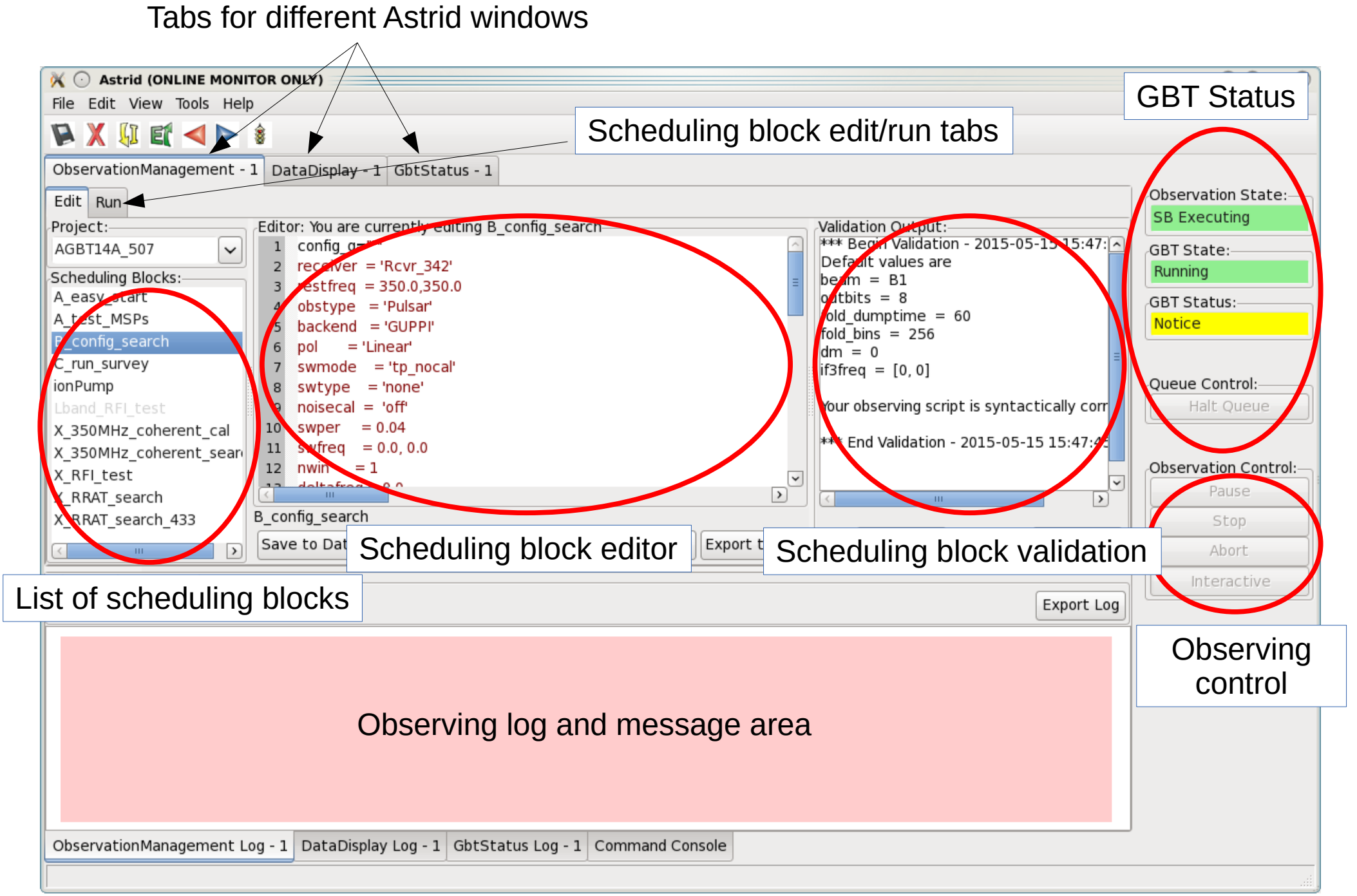
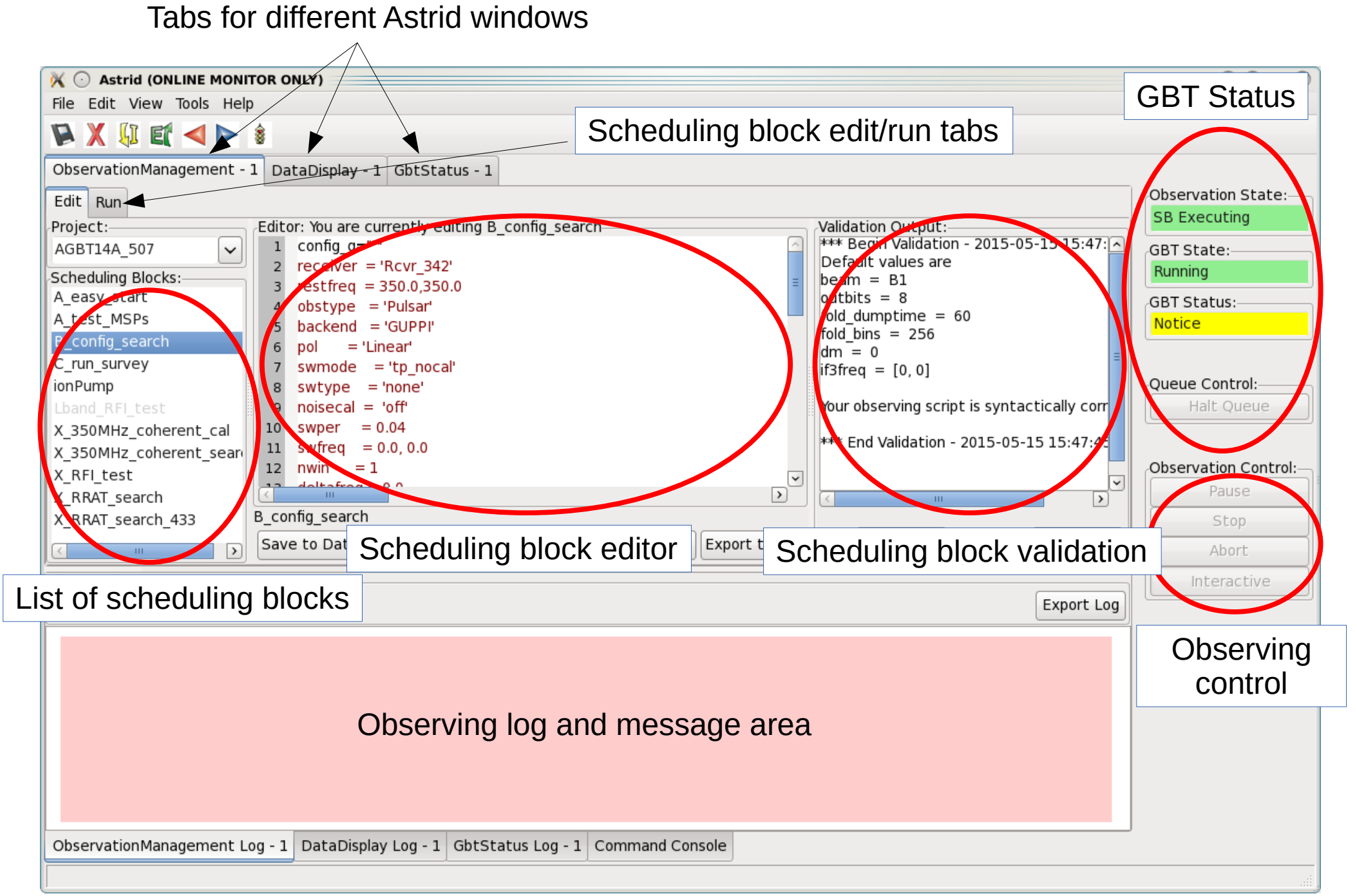
Observing with the Green Bank Telescope

