Supporting material:

Dose perturbation effects near implant surfaces caused by secondary electron transport in photon-beam therapy

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Dose perturbation effects at interfaces between high-Z materials and water have been widely reported in the past. Computing the backward dose perturbation factor, \( p_b \), at the front interface of a high atomic number implant placed within water simply requires taking the ratio of the dose to water with the implant present, \( D_{\text{implant}} \), to the dose at the same point in water in the absence of the implant, \( D_{\text{water}} \):

\[
p_b = \frac{D_{\text{implant}}}{D_{\text{water}}} \tag{1}
\]

The dose perturbation at the distal interface of the implant is calculated in two steps: First the dose to water is calculated accounting for photon attenuation within the Titanium implant, but without electron transport effects (the blue curve in fig 1a, rescaled from the depth dose profile in water in absence of the implant). In the second step, the blue curve serves as the reference for the dose reductions or enhancements by electron transport. In fig 1b, the forward dose perturbation is shown without and with the consideration of photon attenuation in titanium as the black and green points respectively; the green curve shows the values of \( p_f \).

![Fig 1](a) Percent depth dose profiles within water with and without the presence of the titanium implant (b) computed dose perturbation factors \( p_b \) and \( p_f \).

Figs. 2a and c show the energy dependence of \( p_b \) and \( p_f \) for normal incidence, particularly the strong effect of the energy on \( p_f \) as the consequence of pair production in the implant. At 45° incidence, \( p_b \) and \( p_f \) are larger than at normal incidence due to enhanced electron transport out of the high-Z layer, as shown in figs 2a and d.

![Fig 2](a and b): Energy dependence of the backward dose perturbation factor \( p_b \). (c and d): Energy dependence of the forward dose perturbation factor \( p_f \). The effect of inclined incidence at 45° is demonstrated in (b and d).