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Federal Department of Home Affairs
Federal Office of Public Health (FOPH)
Radiation Protection Division

Seminar of the Federal Commission on Radiation Protection

“A glance at current dosimetry topics”

Dosimetry from the Perspective of the Swiss Authorities

Sébastien Baechler, FOPH

Why is dosimetry important for radiological protection authorities ?

- Radiation "dose" is an indicator of radiation risk
- Radiation protection policies are often set in terms of “dose”:
  - Compliance with dose limits (for workers and member of th public in planned exposure situation)
  - Implementation of the optimization principle – use of dose values as criteria for making decision / taking measures:
    - In planned exposure situation: dose constraint (for workers and member of the public) / diagnostic reference levels (patient exposure)
    - In existing or emergency exposure situations: reference levels
  - Information of the population on exposure levels

Occupational dosimetry: how does it work ?

Licence holders
(e.g. hospitals)

Occupationally exposed persons

Warning

Immediate notification

Personal dosimetry services

Normal dose

Dose > notification threshold

Dose > dose limit

National dose registry

- > 100'000 workers
- Clarification for insurance benefit entitlement
- Statistics

Supervisory Authority (FOPH)

- *On-site inspection*
- *Occupational medicine (Suva): decision on a medical examination*
- *Measures to be taken in the service*

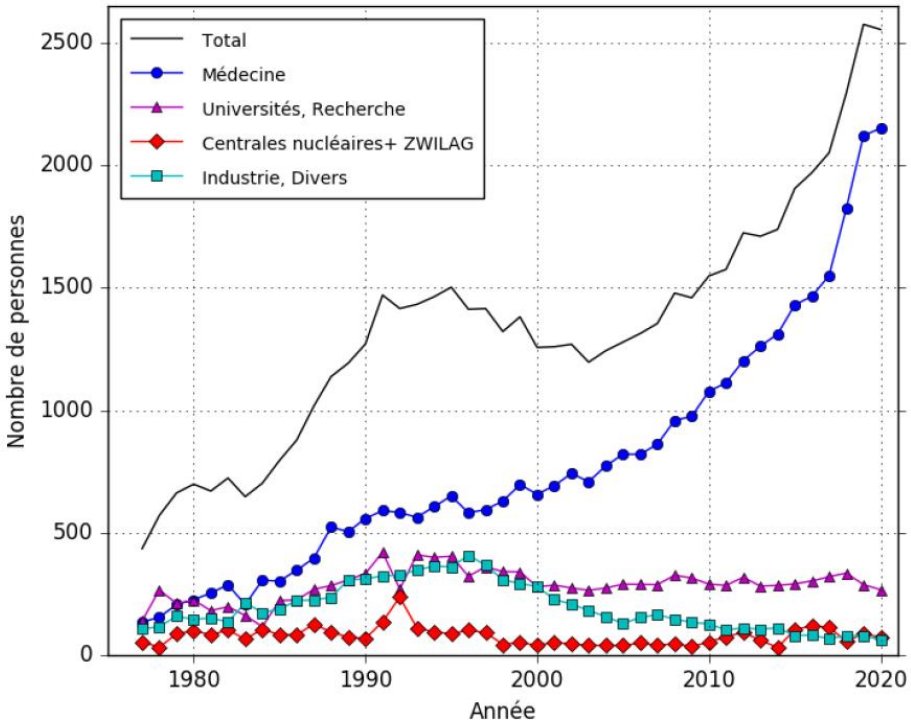
- *Questionnaire*
- *Optimisation*
- *ev. on site inspection*

