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## CORRIGENDUM

## Corrigendum: Determining dose enhancement factors of high-Z nanoparticles from simulations where lateral secondary particle disequilibrium exists (2019 *Phys. Med. Biol.* 64 155016)

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In our paper (Rabus *et al* 2019) we presented a procedure to determine the dose enhancement factors (DEFs) for gold nanoparticles (GNPs) for an extended photon radiation field from simulations with narrow beam geometries. In the context of different work, it has become evident that there has been an error in the ROOT software routine used for processing the simulation data for the purpose of our article. More precisely, in the command line where the deposited energy obtained from the simulation was converted to the energy density in the spherical shells used for scoring, the volume of the spherical shells was implemented as

$$(4/3) * 3.1416 * ((rmax * rmax * rmax) - (rmin * rmin * rmin))$$

Using integers in the factor 4/3 in the first bracket leads to an integer output, i.e. 1 instead of 1.3333... In consequence, the values shown as simulation results in figure 5 of our paper were enhanced by a factor of 4/3 and so were the values for the dose enhancement factors for an extended photon field in figures 6 and 7. The corrected figures are presented below.

Furthermore, we noted the following typos in the article:

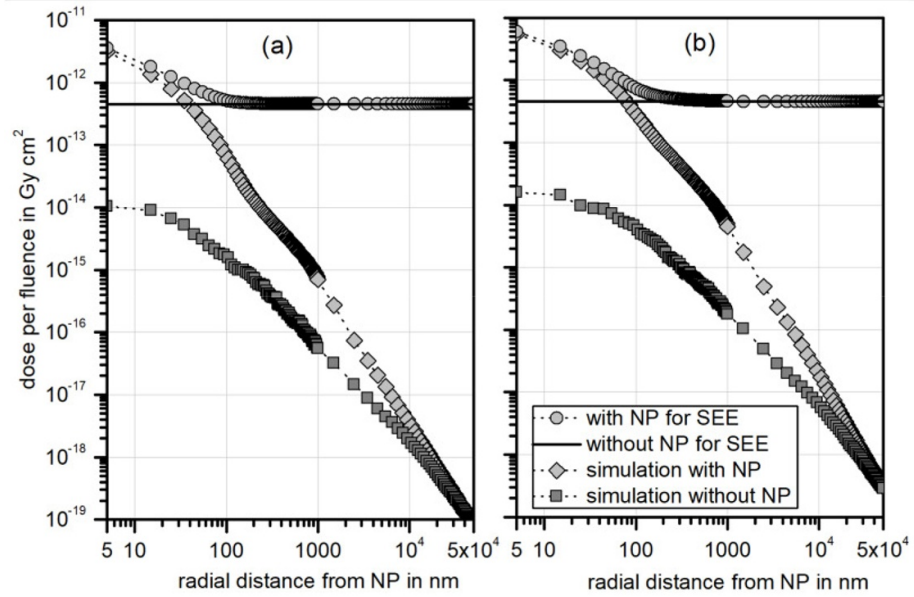
- A wrong sign in the denominator on the right-hand side of equation (4). The correct expression is

$$x_{Au} = \frac{\rho_{Au}}{\rho_w} \times \frac{r_{np}^3}{r_{sp}^3 + \left(\frac{\rho_{Au}}{\rho_w} - 1\right) r_{np}^3} \quad (4)$$

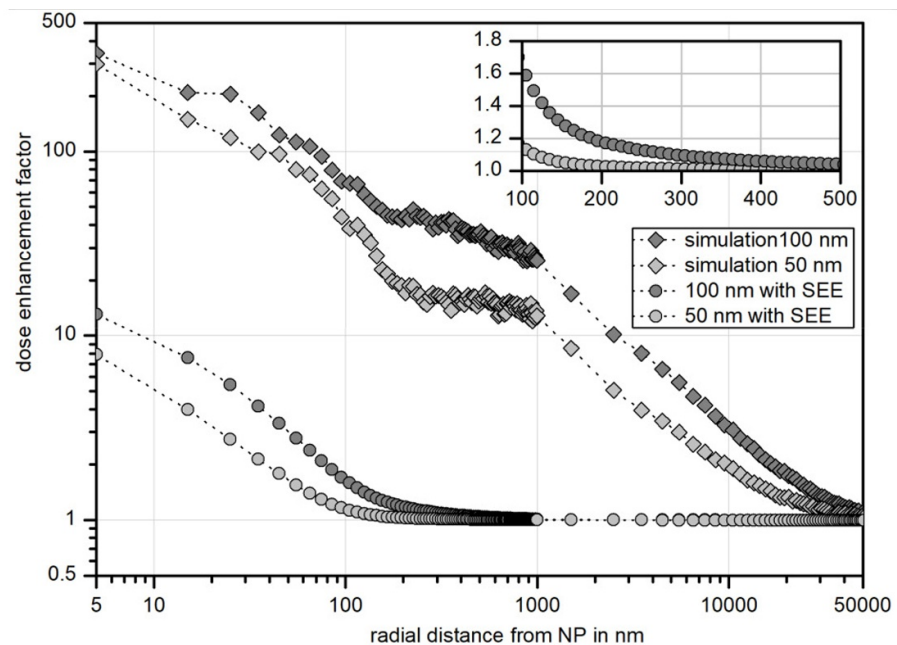
In producing the data for figures 7 and 9, the correct equation as given above was used, however.

