

PULSAR OBSERVATIONS AT SRT

Release 0.3

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Release notes

Issue	Release date	What's new
01	04/02/2016	Issue 0.1
02	06/05/2016	In the SCHEDULE FILES section, added the explanation for the keyword <code>wait</code> (newly added)
03	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 <code>dfbcontroller</code> only) In section 7 the checklist for closing the observing session has been added.

Document presentation

This document illustrates softwares 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 organised in a more uniform way to give the reader the essential informations for conducting radio pulsar observations with SRT. After a brief introduction, management softwares and their essential use are discussed, followed by the detailed description of setup and schedule files for SEADAS. Templates for these files are also provided. A detailed checklist is also present for starting, conducting and closing an observing session. 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 practise.

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 softwares 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 softwares. Section 3 illustrates SEADAS, i.e. the tool for managing the observing sessions, while section 4 illustrates dfbcontroller, i.e. the tool that allows SEADAS to coordinate all PDFB required operations. Section 5 and 6 describe setup and schedule files, and section 7 contains the checklist for performing both single observations and schedule organized sessions.

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 NURAGHE, while the PDFB, the only pulsar backend available to date, is managed by an application, called dfbcontroller, specifically developed for allowing fully automated operations.

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

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 dialogates with NURAGHE for setting up the antenna, including the receiver selection and the active surface shape and behaviour, and for tracking the target source; it also dialogates with the management software that runs on the backend servers, again for setting up the backends with all parameters that are necessary for the desired 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 a dedicated server, named `seadas` , whose access is made via a vnc session. In `nuraghe-obs2` a workspace named `PULSAR` is devoted to host the vnc session to the `seadas` server.

The vnc session to the `seadas` server can be opened by typing in a terminal the following command:

```
vncserver seadas:1
```

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

The user of this session is named `corr`. Two folders in `/home/corr` need total attention, namely `/home/corr/scheds` and `/home/corr/setup`. These folders are devoted to host respectively schedules and setup files, which must be placed in subfolders whose name is the **project code**. E.g. for a project whose code is `S9999`, all schedule files must be placed in `/home/corr/scheds/S9999` , while all setup files must be placed in `/home/corr/setup/S9999`.

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 desired behaviour for the telescope active surface
3. The "Receivers manager" frame (just below the "Antenna & Pointing Management"

- frame), through which the user sets the desired 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.

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".

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 all setup files. This directory is currently set to /home/corr/setup. No other places 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 desired 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.

Buttons "View schedule" and "View obs list" pop up two windows, "Schedule manager" and "Observation List" respectively, for managing the observation schedules.

In the upper side of the "Schedule manager" window, field "Sched file" and buttons "Load sched" and "Reload sched" have the very same functions and work in the very same way like, respectively, field "Setup file" and buttons "Load setup" and "Reload setup", but for schedules. The root directory for schedules is currently set to /home/corr/scheds. 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 applied 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" window 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" windows 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" window.

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 nuraghe 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.

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 "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 nuraghe 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 nuraghe, when clicked, all necessary command to apply the requested attenuations.

4 - The Pulsar Digital Filterbank

The Pulsar Digital FilterBank (PDFB) is currently the only backend 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. In `nuraghe-obs2` a workspace called `MISC` can be used for hosting the vnc window on the `psrdfb`.

The vnc session is be opened by giving in a `nuraghe-obs2` 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 teh 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 coloured labell at the right of the `tkds` label indicates whether the connection has been established (green background, text `CONNECTED`) or not (red bekground, text `DISCONNECTED`). If no connection is active, by clicking on this coloured 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 tecnical 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 - Setup files

Setup files are useful tools in both running a manual observation and preparing a schedule. In the first situation, the user can set in SEADAS all observation's parameters by loading a text file, instead of manually setting them all in the GUI. In the second situation, the structure of a schedule becomes very simple, straightforward human readable.

Setup files must be placed in folder `/home/corr/setup/[project code]` where `[project code]` is the **code** assigned to the project by the Time Allocation Comitee (TAC). This folder can be created by the user, it can be also organized in subfolders, and files can be placed in any of them.

All necessary informations can be in principle written in a single file, but this option may result in files containing several tens of rows. For this reason setup files can be organized in a hierarchical scheme, namely:

- 1) **GENERAL** setup file, where all session parameters are set, and the **ANTENNA** and **BACKENDS** setup files are indicated;
- 2) **ANTENNA** setup file, where all paramters are set for configuring the antenna;
- 3) **BACKEND** setup files, where all data acquisition parameters are set for the related bakend.

