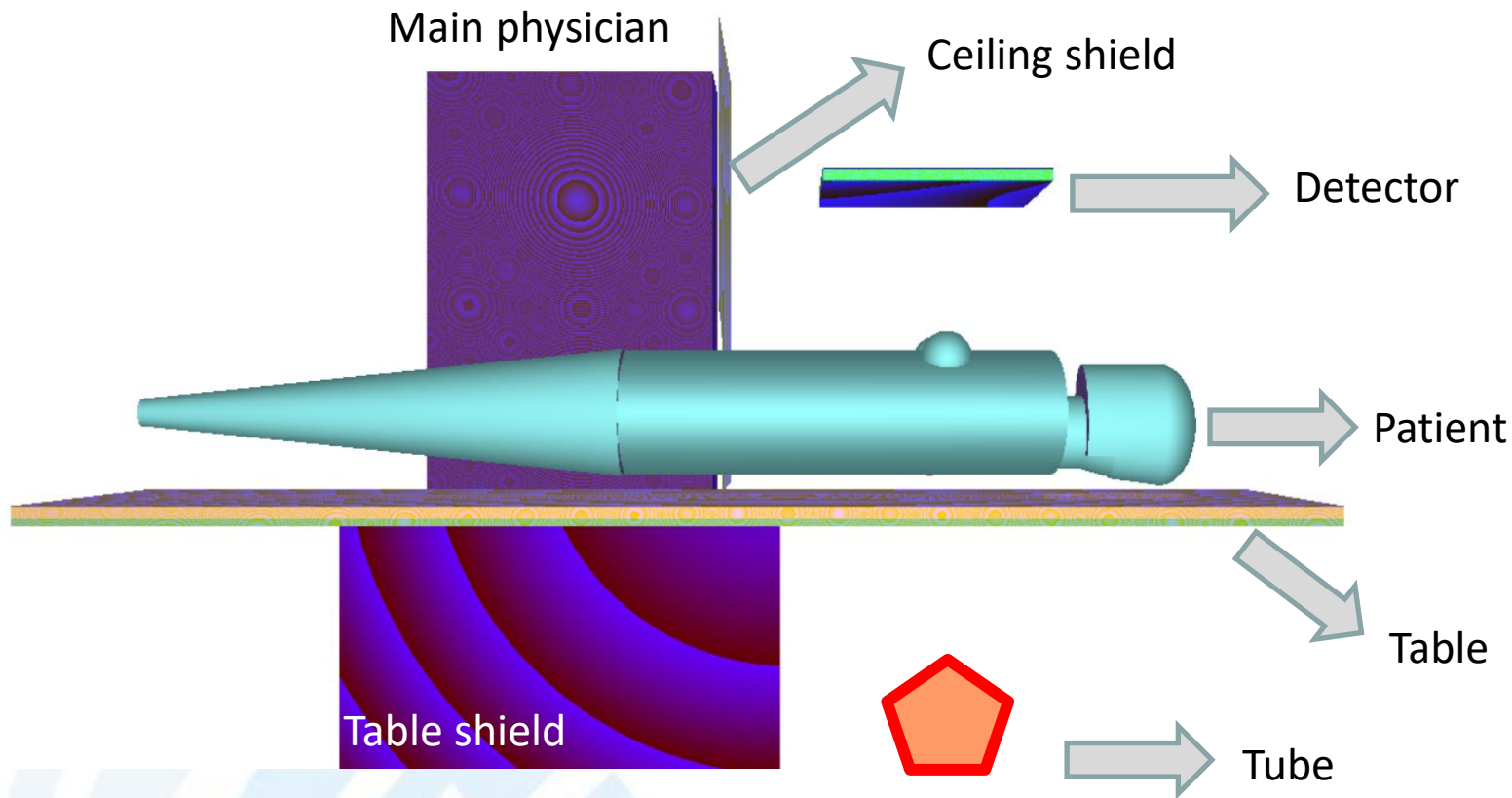
Research into improved patient dose settings for optimized occupational dose

Work-in-progress

Simulation of occupation exposure for different exposure settings to the patient

(Monte Carlo technique)

Based on ICRP 110 Male Phantom



Wearing:

