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Assessing the long-term stability of $N_{D,w}$ calibration coefficient for Markus-type ionization chambers in radiotherapy

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*** an actual scope of accreditation is available on the PCA website: www.pca.gov.pl**

Introduction

Precision and certainty are vital when delivering the planned dose to the target volume, as modern, highly specialised radiotherapy techniques require this.

Even the best and most advanced dosimetry equipment, such as an electrometer and an ionisation chamber, can sometimes malfunction. This can mean that the measurements are no longer reliable.

The risk of malfunction does not depend on the age or type of dosimetry set used, including the electrometer and ionization chamber. Even the slightest malfunction may affect the reliability of the results obtained. Therefore, **regular calibration of dosimetry equipment by an independent laboratory is essential**.

Introduction

In Poland calibration of dosimetry equipment in radiotherapy is provided by the Secondary Standards Dosimetry Laboratory (SSDL) operated by the Department of Medical Physics at the Maria Sklodowska-Curie National Research Institute of Oncology in Warsaw.
The Polish SSDL is a member of the Secondary Standards Dosimetry Laboratory Network, established by the International Atomic Energy Agency and the World Health Organization.

The Polish SSDL fully complies with ISO/IEC 17025 standard and has been accredited by the Polish Centre for Accreditation since May 28, 2014 (accreditation certificate number AP 155).

Material and methods

Each dosimetric set must undergo an initial control procedure before calibration:

- verification of the electrometer's correct operation;
- checking the electrometer's self-leakage - the electrometer's leakage is checked with the chamber to be calibrated connected directly to the electrometer in a room where there is no source of ionising radiation.

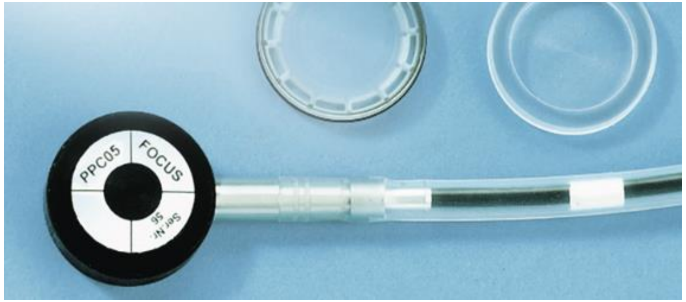
The submitted calibration set is calibrated in a gamma radiation beam generated by a ^{60}Co source if the initial control reveals no irregularities in its operation.
The charge value measured by the calibrated set is compared to the charge value measured by the working standard used at SSDL during calibration.
The measurement is carried out under the same geometric conditions. This is done with the working standard set and the calibrated set.
The calibration results take into account the influence of atmospheric pressure. They also take into account the influence of water temperature in the phantom.
The influence of relative humidity is negated by the adopted calibration conditions, which ensure independence, and relative humidity is controlled.

Material and methods

The uncertainty for Calibration and Measurement Capability (CMC) in the Polish SSDL for ionization chamber calibrations in a ^{60}Co beam is established at 1.5% of the measured value.

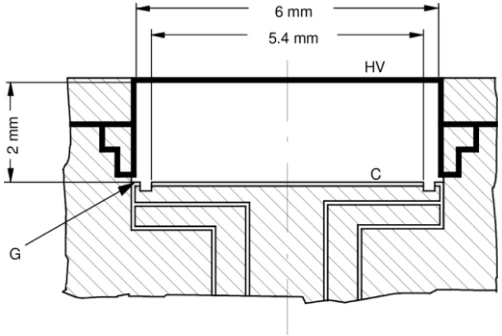
The expanded uncertainty, with a probability of expansion of around 95%, is what is known as the measurement uncertainty for the CMC. This is an indication of the level of confidence in the calibration process, ensuring accurate measurements.

