

The Green Bank Observatory

National Radio Astronomy Observatory



David Frayer
NRAO

“Planning a GBT Proposal”: GBT Science and Capabilities

Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array



Outline:

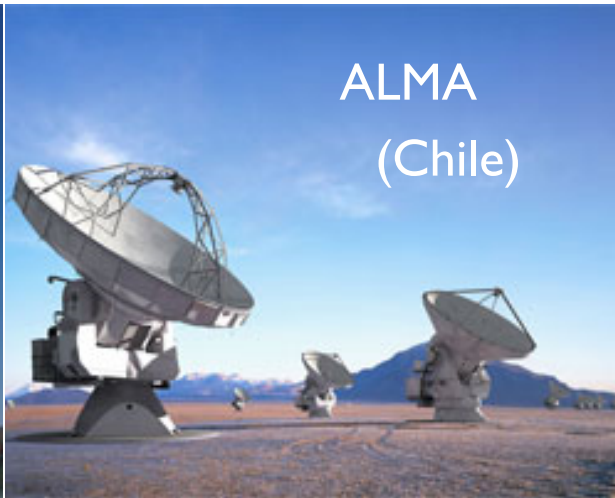
- Green Bank and GBT background
- GBT Science
- GBT Capabilities
- GBT Proposal Process and Planning Tools

NRAO telescopes and facilities

GBT ↓



Green Bank Observatory



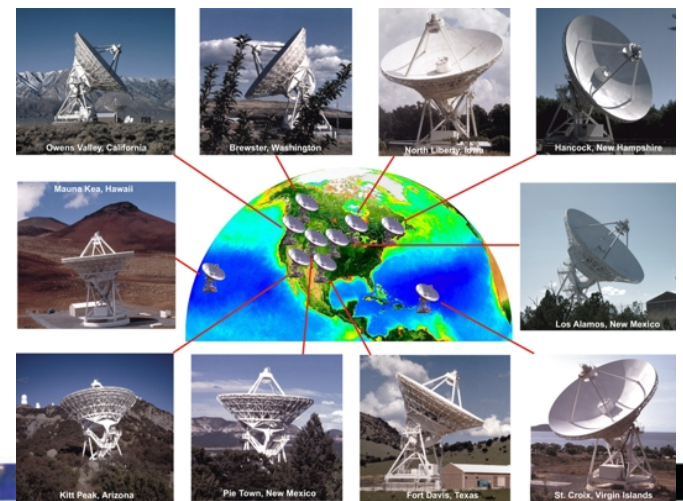
ALMA (Chile)



New Technology Center (Charlottesville, Virginia)



Very Large Array (Socorro, New Mexico)



Very Long Baseline Array

Green Bank is original NRAO site, with world class telescopes for >50 years

Started 1958
Completed 1959



Completed 1995



Completed 1962



Completed 1962



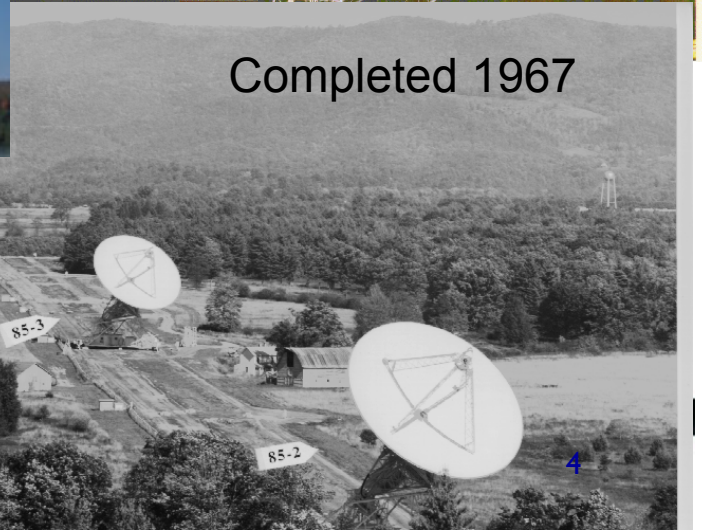
Completed 2000



Completed 1965



Completed 1967

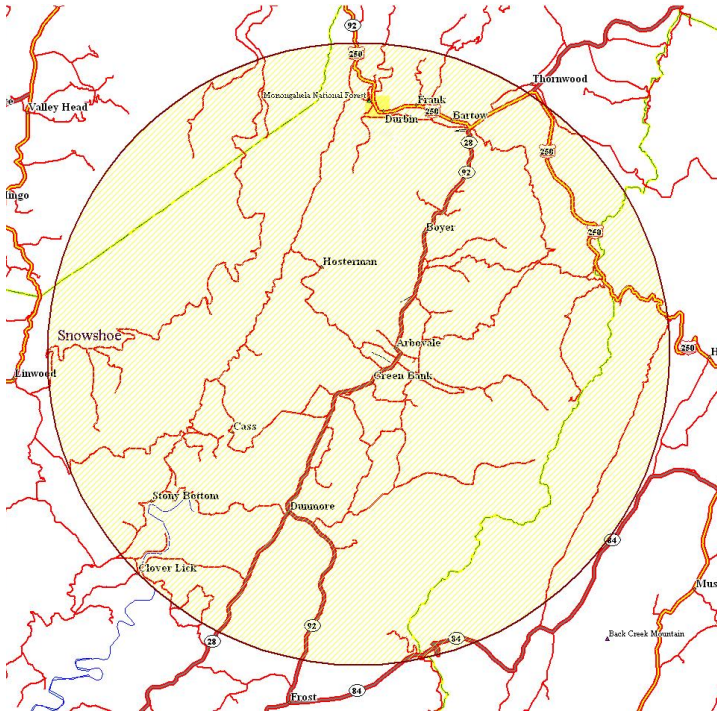


Completed 1994



WV Radio Astronomy Zone

Established by the West Virginia Legislature
(1956)

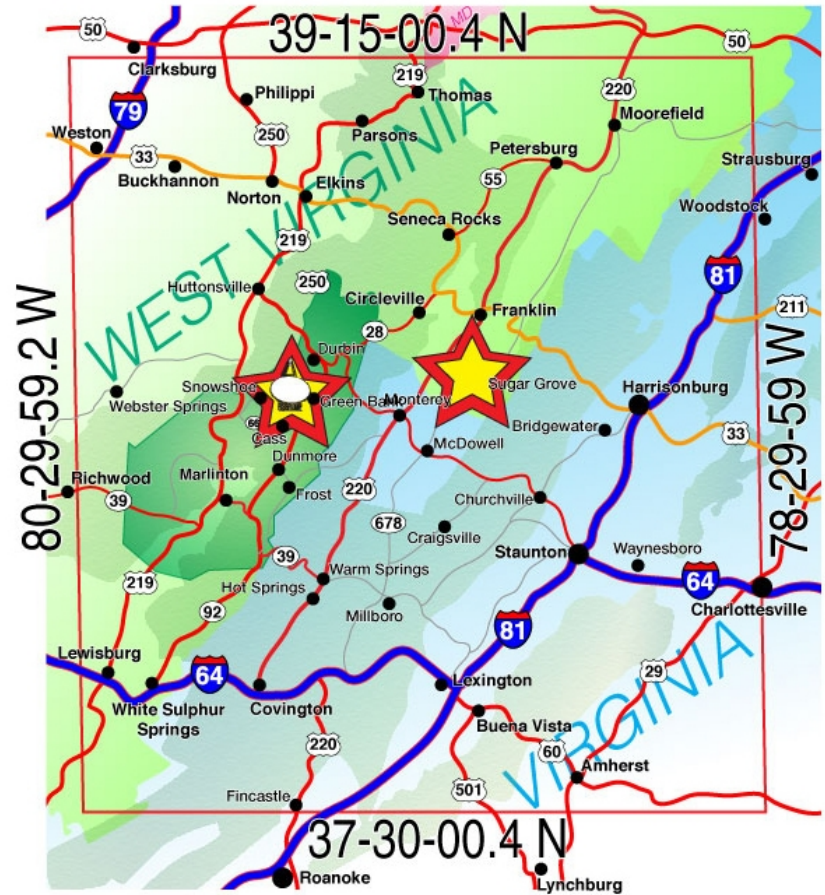


Protection within ten miles
of the Observatory



National Radio Quiet Zone

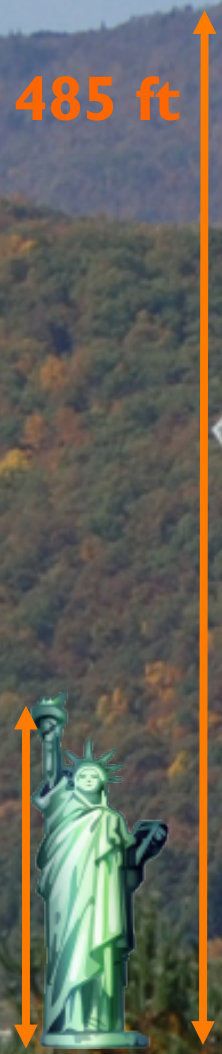
Established by the FCC and NTIA
(1957)



13,000 Square Miles

At 100 m, the GBT is the largest *fully steerable* telescope (and the largest movable structure) in the world.

- Unblocked Aperture
- Active Surface
- Operates from ~100 MHz to 100 GHz
- Fully Steerable
- >85% of total sky covered $\delta \geq -46^\circ$
- Pointing to 1"-2" accuracy
- Surface good for 3mm work
- 2.3 acre collecting area

