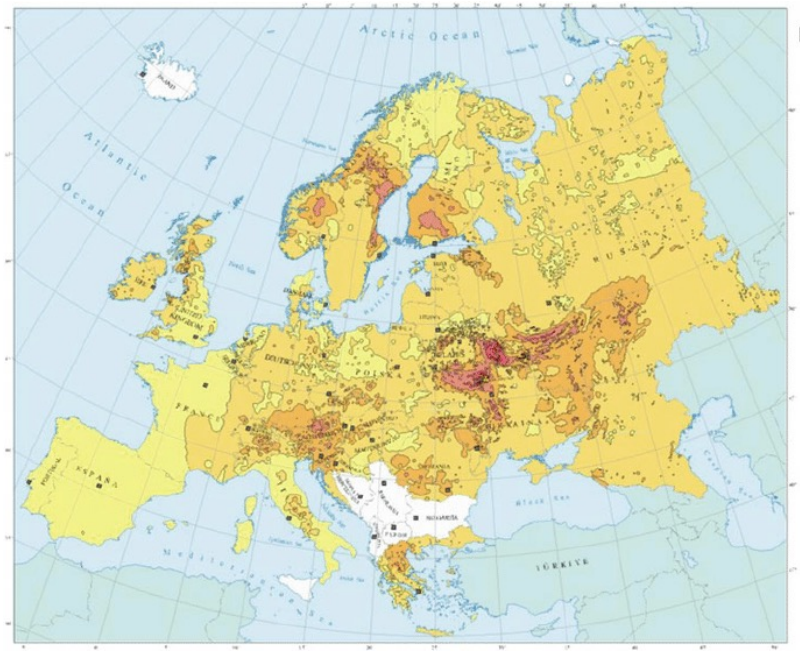


Individualized radiation mass-dosimetry during emergencies

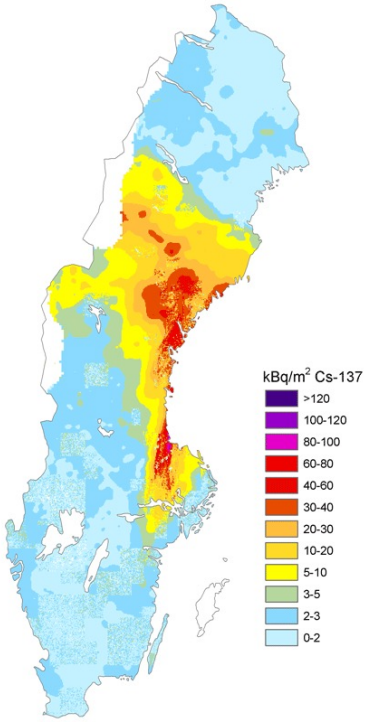
Maria Karampiperi, Christian Bernhardsson
Medical Radiation Physics, Malmö, ITM, Lund University

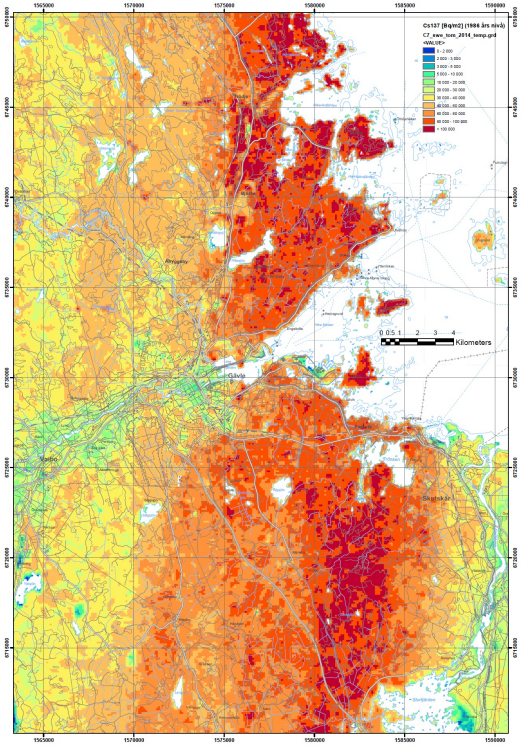
Complex dose estimation: inhomogeneity in radionuclides deposited, residence times, decay

Cs-137 from Chornobyl deposited over Europe, Sweden, and Gävle area in Sweden



De Cort et al. 1998





SGU

→Justification for individualised (external) dosimetry

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Retrospective dosimetry methods

- **Biological**
  - chromosomal aberrations, lymphocytes, radionuclides in the body, etc.
- **Physical**
  - TL*- and OSL** materials, EPR***, radionuclides in the body.
- **Mathematical**
  - Monte Carlo calculations (based on *in situ* measurements).

