DESIGN OF THE BEAM LINES AND THE EXHAUSTED TARGET TEMPORARY STORAGE OF A RADIOACTIVE BEAM FACILITY, FOR CONTAINMENT OF RADIOACTIVE HAZARD AND ENVIRONMENTAL IMPACT

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The main research objectives

The research aims to provide a study of the radioactive impact in a nuclear facility for the production of radioactive ion beams, during the operation phase and along the whole life cycle of the plant. The case study is the SPES (Selective Production of Exotic Species) project, a second generation nuclear facility for the production of Radioactive Ion Beams (RIB) currently under construction at the National Laboratories of Legnaro (LNL), Padova [1-3].

The safety and radiation protection issues during the operation of RIB facilities like SPES are connected to the use of high-intensity proton accelerators and to the generation of radioactive beams thanks to the use of production Targets coupled to a specific Ion Source (TIS unit).

The first contribution is closely connected to the study of the evolution of the conditions of the facility, from the point of view of radioactivity hazard, during the operation phase of the plant (at least fifteen years). From this point of view, the research project aims to:

1. study in depth the design of the beam lines and the strategies to handle the TIS unit, that has a limited live-cycle and need to be removed by the operation area after its use;
2. assess the biological dose that the worker may incur during the necessary access and maintenance interventions in proximity of the SPES facility in the operation phases;
3. implement strategies to minimize the dose, in compliance with the radiation protection principles and with the Italian legislation on radiation protection;
4. design the shielding structure of the temporary storage where the exhausted TIS units removed by the operation area must be stored before being dismantled and disposed.

A second contribution of the research, connected to the previous one, is devoted to the study of the environmental impact of a facility for the production of radioactive ion beam (as SPES) during its life cycle, from the initial design to the final disposal, with a specific regard to:

1. the economic and social aspects to consider for a sustainable development of such a type of facility;
2. the strategies used to manage possible environmental conflicts connected to the operation of the facilities [4].

The methods

The study of the radioactive impact of the SPES facility is carried out using specific Monte Carlo codes. These simulation programs reproduce all the relevant physical interactions and nuclear processes of the particles in the different crossed materials. They are able to collect different information in the field of the radiation protection and dosimetry and on radiation shielding.

In particular, the study of the beam lines is performed using MCNPX [5], that allows the main elements present in the operation area and their materials to be modelled. Interfaced with CINDER [6], MCNPX is able to evaluate the activation of different materials due to the intense nuclear fields.

The secondary line of formation and transport of the RIB beam of radioactive ions is studied with TRACEWIN [7], a software code able to draw the structures of electromagnetic fields, by optimizing the radioactive ions transport to minimize the beam deposition in the materials.

The residual radioactivity in the operation area, its spatial distribution and its temporal dependence are assessed with MCNPX+CINDER and FLUKA [8]. FLUKA can also be used to evaluate the optimum shielding structures of the handling system and on the temporary storage of the exhausted TIS units.

References

[1] G.Prete et al., “The SPES project at the INFN - Laboratori Nazionali di Legnaro”, EPJ Web of Conferences 66, 11030 (2014).

DOI: 10.1051/epjconf/2014-66-11030.

[2] A.Monetti et al., “The RIB production target for the SPES project”, EPJ A 51, 128 (2015).

DOI: 10.1140/epja/i2015-15128-6.

[3] A. Andrighetto et al., “SPES: An intense source of Neutron-Rich Radioactive Beams at Legnaro,” IOP Conf. Series: Journal of Physics: Conf. Series 966, 012028 (2018).

DOI: 10.1088/1742-6596/966/1/012028.

[4] W. Chung et al., “Community relations dealing with a not in my back yard (NIMBY) context: An experimental application of situational theory of publics and social exchange theory”, International Journal of Conflict Management, 27-3, 424 (2016).

DOI: 10.1108/IJCMA-09-2014-0069.

[5] MCNPX^{TM} USER'S MANUAL. Version 2.7.0, April 2011, D.B. Pelowitz editor (2011).

[6] F.X.Gallmeier et al., “The CINDER'90 transmutation code package for use in accelerator applications in combination with MCNPX”, ICANS XIX, 19th Meeting on Collaboration of Advanced Neutron Sources, Grindelwald, Switzerland (2010).

[7] D. Uriot and N. Pichoff, “Status of TRACEWIN code”, Proceedings of IPAC2015, Richmond, VA,USA (2015).

ISBN978-3-95450-168-7 92.

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