BUILDING A GROUND-LEVEL AZ/EL MOUNT: Volume VII

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EXPLORING AN OPTION FOR ELEVATION MAINTENANCE MODE

As described at the end of Volume VI of the real-time progress report documentation series, there are two elevation modes established for this telescope:

1) **Normal Operational Mode** in which the dish elevation angle range is from 90 degrees (bird bath orientation) to 10 degrees. This mode operates suitably well already with the dish firmly attached to the AZ/EL mount via four I-beam/trolley connections, as described in detail in Volume VI, and

2) **Maintenance Mode** in which the dish elevation angle range is from 10 degrees to -90 degrees. In maintenance mode it is possible to place the feed horn close enough to the ground that replacement/maintenance on the feed system may be performed from ground level. As described previously, below a dish elevation angle of 10 degrees the offset center of mass tends to push the dish through the center position unless some physical means is employed to prevent it.

Our approach is to use steel cables attached to both horizontal trolleys and an electric winch mounted onto a square side of the AZ rotating platform. The winch and cable system provides a means to lower the dish elevation angle below 10 degrees safely through the entire maintenance mode range of angles.

The winch/cable system is not attached to the horizontal trolleys during normal operational mode, it is attached only when maintenance mode is desired.

The photograph below shows the dish at a negative elevation angle using maintenance mode.

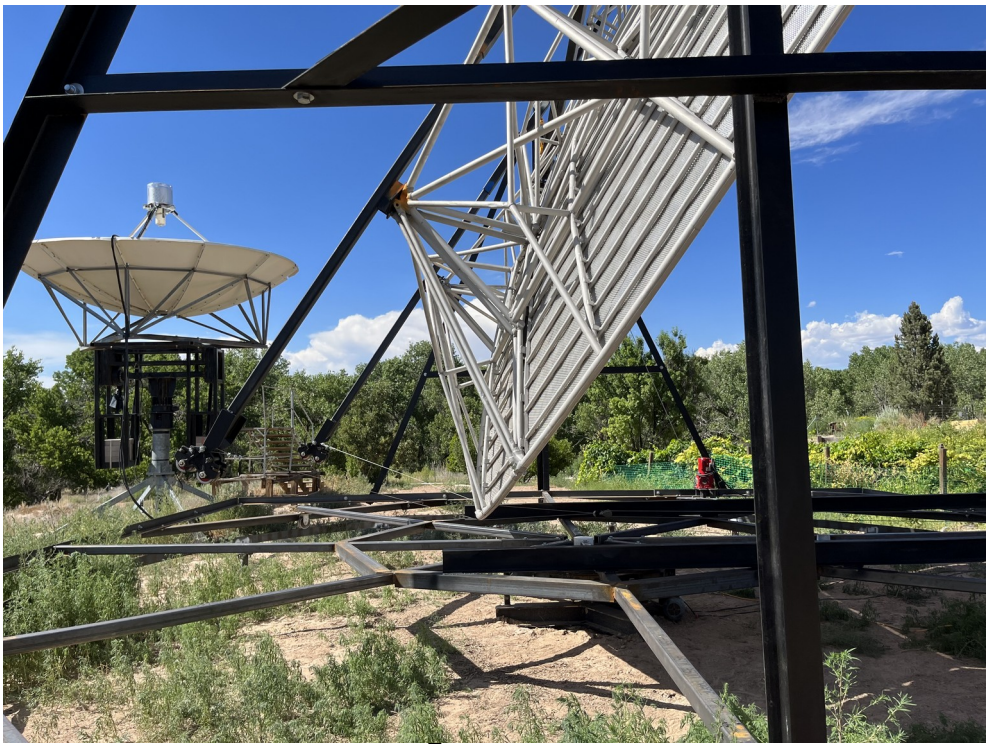

Figure 1. Dish shown at near -45 degrees elevation in maintenance mode (23JUL2023).

Note the steel cables attached to the two trolleys at the ends of the back frame beams. This amount of negative elevation angle is near the angle that will be needed to be able to access a feed horn from ground level. In any case, the dish can easily be lowered to larger negative angles simply by using the winch to release additional cable.

The photograph below shows the winch portion of the maintenance mode cable connections.

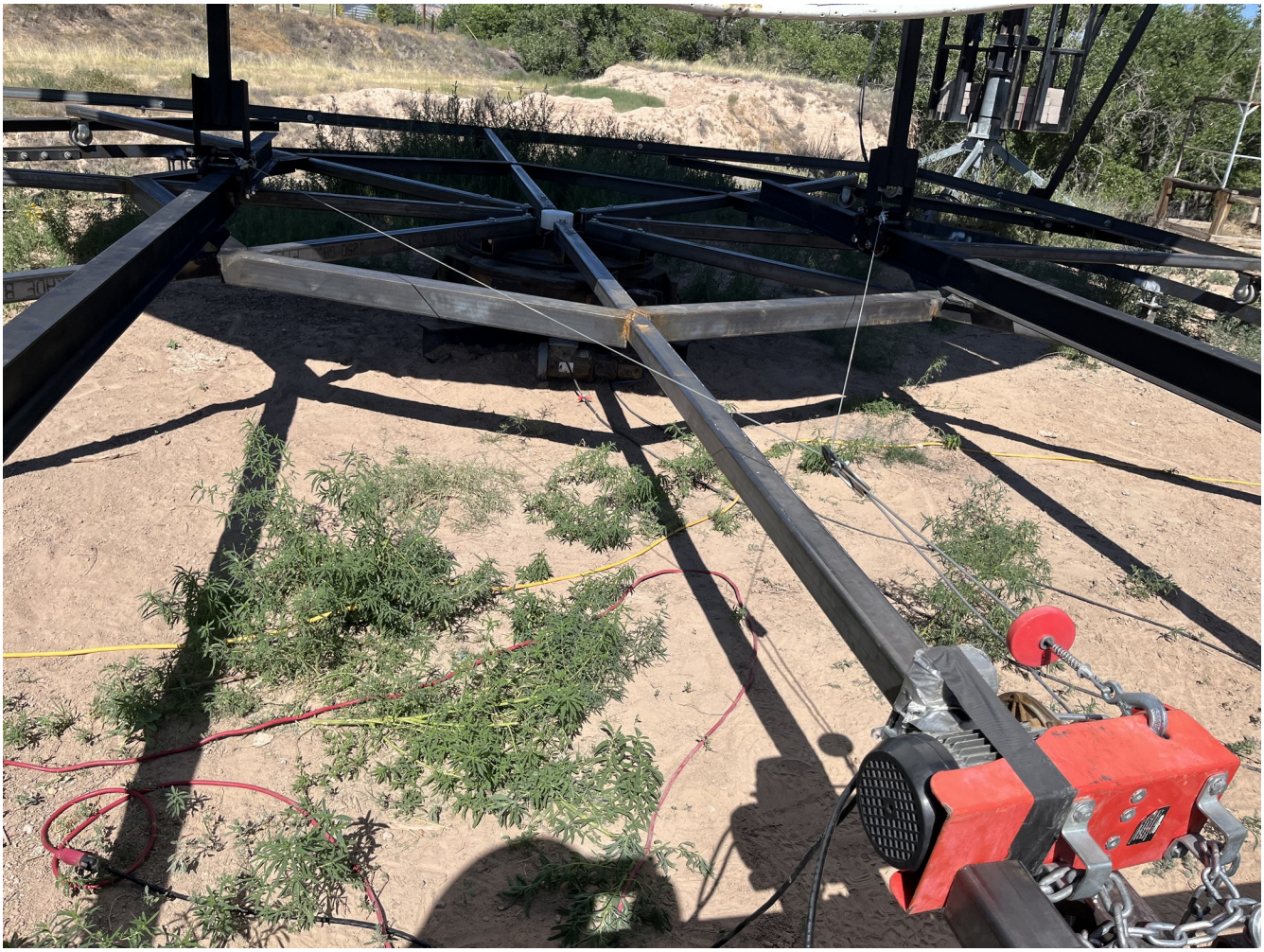

Figure 2. Winch connections for maintenance mode to access negative elevation angles safely (23JUL2023).

For this test an electric winch was temporarily chained to the side of the square perpendicular to the elevation axis of rotation. This configuration is temporary in the sense that it is used primarily to evaluate the concept for accessing negative elevation angles. A more permanent mounting arrangement will be implemented later.

This experiment is the second time we have accessed negative angles in maintenance mode of such a magnitude that the horizontal trolleys traveled off the I-beams. During the first time, the I-beams were not welded onto the AZ mount, whereas this time the I-beams have been welded to the mount. As it happened, re-establishing the trolleys onto the I-beams was easier the first than this time because this time (i.e., with the I-beams welded to the AZ mount) one of the beams is slightly out of alignment with its trolley on the return of the trolley which required that a crow bar be used to force the trolley onto the I-beam. Such an action was unnecessary the first time as the trolleys and I-beams aligned nicely. To remedy the current misalignment the I-beam welds for this I-beam will be cut, the I-beam moved slightly for better return trolley alignment, and re-welded.

The photograph below shows the trolley configuration after being re-established onto the I-beams.

