Kommission für Strahlenschutz und Überwachung der Radioaktivität

Commission fédérale de la protection contre les radiations et de surveillance de la radioactivité

Seminar vom 17. Januar 2001
Séminaire du 17 janvier 2001

Sammlung der Referate
Recueil des exposés

Bern, Februar 2001

Bezugsadresse:
Kommission für Strahlenschutz und Überwachung der Radioaktivität (KSR)
Sekretariat
Bundesamt für Gesundheit
Postfach
3003 Bern

Verteiler:
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INHALTSVERZEICHNIS

Prof. Jean-François Valley

1. Vorwort / Avant-propos

Cette manifestation, 8ème séminaire de la Commission fédérale de radioprotection (qui a préparé le séminaire) et 1er séminaire de la Commission fédérale de protection contre les radiations et de surveillance de la radioactivité (qui a patronné le séminaire), a eu lieu le 17 janvier 2001 à Berne. Elle a réuni une cinquantaine de personnes : membres de la commission, experts, collaborateurs de services et instituts en charge de la radioprotection.

Le but du séminaire est d'informer les personnes en charge de la radioprotection en Suisse sur des thèmes actuels. Le séminaire est aussi un lieu d'échange entre les différents partenaires : représentants des offices de surveillance, de l'industrie, de la recherche. Cette plate-forme doit permettre d'une part un approfondissement des connaissances et d'autre part une amélioration de la convergence dans l'application des principes de base de la radioprotection.

Le séminaire a été consacré en première partie à la présentation de la dosimétrie individuelle en Europe. Le premier exposé a été présenté par M. le Dr David Bartlett du National Radiological Protection Board (UK) et avait pour thème l'harmonisation et l'assurance de qualité de la dosimétrie individuelle de l'irradiation externe. M. Bartlett a présenté les résultats d'une enquête effectuée dans le cadre du groupe EURADOS et visant à analyser non seulement les modalités de la surveillance de l'irradiation externe en Europe, mais aussi le niveau de réglementation dans ce domaine. Ce travail a permis de vérifier que les nouvelles grandeurs de l'irradiation externe, $H_p(10)$ et $H_p(0{,}07)$ et les modalités dosimétriques recommandées par l'ICRU sont reconnues ou en voie de l'être dans tous les pays d'Europe. M. Bartlett a aussi présenté les résultats d'intercomparaisons extensives dans le domaine de la dosimétrie du rayonnement $\beta\gamma$, ainsi que dans le cas du rayonnement neutronique. Alors que dans le cas des photons, les performances des systèmes sont en général très satisfaisantes, un effort reste à consentir dans le cas de la dosimétrie neutronique. A noter que dans ce domaine des méthodes émergent, en particulier celle basée sur le système DIS (direct ion storage), qui pourraient apporter des solutions intéressantes dans les prochaines années.

Le second exposé, présenté par M. Christian Wernli, avait pour thème la situation de la dosimétrie individuelle en Suisse comparée à l'Union européenne. M. Wernli, président du groupe d'experts pour la dosimétrie individuelle de la Commission fédérale de radioprotection, a mis en évidence que la Suisse fait bonne figure, non seulement au niveau de sa pratique, inspirée des dernières recommandations internationales, mais également de sa législation. A ce niveau, l'ordonnance sur la dosimétrie individuelle, entrée en vigueur au 1er janvier 2000, met la Suisse dans une situation très confortable, aussi bien en ce qui concerne la surveillance de l'irradiation externe que celle de la dosimétrie d'incorporation. Cette situation très réjouissante est d'ailleurs confirmée par les résultats des intercomparaisons organisées chaque année par le groupe d'experts pour la dosimétrie individuelle.

Un second thème a ensuite été présenté par M. Bartlett; il s'agissait de l'implémentation des exigences européennes sur la radioprotection du personnel des compagnies d'aviation. Après un rappel des caractéristiques et des doses liées au rayonnement cosmique, M. Bartlett a présenté les mesures prévues par l'Union européenne, à savoir l'évaluation de l'exposition du personnel, la prise en compte de ces doses dans l'organisation du travail, ainsi que l'information du personnel et la possibilité aux femmes enceintes d'être dispensées du service de vol. Cette information est très utile pour notre pays où seules les deux dernières exigences figurent dans l'ordonnance et où une étude est actuellement en cours pour vérifier le degré de réalisation de ces exigences sur le terrain. Ce thème reste actuel et sera une des préoccupations de la nouvelle commission.

Que toutes les personnes qui ont concouru au succès de ce séminaire, les conférenciers et les participants, soient ici remerciés, sans oublier le secrétariat de la commission qui a assuré l'organisation du séminaire et la présente publication des résumés des exposés.

Prof. Jean-François Valley, président

2. Tagesprogramm

09.00 - 09.15	Begrüssung durch Prof. Dr. Jean-François Valley
09.15 - 12.00	**Personendosimetrie in Europa** Moderator: Prof. Dr. Jean-François Valley
09.15 - 10.00	• Dr. David Bartlett (NRPB) **Harmonization and Dosimetric Quality Assurance of Individual Monitoring of External Radiation**
10.00 - 10.20	• Christian Wernli, Dipl. Physiker ETH **Stand der Personendosimetrie in der Schweiz im Vergleich zur Europäischen Union**
10.20 - 10.40	Pause
10.40 - 11.00	• Dr. David Bartlett (NRPB) **Implementation of EU Requirements for the Radiation Protection of Aircraft Crew for Cosmic Radiation**
11.00 - 12.00	• Diskussion
12.00	Schlusswort von Prof. Dr. Jean-François Valley

3. Moderatoren- und Referentenliste

Leitung und Moderation:

- Prof. Dr. ès.sc.nat. Jean-François Valley,
  Präsident der EKS
  Directeur de l'Institut de radiophysique appliquée (IRA),
  Lausanne

Referenten:

- Dr. David Bartlett, NRPB,
  Oxon, United Kingdom

- Christian Wernli, Dipl. Physiker ETH,
  Chef der Sektion Messwesen am Paul Scherrer Institut
  Villigen-PSI

4. Personendosimetrie in Europa

4.1. *Harmonization and Dosimetric Quality Assurance of Individual Monitoring of External Radiation*
Dr. David Bartlett (NRPB)

4.2. *Implementation of EU Requirements for the Radiation Protection of Aircraft Crew for Cosmic Radiation*
Dr. David Bartlett (NRPB)

4.3. *Stand der Personendosimetrie in der Schweiz im Vergleich zur Europäischen Union*
Christian Wernli, Dipl. Physiker ETH

HARMONISATION AND DOSIMETRIC QUALITY ASSURANCE IN INDIVIDUAL MONITORING FOR EXTERNAL RADIATION

The European Radiation Dosimetry Group (EURADOS) is a scientific society founded in 1981 to stimulate and improve co-operation on radiation dosimetry research and related topics within the European Union. The recommendations made and protocols developed by EURADOS are based on the scientific expertise of its members and should therefore provide a good scientific basis for the harmonisation of standards and procedures within the European Union.

EURADOS, in December 1996, set up an Action entitled ‘ Harmonisation and Dosimetric Quality Assurance in Individual Monitoring for External Radiation’.

The principal objectives of this Action were to assist the consolidation within the EU of the quality of individual monitoring using personal dosemeters and to facilitate harmonised procedures.

Also to be considered were:-
dose quantities; dosimetric requirements, including reliability, uncertainties; approval procedures and QA; inventory of dosemeters and methods; consolidated performance test.

EURADOS

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Contents

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EN

Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited period.

The titles of all other Acts are printed in bold type and preceded by an asterisk.

‘individual monitoring shall be systematic for exposed category A workers ... based on individual measurements which are established by an approved dosimetric service’

‘*Approved dosimetric service*: a body responsible for the calibration, reading or interpretation of individual monitoring devices, or for the measurement of radioactivity in the human body or in biological samples, or for assessment of doses, whose capacity to act in this respect is recognised by the competent authorities’

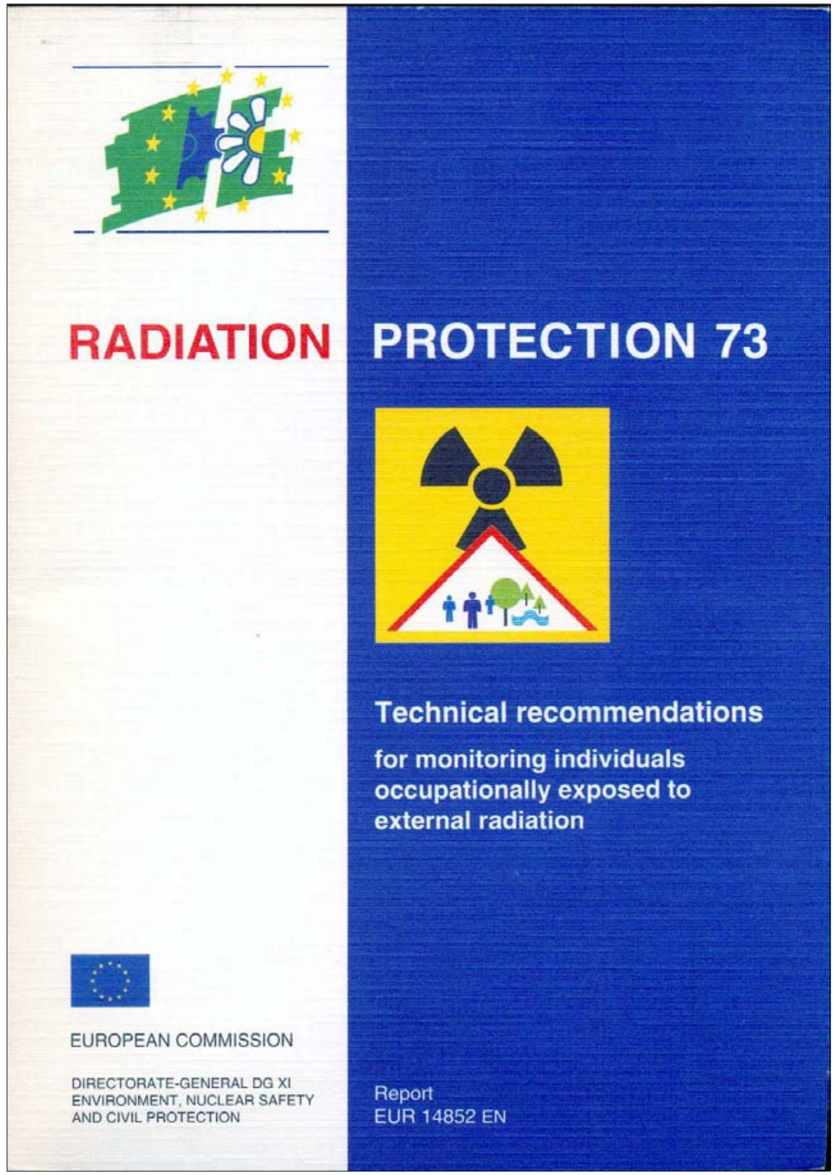
'operational quantities for external radiation are used for individual monitoring for radiation protection purposes’

‘Each Member State shall make the necessary arrangements to recognize, as appropriate, the capacity of the approved dosimetric services’

EURADOS

The principle of the free movement of goods and services within the European Union would suggest that, in due course, an individual measurement of dose made by an approved dosimetric service in one Member State might be acceptable to the relevant authorities in another.

This is already implied by the outside workers directive, in which a dosimetric service in one Member State is authorised to enter dose data into a radiation passbook of a worker from an other Member State.


RADIATION PROTECTION 73

Technical recommendations

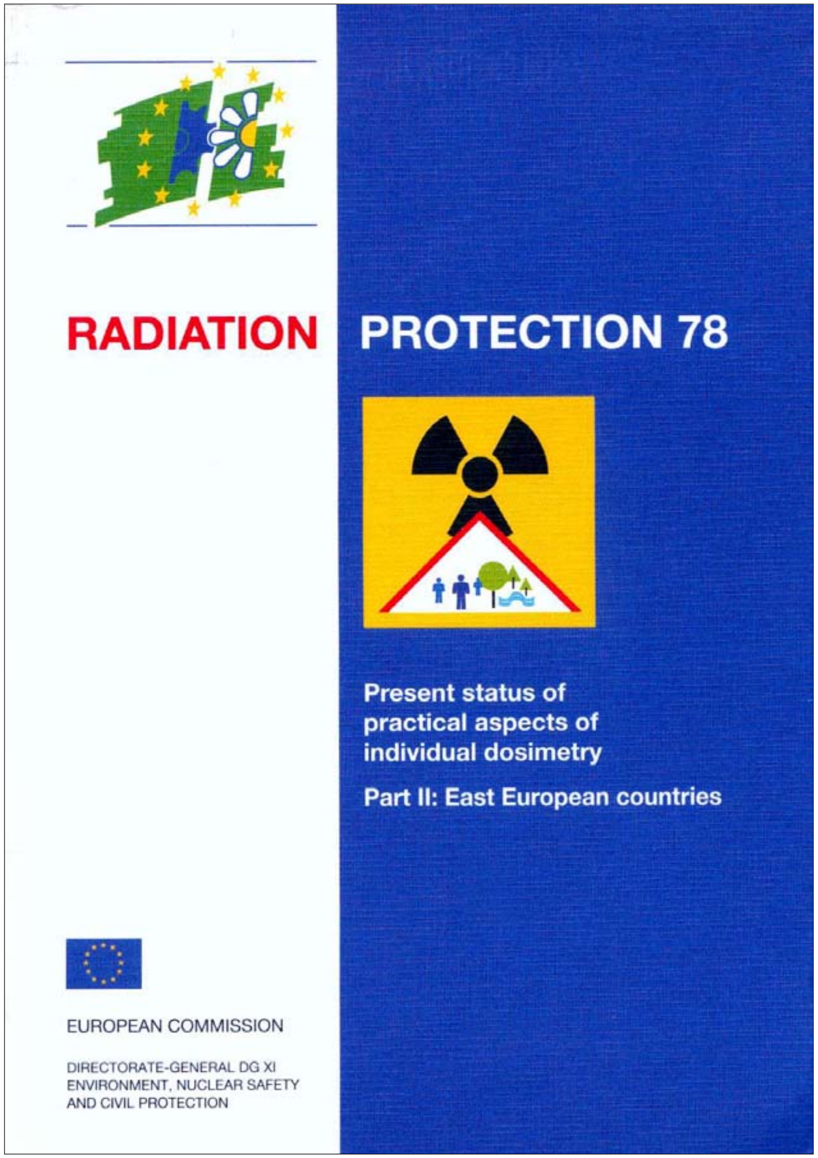
for monitoring individuals occupationally exposed to external radiation

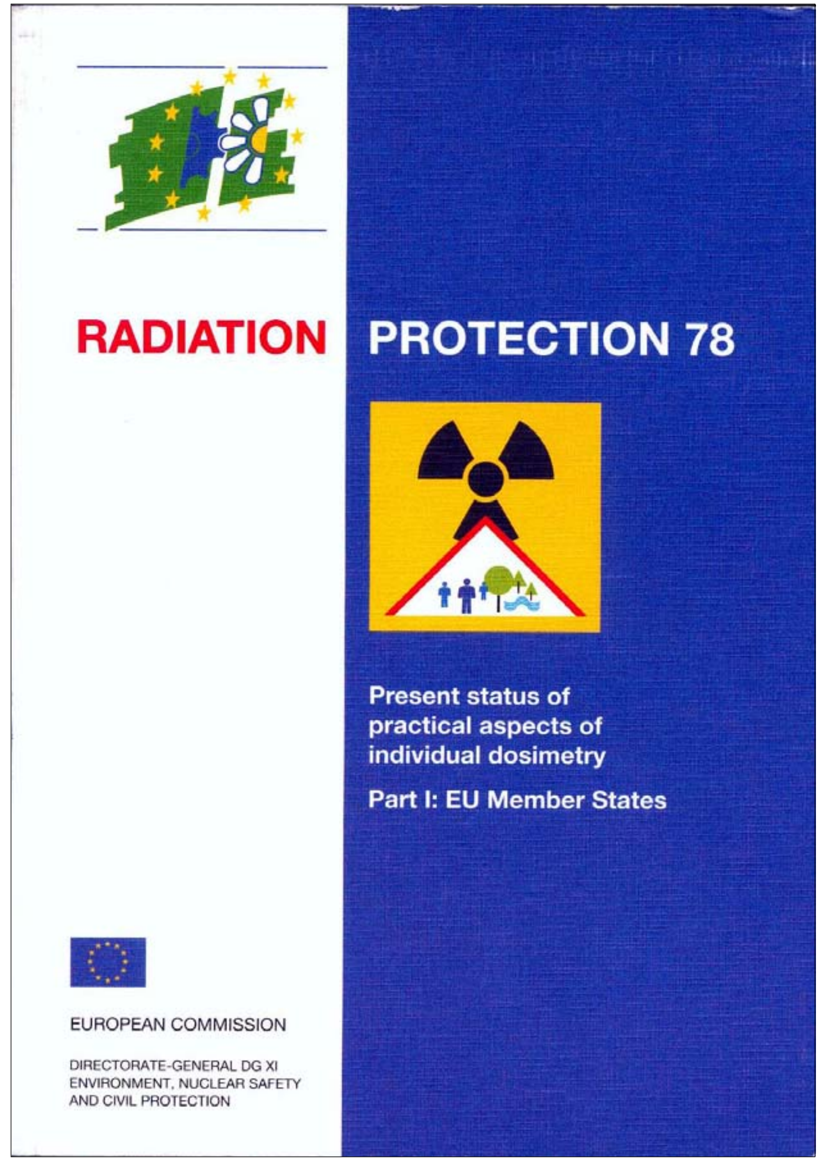
EUROPEAN COMMISSION

DIRECTORATE-GENERAL DG XI
ENVIRONMENT, NUCLEAR SAFETY
AND CIVIL PROTECTION

Report
EUR 14852 EN

EURADOS


RADIATION PROTECTION 78
Present status of practical aspects of individual dosimetry
Part II: East European countries
EUROPEAN COMMISSION
DIRECTORATE-GENERAL DG XI
ENVIRONMENT, NUCLEAR SAFETY
AND CIVIL PROTECTION


RADIATION PROTECTION 78
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EUROPEAN COMMISSION
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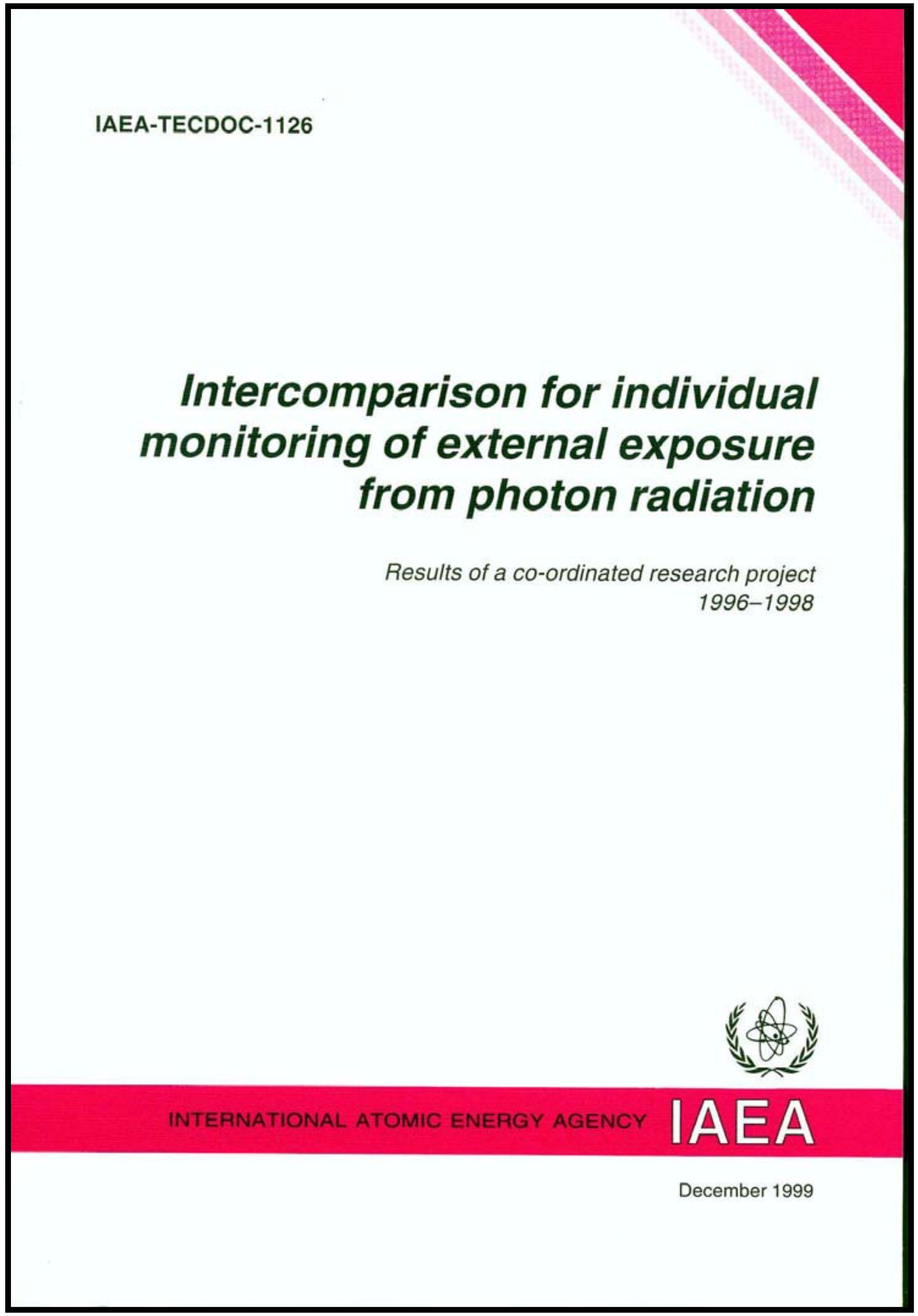


IAEA-TECDOC-1126

Intercomparison for individual monitoring of external exposure from photon radiation

Results of a co-ordinated research project 1996–1998

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

December 1999

EURADOS

Peter Ambrosi (PTB, Germany)
Carlo Back (Ministère de la Santé, Luxembourg)
David Bartlett (NRPB, UK)
Jean-Marc Bordy (IPSN, France)
Poul Christensen (Risø, Denmark)
Tony Colgan (RPII, Ireland)
Antonio F. de Carvalho (ITN, Portugal)
Antonio Delgado (CIEMAT, Spain)
Janwillem van Dijk (NRG, Netherlands)
Elena Fantuzzi (ENEA, Italy)
Hannu Hyvönen (STUK, Finland)
Lennart Lindborg (SSI, Sweden)
Hannes Stadtmann (ARCS, Austria)
Filip Vanhavere (SCK-CEN, Belgium)
Christian Wernli (PSI, Switzerland)
Maria Zamani-Valasiadou (Aristotle Univ. Thessaloniki, Greece)

EURADOS

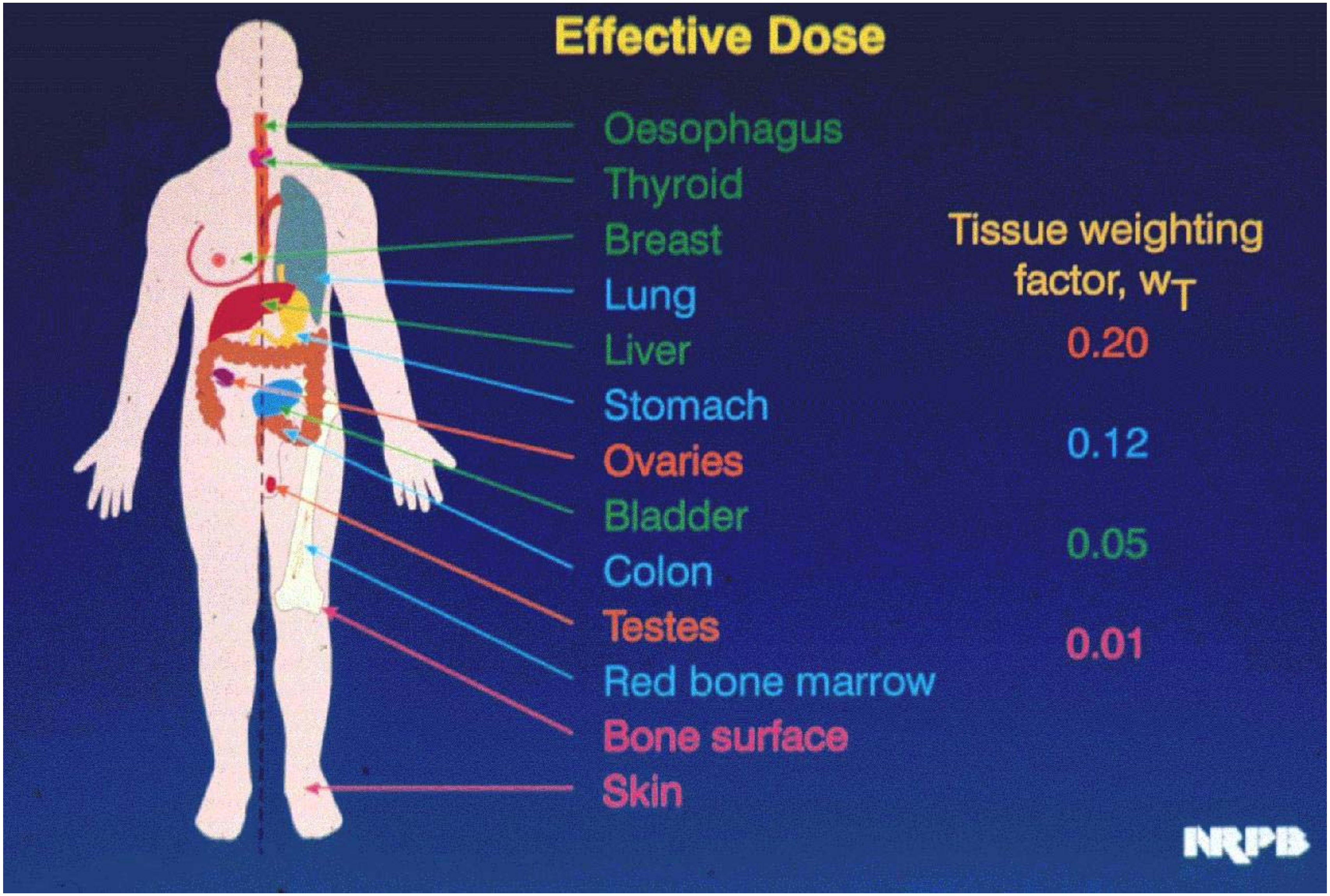
HARMONISATION

The definition of harmonise is
"*to sing or play in harmony, to be in harmony; to agree; to form a concord*"
and of harmony
"combination or adaptation of parts, elements or related things, so as to form a consistent and orderly whole; agreement; congruity"

