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)
```


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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 frequency 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
noisecal    = '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
------------------------------------------------------------------------
                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'
------------------------------------------------------------------------

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_506_01) 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.

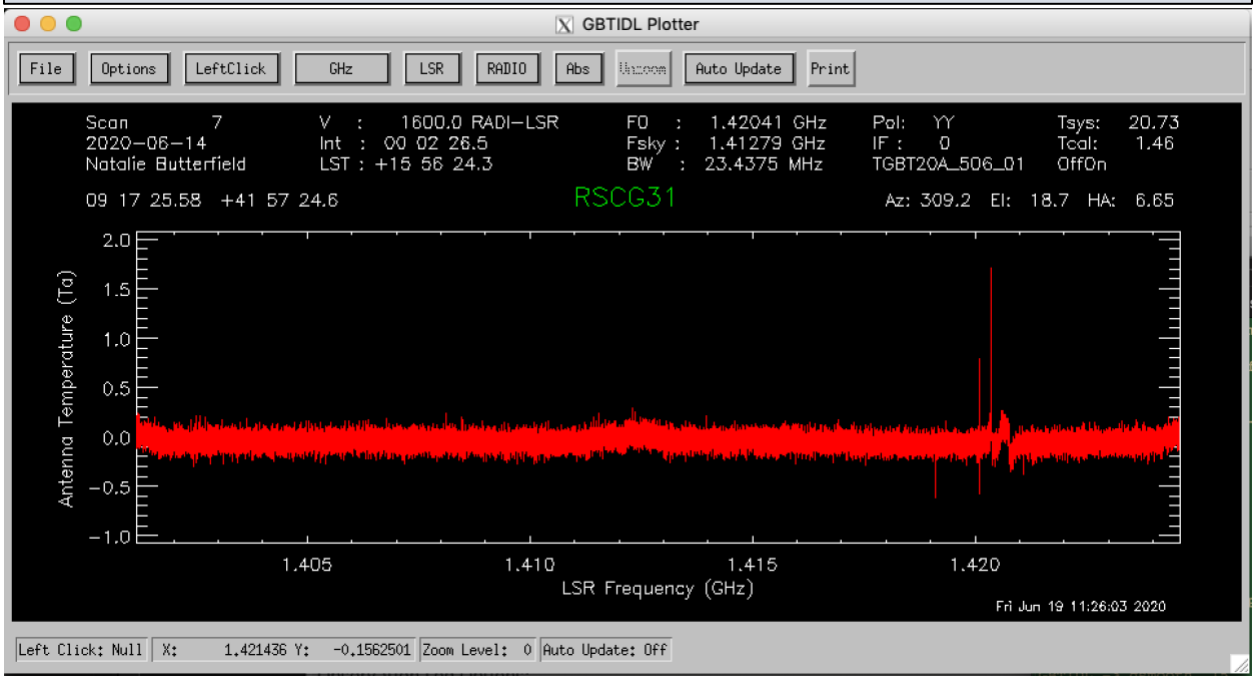
Type ‘summary’ to view your observations:

```
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 scan 6.

```
GBTIDL -> getps, 6
```



Note: You can change the x-axis to the Doppler shifted velocity of the rest frequency (F0) by clicking on the 'GHz' GUI button and selecting 'km/s'.

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

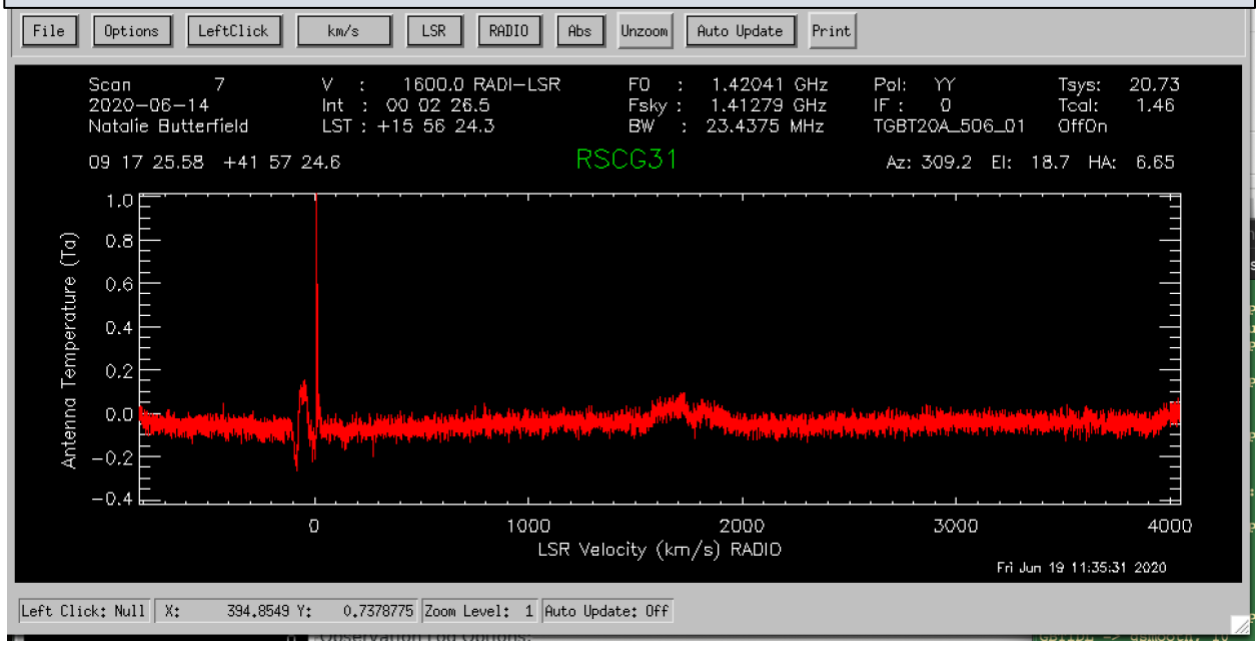
```
GBTIDL -> getps, 6, plnum=1
```

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 by a specific number of channels, you can use the 'gsmooth' command:

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



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

Note: If you have multiple IF tunings, you may view those other IFs by indicating ifnum=0, 1, 2, etc.

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 current directory.