OSIRIS Hackathon 2016-09-07

Final Report

1. Summary

- Code Investigation and changes:
    - Rectification matrix creation routine is normalizing flux correctly
    - Spectral extraction was not assigning blame correctly - have now changed this (created a new blame matrix that is properly normalized, need to tune the sharpening one of the blame matrices) and is in the process of testing. Jessica will put in her fork for now.

    - Can make improvements in making the rectification matrices (like subtracting a bias to account for channel offsets)
    - Investigated the change in PSF width and weight limit for extraction, did not make significant difference. The previous default seems fine.
    - Simplified code in spat. Rectification and added comments
    - Added qlook2, odrfgui into repository
    - Qlook2 bug fixes pending (units bug)
    - Look for new cosmic ray removal algorithm
- Investigated the effects of cosmic ray module
    - Cosmic ray module may cause artifacts in data
    - Cosmic ray module may increase the noise in the spectrum
    - Cosmic ray module also causes flux misassignment in arc lamp data (causes 50% of the flux misassignment in 2016 data)
    - Cosmic ray module affects emission line data more (like galaxies and nebulae)
- Many new tests were created
    - Flux misassignment test for single column data
    - Quasar flux misassignment test
    - Emission galaxy flux misassignment test
    - Spatial rippling test on sky lines
    - Flux conservation test (in progress)
    - Br gamma line test (in progress)
- Scaled sky investigation
- Tracing lenslet spectra
    - Compare sky line trace with white light scans
    - Kbb 100 mas has significant offsets, but Kbb 50 mas does not
- Instrumental PSF
    - 2D PSF of arc lines are more symmetric in 2016 (new detector)
    - Comparisons to sky lines in progress
- IFS simulator created (for creating raw detector images and reduction)
    - OSIRIS part of the simulator needs to be created

Summary of changes between new and old data

- PSF is more symmetric in arcs
- Spectral resolution is slightly increased because of sharper spots
- Most cases, cross talk should be less
- SNR from reduced cubes is likely improved (need more quantification)

Next steps

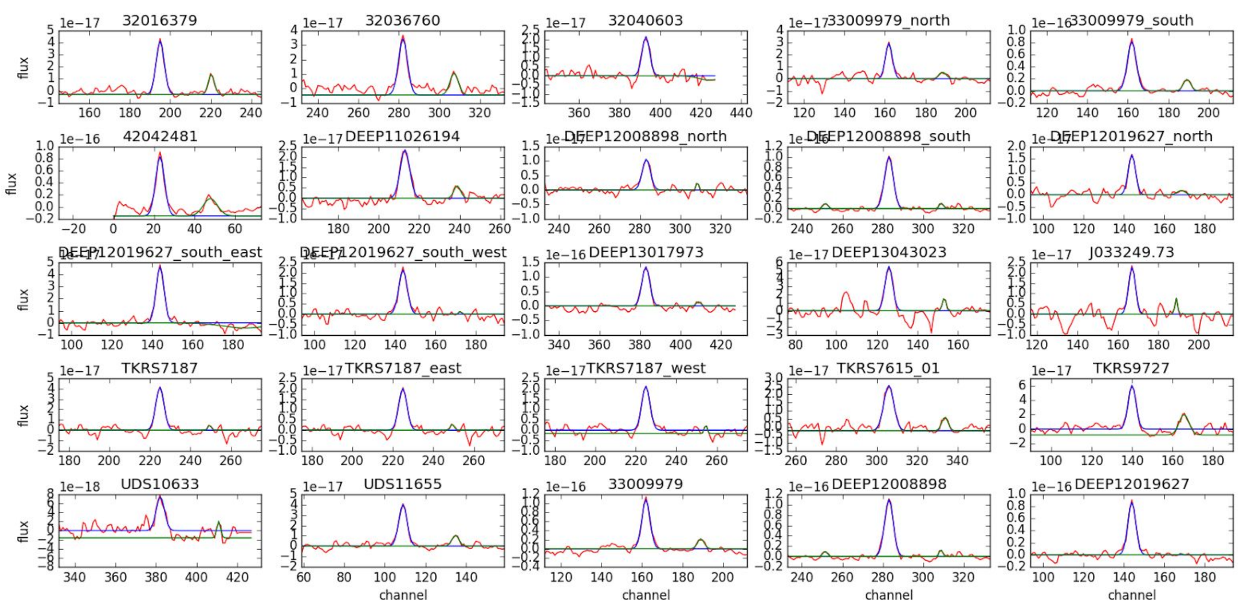
- Change C-code in spatrect.c
- Change cosmic ray removal module
- Qlook2 units bug
- Finish putting tests online
- Figure out how to get test data onto Keck computers for download

- Do pull requests for changes not checked in
- Next OSIRIS Pipeline Telecon: 2 PM PST Sept. 29th

2. Flux Mis-Assignment

Classifying Mis-Assignment in Emission Line Galaxies:

In the emission line galaxies studied in the IROCKS data sample mis-assignment of H**α** flux was commonly seen in the integrated galaxy spectra. Maren fit these spectra with a Gaussian at the H**α** location and at the adjacent false peak in order to quantify the mis-assignment. These fits and the quantities derived from them are shown below. On average, 9.5% of the H**α** flux was misassigned with an average peak ratio of 0.237. All galaxies were observed at 100 mas plate scale and either Jn1 or Jn2.



The fit to H**α** is shown in blue and the fit to the adjacent peak of mis-assigned flux is shown in green.

Object	Percent of flux	Peak Ratio
32016379	22	0.377
32036760	27	0.389
32040603	–	–
33009979_north	16	0.185
33009979_south	16	0.235
42042481	32	0.294
DEEP11026194	15	0.256
DEEP12008898_north	7	1.012
DEEP12008898_south	9	0.104
DEEP12019627_north	–	–
DEEP12019627_south_east	–	–
DEEP12019627_south_west	–	–
DEEP13017973	6	0.106
DEEP13043023	12	0.290
J033249.73	11	0.341
TKRS7187	5	0.123
TKRS7187_east	6	0.145
TKRS7187_west	6	0.218
TKRS7615_01	16	0.300
TKRS9727	37	0.465
UDS10633	18	0.496
UDS11655	18	0.260
33009979	14	0.202
DEEP12008898	9	0.119
DEEP12019627	–	–

The integration of the Gaussian fit in the region of the peaks is evaluated to determine the percent of the total H**α** flux that was mis-assigned and the amplitude of the H**α** and mis-assigned peaks were compared for the peak ratio. Those galaxies with no values listed did not have flux mis-assignment that was noticeable above the noise.

Testing many different modifications to the algorithms for making a rectification matrix (remove clipping, etc.). Cleaning up some of the “old” stuff didn’t seem to make a difference. Note that it does affect a lot of pixels; but not changing them very much.

James, Jessica, and Shelley figured out how to debug the C code line by line. Started saving intermediate arrays (blame, current guess).

Tuan found some strange artefacts in the matrices (continuum pedestals in the rec. Mats that come and go).

Figure XX - A slice from extension 3 of the rectification matrix for Kn5 35 mas (from 150901). There is a slight bias in the flux, which is probably from one of the channels.

TODO: Greg wants to explore some strange noise properties in the quasar data.

Seems consistently 10% flux-misassignment after turning off cosmic-rays across skies, arcs, and emission line galaxies.

2.1. Automated Creation of Rectification Matrices

Rectification matrices used to always be made with the same file name in a single directory. The file name was set by the data that was used to create the rec mat. Anna wrote a python wrapper to making rectification matrices that will allow the modification of the DRP XML files and config files (rpb_confg and the DRP structure). It also modifies the XML file that is used to create the rec mat.

This code has been checked into the OSIRIS repository and merged with the develop branch.

2.2. Tested Wider Slices on Rectification Matrices

The data used are the reduced Kbb/050 arc lamp frame from March 2016 (s160318_c017026_Kbb_050.fits) that only has one lenslet column illuminated. The only difference in each frame is the rectification matrix used (modified by the weight limit and slice/maxslice values as given), and the value of MAXSLICE (to match the rectification matrix) in modules/source/drp_structs.h. Before calculating the flux in each position, the continuum is removed by subtracting a heavily smoothed version of the spectrum from itself (so the average in the continuum is ~0). The absolute value of the flux is then totaled over 25 channels in the original spaxel/correct wavelength, and 19 channels in 4 “wrong” locations. The total flux in all 5 locations is used as the denominator in calculating each percentage in the table below. Overall, changes in the weight limit, slice, and maxslice parameters when creating the rectification matrices and running the DRP did not affect the level of flux misassignment.

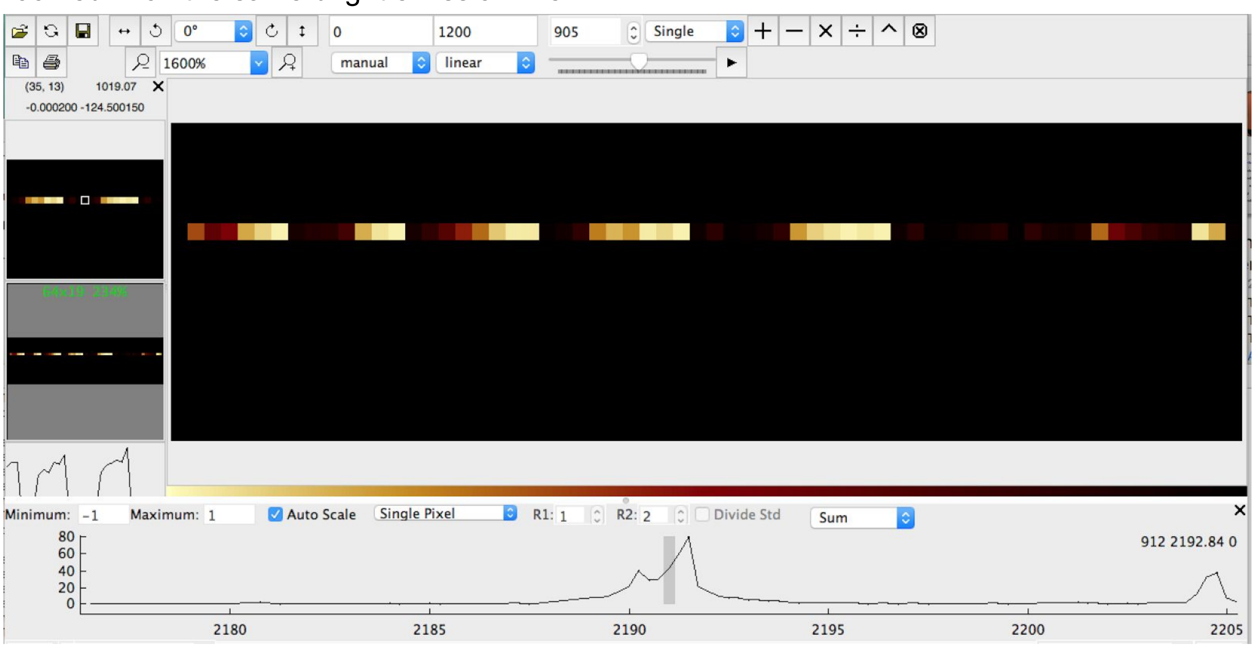
		Locations of flux (integrated)				
Weight Limit	Slice/ Maxslice	Right spaxel, right	-1 spaxel (dark), -32 channels	+1 spaxel (dark), +32 channels	-1 spaxel (dark), right	+1 spaxel (dark), right

		channel			channel	channel
default	default	77.73%	9.81%	12.16%	0.12%	0.18%
0	14/16	77.84%	9.78%	12.08%	0.12%	0.18%
0	20/22	77.74%	9.88%	12.08%	0.12%	0.18%
0	28/30	77.66%	9.94%	12.10%	0.12%	0.18%
0.01	14/16	77.76%	9.79%	12.15%	0.12%	0.18%
0.01	20/22	77.73%	9.81%	12.16%	0.12%	0.18%
0.01	28/30	77.67%	9.85%	12.18%	0.12%	0.18%

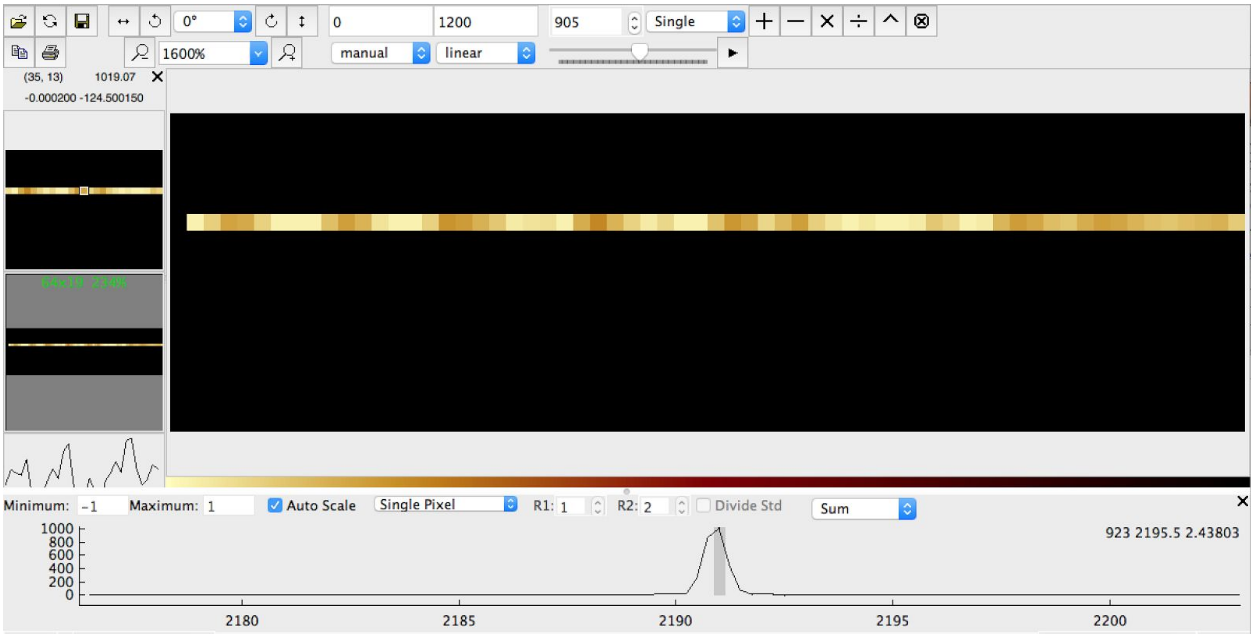
2.3. Tested turning off the Clean Cosmic Rays module

Preliminary testing showed that Clean Cosmic Rays was clipping off the peak of very bright emission lines, particularly when the emission line peak was well-centered on a single pixel; turning off this module restored the peak of the bright emission line and had a secondary effect of improving the flux misassignment. The following subsections detail the results of testing this module on various data sets.

