# Minutes for AMiBA Engineering Telecon

Meeting Date: 09-Oct-2003

Participants:
Australia:
USA: Bob Martin, M.T. Chen, F. Patt, T.H. Chiueh, C.J. Ma, Kyle Lin, P. Ho, Jeff Peterson
Taiwan: C.T. Li, H. Jiang, P. Shaw, Eugene Hwang, Johnson Han

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Minutes Recorder: C.T. Li
previous weeks comments

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## I. New Action Items:

## I. Previous Action Items (still open):

**AI-25Sept03-1:** Bob/Huei – Figure out our obligation to those residual MMIC Bob received. Are we supposed to get back to Todd Gair or not? Are they residual extra, or we're supposed to send somebody to Todd to package them?

Paul Ho – One of the questions last week was whether expansion project can use these MMIC or not? Do we have enough, or we need to order more (for expansion)? Paul Shaw – think the first foundry is sufficient enough for the whole project. The reason to have the second run is we think there might be some improvement. Bob – the point of second run is to revise and build up new design and capability. Also in the beginning, scheduling two was that in case the first one fails. Paul Shaw – That means that if we succeed in the first run, we don't need to have the 2nd run. Bob – Have to check all these with Huei when he is back, the quantity in the package. Paul Ho – This is one of things we have to figure out how much money we can squeeze out the direction. If there is something we don't need to buy, we don't need to order, or push off later, then we can manipulate some of the money.

**AI-25Sept03-2:** Ming-Tang - Volunteered to review all the specs as much as we can, and collect them into one place so that we can look them up.

Ming-Tang – Started with Mike's original spec. Tried to work down the details. Things like collecting the interface in the individual work package so that I can make that a practical spec. Bob – suggested that as you go through, found where there is a gap or problem, send out an email right away to ask somebody to fill out the details.

**AI-18Sept03-1:** Bob - Re-visit the testing of phase shifter in a month.

**AI-14Aug03-1:** Warwick – Become directly involved with offset issue

Kyle – No update on offset. Recently focus on the delay and frequency response of correlator. We measured the IF spectrum before and after the equalizers. After equalizers, there are still about 10 dB gain slope. At higher frequencies, the spectrum is below the noise floor of the spectrum analyzer. The spectra beyond 10 GHz start to drop very fast, at least 20 dB. After equalizers, the correlator only see maybe 2 to 10 GHz. Ming-Tang – will go up with them to check on the instrument. All 4 IF channels from receivers behave quite weird.

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## I. Closed Action Items (as of this meeting):

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## V. Miscellaneous Discussions:

MMIC:

Bob – There was an initial response from State department asking more questions on the export license. They put decision on hold. Have circulated those questions around. Paul (Cenward) responded. Paul's comment was that they just becoming seemingly careful. He did again make them aware that there was a previous approval. The good news is that they didn't rightly say No. The bad news is the process drags on. Paul took the action to send those questions around and explain the answer he is giving. We now wait to see what their response is.

Receiver:
Ming-Tang – Got two new developments going on last week. In email, Todd Gaier found that he had put in wrong resistors in the amplifiers we sent back to him. After the correction, they

improved the amplifier noise temperature from 60 down to 40 K. We will send part of the amplifiers back to him for correction, while keeping some here. In about 6 weeks, after we receive the new batch, we can send back the other batch. The 2nd development is that last week Kyle and I went up the mountain to check on the prototype, wanna investigate the problem of LO power variation. Found out we couldn't do much up there. Took the LO module (DRO) down to Hilo for testing. In the mean time, we're testing the production unit in Taipei. In general, we found in the production unit we got about 2dB variation over 10 degree change of temperature. For the prototype, we had about 2 dB power change when temperature changes about 20 degrees. This could be a problem for the prototype because in prototype, we're using 1st version mixer, which is quite sensitive to LO power. This can cause large variation in IF output. However, this is a drifting, slow change. We'd like to define the variation rate that we can tolerate. We'd like to work out this problem before we ship receiver to Hilo.

Ming-Tang – In the process of testing quartz vacuum windows. New development this week is that we found the LO power fluctuation with temperature. Prof. Chu is investigating the problem we found on the prototype. In the mean time, we want to make some temperature variations on the module we got. The temperature on the LO module, without circulation, will rise up to 40 ~ 50 degrees on the outside. By installing a small fan, Joshua found it we can cool it down to around 30 degrees.

T.H. Chiueh – That is also found the IF power to be anti-correlated with LO power. When LO power drops, IF power rises, and that also correlated with day time. In the day time, the IF output becomes factor of 2 higher, but LO power drops by maybe 30%. The question was why the IF power increases by factor of 2 in day time compared to night time? CJ also recorded the IF power vs RMS coming out of readout chips. As the IF power increases in day time by a factor of 2, the RMS decreases by 30%. The RMS from readout chips has to go through correlator, DC amplifier, and readout chips. In the day time, these three items have changed, opposite to the change of IF power change.

