Dosisreduktion im Herzkatheterlabor Training & Kommunikation

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FA für Innere Medizin & Kardiologie
– Sportmedizin – Intensivmedizin
– Geriatrie – Palliativmedizin – Naturheilkunde
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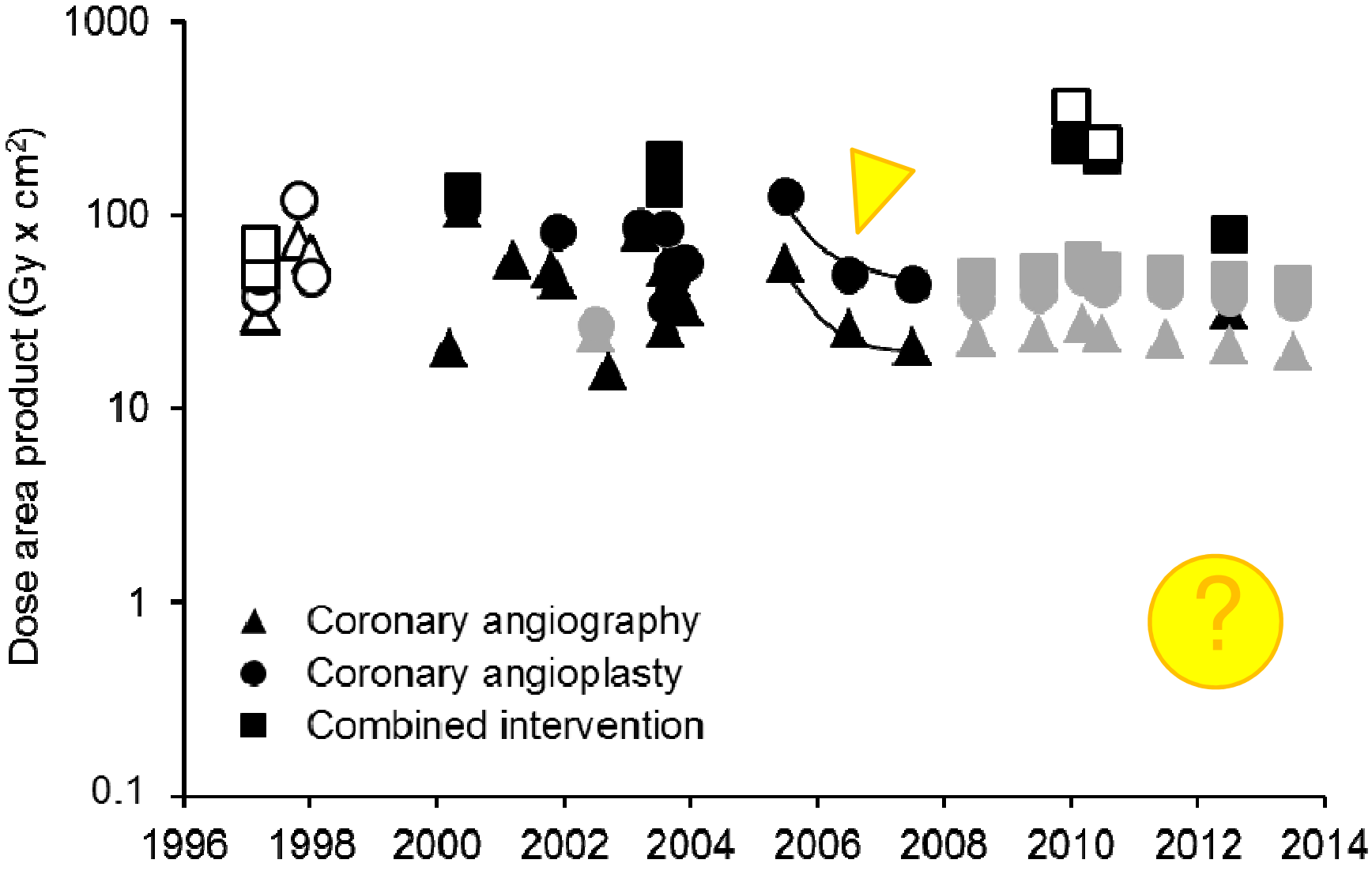
APT-Seminar 12./13. 06. 2015 Nürnberg

- Dosisparameter
- Dosisreduktion
- Verifikation
- Validierung

Dosisflächenprodukt



As

Low

As

Reasonably

Achievable

Man sollte Alles so einfach wie möglich sehen, aber nicht einfacher

Albert Einstein

Wer Tätigkeit nach dieser RöV plant, ausübt oder ausüben läßt, ist verpflichtet, jede Strahlenexposition von Mensch und Umwelt unter

- Beachtung des Standes der Technik
- Berücksichtigung aller Umstände des Einzelfalles

auch unterhalb der Grenzwerte so niedrig wie möglich zu halten.

Stand der Technik

Berücksichtigung aller Umstände des Einzelfalles …

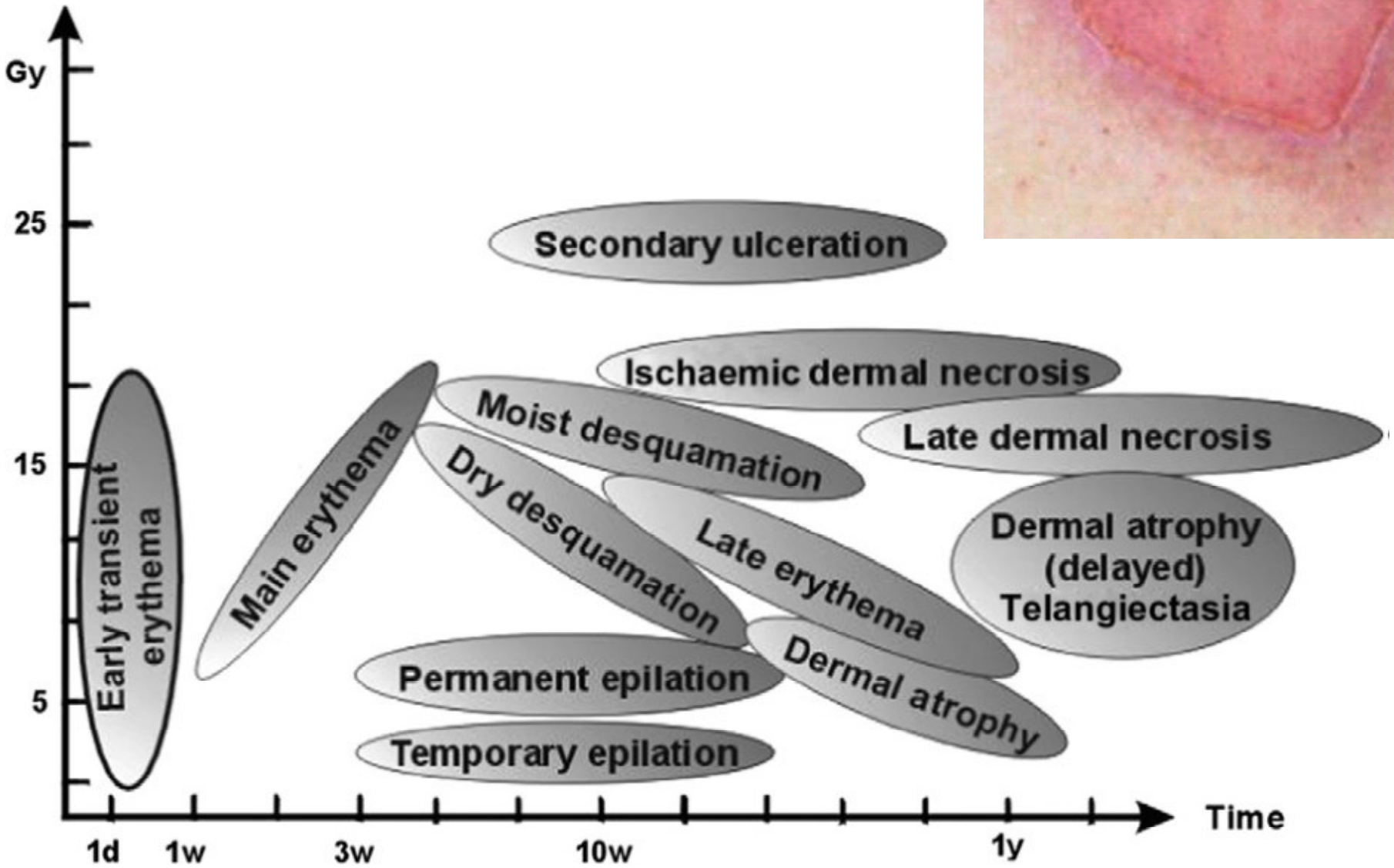
Selbst– und Fremdwahrnehmung in der invasiven Kardiologie

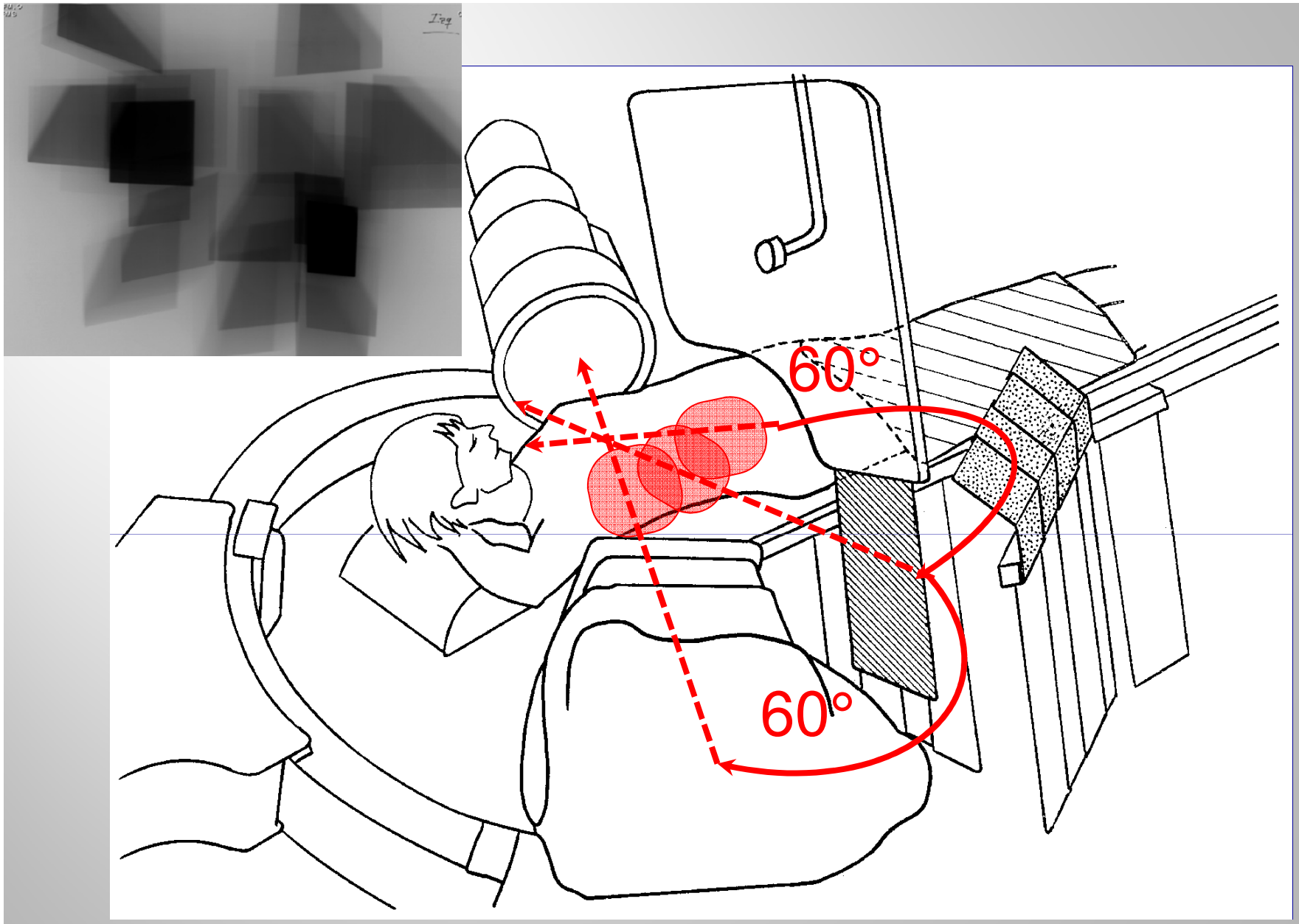
	*n**	Median (IQR)	Mean ± SD
Estimated value [0…10]† attached to ALARA principles by …			
Herself/himself	103	8 (6–9)	7 ± 2
Colleagues	102	7 (5–8)	6 ± 2
International Commission on Radiological Protection	92	5 (4–9)	6 ± 3
German medical societies	95	5 (3–7)	5 ± 3

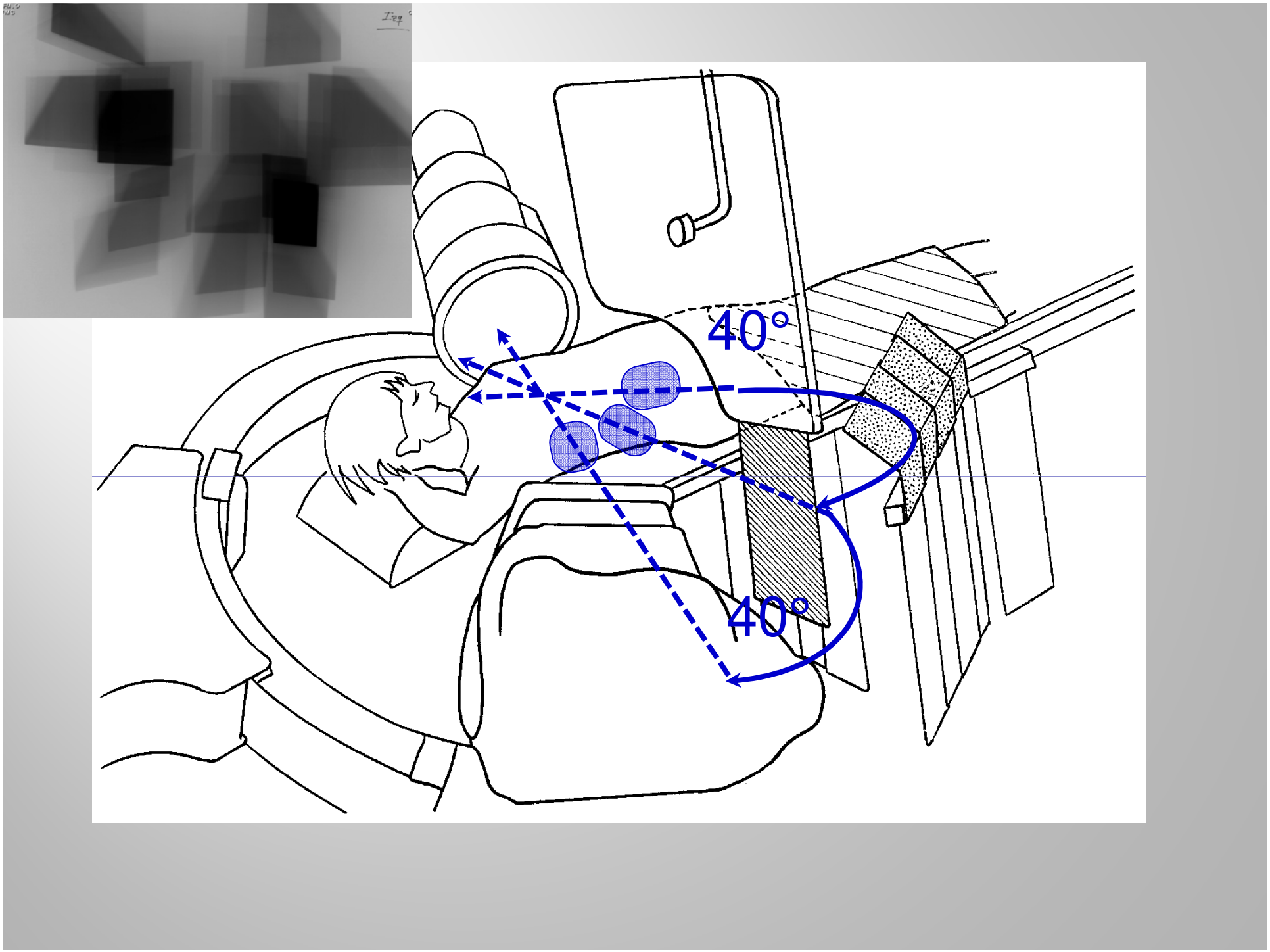
*Responses from 115 questionnaires. †Range between “no” (0) and “extreme” (10) importance. ALARA: as low as reasonably achievable; IQR: interquartile range; SD: standard deviation.

Kuon E, et al. RoeFo 2015 (in press).

