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Activation and neutronics studies for the CERN n_TOF facility with the FLUKA Monte Carlo code

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The n_TOF facility, a spallation neutron source, uses a pure lead target for production of neutrons with a 20 GeV proton beam extracted from the CERN Proton Synchrotron (PS). After four years of operation and three years of cooling, from 2001 to 2007, the target assembly has been successfully removed. After a detailed analysis of the target status, the decision to substitute it with a new target has been taken. Only within few months, a strong effort was put in the development of a new target and a new cooling system, both ready for a restart of the facility in 2008.

This study presents detailed results for the produced nuclide vector in the respective installation and target components, as well as a three-dimensional residual dose rate fields for different geometrical configurations. These calculations formed an important input to prepare and plan intervention scenarios, foresee proper waste disposal and help in the analysis of the target status.

For the design of the new target, numerous aspects were taken into account, including neutronics and activation calculations compared with the ones performed for the old target, and a respective comparison of several possible target configurations is presented in this paper. Furthermore, prompt dose calculations were performed with the finally chosen target design, which is based on a well detailed geometrical implementation in FLUKA, and the comparison with the measurements performed during the commissioning in 2008 are shown.

In 2009 a new target cooling station with improved performances has been installed. It includes a degassing system, which is used to maintain the oxygen level in the cooling water down to an average value of 40 ppb and two ion-exchanger cartridges to retain spallation products. In addition, the primary area is now also being ventilated and maintained with an underpressure of 40 Pa with respect to the surrounding atmospheric pressure. In this context, the impact of an unforeseen release of short lived isotopes from the exhaust stack are shown, as well as the actions taken to mitigate this issue.

Finally, the comparison of the expected fluence - in the experimental area - between the new and the old spallation target is shown, together with the results of the simulation using borated water in the moderator circuit, a recent upgrade of the facility currently in its final preparations.

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