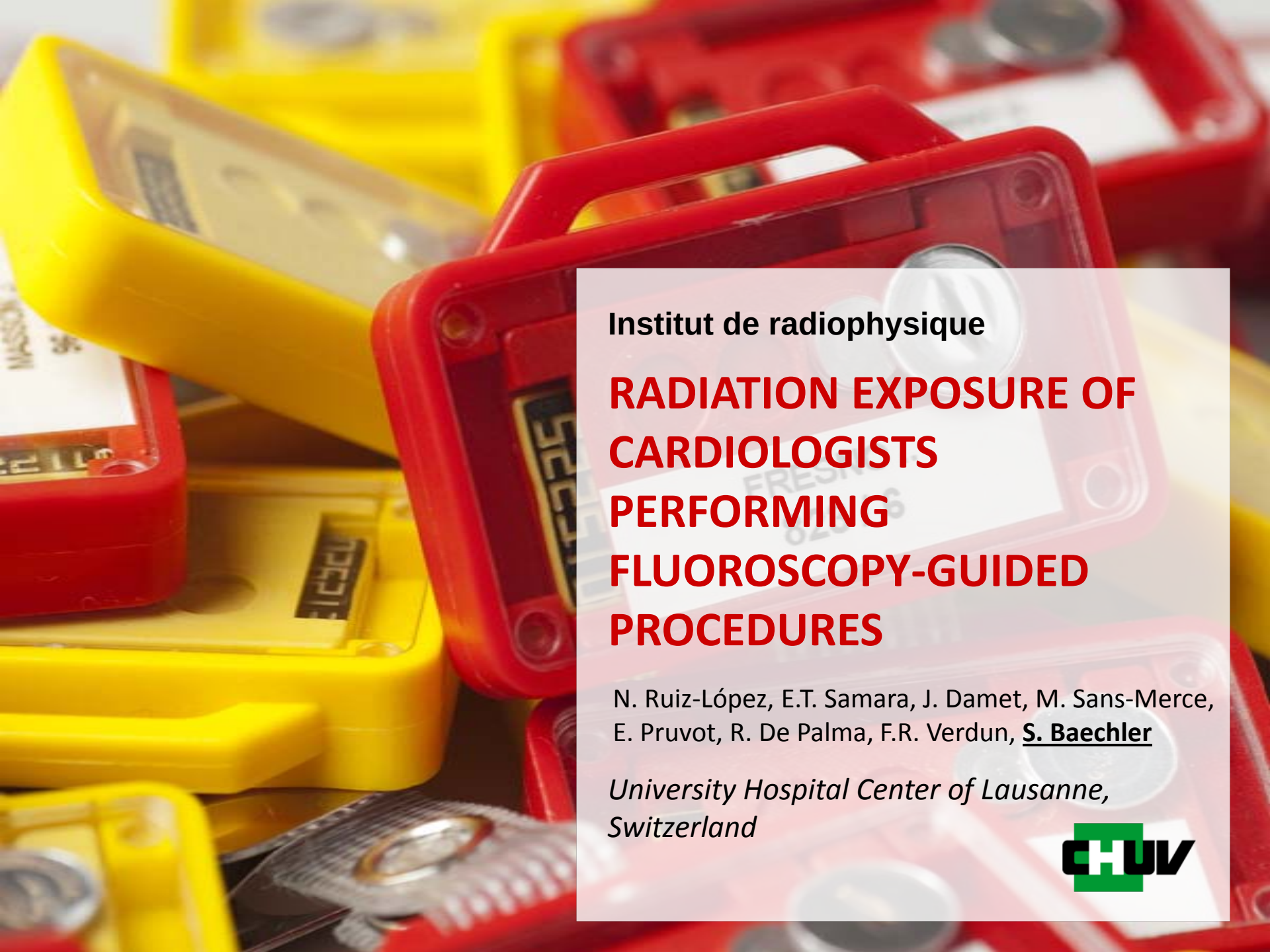

Institut de radiophysique

RADIATION EXPOSURE OF CARDIOLOGISTS PERFORMING FLUOROSCOPY-GUIDED PROCEDURES

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Fluoroscopy-guided procedures in cardiology

- Growing use and increasing complexity
  - higher exposure to both patients and medical staff
- Strategy to manage medical staff exposure
  - Education and training
  - Protective equipments
    - Lead aprons,
    - Thyroid shields
    - Lead glasses,
    - Other shields
  - **Monitoring of radiation exposure**

