5. Content of Experiments

1) Relay of microwave

Place the transmitter and the receiver with amplifier in a line with their horn antennas facing each other. Power the receiver with amplifier on first and then turn the gain knob of the receiver. Now no microwave signal is detected by the receiver, as the transmitter is not turned on yet. Next, power the transmitter on and immediately microwave signal should be detected by the receiver, as the luminous tubes are lit up if under equal amplitude mode or voice is heard from the speaker if under amplitude modulation mode (set “SP” switch to “ON”).

2) Transmission and absorption of microwave

Place the board for absorption in the middle of the horn antennas of the transmitter and receiver, the microwave signal received by the receiver horn should be weakened. Move away the receiver horn and use the dipole to act as the receiver (let the dipole closely behind the board), the absorption effect will be more significant.

3) Microwave as polarized wave

Since the emitted microwave is polarized and the receiver is polarization sensitive, rotate the horn antenna of the receiver by 90° with respect to the horn antenna of the transmitter, no microwave signal (or very weak) should be received by the receiver under this orientation.

4) Reflection of microwave on a metal plate

Configure the setup as shown in Figure 3. When $\alpha=\beta$, the received microwave signal which is reflected by the metal board will be maximum. Also try to use the receiving dipole as receiver and use the protractor/ruler to approximately measure related angles. This verifies experimentally the reflection law of electromagnetic wave, i.e. the angle of incidence with respect to the normal is equal to the angle of reflection.

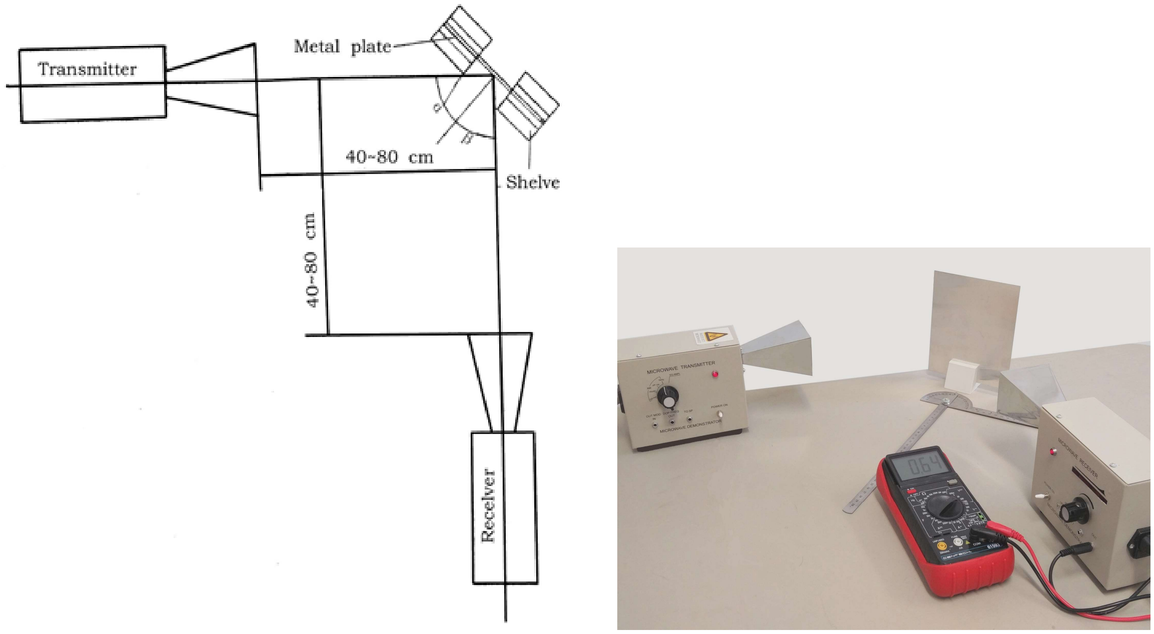
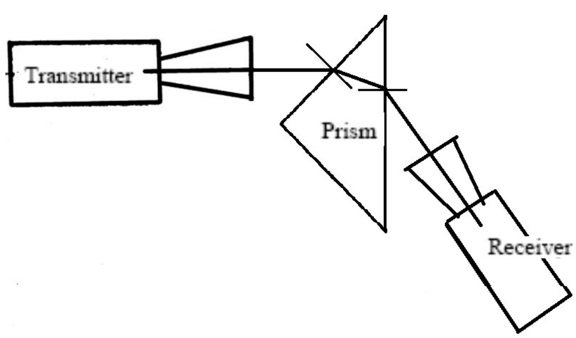
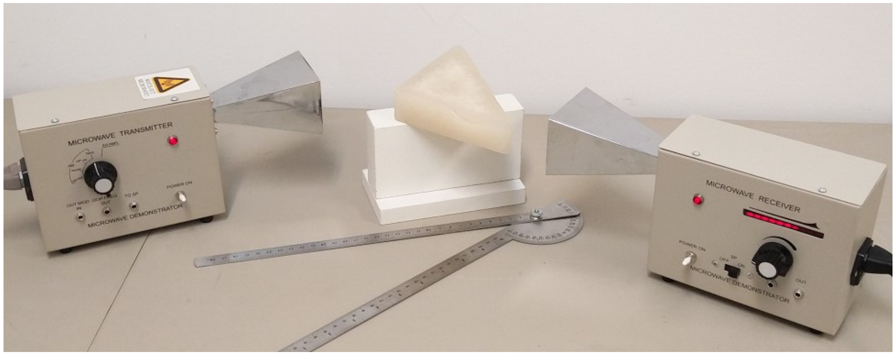


