



# MEASUREMENTS OF EYE LENS DOSES IN INTERVENTIONAL RADIOLOGY AND CARDIOLOGY: FINAL RESULTS OF THE ORAMED PROJECT

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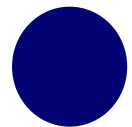
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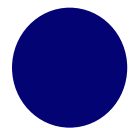
# Importance of eye lens doses?

- Cataract: “loss of transparency of the lens of the eye”
  - Associated with aging and with metabolic conditions like diabetes
  - Also radiation-induced
- Present status radiation protection ICRP
  - Cataract induction = deterministic effect with definite threshold
    - Acute exposure: 0.5-2 Gy
    - Prolonged exposure: 5-6 Gy
  - Latency period that can last for decades
  - dose limits:
    - 150 mSv/year for professional exposure
  - Operational quantity:  $H_p(3)$ 
    - Not measured in practise

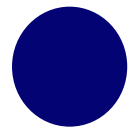


# Recent developments

- Epidemiological studies:
  - Bomb survivors, Chernobyl clean up workers, radiological technologists,...
  - High probability that threshold dose  $<0.8$  Gy
  - Not certain there is a threshold
  - Current limit is too high...
- Different activities are on-going:
  - ICRP, IAEA, many scientific studies,...
  - next talks will also focuss on this problem
- Now we will focuss on the ORAMED results on eye lenses



# ORAMED measurements of eye lens doses



## *ORAMED measurements in IR/IC*



Measurement campaign:

- 6 different countries,
- 3 hospitals per country
- 8 types of procedure
- 10 measurements/type of procedure/hospital

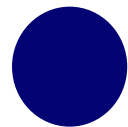
**3 Cardiology  
5 Radiology  
>1300  
measurements**

### **Interventional Cardiology:**

- CA and PTCA
- RF Ablations (RFA)
- Pacemakers and Cardiac Defibrillator Implantations (PM/CD)

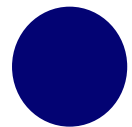
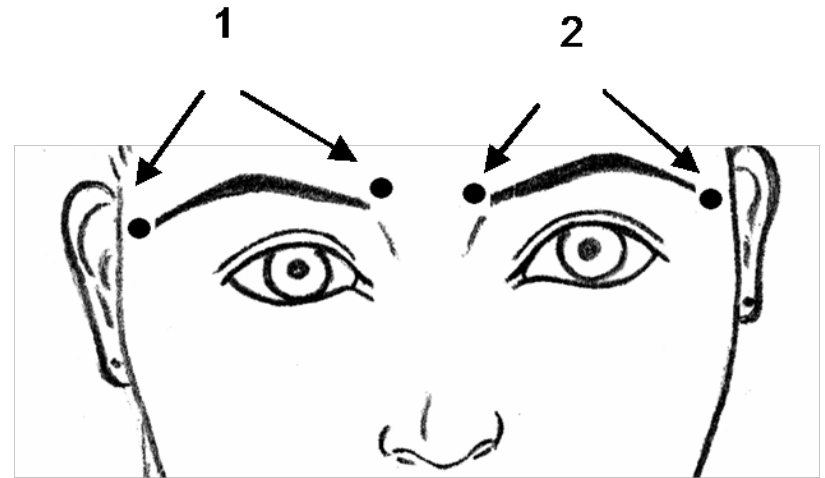
### **Interventional Radiology:**

- Angiography (DSA)/Angioplasty (PTA)
  - o Lower limbs (LL)
  - o Carotids and Brain ( C/B)
  - o Renal
- Embolisations
- Endoscopic retrograde cholangiopancreatography procedures (ERCP)



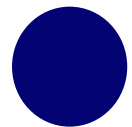
# ORAMED measurements?

- All IR and IC procedures from measurement campaign
- Two measurement for eye doses
  - Middle eye
  - Left/right eye
    - Depending on tube location
- TLD in bag
- Calibrated in  $H_p(0,07)$



# New RADCARD eye lens dosemeter: *EYE-D*<sup>TM</sup>

- Now measurements in terms of  $H_p(3)$
- Available at the end of the project
- Comparison between TLD in bag  $H_p(0.07)$  and  
TLD in eye lens dosemeter  $H_p(3)$ 
  - Tests in hospitals and labs



# Comparison $H_p(0,07)$ and $H_p(3)$ measurements in lab

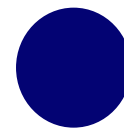
Ratio of calibration coefficients:  $[\text{cts}/\mu\text{Sv}]H_p(3)/[\text{cts}/\mu\text{Sv}]H_p(0.07)$

$H_p(3)/H_p(0.07)$	UPC	NIOM	SCK
N-60	1,01	1,02	1,01
N-80	1,02	0,96	1,03

$H_p(3)$ : eye lens dosimeter, cylindrical phantom, ENEA conversion coefficients

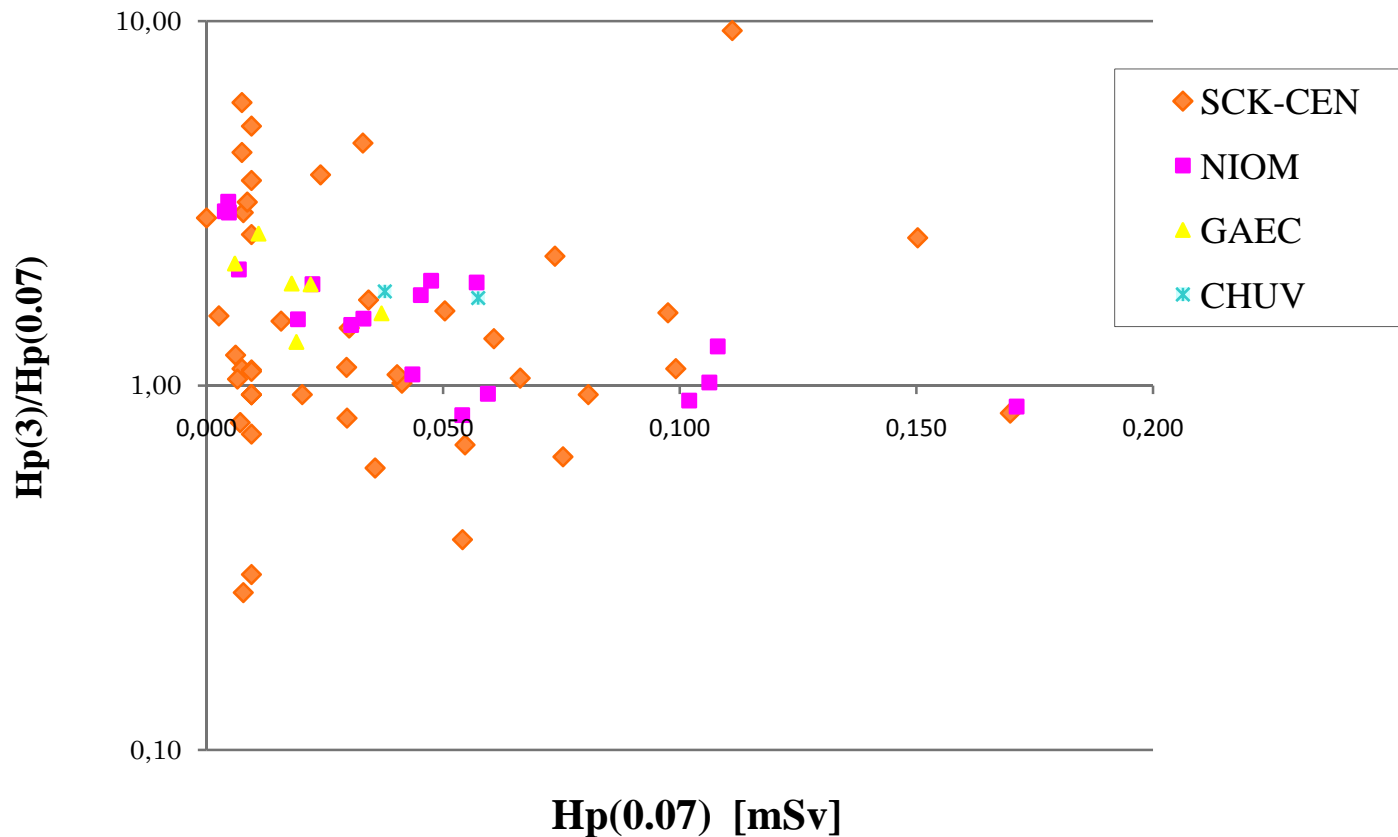
$H_p(0.07)$ : bag, slab phantom, ISO conversion coefficients