Dose

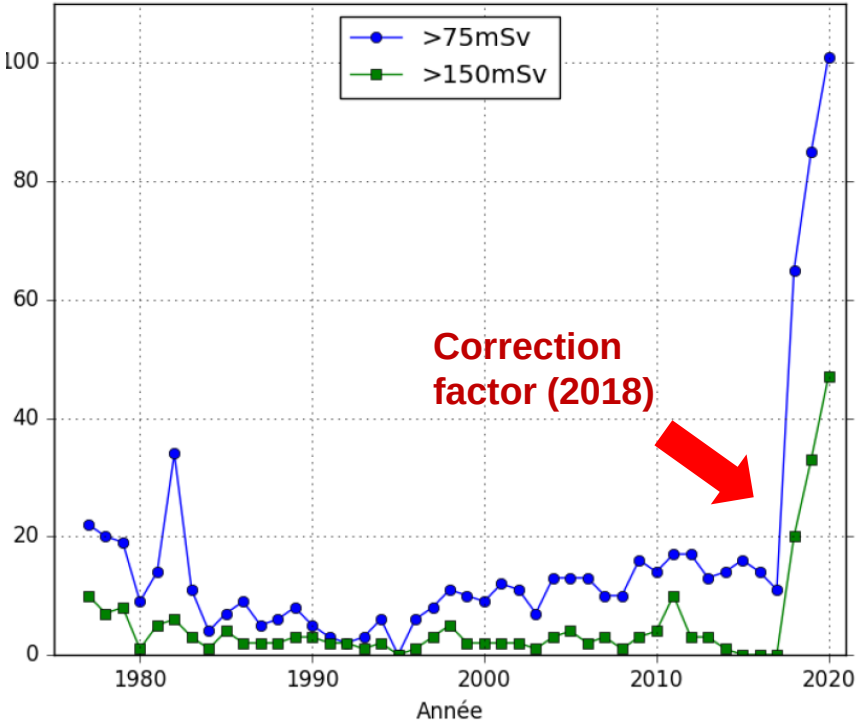
(Dose: $H_p(10)$, $H_p(0.07)$, $H_p(3)$ or E_{50})

Hand dose: general trend

wearing a ring dosemeter



above > 75 mSv/year ; 150 mSv/year



(FOPH Annual dosimetry report 2020)

Dose limit exceedances

Eye lens dose

Since 2019 many cases in:

- interventional cardiology
- interventional radiology
- orthopedic surgery

Annual doses range from 20 to 73 mSv

Accurate ? Overestimated ?

New limit for eye lens dose: 20 mSv / year

Year	Sector	Source	Dose	Notes
2002	hospital	Co-60	E = 22.8 mSv	radiotherapy
	hospital	I-131	H_{extr} = 1256 mSv	nuclear medicine, contamination
2004	dentist	X	E = 22.2 mSv	unclear incident
2005	hospital	X	E = 20.2 mSv	cardiology, fluoroscopy
2007	hospital	Y-90	H_{extr} = 1300 mSv	nuclear medicine
2009	NPP	g	E = 37.8 mSv E = 25.4 mSv	revision work, 2 cases
2010	NPP	g	E = 28 mSv H_{extr} = 7500 mSv	revision work, diver
	hospital	X	E = 30.2 mSv	angiography, fluoroscopy
	hospital	Y-90	H_{extr} = 1000 mSv	research
2011	hospital	X	E = 27 mSv	cardiology, fluoroscopy
	hospital	Y-90	H_{extr} = 2000 mSv	nuclear medicine, contamination
	industry	e^-, g	E = 278 mSv	electron beam cross-linking system
2012	hospital	Y-90	H_{extr} = 1000 mSv	nuclear medicine
2014	hospital / industry	X	H_{extr} = 700 mSv	repair of a fluoroscopy device
2016	hospital	Unknown	E = 24.1 mSv	nuclear medicine
2017	hospital	unknown	E = 29.6 mSv	emergency ward
2018	hospital	PET	H_{extr} = 552 mSv	nuclear medicine
	hospital	PET	H_{extr} = 562 mSv	nuclear medicine
2019	hospital	X	$H_{eyelens}$ = 21 – 73 mSv	25 cases in interventional cardiology, int. radiology, orthopedic surgery
2020	hospital	X	$H_{eyelens}$ = 20 – 65 mSv	7 cases in interventional cardiology, int. radiology, orthopedic surgery
	hospital	X	H_{extr} = 542 mSv	interventional radiology
2021	hospital	X	$H_{eyelens}$ = 21 – 56 mSv	3 cases in interventional radiology and vascular surgery

Monitoring of internal exposure

Screening measurement
(simple, fast, at workplace)

