Physikalisch-Technische Bundesanstalt
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Your reference:
Your letter of:
My reference: 6.3-RB
My letter of:

To all users of the
Beta Secondary Standard 2 (BSS 2)

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Information for the users of the Beta Secondary Standard 2 (BSS 2)

Dear Sir or Madam,
Dear user of the Beta Secondary Standard 2 (BSS 2),

We would like to inform you about a limitation of the BSS 2.

The BSS 2 cannot (or not fully) be used at ambient conditions of quite low air density as the data base for the correction to the actual air density is limited. This can especially occur at high altitudes.

Explanation:
The reference dose rate determined during the source calibration is valid for the reference air density, ϱ_{a0} = 1.197·10^{-3} g/cm³. The deviation of the actual air density, ϱ_{a}, from ϱ_{a0} is interpreted as a small amount of ICRU tissue being added (for $\varrho_{\mathrm{a}}>\varrho_{\mathrm{a0}}$) or subtracted (for $\varrho_{\mathrm{a}}<\varrho_{\mathrm{a0}}$) in front of the object to be irradiated. The tissue-equivalent thickness of that layer is given by $\Delta d = y_0 \cdot \eta_{\mathrm{a,t}} \cdot \frac{\varrho_{\mathrm{a}}-\varrho_{\mathrm{a0}}}{\varrho_{\mathrm{t}}}$ with the distance y_0 between the source and the object to be irradiated, the scaling factor from air to tissue, $\eta_{\mathrm{a,t}}$ = 0.915, and the density of ICRU tissue, ϱ_{t} = 1.0 g/cm³. The corresponding correction factor c_{abs} is calculated from a mean depth dose curve, $T(d)$, via $c_{\mathrm{abs}} = \frac{T(70\ \mu\mathrm{m} + \Delta d)}{T(70\ \mu\mathrm{m})}$ for the quantities $H_{\mathrm{p}}(0.07)$ and $H'(0.07)$ and via $c_{\mathrm{abs}} = \frac{T(3\ \mathrm{mm} + \Delta d)}{T(3\ \mathrm{mm})}$ for the quantity $H_{\mathrm{p}}(3)$. Once $(70\ \mu\mathrm{m} + \Delta d)$ becomes for negative values of Δd smaller than the smallest value of d for which the depth dose curve $T(d)$ has been measured in the past near sea level (i.e. $70\ \mu\mathrm{m} + \Delta d < d_{\mathrm{min}}$), c_{abs} cannot be calculated and an irradiation is not possible[1].

This can especially occur at high altitudes. For example, at 2000 m above sea level, the air pressure is approximately 800 hPa resulting in an air density of about ϱ_{a0} = 0.95·10^{-3} g/cm³. For an irradiation distance of y_0 = 50 cm this leads to $\Delta d = -115$ µm and for y_0 = 30 cm this leads to $\Delta d = -69$ µm. Therefore, an irradiation may be possible at small distances but not at larger ones. As Δd never takes values as small as -3 mm, irradiations in terms of $H_{\mathrm{p}}(3)$ are always possible.

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[1] Currently, the values for d_{min} are between 0 µm and –10 µm for the different sources and distances.

The correction method is described in detail in a paper by Behrens and Buchholz: J. Instrum. **6** P11007 (2011) and Erratum: J. Instrum. **7** E04001 (2012) and Addendum: J. Instrum. **7** A05001 (2012).
A consolidated version is available:
www.ptb.de/cms/fileadmin/internet/fachabteilungen/abteilung_6/6.3/f_u_e/bss2cons.pdf

PTB plans to remove this limitation in the future either by measurements of depth dose curves at high altitudes or by calculations – or by both.

Kind regards,

Dr. R. Behrens