JWST MAGIC: User's Guide - DISCLAIMER

Due to how markdown (MD) files are converted to LaTeX PDF, the folllowing PDF version of the
User's Guide will have some inconsistent numbering with the original markdown files in the repository.
That being said, no content (is expected) to have been lost. If something seems clearly
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- Keira Brooks
- Lauren Chambers
- Sherie Holfeltz

Create PDF from MD files

```
$ source activate astroconda3
$ pip install pandoc
$ cd jwst-magic/fgs-commissioning/docs/magic_user_guide
$ pandoc --from=markdown_github README.md i_introduction.md ii_setting_up.md
  iii_determining_and_loading_the_input_image.md iv_select_stars_and_write_files.md
  v_testing_in_dhas.md vi_contingency_reselect_stars.md
  vii_write_sof.md viii_write_pof.md appendix_a_installing_magic.md
  appendix_b_opening_dhas.md -o magic_user_guide.pdf
```

JWST MAGIC: User's Guide

How to use the Multi-Application Guiding Interface for Commissioning (MAGIC) for simulated and real JWST data.

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- Sherie Holfeltz

Table of Contents

II. Setting Up

Pull latest version of the MAGIC repository

III. Determining and Loading the Input Image

Load an image that you will use for running the MAGIC tools

IV. Selecting Guide & Reference Stars for an Input Image and Writing Files

Select the guide and reference stars to be used for the image loaded in Section III

V. Testing Selections in DHAS

Run ID, ACQ, and TRK images through the DHAS

1. Testing ID
2. Testing ACQ
3. Testing TRK

VI. *Contingency*: Re-selecting Stars and Re-running DHAS

If the DHAS failed on selected guide and reference stars, re-run the tool with new selections

VII. Writing the Segment Override File

Create the Segment Override File for situations with more than one PSF for a guide star

VIII. Writing the Photometry Override File

Create the Photometry Override File for situations with one, un-phased, PSF for a guide star

Appendices

A. Installing the JWST MAGIC Package

B. Setting up DHAS

I. Introduction

The Multi-Application Guiding Interface for Commissioning (MAGIC) is a Python package that provides convenient access to a set of tools that will be used, as the name suggests, with the JWST FGS during OTE Commissioning. The package allows for user interaction with commissioning data and creates files that are needed for the operation of the flight software and the execution of visits. The documents here will walk you through how to use each of the parts of MAGIC and verify those results.

A powerful feature of MAGIC is that is retains information about the image you are working on as long as the window stays open and the file is loaded, so we recommend that while working with MAGIC, you keep the GUI open. If it crashes (which can happen) don't worry, just go to Section II, input the same values that you have been using for that data, and MAGIC will find the dataset that you are working with.

These tools comprise of four main components that can be run individually or together:

NIRCam to FGS image conversion (Image Converter)

This tool can take in a simulated (or real) NIRCam image and will convert it to an FGS (guider 1 or guider 2) image. In addition to rotating the image, adjusting the pixel scale and image size, this tool corrects bad pixels and normalizes the image to a specific magnitude of star.

Section III: Determining and Loading the Input Image

Star Selection Tool (Star Selector)

This tool will take the FGS image either created with the first tool, or an FGS image that it is passed by the user, and allow the user to choose the guide star and reference stars using a GUI.

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Flight Software File Writer (Flight Software (FSW) File Writer)

This module requires an FGS image and a file that includes a list of the coordinates of the guide star and reference stars, along with their count rates. This tool will create all files necessary to test this image different flight software simulators (FGS DHAS, FGSES, etc.) These include all the files necessary to run the ID, ACQ1, ACQ2, and TRK steps in these simulators.

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Segment Guiding Tool (Segment Guiding)

Used to facilitate guiding on unstacked segment PSF arrays (Segment Override), and stacked, but unphase
segment PSFs (Photometry Override) during commissioning.

Segment Override - When provided with:

1. the commanded RA and Dec of a guide star, and
2. the V2/V3 (or x/y) positions of all segments in an array

the segment guiding tool calculates the
effective RA and Dec of all segments on the sky.

Section VII: Writing the Segment Override File (SOF)

Photometry Override - When provided with a count rate factor, the tool will provide
the necessary information to override the guide star catalog with
a new countrate for a specific guide star

Section VIII: Writing the Photometry Override File (POF)

Next

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Previous

Section I: Introduction

II. Setting Up MAGIC

1. If you have not yet installed the tools, go to Appendix A.
2. Check that you are in your astroconda environment.
3. Make sure that you have the most up-to-date version of the tools (`pull` the most recent version of the tools from the repo):

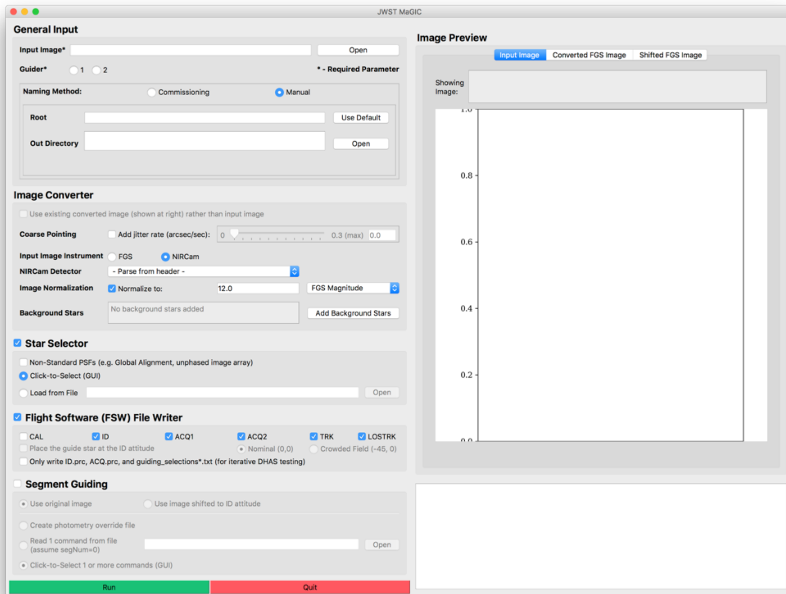
   $ cd /Users//tools

   $ git pull origin master
4. From your astroconda environment, start an IPython session and launch the main GUI (see figure below):

   $ ipython

   In [1]: import jwst_magic

   In [2]: jwst_magic.run_tool_GUI()



Next

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

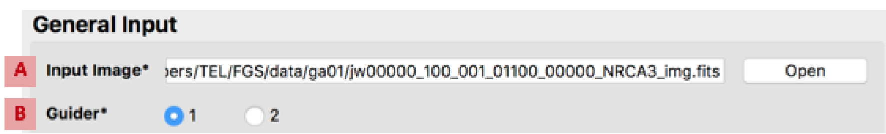
Previous

Section I: Introduction

III. Determining and Loading the Input Image

MAGIC takes in any FGS image or a NIRCam image that was taken with the CLEAR filter (the NIRCam weak lens (WL) filter will cause MAGIC to crash). If you want MAGIC to convert this image into a raw dectector FGS image, you can indicate this by checking the **Convert Image** check box. In most cases MAGIC can determine from the header information which instrument and detector the image is from, however if it can't figure this out from header information, you will have to help it out by telling it which instrument and detector your input image comes from. You can also renormalize and/or add background images to your seed image.

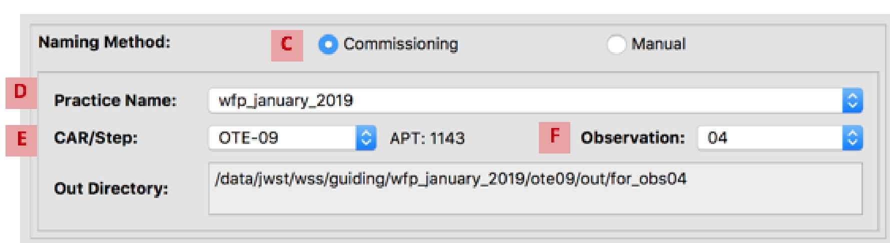
1. Set general input parameters:



1. Load the **Input Image** (A) and a preview of the image and the full path to the image will appear in the **Image Preview** box at right.

2. Specify the **Guider** (B) that the final image should simulate. If this is not known, check the APT file (see Appendix B for more information about using APT).

3. If you are running MAGIC on the SOGS network to generate files for commissioning:

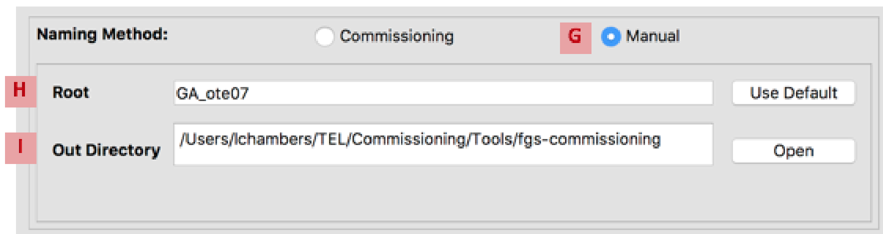


1. Check the **Commissioning** radio button (C) to set the naming method.
2. Select the **Practice Name** (D) corresponding to the current activity.
3. Select the **CAR/Step** name (E) of the activity you are generating an override file for.

