FLUKA SIMULATION IN MEDICAL PHYSICS

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Abstract: FLUKA is a general-purpose tool for calculations of particle transport and interactions with matter, covering an extended range of applications spanning from proton and electron accelerator shielding to target design, calorimetry, detector design, cosmic rays, neutrino physics, dosimetry, medical physics, radiotherapy etc. The FLUKA physical models are described in several journal and conference papers [1][2].

Over the last decades, developments in Monte Carlo radiation transport algorithms have had tremendous impact in different areas of radiation therapy. MC simulations are particularly important to improve the treatment planning algorithms and the quality assurance issues related to the outcoming dose deposition in the patient [3]. The aim of this talk is to give an overview of the FLUKA code and the application in medical physics, mainly in radiation physics.

My research project is focused on the use of FLUKA code for validation of monitoring techniques in proton therapy. This is a valuable method for treatment of radioresistant and deep-seated tumors due to the depth-dose distribution characterized by the Bragg peak. Nuclear interaction between the protons and the phantoms irradiated generate beta+ emitters during the treatment. The detection of this activity signal can be used to perform the validation of the monitoring techniques. FLUKA is used to calculate the expected activity distribution simulating the experimental conditions of irradiation. The data acquisition were performed in Trento proton therapy facility (IT), where a cyclotron of maximum energy of 230 MeV is installed. The activity signals were acquired with a PET system (DoPET) [4] based on two planar 16 cm x 16 cm LYSO-based detectors and designed to be installed along the beam line and acquire data also during the irradiation.

[1] A. Ferrari et al., FLUKA: a multi-particle transport code, CERN-2005-10 (2005), INFN/TC_05/11, SLAC-R-773

[2] T.T. Boehlen et al., The FLUKA Code: Developments and Challenges for High Energy and Medical Applications, Nuclear Data Sheets 120, (2014)211-214

[3] G. Battistoni at al., The FLUKA Code: An Accurate Simulation Tool for Particle Therapy, Front. Onco (2016) 6:116

[4] L. Brombal et al., Proton Therapy treatment monitoring with in-beam PET: investigating space and time activity distributions, Nucl Instr Meth, A861, (2017), 71-76