GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD
Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

EURADOS Intercomparison exercises on whole body and extremity dosemeters (2008-2014) – Outline and Results

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EURADOS Intercomparison 2008-2014
for whole body and extremity dosemeters

Organising Group (OG):

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Aim of EURADOS intercomparisons program

To provide individual monitoring services (IMS) for external dosimetry in Europe with the opportunity to:

- test their performance on a regular time intervals,
- to compare their results with other IMS,
- show compliance with standards/regulations
- improve and harmonize their dosimetry systems

And in addition:

- generate overviews of the present status of external dosimetry across Europe and analyse them

List of European intercomparisons

Organiser	*year*	*#IMS*	*radiation*	*Dosim.*	*comment*
IAEA	1988	20	photon	WB	Phase I
IAEA	1990	24	photon	WB	Phase II
IAEA	1997	??	photon	WB	"Type test"
IAEA	1998	23	photon	WB	"Simulated Workplace Field"
EURADOS	1998	26	photon	WB	"Simulated Workplace Fields"
EURADOS	1998	16	beta	WB	"Simulated Workplace Fields"
EURADOS	1998	8	beta	EXT	"Simulated Workplace Fields"
EURADOS	1998	17	neutron	WB	"Simulated Workplace Fields"
IAEA	1999	35	photon	WB	"Simulated Workplace Fields"
IAEA	2003	34	photon/ neutron	WB	Phase I
IAEA	2004	?	photon/ neutron	WB	Phase II (Simulated Workplace Fields
EURADOS/IAEA	2005	13	photon	WB/APD	
EURADOS/CONRAD	2007	6	photon	WB/APD	Interventional Radiology Fields
EURADOS/CONRAD	2007	24	photon/ beta	EXT	Reference And Workplace Fields
EURADOS	*2008*	*52/62*	*photon*	*WB*	*Reference And Workplace Fields*
EURADOS	*2009*	*44/59*	*photon/beta*	*EXT*	*Reference And Workplace Fields*
EURADOS	*2010*	*70/85*	*photon*	*WB*	*Reference And Workplace Fields*
EURADOS	*2012*	*31/34*	*Neutrons*	*WB*	*Reference And Workplace Fields*
EURADOS	*2012*	*75/88*	*photon*	*WB*	*Reference And Workplace Fields*

Early intercomparisons

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IAEA INTERCOMPARISONS FOR INDIVIDUAL MONITORING OF PHOTON RADIATION 1987–1998

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INVITED PAPER

Abstract — In 1985 a technical committee set up by the IAEA formulated tasks to be performed in individual monitoring and recommended 'some type of personnel dosimetry activity'. Since 1987 several coordinated research projects have been performed within the Agency's Research Contract Programme concerning intercomparisons for individual monitoring. While the first intercomparison focused on the impact of the possible adoption of the new set of operational quantities introduced in ICRU Report 39 in 1985, later intercomparisons concentrated on the performance of personnel dosimetry services. In the last intercomparison, dosimetry services for nuclear power plants in IAEA Member States in Eastern Europe were given an opportunity to gain experience with the recommendations of the IAEA to use the operational quantity $H_p(10)$. This paper analyses whether the important tasks formulated in 1985 were actually solved. It summarises the various intercomparisons carried out between 1987 and 1998 and highlights some results.

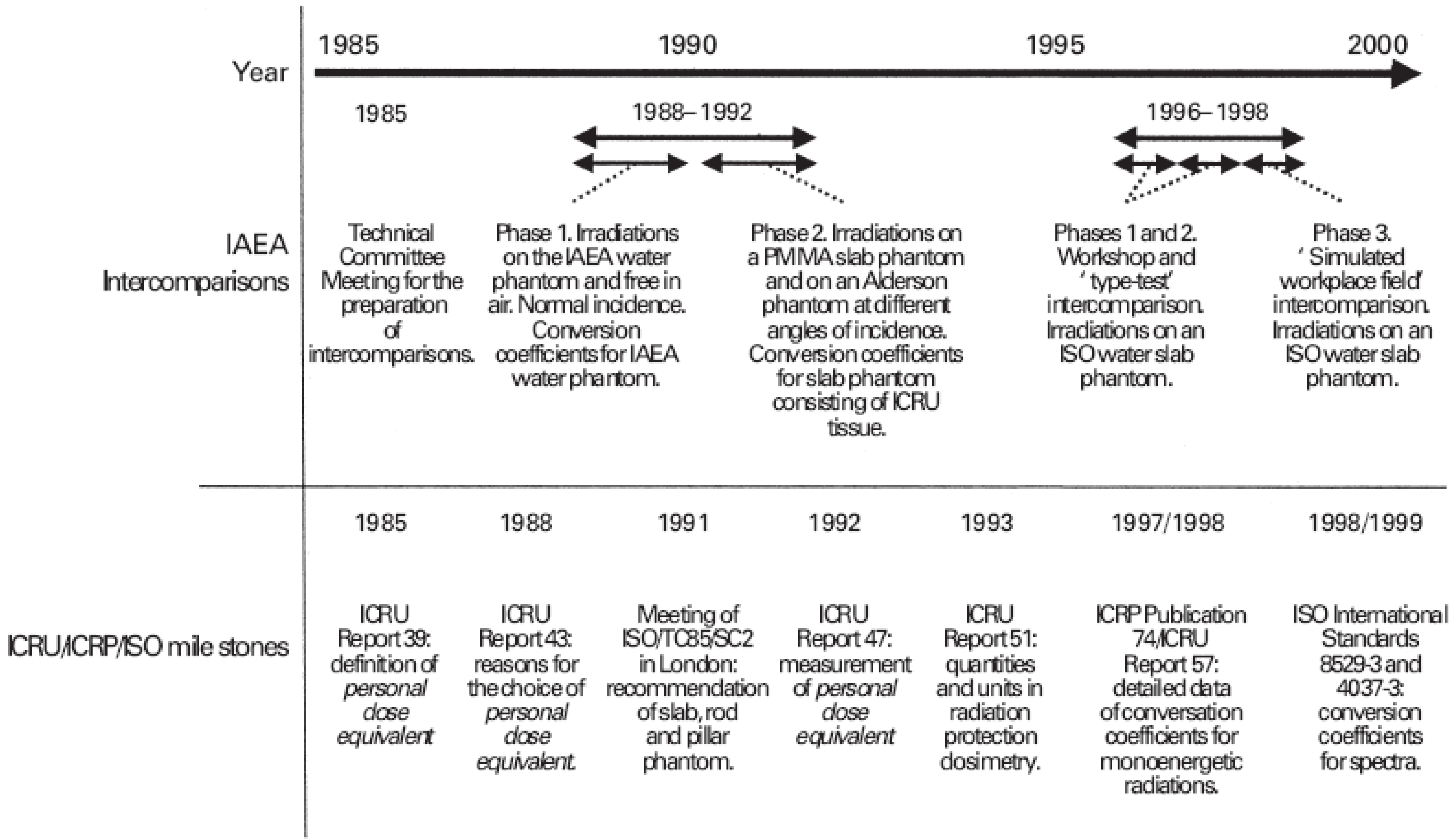


Figure 1. IAEA intercomparisons for individual monitoring and dosimetric milestones related to ICRU, ICRP and ISO between 1985 and 2000.

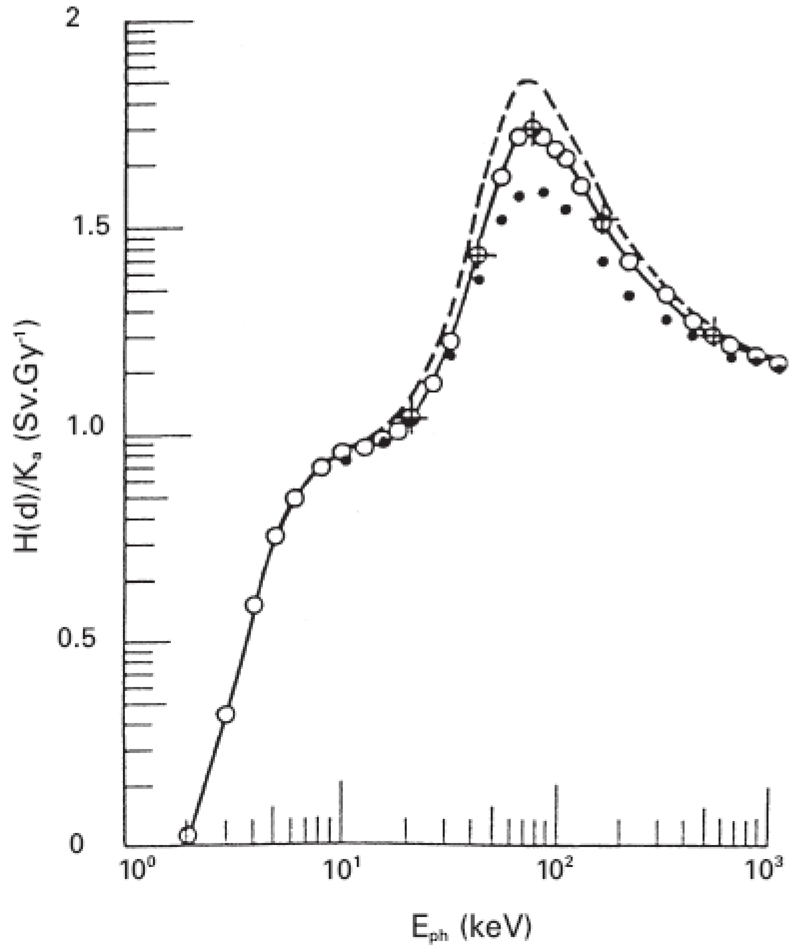


Figure 5. Conversion coefficient H(d)/K$_a$ as a function of photon energy E$_{ph}$ for different phantoms(16). The depth d is 0.07 mm for the ICRU tissue slab phantom (○), the IAEA water phantom (+) and the ICRU sphere (●). For the PMMA slab phantom (- - -) d is 0.1 mm.

ISO 4037-3

INTERNATIONAL STANDARD

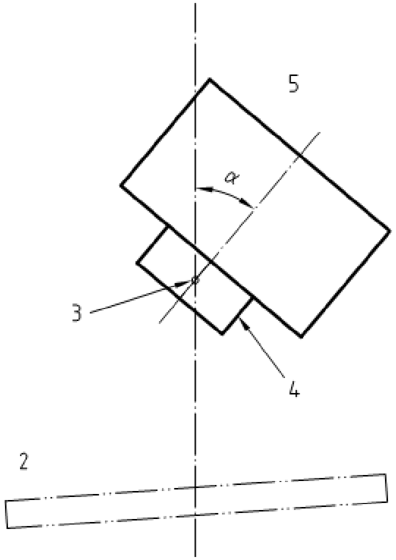
ISO 4037-3

First edition
1999-06-15

X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy —

Part 3:
Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence

Point of test



4.1.5 Point of test and reference point

Measurements shall be carried out by positioning the reference point of the dosemeter at the point of test. The reference point and the reference direction of the dosemeter to be tested should be stated by the manufacturer. The reference point should be marked on the outside of a dosemeter. If this proves impossible, the reference point should be indicated in the accompanying documents supplied with the instrument. All distances between the radiation source and the dosemeter shall be taken as the distance between the radiation source and the dosemeter's reference point.

In the absence of information on the reference point or on the reference direction of the dosemeter to be tested, these parameters shall be fixed by the testing laboratory. They shall be stated in the test certificate.

NOTE In the case of point sources and in the absence of scattered radiation and photon absorption, the dose rate changes with the inverse square of the distance l. A misplacement of the dosemeter's reference point in the beam by the amount of Δl in the direction of the beam will lead to a relative error in the calibration factor of $2\Delta l/l$ at the distance l. Misalignment perpendicular to the beam axis by $\Delta\lambda$ causes a relative error of $(\Delta\lambda/l)^2$. In the presence of scattered radiation and for sources of finite dimensions, the above approximations are limited to values of Δl or $\Delta\lambda$ that are small in comparison to l.

6.3.1 Use of phantoms

Measurements of the response as a function of radiation energy and direction of radiation incidence and calibrations of personal dosemeters should be carried out on a phantom that is suitable in view of the depth of measurement and of the type of dosemeter. As a rule, the depth of 0,07 mm will be applicable only for extremity dosemeters (see note below). For dosemeters worn on the fingers, the ISO rod phantom should be used and, for those worn on the wrist or the ankle, the ISO pillar phantom should be used. The ISO rod phantom is a PMMA cylinder of 19 mm diameter and a length of 300 mm. The ISO pillar phantom is a water-filled hollow cylinder with PMMA walls and an outer diameter of 73 mm and a length of 300 mm. The cylinder walls have a thickness of 2,5 mm and the end faces have a thickness of 10 mm. For dosemeters worn on the body to measure $H_p(10)$, a phantom of outer dimensions 30 cm × 30 cm × 15 cm with PMMA walls (front wall 2,5 mm thick, other walls 10 mm thick) filled with water and termed the ISO water slab phantom, should be used. When using reference radiations with a mean energy equal to or above that of the radionuclide ^{137}Cs, a solid PMMA slab of the same outer dimensions may be used.

When these phantoms are employed as described above, no correction factors shall be applied to the reading of the instrument under test, due to possible differences in back-scatter properties between these phantoms and those of ICRU tissue.

Routine calibrations (see note in 3.2.11) need not always be performed on a phantom but may sometimes be done more simply, free in air, or with another type of radiation than that which the dosemeter is intended to measure. Such simplifications, if they are to be applied, shall be justified prior to their adoption by demonstrating that they lead to results identical to those from procedures described in this part of ISO 4037, or that any differences can be corrected for reliably. This may be done on the basis of the results of a type test.

List of European intercomparisons

Organiser	*year*	*#IMS*	*radiation*	*Dosim.*	*comment*
IAEA	1988	20	photon	WB	Phase I
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EURADOS	*2009*	*44/59*	*photon/beta*	*EXT*	*Reference And Workplace Fields*
EURADOS	*2010*	*70/85*	*photon*	*WB*	*Reference And Workplace Fields*
EURADOS	*2012*	*31/34*	*Neutrons*	*WB*	*Reference And Workplace Fields*
EURADOS	*2012*	*75/88*	*photon*	*WB*	*Reference And Workplace Fields*

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PERFORMANCE TEST OF DOSIMETRIC SERVICES IN THE EU MEMBER STATES AND SWITZERLAND FOR THE ROUTINE ASSESSMENT OF INDIVIDUAL DOSES (PHOTON, BETA AND NEUTRON)

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INVITED PAPER

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Table 1. Number of services taking part in the tests by country and by radiation type.

EU code	Country	Photon	Beta whole-body	Beta extremity	Neutron	Total/ country	Services/ country
A	Austria	2	1	1	1	5	2
B	Belgium	1	1	1	—	3	1
CH	Switzerland	2	2	1	2	7	3
D	Germany	2	—	2	1	5	4
DK	Denmark	1	1	1	1	4	2
E	Spain	2	1	—	1	4	2
EL	Greece	1	—	—	2	3	2
F	France	4	2	1	4	11	5
FIN	Finland	2	1	—	1	4	2
I	Italy	1	1	—	1	3	1
IRL	Ireland	1	1	—	—	2	1
L	Luxembourg	1	—	—	—	1	1
NL	Netherland	1	1	—	—	2	1
P	Portugal	1	—	—	—	1	1
S	Sweden	1	1	—	—	2	1
UK	United Kingdom	3	2	1	3	9	5
	Total	26	15	8	17	66	34

Detailed Information about used Dosemeters

Table 10. Continued.

(c) Extremity dosemeters (all of TLD type)

Code No	Dosemeter category	Detector	Detector thickness ($mg.cm^{-2}$)	Cover thickness ($mg.cm^{-2}$)	Calibr. reference radiation
1	Finger	LiF:Mg,Ti; TLD-100	100	40	Cs-137
2	Finger	LiF-7 Teflon	28	32	Co-60
4	Wrist	LiF:Mg,Ti; TLD-700	100	45	Co-60
5	Finger	LiF:Mg,Cu.P (MCP-Ns)	10	0.5	Co-60
6	Finger	LiF:Mg,Cu.P (MCP-Ns)	8	2	Cs-137
7	Finger	LiF:Mg,Cu.P (MCP-7s)	8	10	Cs-137
8	Finger	LiF-grains (75–106 μm)	5	3.5	Sr/Y-90
9	Wrist	LiF:Mg,Cu.P (1): MCP-Ns (2): MCP-7	 (1): 8 (2): 240	 (1): 1.5 (2): 86	 Cs-137 (a)

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EURADOS TRIAL PERFORMANCE TEST FOR PHOTON DOSIMETRY

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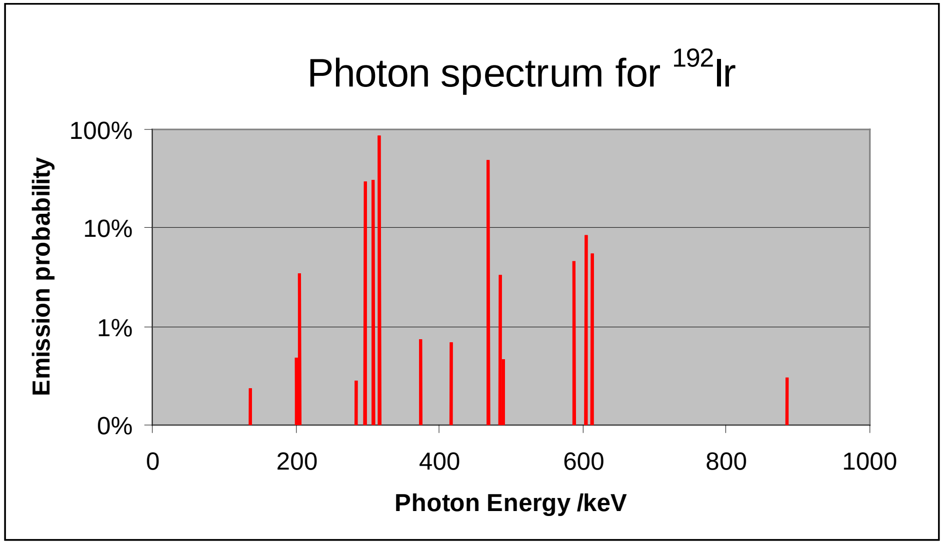
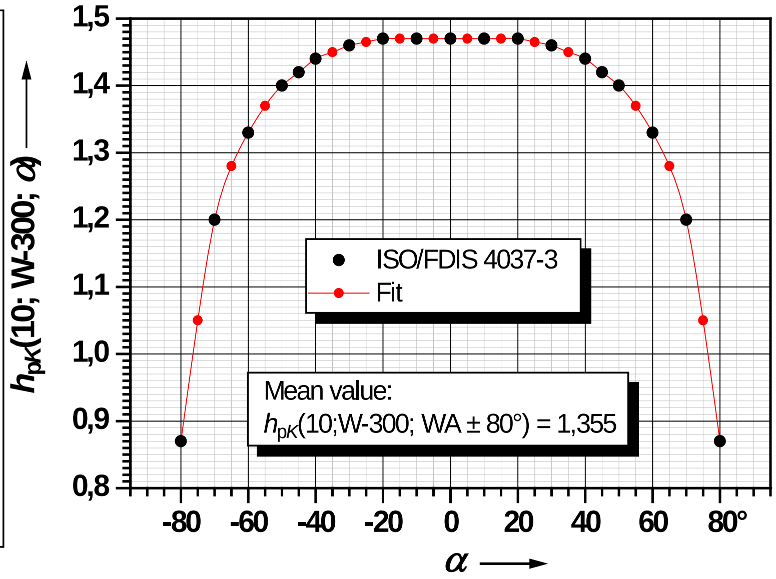
INVITED PAPER

Abstract — Within the framework of the EURADOS Action entitled *Harmonisation and Dosimetric Quality Assurance in Individual Monitoring for External Radiation*, trial performance tests for whole-body and extremity personal dosemeters were carried out. Photon, beta and neutron dosemeters were considered. This paper summarises the results of the whole-body photon dosemeter test. Twenty-six dosimetry services from all EU Member States and Switzerland participated. Twelve different radiation fields were used to simulate various workplace irradiation fields. Dose values from 0.4 mSv to 80 mSv were chosen. From 312 single results, 26 fell outside the limits of the trumpet curve and 32 were outside the range 1/1.5 to 1.5. Most outliers resulted from high energy R-F irradiations without electronic equilibrium. These fields are not routinely encountered by many of the participating dosimetry services. If the results for this field are excluded, most participating services satisfied the evaluation criteria.

Radiation quality	Conversion coefficient h_{pK} (10) Sv / Gy	Standard uncertainty	Mean Energy keV
S-Ir (0°)	1,317 *	0,03	396
S-Ir (WA ± 80°)	1,262 *	0,035	396
W-80 (WA ± 80°)	1,523 *	0,025	57
S-Co (0°)	1,15	0,02	1250
R-F (0°)	1,12	0,029	6610
W-300 (WA ± 80°)	1,355 *	0,025	208
R-F (0°) without electronic equilibrium	1,41 *	0,086	6610





EURADOS Performance test

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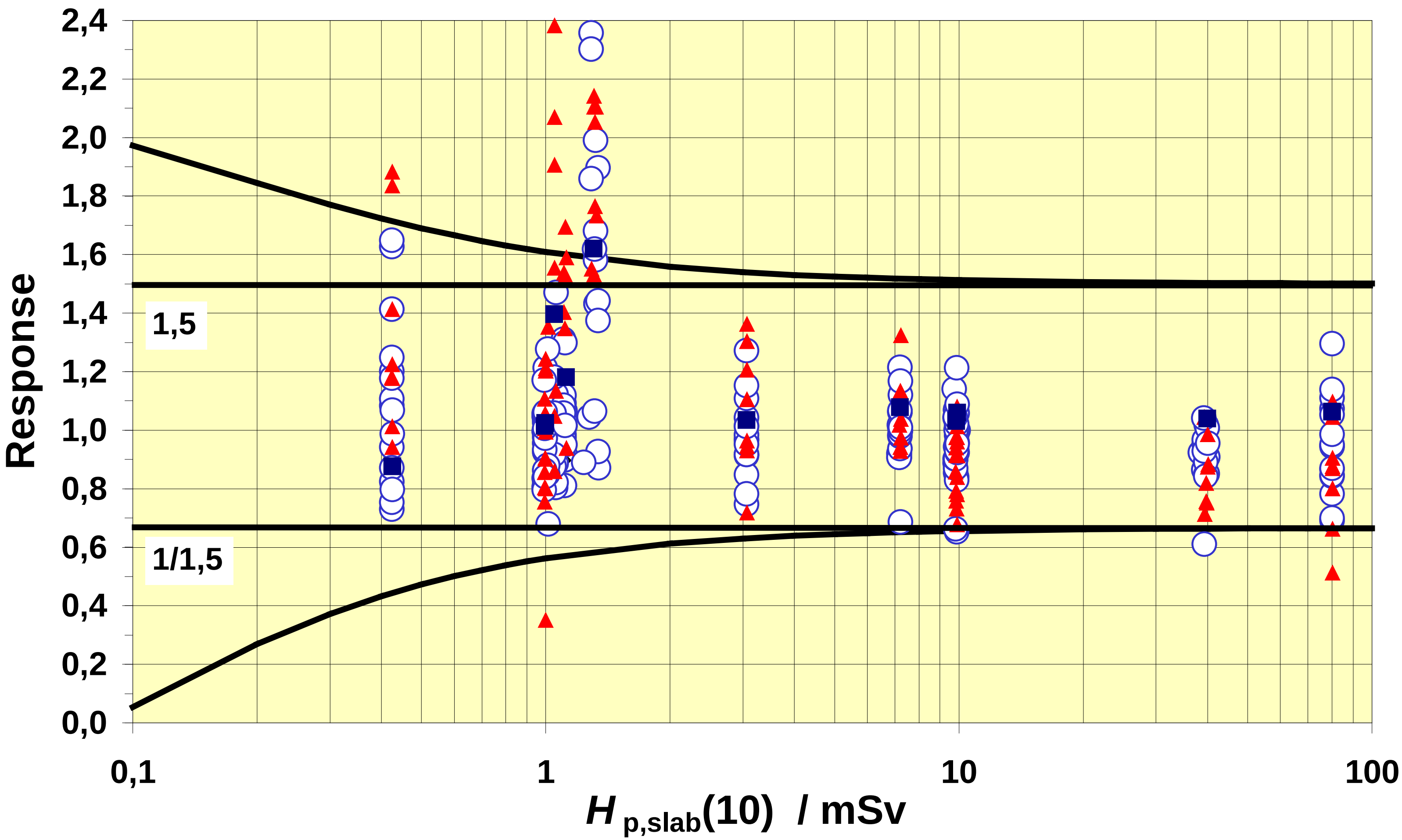
Results



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Trumpet curve				
type	**datapoints**	**outliers**	**outside limits**	**inside limits**
TLD (PT)	204	10	4,9%	95,1%
Film (PF)	96	15	15,6%	84,4%
Glass (PV)	12	1	8,3%	91,7%
All	**312**	**26**	**8,3%**	**91,7%**

1/1,5 to 1,5 range				
type	**datapoints**	**outliers**	**outside limits**	**inside limits**
TLD (PT)	204	10	4,9%	95,1%
Film (PF)	96	21	21,9%	78,1%
Glass (PV)	12	1	8,3%	91,7%
All	**312**	**32**	**10,3%**	**89,7%**

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EURADOS TRIAL PERFORMANCE TEST FOR PERSONAL DOSEMETERS FOR EXTERNAL BETA RADIATION

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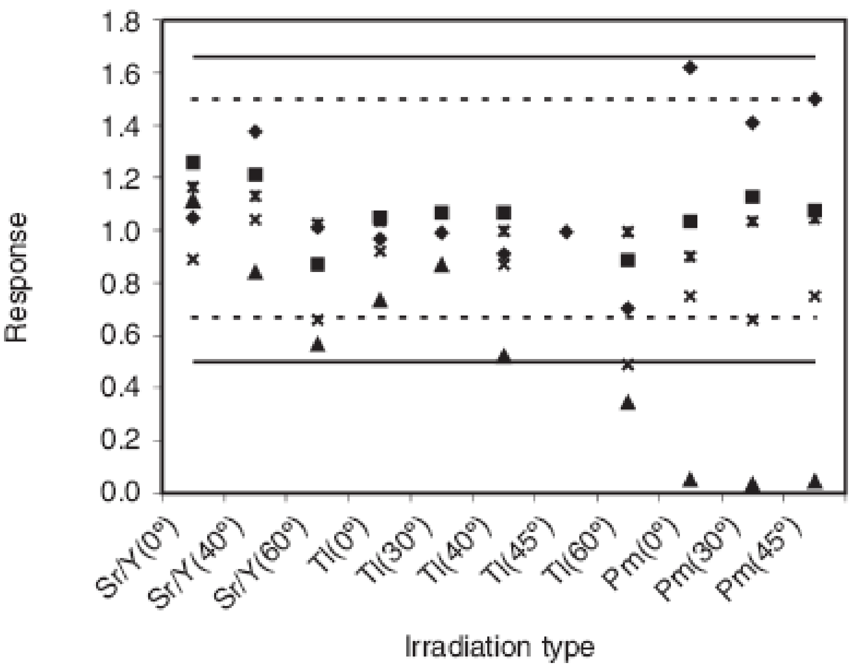
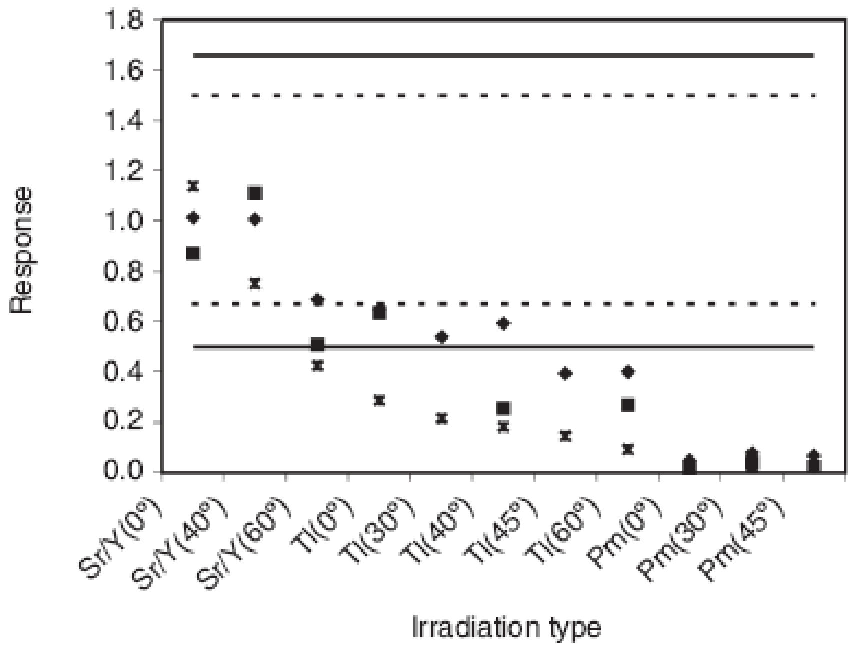
Results (Beta irradiation)





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EURADOS TRIAL PERFORMANCE TEST FOR NEUTRON PERSONAL DOSIMETRY

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F–92265, Fontenay-aux-Roses CEDEX, France
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INVITED PAPER

Abstract — This paper reports on the results of a neutron trial performance test sponsored by the European Commission and organised by EURADOS. As anticipated, neutron dosimetry results were very dependent on the dosemeter type and the dose calculation algorithm. Fast neutron fields were generally well measured, but particular problems were noted in the determination of intermediate energy fields and large incident angles, demonstrating the difficulties of neutron personal dosimetry. Of particular concern from a radiological protection point of view was the large number of results underestimating personal dose equivalent. A considerable over-response was noted in a few cases.

Results (neutron irradiation)

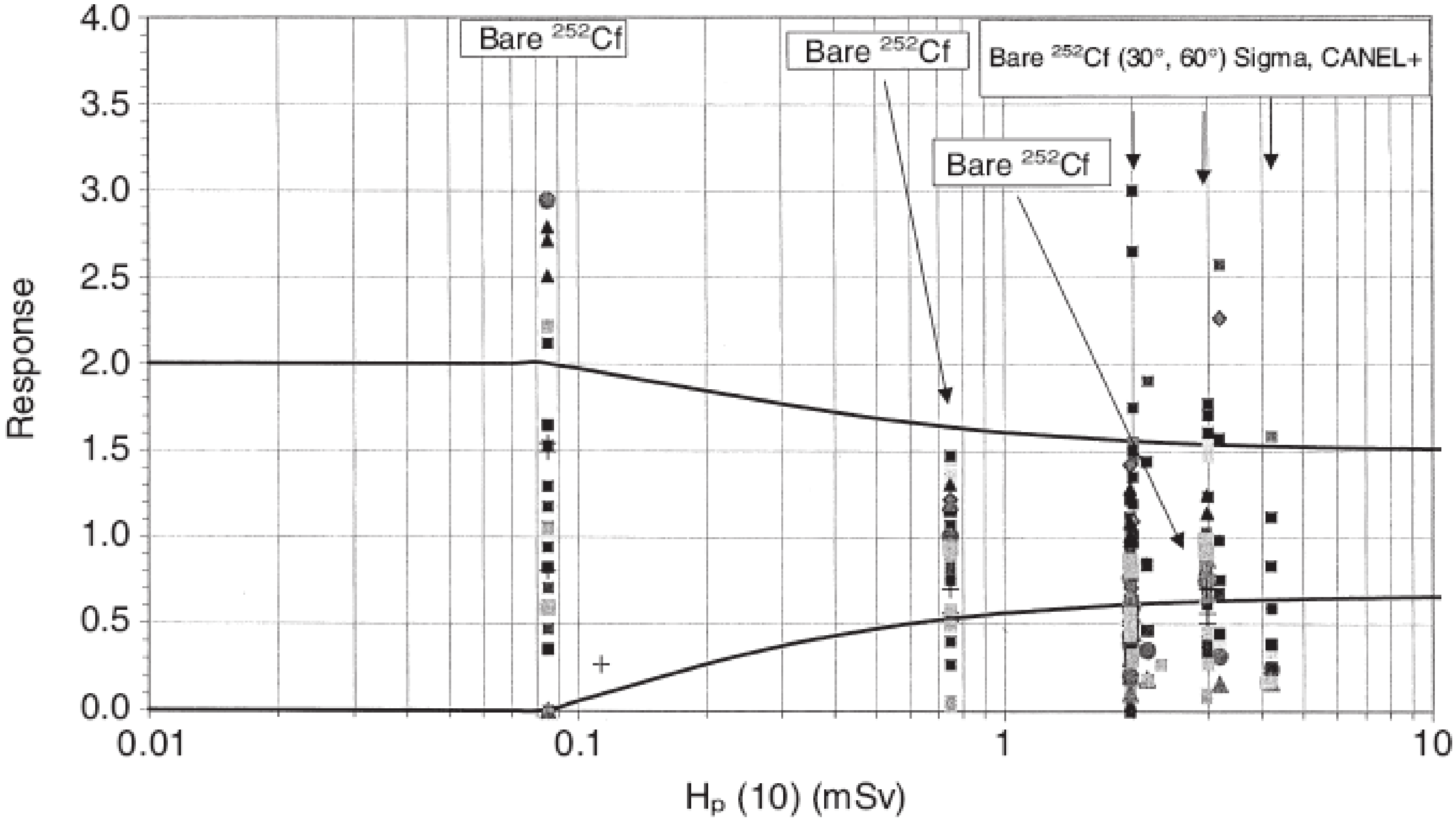
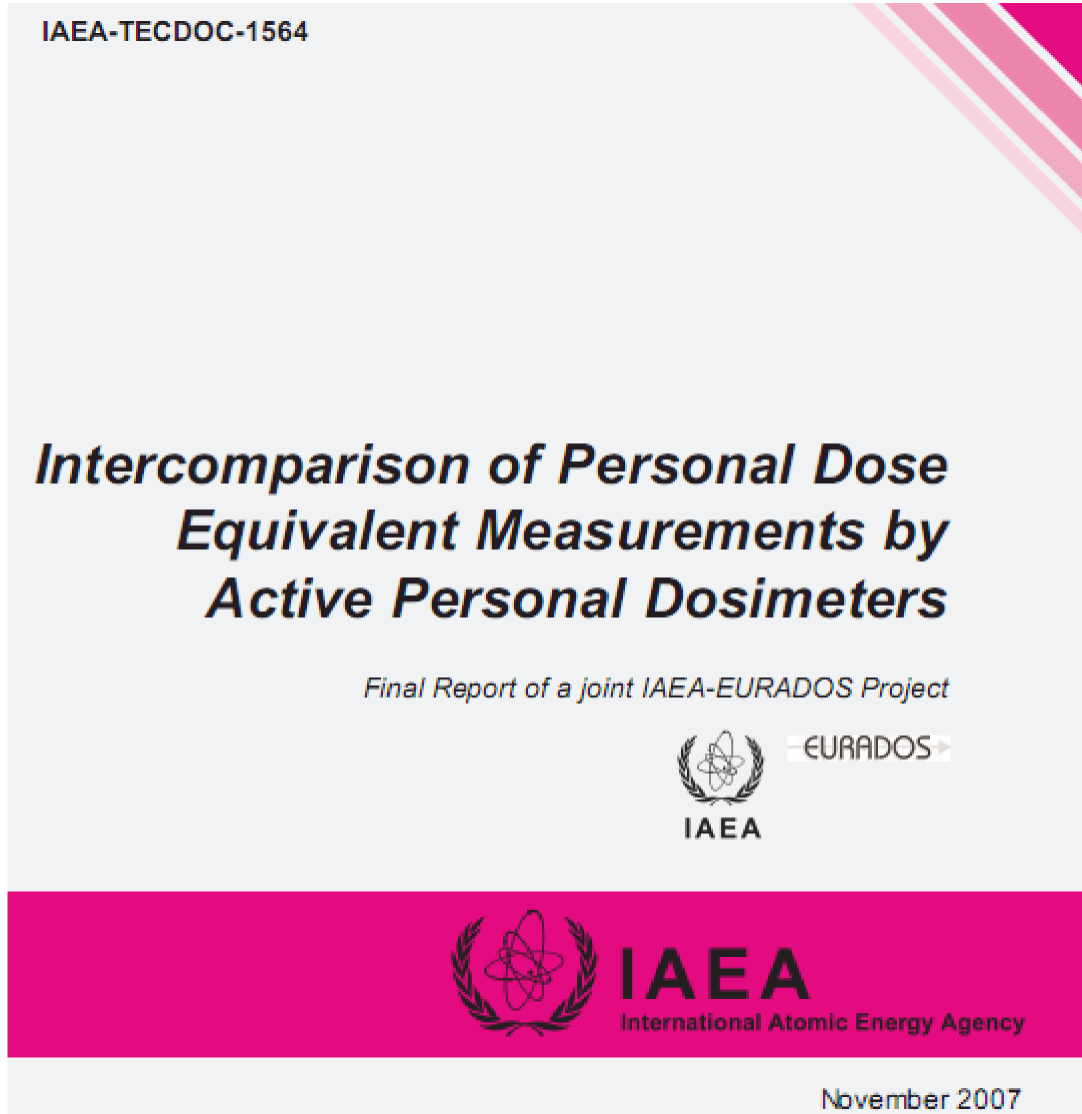


Figure 4. Trumpet curves for corrected results.

List of European intercomparisons

Organiser	*year*	*#IMS*	*radiation*	*Dosim.*	*comment*
IAEA	**1988**	**20**	**photon**	**WB**	**Phase I**
IAEA	**1990**	**24**	**photon**	**WB**	**Phase II**
IAEA	**1997**	**??**	**photon**	**WB**	**“Type test”**
IAEA	**1998**	**23**	**photon**	**WB**	**"Simulated Workplace Field"**
EURADOS	**1998**	**26**	**photon**	**WB**	**"Simulated Workplace Fields"**
EURADOS	**1998**	**16**	**beta**	**WB**	**"Simulated Workplace Fields"**
EURADOS	**1998**	**8**	**beta**	**EXT**	**"Simulated Workplace Fields"**
EURADOS	**1998**	**17**	**neutron**	**WB**	**"Simulated Workplace Fields"**
IAEA	**1999**	**35**	**photon**	**WB**	**"Simulated Workplace Fields"**
IAEA	**2003**	**34**	**photon/ neutron**	**WB**	**Phase I**
IAEA	**2004**	**?**	**photon/ neutron**	**WB**	**Phase II (Simulated Workplace Fields**
EURADOS/IAEA	**2005**	**13**	**photon**	**WB/APD**	
EURADOS/CONRAD	**2007**	**6**	**photon**	**WB/APD**	**Interventional Radiology Fields**
EURADOS/CONRAD	**2007**	**24**	**photon/ beta**	**EXT**	**Reference And Workplace Fields**
EURADOS	***2008***	***52/62***	***photon***	***WB***	***Reference And Workplace Fields***
EURADOS	***2009***	***44/59***	***photon/beta***	***EXT***	***Reference And Workplace Fields***
EURADOS	***2010***	***70/85***	***photon***	***WB***	***Reference And Workplace Fields***
EURADOS	***2012***	***31/34***	***Neutrons***	***WB***	***Reference And Workplace Fields***
EURADOS	***2012***	***75/88***	***photon***	***WB***	***Reference And Workplace Fields***

IAEA - EURADOS



IAEA-TECDOC-1564

Intercomparison of Personal Dose Equivalent Measurements by Active Personal Dosimeters

Final Report of a joint IAEA-EURADOS Project

IAEA

EURADOS

IAEA

International Atomic Energy Agency

November 2007

APD Intercomparison

The IAEA in cooperation with EURADOS organized such an intercomparison in which most of the testing criteria as described in two internationally accepted standards (IEC61526 and IEC61283) were used. Additionally, simulated workplace fields were used for testing the APD reactions to pulsed X ray fields and mixed gamma/X ray fields. This is the first time that results of comparisons of such types are published, which is of great importance for APD end users in medical diagnostic and surgery X ray applications.

Nine suppliers from six countries in Europe and the USA participated in the intercomparison with 13 different models. One of the models was a special design for extremity dose measurements.


ATOMTEX
MGP
Graetz
SAIC
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EURADOS	*2012*	*75/88*	*photon*	*WB*	*Reference And Workplace Fields*

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INTERCOMPARISON OF ACTIVE PERSONAL DOSEMETERS IN INTERVENTIONAL RADIOLOGY

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The use of active personal dosemeters (APD) in interventional radiology was evaluated by Working Group 9 (Radiation protection dosimetry of medical staff) of the CONRAD project, which is a Coordination Action supported by the European Commission within its sixth Framework Programme. Interventional radiology procedures can be very complex and they can lead to relatively high doses to personnel who stand close to the primary radiation field and are mostly exposed to radiation scattered by the patient. For the adequate dosimetry of the scattered photons, APDs must be able to respond to low-energy [10–100 keV] and pulsed radiation with relatively high instantaneous dose rates. An intercomparison of five APD models deemed suitable for application in interventional radiology was organised in March 2007. The intercomparison used pulsed and continuous radiation beams, at CEA-LIST (Saclay, France) and IRSN (Fontenay-aux-Roses, France), respectively. A specific configuration, close to the clinical practice, was considered. The reference dose, in terms of $H_p(10)$, was derived from air kerma measurements and from the measured and calculated energy distributions of the scattered radiation field. Additional Monte Carlo calculations were performed to investigate the energy spectra for different experimental conditions of the intercomparison. The results of this intercomparison are presented in this work and indicate which APDs are able to provide a correct response when used in the specific low-energy spectra and dose rates of pulsed X-rays encountered in interventional radiology.

