DW user Documentation

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Dish Washer (dw) is a software for RFI (Radio Frequency Interference) identification and mitigation on signals collected by single dish radiotelescope.

Dw is in active development state, be forewarned it may be buggy!

CHAPTER ONE

DESCRIPTION

Dish Washer (DW) is a software for RFI (Radio Frequency Interference) detection and mitigation on signals collected by single dish radiotelescopes.

It is developed at the Institute for Radioastronomy - National Institute for Astrophysics (IRA-INAF), Bologna, Italy

DW is a python package providing tools for detection and flagging of RFI on data collected from single dish radiotelescopes. It provides GUI and command line interface through an interactive python console (i.e. iPython). Currently, together with DW, is shipped *libdw*, a C library aimed to provide efficient implementation of RFI detection algorithms. The library is installed with the python package. In the future the library will eventually distributed independently.

The software is intended to work primarily with data acquired with ...

Dw is in active development state, be forewarned it may be buggy!

CHAPTER

TWO

DATA FORMATS

Currently the supported data format is:

- *fits*: the Flexible Image Transport System

Limited features for *hdf5* (the Hierarchical Data Format 5) support have been included but currenlty they are not working for data flagging.

fits

DW support the *fits* file format with the specifications defined for the Italian radio telescopes, see http://www.ira.inaf.it/Observing/download/MED-MAN-FITS-02.pdf

hdf5

DW does not have a complete support for the *hdf5*.

It was implemented in the fists stages of the developement for testing purpouses for the *roach board* custom output. In the future, if a standard will be defined, the support will be completed.

CHAPTER THREE

USER'S INTERFACES

DW provides basically two types of interface:

- a *Text user's interface*
- a *Graphical user's interface*

All the functionalities of DW are available with both interfaces except interactive data visulization/flagging, available with the *Graphical user's interface* only.

Text user's interface

The text user's interface to DW can be used with any interactive python interpreter.

The following preliminary steps are required to start working with DW in text mode.

Preliminary steps

Importing the module

```
import dw.core.data_def as dw
```

Instatiating a DW class

```
dwc = dw.DWData()
```

Opening and closing data

Opening a data file

```
dwc.open_data(filename, [filetype])
```

filename is a string containing the path to the opening file. *filetype* is a string denoting the fileype. Current available filetypes are:

- *fits*: SRT Nuraghe FITS data format
- *hdf*: DW data format in a HDF5 container
- *hdf_pola*: DW polarimeter format in a HDF5 container (experimental)

Closing a data file

```
dwc.close()
```

Retrieving data and metadata

Read a data table

```
m = dwc.dataset2np_array(i_dataset)
```

i_dataset is the index of the corrensponding dataset

m is an array of 2D numpy arrays which are the data of L and R polarizations

Read a polarimeter data table

```
m = dwc.polaset2np_array(i_dataset)
```

i_dataset is the index of the corrensponding dataset

m is an array of 2D numpy arrays which are the data of the stokes parameters (L, R, Q, U, I, V, Phi, P)

Retrieve data time scale

```
t = dwc.get_time_scale(i_dataset)
```

i_dataset is the index of the corrensponding dataset

t is a 1D numpy array containing the time values of the selected dataset samples

Retrieve data time scale in UT format

```
t = dwc.get_ut(i_dataset)
```

i_dataset is the index of the corrensponding dataset

t is a 1D numpy array containing the time values in UT format of the selected dataset samples

Retrieve data frequencies scale

```
f = dwc.get_freq_scale(i_dataset)
```

i_dataset is the index of the corrensponding dataset

f is a 1D numpy array containing the frequency values of the selected dataset samples

Retrieve data bandwidth

```
b = dwc.get_bandwidth(i_dataset)
```

i_dataset is the index of the corrensponding dataset

b is the dataset bandwidth

Retrieve data ascension

```
a = dwc.get_ascension(i_dataset)
```

i_dataset is the index of the corrensponding dataset

a is a 1D numpy array containing the 'per sample' dataset right ascension

Retrieve data azimuth

```
a = dwc.get_azimuth(i_dataset)
```

i_dataset is the index of the corrensponding dataset

a is a 1D numpy array containing the 'per sample' dataset azimuth

Retrieve data declination

```
d = dwc.get_declination(i_dataset)
```

i_dataset is the index of the corrensponding dataset

d is a 1D numpy array containing the 'per sample' dataset declination

Retrieve data elevation

```
e = dwc.get_elevation(i_dataset)
```

i_dataset is the index of the corrensponding dataset

e is a 1D numpy array containing the 'per sample' dataset elevation

Retrieve pointed source name

```
s = dwc.get_source(i_dataset)
```

i_dataset is the index of the corrensponding dataset

s is a 1D numpy array containing the 'per sample' pointed source name

Retrieve the 'on track' flag

```
t = dwc.get_on_track(i_dataset)
```

i_dataset is the index of the corrensponding dataset

t is a 1D numpy array containing the 'per sample' flag stating whether the source is on track (1 = pointing error < 0.1*HPBW) or not (0 = pointing error > 0.1*HPBW)

Correcting data

Open a correction file

```
dwc.open_correction(file_name)
```

file_name is a correction file generated by BPC (see *Band Pass Correction*)

Toggle corrections on data

```
dwc.toggle_correction()
```

This will switch the correction on (or off) while reading data from datasets. To check if the correction is active see the boolean value of:

```
dwc.correction
```

