Aligning the Jlab Tune mode generator 2017

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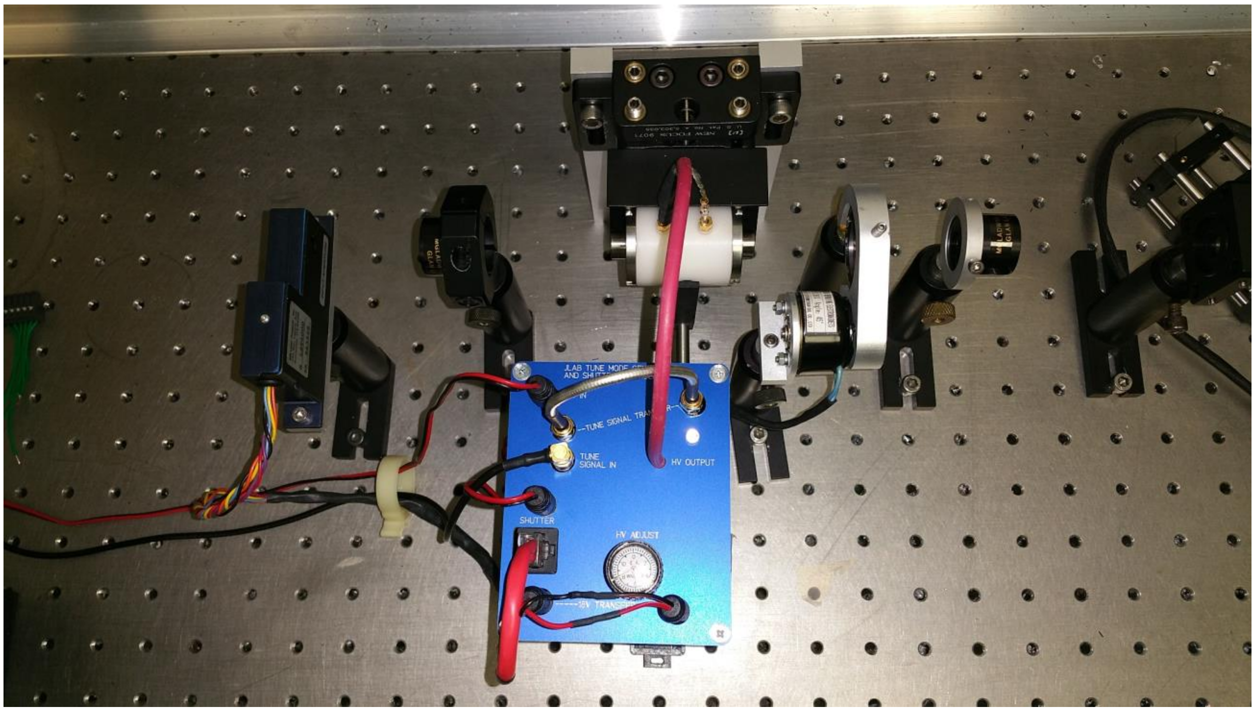
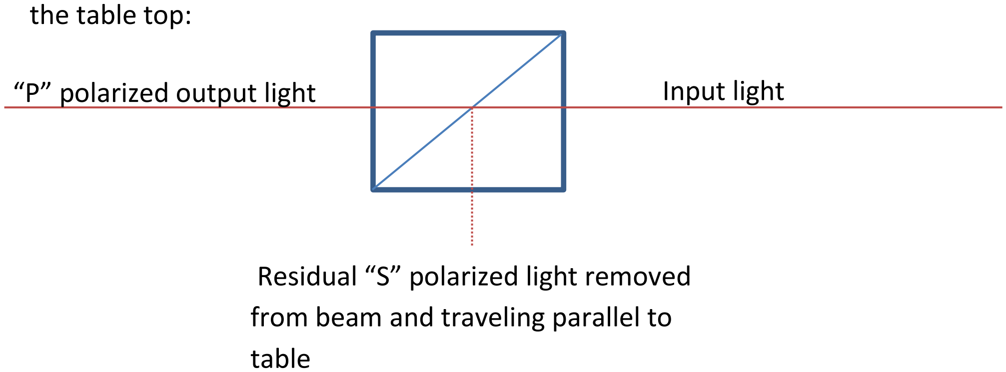
The placement of your components will eventually look like this:



From Left to Right we see the following components: Shutter, Output LP, RTP cell, moving half wave plate, Input LP.