Figure 3 Experimental setup for reflection of microwave on a metal board

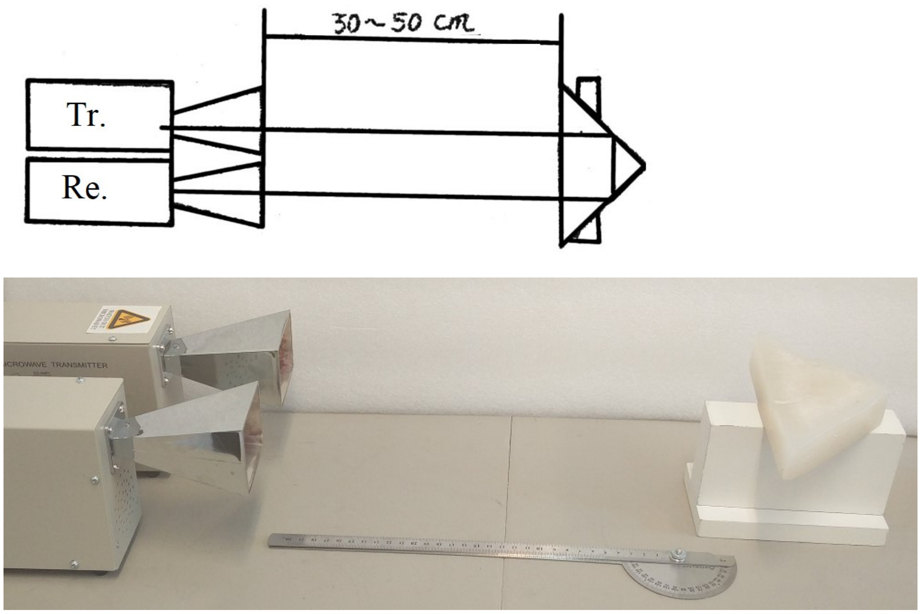
5) Refraction of microwave

Place the paraffin prism on the top side of the board to bring it to the same height as the horn (refer to Fig. 4), configure the experimental setup of microwave refraction using a paraffin prism as shown in Figures 4 (a) and (b). Finely rotate the paraffin prism along its vertical axis or/and move the receiver to achieve maximum receiving signal. At this time, take the paraffin prism away, the received signal should be minimum or significantly weaken (this indicates that the received signal comes from the refraction of the prism other than directly coming from the transmitter). In case (b), it is actually a total internal reflection occurring at the two rectangular surfaces (dielectric-air interface) of the prism.