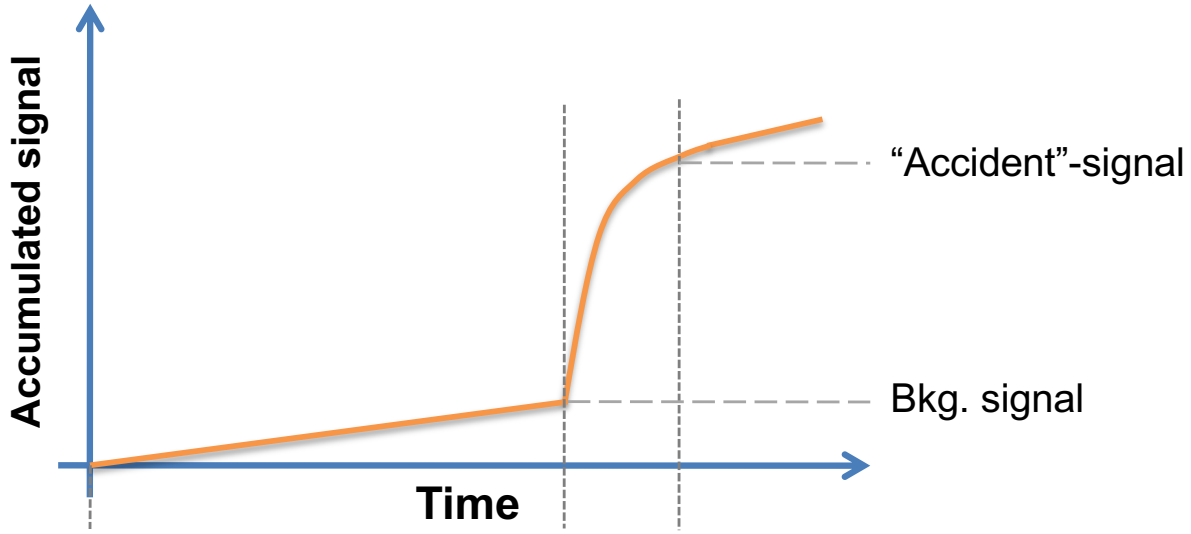
**Thermoluminescence; **Optically Stimulated Luminescence; ***Electron paramagnetic resonance*

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Optically stimulated luminescence dosimetry

Retrospective- and prospective dose determinations on an individual level

- Energy is stored in crystalline defects (quartz, feldspar, salt, and others) when exposed to ionising radiation
- Energy is released, as luminescence, when the material is stimulated by heat (TL) or light (OSL)



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OSL dosimetry with fortuitous materials

Unintentional exposure (OR NOT) to ionising radiation

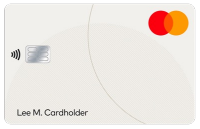


RRADEW



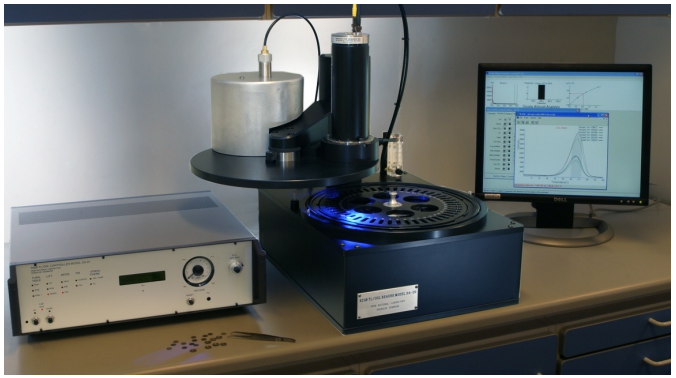


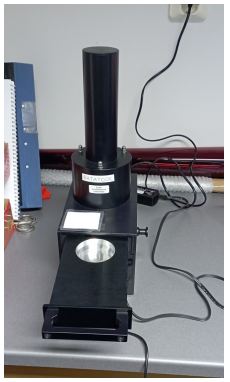




Collection of personal materials

In situ or *ex situ* read-out (+calibration/pre-determined curve)