Individual monitoring in radiology

- Main goals
  - Compliance with dose limits (E, H_{skin}, H_{lens})
  - Detection of unexpected exposure
  - Optimisation (mainly for fluoroscopy)
- Standard method
  - 1 dosemeter, under the apron
  - But: parts of the body are not protected (head, arms)
- For dose-intensive fluoroscopy procedures
  - 2 dosemeters, 1 under and 1 over the apron
  - Extremity ring dosemeters

  (ICRP 85, EU Report n 160 & Swiss regulation)

Objectives of the study

- To assess radiation exposure to cardiologists based on two complementary approaches:

  1. Staff survey based on routine individual monitoring using double dosimetry and extremity dosimetry

  2. Staff dose measurements for specific cardiology procedures

1. Staff survey : method

- Follow up of 30 cardiologists (CHUV) over 5 years (2005-2009)
- Monthly doses were measured using :
  - Whole body dosemeters (TLD-100) under and above the apron

  - Extremity dosemeters (TLD-100)

Swiss algorithm for 2 dosimeters

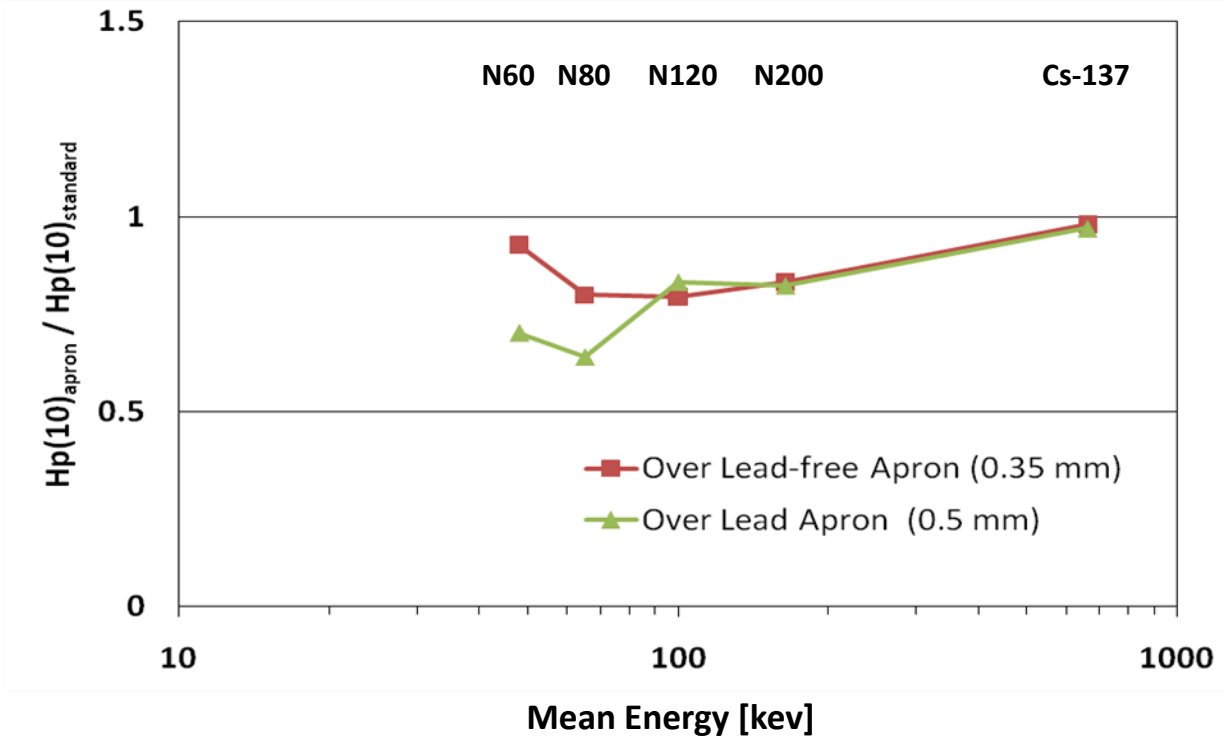
$$H_{total}(10) = H_{under}(10) + a \cdot H_{over}(10)$$

$$H_{total}(0.07) = H_{under}(0.07) + H_{over}(0.07)$$

- If a thyroid shield is worn
  - $a = w_{remainder} = 0.05$
- If a thyroid shield is not worn
  - $a = w_{remainder} + w_{thyroid} = 0.05 + 0.05 = 0.1$
- $H_{total}(10) \rightarrow E$; $H_{total}(0.07) \rightarrow H_{skin}$
- $H_{over}(0.07) \rightarrow \sim H_{lens}$

