

Setting Up the Pipeline

- Untar nifs_pipeline_v4.tgz. There will be 4 directories: py_scripts, idl_scripts, iraf_scripts, ref_files.
- The contents of py_scripts/ can be moved wherever you want. There is a variable (pyscriptpath) at the top of nifs_main_LP.py for you to enter the location of these files.
- The contents of idl_scripts/ can be moved wherever you want, just be sure they are in your IDL path.
- The contents of iraf_scripts/ can be moved anywhere, but update your iraf login.cl file to include the path to the scripts and the names of each of the scripts. For example, to my login.cl file I added:
 - task nfsdist_jonelle = home\$scripts/nfsdist_jonelle.cl
 - task nffixbad_anil = home\$scripts/nffixbad_anil.cl
 - task nftelluric_anil=home\$scripts/nftelluric_anil.cl
 - task nftelluric_aniljonelle=home\$scripts/nftelluric_aniljonelle.cl
 - task nifcube_jonelle=home\$scripts/nifcube_jonelle.cl

In this case, the IRAF scripts are located in /Users/jlwalsh/iraf/scripts/, and at the top of my login.cl file, I specify that home is /Users/jlwalsh/iraf/.

- The contents of ref_files/ can be moved wherever you want. There is a variable (refdir) at the top of nifs_main_LP.py for you to enter to the location of these files.

Setting Up the Pipeline

- You'll need to have the IDL astro library in your IDL path, found here: <http://idlastro.gsfc.nasa.gov/>
- You'll need to have Cappellari's IDL versions of pPXF and his bvls.pro. Included in the pPXF download is log_rebin.pro, which is needed as well. pPXF and bvls.pro can be found here: <http://www-astro.physics.ox.ac.uk/~mxc/software/#ppxf>.
- You'll need to have Craig Markwardt's mpfit.pro, mpfitfun.pro, mpfit2dfun.pro, and mpfit2dpeak.pro in your IDL path. These can be found here: <http://cow.physics.wisc.edu/~craigm/idl/fitting.html>
- You'll need to have sigfig.pro in your IDL path, found here: <http://w.astro.berkeley.edu/~johnjohn/idlprocs/sigfig.pro>
- You'll need to get pIDLy, found here: <https://github.com/anthonyjsmith/pIDLy>. Can install by typing 'pip install pidly'.

Running the Pipeline

1. Make a directory to hold all the raw data. In that directory, make subdirectories for each date following a `yyyymmdd` format. Put the NIFS raw data into the appropriate subdirectories.
2. Edit the top of `nifs_main_LP.py` (originally located in `py_scripts/`). This part is well documented. Note, to determine the names of the galaxies and telluric stars that were observed, see the observing logs (or Gemini Observatory Archive) for the night(s) you are working on.
3. If you have set `reduce_tellurics`, `reduce_galaxies`, or `reduce_psf` to 'yes' AND `flinter_extract` to 'yes' at the top of `nifs_main_LP.py`, then you need to have a DS9 window opened. Before the pipeline starts, the program will remind you to open DS9 if you haven't already.
4. Go to your `rootdir` (variable set at the top of `nifs_main_LP.py`). Open PyRAF, then type:
 - `pyexecute("[pyscriptpath]/nifs_main_LP.py")`
where `pyscriptpath` is the variable set at the top of `nifs_main_LP.py` (the full path to location of data reduction python scripts).

