Welcome, Overview of GBT Science & Capabilities

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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 Science, and GBT Capabilities
  - 15:00 - 15:30: Sensitivity Calculator
  - 15:30 - 16:00: Mapping Calculator
  - 16:00 - 16:30: Proposal Submission Tool
  - 16:30 - 17:00: Helpdesk, tips for a good proposal, and additional discussion

- Office Hour: January 26th — 9:00 - 10:00 EST

- Recordings of today's talks will be available on the workshop webpage

Photo Credit: Green Bank Science Center

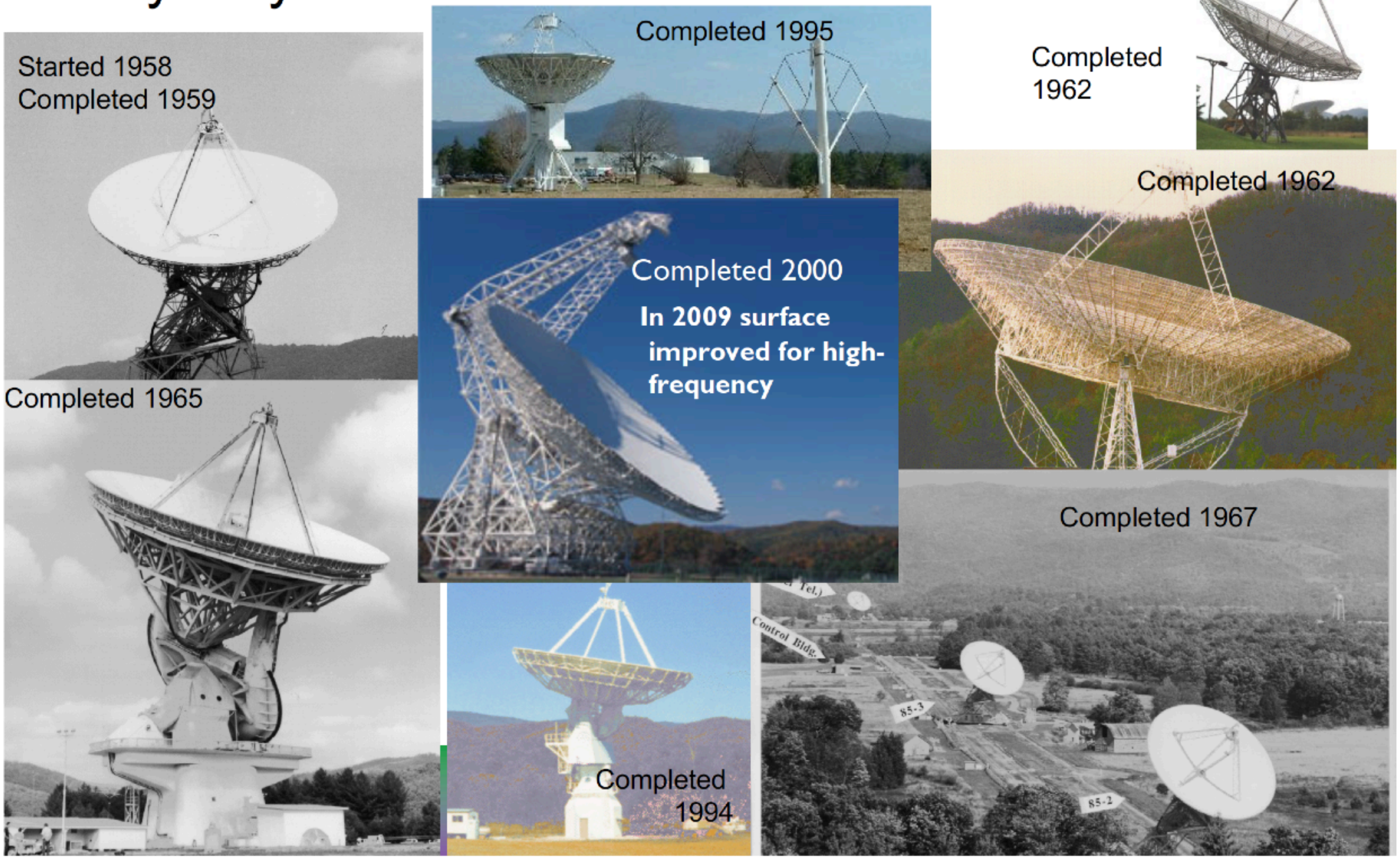
GBT Overview and Current Capabilities

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 2022B Proposal Call

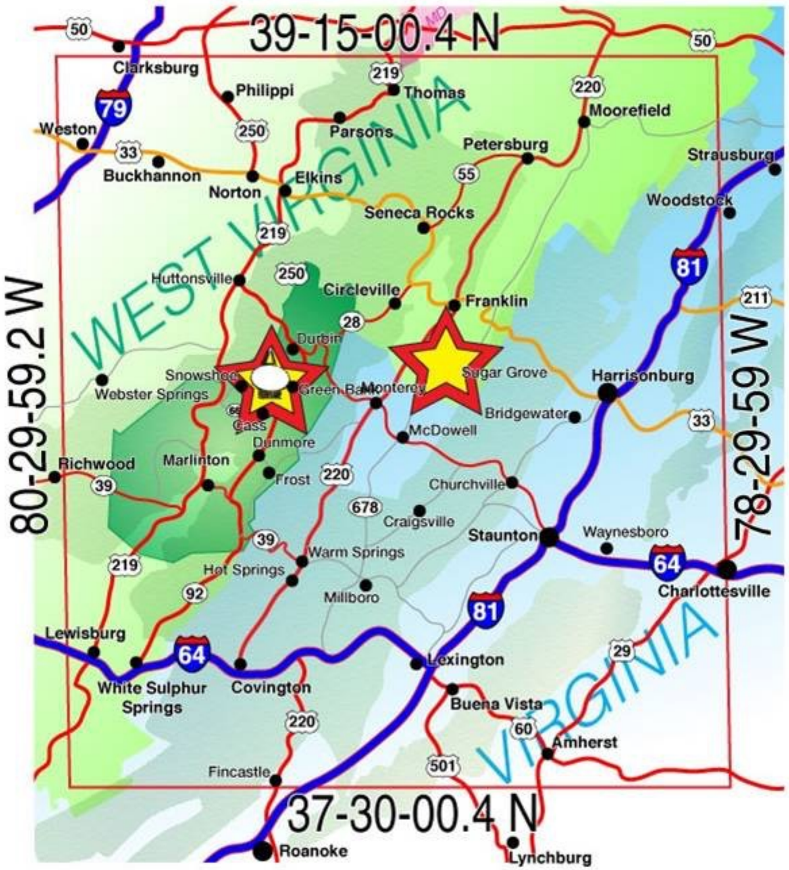
Photo Credit: Jay Young

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