Single column arc (Kbb/050, March 2016, normal reduction, Clean Cosmic Rays module turned on); top panel: channel map at bright emission line, bottom panel: depth plot at one spaxel, zoomed in on the same bright emission line:

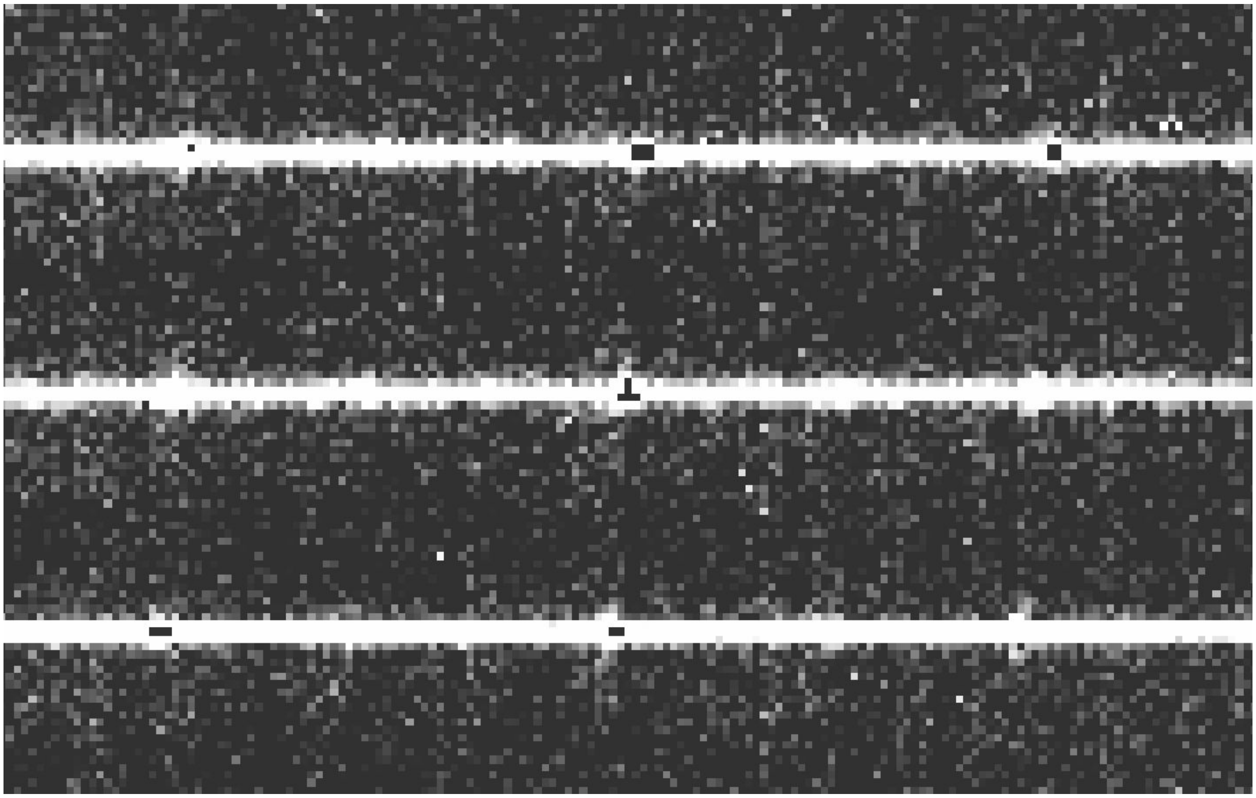


Same as above, but Clean Cosmic Rays turned off; channel map uses the same stretch; depth plot is at the same spaxel as above:

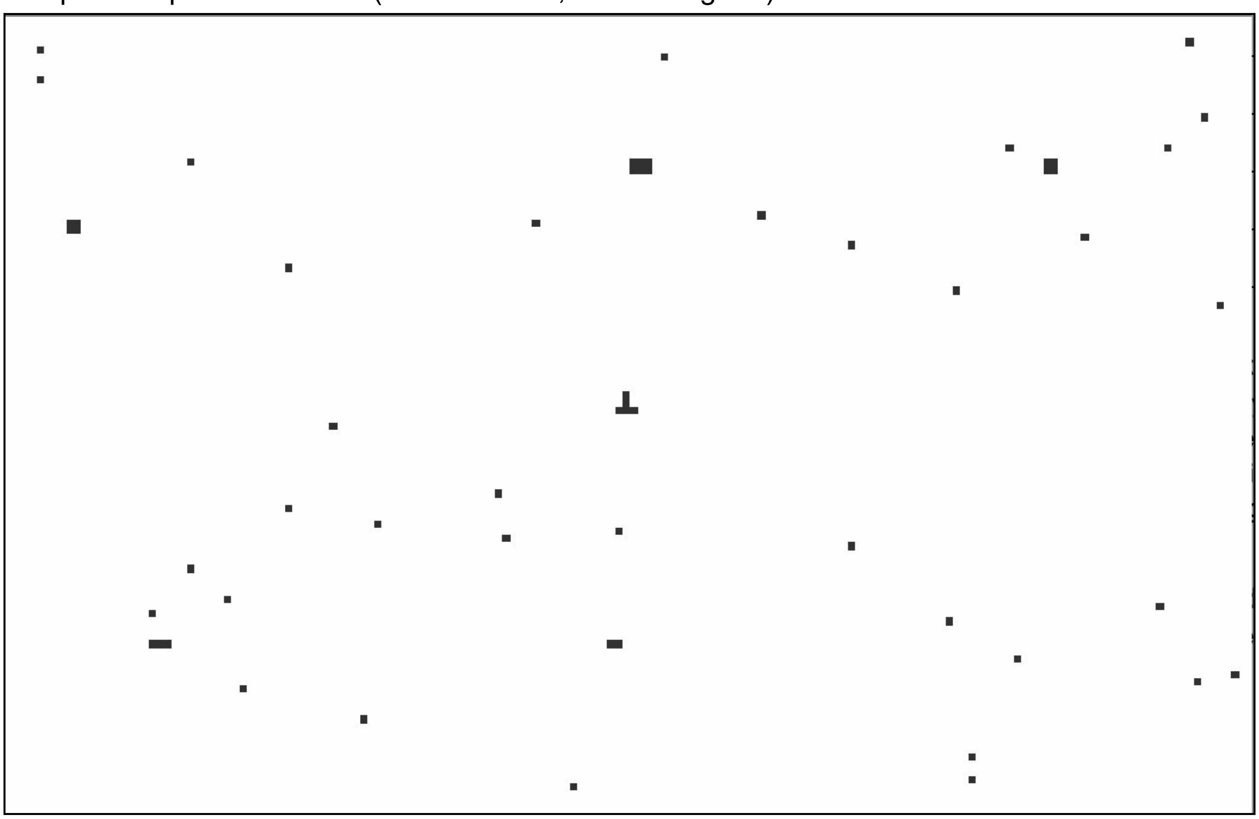


2.3.1. Single column arcs, 2016 data (new detector)

Kbb/050, column 27, Sep 2016, dark subtracted, after Clean Cosmic Rays, before spectral extraction:

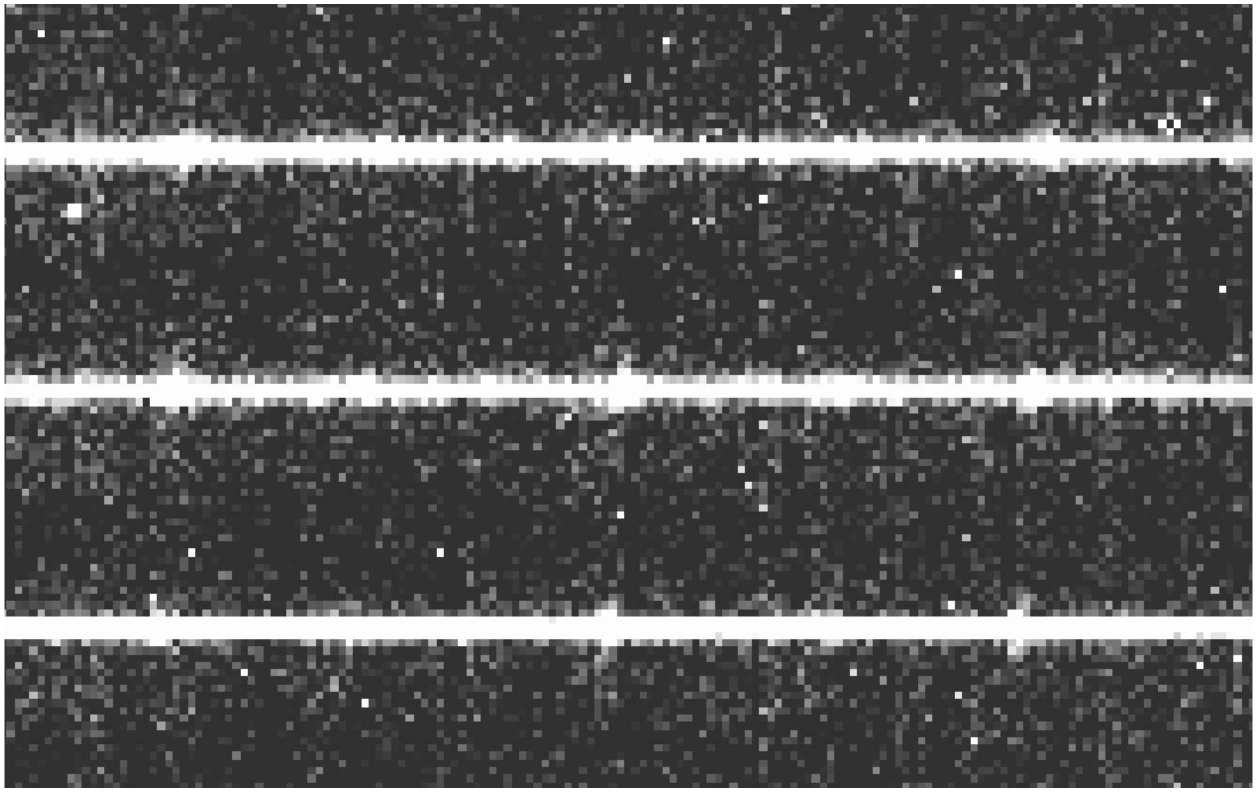


Bad pixel map for this frame (0 = bad/black, 9 = white/good):



→ Some bright emission lines are being clipped as cosmic rays.

Same frame, dark subtracted, Clean Cosmic Rays turned off, before spectral extraction:



→ Bright emission lines are left in the frame.