- rootdir [e.g., /Users/jlwalsh/Data/LP_2016/nifs_data/2016b]
 - datadir [directory holding the raw data, e.g., raw_data]
 - yyymmdd [raw data from different dates, e.g., 20121227]
 - reducedir [directory holding all the data reductions, e.g., reduced_data]
 - daycals [all baseline daytime calibrations]
 - yyymmdd
 - observational setup [filter and central wavelength, e.g., hk_2.20]
 - tellurics [telluric star observations]
 - yyymmdd
 - observational setup
 - star name [e.g., hip10848]
 - galaxy [science object name, e.g., ngc1277]
 - yyymmdd
 - observational setup
 - merged [merged science cubes]
 - observational setup
 - psf [psf star observations]
 - yyymmdd
 - observational setup
 - galaxy for which psf star observation was taken
 - merged
 - observational setup
 - galaxy for which psf star observation was taken

Data Directory Structure

- ‘rootdir’ and ‘datadir’ must be made by the user (see Step #1 of page 3). ‘reducedir’ and all its contents will be made by the pipeline, if the directories don’t yet exist. The user has control over naming ‘rootdir’, ‘datadir’, ‘reducedir’ - see the top of nifs_main_LP.py. Also, the dates in yyymmdd format, the telluric stars, and galaxies entered by the user at the top of nifs_main_LP.py will be used to name the appropriate directories.

Interactive Components of the Pipeline

- The pipeline requires a little bit (or a lot, if the user wants) of interaction. The default interactive components are summarized below. For an overview of the optional interactive steps, see [additional_info_nifspipeline_v4.pdf](#).
- The pipeline create lists of files that will be fed into IRAF (e.g., flatlist contains the names of all the flats for a given night and observational setup) and copies the fits files from subdirectories in the 'datadir' to the appropriate subdirectories in 'reducedir'. The user is asked to check these lists and can make modifications if needed.
- When prompted, the user should follow the on-screen instructions (see examples on pages 6-13) and check that the lists contain the correct fits file names (e.g., flatlist contains the correct file names of all the flats).
- In a separate terminal, the user can edit the lists, remove files from subdirectories in 'reducedir', and copy files from subdirectories in 'datadir' to subdirectories in 'reducedir' at this time if there is a mistake in the automated process. ** Note, in order to sort files and generate lists, the pipeline makes lots of assumptions that are true for the NIFS LP program. This may fail for other NIFS programs (and even the NIFS LP program). It is important to check the lists! **
- All of the default interactive steps occur at the start of the pipeline. After completing the initial steps, no further input is needed and the pipeline will run all the way through (unless an error arises, or the user has requested to run other parts of the pipeline interactively).

Examples of On-Screen Instructions: Baseline Calibration Lists

- After the pipeline sets up the baseline calibration lists, you'll see the following. This is done for each date + observational setup that you want to reduce (see red underline below).

Follow these instructions and check all of the lists to make sure the correct fits files have been identified.

```
*****
Please check the following in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/daycals/20160925/hk_2.20/:
flatlist
flatdarklist
arcdarklist
ronchilist
ronchidarklist
arclist_1
arclist_2
arclist_3
darklist_600

Make sure the fits files in the above lists are correct by looking at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/ and make modifications if needed.

NOTE, if you would like to combine all arc exposures from a single night/setup together, list all arc exposures in a single arclist file and delete any other arclist files that may exist. Will use the first arc in the list for naming the combined arc file.
*****
Are you ready to continue? Type yes to continue, type no to exit pipeline. 
```

Each arc exposure (taken at various points throughout the night; not back-to-back exposures) is listed separately. In this example, arclist_1, arclist_2, and arclist_3 each contain one arc exposure.

When done checking the lists and making modifications, type yes. Typing no will exit the pipeline. Typing anything else (e.g., hitting return) will bring up the same “are you ready to continue?” question. A similar screen will appear for the next set of baseline calibrations, if applicable (from a different date + observational setup).

If instead you want to combine arc exposures together, follow these instructions.

