Subject:
MZM-LORTM EA-FEIC Test Log, 2011 July 25 to August 12

Date:
Aug 23, 2011
DK004_2011

From:
Derek Kubo

To:
Ming-Tang Chen

cc:
Distribution

Location/Phone:
Hilo Office
1-808-961-2926

References: DK002_2011, MZM-LORTM EA-FEIC Test Log, 2011 January 19 to 27
DK003_2011, MZM-LORTM EA-FEIC Test Log, 2011 March 21 to April 1

Monday July 25, 2011

Arrived FEIC ~8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC ~ 5:45 PM

1) Meeting with Eddie about scheduled tests:

Went over "MZM LORTM ORR and FE#15 SN-46" Regular ATP, version July 4.

July 2011

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

August 2011

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

2) Physical inspection of MZM-LORTM unit:

Chia-Hao had already unpacked the 3 Pelican boxes for us on Friday prior to our arrival. Removed both top and bottom covers for the LORTM and inspected the unit. No physical damage, all connections to ADAM module were intact, though some SMA connectors to MZ2 had loosened (retightened).

3) Power-up MZM-LORTM in chamber 2:

FEIC staff had already setup for the "signal path phase stability test and measurement" [FEND-40.09.03.00-00180-00 / T] using the Band 3 / Band 7 phase stability test plate. The Band 7 signal source is a different unit than we used in March. Currently running a baseline test using the TeraXion LORTM.

Setup for 100/106 GHz as follows:
FLOOG = 31.5 MHz
Ref1 Synth = 25.742125 GHz @ +15.0 dBm (+7.55 dBm at end of cable into J5)
Ref2 Synth = 6.000 GHz @ +15.0 dBm (atten = 4.947V, cable + 12 dB pad → 3.000 GHz @ -7.6 dBm into J6)

For Ref2 input into LORTM, initially tried to achieve the desired 3.000 GHz @ -7.5 dBm by adjusting the PIN attenuator voltage but the output power was not stable (fluctuated rapidly by +/-0.05 dB). Instead we used 6 + 6 dB pads to get close then fine adjusted the PIN control voltage 4.947V. I believe the reason for this is that the Hittite PIN attenuator has a very steep attenuation vs. voltage slope for larger attenuations (small variations in voltage result in non-trivial variations in attenuation).

Problem with no light from MZ1 (USB missing)! Removed cover and found a loose FC/APC connector in the MZ1 path of the combiner plate (beneath the EDFA) at the isolator input interface. This connector was loose from the very beginning and opened up during shipment. Tightening connector brought the MZ1 signal back.

4) Baseline LORTM (S/N 002 – belongs to EA-FEIC) phase stability reference test results:

Result of current baseline Allan Deviation test is poor because of our opening and closing of the chamber. Test has been aborted. For comparison they will use results from 2011 June 24, refer to *Figure 1*. 10 seconds → 1.7 fsec, 300 seconds → 3.9 fsec.

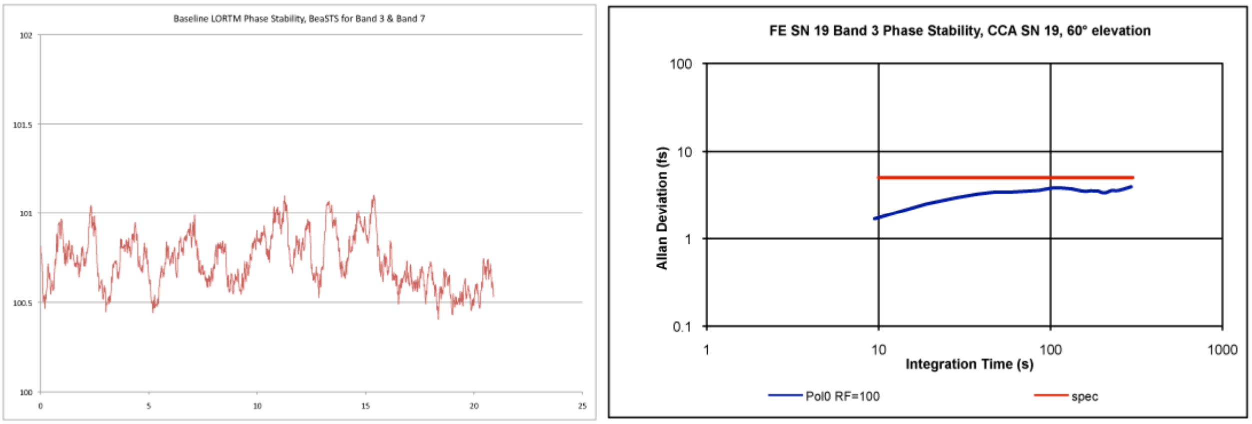

Figure 1 Baseline TeraXion LORTM phase stability test with 100/106 GHz test plate (2011 Jun 24). Left – phase plot 0 to 20 minutes, right – Allan Deviation. 1.7 and 3.0 fsec for 10 and 300 seconds, respectively.

5) MZM-LORTM phase stability run, chamber 2, 100/106 GHz test plate:

Waiting for past 2.5 hours for phase to stabilize. Currently see the phase following a very slow periodic sinusoid with a period of ~90 minutes and amplitude of ~3.5 degrees (~7 degrees peak-to-peak), refer to *Figure 2*. Short term phase over periods of 10 minutes is ~0.75 degrees peak-to-peak and is consistent with what we saw in our Hilo tests. Stick ran an Allan Deviation on the dip part of the sinusoid (flattest portion) and obtained ~3 fsec at 10 seconds, slightly worse than the 2.4 fsec for our final run in Hilo. 100 and 300 seconds exceeded the 5 fsec spec limit.

Went into the chamber after 185 minutes to investigate. MZ2 temperature was 20.0 C (TEC drive was set to 2.1V earlier). Turned on large floor fan and placed it ~2.5 meters away blowing air toward the LORTM rear panel intake at a ~45 degree angle. Also setting up laptop to log internal LORTM thermocouple temperatures. LORTM is still on the cart near the baseline LORTM. MZ2 temperature dropped to 18.0 C, probably due to the floor fan moving warm air away from the LORTM intake. Restarted the test at 4:15PM and ran for ~90 minutes. Slow phase oscillation is no longer apparent, however, short term RMS has gotten worse.

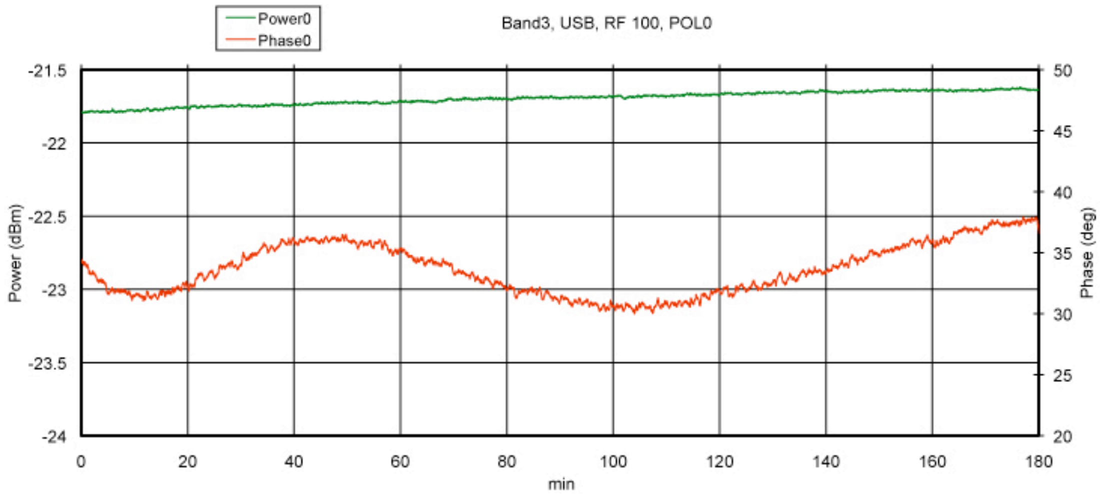

Figure 2 MZM-LORTM with BeaSTS test plate (100/106 GHz), 180 minute run. Note the slow periodic oscillation in phase. Possible cause – temperature variation in intake air, the MZM-LORTM has been shown to exhibit 5 degrees phase movement per 1 degree C temperature. Or possibly a slow drift in the Ref2 IF input power (MZM-LORTM sensitivity is ~32 deg/dB).

6) Final phase stability run for today:

Moved floor fan to back of chamber about 4 meters away from LORTM. This time we setup fan position to blow air at an angle of ~90 degrees to the LORTM intake airflow direction (not blowing directly into intake air vents of LORTM). The MZM-LORTM has been shown to be very sensitive to temperature, 5 degrees phase per 1 degree C, and it has also been shown that air turbulence in the vicinity of the intake air vents contributes to an increase in short term phase fluctuations. Started an 8 hour phase stability run at ~5:30 PM. Monitoring all 7 thermistor temperatures within the MZM-LORTM.

7) Modus driver:

Ranjani installed modbus drivers onto the right hand side PC near chamber 2. Did not test to see if it worked to communicate to the MZM-LORTM ADAM (need IP assigned).

Tuesday July 26, 2011
Arrived FEIC ~8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC ~6:00PM

8) Results of overnight run:

Still see a significant slow variation of 6 to 7 degrees peak-to-peak over the 380 minutes (6.3 hours), refer to *Figure 3*. Note the very flat temperature response for all sensors → phase movement is not likely caused by temperature variation.

Allan Deviation looks good for only the first 30 minutes where the phase is flat, 1.9 fsec at 10 seconds, ~4.7 fsec at 300 seconds. However, when calculated over the entire 380 minutes the ending point at 300 seconds fails due to the large but slow phase variation.

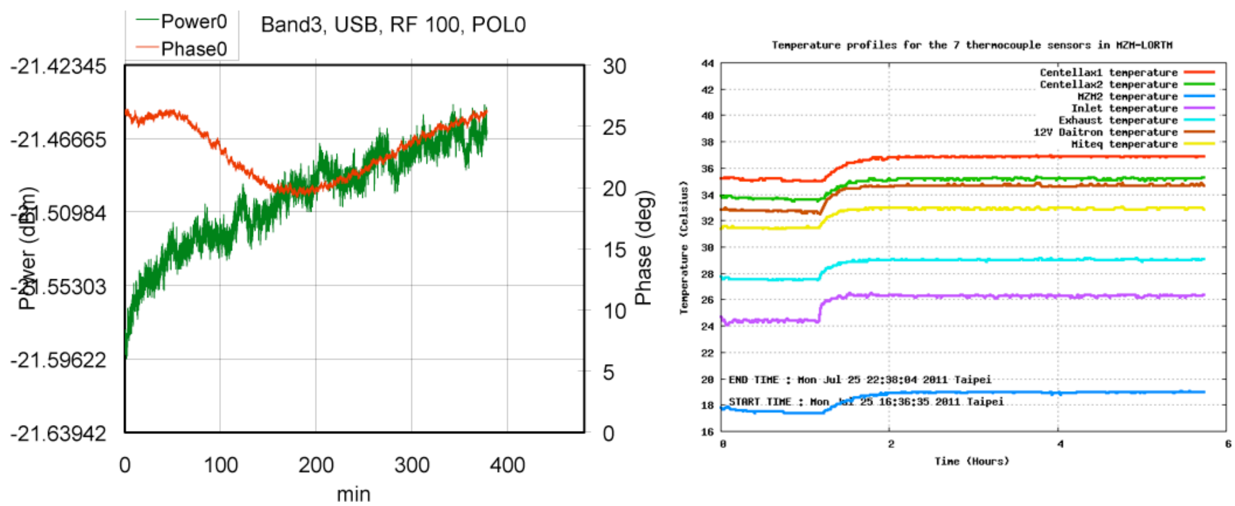

Figure 3 MZM-LORTM with 100/106 GHz BeaSTS test plate, 380 minute run. Left – phase plot, right – internal temperatures. Here again, note the very slow but large phase variation similar to that in Figure 2. Note the 2C jump in temperature at ~1.6 hours due to the relocation of a floor fan. The internal temperatures remained very flat and implies that the phase variation in the left plot are not due to temperature variations within the MZM-LORTM unit.

9) Plans for today:

- AB-mode (currently running): Does AB-mode exhibit better short term phase variations as we saw in Hilo? How does the long term stability look? *Answer – Short term stability maybe slightly better but long term stability shows no improvement.*
- Study "IF Extra Plate" design: Is there anything in the design that could cause even small variations in IF reference power? 32 degrees per dB, we see 7 degrees of phase movement which would correspond to 0.22 dB change in 3.0 GHz power level over 90 minute time scales. *Answer – Yes, the PIN attenuator has a portion of the curve which is 25 dB per Volt. When operating within this portion of the attenuation curve can see IF power vary rapidly in the tenths position (dB).*

10) AB-mode performance:

The short term phase variation appeared to be slightly better in AB-mode as compared to normal mode. Saw 0.5 for AB-mode vs. 0.75 degrees peak-to-peak for normal mode. There was, however, a fairly steep monotonically decreasing phase throughout the entire 100 minute run that resulted in 2.2 fsec at 10 seconds, and 5.1 fsec at 300 seconds.

Interestingly enough, AB-mode in Hilo produced exceptionally good results of 0.7 and 2.2 fsec at 10 and 300 seconds, respectively. Can one then conclude that much of the short term phase variation is being contributed by sources outside of the LORTM?

11) Hittite HMC-C053 PIN diode attenuator:

DC – 20 GHz, 0 – 30 dB, $V_{control}$ = 0 to -3.0V, absorptive. The control voltage, 0 to -6V, is provided an Agilent E3631A DC power supply through a 1 to 2 resistive divider with a total series resistance of ~188 Ohms. The Agilent also provides the +5V and -5V supply power to the attenuator. The attenuation vs. voltage curve is piece-wise linear with 2 basic slopes: 0 – 5 dB from 0 to -2V, and 5 – 30 dB from -2 to -3V.

We are currently operating $V_{control}$ = -4.947V or -2.47V (after voltage divider) at the PIN attenuator which corresponds to ~13 dB of attenuation. The attenuation vs. $V_{control}$ slope is fairly steep at this operating point, ~25 dB per 1V. A 0.01V change in $V_{control}$ will result in ~0.25 dB change in IF power. A 0.25 dB change in IF power will correspond to 8 degrees of phase change for the MZM-LORTM which is similar in magnitude to what we see in Figures 2 and 3.

12) Run with Kikusui DC bias source for $V_{control}$:

Replaced E3631 with Kikusui DC bias source. Also increased pad value from 12 dB to 19 dB and reduced $V_{control}$ from 4.947V to 2.95V (PIN = ~3 dB attenuation). Refer to *Figure 4*. Doing so allows the Hittite PIN attenuator to operate in a much less steep portion of the attenuation/voltage curve.

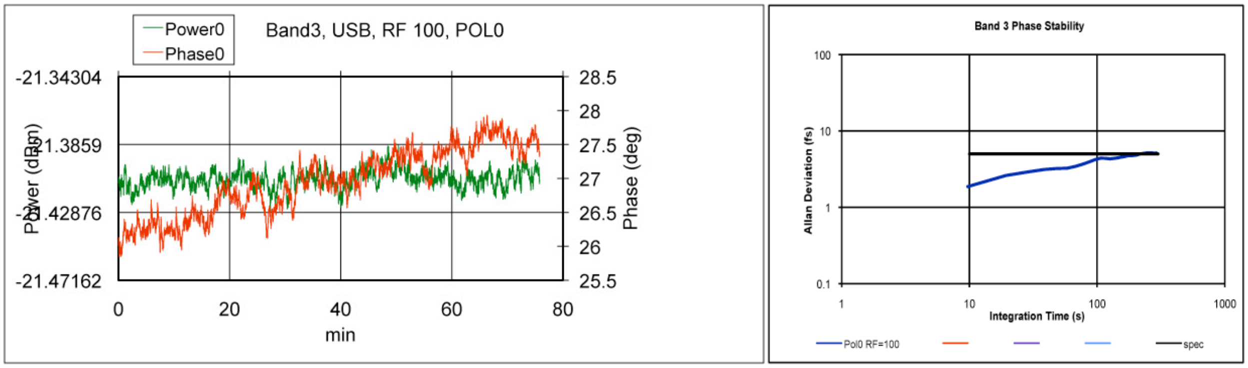

Figure 4 MZM-LORTM with Kikusui precision bias source driving the Hittite PIN attenuator, 75 minute run. Note the constant monotonically increasing phase. Will this slope continue to increase?

13) Final run for today, Kikusui controlling Hittite PIN attenuator, monitoring IF power into LORTM:

Monitoring IF power on power meter while running overnight phase. Added 2-way power divider to IF signal, reduced pad from 19 dB to 16 dB and adjusted $V_{control}$ = 1.8663V (PIN = ~2 dB attenuation). Checked 3.0 GHz spectrum on ASA… looked very good, no spurs and amplitude very stable (even though Mini Circuits ZX60-6013E is in heavy compression). Will attempt to correlate IF power drift with phase drift.