(a)



(b)

Figure 4 Experimental setup of microwave refraction by a paraffin prism

Configure the experimental setup of microwave refraction by a board as shown in Figure 5. <u>Place the dipole as close as possible to the board</u>. If point A receives the strongest microwave signal as seen in Figure 5, then the refractive angle is drawn through point A and therefore the index of refraction of the board is n=sin(α)/sin(β). Use the protractor/ruler to approximately measure angles and a multimeter to monitor microwave strength (set transmitter at "EQ AMPL" mode).

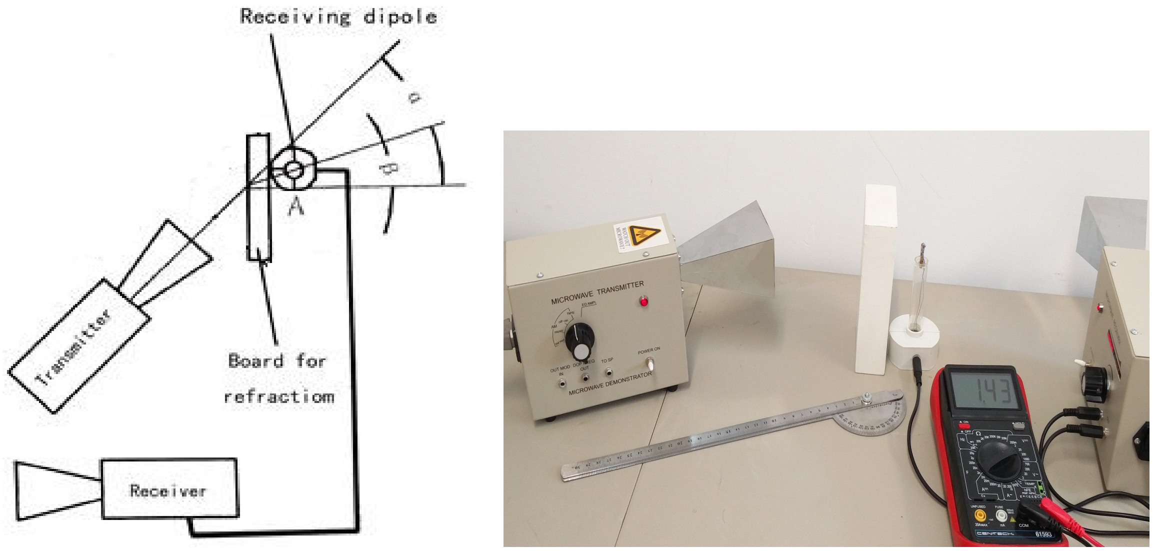


Figure 5 Experimental setup of microwave refraction by a board

6) Interference of microwave

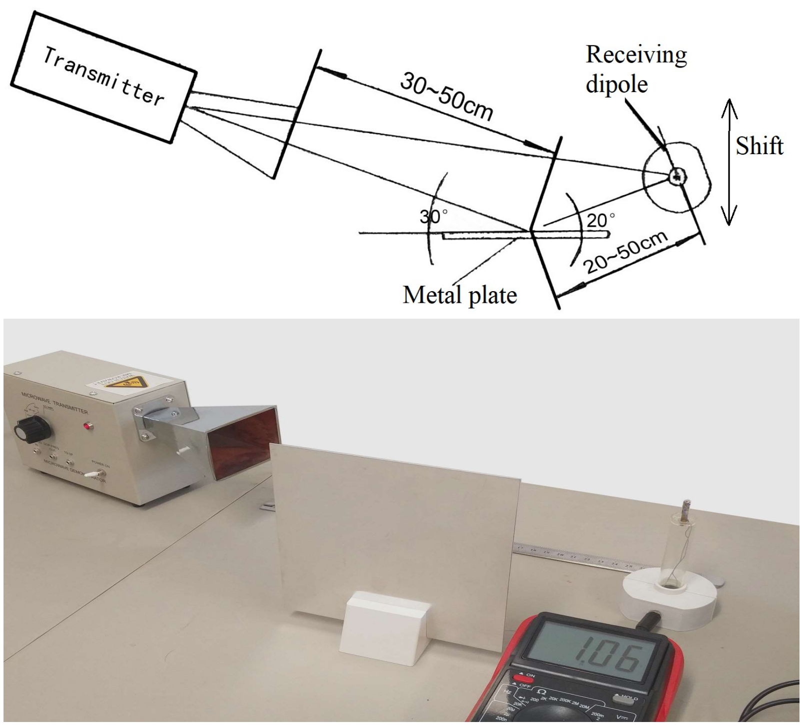


Figure 6 Experimental setup for interference of microwave

Configure the experimental setup for interference of microwave as shown in Figure 6. The interference is generated in the region of a superposition of two microwave beams: one beam directly comes from the Transmitter and the other beam from the reflection of the metal board. When the dipole is shifted along the arrow shown in Fig. 6, the strength of receiving signal changes periodically between weak and strong.

7) Standing wave formation of microwave

Configure the experimental setup for standing wave formation of microwave as shown in Figure 7. If the receiving dipole is moved along the propagation direction of the microwave, it can be used to verify locations of the maximum and minimum peaks of the