



NIRSpec Technical Note NTN-2012-002

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Documentation for `sb_derive_focus.pro`

Abstract:

This document describes the purpose and usage of the `sb_derive_focus.pro` procedure. We also list the prerequisites necessary to run the program and provide a listing of its arguments and keywords.

1 INTRODUCTION

This document describes the `sb_derive_focus.pro` procedure, its usage and functionality. The intended use of `sb_derive_focus.pro` is to derive the best focus position of NIRSpec (in terms of the position of the RMA, the Refocus Mechanism Assembly). In order to accomplish this the program needs a sequence of pinhole image exposures taken with different RMA positions as input. The user then has to select a number of pinholes to fit, and the program computes a focus curve from these images.

In section 2 we list the necessary software to run the program. In section 3 we show how the procedure is run by means of two examples. In appendix A a brief description of all the arguments and keywords of the procedure is given.

2 PREREQUISITES

In order to run `sb_derive_focus.pro` the latest version of the NIRSpec Calibration Software and Database must be installed and correctly configured on your system. Please see Birkmann (2011) and Giardino & Sirianni (2011) for details on how to do this. Also make sure you are using the latest version of the program by checking out the `Software/JWST_IDL/lib/nirspec/` folder.

The program can make use of the NIRSpec database and the exposures in the archive. If that functionality is wanted, it needs to have access to both.

As the program will display SCA images in rather large windows, a computer screen with decent size and resolution (≥ 1080 pixels in vertical direction) is recommended.

3 RUNNING THE PROGRAM

3.1 Example 1: best focus of pinhole images through the fixed slits

In this first example we will determine the RMA position giving best focus (i.e. smallest FWHM) of the pinholes in the PHM imaged through the A-side fixed slits of NIRSpec. The data set we will use has the OBS_ID IMA_FOCUS_SHORT and was obtained during the NIRSpec FM cycle 1 calibration campaign during the confirmation phase. The NIDs for the corresponding test sequence can conveniently be identified using the `nar_find` tool (see Giardino & Sirianni 2011 for more details). In this example, they range from 6319 to 6337.

Start the NIRSpec IDL environment by typing

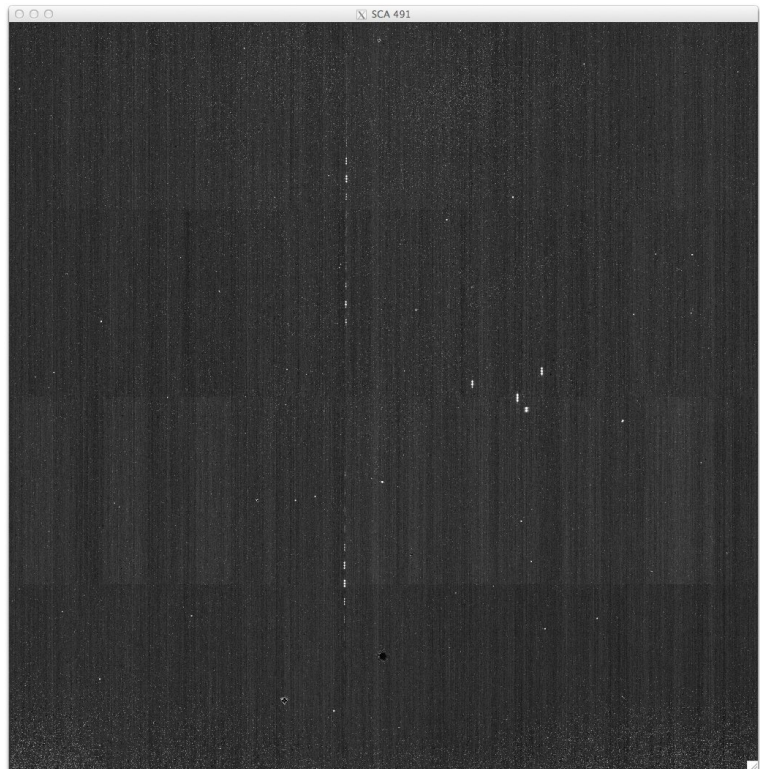
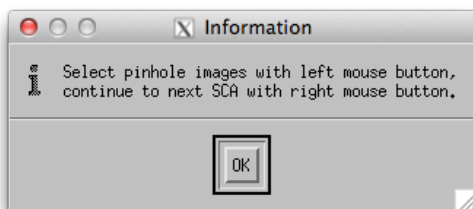
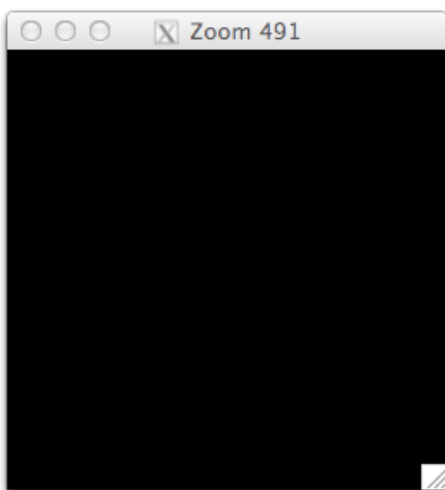
```
/> start_nirspec
```

