An Observer's Introduction to the GBT Dynamic Scheduling System

Jim Braatz
Dana Balser

March 10, 2010

This document gives an introduction to the Dynamic Scheduling System (DSS) for the Robert C. Byrd Green Bank Telescope (GBT). The GBT has been scheduled with the DSS since October 1, 2009. Observers can access the DSS through this site:

https://dss.gb.nrao.edu

Additional information on the DSS can be found here:

http://www.gb.nrao.edu/dss

Overview of the DSS

The primary goal of the DSS is to improve the efficiency of GBT observations by matching the observing schedule to current weather conditions, while allowing each observer to retain interactive control of the telescope. Each day the DSS will examine the weather forecast, equipment availability, observer availability, and other factors, and set an observing schedule for the 24-hour period beginning the next day. Observers will therefore get about 24-48 hours notice before their project will observe. Observers will have the opportunity to pause their observing program, set blackout dates indicating when they are unavailable for observing, and back out of current observations if they find the observing conditions are not suitable to their science goals.

The DSS readily accommodates remote observing, but by being on site in Green Bank observers increase their likelihood of being scheduled during the period of their visit. Observing visits to Green Bank should be arranged in advance with the project's "Friend," and observers should expect to spend five or more days in Green Bank to give enough opportunity for their project to get scheduled at least once. Projects observing at high frequencies typically require staying in Green Bank for a week or longer.

Resources for Getting Help

The main resource for help with the DSS is the email helpdesk:

helpdesk-dss@gb.nrao.edu

There is a link to the helpdesk on the main DSS web site. At the beginning of each trimester, when traffic to the DSS website is highest, there will be a live chat option available from the web site during normal working hours (Monday through Friday, 9:00 AM through 5:00 PM ET). The chat link connects to a member of the DSS team. Also on the web site is a link to online documentation, including a FAQ and a glossary of DSS terms.

DSS Terminology: Projects, Sessions, and Telescope Periods

The process of scheduling GBT observations begins with the preparation of the proposal using the NRAO Proposal Submission Tool (PST). Proposals accepted by the selection committee become GBT *projects* that appear in the DSS system and are identified by an assigned project ID (e.g., GBT09C-001).

Projects are divided into *sessions*, which have associated parameters that define how the observation should be scheduled. These parameters include sky position, time allocated, observing frequency, and minimum and maximum durations preferred for a single, contiguous block. Sessions for monitoring observations have additional parameters describing how often to repeat the observation. The project investigators initially define the session parameters in the proposal, but the parameters may be modified during the refereeing process. Observers can see the most critical session parameters on the DSS web pages.

Completing the observations for a session may require scheduling multiple segments. Each contiguous block of scheduled time is called a *telescope period*.

As telescope periods are completed, the project will be "billed" the time. If any time is lost to weather or an equipment failure, the observer may consult with the telescope scheduler (via email to the DSS helpdesk) and request that the project not be billed for the lost time.

Controlling the Scheduling of Your Project with the DSS

Users can access their DSS account by logging in to the system at https://dss.gb.nrao.edu. The DSS username and password are the same as those used for NRAO Interactive Services (i.e., the Proposal Submission Tool).

From the DSS web site, users can view and manage the scheduling information for their projects. Users can control when their project is scheduled by enabling or disabling sessions, individually. Sessions are enabled for observing simply by clicking a check box. Once enabled, an observing session enters the pool of sessions eligible for scheduling. Note that astronomers intending to observe remotely must be trained and approved by GB staff before the project can be authorized and made eligible for scheduling.

Observers can also enter personal blackout dates. Blackouts can be entered either as one-time events (e.g., May 1, 20:00 UT – May 4, 05:00 UT) or as repeating events (e.g., every Monday from 15:30 – 17:30). If all observers for a given project are blacked out at a given time, that project will not get scheduled. If at least one observer is not blacked out, the project is eligible for scheduling. Observers with more than one project will find that they need to enter blackout dates only once, and the dates will be applied to all their projects. Those visiting Green Bank to observe should use blackout dates to mark the periods of their travel before and after the run to ensure they are scheduled only when available and ready on-site.

Guidelines for the use of blackouts: While blackout dates give observers control of the scheduling process, efficient GBT operation requires that not *too much* time be blacked out or disabled. It is especially important that projects with large observing allocations not have too much time unavailable for scheduling because of blackouts. As a guideline, projects with more than 20 hours of allocated observing should limit time that cannot be scheduled to no more than 20% of the total eligible observing time over the course of a trimester. If a project cannot meet this guideline, the PI is encouraged to increase observing opportunities by enlisting additional observers who are qualified for remote observing. Projects that require observers to visit Green Bank for training are excluded from this guideline until the observers are trained for remote observing.

