The Green Bank Telescope: Pointing Model and Metrology Systems

Ellie White*[1], Frank D. Ghigo[2], Dave T. Frayer[2], Richard M. Prestage[a3], Joe Brandt[2], Dennis Egan[2], Ronald J. Maddalena[2], J.D. Nelson[2], and Jason Ray[2]

[1] Marshall University, Huntington, WV 25755
[2] Green Bank Observatory, Green Bank, WV 24944
[3] West Virginia University, Morgantown, WV, 26506

[a]Deceased

The Green Bank Telescope (GBT) is the largest fully-steerable telescope in the world, weighing $7.7x10^6$ kg ($17x10^6$ pounds), with a 100m x 110m off-axis paraboloid dish. One of the challenges for large, ground-based radio telescopes is achieving sufficient pointing accuracy for observing at high frequencies – up to 116 GHz for the GBT. Accurate pointing requires blind source acquisition and local corrections obtained by observing nearby calibrator sources in order to attain an accurate starting location within a few arcseconds of the target source's position; alignment must be maintained to a fraction of that during subsequent open-loop tracking. The GBT's unique off-axis feed structure compounds the problem of achieving high pointing accuracy; while the off-axis feed is advantageous in that it eliminates blockage of the dish and reduces sidelobe interference, it also creates an unbalanced structure. Factors that degrade the GBT's pointing include gravitational flexure, thermal deformation, azimuth track tilt and irregularity, and small misalignments and offset errors within the telescope's structure. To correct for these effects, a pointing model was developed. In addition to standard geometric corrections, this model utilizes metrology data from the GBT's suite of 19 structural temperature sensors, and data from track levels lookup tables. We present here a summary of the model and corrections that are applied to optimize GBT pointing performance, as well as a discussion of associated metrology systems and an analysis of its current nighttime pointing accuracy of X-Band observations. We find that the effective pointing accuracy achieved by the GBT is as good as 1.2 arcseconds when the model is applied and a calibration scan is done within 10° of the source and within 1 hour of starting the observation. When the pointing model is applied but no local calibrations are performed, the GBT can achieve 9 arcsecond pointing accuracy.