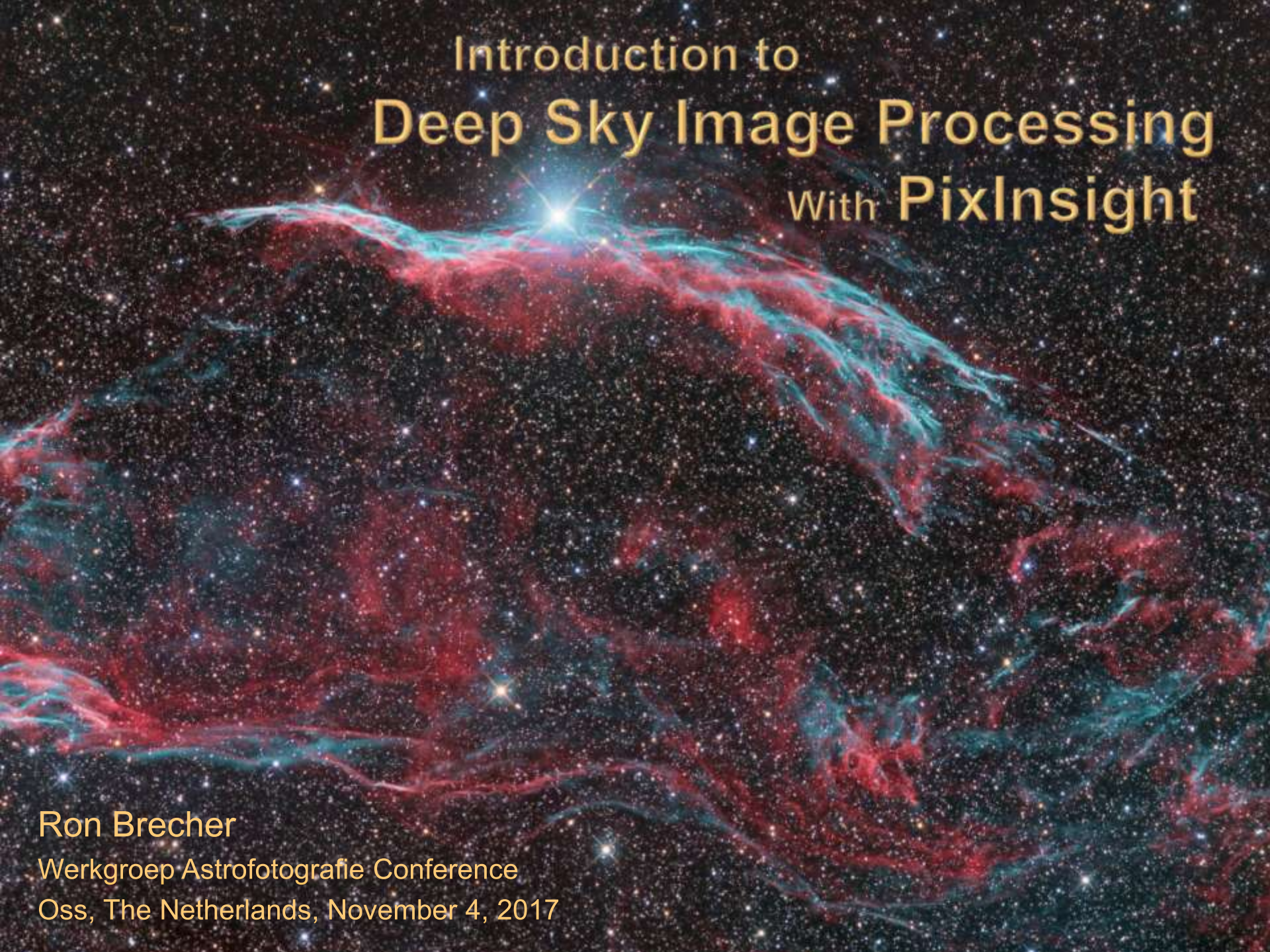



Ron Brecher

Werkgroep Astrofotografie Conference

Oss, The Netherlands, November 4, 2017

# Ron Brecher

- Observing since 1998
- Imaging since 2006
- Pictures and articles in magazines, calendars and more
- Star party workshops and private/group tutoring
- Reach me at rbrecher@rogers.com

# Outline

- Imaging tasks
- Preprocessing
- Basic RGB processing workflow
  - Combine channels to make RGB image
  - Crop
  - Remove gradients
  - Balance color
  - Reduce noise
  - Stretch the histogram
  - Smooth, sharpen, etc.
  - Adjust brightness, contrast, and saturation

# Imaging Tasks

- Data Acquisition
  - Gather raw data
  - Lights, flats, darks, and biases
- Preprocessing
  - Examine light frames and delete inferior frames
  - Calibrate light frames using flats, darks, and biases
  - Align and combine calibrated frames
- Processing
  - Make it pretty or accurate, depending on the goal
- Saving and Sharing
  - Save in various file formats
  - Share your images

# Imaging Tasks

- Data Acquisition
  - Gather raw data
  - Lights, flats, darks and bias
- Preprocessing
  - Examine light frames and delete inferior frames
  - Calibrate light frames using flats, darks, and biases
  - Align and combine calibrated frames
- Processing
  - Make it pretty or accurate, depending on goal
- Saving and Sharing
  - Save in various file formats
  - Share your images