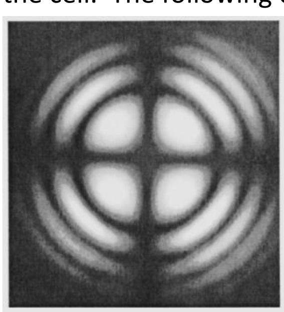
1. To start the optics setup should have a laser, an input linear polarizer (LP) and an output LP mounted 8 inches beyond the input LP. We are saving room for the pockels cell and waveplate to be inserted in later steps.
   a. Our CEBAF PPLN systems output a "P" polarization state, so adjust the input LP optic so it is passing "P" polarized light. How do I know if it is "P"?, when the Glan Laser LP is viewed from above, we should see it is in this position with the exit port beam running parallel to the table top:



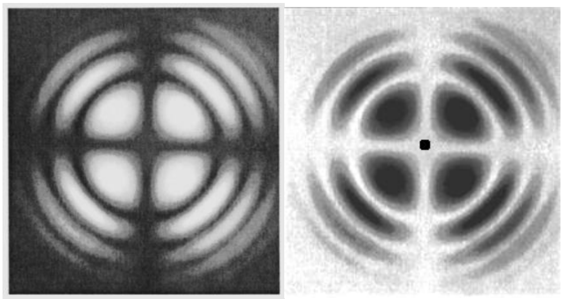
b. The downstream LP is inserted in this same direction to pass the "P" light. Most mounted polarizers have a line across the mounting case to designate the P axis. This line will be parallel to the table top.

2. The next step is to mount the insertable ½ wave plate immediately downstream of the first LP. It must clear the beam when it is in the retracted state and affect the beam in the inserted state. Once in place, you will rotate the waveplate to get maximum extinction past the second LP. Once it is aligned, you should get full "pass" through the system when the waveplate is retracted and full extinction when inserted.
3. Next you will insert the pockels cell on a pitch-yaw stage. If you have P polarized light parallel with the table, as we did in the steps above, you will insert the Pockels cell with the connection leads facing straight up. If you aligned the P polarized light orthogonal to the table for some odd reason, you would insert the pockels cell with the leads parallel to the table.
4. You will center the pockels cell aperture on the laser beam. Adjust its pitch and yaw so it seems to be centered on input and exit sides. At this point, the transmission should look very similar to that of step 2, where you still get full pass when the waveplate is retracted and full extinction when the waveplate is inserted.
5. Next you will put a paper screen a few inches downstream of the second LP. Use a pen or pencil and mark the paper at the location of the laser on the screen. From this point forward, DO NOT move the screen or the pointing of the laser. You will only move the pockels cell.

6. Place a piece of translucent tape over the input to the pockels cell to diffract the light through the cell. The following crystal diffraction pattern should appear on the paper screen:



7. The dark band should be centered on the pencil mark you have placed on the screen in step 5. If it is not centered, you will adjust the pitch and yaw of the cell to move the extinction pattern. You will notice that when you manually lift the waveplate out of the beam, you will see a complete inversion of the pattern where it is in a full passing mode as seen below:



Notice in the "full passing" mode on the right, we see our original pencil mark in the center of the pattern.

8. Remove the tape from the input of the cell that was creating the diffraction pattern.

9. Connect the Tune Mode generator electronics HV leads to the cell. Polarity doesn't matter. Plug in an 18V power source to the cell. If you are in the CEBAF tunnel or UITF, you MUST use the 18V source that passes through the PSS system. Taking the PSS laser chassis to bypass mode with the PSS bypass key will allow it to source 18V to the tune mode generator. You will plug in the shutter and waveplate control cable to the tune mode generator at this time. The Macropulse chassis signal for the "hall" plugs in to the "Tune Signal IN" SMA connector. The tune signal transfer cable and 18V transfer cables should already be plugged in.

