**Virtual Slits: measuring diffraction in the absence of any real diffractive object**

The modulo $2\pi$, phase-only optical elements you’ve begun to create are generally referred to as “**Diffractive Optical Elements**” (DOE), and are marketed across a wide range of categories:

- Diffractive Lenses (Fresnel Zone Lenses, Lens Arrays, Cylindrical Lenses)
- Line Generators, Crosshair Generators
- Beam Splitters: Fan-out-elements, Pattern Generators
- Beam Shaping Elements
- Wave-Front Generators
- Homogenizers / Diffusers / Random Phase Plates
- Structured Pupil Illumination
- Gratings (Phase, Blazed, Amplitude)

**Custom** DOE sell for $10000 - $15000. Suddenly the cost of an SLM seems quite reasonable!

Are you starting to see how you might design DOE of these sorts? — That last entry, “Gratings (Phase, Blazed, Amplitude)” reminds us both of the phase-only blazed diffraction gratings from Fig. 4 of last week’s lab, and also that by adjusting the input Polarizer and output Analyzer, we can tune the transmission function of the system to allow for Amplitude Modulation.

Here, we return to Amplitude-Modulation mode, to define an adjustable “Aperture Function.” Depending on the extent and shape of the aperture the diffraction pattern will vary:
The lens following the analyzer should be positioned **one focal length from the SLM**. One way to achieve this is to temporarily insert some mirrors, so that your collimated beam is sent “backwards” through this lens, as shown in Fig. 2 below:

Fig. 2. Alignment via “back propagation” with the three added alignment mirror in place, adjust the position of the Cylindrical Lens until the collimated input beam is focused onto the SLM. Then flip the alignment mirrors out of the beam path, and place your area detector / camera in the focal plane of the Cylindrical Lens.

Your imaging **screen/detector should be placed one focal length from the Fourier Lens**.

Comment in your notebook about the likely consequences of such an arrangement, where the SLM is in the “back focal plane” of the Cylindrical Lens, and the detector is, as in Fig. 1, in the “front focal plane” of the Cylindrical Lens!!

Adjust the input Polarizer and the output Analyzer so that the system is in **Amplitude-Modulation mode**. For any aperture you create, remember to set the grayscale level to match the **peak** transmittance you experimentally determined in Lab II. Conversely, for any barrier you create, set the grayscale level to match your experimentally determined transmittance **minimum**.
Your notebook should include information about the applied phase profiles and analysis of the results.

A) Enter a single-slit image into the SLM.
B) Adjust the width of the single slit, keeping all else the same, and record the changes in the diffraction pattern.
C) Replace single-slit image with a double-slit image. (You might wish to then eliminate one of those slits, call it Slit #1, then return Slit #1 and eliminate Slit #2. Compare these particular single-slit patterns to the two-slit pattern.)
D) Change the spacing between the two slits, keeping all else the same, and record the changes in the diffraction pattern.
E) Adjust the width of the slits, keeping the widths of the two slits equal, and record the changes in the diffraction pattern.
F) Come up with a procedure to use, to analyze the systematics that emerge as you vary the geometry of these (virtual) diffractive objects.

Opportunities for Initiative:

come up with your own ideas!
All of our published work on Quantum Entanglement and “Ghost Imaging” has used an SLM to create virtual slits:


