The Six Centimeter Feed Experiment

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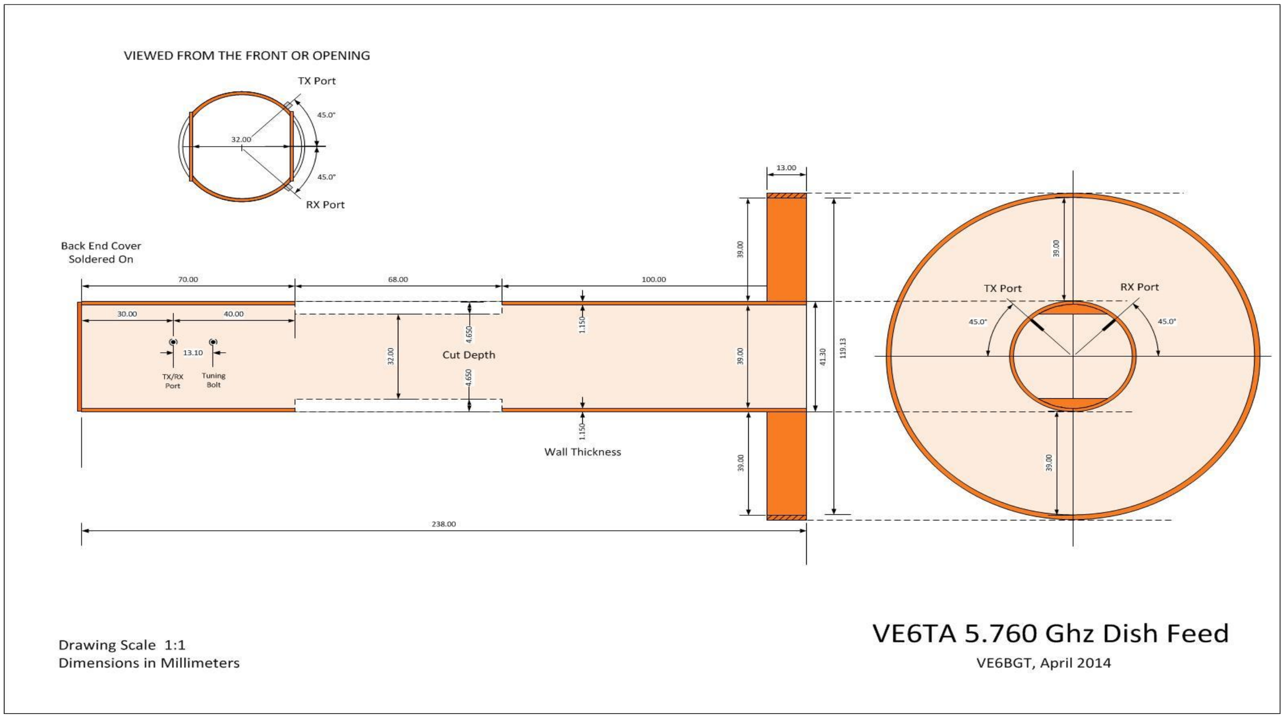
After building successfully the 100 watt Gan FET amplifier, the next step in the 5.760 Ghz experiment was to build up the dish feed assembly. This was going to contain the complete transvertor, amplifier, preamp, and feed ant all on one mounting plate to be placed up on the dish feed mounting shelf. The first part was to build some kind of feed ant. I had built a "squeezed" tube feed a few years earlier for Grant, VE6TA which turned out well. So with that design as one and then scaling down the more common VE4MA bolt polarizer style, I came up with three types or models to experiment with.

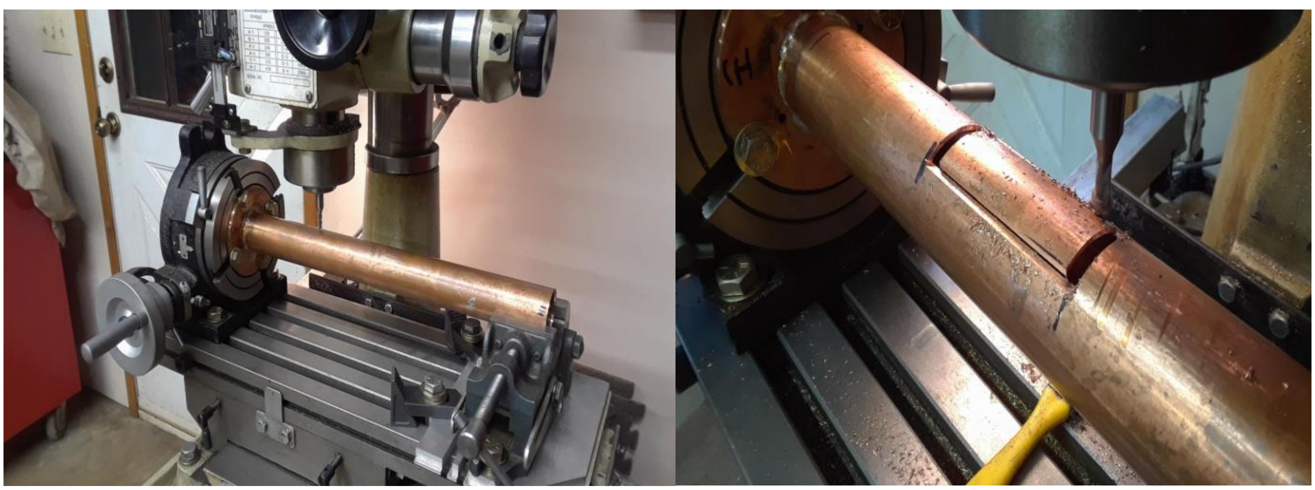
The Three Amigos

I decided to build the squeezed tube one first and tune, then the scaled down bolt polarizer one which made the adjustment bolt placement quite close together. I thought just for experimentation what would happen if I made the copper pipe longer and spaced the polarizer bolts farther apart? So a second one was drawn up and built.

The launcher sections I have used up till now on lower frequencies have always been the scalar ring style. I decided since at this higher frequency and the f/d ratio of my dish being .444, I wanted to try out a W2IMU style of launcher. The same IMU was used at first for all three feeds.



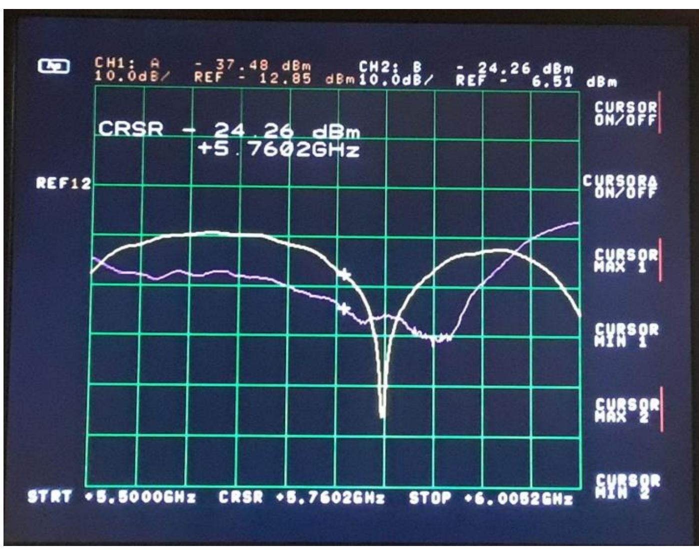
The Original "Squeezed" Feed Specification Drawing

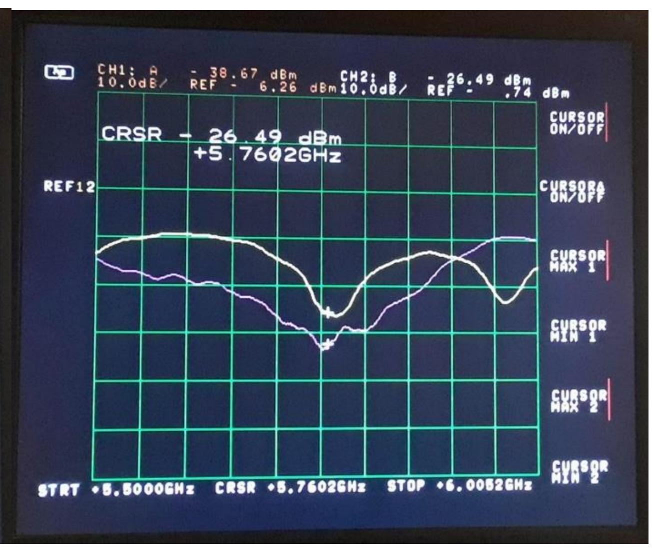


Cutting the CP Holes

The squeezed feed was built from copper pipe with an outside diameter of 41.3 millimeters, inside at 38.5 millimeters. With the copper pipe attached to a rotary table I could take great detail in cutting the two slots or rectangular holes. Then when the copper plates were soldered into the holes the inside spacing between the two plates would have a distance of exactly 32 millimeters. This space is for proper creation of the signal for circular polarization.

This picture shows the finished squeezed feed with the two plates soldered in and the new IMU launcher section. There is also an adjustable sliding back wall or plate to aid in tuning. I planned on using a SMA connector for the transmit probe only and usually a custom made receive connection made from a piece of .141 semi rigid coax to connect directly to the isolation relay, eliminating one connector for less line loss. I decided I would use the SMA connectors for both at first for the testing.

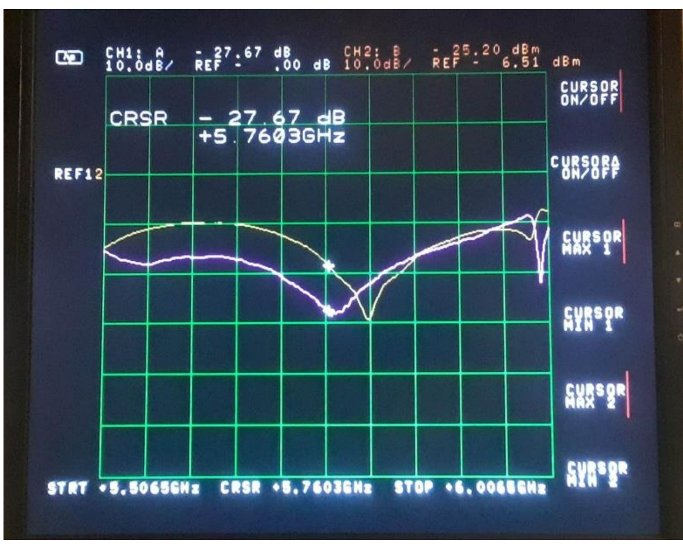


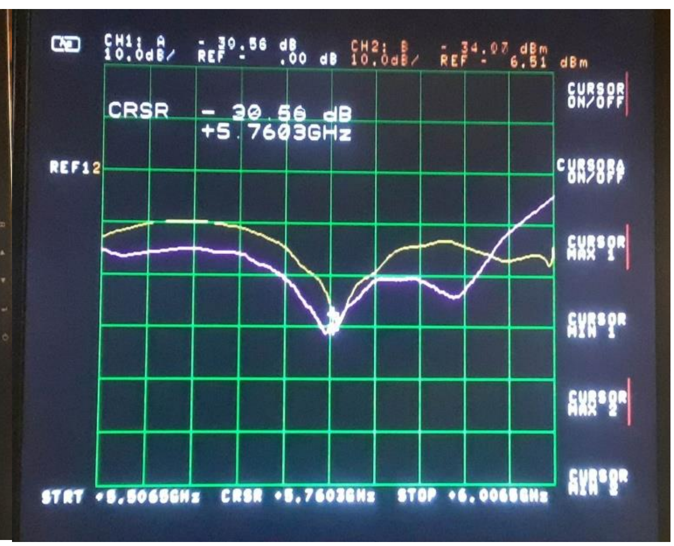


TX Probe Tuning.   **Back Plate and IMU Launcher Adjustment**

These two pixs are the first results of tuning the probes of the squeezed feed tube showing the return loss of TX probe and isolation to the receive probe. The left pix is of just the probe lengths adjusted, the RL is at 25 dB, isolation at 18dB. The right pix is after adjusting the back plate and IMU launcher. Doing this made the resonant dips move right on frequency and help the RL to 32 dB, ISO at 25dB. But the Circular Polarization test came up weak, as much as 5 to 6 dBm difference in amplitude. There is more on this CP test later.

