PULSAR OBSERVATIONS AT SRT

Release 0.4

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Release notes

Issue	Release date	What's new
0.1	04/02/2016	Issue 0.1
0.2	06/05/2016	In the SCHEDULE FILES section, added the explanation for the keyword Wait (newly added).
0.3	01/06/2016	Reorganized in a more logic way. With respect to the previous version: Sections 1, 2 and 8 have been newly added. Sections 3, 5 and 6 have been only numbered, but their contents remain unchanged (a part for some introductory phrases that have been reformulated or removed) Section 4 has been totally rewritten so that is now telescope operations oriented (in the previous release it was the description of dfbcontroller only) In section 7 the checklist for closing the observing session has been added.
0.4	22/03/2018	Added appendix C for illustrating how to prepare the schedule line dedicated to the noise source observation. Removed all indications for creating schedules and setup files (moved to a dedicated document). Modified the PDFB section, accordingly to the removal of all indications for creating schedules. Added the section that illustrates the setup file for the ROACH (i.e. LEAP) backend (in progress). Updated the console where seadas runs, the way to log in and to open the vnc sessions to the backends. Updated the root directories for setup and schedule files. Updated the part for the management of the schedule. Mentioned the possibility of expressing source’s coordinates in the Galactic frame.

Document presentation

This document illustrates software and procedures specifically developed for conducting observations of radio pulsars with the Sardinia Radio Telescope (SRT).

This document does NOT illustrate all procedures for operating SRT: these informations are illustrated in the SRT general manual, which is available at the URL http://discos.readthedocs.org/eng/latest/user/index.html . The reader must read the SRT general manual before the present document, in order to be aware of all telescope standard procedures that may be recalled in this document, without being discussed in detail.

Current version presentation

This version is the first main revision of this manual. It is organized in a more uniform way to give the reader the essential informations for conducting radio pulsar observations with SRT. After a brief introduction, all management software and their essential use are discussed. A troubleshooting section concludes this document.

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1 - Introduction

Pulsar observations with a radio telescope are peculiar for two main reasons:

1) they involve specifically designed backends which require ad hoc procedures for being operated;
2) the simultaneous data acquisition performed by two or more backends is a common practice.

These two main requirements lead to a specific organization for the coordination of all involved devices (i.e. the antenna and any backend) which in turn resulted in the creation of specific management tools.

A particular attention has been given to the usability of the observing tools, so that the observer can to operate the telescope in an easy and straightforward way. For this reason all management software have a graphic interface and observation parameters are written in setup and schedule files with a human readable syntax.

This manual is organized as follows. Section 2 describes the adopted organization, with particular attention to the devices' management software. Section 3 illustrates SEADAS, i.e. the tool for managing the observing sessions, section 4 and 5 illustrate dfbcontroller and leapcontroller respectively, i.e. the tools that allows SEADAS to coordinate PDFB and LEAP cluster operations respectively.

2 - The adopted organization

Like any other radio telescope, SRT can be seen as an ensemble of devices, each of them devoted to a single and specific task. Every device is directly managed by a dedicated software application, that in turn runs on a dedicated server. In this case, devices are the antenna on one side, and each single backend on the other side.

The software that manages the antenna is DISCOS, the PDFB is managed by the application dfbcontroller, the LEAP cluster is managed by the application leapcontroller. Both dfbcontroller and leapcontroller have specifically been developed for allowing fully automated data acquisitions.

Fully automated operations require a specific management tool that communicates with the applications responsible for managing all involved devices. Such a tool, named Srt ExpAndable Data Acquisition System (SEADAS), has been designed and developed to accomplish this task. It communicates via socket connections with DISCOS, dfbcontroller and leapcontroller.

SEADAS provides a graphic user interface through which the observer can easily conduct observing sessions, both single observations and schedule organized sessions.

3 - SEADAS

Srt ExpAndable Data Acquisition System (SEADAS) is the main software for managing pulsar observing sessions. It communicates with DISCOS for setting up the antenna, including the receiver selection and the active surface shape and behavior, and for tracking the target source; it also communicates with the management software that runs on the backend servers, again for setting up the backends with all parameters that are necessary for the requested data acquisition system.

