CLIMB Data Reduction with John Monnier's IDL Pipeline

1. Log into data reduction computer using VNC or SSH

2. Open a terminal in the directory where your data live

3. Start IDL with pipeline settings:
    $ idl83 /git_repos/Monnier_Reduction_Subversion/idl_startup.pro

   You should see a confirmation message that the Astro and MIRC packages were loaded.

4. Start the pipeline:
    >> .run start_climb.script

5. Select directory where the data live using the pop-up GUI. Double click the dirctories in left panel until you're within the one you want and can see the correct path listed at the top of the GUI, then click "OK".

6. If there are observations with different camera settings, choose which ones you want to reduce. You can only reduce one setting at a time – for example, 750 ND vs 750 D – but can merge these later.

7. Select which stars are OBJ vs CAL using GUIs (dark checkbox = selected). I recommend only reducing one target at a time (the object and it's calibrators), so you can use the same settings for all exposures.

8. Edit scans for each exposure using the waterfall GUI. If you don't see any plots, hit "Previous" to load the first exposure. The top left plot is a waterfall plot of the fringe envelope over time (with time running vertically). The top right plot is a waterfall plot of the power spectrum.
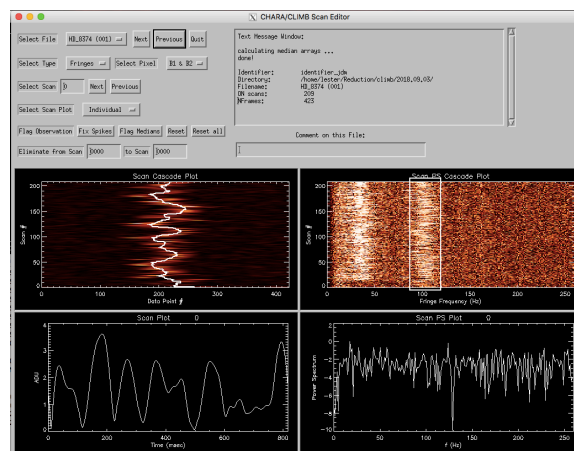

waterfall_gui.png

On a night of good seeing, the fringe waterfall will be concentrated in the center of the scan window. On a night with bad seeing, the position of the fringes will bounce back and forth across the scan window. If there are any gaps in the fringes (vertical regions

where the fringes disappear), then these scans should be removed. First, click the top and bottom bounds of the gap on either waterfall plot. The corresponding scan numbers will appear in the boxes above. To remove the selected region, click on the left box and hit Enter, then click on the right box and hit Enter. The GUI will replot with those scans removed.

Repeat for each baseline (dropdown selection) and exposure (dropdown selection or "Previous/Next" buttons). Click "Quit" when done.

9. The next step is to check the flux levels. The three plot windows will populate:
    (top left) overall summary for each beam and pixel
    (top right) normalized fringe flux
    (bottom right) normalized foreground flux (off fringe)

    Follow the directions printed to the terminal to remove any regions where the normalized flux value deviated too far from 1 (due to clouds, loss of tracking, etc) by clicking on this range in either of the normalized plot windows. When you're satisfied that the mean is around 1 and the variations are within the dashed lines, click to the left of the summary plot's Y-axis to continue. Repeat for each exposure.
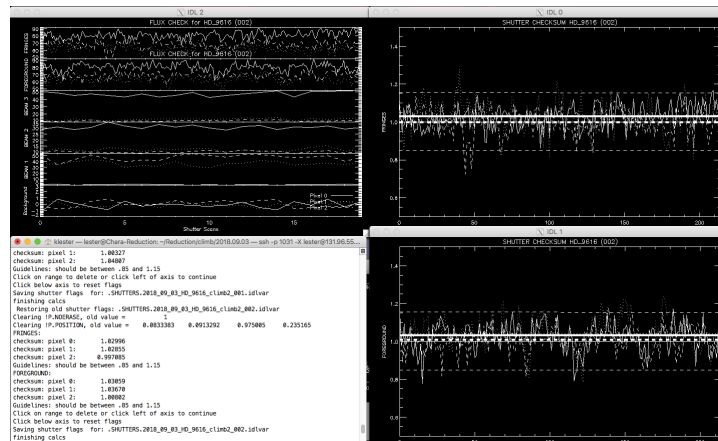
flux_check.png

10. Choose a power spectrum integration range using the GUI. The power spectrum will be plotted on the right for each exposure and each baseline/pixel pair. If no plot is shown, click "Previous" to load the first exposure.
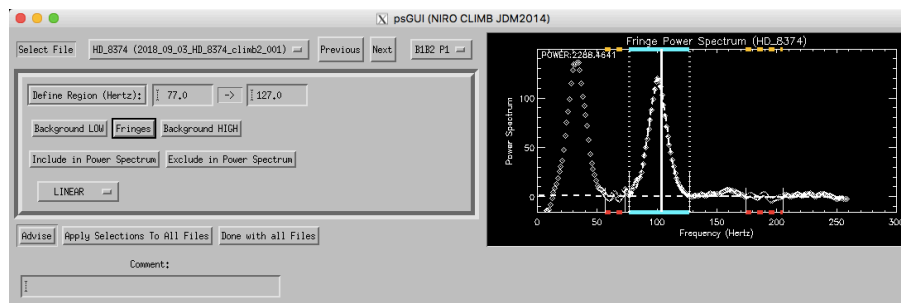
ps_gui.png

