Laser

I. Diagnostics Instruments
   A. Laser Wavelength meter: skip this part since the wavelength meter is not operational.
   B. Power level meter: skip. Same reason as above.
   C. Spectrum analyzer (Fabry-Perot Interferometer): Read the original manual on spectrum analyzer, then read the following.

RC-46 Spectrum Analyzer Controller.

   FRONT PANEL

PHOTOAMP GAIN.
Provides a variable conversion for the photo detector amplifier of 0.004 to 1 V/uW.
PHOTOAMP BIAS provides a voltage offset of the displayed signal.
DISPERSION MULTIPLIER provides a calibrated multiplier to increase the dispersion of magnification by 2x, 5x, 10x, 20x, or 50x, about the center of the total sweep. In the 'off' position the internal ramp is disconnected and the input to the high voltage amplifier is via the EXTERNAL INPUT connector on the rear panel.
CENTERING adjusts bias voltage of the ramp output such that any spectral component can be centered in the oscilloscope display. In the x-y mode when the oscilloscope horizontal sweep is driven by the SWEEP output of RC-46, the spectral component centered in the oscilloscope display remains approximately centered as the dispersion is increased by the DISPERSION multiplier control.
SWEEP controls the ramp time continuously from maximum of 10 seconds for chart recorders to a minimum of 0.01 seconds for oscilloscope display. The ramp flyback is fixed at approximately 0.01 seconds.
CAUTION: Very high sweep rates may distort the spectral features slightly due to the frequency response of the photo detector amplifier. The PHOTOAMPLIFIER GAIN and SCAN RATE controls may need adjustment.
VARIABLE DISPERSION adjusts the amplitude to the ramp output so that the spectral dispersion (i.e. distance between orders in the displayed spectrum) can be varied. The adjustment is used to select the number of orders displayed in a simple analysis or match the intra-order spacing to the graticule division on the oscilloscope screen.

   REAR PANEL

BLANKING OUTPUT provides a 12VDC level during the ramp that goes low (nominal 0 VDC) during ramp return. This signal can be used as a trigger to synchronize the time sweep of an oscilloscope.
SWEEP OUTPUT is a low voltage ramp that is synchronous with the high voltage ramp output but unaffected by the front panel DISPERSION and CENTERING controls. It is used to provide x-sweep voltage in the x-y display mode.

EXP INPUT provides the use of RC-46 as a high voltage amplifier when the DISPERSION MULTIPLIER switch is in 'off' position. The gain of the multiplier is adjustable from 0 to 100 by means of the VARIABLE DISPERSION control. Input signals can be 0-10 V.
H.V. OUTPUT provides the high voltage ramp to the spectrum Analyzer via a gray (Viking) connector.
÷100 OUTPUT provides a low voltage (reduced 100x) copy of the actual ramp voltage to facilitate display on an oscilloscope.
PHOTOAMP INPUT is a 5-pin (Winchester) connector for connecting the photo detector on the spectrum analyzer (SA).
PHOTOAMP OUTPUT provides the amplified photo detector signal for the display on an Oscilloscope or chart recorder.
Experimental setup.

1. Assemble the setup according to the diagram.

The RC-46 Controller is connected to the SA with two cables. One is a high voltage cable which connects the Sealectro coaxial connector on a SA to H.V. OUTPUT on the back of the controller (gray Viking connector). The other is a detector signal cable which connects to PHOTOAMP INUT.
on the back of the controller (brown Winchester connector).

The monitoring oscilloscope is connected to RC-46 controller by two cables. Channel 1 (X-channel) goes to the low voltage ramp (100 OUTPUT). In x-t mode this channel gives a ramp voltage on piezoelectric as a function of time and hence a mirrors' separation as a function of time (since the position of the second mirror connected to the piezoelectric is proportional to the applied voltage). Channel 2 (Y-channel) goes to PHOTOAMP OUTPUT. In x-t mode this channel gives the output signal on the photoamplifier as a function of time. As an external trigger use BLANKING output form the RC-46 controller.

In x-y mode the oscilloscope shows the output signal on the photo-amplifier as a function of applier voltage (or as a function of mirrors' separation).

The ramp generator should now be turned on. And the low voltage ramp should be displayed on the oscilloscope. The ramp generator's scan rate (SWEEP control on the front panel of RC-46 controller should be adjusted to give a flicker-free display and the oscilloscope time base should be adjusted until a positive going slope of the ramp just fills the screen.