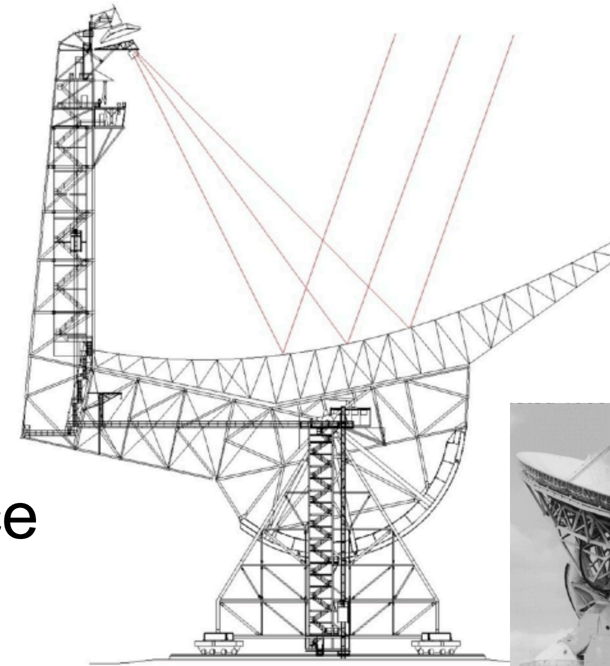


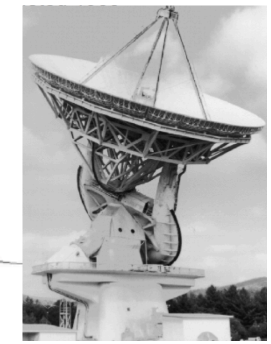


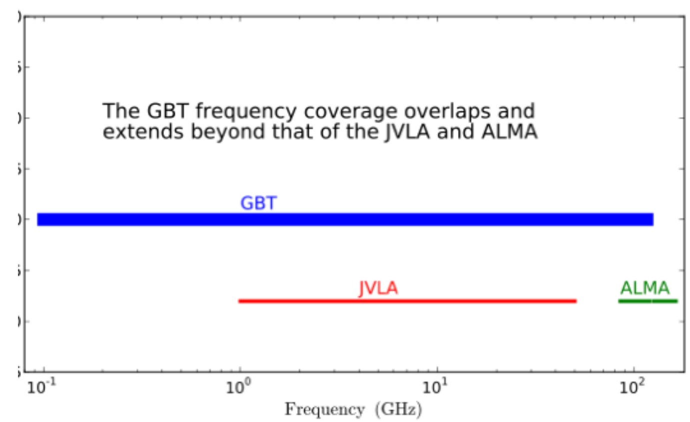
Overview of the GBT

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 (δ≥-46°)
- Located in the National Radio Quiet Zone



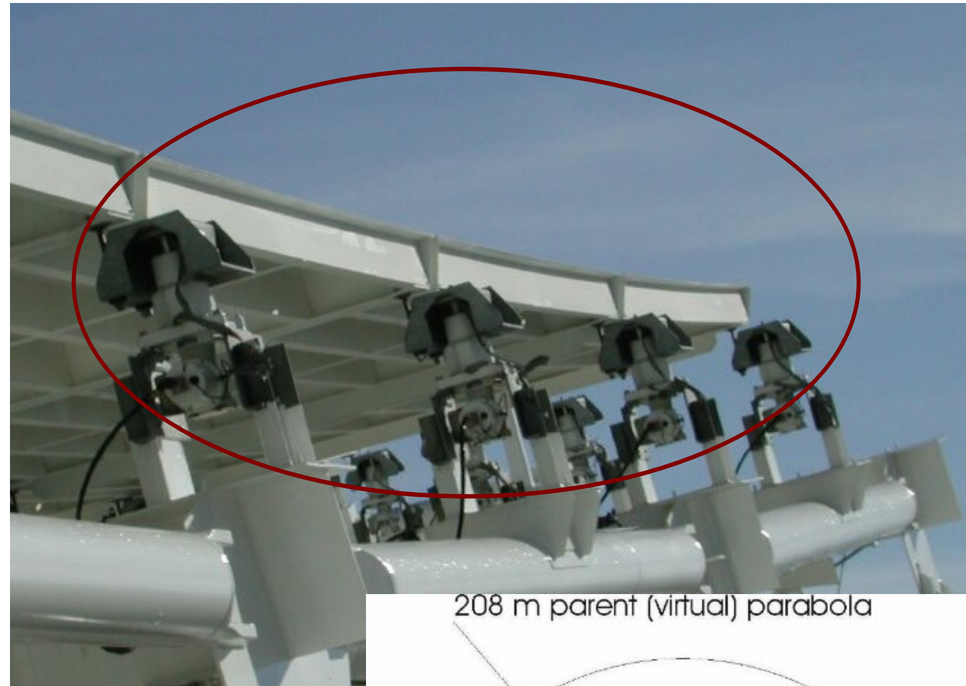


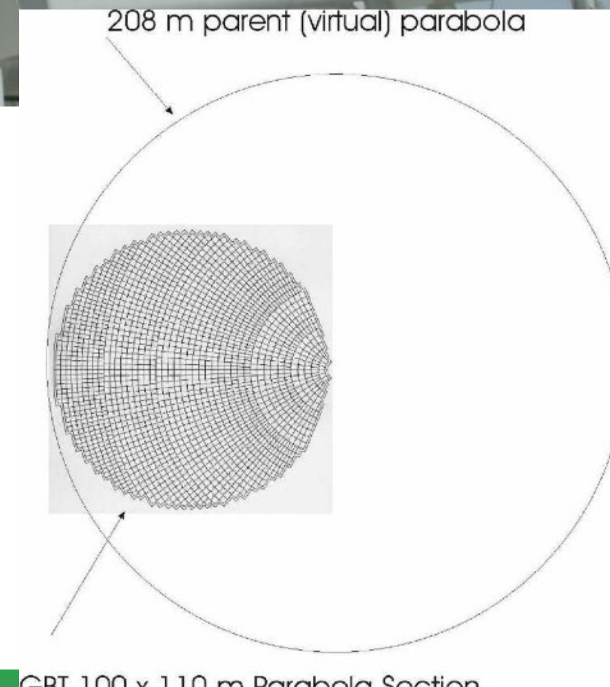


Overview of the GBT

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

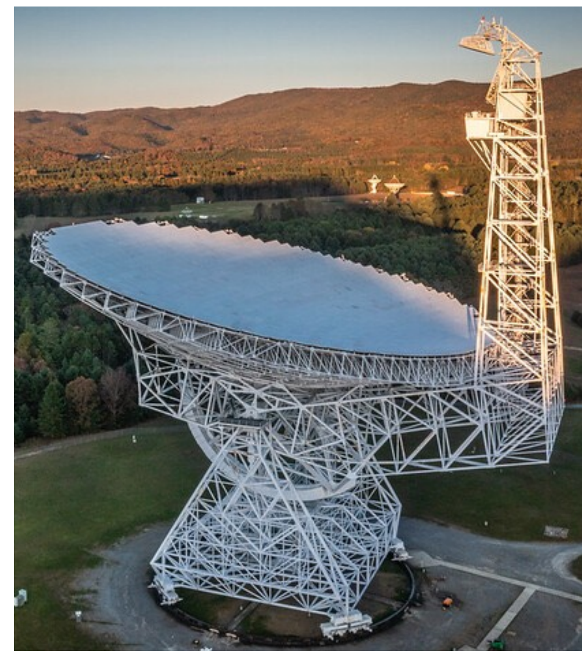


Photo Credit: Jay Young

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-chemisty: 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

GBT Science in the Astro2020 Decadal survey

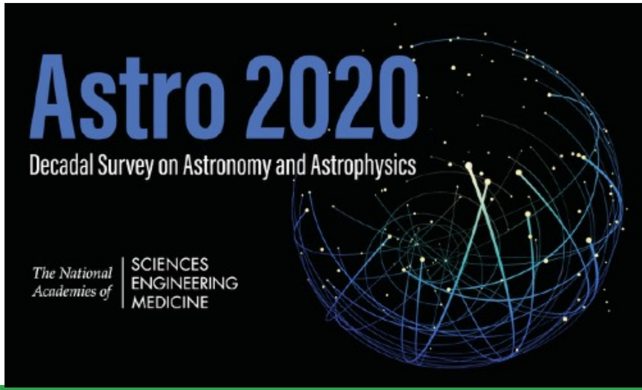
"The decadal report endorsed GBO as an essential facility and recommended sufficient funding to maintain and improve its capabilities."