Flagging data

Create a new flagging set by rectangular area list

```
dwc.new_flagset(i_dataset, flag_areas)
```

i_dataset is the index of the corrensponding dataset

flag_areas is a list of areas to set as flagged (ymin, ymax, xmin, xmax)

Create a new flagging set from a list of arrays

```
dwc.array_flagset(i_dataset, flag_arrays)
```

i_dataset is the index of the corrensponding dataset

flag_arrays is a list of numpy arrays (same shape as data) representing the flagging sets

Retrieve the list of the flagging sets belonging to the selected dataset

```
dwc.get_flagsets(i_dataset)
```

i_dataset is the index of the corrensponding dataset

Read flag data table

```
f = flagset2np_array(i_dataset, k_flagset)
```

i_dataset is the index of the corrensponding dataset *k_flagset* is the key of the flagset in the flagsets dictionary

f is a 2D numpy array of the dimensions of the data which rappresent the matrix of the *k_flagset* of the *i_dataset* dataset

To obtain a dictionary of all the flasgsets of a given dataset

```
d = flagsets2np_array(i_dataset)
```

Merge flagging sets

```
dwc.merge_flagsets(i_dataset, k_flagsets)
```

i_dataset is the index of the corrensponding dataset

k_flagsets is a list of keys of flagsets to merge

Delete flagging sets

```
dwc.del_flagset(i_dataset, k_flagset):
```

i_dataset is the index of the corrensponding dataset

k_flagset is the key of the flagset in the flagsets dictionary

Delete flagging sets intersecating a rectangular area

```
dwc.del_sel_flag(i_dataset, rect_area)
```

i_dataset is the index of the corrensponding dataset

rect_area is a tuple rappresenting a rectangular area: (y_min, y_max, x_min, x_max)

Every flag area intersected by *rect_area* will be removed

Retrieve metadata related to the selected flagging set

```
md = dwc.get_flagset_meta(i_dataset, k_flagset)
```

i_dataset is the index of the corrensponding dataset

k_flagset is the key of the flagset in the flagsets dictionary

md is a dictionary containing the metadata

Copy the flag table to others files

```
dwc.propag_flagtable(filelist)
```

filelist is a list of file paths where the entries of the current flag table will be copied

Automatic flagging

Automatic flagging requires a minimum of two steps to be performed:

- flagging algorithm selection and initialization
- flagging computation

Optionally the user can:

- select algorithm's parameters
- select the algorithm's output (among the algorithm's available selection)

Algorithm selection and initialization

```
dwc.auto_flag_init(i_dataset, alg)
```

i_dataset is the index of the corrensponding dataset

alg is the RFI detection algorithm class.

The available algorthms can be listed using

```
dwc.get_rfi_dect_algorithms()
```

This method returns a dictionary whose keys are the RFI detection algorithm classes. The dictionary contains the name, a short description and a dictionary with the default paremeter's values.

Run the calculation

```
dwc.auto_flag_compute()
```

Flagging matrices are written in the data structure.

Selecting algorithm's parameters

Non default parameters can be selected either by passing a proper dictionary at the initialization

```
dwc.auto_flag_init(i_dataset, alg, **param_dict)
```

or by calling

```
dwc.auto_flag_upd_params(**param_dict)
```

Available parameters are algorithm dependent. Since currently implemented algorithm are for test purpouse, more detailed information about the algorithm's parameters can be found in the developer's documentation.

Selectiong algorithm's output

Each RFI detection algorithm can return more than one flagging matrix.

Available output matrices can be checked without

```
dwc.auto_flag_get_out()
```

The method returns a tuple containing a list with the available option and a dictionary with the current selection.

Output matrices can be selected when invoking the algorithm's computation

```
dwc.auto_flag_compute(out_list)
```

out_list is a list of labels name for the selected output matrices

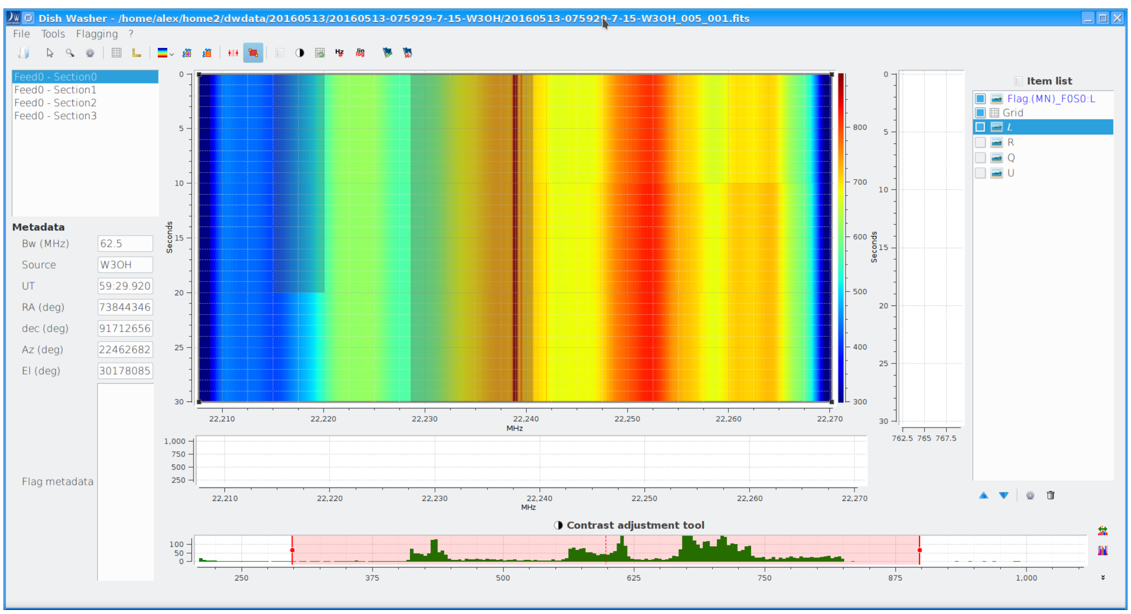
Since currently implemented algorithm are for test purpouse, more detailed information about the output matrices can be found in the developer's documentation.

