Table 7.1.6.2. *X-ray phosphors (from Arndt, 1982)*

Phosphor	Type	Bulk density	No. of photons per 8 keV quantum		Max. emission wavelength (nm)	Decay to 1% (s)
			Produced	Collected*		
ZnS (Ag)	Polycrystal	4.1	750	300	450	3×10^{-7} + slow components
Gd_2O_2S	Polycrystal	7.1	500	200	550	10^{-3}
CsI (Tl)	Monocrytal	4.5	240	62	580	10^{-6}

* These figures are for collection on a photocathode on the opposite side of a fibre-optics face plate, in the absence of a reflective coating.

CCD's are usually operated in this fashion, so that the read–out circuits can have a narrow band-width and produce an excellent signal-to-noise ratio.

For very low X-ray intensities in which the probability of the arrival of a photon per pixel per frame period is much less than one, the camera can be operated at normal frame frequencies in a digital mode. Specially designed circuits detect the charge image produced by a single X-ray photon and find the centroid of this image (Kalata, 1982); the events are 'counted' in a histogramming memory. The method is capable of some energy discrimination and has a high spatial resolution because the centroid of the image can be found to a high precision.

7.1.6.5.1. *X-ray phosphors*

The incoming X-rays are converted to light in a phosphor that is coupled to the first photocathode of the system. Both polycrystalline and monocrystalline phosphors are used for X-ray detection. The former give a higher light output but have a limited resolution; the latter tend to have a poorer light-conversion efficiency but have the best resolution. The most useful phosphors are shown in Table 7.1.6.2.

Many attempts have been made to improve the spatial resolution of phosphor screens by constructing them in the form of scintillating fibres that are optically isolated from one another so that the scintillation does not spread. This can be achieved by growing columnar scintillating crystals (Oba, Ito, Yamaguchi & Tanaka, 1988), by intagliating polycrystalline phosphors (Fouassier, Duchenois, Dietz, Guillemet & Lemonnier, 1988) and by using arrays of scintillating fibres (Bigler, Polack & Lowenthal, 1986; Ikhlef & Skowronek, 1993, 1994).

Image intensifiers designed for radiography with relatively hard radiation usually have an X-ray-transparent window – which may be up to 300 mm in diameter – and an *internal* phosphor–photocathode sandwich deposited on an X-ray-transparent substrate. Problems of compatibility of phosphor and photocathode have restricted the phosphor used, but CsI works well with multialkali photocathodes. Moy and his collaborators have constructed a large-diameter television detector in which the image intensifier has been modified by using beryllium for the window and for the sandwich substrate; this intensifier is coupled to a slow-scan CCD camera (Moy, 1994).

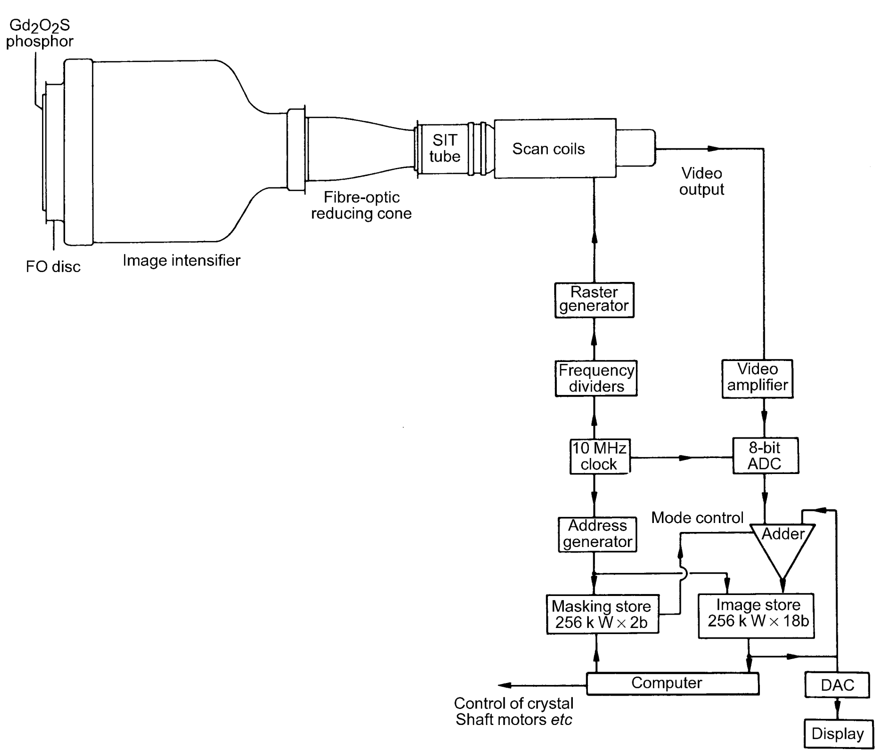

Fig. 7.1.6.7. Fast-scanning television X-ray detector (after Arndt, 1985).

 references