Wednesday July 27, 2011
Arrived FEIC ~8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC ~ 5:00 PM

14) Results from overnight 240 minute run:

The amplitude remained flat, however, the phase continued to increase monotonically over the entire 4 hour duration, refer to *Figure 5*. When we perform Allan Deviation over the entire run the results are 1.81 fsec at 10 seconds, 5.25 fsec at 300 seconds. However, if we select the best 30 minute interval we can pass with 1.76 fsec at 10 seconds, 4.00 fsec @ 300 seconds.

Now that we have eliminated the sinusoidal phase structure it leaves us with a monotonically increasing phase. We monitored the IF power over the entire duration and saw a peak-to-peak fluctuation of 0.01 dB and essentially zero slope. Applying 0.01 dBpp to the 32 degrees/dB we get 0.32 degrees peak-to-peak. Where is the phase slope coming from? It is possible that the MZ1 and MZ2 devices themselves are drifting. We did not see this in Hilo, however, this may be due to test setup differences (in Hilo we only looked at the 6 GHz difference from MZ2 and ignored the MZ1 optical tone). In speaking to Eddie, he felt that the phase slope was shallow enough as to not affect the Allan Deviation. What is hurting us is still the ~1 degree peak-to-peak phase deviation seen over the 60 minute intervals.

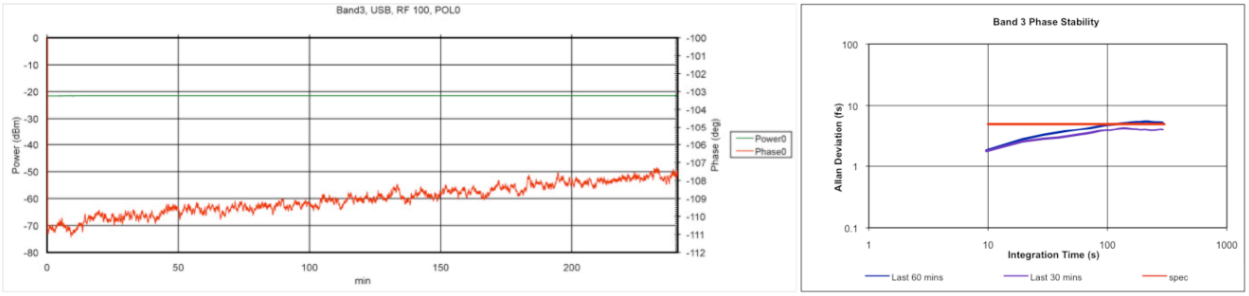

Figure 5 MZM-LORTM with Kikusui precision bias source driving Hittite PIN attenuator. Note the disappearance of the slow sinusoidal phase structure with the Kikusui bias source. The overall slope is +3 degrees over 4 hours. Though this plot looks fairly decent we are still failing Allan Deviation. Blue – Allan Deviation for entire 4 hour run (1.81 fsec at 10 seconds, 5.25 fsec at 300 seconds), purple – Allan Deviation for flat portion after the 200 minute mark (1.76 fsec at 10 seconds, 4.00 fsec @ 300 seconds).

15) Test of modbus drivers

Tested it out this morning using the FEIC controller PC… it works! I.e., can talk to MZM-LORTM through the standalone LabView software.

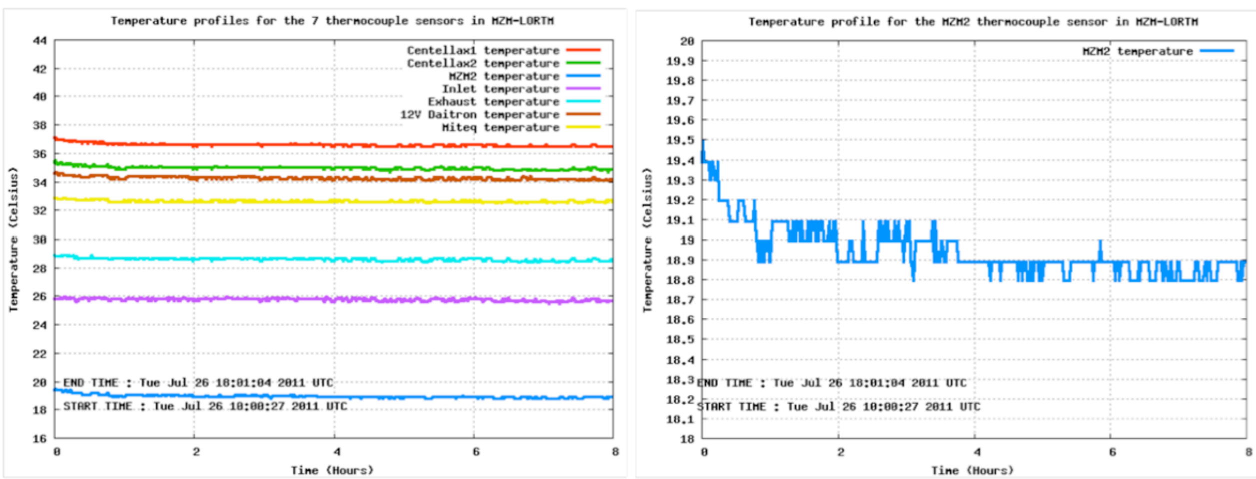

Figure 6 Corresponding internal MZM-LORTM temperatures. The temperatures are relatively flat but there is a very small downward slope as exhibited by the MZ2 temperature in the right panel. Note the monotonically decreasing temperature over the first 4 hours. We see a decrease of 0.4C over the first 4 hours which → 0.4C*5 deg/C = 2 degrees phase slope.

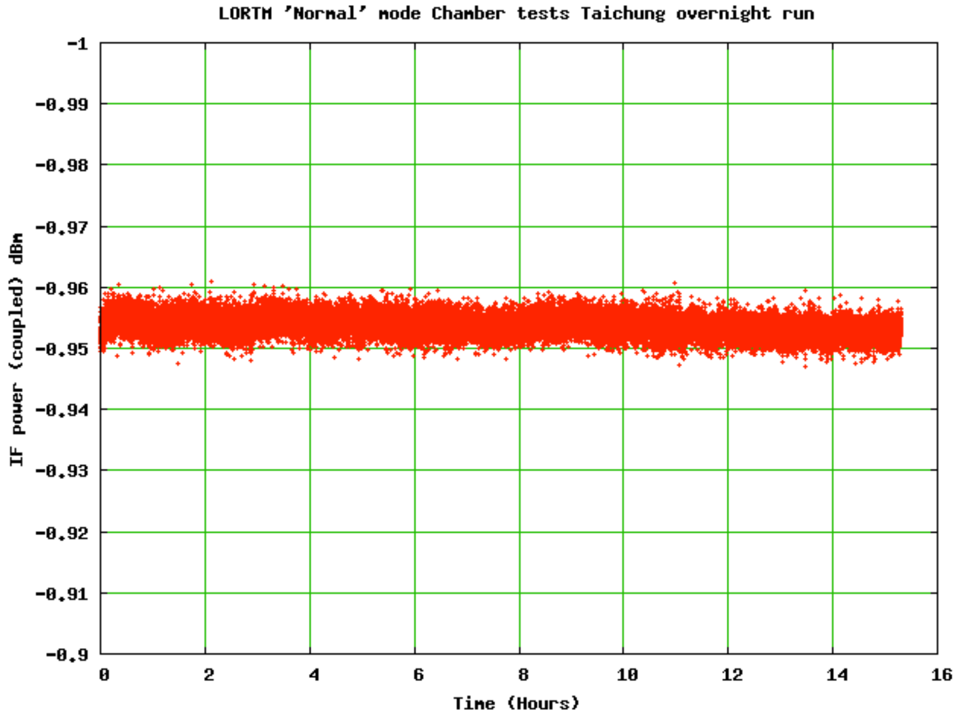

Figure 7 IF power stability as measured at power divider output. Note the 0.01 dB peak-to-peak power variation and near 0 dB phase slope over the first 6 hour phase measurement interval.

16) Fine adjustment of the MZ2 port A DC bias while watching phase (10:00AM)

Fine adjusted the MZ2-A port bias voltages and waited 10 minutes for each as follows:

ADAM	Readback	Clock Time	Chart Time
8.30V	6.650V	10:35 AM	0 – 10 minutes
8.35	6.750	10:45	10
8.40	6.851	10:55	20
8.45	6.952	11:05	30
8.50	7.050	11:15	40
8.30V	6.651V	11:25	50 – 60 minutes
8.25	skipped	--	--
8.20	6.450	11:35	60
8.15	skipped	--	--
8.10	6.251	11:45	70

The results of the bias change were quite surprising, we saw no noticeable effect of phase change with respect to a change in MZ2-A voltage. In contrast our tests in Hilo showed a definitive relationship of +16 degrees phase per 1V change in bias A. Refer to *Figure 8*.

Another interesting observation is the phase was decreasing monotonically over the entire 80 minute test duration. This is opposite from what was seen last night. We saw a corresponding increase in MZ2 temperature from 19.1C to 19.4C over the 80 minute duration, though the chamber 2 temperature remained at a solid 20.1C.

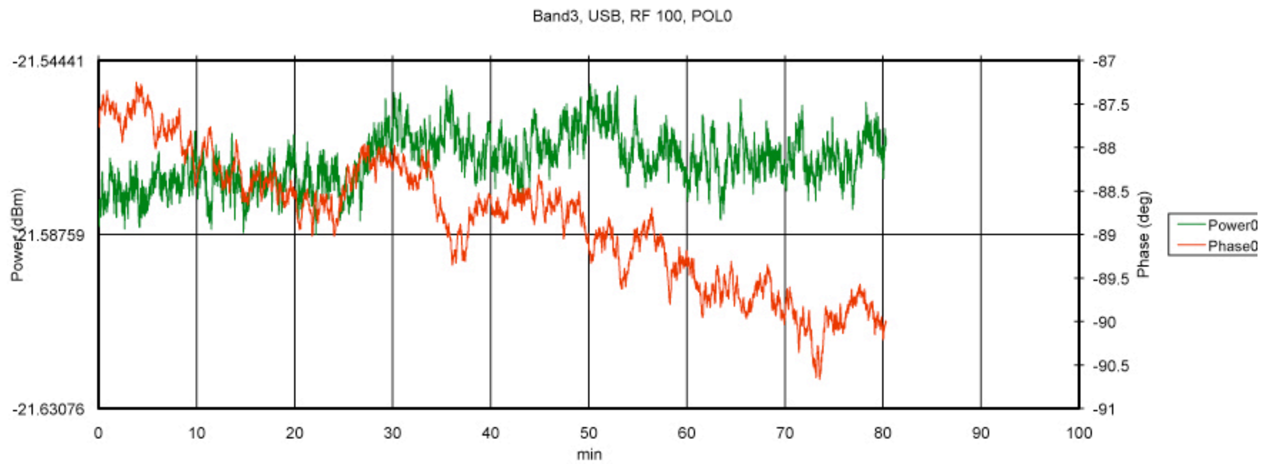

Figure 8 Phase response to MZ2-A bias change (see paragraph 16). Adjusted DC bias from 8.30, 8.35, 8.40, 8.45, 8.50, 8.30, 8.20, 8.10V (minutes 0-10, 10-20, 20-30, 30-40,40-50, 50-60, 60-70, 70-80). Results were surprising – no phase change WRTo MZ2-A DC bias change.

17) Adjustment of IF input power:

Adjusted IF input power -7.50, -8.00, -8.50, -7.50, -7.35 dBm. Refer to *Figure 9* for description and results.

18) Thermal modifications:

Opened cover and added gray foam to the rectangular cutout in the deck near the rear panel. Blocked about 75% of the opening, couldn't block all of it because of fibers. Reinstalled cover. Using yellow tape blocked about 75% of the front panel air exhaust vents (tape was removed later).

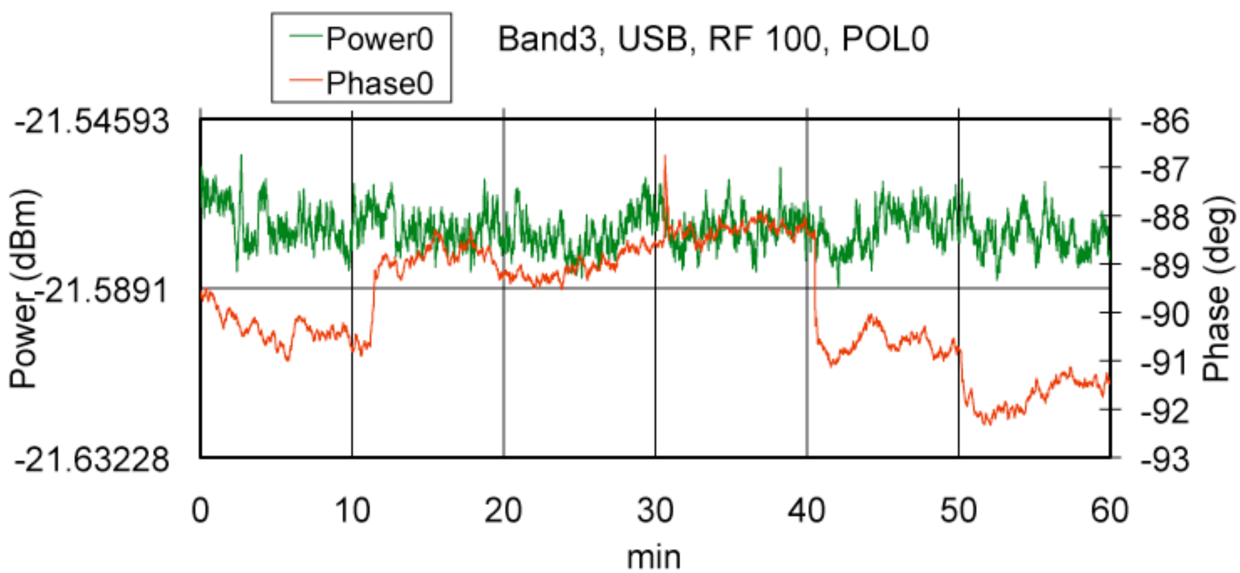

Figure 9 Adjusted IF input power -7.50, -8.00, -8.50, -7.50, -7.35 dBm for intervals 0-10, 10-30, 30-40, 40-50, and 50 to 60 minutes. Note discrete phase jumps at 10, 40, and 50 minutes, but no jump at 30 minutes. It appears that the MZM-LORTM phase was not sensitive to an input power change from -8.0 to -8.5 dBm.

19) Final run of today – AB-mode, 15 hours:

Conditions: Front panel exhaust vent partially blocked with yellow tape (~75% blocked), temperature of MZ2 increased as a result so we compensated by increasing TEC drive to 2.26V. Final MZ2 rest temperature is 19.6C. P_{IF} maintained at -8.5 dBm (nominal is -7.5 dBm). Unit took about 60 minutes to reach new thermal equilibrium after taping the exhaust vents. We are conducting this test in AB-mode. The previous test conducted in AB-mode (paragraph 10) had a non-trivial slow and fast IF power variation going into Ref2 of the MZM-LORTM.

Thursday July 28, 2011
Arrived FEIC 8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:30 PM

20) AB-mode results from overnight run:

Though we tried for an 800 minute run the program stopped collecting after 425 minutes (7.08 hours) which is still plenty of data. Refer to *Figure 10*. We still see a relatively heavy rising slope for a large fraction of the 7 hours. *Figure 11* provides a smaller time spans of 10 minutes. Note the fairly good peak-to-peak phase performance for the 60 minute and 10 minute time spans.

Allan Deviation plots for the entire duration, 278 to 425 minutes, and 278 to 354 minutes are provide in *Figure 12*. 10 second starting values are: 1.83, and 1.83 fsec, 300 second ending values are 5.73, and 5.46 fsec. All 3 have relatively good starting values but fail to meet the 5.0 fsec spec limit at 300 seconds.

Intermediate conclusions:

a) Blocking the front panel exhaust vents did not help (we will remove it later).
b) Performance is much improved over the paragraph 10 run, this is due to improved IF power stability.
c) Don't presently know the cause for the phase slope.
d) Don't presently know the cause for the periodic phase variation (*Figure 10*).

