Contribution ID: **1335** Type: **Parallel Talk**

Crystal-based extraction of the electron beam circulating in the DESY II Booster Synchrotron

Thursday, 7 July 2022 10:30 (15 minutes)

Beam extraction and collimation in particle accelerators using bent crystals as compact elements capable of efficiently steering particle beams has been investigated at several high-energy hadron accelerators, such as SPS and LHC (CERN, Geneva), Tevatron (Batavia, USA), U70 (Protvino, Russia). Due to technological limitations and a not sufficiently deep understanding of the physics at the base of the interactions between charged particle beams and crystals, this technique has never been applied to electron beams.
Recent innovative experiments carried out at SLAC (Stanford, USA) and MAMI (Mainz, Germany) has raised up the technological readiness level and the understanding of the processes of interaction between crystals and electron beams, highlighting the possibility to use bent crystals to extract electron beams from worldwide spread synchrotrons.
In this contribution we report the first design of a proof-of-principle experiment aiming to use bent crystals as elements to achieve the extraction of 6 GeV electrons circulating in the DESY II Booster Synchrotron. This would be possible exploiting the phenomena of "channeling": particles of a beam which are channeled between atomic planes of a crystal are forced to travel between atomic axes or planes; mechanically bending of the crystal results in steering of the beam, with an effect equivalent to the one of a magnetic field of few hundred Tesla.
We investigated the experimental setup in detail, though in this report we will focus on its main aspects, such as the particle beam dynamics during the extraction process, the manufacturing and characterization of bent crystals and the detection of the extracted beam.
We conclude that, following a successful proof-of-principle experiment, this technique can be applied at many lepton accelerators existing in the world for nuclear and particle physics detectors and generic detector R&D, as well as in many projects in high-energy physics requiring fixed-target experiments including projects related to lepton colliders.

In-person participation

Yes

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Session Classification: Accelerators: Physics, Performance, and R&D for future facilities

Track Classification: Accelerators: Physics, Performance and R&D for future facilities