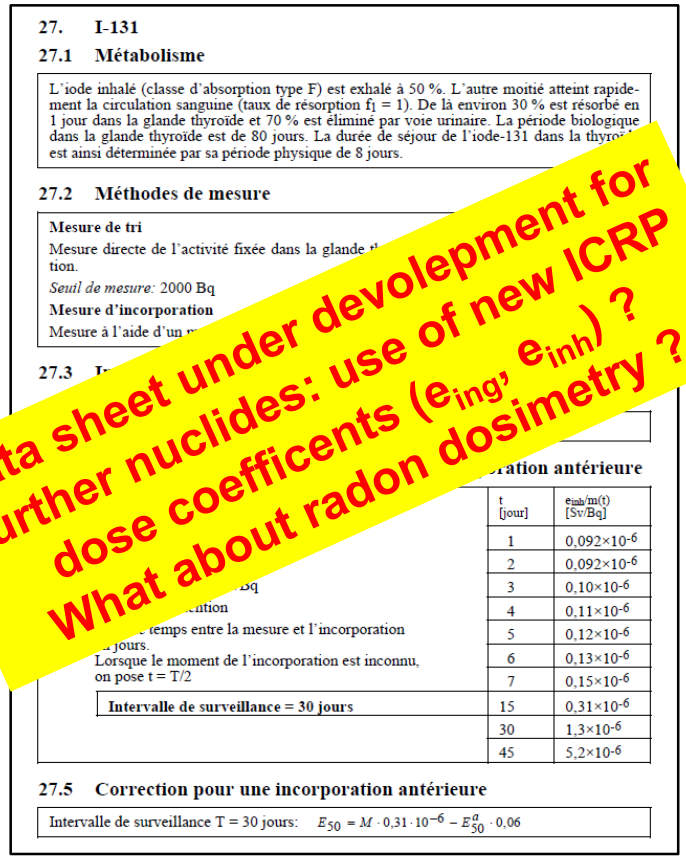
> Threshold ? — yes → **No further measurement**

no

Intake measurement
(by an approved service)

- In vivo: WBC and thyroid monitor
- In vitro (urine, stool): LSC, spectromety

Radionuclide-specific data sheet



27. I-131

27.1 Métabolisme

L'iode inhalé (classe d'absorption type F) est exhalé à 50 %. L'autre moitié atteint rapidement la circulation sanguine (taux de résorption $f_1 = 1$). De là environ 30 % est résorbé en 1 jour dans la glande thyroïde et 70 % est éliminé par voie urinaire. La période biologique dans la glande thyroïde est de 80 jours. La durée de séjour de l'iode-131 dans la thyroïde est ainsi déterminée par sa période physique de 8 jours.

27.2 Méthodes de mesure

Mesure de tri
Mesure directe de l'activité fixée dans la glande t… tion.
Seuil de mesure: 2000 Bq
Mesure d'incorporation
Mesure à l'aide d'un …

27.3 I…

…ration antérieure

t [jour]	$e_{inh}/m(t)$ [Sv/Bq]
1	$0{,}092\times10^{-6}$
2	$0{,}092\times10^{-6}$
3	$0{,}10\times10^{-6}$
4	$0{,}11\times10^{-6}$
5	$0{,}12\times10^{-6}$
6	$0{,}13\times10^{-6}$
7	$0{,}15\times10^{-6}$
15	$0{,}31\times10^{-6}$
30	$1{,}3\times10^{-6}$
45	$5{,}2\times10^{-6}$

…Bq
…ition
…temps entre la mesure et l'incorporation
…jours.
Lorsque le moment de l'incorporation est inconnu, on pose t = T/2

