Calculation of the wall correction factor for the BIPM air-kerma standard for ^{137}Cs using the code PENELOPE

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Introduction

The wall correction factor k_{wall}, which accounts for photon attenuation and scattering in the wall of an ionization chamber, was determined experimentally for the ^{137}Cs air-kerma standard at the BIPM using the extrapolation method. More recently, Monte Carlo calculations have demonstrated that the extrapolation technique may not be valid. Rogers and Treurniet [1], using the Monte Carlo code EGSnrc [2], calculated the wall correction factor for the BIPM standard. In the present work, k_{wall} was calculated using the code Penelope [3].

Method

Source simulation

The BIPM ^{137}Cs source was simulated using the code Pengeom (Penelope geometry code). The source, the source container (aluminum), the housing (lead) and the collimator (tungsten and steel) are shown in Fig.1. The source is 12 mm in diameter and 23 mm in length; the collimator defines a beam of 20 cm in diameter at the reference plane.

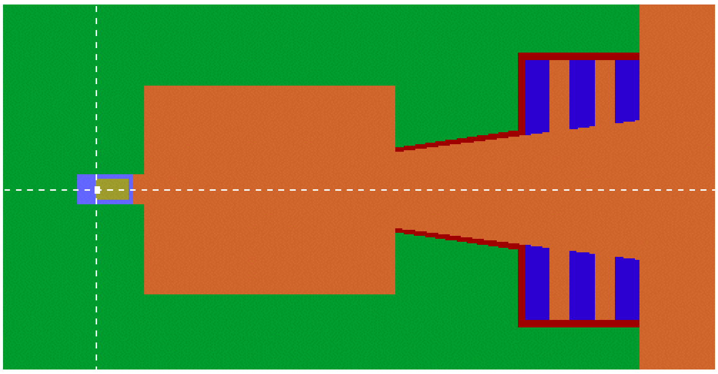

Fig.1. Simulation of the ^{137}Cs source

This geometry was used to create a photon phase-space file at 90 cm from the source. The normalized distribution of photons with energy at this plane is shown in Fig.2. The photon scatter contribution, in terms of relative energy fluence, is about 16 %.

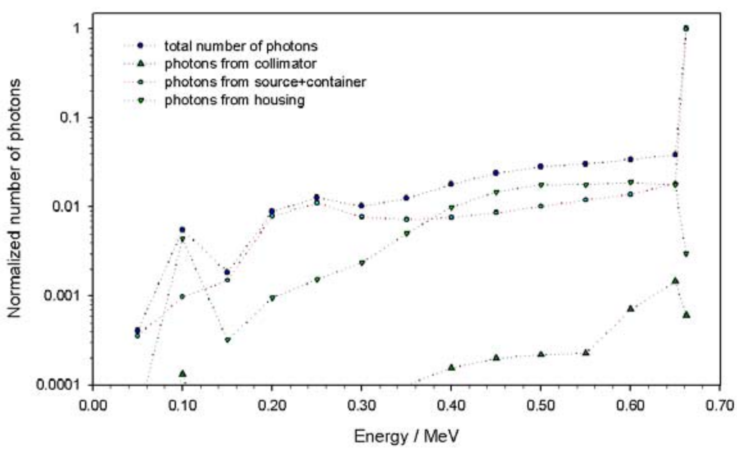

Fig.2. Distribution of photon number with energy

Chamber simulation

The BIPM ^{137}Cs air-kerma standard, serial number CH5-2 was also modelled using the Pengeom code. This chamber is similar to the ^{60}Co air-kerma standard (CH5-1) and details of the model are given in [4].

Calculation of the wall correction factor

The photon phase-space file was used as input for the calculation of k_{wall}. The attenuation component was determined using the photon regeneration technique. Details of the method used in the calculation of k_{wall} are described in [4].

Results

The value for k_{wall} calculated in the present work is shown below, together with the result of Rogers and Treurniet [1]. The statistical standard uncertainty for both results is given in brackets.

Present work	1.000 2(1)
Rogers and Treurniet	0.999 93(6)

Discussion

The value for k_{wall} determined experimentally for the BIPM standard is $k_{\mathrm{wall}} = 1.0022$ (standard uncertainty 0.0016), around 2×10^{-3} higher than the calculated value. The overall uncertainty of the calculated value remains to be evaluated, but is likely to be significantly smaller than the uncertainty of the measured value. The two calculated values are in reasonable agreement.

References

[1] ROGERS, D.W.O., TREURNIET, J., Monte Carlo calculated wall and axial non-uniformity corrections for primary standards of air kerma, *NRCC Report* PIRS-663.

[2] KAWRAKOW, I, ROGERS, D.W.O., The EGSnrc code system: Monte Carlo simulation of electron and photon transport, 2000, *NRCC Report* PIRS-701 (National Research Council of Canada).

[3] SALVAT, F., FERNANDEZ-VAREA, J.M., ACOSTA, E., SEMPAU, J., PENELOPE – A Code System for Monte Carlo Simulation of Electron and Photon Transport, NEA/NSC/DOC(2001)19 (ISBN 92-64-18475-9).

[4] BURNS, D.T., Calculation of k_{wall} for ^{60}Co air-kerma standards using PENELOPE, CCRI(I)/03-40.