You should now see the `NIRSpec>` prompt. Given that we already know the right range of exposures (NIDs 6319 to 6337) and that cycle 1 data is in general free of significant background, we can create the list of proper NIDs and launch the program by typing:

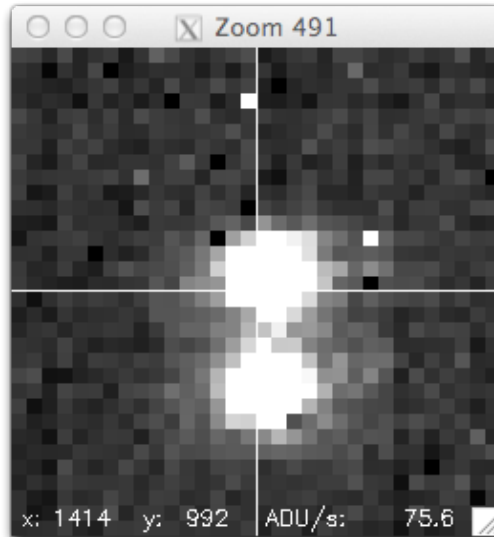
```
NIRSpec> nid = indgen(19)+6319
```

```
NIRSpec> sb_derive_focus, nid
```

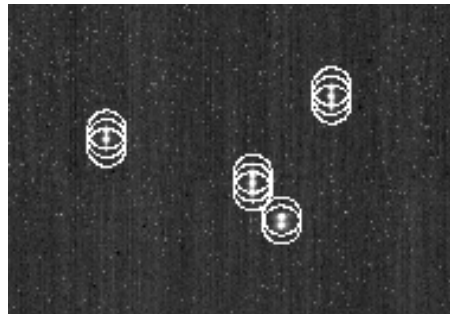
The program might take a while to locate and load the first exposure, but eventually you will be confronted with three windows in total. At the right there should be a large display named “SCA 491” showing the count rate image of SCA 491, in the center you should find a notification with some instructions, and in the upper left should be a smaller display window. Your screen should look similar to this (windows not to scale):



Once you have read the instructions, click “OK” to dismiss the dialog and move the mouse over the “SCA 491” window. You will notice that the smaller display window on the upper left will display a zoomed in region around the location of the mouse pointer:

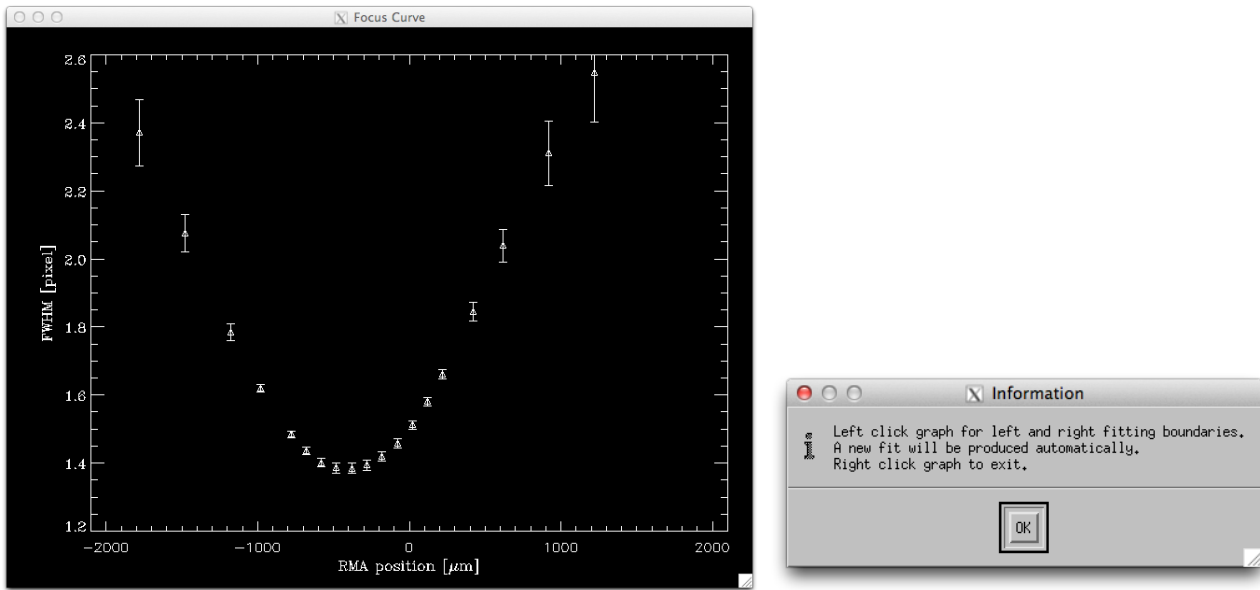


Now carefully select all the pinholes located in the fixed slits by left clicking approximately on their centers. You will notice a circle appearing around every pinhole you click. The region around the fixed slits should end up looking like this:

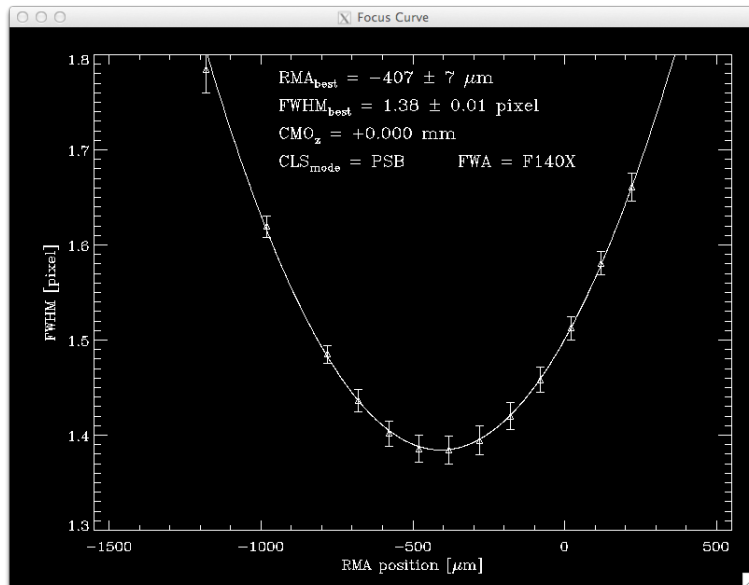


Click the right mouse button once you are done. The program will load the count rate image of SCA 492 of this exposure and display it in the large window, now titled “SCA 492”. Since there are no pinholes easily to identify here, do not select any and continue by clicking the right mouse button again.

The program will now go through all the exposures and fit a 2D Gaussian to the pinhole images, computing the average FWHM for each RMA position. You should see a progress meter in terms of percentage done in the NIRSpc IDL environment window. Once done, the program will display the FWHM plot in a window in the lower left named “Focus Curve” and an instructions window in the center:



Read the instruction and dismiss the notification by clicking “OK” once you are done. The program estimates the best focus position by fitting a parabola to the focus curve, so take a look at it and choose a left and right boundary for the fit that seems suitable to you with the left mouse button. You will see dotted vertical lines when you do so, and once you selected the right boundary the computed fit through the focus curve will be shown, which could look similar to this:



If you are unhappy with the fit for some reason, you can create a new one by selecting new boundaries as above. You can also show all points again by selecting only two or less data points e.g. by choosing a left boundary (first left click) that is larger (more to the right) than the right boundary. In that case you will get a warning message that you can dismiss by clicking “OK”.

Once you are happy with the fit click the right mouse button to continue. You will be asked whether you want to save the positions of the selected pinhole images to file, allowing you to re-run the program without the need to select pinholes by hand. If you answer “Yes” you will be prompted to select a name for the output file via a dialog window and the pinhole positions will be saved in a binary fits table.

Finally, you will be asked whether you want to create an encapsulated postscript file of the focus curve and fit. If you do you will again encounter a dialog in order to provide a file name for the eps output file.