LO/IF:

See the 2nd development above.

Correlator:

Kyle – Two days ago we tested two Marki production units we have been using on the prototype in the lab with two synthesizers to measure the amplitude and relative delay at different frequencies. The result is similar to what Derek and CT have measured before for Marki engineering module. Tried to understand whether the higher responsivity at low frequencies, combined with pretty flat IF spectrum, can produce the fringe delay problem we've seen before?

T.H. Chiueh – There is some subtle difference between two production type correlator modules.

Kyle – Our measurement only has 1 GHz resolution. We increment the frequency 1GHz at a time. At 3 GHz, the two production modules have similar responsivity, and at 2 GHz, the #2 module has lower responsivity than at 3 GHz, but for #1 module, 2GHz responsivity is higher than at 3 GHz. So the #1 production module has more peaks (in responsivity) at low frequencies.

T.H. Chiueh – In other words, one has the tendency that the responsivity shoots up at lower frequency. The lowest frequency measurement that Kyle and CJ did is at 2 GHz. They can only see the tendency, not anything below 2 GHz. The suspicion is that at frequencies lower than 2 GHz, the power (responsivity?) is even larger (for production module #1?). The difference between these two production type correlators can at least qualitatively explain why the delay (phase difference?) in the production one is smaller than production two, because low frequency dominates. Bob – That emphasizes the reason for testing all the production units to characterize them. T.H. Chiueh – The main body of frequency spectrum of responsivity are pretty much the same, except at very low frequency. Bob – That is not surprising because that is where they put in the absorber material. That could depend on the handwork quality.

Kyle – According to Derek, the spec on overall responsivity must be greater than 80 Vrms/Watts. In the measurements we've got for Marki modules, everyone has passed this specification. But the other spec is that amplitude variation should be within 3dB. Right now these two modules have more than 3-dB variation. We have tried other way to analyze the data. As Prof. Chiueh suggested, one way is to shift data from different lags by some amount, then add the data together. Shifting these data corresponds to some delay at different IF frequencies, also RF frequencies. This creates some frequency filter. However, this is not a very sharp filter – 10-GHz wide frequency filter. Our results showed that the 1st module has more peaks at low frequency. It's consistent with what we got from the synthesizer test (as well as the delay).

Kyle – We do have one problem – do we need to drive the correlator at like –10 dBm as with noise source, because right now we're using CW signals, the power is at –23 dBm. Are we under-driving the correlator? The concern is because higher (CW) power will saturate the DC amplifier, so we have to use the low power. CT – I think using low power is OK. It's better than saturating the correlator. Bob – You can kind of test by changing the power input by a factor 2 to see if you're in the linear region? CT – You can calculate the responsivity vs. input power to see whether you're saturating the device or not. You wanna operate below the saturation point. Kyle – In reality, our correlator is operated at –10dBm with noise, should we take it at that condition? CT – It's hard to convert from CW power to noise power, not sure how much power you wanna put in for CW? So I usually characterize them below the compression.

Jeff - The noise power are un-correlated, so don't tend to produce much DC output. Kyle – You mean driving the mixer at different modes? Jeff – I guess it's probably OK as long as –10dBm and –23dBm both in that linear region. The reason you get so much output, getting close to limiting of DC amplifier, is because your signals are fully correlated, while two noise signals you feed in are not very correlated, so they don't produce much output. That is the reason that you have to use lower level for the synthesizer test. I think you're stuck. You have to use low level, and I think it's OK.

T.H. Chiueh – There is another way of doing that. You have a low level of CW, plus some certain amount of noise. Then you adjust the noise level to –10dBm, while the CW is still very small. The resulting signal coming out of correlator will be dominated by the CW.

Jeff – You could do that way. Seems to be a bit of work to set that up. That's a good way to simulate the performance of correlator because the correlator operates with tiny correlated input on top of large un-correlated noise. So testing in the lab with the simulation of that is a sensible thing to do. Remember when Derek is doing that, his two noises got coupled to each other a little bit. He did the lab test, which he fed un-correlated noise on both sides, then send one small correlated noise into the splitter, and to both sides, and he ended up with correlated noise passing from one side to another.

C.T. – It's weird that the LO power decreases, then the IF power increases, at the same time, the RMS also decreases. Is it possible that you're saturating the correlator so that as the IF power increases, you're into the compression that you got less RMS? Kyle – We have some data before, we changed the IF power to record the RMS. It's linear up to –6dBm. We're operating below –6dBm so far.

