Welcome + Overview of GBT Capabilities, Observing Strategies, and Current Proposal Call

Speaker: Emily Moravec, Authors: Natalie Butterfield & Emily Moravec
Welcome and Workshop Information

• **Goals of this Workshop**
  • Train new GBT users how to propose for telescope time
  • Update community on current GBT capabilities
  • Address questions about submitting GBT proposals

• **Summary of Workshop Schedule**
  • 14:00 – 15:00: Welcome, Overview of GBT Capabilities, Observing Strategies, and Current Proposal Call
  • 15:00 - 15:10: Upcoming Capabilities - Ultra-wide Band Receiver
  • 15:10 - 15:40: Sensitivity Calculator
  • 15:40 - 16:10: Mapping Calculator
  • 16:10 - 17:00: Proposal Submission Tool and Proposal Writing Tips

• Office Hour: July 15th — 9:00 - 10:00 EST

• Recordings of today’s talks will be available on the workshop webpage

Photo Credit: Green Bank Science Center
GBT Overview and Current Capabilities

Outline of Talk

1. Basic Overview of the GBT
2. GBT Science Areas
3. Capabilities and Performance of the GBT
4. Observing Strategies
5. Current 2023A Proposal Call
Green Bank is the original NRAO site and has been operating world-class radio telescopes for nearly 60 years.....
Overview of the GBT

Radio Quiet Zone

Established by the Federal Communications Commission (FCC) and by the Interdepartmental Radio Advisory Committee (IRAC) on November 19, 1958 to minimize possible harmful interference from transmitters.
Overview of the GBT

Key Capabilities of the GBT

- 100 meter diameter unblocked
- Receivers cover 0.1 to 116 GHz
- Excellent sensitivity for point-source and extended objects
- >85% of total sky covered ($\delta \geq -46^\circ$)
- Located in the National Radio Quiet Zone

The GBT frequency coverage overlaps and extends beyond that of the JVLA and ALMA
Overview of the GBT

Active Surface Dish

- 2209 actuators
  - Located at the corner of each of the 2004 panels
- Allows for high frequency observations (3 mm)
- Surface rms ~230 μm at night
Overview of the GBT

Outline

• Fully Steerable
• Elevation Limit: 5° above horizon
• Slew Rates:
  • Azimuth <= 40°/min
    • Avg ~ 35.2°/min
    • Cut to half rate - when T < 17 °F
  • Elevation <= 20°/min
    • Avg ~ 17.6°/min
GBT Science Areas

Wide range of Science Topics

- **Pulsars:** Discovery of new pulsars, the most massive pulsar, gravitational waves via pulsar timing (NANOGrav)
- **Neutral Hydrogen HI:** Masses and kinematics of local galaxies/dark matter
- **High-redshift/Cosmology:** Galaxy clusters, CO in the early universe, HI intensity mapping at high-redshift
- **Interstellar Organic Molecules/Astro-chemistry:** Organic chemistry in space
- **Masers:** black hole masses, distances via proper motions and independent measurement of Hubble constant
- **Star Formation:** NH3 mapping, cold and dense gas tracers at 3-4mm
- **Basic Physics:** The search for Gravitational Radiation, limits on Fundamental “constants”
- **Solar system astronomy:** planetary radar, chemical composition of comets
- **SETI:** Breakthrough Listen project
- **Fast Radio Bursts:** Connection with CHIME array, repeating signals, characteristics
"The decadal report endorsed GBO as an essential facility and recommended sufficient funding to maintain and improve its capabilities.”

