



Pulsar Observing

2023 Winter Observer Training
Workshop



Some import terms...

- **Astrid:** *Astronomers Integrated Desktop*; Interface for controlling the GBT and monitoring observations
- **Scheduling Block:** A list of observing commands submitted through Astrid
- **Configuration/Config:** A special set of keywords and values that are used to setup the GBT for various types of observations
- **CLEO:** *Control Library for Operators and Engineers*; Useful tools + expert control of all GBT systems
- **Talk & Draw:** A CLEO chat tool

Tabs for different Astrid windows

The screenshot shows the Astrid (ONLINE MONITOR ONLY) interface. At the top, there is a menu bar (File, Edit, View, Tools, Help) and a toolbar. Below the toolbar, there are tabs for "ObservationManagement - 1", "DataDisplay - 1", and "GbtStatus - 1". The main area is divided into several sections:

- Scheduling block edit/run tabs:** Located at the top left, showing "Edit" and "Run" buttons.
- List of scheduling blocks:** A list on the left side of the editor, including "A_easy_start", "A_test_MSPs", "B_config_search" (selected), "C_run_survey", "ionPump", "Lband_RFI_test", "X_350MHz_coherent_cal", "X_350MHz_coherent_search", "X_RFI_test", "X_RRAT_search", and "X_RRAT_search_433".
- Scheduling block editor:** The central area where the configuration for the selected block is edited. It shows a list of parameters for "B_config_search", such as "receiver = 'Rcvr_342'", "testfreq = 350.0,350.0", "obstype = 'Pulsar'", "backend = 'GUPPI'", "pol = 'Linear'", "swmode = 'tp_nocal'", "swtype = 'none'", "noisecal = 'off'", "swper = 0.04", "swfreq = 0.0, 0.0", "nwin = 1", and "deltafreq = 0.0".
- Scheduling block validation:** A panel on the right showing the validation output. It includes a "Validation Output" section with a timestamp and a message: "Your observing script is syntactically correct".
- GBT Status:** A panel on the far right showing the status of the GBT. It includes "Observation State: SB Executing", "GBT State: Running", and "GBT Status: Notice".
- Queue Control:** A panel below the GBT status, containing buttons for "Halt Queue", "Pause", "Stop", "Abort", and "Interactive".
- Observing control:** A large red rectangular area at the bottom, labeled "Observing log and message area".
- Export Log:** A button located at the bottom right of the interface.

At the bottom of the interface, there are tabs for "ObservationManagement Log - 1", "DataDisplay Log - 1", "GbtStatus Log - 1", and "Command Console".

Astrid (ONLINE MONITOR ONLY)

File Edit View Tools Help

ObservationManagement - 1

DataDisplay - 1

GbtStatus - 1

Edit

Run

Project:

AGBT14A_507

Session:

183

Observer:

Ryan Lynch

Operator:

Rob Whalen

Available Scheduling Blocks:

Scheduling Block	Last Modified
A_easy_start	2015-05-11 17:55:56
A_test_MSPs	2015-05-14 00:00:23
B_config_search	2015-05-12 18:31:26
C_run_survey	2015-05-14 00:00:37
ionPump	2014-02-28 15:47:47
X_350MHz_coherent_cal	2014-02-28 15:49:02
X_350MHz_coherent_search	2014-02-28 15:49:56
X_RFI_test	2014-05-03 17:12:29
X_RRAT_search	2014-02-28 15:50:52
X_RRAT_search 433	2014-02-28 15:51:31

Submit

Session History:

Run Queue:

Move Up

Move Down

Remove

Observation Log Options:

☒ Comment

☐ Trace

☐ Sounds

Export Log

ObservationManagement Log - 1

DataDisplay Log - 1

GbtStatus Log - 1

Command Console

Observation State:

Idle

GBT State:

Ready

GBT Status:

Fault

Queue Control:

Halt Queue

Observation Control:

Pause

Stop

Abort

Interactive

Session Info (Editable)

The screenshot displays the Astrid (ONLINE MONITOR ONLY) interface. At the top, a menu bar includes File, Edit, View, Tools, and Help. Below the menu, there are tabs for ObservationManagement - 1, DataDisplay - 1, and GbtStatus - 1. The main area is divided into several sections:

- Session Info (Editable):** This section includes fields for Project (AGBT14A_507), Session (183), Observer (Ryan Lynch), and Operator (Rob Whalen). Arrows from the label point to these fields.
- Available Scheduling Blocks:** A table listing various scheduling blocks and their last modified times. This section is circled in red.
- Session History:** A section for viewing session history, also circled in red.
- Run Queue:** A section for managing the run queue, circled in red.
- Observation State:** A panel on the right showing the current state of the observation, including Idle, Ready, and Fault (highlighted in orange).
- Queue Control:** A panel on the right with buttons for Halt Queue, Pause, Stop, Abort, and Interactive.
- Observation Control:** A panel on the right with buttons for Pause, Stop, Abort, and Interactive.
- List of scheduling blocks:** A section at the bottom left, circled in red, containing a list of scheduling blocks and their last modified times.

The bottom of the interface features a status bar with tabs for ObservationManagement Log - 1, DataDisplay Log - 1, GbtStatus Log - 1, and Command Console.

Scheduling Block	Last Modified
A_easy_start	2015-05-11 17:55:56
A_test_MSPs	2015-05-14 00:00:23
P_config_search	2015-05-12 18:31:26
C_run_survey	2015-05-14 00:00:37
ionPump	2014-02-28 15:47:47
X_350MHz_coherent_cal	2014-02-28 15:49:02
X_350MHz_coherent_search	2014-02-28 15:49:56
X_RFI_test	2014-05-03 17:12:29
X_RRAT_search	2014-02-28 15:50:52
X_RRAT_search_433	2014-02-28 15:51:31

Astrid (ONLINE MONITOR ONLY)

File Edit View Tools Help

ObservationManagement - 1DataDisplay - 1GbtStatus - 1

Observer:	unknown	Last Update:	2015-05-20 15:50:19
Project ID:	AGBT14B_342_29	UTC Date:	2015/05/20
Status:	Fault	UTC Time:	19:50:19
LST:	06:23:33	MJD:	57162.8266152
Az commanded (deg):	162.652	EI commanded (deg):	25.808
Az actual (deg):	162.6524	EI actual (deg):	25.8079
Az error (arcsec):	-0.631	EI error (arcsec):	-0.758
Coordinate Mode:	J2000	Antenna State:	Tracking
Major Coord:	07:31:06 (RA)	Minor Coord:	-23:41:47 (Dec)
Major Cmd Coord:	07:31:06 (RA)	Minor Cmd Coord:	-23:41:47 (Dec)
LPCs Az/XEI/EI ("):	(0.000 0.000 0.000)	LFCs (XYZ mm):	(0.00 0.00 0.00)
DC Az/XEI/EI ("):	(0.000 -6.727 11.441)	LFCs (XYZ deg):	(0.00 0.00 0.00)
AS FEM Model:	On	DC Focus Y (mm):	-2.322169312
AS Zernike Model:	On	AS offsets:	On
AS Zernike Thrm Mdl:	Off		

Observation State:

SB Executing

GBT State:

Ready

GBT Status:

Fault

Queue Control:

Halt Queue

Observation Control:

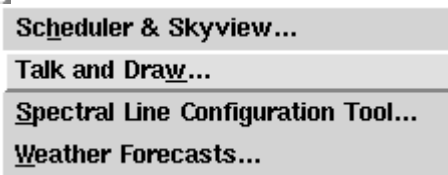
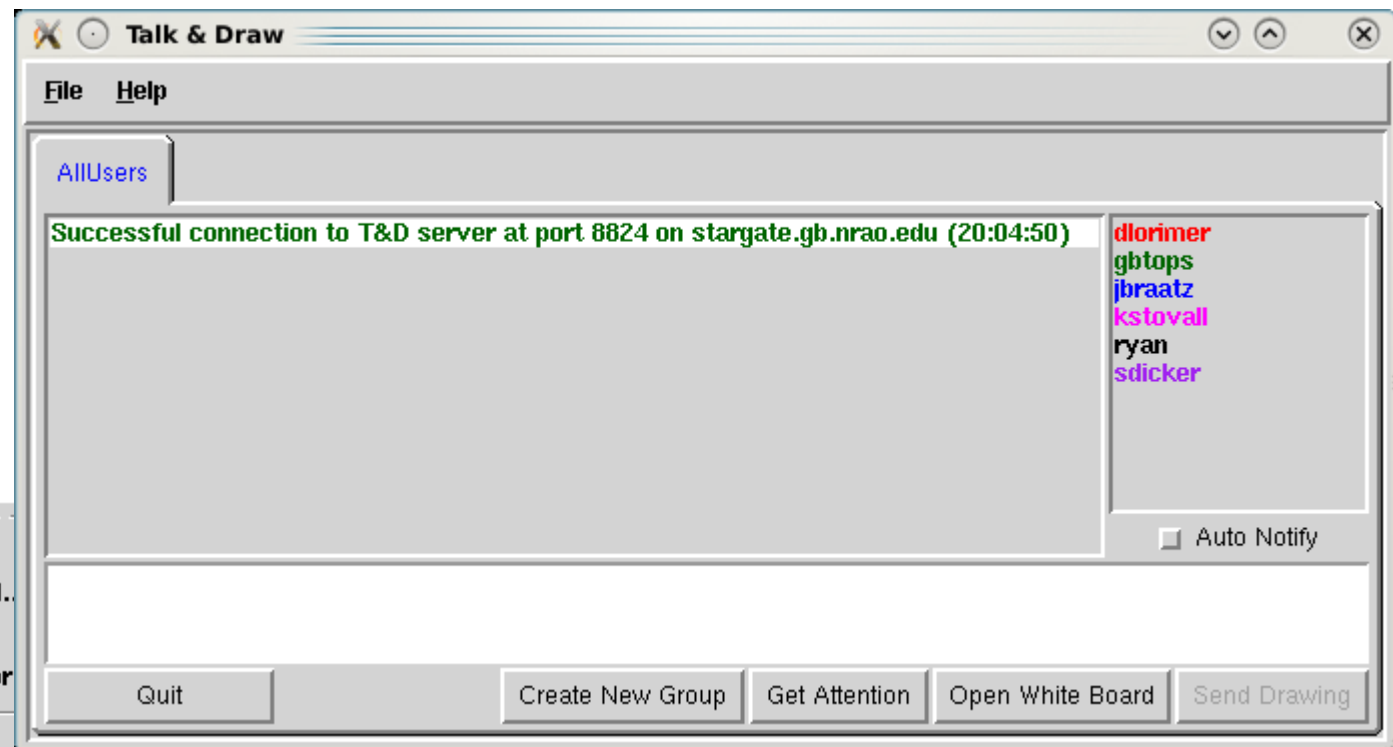
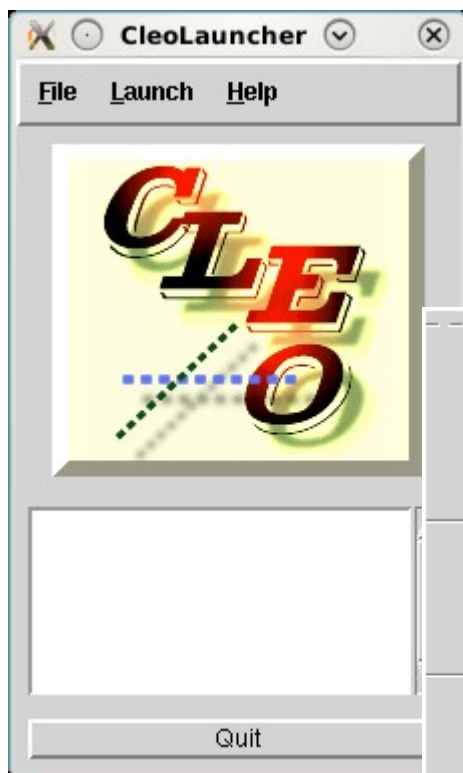
Pause

Stop

Abort

Interactive

ObservationManagement Log - 1DataDisplay Log - 1GbtStatus Log - 1Command Console



- Key parts of scheduling block are
 - Catalog(<catalog>): Loads a list of sources
 - Slew(source): Moves the telescope to a source
 - config: Defines backend and IF/LO parameters
 - Configure(config): Executes config instructions
 - Balance: Adjusts power levels to optimal range
 - Observing Directive
- There are *lots* of Astrid commands, and you can use python to make fairly complicated scripts
 - When in doubt, try Catalog(pulsars_all_GBT)
 - Note that this catalog may not be up-to-date with the brand new pulsars
- Let's look at the config portion more carefully...

Catalogs

- Simple text files that specify source name, coordinates, and coordinate system
- Used in Astrid similar to Python dictionaries
- Users can specify custom fields and access them in Astrid to build more sophisticated scripts

head=name	ra	dec
0034+69	00:33:13.03200000	+69:43:45.4800000
0510+38	05:09:31.78854365	+38:01:18.0575238
0636+51	06:36:04.84542630	+51:28:59.9831111
0742+66	07:40:45.79660905	+66:20:33.5892639
1124+78	11:25:59.83760878	+78:19:48.7496278
1649+80	16:41:20.84202477	+80:49:52.9304759
1816+45	18:16:35.93390826	+45:10:33.8680587
1939+66	19:38:56.91758504	+66:04:31.7513018
1309-23	13:09:27.42463533	-23:33:25.1647258

I

```

format=spherical
coordmode=J2000
head = name  jname      alias      ra          dec          S1400_Jy
# Flux calibration sources from PSRCHIVE fluxcal.cfg
1413+1509    J1413+1509    1413+15    14:13:41.660 +15:09:39.524 0.525662
3C48         J0137+3309    0137+33    01:37:41.300 +33:09:35.13  16.2554
3C123        J0437+2940    0437+29    04:37:04.375 +29:40:13.82  48.3292
J0444-2809   J0444-2809    0444-28    04:44:37.708 -28:09:54.403 6.88461
J0519-4546   J0519-4546    PicA       05:19:49.723 -45:46:43.855 67.1838
3C138        J0521+1638    0521+16    05:21:09.900 +16:38:22.12  8.56402
3C147        J0542+4951    0542+49    05:42:36.127 +49:51:07.23  22.1705
3C196        J0813+4813    0813+48    08:13:36.056 +48:13:02.64  14.4286
3C218        J0918-1205    HyDA       09:18:05.669 -12:05:43.95  44.0132
3C274        J1230+1223    M87        12:30:49.423 +12:23:28.04  212.310
3C286        J1331+3030    1331+30    13:31:08.284 +30:30:32.94  15.0838
3C295        J1411+5212    1411+52    14:11:20.647 +52:12:09.04  22.4993
3C348        J1651+0459    HerA       16:51:08.024 +04:59:34.91  47.6466
3C353        J1720-0058    1720-00    17:20:28.150 -00:58:46.80  57.4059
3C380        J1829+4844    1829+48    18:29:31.781 +48:44:46.159 13.142
3C405        J1959+4044    CygA       19:59:28.357 +40:44:02.097 1579.96
3C444        J22214-1701   2214-17    22:14:25.752 -17:01:36.290 9.07134
3C190        J0801+1414    0801+14    08:01:33.52  +14:14:42.2  2.46364
1445+0958    J1445+0958    1442+101   14:45:16.440 +09:58:35.040 2.35757
3C43         J0129+2338    0129+23    01:29:59.79  +23:38:19.4  2.83034
3C394        J1859+1259    1859+129   18:59:23.3   +12:59:12    2.88127
B2209+080    J2212+0819    2212+08    22:12:01.5685 +08:19:15.5868 1.70936
NGC7027      J2107+4214    2107+42    21:07:01.530 +42:14:11.500 1.43339