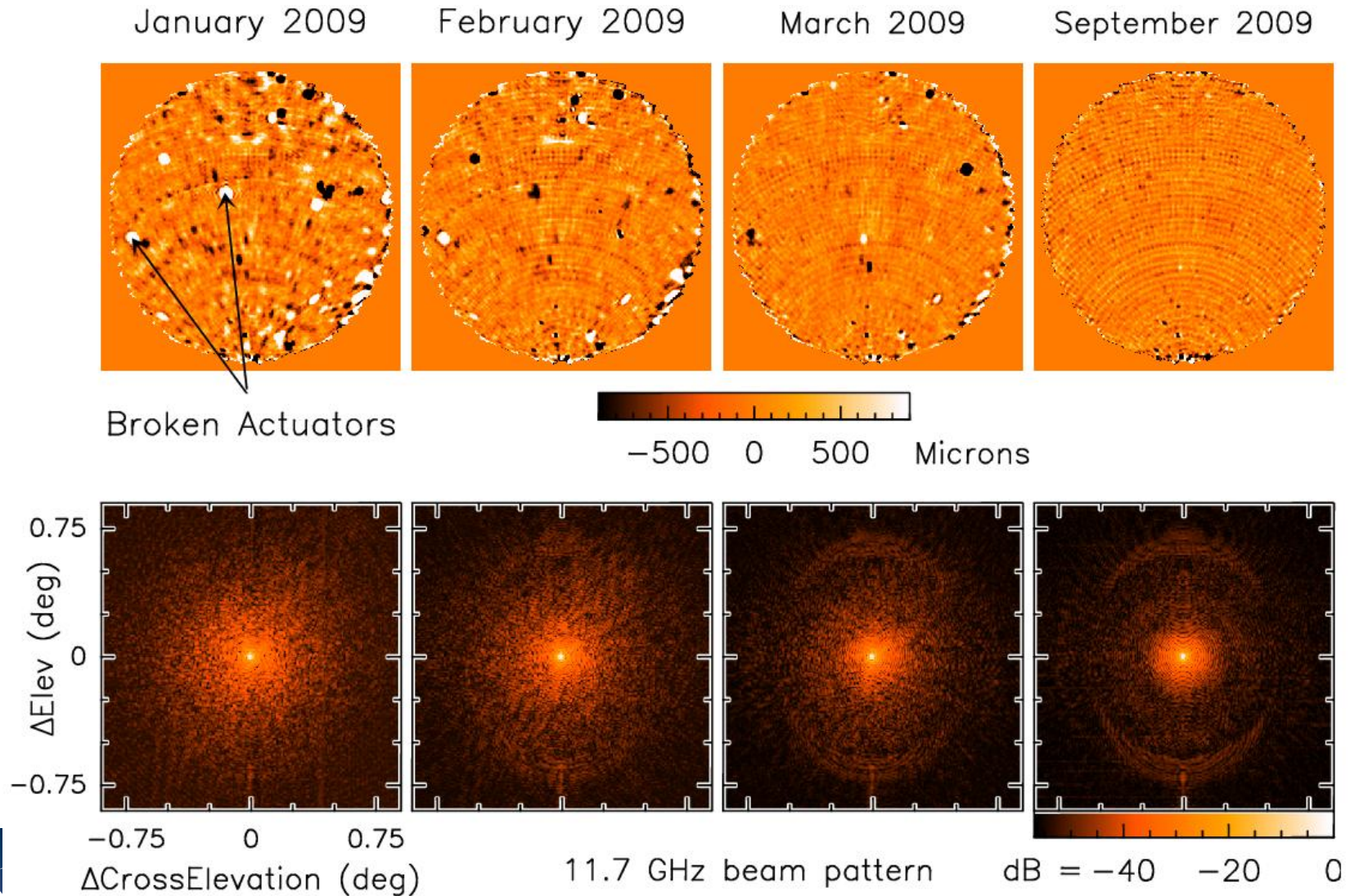


The Active Surface 2209 actuators

Currently rms < 240 μ m at night, the goal is 210 μ m



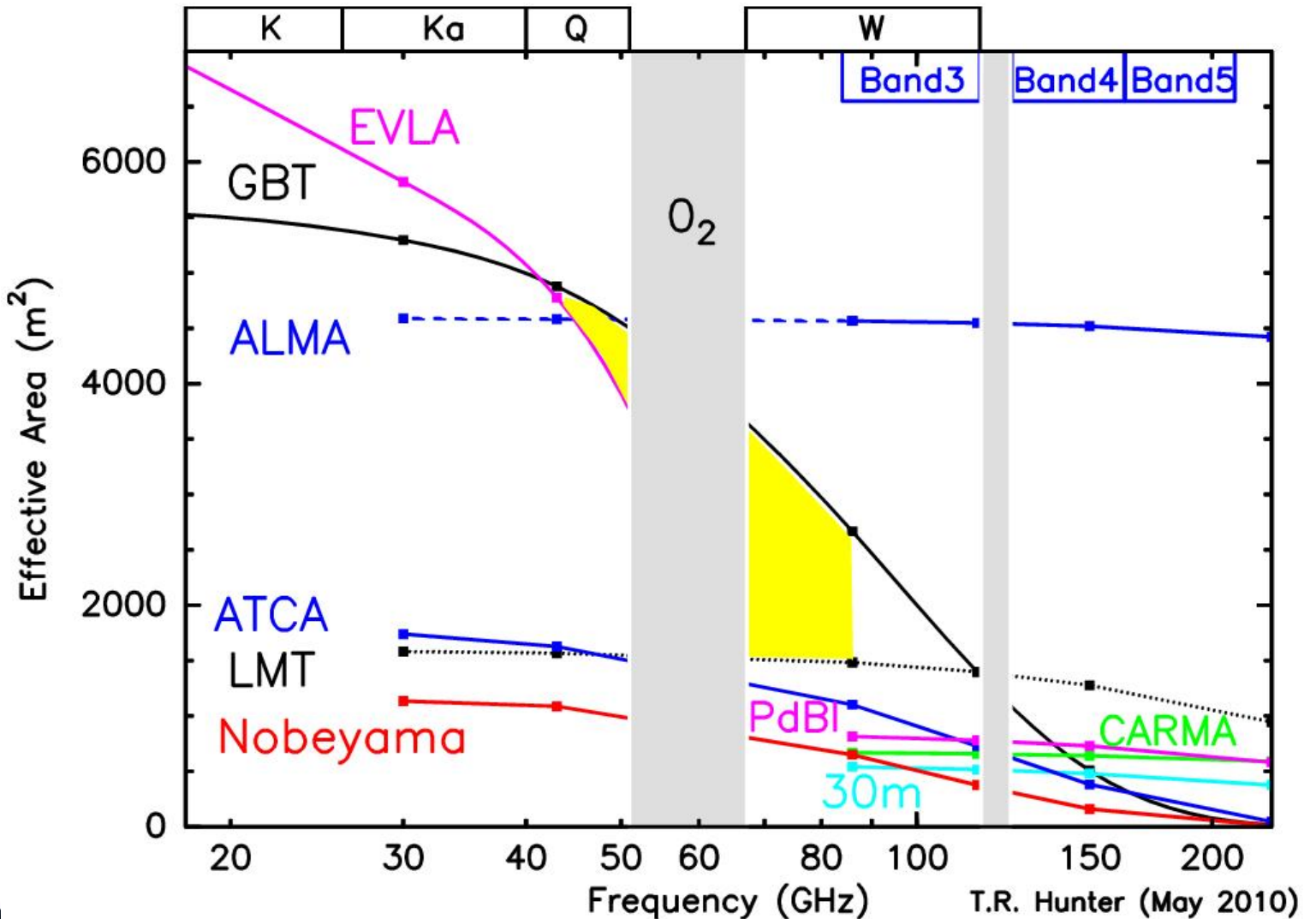
Improvements to Surface Makes 3mm Possible

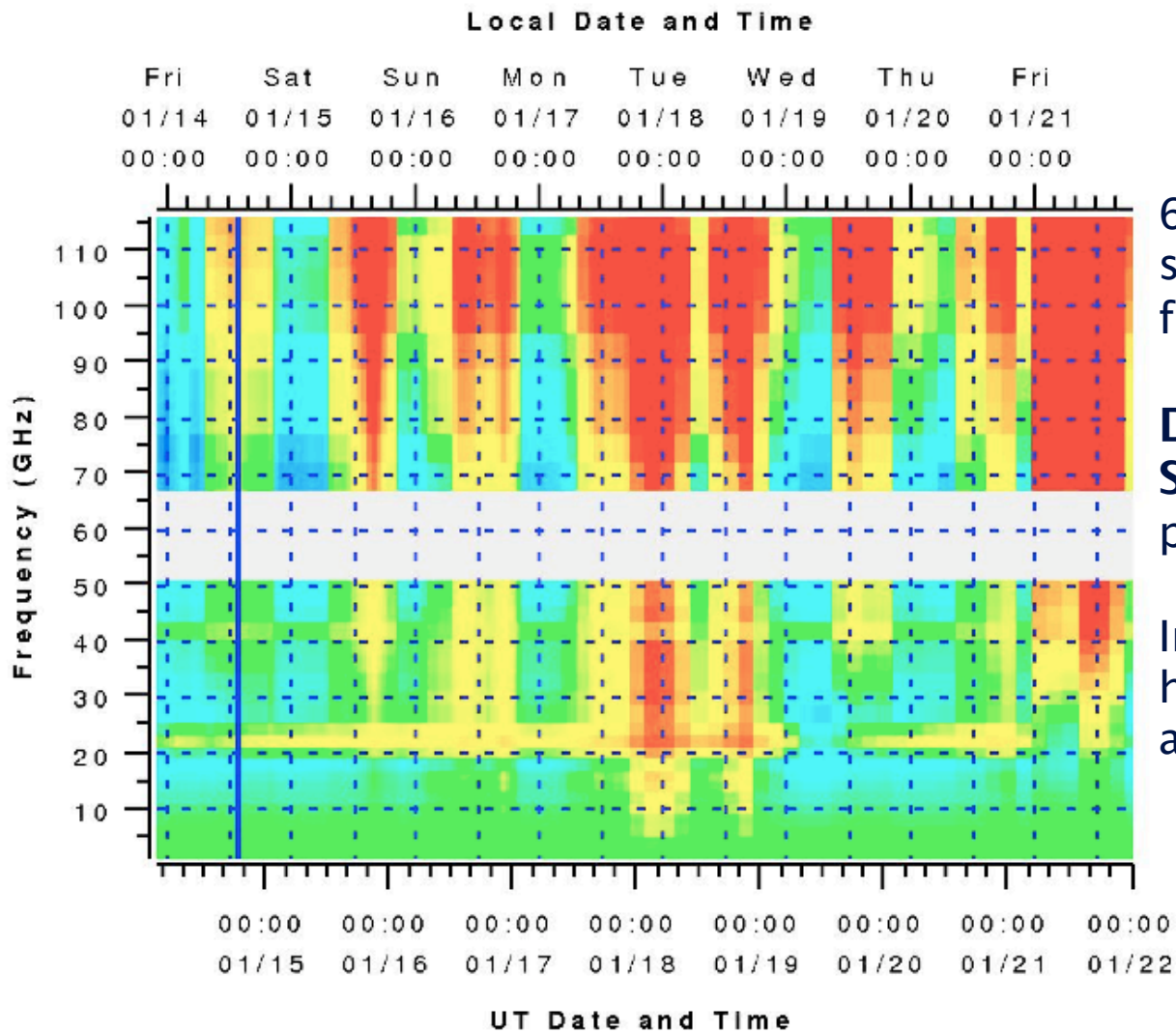


GBT Effective Collecting Area ($\eta_a * \text{Area}$)

Assumes
current
~240um rms
surface
errors → 35%
at 90 GHz

→ most
sensitive
facility at Q
and W-low
(ALMA-
band2, 4mm).





6500 hours a year
scheduled
for astronomy on the GBT

**Dynamic Scheduling
System (DSS)** matches the
project to the weather

In 2010 there were 1776
hours used at frequencies
above 18 GHz

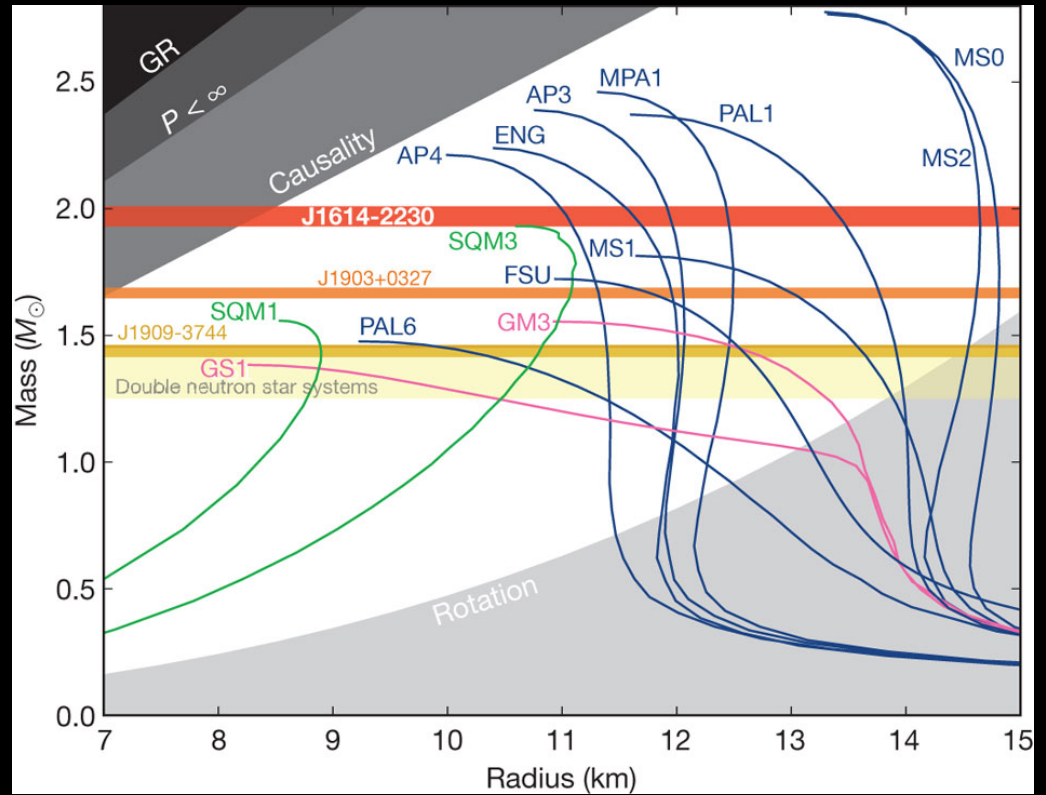
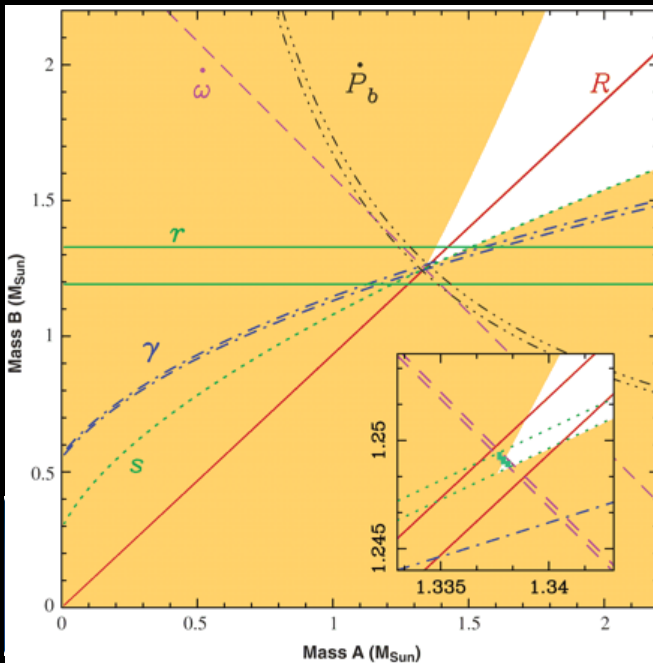
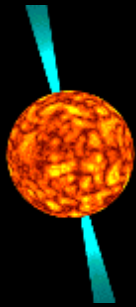
Outline:

- ~~Green Bank and GBT background~~
- **GBT Science**
- GBT Capabilities
- GBT Proposal Process and Planning Tools

Some Key GBT Science Areas:

- (~30%) **Pulsars:** Discovery of new pulsars, the most massive pulsar, search for gravitational radiation
- (~30%) **Neutral Hydrogen HI:** Gas masses of local galaxies, Kinematics of galaxy and local group/dark matter, HI intensity mapping at high-redshift
- (~30%) **High-frequency science:**
 - 90 GHz imaging with Mustang
 - CO at redshift (K/Ka{+Zspectrometer}/Q)
 - Interstellar Organic Molecules & Astro-chemistry
 - Masers: black hole masses, distances via proper motions
 - Star Formation: NH₃ mapping (KFPA)
- Solar system astronomy (radar mapping)

