International Tables for Crystallography (2006). Vol. C, Figure 7.1.6.1, p. 624.

photons; this signal may then be digitized for recording purposes.

The choice of a linear or of a two-dimensional, or area, PSD depends on its detection efficiency, linearity of response to incident X-ray flux, dynamic range, and spatial resolution, its uniformity of response and spatial distortion, its energy discrimination, suitability for dynamic measurements, its stability, including resistance to radiation damage, and its size and weight.

Before discussing a few of the many types of PSD individually, we shall examine these criteria in a general way. Some of them have been discussed by Gruner & Milch (1982). Table 7.1.6.1 shows the importance, on a scale of 0 to 3, of some of the factors in different fields of study. Other properties, such as stability and sensitivity, are equally important for *all* PSD's.

7.1.6.1.1. *Detection efficiency*

The detection efficiency of a detector is determined in the first instance by the fraction of the number of incident photons transmitted by any necessary window or inactive layer, multiplied by the fraction usefully absorbed in the active region of the detector. This product, which is often called the absorption efficiency or the quantum efficiency, should be somewhere between 0.5 and 1.0 since the information loss due to incident photons not absorbed in the active region cannot be retrieved by subsequent signal amplification. The *useful* efficiency is best described by the so-called detective quantum efficiency (DQE), ε (Rose, 1946; Jones, 1958). For our purposes, this can be defined as

$$\varepsilon = S^2/\sigma^2 N, \qquad (7.1.6.1)$$

where N is the number of quanta incident upon the detector and σ is the standard deviation of the analogue output signal of amplitude S. For a photon counter with an absorption efficiency q, $S = qN$, $\sigma = (qN)^{1/2}$, and $\varepsilon = q$. An analogue detector with a DQE ε thus behaves like a perfect counter that only detects a fraction ε of the incident photons.

Table 7.1.6.1. *The importance of some detector properties for different X-ray patterns*

Detector property	Type of pattern: Solution	Fibre	Powder	Single crystal	Topographic	Orientation Laue
Spatial resolution	1	2	3	3	3	2
Lack of parallax	0	1	3	3	0	1
Accuracy of intensity measurement	3	3	3	3	1	1
High count rate capability	2	2	2	3	1	1
Suitability for short time slices	3	3	3	2	3	0
Suitability for short wavelengths	0	0	2	2	1	3
Energy discrimination	1	1	2	2	0	0

0 = unimportant; 3 = very important.

Under favourable conditions, the DQE of analogue detectors for X-rays is in excess of 0.5, but ε varies with counting rate and is lower for detectors with a very large dynamic range, as shown below.

The DQE of CCD- and vidicon-based X-ray detectors has been discussed by Stanton, Phillips, Li & Kalata (1992*a*).

7.1.6.1.2. *Linearity of response*

The linearity of a counter depends on the counting losses, which are due to the finite dead-time of the counter and its

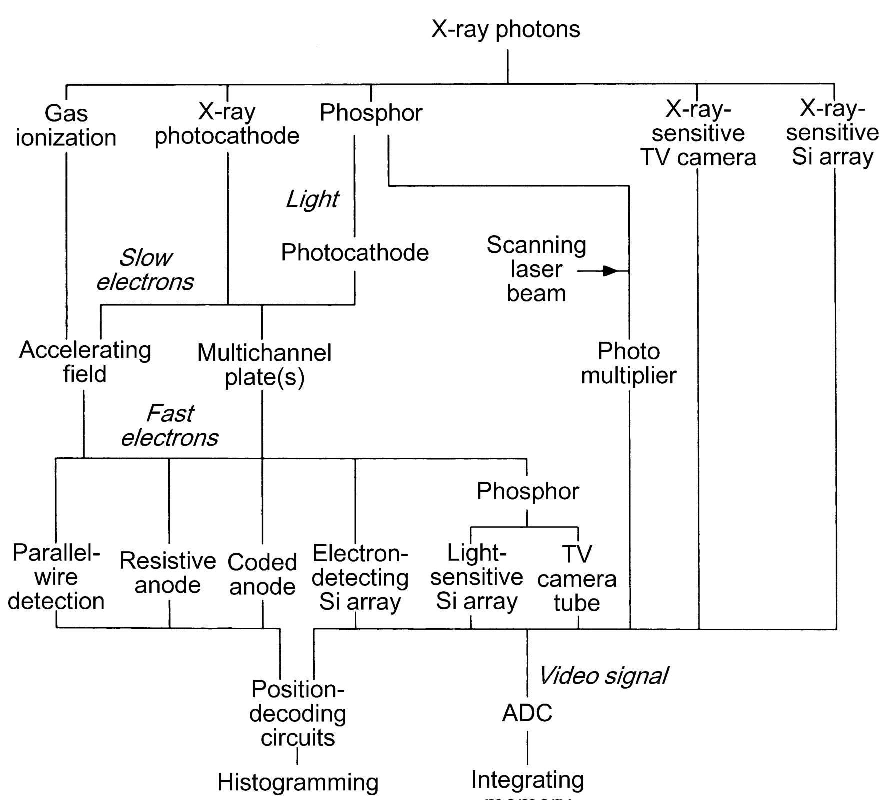

Fig. 7.1.6.1. Possible combinations of detection processes, localization methods and read-out procedures in PSD's.

references