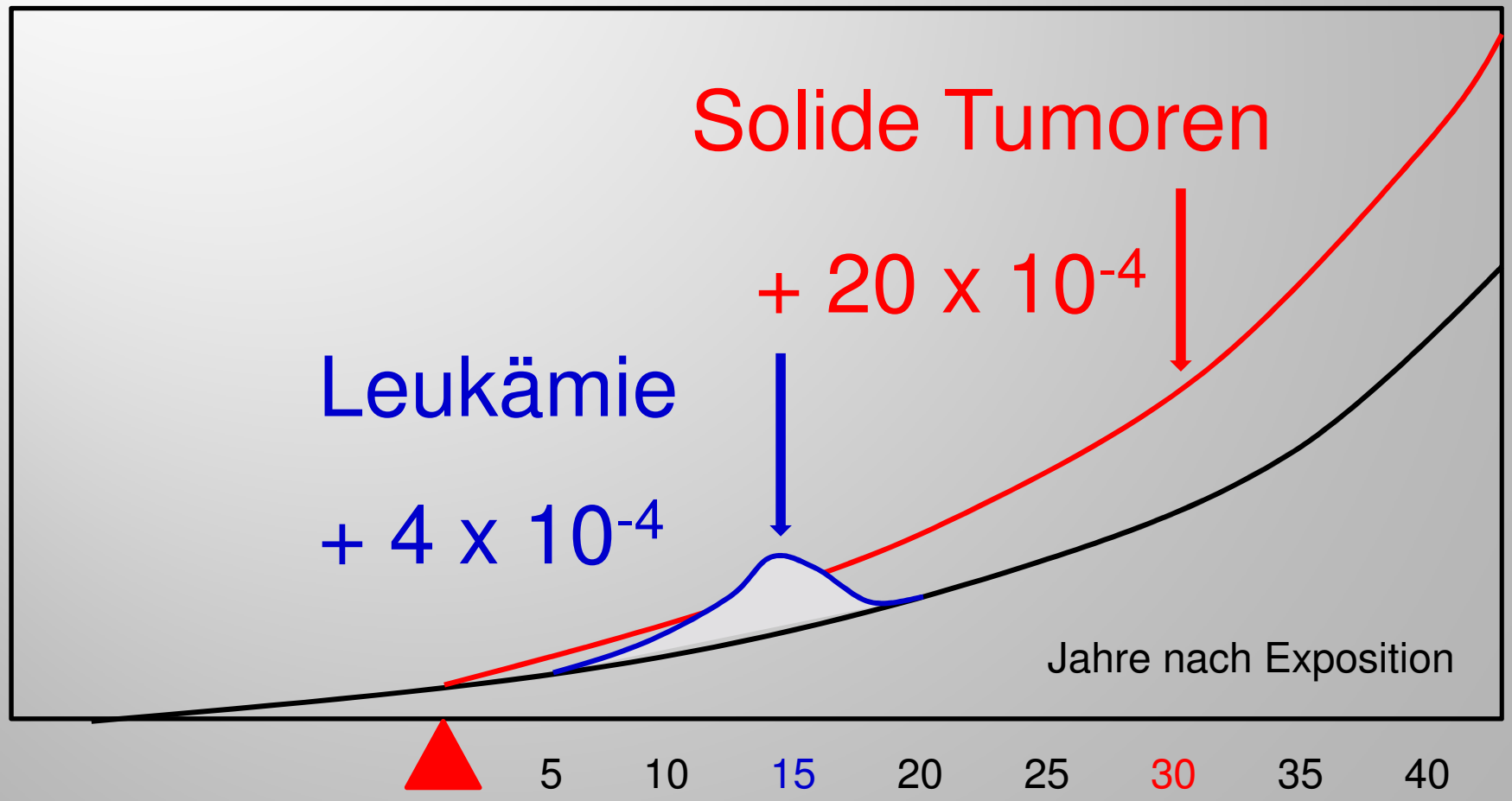
Deterministische Strahlenschäden

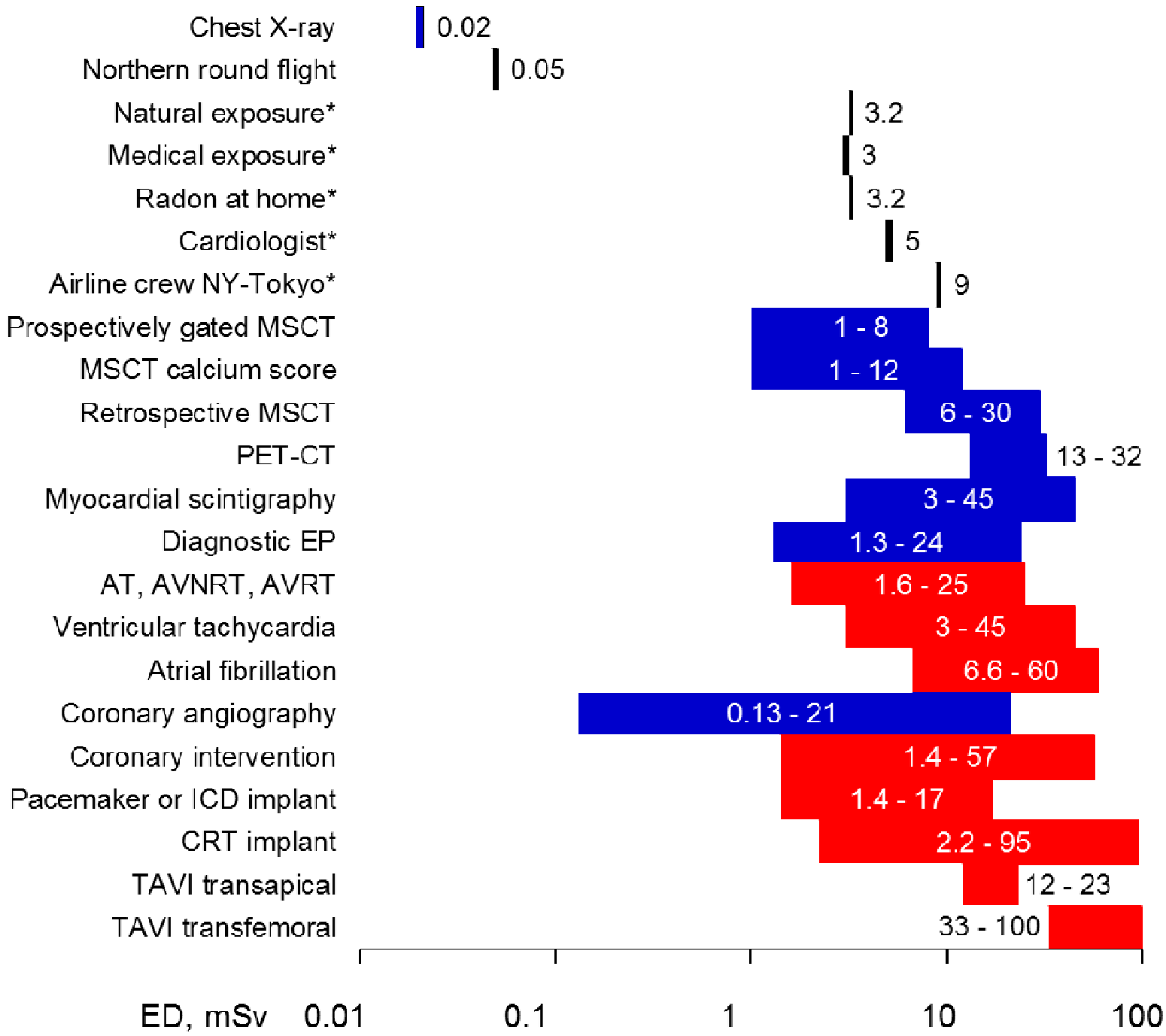



60°
60°

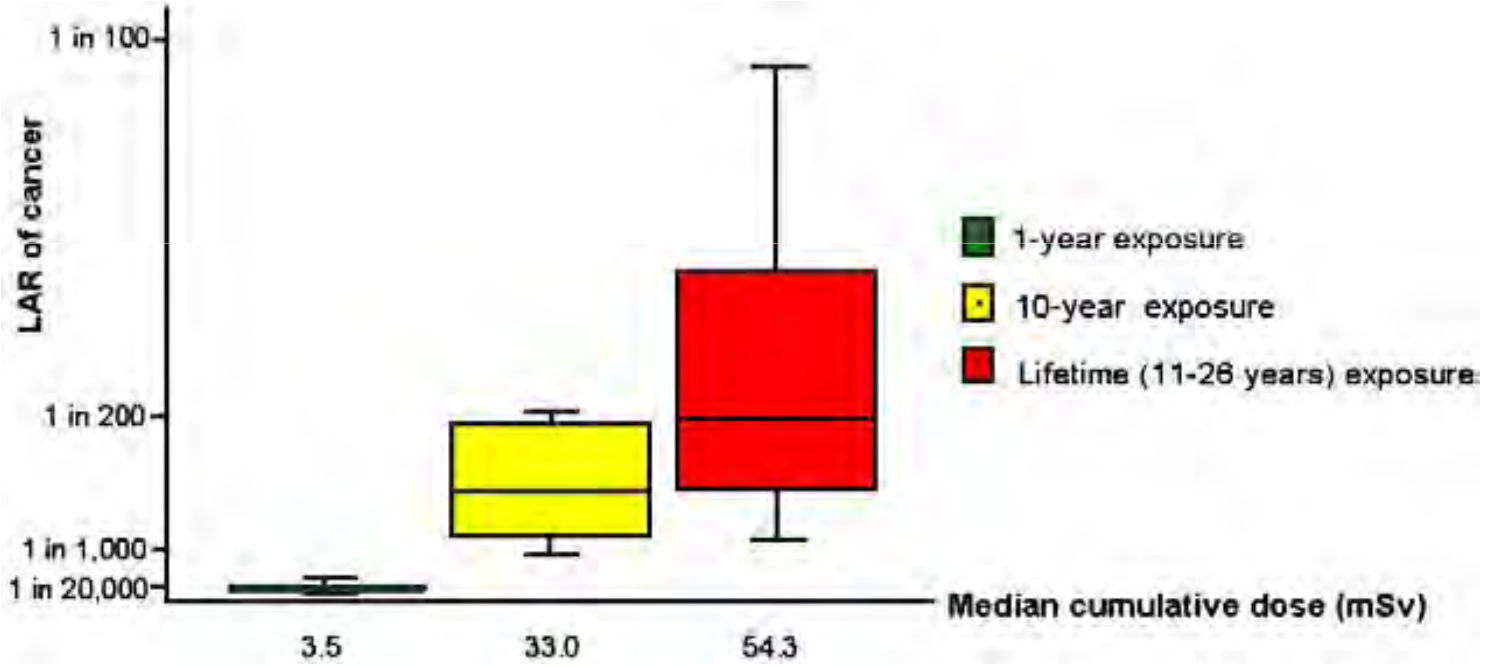

40°
40°

Stochastische Strahlenschäden
Krebsrisiko: 0.5 – 1.1% / 100 mSv



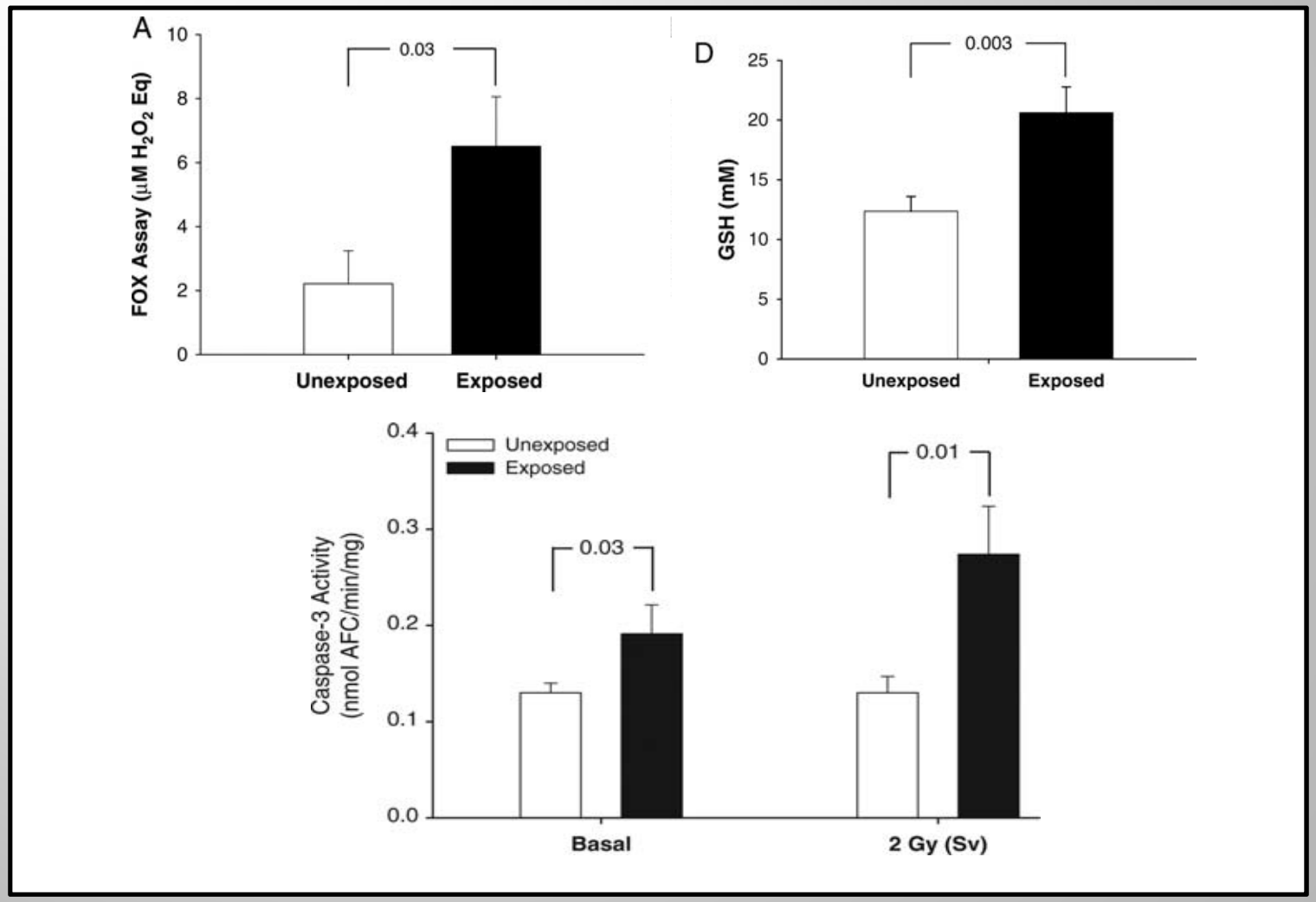

Chest X-ray
0.02
Northern round flight
0.05
Natural exposure*
3.2
Medical exposure*
3
Radon at home*
3.2
Cardiologist*
5
Airline crew NY-Tokyo*
9
Prospectively gated MSCT
1 - 8
MSCT calcium score
1 - 12
Retrospective MSCT
6 - 30
PET-CT
13 - 32
Myocardial scintigraphy
3 - 45
Diagnostic EP
1.3 - 24
AT, AVNRT, AVRT
1.6 - 25
Ventricular tachycardia
3 - 45
Atrial fibrillation
6.6 - 60
Coronary angiography
0.13 - 21
Coronary intervention
1.4 - 57
Pacemaker or ICD implant
1.4 - 17
CRT implant
2.2 - 95
TAVI transapical
12 - 23
TAVI transfemoral
33 - 100
ED, mSv
0.01
0.1
1
10
100

Life-attributable cancer risk interventioneller Kardiologen



Venneri L, Rossi F, Botto N, et al. Am Heart J. 2009;157:119–24.

Cellular adaptive response to chronic radiation exposure in interventional cardiologists



Russo GL, Tedesco I, Russo M, et al. Eur Heart J Advance Access, August 23, 2011.

