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German Research Center for Environmental Health

EURADOS intercomparisons on whole body dosemeters for photons from 2008 to 2014

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Participants and Systems

	2008	2010	2012	2014
institutes	52	70	74	96
systems	62	85	87 (88)*	112
countries	24	30	30	35
dosemeters	1612	2210	2288	3360

* one withdrawel

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System Types

	$H_p(10)$				$H_p(10)$ & $H_p(0.07)$				All			
	2008	2010	2012	2014	2008	2010	2012	2014	2008	2010	2012	2014
TLD	7	10	9	19	39	49	50	60	46	59	59	79
Film	5	7	7	8	5	6	5	4	10	13	12	12
OSL		0	2	4		8	9	7		8	11	11
other	1	1	0	2	5	4	5	8	6	5	5	10
All	13	18	18	33	49	67	69	79	62	85	87	112

Type of Detector

2008

Type/detector	systems	% of all	% of type
TLD	46	74%	100%
LiF:Mg,Ti	29	47%	63%
LiF:Mg,Cu,P	6	10%	13%
Li2B4O7/CaSO4	6	10%	13%
Li2B4O7	1	2%	2%
CaF2	1	2%	2%
CaSO4:Dy/PTFE	1	2%	2%
different	2	3%	4%
Film	10	16%	100%
Agfa	4	6%	40%
Kodak	4	6%	40%
?	2	3%	20%
Other	6	10%	100%
OSL	2	3%	33%
RPL	2	3%	33%
?	2	3%	33%
All	62	100%	100%

2010

Type/detector	systems	% of all	% of type
TLD	59	69%	100%
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%	100%
Agfa	8	9%	62%
Kodak	4	5%	31%
FOMA	1	1%	8%
OSL	8	9%	100%
Al2O3:C	7	8%	88%
BeO	1	1%	13%
other	5	6%	100%
RPL	2	2%	40%
DIS	2	2%	40%
APD	1	1%	20%
All	85	100%	100%

2012

Type/detector	systems	% of all	% of type
TLD	59	68%	100%
LiF:Mg,Ti	26	30%	44%
LiF:Mg,Cu,P	14	16%	24%
Li2B4O7:Cu/CaSO4	8	9%	14%
?	5	6%	8%
LiF	2	2%	3%
LiF/Li2B4O7	2	2%	3%
CaSO4:Dy/PTFE	1	1%	2%
Al2O3:C	1	1%	2%
Film	12	14%	100%
Agfa	6	7%	50%
?	3	3%	25%
FOMA	2	2%	17%
Kodak	1	1%	8%
OSL	11	13%	100%
Al2O3:C	8	9%	73%
BeO	2	2%	18%
?	1	1%	9%
other	5	6%	100%
EPD	2	2%	40%
RPL	2	2%	40%
DIS1	1	1%	20%
All	87	100%	100%

2014

Type/detector	systems	% of all	% of type
TLD	79	71%	100%
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%	100%
Agfa	9	8%	75%
FOMA	3	3%	25%
OSL	11	10%	100%
Al2O3:C	8	7%	73%
BeO	3	3%	27%
Other	10	9%	100%
DIS	5	4%	50%
APD	3	3%	30%
RPL	2	2%	20%
All	112	100%	100%

Irradiation Plan

Quality		2008	2010	2012	2014
Gamma	S-Cs-L	0.5	0.5		1
	S-Cs-M	3	2.5	7	8
	S-Cs-H	10	12		
	S-Co-L			5	8
	S-Co-M			50	80
	S-Co-H	150	250	500	550
	S-Co			7	
X-Ray	N-40 0°			6	
	N-40 30°		1		
	N-60	3		6	
	N-60 45°	3			
	N-60 60°			6	
	N-150 45°	3			
	W-80				9
	W_80/60°				9
	W-110/±45°/y		5		
	W-110/±45°/x		5		
	W-150				9
	RQR7				9
Mixed	N-40 + S-Cs		3		
	N-60 + S-Cs	(3 + 1)			
	S-Cs + N-60	(3 + 1)			
	S-Cs + N-150/45°			(4+3)	
	W-250 + S-Cs		3		

$H_p(10)$ in mSv (+/-20%)

