

SpectraCyber Neutral Hydrogen Measurements

using the Deep Space Exploration Society

60-foot Antenna System

Richard Russel D.Cs., Ae.E.; Gary Agranat

Deep Space Exploration Society

Abstract:

The Deep Space Exploration Society (DSES) has enhanced the 60-foot dish located at the Paul Plishner Radio Astronomy and Space Science Center near Haswell, Colorado, to detect 1420 Mhz. signals. A SpectraCyber was installed and numerous radio astronomy sources were detected. This paper documents the radio telescope setup and results.

Introduction:

The Deep Space Exploration Society (DSES) (Deep Space Exploration Society) has spent many years repairing the 60-foot dish at the Paul Plishner Radio Astronomy and Space Science Center near Haswell, Colorado. The dish was outfitted with a 1420 Mhz. feed system, fiber optics from the feed to a communications trailer, and a SpectraCyber system as a receiver. The dish has also been outfitted with a manual control system and a dish pointing system that allows for the pointing of the dish in azimuth/elevation and Right Ascension (RA) / Declination (DEC) using a real-time indication.

The Antenna System:

The Haswell site began as a National Bureau of Standards project started in the early 1950's. The site was operational from 1955 to 1974. Starting in 1959, the dish was used for Tropospheric radio propagation studies for design of communications systems in Northern Latitudes. This site was one of several similar sites located from Boulder, CO to Arkansas that supported the construction of the DEW Line from Alaska to Greenland.

The antenna specifications are:

- **Frequencies:** 400 Mhz to 2 Ghz
- **Diameter:** 60 feet
- **Antenna Gain:** 42.5 dbi at 1 Ghz
- **Beam Width:** 2.6 degree at 400 Mhz (0.8 degree at 1.2 Ghz)
- **Noise Temperature:** 1-2db at 400 Mhz total system
- **Noise Figure:** 0.8db at 400 Mhz w/20db LNA
- **Coverage:** Full Hemisphere
- **Slew Rate Max Az/El:** 40/40 deg/min

The feed is installed using the vertical platform shown in figure 1.



Figure 1: 60-foot Dish in Maintenance Position

The Feed:

The feed was built by the current DSES President, Steve Plock. This is the current 21cm feed (figure 2). It was placed in service on 28 June, 2018. The 1/4" base plate was professionally welded to the cylindrical waveguide section. The 1420 Mhz. feed has a gain of 40 dB and a noise figure of 0.29 dB.



Figure 2: 1420 Mhz. Feed

Communications Trailer:

A trailer was installed close to the dish to provide the shortest path from the antenna to the receivers. The feed is connected to a communications trailer (figure 3) by 120 feet of fiber optics. The fiber optics is connected to a 1420 Mhz. to 70 Mhz. down converter and then to the SpectraCyber system (SpectraCyber) (SpectraCyber I/II Installation and Operations Manual).



Figure 3: Communications Trailer and Equipment Rack

Pointing System:

The dish is manually pointed by use of controls in the trailer. The azimuth and elevation of the dish is measured by a 12-bit encoder system. The dish position is displayed real-time in the trailer in both azimuth/elevation (AZ/EL) and Right-Ascension/Declination (RA/DEC). (figure 4) This system allows the dish to be pointed directly at an astronomical object and limits the requirement of having to use drift scan.

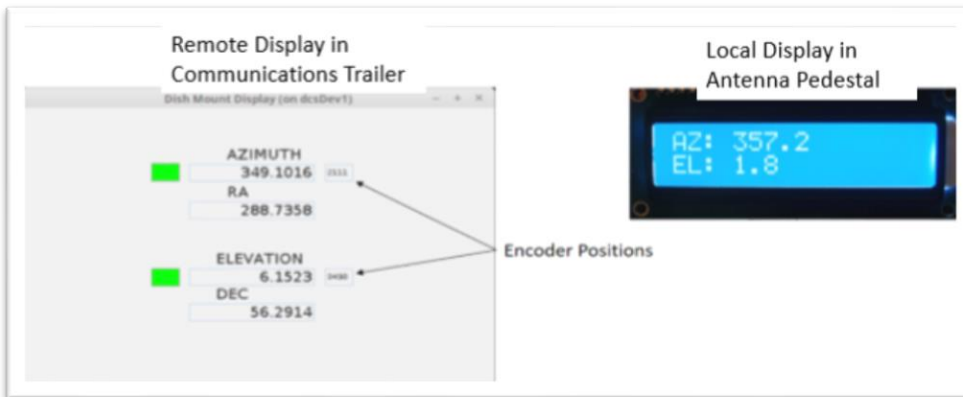


Figure 4: Dish Position Control Indicator

Operations:

Observing was conducted in the trailer. The astronomical sources were selected and the dish was steered to the RA/DEC of the source. The crew consisted of an antenna operator and a SpectraCyber operator. (figures 5 and 6)



Figure 5: DSES Communications Trailer and Operators



Figure 6: Recording SpectraCyber data

SpectraCyber Settings:

The SpectraCyber was designed for smaller antennas. The initial data taken with the 60-foot antenna system with its large gain resulted in saturation which maxed out the chart. The solution was to specify a gain of 5 and an Offset Volts of 4.00. Note: It was found that a gain of 1 does not work on this system. The settings tab used are shown in figure 7.

