Channeling, Volume Reflection and Gamma Emission Using 14GeV Electrons in Bent Silicon Crystals

By Brandon Benson

Accelerator undulators cause charged particles to oscillate back and forth. The oscillation of a charge in these undulators produces only specific frequencies of radiation. As a result, undulators are used to make laser light that can be used to track chemical reactions and create videos on the atomic level. Undulators are very expensive and large (100m long in the case of LCLS undulator). In this paper, we aim to learn more about an alternative method for creating laser light that is less expensive and more compact. High energy electrons can be sharply deflected using a bent silicon crystal. This produces high energy light. As these crystals can be thin, a series of bent silicon crystals with alternating direction can cause the electron beam to zigzag between crystals, mimicking the oscillation of charged particles in undulators. Just like in an undulator, this oscillation would create laser light. Silicon crystals provide an inexpensive and compact alternative to producing this laser light. Additionally, because the crystals are compact, they would result in higher energy radiation, known as gamma rays. These could be used for probing through materials currently impenetrable by x-rays. To understand these crystal undulators better, we measured the spectrum of light emitted from bent silicon crystals. The spectra of light that we collected show some expected trends, but we had too much error in our measurements to make any more claims. We also investigated electron motion in the crystal. This extended our understanding of crystal undulators to higher energies. We have a better understanding of crystal undulators and the trends that we saw show us what to look at in the future to test our current model.

SLAC National Accelerator Laboratory, 2575 Sand Hill Road, Menlo Park, CA 94025

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