Thin Diamond Radiator Fabrication and Characterization for The GlueX Experiment

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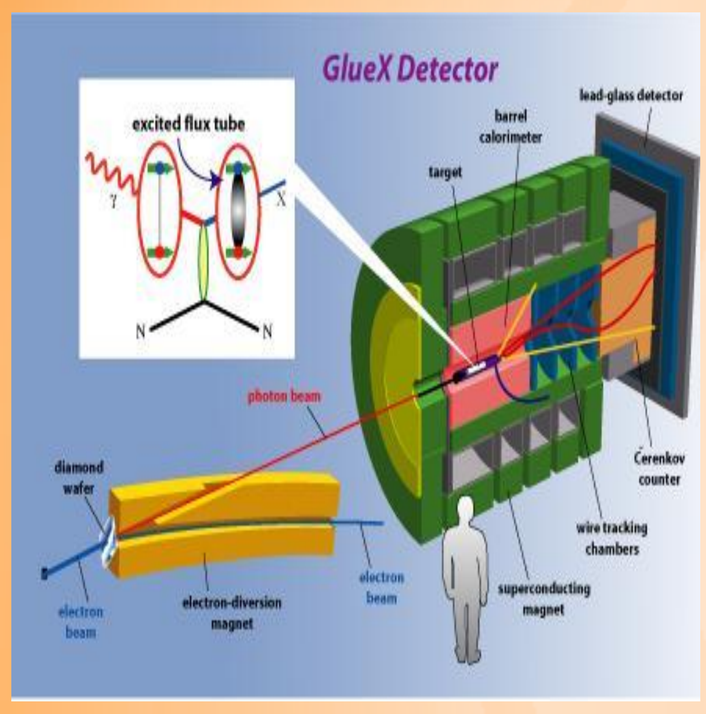
Abstract

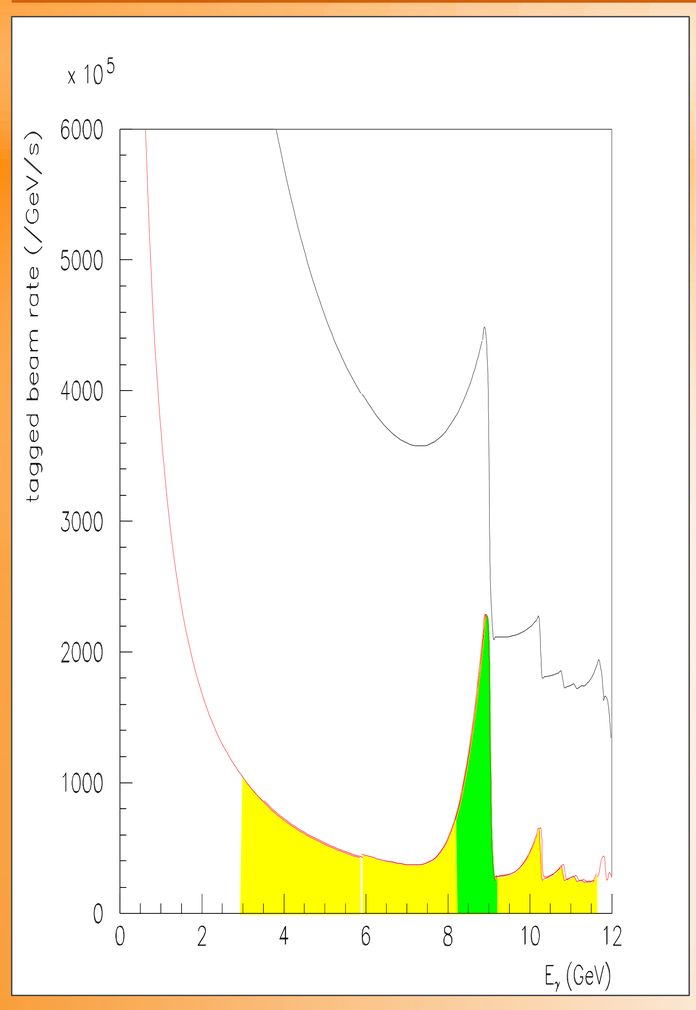


The GlueX experiment at the Thomas Jefferson National Lab in Newport News Virginia is a photonuclear experiment design to explore the excited gluonic bonds between quarks. A beam of polarized photons will be set incident on a 30cm liquid hydrogen target. To create a well collimated polarized photon beam, coherent bremsstrahlung radiation was chosen.

