



HelmholtzZentrum münchen
German Research Center for Environmental Health



EURADOS INTERCOMPARISONS ON WHOLE BODY DOSEMETERS (2014) –

Participants meeting

European Radiation Dosimetry Group

EURADOS →

Organisation Group / Coordinators



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³ NRG, Radiation and Environment, the Netherlands

⁴ Ciemat, Spain

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Participants / Systems

Country	Participants
Italy	11
Belgium	10
Romania	6
United Kingdom	6
Spain	5
Turkey	5
Switzerland	4
France	3
Czech Republic	3
Austria	3
Bulgaria	3
Finland	3
Germany	3
Croatia	2
Denmark	2
Bosnia and Herzegovina	2
Argentina	2
Israel	2
Netherlands	2
United States	2
Poland	2
Japan	2

Country	Participants
Lebanon	1
Luxembourg	1
Macedonia FYROM	1
Estonia	1
Norway	1
India	1
Portugal	1
Ukraine	1
Serbia	1
Lithuania	1
Slovenia	1
Greece	1
Sweden	1

- 96 Participants
 - (20 sponsoring Inst.)
 - 112 Systems
 - 35 Countries
-
- Meeting: 62 Persons from 37 services

Final irradiation plan $H_p(10)$

	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

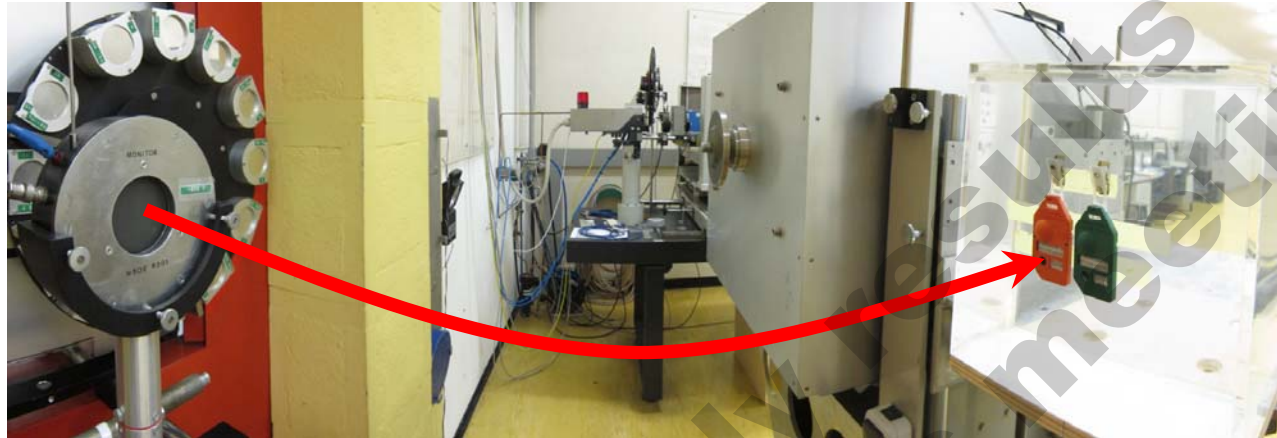
[02.122](#)

