

Satellite Communications with NRAO Green Bank Antennas

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The National Radio Astronomy Observatory (NRAO) has new opportunities to partner with organizations in addition to the NSF using the assets at the Green Bank site. The 100 m Green Bank Telescope (GBT) is the world's largest and most sensitive fully-steerable telescope, and can track at 20 deg min^{-1} in elevation and 40 deg min^{-1} in azimuth, providing the ability to track medium Earth orbit, geostationary, and deep space spacecraft. At X-band, its gain of 77 dB is unsurpassed by any fully steerable antenna. In addition to the GBT, the fully steerable, polar-mounted NRAO 140-ft telescope, with tracking rates of 20 deg min^{-1} , and the 20 m telescope, with tracking rates of 120 deg min^{-1} , provide a significant suite of instruments that can be deployed for spacecraft communications. Scheduled and target of opportunity observations are supported, allowing regular monitoring of and rapid response to targets.

The GBT is equipped with cryogenic low-noise wideband receivers covering 93% of the spectrum between 0.3 GHz and 50 GHz, and W-band at 68 – 92 GHz. Of particular interest is the X-band receiver at 8 – 10 GHz, the Ku-band receiver at 12 – 18 GHz, and the Ka-band receiver covering 28 – 40 GHz. The 140-ft antenna is currently equipped with an uncooled X-band receiver. The GBT's Gregorian and the 140-ft's Cassegrain focus cabins hold multiple receivers simultaneously and receiver changes are fast.

Common resources available to these antennas include a hydrogen maser frequency reference and flexible FPGA-based signal processors. The maser reference provides a resource for performing precision Doppler measurements on communication downlinks. Each antenna is equipped with fiber optic transmission systems to bring the IF from the receivers to the Jansky Laboratory, which has well-regulated, highly-reliable line power and generator back-up, and shielded, climate-controlled control and equipment rooms. Available backends include the Versatile GBT Astronomical Spectrometer, which has a wide bandwidth of up to 10 GHz, and the special-purpose JPL Frequency Agile Receiver signal processor, which is available for high-resolution Doppler measurements or other high time resolution experiments. User supplied signal processing equipment is easily accommodated for all three antennas.

This paper describes and demonstrates capabilities of the 100 m, 140-ft, and 20 m antennas at the NRAO Green Bank site.