Dosemeter Algorithms

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Two element whole body dosemeter

- **HARSHAW dosemeter card**
- **2 LiF:Mg,Ti chips**
  (3.2 mm x 3.2 mm x 0.38 mm) .
- The wrapped card is worn in a service specific dosemeter badge (containing the different filter elements)
- Application of a **dose algorithm** on the basis of the dose information of each single TL chip allows the calculation of the personal dose in the appropriate dose quantity.

Example for application of Algorithms

ELSEVIER

Available online at www.sciencedirect.com
ScienceDirect

Radiation Measurements 43 (2008) 571–575

Radiation Measurements

www.elsevier.com/locate/radmeas

Comparison of different dose algorithms used to evaluate a two element LiF:Mg,Ti TL personal dosemeter

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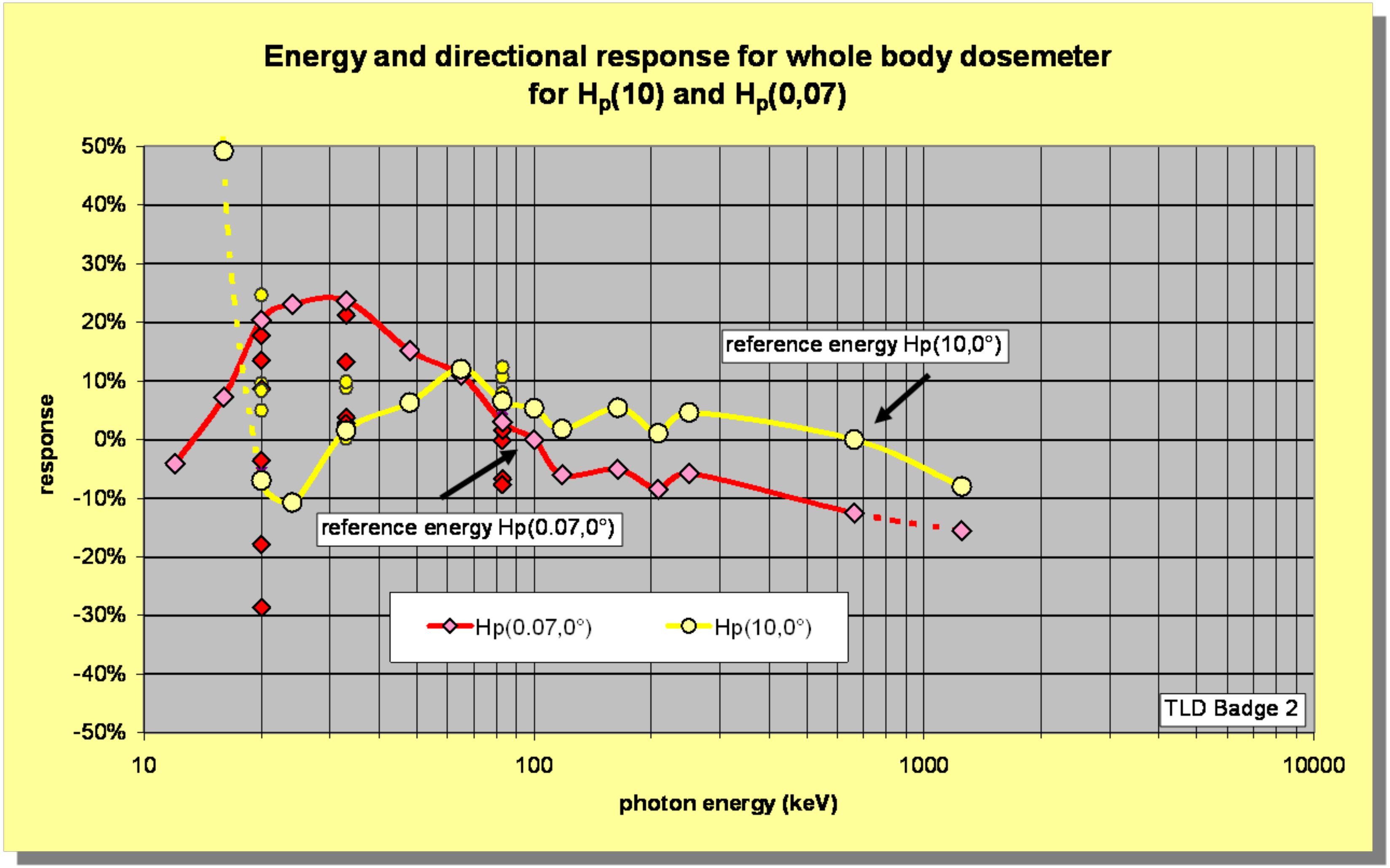
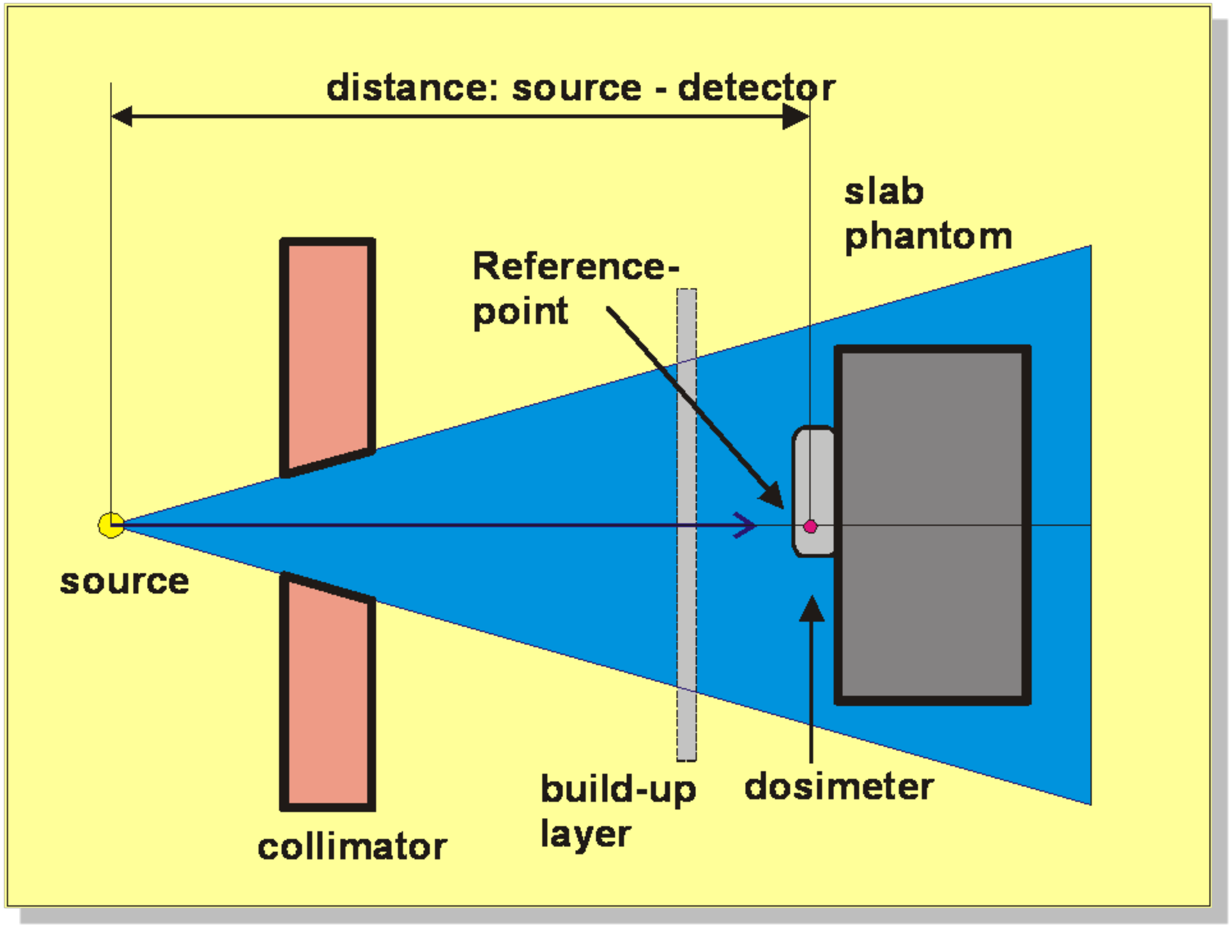
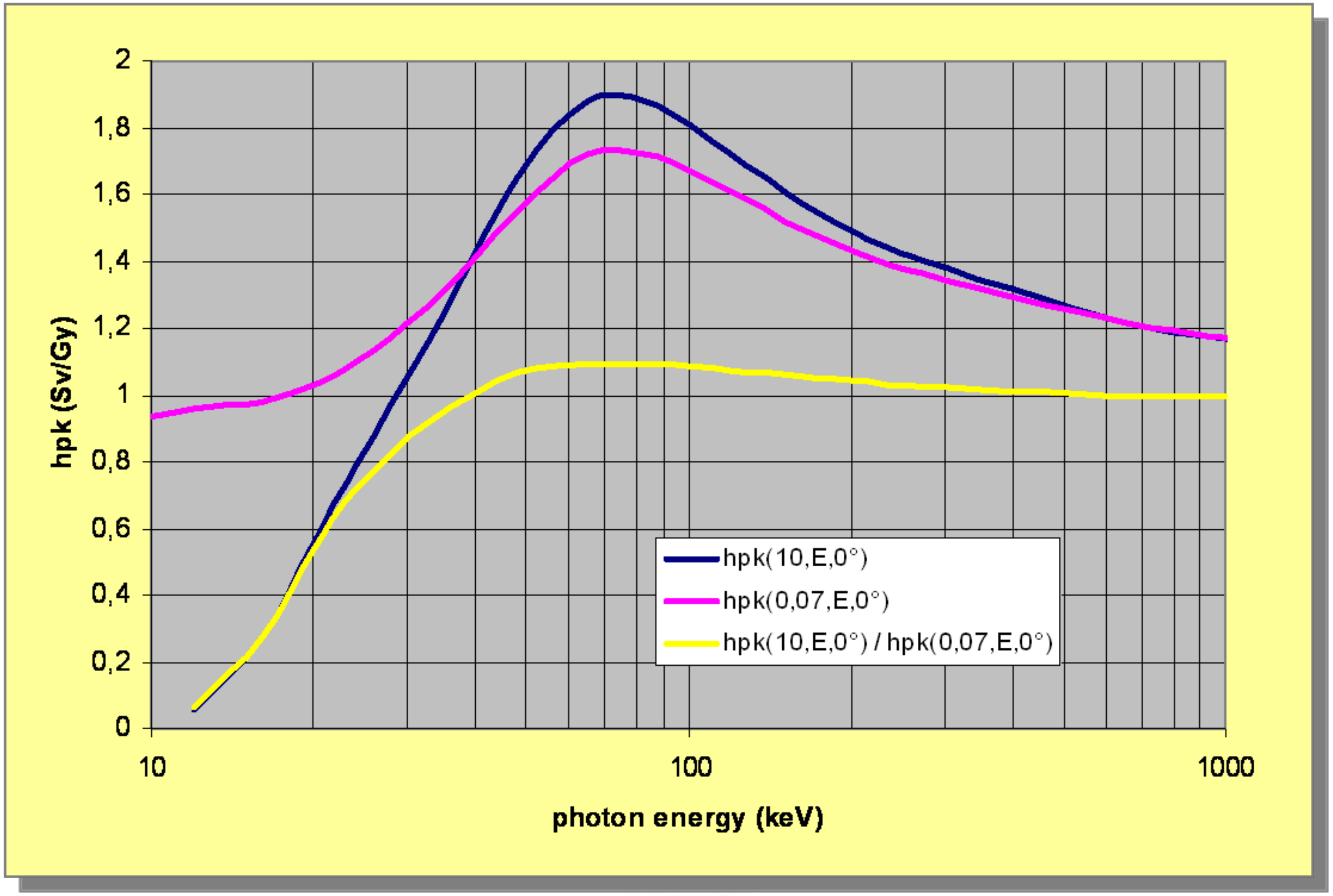