Calibration of whole body dosemeters

- Standard reference geometry [ISO 4037]
- Influence of the apron on the reading
  - Dosimeters over the apron fixed on the water phantom



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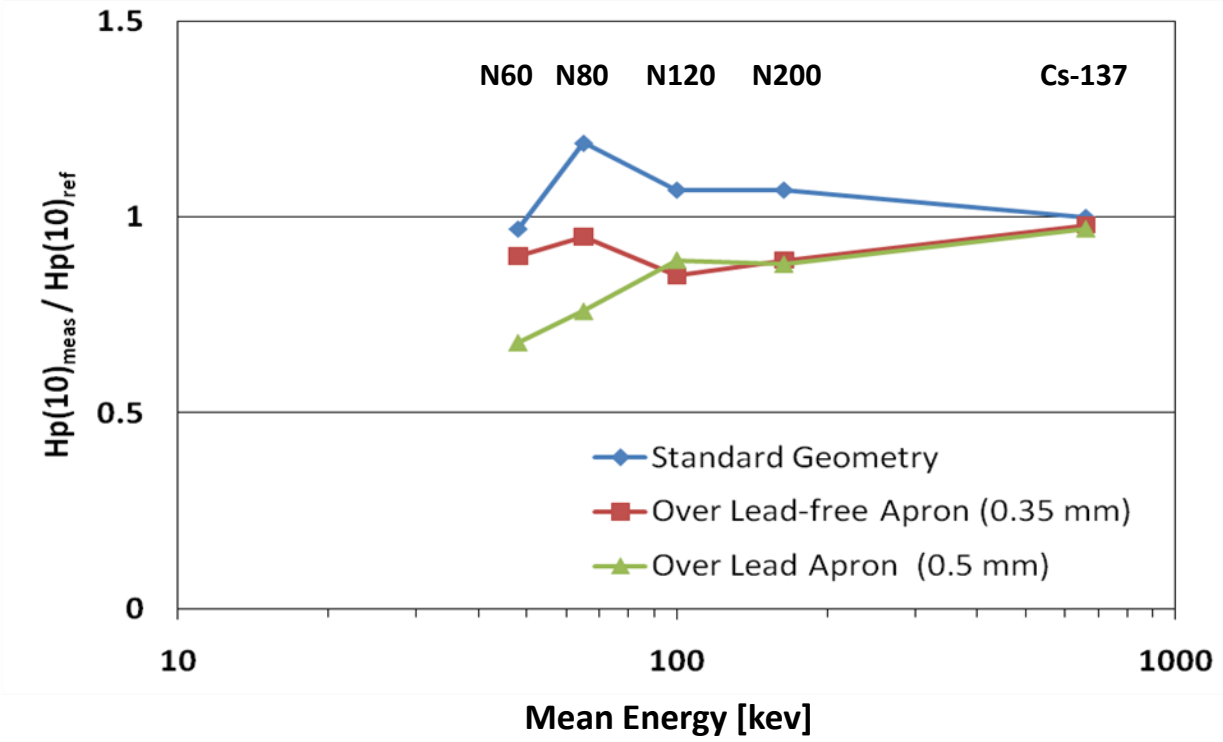


2. Staff dose specific measurements : method

- 5 procedures from IC and electrophysiology
  - Percutaneous coronary intervention (PCI)
  - Patent foramen ovale (PFO) closure
  - Atrial septal defect (ASD) closure and paravalvular leak closure
  - Pacemaker (PM) implantation
  - Radiofrequency (RF) ablation
- Monitoring of operators, 1 dosimeter over the apron
- Dosemeters used:

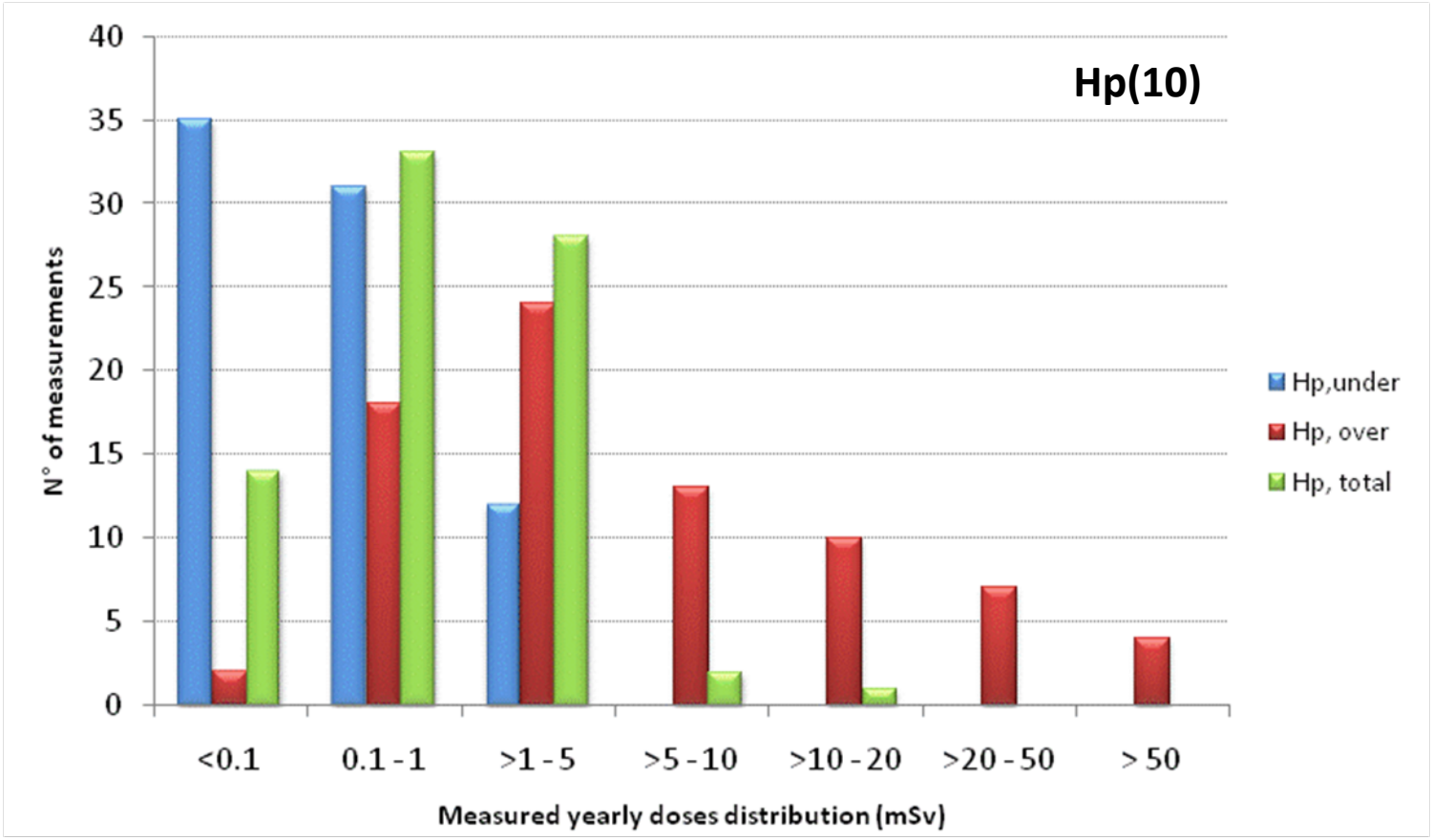
TLD (IRA-Rados)

OSL (InLight - Landauer)