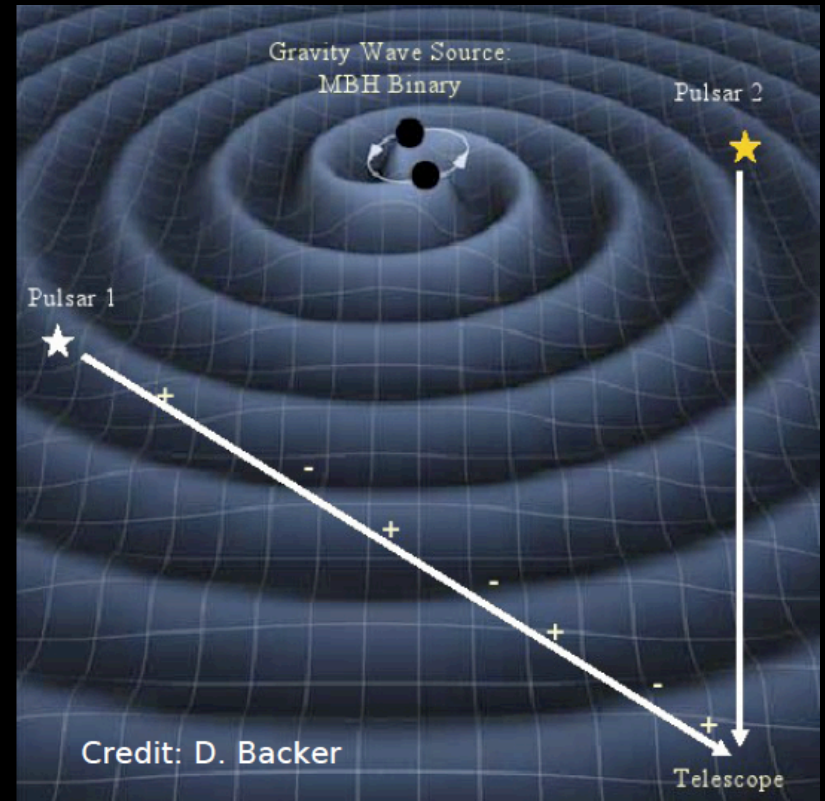
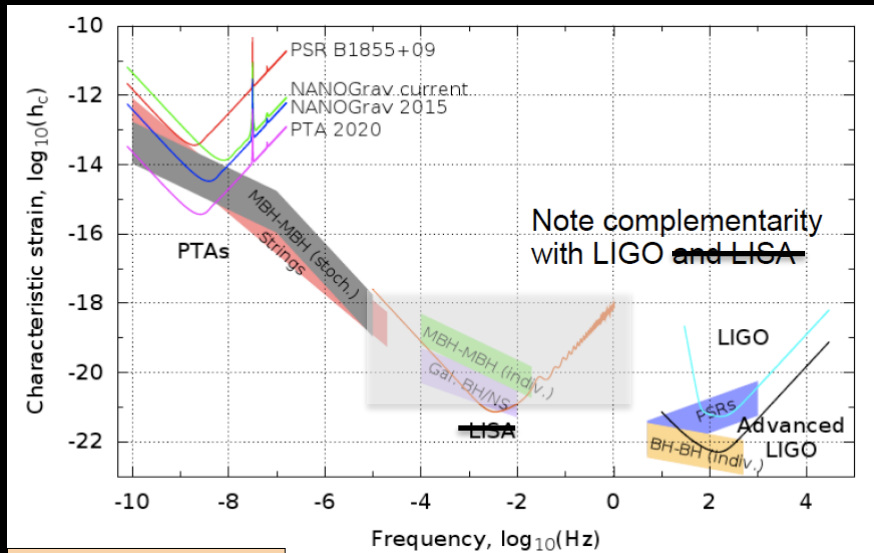
Pulsar timing results



Most massive neutron star
PSR J1614-2230 $\sim 2M_{\text{sun}}$
Demorest et al. 2010

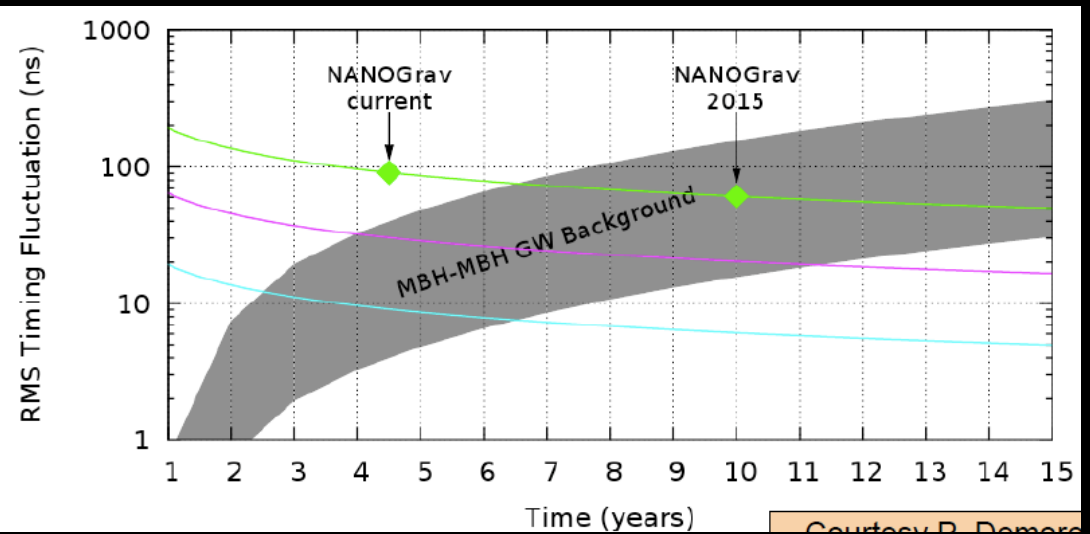
Measuring binary pair eccentricity
to test general relativity

Gravity Waves NANOGrav

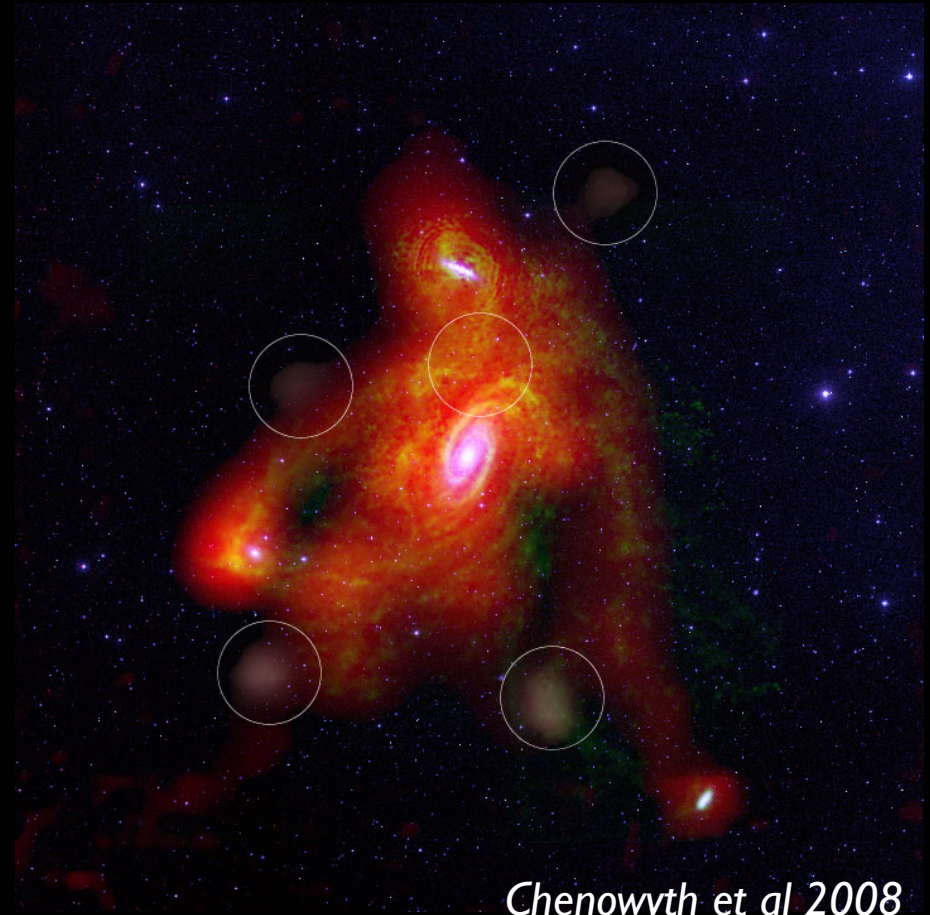
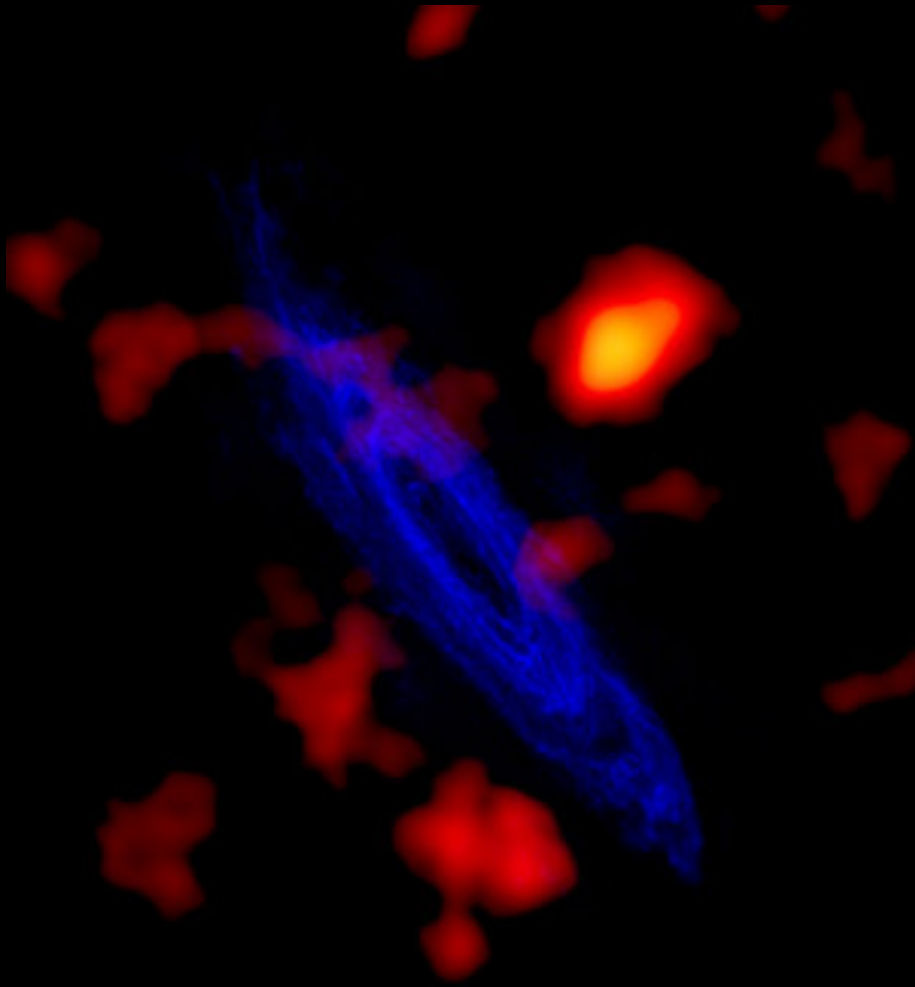


The GBT may provide
first detection of
gravitational waves

Need 40 pulsars with $<100\text{ns}$
timing residuals

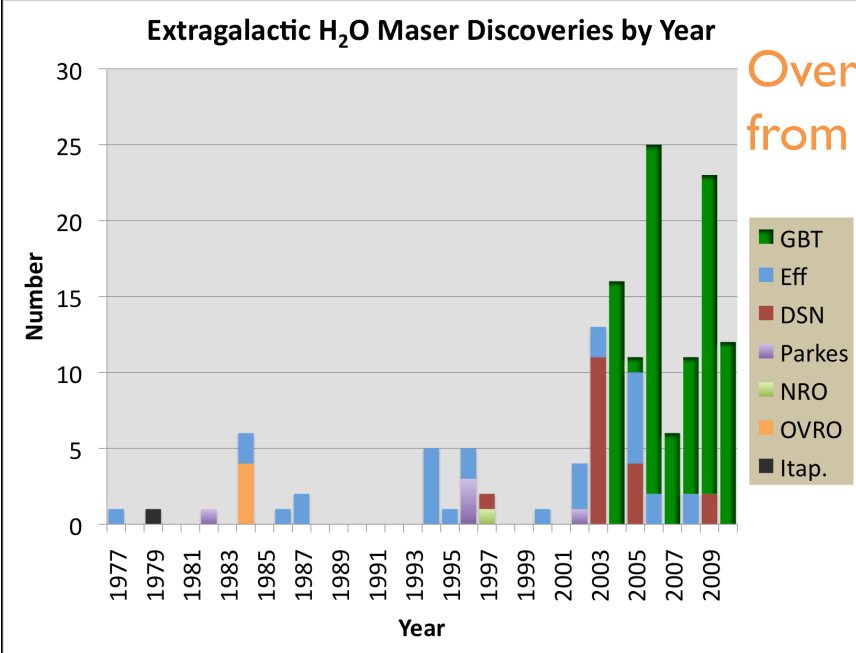


Local Galaxies and Dark matter via HI



Chenoweth et al 2008

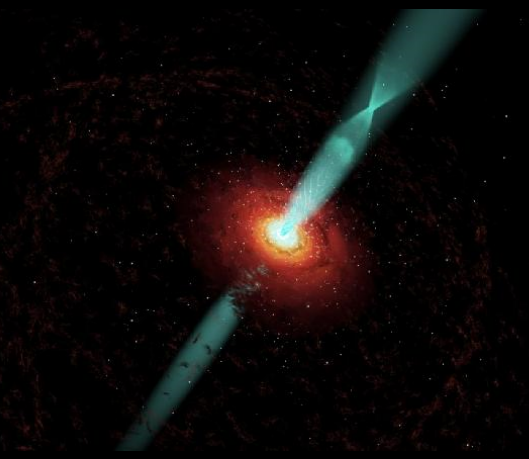
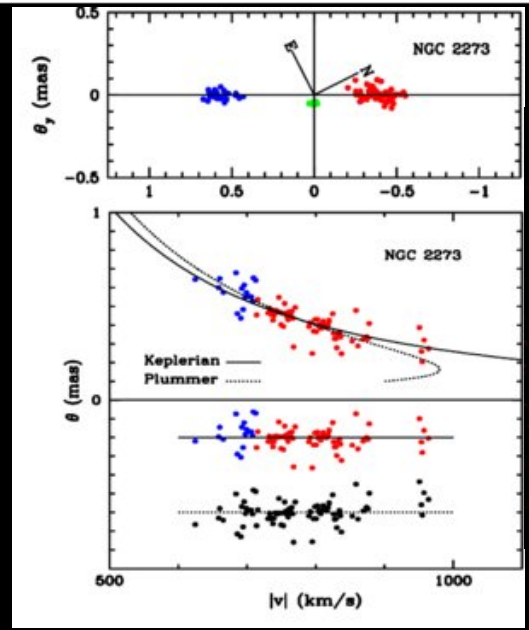
Measurements of H_0 and SMBH masses via H₂O Masers