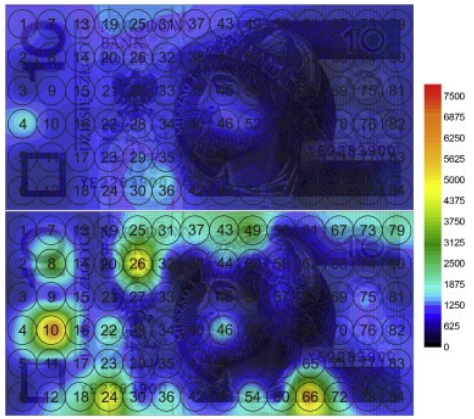




Reporting of estimated doses (if *in situ* – potential for triage support)

Analysis of OSL signal vs absorbed (whole-body) dose – estimation of effective dose

10 PLN sedel



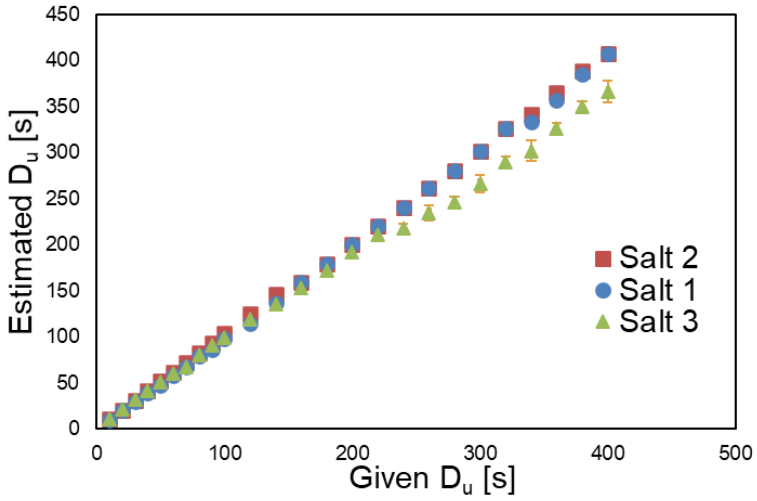
https://doi.org/10.1016/j.radmeas.2017.04.012

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Salt (NaCl) for OSL dosimetry

- **Dosimetric properties of (NaCl pellets)**
  - Minimum detectable dose ~10 µGy (normal bkg. radiation ca. 3 µGy per 24 h)
  - Reproducibility: ca. 2%
  - Dose-reconstruction:







- **Pros./cons.: must be kept shielded from light**

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Salt as a prospective OSL dosemeter

- A cost-effective and available alternative to conventional detectors and methods for radiation dose determinations



+





=



€1

€1000

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Salt as an OSL dosemeter

- 102 different salts from 47 countries and 6 continents

Table 1. The 102 salts investigated with information on country where the salt was bought, the type (Sea salt (S), Rock salt (R), Pure salt (P)), iodine and anti-caking agent (yes/no (Y/N)) and the grain size fraction used in this study. The table is sorted alphabetically according to country of purchase.

Country of purchase	Type	Iodine	Anti-caking	Grain size	Country of purchase	Type	Iodine	Anti-caking	Grain size
Australia 1	S	Y	Y	100-250	Morocco 2	-	Y	Y	100-250
Australia 2	S	N	Y	100-400	Morocco 3	-	Y	N	100-250
Austria 1	R	Y	Y	100-250	Netherlands 1	R	N	Y	100-250
Austria 2	R	Y	-	100-250	Netherlands 2	R	Y	Y	100-250
Bangladesh 1	S	Y	N	100-250**	Norway 1	S	N	Y	100-250
Belarus 1	R	Y	Y	100-250	Peru 1	R	Y	Y	100-250



Table 3. The dosimetric properties of all 102 salts, both for grains and for pellets. Also shown are the categorisations of type of salt and iodine and anti-caking agent content.