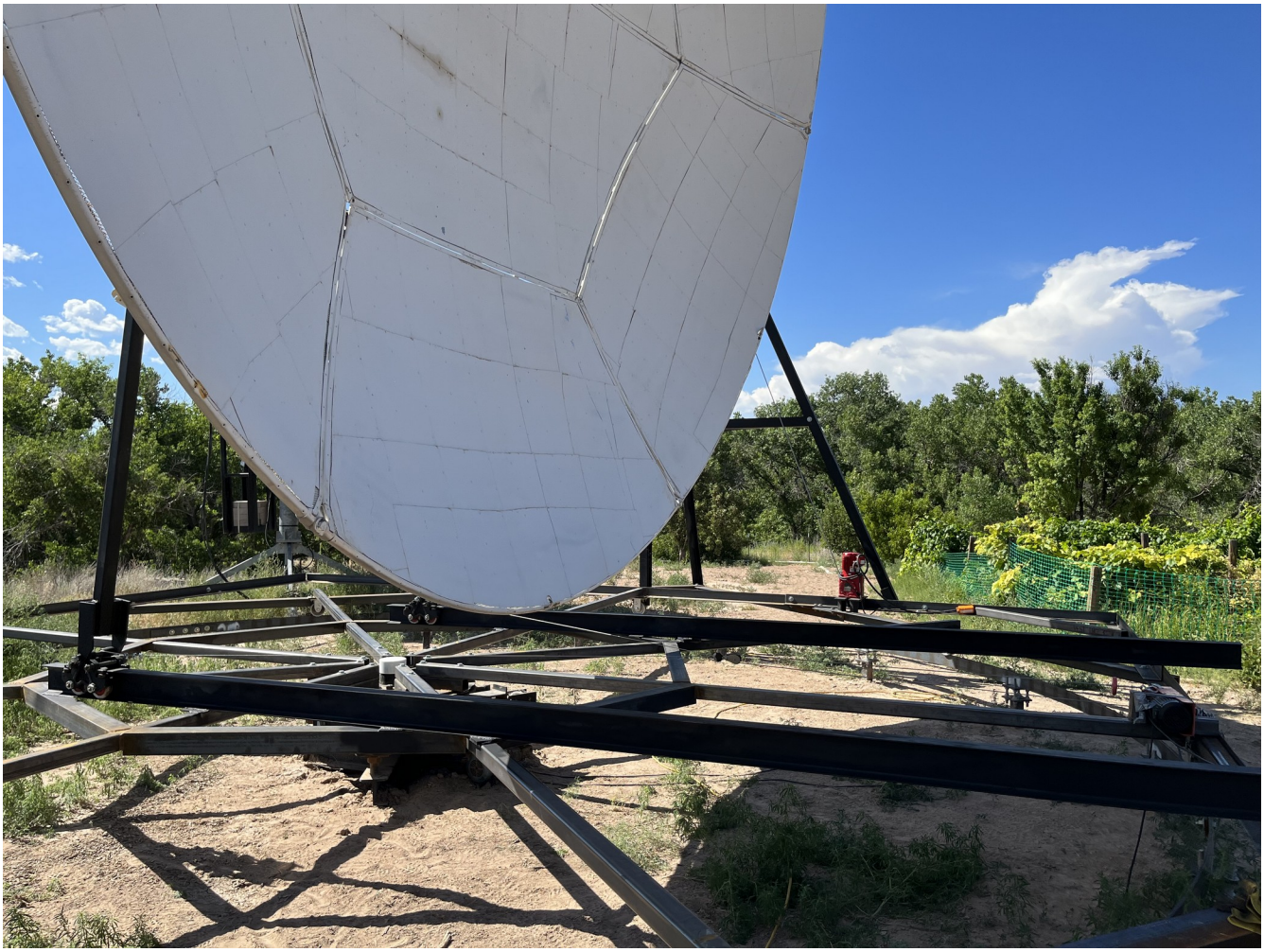

Figure 3. Configuration after the trolleys have been re-established onto the I-beams (23JUL2023).

In this photograph the elevation angle is still negative but with the trolleys now back in place the dish can be returned to a positive elevation angle equal to or greater than 10 degrees. After reaching positive elevation angles again, the winch cables can simply be disconnected from the horizontal trolleys to return the telescope to normal operational mode.

The photograph below shows how the maintenance mode cable connection is made to the horizontal trolleys.

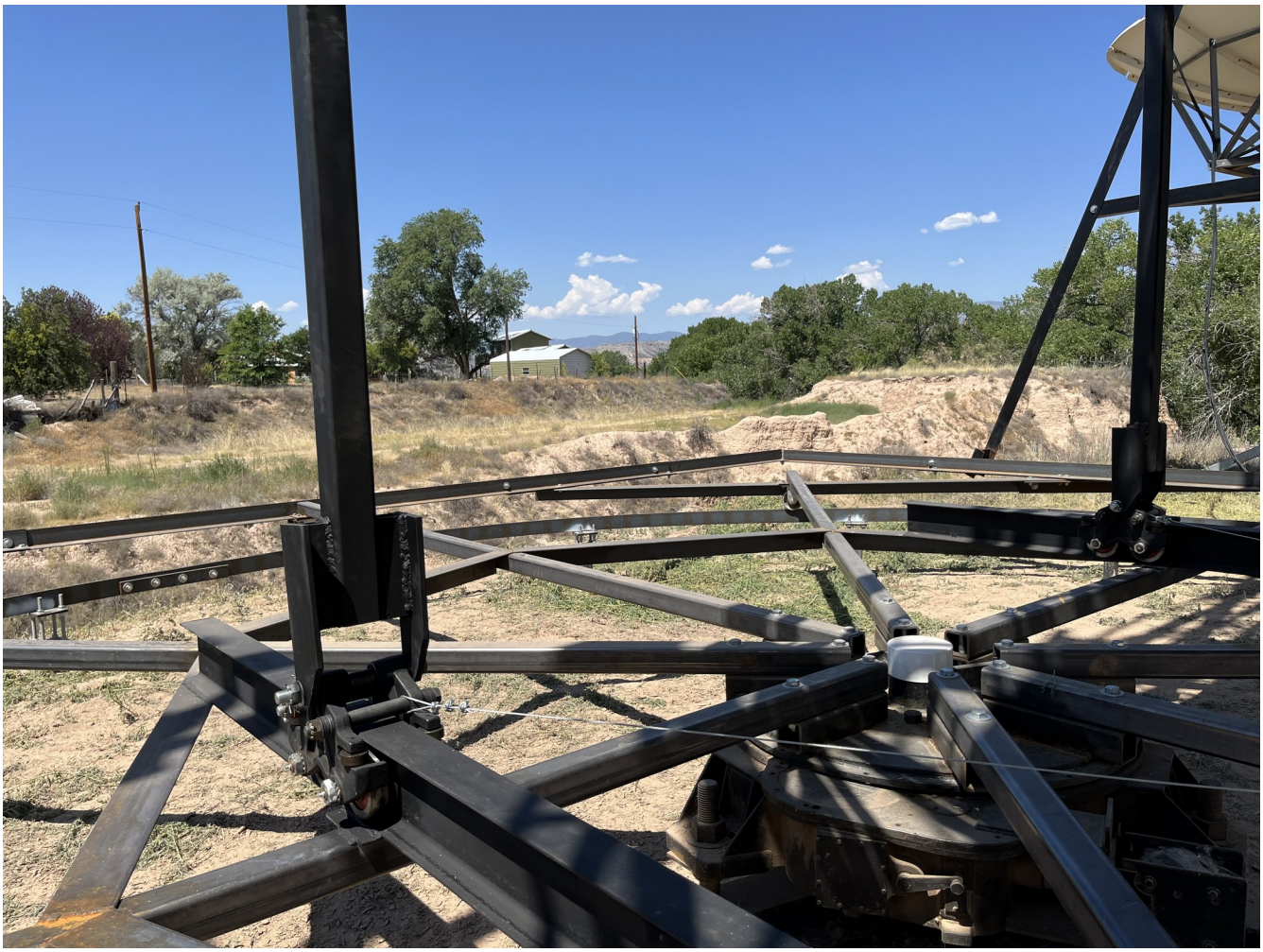

Figure 4. View showing how the maintenance mode cable connection is made to the horizontal trolleys (25JUL2023).

The front cross bolt position of the trolley was selected as the tie point to keep the back portion of the trolley level when the trolley is not established onto the I-beam. Trials using the top cross bolt proved unsatisfactory. In this current position the trolley nicely re-establishes itself onto the I-beam when it returns from large negative elevation angle positions without needing any intervention by the operator at the trolley position.

The photograph below shows the dish at zero degrees elevation (i.e., pointing toward the horizon) in maintenance mode.

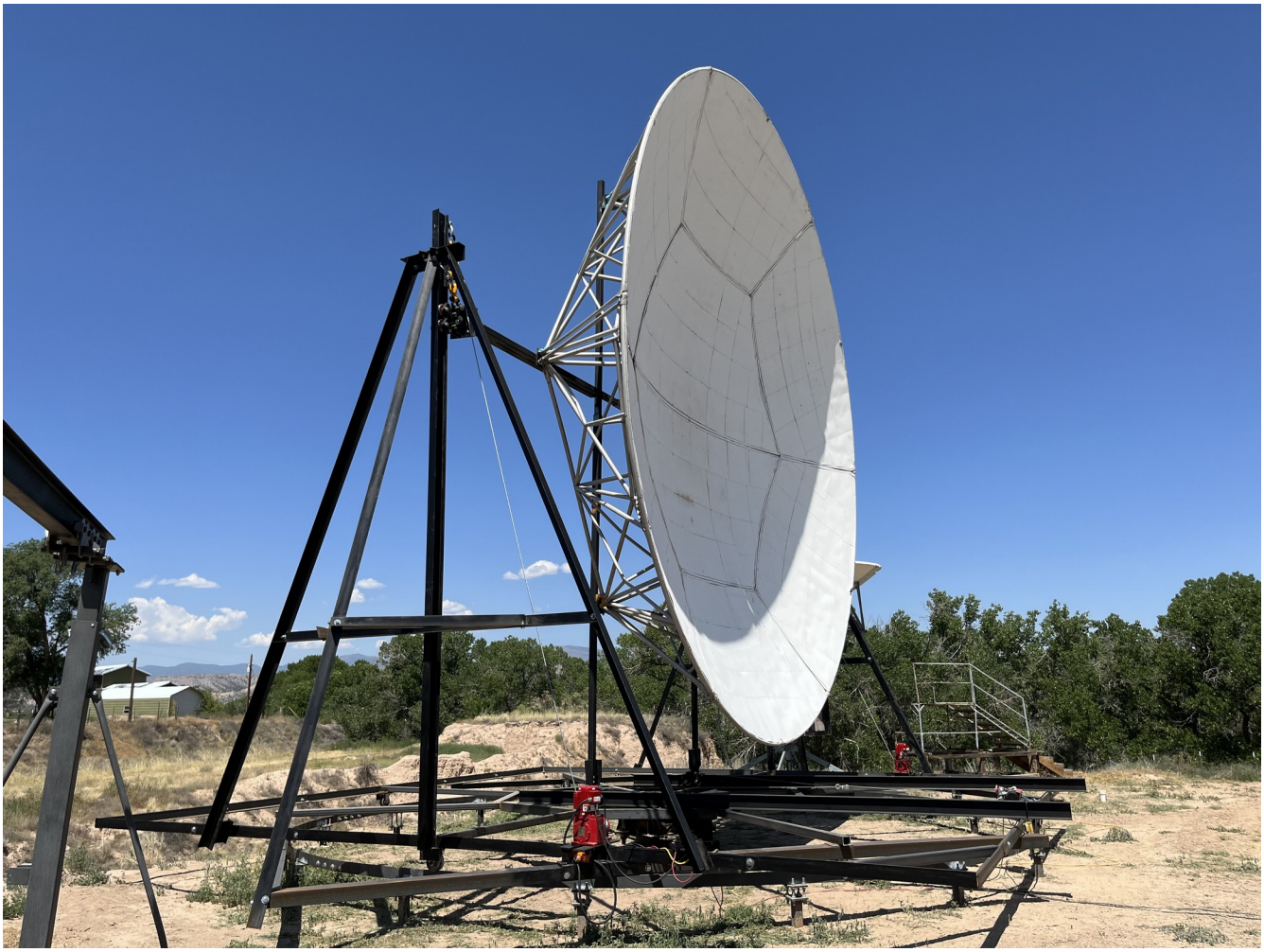

Figure 5. Dish shown at zero degrees elevation angle in maintenance mode (25JUL2023).

The photograph below shows the dish in the storage (bird bath) position, normal operational mode.

