T590: Development of proton-beam deflection using a bent silicon crystal with KEK 12-GeV Proton Synchrotron

V. Biryukov[1], Yu. Chesnokov[1], I. Endo[2], M. Iinuma[2], H. Kuroiwa[2], T. Ohnishi[2], H. Sato[2], S. Sawada[3], S. Strokov[2], T. Takahashi[2], K. Ueda[2]

[1]*Institute for High Energy Physics (IHEP), Russia*

[2]*Hiroshima University, Japan*

[3]*High Energy Accelerator Research Organization (KEK), Japan*

Crystal channeling is a phenomenon where a charged particle is trapped in a potential between crystallographic planes. One of the most remarkable characteristics of the phenomenon is a possibility to bend a beam with a tiny crystal. If crystal channeling can be applied to beam handling in high intensity accelerator facilities such as a beam separation device at the slow extraction facility of the 50-GeV proton synchrotron of J-PARC, it may be greatly beneficial to reduce beam loss at the separation point because the total amount (thickness) of the materials inside the beam can be reduced by using a tiny crystal. In addition, if crystal channeling can be applied to electron beams, it could be used for halo collection in the future International Linear Collider.

In this test experiment, deflection of a 12-GeV proton beam by a bent crystal was performed. A silicon bent crystal was used, which is 10mm of the length, 1mm^2 of the cross section (about 3mm high and 0.3mm thick), with a bent angle of 32.6mrad. The experiment was performed at a free space on the EP2-A beam line between the K2D1 magnet and the beam dump. As shown in Fig. 1, the bent crystal was inserted into the 12-GeV proton beam, and the bent beam was observed by a tube camera looking at a CsI fluorescent screen on a ceramic phosphor plate, located at about 1.5m downstream. The bitmap images taken by the camera were electronically transferred and stored in a computer. An observed image with preliminary background subtraction is shown in Fig. 2. As a result of data analysis, we can preliminary conclude that we could bend the proton beam of 10^7 particles/pulse out of the total beam of 10^{12} particles/pulse with a bending angle of 32.6 mrad, and the deflection efficiency of the crystal was about 15 – 80 %.

This is the first step to develop a beam splitting device at the 50-GeV facility of J-PARC. Careful design of a crystal and its supporting device as well as tests with beams would be necessary for realization.

We would like to thank all the KEK staff who supported the experiment during preparation and the beam time. In addition, we would like to express sincere gratitude to other experimental groups who accepted inconvenience and inefficient beam time in a period when we tuned the primary beam only for our purpose.

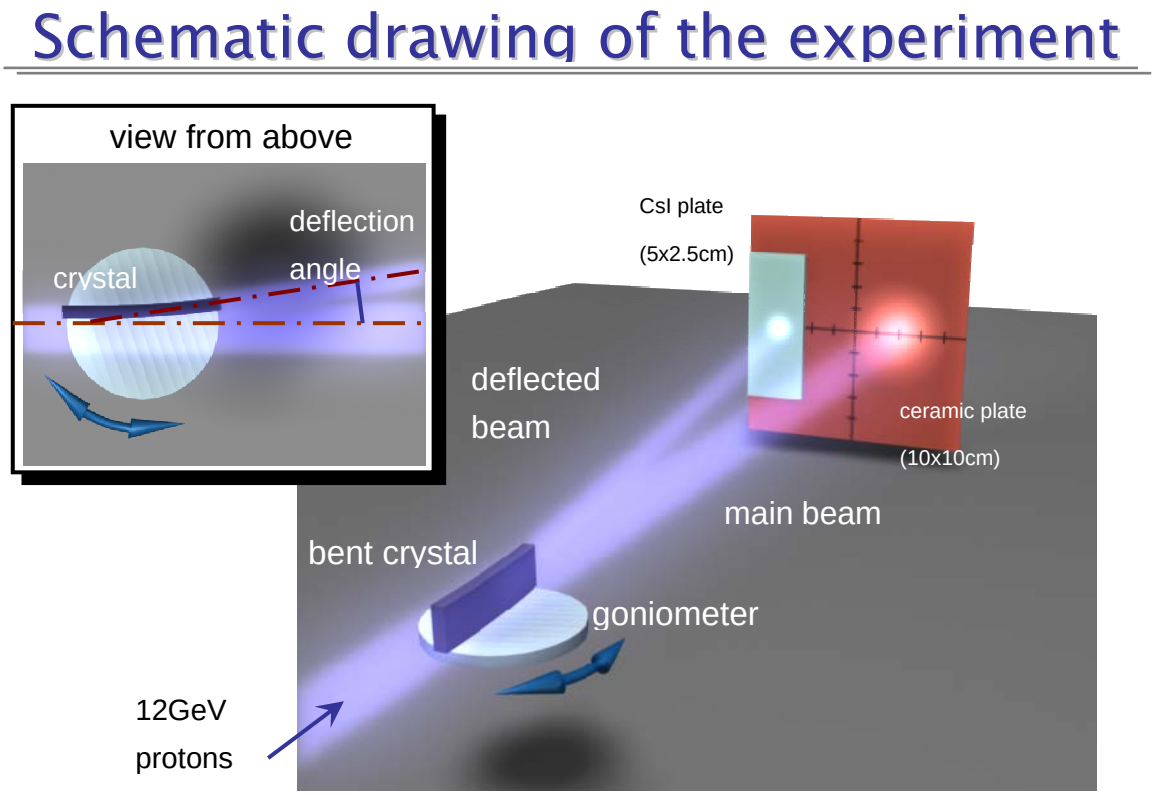

Fig. 1: Schematic drawing of the experimental apparatus.

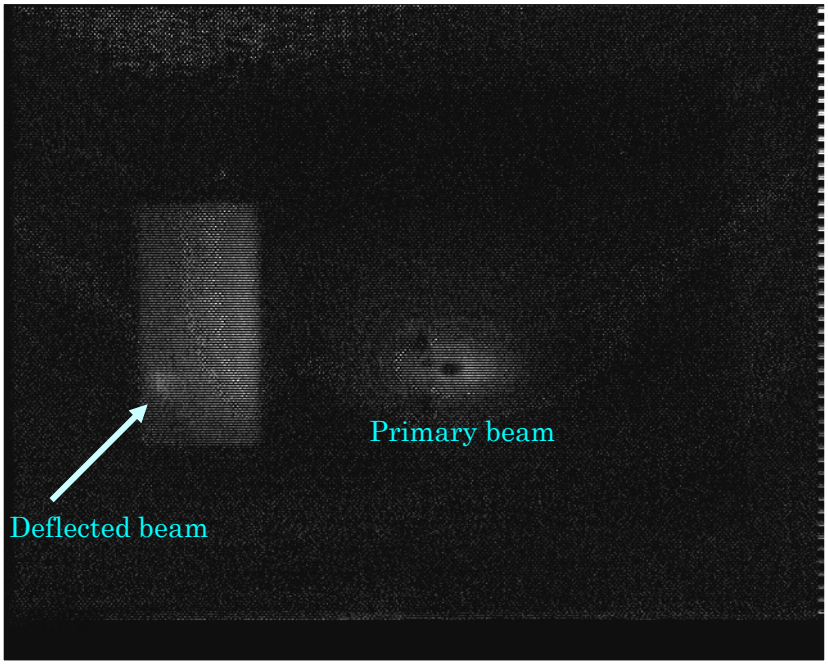

Fig. 2: Image of the CsI plate on the phosphor plate after background subtraction.