standing wave. By measuring the distance between two adjacent maxima (or minima) (it is half a wavelength), the wavelength of microwave can be calculated. The distance between two adjacent maxima (or minima) is half a wavelength (for this apparatus wavelength is about 2.7 +/- 0.3 cm).

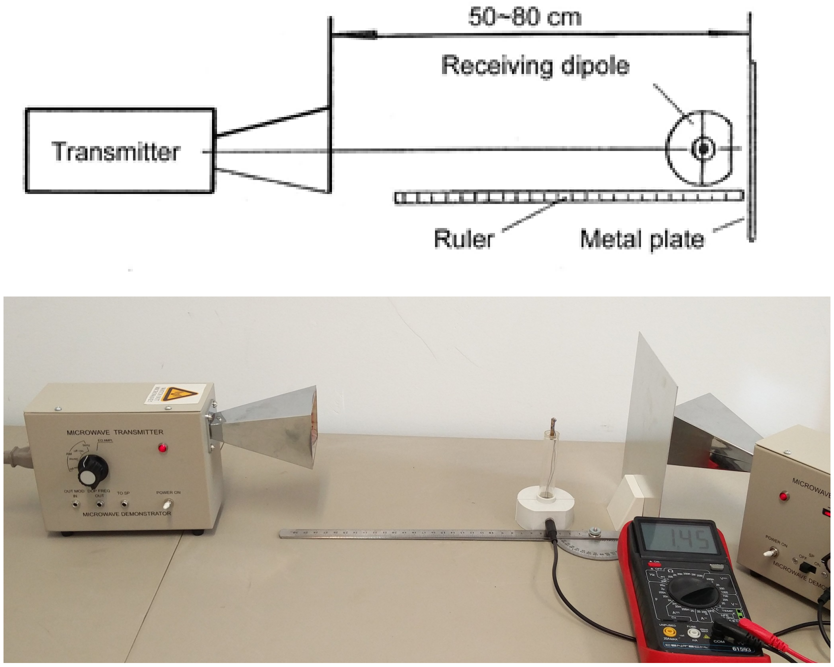


Figure 7 Experimental setup for standing wave formation of microwave

8) Diffraction of microwave

Configure the experimental setup for diffraction of microwave as shown in Figure 8. As seen in this figure, microwaves are radiated towards the edge of a metal plate, and the receiving dipole located behind the metal plate still detects the microwave signal proving that microwaves are diffracted into the blocked region at the edge of the metal plate.

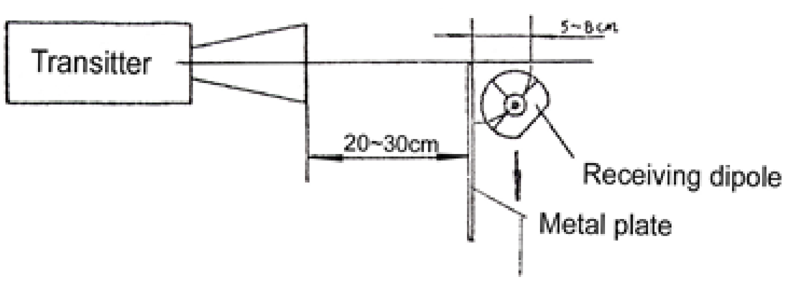


Figure 8 Experimental setup for diffraction of microwave at the edge

Configure the experimental setup for microwave diffraction at a single slit (set slit width about 5.5 cm) as shown in Figure 9. When moving the dipole along the arrow direction, it is found that besides of the strong maximum microwave signal at the central region, there are two weaker maximum peaks of microwave signals located on either side of the central position. Use a multimeter to measure the "OUT" strength of the receiver (set transmitter at "EQ AMPL" mode) and a protractor to measure the corresponding angle of the dipole, a plot of diffractive strength distribution can be drawn. An example is shown in Figure 10.

