beams is x-ray radiation that is emitted tangentially to the beam orbit. CHESS focuses these x-rays on various materials and macromolecules in order to study their structure and properties. My project was concerned with automating the x-ray beam lines in order to improve the efficiency and accuracy of data collection by scientists using the facilities.

Introduction

The growing demand for beam time at synchrotron radiation sources throughout the nation has made it a priority to increase the efficiency at which users conduct experiments at these facilities. One idea being pursued by several labs is automating the process of mounting and centering of crystals on x-ray beam lines. Currently at CHESS crystals are mounted and centered in the x-ray beam by hand. Because of safety considerations and the imprecise nature of hand mounting, users often have to enter and leave the x-ray hutch several times before a crystal is mounted satisfactorily. Users must also be present to mount and center each crystal, which may require working long into the night. In these cases, fatigue can lead to mistakes that hurt or slow down data collection. Automating the crystal mounting and centering process using a combination of robots, crystal imaging systems and computer algorithms will save time and stress, making CHESS a more desirable facility for users to conduct research.

The automated crystal mounting and centering project at CHESS is divided into three goals. The first goal is to allow users to center the crystals from outside the hutch using a computer and video monitor linked to motorized goniometer head which holds the crystal. This will alleviate the need for users to reenter the hutch to adjust crystal centering but it will still require them to mount each crystal by hand. The second goal is to design an imaging system that will recognize and center crystals at the push of a button. Users will still have to mount each crystal by hand, but even the most inexperienced user can do crystal centering outside the hutch. The third goal is to completely automate the process by including a robot that can mount and dismount a series of crystals onto the goniometer head. A digital imaging system and algorithm will then automatically center the crystals for optimal x-ray diffraction. At this level it would be possible for users to not even be on site to conduct their experiments. A tray of crystals could be installed in holding device near the robot. The robot and other instruments in the hutch could then be programmed to mount and center a crystal, expose it to x-rays at several different angles, store the data and then dismount the crystal. This could be done repeatedly with no human intervention. Users at a remote location could monitor and adjust the crystal mounting and centering process through a web page.

Current Crystal Mounting and Centering Process

Currently, crystal mounting and centering is done by hand at CHESS. Crystals, varying from a millimeter to 100 microns across, are secured by hand to thin wire loops attached to a magnet. This magnet is then placed on a magnet that is at center of the goniometer’s rotating spindle axis. The goniometer head is placed parallel to the path of the x-ray beam so that crystal loop is sticking into the beam. A microscope camera linked to a video monitor in the hutch (the chamber where x-ray exposures are taken) allows the user to view the crystal on the goniometer head. Cross hairs on the video monitor indicate the