Some capabilities specifically highlighted in the decadal survey concerning GBT science:

- pulsar timing and the detection of gravitational waves
- time domain and multi-messenger astronomy
- the search for the biochemical signatures of life
- origins and evolution of stars and galaxies

ngVLA collaboration/integration

See GBO Community Zoom by Director Jim Jackson: https://www.youtube.com/watch?v=DAEy3scDzDA
GBT Science in the Astro2020 Decadal survey

![Bar chart showing the number of white papers in various scientific categories in the Astro2020 Decadal survey. The categories include Star and Planet Formation, Cosmology and Fundamental Physics, Formation and evolution of compact objects, Multi-Messenger, Galaxy Evolution, Astronomy and Astrophysics, Resolved stellar populations and their environments, Planetary Systems, Stars and Stellar Evolution. The bars are color-coded to represent Explicit GBT, Implicit + Explicit GBT, and GBT science.]
## GBT Capabilities

### Summary of GBT Specs

<table>
<thead>
<tr>
<th>Location</th>
<th>Green Bank, West Virginia, USA</th>
</tr>
</thead>
</table>
| Coordinates      | Longitude: 79°50'23.406" West (NAD83)  
Latitude: 38°25'59.236" North (NAD83)  
Track Elevation: 807.43 m (NAVD88) |
| Optics           | 110 m x 100 m unblocked section of a 208 m parent paraboloid  
Offaxis feed arm |
| Telescope Diameter | 100 m (effective) |
| Available Foci   | Prime and Gregorian  
f/D (prime) = 0.29 (referred to 208 m parent parabola)  
f/D (prime) = 0.6 (referred to 100 m effective parabola)  
f/D (Gregorian) = 1.9 (referred to 100 m effective aperture) |
| Receiver mounts  | Prime: Retractable boom with  
Focus-Rotation Mount  
Gregorian: Rotating turret with  
8 receiver bays |
| Subreflector      | 8-m reflector with Stewart Platform (6 degrees of freedom) |
| Main reflector    | 2004 actuated panels (2209 actuators)  
Average intra-panel RMS 68 µm |
| FWHM Beamwidth    | Gregorian Feed: ~ 12.60/\(f_{GHz}\) arcmin  
Prime Focus: ~ 13.01/\(f_{GHz}\) arcmin (see Section 4.1.1) |
| Elevation Limits  | Lower limit: 5 degrees  
Upper limit: ~ 90 degrees |
| Declination Range | Lower limit: ~ -46 degrees  
Upper limit: 90 degrees |
| Slew Rates        | Azimuth: 35.2 degrees/min  
Elevation: 17.6 degrees/min |
| Surface RMS       | Passive surface: 450 µm at 45° elevation, worse elsewhere  
Active surface: ~ 250 µm, under benign night-time conditions |
| Pointing accuracy | 1σ values from 2-D data  
5” blind  
2.2” offset |

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Photo Credit: Jay Young

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Proposal Planning Workshop — July 2022
GBT Capabilities

Available Receivers

• Prime Focus
  • Retractable boom
  • Low frequency (<1 GHz)
  • Only 1 receiver on the telescope at any time

• Gregorian
  • Uses sub-reflector
  • Higher frequency (>1 GHz)
  • 8 receivers in turret and on telescope at any time
GBT Capabilities

Prime Focus Receivers

- PF1 has four different frequency receivers (bands)
  - 342 MHz (290-395 MHz)
  - 450 MHz (385-520 MHz)
  - 600 MHz (510-690 MHz)
  - 800 MHz (680-920 MHz)
- 450 & 600 MHz receivers overlap with digital TV signals → Strong RFI
  - Observers should contact a support scientist before submitting a proposal for these feeds
- PF2 (0.910-1.23 GHz)
  - Bandwidth options of 20, 40, 80, 240 MHz
- Need maintenance day to switch out PF receivers
GBT Capabilities

Prime Focus Receivers

• New receiver: Ultra-Wideband (UWB)
  • 0.7-4 GHz
  • Wide instantaneous bandwidth - 6:1
  • Science: optimized for high-precision pulsar timing and wide-band observations of fast transients
  • Dual polarization
• Commissioning during summer 2022 - affects availability of PF/800 and PF/342
• More from Ryan
GBT Capabilities