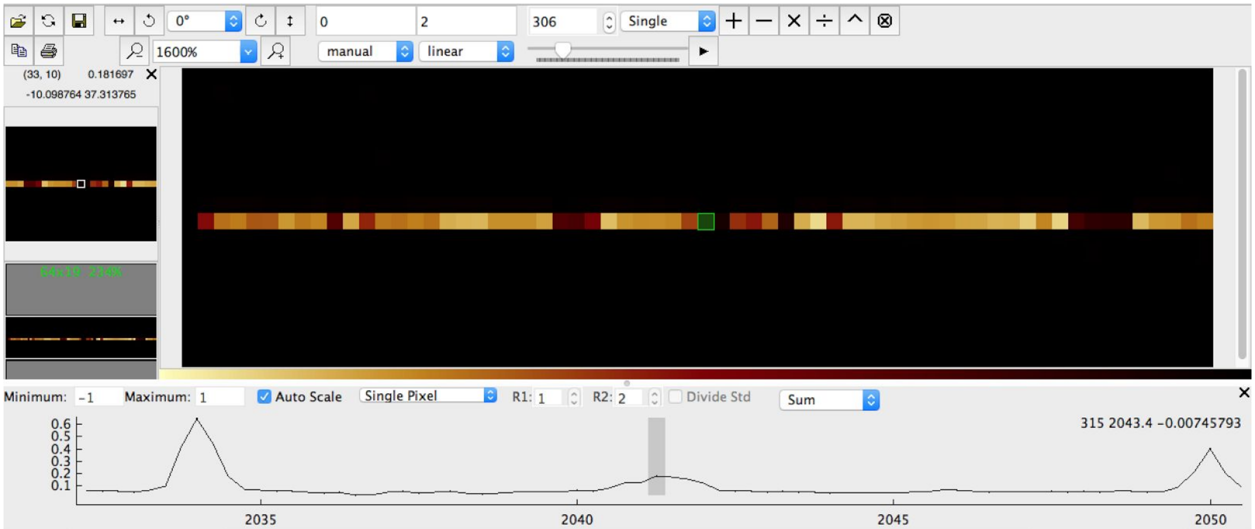
Quantifying the amount of flux misassignment in 2016 arc lamp data. About half of the flux misassignment is corrected in these data when the Clean Cosmic Rays module is turned off:

			Locations of flux (integrated)				
Date	Mode	Clean Cosmic Rays run?	Right spaxel, right channel	-1 spaxel (dark), -32 channels	+1 spaxel (dark), +32 channels	-1 spaxel (dark), right channel	+1 spaxel (dark), right channel
03/2016	Kbb/050	yes	77.73%	9.81%	12.16%	0.12%	0.18%
03/2016	Kbb/050	no	89.82%	4.20%	5.77%	0.08%	0.12%
09/2016	Kbb/020	yes	75.36%	8.61%	10.98%	4.20%	0.84%
09/2016	Kbb/020	no	85.66%	3.80%	5.73%	4.30%	0.51%

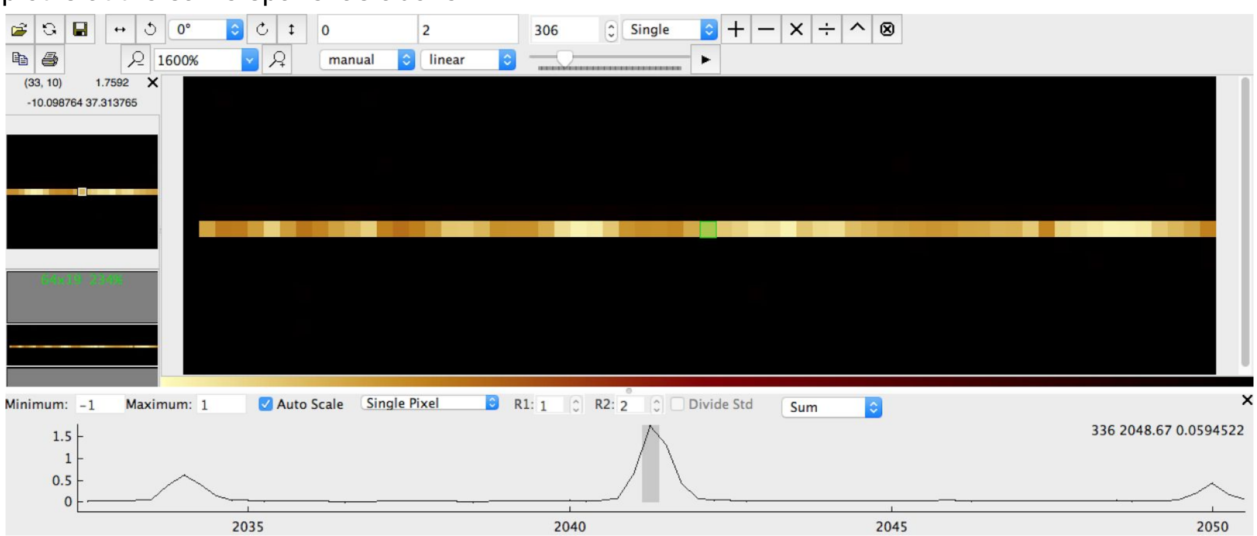
2.3.2. Single column skies, 2016 data (new detector)

The arc lamp emission lines are very sharp and undersampled---is this effect also present in sky lines, which are likely wider?

Single column sky (Kbb/050, September 2016, normal reduction, Clean Cosmic Rays module turned on); top panel: channel map at bright emission line, bottom panel: depth plot at one spaxel, zoomed in on the same bright emission line:

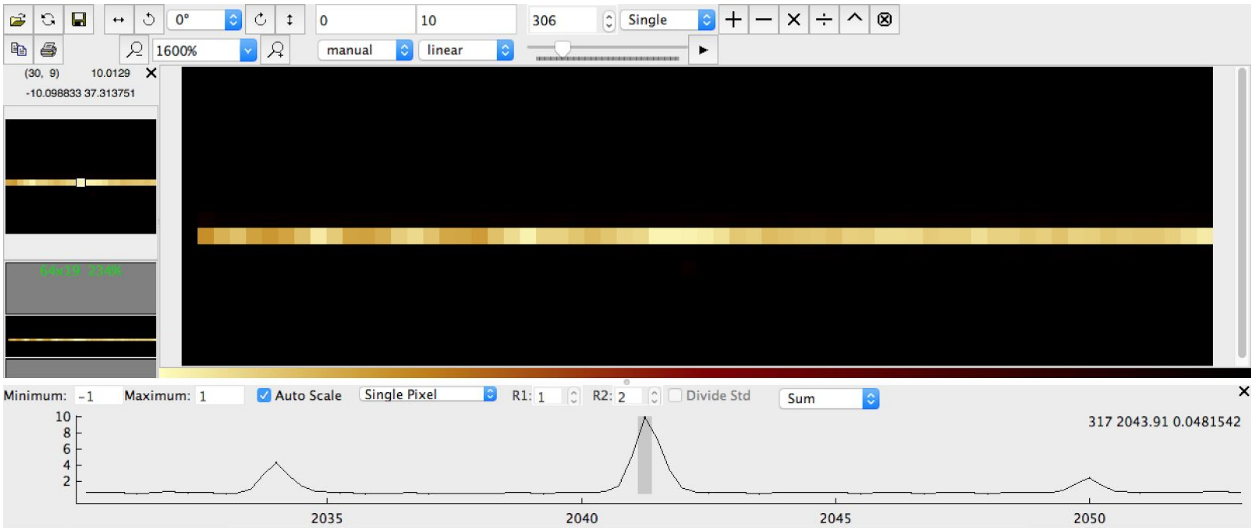


Same as above, but Clean Cosmic Rays turned off; channel map uses the same stretch; depth plot is at the same spaxel as above:

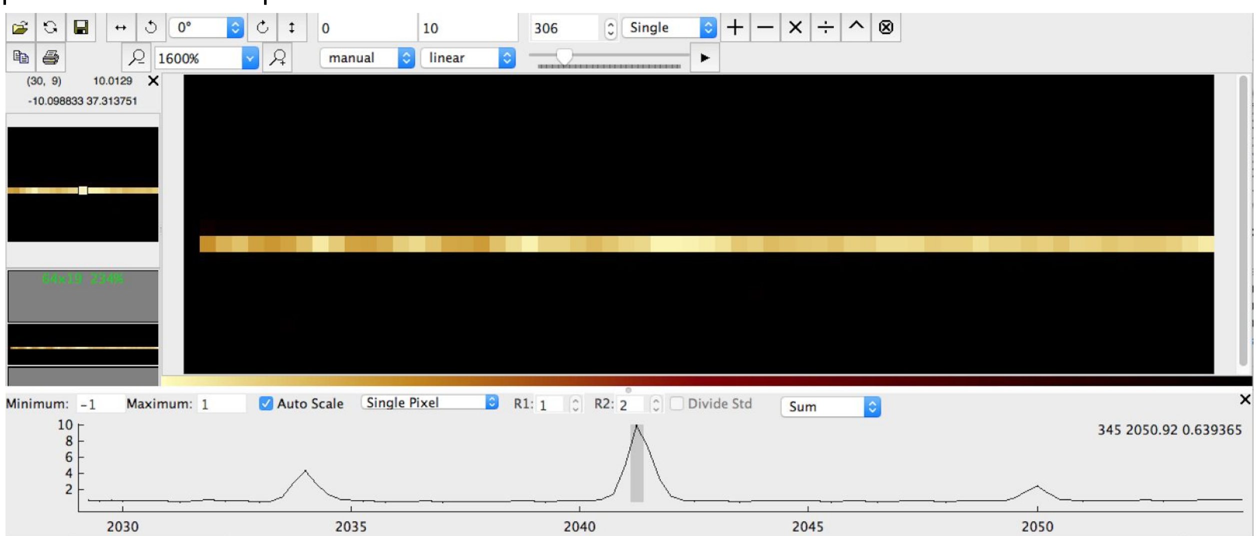


→ 2016 skies are also affected by the Clean Cosmic Rays module

Single column sky (Kbb/100, September 2016, normal reduction, Clean Cosmic Rays module turned on); top panel: channel map at bright emission line, bottom panel: depth plot at one spaxel, zoomed in on the same bright emission line:



Same as above, but Clean Cosmic Rays turned off; channel map uses the same stretch; depth plot is at the same spaxel as above:



→ 100 mas skies have a wide enough PSF to not be affected by the Clean Cosmic Rays module

Quantifying the level of flux misassignment in sky data, with the Clean Cosmic Rays module turned on and off. All sky data are from 2016 (new detector). Color coding marks the same data, reduced with and without the Clean Cosmic Rays module:

				Locations of flux (integrated)				
Mode	Column	Int. Time	Clean Cosmic Rays run?	Right spaxel, right channel	-1 spaxel (dark), -32 chan.	+1 spaxel (dark), +32 chan.	-1 spaxel (dark), right channel	+1 spaxel (dark), right channel

Kbb/050[1]	26	600 s	yes	77.36%	6.74%	7.30%	3.05%	5.55%
Kbb/050[1]	26	600 s	no	79.04%	5.71%	6.68%	3.01%	5.56%
Kbb/100	26	600 s	yes	70.52%	6.18%	9.89%	4.96%	8.45%
Kbb/100	26	600 s	no	70.32%	6.17%	10.09%	4.98%	8.44%
Kbb/100[2]	27	600 s	yes	73.31%	5.40%	9.45%	3.77%	8.08%
Kbb/100[2]	27	600 s	no	73.14%	5.52%	9.53%	3.76%	8.05%
Kbb/100	27	300 s	yes	72.82%	6.52%	8.84%	5.29%	6.54%
Kbb/100	27	300 s	no	72.67%	6.56%	8.90%	5.33%	6.53%

[1]Screenshots of this mode are shown in the top 2 figures in this subsection, 2.3.2.
[2]Screenshots of this mode are shown in the 3rd and 4th figures in this subsection, 2.3.2.

→ Lower S/N in the sky data makes a clear determination difficult, but it looks like there is a small improvement in 50 mas data, where the PSF is undersampled. Kbb/020 skies were also taken (and presumably should show the same improvement in flux misassignment as in the Kbb/050 data) but the S/N was too low to make a robust determination of the flux misassignment.

2.3.3. Single column arcs, 2016 data, testing weight limits/slice/maxslice

Tests reported in Section 2.2 were repeated on the same data set and with the same set of 6 rectification matrices, but with the cosmic ray module turned off. As shown in the table below, the results show an overall increase in the properly assigned flux (correct spaxel, correct wavelength) by over 10% due to skipping the cosmic ray module. There is a negligible difference between the different rectification matrices. We conclude that changing the weight limit and the slice/maxslice do NOT improve the flux misassignment issue in the arc lamp data set.

		Locations of flux (integrated)				
Weight Limit	Slice/ Maxslice	Right spaxel, right channel	-1 spaxel (dark), -32 channels	+1 spaxel (dark), +32 channels	-1 spaxel (dark), right channel	+1 spaxel (dark), right channel
0	14/16	89.87%	4.26%	5.67%	0.08%	0.12%
0	20/22	89.86%	4.32%	5.63%	0.08%	0.12%
0	28/30	89.90%	4.33%	5.57%	0.08%	0.12%

0.01	**14/16**	**89.82%**	**4.20%**	**5.78%**	**0.08%**	**0.12%**
0.01	20/22	89.84%	4.21%	5.76%	0.08%	0.12%
0.01	28/30	89.84%	4.23%	5.74%	0.08%	0.12%

Bold indicates the default rectification matrix.

2.3.4. Single column arcs, 2015 data (old detector)

A good improvement (~10 percentage points) was seen when turning off the Clean Cosmic Rays module for 2016 arcs. Is this same improvement seen in older data?

			Locations of flux (integrated)				
Date	Mode	Clean Cosmic Rays run?	Right spaxel, right channel	-1 spaxel (dark), -32 channels	+1 spaxel (dark), +32 channels	-1 spaxel (dark), right channel	+1 spaxel (dark), right channel
04/2015	Kbb/050	yes	70.23%	5.66%	8.23%	3.07%	12.81%
04/2015	Kbb/050	no	72.34%	4.70%	7.27%	2.59%	13.10%

→ A small improvement is made in turning off Clean Cosmic Rays in 2015 single column arc data, but not as much as in 2016 single column arc data.