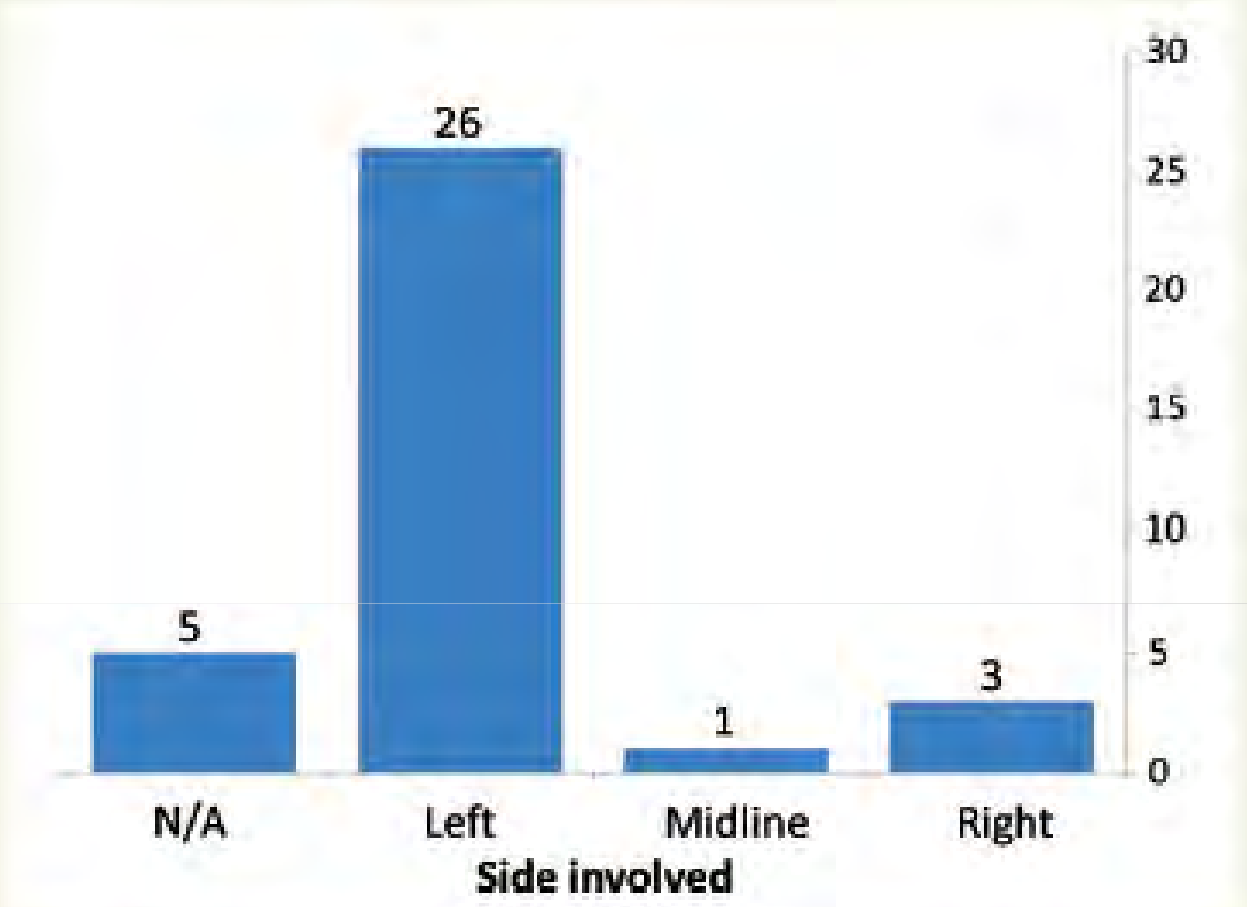
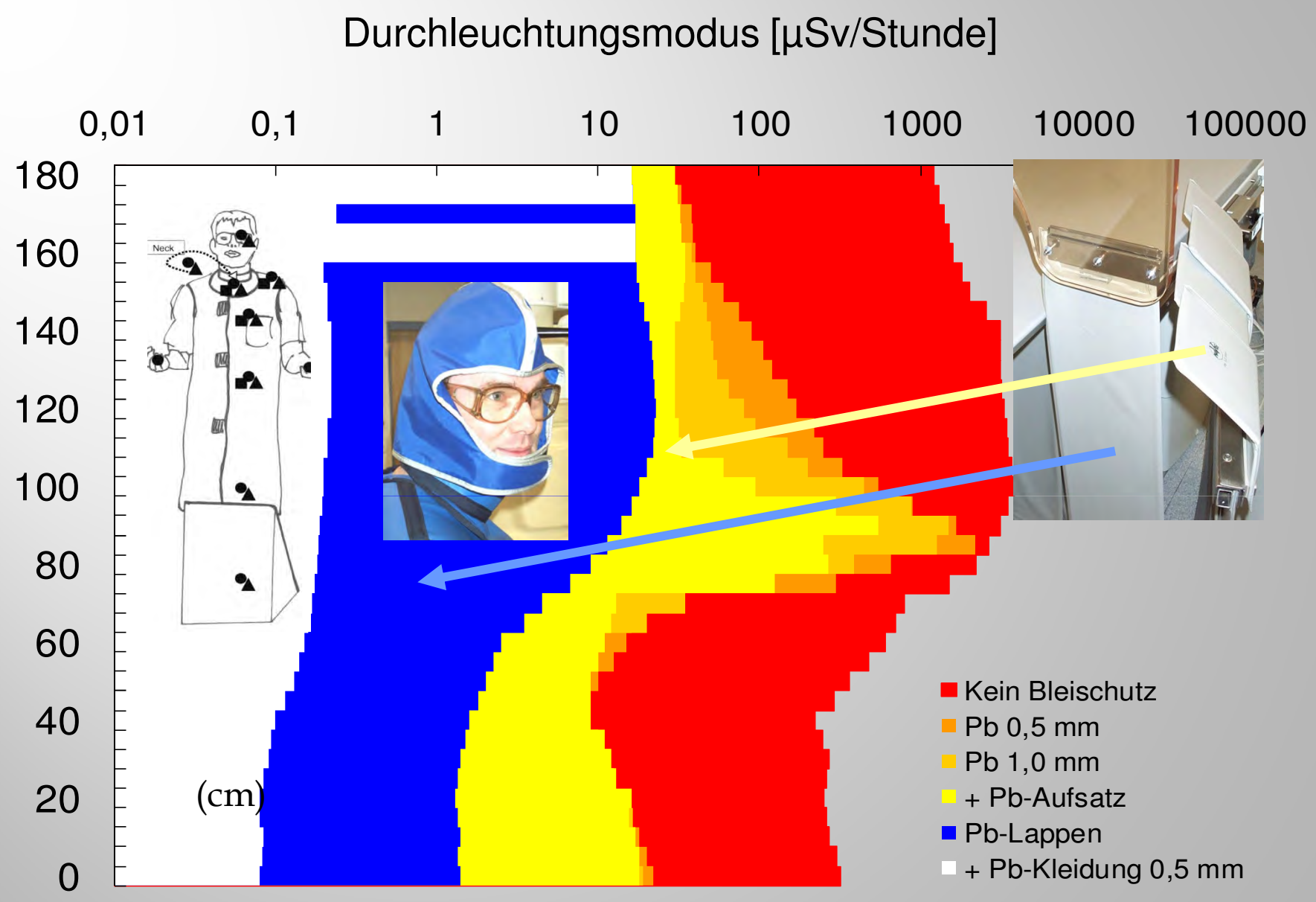
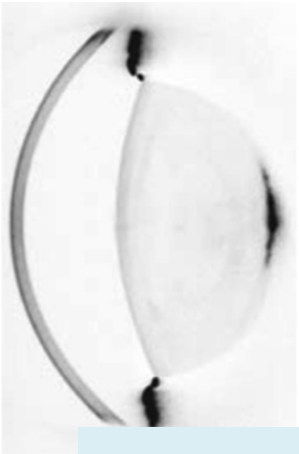


Figure 1 Brain malignancies among 35 interventional physicians working with ionising radiation. The figure shows the side of the brain involved.

Roguin A. Radiation in Cardiology. Can't live without it! Eur Heart J 2014;35:599–604



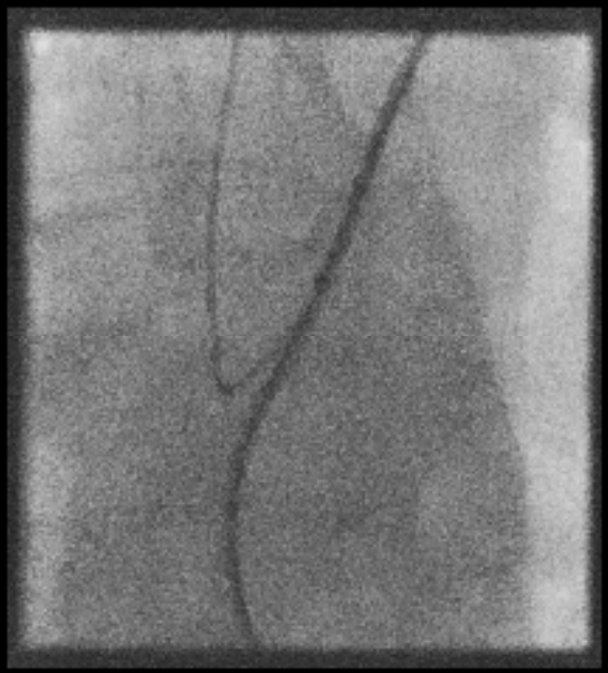
Kuon E, Schmitt M, Dahm JB. Am J Cardiol 2002;89:44–9.
Kuon E, Günther M, Dahm JB. RöFo 2003;175:1545–50.
Kuon E, Birkel J et al. Heart 2003;89:1205–10.

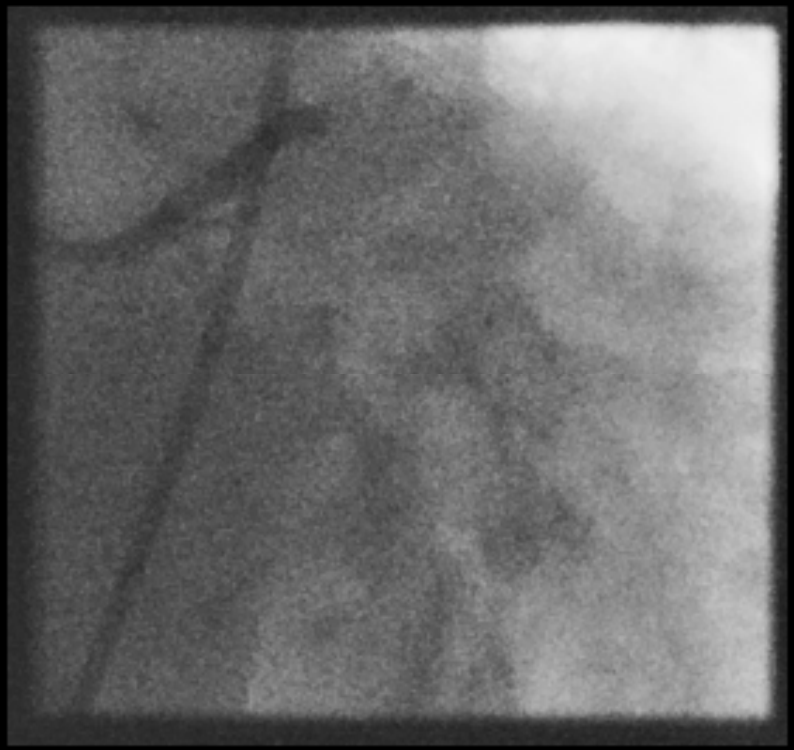


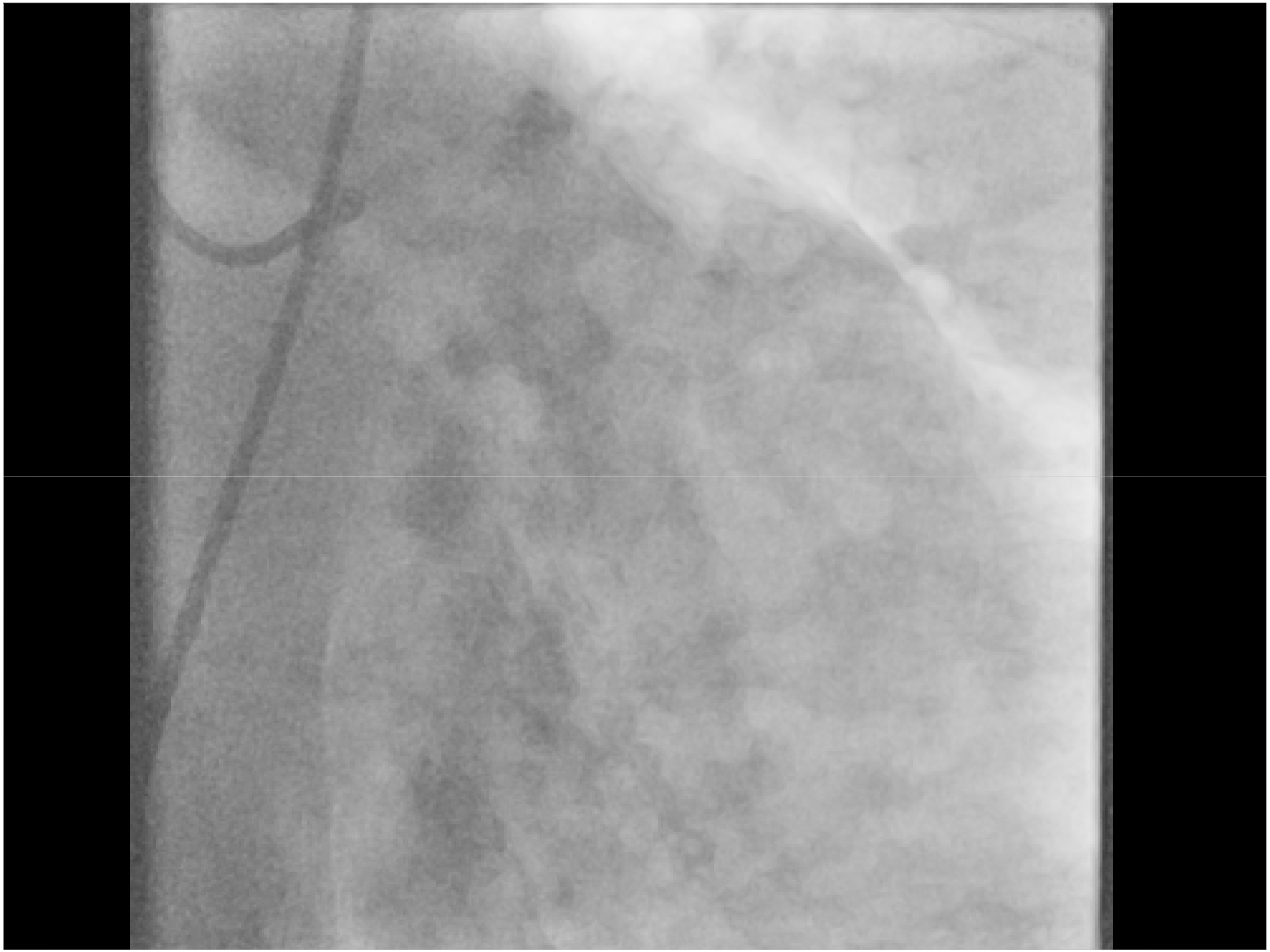
Radiation protection devices in invasive cardiology

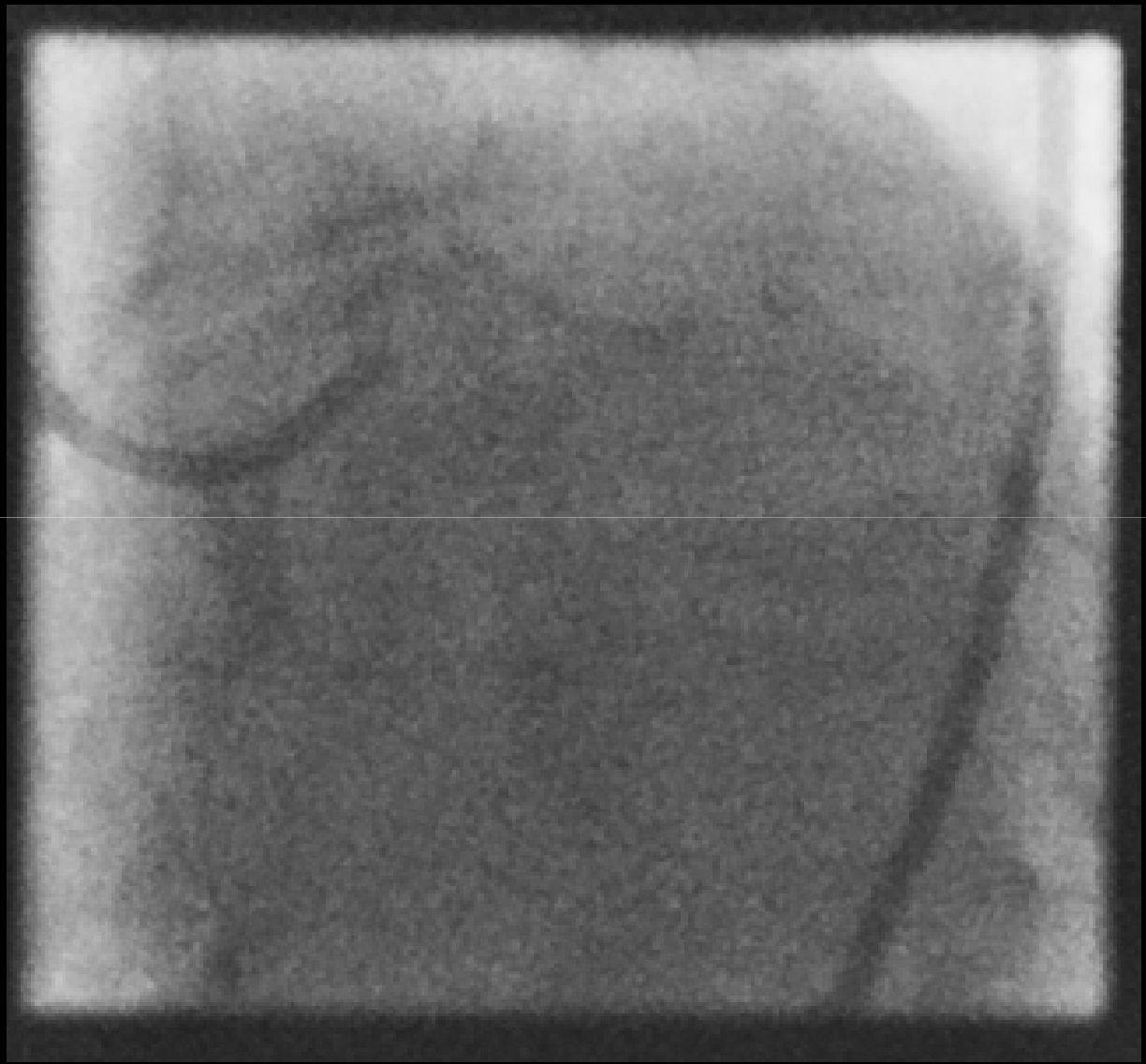
	individual use [%]			attached importance [0…10]†		
Lead protection	***n****	**Median (IQR)**	**Mean ± SD**	***n****	**Median (IQR)**	**Mean ± SD**
Apron	111	100 (100–100)	100 ± 0	101	10 (10–10)	10 ± 0
Glass sheet	111	100 (100–100)	95 ± 18	96	10 (10–10)	10 ± 1
UCS – longitudinal	109	100 (100–100)	94 ± 25	96	10 (9–10)	9 ± 2
Collar	110	100 (100–100)	89 ± 30	99	10 (10–10)	9 ± 2
UCS – transversal	104	100 (0–100)	69 ± 46	93	10 (5–10)	8 ± 4
Eyeglasses	109	0 (0–80)	28 ± 42	95	5 (2–10)	5 ± 3
Cover around patients' thighs	108	0 (0–10)	19 ± 36	81	5 (1–7)	5 ± 3
Foot switch shield	107	0 (0–0)	7 ± 25	92	2 (0–5)	3 ± 3
Gloves	109	0 (0–0)	3 ± 15	93	2 (0–4)	2 ± 3
Cap	109	0 (0–0)	1 ± 8	92	0 (0–2)	1 ± 2