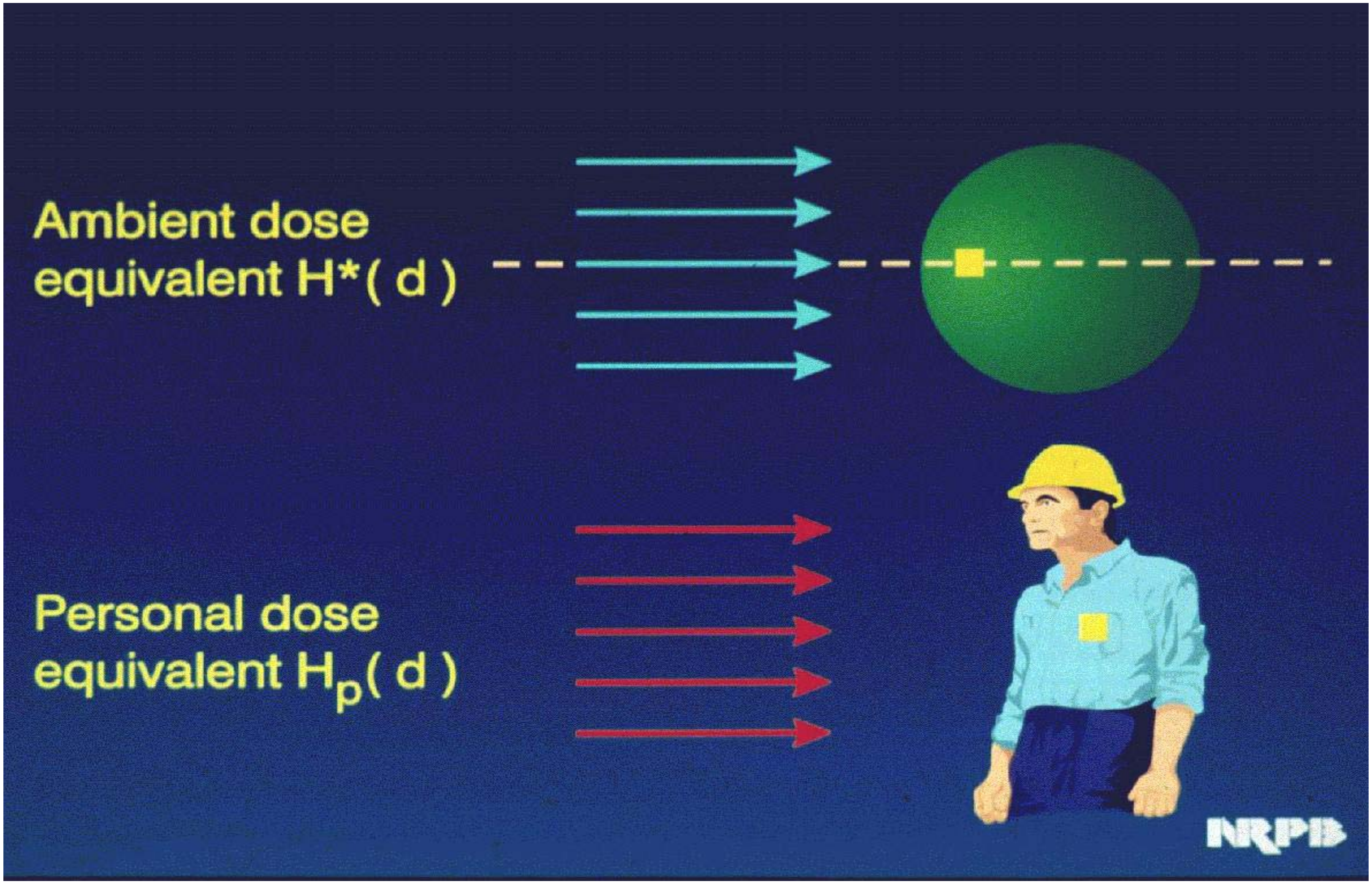
Harmony is a musical term and the musical definition is
"The combining of notes simultaneously, and their successive use to produce chord progressions……harmony is concerned with the movement of individual voices"

Harmonisation as applied to dosimetric services, for example, does not mean that they should all follow exactly the same procedures, any more than different voices should sing the same notes to be in harmony. The dosimetric services should aim to meet the same general requirements, and be in the same 'key', to follow the music parallel.


Clavinova

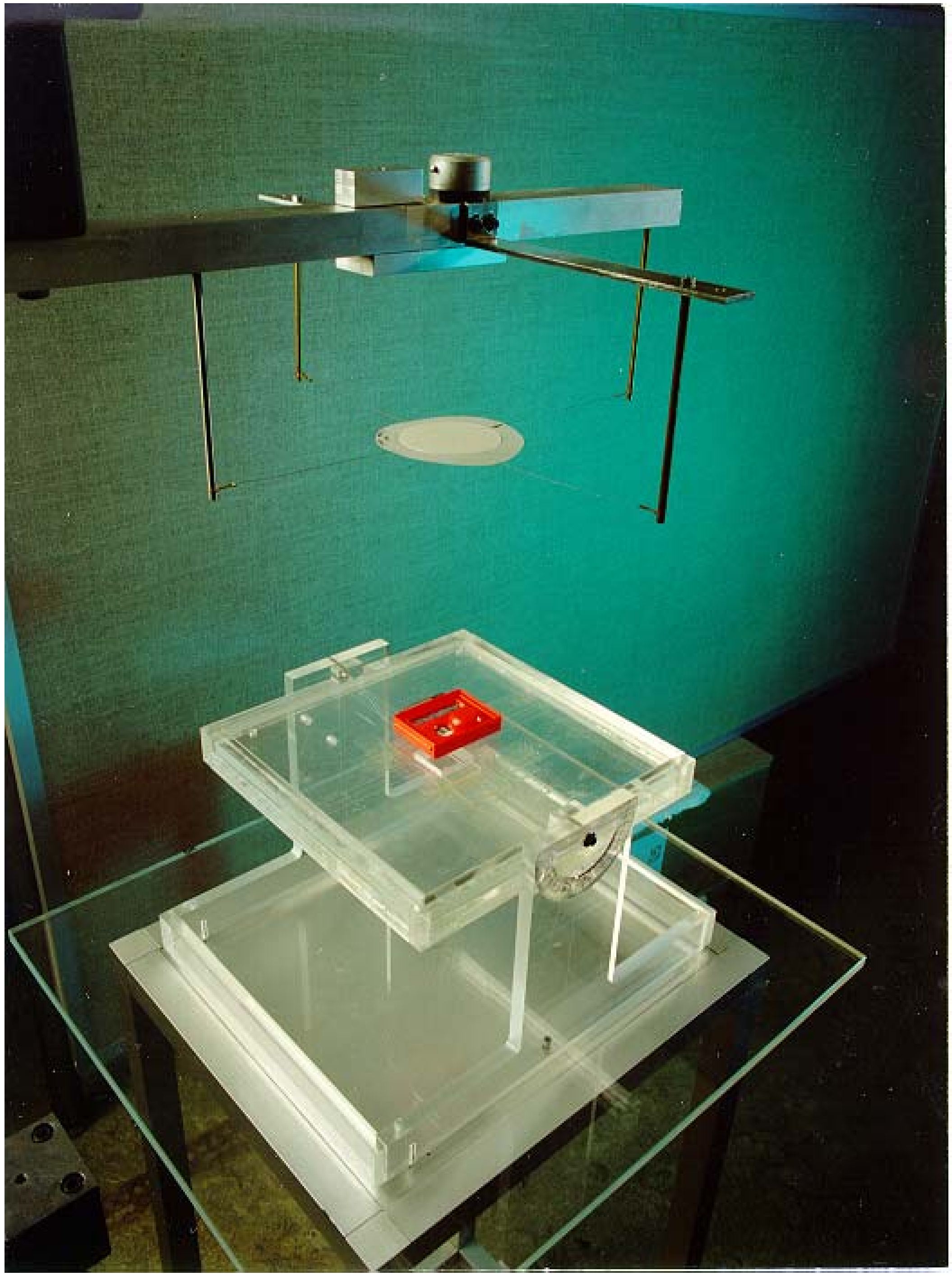

Effective Dose
Oesophagus
Thyroid
Breast
Lung
Liver
Stomach
Ovaries
Bladder
Colon
Testes
Red bone marrow
Bone surface
Skin
Tissue weighting factor, w_T
0.20
0.12
0.05
0.01
NRPB

ENRADOS

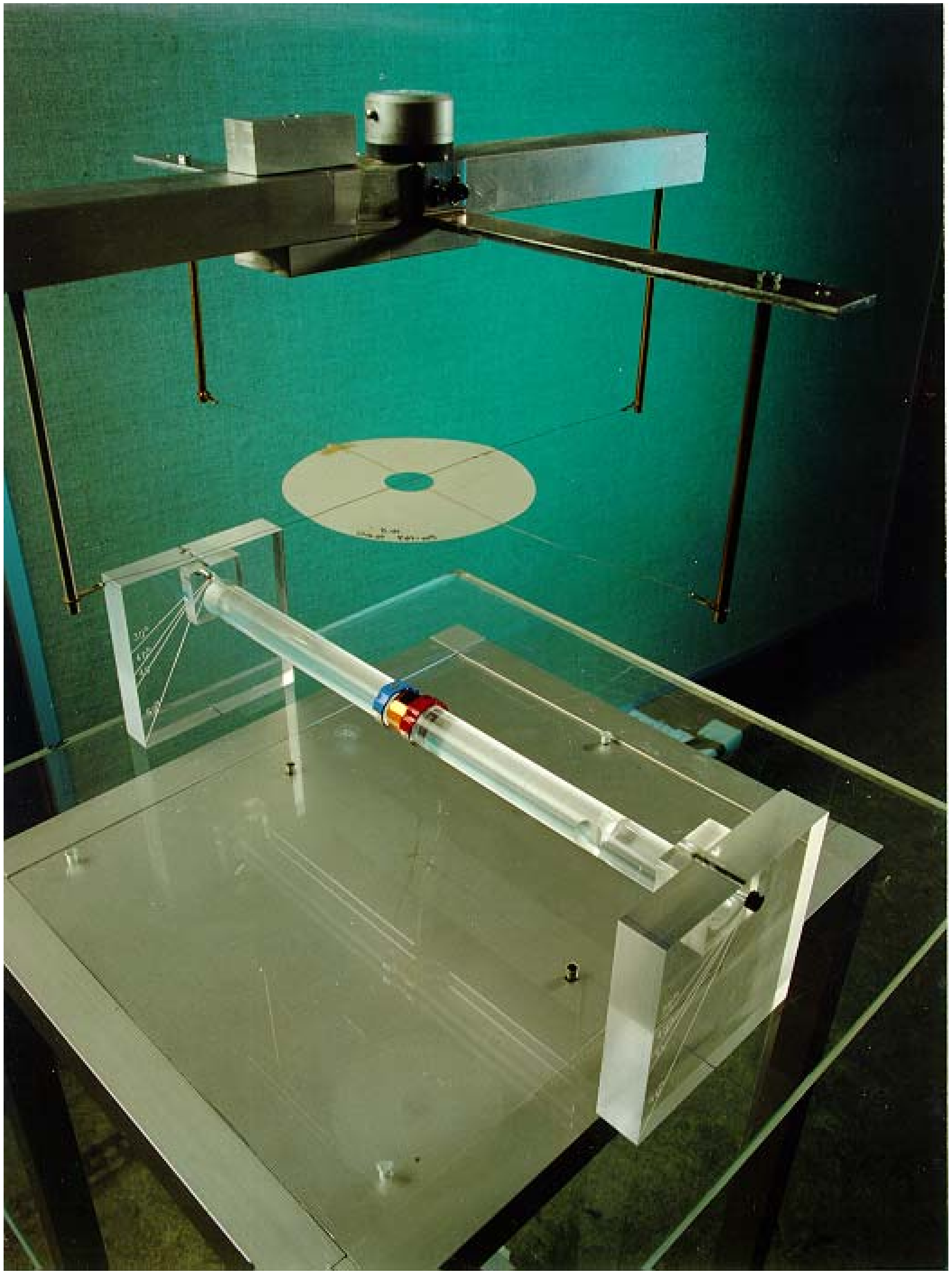


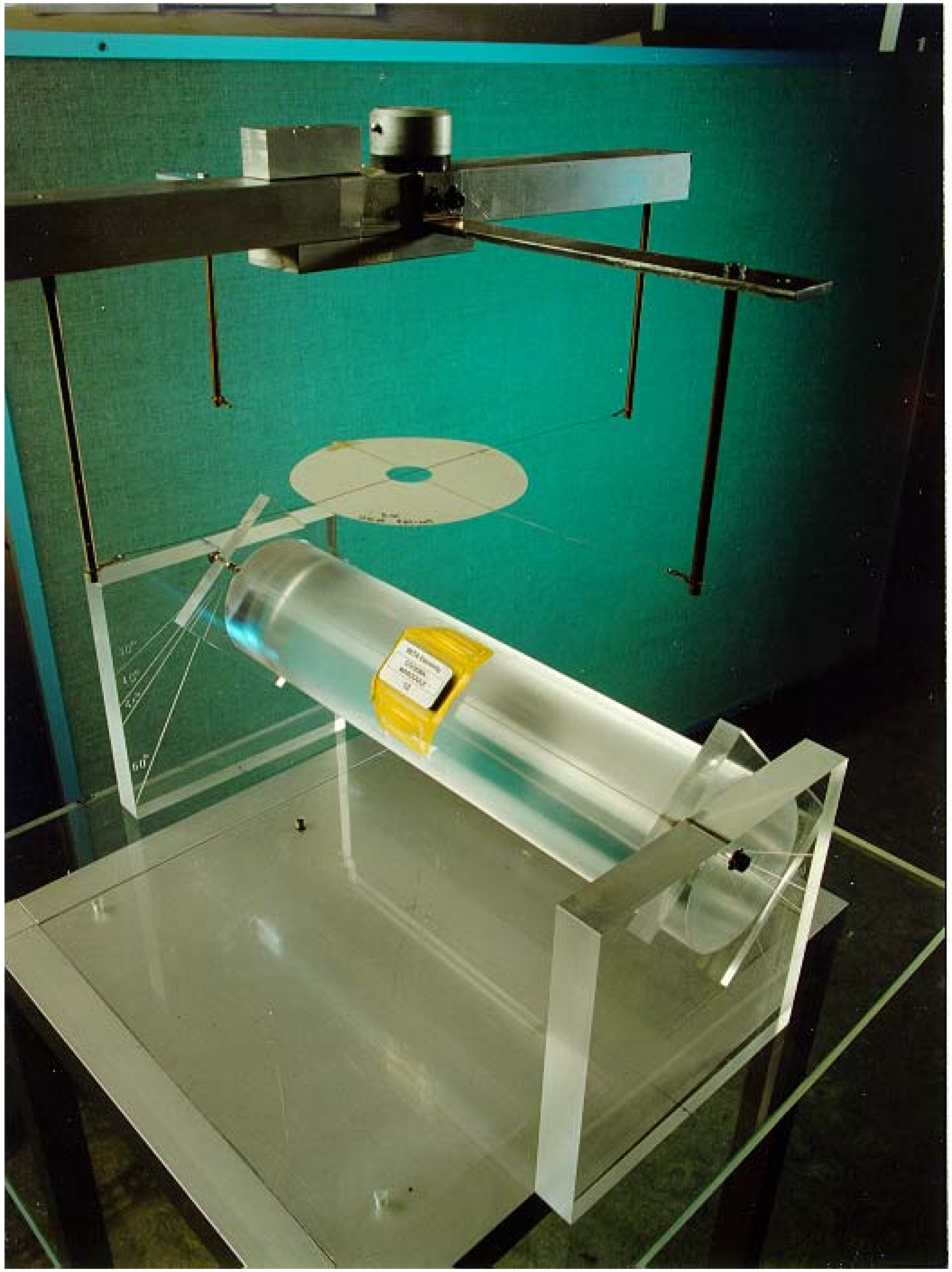
Ambient dose equivalent H*(d)
Personal dose equivalent H_p(d)
NRPB

EURADOS



EURADOS





EURADOS

Sub-group A

The task was to prepare a report on the current status within EU Member States and Switzerland of requirements for approved dosimetric services. The present situation amongst Member States is that there are widely differing national requirements for the performance of dosimetric services and dosemeters. It is clear that with the free movement of workers within the EU and the multinational ownership of companies, a degree of harmonisation of requirements and procedures would be desirable. The purpose of the report is to assist harmonisation, by giving the current status of procedures and requirements in Member States and Switzerland thereby allowing comparisons to be made.

Sub-group B

The purpose was to present an overview of dosemeters and dosimetric services within EU member states and Switzerland that were able to estimate external radiation doses as personal dose equivalent, $H_p(d)$. The total number of dosimetric services in the EU and Switzerland was estimated to be approximately 200. Questionnaires requesting information on various topics concerning the dosimetric systems used, were sent to these services. Of the dosimetric services that responded, 45 reported that they estimated the external radiation doses as personal dose equivalent, $H_p(10)$ and $H_p(0.07)$. The majority of these services used thermoluminescence dosemeters (TLDs). From the results of this study combined with some information from other studies, it was estimated that roughly 50% of the radiological workers in the EU and Switzerland were monitored in terms of personal dose equivalent

Sub-group C

The task was to gain an overall assessment of the ability of current dosimetric services to determine the operational quantities $H_p(10)$ and $H_p(0.07)$, with emphasis on the performance in workplace fields, and to understand the physical basis for the performance characteristics, and to allow an assessment to be made as to whether proposed dosimetric requirements, in particular performance test criteria in use or proposed, were suited to present dosimetric services

Sub-group A:
Procedures for routine individual dose assessment of external radiation within EU Member States and Switzerland- status of harmonisation on 1st April 1999

P. Ambrosi (co-ordinator)
E. Fantuzzi   A. F. de Carvalho
A. Delgado L. Lindborg   D. T. Bartlett

EURADOS

Statistics of services and persons monitored

Code	No. of services	Total no. of persons monitored	No of persons monitored with dosemeters worn on					
			the trunk for			the extremities for		
			photons	neutrons	betas	photons	neutrons	betas
A	4	35 500	35 000	250	—	2 000	—	—
B	13	43 500	43 500	350	—	—	—	—
CH	10	62 000	62 000	5 000	60 000	1 500 [ch])	—	1 500 [ch])
D	6	288 000 [d])	288 000 [d])	6 600 [d])	—	12 000 [d])	—	320 [d])
DK	3	11 000	11 000	155	11 000	50	—	50
E	20	87 000	87 000	~ 5 000	~3 000	~3 000	—	~300
EL	1	7 000	7 000	100	—	100	—	—
F	7	230 000	230 000	16 700	29 800	16 300 [f])	7 250 [f])	9 600 [f])
FIN	3	12 000	12 000	80	—	370	—	—
I	80 [i])	130 000	128 000	2 000	—	30 000	—	—
IRL	3 [irl])	5 850	5 850	80	—	250	—	40
L	1	1 100	1 100	—	1 100	—	—	—
NL	5	34 000	34 000	—	3 500	—	—	—
P	2	9 000	9 000	—	—	100 [p])	—	—
S	12	20 000	20 000	2 000	—	—	—	—
UK	28 [uk1])	150 000 [uk2])	150 000 [uk2])	25 000 [uk2])	150 000 [uk2])	10 000 [uk2])	—	10 000 [uk2])
Total	198	1 125 950	1 123 450	63 315	258 400	76 670	7 250	21 810

The ICRP75 recommendations, applied to the magnitude of the quotient of the measured dose value, H_m, and the conventionally true value, H_t, may be interpreted as follows:

for a dose value equal to or approaching the annual dose limit, acceptable performance is described by the relation 1.5 > H_m/H_t > 1/1.5 at the 95 % confidence level, *i.e.* with a standard uncertainty with a coverage factor of 2

for a dose value less than or equal to H_r, the recording level for a monitoring period, the corresponding relation is 2.0 > H_m/H_t > 0, no confidence levels are given

ICRU Report 47
'a total uncertainty in the measurement of the operational quantity of one standard deviation of 30% should be acceptable'
'the error of instruments may substantially exceed the value of 30% at some neutron energies or angle, but be acceptable for workplace fields with broad energy and angle distributions'

Personal dosimeters will, at best, only register the dose equivalents received by the regions of the body that are in proximity to these devices. As a general rule, errors in the determination of dose equivalents in radiation protection should be on the safe side

The general requirements are considered, and their routine application, categorised in this study as 'trumpet curves'; 'criteria based on consideration of bias and standard deviation'; or 'criteria based on the analysis of measurement data'

National requirements on overall accuracy for individual monitoring with reference to international standards

Code	Requirements on overall accuracy
A	95 % level: $\lvert H_m - H_{m,ref} \rvert / H_{m,ref} < 0,5 + H_0 / (H_0+H_t)$ Eq. A1 $H_0 < 0,2$ mSv for $H_p(10)$ and $H_0 < 1,0$ mSv for $H_p(0,07)$ $\lvert H_t - H_{m,ref} \rvert / H_t < 0,4$ for $H_t < 1$ mSv $\lvert H_t - H_{m,ref} \rvert / H_t < 0,25$ for $H_t > 1$ mSv
B	There are no official requirements, but the performance of the dosemeter is judged by an expert of the ministry
CH	Must fulfil overall accuracy requirement of EUR 73
D	92 % level: $1 + 0.4 \cdot t(H_t) > H_m/H_{m,ref} > 1 - 0.4 \cdot t(H_t)$, $H_0 < 0.2$ mSv
DK	Must fulfil overall accuracy requirement of EUR 73
E	IEC 1066
EL	According to EUR 73
F	IEC 1066, ISO 14146
FIN	According to EUR 73
I	$0.7\ [1-2\ K_0/(K_0+K_t)] < K_m/K_t < 1.5\ [1 + K_0/(2\ K_0 + K_t)]$
IRL	According to EUR 73
L	None
NL	Must fulfil overall accuracy requirement of EUR 73
P	There are no official requirements
S	According to EUR 73
UK	For thermoluminescent and photographic film dosemeters to assess $H_p(10)$ or $H_p(0.07)$: 95 % level: $1.5 > H_m/H_t > 1 / 1.5$ for $H_t \approx H_a$ (H_a = 50 mSv [ICRP 26]) ($\overline{H}_a$ = 20 mSv [ICRP 60]) $2.0 > H_m/H_t > 0.5$ for $H_t < 10$ mSv [ICRP 35] $2.0 > H_m/H_t > 0$ for $H_t = H_r$, $H_r = 0.2$ mSv [$H_p(10)$] or $H_r = 2$ mSv [$H_p(0.07)$]
ICRP 35	95 % level: $1.5 > H_m/H_t > 1 / 1.5$ for $H_t \approx H_a$ (H_a = 50 mSv [ICRP 26]) ($\overline{H}_a$ = 20 mSv [ICRP 60]) $2.0 > H_m/H_t > 0.5$ for $H_t < 10$ mSv [ICRP 35] $2.0 > H_m/H_t > 0$ for $H_t = H_r$, $H_r = H_a / 120$
ICRP 60	$1.5 > H_m/H_t > 1 / 1.5$ for $H_t \approx H_a = 20$ mSv
ICRP 75	95 % level: $1.5 > H_m/H_t > 1 / 1.5$ for $H_t \approx H_a$ ($\overline{H}_a$ = 20 mSv [ICRP 60]) $2.0 > H_m/H_t > 0$ for $H_t = H_r$, $H_r > 0.085$ mSv
EUR 73	95 % level: trumpet curve with $H_0 = H_l / 10$ ($2.0 > H_m/H_t > 0$ for $H_t = H_0$) (H_0 is lowest dose required to be measured) H_a = 20 mSv as given by ICRP 60 ➦ $H_0 = 0.17$ mSv for monthly monitoring period, H_l = 20 mSv/12 ➦ $H_0 = 0.08$ mSv for two-weekly monitoring period, H_l = 20 mSv/24
ISO 1757	No special requirements

Continued

Code	Requirements on overall accuracy
ISO 14146 d	90 % level: trumpet curve ($H_0 > 0.2$ mSv is the lower limit of the dose range specified in the type test)
IEC 1066	no requirement *(95 % level: $1.77 > H_m/H_t > 0.33$ Calculated according to ISO guide)*
IEC 1283 ser.	no requirement *(95 % level: $2.1 > H_m/H_t > 0.0$ Calculated according to ISO guide)*
IAEA 99	as EUR 73
Definitions:	H_m, K_m := measured dose or air kerma value for the period considered $H_{m,ref}$:= measured dose value under reference conditions H_t, K_t := conventional true value of the dose or air kerma K_0 := minimum kerma value for the irradiation test (0.1 mGy or 0.05 mGy for trunk and for extremity dosemeters respectively) H_a := dose limit for the period of one year H_r := recording level for the period of one month H_l := dose limit for the period considered U_{95} := absolute uncertainty of H_m on 95 % level trumpet curve: $\frac{1}{1.5}\left(1-\frac{2H_0}{H_0+H_t}\right) \le \frac{H_m}{H_t} \le 1.5\left(1+\frac{H_0}{2H_0+H_t}\right)$ trumpet function: $t(H_t)=1+\frac{20}{9}\frac{H_0}{H_0+H_t}$, H_0 := lowest dose for which trumpet curve can be used