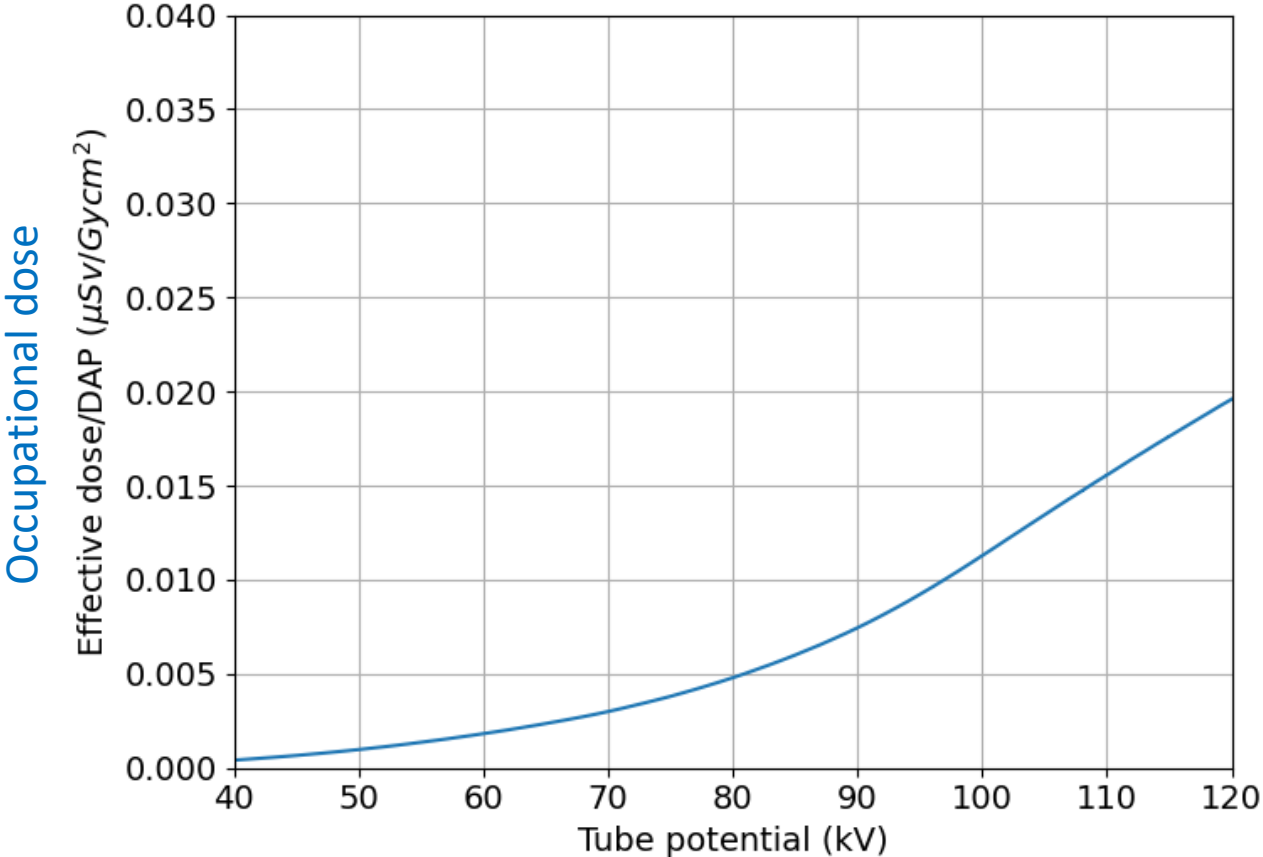
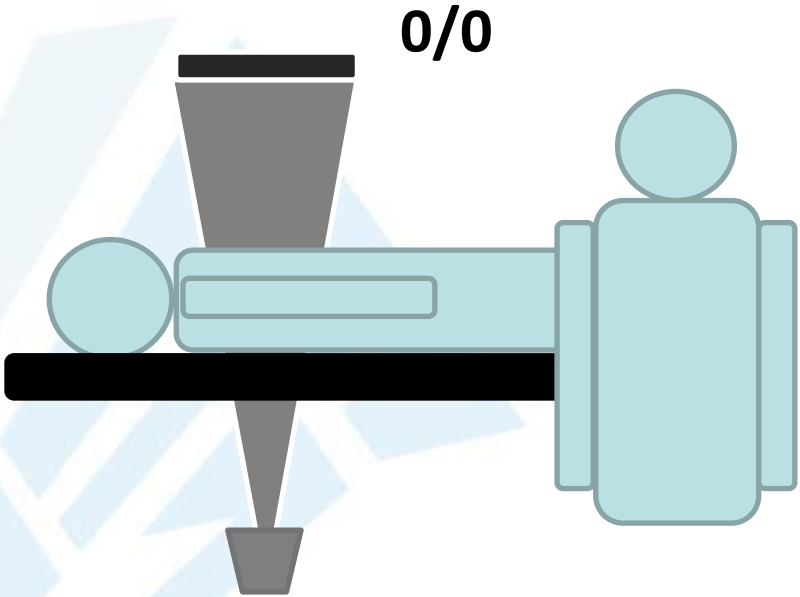
- Lead apron
- Thyroid shield
- Lead glasses

