

# DOSIMETRIC STANDARD FOR MEDIUM ENERGIES X-RAYS RANGE AT LNHB: PROGRESS OF THE PROJECT

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## CONTEXT

The I.C.R.P. (International Commission of Radiological Protection) enacted the first recommendations to protect against the effects of the ionizing radiations (ex erythemas and leukaemias).

The recommendations were modified along the years and are today the roots of the 96/29 Euratom directive which ensures the protection of the public and the workers.

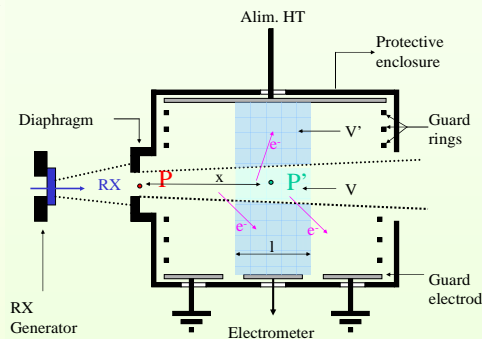
The 97/43 Euratom directive is particularly applied in the medical field for irradiations of patients to optimize benefit-to-risk ratios.

The application of these directives transcribed in the French legislation, set rules for maintenance, internal and external quality control of the machines, written procedures and a metrological traceability.

The LNHB, french national laboratory for metrology of ionizing radiations, has to deliver to secondary accredited laboratories, or directly to users, dosimetric standards for continuous X-rays of medium-energies.

## METHOD

Air-Kerma rate (in Gy.s<sup>-1</sup>) measurement with Free-Air Ionization Chamber



$$\dot{K}_{air} = \frac{I}{\rho_{air} \cdot V} \cdot \frac{W_{air}}{e} \cdot \frac{1}{1-g} \cdot \prod_i k_i$$

## X-RAYS RADIATION QUALITIES

Radiation qualities according to the recommendations of the C.C.E.M.R.I.

Generating potential (kV)	100	135	180	250
Additional Al filtration (mm)	0.318	-	-	-
Additional Cu filtration (mm)	-	0.206	0.459	1.552
Al HVL (mm)	4.044	-	-	-
Cu HVL (mm)	-	0.488	0.981	2.487
(μ/ρ) <sub>air</sub> (cm <sup>2</sup> /g)	0.256	0.187	0.166	0.141
Air-kerma rate (mGy/s)	0.52	0.48	0.50	0.53

Radiation qualities according to the recommendations of the NF ISO 4037

Generating potential kV	Energy KeV	Resolution RE %	additional filtration (mm)			1st HVL mm Cu	2nd HVL mm Cu
			Pb	Sn	Cu		
100	83	28	-	-	5.0	1.11	1.17
120	100	27	-	1.0	5.0	1.71	1.77
150	118	37	-	2.5	-	2.36	2.47
200	164	30	1.0	3.0	2.0	3.99	4.05
250	208	28	3.0	2.0	-	5.19	5.23

## CORRECTION FACTORS

The characteristic correction factors of the detector are given for each radiation quality (C.C.E.M.R.I.)

Correction Factors	Generating potential				Relative uncertainty	
	100kV	135kV	180kV	250kV	Type A	Type B
*k <sub>sc</sub> scattered radiation	0.9936	0.9946	0.9953	0.9965	-	0.07%
*k <sub>e</sub> electron loss	1.0001	1.0010	1.0031	1.0065	-	0.10%
k <sub>r</sub> recombinaison	1.0003	1.0002	1.0002	1.0003	0.08%	-
k <sub>pol</sub> polarization	1.0001	0.9999	0.9999	1.0001	0.05%	-
k <sub>air</sub> attenuation	1.0092	1.0067	1.006	1.0051	-	0.10%
k <sub>d</sub> field distortion	1.0000	1.0000	1.0000	1.0000	-	0.10%
k <sub>t</sub> transmission through diaph.	0.9999	0.9999	0.9999	0.9999	-	0.01%
k <sub>w</sub> transmission through walls	0.9998	0.9998	0.9998	0.9998	-	0.01%
k <sub>h</sub> humidity	0.9980	0.9980	0.9980	0.9980	-	0.03%
Total	1.0009	1.0001	1.0021	1.0061	0.09%	0.19%

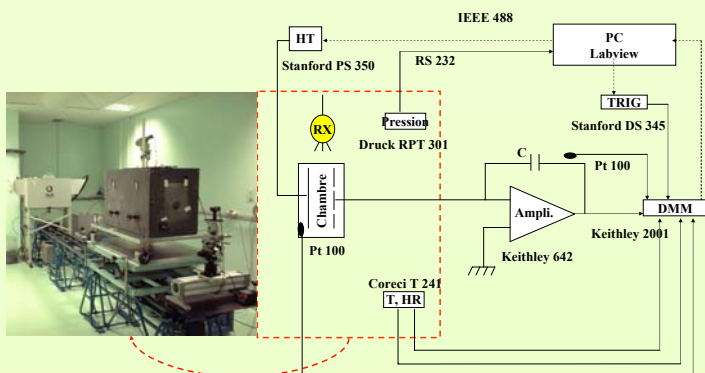
\* Factors determined by Monte-Carlo simulation (PENELOPE Code)

## THE LNHB STANDARD (WK06)



Standard WK06	
Aperture diameter (cm)	1.0074
Air path length PP' (cm)	31.8
Collecting width (cm)	23.1
Electrode separation (cm)	18.0
Collecting length (cm)	6.0004
Measuring volume (cm <sup>3</sup> )	4.7827
bias voltage (V)	5000

## EXPERIMENTAL CONDITIONS



## ESTIMATED UNCERTAINTIES

Air-kerma rate	Relative uncertainty	
	Type A	Type B
Volume	-	0.05%
Positioning	-	0.10%
Ionization current	0.02%	0.15%
Correction factor k <sub>r</sub>	-	0.04%
Correction factor k <sub>p</sub>	-	0.02%
Correction factors k <sub>i</sub>	0.09%	0.19%
Physical Constants (W <sub>air</sub> /e and ρ <sub>air</sub> )	-	0.15%
Air-kerma rate	0.10%	0.31%
Quadratic sum	0.32%	

Uncertainties on the air-kerma rate

Calibration coefficient	Relative uncertainty	
	Type A	Type B
Standard air-kerma rate	0.10%	0.31%
Positioning of transfer chamber	-	0.10%
Ionization current I <sub>tr</sub>	0.02%	0.15%
Correction factor k <sub>r</sub>	-	0.04%
Correction factor k <sub>p</sub>	-	0.02%
N <sub>K</sub>	0.10%	0.36%
Quadratic sum	0.37%	

Uncertainties for the calibration of a transfer chamber