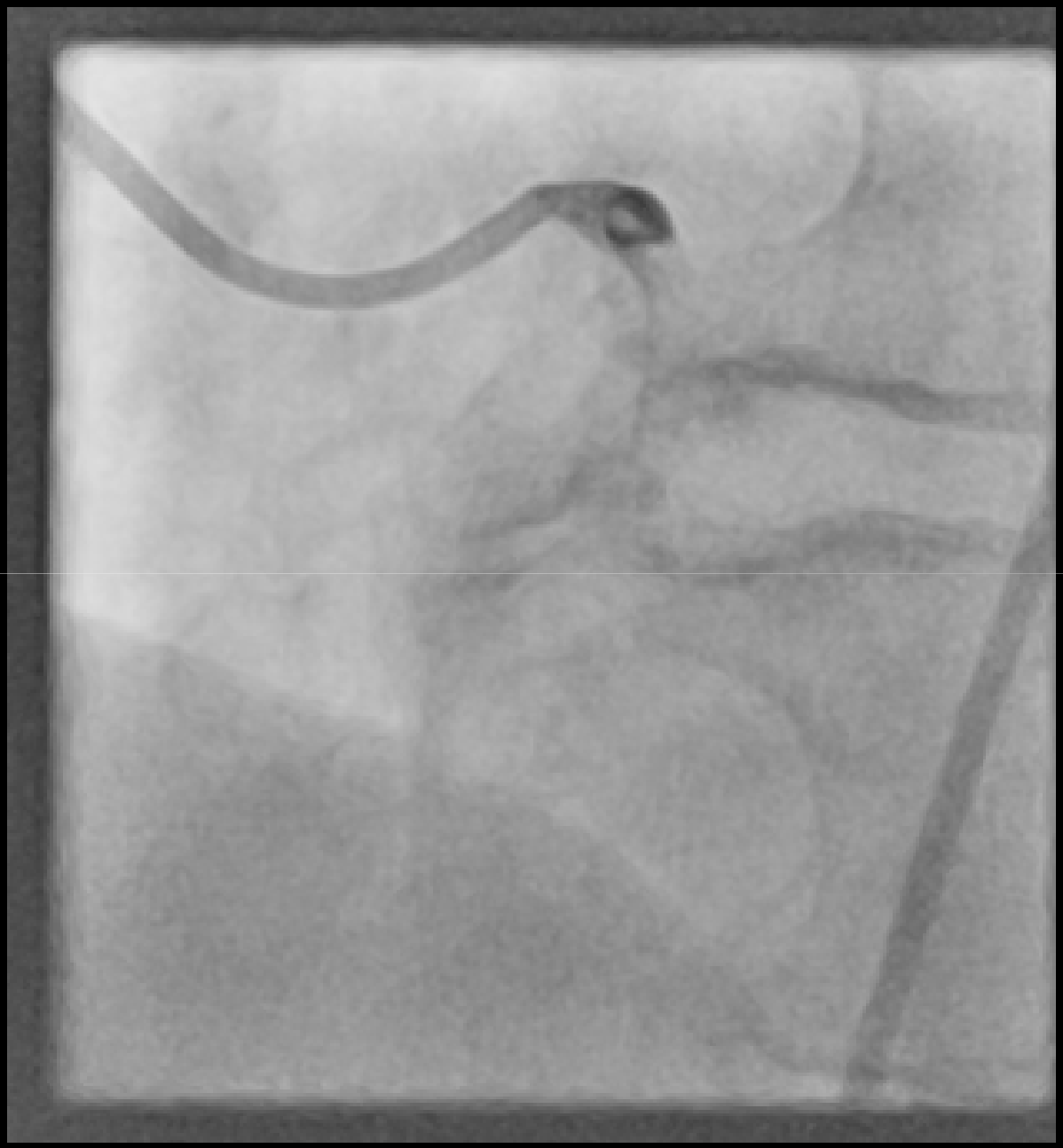
Kuon E, et al. RoeFo 2015 (in press).



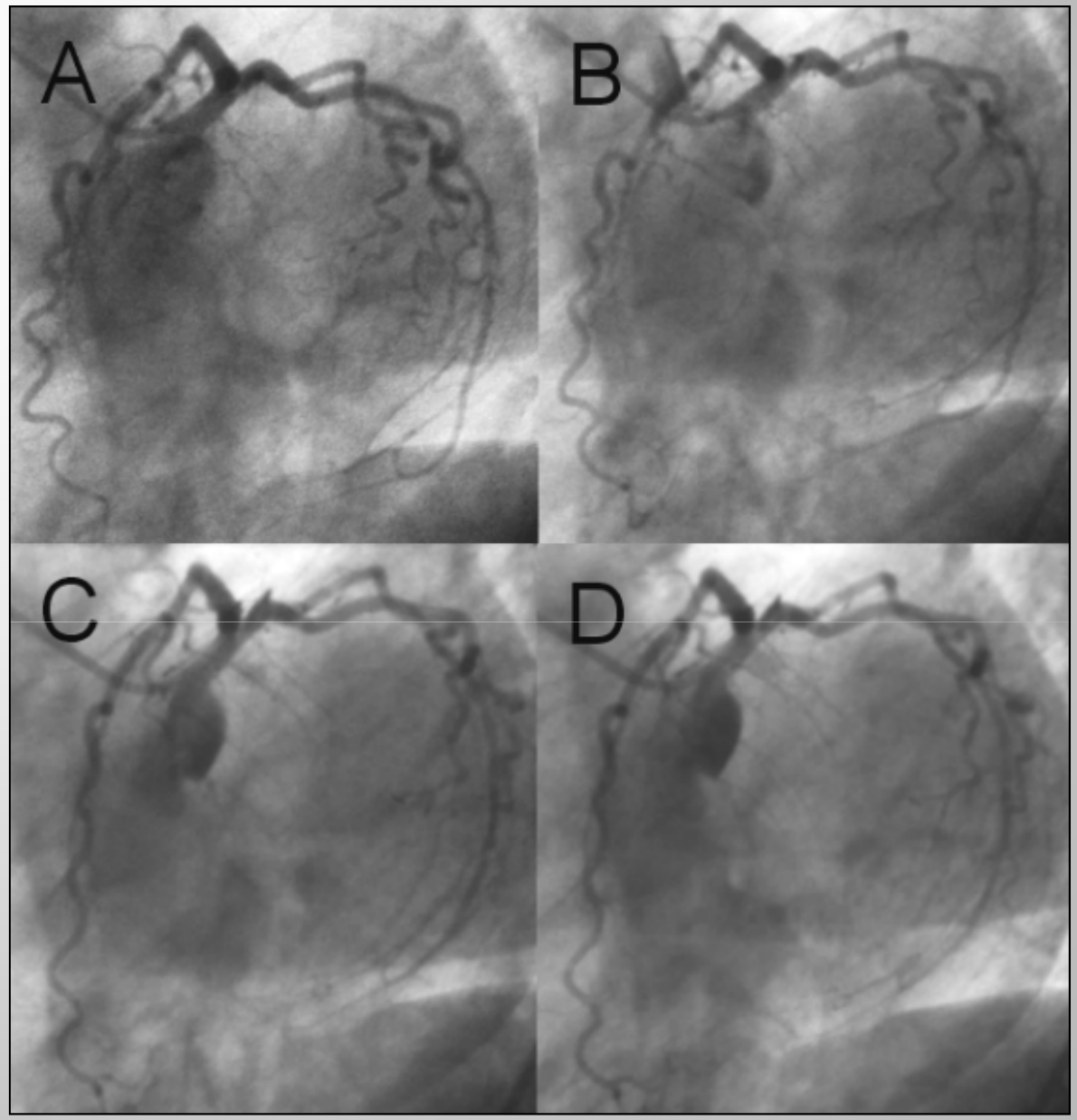








BV-Eingangs-Dosis



x 1

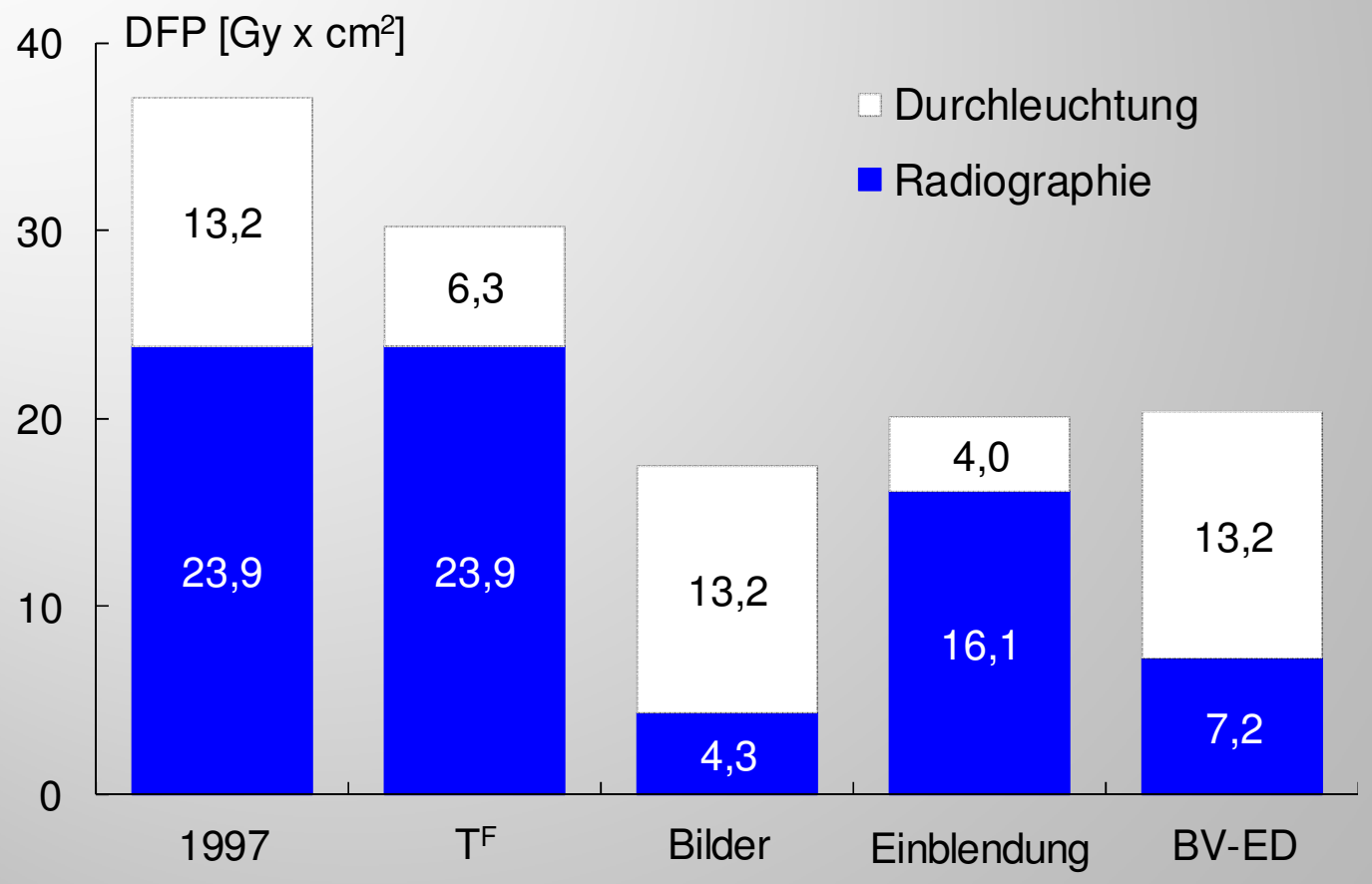
x 2

x 3

x 4

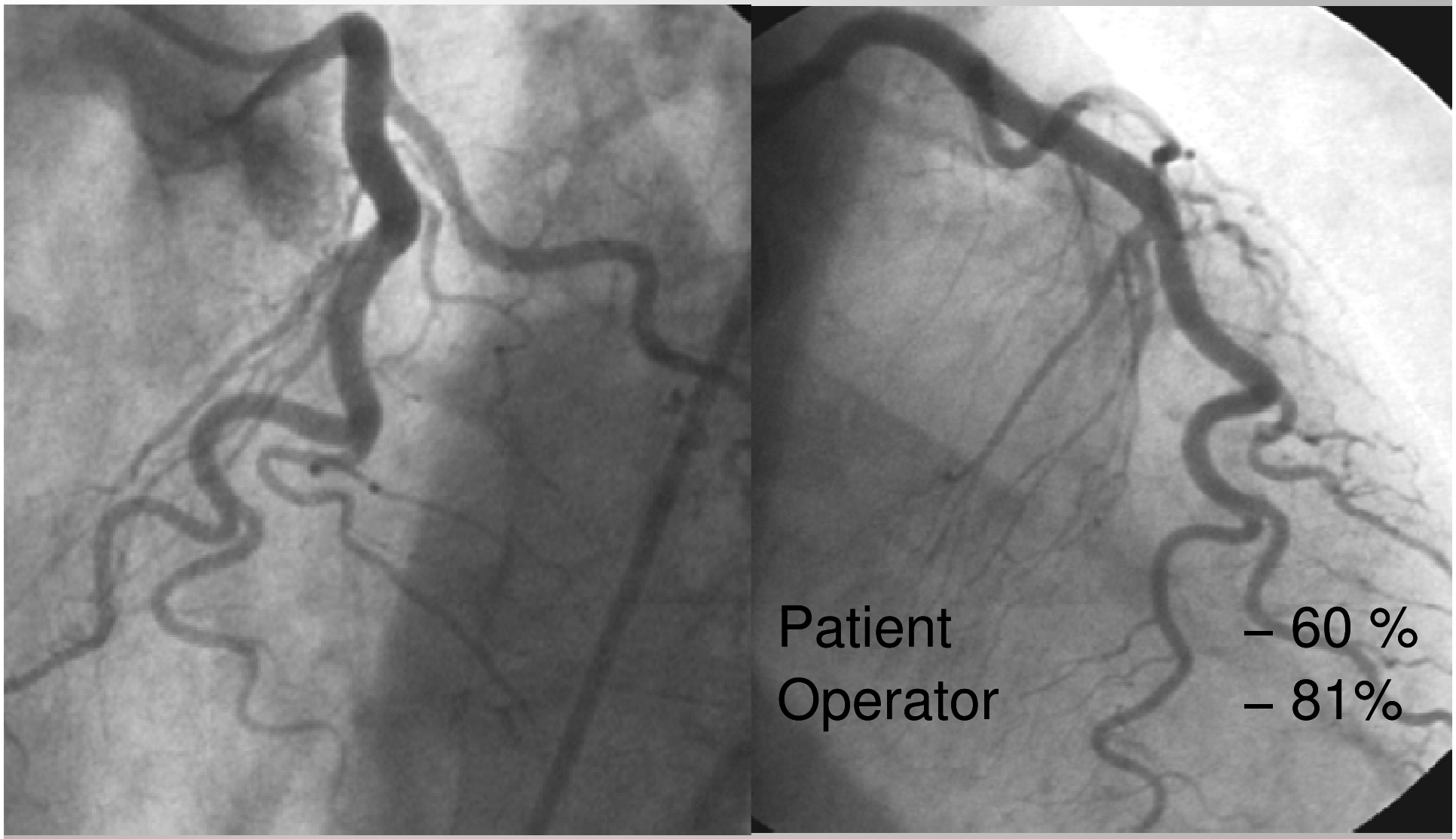
Kuon E, Dorn C, Schmitt M, Dahm JB. Health Phys 2003;84:626–31.

Koronarangiographie Ebermannstadt – 1997 vs 2001



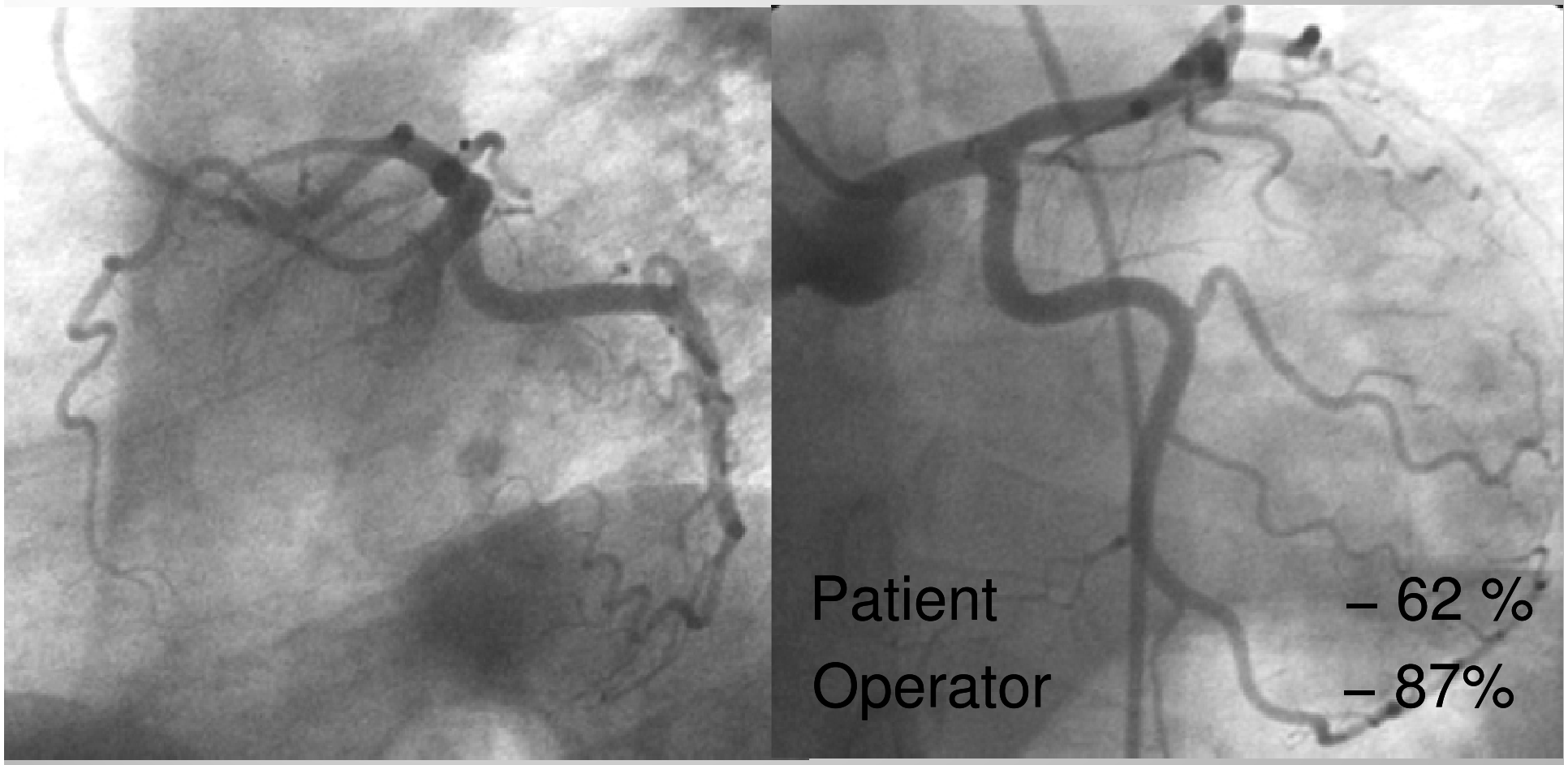
Kuon et al. Fortschr Röntgenstr 2005;177:812–17.