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EXTREMITY RING DOSIMETRY INTERCOMPARISON IN REFERENCE AND WORKPLACE FIELDS

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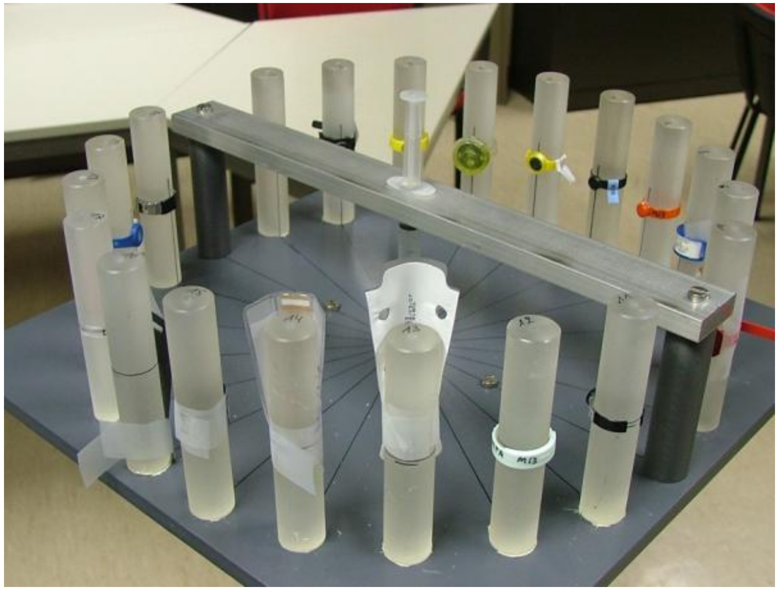
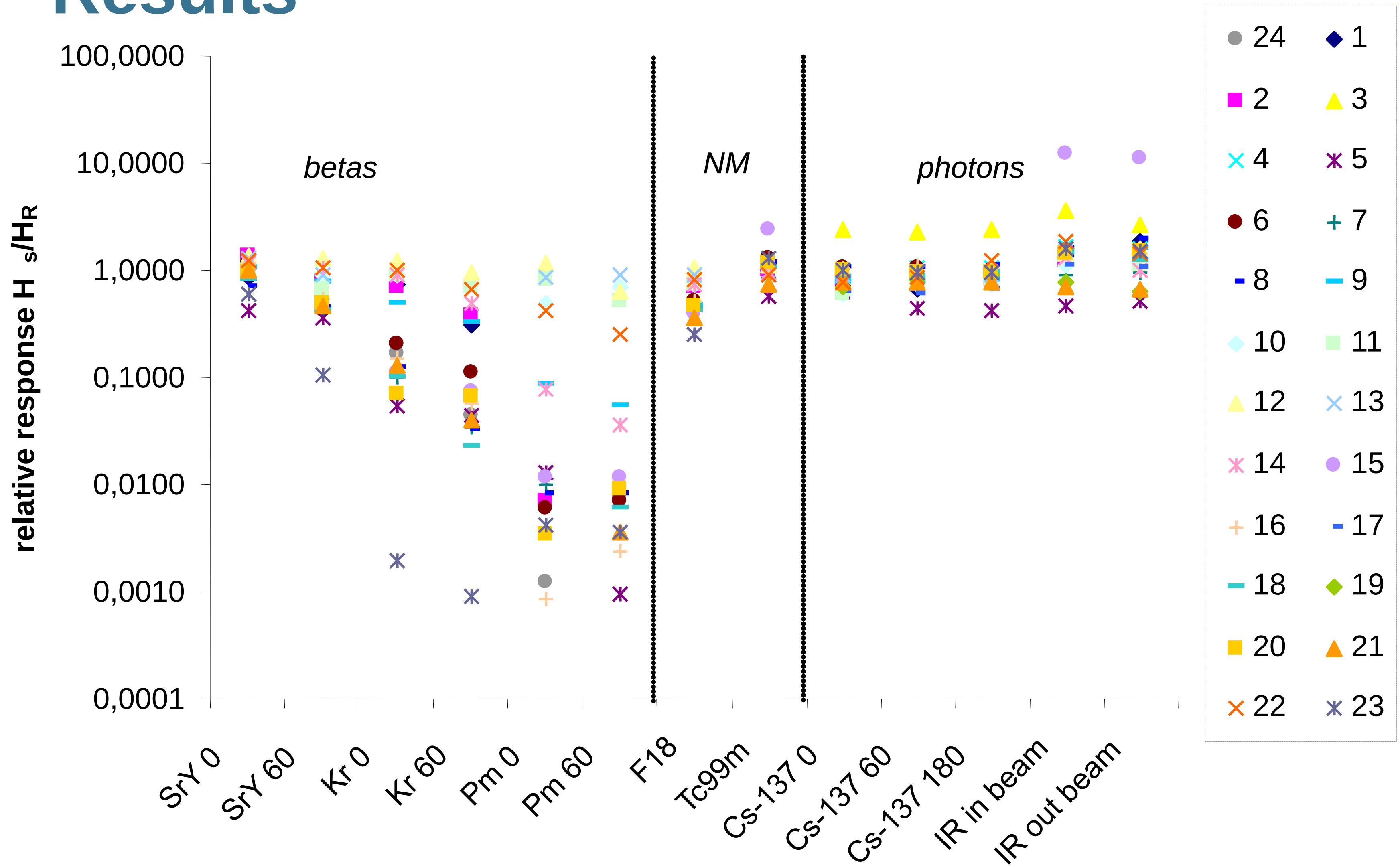
An intercomparison of ring dosemeters has been organised with the aim of assessing the technical capabilities of available extremity dosemeters and focusing on their performance at clinical workplaces with potentially high extremity doses. Twenty-four services from 16 countries participated in the intercomparison. The dosemeters were exposed to reference photon (^{137}Cs) and beta (^{147}Pm, ^{85}Kr and ^{90}Sr/^{90}Y) fields together with fields representing realistic exposure situations in interventional radiology (direct and scattered radiation) and nuclear medicine (^{99m}Tc and ^{18}F). It has been found that most dosemeters provided satisfactory measurements of $H_p(0.07)$ for photon radiation, both in reference and realistic fields. However, only four dosemeters fulfilled the established requirements for all radiation qualities. The main difficulties were found for the measurement of low-energy beta radiation. Finally, the results also showed a general under-response of detectors to ^{18}F, which was attributed to the difficulties of the dosimetric systems to measure the positron contribution to the dose.

Results

$H_p(0.07)$ [mSv]	Radiation quality	Mean response	Response range	Nº services outside the trumpet curve
8.2	^{90}Sr-^{90}Y, 0°	1.00	0.38 – 1.42	1/20
9.0	^{90}Sr-^{90}Y, 60°	0.63	0.03 – 1.30	10/20
10.3	^{85}Kr, 0°	0.45	0 – 1.31	12/20
11.0	^{85}Kr, 60°	0.29	0 – 0.95	15/20
5.8	^{147}Pm, 0°	0.25	0 – 1.34	15/20
8.3	^{147}Pm, 60°	0.16	0 – 0.95	16/20
10.1	^{18}F	0.55	0.02 – 1.08	13/20
4.2	^{99m}Tc	1.08	0.48 – 2.36	1/20
4.5	^{137}Cs, 0°	0.92	0.35 – 2.35	1/24
4.8	^{137}Cs, 60°	0.91	0.38 – 2.37	2/24
5.2	^{137}Cs, 180°	0.96	0.37 – 2.52	2/24
2.6	IR in beam	1.86	0.27 – 12.5	3/24
0.7	IR outside beam	1.86	0.21 – 11.7	3/24



Results



GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

List of European intercomparisons

Organiser	*year*	*#IMS*	*radiation*	*Dosim.*	*comment*
IAEA	**1988**	**20**	**photon**	**WB**	**Phase I**
IAEA	**1990**	**24**	**photon**	**WB**	**Phase II**
IAEA	**1997**	**??**	**photon**	**WB**	**“Type test”**
IAEA	**1998**	**23**	**photon**	**WB**	**"Simulated Workplace Field"**
EURADOS	**1998**	**26**	**photon**	**WB**	**"Simulated Workplace Fields"**
EURADOS	**1998**	**16**	**beta**	**WB**	**"Simulated Workplace Fields"**
EURADOS	**1998**	**8**	**beta**	**EXT**	**"Simulated Workplace Fields"**
EURADOS	**1998**	**17**	**neutron**	**WB**	**"Simulated Workplace Fields"**
IAEA	**1999**	**35**	**photon**	**WB**	**"Simulated Workplace Fields"**
IAEA	**2003**	**34**	**photon/ neutron**	**WB**	**Phase I**
IAEA	**2004**	**?**	**photon/ neutron**	**WB**	**Phase II (Simulated Workplace Fields**
EURADOS/IAEA	**2005**	**13**	**photon**	**WB/APD**	
EURADOS/CONRAD	**2007**	**6**	**photon**	**WB/APD**	**Interventional Radiology Fields**
EURADOS/CONRAD	**2007**	**24**	**photon/ beta**	**EXT**	**Reference And Workplace Fields**
EURADOS	***2008***	***52/62***	***photon***	***WB***	***Reference And Workplace Fields***
EURADOS	***2009***	***44/59***	***photon/beta***	***EXT***	***Reference And Workplace Fields***
EURADOS	***2010***	***70/85***	***photon***	***WB***	***Reference And Workplace Fields***
EURADOS	***2012***	***31/34***	***Neutrons***	***WB***	***Reference And Workplace Fields***
EURADOS	***2012***	***75/88***	***photon***	***WB***	***Reference And Workplace Fields***

European Radiation Dosimetry Group (EURADOS)

EURADOS (European radiation Dosimetry Group)

chaired by Helmut Schuhmacher , PTB (Werner Rühm, HMGU)

Working Group (WG) 2

Harmonisation of Individual Monitoring in Europe

chaired by Vasiliki Kamenopoulou, GAEC (Joao Garcia Alves, IST)

Subgroup (SG) 1

coordinated by Joao Garcia Alves - ITN

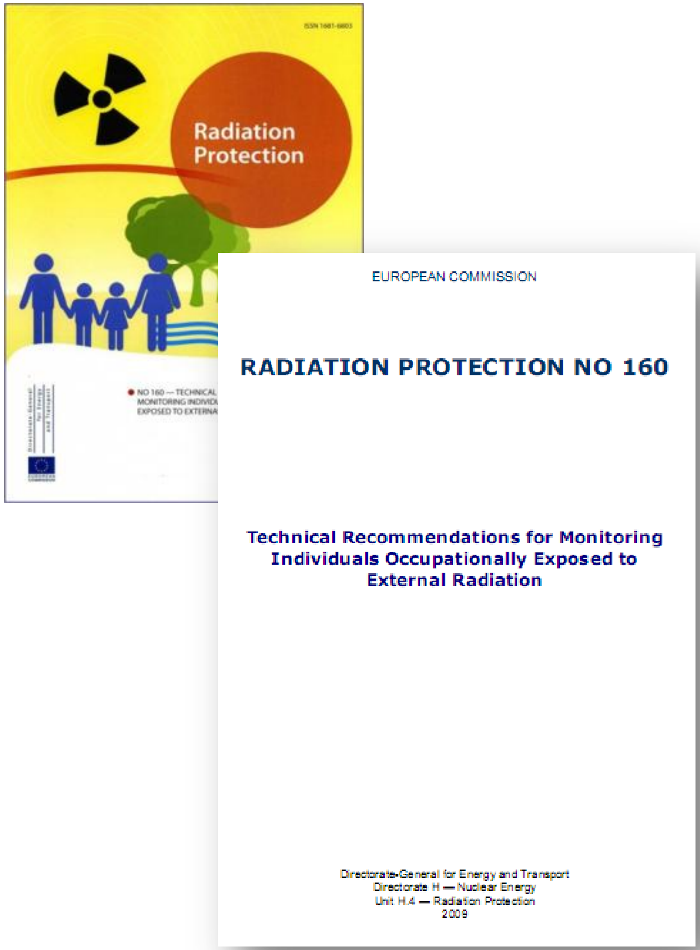
Technical Recommendations
for Monitoring Individuals
Occupationally Exposed to
External Radiation

Subgroup (SG) 2

coordinated by Tom Grimbergen - NRG
(Andrew McWhan – BNL)
(Hannes Stadtmann – Seiberdor Lab)

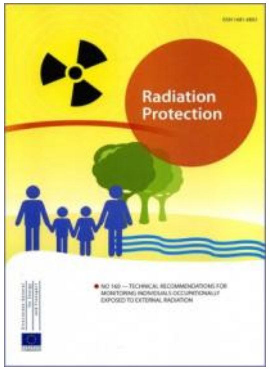
Programme for
self-supporting
intercomparisons
in Europe

EURADOS WG2/SG1



Subgroup (SG) 1

Technical Recommendations
for Monitoring Individuals Occupationally Exposed to External Radiation



RP - 160

8.6 Participation in national/international intercomparisons

An intercomparison exercise among dosimetry services can be seen as an announced performance test. Generally the results of such intercomparisons are published but anonimized. In many Member States participation in national and international intercomparisons, though not mandatory is strongly recommended as results can be used to support an application for approval or accreditation. Periodic intercomparison exercises within the EU would be a first step towards awareness of performance of dosimetry services. This would stimulate services to investigate and improvetheir dosimetry systems in order to achieve successful results in the tests.

EURADOS WG2/SG2

EURADOS SELF SUSTAINED PROGRAMME OF INTERCOMPARISONS FOR INDIVIDUAL MONITORING SERVICES

T.W.M. Grimbergen[1,*], M. Figel[2], A. M. Romero[3], H. Stadtmann[4] and A.F. McWhan[5]

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[2] Helmholtz-Zentrum Muenchen, Germany
[3] Ciemat, S
[4] Seibersdo
[5] VT Grou

Abstract

Within EU
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Radiation Protection Dosimetry (2010), Vol. 0, No. 0, pp. 0–0

RESULTS OF THE EURADOS EXTREMITY DOSEMETER INTERCOMPARISON 2009

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Received X 2010, amended X 2010, accepted X 2010

This paper presents the results of an intercomparison for extremity dosemeters organized by EURADOS in 2009. In total 59 systems were tested during this exercise including ring, stall and wrist dosemeters. 1652 dosemeters were irradiated in the selected fields of photons and beta radiation qualities on appropriate phantoms (ISO finger and pillar phantom) in the dose quantity $H_p(0.07)$. All irradiations were carried out in selected accredited reference dosimetry laboratories (Seibersdorf Laboratories - Austria and IRSN - France). The results show that, especially at low energy beta radiations (^{85}Kr) and for beta irradiations with large angles of incidence (60°), many tested systems show pronounced under responses. On the other hand, for photon irradiations down to energies of 16 keV most systems showed good results. A participants meeting was held at IM2010 with discussion on both general aspects of this intercomparison and specific problems.

KEYWORDS: extremity dosemeter, personal dosemeter, intercomparison, photon radiation, beta radiation, performance, trumpet curve, EURADOS

Subgroup (SG) 2

Programme for
self-supporting
intercomparisons
in Europe

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H. Stadtmann[4] ,
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Radiation Protection Dosimetry (2011), pp. 1–4 doi:10.1093/rpd/ncq489

H_p(0.07) PHOTON IRRADIATIONS AT SEIBERSDORF FOR THE EURADOS EXTREMITY DOSEMETER INTERCOMPARISON 2009

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*Corresponding author: hannes.stadtmann@seibersdorf-laboratories.at

In August 2009, almost 1000 passive extremity dosemeters were irradiated at the Dosimetry Laboratory Seibersdorf as part of the EURADOS intercomparison IC2009. Forty-four European individual monitoring services participated, with a total of 59 dosim
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Radiation Measurements 46 (2011) 1829–1834

Contents lists available at ScienceDirect

Radiation Measurements

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

EURADOS intercomparisons on whole body and extremity dosemeters (2008–2009) – Results and comparison of different dosemeter designs

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EURADOS
European Radiation Dosimetry Group e. V.

EURADOS Report 2012-01

Braunschweig, January 2012

EURADOS Intercomparison 2008 for Whole Body Dosemeters in Photon Fields

T. W. M. Grimbergen, M. Figel, A. M. Romero, H. Stadtmann and A. F. McWhan

ISSN 2226-8057

ISBN 978-3-943701-00-5

Content

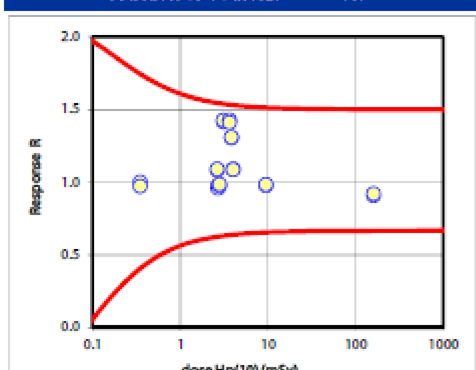
Laboratory Nr. 43 (TLD) for dose quantity Hp(0.07)

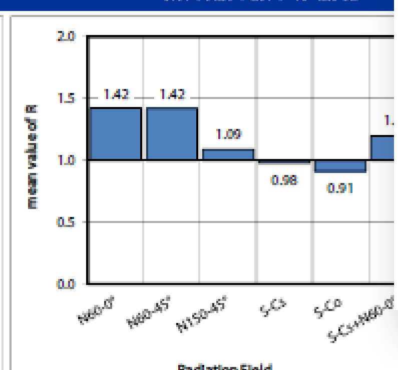
	values reported by the irradiating laboratory			reported by participant	Result	
Radiation Quality	Dosimeter ID	Irradiation Date	Dose mSv	Dose mSv	Response R (reported/true)	
N60-0°	11	31/07/08	3.10	4.39	1.42	OK
	12	31/07/08	3.10	4.42	1.43	OK
N60-45°	17	01/08/08	3.65	5.21	1.43	OK
	18	01/08/08	3.65	5.15	1.41	
N150-45°	19	04/08/08	2.65	2.87	1.08	
	20	04/08/08	2.65	2.89	1.09	
S-Cs	1	24/07/08	0.35	0.35	1.00	
	2	24/07/08	0.35	0.34	0.97	
	3	29/07/08	2.70	2.64	0.98	
	4	29/07/08	2.70	2.59	0.96	
	5	29/07/08	2.80	2.73	0.98	
	6	29/07/08	2.80	2.76	0.99	
	7	29/07/08	9.50	9.29	0.98	
	8	29/07/08	9.50	9.34	0.98	
S-Co	9	04/08/08	160.00	145.28	0.91	
	10	04/08/08	160.00	147.10	0.92	
S-Cs+N60-0°	13	24/07/08	3.83	5.00	1.31	
	14	24/07/08	3.83	5.02	1.31	
	15	29/07/08	4.03	4.39	1.09	
	16	29/07/08	4.03	4.38	1.09	
not irradiated	21	NIR		0.00		
	22	NIR		0.00		
	23	NIR		0.00		
	24	NIR		0.00		
	25	BGR		0.15		
	26	BGR		0.14		

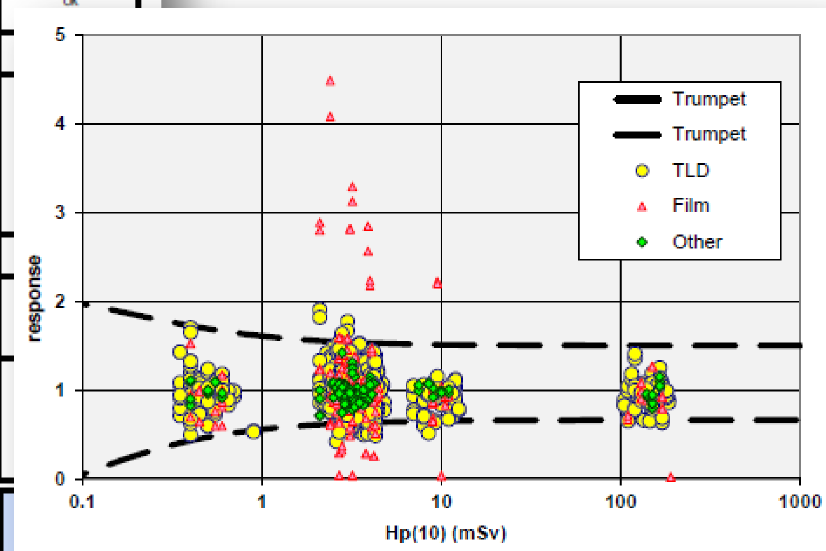
Radiation Quality	Number of values	Median value (R)	Mean value (R)	Maximum value (R)	Minimum value (R)	
N60-0°	2	1.42	1.42	1.43	1.42	0%
N60-45°	2	1.42	1.42	1.43	1.41	1%
N150-45°	2	1.09	1.09	1.09	1.08	0%
S-Cs	8	0.98	0.98	1.00	0.96	1%
S-Co	2	0.91	0.91	0.92	0.91	
S-Cs+N60-0°	4	1.20	1.20	1.31	1.09	
All	20	1.04	1.12	1.43	0.91	

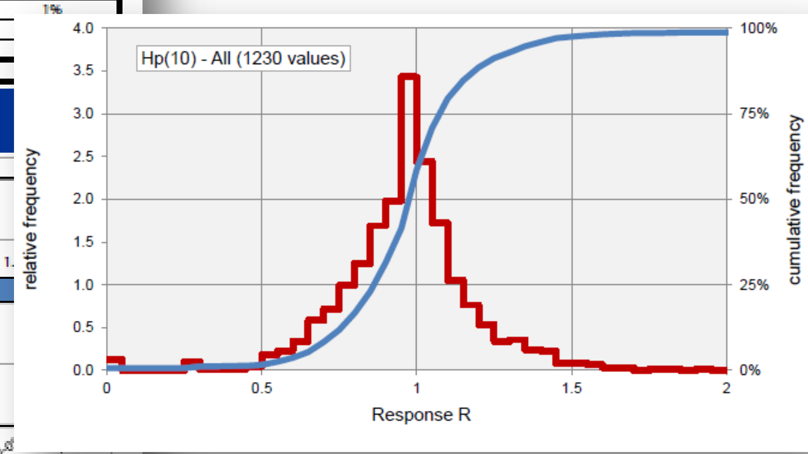
Number of outliers: 0 **Arithmetic mean value of all R:**

Fraction of outliers: 0% **Median value of all R:**









EURADOS Working group2 / Subgroup 2: Self-supporting intercomparisons

- Self-supporting regular intercomparison programm
  - Self-supporting: all costs covered by participants fees
  - Paid service to individual monitoring services
  - Periodic: one intercomparison per year

photon **whole body** IC2008	Special **extremity** IC2009	photon **whole body** IC2010	2011	photon IC2012ph neutron IC2012n **whole body**	2013	photon **whole body** IC2014

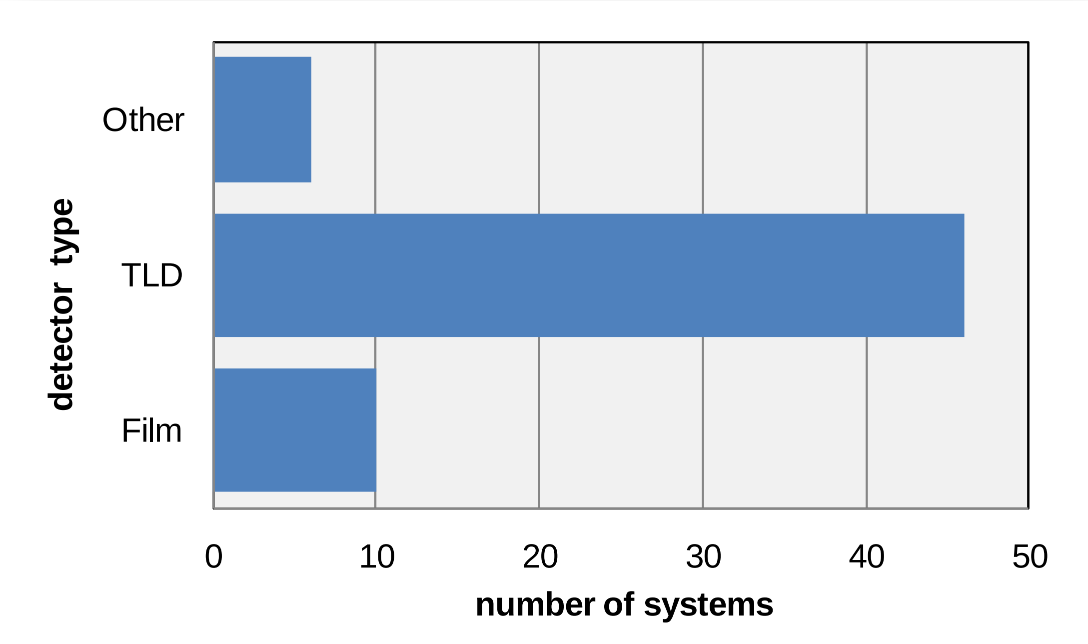
1 year

2 year

- Alternate whole body and specials
  - Specials: extremity, neutron, …?

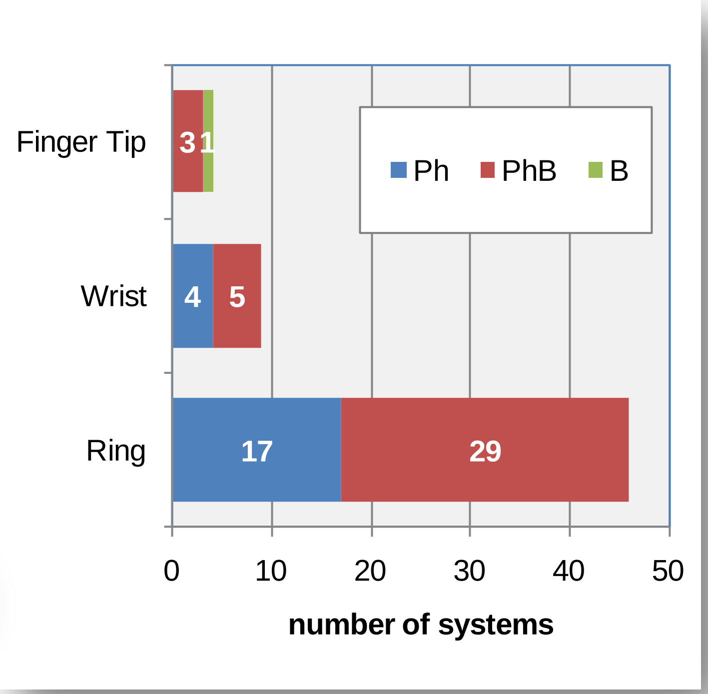

IC2008- Whole body dosemeters

- 52 institutes / 62 systems
- 24 European countries
- Dosemeter type
  - Film (10)
  - TLD (46)
  - Others (6)
- Dose quantity
  - $H_p(10)$ 62 systems
  - $H_p(0.07)$: 48 systems
- 1620 Dosemeters
  - 26 (20 irradiated) / sys



IC2009 - Extremity dosemeters

- 44 institutes / 59 systems
- 18 European countries
- Radiation type
  - Photon dosemeter (Ph)
  - Photon and beta dosemeter (PhB)
  - Beta dosemeter (B)
- Hanger type
  - Ring dosemeter (46)
  - Wrist dosemeter (9)
  - Finger tip dosemeter (4)
- Dose quantity
  - $H_p(0.07)$
- 1652 Dosemeters
  - 28 (22 irradiated) / sys



Type	Ph	PhB	B	All
Ring	17	29	0	**46**
Wrist	4	5	0	**9**
Finger Tip	0	3	1	**4**
All	**21**	**37**	**1**	**59**

IC2010 - Whole body dosemeters

- 70 institutes / 85 systems
- 30 countries
- Dosemeter type
  - Film (13)
  - TLD (59)
  - OSL(8)
  - Others (5)
- Dose quantity
  - $H_p(10)$ 85 systems
  - $H_p(0.07)$: 67 systems
- 2210 Dosemeters
  - 26 (20 irradiated) / sys

Type/detector	systems	% of all	% of type
TLD	**59**	**69%**	69%
LiF:Mg,Ti	37	44%	63%
LiF:Mg,Cu,P	10	12%	17%
Li2B4O7:Cu/CaSO4:TM	8	9%	14%
LiF:Mg,Cu,P/CaF:Mn	1	1%	2%
LiF:Mg,Ti/CaF2:Dy	1	1%	2%
LiF:Mg,Ti/Li2B4O7:Mn.Si	1	1%	2%
LiF:Mg,Ti/LiF:Mg,Cu,P	1	1%	2%
Film	**13**	**15%**	15%
Agfa	8	9%	62%
Kodak	4	5%	31%
FOMA	1	1%	8%
OSL	**8**	**9%**	9%
Al2O3:C	7	8%	88%
BeO	1	1%	13%
other	**5**	**6%**	6%
glas	2	2%	40%
DIS	2	2%	40%
APD	1	1%	20%
All	**85**	**100%**	100%

	Hp(10) / Hp(0.07)	Hp(10)	All
TLD	49	10	59
Film	6	7	13
OSL	8		8
other	4	1	5
All	**67**	**18**	**85**

IC2012 - Whole body dosemeters

- 75 institutes / 88 systems (one withdrawal)
- 30 countries
- Dosemeter type
  - Film (12)
  - TLD (59)
  - OSL(11)
  - Others (5)
- Dose quantity
  - $H_p(10)$ 87 systems
  - $H_p(0.07)$: 69 systems
- 2288 Dosemeters
  - 26 (20 irradiated) / sys

	Hp(10) / Hp(0.07)	Hp(10)	All
TLD	50	9	59
Film	5	7	12
OSL	9	2	11
other	5		5
All	69	18	87

Type/detector	systems	% of all	% of type
TLD	**59**	**68%**	68%
LiF:Mg,Ti	26	30%	44%
LiF:Mg,Cu,P	14	16%	24%
Li2B4O7:Cu/CaSO4	9	10%	15%
?	5	6%	8%
LiF	2	2%	3%
LiF/Li2B4O7	2	2%	3%
Al2O3:C	1	1%	2%
Film	**12**	**14%**	14%
Agfa	6	7%	50%
?	3	3%	25%
FOMA	2	2%	17%
Kodak	1	1%	8%
OSL	**11**	**13%**	13%
Al2O3:C	8	9%	73%
BeO	2	2%	18%
?	1	1%	9%
other	**5**	**6%**	6%
EPD	2	2%	40%
RPL	2	2%	40%
DIS	1	1%	20%
All	**87**	**100%**	**100%**

IC2014 - Whole body dosemeters

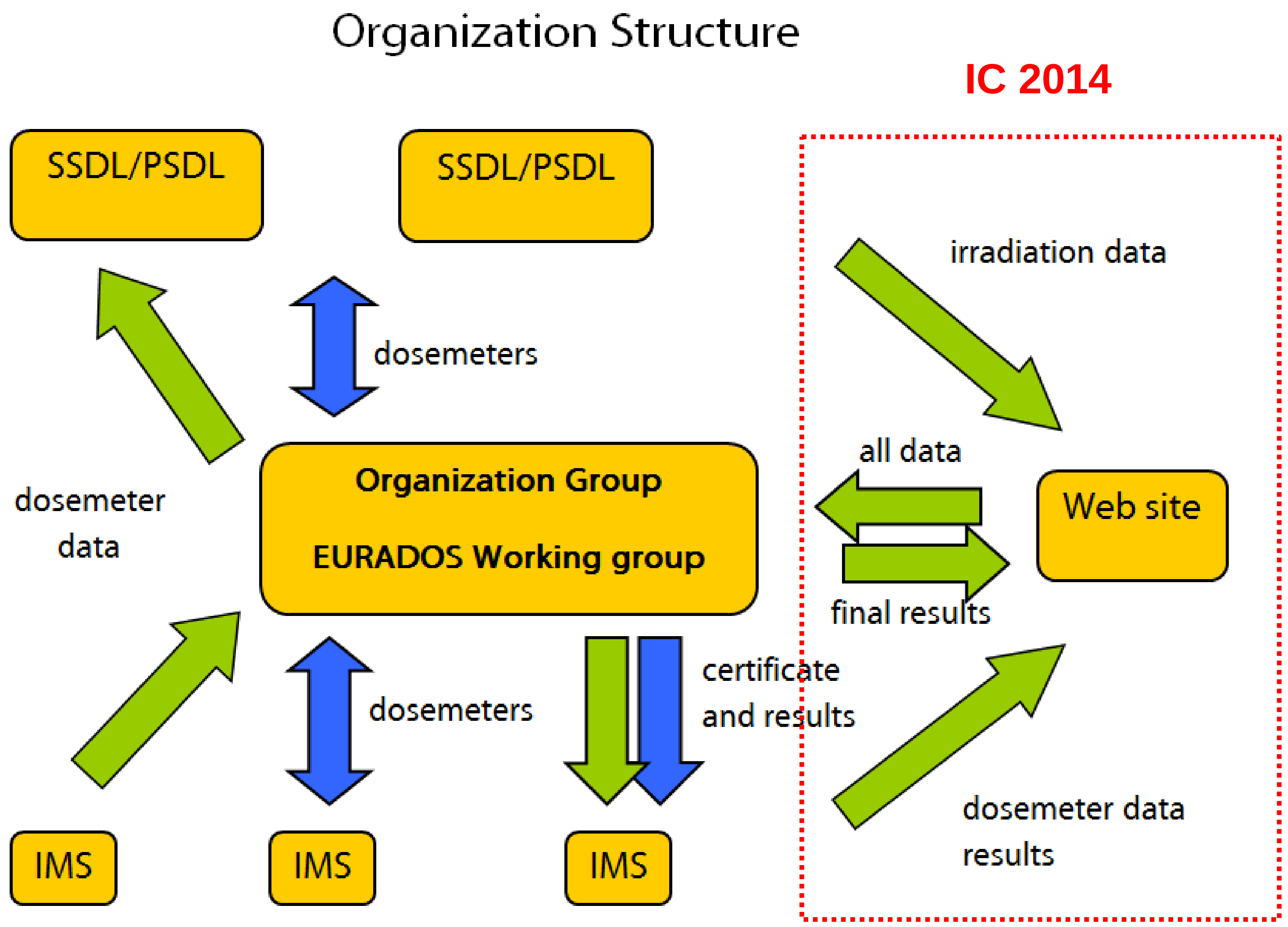
- 96 institutes / 112 systems
- 35 countries
- Dosemeter type
  - Film (12)
  - TLD (79)
  - OSL(11)
  - Others (10)
- Dose quantity
  - $H_p(10)$: 112 systems
  - $H_p(0.07)$: 79 systems
- 2912 Dosemeters
  - 26 (20 irradiated) / sys

Typ1	Hp(10)	Hp(10)/Hp(0.07)	All
TLD	19	60	79
Film	8	4	12
OSL	4	7	11
Other	2	8	10
All	**33**	**79**	**112**

Type/detector	systems	% of all	% of type
TLD	**79**	**71%**	71%
LiF:Mg,Ti	44	39%	56%
Li2B4O7/CaSO4	15	13%	19%
LiF:Mg,Cu,P	14	13%	18%
LiF	2	2%	3%
CaSO4:Dy	2	2%	3%
CaSO4: Dy/PTFE.	1	1%	1%
LiF / Li2B4O7: Mn, Si	1	1%	1%
Film	**12**	**11%**	11%
Agfa	9	8%	75%
FOMA	3	3%	25%
OSL	**11**	**10%**	10%
Al2O3:C	8	7%	73%
BeO	3	3%	27%
Other	**10**	**9%**	9%
DIS	5	4%	50%
APD	3	3%	30%
RPL	2	2%	20%
All	**112**	**100%**	**100%**

Summary: 2008 - 2014

	2008	2009 (ext)	2010	2012	2012 (n)	2014
institutes	52	44	70	75	31	96
systems	62	59	85	88	34	112
countries	24	18	30	30	18	35
dosemeters	1612	1652	2210	2288	1224	2912


Organization Structure
IC 2014
SSDL/PSDL
SSDL/PSDL
irradiation data
dosemeters
dosemeter
data
Organization Group
EURADOS Working group
all data
Web site
final results
dosemeters
certificate
and results
dosemeter data
results
IMS
IMS
IMS

EURADOS European Radiation Dosimetry Group

Whole body dosemeter intercomparison IC2014ph

Start page ◆ Documents ◆ Feedback ◆ Logout (hannes.stadtmann@s-l.at)
Status ◆ Individual Monitoring Service ◆ Contact Person ◆ Dosimetry Systems ◆ Change password ◆ Tools

◆ Welcome! ◆

Welcome to the Eurados Whole body dosemeter intercomparison IC2014ph!

On this homepage, you can register for participation in the Whole body dosemeter intercomparison IC2014ph, log in and enter details about your Dosimetry System(s), check the current status of the intercomparison, receive information about the irridiation process, enter your dose values and much more.

For the documentation please have a look at the file 'IC2014ph Online Platform Documentation.pdf' which is available via the 'Documents' link!

For registration, please click on the link 'Registration' in the menu bar! The registration is available from Monday, 2014-03-03, 00:00 (CET) to Tuesday, 2014-04-01, 23:59 (CEST).

By the way: you can change the language of this homepage in the bottom left corner.