A 12GeV electron beam will pass through a 20μm thick diamond wafer and undergo the bremsstrahlung process. The spread of photon production is not only a function of the thickness of diamond wafer used, but also of its planarity. The lattice structure of the diamond is what makes it a good choice, however modern machining techniques tend to leave the diamonds curved and stressed resulting in a wide bremsstrahlung peak.

The collaboration group at UConn has developed a laser ablation process to create 20μm CVD diamond radiators free from strain and warping. Surface profiles and rocking curve measurements are presented which demonstrate that this process results in diamond radiators which meet the GlueX criteria for thickness, flatness, and crystal mosaic spread.

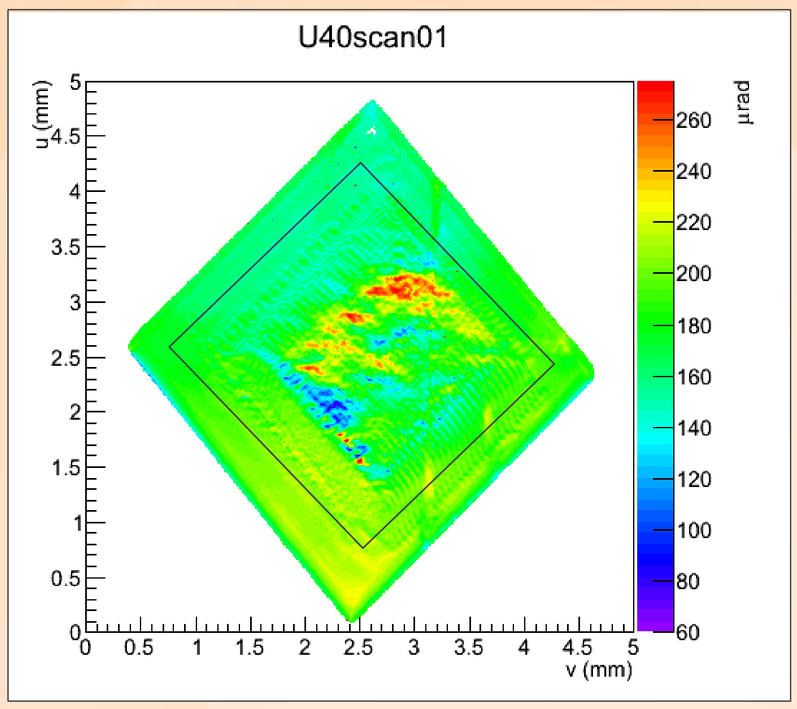