Approval of (or acceptance requirements for) dosemeters

Code	Legal basis for approval for			Type of Approval and who did it	Approval frequency	Remark
	photons	neutrons	betas			
A	(A3, A4)	None	None	formal type test by BEV [a1])	Once	—
B	(B2)	(B2)	(B2)	Report judged by expert of Ministry	10 years	—
CH	(CH2, CH3)	(CH2, CH3)	(CH2, CH3)	Part of approval procedure for service	5 years	—
D	(D7, D8, D9)	(D8)	(D8)	Photons: type-test by PTB [d1]) All: Formal approval by BLA [d1])	Once	—
DK	Compliance with intern. standards	Compliance with intern. standards	Compliance with intern. standards	Details of dosemeter characteristics to be provided as part of approval of service	Once	None
E	(E1)	(E1)	(E1)	Comparison with (15)	Once	None
EL	Compliance with intern. standards	Compliance with intern. standards	None	GAEC [el])	GAEC	—
F	(F1 – F3, F8, F12 – F15)	Compliance with intern. standards	Compliance with intern. standards	Mandatory tests [f1])	Once a year [f2])	—
FIN	(FIN10)	None	(FIN10)	Inspector on site by STUK	Before the service starts	—
I	Art. 107[(14)] [i1])	None	None	'Type test' done by 'Control Institutes' [i1])	—	—
IRL	Compliance with intern. standards	Compliance with intern. standards	Sourced Externally	Approved by Radiological Protection Institute of Ireland (RPII)	Before the service starts	—
L	None	None	None	—	—	None
NL	(NL2)	(NL2)	(NL2)	Type-test report, Ministry for SZW	Once	—
P	None [p])	None [p])	None [p])	—	—	None
S	(S3)	(S3)	(S3)	Photon and beta tests [s])	2 years	—
UK	None	None	None	Details of dosemeter characteristics to be provided as part of approval of service	5 years	[uk])

QA Procedure officially prescribed

Abbreviations used in the table: at.: announced test; int.: intercomparison; pt.: performance test; st.: surprise test

Code	Legal or other basis for external performance testing for			Dosimetric method for external performance testing for			Remark
	photons	neutrons	betas	photons	neutrons	betas	
A	(A3) [a])	None	None	Monthly at. [a])	None	None	—
B	None	None	None	None	None	None	—
CH	(CH2)	(CH2)	(CH2)	annual at.	irregular at.	irregular at.	—
D	(D3, D6)	(D8)	(D8)	annual st.	annual at.	annual at.	—
DK	compliance with intern. Standards	compliance with intern. Standards	compliance with intern. Standards	annual at.	—	annual at	—
E	None	None	None	voluntary tests	None	None	—
EL	None	None	None	annual at. and st.	annual at. and st.	—	—
F	Mandatory test [f])	None	None	Annual at.	None	None	—
FIN	Inspection [fin])	Inspection [fin])	Inspection [fin])	Periodical pt.	None	Periodical pt.	—
I	None	None	None	EDP: voluntary test	none	none	[I])
IRL	informal pt.	informal pt.	None	Bi–annual int.	None	Bi–annual int.	
L	None	None	None	None	None	None	—
NL	None	None	None	None	None	None	—
P	None	None	None	None	None	None	—
S	(S3)	(S3)	(S3)	Bi-annual at.	Bi-annual at.	Bi-annual at.	—
UK	Regulation 15 of IRR 85 (UK2)	Regulation 15 of IRR 85 (uk2)	Regulation 15 of IRR 85 (uk2)	pt. at intervals of 18 months [uk1])	Currently no performance tests [uk2])	Currently no performance tests [uk2])	[UK2])

ENRADOS

Sub-group B:
A catalogue of dosemeters and dosimetric services within EU Member States and Switzerland able to estimate external radiation doses as personal dose equivalent

J.W.E. van Dijk (co-ordinator)
J.M. Bordy F. Vanhavere
C. Wernli M. Zamani-Valasiadou

Aim of the catalogue

Facilitating harmonisation by sharing the information on the design and properties of personal dose equivalent dosemeters and on the quality assurance of individual monitoring

Country Code	EURADOS Part I Table 8		EURADOS Part II Questionnaire		EURADOS Part II Hp only	
	Services	Workers	Services	Workers	Services	Workers
A	4	35 500	4	33 500	-	-
B	13	43 500	3	6 000	3	6 000
CH	10	62 000	7	44 900	7	44 900
D	6	287 930	6	122 000	1	-
DK	3	11 000	3	11 000	3	11 000
E	20	87 000	4	52 800	4	52 800
EL	1	7 000	2	6 000	2	6 000
F	7	230 000	7	224 900	7	224 900
FIN	3	12 000	2	3 400	2	3 400
I	80	130 000	2	8 000	2	-
IRL	3	5 850	1	4 500	1	4 500
L	1	1 100	1	1 100	1	1 100
NL	5	33 000	4	32 600	4	32 600
P	2	8 000	1	4 000	1	4 000
S	12	20 000	3	13 300	3	13 300
UK	28	200 000	7	46 900	7	46 900
Total	**198**	**1 173 880**	**57**	**614 900**	**48**	**451 400**

Statistics of dosimetric methods of dosemeters worn on the trunk

The following abbreviations are used: NT: Nuclear emulsion detector (NTA); PL: Photoluminescence detector; ED: Electronic dosemeter; BD: Bubble detector; Cd: Photographic film plus Cd converter

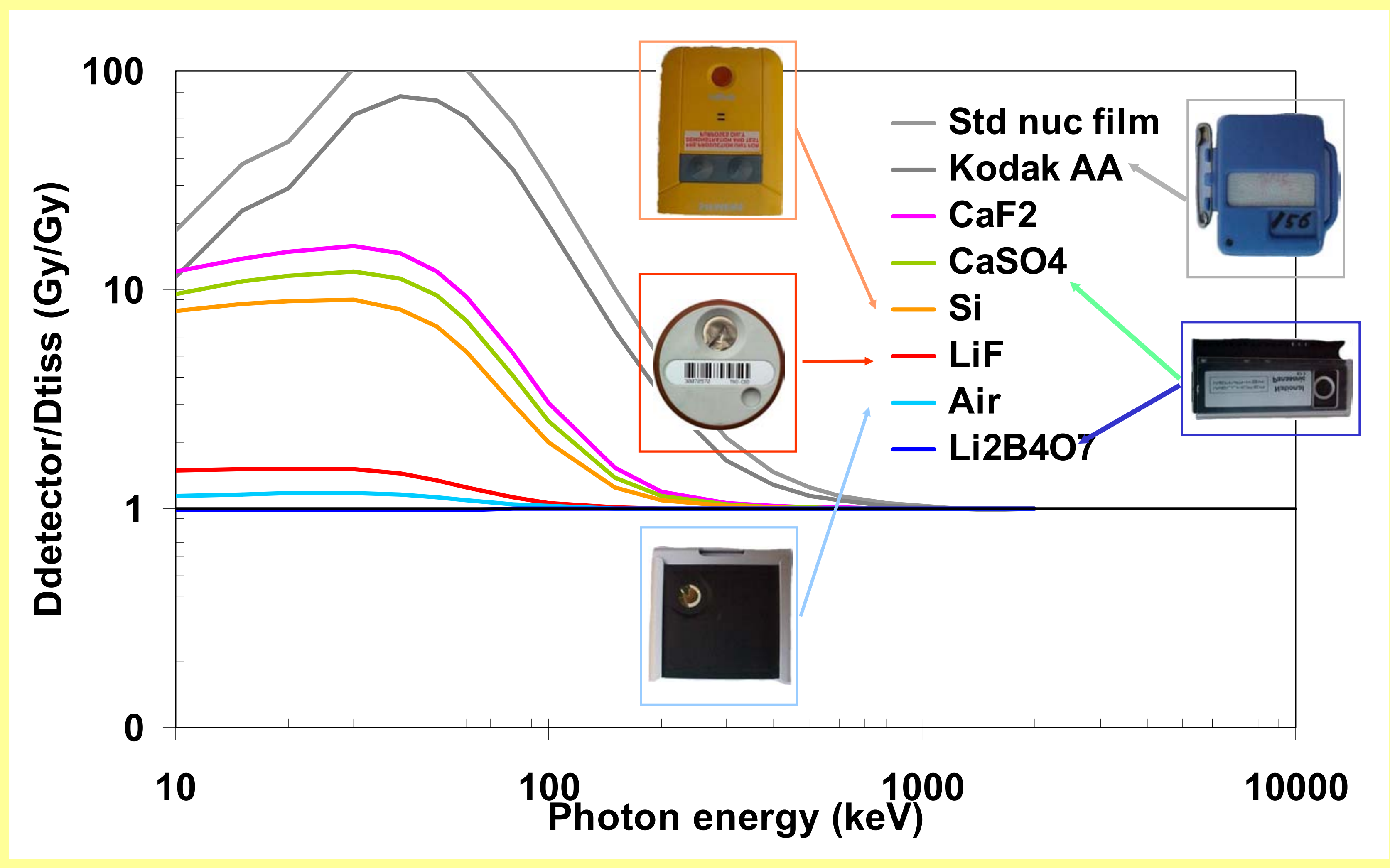
Code	No of persons monitored with dosemeters worn on the trunk for							
	photons using			neutrons using			betas using	
	TLD	Film	other	TLD	Track etch	other	TLD	other
A	35 000	—	—	250	—	—	—	—
B	~31 500 [b])	12 000 [b])	—	—	—	—	—	—
CH	56 000	6 000	—	—	1 000	NT: 4 000	54 000	6 000
D	5 600	273 000	PL: 9 500	5 600	50	NT: 600	—	—
DK	2 000	9 000	—	400	155	—	2 000	Film: 9 000
E	87 000	—	—	~5 000	—	—	~3 000	—
EL	—	7 000	—	100	—	—	—	—
F	11 100	230 000	EPD: 20 000	12 100		NT: 4 600 BD: 1 000 Cd: 3 300	11 100	Film: 29 800
FIN	12 000	—	—	80	—	—	12 000	—
I	80 000 [i])	50 000 [i])	—	2 000	1 000	—	—	—
IRL	5 850	—	—	—	—	NT: 80	—	—
L	1 100	—	—	—	—	—	1 100	—
NL	34 000	—	—	1000	—	—	3 500	—
P	6 500	2 500	—	—	—	—	—	—
S	10 000	10 000	—	2 000	—	—	—	—
UK	100 000	50 000	EPD: 150	100	10 000	NT: 5 000 Cd: 10 000	100 000	50 150
Total	477 650	649 500	29 650	28 630	12 205	28 580	186 700	94 950

[b]) Estimated values

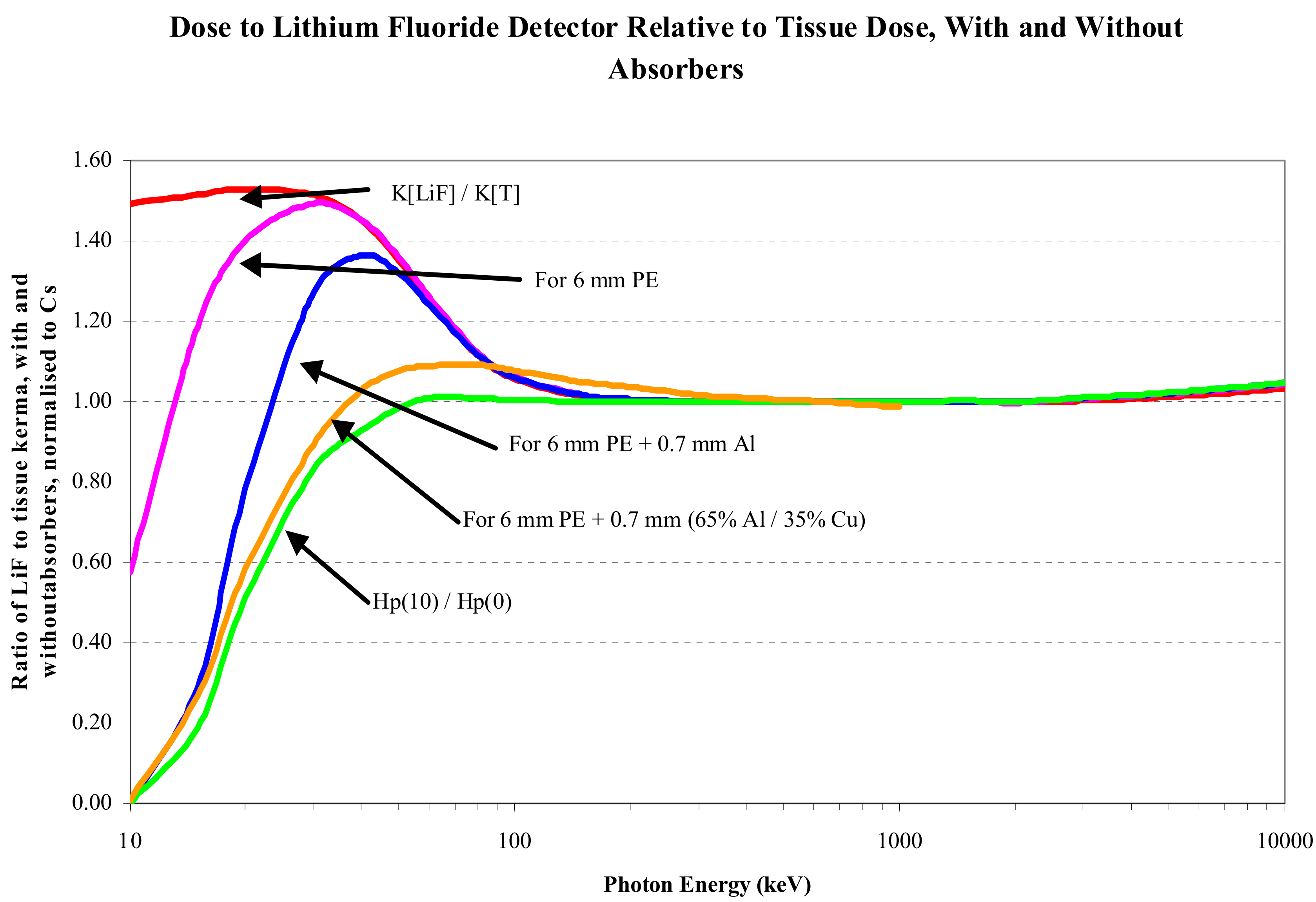
[i]) Estimated values

ENRADOS

Absorption of detector materials relative to soft tissue

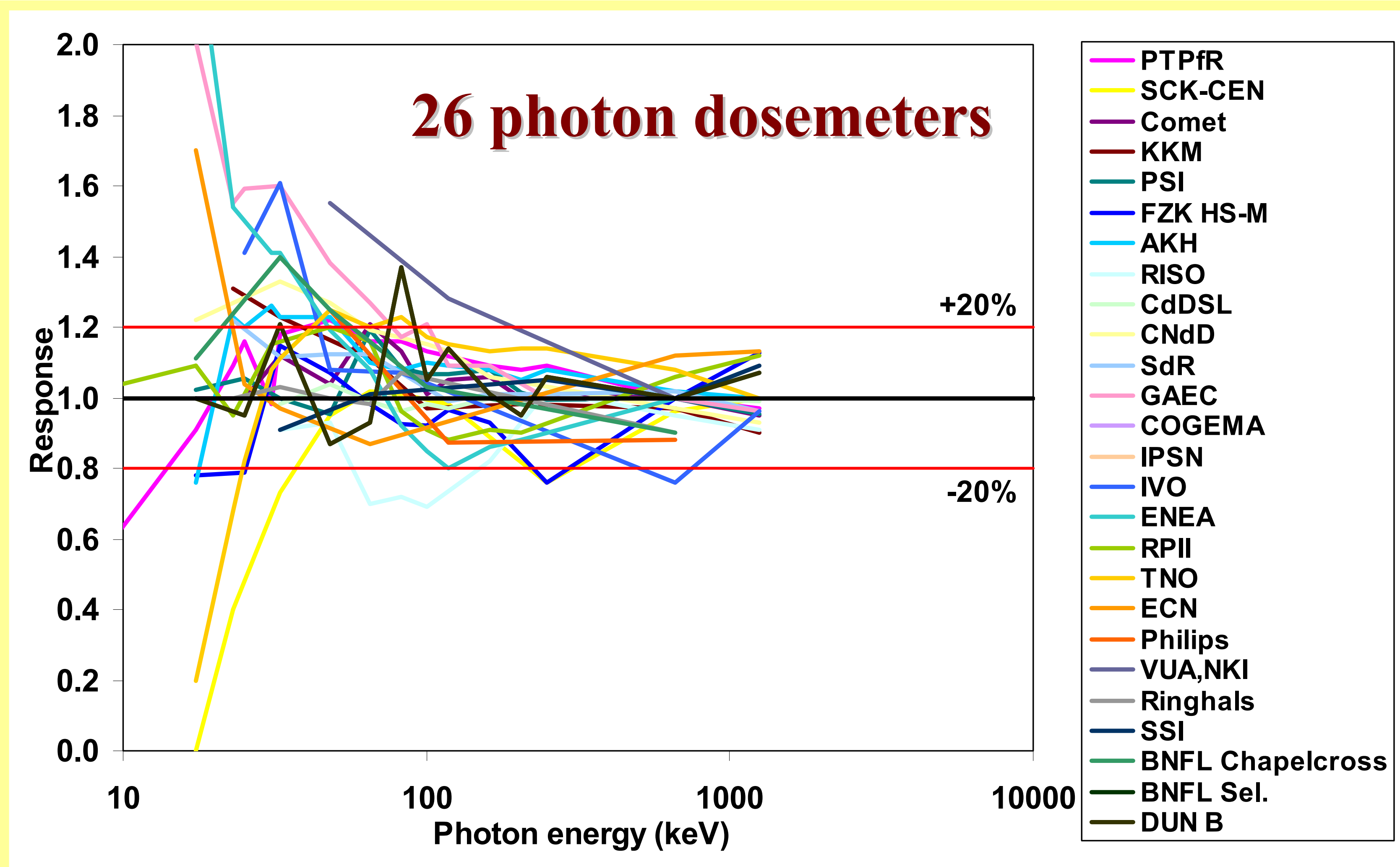


EURADOS



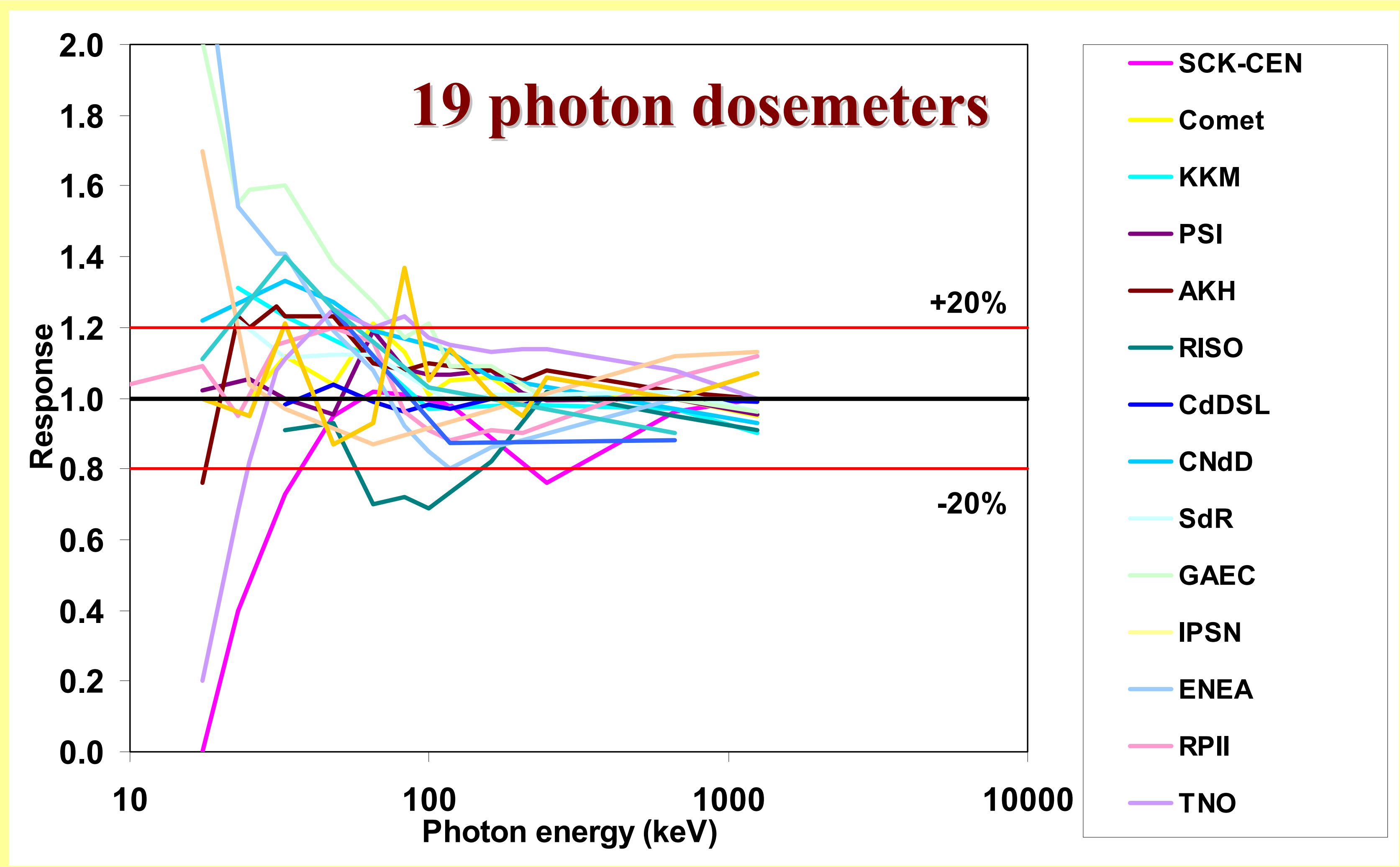
Dose to Lithium Fluoride Detector Relative to Tissue Dose, With and Without Absorbers
Ratio of LiF to tissue kerma, with and withoutabsorbers, normalised to Cs
Photon Energy (keV)
K[LiF] / K[T]
For 6 mm PE
For 6 mm PE + 0.7 mm Al
For 6 mm PE + 0.7 mm (65% Al / 35% Cu)
Hp(10) / Hp(0)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
10
100
1000
10000