Timetable (IC2008)

Information collected (EXT)

Just for the final scientific report, please indicate:

a. Number of detectors 1
b. Filter material*) Black PVC
c. Filter thickness*) 10 mg.cm^{-2}
d. Reference energy/quality Cs-137
e. Any algorithm used? NO ☒

YES ☐ Specify: ☐ Linear
☐ Non Linear
☐ Branching

Please mark the results that you want to appear in the Certificate of Participation	Only photon fields	☐
	Only beta fields	☐
	Both photon and beta fields	☒

European Radiation Dosimetry Group

EURADOS

European Radiation Dosimetry Group e.V. • Bundesallee 100 • D-38116 Braunschweig | *Certificate of Participation EURADOS- 2010-S40*

Certificate of Participation

for the EURADOS Intercomparison 2010

Certificate number: EURADOS- 2010-S40

Number of pages: 2

Date of Issue: 10 February 2011

Participating institute: Berkeley Approved Dosimetry Service

Dosimetry system: Thermo Fisher Mark 2.5 EPD
ADS 120
Current UK certificate of approval : DG24/200

Reporting ID number used in publications: 82

Intercomparison procedure: The EURADOS Intercomparison 2010 for who
ordinated on behalf of EURADOS by the WG2
The OG established the irradiation plan and a
range limits of the doses and radiation qualitie

Participants were asked to indicate details of t
application form. After completing application
dosemeters, according to the instructions of th
/September 2010). The Coordinator relabeled
on page 2, and sent all dosemeters, along wit
The laboratory irradiated the dosemeters acc
the dosemeters back to the coordinator (Octo

The Coordinator then returned the dosemeter
indicated which dosemeters were not irradiate
normal routine procedures as far as possible.
dosemeter readings to the coordinator (Decen
results, the coordinator sent the irradiation da

Number of participants 70 institutes participated in IC2010 with a total

Irradiation data: See the certificate of the irradiation laboratory

Participant results: See the attached report of the participant

Intercomparison results: See the table on page 2 of this certificate

On behalf of the intercomparison Organization Group:

Andrew McWhan

Andrew McWhan
Coordinator

On behalf of

Helmut Schul
Chairperson

European Radiation Dosimetry Group

EURADOS

European Radiation Dosimetry Group e.V. • Bundesallee 100 • D-38116 Braunschweig | *Certificate of Participation EURADOS- 2010-S40*

Result of the intercomparison:

			Hp(10)			Hp(0.07)		
Dosemeter id coordinator	Dosemeter id participant	Quality	Participant's value (mSv)	Reference value (mSv)	Ratio	Participant's value (mSv)	Referenc e value (mSv)	Ratio
2	255382	W250/ S-Cs 0°	2.520	2.40	1.05	2.590	2.36	1.10
12	255475	S-Cs 0°	9.552	9.6	1.00	9.552	9.6	1.00
11	255719	S-Cs 0°	9.714	9.6	1.01	10.055	9.6	1.05
19	255762	S-Co 0°	155.667	200	0.78	155.667	200	0.78
23	255815	NIR						
7	255829	W110 45° y-axis	3.605	4.00	0.90	3.605	3.83	0.94
1	255853	W250/ S-Cs 0°	2.514	2.40	1.05	2.578	2.36	1.09
16	255863	S-Cs 0°	1.999	2.00	1.00	1.999	2.00	1.00
20	255928	S-Co 0°	155.586	200	0.78	155.586	200	0.78
22	255942	NIR						
6	256016	N40 0°	0.760	0.80	0.95	0.979	0.88	1.11
5	256303	N40 0°	0.762	0.80	0.95	0.987	0.88	1.12
26	256311	NIR						
3	256315	N40/ S-Cs 0°	2.361	2.40	0.98	2.724	2.47	1.10
18	256316	S-Cs 0°	0.394	0.400	0.99	0.394	0.400	0.99
21	256325	WIR						
4	256326	N40/ S-Cs 0°	2.364	2.40	0.99	2.716	2.47	1.10
17	256327	S-Cs 0°	0.397	0.400	0.99	0.415	0.400	1.04
14	256331	S-Cs 0°	1.983	2.00	0.99	1.983	2.00	0.99
15	256332	S-Cs 0°	1.976	2.00	0.99	1.976	2.00	0.99
9	256333	W110 45° x-axis	4.136	4.00	1.03	4.136	3.82	1.08
25	256334	NIR						
8	256335	W110 - 45° y-axis	3.757	4.00	0.94	4.176	3.83	1.09
13	256336	S-Cs 0°	1.983	2.00	0.99	2.176	2.00	1.09
10	256337	W110 -45° x-axis	3.747	4.00	0.94	3.920	3.82	1.03
24	256341	NIR						

Notes:
NIR: Not IRadiated
WIR: Wrong IRadiated

Physikalisch-technischer Prüfdienst

BEV Bundesamt für Eich- und Vermessungswesen

A-1160 Wien, Arltgasse 35 • Tel. +43(0)1-21110-6327 • Fax +43-(0)1-21110-6000 • E-Mail: ptp@

Prüfungsschein

Measurement Certificate

Prüfungsschein Nr. T10-11

Measurement Certificate No

Gegenstand *Object*	**EURADOS Intercomparison 2010 (IC2010/01)**
Type, Bauart Fabrikations Nr. *Type, Serial number*	**Personal dosemeter S14-01 to S14-26 (as labeled by the custumer)**
Hersteller *Manufacturer*	-
Auftraggeber *Customer*	**EURADOS Intercomparison 2010 Organisation Group**
Auftragsnummer des Auftraggebers *Order number of Customer*	**IC2010/01 from 2010-09-15**
Auftragsnummer *Order number*	**T10-1118 from 2010-09-01**
Anzahl der Seiten *Number of pages*	**4**
Eingangsdatum *Date of receipt*	**2010-09-30**
Datum der Prüfung *Date of test*	**2010-10-06 to 2010-10-27**

Stempel *Seal* | Datum *Date* | Der Leiter des Prüfdiens *Head of testing servic*

2 0. DEZ. 2010

Mag. Robert Edelmaie

DVR: 0037028
FL54010701 – 07.2007

PTP | **BEV - Bundesamt für Eich- und Vermessungswesen**

Prüfungsschein Nr. T10-1118/14
Measurement certificate No. T10-1118/14

Kenndaten:
Characteristic values:

Personal dosemeters delivered by the participant with dosemeter identifi
Assignment of the dosemeter identification numbers by the EURADOS
(Coordinator Andrew McWhan).

Reference point and reference direction of dosimeter: As defined by th
received, the reference point will be considered as the centre of the
reference direction will be considered perpendicular to the frontplane of

Prüfverfahren:
Test procedure:

The dosemeters were irradiated in the dosimetry laboratory of the BEV.
values have been obtained using the primary standards of the BEV for X
qualities. The standard of air kerma of the BEV for the X-ray radiation qu
free air parallel plate ionisation chamber and for gamma radiation from 1
the Graphite – cylindrical cavity ionisation chamber. For dose equivalent
are created according to ISO 4037 standards set. Suitable conversion c
as well, or they are calculated from measured real X-ray spectra.

Quantity to be measured: personal dose equivalent $H_p(10)$ and $H_p($

Phantom: slab water phantom according to ISO 4037

Irradiation conditions:
137-Cs irradiation facility: Reference beam facility
Focus to phantom distance is 2000 mm respectively 3000 mm, Field dia
respectively 78 cm.

60-Co irradiation facility: Picker Type C8MI 80,
Focus to phantom distance is 2000 mm, Field size at the phantom surfa

X-ray facility: Philips type MG 320, inherent filtration of X-ray tube: 2,5 m
Focus to phantom distance is 2500 mm, Field diameter at phantom surf

Environmental conditions during irradiations:
Air temperature: 19,5°C – 20,5°C
Atmospheric pressure: 97,0 kPa – 101,0 kPa
Relative air humidity: 40% – 50%

DVR: 0037028
FL54010701 – 07.2007

PTP | **BEV - Bundesamt für Eich- und Vermessungswesen**

Prüfungsschein Nr. T10-1118/14
Measurement certificate No. T10-1118/14

Ergebnisse der Prüfung:
Results:

Resulting dose equivalent values and related uncertainties for the dosemeters of the participant's dosemeter system are given in the following table.

whole body dose-meter	irradiation date	radiation quality	angle of radiation incidence	air kerma rate	personal dose equivalent per irradiation	expanded un-certainty	total personal dose equivalent	personal dose equivalent per irradiation	total personal dose equivalent	re-mark
		ISO 4037	α,°	K_a mGy/s	$H_p(10)$ mSv	$U(k=2)$ %	$H_p(10)$ mSv	$H_p(0,07)$ mSv	$H_p(0,07)$ mSv	
S14-01	06.10.2010	W250	0	0,0065	1,50	5,0	3,00	1,44	2,94	1)
	21.10.2010	S-Cs	0	0,012	1,50	4,0		1,50		
S14-02	06.10.2010	W250	0	0,007	1,50	5,0	3,00	1,44	2,94	1)
	21.10.2010	S-Cs	0	0,012	1,50	4,0		1,50		
S14-03	07.10.2010	N40	0	0,0021	1,50	5,0	3,00	1,59	3,09	1)
	21.10.2010	S-Cs	0	0,012	1,50	4,0		1,50		
S14-04	07.10.2010	N40	0	0,0021	1,50	5,0	3,00	1,59	3,09	1)
	21.10.2010	S-Cs	0	0,012	1,50	4,0		1,50		
S14-05	07.10.2010	N40	30	0,0021	1,00	5,0	1,00	1,10	1,10	-
S14-06	07.10.2010	N40	30	0,0021	1,00	5,0	1,00	1,10	1,10	-
S14-07	13.10.2010	W110	45 y-axis	0,023	5,00	5,0	5,00	4,79	4,79	-
S14-08	13.10.2010	W110	-45 y-axis	0,023	5,00	5,0	5,00	4,79	4,79	-
S14-09	14.10.2010	W110	45 x-axis	0,023	5,00	5,0	5,00	4,78	4,78	-
S14-10	14.10.2010	W110	-45 x-axis	0,023	5,00	5,0	5,00	4,78	4,78	-
S14-11	18.10.2010	S-Cs	0	0,012	12,0	4,0	12,0	12,0	12,0	-
S14-12	18.10.2010	S-Cs	0	0,012	12,0	4,0	12,0	12,0	12,0	-
S14-13	19.10.2010	S-Cs	0	0,012	2,50	4,0	2,50	2,50	2,50	-
S14-14	19.10.2010	S-Cs	0	0,012	2,50	4,0	2,50	2,50	2,50	-
S14-15	19.10.2010	S-Cs	0	0,012	2,50	4,0	2,50	2,50	2,50	-
S14-16	19.10.2010	S-Cs	0	0,012	2,50	4,0	2,50	2,50	2,50	-
S14-17	25.10.2010	S-Cs	0	0,0052	0,500	4,0	0,500	0,500	0,500	-
S14-18	25.10.2010	S-Cs	0	0,0052	0,500	4,0	0,500	0,500	0,500	-
S14-19	27.10.2010	S-Co	0	0,72	250	4,0	250	250	250	-
S14-20	27.10.2010	S-Co	0	0,72	250	4,0	250	250	250	-
S14-21	-	-	-	-	-	-	-	-	-	2)
S14-22	-	-	-	-	-	-	-	-	-	2)
S14-23	-	-	-	-	-	-	-	-	-	2)
S14-24	-	-	-	-	-	-	-	-	-	2)
S14-25	-	-	-	-	-	-	-	-	-	2)
S14-26	-	-	-	-	-	-	-	-	-	2)

1) Expanded uncertainty for the total personal dose equivalent: U = 3,2 % (k = 2)
2) unradiated

DVR: 0037028
FL54010701 – 07.2007

Seite 3 von 4 Seiten
page 3 of 4 pages

Irradiation plan (IC2008-WB)

Radiation	Quality	Irrad	Hp(10) mSv	max mSv	min mSv
X-ray	**N60; 0°**	X1	**2,9**	3,4	2,1
	N60; 45°	X2	**2,8**	3,6	2,1
	N150; 45°	X3	**3,0**	3,6	2,1
Gamma	**S-Cs; 0°**	G1	**0,5**	0,9	0,4
		G2	**2,8**	3,6	2,2
		G3	**9,7**	12,5	7,0
	S-Co; 0°	G4	**146**	190	105
Mixed	**N60; 0° + S-Cs; 0°**	XG1	**4,0**	4,4	3,4
	S-Cs; 0° + N60; 0°	XG2	**4,0**	4,8	2,9

All radiation qualities according to ISO 4037

Irradiation plan (IC2009-EX)

Radiation	Quality	Nr	Hp(0.07) mSv	Min mSv	Max mSv
Beta	**Kr-85; 0°**	B1	**24.8**	22.0	28.2
	Sr-90/Y-90; 0°	B2	**9.8**	8.2	11.5
	Sr-90/Y-90; 60°	B3	**9.8**	8.5	11.7
Photon	**N-20; 0°**	P1	**39.4**	32.1	48.0
	W-80; 0°	P2	**4.9**	4.0	6.0
		P3	**49.3**	39.9	60.3
		P5	**394.1**	320.0	480.0
	W-80; 60°	P4	**49.3**	40.0	60.2
	N-150; 0°	P6	**24.6**	20.0	30.1
	S-Cs; 0°	P7	**29.8**	24.0	36.0

All radiation qualities according to ISO 4037 and ISO 6970

Irradiation plan (IC2010-WB)

Hp(10)	Dose (mSv)			
	Min	Mean	Max	dosemeters
N40/30°	0.8	1.0	1.2	170
N40/S-Cs	2.4	3.0	3.6	170
W110/45°/x	4.0	5.0	6.0	170
W110/45°/y	4.0	5.0	6.0	170
W250/S-Cs	2.4	3.0	3.6	170
S-Cs-L	0.4	0.5	0.6	170
S-Cs-M	2.0	2.5	3.0	340
S-Cs-H	9.6	12.0	14.4	170
S-Co	200	250	300	170
All	0.4	28	300	1700

All radiation qualities according to ISO 4037 and ISO 6970

Irradiation plan (IC2012-WB)

Hp(10)	Dose (mSv)			
	Min	Mean	Max	dosemeters
N40	5,3	5,7	6,0	174
S-Cs/N150/45°	5,6	6,3	7,0	174
N60	5,3	5,6	6,0	174
N60/60°	5,3	5,6	6,0	174
S-Cs	5,8	6,5	7,0	348
S-Co-L	4,4	4,8	5,1	174
S-Co-S	5,8	6,6	7,0	174
S-Co-M	44,1	47,8	52,2	174
S-Co-H	420	466	507	174
All	4,4	56	507	1740

All radiation qualities according to ISO 4037

Irradiation plan (IC2014-WB)

	Hp(10)	Dose (mSv)		
Radiation	**Quality**	**Mean**	**Min**	**Max**
X-Ray	RQR7	8.7	7.8	9.9
	W-80	8.6	7.6	9.7
	W-80/60°	8.3	7.3	9.4
	W-150	8.4	7.4	9.5
Gamma	S-Cs-L	1.0	0.9	1.1
	S-Cs-M	8.1	7.1	9.2
	S-Co-L	8.9	7.9	10.0
	S-Co-M	80.8	71.0	92.0
	S-Co-H	449	413	499

All radiation qualities according to ISO 4037 and IEC 61267

Reference radiation fields

INTERNATIONAL STANDARD

ISO 4037-1

First edition
1996-12-15

X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy —

Part 1:
Radiation characteristics and production methods

INTERNATIONAL STANDARD

ISO 4037-3

First edition
1999-06-15

X and gamma reference radiation for calibrating dosemeters and doserate meters and for determining their response as a function of photon energy —

Part 3:
Calibration of area and personal dosemeters and the measurement of their response as a function of energy and angle of incidence

ISO 4037

Reference radiation fields

NORME INTERNATIONALE

CEI
IEC

INTERNATIONAL STANDARD

61267

Deuxième édition
Second edition
2005-11

**Equipement de diagnostic médical à rayonnement X –
Conditions de rayonnement pour utilisation dans la détermination des caractéristiques**

**Medical diagnostic X-ray equipment –
Radiation conditions for use in the determination of characteristics**

IC2014

ISO 4037:
Different spectra series

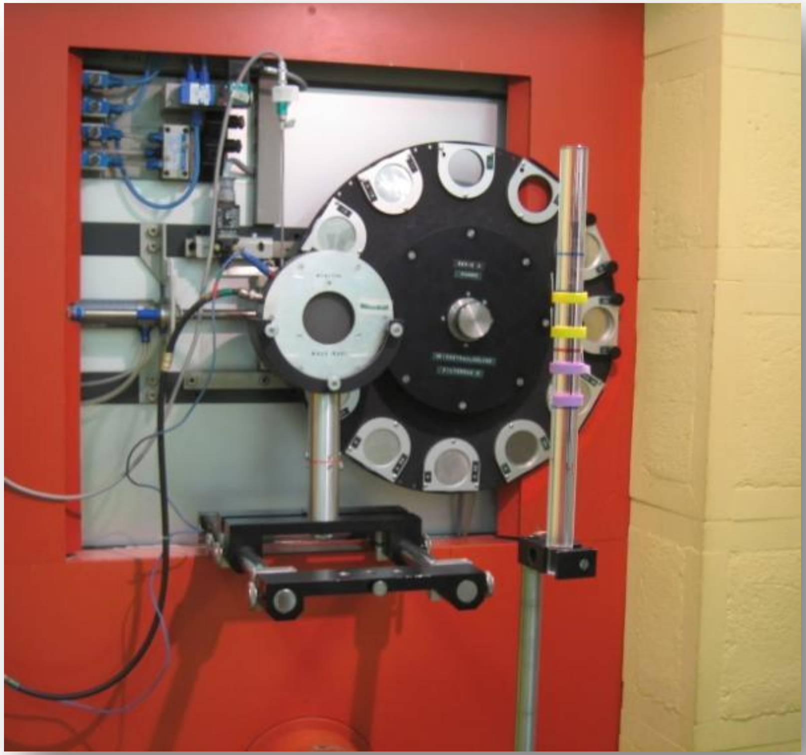
Table 2 — Specifications of filtered X radiation

Name of series	**Resolution, R_E** %	**Homogeneity coefficient, h** (approximate values)	**Typical air-kerma rates**[1), 2)] $Gy \cdot h^{-1}$
Low air-kerma rate	18 to 22	1,0	3×10^{-4} [3)]
Narrow spectrum	27 to 37	0,75 to 1,0	10^{-3} to 10^{-2} [3)]
Wide spectrum	48 to 57	0,67 to 0,98	10^{-2} to 10^{-1} [3)]
High air-kerma rate	Not specified	0,64 to 0,86	10^{-2} to 0,5

1) At a distance of 1 m from the X-ray focal spot, with the tube operating at 1 mA.
2) Under conditions of charged-particle equilibrium, the value of air kerma is approximately equal to the absorbed dose to air.
3) At mean energies of less than 30 keV, other values may apply.

ISO 4037

Filtration of x-ray beams



Narrow spectrum series (N)

Table 4 — Characteristics of narrow-spectrum series

Mean energy, $\overline{E}$ keV	Resolution, R_E %	Tube potential[1)] kV	Additional filtration[2)] mm Pb	Sn	Cu	Al	1st HVL[4)] mm	2nd HVL[4)] mm
8	28	10				0,1[3)]	0,047 Al	0,052 Al
12	33	15				0,5[3)]	0,14 Al	0,16 Al
16	34	20				1,0[3)]	0,32 Al	0,37 Al
20	33	25				2,0[3)]	0,66 Al	0,73 Al
24	32	30				4,0[3)]	1,15 Al	1,30 Al
33	30	40			0,21		0,084 Cu	0,091 Cu
48	36	60			0,6		0,24 Cu	0,26 Cu
65	32	80			2,0		0,58 Cu	0,62 Cu
83	28	100			5,0		1,11 Cu	1,17 Cu
100	27	120		1,0	5,0		1,71 Cu	1,77 Cu
118	37	150		2,5			2,36 Cu	2,47 Cu
164	30	200	1,0	3,0	2,0		3,99 Cu	4,05 Cu
208	28	250	3,0	2,0			5,19 Cu	5,23 Cu
250	27	300	5,0	3,0			6,12 Cu	6,15 Cu

1) The tube potential is measured under load.

2) Except for the five lowest energies, where recommended inherent filtration is 1 mm Be, the total filtration consists of the additional filtration plus the inherent filtration, adjusted to 4 mm of aluminium (see 4.2.3).

3) The recommended inherent filtration is 1 mm Be, but other values may be used provided that the mean energy is within ± 5 % and the resolution is within ± 15 % of the values given in the table.

4) The HVLs are measured at 1 m from the focal spot.

ISO 4037

Wide spectrum series (W)

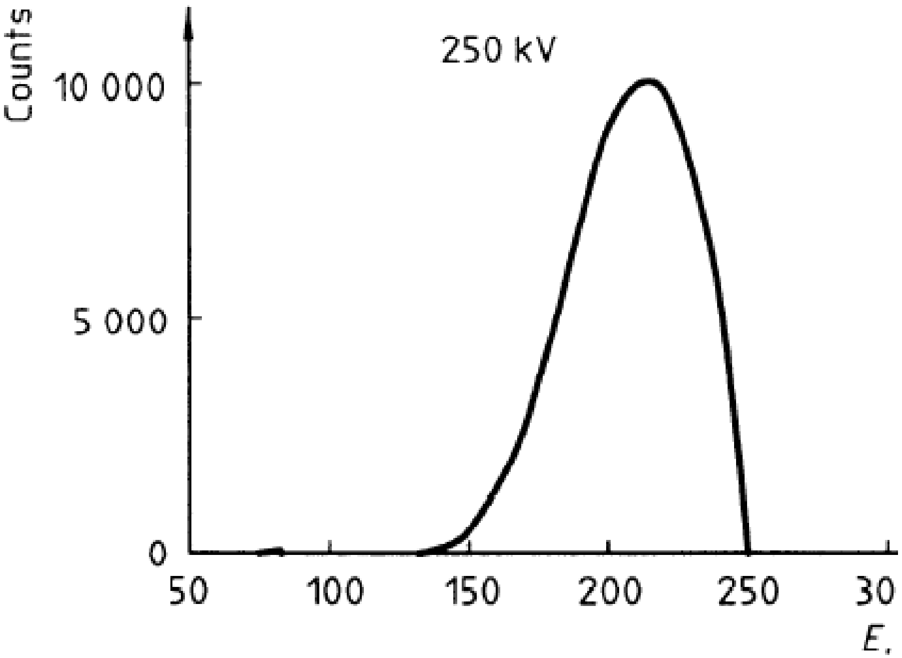
Table 5 — Characteristics of wide-spectrum series

Mean energy, $\overline{E}$ keV	Resolution, R_E %	Tube potential[1)] kV	Additional filtration[2)] mm Sn	Additional filtration[2)] mm Cu	1st HVL Cu[3)] mm	2nd HVL Cu[3)] mm
45	48	60		0,3	0,18	0,21
57	55	80		0,5	0,35	0,44
79	51	110		2,0	0,96	1,11
104	56	150	1,0		1,86	2,10
137	57	200	2,0		3,08	3,31
173	56	250	4,0		4,22	4,40
208	57	300	6,5		5,20	5,34

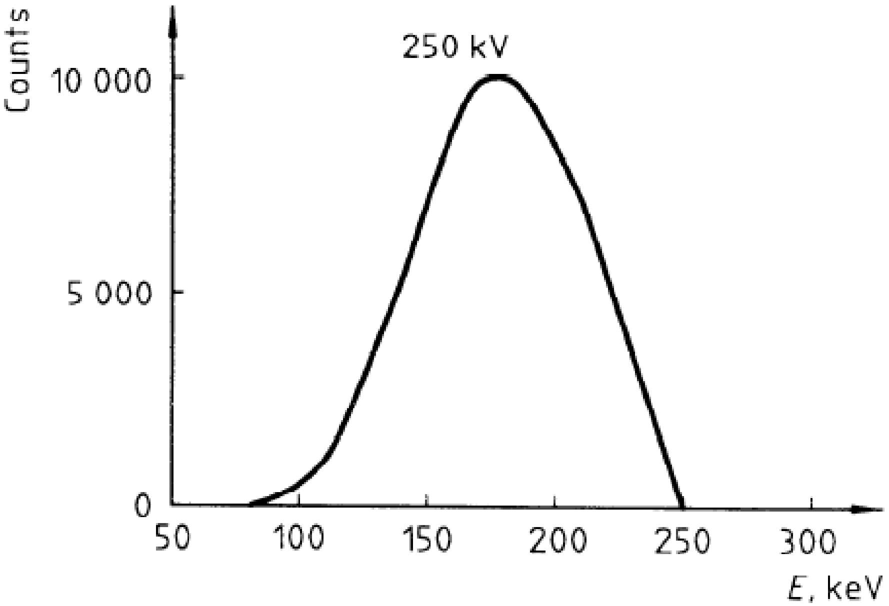
1) The tube potential is measured under load.
2) The total filtration consists, in each case, of the additional filtration plus inherent filtration, adjusted to 4 mm of aluminium (see 4.2.3).
3) The HVLs are measured at 1 m from the focal spot.

ISO 4037

N-250 vs. W-250



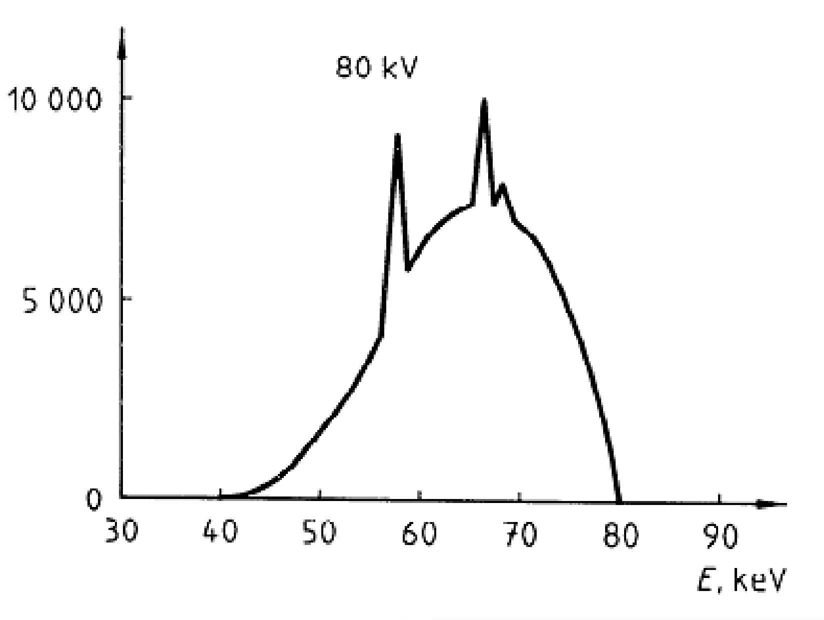
N-250 (208 keV)

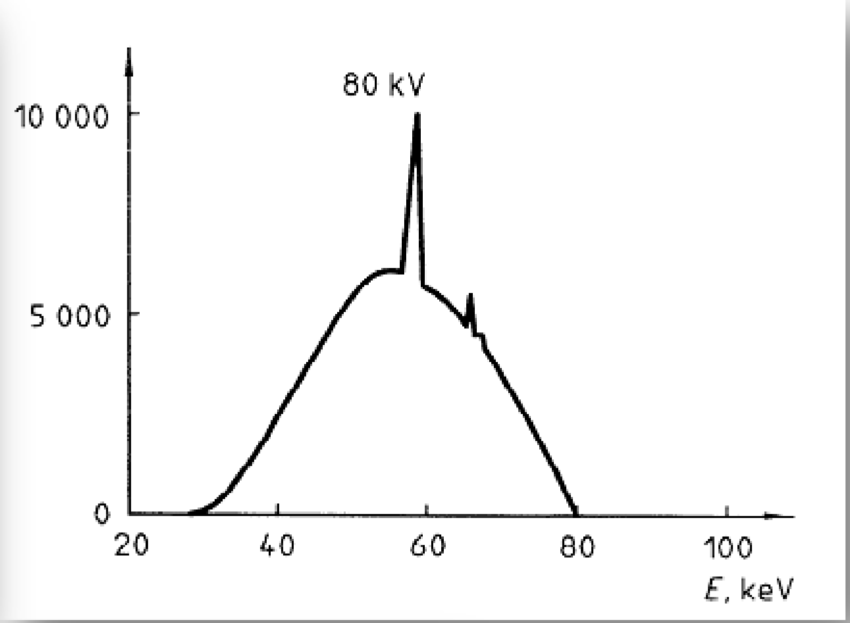


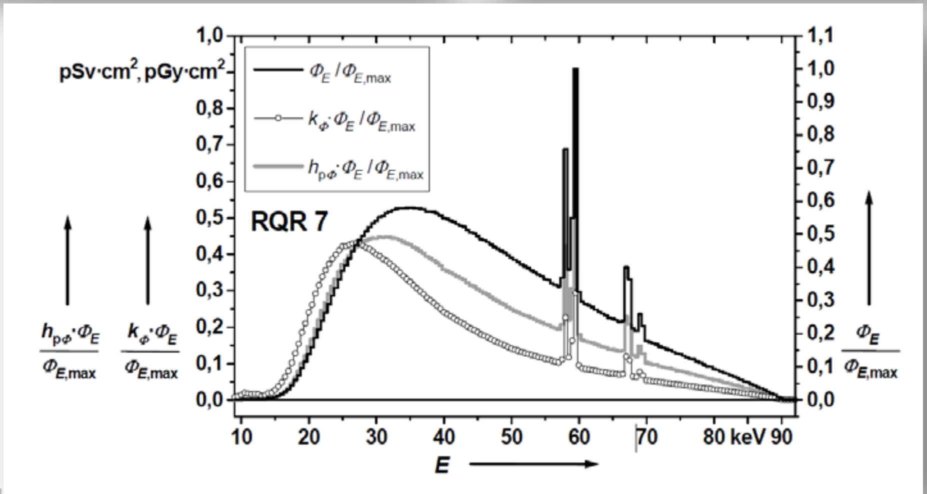
W-250 (173 keV)

ISO 4037

N-80, W-80 and RQR7

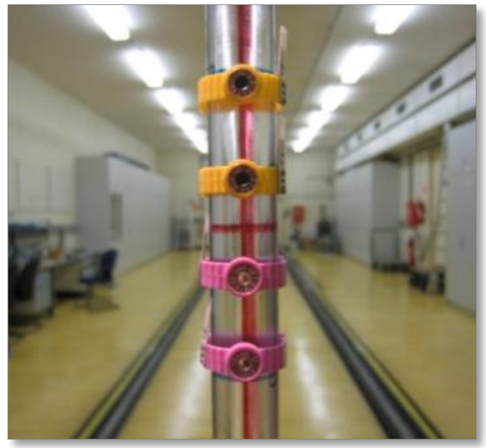


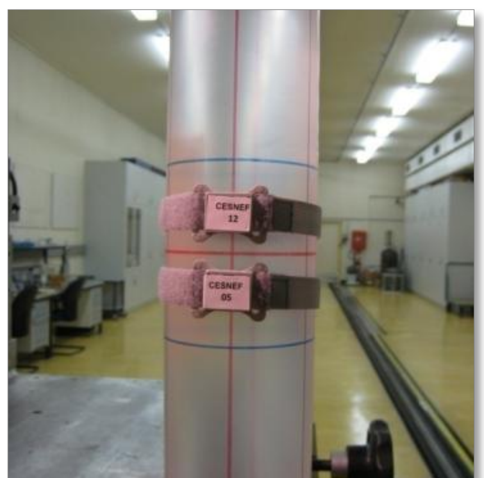




ISO 4037
PTB-Bericht Dos-34

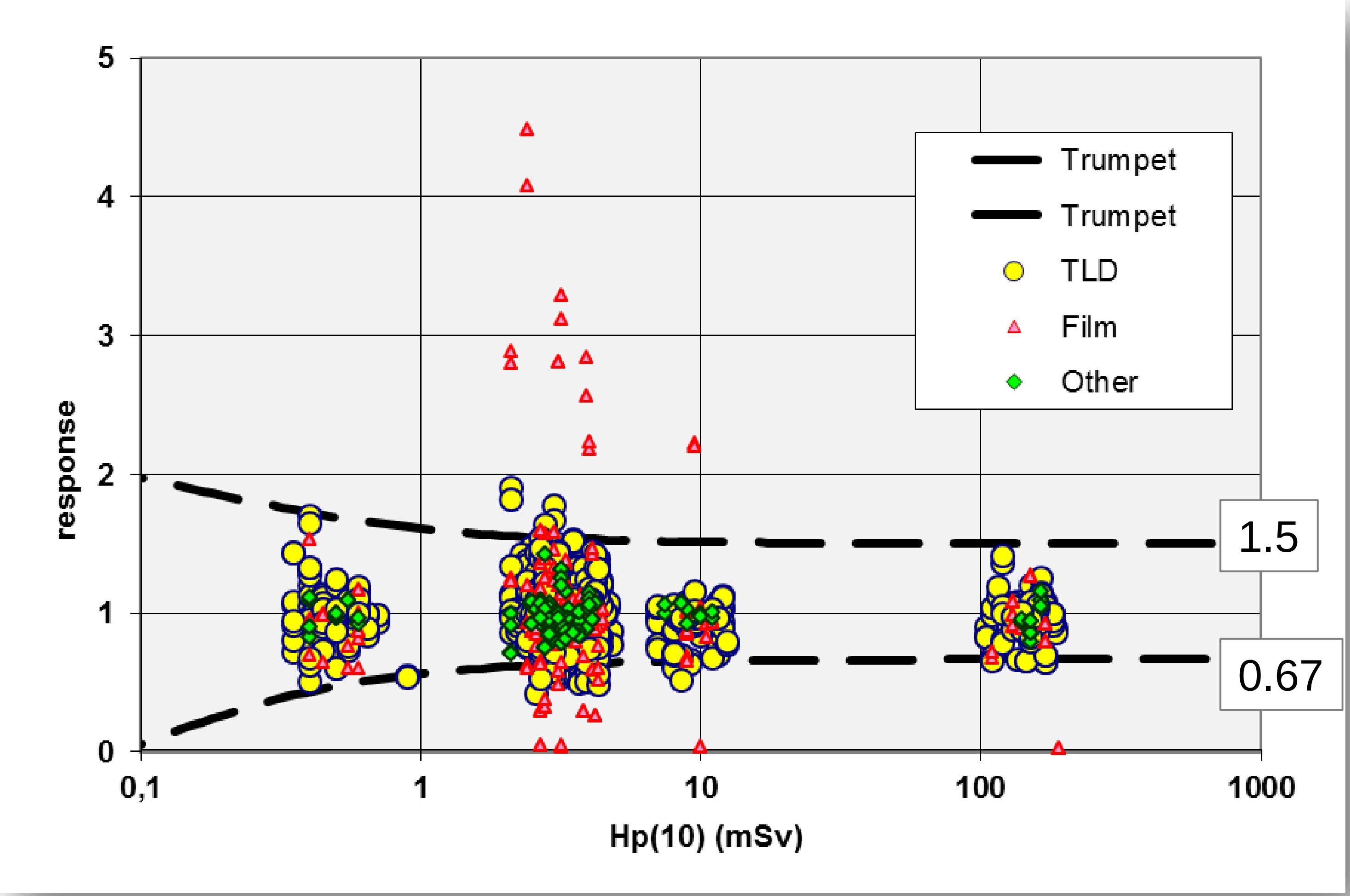
Irradiation conditions:
Calibration phantoms / irradiation set up



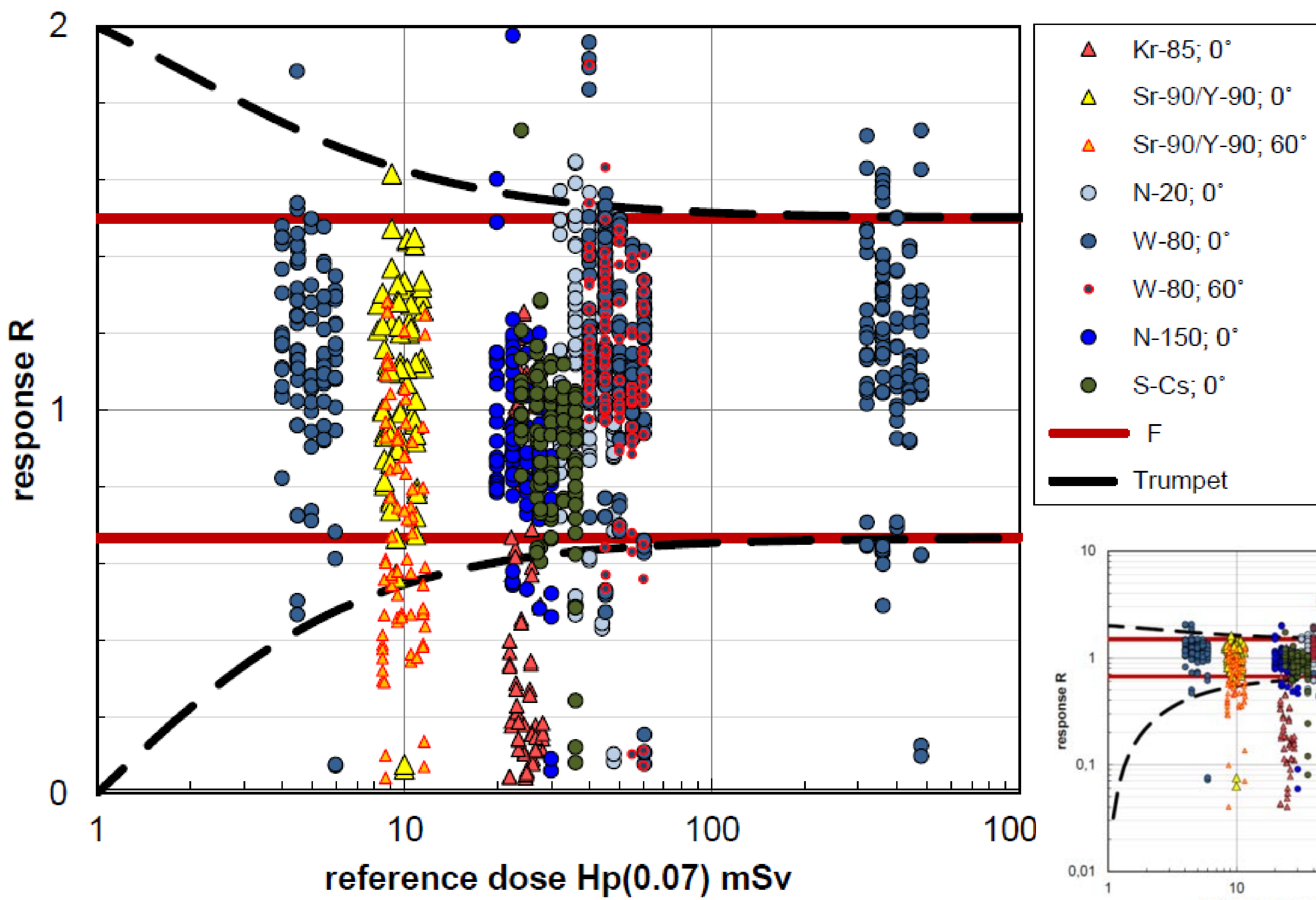


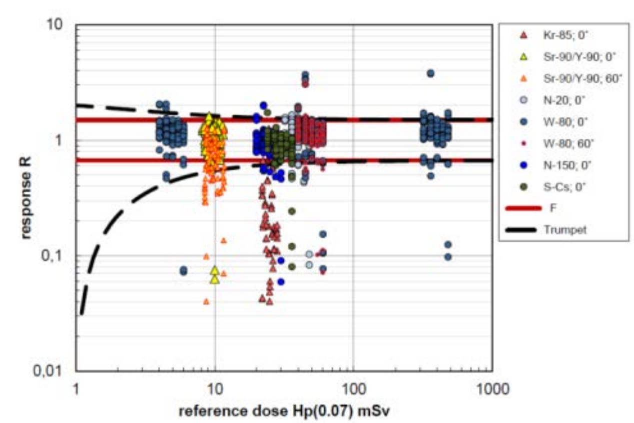
All irradiations were carried out in **accredited calibration Labs** and according to **ISO 4037, ISO 6970** and **IEC 61267**

All response values (IC2008-WB)

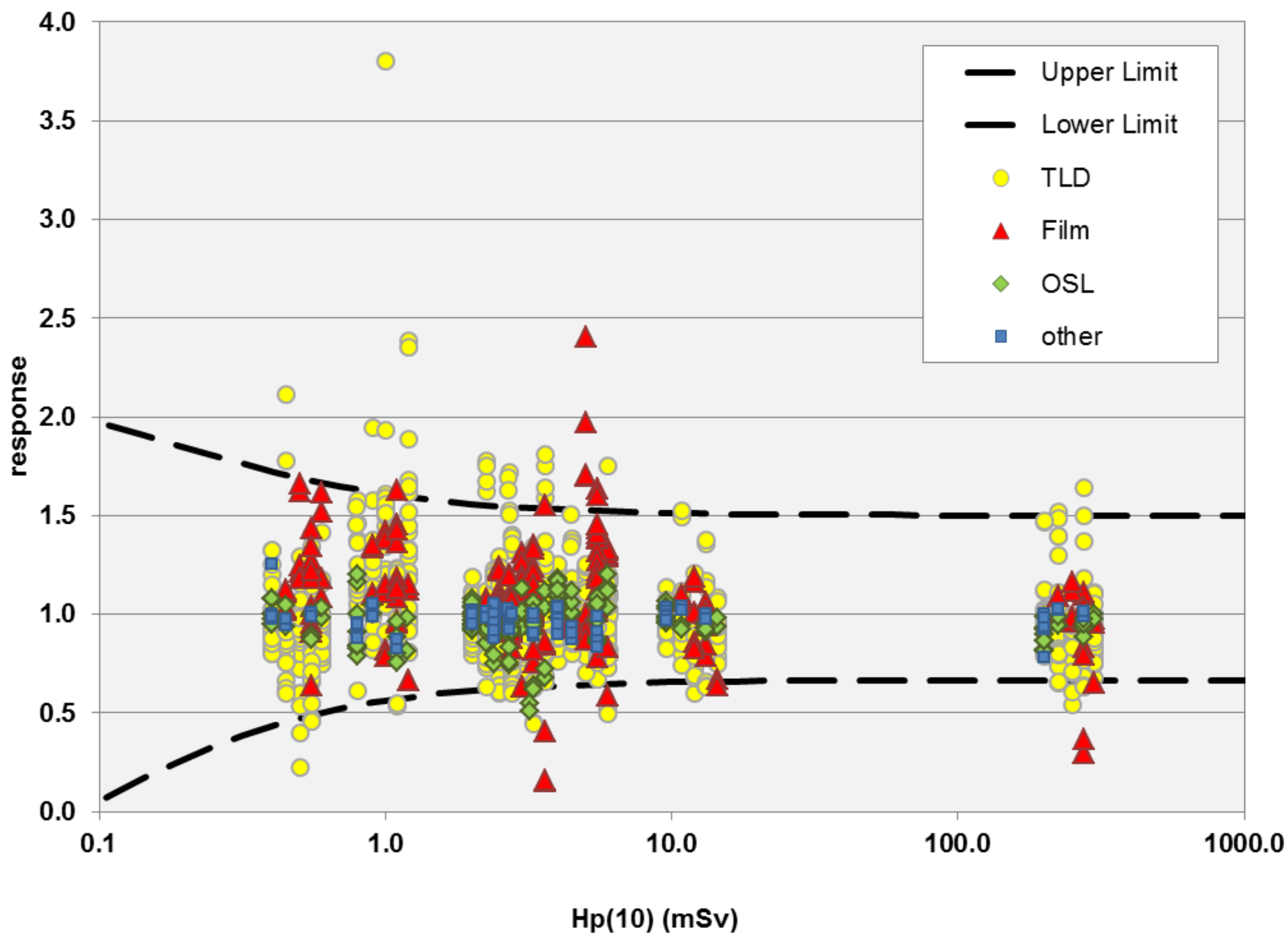


All response values (IC2009-Ext)