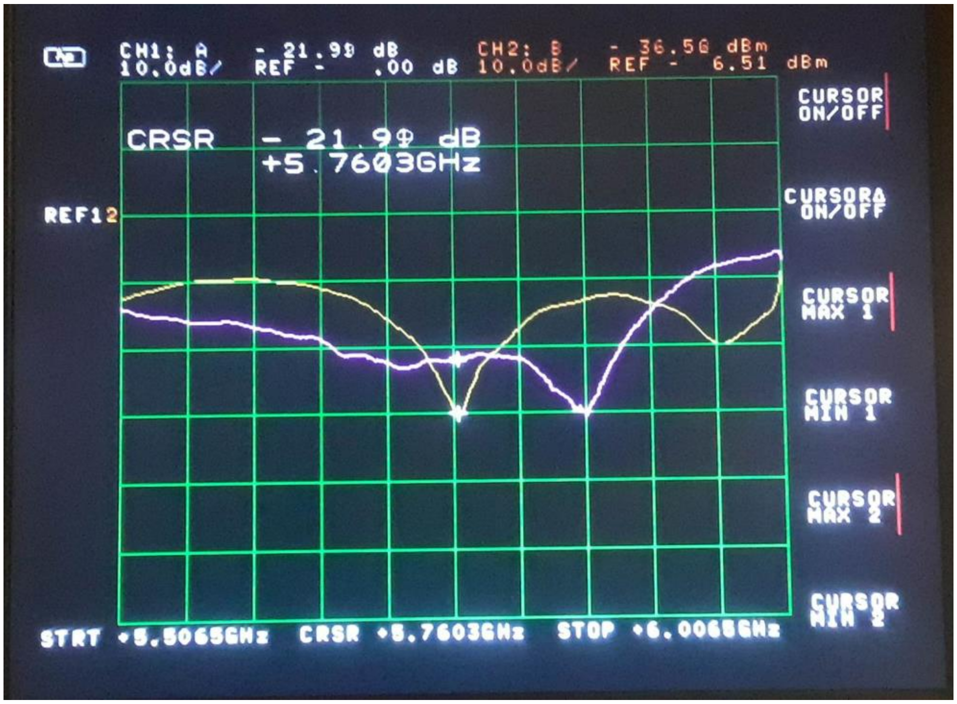
I then wanted to convert the feed over to an N connector for the TX probe and a custom rigid line connector for the RX probe. This RX probe line hooks directly to the SMA Isolation relay.





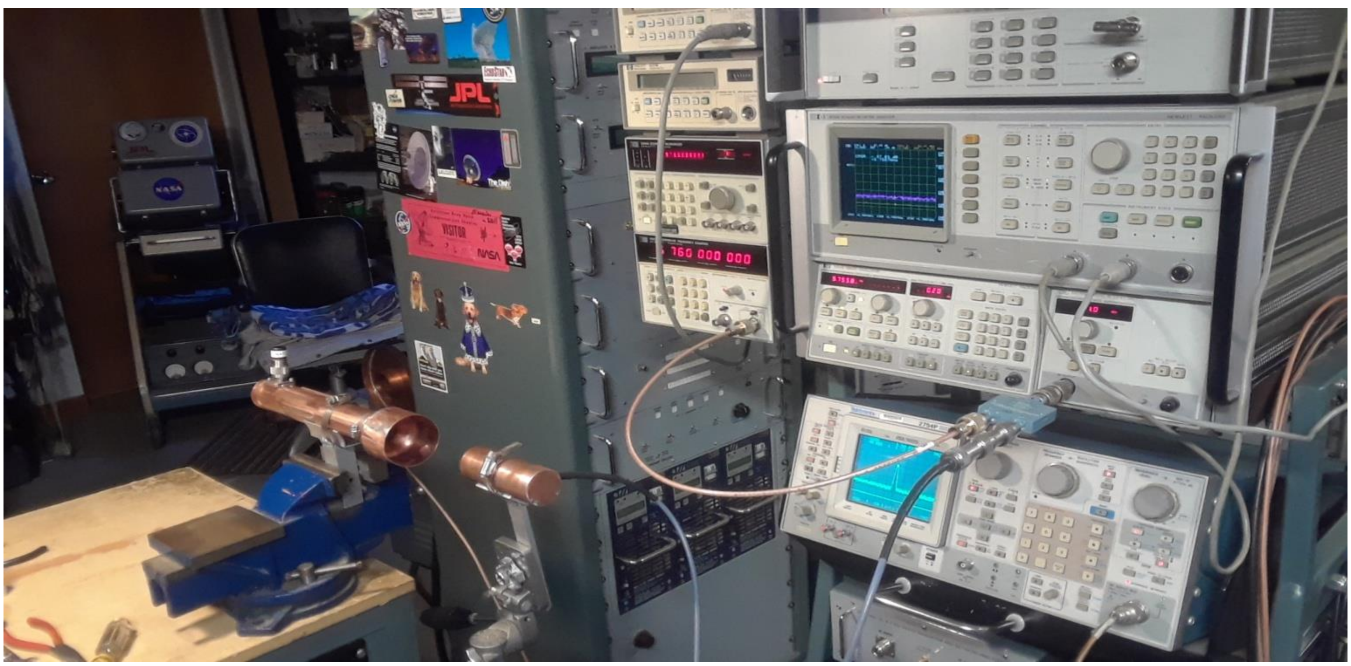
First Sweep: RL = 27 dB, ISO = 19 dB   Best Adjustments: RL = 30 dB, ISO = 28 dB

After the new connectors were added the probes were swept and tuned again. The pix on the left are the probes adjusted and the back plate tight up against the body, the IMU launcher is completely off. The right pix is the best of all adjustments, the back plate moved out 1 mm, the IMU installed and slid out 4.5 mm. One thing I really noticed was the accuracy of construction the IMU launcher needed to be.



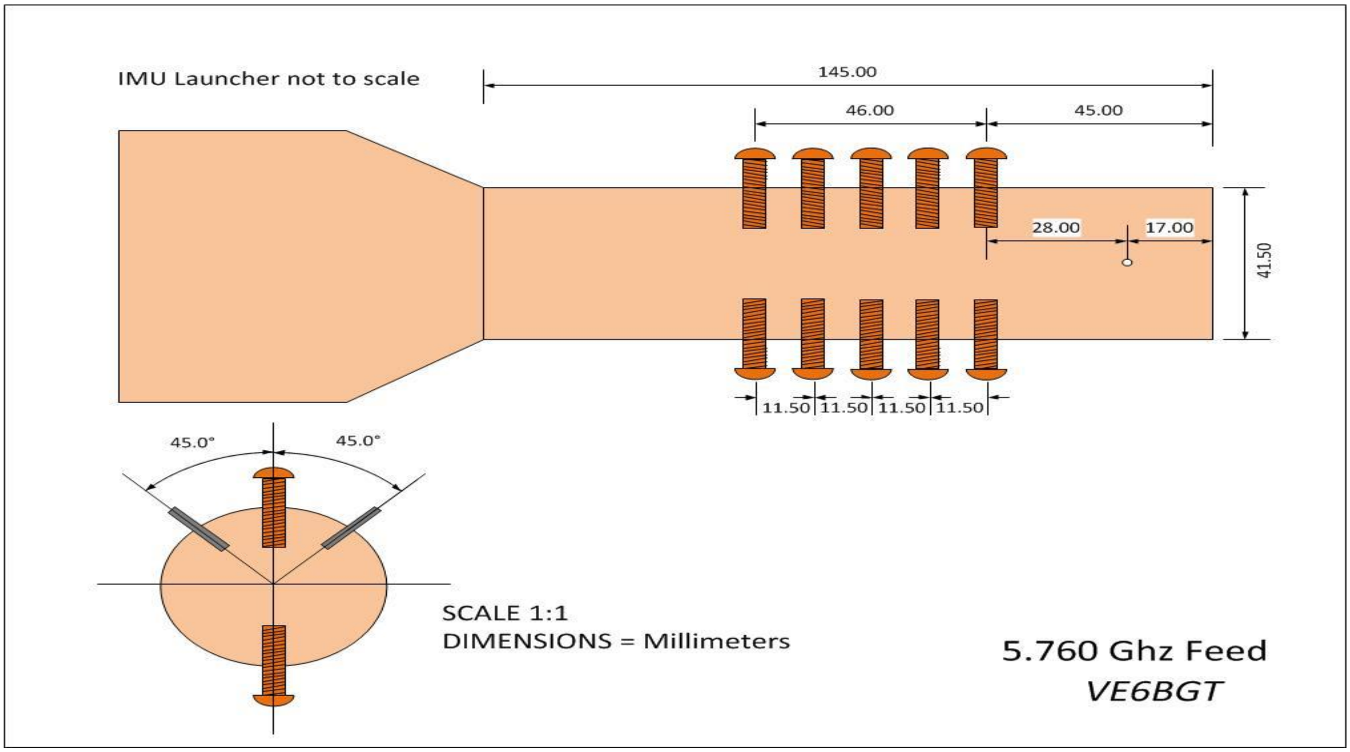
Twisting the IMU launcher section mounted on the end of the feed tube really shifted the RL dip of the TX probe off frequency. This showed me that the IMU section wasn't built concentric or true accurately enough.

