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

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Laboratory accredited by the Polish Centre for Accreditation, accreditation No AP 155*

*** an actual scope of accreditation No AP 155 is available on the PCA website: www.pca.gov.pl**

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Introduction

- Modern highly specialized radiotherapy techniques require precision and certainty that the dose delivered to the target volume is consistent with the planned dose for that volume.
- Ensuring of confidence and accuracy in the delivery of planned treatment can be achieved through highly skilled and experienced professionals who adhere to established procedures and use properly calibrated equipment.
- Even the best and most advanced dosimetry equipment, such as an electrometer and ionization chamber, runs the risk of malfunction, which can compromise the reliability of measurements.
- Regular calibration of dosimetry equipment by an independent laboratory is essential to reduce the risk of receiving invalid measurement results.
- This callibration 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.
- Our laboratory 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).

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Material and methods

- Based on the experience of the Polish SSDL, the stability of the $N_{D,w}$ coefficient has been analyzed. This study focuses on Farmer-type ionization chambers, which are widely used in dosimetric measurements in radiotherapy.
- Before calibration each dosimetric set undergoes an initial control involving:
  - verification of the proper operation of the electrometer;
  - check of electrometer's self-leakage;
  - check of electrometer's leakage with the chamber to be calibrated connected directly to the electrometer in a room where there is no source of ionizing radiation.

  In no case has the signal registered by the chamber connected directly to the electrometer been greater than 0.2% of the signal recorded when the chamber was placed in the gamma radiation beam.
- If the initial control reveals no irregularities in the operation of the submitted calibration set, its calibration is performed in a gamma radiation beam generated by a ^{60}Co source.
- During calibration, the charge value measured by the calibrated set is compared to the charge value measured by the working standard used at SSDL.
- The measurement with the working standard set and the calibrated set is carried out under the same geometric conditions.
- The calibration results take into account the influence of atmospheric pressure and water temperature in the phantom.
- Relative humidity is controlled, and the adopted calibration conditions ensure independence from the influence of relative humidity.

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Material and methods

- In the Polish SSDL, the measurement uncertainty for Calibration and Measurement Capability (CMC) for ionization chamber calibrations in a ^{60}Co beam is established at 1,5% of the measured value.

  Note:
  The measurement uncertainty for the CMC is the expanded uncertainty with the probability of expansion about 95%.This indicates the level of confidence in the calibration process, ensuring accurate measurements.

- In this work, we are presenting calibration coefficients for selected dosimetric sets which were calibrated at least 5 times, what translates to a minimum of 10 years of given dosimetric set's operation.

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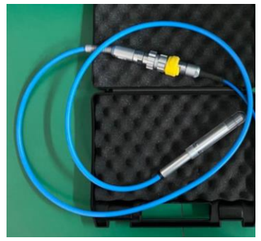
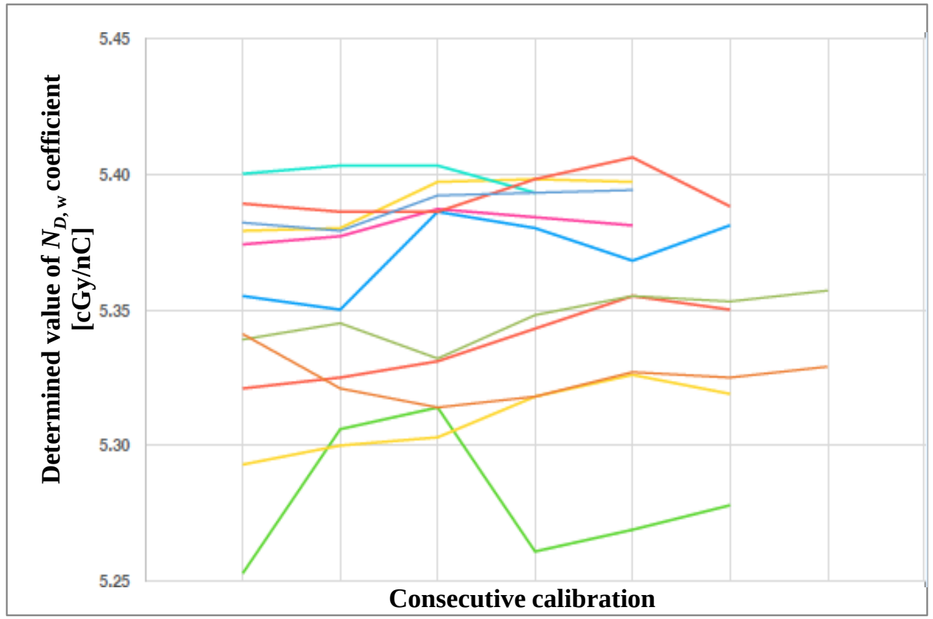
Results

