Report on Installation Activities at the LWDA Site

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Introduction

This brief report offers a summary of the Long Wavelength Demonstrator Array (LWDA) installation activities that occurred during the week of June 19-23, 2006. We will focus on briefly identifying what was accomplished, what remains to be done, and then some interesting points to guide future efforts at the site.

Accomplishments

The primary goals of this installation trip were to deliver the shelter to the LWDA site, expand on the established site infrastructure, and test packaged LWDA electronics in the NRAO test facility to verify measurements made at ARL:UT.

Shelter Transit

The shelter was installed at the site after being towed from Austin, TX by Charlie Slack and John Copeland to the site at the VLA. There were no problems in towing the trailer on the highway at speeds up to 70 mph. A temporary transit license tag was used (good for several days), though only a day and a half were necessary to complete the trip.

On entering the site, there was a point at which the truck pulling the trailer became temporarily stuck in the sand near the site. Assistance from NRAO personnel helped get the vehicle moving again, and there were no further problems.

Figure 1. Shelter arriving at the LWDA site. AC unit is at the front of the trailer.

Site Inspection

We conducted an initial inspection of the site to identify any unexpected features, and to familiarize the team with the overall layout. There were no great surprises during this inspection.

Figure 2. Photos showing the array and conduit runs that were previously installed.

Figure 3. Photo showing center of array marker on the left, and foundation blocks on the right.

Shelter Installation

We installed the shelter at the site, mounting it on four of the five provided jacks and seated on four of the concrete pads procured and left at the site by Walter Gerstle of UNM. The fifth jack is the tongue jack, positioned in the triangular portion of the trailer frame. This jack was not used because it is close to two of the other jacks, and it is difficult to maintain an even weight distribution across all three.

The power cable was run from the trailer to the electrical junction box, and power connected to the shelter. We tested the shelter power systems, verified they were working, and proceeded to use them during the remaining portion of the installation. The AC unit was connected to power is working. It is controlled by a thermostat in the shelter. When we departed, the termostat was left at a setting of 80^oF.

We had intended to install an external light fixture to the shelter. However, the site light located at the junction box illuminates the external stairs to the shelter, and the shelter mounted light fixture was not needed immediately. A revised location for this light will be determined and it will be installed on a subsequent visit.

The network connection will be discussed in a following paragraph.

Figure 4. Photos of the shelter installation. Clockwise from top: positioning the shelter, concrete pad for the shelter jacks, the lights illuminating front of the shelter, and the final shelter location with the junction box at right.

Fiber and Network Connections.

The fiber patch cord running from the shelter to the junction box was installed. NRAO had replaced the junction box previously installed with a better junction box. This box had a penetration cut in it which was too large for the conduit NRAO uses, but which worked for the LWDA conduit.

The NRAO fiber in the box was not terminated in connectors, and so could not be connected to the LWDA patch cord. As it turned out, further testing of this link by NRAO staff indicated a problem on the line that they installed. On Friday, NRAO staff were continuing to troubleshoot the problem.

Figure 5. Photos showing the installation of the fiber conduit from junction box to shelter.

Conduit Installation for Antenna Cables

The intended goal here was to complete the conduit installation begun by Walter Gerstle and Greg Taylor of UNM. However, it was decided to revise the original conduit installation to account for two factors.

1. A slightly different location of the shelter was used than originally indicated in site drawings that were provided to UNM.
2. The conduits that had been installed did not penetrate the collector box at right angles to the sides, making the sealing of the penetrations against water difficult.

Revisions to the conduit took a considerable part of the week, and this suggests that in the future more detailed drawings and planning are required for this work. Conduit runs were completed for all antennas and the incoming fiber.

We attempted, but failed, to install the trailer tie-down hardware which would anchor the shelter in a serious wind storm. It was not possible to drive the large anchoring screws into the ground with the manual equipment available. We may want to investigate having a contractor take care of this for us (a contractor with the requiste power tools!).

It is useful to note that the temporary solution of sealing the ends of the (incomplete) conduit with duct tape worked well. No local residents had taken up occupancy in these desireable pieces of real estate.

Figure 6. Photos showing the relocation of the two 2” conduit lines from the collector box at the array edge to fit the actual shelter location.

Figure 7. Top photo shows completed antenna and fiber conduit running to shelter patch panel. Bottom photo shows detail of the conduit meeting the patch panel, as well as one of the shelter tie-downs.

