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Recent advances of crystal channeling in accelerating science.

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A.G. Afonin, M.Yu.Chesnokov, Yu.A.Chesnokov, V.A.Maisheev, A.A.Yanovich,
Institute for High-Energy Physics (IHEP) in National Research Center "Kurchatov Institute",
Protvino, Moscow region, 142281 Russia

Ideas of use the particle channeling in bent crystals for steer the beams have been checked up and advanced in many experiments. Recently, a curved single crystal was tested at the LHC for the task of the beam collimation [1]. This method is also widely used in U-70 accelerator of IHEP, where crystals are used in regular runs for beam extraction and forming [2]. However, until now, this method of beam formation has limitations in application, since the channeling process involves beam particles with low angular divergence, limited by the angle of Lindhardt (it is equal to 25 microradians for the energy of the Protvino accelerator U-70 for 70 GeV). Here we describe two crystal devices, the focusing crystals and multistripe crystals, which expand the boundaries of application of bent crystals at accelerators. The created focusing crystal [3] reveal the possibility of a new optics of the beams for extremely high energies. Modern accelerators go into the TeV Energy region, the LHC is already operating at 6.5 TeV. The FCC and SPPC with energies up to 100 TeV are planned. In this region of energies, the scattering of secondary particles from the targets is very narrow, a fraction of milliradian. We propose special crystal elements with a focusing edge for the formation of particle beams of such energies. These crystals can work as super-strong lenses with a focal length of about 1m, with an equivalent magnetic field of 1000 Tesla. The proposed ideas are supported by experimental studies on the U-70. Multistrip crystals [4] are also created, which can deflect beams of positively and negatively charged particles due to the phenomenon of reflection from curved atomic planes by more than 90% efficiency. These devices are promising for radiation-protection septum SM24 and collimation of the proton beam crystals in a magnetic block 86 accelerator U-70. Also, multilayer crystal structures can be used to protect the electrostatic septum of the SPS accelerator at CERN [5], for which the corresponding calculations will be carried out using the proposed algorithm.
References.

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Author: CHESNOKOV, Yury (Institute for High Energy Physics of NRC Kurchatov Institute (R)

Presenter: CHESNOKOV, Yury (Institute for High Energy Physics of NRC Kurchatov Institute (R)

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