11 Gregorian Receivers

- L band (1.15-1.73 GHz)
  - Notch filter (1.2-1.34 GHz) to suppress RFI
- S band (1.73-2.60 GHz)
- C band (3.95-7.8 GHz)
  - Only linear polarization recommended, circular polarization not recommended
- X band (7.8-11.6 GHz)
  - Polarization purity degrades above 10 GHz
  - New X-band receiver commissioning Fall 2022: improved gain at high frequencies/larger BW
- Ku band (12-15.4 GHz)
  - 2 beams
- KFPA (18.0-27.5 GHz)
  - Multi-pixel receiver (7 pixels)
  - Narrowband mode: 1.8 GHz maximum bandwidth
  - Broadband mode: 7.5 GHz maximum bandwidth, but only 1 pixel (beam 1 or beam 2)
- Ka band (26-39.5 GHz)
  - 2 beams - single polarization
  - 3 subbands: 26.0-31.0, 30.5-37.0, 36.0-39.50 GHz
- Q band (39.2-50.5 GHz)
  - 2 beams
- W band (67-93 GHz)
  - 2 beams
  - 4 subbands: 67-74, 73-80, 79-86, 85-93.0 GHz
- Mustang2 (80-100 GHz)
  - Bolometer Camera
  - Must have permission from the Mustang team to use
- Argus (80-115.3 GHz)
  - Multi-pixel receiver (16 pixels)
  - Single polarization
### GBT Capabilities

#### Summary of Available Receivers

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Band</th>
<th>Frequency Range (GHz)</th>
<th>Focus</th>
<th>Polarization</th>
<th>Beams</th>
<th>Polarizations per Beam</th>
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<tr>
<td>PF1</td>
<td>342 MHz</td>
<td>.290–.395</td>
<td>Prime</td>
<td>Lin/Circ</td>
<td>1</td>
<td>2</td>
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<tr>
<td></td>
<td>450 MHz*</td>
<td>.385–.520</td>
<td>Prime</td>
<td>Lin/Circ</td>
<td>1</td>
<td>2</td>
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<tr>
<td></td>
<td>600 MHz*</td>
<td>.510–.690</td>
<td>Prime</td>
<td>Lin/Circ</td>
<td>1</td>
<td>2</td>
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<tr>
<td></td>
<td>800 MHz*</td>
<td>.680–.920</td>
<td>Prime</td>
<td>Lin/Circ</td>
<td>1</td>
<td>2</td>
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<tr>
<td>PF2*</td>
<td>—</td>
<td>.910–1.23</td>
<td>Prime</td>
<td>Lin/Circ</td>
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<td>2</td>
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<td>L-Band</td>
<td>—</td>
<td>1.15–1.73</td>
<td>Greg.</td>
<td>Lin/Circ</td>
<td>1</td>
<td>2</td>
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<tr>
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<td>—</td>
<td>1.73–2.60</td>
<td>Greg.</td>
<td>Lin/Circ</td>
<td>1</td>
<td>2</td>
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<tr>
<td>C-Band</td>
<td>—</td>
<td>3.95–8.0</td>
<td>Greg.</td>
<td>Lin/Circ</td>
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<td>2</td>
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<td>8.00–11.6</td>
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<td>Circ</td>
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<td>2</td>
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<td>—</td>
<td>12.0–15.4</td>
<td>Greg.</td>
<td>Circ</td>
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<td>2</td>
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<td>KFPA</td>
<td>—</td>
<td>18.0–27.5</td>
<td>Greg.</td>
<td>Circ</td>
<td>7</td>
<td>2</td>
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<tr>
<td>Ka-Band</td>
<td>MM-F1</td>
<td>26.0–31.0</td>
<td>Greg.</td>
<td>Circ</td>
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<td>1</td>
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<td>MM-F2</td>
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<td>Circ</td>
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<td>MM-F3</td>
<td>36.0–39.5</td>
<td>Greg.</td>
<td>Circ</td>
<td>2</td>
<td>1</td>
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<td>Q-Band</td>
<td>—</td>
<td>38.2–49.8</td>
<td>Greg.</td>
<td>Circ</td>
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<td>2</td>
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<tr>
<td>W-Band 4mm</td>
<td>MM-F1</td>
<td>67–74</td>
<td>Greg.</td>
<td>Circ</td>
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<td>2</td>
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<td></td>
<td>MM-F2</td>
<td>73–80</td>
<td>Greg.</td>
<td>Circ</td>
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<td>2</td>
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<tr>
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<td>Greg.</td>
<td>Circ</td>
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<td>2</td>
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<tr>
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<td>85–93.3</td>
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<td>Circ</td>
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<tr>
<td>Mustang2</td>
<td>—</td>
<td>80–100</td>
<td>Greg.</td>
<td>—</td>
<td>200</td>
<td>—</td>
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<tr>
<td>ARGUS</td>
<td>—</td>
<td>80–115.3</td>
<td>Greg.</td>
<td>Circ</td>
<td>16</td>
<td>1</td>
</tr>
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</table>