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
Astrid (ONLINE MONITOR ONLY)
File Edit View Tools Help
ObservationManagement - 1
DataDisplay - 1
GbtStatus - 1
Scheduling block edit/run tabs
GBT Status
Edit
Run
Project:
AGBT14A_507
Scheduling Blocks:
A_easy_start
A_test_MSPs
B_config_search
C_run_survey
ionPump
Lband_RFI_test
X_350MHz_coherent_cal
X_350MHz_coherent_sear
X_RFI_test
X_RRAT_search
X_RRAT_search_433
Editor: You are currently editing B_config_search
config_g="
receiver = 'Rcvr_342'
restfreq = 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
B_config_search
Save to Dat
Export t
Validation Output:
*** Begin Validation - 2015-05-15 15:47:
Default values are
beam = B1
outbits = 8
fold_dumptime = 60
fold_bins = 256
dm = 0
if3freq = [0, 0]
Your observing script is syntactically corr
*** End Validation - 2015-05-15 15:47:4
Scheduling block editor
Scheduling block validation
List of scheduling blocks
Observation State:
SB Executing
GBT State:
Running
GBT Status:
Notice
Queue Control:
Halt Queue
Observation Control:
Pause
Stop
Abort
Interactive
Observing control
Export Log
Observing log and message area
ObservationManagement Log - 1
DataDisplay Log - 1
GbtStatus Log - 1
Command Console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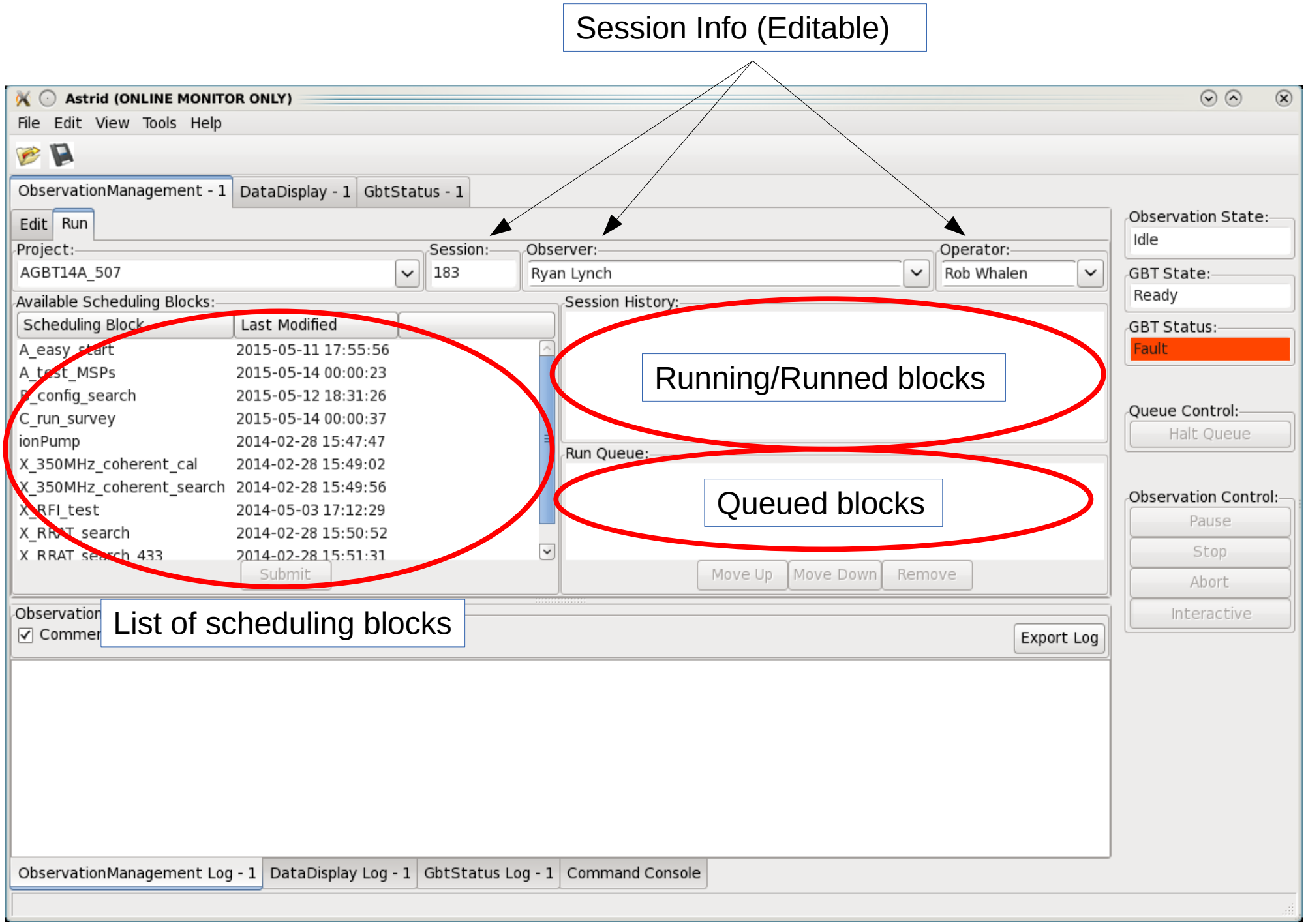
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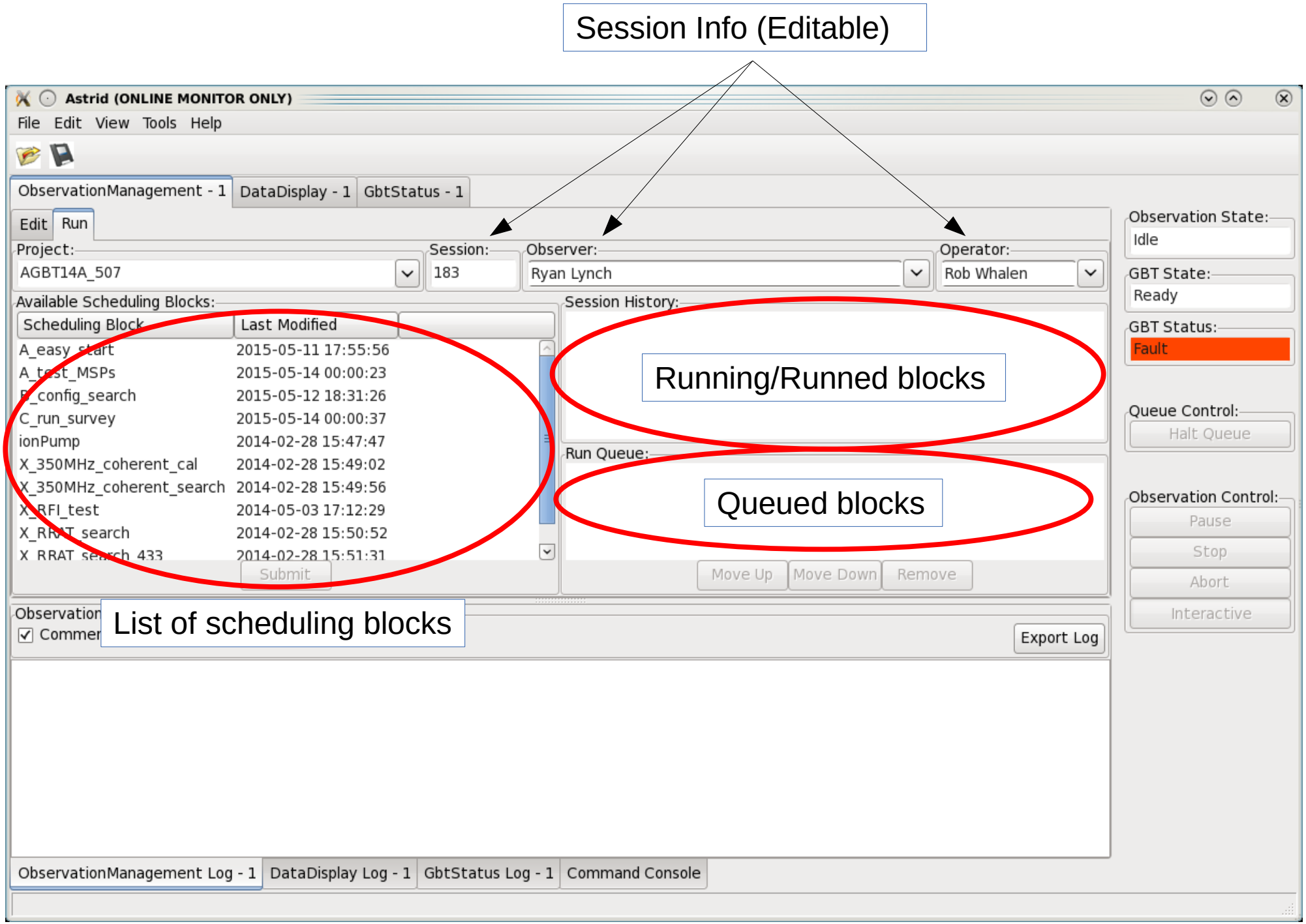
Astrid (ONLINE MONITOR ONLY)
File Edit View Tools Help
ObservationManagement - 1
DataDisplay - 1
GbtStatus - 1
Edit
Run
Project:
AGBT14A_507
Session:
183
Observer:
Ryan Lynch
Operator:
Rob Whalen
Available Scheduling Blocks:
Scheduling Block
Last Modified
A_easy_start 2015-05-11 17:55:56
A_test_MSPs 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:
Running/Runned blocks
Run Queue:
Queued blocks
Move Up
Move Down
Remove
List of scheduling blocks
Observation
Commer
Export Log
Observation State:
Idle
GBT State:
Ready
GBT Status:
Fault
Queue Control:
Halt Queue
Observation Control:
Pause
Stop
Abort
Interactive
ObservationManagement Log - 1
DataDisplay Log - 1
GbtStatus Log - 1
Command Console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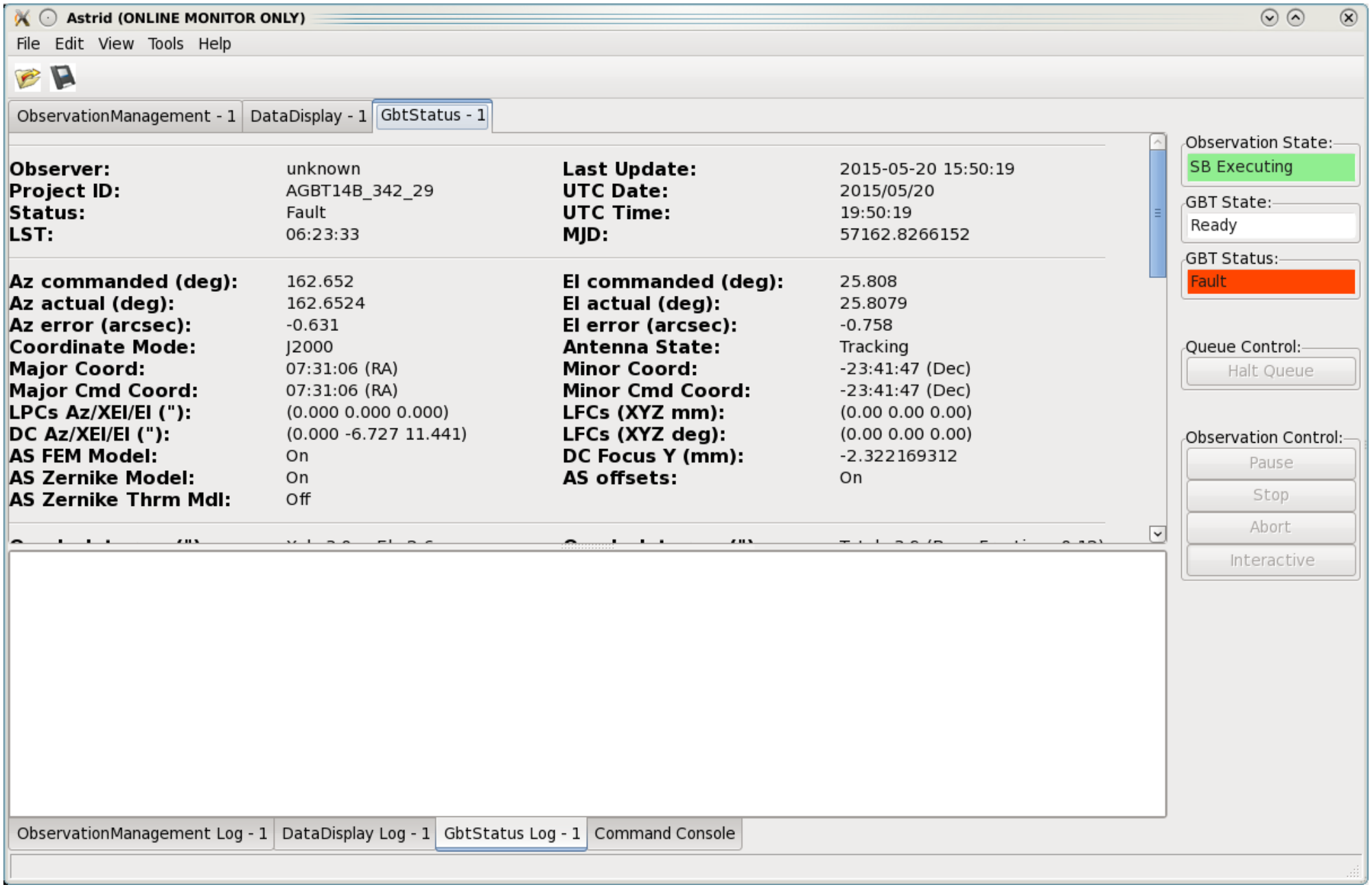
