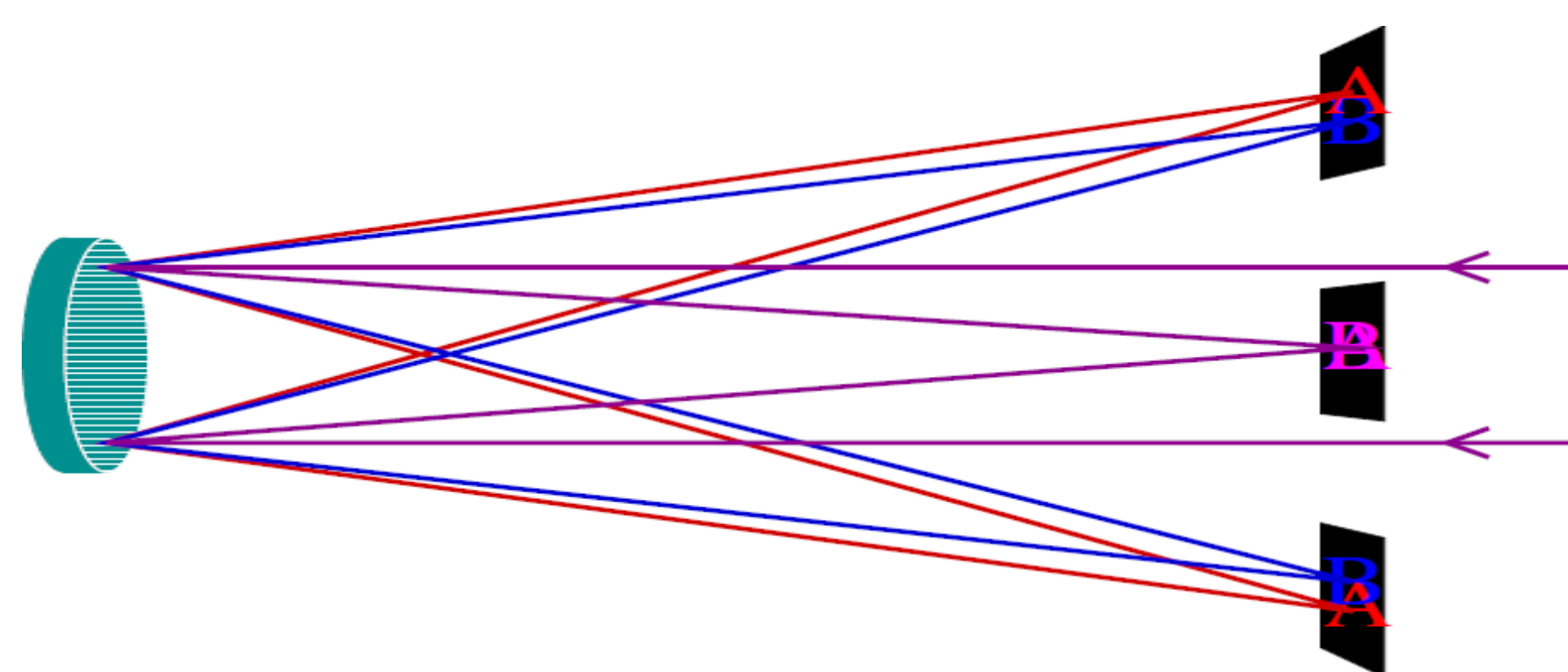


## Abstract

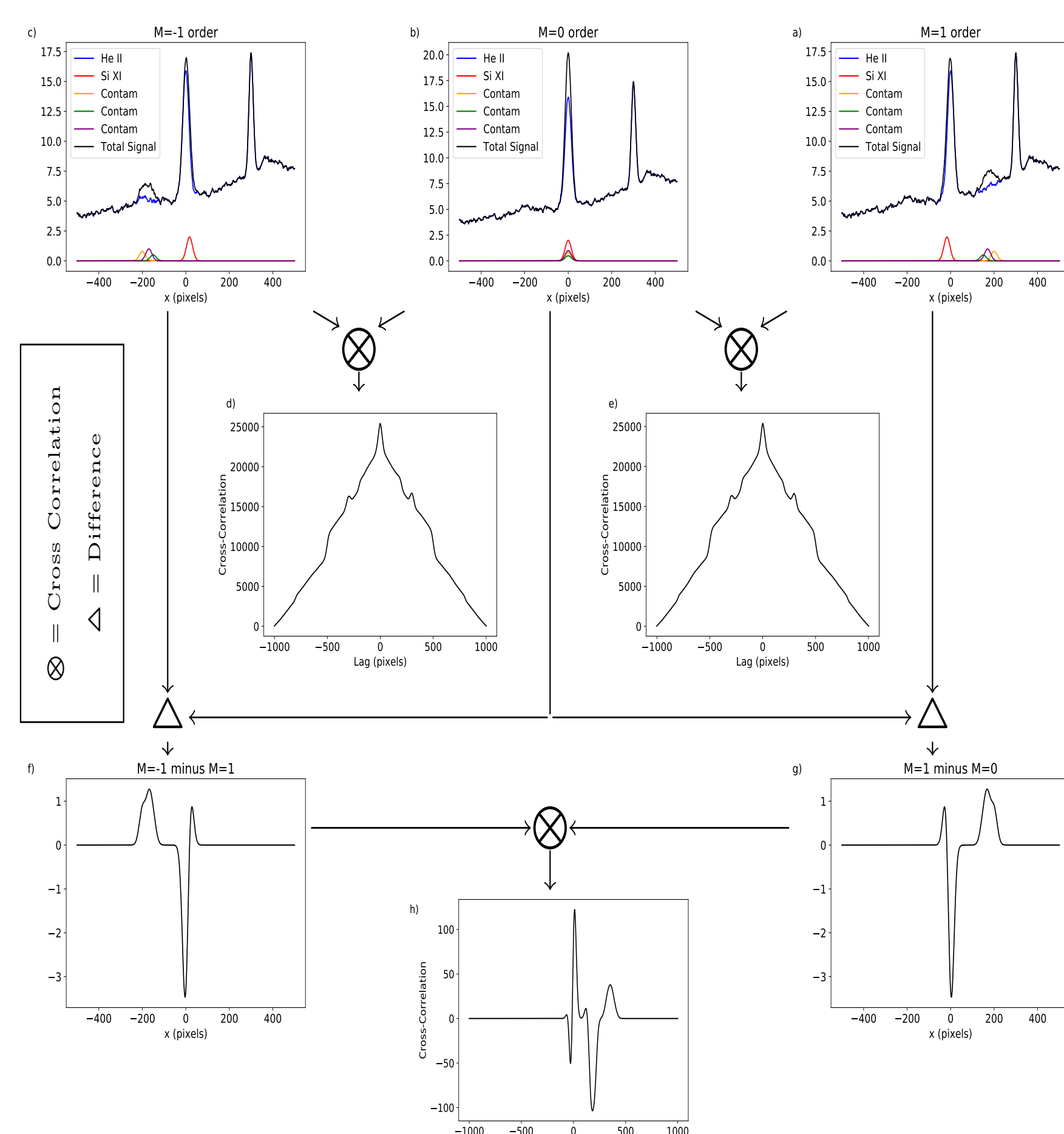
The *MOSES* (Multi-Order Solar EUV Spectrograph) sounding rocket was launched February 8th, 2006 to capture images of the sun at 304 Å. The *MOSES* concave grating forms solar images in multiple spectral orders, in an effort to measure line profiles from a single exposure over a wide field of view. We present a preliminary identification of spectral content in *MOSES* images. The cross correlation of subtracted images provide evidence of spectral content besides the normal 304 Å He II line. We attempt to forward model the spectral content through the use of co-temporal observations from *EIT* (EUV Imaging Telescope) observations and synthetic Chianti spectra. We plan to modify the DEM used to better fit the *MOSES* data and more carefully quantify the extra spectral content in *MOSES* images.

