5. Experimental Examples

5.1 Observe Diffraction Pattern

1. Insert laser tube in laser tube holder and mount them onto the universal carrier locating at one end of the rail. Place the lateral measurement stage (with photo detector mounted) at the other end of the optical rail.
2. Turn on the laser. Set proper slit width of the lateral measurement unit, and turn the drum to move the slit to an appropriate position to ensure the input tube is aligned to the laser beam.
3. Adjust the height and/or tilt of the laser tube to let the laser beam hit the center of the alignment aperture and at the same time parallel to the surface of the optical rail.
4. Mount the acousto-optic modulator on the 2-D holder and supply the 100-MHz modulation signal to the acousto-optic device. Adjust the height of the acousto-optic device to let the laser beam pass through the center of the device. Make sure the "Modulation" switch on the main control unit is at "OFF" state.
5. Place a piece of white paper in front of the photo detector to observe the diffraction pattern. Adjust the tilt of the 2-D holder of the acousto-optic device and rotate the 2-D holder to maximize the intensity of the 1^{st}-order diffracted light. **Note**: the diffraction efficiency of AO device is very sensitive to beam incident angle, so careful adjustment of the device is needed.

5.2 Display Acousto-Optic Modulation Signal

1. Change the "Modulation" switch from Off to On state to allow external modulation signal to be input to the acousto-optic device.
2. Input the built-in 1-kHz modulation signal to the acousto-optic device by connecting the "Sine Curve Output" to "Modulation Input" using a BNC cable.
3. Connect the "Demodulation Output" to a channel of an oscilloscope to observe the waveform of the demodulated signal (the original modulation signal is ~1 KHz sine wave).

5.3 Measure Diffraction Intensity Distribution

1. Use the internal 100-MHz modulation signal to drive the acousto-optic device ("Modulation" switch set at OFF). Turn the drum of the lateral measurement unit so that the 0^{th}-order light at the center enters the input aperture of the photo detector. Turn the drum finely to maximize the reading on the photo current amplifier.
2. Record the location of the photo detector head from the ruler and the scale of the drum while writing down the value of relative intensity from the "Light Intensity" meter.
3. Continue to turn the drum <u>in one direction</u> ("Modulation" switch set at ON) to locate and record the position of the detector head with the corresponding relative diffraction intensity for the $+1^{st}$-order or -1^{st}-order diffraction light. **Note**: the laser and the photo detector should warm up for 10 to 20 minutes before actual measurement begins.

5.4 Calculate Diffraction Efficiency of Acousto-Optic Modulator

Divide the measured intensity of the $+1^{st}$-order or -1^{st}-order diffracted light in the presence of ultrasound by the intensity of the 0^{th}-order undiffracted light in the absence of ultrasound to

calculate the diffraction efficiency of the acousto-optic device. **Note**: accurate alignment of the AO modulator is needed for achieving maximum diffraction efficiency.

5.5 Calculate Bragg Angle

Use the measured positions of the photo detector head to calculate the spacing (ΔL) between the $+1^{st}$-order or the -1^{st}-order diffracted light and the 0^{th}-order undiffracted light. If the distance between the exit aperture of the acousto-optic device and the detector head is L, then the Bragg angle of the device is $\theta_B = \Delta L/(2L)$.

5.6 Calculate Velocity of Sound in Acousto-Optic Medium

Use the measured Bragg angle to calculate the traveling velocity of sound waves in the device based on equation (17). Here λ_0=632.8 nm, and f_s=100 MHz.

5.7 Demonstrate Optical Communication using Acousto-Optic Modulation

1. Change the "Modulation" switch from Off to On state to allow external modulation signal to be input to the acousto-optic device.
2. Input an audio signal from a radio, a recorder, a PC or a MP3 player to the "Modulation Input" of the main control unit (through a female BNC cable at both ends) using the BNC-Earphone-plug cable marked with "To audio source-To modulation input".
3. Connect the "Demodulation Output" to the speaker (through a female BNC cable at both ends). The input audio signal can be heard from the speaker. If an opaque plate is inserted between the laser and the AO device to block the laser beam, then no audio will be heard from the speaker; if the opaque plate is removed, then the audio can be heard again from the speaker. This indicates that the laser beam can carry an audio signal via acousto-optic modulation for optical communication. Finally, the volume of the audio can be controlled by adjusting "Modulation Adjust" knob.