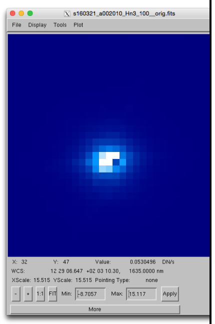
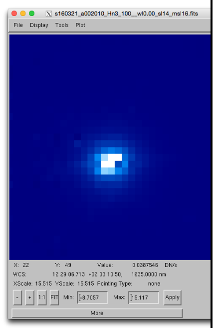
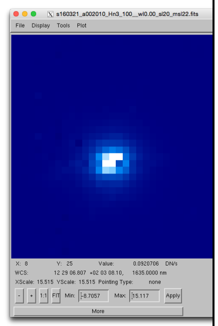
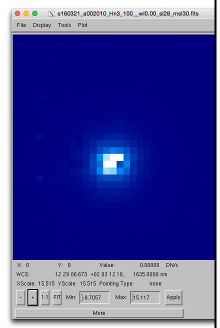
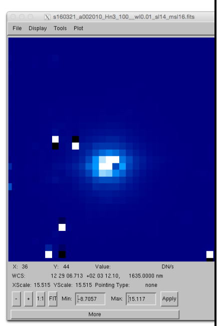
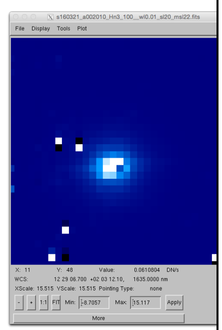
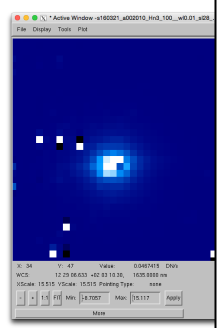
2.3.5. QSO data, testing weight limits/slice/max slice

- Filter: Hn3
- Scale: 100 mas
- Date: 2016 data (new detector)

The QSO data saw miniscule improvement with the increase with weight limit/slice/maxslice. However, the flux increase was roughly relative when compared to the nearby pixels.

Images of the QSO in quicklook2 (median combined) with varying weight limit (WL) / slice (SL) / max slice (MSL). Note: when the weight limit is set to 0.01, artifacts appear in the data.

	Original	SL=14, MSL=16	SL=20, MSL=22	SL=28, MSL=30

WL=0.00				
WL=0.01				

Pixel values, with the center at the “dark” pixel.

<table>
<tr><th></th><th>Original</th><th>SL=14, MSL=16</th><th>SL=20, MSL=22</th><th>SL=28, MSL=30</th></tr>
<tr><td>WL=0.00</td>
<td><table><tr><td></td><td>19.57</td><td></td></tr><tr><td>157.90</td><td>4.22</td><td>9.44</td></tr><tr><td></td><td>12.11</td><td></td></tr></table></td>
<td><table><tr><td></td><td>19.53</td><td></td></tr><tr><td>157.26</td><td>4.36</td><td>7.50</td></tr><tr><td></td><td>11.89</td><td></td></tr></table></td>
<td><table><tr><td></td><td>19.83</td><td></td></tr><tr><td>159.86</td><td>4.43</td><td>7.57</td></tr><tr><td></td><td>12.06</td><td></td></tr></table></td>
<td><table><tr><td></td><td>20.18</td><td></td></tr><tr><td>162.73</td><td>4.51</td><td>7.69</td></tr><tr><td></td><td>12.27</td><td></td></tr></table></td>
</tr>
<tr><td>WL=0.01</td>
<td></td>
<td><table><tr><td></td><td>19.89</td><td></td></tr><tr><td>157.63</td><td>4.53</td><td>9.35</td></tr><tr><td></td><td>12.13</td><td></td></tr></table></td>
<td><table><tr><td></td><td>20.25</td><td></td></tr><tr><td>160.23</td><td>4.63</td><td>9.50</td></tr><tr><td></td><td>12.33</td><td></td></tr></table></td>
<td><table><tr><td></td><td>20.61</td><td></td></tr><tr><td>163.09</td><td>4.74</td><td>9.68</td></tr><tr><td></td><td>12.55</td><td></td></tr></table></td>
</tr>
</table>

Note: The gray cell is the “dark” pixel and blue cell is the bright center pixel.

Percent flux ratio between “dark” pixel and bright center pixel.

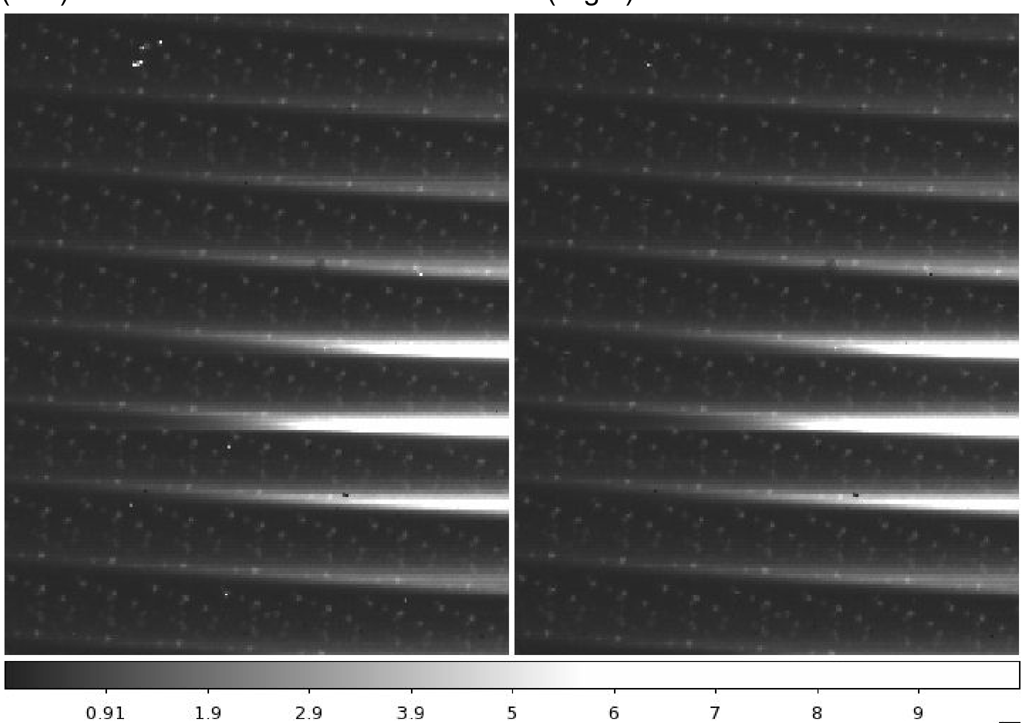
	Original	SL=14, MSL=16	SL=20, MSL=22	SL=28, MSL=30
WL=0.00	2.67%	2.77%	2.77%	2.77%
WL=0.01		2.87%	2.89%	2.91%

2.3.6. QSO data, testing turning off Clean Cosmic Rays module

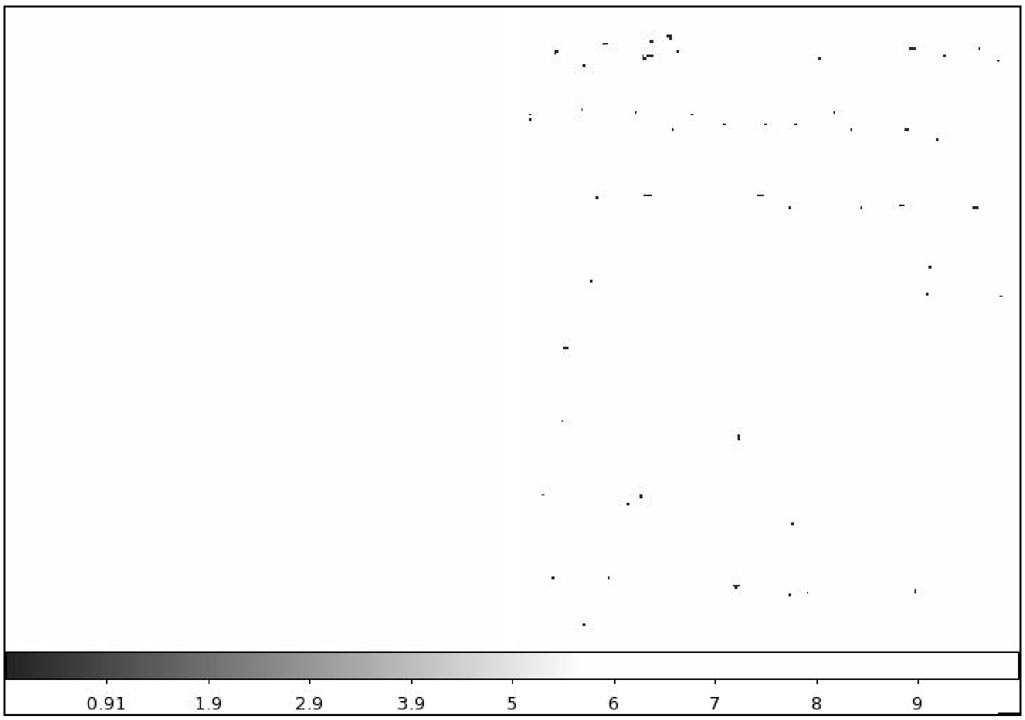
- Filter: Hn3
- Scale: 100 mas
- Date: 2016 data (new detector)

Turning Clean Cosmic Ray off did not fix the missing flux from the spaxel.

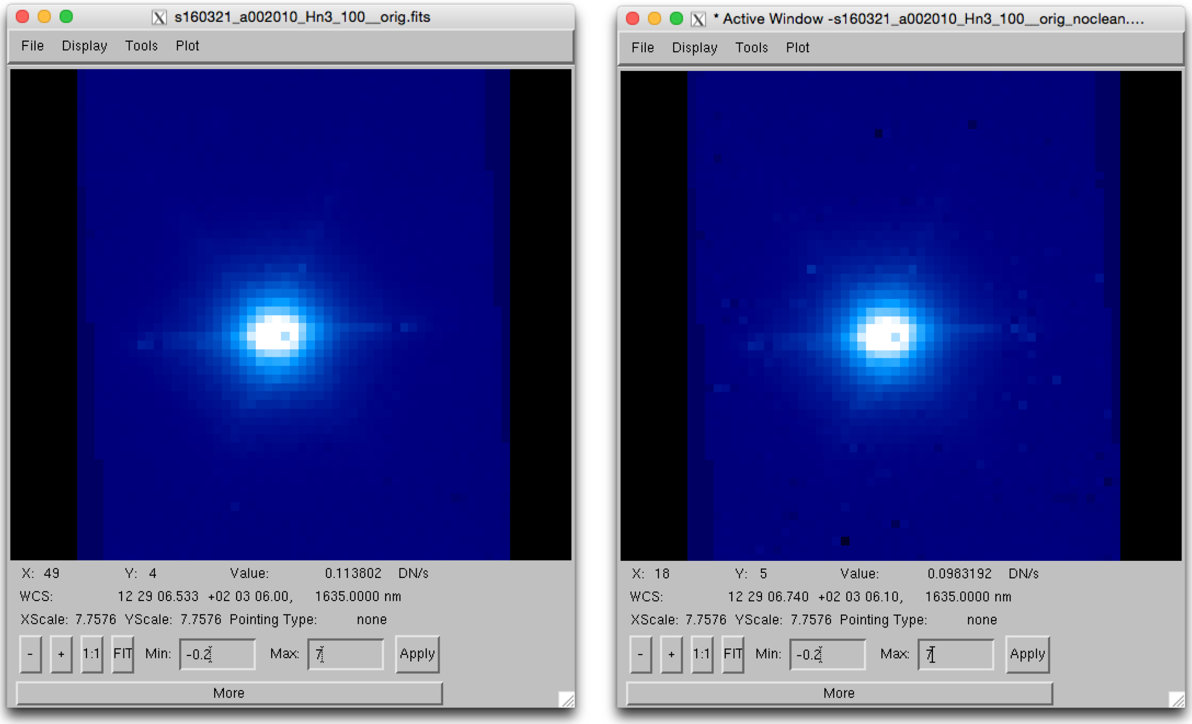
(Left) Clean turned off in 2d science data. (Right) Clean turned on in 2d science data.



(Left) Clean turned off in 2d mask data. (Right) Clean turned on in 2d mask data.