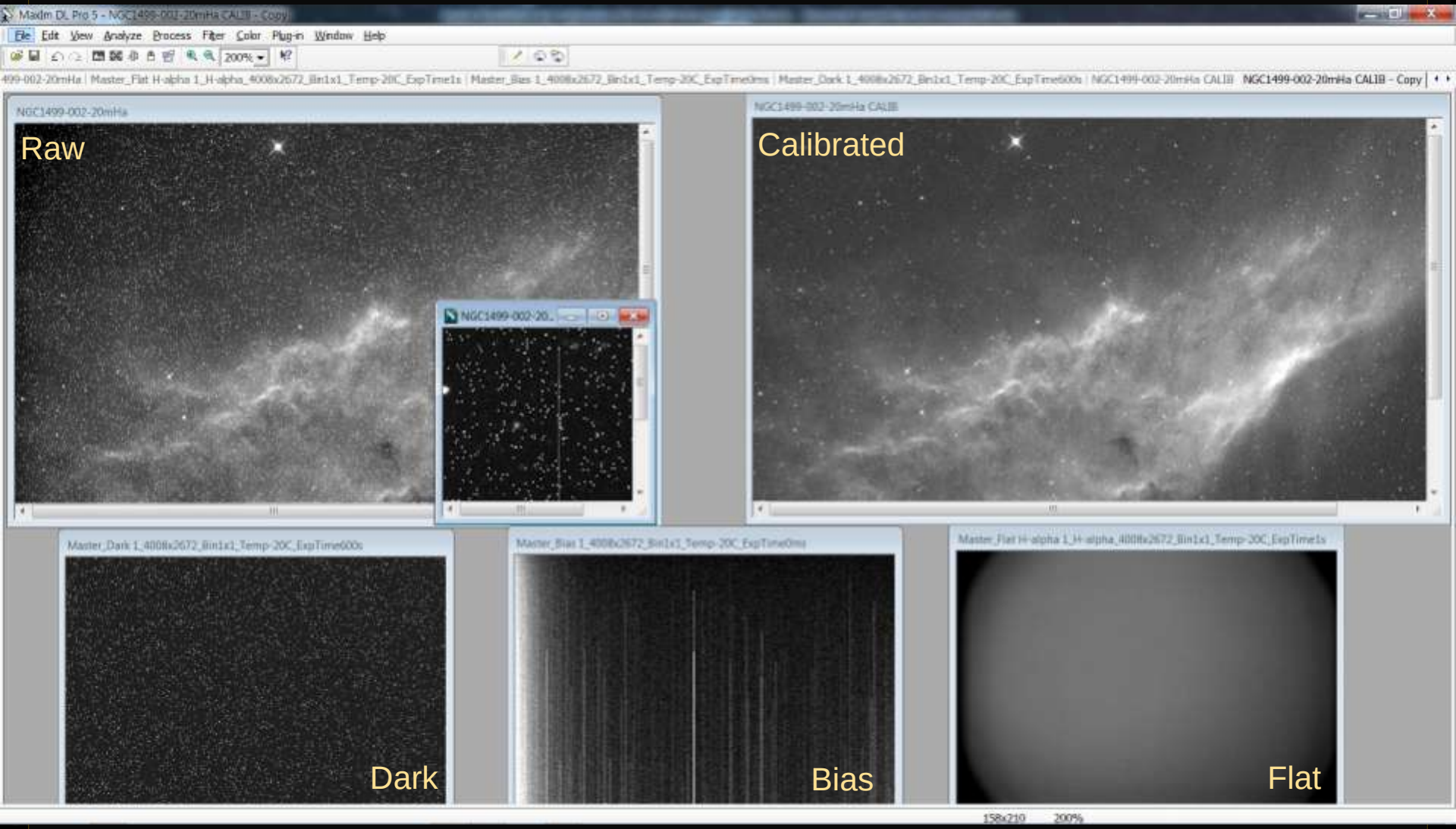
# Image Calibration

- Calibration corrects:
  - Noise
    - Thermal - generated over time in the sensor
    - Readout - generated when data is read from the sensor
  - Image defects and artifacts
    - Optical and mechanical imperfections
    - Dust motes
    - Uneven sensor response

# Calibration Misperceptions

- 'My images look fine without calibration'
  - For deep sky objects, calibration gives a huge benefit
  - Some image processing techniques only work well on calibrated images
- 'Calibration cuts into imaging time'
  - Most calibration can be done when you're not imaging
- 'Calibration is hard'
  - Software can acquire and apply calibration frames automatically
  - Lots of information available online on how to acquire calibration frames with different setups