LAO cranial 50°/20° → PA cranial 0°/30°

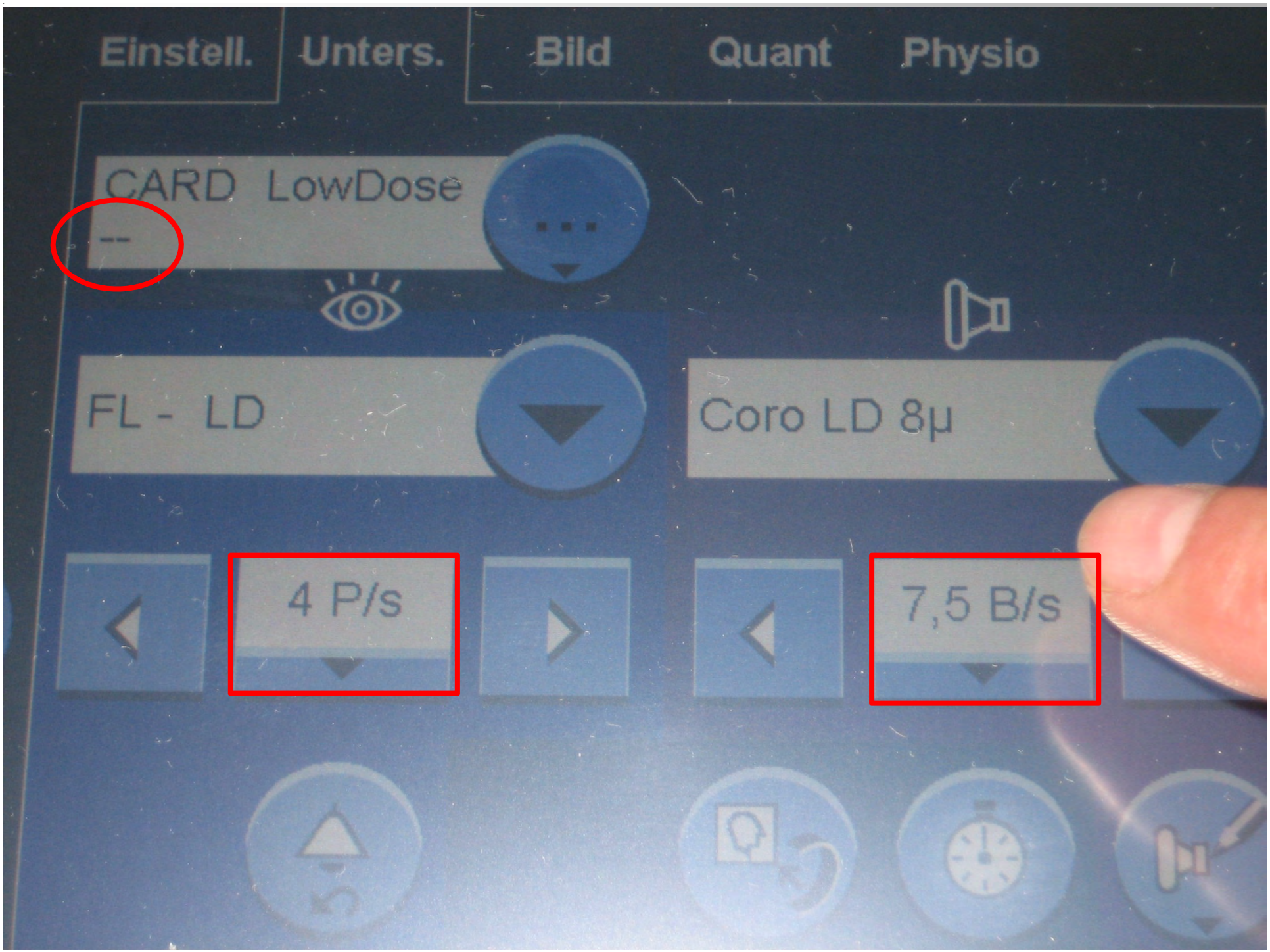


Kuon E. Radiation exposure in invasive cardiology. Heart 2008;94:667–674
Kuon E et al. Less irradiating angulations in invasive cardiology. J Am Coll Cardiol 2004;44:1420–8

Spider view → PA caudal 0°/30°

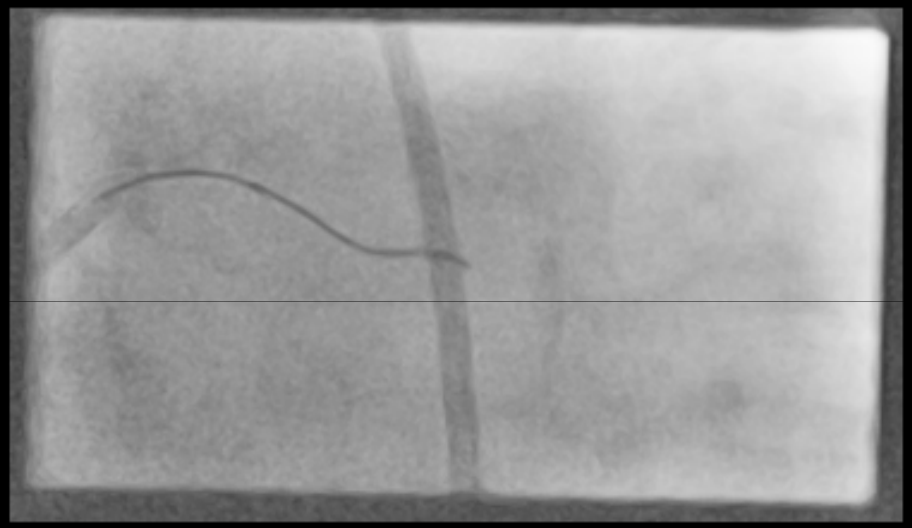


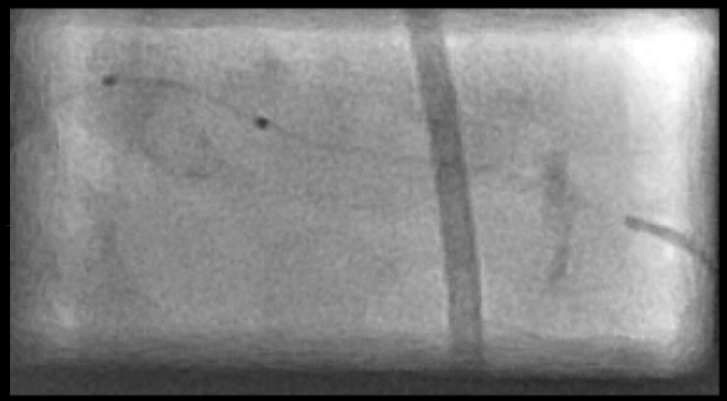
Kuon E. Radiation exposure in invasive cardiology. Heart 2008;94:667–674
Kuon E et al. Less irradiating angulations in invasive cardiology. J Am Coll Cardiol 2004;44:1420–8

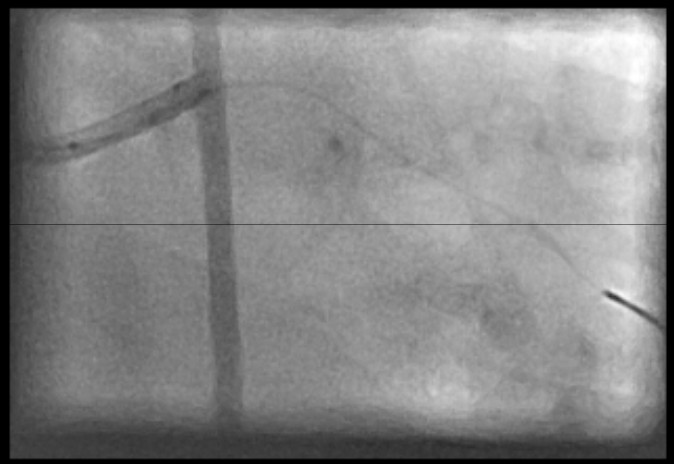

Einstell.
Unters.
Bild
Quant
Physio
CARD LowDose
--
FL - LD
Coro LD 8µ
4 P/s
7,5 B/s

Technical Optimisation CA [n =100]	Conventional Equipment	Axiom Artis zee
DAP [Gy x cm²]	7,0	2,4
T^R [s]	9,4	12,2
T^F [s]	122	120
DAP^R/s [mGy x cm²]	436	130
DAP^F/s [mGy x cm²]	21,6	4,4
Ratio R/F	20	30

Kuon E, Empen K et al. Submillisievert coronary angiography. Herz 2013 [Epub ahead of print]







9 Schritte zu effizientem Strahlenschutz

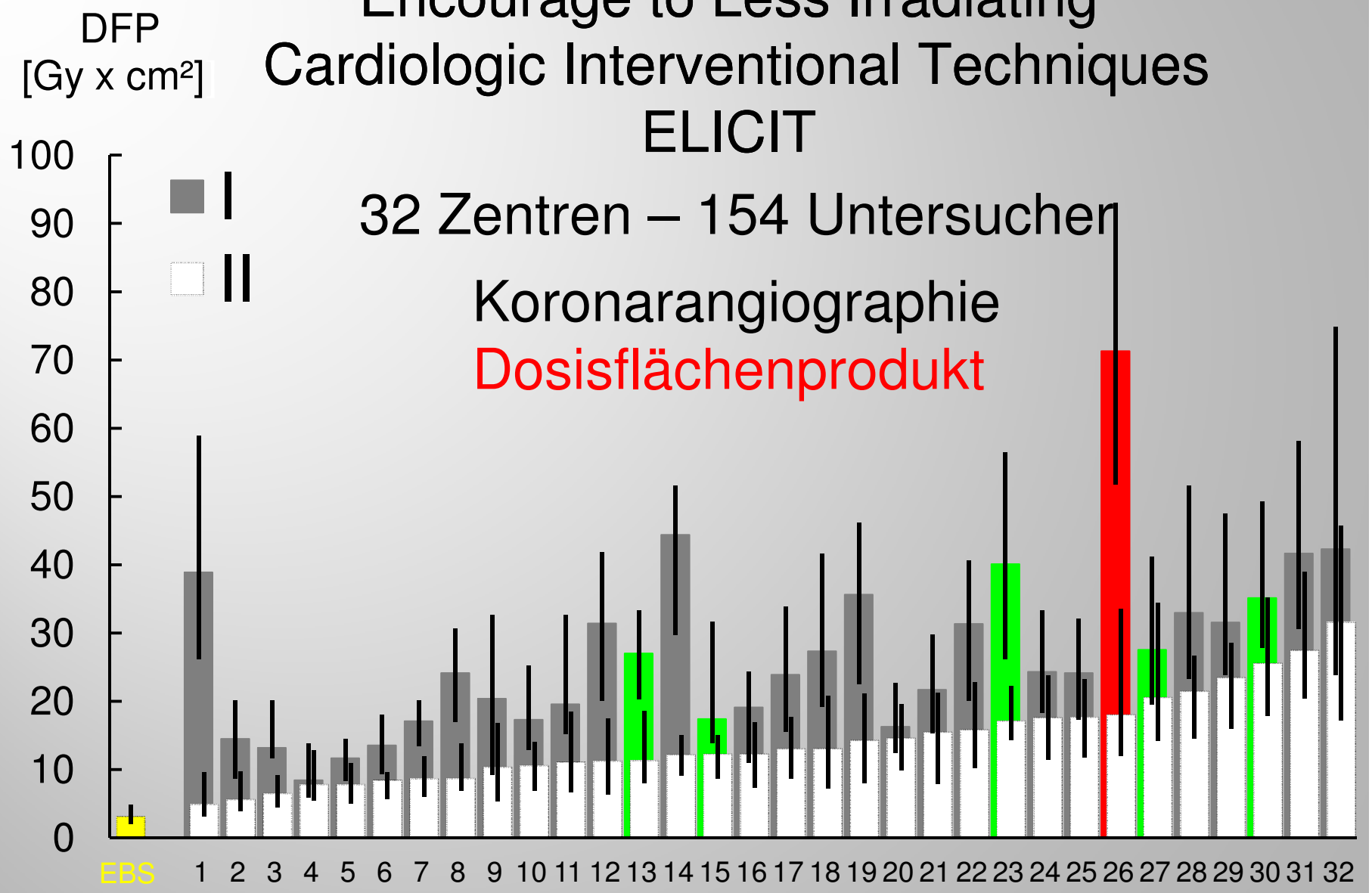
1. Hinreichende Bilder- & Serienanzahl
2. Einblenden auf „Region of Interest“ (ROI)
3. Hinreichende Bildqualität
4. Strahlenschonende Angulationen
5. Herzfrequenzadaptierte Bildraten
6. Interventionsadaptierte Pulsfrequenzen
7. Radiographie in tiefer Inspiration
8. Arbeiten Sie nicht übermüdet
9. Optimieren Sie nun ihre DL-Zeiten

Encourage to Less Irradiating Cardiologic Interventional Techniques ELICIT

32 Zentren – 154 Untersuchen

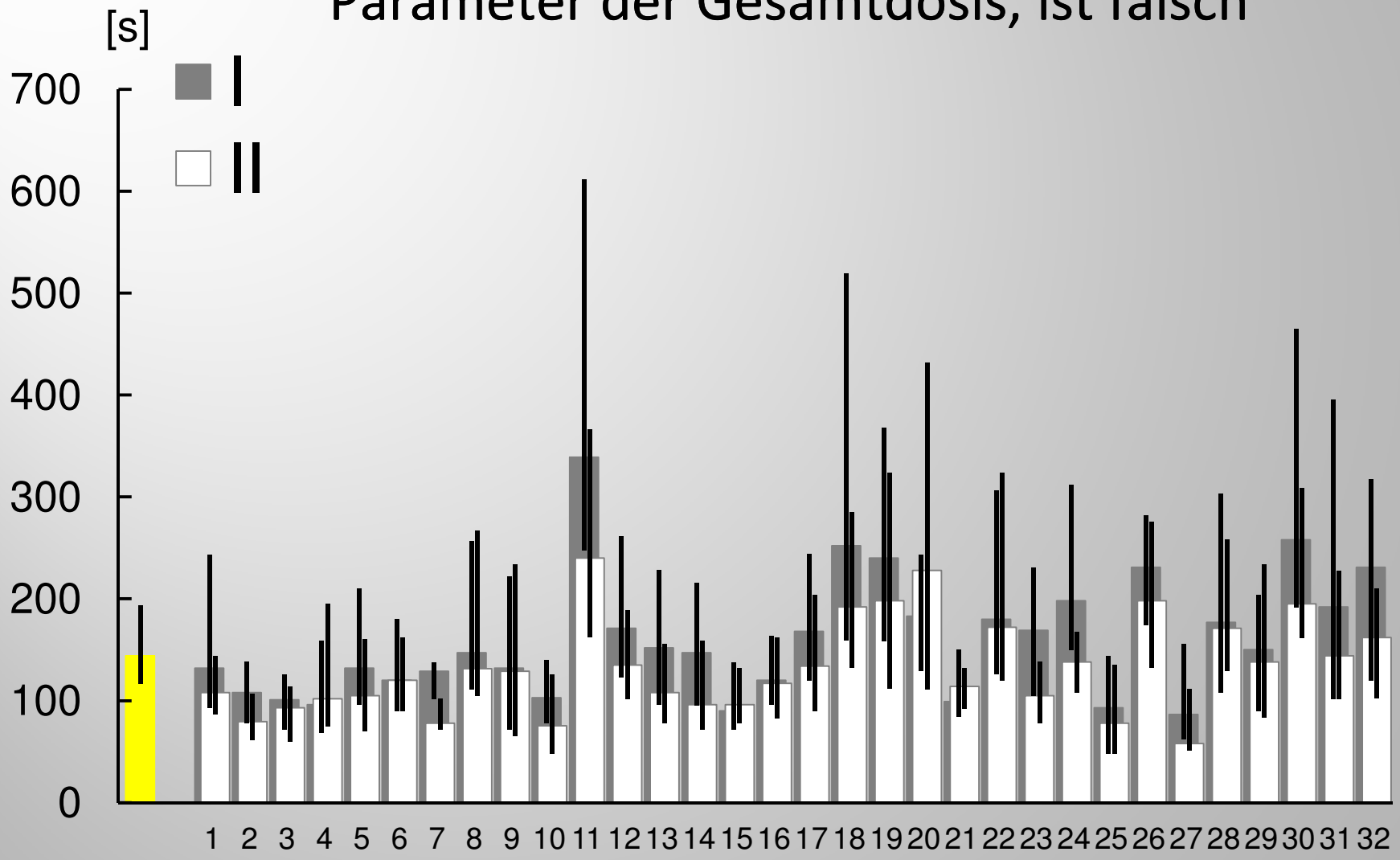
Koronarangiographie

Dosisflächenprodukt



Kuon et al. JACC Cardiovascular Interventions 2014;7:382–90.