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

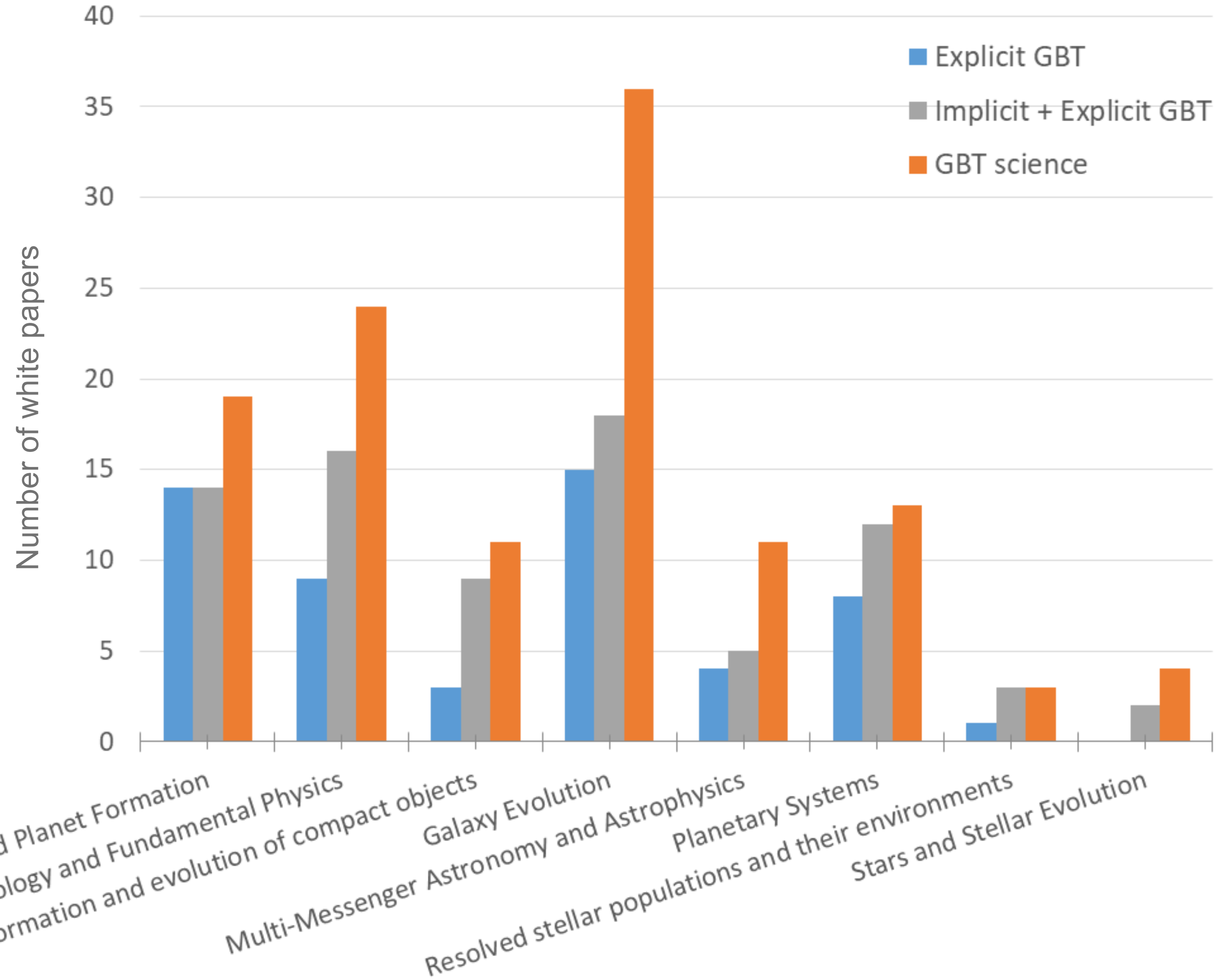
- pulsar timing and the detection of gravitational waves
- time domain and multi-messenger astronomy
- the search for the biochemical signatures of life
- origins and evolution of stars and galaxies

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



GBT Capabilities

See page 1 in the proposers guide (table 1)

