# AbstractID: 7733 Title: Different methods of organ equivalent dose scoring in Monte Carlo neutron dose calculations

**Purpose:** In proton therapy, neutrons are generated in treatment head and patient. Monte Carlo simulations are widely used to study secondary neutrons. Neutron quality factors are defined conservatively and do not necessarily take into account that dose might be deposited by secondary particles generated by neutrons, which might have a different quality factor. The purpose of this study was to assess how the organ equivalent neutron dose depends on different scoring methods.

**Method and Materials:** Six voxelized phantoms representing patients of different age have been implemented into our Monte Carlo code. Organ doses, $D$, were combined with weighting factors to calculate organ equivalent doses, $H$. Method 1 is based on:

$$H_1 = D_{pp1}*1.1+D_{pp2}*2.5+D_{pp3}*5+H_{pnw}+D_{ep}*1.1+H_{enw}+D_{other}*w_R$$

($D_{ppi}$, $D_{ep}$, $D_{other}$:$D$ for different proton energy intervals, $D$ from electrons originating from protons and $D$ from particles other than protons or electrons, respectively; $H_{pnw}$, $H_{enw}$: event-by-event $w_R$-weighted energy deposition by protons originating from neutrons and by electrons originating from neutrons, respectively; $w_R$: neutron weighting factors weighed by the fluence spectrum of the neutrons entering the organ). Method 2 is based on the products of the $w_R$ value and the sum of doses deposited by all particles:

$$H_2 = (D_{pp1}+D_{pp2}+D_{pp3}+D_{pn}+D_{ep}+D_{en}+D_{other})*w_R$$

($D_{pn}$ ($D_{en}$): organ doses deposited by protons (electrons) originating from neutrons, respectively). Method 3 is a variation of method 1 by replacing the newly proposed ICRP neutron radiation factors by its current definition.

**Results:** We found significant relative differences in organ equivalent dose between methods 1 and 2, i.e. 20-50%. We found an increasing discrepancy with increasing age of the phantom but no dependence on the distance of the organ from the PTV. Of all methods, method 1 gives the highest values of organ equivalent dose.

**Conclusion:** When calculating neutron doses using Monte Carlo simulations, the organ equivalent dose depends significantly on the applied scoring method.