Graphical user's interface

The graphical users's interface provides access to the DW functionalities available with the text interface and data visualization.

Interface elements

In this Figure an example of the DW GUI is given.



The GUI consists of several panels:

Datasets and metadata

On the left side of the GUI there:

- ***top*: a list of selectable datasets found in the file.** A data file may contain data from a number of feeds, each contaning information from a number of spectral sections. In the above example, the observation has been done with a mono-feed receiver (there is only Feed 0) and contains data from the four different spectral sections delivered by the backend. In this panel one can select the proper combination of feed+spectral section, and the correspondent data are shown in the waterfall plot (see below).

- ***bottom*: a number of metadata characterizing the observation and flagging.** Observational metadata are taken from the headers of the FITS files. Flagging metadata are listed if data already contain a flagging table (see next chapters). The listed metadata are:
  - *Bandwidth:* Is a float number expressing the bandwidth of the dataset, in MHz.
  - *Source:* Name of the observed source.
  - *UT:* UT of the observation.
  - *RA:* Right Ascension (degrees)
  - *Dec:* Declination (degrees)
  - *Az:* Azimut (degrees)
  - *El:* Elevation (degrees)
  - *Flag Metadata:* A list of metadata of the selected flag. These values depends of the method by which the flag was defined.

Item list

On the right of the main window there is an item list that displays data from the combination feed+section that has been selcted in the left panel. Typically, the L, R, Q, U (if present) are listed. Also the flagging regions are listed here, as well as other items like cross sections (see below).

DW differentiates between "visualization" and "action". The *visualization* of an item is regulated by its associated tickmark in the list. To actually *act* (i.e. perform flagging, cross sections etc.) with the available tools on one item, tickmarking is not enough. The item itself has to be highlighted by clicking on it with the mouse, and it becomes highlighted in blue.

The item list is equivalent to a hierarchy of layers in the central panel. If more than one item is tickmarked, the first item in the list is the visible layer.

The flagged regions are shown as grey areas of different transparency depending if they have been already saved in the data or not. Light grey is used for already saved flagging regions.

By default, a Grid item is always present and can be deactivated by un-tickmarking it.

Waterfall plot and cross-sections

At the centre of the GUI the waterfall image of the selected data is shown. The x and y axes of the image represent respectively frequency and time. Default units are respectively MHz and sec. On the sides of the image, there are two panels used to display the cross-section tool results.

Data cross sections are displayed by means of the *Cross section* tool, the *Average cross section*. The Average Cross Section computes and displays the cross section of data inside the selected rectangular region. Non-persistent cross section tool can be activated pressing *Alt* button and moving the mouse pointer over the data.

Data value in a given position can be retrieved by clicking the *Selection* button (the arrow button belo thw Tools menu) and then moving the mouse pointer on the image while keeping the Alt key pressed.

Contrast tool

At the bottom of the GUI there is a panel to control the contrast levels of the item selected from the data list.

As already said, this tool *acts* on the selected item of the data list, so the item must be selected and not only tickmarked.

Menus

File menu

- *Open:* start the open file dialog
- *Close:* close file
- *Quit:* quit DWData

Tools menu

- *Ipython console:* start the Ipython console (currently works only inside spyder for debug purpouse)
- *Band pass correction tool:* Start the BPC tool (see *Band Pass Correction*)
- *Open a correction file:* Load in DW a correction file generated by *Band Pass Correction*
- *Apply/unapply correction:* Apply/remove a correction file generated by *Band Pass Correction*.

Flagging menu

- *Flag:* create a flagging matrix from the selected areas (require area/s is/are selected usign a selecion tool)
- *Deflag intesected:* deflag all previous flags intersecting a rectangle area (require area/s is/are selected usign a selecion tool) **BUG: THIS FEATURE IS NOT WORKING PROPERLY IN CURRENT VERSION**
- *Delete selected:* delete the selected flagging areas
- *Flag widget:* start the flag widget to flag time and/or channels range
- *Propagate flag table to files:* Appy an existing flag table to other data. **NOT IMPLEMENTED YET**
- *Auto RFI detection:* start the automatic RFI detection widget