# Image Calibration

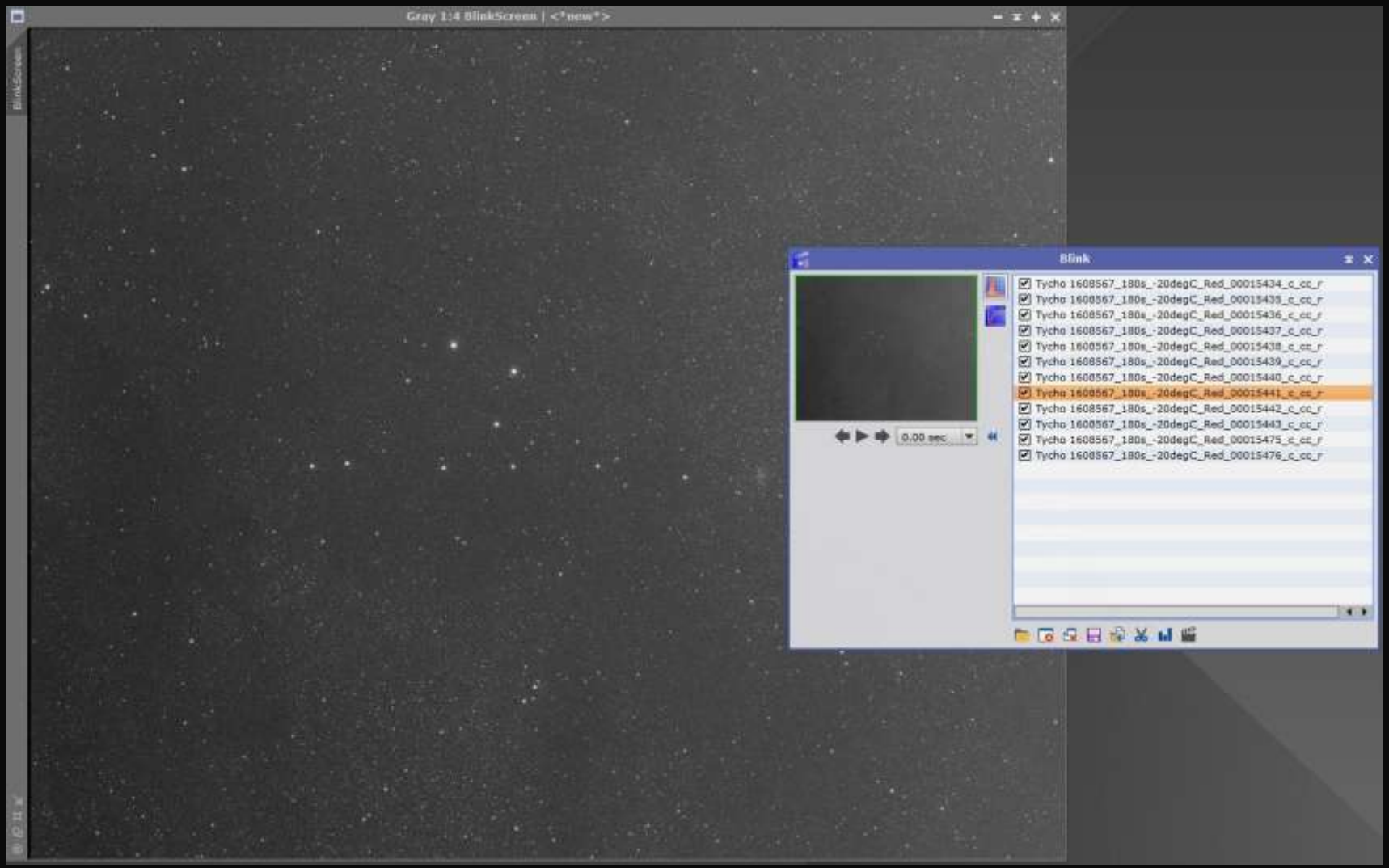


# Image Inspection

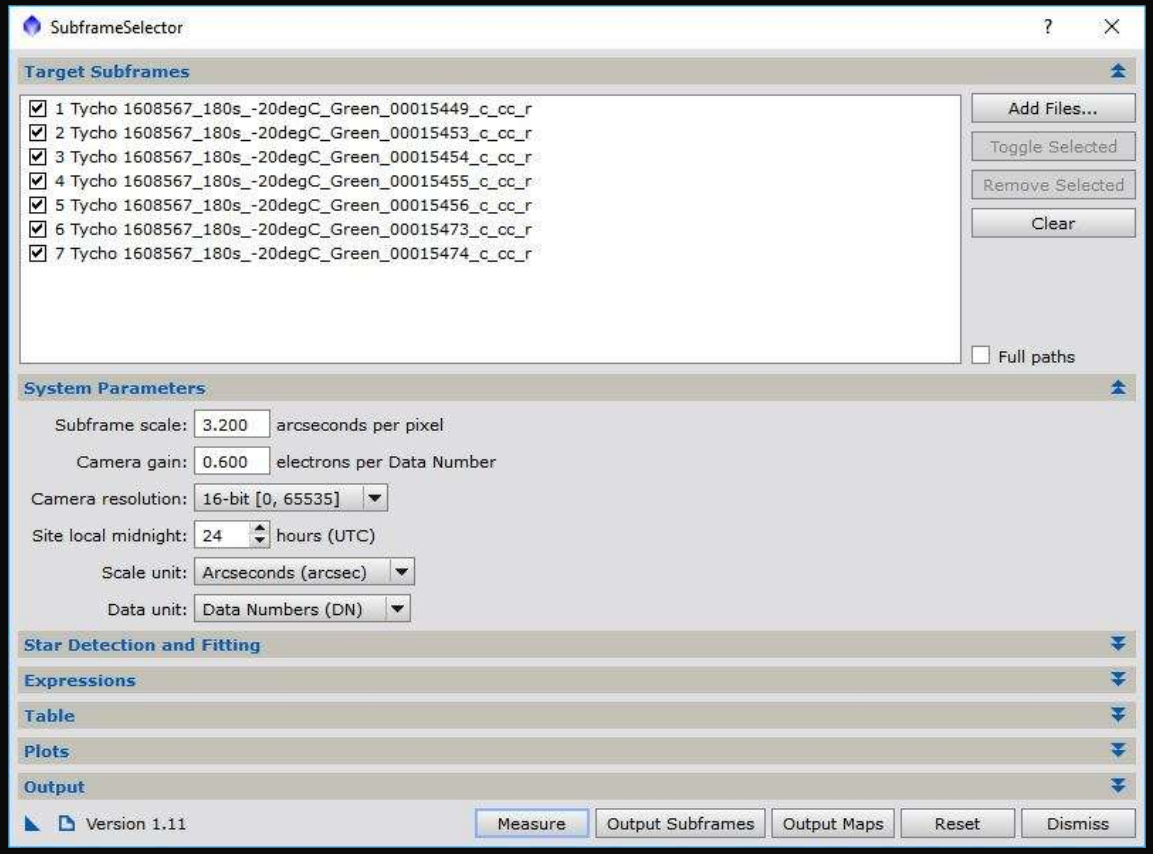
- Important to delete bad data before making master
  - Clouds or extraneous light
  - Stars out of focus or not round

- Two-step approach
  - Blink before calibration
    - Quickly identify bad frames and move to another directory
  - SubframeSelector script before alignment
    - Identify the ‘best’ frame in a set to use as reference for manual alignment and integration