	MDD [μGy]		c_{spec} [counts/mGy·mg]		Reproducibility Dose [%]		Sensitisation [%]		Dose est. Eq. slope	
Country	Grain	Pellet	Grain	Pellet	Grain	Pellet	Grain	Pellet	Grain	Pellet
Australia 1	13	6.1	869	961	0.96	0.13	57	1.4	0.79	0.99
Australia 2	9.2	13	954	1043	0.20	0.48	86	1.7	0.76	0.98
Austria 1	36	16	133	385	0.77	0.30	25	4.6	0.91	1
Austria 2	17	31	154	525	1.12	0.24	38	3.1	0.83	1
Bangladesh 1	121	17	41	277	2.05	0.26	28	1.7	0.84	1
Belarus 1	35	22	107	393	0.26	0.49	63	9.1	0.75	1
Belarus 2	76	23	201	335	1.18	0.85	51	7.5	0.8	0.99
Belarus 3	26	14	344	501	1.21	0.67	60	2.3	0.73	1.03
Belgium 1	7.3	16	847	906	0.46	0.38	42	8.1	0.88	0.98
Canada 1	23	6.3	253	1653	0.75	0.13	69	-0.2	0.8	1
China 1	7.3	29	463	212	0.48	0.46	133	4.9	0.67	1.03
China 2	56	19	90	569	0.80	0.40	35	2.3	0.84	1
Croatia 1	37	20	90	1041	0.84	0.19	26	1.7	0.9	1
Croatia 2	27	8.7	152	661	0.89	0.30	41	8.2	0.84	0.99
Czech republic 1	106	230	581	766	0.67	0.27	34	2.6	0.81	1.03
Denmark 1	12	11	336	537	0.37	0.16	128	6.5	0.67	0.99

See Waldner L. thesis (2020) for the full list of salts investigated: https://portal.research.lu.se/en/publications/optically-stimulated-luminescence-dosimetry-with-nacl-pellets-dos

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NaCl pellets – applications within environmental radiology



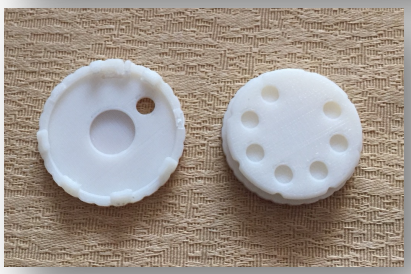






Table 2. Average external dose rates (mean value ±1 SD of the mean value for each type of house) inside the houses and outside in the gardens as registered by the different dosimeters and detectors. The following house types represent the majority of the houses in the village: 1) wooden house, not decontaminated; 2) wooden house, decontaminated; 3) brick house, not decontaminated; 4) brick house, partly decontaminated. The indicated values refer to averages over several measurements inside and outside the houses. Note that the dosimeter signals are given as absorbed dose rate.

