Report from LWDA Site Field Trips
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Summary

Lessons from an antenna deployment field exercise and follow-up LWDA site visit in the winter of 2007-2008 are briefly reported. The main results pertain to the ruggedness and survivability of certain types of candidate LWA infrastructure. Most notably and contrary to experience previously limited to warmer weather, exposed above ground co-axial cable, even within fenced enclosures, is subject to damage by animals. It is therefore not an option for long term antenna deployment for the LWA project.

Background

In late November 2007 Henrique Schmitt, Brian Hicks, and Ken Stewart traveled to the LWDA site with support from a UNM-based team for a pre-planned sequence of RTA (cf. LWA Memo 91) installation and testing activities. The objectives of the trip included: 1) to inspect and retrofit, if needed, a previously deployed row of 8 RTA-2 antennas installed east of the main LWDA fenced enclosure; 2) to deploy a second row of 8 RTA-2 antennas parallel to the initial row; 3) to deploy four RTA-1 antennas within the LWDA fenced enclosure; and 4) to deploy the required electronics (e.g. active baluns and bias-T powered cabling) to support initial test observations including drift scan total power measurements using the SPECMASTER data acquisition system. Additional objectives included conducting an inventory of RTA equipment and inspecting the integrity of the site, including the LWDA.

As described below, unforeseen challenges including inclement weather but most notably cable damage by animals, precluded obtaining sky measurements. Nevertheless the relatively brief field trip provided useful lessons. A brief follow-up visit a few weeks later exposed additional problematic infrastructure issues, and the lessons from both field trips are summarized at the end of this report.

RTA Antennas

The first task involved modifying the 8 RTA-2 antennas installed at the outlier site (prior to the arrival of the NRL team) to facilitate their attachment to the active baluns. This unforeseen retrofit was needed because an alteration from the original design required an unworkably long lead to connect the blades to the baluns. This problem was addressed by attaching 45º brackets to the end of the blades, allowing their direct connection to the baluns. While making these changes the team noted that the 8 pre-installed RTA-2 antennas were unacceptably inhomogeneous (Fig. 1). For example, it was necessary to file the ends of the brackets to eliminate fragments of aluminum that would otherwise pose a hazard to the active baluns. The position of the top bar of the antennas (in another unexpected design deviation) was at odd angles, often making it hard to attach the brackets. Furthermore, the three aluminum rods that constitute the main body of the blade did not always properly converge at the apex, an indication of unwanted incongruous opening angles. A second set of 12 new antennas (8 for RTA-2, 4 for RTA-1) were brought to the site and installed on Friday (11/30/07) by a UNM team including Eduardo Aguilera, Ylva Pihlstrom, Masaya Kunyioshi and David Martin. These antennas (see Fig. 2) were much more homogeneous and generally reflected much better craftsmanship than the pre-installed first set of 8 RTA-2 antennas.

Despite inclement weather (extensive periods of rain in near freezing temperatures) all 20 RTA antennas were successfully deployed by the end of the day on Friday, together with their respective ground screens (Figs. 2-4). However, due to cable damage (see below) electrical testing was not possible. Since it would have been necessary to remove the baluns to install new cables on any future RTA effort, the decision was made to leave the antennas in a relatively good preliminary alignment, and forego a more accurate alignment to a subsequent trip when the outstanding infrastructure issues can be addressed.

Figure 1: Example of inadequate RTA antenna construction.