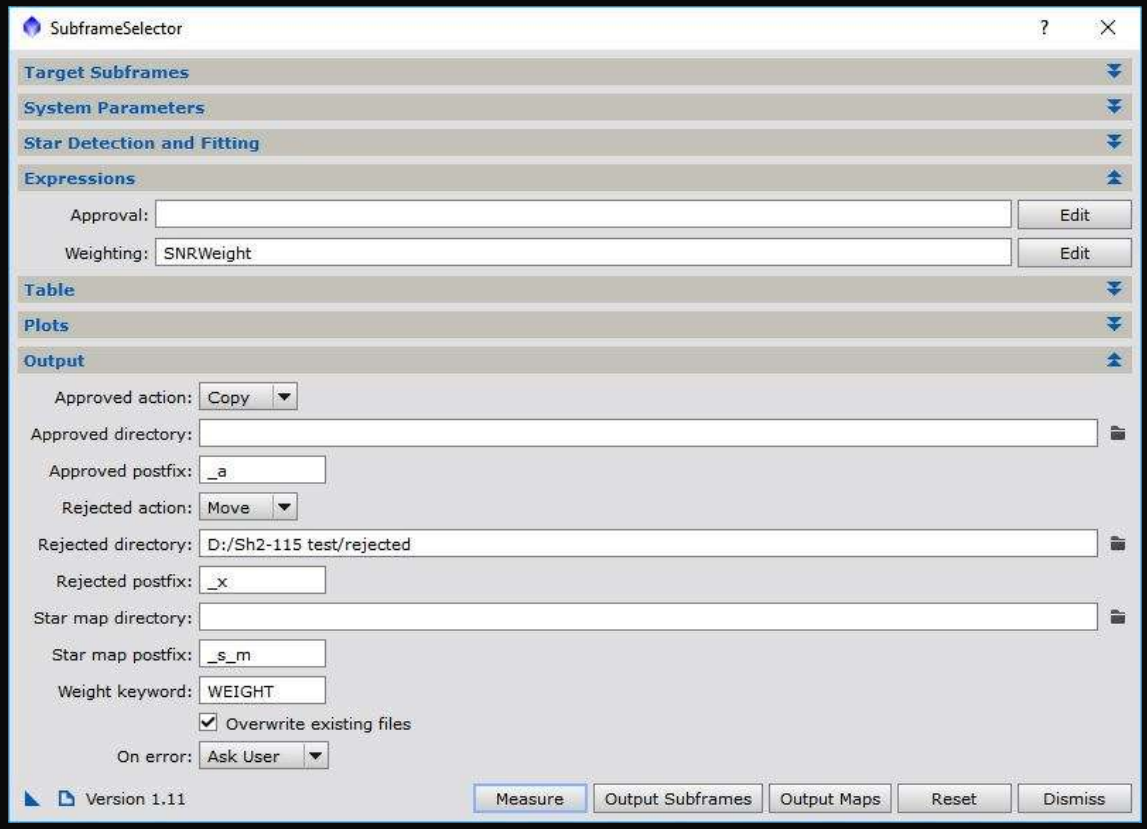
# Blink


Gray 1:4 BlinkScreen | <*new*>
BlinkScreen
Blink
0.00 sec
Tycho 1608567_180s_-20degC_Red_00015434_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015435_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015436_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015437_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015438_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015439_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015440_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015441_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015442_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015443_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015475_c_cc_r
Tycho 1608567_180s_-20degC_Red_00015476_c_cc_r