```

receiver = 'Rcvr1_2'
restfreq = 1500.0
obstype = 'Pulsar'
backend = 'VEGAS'
pol = 'Linear'
swmode = 'tp_nocal'
swtype = 'none'
noisecal = 'off'
swper = 0.04
swfreq = 0.0
nwin = 1
deltafreq = 0
ifbw = 0
bandwidth = 800
tint = 81.92e-6
vlow = 0
vhigh = 0
vframe = 'topo'
vdef = 'Radio'

vegas.obsmode = 'search'
vegas.numchan = 2048
vegas.polnmode = 'full_stokes'
vegas.scale = 10000
vegas.outbits = 8
vegas.fold_dumptime = 10
vegas.fold_bins = 256
vegas.fold_parfile = "/users/rlynch/myparfile.par"
vegas.dm = 50

- swmode: Switching mode ('tp' or 'tp_nocal')
- swtype: Only used for frequency switching
- noisecal: Controls noise diode ('lo' or 'hi' or 'off')
- swper: Switching period (always 0.04 [25 Hz] for pulsar observing)
- swfreq : Only used for frequency switching
- nwin: Number of spectral windows (only needs to be specified when using certain syntax)
- deltafreq: Offset of spectral windows (always 0 for pulsar observing)
- ifbw: BW of filter in IF rack (80 for 100 MHz total bandwidth, otherwise 0)

- vegas.obsmode
 - fold, cal, search, coherent_{fold,cal,search}
- vegas.numchan
 - 2^n , $n = 6 \dots 11$ (64...4096 [8192])
 - Max depends on bandwidth
- vegas.polnmode
 - full_stokes or total_intensity
- vegas.scale
 - Varies with setup, but fairly stable
- vegas.outbits
 - Always 8

- `vegas.fold_dumptime`
 - Typically 10
- `vegas.fold_bins`
 - Typically 256, higher for coherent modes
- `vegas.fold_parfile`
 - Always make sure this is correct!!
- `vegas.dm = 50`
 - Specific to `coherent_search`

A word on tint

$$\text{tint} = \text{acc_len} * \text{vegas.numchan} / \text{bandwidth}$$

- acc_len is a hardware parameter not directly set by the user
 - acc_len > 4 for 100 and 200 MHz modes
 - acc_len > 16 for 800 MHz mode
 - acc_len < 100 recommended

Configuring and Balancing

- To configure the telescope, use the Configure command
 - Argument is the configuration string defined above
 - `Configure(config_vegas)`
- The Balance() command adjust amplifier and attenuators throughout signal path
 - Good idea to balance when changing sources
 - But do **NOT** balance between pulsar calibration scan and main science scan

- How do we calibrate pulsar data?
 - Raw data are recorded in units of “counts”, which change depending on how the system is balanced
 - We want physical units (Jansky)
- 1) Observe a standard source of known flux density
- 2) Use this to measure the strength of the GBT noise diode
- 3) Balance the system at the position of the pulsar and observe the noise diode
- 4) Observe the pulsar **without rebalancing**, and use the noise diode to calibrate the pulsar data
- Note: You *can* (and should) balance between flux calibrator observation and other scans

Observing Directive

- Pulsar observers almost always will use the Track command to take data
- Standard arguments are
Track(<source name>, None, <scan length>)
 - The None argument could be replaced with a position offset at which to end the scan, but we never use this

- Write a simple observing script to observe B1937+21 in search mode for 30 minutes
 - 2048 channels, 40.96 us time resolution, total intensity, 800 MHz bandwidth
 - L-Band receiver
 - Center frequency of 1500 MHz
- Ask yourself
 - How will Astrid know the location of the source?
 - How do things need to be configured?
 - Is the system balanced?
 - How do I tell Astrid to start taking data?
- You may reference

https://safe.nrao.edu/wiki/bin/view/CICADA/VegasPulsarObservingInstructions#Example_Configurations

Catalog(<path on disk>)

config_string = ""

receiver = 'Rcvr1_2'

...