Toolbar buttons

- *Open file:* start the open file dialog.
- *Selection:* if enabled, by keeping the Alt key pressend data values and coordinates at the cursor position are displayed.
- *Rectangle zoom:* zoom on the selected area
- *Parameters:* open a dialog to set some visualization parameter
- *Grid:* open a dialog to set some grid visualization parameter
- *Axes style:* open a dialog to set some axis visualization parameter
- *Select colormap:* select the colormap for the active data
- *Cross section:* create a cross section item
- *Average cross section:* create an average cross section item. It displays the averaged cross sections of the selected area.
- *Channel range flagging:* manual tool to flag a channel (spectral) range. It creates a flagging item.
- *Area flagging:* manual tool to flag a rectangular. It creates a flagging item.
- *Item list manager:* toggle on/off the item list panel

- *Contrast panel:* toggle on/off the contrast panel
- *Grid:* toggle on/off the data grid
- *Toggle axis:* toggle axis measurement units from (MHz, sec) to (Channel Number -Time Sample).
- *Y scale toggle:* toggle on and off log scale on y axis **NB CHECK THIS **
- *Flag:* save the selected flagging items in the data flagging table. Multiple items can be selected and saved at once by keeping presseld the Shift key.
- *Deflag intesected:* deflag flagged regions intersected by a rectangular area **NOTE IT CURRENTLY ACTS ONLY ON FLAGGED ITEMS NOT ALREADY SAVED IN THE FLAG TABLE**

CHAPTER

FOUR

FLAGGING

Manual flagging

To mannually flag an area of the waterfall plot there are two tools:

- *Channel range flagging*
- *Area flagging*

They will create an element in the data list.

One or more of these elements can be selected and saved as a flagset with the command *Flag* found in the flag toolbar or in the flag menu.

Auto RFI detection

To run the *automatic RFI detection*:

- select *Flagging -> Auto RFI detection*.
- choose the detection algorithm to use and press *OK*
- change the default parameters if necessary, then press *OK*
- choose the flagging matrices to calculate.

Automatic detected RFI matrices are added to the data structure.

To see the available algorithms refer to next Section.

Automatic RFI Detection Algorithms

Currently only one automatic algorithm for RFI detection is implemented.

Simple Threshold Algorithm

Method: sigma-clipping.

Parameters: number of r.m.s. above the median data value.

The user defines the flagging threshold as a multiple of the data r.m.s. To help in this choice, the mean, median and r.m.s. for each data type (L, R, Q, U) are displayed. The user may chose to apply the flagging to one or more data types. In case more data types are to be flagged simultaneously, the proper threshold for each type is computed wit the related r.m.s. The algorithm identifies all the data above the threshold, creating a number of rectangular regions defining the flagged areas. These regions are displayed on the image and listed as a single item in the item list.

CHAPTER

FIVE

BAND PASS CORRECTION

The DW package includes also a tool for the *correction* of the band pass, BPC.

Note that this tool is not for calibration purposes and has not been tested yet.

The uderlying idea is to correct data for the shape of the bandpass, to make it easier the subsequent identification of RFI with dedicated automatic algorithms.

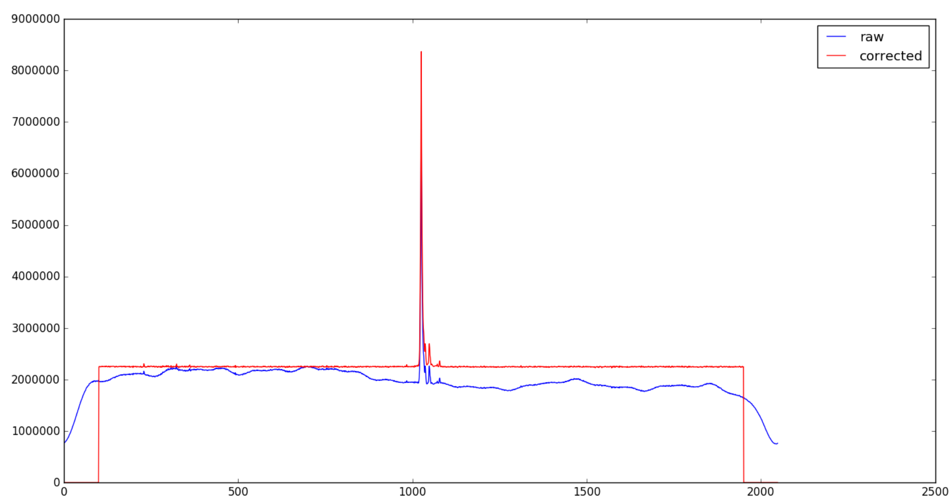
The bandpass shape is computed on raw data that are free from source and RFI signal. Such data must be carefully selected by the user, and are processed to derive a polynomial curve describing the bandpass shape that will be later used to correct the raw data themselves.

All data to be considered to compute a bandpass correction must reside in the same directory. This reflects the way fits data from the same scan are organized, following the scheme in use at the Italian radio telescopes,

The bandpass correction can be subdivided in the following steps:

- Select the useful data by automatically evalutating the median (in the time domain) of every subscan
- Build the bandpass curve by median-combining all the selected data
- Fit the bandpass curve
- Normalize the fit at peak value
- Divide each selected raw data by the normalized curve, create a new corrected data table and append it to the original file

An example of raw and corrected data is shown below.



BPC provide, like DW, two types of interface:

- a *Text user's interface*
- a *Graphical user's interface*

Text user's interface

The text user's interface can be used with any interactive python interpreter.

Peliminary steps

Importing the module

```
import dw.core.data_def as dw
```

This is the same DW module, and it will import also the text mode capabilities of BPC.

