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GEANT4 Simulation for nuclear and interdisciplinary physics

venerdì 21 giugno 2024 11:40 (20 minuti)

GEANT4 is a powerful tool to characterize the capabilities of an experimental setup. In this talk, I will present the preliminary results of GEANT4 simulations for two different apparatuses: the Beta decay station, soon to be installed at the INFN laboratories of Legnaro and the Begam project for the study of radiopharmaceuticals.

The beta decay station focuses on studying exotic ions. Investigating the β decay of these isotopes provides crucial insights into nuclear structure, astrophysical processes, fundamental interactions, and the limits of our current understanding of the universe. To achieve accurate simulations of the beta decay station, several considerations must be addressed. GEANT4's built-in radioactive decay option does not account for β decays with delayed neutron emission, the database may not be fully up-to-date for exotic isotopes, and furthermore the proper timing of the measurements is essential.

To address these issues, four Wolfram Mathematica software have been developed to be used in advance of the simulation. These software provide comprehensive information for the simulation by: listing all the decay processes for a given ion, optimizing the measurement and implantation time windows and calculating conversion coefficients to update the GEANT4 database. The simulation and the Wolfram Mathematica codes have been validated using a beam of ^{148}Cs isotopes, obtaining satisfactory results. We expect both the software and the simulation to became a useful tool that can help to better understand the measurements that will be performed in the future, once the beta decay station will be fully operational.

The second part of the talk will focus on the Begam project, which involves developing a new apparatus to detect β^- contaminants in radiopharmaceuticals through coincidence (or anti-coincidence) measurements of β particles and γ rays.

At this stage we are implementing GEANT4 simulations to test the realistic configuration of the proposed device. This device features a hollow cylindrical plastic scintillator to hold the radioactive sample, mounted on top of a solid CsI cylinder. The two layers are surrounded by CsI(Tl) sectors, ranging from four to eight, arranged to form a cylinder. The dimensions and number of the scintillators will be determined based on the simulation results.

The first test will be performed on an eluate of ^{99m}Tc, as its production through radionuclide generators may result in the presence of the β decaying radioisotope ^{99}Mo. In fact, the acquisition of the γ spectrum in coincidence with respect to the β signals, will allow to select the γ radiations coming from the ^{99}Tc levels populated by the parent ^{99}Mo nucleus, rejecting the γ rays coming from the IT decay of the 143 keV isomeric level of ^{99m}Tc. This will make it easier to accurately estimate the percentage of ^{99}Mo present in the solution.
In a further future BEGAM will be used to analyze the purity of the radionuclides produced at medical cyclotrons like for example the ^{68}Ga.

Autore principale: PERRI, Marco (Istituto Nazionale di Fisica Nucleare)

Relatore: PERRI, Marco (Istituto Nazionale di Fisica Nucleare)

Classifica Sessioni: Future projects

Classificazione della track: Detectors