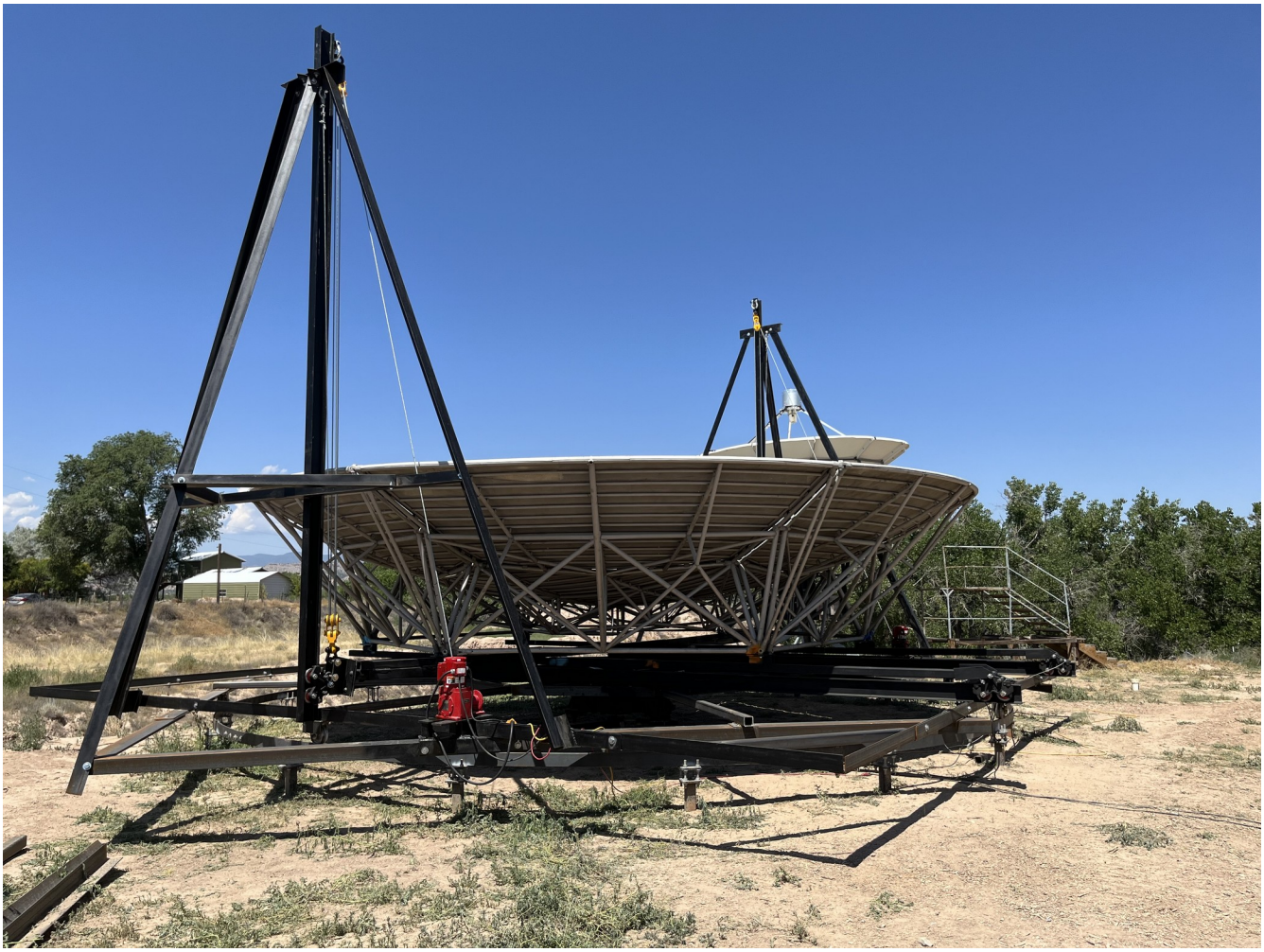

Figure 6. Dish shown in the storage position, normal operational mode (25JUL2023).

Next task is to repair/refurbish the feed horn support structure which was damaged during the previous disassembly and removal from the former tower mounting.

REPAIR/REFURBISHMENT AND INSTALLATION OF FEED HORN SUPPORTS

As the feed horn support assembly was damaged during the previous dish disassembly and removal from its former mounting on a tower the assembly will need to be repaired before being installed onto the dish.

The photographs below show the feed horn structural components needing repair.

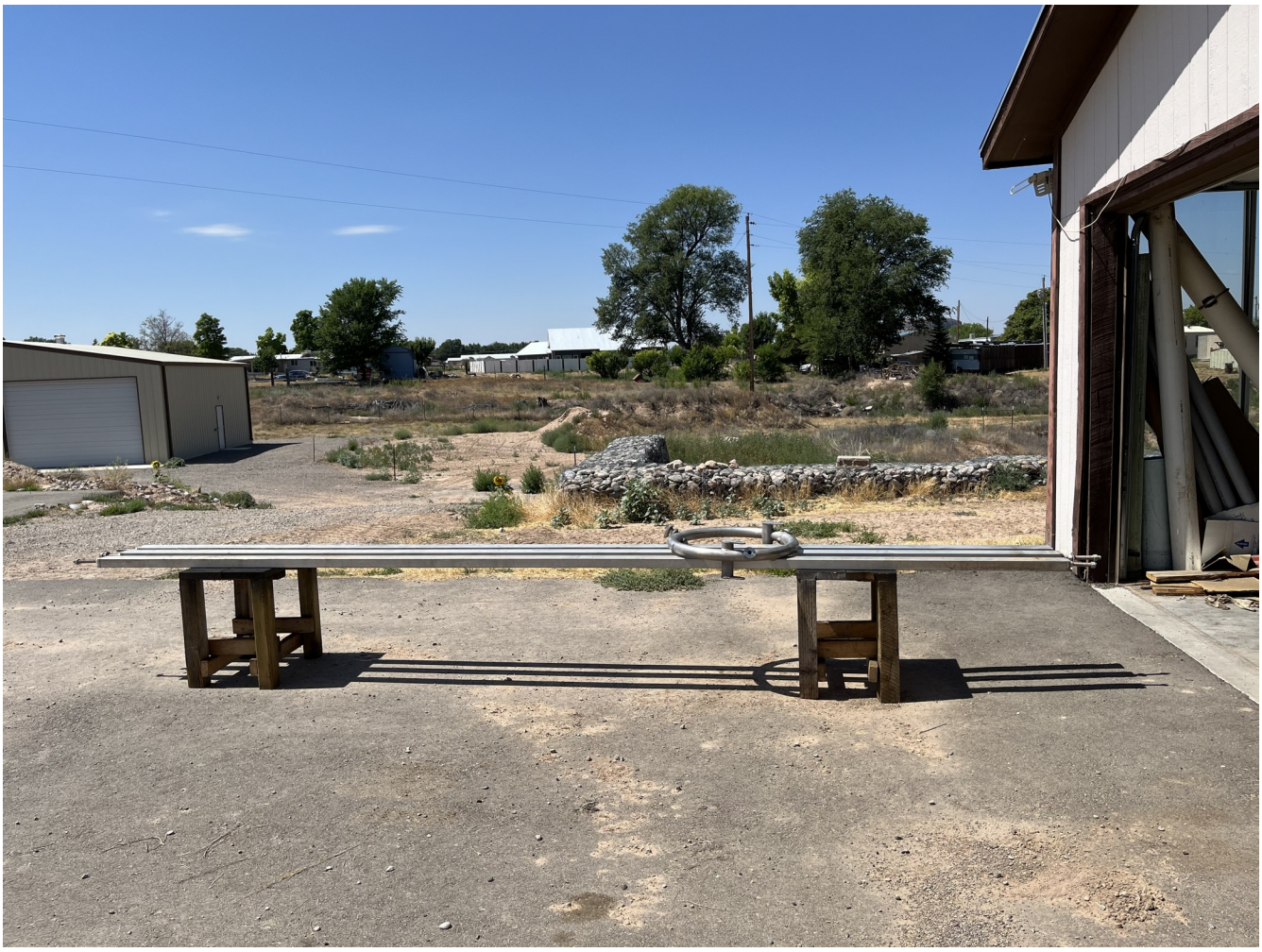

Figure 7. Feed horn support assembly components (25JUL2023).

The feed horn support assembly consists of 2”x4”x16’ aluminum beams with steel threaded rods at both ends and a circular mounting ring into which the feed horn mounts. One end of each of the beams bolts onto the rim of the dish and the other end bolts onto the circular ring visible in the photograph.

The photograph below shows damage to be repaired at the circular ring ends of the support beams.

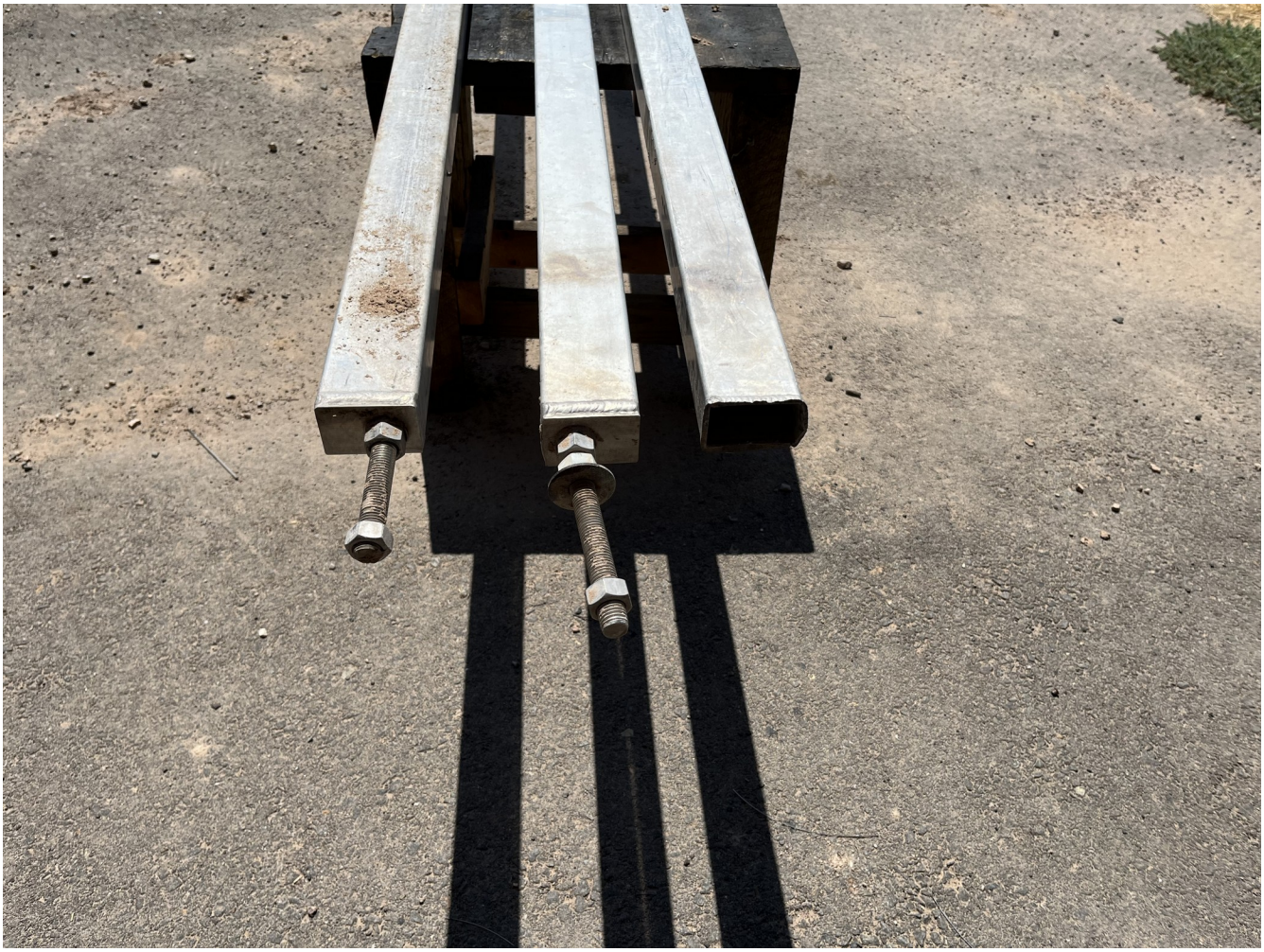

Figure 8. Circular ring ends of the feed support beams (25JUL2023).