Caution Regarding Blackouts: Blackout dates must be used with caution, especially for projects having only one observer. Repeating blackout dates, in particular, can severely limit scheduling opportunities. Targets with low declinations, such as the Galactic Center, have narrow observing opportunities to begin with, so observers should consider the effect of blackout dates carefully before entering blackouts too freely. Consider, as an example, a project that has a session with a 4-hour duration. If the observer has a repeating 1-hour blackout date, the entire session becomes ineligible each time the blackout intersects the 4-hour window.

When entering blackouts, keep in mind, too, that projects do expire, so it is in the interest of the observer to keep the projects eligible for scheduling as much as possible.

Contact Information and Project Notes

Observers can specify how they should be contacted, prior to and during their observations. *The GBT operations staff stress that it is critical to keep contact information current*. Each observer can provide "dynamic contact" information in a free-format text box. Here the observer should provide home and cell phone numbers and any other relevant contact information. Observers can specify the order in which they should be contacted by GBT operations, in the event of any schedule changes or in case there is need to contact the observer for any reason prior to the scheduled start time.

Finally, observers can record "Project Notes" on the DSS project web page. Project notes provide observers a place to store and share observing instructions. The notes are visible to all project team members as well as the GBT operations staff and GBT schedulers.

Observers who need to share instructions or other information with the GBT operator prior to the start of an observation can provide these instructions in the project notes area. Project notes are not intended to be a log for observations, but rather a place to store brief instructions or news that should be shared among observers and the GBT operator.

The DSS Software

Upon logging in to the DSS system, users arrive at their DSS home page (Figure 1) where they see a list of active projects on which they appear as co-investigator. From the DSS home page, users can:

- Access the project page for each of their affiliated projects
- See a list of upcoming observations
- See a list of upcoming Green Bank room reservations
- See their "static" contact information, as entered in the NRAO Interactive Services system (http://my.nrao.edu)
- Set "dynamic" contact information
- Set blackout dates
- Link to the current GBT fixed schedule

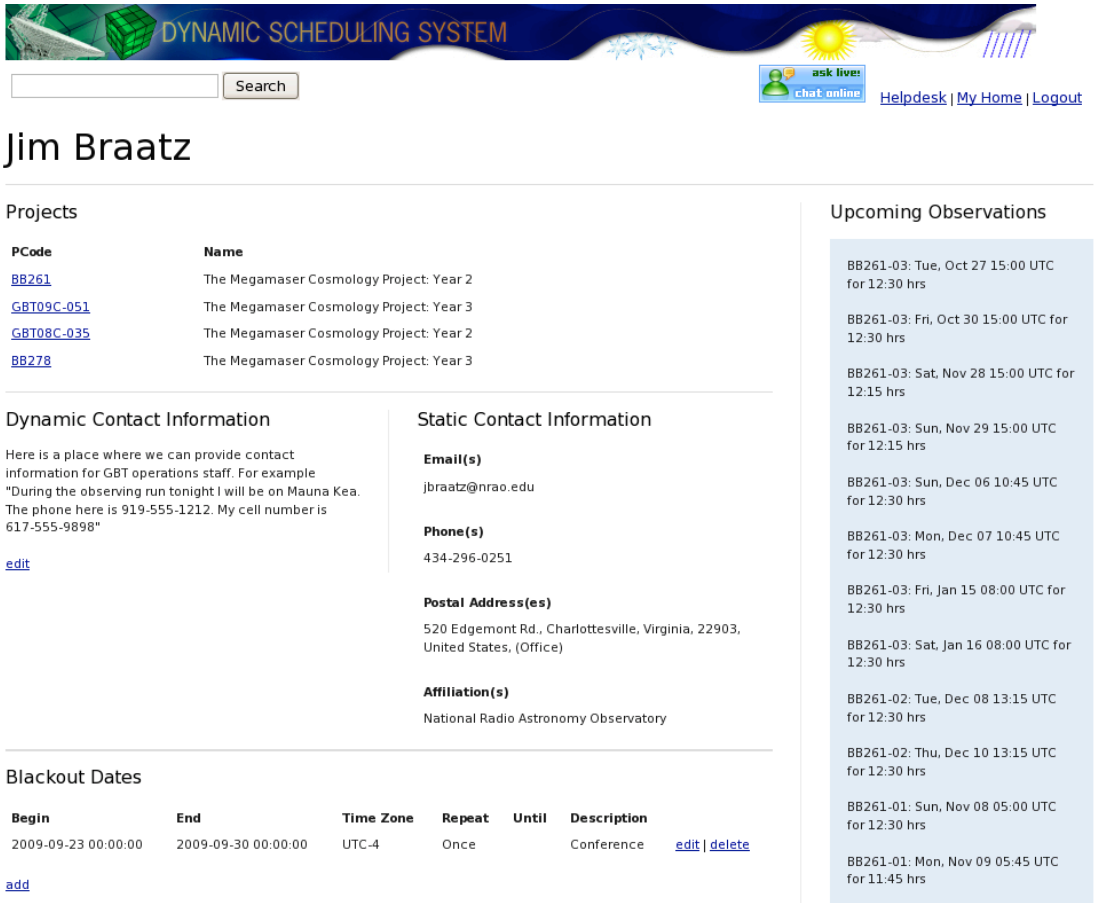

Figure 1: A sample DSS home page

By selecting a project ID, observers are presented with the project page, where they can:

- See a project calendar
- Inspect session parameters
- Specify observers from the project team, and set the order they should be contacted by GBT operations
- See a list of blackout dates for all observers on the project
- See a list of completed telescope periods
- Store and share project notes

The project calendar gives observers an idea when their project is eligible for scheduling. Regardless of the weather, there will be times when a project is not eligible for scheduling, for example because of no receiver availability, observer blackouts, fixed maintenance, and other fixed projects appearing on the GBT schedule. Times not eligible for scheduling will be grayed out on the project calendar.

The project calendar helps with planning in a number of ways. For example, by identifying days when they are not likely to be scheduled, observers can "tune out" of the DSS system for a while. However, it is important to understand that a session's eligibility is based on ever-changing constraints, and can change from "not eligible" to "eligible" at any time. Therefore, if observers wish to take a break from observing based on the calendar outlook, they should either disable all sessions until they are ready to resume with the observing, or enter blackout dates to cover the period they do not wish to observe.

The project page includes a panel with project team members listed. Using a checkbox, team members can select or deselect those identified as observers. They can also rearrange the order observers are listed. The top observer in the list is expected to observe the next scheduled session. If there is a change in schedule, this person will be called first.

Responsibilities of the Project Personnel

Each project has a Principal Investigator (PI) and, optionally, a list of additional investigators. An investigator is eligible to be an *observer* for a given project if that person is qualified for remote observing or is on site in Green Bank.

It is essential that one of the observers for a scheduled project contact GBT operations at least 30 minutes prior to the start of the observation. Observers can contact the GBT operator by telephone (304-456-2341), by the CLEO chat program (for qualified remote

observers), or by showing up in the GBT control room. If the GBT operator has not been contacted within 30 minutes of a session's start time, the operator will phone observers in the order they are listed on their project web page.

The PI is responsible for:

- Managing the project
- Identifying all associated observers
- Working with project team members and the GBT project Friend to ensure that observing scripts are properly and promptly prepared.
- Enabling each session by clicking the "enable" button on the project's web page. Sessions should be enabled only if they will be ready for observing in the next 24 hours.
- Ensuring that all associated observers have provided contact information, including a current telephone number and an email address for each observer.
- Ensuring that a project's scheduling information is current. This includes checking the hours remaining on the project and ensuring that the session parameters are up-to-date and accurate.
- Ensuring that each scheduled telescope period has an observer who is available at least 30 minutes before the session is scheduled to begin.

Observers are responsible for:

- Ensuring that the DSS project web page has their current contact information. For remote observers, this includes entering telephone numbers where they can be reached at the time of observation.
- Contacting GBT operations 30 minutes prior to the start time of an observation.
- Attending to observations during a scheduled telescope period.
- Notifying GBT operations if they find conditions unsuitable for their session.

Remote Observing and the DSS

The policies and instructions relating to remote observing remain the same. To use the GBT remotely, observers must first be trained and certified by Green Bank staff. In general, astronomers must observe at least once in Green Bank before being certified for remote observing. Please note that students should be trained on site by GBT staff, not off site by others. Training and certification received prior to the DSS test period are still valid. Experienced observers, when using instruments or observing modes unfamiliar to them, should plan to visit Green Bank if they require assistance. Additional information on remote observing is available at:

http://www.gb.nrao.edu/gbt/remoteobserving.shtml

Contact your project Friend or the DSS helpdesk (helpdesk-dss@gb.nrao.edu) if you believe the DSS does not have you listed properly as a qualified remote observer.