PENELOPE (v. 2018) + penEasy (v. 2020)

Courtesy Rodrigo Trevisan Massera; data not yet published, but you are welcome to contact us

Research into improved patient dose settings for optimized occupational dose

Patient dose and occupational dose are linked

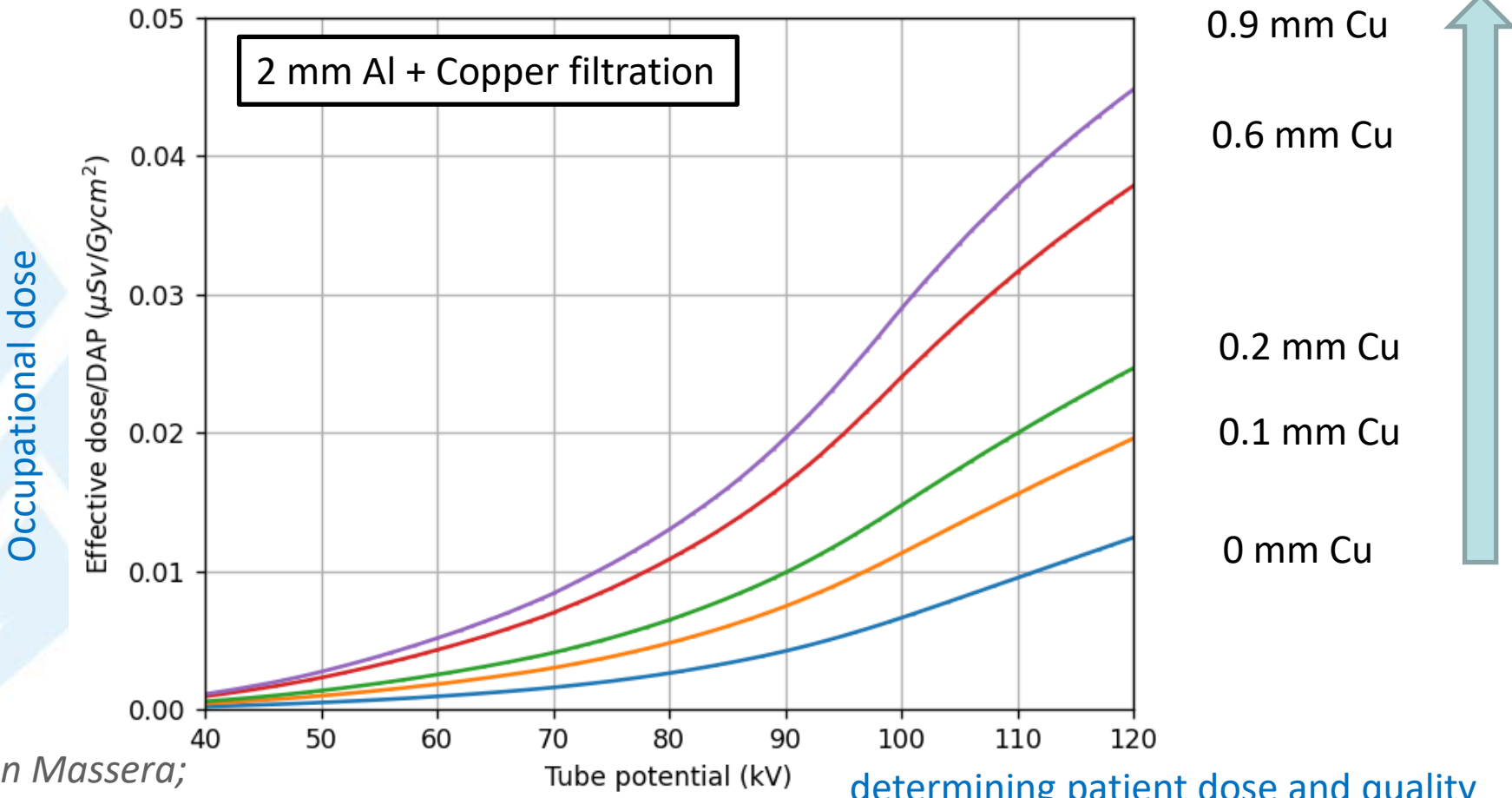


determining patient dose and quality

Courtesy R Trevisan Massera; data not yet published, but you are welcome to contact us

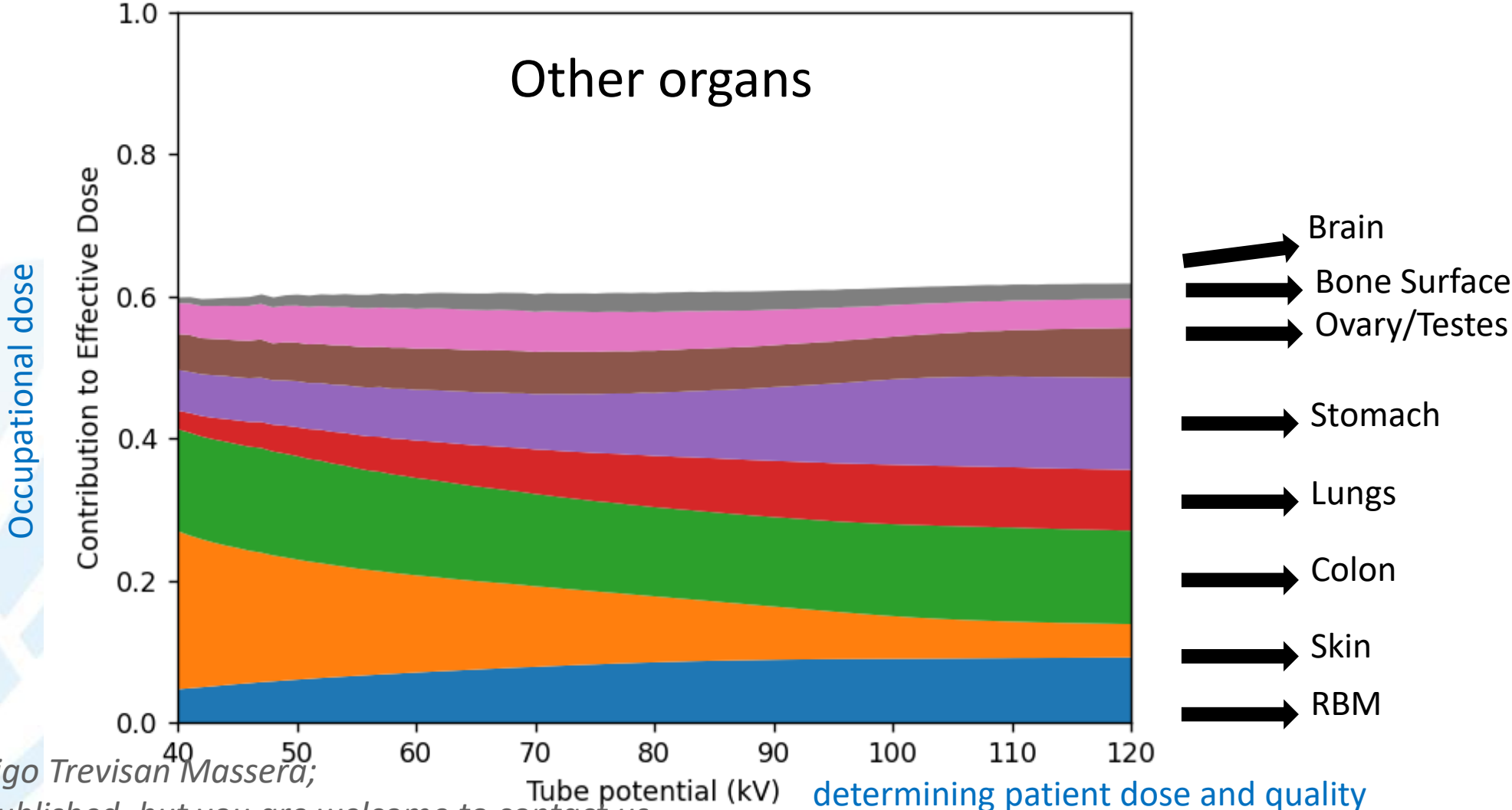
Research into improved patient dose settings for optimized occupational dose

