A CCD-based Beam Monitor

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A "Beam Monitor" is an X-ray area detector designed for viewing an X-ray beam. It comprises of a beryllium window, an phosphor, a tandem lens system, and a cooled-CCD camera (Figure 1). The phosphor is a 10-μm thick P43 (Gd_2O_2S:Tb) coated on a quartz plate. The tandem lens system is made of two identical lenses of F = 1.24 and diameter = 50mm. The image on the phosphor is projected onto the CCD without magnification. For the protection of the optical system from X-ray damages, a pair of lead glasses are inserted between the phosphor and the lens. There is a mirror which changes the direction of the light to protect the CCD from X-rays. The CCD camera (Hamamatsu Photonics C4880-17) has 1000×1018 12-μm square pixels. Thus the active detector area is about 12mm square. The CCD is cooled to −30 °C.
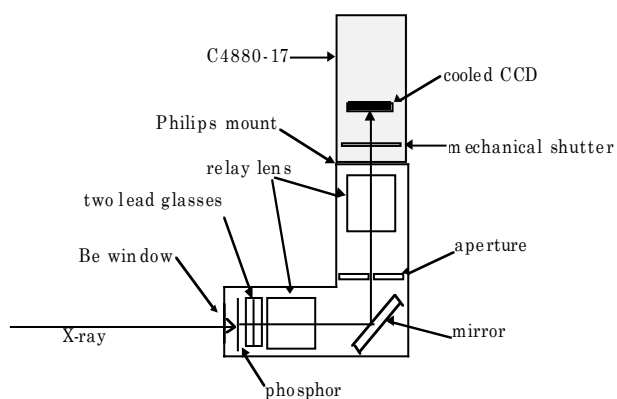
The beam monitor has a spatial resolution of about 20 μm. The exposure time can be changed by a mechanical shutter between 20 msec and 30 min. There is an aperture in the lens system which can control the amount of light that is transmitted to the CCD by about 1000-fold. Together with the wide dynamic range of the cooled-CCD itself (about $1×10^4$) and its sensitivity selection of about 12-fold, the entire system has a dynamic range covering 10 orders of magnitude which makes it possible to observe both a very intense X-ray beam such as a monochromated undulator beam and single X-ray photon. Since the beryllium window and the gadolinium-containing phosphor are employed, the detector is useful over a wide range of energy from 3 keV to about 100 keV.

Currently, this "beam monitor" is used (1) to observe an X-ray beam for diagnosis of a monochromator and an undulator, (2) in X-ray imaging experiments.

The detector head is now commercially available from Hamamatsu Photonics as "Beam Monitor AA20."

"Beam Monitor"

Camera Head