Select a range around the fringe peak located closest to the solid vertical line, then hit

"Fringe" to apply. A Gaussian fit to the fringe should appear. Then, select a range on the left of the peak that well represents the background noise level at low frequencies, and click "Background Low". Select a range on the right of the peak that represents the noise at high frequencies, and click "Background High". Once both background regions are selected, a linear fit to this background noise is calculated and overplotted as a dashed line. You can change what function is used to fit the background using the dropdown menu; the options are flat, linear, exponential, and power.

To use this same set of integration ranges for all exposures, click "Apply Selection to All Files". This integration range only applies to the current baseline/pixel, but you can check how it looks using the "Previous / Next" buttons to flip through the exposures.

Repeat for each baseline/pixel combination using the dropdown menu. When finished, click "Done with All Files".

11. The program will calculate the raw V2 and CP from the mean power spectrum using a bootstrapping method. Then it's time to calibrate the data. By default, the pipeline tries read in a text file with the information for your calibrator stars, called "niro_caldiameters.txt". This file has four columns: HD number (or object name), angular diameter (mas), uncertainty (mas), and comments. The last column is typically used to note the reference for the angular diameter measurement.

```
HD_8774    0.375    0.0089    SearchCal
HD_9616    0.383    0.0108    SearchCal
```

If this file isn't in the working directory, it asks you to enter the info in a pop-up box, then creates "niro_caldiameters.txt" with this info.

Pro tip: Keep one master version of this file with all of your calibrator information, then just create a symbolic link to the file in each of the directories where you run the pipeline.

12. The pipeline does a linear fit to the calibrator's V2 for all exposures, grouped by when you aligned the camera. Follow the instructions printed to the terminal: Click on the plot of V2 vs UT time to mark when NIRO alignments were done, which will appear as dashed lines separating calibration groups.

It will then plot a fit to the calibrator V2. To change the time smoothing, click to the left of the plot's Y axis. To continue, click to the right of the plot (in the margin). A plot with the calibrated visibilities will appear in the next plot winow.

Repeat for each baseline/pixel combination and the closure phases.
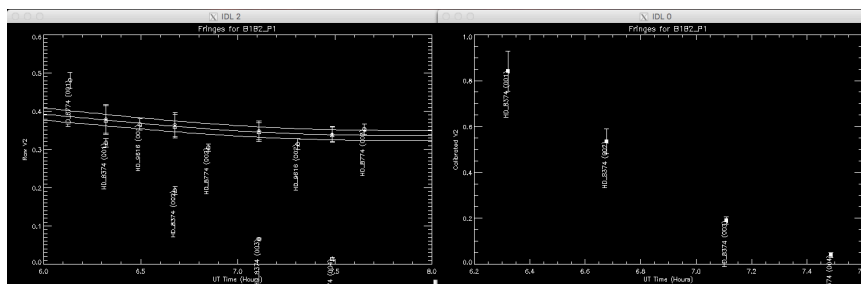
niro_v2.png

13. Enter a suffix for the output filenames in a pop-up GUI [optional]. The default is today's date, but you can erase the entry to skip adding a suffix.

The pipeline saves the results in several "oifits" files in the current directory. There are files for the visibilities from each baseline/pixel combination and for the closure phases, as well as a master file with all of the results. For example:

```
2018Sep03_HD_8374_B1B2_P1_DESTRUC_034Hz.oifits
2018Sep03_HD_8374_B1B2_P2_DESTRUC_034Hz.oifits
2018Sep03_HD_8374_B1B3_P1_DESTRUC_034Hz.oifits
2018Sep03_HD_8374_B1B3_P2_DESTRUC_034Hz.oifits
2018Sep03_HD_8374_B2B3_P0_DESTRUC_034Hz.oifits
2018Sep03_HD_8374_B2B3_P1_DESTRUC_034Hz.oifits
2018Sep03_HD_8374_B2B3_P2_DESTRUC_034Hz.oifits

2018Sep03_HD_8374_T3PHI_DESTRUC_034Hz.oifits

2018Sep03_HD_8374_DESTRUC_034Hz.oifits
```

Here, the last file is the masterfile, which you can read into the data analysis program of your choice.

14. If you want to combine multiple files – for example, combining some 750 ND exposures with some 750 D exposures that you had to reduce separately – use merge_oidata.pro in IDL by simply specifing the input and output file names:

>> merge_oidata, outfile = 'star.oifits', infiles = ['star_750ND.oifits', 'star_750D.oifits']