The photograph above shows that two of the three aluminum support beams have suffered damage on the circular ring mounting ends. One beam is missing the attachment bolt and end flange entirely and one beam has the attachment bolt bent. Care will need to be exercised while straightening the bent bolt as the bolt is made of steel; which, of course, is much stronger than the aluminum mount into which it resides. There is a possibility of inadvertently damaging the aluminum flange while trying to straighten the steel bolt.

The photograph below shows the opposite ends of the support beams.

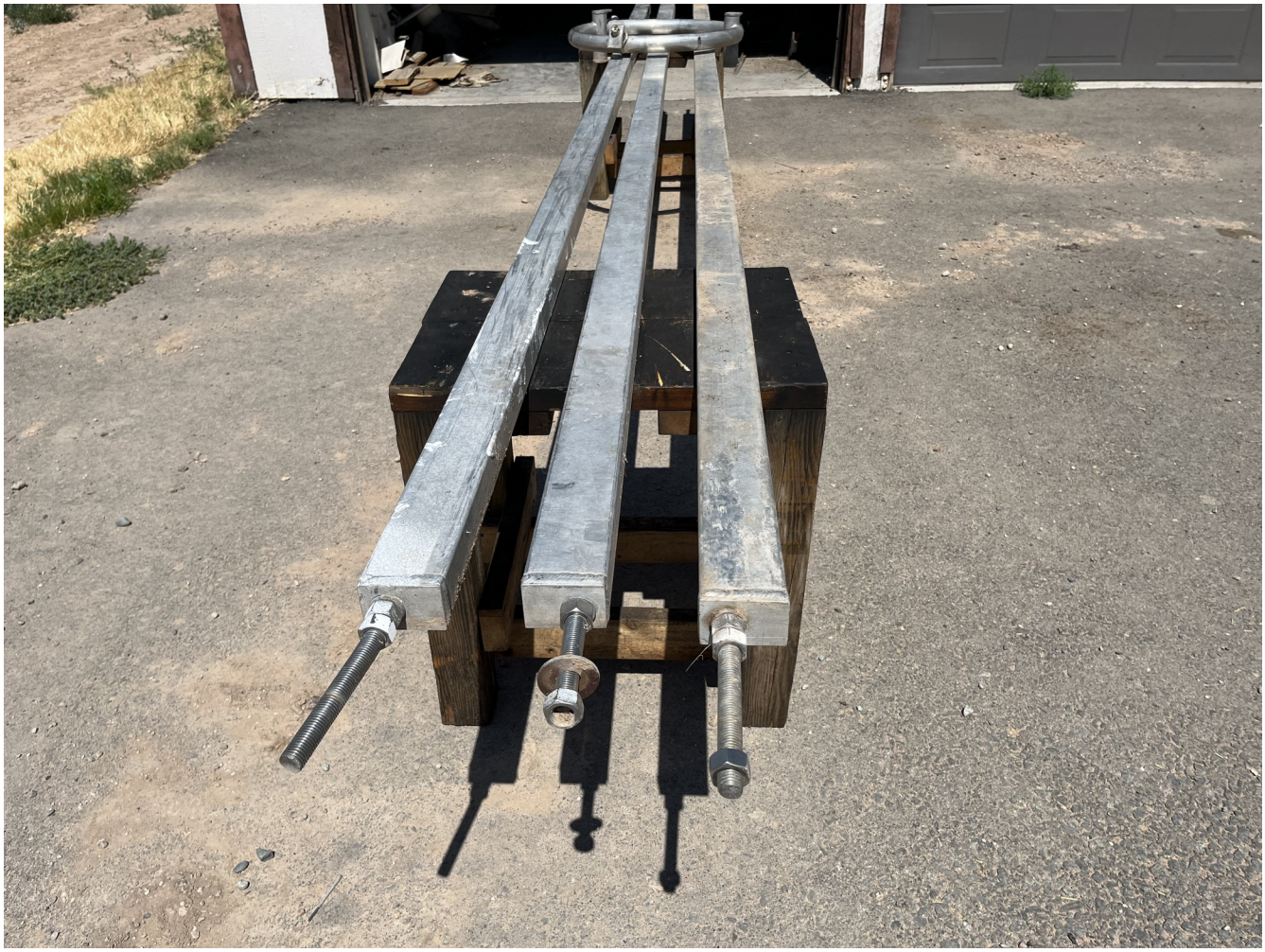

Figure 9. Dish rim ends of the feed horn support beams (25JUL2023).

The photograph above illustrates that two of the aluminum beam ends are usable without repair but one has a bent threaded bolt that must be carefully straightened.

The photograph below shows the ring component of the feed horn mount assembly.

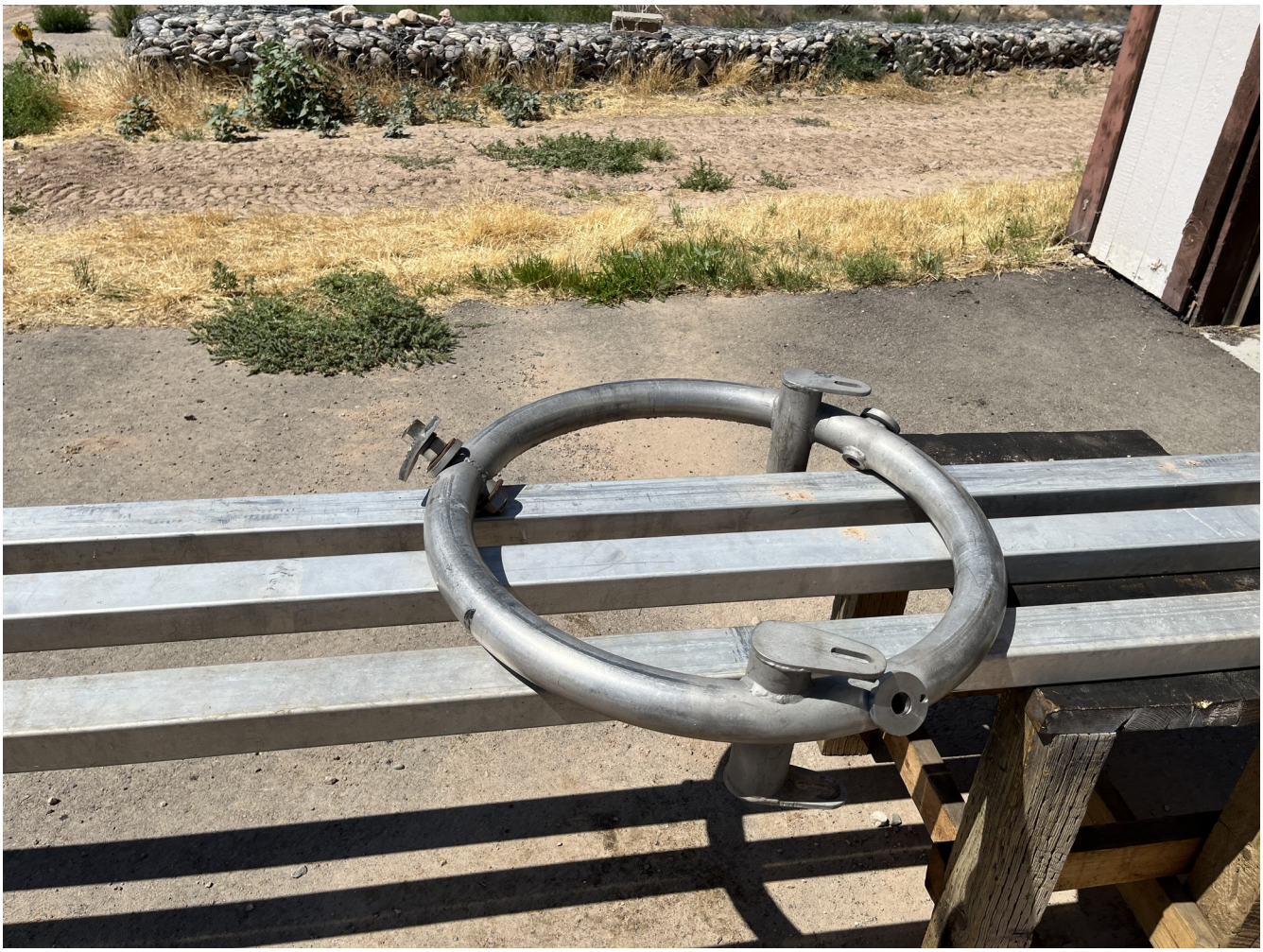

Figure 10. Feed horn mounting ring component of the feed horn support assembly (25JUL2023).

The feed horn mounting ring appears to be in good shape with no significant damage. The "missing" end piece of one of the support beams is seen still attached to the mounting ring, therefore fabrication of a new end piece for that beam may not be necessary. The end piece is shown at the upper left portion of the ring as viewed in the photograph. The aluminum flange piece is bent but can likely be straightforwardly straightened once it is removed from the ring. Remounting the flange piece into the beam may be challenging as aluminum welding is not my strong suite. An alternative option for this repair might be to bolt it into position on the beam instead of welding it. This possibility will be examined once the piece is removed from the ring and the condition of the beam end evaluated.

The photograph below shows that the bent threaded rods have been straightened.