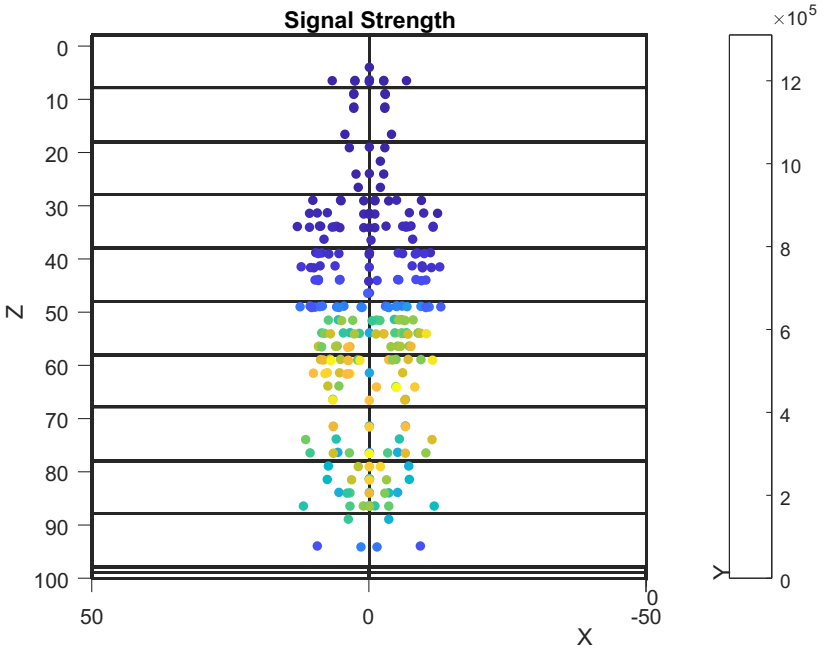
House type	Average dose rate (μGy h^{-1})				Average dose rate (μSv h^{-1})			
	Inside		Outside		Inside		Outside	
	NaCl	LiF	NaCl	LiF	NaI(Tl)	HPIC	NaI(Tl)	HPIC
1.	0.13±0.03	0.13±0.03	0.20±0.04	0.18±0.05	0.14±0.02	0.13±0.02	0.21±0.04	0.28±0.10
2.	0.14±0.02	0.12±0.03	0.19±0.06	0.16±0.01	0.15±0.04	0.12±0.02	0.21±0.05	0.17±0.02
3.	0.09±0.00	0.11±0.00	0.23±0.01	0.25±0.03	0.10±0.00	—	0.26±0.03	—
4.	0.12	0.11	0.22	0.16	0.14	0.11	0.27	0.28