3.2 Example 2: best focus of the RCSS through the A_1600 slit

In this second example we will determine the RMA position for best focus of the RCSS imaged in sub-array mode through the A_1600 slit. The exposures used were taken during the first calibration campaign and have the OBS_ID IMA_PSF, the NID values range from 5820 to 5934.

If not already done so start up the NIRSpec IDL environment like in example 1 above. Then, define the range of NIDs and start the program:

```
NIRSpec> nid = indgen(115)+5820
NIRSpec> sb_derive_focus, nid, /VERB, /RCSS
```

You will note that this time we told the program to be more verbose in its output during run time, and that the source we are looking at is the RCSS. Only effect of the latter switch is that the program will take the RCSS lamp settings when displaying the focus curve instead of the CLS ones.

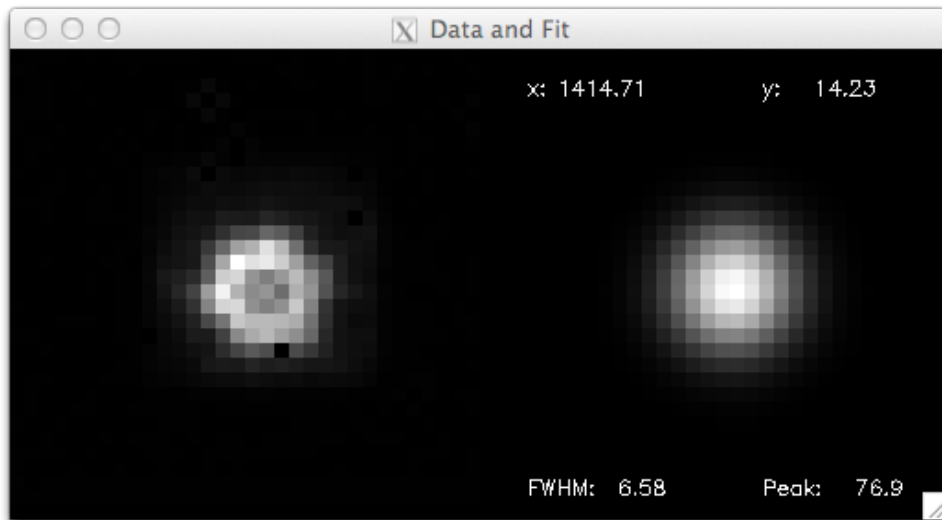
You will see again the two display windows and the notification popping up. This time the window on the upper right will have a rather small vertical dimension and should look similar to this:



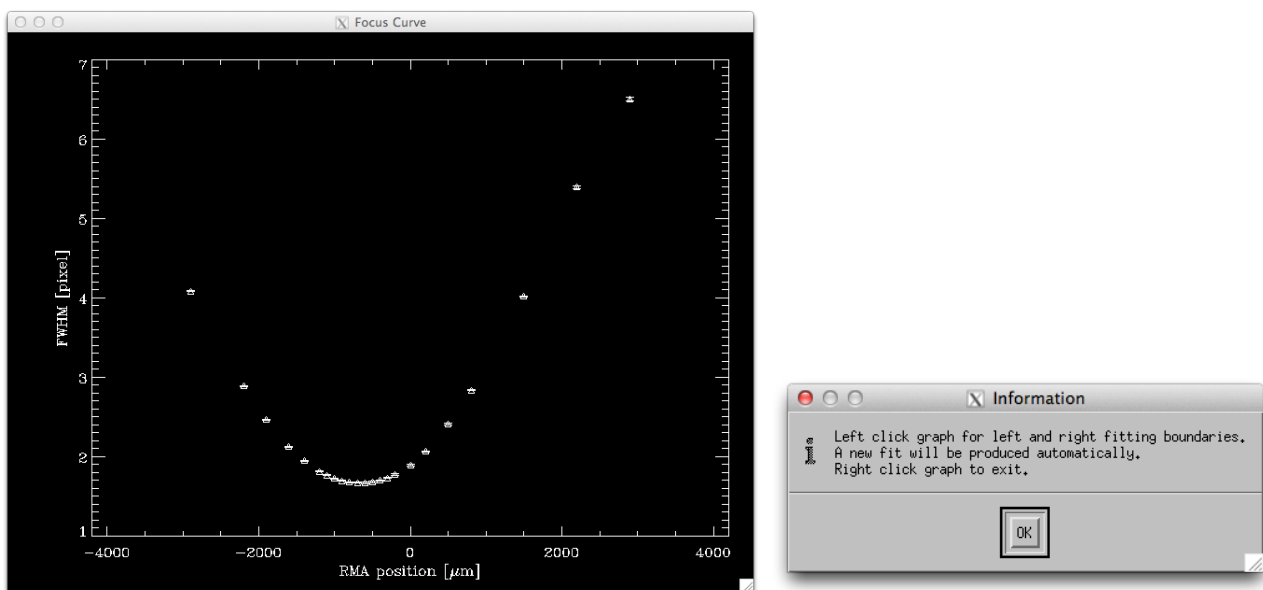
The reason for this is that the data was taken in sub-array mode in order to prevent saturation of the bright source.