C.T. – When I looked at the fringe of moon drift scan, I found within the beam envelop, the amplitude of 4 lag fringe doesn't change much. Is it possible that the pointing does not coincide with the zero-delay? Because when we measured the moon fringe early this year, within the beam pattern, we can see clearly some amplitude variation of fringe of each lag. Have you done anything to the IF path so that the zero-delay is off from the physical phase center of the platform? Kyle – I don't think we've changed that part. We're not sure about the absolute pointing. We used to check the relative pointing.

T.H. Chiueh – C.J. replaced the engineering model with another production model. That new production unit performed similarly to the engineering model, different from the first production unit. We have to check all the production modules.

C.T. – Still checking the timing of the data acquisition circuits. It's delayed already. Hopefully we can have the design finished soon.

T.H. Chiueh – Another thing mysterious is the noise from 4 lags. The noise from 4 lags should come from the common source, and they should be highly correlated. It's found that adjacent lags have higher correlation than distant lags. Kyle - We're correlating noise from receivers. We think that these 4 correlations would be almost the same. We should see the same correlation between any two lags. Mike – I thought that is very puzzling. I don't think you should. I really wonder if you're looking at the effect of DC offset. The receiver noise shouldn't be correlated. You're outside of that window. I don't have explanation of DC offset. It strikes me that(DC offset) is more likely to be the cause of correlation than receiver noise itself. We should go through the numbers, and calculate quite correctly what you gonna see the different lag. But I think it certainly stop? the noise in the multiplier stage. I think you're getting 2$^{nd}$ order type correlation, certainly should be very small. I'll work through that to see one of opinion based on the algebra.

Platform/Mount:

Calibration System:

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DC Power/ Distribution:

Enclosures:

Site:
Ferdinand – Talked to the person from Tai-sei? And we will have a visit to ML next Thursday. There is also visitor from Tai-sei Japan joining us – one of Tai-sei excavator folk. The big factor is the excavation. If we're able to sub-contract that out or have that done as quickly as possible. It's easier for other firms to give us the estimate. What I think the best approach is for Luke? to go ahead and do the excavation work. That also gives the other folks who would then do the concrete work, and casting and all that, give them a really good idea what they're actually dealing with. Luke is busy now (he got another contract). If we can go rent the equipment from Allies? and hire operator, just get started, in my estimate, I have excavator, the back-haul, and two operators, and that will cost us 12,000 dollars for one month. In the site development budget, Neil Harrison is supervising the main steps, make sure that the excavation is done right, make sure the casting, rebar work is done right, grounding system, then the next will be the concrete work. He will supervise these steps, not on the daily basis.
Paul Ho – We have the one option, which is Lusier. Let's develop the other option if we do hire our own equipment and our own operators. Use the scenario whether we can actually do this?

Ferdinand – Received the blue prints from Neil Harrison. There is some changes, mainly to the rail running from the top of the wall. They made the suggestion to minimize the excavation, and digging the back? rock. May have the effect on seeing of telescope. We have to look into some details. Got a quote for the shelter. That looks OK, didn't change from the budget - 65,000 USD, including shipping. Got a quote for the grounding system, and look into some details to see if the quote I got is different than the bid from contractor. Sure they're (different). If we have these ordered by the contractor, we will pay almost twice the money. So there is the money saver.

Dishes:
60-cm dish testing
Ferdinand - For the transmitter, receiver part, that seems to work. I have it all layout and tested in the lab, like both Gunns working together, slightly offested. I got the total power detector and the amplifier chain after the mixer. I got about 40dB dynamic range, which we may need. Nevertheless, I think to do this with antenna 8 is not feasible because you need to set the feed at the right focus position, and to use antenna 8 - the back of the shutter, the little compartment you can use there - and have the antenna mount there, and the feed, LO part, IF part of power detector will be in the shutter, we would have no access place. In order to do the focus adjustment, either we ought to motorize all the drives - x,y, and z, or we have to remove it each time. Considering the situation on MK, it may not be feasible. We need a multiple run, and motorize these stages. It will cost a lot of manpower to do this. We can set up something later if you want to test all the dishes. At the moment, you can't do it in the timely manner. Bob – Do you have any backup idea on astronomical source or something else? Ferdinand – Put it on the test mount, and have a drift scan on the planet to see the side lobe and have a good idea about the beam size. Could we do it on ML looking down to the road or visitor parking? Bob – Do you think you have enough power to do it all the way across the valley to HP?

Ferdinand - Putting things together. Finished couple of noise measurements. I got the transmitter gunn working again. Got a blue print from the shutter. Everything will fit in the housing of shutter, sub-reflector box. Just one simple cable going down, feeding to the telescope. Very much possible (running out of time of doing that). We will need the shutter. There is too much work to replace the shutter by the metal stretcher.

2-Element Prototype Testing:

C.J. – Yesterday we just tested the optical telescope with aperture mostly covered by the cardboard. I think we can still use it for 60-cm dish for the prototype.

Schedule: