Radioactive waste study of the ATLAS detector with the FLUKA Monte Carlo code

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The collisions of the two 7 TeV proton beams at the centre the ATLAS detector of the future CERN Large Hadron Collider will result in material activation. The general purpose in the establishment of a radiological waste study is the understanding of the production of waste and of the evolution of its radiological and physical characteristics. In particular, this should include the identification of the detector components and the areas in the experimental hall where only conventional waste will be found from those areas where radioactive waste may be produced.

Extensive simulations with the Monte Carlo code FLUKA were performed using a complex model of the 50 m long ATLAS detector, consisting of more than 800 regions. The source of particles was created with an offline generator of p-p collisions. Specific biasing techniques in the transport of low-energy neutrons and the latest heavy-fragment evaporation model were adopted. Trace elements were included in the less exposed components of the detector. A virtual isotropic source of neutrons was also used to estimate the region volumes by scoring the neutron track-length inside each region.

FLUKA allows scoring the nuclide production-rate per p-p interaction. The activity of each nuclide after a predefined irradiation cycle was normalized online to reference values taken from the European legislation, to obtain an absolute estimate of the radiological hazard. The impact of changing the irradiation period, the beam luminosity and the waiting time on the zoning was investigated. This study also provides a comparison between the distribution of inelastic interactions, specific activity and hadron fluence, as well as a list of the most hazardous radionuclides.