Energy and directional response for whole body dosemeter
for $H_p(10)$ and $H_p(0,07)$
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
response
10
100
1000
10000
photon energy (keV)
reference energy Hp(10,0°)
reference energy Hp(0.07,0°)
Hp(0.07,0°)
Hp(10,0°)
TLD Badge 2

Calibration on the phantom (H_p)



Conversion factors h_{pk} (ISO 4037-1)



Dose Quantity used in Austria for personal monitoring

- Photon dose equivalent H_x [Sv]
  - Definition: $H_x = 0.01$ Sv/R· X
  - Relation: $H_x \cong 1.139$ Sv/Gy · K_a

    X standard exposure

    K_a air kerma

The **kerma**, K, is the quotient of dE_{tr} by dm, where dE_{tr} is the sum of the initial kinetic energies of all the charged particles liberated by uncharged particles in a mass dm of material, thus

$$K = \frac{dE_{tr}}{dm} .$$

Unit: J kg^{-1}

The special name for the unit of kerma is gray (Gy).

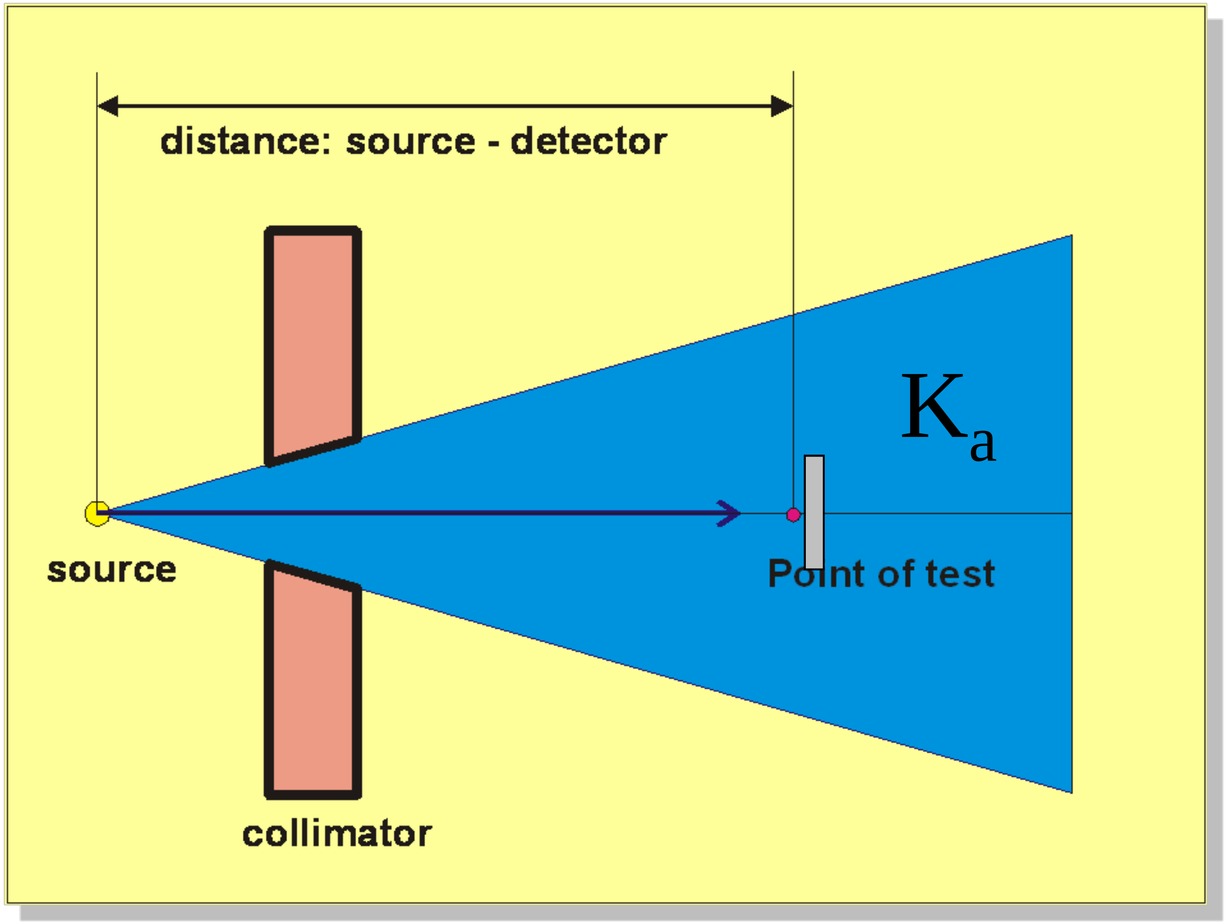
- Personal dose equivalent $H_p(d)$ [Sv]
  - $H_p(10)$
  - $H_p(0.07)$

The **personal dose equivalent,** $H_p(d)$, is the dose equivalent in soft tissue, at an appropriate depth, d, below a specified point on the body.

