AY 105 Lab Experiment #1 explanatory supplement
The effect of photodiode rotation on measured current

When you did Experiment 1, and rotated the photodiode and measured the current as a function of angle, most of you predicted a current profile of $I/I_0 = \cos\theta$, but obtained a curve more closely resembling $I/I_0 = \cos^2\theta$. The explanation for this result is quite subtl.

Note that we should expect $I/I_0 = 1$ for small angles. This is because the filament image size is smaller than the detector width, so as you rotate it through a small angle, the entire image should continue to fit on the detector for a while, producing no fall-off in current.

Although no "falloff" at small angles makes sense in theory, it is likely that the alignment of the apparatus would be imperfect, resulting in the $I/I_0 = \cos\theta$ falloff that most of you expected. If the image is a little defocused, or off-center, or the rotational axis is not directly beneath the detector, then the image will start to "fall off" the detector very quickly, and you'll see $I/I_0 = \cos\theta$, just as you'd expect if the detector were in, e.g., a collimated beam much larger than itself.

The other issue is that the detector sits behind a glass window which, as some of you noticed, reflects a larger fraction of the incident light at you move toward grazing incidence (large angles off-axis). If you look at, e.g., Jackson's *Introduction to Electrodynamics*, page 367, there is a plot and functional form for the transmitted fraction. This function resembles a cosine, and hence in combination with the above effect can provide the approximately $\cos^2\theta$ falloff that you observed.

At large angles, many of you noticed that the detector housing would begin to cast shadows on the detector. This probably has some effect, but at the same time, light begins to fall on the polished walls of the detector housing, and there's probably a lot of scattered light falling on the detector that partially diminishes this effect.