This is a sample of what is sent out by Mario Mateo to users of M2FS

M2FS May/June AND July 2017:
Run Preparation Information and Deadlines

1. Key Dates and Changes from Previous Document

1. Date for submission of setup coordinates:	**Friday, March 24, 2017 (both runs)**
2. Date for submission of configuration details:	**Friday, May 5, 2017**
3. Run dates (Note: **Two runs**.)	**May 20-June 3, July 7-10, 2017 (less May 27,28)**

2. Introduction

Please read through this document and return the requested information to Mario Mateo (mmateo@umich.edu) by the dates noted. Feel free to contact MM if you have any questions (mmateo@umich.edu). Relevant deadlines are listed above.

2. Target Coordinates

In order to produce the plug plates required for the run, please send the target coordinate information described below by the deadline listed at the top of this document. Given the compressed timescale for this run in the upcoming semester, there is little leeway on the schedule so PLEASE SUBMIT YOUR COORDINATE FILES to mmateo@umich.edu by the deadline noted above. The information in this section gives the rules for constructing files that define M2FS 'fields'.

2.1. Definitions: A 'field' is a region of 29.2-arcmin maximum diameter centered on a suitable Shack-Hartmann (SH) star. A 'region' has no size limitations on the sky and may contain multiple overlapping fields. A 'target' corresponds to an astronomical source or reference position (e.g. a sky fiber, a guide star, etc.) for which you specify coordinates. It is your responsibility to ensure that every target in a region can be validly assigned to a field (that is, all targets need to be within 14.65 *arcmin* of a suitable SH star). You should submit coordinates for individual fields (with one SH star per listing). If, instead, you send us targets and potential SH stars for an entire region, be aware that we will arbitrarily assign SH

stars and targets without further feedback from you. You clearly will have best control over the assignments in the former case.

Observations are further defined by 'configurations' which specify the spectrograph parameters in use to take data. Fields can be associated with one or more 'plates' (the physical plug plates used to hold fibers in position during observations). Specification of a plate+field+configuration constitutes a 'setup'. This document describes the details of how to define 'field' files and includes a form so you can define the 'configurations' you desire.

2.2. Target Types: Targets are coded by type. Science targets (code 'T' for 'target') and science sky positions (code 'S') feed directly into the M2FS spectrographs. **Note that we no longer use the code 'O' for object/target as we did for the first M2FS runs.** Shack-Hartmann stars (code 'C') define a field center. Not that it is possible, but not recommended, to observe a field w/o a suitable SH star; however, even in this case a field center needs to be specified (see below). Guide stars (code 'G') should be positioned in the outer half of the field if possible. Alignment/acquisition stars (code 'A') are used to fine-tune plate alignment on a field and should also be positioned in the outer half of the field if possible. Any specific calibration stars that you would like to have observed for your project should be denoted with the letter 'Z' (these do not have to be in the same fields as science targets). Note that guide, alignment and SH stars will automatically have infinitely high priority and will trump any and all target objects. It is up to you to ensure that these operational targets to not cause us to reject any of your most important science targets.

2.3. Target Positional Restrictions: You may send us coordinates without regard to position restrictions, but if you do be aware that we may have to arbitrarily deal with fiber collisions and other interferences in ways that might not be good for your science goals. If you want more control about this you should ensure that your targets and auxiliary stars (guide, alignment and SH stars) satisfy the following positional restrictions:

2.3.1. Shack Hartmann Stars: No science targets or alignment stars should be located within 25 *arcsec* center-to-center from these stars. No guide star should be located within 58 arcsec center-to-center from a SH star in the same field.

2.3.2. Guide Stars: These stars must be separated by at least 33 arcsec center-to-center from any neighboring science or alignment target. Any two guide stars in a given field must be separated by at least 66 arcsec, center-to-center.

2.3.3. Science Targets and Alignment Stars: These must be separated by at least 13 arcsec center-to-center from other science/alignment stars.

A maximum of 256 science targets can be assigned for a given field. You may provide more science targets than this for a given field to allow for the loss of targets due to conflicts with fibers in other fields on the same plate or other fibers in the same fields if the targets were not pre-filters by the separation restrictions above. A list containing more than 256 targets would also be appropriate if it is necessary to visit a field multiple times with repositioned fibers. As previously noted, the full useable diameter of a field is taken to be 29.2 *arcmin*. If you do provide more than 256 targets with identically high priorities, we will arbitrarily—and possibly randomly—select among these for assignment to a plate.