Unit: J kg^{-1}

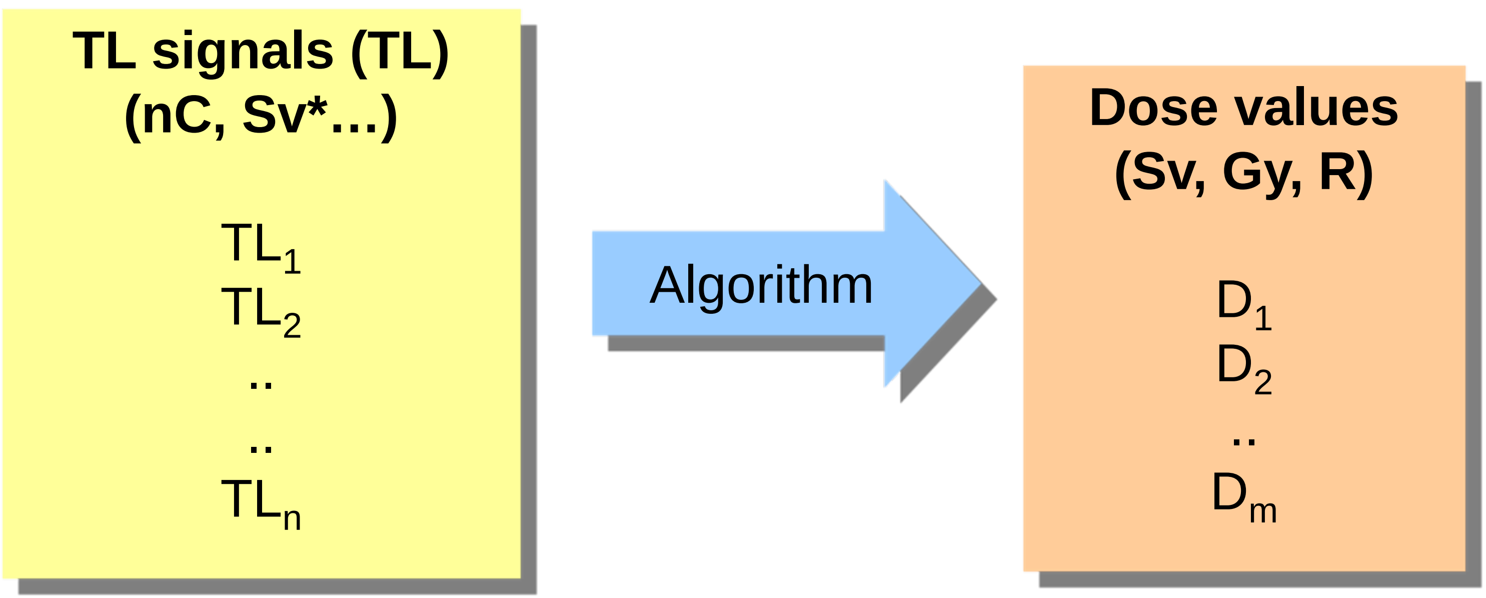
The special name for the unit of personal dose equivalent is sievert (Sv).

Free in air calibration (K_a)

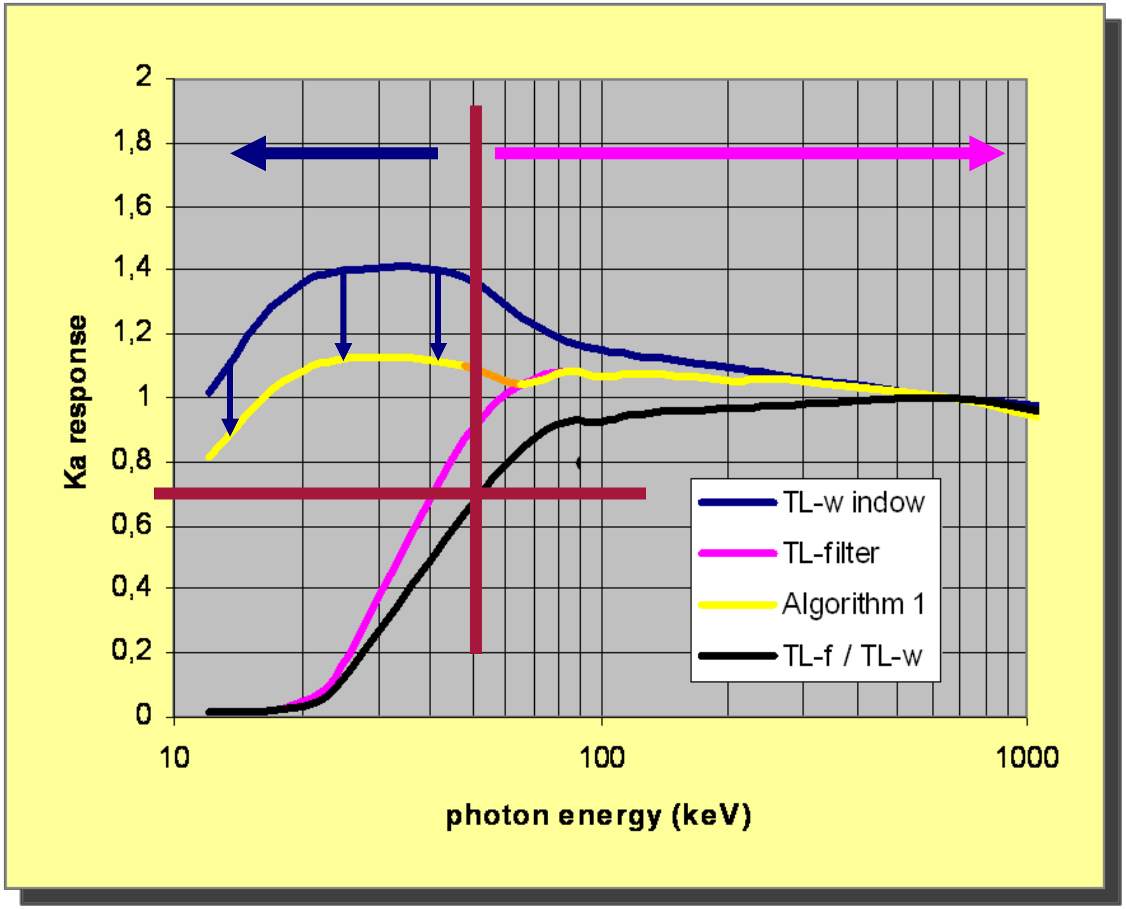


Dose Algorithm

- Each of n TL-Element gives (at least) one detector signal TL_i
- **Combination of all detector signals** TL gives dose values D_i in the appropriate dose quantity



