IN-PHANTOM AND WELL-TYPE IONIZATION CHAMBER CALIBRATION TECHNIQUES COMPARISON FOR IR-192 HDR BRACHYTHERAPY

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Introduction:

PTW Al T9193 phantom is being used to measure the air-Kerma strength $K_{a,100}$ Ir-192 Source. The $K_{a,100}$ utilizing Well-type ionization chamber (WIC) measurements, the standard method to measure the Air-Kerma strength $K_{a,100}$ for the Ir-192, used as a reference for the VariSource HDR ^{192}Ir sources.
The aim of this study was to compare air kerma strength measurements $K_{a,100}$ using in-phantom method with the WIC calibration method.

Method:

For phantom measurement, Farmer chamber PTW 30012-1, with volume of 0.6 cc and electrometer PTW UNIDOS E were used. The chamber has a calibration factor in terms of $N_{D,\,W.}$ at reference beam quality *Co-60*.
The phantom is 20-cm diameter and 12-cm height. In the center, there is a hole for afterloading applicator. There are 4 holes for detector adaptors with $\theta = 90^{o}$ located 2 cm from the edges and 8 cm from the central hole. The phantom placed on a tripod Cullman REF L651002 to avoid backscattering. At each position, a 3×60 sec charge measurements were acquired. The mean value over all measurements (nC/min) was acquired in the 4 peripherals (θ = 90o) position aforementioned $\bar{M}_{PMMA}$.
For the WIC measurements, Imaging HDR-1000 plus with its electrometer CDX-2000B used in this work.

Results:

The formalism (*) was applied to calculate the $K_{a,100}$. Where M_{PMMA} is the mean value (*nC/min*). A global correction factor $(K_{tot})_{K_{a,100}}$ includes factors $K_Q$to correct the beam quality deviation, $(1-g_w)^{-1}$ correction for energy loss due to bremsstrahlung in water, $S_{a,w}$ for the conversion of water into air-kerma, K_{wp} perturbation factor for PMMA measurement, K'_{zp} correction for the influence of the PTW phantom. A global correction factor was calculated to be equal to 0.0068.
From table 1, The $K_{A,100,PMMA}/K_{A,100,HDR\text{-}1000}$ is approximately constant for the five sources, a mean value equal to 0.997±0.005.

Table 1: Comparison of the Calibration Results for Both Well-Type Chambers and the Cylindrical Phantom

Measurements	RAKR0, phantom	RAKR0, HDR-1000	Ratio
1	46.17	46.28	0.998
2	44.95	45.08	0.997
3	46.54	46.97	0.991
4	47.69	47.65	1.001
5	45.09	45.62	0.988
Mean =	46.17	46.28	
Residual Mean Square =	0.000108		

$$\dot{K_{a,100}} = M_{PMMA}\times N_{D,w}\times K_Q\times(1-g_w)^{-1}\times S_{a,w}\times K_{wp}\times K'_{zp}\times K_V\times K_r. \qquad (*)$$

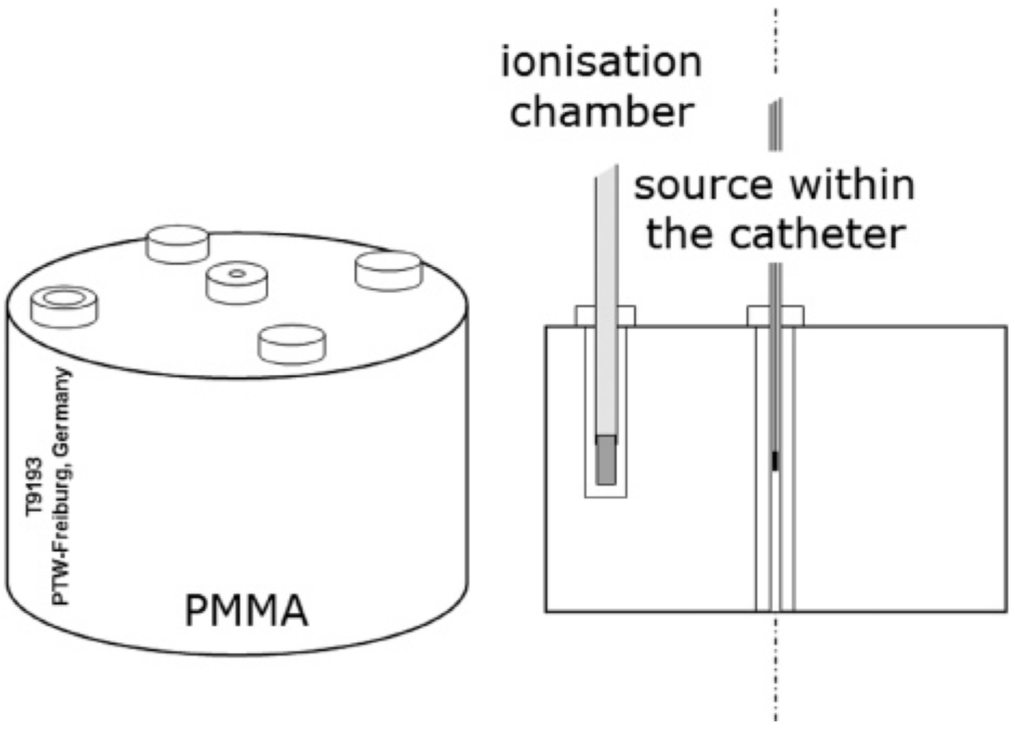

Table 2: Deviation from the manufacturer's certificate

Measurements	RAKR0, Meas	RAKR0, Cert	Diff (%)
1	46.17	46.565	-0.85
2	44.95	44.491	1.04
3	46.54	46.91	-0.78
4	47.69	47.554	0.28
5	45.09	45.16	-0.16

Conclusion:

The results underline the equivalence of *in-phantom* calibration method to the WIC. The in-phantom calibration technique showed lower values for the five sources than the manufacturers within 5 % as shown in table.2. The mean deviations were 0.63% ± 0.1. However, a high degree of agreement was demonstrated over the five sources.

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