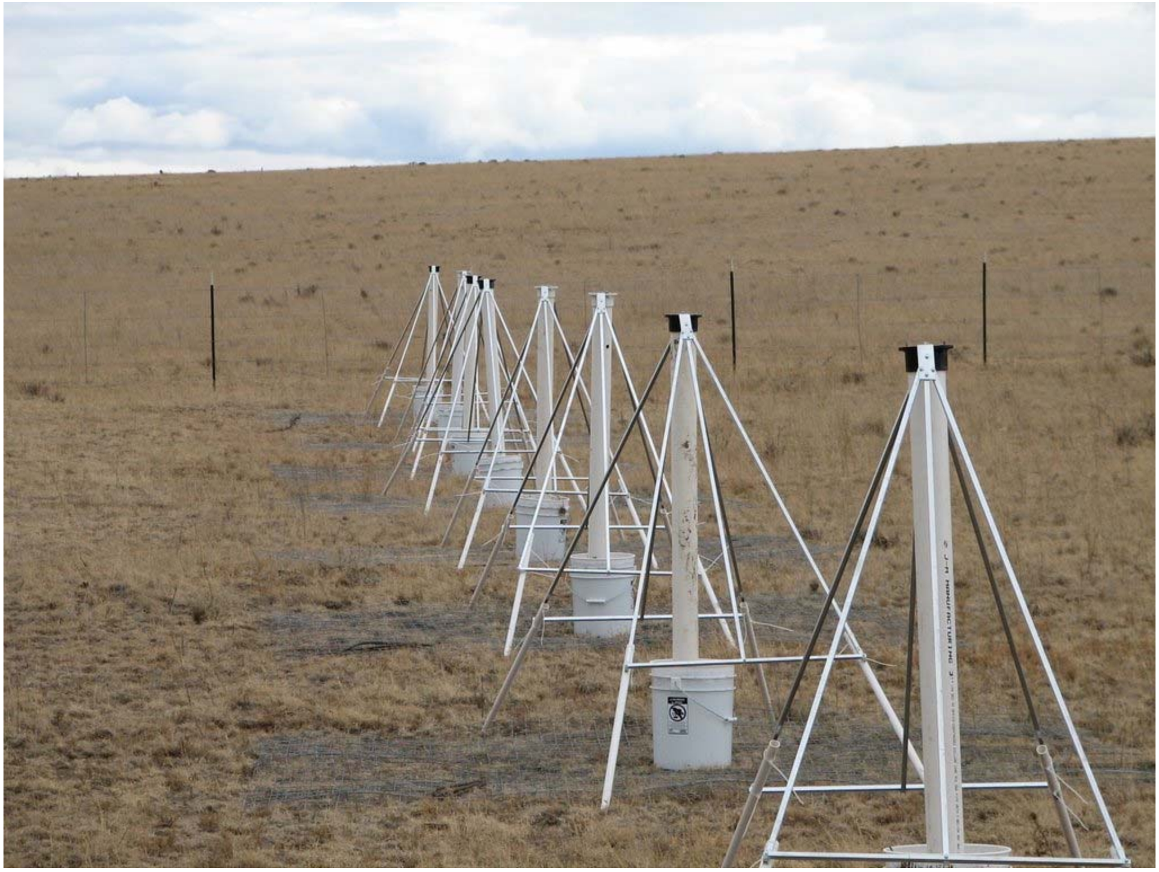

Figure 2: Single row of reconstructed and improved RTA-2 antennas. Unfortunately the improvised anchoring system using buckets of sand failed after a strong wind storm.