Instantiating a BPC class

```
bpc = dw.DWObs()
```

This instantiates a BCP data object.

DWObs is a class with the following attributes:

dir_name is the directory name

files_type is the extension of the files in the direcory

dir_datasets is a list of DW object DWData()

feeds is a list of feeds

sections is a list of sections

polars is a list of polarizations

dssel is the current selection of feed, section and polarization

Opening data

Opening an observation directory

```
bpc.open_dir(dirname, [filestype])
```

dirname is a string containing the path to the directory containing the data to be used for bandpass correction computations.

filestype is a string denoting the fileype of the files in the observation directory. Current available filetypes are:

- *fits*: DW data format in a FITS container

When a directory is opened, all the data files inside that directory are opened as DWData() objetcs and listed in the attiribute *dir_datasets*.

Retrieving data

Getting the median of a datasets

A dataset may be composed by one or more FITS data files.

```
bcp.get_median_data(ldataset, section, pol, lrangei, lranges, lexcluded)
```

ldatasets is a N-list of indices of the considered datasets

section is the index of the working section (starting from 0)

pol is the index of the working polarization (L=0, R=1, Q=2, U=3)

lrangei is a N-list of values of spatial samples at the beginning of each subscan to be used for computation of the median (for OTF scan observations). It assumes that a source, if prpesent, will not fall in the initial and final part of a subscan. A value equal to 0 means to use all the available spatial samples in the subscan.

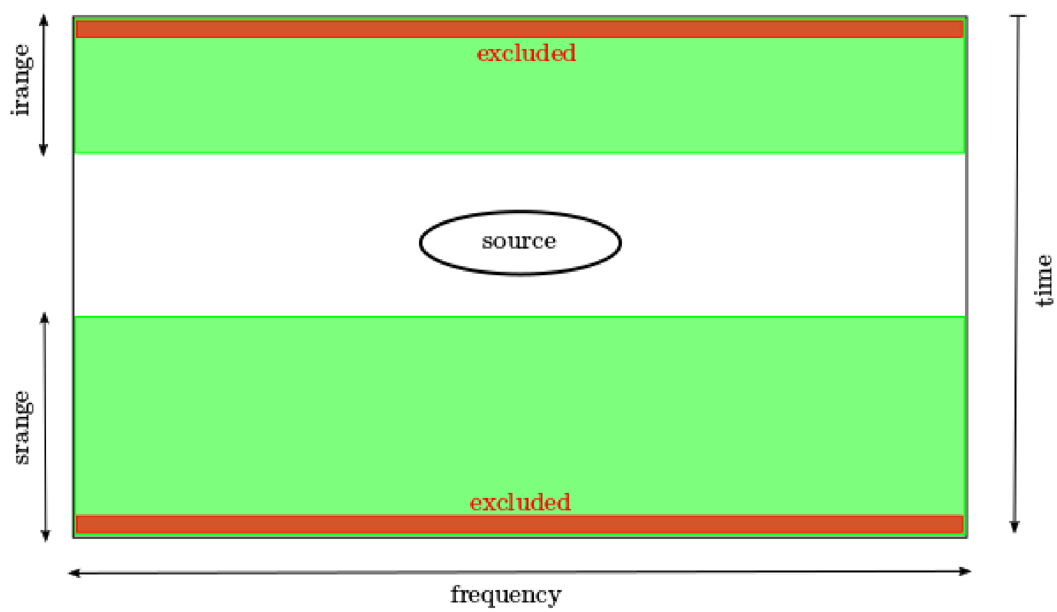
lranges is a N-list of values of spatial samples at the end of the subscan to be used for computation of the median (for OTF scan observations). It assumes that a source, if prpesent, will not fall in the initial and final part of a subscan. A value equal to 0 means to use all the available spatial samples in the subscan.

lexcluded is a N-list of values of spatial samples to be excluded at the beginning and at the end of a subscan.

It returns a list of two np-arrays [x, y].

This function has been designed to compute both the median of the time samples in a single file and the median of several concatenated files.

Once section and polarization are chosen, to build the median three values are needed for each file, provided by the lists *lrangei*, *lranges*, *lexcluded*.



The combination of these three parameters set the sample ranges at the begining and at the end of the subscan (green areas) to be used for median computing. The size of the red areas is described by the *lexcluded* parameter.

For example, on a subscan of *n* time samples if we set:

- *irange* = 100
- *srange* = 200
- *excluded* = 3

to compute the median the first 100 and the last 200 samples, excluding the fisrt and the last 3, will be used. These parameters are useful only in the case of an OTF scan.**NOTE THIS SENTENCE HAS TO BE CLARIFIED**

After the median computation, the values of feed, section and polarization are saved as current working dataset in the *dssel* attribute.**NOTE THIS SENTENCE HAS TO BE CLARIFIED**

Getting a preflag**NOTE THIS DESCRIPTION HAS TO BE CLARIFIED**

This function computes the fit of *data* using the specified fit type.

```
bcp.get_flag_curve(file_name, section)
```

file_name file in which there are the flag data

section is the section in use

It returns a nparraywhose elements are equal to one except for the flagged values, that are set to zero.

This function is useful if RFI is present in every data file and therefore it is not possible to find "clean" data for bandpass correction.

The result can be used as a weight for the fit funcion.