Figure 8. Clockwise from top left: 1) flexible conduit attached to antenna mast, 2) trenching for the final connection to the antennas, 3) looking out from the shelter to the completed (but filled) runs, and 4) a completed, unburied section, of the flexible conduit running to an antenna

Cables, Baluns and Lightning arrestors

We successfully installed LMR-240 cable between all 16 antennas and the shelter. This required running two cables through the installed conduits, and then attaching connectors to the cables. At the antennas, these cables were tied to lightning arrestors. Short pieces of pre-fabricated cable were used to run from the lightning arrestor to the balun. We performed some basic checks to ensure that all installed cables were properly built (i.e. not shorted). We installed the baluns at each of the 16 antennas and these were connected to the incoming cables.

Figure 9. Photos of the incoming antenna cables at the shelter. Fiber is the yellow cable on the right of the bottom photo.

Figure 10. Photo showing an installed balun.

Data Collection on Wednesday

On Wednesday during the VLA maintenance period, we setup the North-South dipoles on antenna stands #9 and #10 for data collection. The two antennas were temporarily wired using coaxial cable strung along the ground through spare connectors on the shelter to a sealed NEMA box containing the receive chain. The receive chain hardware and software was nearly identical to that used on the May 24, 2006 trip to Palmetto State Park. The two antennas were calibrated for both amplitude and noise figure using a noise source. Following calibration, data was taken for nearly 8 hours, and includes both power measurements entire over the 60-88 MHz band and 5 second snapshots of the 73.0-74.6 MHz astronomy band taken approximately every 3 minutes. Additional longer data collections were taken at other frequencies of interest. This data will be made available to anyone with an interest in it.

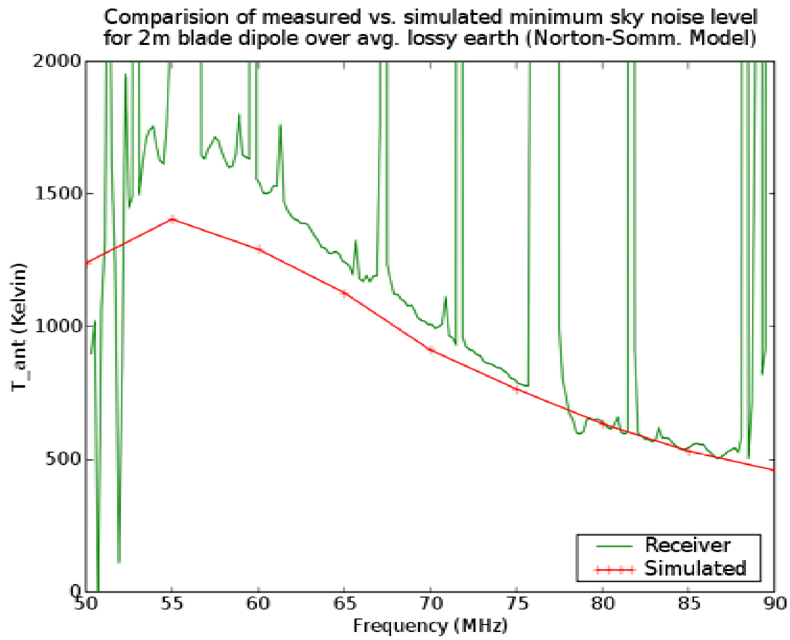

Figure 11. Measured and simulated sky noise results. The measured values were taken at the LWDA site with the LWDA receive chain.

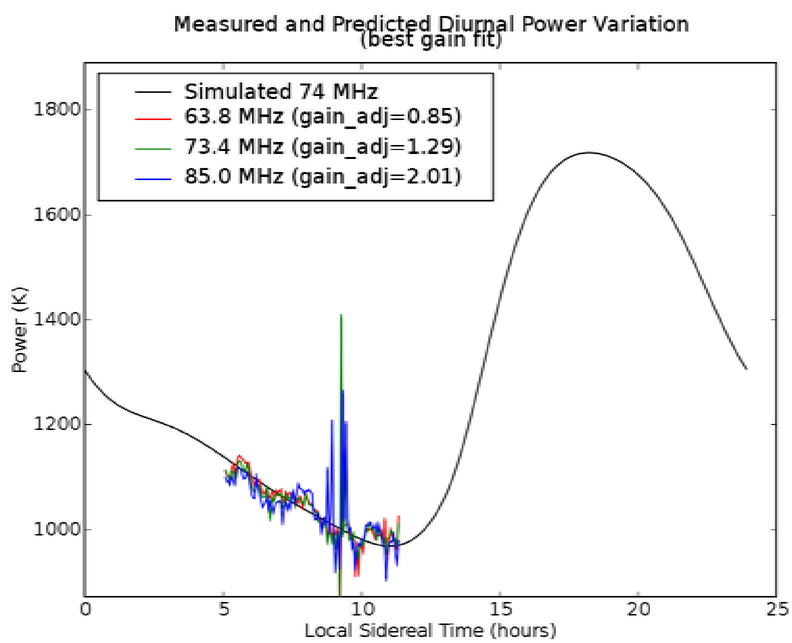

Figure 12. Measured sky noise in quiet bands as a function of time. A frequency-dependent gain adjustment (of 29% at 73.4 MHz) has been applied to the measured results. No attempt was made to eliminate RFI from the raw data.