2240 IRRADIATED PERSONAL DOSEMETERS FOR THE EURADOS IC2014ph

INTERCOMPARISON AT SEIBERSDORF

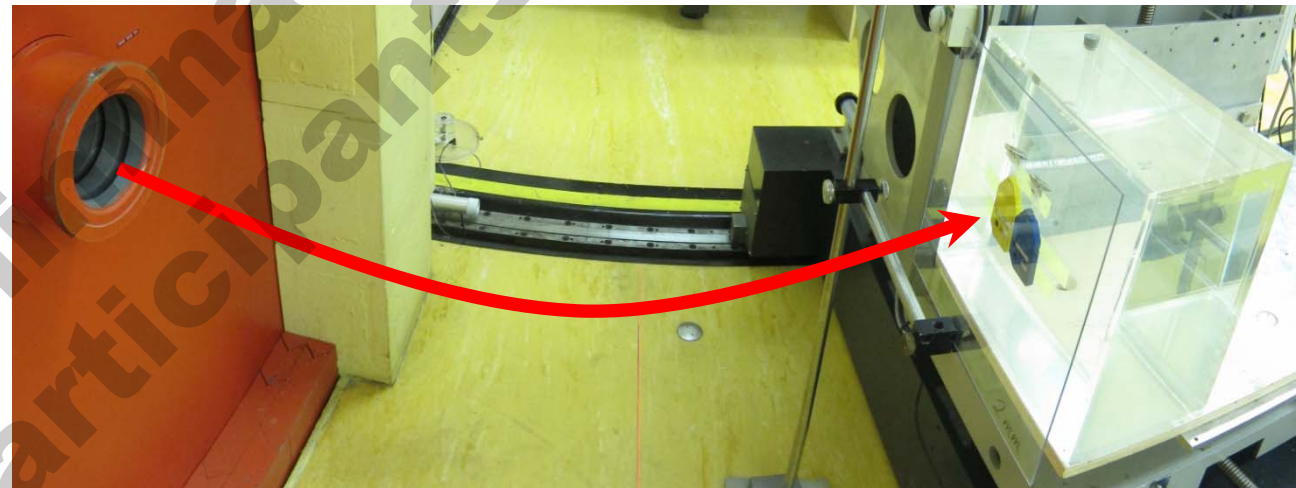
C Hranitzky

Irradiation on the water filled PMMA ISO slab phantom



X-ray irradiations

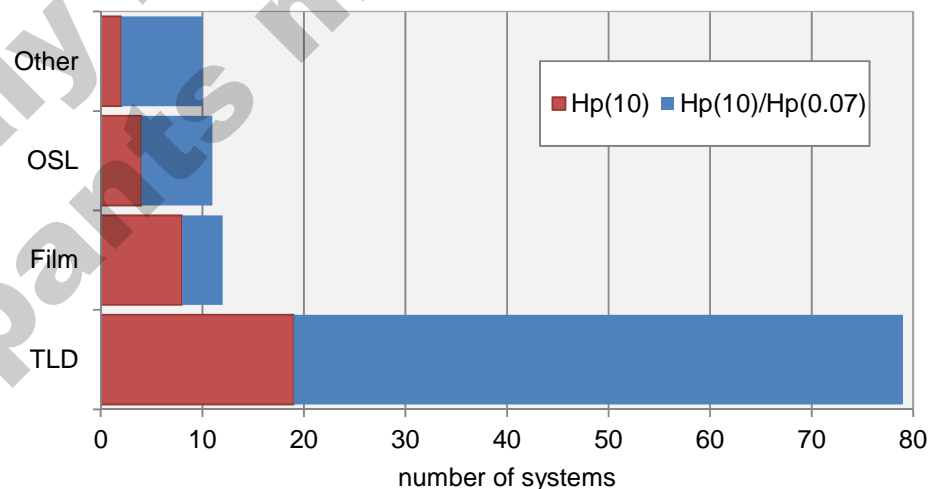
Gamma - irradiations



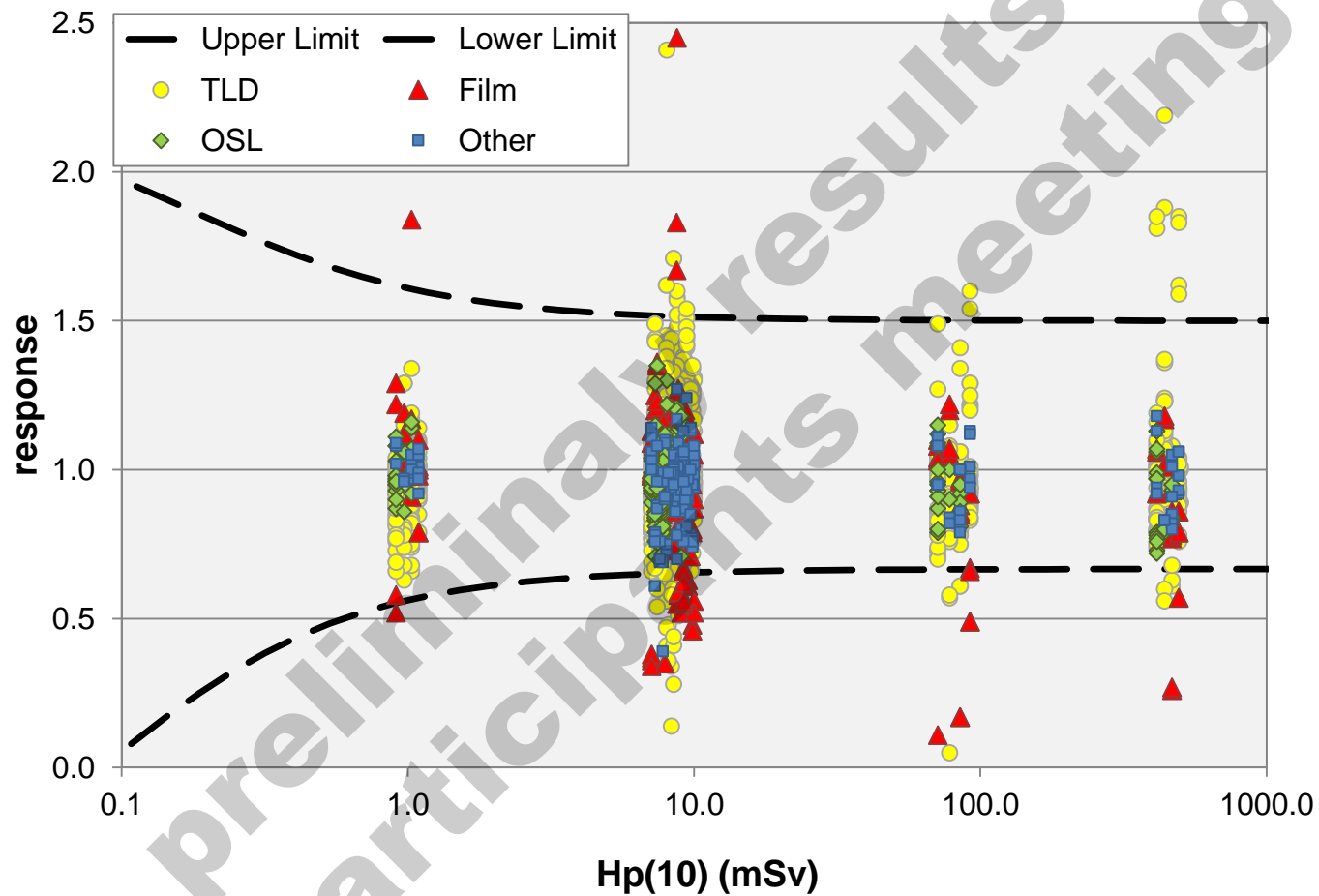
Dosemeter types + quantity

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%

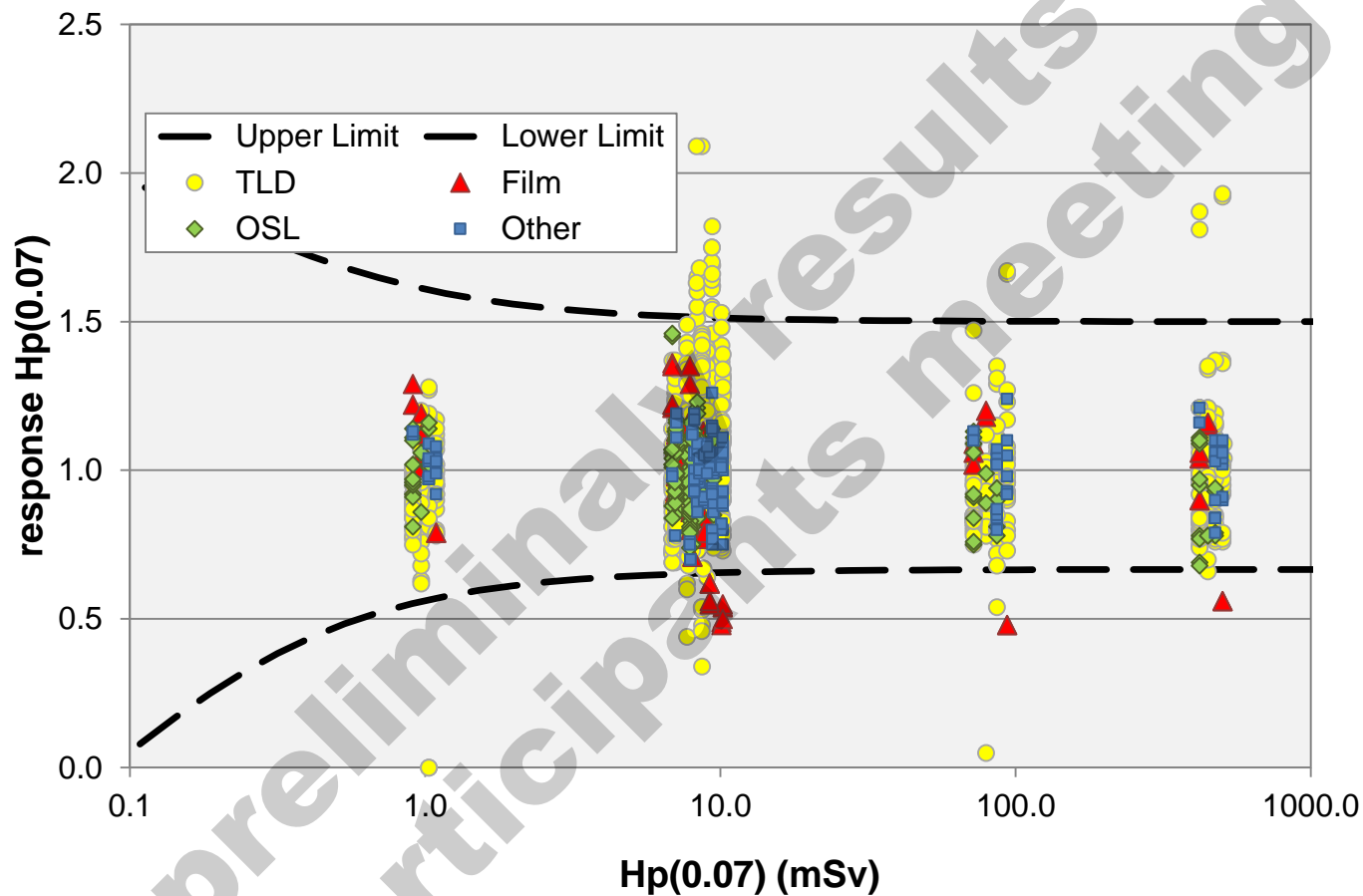
Typ1	Hp(10)	Hp(10)/Hp(0.07)	All
TLD	19	60	79
Film	8	4	12
OSL	4	7	11
Other	2	8	10
All	33	79	112