2.4. Brightness and Quantity Guidelines: Please follow these guidelines whenever possible. If you cannot—say, due to a lack of suitable guide or Shack-Hartmann stars—contact MM for guidance.

2.4.1. Science Targets: The faintest targets allowed are limited by system throughput for the desired resolution, grating tilt/elevation, etc. In order to limit the effects of ghost images, however, it is recommended whenever possible to restrict science targets to a range of under 2.5-3 magnitudes. If this is not possible, be sure to include the apparent magnitudes of the targets in the last column of the target list (see below) so we can optimize where to put the brighter sources. Up to 256 science targets can be assigned per field and they can be positioned anywhere in the 29.2-arcmin diameter field.

2.4.2. Alignment Stars: Best if in the range $12 < V < 15.5$ and if all are similar in brightness to within about ± 0.5 mag. *A minimum of three alignment stars are required per field*, with up to 8 observable simultaneously. It is recommended to assign at least four per field and that they be located in the outer half (by area) of the field.

2.4.3. Guide Stars: Best if brighter than $V \sim 15$ though we can go as faint as $V \sim 16$ in a pinch. *At least two guide stars are required per field.* We recommend you specify 3-4 per field in case any have problems (sometimes they turn out to be unresolved doubles or too faint). Guide stars should also be located in the outer half (by area) of the field if at all possible. If you plan to use LoRes mode or you expect long dwell times on fields in HiRes mode, somewhat brighter stars (by about 0.7 mag or more) are recommended. This allows us to guide using colored filters so we can track the portion of the image corresponding to the spectral region of interest. The blue filter in particular needs more light due to the comparatively poor short-wavelength sensitivity of the guide CCDs.

2.4.4. Shack-Hartmann Stars: Best if brighter than $V \sim 14$ but fainter than $V \sim 9$. Normally, SH stars define the field center. If no suitable star exists at the field center, it is possible to observe without a SH star by periodically offsetting to a suitably bright star for primary-mirror wavefront corrections while incurring significant added overheads and degraded image quality between re-focusing. Somewhat fainter stars—down to $V \sim 15$—can be used by increasing the SH exposure time, but with inevitable increases in overhead losses during field acquisition. Please contact MM if either issue—no or faint SH star—arises for any of your fields. Note that if no suitably bright SH star exists at your field center (or no star at all), you must still define the field center in your coordinate list using the code 'C'. It is your responsibility to ensure that every target is located within a 'field' that is defined as a region with a 29.2-arcmin maximum diameter centered on the 'C' location whether or not there is an actual Shack-Hartmann star at the location.

If you are using one of the bluer filters in HiRes mode, it would be good to supply guide and acquisition stars that run about 1 mag brighter than the guidelines above. For such cases, we prefer to use the blue guider filter which, due to the red CCD response, cuts the detection sensitivity on the guide camera noticeably. The use of this filter in the blue is highly recommended to compensate for differential refraction as it allows us to guide on the part of the image that we want to get into the science fibers.

2.5. Coordinate Precision: For a specified equinox, we require a list the RA/Dec of your targets to a uniform relative precision of better than 0.2 arcsec rms (approximately what the USNO-B provides in most fields).

2.6. Data format: We require target coordinates to be transmitted within simple ASCII files in a specific format. Each field is specified by a file that contains the information for all targets, guide/alignment stars, etc. required to observe that field. The rules for the format of field files are defined here:

- Submit one file per field.
- A field is identified by a 'field name' entry in the coordinate file. The format for this is 'Field = xxxxx' where 'xxxxx' is a unique name assigned to that field. It is expected that the field name identifier will be the first line in the file.
- If you want to ensure that none of your highest priority targets are dropped, include the key value pair 'MustKeep = Yes' in your file. If you have more targets with this designation than there are fibers to assign for your configuration, we will drop targets without consulting you (though you will get a log of actual assignments after the fact, of course).
- If you want to ensure a minimum number of sky fibers include the key value pair 'minsky = #' in your file. Otherwise sky targets will be dropped as needed to accommodate as many science targets as possible. This keyword only matters if you are providing more targets than usable fibers.
- You may list more targets that assignable fibers, but please be sure to give useful relative priorities in such cases since some targets *will* have to be removed (see previous bullet).
- Any line in your coordinate file starting with '# (hash or pound) is a comment.
- Column heading lines are assumed to start with 'R' or 'r' (for 'RA', case insensitive); see next bullet. There may be leading spaces before the 'R' or 'r'.
- The first six columns defined MUST be 'RA', 'Dec', 'Epoch', 'ID', 'Type', and 'Priority'. RA and Dec can be entered in sexigesimal format (HH:MM:SS.SSS and SDD:MM:SS.SS, *colons required*) or as decimal degrees. In either case, you must ensure the coordinates are provided to the required precision (see section 2.5). 'ID' is the target identifier, which can be up to 25 characters long (no spaces). 'Type' refers to the classes

