International Tables for Crystallography (2006). Vol. C, Figure 7.1.4.1, p. 621.

conditions, one should avoid excessively high voltages and amplifier gains, which may cause noise pulses and unstable operation. Optimum settings can be determined by experiment and from manufacturer's instructions. The average pulse height should be set at about 20–25% of the full range of the pulse-height analyser. Lower settings move the low-energy tail into the noise, and high settings broaden the distribution and may be too wide for the window.

The pulse-amplitude distribution can be measured with a narrow (1–3 V) upper level and increasing the lower level by small equal steps. When making this calibration, it is advisable to keep the incident count rate below 10^4 counts s^{-1} to avoid nonlinearity and pulse pileup. A plot of intensity *versus* lower-level setting shows the distribution, Fig. 7.1.4.1(*a*). In some electronics, this can be done automatically and displayed on a screen. The window should be set symmetrically around the peak with the window decreasing the characteristic line intensity only a few per cent below that obtained with the lower-level set to remove only the circuit noise. The intensity change can be seen with a rate meter. Narrow windows cause a larger percentage loss of intensity than the decrease in background and, hence, the peak-to-background ratio is reduced. Asymmetric windows are sometimes used to decrease the fluorescence background.

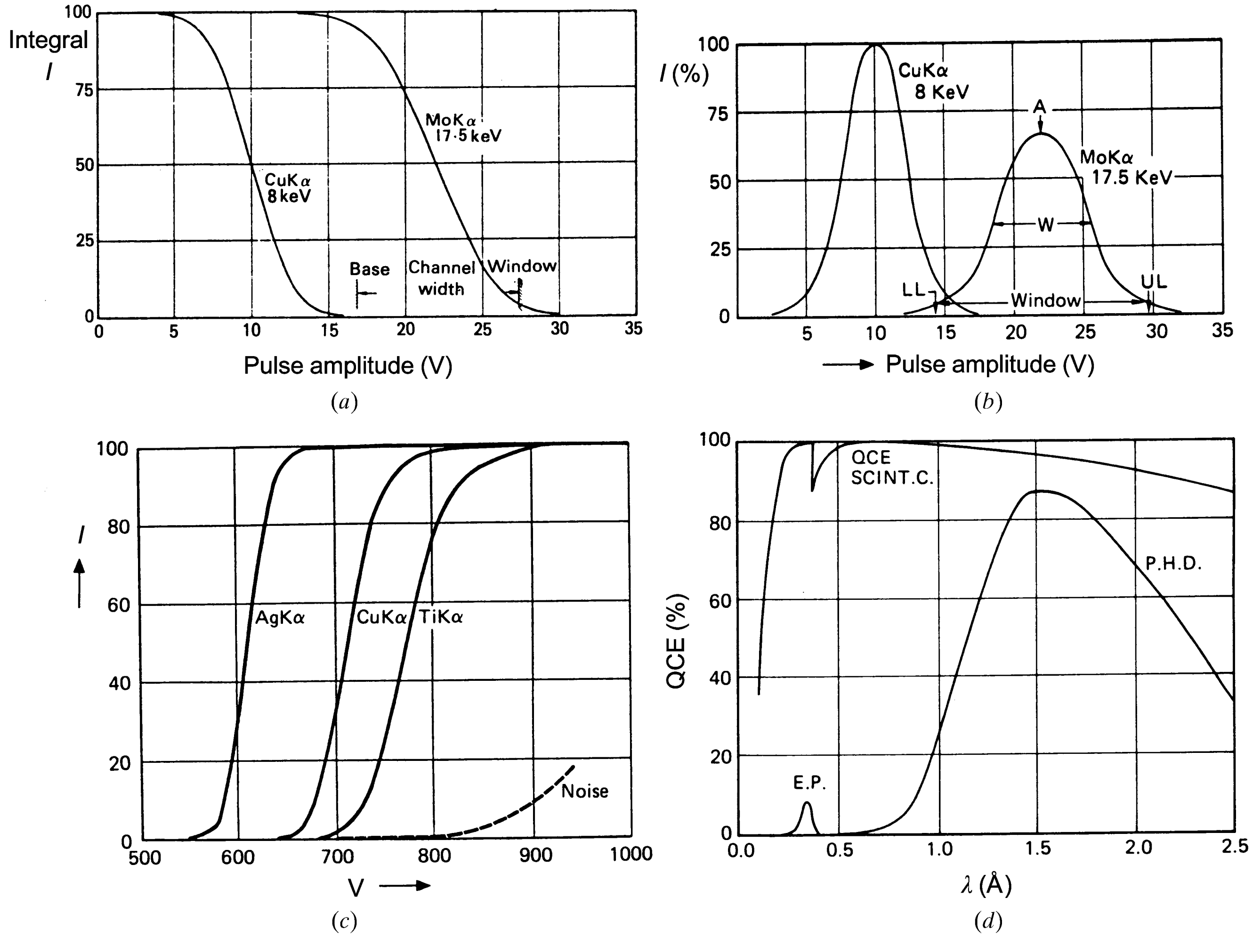
7.1.4.4. *Quantum-counting efficiency and linearity*

The quantum-counting efficiency E of the detector, its variation with wavelength, and electronic discrimination determine the response to the X-ray spectrum. E is determined by

$$E = f_T f_A, \tag{7.1.4.1}$$

where f_T is the fraction of the incident radiation transmitted by the window (usually 0.013 mm Be) and f_A is the fraction absorbed in the detector (scintillation crystal or proportional-counter gas). E varies with wavelength as shown in Fig. 7.1.4.1(*d*). The scintillation counter has a nearly uniform E approaching 100% across the spectrum and detects the short-wavelength continuous radiation with about the same efficiency as the spectral lines. The gas-filled counters have a lower E for the short wavelengths and, therefore, may have a slightly lower inherent background; high-pressure gas counters have a higher and more uniform spectral efficiency.

The effectiveness of electronic discrimination with a scintillation counter is shown in Fig. 2.3.5.3(*c*) for 50 kV Cu target radiation. The method cannot separate the $K\alpha$-doublet components because of their small energy difference, and has little effect on the $K\beta$ peak. The results are greatly enhanced by the addition of a $K\beta$ filter, which removes most of the $K\beta$ peak and a portion of the continuous radiation below the filter absorption



(*a*) (*b*)

(*c*) (*d*)

Fig. 7.1.4.1. Calculated pulse-amplitude distributions of Cu $K\alpha$ and Mo $K\alpha$ in the form of (*a*) integral curves and (*b*) differential curves. Resolution W/A for Cu $K\alpha = 50\%$. Analyser settings show window between lower level (*LL*) and upper level (*UL*). (*c*) Plateaux of scintillation counter for various wavelengths and fixed amplifier gain. Curves normalized to same intensity at highest voltage. Noise curve is plotted in counts s^{-1}. Curves can be moved to higher or lower voltages by changing amplifier gain. (*d*) Calculated quantum-counting efficiency (QCE) of scintillation counter as a function of wavelength (top curve) and its reduction when the pulse-height analyser is set for 90% Cu $K\alpha$. E.P. is escape peak at lower left.

references