Running the room-temperature CTN experiment

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1 Cavity locking procedure

1.1 Lock the pre-modecleaner

1. On `fb2`, there is an MEDM screen for locking the PMC. The voltage slider goes from 0 to 300 V. There is a CCD set up to monitor the transmission through the curved mirror of the PMC. Adjust the voltage slider until the PMC is approximately on the TEM_{00} resonance. Then enable the lock.

   ☞ The PMC transmission PD is not currently hooked up.

2. The range of the PMC PZT is not sufficient to span a full FSR of the PMC. To fix this, there is a 100 Ω resistive heater wrapped around the metal endcap of the PMC. Applying a few volts to the heater should be sufficient to move the PMC cavity length into a region where it can be locked with the PZT.

1.2 Lock the north (or south) cavity

1. On the TTFSS interface board, make sure that PZT feedback is disabled (i.e., the first switch is set to TEST). On `fb2`, make sure that thermal ("slow") feedback is disabled
2. On `fb2`, adjust the laser's slow feedback voltage so that the cavity is near resonance. The easiest way to monitor the cavity buildup is to look at the transmission camera.
3. On the TTFSS interface board, flip the first switch from TEST to OFF (this engages the servo). If the lock engages, the camera transmission should increase dramatically.
4. For monitoring the error and control signals, we usually use COM OUT1 and FAST OUT2 on the TTFSS.
5. To engage the digital slow (temperature) feedback, run the fast control into the ADC. Then engage the slow feedback on the laser MEDM screen. This should bring the fast control signal to 0 V.

   ☞ The ADC has no input buffer; just a parallel capacitor on the input. If the control signal is monitored on a scope while plugged into the ADC, it will appear low-passed.

6. Repeat for the other cavity.

1.3 Lock the PLL

The beat note is read out with a New Focus 1811.

1. Look at the ac readout on a 50 Ω, ac-coupled scope, and optimize the E-field overlap if necessary. There is currently a 20 dB coupler on the ac readout for this purpose.
   a) The rf power of the beat note should be large: with good mode overlap, the total rms rf power is $\sqrt{P_1 P_2} \approx 500\ \mu\text{W}$ for $P_1 \approx P_2 \approx 500\ \mu\text{W}$. This typically requires an ND filter to prevent the NF1811 from saturating.

      ☞ The optical layout has not been modified to handle the birefringence of the cavities. Each cavity tends to lock on either of its two TEM_{00} modes, with little preference for one over the other. Therefore, if one (or both) cavities is relocked, the beat note power may drop because the relative polarization of the beams has changed.

   b) The frequency of the beat note should be below 120 MHz or so (the bandwidth of the NF1811), and above the bandwidth of the PLL low-pass filter. The frequency can be changed by changing the north cavity temperature (coarse adjust) or the vacuum chamber temperature (fine adjust).
2. Dial in the approximate beat note frequency into the Marconi. Choose the appropriate LO level for the mixer. I believe what we have now is a ZRPD-1+, which is a 7 dBm double-balanced mixer (DBM).
3. Is the rf beat note at an appropriate power for the DBM? The ZRPD-1+ is meant to be driven with similar LO and RF powers (i.e., 7 dBm) for both.
4. The mixer IF is terminated, sent through a low-pass filter, and then into an SR560. The SR560 is set to have a flat gain.

   ☞ Because the mixer is a phase detector and the VCO is a frequency actuator, the OLTF of the PLL has an intrinsic $1/f$ shape despite having a flat electronic gain. No additional low-passing in the electronic portion of the loop should be necessary.

   The output of the SR560 is sent into the Marconi's VCO input. The Marconi's VCO is set to accept dc-coupled FM. In order to lock, the FM deviation on the Marconi typically needs to be something like 1 to 10 kHz.

   ☞ A Marconi setting of "10 kHz" FM deviation means a VCO actuation coefficient of $(10\ \text{kHz}_\text{pk})/(1\ \text{V}_\text{rms}) = (10/2^{1/2})\ \text{kHz}_\text{pk}/\text{V}_\text{pk}$.

5. Lock the PLL by spinning the carrier frequency dial on the Marconi. Here it is advantageous to monitor the PLL control signal on a scope.
6. With the PLL locked, you can now read out the beat note frequency spectrum in real time by monitoring the control signal with a spectrum analyzer.