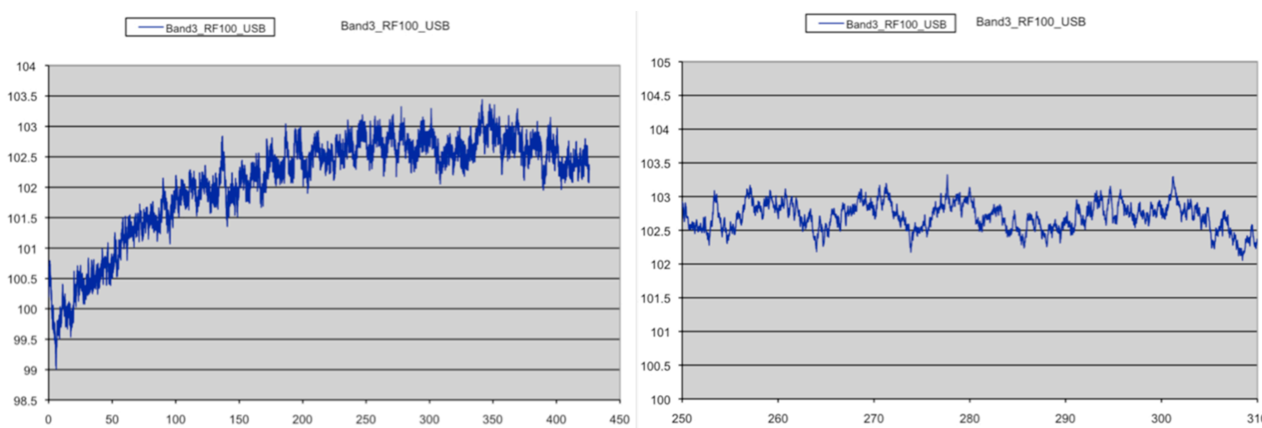

Figure 10 AB-mode overnight run. Note the increasing phase slope of 3.25 degrees over the first 250 minutes (4.17 hours). Right panel - span in view from 250 to 310 minutes. Peak-to-peak phase deviation for this 60 minute duration is 1.15 degrees. See about 5 cycles of phase movement → 12 minute period.

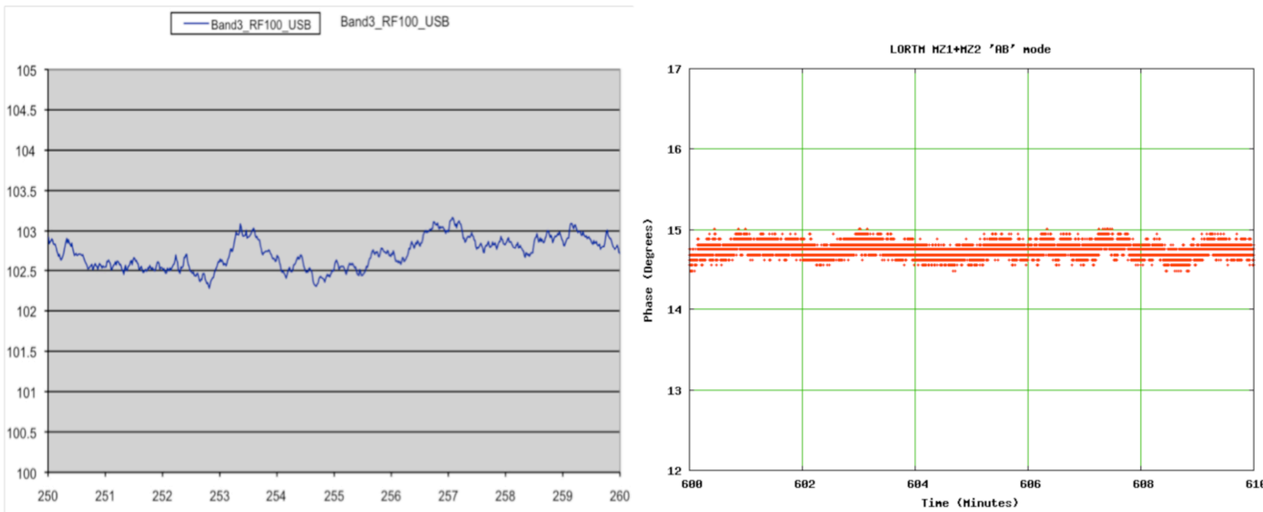

Figure 11 Left panel - AB-mode overnight run, span in view from 250 to 260 minutes. Peak-to-peak phase deviation for this 10 minute duration is 0.8 degrees peak-to-peak. Right panel – AB mode from Hilo tests over the same 10 second time interval produced ~0.4 degrees peak-to-peak.

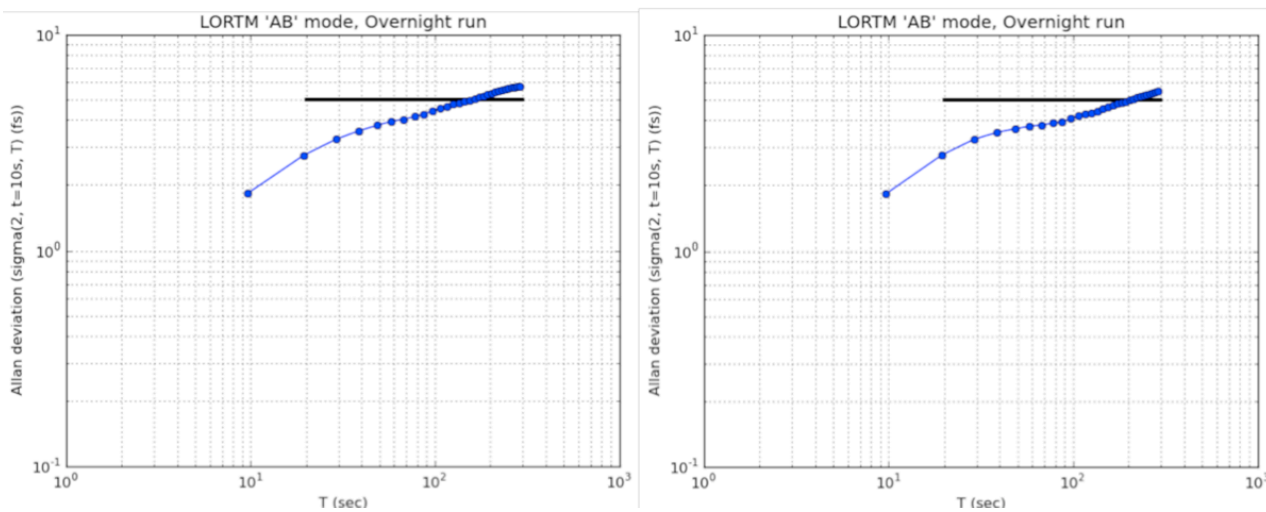

Figure 12 AB-mode overnight run, left panel - Allan Deviation plot from 278 to 425 minutes (147 minute duration), 1.83 and 5.73 fsec at 10 and 300 seconds, respectively. Right panel - plot from 278 to 354 minutes (76 minute duration), 1.83 and 5.46 fsec at 10 and 300 seconds, respectively. Note the same starting point at 1.83 fsec for both runs. The 300 second performance degrades slightly over the longer 147 minute duration).

21) Near term plans:

We are running out of time with phase stability and need to move on to the next set of tests. Suggest the following:

a) Remove tape from front panel and set TEC drive voltage back to original value (~19C for MZ2). *Done*
b) Mount MZM-LORTM onto tilt table. *Done*
c) Mount Kikusui bias source onto tilt table. *Done*
d) Baseline LORTM phase stability test. *Partial test complete, stopped to run MZM-LORTM overnight*

Other suggested lower priority tests:

e) Try phase stability test with U2T photomixer for a direct comparison to Hilo tests.

f) Try locking both WCA and signal source to "below reference" (historically we've locked to "above reference").

22) Verification of Ref1 input power:

Unfortunately could not locate a power sensor that goes up to our desired frequency of 26.492125 GHz (AB-mode, 100 & 106 GHz). In lieu of that I used the E4412A sensor (good to 18 GHz) to measure relative power at the E8257D synthesizer output vs. the output of the official black cable and measured a difference of 7.5 dB. The synthesizer was set to +15.0 dBm and if accurate would translate to our desired RF input power level of +7.5 dBm. The MZM-LORTM is not very sensitive to Ref1 input power.

23) Baseline test with TeraXion LORTM (power on at 12:15PM, start setup at 1:15PM):

100 / 106 GHz, locked both WCA and signal source to "below reference". Conditions:

Ref1 synthesizer set to 14.736430 GHz @ +17.0 dBm
Ref2 synthesizer set to 6.000 GHz @ +15.0 dBm (this never changes)
Kikusui PIN control set to 4.918V (pads at end of cable removed)

So far after 100 minutes the phase stability looks relatively poor with 2 cycles of a "V" shaped variation of ~4 degrees peak-to-peak. Stopped run to investigate. It appears that the TeraXion LORTM just needed more time to stabilize after power on. Behavior appears much better now at 4:30PM but part of this may be because Stick and Eddie changed the VNA resolution from 10 Hz to 1 Hz. This seems to improve or reduce the overall peak-to-peak phase performance and is acceptable for ORR tests (but not PAI tests).

24) Re-bias of MZ1 and MZ2:

In the event that the TeraXion LORTM test may be extend overnight, started reconditioning of MZ1 and MZ2 devices within the MZM-LORTM. We planned to complete this in Hilo prior to shipment but ran out of time. Historical note – the MZ devices normally require 0V to operate in full-bias mode and 5.0V for null-bias mode. Ports A & B are operated in null-bias while port C is operated in full-bias mode. The required voltage to maintain null-bias mode will drift very slowly with time so we need to periodically recondition it to set it back to 5.0V (otherwise the table values will be incorrect).

Re-bias terminated at ~5:00PM for another MZM-LORTM overnight run.

25) Setup MZM-LORTM for another overnight run:

Normal-mode, 100 / 106 GHz, locked both WCA and signal source to "above reference". VNA set to 1 Hz resolution BW, programmed to collect 100 minutes of the most recent data (can't collect more than 100 minutes with this RBW). Conditions:

Ref1 synthesizer set to 25.742125 GHz @ +15.0 dBm → +7.5 dBm at unit J5 input
Ref2 synthesizer set to 6.000 GHz @ +15.0 dBm (this never changes)
Kikusui PIN control set to 2.0160V with 10 + 9 dB pad at end of cable → -7.50 dBm at unit J6 input
J1 = Band 3 WCA, J2 = Band 7 signal source

Friday July 29, 2011
Arrived FEIC 8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:50 PM

26) Results from over night MZM-LORTM run with 1 Hz RBW:

The last 100 minutes of the VNA was captured at ~8:50AM, refer to *Figure 13* for phase plot and overnight temperature plots. Note the position of the markers on both traces where we went into the chamber to save the VNA data. See an absolute peak-to-peak of 1.2 degrees phase over entire 100 minutes. *Figure 14* provides closer spanned in views for 60 and 10 minutes.

Allan Deviation performance is shown in *Figure 15* for both 100 and 30 minute durations. The MZM-LORTM fails the 5 fsec spec for both, though is very close for the latter shorter time interval. The 30 minute interval performance shows a performance of 2.4, 5.0, and 4.9 fsec at 10, 210, and 300 seconds, respectively. As a comparison, our best Normal-mode run in Hilo was 2.4, 4.0, and 3.3 fsec for 10, 100, and 300 seconds, respectively. Exactly the same starting 10 second starting values.

The main difference between the tests in Hilo and FEIC is that in Hilo we were using a low frequency U2T photomixer to detect the 6 GHz optical difference LSB2 – LSB1. At FEIC we are detecting the overall difference of USB – LSB1 which locks to the signal source, and USB – LSB2 which locks to the WCA. The difference between the signal source and WCA, USB – LSB1 – (USB – LSB2) = LSB2 – LSB1, produces the desired 6 GHz tone. It makes logical sense that going through both the WCA and signal source should add more phase perturbations (more fiber and hardware). The question is "is it reasonable to expect an additional 1 to 2 fsec?

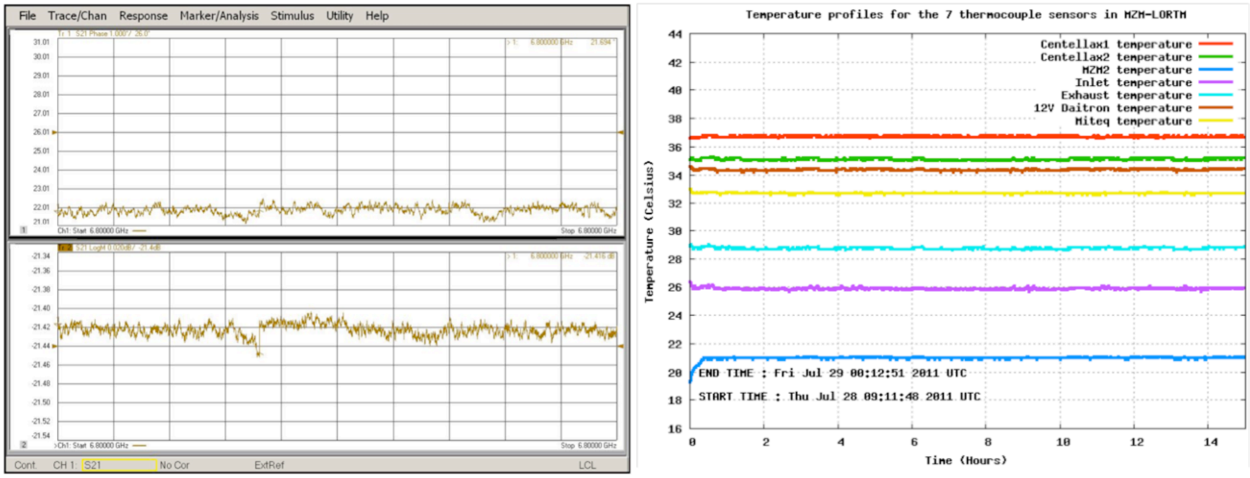

Figure 13 MZM-LORTM normal-mode run, VNA at 1 Hz RBW. Left panel - 100 minutes phase data, note glitch at ~37 minutes when chamber door was opened (VNA continuous sweep in loop fashion). Right panel - internal MZM-LORTM temperatures, note that we changed the TEC drive from 2.114V to 1.914V at the very beginning of the run.

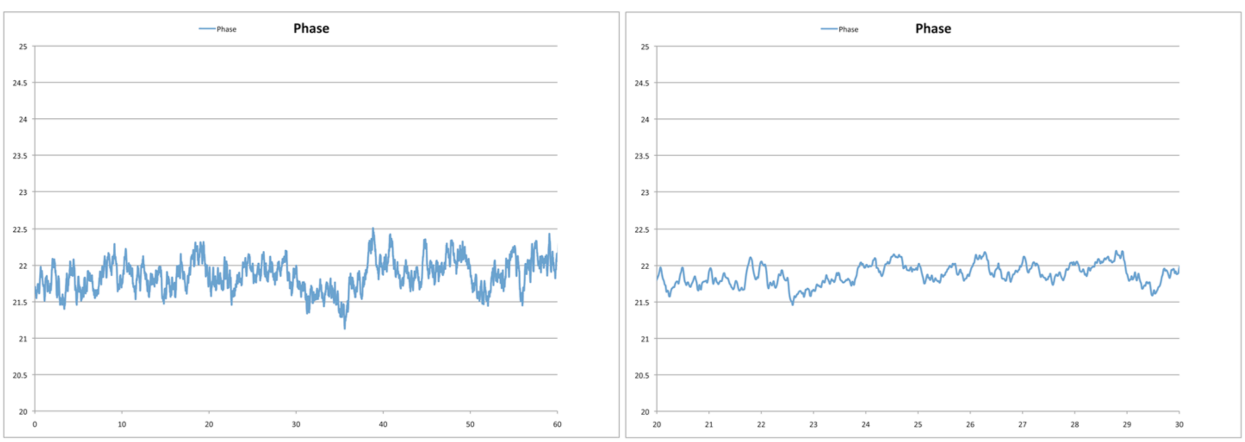

Figure 14 Left – 0 to 60 minute view, right – 20 to 30 minute view of phase.

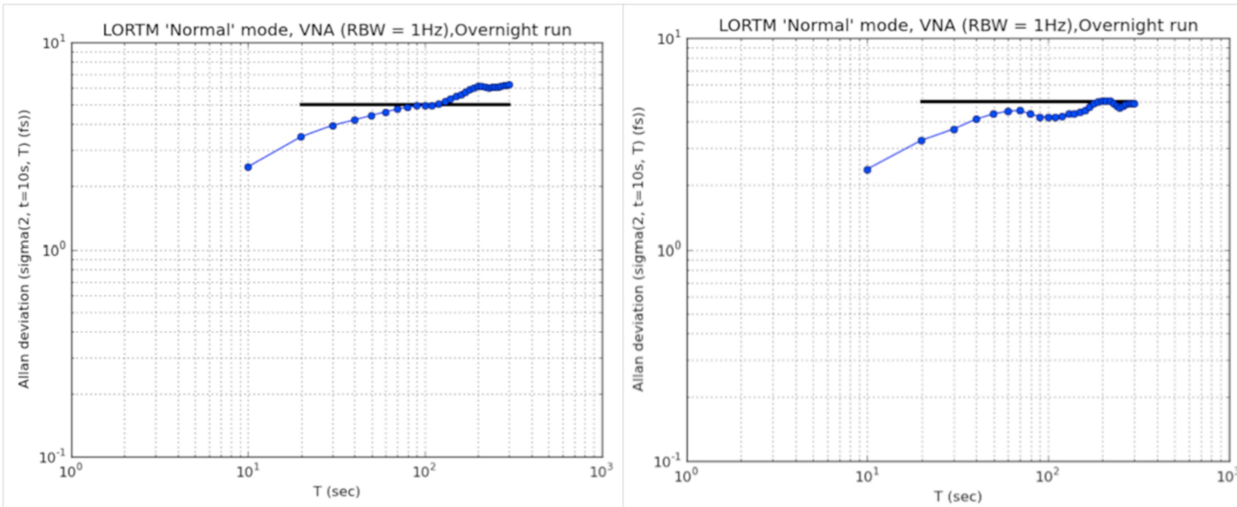

Figure 15 Left - Allan Deviation performed over entire 100 minute run, 2.48 and 6.25 fsec for 10 and 300 seconds, respectively. Right panel - Allan Deviation performed over initial 30 minutes, 2.38 and 4.89 fsec for 10 and 300 seconds, respectively. The data crosses over the spec line at 210 seconds with a value 5.03 fsec. This run is very close to passing spec.