SEADAS allows the user to perform a single observation in MANUAL mode, i.e. by setting by hand all necessary parameters, or to run an entire observing session whose observations are specified in a SCHEDULE file.

SEADAS GUI has been designed for making observing operations as much easy as possible. For this reasons is has been organized in frames, each of them dedicated to a single aspect of the observations management.

SEADAS runs in the console viewer01 located in the control room, under the username pulsar (ask staff for the password). Schedules and setup files must be placed in the folder

/home/pulsar/scheds/[project code]

where [project code] is the code assigned by the TAC to the project.

SEADAS GUI

SEADAS GUI is organized in frames:

1. The "Session Management" frame (top left side of the GUI), through which the user sets the session's main informations, selects the session mode (manual or schedule mode), loads a setup file and starts the observations.
2. The "Antenna & Pointing Management" frame (top right side of the GUI), through which the user sets the source to be tracked by the antenna, and selects the requested behavior for the telescope active surface
3. The "Receivers manager" frame (just below the "Antenna & Pointing Management" frame), through which the user sets the requested receiver and all related parameters, enables/disables the calibration signal, and sets the signal attenuation levels and frequency for its downconversion system
4. The DFB frame, through which the user sets all DFB parameters, by either loading a setup file or manually entering all values in the dedicated fields, and checks the data acquisition progress.
5. The ROACH frame, through which the user sets all LEAP cluster, a.k.a ROACH, parameters, by either loading a setup file or manually entering all values in the dedicated fields, and checks the data acquisition progress.

In the above list it has been cited the concept of setup files. The number of parameters to be set for an observation is of order of some tens, and mistakes can be easily done if all values are manually entered. A setup file is a simple ASCII file where all these values can be written. Its use is strongly recommended in both performing a single observation and

running an observation schedule. In both cases they allow to set all necessary parameters by loading a text file. Moreover, in the latter case the structure of a schedule becomes much simpler and easier to be read. A separated document illustrates how setup files are structured and the syntax for setting all parameters. The same document also illustrates the schedules' structure.

SEADAS essential use

Despite the high number of items in the GUI, an essential use of SEADAS requires the knowledge of very few items, namely:

1. In the "Session Management" frame: all items
2. In the "Antenna & Pointing Management" frame: the colored label at the top right (it displays the words DISABLED/ENABLED), the button "Source name" and the field at its right, and the "Coordinate" combo box.
3. In the "DFB" frame: the colored label at the top left corner of the frame, which displays the string "DFB".
4. In the "ROACH" frame: the colored label at the top left corner of the frame, which displays the string "ROACH".

Items in the "Session Management" frame

The most important item in this frame is the "Project ID" field, where the user must enter the code assigned to the project by the telescope time allocation committee. No observations can be done if this field remains empty. This field can be filled by manually typing the project code, or by loading a setup file in which this information is specified.

The "Project Name" and "Observer(s)" fields display, respectively, the name of the project and of the observers. They are not essential for running observation, but it's strongly recommended to fill these fields.

The "Session mode" combo box allows to switch the mode of the observation, namely "Manual" for a single and manually set observation, and "Schedule" for running a schedule.

In manual mode setup files can be managed through the "Setup file" field and the "Load setup" and "Reload setup" buttons. The name of a setup file can be directly typed in the "Setup file" field, and all informations are automatically displayed in SEADAS GUI. The setup file name has to be entered with its relative path to the root directory for storing setup files. The root directory must be /home/pulsar/scheds/[project code]. No other places but subfolders of the above location are allowed. A setup file can be also loaded by clicking on the "Load setup" button: a system window pops up for browsing system directories and selecting the requested file. The "Reload setup" button allows to re-read a setup file whose name is already displayed in the "Setup file field".

Fields "Obs length (s)", "UTC start" and "UTC stop" allow to manage the duration of an observation. Their meaning is, respectively, the duration of the observation, the earliest UTC at which the observation can start and the latest UTC at which the observation must

stop. "UTC start" and "UTC stop" parameters are mainly used in time tagged schedules and can be ignored in manually run observations.

The button "Observe" starts a single observation in manual mode, or the first selected observation in a schedule managed session. The "Stop obs" button interrupts the current observation, whatever is the session mode. The "Suspend" button can be used in the schedule mode only: When it's pressed, the schedule is stopped at the end of the running observation.

The button “Schedule management” pops up the window for managing the project schedule. This window is organized in two frames: the "Schedule manager", the upper one, and the "Observation List", the lower one.

In the upper side of the "Schedule manager" frame, field "Sched file" and buttons "Load sched" and "Reload sched" have the very same functions and or work in the very same way like, respectively, field "Setup file" and buttons "Load setup" and "Reload setup", but for schedules. Once selected in any allowed way, the schedule is displayed in the gray frame. Observation lines can be singularly or all at once selected. A single line is selected by clicking on it, while the entire schedule is selected by clicking the "Select all" button. Once displayed, a schedule can be directly edited in the "Schedule manager" window, by clicking on the "Start edit" button. The "Save" button allows to save all changes in the current file, the "Save as..." button opens a system window for saving the modified schedule with a different name, and the "Clear changes" removes all apported changes. When any button of these three is clicked, "Schedule Manager" exits the schedule edit mode. A schedule can be also edited with the emacs text editor, by clicking on the "emacs edit" button. After all changes are saved, the schedule must be manually reloaded by clicking on either "Load sched" or "Reload sched" button.

The "Observation List" frame shows all selected schedule lines. Only those lines that are displayed in this window will be executed. Therefore, if this window is empty, no observations are done. Schedule lines can be rearranged in this window by a cut/paste action. A mouse left button click on a line removes it from the window, while a mouse middle button click inserts the last cut line at the cursor position. The last cut line can be pasted multiple times. The "Clear" button simply removes all displayed lines in the "Observation List" window.

All described actions in both "Schedule manager" and "Observation List" frames can be done not only before starting the observations, but also while observations are in progress: the ongoing observation is not affected at all since its schedule line does not appear in the "Observation List"frame.

Items in the "Antenna & Pointing Management" frame

The colored label at the top right corner of this frame indicates if the antenna control is enabled or disabled. If the control is disabled, its color is red and it displays the word DISABLED, while the displayed word is ENABLED and its color is green if the antenna control is enabled. A mouse left button click on this label switches between the two situations. Disabling the antenna control is always successful, while the opposite requires that the socket connection between DISCOS and SEADAS is established. In order to run any observation, the antenna control must be ENABLED.

In manual mode, the source to be tracked can be set by typing its name in the field at the very right of the "Source name" button. If the typed string is the name of a catalogue pulsar, its catalogue coordinates, in the frame selected by the "Coordinates" combo box, are automatically loaded. A catalogue pulsar can be also loaded by clicking the "Source name" button: a window pops up and a source can be selected by clicking with the mouse left button on its line. The selected source's name and J2000 celestial coordinates are in this way automatically displayed in the GUI. Coordinates values can be also manually modified.

In manual mode, the "Coordinates" combo box allows to select the coordinate system of the point to be tracked. Allowed values are "AZ/EL" for pointing at fixed azimuth and elevation, "J2000" for tracking a source whose coordinates are expressed in the J2000 celestial frame, “Galactic” for tracking a source whose coordinates are expressed in Galactic coordinates.

Items in the "DFB" frame

The colored label at the top left corner of this frame always displays the string "DFB", and its color indicates whether the data acquisition by this backend is controlled by seadas: red means control disabled and socket connection closed, green means control enabled and socket connection established. A mouse left button click on this label allows to switch between these two situations. While the disabling action is always successful, the enabling action is successful only if the socket connection to the "DFB" is successfully established. If a connection cannot be established, i.e. the colored label remains red, check if the graphic tool "dfbcontroller" is running on the DFB server.

Items in the "ROACH" frame

The colored label at the top left corner of this frame always displays the string "ROACH", and its color indicates whether the data acquisition by this backend is controlled by seadas: red means control disabled, green means control enabled. A mouse left button click on this label allows to switch between these two situations.

Items in the "Receivers manager" frame

The "Receiver" combo box allows to select the receiver to be used. Whenever a selection is made, graphic items appear in this frame, through which the receiver's parameters can be set.

At the very right of the "Receiver" combo box, the "Configure" button is present. When this button is clicked, SEADAS sends to discos all necessary parameters to effectively configure the antenna as indicated in the "Receivers manager" frame.

Two radio buttons at the right of the "Cal source" label switch off and on the signal's calibration source.

When a receiver is selected, combo boxes appear below the "Attenuation levels (DB)" label. These items allow to select the signal attenuation level for the two polarizations separately. The button "set atten.", placed just above the "Attenuation levels (DB)" label, sends to discos, when clicked, all necessary command to apply the requested attenuations.

4 - The Pulsar Digital Filterbank

The Pulsar Digital FilterBank (PDFB) is first backend at SRT, devoted for pulsar observations. The detailed documentation can be found at http://www.jb.man.ac.uk/~pulsar/observing/DFB.pdf. The reader is encouraged to read this document, with particular attention to section 6.

PDFB operations are controlled through its main server, named psrdfb. The observer needs to open a vnc session on psrdfb before starting any observing session.

The vnc session is opened from viewer01 by giving in a terminal the following command:

vncviewer psrdfb:2

a password (ask staff for it) is required to finalize the session opening.

The user of this session is named corr. The PDFB control software can be launched only after the backend is up and running. In the psrdfb vnc window the following command has to be given:

/home/corr/software/seadas/bin/dfbcontroller

This command launches dfbcontroller, which in turn opens pdfb3 and tkds. The observer has to verify that pdfb3, tkds and dfbcontroller windows are all three up.

The observer must also verify that dfbcontroller is connected to tkds: a colored label at the right of the tkds label indicates whether the connection has been established (green background, text CONNECTED) or not (red background, text DISCONNECTED). If no connection is active, by clicking on this colored label the connection can be established.

The control mode combo box, just above the log messages frame, must always be set on DIRECT. The other option for this setting, named PASSIVE, allows to operate the PDFB in piggy-back mode. Such modality is currently allowed for the LEAP project only.

No further user actions are required for an observing session managed by SEADAS, nevertheless dfbcontroller can be used for directly operate the PDFB. Direct operations of the PDFB through dfbcontroller need a good knowledge of the backend, for what concerns its technical settings, and of pulsar astronomy for what concerns the data acquisition settings.

Once the observing session is finished, dfbcontroller, tkds and pdfb3 have to be closed strictly in the given order before switching the PDFB off and closing the vnc session on psrdfb.

5 – The ROACH backend (a.k.a. LEAP cluster)

The ROACH backend works in baseband, fold, psrcal and search modes. Its operations

The vnc session is opened from viewer01 by giving in a terminal the following command:

vncviewer leap0:2

a password (ask staff for it) is required to finalize the session opening.

In a terminal, give the following command:

/home/user/seadas/bin/leapcontroller

Nothing else is required to manage the data acquisition.

Some rules must be followed for some parameters.

The bandwidth must be an integer multiple of 16 MHz, not greater than 128MHz. The central frequency is adjusted so that the requested bandwidth is along entire 16 MHz sub-bands. The number of channels is adjusted so that it is an integer power of 2 times the number of requested sub bands. All these adjustments are done to the closest value that matches the mentioned requirements.

APPENDIX A – Checking and setting the system clock for the Pulsar Digital Filterbank

1) Checking the system clock

Open a shell on psrdfb
Give at prompt the command "atdc"
Hit return twice until the "Function" options are displayed
Type 1 for selecting."Terminal line"
Hit the return key until the terminal displays the system clock
Read the "Tick Phase" value, which should be of some hundreds. If much higher, i.e. some or even several thousands, the clock has to be set as indicated in section "Setting the system clock"
Hit the "q" key to exit atdc

2) Setting the system clock

Open a shell on psrdfb
Give at prompt the command "atdc"
Hit return twice until the "Function" options are displayed
Type 2 for selecting "Clock control"
Hit enter until the text "Enter SU password" is displayed
Type the SU password (ask staff for it), then hit return
Type 2 for selecting the option "Set the time only"
Hit return until the following text appears:

> Enter UTC in DD MMM YYYY HH MM SS (eg 1 jan 1998 13 10 15)
>
> The entered time should be in a very next future, e.g. if the control room clock displays 15:23:20, enter 15 24 00.