**! Not much difference in calibration values**

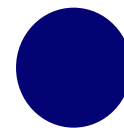




# Comparison $H_p(0,07)$ and $H_p(3)$ measurements in hospitals



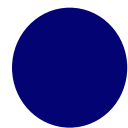
Per procedure, simultaneous measurement with eye lens dosemeter and bag



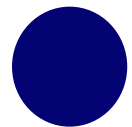
# Comparison $H_p(0,07)$ and $H_p(3)$ measurements in hospitals

$H_p(3)/H_p(0.07)$	GAEC	NIOM	SCK
Average all	1,91	1,67	2,14
Median all	1,90	1,52	1,07
Average >0.1mSv	-	1,15	1,18
Median >0.1mSv	-	1,15	1,11

**! Good agreement, no need to change ORAMED measurement data**



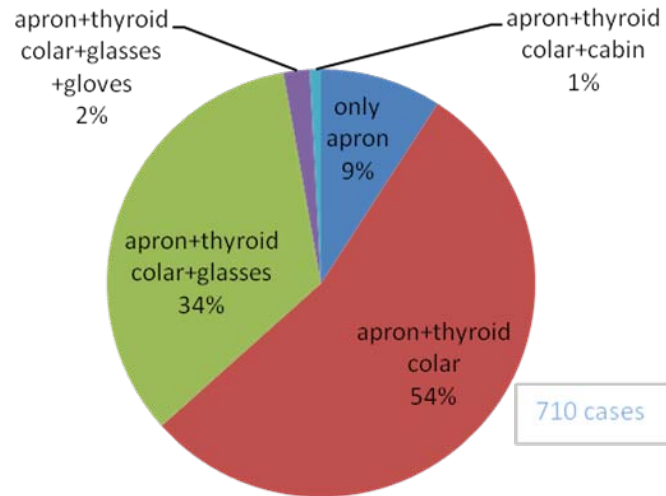
# Results of eye lens dose measurements



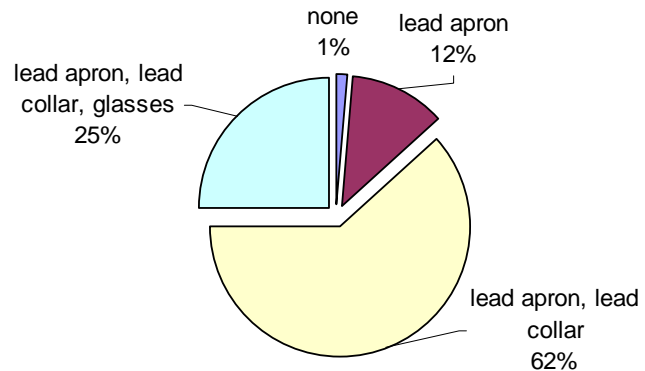
# STATISTICS WITH THE USE OF THE PERSONAL PROTECTIVE EQUIPMENT



## Interventional cardiology



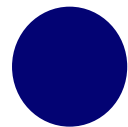
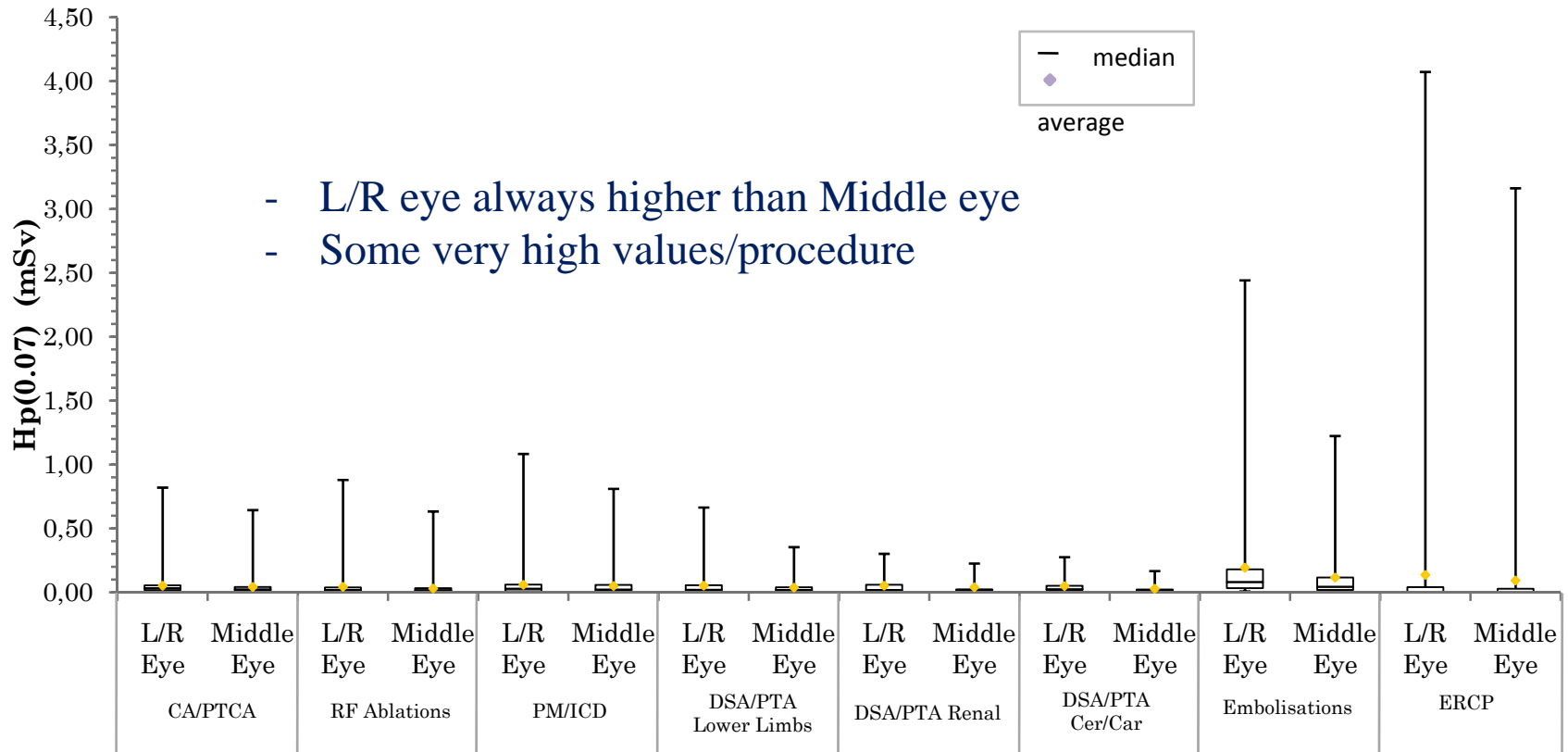
## Interventional radiology