Intervalle de surveillance = 30 jours

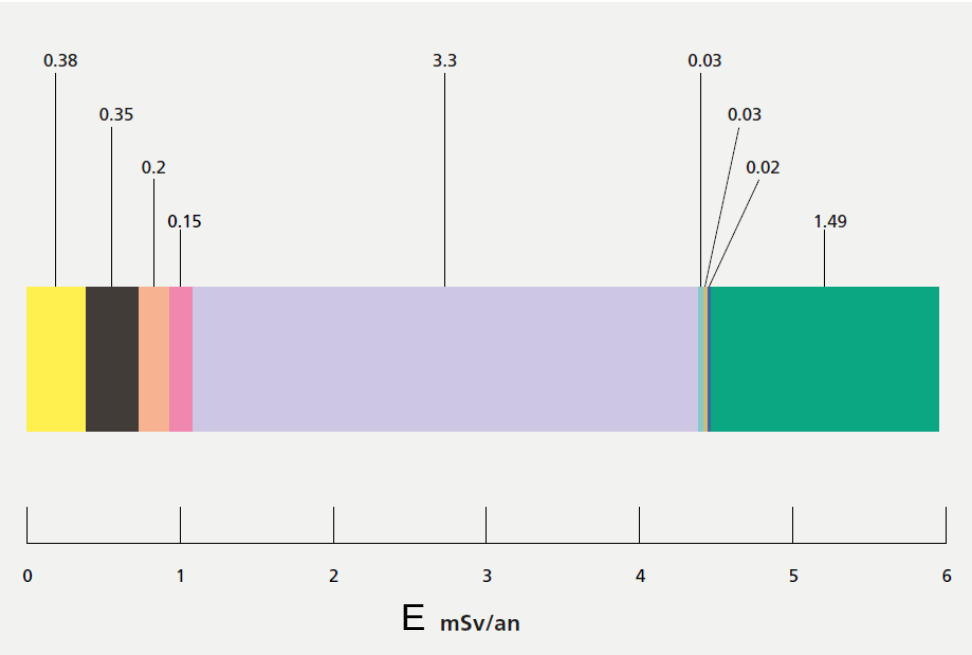
27.5 Correction pour une incorporation antérieure

Intervalle de surveillance T = 30 jours: $E_{50} = M \cdot 0{,}31 \cdot 10^{-6} - E^{a}_{50} \cdot 0{,}06$

Data sheet under devolepment for further nuclides: use of new ICRP dose coefficents (e_{ing}, e_{inh}) ? What about radon dosimetry ?

Dosimetry for public exposure

- Models to verify compliance with dose limits
  - G14 ENSI Directive (currently under revision)
- Models to estimate the average exposure of the Swiss population

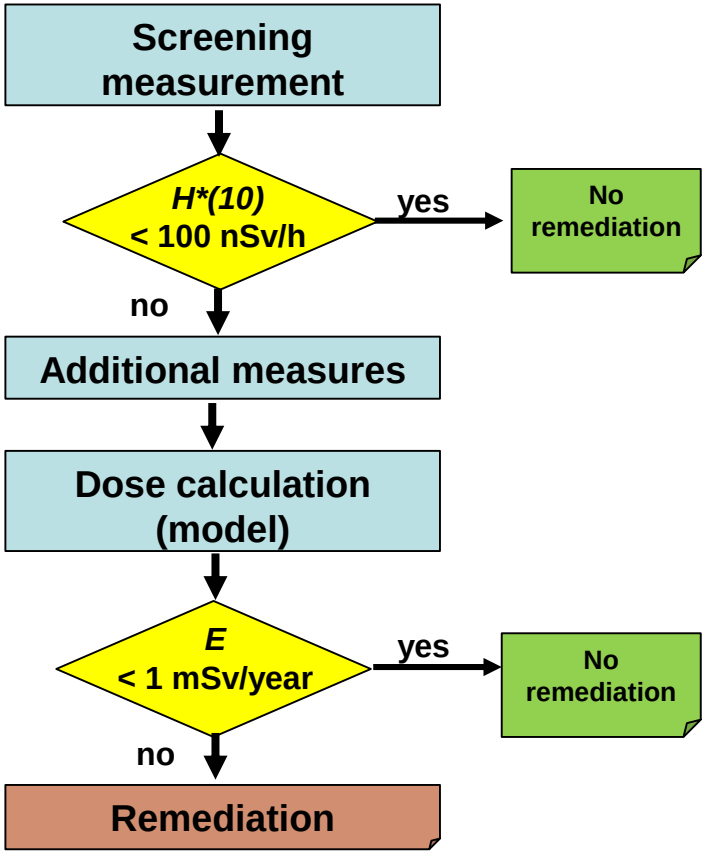


Legacies

(FOPH Annual report 2020)