System Performance $H_p(10)$

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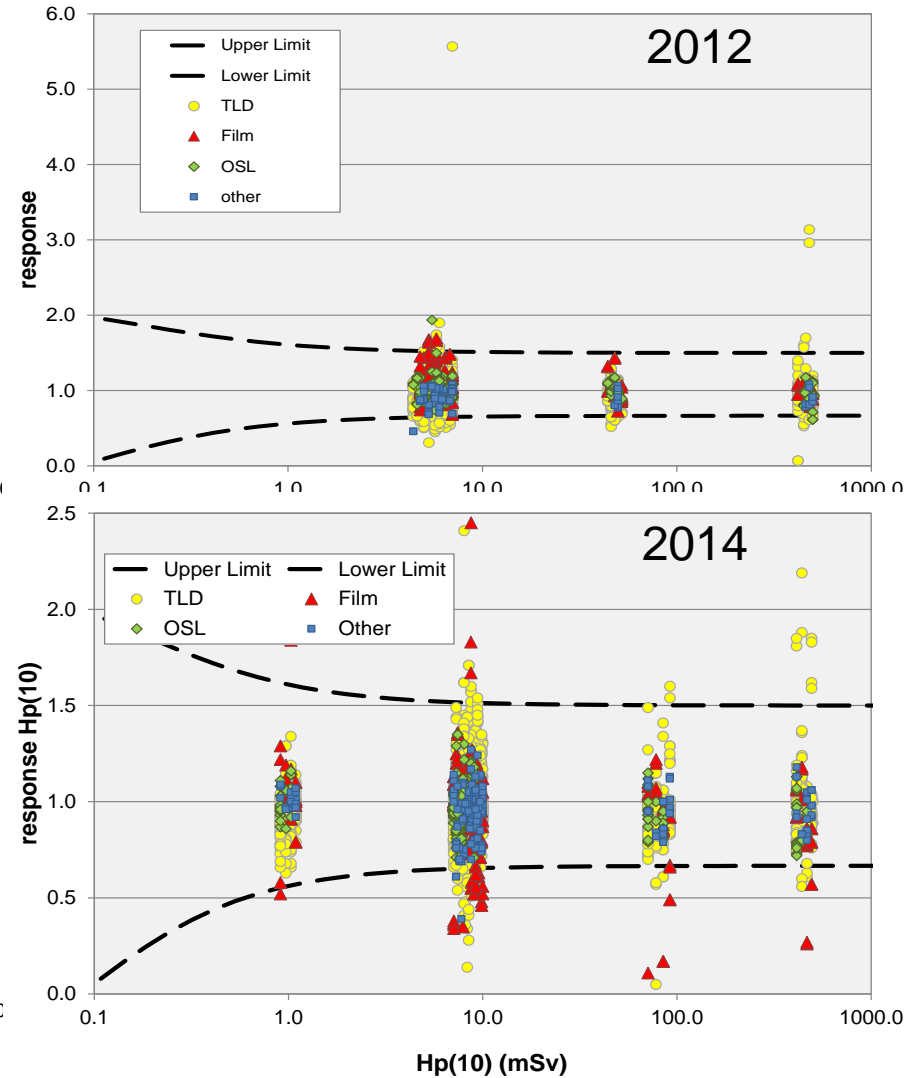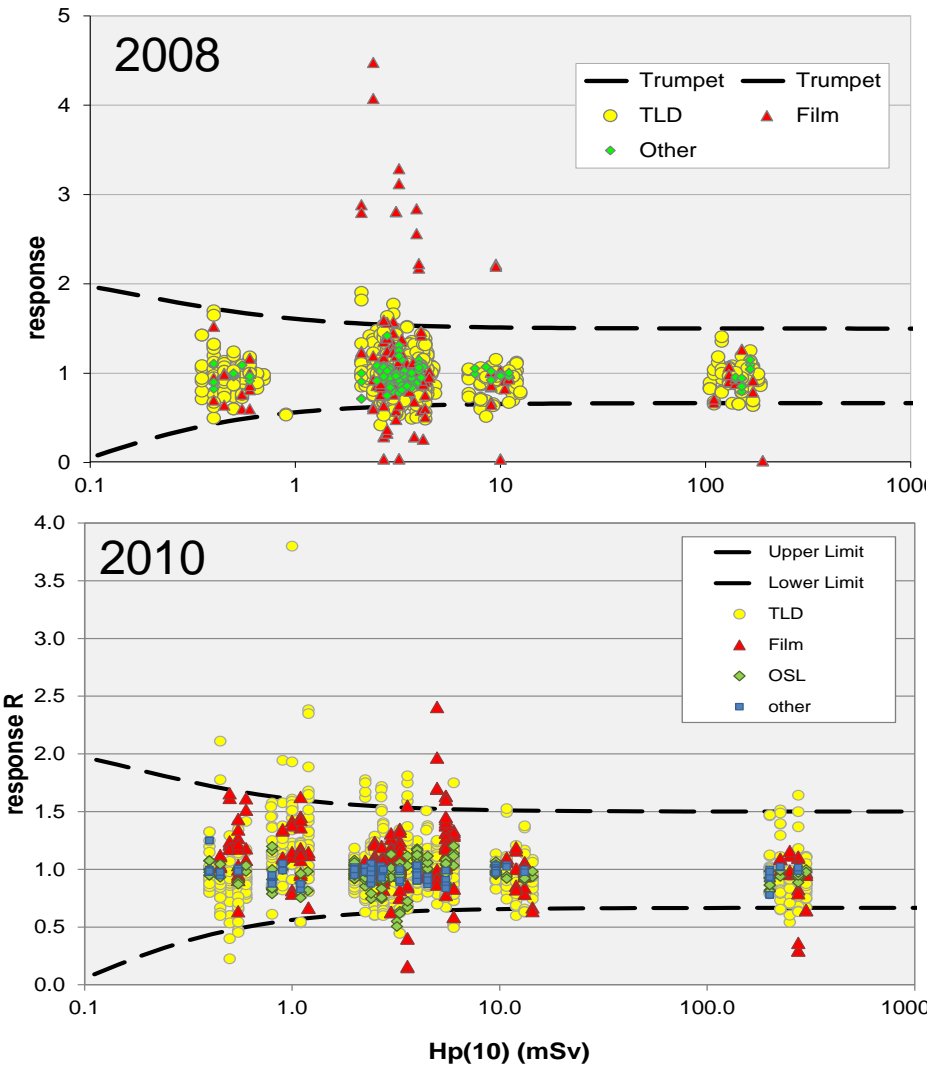auswertungsstelle