Health Phys. 103(6):740Y749; 2012

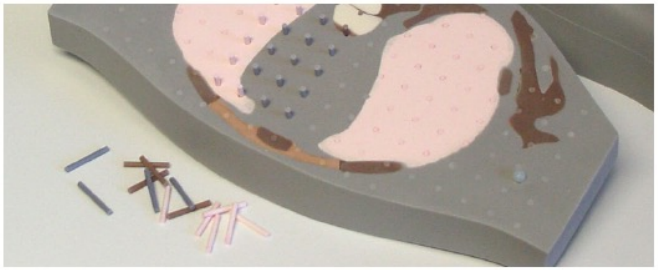


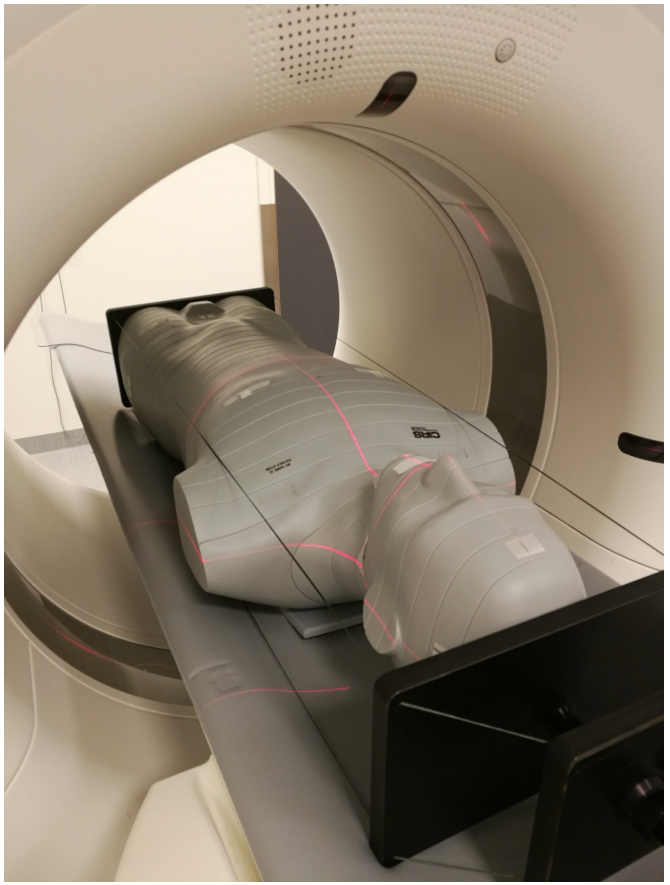


NaCl pellets – applications for CT





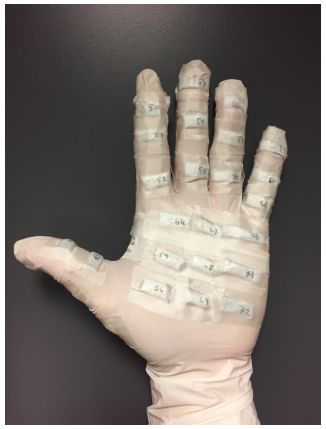


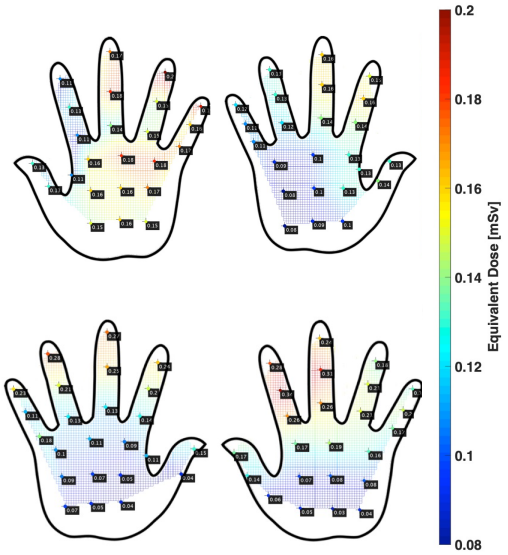


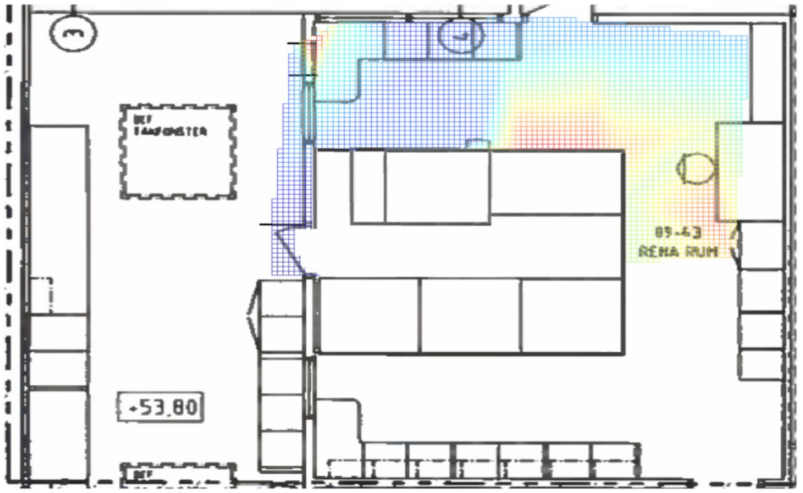
Effective dose: 5.6 mSv

Estimated effective: 3.7-4.9 mSv

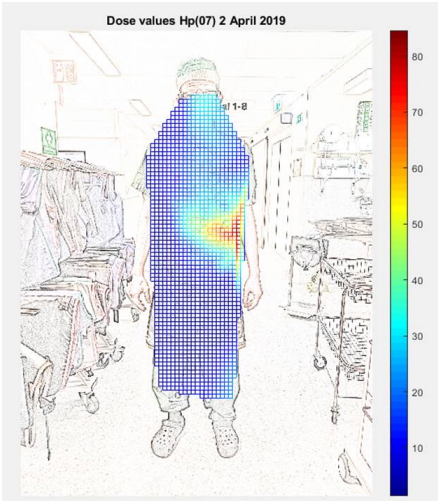
NaCl pellets – clinical applications

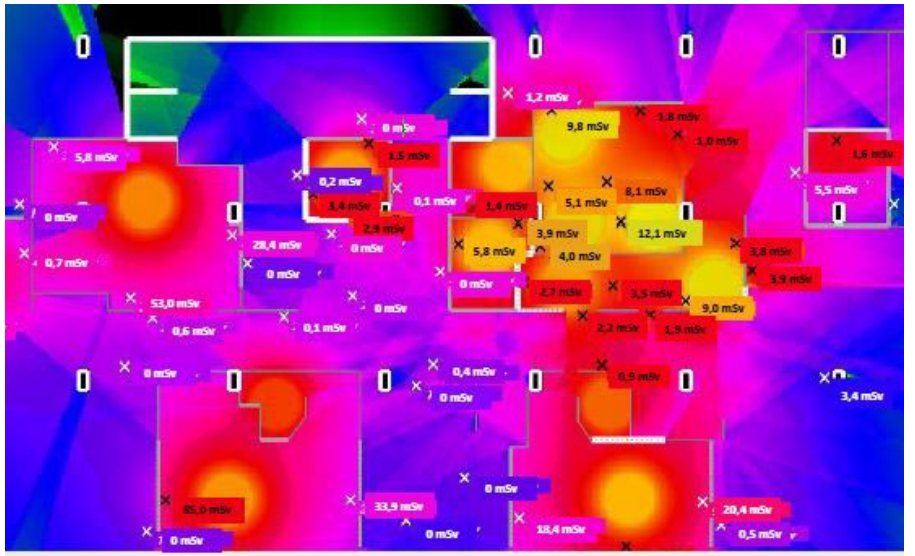












Radiation Measurements 179 (2024) 107323

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Radiation Measurements

journal homepage: www.elsevier.com/locate/radmeas



Evaluation of a portable OSL/IRSL reader for radiation dose assessment of NaCl pellets – *In situ* individualised screening during R/N emergencies

Maria Karampiperi *, Christopher L. Rääf, Christian Bernhardsson

