Purpose: To study the dose enhancement of golden nanoparticles on a voxellized cell phantom irradiated by proton beam.

Methods: A Monte Carlo application was constructed with GEANT4 version 9.4 using various physics processes. A water cube of 5 mm x 5 mm x 5 mm consisting of a realistic human keratinocyte voxellized cell phantom was irradiated with 1.5 MeV proton beam. The cell is represented by a three dimensional phantom obtained from confocal microscopy technique with realistic nucleus and cytoplasm chemical compositions. Detailed cell phantom information is demonstrated in one of Geant4 examples 'microbeam'. Beam quality of 20 nm FWHM with 20 keV Gaussian energy spread FWHM was used. Golden nanoparticles (size: 50 nm x 50 nm x 50 nm) with 250 nm apart from each other were administered in the phantom to form a solution with concentration of about 2 mg/ml. Simulations of the dose deposited with and without nanoparticles were recorded in each voxel of the cell phantom.

Results: The dose distribution histograms in the voxels of the cell nucleus and cytoplasm were obtained. Our results found that the total dose deposited in the cell increased by 12.2% and the mean dose deposited in the voxels of cell nucleus increased by 16.7%.

Conclusions: This present work shows a dose enhancement effect of administering golden nanoparticles in a realistic microscopy cell environment for proton beam irradiation. Our results agree well with the observation in the previous experiments from literature. This particular application demonstrates the usefulness of GEANT4 toolkit as a powerful tool to understand the dosemetric distribution in small nanoscale target for particle therapy.