

HI Observations with the GBT

Position Switched, Single-Pointing Observations

More detailed information can be found in the GBT Observer's Guide:

<http://www.gb.nrao.edu/scienceDocs/GBTog.pdf>

```
# Observing script for spectral line observations of HI using position switching.

# Reset configuration from prior observation.
ResetConfig()

# Import catalog of flux calibrators and user defined sources.
Catalog(fluxcal)
Catalog('/home/astro-util/projects/quick_guide/catalogs/ps_HI.cat')

# Define configuration parameters
ps_HI_config=''
receiver      = 'Rcvr1_2'
obstype       = 'Spectroscopy'
backend       = 'VEGAS'
restfreq      = 1420.4058
bandwidth     = 23.44
nchan         = 32768
vegas.subband = 1
swmode        = 'tp'
swtype        = None
swfreq        = 0, 0
swper         = 1.0
tint          = 6.0
vframe        = 'lsrk'
vdef          = 'Optical'
noisecal      = 'lo'
pol           = 'Linear'
notchfilter   = 'In'
''

# Configure telescope.
Configure(ps_HI_config)

# Slew to your source or calibrator.
Slew('3C196')

# Perform position and focus correction on nearby calibrator.
# Leaving the '()' blank will have the system choose your calibrator for you.
AutoPeakFocus('3C196')

# Slew to your source.
Slew('RSCG31')

# Reconfigure after calibrator corrections.
Configure(ps_HI_config)

# Balance the IF system
Balance()

# OffOn produces two scans each of the specified duration (in seconds) which
# tell the GBT to take data for 10 minutes.
OffOn('RSCG31', Offset('J2000', '-00:05:00', 0.0, cosv=True), 300)
```

Catalogs

To find out more about catalogs: [GBT Observer's Guide: Section 6.3](#)

Here is an example of a RA/Dec coordinate system catalog with velocity:

```
# Source List for HI observing with RA/Dec coordinates.

Coordmode = J2000
HEAD = NAME      RA      DEC      VEL
RSCG31      09:17:26.5  41:57:18    1600
RSCG64      12:41:33.2  26:03:56    4800
```

Note: Vel is source velocity in units of km/s. Reference frames can be set using the VDEF keyword in the config. You can also include any number of user defined keywords. See Observer's guide for more information.

Note: These should be saved as a '.cat' file, in a known location, to be called later.

Configurations

To find out more about configurations: [GBT Observer's Guide: Section 6.2](#)

Here is an example of a position switched configuration for HI observations:

```
# Configuration parameters for spectral line observations of HI using position switching.

ps_HI_config=''
receiver      = 'Rcvr1_2'      # Specifies L-Band receiver for HI
obstype       = 'Spectroscopy' # Specifies spectral line observations
backend       = 'VEGAS'        # Specifies spectral line backend
restfreq      = 1420.4058      # Specifies rest frequency for HI (MHz)
deltafreq     = 0.0            # Specifies offsets for each spectral window (MHz)
bandwidth     = 23.44          # Defined by chosen VEGAS mode (MHz)
nchan         = 32768          # Specifies number of channels in spectral window
vegas.subband = 1              # Specifies single or multiple spectral windows (1 or 8)
swmode        = 'tp'           # Specifies switching mode, switching power with noise diode
swtype        = None           # Specifies frequency switching
swper         = 1.0            # Specifies length of full switching cycle (seconds)
swfreq        = 0, 0           # Specifies frequency offset (MHz)
tint          = 6.0            # Specifies integration time (sec; integer multiple of swper)
vframe        = 'lsrk'         # Specifies velocity reference frame
vdef          = 'Optical'      # Specifies Doppler-shifted velocity frame
noiselevel    = 'lo'           # Specifies level of the noise diode, use 'lo' for 'fsw'
pol           = 'Linear'       # Specifies 'Linear' or 'Circular' polarization
notchfilter   = 'In'           # Specify 'In' to block 1200-1310 MHz RFI signal
'''
```

NOTE: Your parameters may differ based on your specific science goals.

Scripts (Scheduling Blocks)

To find out more about scripts: [GBT Observer's Guide: Section 6.1](#)

Astrid is used to submit scripts, or Scheduling Blocks, for GBT observations. Astrid is Python based and can incorporate custom user scripts. Here is an example of a basic position switched, tracking observation for HI observing.

```

# Observing script for spectral line observations of HI using position switching.

# Reset configuration from prior observation.
ResetConfig()

# Import catalog of flux calibrators and user defined sources.
Catalog(fluxcal)
Catalog('/home/astro-util/projects/quick_guide/catalogs/ps_HI.cat')

# Define configuration parameters
ps_HI_config=''
receiver      = 'Rcvr1_2'
obstype       = 'Spectroscopy'
backend       = 'VEGAS'
restfreq      = 1420.4058
bandwidth     = 23.44
nchan         = 32768
vegas.subband = 1
swmode        = 'tp'
swtype        = None
swfreq        = 0, 0
swper         = 1.0
tint          = 6.0
vframe        = 'lsrk'
vdef          = 'Optical'
noisecal      = 'lo'
pol           = 'Linear'
notchfilter   = 'In'
'''

# Configure telescope.
Configure(ps_HI_config)

# Slew to your source or calibrator.
Slew('3C196')

# Perform position and focus correction on nearby calibrator.
AutoPeakFocus('3C196')

# Slew to your source.
Slew('RSCG31')

# Reconfigure after calibrator corrections.
Configure(ps_HI_config)

# Balance the IF system.
Balance()

# OffOn produces two scans each of the specified duration (in seconds) which tell
the GBT to take data for 10 minutes.
OffOn('RSCG31', Offset('J2000', '-00:05:00', 0.0, cosv=True), 300)
OnOff('RSCG31', Offset('J2000', '00:05:00', 0.0, cosv=True), 300)

# Repeat for second source.
Slew('RSCG64')

Balance()

OffOn('RSCG64', Offset('J2000', '-00:05:00', 0.0, cosv=True), 300)
OnOff('RSCG64', Offset('J2000', '00:05:00', 0.0, cosv=True), 300)

```

Data Reduction

To find out more about data reduction: [GBTIDL User's Guide](#)

Our current data reduction routines are written in IDL. Users can build custom scripts incorporating generic IDL commands. We will run through some common GBT IDL commands below.

From a Green Bank Observatory data reduction machine (Fourier, Arcturus, Planck, Newton, Euclid), log into GBTIDL by typing "gbtidl" from a terminal.

```
bash$ gbtidl
Starting GBTIDL

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Welcome to GBTIDL v2.10.1

For news, documentation, enhancement requests, bug tracking,
discussion, and contributions, visit:

http://gbtidl.nrao.edu

For help with a GBTIDL routine from the command line, use
the procedure 'usage'. For example:

usage,'show'      ; gives the syntax of the procedure 'show'
usage,'show',/verbose ; gives more information on 'show'

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GBTIDL ->
```

To access test the data presented in this reference guide type 'offline' followed by the project name:

```
GBTIDL -> offline, 'TGBT20A_506_01'
```

*Note: 'Connecting to file' tells you where the raw data files are located.
File updated shows how long ago the last scan was updated.*

Note: To view data from a different observing project, replace the (TGBT..) with the information for your project:

- Semester number (e.g., AGBT20A)
- Project number (e.g., 108)
- Session number (e.g., 01)

Note: To access current observations, or see real-time data during an observing session, type 'online' from the command line. The project code is not needed in online mode.

Type 'summary' to view your observations:

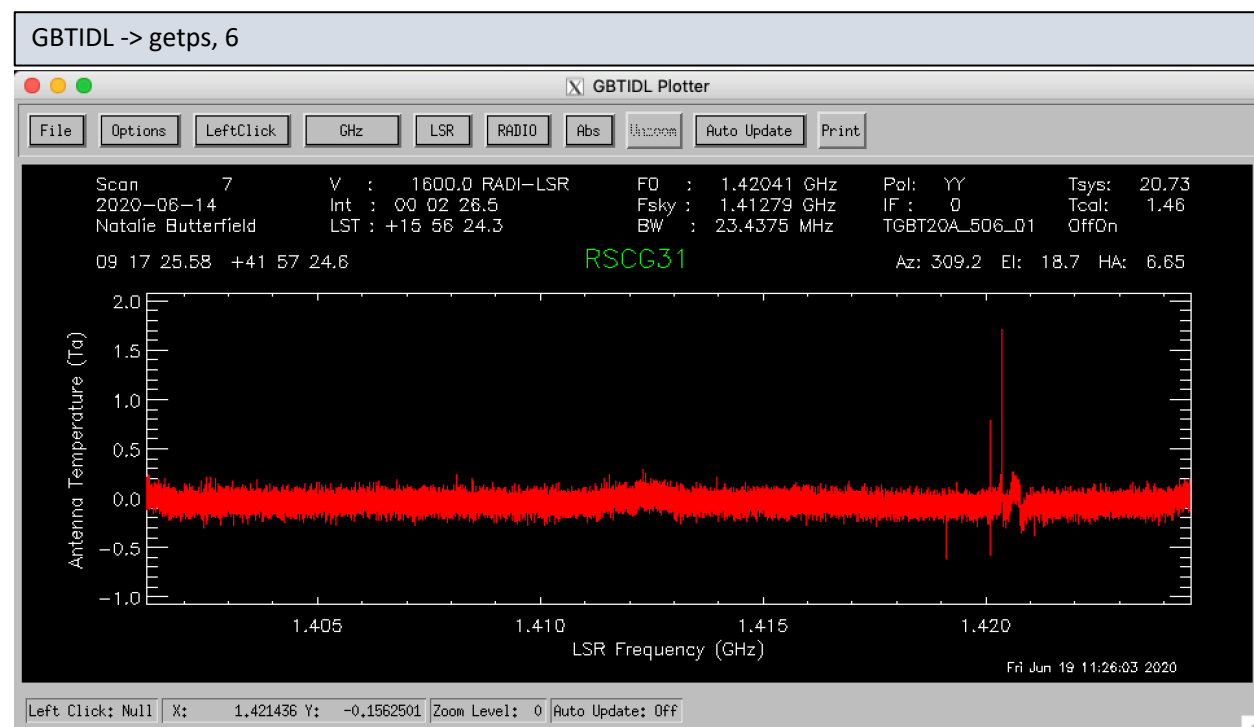
```
GBTIDL -> summary
```

Scan	Source	Vel	Proc	Seq	RestF	nIF	nInt	nFd	Az	El

6	RSCG31	1600.0	OffOn	1	1.420	1	51	1	309.1	18.7
7	RSCG31	1600.0	OffOn	2	1.420	1	51	1	309.2	18.7
8	RSCG31	1600.0	OnOff	1	1.420	1	51	1	309.8	17.9
9	RSCG31	1600.0	OnOff	2	1.420	1	51	1	309.8	17.9
10	RSCG64	4800.0	OffOn	1	1.420	1	51	1	271.2	43.3
11	RSCG64	4800.0	OffOn	2	1.420	1	51	1	271.2	43.2
12	RSCG64	4800.0	OnOff	1	1.420	1	51	1	272.0	42.2
13	RSCG64	4800.0	OnOff	2	1.420	1	51	1	272.1	42.1

Note: For more information on what each column is, please see the GBTIDL User's Guide [GBTIDL User's Guide: Section 4.7](#).

Use the 'getps' command to view your position switched observations.
Include which scan you would like to look at. Here, we will analyze at scan 6.



Note: This will give you the x-axis in frequency and one polarization. If polarization is not specified, the default is 0.

Note: You can then change the x-axis to velocity, using the buttons on the GUI interface. You can do this using the fourth button on the GUI display.

To get the second polarization, you can in turn type:

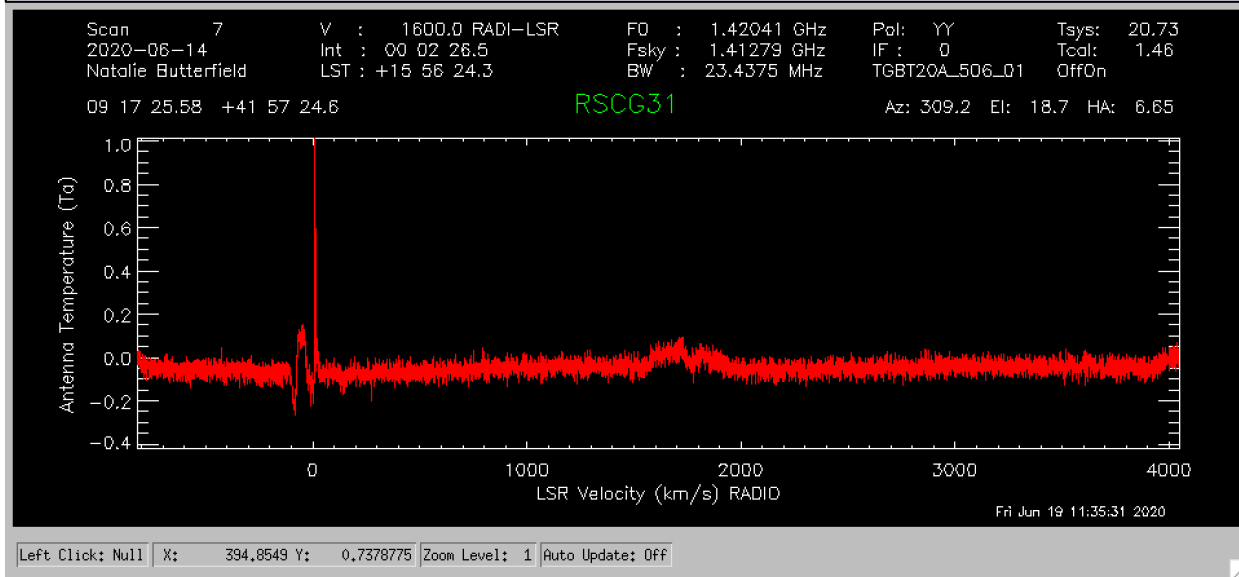
```
GBTIDL -> getps, 6, plnum=1
```

To stack/average multiple scans together to improve signal to noise in the spectrum:

```
GBTIDL -> getps, 6
GBTIDL -> accum
GBTIDL -> getps, 8
GBTIDL -> accum
GBTIDL -> ave
```

To smooth out your spectra, you can use the 'gsmooth' command:

```
GBTIDL -> getps, 6
GBTIDL -> gsmooth, 5
```



You can do all this for the second source as well.

Saving and/or exporting your data can be done in multiple ways. All of these procedures are located in the [GBTIDL User's Guide: Section 9](#).

One example of this is the write_ascii command:

```
GBTIDL -> write_ascii, 'mydata.txt'
ASCII file written:data
```

This will output the data into the currently directory.