# Implementation of Absolute Point of Focus Technology in Solar Image Processing

Iona Jones, ionapatriciajones@gmail.com, NSF NCAR Earth System Science Intern

Acknowledgements: Scott Sewell[1], Dennis Gallagher[1], Finnian Rogers[2], Christoph Kaltseis, Jerry Cyccone[3], Benjamin Fellman[3]

1. High Altitude Observatory 2. Laboratory for Atmospheric and Space Physics 3. NSF NCAR Earth Systems Science

## Capturing the Solar Chromosphere

The goal of this project was to develop high quality solar images using an H-alpha filter. With the absolute point of focus technology, images are post processed to a higher level of sharpness and caliber. These photos will be used for a better understanding of the sun and its atmosphere, along with a further scientific study of electricity and magnetism on the sun.



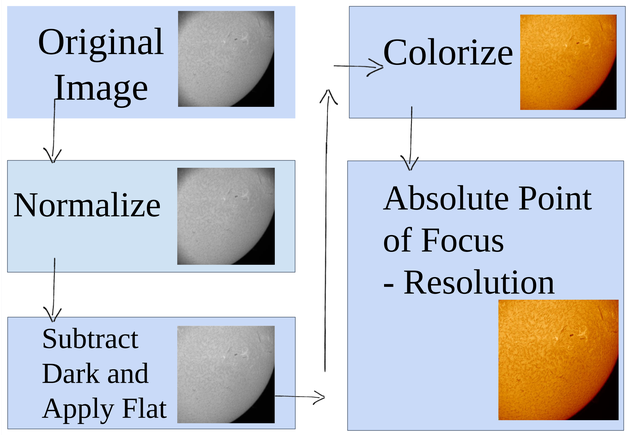
To the left is the High Altitude Observatory (HAO), where this research was conducted.

## Equipment for Solar Photography




Daystar H-alpha filter 0.4 Å
Telecentric Lens Baader 3x for H-alpha
8 inch Baader Schmidt Cassegrain
Baader 0.4x Telecompressor Lens
ZWO ASI 533 mm Pro Camera (3008 x 3008 pixels), 3 micron pitch, plate scale of 0.38 arcseconds per pixel
Sharpcap Image Processing

## Steps of Solar Image Post Processing

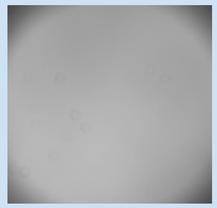



**Steps Designed to Account for Limitations in our Optical Instruments**

## Why Do We Do Solar Image Processing?

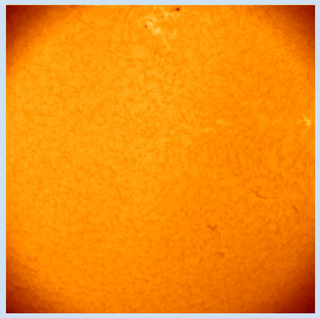


**Dark Image**

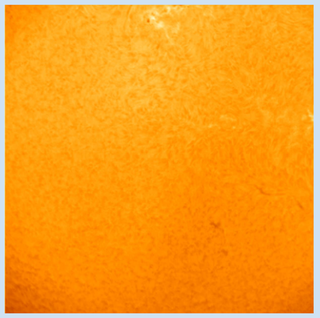


**Flat Image**

Solar image processing steps like dark subtraction and flat field allow for correction of optical errors. This can increase the quality of our images, allowing us to better observe and understand solar activity.