Results of the staff survey

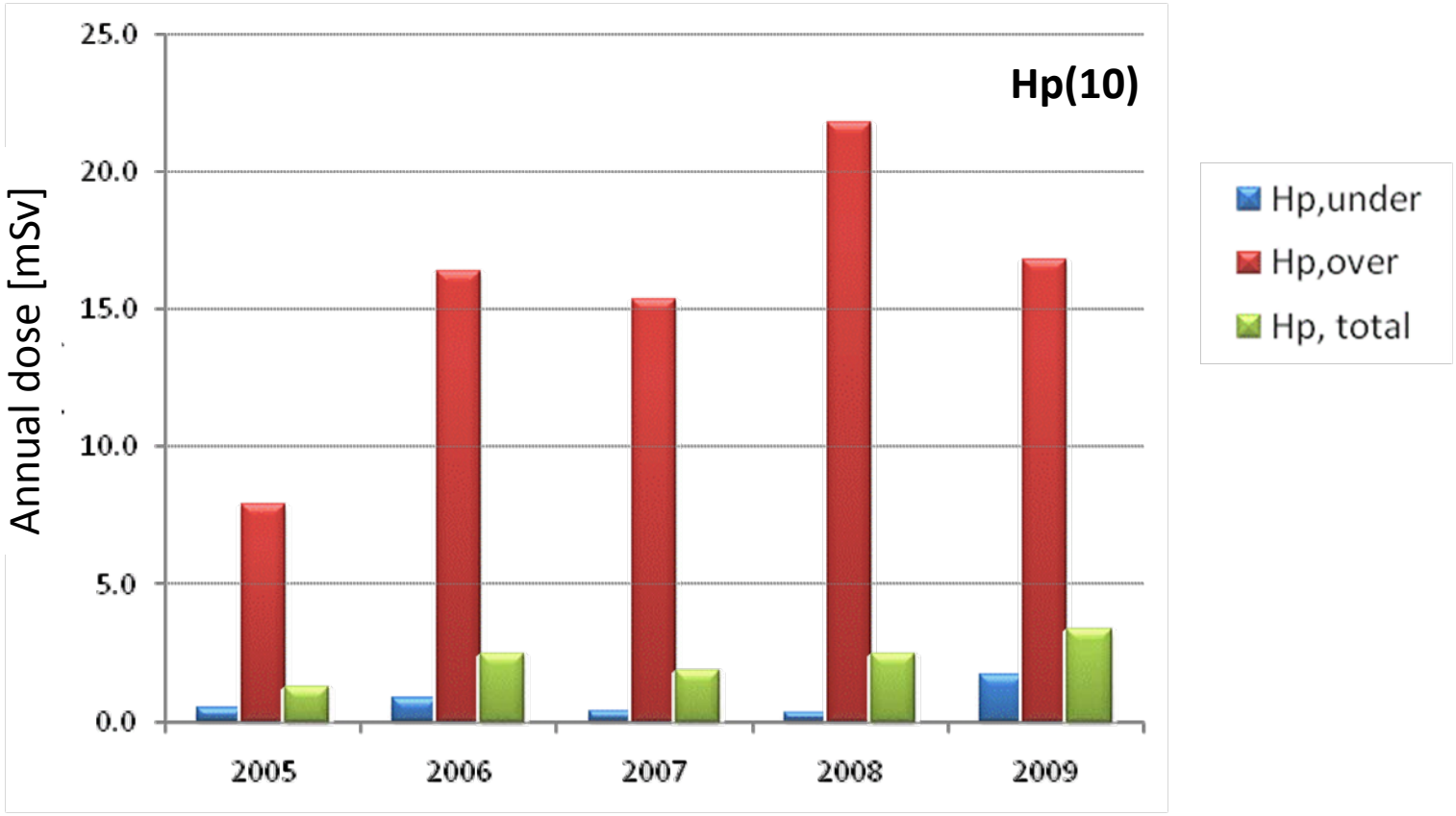
~60% of monthly doses : Hp(10) = 0 under and over the apron

Annual dose distribution, 2005-2009, (78 person-years)