# ORAMED results: comparison of different procedures

Eyes

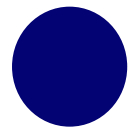
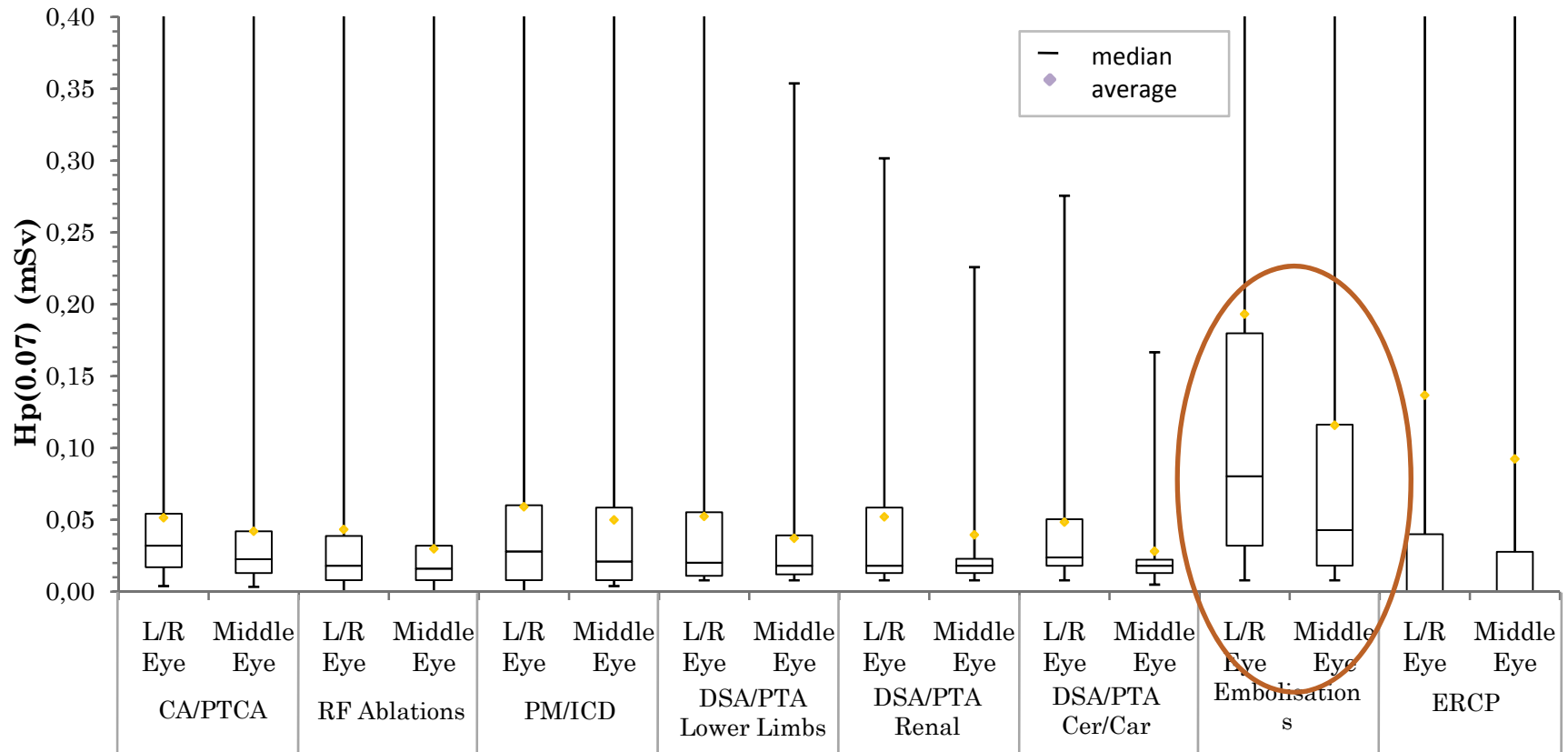
## Hp(0.07)



# Highest eye lens doses in embolizations (median around $60\mu\text{Sv}$ /per procedure)

Eyes

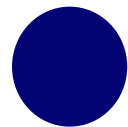
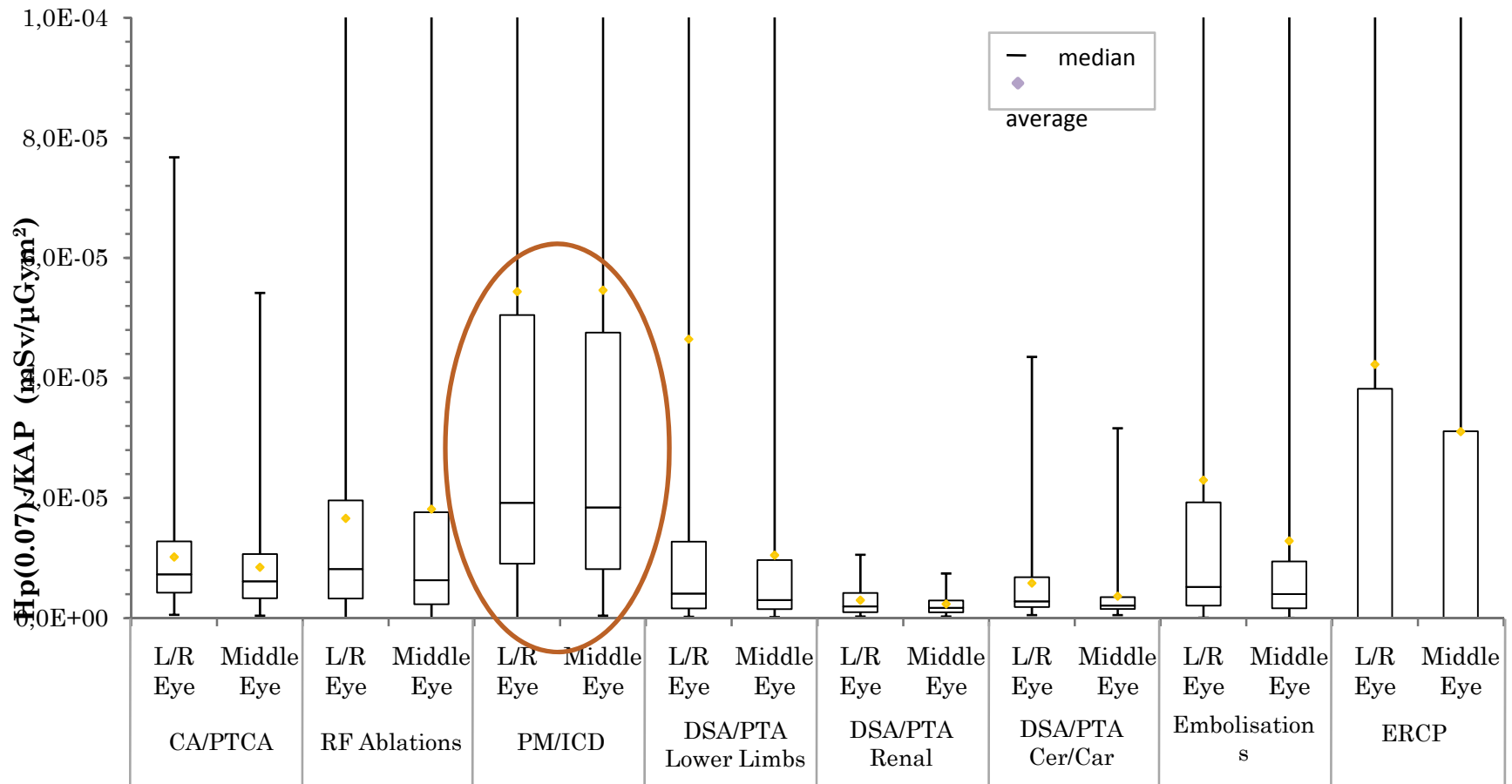
Hp(0.07)