## Instrument Concept



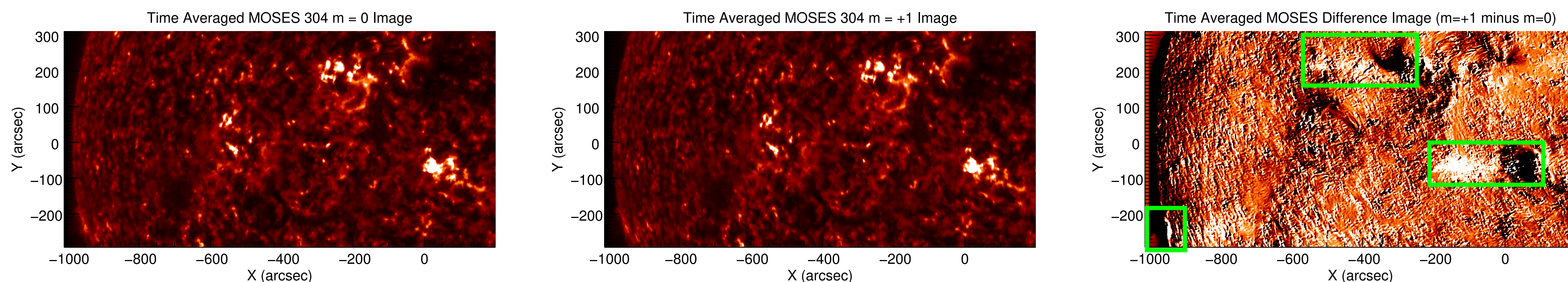
The *MOSES* optics consist of a concave grating, secondary fold flat mirror, and three Charged Couple Device (CCD) detectors. Incident light on the grating is diffracted onto the CCD's in the  $m = -1, 0,$  and  $+1$  spectral orders. Each order contains different combination of spectral and spacial information. [0]

## Cross-Correlation Method



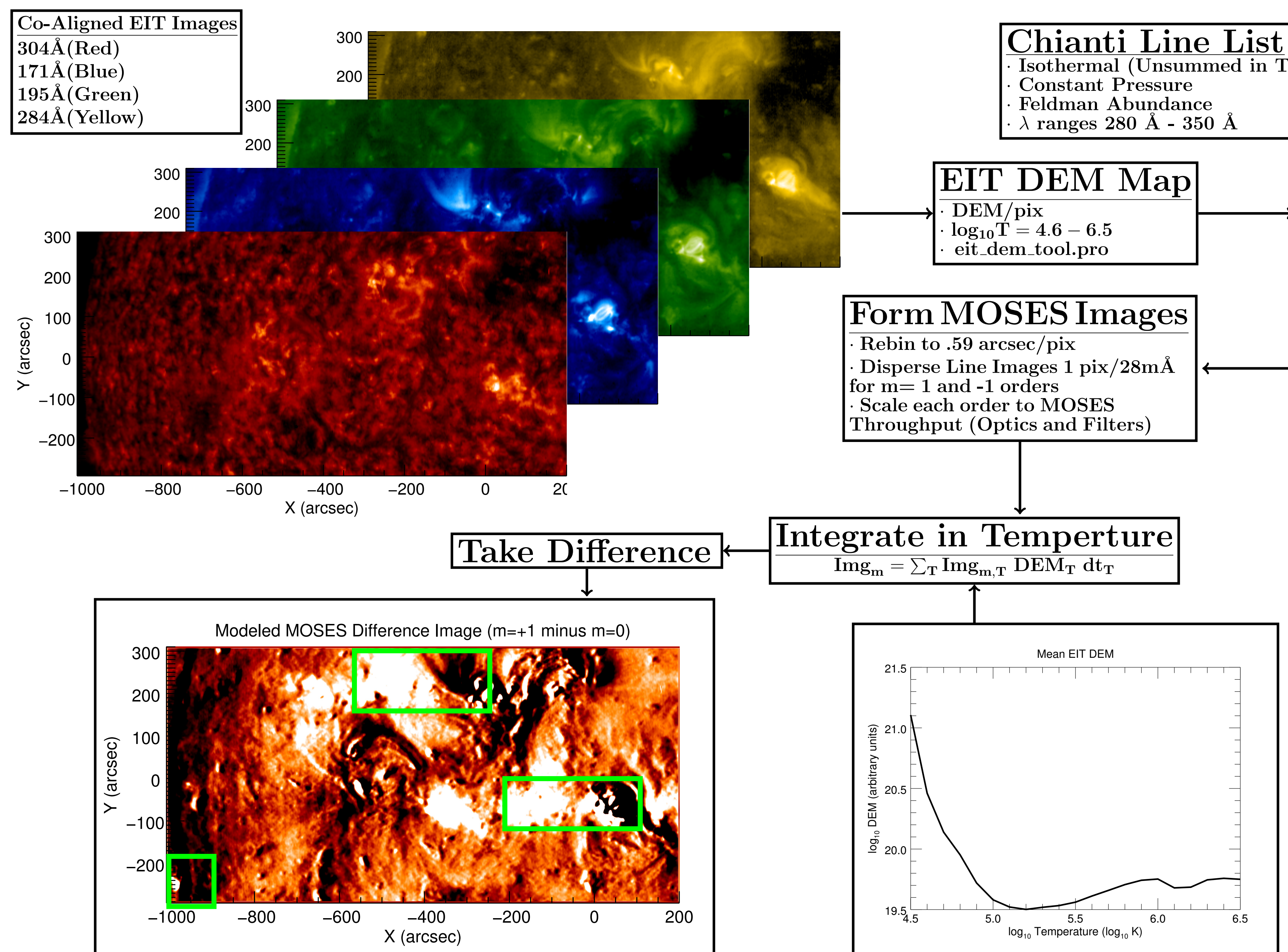
To identify subtle contributions to the spectral content of *MOSES* images we employ cross-correlation in the dispersion direction. Figures a, b, and c show how a signal would appear in each *MOSES* order. Figures d and e show a cross-correlation of two orders that is dominated by the He II signal autocorrelation. By cross-correlating subtracted signals (f and g) we eliminate the He II autocorrelation so that peaks in cross-correlation (h) are now indicative of extra spectral content.