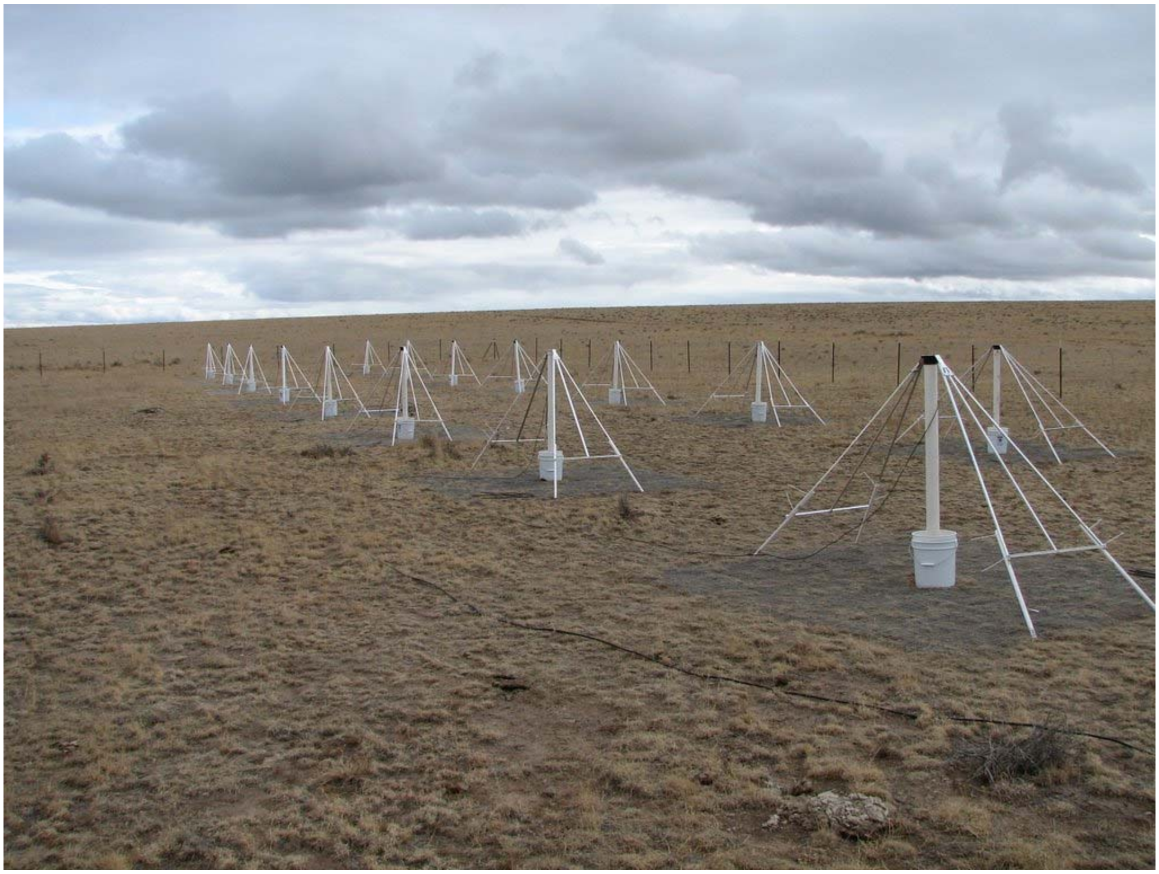

Figure 3: Two parallel rows of RTA-2 antennas.


Figure 4: View from fenced LWDA site of RTA-2 antennas at eastern outlier location.

Exposed Cable Damage

An inspection of the 8 x 30m LMR200 cables available at the RTA-2 site showed that 7 of them had been chewed by animals and some of them also had severe kinks (see Figs. 5-7). In some cases the holes affected only the outer mesh, but in most the cuts penetrated to the inner part of the cable rendering it unusable. Samples were brought back. The assumption is that these cuts were probably caused by rabbits (or other rodents). In the case of the kinks, the origin is less clear, but they may have been caused by the same cattle that destroyed an earlier initial deployment of 4 RTA-2 antennas. The team also inspected the 2 x 300m LMR400 cables running from the electronics shelter to the RTA-2 outlier site and discovered that they had also been chewed, particularly close (between 15 and 50 m) to the RTA-2 fence. The NRL team also determined that one of the cables ***inside*** the LWDA enclosure was chewed, specifically the cable going from the shelter to BB3, just outside the point where the cables leave the PVC conduit. It may be possible to substitute this cable with LMR240 (previously utilized at the NLTA) available in the shed during a future field trip.

A clear lesson was the need to protect all above ground cabling inside suitably rugged conduit (or by other means), including those extending at least 1 foot above ground. This was because in some cases the damaged cable segments extended at least that high above ground. Since the trip, we have been made aware (by NRAO) of a technique of deploying cables above ground within a protective, inexpensive covering that may serve as an alternative means of protection for the LWA cables.

Figure 5 (left) and 6 (right): Examples of cable damage from animals.

Figure 7: Another example of cable damage from animals.

LWDA Infrastructure

A check of the LWDA infrastructure indicated that everything was in order with all visible hardware intact and undamaged. However, the team discovered a set of large holes on the ground, close to the center of the array, indicating that a family of rabbits, prairie dogs, gophers, or related species, had recently been active there (Fig. 8). No damage from their activity was readily visible, though it is not clear what kind of damage they may have caused underground, either now or in the future. It reinforced the lesson that it is probably necessary to install all future LWA cables in conduit, both above and below ground.