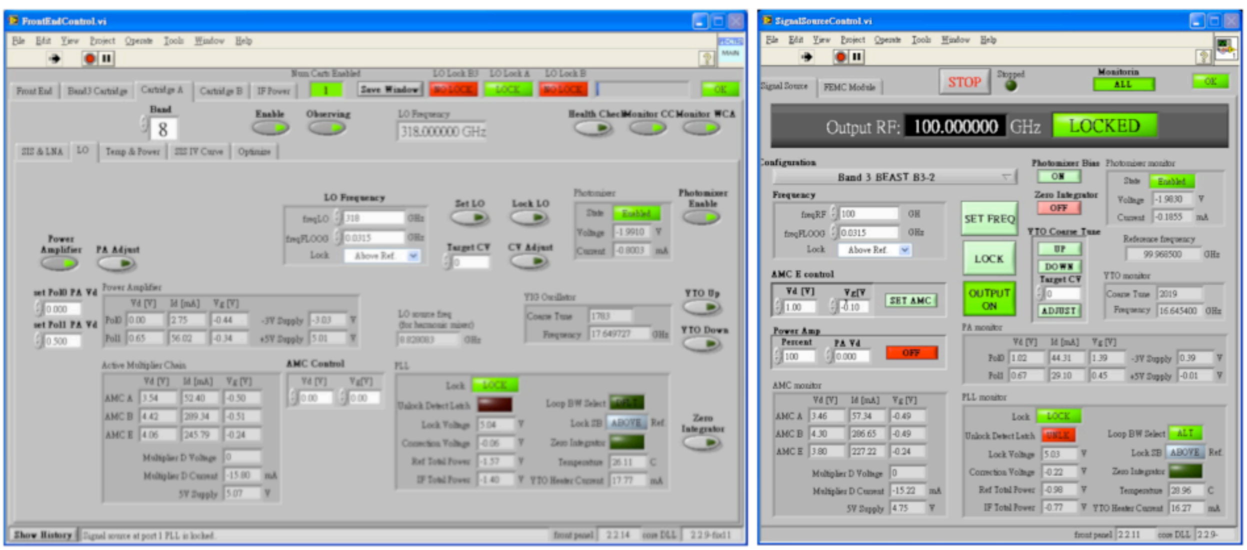

Figure 16 Control windows for FrontEndControl (WCA) and SignalSouceControl (signal source) windows.

27) Installed MZM-LORTM onto chamber 2 tilt table:

Also tied down the Kikusui DC bias source but found out that we will move to chamber 1 this afternoon so did not spend time tying down the harnesses. Performing a phase stability run with the unit on the table. Observed the temperature sensors have dropped by ~2.7C with the MZM-LORTM oriented in the vertical direction (front panel facing the sky).

	Horizontal	Vertical	Delta
Centellax1 RF power amp	38.6	36.0	-2.6
Centellax2 RF power amp	37.1	34.5	-2.6
MZ2 (TE cooled)	19.5	20.2	adjusted TEC
Intake vent	28.7	25.2	-2.5
Exhaust vent	31.4	28.2	-3.2
Daitron +15V supply	36.6	33.8	-2.8
Miteq IF power amp	34.9	32.0	-2.9

28) Results with the MZM-LORTM mounted on chamber 2 tilt table, 0 degrees:

Refer to *Figure 17*. After mounting and powering on the MZM-LORTM, we waited about 100 minutes for the phase and amplitude to settle down. Then at 110 minutes (10 minutes on the graph) we decreased MZ2-C commanded bias voltage from 6.100V to 6.000V. At 30 minutes (on the graph) we changed the bias from 6.000V to 5.900V. And finally at 40 minutes we returned the bias back to 6.000V and ran for 60 minutes.

Allan Deviation for the 40 to 70 minute section is 1.69 and 5.51 fsec for 10 and 300 seconds, respectively. And for the 40 to 100 minute duration is 1.72 and 5.87 fsec for 10 and 300 seconds, respectively. Refer to *Figure 19*. With such a good 10 second starting point of 1.7 fsec it may have been possible to achieve good 300 second performance had we waited a few more hours for the system to stabilize after mounting to the tilt table. Particularly since this is the first time we have operated the MZM-LORTM in a vertical position.

A decision was made to move the MZM-LORTM tests to chamber 1 so that chamber 2 could continue with FE tests. We began dismantling the hardware at ~3PM.

29) Chamber 1 tests:

We are adhering to our initial plan of re-biasing MZ1 and MZ2 over the weekend. In the meantime a baseline phase stability test is being run over the weekend using the TeraXion LORTM (still mounted on the tilt table). The test plate has been moved from chamber 2 and mounted to the tilt table in preparation for workmanship tests on Monday morning.

30) Plans for Monday:

- Analyze weekend long run of baseline TeraXion LORTM phase performance (using NRAO's good unit – will eventually be shipped back).
- Mount MZM-LORTM onto chamber 2 tilt table. Done
- Workmanship ORR test. Delayed until Tuesday
- LabView software installation. Delayed until Tuesday
- Overnight phase stability test. 60 degree done

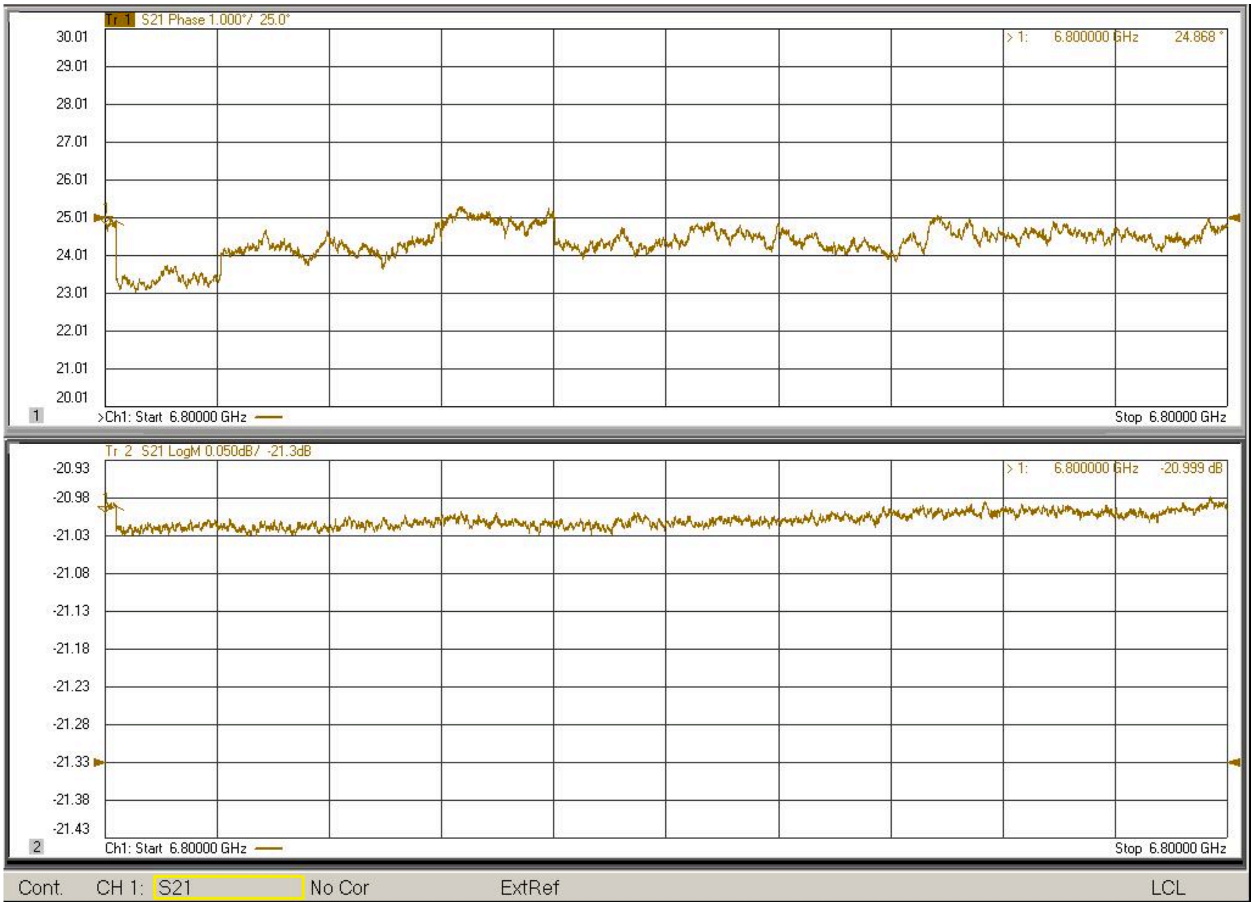

Figure 17 100 minute run with MZM-LORTM mounted on chamber 2 tilt table. During this run we made changes to MZ2-C bias at 10 minutes (obvious upward step in phase), at 30 minutes (less obvious), and finally at 40 minutes (obvious downward step in phase).

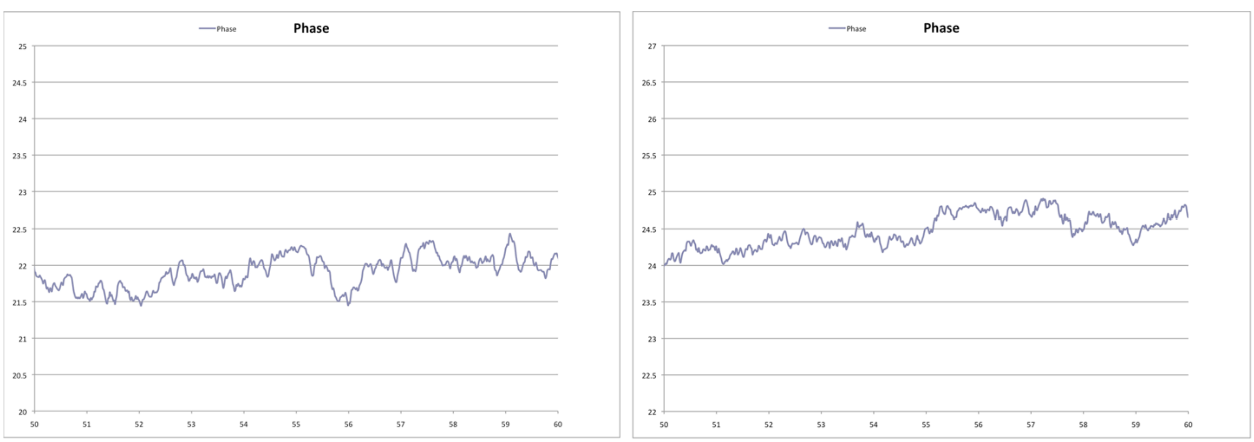

Figure 18 Comparison of 50 to 60 minute intervals for before and after MZ2-C DC bias change. Left panel is for MZM-LORTM sitting on cart, right panel is for MZM-LORTM installed onto tilt table & after MZ2-C DC bias change.

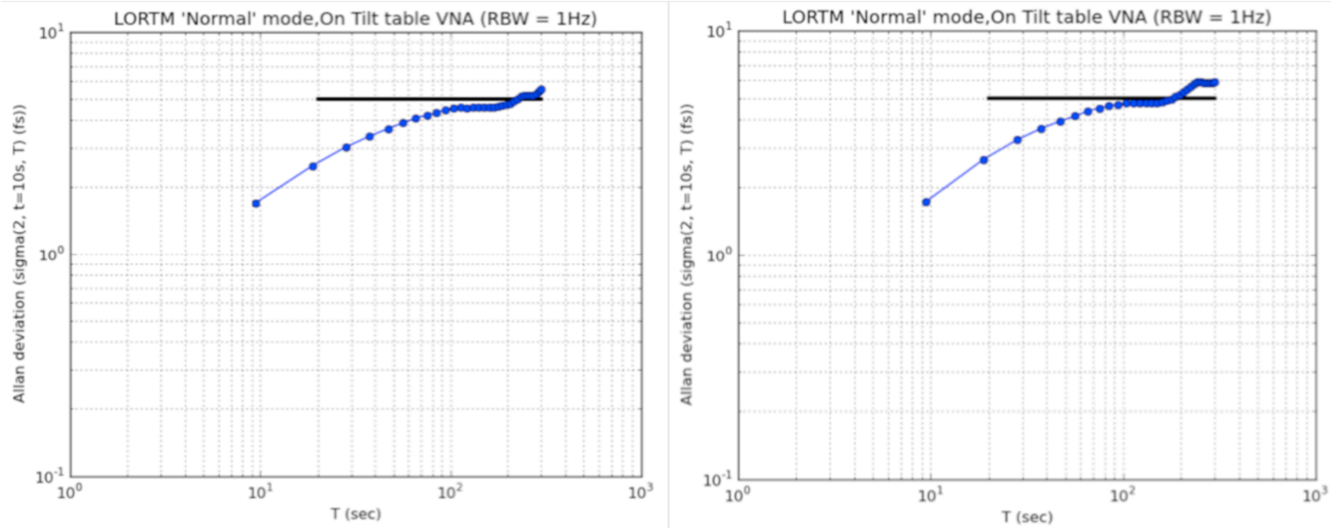

Figure 19 *100 minute run with MZM-LORTM mounted on chamber 2 tilt table.* Left panel - Allan Deviation for the 40 to 70 minute section is 1.69 and 5.51 fsec for 10 and 300 seconds, respectively. *Note the fairly good 1.7 fsec starting point after changing MZ2-C DC bias. Right panel* - Allan Deviation calculated for the 40 to 100 minute section is 1.72 and 5.87 fsec for 10 and 300 seconds, respectively. *Note for this 60 minute duration the starting point remains low at 1.7 fsec, however, the ending point increased due to the inclusion of larger slow moving phase fluctuations*

Monday August 1, 2011
Arrived FEIC 8:35 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:05 PM

31) Weekend run with TeraXion LORTM, S/N 005 (good one borrowed from NRAO):

The VNA was set for 1 Hz resolution BW and to collect the last 100 minutes of data (overwrites previous data). Both phase and Allan Deviation look good, refer to *Figure 20*. Peak-to-peak phase for the 100 minutes is 0.6 degrees. Allan Deviation 1.2 and 3.7 fsec and 100 and 300 seconds, respectively. Note that S/N 005 will be returned to to NRAO on August 26, 2011.

32) Weekend re-bias results:

Will need to continue re-biasing overnight for several more nights (or another weekend).

33) MZM-LORTM onto chamber 1 tilt table:

Ran into a problem with Agilent E8257D Ref1 synthesizer, its option supports only up to 20.0 GHz. Swapped out with the Ref2 synthesizer from chamber 2 (maximum required frequency for Ref2 is </= 20 GHz). Conditions:

Ref1 synthesizer set to 25.742125 GHz @ +14.04 dBm → +7.50 dBm at unit J5 input
Ref2 synthesizer set to 6.000 GHz @ +15.0 dBm (this never changes)
Kikusui PIN control set to 3.2294V with 8 + 9 dB pad at end of cable → -7.49 dBm at unit J6 input
J1 = Band 7 signal source, J2 = WCA

Physical orientation of MZM-LORTM is such that when cryostat is pointed toward zenith (defined as 90 degrees) the MZM-LORTM is upside down (bottom cover facing sky)… we will fix this at the end of today. Also should note that the 3.0 GHz Ref2 spectrum has spurs about the carrier at spacings of: +/-50 MHz @ -20 dBc); +/-100 MHz @ -25 dBc), and +/-150 MHz @ -32 dBc. We did not see these spurs in chamber 2.