of objects noted above ('T', 'S', 'C', 'G', 'A', or 'Z'; see Section 2.2 for details). Priorities can be any numerical values with larger values implying higher priority (e.g., −100.0 is lower priority than +0.01). We recommend that you prioritize in some simple range, such as 0.0 to 1.0 or 0.0 to 10.0, say.

- Names specified on column heading lines are case-insensitive: Ra = RA = rA = ra.
- If known, proper motions can also be included in units of arcsec/year. Their column headings are 'PM_RA' and 'PM_Dec'. It is recommended that these data be listed immediately after the six columns defined in the previous bullet.
- You may add any number of additional column headings of arbitrary length and separated by spaces. There cannot be any internal spaces for any given heading ('Oscillation_Period' is fine, but 'Osc Per' is not).
- In addition to the ones described above, some additional columns names are 'reserved', so do not label columns as 'Fiber', 'x', 'y', 'z', 'R', 'Ep' or 'De'.
- You may change column headings by introducing a new heading line at any point in the file. Any column headings remain in force until a new heading line is encountered. However, remember to re-enter the six primary column headings each time you re-define the columns.
- You must enter unspecified values for a given column with a single hyphen. This includes unused trailing columns.
- If you want, you may line up the columns using tabs or spaces as you prefer. Precise alignment of the columns is *not* necessary.

The following example should clarify the format rules:

```
# This line is a comment (as are the next two).
#
# The next line defines the field.
Field = Your_Field_Name_Here
# The next line defines the initial headings to be used in the file.
   RA Dec Epoch ID Type Priority PM_RA PM_Dec Oscillation_period Reference URL
05:33:25.57  -00:38:35.0  2000.0  Field_Name C 1.00 - - - - -
05:33:26.35 -00:37:46.1 2000.0 50914174 O  1.0 13.4 14.7 18.939 W09 http://blah.com
05:33:27.64 -00:38:17.0 2000.0 50914781 S  0.5   -    -     -   W09 -
05:33:25.57    -00:38:35.0 2000.0    50913779  T  1.00  -4.50  W12 http://qso_rus.edu
```

```
# Now we change the headings and number of columns for all subsequent targets.
RA  Dec    Epoch ID Type Priority PM_RA PM_Dec Redshift Reference
5.12773 -0.65763  2005.0 BK1002 T  0.98  0.0  0.0 2.57  Zachary_et_al_2001
5.12898 0.123003  2005.0 Sky  S    1.00  0.0  0.0  - -
5.18658 -0.123003  2005.0 GuideStar  G    0.00  0.0  0.0 - -
# The next line is NOT valid b/c the trailing columns are not indicated as hyphens
5.23456 -1.4562  2005.0  Target_A  T  1.00  0.0  0.0
# The next line is NOT valid b/c the RA/Dec fields are not ALL separated by colons.
5:23;45.324 -43 52’ 45”.004  2005.0  Target_B  T  0.99  - - - -
```

Note the change in header definition midway through the file. Note the dashes; the last lines indicates that trailing dashes are optional.

3. Specifying Observing Mode Parameters

M2FS consists of two identical, independent spectrographs, each fed by 128 optical fibers. Like the spectrographs, the 256 fibers deployed with M2FS are identical. For historical reasons, the spectrographs are denoted ‘B’ and ‘R’ and the fibers and spectrographs are accordingly color-coded using blue and red labels and other cues. Do not be confused: Neither spectrograph is optimized in the blue or red relative to the other. These terms are *only* used for identification of the two spectrographs.

Please specify the information on the form attached at the end of this file regarding the detailed observing setups for the B and R M2FS spectrographs. Since the spectrographs are independent, the setups do not have to be identical when observing a given field. Since such multi-mode operation is new with M2FS, we will need to work with you to figure out how best to carry it out. Contact MM direct as soon as possible so that we can sort out the logistical details. We want multi-mode operations to become a routine M2FS option, so do not hesitate to consider it. Here are some basic guidelines for multi-mode operations:

- If you have many fields with, say, fewer than 64 total targets that require single orders, we may ‘gang’ these together when observing to improve efficiency. In such cases, low target counts (probably as low as 10-20) and/or short exposures (under 30 min total time on-field) begin to make sense. Please contact MM for details.