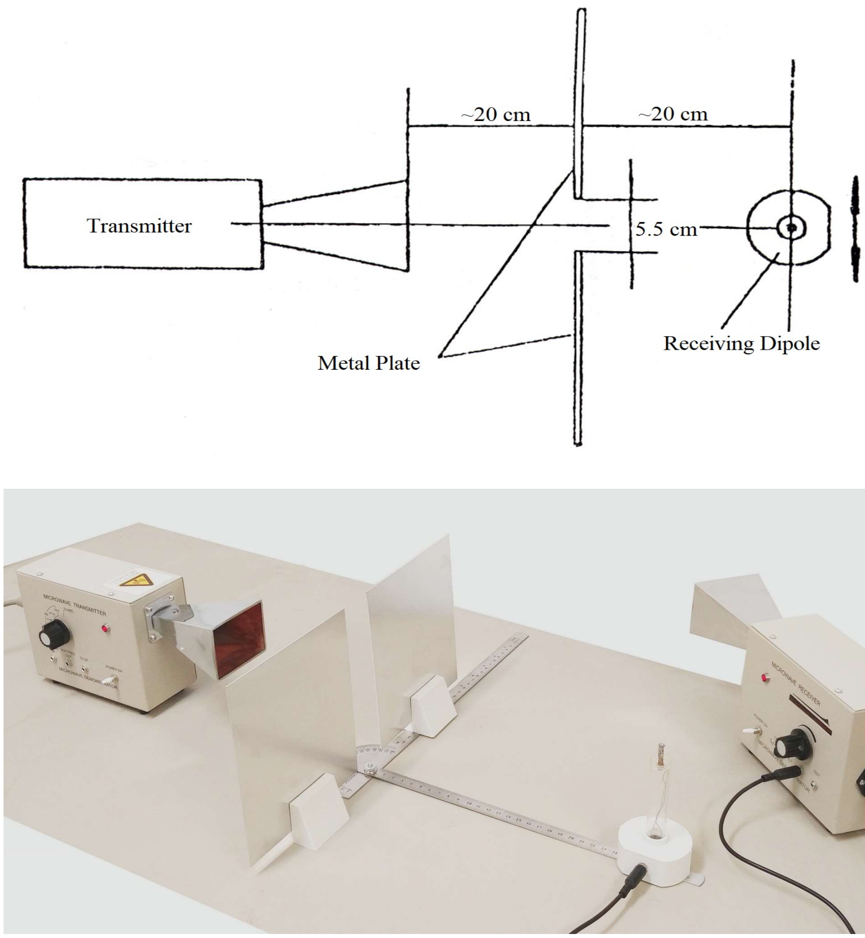


Figure 9 Experimental setup for microwave diffraction at a single slit

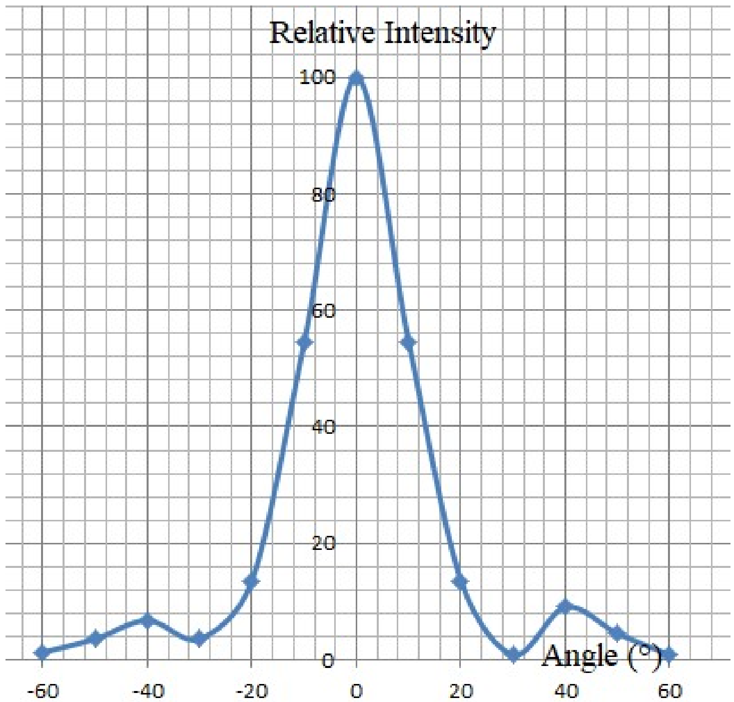
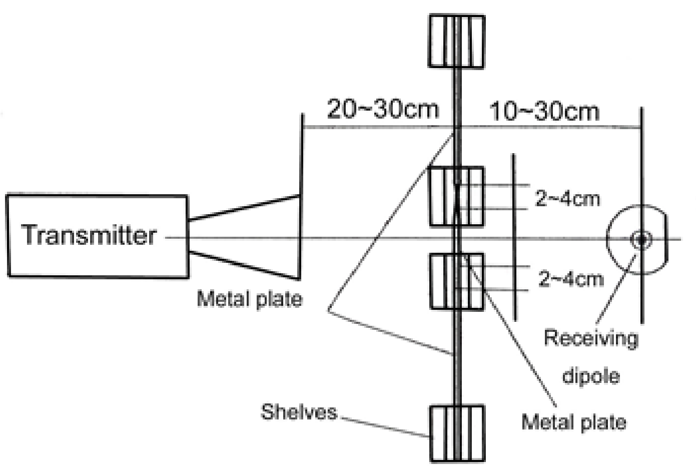


Figure 10 Diffractive intensity distribution along angle of a single slit.

9) Double slits interference of microwave

Configure the setup for microwave interference due to diffraction at double slits per Figure 11. When moving the dipole along the arrow direction, it