Over 80 masers from the GBT

Measuring H_0 within 3% precision by obtaining geometric distances to water masers in other galaxies*

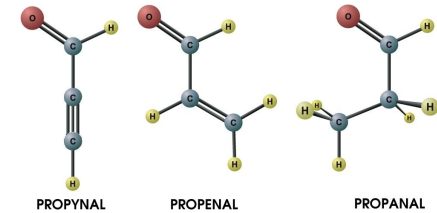
Measuring precise masses of the black holes in megamaser disk galaxies*



*GBT used both for Maser discovery and providing necessary sensitivity to VLBA



Organic chemistry in interstellar clouds



- H₂O (water)
- H₂CO (formaldehyde)
- NH₃ (ammonia)
- CO (Carbon monoxide)
- HCOOH (formic acid)
- CNCHO (cyanoformaldehyde)
- CH₃OH (methanol)
- CH₂CHCN (vinyl cyanide)
- HOCH₂CH₂OH (ethylene glycol)
- CH₃CO₂H (acetic acid)
- CH₃CH₂OH (ethyl alcohol)
- CH₂OHCHO (glycolaldehyde)

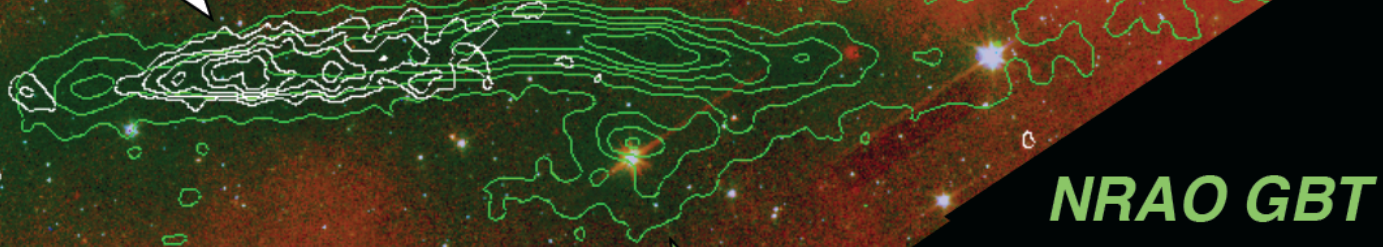
The GBT has detected 14 new interstellar organic molecules including the first interstellar anions: C₆H⁻ & C₈H⁻ (McCarthy et al 2006; Cordiner et al 2011)

Mapping of Star-Formation Regions with the K-FPA

Taurus Molecular Cloud

Nearby site of formation of large molecules in our Galaxy

Cyanotriacetylene (HC_7N)



NRAO GBT
18-27.5 GHz
Focal Plane Array

Ammonia (NH_3)

Contours show molecular chemistry dynamics in cold, dark, star forming clouds. White contours mark molecule HC_7N . Green contours mark ammonia distribution. Background image is a color composite of Spitzer Space Telescope IRAC channels 1, 2 and 4 (Langston et al. 2011).

Moon image included for scale comparison, showing the large size of molecular clouds.

Mustang 3mm Imaging of SZ-Effect and Cluster Structure

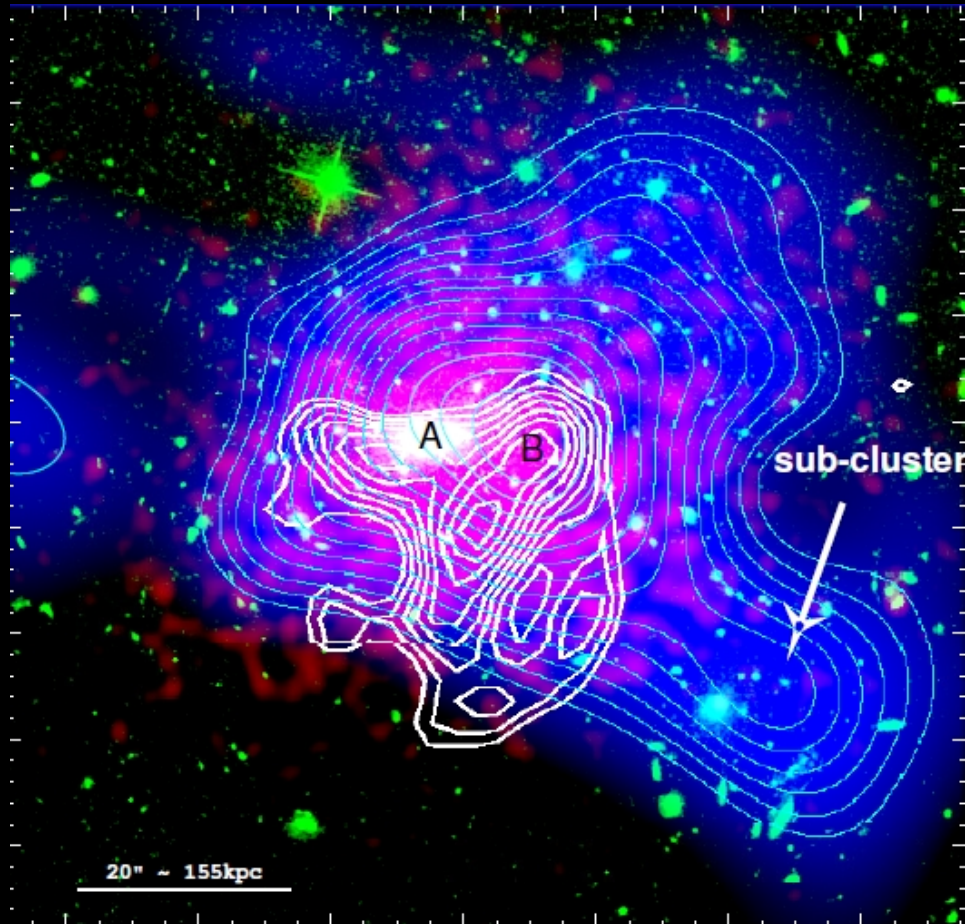
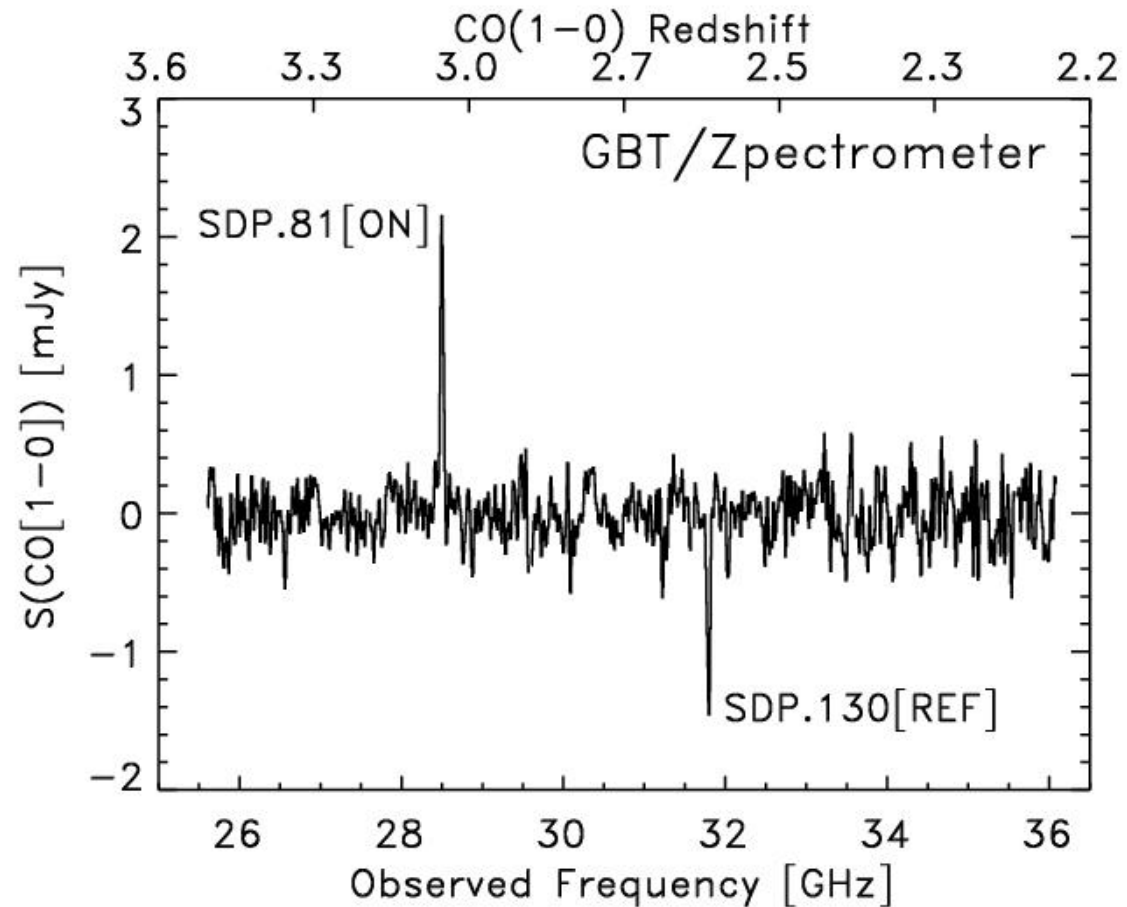


Image of CL1226.9+3332 ($z = 0.89$); White is MUSTANG; Green is optical (HST); Red is X-ray (Chandra); Blue is mass density (HST) *Courtesy Korngut, et al.*

Studying star formation in the early universe via high-redshift CO

Frayer et al. 2011:
Molecular gas
measurements and
redshifts of ultra-
luminous infrared
galaxies discovered
by Herschel with the
GBT/Zpectrometer.
(around 15-20
Herschel sources
with GBT redshifts)



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Current Instruments – Front Ends

Example lines:

HI, OH

NH₃,
HC₅N,
C₂S, H₂O

HCN, HNC,
HCO⁺, HDO,
DCN, SiO,
SO₂, H₂CO,
N₂H⁺, N₂D⁺,
CH₃CN, C₂H

Receiver	Band	Frequency Range (GHz)	Focus	Polarization	Beams
PF1	342 MHz	.290-.395	Prime	Lin/Circ	1
	450 MHz	.385-.520	Prime	Lin/Circ	1
	600 MHz	.510-.690	Prime	Lin/Circ	1
	800 MHz	.680-.920	Prime	Lin/Circ	1
PF2	---	.910-1.23	Prime	Lin/Circ	1
L-Band	---	1.15-1.73	Greg.	Lin/Circ	1
	S-Band	---	1.73-2.60	Greg.	Lin/Circ
C-Band	---	3.95-6.1	Greg.	Lin/Circ	1
X-Band	---	8.00-10.0	Greg.	Circ	1
Ku-Band	---	12.0-15.4	Greg.	Circ	1
	K-Band	lower	18.0-22.4	Greg.	Circ
upper		22.0-26.5	Greg.	Circ	2
Ka-Band	MM-F1	26.0-31.0	Greg.	Circ	2
	MM-F2	30.5-37.0			
	MM-F3	36.0-39.5			
Q-Band	---	38.2-49.8	Greg.	Circ	2
Mustang	---	80-100	Greg.	---	64
	{W-band (4mm Rx)	67-93.3	Greg.	Lin/Circ	2}

KFPA
27



Current Instruments – Front Ends-2

Receiver	FWHM	Gain (K/Jy)	Aperture Efficiency	SEFD (JY)	T_{rec} (K)	T_{sys} (K)
PF1	36'	2.0	70%	23	12	46 + T_{bg}
	27'	2.0	70%	22	22	43 + T_{bg}
	21'	2.0	70%	11	12	22 + T_{bg}
	15'	2.0	70%	15	21	29 + T_{bg}
PF2	12'	2.0	70%	9	10	17 + T_{bg}
L-Band	9'	2.0	70%	10	6	20 + T_{bg}
S-Band	5.8'	1.9	70%	11	6-10	20 + T_{bg}
C-Band	2.5'	1.85	70%	8	5	18 + T_{bg}
X-Band	1.4'	1.8	70%	15	13	27 + T_{sky}
Ku-Band	54''	1.7	70%	18	14	30 + T_{sky}
K-Band	37''	1.5	67% 68%	23	21	30 – 40 + T_{sky}
	30''	1.5	65% 67%	24	21	30 – 40 + T_{sky}
Ka-Band	26.8''	1.5	56-64% 65%	27	20	45 + T_{sky}
	22.6''			20		35 + T_{sky}
	19.5''			43		70 + T_{sky}
Q-Band	16''	1.0	47-56% 60%	67-134	40-70	67 – 134 + T_{sky}
Mustang	10''	—	20% 35%	—	—	—

Backends/Spectrometers

- Spectrometer with bandwidths: 800, 200, 50, 12.5 MHz. Maximum resolution is 49 Hz with 12.5MHz bandwidth. Minimum integration times 1-2 sec.
- Spectral Processor (FFT spectrometer) for high-time resolution data (useful at low freq where RFI is an issue).
- Continuum with DCR (digital continuum receiver) for most bands, CCB used for continuum at Ka, and Mustang for continuum at 90GHz.
- GUPPI used for Pulsar Observations
- **VEGAS** (VErsatile GBT Astronomical Spectrometer) is the new replacement for the Spectrometer available in 2012 (FPGA based).