- If your long exposures can be split into multiple nights, please let us know. This too can improve efficiencies in some cases.
- We have now defined over 20 different 'configurations' defined by grating angles, HiRes or LoRes modes, slit widths, etc. We may suggest some pre-existing modes if they seem suitable to your project. Using a limited number of modes makes it easier to obtain calibration data for a wide range or projects.
- Not all filters are listed on the form. The ones that are not are likely only useful to a few users, but if you are searching for a filter not in the list, please contact us to check on availability.
- Be sure to submit the observing setup form by the date listed at the top of this document. We really do need these forms in order to plan observations and define new configurations as needed. **PLEASE USE THE FORM BELOW AND SUBMIT THEM ON TIME.** We would hate to have to get strident about this in the future.

Preliminary throughput values for M2FS imply that its overall efficiency is approximately $22 \pm 2\%$ in HiRes mode, and around 35-40% (peak) in LoRes using the current 600-line, blue optimized grating. Use the MIKE manual throughput curves to estimate your exposure times (you can find the MIKE manual under Magellan Instrumentation at www.lco.cl). Using the slits on M2FS will affect resolution and throughput as follows:

Slit Width (microns)	**Projected Pixels**	**Resolution**	**Relative Throughput**
180	10.0	20,000	100%
125	8.3	22,500	92%
95	6.3	27,000	75%
75	5.0	31,000	61%
58	3.9	34,000	48%
45	3.0	38,000	38%

4. Plate Charges

After analysis of the tooling, raw materials and shop time costs associated with making M2FS plates, we have concluded that observers will be charged $70 per field machined in the plug plate blanks regardless of number of targets in a field and regardless of whether the fields are ultimately used or not. Please be aware of this as you plan your field setups. Note too that this charge has changed since the first M2FS science run after a more careful analysis of costs for the plates made for that run.

M2FS Setup Form:

Field Name(s) (required to match up with coordinate list(s)):

B Side Spectrograph

B.A. Spectroscopic mode (choose one)
1. HiRes
2. LoRes

B.B. If HiRes, blocking filter required (choose one):
1. No filter - All orders, approx 3700-9800 AA (2 targets)
2. Mgb_1 - Order 69, 5093-5219 AA (128 targets)
3. Mgb_2 - Order 69, 5119-5205AA (128 targets)
4. Ca_IR_Triplet_1 - Order 41, 8471-8819 AA
5. HotJupiters - Orders 49-50, 7047-7337 AA (64 targets)
6. IanR_Abundances – Orders 77-80, 4419-4661 AA (~40 targets)
7. H-alpha/Li – Orders 53-54, 6528-6791 AA (64 targets)
8. Mgb_Extended – Orders 66-69, 5119-5443 AA (48 targets)
9. Bulge_GC1 – Orders 53-58, 6151-6719 AA (48 targets)

B.C. If LoRes, specify center of desired wavelength range. LoRes blazed 5000 AA, single-order wavelength range ~2000 AA.

B.D. Detector parameters: Binning, number of amps, readout speed.

B.E. Desired slit width (see table above).

R Side Spectrograph

R.A. Spectroscopic mode (choose one)
1. HiRes
2. LoRes

R.B. If HiRes, blocking filter required (choose one):
1. No filter - All orders, approx 3700-9800 AA (2 targets)
2. Mgb_1 - Order 69, 5093-5219 AA (128 targets)
3. Mgb_2 - Order 69, 5119-5205 AA (128 targets)
4. Ca_IR_Triplet_1 - Order 41, 8471-8819 AA
5. HotJupiters - Orders 49-50, 7047-7337 AA (64 targets)
6. IanR_Abundances – Orders 77-80, 4419-4661 AA (~40 targets)
7. H-alpha/Li – Orders 53-54, 6528-6791 AA (64 targets)
8. Mgb_Extended – Orders 66-69, 5119-5443 AA (48 targets)
9. Bulge_GC1 – Orders 53-58, 6151-6719 AA (48 targets)

R.C. If LoRes, specify center of desired wavelength range. LoRes blazed 5000 AA, single-order wavelength range ~2000 AA.

R.D. Detector parameters: Binning, number of amps, readout speed.

R.E. Desired slit width (see table above).

D. Additional comments. Include required S/N requirements for typical targets in your field.