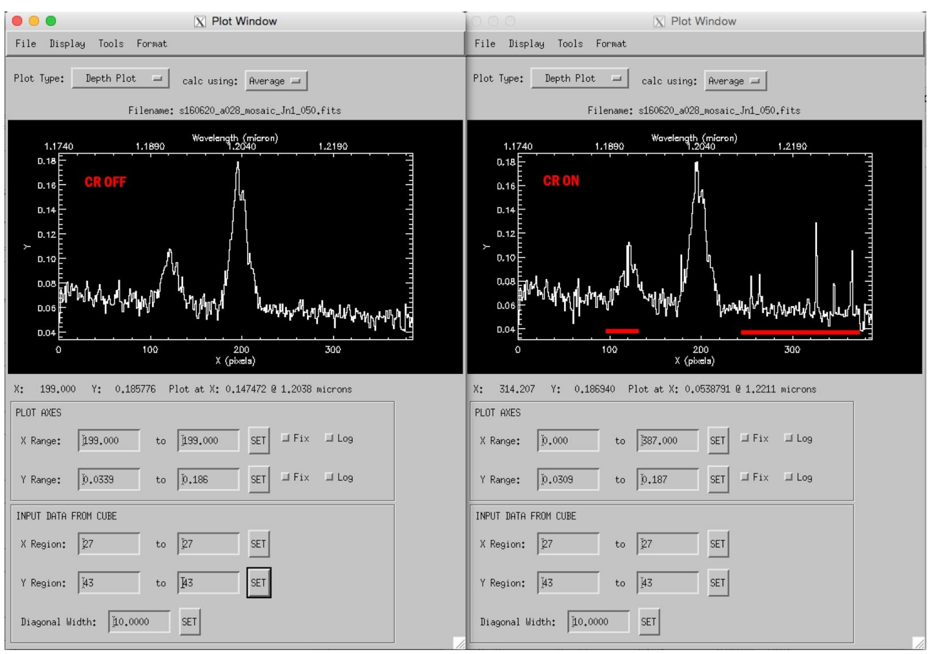


(Left) QSO with Clean Cosmic Ray on. (RIght) QSO with Clean Cosmic Ray off.



When the stretch is adjusted appropriately, you can see that the bad pixels appear with the Clean CR is turned off.

Clean cosmic rays off vs on on 2016 quasar data. Jn1 50 mas mode:



Data reduced with scaled sky subtraction. Presence of additional noise on the right side of the emission line at the same location where OH sky lines are present. Noise possibly due to clipping of OH sky lines in clean cosmic rays routine that causes poor sky subtraction in scaled sky routine. Additional clipping in quasar emission near channel 100.

2.3.7. Clean cosmic module on emission line data

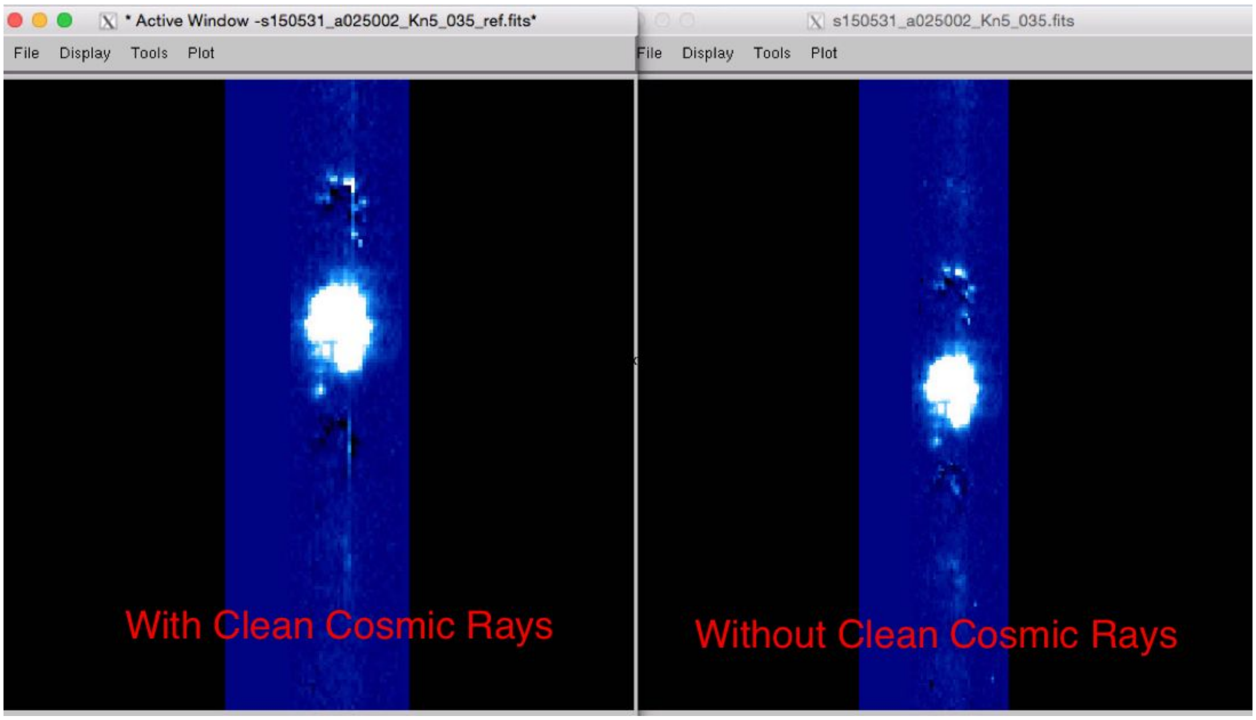


Figure XX - Emission lines from a Nova, part of the `test_emission_lines` test. Left: with cosmic ray removal module turned on. Right: Without clean cosmic ray module. There are fewer artifacts without running the cosmic ray module. Clean cosmic ray is able to remove true cosmic rays.

2.4. PSF Trace in White Light vs. On Sky

The purpose of the following test is to determine whether the trace of the spectra from the lenslets on the detector is the same with the white-light calibration scans as with on-sky data. This test requires observations of the sky continuum that is bright enough to trace. It also requires a lenslet mask so that only a single column is illuminated in order to easily isolate the traces. The appropriate dataset were taken by S. Wright et al. on 2016-09-02. These data includes sky observations as well as arcs and white light observations in column 26 and 27 at multiple plate scales in Kbb.

To determine the trace of the spectrum, we extract the line profile at each position in X and then fit a Gaussian to the profile to determine the Y centroid of the trace. We sample in X position where there is significant flux.

Filter	Scale (mas)	Average Peak Difference (Sky - White light)	Standard deviation	Average FWHM Difference (Sky - White light)	Standard Deviation
Kbb	100	-0.143	0.22	0.30	0.08
Kbb	50	0.033	0.11	-0.014	0.077

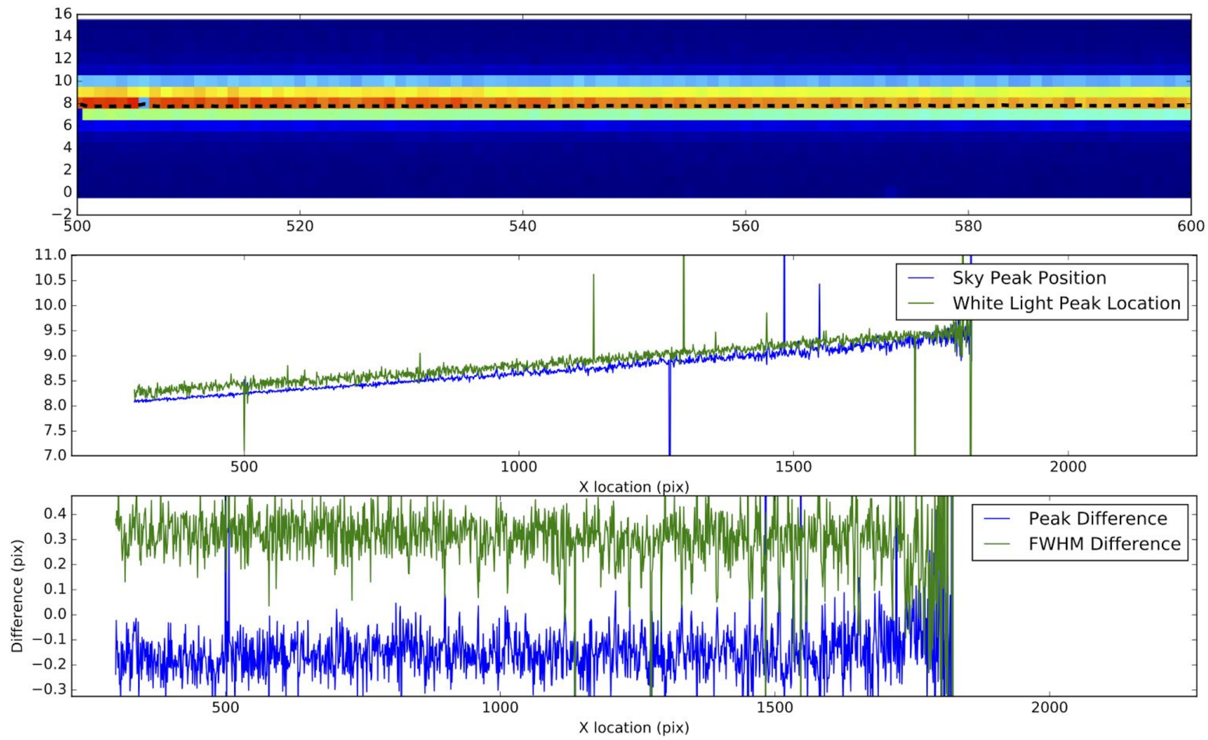


Figure XX - Trace for Kbb 100 mas. Top: Slice from sky observations centered at y pixel 1089 corresponding to the spectrum of one lenslet. Center: the Y centroid of the trace across the detector for the sky continuum compared to the white light scan. Bottom: the difference between the Y position of between the sky and white light scan (blue) as well as the difference in FWHM (green).

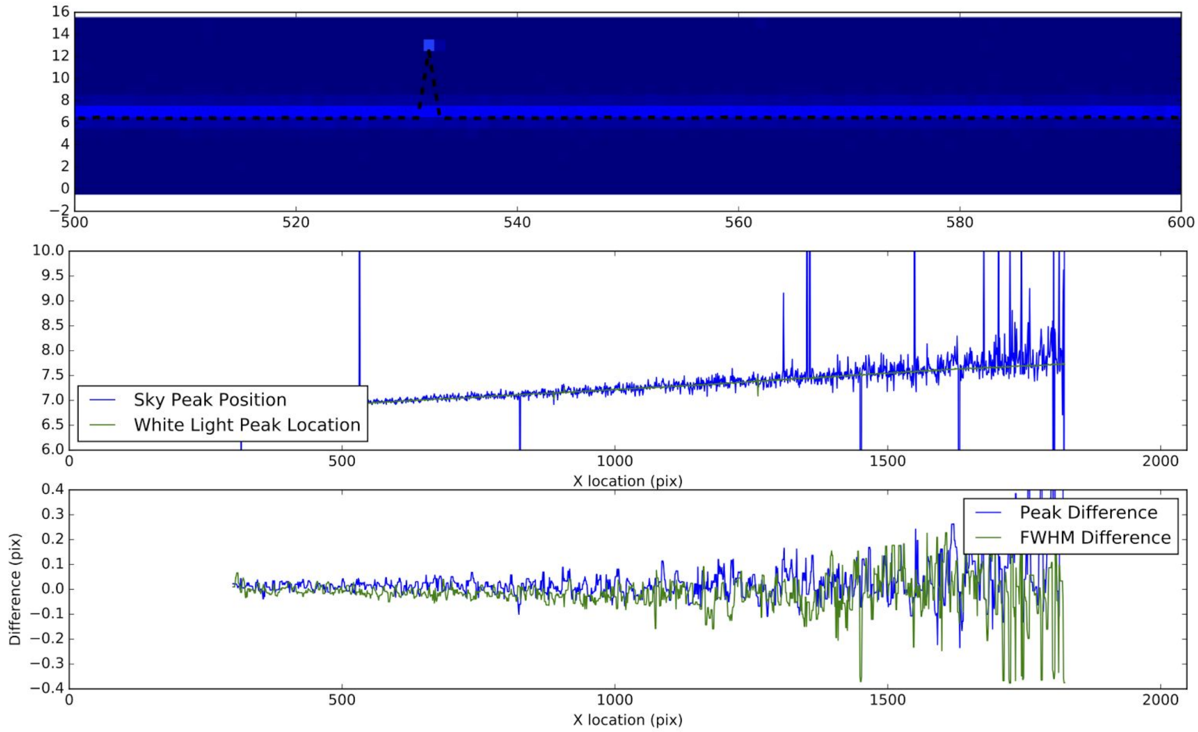


Figure XX - Trace for Kbb 50 mas. Top: Slice from sky observations centered at y pixel 1089 corresponding to the spectrum of one lenslet. Center: the Y centroid of the trace across the detector for the sky continuum compared to the white light scan. Bottom: the difference between the Y position of between the sky and white light scan (blue) as well as the difference in FWHM (green).