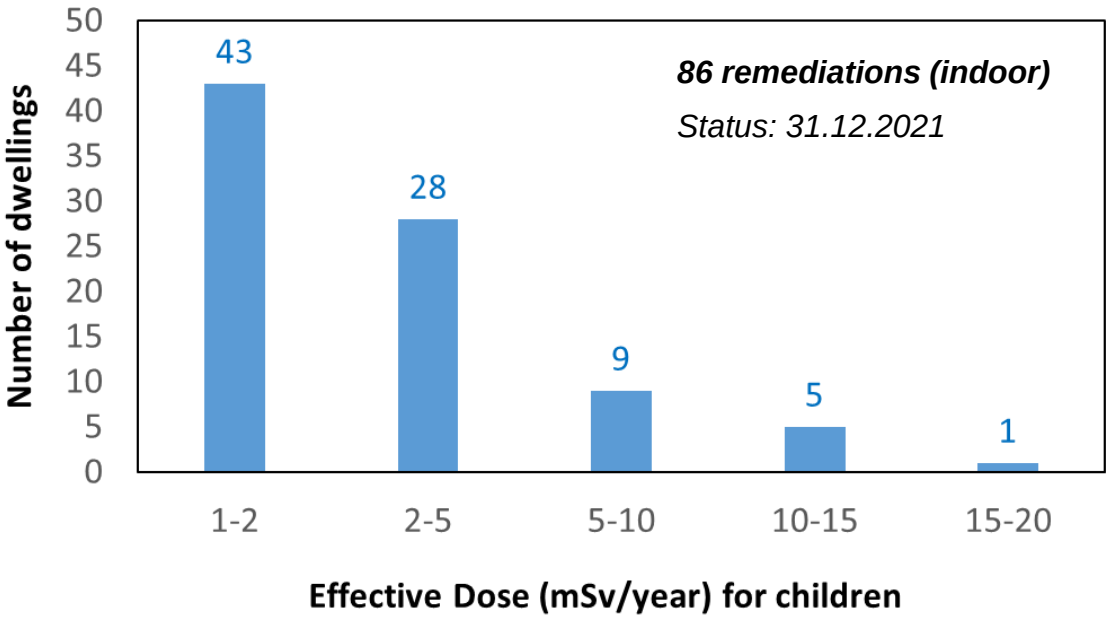
Action Plan 2015-2022 on radium legacies

More than 1000 properties potentially contaminated with radium (watch industry)



Modelling the resident exposure to radium

- Estimation of effective dose due to external exposure and ingestion received by any current or future resident
- Parameters: adults/children, room occupancy, position (standing, sitting, lying on the floor), …



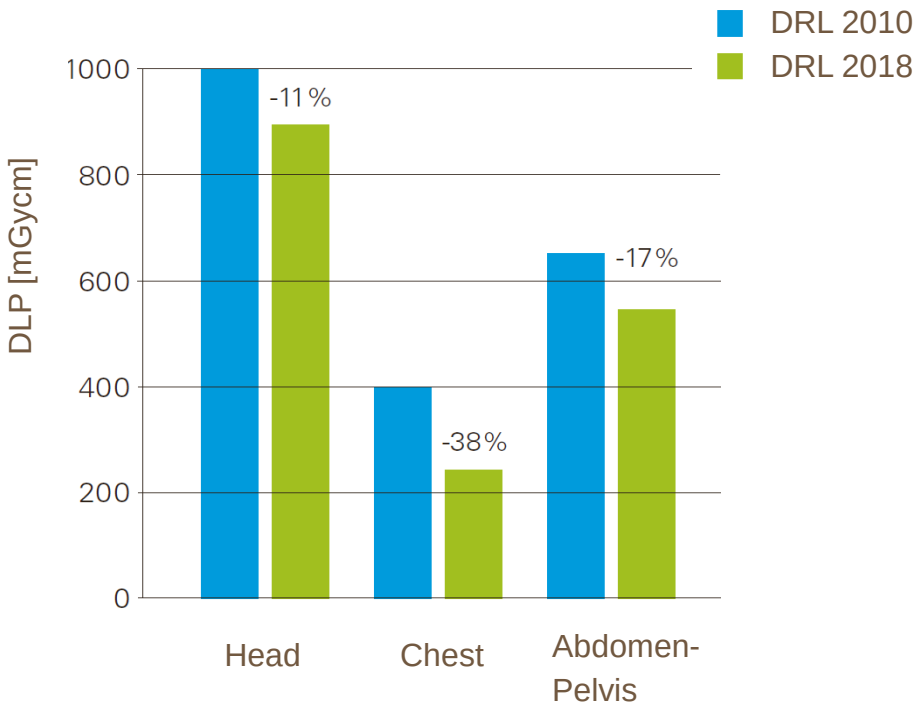
Patient Dose Management

The optimisation is best described as the management of the radiation dose to the patient to be commensurate with the medical purpose (ICRP)