Dismiss the instructions window by clicking “OK” and select the image of the RCSS point source with the left mouse button. You will notice that all you see is actually the full A_1600 aperture, illuminated by the RCSS halo. The zoomed in display on the left should help here because i) you can read the count rate under the cursor and ii) when in RCSS mode the program will constantly rescale the cuts for the zoomed image region for better visibility. Once selected, hit the right mouse button to go to the count rate image of SCA 492. There is nothing to see here, so click the right mouse button again.

The program will then go through all the exposures and fit a 2D Gaussian to all RCSS images. Since we are in verbose mode this time, you will notice that the window in the upper left changed and is now titled “Data and Fit”. It displays the count rate data on the left and the fit to it on the right. For me, the window looked like this at the very end, showing a very defocussed RCSS image:

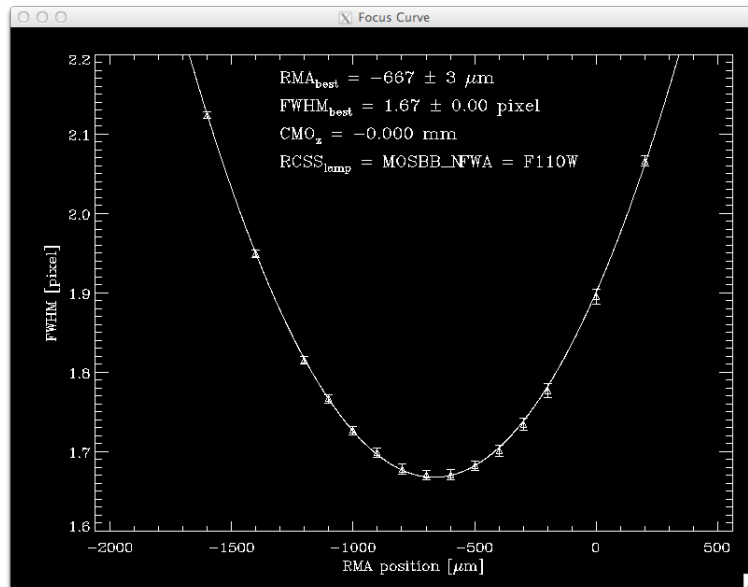


The computed focus curve will be shown in the lower left, together with the instruction window in the center of the screen, and should look like this:



You will notice that although we used 115 input exposures, there are by far not 115 different RMA positions in this plot. The reason for this is that the RCSS was slightly moved between exposures using a five point dither pattern at each RMA position. The determined FWHMs for these dither exposures are then averaged like the FWHMs of individual pinhole images in example 1.

Dismiss the instructions window by clicking "OK" and define left and right fit boundaries by clicking left in the "Focus Curve" window. Examine the fit and derived best focus position and repeat as necessary, then finish by clicking the right mouse button. You should get a plot similar to this one:



You will be asked if you want to write out the pinhole (RCSS image) position and/or the generated focus curve (see example above for more details). Then, the program will end.

4 REFERENCES

- Birkmann, S. 2011, Installing the NIRSpec Calibration Software and Database on Mac OS X 10.7 (Lion), NIRSpec Technical Note NTN-2011-007, ESA/ESTEC
- Birkmann, S. 2012, Documentation for sb_distortion.pro, NIRSpec Technical Note NTN-2012-003, ESA/ESTEC
- Giardino, G. & Sirianni, M. 2011, NIRSpec Archive and Database, NIRSpec Technical Note NTN-2011-003, ESA/ESTEC

A REFERENCE GUIDE

Syntax | Arguments | Keywords | Examples

sb_derive_focus

The `sb_derive_focus` procedure allows the user create a focus curve and determine the best focus position of NIRSpec from a set of PHM or RCSS exposures taken with different RMA positions.

