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Gamma-Detection Efficiency of Organic Phosphors

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This nomogram and the accompanying curves make possible a rapid determination of the detection efficiency of an organic phosphor.

For detection, a certain minimum energy must be transferred to a Compton electron. The cross section can be calculated by integrating the differential Compton cross section from the corresponding minimum photon scattering angle to 180 degrees.

One starts with the minimum acceptable energy transfer (discriminator-bias setting). From Fig. 1 one then finds the cross section for detectable energy transfer, σ. To determine the corresponding absorption coefficient μ, ($= \varrho\sigma$) we use the three scales on the left of the nomogram. The nomogram then determines the efficiency ($1 - e^{-\mu\chi}$) from μ and the thickness χ.

The method assumes equality of total linear absorption coefficient and detection absorption coefficient. This is generally justified by crystal geometries in which a photon that is scattered by an event *not* leading to detection cannot escape from the crystal without traversing the remainder of the path lengths.

With 25-keV bias we observe efficiencies that correspond to our curve above 200 keV. Below 200 keV the cross section is larger than calculated, apparently due to multiple collisions.

Example: Discriminator bias is at 25 keV, and we are detecting 200 keV photons in a 10cm thick plastic phosphor. From the curves we find a detection cross section of 0.27 barns. A representative phosphor has $\varrho = 3.4 \times 10^{23}$ electrons/cm^3. With this assumption we find a detection efficiency of 60%.

Note: All standard Eljen Technology plastic scintillators have electron densities of 3.4×10^{23} electrons per cm^3.

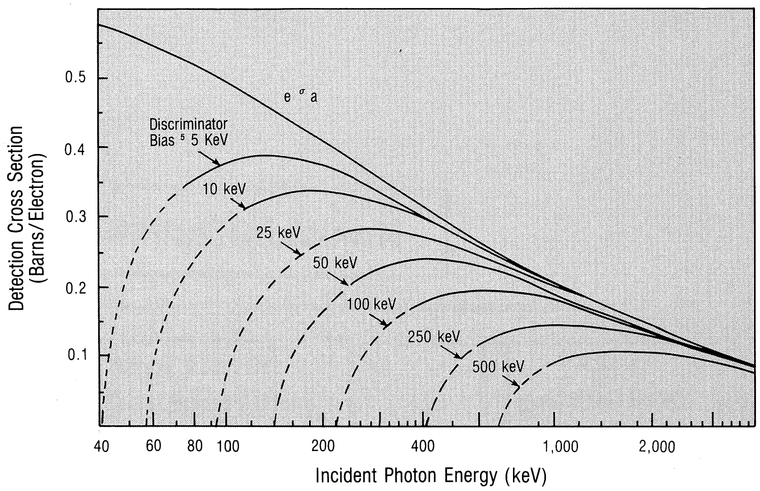
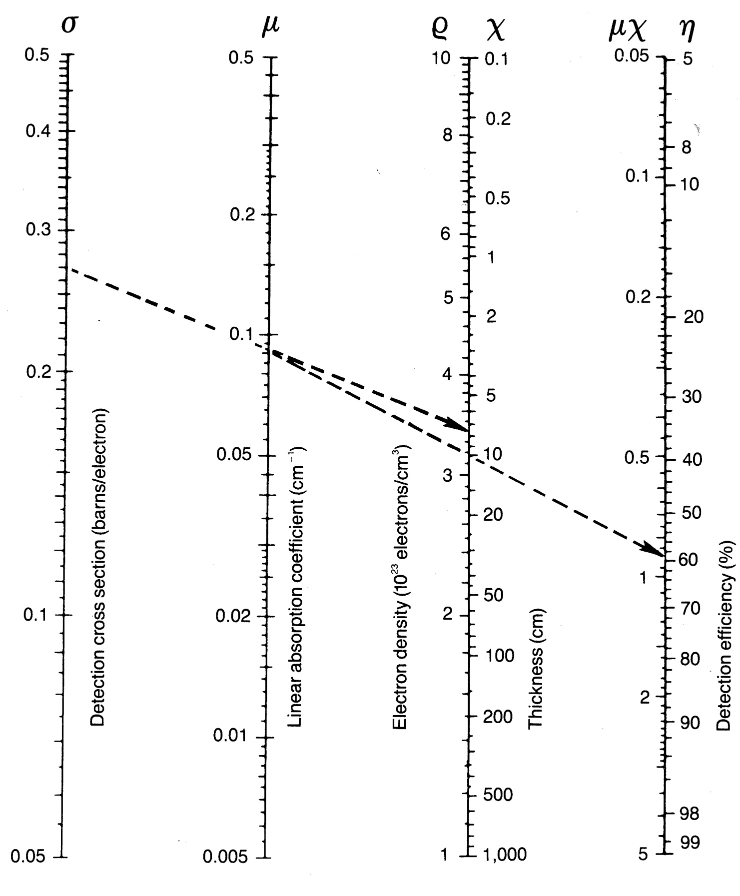


Fig. 1. Detection cross section vs incident photon energy



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