Summary of GBT Specs

Photo Credit: Jay Young

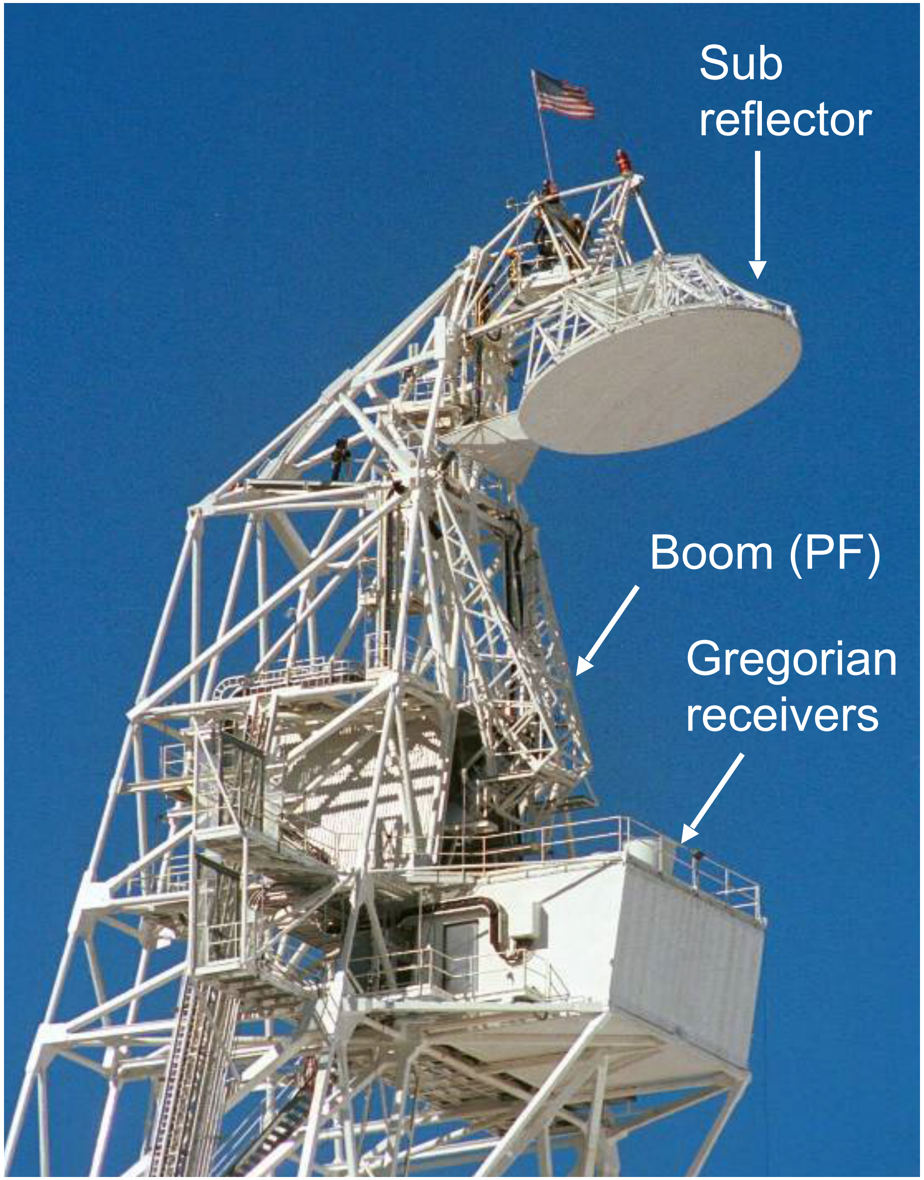
Location	Green Bank, West Virginia, USA
Coordinates	Longitude: 79°50′23.406″ West (NAD83) Latitude: 38°25′59.236″ North (NAD83) Track Elevation: 807.43 m (NAVD88)
Optics	110 m x 100 m unblocked section of a 208 m parent paraboloid Offaxis feed arm
Telescope Diameter	100 m (effective)
Available Foci	Prime 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: $\sim 12.60/f_{GHz}$ arcmin Prime Focus: $\sim 13.01/f_{GHz}$ arcmin (see Section 4.1.1)
Elevation Limits	Lower limit: 5 degrees Upper limit: $\sim$ 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: $\sim$ 250 μm, under benign night-time conditions
Pointing accuracy	1σ values from 2-D data 5″ blind 2.2″ offset

GBT Capabilities

Available Receivers

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

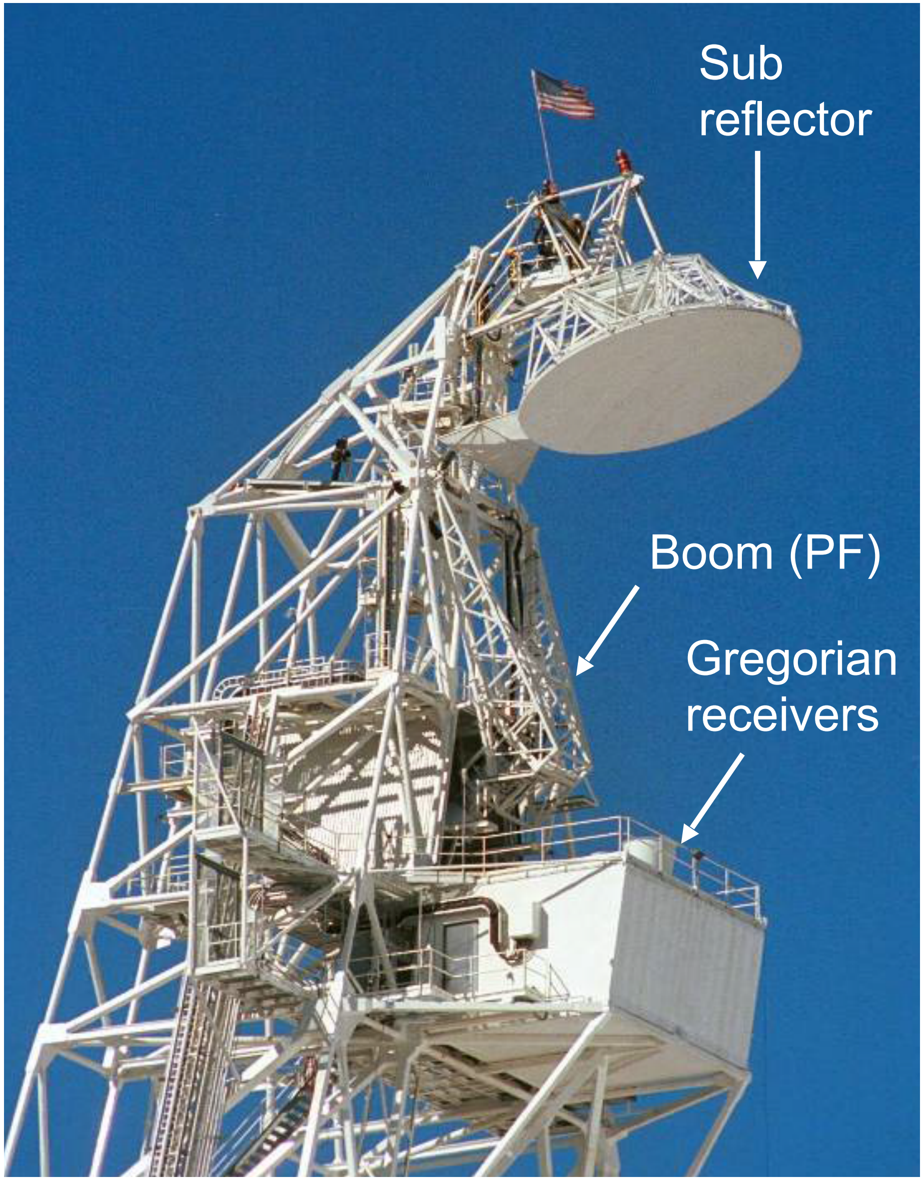
- Gregorian
  - Uses sub-reflector
  - Higher frequency (>1 GHz)
  - 8 receivers in turret and on telescope at any time



GBT Capabilities

Prime Focus Receivers

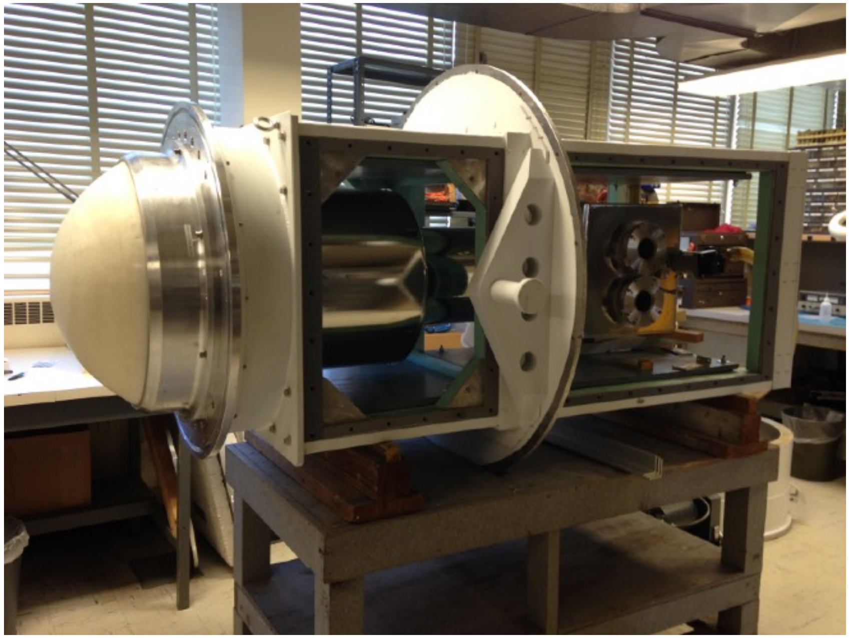
- PF1 has four different frequency receivers (bands)
  - 342 MHz (290-395 MHz)
  - 450 MHz (385-520 MHz)
  - 600 MHz (510-690 MHz)
  - 800 MHz (680-920 MHz)
- 450 & 600 MHz receivers overlap with digital TV signals ➔ Strong RFI
  - Observers should contact a support scientist before submitting a proposal 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

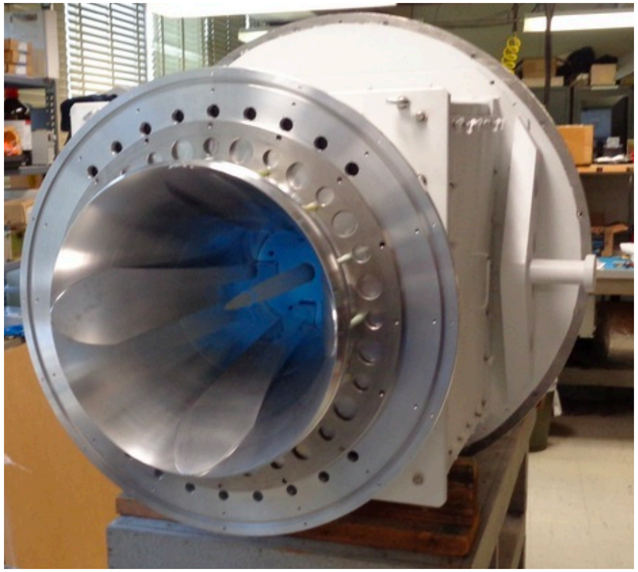


GBT Capabilities

Prime Focus Receivers

- New receiver: Utlra-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
  - Target Tsys is <30 K across the band and the target efficiency is 70% at the low end, tapering to 50% at the high end.
  - Dual polarization
- Commissioning during spring/summer 2022 - affects availability of PF/800 and PF/342
- Anticipate ready for 23A call, but in 22B proposal can indicate that if UWB receiver goes through commissioning switch from current receiver to UWB receiver





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
  - Commissioning new X band receiver spring or summer 2022
- 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

See page 10 in the proposers guide (table 3)

Summary of Available Receivers

Receiver	Band	Frequency Range (GHz)	Focus	Polarization	Beams	Polarizations per Beam
PF1	342 MHz	.290-.395	Prime	Lin/Circ	1	2
	450 MHz*	.385-.520	Prime	Lin/Circ	1	2
	600 MHz*	.510-.690	Prime	Lin/Circ	1	2
	800 MHz	.680-.920	Prime	Lin/Circ	1	2
PF2*	——	.910-1.23	Prime	Lin/Circ	1	2
L-Band	——	1.15-1.73	Greg.	Lin/Circ	1	2
S-Band	——	1.73-2.60	Greg.	Lin/Circ	1	2
C-Band	——	3.95-8.0	Greg.	Lin/Circ	1	2
X-Band	——	8.00-11.6	Greg.	Circ	1	2
Ku-Band	——	12.0-15.4	Greg.	Circ	2	2
KFPA	——	18.0-27.5	Greg.	Circ	7	2
Ka-Band	MM-F1	26.0-31.0	Greg.	Circ	2	1
	MM-F2	30.5-37.0				
	MM-F3	36.0-39.5				
Q-Band	——	38.2-49.8	Greg.	Circ	2	2
W-Band 4mm	MM-F1	67-74	Greg.	Circ	2	2
	MM-F2	73-80	Greg.	Circ	2	2
	MM-F3	79-86	Greg.	Circ	2	2
	MM-F4	85-93.3	Greg.	Circ	2	2
Mustang2	——	80-100	Greg.	—-	200	—-
ARGUS	——	80-115.3	Greg.	Circ	16	1

GBT Capabilities

See page 10 in the proposers guide (table 3)

Receiver Performance and Bandwidth

Receiver	Band	Beam Separation	FWHM	Gain (K/Jy)	Aperture Efficiency	Maximum Instantaneous Bandwidth (MHz)
PF1	342 MHz 450 MHz* 600 MHz* 800 MHz	—— —— —— ——	36′ 27′ 21′ 15′	2.0 2.0 2.0 2.0	72% 72% 72% 72%	240
PF2*	——	——	12′	2.0	72%	240
L-Band	——	——	9′	2.0	72%	650
S-Band	——	——	5.8′	2.0	72%	970
C-Band	——	——	2.5′	2.0	72%	3800
X-Band	——	——	1.4′	2.0	71%	2400
Ku-Band	——	330"	54"	1.9	70%	3500
KFPA	——	96"	32"	1.9	68%	1800,8000
Ka-Band	MM-F1 MM-F2 MM-F3	78"	26.8" 22.6" 19.5"	1.8	63-67%	4000
Q-Band	——	58"	16"	1.7	58-64%	4000
W-Band 4mm	MM-F1 MM-F2 MM-F3 MM-F4	286"	10"	1.0	30-48%	6000 4000 4000 4000
Mustang2	——	—-	10"	—-	35%	20000
ARGUS	——	30.4"	8"	—-	20-35%	1500

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 availability 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

Underneath Gregorian Receiver Turret

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

See page 14 in the proposers guide (table 5)

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

Mode	Spectral Windows per Spectrometer	Bandwidth per Spectrometer (MHz)	Number of Channels per Spectrometer	Approximate Spectral Resolution (kHz)
1	1	1500 (a)	1024	1465
2	1	1500 (a)	16384	92
3	1	1080 (b)	16384	66
4	1	187.5	32768	5.7
5	1	187.5	65536	2.9
6	1	187.5	131072	1.4
7	1	100	32768	3.1
8	1	100	65536	1.5
9	1	100	131072	0.8
10	1	23.44	32768	0.7
11	1	23.44	65536	0.4
12	1	23.44	131072	0.2
13	1	23.44	262144	0.1
14	1	23.44	524288	0.05
15	1	11.72	32768	0.4
16	1	11.72	65536	0.2
17	1	11.72	131072	0.1
18	1	11.72	262144	0.05
19	1	11.72	524288	0.02
20	8 (c)	23.44	4096	5.7
21	8 (c)	23.44	8192	2.9
22	8 (c)	23.44	16384	1.4
23	8 (c)	23.44	32768	0.7
24	8 (c)	23.44	65536	0.4
25	8 (c)	16.875	4096	4.1
26	8 (c)	16.875	8192	2.0
27	8 (c)	16.875	16384	1.0
28	8 (c)	16.875	32768	0.5
29	8 (c)	16.875	65536	0.26

(a) The useable bandwidth for this mode is 1250 MHz.

