Fluence perturbation of the secondary electrons from clinical proton beams (50-250 MeV) by thin high-Z planar interfaces was studied with Monte Carlo simulations. Starting from mono-energetic proton pencil beams, proton depth doses and proton fluence spectra were calculated, both in homogeneous water and near thin high-Z interfaces by using the proton transport Monte Carlo code PTRAN. This code was modified extensively to enable modeling of proton transport in non-homogeneous geometries. Electron generation spectra were calculated analytically and were then used as input for an electron transport calculation with the Monte Carlo code EGS4/PRESTAII to obtain electron doses and electron fluence spectra in the water. The interface materials used in the study were graphite, Al, Ti, Cu, Sn and Au.

We found large electron fluence perturbations on both sides of the planar interfaces, resulting in a large electron dose increase upstream and a large dose decrease downstream from the interfaces, depending strongly on the atomic number of the interface. We obtained also a modest shift in average electron energy. For the most extreme case studied, 250 MeV protons and a gold interface, we obtained an electron dose increase of 43% upstream of the interface and a decrease of 18% downstream with both perturbations having an extent of about 0.5 mm. The total dose perturbation due to this effect amounts to 5% and 2%, respectively. A detailed analysis of dose and fluence perturbation will be presented for a wide range of materials and proton energies.