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Development of a Monte Carlo simulation workflow for the study of the radionuclide deposition process on the collection target in the context of Selective Production of Exotic Species (SPES) facility

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SPES (Selective Production of Exotic Species) is a second-generation ISOL facility for the production of Radioactive Ion Beams (RIBs), under completion stage at the Laboratori Nazionali di Legnaro of the Istituto Nazionale di Fisica Nucleare (LNL-INFN), Padua, Italy. The Isotope Separation On-Line (ISOL) technique is one of the most utilized methods for the production of high intensity and high purity RIBs, that are of high interest for both basic and applied nuclear physics research. In the case of SPES, neutron-rich isotopes will be produced with a $40\,\mathrm{MeV}$, $200\,\mu\mathrm{A}$ primary proton beam impinging on a $^{238}\mathrm{UCx}$ target, the expected reaction rate being about 10^{13} fission/s. Since the target is operated at high temperature (above 2000 °C), the produced radionuclides undergo in-target diffusion, effusion and ionization; the beam is then extracted, mass separated and delivered to the experiments. One of such experiments is ISOLPHARM (ISOL technique for radioPHARMaceuticals), a research activity dedicated to the development of innovative radiopharmaceuticals exploiting the high purity radionuclides produced in the SPES ISOL facility. For such scope, a dedicated system called IRIS (ISOLPHARM Radionuclide Implantation Station) will be coupled with the RIB line to handle the collection targets where radionuclides of medical interest are deposited. $^{111}\mathrm{Ag}$ is one of the most promising medical radioisotopes produced by SPES for its potential in therapeutic use. The deposition of radionuclides with mass number = 111 u and the radiological safety issues raised by such an amount of radioactive species are studied, by means of Monte Carlo codes FLUKA and PHITS. The work flow includes calculation of the in-target production due to $^{238}\mathrm{U}$ fission, selection of isotopes forming the RIB and realistic estimation of their activities, and evaluation of the ambient dose equivalent rate around IRIS at different times during and after the production phase. The methodology provides a guideline for estimating the available activities at the end of RIB line, taking into account that all physical processes undergone by the RIBs before reaching the IRIS system present a specific efficiency. Furthermore, the obtained results will be used for the design of the shielding for the handling of the IRIS collection targets.

Scientific Topic 1

Source terms, new accelerator facilities and related topics

Scientific Topic 2

Scientific Topic 3

Scientific Topic 4

Shielding and dosimetry

Scientific Topic 5

Scientific Topic 6

Scientific Topic 7

Scientific Topic 8

Primary author: Mr CHEN, Daiyuan (Università degli Studi di Padova, Dipartimento di Fisica e Astronomia and INFN Sezione di Padova)

Co-authors: Dr BALLAN, Michele (INFN, Laboratori Nazionali di Legnaro); Dr DONZELLA, Antonietta (Università degli Studi di Brescia, Dipartimento di Ingegneria Meccanica e Industriale and INFN Sezione di Pavia); Dr MONETTI, Alberto (INFN, Laboratori Nazionali di Legnaro); Dr KHWAIRAKPAM, Omorjit Singh (INFN, Laboratori Nazionali di Legnaro); Prof. LUNARDON, Marcello (Università degli Studi di Padova, Dipartimento di Fisica e Astronomia and INFN Sezione di Padova); Dr ANDRIGHETTO, Alberto (INFN, Laboratori Nazionali di Legnaro)

Presenter: Mr CHEN, Daiyuan (Università degli Studi di Padova, Dipartimento di Fisica e Astronomia and INFN Sezione di Padova)

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