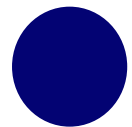
# Highest eye lens doses in PM (per KAP)

Eyes

## Hp(0.07)/KAP

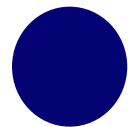
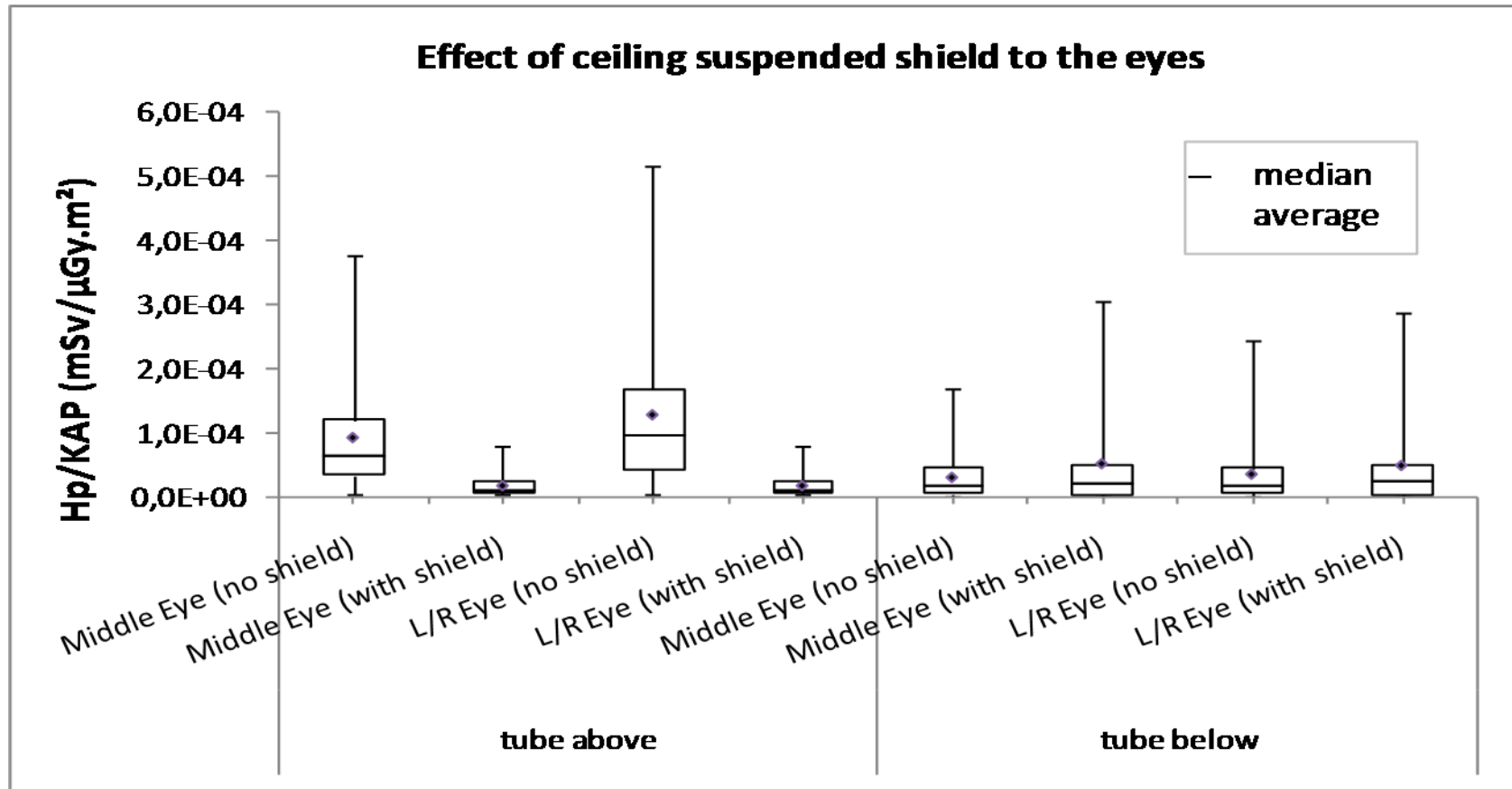


