

The Green Bank Telescope: A Status Update Richard Prestage, Robert Anderson, et al

GREEN BANK OBSERVATORY





Green Bank Observatory

- Formally began doing business as GBO October 1, 2016
- Allows us the flexibility to engage in partnerships/contracts
 - Breakthrough Listen Project
 - NanoGrav Project
 - West Virginia University
 - RadioAstron Earth Station (Roscosmos)
- Actively seeking other partnerships: NSF funding for 'Open Skies' observing is reduced to 66% in FY 2017/2018
 - FY 2019 funding and beyond is undetermined







Green Bank Observatory

- 20m and 140 foot Telescopes, as well as the GBT, available for new partnerships
 - Develop Radar Capability: Planetary/Low Earth Orbit
 - Earth Station for High Earth Orbit or Deep Space Probes
 - Facilities for project incubation/testing/development
 - Precision Machine Shop

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Over 800 letters/emails submitted in support of GBO during the Environmental Impact Statement Comment Period (Thanks!)



Green Bank Observatory

Same devoted staff!

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Green Bank Telescope Research

Fundamental Physics

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- Testing matter at extreme densities (neutron stars, pulsars, black holes)
- Star Formation/Evolution
 - How do stars form and die?

Origin of Life – Planetary Birth and Evolution

- Where and how can life form, and how did life arrive on earth?
- Galaxies across Cosmic Time
 - What is the distribution of matter across the universe?
 - How do galaxies and clusters of galaxies form?



Antenna Systems

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- Original Azimuth Track Replaced in 2007
 - New wear plates developed bottom surface cracks at the ends in 2010
 - Attributed to fretting
 - Some plates replaced this year when cracks propagated to the top surface
 - Mitigated by shifting of plates around the circle and annual replacement of bronze/Teflon/molybdenum lubricating layer





Antenna Systems

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- Original Receiver Turret replaced in 2010
 - · Original turret could not be adequately maintained
 - Telescope had to be moved to vertical to rotate, increasing observing overhead
 - New Turret has 4x the Torque of the Original to accommodate our larger receivers
 - Receivers can be rotated into position 'on the fly', regardless of elevation angle

















Antenna Systems

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- Main Drives Control System Upgraded
 - PLC based interface
 - Motor Tachometers replaced with Optical Encoders
 - Position Encoders now utilize full 26 bits available (previously limited to 24)
 - Sampled at 1 kHz with digital signal processing to beat down noise
 - Position Loop closure rate increased as well
 - 21st Century Software and Architecture
 - Provides the basis for further development to minimize tracking error and increase disturbance rejection





New Instrumentation

- Receivers
 - MUSTANG Version 2 (UPenn Devlin)
 - 223 unpolarized, feedhorn-coupled bolometers covering 75 105 GHz
 - > 4 arcminute field of view with 9 arcsecond resolution
 - Expected 50 µJy rms point source sensitivity over 4x4 arcminute area in 1 hour
 - Now in science operation!!





New Instrumentation

- Receivers

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- ARGUS (Stanford Church)
 - 16 pixel W-Band focal plane array
 - Miniature Heterodyne Receiver Modules
 - Science Objective is Millimeter Spectroscopy with high resolution
 - Vastly improved mapping speeds for rapid surveys of large areas of the sky
 - Also up and ready for science!







New Instrumentation

- New Spectrometer
 - VEGAS; developed by GBO and UC Berkeley
 - Replaces the original, 20 yr. old GBT Spectrometer
 - FPGA based frontend, heterogeneous computing backend comprised of Graphical Processing Units and CPU's
 - 8 ROACH II Boards, 16 high-speed (5GSPS) ADC's,8 high performance computers with GPU's
 - 1.25GHz/input bandwidth for 8 dual or 16 single polarization inputs
 - Our Spectral Line Instrument; Pulsar Modes early 2017







Software

- Monitor and Control and Large Data Set Handling
 - Original software built for 10MB/s data rates; new multi-pixel cameras generate 10GB/s
 - Communications Infrastructure updated using ZeroMQ
 - Expected to handle higher data rates from newest cameras
 - Data Processing Not Dependent on Output Formats
 - Streaming Architecture allows flexible processing pipelines without reading/writing large intermediate files to disk
 - · Unifies Publishing into One Interface







Green Bank Telescope - Summary

- The Green Bank Telescope remains the premier pulsar telescope for discovery and monitoring.
- Receiver cabin and prime focus apparatus provide highly flexible platforms for development of new receivers
- Data Collection and Processing ready to support current multi-pixel cameras





greenbankobservatory.org

The Green Bank Observatory is a facility of the National Science Foundation operated under cooperative agreement by Associated Universities, Inc.