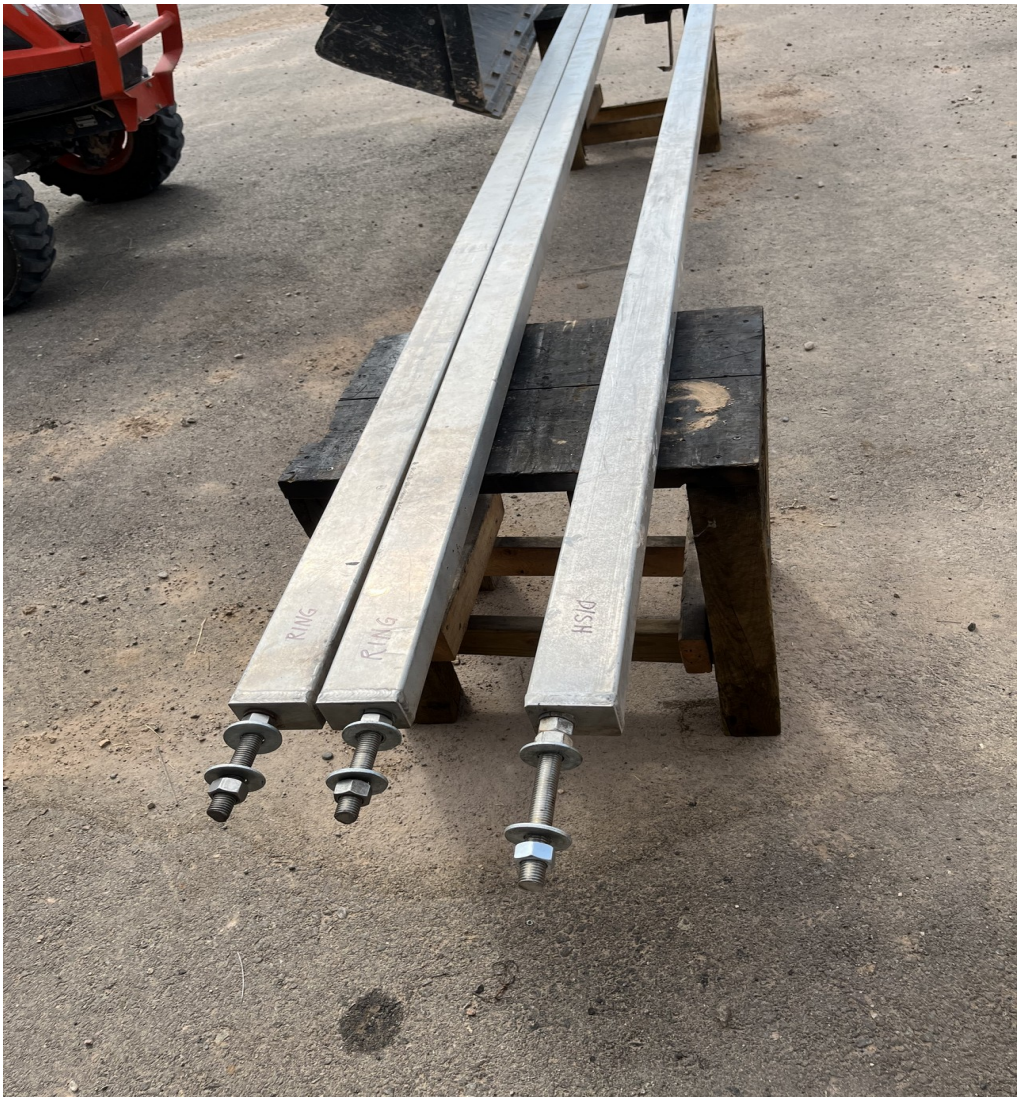

Figure 11. the previously bent threaded rods have been straightened without damaging the aluminum beams (26JUL2023).

Missing hardware on the beams have been replaced.

The photograph below shows the broken and bent end piece shown earlier now straightened and positioned for welding to the beam.

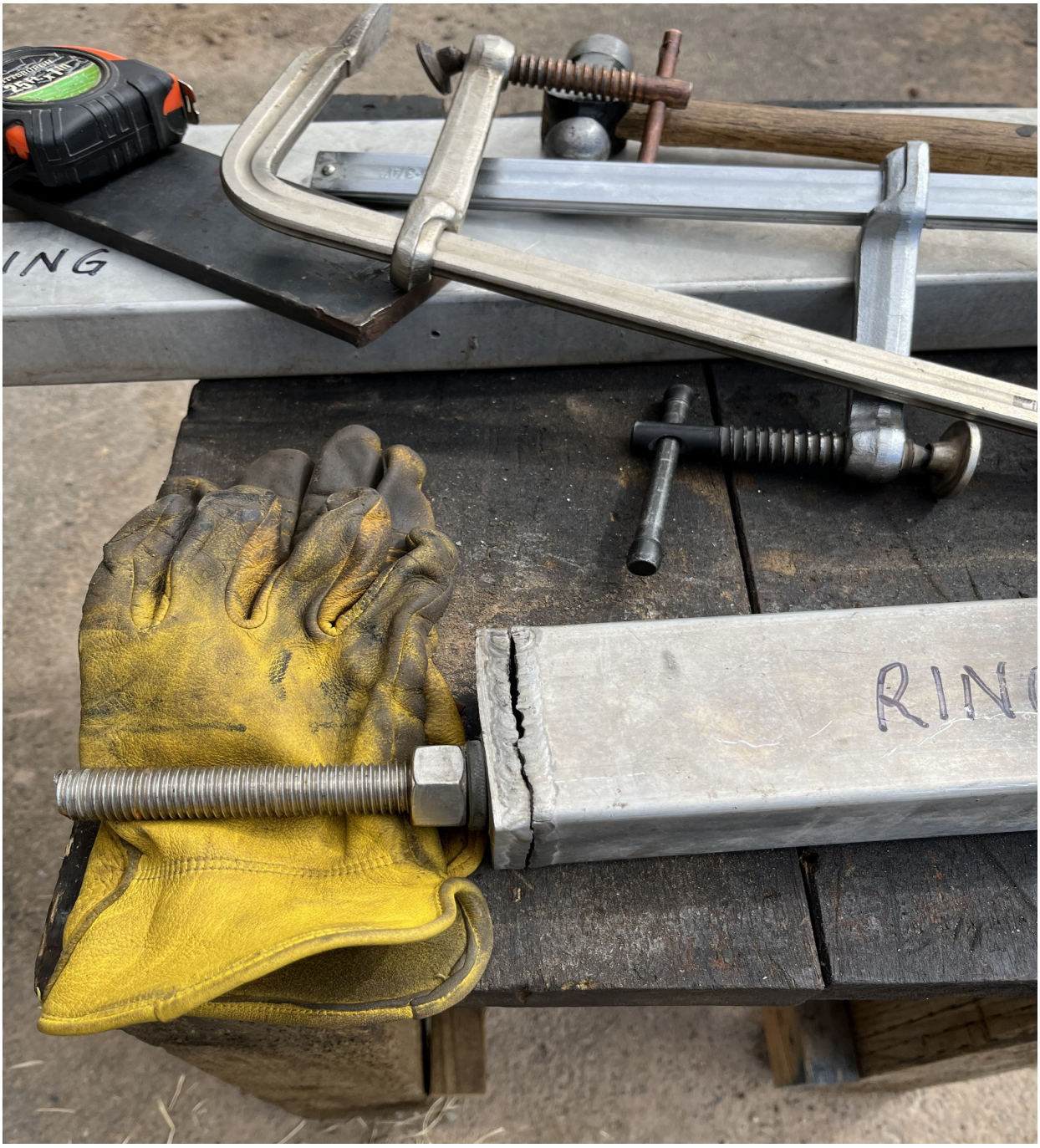

Figure 12. Broken end piece in position for welding (26JUL2023).

The photograph below shows the repaired beam after welding.

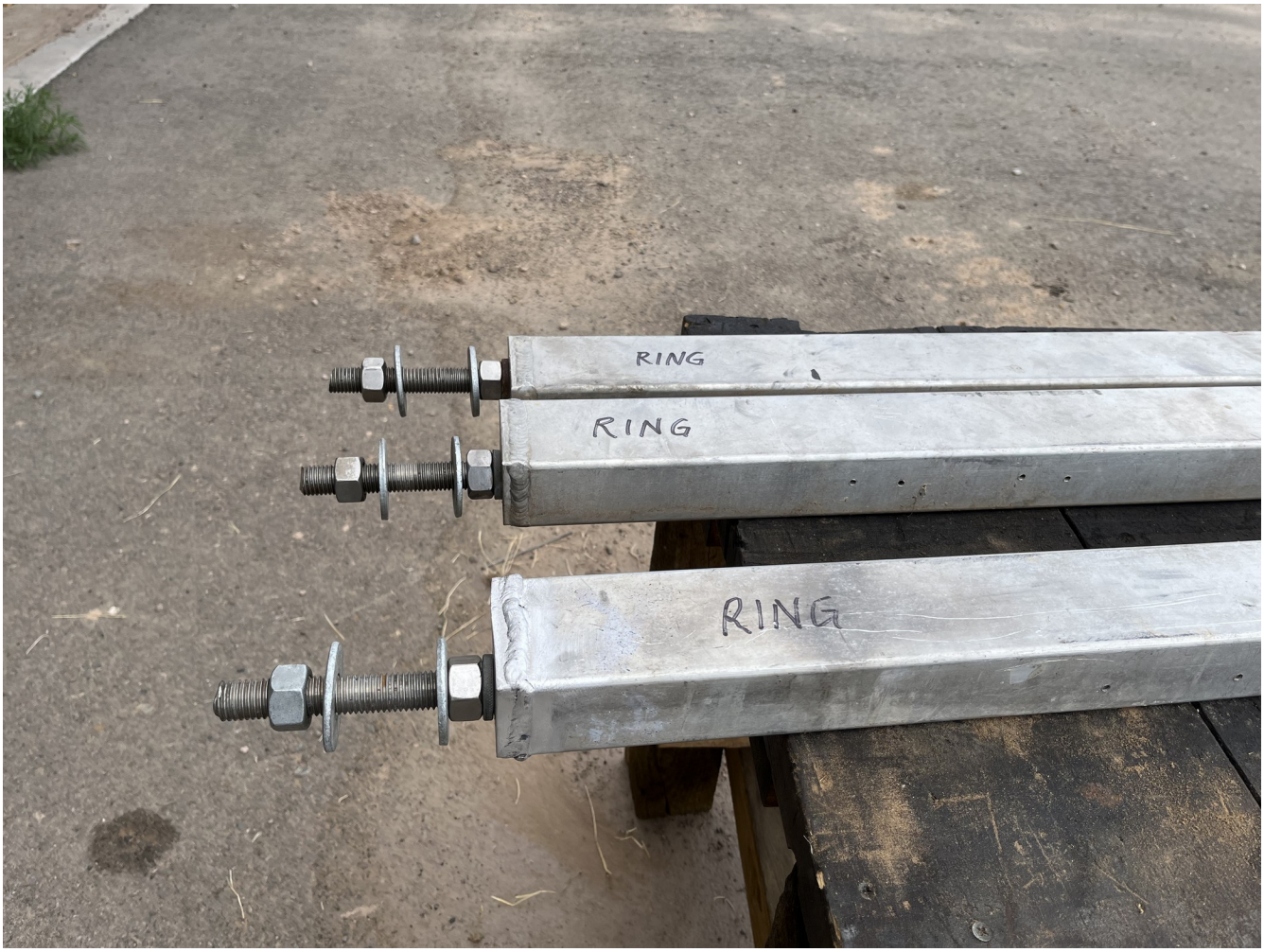

Figure 13. Repaired end piece after welding (26JUL2023).

All components of the feed horn support structure are now repaired and are ready for installation onto the dish.

SECOND REPAIR OF THE SUPPORT BEAM END

As luck would have it the newly repaired beam end broke at the repair during my installation attempt. Both ends of two of the support beams, the circular ring, and one end of the third support beam are bolted into place. The broken end (circular ring end) is temporarily held onto the circular ring using an adjustable strap until a repair can be performed on the beam end *in situ*.

The photograph below shows the dish being lowered into bird bath position with the feed support structure in place, including the temporarily strapped beam end.