It is strongly recommended to adopt the hierarchical scheme when preparing the observation/schedule setup file. All settings for a given backend have to be placed in the same file; settings for different backends must be placed in separated files.

In setup files the syntax for setting a parameter takes the form of a value assignment:

```
[keyword] = [value(s)]
```

where `[keyword]` is keyword that identifies the parameter to be set and `[value(s)]` is a string containing the value(s) to be assigned. Here is an example:

```
ProjectCode = RFITEST
```

A given keyword may require one or more values to be specified. In the latter case, values are separated by the comma ',' character. Example:

```
Source = J0737-3039A , J2000 , 07:37:51.248419 , -30:39:40.71431
```

Unless explicitly indicated, a keyword requires one value only to be specified. A file line can contain the value assignment for one keyword only. Comments are also allowed in setup files. Any text placed at the right side of the # character is a comment. Examples:

```
Source = B0329+54           # this is a comment  
# this is another comment
```

The general setup file

The general setup file contains all informations about the observing session, the antenna configuration and the backend(s) to be used. It can also contain the name of a source to be observed, possible pointing offsets with respect to the source coordinates, the telescope azimuth sector and the observation length.

In the general setup file, settings for the antenna have the following syntax:

```
ANTENNA > [antenna setting]
```

where [antenna setting] can be:

- 1) `Setup = [projectcode]/[file name]`: this line loads the antenna's setup file, which is mandatory located in folder `/home/corr/setup/[projectcode]`, or a subfolder of it.
- 2) `[keyword] = [value(s)]`: this line assigns the value [value(s)] to the antenna's parameter identified by the keyword [keyword] (see antenna sections for allowed keywords and related syntax).

Similarly, settings for backends have the following syntax:

```
[backend identification code] > [backend setting]
```

where [backend identification code] is a three character code that identifies the backend, and [backend setting] is one of the following strings:

- 1) `DISABLE` or `ENBLE`: this line disables/enables the backend
- 2) `Setup = [projectcode]/[file name]`: this line loads the backend's setup file, which is mandatory located in folder `/home/corr/setup/[projectcode]`, or a subfolder of it.
- 3) `[keyword] = [value(s)]`: this line assigns the value [value(s)] to the backend's parameter identified by the keyword [keyword] (see backends' sections for allowed keywords and related syntax).

Keywords list and syntax

`AzSector(*)` - The telescope's azimuth sector to be used for pointing the antenna. Allowed values are `CW` for the clockwise sector, `CCW` for the counterclockwise sector, `NEUTRAL` for letting the pointing system to automatically choose the best sector. If unsure use the value `NEUTRAL`.

`ObserverName` - The name of the observers. Any text string is an allowed value.

`ObsLength` - The observation length in seconds. Its allowed values are integer numbers

only.

`Offsets(*)` - Pointing offsets with respect to the source coordinates. Two syntaxes are allowed:

```
Offsets = OFF
```

No offsets are applied to the source coordinates.

```
Offsets = [coordinate system],[long. offset],[lat. offset]
```

[coordinate system] is the coordinate system in which offsets value are expressed. Allowed values are J2000 (celestial coordinates) and AZ/EL (horizontal coordinates). [long. offset] is the offset in decimal degrees to be applied to the right ascension or the azimuth coordinate while [lat. offset] is the offset in decimal degrees to be applied to the declination or the elevation coordinate, accordingly to the value of [coordinate system].

`ProjectCode` - The project code, i.e. the code assigned by the TAC.

`ProjectName` - The project name. Any text string is an allowed value.

`Source(*)` - The source name and its coordinates. Two syntaxes are allowed.

```
Source = [source name]
```

The source whose name is [source name] is set with its J2000 catalogue coordinates.

```
Source = [source name],[coordinate system],[longitude],[latitude]
```

The source whose name is [source name] is set with coordinates [longitude] and [latitude], expressed in the [coordinate system] coordinate system. Allowed values for [coordinate system] are J2000 (celestial coordinates) and AZ/EL (horizontal coordinates). [longitude] is the right ascension or the azimuth value, [latitude] is the declination or elevation value, accordingly to the value for [coordinate system].

