Models and algorithms development for the studying of heavy ion accelerators radiation safety issues at FLNR JINR by using Monte-Carlo simulation

Supervisors: S. Mitrofanov[1], K. Katovský[2]

[1]FLNR JINR, Dubna; [2]BUT Czech Republic

A lot of secondary particles are born when accelerated heavy ions interact with the nuclei of a matter. As a result of nuclear fission reactions and fragmentation of nuclear projectiles more complex products can be produced. The energy of most secondary particles can form particles of the third, etc., generations in the following nuclear interactions. In the thickness of the matter, the number of secondary particles produced in the process of inelastic interactions increases, that is, the internuclear cascade progresses. The main products of nuclear reactions in these cascades are neutrons of a wide range of energies, which determine the radiation situation behind the biological protection of the accelerator.

The main problem in the construction of radiation protection at accelerator complex is the problem of correct describing the passage through matter of radiation emitted by heavy ions. A detailed and accurate calculation of the radiation fields can be performed by using multiphysical software's based on Monte-Carlo method, which aim models and algorithms development for the studying radiation safety of DC-280 (complex of the physical setups based on it was named SHE – Super Heavy Element factory), DC-140 which is under constructing at FLNR JINR now and modernization of U-400 and U-400M according to the frequently software packages such as FLUKA (FLUctuated KAskade) and GEANT4 (GEometry ANd Tracking).

The main thing that distinguishes DC-280 from its historical predecessors is the ability to accelerate high intensity species a wide range of nuclei from neon to uranium. It means that particular attention in this project should be paid for radiation safety issues.

The DC-140 will be dedicated machine for apply science at FLNR (the production of the heterogeneous micro - and nano-structured materials; testing of avionics and space electronics for radiation hardness; ion-implantation nanotechnology and radiation materials science). Heavy ions from neon to bismuth with energies 2 and 4.8 MeV/nucleon will be used for these. Due to the different requirements of setups and irradiation procedures, the dedicated casemate should be constructed for each of application to allow parallel experiment preparation and full time (24/7/365) usage of beam time. Following aforesaid, the safe physical environment for staff should be provided while using this multipurpose applied science facility at FLNR.

In addition, it is necessary to carry out the experimental verification and calculation corrections for low-energy heavy ion accelerators, because FLUKA and GEANT4 are used mainly for high-energy accelerators.