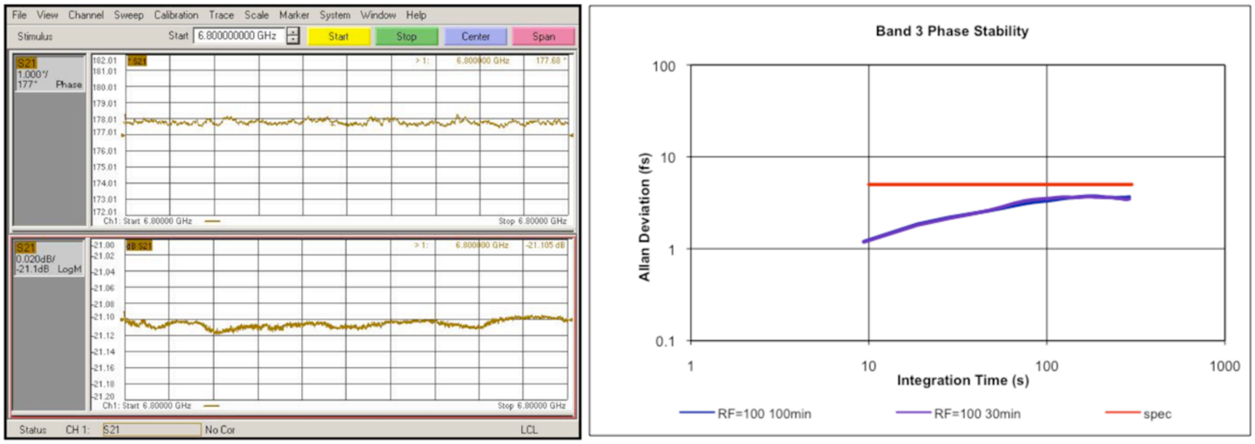

Figure 20 100 minute run with TeraXion LORTM mounted on chamber 1 tilt table, 0 degree. This test was started on Friday night and ran continuously over the weekend. Plot above represents last 100 minutes of captured data (1 Hz RBW). Peak-to-peak phase is 0.6 degrees over the entire 100 minute data set. Allan Deviation performance is 1.2 and 3.7 fsec for 100 and 300 seconds, respectively.

34) MZM-LORTM DC bias tests in chamber 1:

Started initial bias tests around 10:30A. MZM-LORTM temperatures took ~1 hour to reach equilibrium temperature after connecting Ref1 and Ref2 signal inputs. Made a change to MZ2-A from +8.2V to +8.6V. Note the ideal relationship between "setting X" and "read back Y" is Y = 2*x – 10V.

	Initial stock setting			Fine adjusted setting		
	A	B	C	A	B	C
MZ1 setting	+5.000	+5.000	+5.600V		no change	
Read back	-0.084	0.000	+1.163			
MZ2 setting	+8.200	+6.400	+6.000V	+8.600	+6.400	+6.000V
Read back	+6.453	+2.856	+2.074			

35) Internal MZM-LORTM temperatures after connection of RF & IF (~10:20AM):

MZM-LORTM in vertical position (tilt table angle 0 degrees) with front panel pointing toward sky. Temperatures are very stable WRTo time in chamber 1.

	11:20AM	1:20PM	2:15PM
Centellax1 Amp	35.9	35.8	35.8C
Centellax2 Amp	34.2	34.2	34.2
MZ2 (TE cooled)*	19.7	19.7	19.7
Intake Vent	25.4	25.3	25.4
Exhaust Vent	28.0	28.0	28.0
Daitron +24V	33.6	33.5	33.5
Miteq Amp	31.8	31.8	31.8

*TEC driver set to 1.914V

36) MZM-LORTM 100 minute run, chamber 1, tilt table at 0 degree:

Test started at 1:30PM and ended at 3:10PM. *Figure 21* represent the phase and Allan Deviation. Results look quite good, 1.5 and 3.1 fsec for 10 and 300 seconds, respectively, for the full 100 minute data set. These results are comparable to the TeraXion LORTM (S/N 005) results of 1.2 and 3.7 fsec for 10 and 300 seconds.

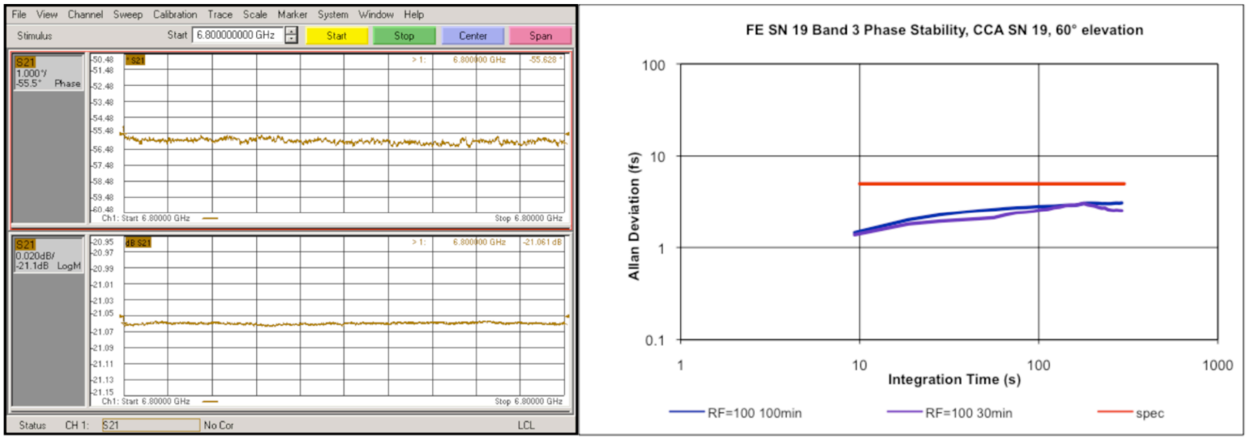

Figure 21 Phase and amplitude stability for MZM-LORTM, chamber 1 tilt table, 0 degrees. Right panel - purple trace represents the first 30 minutes of data, 1.4 and 2.5 fsec for 10 and 300 seconds, respectively. Blue trace represents the full 100 minute data, 1.5 and 3.1 fsec for 10 and 300 seconds, respectively.

37) Remounted MZM-LORTM such that at 90 degrees tilt table angle the unit sits right side up:

This orientation provides more predictable thermal properties (all of our tests in Hilo was with the LORTM in the right side up position (90 degree tilt table angle). In paragraph 28 we found that the MZM-LORTM cooling improves or lowers by ~2.7C when operated in the vertical as opposed to the horizontal right side up position.

38) MZM-LORTM 100 minute looped run, chamber 1, tilt table at 60 degree:

Will run this configuration overnight.

39) Plans for Tuesday, August 2:

- Analyze 60 degree tilt table phase stability data. Failed
- Without opening the chamber or changing the tilt angle, change MZ2-A bias from 6.8V to 6.2V. No difference
- Workmanship tests (0, 90, 0, 90 degrees… tilt vs. phase). Completed
- Install LabView software for lock tests (~4 hours). Delayed until next week (see paragraph 42)
- Overnight 90 degree tilt table phase stability test. Completed (but marginal performance)

Tuesday August 2, 2011
Arrived FEIC 8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 6:00 PM

40) Results - MZM-LORTM 100 minute looped run, chamber 1, tilt table at 60 degree:

Refer to *Figure 22*. Allan Deviation for this run failed with 1.9 and 5.5 fsec for 10 and 300 seconds, respectively. Why would the unit pass 0 degree and fail 60 degrees? The unit was originally mounted on the tilt table upside down (doesn't matter for 0 degree position) and we removed and replaced it in the correct position for the 60 degree run.

Checked DC biases to MZs, RF and IF connections to MZM-LORTM - OK. Noticed the fibers to the MZM-LORTM were stressed so re-taped to remove tension. Interestingly just performing this re-taping of fibers produced 6 degrees peak-to-peak phase movement. Phase is indeed extremely sensitive to the physical fiber position.

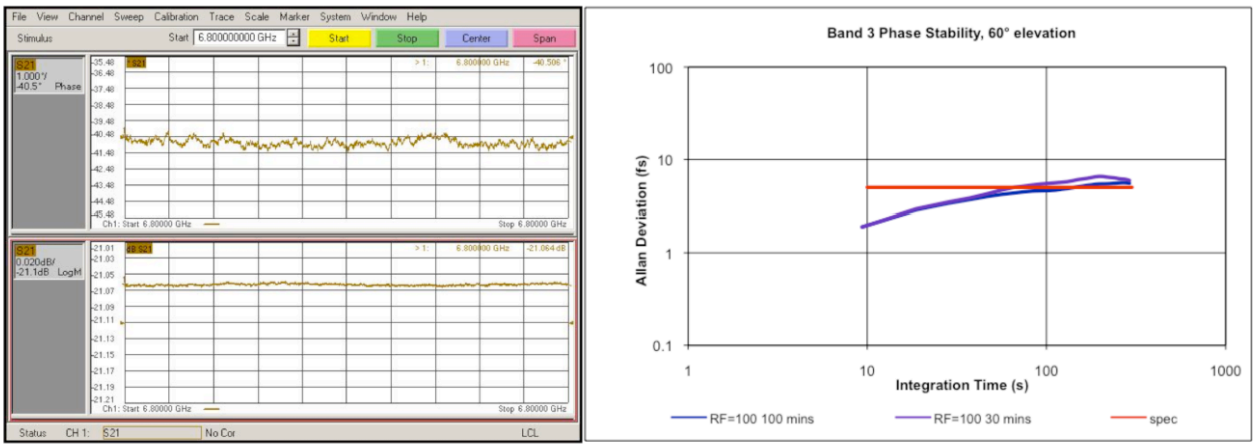

Figure 22 Left panel - phase and amplitude stability for MZM-LORTM, chamber 1 tilt table, 60 degrees. Note this performance is not as nearly good as the 0 degree tilt table angle. Should also note that we removed and replaced the MZM-LORTM between these 2 runs to flip the unit over so that the top cover faces the ceiling when at 90 degrees tilt table angle. Right panel - purple trace represents the first 30 minutes of data, 1.9 and 5.9 fsec for 10 and 300 seconds, respectively. Blue trace represents the full 100 minute data, 1.9 and 5.5 fsec for 10 and 300 seconds, respectively. Both starting and ending point performances have degraded at this 60 degree tilt table angle.

41) Returned back to 0 degree tilt table angle (11:00AM):

The phase stability for 90 degrees appeared poor so returned to 0 degree tilt table angle to see if yesterday's performance could be repeated. The phase dropped monotonically (exponential shape) ~5 degrees over 60 minutes. This phase movement is likely from the combined effect of the test plate, interconnect fibers, IF Extra Plate, and MZM-LORTM. Different physical orientations change the temperature of active devices and gravity vector on the fibers.

Performance at 0 degree tilt table angle is 1.6 and 3.0 fsec for 10 and 300 seconds, respectively. The performance from yesterday was 1.5 and 3.1 fsec, very close. The intermediate conclusion is that the performance of the MZM-LORTM is worse at a tilt table angle of 60 degrees (MZM-LORTM angle of 30 degrees WRTo horizontal, front panel higher than rear panel).

42) Schedule re-planning:

Had a short meeting with Eddie. They are planning to warm-up FE #14 in chamber 1 on Friday to replace the Band 6 cartridge. Eddie suggested that we spend the remaining portion of this week completing the 60 and 90 degree phase stability measurements and workmanship (3 more tests). Then on Friday we can try a Beam Pattern measurement though FE #14 prior to warming up.

This new schedule change pushes the LabView installation and lock tests out until next week.

43) Workmanship test:

Began workmanship test at ~1:20PM. We were sitting at 0 degree tilt table since 11:00AM so the LORTM unit reached thermal equilibrium for this angle. The tilt cycle starts at 0 degrees and moves to 90 degrees, stays at 1 minute on each angle and 0.5 minutes to transition. Our initial run failed because we had a nontrivial amount of upward slope after 5 cycles. We decided to sit at 45 degrees for 40 minutes to allow the MZM-LORTM reach thermal equilibrium prior to performing a second run. Refer to *Figures 23 and 24*.

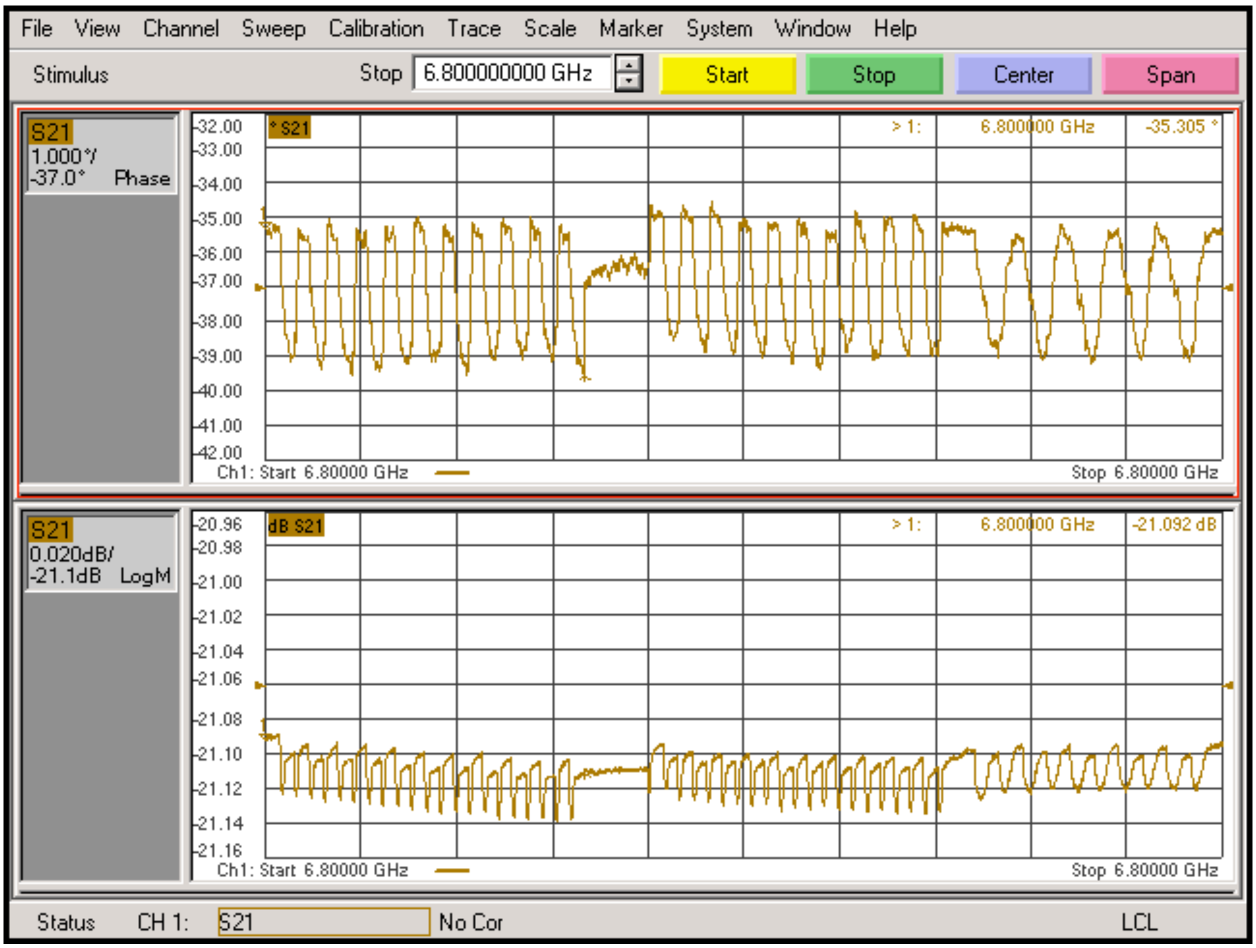

Figure 23 Workmanship test raw data. The tilt table was moved between 0 to 90 degrees while monitoring phase & amplitude. Each of the 2 angles were held constant for a period of 1 minute. Slew time between angles was 0.5 minutes for a total period of 2.5 minutes. Total time is 100 minutes (10 minutes per division). At 70 minutes the period was increase from 2.5 minutes to 5 minutes per cycle (old version of ORR workmanship test).