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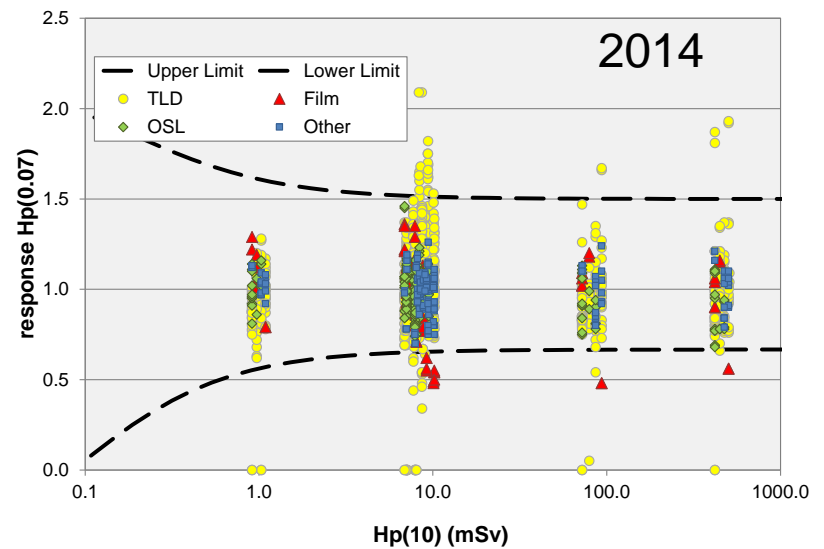
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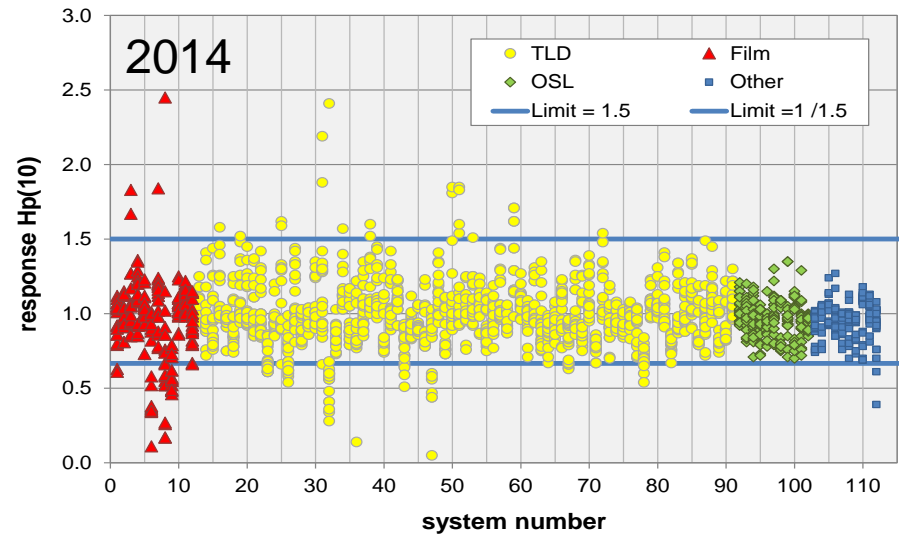