HI Observations with the GBT
Position Switched, Single-Pointing Observations

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

# 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 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 0)
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'
oisecal = '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:

<table>
<thead>
<tr>
<th>Scan</th>
<th>Source</th>
<th>Vel</th>
<th>Proc Seq</th>
<th>RestF</th>
<th>nIF</th>
<th>nInt</th>
<th>nFd</th>
<th>Az</th>
<th>El</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>RSCG31</td>
<td>1600.0</td>
<td>OffOn</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>309.1</td>
<td>18.7</td>
</tr>
<tr>
<td>7</td>
<td>RSCG31</td>
<td>1600.0</td>
<td>OffOn</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>309.2</td>
<td>18.7</td>
</tr>
<tr>
<td>8</td>
<td>RSCG31</td>
<td>1600.0</td>
<td>OnOff</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>309.8</td>
<td>17.9</td>
</tr>
<tr>
<td>9</td>
<td>RSCG31</td>
<td>1600.0</td>
<td>OnOff</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>309.8</td>
<td>17.9</td>
</tr>
<tr>
<td>10</td>
<td>RSCG64</td>
<td>4800.0</td>
<td>OffOn</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>271.2</td>
<td>43.3</td>
</tr>
<tr>
<td>11</td>
<td>RSCG64</td>
<td>4800.0</td>
<td>OffOn</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>271.2</td>
<td>43.2</td>
</tr>
<tr>
<td>12</td>
<td>RSCG64</td>
<td>4800.0</td>
<td>OnOff</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>272.0</td>
<td>42.2</td>
</tr>
<tr>
<td>13</td>
<td>RSCG64</td>
<td>4800.0</td>
<td>OnOff</td>
<td>1.420</td>
<td>1</td>
<td>51</td>
<td>1</td>
<td>272.1</td>
<td>42.1</td>
</tr>
</tbody>
</table>

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
```

![GBTIDL Plotter](image)

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:

```plaintext
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:

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

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:

```plaintext
GBTIDL -> write_ascii, “mydata.txt”
ASCII file written:mydata
```

This will output the data into the current directory.

---

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:

```plaintext
GBTIDL -> write_ascii, “mydata.txt”
ASCII file written:mydata
```

This will output the data into the current directory.