Computational Medical Physics Working Group Workshop II, Sep 30 – Oct 3, 2007
University of Florida (UF), Gainesville, Florida USA on CD-ROM, American Nuclear Society, LaGrange Park, IL (2007)

Comparative Analysis of Nuclear Cross Sections in Monte Carlo Methods for Medical Physics Applications

Chris Myers *
Georgia Institute of Technology
gtg036q@mail.gatech.edu

Bernadette L. Kirk
Oak Ridge National Laboratory
blk@ornl.gov

Luiz C. Leal
Oak Ridge National Laboratory
leallc@ornl.gov

ABSTRACT

Monte Carlo (MC) simulations are increasingly implemented for medical physics applications. MC simulations offer a simple and controlled way to determine the effects of various sources in a variety of materials. They are also very useful for treatment planning purposes. There are a number of Monte Carlo code packages available that can be utilized. However, results using one package might contain variations when compared to other packages. The differences arising among the solutions of different Monte Carlo simulations can be the result of three cases: 1) differences in the computing system with which the calculation is implemented; 2) relative errors introduced to the solution due to differences in nuclear data libraries that come with the Monte Carlo packages; 3) differences in the methods used by the Monte Carlo package to produce the results from the provided data. The relative contribution of each of these three cases to the total variation in the final results can not be known when all of them exist simultaneously. To understand the discrepancies in the results, it is beneficial to isolate each of these cases and study them individually. The relative error emanating from the computing system can be eliminated by using the same initial random numbers and the same technique to generate the random numbers. Also, the relative error from data inconsistencies can be eliminated by transferring the data of one code to the other. Two Monte Carlo codes, EGSnrc and MCNPX, were selected as a means of comparison. MCNPX is run using the ITS electron step algorithm and the default data libraries mcplib04 and el03. Two runs are made with EGSnrc. The first simulation uses the default PEGS cross section library. The second simulation utilizes a PEGS input file created using pgs4form.dat and pgs4pepr.dat files that were updated with the data from MCNPX, the National Institute of Standards and Technology (NIST) bremsstrahlung cross section library, and the EPDL cross sections which have been updated to match the much finer energy grid found in mcplib04. The electron impact ionization cross sections were replaced with values from the ENDF/B-VI.8 evaluation and the binding energy values in the files - photo_relax.data and incoh.data - were replaced to match the number of significant figures used by MCNPX. The

*

photoelectric cross sections that EGSnrc simulates from the data in the file – photo_cs.data – were fit to the formulas found in the manual. All energy threshold values and physics options are made to be identical. A simple case was created in both EGSnrc and MCNPX that calculates the radial depth dose from an isotropically radiating disc in water for various incident, monoenergetic photon and electron energies. Initial results show that much less central processing unit (cpu) time is required by the EGSnrc code for simulations involving large numbers of particles, primarily electrons, when compared to MCNPX. The detailed particle history files - ptrac and iwatch - are investigated to compare the number and types of events being simulated to investigate the reasons for the run time differences