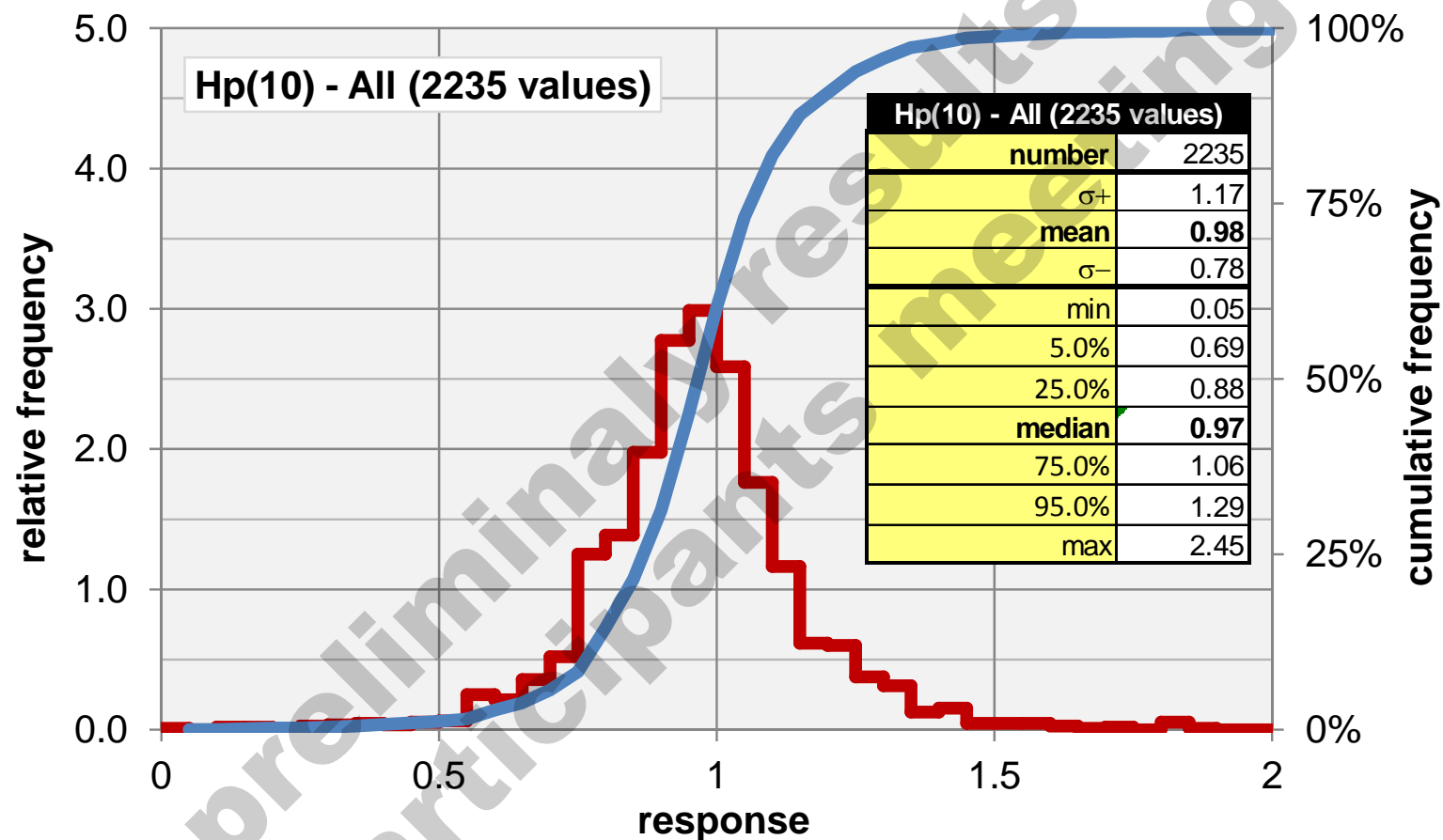
Trumpet curve $H_p(10)$



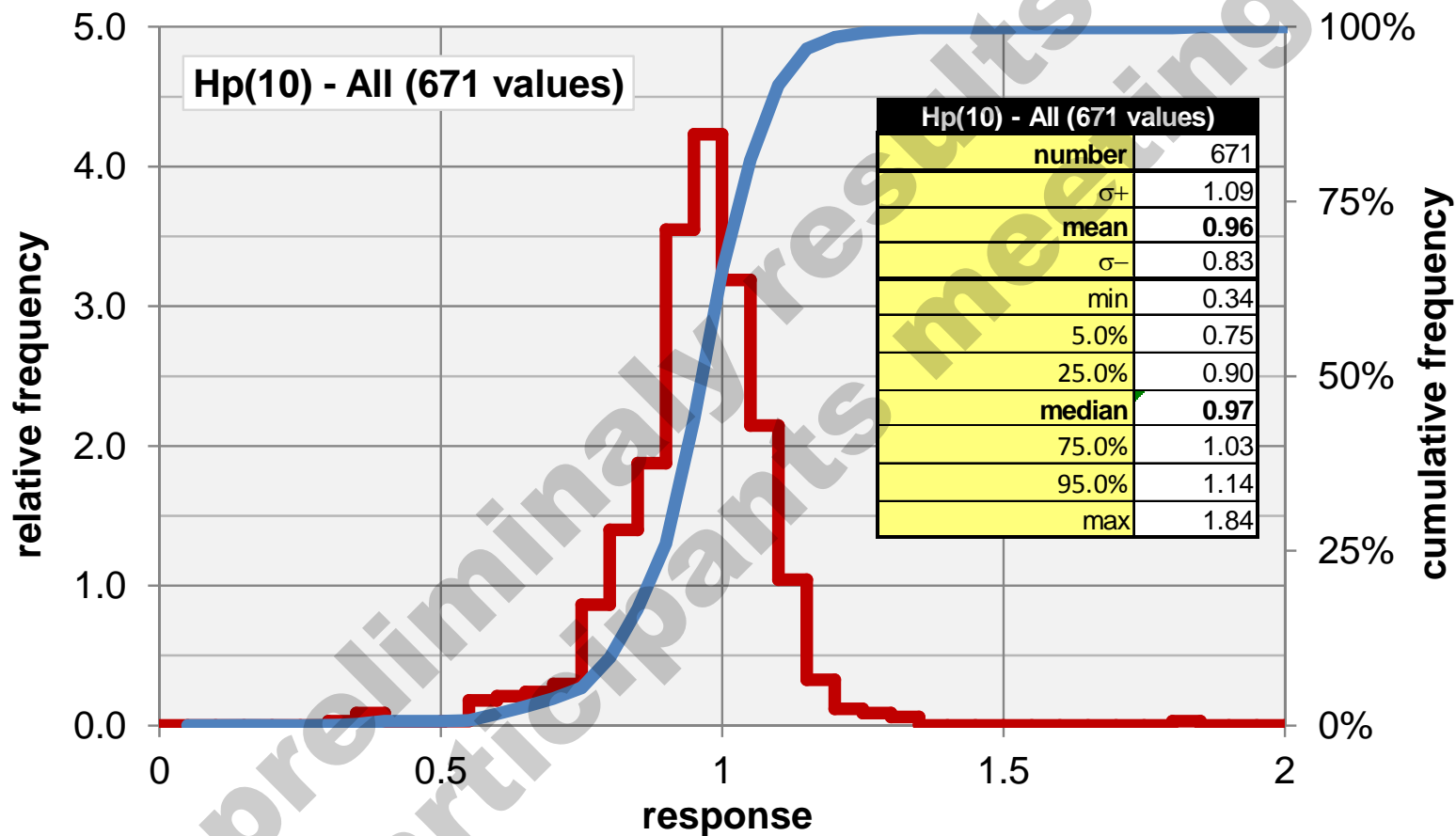
Trumpet curve $H_p(0.07)$



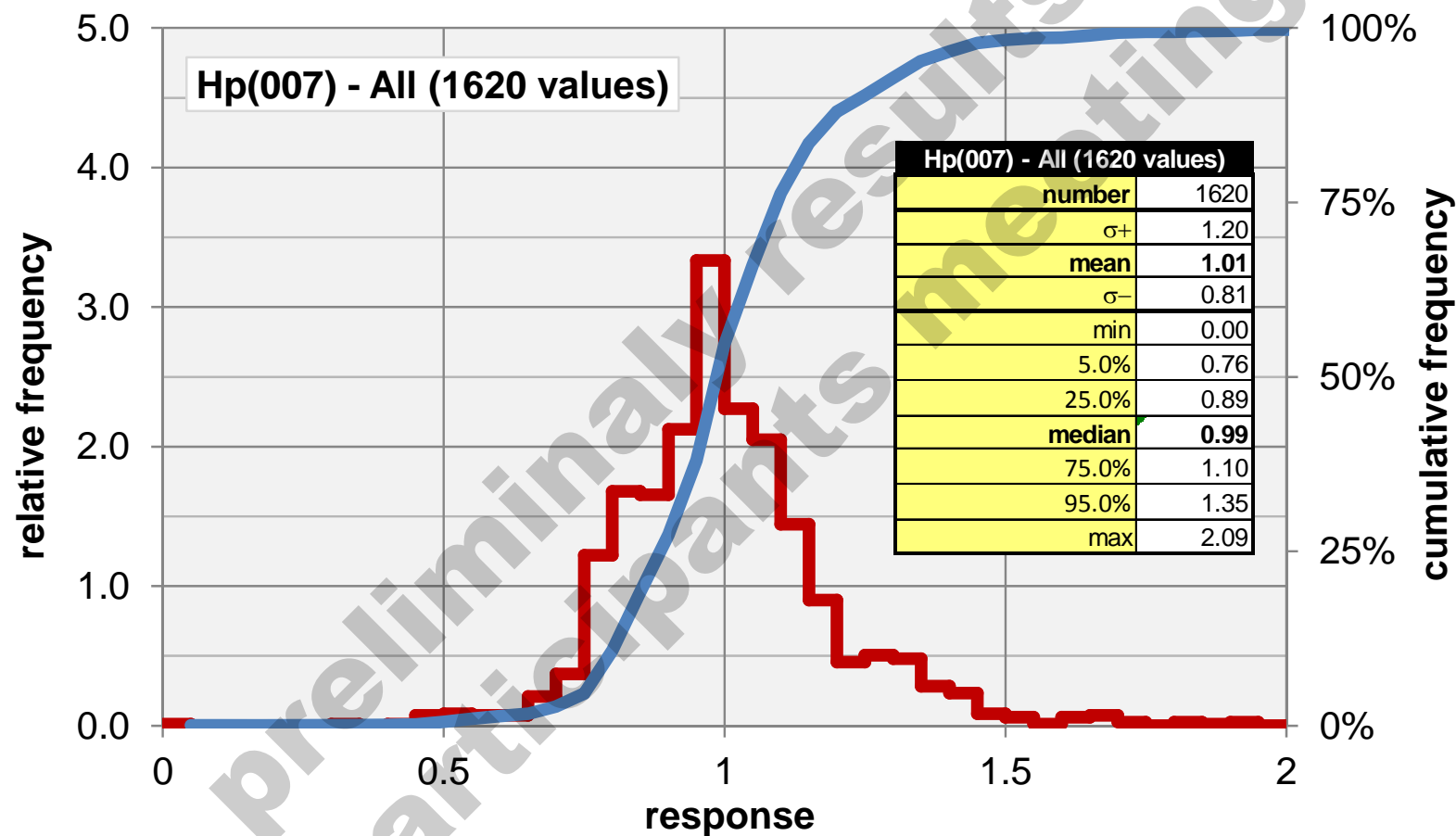
All response values $H_p(10)$



All response values S-Cs $H_p(10)$



All response values $H_p(0.07)$



Outliers: trumpet curve condition

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

Where:

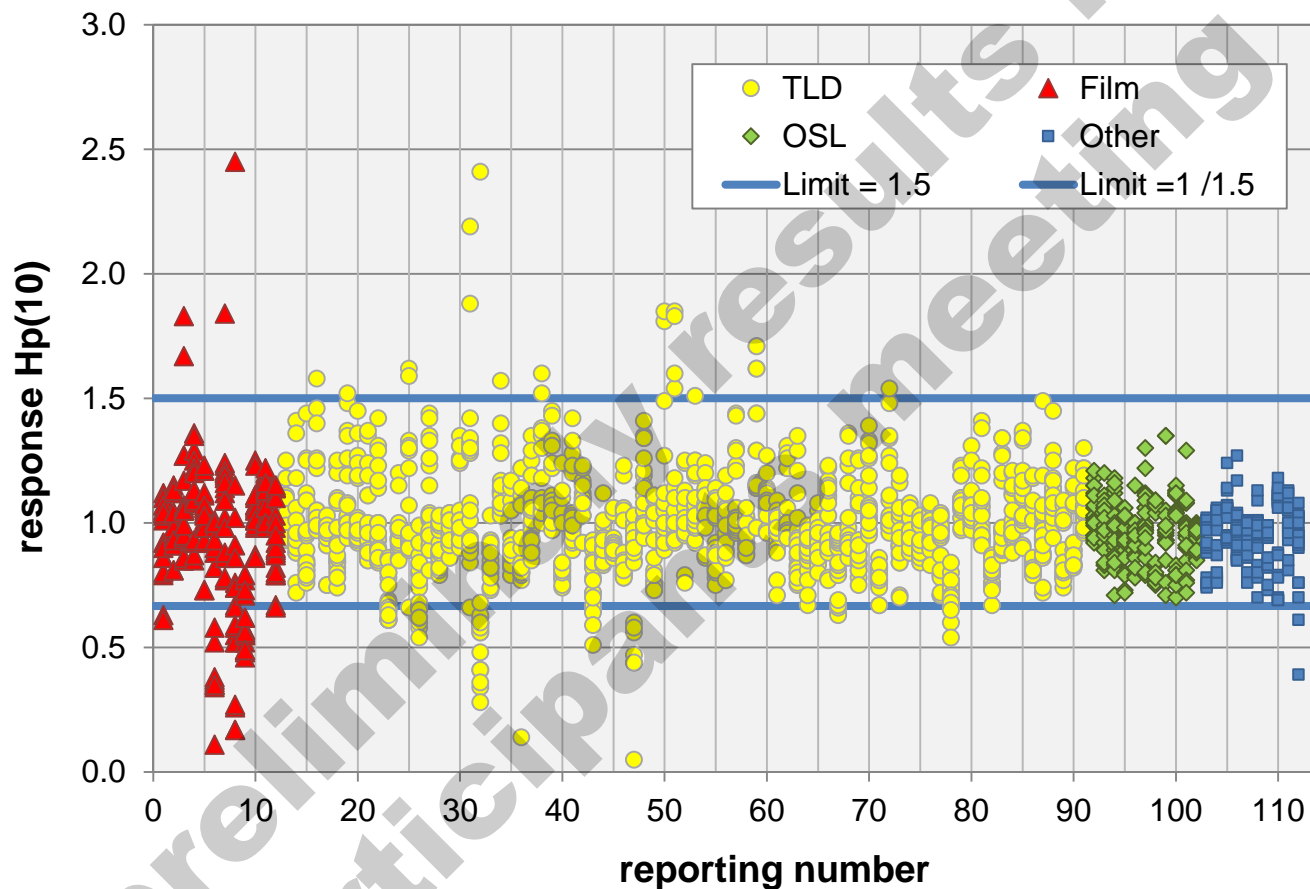
- **F = 1.5**
- *Whole body Dosemeters: H₀ = 0.085 mSv*
H_p(10), H_p(0.07)