""

Configure(config_string)

Slew(<source name>)

Balance()

Track(<source name>, None, 1800)

- Scheduling blocks use Python!

```
sources = ["B1937+21", "J1713+0747"]  
for src in sources:  
    Slew(src)  
    Balance()  
    Track(src, None, 20*60)
```



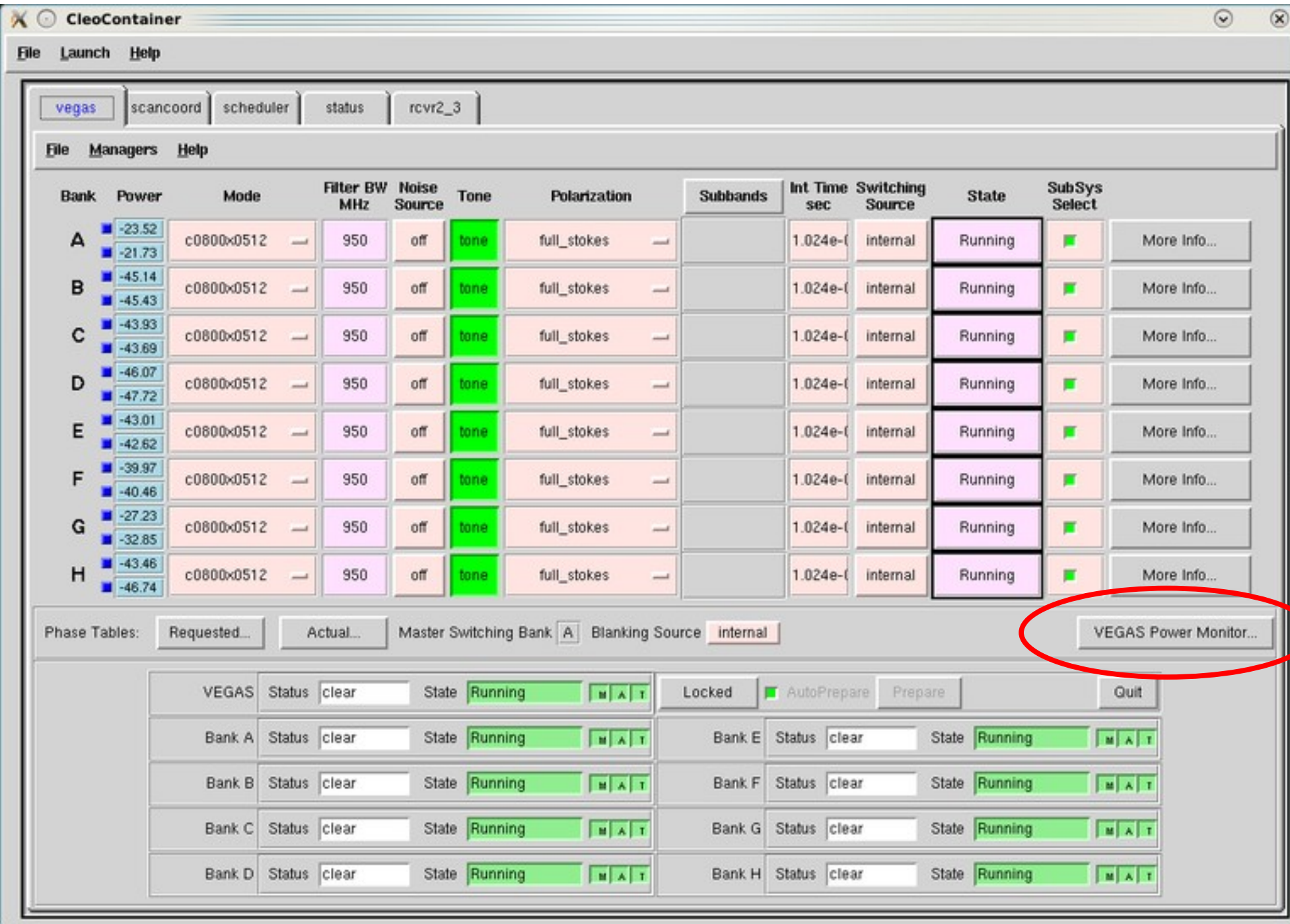
```
for src in sources:
    config = """
    ...
    vegas.fold_parfile = "/home/gpu/tzpar/{src}.par"
    """.format(src=src)
```

```
srcdict = {
    "B1937+21": {"DM": 50, "parfile": "mypar"},
    "J1713+0747": {"DM": 100, "parfile": "mypar2"}}
for src in srcdict:
    config = """
    ...
    vegas.fold_parfile = {parfile}
    """.format(parfile=src["parfile"])
```

- Astrid has a number of useful convenience functions and options
 - Track() can take startTime and stopTime instead of scan length
 - Horizon() objects can be used to define times based on a source's elevation (.e.g., start observing when a source rises or stop when it sets)
 - OnOff() is useful for flux calibration scans
 - Observe an On source and Off source position automatically
 - AutoPeakFocus() necessary at high frequencies (roughly C-band and above) and for UWBR