Medical Radiation Physics, Department of Translational Medicine, Lund University, Sweden

13th of November
SESSION 7B

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Why NaCl pellets? Why OSL?

NaCl:

- ✓ Cheap
- ✓ Common
- ✓ Good luminescence properties
- ✓ No need for pre-treatment

NaCl pellets:

- ✓ Uniform
- ✓ Higher reproducibility

OSL → No need of N_2

Readers

Cheaper → Network

Portable → *In situ* + *No need of external power*

Network + *In situ* + *No need of external power* → Rapid results

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NaCl properties vs. other dosemeters

Radiation Measurements 177 (2024) 107233

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journal homepage: www.elsevier.com/locate/radmeas



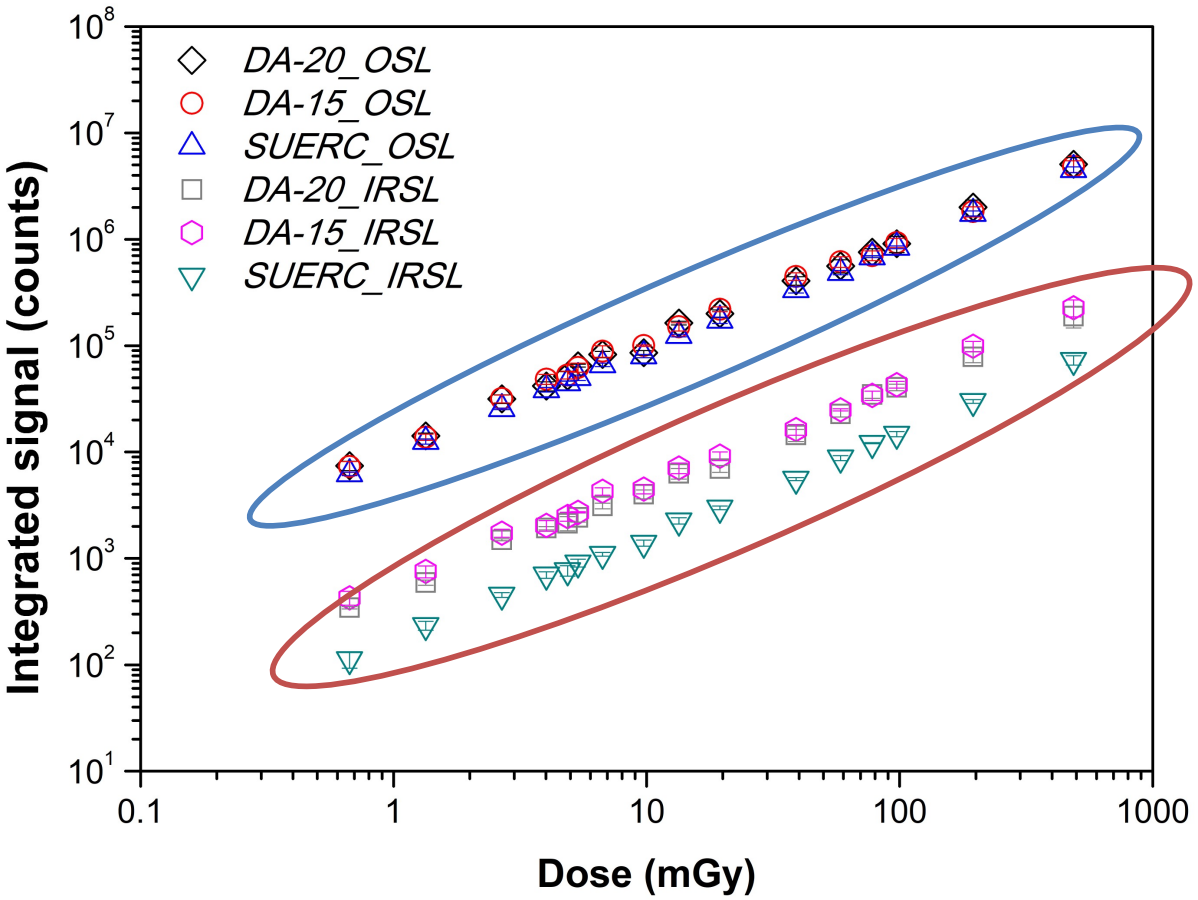
OSL dosimetry with table salt for mass screening of individual doses during radiological or nuclear emergencies