# Influence factors on eye lens doses

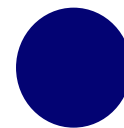
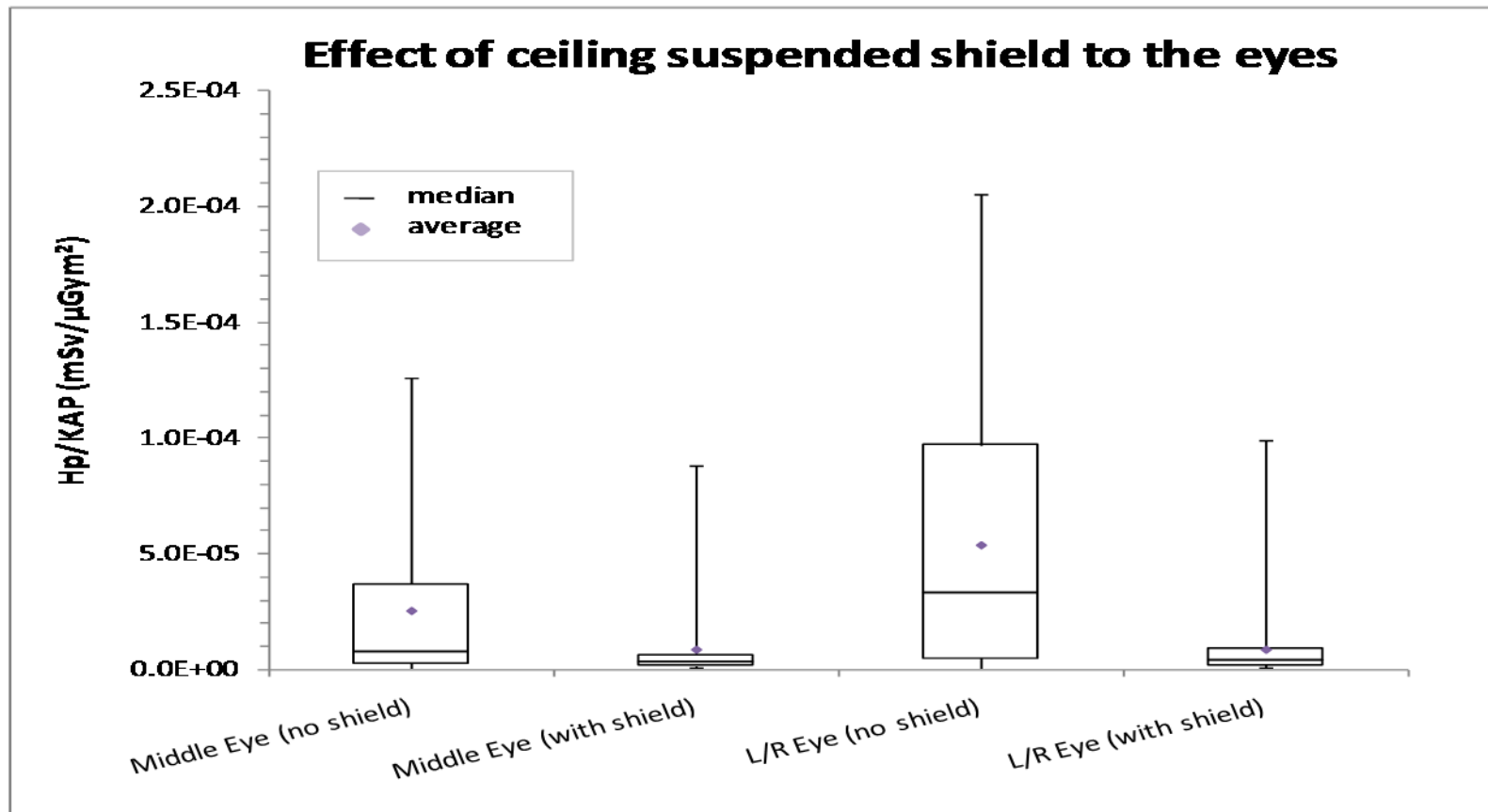




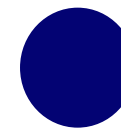
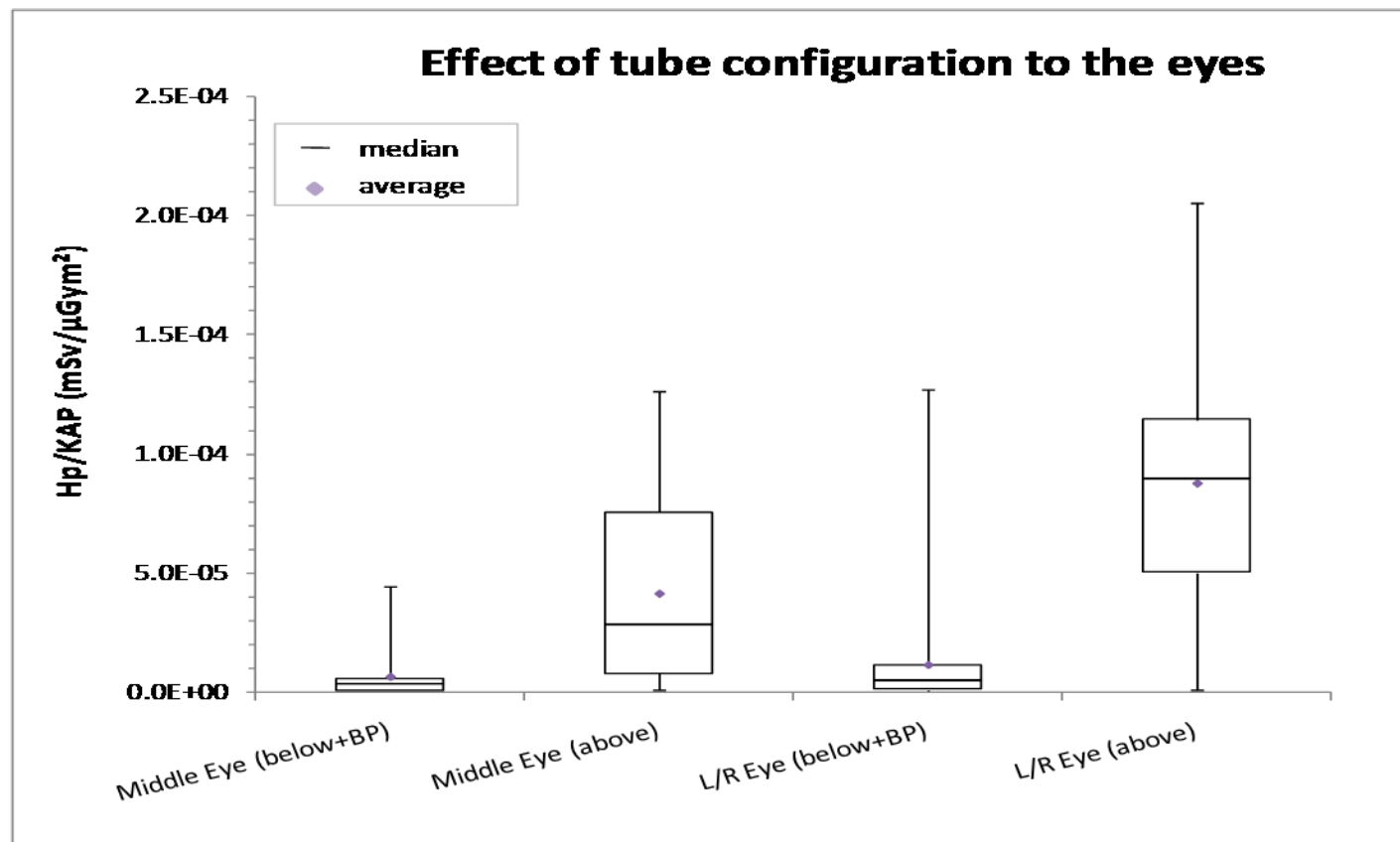
# ERCP: ceiling shield important for tube above: Factor 5 to 8 dose reduction



