**PHOTON DOSE CALCULATION BASED ON MONTE CARLO FINITE-SIZE PENCIL BEAM MODEL IN ACCURATE RADIOTHERAPY**

Huaqing Zheng1, Guangyao Sun1,2, Gui LI1, Mengyun Cheng1, Ruifen Cao1, Gui Li1, Gang Song1, Liqin Hu1,2, Yican Wu1,2, FDS Team

1. Institute of Nuclear Energy Safety Technology, Chinese Academy of Sciences, Hefei, Anhui, 230031, China

2. School of Nuclear Science and Technology, University of Science and Technology of China, Hefei, Anhui, 230027, China

 (Corresponding Author: Huaqing ZHENG, Email: huaqing.zheng@fds.org.cn)

**Abstract:**

**Purpose:** Dose calculation is one of the core functions in radiotherapy Treatment Planning System (TPS). International Commission on Radiation Units and Measurements (ICRU) NO.24 report points out that the error of the primary focus’ radical dose should be lower than 5%, otherwise the primary focus tumors will be out of control. There are two types of dose calculation methods: analytic method and Monte Carlo (MC) method. Conventional analytic dose calculation method may result in large errors in the heterogeneous region; but in homogeneous region, analytic method may achieve good dose calculation results with high speed. Monte Carlo method may get the great accurate dose calculated result in both the homogeneous and heterogeneous region by simulating the transport of particles, but it is time-consuming in clinical usage.This study mainly focused on the key technologies, the photon dose calculation based on the Monte Carlo Finite-Size Pencil Beam (MCFSPB) in the Accurate Radiation Therapy System (ARTS).

**Methods:** In the MCFSPB model, the acquisition of pencil beam kernel is one of the most important technologies. In this study, by analyzing the demerits of the clinical pencil beam dose calculation methods, a new pencil beam kernel model was developed based on the MC simulation and the technology of medical accelerator energy spectrum reconstruction. According to the axial symmetry principle, the only part of simulation results was used for the data of pencil beam kernel, which greatly reduced the data size of the pencil beam. Based on the above studies, we designed the MCFSPB method and implemented it with the Visual C++ development tool.

**Results:** With several tests including the comparisons among the American Association of Physicists in Medicine (AAPM) NO.55 report sample, the Monte Carlo dosimetry verification, and the ion chamber measurement, the results showed that the maximum error was less than 0.5% in the homogeneous phantom and less than 3% in the heterogeneous phantom.

**Conclusions:** This method met the clinical criteria, and would be expected to be used as a fast and accurate dose calculation engine for clinical TPS. Some advanced functions are under development.

***KEYWORDS:*** *Monte Carlo, Accurate radiotherapy, Dose calculation, Pencil beam*