4. Select the **Observation** number (F) of the activity you are generating an override file for. *(The observations in the dropdown box that are preceded by + are extras, in the case that an unplanned observation gets generated on-the-fly.)*

Considering these parameters all together, the output files will be saved in the `/data/jwst/wss/guiding/{practice}/{car}/out/for_obs{obs}/` directory, with the root `for_obs{obs}_G{guider}`.

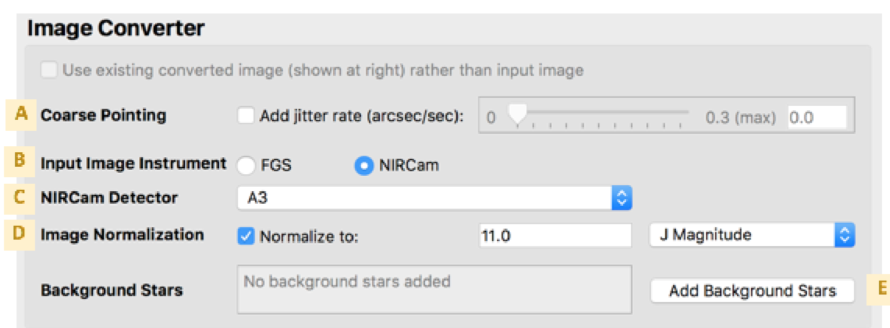
1. If you are running MAGIC outside of SOGS, or to generate test data:



1. Check the **Manual** radio button (G) to set the naming method.
2. Specify a **Root** name (H) If different than the default name that was created when the input image was uploaded. The root will be used to to create the output directory where all created files will reside, out/{root}.
3. Change the **Out** directory (I) Choose the location to where the files will be saved. An `out/` directory will be created in this location, and this is where all the files will be saved.

Considering these parameters all together, the output files will be saved in the `{out}/out/{root}/` directory, with names of the format `{root}_G{guider}`

1. Set image conversion parameters: (Note: The steps labelled "optional" below will create higher-fidelity simulations, but are not necessary when using MAGIC to generate FSW input or segment override files.)



1. (Optional) Simulate the effects of **Coarse Pointing** (A) by specifying the

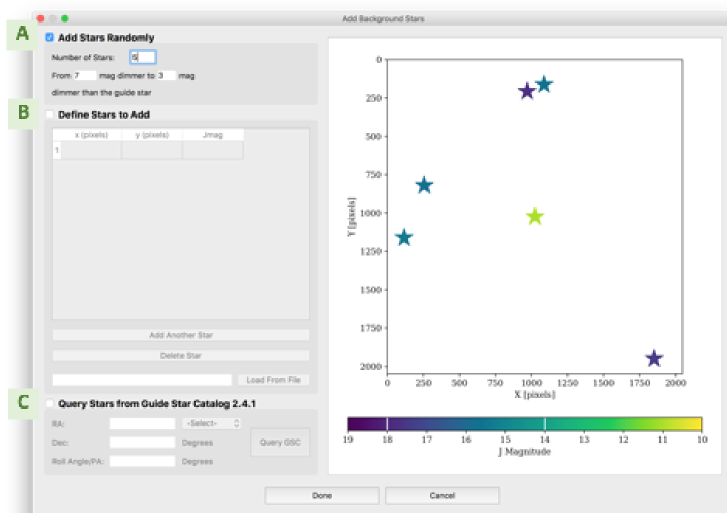
jitter rate of the observatory. A jitter rate of 0.7 arcsec/sec creates images that are similar to ITM simulations in coarse point. Otherwise, ensure the **Add jitter rate** box is unchecked.

2. Check that the **Input Image Instrument** (B) and **NIRCam detector** (C) used to take the input image are set to the correct values; change them if not. (If the NIRCam detector is not defined, the tool will attempt to parse it from the input FITS header.) The FGS-formatted image will be saved to `out/{root}/FGS_imgs/{input_image}_G{guider}.fits`

3. (Optional) Specify the magnitude or counts for the **Image Normalization** (D) of the final image. Otherwise, ensure the **Normalize to** box is unchecked.

4. (Optional) Add **Background Stars** to the final image.

   (a) Click **Add Background Stars** (E). The background stars dialog box will appear:



   (b) Select which method you wish to use to add stars to the image: randomly, with a user-defined table, or with a Guide Star Catalog (GSC) 2.4.1 query.

      i. To add stars randomly:

         A. Select the **Add Stars Randomly** (A) checkbox.
         B. Input the number of stars you want to add to the image
         C. Specify the magnitude range that these additional stars will lie between (relative to the magnitude of the guide star)

ii. To add stars individually:

   A. Select the **Define Stars to Add** (*B*) checkbox.
   B. If you wish to load star locations and brightness from a file, indicate the location of that file.
   C. Otherwise, enter into the table the X position in pixels, the Y position in pixels, and the countrate in J Magnitude of each star you wish to add. Click the **Add Another Star** button to add another row to the table, or the **Delete Star** button to remove a row.

iii. To add stars using a web query from the Guide Star Catalog:

   A. Select the **Query Stars from Guide Star Catalog 2.4.1** (*C*) checkbox.
   B. Enter the RA and Dec of the guide star, being sure to specify if the RA units as either hours or degrees.
   C. Enter the position angle (roll angle) of the observatory.
   D. Click the **Query GSC** button to add the stars that are visible in the FOV of the selected guider.

(c) Click **Done** to save and apply these selections, or click **Cancel** to close the window without updating the background star selections.

(d) Verify that the indicator shows that the correct number of background stars have been added.

Next

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

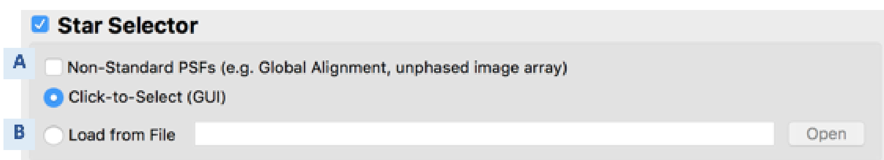
Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

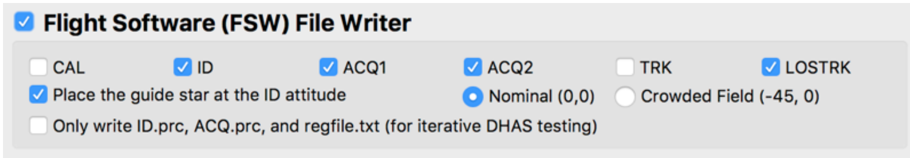
IV. Selecting Guide & Reference Stars for an Input Image and Writing Out Files

One of the main features of MAGIC is that it allows the user to determine the guide and reference stars for a specific scene. While during normal opterations this is determined by the Guide Star Selection System (GSSS), during commissioning the MAGIC user will determine which PSFs will be used for guiding and as reference stars. You can turn on this feature by selecting the **Star Selector** check box.

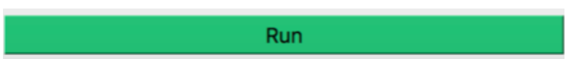
1. Set star selection parameters:



1. Ensure the **Star Selector** box is checked.
2. Inspect the input image and if the segment PSFs are arranged in an image array check the **Non-Standard PSFs** box. (*A*) This flag alters the PSF-finding algorithm in the star selector tool to widen the smoothing filter for diffuse images in early commissioning stages when the telescope is unphased. If you are unsure if the PSFs are phased, consult the "Guiding Method" row in the Guider Commissioning Summary Table on Innerspace.
3. If desired, load pre-selected guide and reference stars from a file by selecting the **Load from File** (*B*) option and selecting the desired input file. This file must include X/Y pixel coordinates and count rates in the form of a filepath to a regfile.txt or .incat file. Providing this will bypass using the Star Selection GUI to **Click-to-Select** the guide and reference stars.
4. Set file writer parameters:



1. Ensure the **Flight Software (FSW) File Writer** box is checked.
2. Check that all of the *necessary FGS steps* are selected.
   (a) For general guiding, this includes all of the operational steps: ID, ACQ, and TRK. (These are the default selections.)
   (b) For calibration observations, add the CAL step.
3. If you want to shift your image so that the selected guide star is moved to the center of the image, ensure the **Place the guide star at the ID attitude** box is checked. Designate whether the guiding field is crowded enough that the alternate ID attitude at (Ideal X, Ideal Y) = (-45, 0) should be used (**Crowded field**). Otherwise, leave the **Nominal** button selected such that the star is placed at (Ideal X, Ideal Y) = (0, 0).
4. Run the tool