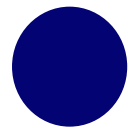
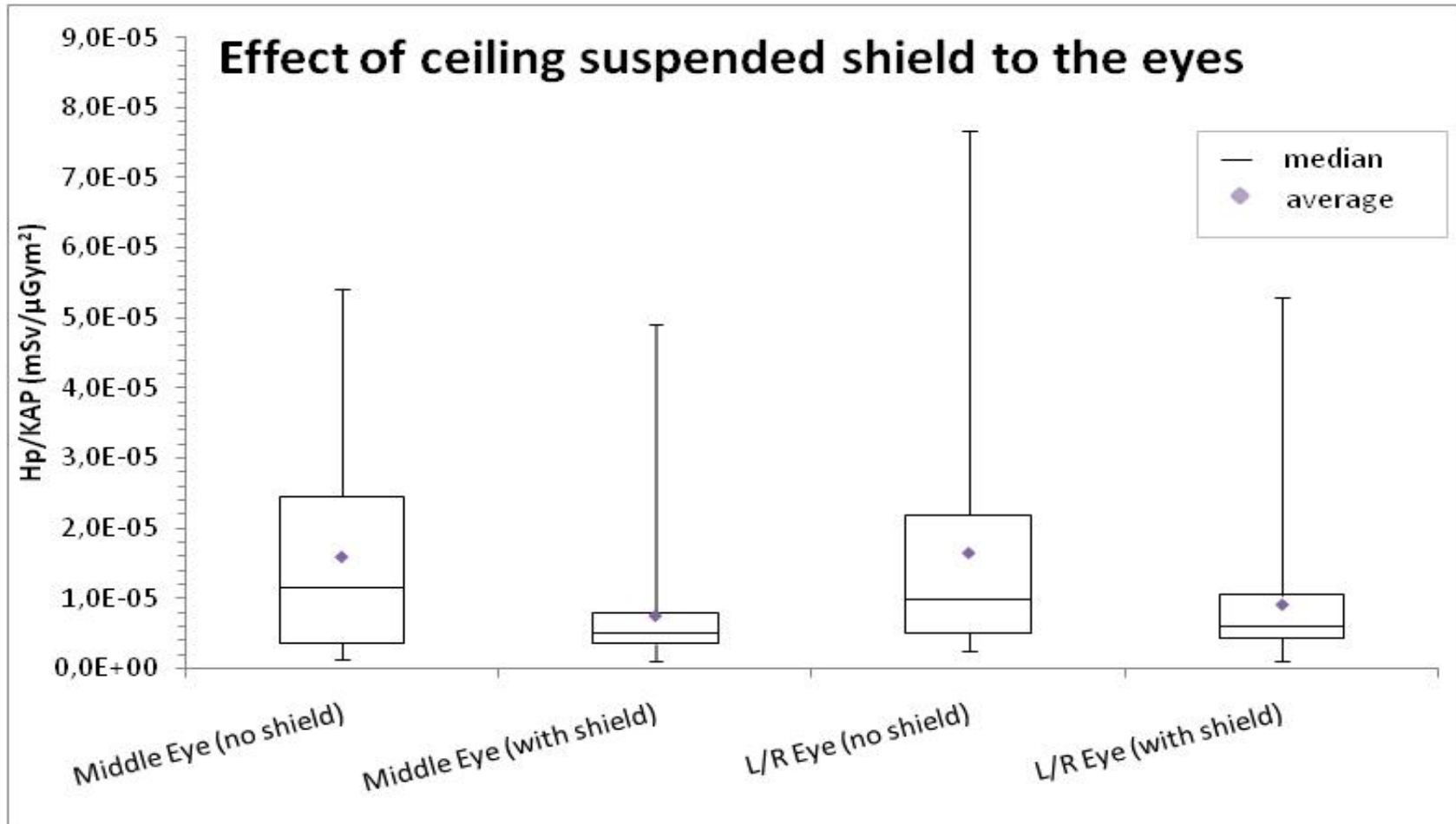
# Embolizations: ceiling shield important : Factor 3 to 7 dose reduction



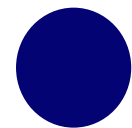
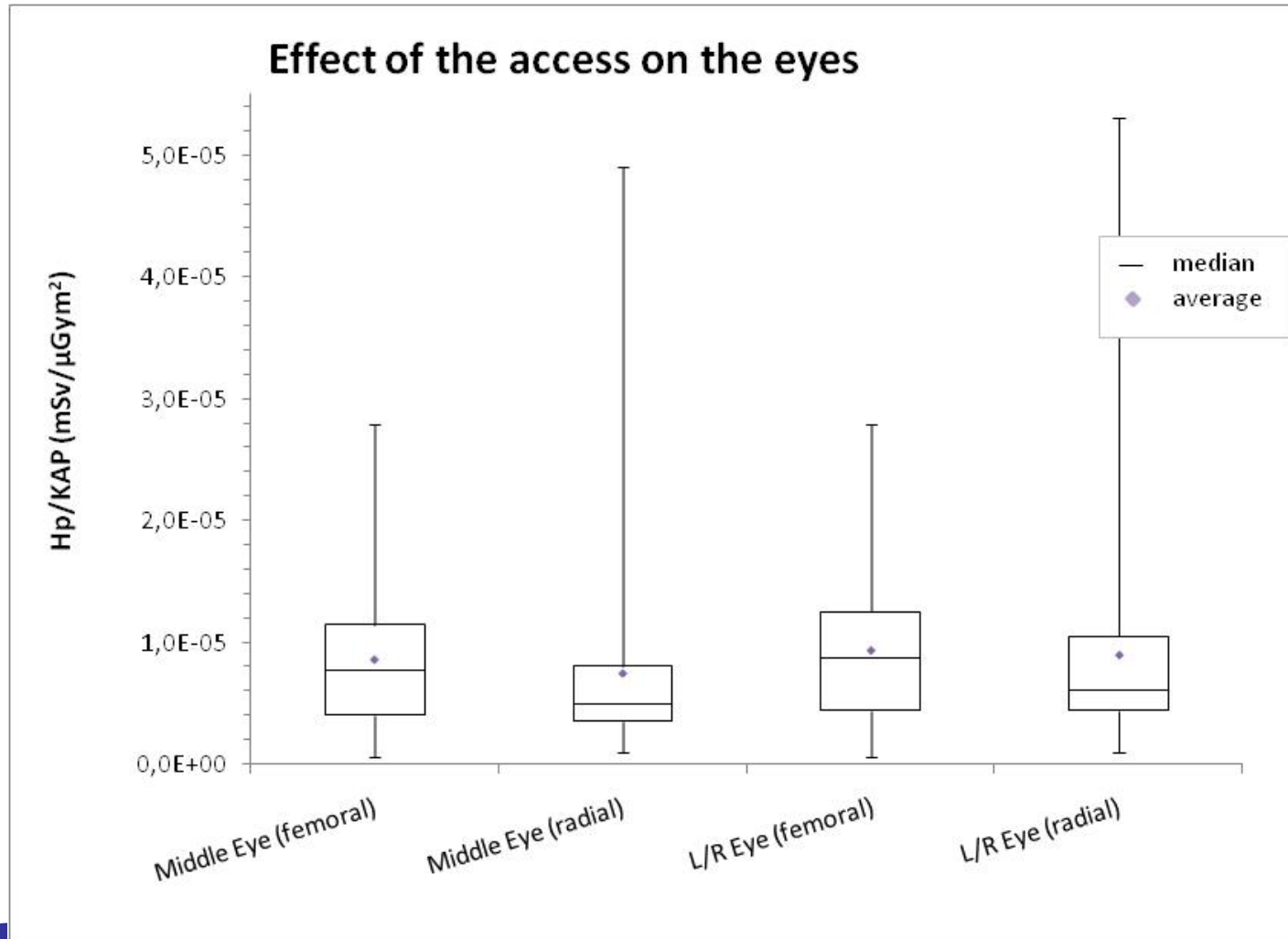
# Embolizations: tube below gives lower eye lens doses: Factor of 8-20 dose reduction