is found that the strength of the received signal varies periodically. Use a multimeter to measure the "OUT" strength of the receiver (set transmitter at "EQ AMPL" mode) and a protractor to measure the corresponding angle of the dipole, a plot of strength distribution of interference can be drawn. An example is shown in Figure 12.



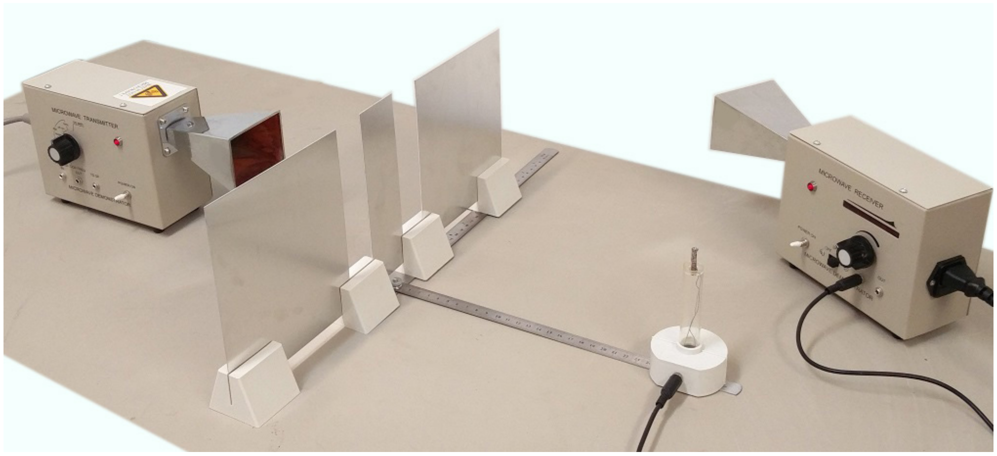


Figure 11 Experimental setup for microwave interference due to diffraction at double slits

