MAGE Data Reduction

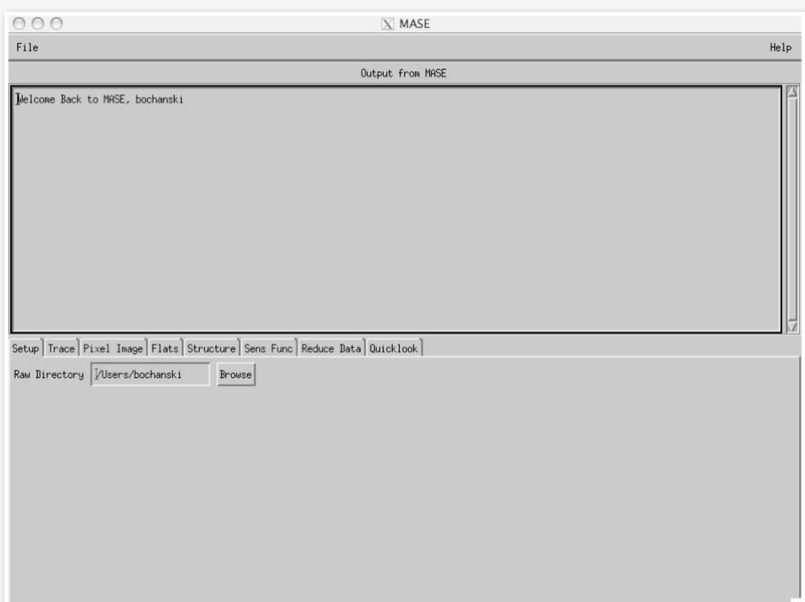
After returning from the mountain, unpack your data into a working directory. The structure should be similar to the following:

/Some_path_to_data/MAGE/utXXXXXX/data/

I will refer to the "data" directory as the raw directory, where all of your raw frames from the telescope will be located. The directory above the raw directory is the "working" directory.

Starting MASE

Starting MASE is simple. Open a shell window, change to the directory just above the raw directory (utXXXXXX, in this example) and start idl. Note that MASE is written for 32 bit architecture. If you have a 64 bit machine, start idl by typing "**idl -32**". Once in IDL, type **mase**.   You should see the following screen:



Main MASE GUI

Click to expand

Selecting the Raw Directory

Selecting the Raw Directory

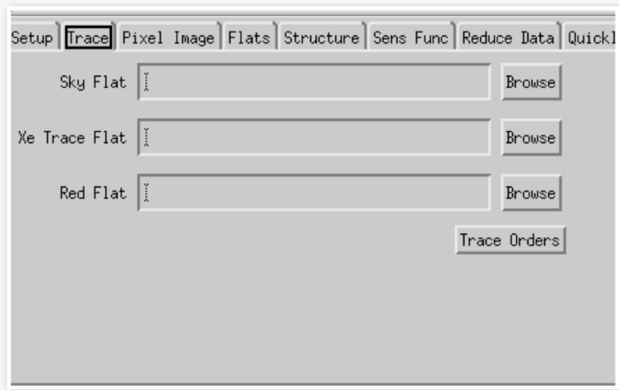
Click on **Browse** in the Setup tab. This will open a file browser. In this window, select the raw directory.

What happens?

The window will close and your choice will be echoed in the main MASE GUI window.

Creating a Trace Flat

Using the calibration files described in the Calibration section, you can construct a quick trace of the orders in a given MAGE image. Under the trace section (shown right) select three files, using the **Browse** button. The sky flat is a twilight flat taken with your science slit. If you don't have these flats, you can substitute a Xe-Flash flat. Select a Xe-Flash flat in the next box. Finally, a Quartz flat (QF) is used for the Red flat. After selecting these three files, click **Trace Orders**.



Trace tab

What happens?