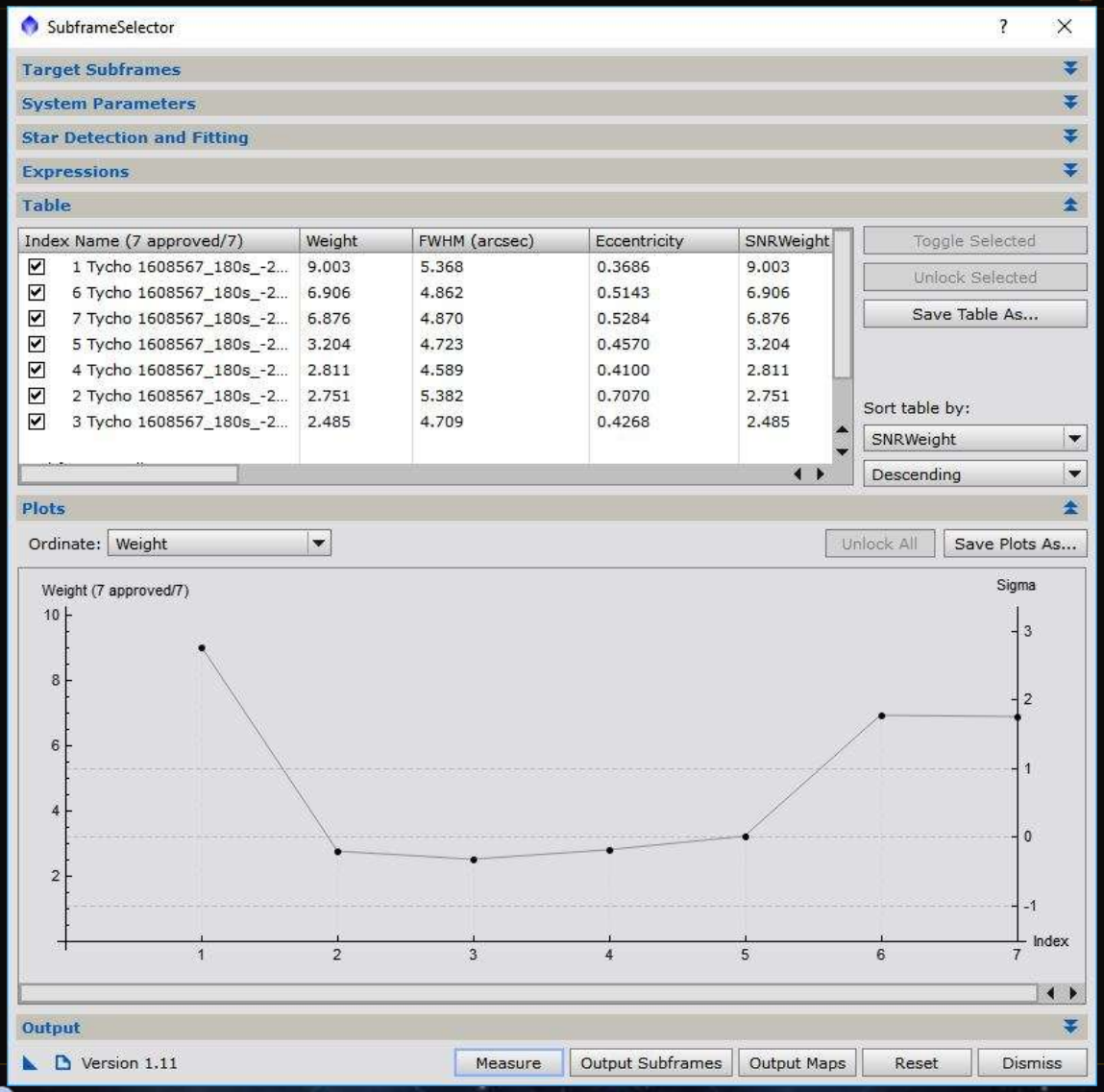
# SubframeSelector Script



# SubframeSelector Script



# SubframeSelector Script



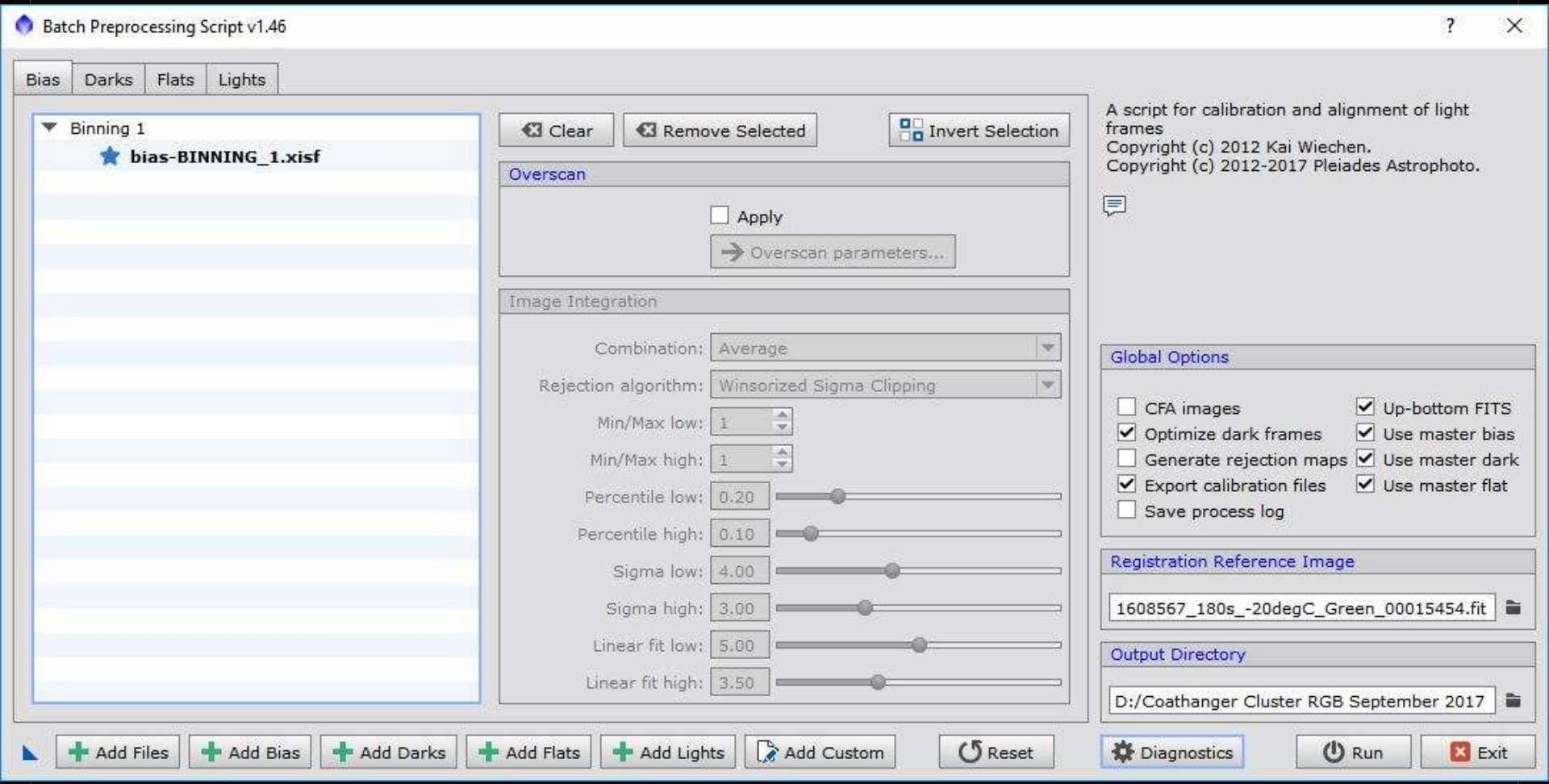
# BatchPreprocessing Script

- Automates calibration, alignment, and integration
- Produces masters for each filter (or OSC/DSLR)
  - Easiest way to make master calibration files
- All intermediate working frames are available
- Convenient, but has some significant limitations