- `Track(src, None, 3600)`
- `Track(src, None, 3600, startTime="15:15:00")`
- `Track(src, None, startTime="15:15:00", stopTime="16:15:00")`
- `myhorizon = Horizon(6.0)`
 - `Track(src, None, stopTime=myhorizon)`
 - `Track(src, None, startTime="15:15:00", stopTime=myhorizon)`
- `OnOff("3C48", Offset(0,1,cosv=False), 90)`

- VEGAS is controlled through the GBT but there are standalone tools used to monitor observations
- Some are always used, some are specific to coherent and incoherent modes





VEGAS

FileManagersHelp

VEGAS

A-HI-PQ-XMisc

Observing Mode

hbw

Dedispersion Mode

Dispersion Measure

0.00000

of Bits

8

of Profile Bins

2048

Sub-Int. Dump Time

10.0

Blanking Source

internal

Switching Master

VEGAS

Master Sw. Bank

BANKA

Requested Phases ...

Actual Phases ...

Data Monitor ...

More Info ...

A

Ready

B

Ready

C

Off

D

Off

E

Off

F

Off

G

Off

H

Off

I

Off

J

Off

K

Off

L

Off

M

Off

N

Off

O

Off

P

Off

Q

Off

R

Off

S

Off

T

Off

U

Off

V

Off

W

Off

X

Off

Locked

☐ Auto Prepare

Prepare

VEGAS Status

clear

State







Ready

M

A

T

VEGAS A-H I-P Q-X Misc

Bank	Power	Roach	Mode	Filter BW MHz	Polar	Nchan	Sampling Time	Center Frequency	State	SubSys Select	Sub Bands	More Info
I		vegasr2-1-10-6	c1500x1024uwb	1400	self	1024	.6666666666e-07	1225.0	Off	<input type="checkbox"/>	Sub	More
J		vegasr2-1-10-7	c1500x1024uwb	1400	self	1024	.6666666666e-07	1225.0	Off	<input type="checkbox"/>	Sub	More
K		vegasr2-2-10-1	c1500x1024uwb	1400	self	1024	.6666666666e-07	2350.0	Off	<input type="checkbox"/>	Sub	More
L		vegasr2-2-10-2	c1500x1024uwb	1400	self	1024	.6666666666e-07	2350.0	Off	<input type="checkbox"/>	Sub	More
M		vegasr2-2-10-3	c1500x1024uwb	1400	self	1024	.6666666666e-07	2350.0	Off	<input type="checkbox"/>	Sub	More
N		vegasr2-2-10-4	c1500x1024uwb	1400	self	1024	.6666666666e-07	2350.0	Off	<input type="checkbox"/>	Sub	More
O		vegasr2-2-10-5	c1500x1024uwb	1400	self	1024	.6666666666e-07	2350.0	Off	<input type="checkbox"/>	Sub	More
P		vegasr2-2-10-6	c1500x1024uwb	1400	self	1024	.6666666666e-07	2350.0	Off	<input type="checkbox"/>	Sub	More

BankIMgr Status	clear	State	Off	M A T	BankMMgr Status	clear	State	Off	M A T
BankJMgr Status	clear	State	Off	M A T	BankNMgr Status	clear	State	Off	M A T
BankKMgr Status	clear	State	Off	M A T	BankOMgr Status	clear	State	Off	M A T
BankLMgr Status	clear	State	Off	M A T	BankPMgr Status	clear	State	Off	M A T

The screenshot shows a terminal window titled 'vegas status' with a menu bar (File, Edit, View, Scrollback, Bookmarks, Settings, Help). The main content is divided into two sections: 'HPC Node Status' and 'Manager Logs'.

HPC Node Status:

node	OBSFREQ	NETSTAT	DISPSTAT	CURBLOCK	DROPTOT
vegas-hpc1:	1850.78	exiting	exiting	3	0
vegas-hpc2:	1750.78	exiting	exiting	7	0
vegas-hpc3:	1650.78	exiting	exiting	7	0
vegas-hpc4:	1550.78	exiting	exiting	7	0
vegas-hpc5:	1450.78	exiting	exiting	7	0
vegas-hpc6:	1350.78	exiting	exiting	7	0
vegas-hpc7:	1250.78	exiting	exiting	7	0
vegas-hpc8:	1150.78	exiting	exiting	7	0

Manager Logs:

```
vegas-hpc1: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc2: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc3: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc4: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc5: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc6: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc7: Wrote subint 3 (total time 30.7s)
             Wrote subint 4 (total time 41.0s)

vegas-hpc8: Wrote subint 4 (total time 41.0s)
             Wrote subint 5 (total time 51.2s)
```

Last update: Fri Feb 16 03:53:21 2018 - Press 'q' to quit

The terminal window has a taskbar at the bottom with icons for 'titania', 'vegas status' (active), 'guppi status', 'beef', and 'euclid'.