See page 10 in the proposers guide (table 3)
## GBT Capabilities

### Receiver Performance and Bandwidth

<table>
<thead>
<tr>
<th>Receiver</th>
<th>Band</th>
<th>Beam Separation</th>
<th>FWHM</th>
<th>Gain (K/Jy)</th>
<th>Aperture Efficiency</th>
<th>Maximum Instantaneous Bandwidth (MHz)</th>
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</thead>
<tbody>
<tr>
<td>PF1</td>
<td>342 MHz</td>
<td>——</td>
<td>36’</td>
<td>2.0</td>
<td>72%</td>
<td>240</td>
</tr>
<tr>
<td></td>
<td>450 MHz*</td>
<td>——</td>
<td>27’</td>
<td>2.0</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>600 MHz*</td>
<td>——</td>
<td>21’</td>
<td>2.0</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>800 MHz</td>
<td>——</td>
<td>15’</td>
<td>2.0</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>PF2*</td>
<td>——</td>
<td>——</td>
<td>12’</td>
<td>2.0</td>
<td>72%</td>
<td>240</td>
</tr>
<tr>
<td>L-Band</td>
<td>——</td>
<td>——</td>
<td>9’</td>
<td>2.0</td>
<td>72%</td>
<td>650</td>
</tr>
<tr>
<td>S-Band</td>
<td>——</td>
<td>——</td>
<td>5.8’</td>
<td>2.0</td>
<td>72%</td>
<td>970</td>
</tr>
<tr>
<td>C-Band</td>
<td>——</td>
<td>——</td>
<td>2.5’</td>
<td>2.0</td>
<td>72%</td>
<td>3800</td>
</tr>
<tr>
<td>X-Band</td>
<td>——</td>
<td>——</td>
<td>1.4’</td>
<td>2.0</td>
<td>71%</td>
<td>2400</td>
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<tr>
<td>Ku-Band</td>
<td>——</td>
<td>——</td>
<td>330”</td>
<td>54”</td>
<td>70%</td>
<td>3500</td>
</tr>
<tr>
<td>KFPA</td>
<td>——</td>
<td>——</td>
<td>96”</td>
<td>32”</td>
<td>68%</td>
<td>1800,8000</td>
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<tr>
<td>Ka-Band</td>
<td>MM-F1</td>
<td>78”</td>
<td>26.8”</td>
<td>1.8</td>
<td>63-67%</td>
<td>4000</td>
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<tr>
<td></td>
<td>MM-F2</td>
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<td>22.6”</td>
<td></td>
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<td>MM-F3</td>
<td></td>
<td>19.5”</td>
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</tr>
<tr>
<td>Q-Band</td>
<td>——</td>
<td>58”</td>
<td>16”</td>
<td>1.7</td>
<td>58-64%</td>
<td>4000</td>
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<td>W-Band 4mm</td>
<td>MM-F1</td>
<td>286”</td>
<td>10”</td>
<td>1.0</td>
<td>30-48%</td>
<td>6000</td>
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<tr>
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<td>MM-F2</td>
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<td></td>
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<td>4000</td>
</tr>
<tr>
<td>Mustang2</td>
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<td>——</td>
<td>10”</td>
<td>——</td>
<td>35%</td>
<td>20000</td>
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<tr>
<td>ARGUS</td>
<td>——</td>
<td>30.4”</td>
<td>8”</td>
<td>——</td>
<td>20-35%</td>
<td>1500</td>
</tr>
</tbody>
</table>

See page 10 in the proposers guide (table 3)
GBT Capabilities

Receiver availability

- Popular receivers that are available most of the semester: L-band, X-band, Mustang2, ARGUS and KFPA
- UWB testing - PF/800 available irregularly in 22B
- New X-band receiver is currently being commissioned