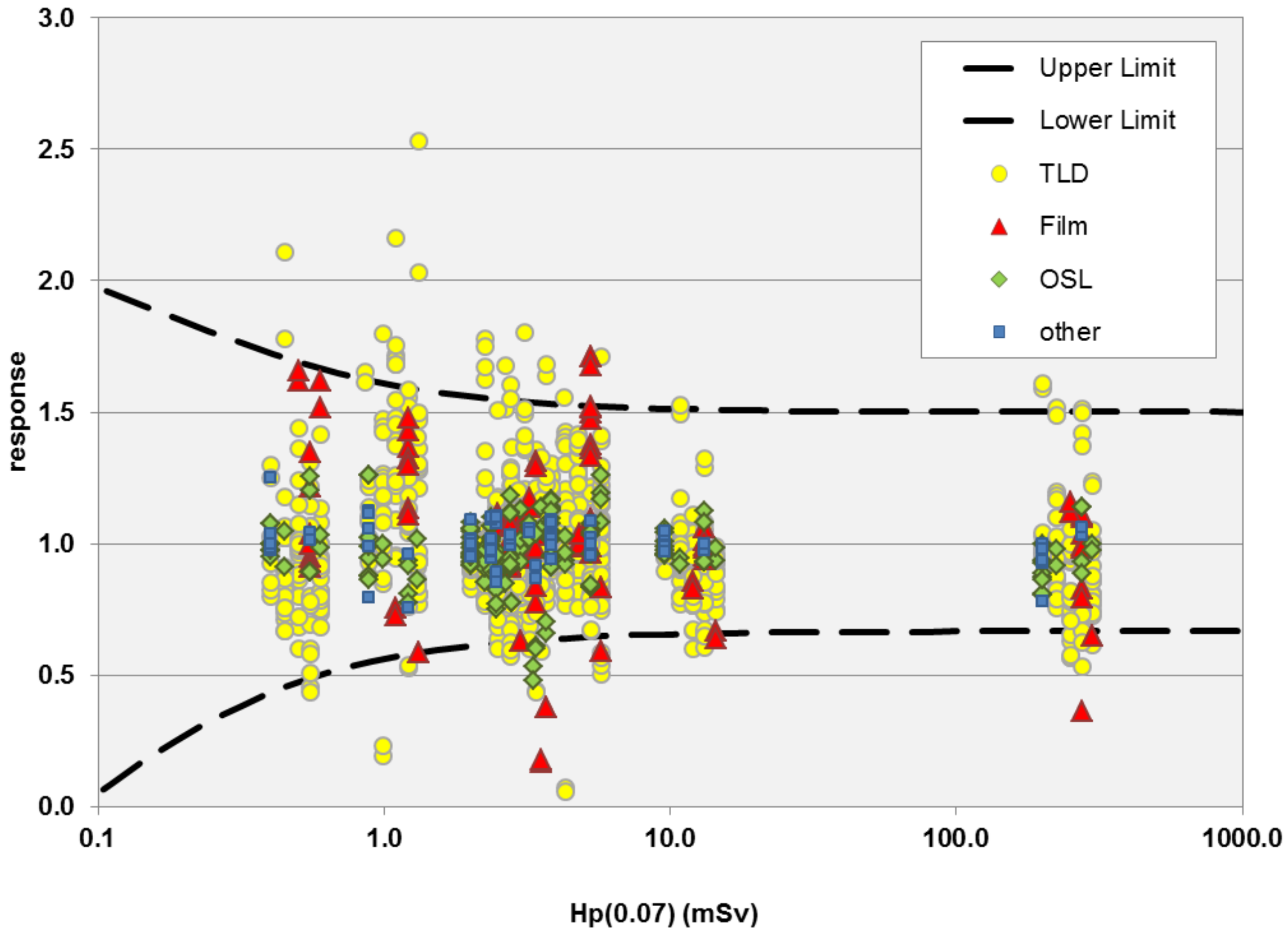




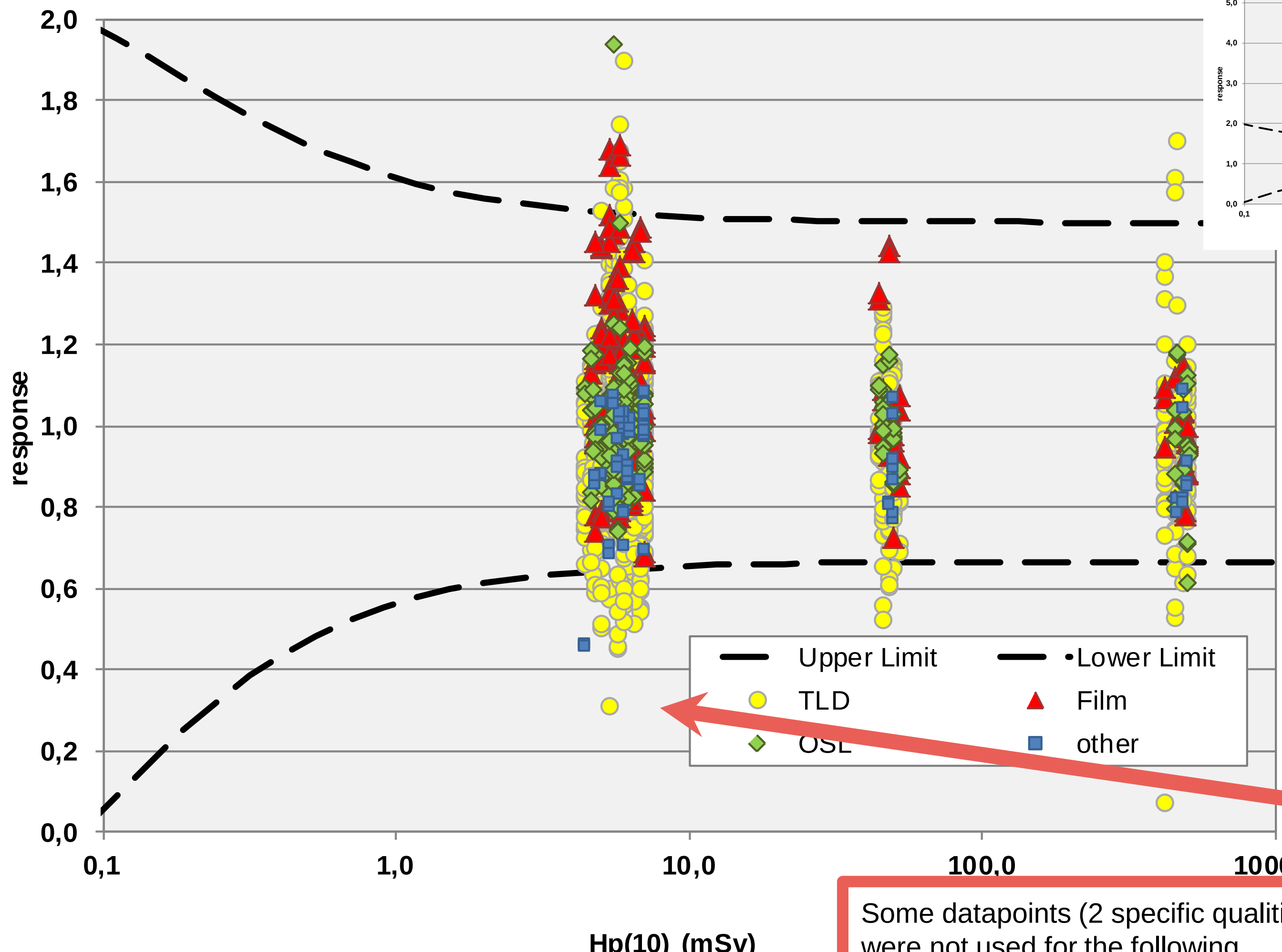
All response values (IC2010-WB)

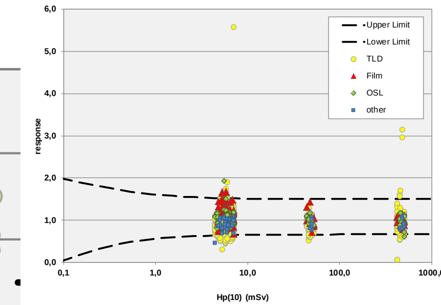


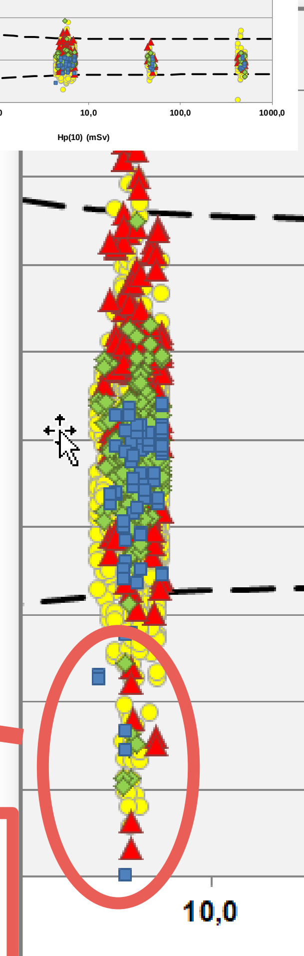
Trumpet curve for $H_p(0.07)$ results (IC2010-WB)



All response values (IC2012-WB)

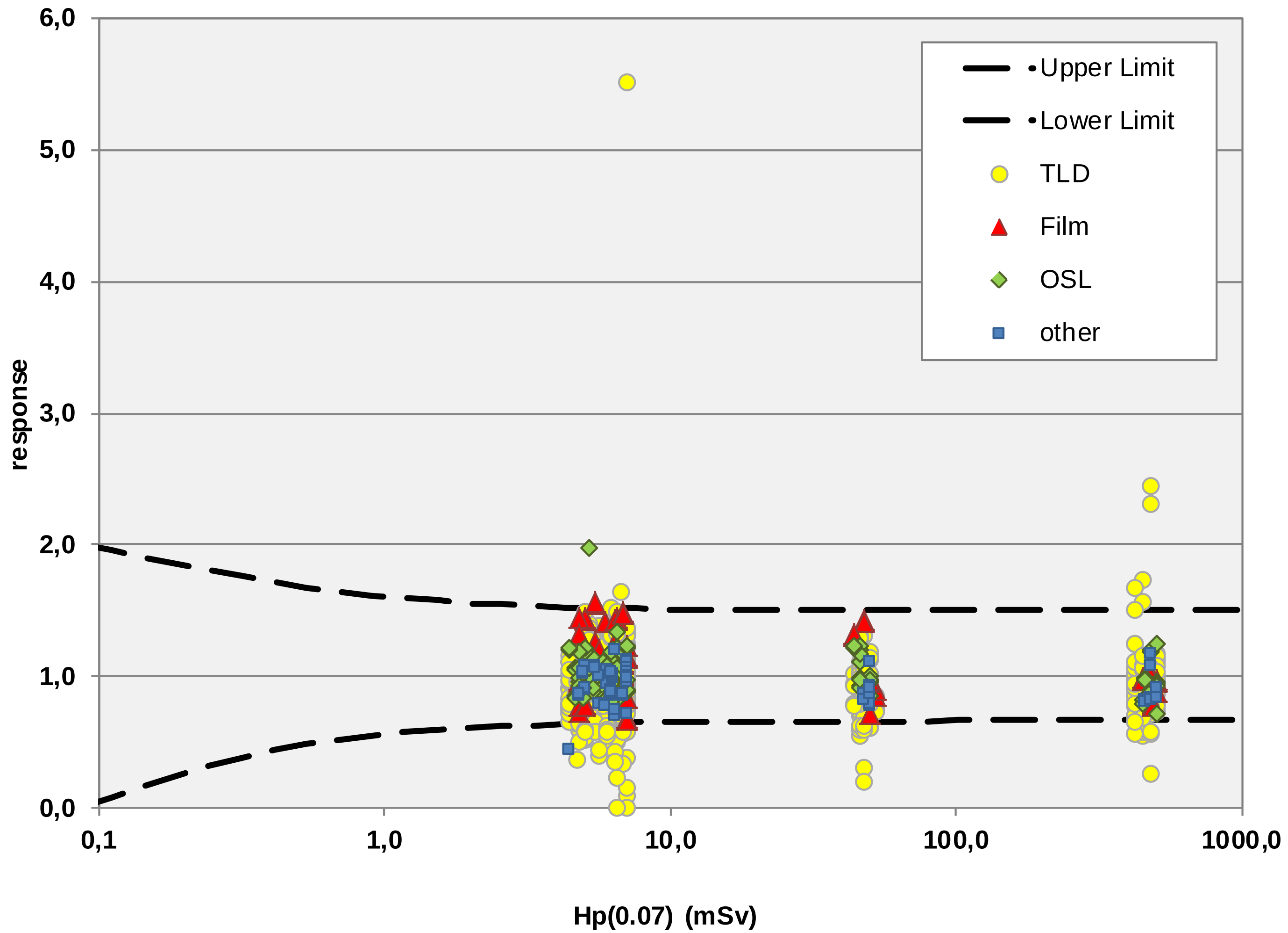






Some datapoints (2 specific qualities) were not used for the following analysis and statistics due to incorrect irradiations

Trumpet curve for $H_p(0.07)$ results (IC2012-WB)



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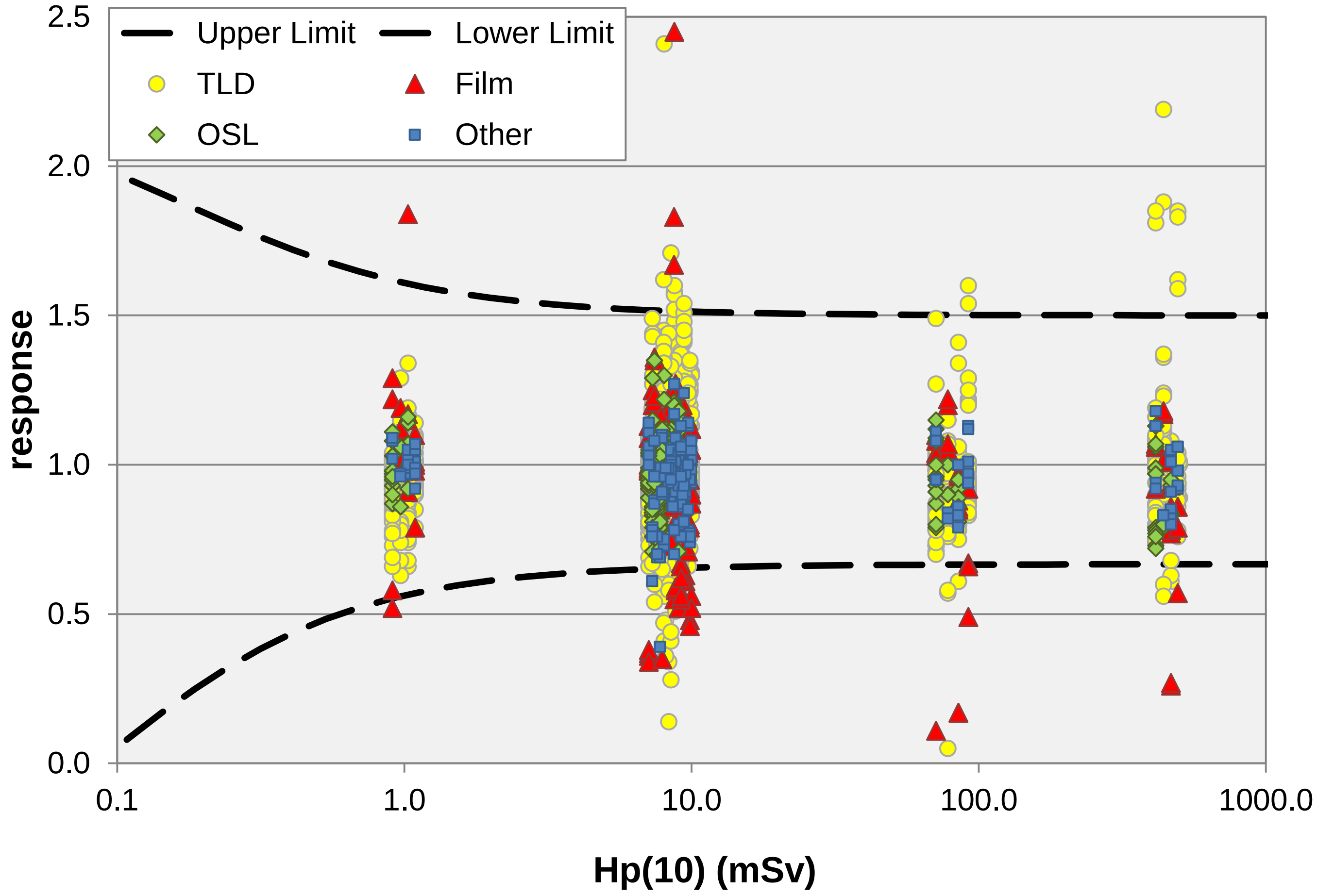
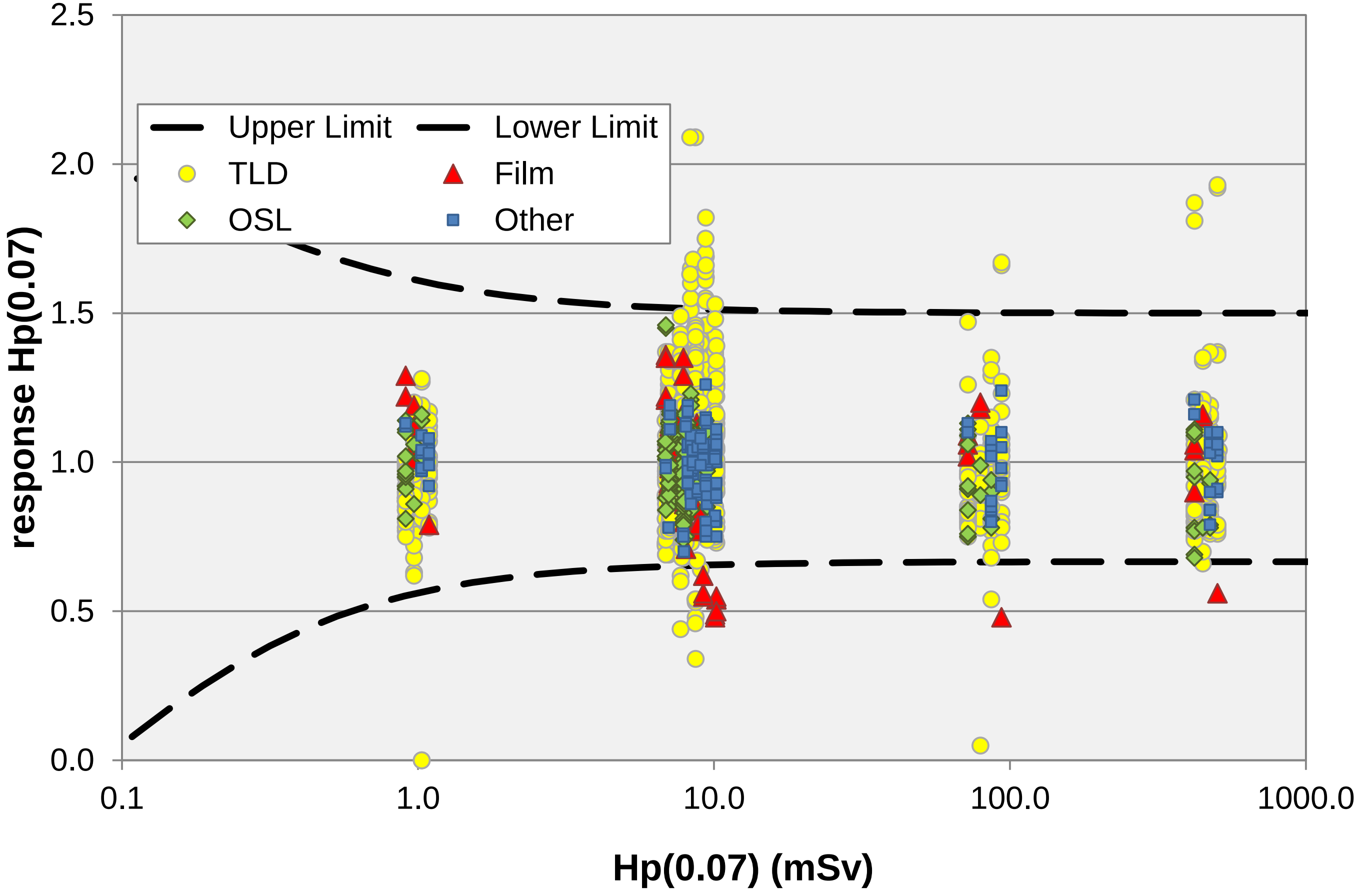
All response values (IC2014-WB)



Trumpet curve for H_p(0.07) results (IC2014-WB)



Outliers: trumpet curve

$$\frac{1}{F}\left(1-\frac{2H_0}{H_0+H_c}\right) \le R \le F\left(1+\frac{H_0}{2H_0+H_c}\right)$$

Where:

- ***F* = 1.5 (1/F = 0.667)**
- *Whole body Dosemeters:* $\mathbf{H_0}$ **= 0.085 mSv**
- *Extremity Dosemeters:* $\mathbf{H_0}$ **= 1.00 mSv**

Note:

According to ISO 14146 H_0 is the *"lower limit of the dose range for which the system has been approved"*.

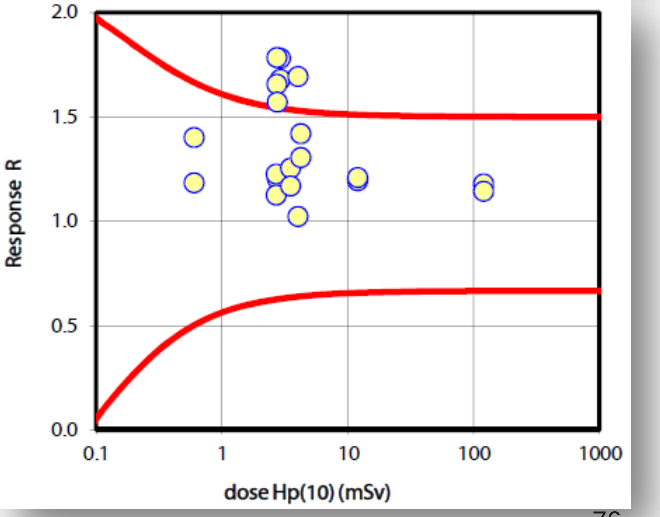
Acceptance criteria: 10% outliers are accepted

INTERNATIONAL STANDARD

ISO 14146

First edition
2000-06-01

Radiation protection — Criteria and performance limits for the periodic evaluation of processors of personal dosemeters for X and gamma radiation



Outliers IC2008-WB (Trumpet)

Hp(10) Outliers/Tr	Quality	Film	TLD	Other	All
X-ray	N60; 0°	35%	2%	0%	**7%**
	N60; 45°	50%	8%	8%	**15%**
	N150; 45°	20%	4%	0%	**6%**
Gamma	S-Cs; 0°	15%	3%	0%	**5%**
	S-Co; 0°	20%	7%	0%	**8%**
Mixed	N60; 0° + S-Cs; 0°	45%	0%	0%	**7%**
	S-Cs; 0° + N60; 0°	20%	5%	0%	**7%**
All		**25%**	**4%**	**1%**	**7%**

Hp(0.07) Outliers/Tr	Quality	Film	TLD	Other	All
X-ray	N60; 0°	60%	13%	0%	**16%**
	N60; 45°	60%	16%	10%	**20%**
	N150; 45°	30%	6%	0%	**8%**
Gamma	S-Cs; 0°	5%	12%	0%	**10%**
	S-Co; 0°	0%	11%	0%	**9%**
Mixed	N60; 0° + S-Cs; 0°	50%	10%	0%	**13%**
	S-Cs; 0° + N60; 0°	20%	14%	0%	**13%**
All		**24%**	**12%**	**1%**	**12%**

Outliers IC2009-Ext (Trumpet)

Outliers	Quality	Ph	PhB	B	All
Beta	Kr-85; 0°	-	64%	100%	65%
	Sr-90/Y-90; 0°	-	3%	-	3%
	Sr-90/Y-90; 60°	-	41%	50%	41%
Beta all		**-**	**36%**	**50%**	**36%**
Photon	N-20; 0°	15%	12%	-	13%
	W-80; 0°	10%	11%	-	11%
	W-80; 60°	13%	9%	-	11%
	N-150; 0°	10%	14%	-	12%
	S-Cs; 0°	8%	7%	-	7%
Photon all		**11%**	**11%**	**-**	**11%**
All		**11%**	**18%**	**50%**	**16%**

Outliers IC2010-WB (Trumpet)

Outliers / Trumpet						
Quantity		**TLD**	**Film**	**OSL**	**other**	**All**
Hp(10)	N40/30°	10%	4%	0%	0%	8%
	N40/S-Cs	7%	8%	19%	0%	8%
	W110/45°	2%	17%	0%	0%	4%
	W250/S-Cs	2%	15%	0%	0%	4%
	S-Cs	4%	1%	0%	0%	3%
	S-Co	8%	19%	0%	0%	8%
Hp(10) All		5%	8%	2%	0%	**5%**

Outliers / Trumpet						
Quantity		**TLD**	**Film**	**OSL**	**other**	**TLD**
Hp(0.07)	N40/30°	16%	17%	0%	0%	13%
	N40/S-Cs	9%	17%	25%	0%	11%
	W110/45°	5%	21%	0%	0%	6%
	W250/S-Cs	7%	17%	0%	0%	7%
	S-Cs	10%	2%	0%	0%	8%
	S-Co	16%	25%	0%	0%	14%
Hp(0.07) All		10%	13%	3%	0%	**9%**

Systems with outliers (IC2010-WB)

$H_p(10)$: 22 of 85 systems

outlier Hp10																						
N40/30°	1	0	0	2	0	2	0	0	2	1	0	0	0	0	0	1	0	2	0	0	1	1
N40/S-Cs	2	2	0	2	0	2	0	0	2	0	0	0	0	0	0	0	2	0	0	1	0	0
W110/45°	0	2	0	0	0	1	4	4	0	0	2	0	0	0	0	1	0	0	0	0	0	0
W250/S-Cs	1	2	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
S-Cs	7	1	4	2	3	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0
S-Co	1	2	2	0	2	0	0	0	0	0	1	1	0	2	2	0	0	0	1	0	0	0
All	**12**	**9**	**7**	**6**	**5**	**5**	**4**	**4**	**4**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**

Number of outliers (1 out of 10) IC2010-WB

Hp(10)											Hp(10)	
# outliers (sys)	0	1	2	3	4	5	6	7	9	12	0-2	> 2
TLD	76%	5%	3%	3%	3%	3%	2%	2%	-	2%	85%	15%
Film	54%	-	23%	8%	8%	-	-	-	8%	-	77%	23%
OSL	75%	13%	13%	-	-	-	-	-	-	-	100%	0%
other	100%	-	-	-	-	-	-	-	-	-	100%	0%
All	**74%**	**5%**	**7%**	**4%**	**4%**	**2%**	**1%**	**1%**	**1%**	**1%**	**86%**	**14%**
		86%					**14%**					

Hp(0.07)													Hp(0.07)	
# outliers (sys)	0	1	2	3	5	6	7	9	11	12	13	20	0-2	> 2
TLD	65%	8%	8%	2%	2%	2%	2%	2%	2%	2%	2%	2%	82%	18%
Film	50%	17%	-	17%	-	-	-	-	17%	-	-	-	67%	33%
OSL	75%	-	25%	-	-	-	-	-	-	-	-	-	100%	0%
other	100%	-	-	-	-	-	-	-	-	-	-	-	100%	0%
All	**67%**	**7%**	**9%**	**3%**	**1%**	**1%**	**1%**	**1%**	**3%**	**1%**	**1%**	**1%**	**84%**	**16%**
		84%						**16%**						

Outliers IC2012-WB (Trumpet)

Outliers / Trumpet						
Quantity	**Quality**	**TLD**	**Film**	**OSL**	**other**	**All**
Hp(10)	S-Cs	4%	0%	0%	0%	3%
	S-Co	8%	0%	2%	5%	6%
	N60	8%	4%	5%	0%	6%
	N60/60°	14%	25%	0%	0%	13%
	All	8%	4%	2%	3%	6%

Outliers / Trumpet						
Quantity	**Quality**	**TLD**	**Film**	**OSL**	**other**	**All**
Hp(0.07)	S-Cs	12%	0%	0%	0%	9%
	S-Co	15%	0%	0%	5%	12%
	N60	5%	30%	6%	0%	6%
	N60/60°	5%	0%	0%	0%	4%
	All	12%	4%	1%	3%	9%

Systems with outliers (IC2012-WB)

$H_p(10)$: 27 of 87 systems

	52	79	60	30	80	58	46	84	55	34	65	15	77	6	27	2	56	11	44	81	62	12	24	78	43	50	51
S-Cs	4	4	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S-Co	8	8	2	1	4	2	4	1	2	0	0	0	0	0	2	2	0	0	2	1	1	0	0	1	0	0	0
N60	2	0	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
N60/60°	1	0	2	1	0	0	0	2	0	2	2	2	2	2	0	0	2	2	0	0	0	0	0	0	1	0	1
All	**15**	**12**	**6**	**5**	**4**	**4**	**4**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

$H_p(0.07)$: 18 of 69 systems

	60	52	56	61	48	79	55	80	58	6	2	63	44	33	24	62	17	43
S-Cs	4	4	4	4	4	3	1	0	0	0	0	0	0	0	0	0	0	0
S-Co	8	8	7	8	8	8	4	4	2	0	2	2	2	1	0	1	0	0
N60	2	2	0	0	0	0	0	0	1	2	0	0	0	0	1	0	1	0
N60/60°	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
All	**16**	**14**	**13**	**12**	**12**	**11**	**5**	**4**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**

Number of outliers (1 out of 10) IC2012-WB

Hp(10)									
# outliers (sys)	0	1	2	3	4	5	6	12	15
TLD	66%	10%	8%	3%	5%	2%	2%	2%	2%
Film	67%	8%	25%	-	-	-	-	-	-
OSL	73%	18%	9%	-	-	-	-	-	-
other	80%	-	20%	-	-	-	-	-	-
All	68%	10%	11%	2%	3%	1%	1%	1%	1%
	90%			10%					

Hp(0.07)											
# outliers (sys)	0	1	2	3	4	5	11	12	13	14	16
TLD	74%	6%	4%	2%	2%	2%	2%	2%	2%	2%	2%
Film	60%	20%	20%	-	-	-	-	-	-	-	-
OSL	89%	11%	-	-	-	-	-	-	-	-	-
other	80%	-	20%	-	-	-	-	-	-	-	-
All	75%	7%	6%	1%	1%	1%	1%	1%	1%	1%	1%
	88%			12%							

Outliers IC2014-WB (Trumpet)

Outliers / Trumpet						
Quantity	**Quality**	**TLD**	**Film**	**OSL**	**Other**	**All**
Hp(10)	RQR7	5%	8%	0%	10%	5%
	W-80	6%	8%	0%	0%	5%
	W-80/60°	8%	25%	0%	5%	9%
	W-150	5%	17%	0%	0%	5%
	S-Cs	1%	14%	0%	2%	3%
	S-Co	5%	24%	0%	0%	6%
	All	4%	17%	0%	2%	5%

Outliers / Trumpet						
Quantity	**Quality**	**TLD**	**Film**	**OSL**	**Other**	**All**
Hp(007)	RQR7	9%	25%	0%	0%	8%
	W-80	7%	0%	0%	0%	6%
	W-80/60°	7%	25%	0%	0%	6%
	W-150	0%	0%	0%	0%	0%
	S-Cs	1%	17%	0%	0%	1%
	S-Co	2%	25%	0%	0%	3%
	All	3%	18%	0%	0%	3%

Systems with outliers (IC2014-WB)

Mean response R / Quality	Film												OSL											Other									
	1	2	3	4	5	6	7	8	9	10	11	12	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112
RQR7	0.80	1.04	0.99	0.86	0.93	0.92	1.09	0.67	0.47	0.99	1.12	0.94	1.14	0.94	0.92	0.95	0.84	1.01	0.79	0.94	0.79	0.77	0.89	0.75	0.77	1.06	0.99	0.82	1.05	0.97	0.69	1.00	0.39
W-80	1.04	1.04	1.06	0.93	1.12	1.01	1.13	0.52	0.71	1.02	1.02	1.09	1.17	1.01	0.95	1.03	0.96	1.10	0.76	0.92	0.73	0.97	0.88	0.77	0.79	1.14	1.04	0.83	0.94	0.97	0.70	0.93	0.73
W-80/60°	0.99	1.14	1.75	1.23	1.07	0.99	1.24	1.50	0.55	1.11	1.03	0.81	1.16	1.13	0.89	1.04	1.08	1.26	0.84	0.74	0.80	1.14	0.86	0.89	0.92	1.16	1.22	0.93	0.74	0.74	0.79	0.87	0.69
W-150	0.62	0.81	1.27	1.36	1.22	0.85	1.00	0.59	0.75	0.87	0.99	0.89	1.07	1.07	0.97	1.03	0.99	1.09	0.79	1.35	0.81	1.04	0.97	0.91	0.97	0.93	0.92	0.93	1.05	0.98	0.88	0.98	1.02
S-Cs-L	1.06	0.91	1.12	1.26	1.03	0.55	1.41	1.09	0.79	1.09	1.16	0.99	1.00	1.00	1.15	0.94	0.91	0.96	1.08	0.97	1.07	0.94	0.97	0.97	1.04	1.06	0.97	0.97	1.00	0.97	1.09	0.98	1.02
S-Cs-M	1.06	0.97	0.95	1.11	0.99	0.36	1.20	0.78	0.59	1.06	1.15	1.13	1.02	1.08	1.06	0.92	0.95	0.98	1.07	0.98	1.04	0.95	0.96	0.99	1.03	1.04	0.97	1.00	1.00	0.97	1.11	1.03	1.02
S-Co-L	1.09	1.13	1.05	1.12	0.73	0.35	1.18	0.89	0.54	1.24	1.14	0.89	0.97	0.97	0.95	0.83	0.92	0.96	1.08	1.00	1.12	0.91	0.98	1.00	1.04	0.95	0.88	0.98	0.91	0.86	1.10	1.07	0.91
S-Co-M	0.92	0.97	0.85	1.09	1.04	0.11	0.87	0.17	0.49	1.06	1.21	0.67	0.94	0.85	0.84	0.80	0.89	0.95	1.09	0.93	1.14	0.94	0.98	0.99	1.00	0.94	0.86	1.00	0.81	0.83	1.10	1.13	0.95
S-Co-H	0.86	0.94	0.86	0.92	1.07		0.78	0.27	0.57	1.01	1.18	0.79	0.94	0.84	0.84	0.73	0.79	0.80	1.07	0.98	1.13	0.77	0.97	0.98	1.04	0.93	0.85	0.96	0.81	0.83	1.16	1.06	0.93
All	0.95	0.99	1.08	1.10	1.02	0.64	1.11	0.72	0.60	1.05	1.11	0.93	1.04	0.99	0.96	0.92	0.93	1.01	0.96	0.98	0.97	0.94	0.94	0.92	0.96	1.02	0.97	0.94	0.93	0.91	0.97	1.01	0.89
Outliers	2		2			11	1	10	14			1																					4

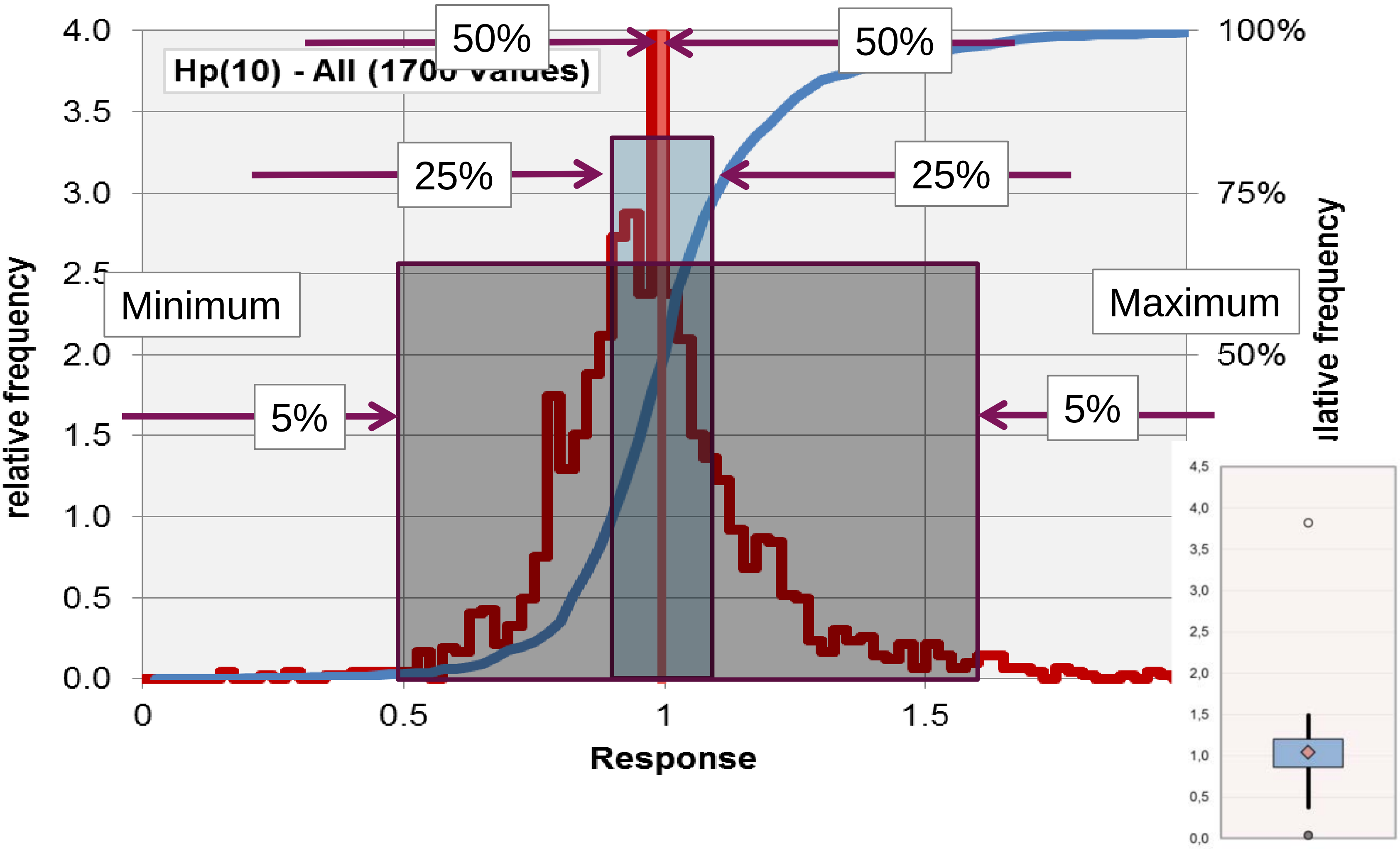
Mean response R / Quality	TLD																										
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
RQR7	1.18	0.74	1.17	1.33	0.96	1.24	1.36	1.26	1.22	1.16	0.80	0.86	0.90	0.65	1.38	1.00	1.02	1.29	1.32	0.35	0.89	1.04	1.12	1.13	1.24	1.38	1.32
W-80	1.06	1.12	1.19	1.24	0.91	1.04	1.23	1.19	1.11	1.27	0.77	0.90	0.80	0.56	1.25	0.92	0.92	1.25	1.29	0.45	0.74	1.30	1.05	0.61	1.14	1.33	1.23
W-80/60°	1.18	1.39	1.27	1.52	0.99	1.15	1.50	1.41	1.36	1.36	0.86	1.18	1.20	0.63	1.40	0.93	0.94	1.30	1.37	1.41	0.86	1.49	1.17	1.22	1.30	1.56	1.44
W-150	1.10	0.94	0.97	1.03	0.75	1.03	1.08	1.01	0.97	0.98	0.68	0.96	0.96	0.64	1.10	1.00	0.90	0.95	0.80	0.42	0.77	1.13	0.92	0.92	1.10	1.14	1.10
S-Cs-L	1.00	0.96	0.82	1.04	0.95	0.79	0.99	0.94	0.97	1.00	0.67	0.94	0.93	0.93	0.90	1.02	1.01	0.95	0.89	0.66	0.93	1.12	0.90	0.80	0.93	1.04	1.07
S-Cs-M	1.01	0.91	0.81	1.00	0.95	0.86	1.01	0.98	0.88	0.90	0.66	0.93	0.93	0.79	0.97	0.86	0.97	1.00	0.89	0.60	0.86	1.13	0.88	0.81	1.03	1.07	1.03
S-Co-L	0.96	0.93	0.89	1.00	0.99	0.81	1.00	0.95	0.89	0.90	0.62	0.98	1.31	0.86	0.89	0.82	0.99	0.96	0.97	0.60	0.87	1.07	0.84	0.81	1.00	1.02	1.00
S-Co-M	0.94	0.92	0.86	1.02	1.00	0.83	0.98	0.93	0.85	0.86	0.61	0.98	1.26	0.82	1.02	0.88	0.93	0.97	1.07	0.58	0.91	1.06	0.83	0.80	0.90	1.02	1.02
S-Co-H	0.94	0.93	0.77	1.03	0.98	0.86	0.98	0.99	0.91	0.89	0.62	1.00	1.61	0.73	0.95	0.89	0.93	1.01	2.04	0.58	0.91	1.06	0.79	0.82	0.89	1.04	1.04
All	1.04	0.97	0.96	1.12	0.94	0.95	1.11	1.06	1.00	1.02	0.69	0.96	1.08	0.74	1.08	0.92	0.96	1.07	1.15	0.62	0.86	1.15	0.94	0.87	1.05	1.16	1.13
Outliers				1			1				9		2	6					2	18		1		1		2	

Number of outliers (1 out of 10) IC2014-WB

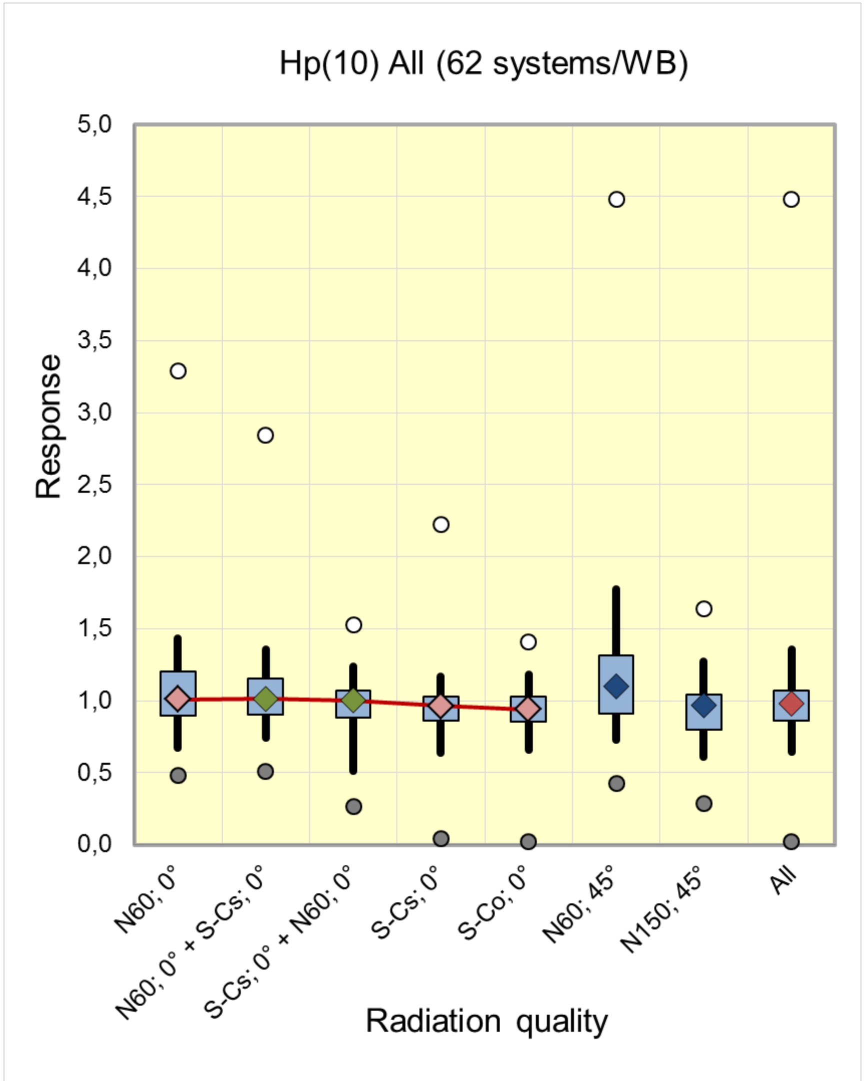
Hp(10)														
# outliers (sys)	0	1	2	3	4	6	7	9	10	11	14	18	0-2	> 2
TLD	77%	6%	6%	1%	4%	1%	1%	1%	-	-	-	1%	**90%**	**10%**
Film	42%	17%	17%	-	-	-	-	-	8%	8%	8%	-	**75%**	**25%**
OSL	100%	-	-	-	-	-	-	-	-	-	-	-	**100%**	**0%**
Other	90%	-	-	-	10%	-	-	-	-	-	-	-	**90%**	**10%**
All	77%	6%	6%	1%	4%	1%	1%	1%	1%	1%	1%	1%	**89%**	**11%**
	89%			**11%**										

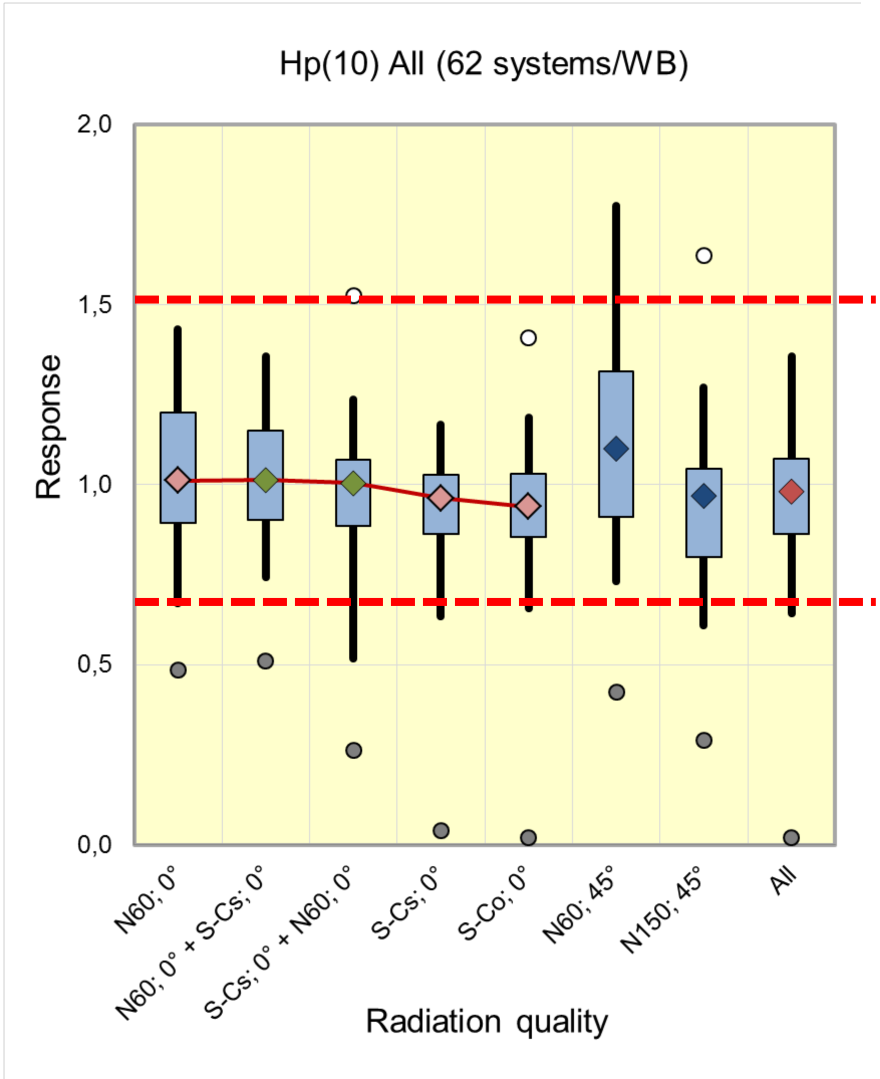
Hp(0.07)										
# outliers (sys)	0	1	2	3	4	6	7	14	0-2	> 2
TLD	82%	5%	2%	2%	5%	2%	3%	-	**88%**	**12%**
Film	75%	-	-	-	-	-	-	25%	**75%**	**25%**
OSL	100%	-	-	-	-	-	-	-	**100%**	**0%**
Other	100%	-	-	-	-	-	-	-	**100%**	**0%**
All	85%	4%	1%	1%	4%	1%	3%	1%	**100%**	**-**
	90%			**10%**						

Frequency distribution of R

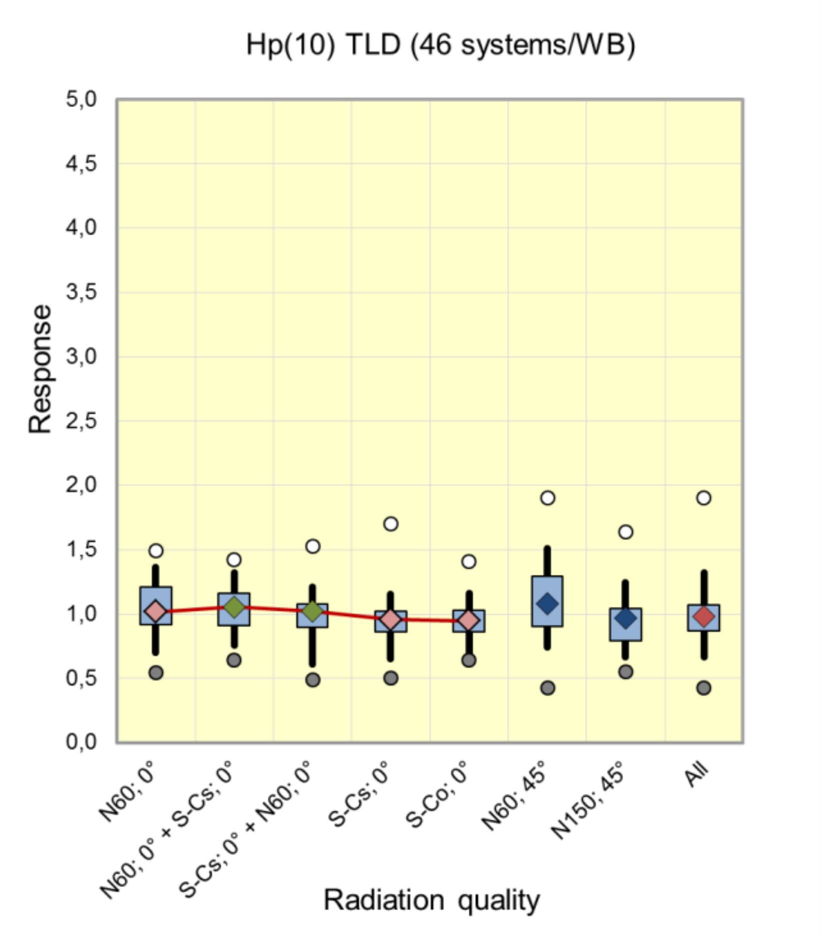


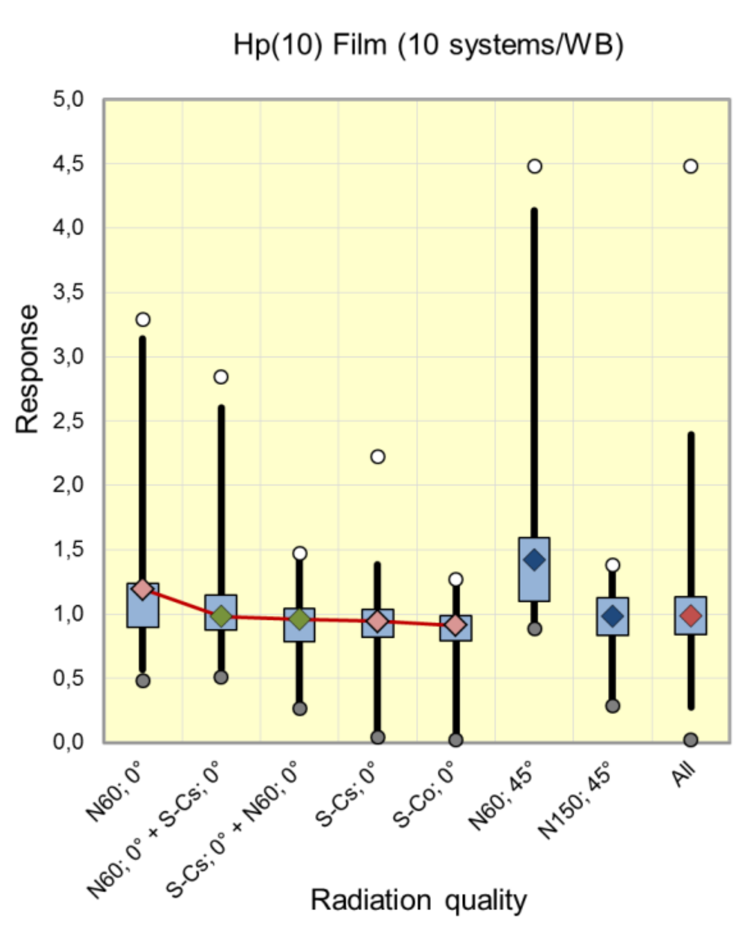
Results IC2008-WB





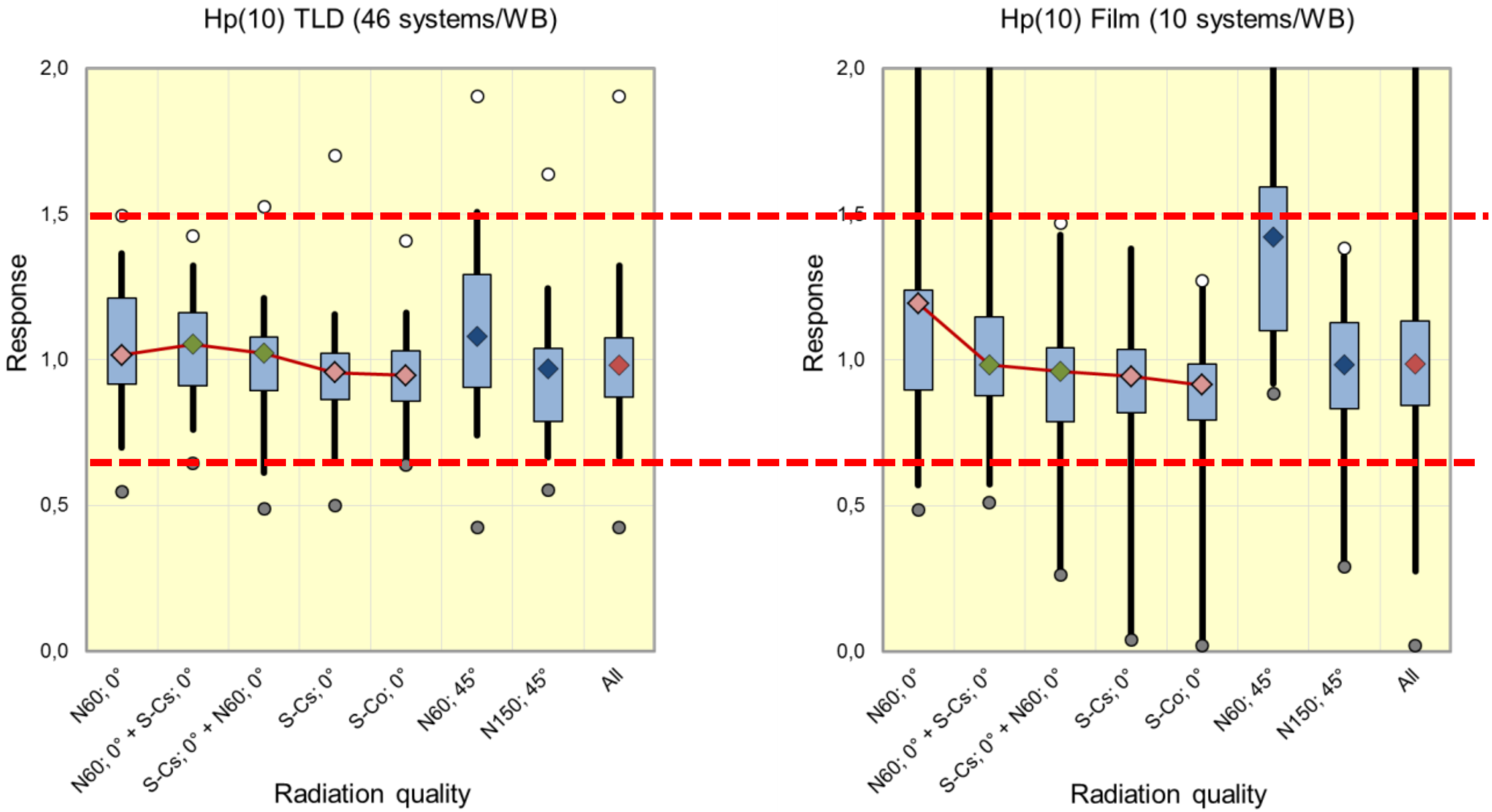
Comparison TLD vs. Film (1)



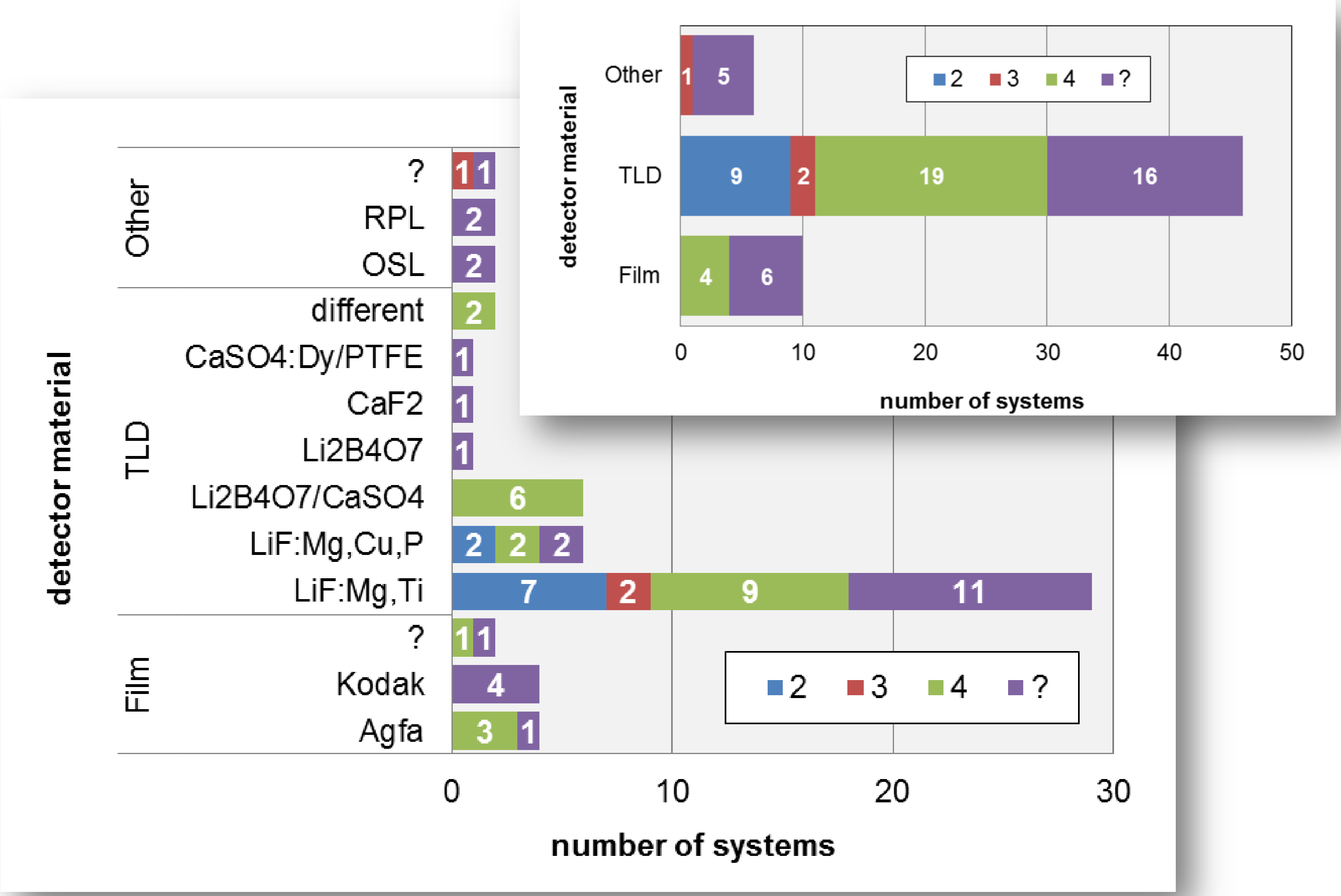


IC2008-WB

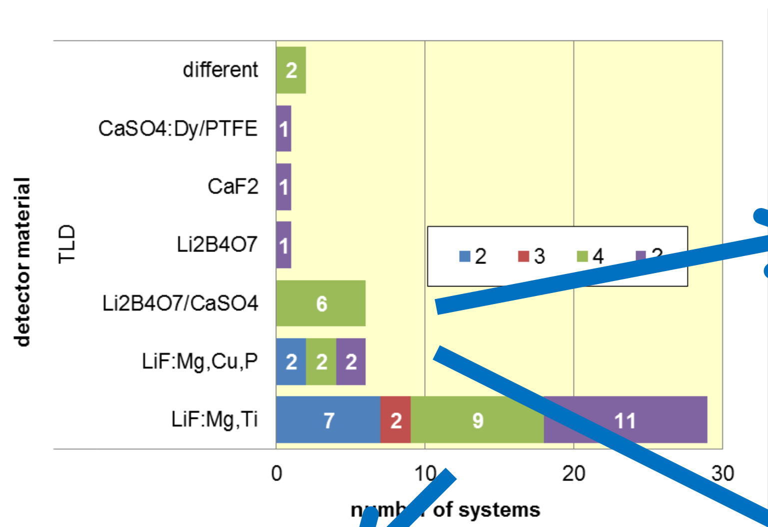
Comparison TLD vs. Film detail (2)

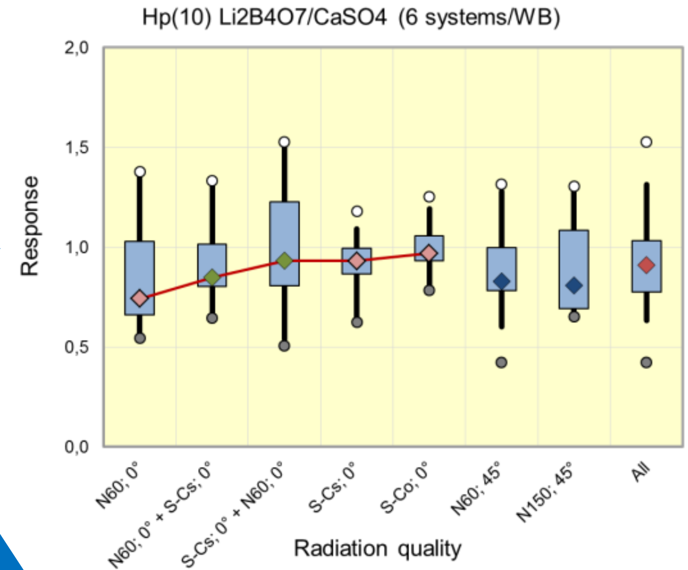


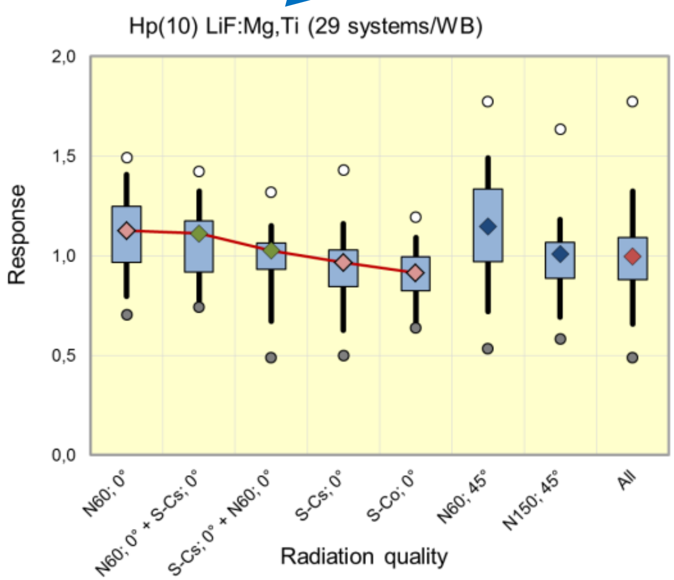
Dosemeter types (IC2008-WB)

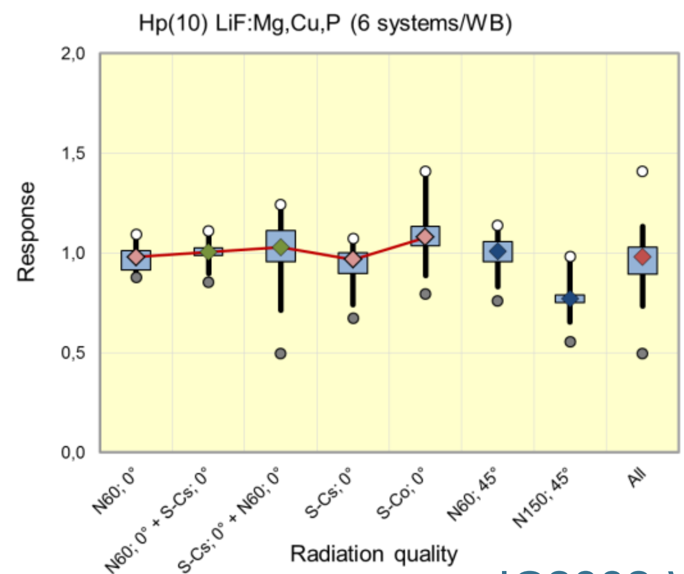


Comparison for diff. detector materials

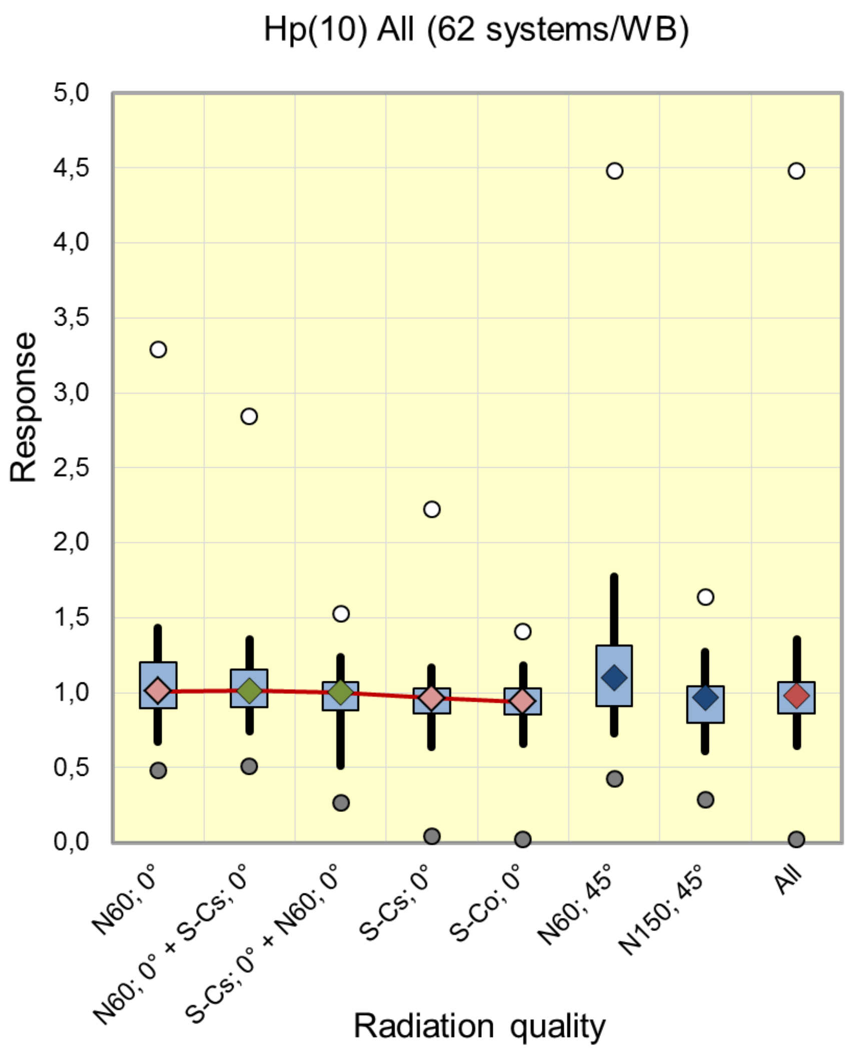


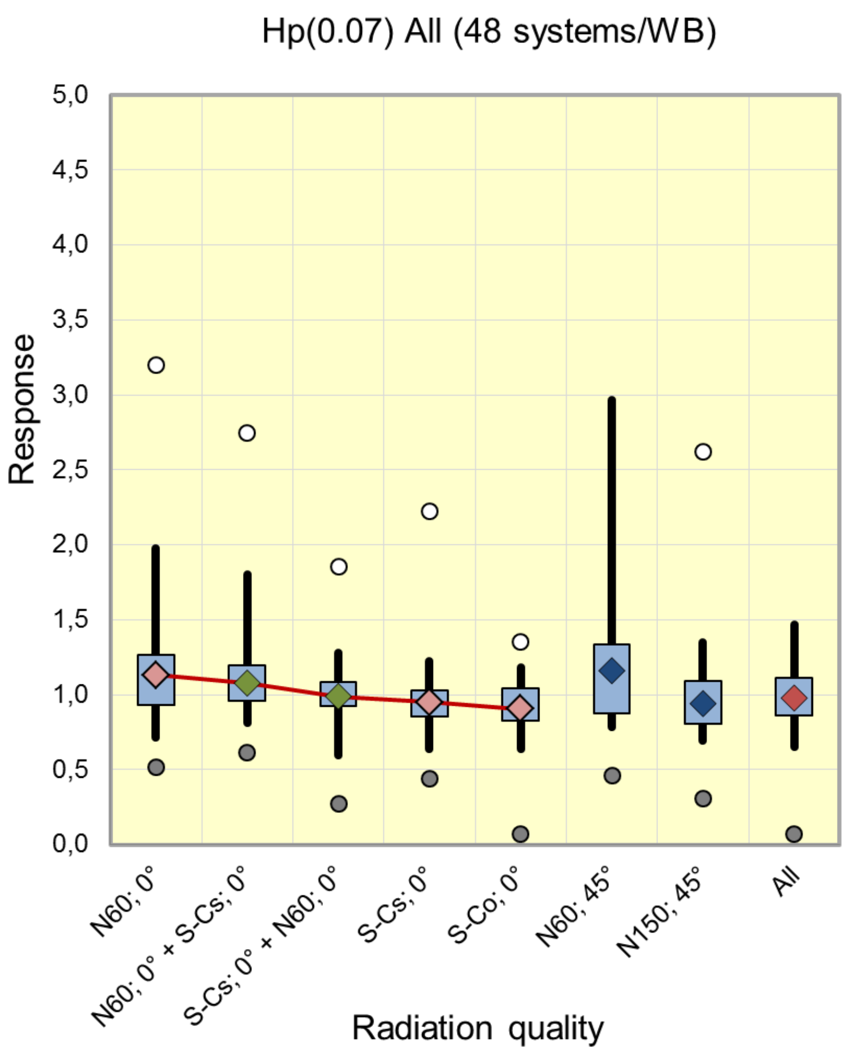




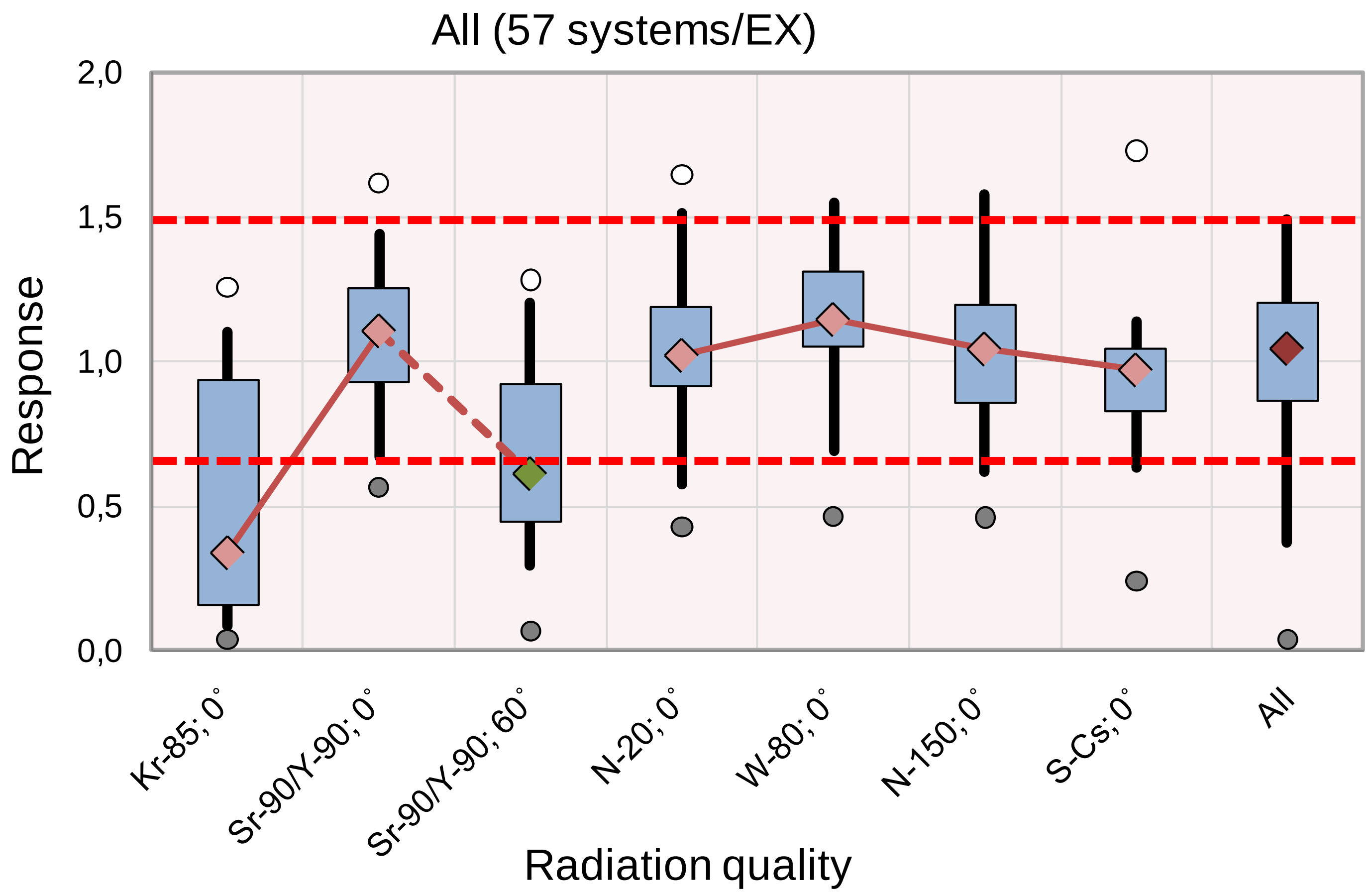


Dose quantity: $H_p(10)$ vs. $H_p(0.07)$

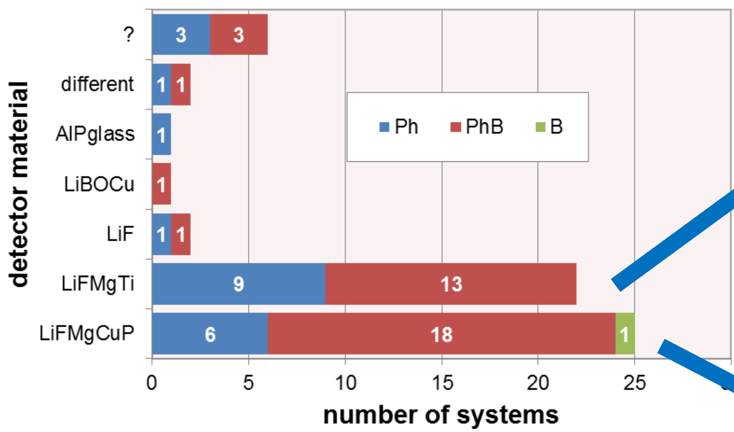


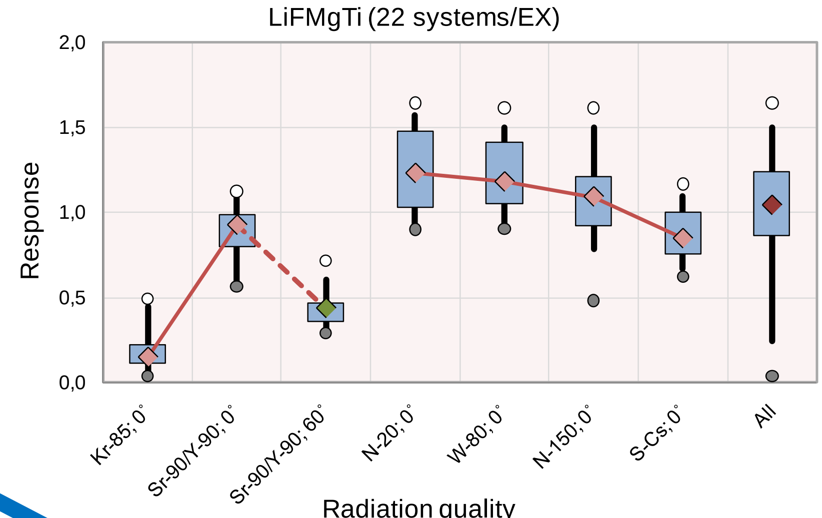


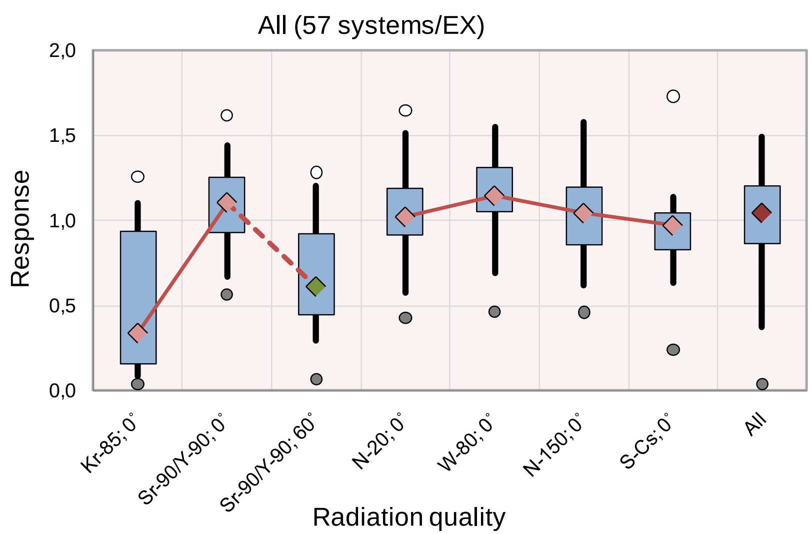
Results: IC2009-Ext

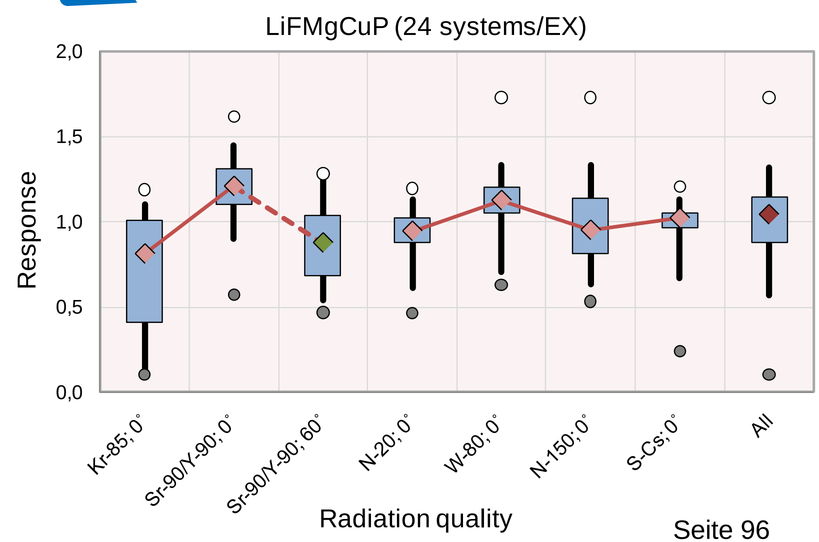


Results extremity dosemeters

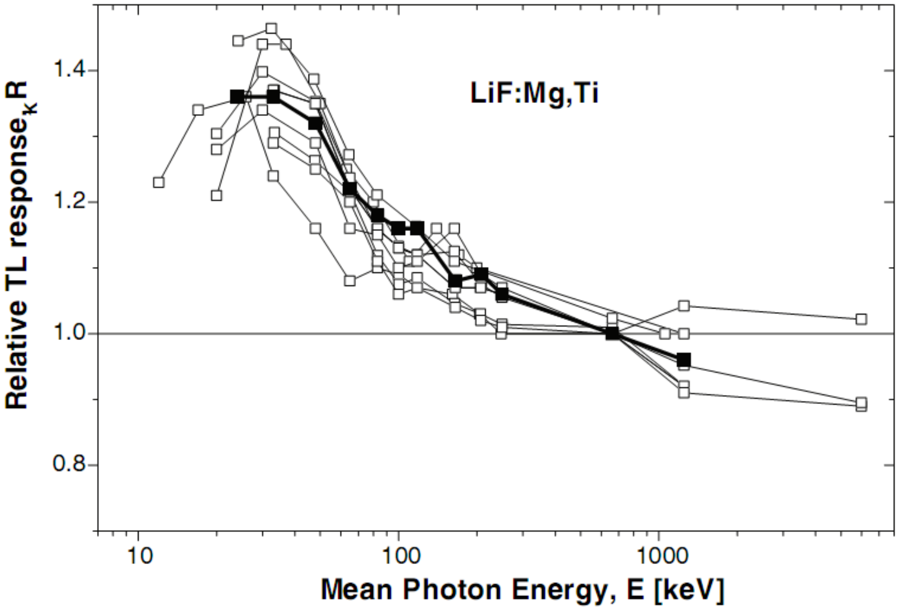


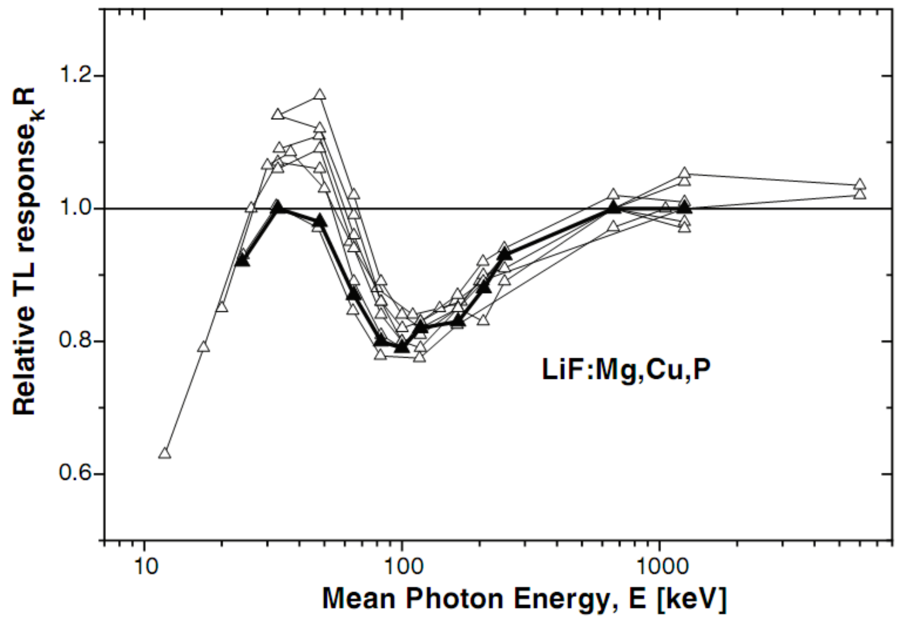






Measured energy resonse (K_a): LiF:Mg,Ti and LiF:Mg,Cu,P





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Mean response (IC2009-Ext)

