Development of X-ray Streak Camera

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Introduction

We are developing an x-ray streak camera in order to view ultrafast phenomena that occur on a timescale faster than the APS bunch duration. Such phenomena include coherent phonons, nonthermal melting, and transient states in organic films. The time resolution in pump-probe experiments is typically limited by the timing jitter between the pump and probe or the temporal width of the probe. The femtosecond laser (pump) at sector 7 at the APS is phase locked to a single x-ray bunch with a jitter considerably better than the bunch duration. Temporal resolution is thus limited to the bunch length. However, better resolution can be afforded by a state-of-the art detector such as a picosecond x-ray streak camera. Thus, the internal structure within an x-ray pulse can be resolved to a few picoseconds. The x-ray pulse duration then acts as a time scan for studying ultrafast dynamics.

Methods and Materials

The camera was designed to minimize its weight such that it could be mounted on a standard goniometer. In addition, the components are all ultrahigh vacuum (UHV) compatible, and a modular design allows for quick changes to the photocathode, anode, electron optics, and streak plates. The photocathode is 1000-Å CsI on Lexan. The imaging system consists of a single microchannel plate intensifier and a lens coupled digital charge-coupled device (CCD) camera.

Results and Discussion

The temporal resolution of this streak camera was demonstrated to be 2 ps when run in an averaging mode. A streaked image of a 10-keV x-ray bunch is shown in Fig. 1, and Fig. 2 is a picture of the detector mounted on a goniometer arm. A full width at half maximum (FWHM) of 60 ps was measured. This is shorter than the 90 ps expected; however, nonlinearities in the sweep of the detector underestimate the actual bunch length. This image was an exposure of 600,000 shots.

The camera will be developed further in the coming year to increase the temporal resolution and alleviate nonlinearities in the sweep. A resolution of better than 1 ps is expected across a dynamic range of 100 ps.

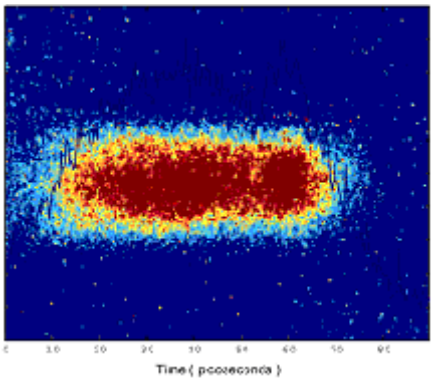

FIG. 1. A streaked image of a 10-keV x-ray bunch captured on the steak camera.

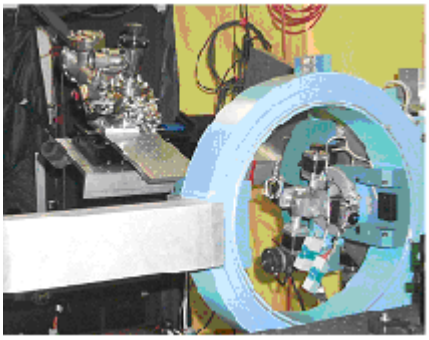

FIG. 2. Picture of the upcoming streak camera installed on a goniometer arm at the MHATT-CAT experimental hutch.

Acknowledgments

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