- Less popular but would be made available for high ranking proposals: PF/342, S-band, C-band, Ku-band, Ka-band, Q-band, W-band, and other PF feeds
GBT Capabilities

Available GBT Backends

• VEGAS (most used)
  • Spectral-Line Mode
  • Pulsar Mode

• Digital Continuum Receiver (DCR)

• Caltech Continuum Backend (CCB, Ka-band only)

• Mark 6 VLBA Disk Recorder (VLBI)

• JPL Radar Backend

• Breakthrough Listen
GBT Capabilities

VEGAS Spectra Line Mode

- VEGAS mode determines the bandwidth and spectral/velocity resolution
- Modes 20-29 use sub-banding (see note c)
- These modes will be used in the sensitivity and mapping calculations and the PST
- Identify the bandwidth and spectral resolution you want to determine mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>Spectral Windows per Spectrometer</th>
<th>Bandwidth per Spectrometer (MHz)</th>
<th>Number of Channels per Spectrometer</th>
<th>Approximate Spectral Resolution (kHz)</th>
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<td>1</td>
<td>1</td>
<td>1500 (a)</td>
<td>1024</td>
<td>1.465</td>
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<td>2</td>
<td>1</td>
<td>1500 (a)</td>
<td>16384</td>
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<td>3</td>
<td>1</td>
<td>1080 (b)</td>
<td>16384</td>
<td>66</td>
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<td>32768</td>
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<td>100</td>
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<td>32768</td>
<td>0.5</td>
</tr>
<tr>
<td>29</td>
<td>8 (c)</td>
<td>16.875</td>
<td>65536</td>
<td>0.26</td>
</tr>
</tbody>
</table>

(a) The usable bandwidth for this mode is 1250 MHz.
(b) The usable bandwidth for this mode is 850 MHz.
(c) For modes 20-24, the spectral windows must be placed within 1500 MHz with a usable frequency range of 150 to 1400 MHz. For modes 25-29, the spectral windows must be placed within 1000 MHz with a usable frequency range of 150 to 950 MHz.
GBT Capabilities

VEGAS Pulsar Mode

- Coherent and Incoherent dedispersion modes
- Bandwidth: 100-1500 MHz
- Number of channels: 64-4096

More information is available here for the VEGAS pulsar modes: [https://safe.nrao.edu/wiki/bin/view/CICADA/VegasPulsarObservingInstructions](https://safe.nrao.edu/wiki/bin/view/CICADA/VegasPulsarObservingInstructions)
GBT Observing Strategies

The GBT provides a lot of observing options – multiple instruments and several observing modes

- Pick receiver based on frequency
- Pick backend based on observing type (spectral line, continuum, pulsar, ....)
- Pick observing techniques based on science goals (point source, large field, narrow lines vs broad lines....)
- Calibration strategies depend on receiver and science needs
  - High frequency - OOF
  - Gregorian - focus corrections
  - PF - no focus corrections
GBT Observing Strategies

Different observing modes to derive reference data

• Frequency Switching (FS)
• Position Switching (PS)
• Dual-Beam Position Switching
GBT Observing Strategies

Frequency Switched Observations: Definition

Obtains blank sky information by keeping the telescope pointed at object of interest, but switching the center frequency of the measurements (the LO)

Single Dish Calibration Techniques at Radio Wavelengths, K. O’Neil, Section 4.2
Reduction and Analysis Techniques, R. Maddalena, Fig. 10
GBT Observing Strategies

Frequency Switched Observations: Use Cases

• Want to increase on-source time and have well constrained redshift of object
• Narrow line observations in a clean (non-crowded) spectrum
• Galactic HI observations

Advantages
• Rapid switch between ON and OFF and reduces the amount of time spent slewing to off positions.
• Avoids having to find an emission free reference position when observing in an area that may be more crowded

Disadvantages
• Redshift must be well-constrained beforehand
• System must be stable enough that the baselines of the primary observation and the frequency switched observation are virtually identical
• Significant standing waves
GBT Observing Strategies