The Daily Schedule

Each day by about 10:00 AM ET the telescope schedule is fixed for the 24-hour period beginning 8:00 AM ET the next day. For example, by 10:00 AM Monday, the observing schedule is fixed for the period 8:00 AM Tuesday through 8:00 AM Wednesday. Shortly after 10:00 AM the daily schedule is published and can be viewed on the DSS web site by anyone. Those with projects on the 24-hour fixed schedule will be notified by email.

Observers must ensure that their blackout dates and "session enabled" flags are up to date each day by 8:00 AM ET. Changes made after this time may not be reflected in the upcoming day's schedule.

It is possible that weather conditions may change after a schedule is published, compromising the observing efficiency for some scheduled telescope periods. The observer or GBT staff may then decide to cancel a telescope period and substitute an alternate "backup" observation in its place. Note that the observer may decide that the weather conditions are too poor even after beginning the observation. Equipment failure can also lead to cancellations. If GBT staff must change the 24-hour schedule for these reasons, affected observers will be notified immediately by email or telephone.

Backup Projects

When a scheduled telescope period is cancelled, a backup project will fill the time. Backup projects can come in two categories: observer-run and operator-run.

Observer-run backup projects are those for which observers have volunteered to be called on short notice. The notice could be as little as 15 minutes, although the GBT staff will attempt to make the lead time as long as possible. Backup project observers should be ready to take control of the telescope at any time of the day or night, consistent with their observing program and blackout dates. These call-outs are expected to be rare. By volunteering as a backup project, observers improve their project's chances of getting observing time. Note that identifying a project as a backup does not penalize that project during the normal scheduling procedure. The project will compete for regular scheduling on an equal footing with all other projects, but the PI is agreeing to make the project available as a backup *in addition* to regular scheduling. Note that observer-run backup projects will not be called on to observe during times they have blacked out on their DSS calendar.

Operator-run projects contain observing scripts that may be run by the GBT operator, without need for direction from project team members. The observational strategy must be simple. Operator-run projects are characterized by:

- Minimal calibration requirements, e.g. a single pointing/focus calibration at the beginning of the run. If the observation requires more calibration than a single

pointing/focus or simple repetition of a pointing/focus script at regular intervals then it will not qualify as an operator-run candidate.

- Minimal changes in observing mode.
- Use of only one receiver.
- No scientist intervention required. An operator can be expected to determine if a point/focus measurement is reliable but cannot be asked to judge the quality of astronomical data. The operator also cannot be asked to judge which source would be best to observe at any given time. If there is any doubt whether an observation will produce reliable "blind" results then this project is not suitable as an operator-run candidate.
- Clearly written instructions for the telescope operator describing the observing procedure, including which scripts to run. These instructions can be stored in the "Project Notes" on the DSS web page.

These requirements bias operator-run projects to low frequency observations, but high frequency projects can be considered as well. There is no intention to implement "service observing" by GBT scientific staff. Green Bank scientific staff will not be on hand to check operator-run projects.

Getting a project approved as an operator-run backup requires consent from the GBT Friend and the GBT DSS staff. To identify your project as a backup project of either sort, inform your GBT Friend.

Appendix I : Session Types

There are three types of sessions defined for astronomy projects: *open*, *windowed*, and *fixed*. Open sessions have no major constraints on when they can be scheduled, beyond the functional requirements that an observer is available, the source is above the horizon, and the weather is suitable. Most sessions fall into this category and provide the most flexibility in the DSS. At the other extreme are fixed sessions that have no flexibility and are prescheduled at a particular date/time; that is, their telescope periods have already been defined.

The third type is windowed sessions, which have some constraints but are not fixed on the schedule. The most common examples are monitoring sessions, where the science demands that an object must be observed at defined intervals. Windowed sessions are defined by a cadence that may be either periodic or irregular. For example, an observer may require observing a target once per month for five months, with each observation having a tolerance of plus or minus 3 days. In this example, the window size is 7 days.

Currently, windowed sessions are scheduled in the following way. The cadence information from the proposal is used to preschedule all windowed sessions whereby all of the telescope periods are temporarily fixed in what are called default periods. The user is given the window template (e.g, 8-14 January; 8-14 February; 8-14 March; 8-14 April; and 8-14 May). Within a windowed period, a windowed session will be considered like

an open session. Near the end of each window range is a default period. If the session has not been selected by the time the default period arrives, the session will be scheduled in the default period. The default period may be moved manually to a later time slot within the window if the human scheduler notices a problem with the original default period. When the windowed period is scheduled, the observer will be informed 24-48 hours in advance, just like an open session. The only difference is that the observer will be provided with the window template for planning purposes. In the future, historical weather data (climate) will be used to schedule such sessions more efficiently within the window.