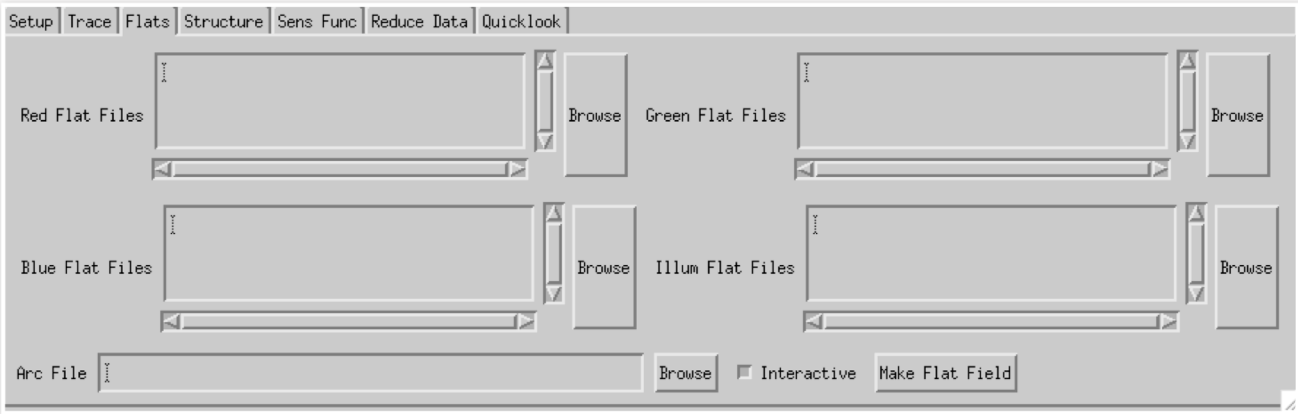
A xatv window will show the resulting trace image with the orders overlaid. If the trace looks bad, try another set of flats. This will create two files: Orders.fits and OStr_mage.fits in your working directory.

Creating Flats

The Flats tab (shown below) has four boxes, one for each calibration set taken at the telescope. You will need to create a new flat for each science slit used. First, select an Arc image (preferably taken close to the time you took your flats) with the **Browse** button at the bottom of the tab. This creates a preliminary wavelength solution used to construct the flats. For Red flats, you will use Quartz flats. Click **Browse** and select ALL of the red flats from your science slit. Click Ok and your selections will be echoed to the screen. The Xe-Flash flats are used for the Green flat files, and twilight flats are used for the Blue flats. Twilight flats should be used for the Illumination flats. Once all your files are selected, click '**Make Flat Field**'. This process is CPU intensive and can take some time.

What happens?

If the interactive button is enabled, then the flat field generated from each file will be shown in a xatv window. Press **q** to quit each window.   At the end of the flat field processing, the final pixel flat and illumination flat are displayed in an xatv window, whether the interactive viewing is selected or not. After quitting out of these two windows, the MASE GUI window should echo that the process is complete. The Flats directory is created and two files are created Pixflat.fits and Illumflat_XXX.fits, where XXX corresponds to the slit used.



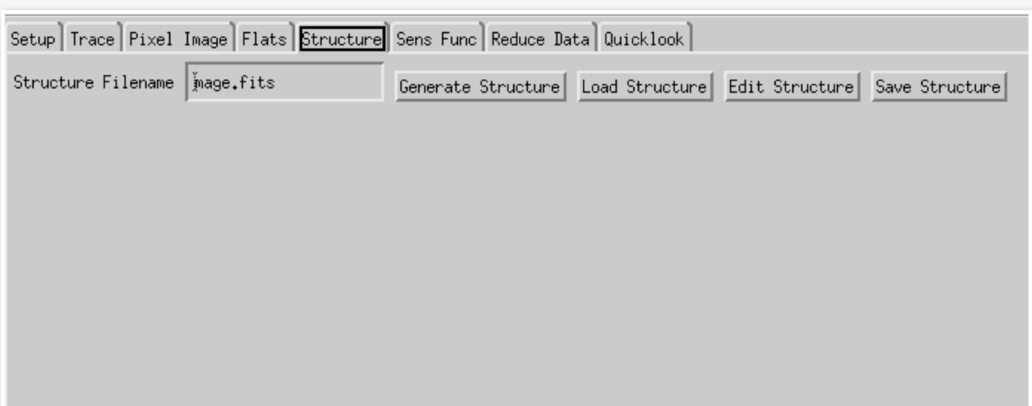
Flats tab

The MASE Structure Tab

The MASE structure tab controls most of the book-keeping for a given night. After creating flats, press the **Generate Structure** button to create a fits file with the night's data. This routine identifies the science objects and associates them with ThAr arc images.