Coherent Bremsstrahlung

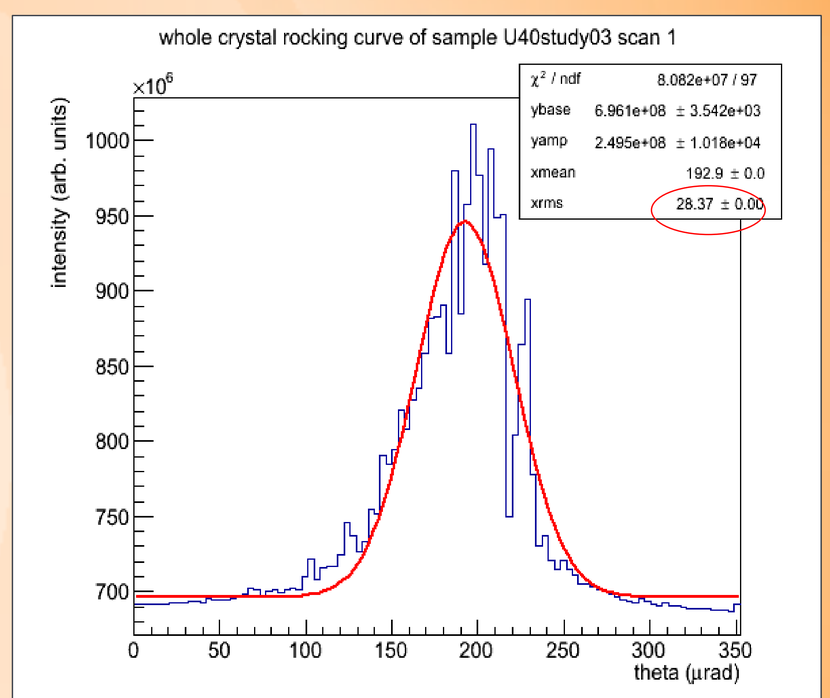


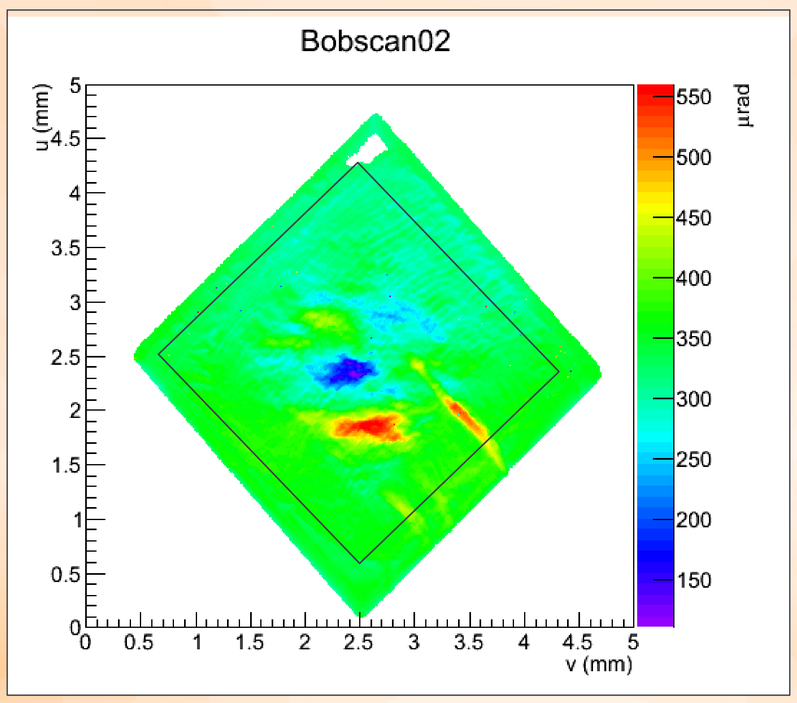
Bremsstrahlung produces electromagnetic radiation when a charged particle is deflected by another particle. In the GlueX experiment, a 12GeV electron will decelerate when it passes through a diamond radiator producing photons with about 9GeV. In order to create the sharp peak in the otherwise smeared bremsstrahlung radiation energy spectrum, the resulting photon beam will be collimated, also known as coherent bremsstrahlung.

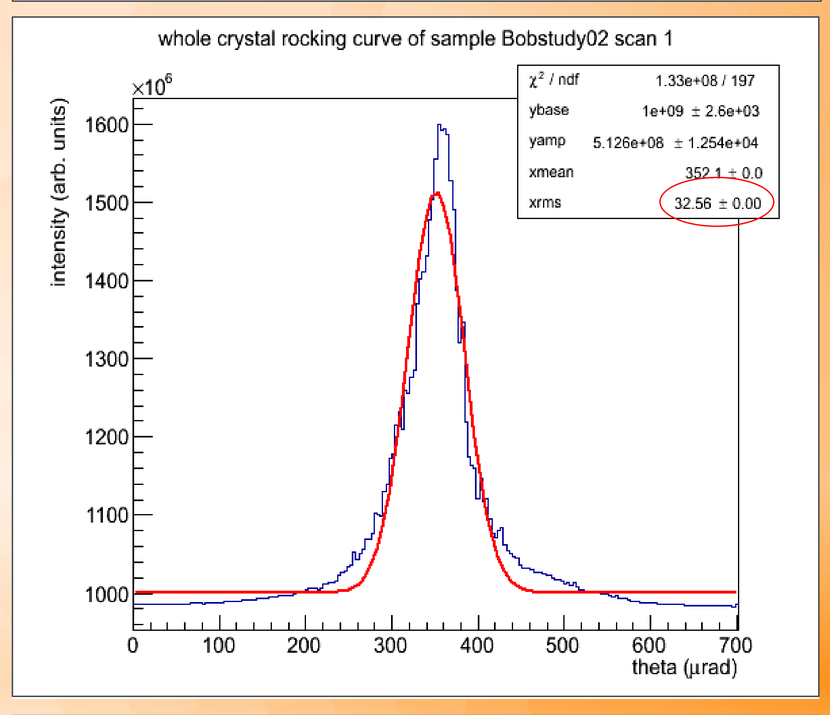
Compton scattering was also considered for GlueX photo-production and although this process achieves nearly 100% polarization and has very low background, it was not chosen due to its insufficient energy and flux.