10. You are now ready to use the normal EPICS control of the tune mode generator or you can connect a function generator if EPICS is not available. The system is expecting 5V TTL levels. Here you will put it in the different modes and verify the proper response of the system. The dial labeled "HV ADJUST" is used to adjust the proper voltage to the pockels cell for half-wave retardation. This is generally about 2000 volts (depends on cell diameter and wavelength) and the unit puts out 4000V at full scale, so a setting near 5.00 is a good starting point to see a response from the system. You will now have to do very fine adjustment to the waveplate rotation, pitch and yaw to maximize the extinction ratio of the system.

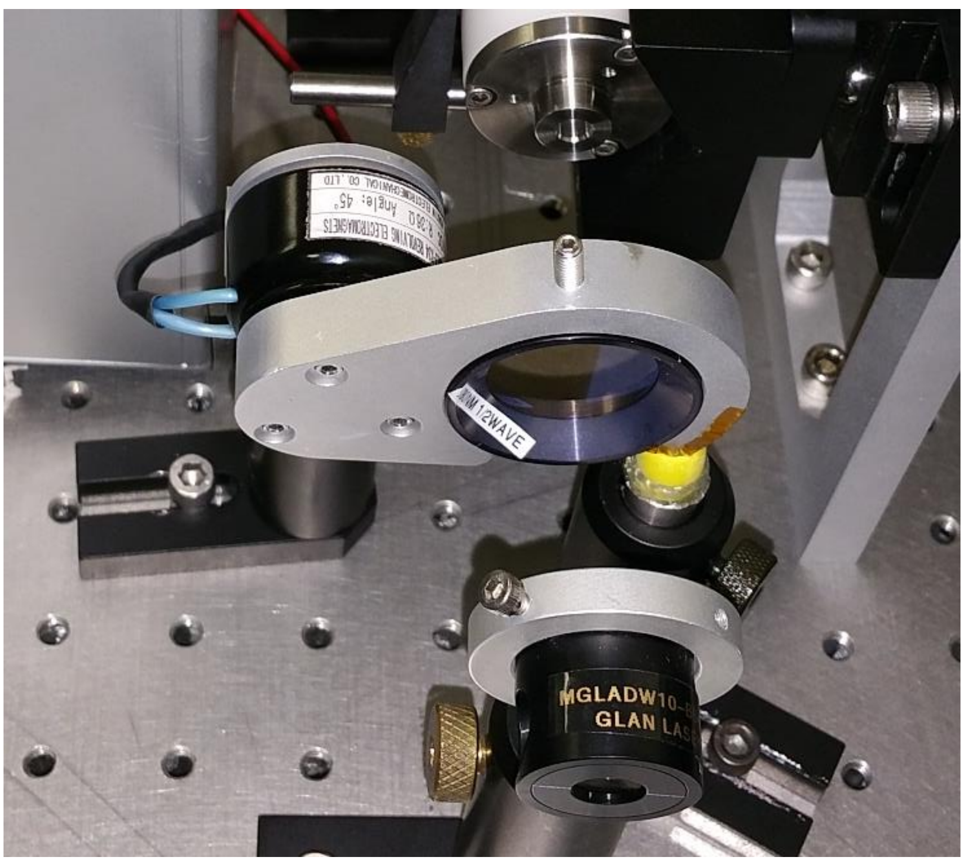
11. You may be wondering how we know the exact adjustment for the HV ADJUST. You will need an oscilloscope and a fast photodiode. Put the system in Viewer limited mode using EPICS. In this mode, the waveplate is inserted and the high voltage is pulsing on the pockels cell. It is turning on for the VL pulsewidth (typically 1-10us) at a 60 Hz rate. Put a Tee in the "Tune signal IN" line so you can use the electrical signal for a scope trigger. When properly triggered you should be able to see the tune signal pulsing in the photodiode. You might need to put a 50 ohm load on the scope input to see the signal in its true form, because an unloaded line might show up as a slow broad pulse.