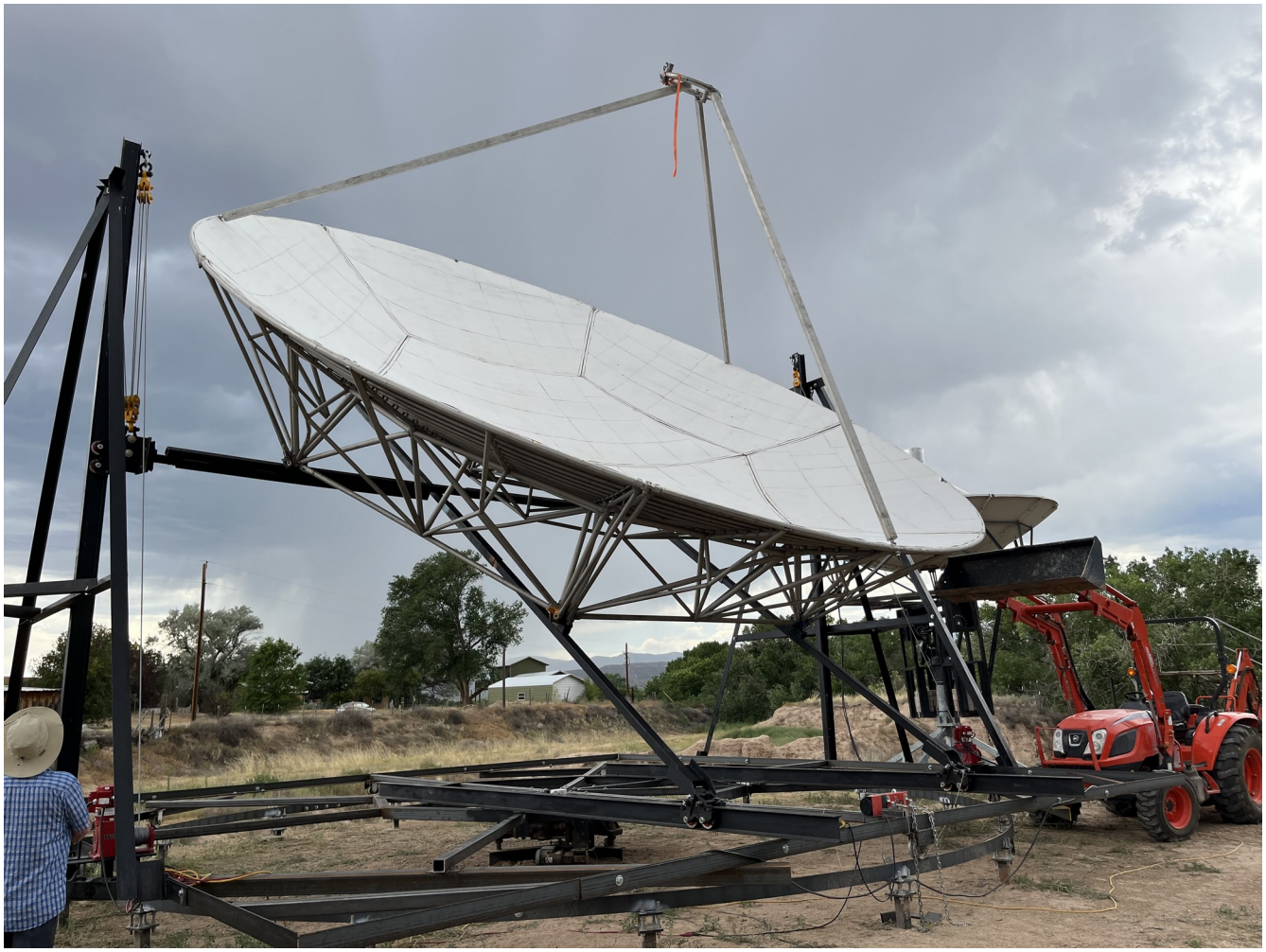

Figure 14. Dish being lowered into bird bath position with the broken-end support temporarily strapped to the mounting ring (27JUL2023).

With rain closing in the work had to be temporarily suspended. The dish is being lowered into a safe orientation with the broken end beam temporarily strapped to the mount ring with the orange strap. The broken beam end will be repaired in place after the weather front moves through, with the dish pointing in a negative elevation angle to put the ring and broken end near or onto the rotating base platform to make access convenient. The tractor visible in the photograph wasn't used in the operation but was located nearby in case it was needed.

The photograph below shows the dish with the feed horn mounting ring lowered to the rotating platform level so that the broken beam end can be repaired in place.

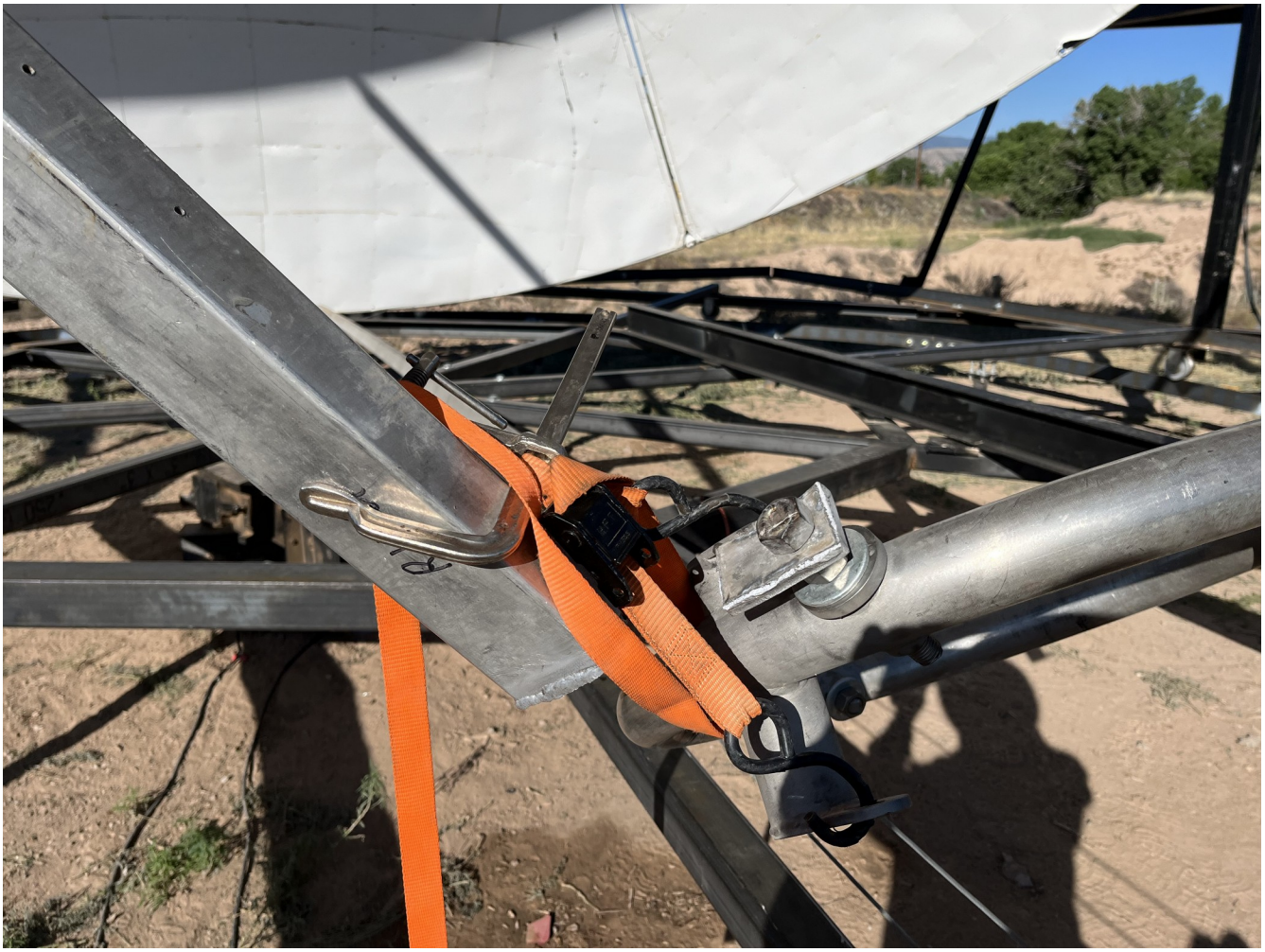

Figure 15. Broken beam end is strapped near the mating piece which is mounted onto the ring (28JUL2023).

The photograph below shows the broken beam and mating piece clamped ready to begin welding them together.

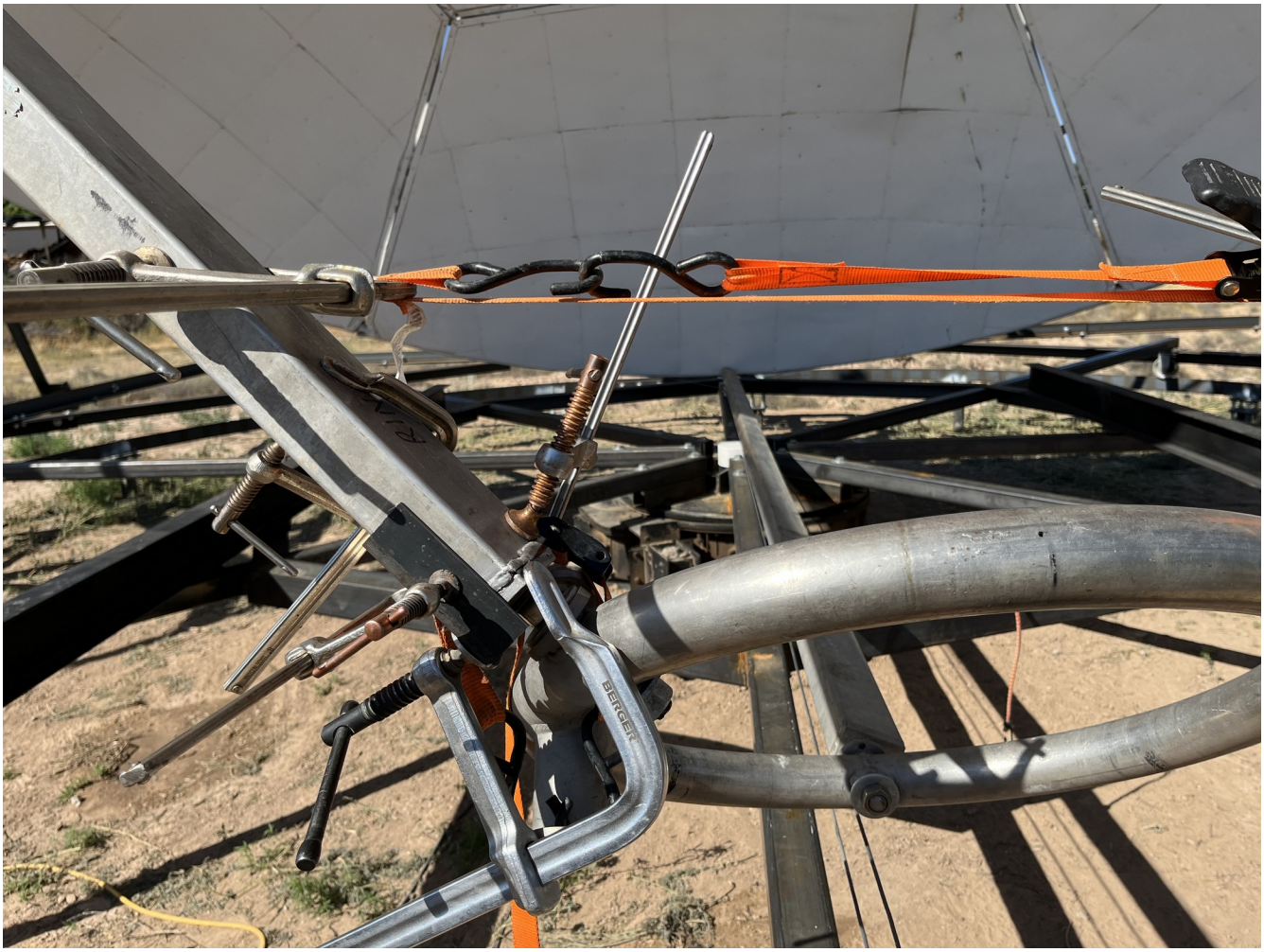

Figure 16. Multiple clamps and straps were used to hold the broken beam end onto the mating piece for welding (28JUL2023).