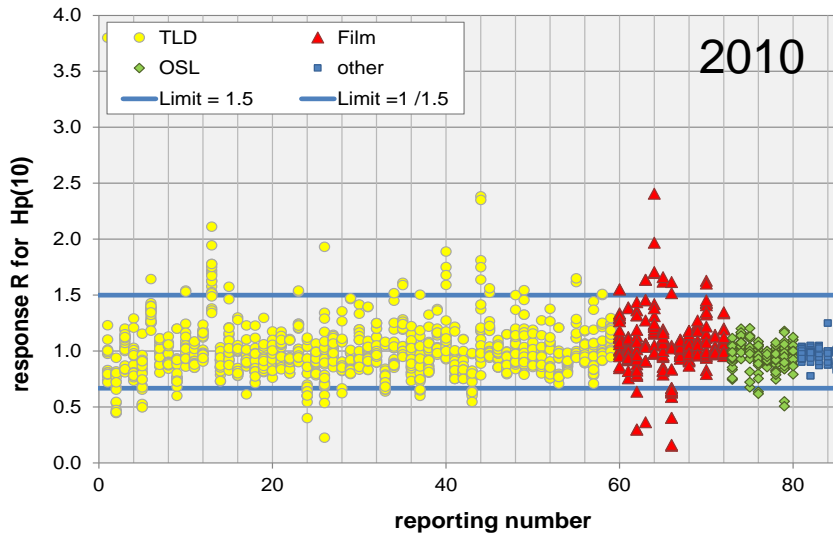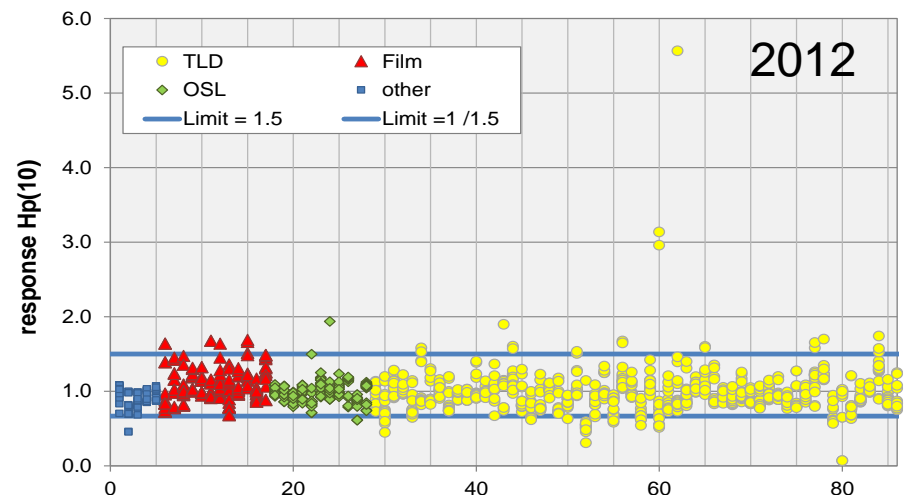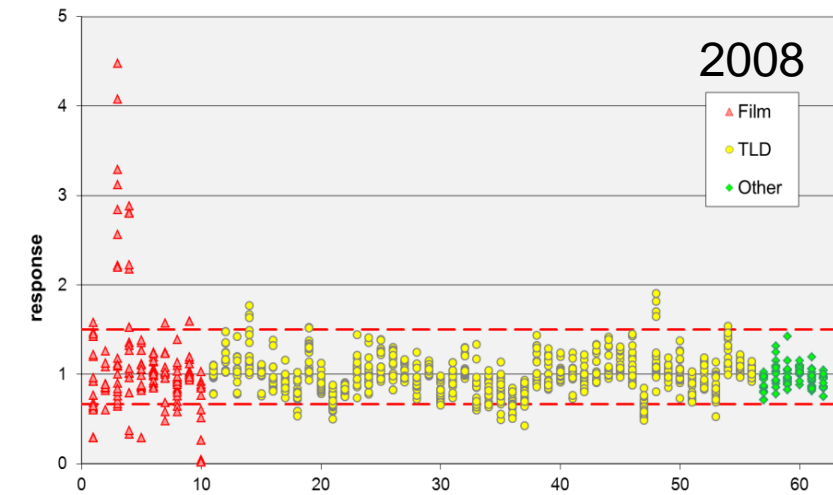
System Performance $H_p(0.07)$
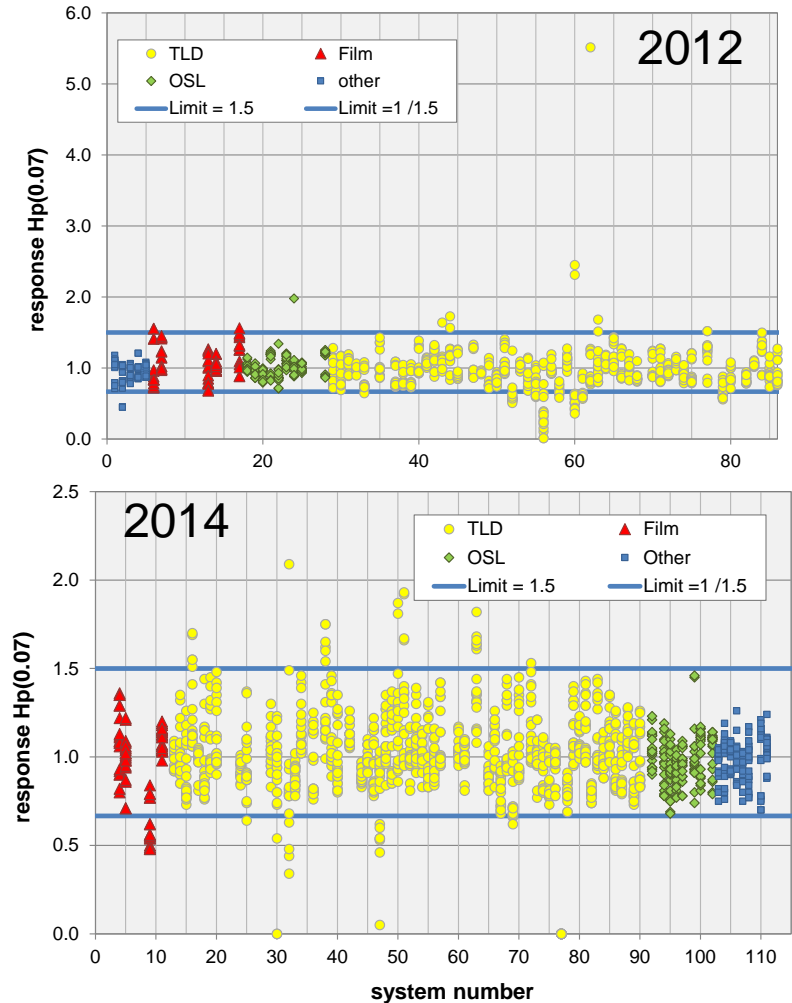