- PTW 30013 chamber
- operating voltage of +400 V

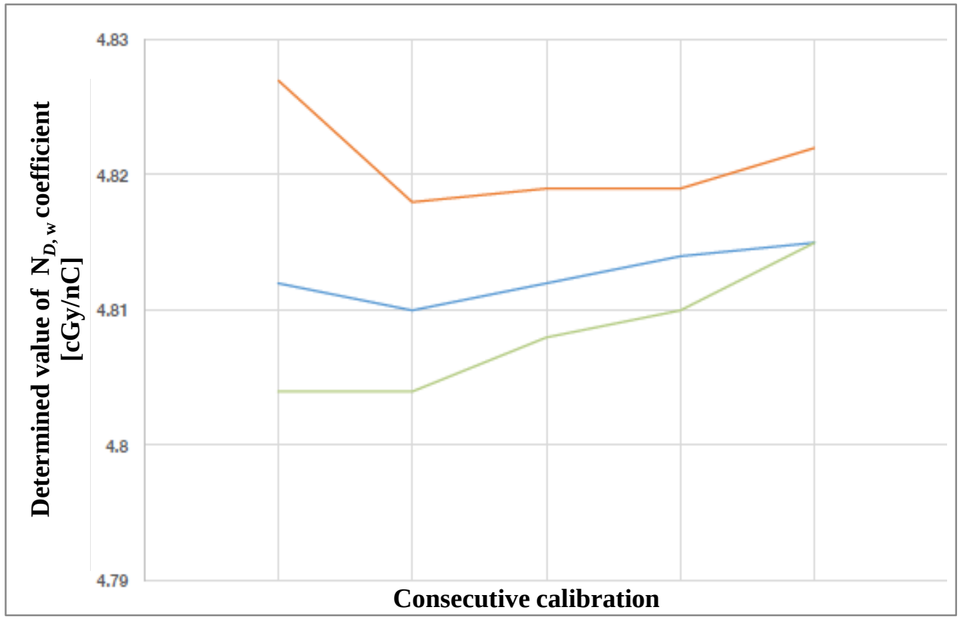


- IBA Dosimetry FC65-G chamber
- operating voltage of +300 V

Note: The results obtained up to May 27, 2014 were not within the scope of PCA accreditation No. AP 155.



The uncertainty values associated with presented calibration coefficients fall within the range of 0.075 cGy/nC to 0.095 cGy/nC.



- **The calibration coefficient for chambers manufactured by PTW is significantly higher compared to chambers manufactured by IBA Dosimetry.**
- **Among the group of chambers manufactured by PTW, one set showed a 1.0% change in the calibration coefficient between successive calibrations.**
- **For all other calibrations, the change in the calibration coefficient ranged from 0.67% to -0.37%. The average change in the calibration coefficient between successive calibrations in the examined set group was 0.05%.**

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Results

- Data presented for the set that underwent the highest number of calibrations.
- The calibration coefficient changed by 0.7% over the entire period of operation.
- These changes did not occur linearly, and the maximum difference between the previously determined calibration coefficient and the currently determined one was 0.2%.

Note:
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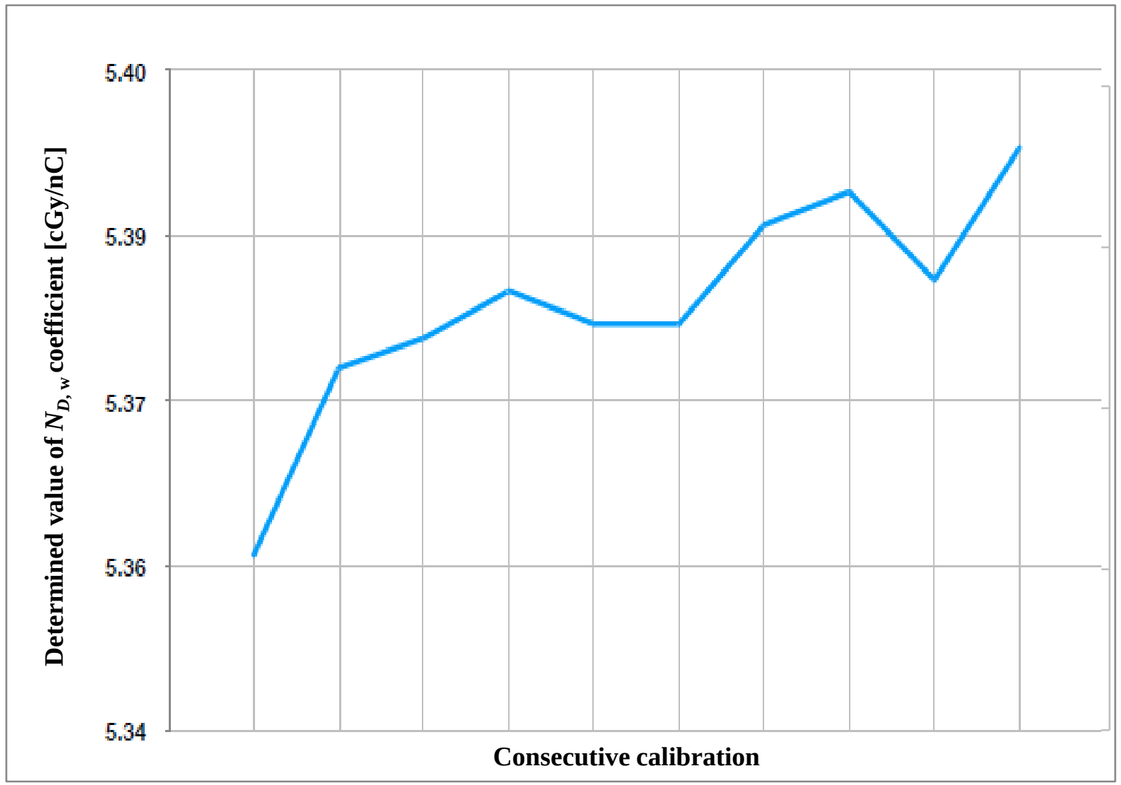

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Conclusions

- Regular calibration performed by external laboratories with appropriate competence allows for:
  - measurements to be carried out according to the commonly accepted procedures outlined in IAEA Technical Report Series No. 398 [1];
  - detection and elimination of ionization chambers and electrometers that exhibit signs of wear or damage during operation.

- Users are informed by the SSDL about any abnormalities identified during calibration of customer's dosimetric set. If these abnormalities directly affect the measurement results, the set is returned to the user for further diagnostics and repair.

- **Proper working conditions of the dosimetric set can be assured by regular callibration.**

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References

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Absorbed Dose Determination in External Beam Radiotherapy, Technical Reports Series No. 398, IAEA, Vienna (2020)

Thank you for your attention.