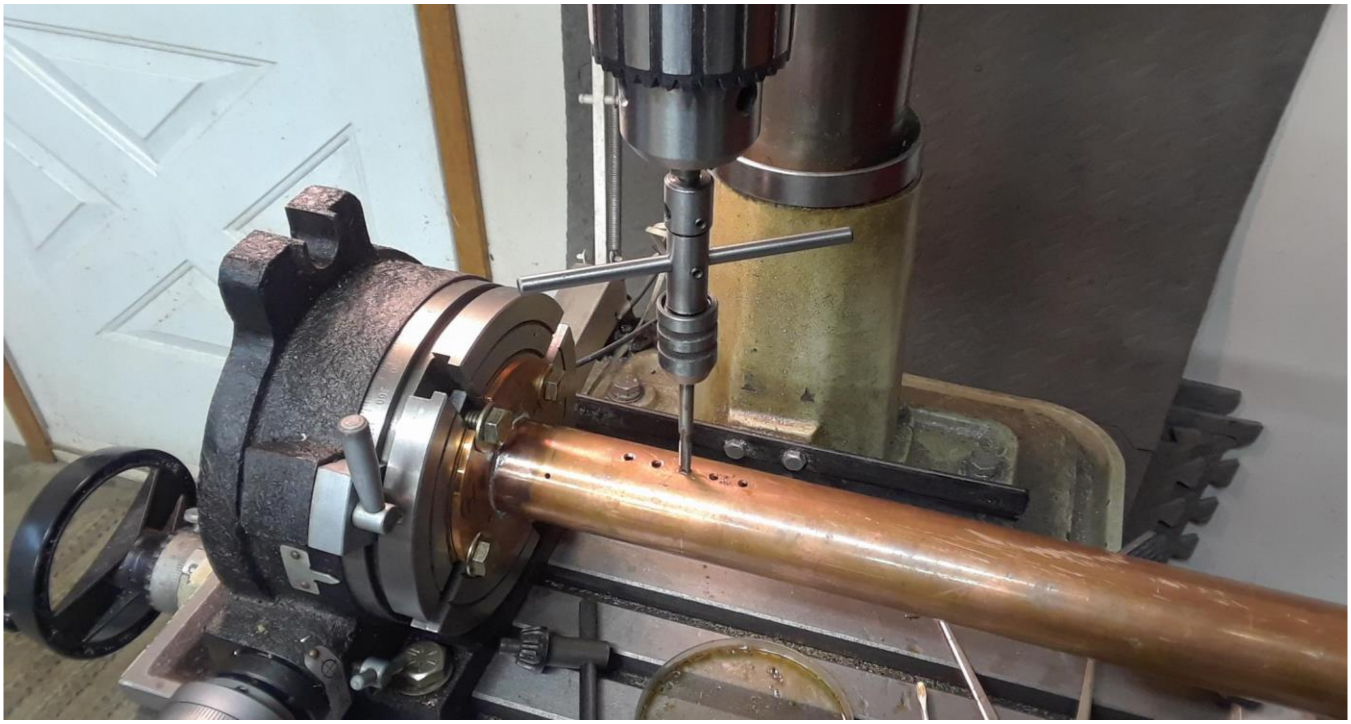
The Circular Polarization Test



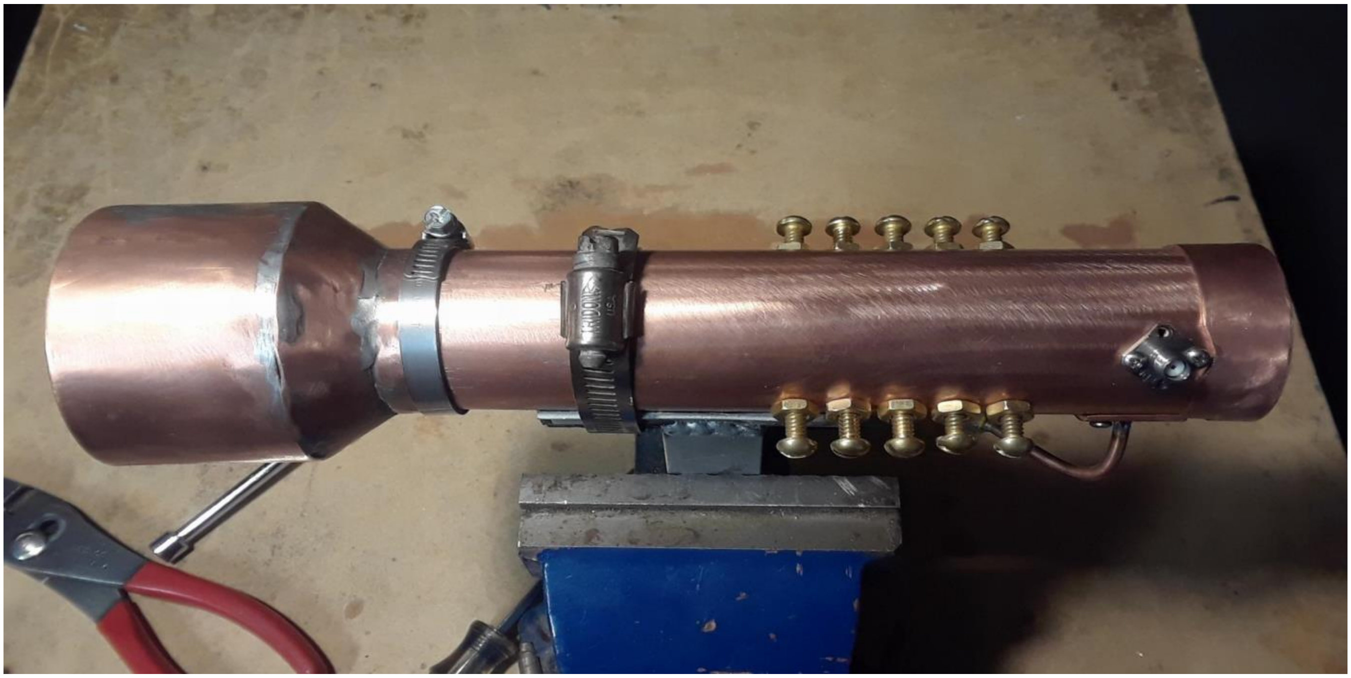
I setup a test to check the circular polarization using a single probe linear feed connected to the sweep generator in CW mode locked by a synchronizer. This linear feed transmits into the squeezed feed under test and the RX probe hooked to a spectrum analyzer for signal detection. I then rotated the linear test feed back and forth and noted the change in amplitude as I went through the different orientation positions. Unfortunately the circular polar (CP) test came up weak, I saw a change in amplitude between 4 to 5 dBm as I rotated the linear test feed. This squeezed feed cannot be adjusted very easily.

The Next New Idea, The Short Bolt Style Feed

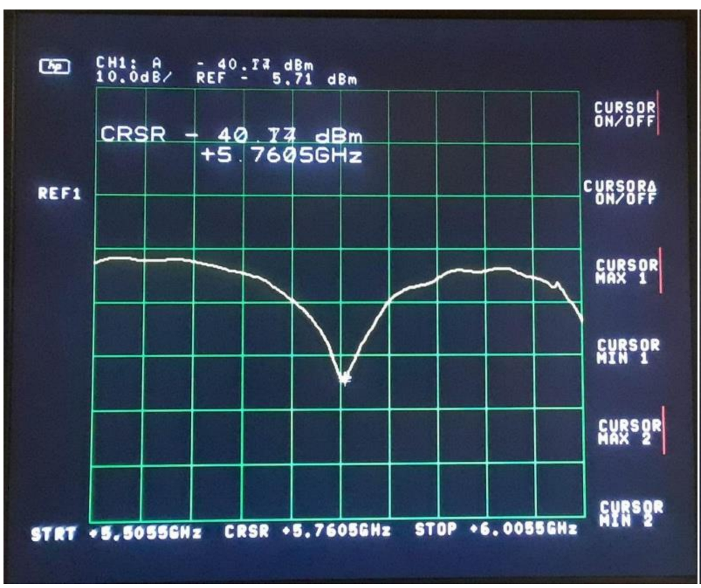


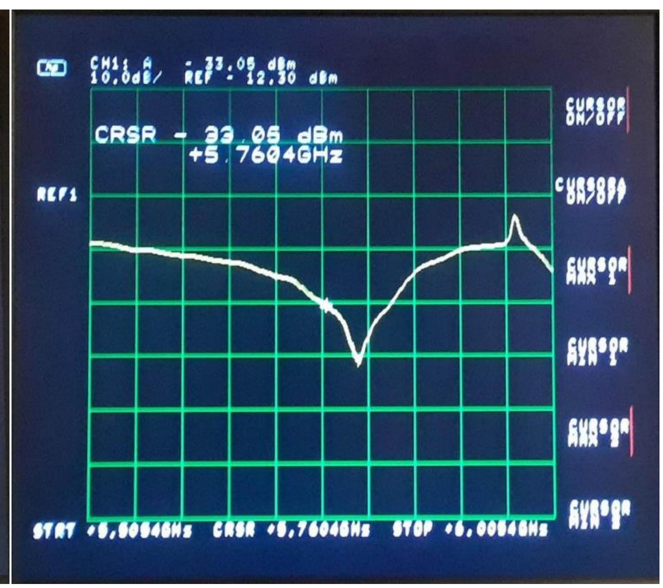


So having good success with the “VE4MA” style of feeds on the lower frequencies, I took the drawings and scaled them to the frequency of 5.760 Ghz. This style of feed uses 10 bolts for achieving the circular polarization and makes it possible to adjust for best results. So back to the milling machine and rotary table to get all the holes accurately drilled and tapped plus the probe connector holes.



The New Constructed Short Feed, TX Probe Using a SMA Connector

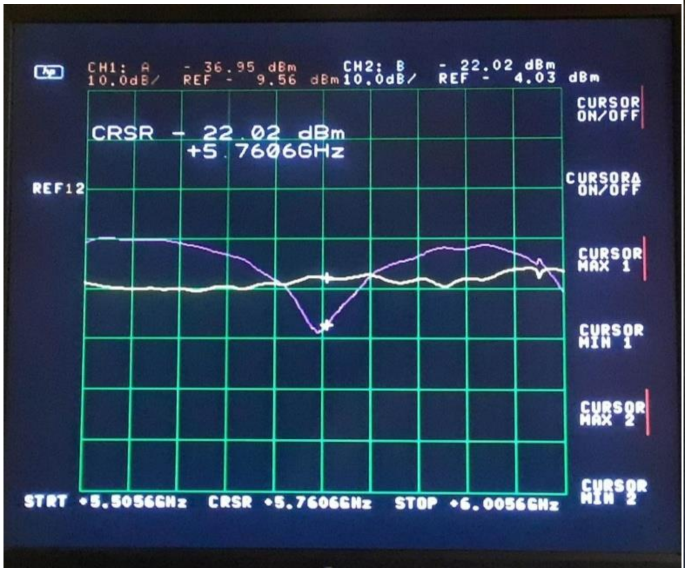


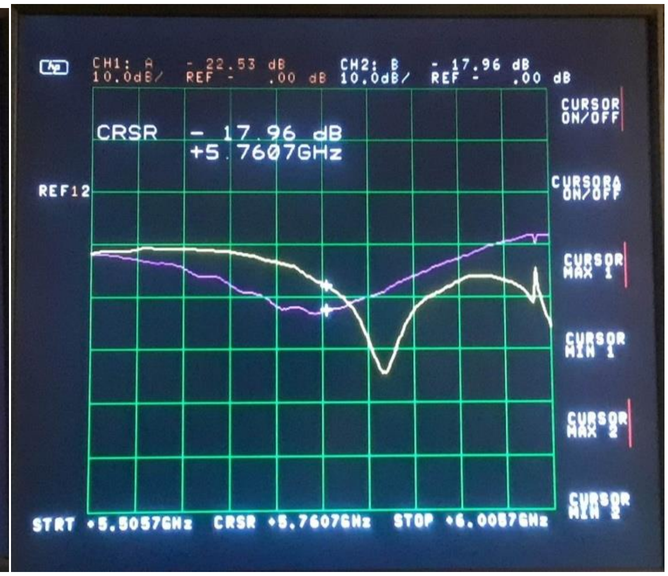


TX Probe, RL = 35 dB **RX Probe, RL = 21 dB**

The first frequency test sweeps and probe adjustments turned out not to bad for the first attempt. This was done also by adjusting the back plate and sliding the IMU launcher section back and forth for the best results.