Response: All			50	26	07	59	14	30	34	06	57	46	55	09	53	41	19	32	03	58	12	48	40	16	18	13	54	23	49	15	43	31	52
Beta	Kr-85; 0°	B1	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.2	0.3	0.4	0.1	0.0	0.3	0.0	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.8	0.1	0.3	0.2	0.6	1.0	0.1
Beta	Sr-90/Y-90; 0°	B2	0.1	0.8	0.5	0.6	0.8	0.1	0.6	0.7	0.4	0.4	0.8	0.8	1.1	0.8	0.7	0.9	0.7	1.1	1.1	1.0	1.0	0.9	1.0	1.1	1.0	0.8	0.9	0.9	1.2	1.0	0.9
Beta	Sr-90/Y-90; 60°	B3	0.1	0.4	0.3	0.5	0.3	0.0	0.3	0.3	0.1	0.2	0.5	0.5	0.9	0.3	0.3	0.4	0.6	0.7	0.5	0.6	0.5	0.3	0.9	0.5	1.0	0.5	0.1	0.4	0.5	0.9	0.4
Photon	N-20; 0°	P1	0.1	0.5	0.7	0.5	0.6	0.4	0.9	1.0	0.9	1.0	0.9	1.0	0.8	1.1	1.1	1.2	1.1	0.8	0.9	0.9	1.0	1.3	0.9	0.9	0.9	1.2	1.3	1.3	1.0	0.9	0.9
Photon	W-80; 0°	P2	0.1	0.5	0.6	0.7	0.7	1.2	0.9	0.9	1.1	1.1	1.0	1.2	0.8	1.0	1.2	1.0	1.1	1.2	1.1	1.1	1.1	1.2	1.2	1.2	1.0	1.3	1.2	1.2	1.1	1.1	1.4
Photon	W-80; 0°	P3	0.1	0.5	0.6	0.7	0.7	1.0	0.9	0.9	1.1	1.1	1.0	1.0	0.9	1.0	1.1	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.0	1.1	1.3	1.2	1.1	1.1	1.4
Photon	W-80; 0°	P5	0.1	0.5	0.6	0.6	0.7	1.3	0.9	0.9	1.1	1.1	1.0	1.0	0.9	1.1	1.0	1.1	1.1	0.6	1.1	1.2	1.1	1.2	0.6	1.2	1.0	1.2	1.3	1.2	1.1	1.0	1.2
Photon	W-80; 60°	P4	0.1	0.6	0.6	0.6	0.7	0.7	0.9	0.9	1.0	1.0	1.0	0.5	0.9	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	1.0	1.1	1.1	1.0	1.2	1.2	1.1	1.0	1.0	1.3
Photon	N-150; 0°	P6	0.1	0.6	0.5	0.5	0.6	0.9	0.8	0.7	0.9	0.9	0.8	0.8	0.7	0.8	0.9	0.7	0.9	0.9	0.8	0.8	0.8	0.9	0.8	0.8	0.8	1.0	0.8	1.0	0.9	0.8	0.9
Photon	S-Cs; 0°	P7	0.1	0.6	0.5	0.6	0.7	1.0	0.7	0.7	0.8	0.8	0.7	0.7	0.8	0.7	0.8	0.8	0.8	1.1	1.0	1.1	1.0	0.8	1.1	1.0	0.9	0.9	0.8	0.8	1.0	1.0	0.9
All			0.1	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0

Response: All			17	39	20	35	24	27	21	33	25	36	44	37	42	05	45	10	47	56	11	02	28	08	01	22	29	38	04	51	All
Beta	Kr-85; 0°	B1	0.2	0.3	0.6	0.6	0.3	1.0	1.0	0.1	0.4	1.0	1.0	0.2	0.2	0.1	0.2	0.7	0.9	0.2	0.1	0.8	1.1	0.2	1.0	0.3	0.0	0.5	1.1	1.3	0.4
Beta	Sr-90/Y-90; 0°	B2	1.4	1.2	1.3	1.3	1.1	1.2	1.3	1.0	1.2	1.3	1.2	1.0	1.1	0.9	1.0	1.5	1.2	1.0	1.0	1.3	1.3	1.1	1.4	1.2	0.7	1.1	1.3	1.2	1.0
Beta	Sr-90/Y-90; 60°	B3	0.8	0.6	0.6	0.7	0.5	0.9	0.8	0.4	0.8	1.1	1.0	0.6	0.5	0.4	0.5	0.6	1.1	0.3	0.5	1.0	1.3	0.4	1.2	0.7	0.2	0.7	1.1	0.9	0.6
Photon	N-20; 0°	P1	1.0	1.0	1.0	1.1	0.9	1.0	1.0	1.5	0.9	1.0	1.1	1.4	1.2	1.5	1.5	1.1	1.0	1.5	1.5	0.9	1.1	1.6	1.1	1.5	0.8	1.5	1.1	1.2	1.0
Photon	W-80; 0°	P2	1.0	1.3	1.0	1.1	1.3	1.0	1.1	1.3	1.1	1.1	1.2	1.4	1.3	1.4	1.5	1.2	1.3	1.4	1.5	1.3	1.1	1.5	1.2	1.5	2.0	1.5	1.4	2.0	1.2
Photon	W-80; 0°	P3	1.1	1.2	1.2	1.1	1.3	1.0	1.0	1.3	1.3	1.1	1.1	1.4	1.4	1.4	1.4	1.3	1.3	1.4	1.4	1.3	1.2	1.5	1.2	1.4	1.9	1.5	1.3	3.4	1.2
Photon	W-80; 0°	P5	0.9	1.2	1.2	1.0	1.3	1.0	1.1	1.3	1.7	1.1	1.1	1.4	1.3	1.4	1.4	1.4	1.2	1.6	1.5	1.4	1.2	1.6	1.2	1.4	1.7	1.5	1.3	3.8	1.2
Photon	W-80; 60°	P4	1.1	1.1	1.0	1.0	1.2	1.0	1.0	1.2	1.4	1.0	1.1	1.3	1.3	1.4	1.3	1.2	1.3	1.4	1.4	1.3	1.2	1.4	1.1	1.5	1.7	1.4	1.4	3.1	1.1
Photon	N-150; 0°	P6	1.0	0.9	0.9	0.9	0.8	0.8	0.8	1.0	0.9	0.8	0.9	1.1	1.2	1.2	1.1	0.9	0.9	1.2	1.2	1.0	0.9	1.1	1.1	1.1	1.5	1.2	1.1	2.0	0.9
Photon	S-Cs; 0°	P7	1.3	1.0	0.9	1.1	0.9	1.0	1.0	1.0	0.6	1.0	1.1	1.0	1.1	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.1	0.9	1.2	1.0	0.9	1.0	1.1	1.3	0.9
All			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.2	2.1	1.0

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Outliers OK values – IC2009-Ext (trumpet)

26 services : 0 outliers

32 services < 2 outliers

Outlier: OK / Trumpet			31	01	54	57	04	02	10	36	13	37	21	40	27	41	03	43	12	44	24	46	06	47	28	48	15	52
Beta	Kr-85; 0°	B1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sr-90/Y-90; 0°	B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sr-90/Y-90; 60°	B3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Photon	N-20; 0°	P1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W-80; 0°	P2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		P3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		P5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	W-80; 60°	P4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	N-150; 0°	P6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	S-Cs; 0°	P7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Outlier: OK / Trumpet			35	45	53	39	20	56	30	22	11	17	38	42	14	23	58	18	05	16	34	55	19	33	25	09	49	32	07	08	29	59	51	26	50	All
Beta	Kr-85; 0°	B1	1	0	2	2	2	0	0	0	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0	2	2	49
	Sr-90/Y-90; 0°	B2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
	Sr-90/Y-90; 60°	B3	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	2	2	2	2	2	2	0	2	2	2	0	2	0	1	0	2	2	28
Photon	N-20; 0°	P1	0	1	0	0	0	0	2	1	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	2	2	15
	W-80; 0°	P2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	2	6
		P3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	0	4	4	4	18
		P5	0	0	0	0	0	2	0	1	0	0	0	0	0	0	2	2	0	0	0	0	0	0	2	0	0	0	2	2	2	2	2	2	2	23
	W-80; 60°	P4	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	2	2	2	11
	N-150; 0°	P6	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	1	2	2	2	2	14
	S-Cs; 0°	P7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	1	0	0	2	7
All			1	1	2	2	2	2	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	5	8	9	10	10	12	16	22	173

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

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Reproducibility IC2009-Ext (Coefficient of variation %)

CV (%)	B1	B2	B3	P1	P2	P3	P5	P4	P6	P7	All
Mean	**13%**	**4%**	**12%**	**4%**	**4%**	**4.2%**	**4%**	**6%**	**5%**	**6%**	**6%**
Std. Dev.	0.23	0.04	0.16	0.04	0.05	0.05	0.05	0.15	0.08	0.13	0.12
Median	**5%**	**3%**	**7%**	**2%**	**2%**	**3.0%**	**1%**	**3%**	**2%**	**2%**	**3%**
Minimum	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Maximum	141%	18%	100%	20%	25%	29%	28%	113%	40%	88%	141%
Count	59	59	59	59	59	59	59	59	59	59	590

CV (%): All			18	46	28	36	38	27	45	01	06	31	15	21	37	55	34	13	43	59	39	54	41	11	24	08	53	07	33	12	16	20	51
Beta	Kr-85; 0°	B1	4	0	5	1	1	1	7	0	4	3	8	4	6	19	13	12	2	0	4	1	0	18	2	6	1	2	4	3	2	2	0
	Sr-90/Y-90; 0°	B2	0	1	1	4	1	2	0	0	1	0	4	2	3	1	0	0	4	11	0	7	3	1	7	6	8	4	4	3	1	8	4
	Sr-90/Y-90; 60°	B3	1	3	2	1	11	3	0	3	3	13	7	9	10	2	0	2	8	11	1	4	22	13	9	4	4	2	5	12	17	3	25
Photon	N-20; 0°	P1	1	1	0	4	2	1	5	1	2	1	0	0	0	3	2	1	1	4	7	3	0	0	2	2	4	4	5	6	6	1	1
	W-80; 0°	P2	1	1	1	0	1	1	2	1	0	2	0	2	2	0	3	1	2	0	6	4	2	0	3	4	8	8	2	6	7	5	6
		P3	1	1	1	1	1	1	2	3	3	1	1	3	1	2	0	2	3	4	6	4	2	3	5	6	2	2	9	3	2	5	8
		P5	0	1	1	1	0	4	1	4	0	1	1	0	1	0	3	1	2	0	5	0	2	0	2	1	1	0	7	3	3	0	1
	W-80; 60°	P4	1	1	1	2	0	3	0	3	2	1	0	2	3	0	1	3	2	0	3	6	2	1	5	7	3	11	5	1	6	5	3
	N-150; 0°	P6	0	0	0	1	0	1	1	1	2	2	1	2	0	0	5	1	4	0	1	1	2	0	2	4	7	9	1	5	1	7	1
	S-Cs; 0°	P7	0	1	3	2	0	3	0	4	6	2	2	0	1	1	0	5	2	4	1	5	1	0	3	1	4	0	3	1	3	12	0
All			1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5	5	5

CV (%): All			05	47	35	26	42	10	40	04	58	23	03	19	32	02	52	30	56	44	49	14	22	48	25	09	57	29	17	50	All
Beta	Kr-85; 0°	B1	18	6	11	15	6	7	12	1	38	1	34	2	1	23	11	5	39	4	4	66	38	68	5	2	141	40	5	7	13
	Sr-90/Y-90; 0°	B2	2	9	5	1	3	7	5	1	15	11	4	5	0	6	5	18	13	9	1	9	2	14	6	1	0	3	1	12	4
	Sr-90/Y-90; 60°	B3	16	5	11	4	21	11	14	5	3	15	8	7	0	27	14	30	17	22	45	4	10	5	6	2	5	100	17	60	12
Photon	N-20; 0°	P1	0	3	1	4	4	2	5	15	1	6	4	2	5	0	9	2	1	6	3	1	16	13	4	1	0	10	20	15	4
	W-80; 0°	P2	5	1	0	5	1	1	0	9	0	6	2	8	12	2	2	4	1	18	5	3	8	5	3	17	1	2	25	3	4
		P3	2	4	3	5	4	4	4	8	0	9	4	2	4	2	6	8	2	3	4	5	7	3	5	1	2	3	25	29	4
		P5	1	8	1	14	5	4	1	8	1	6	1	3	5	5	8	1	1	10	6	2	11	5	4	0	1	4	28	17	4
	W-80; 60°	P4	1	5	7	5	4	2	6	5	1	1	4	10	5	5	11	5	4	10	10	1	12	4	5	113	0	15	18	31	6
	N-150; 0°	P6	2	8	9	0	2	6	3	7	0	4	2	9	40	1	6	2	1	10	34	24	8	4	2	2	1	5	2	29	5
	S-Cs; 0°	P7	4	2	4	1	4	14	7	1	1	3	1	16	1	2	2	4	2	1	3	1	10	4	88	3	2	2	50	28	6
All			5	5	5	5	5	6	6	6	6	6	6	6	7	7	7	8	8	9	12	12	12	12	13	14	15	18	19	23	44

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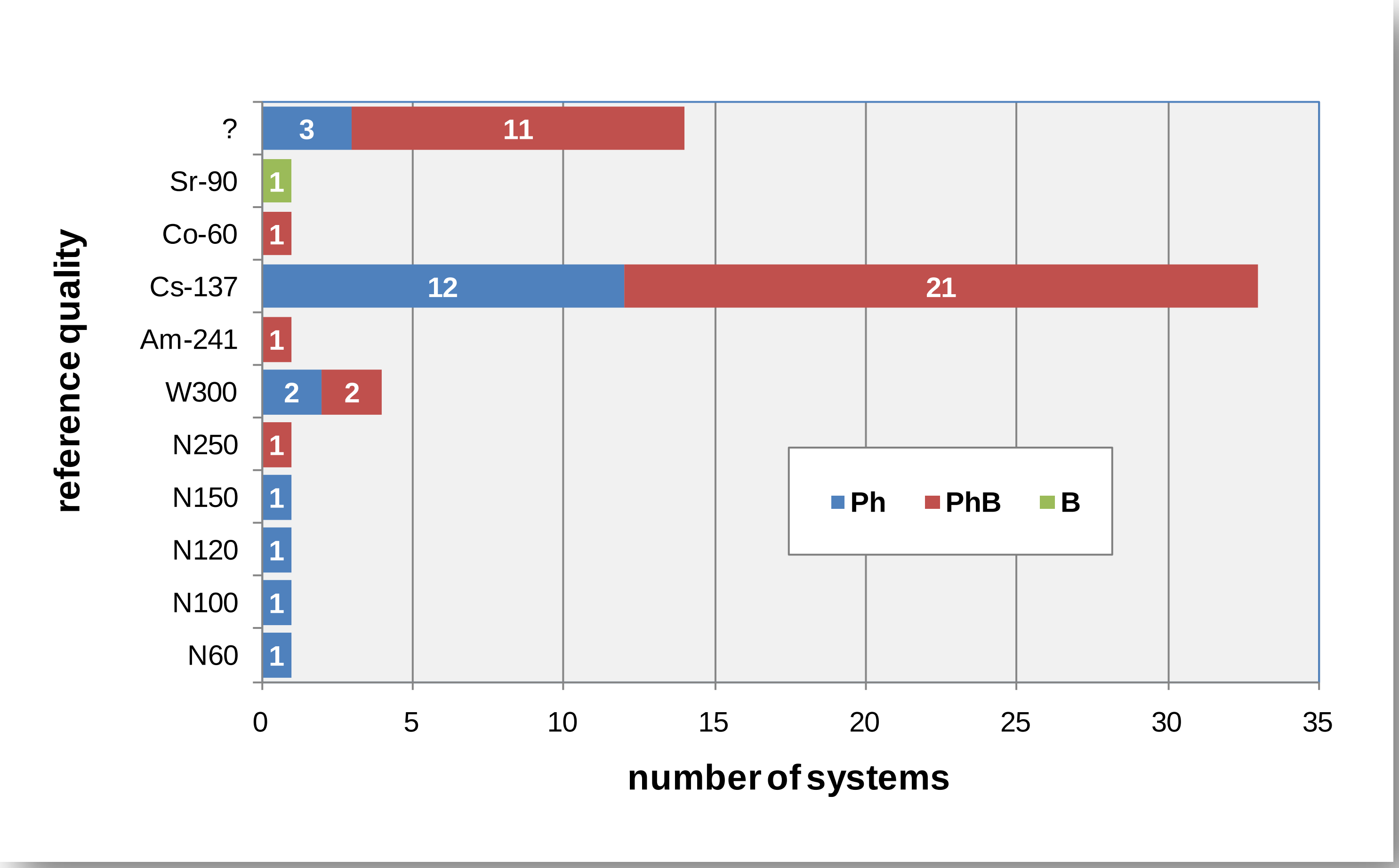
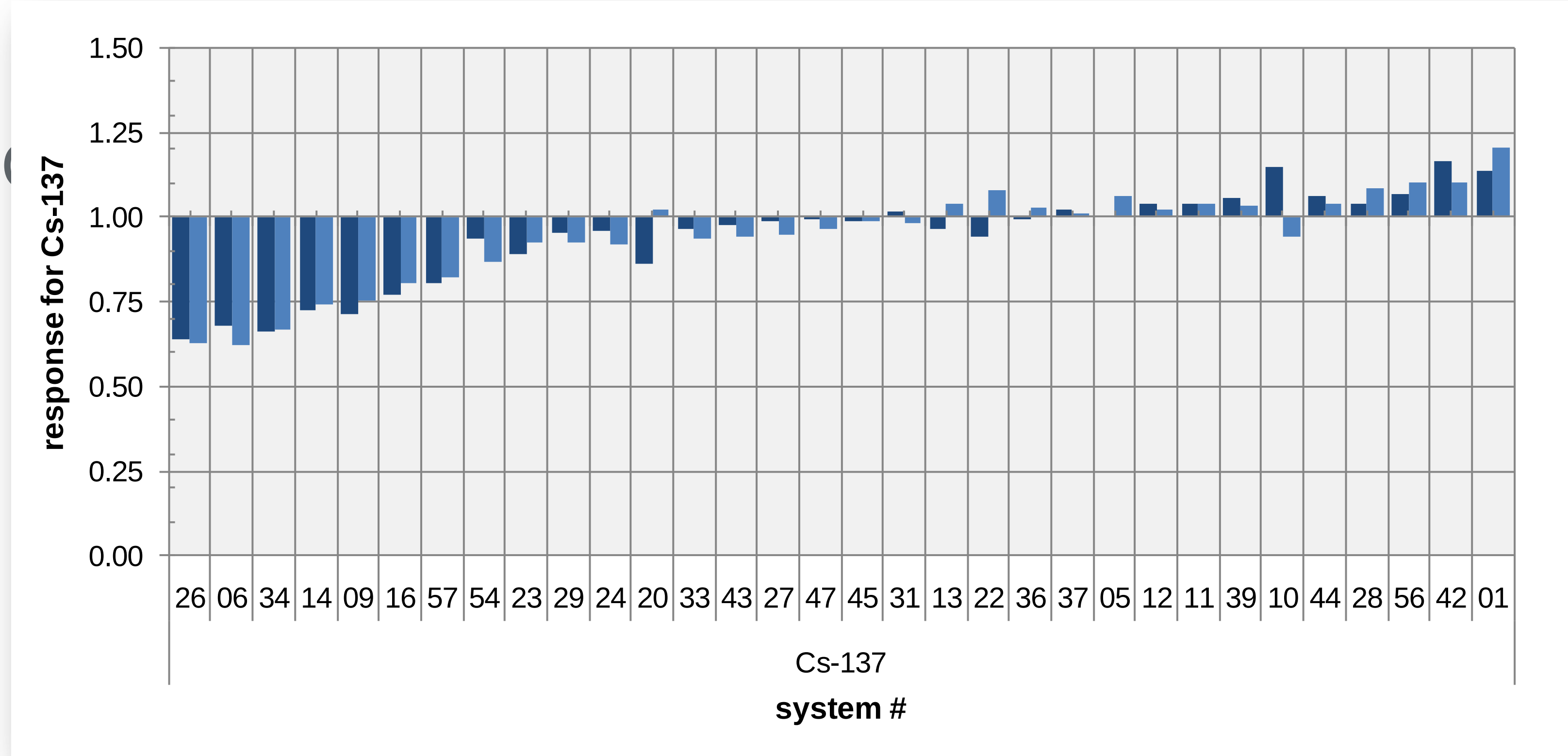
Reference radiation quality (IC2009-Ext)



Response for Cs-137



Only systems with Cs-137 reference radiation quality were considered!

GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

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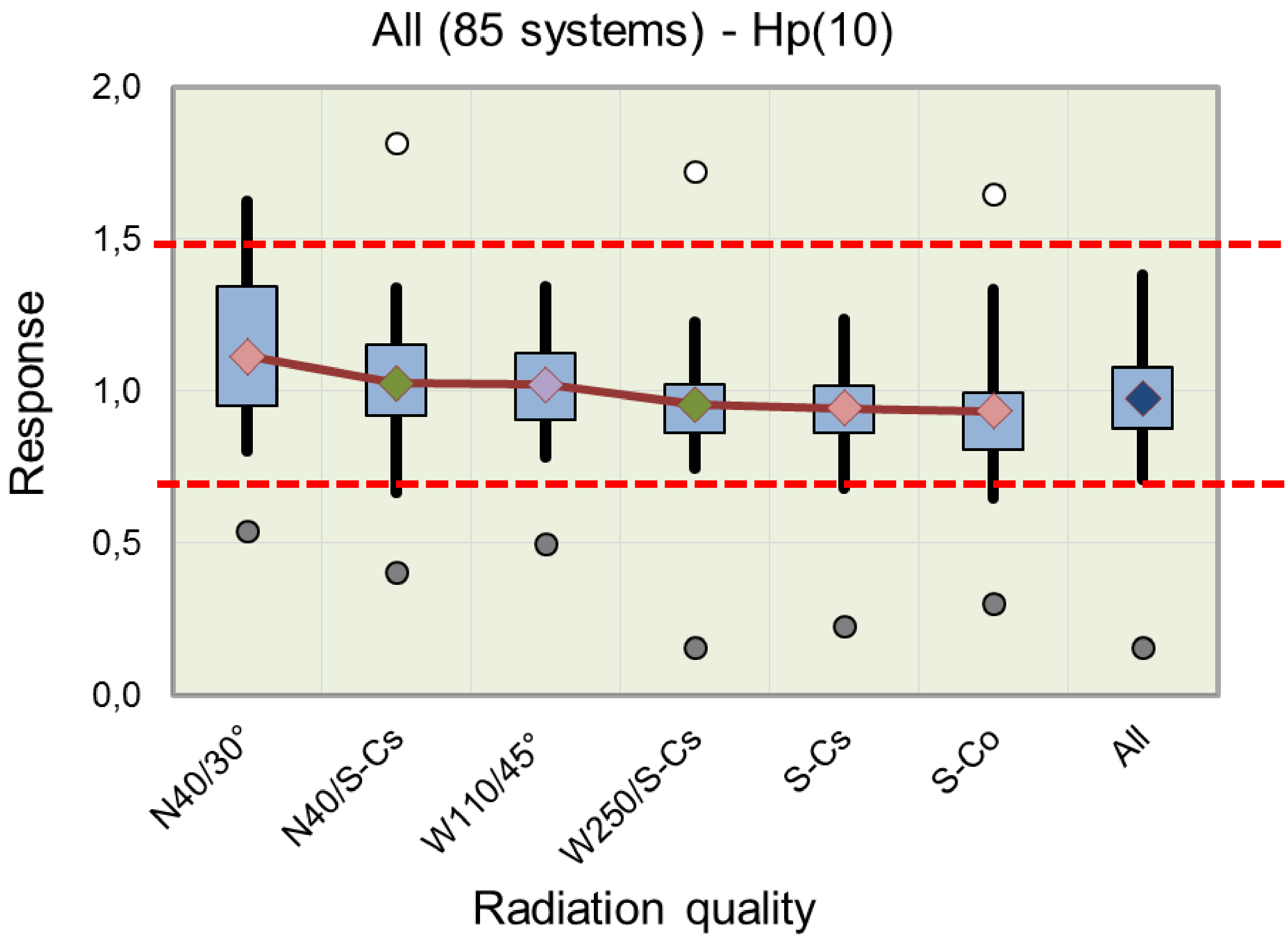
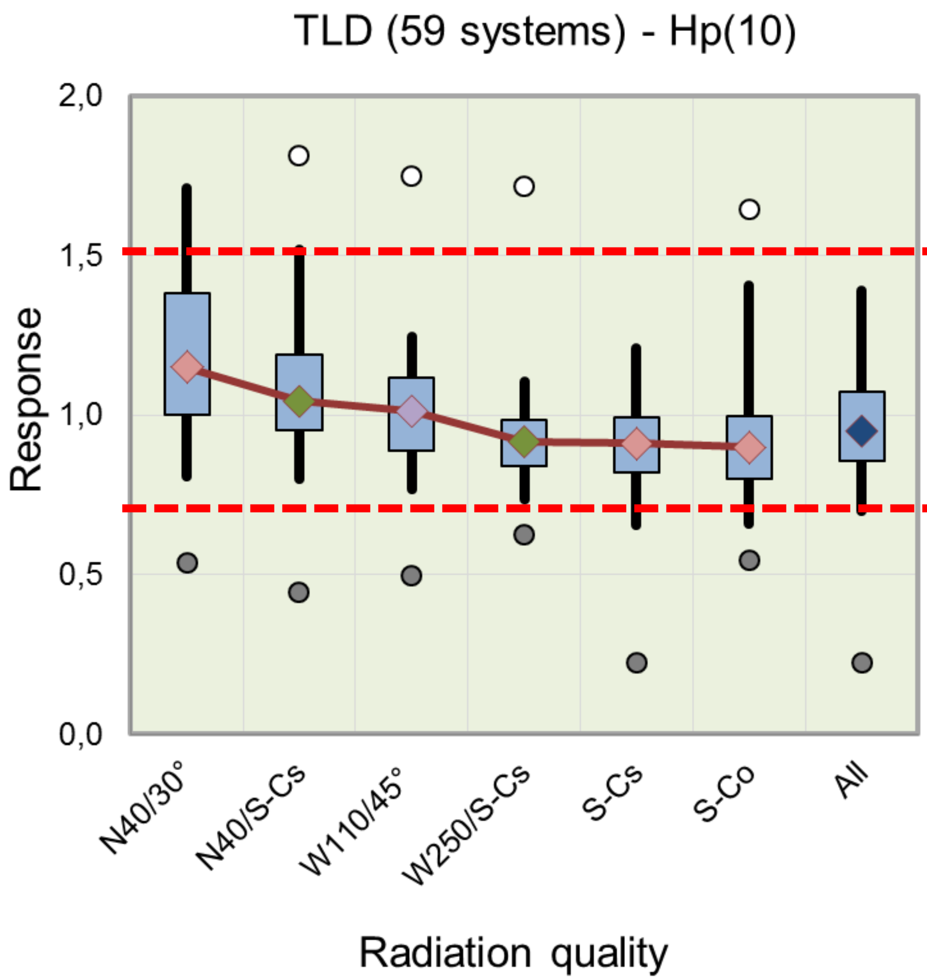
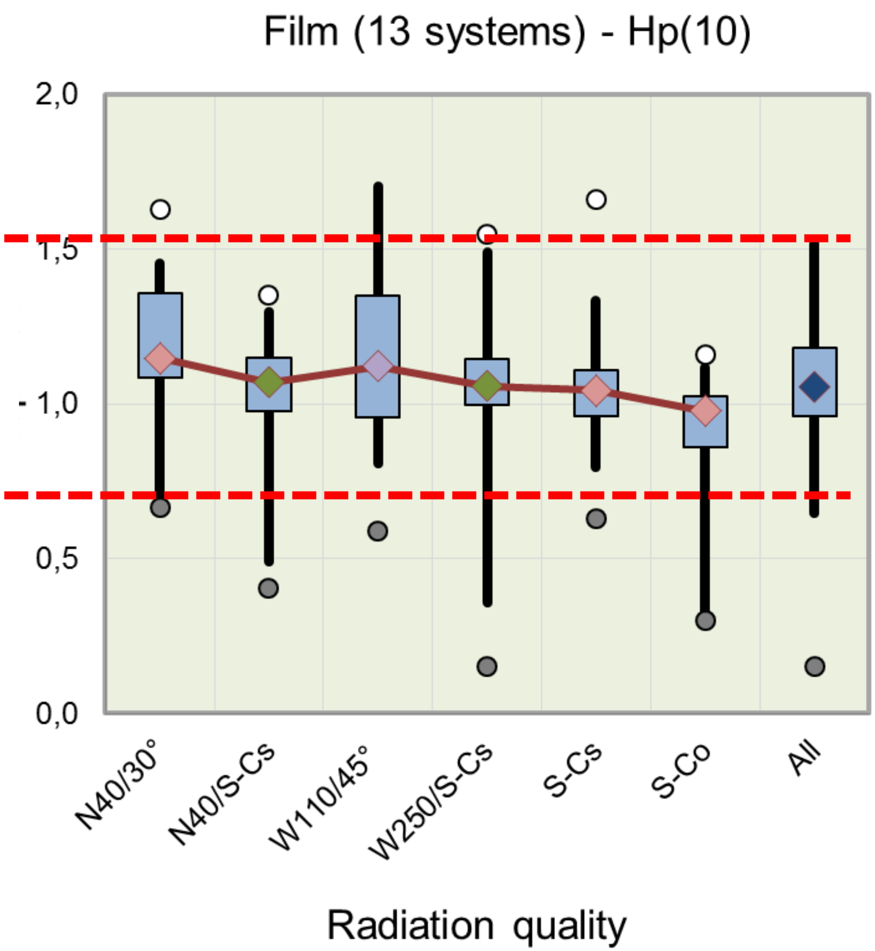
Results: IC2010-WB $H_p(10)$

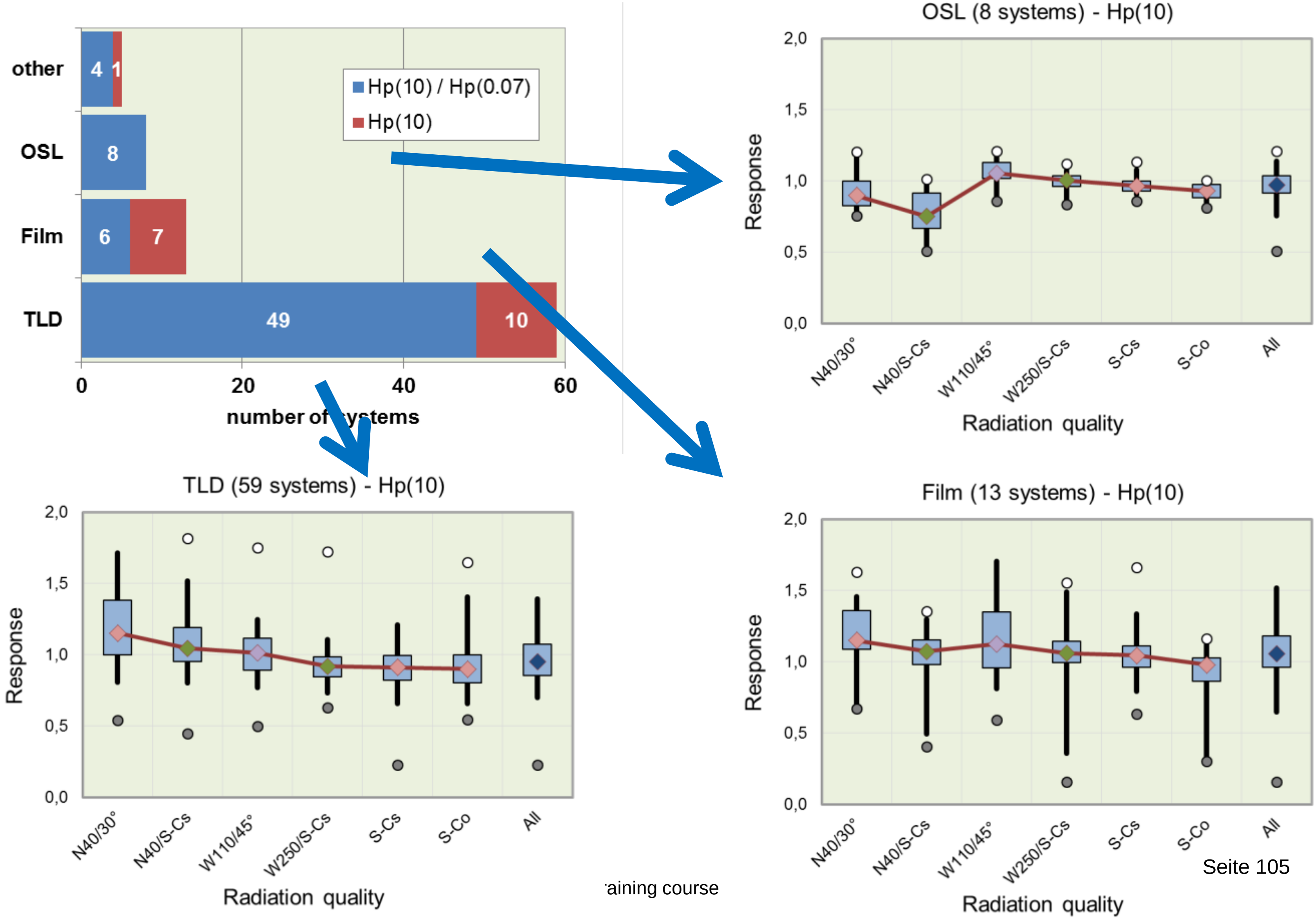


IC2010-WB $H_p(10)$ - TLD vs. Film



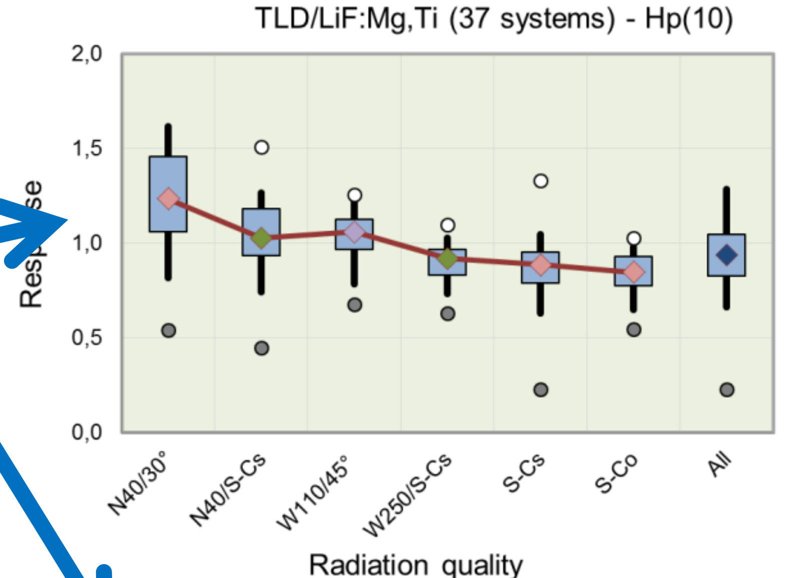


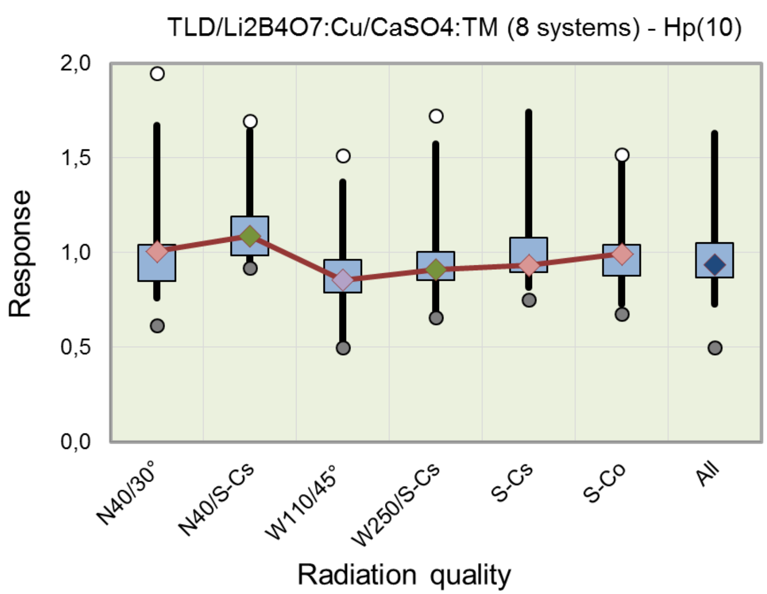
IC2010-WB $H_p(10)$ TLD/Film/OSL

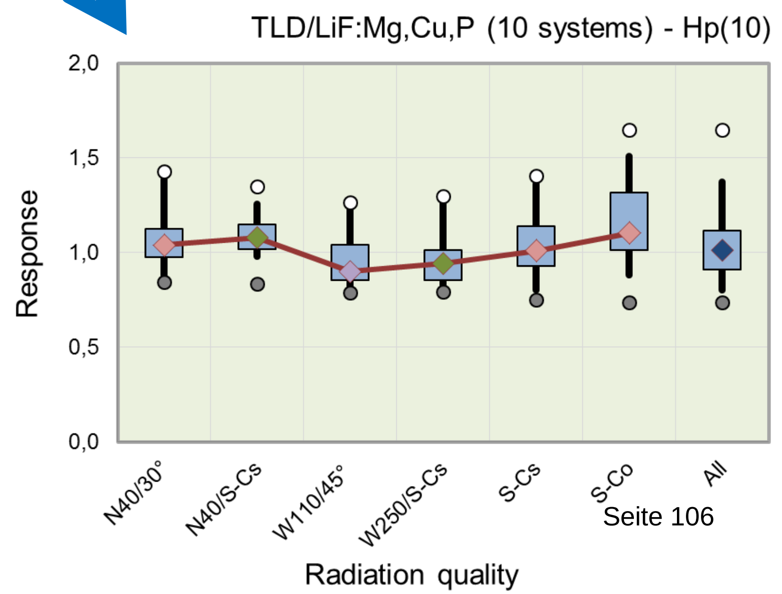


IC2010-WB $H_p(10)$

Type/detector	systems	% of all	% of type
TLD	**59**	**69%**	69%
LiF:Mg,Ti	37	44%	63%
LiF:Mg,Cu,P	10	12%	17%
Li2B4O7:Cu/CaSO4:TM	8	9%	14%

