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Blue Channel Echellette Trace Positions

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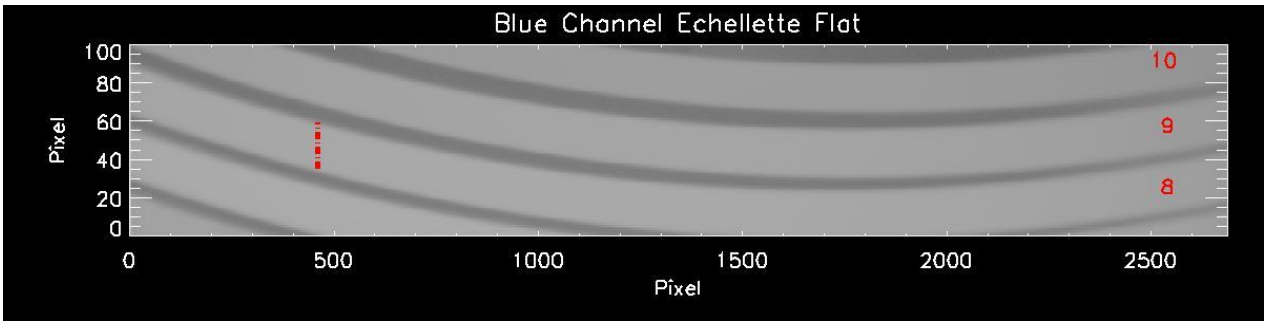
Introduction

With the addition of an upgraded CCD in the Blue Channel (BC) dewar, observers discovered that the orders obtained during echellette spectroscopy had changed from the configuration obtained with the previous CCD. Originally, BC echellette images contained orders 7-17 (with red being the reddest at the top of the CCD) but with the new CCD, order 7 is only partially observed (to the point of being unusable) and order 18 now appears on the CCD (although this order is very far in the blue and contains very little signal due to the severe blaze function). Furthermore, the orders have flipped in orientation on the detector - while order 7 was previously at the top of the detector, order 18 is now on the top and order 8 is the last fully imaged order at the bottom of the array. Here, we investigate possible solutions to have data taken with the current CCD more closely match that obtained in its previous configuration.

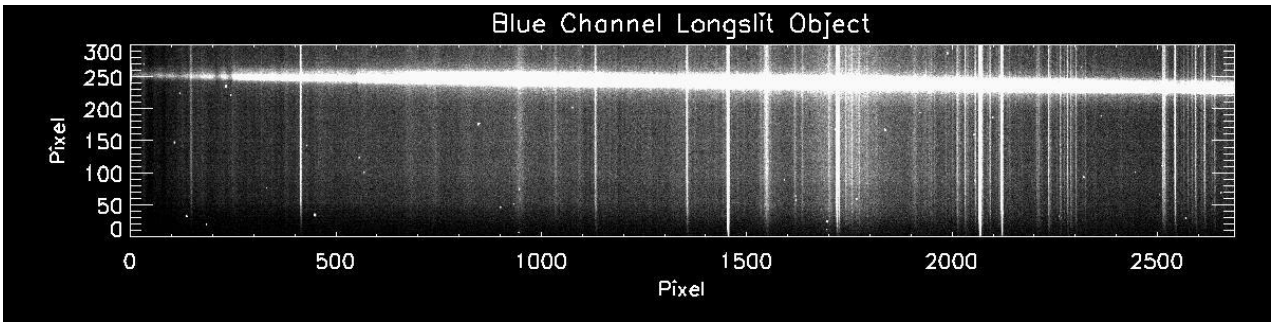
The figure below shows the bottom 100 pixels of a BC echellette flat field image obtained in August, 2011. The red numbers on the right denote the order numbers for each trace. Order 7 is the order at the bottom of the image which is only partially observed. The dot-dashed line shows the approximate location of 6563Å - the rest wavelength for H-alpha.



This image marks two possible problems with the current configuration of the echellette. First, order 7 is completely unusable. This order is approximately 7100-8100Å, and thus very red compared to the peak in throughput for BC, yet observers have expressed interest in simultaneously reaching further in the red without losing signal in the blue (and thus simply using Red Channel's echellette isn't an ideal solution). Secondly, order 8, especially in flat field images, loses a handful of pixels near pixel 1500 (~6800Å). That said, a point source imaged in the middle of the slit is still extractable and the data, with adequate care, are calibratable. Thus, while order 8 is usable, ensuring the proper reduction of data from this (very important due to the presence of H-alpha) order is likely a bottleneck in the handling of BC echellette data.

Possible Solutions:

The most straightforward solution to these issues would be to simply adjust the position of the CCD in the dewar to fully image order 8 and possible add order 7. This solution leads to complications with longslit spectroscopy, however. Below is an image of the lower 300 pixels of a longslit exposure with BC.