Position Switched Observations: Definition

ON Source

OFF Source
GBT Observing Strategies

Position Switched Observations: Definition

**ON Source**

\[ T_{\text{source}} + T_{\text{everything else}} \]

**OFF Source**

\[ T_{\text{everything else}} \]
GBT Observing Strategies

Position Switched Observations: Definition

ON - OFF

\( (T_{\text{source}} + T_{\text{everything else}}) \quad \text{——} \quad (T_{\text{everything else}}) \)
GBT Observing Strategies

Position Switched Observations: Use cases

- Narrow line (< 100 km/s) in crowded spectral region or significant RFI
- Broad line (>100 km/s)
- Want best baseline measurements possible
- Compact sources

**Advantages**
- Little a priori information about object needed
- Typically gives very good results

**Disadvantages**
- Requires repointing of telescope
- Results in time off source
- Sky position must be carefully chosen
- Source must not be too extended
GBT Observing Strategies

Dual-Beam Position Switching: Definition

• Nod or nodding - moving telescope to move source between beams
• subBeamNod - using Subreflector to nod source between beams

Dual-Beam Position Switching: Use Cases

• Only used with multi-beam receivers
• Useful when observing small angular diameter sources and when best possible baselines are needed
• Source must not be extended beyond beam size
GBT Observing Strategies

Different observing modes to derive reference data

• Frequency Switching (FS)
  – In or Out-of-band

• Position Switching (PS)
  – Reference-Off
  – Mapping-Off

• Dual-Beam Position Switching
  – Nod -- Move telescope
  – SubBeamNod -- Move Subreflector
GBT Observing Strategies

Observing Mode - Small source

• Source size < beam + Line Obs + PS:
  • Nod {two beams} – for K-band and W-band
  • SubBeamNod {two beams} – for Ka, Q, and Argus
  • OnOff {one beam} (usual PS)
  • Track (with and w/o offset)

• Source size < beam + Line Obs + FS:
  • ‘Track’ scan

• Source size < beam + Continuum Obs:
  • Daisy map (efficient way to deal with 1/f noise)
GBT Observing Strategies

Observing Mode - Large source

• Map > FOV of instrument
  • RaLongMap and/or DecLatMap

• Map <~ FOV of instrument (optimal method depends on several factors)
  • RaLong/DecLat mapping (significant overheads for turn arounds)
  • Daisy (if only interested in central point)
  • PointMap (Grid) if needing a deep spectrum
GBT Observing Strategies

**Observing - Overhead Estimates**

- Should point+focus every 30min-1hr depending on frequency and time of day (point+focus takes ~5min).
  - C/X-band: every 1hr during day; 2-3hr at night
  - Ku/K-band: every 1hr during day; 1-2hr at night
  - Ka/Q-band: every 30-40min during day; 1hr at night
  - W-band: every 20-30min during day; 40-50min at night
  - M2: every 30 min (only at night)
  - ARGUS: every 30-50 minutes depending on conditions

- AutoOOF (which takes ~30min) is used to correct the surface for thermal effects for Q-band, W-band, MUSTANG-2, and ARGUS at night. OOF solutions good for 2-6hrs at night.

- State your logic of your overhead estimate explicitly in your proposal! Under the technical justification.
GBT Observing Strategies

Observing - Sources and Sessions

• Group your sources into sessions.

• Advice for creating sessions.
  • 15 min increments (0.25 hr)
  • Less than 6 hrs
  • Only include receivers and backends that must be used together in a single observation
  • Sources should be within 2 to 3 hours of one another in Right Ascension
  • Sources should be visible at same time for at least 1 to 2 hours
  • Declinations within a few 10s of degrees of one another
  • Sources with Declinations less than the latitude of the GBT (38°25’59.236”) should not be in the same session as sources with Declinations greater than the latitude of the GBT

This information is also listed in Section 6 of the Proposer’s Guide
Proposal Call

- Deadline: Monday August 1st at 17:00 EST (22:00 UTC)

- Proposal Call Link: https://greenbankobservatory.org/science/gbt-observers/proposals/2023a-call-for-proposals/