The numerous clamps and straps were necessary due to the angles present. The beam end and piece were welded in short sections in turn as each clamp was removed. The photograph below shows the tractor loaded with the MIG welder and Argon gas bottle to move the equipment to the dish to weld the aluminum beam *in situ*.

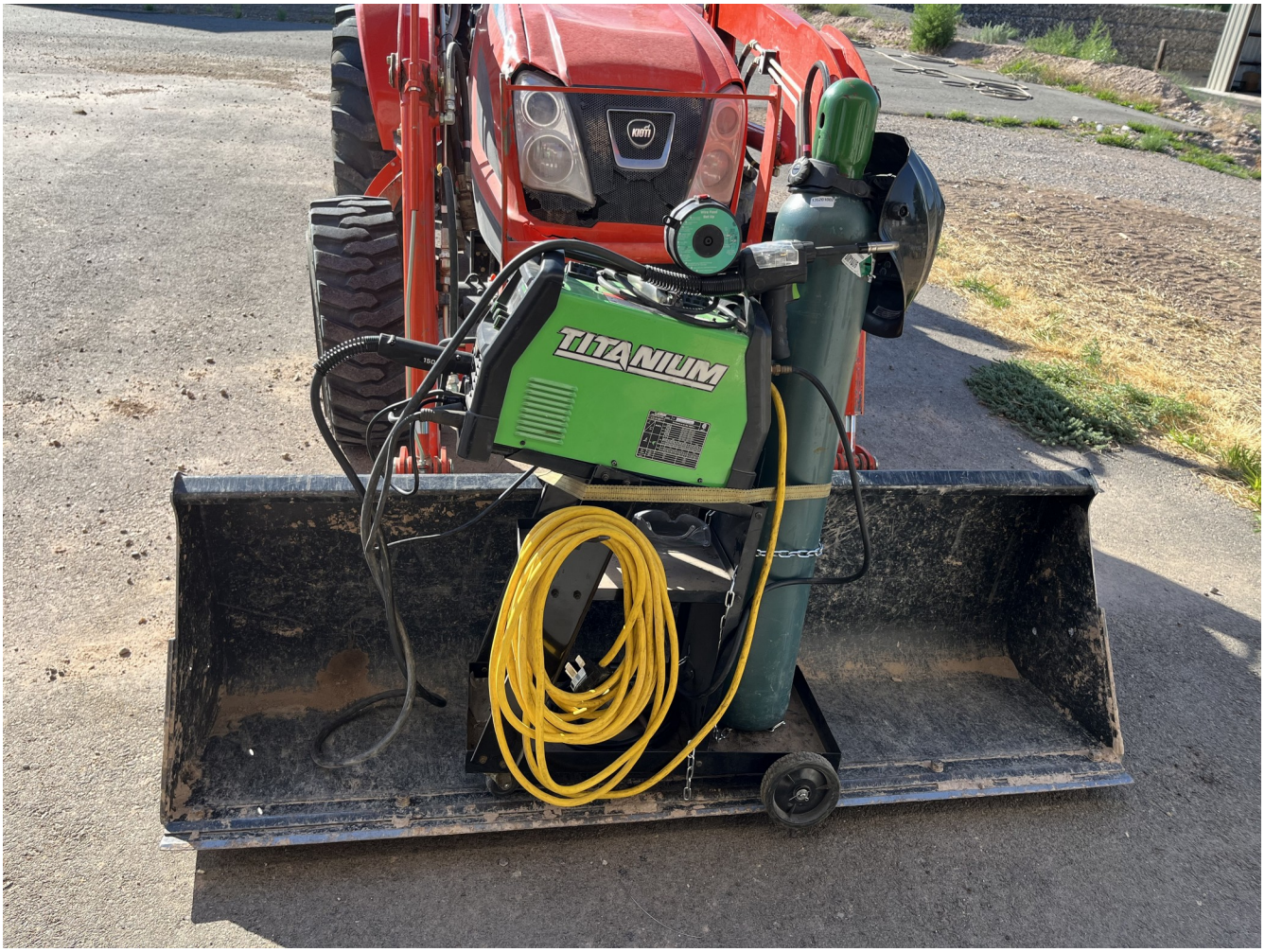

Figure 17. The MIG welder has been fitted with a spool gun and Argon gas bottle to weld aluminum (28JUL2023).

The welder cart was strapped onto the tractor bucket before moving the welder to the dish.

The photograph below shows the completed aluminum weld.

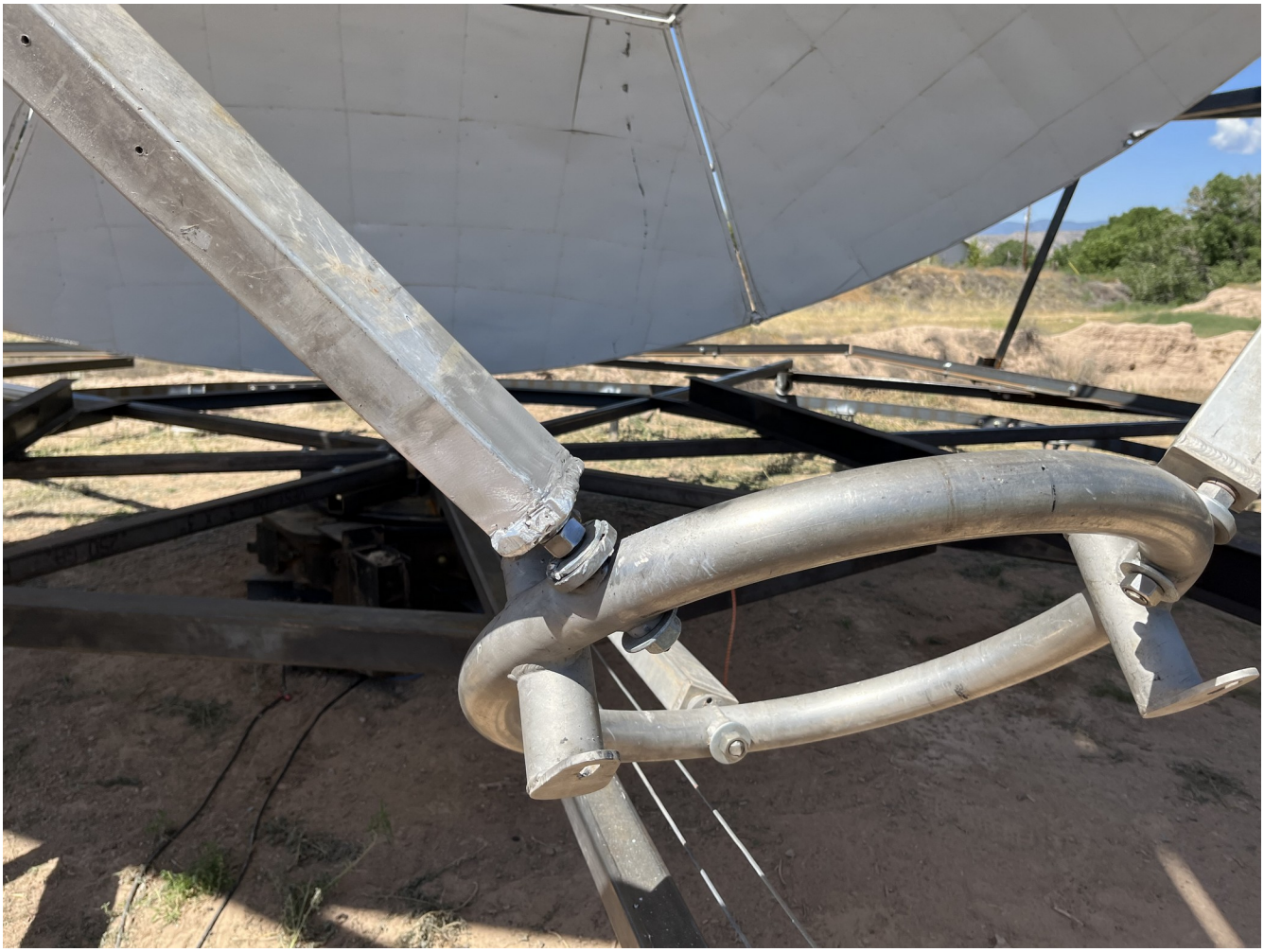

Figure 18. View showing the completed aluminum weld of the support beam.

Admittedly, the welding job on this beam end is amateurish as my skill and experience welding aluminum is minimal at best. Fortunately, in use the weld won't experience the stress that the professional weld experienced during beam installation when the professional weld broke. It is hoped, even expected, that this weld is sufficiently strong that it will hold as needed for the life of the telescope.

ADDING A FEED HORN

The initial feed horn that will be installed on this radio telescope is an L-band feed centered at the rest frequency of the neutral hydrogen emission line, 1420 MHz. This particular feed horn has been used with this dish before, extensively; therefore mounting it near its optimal performance position is straightforward. It is known already that the focal point of the dish lies 23" inward from the circular mounting ring. That is the position at which the phase center of this feed horn will be positioned. The design of the AZ/EL mount allows for installation of the feed horn and associated components from ground level.

The photograph below shows the dish tilted downward such that the feed horn may be installed from ground level.