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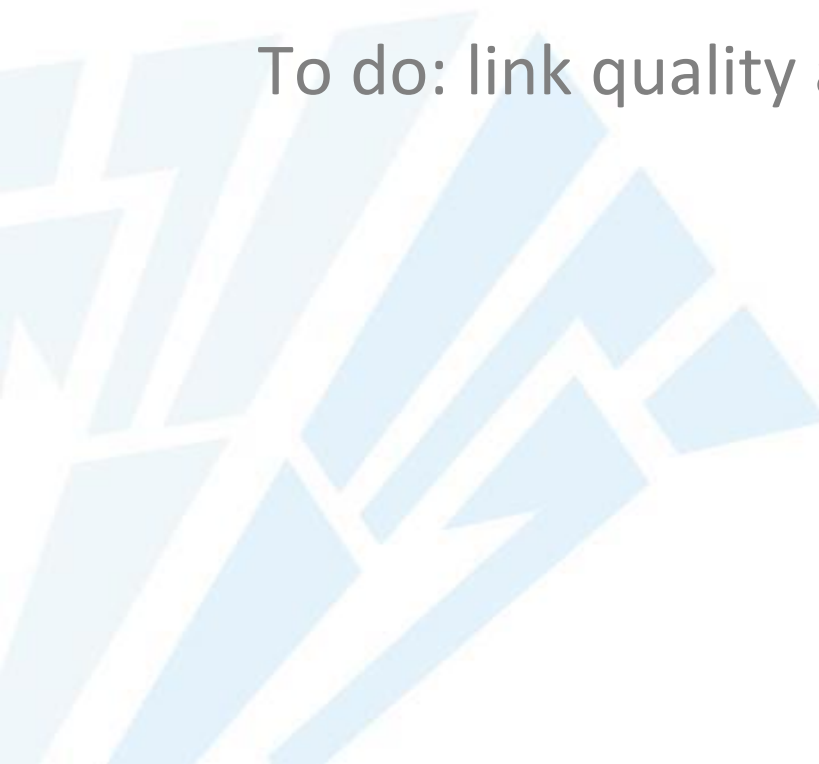
determining patient dose and quality

Research into improved patient dose settings for optimized occupational dose

Patient dose and occupational dose are linked

Patient dose and image quality are linked

To do: link quality and occupational dose, and perform optimization



Research into improved patient dose settings for optimized occupational dose

Possible approach, on-going work

For a given patient thickness, for a set image quality level,
determine optimal exposure settings in terms of patient dose
determine optimal exposure settings in terms of occupational dose
then find compromise, or choose priorities.