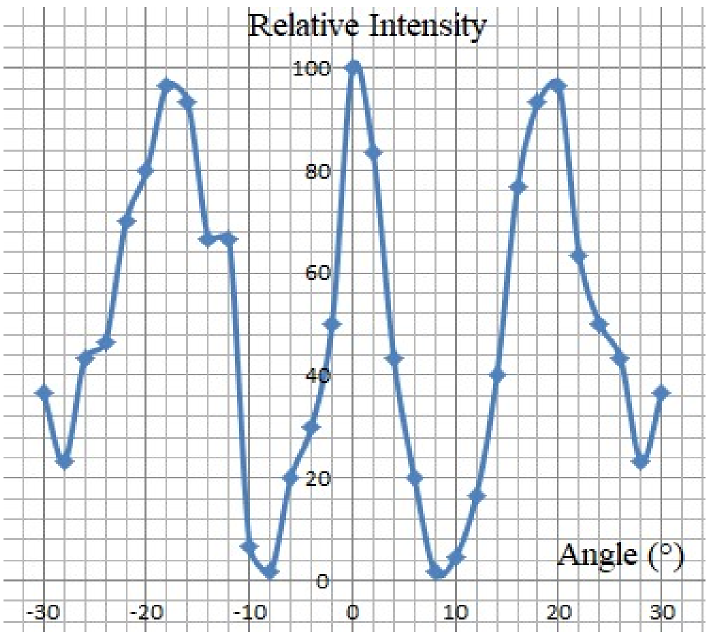
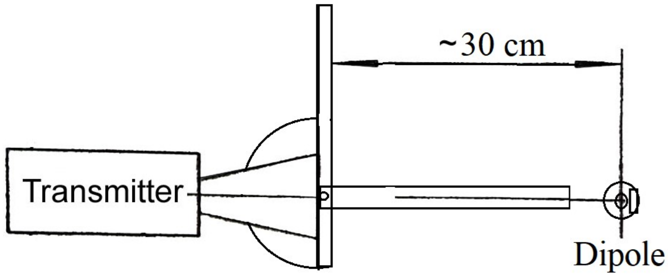


Figure 12 Intensity distribution along angle of double slit interference

9) Directive transmission of microwave

The horn antenna of transmitter emits a divergent microwave beam. The beam intensity varies along the directional angle. Configure the setup as per Figure 13. Use a multimeter to measure the "OUT" strength of the receiver (set transmitter at "EQ AMPL" mode) and a protractor to measure the corresponding angle of the dipole, a plot of strength distribution related to directional angle of the microwave beam can be drawn (an example is shown in Figure 14).



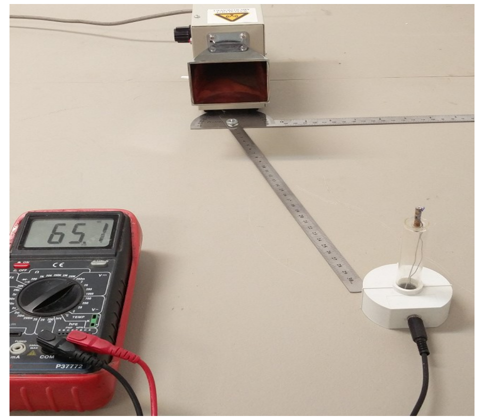


Figure 13 Experimental setup for studying directional characteristic of horn antenna

