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Monte Carlo Dose Calculations in Homogeneous and Heterogeneous Media: A Comparison between the PMCEPT Code and the MCNP5, EGS4, DPM Codes, and Experiments

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The Monte Carlo method for coupled photon and charged particle transport is the most accurate means for predicting absorbed dose distributions in radiotherapy. However, the large amount of computing time required by general purpose Monte Carlo codes has prevented their routine uses of dose calculations for customized radiation treatment planning in spite of the rapid development of computer hardware and network technologies. This difficulty could be solved by either using faster computers or introducing new calculation tech-niques or both. The parallel Monte Carlo electron and photon transport (PMCEPT) code [Kum and Lee, J. Kor. Phys. Soc. 47 (2005) 716] for calculating electron and photon beam doses has been developed based on the three dimensional geometry defined by computerized tomography (CT) images and imple-mented on a Beowulf PC cluster. The PMCEPT code was validated on the homogeneous and multi-layered targets for megavoltage electron beams by comparing with the results of experiments and calculations from conventional Monte Carlo codes such as the MCNP5, EGS4, and DPM. The computing time benchmark result showed that the PMCEPT code was approximately twenty times faster than that of MCNP5 on the IBM ThinkPad X40 (laptop) with 1.2-GHz CPU and 512-MB RAM memory operated by RedHat Linux 9. Overall, the PMCEPT results agreed well with others in homogeneous and heterogeneous media within a maximum of 2--3% error. The capability of the PMCEPT code is being enhanced to include therapeutic proton beam simulations with a simpler Bethe-Block relative proton stopping power formula.

Keywords : Customized Radiation Therapy Planning Simulation System, PMCEPT Code, Monte Carlo