CERN's Large Hadron Collider – Radiation Protection Aspects of Design and Commissioning

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Abstract

CERN, the world's largest particle physics laboratory provides high energy hadron beams for experiments exploring matter. For this purpose various accelerators are operated and in 2008 the last link will be added to the accelerator chain: beam will be injected into CERN's new "flagship", the Large Hadron Collider (LHC). From then on high energy physics experiments will exploit the LHC's colliding beams of protons and lead ions with a center of mass energy of 14 TeV and 1150 TeV, respectively.

Radiation Protection aspects were taken into account during the whole duration of the design phase. Conservative design constraints were defined in 1996; some years later some of them, in particular with respect to the dose to occupational exposed workers, had to be readjusted to account for the latest development in CERN's radiation protection rules and regulations.

Numerous radiation protection studies had been performed to ensure a lay-out of the machine and its experiments in compliance with these constraints. These studies assessed all radiation risks related to the various beam-operation modes of the accelerator. In all cases external exposure was identified as the major risk: due to high energetic, mixed radiation fields during beam-on and due to beta and gamma radiation fields caused by induced radioactivity during beam-off. Counter measures were implemented like an optimized beam operation to limit beam losses, installation of thick shielding, prohibition of access to the major part of the LHC underground areas during beam-operation and optimization of the equipment and its handling during maintenance and repair. Detailed Monte Carlo simulations were performed to derive from the various beam loss scenarios the dose rates the workers will be exposed to. Individual and collective doses were projected based on the calculations and the maintenance scenarios provided by the teams concerned. In an iterative way the lay-out of the various regions were optimized as function of the doses.

During commissioning of the accelerator radiological quantities like ambient dose rates or specific activity will be closely monitored and the results compared to the predictions of the theoretical studies.

KEYWORDS: Large Hadron Collider, CERN, design constraints, Monte Carlo studies

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