Bandwidth (MHz)	Number of Spectral Windows	Number of Beams	Channels - Approximate Resolution (kHz)	Minimum Integration Time (sec)	Notes
1500	1 or 2	1	1024 – 1464.844	0.5	1st priority mode
1500	1	2	1024 – 1464.844	0.5	1st priority mode
1000	1 or 2	1	2048 – 488.281	0.7	
1000	1	2	2048 – 488.281	0.7	
800	1 or 2	1	4096 – 195.313	1.3	
800	1	2	4096 – 195.313	1.3	
500	1 or 2	1	8192 – 61.035	2.5	
500	1	2	8192 – 61.035	2.5	
400	1 or 2	1	16384 – 24.414	5.0	
400	1	2	16384 – 24.414	5.0	

Table 7: VEGAS Large Bandwidth, Few Spectral Window Modes.

VEGAS:

Supports 8 beams, dual polarization (e.g., K-FPA).

Up to 16 windows (one beam), 8 windows (two beams).

Maximum continuous bandwidth of 10 GHz, eventually.

Bandwidth (MHz)	Number of Spectral Windows	Number of Beams	Channels - Approximate Resolution (kHz)	Minimum Integration Time (sec)	Notes
250	1 or 2	1	32768 – 7.629	10	
250	1	2	32768 – 7.629	10	
100	1 or 2	1	32768 – 3.052	10	
100	1	2	32768 – 3.052	10	
50	1 or 2	1	32768 – 1.526	10	
50	1	2	32768 – 1.526	10	
25	1 or 2	1	32768 – 0.763	10	
25	1	2	32768 – 0.763	10	
10	1 or 2	1	32768 – 0.305	10	3rd priority mode
10	1	2	32768 – 0.305	10	3rd priority mode
5	1 or 2	1	32768 – 0.153	10	
5	1	2	32768 – 0.153	10	
1	1 or 2	1	32768 – 0.031	10	4th priority mode
1	1	2	32768 – 0.031	10	4th priority mode

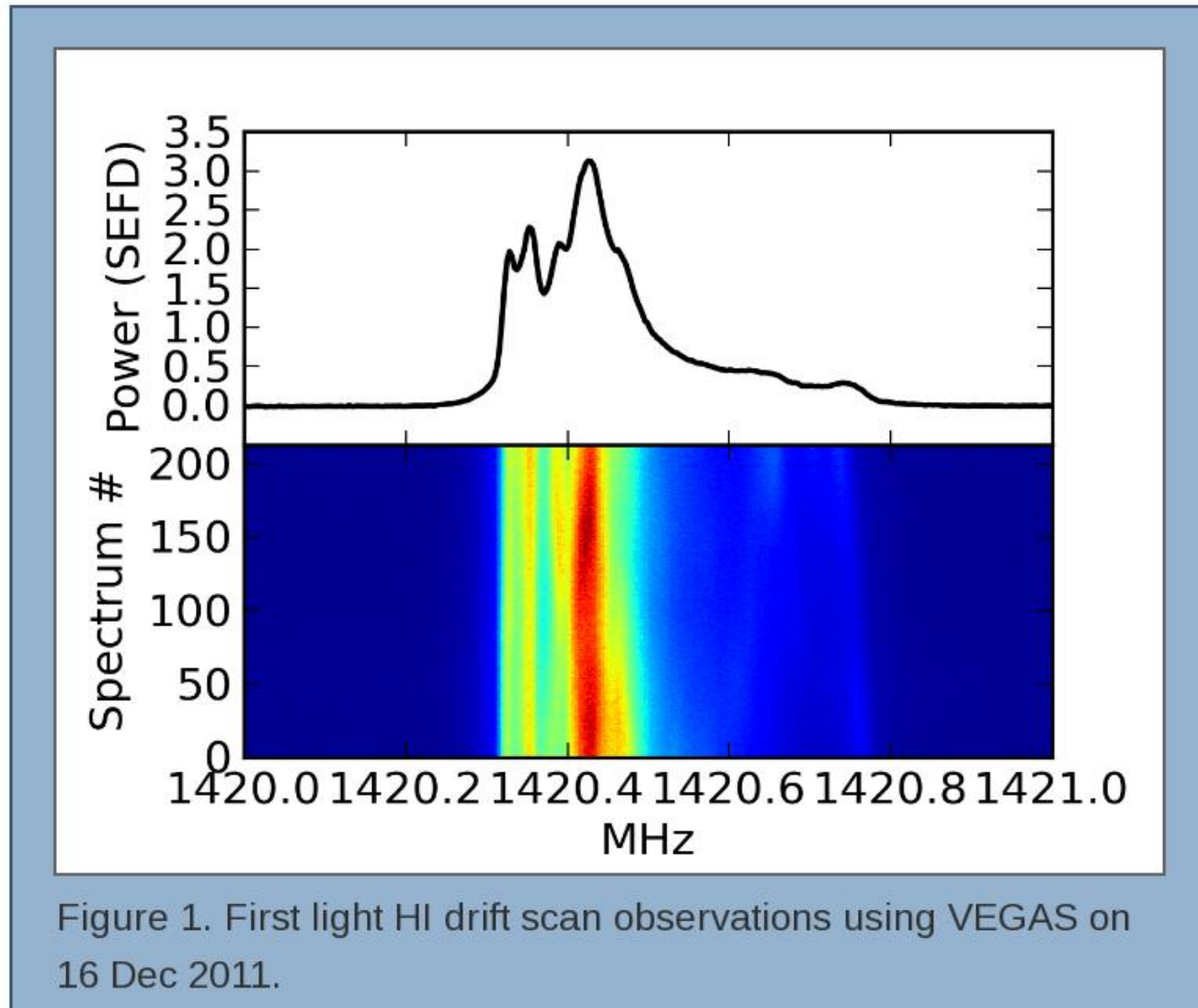
Table 8: VEGAS Small Bandwidth, Few Spectral Window Modes.

Bandwidth (MHz)	Number of Spectral Windows	Number of Beams	Channels - Approximate Resolution (kHz)	Minimum Integration Time (sec)	Notes
30	8 or 16	1	4096 – 7.324	10	
30	8	2	4096 – 7.324	10	
15	8 or 16	1	4096 – 3.662	10	2nd priority mode
15	8	2	4096 – 3.662	10	2nd priority mode
10	8 or 16	1	4096 – 2.441	10	
10	8	2	4096 – 2.441	10	
5	8 or 16	1	4096 – 1.221	10	
5	8	2	4096 – 1.221	10	
1	8 or 16	1	4096 – 0.244	10	
1	8	2	4096 – 0.244	10	

Table 9: VEGAS Small Bandwidth, Many Spectral Window Modes.



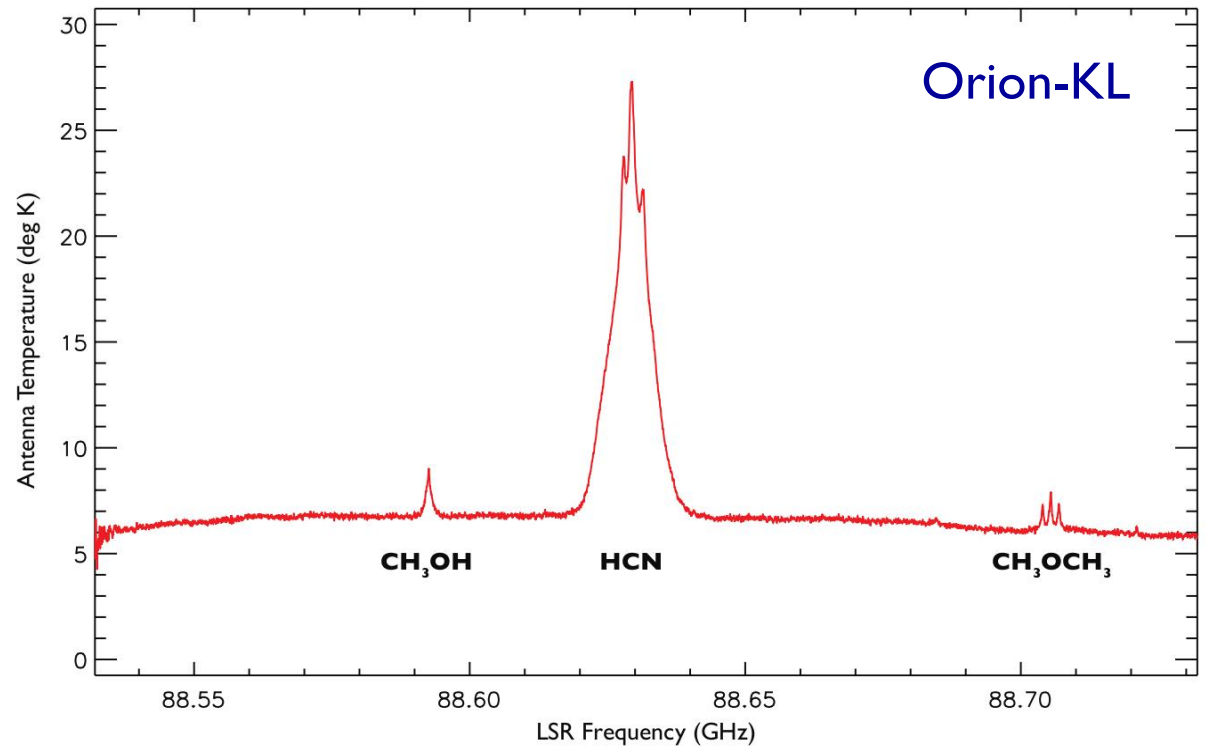
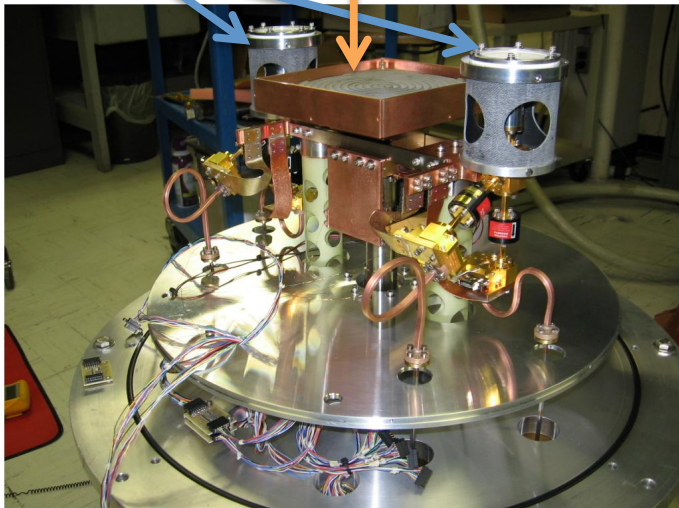
VEGAS First Light Dec 2011



GBT's newest receiver: The 4mm Receiver (67-93.3 GHz). First Light, May 2011: HCN in Orion-KL {couple of minutes taken during the day in marginal weather}

Commissioned: 2012 Jan-Mar

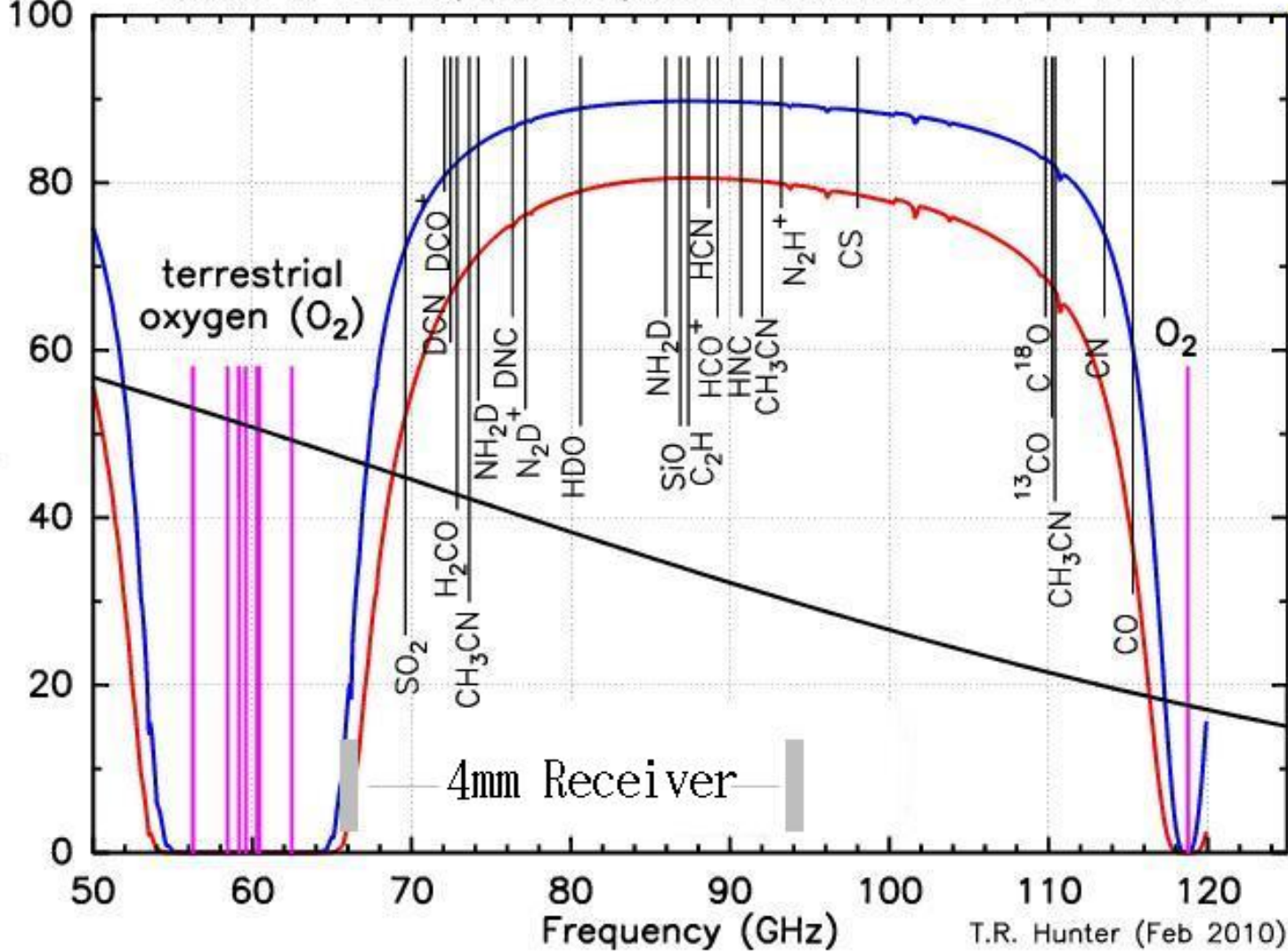
Feeds, Cold Load



See <http://www.gb.nrao.edu/4mm> for more details.