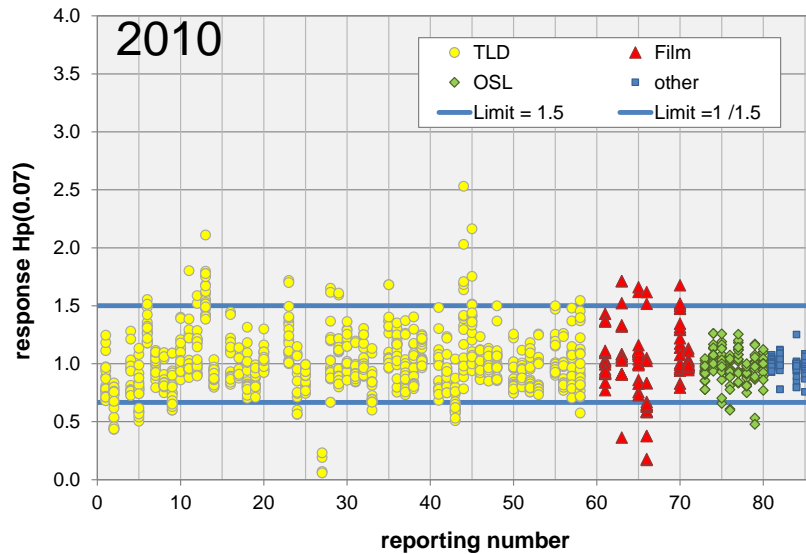
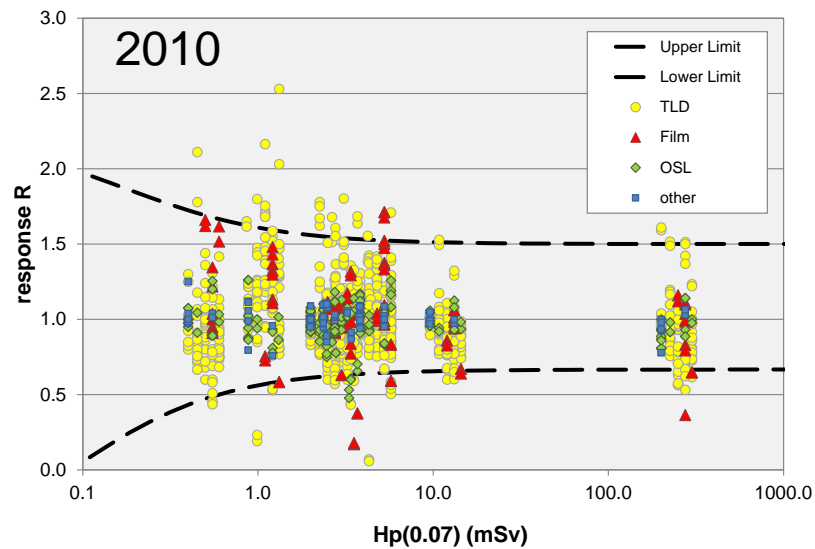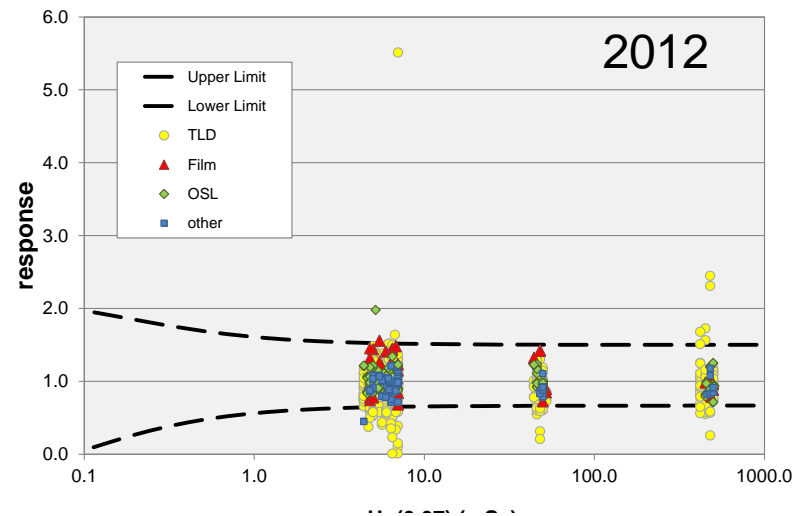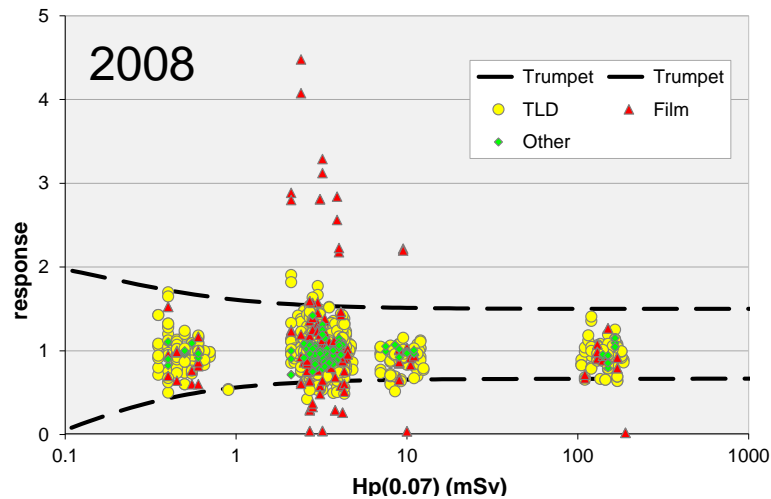# Performance – Trumpet Curve