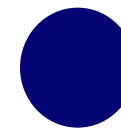
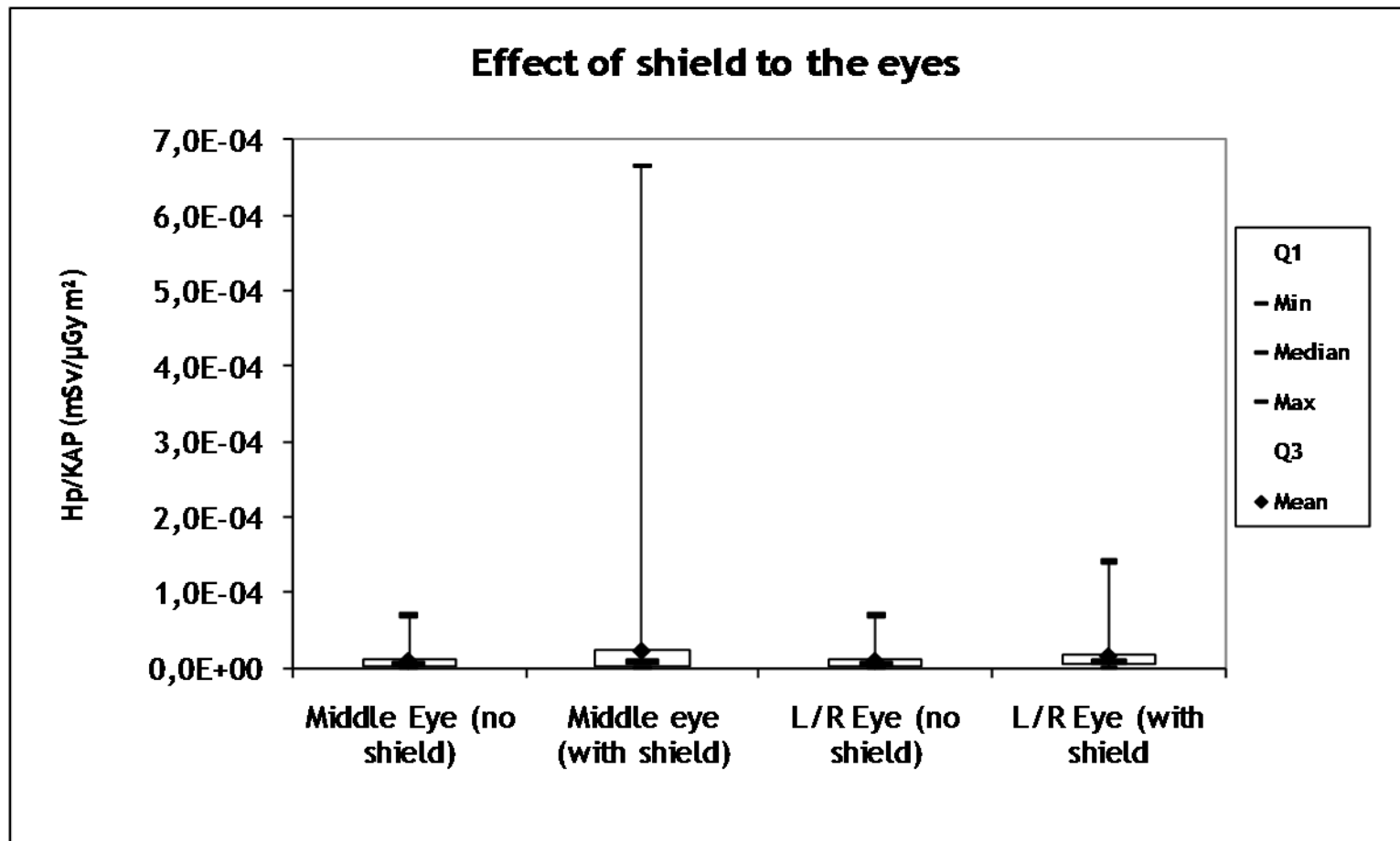
# CA/PTCA: ceiling shield important : Factor 1.5 to 2.5 dose reduction



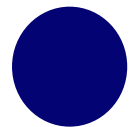
# CA/PTCA: no clear influence of access on eye lens doses



# RF ablations: ceiling shield reduces the eye lens doses with around 50%

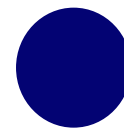


# Extrapolation to annual doses



# Extrapolation to annual eye lens doses

- For all participating operators we have tried to calculate the annual doses
- Use of annual workload (# procedures)
  - From logbook
  - From personal contact
- Multiplied with average doses measured
- Often underestimation, because they perform other procedures that are not measured
  
- Category A workers if 3/10th of limit can be reached
  - Monitoring required

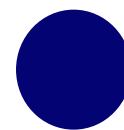




# Annual doses ERCP:

Low, monitoring normally not needed

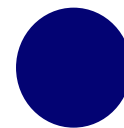
Operator	Procedure	# procedures	Annual dose [mSv]
1	ERCP	100	<b>50</b>
2	ERCP	107	<b>3,9</b>
3	ERCP	30	<b>0,3</b>
4	ERCP	70	<b>0,6</b>
5	ERCP	110	<b>2</b>
6	ERCP	100	<b>0,2</b>
7	ERCP	300	<b>0,4</b>
8	ERCP	1281	<b>17</b>
9	ERCP	689	<b>6</b>
10	ERCP	70	<b>0,7</b>
11	ERCP	107	<b>5</b>
12	ERCP	250	<b>2</b>
13	ERCP	125	<b>1,2</b>
14	ERCP	150	<b>1,4</b>
15	ERCP	230	<b>2</b>
16	ERCP	36	<b>3,4</b>
17	ERCP	150	<b>9</b>



# Annual doses CA/PTCA:

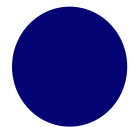
Can be high, monitoring recommended

Operator	Procedure	# procedures	Annual dose [mSv]
1	CA/PTCA	260	10
2	CA/PTCA	230	28
3	CA/PTCA	750	47
4	CA/PTCA	1200	69
5	CA/PTCA	1000	46
6	CA/PTCA	710	10
7	CA/PTCA	900	26
8	CA/PTCA	600	11
9	CA/PTCA	630	11
10	CA/PTCA	630	12
11	CA/PTCA	500	5
12	CA/PTCA	1000	27
13	CA/PTCA	500	30
14	CA/PTCA	600	9
15	CA/PTCA	1100	9



# Annual doses PM&ICD: Low, monitoring not required

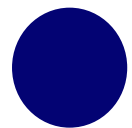
<b>Operator</b>	<b>Procedure</b>	<b># procedures</b>	<b>Annual dose [mSv]</b>
1	PM&ICD	44	1.1
2	PM&ICD	400	31
3	PM&ICD	100	6.1
4	PM&ICD	100	1.6
5	PM&ICD	110	0.1
6	PM&ICD	100	0.2
7	PM&ICD	144	1.2



