INTERNATIONAL CONFERENCE ON RADIATION IN VARIOUS FIELDS OF RESEARCH
RAD 10th Jubilee Spring Edition
June 13-17, 2022 | Hunguest Hotel Sun Resort
Herceg Novi | Montenegro

# ISO 4037:2019 VALIDATION OF RADIATION QUALITIES USING THE HALF-VALUE LAYER AT THE NATIONAL SECONDARY STANDARD DOSIMETRY LABORATORY OF MOROCCO

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# INTRODUCTION

To ensure that the testing and calibration of radiation protection instruments, namely dosimeters and dose rate meters, as well as the determination of their response, are carried out in a reliable and traceable manner, it is necessary to use the reference radiation validated and for this purpose and for standardization between different organizations, the international standard has revised and discontinued the ISO 4037 1996 series of technical specifications and made available ISO4037-1:2019,ISO4037-2:2019,ISO4037-3:2019 and ISO4037-4:2019.

# INTRODUCTION

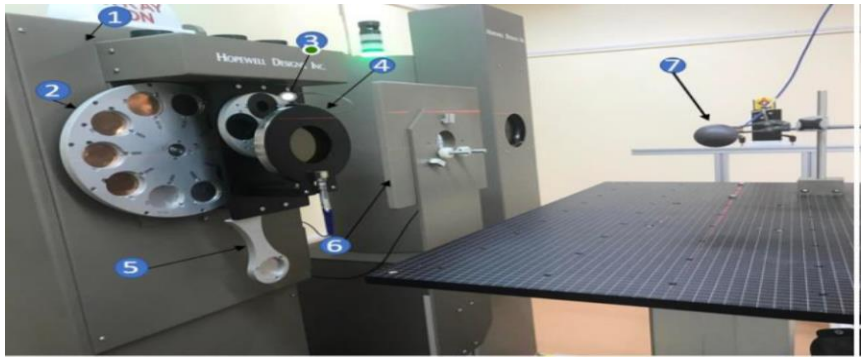
In this work, the narrow-spectrum X-ray series ranging from 30 kVp to 300 kVp has been established according to the above-mentioned standards, the inherent filtration of the tube, the additional filtration, the first half-attenuation layer (1st HVL), the second half-attenuation layer (2nd HVL) and the homogeneity coefficient were measured experimentally.

# MATERIALS

Measurements were performed with an X-ray irradiator model X80-320 apparatus represented by HOPEWELL DESIGNS, INC, it has a ceramic tube and tungsten anode target with a 20° angle, a 5.5 mm focal field and inherent 3 mm beryllium filtration.

# MATERIALS

The major subsystems of the x-ray system are: 1) shielded enclosure 2) filter wheel 3) shutter and beam collimator 4) control chamber 5) added filtration6) HVL holder 7) Ps (50) ion chamber



# METHODS

## Inherent filtration

Without any additional filtration and at 60 kV, the inherent filtration was measured using the Ps (50) ionization chamber placed at 1m from the center of the tube.

The measurement method consists of 10 charge readings of 60 seconds each, taken with an overlay of additional aluminum filters placed in such a way as to obtain a reduction of about 50% of the initial charge.

The inherent filtration was calculated based on Table 9 of ISO 4037 using interpolation with a second order polynomial.

# METHODS

Half-value layer

The first half-value layer is described in ISO4037 as the thickness of the specific material that attenuates the radiation beam to a measurement of half its original value, while the second half-value layer is described as the thickness of the same material for the measurement of the first half-value layer that attenuates the beam to a measurement of one-quarter its original value minus the first half-value layer.