Examples of On-Screen Instructions: Baseline Calibration Lists

- The pipeline creates the following lists for a given date + observational setup (as seen on page 6):
 - flatlist contains all of the flat exposures
 - to correct for transmission and illumination, and to locate spectra on the detector
 - flatdarklist contains all of the dark exposures for the flats
 - arclist_* contains all of the arc lamp exposures
 - for wavelength calibration
 - arcdarklist contains all of the darks for the arc lamp exposures
 - ronchilist contains all of the ronchi mask exposures
 - for determining the spatial distortion
 - ronchidarklist contains all of the darks for the ronchi mask exposures
 - darklist_600 contains all of the long-exposure darks
 - for reducing the 600 s sky exposures the accompany the galaxy exposures
 - the suffix (e.g., _600) will change depending on the exposure time

Examples of On-Screen Instructions: Telluric Star Lists

- After the pipeline sets up the telluric star lists, you'll see the following. This is done for each date + observational setup + star you want to reduce (see red underline below).

Follow these instructions and check all of the lists to make sure the correct fits files have been identified.

```
*****
Please check the following in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/tellurics/20160925/hk_2.20/hip10512/:
telluriclist_1
skylist_1
skylistshort_1

Make sure the fits files in the above lists are correct by looking at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/ and make modifications if needed.

Sky file #1 will be subtracted from telluric file #1, so the number of telluric and sky exposures need s to be the same. It is okay to duplicate sky exposures in skylist. However, skylistshort should contain only unique sky exposures.
*****
Are you ready to continue? Type yes to continue, type no to exit pipeline. ☐
```

Each line of skylist_1 will be subtracted from the corresponding line of telluriclist_1, so the number of lines must be equal. skylistshort_1 contains only unique sky exposure fits file names (no duplicate names, like may be seen in skylist_1).

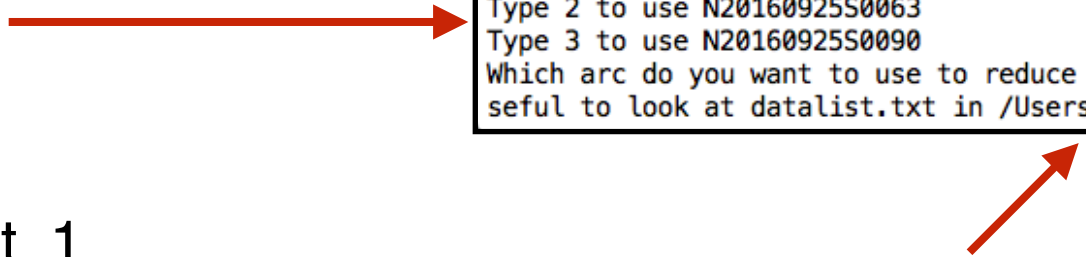
When done checking the lists and making modifications, type yes. The next step will be to specify which arc exposure should be used to wavelength calibrate the telluric star exposures given in telluriclist_1 (and, if applicable, telluriclist_2, and so on).

- telluriclist_1 contains the telluric star exposures taken together as sequence, while skylist_1 and skylistshort_1 contain the corresponding sky exposures for telluriclist_1. One fits file name is listed per line.
- If the same telluric star was observed multiple times during the night using the same observational setup (and was not observed through a series of back-to-back exposures), there will be telluriclist_2, skylist_2, and skylistshort_2, and so on.

Examples of On-Screen Instructions: Telluric Star Lists

- The pipeline asks which arc exposure should be used to wavelength calibrate all of the telluric star exposures given in telluriclist_* (on page 8). This is done for each date + observational setup + star you want to reduce (see red underline below).

Here, there are 3 arclist files (on page 6), each containing the fits file name of a single arc exposure. For example, arclist_1 contains one line with the fits file N20160925S0054.



```
*****  
Provide the following information for exposures in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pi  
peline_v4/reduced_data_test/tellurics/20160925/hk_2.20/hip10512/:  
Type 1 to use N20160925S0054  
Type 2 to use N20160925S0063  
Type 3 to use N20160925S0090  
Which arc do you want to use to reduce telluriclist_1 (starting with file N20160925S0066)? It may be u  
seful to look at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/. 
```