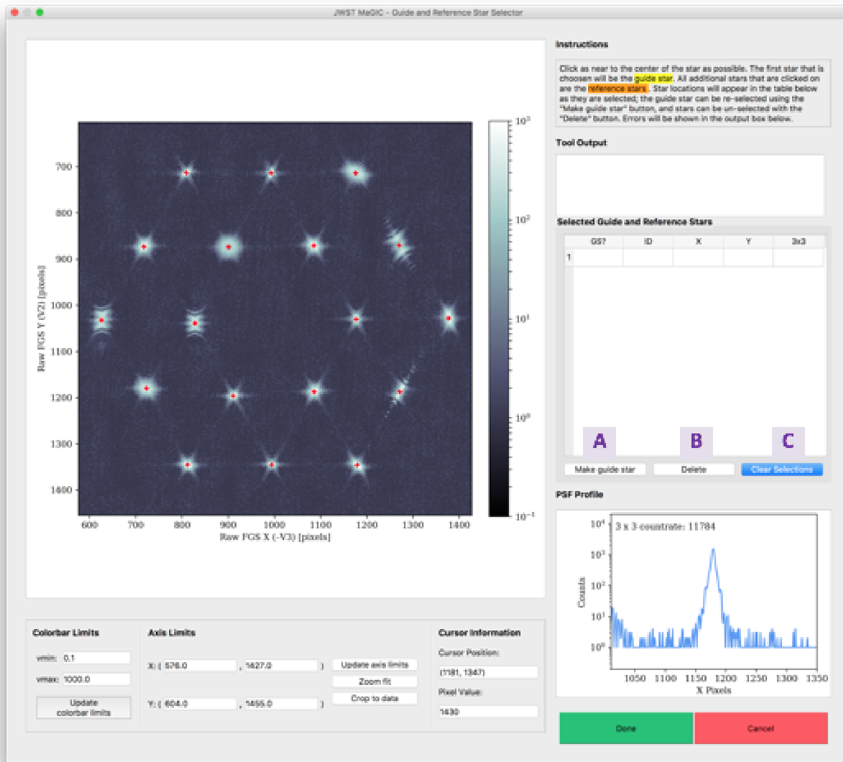


1. Monitor the terminal window from which you launched the GUI to notice any possible errors that are raised.

Note: The output that appears in the command line is also written to:

`/data/jwst/wss/guiding/MAGIC_logs/`

1. When the Star Selection GUI appears:



1. Inspect the PSFs in the image by moving your cursor over different PSFs. Examine the profile plot to see the distribution of light.
2. Select, by clicking, which PSFs will be the guide star and the reference stars. The first star selected will be the guide star, while any subsequent stars will be reference stars. *See Appendix D to choose the guide and reference stars based on the mirror state.*
3. If you want to change your selections while in the tool, use the **Make Guide Star** (*A*) button to change the guide star, use the **Delete** button (*B*) to remove individual selections, and use the **Clear Selections** button (*C*) to start over.
4. When you are happy with your selections, click **Done**

The output files will be located in the specified out directory.

Next

Section V: Testing Selections in DHAS

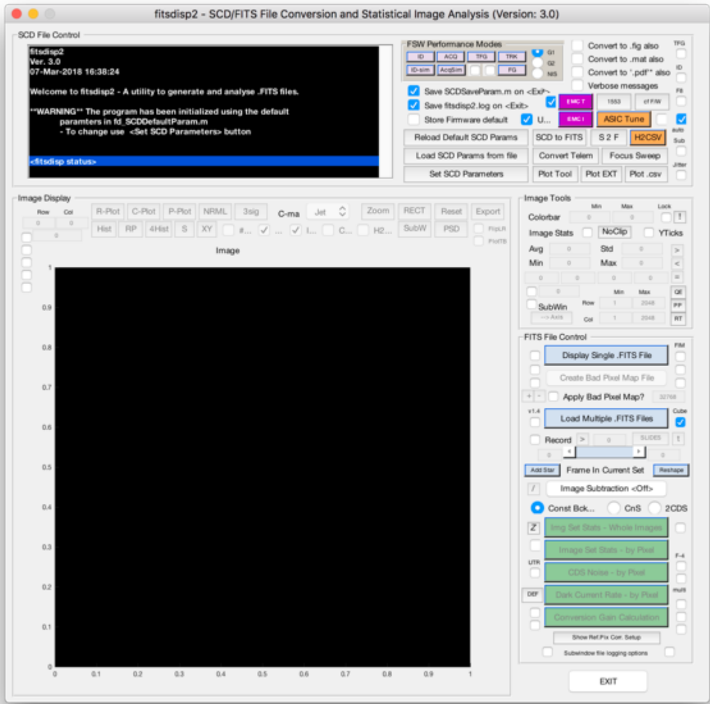
Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Previous

V. Testing Selections in DHAS

After selecting the guide and reference stars, we have to determine whether or not this selection will be successful with the flight software (FSW). To do this, we can use the files created in the last section to run our images through the FSW simulator, the FGS Data Handling Analysis System (DHAS) (see figure below). (If you do not have the DHAS set up, see Appendix B)

Don't close the MAGIC GUI while you are working in DHAS; you will need to use that open MAGIC window later.

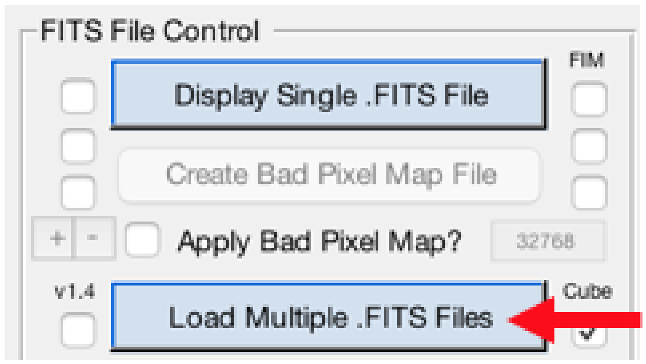


This section includes testing ID, ACQ, and TRK images with the DHAS. Make sure you know which steps you are testing before continuing, and then use the links below:

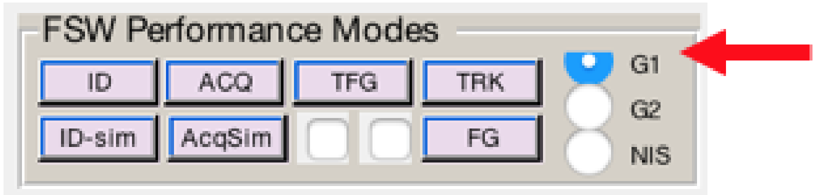
1. Testing ID
2. Testing ACQ
3. Testing TRK

Testing ID in DHAS

1. Load the `{root}_IDstrips.fits` file for the current data:
2. Click the blue **Load Multiple .FITS Files** button



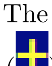
3. Using the *Current Directory* drop-down menu (or by typing the path directly into the textbox), navigate to the `out/{root}` directory where the images have been saved
4. Go the `dhas` subdirectory
5. Check the **Show All Files** box
6. Select the `{root}_IDstrips.FITS` file
7. Click **Add** →
8. Click **Done**
9. Add the Bad Pixel Map
10. Check the **Apply Bad Pixel Map?** box above the **Load Multiple .FITS Files** button (see figure above). *If the box is checked with a path next to it, a bad pixel map has already applied for the guider used for the last simulation; continue to step 3.*
11. In the finder window that opens, choose the most recent bad pixel map for the corresponding guider (check the "rev" number on files with a .pix extention). For DHAS verson 3.0, this file is `G1_F11_CV3_Rev_63.pix` for guider 1 and `G2_F14_CV3_Rev_63.pix` for guider 2.
12. Click **Open**
13. When the finder box disappears, the **Image Size Mismatch...** dialog box, will appear; this concerns the alignment of the subarrays with bad pixel map and the default values may be accepted by clicking **OK**.
14. Run the ID simulator
15. Click the corresponding G1 or G2 button depending on if this is a guider 1 vs. guider 2 image at the top of the page

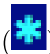


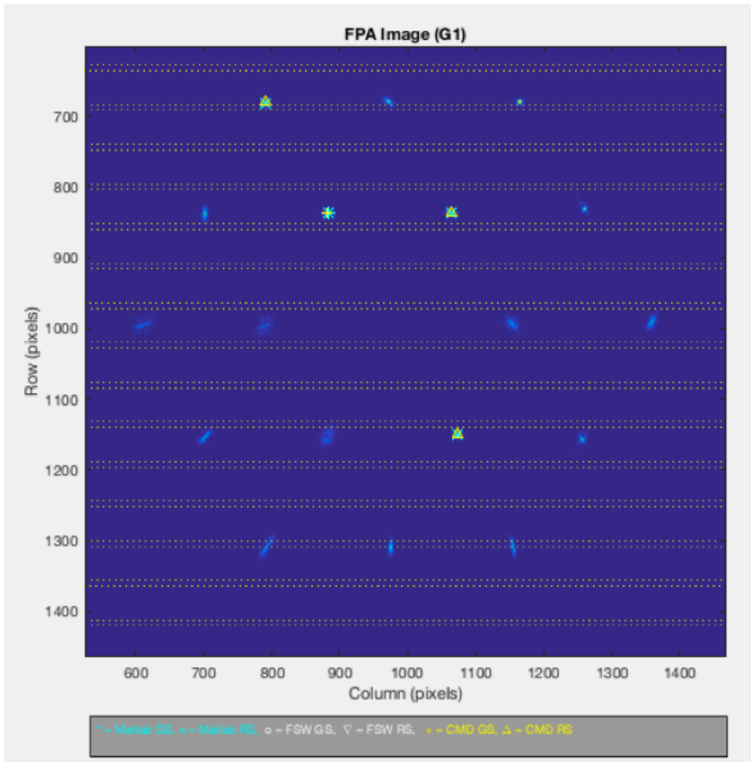
16. Click the small pink **ID-sim** button at the top of the page

