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Crystal collimation for LHC

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One of the main challenges at the CERN Large Hadron Collider (LHC) is to handle the unprecedented stored beam energies that are expected to be up to 360MJ with 7˜TeV beams at 25˜ns bunch spacing. This may increase to 500˜MJ in the LHC High Luminosity upgrade project (HL-LHC). A complex collimation system, able to intercept and to absorb beam halo particles efficiently is used to minimize losses onto superconducting magnets that could cause them to quench. The present collimation system consists of about 50 two-sided collimators per beam, which are precisely placed at the edge of the transverse beam envelope in a four-stage hierarchy. This system has worked very well during LHC Run˜1 at 3.5 and 4 TeV, essentially achieving the design cleaning inefficiency of about 10^{-5}. However, this will be not enough for the future operational challenges of the LHC and its upgrades. A very promising technology to overcome the limitations of the present system is based on silicon crystals instead of amorphous primary collimators. A bent crystal can be used as a primary collimator, using the principle of channeling by the atomic planes, to deflect halo particles onto a heavy absorber. Experimental tests have been carried out over the last 4 years at the CERN Super Proton Synchrotron (SPS), showing the feasibility of beam cleaning using channeling. Application in the LHC requires detailed simulations and the execution of beam tests in the LHC itself, which are foreseen in 2015. Extensive design studies have been carried out to integrate suitable crystals into the collimation system layout, and samples are presently being installed in the LHC. According to simulations, this should lead to an improvement of up to a factor 10 in collimation cleaning thanks to efficient steering of halo particles onto a single absorber. The design of the crystal layout for the first LHC beam tests and the state of simulation tools for crystal collimation studies, bench-marked against the SPS beam measurements, will be discussed.

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