- In the paragraph on page 7 below equation (12), it should read ‘... is on the order of  $\frac{1}{3} (\mu r)^2$ . ... z in equation (11) ...’
- In the Conclusion, the second recommendation should read ‘... as given in equation (8). ...’

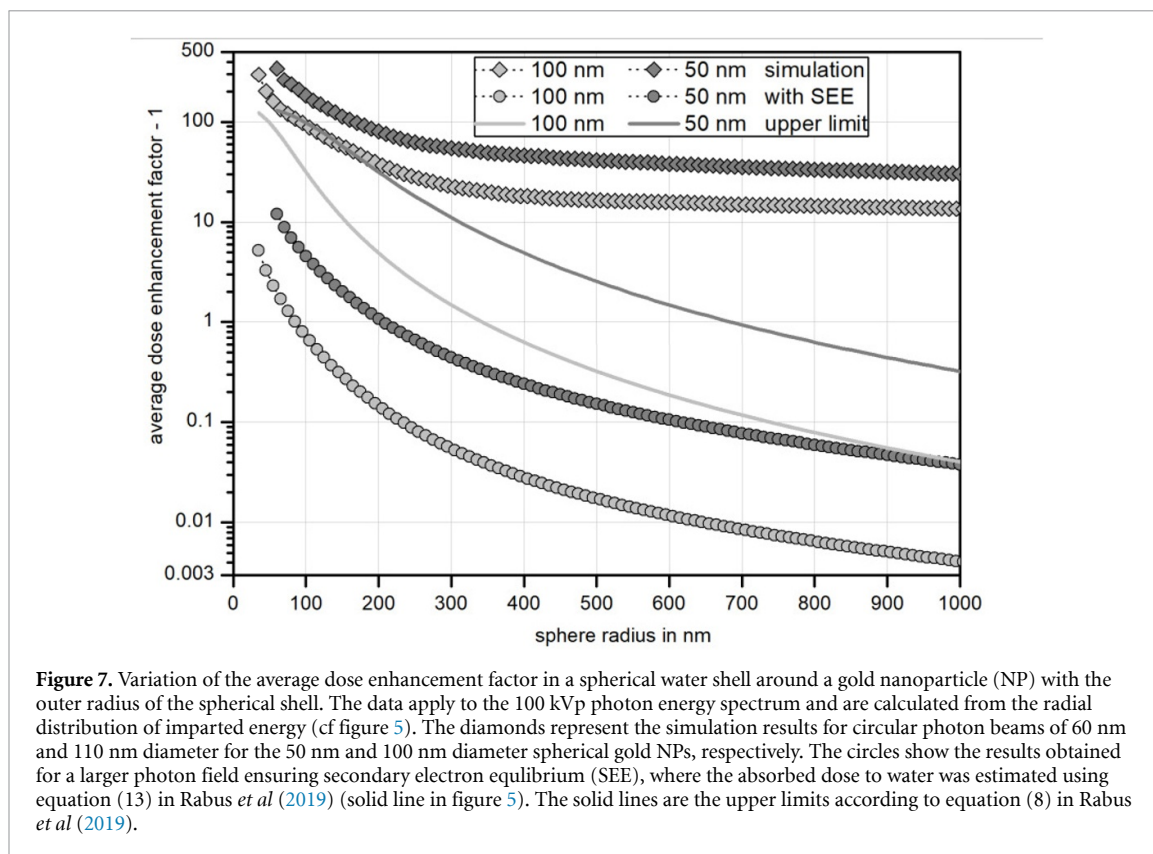
Correcting the identified data processing error leads to a reduction of the predicted DEF for GNPs irradiated with an extended field of diagnostic x-rays by a factor of  $\frac{3}{4}$ . In consequence, the conclusions of our publication (regarding the magnitude of the DEFs for an extended beam and the limited radial range where significant DEFs occur) remain.



**Figure 5.** Dose per fluence as a function of the radial distance from a gold nanoparticle (NP) of (a) 50 nm and (b) 100 nm diameter surrounded by water that is centrally irradiated by a 100 kVp photon beam with diameter of NP diameter + 10 nm for the case that the NP volume is filled with water (dark-grey squares) or gold (light-grey diamonds). The solid line is the value obtained for the absorbed dose in water estimated by taking into account only the primary photons and assuming secondary electron equilibrium (SEE) conditions. The light-grey circles indicate the estimated absorbed dose per fluence in the presence of the gold NP.




**Figure 6.** Dose enhancement factors for the 100 kVp photon energy spectrum calculated from the radial distribution of imparted energy (cf. figure 5). The diamonds represent the results from the simulation with circular photon beam sizes of 60 nm and 110 nm diameter for the 50 nm and 100 nm diameter spherical gold nanoparticles, respectively. The circles show the results obtained for a larger photon field ensuring secondary electron equilibrium (SEE), where the absorbed dose to water was estimated based on equation (13) in Rabus et al (2019) (solid line in figure 5). The inset shows a close-up of the latter data in the 100 nm to 500 nm range.



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## Reference

Rabus H, Gargioni E, Li W B, Nettelbeck H and Villagrasa C 2019 Determining dose enhancement factors of high-Z nanoparticles from simulations where lateral secondary particle disequilibrium exists *Phys. Med. Biol.* **64** 155016