BUT when the isolation was checked between the receive and transmit probes, it was nothing special…

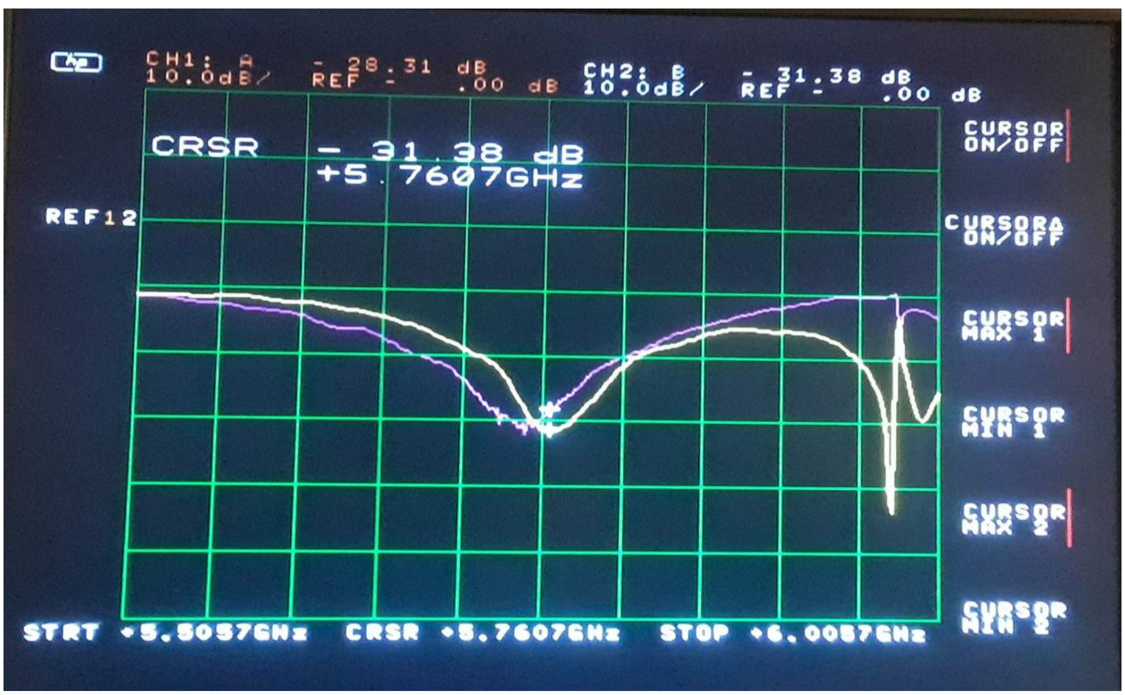




Isolation between probes, around 18 dB

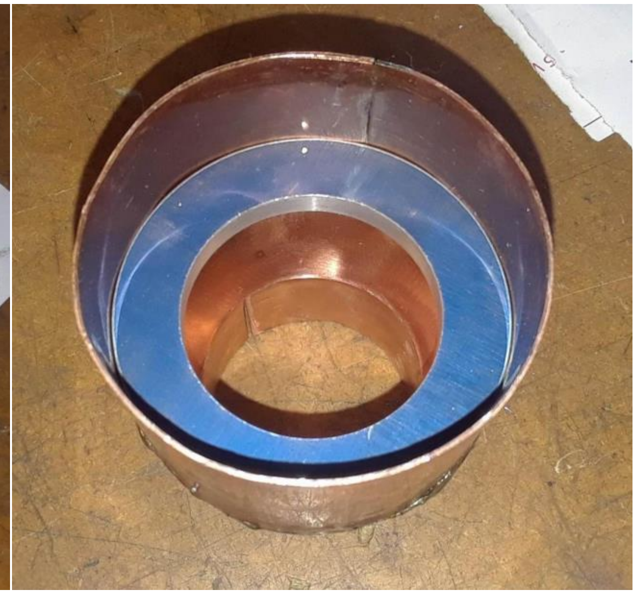
Changed to N connector, ISO 18dB, RL 22dB

I began using a SMA connector and again changed it to an N type as before with the squeezed feed. It wasn't until I set it up for doing the Circular Polarization adjustment that things really came together.

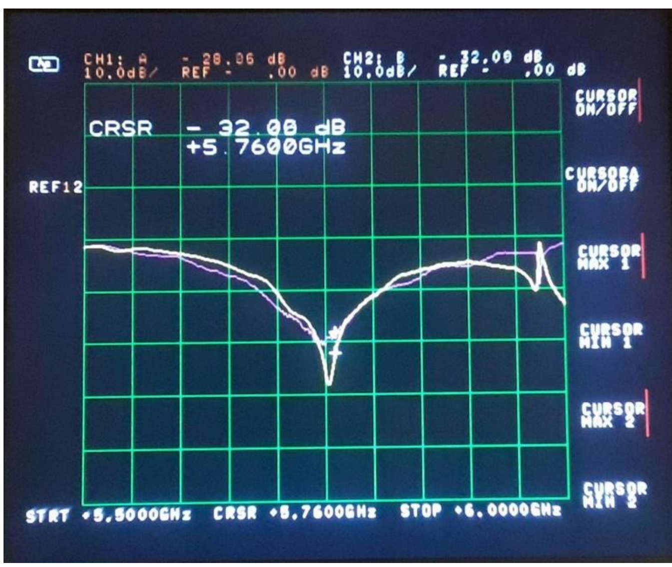


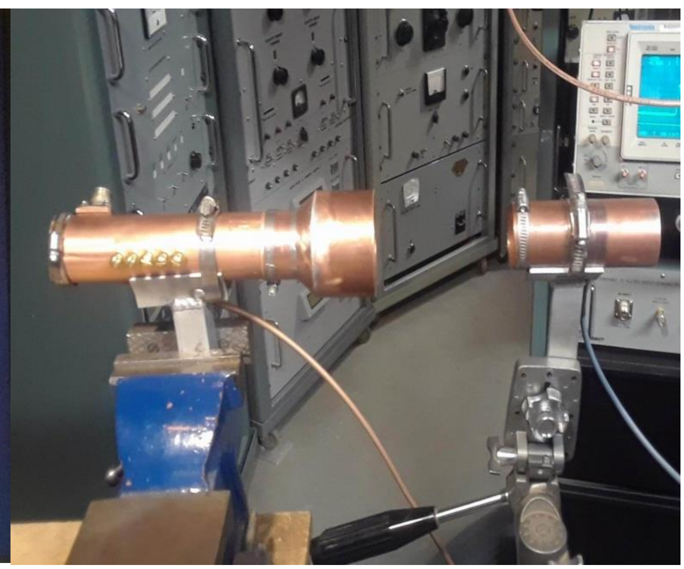
To my surprise after tuning the ten bolts for a real good circular polar test and then going back to recheck the return loss and isolation between probes, the isolation had increased significantly and also nicely lined up the dips on frequency. Readjusting the IMU and back plate and tweaking the bolts even made it better. I then rechecked the circular polarization and saw very little change in it. Once again though I noticed rotating the IMU launcher around the tube shifted the Return Loss dip off frequency. So it was time for a new IMU section.

The New IMU Launcher Construction



With a special ring lathed from aluminum and placed inside the launcher section, it held the funnel centered and clamped on the main copper pipe waveguide. It was then soldered being held in place making it concentric or true.

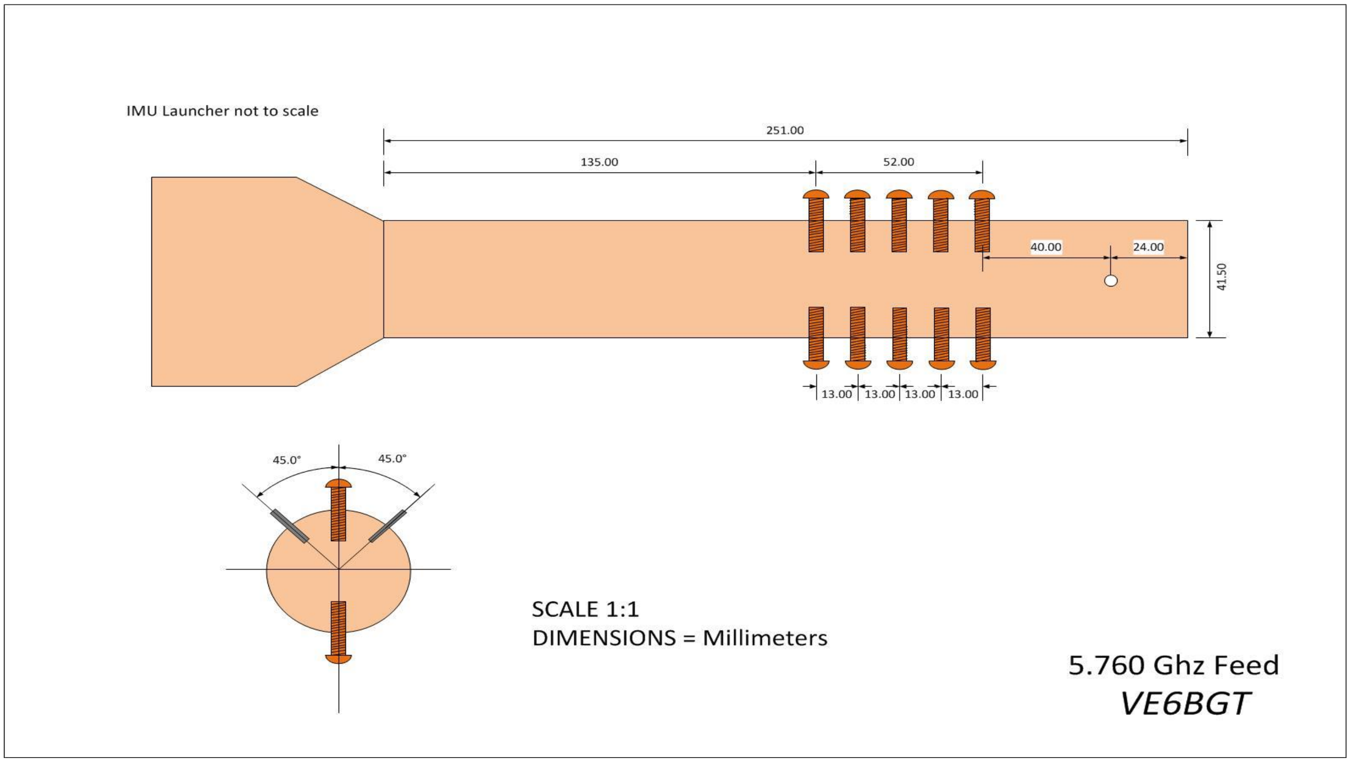




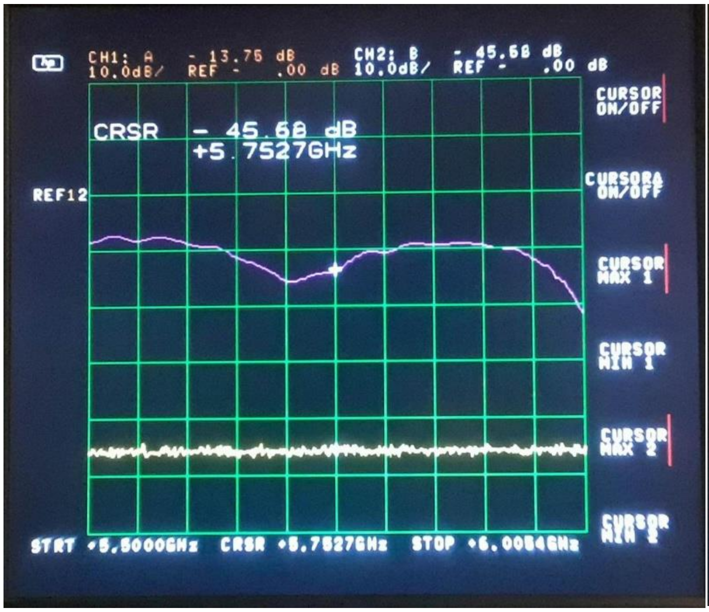
With the improved IMU launcher section mounted the whole feed was once again rechecked and tuned for best results. The TX probe Return Loss was about 28 dB and the Isolation test between the two probes came in around 32 dB. Very little changed now when the IMU was rotated around the feed pipe.

The Circular Polarization was again adjusted and checked; the difference when the test linear feed rotated now was less than 1 dB change in amplitude, the best CP so far.

The Other Big Idea, Would Longer Be Better?