$H_p(10)_{measured}/H_p(10)_{true}$

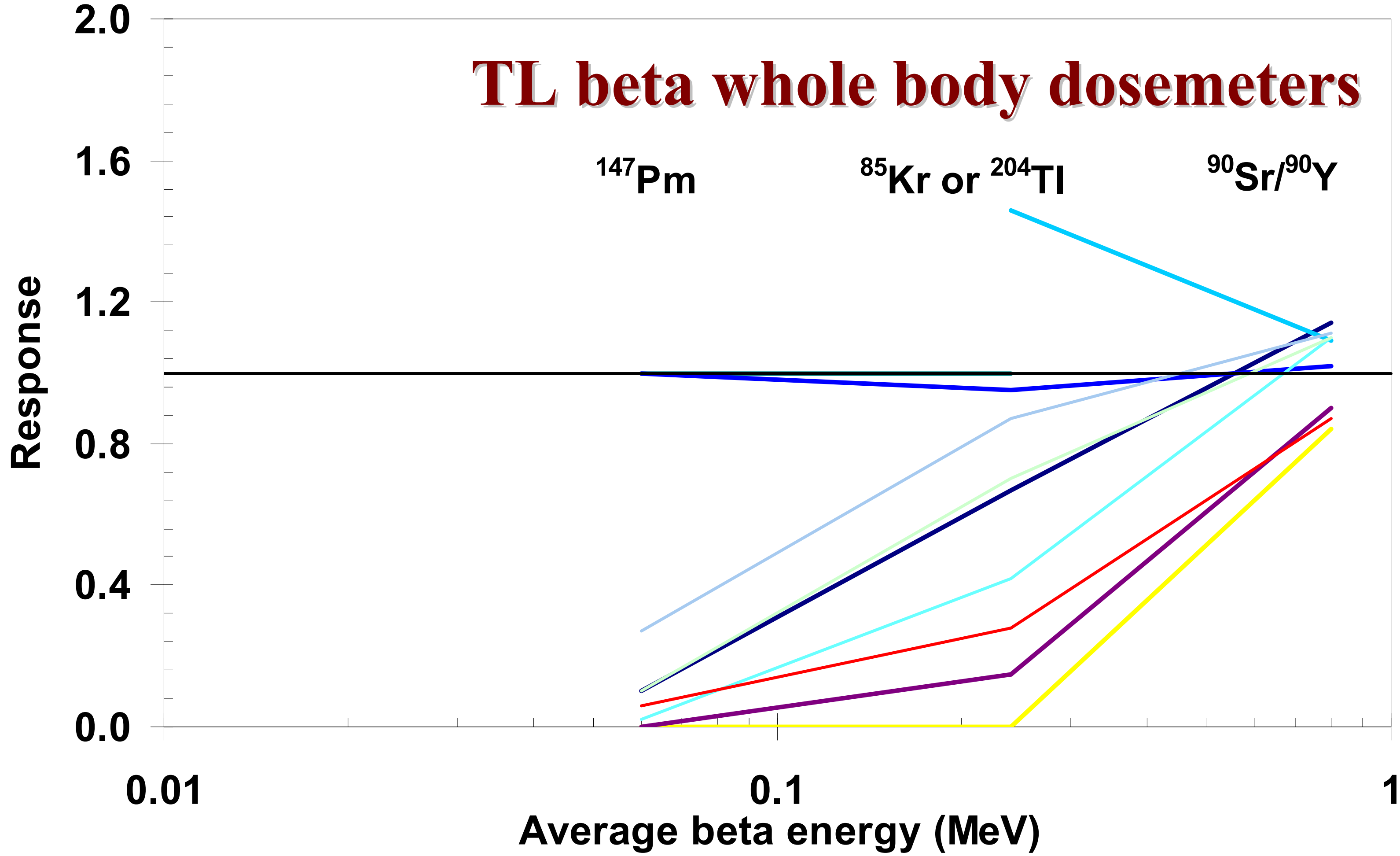


EURADOS

$H_p(0.07)_{measured}/H_p(0.07)_{true}$

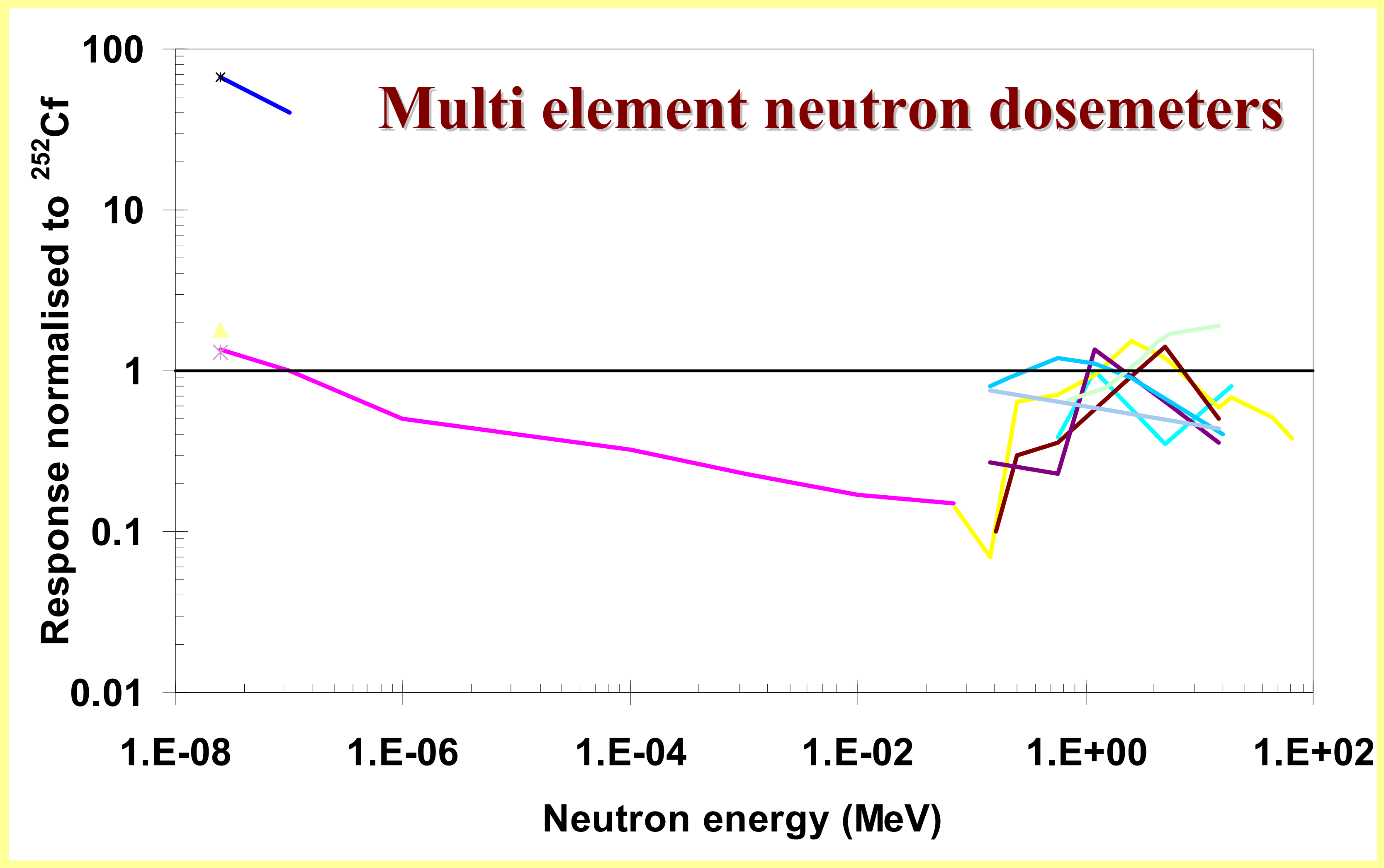


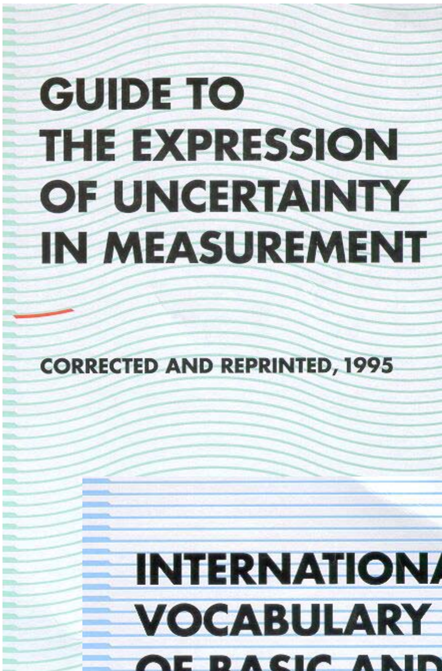
$H_p(10)_{measured}/H_p(10)_{true}$

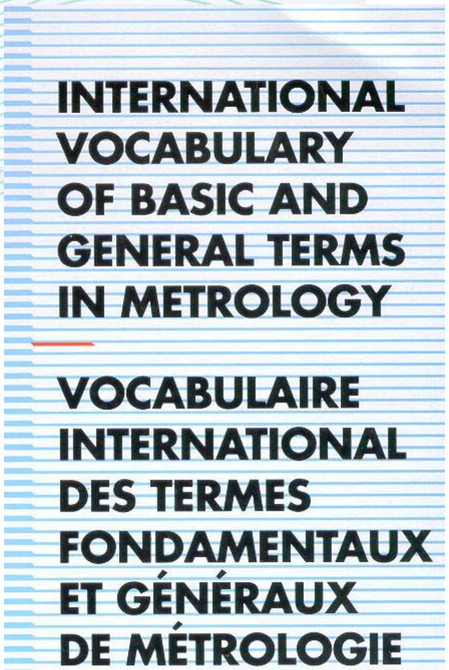


EURADOS

$H_p(10)_{measured}/H_p(10)_{true}$







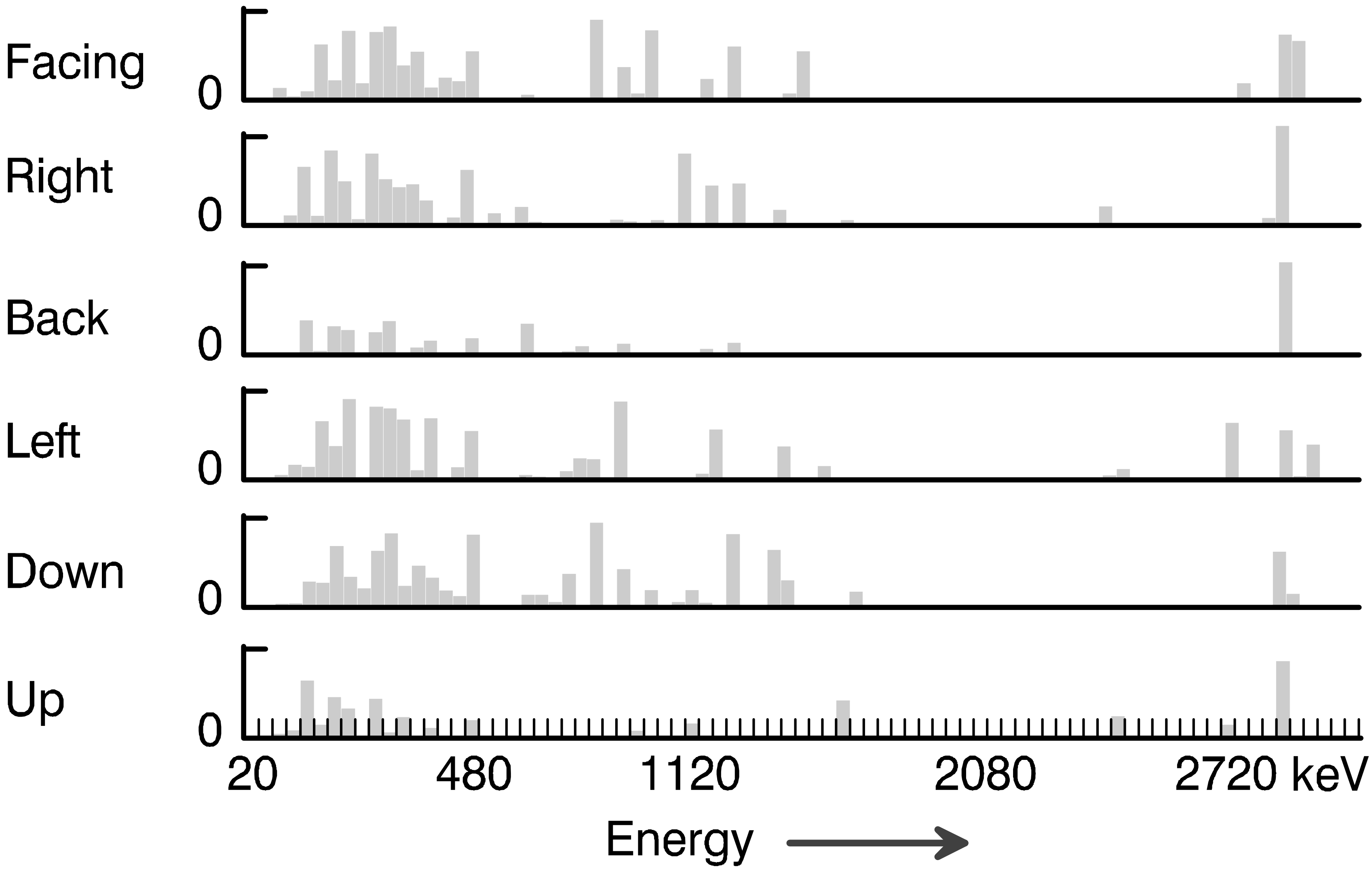
Uncertainty

1. **Main sources of uncertainty**
2. **Uncertainty in dose measurement**
3. **Detection limit**

Sub-group C:
Trial performance test of dosimetric services in the EU Member States and Switzerland for the routine assessment of individual doses (photon, beta, and neutron)

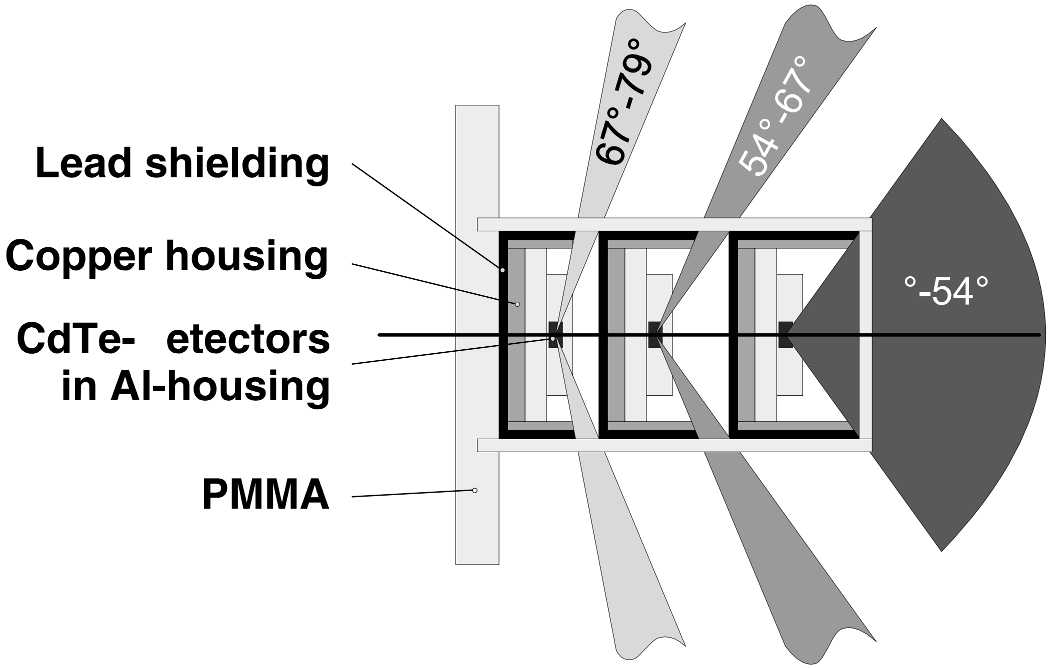
J.M. Bordy (co-ordinator)
H. Stadtmann P. Ambrosi
D. T. Bartlett P. Christensen
T. Colgan

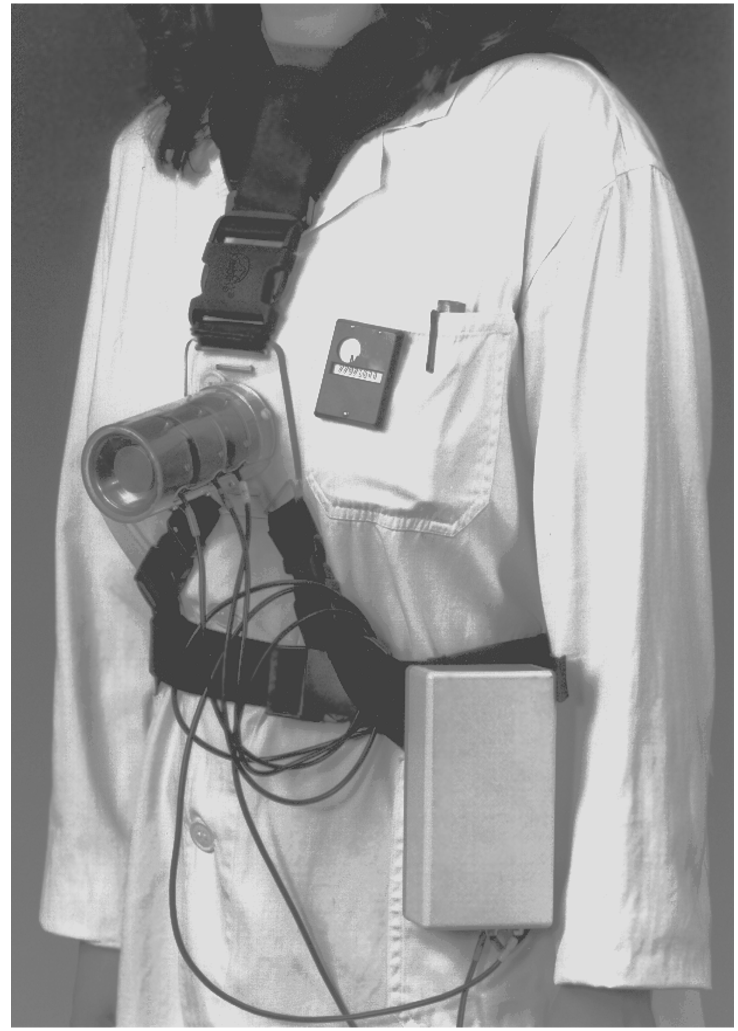
EURADOS

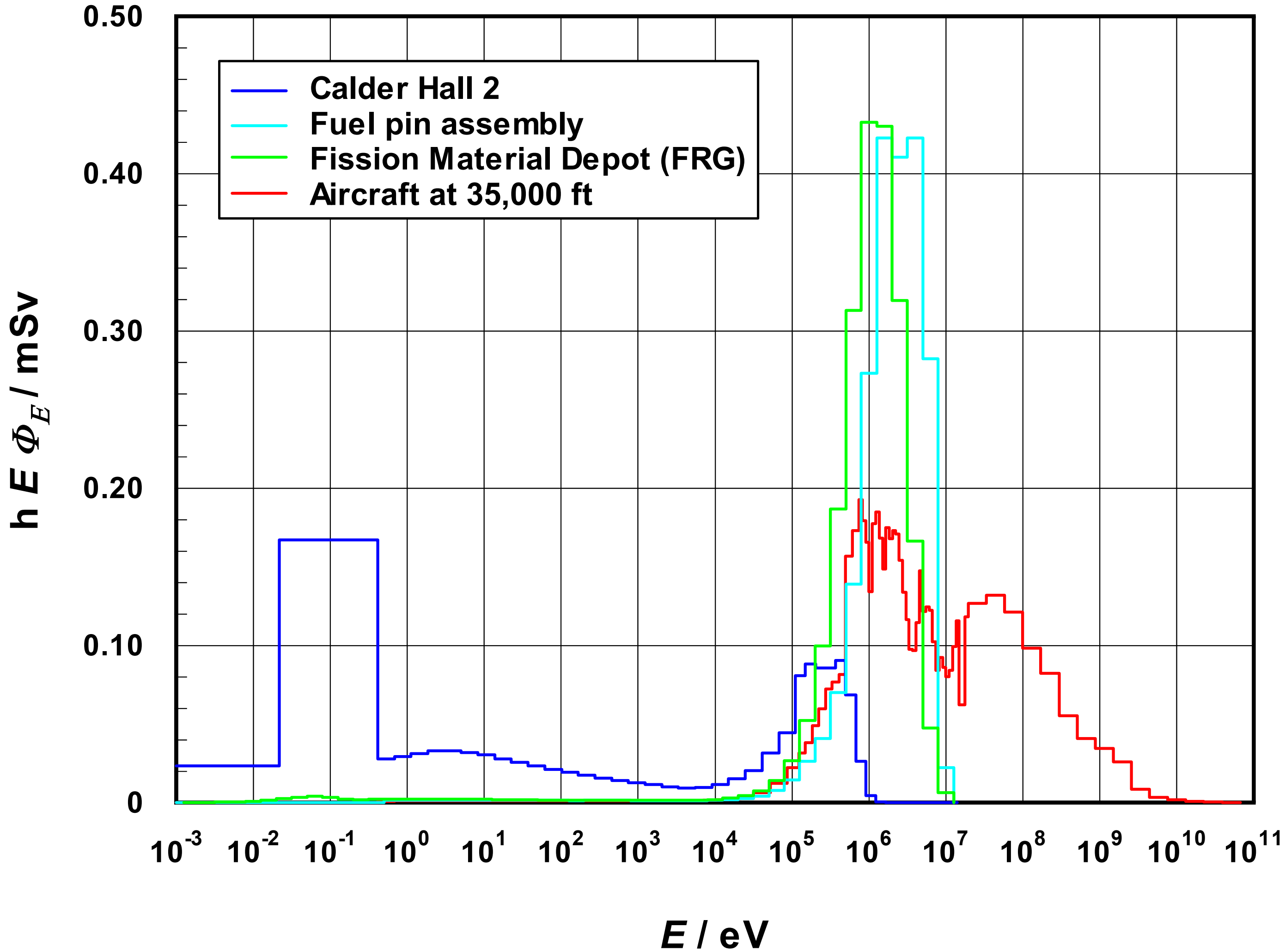


Facing
Right
Back
Left
Down
Up
0
20
480
1120
2080
2720 keV
Energy

ENRADOS


Lead shielding
Copper housing
CdTe- etectors
in Al-housing
PMMA
67°-79°
54°-67°
°-54°





Calder Hall 2
Fuel pin assembly
Fission Material Depot (FRG)
Aircraft at 35,000 ft
h E Φ_E / mSv
0.50
0.40
0.30
0.20
0.10
0
10^{-3} 10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11}
E / eV

EURADOS

	A	F	G	L	D	E	P
AP (front)	31	46	21	33	38	39	68
PA (back)	12	7	18	4	6	6	1
LAT (average)	13	15	15	15	14	14	11
TOP	24	9	24	22	14	14	4
BOTTOM	7	8	7	11	14	13	6
As above interpreted as two field components, AP and ISO							
AP (front)	17	35	4	20	25	26	61
ISO	83	65	96	80	75	74	39

ENVADOS

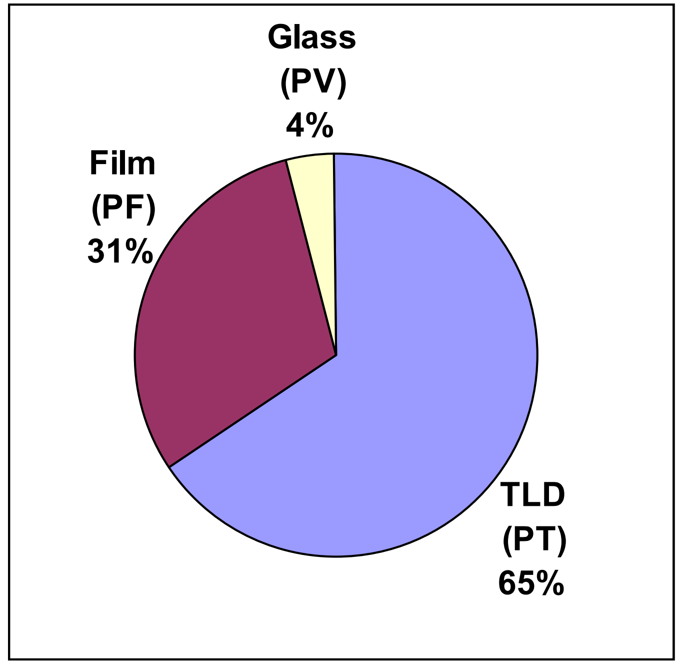
Radiation Fields Used

Radiation Field Code.	Radiation quality	Irrad. lab.	Nominal $H_p(10)_{slab}$ dose value
P01	R-F (0°) + W-300 (WA ± 80°) [50 % + 50 %]	PTB	1,0 mSv
P02	R-F (0°) + W-300 (WA ± 80°) [20 % + 80 %]	PTB	7,2 mSv
P03	R-F (0°)	PTB	1,0 mSv
P04	R-F (0°) without electronic equilibrium	PTB	1,0 mSv
P05	S-Ir (0°) + S-Ir (WA ± 80°) [50 % + 50 %]	ARCS	10,0 mSv
P06	S-Ir (0°)	ARCS	1,0 mSv
P07	S-Ir (0°)	ARCS	40,0 mSv
P08	S-Ir (WA ± 80°)	ARCS	10,0 mSv
P09	S-Co (0°) + W-80 (WA ± 80°) [50 % + 50 %]	NRPB	3,0 mSv
P10	S-Co (0°) + W-80 (WA ± 80°) [80 % + 20 %]	NRPB	80,0 mSv
P11	S-Co (0°) + W-80 (WA ± 80°) [80 % + 20 %]	NRPB	1,0 mSv
P12	W-80 (WA ± 80°)	NRPB	0,4 mSv

EURADOS

Dosemeters used

Dosemeter code and (type)			Number of dosemeter
PT (TLD)	Li F^7	4 elements	2
		3 elements	1
		2 elements	1
		1 element	1
	LiF nat.	4 elements	3
		2 elements	2
	$Li_2B_4O_7$ $CaSO_4$	4 elements	4
	$Li_2B_4O_7$	1 element	1
	$Li_2B_4O_7$ LiF	4 elements	1
	LiF^7 + LiF nat.	3 elements	1
PF	(Film)	7 elements	2
		6 elements	1
		5 elements	3
		2 elements	2
PV	(Glass)	1 element	1
	Total number		**26**



Dosimeter codes:

PF, photographic film

PT, thermoluminescent detector

PV, various(radiophotoluminescent detector, electronic,)

Evaluation of the submitted data

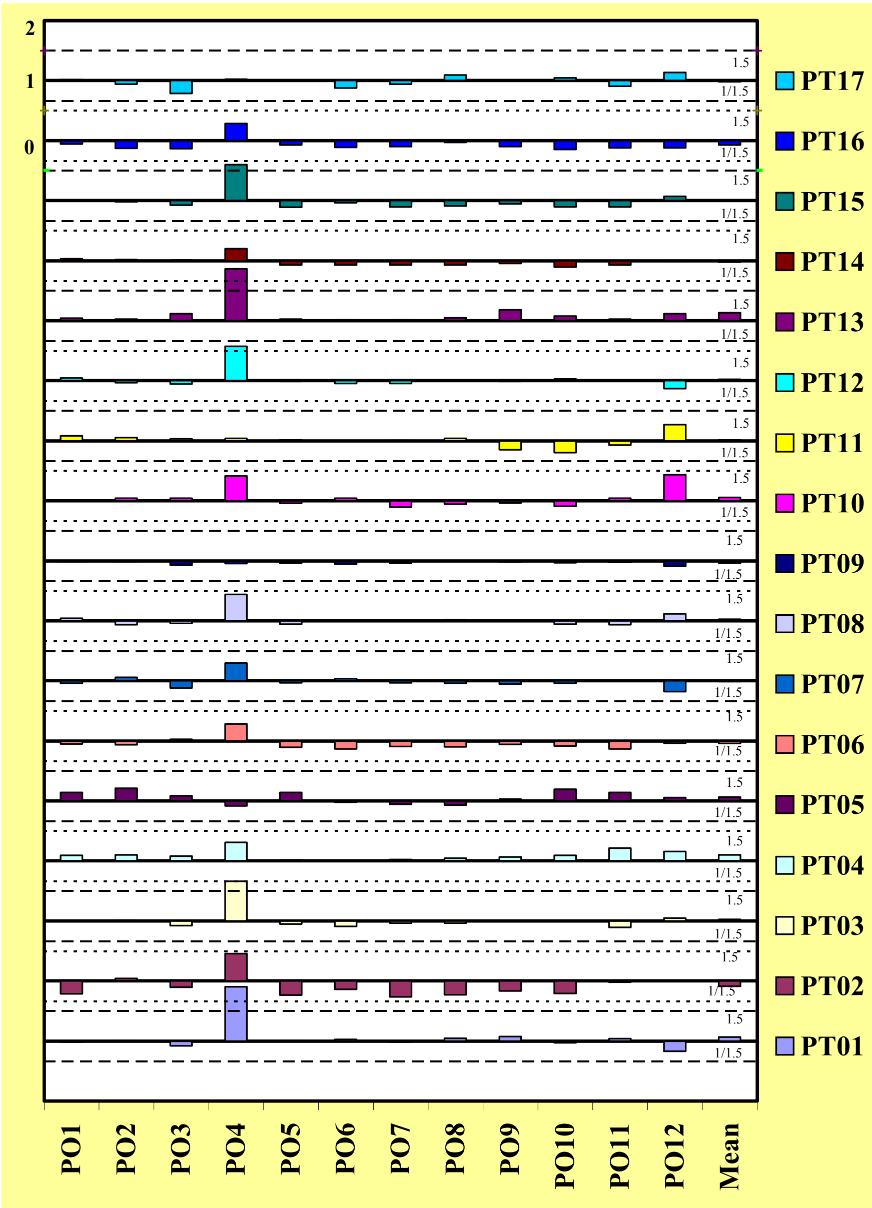
- **12 dosimeters** of each participant **were irradiated**.
- No information about the radiation quality or the angle of incidence was given.
- The participants were requested to **report their results in term of personal dose equivalent** $H_p(10)$ on a prepared data-sheet.

