# A Hands-On Radio Telescope for WKU

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**Figure 1.** Pieces of the salvaged satellite dish system before moving. The welded steel post, bracket and supports are shown with the aluminum feedstock and the 10-ft dish itself, and are in good condition given their age.

## Summary

In the summer of 2016, the WKU Physics and Astronomy Department acquired a vintage television receive-only (TVRO) C-band 4 GHz satellite system, including a 10-foot parabolic dish, mounting hardware, and electronics, from neighbors of graduate student S. Hicks. The dish and hardware were moved to WKU's Bell Observatory, and the electronics were taken to the university for testing. By using the existing hardware and new consumer television amplifier/downconverter systems, the Department is developing an effective instrument for research training and education at a greatly reduced cost compared to purchasing a new system. When the project is complete, the observatory will be equipped with a radio telescope capable of observing thermal emission from nearby celestial objects, such as the Sun, Moon, and Jupiter, as well as more distant sources of radio emission in the microwave bands. It can then be used for astronomy education and public outreach through experiments such as observing the August 2017 total Solar eclipse in radio waves.

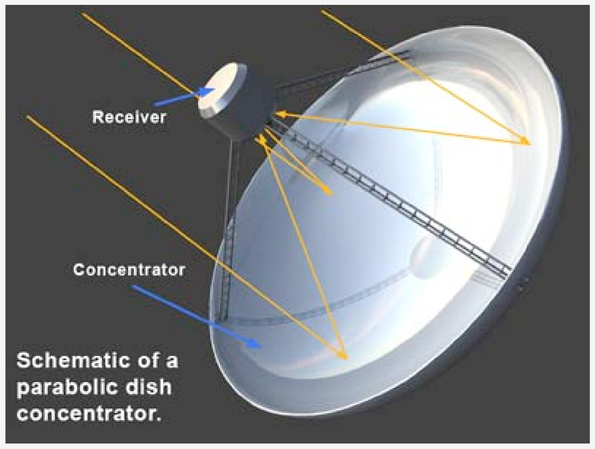



**Figure 2.** Radio waves arriving from distant objects are focused by the parabolic reflector dish into the feed, where they are converted into electrical signals.

**Figure 3.** Physics & Astronomy students and faculty preparing to load the dish into a rental truck for transportation to Bell Observatory. Pictured are J. Boyles, T. Carter, J. Stewart, and R. Brown.

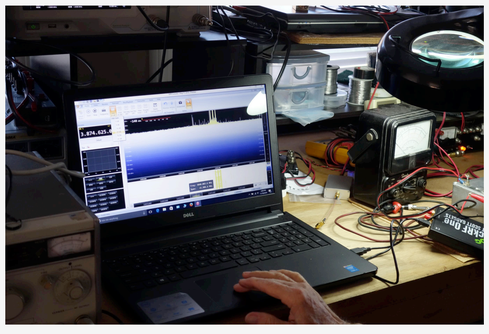


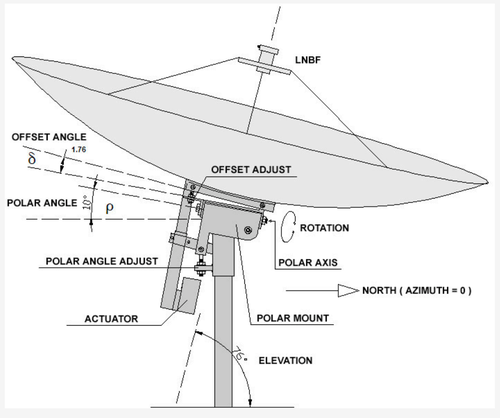
**Figure 4.** H. Cantrell's testing workbench with laptop showing received power vs. frequency and time in "waterfall" display from radio telescope feed.

## Progress and Future Steps

- The dish and hardware were moved to the Observatory over the summer by several students and faculty. Rusted bolts were freed and bent brackets were straightened in the fall; when weather became warm enough in the spring, damage to the fiberglass dish was repaired.
- As the original set-top box (used to control the dish from indoors) was not found, we used a bias tee diplexer to provide power to the receiver electronics through the coaxial signal cable. Although the low noise amplifier worked fine, the frequency downconverter was inoperative. Experiments continued with a smaller 6 ft dish with H. Cantrell's test equipment; using a software-defined radio (SDR) receiver module and spectral display software, the radio signature of the Sun was detected.
- Modern television electronics, including new C-band and Ku-band feed horns, have been purchased to replace the original systems. In addition, small SDRs, Raspberry Pi single-board computers, motor interface boards, and related components have been ordered for controlling the dish's pointing and sampling the received signal.
- D. Harper's PHYS 318 class is working on a *LabVIEW* software interface to perform computational and visualization tasks with the raw data from the SDR module output, such as converting the wideband received signal into a manageable data stream and converting the system response into brightness traces on the sky. The interface will also allow students and faculty to operate the telescope remotely over the internet.
- The final installation of the dish will require digging a post hole and cable trenches at the observatory, then leveling and setting the post in the ground with concrete mix and burying the power and data cables.

**Figure 5.** After cleaning and sanding the surface, cracks and the damaged edge of the dish were repaired using fiberglass cloth and automotive fiberglass resin. While at Bell Observatory, the steel support hardware was measured and inspected for bends and corrosion.

**Figure 6.** P. Wilkerson transferring measurements of the east-west slew actuator piston and mounting bracket into a *SolidWorks* Computer Aided Design software model to evaluate the telescope support structure's range of motion and to track needed replacement hardware, including new galvanized nuts, bolts, and bearings.



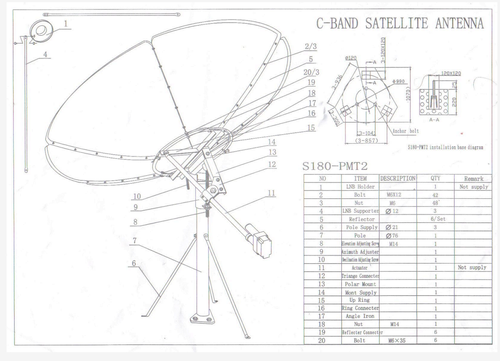




**Figure 7.** Schematic diagrams and parts list for a typical C-band TVRO dish and mounting system.

### References

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**For more information, please see physics.wku.edu/~gibson**