Das Dogma, die Durchleuchtungszeit sei wichtigster Parameter der Gesamtdosis, ist falsch



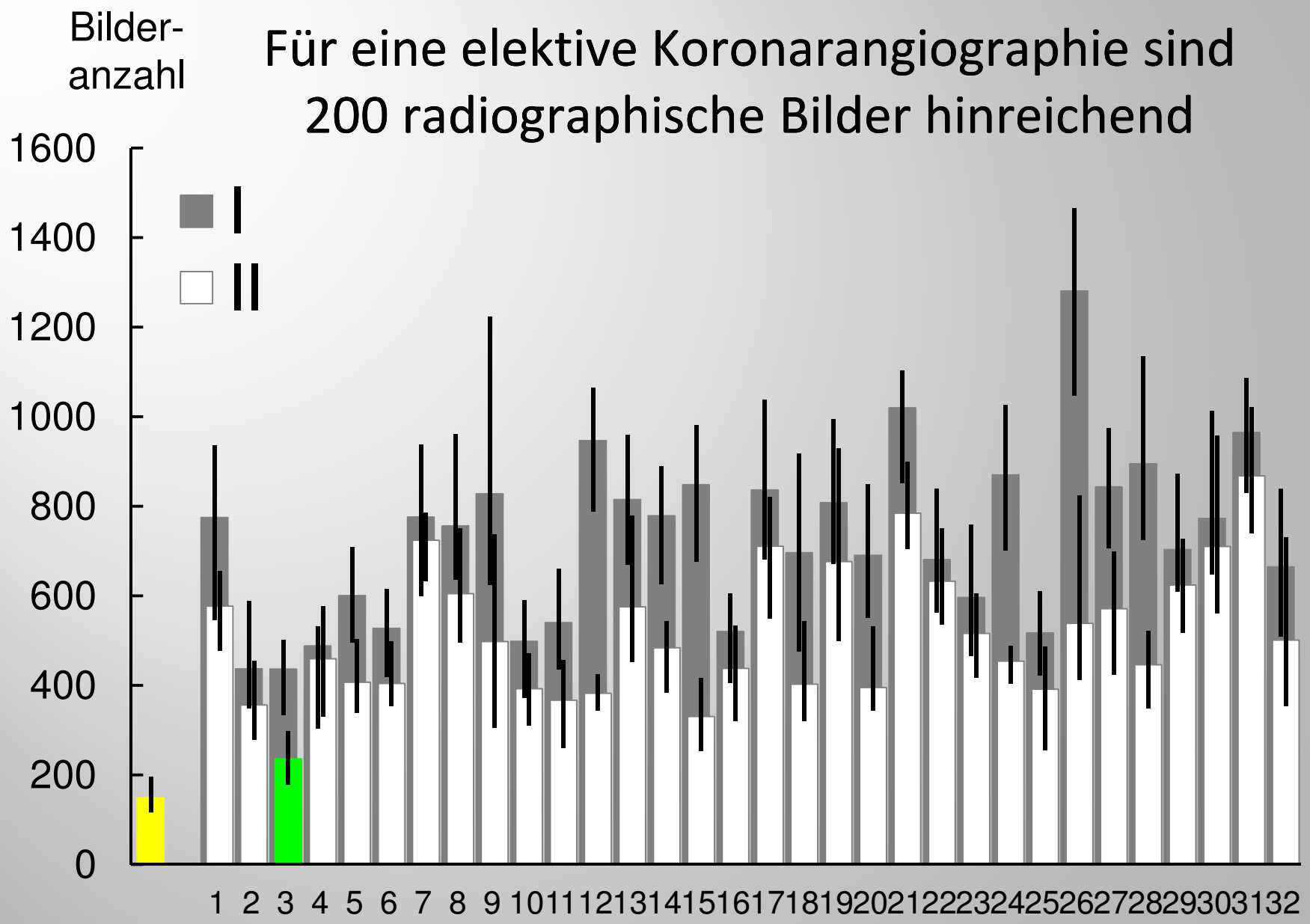
Correlation between DAP and the other radiation dose parameters

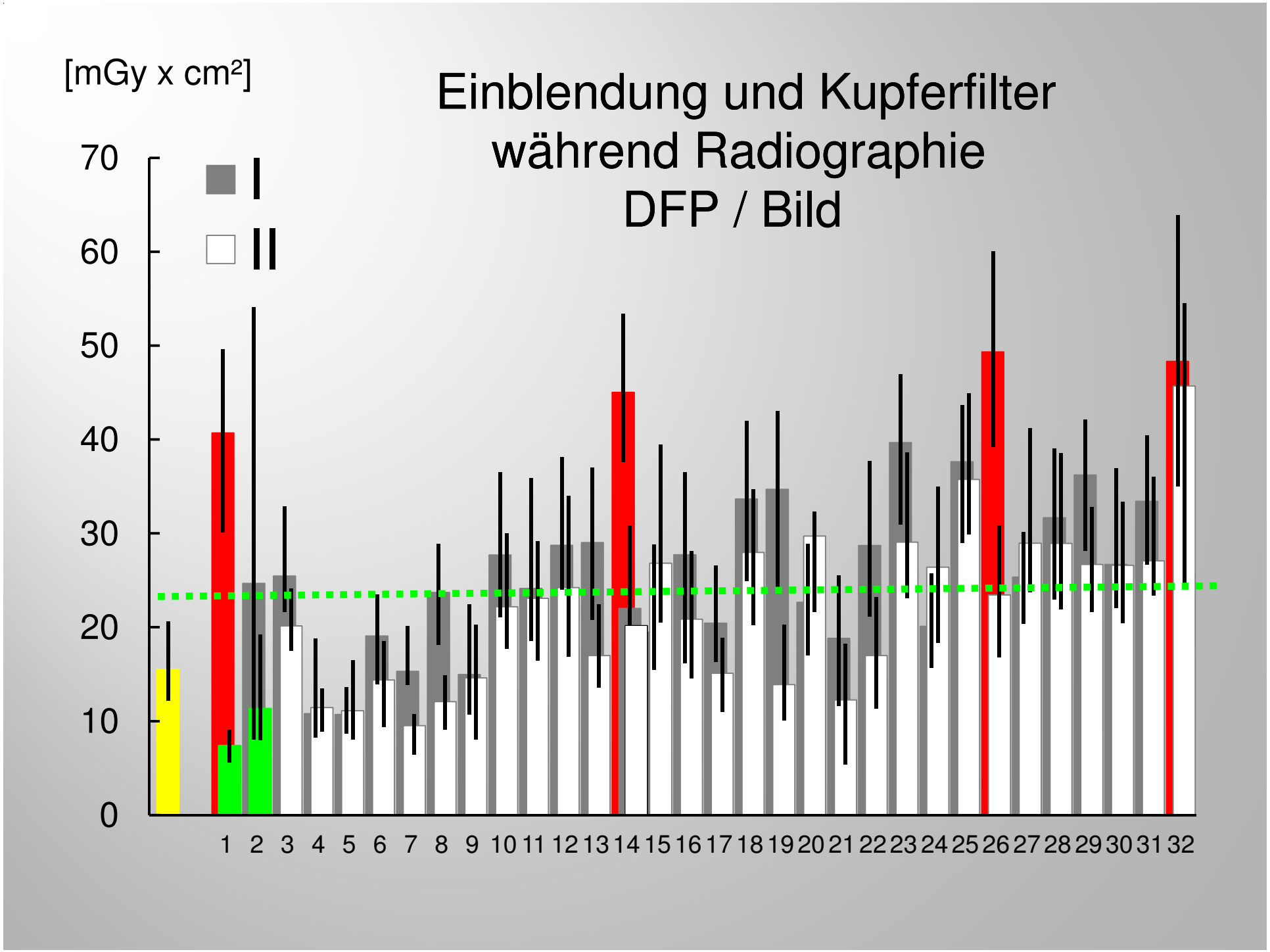
	Spearman correlation coefficients		
	Before Mini-course	After Mini-course	*P*-Value
DAP	1.00	1.00	
DAP^R	0.95	0.95	<.001
DAP^F	0.76	0.71	<.001
No. of frames	0.61	0.54	<.001
No. of radiographic runs	0.51	0.36	<.001
No. of frames/run	0.32	0.37	<.001
T^F	0.54	0.40	<.001
DAP^R/frame	0.76	0.75	<.001
DAP^F/s	0.52	0.57	<.001

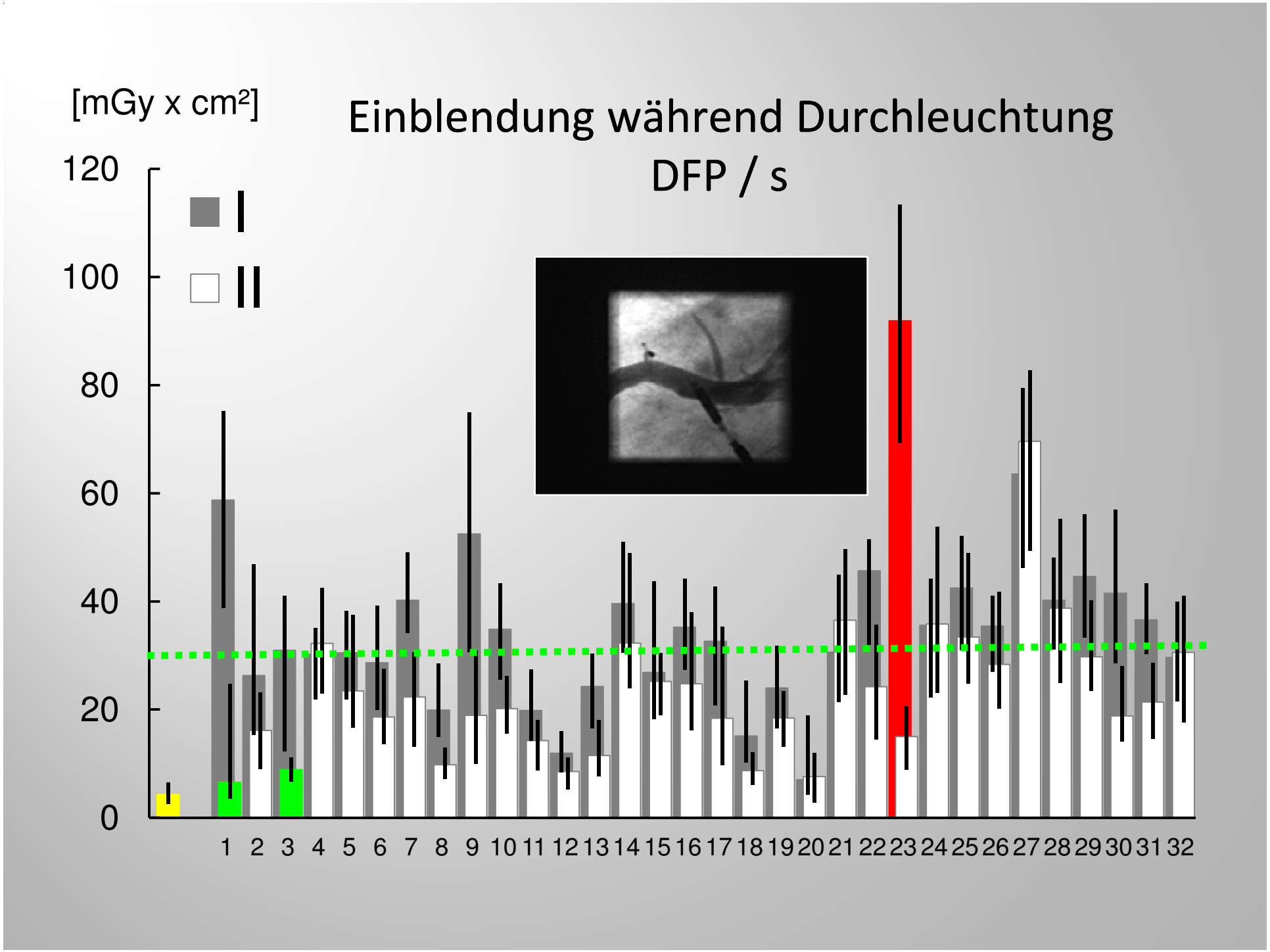
**P*-values for both: correlation coefficients before and after the course

Kuon et al. JACC Cardiovascular Interventions 2014;7:382–90.

Für eine elektive Koronarangiographie sind 200 radiographische Bilder hinreichend




[mGy x cm²]
Einblendung und Kupferfilter
während Radiographie
DFP / Bild
I
II
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32


[mGy x cm²]
Einblendung während Durchleuchtung
DFP / s
I
II
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

		Patients (n = 2,260)			Operators (n = 113)		Centers (n = 27)	
Baseline 26.6 Gy x cm²	Constant	BMI kg × m²	Age per decade	Sex ♂	After Minicourse	Operator experience	Team leader attendance	Advanced system
							(*n* = 15)	(*n* = 6)
DAP [Gy × cm²]	–13.0	**+1.4**	**+1.2**	**+5.9**	**–16.1**	**–0.7**	**–9.4**	**+6.6**
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.030
DAP^R [Gy × cm²]	–4.7	+1.0	+0.7	+4.6	–12.1	–0.4	–12.6	+2.6
p-value	0.057	<0.001	<0.004	<0.001	<0.001	<0.002	<0.001	<0.030
DAP^F [Gy × cm²]	–5.2	+0.4	+0.5	+0.3	–4.0	–0.3	–1,9	+1.0
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.020	0.290
DAP^R/F [mGy × cm²]	–14.9	+1.5	+0.7	+4.7	**–8.9**	–0.2	**–7.6**	+1.5
p-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.030	<0.001	0.088
DAP^F/s [mGy × cm²]	–13.2	+1.7	+0.4	+5.3	**–13.8**	–0.1	**–3.4**	–2.3
p-value	<0.001	<0.001	0.226	<0.001	<0.001	0.666	0.366	0.406
Frames [*n*]	+718	+1	+13	+63	**–197**	–7	**–159**	**+43**
p-value	<0.001	0.345	<0.002	<0.001	<0.001	<0.030	<0.001	0.071

Kuon E, et al. RoeFo 2015 (in press).

Strahlenschutz im Herzkatheterlabor

"DESPITE SIGNIFICANT REQUIRED TRAINING IN RADIATION SAFETY FOR ALL INTERVENTIONAL CARDIOLOGISTS, THE PRESENTED ADDITIONAL 90-MIN. MINI-COURSE SIGNIFICANTLY REDUCED PATIENT DOSE."

Kuon et al. JACC Cardiovascular Interventions 2014;7:382–90.

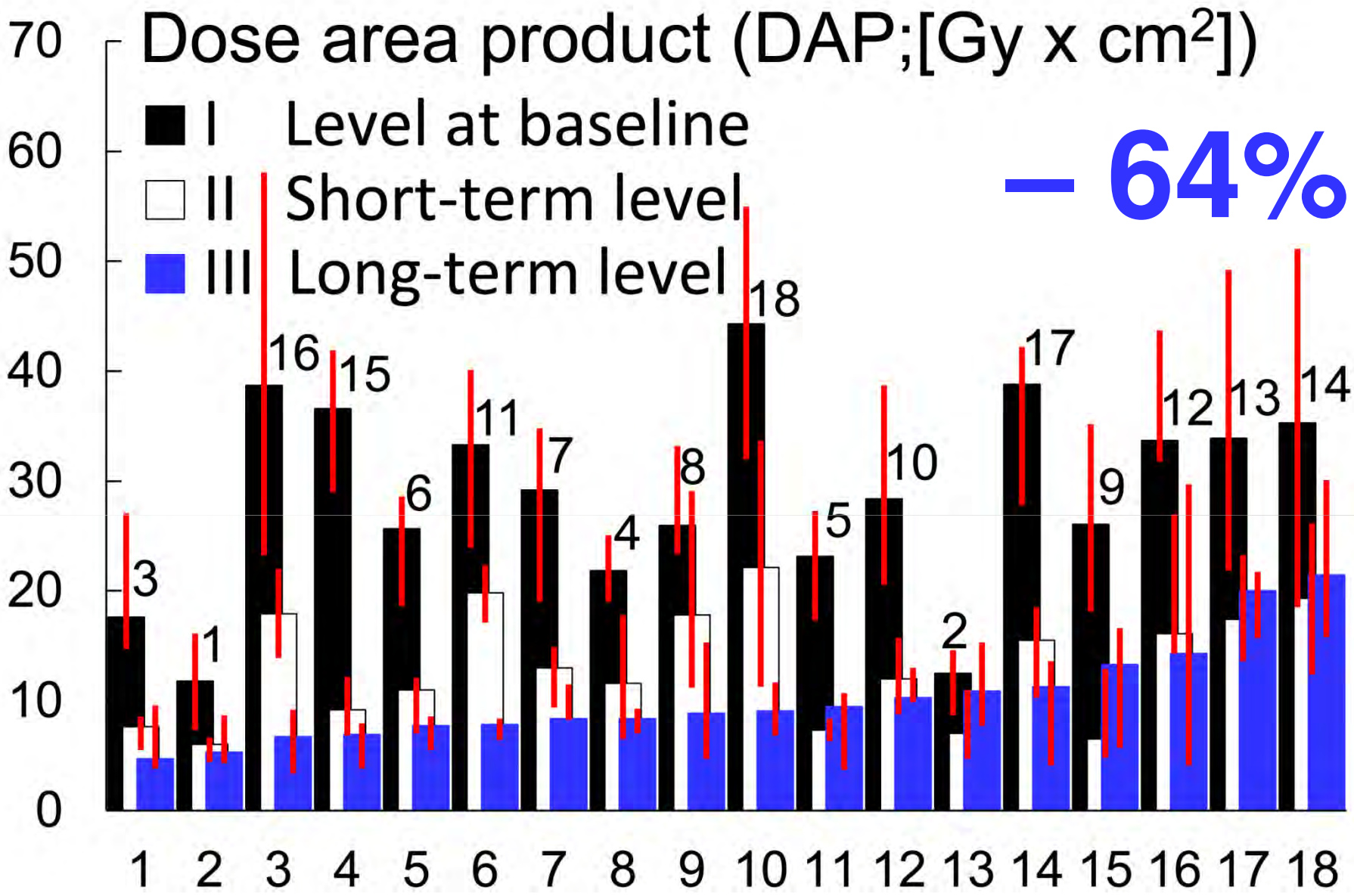
Plan – Do – Check – Act
Kontrolle & Schulung