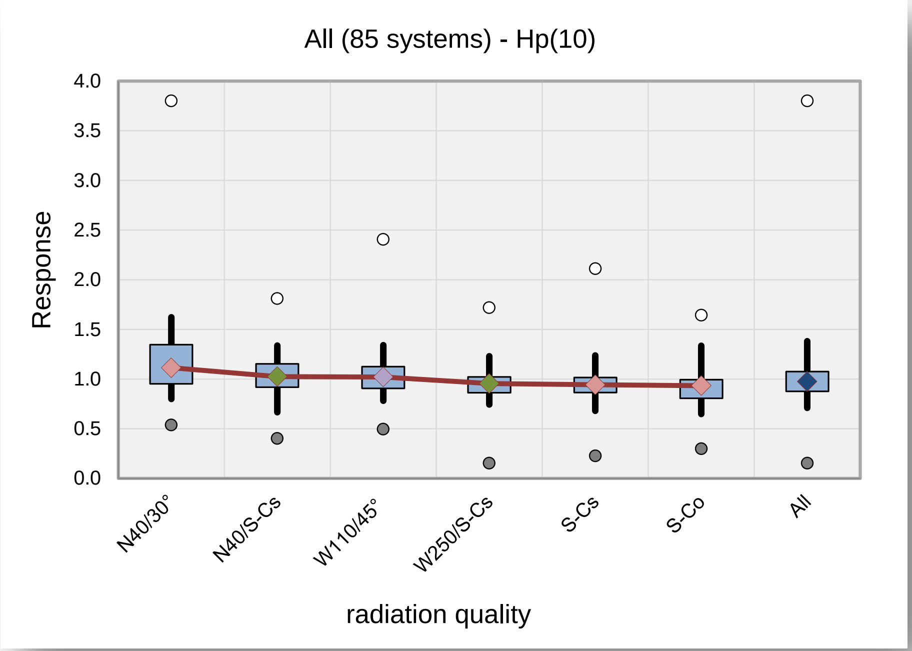


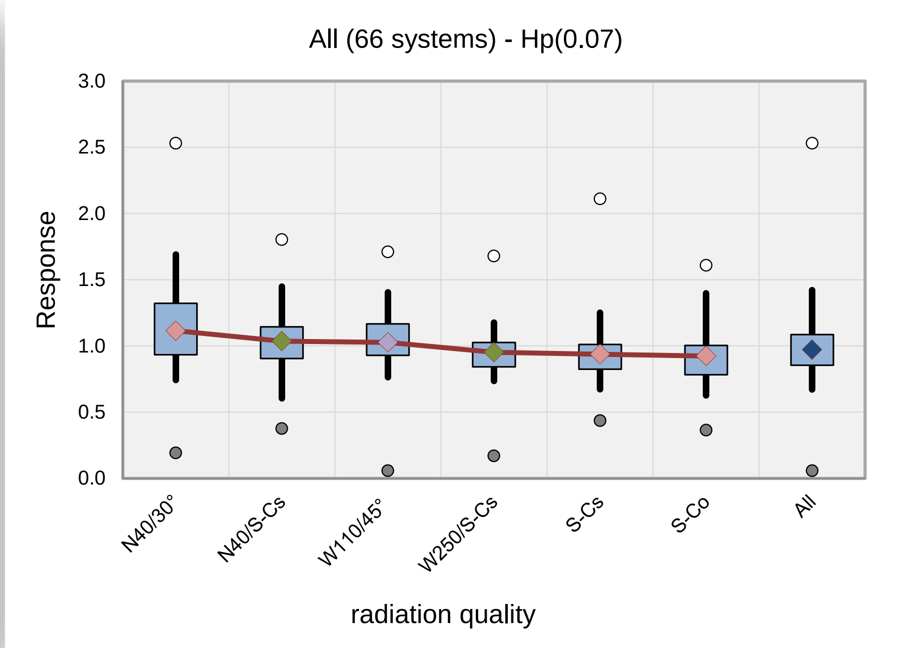




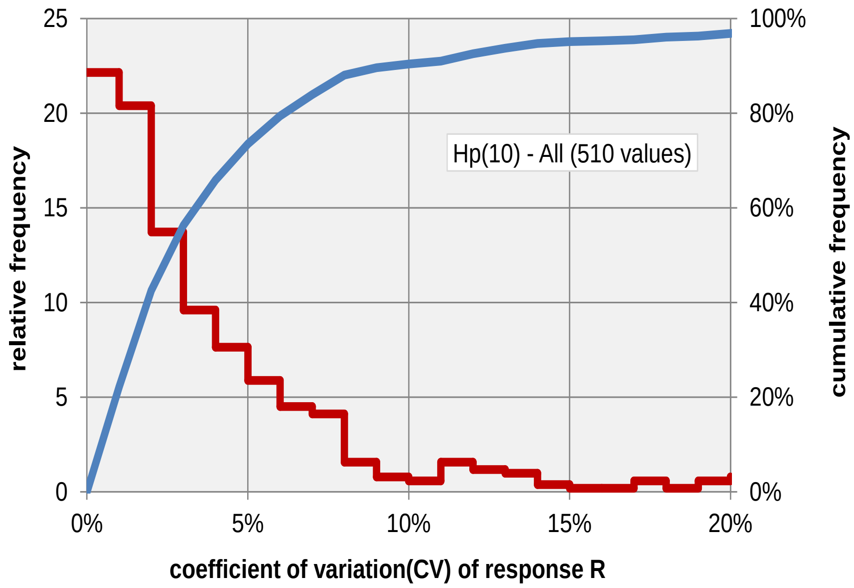
:ourse

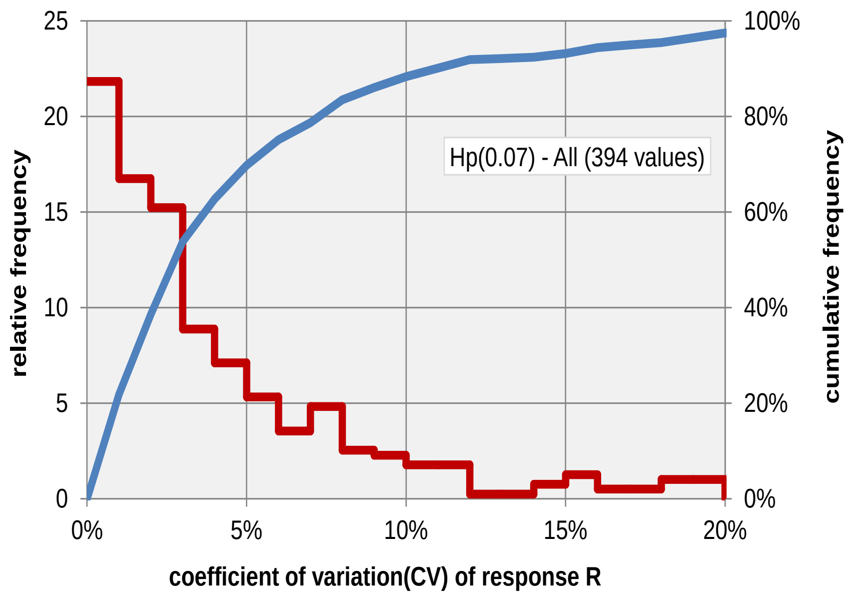
Dose quantity: $H_p(10)$ vs. $H_p(0.07)$



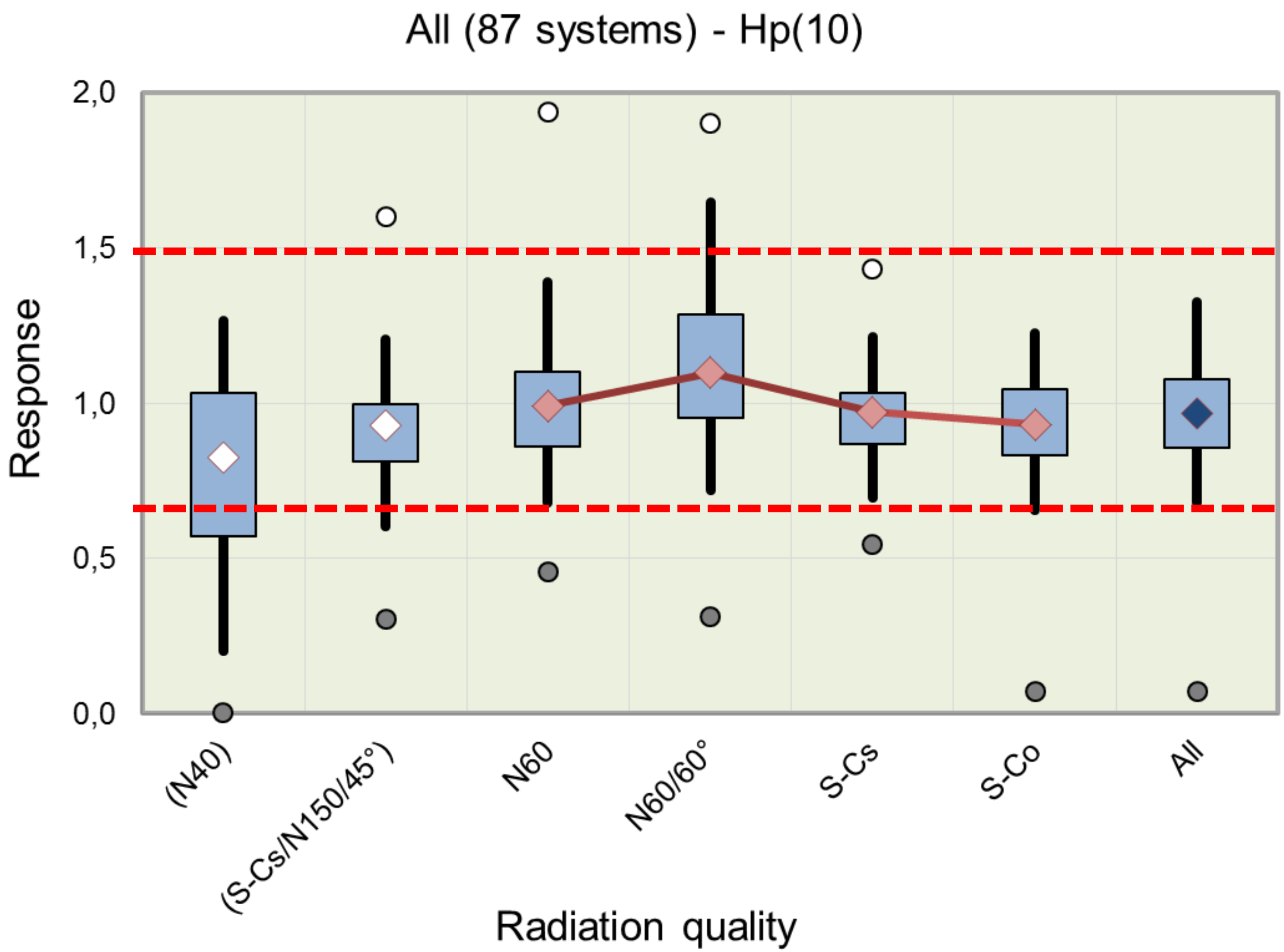


Reproducibility (IC2010-WB)

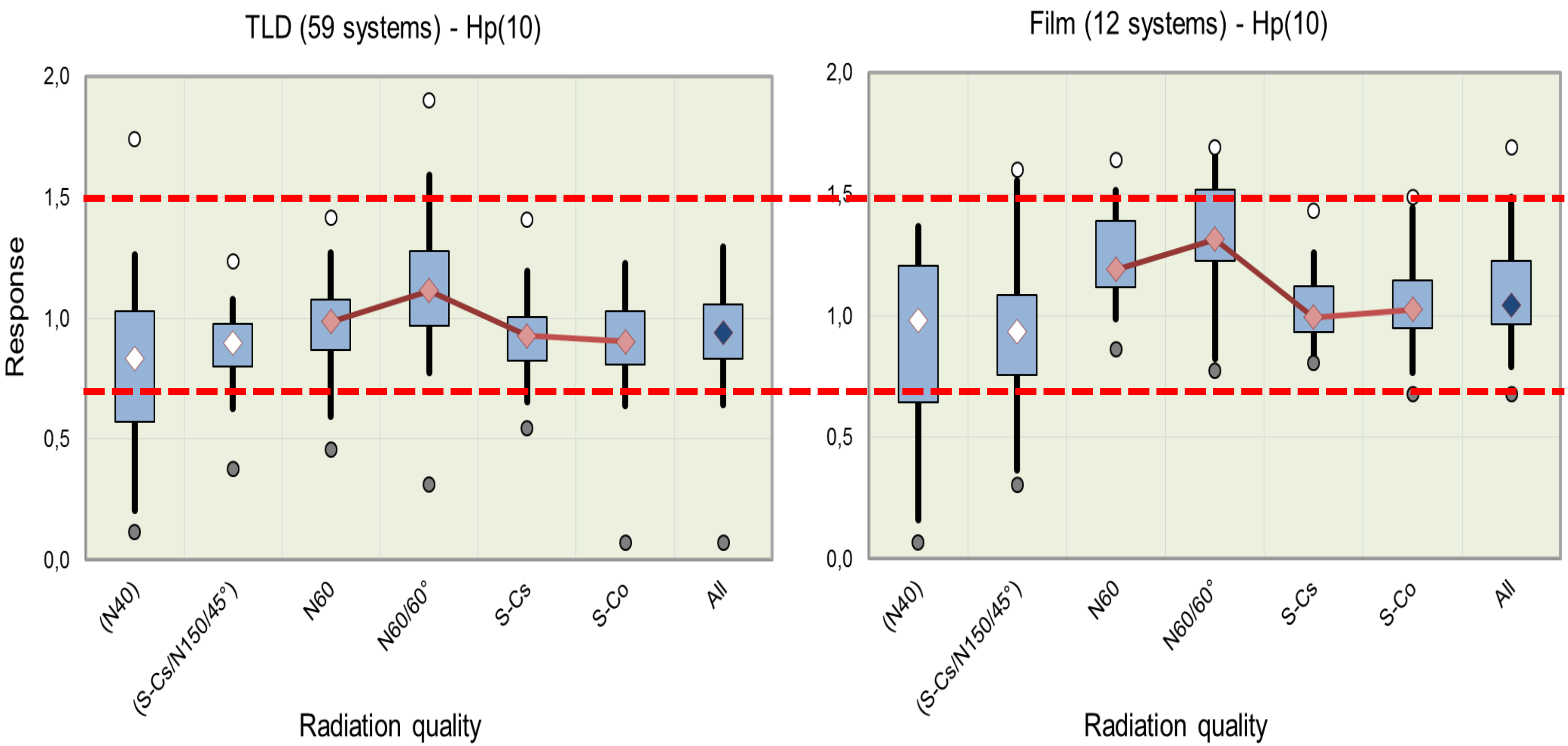




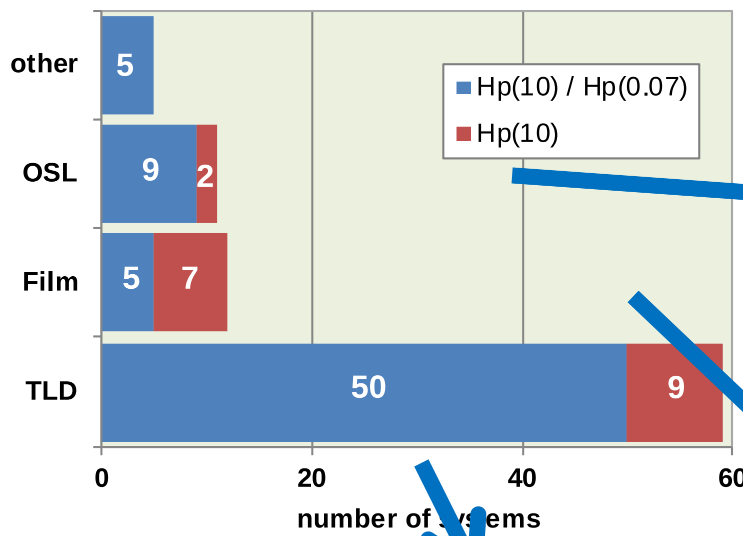
Results: IC2012-WB $H_p(10)$

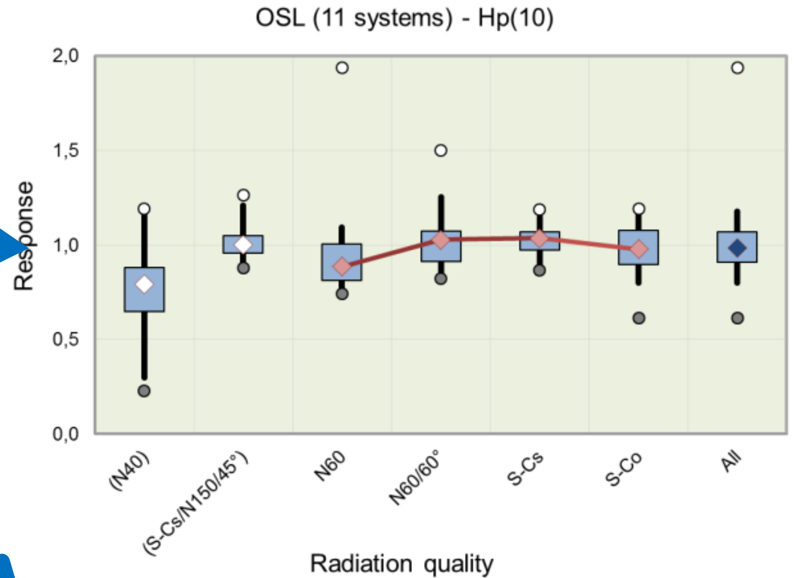


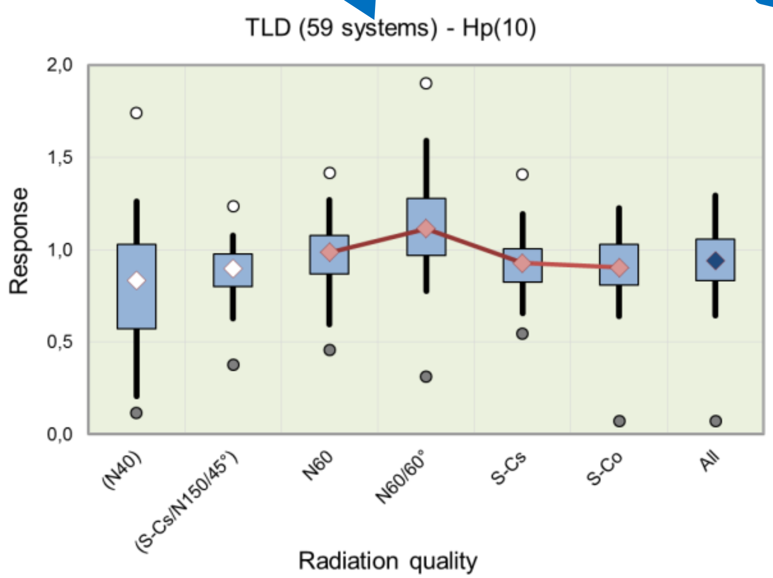
IC2012-WB H_p(10) - TLD vs. Film

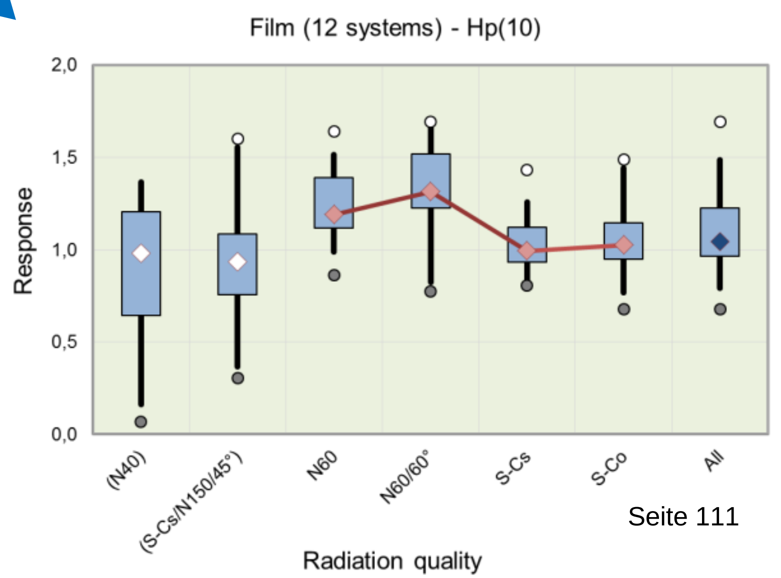


IC2012-WB $H_p(10)$ TLD/Film/OSL

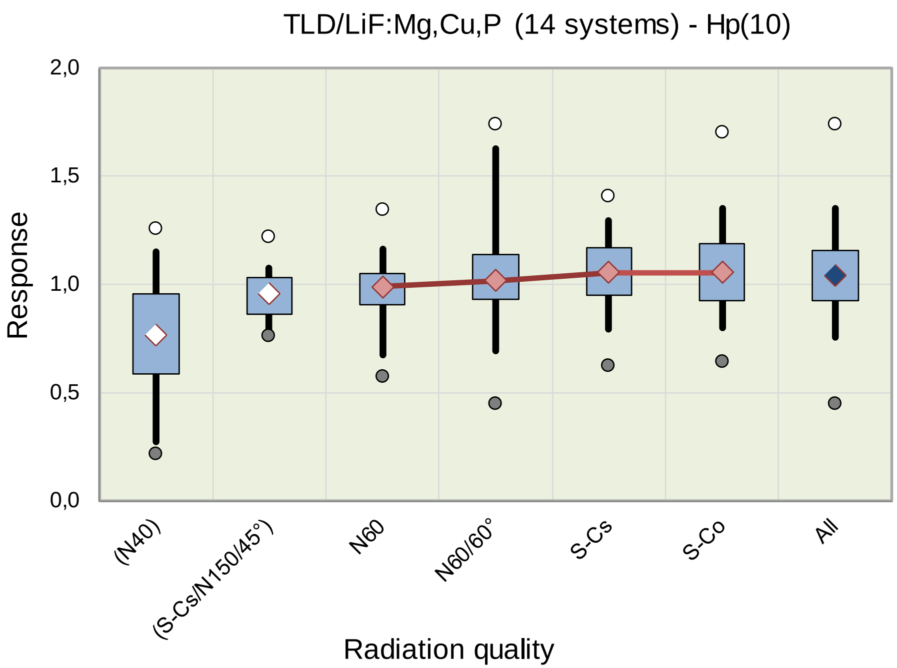


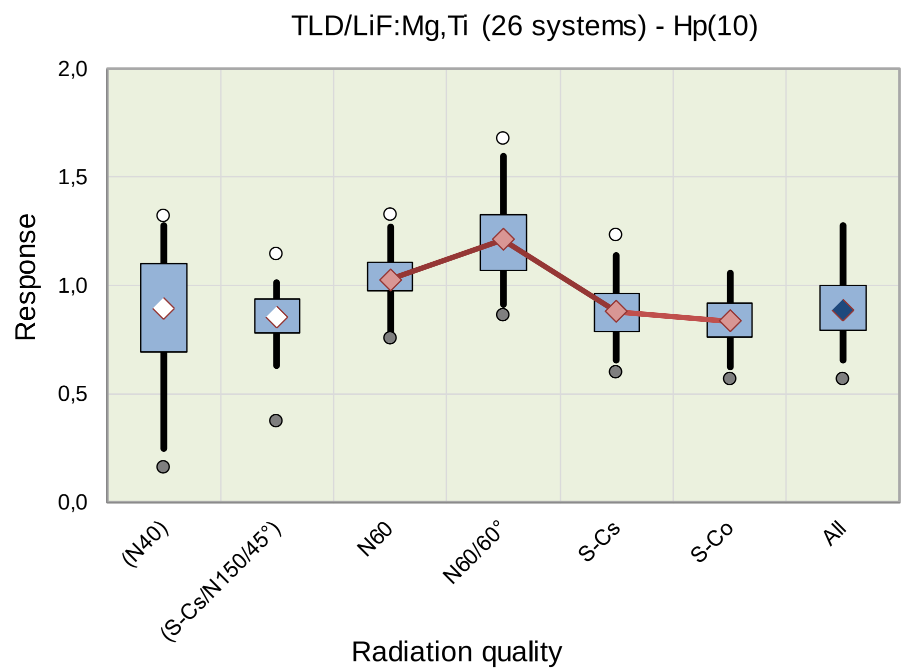






IC2012-WB $H_p(10)$
Different TLD materials





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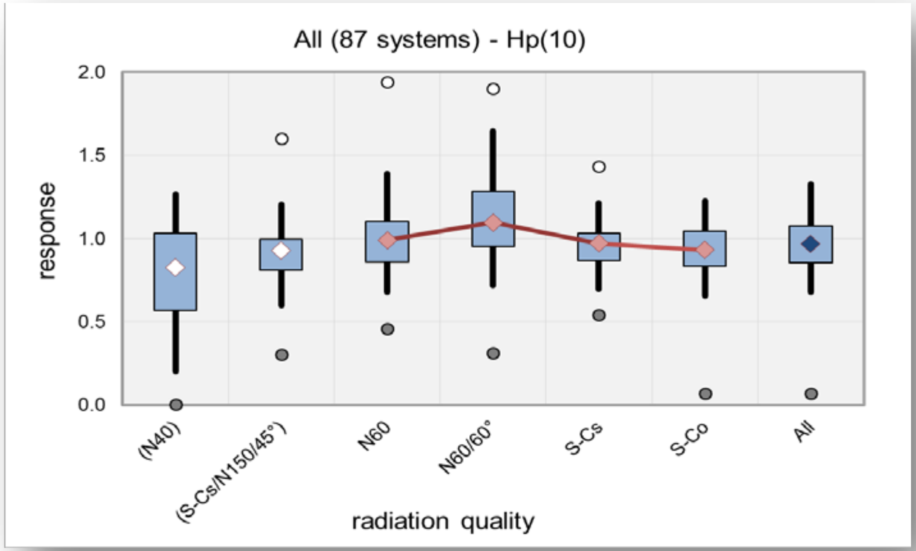
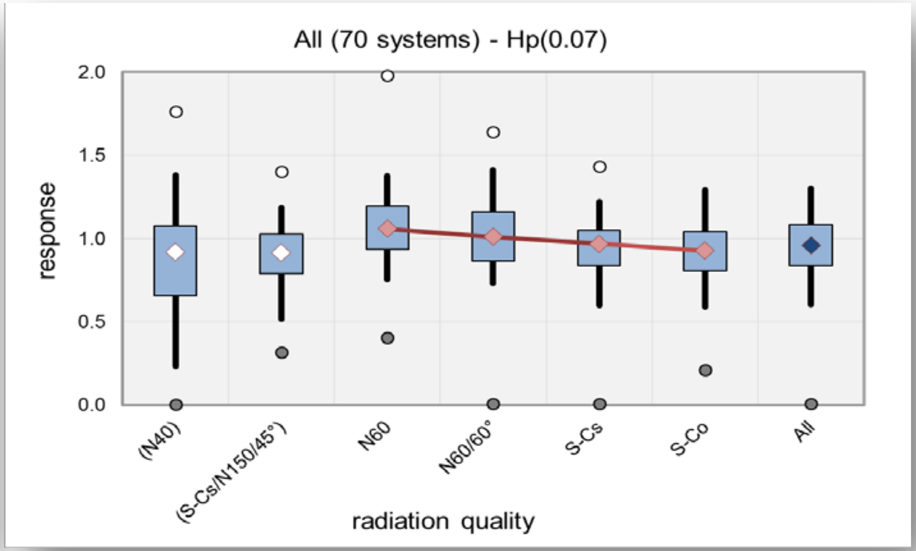
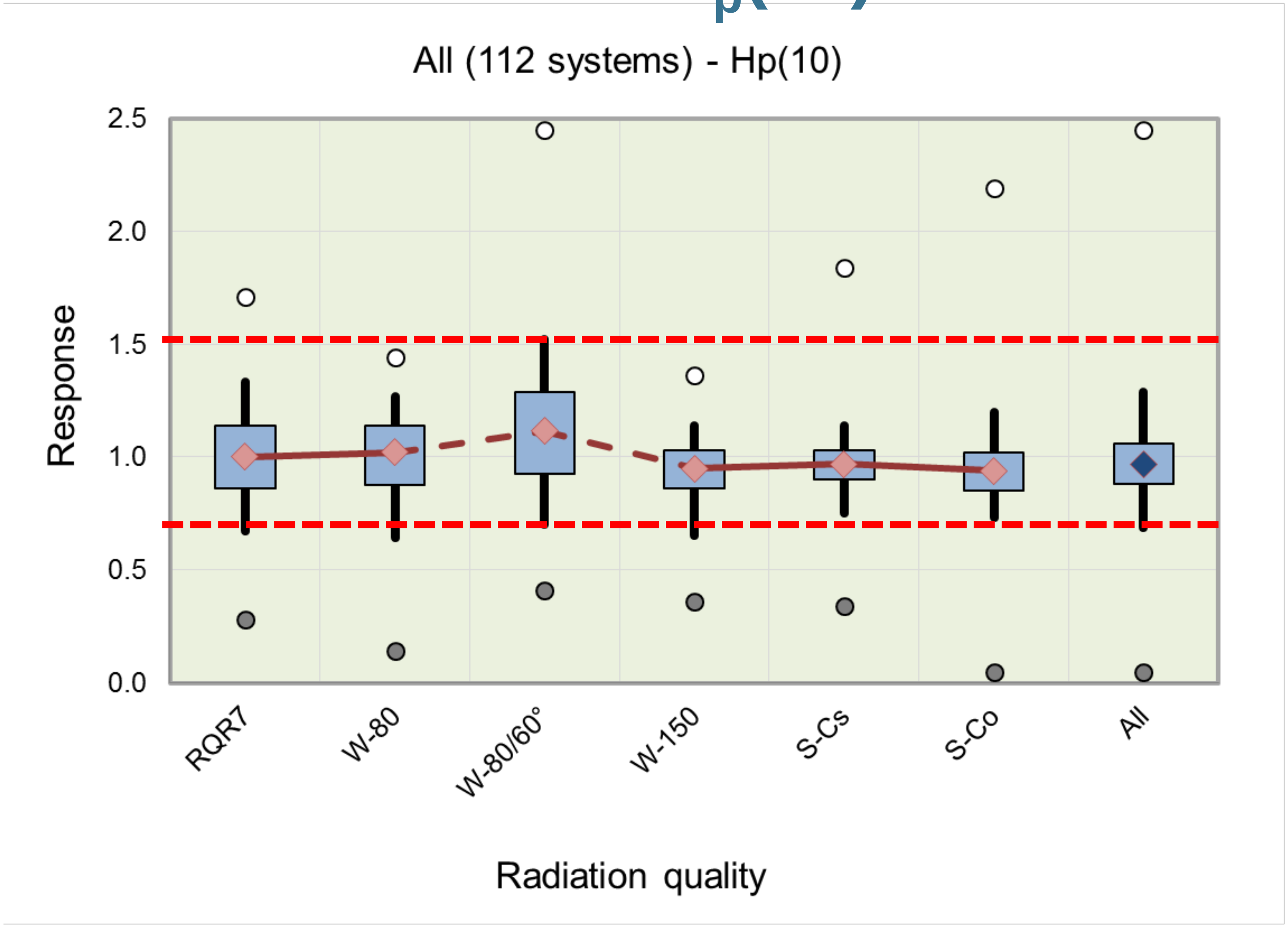
Dose quantity: $H_p(10)$ vs. $H_p(0.07)$

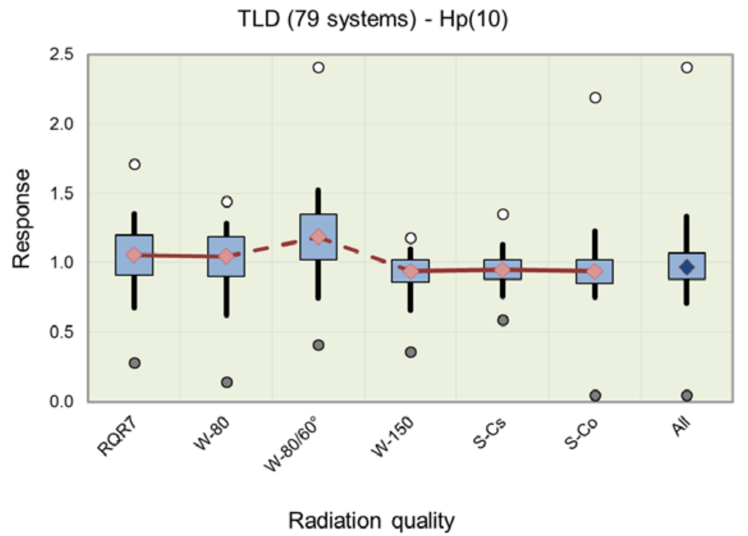


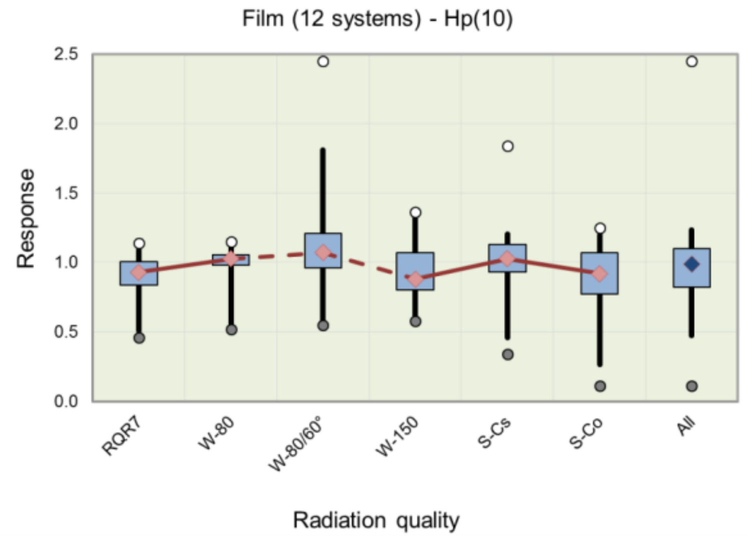


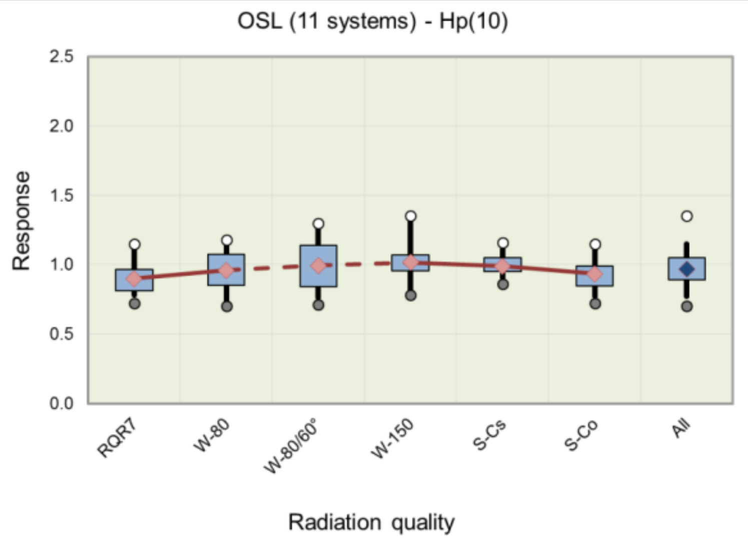
Results: IC2014-WB $H_p(10)$

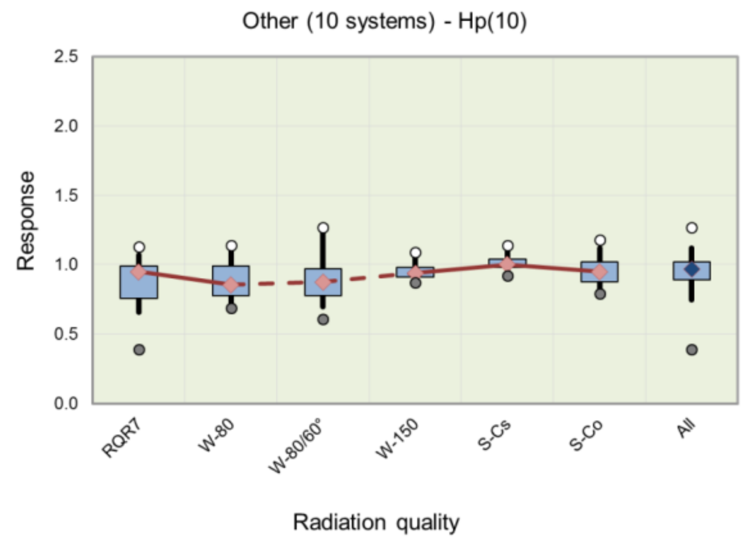


IC2014-WB $H_p(10)$ TLD/Film/OSL/Others









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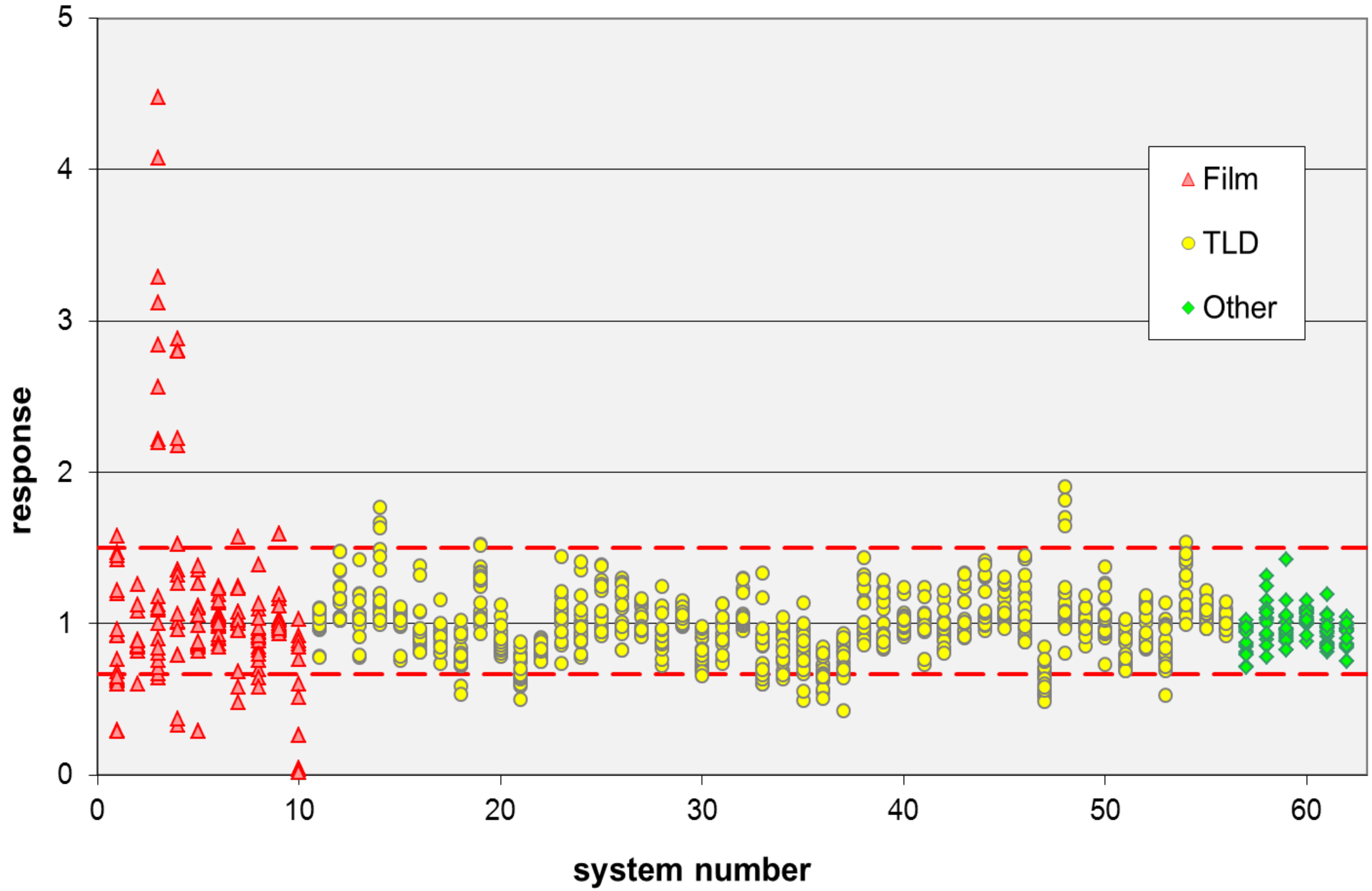
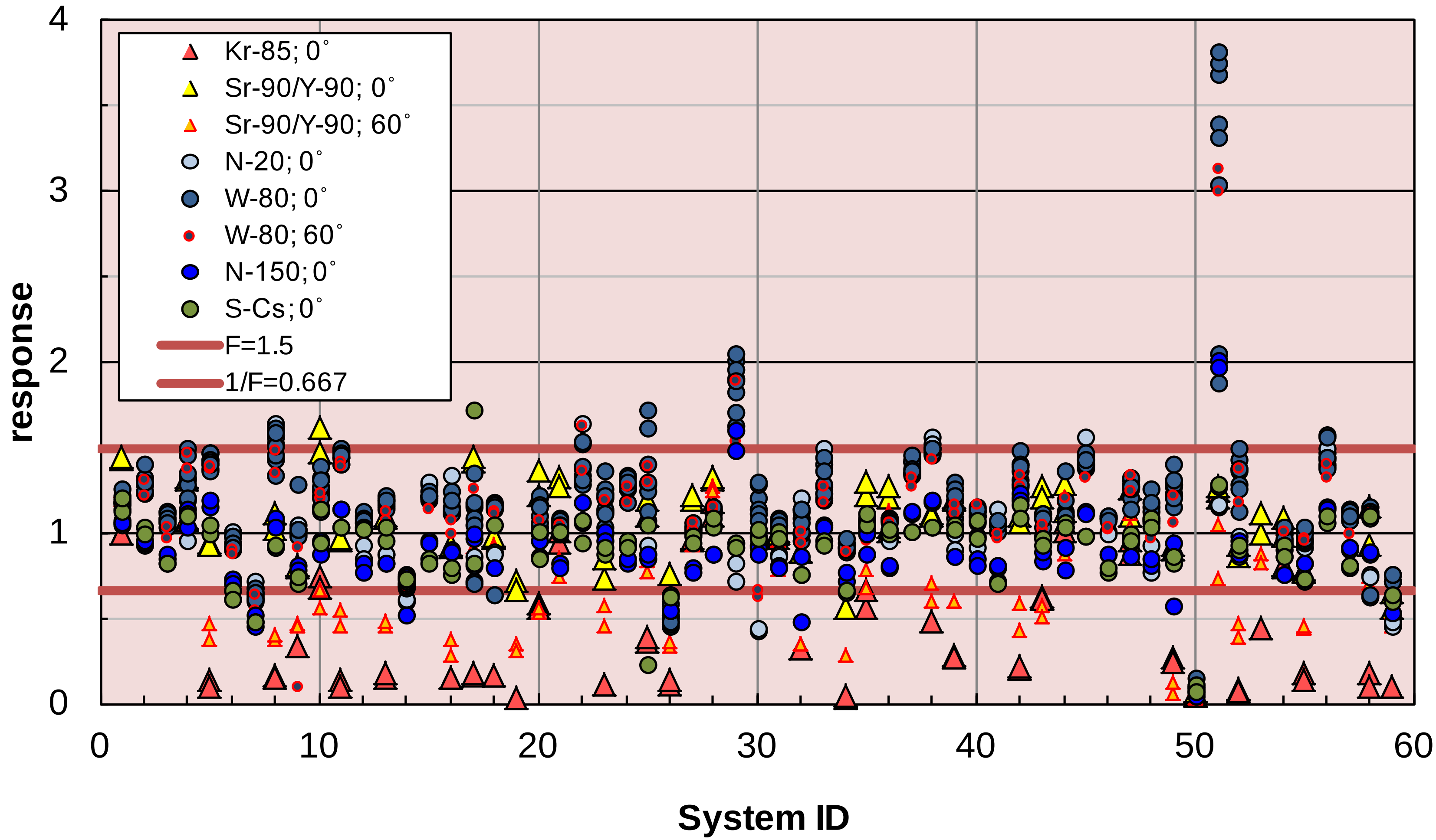
IC2008-WB