17. A finder window will appear with the expectation that the user will choose the appropriate .prc file (no text indicates this). For this step (ID) open the ID.prc file corresponding to the IDstrips.fits file that you selected (in the above example, GA_obs1_WFR_G1_ID.prc)
18. When the star_catalog_page dialog box appears:
    (a) Set the Row and Column values to be 12 and 0 (in the bottom left corner of the window), respectively (the X-Angle and Y-Angle values will automatically change to reflect this):

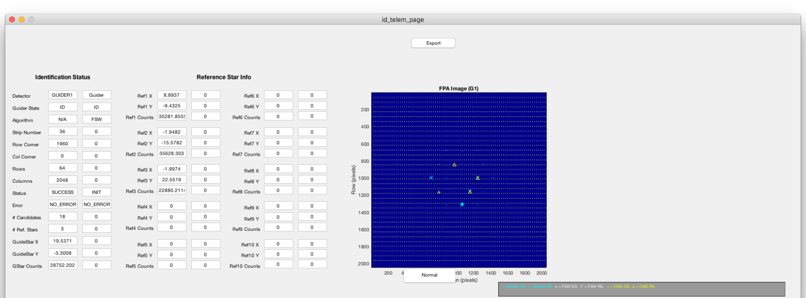
    (b) If you want to alter your guide & reference star selections, do so here by toggling the **GS** (guide star) and **RS** (reference star) buttons
    (c) Click the "Done" button.
19. When the ID Mode Setup dialog box appears, click **OK**.
20. Wait for the simulator to run
21. When the finder window pops up, press **Cancel**
22. DHAS results: Commanded (CMD) reference stars are denoted by yellow triangles (). The commanded (CMD) guide star is denoted by a yellow cross/plus sign (). The reference stars that the DHAS has found are

denoted by blue x's () and the guide star is denoted by a blue asterisk (). See the figure below for an example of a successful DHAS run.

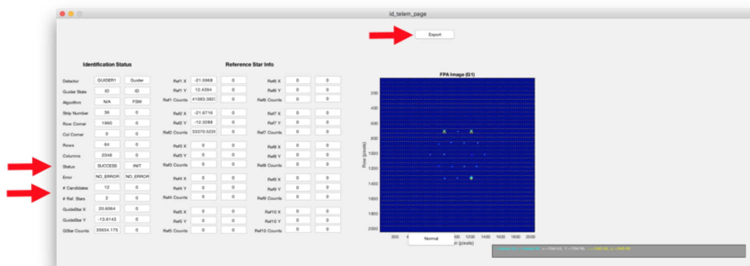


23. Inspect the DHAS results

24. Do the stars that DHAS found (in blue) match the stars you commanded it to find (in yellow)? If not, ID has FAILED. In the example below, note that DHAS labeled this as a success, even though you can tell in the plot that it failed.



25. For a more detailed DHAS diagnosis:
    (a) Does DHAS think it successfully found the guide star? (Does **Status** equal SUCCESS?)
    (b) Did DHAS find all of the stars? (How many **# Candidates** were found (if less than 18 for GA or image array steps, are some of the PSFs difuse?)?)
    (c) If necessary, click the **Export** button to more closely examine DHAS's output plot and/or save the image as a .PNG

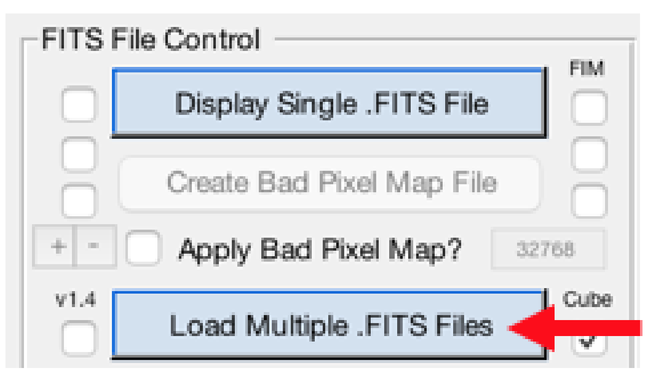


If DHAS ID fails, we need to try a different orientation of guide and reference stars until we find a successful one. Continue to Section VI.

If DHAS ID succeeds, continue on to test ACQ.

Testing ACQ in DHAS

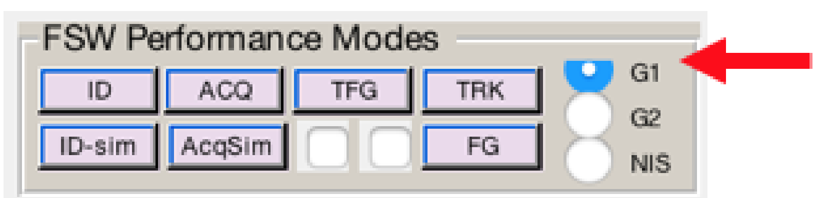
1. Load the `{root}_ACQ.fits` file you just created:
2. Click the blue **Load Multiple .FITS Files** button



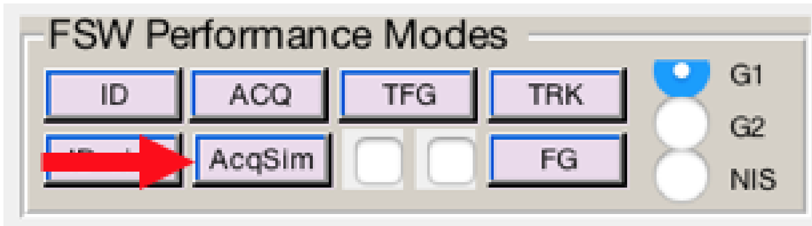
3. Using the *Current Directory* drop-down menu (or by typing the path directly into the textbox), navigate to the `out/{root}` directory where the

images have been saved

4. Go the `dhas` subdirectory
5. Check the **Show All Files** box
6. Select the `{root}_ACQ1.FITS` file
7. Click **Add** →
8. Select the `{root}_ACQ2.FITS fits` file
9. Click **Add** →
10. Click **Done**
11. Add the Bad Pixel Map *(if the box is checked with a path next to it, a bad pixel map has already applied for the guider used for the last simulation)*
12. Check the **Apply Bad Pixel Map?** box above the **Load Multiple .FITS Files** button (see Figure 10 above)
13. In the finder window that opens, choose the most recent bad pixel map (check the "rev" number on files with a .pix extention). For DHAS verson 3.0, this file is G1_F11_CV3_Rev_63.pix for guider 1 and G2_F14_CV3_Rev_63.pix for guider 2.
14. Click **Open**
15. When the finder box disappears, the **Image Size Mismatch...** dialog box, will appear; this concerns the alignment of the subarrays with bad pixel map and the default values may be accepted by clicking **OK**.
16. Run the ACQ simulator
17. Click the corresponding G1 or G2 button depending on if this is a guider 1 vs. guider 2 image at the top of the page



18. Click the small pink **AcqSim** button at the top of the page



19. A finder window will appear; select the appropriate `ACQ.prc` file and click **Open** (or double click on the `.prc` file).

20. The **acq_star_catalog_page** dialog box will appear. You may adjust the guide star and ACQ1/2 window positions if you wish on this page; when you are happy with the values (defaults should be fine), click **DONE**.

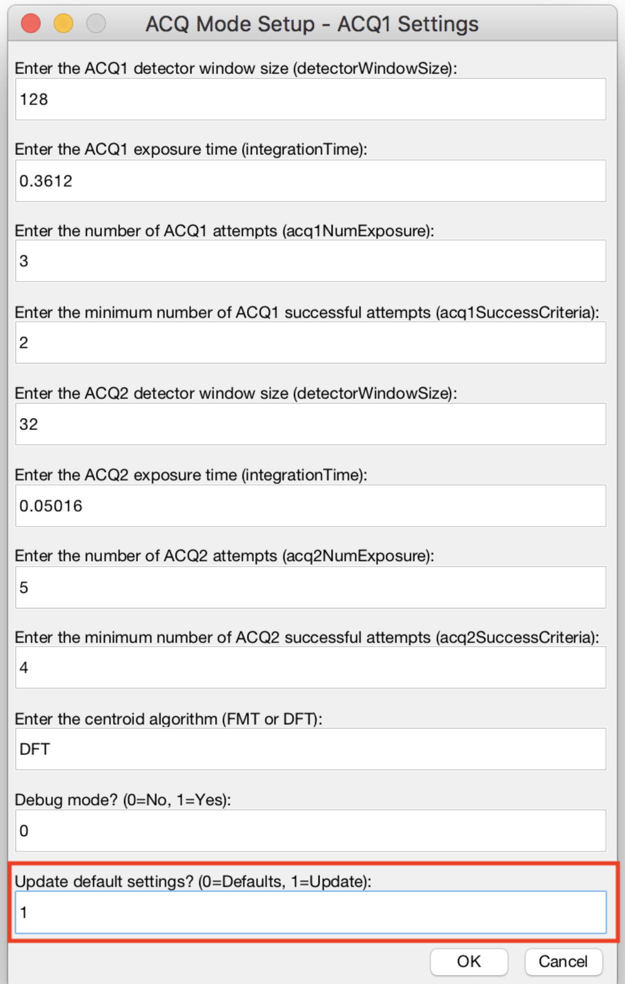
    NOTE: We might need to press the "Auto" button here in order for ACQ to be successful. Investigation needed.