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

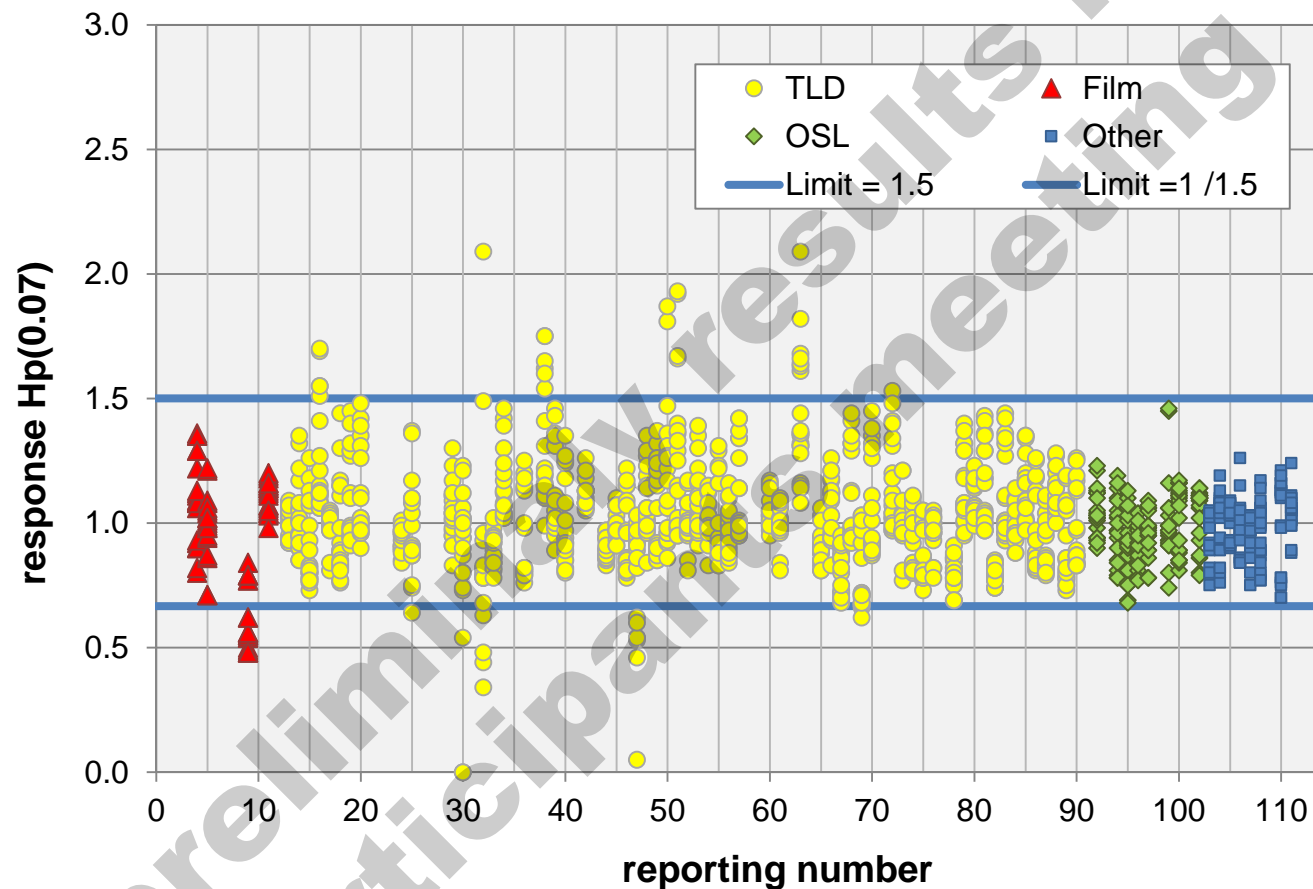
Note:

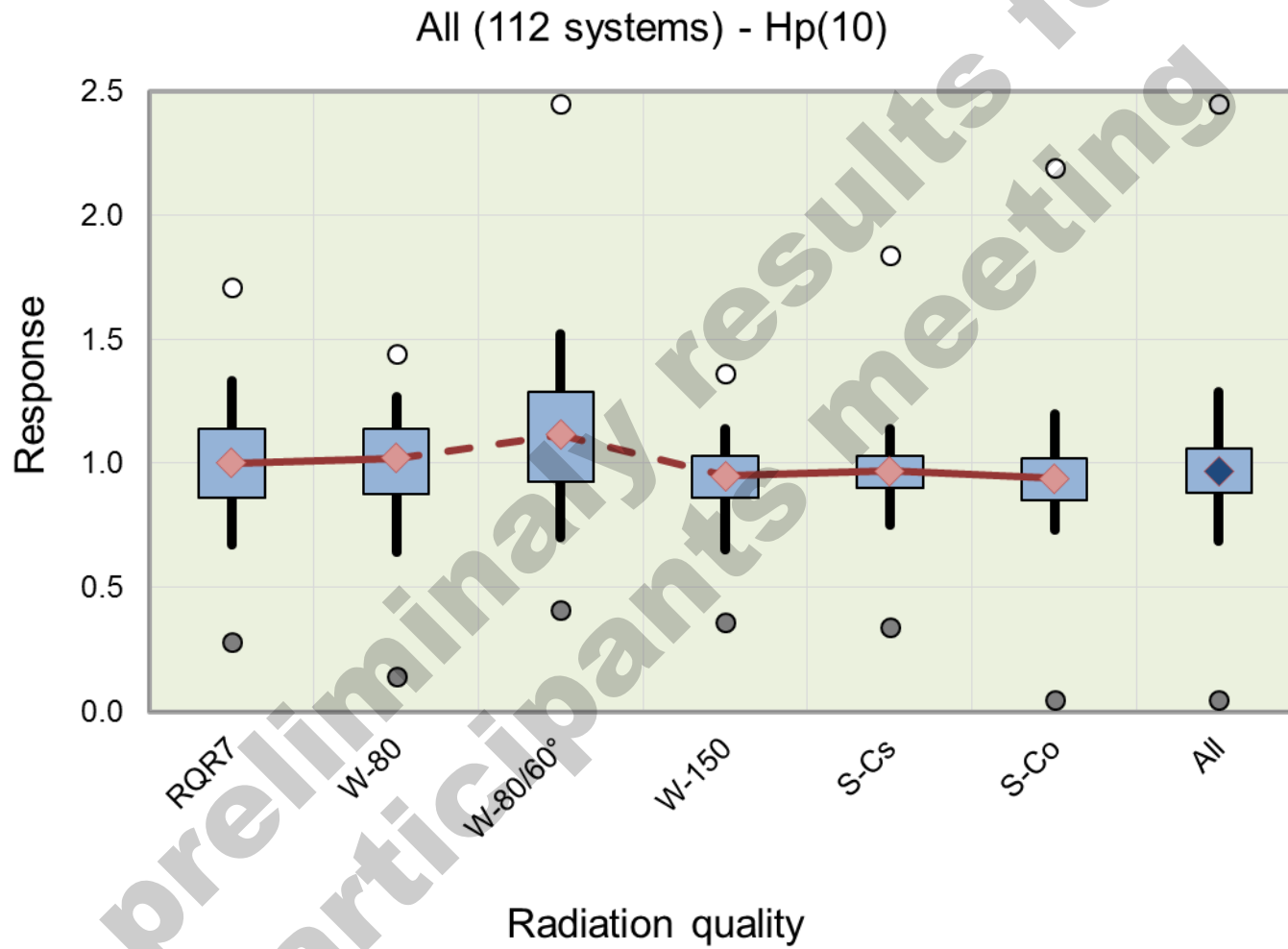
- According to ISO 14146 *H₀* is the “*lower limit of the dose range for which the system has been approved*”.
- 10% of outliers are accepted