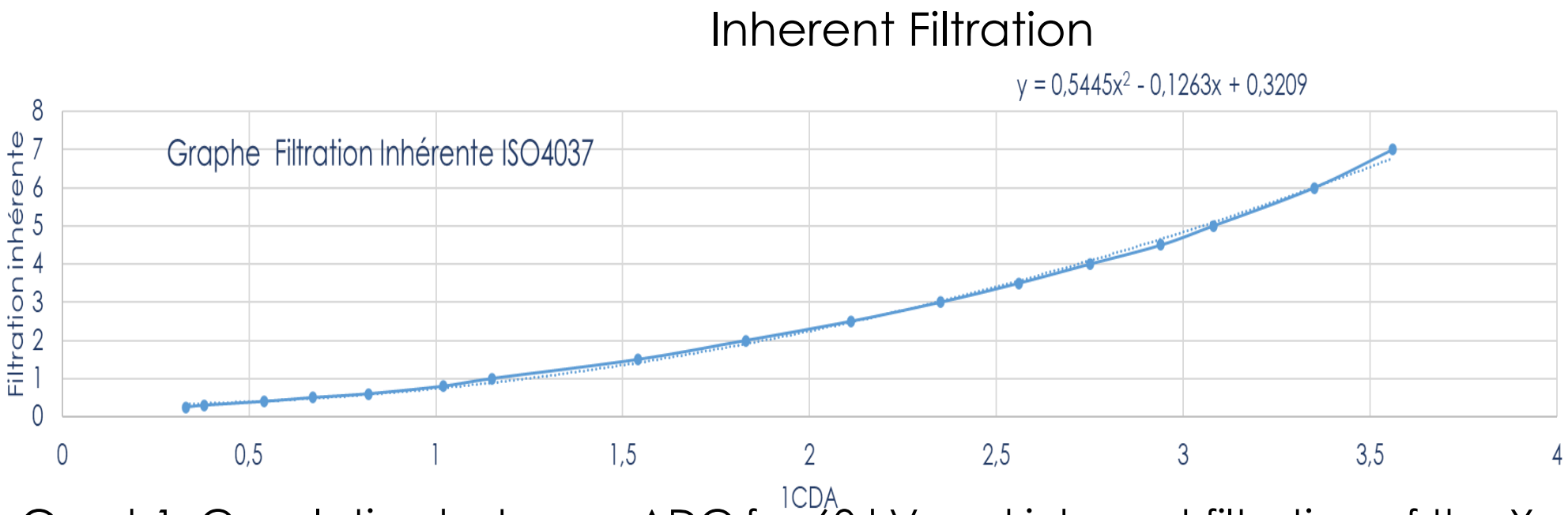
For homogeneity, this is the ratio of the 1st HVL to the 2nd HVL.

# METHODS

In the presence of inherent filtration, and using different thicknesses of copper or Al filters, HVL measurements of different radiation qualities were performed according to ISO4037:2019.

The HVL measurement procedure consists of either determining the attenuation curves or using interpolation for the determination of the 1stHVL and 2ndHVL while taking the 1st measurement in the absence of filter as reference values which correspond to 100%

# RESULTS




Graph1. Correlation between ADC for 60 kV and inherent filtration of the X-ray tube according to ISO 4037-1.

# RESULTS

| | |
|---|---|
| 1 Ere CDA (mm d'Aluminum) à 60KV | 0,3844 |
| Filtration Inhérente du tube (mm d'Aluminium) | 0,29290931 |
| Filtration Inhérente Supplémentaire (mm d'Aluminium) | 3,70709069 |

Table 1. Result of the inherent filtration

# RESULTS

Half-value layer

The variety of the first half-value layer (1st HVL) and the second HVL (2nd HVL) between the experimental results and the values given in ISO 4037-1:2019 were all within 10% likewise, the homogeneity coefficients h were for most beam codes between 0.88 and 1.0 according to ISO 4037:2019.

# RESULTS

| | Valeur mesurée | épaisseur |
|---|---|---|
| Valeur supérieur | 5,875 | 1,75 |
| Valeur inférieur | 5,773 | 1,8 |
| 1$^{er}$ CDA | 1,761 | |
| Valeur supérieur | 2,9325 | 3,6 |
| Valeur inférieur | 2,83183 | 3,7 |
| 1er+2éme CDA | 3,606 | |
| 2éme CDA | 1,845 | |

Table2. Example of a measurement table for the N-120 series

# CONCLUSION

This work presented the procedure applied for the determination of the characteristics recommended by the ISO 4037 standard to establish the standard radiation qualities for the calibration of radiation protection instruments.

The results obtained for the 1st HVL and the 2nd HVL are all in agreement with the recommended values, these qualities can now be applied to the calibration of measuring instruments in radiation protection.