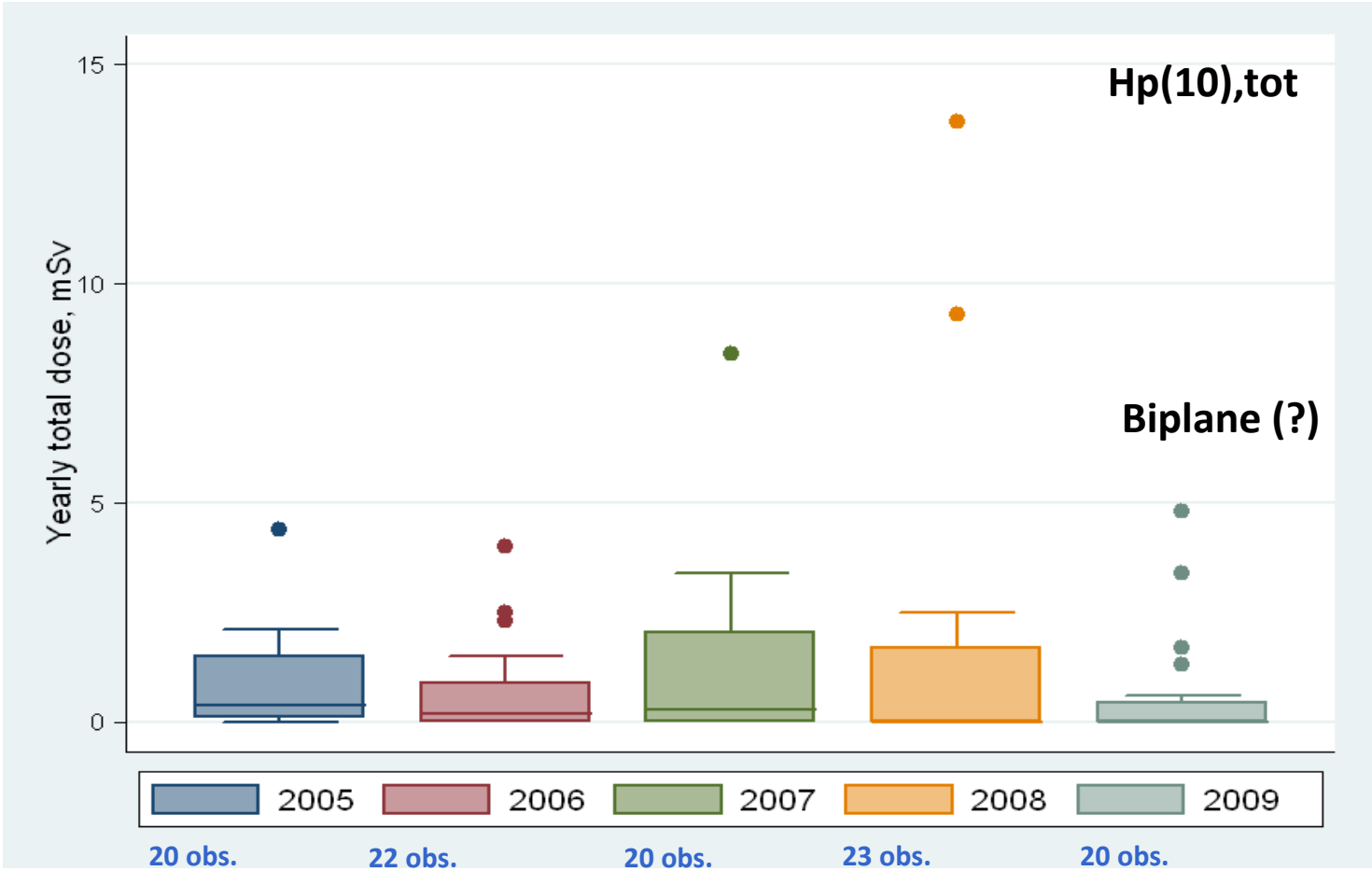


Results of the staff survey

For a particular cardiologist



Results of the staff survey



Results of the staff survey