21. Adjust ACQ parameters:

    (a) First, the **ACQ Mode Setup – ACQ1 Settings** dialog box will appear. You may adjust ACQ1 and ACQ2 table parameters here if you wish.

    For simulations of commissioning data pre-MIMF, change the following values:

Parameter Name	Old Value	New Value
`Update default settings?`	0	1



When you are happy with the values, click **OK**. If you did not change `Update default settings?` to 1, continue on to step 4.

(b) Second, the **ACQ Mode Setup - ACQ1 Scanning Parameters** dialog box will appear. You may adjust ACQ1 table parameters here if you wish.

No parameters on this window need to be changed for pre-MIMF commissioning simulations.

When you are happy with the values, click **OK**.

(c) Third, the **ACQ Mode Setup - ACQ1 Centroid Parameters** dialog box will appear. You may adjust ACQ1 table parameters here if you wish.

No parameters on this window need to be changed for pre-MIMF commissioning simulations.

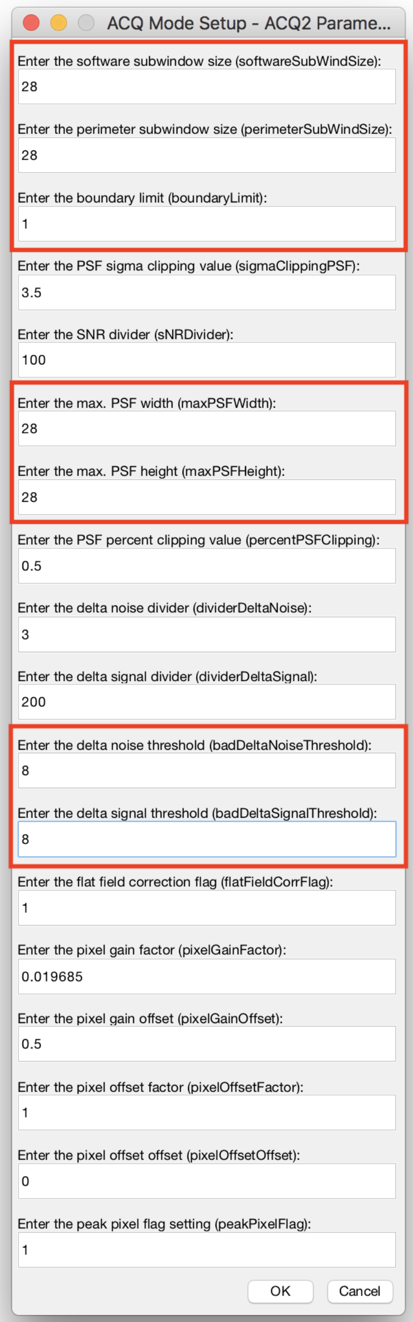
When you are happy with the values, click **OK**.

(d) Fourth, the **ACQ Mode Setup - ACQ2 Parameters** dialog box will appear (see screenshot below). You may adjust ACQ2 table parameters here if you wish.

For simulations of commissioning data pre-MIMF, change the following values:

Parameter Name	Old Value	New Value
`softwareSubWindSize`	8	28
`perimeterSubWindSize`	16	28
`boundaryLimit`	2	1
`maxPSFWidth`	8	28
`maxPSFHeight`	8	28
`badDeltaSignalThreshold`	6	8
`badDeltaNoiseThreshold`	6	8

When you are happy with the values, click **OK**.

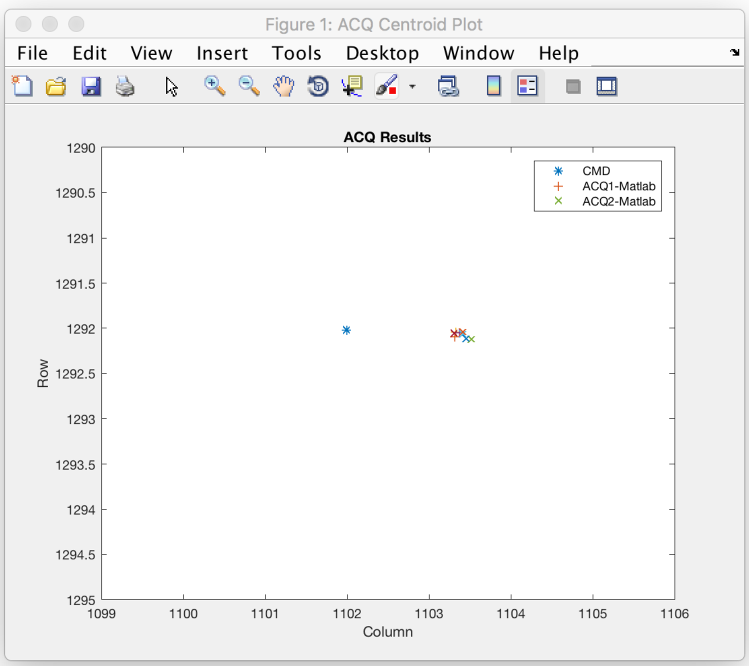

ACQ Mode Setup - ACQ2 Parame...
Enter the software subwindow size (softwareSubWindSize):
28
Enter the perimeter subwindow size (perimeterSubWindSize):
28
Enter the boundary limit (boundaryLimit):
1
Enter the PSF sigma clipping value (sigmaClippingPSF):
3.5
Enter the SNR divider (sNRDivider):
100
Enter the max. PSF width (maxPSFWidth):
28
Enter the max. PSF height (maxPSFHeight):
28
Enter the PSF percent clipping value (percentPSFClipping):
0.5
Enter the delta noise divider (dividerDeltaNoise):
3
Enter the delta signal divider (dividerDeltaSignal):
200
Enter the delta noise threshold (badDeltaNoiseThreshold):
8
Enter the delta signal threshold (badDeltaSignalThreshold):
8
Enter the flat field correction flag (flatFieldCorrFlag):
1
Enter the pixel gain factor (pixelGainFactor):
0.019685
Enter the pixel gain offset (pixelGainOffset):
0.5
Enter the pixel offset factor (pixelOffsetFactor):
1
Enter the pixel offset offset (pixelOffsetOffset):
0
Enter the peak pixel flag setting (peakPixelFlag):
1
OK
Cancel

22. Inspect the DHAS Results:

    The *ACQ Centroid Plot* and *ACQ Centroid Telemetry* reports will pop up when the simulation is complete.

    In the *ACQ Centroid Telemetry* report table, verify that 1) there are 8 acqSim entries, and 2) the last `IFGS_ACQ_STAT` telemetry value is `SUCCESS`. If either of these is not the case, ACQ has FAILED.

    View the *ACQ Centroid Plot* (see figure below). The acquired guide star locations are denoted with `X` and `+`, and the commanded guide star position is denoted with `*`. Check that 1) the acquired guide star locations are not more than ~10 pixels away from the commanded guide star position and 2) there is not a lot of spread (i.e. more than a couple pixels) within the acquired guide star locations. If either of these is not the case, consult with the FGS SI team about the success of ACQ.

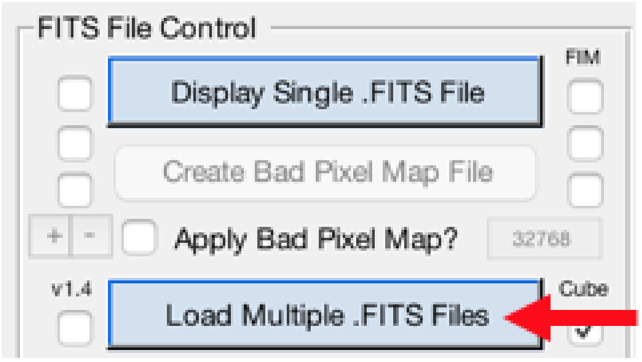


If DHAS ACQ fails, we need to try a different orientation of guide and reference stars until we find a successful one. Continue to Section VI.

If DHAS ACQ succeeds, continue on to test TRK.