- Launched by typing
vpmHPCStatus

The screenshot shows a terminal window titled "vpmHPCStatus" with a menu bar (Menu, edit, View, Scrollback, Bookmarks, Settings, Help). The main content is divided into two sections: "HPC Node Status:" and "Manager Logs:". The node status section is a table with 6 columns: node, OBSFREQ, NETSTAT, DISPSTAT, CURBLOCK, and DROPTOT. It lists 8 nodes (vegashpc1 to vegashpc8). Nodes 3 and 4 are active, showing receiving and processing states. Nodes 5, 6, 7, and 8 are inactive. The manager logs section shows messages for each node, indicating that nodes 3 and 4 have written subintents, while the others are not in use. At the bottom, it says "Last update: Sun Jun 2 03:34:09 2019 - Press 'q' to quit".

```
HPC Node Status:
node      OBSFREQ    NETSTAT    DISPSTAT    CURBLOCK    DROPTOT
vegashpc1:      N/A        N/A        N/A        N/A        N/A
vegashpc2:      N/A        N/A        N/A        N/A        N/A
vegashpc3:  870.78125  receiving  processing    1  0.00629097
vegashpc4:  770.78125  receiving  processing    2  0.00565464
vegashpc5:      N/A        N/A        N/A        N/A        N/A
vegashpc6:      N/A        N/A        N/A        N/A        N/A
vegashpc7:      N/A        N/A        N/A        N/A        N/A
vegashpc8:      N/A        N/A        N/A        N/A        N/A

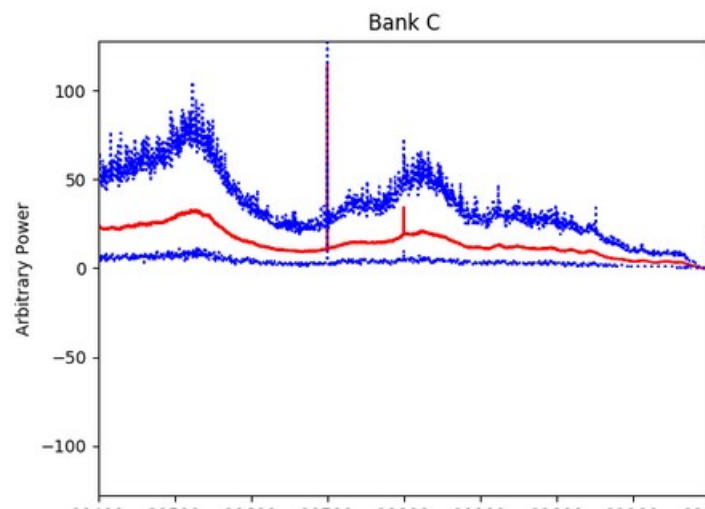
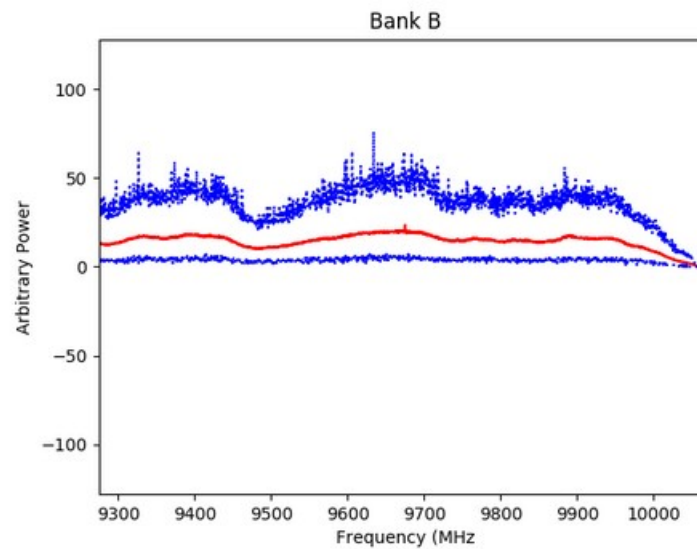
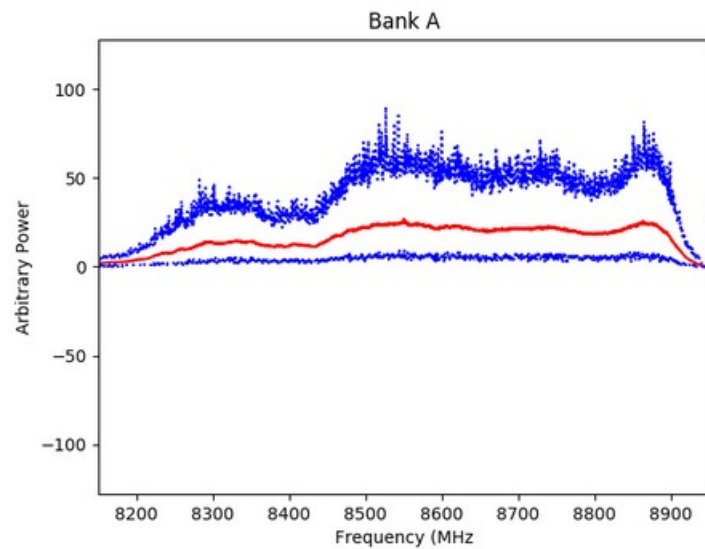
Manager Logs:
vegashpc1: This bank is not currently in use
vegashpc2: This bank is not currently in use
vegashpc3: Wrote subint 6 (total time 59.8s)
           Wrote subint 7 (total time 69.9s)

vegashpc4: Wrote subint 7 (total time 69.9s)
           Wrote subint 8 (total time 80.0s)

vegashpc5: This bank is not currently in use
vegashpc6: This bank is not currently in use
vegashpc7: This bank is not currently in use
vegashpc8: This bank is not currently in use

Last update: Sun Jun 2 03:34:09 2019 - Press 'q' to quit
```