- **In radiotherapy, dose management is fully integrated into clinical practice**
  - **Key point**: the dose to the target volume as well as to healthy tissues
  - Leading role of medical physicists is well established
  - New dosimetric capabilities always needed for emerging modalities, e.g. FLASH-RT
- **In medical imaging, managing patient dose involves:**
  - **Key point**: the level of image quality required (clinical standards needed)
  - Optimisation of protocols (patient dose AND image quality)
  - Display, evaluate and register patient dose (radiation quantities)
  - Use of dose management systems
  - Involvement of medical physicists
  - Inter-center comparison (benchmarking)
  - Use of diagnostic reference levels (local/national DRLs)

Trends in National DRLs

Adult CT in Switzerland



Substantial reduction compared to DRLs 2010

All relevant stakeholders have been involved in the optimization process

! Image quality !

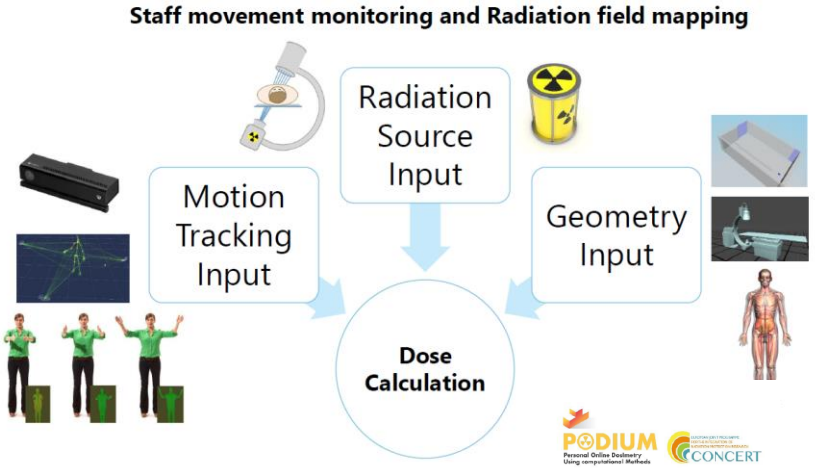
! Standardized data collection !