Astrid (ONLINE MONITOR ONLY)
File Edit View Tools Help
ObservationManagement - 1
DataDisplay - 1
GbtStatus - 1
Observer: unknown
Project ID: AGBT14B_342_29
Status: Fault
LST: 06:23:33
Last Update: 2015-05-20 15:50:19
UTC Date: 2015/05/20
UTC Time: 19:50:19
MJD: 57162.8266152
Az commanded (deg): 162.652
Az actual (deg): 162.6524
Az error (arcsec): -0.631
Coordinate Mode: J2000
Major Coord: 07:31:06 (RA)
Major Cmd Coord: 07:31:06 (RA)
LPCs Az/XEl/El ("): (0.000 0.000 0.000)
DC Az/XEl/El ("): (0.000 -6.727 11.441)
AS FEM Model: On
AS Zernike Model: On
AS Zernike Thrm Mdl: Off
El commanded (deg): 25.808
El actual (deg): 25.8079
El error (arcsec): -0.758
Antenna State: Tracking
Minor Coord: -23:41:47 (Dec)
Minor Cmd Coord: -23:41:47 (Dec)
LFCs (XYZ mm): (0.00 0.00 0.00)
LFCs (XYZ deg): (0.00 0.00 0.00)
DC Focus Y (mm): -2.322169312
AS offsets: On
Observation State:
SB Executing
GBT State:
Ready
GBT Status:
Fault
Queue Control:
Halt Queue
Observation Control:
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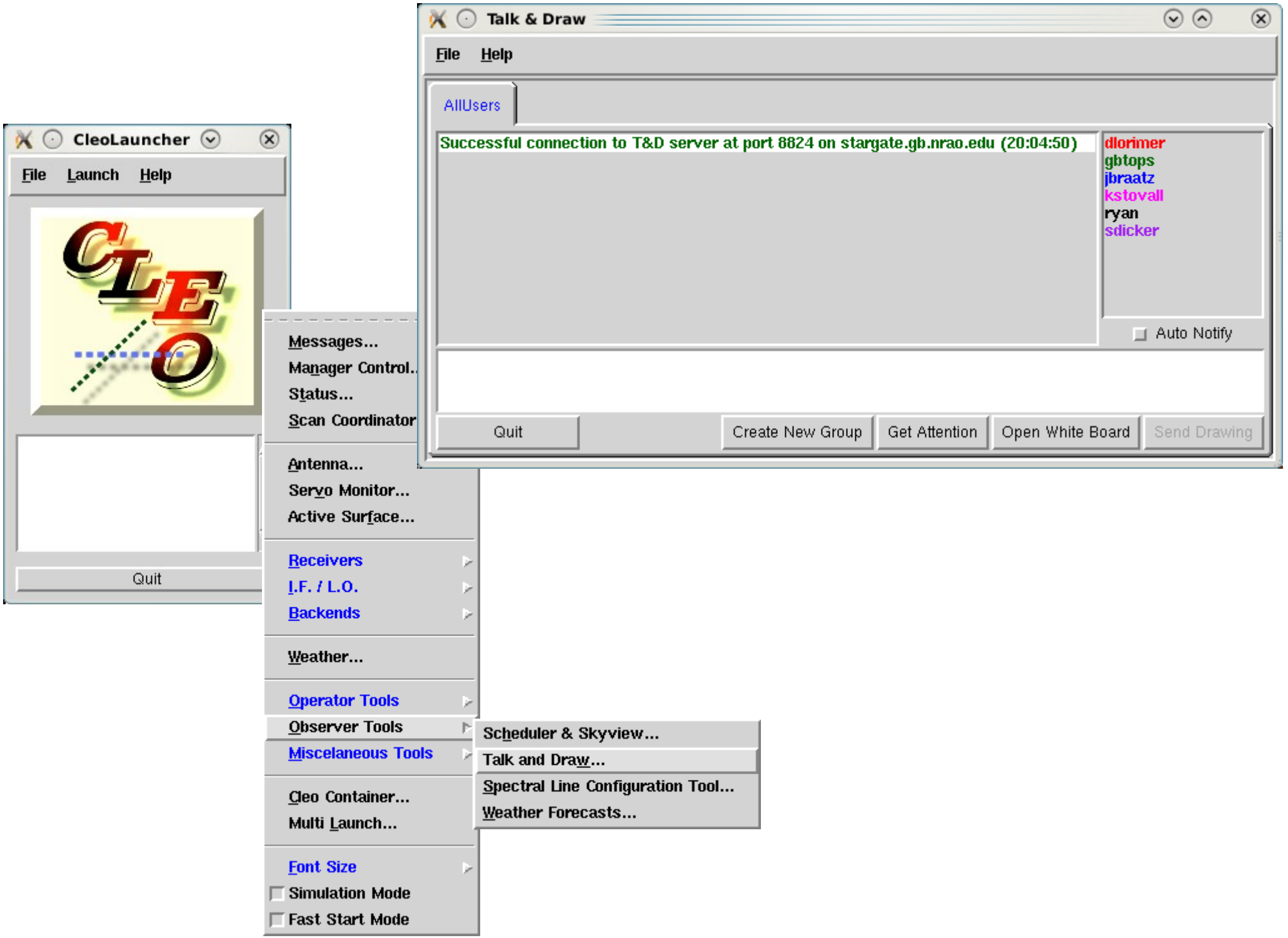
Command Console