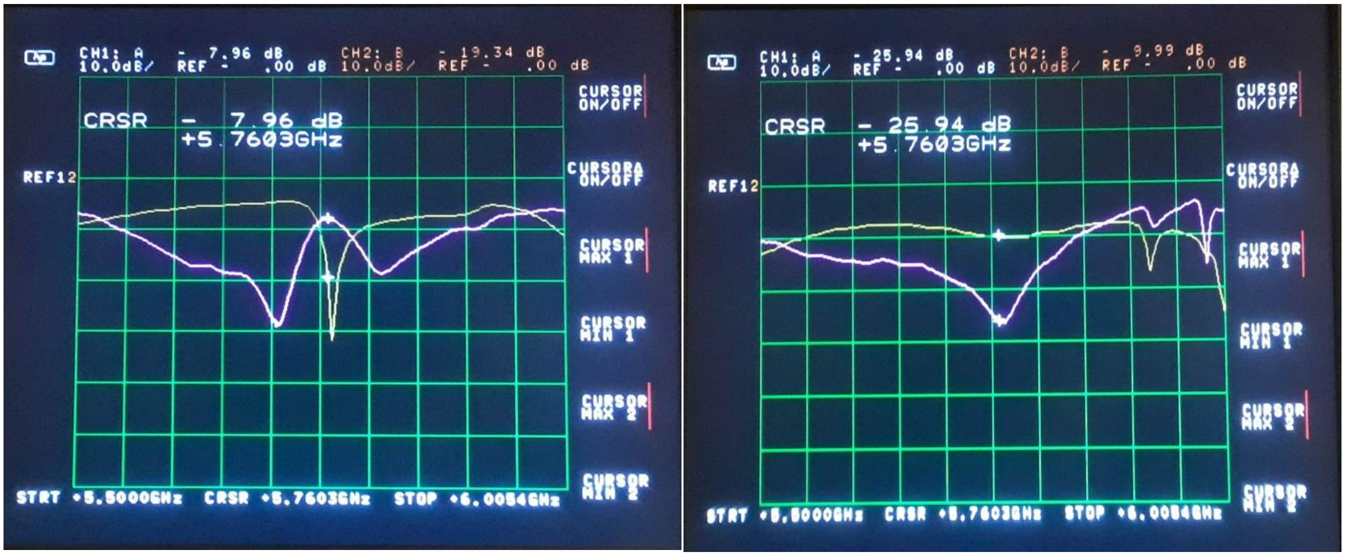


So I wanted to know if I made the overall feed longer and have more room for the CP bolt lock nuts, what would the results be? I started again using a SMA connector on the TX probe.

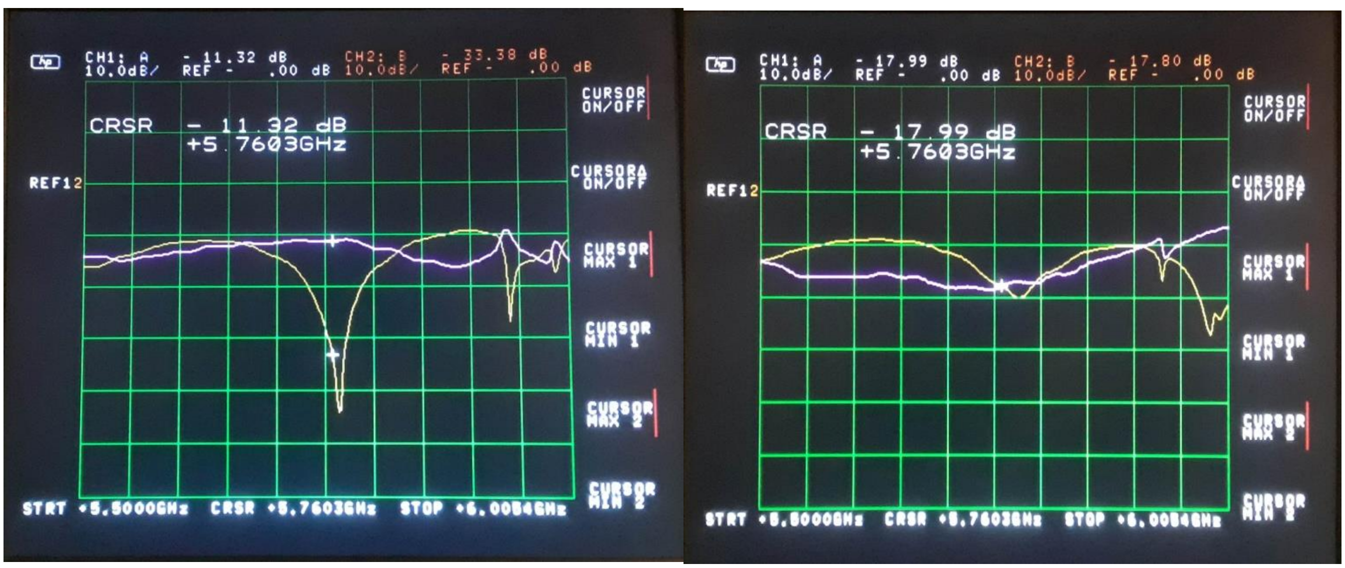


The left pix is trying to adjust the probe only using different thickness of wire. Then on the right pix the IMU launcher and back plate being adjusted for a Return Loss of 29 dB. Isolation again between receive and transmit probes is poor at only around 13 dB. Next was to try the CP bolt adjustment.

The Circular Polarization Adjustment Battle

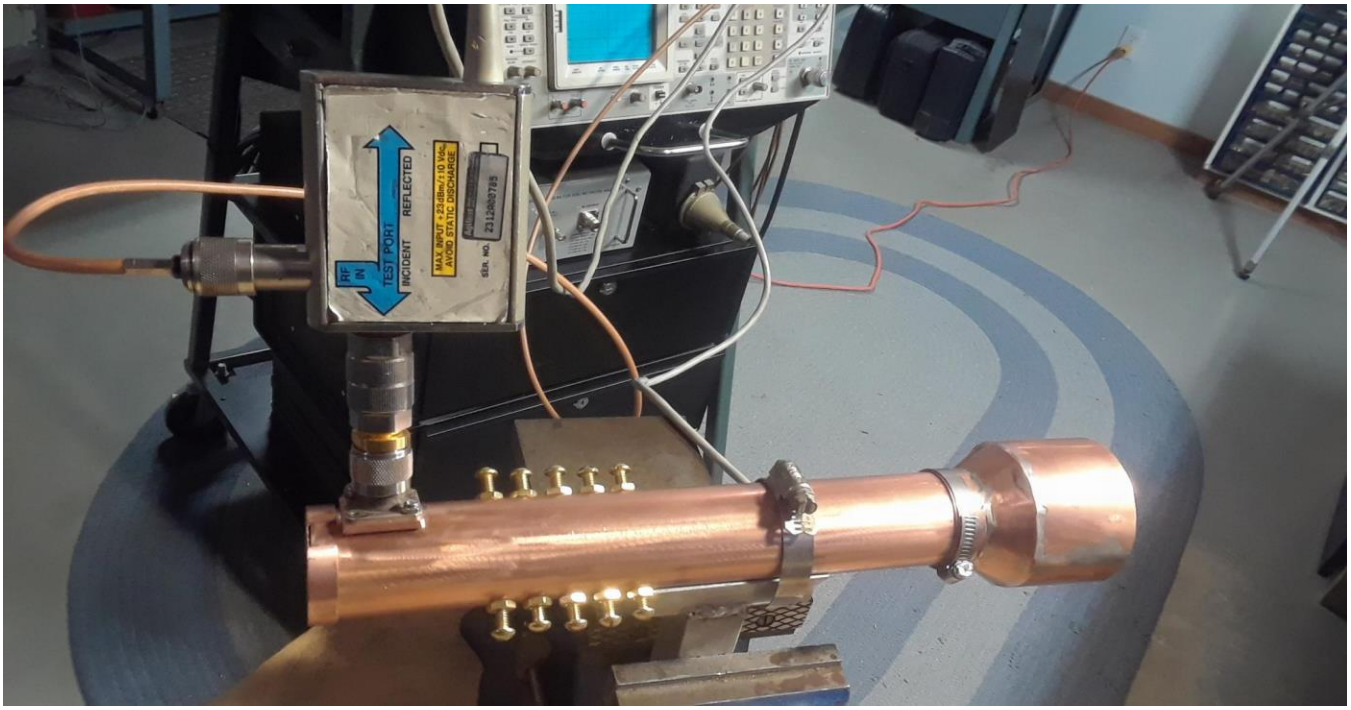


The Multiple Sweep Results Trying to Get the Conditions Right

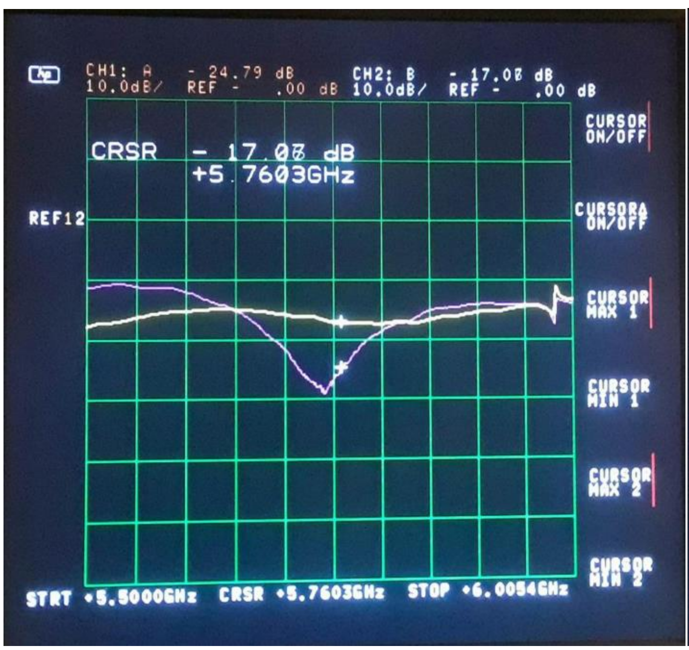


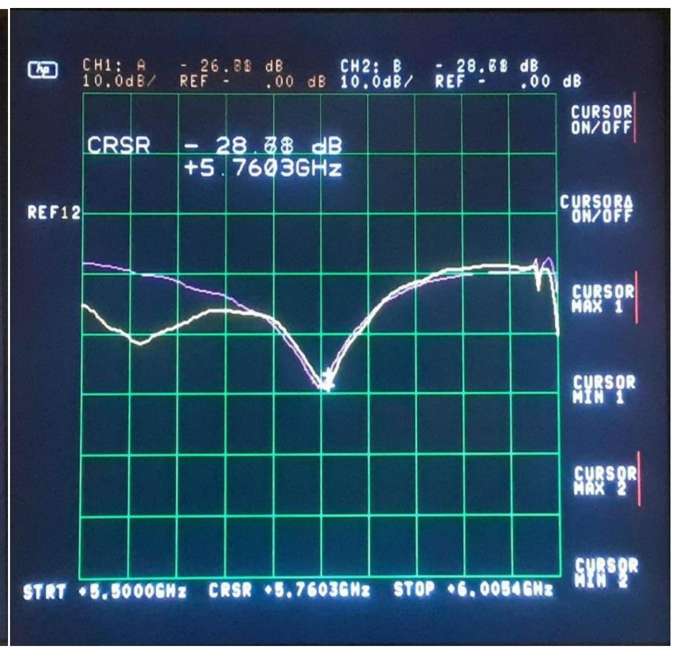
Either the Return Loss Would Be Good, or The Isolation, Never Together

Like before with the shorter feed that tuned well with the CP bolt adjustments, I set out to tune this longer one to improve the Isolation and Return Loss. It was not to be; no matter what I did or tried I could not get both situations to improve together. It was a battle and I spent a long time on it trying to see what would be the sweet spot. The only difference again was that I had a SMA connector on the TX probe, and the spacing between the CP bolts is wider compared to the shorter feed.