Yearly dose

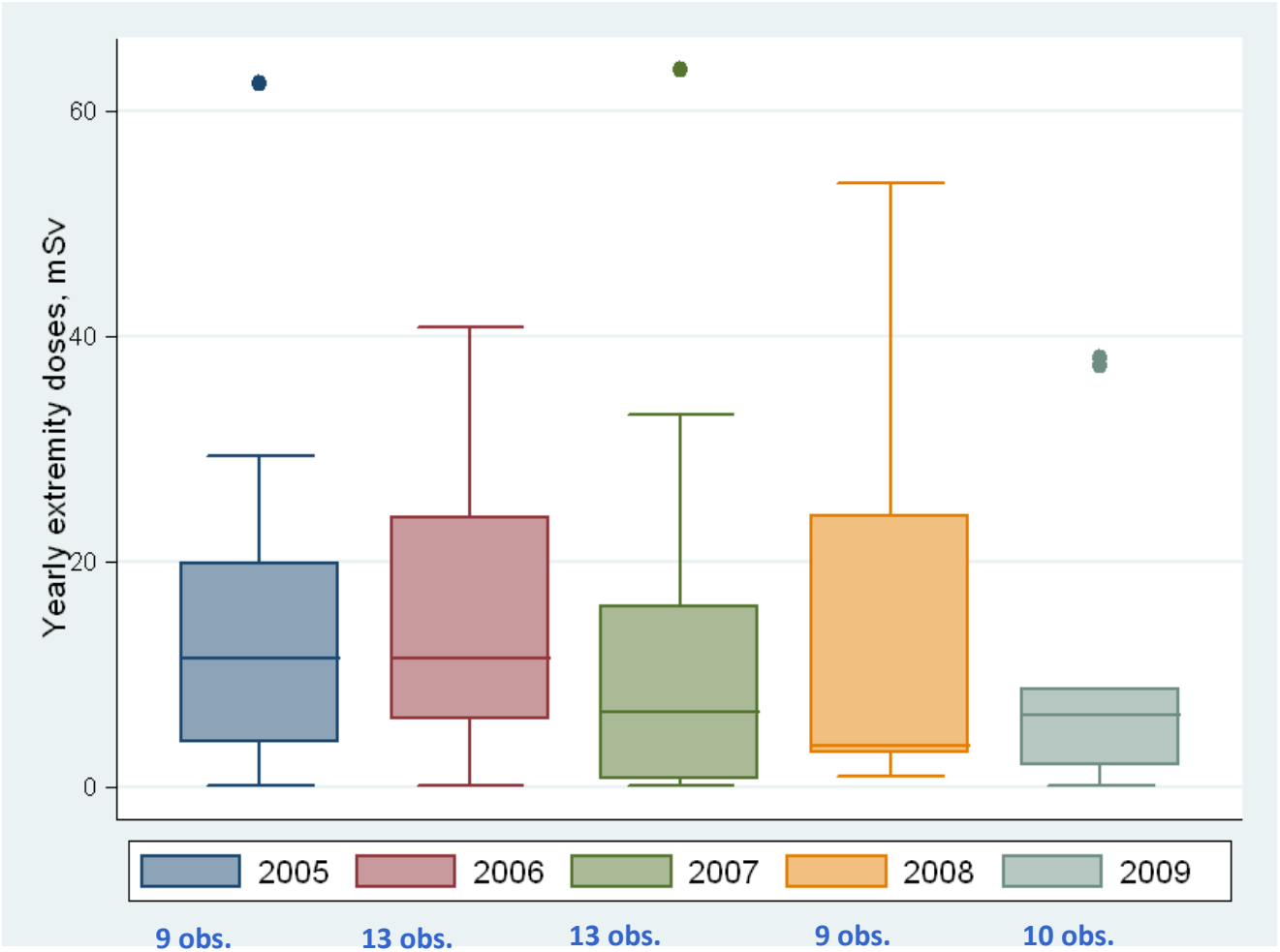
	Hp(10),under	Hp(10),over	Hp(10),total
Max, mSv	3.7	101	13.7
Mean, mSv	0.3	7.9	1.0