Talk & Draw
File
Help
AllUsers
Successful connection to T&D server at port 8824 on stargate.gb.nrao.edu (20:04:50)
dlorimer
gbtops
jbraatz
kstovall
ryan
sdicker
Auto Notify
Quit
Create New Group
Get Attention
Open White Board
Send Drawing
CleoLauncher
File
Launch
Help
Quit
Messages...
Manager Control...
Status...
Scan Coordinator
Antenna...
Servo Monitor...
Active Surface...
Receivers
I.F. / L.O.
Backends
Weather...
Operator Tools
Observer Tools
Miscelaneous Tools
Cleo Container...
Multi Launch...
Font Size
Simulation Mode
Fast Start Mode
Scheduler & Skyview...
Talk and Draw...
Spectral Line Configuration Tool...
Weather Forecasts...

- 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
- Let’s look at the config portion more carefully…

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 (usually 1 for pulsar observing)
- 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…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

tint = acc_len * vegas.numchan/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

- 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
- 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?

- Write a simple observing script to observe J1713+0747 using coherent fold mode for 20 minutes
  - 512 channels, 800 MHz bandwidth, (what is tint?)
  - Include all the necessary steps to fully **calibrate** the data

- 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

- 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)

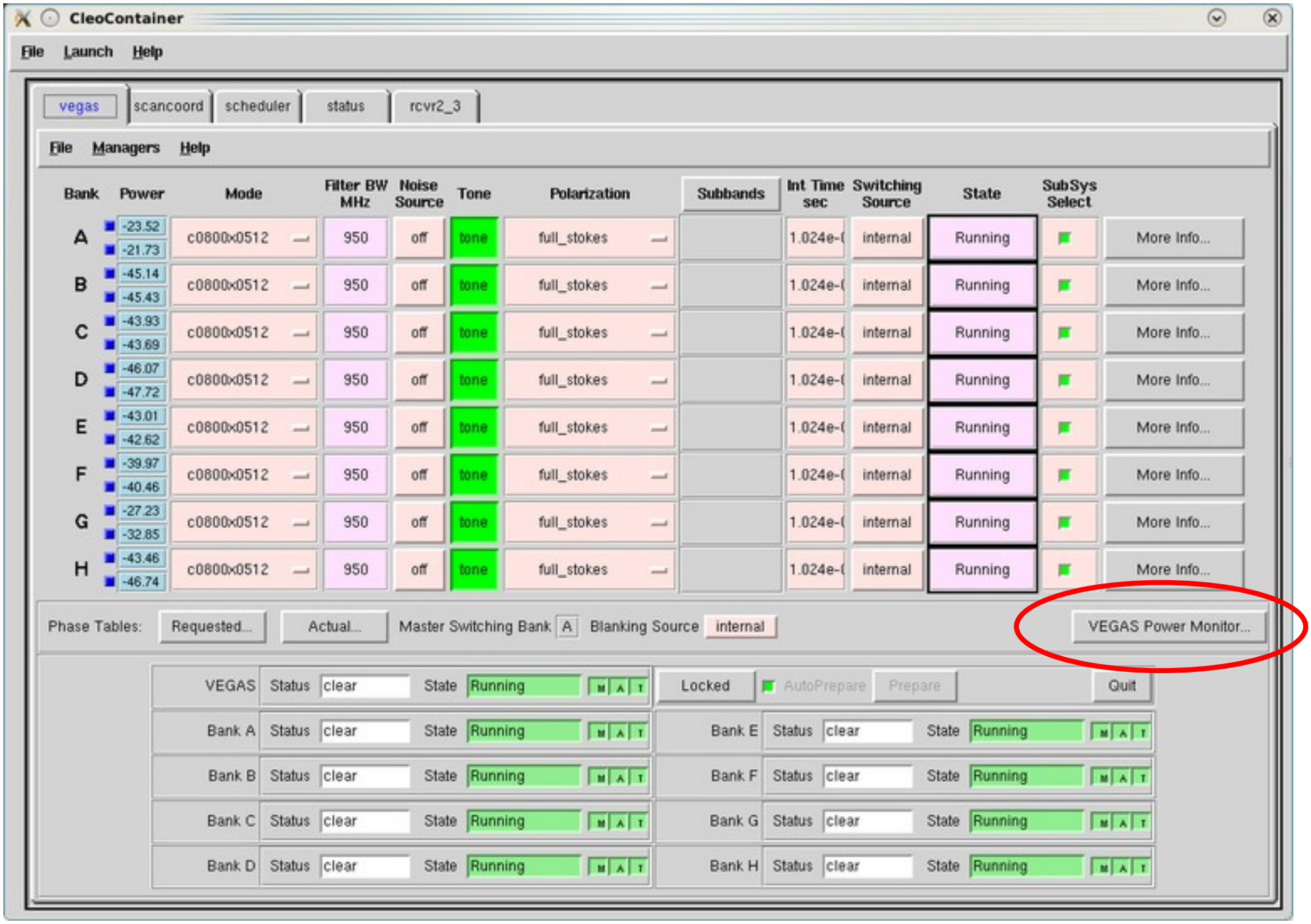
- Track(src, None, 3600, startTime=”15:15:00”)
- Track(src, None, startTime=”15:15:00”, stopTime=”16:15:00”)