Research into improved patient dose settings for optimized occupational dose

Possible approach, on-going work

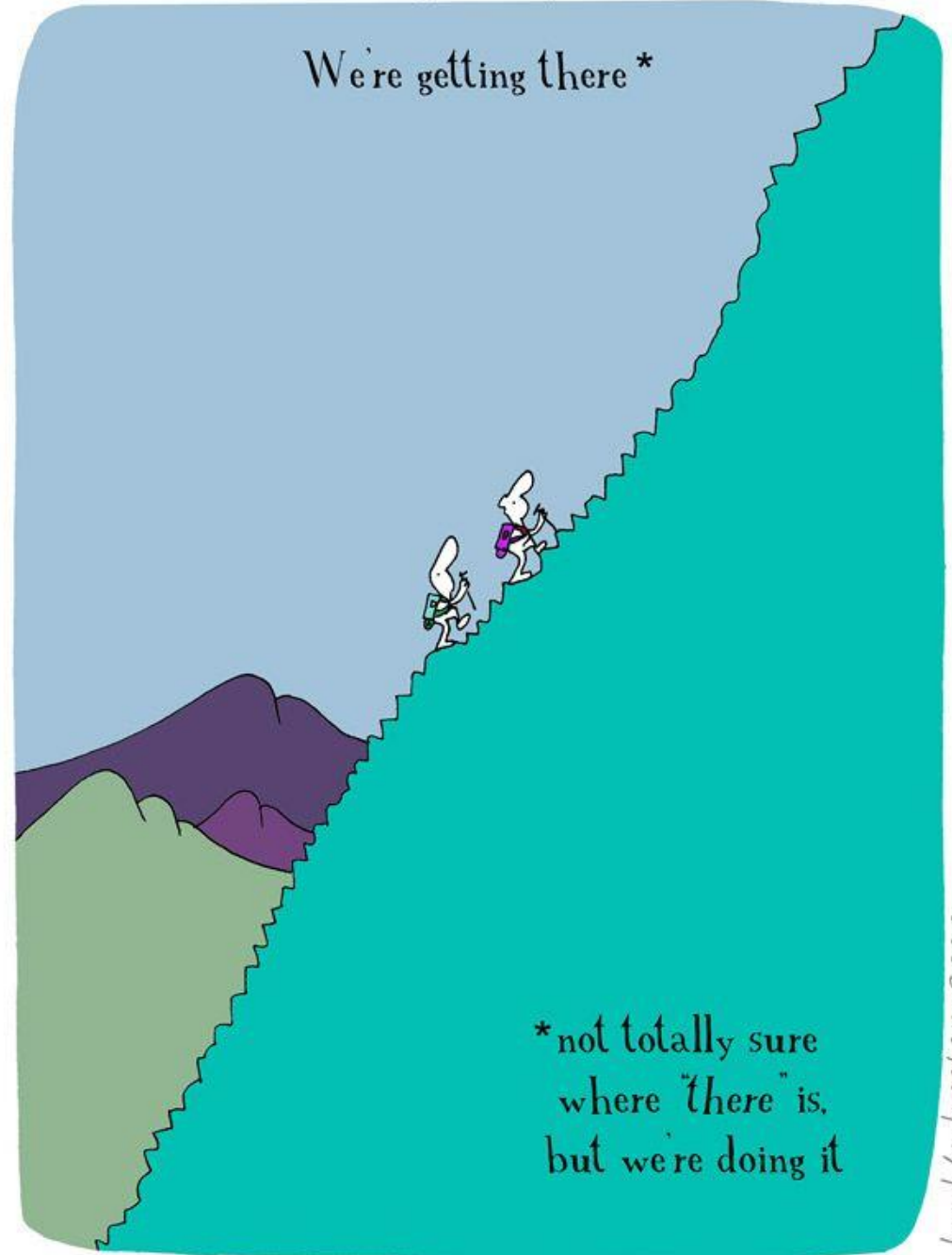
For a given patient thickness, for a set image quality level,
determine optimal exposure settings in terms of patient dose
determine optimal exposure settings in terms of occupational dose
then find compromise, or chose priorities.

It becomes challenging when 'quality' has to take into account motion, spatial frequencies, image processing (AI), materials or simply the critical tasks ... on the fly and smoothly for all thicknesses / orientations

In summary ...

We are getting there.... Right?


We're getting there *



*not totally sure
where "there" is,
but we're doing it

Steve Balter's view....

General comments

- Fluoroscopic dose is not preset by setting the equipment's controls.
 - Total patient irradiation is determined by complex interactions between the:
 - Equipment and configuration
 - Patient anatomy and clinical condition
 - **Operator**
 - Optimization involves consideration of all factors.
- 

Will have to teach

In summary ...

- Yes, we can do it
- It will require scientific time, involvement of the vendor and **TEACHING** of the medical teams and physicists





Grateful for a fantastic team