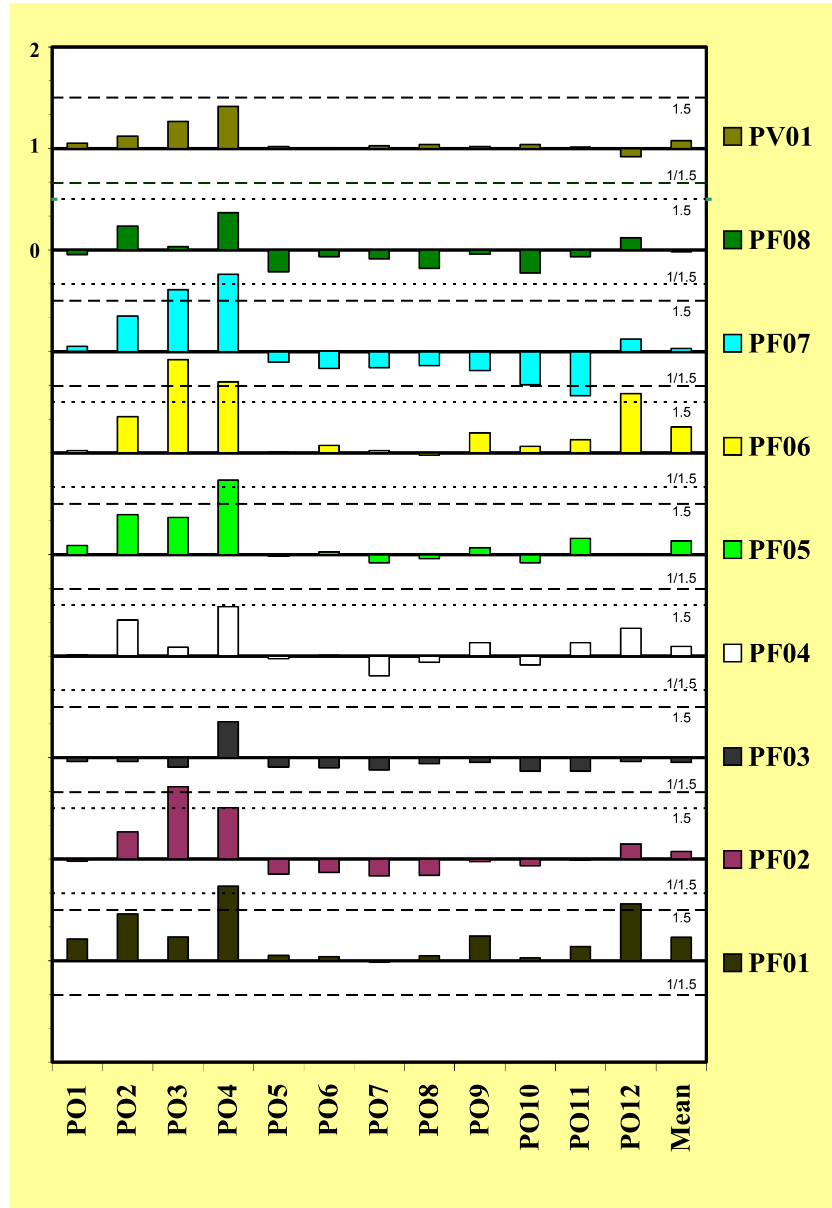
EURADOS

Summary of all Results

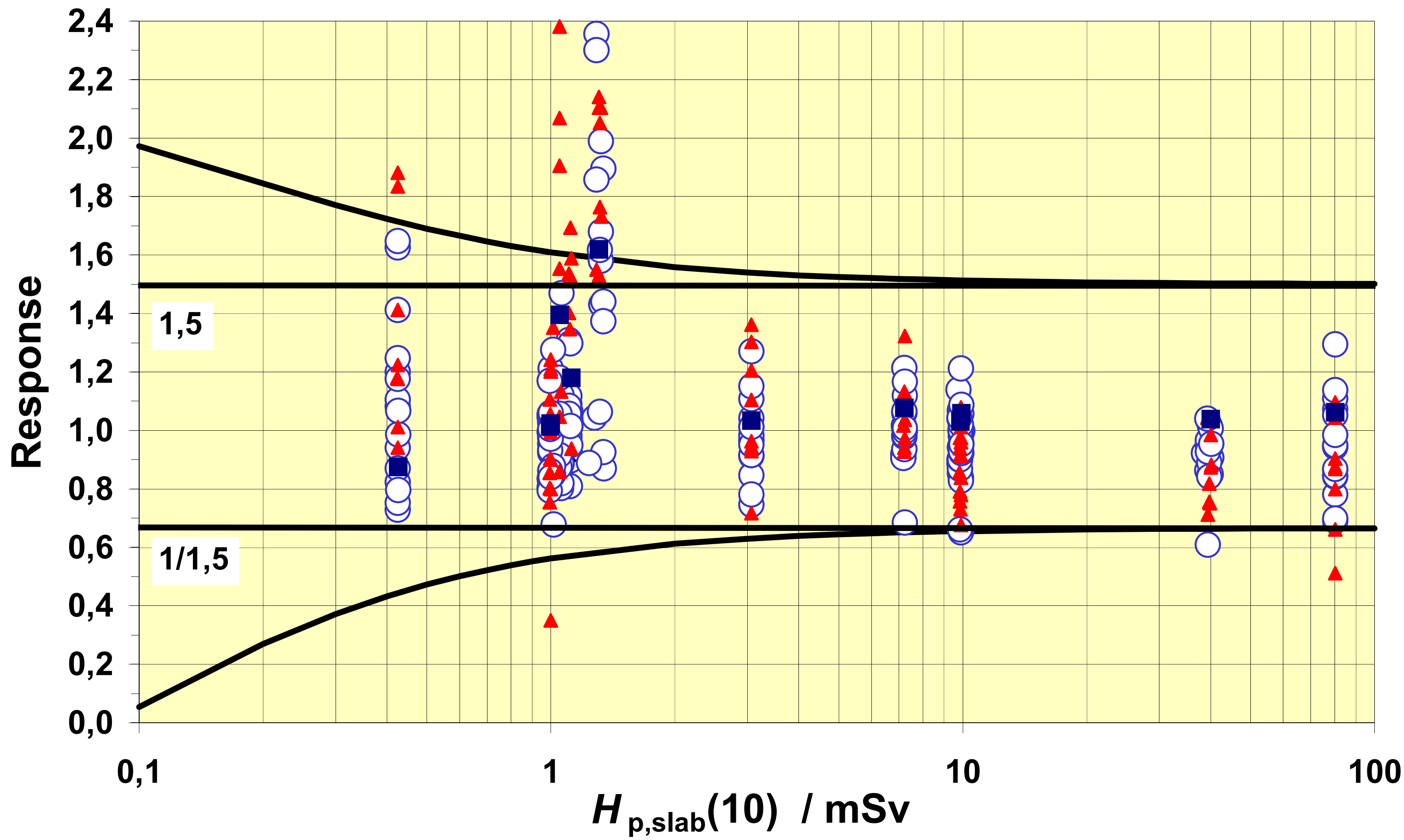
Radiation Quality	R-F + W-300		R-F	R-F *	S-Ir				S-Co + W-80			W-80	Mean Values	Number of outliers
Direct. of incidence	0° + WA		0°	0°	0° + WA	0°	0°	WA	0° + WA			WA		
Dose distribution	50%+50%	20%+80%	-	-	50%+50%	-	-	-	50%+50%	80%+20%		-		
Nominal dose / mSv	7,2	1	1	1	10	1	40	10	3	80	1	0,4		
Lab. Nr. PT01	0,98	1,01	0,88	2,35	1,01	1,04	0,97	1,07	1,11	0,95	1,06	0,75	1,10	1
PT02	0,68	1,07	0,85	1,68	0,65	0,79	0,61	0,66	0,75	0,69	0,97	0,99	0,87	3
PT03	1,01	1,02	0,88	1,99	0,93	0,86	0,95	0,95	1,01	0,99	0,84	1,07	1,04	1
PT04	1,14	1,15	1,12	1,46	1,03	1,01	1,04	1,07	1,10	1,14	1,32	1,24	1,15	0
PT05	1,21	1,31	1,13	0,87	1,21	0,97	0,92	0,90	1,04	1,29	1,21	1,08	1,10	0
PT06	0,92	0,90	1,04	1,43	0,84	0,80	0,86	0,85	0,91	0,87	0,80	0,94	0,93	0
PT07	0,94	1,09	0,82	1,44	0,95	1,05	0,95	0,94	0,92	0,94	1,01	0,73	0,98	0
PT08	1,06	0,90	0,94	1,66	0,91	1,01	1,00	1,03	1,01	0,92	0,90	1,18	1,04	1
PT09	0,98	0,98	0,89	0,93	0,94	0,92	0,94	1,00	0,97	0,95	0,96	0,87	0,94	0
PT10	1,00	1,06	1,06	1,62	0,94	1,06	0,84	0,92	0,95	0,87	1,06	1,65	1,09	1
PT11	1,12	1,08	1,05	1,06	1,02	1,00	1,01	1,06	0,78	0,70	0,89	1,41	1,02	0
PT12	1,07	0,95	0,92	1,86	0,98	0,93	0,93	1,00	0,98	1,05	0,99	0,80	1,04	1
PT13	1,06	1,04	1,18	2,30	1,04	1,02	1,02	1,07	1,27	1,11	1,04	1,18	1,19	1
PT14	1,05	1,03	1,02	1,30	0,89	0,89	0,89	0,89	0,93	0,84	0,89	0,99	0,97	0
PT15	1,01	0,97	0,89	1,90	0,83	0,95	0,85	0,87	0,92	0,84	0,85	1,11	1,00	1
PT16	0,91	0,81	0,80	1,43	0,89	0,83	0,85	0,96	0,85	0,78	0,82	0,82	0,90	0
PT17	1,02	0,91	0,68	1,04	1,00	0,82	0,91	1,14	1,01	1,07	0,86	1,20	0,97	0
PF01	1,32	1,69	1,35	2,10	1,08	1,06	0,98	1,07	1,36	1,04	1,21	1,84	1,34	3
PF02	0,97	1,40	2,07	1,76	0,78	0,80	0,75	0,76	0,96	0,90	0,99	1,22	1,11	2
PF03	0,94	0,94	0,86	1,53	0,86	0,85	0,82	0,91	0,93	0,80	0,80	0,94	0,93	0 (1)
PF04	1,02	1,53	1,13	1,73	0,96	1,01	0,71	0,91	1,20	0,87	1,20	1,41	1,14	1 (2)
PF05	1,13	1,59	1,55	2,10	0,97	1,04	0,88	0,94	1,10	0,88	1,24	1,01	1,20	1 (3)
PF06	1,04	1,54	2,38	2,05	1,01	1,11	1,04	0,97	1,30	1,10	1,20	1,88	1,39	3 (4)
PF07	1,08	1,52	1,91	2,14	0,84	0,75	0,76	0,79	0,72	0,51	0,35	1,18	1,05	4 (5)
PF08	0,93	1,35	1,05	1,55	0,68	0,90	0,87	0,73	0,94	0,66	0,90	1,18	0,98	1
PV01	1,08	1,18	1,40	1,62	1,03	1,01	1,04	1,06	1,03	1,06	1,02	0,88	1,12	1
Mean values	1,03	1,15	1,15	1,65	0,93	0,94	0,90	0,94	1,00	0,92	0,98	1,14	1,06	-
Number of outliers	0	1 (5)	3 (4)	15 (16)	1	0	1	0	0	2	1	2	-	26 (32)

Results given as response values for all participating laboratories and for all different radiation qualities. The number of outliers are values outside the trumpet curve; the numbers in bracket are values outside the 1/1.5 to 1.5 range criterion (WA = wide angle ±80°, R-F* = R-F without electronic equilibrium)


2
1
0
1.5
1/1.5
PT17
PT16
PT15
PT14
PT13
PT12
PT11
PT10
PT09
PT08
PT07
PT06
PT05
PT04
PT03
PT02
PT01
PO1
PO2
PO3
PO4
PO5
PO6
PO7
PO8
PO9
PO10
PO11
PO12
Mean

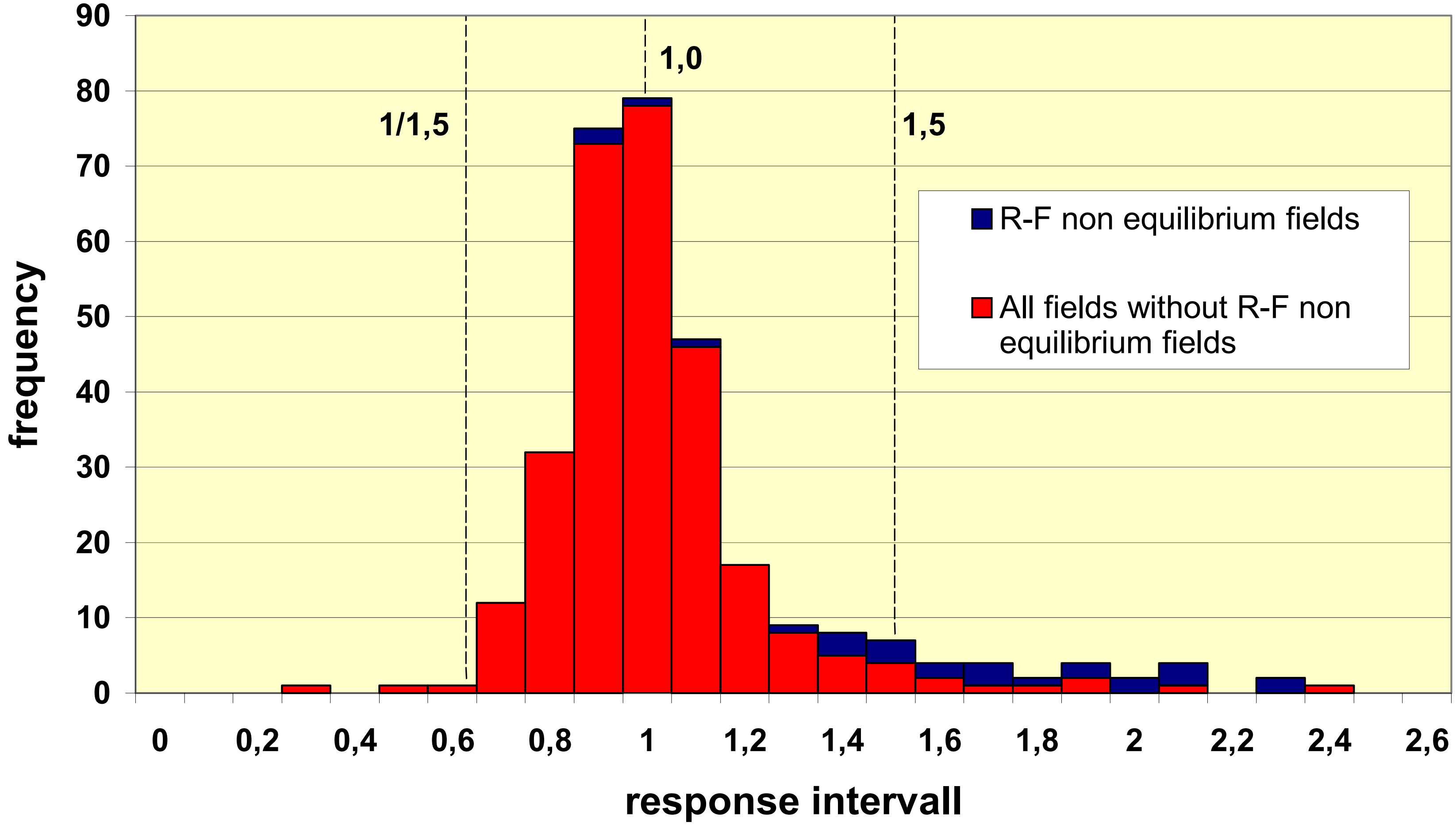

2
1
0
1.5
1/1.5
PV01
PF08
PF07
PF06
PF05
PF04
PF03
PF02
PF01
PO1
PO2
PO3
PO4
PO5
PO6
PO7
PO8
PO9
PO10
PO11
PO12
Mean

Trumpet curve of all responses



EURADOS

Results



90
80
70
60
50
40
30
20
10
0
frequency
1/1,5
1,0
1,5
R-F non equilibrium fields
All fields without R-F non equilibrium fields
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
2,2
2,4
2,6
response intervall

Conclusion

- **Most results** of tested photon dosemeter fall within the limits of the trumpet curve (91,7 %) and within the 1/1,5 to 1,5 range (89,7 %) and **fulfil the performance requirements**
- The majority of outliers were found for the R-F radiation field without electronic equilibrium. This special field is not routinely encountered by many of the dosimetric services and the dosemeters used are not designed and type tested for this field.

Conclusion (2)

- It was found that the **TLD based dosemeter results are better than the film based dosemeter** ones.
- Comparing with the data of **type tests**, where better results are reported for film based dosemeter, it seems that it is more difficult to obtain good results with film based dosemeters **in workplace fields**.

18 beta whole body dosemeters

- **16 TLDs**
- **2 film dosemeters**

8 extremity dosemeters

- **all TLDs**
- **6 finger dosemeters**
- **2 wrist dosemeters**

Questionnaire for participants of the beta dose test programme

Detector: type:……. ; thickness: ……………mg/cm^2; area/diameter:………………..

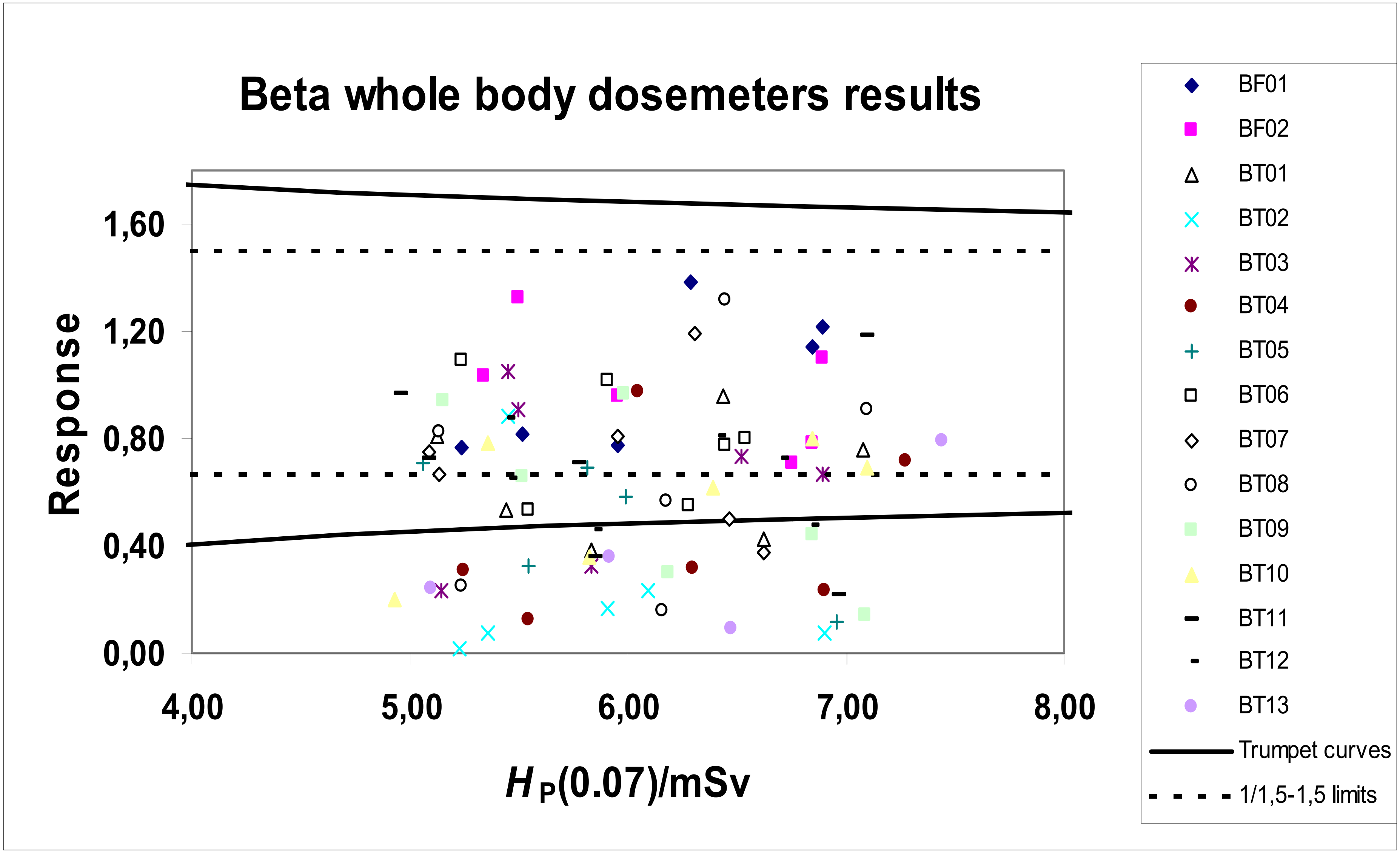
Beta window: please make a sketch of the beta window above the detector with indication of diameter,(for conical windows max. and min. diameter) and distance (in mm) between upper surface of detector and upper surface of beta window and mention diaphragm material.

Protective cover: material:…………………..; thickness:……………..mg/cm^2;

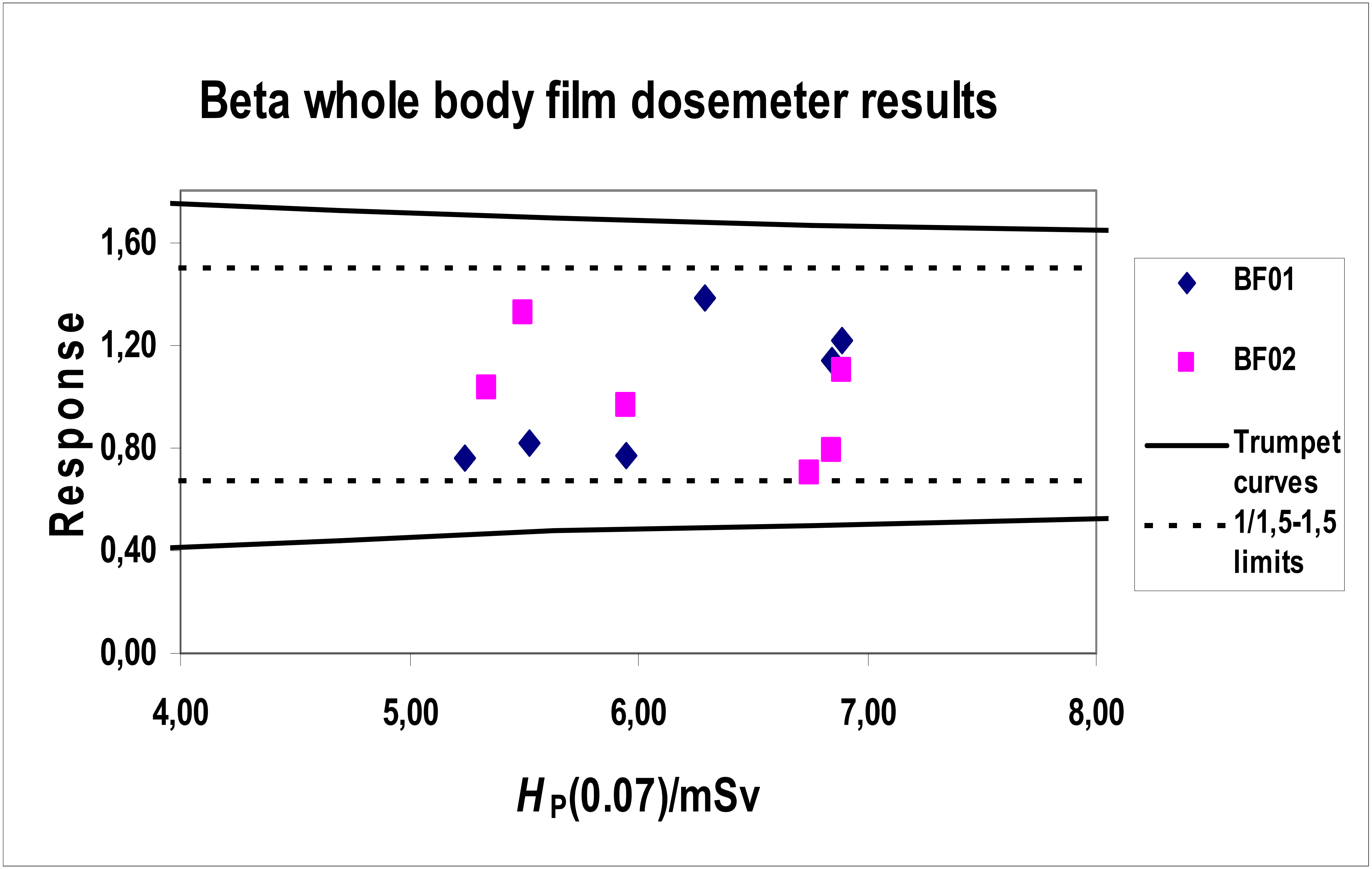
Dose evaluation: Ref. radiation used for calibration(^{60}Co, ^{137}Cs, ^{90}Sr,others):…………

No use of beta-energy analysis:……………

Use of beta-energy analysis (by use of filters):……………………


Beta whole body dosemeters results
Response
1,60
1,20
0,80
0,40
0,00
4,00
5,00
6,00
7,00
8,00
H P(0.07)/mSv
BF01
BF02
BT01
BT02
BT03
BT04
BT05
BT06
BT07
BT08
BT09
BT10
BT11
BT12
BT13
Trumpet curves
1/1,5-1,5 limits

EURADOS



Beta whole body film dosemeter results
Response
1,60
1,20
0,80
0,40
0,00
4,00
5,00
6,00
7,00
8,00
HP(0.07)/mSv
BF01
BF02
Trumpet curves
1/1,5-1,5 limits