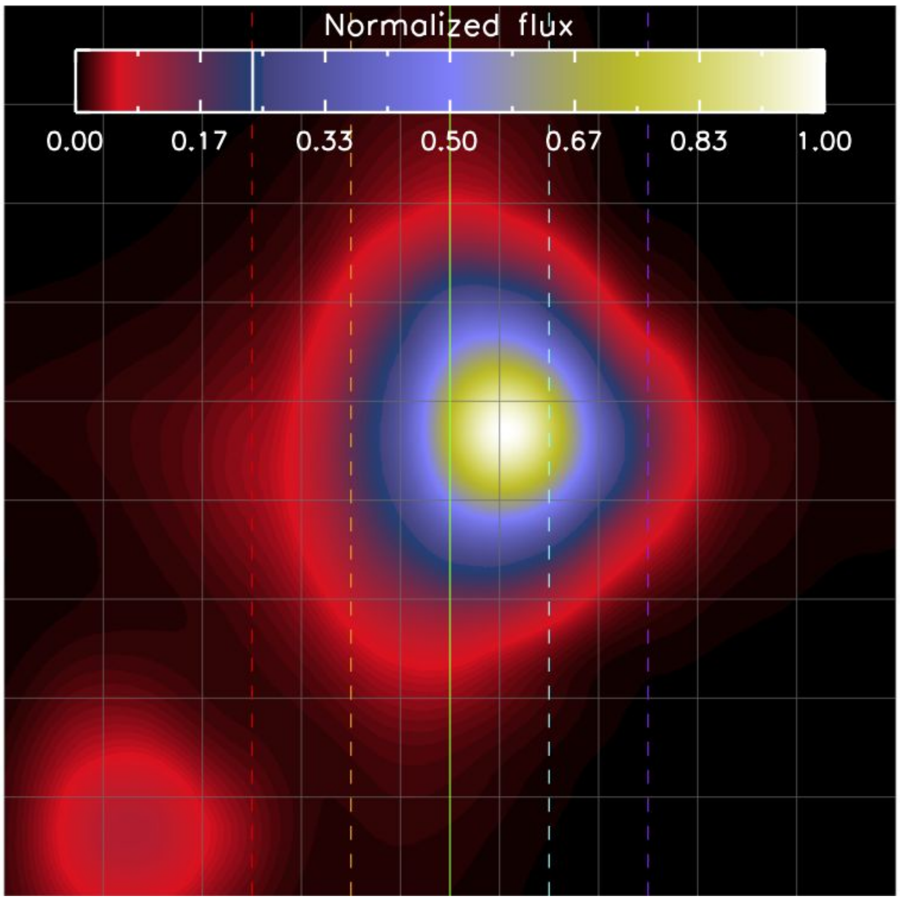
Conclusions: Kbb 100 mas has significant differences both in the offset of the trace as well as the FWHM of the line profile from lenslets. Kbb 50 mas does not appear to have these shifts within our ability to measure at this time, but the data is noisier. The cause may be because of differences in the pupils in the two scales. The offsets do not vary significantly between a lenslet spectrum at the top of the detector compared to the bottom of the detector. There also does not appear to be a difference at short wavelengths compared to longer wavelengths.

2.5. 2D PSF

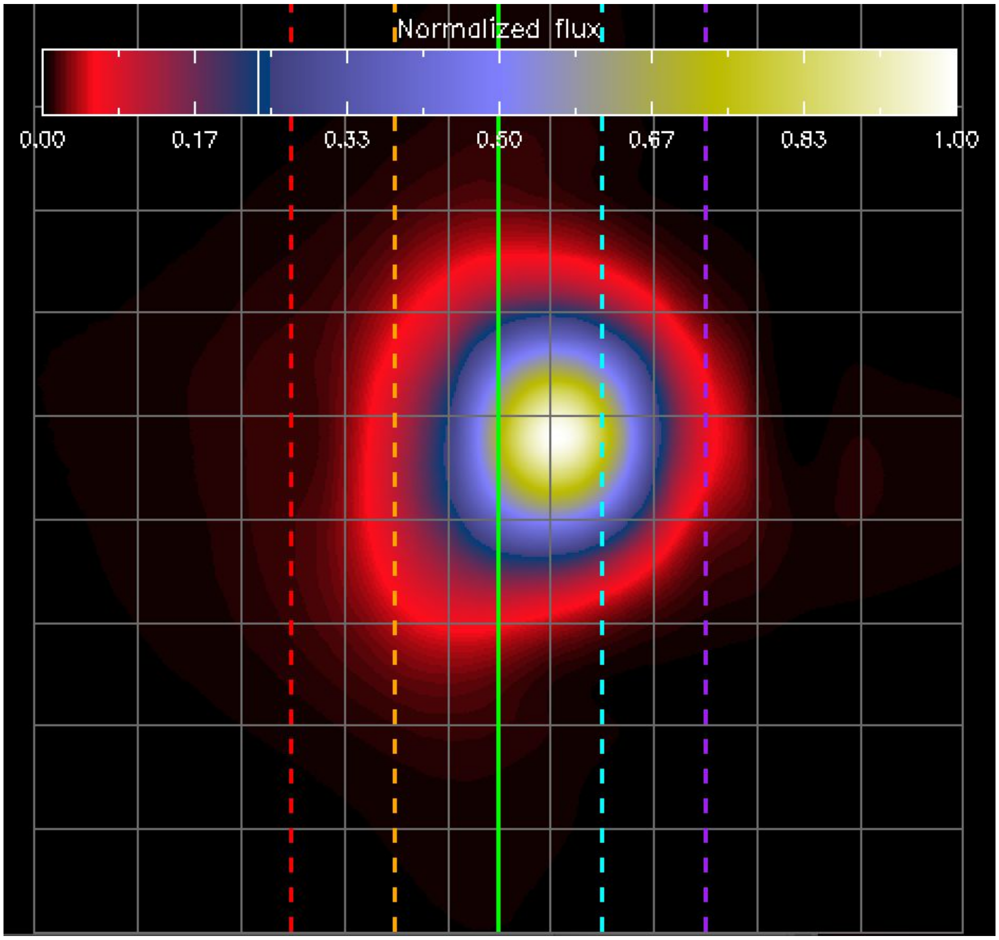
Correcting the flux misassignment may ultimately require a two-dimensional implementation of the spectral extraction routine, versus the current one-dimensional implementation. In anticipation of that potential change, we investigate the two-dimensional PSF as seen on the raw detector, using a selection of arc lamp and OH sky lines. For each figure, one emission line in a given wavelength channel was located via centroiding in each illuminated spaxel in a raw frame; each emission line was clipped. The resulting line images are heavily supersampled using a cubic interpolation and median stacked. The faint gray lines indicate the original pixel boundaries and the green vertical line marks the x-position of the centroid (note that the centroid is offset from the bright peak, due to the PSF asymmetry).

Overall, we discover that the 2D PSF as measured via arc lamp lines is more symmetric since the new detector was installed (2016 data vs. 2015 data). The 2D PSF as measured from OH sky lines is similar to the arc lamp 2D PSF, but slightly elongated in the dispersion direction.

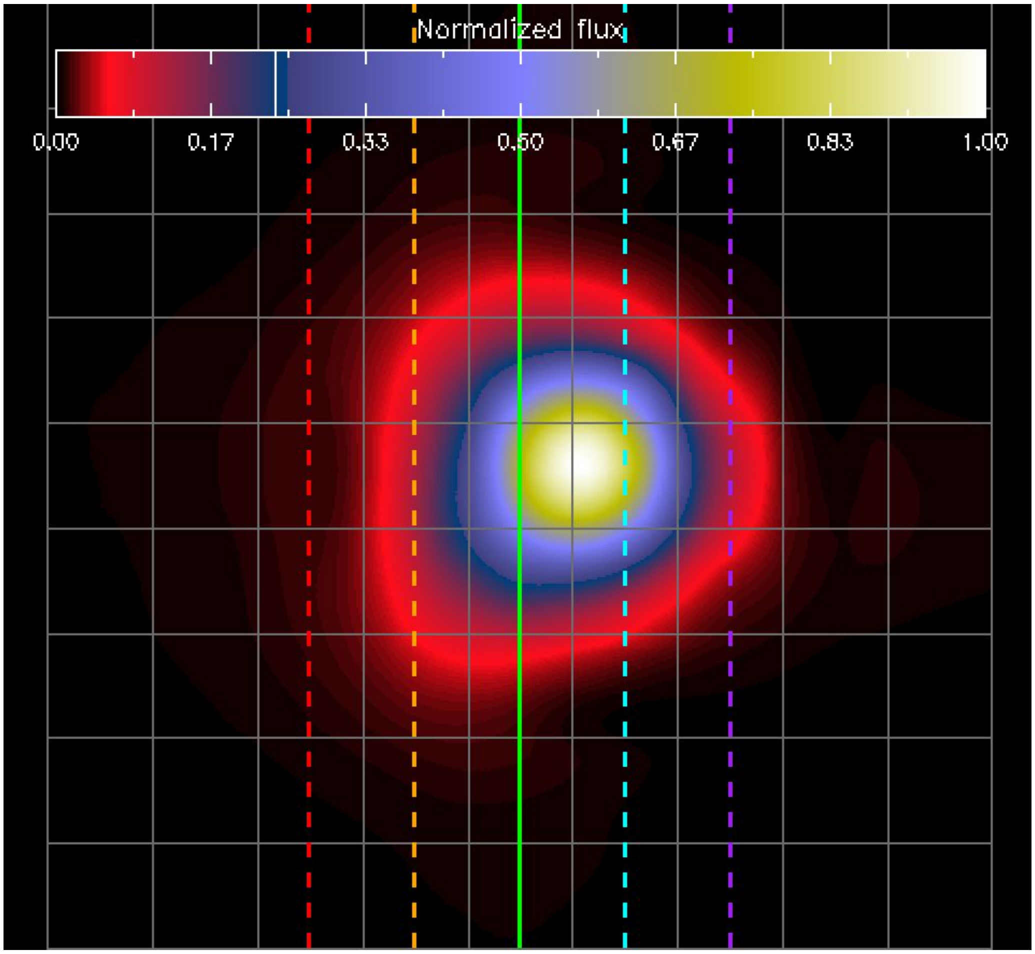
Arc line, old detector (Kbb/050, October 2015 data, line at mid-bandpass):



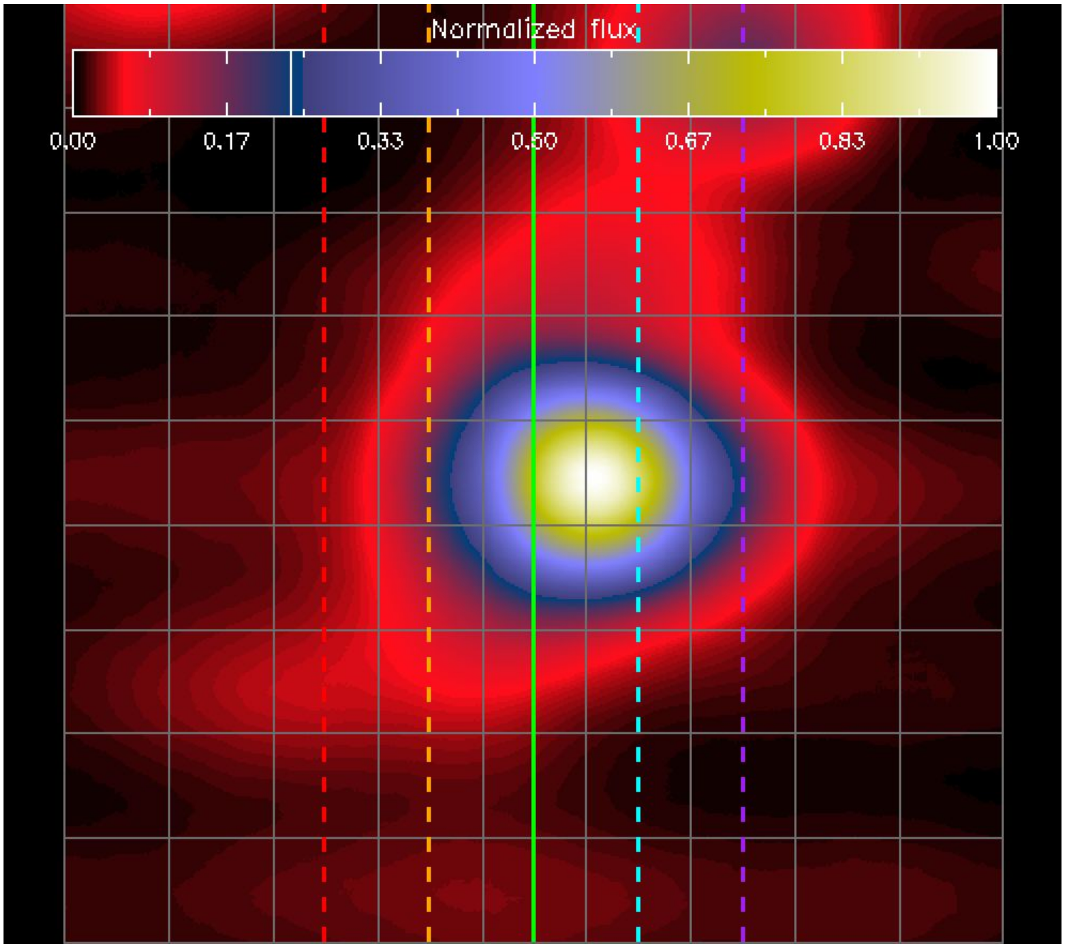
Arc line, new detector (Jbb/050, March 2016 data, line from red end):



