Purpose: The proton macro Monte Carlo (PMMC) method uses a fast macro Monte Carlo radiation transport algorithm for high-energy proton transport through an absorbing medium.

Methods: PMMC uses results derived from traditional Monte Carlo simulations of proton transport through macroscopic cylinders of varying length, radii and material composition. These traditional Monte Carlo simulations are done for many incident proton energies and the results are used to transport protons through an absorber geometry in a step-by-step manner. The absorber geometry consists of a three-dimensional (3D) density matrix that can represent objects like a water phantom or computed tomography data. The source is specified by the user in terms of gantry angle and beam characteristics like position, energy and size. During proton transport, energy lost by the protons during each step is scored in a 3D dose grid. The creation of secondary neutrons is tracked as well to allow for estimation of the neutron dose.

Results: The algorithm, which was written in C++, is currently capable of simulating 1 million protons per minute. The accuracy of the PMMC simulations was assessed by comparing the results to simulations done with the same source parameters in MCNPX. The simulations consisted of monoenergetic pencil beams and Gaussian-shaped beams directed onto a water phantom. In general, PMMC and MCNPX are in good agreement in the high-energy proton region before the Bragg peak, differing by less than 3%. PMMC performs worse at the depth of maximum dose, differing by as much as 10%.

Conclusions: Forthcoming modifications to PMMC will address the discrepancies in the Bragg peak region and further modifications are underway to allow PMMC to be used with absorbers that are heterogeneous in density and material composition.