Click return about ten seconds before the control room clock marks the manually entered time
Click again return when the control room clock exactly marks the given time.
Click the "q" key until the terminal exits from atdc and returns the prompt
Check the system clock as described in paragraph "Checking the system clock".

APPENDIX B – Adjusting attenuation levels for the Pulsar Digital Filterbank

Signal's attenuations have to be tuned so that the PDFB backend has a signal r.m.s. as close as possible to 13.

The signal's r.m.s. can be read in the pdfb3 window, by clicking on the "SAMPLERS" button, in the frame under the mentioned button itself.

Attenuation values are set in seadas. In the "Receivers manager" frame combo boxes below the label "Attenuation levels (DB)" allow to select the requested attenuation level, while the button "set atten.", placed just above the mentioned label, sets the attenuation

1. Load your seadas setup file
2. Switch seadas into schedule mode
3. Load the schedule TEST/TEST.txt (see section 4b for instructions about how to load a schedule)
4. Select a source in this schedule, from the group which correspond to the requested bandwidth (see section 4b for instructions about how to select a schedule line)
5. In seadas gui, click the "Observe" button placed in the "Session Management" frame
6. In pdfb3 window read the values for the signal's r.m.s. (it takes at least one DFB cycle time to display the correct values)
7. If the r.m.s. values are not close to 10, change the attenuation levels as described above.
8. Repeat points 6 and 7 until the signal's r.m.s. is close to 10.
9. In seadas gui, click the "Stop obs" button placed in the "Session Management" frame.

9 - Troubleshooting

This section is meant to contain all procedures to follow whenever problems occurr. Since a procedure can be effectively exploited after a given problem erises, it cannot be considered complete. Therefore, indications are also given for addressing those cases not yet included in this list.

Part 1: DISCOS problems

For any problem withDISCOS, stop any data acquisition and refer to DISCOS manual at http://discos.readthedocs.org/eng/latest/user/index.html . If the problem cannot be solved, the observing session has to be interrupted.

Part 2: SEADAS problems

0) A problem with SEADAS is either not known or persists.
Observations can still be manually conducted. The antenna can be configured and operated by giving the opportune commands in the terminal window of discosConsole, and the PDFB can be directly operated by acting on dfbcontroller. In this case, the observer should also regularly check that the antenna is tracking the requested target and that the data acquisition with the PDFB proceeds without problems.

1) SEADAS crashes during an observation.
The observer must check that a) the antenna is still tracking the requested source, by looking at the informative terminals of discosConsole and b) the PDFB is still acquiring data by looking at dfbcontroller graphic window.
If both these two checks return a positive response, the observer has to
- wait that the PDFB terminates its data acquisition,
- relaunch SEADAS and continue with the observing session

Part 3: PDFB problems

0) A problem with dfbcontroller is either not known or persists.
Observations can still be manually conducted. The antenna can be configured and operated by giving the opportune commands in the terminal window of discosConsole, and the PDFB can be directly operated by acting on tkds. In this case, the observer should also regularly check that the antenna is tracking the requested target and that the data acquisition with the PDFB proceeds without problems.

1) A problem with tkds or pdfb3 is either not known or persists.
If these problems cannot be solved by stopping pdfb3, tkds, and dfbcontroller an relaunching dfbcontroller, the DFB cannot be operated. The session must be interrupted.

2) tkds fails to open when dfbcontroller is launched.
The observer has to close pdfb3 and dfbcontroller, then in a terminal he/she has to give the following commands:

corkill
bcckill

Once these commands have been executed, the observer can relaunch dfbcontroller.

3) dfbcontroller crashes during an observation.
The observer must check that a) the antenna is still tracking the requested source, by looking at the informative terminals of discosConsole and b) the PDFB is still acquiring data by inspecting pdfb3 window.
If both these two checks return a positive response, the observer has to
- wait that the PDFB terminates its data acquisition, by inspecting the in the data file the data acquisition length.
- once the requested data acquisition length has been reached, the observer clicks on the stop button in tkds window and waits for the PDFB to stop, then
- he/she the command fc in tkds command field.
- relaunch dfbcontroller and continue with the observing session