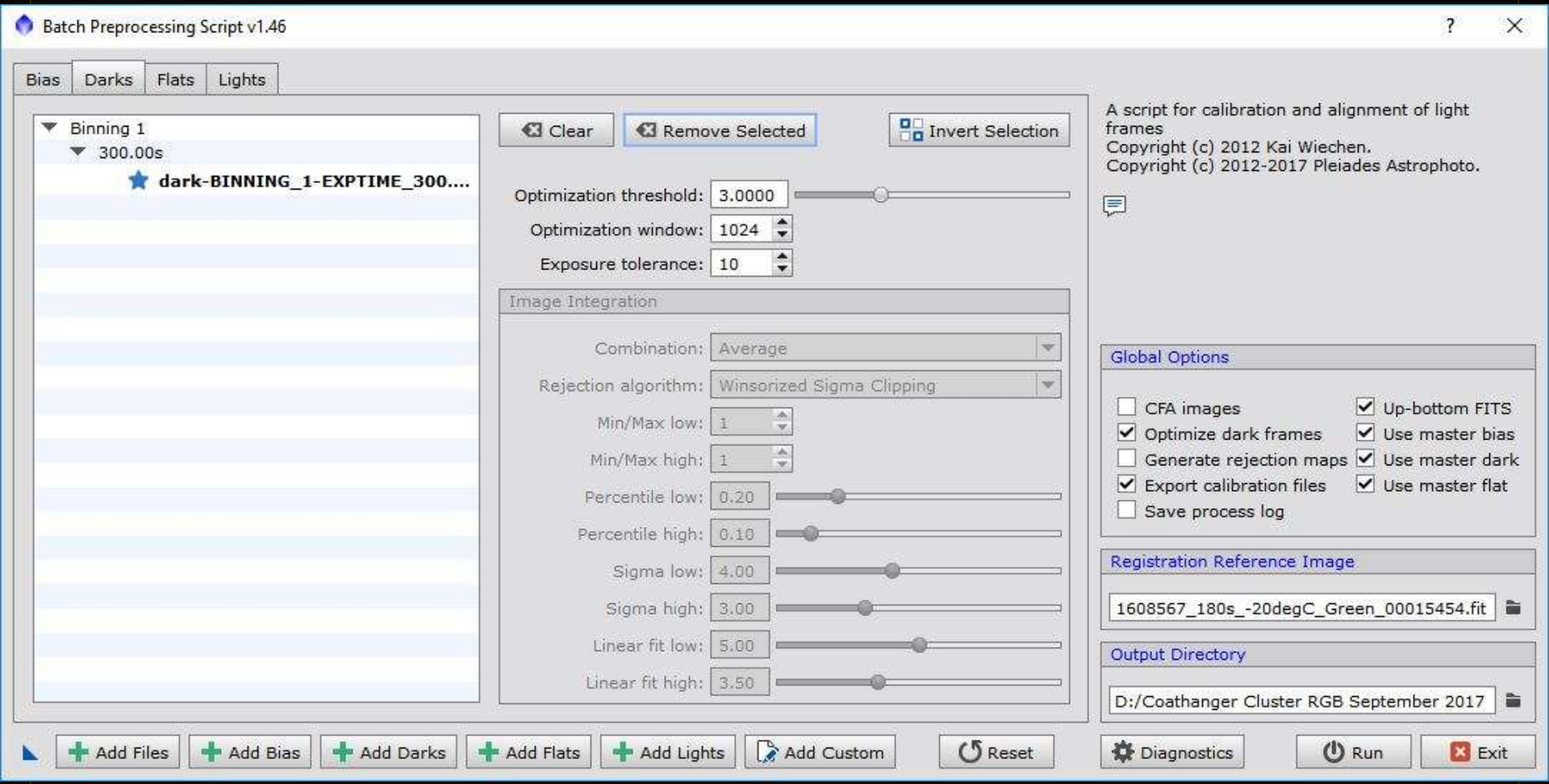
# BatchPreprocessing Script

- Limitations that Matter
  - Can’t select reference frames for alignment or integration
  - Only one rejection algorithm can be used for all filters
  - Does not use new (v1.8.5) processes and features:
    - LocalNormalization can normalize all frames (by-region) to the best frame in a set. Useful when some frames are much better than others (e.g. gradients due to moonlight or light pollution)
    - ImageIntegration has a new feature to reject large-scale structures like satellite trails
  - Only partially supports use of DrizzleIntegration
    - StarAlignment, ImageIntegration, and DrizzleIntegration must be used to align and integrate images