$$\frac{1}{F}\left(1-\frac{2H_0}{H_0+H_c}\right) \le R \le F\left(1+\frac{H_0}{2H_0+H_c}\right)$$
$$F = 1.5 \qquad H_0 = 0.085\,mSv$$

Performance – Trumpet Curve $H_p(0.07)$

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Response Values - Statistics

Intercomparison	Response R - $H_p(10)$			
	2008	**2010**	**2012**	**2014**
number of valid values	**1229**	**1700**	**1392**	**2235**
$\sigma+$			1.23	1.17
mean	**0.99**	**1.00**	**0.98**	**0.98**
$\sigma-$			0.73	0.78
min	0.02	0.15	0.07	0.05
5%	0.55	0.63	0.68	0.69
25%		0.88	0.86	0.88
median (50%)	**0.98**	**0.98**	**0.97**	**0.97**
75%		1.08	1.07	1.06
95%	1.48	1.54	1.33	1.29
max	4.50	3.80	5.57	2.45

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Linearity
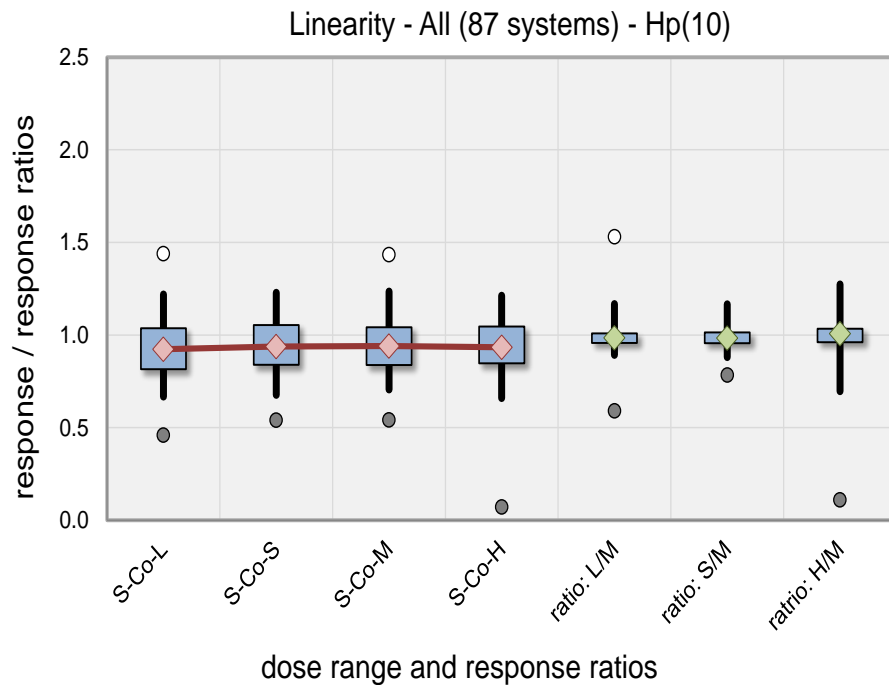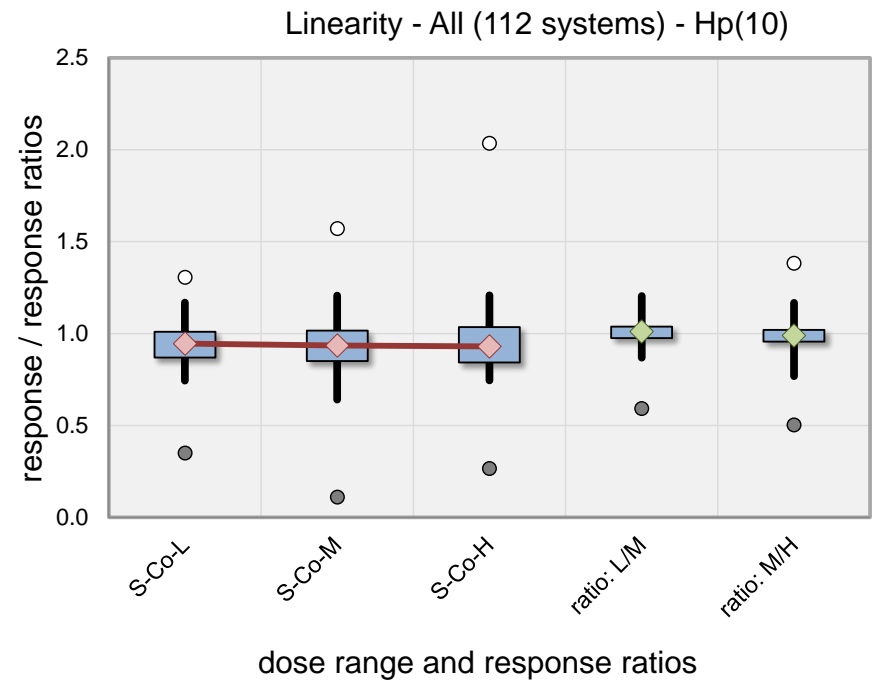
Number of Outliers – $H_p(10)$