Keywords indicated by the (*) mark denote parameters, whose values can be set in both the general and the antenna setup file. The syntax is the exactly the same, regardless on the file where settings for these parameters are placed.

General setup file template:

```
ProjectCode = RFITEST
ProjectName = RFI investigation tests
ObserverName = Bachisio Angius
ObsLength = 7200
Source = B0329+54
AzSector = CCW
Offsets = J2000,0.5,1.5
ANTENNA > Setup = RFITEST/antenna-setup.txt
DFB > ENABLE
DFB > Setup = RFITEST/dfb-search.txt
DFB > Bandwidth = 512.000
```

The antenna setup file

The antenna setup file contains the entries for selecting and configuring the receiver, enabling or disabling the calibration source, and setting the active surface shape. In this setup file, entries are also allowed for the Source name and coordinates (keyword `Source`), the pointing offsets (keyword `Offsets`), and the azimuth track sector (keyword `AzSector`); see previous section for details about their syntax.

Keywords list and syntax

`ActiveSurface` - The shape and behaviour of the active surface. Allowed values are:

- `Parabolic` - The shape is set to `parabolic` and the surface is continuously controlled.
- `ParabolicFixed` - The shape is set to `parabolic` and the surface is kept fixed.
- `Shaped` - The shape is set to `shaped` and the surface is continuously controlled.
- `ShapedFixed` - The shape is set to `shaped` and the surface is kept fixed.
- `ReceiverDefault` - Each receiver has been assigned a default configuration for the active surface. These defaults are `ParabolicFixed` for the L-Band, P-Band and LP-DUAL receiver, `Shaped` for the C-BAND receiver. If unsure use this value.

`CalSource` - This keyword allows to switch ON and OFF the calibration source. It must be placed after the `Receiver` keyword. Values are ON and OFF, with an obvious meaning.

`Receiver` - The receiver to be used and its configuration parameters. Its syntax is:

```
Receiver = [receiver name],[receiver parameters]
```

where `[receiver name]` is the name of the desired receiver and `[receiver parameters]` is a sequence of comma separated values. The number and meaning of these values depend on the selected receiver.

P-BAND

```
Syntax: Receiver = P-BAND,[frequency filter],[polarization]
```

`[frequency filter]`: a one digit number that identifies the receiver's frequency filter (see NURAGHE manual for details);

`[polarization]`: values are `Circular` or `Linear` with obvious meaning;

L-BAND

```
Syntax: Receiver = L-BAND,[frequency filter],[polarization],[local oscillator frequency]
```


[frequency filter]: a one digit number that identifies the receiver's frequency filter (see NURAGHE manual for details);
[polarization]: values are Circular or Linear with obvious meaning;
[local oscillator frequency]: the frequency in MHz of the local oscillator for signal's downconversion (see NURAGHE manual for the range of allowed values).

LP-DUAL

Syntax: Receiver = LP-DUAL,[P-BAND frequency filter],[P-BAND polarization],[L-BAND frequency filter],[L-BAND polarization],[L-BAND local oscillator frequency]

[P-BAND frequency filter]: a one digit number that identifies the P-BAND receiver's frequency filter (see NURAGHE manual for details);
[P-BAND polarization]: P-BAND polarization mode: Circular or Linear;
[L-BAND frequency filter]: a one digit number that identifies the L-BAND receiver's frequency filter (see NURAGHE manual for details);
[L-BAND polarization]: L-BAND polarization mode: Circular or Linear;
[L_BAND local oscillator frequency]: the frequency in MHz of the local oscillator for the L-BAND signal's downconversion (see NURAGHE manual for the range of allowed values).

C-BAND

Syntax: Receiver = C-BAND,[local oscillator frequency],[bandwidth]

[local oscillator frequency]: the frequency in MHz of the local oscillator for signal's downconversion (see NURAGHE manual for the range of allowed values).
[bandwidth]: the width in MHz of the receiver's frequency filter. NURAGHE manual contains the allowed values. Due to a still unfixed bug, values have to be specified with only one decimal digit. Example: if the desired bandwidth is 300MHz, the string 300.0 has to be specified.