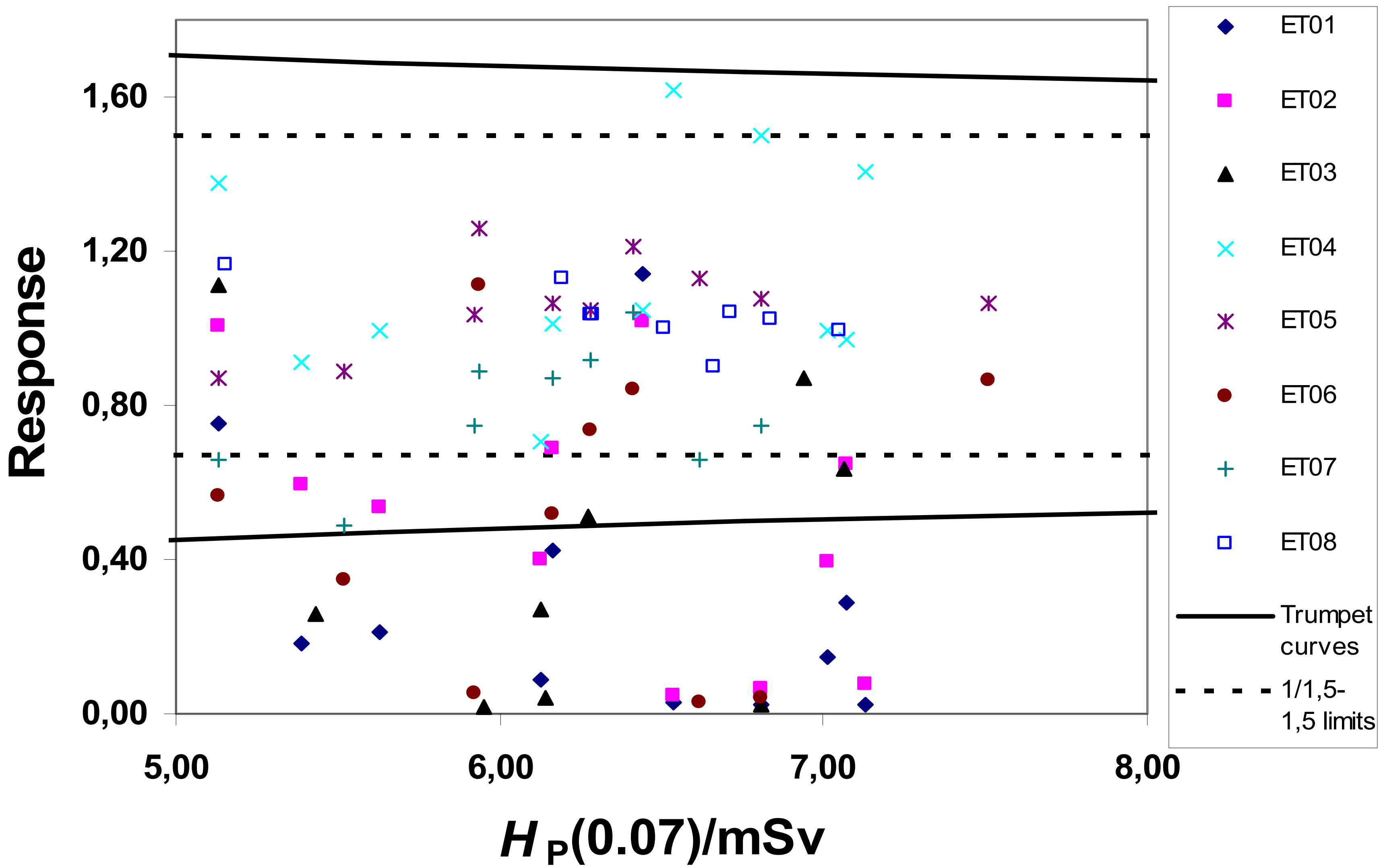
EURADOS

Beta TLD whole body dosemeters		$^{90}Sr/^{90}Y$ 0°	$^{90}Sr/^{90}Y$ 40°	$^{90}Sr/^{90}Y$ 60°	^{204}Tl 0°	^{204}Tl 40°	^{204}Tl 60°	Total
Total No.		13	13	13	13	13	13	78
Inside trump. curve limits	No.	13	11	2	10	8	2	46
	(%)	100	85	15	77	62	15	59
	Mean of source	Total: 26 (74 %)			Total: 20 (51 %)			
Inside 1/1.5-1.5 limits	No.	13	10	0	9	5	0	37
	(%)	100	77	0	69	38	0	47
	Mean of source	Total: 23 (59 %)			Total: 14 (36 %)			

Detector	Detector thickness (mg/cm^2)	Cover thickness (mg/cm^2)	Beta window edge/ shadow effect	Use of algorith for dose evaluat.
Kodak 2	Thin	25+0/50/300		X
Kodak 2	Thin	25+0/50/300		X
LiF-7 Teflon	44	4		
LiF:Mg,Ti TLD-700	240	7	X	
LiF:Mg,Ti TLD-100	100	13		
$Li_2B_4O_7$:Mn,Si (Alnor)	190	10	X	
$Li_2B_4O_7$:Cu (Panasonic)	14	20	X	X
LiF:Mg,Ti TLD-720	24	20	X	
LiF:Mg,Cu,P GR-200	208	20	X	X
$Li_2B_4O_7$:Cu (Panasonic)	15	3	X	X
LiF:Mg,Ti TLD-700	240	45		
LiF:Mg,Ti TLD-700	240	45		
LiF:Mg,Ti TLD-100	100	30	X	X
LiF:Mg,Ti TLD-720	24	20	X	
LiF:Mg,Ti TLD-100	100	47	X	

EURADOS

Extremity dosemeter results

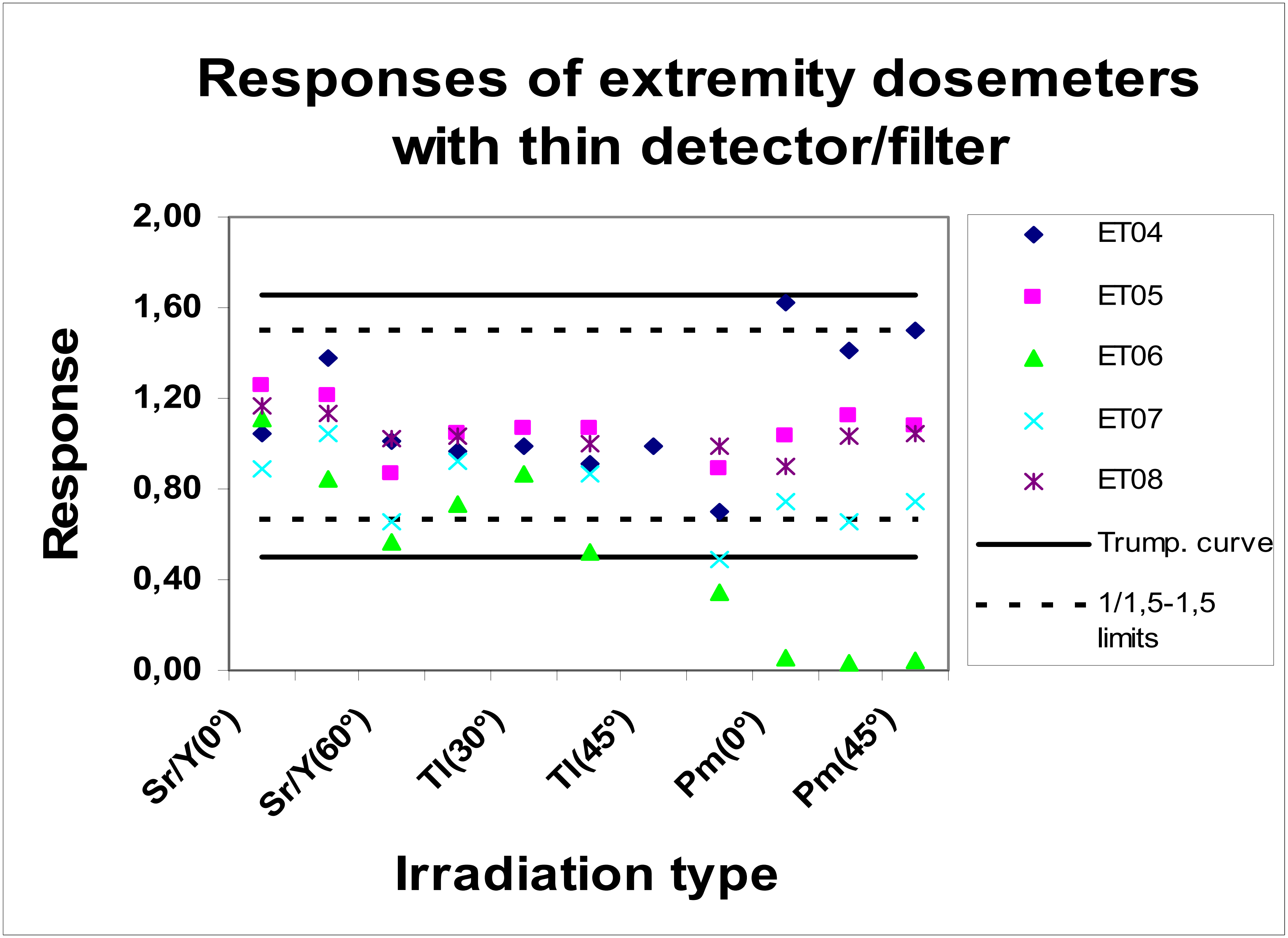


EURADOS

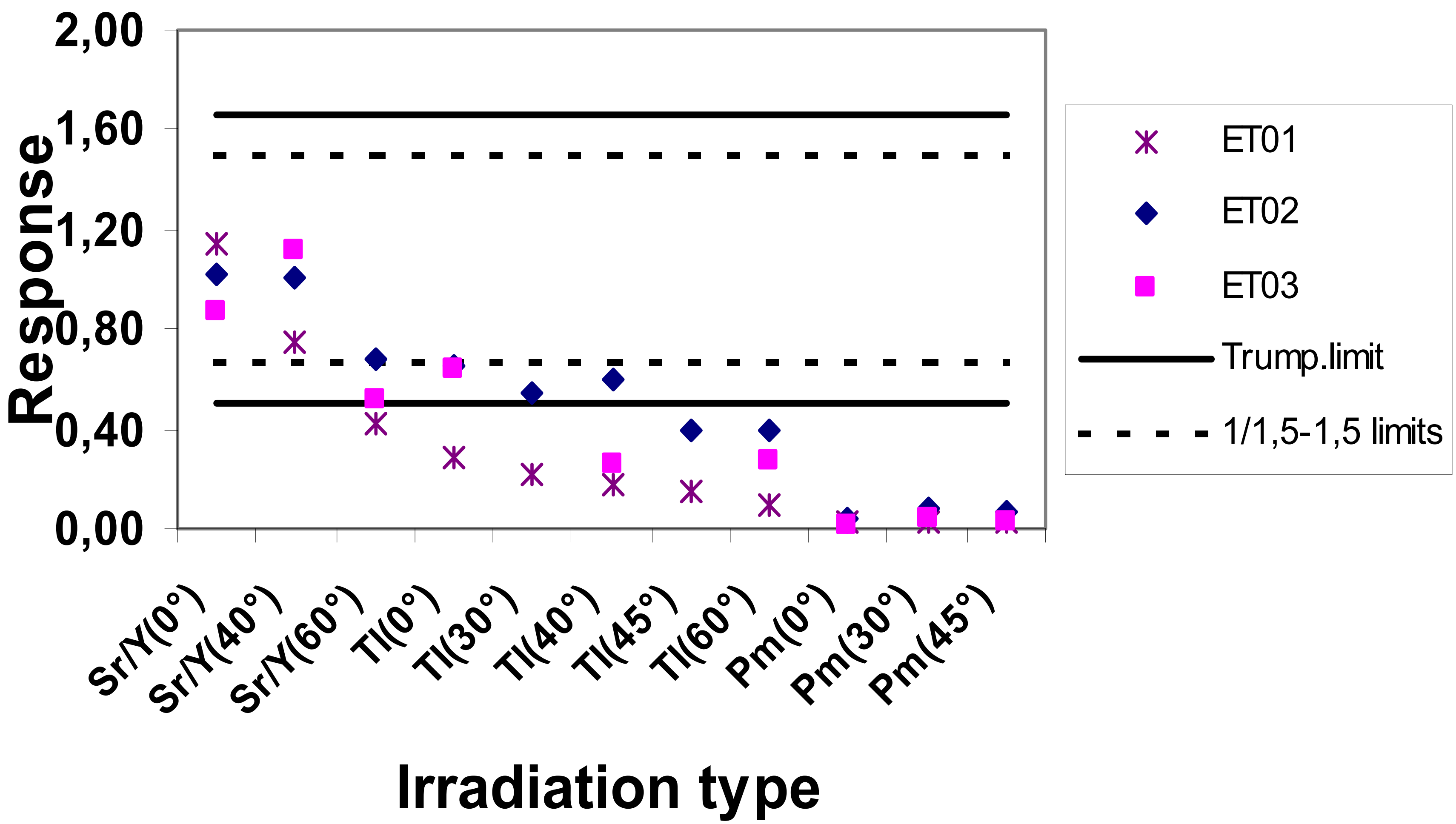
Extremity dosemeter results		^{90}Sr/Y			^{204}Tl					^{147}Pm			Total
		0°	40°	60°	0°	30°	40°	45°	60°	0°	30°	45°	
Total No.		8	8	8	8	5	8	3	8	8	8	8	80
Inside trump. curve limits	No.	8	8	7	7	4	6	1	4	4	4	4	57
	(%)	100	100	88	88	80	75	33	50	50	50	50	71
	Mean of source	Total: 23 (96 %)			Total: 22 (69 %)					Total: 12 (50 %)			
Inside 1/1.5-1.5 limits	No.	8	8	4	5	3	4	1	3	3	4	3	46
	(%)	100	100	50	63	60	50	33	38	38	50	38	58
	Mean of source	Total: 20 (83 %)			Total: 16 (50 %)					Total: 10 (42 %)			

Partici-Pant Code	Dosemeter category	Detector	Detector thickness (mg/cm^2)	Cover thickness (mg/cm^2)	Calibr. Reference radiation
ET01	Finger	LiF:Mg,Ti TLD-100	100	40	Cs-137
ET02	Finger	LiF-7 teflon	28	32	Co-60
ET03	Wrist	LiF:Mg,Ti TLD-700	100	45	Co-60
ET04	Finger	LiF:Mg,Cu.P (MCP-Ns)	10	0.5	Co-60
ET05	Finger	LiF:Mg,Cu.P (MCP-Ns)	8	2	Cs-137
ET06	Finger	LiF:Mg,Cu.P (MCP-7s)	8	10	Cs-137
ET07	Finger	LiF-grains (75-106 μm)	5	3.5	Sr/Y-90
ET08	Wrist	LiF:Mg,Cu.P (1): MCP-Ns (2): MCP-7	(1): 8 (2): 240	(1): 1.5 (2): 86	Cs-137[(a)]

EURADOS


Responses of extremity dosemeters
with thin detector/filter
Response
2,00
1,60
1,20
0,80
0,40
0,00
Sr/Y(0°)
Sr/Y(60°)
Tl(30°)
Tl(45°)
Pm(0°)
Pm(45°)
Irradiation type
ET04
ET05
ET06
ET07
ET08
Trump. curve
1/1,5-1,5 limits

Responses of extremity dosemeters with thick detector/filter



Number of services taking part in the neutron test by country and by radiation type.

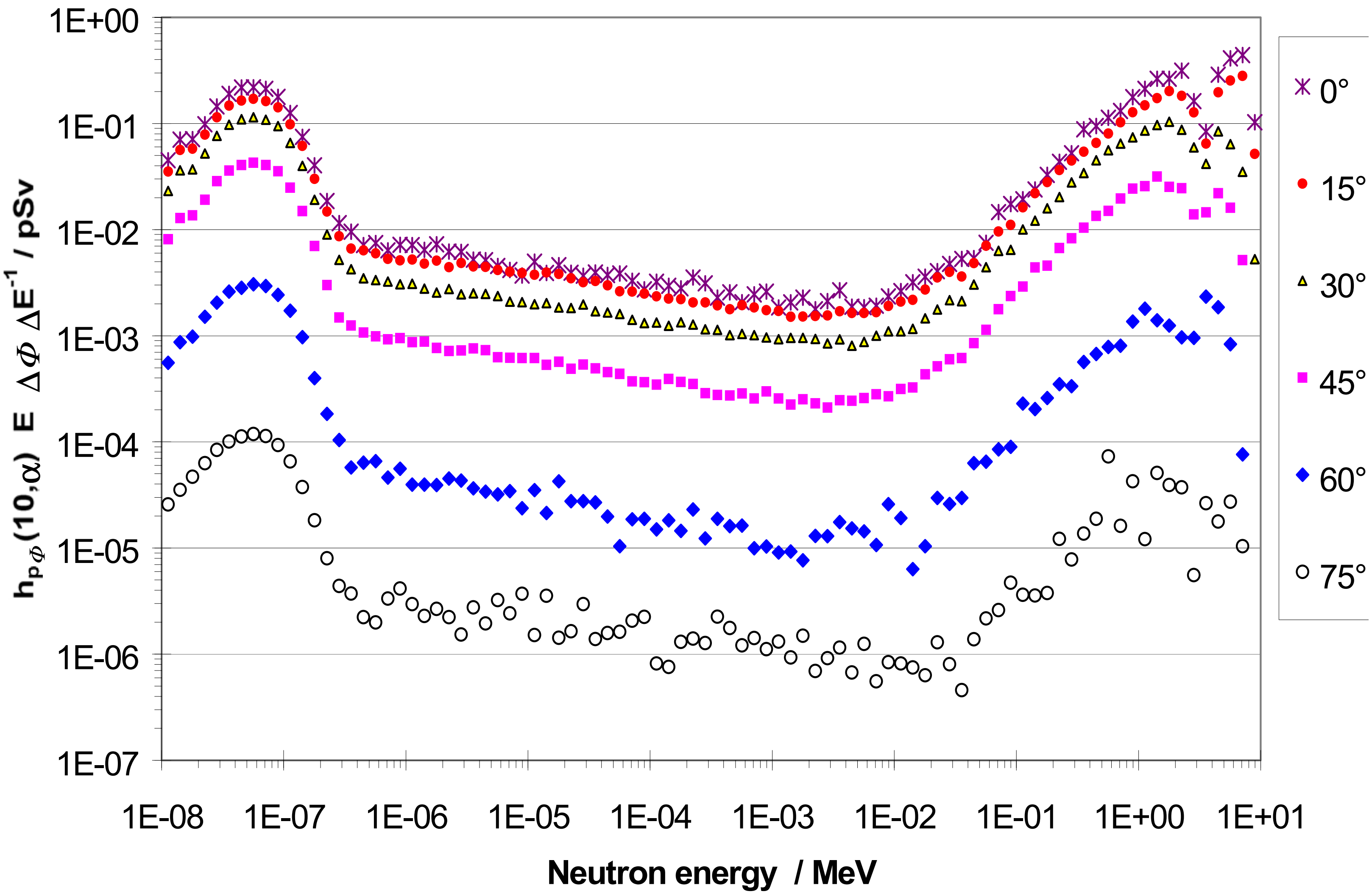
Country	Number of services	Country	Number of services
Austria	1	Greece	2
Switzerland	2	France	4
Germany	1	Finland	1
Denmark	1	Italy	1
Spain	1	United Kingdom	3

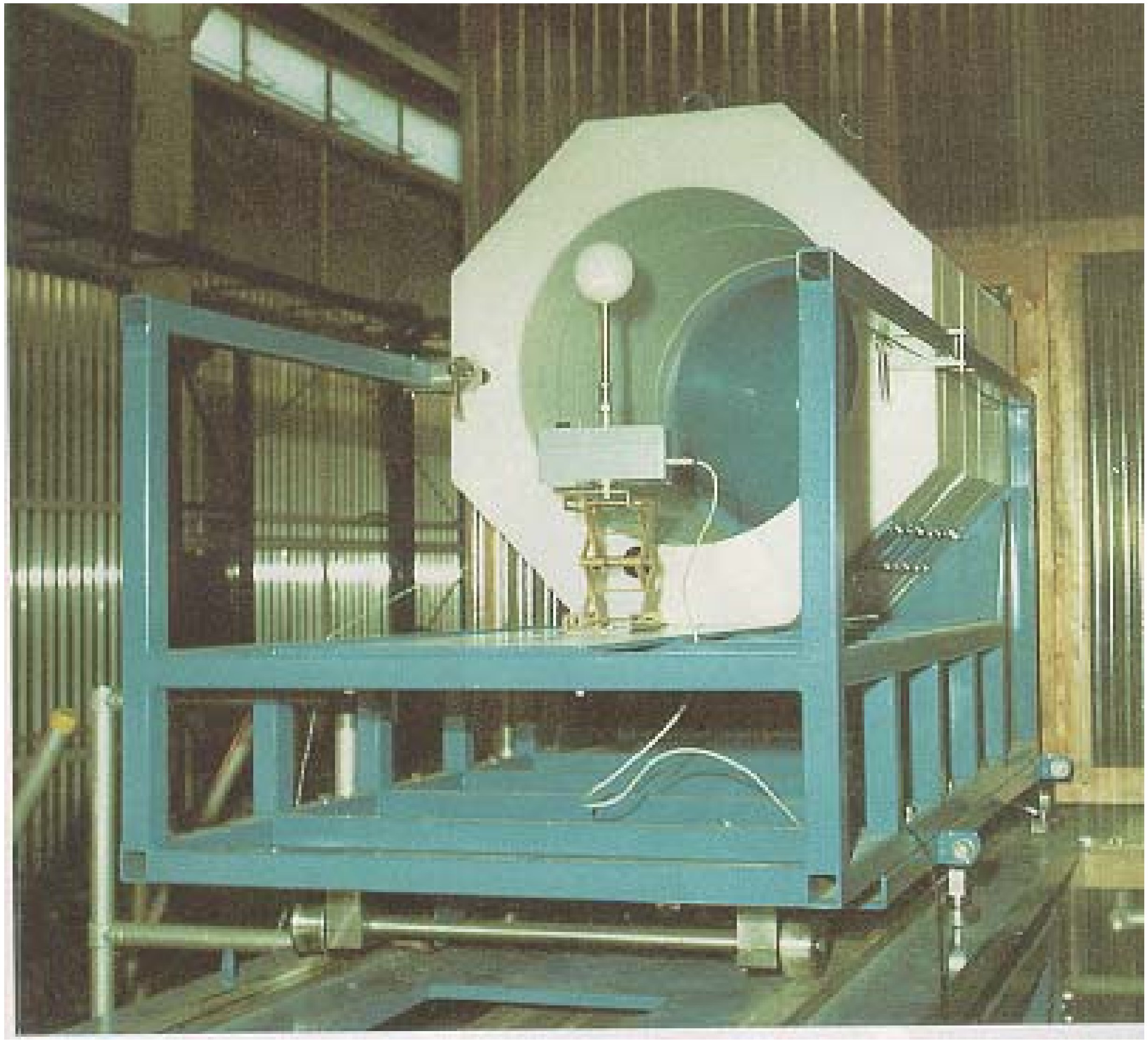
17 services

Main characteristics of the radiation fields.