Fitting data

```
bcp.get_fit(fit_type, data, order, smooth, degree, begin, end, weight)
```

fit_type is the fit type. Aviable values are:

- *spline*
- *chebyshev*

data is a list of two nparray [x, y]

order is the spline order, ranging from 1 to 5 (default = 3, cubic spline)

smooth is a positive smoothing factor used to choose the number of knots. The bigger is *smooth*, the smaller is the number of the nodes.The number of knots will be increased until the smoothing condition is satisfied:

$$\sum_i (w(i)(y(i) - spl(x(i))))^2 \leq smooth$$

where *y* are the data, *spl* the spline functions and *w* the weights. The *order* and *smooth* parameters are meaningful only if *fit_type* is "spline" and are ignored otherwise.

degree is the degree of the chebyshev polynomial. This parameter is used only if *fit_type* is "chebyshev".

begin and *end* determine the range (in frequency samples) in which the fit is to be computed.

weight is a optional nparray which is used as weights in the fit computation.

It returns a list of two nparrays [x,y]

The correction curve is normalized at the peak and the points outside the fit range are set to value -1 ("diasabled").

Save an apply to data

The following functions are used to generate and update a bandpass correction file and to apply it to the observation files, generating tables of corrected data.

Generate and update the bandpass correction file

```
bcp.fitfile(file_name, fit)
```

namefile is the path of the new file

fit are the fit data

This function create or, if it already exists, update the file containing the bandpass correction curve and a list of the files of the observation.

Apply the correction to a set of files

```
bcp.applycorr(file_name, filelist)
```

namefile is the path of the correction file *filelist* is a list of path

The function *applycorr* applies the correction found in the *file_name* file to: * all the raw data files in the working directory (typically the scan directory,

> containing a number of subscan FITS files) if filelist is not specified, or
>
> - the files listed in the *filelist* parameter.

A FITS extension table called “CORR DATA TABLE” is created and appended to each raw data file.

This function divides the raw data by the normalized fit curve, setting data to zero where and where the normalized curve is “disabled” (curve value -1).

The CORR DATA TABLE is recognized by DW and can be used for RFI flagging operations.

Usage Example

Here is an example of tipical usage of the bandpass correction tool.

The first step is to instantiate the BPC class and to open the direcory:

```
import dw.core.data_def as dw
bpc = dw.DWObs()
bpc.open_dir("YYYYMMDD-HHMMSS-Project-Suffix/")
```

files and data are now in the attribute *dir_datasets*. For example, if one wants the title of the files in the form “Scan#.Subscan#” it is possible to write:

```
for f in bpc.dir_datasets:
        print f.title
```

To evalutate the median of a dataset some plotting tools are to be imported. For example to compute the median of the third file, feed 0, section 1, polarization R, full spatial sample, one could write:

```
from matplotlib import pyplot as plt
med = bpc.get_median_data([2], 0, 1, 1, [0], [0], [0])
plt.plot(med[0], med[1])
plt.show()
```

Once selected the files to be used (for example 2, 4, 5, 7), a global median can be generated:

```
gmed = bpc.get_median_data([2, 4, 5, 7], 0, 1, 1, [0, 0, 0], [0, 0, 0], [0, 0, 0])
plt.plot(gmed[0], gmed[1])
plt.show()
```

and the fit can be done. For example, chebyshev of 90th degree, from the 100th to the 1900th frequency sample:

```
fit = bcp.get_fit("chebyshev", gmed, 0, 0, 100, 100, 1900)
plt.plot(gmed[0], gmed[1], fit[0], fit[1])
plt.show()
```

Optionally, if all the available raw data are heavily contaminated by RFI and a "clean" dataset for bandpass correction cannot be selected, a correction file computed for a different (clean) dataset may be imported and used:

```
flag = bcp.get_flag_curve("flagged_file.fits", 1)
flag_fit = bcp.get_fit("chebyshev", gmed, 0, 0, 100, 100, 1900, flag)
plt.plot(gmed[0], gmed[1], fit[0], fit[1], flag_fit[0], flag_fit[1])
plt.show()
```

Once the fit is acceptable, we can save the data in a file:

```
bpc.fitfile("correction_filename.fits", fit)
```

or, if flagged **WHAT DOES THIS MEAN?**

```
bpc.fitfile("correction_filename.fits", flag_fit)
```

This step creates the file, if not existing, and fill thhat part of the table relative to the chosen dataset (feed 0, section 1 and polarization R in this example).

Once the bandpass correction file is filled, it is possible to apply it to all the raw data with:

```
bpc.applycorr("correction_filename.fits")
```

or to a selectd list of files:

```
bpc.applycorr("correction_filename.fits", [file1.fits, ..., fileN.fits])
```

Each raw data file will now contain an extension table with the bandpass corrected data.

Graphical user's interface

The Graphical User Interface of the bandpass correction tool provides all the text functionalities plus a graphical rappresentation of data.

The GUI can be launched with the command *bpcgui* or from the "tools" menu in DW.

Interface elements

Menu

File menu

Open: start the "open directory" dialog box.

Quit: quit the Bandpass Correction Tool.