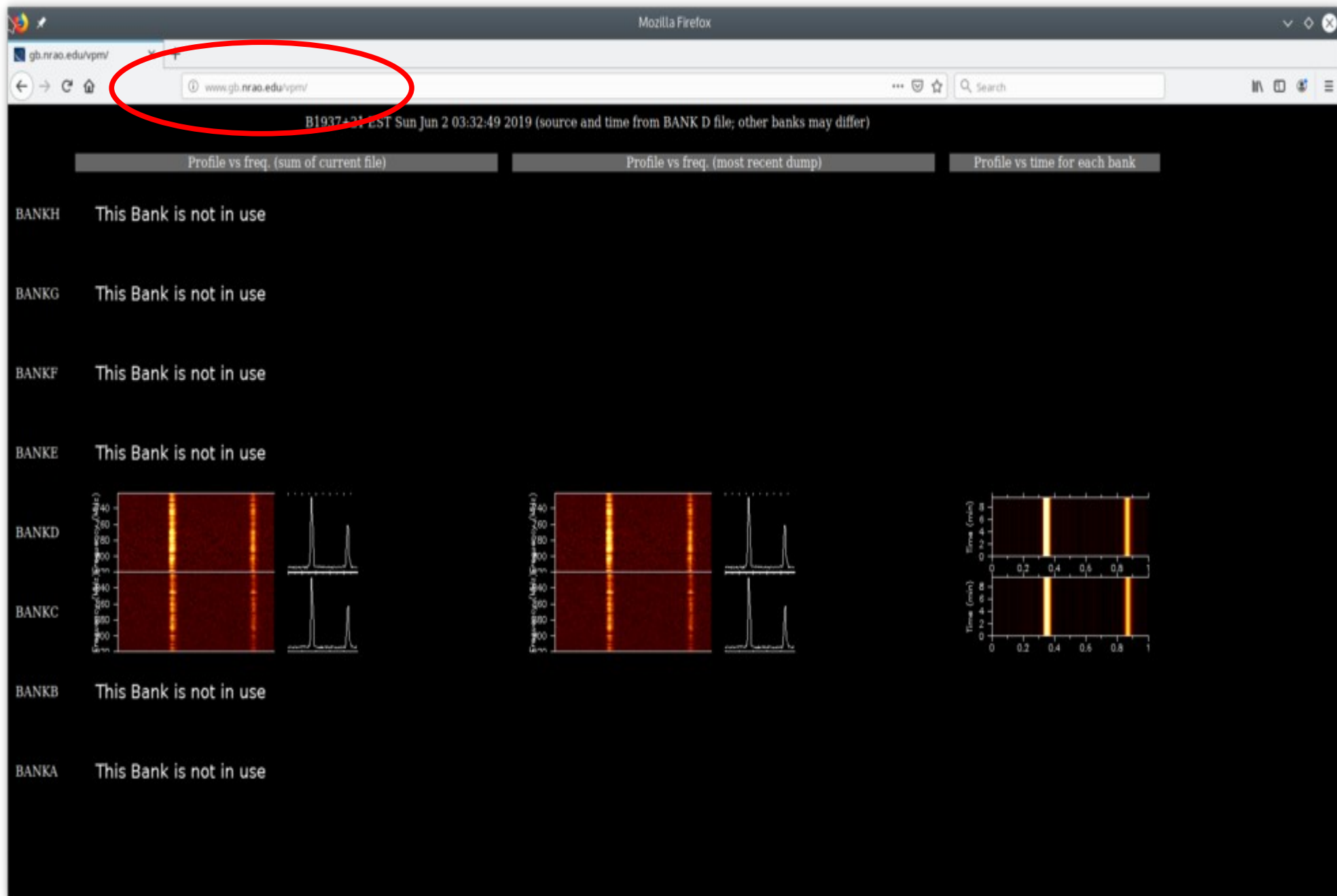
- Launched by typing `vpmHPCStatus`



Bank D

VEGAS is not currently configured for pulsar mode

www.gb.nrao.edu/vpm/vpm_monitor



www.gb.nrao.edu/vpm