01-Instrumentation and Experimental Techniques (X-rays, Neutrons, Electrons)

OCM-01.03.02 X-RAY TV DETECTOR FOR STRUCTURAL STUDIES WITH SYNCHROTRON RADIATION SOURCE. by
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X-ray TV detectors have been developed for structural studies with synchrotron radiation, especially for exeriments in which real-time measurements and dynamic observations of X-ray diffraction patterns are required. A prototype of the X-ray TV detector (the first generation) consists of four major components;i)phosphor screen,ii) visible-light image intensifier,iii) optical-lens coupling, and iv) a cooled CCD (charge coupled device). In the system, incident X-rays are converted to visible light by a phosphor screen (Y_2O_2S:Tb or CsI:Na) which is evaporated on a fiberoptic plate. The fiberoptic plate is attached to the input surface of a large-aperture (100mmf) visible-light image intensifier. The image intensifier multiplies the number of visible light photons by about 70 times and the image size is de-magnified to one fourth. The intensified image (25mmϕ) on the output phosphor of the image intensifier is viewed through a 1:1 optical lens coupling by the cooled CCD (Thomson: THX31156). The CCD has 1024x1024 pixels (pixel size : 19μm x 19μm), a pixel well-depth of 290,000 electrons, and a readout noise of 20 electrons rms.
The prototype has the following characteristics: The active area is 78mm x 78mm.The spatial resolution is 150μm x 150μm (fwhm). The detective quantum efficiency is about 60% for 8 kev, and the dynamic range is more than 104. The readout time is 4 sec. As to the non-uniformity of response, the intensity response at the peripheral is about 65% of that at the central region. This is due mainly to time-invariant vignetting of the image intensifier. The non-uniformity of response can be corrected by using a shading pattern which is obtained by uniform irradiance from a radioactive isotope source. The CCD is cooled to -35C to -45C to reduce the dark current (-5 electron/pixel/sec @ -45C) during measurements. The rms noise of the TV detector (-20electron/pixel) is comparable to the signal produced by one X-ray photon per pixel. The prototype was applied to measure small-angle X-ray diffraction patterns of collagen and of muscle.
The second generation of the X-ray TV detector is developed mainly for time-resolved measurements. In this detector is, a Hi-selvicon camera (avalanched Saticon camera) which has the capability of intensifying the signal amplitude is used in place of the cooled CCD. The output signals of the Hi-selvicon camera are in the standard TV scan mode called NTSC, and are digitized by a 8-bit image-digitizer system which can record successive 64 images of 512x512 pixels in a memory at a speed of 30 images per second. Time-resolved X-ray diffraction patterns from a contracting frog muscle can be recorded of up to a 5.9nm actin layer line with a 33ms time resolution by only one repetition of muscle contraction cycle .The experiments were carried out at BL-15A at Photon Factory, where a mirror-monochromator doubly-focusing X-ray optical system is installed. The camera length was short (675 mm) enough to record a diffraction pattern of up to 5.1 nm actin reflection in the area size of 51.2 mm x 38.4 mm. Dynamic observation of X-ray diffraction patterns during twitch and tetanus muscle contraction will be shown by a video tape.
In order to realize a large area size of the detector, an X-ray image intensifier with a beryllium-window (150mmf) has been recently developed on the basis of a technology for aluminum-windowed medical X-ray image intensifiers. With the Be-window X-ray image intensifier, the photon gain is also improved by more than 10 times compared with the visible-light image intensifier. This improvement has enabled the use of the standard CCD in place of the Hi-selvicon to perform time-resolved measurements at a rate of 30 frames per second (the third generation). The detailed performance of the third generation X-ray TV detector with the Be-window X-ray image intensifier will be described as well as preliminary applications to small-angle X-ray scattering and protein crystallography.

OCM-01.03.03 GAS DETECTORS AND IMAGE PLATES. THE PROS, THE CONS, THE FUTURE.
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Modern x-ray diffraction experiments, particularly those using synchrotron x-ray sources, often impose extremely stringent requirements on detection systems. Different detector systems have varying strengths and weaknesses, and in order to perform competitive science, it is important that the detector is well matched to the type of experiment. As a result it is often necessary to develop detectors aimed at specific areas of work. At the Daresbury SRS, detector development for x-ray diffraction has concentrated on the production of high speed gas proportional counters and the assessment and operation of commercial image plate phosphor systems.
Gas detectors have certain characteristics that make them well suited to experiments requiring good time resolution and excellent dynamic range. They do however, suffer from counting rate limitations, parallax problems, and have often been considered to be unreliable and difficult to maintain. The gas detector development program at Daresbury has led to the production of a variety of gas detectors that have been in continuous routine operation on small angle scattering beamlines for over six years. The performance of these and other gas detector systems and technologies will be reviewed including;

1) Existing delay line area, linear and quadrant detectors,
2) The recently completed ultra high speed multi-channel microgap linear detector,
3) Results from the prototype high speed multi-channel area detector,
4) Gas microstrip and microgap technology.

For those experiments where fast time resolution is not required, image plate phosphors are rapidly replacing x-ray film. For many experiments they offer much higher dynamic range and lower noise levels. Experience with various types of image plate scanners will be detailed with particular emphasis on the strengths and weaknesses of the various systems.
In conclusion, likely future improvements to detector systems technology will be discussed in the light of x-ray diffraction requirements.

OCM-01.03.04 DAFS AND DANES: TWO NEW X-RAY DIFFRACTION TECHNIQUES USING REAL PHOTONS AND VIRTUAL PHOTOELECTRONS. by
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This talk will describe two new anomalous x-ray diffraction techniques that use the fine structure versus photon energy in the elastic diffraction intensities to provide spatial, site and