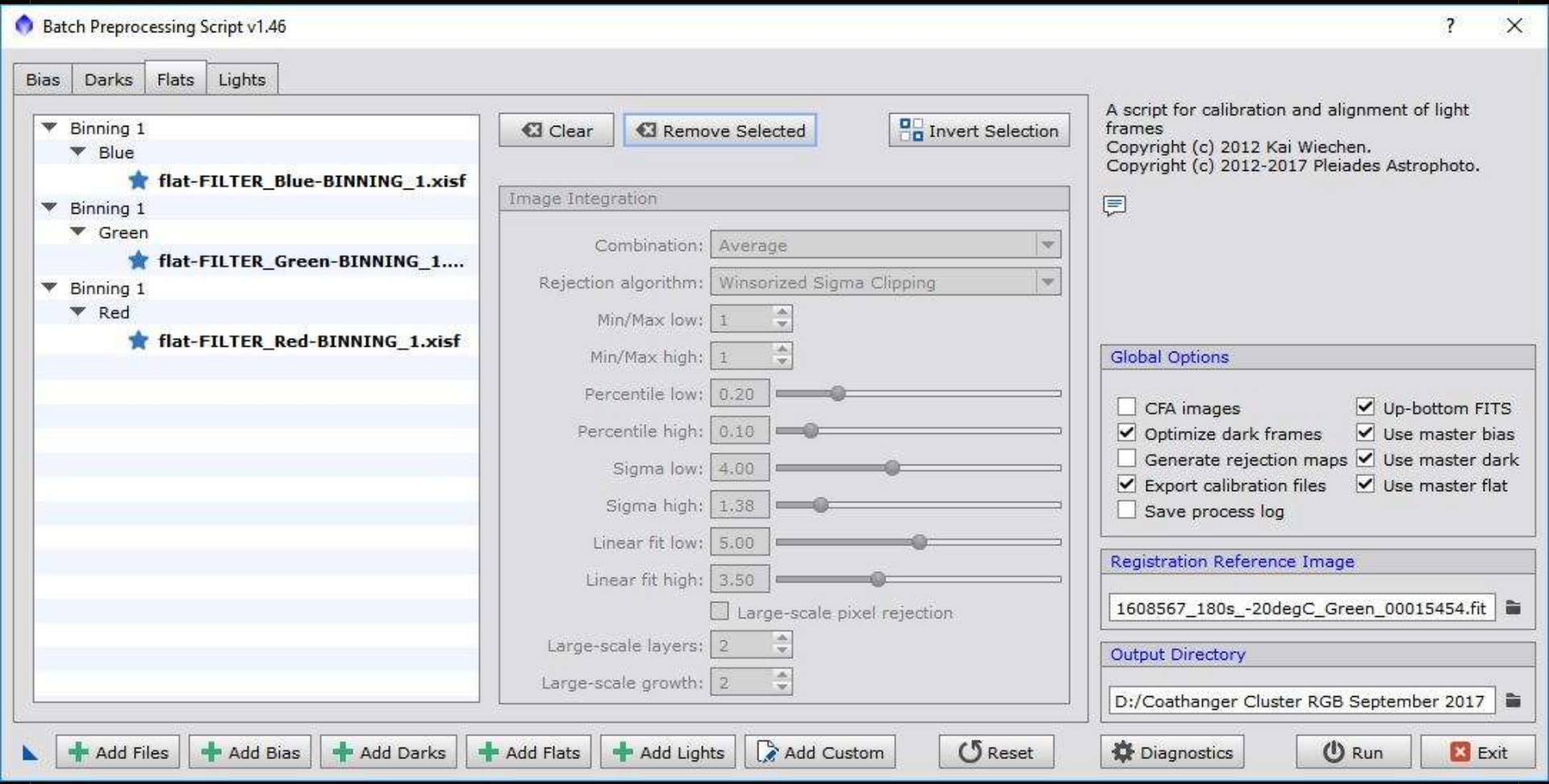
# BatchPreprocessing Script



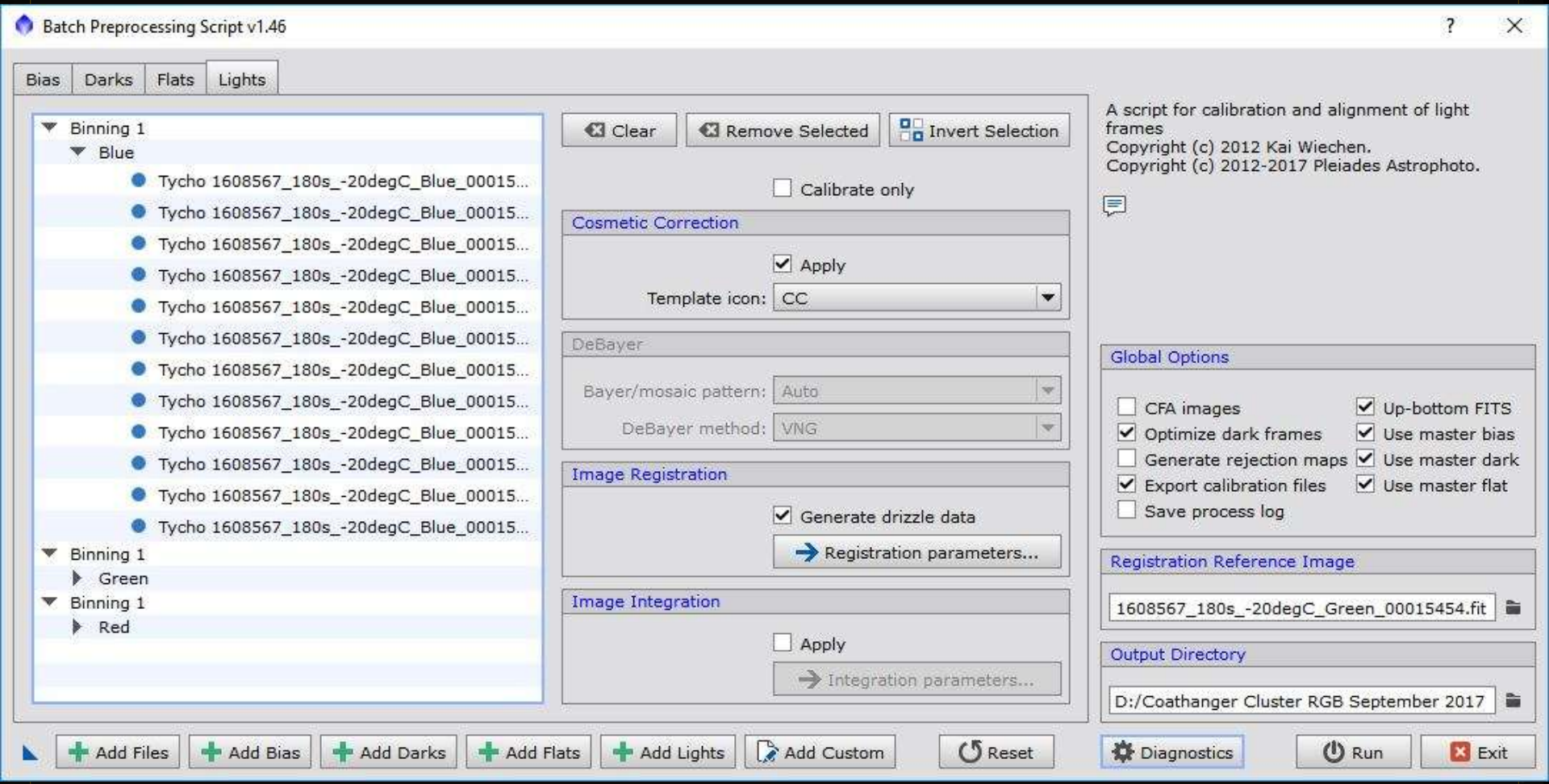
# BatchPreprocessing Script



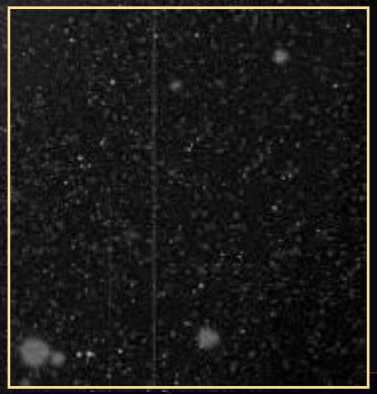
# BatchPreprocessing Script



# BatchPreprocessing Script



# BatchPreprocessing Script



# BatchPreprocessing Script

# Preprocessing with BPP

- Find and delete bad raw frames (Blink)
- Calibrate, align, and integrate frames (BatchPreprocessing script)
- Use multiple runs if there are big differences in the number of subframes per filter
  - For guidance on selection of clipping method, see the Rejection Algorithm tool tip

# Preprocessing Best Practice

- Find and delete bad raw frames (Blink)
- Calibrate frames using BPP (alternately, ImageCalibration and CosmeticCorrection)
- For each filter:
  - Identify best calibrated frame (SubrameSelector script)
  - Normalize all calibrated frames to ‘best’ calibrated frame (LocalNormalization)
  - Align calibrated frames using the ‘best’ calibrated frame as the reference image (StarAlignment)
  - Integrate aligned frames using ‘best’ frame as the reference image and the LocalNormalization output files (ImageIntegration and optionally DrizzleIntegration)

# Preprocessing Hybrid Approach

- Find and delete bad raw frames (Blink)
- Use BPP to calibrate and align* frames
- For each filter:
  - Identify ‘best’ aligned frame (Blink)
  - Normalize all aligned frames to ‘best’ aligned frame (LocalNormalization)
  - Combine using ‘best’ frame as reference and the output files from LocalNormalization (ImageIntegration and optionally DrizzleIntegration)

# Imaging Tasks

- Data Acquisition
  - Gather raw data
  - Lights, flats, darks and bias
- Pre-processing
  - Examine light frames and delete inferior frames
  - Calibrate light frames using flats, darks and bias
  - Align and combine calibrated frames
- Processing
  - Make it pretty or accurate, depending on goal
- Saving and Sharing
  - Save in various file formats
  - Share your images