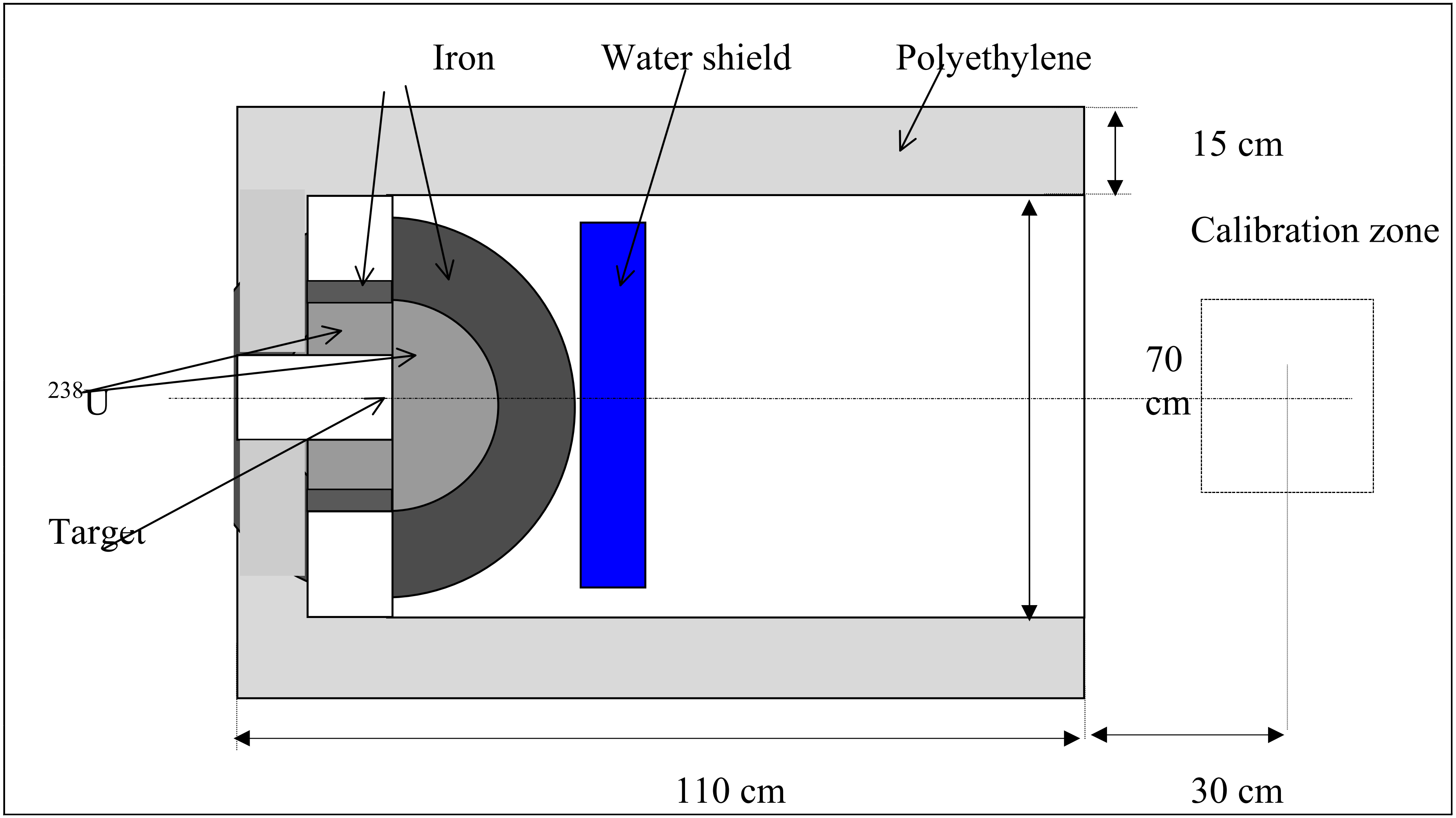
Radiation fields	Nominal $H_{p,slab}(10)$ values	Radiation fields	Nominal $H_{p,slab}(10)$ values
^{252}Cf bare (0°)	0.1 mSv	^{252}Cf bare (60°)	2 mSv
^{252}Cf bare (0°)	0.75 mSv	Graphite thermalised AmBe (Sigma)	2 mSv
^{252}Cf bare (0°)	3 mSv		
^{252}Cf bare (30°)	2 mSv	CANEL + assembly	2, 3, 4 mSv

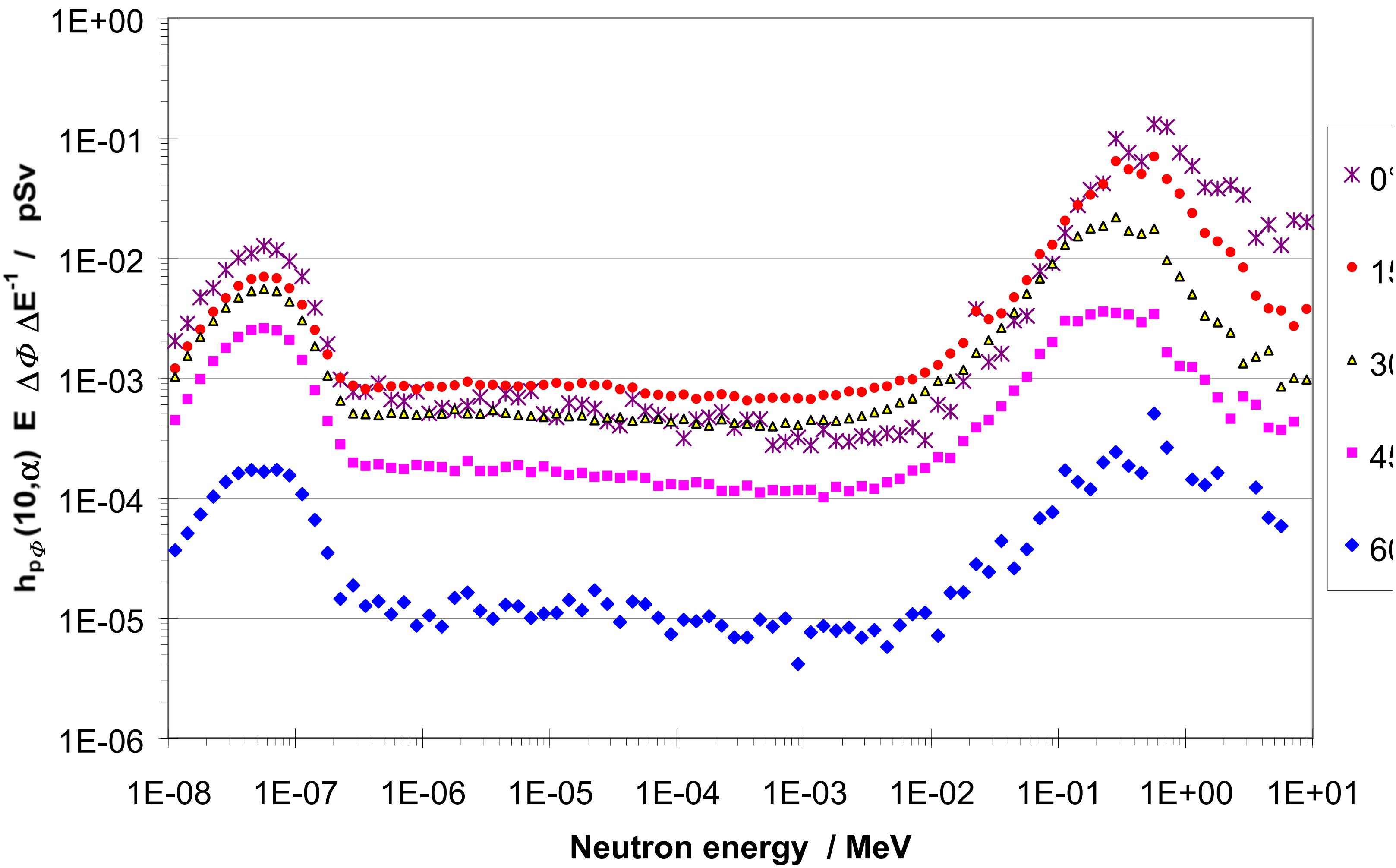
ENVADOS


$h_{p\Phi}(10,\alpha)$ E $\Delta\Phi$ ΔE^{-1} / pSv
1E+00
1E-01
1E-02
1E-03
1E-04
1E-05
1E-06
1E-07
1E-08
1E-07
1E-06
1E-05
1E-04
1E-03
1E-02
1E-01
1E+00
1E+01
Neutron energy / MeV
0°
15°
30°
45°
60°
75°



EURADOS


Iron
Water shield
Polyethylene
15 cm
Calibration zone
70 cm
238U
Target
110 cm
30 cm



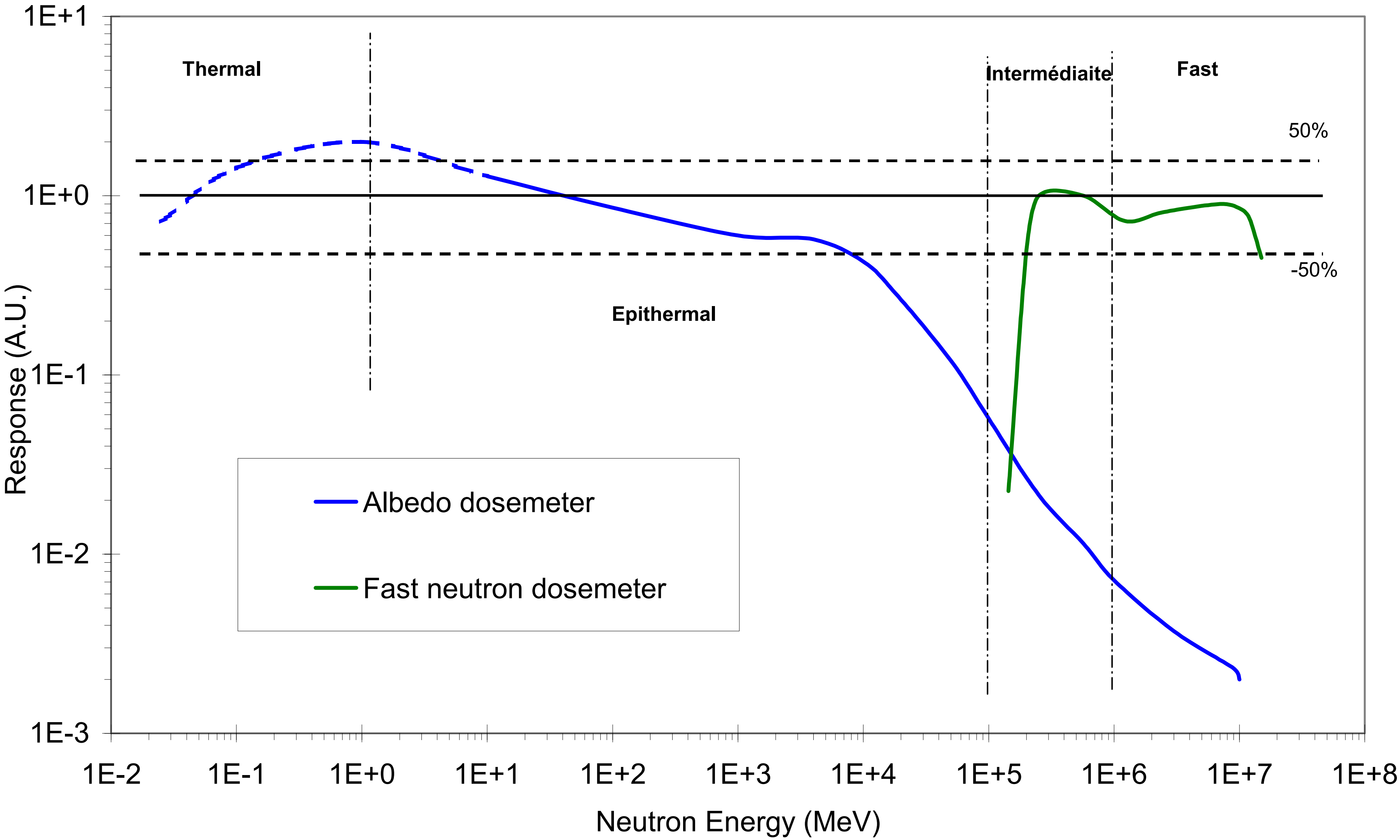
1E+00
1E-01
1E-02
1E-03
1E-04
1E-05
1E-06
$h_{p\Phi}(10,\alpha)$ E $\Delta\Phi$ ΔE^{-1} / pSv
1E-08
1E-07
1E-06
1E-05
1E-04
1E-03
1E-02
1E-01
1E+00
1E+01
Neutron energy / MeV

- NA, albedo dosemeters, mainly: (i) TLD lithium 6 based, (ii) photographic films behind cadmium converter.

- NH, high energy neutron dosemeters, mainly: (i) NTA emulsions (n.b. thermal neutron detection can be done through n,p reaction), (ii) track etch detector with proton recoil radiators e.g. polyethylene or tissue equivalent material.

- NS, multi-element dosemeters in which one detector type, usually track etch or TLD, plus more than one converter or filter to cover the widest possible part of the neutron energy range.

- NM, multi-element dosemeters in which at least two different detector types, for instance a film badge and a NTA emulsion with one or more converters or filters, are used together to cover the



1E+1
1E+0
1E-1
1E-2
1E-3
Response (A.U.)
Thermal
Intermédiaite
Fast
50%
-50%
Epithermal
Albedo dosemeter
Fast neutron dosemeter
1E-2
1E-1
1E+0
1E+1
1E+2
1E+3
1E+4
1E+5
1E+6
1E+7
1E+8
Neutron Energy (MeV)

The value of the correction factor is derived from the dosemeter reading

The value of the correction factor is derived from specific work place radiation field information

Fast neutron sources (for example americium-beryllium)

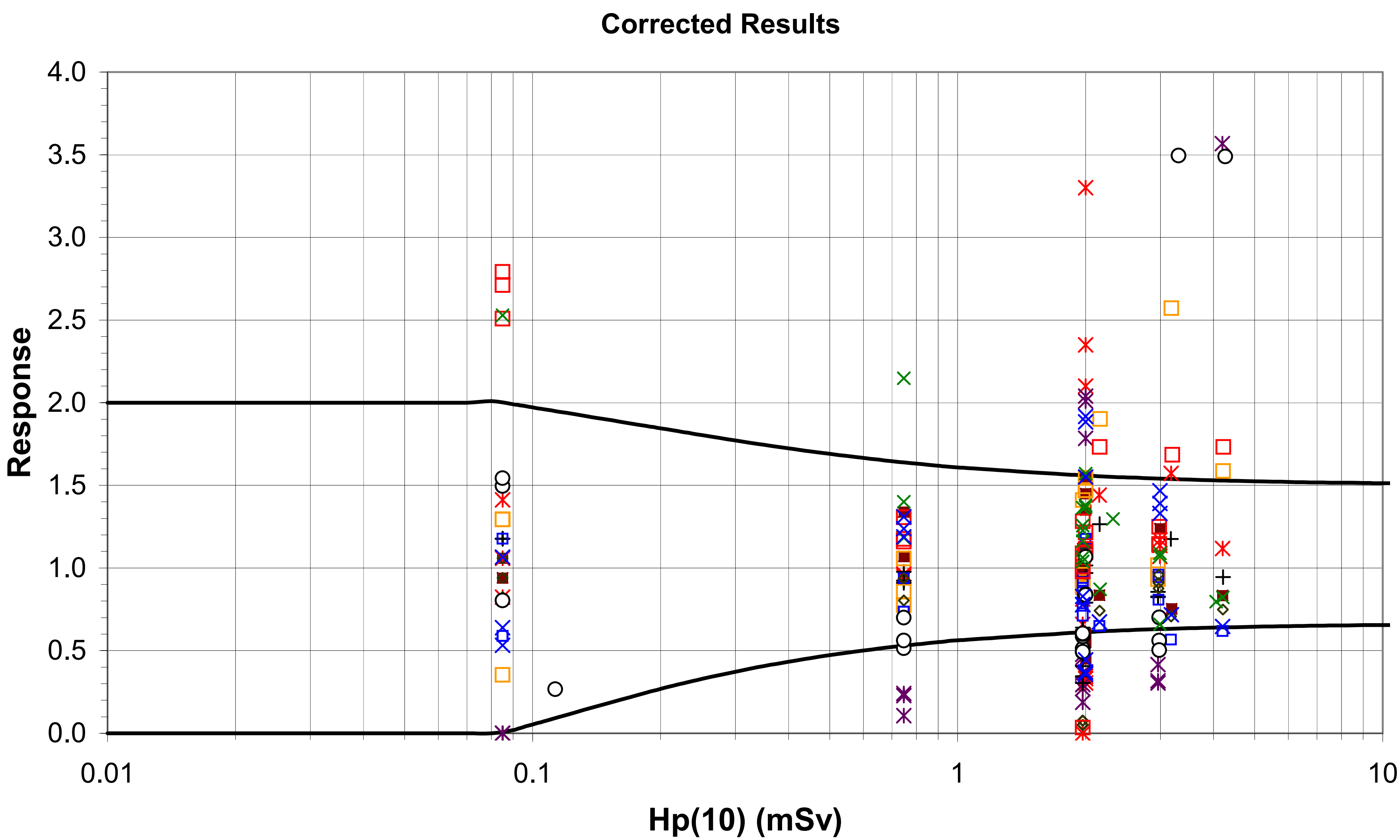
Californium 252 moderated with heavy water sphere 30 cm diameter.

Use of a normalisation factor based on calibration plus workplace field response characteristics.

Use of different correction factors for different work place fields.

For 10 services, additional information on the neutron spectra are needed to derive personal dose equivalent

7 services claimed to be able to derive personal dose equivalent without a priori knowledge of the radiation field.



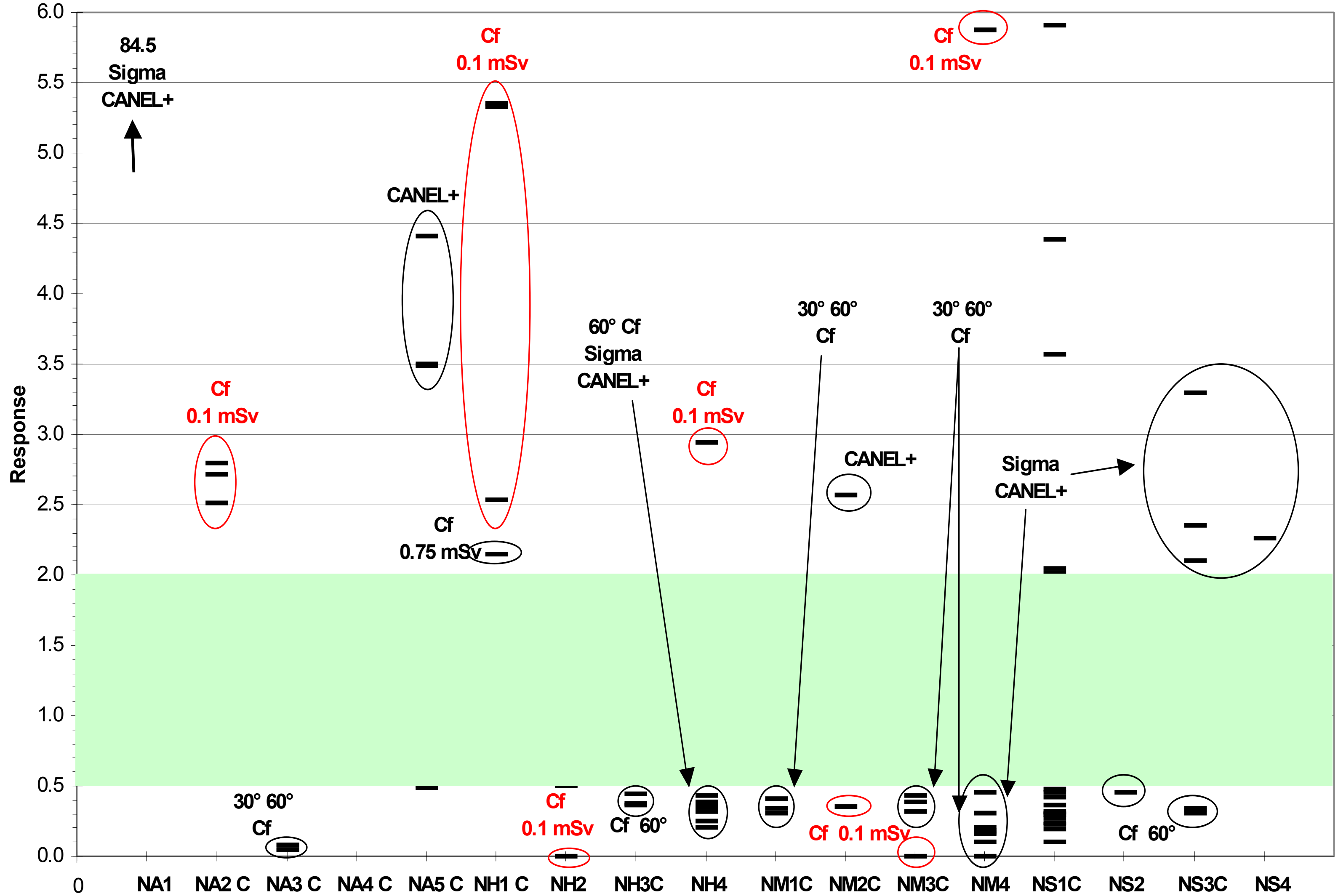
Corrected Results
Response
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.01
0.1
1
10
Hp(10) (mSv)

EURADOS

Overall, for uncorrected results, 34% of the results lie outside the limits of the trumpet curve, 47% lie outside the interval 1/1.5 to 1.5.

For corrected results, this trend seems to be softened by the use of a correction factor or special algorithm but the corrected results for californium irradiation with normal incidence are not as good. As a result, about the same proportion of results lie outside the limits, 33% for the trumpets curves and 44% for the interval 1/1.5 to 1.5.

	NA	NH	NS	NM	Total
[1/5 ; 1.5]	-	-	-	-	-
Trumpet curves (H0=0.085)	NA4	-	-	-	**1**
[~0.5 ; ~1.5]	NA4	NH2	NS2	-	**3**
[~0.5 ; ~2]	NA4	NH2	NS2 – NS4	NM2	**5**
[~0.5 ; ~2] without bare Cf (0.1 mSv)	NA4 – NA2	NH2 - NH1	NS2 – NS4	NM2	**7**
Total	2	2	2	1	



Response
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
NA1
NA2 C
NA3 C
NA4 C
NA5 C
NH1 C
NH2
NH3C
NH4
NM1C
NM2C
NM3C
NM4
NS1C
NS2
NS3C
NS4
84.5 Sigma CANEL+
Cf 0.1 mSv
CANEL+
Cf 0.1 mSv
Cf 0.75 mSv
30° 60° Cf
Cf 0.1 mSv
60° Cf Sigma CANEL+
Cf 60°
Cf 0.1 mSv
30° 60° Cf
CANEL+
Cf 0.1 mSv
30° 60° Cf
Cf 0.1 mSv
Sigma CANEL+
Cf 60°

The need to introduce into national legislation the requirement of the Council Directive 96/29/EURATOM[(1)] has stimulated the examination and revision of procedures. The information collected has been made easily and widely available, and it is considered that this should assist the implementation of new requirements and help towards their harmonisation, with the possibility of some convergence of procedures

Not all the dosimetric services who responded to the questionnaire sent out by the action group used the operational quantity personal dose equivalent: the information contained in the report, including the discussion of dosemeter design, may assist them in doing so. The study showed that in spite of their increased introduction in recent years, formal quality assurance programmes are not general practice

EURADOS

The results of the trial performance tests show that many dosimetric services for photons (particularly) and beta particles can meet, or should be able to meet proposed requirements for dosimetric accuracy, but some relaxation may be required for neutron dosimetric services. Examination of the reported results together with the details of dosemeter design should assist in improvements where necessary

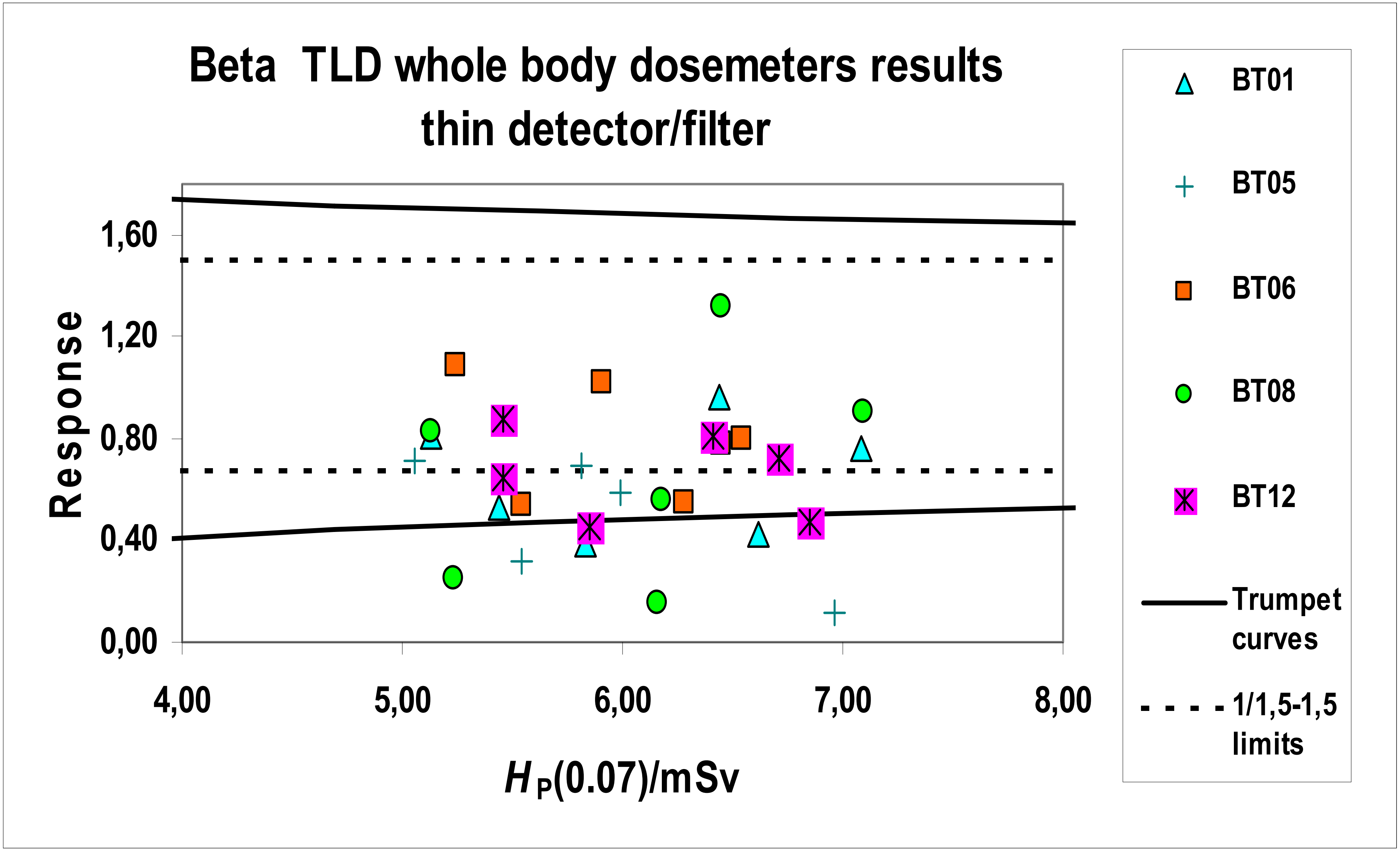
EURADOS

The EURADOS Action Group 'Harmonisation and dosimetric quality assurance in individual monitoring for external radiation' recommends that to assist harmonisation, it would be helpful if there were periodic performance tests or inter-comparison exercises within the European Union and Switzerland. Such tests would serve as a means to assess the dosimetric quality of individual dosimetry measurements and to harmonise quality control