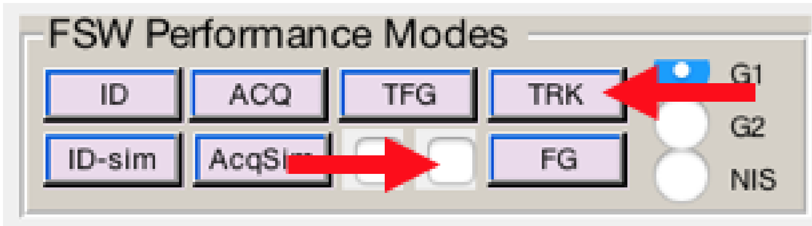
Testing TRK in DHAS

1. Load the `{root}_TRK.fits` file for the current data:
2. Click the blue **Load Multiple .FITS Files** button

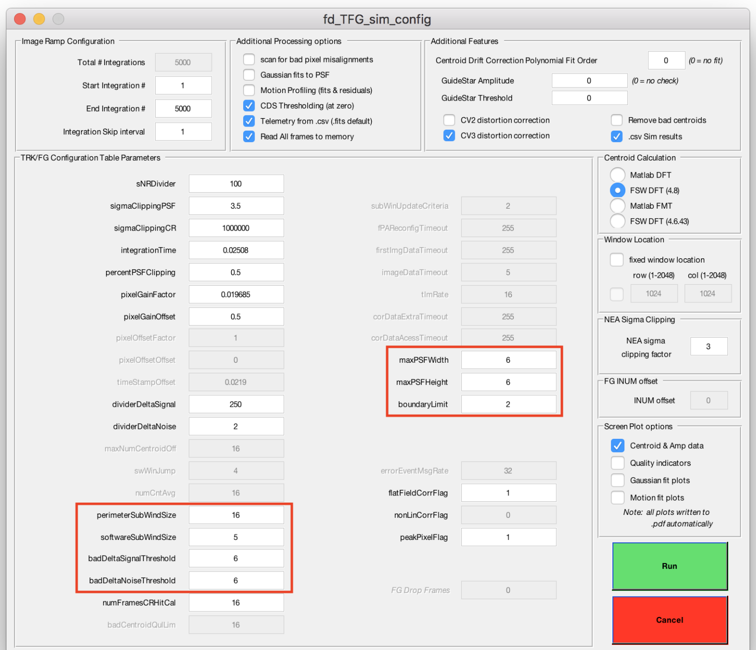


3. Using the *Current Directory* drop-down menu (or by typing the path directly into the textbox), navigate to the `out/{root}` directory where the images have been saved
4. Go the `dhas` subdirectory
5. Check the **Show All Files** box
6. Select the `{root}_TRK.FITS` file
7. Click **Add** →
8. Click **Done**
9. Run the TRK simulator
10. Click the corresponding G1 or G2 button depending on if this is a guider 1 vs. guider 2 image at the top of the page

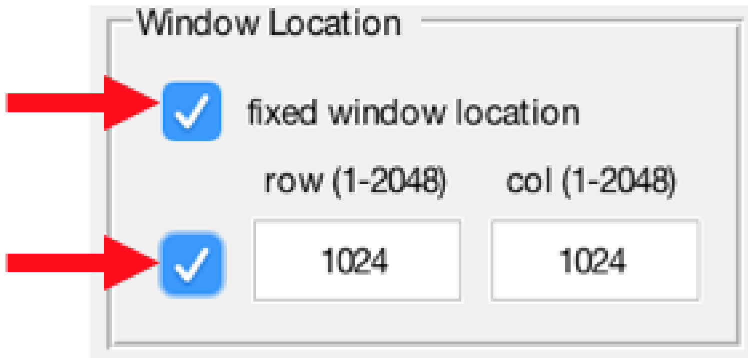
11. Click the TRK stand-alone mode button and then the TRK button



12. The **fd_TFG_sim_config** dialog box will appear:



Click **fixed window location** and the radio button next to 1024, 1024 in the *Window Location* pane on the right of the dialog box; see below. (*Note: this is only accurate if the guide star starts at the center of the detector, and will become inaccurate if the TRK box moves at all over the course of TRK. But, from Sherie's best understanding, it is still better to always select this than to not.*)



You can adjust some, but not all, table settings here if you wish. For simulations of commissioning data pre-MIMF, change the table parameters listed in the table:

Parameter Name	Old Value	New Value
`perimeterSubWindSize`	16	28
`softwareSubWindSize`	5	28
`badDeltaSignalThreshold`	6	8
`badDeltaNoiseThreshold`	6	8
`maxPSFWidth`	6	28
`maxPSFHeight`	6	28
`boundaryLimit`	2	1

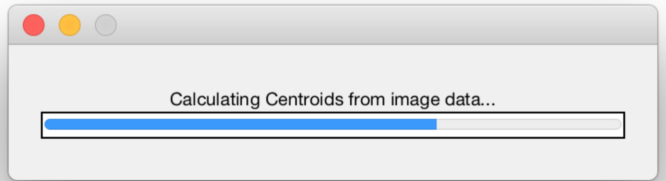
Note that the `subWinUpdateCriteria` and `swWinJump` parameters should ideally also be changed, to 28 and 28 respectively, but those changes would need to be made direclty to the `fd_TRK_table.m` file in the DHAS source code. For now, proceed without changing those parameters.

When you are happy with the values, click the green **Run** button.

13. A finder window will appear; select the appropriate bad pixel map file (G1_F11_CV3_Rev_63.pix for guider 1 and G2_F14_CV3_Rev_63.pix for guider 2) and click **Open**.

14. Another finder window will appear; from this one, select the Flat-Field file for either guider 1 (`G1_F011_FlatField_int_60.fits`) or 2 (`G2_F014_FlatField_int_60.fits`) and click **Open**.

15. It may take a few seconds for the thermometer-like status bar (see below) to appear and/or to begin to register progress in the simulation. If the status bar ever stalls after initial progress has been made, the simulation is not likely to recover. ***This is considered this a FAILED simulation***.

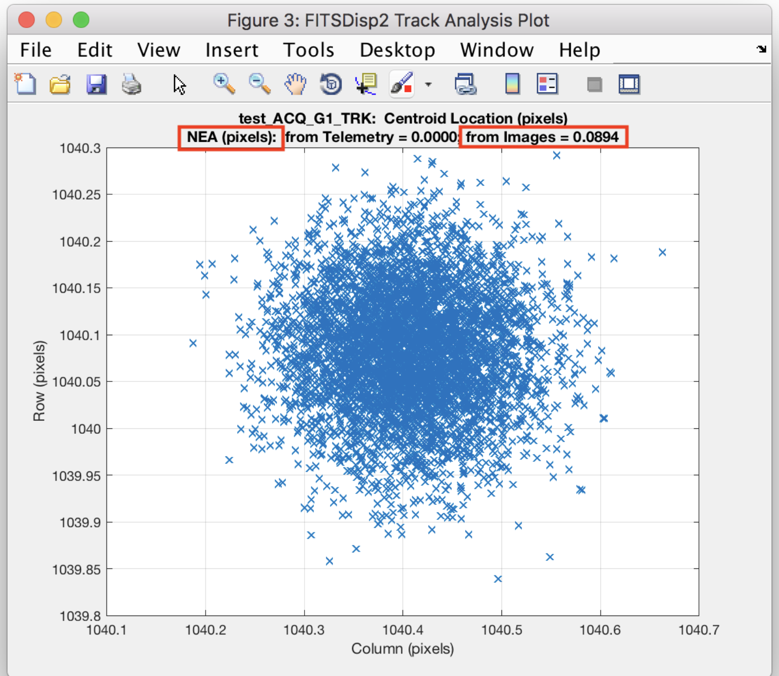


16. Inspect the DHAS Results:

Several diagnostic plots will automatically pop up. The same plots are written to the same directory where you got the TRK files as a *.ps* file.

View the **test_ACQ_G1_TRK: Centroid Location** plot (see example below). Ensure that the NEA (noise equivalent angle) value in pixels, listed underneath the plot title, is below the required threshold.

Ed still needs to provide us with a table of acceptable NEA thresholds for different CARs.



If the NEA is above the threshold, TRK has FAILED.

If DHAS TRK fails, we need to try a different orientation of guide and reference stars until we find a successful one. Continue to Section VI.

If DHAS TRK succeeds, continue on to Section VII to create a segment override file (SOF) or Section VIII to create a photometry override file (POF).

Next

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

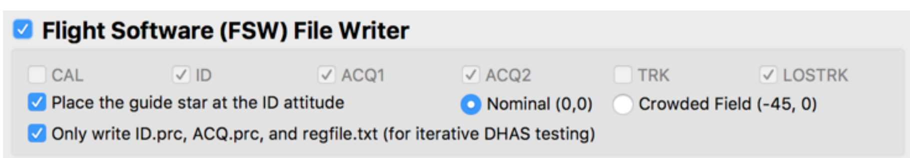
Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

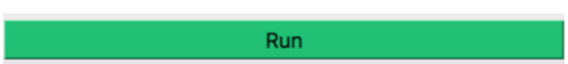
VI. Contingency: Re-selecting Stars and Re-running DHAS

When re-selecting stars for testing in the DHAS, not all of the files generated by the commissioning tools need to be rewritten; only the files that specify which segments are the guide star and reference stars need to be changed (namely, the ID.prc and regfile.txt files). Thus, though completely re-running the tool would work to re-select the guide and reference star segments (see section IV), it is not necessary. We have developed a faster method for re-selection and file rewriting, detailed here:

1. In the main GUI, select the **Only write...** button within the Flight Software File Writer box. All other options in the interface will be disabled.



1. Run the tool:



1. When the Star Selection GUI appears, again examine your input image. Note: If you prefer to analyze the image in DS9, you can do so by typing `$ ds9 name_of_image.fits` into the command line or `!ds9 name_of_image.fits` in IPython. Be sure to load the image in the `.../FGS_imgs/` directory, which is your FGS image. Since DS9 displays

images differently than Python, go to the Zoom menu in the menu bar of DS9 and select **Invert Y**.

2. Select new guide/reference stars and click **Done**.

   See Appendix D to choose the guide and reference star based on the mirror state.

   This step will overwrite the existing ID.prc and regfile.txt files with the new star commands.

3. Re-run DHAS (section V)

If DHAS fails again, we still need to try a different orientation of guide and reference stars until we find a successful one. Repeat this section until successful. If DHAS suceeds, continue to Section VII to create a segment override file (SOF) or Section VIII to create a photometry override file (POF).