Type the number of the arc exposure you want to use to wavelength calibrate all of the telluric star exposures in telluriclist_1 (on page 8). Here, the options are to type 1, 2, or 3. The first telluric star exposure listed in telluriclist_1 is provided to aid in determining which arc exposure to select, and it may be helpful to look at datalist.txt in the appropriate subdirectory in 'datadir'. Typing anything other than one of the allowed numbers (e.g., hitting return) will bring up the same "which arc do you want to use?" question. The next step will be to specify which arc exposure should be used to wavelength calibrate all of the telluric star exposures in telluriclist_2, and so on, if applicable. After going through all the telluriclist_* lists, a screen similar to the one on page 8 will appear for the next set of telluric star observations, if applicable (from a different date + observational setup + star).

- This question will only be asked if there are multiple arclist_* files (on page 6). If only one arc exposure was taken, or if the user has combined all arcs from this night and observational setup together, this question will not be asked.

Examples of On-Screen Instructions: Galaxy Lists

- After the pipeline sets up the galaxy lists, you'll see the following. This is done for each galaxy + date + observational setup you want to reduce (see red underline below).

Follow these instructions and check all of the lists to make sure the correct fits files have been identified.

```
*****
Please check the following in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/ngc1022/20160925/hk_2.20/:
*****
gallist
skylist
skylistshort

Make sure the fits files in the above lists are correct by looking at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/ and make modifications if needed.

The file skylist will be subtracted from the file gallist, so the number of galaxy and sky exposures needs to be the same. It is okay to duplicate sky exposures in skylist. However, skylistshort should contain only unique sky exposures.
*****

Are you ready to continue? Type yes to continue, type no to exit pipeline. 
```

Each line of skylist will be subtracted from the corresponding line of gallist, so the number of lines must be equal. skylistshort contains only unique sky exposure fits file names (no duplicate names, like may be seen in skylist).

When done checking the file lists and making modifications, type yes. The next step will be to check the telluric correction list, containing the telluric star exposures that will be used to correct the galaxy exposures given in gallist.

- gallist contains all of the galaxy exposures for this night + observational setup, while skylist and skylistshort contain the corresponding sky exposures for gallist. One fits file name is listed per line.

Examples of On-Screen Instructions: Galaxy Lists

- After the pipeline selects the best telluric star exposures to use to telluric correct the galaxy exposures, you'll see the following. This is done for each galaxy + date + observational setup you want to reduce (see red underline below).

Follow these instructions and check the list to make sure the correct fits files have been identified.

```
*****
Please check the following in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/ngc1022/20160925/hk_2.20/:
telcorrlist

Make sure the fits files in the above lists are correct by looking at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/ and make modifications if needed.

NOTE, gallist/psflist will be corrected by the telluric star given in telcorrlist on a line-by-line basis. telcorrlist was generated by searching for the telluric star set observed closest in time to the galaxy/psf exposure; you may want to check/modify based on a match in airmass as well!
*****

Are you ready to continue? Type yes to continue, type no to exit pipeline. 
```

Each line of telcorrlist will be used to correct the corresponding line of gallist (on page 10), so the number of lines must be equal.

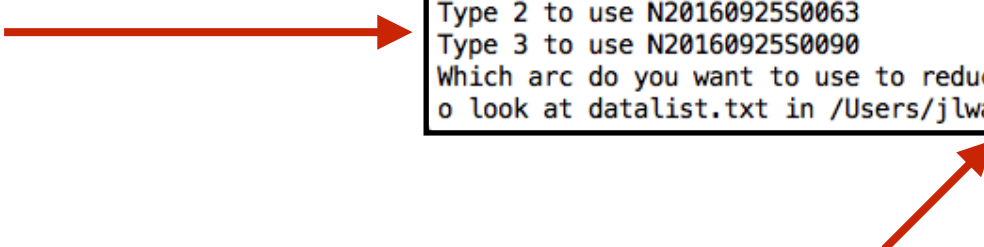
When done checking the file list and making modifications, type yes. The next step will be to specify which arc exposure should be used to wavelength calibrate the galaxy exposures given in gallist (on page 10).