- Disposition letters will be sent out in early November

- 2023A observations begin February 1st 2023 - July 31st, 2023

- Observer Training School held August 3-5, 2022
  - Fully virtual
Proposal Call
Joint Proposals

Primary is not GBT and “supporting” is GBT

• SOFIA
  • 5% of GBT open skies time
• XMM-Newton
  • 3% of GBT open skies time
• FERMI
  • Up to 3% of GBT open skies time
• CHANDRA
  • Up to 3% of GBT open skies time
• SWIFT
• HST
  • Up to 3% of GBT open skies time

Primary is GBT and “supporting” is not GBT

• SOFIA
  • 3% of SOFIA Guest Observer Time
• XMM-Newton
  • 150 ks of XMM-Newton time per year
• CHANDRA
  • Up to 120 ksec will be made available to GBO/NRAO proposers annually
• SWIFT
  • GBO/NRAO up to 300 kiloseconds of Swift observing time per year
• HST
  • 30 orbits per year of HST time for allocation by the GBO/NRAO TAC

More information under “Joint Observatory Observation Opportunities” on https://greenbankobservatory.org/science/gbt-observers/proposals/2022b-call-for-proposals/
Proposal Categories

Regular and Large Proposals

Regular

– 0.3 – 8 GHz (any weather): < 400 hours and <= 1 year
– 8 – 18 GHz (good weather): < 200 hours, <= 1 year
– 18–27.5 / >50 GHz (excellent weather): < 100 hours, <= 1 year
– Fixed time / monitoring (all weather): < 200 hours, <= 1 year

Large

– 0.3 – 8 GHz (any weather): >= 400 hours and > 1 year
– 8 – 18 GHz (good weather): >= 200 hours, > 1 year
– 18–27.5 / >50 GHz (excellent weather): >= 100 hours, > 1 year
– Fixed time / monitoring (all weather): >= 200 hours, > 1 year

Large GBT proposals will **only** be accepted in the **February** deadlines!
Proposal Categories

Triggered and DDT Proposals

Triggered proposals
– Submitted at the normal proposal deadlines
– Intended for pre-planned observations of transients whose times are not known a priori
– Must include clear, well-justified trigger criteria

Director’s Discretionary Time (DDT)
– Target of Opportunity: Unexpected phenomena, rapid response
– Exploratory Time: Typically a few hours or less, intended for pilot projects taking advantage of a new idea or capability
Proposal Categories

VLBA + GBT Proposals

• Including the GBT in VLBA observations will improve sensitivity

• Backend: Mark6 VLBA Disk Recorder
  • Bandwidth: 1024 MHz

• All proposals need to include overhead estimates in the time estimates!
  • For VLBA with GBT: 30 minutes at the start of the observation for the set up and pointing

• Additional information on VLBI and the GBT can be found here:
  • https://www.gb.nrao.edu/~gbvlbi/vlbinfo.html
  • https://science.nrao.edu/facilities/vlba/docs/manuals/propvlba/referencemanual-all-pages
Observations and Data Reduction

• Successful proposals will be observed by the PI or another member of the proposal team
  • Observations that do not require AutoOOF can be operator run

• GBT training schools are offered three times a year for observers to learn how to control the telescope and perform data reduction
  • January/February, May, September
  • Observer Training Workshop - August 3-5, 2022

• GBTIDL for GBT spectral line data reduction
  • https://www.gb.nrao.edu/GBT/DA/gbtidl/users_guide/

• GBT data reduction pipeline (Jim Braatz & Joe Masters)
  • https://safe.nrao.edu/wiki/pub/GB/Gbtpipeline/PipelineRelease/MappingPipelineUG.pdf
Proposal Checklist

• Scientific justification
  • Regular: 4 pages (no less than 11pt font) on what you want to observe and why
  • Large: 10 pages

• Technical Justification
  • Total time request
    • Time on-source for your object - output of Sensitivity Calculator
    • How much time you need to make a map - output of Mapping Calculator
    • Overhead calculations
  • Impact of RFI on your data

• Sources - RA, Dec, z
• Resources - receivers and backends
• Sessions - group your sources into sessions with receiver and backend information
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Photo Credit: GBO Science Center