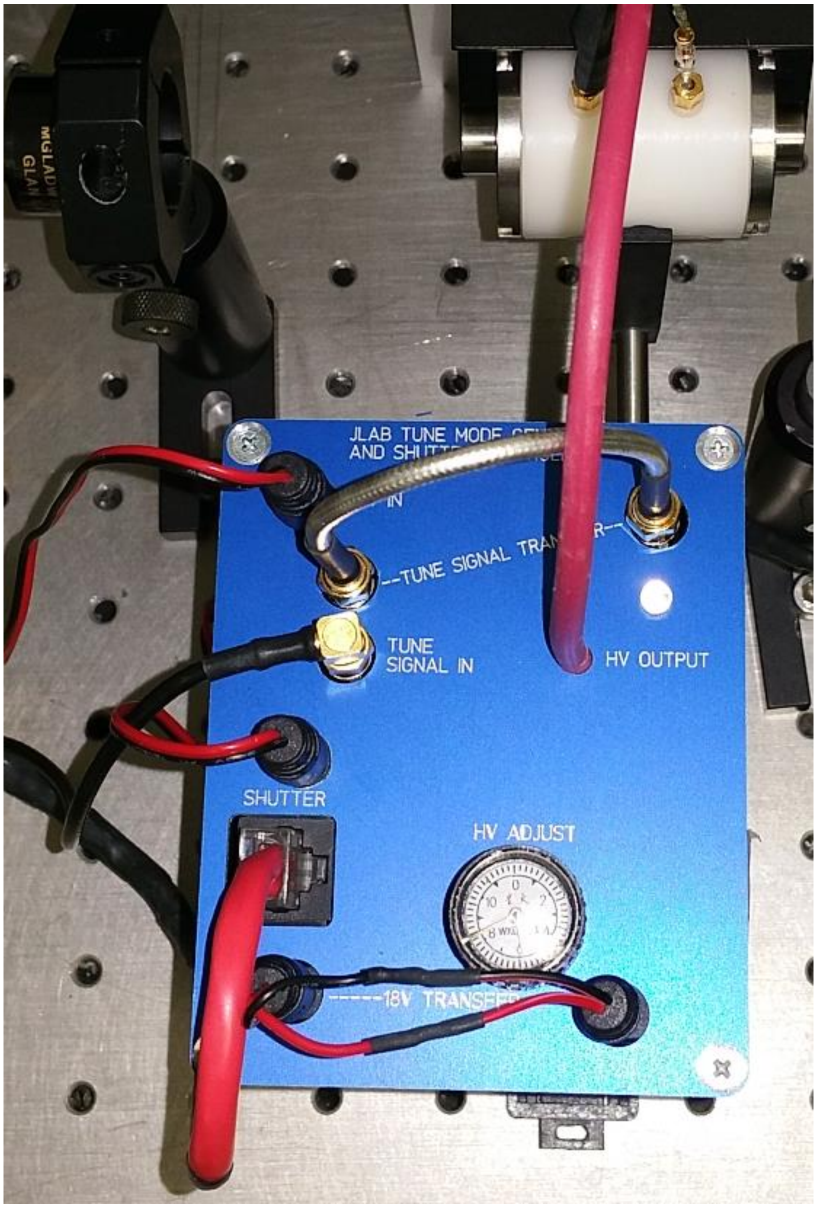
12. You will notice as you turn the HV ADJUST, you can make these pulses reach a peak level and then they will start to get lower in amplitude if you go too far. This will not seem very sensitive and you will find a broad setting that appears to create the highest amplitude. To get a more accurate setting, you will manually lift the waveplate so it is in a retracted state. Once retracted,

the cell is in full pass mode, and the pulses from EPICS for VL mode will be taking the beam to full extinction. Now it will be much easier to turn the HV ADJUST dial and find the proper setting as you watch the oscilloscope. When you have reached the highest extinction of light during each voltage pulse, you are at the ideal setting. This has to be done as the final step of your alignment, because if you have not already aligned it mechanically, you will not be able to see the highest extinction.

13. You can now let the waveplate drop to its normal inward state and you are finished with the alignment.

14. Notice in the image below, we use a soft yellow earplug as an end stop for the insertable wave plate. This plug has been squeezed into the ¼” threaded end of an optical post and glued with hot glue so it will never back out. This material is extremely impact resistant and resilient. I have tested it with 600,000 cycles of the waveplate and it has not broken down or shown any sign of stress damage. This soft polymer limits the impact vibration from the waveplate falling to the inserted position. Kapton tape is placed on the moving arm to prevent the aluminum from wearing off on the polymer, so neither the aluminum, nor the polymer earplug are showing wear.





The connections to the tune mode generator should look like the image above. The waveplate driver connection was not part of the original design, so it has no engraved label. It plugs in immediately above the CAT5 plug for the shutter.