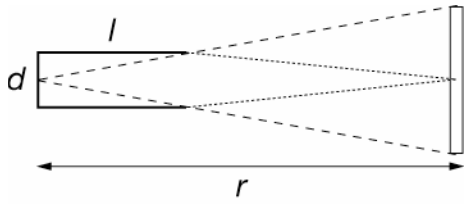
HW6

1. Collimators in gamma cameras have an acceptance angle (dashed lines in figure below) determined by the length *l* of the collimator and the diameter *d* of its aperture. Show that the volume of tissue sampled at a distance *r* from the distal end of the collimator (rectangle) is proportional to $1/r^2$. Now consider the fraction of emission that reaches the collimator from the tissue volume at distance *r* (dotted lines) to show that the sensitivity of gamma photon detection ("efficiency") is approximately invariant with distance. What is the effect on *spatial resolution* of the *r*-dependence of the sampled volume, and why?



2. Explain or derive the formula for the rate of random coincidences between any pair of detectors in a PET scanner:

   $R_{\text{random}} = 2\tau S_1 S_2$

   where τ is the time window within which coincidences must occur, and S_1 and S_2 are the singles rates of the two detectors. If 10^5 positron annihilations per second give rise to events detected evenly across a 100-detector PET scanner (in the absence of scatter and attenuation), what value of R_{random} would be observed for each pair of detectors, with $\tau = 100$ μs, and what fraction of the total number of events would this represent?