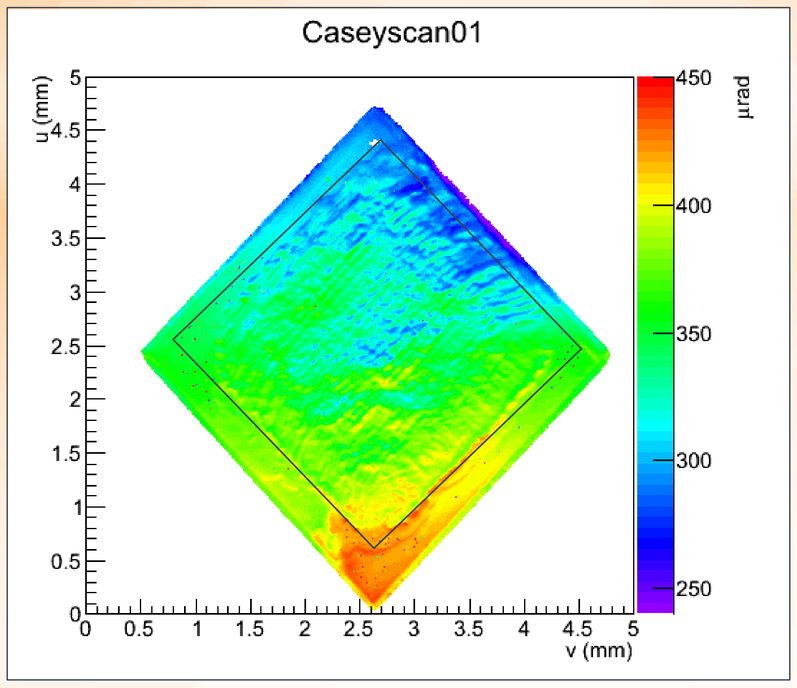
X-Ray Rocking Curves of UConn Samples taken at Cornell High Energy Synchrotron Source