Monthly dose

	Hp(10),under	Hp(10),over
Max, mSv	1.1	16.8

Results of the staff survey

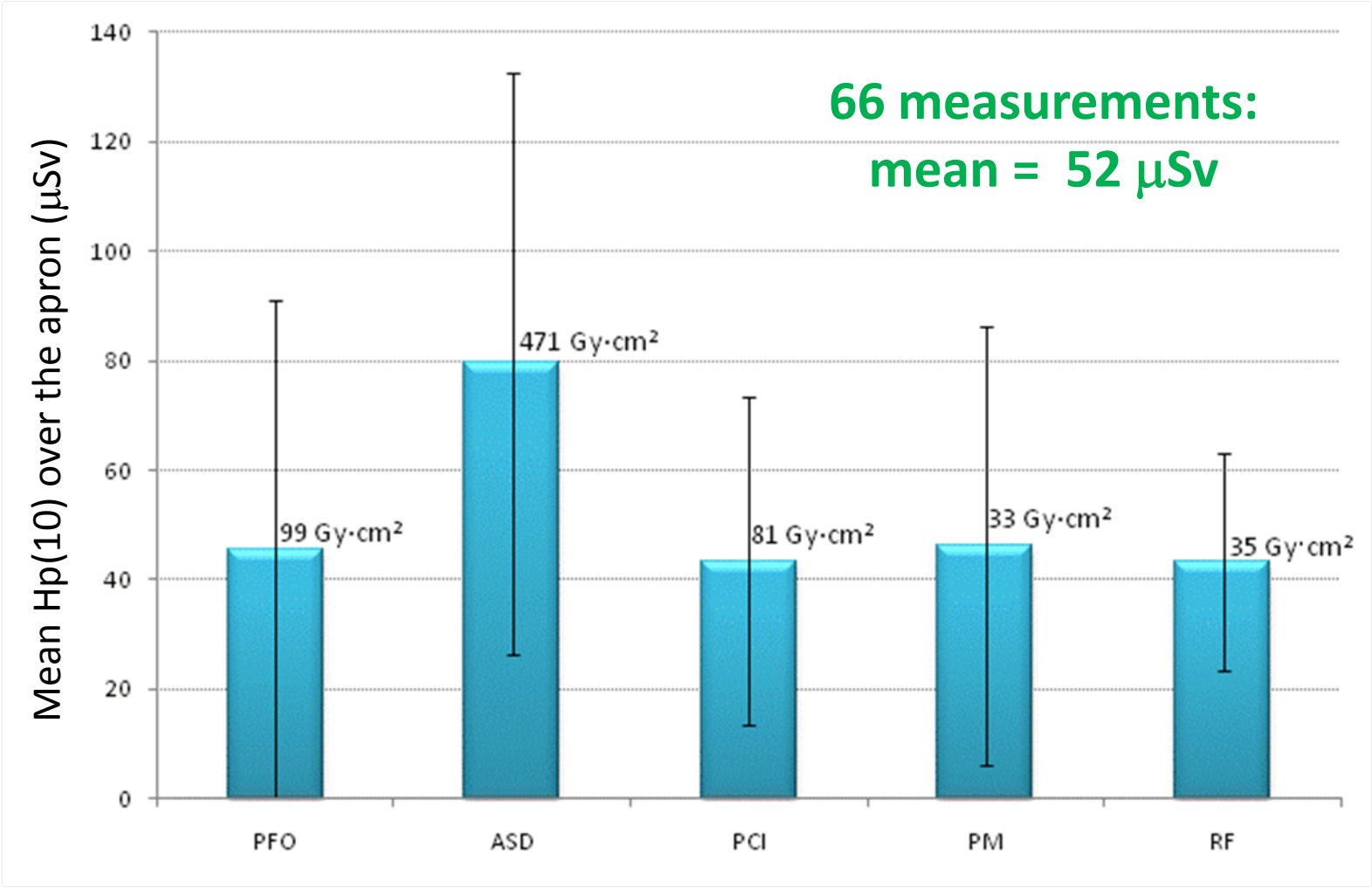
Yearly dose to extremity



Mean :

14.2 mSv

Results for specific measurements



Does this fit with the survey results ?

- Over the lead apron
  - 200 procedures per year times ~ 50 μSv per procedure = 10 mSv over the apron
  - From the survey : mean yearly dose : 7.9 mSv
- Under the lead apron
  - Mean yearly dose
    - 10 mSv over the apron / attenuation factor of 20 = 0.5 mSv
    - From the survey : 0.3 mSv
  - Monthly dose : 0.5 mSv / 12 → 0 mSv

Double dosimetry: yes or no ?

	⊕	⊖
Only 1 dosemeter under-apron	- Simple (no risk of inversion)	- Often zero dose - underestimate E - No optimisation incitement
Only 1 dosemeter over-apron	- Simple (no inversion) - good estimate of E with apron - Estimate of H_{lens}	- No more relevant without apron - Incident detection ?
Double dosimetry	- Good estimate of E with and without apron - Estimate of H_{lens}	- Complex (inversion) - Bad interpretation

Conclusions

- Both routine and procedure-specific measurements showed that yearly doses over the apron can be high.
- Wearing only the dosemeter under apron underestimates the effective dose since large parts of the body are not protected by the apron.
- Cardiologists performing fluoroscopy-guided procedures should wear both under and over apron dosimeters to better estimate E (standard algorithm in the future?)
- Increased awareness of cardiologists on occupational exposure and radiological risk $\rightarrow$ good opportunity to set up double dosimetry