- Anonymisiertes Feedback „without risk of blame“
- 9 Dosisparameter während nur 10 konsekutiver Koronarangiographien
- Aussagen zu individueller Arbeitsweise
- Vergleich mit der Arbeit akzeptierter Kollegen, Herzzentren an identischen Katheteranlagen
- Iteratives Selbstmonitoring & -training

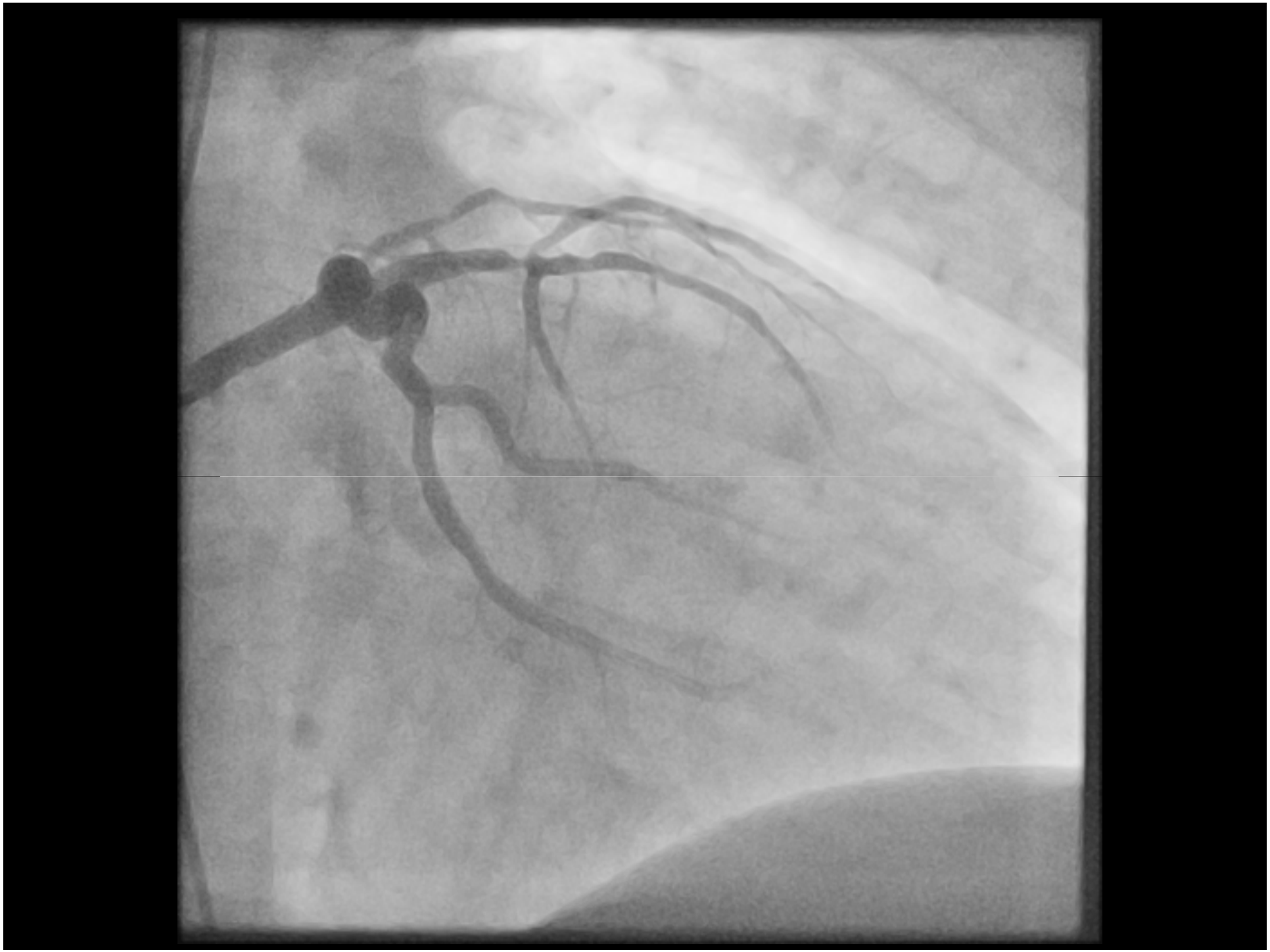
Iteratives Selbstcoaching benötigt

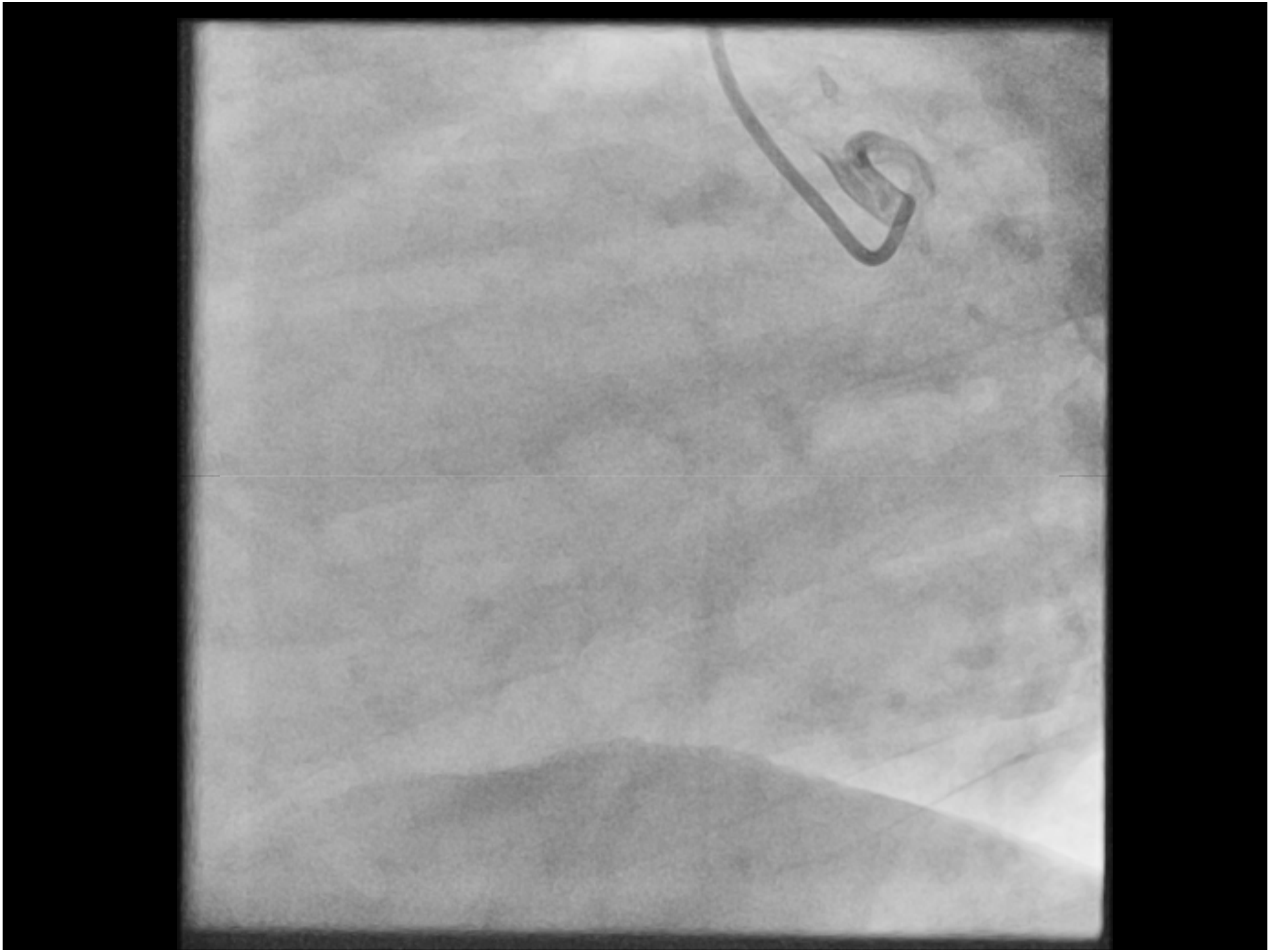
1. Dosisflächenprodukt
2. Radiographisches DFP^R > Haupt-Dosis-
3. Fluoroskopisches DFP^F > reduktionspotential
4. Bilderanzahl > Dokumentionszeit
5. Serienanzahl
6. Durchleuchtungszeit

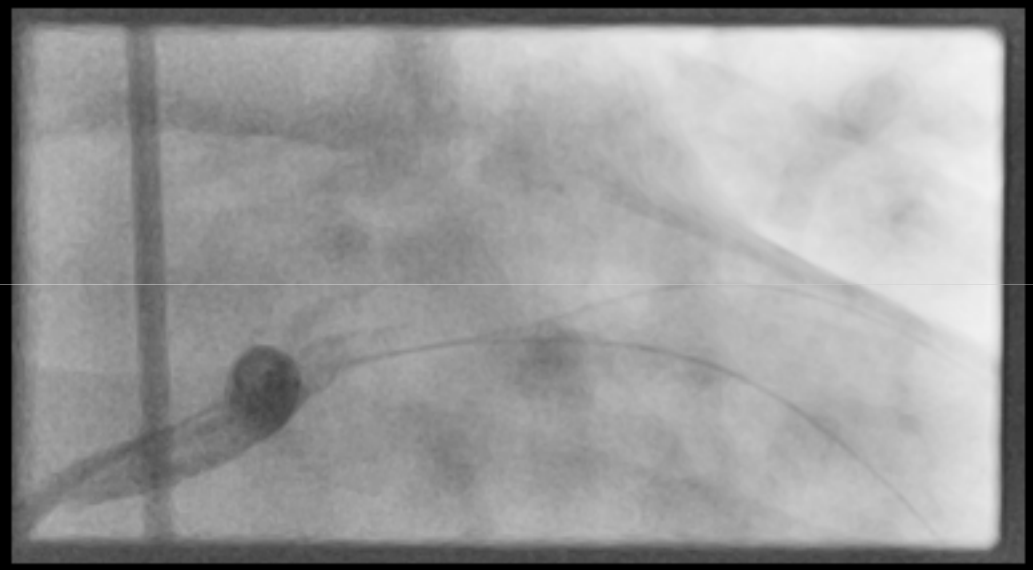
7. Bilder/Serie > Seriendauer
8. DFP^R/Bild > Einblendung/Bildrate
9. DFP^F/Sekunde > Einblendung/Pulsrate

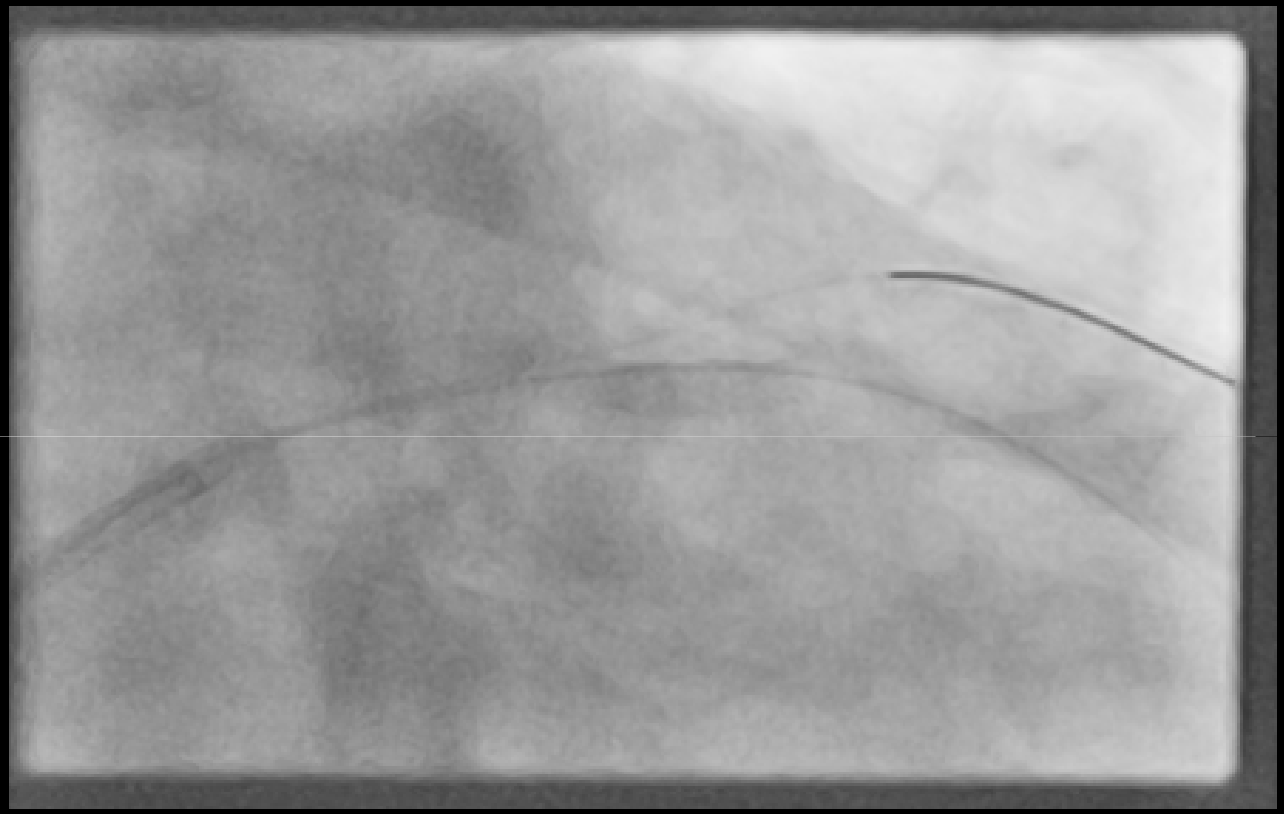


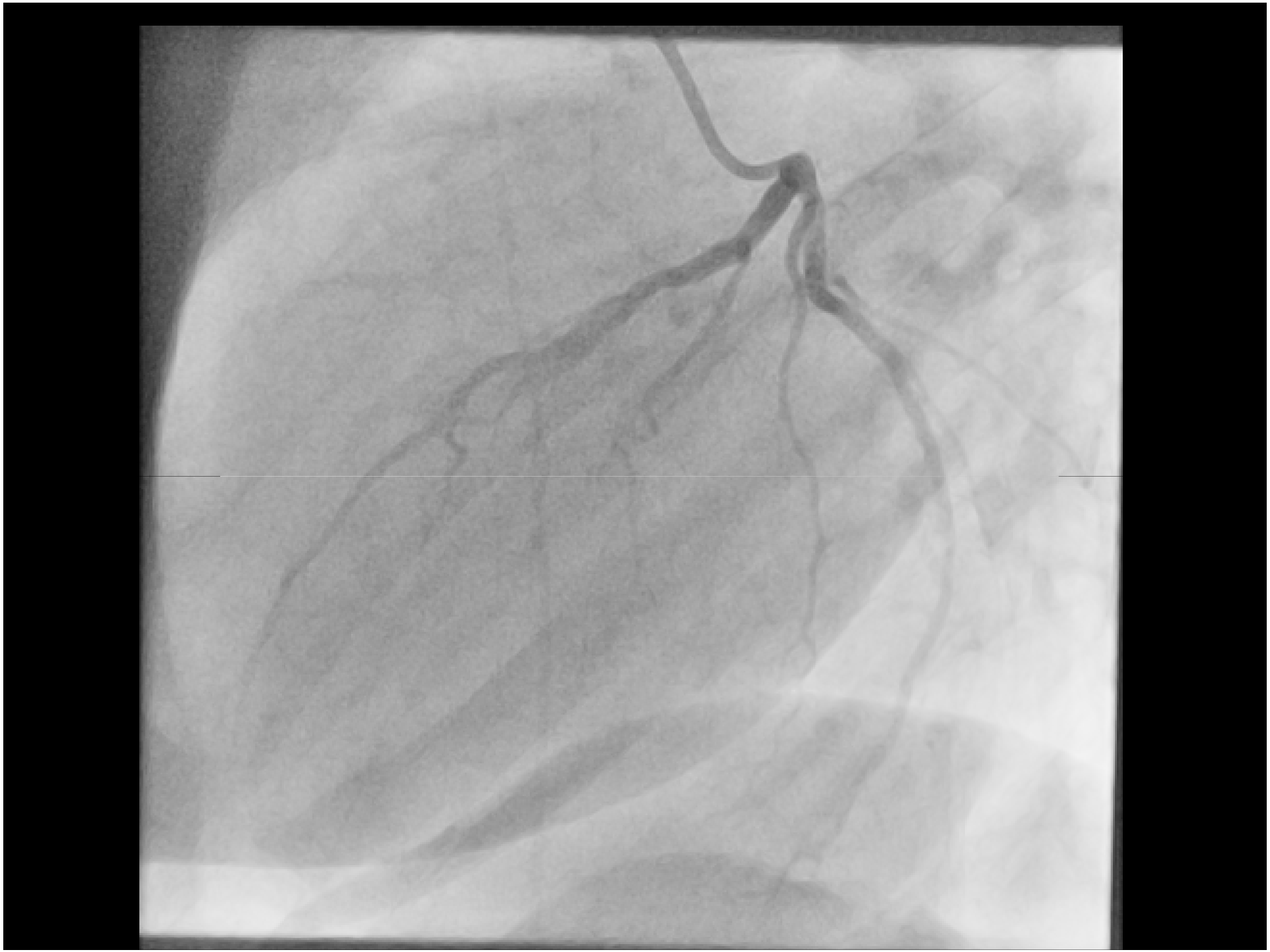
Kuon E, et al. Am J Cardiol. 2015;115:367-373