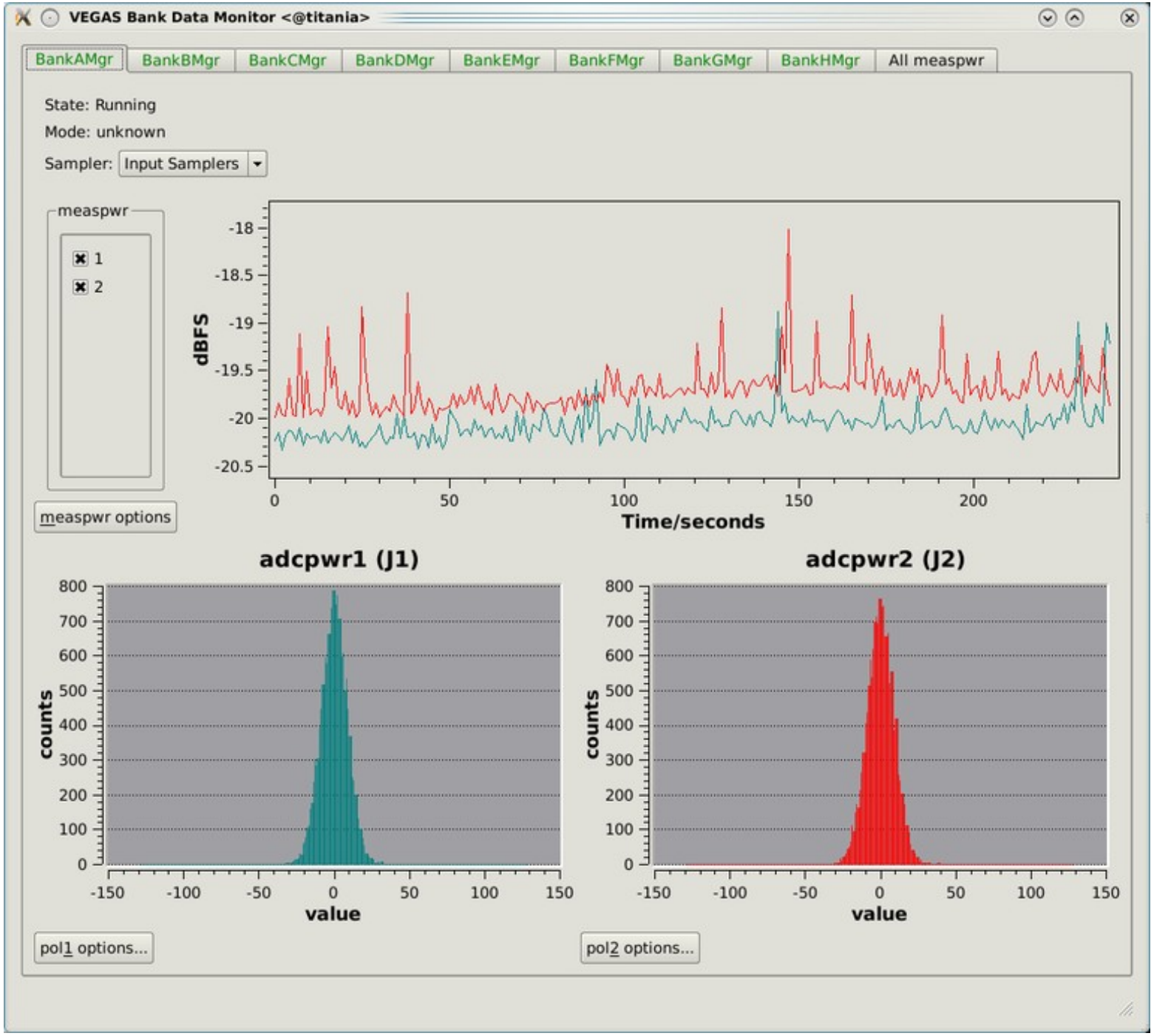
- myhorizon = Horizon(6.0)
  - Track(src, None, stopTime=myhorizon)
  - Track(src, None, startTime=”15:15:00”, stopTime=myhorizon)

- OnOff(“3C48”, Offset(0,1,cosv=False), 90)

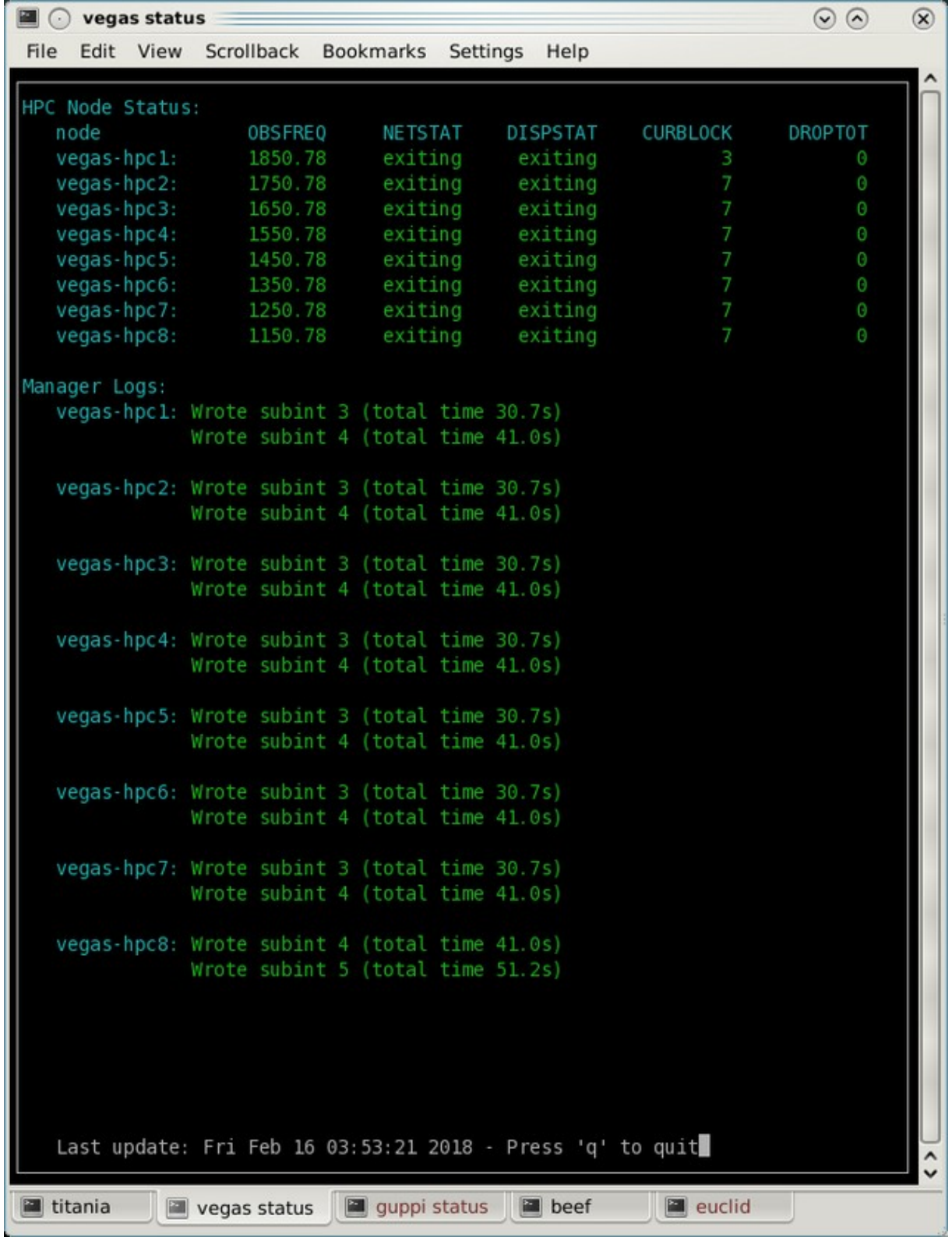
- Write an observing script that will loop over B1937+21, J1713+0737, and J1124+78
  - Perform a cal scan and online folding scan on each using coherent modes
  - You may specify the parfile in any way you choose
  - Do a 90 second cal scan and a 20 minute pulsar scan