What happens?

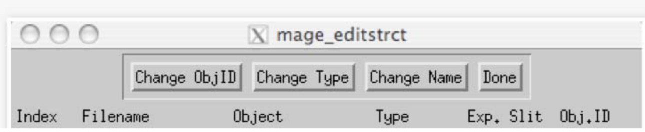
This file is specified by the name (**mage.fits** in this case). If you have previously created a fits structure, it can be loaded by pressing the **Load Structure** button. The Edit Structure button is explained below. Finally, if you wish to save your structure to a different filename, enter the filename and press the **Save Structure** button.



Structure Tab

Editing MASE Structures

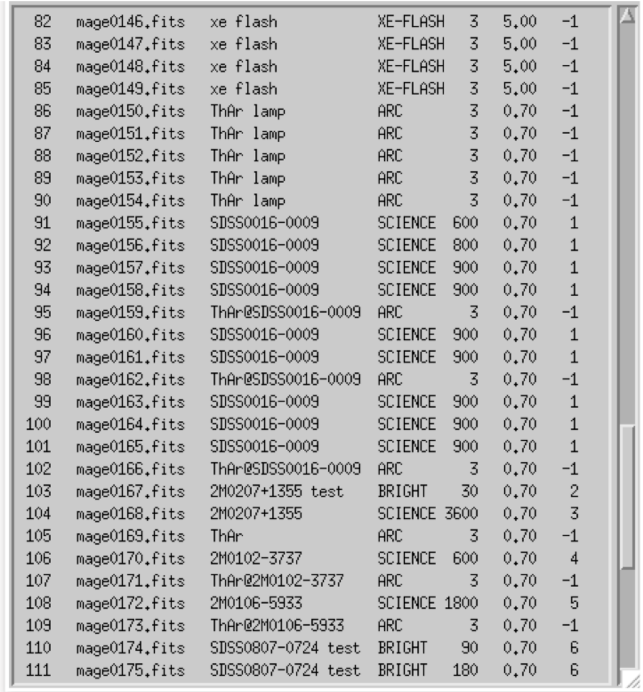
When the user clicks the **Edit Structure** button, a separate widget GUI opens, which allows the user to change the initial settings. An example is shown at right. The columns listed are: index, filename, object, type, exposure time, slit width, and object id. The index simply refers to the exposures index in



the MASE fits structure. The filename corresponds to the name of the file. The object name is assigned at the telescope, but can be changed with the **Change Name** button on the top of the window. The object type dictates how the file is used in reductions, and can be changed with the **Change Type** button. The window at right shows many object types, including flats, arcs, science and bright observations. **BRIGHT** observations are science observations of bright stars, where night sky emission lines are not strong (usually for exposures < 500 seconds). Exposure times and slit widths are listed for reference, along with the Object ID. To be extracted as a science object, an observation must have an ID. This can be changed with the **Change ObjID** button. Finally, if you don't want to extract a spectrum, change its type to **TRASH** with the "**Change Type**" button.

What happens?

After editing the structure, click **Done** and the new structure will be saved under the name specified in the main MASE GUI.