Acknowledgements

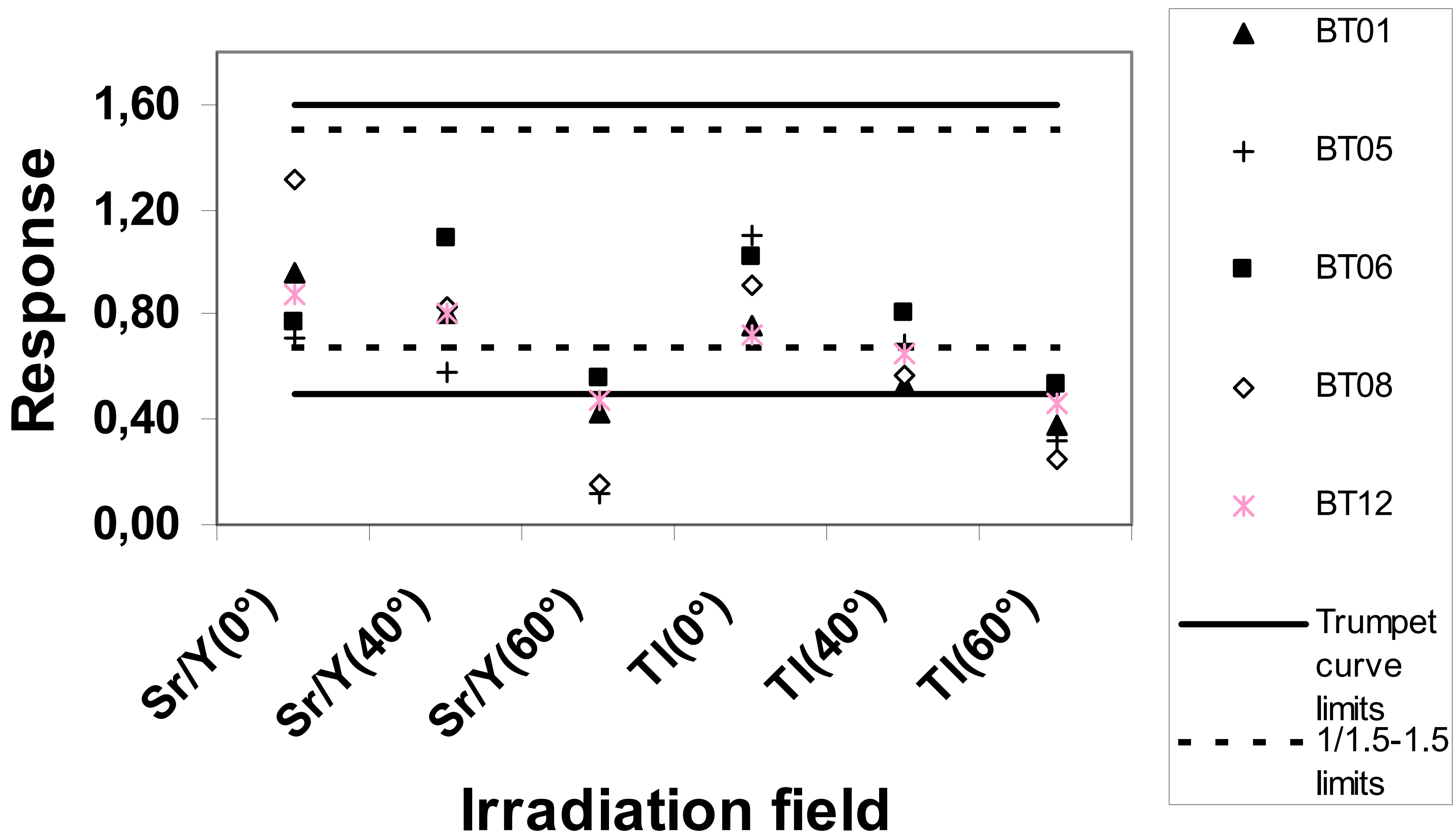
EURADOS are grateful to the dosimetric services who took part in the test and those who provided information on their routine dosimetry procedures.
The work of the action group members involved considerable liaison with colleagues in the dosimetry, metrology and regulatory communities in their respective countries. Their very significant contribution to the content of the three sub-group reports is gratefully acknowledged

EURADOS

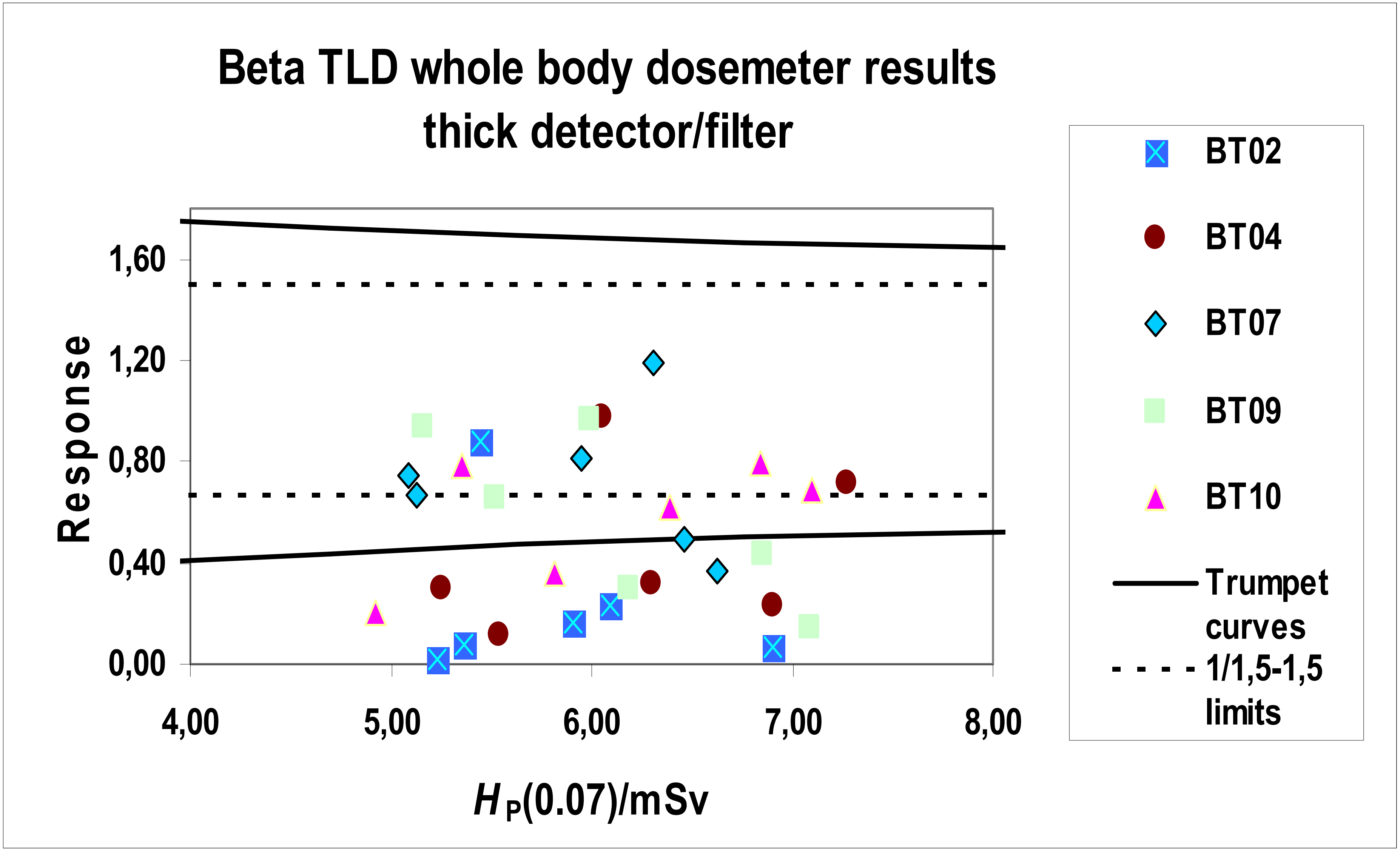

Beta TLD whole body dosemeters results
thin detector/filter
Response
1,60
1,20
0,80
0,40
0,00
4,00
5,00
6,00
7,00
8,00
HP(0.07)/mSv
BT01
BT05
BT06
BT08
BT12
Trumpet curves
1/1,5-1,5 limits

ENVIRDOS

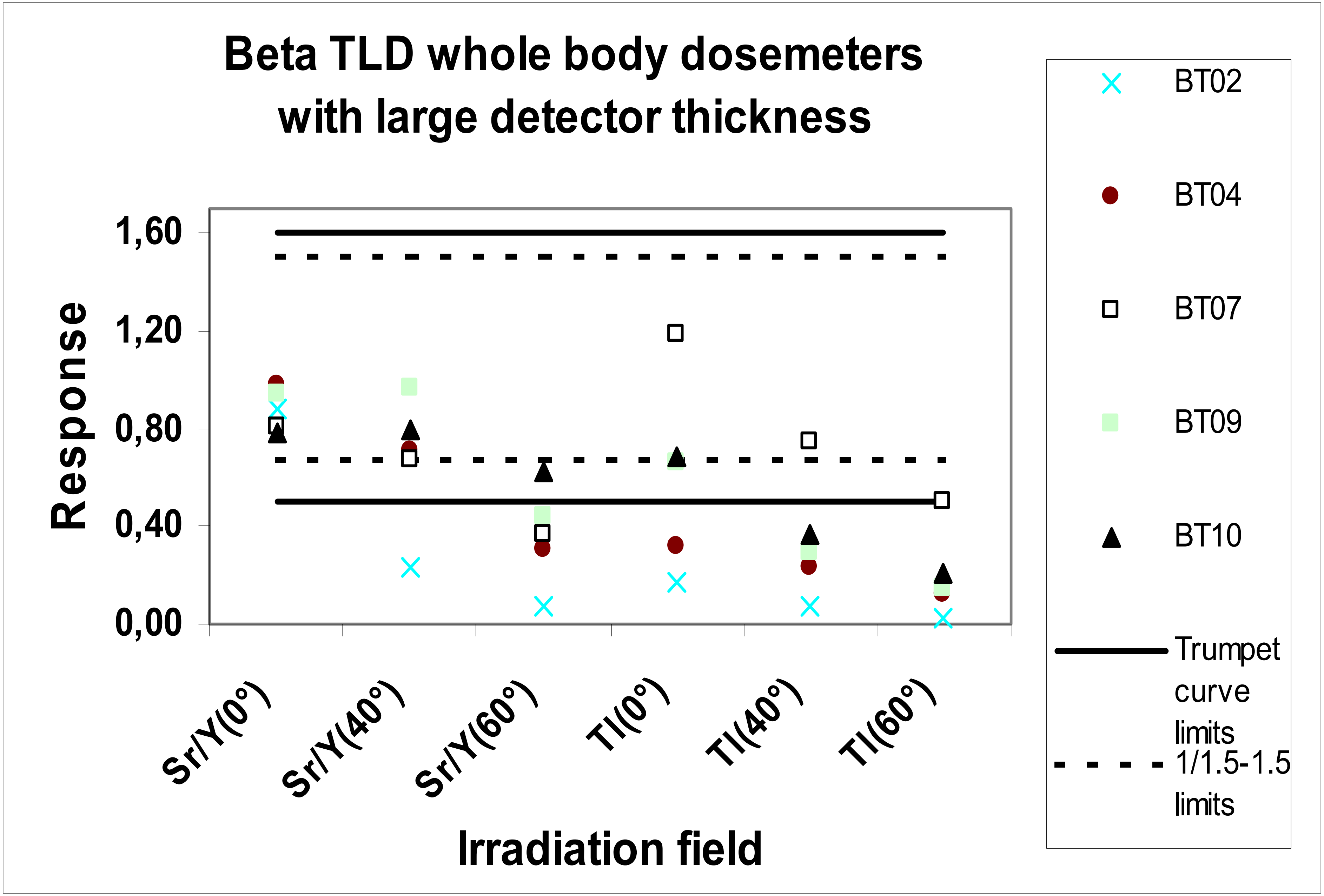
BetaTLD whole body dosemeters with small detector/filter thickness



EURADOS



Beta TLD whole body dosemeter results
thick detector/filter
Response
1,60
1,20
0,80
0,40
0,00
4,00
5,00
6,00
7,00
8,00
H P(0.07)/mSv
BT02
BT04
BT07
BT09
BT10
Trumpet curves
1/1,5-1,5 limits



Beta TLD whole body dosemeters
with large detector thickness
Response
1,60
1,20
0,80
0,40
0,00
Sr/Y(0°)
Sr/Y(40°)
Sr/Y(60°)
Tl(0°)
Tl(40°)
Tl(60°)
Irradiation field
BT02
BT04
BT07
BT09
BT10
Trumpet curve limits
1/1.5-1.5 limits

1. KSR-Seminar: Personendosimetrie in Europa

17. Januar 2001

1. KSR-Seminar:
Personendosimetrie in Europa

Stand der Personendosimetrie in der Schweiz im Vergleich zur Europäischen Union

Christian Wernli, PSI

Gesetzliche Grundlagen

Schweiz

- Strahlenschutzgesetz (StSG) vom 22. 3. 1991
- Strahlenschutzverordnung (StSV) vom 22. 5. 1994
- Dosimetrieverordnung (DoV) vom 7. 10. 1999

EU

- Richtlinie 96/29 vom 13. Mai 1996 und verschiedene nationale Gesetzgebungen

Rechtliche Form der Dosimetriestellen

	Anzahl Länder ja	EU mit nein	CH
Anerkennung Dos. stellen	11	4	ja
Neutronendosimeter	8	7	ja
Anerkennung Inkor-porationsüberwachung	3	12	ja

Anzahl Dosimetriestellen

- EU: ca. 200 (Mittel 6'000 Personen)
- CH: 10 (Mittel 6'000 Personen)

Anzahl beruflich strahlenexponierte Personen

- EU: 1.2 Millionen (0.4 % der Bevölkerung)
- CH: 62'000 (0.9 % der Bevölkerung)

Nationales Dosisregister

- Anzahl Länder mit Dosisregister: 12 (+ CH)
- Anzahl Länder ohne Dosisregister: 3

Messgrössen für Photonen

	Anzahl Länder
$H_p(0.07)$ und $H_p(10)$	5 (+ CH)
$H_p(10)$	6
H_x	2
H_{MADE}	1
K_a, D_t	1

Empfehlung der Expertengruppe

- Meldung an ZDR:
  Immer $H_p(0.07)$ und $H_p(10)$

- $H_p(0.07)$ kann gleich $H_p(10)$ gesetzt werden, falls Unterschied gering

- Messung beider Grössen anstreben

Dosimetriesysteme

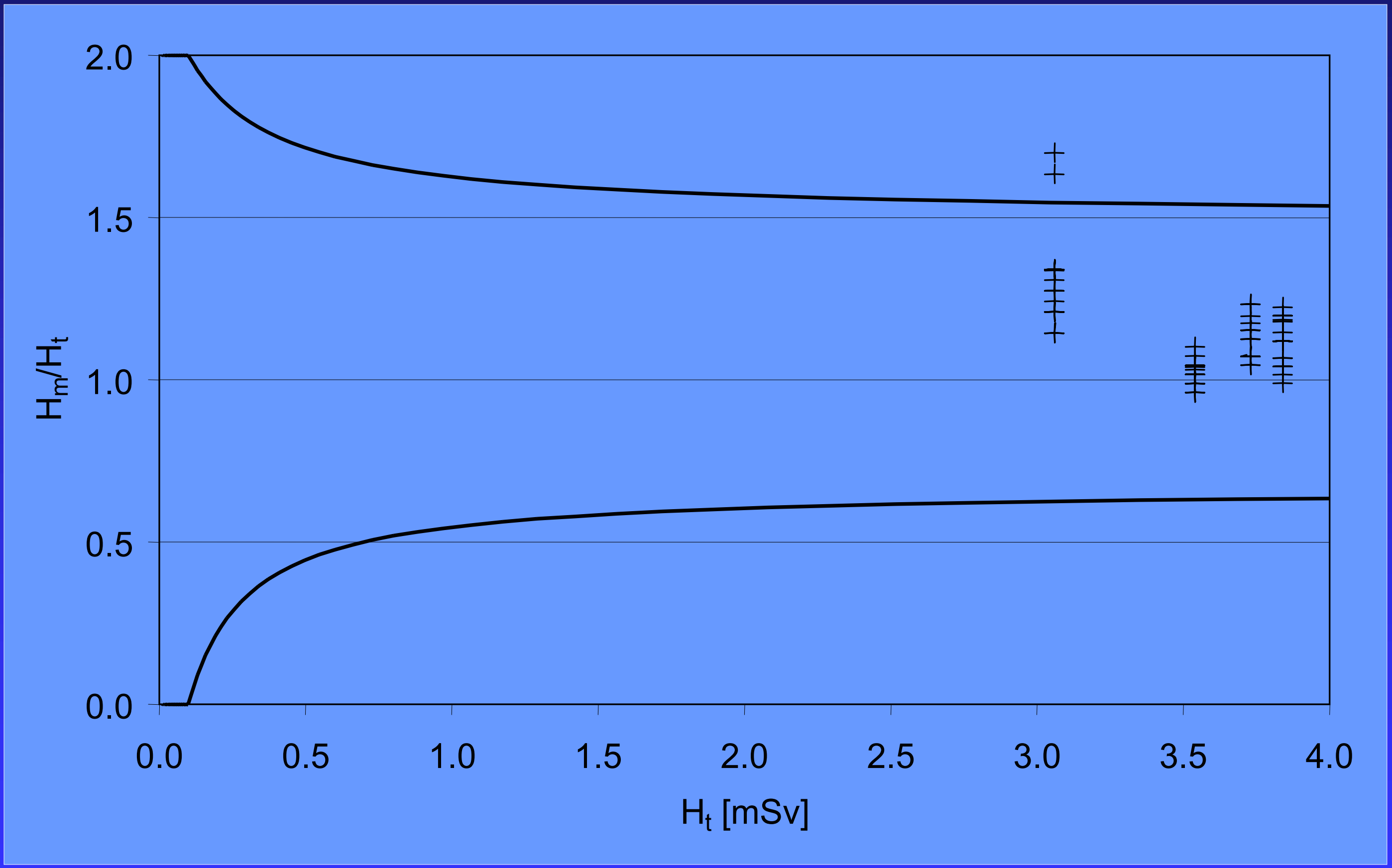
	% EU	% CH
Photonen		
TLD	41	90
Film	56	10
Andere	3	-
Neutronen		
NTA Film	41	80
Albedo	41	-
Track etch	18	20

Anerkannte Personendosimeter CH

Auditierte QM Systeme

	Anzahl EU	Anzahl CH
Akkreditiert	7	1
ISO Zertifiziert	4	-

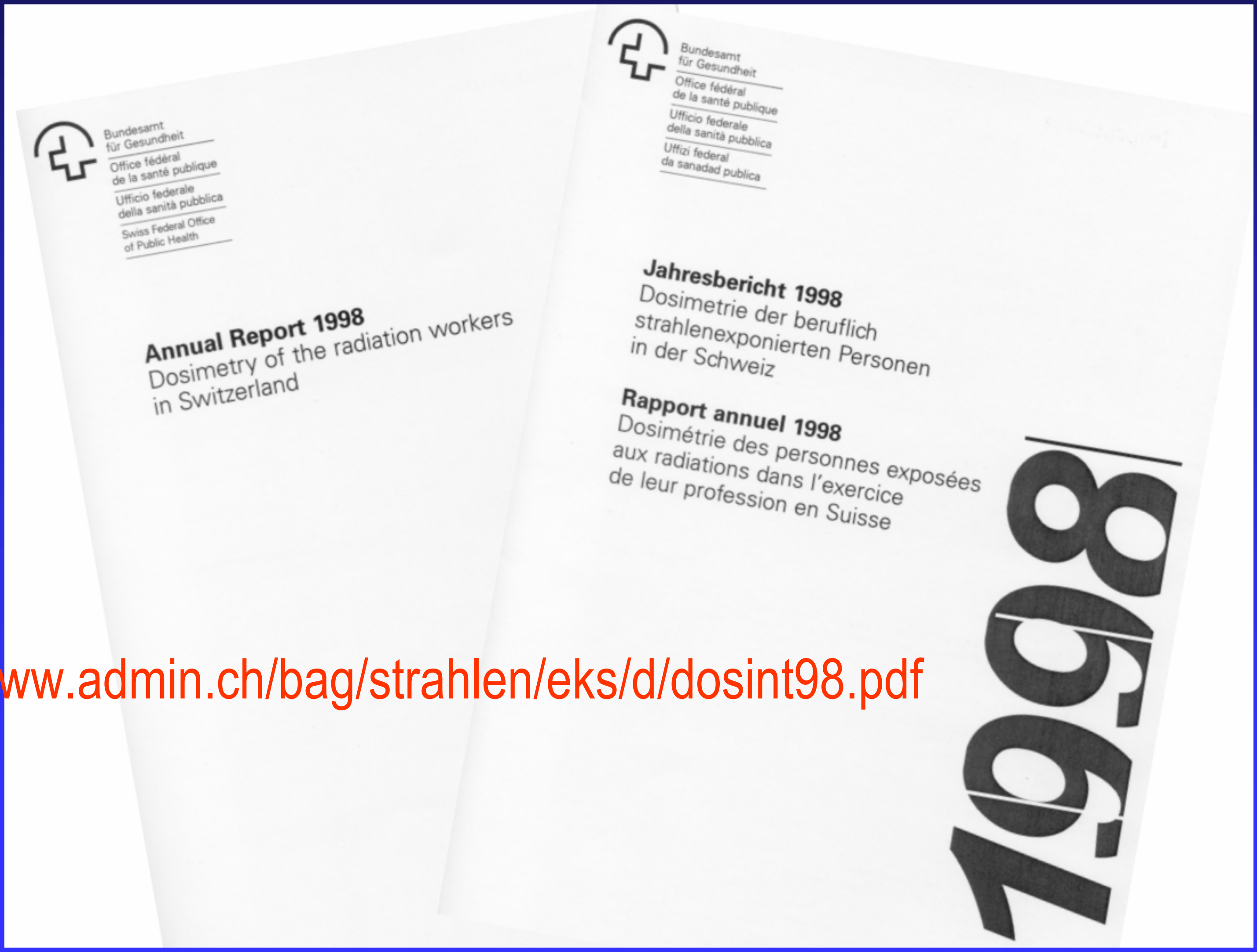
Ergebnisse der Vergleichsmessung 2000



Dosisstatistik

mSv	EU 1995	CH 1995	CH 1999
0 - 1	682'515	58'649	60'686
1 – 5	227'857	1'783	1'543
5 – 15	13'762	452	280
15 – 50	2'989	7	2
> 50	97		

Publikationen der Expertengruppe



http://www.admin.ch/bag/strahlen/eks/d/dosint98.pdf

WHO/IARC Studie (BAG)

- Grosse internationale epidemiologische Studie im Bereich Kernenergie (International Study of Cancer Risk among Nuclear Industry Workers)
- Insgesamt rund 600’000 erfasste Personen
- Rund 2000 Personen aus der Schweiz
- Erste Ergebnisse Sommer 2001

Umsetzung DoV

- Anzahl Gesuche für Anerkennung als Inkorporationsmessstelle: 8 (?)
- Provisorische Anerkennung einer Messstelle auf den 01.01.01
- Anzahl Anträge für Durchführung von Triagemessungen: 4 (?)
- Anzahl Freigaben/Bewilligungen: 4 (?)

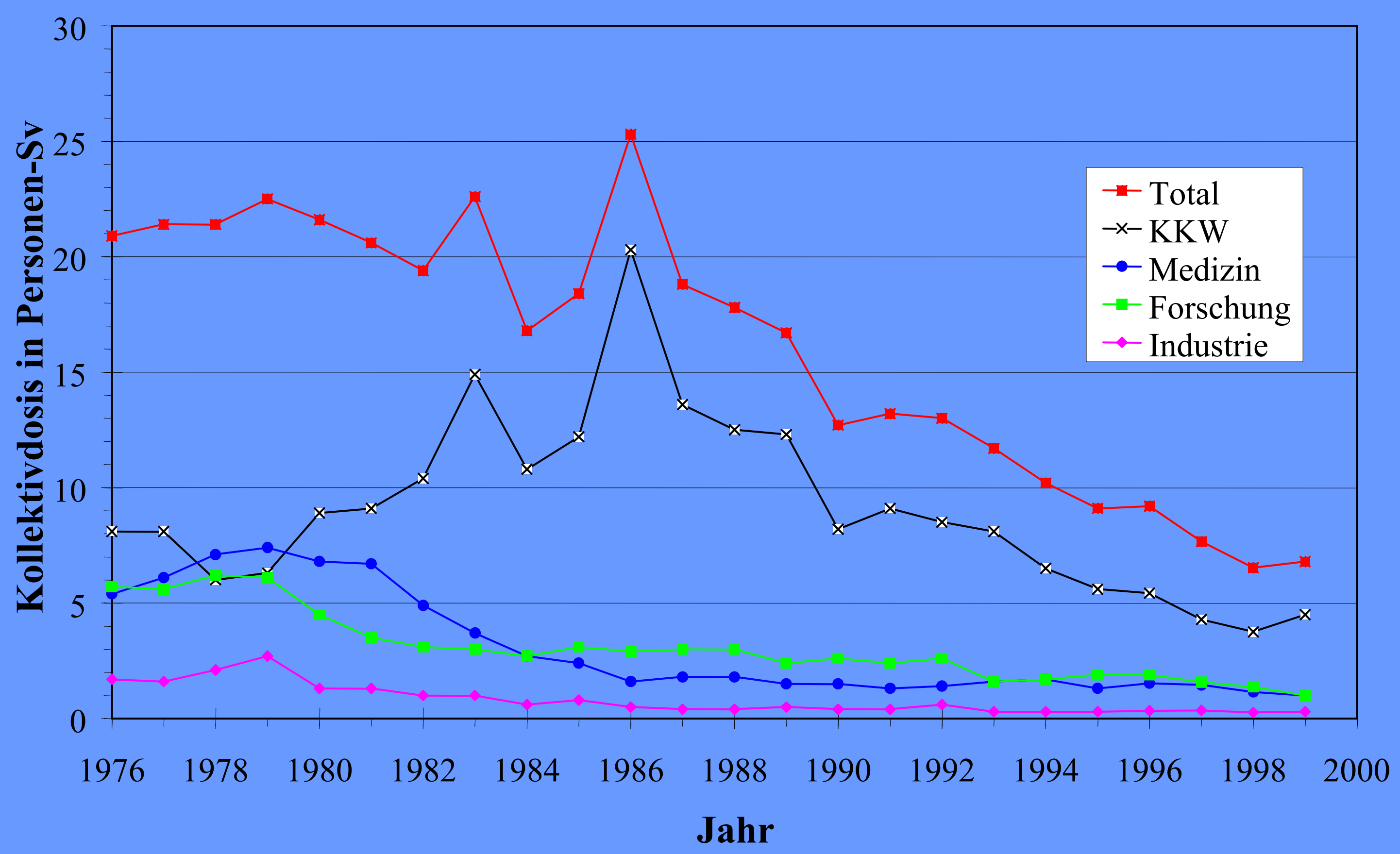
DIS Dosimeter und Leser

Aktueller Stand CH

- EU Richtlinie vom 13. Mai 1996 in der Schweiz weitgehend erfüllt *)
- Erste Inkorporationsmessstelle anerkannt
- Erstes elektronisches System (DIS-1) anerkannt
- * Air-Crew Dosimetry nicht auf dem Stand der EU-Anforderungen, Erfüllung StSV in Abklärung

1. KSR-Seminar: Personendosimetrie in Europa

Entwicklung der Kollektivdosis



Anzahl beruflich strahlenexponierte Personen