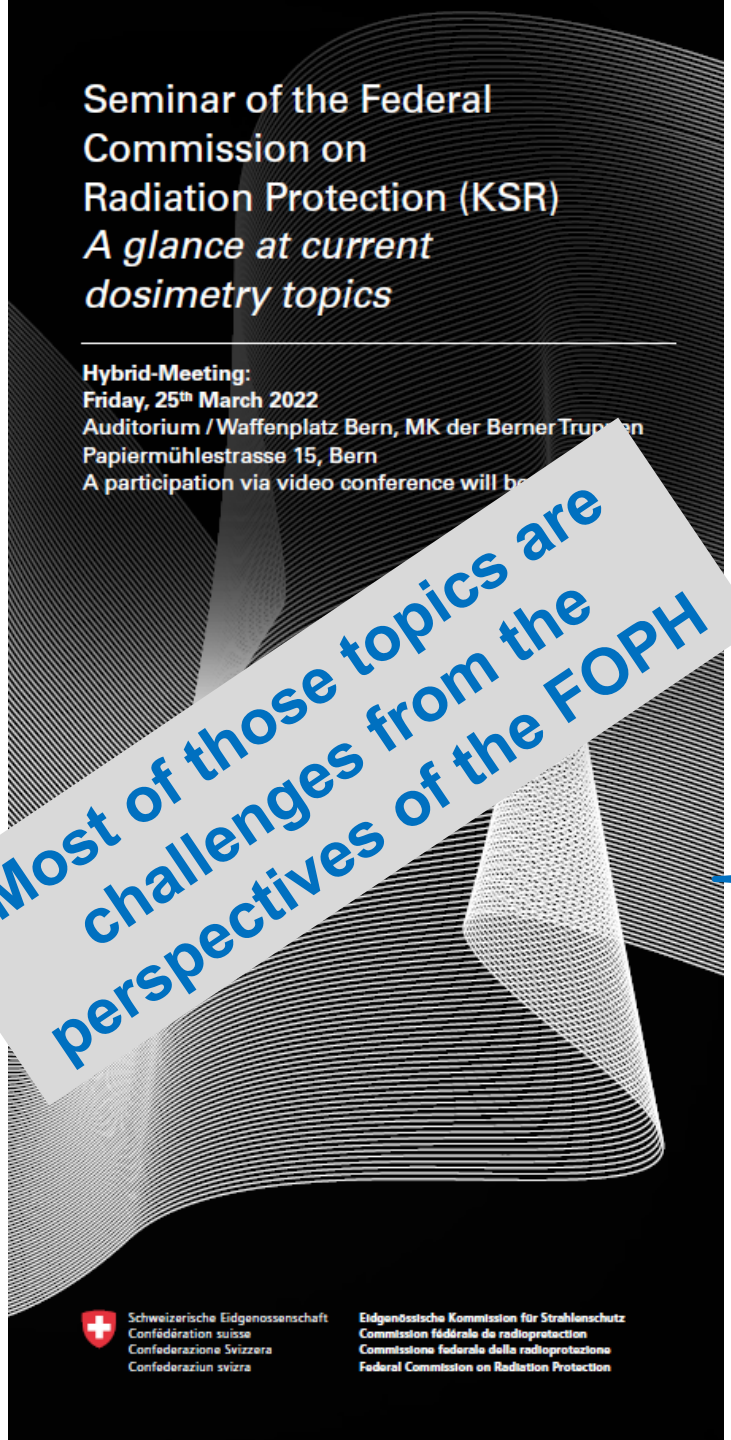
! Regular updates !

Source: Aberle et al. Eur Radiol (2020)

Future: challenges and key issues

- Maintenance of competences in dosimetry in Switzerland:
  - Setting up networks: dosimetry expert group of the KSR, involvement of key players such as CERN, IRA, METAS, PSI, SSRMP, other professional bodies, …
- Increasing contribution of computational dosimetry and artificial intelligence
  - No more physical dosimeters in personal dosimetry → project PODIUM *(Personal Online DosImetry Using Using computational Methods)*
  - *Predicting doses instead of measuring or simulating ?*





Program

08:30	**Reception, Arrival coffee**
09:00	**Welcome** Flurin Sarott, President KSR Sabine Mayer, President Expert Group Dosimetry KSR
09:05	**Dosimetry from the Perspective of the Swiss Authorities** Sebastien Baechler, Radiation Protection Division (FOPH) Rosa Sardella, Radiation Protection Division (ENSI)
09:30	**ICRU 95- Operational Quantities for External Radiation Exposure** Hans Menzel, International Commission on Radiation Units & Measurements (ICRU)
10:00	**Internal Dosimetry of Workers** François Paquet, Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
10:30	**Coffee break**
11:00	**Radon Dosimetry** Roland Krischek, SUVA
11:30	**Dosmetry during Decommissioning of Nuclear Installations** Andreas Leupin, ENSI
12:00	**Retrospective Dosimetry** François Trompier, Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
12:30	**Lunch**
13:45	**Eye Lens Dosimetry** Marta Sans-Merce, Geneva University Hospitals (HUG)
14:15	**Radiation Quantities in Medical Imaging** Jérôme Damet, Lausanne University Hospital (CHUV)
14:45	**New Reference Computational Phantoms** Nina Petoussi-Henss, Helmholtz Zentrum München
15:15	**New Techniques in External Dosimetry** Eduardo Yukihara, Paul Scherrer Institut (PSI)
15:45	**Dosimetry in Modern Radiation Therapy** Claude Bailat, Lausanne University Hospital (CHUV)
16:15	**Closing words** Flurin Sarott, President KSR
16:30	**End of seminar**

Thank you for your attention