82	mage0146.fits	xe flash	XE-FLASH	3	5.00	-1
83	mage0147.fits	xe flash	XE-FLASH	3	5.00	-1
84	mage0148.fits	xe flash	XE-FLASH	3	5.00	-1
85	mage0149.fits	xe flash	XE-FLASH	3	5.00	-1
86	mage0150.fits	ThAr lamp	ARC	3	0.70	-1
87	mage0151.fits	ThAr lamp	ARC	3	0.70	-1
88	mage0152.fits	ThAr lamp	ARC	3	0.70	-1
89	mage0153.fits	ThAr lamp	ARC	3	0.70	-1
90	mage0154.fits	ThAr lamp	ARC	3	0.70	-1
91	mage0155.fits	SDSS0016-0009	SCIENCE	600	0.70	1
92	mage0156.fits	SDSS0016-0009	SCIENCE	800	0.70	1
93	mage0157.fits	SDSS0016-0009	SCIENCE	900	0.70	1
94	mage0158.fits	SDSS0016-0009	SCIENCE	900	0.70	1
95	mage0159.fits	ThAr@SDSS0016-0009	ARC	3	0.70	-1
96	mage0160.fits	SDSS0016-0009	SCIENCE	900	0.70	1
97	mage0161.fits	SDSS0016-0009	SCIENCE	900	0.70	1
98	mage0162.fits	ThAr@SDSS0016-0009	ARC	3	0.70	-1
99	mage0163.fits	SDSS0016-0009	SCIENCE	900	0.70	1
100	mage0164.fits	SDSS0016-0009	SCIENCE	900	0.70	1
101	mage0165.fits	SDSS0016-0009	SCIENCE	900	0.70	1
102	mage0166.fits	ThAr@SDSS0016-0009	ARC	3	0.70	-1
103	mage0167.fits	2M0207+1355 test	BRIGHT	30	0.70	2
104	mage0168.fits	2M0207+1355	SCIENCE	3600	0.70	3
105	mage0169.fits	ThAr	ARC	3	0.70	-1
106	mage0170.fits	2M0102-3737	SCIENCE	600	0.70	4
107	mage0171.fits	ThAr@2M0102-3737	ARC	3	0.70	-1
108	mage0172.fits	2M0106-5933	SCIENCE	1800	0.70	5
109	mage0173.fits	ThAr@2M0106-5933	ARC	3	0.70	-1
110	mage0174.fits	SDSS0807-0724 test	BRIGHT	90	0.70	6
111	mage0175.fits	SDSS0807-0724 test	BRIGHT	180	0.70	6

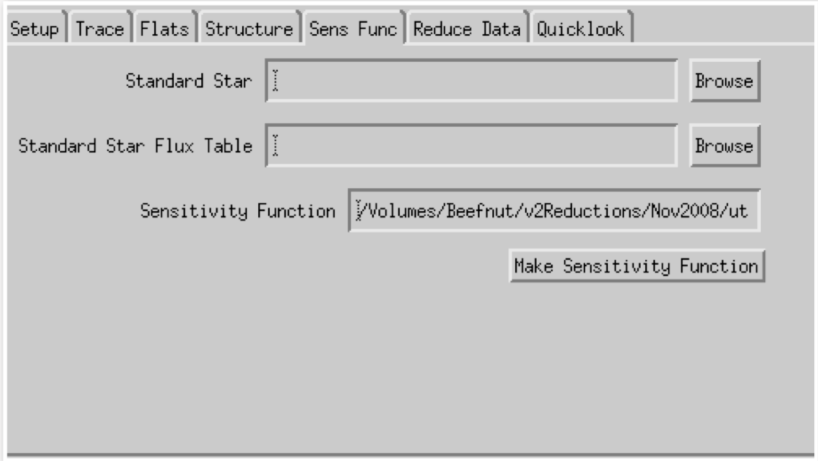
Edit Structure Widget

Sensitivity Function Tab

Sensitivity functions, which convert the observed counts to a flux, are created in the Sens Func tab. **NOTE:** Make sure your standard star observation is marked with the STD type by editing the MASE structure (explained above). Select a standard star raw frame, the ESO / HST flux table (listed HERE and HERE). Finally, edit the **Sensitivity Function** box to choose the name of your derived sensitivity function. Click **Make Sensitivity Function** to start the process.

What happens?

This will extract the spectrum, creating the Object directory and ObsStrXXX.fits file. It will also launch the interactive fitting GUI. Press "**H**" in this window for an explanation of the keystrokes. Our experience has shown that strong lines should be masked out, and lower order polynomials avoid large changes near the edges of orders. Note that you MUST have a standard star reduced (and a sensitivity function defined) to reduce the night. The standard star reduction is used as an initial guess for the trace of each science object. If you didn't observe a standard on a given night, copy the corresponding raw frame and ObsStrXXX.fits from the other night's Object directory.