Algorithm 1 (for Air Kerma / free in air)



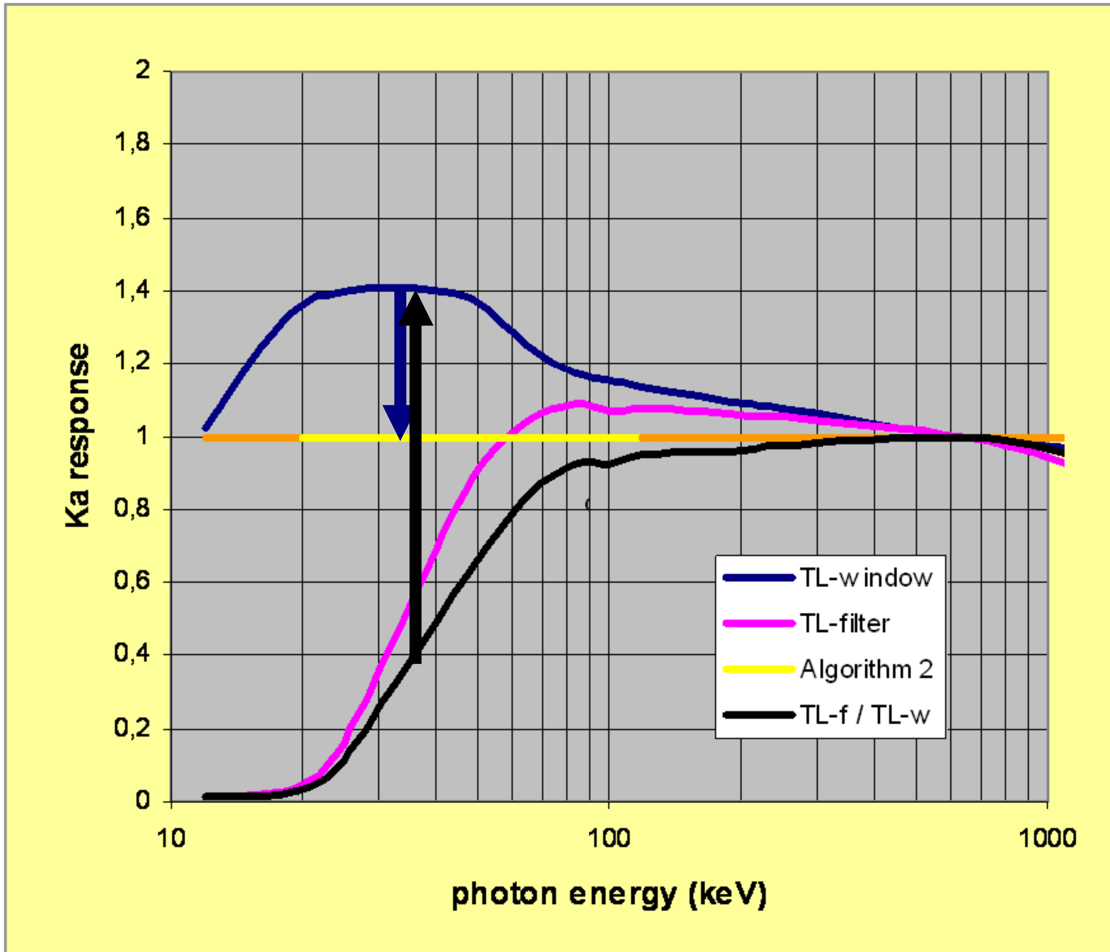
"if" dose algorithm 1:

$$\frac{TLf}{TLw} \geq 0.7 \Rightarrow K_a = N \cdot TLf$$

$$\frac{TLf}{TLw} < 0.7 \Rightarrow K_a = N \cdot 0.8 \cdot TLw$$

$\Rightarrow$ energy response $< \pm 20\%$

Algorithm 2 (for Air Kerma / free in air)



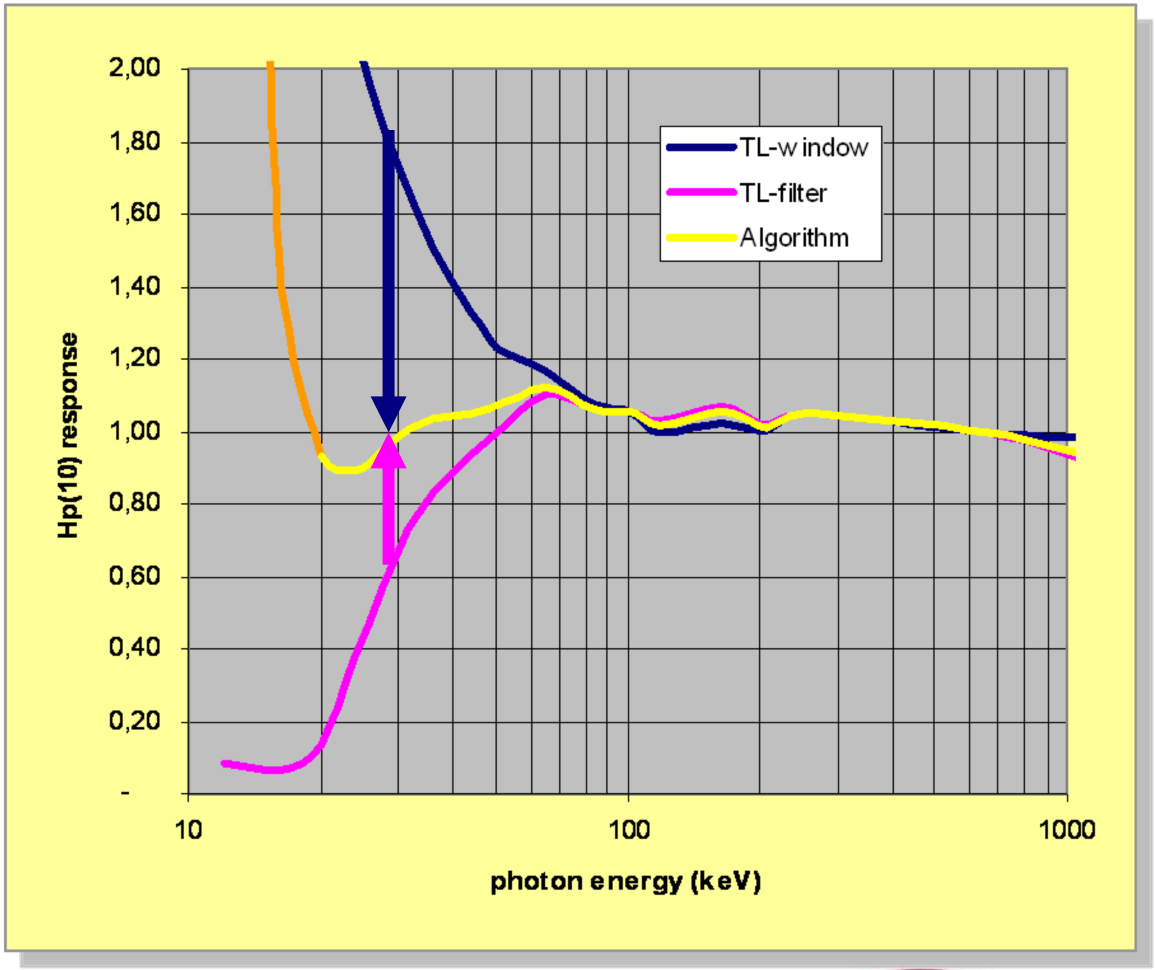
"spccial" dosc algorithm 2 :

