

# Introduction to Microwave Optics

1. Transmitter with horn at pivot(end of horn, & start of horn) and receiver with horn  
Startup microwave transmitter and computer ( See instruction in writeup for microwave Bragg experiment.  
Rotate receiver about horizontal so slot at right angles to transmitter  
Remove receiver horn  
Resolution of detector
2. Angular distribution  
Transmitter slot vertical  
no horn  
horn  
Transmitter slot horizontal  
no horn  
horn
3. Two source (slit) interference. Using Tee, two elbows, and two horns  
Transmitter slot vertical  
Transmitter slot horizontal
4. Single slit diffraction
5. Two slit diffraction
6. Loydd mirror
6. Grating  
Cardboard  
1-D crystal
7. Lenses  
. Determine how parallel the microwaves from the source are. Use a lens ( A chunk of wax about 30 cm square and about 3 cm thick) to try to produce parallel microwaves. What is the focal length of the lens?  
Focal length  
Resolution of detector
8. Prisms (See Feynman )

What materials block, reflect and transmit microwaves?

Simulate thin film (two reflecting plane) interference with the system.

## Equipment Procedure for Microwave Optics

### To Start system:

1. Match transmitter and receiver horn heights
2. Point horns at each other ( about 30 cm apart)
3. On CENCO 3 cm microwave transmitter  
**INTERNAL modulation**  
Klystron voltage ~ **2:00 o'clock**
4. On 415D SWR Meter  
Gain (outer dial ) and gain vernier ( inner dial) arrows **straight up**  
Range SWR DB (outer dial) **40**, Expand (inner dial) **Normal**  
Input selector **XTAL 200  $\Omega$**   
Power **AC**
5. Maximize output of the transmitter by adjusting klystron voltage to peak SWR meter reading.  
Adjust separation distance as needed.
6. Allow a bit of warm-up time.
7. Note higher SWR scale is more sensitive
8. The SWR meter measures power, **P**, in terms of the meter reading of attenuation, **A**, from a standard power **P<sub>0</sub>**. You can set the standard power, **P<sub>0</sub>**, with the gain knobs to an arbitrary value on the scale.  $A = 10 \log_{10} \left( \frac{P_0}{P} \right)$  or  $P = P_0 10^{-A/10}$ . Thus the power associated a meter reading of 60 dB is 1/10 the power associated with a reading of 50 dB, Note dB is decibel.

### Questions:

1. What does the 415D SWR meter measure?
2. What does SWR stand for?
3. What is a dB or decibel?
4. Is the reading of the SWR meter an absolute or relative measurement?
5. Is the dB scale linear?
6. How is what is measured by the SWR meter related to the intensity of the microwaves?
7. How is what is measured by the SWR meter related to the amplitude of the electric field of the microwaves?
8. How does a klystron work?
9. Why is the received signal larger if the klystron is modulated.
10. Describe the standing wave microwave field used to measure the wavelength of the microwaves and how this field is created?
11. In the standing wave field, what is the relationship between the distance between maxima and the wavelength of the microwaves?
12. In the section title "To Start System" step #5 it is suggested to, "Adjust separation distance as needed." Why?
13. What is the energy (in eV) of a single microwave photon used in this experiment?
14. What is the angle of divergence of the microwaves from the transmitter? If you remove the "horn" from the transmitter, how does this change?
15. What is the spacial resolution of the detector? Does removing the horn from the transmitter change this? Does it change the intensity of the signal received?
16. Do microwaves go above, below, or around the lense and get detected?