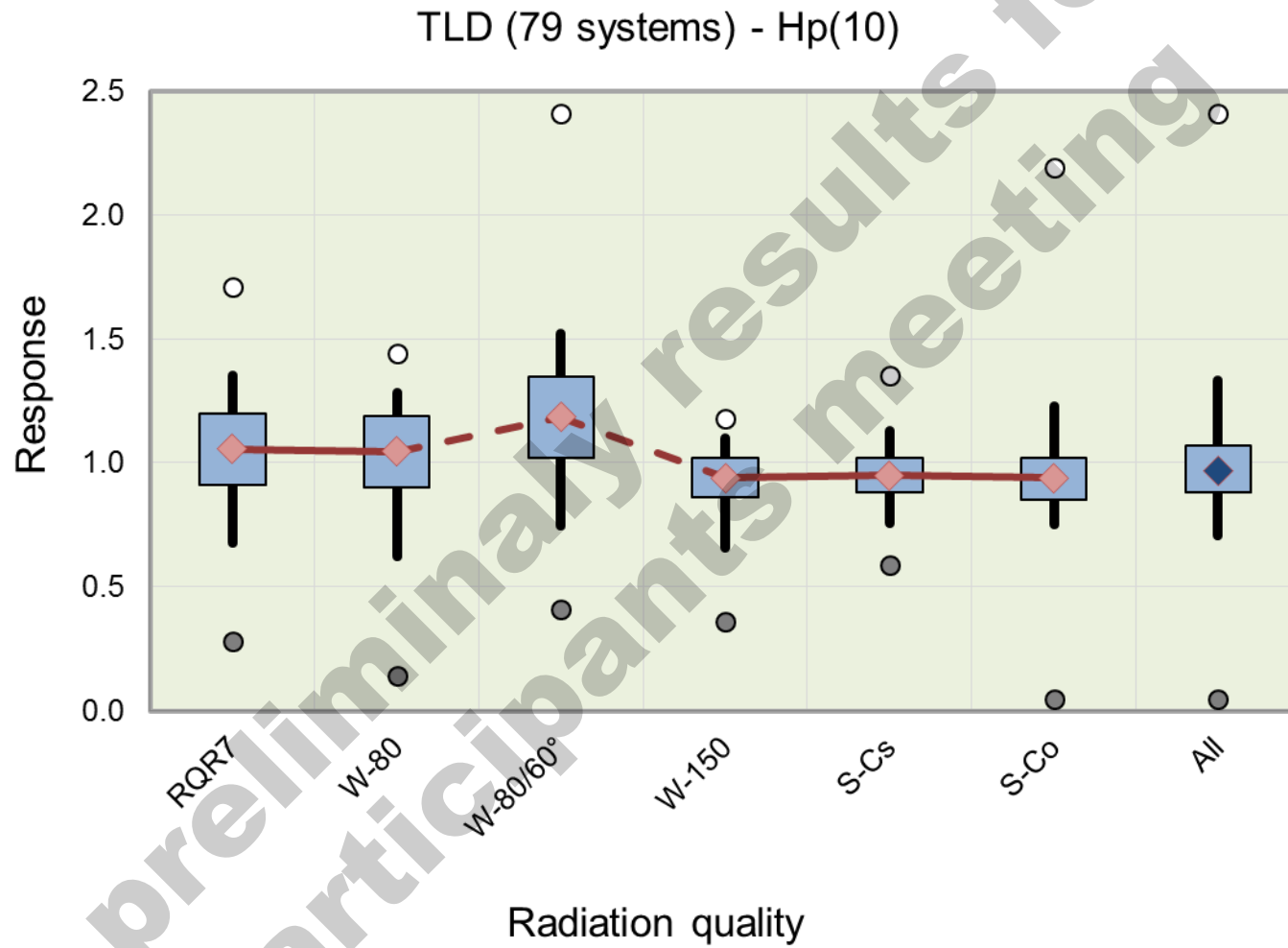
Individual results $H_p(10)$

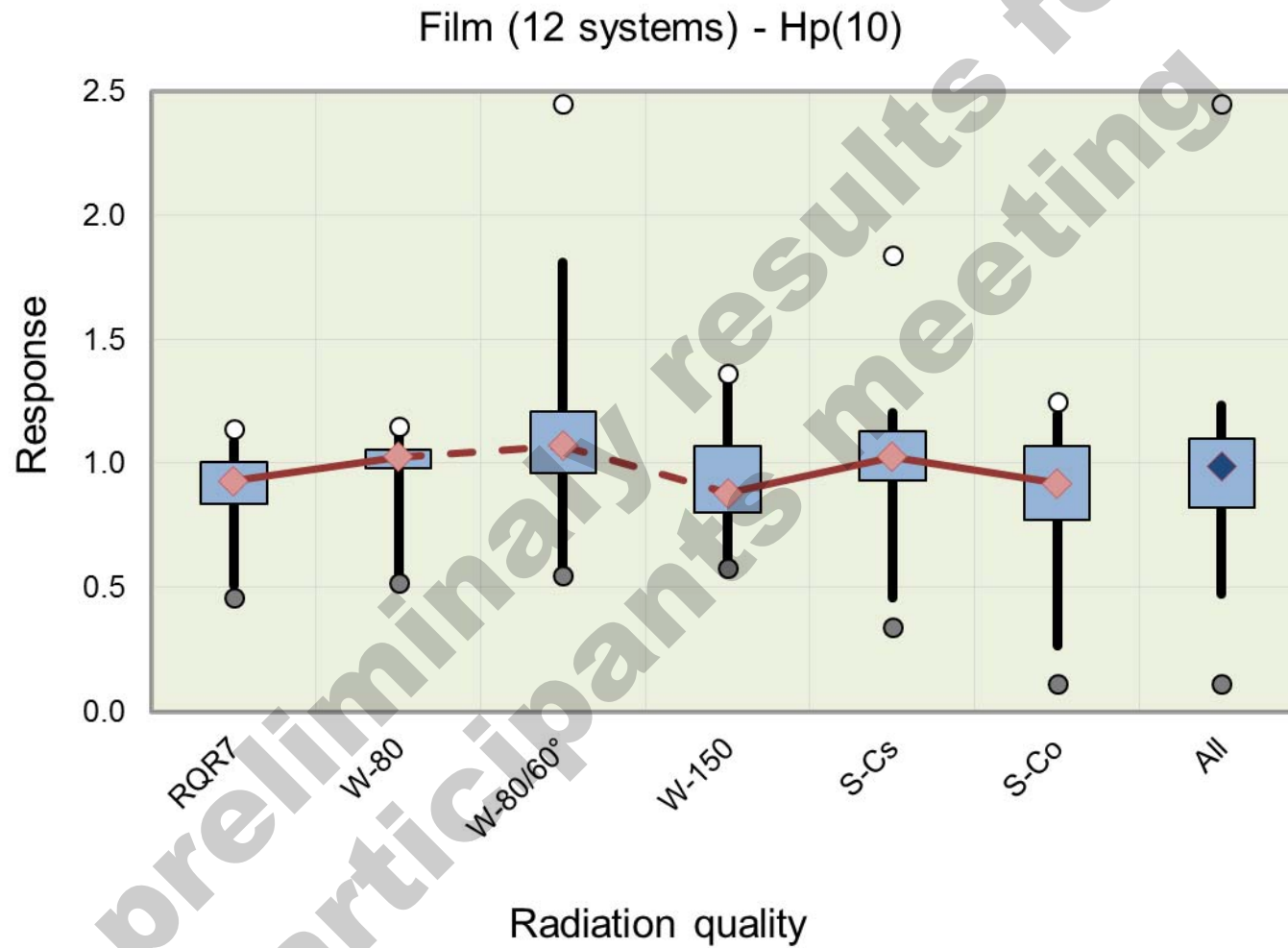


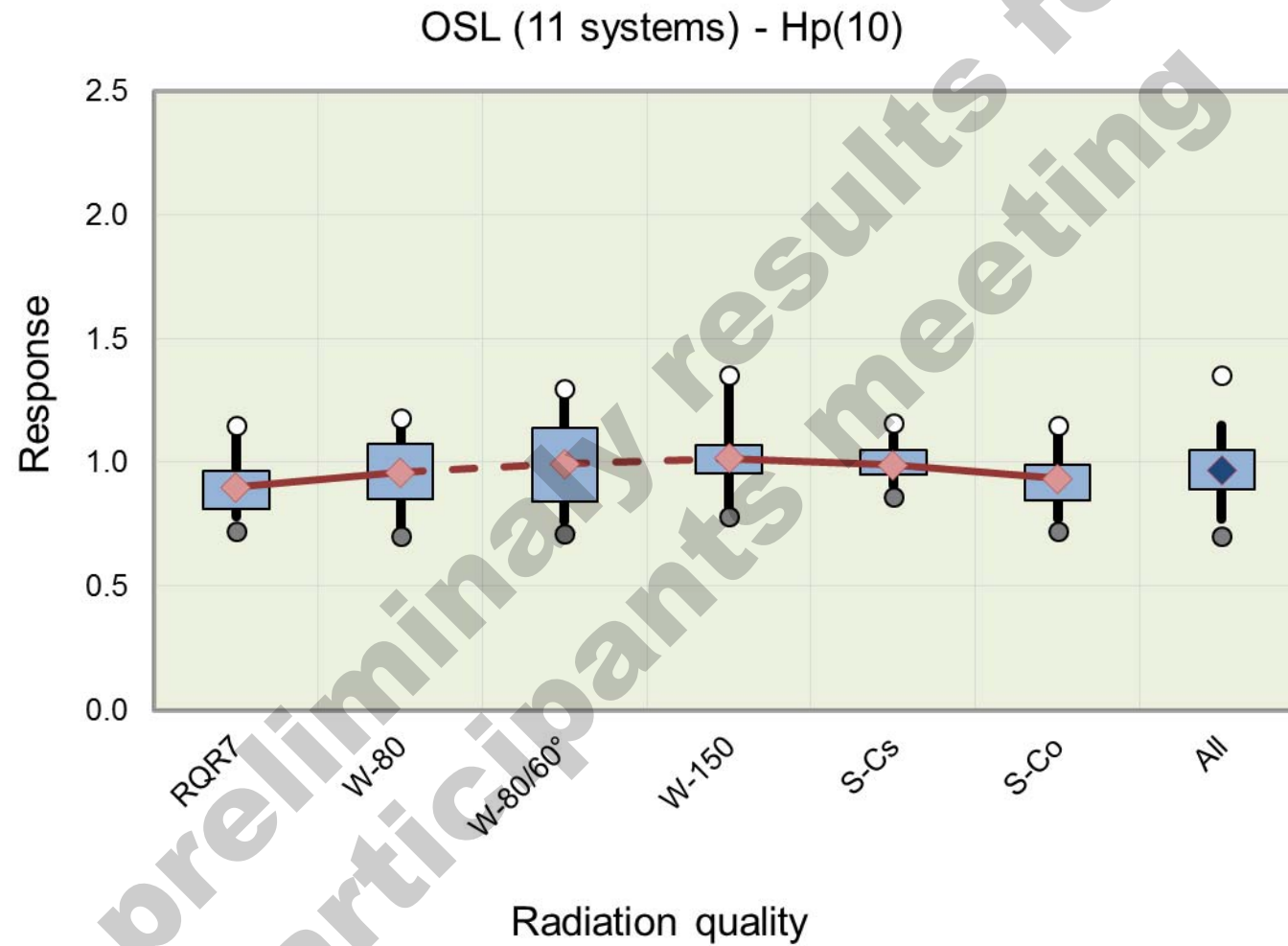
Individual results $H_p(0.07)$

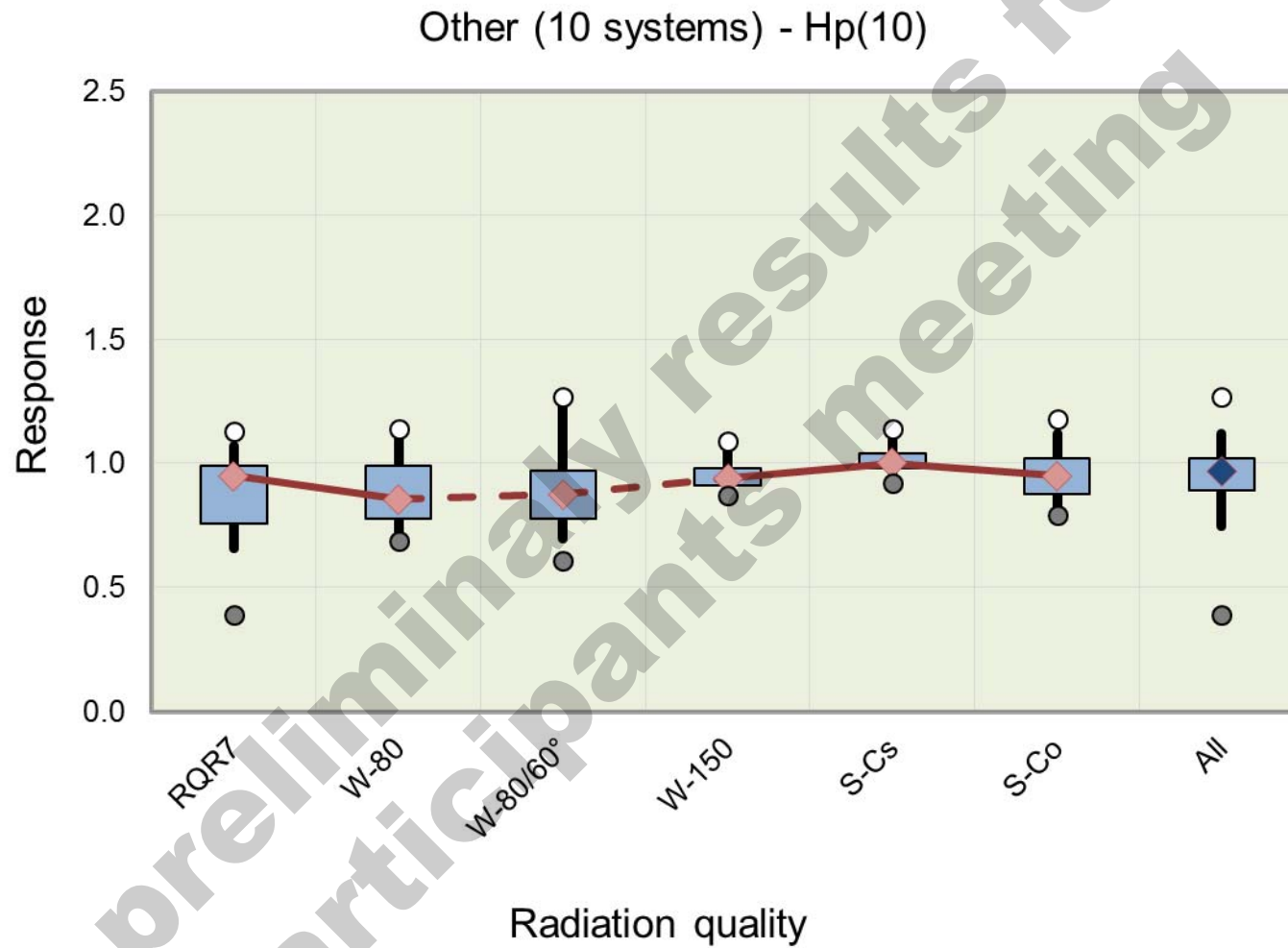




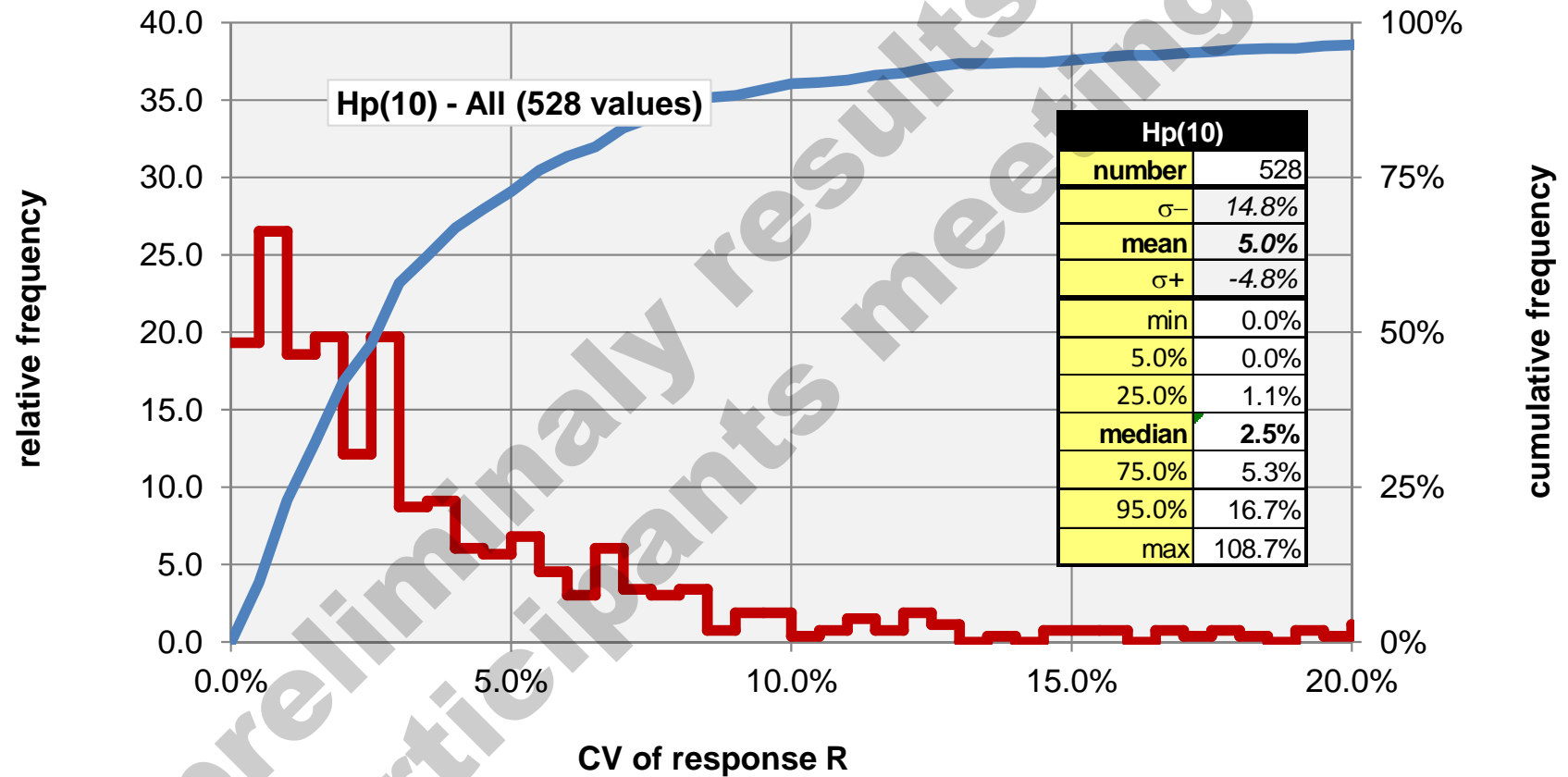




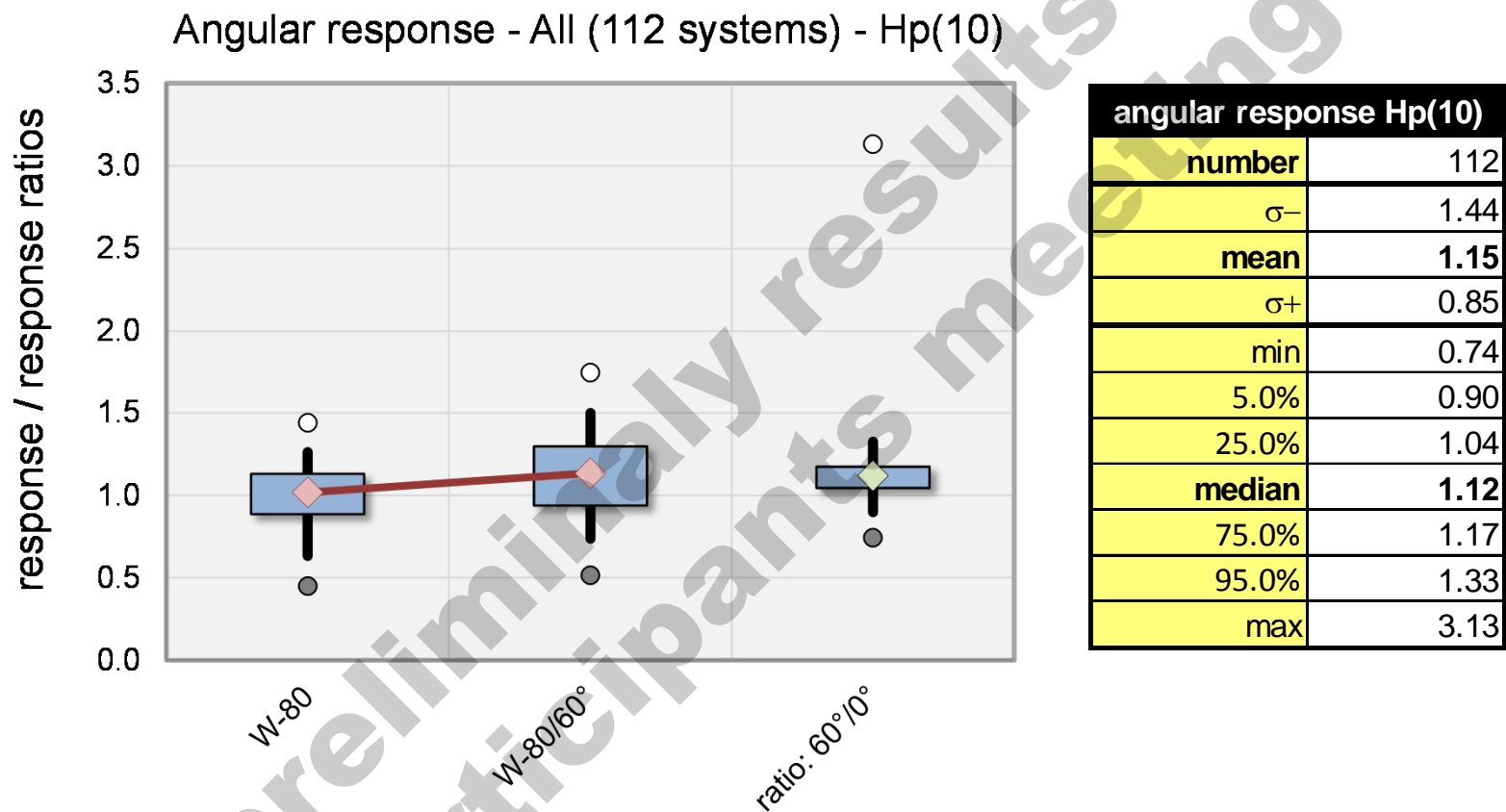