Antenna setup file templates:

P-BAND template:

```
ActiveSurface = ReceiverDefault  
Receiver = P-BAND,2,Linear  
CalSource = OFF
```

L-BAND template:

```
ActiveSurface = ReceiverDefault  
Receiver = L-BAND,4,Linear,2188.000
```

CalSource = OFF

LP-DUAL template:

ActiveSurface = ReceiverDefault

Receiver = LP-DUAL,2,Linear,4,Linear,2188.000

CalSource = OFF

C-BAND template:

ActiveSurface = ReceiverDefault

Receiver = C-BAND,5800.0,730.0

CalSource = OFF

The backend setup file

The backend setup file contains entries for setting the data acquisition parameters for a given backend. Data acquisition parameters can be divided in two groups. To the first one those parameters belong, that are common to any backend (e.g. the central value and width of the frequency band, the number of frequency channels, etc.). To the second group those parameters belong, that are specific for a given backend (e.g. the cycle period for the Pulsar Digital Filterbank). Keywords for first group parameters are illustrated in this section, while keywords for second group parameters are illustrated in the related backend section. Complete templates are provided for each backend at the end of the related sections.

Keyword list and syntax

Bandwidth - The width in MHz of the frequency band (e.g. 512.000).

BitsPerSample - The number of bits to represent each data sample (1,2,4,8)

ChannelWidth - The width in MHz of each frequency channel (e.g. 0.500).

Frequency - The value in MHz of the central frequency (e.g. 1548.000).

InvertedFreqs - YES if the observing band is inverted after signal's down conversion, else NO (case insensitive).

Mode - The data acquisition mode. See each backend section for the allowed values .

NumberOfChannels - The number of channels in the frequency band (e.g. 512).

NumberOfPols - The number of polarization to be recorded. values are 1 = total intensity , 2 = left and right intensity only, 4 = left and right intensity and phase

ProfileBins - The number of bins in profile (pulsar FOLD mode only, integer powers of 2)

SubintTime - The subintegration's time (seconds, pulsar FOLD mode only)

SamplingTime - The sampling time (microseconds, pulsar SEARCH mode only)

Pulsar Digital Filterbank setup file

The Pulsar Digital Filterbank is identified in the general setup file by the keyword **DFB**. Its custom parameters' keywords are illustrated here below.

Keyword list and syntax

CalPars - Parameters for the calibration source. The syntax is:

CalPars = [cal phase],[cal width]

where [cal phase] is the pulse phase at which the cal signal rises, and [cal width] is the width of the cal signal. Both values are float numbers between 0.0 and 1.0 in units of the pulsar period.

ChannelRange - The channel range to be acquired. Values are **all** => all channels, **ch1-ch2** => channel range (e.g. 20-980)

ConfigFile - The Pulsar Digital Filterbank configuration file. See the related documentation for the allowed configurations.

Cycle - The cycle period, between 2 and 30 seconds.

MaxFileLength - The maximum file length in seconds (pulsar **SEARCH** mode only, integer values, 0 = unlimited length)

Mode - The data acquisition mode. Allowed values for this backend are **FOLD**, **PSRCAL**, **SEARCH**, **SEARCHSET**.

ObservationType - The observation type: **NORMAL**, **WBPSR**. Set **WBPSR** for all pulsar modes.

SamplesSubint - The number of samples for each data block (**SEARCH** mode only, integer power of 2)

TimeConstant - The time to calculate the average bandpass in seconds (integer values greater or equal to 1. If unsure use 1)

writeFile - **YES** means that data are written on file, **NO** means that no file is open for writing data. Ignored in **SEARCHSET** mode.

Pulsar Digital Filterbank template for pulsar FOLD mode

```
Mode = FOLD
Frequency = 1548.000
Bandwidth = 512.000
InvertedFreqs = No
ChannelWidth = 1.000
SubintTime = 60
NumberOfPols = 4
BitsPerSample = 8
ObservationType = WBPSR
ConfigFile = pdfb3_512_512_512
ChannelRange = all
writeFile = YES
Cycle = 10.000
```

Pulsar Digital Filterbank template for pulsar PSRCAL mode

```
Mode = PSRCAL
Frequency = 1548.000
Bandwidth = 512.000
InvertedFreqs = No
ChannelWidth = 1.000
SubintTime = 60
NumberOfPols = 4
BitsPerSample = 8
ObservationType = WBPSR
ConfigFile = pdfb3_512_512_512
ChannelRange = all
writeFile = YES
Cycle = 10.000
CalPars = 0.25,0.50
```