- telcorrlist contains the fits file names of the telluric star exposures that will be used to correct the galaxy exposures in gallist (on page 10). One fits file name (and full directory path) is listed per line.
- The pipeline selects the telluric star observation that is closest in time to each galaxy exposure. It does not check airmass! You may want modify telcorrlist to achieve a better match in airmass.

Examples of On-Screen Instructions: Galaxy Lists

- The pipeline asks which arc exposure should be used to wavelength calibrate all of the galaxy exposures given in gallist (on page 10). This is done for each galaxy + date + observational setup you want to reduce (see underline in red below).

Here, there are 3 arclist files (on page 6), each containing the fits file name of a single arc exposure. For example, arclist_1 contains one line with the fits file N20160925S0054.



```
*****
Provide the following information for exposures in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pi
pipeline_v4/reduced_data_test/ngc1022/20160925/hk_2.20/:
Type 1 to use N20160925S0054
Type 2 to use N20160925S0063
Type 3 to use N20160925S0090
Which arc do you want to use to reduce gallist (starting with file N20160925S0078)? It may be useful t
o look at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/. 
```

Type the number of the arc exposure you want to use to wavelength calibrate all of the galaxy exposures in gallist (on page 10). Here, the options are to type 1, 2, or 3. The first galaxy exposure listed in gallist is provided to aid in determining which arc exposure to select, and it may be helpful to look at datalist.txt in the appropriate subdirectory in 'datadir'. A screen similar to the one on page 10 will appear for the next set of galaxy observations, if applicable (from a different galaxy + date + observational setup).

- This question will only be asked if there are multiple arclist_* files (on page 6). If only one arc exposure was taken, or if the user has combined all arcs from this night and observational setup together, this question will not be asked.

Examples of On-Screen Instructions: PSF Star Lists

- The same procedure for the galaxy lists is repeated for the PSF star lists, including checking/modifying the psflist/skylist/skylistshort, selecting the best telluric star exposures to use to telluric correct the PSF star exposures, and choosing the arc exposure to use to wavelength calibrate all of the PSF star exposures given in psflist. This is done for each date + observational setup + PSF star you want to reduce.
- The on-screen instructions are nearly identical to those shown on pages 10-12.

```
*****
Please check the following in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/psfs/20160925/hk_2.20/psf_ngc1022/:

psflist
skylist
skylistshort

Make sure the fits files in the above lists are correct by looking at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/ and make modifications if needed.

The file skylist will be subtracted from the file psflist, so the number of psf and sky exposures need s to be the same. It is okay to duplicate sky exposures in skylist. However, skylistshort should contain only unique sky exposures.
*****

Are you ready to continue? Type yes to continue, type no to exit pipeline. ☐
```

```
*****
Please check the following in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/psfs/20160925/hk_2.20/psf_ngc1022/:

telcorrlist

Make sure the fits files in the above lists are correct by looking at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/ and make modifications if needed.

NOTE, gallist/psflist will be corrected by the telluric star given in telcorrlist on a line-by-line basis. telcorrlist was generated by searching for the telluric star set observed closest in time to the galaxy/psf exposure; you may want to check/modify based on a match in airmass as well!
*****

Are you ready to continue? Type yes to continue, type no to exit pipeline. ☐
```

```
*****
Provide the following information for exposures in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/nifs_pipeline_v4/reduced_data_test/psfs/20160925/hk_2.20/psf_ngc1022/:

Type 1 to use N20160925S0054
Type 2 to use N20160925S0063
Type 3 to use N20160925S0090
Which arc do you want to use to reduce psflist (starting with file N20160925S0073)? It may be useful to look at datalist.txt in /Users/jlwalsh/Data/LP_2016/nifs_data/2016b/raw_data/20160925/. ☐
```