In order to observe the laser signal it is necessary to align the laser and the SA. The laser beam should be adjusted so that it propagates approximately parallel to the table at height of the optical axis of the SA. This preliminary adjustment is important so that SA’s mechanical adjustment range is adequate to compensate for a sloping beam.

Spectrum Analyzer adjustments.

1. Take out the photodetector; unscrew the collet lock (the black knurled ring), the rear mirror holder, and the front mirror holder (the silver knurled ring).
2. Put a laser beam into the beamsplitter window (as shown on the Diagram). Make sure that the beamsplitter window is perpendicular to the beam.
3. Adjust outside vertical and horizontal adjusting screws until photodetector side of Spectrum Analyzer (SA) is on the same horizontal line with the beamsplitter side SA. Make sure that initial and output laser beams are perpendicular to each other and are in a horizontal. Do additional adjustment using both inside and outside adjusting screws until the laser beam is coming out exactly through the center of the photodetector side of SA, so when you put back a front mirror holder the laser beam will be exactly in the center of the front mirror. (Use a small piece of paper to track the laser beam coming out from the SA.)
4. Make sure that the SWEEP is not set to its minimum value. Put back a front mirror holder. Put a white screen behind it (a piece of paper). You will see one very bright spot and one very faint spot. Adjust horizontal and vertical inside screws until both spots coincide.
5. Put back a collet lock and rear mirror holder (do not put the photodetector yet). On the screen you
will most probably see a circle, ellipsoid or a line. Adjustment inside adjusting screw (both horizontal and vertical) until the circle/ellipsoid/line shrinks to a small dot.

5. Now, mount the photodetector back on. Observe the signal. You should be able to see spectrum peaks. *(Note: If no signal from photodetector is observed, (1) adjust the position of the photodetector while monitoring the signal on the scope, and (2) try to adjust photodetector BIAS potentiometer.)*

6. The final step is to continue the adjustments until the displayed spectral peaks are of maximum amplitude and minimum width (i.e. highest finesse). For that try to vary mirror’s spacing by loosening collet nut turning silver knurled ring (rear mirror holder). Once the finesse has been maximized, the collet lock ring should be retightened to preserve the alignment. Note the detector can remain attached to the SA body during these adjustments because it is magnetically coupled to the body. As one continues to improve the signal from the SA, one frequently achieves the condition of partial mode matching. This is no problem with operating in this mode so long as one is aware that the weaker signal is simply another interferometer order, and not a second frequency in the laser output.

**Analyzing the spectrum.**

1) Determine the spectral line width of HeNe laser. For that In y-t mode measure the distance between adjacent spectrum lines. This will give you a time scale. *(During this time the piezoelectric shifts for one wavelength (633nm)).* Now change the range on t-scale. Measure the line’s width. *(Note: to correctly calculate the width you need keep track of how much you change the t-scale.)*

2) Determine the linear polarization if the HeNe laser output using the large Polaroid sheets. In your laboratory notebook explain your method for determining the polarization axes of the Polaroid sheets. Explain the relationship between the linear polarization you observe for the external beam of the HeNe laser and the orientation of the Brewster window of the HeNe plasma tube.

**II. Making Laser**

Hints on “Making Laser”

1. Place the He-Ne discharge tube as horizontally as you can on the two support rods.
2. Place a square sheet of paper with a circular hole cut out around the Brewster window *(Do not touch the Brewster window.)*. The paper helps you to see the
reflection from the output mirror.

3. Adjust the height of the center of the output mirror to be the same as the center of the Brewster window. Make sure that the surface of the output mirror makes a plane perpendicular to the line connecting two mirrors.

4. Place a white paper beyond the output mirror to observe the light that is transmitted through the output mirror (as instructed in the manual). You should see a bluish transmitted light on the paper. Check that the center of the blue light is same as the centers of the output mirror and the Brewster window. If not, make adjustments.

5. The location of the output mirror along the optical track is not very crucial.

6. When adjusting the angle of the output mirror as described in the manual, search for the angle which reflects the light directly back to the Brewster angle. The paper placed around the window helps you to locate the reflection.

7. There are two adjusting screws which are used to change the tilt. After each small change in the tilt angle, rotate the mirror around its vertical axis so that the reflection is swept over the Brewster window. Continue adjustment till you see a flick of red lasing light. You will likely need to play with both screws. If the discharge tube and the output mirror are placed horizontally, the output mirror would be vertical when properly adjusted. (Note: do your adjustments slowly. If you sweep the reflection over the Brewster mirror too fast you could miss the resonance position.)

8. Be patient in changing the angles. When you see the lasing red light, you will have made your own laser!!! After you see the initial lasing, optimize the angle by maximizing the intensity.