# Annual doses RF ablations:

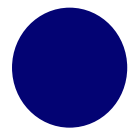
## Low, monitoring not required

<b>Operator</b>	<b>Procedure</b>	<b># procedures</b>	<b>Annual dose [mSv]</b>
1	RF Abl	180	1.7
2	RF Abl	60	1.1
3	RF Abl	100	1.8
4	RF Abl	70	0.6
5	RF Abl	100	6.3
6	RF Abl	65	0.2
7	RF Abl	160	2.0
8	RF Abl	210	8
9	RF Abl	60	4



However, annual doses both PM&ICD and RF ablations:  
monitoring required

Operator	Procedure	# procedures	Annual dose [mSv]
1	PM&ICD+RF abl	150+60	<b>88+63</b>
2	PM&ICD+RF abl	190+190	<b>24+13</b>
3	PM&ICD+RF abl	90+190	<b>25+7</b>
4	PM&ICD+RF abl	110+50	<b>0.8+1.5</b>
5	PM&ICD+RF abl	40+20	<b>4+0.1</b>
6	PM&ICD+RF abl	40+20	<b>7+0</b>
7	PM&ICD+RF abl	80+350	<b>1+5</b>



Annual doses:

Embolizations and angiographic procedures:

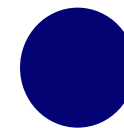
often combinations different type of procedures:

difficult to estimate:

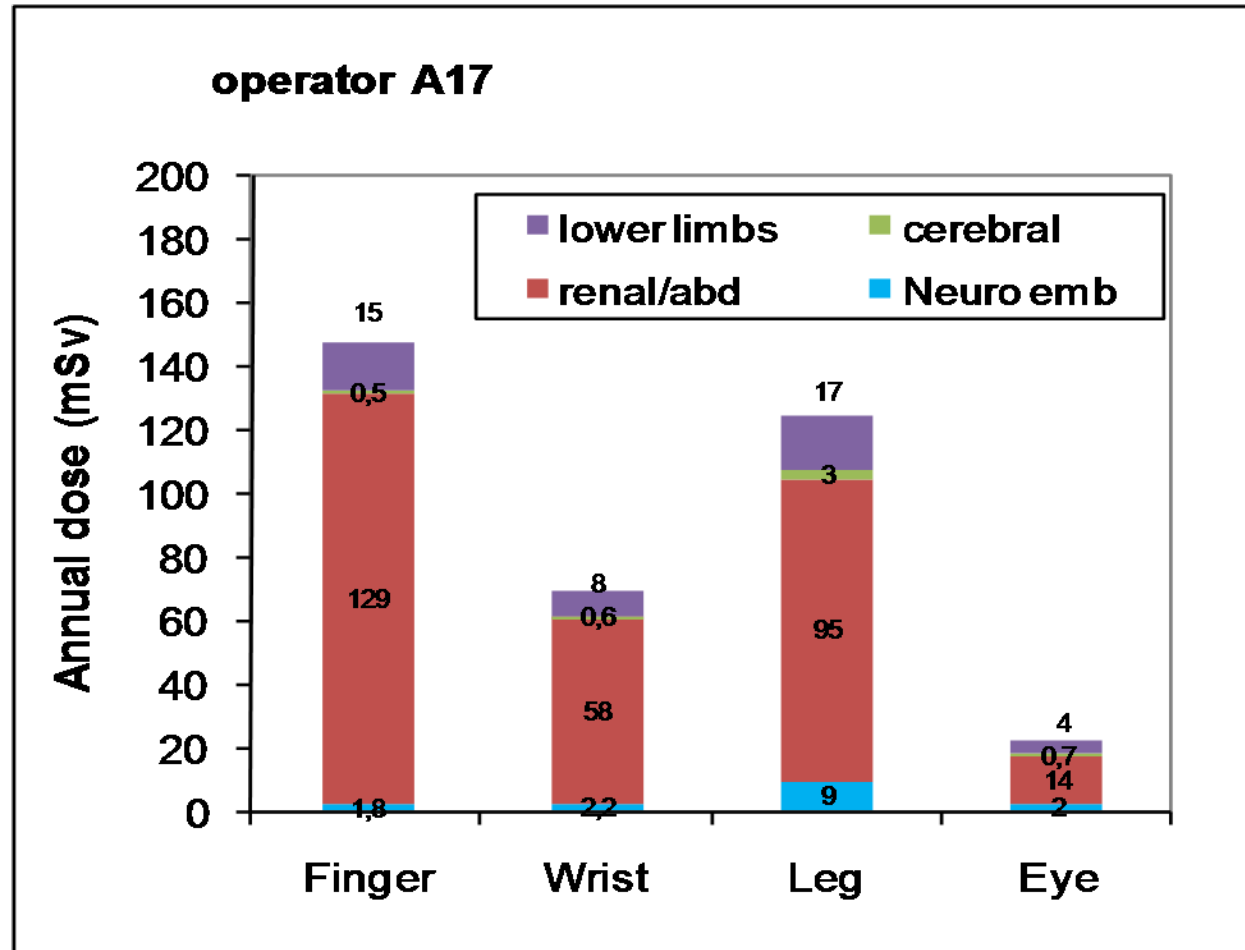
High, monitoring is required

Operator	Annual dose [mSv]
1	27
2	23
3	6
4	4
5	15
6	4
7	11
8	31

Operator	Annual dose [mSv]
9	14
10	10
11	7
12	14
13	20
14	49
15	85
16	9

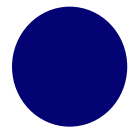


# Annual doses: Embolizations and angiographic procedures: one example

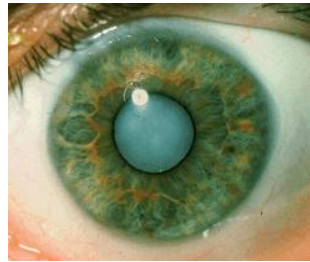
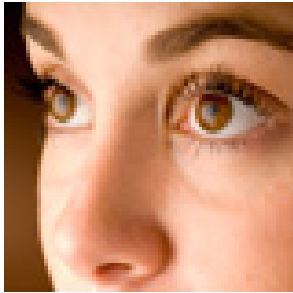


# Conclusion

- Measurements of  $H_p(0.07)$  in bag gives comparable results with  $H_p(3)$  and eye lens dosimeter
- Highest doses per procedure found for embolizations
  - Around  $60 \mu\text{Sv/procedure}$
- Ceiling shield reduces the eye lens doses with
  - A factor 3 to 8 for ERCP, embolizations
  - A factor 1.5 to 2.5 for CA/PTCA, ablations
- Tube below table gives lower eye lens doses
- Lead glasses reduce with factor 3 to 6 (simulations)
- Doses dependent on work load and protection measures
  
- Recommended to use ceiling suspended shield and lead glasses
  
- Monitoring recommended for
  - All procedures
  - Except ERCP
  
- Certainly if dose limit is reduced !!!







*Thank you for you  
attention!*



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