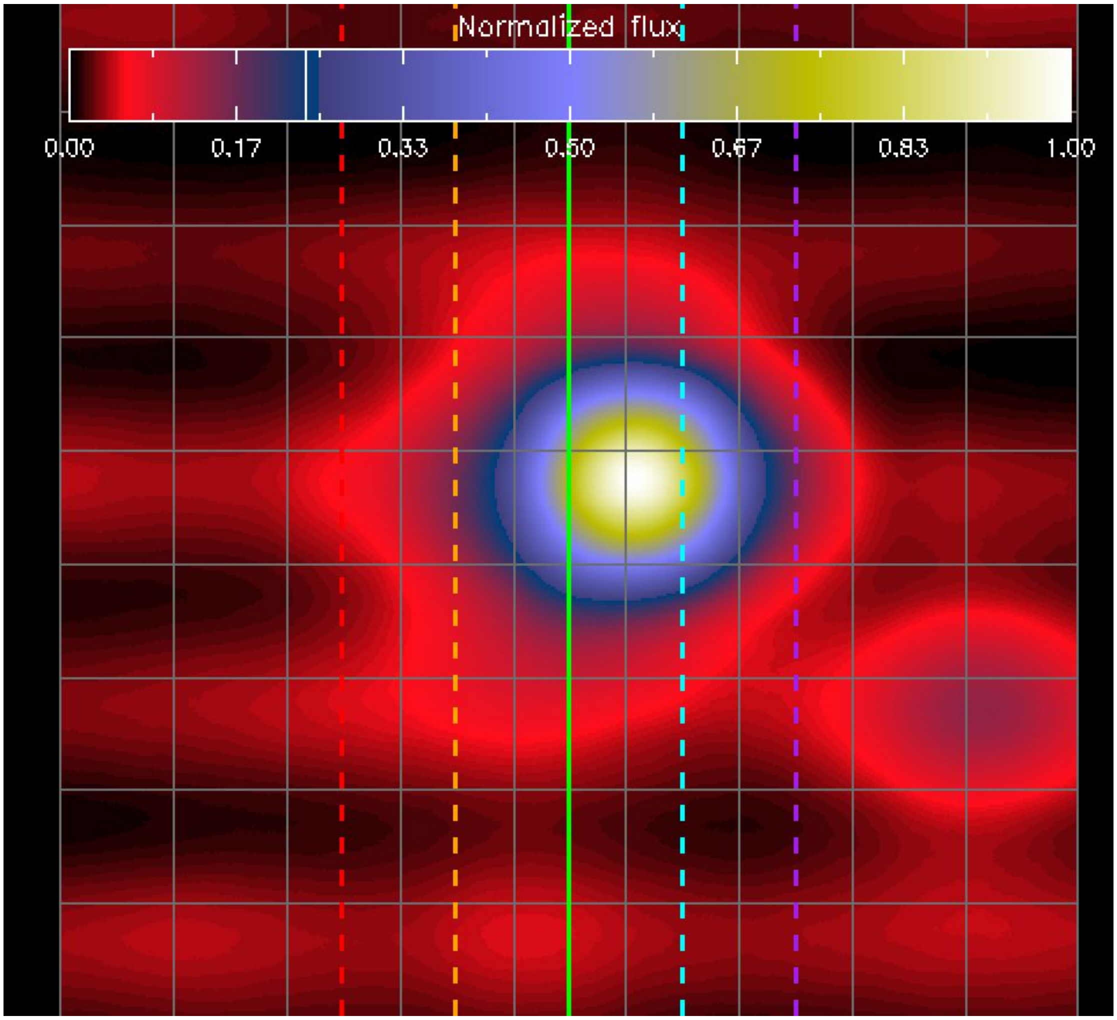
Arc line, new detector (Jbb/050, March 2016 data, line from blue end):



Sky line, new detector (July 2016, Kbb/035, line on blue end):



Sky line, new detector (July 2016, Kbb/035, line in middle of spectrum):



2.6. Changing Blame/Weighting Normalization

James is working on this.

2.7. Debugging the C-code

Jessica and Shelley are working on this.

3. Rippling Effect

4. Tests Created

4.1. Migrated Test Data Repository to Keck

The OSIRIS tests require large data files (rectification matrices, raw data, skies, etc.). This data is too large to keep in the github repository. Instead, we maintain an external repository and the testing framework automatically downloads the data as needed. Previous to this hackathon, we kept this data on Jessica Lu's dropbox. During this hackathon, we migrated this repository to a Keck site that is accessible through the web:

- http://tkserver.keck.hawaii.edu/osiris/data/tests/

Data can be added to this repository through an FTP site. See more instructions below.

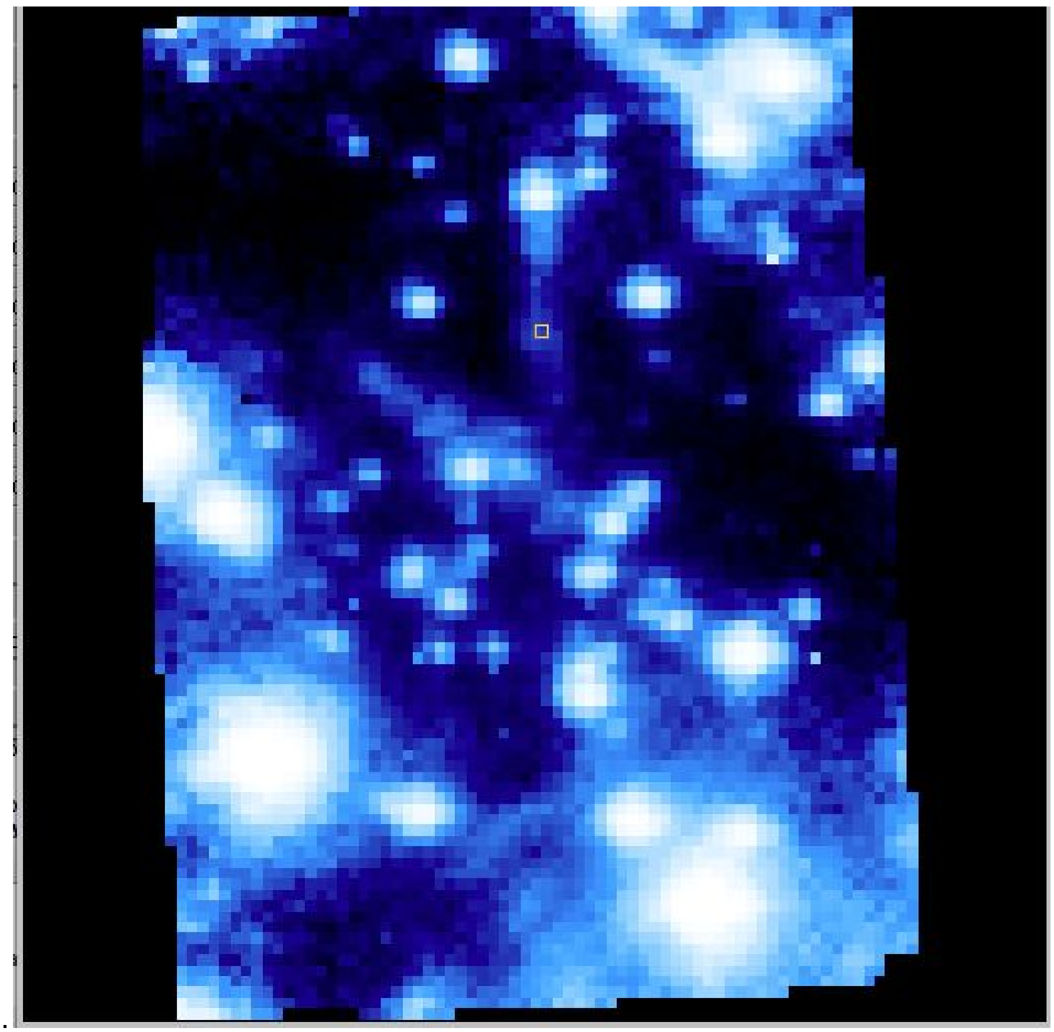
- ftp://ftp.keck.hawaii.edu/incoming/OsirisDRP/

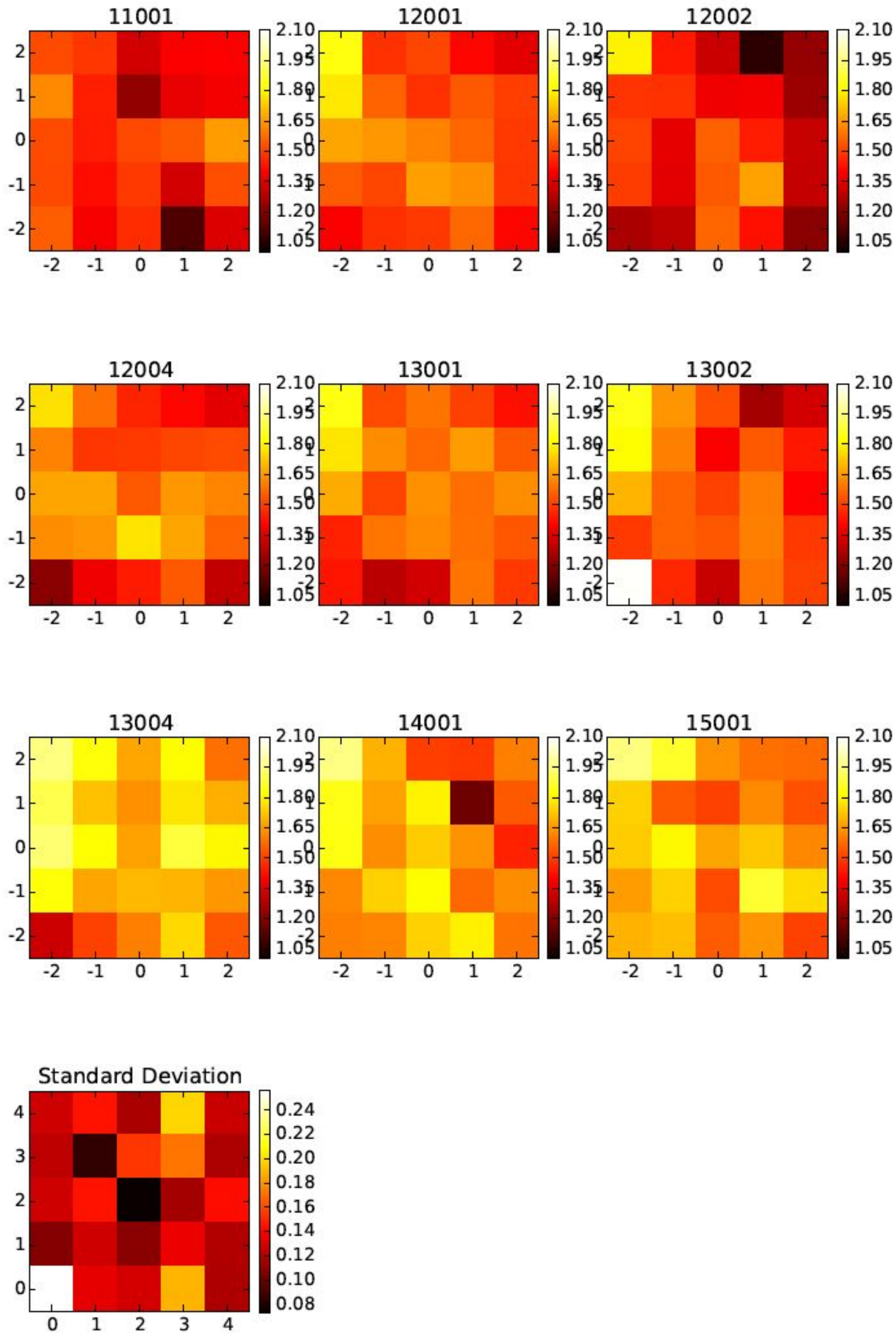
4.2. Documentation for Creating New Tests

We added instructions for creating a new test and for uploading the data to the Keck data repository. These instructions can be found in tests/README.md on the develop branch on github.

4.3. Estimate the Spatial Rippling on GC Science Data

There is Br-gamma emission in the observations of the Galactic Center around Sgr A*. Devin Chu is working on a data set from 2013-07 where there are 9 different dither positions. A single spot on the sky was chosen (frame 12001, cube x=36, y=33) and examined at different positions on the detector as we dithered. The Br-gamma line flux is integrated over 16 spectral channels (configurable) and the line intensity is compared over all the different dither positions.
STATUS: Compare the values between the frames, calculates STD (residuals? STD?)
TO DO: labels are messy at the moment, sorry (code in /u/devinchu/Research/osiris_hackathon/br_gamma_test along with data)





4.4. Check Mis-Assigned Flux on Old Science Data of an Emission-Line Galaxy

Maren takes a bright galaxy from Shelley's IROCKS program from 2013-08 and runs it through the pipeline with a newly reduced "old" rectification matrix. Extract the 1D spectrum over the galaxy and calculate the amplitude of the H-alpha peak and then do the same 32 pixels over in

the adjacent lenslets. Calculate the fraction of flux in non-Halpha wavelengths coming from H-alpha emission. Written as python script.
It should be noted that the reduction of this data requires two steps and therefore two .xml files. This resulted in the finding of a bug in the consume_queue_directory module. In order for this to run , all files called in *both* .xml files need to be present before the first is run. In this case a reduced sky cube is produced in the first reduction and used in the second, but this file must already be present from the outset in order for either reduction to run. This file will be overwritten by the first .xml file before the second makes use of it, so the bug is not a high priority to fix.
Testing the reduction without clean cosmic rays resulted in a 7% decrease in the peak ratio.