So again I replaced the TX probe SMA connector to an N connector and began adjusting and testing.

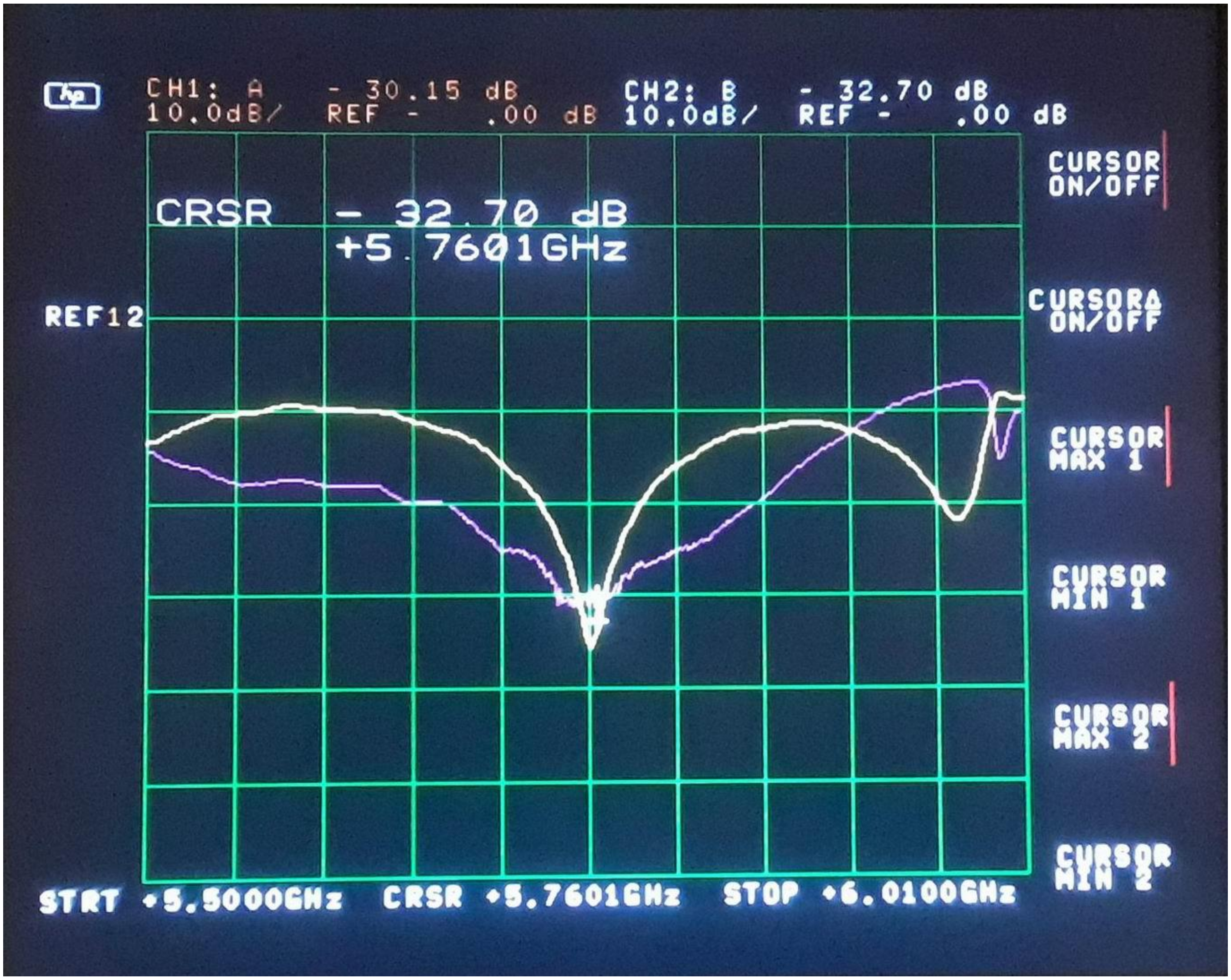




Once again it seemed the N connector was the answer. The pix on the left are the Return Loss and Isolation Sweep adjustment before the CP bolts were screwed in at all. The RL is around 24 dB and the Isolation at around only 17 dB, similar to the other feeds at this point.

The right pix shows how good it improved after the ten brass bolts were adjusted for the best Circular Polarization. As before with the shorter feed having the CP adjusted, it greatly improved the RL and especially the Isolation test between probes. RL is now at around 26 dB with the Isolation around 28 dB.

1 - Final Comparison – “Squeezed” Feed



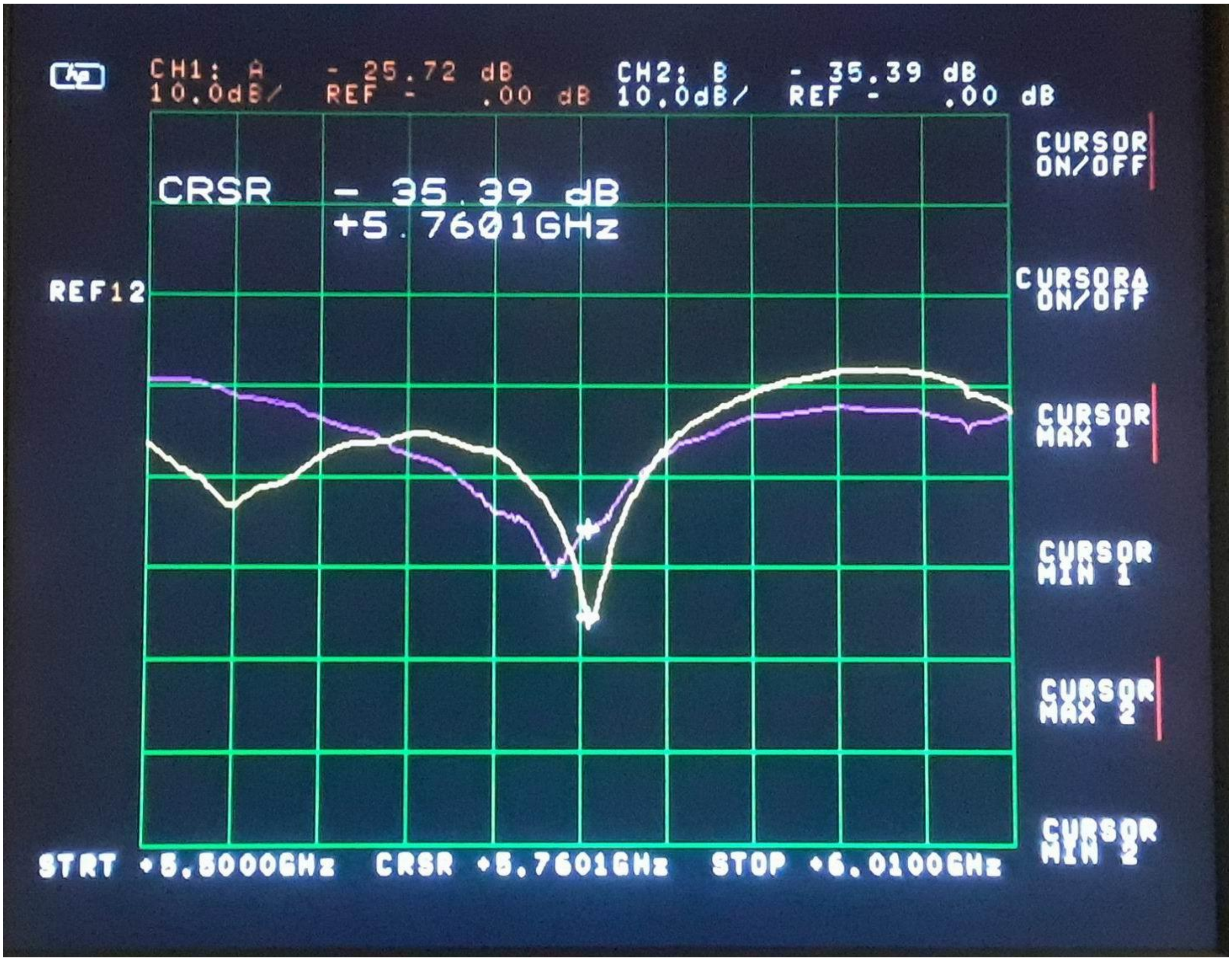
So the final results are in. This final comparison between all three tubes shows that they are very similar but each is better in certain areas.

This pix of the final sweep of the “squeezed” feed shows that the Return Loss of the TX probe measuring around 30 dB, very useable.

The Isolation test between the probes also was good at around 32 dB.

The only weak part of this feed was the Circular Polarization results. When the linear transmitting test feed was rotated there was a significant change in amplitude from the RX probe of the Squeezed feed. As much as 4 to 5 dBm in amplitude was seen on the spectrum analyzer when the test signal was rotated. Since this type of feed has fixed plates it is hard to impossible to adjust for a better Circular Polarization result.

2 – Final Comparison – Long Bolt Polarizer Feed



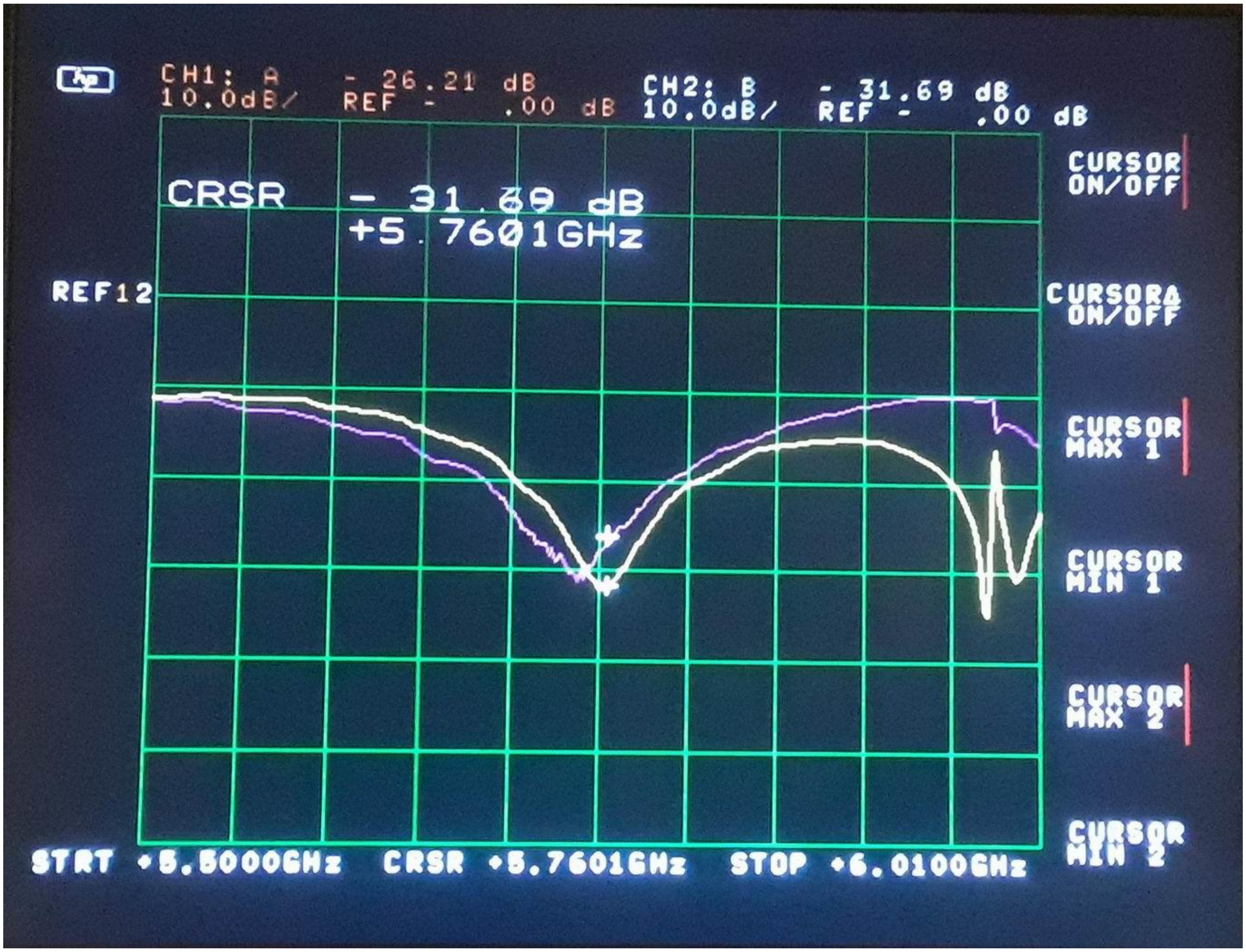
This feed with the longer copper pipe waveguide and using the ten brass bolts for the Circular Polarization was at first a battle to get adjusted and tuned.