(b) The useable bandwidth for this mode is 850 MHz.

(c) For modes 20-24, the spectral windows must be placed within 1500 MHz with a useable frequency range of 150 to 1400 MHz. For modes 25-29, the spectral windows must be placed within 1000 MHz with a useable 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

Name	Dedispersion Mode	Bandwidth (MHz)	nchan	Notes
c0100x0064	Coherent	100	64	Full Stokes only
c0100x0128	Coherent	100	128	Full Stokes only
c0100x0256	Coherent	100	256	Full Stokes only
c0100x0512	Coherent	100	512	Full Stokes only
c0200x0064	Coherent	200	64	Full Stokes only
c0200x0128	Coherent	200	128	Full Stokes only
c0200x0256	Coherent	200	256	Full Stokes only
c0200x0512	Coherent	200	512	Full Stokes only
c0200x1024	Coherent	200	1024	Full Stokes only
c0800x0128	Coherent	800	128	Full Stokes only
c0800x0256	Coherent	800	256	Full Stokes only
c0800x0512	Coherent	800	512	Full Stokes only
c0800x1024	Coherent	800	1024	Full Stokes only
c0800x2048	Coherent	800	2048	Full Stokes only
c0800x4096	Coherent	800	4096	Full Stokes only
c1500x0128	Coherent	1500	128	Full Stokes only
c1500x0256	Coherent	1500	256	Full Stokes only
c1500x0512	Coherent	1500	512	Full Stokes only
c1500x1024	Coherent	1500	1024	Full Stokes only
c1500x2048	Coherent	1500	2048	Full Stokes only
c1500x4096	Coherent	1500	4096	Full Stokes only
i0100x0512	Incoherent	100	512	Total intensity available in search-mode
i0100x1024	Incoherent	100	1024	Total intensity available in search-mode
i0100x2048	Incoherent	100	2048	Total intensity only
i0100x4096	Incoherent	100	4096	Total intensity only
i0100x8192	Incoherent	100	8192	Total intensity available in search-mode
i0200x1024	Incoherent	200	1024	Total intensity available in search-mode
i0200x2048	Incoherent	200	2048	Total intensity only
i0200x4096	Incoherent	200	4096	Total intensity only
i0200x8192	Incoherent	200	8192	Total intensity only
i0800x0128	Incoherent	800	128	Total intensity available in search-mode
i0800x0256	Incoherent	800	256	Total intensity available in search-mode
i0800x0512	Incoherent	800	512	Total intensity available in search-mode
i0800x1024	Incoherent	800	1024	Total intensity available in search-mode
i0800x2048	Incoherent	800	2048	Total intensity available in search-mode
i0800x4096	Incoherent	800	4096	Total intensity available in search-mode
i1500x0128	Incoherent	1500	128	Total intensity available in search-mode
i1500x0256	Incoherent	1500	256	Total intensity available in search-mode
i1500x0512	Incoherent	1500	512	Total intensity available in search-mode
i1500x1024	Incoherent	1500	1024	Total intensity available in search-mode
i1500x2048	Incoherent	1500	2048	Total intensity available in search-mode
i1500x4096	Incoherent	1500	4096	Total intensity available in search-mode

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

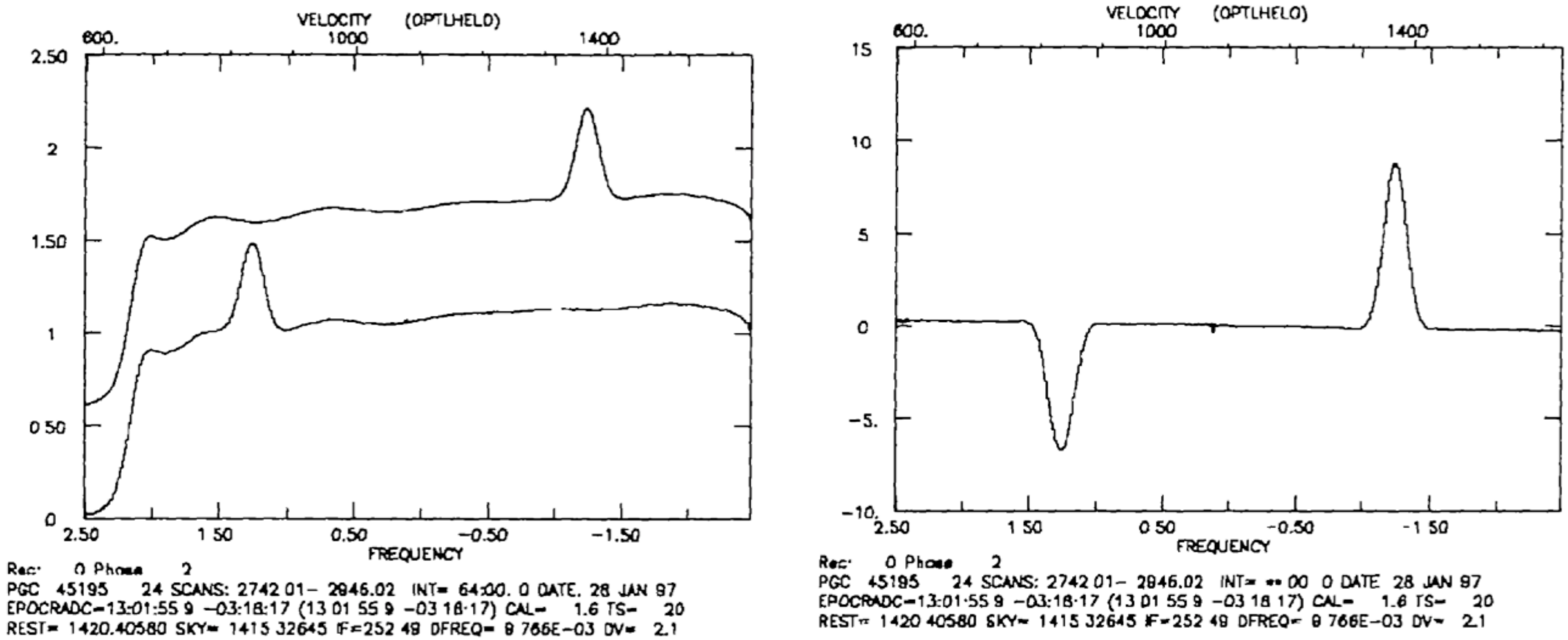
Different observing modes to derive reference data

- Frequency Switching (FSW)
- 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)



Citations: NAIC-NRAO School on Single-dish Radio Astronomy: Techniques and Applications, ASP Conference Series, Vol 278, 2002
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 well constrained redshift of object
- Narrow line observations in a clean (non-crowded) spectrum
- Galactic HI observations