$$K_a = N \cdot \frac{TLw}{f_w\left(\frac{TLf}{TLw}\right)}$$

f_w(R)......energy respons of TLw

$\Rightarrow$ Energy response $\approx$ 0%

Algorithm 3a (for $H_p(10)$ / on slab phantom)



"linear" dose algorithm 3a :

$$H_p(10) = N \cdot \left(a \cdot TLw + (1-a) \cdot TLf\right)$$

$\Rightarrow$ Energy response $< \pm 15\%$

$\Rightarrow$ Reference radiation quality : S - Cs

Dose algorithms used in Eurpoe

Radiation Protection Dosimetry (2004), Vol. 112, No. 1, pp. 45–68
doi:10.1093/rpd/nch283

A CATALOGUE OF DOSEMETERS AND DOSIMETRIC SERVICES WITHIN EUROPE—AN UPDATE

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- **From 43 European services:**
  - No algorithm: 60%
  - „If“ algorithm: 10%
  - Linear combination: 30%

Linearity of Algorithms

Linearity :

$$D(\ )\ \ldots\ldots\ldots\ \ H_x,\ H_p(10),\ H_p(0.07)$$

$$D(TLw_1 + TLw_2, TLf_1 + TLf_2) = D(TLw_1, TLf_1) + D(TLw_2, TLf_2)$$

Algorithms

Linearity :

$D(\ )$ .... H_x, $H_p(10)$, $H_p(0.07)$

$$D(TLw_1 + TLw_2, TLf_1 + TLf_2) = D(TLw_1, TLf_1) + D(TLw_2, TLf_2)$$

"if" dose algorithm 1 :

$$\frac{TLf}{TLw} \geq 0.7 \Rightarrow K_a = N \cdot TLf$$

$$\frac{TLf}{TLw} < 0.7 \Rightarrow$$

$\Rightarrow$ energy r

"special" dose algorithm 2 :

$$K_a = N \cdot \frac{TLw}{f_w\left(\frac{TLf}{TLw}\right)}$$

$f_w(\mathrm{R})$......energy respons of TLw

$\Rightarrow$ Energy response $\approx 0\%$

"linear" dose algorithm 3a :

$$H_p(10) = N \cdot (a \cdot TLw + (1-a) \cdot TLf)$$

$\Rightarrow$ Energy

$\Rightarrow$ Referen

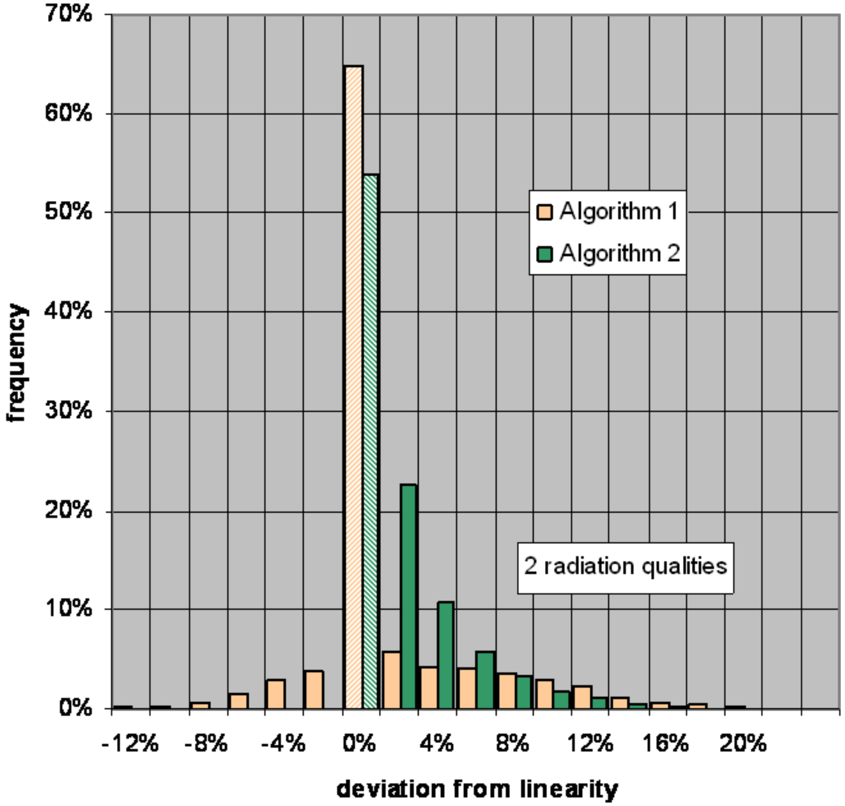
"linear" dose algorithm 3b :