IC	Quality		TLD	Film	OSL	Other	All
2008	**X-ray**	N60	2%	35%		0%	**7%**
		N60/45°	8%	50%		8%	**15%**
		N150/45°	4%	20%		0%	**7%**
	Gamma	S-Cs	3%	15%		0%	**5%**
		S-Co	7%	20%		0%	**8%**
	Mixed	N60/S-Cs	0%	45%		0%	**7%**
		S-Cs/N60	5%	20%		0%	**7%**
	All		**4%**	**25%**		**1%**	**7%**
2010	**X-ray**	N40/30°	10%	4%	0%	0%	**8%**
		W110/45°	2%	17%	0%	0%	**4%**
	Gamma	S-Cs	4%	1%	0%	0%	**3%**
		S-Co	8%	19%	0%	0%	**8%**
	Mixed	N40/S-Cs	7%	8%	19%	0%	**8%**
		W250/S-Cs	2%	15%	0%	0%	**4%**
	All		**5%**	**9%**	**2%**	**0%**	**5%**
2012	**X-ray**	N60	8%	4%	5%	0%	**6%**
		N60/60°	14%	25%	0%	0%	**13%**
	Gamma	S-Cs	4%	0%	0%	0%	**3%**
		S-Co	8%	0%	3%	5%	**6%**
	All		**8%**	**4%**	**2%**	**3%**	**6%**
2014	**X-ray**	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%**
	Gamma	S-Cs	2%	14%	0%	2%	**3%**
		S-Co	5%	24%	0%	0%	**6%**
	All		**4%**	**17%**	**0%**	**2%**	**5%**

Number of Outliers – $H_p(0.07)$

IC	Quality		TLD	Film	OSL	Other	All
2008	**X-ray**	N60	13%	60%		0%	**16%**
		N60/45°	16%	60%		10%	**20%**
		N150/45°	6%	30%		0%	**8%**
	Gamma	S-Cs	12%	5%		0%	**10%**
		S-Co	11%	0%		0%	**9%**
	Mixed	N60/S-Cs	10%	50%		0%	**13%**
		S-Cs/N60	14%	20%		0%	**13%**
	All		**12%**	**24%**		**1%**	**12%**
2010	**X-ray**	N40/30°	16%	17%	0%	0%	**13.4%**
		W110/45°	5%	20.8%	0%	0%	**5.6%**
	Gamma	S-Cs	10%	2%	0%	0%	**7.6%**
		S-Co	16%	25%	0%	0%	**14.2%**
	Mixed	N40/S-Cs	9%	17%	25%	0%	**11.2%**
		W250/S-Cs	7%	17%	0%	0%	**6.7%**
	All		**10%**	**12.5%**	**3%**	**0%**	**8.7%**
2012	**X-ray**	N60	5%	30%	6%	0%	**6%**
		N60/60°	5%	0%	0%	0%	**4%**
	Gamma	S-Cs	12%	0%	0%	0%	**9%**
		S-Co	15%	0%	3%	5%	**12%**
	All		**12%**	**4%**	**1%**	**3%**	**9%**
2014	**X-ray**	RQR7	9%	25%	0%	0%	**8%**
		W-80	7%	8%	0%	0%	**6%**
		W-80/60°	7%	25%	0%	0%	**6%**
		W-150	0%	0%	0%	0%	**0%**
	Gamma	S-Cs	1%	17%	0%	2%	**1%**
		S-Co	3%	24%	0%	0%	**3%**
	All		**3%**	**17%**	**0%**	**0%**	**3%**

Outliers $H_p(10)$ – Number of Participation

participated for the 1st time

2014

Outliers / Trumpet						
Quantity	Quality	TLD	Film	OSL	Other	All
Hp(10)	RQR7	14%	0%	0%	33%	14%
	W-80	19%	33%	0%	0%	18%
	W-80/60°	14%	33%	0%	17%	16%
	W-150	10%	67%	0%	0%	14%
	S-Cs	0%	28%	0%	6%	4%
	S-Co	2%	56%	0%	0%	8%
	All	6%	38%	0%	7%	10%

participated for the 3rd for 4th time

2014

Outliers / Trumpet						
Quantity	Quality	TLD	Film	OSL	Other	All
Hp(10)	RQR7	2%	13%	0%	0%	3%
	W-80	2%	0%	0%	0%	1%
	W-80/60°	6%	25%	0%	0%	7%
	W-150	4%	0%	0%	0%	3%
	S-Cs	1%	10%	0%	0%	2%
	S-Co	5%	15%	0%	0%	5%
	All	3%	11%	0%	0%	4%

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Summary

- Number of participants and systems nearly doubled from 2008 to 2014

- EURADOS intercomparisons get more international (outside EU)

- Overall response values remain stable, close to 1 and spread of the distributions get smaller

- Coefficient of Variation for identical irradiation conditions are about 2 - 4% and remain stable

- In each intercomparsion a few services show problems with their calibration

- There is no bad system type: for example, TLD and Film show very good and low performing systems. All system types show outliers between 2008 - 2014

- Systems that participate regularly perform better, than systems from new participants

- Outliers for $H_p(0.07)$ systems where reduced from 12% to 4% (mainly caused by improved quality of TLD systems)

EURADOS regular intercomparisons became an important factor for improving the quality of individual monitoring in Europe and even world wide