## MOSES Images



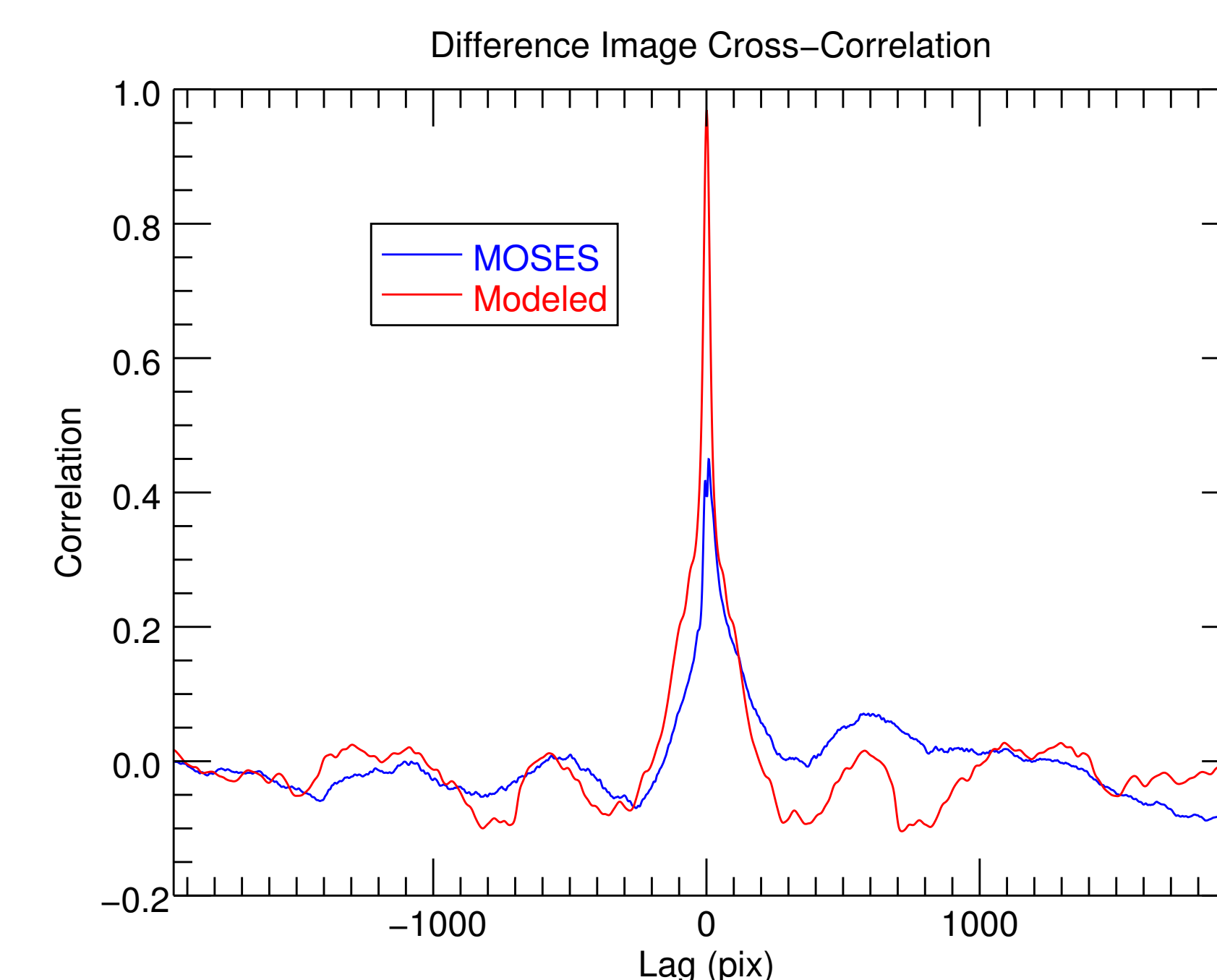
Pictured here are the zero and plus order *MOSES* images, as well as an image of the zero order subtracted for the plus order. The plus and zero order images have been aligned to maximize the cross correlation in the grating dispersion (horizontal) direction as well as averaged over all exposures. The subtracted image highlights the subtle differences between the two images. These differences are caused by objects differing in wavelength from the dominant (He II 304 Å) wavelength. Small differences are caused by differing point spread functions between orders and by Doppler shifted material. Large differences, boxed in green, are indicative of extra spectral content. That content is identified by cross correlating subtracted images in the dispersion direction.

## Forward Model



*MOSES* difference images are forward modeled using images from *EIT* [1] and the Solar Soft package Chianti [2]. Using *eit\_dem\_tool.pro* we generate a DEM for every pixel from 4 *EIT* images taken closest to the *MOSES* launch. Using this DEM map along side a Chianti synthetic spectra, an image can be generated for each line, at each position in temperature. Each image is rebinned to *MOSES* resolution and shifted in the outboard orders due to wavelength dispersion. Modeled images are then subtracted and cross-correlated along image rows. A comparison of the modeled and actual cross-correlation functions is shown in the adjacent poster column. This modeled difference image is scaled identically to the difference image above for direct comparison.

## Fit



## Work In Progress

While the agreement between the actual and modeled cross-correlation functions is ok, it is far from perfect. Moving forward we hope to minimize the difference between cross-correlation functions by modifying the DEM used in generating synthetic data. We will also include a factor in our fit merit function that encourages the DEM to be smooth. The end goal being to generate a solar DEM from three *MOSES* images from which we can better quantify the extra spectral content within. Quantifying extra spectral content will help us minimize residuals when inverting for the *MOSES* spatial spectral cube.

## Acknowledgment

This work is partially supported by the NASA Heliophysics Sounding Rocket Program, grant NNX14AK71G.

## References

- [0] Fox et al., 2010
- [1] Delaboudini-Åre, J.-P. et al., 1995
- [2] Dere et al., 1997; Landi et al., 2012; ApJS, 744, 99