Vadim Chumak [a,b,*], Elena Bakhanova [a], Maria Karampiperi [c], Christian Bernhardsson [c]

[a] National Research Centre for Radiation Medicine, Hematology and Oncology NAMS Ukraine, 04050, 53 Yu.Illyenko Str., Kyiv, Ukraine
[b] RPE DOSIMETRICA, P.O. Box 40, Kyiv, 04119, Ukraine
[c] Medical Radiation Physics, Department of Translational Medicine, Lund University, Malmö, Sweden

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Performance



OSL and IRSL dose response for irradiations with $^{90}Sr/^{90}Y$, for all 3 readers.

Tested for β & γ

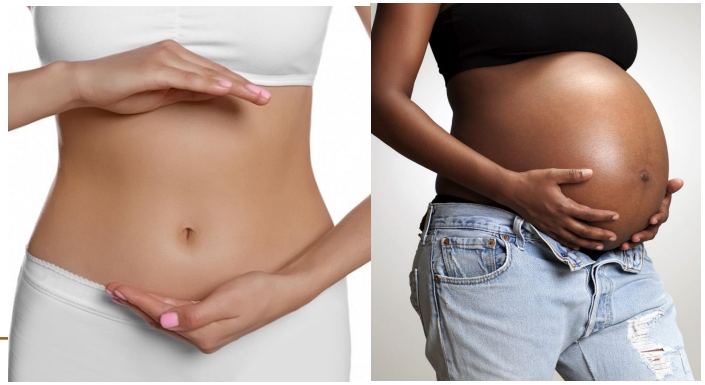
SUERC → 5 pellets together

Detection limits:

- OSL → 3 μGy
- IRSL → 50-80 μGy

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Potential in war-time



- No need for power supply
- Low-cost → building a larger network of readers
- In situ → overcomes the difficulty of transporting samples through borders
- No limitations due to communication disruption during war
- Linear response to dose → Ability to retrieve the dose
- Low detection limit → can relief even the "worried-well"
- Higher residuals → re-reading the same samples
- Combination of IRSL and OSL
- Helpful for triage → can even read many samples together and do 1-1 analysis only to batches that the dose appears higher than the threshold

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RRADEW - Resilience to RADiological Events in Wartime

- WP4 (Ukrainian case study)
- Develop information material to the public
  - Packaging material & method, optimal positioning on the body, labelling, general information
- Study optimal ways of broadcasting the information
- Establishing workflow for the chain packing-collection-readout-reporting back the results
- Testing parts or the whole chain of the proposed guideline for using NaCl as a “folk-dosemeter”

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Thank you for your attention!



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FACULTY OF MEDICINE

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https://www.msf-malmo.lu.se/