Next

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

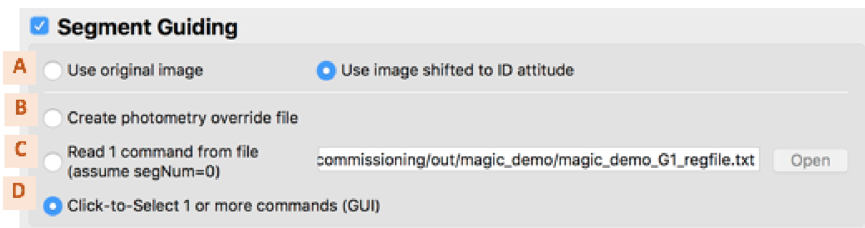
Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

VII. Writing the Segment Override File (SOF)

Another very important part of MAGIC is creating the override file that can be used to override the way guide and reference stars are selelcted by the GSSS. This file only has to be created when using MAGIC for commissioning activities and their rehearsals where the segments of JWST's primary mirror are unstacked. In that case we use the PSFs created by each segment as our guide and reference stars.

1. In the main GUI, select the **Segment Guiding** box. All other options in the interface will be disabled.



1. If the image has been shifted so the guide star is at the ID attitude, use the radio buttons (A) to designate whether to generate the override file using the original (unshifted) image (**Use original image**) or using the shifted image (**Use image shifted to ID attitude**).

2. Determine whether to generate an override file from an existing file or using the click-to-select GUI:

3. If creating a photometry override file using the **Create photometry override file** radio button (B), see Section VIII.

4. If creating an override file for a visit where the mirrors are in an array and you wish to use the *same* guide and reference stars from Section III, select the **Read 1 command from file** radio button (C) and don't change the auto-populated segment guiding filepath. This creates the segment override file so that it only uses the guide and reference stars selected by the user in Section III and will bypass the override file creation using the Segment Guiding GUI. If making this selection, skip to step 6 below.

5. If creating an override file for a visit where the mirrors are in an array and you wish to use *different* guide and reference stars from Section III that are specified in a different file (most likely a regfile.txt or a .incat file), select the **Read 1 command from file** radio button (C) a and specify the path to this file. Providing this file will create the segment override file so that it only uses the guide and reference stars selected by the user in Section III and will bypass the override file creation using the Segment Guiding GUI. Once this file is selected, skip to step 6 below.

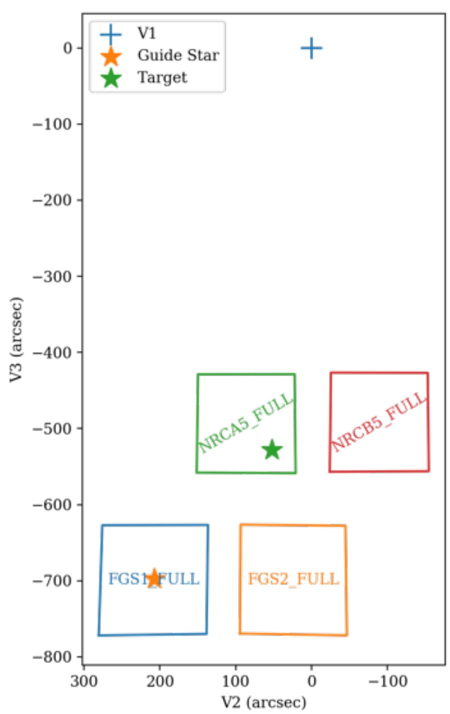
6. Otherwise, select the **Click-to-Select 1 or more commands (GUI)** radio button (*D*) to launch the GUI (see figure below) that will allow you to click-to-select multiple orientations of guide and reference stars.

7. Before running the tool, obtain the following parameters with the following methods:

8. APT parameters: If you do not know, ask the Wavefront Ops for the **Program Number**, **Observation Number**, and the **Visit Number**.

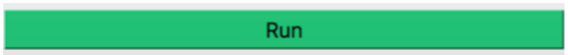
9. Guide star **RA** & **Dec**: Retrieve the guide star ID from the APT file (see Appendix C for a step-by-step guide for doing this). Go to the Guide Star Catalog webform (http://gsss.stsci.edu/webservices/GSC2/WebForm.aspx), and query with the guide star ID in the "HST ID" field to determine the RA and Dec.

10. **Position Angle**: Ask the S&OC for the visit position angle at the guide star (V3PA@GS).
    See the Figure 14 to clarify the difference between V1, the target, and the guide star.

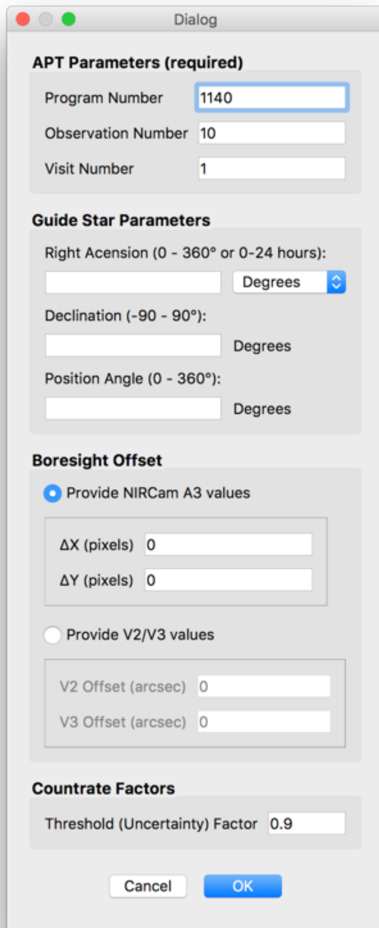


1. Get the current **V2 & V3 boresight offset** from the Wavefront Ops.

2. Run the tool:



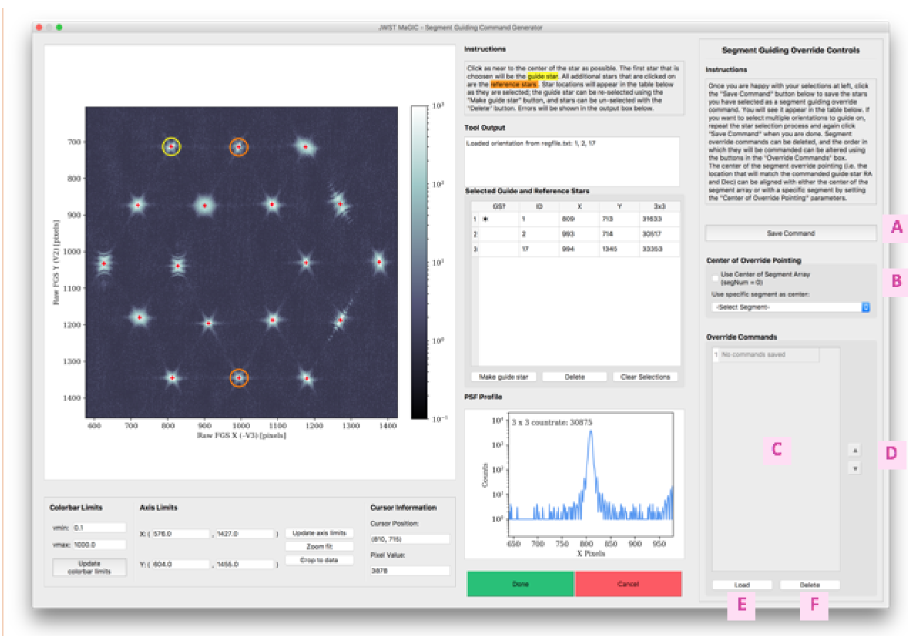
1. When the Segment Guiding Dialog Box appears (shown in Figure 15), define the segment guiding parameters, including:



1. **Program Number** – of the current APT program; three to five digits
2. **Observation Number** of the observation that will be executed
3. **Visit Number** – of the visit that will be executed (this is usually 1, but will be different when mosaics, etc. are taken)
4. **Right Ascension** (optional) – of the guide star

5. **Declination** (optional) – of the guide star
6. **Position Angle** – of the observatory at the guide star at the time of the visit
7. **V2 Boresight offset** (optional) – that will be applied before the observation this file is for
8. **V3 boresight offset** (optional) – that will be applied before the observation this file is for
9. **Uncertainty factor** (optional) – the degree of uncertainty in the countrate of each segment. e.g., an uncertainty factor of 0.9 for a star with a countrate of 1,000 writes an uncertainty of 900.
10. Click **OK** to continue.

If the **Click-to-Select 1 or more commands (GUI)** radio buttonwas selected, the Segment Guiding GUI will appear:



1. If the Segment Guiding GUI is being used, repeat the steps outlined in Section III to select the guide and reference stars – the ones that you verified were successful with DHAS – for one segment guiding override command.
2. When you are happy with your selections, click the **Save Command** button (*A*). You will see the IDs of the stars you selected appear in the **Override Commands** table (*C*).

3. To add another command, again repeat the steps outlined in Section III to select guide and reference stars, and again click the **Save Command** button (*A*).
4. To change the order of the commands, use the up and down arrow buttons (*D*). To view a saved command on the plot, click the **Load** button (*E*). To remove a command from the list, click the **Delete** button (*A*).
5. Choose the center of override pointing (*B*). This sets the origin of the ideal frame (i.e. the location of the guide star if the segments were stacked). It can either be set as the center of the segment array, using the **Use Center of Segment Array** checkbox, or the location of a specific segment using the dropdown box.