RF Emissions Testing

During the early part of the week, we performed a limited amount of emissions testing on LWDA electronics using NRAO's reverberation chamber at the VLA. Our focus was to verify previous emissions measurements made at ARL of a full LWDA receive chain. The components in the setup consisted of two Minicircuits ZKL-2R7 gain blocks (one for each channel), two ARL SGS variable gain blocks, and near final versions of the receiver and adder connected together inside a highly shielded NEMA enclosure; all individual circuit boards were placed inside final or near-final versions of the board enclosures.

We measured emissions of the receive chain by performing measurements with the NEMA enclosure lid open. A second set of measurements, made with the lid close, will provide us with an estimate of te the shielding provided by the enclosure. Initial results suggest that RF emissions of the receive chain, as measured in the NRAO chamber, largely agreed with those taken at ARL. This allows us to form a reasonable estimate of the emissions that should be expected from the full deployment of 16 receive chains, which in turn will guide development over the next few weeks of the rack enclosures which will house these components.

One interesting point we encountered during these measurements was that we needed to follow a somewhat different measurement procedure than NRAO typically uses to measure emissions from their equipment. LWDA electronics emissions are dominated by clock harmonics, which required us to employ narrower spectrum analyzer sweep spans and wider resolution bandwidths than is typically used in order to capture the full power of the harmonics. We will need to coordinate with Ylva Pihlstrom and Dan Merteley of NRAO to determine measurement settings that will be used in the future to measure LWDA equipment. Very limited measurements were also made in the chamber with a laptop connected to the receive chain. Though wideband noise was emitted by the computer, it was not terribly strong. No attempt was made, however, to find clock harmonics emitted by the device, which may be much higher in power than the wideband noise.

We are planning to analyze the data collected in these measurements and the results will be provided in a more extensive writeup next week. In addition, the raw data files will be provided to Ylva Pihlstrom and Dan Mertely so that they can perform an independent analysis.

Open Items

The following items remain open and need to be completed in the near future.

1. The trailer tie downs need to be installed.
2. A new location for the shelter light needs to be identified and installation needs to be completed.
3. NRAO needs to complete work on resolving fiber connection problem.
4. NRAO fiber needs to be mated to the patch cord currently installed to the junction box.

5. One of the baluns was pulled from an antenna and it needs to be replaced.
6. The shelter needs to be grounded to the NRAO installed ground wire. This requires an end lug. One hundred feet of #6 bare copper wire ground cable is located on a reel in the shelter.
7. We need to identify whether SEC put surge protectors on the inputs of the transformers.
8. We need to obtain a final surveyed set of antenna position measurements to help with calibration. A quick check indicated that the antennas might not be where expected - but this needs to be repeated.

Lessons Learned

1. For towing the shelter and trailer, a four wheel drive vehicle is recommended, particularly on the sandy soils characteristic of the site.
2. Power outages, surges and sags are common during this time of year. This became evident Thursday afternoon when there was a power failure for four hours. Since we are directly on the SEC grid, we have no access to the VLA backup power. We were fortunate that the we were able to borrow a generator from NRAO staff.
    a. We may want to consider locating a generator permanently at the site.
    b. The implications of power interruptions need to be considered for LWA. Is there a need to have more than a simple UPS at each site? Does each site need a generator.
3. The collector box at the edge of the array allowed us to go from 16 conduits(0.75” in diameter) to 2 wider conduits (2” in diameter). Only pulling the final 2-4 cables became difficult, but not enough to warrant a larger conduit size.
4. During the late afternoons, wind blown sand made it difficult to work for about an hour. It would be a good idea for anyone working at the site to have protective glasses for such events.

Acknowledgements

The authors would like to acknowledge the support from the NRAO personnel who took time to help resolve problems and talk to us about the standard operating procedures at the VLA, and life working in New Mexico. We would particularly like to acknowledge the help of the VLA Safety Officer James Sullivan, site electrical engineer Bob Broilo who provided a generator for us to use during the power outage, and Tom Baldwin for his assistance with issues regarding the fiber.