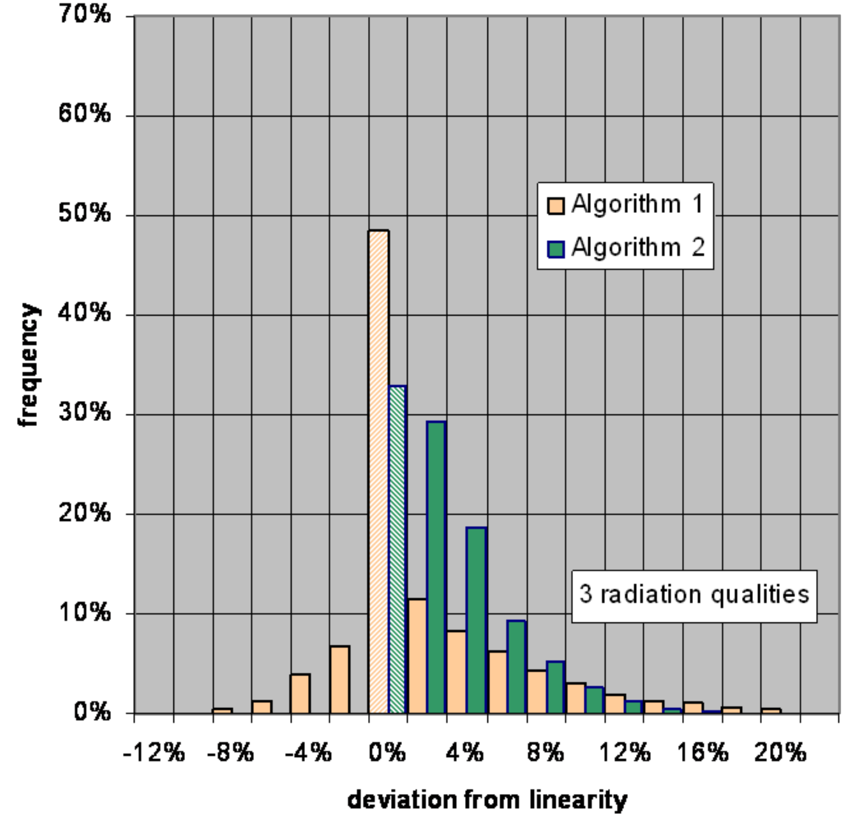
$$H_p(0.07) = N \cdot (b \cdot TLw + (1-b) \cdot TLf)$$