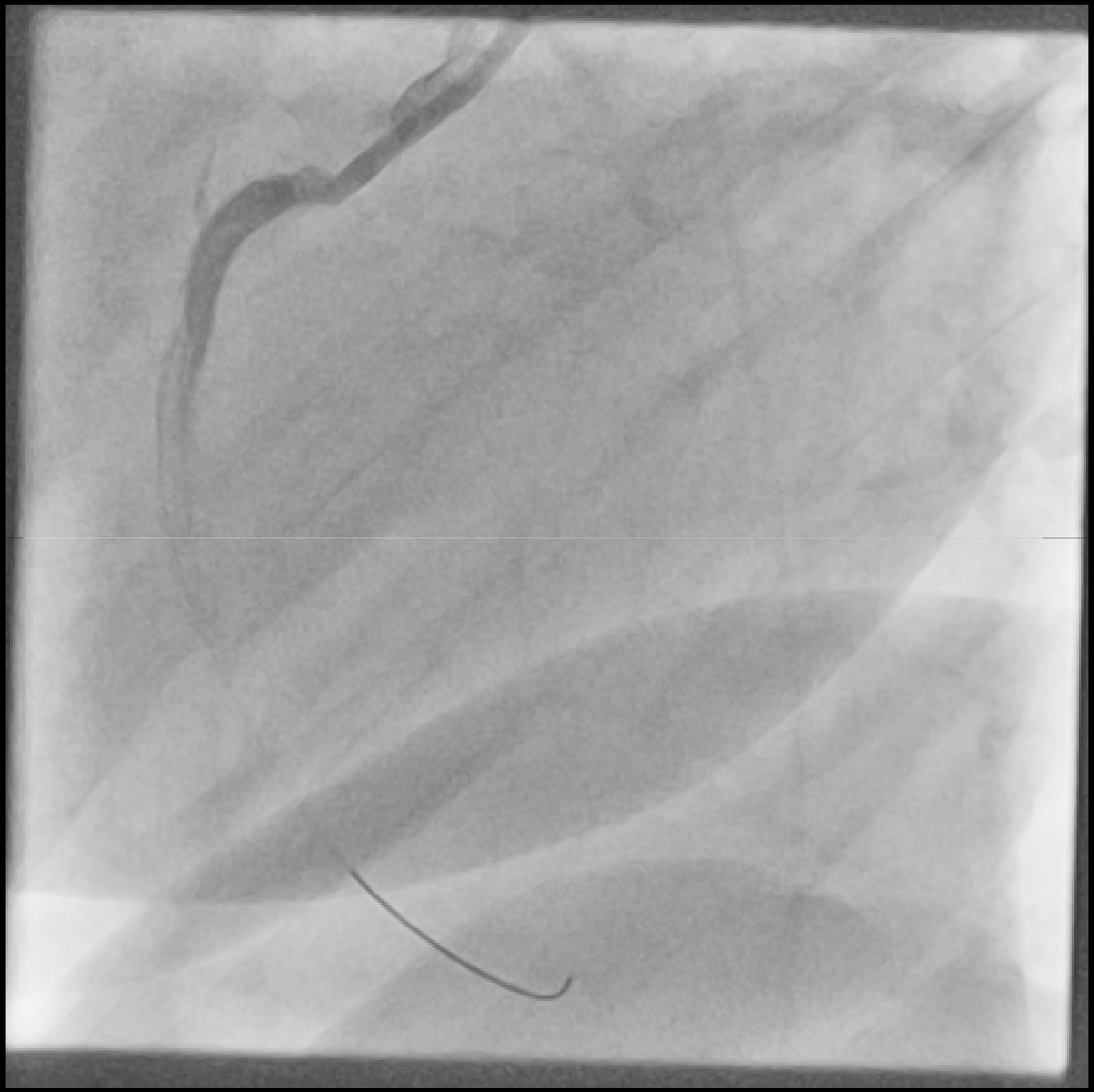


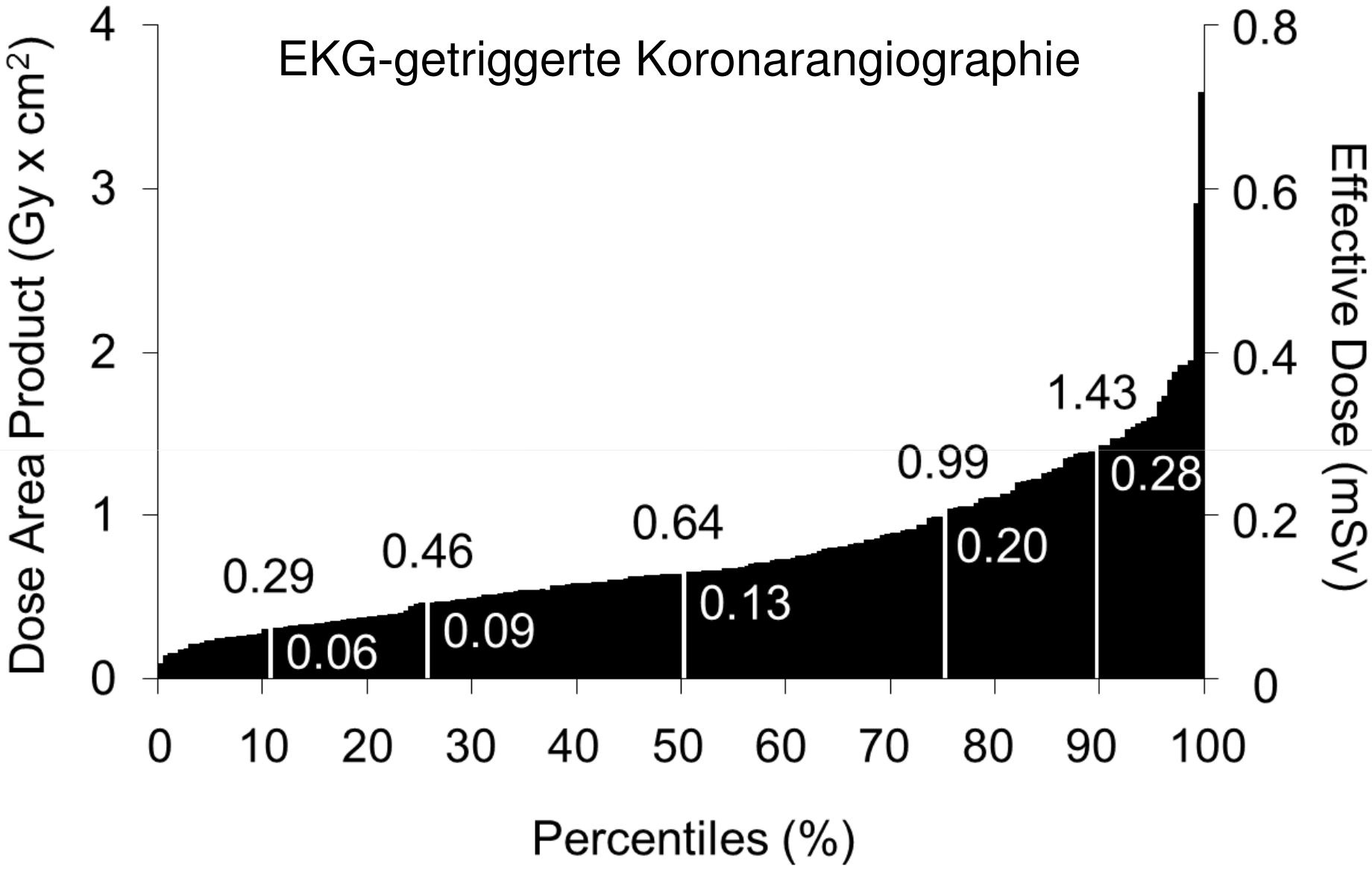












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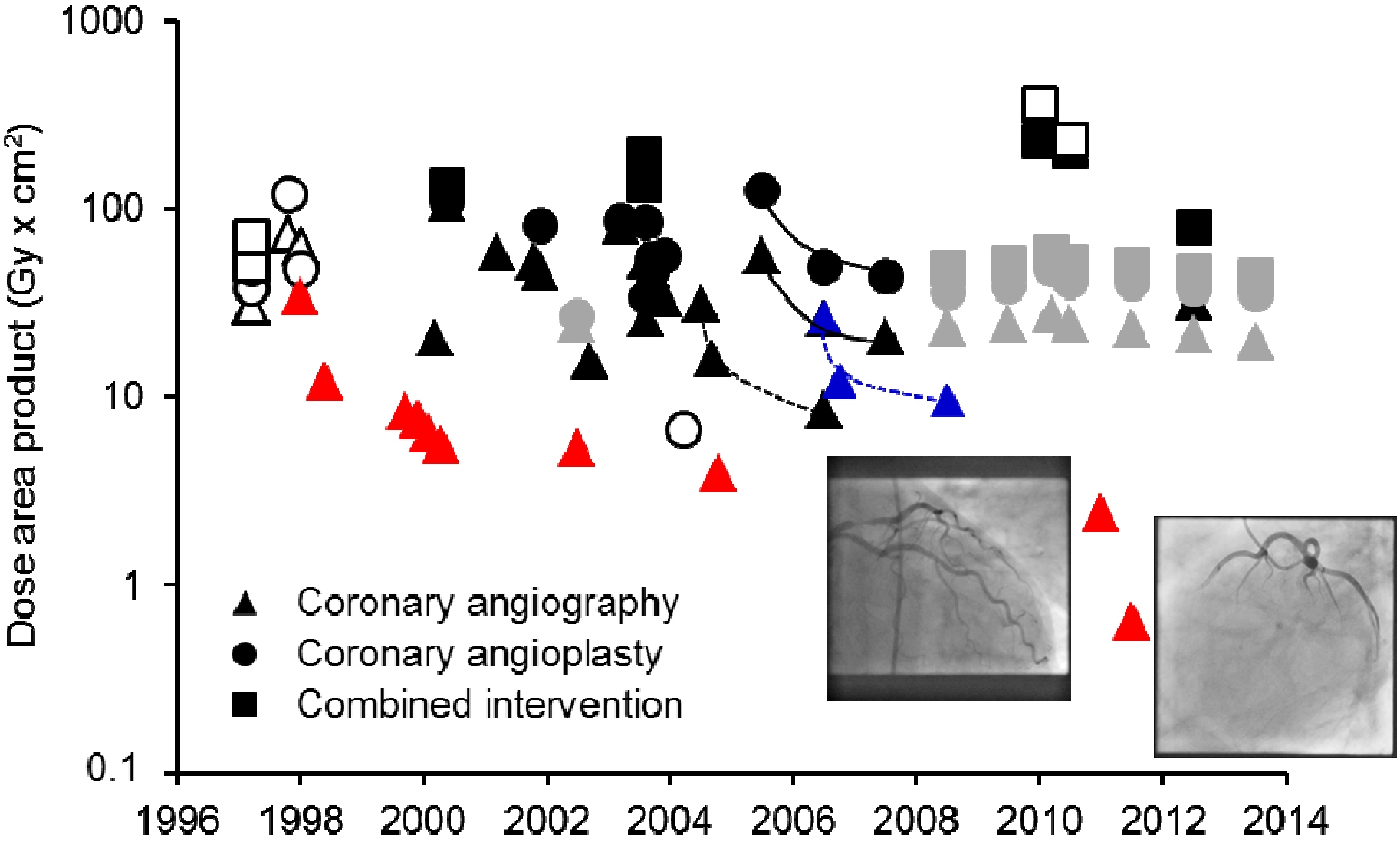
Leitlinie zum Einrichten und Betreiben von Herzkatheterlaboren und Hybridoperationssälen/ Hybridlaboren

3. Auflage 2015

Schlüssel zum Erfolg

- Keine Bewerbung moderner Anlagen durch „schöne Bilder“, sondern durch multiple Einstellmodi
- CE-Zertifizierung von Anlagen inkl. Strahlenschutzvorrichtungen
- Referenzwerte auf Basis der AQUA-Daten
- 9 automatisierte Dosisparameter
- Kardiologische Strahlenschutzkurse vor Ort
- … unter Teilnahme der Teamleader
  - Interventionelle Erfahrung ≠ Strahlenschutz
  - Abbau steiler Hierarchien

3 – 10 % des AQUA-Datenmedians



Bleibt Alles anders, nur auf höherem Niveau?

- Umfassende Datendokumentation ?
- Herausforderung der DGK-HK ?
- Optimierung von Leitlinien ?
- Radiologische Leitung von HKL ?
- Optimierte Verordnungen ?
- Projektfinanzierung ?

Oder …

- Praktische Schulung des Strahlenschutzes in Abwägung von
  - Indikationsstellung
  - Interventioneller Sicherheit
- „Encourage to Less Irradiating Cardiologic Interventional Techniques“
  - In House Workshops (für Teamleader)

Dosisreduktion im Herzkatheterlabor

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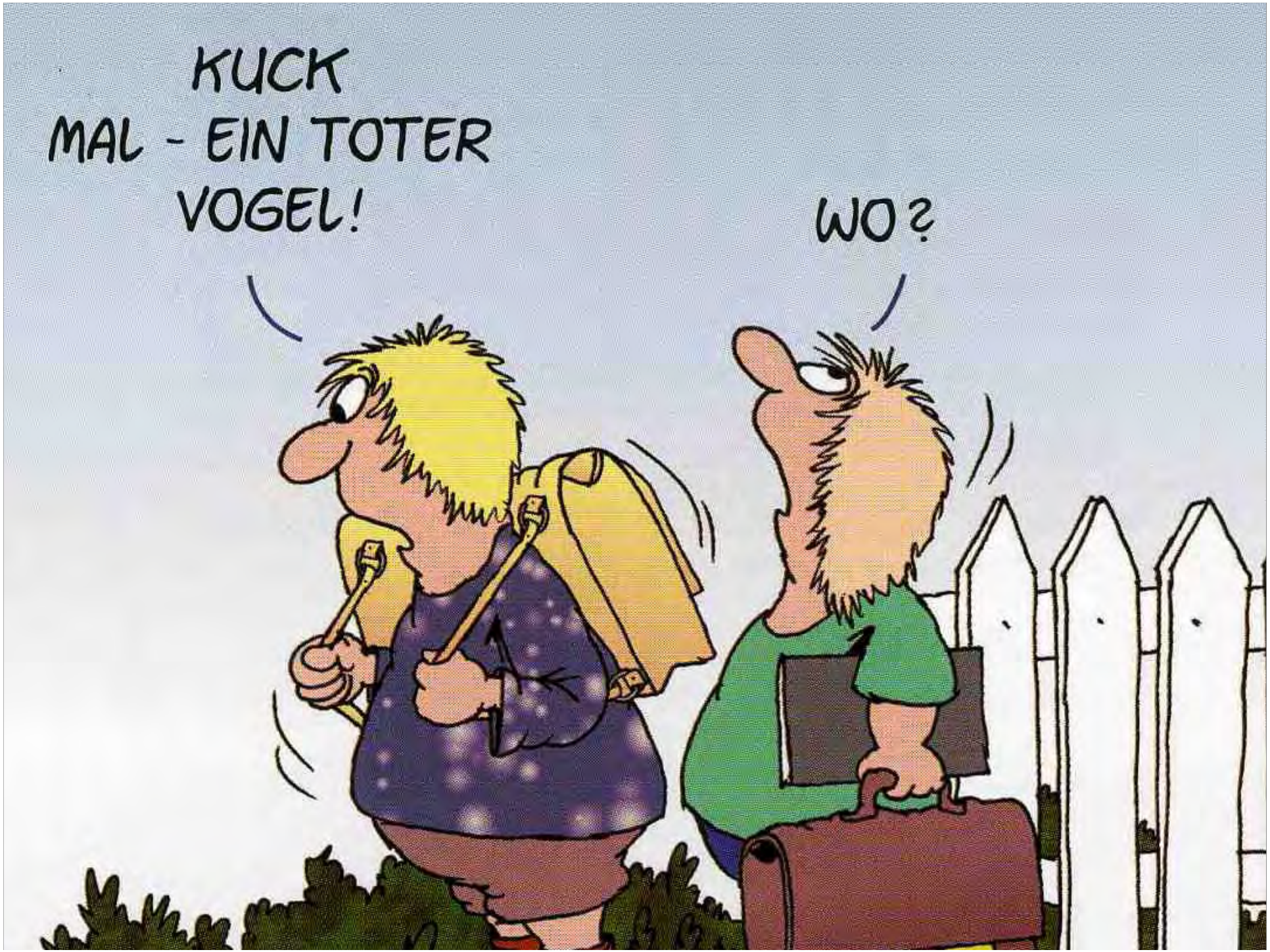
eberhard.kuon@klinik-fraenkische-schweiz.de

Literatur: google > Pubmed > kuon

7. Interventionelles Training

Universität Greifswald, 25./26. 9. 2015


KUCK MAL - EIN TOTER VOGEL!
WO?

Dosisreduktion im Herzkatheterlabor

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FA für Innere Medizin & Kardiologie
– Sportmedizin – Intensivmedizin
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Literatur: google > Pubmed > kuon e

APT-Seminar 12./13. 06. 2015 Nürnberg