

Latest developments in beta-radiation metrology (primary dosimetry, ISO 6980 revision, and ICRU 95 impact)

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For decades, primary beta dosimetry has been based on extrapolation chamber measurements utilizing many different correction factors, see the ISO series 6980 as of 2004 to 2006 [1], [2], [3]. The basis for all these correction factors are measurements which were performed a long time ago [4] and are in worldwide use by means of the BSS 2, a commercially available secondary irradiation facility [5], [6]. Nevertheless, the only operational quantity being properly disseminated is the personal dose equivalent at a depth of 0.07 mm in a slab phantom, $H_p(0.07)_{\text{slab}}$ [3]. This does not account for the fact that most beta dosimeters are ring dosimeters calibrated on a rod phantom in terms of $H_p(0.07)_{\text{rod}}$ and, lately, eye lens dosimeters calibrated on a cylinder phantom in terms of $H_p(3)_{\text{cylinder}}$; finally, the area quantities $H'(0.07)$ and $H'(3)$ are of interest, too.

Consequently, correction factors for primary beta dosimetry have been re-determined by means of Monte Carlo transport simulations of the beta reference radiation fields [8] and have been available for a few years [9], [10]. Furthermore, correction factors to account for the different operational quantities have been available for a long time [11]. To account for all these updates, in 2019, the ISO working group on "Reference radiation fields", [ISO TC85 SC2 WG2](#), started the revision of the ISO 6980 series (all three parts in parallel). Within this revision, in addition to the topics outlined above, some further changes are being considered, among others the inclusion of two new radiation fields with a mean energy between the ones of ^{85}Kr and $^{90}\text{Sr}/^{90}\text{Y}$ (based on $^{90}\text{Sr}/^{90}\text{Y}$ behind thin absorbers made of a PMMA) [12] and the inclusion of the Spencer-Attix besides the Bragg-Gray theory [13], [14]. At this very moment, June 2022, the final draft international standards (FDIS) are being prepared. The final standards are expected to be published by the end of 2022 / beginning of 2023.

Finally, the International Commission on Radiation Units and Measurements, ICRU, recently issued a report on new operational quantities [15]. If these new quantities were implemented, primary beta dosimetry measurements would remain unchanged, however, it was realized that new correction factors would be needed. Consequently, these correction factors were determined and their impact on the operational quantities was investigated [16].

References:

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- [2] ISO 6980-2 International Organization for Standardization *Reference beta-particle radiation – Part 2: Calibration fundamentals related to basic quantities characterizing the radiation field* [ISO 6980-2 \(2004\)](#)

- [3] ISO 6980-3 International Organization for Standardization *Reference beta-particle radiation – Part 3: Calibration of area and personal dosimeters and the determination of their response as a function of beta radiation energy and angle of incidence* [ISO 6980-3 \(2006\)](#)
- [4] Böhm J *The national primary standard of the PTB for realizing the unit of the absorbed dose rate to tissue for beta radiation* [PTB-Report PTB-Dos-13, ISSN 0172-7095 \(1986\)](#)
- [5] Ambrosi P, Buchholz G and Helmstädter K *The PTB Beta Secondary Standard BSS 2 for radiation protection* [J. Instrum. 2 P11002 \(2007\)](#)
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- [7] Manufacturer's website of the Beta Secondary Standard 2: Eckert & Ziegler Strahlen- und Medizintechnik AG www.ezag.com (visited 2022-06)
- [8] Behrens R *Simulation of the radiation fields of the Beta Secondary Standard BSS 2* [J. Instrum. 8 P02019 \(2013\)](#) and [Addendum J. Instrum. 14 A07001 \(2019\)](#) The phase space files are available at the corresponding websites for download.
- [9] Behrens R *Correction factors for primary beta dosimetry* [Metrologia 57 065022 \(2020\)](#)
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- [11] Behrens R *Correction factors for the ISO rod phantom, a cylinder phantom, and the ICRU sphere for reference beta radiation fields of the BSS 2* [J. Instrum. 10 P03014 \(2015\)](#)
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- [14] Palani Selvam T, Shrivastava S, Bakshi AK *Monte Carlo calculation of Spencer-Attix and Bragg-Gray stopping power ratios of tissue-to-air for ISO reference beta sources – an EGSnrc study* [J. Instrum. 16 P03006 \(2021\)](#)
- [15] International Commission on Radiation Units and Measurements (ICRU) *Operational Quantities for External Radiation Exposure* [ICRU Report 95, J. ICRU 20\(1\) \(Sage Publishing, Thousand Oaks, CA\) \(2020\)](#)
- [16] Behrens R *Conversion coefficients from absorbed dose to tissue to the newly proposed ICRU/ICRP operational quantities for radiation protection for beta reference radiation qualities* [J. Radiol. Prot. 41 871 \(2021\)](#)