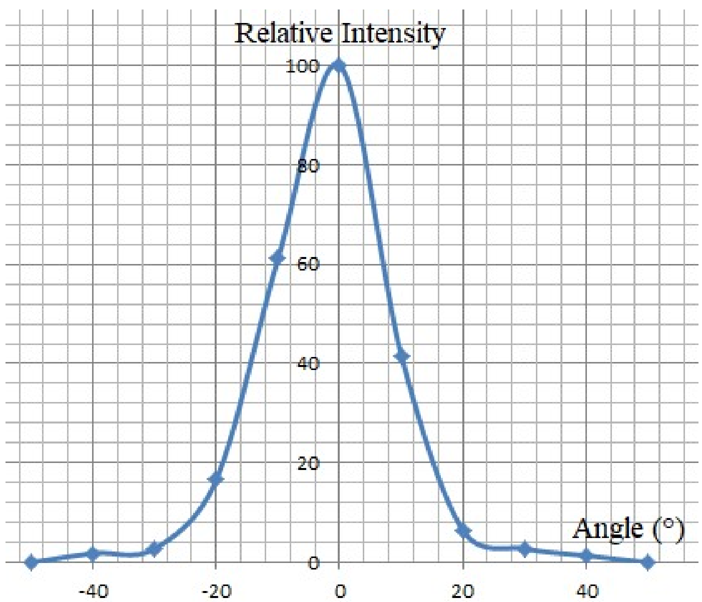


Figure 14 Directional distribution of microwave power

10) Doppler effect

Configure the experimental setup for Doppler effect of microwave as shown in Figure 12. Set transmitter's signal mode at "off-on" or "1kHz"; connect "DOP FREQ OUT" to an oscilloscope (with 3.5 mm earphone plug); As seen in this figure, if the metal plate is moved towards or away from the transmitter, sinusoidal oscillations on the signal envelope curve are observed on the oscilloscope (with proper time scale). The number of recorded oscillations depends on the velocity of the moving plate.

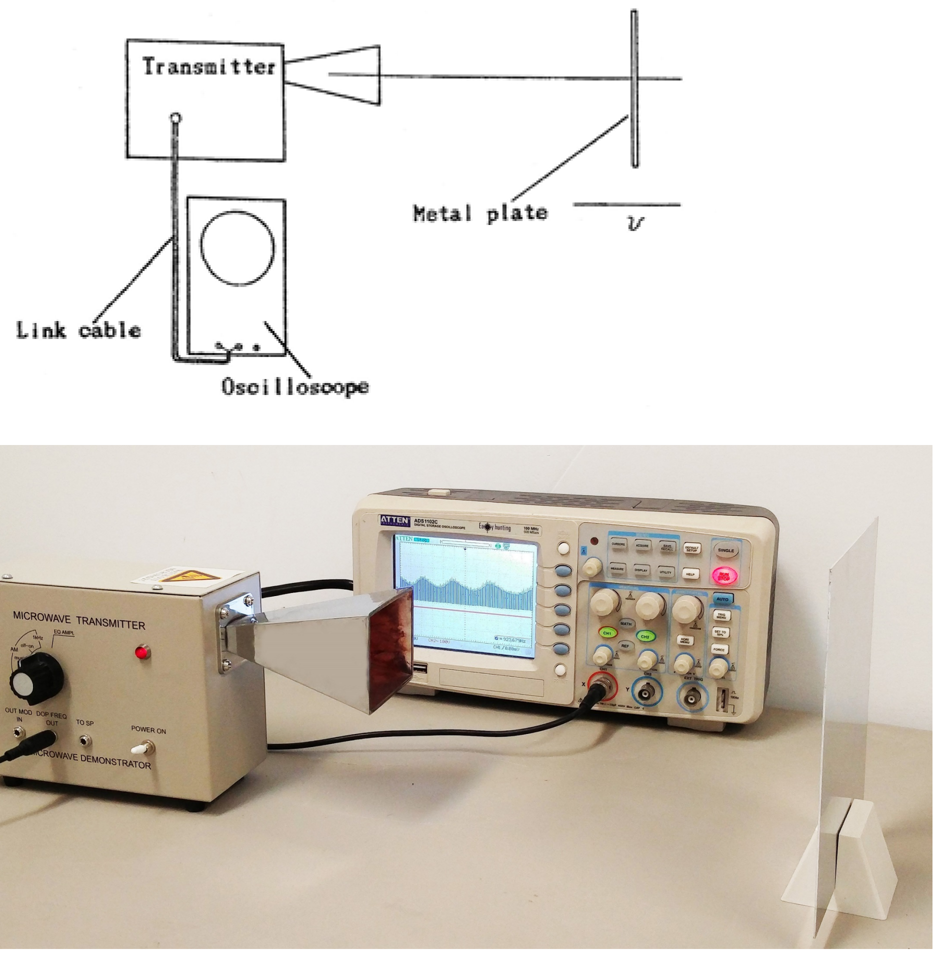


Figure 12 Experimental setup for observing Doppler effect of microwave