All required .fits files are uploaded to the google drive hackathon folder in "/2016-09-07 OSIRIS Hackathon/Data/test_IROCKS_data". The calibration matrix is in the subfolder "calib".

4.5. Check Mis-Assigned Flux on on Quasars

Andrey is taking observations of a bright quasar that is mostly a continuum source (no emission lines). Currently, the continuum shape varies across the cube in unphysical ways (Figure 4.5a).

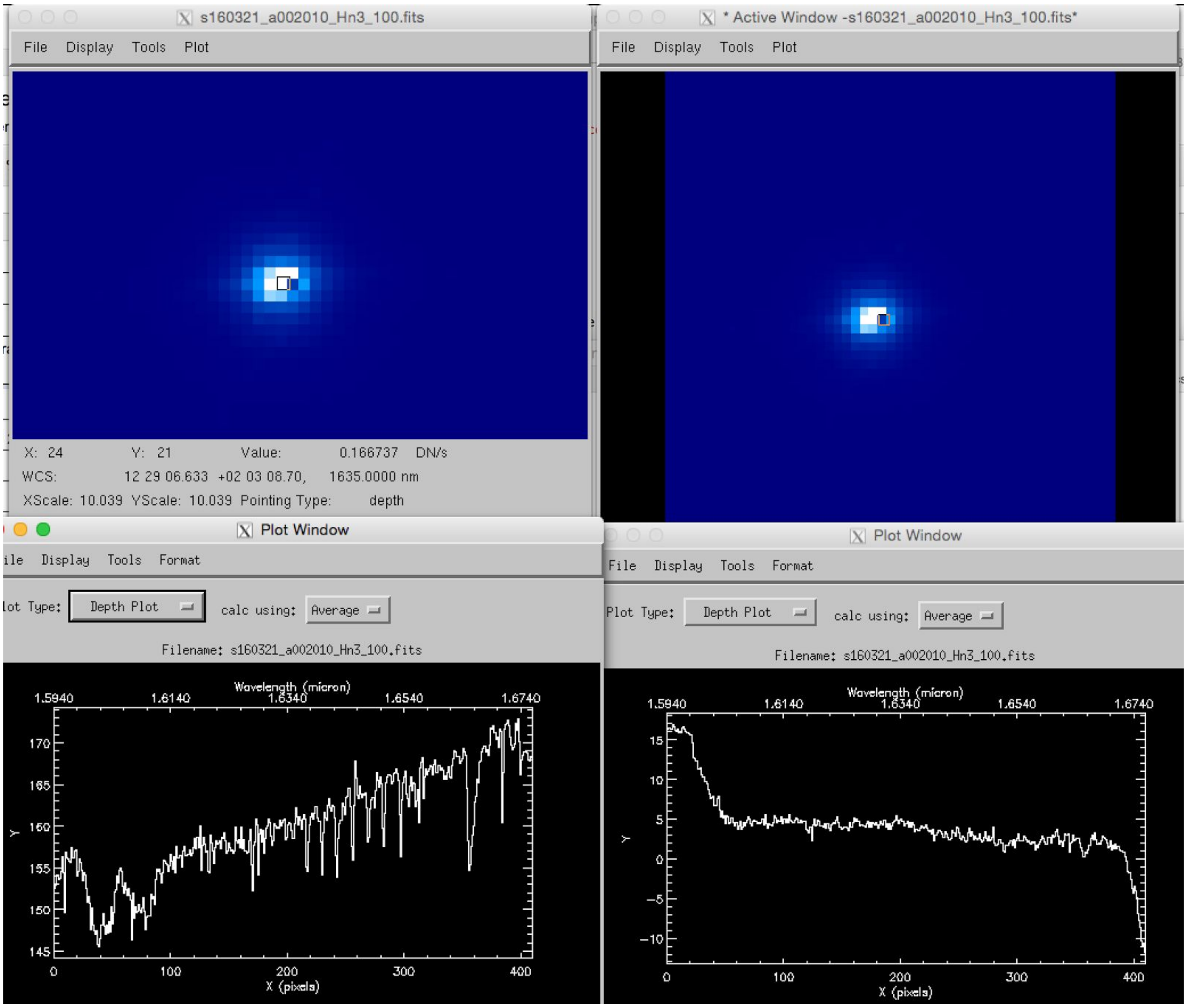


Figure 4.5a: Good spectrum (left) and bad spectrum (right) of a bright quasar with continuum emission.

He is writing a test to compare the shape in the good spaxel with the bad spaxel (locations are hard-coded for this data set). Three spaxels are defined: 2 good spaxels (g1, g2) and one bad (b1). Then take the ratio of the goods (ratio1 = g1 / g2) and the ratio of bad-to-good (ratio2 = b1 / g2). Calculate the STD of ratio1 and ratio2 and compare these two values. This test can be run with different rectification matrices and pipeline versions to see if there are improvements.
STATUS: Working on getting this into a test framework.
TODO: Add one for the old data as well.

4.6. Checking the Sky Lines Spatial Variability in New Data - Rippling

Sam wrote tests to use data from 2016-07 single sky frames (Kbb 35 mas) to check the uniformity of the sky line and quantify the spatial variation. The data is dark subtracted and assembled into a cube. Every spaxel is integrated over a window of 2071 to 2075 nm. Then calculate the STD over the entire frame and over a specific row (row=41 in cube). The dark subtracted cube is compared against a reference cube and the ratio of STD across a specific row and that across the entire frame is checked to make sure they are within 3% of each other. STATUS: all uploaded as automated test case.

Wavelength Range (nm)	STD Frame	STD Row 16	STD Row 41	STD Row 60
1976-1978	0.3613	0.3627	0.3516	0.3371
2055-2057	0.7833	0.5259	0.6024	0.5026
2055.5-2056.5	0.4265	0.2810	0.3171	0.2701
2054-2058	0.8968	0.6326	0.6849	0.6052
2071-2075	0.4961	0.4772	0.4943	0.04756
2117-2119	0.2952	0.2806	0.2923	0.2831
2204-2206	0.5021	0.4877	0.4949	0.4779
2230-2232	0.6612	0.6559	0.6465	0.6400

4.7. Checking the Flux Conservation Between 2D Data and a 3D Cube

Sam used white light test data from 2015-05. The data is dark-subtracted and the resulting flux on the 2D data is integrated using a quadrilateral aperture. The 3D cube is integrated over wavelength and the y axis. The total flux is integrated along the x axis within a few (6) pixels of the peak column/pixel. The flux from the 3D cube and the 2D data are compared.
TODO: Work on making an automated test.

5. Scaled-Sky Subtraction

Anowar ran the scaled-sky module on old (2015) vs. new (2016) data and looked at the RMS of the residuals in a small patch of the sky. Hn1 100 mas in 2016 data. Hbb 100 mas on the 2015 data. The spectral channels were clipped around one of the strongest OH lines. Currently, the scaled subtraction seems to do a better job than straight sky subtraction in 2016.

Done: Do separate sky-frame subtraction without scaling and compare this to the scaled sky results.
Done: Currently using all wavelength channels… switch to a few around a single sky line.

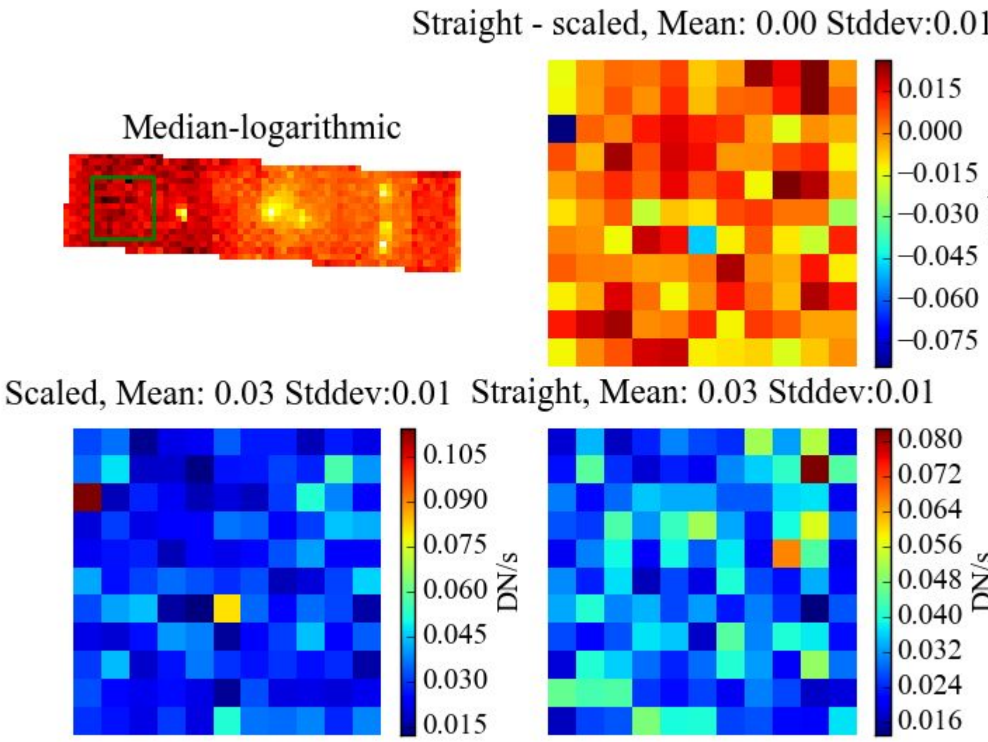


Figure 5a: Scaled sky subtraction on 2015 data (taken 08/09/15). The green rectangle in top left figure shows the sky patch in the science image. Three other boxes show straight - scaled sky subtraction, scaled sky subtraction, and straight sky subtraction in the green rectangle.

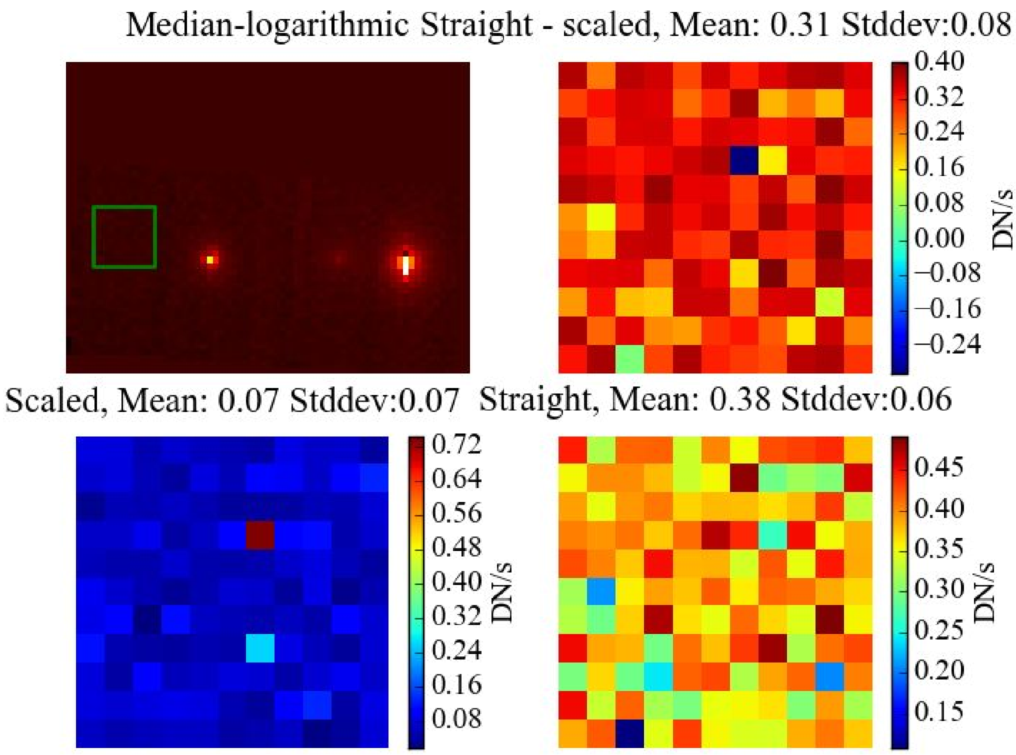


Figure 5b: Scaled sky subtraction on 2016 data (taken 08/09/15). The green rectangle in top left figure shows the sky patch in the science image. Three other boxes show straight - scaled sky subtraction, scaled sky subtraction, and straight sky subtraction in the green rectangle.

6. Infrastructure

Jim bundled QuickLook 2 and the GUIs to put into the github repository.

The OSIRIS manual has been updated to v4.0 beta. We still need to put many of the new detector stuff in it.
TO DO: Update with new detector materials in the manual (on Google Drive).

7. Simulators

Mike Fitzgerald is working on a first-principles simulator for IFS data. Previously you can pass in any stack of lenslets and intrinsic spectra. You could make raw science data; but couldn't extract it. He is working on making artificial white-light scan data (single-column). The PSF is currently hard-coded for both the science and white-light data to elliptical gaussian (no rotation). Currently this is noise free. TO DO: Go from white light scans to a rectification matrix. Ultimately he is interested in changing the approach of cube reconstruction. Future approaches might include converting to matrix forms and using standard sparse matrix linear algebra routines, maximum entropy or least-squares approaches. In principle, this can be used to simulate any type of IFS data.