Figure 7: SpectraCyber Settings Tab

Observations:

The goal of the initial observation was to replicate the results from the RASDR-2 (Oxley) and RASDR-4 observation made by Tony Bigsbee of a HI absorption “Dark Cloud” located at: RA: 18.15035 hrs. DEC: -19.999 deg. The results of the SpectraCyber observation is shown in figure 8. Note that there is a significant dip in signal strength in the center of the observation. This is believed to be the result of a cold HI cloud that is between the “hot” HI source and the Earth. This

would cause the signal at 1420.406 Mhz. to be absorbed and therefore reduce detected signal strength.

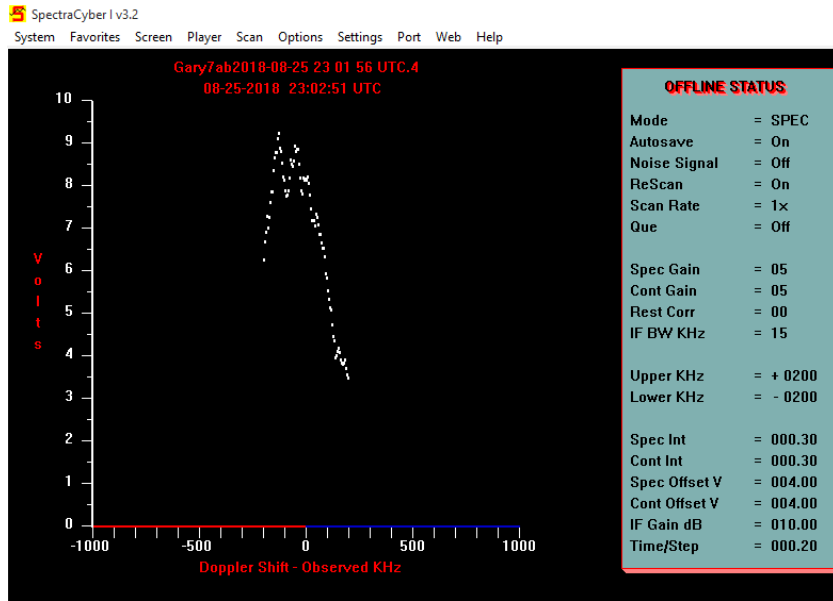


Figure 5: "Dark Cloud" Detection using the SpectraCyber on DSES 60-foot dish

A comparison of the RASDR-2, RASDR-4 and SpectraCyber observation of this source is shown in figure 9.

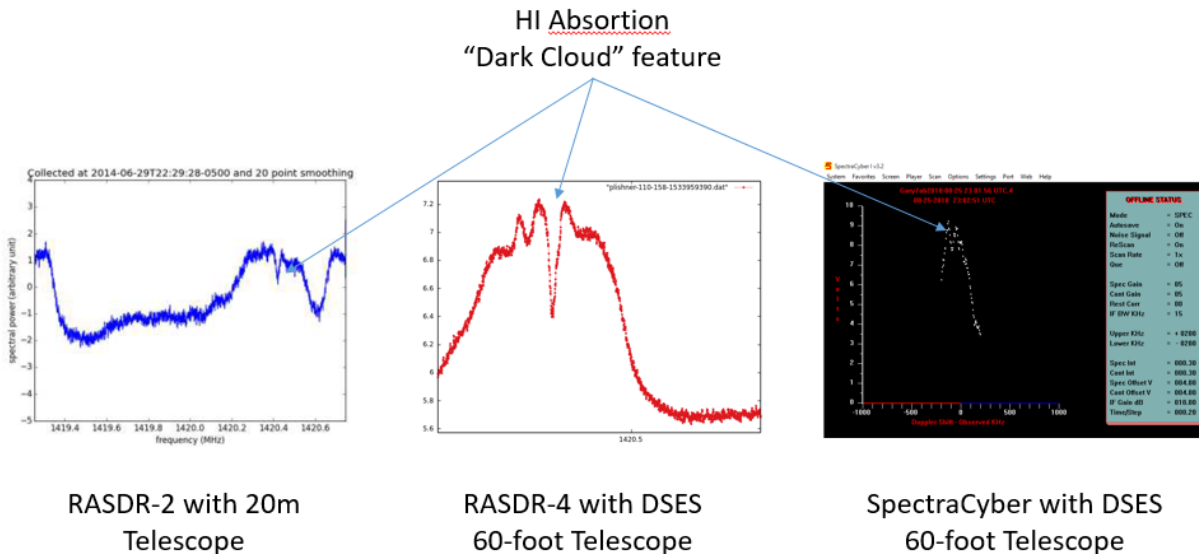


Figure 6: Dark Cloud Target using the RASDR-2, RASDR-4 and SpectraCyber

Follow-up Tasks:

Future upgrades are planned to enhance the overall radio telescope system:

- Record antenna position vs. time and make available for off-line processing with the receiver data.
- Calibrate the signal strength using a local source and astronomical sources
- Calibrate the Doppler center frequency using a local 1420.406 Mhz. source
- Add procedures to properly record the required data for scientific quality observations

Summary:

The Deep Space Exploration Society has established a baseline capability to observe neutral hydrogen Doppler measurements using the SpectraCyber system in conjunction with the 60-foot dish. The settings and observation techniques were worked out and tested. The test to reproduce the “Dark Cloud” observation was successful.

The DSES antenna and SpectraCyber system is ready to support scientific observations. To reserve time on the antenna, contact DSES through the website: www.DSES.science .

References:

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