Green Bank Telescope – Unique features and their effectiveness

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The Green Bank Telescope (GBT) was commissioned in early 2001 and has resulted in a number of scientific publications during its 13 years' of operation. Pulsars, nature of dark energy, galaxy formation, black holes and Hubble Constant are some examples of research discoveries made with the GBT. The GBT is a fully steerable telescope with a double-offset reflector design. The main reflector is completely unblocked and has a projected aperture of 100 meters in diameter. The subreflector is a section of an ellipsoid 7.55x7.95 meters in size. The telescope operates at prime focus from 290 MHz to 1200 MHz and at secondary focus in the 1.15 GHz to >100 GHz range. The main reflector has about 2000 actuators that are used to compensate for deformations mainly due to gravity and in some cases due to thermal effects.

The most striking feature of the GBT is the unblocked aperture that results in low sidelobes and a high dynamic range. Measurements at L-band substantiate simulations of beam patterns of the telescope carried out with sophisticated electromagnetic software. The absence of blockage also leads to excellent spectral baselines resulting in high sensitivity to low surface brightness. Measured aperture efficiency is relatively high compared to an on-axis telescope. The active surface compensates for deformations resulting in improved surface rms and efficiency and is normally turned on at frequencies >15 GHz. The illumination patterns of the primary feed horn have been carefully chosen for optimizing the gain/system temperature as a function of frequency. Scattering from the feed support structures, though secondary, could add to the system temperature. In order to minimize this contribution, a spillover shield has been installed which redirects scattering on to the cold sky, instead of the scattered radiation reaching the warm ground.

The scattering from the gaps between the reflector panels contribute to baseline ripples. Care has been taken to align the panels on the subreflector minimizing this contribution. The panels on the main reflector edge have not been trimmed to form a smooth contour. The serrated edge results in smearing of the sidelobe structure.

Simulated and/or measured results to show the effectiveness of some of the unique features of the GBT will be presented. Ongoing development program is in place to ensure that the GBT remains in the forefront of cutting edge instrumentation for doing single dish astronomy. Phased array feed development for the GBT for example; will be able to synthesize multiple simultaneous beams on the sky for complete coverage of the field of view without loss of sensitivity in each beam.

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[1] *The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.*