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Coherent interactions in crystals as a tool for manipulation of ultrarelativistic electron and positron beams

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Coherent interactions of charged particles in crystals are known since the 60s and are exploited for material analysis by ion channeling and for the generation of polarized gamma-beams through coherent bremsstrahlung in the periodical crystal structure.

In the field of hadron accelerators, a collimation scheme based on channeling in bent crystals has been investigated at the CERN-SPS and, recently, at the LHC by UA9 experiment. Moreover, the CRYSBEAM project is currently studying the feasibility of a crystal-based extraction for the LHC.

In the case of future electron/positron colliders, e.g., FCC-ee or ILC, a possible application of coherent effects in crystals could be the generation of intense positron beams through axial channeling [1].

Moreover, for linear colliders it has been suggested to improve the beam collimation by exploiting volume reflection in bent crystals [2]. Here, we present an investigation on this possibility carried out on the H4 extracted line of SPS by using a 120 GeV/c e- beam interacting with a 2 mm-long bent Si crystal [3]. The beam was deflected by the crystal at an angle of 11 μrad and 40 μrad through single and multiple volume reflection, respectively. The energy loss by electrons inside the crystal was far more intense with respect to the case of an amorphous medium. The loss enhancement was more pronounced under multiple volume reflection, for which the stronger axial potential plays the main role [3].

By combining the deflecting power with a large energy loss, coherent interactions in bent crystals can be envisaged as good candidates for manipulation of hundreds-GeV beams in future electron/positron colliders, as already proposed for the ILC collimation [2,3].

References

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