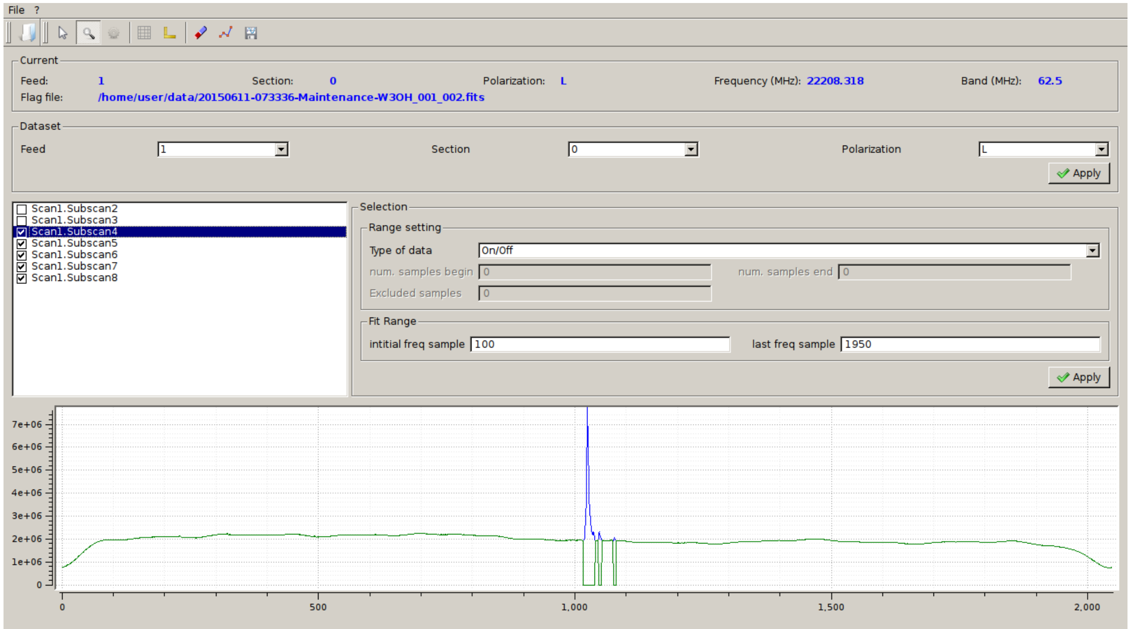
? menu

About: version information

Toolbar buttons

- *Open file:* start the open directory dialog box.
- *Selection:*
- *Rectangle zoom:* zoom on the selected area
- *Parameters:* open a dialog box to set some visualization parameter
- *Grid:* open a dialog box to set some grid visualization parameter
- *Axis style:* open a dialog box to set some axis visualization parameter
- *Get preflag:* open a file preflagged by DW **CLARIFY**
- *Fit:* open the fit window
- *Apply:* apply the correction curve to all, or part of, the data files in the directory

Main window



The main window, as we can see in the picture, is divided in five areas:

Current

A box with information on:

- *feed*
- *section*
- *polarization*
- *frequency*
- *bandwidth*
- *file for the preflag*

Dataset

A selector for the working dataset:

- *feed*
- *section*
- *polarization*

The *apply* button set the selected dataset. It will set the *dssel* parameter described in *Text user's interface*.

List

A list of files in the observation directory, selectable by means of checkboxes.

Here it is possible to select the files to be used for the correction curve (**NOTE: also its application?**).

Selection

The selection box is divided in two subboxes:

- *Range settings*
- *Fit range*

The *range setting* can be used to set the type of observation and to set a range of spatial samples to be used for the median computation:

- *type of data:* the type of observation. Values are: "On/Off", "Cross Scan" and "Map"
- *select region inf:* set a number of spatial samples at the beginning of the data to be used for the median computation. A value equal to 0 means to use all available samples.
- *select region sup:* set a number of samples at the end of the data to be used for the median computation. A value equal to 0 means to use all available samples.
- *excluded region:* set a number of samples at the beginning and at the end of the data to be excluded from the computation (useful to exclude ramps).

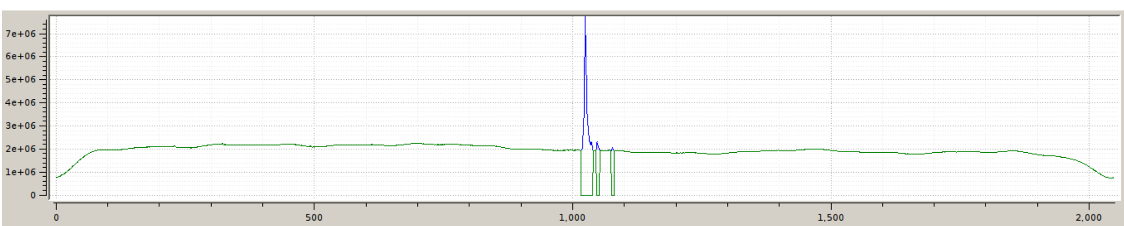
The *select region inf* and *select region sup* are active only if *type of datas* is "Cross scan" or "Map".

The *fit range* parameter sets a range for the computation of the fit. The fit is computed in the region included within *select fit region inf* and *select fit region sup*.