The Return Loss came in at around 25 dB and the Isolation between probes finally at around 35 dB.

The Circular Polarization test came in better than the “Squeezed” feed. The amplitude difference I saw was around 2 dBm only. This could be because of the wider bolt pattern of the ten brass CP adjustment bolts.

Again this is quite a usable feed.

3 – Final Comparison – Shorter Bolt Polarizer Feed, The Winner



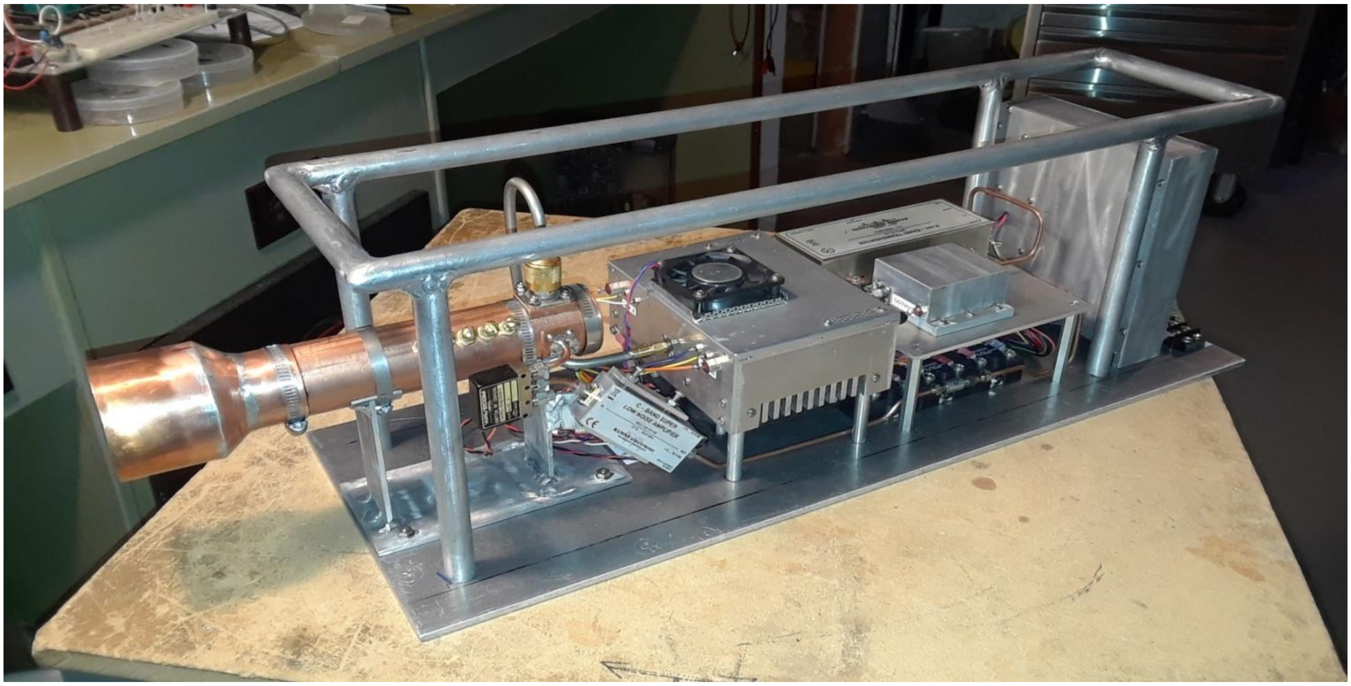
Again the final test of this shorter copper pipe wave guide type feed is excellent. It did seem to tune up easier than the longer one, the Return Loss around 26 dB with the Isolation between probes at 31 dB.

The biggest improvement was with the Circular Polarization test. The difference I measured when rotating the test linear feed was less than 1 dBm at the most. This could possibly result from the ten brass bolts being closer together than the wider spaced ones on the longer feed pipe.

Other Final Conclusions or Results

It seemed that using N connectors made getting better results a lot easier for all three feeds. I was going to use SMA originally but remembered with the 9 CM feed I built before, N connectors just worked better. I did try different types and makes of SMA connectors with the same results. I wouldn't write off SMA connectors all together though. The other big thing I noticed was the effect the IMU launcher had on tuning. To exchange the IMU launcher to scalar rings to see if a solar noise test improved, this would require that the whole feed to be retuned or adjusted.

The Complete 6 CM Feed Assembly

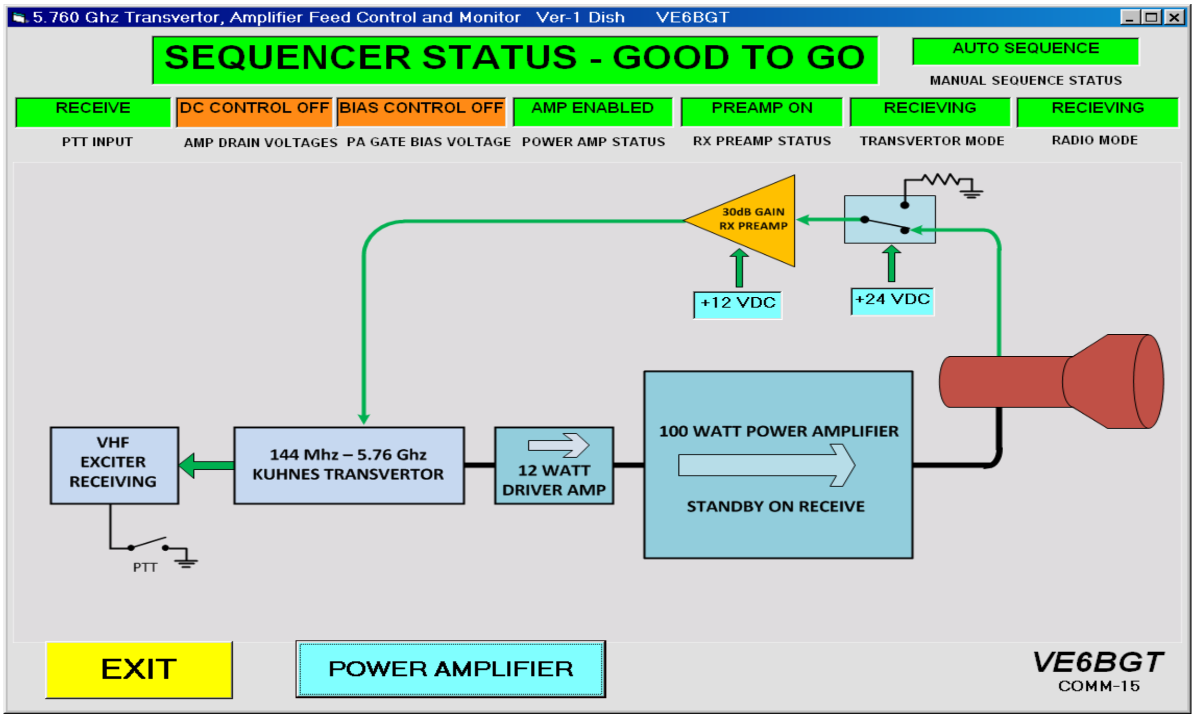


This is a pix of the new complete 6 CM feed assembly ready to be placed on the dish feed mounting shelf. It’s controlled and monitored by a PIC microprocessor in the back box, and uses a Kuhnes transvertor and receive preamp. Lots of testing of the circuits was done to get to this point of the project.

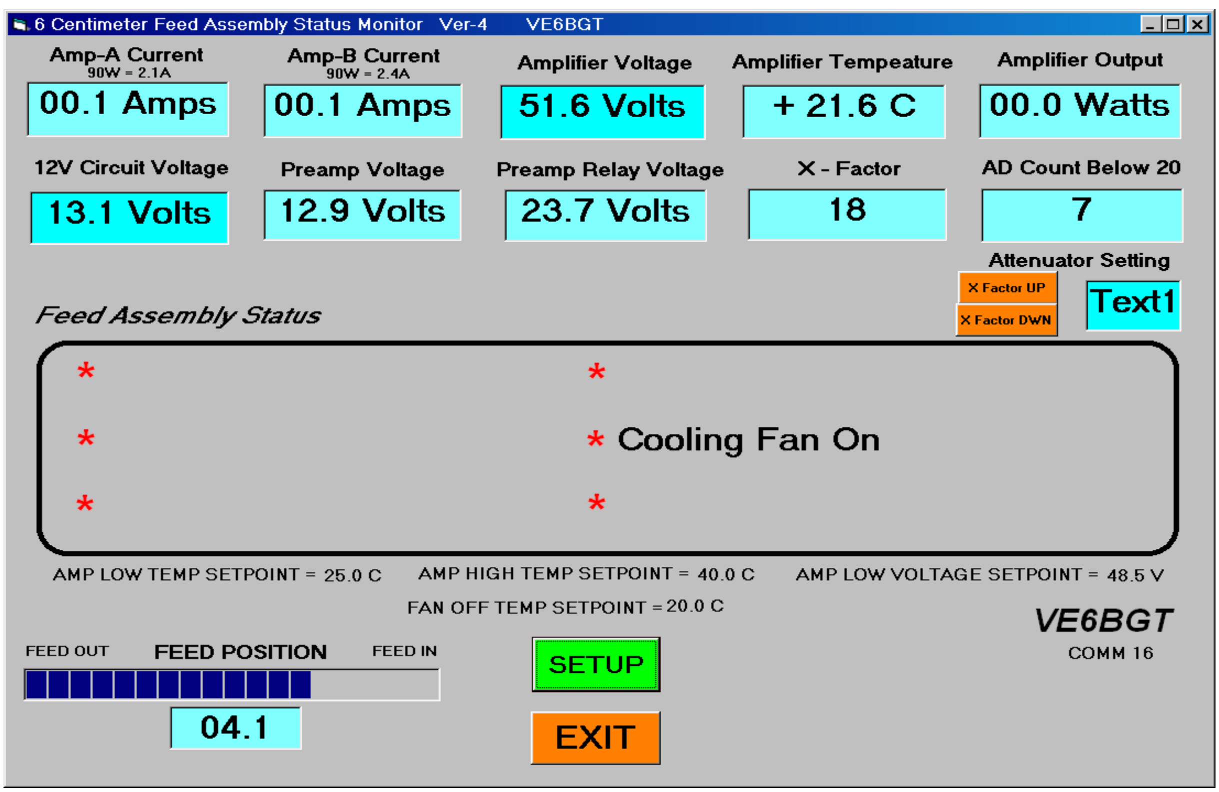
The new 6 CM feed assy. mounted on the 21 foot dish for final testing. Underneath is a feed position actuator to slide the assembly in and out for peaking on solar noise etc.