Pulsar Digital Filterbank template for pulsar SEARCH mode

```
Mode = SEARCH
Frequency = 1548.000
Bandwidth = 512.000
InvertedFreqs = NO
ChannelWidth = 2.000
SamplingTime = 125
NumberOfPols = 1
BitsPerSample = 1
ObservationType = WBPSR
ConfigFile = srch_512_128
ChannelRange = all
TimeConstant = 1
MaxFileLength = 0
writeFile = YES
Cycle = 10.000
SamplesSubint = 512
```

Pulsar Digital Filterbank template for pulsar SEARCHSET mode

```
Mode = SEARCHSET
Frequency = 1548.000
Bandwidth = 512.000
InvertedFreqs = NO
ChannelWidth = 2.000
SamplingTime = 125
NumberOfPols = 1
BitsPerSample = 1
ObservationType = WBPSR
ConfigFile = srch_512_128
ChannelRange = all
TimeConstant = 1
MaxFileLength = 0
Cycle = 10.000
SamplesSubint = 512
```

6 - Schedule files

A schedule is a file that contains informations about all observations to be done in an observing run. A schedule file is organized in rows, i.e. each row contains all informations about one and one only observation. Here below is a schedule example:

```
Source = B0329+54 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B0355+54 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B0950+08 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B1929+10 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B1933+16 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B1952+29 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B2020+28 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
Source = B2021+51 ; ObsLength = 1800 ; Setup = RFITEST/seadas-dfb-Cband.txt
```

Each row contains value assignments to parameters, separated by the semicolon character ';'. There are no limits on the number of lines in a schedule file and of entries in each row. It is strongly recommended to reduce as much as possible the number of entries in each line by making use of setup files. The above schedule example also shows lines with the essential entries, namely the source name, the observation length (keywords `Source` and `ObsLength`, see the general setup file section for details) and the global setup file (keyword `Setup`, see below).

All parameters that can be set in a setup file, can be also set in a schedule file. They are set by using the same keywords and the same syntax as in the **general setup file**. Backend identification codes are also the same to be used in the **general setup file**.

Other parameters can be set only in a schedule file and are NOT allowed in any setup file. These parameters are name and path of the general setup file, the observation's UTC start and stop or the wait time before the data acquisition start.

The general setup file is indicated with the following syntax:

```
Setup = [projectcode]/[file name]
```

where `[projectcode]` is the project code and indicates that the general setup file is placed in `/home/corr/setup/[projectcode]`, and `[file name]` is the name of the file.

The observation's UTC start, keyword `ObsStartHour`, and UTC stop, keyword `ObsStopHour`, and the observation length, keyword `ObsLength`, allow to manage the timing of a data acquisition. UTC start and stop allowed values are expressed in the `HH:MM:SS` format, if the user wants to set a value for them, or assume the value 0 if the user wants to leave them unset. The observation length can be also left unset by setting `ObsLength = -1`. Several timing options are allowed.

1) `ObsLength = [obs. length] ; ObsStartHour = 0 ; ObsStopHour = 0`

The observation starts as soon as the telescope tracks the source, and lasts as indicated

by `ObsLength`.

2) `ObsLength = [obs. length] ; ObsStartHour = HH:MM:SS ; ObsStopHour = 0`
The observation starts at the UTC indicated by `ObsStartHour` or as soon as the telescope tracks the source, depending on which condition occurs last. The observation will last as indicated by `ObsLength`.

3) `ObsLength = [obs. length] ; ObsStartHour = 0 ; ObsStopHour = HH:MM:SS`
The observation starts as soon as the telescope tracks the source. It lasts as indicated by `ObsLength` or at the UTC indicated by `ObsStopHour`, depending on which condition occurs first.

4) `ObsLength = -1 ; ObsStartHour = 0 ; ObsStopHour = HH:MM:SS`
The observation starts as soon as the telescope tracks the source, and ends the UTC indicated by `ObsStopHour`.

5) `ObsLength = [obs. length] ; ObsStartHour = HH:MM:SS ; ObsStopHour = HH:MM:SS`
The observation starts at the UTC indicated by `ObsStartHour` or as soon as the telescope tracks the source, depending on which condition occurs last. It lasts as indicated by `ObsLength` or at the UTC indicated by `ObsStopHour`, depending on which condition occurs first.

