OH Observations with the GBT
Frequency 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 OH using frequency
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/fs_OH.cat')

# Define configuration parameters
fs_OH_config='''
receiver          = 'Rcvr1_2'
obstype           = 'Spectroscopy'
backend           = 'VEGAS'
restfreq          = 1665
bandwidth         = 23.44
nchan             = 32768
vegas.subband     = 1
swmode            = 'sp'
swtype            = 'fsw'
swfreq            = 0, -5.0
swper             = 1.0
tint              = 6.0
vframe            = 'lsrk'
vdef              = 'Optical'
noisecal          = 'lo'
pol               = 'Linear'
notchfilter       = 'In'
'''

# Configure telescope.
Configure(fs_OH_config)

# Slew to your source or calibrator.
Slew('0228+6721')

# Perform position and focus correction on nearby calibrator.
# Leaving the '()' blank will have the system choose your calibrator for you.
AutoPeakFocus('0228+6721')

# Reconfigure after calibrator corrections.
Configure(fs_OH_config)

# Slew to your source.
Slew('W3OH')

# Balance the IF system
Balance()

# Track produces one scan of specified duration (in seconds) which tell the
GBT to take data for 5 minutes.
Track('W3OH', None, 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 OH observing with Equatorial coordinates.

Coordmode = J2000
HEAD = NAME RA DEC VEL
W3OH        02:27:04.10 +61:52:21.80 0.0
0228+6721   02:28:50.05 +67:21:03.03 0.0
```

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

Configurations

To find out more about configurations: GBT Observer's Guide: Section 6.2

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

```
# Configuration parameters for spectral line observations of OH using frequency
switching.
fs_HI_config='''
receiver       = 'Rcvr1_2'      # Specifies L-Band receiver for OH
obstype        = 'Spectroscopy' # Specifies spectral line observations
backend        = 'VEGAS'        # Specifies spectral line backend
restfreq       = 1665           # Specifies rest frequency for OH (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         = 'sp'           # Specifies switching mode, switching power with noise diode
swtype         = 'fsw'          # Specifies frequency switching
swper          = 1.0            # Specifies length of full switching cycle (seconds)
swfreq         = 0, -5.0        # 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 frequency switched, tracking observation for OH observing.

```
# Observing script for spectral line observations of OH using frequency
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/fs_OH.cat')

# Define configuration parameters
fs_OH_config='''
receiver      = 'Rcvr1_2'
obstype       = 'Spectroscopy'
backend       = 'VEGAS'
restfreq      = 1665
bandwidth     = 23.44
nchan         = 32768
vegas.subband = 1
swmode        = 'sp'
swtype        = 'fsw'
swfreq        = 0,  -5.0
swper         = 1.0
tint          = 6.0
vframe        = 'lsrk'
vdef          = 'Optical'
noisecal      = 'lo'
pol           = 'Linear'
notchfilter   = 'In'
'''

# Configure telescope.
Configure(fs_OH_config)

# Slew to your source or calibrator.
Slew('0228+6721')

# Perform position and focus correction on nearby calibrator.
AutoPeakFocus('0228+6721')

# Slew to your source.
Slew('W3OH')

# Reconfigure after calibrator corrections.
Configure(fs_OH_config)

# Balance the IF system.
Balance()

# Track produces one scan of specified duration (in seconds) which tells the GBT
to take data. If you have multiple sources repeat the Slew, Balance, Track
commands. Here we are looking at a single source.

Track('W3OH', None, 60.0)

Track('W3OH', None, 60.0)

Track('W3OH', None, 60.0)
```

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'

------------------------------------------------------------------------
```

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

```
GBTIDL -> offline, ‘TGBT21A_504_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:

- *o Semester number (e.g., AGBT20A)*
- *o Project number (e.g., 108)*
- *o 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.