Advantages

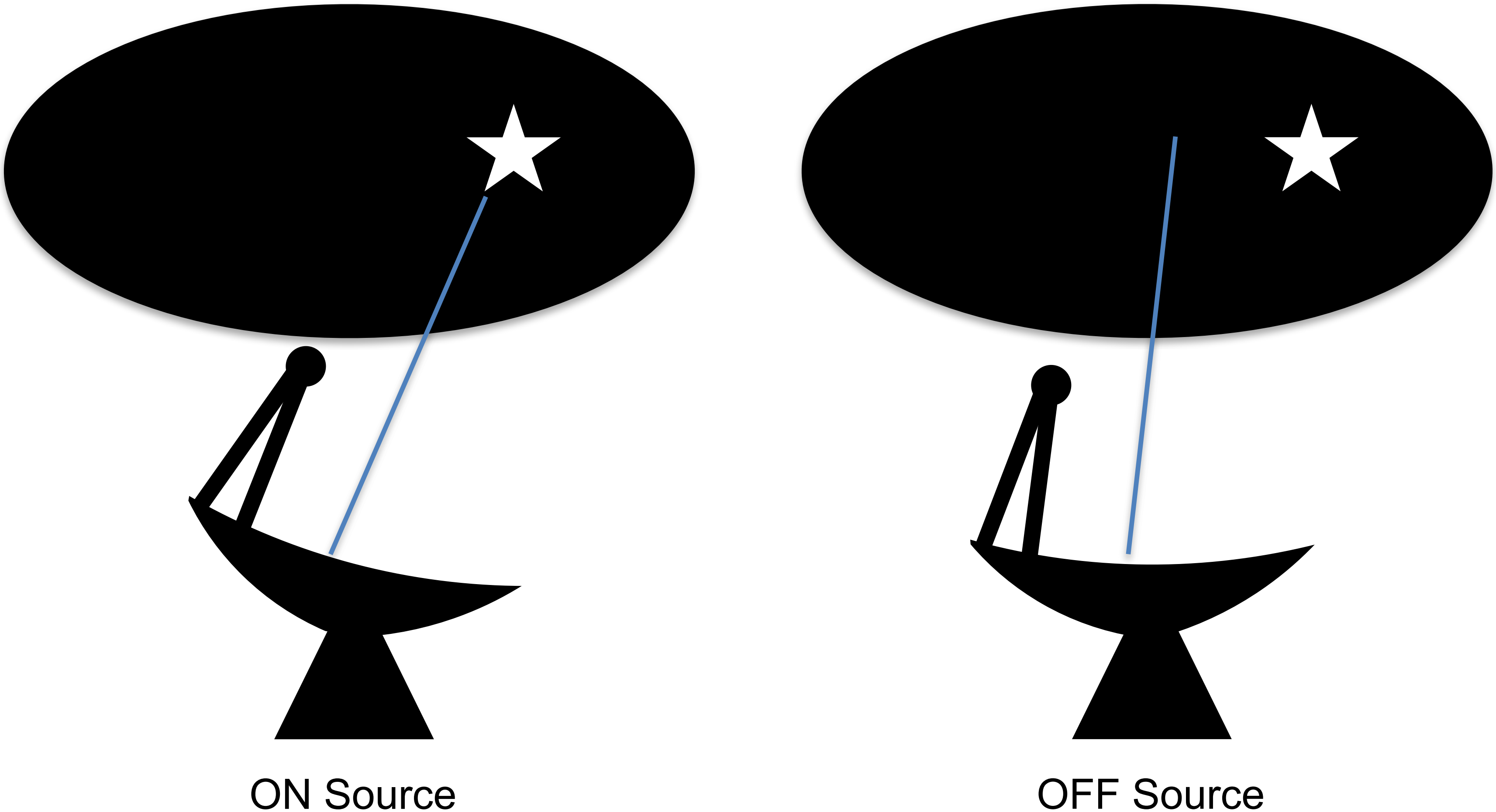
- Rapid switch between ON and OFF and reduces the amount of time spent slewing to off positions.
- Avoids having to find an emission free reference position when observing in an area that may be more crowded

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

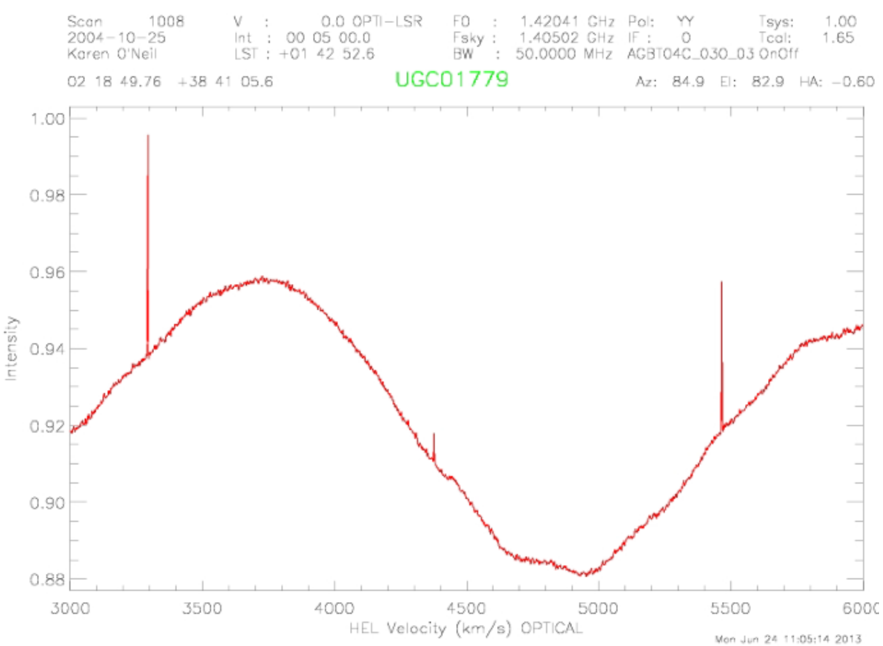
Position Switched Observations: Definition