Material and methods



IBA Type PPC-05 ionization chamber

PTW Type 23343 ionization chamber

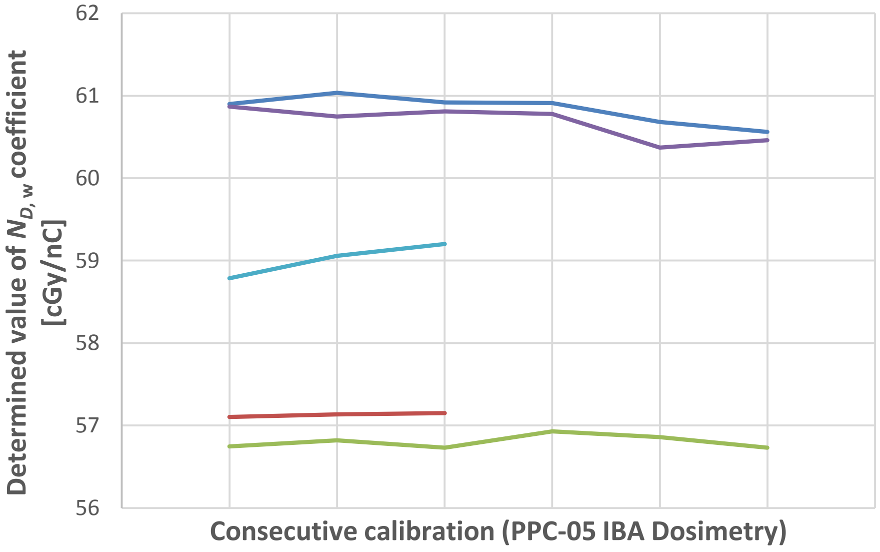


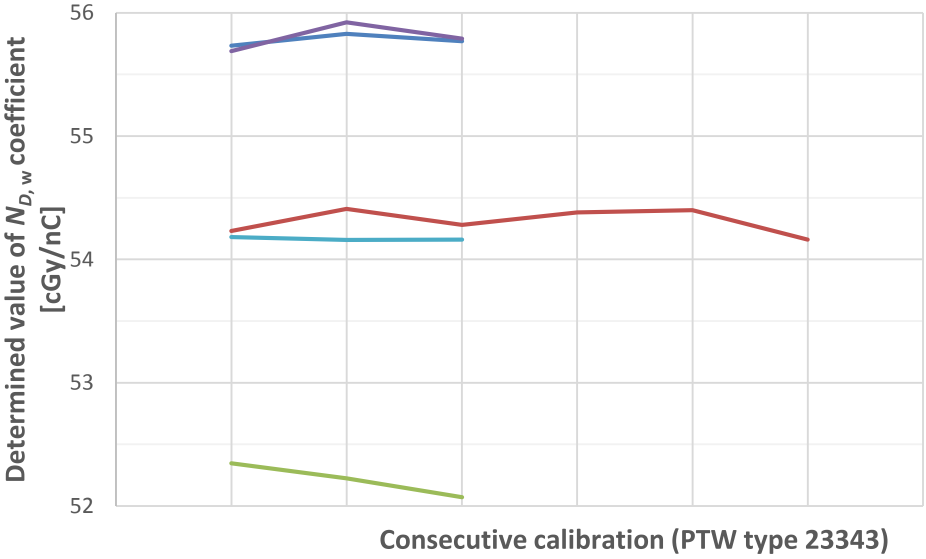
The technical specifications of the Markus chamber PTW 23343 with high-voltage electrode (HV), collecting electrode (C) and guard-ring (G)

This study focuses on **Markus-type ionization chambers**, widely used for electron beam dosimetry in radiotherapy. According to it's specification it can also be used to measure proton beams. Its volume allows good spatial resolution to be obtained. Special design features reduce the influence of scattered radiation.

In this study, we are presenting the calibration coefficients ($N_{D,w}$) for a selection of dosimetric sets that have been calibrated on at least three occasions, which equates to a minimum of six years of operation for the given dosimetric set.

Results





Despite the fact that the polarity voltage of both chambers is the same at +300 V, the calibration coefficient for chambers manufactured by IBA Dosimetry is significantly higher compared to those manufactured by PTW.
For all the successive calibrations, the change in the calibration coefficient was between 0.68% and -0.46%. The average change in the calibration coefficient between successive calibrations within the examined group was 0.01%.

References

PTW Detectors (2015 edition)

IBA Detectors For Relative and Absolute Dosimetry

Palm, A & Mattsson, O & Andreo, Pedro. (2000). Calibration of plane-parallel chambers and determination of p(wall) for the NACP and Roos chambers for Co-60 gamma-ray beams. Physics in medicine and biology. 45. 971-81.

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Thank you for your attention.