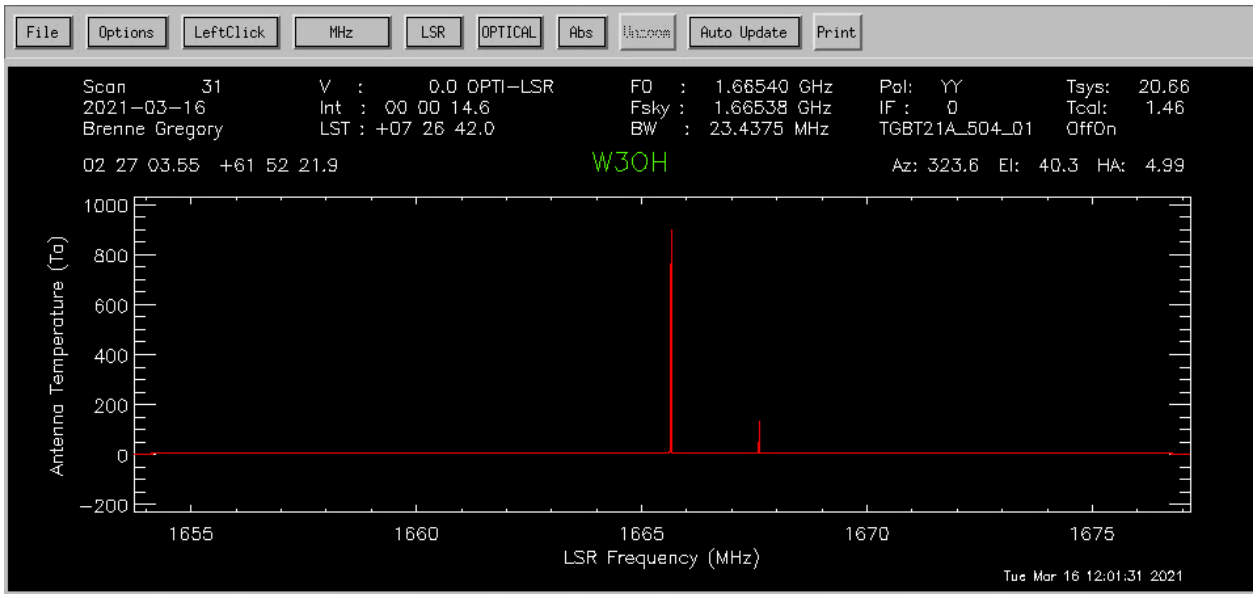
Type ‘summary’ to view your observations:

```
GBTIDL -> summary
Scan  Source  Vel  Proc  Seq  RestF  nIF  nInt  nFd  Az   El
-------------------------------------------------------------
20   W3OH    0      Track 1  1.665   1    11    1  323.4  41.6
21   W3OH    0      Track 2  1.665   1    11    1  323.4  41.5
22   W3OH    0      Track 1  1.665   1    11    1  323.4  41.3
23   W3OH    0      Track 2  1.665   1    6     1  323.4  41.1
24   W3OH    0      Track 1  1.665   1    6     1  323.4  41.0
25   W3OH    0      Track 2  1.665   1    6     1  323.5  41.0
```

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 ‘getfs’ command to view your frequency switched observations. Include which scan you would like to look at. Here, we will analyze scan 24.

```
GBTIDL -> getfs, 24
```



Note: This will give you the x-axis in frequency and one polarization. If polarization is not specified, the default is 0, corresponding to YY polarization for receivers with linear polarization. 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 polarisation, you can type:

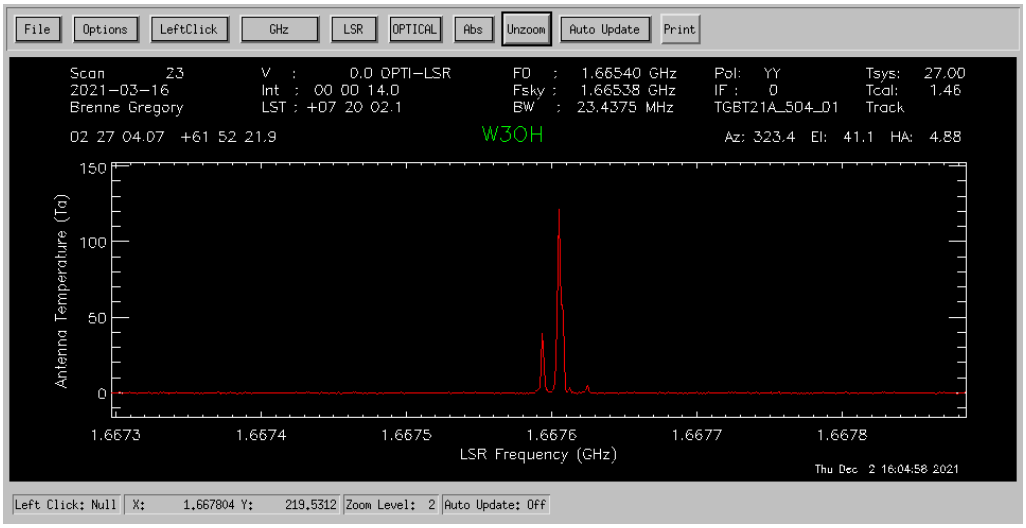
```
GBTIDL -> getfs, 6, plnum=1
```

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

```
GBTIDL -> getfs, 24
GBTIDL -> accum
GBTIDL -> getfs, 25
GBTIDL -> accum
GBTIDL -> ave
```

To zoom in, you can use use the middle mouse button, clicking twice to specify the corners of a zoom box.

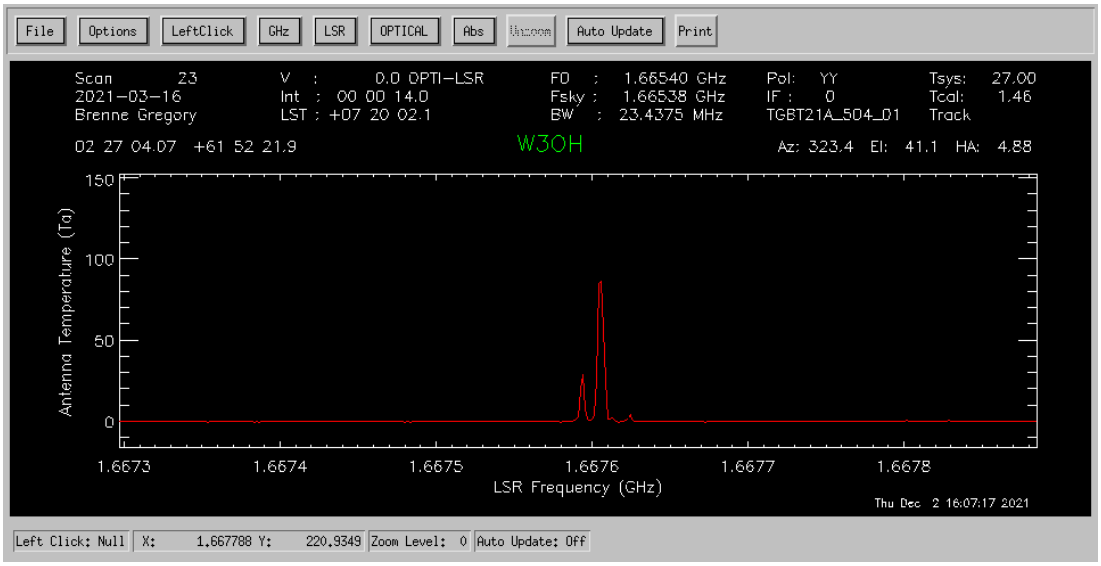
You may also use the ‘setxy’ command, placing a stretchable box on the plot. In order to unzoom, simply type ‘unzoom’ or click the *Unzoom* button on the plotter.



Here we have zoomed in to one of the OH Lines. You can do all this for all of your sources.

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

```
GBTIDL -> getfs, 23
GBTIDL -> gsmooth, 2, /decimate
```



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, 'data'
ASCII file written:data
```

This will output the data into the currently directory.