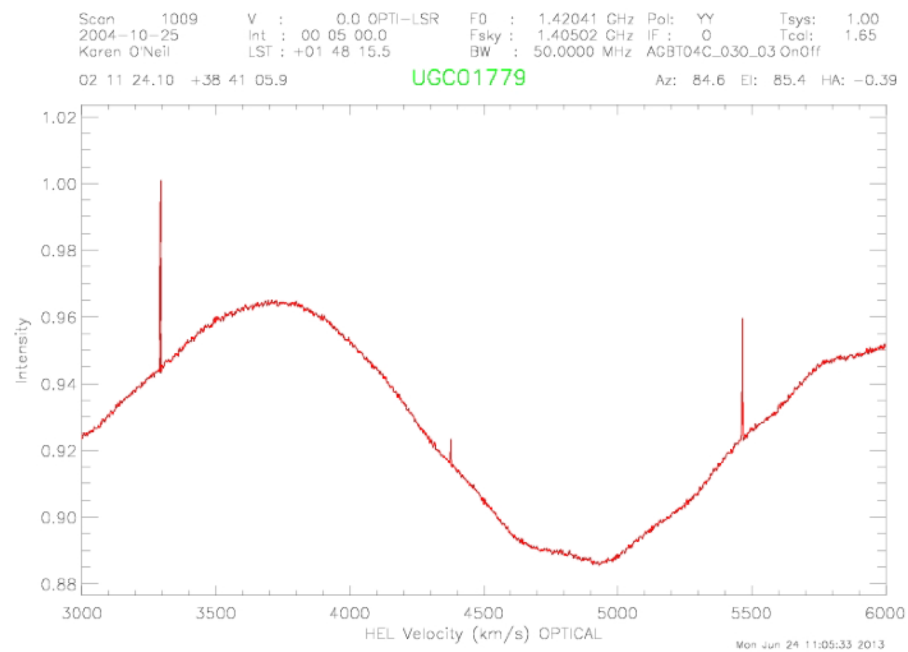


GBT Observing Strategies

Position Switched Observations: Definition

ON Source	OFF Source
$T_{source} + T_{everything\ else}$	$T_{everything\ else}$



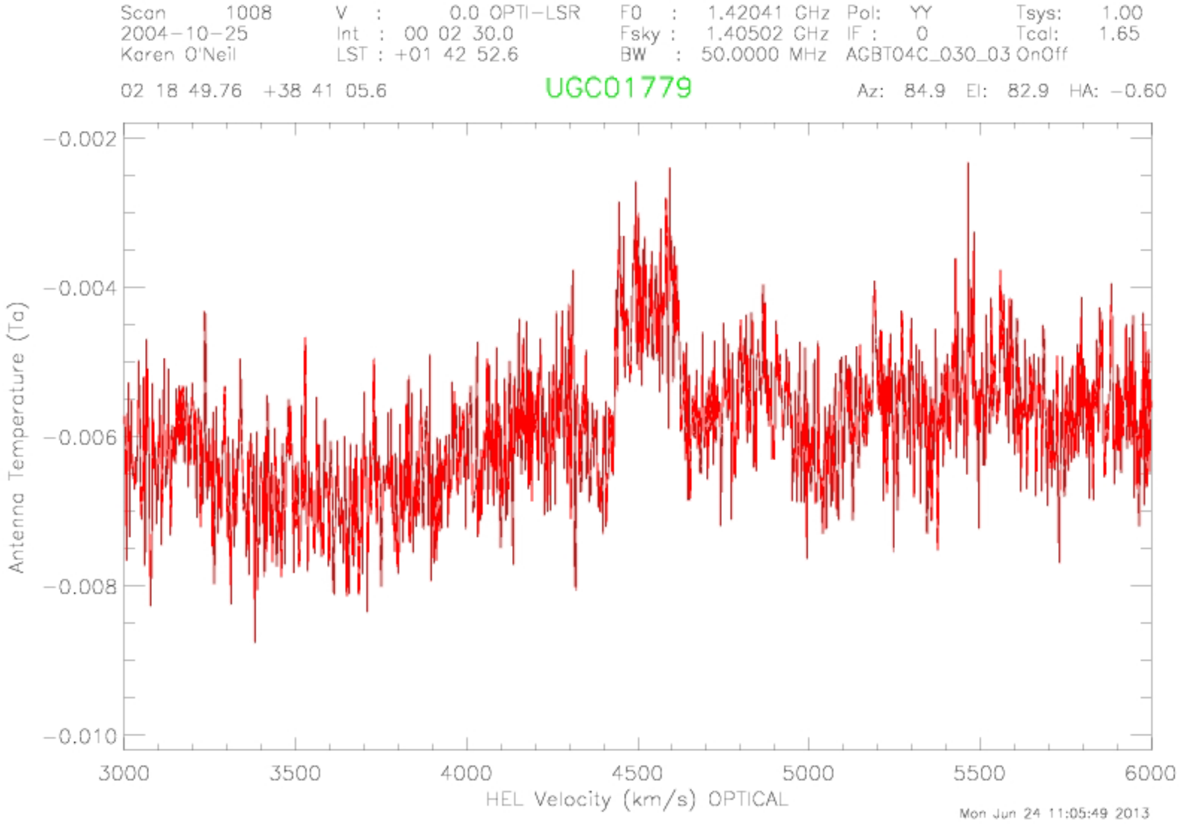


GBT Observing Strategies

Position Switched Observations: Definition

ON - OFF

$$(T_{\text{source}} + T_{\text{everything else}}) - (T_{\text{everything else}})$$



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 (FSW)**
  - 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

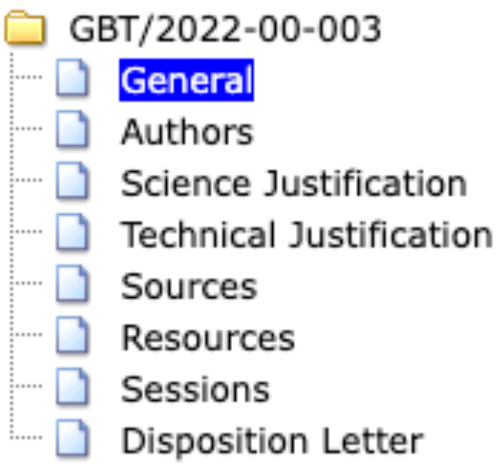
GBT Observing Strategies

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 (38º25’59.236”) 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

2022B Proposal Call

- Deadline: **Tuesday February 1st at 17:00 EST** (22:00 UTC)
- Proposal Call Link: https://greenbankobservatory.org/science/gbt-observers/proposals/2022b-call-for-proposals/
- Disposition letters for the 2022B cycle will be sent out in late May
- 2022B observations begin August 1st 2022 - Jan 31st, 2023
- Observer Training School held in late February 16-18, 2022
  - https://greenbankobservatory.org/science/gbt-observers/observer-training-workshops/
  - Fully virtual
- Single Dish School in May - beginning radio astronomy
  - https://greenbankobservatory.org/science/gbt-observers/single-dish-training-workshop/

2022B Proposal Call

Joint Proposals

This information is also listed in Section 2.2 of the Proposer's Guide

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

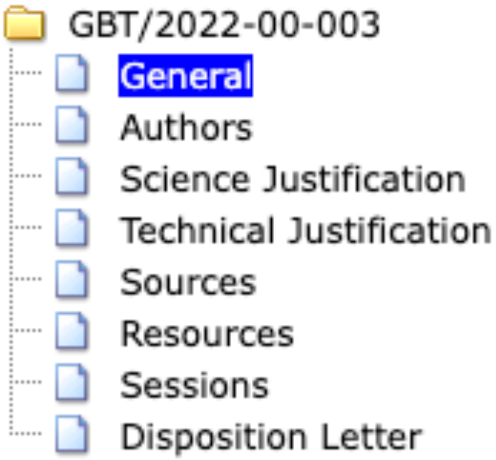
- Successful proposals will be observed by the PI or another member of the proposal team
  - Observations that do not require AutoOOF can be operator run

- 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

- 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

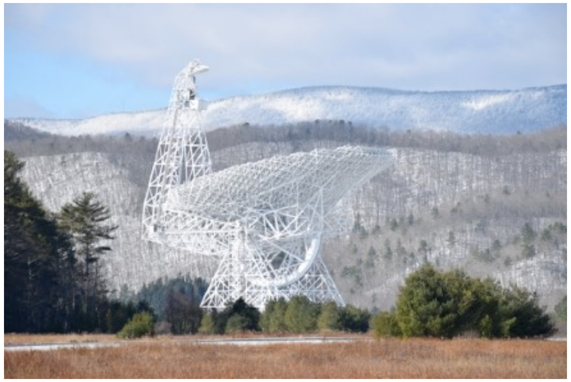
Proposal Checklist



- 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

GREEN BANK OBSERVATORY

greenbankobservatory.org



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