GBT Aperture Efficiency (240 μ m rms, 13dB taper)

Some of the important spectral lines in the 3mm window



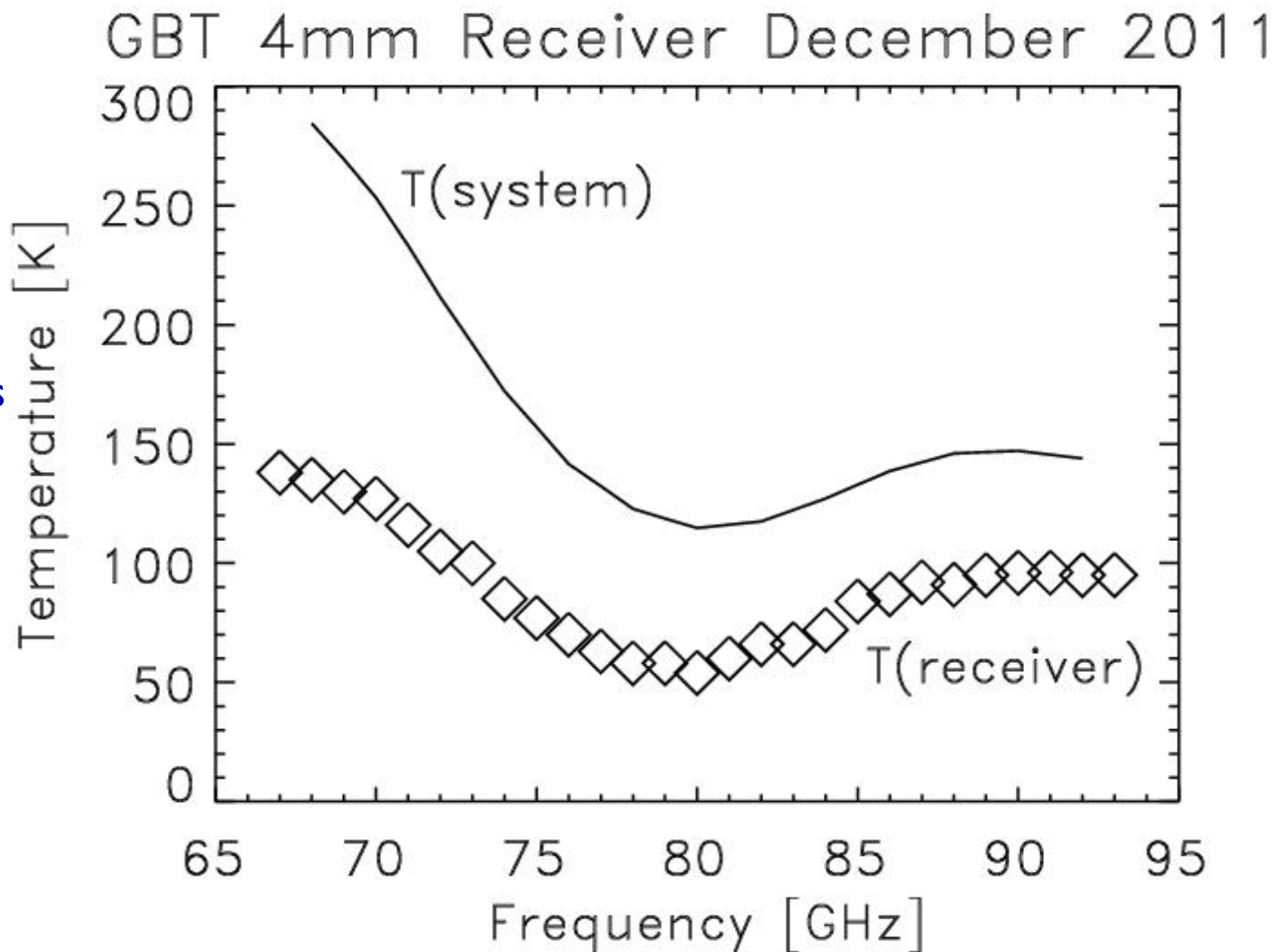
ATM Transmission (T=273K, Humid=90%) Elev=90°, 30°



4mm System Performance {with current non-optimized amplifiers}

With resources and a bit of effort could reach $T(\text{rx}) \sim 40\text{K}$ across the band.

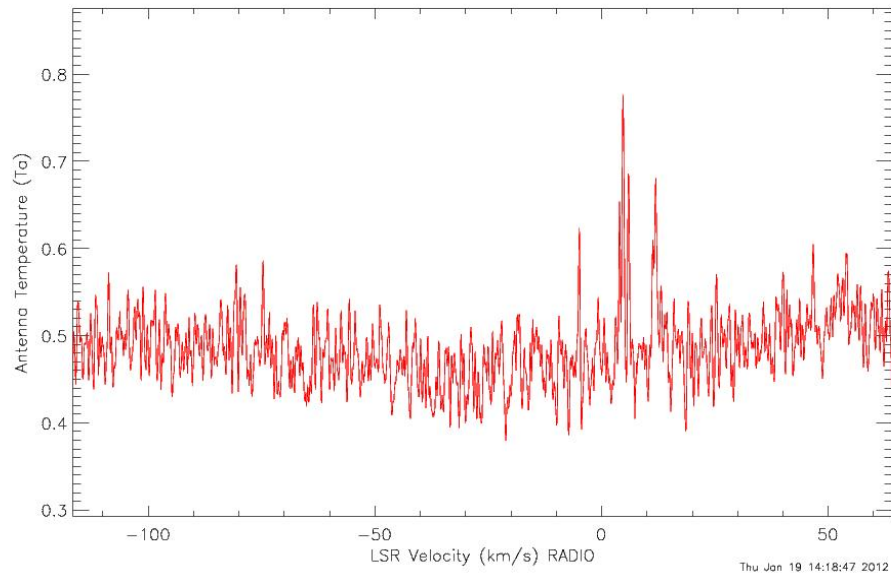
Solid curve shows T_{sys} for “typical” weather scheduled by DSS. In good weather, sky contributes $<30\text{K}$.



4mm Rx: Cold starless-cores → molecular freeze-out → D-species enhanced

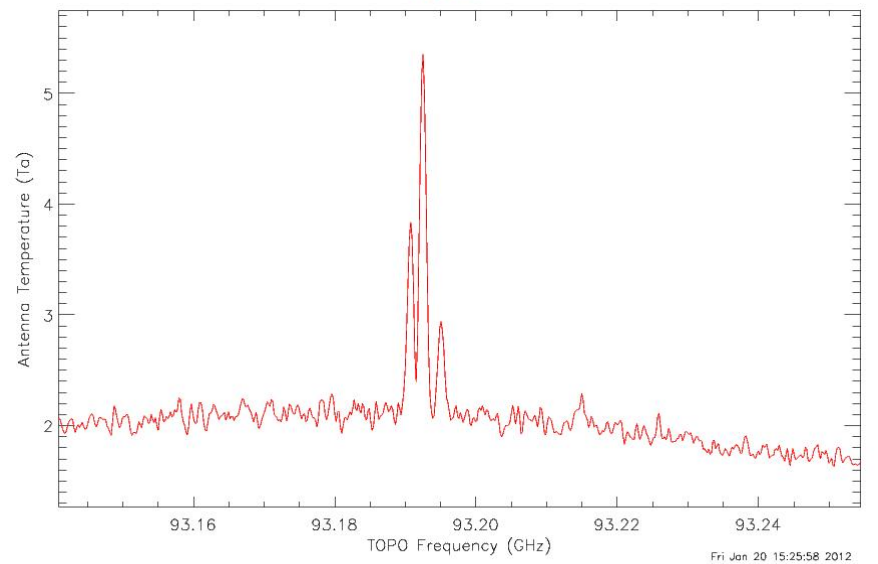
N₂D⁺ in L1544 at 77 GHz (S. Schnee et al.)

Scan 45 V : 5.0 RADJ-OBS F0 : 77.10900 GHz Pol: XX Tsys: 120.00
2012-01-19 Int : 00 02 29.3 Fsky : 77.10771 GHz IF : 0 Tcal: 1.00
David Frayer LST : +09 16 31.3 BW : 50.0153 MHz TGBT11B_503_06 OnOff
05 04 15.09 +25 11 07.8 L1544 Az: 275.5 El: 36.0 HA: 4.20



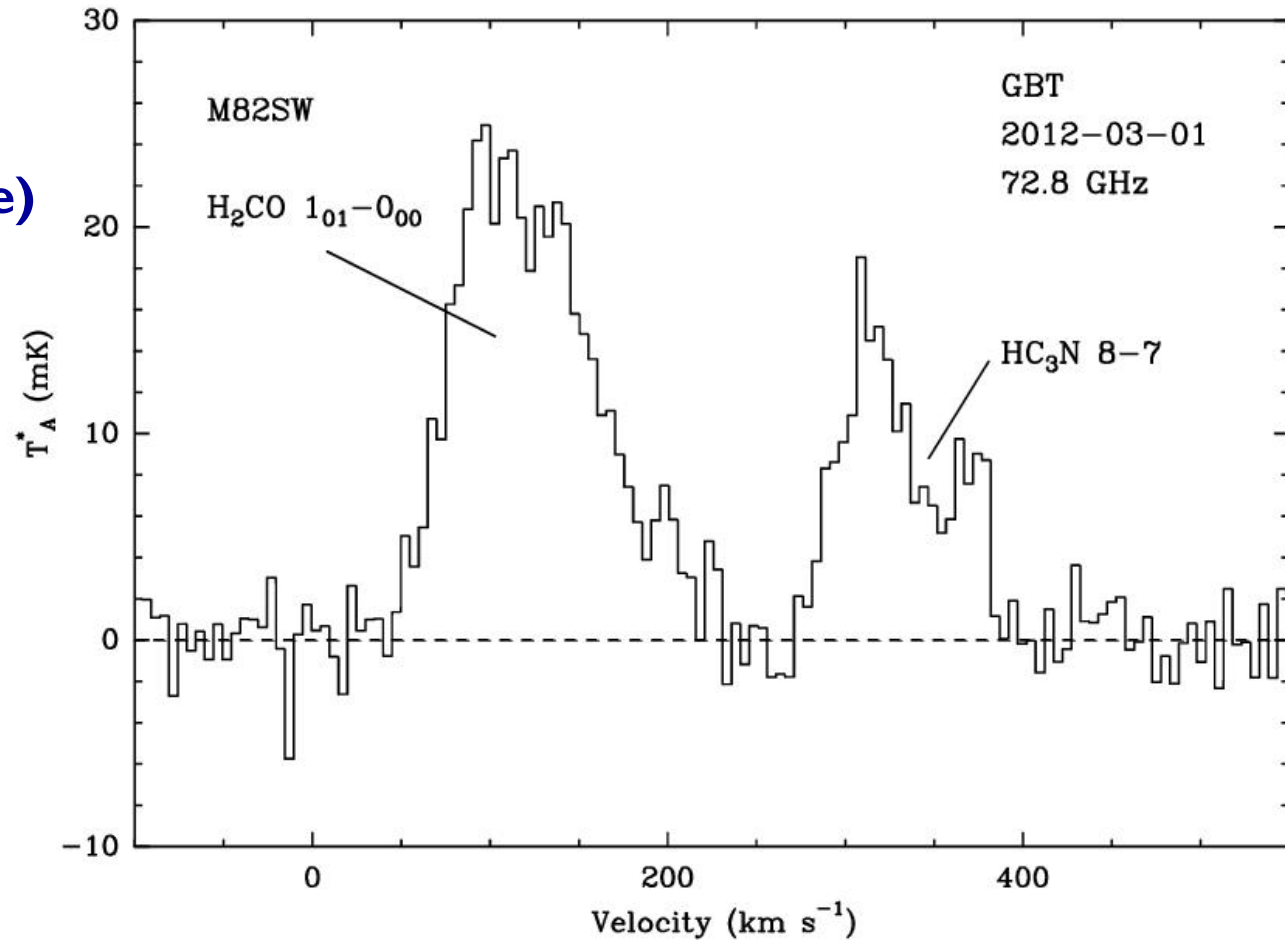
N₂H⁺ in W3OH at 93 GHz

Scan 294 V : -46.4 RADJ-OBS F0 : 92.90000 GHz Pol: YY Tsys: 161.71
2011-10-23 Int : 00 00 59.0 Fsky : 92.91418 GHz IF : 0 Tcal: 1.00
David Frayer LST : +05 20 59.2 BW : 800.0000 MHz TGBT11B_503_03 OnOff
02 27 04.71 +61 52 24.2 W3OH Az: 326.0 El: 54.8 HA: 2.90



4mm: Dense gas and Molecular Diversity in Nearby Galaxies

M82
H₂CO
(formaldehyde)
& HC₃N
(J. Mangum)



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NRAO Semester 2013A Call for Proposals

- The NRAO Semester 2013A Call for Proposals for the Green Bank Telescope, Jansky Very Large Array, and Very Long Baseline Array/High Sensitivity Array will be published as a special issue of the NRAO eNews on Monday, 9 Jul 2012.
- The 2013A proposal submission deadline will be

Wed, 1 Aug 2012, at 5 p.m. EDT.