**Before Flat Field Correction**



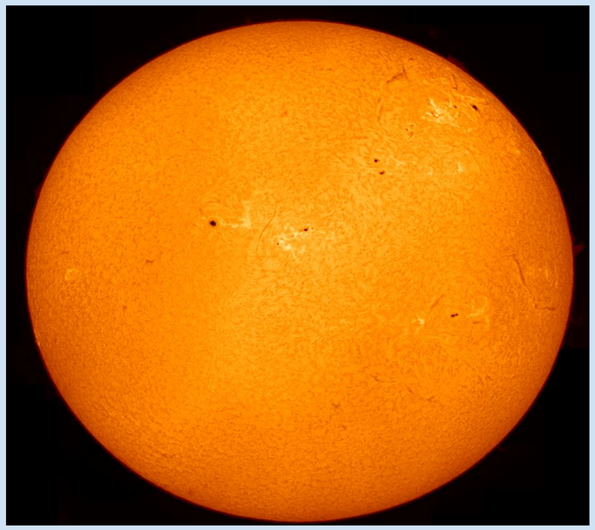
**After Flat Field Correction**

Vignetting and dust spots have been removed from the image. These are caused by error in our camera and by clipping from our filter.



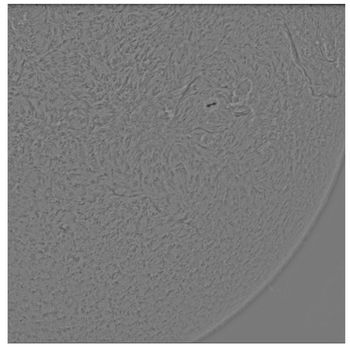
**Sunspot**

Sunspots are a type of solar activity that we try to look for.

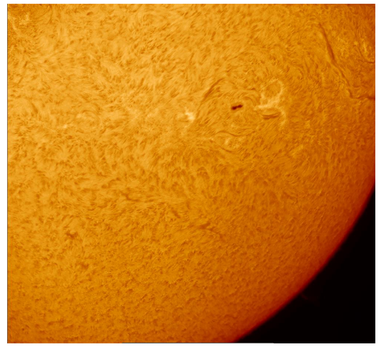


Featured above is a full disk image of the sun taken by us. This is what a finished product of our images looks like.

## Application of Absolute Point of Focus Technology



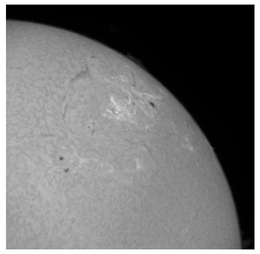
**Layers of the APF-R**



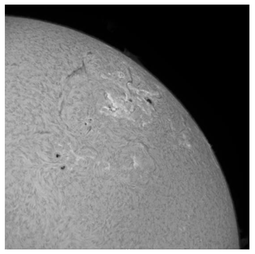
**Final Results**

The left image shows a single layer that goes into an APF-R image. The general process can involve up to 50 layers, although the plugin allows for simplification.

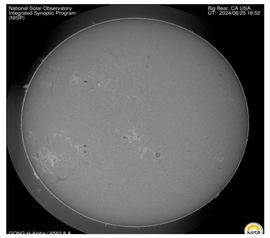
The absolute point of focus technique is a post processing type of editing that sharpens without creating noise. The Photoshop plugin created by Christoph Kaltseis detects “borders” and uses this to select objects, so that the individual part of the image can be edited. This process is different every time. APF-R is even used on the Hubble Spacecraft. The borders are detected by areas of contrast, and the radius for the border of the object can be altered step by step. This allows for more objects to be pulled out and altered, one by one. The Gaussian blur is applied to these “objects” multiple times in different layers, in order to find the best focus for each region of the image.



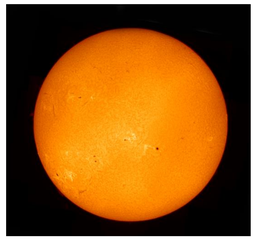
**Before**



**After**



**Gong Images from NOAA**



**Our Images**

On the left are images from the Global Oscillation Network Group (GONG) and their solar imaging stations. We have compared our images to GONG in the hope of taking images at equal or greater quality.

## Going Forward

This project was run through the High Altitude Observatory (HAO) in Boulder, Colorado. The HAO is currently developing a birefringent filter. The filter is intended to be used with a satellite in order to take more photos of the sun.