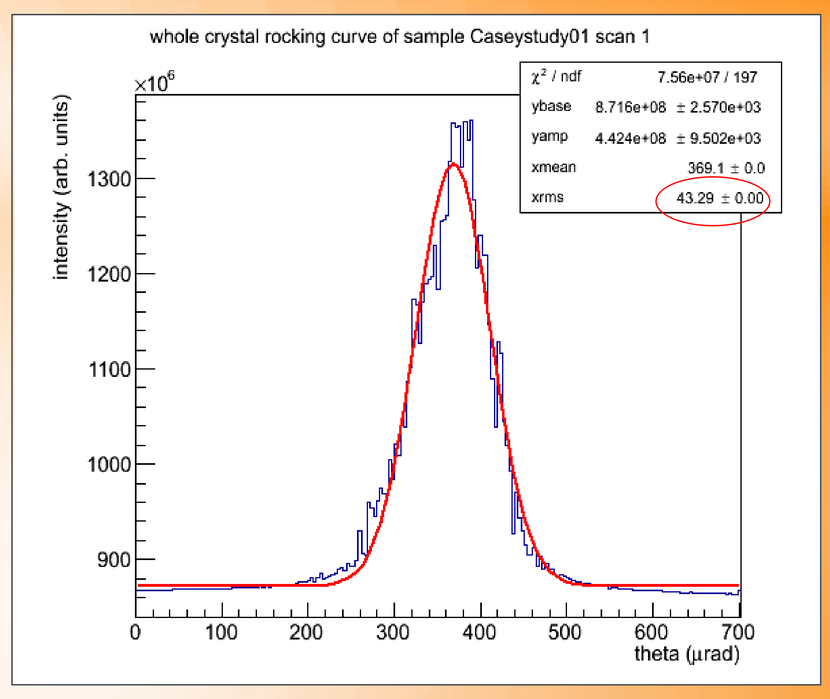




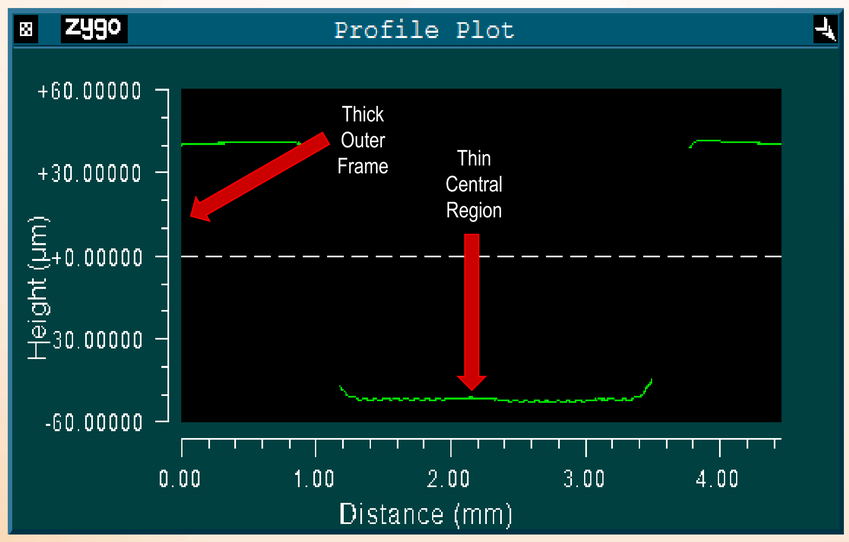






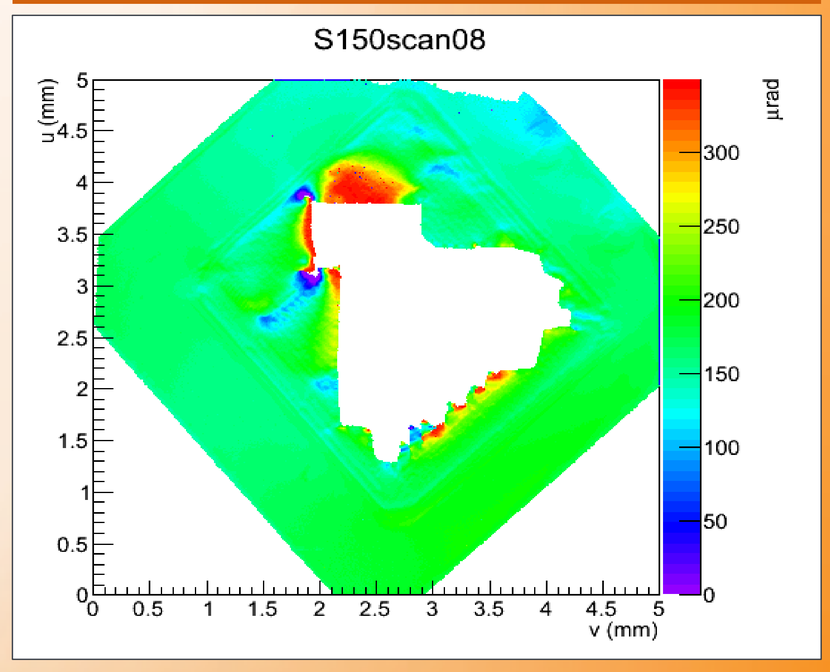


Promising Results



The plot below shows a cross section of sample S150 taken with a Zygo white light profilimeter. After 100μm was removed from the central region, the interior surface remained exceptionally flat and the vertical walls steep; both of which are crucial requirements for the GlueX experiment.

Oops!



Citations

1. The GlueX Experiment, (http://www.gluex.org).
2. http://zeus.phys.uconn.edu/wiki/

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