- 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

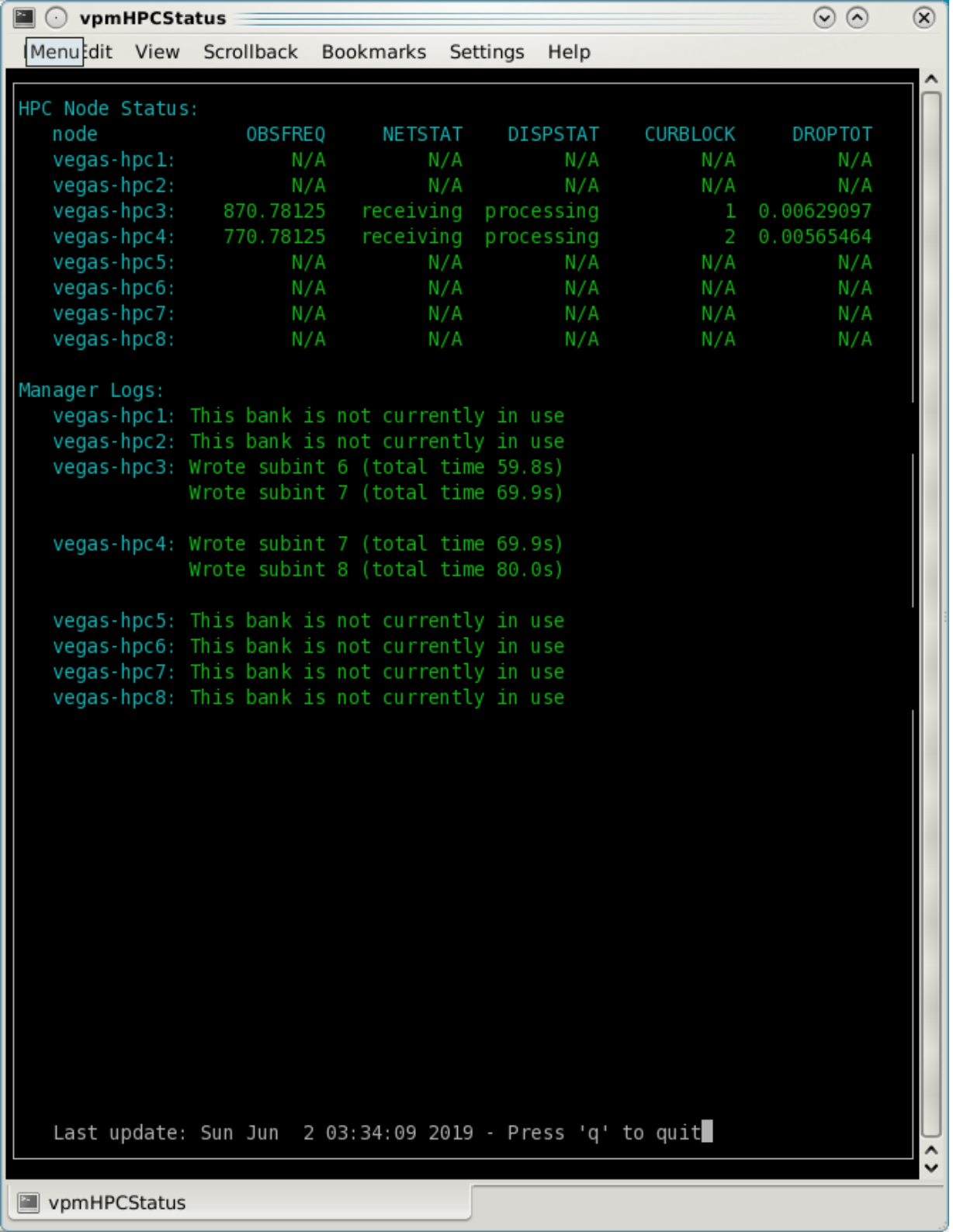

CleoContainer
File Launch Help
vegas scancoord scheduler status rcvr2_3
File Managers Help
Bank Power Mode Filter BW MHz Noise Source Tone Polarization Subbands Int Time sec Switching Source State SubSys Select
A -23.52 -21.73 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
B -45.14 -45.43 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
C -43.93 -43.69 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
D -46.07 -47.72 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
E -43.01 -42.62 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
F -39.97 -40.46 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
G -27.23 -32.85 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
H -43.46 -46.74 c0800x0512 950 off tone full_stokes 1.024e-(internal Running More Info...
Phase Tables: Requested... Actual... Master Switching Bank A Blanking Source internal
VEGAS Power Monitor...
VEGAS Status clear State Running M A T
Locked AutoPrepare Prepare Quit
Bank A Status clear State Running M A T
Bank B Status clear State Running M A T
Bank C Status clear State Running M A T
Bank D Status clear State Running M A T
Bank E Status clear State Running M A T
Bank F Status clear State Running M A T
Bank G Status clear State Running M A T
Bank H Status clear State Running M A T


VEGAS Bank Data Monitor <@titania>
BankAMgr
BankBMgr
BankCMgr
BankDMgr
BankEMgr
BankFMgr
BankGMgr
BankHMgr
All measpwr
State: Running
Mode: unknown
Sampler: Input Samplers
measpwr
1
2
measpwr options
dBFS
-18
-18.5
-19
-19.5
-20
-20.5
0
50
100
150
200
Time/seconds
adcpwr1 (J1)
counts
800
700
600
500
400
300
200
100
0
-150
-100
-50
0
50
100
150
value
pol1 options...
adcpwr2 (J2)
counts
value
pol2 options...

