Contribution ID: **457** Type: **Oral talk (15 min + 5 min questions)**

THE PIPLAN2021 PROTON AND CARBON ION RADIATION THERAPY TREATMENT PLANNING SYSTEM

Tuesday, 12 July 2022 12:50 (20 minutes)

This paper describes the main features of newest version of the PIPLAN Proton-Carbon Ion Radiation Therapy Treatment Planning System. The PIPLAN 2021 code [1] was assigned for precise Monte Carlo treatment planning for heterogeneous areas, including lung, head and neck location. Three various computer methods are used to modeling the interactions between the proton and carbon ion beam and the patient's anatomy to determine the spatial distribution of the radiation physical and biological dose. The first algorithm is based on the use of the RTS&T 2021 precision radiation transport code system. The RTS&T [1] code (Radiation Transport Simulation and Isotopes Transmutation Calculation) was assigned for detailed Monte Carlo simulation of many particle types (γ, e±, p, n, π±„ , antinucleons, muons, ions and etc.) transport in a complex 3D geometry's with composite materials in the energy range from a fraction eV to 20 TeV and calculation of particle fluences, radiation field functionals and isotopes transmutation problem as well. A direct using of evaluated nuclear data libraries (data-driven model) (ENDF/B, ROSFOND, JENDL, BROND, TENDL etc. - total 14 libraries) to N, d, t,3He,4He particles transport and isotopes transmutation modeling in low and intermediate (E<200 MeV) energy regions is the general idea low-energy part of the RTS&T code. In general, this approach is limited by the available evaluated data to particle kinetic energies up to 20 MeV, with extensions up to 30 MeV or 200 MeV. To generate the output characteristics of secondary particles in NA-interactions in the energy region exceeding 200 MeV, as well as to model acts of inelastic hA- and AA interactions in the entire range of energies under consideration, software implementations of the JQMD model (JAERI Quantum Molecular Dynamics) were used and the cascade-exciton model (CASCADE), including the generation of nuclear fragments in both the post-cascade and fast stages of the reaction (up to the complete break-up of the nucleus). In the process of transport simulation, the decay processes of metastable fragments with the subsequent transport of decay products were considered.The second and third algorithms are based on the original Bortfeld's [2] and Ulmer's [3] methods for primary proton beam and adapted these algorithms for primary carbon ion beam.

1. I.I. Degtyarev, F.N. Novoskoltsev, O.A. Liashenko, E.V. Gulina, L.V. Morozova, The RTS&T-2014 code status, Nuclear Energy and Technology, v.1, Issue 3, Nov. 2015, p.222-225.
2. T. Bortfeld, An analytical approximation of the Bragg curve for therapeutic proton beams, Med. Phys., 24(12), Dec. 1997. p. 2024-2033.
3. W. Ulmer, E. Matsinos, Theoretical methods for the calculation of Bragg curves and 3D distributions of proton beams, The European Physical Journal Special Topics, v. 190, p.1–81, 2010.

The speaker is a student or young scientist

No

Section

1. Nuclear technology and methods in medicine, radioecology

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Session Classification: Nuclear technology and methods in medicine, radioecology.