Instead of explicitly setting the UTC start, the data acquisition start can be delayed by inserting in the observation line the string:

`Wait = [delay]`

where `[delay]` is expressed in seconds. The antenna and backend configuration, as well as the telescope's slewing to the source coordinates, will begin when the schedule line is read. In this way the given delay is, within few seconds, the effective time lag since the end of the previous data acquisition to the beginning of the current one.

A schedule line is processed only after the previous observation (if any) is finished. This means that in order to be sure that an observation starts at a given UTC, the schedule line for the previous one should contain an opportune UTC stop value.

Schedule files must be placed in folder `/home/corr/scheds/[project code]` where `[project code]` is the **code** assigned to the project by the TAC. If it does not exist, this folder can be created by the user as subfolder of `/home/corr/scheds` folder. It can be in turn organized in subfolders, and files can be placed in any of them.

7 - Observations checklist

This section illustrates a crude checklist for setting up and conducting a pulsar observing session. The reader is kindly asked to have entirely read all previous sections of this document before following this check while running an observing session.

Part 0: before starting the session

- Place your seadas setup files in folder: `corr@seadas:/home/corr/setup/[your project code]`
- Place your seadas schedule file in folder `corr@seadas:/home/corr/scheds/[your project code]`

Part 1: unstowing the antenna

If the antenna is stowed, it has to be unstowed following the procedure indicated in NURAGHE handbook. The procedure can be found at the following link:

<http://discos.readthedocs.org/en/latest/user/srt/source/Checklist.html>

in the box under the label **Initial setup**.

If the antenna azimuth position is above 82 degrees, in the OperatorInput terminal of Nuraghe console give the following command:

- `goTo=*,81.9d`

Part 2: opening seadas

- In nuraghe-obs1 open a terminal
- Give the following command: `vncviewer seadas:1`
- Type the password at prompt (ask staff for it)
- In the vnc window open a terminal
- Give the command: `seadas`
- In the log frame of seadas main window check that seadas connects to nuraghe
- Click on the red label at the top right corner of the *Antenna and Pointing Management* frame.
- Check that the clicked label becomes green and displays the word "ENABLED"

Part 3: setting up the DFB

- Ask the SD to verify that the DFB is correctly cabled for the requested receiver
- Ask the SD to verify that the DFB is switched on

- In nuraghe-obs1 open a terminal
- Give the command: vncviewer psrdfb:2
- Type the password at prompt (ask staff for it)
- Verify the system clock (see appendix A for procedure)
- In the vnc window open a terminal
- Give the command: /home/corr/software/seadas/bin/dfbcontroller
- In dfbcontroller window, check that the colored label at the right of the "tkds" label is green and displays the word "CONNECTED". If not, click on it.

Part 4: starting the observing session

All actions have to be done on SEADAS window

- Verify and adjust attenuation levels (see appendix B for procedure). **This procedure must be repeated whenever the frequency bandwidth and/or receiver is changed.**

Part 4a: manual driven observation

- Select "Manual" in the "Session mode" combo box
- Load your setup file or manually set all observation parameters
- Modify parameters in the GUI, if necessary
- Click "Observe"

Part 4b: schedule session

- Select "Schedule" in the "Session mode" combo box
- Click "View obs list". A window named "Observations List" pops up
- Click "View schedule". A window named "Schedule Manager" pops up
- Click "Load sched" in "Schedule Manager" window. A system window pops up for browsing system directories and selecting the schedule file
- In "Schedule manager" window select schedule lines to be done (mouse left click on each single line) or click button "Select all" for loading the entire schedule in the "Observations List" window
- If necessary, rearrange the order of the observations in the "Observations List" window (left button click == cut line ; mid button click == paste line)
- Click "Observe"

Part 5: closing the session

- Close SEADAS
- Close the vnc session on seadas
- Close, in the given order, dfbcontroller, tkds and dfb3
- Close the vnc session on psrdfb
- Switch off the PDFB
- Park the antenna by following the procedure indicated in NURAGHE manual.

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 10.

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 desired 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 desired 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.

8 - Troubleshooting

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

Part 1: NURAGHE problems

For any problem with NURAGHE, stop any data acquisition and refer to NURAGHE 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 nuragheConsole, 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 desired 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 desired source, by looking at the informative terminals of nuragheConsole 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 nuragheConsole, 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 desired 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 and relaunching dfbcontroller, the PDFB 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 desired source, by looking at the informative terminals of nuragheConsole 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 desired 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