16.X–5 **HIGH-RESOLUTION TOPOGRAPHY DETECTOR.** By J. Chikawa, F. Sato and I. Fujimoto, NHK Broadcasting Science Research Laboratories, 1-10-11, Kinuta Setagaya-ku, Tokyo, 157, Japan.

An x-ray sensing camera tube with a high resolution, high detection efficiency and low beam-discharge lag was developed for live topography with synchrotron radiation.

To achieve high resolution with a high signal-to-noise ratio, detection efficiency must be high even with synchrotron radiation which provides 10 to 100 times higher diffracted intensities than a rotating-target x-ray generator. For this purpose, we employed amorphous photoconductive layers which have been known as "Saticon" camera tubes for color TV broadcasting.

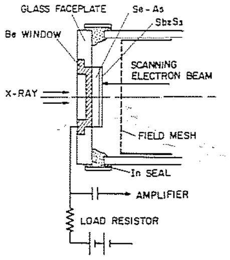

Fig.1. Structure of the target

The target structure of the tube is shown in Fig. 1. The photoconductive layer is comprised mainly from amorphous selenium which has a very high registivity larger than $10^{12}\Omega$ cm in dark. Since crystalline Se is metallic, As was added at a few % in weight to stabilize the amorphous state. A blocking contact is formed between the x-ray window material and Se-As alloy layer to prevent holes from flowing into the layer [Fig. 2]. Incident x-rays form electrons and holes in the layer, and the latter migrates toward the scanning-electron-beam side and contributes to the video signal. On the surface of Se-As layer, an Sb_2S_3 was evaporated to form another blocking contact which improves landing characteristic of the scanning electron beam and prevents penetration of the electrons into the Se-As layer.

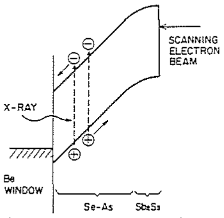

Fig.2. Potential in the target

The thickness of the Se-As layer was 20 µm and has an absorption efficiency of 52% for MoKα radiation and 76% for the wavelengths near Se absorption edge. No degradation of resolution was observed by increasing the target thickness when the target voltage is increased proportionally to the thickness. This characteristic is an important advantage of the amorphous photoconductive layers with high resistivities in dark.

For such amorphous layers, therefore, the focal size of the scanning electron beam on the target determines the resolution, and a diode-type electron gun having barium-impregnated cathodes with high electron emissivities was employed, to obtain a narrow beam intense enough to handle signal current. This type of camera tubes was named "Diode-operation Impregnated-cathode Saticon"(DIS-type)(Isozaki et al. 1981, IEEE Trans. **ED-28**, 1500).

The square-wave modulation transfer functions (MTF) of the DIS-type is shown in Fig. 2. The limiting resolution (at MTF=5 %) as high as 6 µm was achieved by the 20-µm-thick Se-As target. For comparison, those of the PbO and Se-As camera tubes with conventional crossover-type electron guns were 25 and 15 µm, respectively, as seen from Fig. 3.

The characteristics were demonstrated by imaging a transmission topograph for a silicon wafer, using white radiation from the storage ring (Photon Factory) operated at 2.5 GeV and 50 mA. The contrast of dislocation images was found to be twice higher than that by a PbO camera tube, owing to the difference in resolution. The TV image compares favorably with the photographic one.

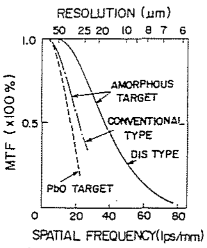

Fig.3. MTF for the three types

16.X–6 CHARGE-COUPLED DEVICE IMAGERS FOR X-RAY AREA DETECTION. By N. M. Allinson, Department of Electronics, York University, York, England.
INVITED PAPER AT THE MICROSYMPOSIUM ORGANISED BY U. ARNDT

CCD imagers offer a number of improvements over conventional detectors, for example, in dynamic range, sensitivity and resolving power. Sensitivities of two orders of magnitude lower than conventional Film have been reported. The use of unthinned back-illuminated devices, with high resistivity substrates, appears to be particularly promising for direct x-ray detection. However, the direct detection of x-rays presents the problem of radiation damage to these devices, due to charge build-up in insulating layers and at interfaces. This causes an increase in the background signal levels and poor signal transfer efficiency, and hence progressive reduction in overall signal performance. Modifications in device manufacture and operation can allow extended operation in harsh environments. These modifications can conflict with other aspects of device performance. The properties of existing imagers will be reviewed, together with the necessary developments to improve their performance.

Preliminary results from a comparative study of devices at the Synchrotron Radiation Source, Daresbury Laboratory will be presented.

16.X–7 INTEGRATING MULTI-WIRE GAS CHAMBERS
By Ken-ich HASEGAWA and Koh-ichi MOCHIKI, Dept.of Nuclear Engineering, University of Tokyo, Bunkyo-ku, Tokyo, 113, Japan

A position-sensitive proportional counter with strip cathodes can be operated in a charge integrating readout mode which is a similar technique adapted to photodiode arrays with MOS FET switches.(Hasegawa,IEEE Trans. on Nucl.Sci.(1981) NS-28,3660) Each cathode strip is connected to a capacitor which is used for charge accumulation. Analog multiplexers consisting of MOS switches are driven to transfer the accumulated charges from the capacitors to a charge-sensitive amplifier follwed by a signal processor.
The counting characteristics of this integrating PSPC depend only on the gas gain decreasing at high count rates because the signal processing time of the electronics has no effect on the charge accumulation. The gas gain decreasing can be avoided by using a lower value of the high voltage applied to the counter. We can obtain a wider range of gas gain than $1\text{-}10^4$ by adjusting the high voltage. Thus the maximum count rate of more than 10^8 photons/sec/channel can be obtained. The minimum one depends on the offset voltages and leakage currents of the multiplexers.
The problem to apply the integrating readout method to area detectors is the cost of multiplexers. In the case of a 128 x 128 channel detector, 1024 analog multiplexers with 16 ch. are required, so the cost per channel must be reduced.
We made a small multi-wire gas chamber with 15 x 8 channels for a preliminary test. It has a chekerboard cathode with a pitch of 2.1 x 2.1mm. The spatial resolution is almost equal to the pitch. The minimum detectable photon rate of 8keV X-ray is about 100 photons/sec/ch. This type of detector is suitable for synchrotron X-radiation experiments.