See Appendix D for more about selecting the center of override pointing based on the mirror state.

Next

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

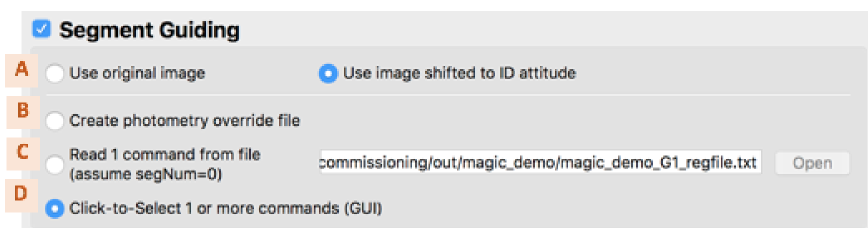
Section VII: Writing the Segment Override File (SOF)

VIII. Writing the Photometry Override File (POF)

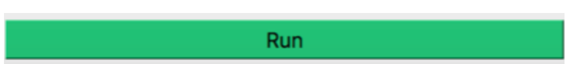
In the case of MIMF where we only need to change the photometry of the guide star (the RA and Dec and expected count rates are taken from the APT file), we need to make an override for Planning & Scheduling but this is for the photometry and will have no information about the segments (because the PSFs from the individual segments are stacked).

Creating a photometry override file through MAGIC:

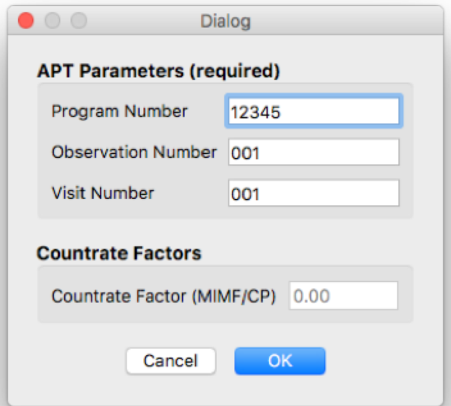
1. Load the file for this observation, select the guider, the set the out directory and root.
2. As in section VII, in the main GUI, select the **Segment Guiding** check box. All other options in the interface will be disabled. Note: You do not need to run the other parts of MAGIC when creating a photometry override file.
3. Select the **Create photometry override file** radio button (*B* in figure below)



1. Run the tool.



1. When the Segment Guiding Dialog box opens, fill in the Program ID, Observation Number, and Visit Number just as you would for creating a segment override file. Additionally, you can add the countrate factor:



Countrate factor: A factor between 0 and 1 that all countrates and thresholds are to be multiplied by. This factor is used for cases such as MIMF and CP when the segments are stacked but unphased, and so the brightness of the guide star is dimmed.

See Appendix D for information about the countrate factor based on the mirror state.

1. Click **OK**

Creating a photometry override file in IPython:

Alternatively, in the case of having to create multiple photometery override files, this can be done in IPython with a for loop.

- **root** – the root name that will be used for the observation. This has to do with where files are saved so consistency is important
- **program_id** – ID of the current APT program; three to five digits
- **observation_num** – the observation number for this observation
- **visit_num** – the visit number for this visit
- **countrate_factor** – factor by which to multiply all countrates and thresholds
- **out_dir** – path to the out directory where all files will be saved

```
In [1]: from jwst_magic.segment_guiding import segment_guiding

In [2]: root = ['root1', 'root2', 'root3', 'root4', 'root5'] #Root used for this dataset
```

```
In [3]: program_id = 12345 #Program ID - int

In [4]: observation_num = [1, 3, 4, 5, 7] #List of Observation numbers

In [5]: visit_num = [1, 1, 1, 2, 1, 1] #List of Visit numbers

In [6]: countrate_factor = 0.6 #Float between 0.0 and 1.0

In [7]: out_dir = '/path/to/out/directory'

In [8]: for i, (r, o, v) in enumerate(zip(root, observation_num, visit_num)):
            segment_guiding.run_tool(root=r, program_id=program_id,
                                     observation_num=o, visit_num=v,
                                     countrate_factor=countrate_factor,
                                     out_dir=out_dir)
```

Next

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A. Installing the JWST MAGIC Package

This section is only if you are install MAGIC on your own machine. For SOGS, you will have to follow the instructions on the JWST ITAR Wiki.

1. Activate your astroconda (Python 3) environment (For installing astroconda go here)
2. `$ cd` into the directory where you want to keep the package
3. Clone the tools from the grit repository:

   ```
   $ git clone git@grit.stsci.edu:wfsc/tools.git
   ```

4. Install the jwst_magic package:

   ```
   $ cd tools/fgs-commissioning
   ```

   ```
   $ pip install -e .
   ```

The package installation process will also check for the following package dependencies, and automatically install them using pip if they are not found:

- `astropy`
- `matplotlib`
- `numpy`
- `photutils`
- `PyQt5`
- `pysiaf`
- `pytest`
- `pyyaml`
- `requests`

Next

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B. Setting UP DHAS

1. If you are working on SOGS and you have not already configured DHAS to work on your personal SOGS account, follow the instructions on Innerspace for setting DHAS up correctly on SOGS.
2. Find the MATLAB icon on the dock and double click to open MATLAB (or press CMD + space to open Spotlight and search for MATLAB)
3. In the MATLAB interface, if not already there, navigate to the DHAS, version 3.0 directory

   ```
   $ cd /Users/<username>/Documents/MATLAB/dhas/v3.0/fitsdisp2_v3p0/
   ```
4. Start the DHAS GUI:

   ```
   $ fitsdisp2
   ```

Next

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

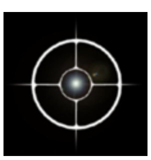
Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C. Using APT to Get Guide Star RA & Dec

1. Open APT



1. Load the APT file for the current program:
2. File > Retreive from STScI > Retreive using Proposal ID...
3. Enter the proposal number (e.g. 1141 for Global Alignment). If you're not sure of the number, check out this table of proposals (but maybe wear sunglasses while doing so).

4. Using the navigation panel at left, navigate to the "Observations" folder, open the desired observation folder, and look at the form editor for the desired observation. The observation forms are the ones that have (Obs #) in their name.
5. Click the **Special Requirements** tab
6. If the observation is a NIRCam observation ("Instrument" is NIRCAM or WFSC):
7. If there is a special requirement called "Guide Star ID":
   (a) Take note of that ID (e.g. N13I018276)
   (b) Query for this guide star using the Guide Star Catalog webform, inputting that ID as the HST ID
   (c) Copy the RA and Dec from the web results
8. If there is no "Guide Star ID" special requirement and there is a requirement that states "PCS Mode COARSE", then that observation is taking place in coarse pointing mode and guiding will not be involved. Ask yourself why you are doing this in the first place.
9. If there is no "Guide Star ID" special requirement and guiding is taking place, it is not possible to get the guide star from this APT file. Talk to Ed Nelan (nelan@stsci.edu).
10. If the observation is an FGS observation:
11. If there is a special requirement called "Fiducial Point Override" that specifies a NIRCam aperture, it is not possible to get the guide star from this APT file. Talk to Ed Nelan (nelan@stsci.edu).
12. Otherwise, take note of the number and name of the target for this observation.
13. Using the navigation panel at left, navigate to the "Targets" folder, open the "Fixed Targets" folder, and look at the form editor for the selected target.
14. Use the RA and Dec of this star for Section VII

Next

Appendix D: Mirror State Procedures

Previous

Section I: Introduction

Section II: Setting Up MAGIC

Section III: Determining and Loading the Input Image

Section IV: Selecting Guide & Reference Stars for an Input Image and Writing Out Files

Section V: Testing Selections in DHAS

Section VI: Contingency: Re-selecting Stars and Re-running DHAS

Section VII: Writing the Segment Override File (SOF)

Section VIII: Writing the Photometry Override File (POF)

Appendix A: Installing the JWST MAGIC Package

Appendix B: Setting Up DHAS

Appendix C: Using APT to Get Guide Star RA & Dec

Appendix D. Mirror State Procedures

Mirror State	Guide and Reference Star Selection Criteria	Center of Pointing	Countrate Factor
Image Array (large or small) 	*Guide Star:* • Choose the PSF with the most compact shape and sharpest peak. *Reference Stars:* • Choose two (2) reference PSFs, preferably on the outer ring of the image array, that are as compact as possible. Be sure that the distances between selected PSFs are unique (a good idea is to choose one star close to the guide star and one that is far away).	The center of the image array	N/A
Small Image Array with one PSF kicked out 	*Guide Star:* • Choose the PSF that has been kicked out. *Reference Stars:* • Choose two (2) reference PSFs, preferably on the outer ring of the image array, that are as compact as possible. Be sure that the distances between selected PSFs are unique (a good idea is to choose one star close to the guide star and one that is far away).	The center of the image array	N/A
Stacked PSFs with one kicked out 	*Guide Star:* • Choose the PSF that has been kicked out. *Reference Stars:* • Stacked PSFs	The stacked PSF	N/A
Stacked PSFs 	*Guide Star:* • N/A *Reference Stars:* • N/A	N/A	Image Stacking/Coarse Phasing: 0.1* MIMF: 0.001 *These values are a guess and will be updated in the future