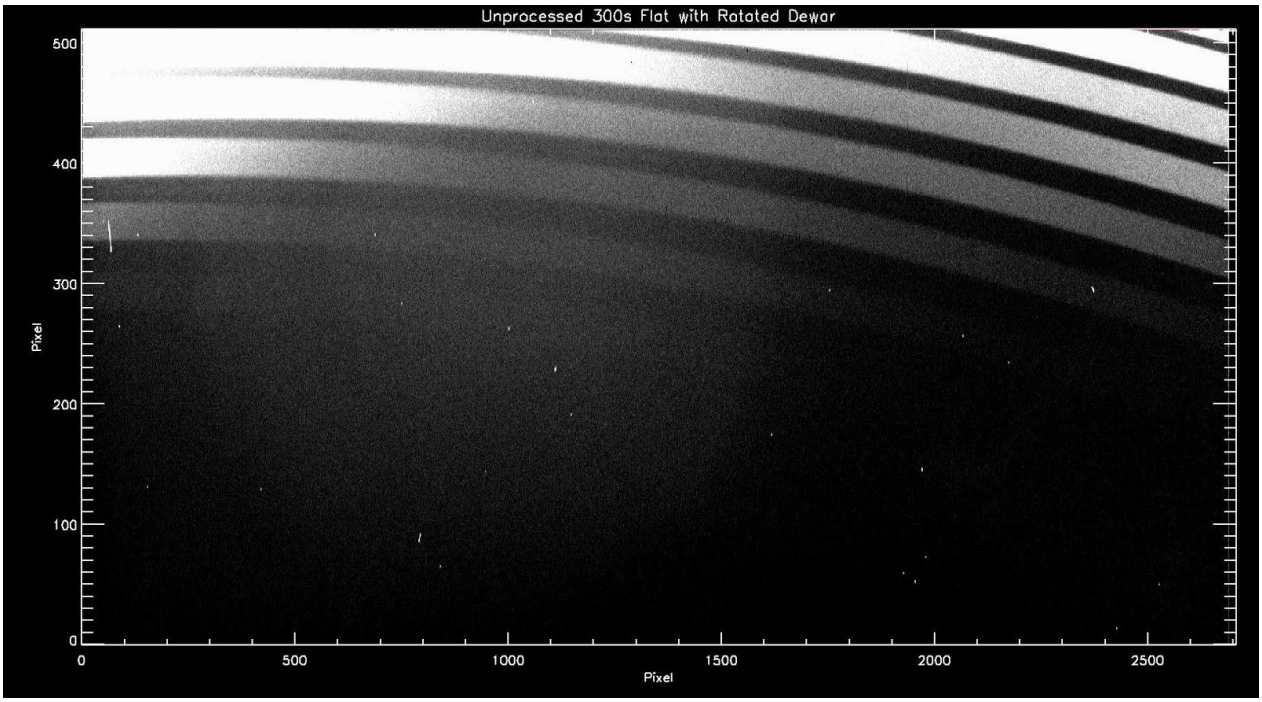


At the bottom of this image, one can see that the brightness (both in the lines and sky continuum) fade in brightness as they approach pixel 0. This occurs as the current CCD placement in the dewar is such that it is not perfectly centered on the middle of the spectrograph slit - the bottom of the image is imaging the end of the slit.

In order to add order 7 onto the echellette images, one would want to shift the detector such that the current pixel 0 would be approximately pixel 23 after the detector were moved. That is, we would effectively image 20-25 pixels below the current bottom of the images shown above. While this would help echellette spectroscopy, it would result in less of the slit being imaged for the vast majority of the operations of the spectrograph and thus is not likely the optimal route.

The second option is to rotate the BC dewar 180 degrees during echellette observations. In the case that the CCD were perfectly centered in the dewar, this would do nothing to the final images other than flip the top/bottom orientation of the images. If, however, the CCD is not perfectly centered, this rotation may be enough to add extra pixels redward of the 8th order in echellette mode.

Tests with a rotated Blue Channel dewar were completed on December 28, 2012. Unfortunately, they indicate that the rotation will not correct the problems noted above. The center of rotation for the dewar is centered considerably blueward of the center of the current CCD center. When rotated, rather than extending coverage into the red to gain the 7th order, we instead image areas on the image plane blueward of the bluest orders currently probed. For example, below is a 300s flat image with bright lamps taken with the rotated dewar.



It's clear from this image that the rotation only worsens the problem. At this point, no simple correction will extend the coverage of the Blue Channel echellette to the red while not simultaneously adversely affecting non-cross dispersed observations.

Conclusion

After investigating several possible solutions which would allow for slightly redder observations with the echellette mode on Blue Channel in order to better match the performance possible with the previous CCD, we find no simple solution which increases efficiency for cross dispersed spectroscopy while not hindering more traditional single-order spectroscopy. Individually, moving the CCD in the dewar or rotating the dewar with respect to the grating are not sufficient.