Sensitivity Function Tab

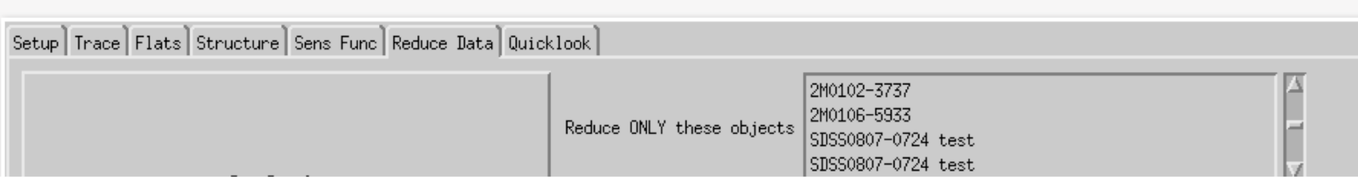
Data Reduction Tab

Once your MASE fits structure is defined and edited to your liking and a standard star has been reduced, the rest of the data are ready to be reduced. Currently, clicking on the list on the right of the tab does not do anything, but this will be implemented in later versions of the pipeline. If an object has been observed many times in a given night, and you would like both the single exposures and the coadded observation, make sure the **Singles** option is selected. Then just click **Run Pipeline**.

What happens?

Two windows showing the object cross-section and the trace position as a function of order number are shown during the reduction process. This step is also CPU intensive, with a typical night of observations taking a few hours to run. It also creates the Arcs, Final, FSpec and Object directories. The wavelength solutions and QA plots are output in the **Arcs** directory. Various useful 2D images (sky, noise, masks, etc) are recorded in the **Final** directory. The object structure, with both counts and flux as a function of wavelength and order is recorded in the **Object** directory. Finally, The 1D spectra are saved in the **FSpec** directory, and can be easily examined with **x_specplot** from the XIDL package. Press H for help with x_specplot. The naming scheme for the 1D spectra are as follows:

objectname_F.fits - flux vs. wavelength
objectname_E.fits - error vs. wavelength
objectname_comb.fits - both the flux and error arrays recorded in different fits arrays.
objectname_s_n_F.fits - the flux vs. wavelength for a single observation of an object observed multiple times



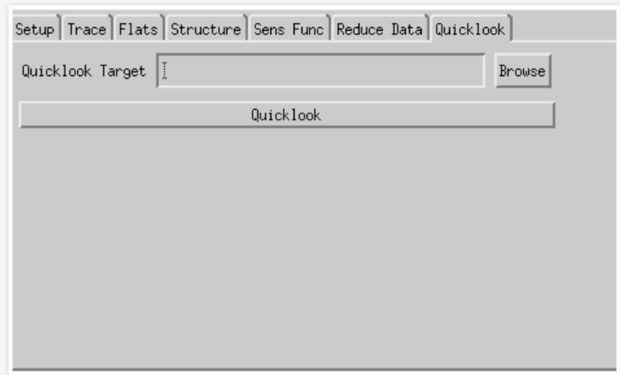
Data Reduction Tab

Quicklook Tab

Since real data reductions usually take a few hours, we've included a quicklook tool which can reduce a raw spectrum in a few minutes. This tool uses archival flats, arcs and sensitivity functions and does not use optimal extraction. But it useful for a quick estimation of signal to noise and an confirm the spectral energy distribution of an object. It is accessed in the last tab. Select a file using **Browse** and press the **Quicklook** button to start the reduction.

What happens?

A temporary file (ql.fits) is created and the spectrum will be shown in a **x_specplot** window after extraction.



Quicklook Tab

Feedback

This is the first release of the MASE data reduction package. If you find a bug or have suggestions for improvement, please do not hesitate to contact me via email. I will do my best to ensure a quick response.