See NRAO web pages for the eNews Proposal call and GBT proposal guide to get the latest information

Practical Information For Astronomers — Science Website

https://science.nrao.edu/facilities/gbt/practical-information-for-astronomers

Wells Fargo ...day's Rates U.S. Treasury Bond-future http://www....match.aspx Tour de France 2011 Tour de Fran...rdian.co.uk Tour de Fran...rdian.co.uk SpeedStream ...t Interface David T. Fr...s Home Page Apple Yahoo! >>

Practical Information For Astronomers

Proposing on the GBT	Observing	Helpdesk	Schedules	Single Dish Radio Astronomy Basics
Data Reduction and Archive	Financial Support	Scientific Visitor Info		Observer Alerts!

Proposing on the GBT

- [Call For Proposals](#) for all NRAO telescopes
- [General Proposal Information](#) describes the proposal evaluation and time allocation process. Starting February 2011, the NRAO's uses an Observatory-wide panel system that is no longer telescope based, that depends on community members for scientific evaluation, and the NRAO staff for technical reviews only.
- [Practical GBT Information and Proposer's Guide](#) updated prior to each proposal deadline, provides essential information for the preparation of proposals, including a detailed description of the submission process, instrument status, observing modes, and staff contacts.
- [Proposal Submission Tool](#) for the GBT, EVLA, and VLBA telescopes.
- [Sensitivity Calculator](#), an on-line tool for calculating the the time required for science on the GBT.
- [Mapping Planner](#), an online tool to plan on-the-fly mapping
- [Known Sources of Radio Frequency Interference](#) shows recent observations of the local, very helpful when planning observations.

Observing

- [Observing with the GBT](#) (PDF) provides detailed information for executing observations with the GBT.
- [Observing Policies and Practices](#) for observing with the GBT

GBT Proposal Guide

https://science.nrao.edu/facilities/gbt/proposing/GBTpg.pdf

Wells Fargo ...day's Rates U.S. Treasury Bond-future http://www....match.aspx Tour de France 2011 Tour de Fran...rdian.co.uk Tour de Fran...rdian.co.uk SpeedStream ...t Interface David T. Fr...s Home Page Apple Yahoo!

1 / 37 100%

Comment Share

The Proposer's Guide for the Green Bank Telescope

GBT Support Staff
January 24, 2012

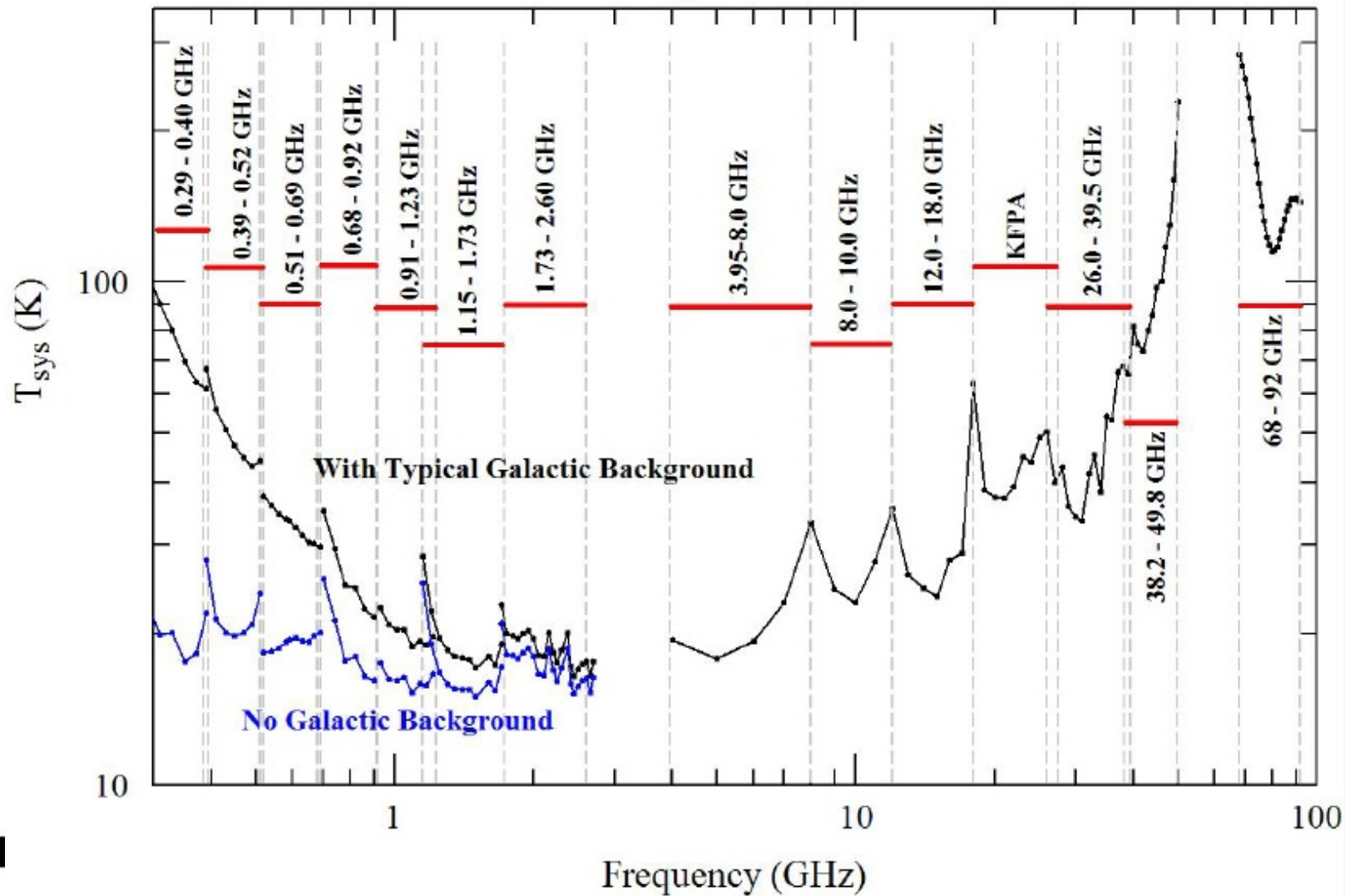


This guide provides essential information for the preparation of observing proposals on the Green Bank Telescope (GBT). The information covers the facilities that will be offered in **Semester 12B**.

- Introduction to the GBT
- Submitting a proposal
- GBT Instruments
- GBT Observing Modes
- Defining Sessions
- Estimating Overhead Time
- RFI
- Tips for Writing Your Proposal
- Further information
- Appendix

GBT Performance

Log-Log Plot of Expected T_{sys} for Typical Weather Conditions



GBT Web Links related to proposals:

Useful Web Links

Description	Link
GBT Astronomers Web Page	http://www.gb.nrao.edu/astronomers.shtml
Proposal Writing Tips	http://www.naic.edu/~astro/School/Talks/salter_prop.pdf
GBT General Proposal Information	http://www.gb.nrao.edu/gbtprops/generalproposalinfo.shtml
GBT Latest Call For Proposals	http://www.gb.nrao.edu/gbtprops/latestgbtcfp.shtml
GBT Observation Planning	http://www.gb.nrao.edu/~rmaddale/GBT/ReceiverPerformance/PlaningObservations.htm
NRAO Proposal Submission Tool	http://www.gb.nrao.edu/nraoPST.htm
GBT Sensitivity Calculator	http://wwwlocal.gb.nrao.edu/GBT/setups/senscalc.html
GBT Spectral Line Wizard	http://wwwlocal.gb.nrao.edu/GBT/setups/configwiz.html
GBT Pointing Strategies	GBT Observer's Guide
GBT 60 Hour Weather Forecasts	http://www.gb.nrao.edu/~rmaddale/Weather/
GBT Mapping Planner	http://wwwlocal.gb.nrao.edu/GBT/setups/mapplan.html
Spigot Card	http://www.gb.nrao.edu/GBT/spectrometer/spigot_card/index.html
GBT VLBA Recorder	https://safe.nrao.edu/wiki/pub/GB/Knowledge/GBTMemos/GBT_Mark5A_S2.pdf
VLBI Information	http://www.gb.nrao.edu/~fghigo/gbt/doc/vlbinfo.html
Mark5 Single Dish Mode	https://safe.nrao.edu/wiki/bin/view/GB/Data/HowToObserveReduceMark5AandS2Data
Astrid	GBT Observer's Guide
GBTIDL	http://gbtidl.nrao.edu
RFI	http://www.gb.nrao.edu/IPG/
Guppi	https://safe.nrao.edu/wiki/bin/view/CICADA/GUPPiUsersGuide

Table 15: Useful Web Sites for Proposal Writers.



GBT Proposals are submitted via the “PST” (Proposal Submission Tool)

The screenshot shows a web browser window titled "NRAO: Proposals" with the URL "https://my.nrao.edu/nrao-2.0/secure/ProposalList.htm". The page header includes the NRAO logo and the text "National Radio Astronomy Observatory". A navigation bar contains buttons for "Dashboard", "Proposals", "Reviews", "Data Processing", "Obs Prep", "Helpdesk", and "Profile". The user is logged in as "Hi, David" with a "Sign Out" link. Below the navigation bar, there are tabs for "My Proposals", "Available Authors", and "Available Organizations". The main content area displays three proposal submission options, each with a radio button and a corresponding image of a radio telescope:

- EVLA: Accompanied by an image of the Very Large Array (VLA) in a field of purple flowers.
- VLBA/HSA: Accompanied by an image of a single large radio telescope dish.
- GBT: Accompanied by an image of the Green Bank Telescope (GBT) on a hillside. This option is highlighted with a blue circle.

At the bottom right of the main content area, there are "Create" and "Help" buttons. The date "Sunday 10 June 2012" is displayed in the top right corner of the page content.

1st step, click here;-)



National Radio Astronomy Observatory

- Dashboard
- Proposals
- Reviews
- Data Processing
- Obs Prep
- Helpdesk
- Profile

Hi, David | Sign Out

- My Proposals
- Available Authors
- Available Organizations

Sunday 10 June 2012

- Validate
- Print
- Submit

Click here when done

Help

GENERAL

General

Status: SUBMITTED
Create Date: 07/30/2011
Modify Date: 08/01/2011
Submit Date: 08/01/2011
Total Time: 5.0



Observing Proposal

Title

GBT 68--92 GHz Spectral Line Survey of Orion-KL

Type

Regular

Scientific Category

Star Formation

Abstract

We propose to carry out a spectral line survey of Orion-KL with the new 4mm Receiver on the GBT. The observations will probe deeper than previous surveys and will be observed at low frequencies which have not yet been previously explored. The observations are better matched to the size of the Orion-KL bright core than the previous Turner NRAO 11m survey, and this modest survey will improve upon the sensitivity of the 11m survey by a factor of 100. The results of the full survey will be made public immediately for use by other teams.

Joint

Not a Joint Proposal

Observing Type(s)

Spectroscopy

Dissertation Research Plan

Dissertation Research Plan(s) not required

Observer Present for Observations

yes

Staff Support Required

None

Related Proposals

- Options
- My Proposals
 - VLA/12B-217
 - VLA/12B-124
 - VLA/12A-201
 - VLA/11B-044
 - VLA/11A-182
 - VLA/10C-231
 - VLA/10C-218
 - VLA/10C-205
 - VLA/10B-203
 - VLA/10A-211
 - VLA/10A-146
 - VLA/09A-122
 - VLA/07B-236
 - VLA/07A-224
 - GBT/2012-05-002
 - GBT/2012-00-082
 - GBT/2011-07-032
 - GBT/12B-348
 - GBT/12B-322
 - GBT/12B-297
 - GBT/12B-261
 - GBT/12B-259
 - GBT/12A-436
 - GBT/12A-376
 - GBT/12A-364
 - General**
 - Authors
 - Science Justification
 - Sources
 - Resources
 - Sessions
 - Student Support
 - Print Preview

Fill out proposal sections



Validate Print

Help

SOURCES

Sources << >>

- Options**
- My Proposals
 - VLA/12B-217
 - VLA/12B-124
 - VLA/12A-201
 - VLA/11B-044
 - VLA/11A-182
 - VLA/10C-231
 - VLA/10C-218
 - VLA/10C-205
 - VLA/10B-203
 - VLA/10A-211

Orion-KL Show Sessions up / down

Order	Name	Position	Velocity
Coordinate System		Equatorial	Convention Radio
Equinox		J2000	
Right Ascension		Value: 05:35:14.51	Ref. Frame LSRK
Declination		Value: -5:22:30.6	Velocity 8.8 km/s
		Range(±): 00:00:00.0	
		Range(±): 00:00:00.0	

Validate Print

New Resource Group Help

GBT RESOURCES

Resources << >>

- Options**
- My Proposals
 - VLA/12B-217
 - VLA/12B-124
 - VLA/12A-201
 - VLA/11B-044
 - VLA/11A-182
 - VLA/10C-231
 - VLA/10C-218
 - VLA/10C-205
 - VLA/10B-203
 - VLA/10A-211
 - VLA/10A-146
 - VLA/09A-122
 - VLA/07B-236
 - VLA/07A-224
 - GBT/2012-05-002
 - GBT/2012-00-082
 - GBT/2011-07-032
 - GBT/12B-348
 - GBT/12B-322
 - GBT/12B-297
 - GBT/12B-261
 - GBT/12B-259
 - GBT/12A-436
 - GBT/12A-376
 - GBT/12A-364
 - General
 - Authors
 - Science Justification
 - Sources
 - Resources**
 - Sessions
 - Student Support

Orion-KL-4mm Show Sessions up / down

Order	Name	Receiver	Back End
Rest Frequencies:		68.4,71.2,74,76.8,79.6,82.4,85.2,88,90.8,92 GHz	
Bandwidth:		800 MHz	
Number of Spectral Windows:		4	
Sampling Level:		3	
Desired Frequency Resolution:		390. kHz	

SESSIONS

Sessions << >>

Session	Number of Sessions	Separation	Min. Start LST	Max. End LST	Min. Elevation
Orion-4mm	1 X 5.0	0 day	00:00:00	10:00:00	25.0

Constraints: Comments:

Source Groups	Resource Groups	Time/Session (hrs)
Orion-KL	Orion-KL-4mm	5.00

Use GBT Sensitivity Calculator for proposal time estimates, and also used for verifying available modes.