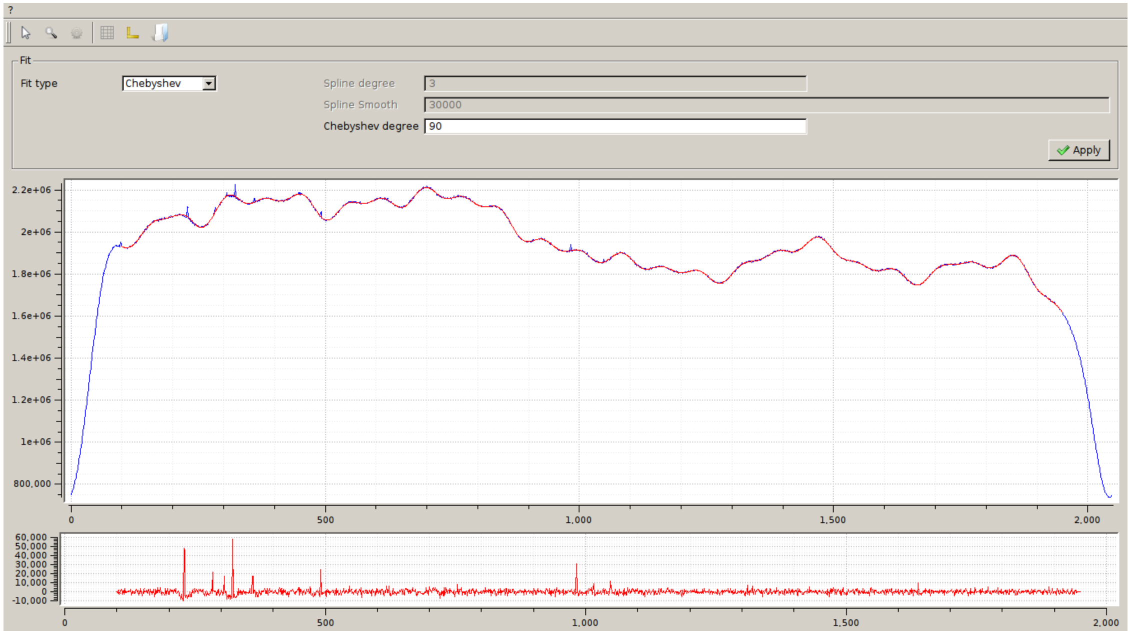
The *apply* button saves these settings and updates the plot.

Plot area

The area in which the median plot (blue) and median "cut" by preflagging, if applied (green) **[???]** are shown.



Fit Window



In the toolbar of the Fit Window the folowing buttons are available:

- *Selection:*
- *Rectangle zoom:* zoom on the selected area
- *Parameters:* open a dialog box to set some visualization parameter
- *Grid:* open a dialog box to set some grid visualization parameter
- *Axis style:* open a dialog box to set some axis visualization parameter
- *Save fit:* save the current fit to the "fit_data_correction.fits" file in the root direcory.

The fit window is divided in two areas:

- *fit settings*
- *view area*

Fit settings

These are:

Fit type is a selector for the type of the fit. Current supported types are: * *Spline* * *Chebyshev*

Spline degree and *Spline smooth* are free parameters for the spline method. The meaning of these parameters is explained in the *Text user's interface* section.

Chebyshev degree is the degree of the Chebyshev polynomes.

The button *apply* starts the computation and visualizes the result in the plot area.

Plot area

It is the area for visualizing the data (blue) and the fit (red).

Usage example

Operations needed to build the the bandpass correction file and to apply it to the raw data are the same of the text user interface case.

Once opened the directory of the observation, files browsing is possible thanks to the list widget. Also, selecting feeds, spectral sections and polarizations is possible using the dataset box.

In the case of OTF observing modes ("Cross scan" or "Map") the ranges of spatial samples to use are to be set, as explained in *Text user's interface*.

Tthanks to the checkboxes on the list widget, only the files whose median does not present excessive irregularities can be selected.

The fit window can be opened by means of the toolbar button. The window will show the median of all the selected files.

Some tests to obtain the best fit possibile can be done, and result can be finally saved by means of the toolbar button. Fit data will be saved in the file "fit_data_correction.fits" file.

Once closed the fit window, one can perform the same operation on some or all the feed/section/polarization combinations. Finally, the bandpass correction can be applied to all the raw data files and for each of them the FITS extension table containing corrected data is written.

Correction file

To be done.

CHAPTER

SIX

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Version 3, 29 June 2007

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To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively state the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

> <one line to give the program's name and a brief idea of what it does.> Copyright (C) <year> <name of author>
>
> This program is free software: you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation, either version 3 of the License, or (at your option) any later version.
>
> This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.
>
> You should have received a copy of the GNU General Public License along with this program. If not, see <http://www.gnu.org/licenses/>.

Also add information on how to contact you by electronic and paper mail.

If the program does terminal interaction, make it output a short notice like this when it starts in an interactive mode:

> <program> Copyright (C) <year> <name of author> This program comes with ABSOLUTELY NO WARRANTY; for details type 'show w'. This is free software, and you are welcome to redistribute it under certain conditions; type 'show c' for details.

The hypothetical commands 'show w' and 'show c' should show the appropriate parts of the General Public License. Of course, your program's commands might be different; for a GUI interface, you would use an "about box".

You should also get your employer (if you work as a programmer) or school, if any, to sign a "copyright disclaimer" for the program, if necessary. For more information on this, and how to apply and follow the GNU GPL, see <http://www.gnu.org/licenses/>.

The GNU General Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Lesser General Public License instead of this License. But first, please read <http://www.gnu.org/philosophy/why-not-lgpl.html>.

CHAPTER

SEVEN

SEARCH:

- search