Coefficient of variation (CV) of R for $H_p(10)$

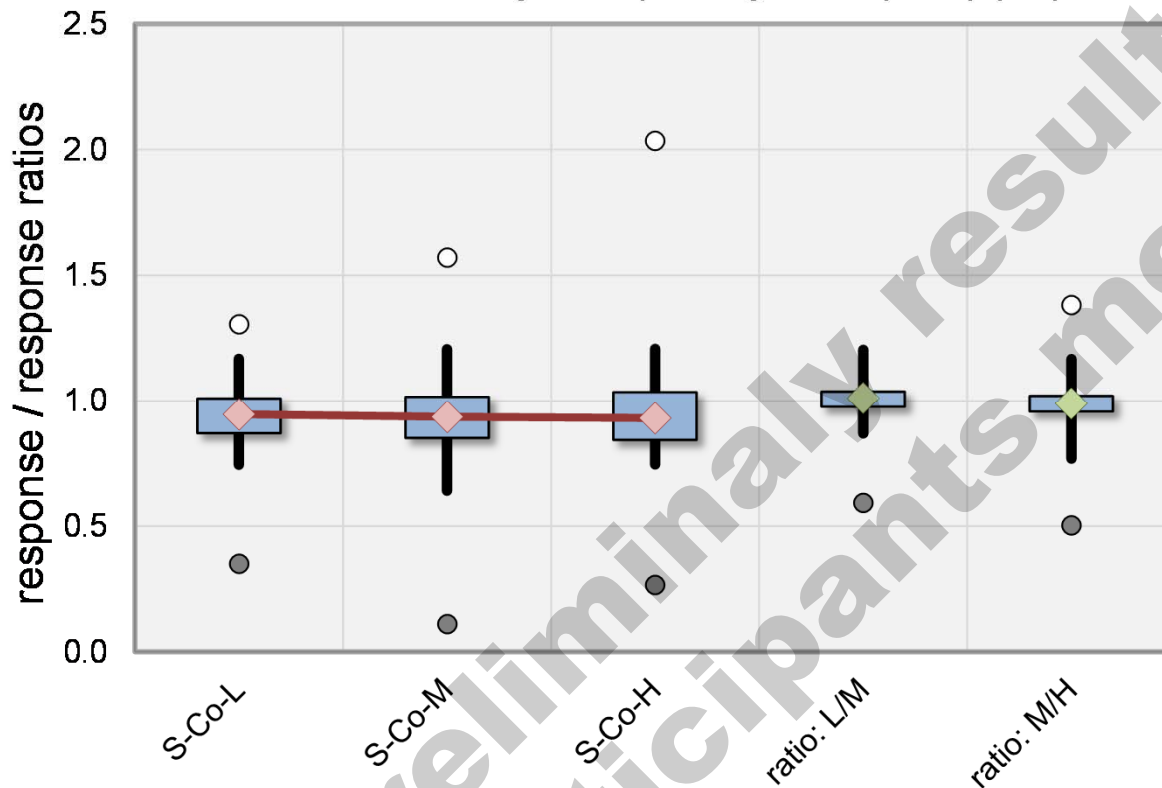


Angular response W-80/60°



Linearity S-Co

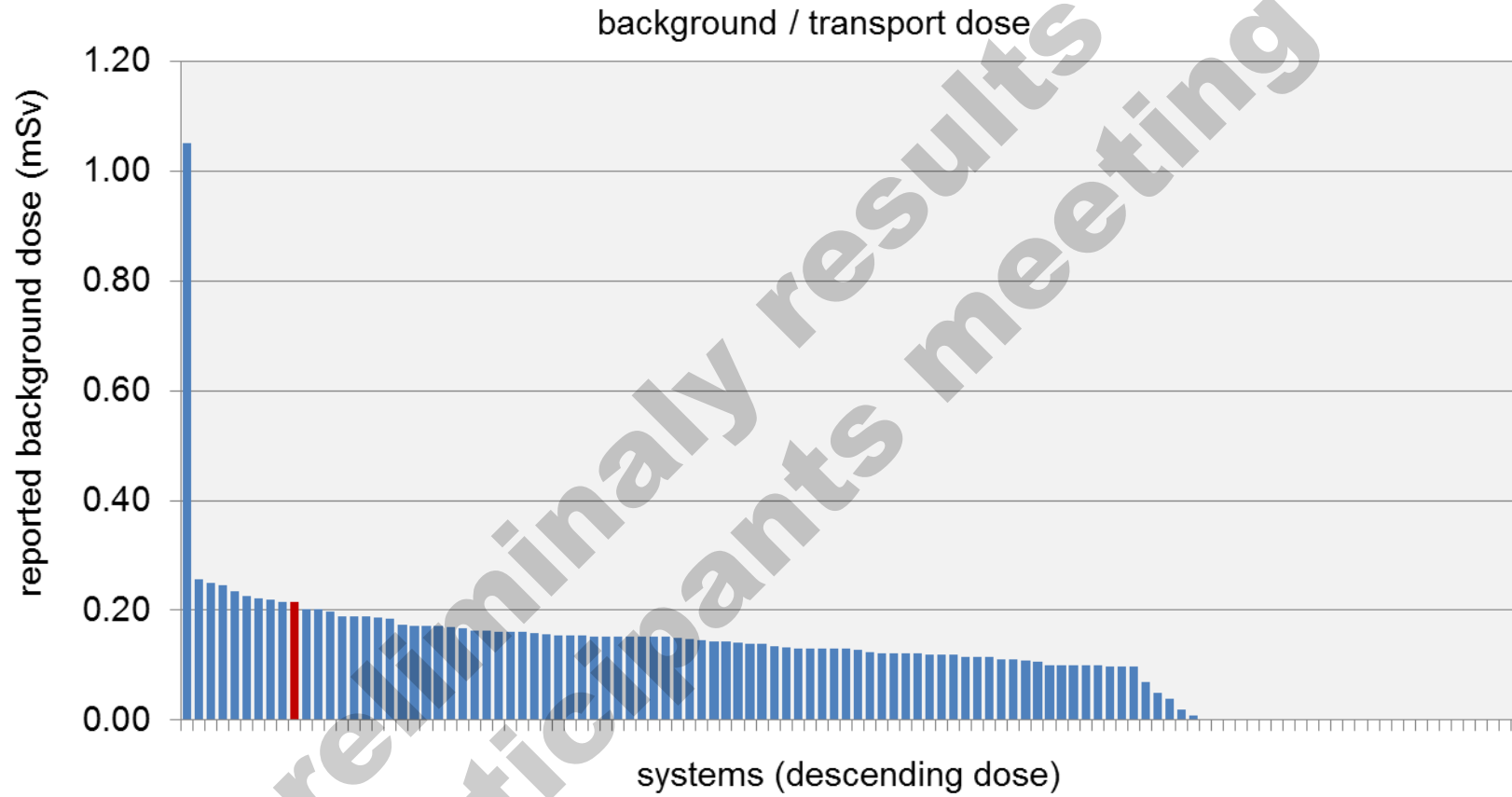
Linearity - All (112 systems) - Hp(10)



ratio: L/M		ratio: M/H	
number	112	number	111
σ^-	1.53	σ^-	1.11
mean	1.07	mean	0.98
σ^+	0.61	σ^+	0.86
min	0.59	min	0.50
5.0%	0.87	5.0%	0.77
25.0%	0.98	25.0%	0.96
median	1.01	median	0.99
75.0%	1.04	75.0%	1.02
95.0%	1.20	95.0%	1.17
max	5.21	max	1.38

dose range and response ratios

Background



Outliers $H_p(10)$

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 $H_p(0.07)$

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%

Number of outliers $H_p(10)$ (approx. 1 out of 10)