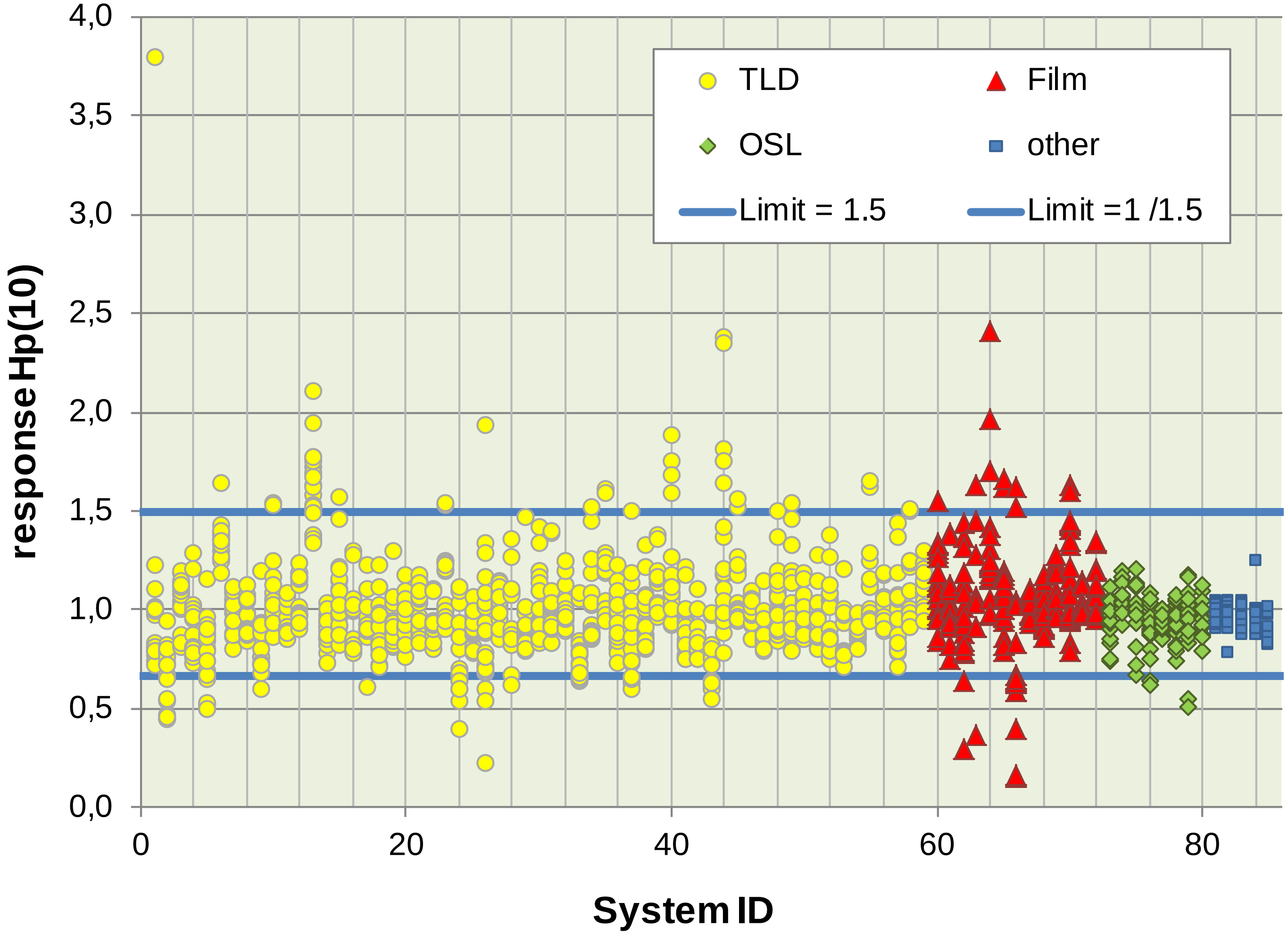
5
4
3
2
1
0
response
0
10
20
30
40
50
60
system number
Film
TLD
Other

IC2009-EX



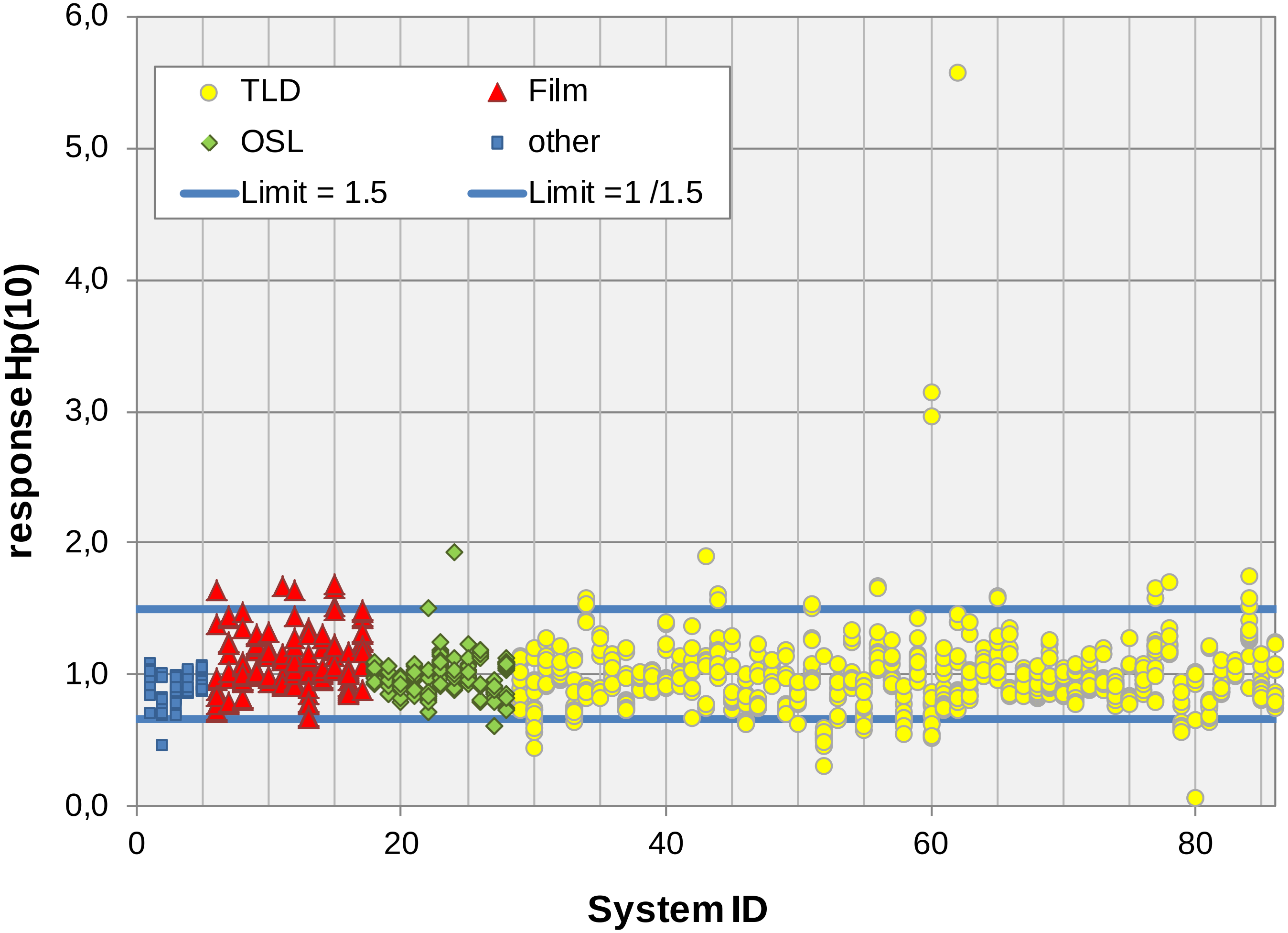
Kr-85; 0˚
Sr-90/Y-90; 0˚
Sr-90/Y-90; 60˚
N-20; 0˚
W-80; 0˚
W-80; 60˚
N-150; 0˚
S-Cs; 0˚
F=1.5
1/F=0.667
response
System ID
0
1
2
3
4
0
10
20
30
40
50
60

IC2010-WB



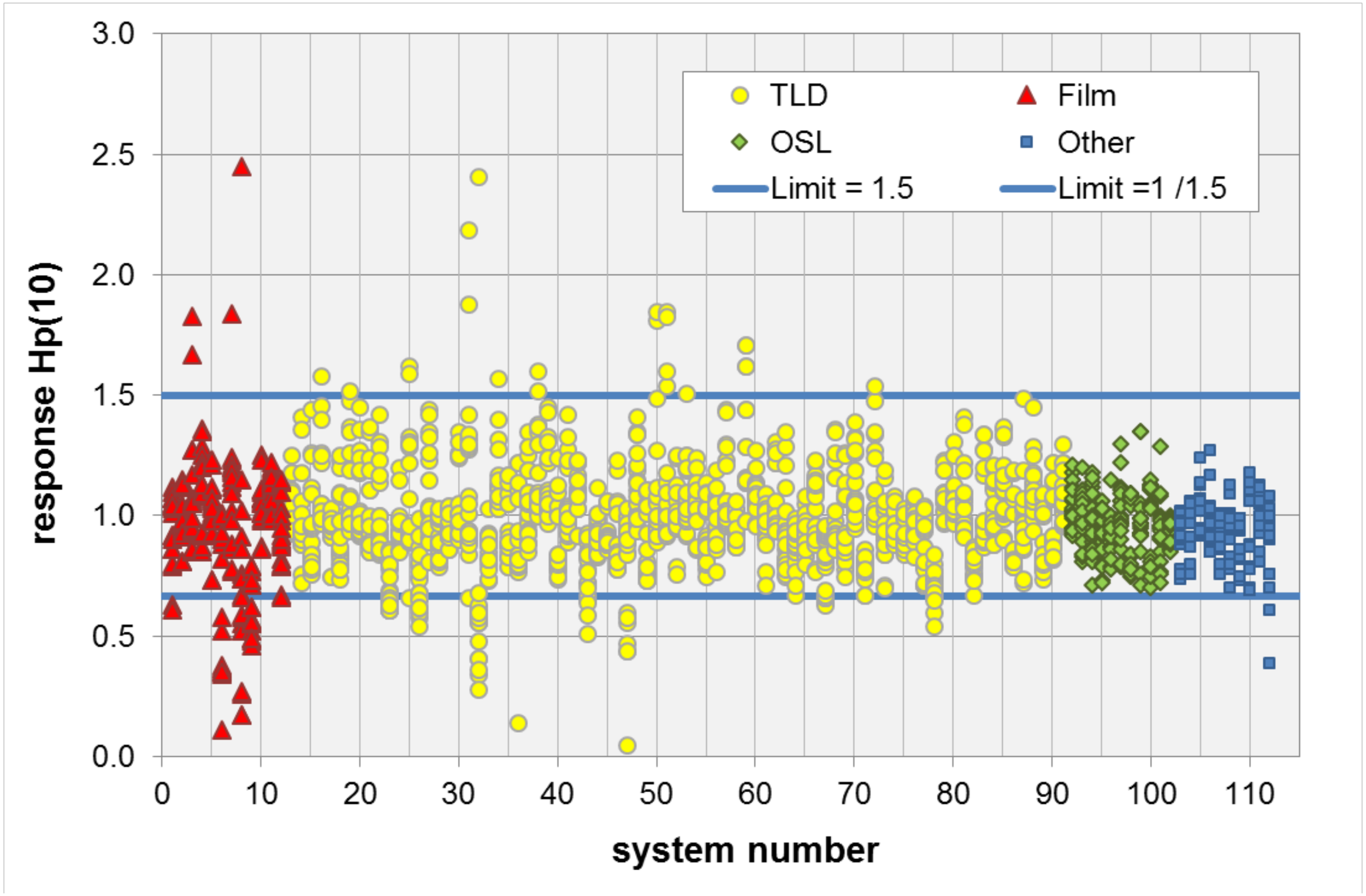
4,0
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0,0
0
20
40
60
80
response Hp(10)
System ID
TLD
Film
OSL
other
Limit = 1.5
Limit =1 /1.5

IC2012-WB



TLD
Film
OSL
other
Limit = 1.5
Limit =1 /1.5
6,0
5,0
4,0
3,0
2,0
1,0
0,0
response Hp(10)
0
20
40
60
80
System ID

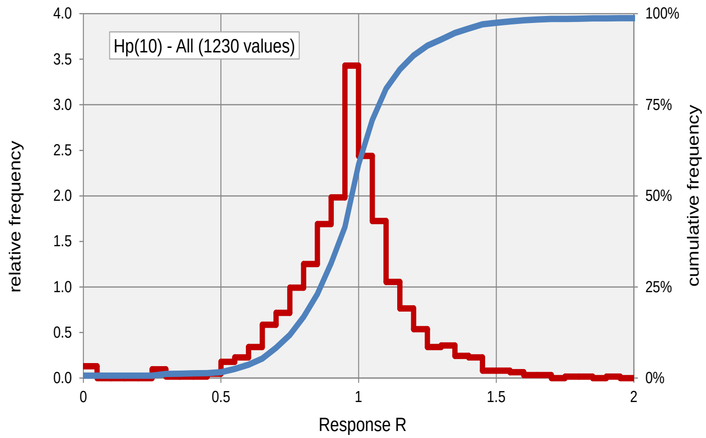
IC2014-WB



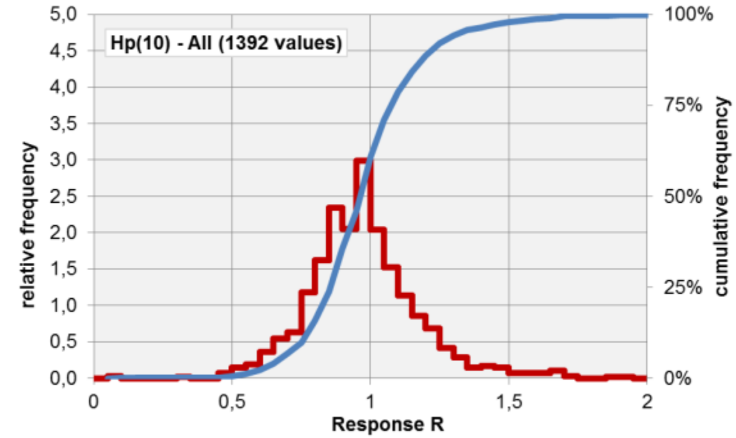
3.0
2.5
2.0
1.5
1.0
0.5
0.0
response Hp(10)
0
10
20
30
40
50
60
70
80
90
100
110
system number
TLD
Film
OSL
Other
Limit = 1.5
Limit =1 /1.5

Frequency distribution WB 2008-2014 $H_p(10)$

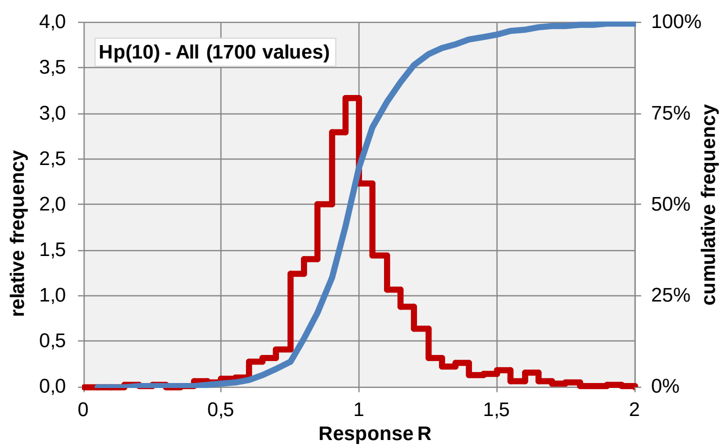
IC 2008



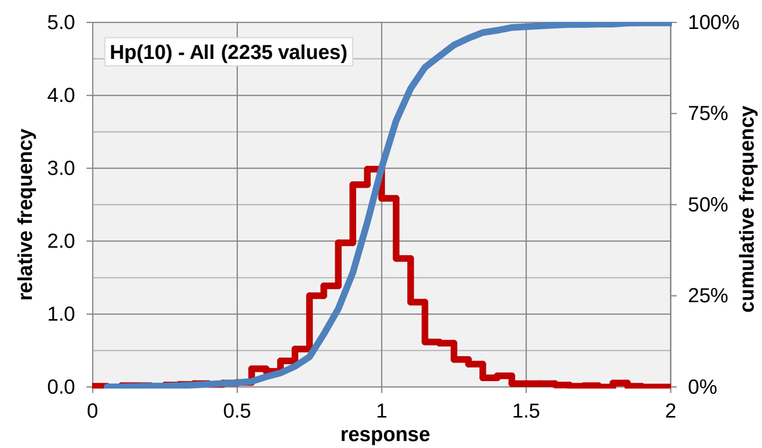
IC 2012



IC 2010

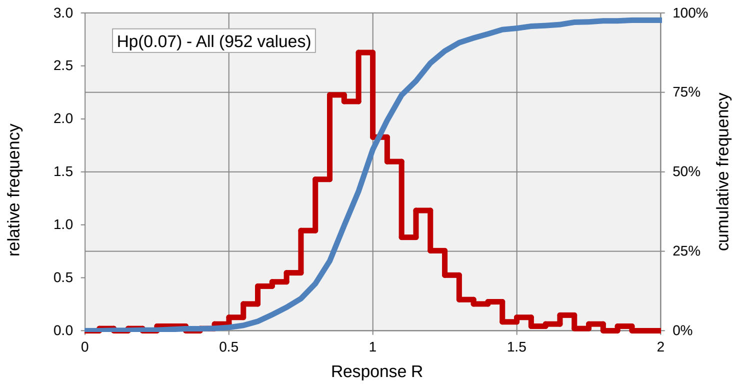


IC 2014

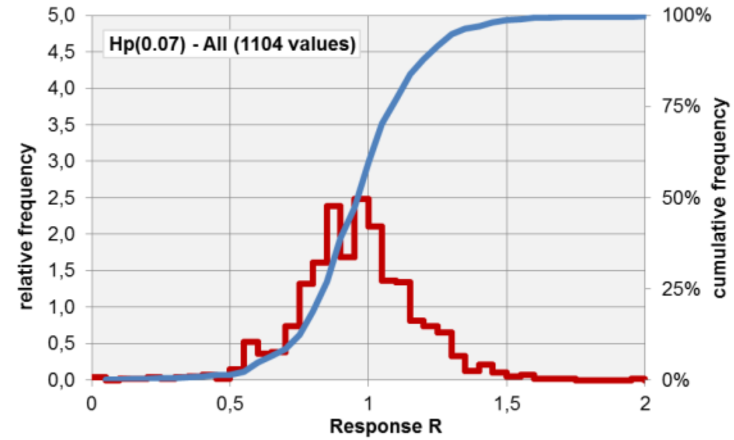


Frequency distribution WB 2008-2014 $H_p(0,07)$

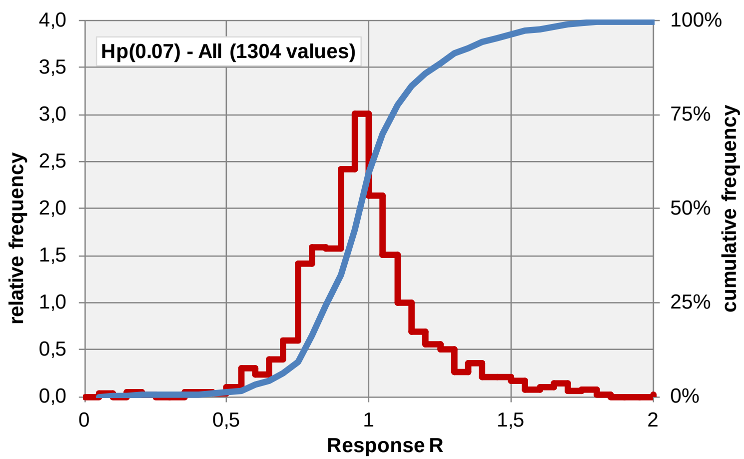
IC 2008



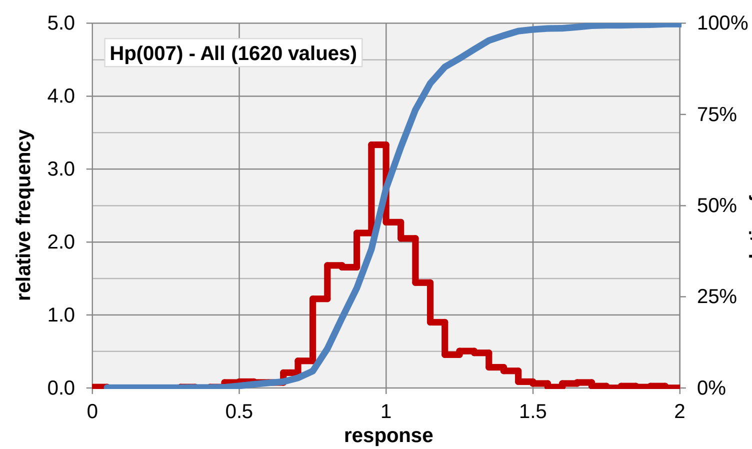
IC 2012



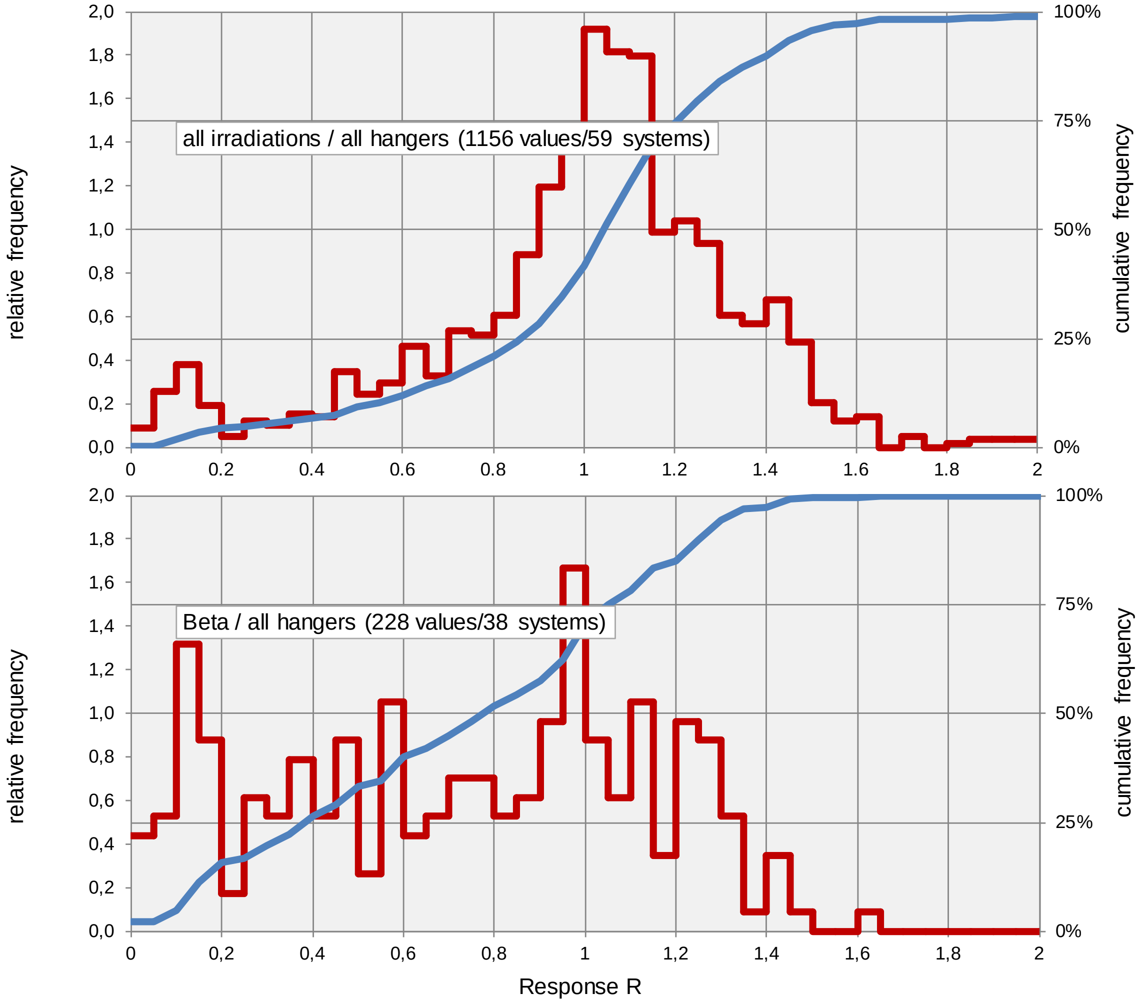
IC 2010



IC 2014



IC2009-Ext



all irradiations

beta irradiations

Outliers

IC 2008

Hp(10) Outliers/Tr	Quality	Film	TLD	Other	All
X-ray	N60; 0°	35%	2%	0%	**7%**
	N60; 45°	50%	8%	8%	**15%**
	N150; 45°	20%	4%	0%	**6%**
Gamma	S-Cs; 0°	15%	3%	0%	**5%**
	S-Co; 0°	20%	7%	0%	**8%**
Mixed	N60; 0° + S-Cs; 0°	45%	0%	0%	**7%**
	S-Cs; 0° + N60; 0°	20%	5%	0%	**7%**
All		**25%**	**4%**	**1%**	**7%**

IC 2012

Outliers / Trumpet						
Quantity	Quality	TLD	Film	OSL	other	All
Hp(10)	S-Cs	4%	0%	0%	0%	3%
	S-Co	8%	0%	2%	5%	6%
	N60	8%	4%	5%	0%	6%
	N60/60°	14%	25%	0%	0%	13%
	All	8%	4%	2%	3%	6%

IC 2010

Outliers / Trumpet						
Quantity		TLD	Film	OSL	other	All
Hp(10)	N40/30°	10%	4%	0%	0%	8%
	N40/S-Cs	7%	8%	19%	0%	8%
	W110/45°	2%	17%	0%	0%	4%
	W250/S-Cs	2%	15%	0%	0%	4%
	S-Cs	4%	1%	0%	0%	3%
	S-Co	8%	19%	0%	0%	8%
Hp(10) All		5%	8%	2%	0%	5%

IC 2014

Outliers / Trumpet						
Quantity	Quality	TLD	Film	OSL	Other	All
Hp(10)	RQR7	5%	8%	0%	10%	5%
	W-80	6%	8%	0%	0%	5%
	W-80/60°	8%	25%	0%	5%	9%
	W-150	5%	17%	0%	0%	5%
	S-Cs	1%	14%	0%	2%	3%
	S-Co	5%	24%	0%	0%	6%
	All	4%	17%	0%	2%	5%

Whole body dosemeters (IC2008)

Ring dosemeters (IC2009)

Wrist dosemeters (IC2009)

Finger tip dosemeters (IC2009)

Whole body dosemeters (IC2014)

IC2012- Neutrons organisation group

NEUDOS 12

NEUTRON AND ION DOSIMETRY SYMPOSIUM

EURADOS

IC2012n results

David Thomas, Elena Fantuzzi, Marie-Anne Chevallier, Rodolfo Cruz-Suarez, Marlies Luszik-Bhadra, Sabine Mayer, Rick Tanner , Filip Vanhavere

IC2012n Participant Meeting, NEUDOS12

4th June 2013

ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development

IAEA

IRSN

NPL National Physical Laboratory

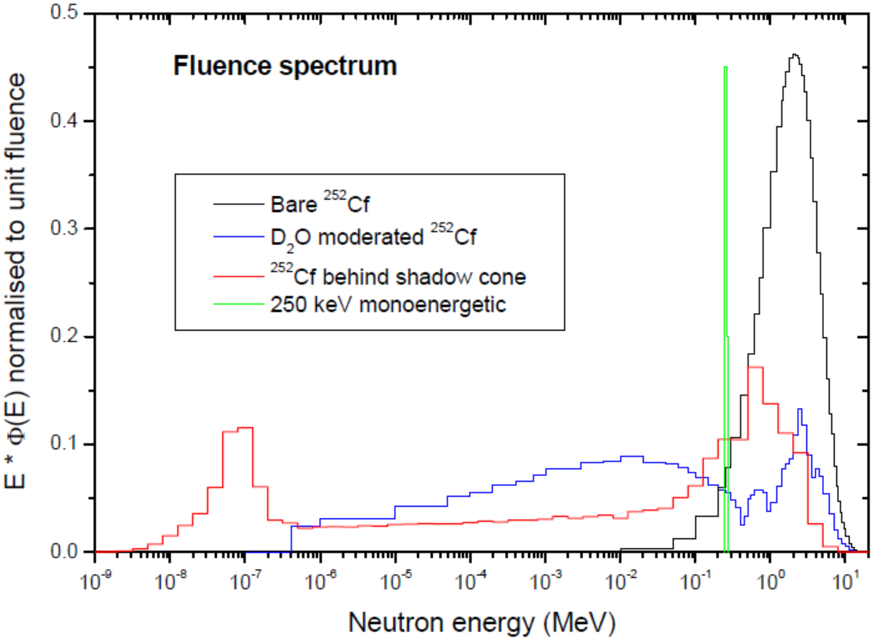
PAUL SCHERRER INSTITUT PSI

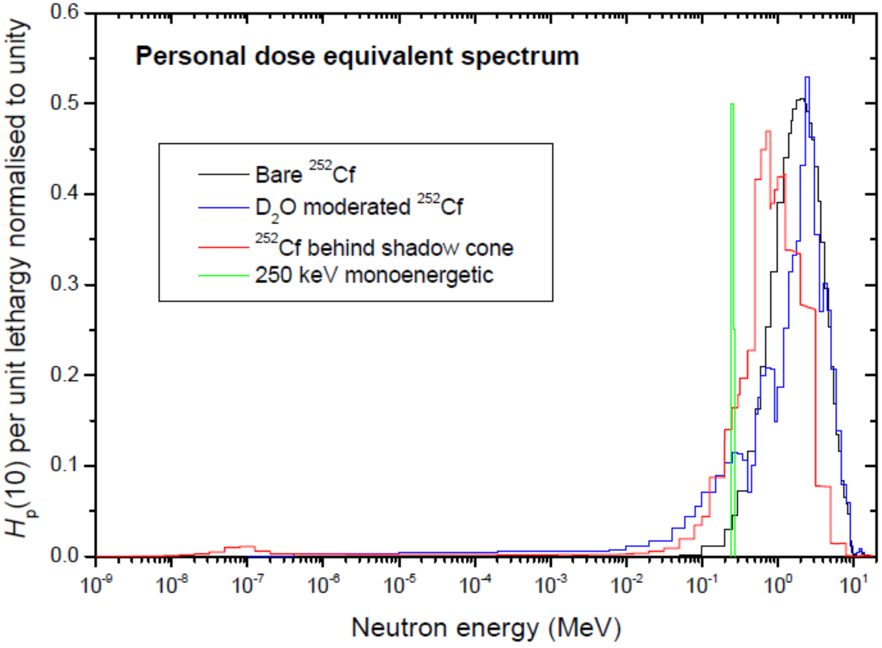
PTB

Public Health England

SCK•CEN

IC2012- Neutrons irradiated neutron fields





IC2012- Neutrons dosemeter systems

- A. Etched track + TLD (4 systems)
  etched track sensor for fast and TLD for albedo
- B. Etched track + converter (9 systems)
  etched track for fast and etched track with converter for albedo
- C. Etched track fast only (4 systems)
  no evidence of a thermal sensor

Etched track

- D. Albedo TLD + Cd shield (3 systems)
- E. Albedo TLD + B loaded shield (6 systems)
- F. Albedo ! (3 systems)
  no information about shielding of direct neutrons
  only a limited no. of results provided by one system

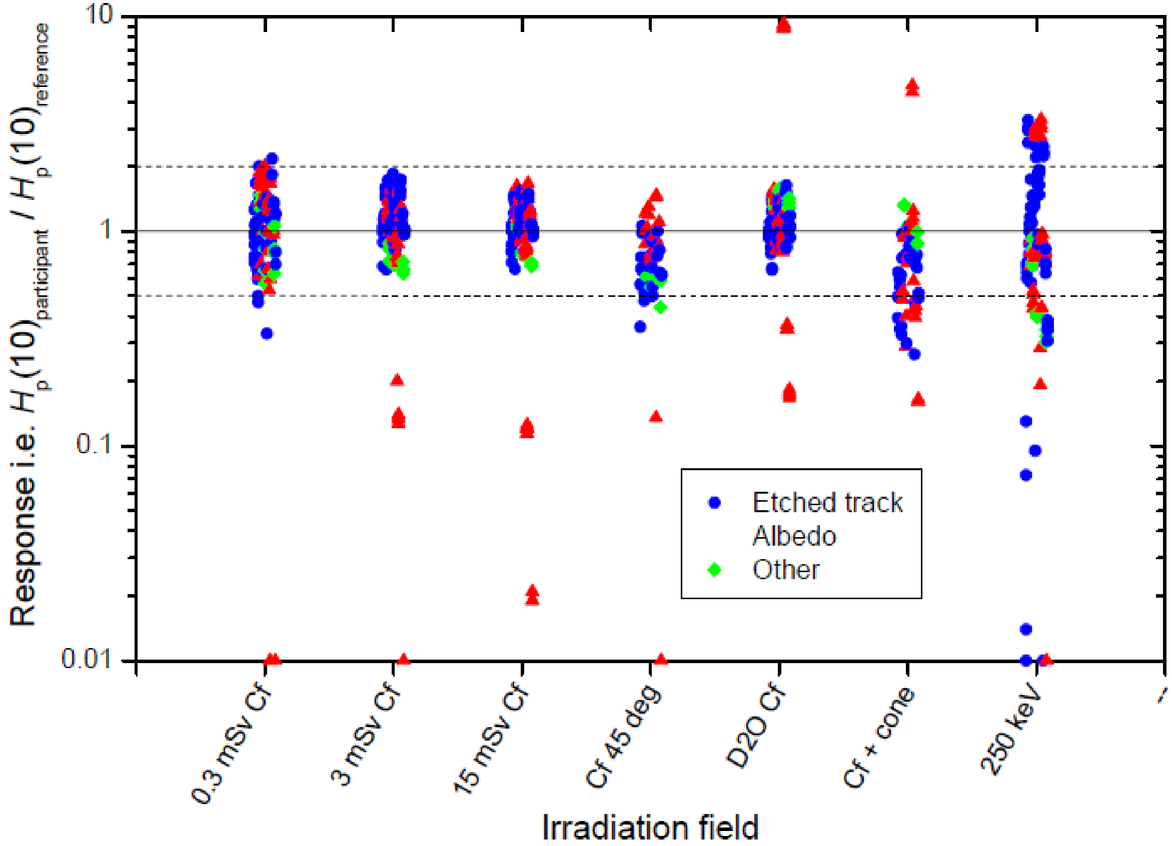
Albedo

- G. Fission track (1 system)
- H. Electronic (2 systems)

Other

7

IC2012- neutron: Results



Eurados Reports on IC

http://www.eurados.org/en/Documents_Publications

Next intercomparison 2015ext

European Radiation Dosimetry Group

EURADOS

Announcement of the
EURADOS Intercomparison 2015 for extremity dosemeters

Scope

The 2015ext intercomparison concerns to extremity dosemeters intended to estimate $H_p(0,07)$. The dosemeters may be of type ring, stall or wrist, designed to be worn on fingers, wrist or ankle, and are used ***routinely*** in individual monitoring of exposed workers.

Irradiations, restricted to photons and betas, will be performed in European irradiation facilities in terms of $H_p(0,07)$ in the following ranges:

- Photon energy: 16 to 662 keV
- Beta mean energy: 250 to 935 keV
- Dose: 0,5 mSv to 1 Sv
- Angle of incidence: ± 60°

Registration for IC2015ext

Contact: coordinator@ic2015ext.org
Registration: http://www.ic2015ext.org

Registration available until Sunday, 31/05/2015

The participation fee is 1250 Euro per dosimetry system. EURADOS sponsors will pay 1125 Euro for one system and 1250 Euro for any additional systems. Fees must be transferred in advance to the EURADOS bank account (free of bank transfer costs) after receiving the invoice from EURADOS. Refunding will only be possible in the unlikely event that the intercomparison is cancelled by EURADOS.

Thank you very much for your attention!

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