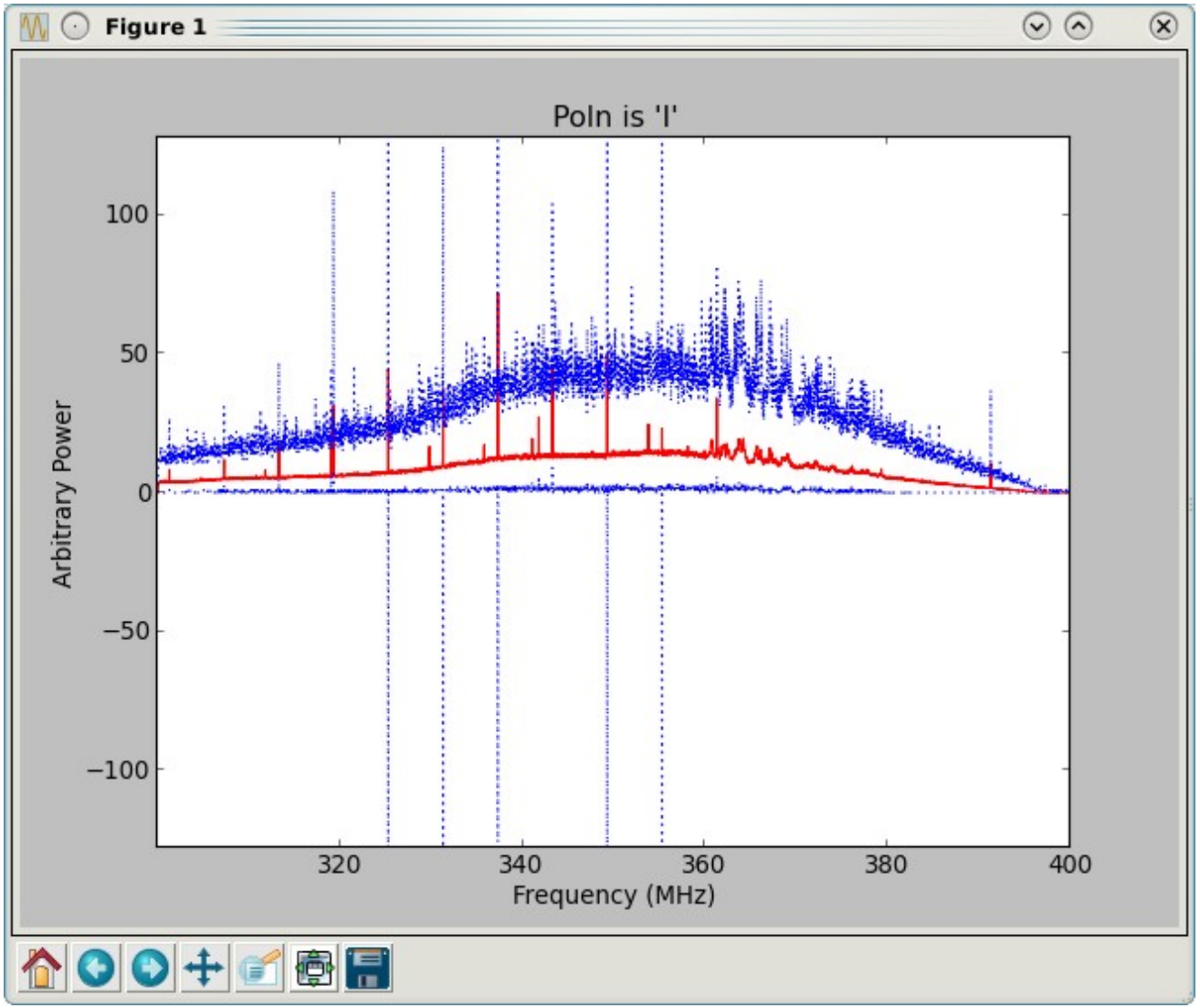
- Launched by typing `vpmStatus`



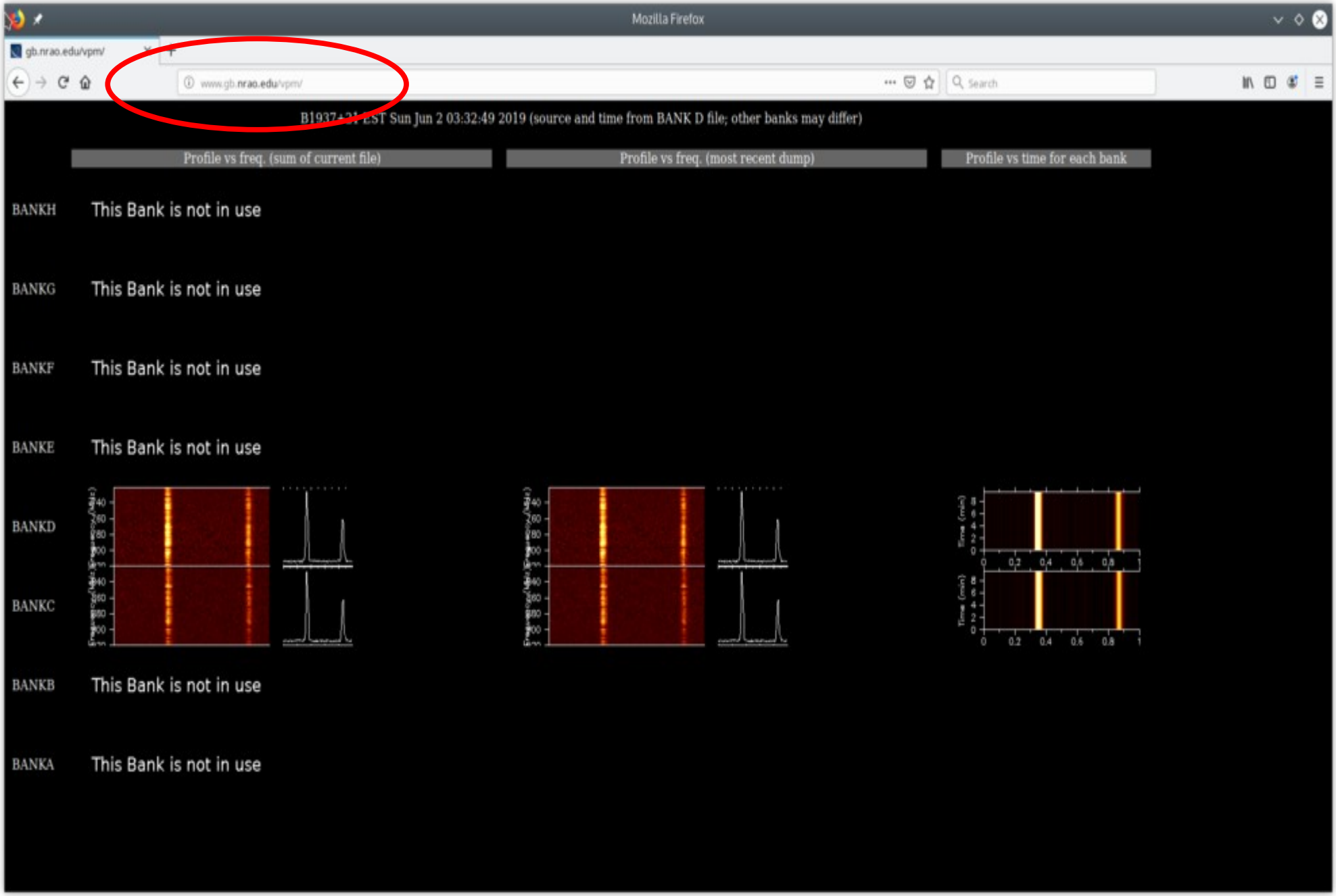
- Launched by typing `vpmHPCStatus`



- Launched by typing `vpmHPCStatus`



- Launched by typing `vpmMonitor` while data is flowing or by visiting www.gb.nrao.edu/vpm/vpm_monitor



www.gb.nrao.edu/vpm

- Final task: Write an observing script to observe some test pulsars (we will specify them later) using coherent fold mode
  - Don’t worry about the Catalog and specific sources for now
  - Include a cal scan
  - You can be as pythonic as you want, or you can hard code things by hand
- When you are done, ask me to check your work

- Astrid has a number of useful convenience functions and options
  - Can supply 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)
  - AutoPeakFocus() necessary at high frequencies (roughly C-band and above)
    - Never hurts at lower frequencies, but it has little benefit and takes time

- 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)