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%										

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

$$F = 1.5 \quad H_0 = 0.085 \text{ mSv}$$

10% of outliers are accepted

Number of outliers $H_p(0.07)$ (approx. 1 out of 10)

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%						

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

$$F = 1.5 \quad H_0 = 0.085 \text{ mSv}$$

10% of outliers are accepted

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	

Mean response R /	TLD																										
Quality	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
RQR7	1.07	0.92	1.10	0.69	0.85	1.06	1.06	0.44	1.07	1.05	0.98	1.04	0.99	1.23	1.06	1.07	1.10	1.30	0.92	1.71	1.13	0.99	1.27	1.17	0.98	0.84	0.78
W-80	1.01	1.26	1.13	0.63	0.86	0.92	1.03	0.59	1.15	0.90	1.07	1.12	0.96	1.23	1.06	1.03	0.83	1.22	0.94	1.44	1.14	0.89	1.22	1.00	0.79	0.85	0.93
W-80/60°	1.19	1.38	1.22	0.71	1.07	1.05	1.21	0.52	1.08	1.11	1.09	1.14	1.12	1.35	1.09	1.12	1.06	1.44	0.98	1.62	1.24	0.98	1.30	1.32	0.93	0.97	1.03
W-150	0.83	1.04	0.92	0.58	0.92	0.89	0.87	0.88	0.98	0.96	0.99	1.01	0.78	1.05	0.87	0.91	0.97	1.06	1.00	0.98	0.97	0.74	1.05	0.87	0.69	0.89	0.92
S-Cs-L	0.81	0.99	1.03	0.80	0.96	0.90	0.81	0.98	1.27	0.75	0.93	0.94	0.97	1.01	0.99	0.86	0.95	1.02	1.04	1.29	1.06	0.97	0.99	0.82	0.94	0.97	1.14
S-Cs-M	0.82	1.00	1.08	0.86	0.88	0.90	0.82	0.96	1.14	0.78	0.96	0.99	1.13	1.05	1.07	0.86	0.95	1.01	1.02	1.15	1.08	0.97	0.98	0.90	0.90	0.92	1.11
S-Co-L	0.76	0.95	1.10	0.84	0.90	0.87	0.81	0.86	1.19	0.76	0.90	0.93	1.01	0.99	1.13	0.78	1.07	0.98	0.89	1.16	1.05	1.03	0.96	0.78	0.90	0.88	1.19
S-Co-M	0.78	1.21	1.15	0.92	0.97	0.90	0.79	0.48	1.38	0.73	1.38	1.57	0.99	0.97	1.07	0.79	1.01	0.97	0.87	1.15	1.04	1.02	0.94	0.80	0.92	0.85	1.03
S-Co-H	0.80	0.93	1.23	0.87	0.87	0.92	0.79	0.96	1.00	1.03	1.83	1.84	1.04	1.04	1.19	0.89	0.93	1.01	0.90	1.14	1.04	1.05	0.95	0.82	0.85	1.07	1.17
All	0.89	1.06	1.10	0.77	0.91	0.93	0.90	0.76	1.14	0.88	1.11	1.16	1.01	1.09	1.06	0.92	0.98	1.10	0.96	1.28	1.08	0.96	1.06	0.94	0.88	0.91	1.04
Outliers				4				7			2	4								4							

Mean response R /	TLD																								
Quality	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
RQR7	0.68	1.25	1.12	1.23	0.79	1.35	0.92	0.95	0.92	0.91	0.80	0.76	1.09	1.01	1.07	0.85	1.28	1.21	1.17	1.08	0.73	1.13	1.05	1.15	1.21
W-80	0.64	1.16	1.08	1.30	0.67	1.26	0.84	1.02	0.99	1.00	0.71	0.71	1.19	1.08	1.21	0.74	1.19	1.13	1.01	1.01	1.05	1.14	1.01	1.08	1.12
W-80/60°	0.80	1.36	1.26	1.36	0.77	1.51	0.97	1.07	1.02	0.92	0.79	0.76	1.23	1.28	1.40	0.77	1.34	1.14	1.24	1.19	1.34	1.32	1.05	1.22	1.26
W-150	0.66	1.00	0.91	1.10	0.85	1.10	0.71	0.96	0.92	0.89	0.72	0.57	1.10	1.05	1.04	0.76	0.98	1.01	0.91	0.86	1.03	0.97	0.86	0.92	1.01
S-Cs-L	0.91	0.92	0.93	1.06	0.76	1.01	0.90	0.96	0.91	1.03	0.95	0.68	1.08	1.05	1.10	0.83	0.97	0.88	1.11	0.84	0.98	1.12	0.78	0.88	1.03
S-Cs-M	0.93	0.93	0.85	1.01	0.80	1.01	0.92	0.94	0.90	0.99	0.99	0.71	1.06	1.06	0.97	0.80	0.96	0.97	1.15	0.82	0.94	1.07	0.81	0.88	1.06
S-Co-L	0.94	0.91	0.82	0.97	0.80	0.97	0.91	0.89	0.87	1.02	1.01	0.71	1.02	1.01	0.94	0.82	0.90	0.96	1.19	0.81	0.90	1.15	0.79	0.83	0.97
S-Co-M	0.96	0.88	0.77	1.02	0.77	0.99	1.05	0.89	0.85	1.05	1.00	0.71	0.98	0.98	0.92	0.86	0.89	0.98	1.03	0.80	0.92	1.27	0.76	0.83	1.04
S-Co-H	0.84	0.91	0.86	1.01	0.83	1.01	1.18	0.92	0.87	1.07	0.94	0.77	1.08	1.13	0.94	0.77	0.91	0.98	1.37	0.80	0.90	1.03	0.84	0.84	1.08
All	0.83	1.02	0.94	1.10	0.78	1.12	0.93	0.95	0.91	0.98	0.89	0.71	1.09	1.07	1.05	0.80	1.04	1.02	1.13	0.90	0.97	1.13	0.87	0.95	1.08
Outliers	2					1						3													

Summary 1

Number of participating systems was continuously increasing
(from 62 to 112)

Radiation qualities:

- For x-rays wide spectra qualities were used

Fraction of outliers :

- 77% systems show no outliers of the trumpet curve criteria.
- 89% systems fulfil the ISO 141406 performance criteria
(max. 2 outliers are allowed)
- Overall performance results remains stable (from 5% to 6%)
- FILM performance decreased (from 4% to 17%)
- TLD performance increased (from 8% to 4%)
- OSL performance increased (2% to 0%)

Summary 2

Responses:

- Overall mean response **0.98 (1.01)**
- Overall median response **0.97 (0.99)**

Calibration:

- Better results could be achieved by improved calibration procedure by some services

Radiation qualities/Problems:

- The radiation Quality W-80/60° show significant over response by a number of systems

Coefficient of variation:

- Typical CV for identical irradiation condition are 2 - 4% (similar in previous intercomparisons)

Other presentations at IM2015

02.171	The results of the EURADOS intercomparisons IC2014ph on whole body doseimeters for photons H Stadtmann, T W M Grimbergen, A McWhan, A M Romero, M Figel and C Gärtner
02.195	EURADOS intercomparisons on whole body doseimeters for photons from 2008 to 2014 M Figel, H Stadtmann, T W M Grimbergen, A McWhan and A M Romero
02.136	EURADOS program of intercomparisons for Individual Monitoring Services: 7 years of development and future plans T Grimbergen, M Figel, A McWhan, A M Romero and H Stadtmann
02.242	EURADOS intercomparisons in external radiation dosimetry: similarities and differences among exercises for whole body photon, whole body neutron, extremity, eye-lens and environmental doseimeters A M Romero, T Grimbergen, A McWhan, H Stadtmann, E Fantuzzi, I Clairand, S Neumaier and M Figel
10.132	EURADOS WG02 actions in the period 2010-2015 J G Alves, P Ambrosi, C Cherestes, J van Dijk, E Fantuzzi, M Figel, P Gilvin, T Grimbergen, O Hupe, R Kopec, M Lehtinen, A McWhan, A Romero, F Rossi, H Stadtmann and B Vekic

Next Intercomparison

- 
- IC2008
 - IC2009_{ext}
 - IC2010
 - IC2012
 - IC2012_n
 - IC2014
 - IC2015_{ext}**

**Intercomparison for
extremity dosimeters**

Next intercomparison 2015ext

European Radiation Dosimetry Group

EURADOS →

Announcement of the EURADOS Intercomparison 2015 for extremity dosimeters

Scope

The 2015ext intercomparison concerns to extremity dosimeters intended to estimate $H_p(0,07)$. The dosimeters 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: $\pm 60^\circ$
- > 20 dosimeters for irradiation
- > 10 transit / spare dosimeters

Next intercomparison 2015ext

Provisional Schedule – dates to be confirmed

Announcement - Call for participants	April 2015
*Registration of participants and systems	April 2015 – 15 May 2015
Deadline for IMS sending application forms	15 May 2015
Deadline for IMS sending dosimeters to OG	30 June 2015
Irradiations	July - August 2015
OG sending dosimeters for readout	15 September 2015
Deadline for IMS sending dosimeters results to OG	15 November 2015
Final results available	01 January 2016
IMS receiving certificates of participation	01 February 2016

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.

Registration for IC2015ext



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

