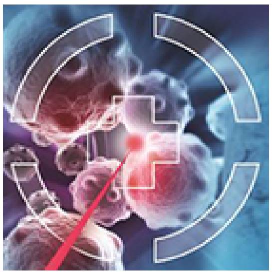

Contribution ID: **21** Type: **not specified**

A data-driven nuclear fragmentation model for a fast Monte-Carlo code, FRED, in Particle Therapy with Carbon beams

Thursday, 5 September 2019 09:50 (20 minutes)

To really exploit the potential benefits of Particle Therapy (PT), the highest possible accuracy in the calculation of dose and its spatial distribution is required in treatment planning. Commonly used Treatment Planning Software (TPS) solutions adopt a simplified beam–body interaction model using a 3D water equivalent representation of the patient morphology. An alternative is the use of Monte Carlo (MC) simulations which explicitly take into account the interaction of charged particles with actual human tissues. Full MC calculations are not routinely used in clinical practice because they typically demand for substantial computational resources and they are usually only used to check treatment plans for a restricted number of difficult cases. Therefore, presently one of the major issues related to TPS improvement is the high computational time required in order to meet the goal of high accuracy. The code FRED (Fast paRticle thErapy Dose evaluator) has been developed to allow a fast optimization of the treatment plans in charged PT while profiting from the dose release accuracy of a MC tool. Within FRED the proton and ion interactions are described with the precision level available in leading edge MC tools used for medical physics applications, with the advantage of reducing the simulation time up to a factor 1000. Moreover, running on GPU cards, the code allows a plan re-optimization in few minutes instead of several of hours on CPU hardware. FRED can transport particles through a 3D voxel grid using a class II MC algorithm. Both primary and secondary particles are tracked, and their energy deposition is scored along the trajectory. Effective models for particle–medium interaction have been implemented, balancing accuracy in dose deposition with computational cost. Currently, the most refined module is the transport of proton beams in water and the code is already used as research tool for proton beams at several clinical and research centres in Europe (Krakow, Trento, Maastricht, Lyon). The excellent results achieved with protons determined the interest of the CNAO (Centro Nazionale di Adroterapia Oncologica) center (Pavia, Italy) to develop FRED also for Carbon therapy applications. Models for the interaction of Carbon ions with matter are currently under development to be implemented in the FRED code. In particular, the main difference is in the fragmentation of the projectile since protons do not fragment while ions do. As the beam fragmentation process is related to the dose release outside the tumor region its description is of paramount importance and has to be accurately modeled. Currently, the development of the model is based on the use of data taken during experiments at GANIL (laboratory of CAEN, France) where the fragmentation of Carbon ions on thin targets (H, C, O, Al and Ti) has been studied (J. Dudouet, et al, DOI:10.1103/PhysRevC.88.024606). To tune the algorithm in the energy range used in PT treatments, and not only at beam energies of the GANIL experiment, an appropriated scaling is used, obtaining energy and angular cross-sections specific for every energies. In the next future, new data from other experiments (i.e. FOOT experiment) will be used to improve the model. The status of new developments and the performance of FRED will be presented.

Primary authors: SCIUBBA, Adalberto (Sapienza Universita e INFN, Roma I (IT)); SARTI, Alessio (INFN); SCHIAVI, Angelo (Università di Roma "La Sapienza"); GIOSCIO, Eliana; TRAINI, Giacomo; FISCHETTI, Marta (INFN - National Institute for Nuclear Physics); MARAFINI, Michela (INFN Roma1 - Centro Fermi); Mrs DE SIMONI, Micol (Università di Roma ”La Sapienza”, Fisica, Rome, Italy); MIRABELLI, Riccardo (INFN); PATERA, Vincenzo (University of Rome Sapienza)

Presenter: Mrs DE SIMONI, Micol (Università di Roma ”La Sapienza”, Fisica, Rome, Italy)