Physics 545 -- R. J. Wilkes
Lab 7: Interference and Diffraction

1. Two slit interference
A 135 mm photographic lens is placed with the spatial filter at its focal point, producing a collimated beam (plane waves) that strikes the slide holder. (The beam is collimated when its spot width does not change between lens and screen.) The screen is placed a known distance (say, 1 m) from the slide holder. (Same setup as for Fraunhofer diffraction, below.)

First place the adjustable single slit in the holder, and observe the variation of the diffraction pattern with slit width. Then insert the 2-slit slide in the slide holder and observe the patterns for the four combinations of slit width and spacing. Observe how the interference pattern is modulated by the 1-slit diffraction pattern. For the narrow-slit, close-spaced combination, find the slit width $w$ and spacing $a$:

- Put a piece of graph paper on the screen and mark the pattern features; then measure a) the distance between interference fringes; b) the halfwidth of the central diffraction peak. The fringe spacing is given by $\Delta y = \lambda d/a$, and the halfwidth is given by $\Delta y = \lambda d/w$. Recall that the laser has $\lambda = 632.8$ nm for red and 543.5 nm for green.

2. Fraunhofer diffraction
Use the 135 mm photographic lens to focus an image of the spatial filter pinhole onto a screen about 1 m away. (Thus you are bringing "infinity" onto the screen.) Place the slide holder after the lens, at a point where the beam spot is big enough to cover the object (or, you may need to use an iris to reduce spot size to cover only one area of the slide). You can use the linear CCD array readout to see details of the pattern variation on the oscilloscope. Try the variable slit and note the pattern as you go to very small slit widths. Use the slide marked "Lattice Diffraction Patterns" and first try the square array of wires. Wiggle various components and see what does and does not affect the pattern. Try the Ronchi rulings = arrays of clear and black stripes of equal width (marked on slide: is it mm or inches? Deduce from pattern)

3. Fresnel diffraction
Remove the 135 mm lens and you get the near-field (Fresnel) pattern. You must put the mask very close to the spatial filter to get near field case even though distance to screen is long. You can magnify the image by putting the camera lens between the slide and the screen (or not). Use the variable slit to observe changes in the pattern. Try the 2-slit slides. Compare with patterns from for Fraunhofer and Fresnel cases. To see the Fresnel pattern appear, move the slit mask from very close to the spatial filter to about 10 cm away.

With the Fresnel setup, observe the patterns produced by i) a razor blade edge; ii) circular apertures (iris, and plate with drilled holes, iii) a ball bearing (inverse of circular aperture). Handle this carefully: ball will fall off slide! Use the CCD array readout to see details of the pattern variation on the oscilloscope.