This actuator has a position sensor that is connected to the PIC circuit and position data is sent back to the shack for monitoring.

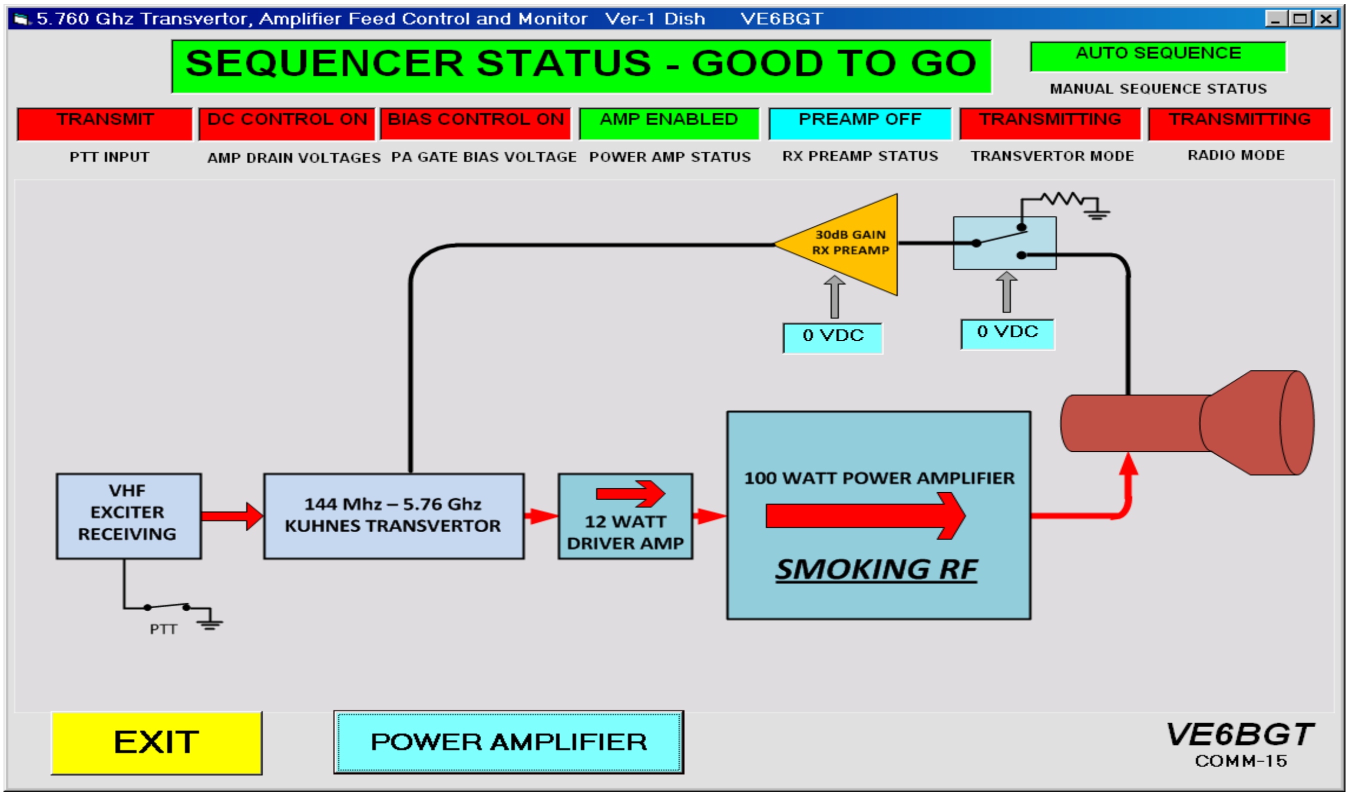
The 6 CM Monitoring and Control Screens



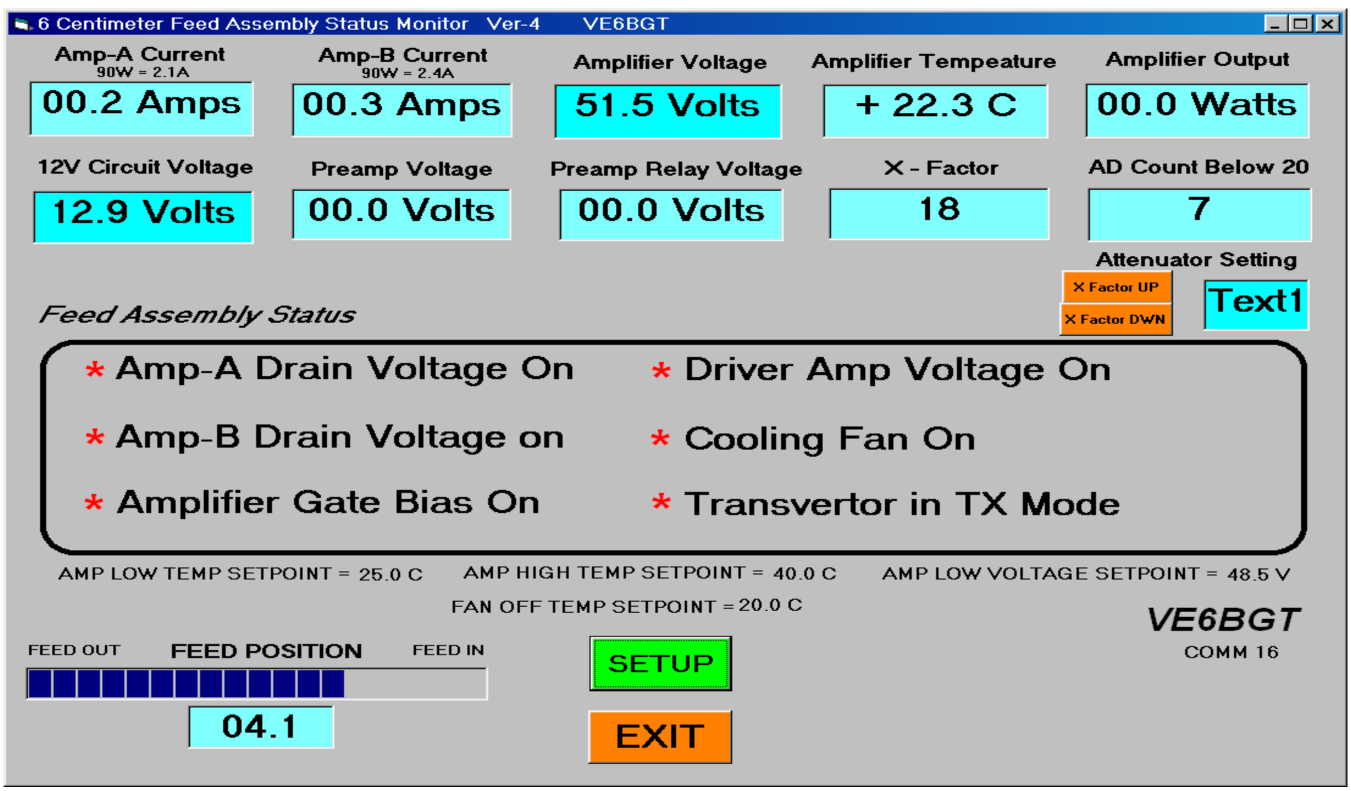
A screen shot of the 6 CM system status in receive mode.



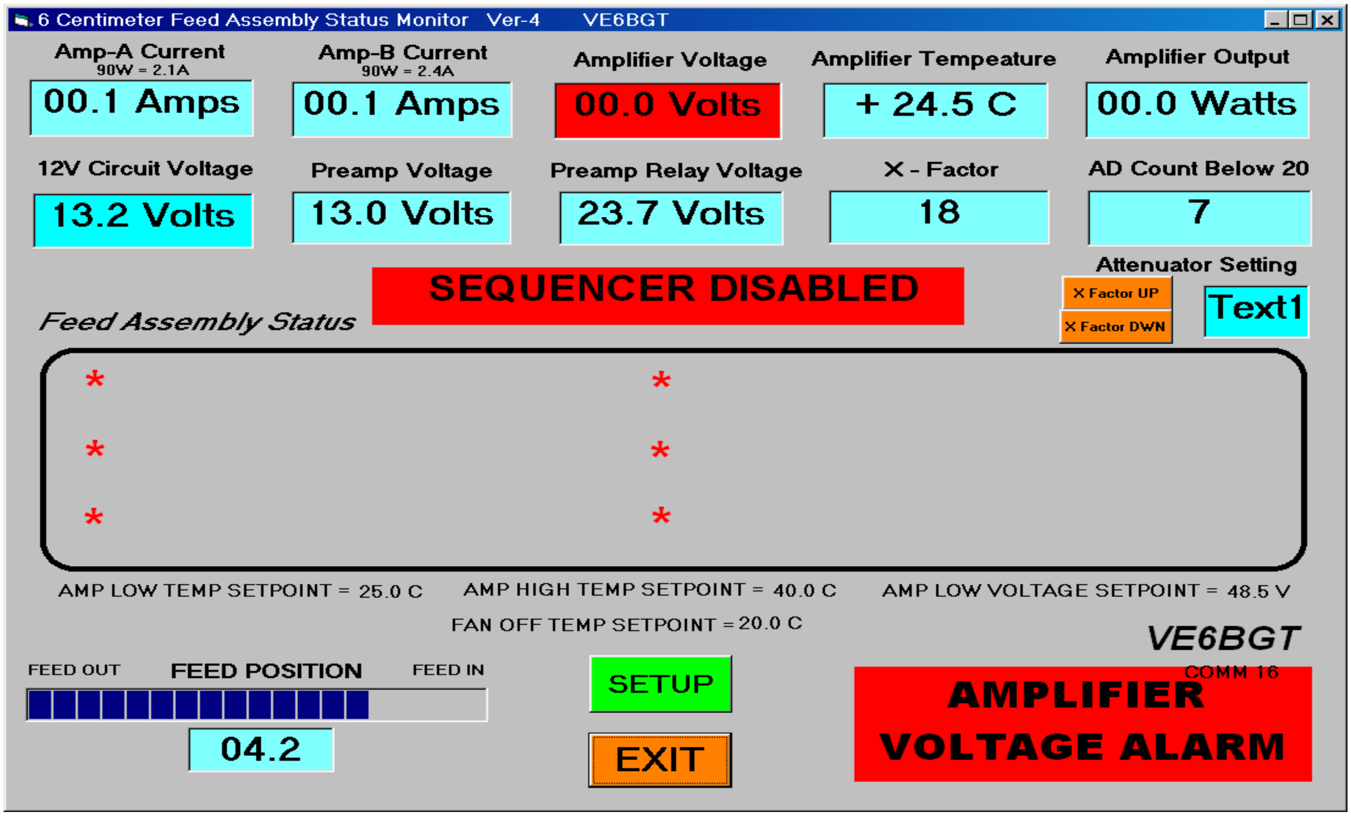
The 100 watt amplifier and various voltage point status monitoring in receive mode.



6 CM System Status in Transmit Mode.



Amplifier Circuit and Voltage Points in Transmit Mode, Keyed Only.



One of the Numerous Fault Warnings, Missing Amp Voltage.

The Dish and Testing the New 6 CM System.