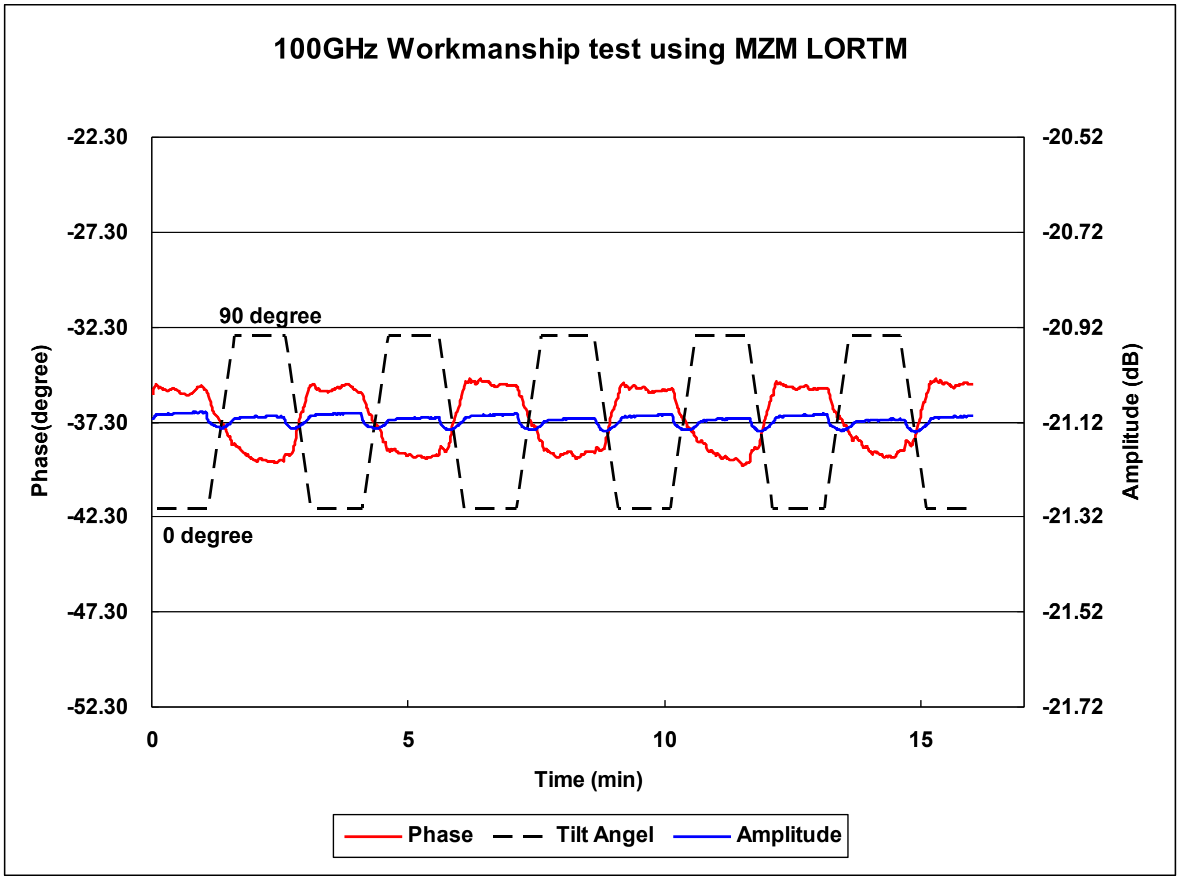

Figure 24 Workmanship test, post processed data.

44) Evaluation of phase stability vs tilt table angle:

While sitting at the 45 degree angle we observed the phase to be worse than at the 0 degree angle. Is this difference caused by thermal changes within the LORTM? We don't believe this to be the case based on yesterday's temperature data at 0 and 60 degrees tilt table angles:

	11:20A (0)	1:20P (0)	**2:15P (0)**	3:40P (60)	**4:05P (60 tilt)**
Centellax1 Amp	35.9	35.8	**35.8**	36.1	**35.9**
Centellax2 Amp	34.2	34.2	**34.2**	34.3	**34.1**
MZ2 (TE cooled)*	19.7	19.7	**19.7**	19.9	**19.8**
Intake Vent	25.4	25.3	**25.4**	25.3	**25.2**
Exhaust Vent	28.0	28.0	**28.0**	28.1	**27.9**
Daitron +24V	33.6	33.5	**33.5**	33.5	**33.4**
Miteq Amp	31.8	31.8	**31.8**	31.8	**31.6**

The temperatures within the LORTM are quite stable and independent of tilt angle (inconsistent with paragraph 27). If temperature is not the cause what could be the cause of the worse phase stability at higher tilt table angles? Check the following:

- MZ2-B bias, MZ1-C bias (the only 2 we have not changed)
- 6 GHz IF cable to from test plate to VNA
- IF signal fidelity and power at 90 degrees
- RF signal power at 90 degrees
- Phase stability vs MZ2 temperature (change TEC drive)

45) Possible explanation for poor phase performance at large tilt angles:

At 0 degree tilt table angle the MZM-LORTM (and IF Extra Plate, Agilent E8257D) rear panel faces the ground. The rear panel has 2 air intake vents that draw in ambient air and exhaust through the front panel. Our performance at 0 degree tilt meets spec with margin.

At 60 and 90 degrees the rear panel becomes elevated and faces toward the rear wall of the chamber at a height of ~3 meters from the ground. At this height there is a lot of cold air turbulence from the air conditioning system prior to mixing with the chamber air. It is essentially "windy" in the vicinity of the LORTM air intake at 60 and 90 degrees tilt. In Hilo we attempted to mix the air up in the vicinity of the rear panel (to overcome AC cycling effects) by using a large floor fan, however, doing so resulted in poor phase stability performance. The MZM-LORTM has a phase to temperature coefficient of ~5 degrees phase per degree C. A 0.1 C fluctuation in temperature will produce an additional 0.5 degree peak-to-peak fluctuation in phase, enough to push the performance over the spec requirement.

46) Overnight run at tilt table angle of 90 degrees, 100/106 GHz test plate:

We attempted to block some of the turbulent air using foam and bubble wrap around the rear of the tilt table equipment rack. It took several hours for the equipment to reach a new equilibrium temperature. Currently running a 100 minute overnight loop test.

Wed August 3, 2011
Arrived FEIC 8:35 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:20 PM

47) Results of overnight 90 degrees tilt table test using 100/106 GHz test plate:

Refer to Figure 25. *For the first 30 minutes of data we see 2.3 and 4.0 fsec for 10 and 300 seconds, respectively. The full 100 minute data produces 2.3 and 4.6 fsec for 10 and 300 seconds, respectively. We pass the 5 fsec spec limit.*

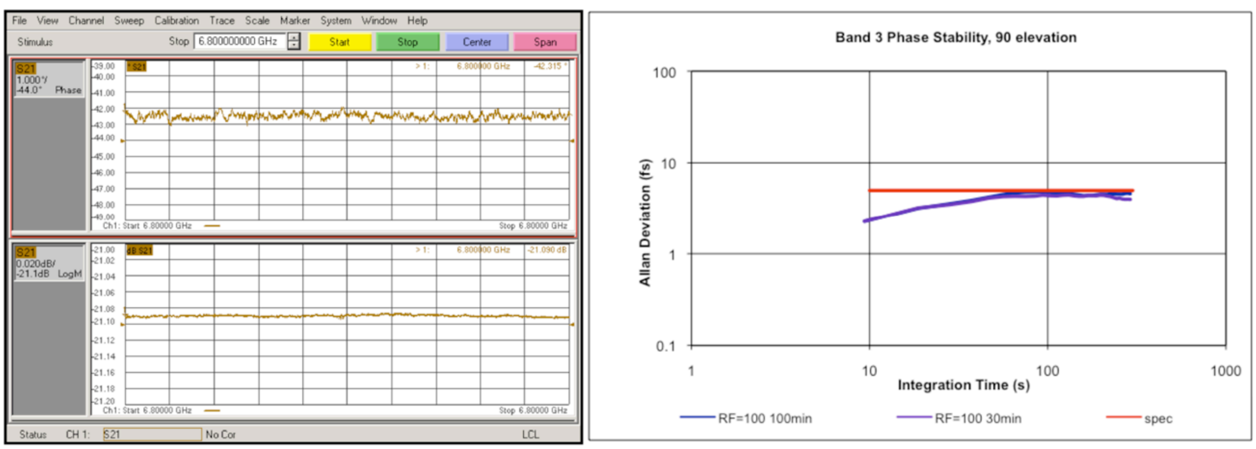

Figure 25 Phase and amplitude stability for MZM-LORTM, chamber 1 tilt table, 90 degrees. Note for this run we added bubble wrap and foam to insulate the rear portion of the equipment rack on the tilt table. Doing so required several hours for the equipment to reach thermal equilibrium, however, likely improved the phase stability performance. Right panel - Allan Deviation for MZM-LORTM, chamber 1 tilt table, 90 degrees. Purple trace represents the first 30 minutes of data, results are 2.3 and 4.0 fsec for 10 and 300 seconds, respectively. Blue trace represents the full 100 minute data, 2.3 and 4.6 fsec for 10 and 300 seconds, respectively. Both sets meet spec.

48) Ducting of MZM-LORTM intake vents:

Used aluminum dryer duct to draw the MZM-LORTM intake vents from a location about 1 meter below the unit. Refer to *Figures 26*. At a tilt table angle of 60 degrees we watched the phase and began to notice periodic phase fluctuations, ~0.5 degrees peak-to-peak, ~2.5 minutes per cycle.

The MZM-LORTM intake vents are now relocated to draw air in from the bottom of the tilt table and, therefore, we believe the remaining phase fluctuation is caused by either the Extra IF Plate or the Agilent E8257D Ref1 synthesizer (rack order from top: DC power supply & RF switch controller, IF Extra Plate, Agilent E8257D, MZM-LORTM). Assuming that the baseline LORTM performs within spec for tilt table angles of 60 and 90 degrees, it is unlikely that the E8257D Ref1 is changing phase WRTo temperature. This leaves the IF Extra plate which may be changing IF power as a function of air temperature variations. The MZM-LORTM has a phase to IF power sensitivity of 32 degrees per 1 dB. A 0.02 dBpp change in IF power would translate to 0.64 degrees phase.

49) Eddie's suggestion for solving temperature fluctuation issues:

Chamber 2 is physically a larger than chamber 1 and, furthermore, has the ability to redirect the air conditioned air (away from the tilt table rack that houses the MZM-LORTM and associated equipment). Good suggestion – alleviates us from having to come up with a thermal solution… if it works. The downside is that we will have to spend ½ day to move and stabilize the hardware. We may move over to chamber 2 next week.

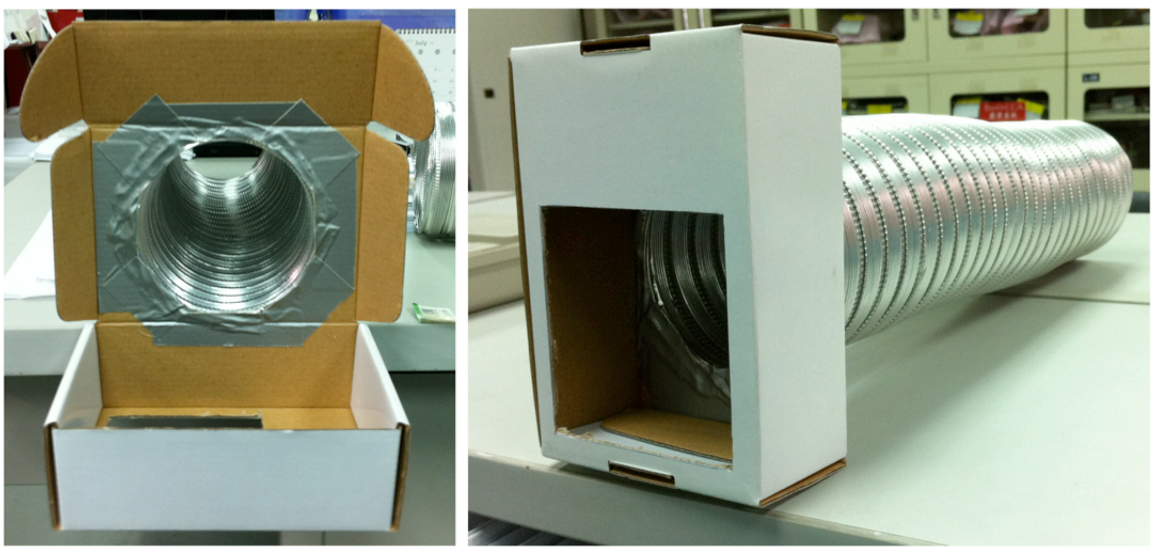

Figure 26 One of two air intake ducts for the MZM-LORTM. These ducts allow the MZM-LORTM unit to draw cool air into the unit from about 1 meter above the floor while at a tilt table angle of 90 degrees. Adding these 2 ducted intakes did not seem to appreciably help the phase stability performance.

50) Re-run of 60 degree tilt table angle, 100/106 GHz test plate:

With ducting installed onto the MZM-LORTM and additional bubble wrap and foam placed around the rear of the tilt table rack, we re-ran the 90 degree tilt table case once again and passed this time. This time we passed the spec limit, but only by a small margin. Refer to *Figure 27*.

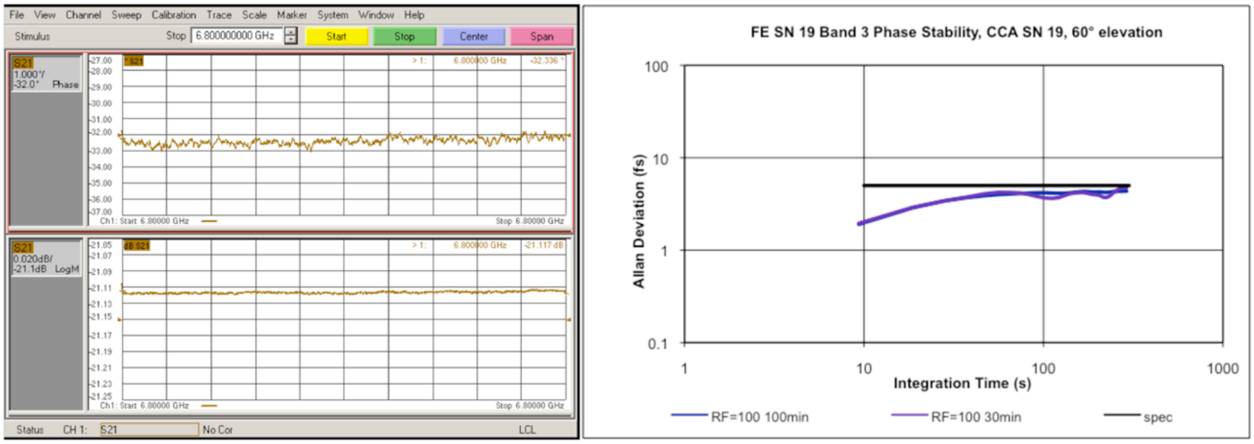

Figure 27 Rerun of phase and amplitude stability for MZM-LORTM with insulation at rear of tilt rack, 100/106 GHz test plate, chamber 1 tilt table, 60 degrees. Right panel - Allan Deviation, purple trace represents the first 30 minutes of data, 2.0 and 4.8 fsec for 10 and 300 seconds, respectively. Blue trace represents the full 100 minute data, 1.9 and 4.4 fsec for 10 and 300 seconds, respectively. Both sets meet spec.

51) Setup for Band 9 phase stability test:

Remove test plate from tilt table, install Band 9 signal source. Tilt table at 60 degree elevation, LO = 622, 670, and 694 GHz, RF = 628, 676, and 700 GHz.

Overnight run will be at 670 and 676 GHz. Locked Band 9 LO and signal source 4:40PM. Adjusted signal source polarization to 45 degrees to achieve equal power on both pols. MZ2 temperature rose to 24C so turned up TEC voltage to 2.425V which pushed the MZ2 temperature down to ~21C.

Ref1 synthesizer set to 18.686569444 GHz @ +14.0 dBm → x dBm at unit J5 input
Ref2 synthesizer set to 6.000 GHz @ +15.0 dBm (this never changes)
Kikusui PIN control set to 3.2970V with 9 + 8 dB pad at end of cable → -7.50 dBm at unit J6 input & stable
J1 = signal source, J2 = Band 9 FE
TEC = 2.425V (MZ2 ~ 21C)

Thursday August 4, 2011
Arrived FEIC ~8:35 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:15 PM

52) Band 9 phase stability test results, chamber 1, 60 degree tilt, 670/676 GHz:

Refer to Figure 28. *Results for pol 0 are 2.1 and 5.3 fsecs for 10 and 300 seconds, respectively. Results for pol 1 are 2.0 and 5.4 fsecs, for 10 and 300 seconds, respectively. Spec limit is 10 fsecs, we pass with plenty of margin.*

Ref1 synthesizer set to 18.686569444 GHz @ +14.0 dBm → x dBm at unit J5 input

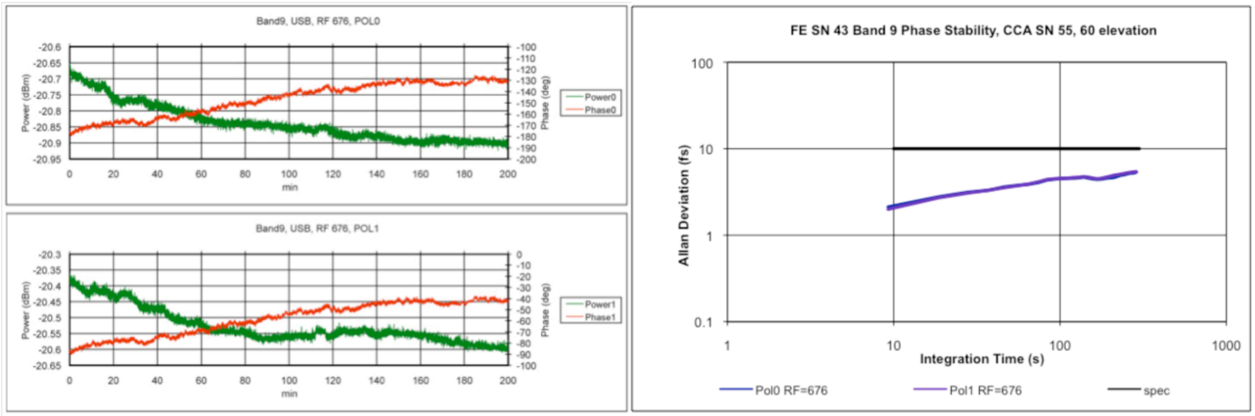

Figure 28 Phase and amplitude stability for MZM-LORTM, Band 9, 670/676 GHz, chamber 1 tilt table, 60 degrees. Allan Deviation Pol 0 → 2.1 and 5.3 fsecs for 10 and 300 seconds, respectively. Pol 1 → 2.0 and 5.4 fsecs, for 10 and 300 seconds, respectively. Spec limit is 10 fsecs.

53) Band 9 phase stability test results, chamber 1, 60 degree tilt, 622/628 GHz:

Refer to Figure 29. Results for pol 0 are 2.1 and 5.3 fsecs for 10 and 300 seconds, respectively. Results for pol 1 are 2.0 and 5.4 fsecs, for 10 and 300 seconds, respectively. Spec limit is 10 fsecs, we pass with plenty of margin. Figure 30 provides a sample control window for controlling both the FE LO and signal source.

Ref1 synthesizer set to 17.353236111 GHz @ +14.0 dBm → x dBm at unit J5 input

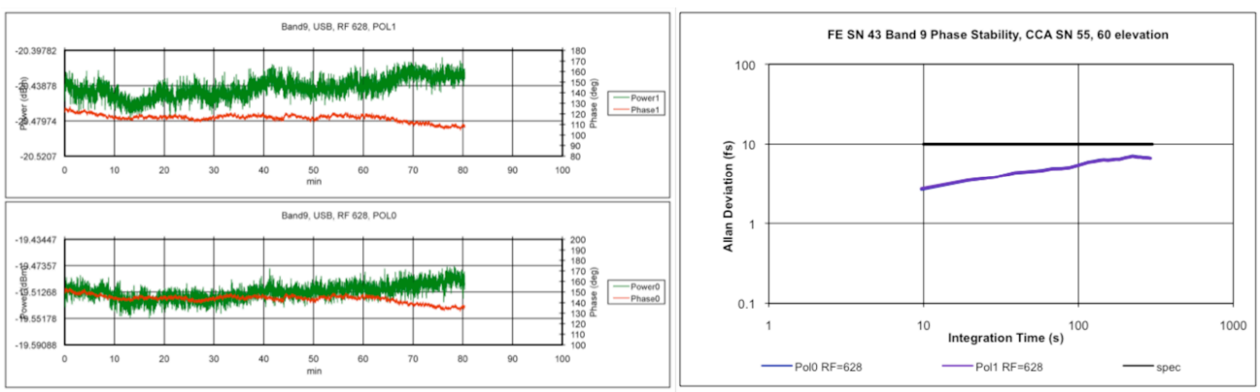

Figure 29 Phase and amplitude stability for MZM-LORTM, Band 9, 622/628 GHz, chamber 1 tilt table, 60 degrees. Allan Deviation for Pol 0 are 2.7 and 6.7 fsecs for 10 and 300 seconds, respectively. Results for Pol 1 are 2.7 and 6.7 fsecs, for 10 and 300 seconds, respectively.

Figure 30 Screen shots Front End Control and Signal Source Controls for 622/628 GHz FE test.

54) Band 9 phase stability test results, chamber 1, 60 degree tilt, 694/670 GHz:

Refer to *Figure 31*. Results for pol 0 are 2.1 and 5.3 fsecs for 10 and 300 seconds, respectively. Results for pol 1 are 2.0 and 5.4 fsecs, for 10 and 300 seconds, respectively. Spec limit is 10 fsecs, we pass with plenty of margin.

Ref1 synthesizer set to 19.353236111 GHz @ +14.0 dBm → x dBm at unit J5 input

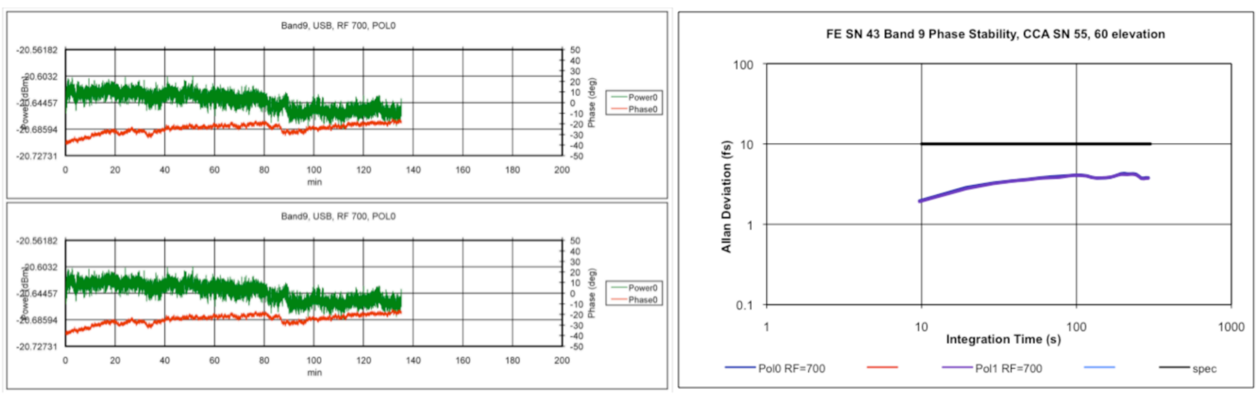

Figure 31 Left - phase and amplitude stability for MZM-LORTM, Band 9, 694/670 GHz, chamber 1 tilt table, 60 degrees. Right – associated Allan Deviation, results for pol 0 are 2.0 and 3.8 fsecs for 10 and 300 seconds, respectively. Results for pol 1 are 1.9 and 3.7 fsecs, for 10 and 300 seconds, respectively.

55) Setup for re-biasing of MZ1 and MZ2:

Started re-biasing MZ1 and MZ2 at ~5PM.

56) Plans for tomorrow, Friday August 5:

Install LabView software, warm-up FE#14, continue re-biasing MZ1 & MZ2.

Friday August 5, 2011
Arrived FEIC ~8:35 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:15 PM

57) Installation of LabView software:

Ranjani has spoken to Morgan M. yesterday evening and received some necessary configuration files this morning. She is in the process of installing the LabView software onto the chamber 1 controller PC. Managed to lock the Band 3 cartridge at 92 GHz by the end of the day using the LabView software. Will attempt automated swept lock tests on Monday.

58) Weekend re-biasing of MZ1 and MZ2:

Will perform ~65 hours of re-biasing over this weekend. Should be very close to being near desired condition (full bias = 0V, null bias = 5V) by Monday morning.

Monday August 8, 2011
Arrived FEIC ~8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:45 PM

59) Static WCA lock tests:

Using the LabView interface, manually set the LO Frequency and associated signal source (even though no signal source was present). Adjusted the LPR EDFA gain at the beginning of each band test to make sure the IF Total Power on the WCA meets the -0.5 to -4.0 V lock requirement range.

Band	LO Freq	IF Power	PM Current	LPR EDFA Gain
3	92 GHz	-2.11 V	+0.38 mA	+1.74 V
"	100	-1.16	+0.25	+1.74
"	108	-1.42	+0.34	+1.74
4	133	-2.11	+0.48	+1.74
"	137	-1.95	+0.50	+1.74
"	141	-3.03	+0.50	+1.74
"	149	-2.90	+0.50	+1.74
"	155	-2.75	+0.50	+1.74
6	221	-1.08	-0.72	+1.80
"	245	-1.38	-0.68	+1.80
"	261	-2.03	-0.69	+1.80
"	265	-1.59	-0.68	+1.80
7	283	-3.82	+1.10	+1.70
"	299	-2.14	+1.02	+1.70
"	315	-2.85	+0.98	+1.70
"	339	-1.61	+1.03	+1.70
"	355	-0.86	+0.97	+1.70
"	365	-0.69	+0.95	+1.70

Band	LO Freq	IF Power	PM Current	LPR EDFA Gain
8	393	-1.50	+0.58	+1.65
"	413	-1.94	+0.59	+1.65
"	437	-3.61	+0.61	+1.65
"	469	-2.35	+0.60	+1.65
"	492	-2.27	+0.55	+1.65
9	614	-1.32	+0.53	+1.65
"	638	-3.60	+0.59	+1.65
"	654	-3.58	+0.58	+1.65
"	670	-2.91	+0.56	+1.65
"	686	-2.77	+0.58	+1.65
"	710	-3.23	+0.56	+1.65

60) Automated WCA lock tests:

Success… got the automated software running after several hours of trouble-shooting. As a quick end of the day test run we ran the Band 3 LO from 92 to 108 GHz in 2 GHz increments. The FE LO locked at each step and we verified that the IF Total Power and Photomixer Current were recorded for each increment. We did not have the spectrum analyzer connected to the FLOOG error test point so no PLL plots yet. Eddie commented that the we will likely have to add time delays in the program to allow for the spectrum analyzer to complete its sweep prior to proceeding to the next frequency increment.

61) Final day of MZ1 and MZ2 re-biasing:

We are very close to nominal DC bias for MZ1 and MZ2, just 12 or so hours left. After normalized we can then generate new and refined bias tables.

62) Plans for remaining portion of this week:

- Tuesday – Lock Tests for 6 bands, time permitting. Record data in MZM-LORTM ORR Data Report in preparation for meeting on Wednesday.

- Wednesday – Generate refined bias tables for MZ1 and MZ2 and gain table for EDFA.

- Thursday – With FE#14 cooled, repeat phase stability tests with BeaSTS at different tilt table angles. Come up with a more specific and refined solution to "air turbulance" problem.

- Friday – Continue with phase stability tests. Pack test equipment and supplies for return trip to Hilo.

Tuesday August 9, 2011
Arrived FEIC ~8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 4:15 PM

63) Automated WCA LO lock tests:

Plan for today is to perform swept lock tests for Bands 3, 6, 7, 9 and time permitting, 4 and 8, in this order. Bands 3, 6, 9, and 4 locked without incident throughout the entire band ranges.

We encountered problems with Band 7 in that the minimum (magnitude) IF Total Power of -0.5V was difficult to achieve at the high end of the frequency range near 365 GHz. Since N = 3 for Band 7 the optical reference LO is ~122 GHz and is near the MZ devices practical frequency limit (Ref1 into the LORTM ~31 GHz). In order to resolve this we had to turn up the LPR EDFA gain. We also encountered a problem with Band 8, however, this was due to a communication problem with the cartridge (a config file contained an incorrect set of WCA YIG tuning limits).

Figures 32 through 37 represent the results of the lock tests. Each figure provides a plot of the IF Total Power and photomixer current as a function of frequency. In addition, a reference plot is provided for the TeraXion LORTM for direct comparison.

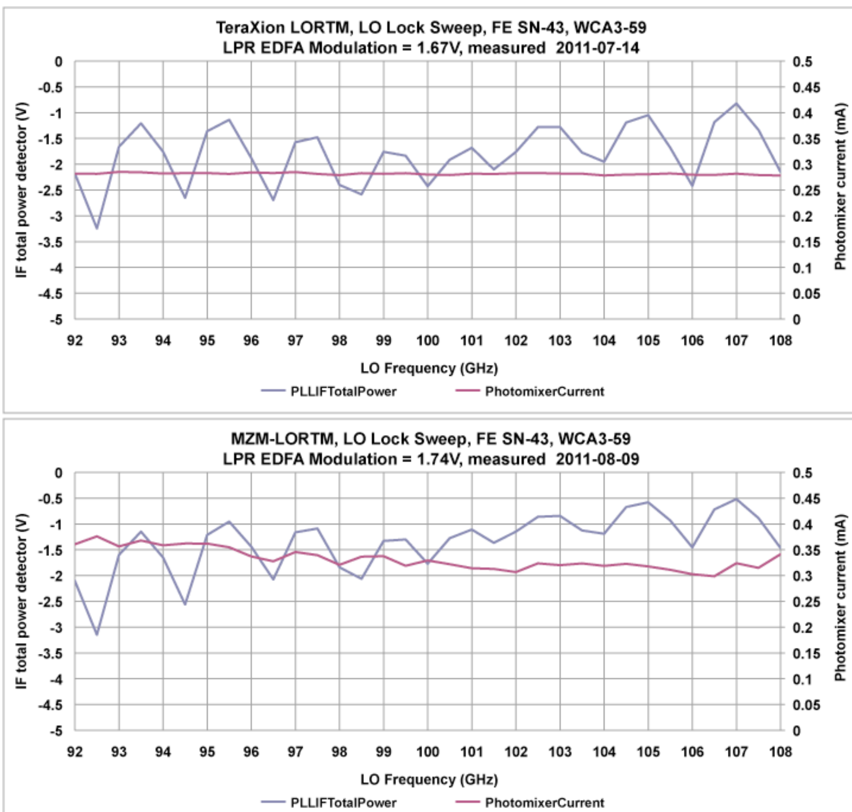

Figure 32 Band 3 automated lock test results.

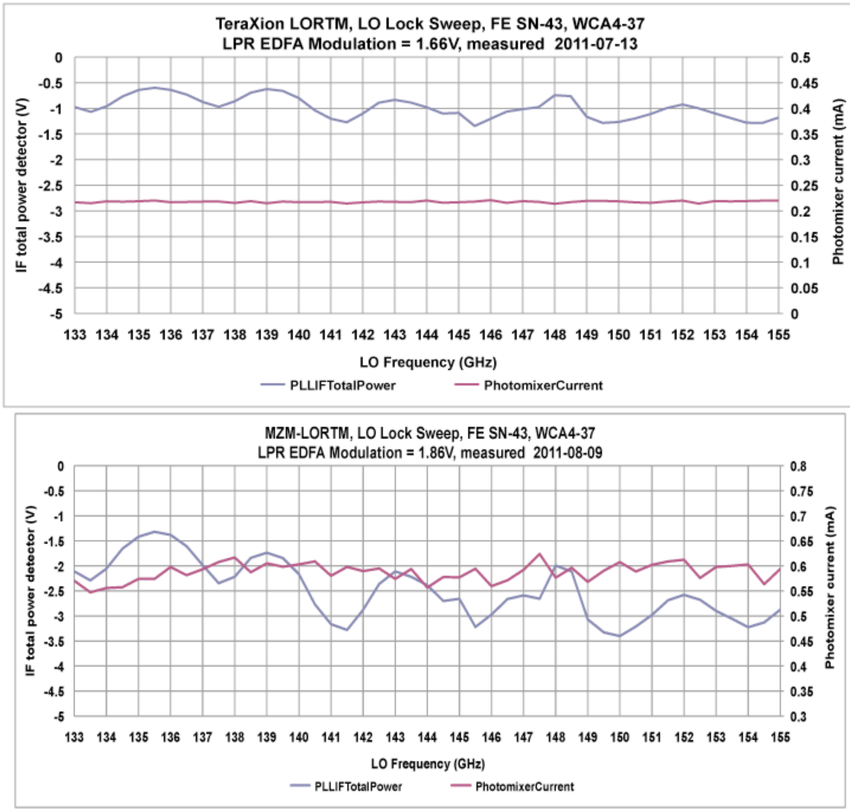

Figure 33 Band 4 automated lock test results.

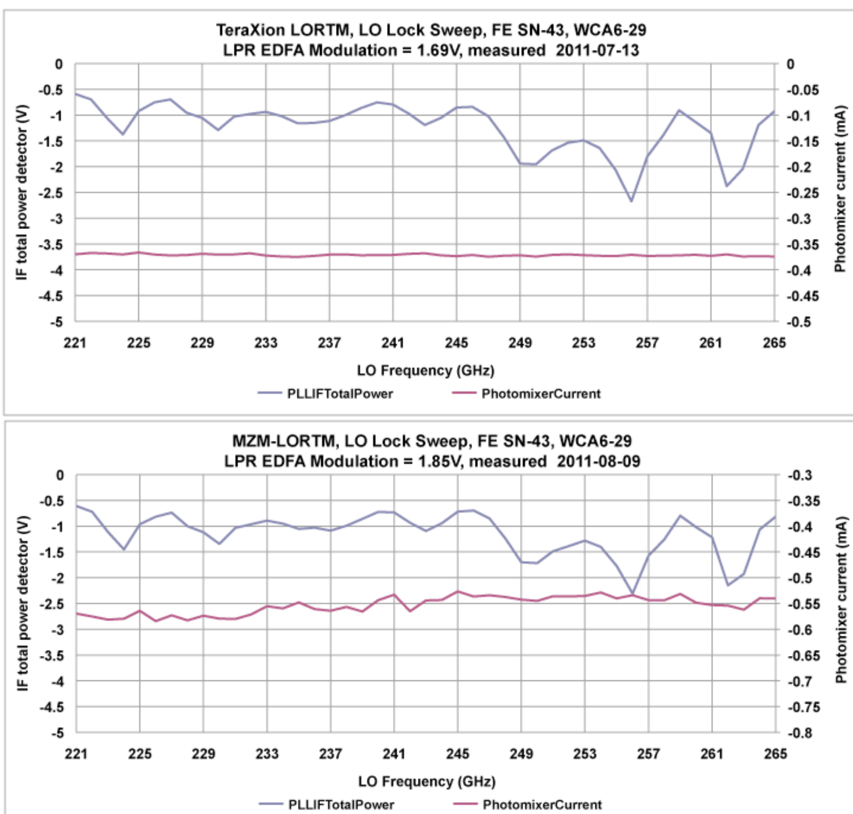

Figure 34 Band 6 automated lock test results.

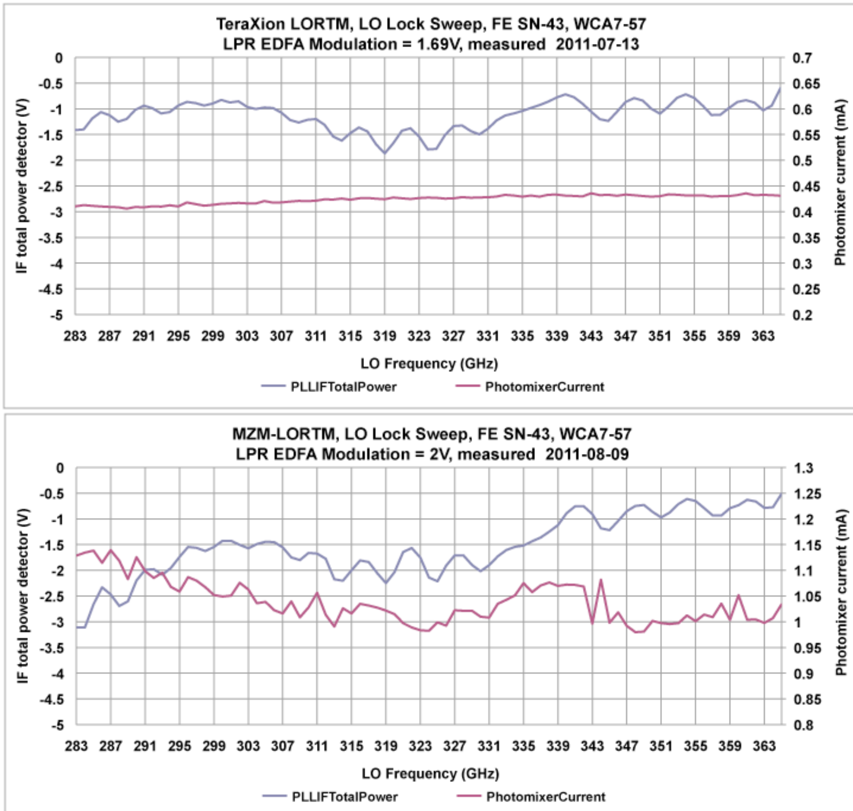

Figure 35 Band 7 automated lock test results. Note the unusually high photomixer current required.

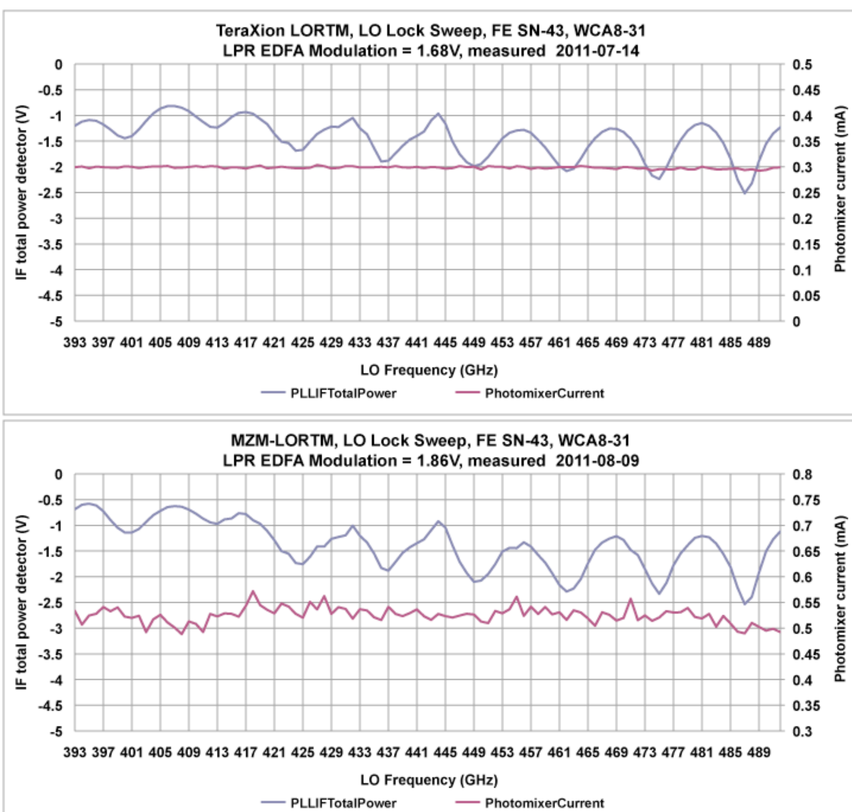

Figure 36 Band 8 automated lock test results.

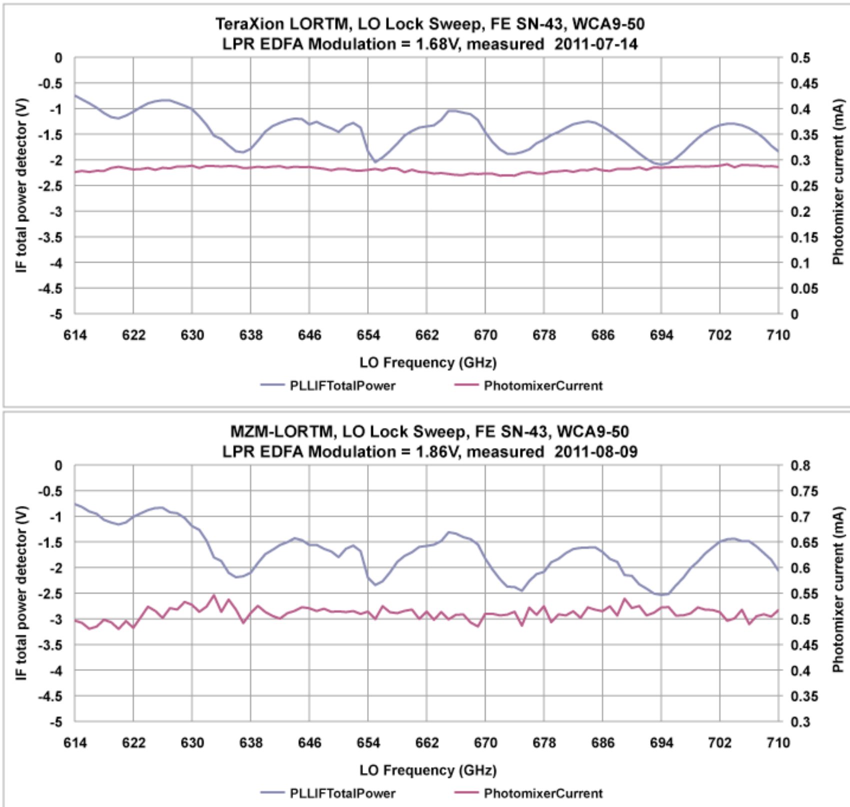

Figure 37 Band 9 automated lock test results.

Wednesday August 10, 2011
Arrived FEIC ~8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:45 PM

64) Updated ORR report:

Added missing Band 4 automated lock test results and had Eddie send it out for tonights ORR meeting review. Also added a summary at the very end of the report.

65) Custom removable wind shroud for tilt table rack:

Fabricated a custom removable wind shroud for the tilt table rack out of cardboard. See Figure 38. Performing a short phase stability run at 60 degrees with the Band 3/7 BeaSTS test plate. Results are puzzling, see relatively clean short term phase (thin yellow line) but there are 1 degree sinusoidal peak-to-peak variations every few minutes. Appears to be a servo related response. Adding a floor fan positioned to blow toward the rack seems to flatten the large slow periodic variations but introduces fast ½ degree peak-to-peak variations (fat yellow line).

66) MZ1 and MZ2 bias tables (14:10):

Terminated the phase stability tests to begin generation of new bias tables for MZ1 and MZ2. Completed.

67) Start overnight phase stability test with BeaSTS, 100/106 GHz, tilt = 60 degrees (17:30):
Still using floor fan but at lowest speed and with ~75% of the intake blocked with bubble wrap. Can barely feel the effect in the vicinity of the open portion of the tilt table rack. Locked both signal source and LO and verified decent IF Total Power on both. 6 GHz IF spectrum is doing something a bit strange where the noise floor is changing periodically. Tried fixing by restarting LabView but this did not help. Phase stability appears OK so will go with this for the overnight run.

68) ORR of MZM-LORTM performance (19:00):
Meeting to review MZM-LORTM ORR Report. Attendees: Tetsuo Hasegawa (leader), Nagayoshi Ohashi, Ted Huang, Ravinder Bhatia, Pavel Yagoubov, Ranjani and Derek. Summary – MZM-LORTM performance meets the requirements. Action items: 1) Record optical power, IF Total Power, and photomixer current vs. frequency for bands 3 and 7; 2) Plot of phase vs. tilt table elevation from 0 to 60 degrees using BeaSTS test plate (how long does it take for phase to flatten out?).

Figure 38 Removable cardboard shroud around tilt rack at 0 degree elevation. The shroud covers the entire left side, about 75% of the rear panel area, and it open on the right side. At 60 and 90 degrees the bottom portion faces the rear wall. Air channels up through the rear bottom portion and out the top opening. This photo was taken prior to the moving of the Extra IF Plate chassis (2nd from left).

Thursday August 11, 2011
Arrived FEIC ~8:25 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 5:50 PM

69) Overnight phase stability results:
Refer to *Figure 38*. Results of this overnight run are poor. *Figure 27* was performed with pink bubble wrap around the tilt rack. This run was performed with a removable cardboard shield. What is the difference? Could it be that the integrity of this cardboard shield is too good and causing the E8257D Ref1 synthesizer to servo itself for cooling? Will try again tonight but with some small vents cutout in the cardboard to purposely generate some leaks.

70) Removal and replacement of FE#14 Band 6 CCA:
Stopped phase stability run so that Bill and company can replace the Band 6 CCA in chamber 1.

71) Generation of EDFA gain table (09:30):

Ranjani running gain calibration routine… will require 4 to 5 hours. Being done concurrently with the swapping of the Band 6 CCA. A breaker on the tilt table tripped toward the end of the run and shut down the LORTM. This corrupted some of the data toward the end of the run.

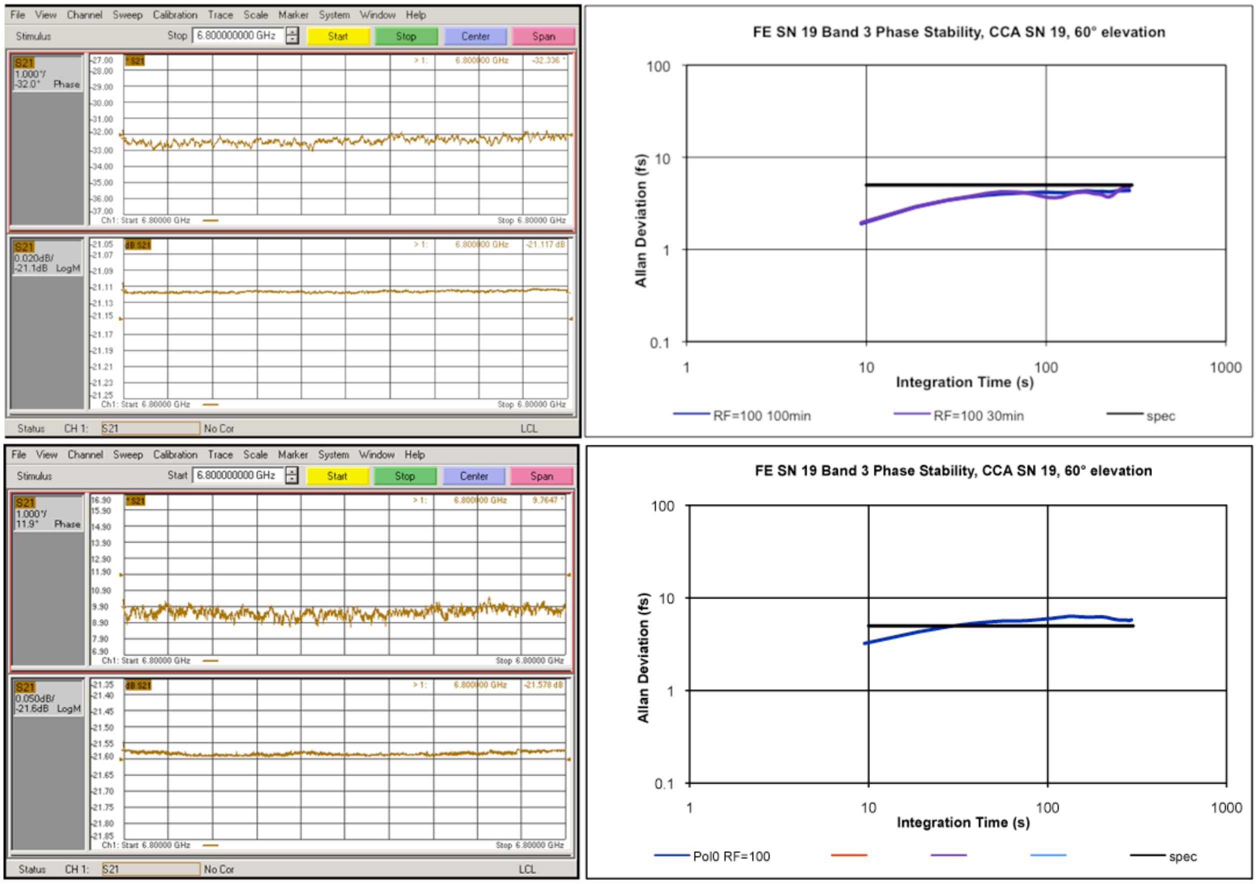

Figure 39 Upper plot shown for reference taken from Figure 27 on August 3. Lower plot is for phase stability performance with cardboard shield over tilt rack, floor fan blowing lightly toward the shield. Performance has obviously worsened.

72) MZM-LORTM User Operation Notes:

Since Chia-Hao will be leaving ASIAA and EA-FEIC at the end of our stay we have started a rudimentary memo describing the general operation of the MZM-LORTM. Jeff and Stick have a good feel for the LabView interface so this document will attempt to capture other essential information as well.

73) Attempts to improve phase stability at 60 degrees elevation:

Tonight will be our last overnight run.

a) Cut out a louvered slot at the top of the cardboard shroud to act as an exhaust of warm air. This is an attempt to simulate leaks in our earlier bubble wrap shroud.

b) Moved the DC power supply and switch controller toward the top of the rack by ~1.5 inches. This allowed us to move the Extra IF Plate away from the Agilent E8257D synthesizer. The 2 instruments were touching cover to cover, now there is a ~1.5 inch gap. The E8257D draws air in through the rear panel and exhausts through vents located along the right side panel. Added a cardboard shroud to block this warm air from directly reaching the Extra IF Plate intake air vent.

c) Rechecked the Ref2 input power level and measured -5.0 dBm (should have been -7.5 dBm. The synthesizer was set correctly to 6.0 GHz, N = 1. Changed 8 + 8 dB pad to 8 + 10 dB pad and adjusted Kikusui to 3.155 V to achieve -7.5 dBm (0.000 V produced -6.5 dBm but did not have a 9 dB pad handy).

74) Overnight run cancelled:

Our last overnight run was cancelled due to an issue with LabView requiring a restart of the controller PC. We could not perform the restart because the cryostat was being pumped down and was being monitored by the same PC.

Friday August 12, 2011
Arrived FEIC 8:30 AM, D. Kubo, R. Srinivasan, C.-H. Wu
Depart FEIC 4:00 PM

74) User training day:

Today has been reserved entirely for training. The 2 main individuals we communicated with at EA-FEIC were Stick and Jeff. Ranjani had been working with both for the past 2 weeks. Toward the end of the day we started from the MZM-LORTM in a powered off state and had them demonstrate to us how to setup the hardware and software. It took them only a few minutes to set the LabView windows up for locking the FE WCA LO and the Signal Source. They also were able to demonstrate FE WCA LO lock sweep tests for a Band 7 Signal Source.

Also went over the use of the Agilent OSA and performed some final packing of the 2 Pelican cases to be shipped back to Hilo.

END