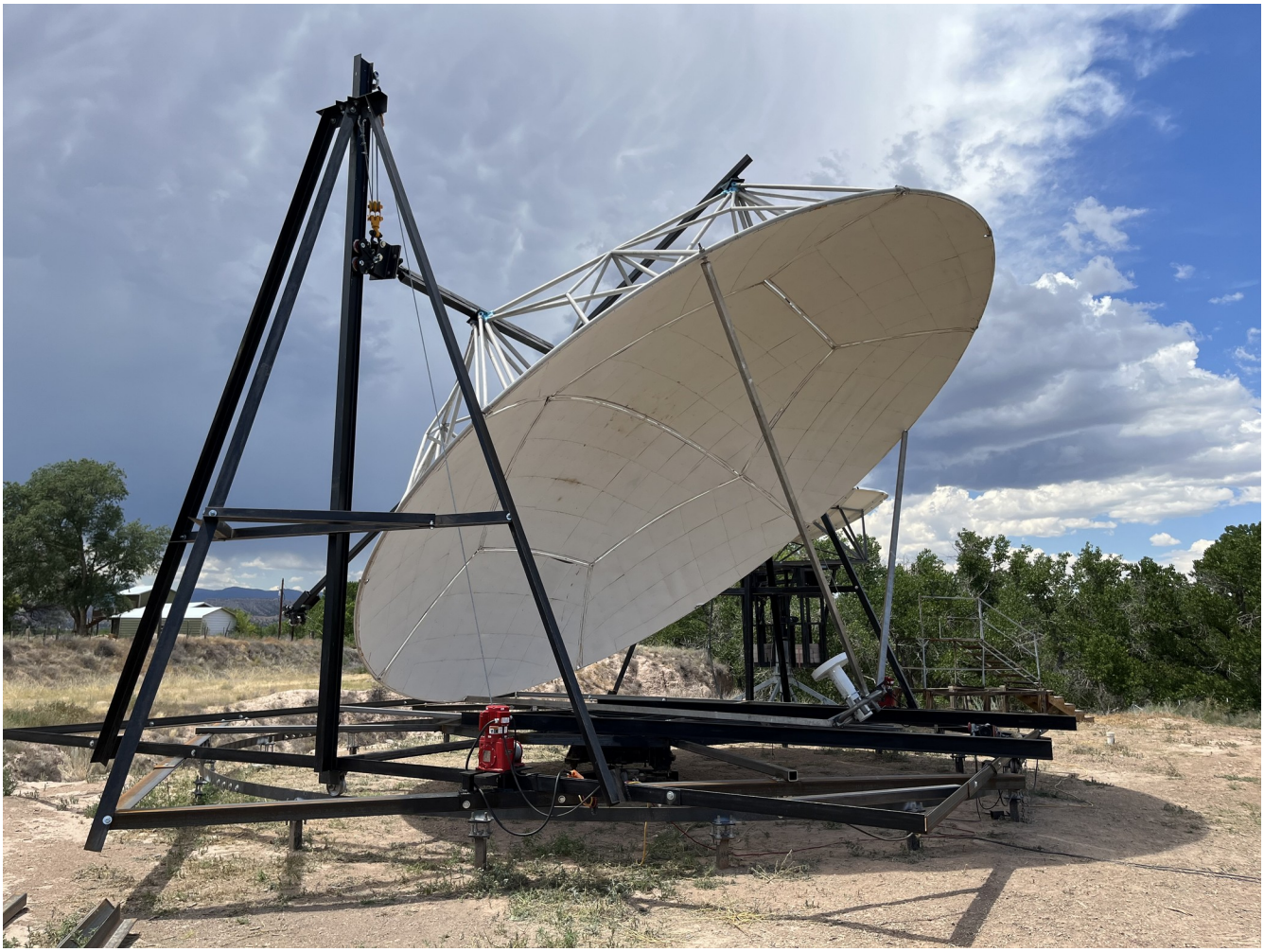

Figure 19. The dish has been tilted so that the feed horn may be straightforwardly installed from ground level (28JUL2023).

The L-band feed horn has been installed from ground level in maintenance mode with the end of the feed horn only 36” above ground level.

The photograph below shows the dish pointed skyward after the feed horn has been installed.

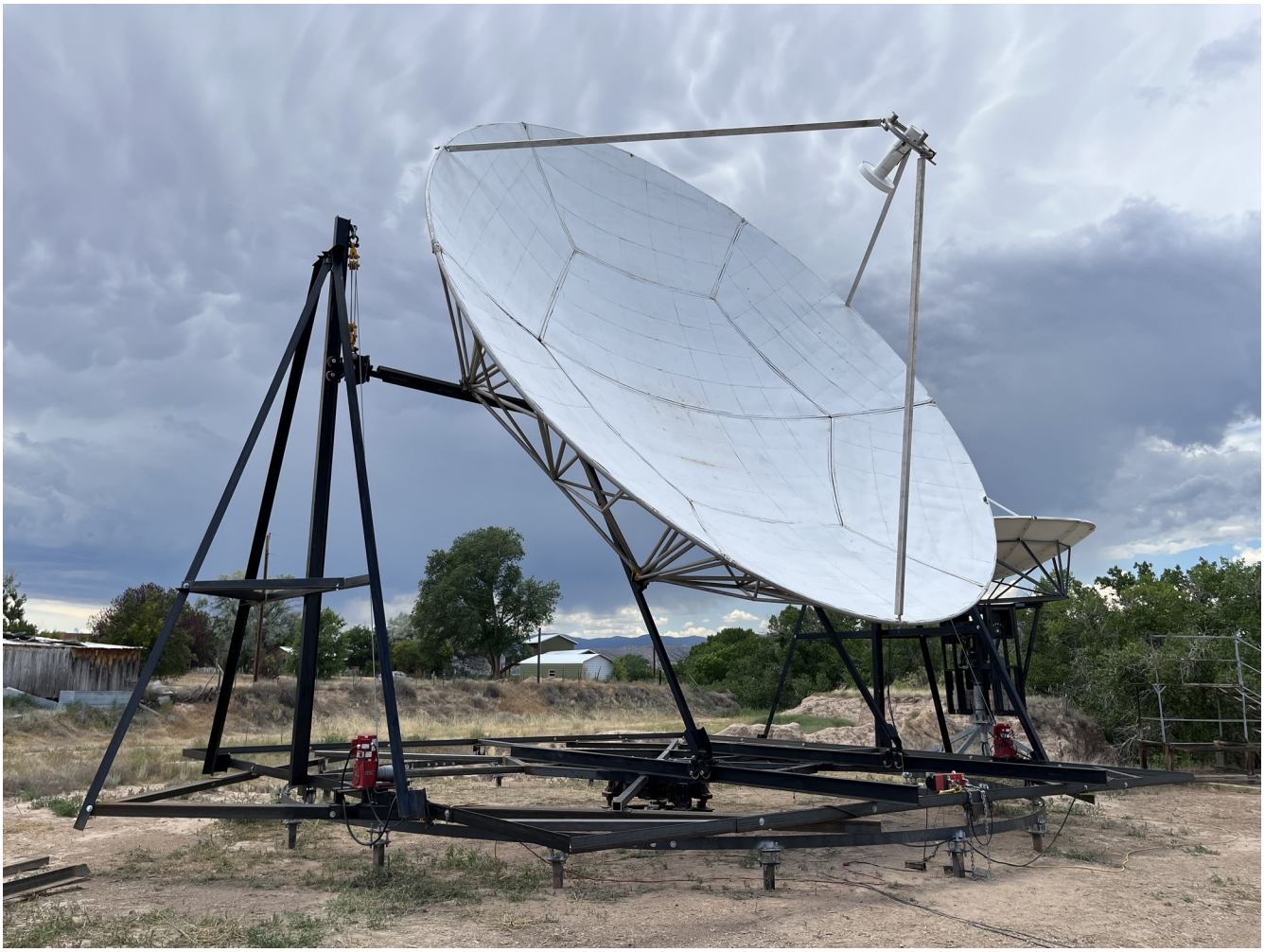

Figure 20. Dish is pointed skyward after installation of the feed horn (28JUL2023).

The dish is shown pointed skyward in normal operational mode.

The photograph below shows the dish stored in the bird bath position in normal operational mode.

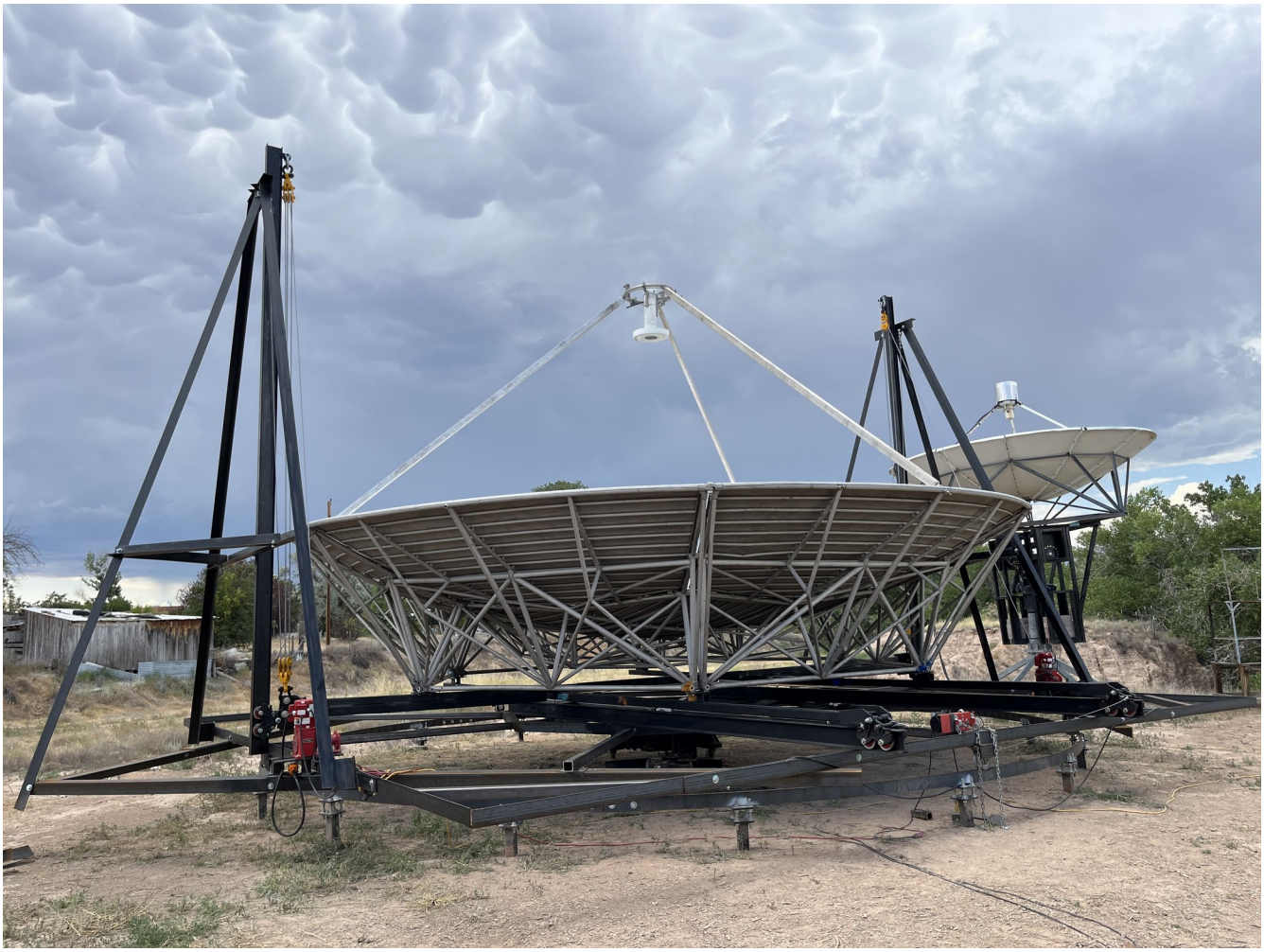

Figure 21. Dish is shown stored in bird bath position in normal operational mode (28JUL2023).

The configuration shown above is how the dish will be stored and how it will be oriented when foul weather occurs.

CONCLUSION

At this point, construction of the Ground Level AZ/EL Mount is effectively completed and the dish and mount are ready to be configured for use as a radio telescope. Further work on the system will involve tasks similar to the tasks anyone would need to perform when bringing a new telescope on line; namely, providing power, control, and signal lines from the telescope control room to the mount and dish and commissioning the telescope by measuring critical performance parameters for it.

Certainly, further work will be done on this mount to create a workable radio telescope, including performance testing but recording of such efforts may be viewed as outside the intended scope of this series of real-time progress report documents. It may be better to create a new series of reports that detail how this mount is brought into service and how its performance as part of a radio telescope will be measured; or not, depending upon feedback that I receive regarding documenting such work.