The screenshot shows the GBT Sensitivity Calculator web application. The interface is divided into several sections:

- General Information:**
 - Derive: Observing Time from Desired Sensitivity
 - Sensitivity Units: Flux Density (mJy)
 - Desired Sensitivity: 5
- Hardware Information:**
 - Backend: GBT Spectrometer
 - Mode: Spectral Line
 - Receiver: W (68.0 - 92.0 GHz)
 - Beams: 1
 - Polarization: Dual
 - BandWidth (MHz): 200
 - Number of Spectral Windows: 1
 - Switching Mode: Position Switching
- Source Information:**
 - Frequency Specified in the: Rest Frame
 - Rest Frequency (MHz): 80000
 - Doppler Correction: Optical
 - Source Velocity (km/s): 0
 - Source Diameter (arc minutes): 0
 - Source Contribution Corrections: No Correction
- Controls:**
 - Buttons: Update Results, Save to File
- Results:**
 - Derived Total Observing Time: 00:39:46.2 HH:MM:SS.S
 - Time at Signal Position or Frequency: 00:19:53.1 s
 - Time at Reference Position or Frequency: 00:19:53.1 s
 - Effective Integration Time: 00:09:56.6 s
 - Obs. Mode Time Mult. Factor: 2
 - FWHM Beamwidth: 0.2'
 - Aperture Efficiency: 0.41
 - Extended Source Efficiency: 0.41
 - Confusion Limit: 0.00 S (mJy)
 - # Hrs Above Min Elevation: 6.13 hours
 - Topocentric Frequency: 80000.000 MHz
 - Min. Topocentric Channel Width: 6.104 kHz
 - Desired Freq. or Vel. Resolution: 1.000000
 - Typical Air Mass: 1.5
 - Typical Atmospheric Attenuation: 1.292
 - Typical System Temperature: 134.2 K
 - Backend Sampling Efficiency (K1): 1.2350
 - Backend Channel Weighting (K2): 1.2100
- Other Results:**
 - Typical Atmospheric Opacity: 0.170 Nepers
 - observing_method: 1
 - eta_dss: 0.50
 - eta_surf: 1.00
 - Maximum Elevation: 51.6 d
 - max_el_rad: 0.900
 - Typical Effective Tsys: 177.8 K
 - Receiver's Contribution to Tsys: 75.0 K
 - Source Diameter: 0.0'
 - Topocentric Wavelength: 0.37 cm
 - n_ref_smth_avg: 1.000
 - Typical Weighted Mean Temp. of Atmos: 247.1 K
 - dual_pol: 2
 - Best Possible Effective Tsys: 125.7 K
 - c2: 0.351580
 - a: 141.121084 mK / (s^1.5)
 - min_el_rad: 0.576



Sensitivity Calculator – Hardware modes

Sensitivity Calculator

https://dss.gb.nrao.edu/calculator-ui/war/Calculator_ui.html

Wells Fargo ...day's Rates U.S. Treasury Bond-future http://www....match.aspx Tour de France 2011 Tour de Fran...rdian.co.uk Tour de Fran...rdian.co.uk SpeedStream ...t Interface David T. Fr...s Home Page Apple Yahoo! Google Maps Wikipedia News (1442)

General Information

Derive: Observing Time from Desired Sensitivity
 Sensitivity from Observing Time

Sensitivity Units: Flux Density (mJy)
 Antenna Temp., Ta (mK)
 Radiation Temp., Tr (mK)

Desired Sensitivity:

Hardware Information

Answer questions from top to bottom. If you change a question that was answered previously, check all answers that follow. Some answers will dictate the answer for other questions.

Backend:

Mode:

Receiver:

Beams:

Polarization:

BandWidth (MHz):

Number of Spectral Windows:

Switching Mode:

Controls

Results

Results	
Derived Total Observing Time:	01:03:10.1 HH:MM:SS.S
Time at Signal Position or Frequency:	00:31:35.0 s
Time at Reference Position or Frequency:	00:31:35.0 s
Effective Integration Time:	00:21:03.4 s
Obs. Mode Time Mult. Factor:	4
FWHM Beamwidth:	0.14 '
Aperture Efficiency:	0.36
Extended Source Efficiency:	0.36
Confusion Limit:	0.00 S (mJy)
# Hrs Above Min Elevation:	7.65 hours
Topocentric Frequency:	88500.000 MHz
Min. Topocentric Channel Width:	390.625 kHz
Desired Freq. or Vel. Resolution:	20.000000
Typical Air Mass:	1.7
Typical Atmospheric Attenuation:	1.231
Typical System Temperature:	125.3 K



Sensitivity Calculator – Source Info

Sensitivity Calculator

https://dss.gb.nrao.edu/calculator-ui/war/Calculator_ui.html

Wells Fargo ...day's Rates U.S. Treasury Bond-future http://www....match.aspx Tour de France 2011 Tour de Fran...rdian.co.uk Tour de Fran...rdian.co.uk SpeedStream ...t Interface David T. Fr...s Home Page Apple Yahoo! Google Maps Wikipedia News (1442) >>

Source Information

Frequency Specified in the: Topocentric Frame
 Rest Frame

Rest Frequency (MHz):

Doppler Correction: ▾

Source Velocity (km/s):

Source Diameter (arc minutes): 0

Source Contribution Corrections

Source Contribution to System Temperature: No Correction
 User Estimated Correction
 Internal Galactic Model

Source Declination (Deg): 0

Minimum Elevation (Deg): 25

Topocentric Frequency:	88500.000 MHz
Min. Topocentric Channel Width:	390.625 kHz
Desired Freq. or Vel. Resolution:	20.000000
Typical Air Mass:	1.7
Typical Atmospheric Attenuation:	1.231
Typical System Temperature:	125.3 K
Backend Sampling Efficiency (K1):	1.2350
Backend Channel Weighting (K2):	1.2100

Messages

Warning - Time*(Bandwidth resolution) exceeds the suggested limit for 1. observing techniques may be required to reach your scientific goals. Please provide technical justification.

Other Results

Typical Atmospheric Opacity:	0.124 Nepers
observing_method:	2
eta_dss:	0.50
eta_surf:	1.00
Maximum Elevation:	51.6 d
max_el_rad:	0.900
Typical Effective Tsys:	157.4 K
Receiver's Contribution to Tsys:	75.0 K
Source Diameter:	0.0'



Sensitivity Calculator – Data processing

Sensitivity Calculator

https://dss.gb.nrao.edu/calculator-ui/war/Calculator_ui.html

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Data Reduction

Ratio of observing time spent on-source/on-frequency to that spent on a reference position/reference frequency.

In data reduction you have the option to average multiple reference observations in order to improve the noise. Enter number of reference observations that will be averaged together.

Average Orthogonal Polarizations

Difference Signal and Reference Observations

Smoothing

Smooth On-source Data to a Velocity Resolution in the Rest Frame Desired:

Frequency Resolution in the Topocentric

Frequency Resolution in the Rest Frame

Desired Resolution (km/s):

To improve signal-to-noise you can smooth reference observations to a resolution that is a few times courser than the signal observation. Select the factor by which you want to smooth the reference observation:

Smoothing Factor: 1 2 4 8

Topocentric Frequency:	88500.000 MHz
Min. Topocentric Channel Width:	390.625 kHz
Desired Freq. or Vel. Resolution:	20.000000
Typical Air Mass:	1.7
Typical Atmospheric Attenuation:	1.231
Typical System Temperature:	125.3 K
Backend Sampling Efficiency (K1):	1.2350
Backend Channel Weighting (K2):	1.2100

Messages

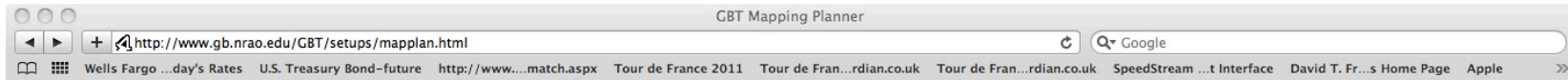
Warning - Time*(Bandwidth resolution) exceeds the suggested limit for 1. observing techniques may be required to reach your scientific goals. Please provide technical justification.

Other Results

Typical Atmospheric Opacity:	0.124 Nepers
observing_method:	2
eta_dss:	0.50
eta_surf:	1.00
Maximum Elevation:	51.6 d
max_el_rad:	0.900
Typical Effective Tsys:	157.4 K
Receiver's Contribution to Tsys:	75.0 K
Source Diameter:	0.0 '



GBT Mapping Planner



Plan GBT mapping

On-the-fly mapping with the GBT is done by driving the telescope along one coordinate axis to scan one stripe, then step in the orthogonal direction for the next stripe. The procedures are named "RALongMap" (scanning in the RA or longitude direction), or "DecLatMap" (scanning in the Dec or latitude direction).

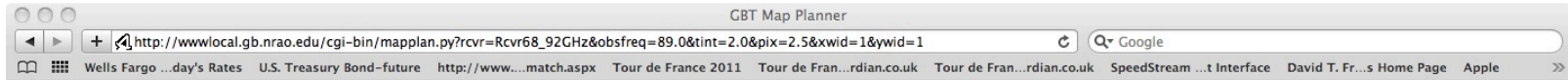
Given the desired integration time per pixel, number of pixels per beam, and total size of the area to be mapped, this figures out the scanning rate, number of stripes, and total time required.

Note also its a good idea to increase the map width about 10% in the direction of scanning to avoid scan startup effects.

Receiver	Obs.Freq.	Integration per pixel	Pixels per beam	Map: X width	Map: Y width
Rcvr68_92GHz ▾	89.0 GHz	2.0 sec	2.5	1 arcmin	1 arcmin

Evaluate

GBT Mapping Planner: Results



GBT Map Planner Results

Receiver	Obs.Freq.	Tpix	Pix/beam	X width	Y width
Rcvr68_92GHz	89.0 GHz	2.0 sec	2.5	1.0 arcmin	1.0 arcmin
...					
HPBW(°)	DY(°)	Xrate(/min)	Tstripe	Xpix	Ypix
0.139	0.056	1.67	0.60 min	18	18
...					
Total Time					
19.80 min					

- HPBW = half power beam width for the given Obs.Freq.
- DY = pixel size (arcmin), and spacing between stripes.
- Xrate = scanning rate in the x-direction.
- Tstripe = time to traverse one stripe.
- Total time includes overhead of 30 seconds per stripe, which is typical for back-and-forth scanning. (One hopes the overhead can be reduced in the future)

Example Astrid commands

If X/Y are RA/DEC with coordinate mode J2000.

- hlen = Offset("J2000", 0.0167, 0)
- vlen = Offset("J2000", 0, 0.0167)
- vdel = Offset("J2000", 0, 0.0009)
- hdel = Offset("J2000", 0.0009, 0)

- RALongMap(mapcenter, hlen, vlen, vdel, scanDuration=36)
- or
- DeclatMap(mapcenter, hlen, vlen, hdel, scanDuration=36)



Help?? --- NRAO HelpDesk

HelpDesk — Science Website

https://science.nrao.edu/observing/helpdesk

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HelpDesk

HelpDesk

For all questions related to observing within NRAO please use the [NRAO HelpDesk](#). To log in, use the same user ID and password as when accessing the Proposal Submission Tool or the Observation Preparation Tool. [If you haven't registered yet, please do so first at NRAO Interactive Services](#).

For department related questions (EVLA, GBT, VLBA, CASA, AIPS, GBT IDL etc.), please select the appropriate department during the ticket submission process.

For ALMA related questions, please go to the separate [ALMA Help Desk](#).

ALMA / NAASC

ALMA Proposer's Guide

EVLA

GBT

VLBA

Help?? --- GBT Contacts (listed in GBTPg)

Topic	Staff Member and Contact Details	
General Questions on Capabilities	Toney Minter	tminter@nrao.edu
Proposal submission and scheduling	Toney Minter	tminter@nrao.edu
Pointing, focus calibrations	Frank Ghigo	fghigo@nrao.edu
Receivers	Ron Maddalena	rmaddale@nrao.edu
4mm Receiver	David Frayer	dfrayer@nrao.edu
GBT Spectrometer	Ron Maddalena	rmaddale@nrao.edu
VEGAS	Anish Roshi	aroshi@nrao.edu
Spectral Line Observing	Ron Maddalena	rmaddale@nrao.edu
Continuum Observing	Toney Minter	tminter@nrao.edu
VLBA/VLBI Observing	Frank Ghigo	fghigo@nrao.edu
Pulsar Observing	Scott Ransom	sransom@nrao.edu
Radar Observing	Frank Ghigo	fghigo@nrao.edu
General software issues	Mark Clark	mclark@nrao.edu
GBT/ Green Bank policy	Toney Minter Karen O'Neil	tminter@nrao.edu koneil@nrao.edu
RFI Management	Toney Minter	tminter@nrao.edu
Observational Support	Toney Minter Frank Ghigo Ron Maddalena Dan Perera Dave Frayer Anish Roshi	tminter@nrao.edu fghigo@nrao.edu rmaddale@nrao.edu dperera@nrao.edu dfrayer@nrao.edu aroshi@nrao.edu

Table 14: GBT Contacts



Summary

- The GBT is a powerful instrument – single-dish flexibility, large collecting area, wide-frequency coverage
 - Diverse science
 - Development ongoing (higher frequency, multi-pixel/ feeds frontends, flexible backends) to enhanced capabilities
- **The 2013A proposal submission deadline will be **Wed, 1 Aug 2012, at 5 p.m****