Figure 8: Example of digging activity near the center of the LWDA site. There is currently no evidence of any damage, either above or below ground, to the conduit-protected cabling associated with the LWDA.

Considerations for future work and related issues

The unforeseen damage to the infrastructure precluded obtaining any sky measurements with the newly deployed RTA antennas, and a decision has been made to cease current work on the project. In order to permit any future deployment of the type originally proposed for the RTA, for example for environmental testing or interferometer test observations of LWA-1 prototype hardware, protection of cables, for example within buried conduit, will be required. For the cables inside the outlier enclosure it may suffice to leave the conduit (or other form of protected cable) above ground. In the case of the 300 m cable run between the outlier site and the LWDA electronics shelter it may be necessary to bury the conduit, since leaving it above ground may expose it to damage by passing cattle (TBD). The fenced outlier site remains a valuable asset for future test observations since a baseline at least that long is required to resolve out the Galactic background emission sufficiently for sensitive interferometer measurements (see Memo 92).

The suggestion to employ student labor both for educational as well as cost savings purposes remains attractive and valid. However the experience from this trip indicated that future student-based work, including construction work for deployment of experimental hardware, needs to be much more closely supervised. A related lesson was to avoid deviation from an adopted design and installation plan except after very careful consideration and review. This lesson was driven home when soon after the trip a wind storm knocked over several of the RTA antennas. This was an indication that a well intentional but insufficiently tested deviation in the anchoring system from the original antenna installation plan had failed.

Experience from the January 2008 Follow-up Field Trip

During a one-day follow-up visit to the site on January 17, 2008, Tracy Clarke and Henrique Schmitt noted the following issues. The PVC pipe covering incoming cables at the LWDA site, by the power meter, was broken, exposing the cables (Fig. 9). They suspect the pipe may have been broken by an animal digging a hole under the shed. They also noticed that in some places there were holes dug along the buried pipes, although in that case they did not notice any damage to the pipes (Fig. 10).

Figure 9: Broken PVC pipe covering incoming cables at LWDA site.

An inspection of the LWDA antennas showed that, in some cases, the sealant at the ends of the conduit covering the cables may be degrading and getting disconnected from the pipes (Fig. 11). Also, it was noticed that the screws attaching the blade stabilizers to the masts were starting to get lose and require fastening to secure the integrity of the array.

Figure 10: Example of holes dug around buried pipes associated with the LWDA.


Figure 11: Example of sealant coming lose at conduit joint.

Closing Summary and Lessons Learned

The goals of deploying antennas and obtaining test observations on this trip fell short of expectations, though not from a lack of effort. While disappointing, the lessons learned were nevertheless valuable – we list those below:

1) Contrary to prior experience, laying exposed co-axial cable above ground, even within fenced enclosures such as the LWDA site, is not an option for the LWA project. Moreover, the evidence of extensive under- and above-ground rodent activity indicates that ***all*** LWA cabling likely needs to be enclosed in rugged conduit or otherwise protected.
2) At least one example of above ground broken PVC pipes now exists at the site. Until the source of the damage is understood, future deterioration of PVC-based infrastructure probably can be expected.
3) Significant burrowing activity associated with buried conduits is present and increasing at the site, although there is currently no evidence for any underground damage to conduit-protected cabling.
4) Sealant associated with LWDA conduit joints is deteriorating.
5) The LWDA itself continues to prove very rugged and has sustained little if any damage. However various nuts and bolts are loosening up with notable implications for future deployments of much larger numbers of antennas.

6) Both trips exposed the need for more frequent monitoring of the site to check the integrity of installed equipment and infrastructure on a regular basis.
7) Critical-path student activities need to be more closely supervised, especially if relied upon for experimental deployments tied to inflexible timeline and schedules.
8) Deviations in pre-planned design and deployment activities must only be adopted after careful review and preferably advanced field testing. For example the improvised technique of anchoring antennas using buckets of sand failed in the first high wind storm.
9) We recommend adopting a contingency to accommodate schedule slippage of at least 50% due to unforeseen delays related to inclement weather and other unforeseen challenges.
10) For winter trips especially, field teams should bring foul weather gear in anticipation of the most inclement weather conditions.