In order to accomplish this the program prompts the user to select one or more pinhole images from a the set of exposures. The program then determines the full width half maximum (FWHM) of the pinholes using a two dimensional gaussian fit, averaging the FWHMs of all pinholes for each RMA position. Then a parabola is fitted to these FWHM values with user selectable bounds. The location of the minimum FWHM is regarded as the best focus position. If the procedure is called with a list of NIDs, it needs the `start_nirspec` environment and access to the NIRSpec data base and exposures.

This routine is written in the IDL language. Its source code can be found in the file `sb_derive_focus.pro` in the `Software/JWST_IDL/lib/nirspec/misc/` subdirectory of the NIRSpec Calibration Software and Database installation.

Syntax

```
sb_derive_focus [, nid] [, BKGD_NID=vector] [, SEL_INDEX=value] [ , PINHOLES=string] [,
IMG_OFFSET=value] [, IMG_SCALE=value] [, /VERBOSE] [, /SILENT] [, /NO_MESSAGES]
[, /MOFFAT] [, /RCSS] [, /CMO]
```

Arguments

nid

Either a vector of integer type or a string. If a vector of integers is given, the values are interpreted as the NIDs of the exposures to be used. If this argument is a string containing one or more forward slashes ('/'), it is regarded as the directory or directories (the string can contain common wildcards) where all the exposures are located. Otherwise, the string is interpreted as a search expression for the NIRSpec exposure data base and all exposures matching the search expression are used as input.

If `nid` is not given, then the user will be prompted to select a directory. If no directory is provided, the user will be prompted to select multiple files via a file select dialog. If the user does not give these, the program will terminate without further action.

Keywords

BKGD_NID

Set this keyword to an integer scalar or vector giving the NID(s) of the background/dark exposures to be subtracted from the input exposures. If shorter than the list of input exposures, the last background image in the list will be used for the remaining input images.

SEL_INDEX

Set this keyword to an integer number between zero and the total number of exposures minus one to specify the index of the exposure the program should display for pinhole image selection. The default value is zero (first exposure/NID in the input list). The same can be achieved by specifying the exposure that should be displayed for pinhole selection as the first in the input nid list.

PINHOLE

Set this keyword to a string giving the file name of a fits binary table holding the coordinates of pinhole images to be used by the program. Such a file can be created e.g. by `sb_derive_focus` itself or by `sb_distortion` (see Birkmann 2012). The user can still select additional pinhole images manually, if desired.

IMG_OFFSET

Set this keyword to a scalar value between 0 and 255 giving the grey value that the (clipped) mean of the input image will be displayed with. Default value is 50.

IMG_SCALE

Set this keyword to a scalar value greater than 0 giving the scaling of the input image from black to white in multiples of the (clipped) standard deviation of the input image displayed. Default value is 20.

VERBOSE

Set this keyword in order to display some details when fitting the pinhole images.

SILENT

Set this keyword in order to suppress warning messages.

NO_MESSAGES

Set this keyword in order to suppress the pop-up instruction windows. Only recommended for experienced users and/or those who have read this guide.

MOFFAT

Set this keyword to use a symmetrical 2D Moffat to fit the pinhole images. Default is to use a symmetrical 2D Gaussian.

RCSS

Set this keyword in order to indicate that the focus curve is for the RCSS. The program will then use the corresponding CMO coordinates from the fits headers and rescale the cuts of the zoomed in region displayed on the fly.

CMO

Set this keyword in order to indicated that the focus sweep was done with the CMO and not the RMA. The basic functionality of the program stays the same, but some axes labels and plot annotations are changed.

Examples

The following command runs the program on the exposures with the NIDs 6319 to 6337.

```
NIRSpec> sb_derive_focus, indgen(19)+6319
```

The following command runs the program on all exposures in the /JWST/Stephan/Focus/ directory, does not display any instruction windows, but shows the pinhole images when fitted.

```
NIRSpec> sb_derive_focus, '/JWST/Stephan/Focus/', /NO_MESSAGES, /VERBOSE
```

The following command runs the program on all exposures in the NIRSpec data base the have an OBS_ID of IMA-FOCUS, have an NID that is at least 5000, and were taken with the broad band target acquisition filter:

```
NIRSpec> sb_derive_focus, 'OBS_ID=IMA-FOCUS,NID>5000,FWA_POS=F140X'
```