$\Rightarrow$ Energy response $< \pm 25\%$

$\Rightarrow$ Reference radiation quality : N-120

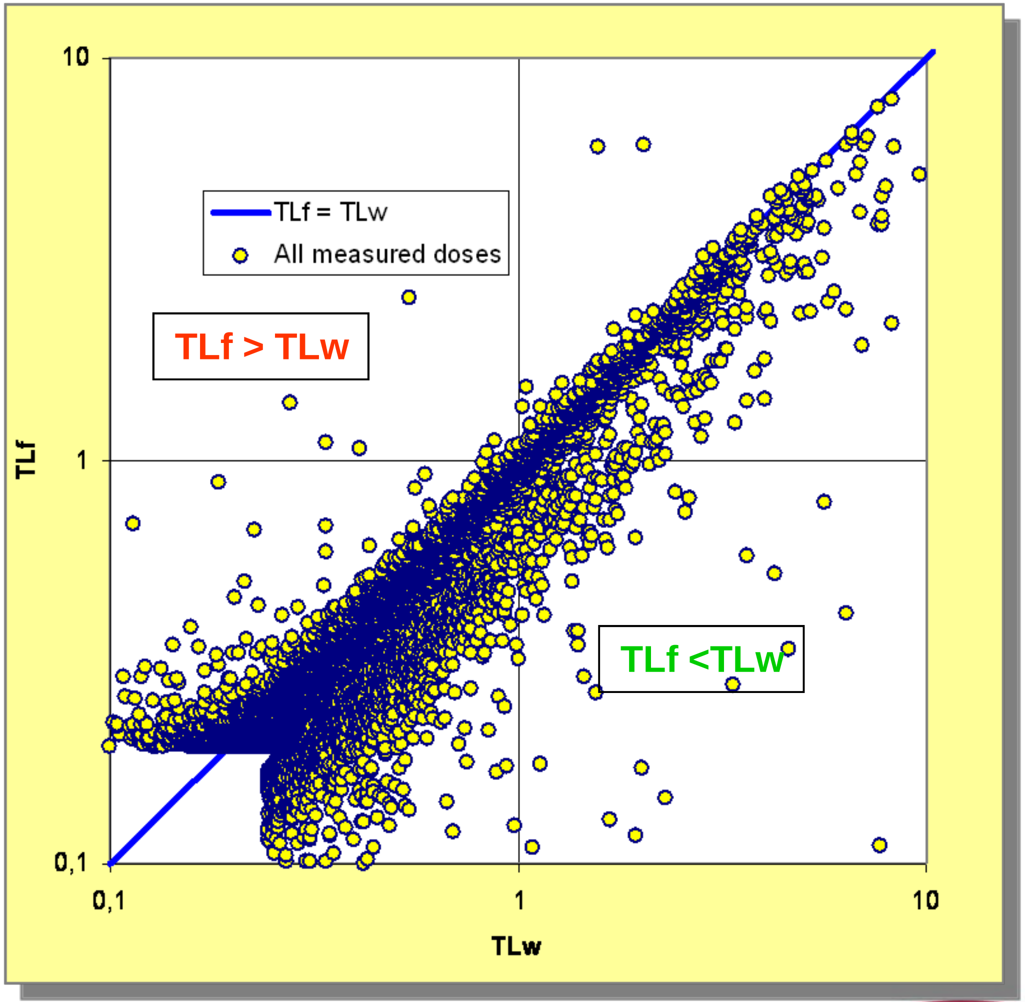
Simulation of „mixed fields“

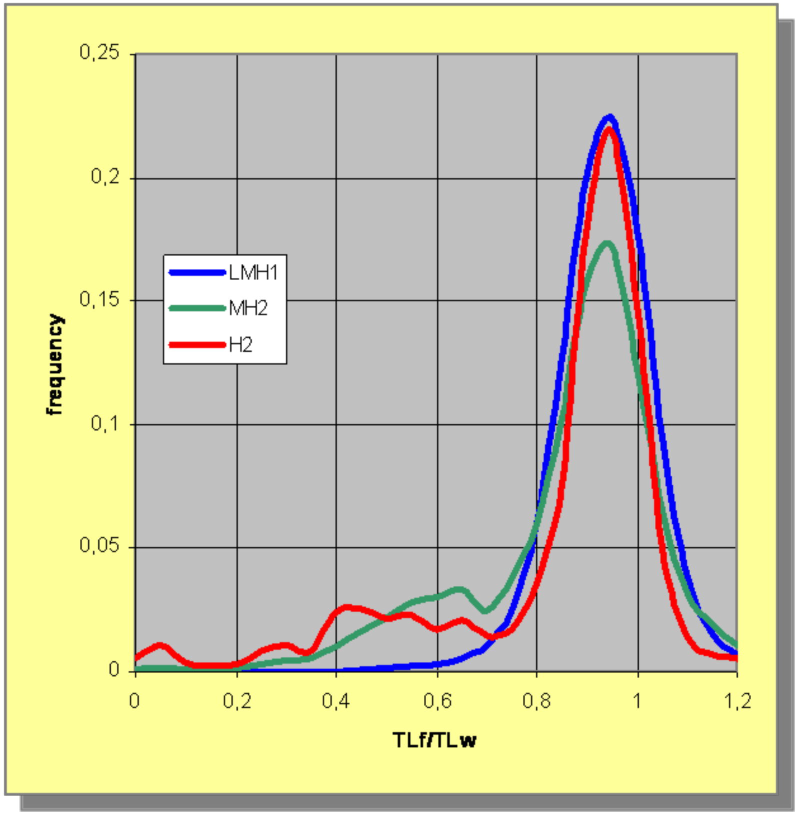




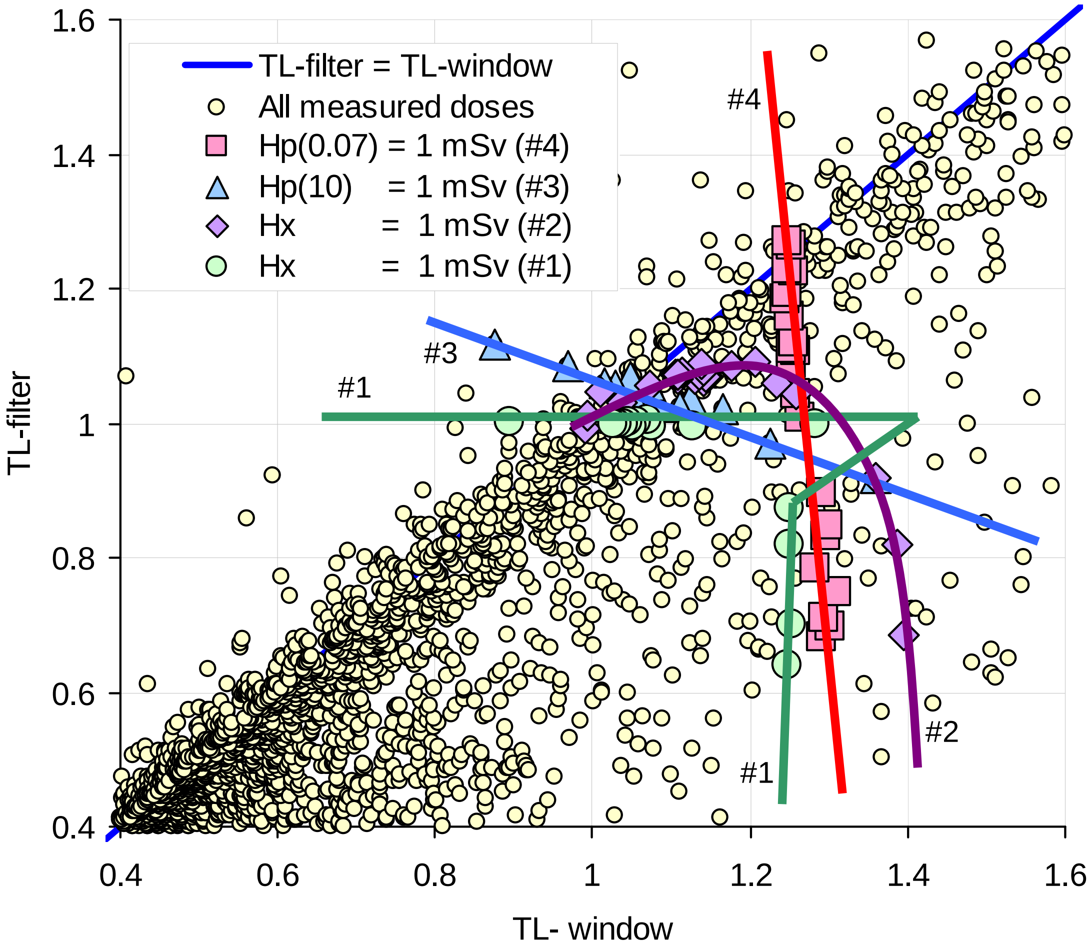
$$deviation = D(TLw_1 + TLw_2, TLf_1 + TLf_2) - \left(D(TLw_1, TLf_1) + D(TLw_2, TLf_2)\right)$$

Single measured doses





Single measured doses



The best directional and energy response does not work if …