# Basic Processing Steps

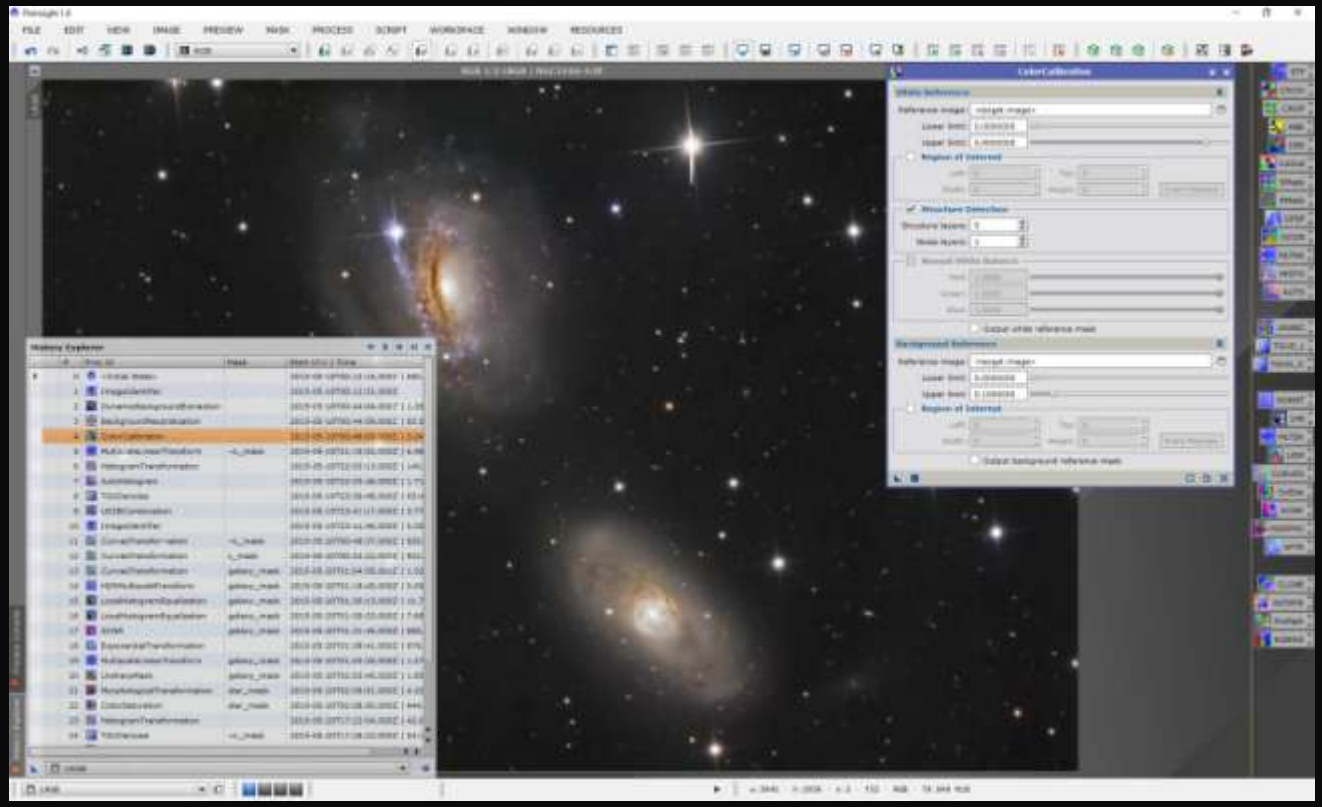
- Combine masters
- Crop to frame subject
- Remove gradients
- Balance colors
- Reduce noise
- Stretch ('develop') the picture
- Smooth and sharpen
- Adjust appearance

# Basic Processing Steps

- Combine masters - ChannelCombination
- Crop to frame subject - DynamicCrop
- Remove gradients - DBE/ABE
- Balance colors - ColorCalibration or PhotometricCC
- Reduce noise - MultiscaleLinearTransform
- Stretch ('develop') the picture - HistogramTransformation
- Smooth and sharpen - TGVDenoise, MLT, UnsharpMask
- Adjust appearance - Curves

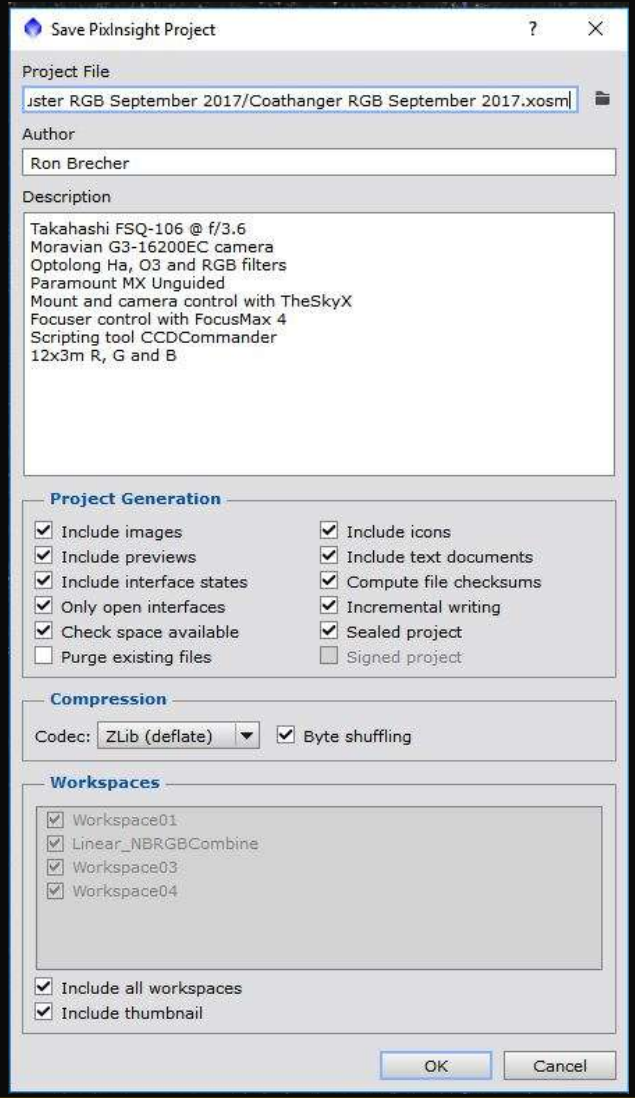
# The Power of Projects

- Complete History Tracking
- Stores all masters, working images, masks, etc.



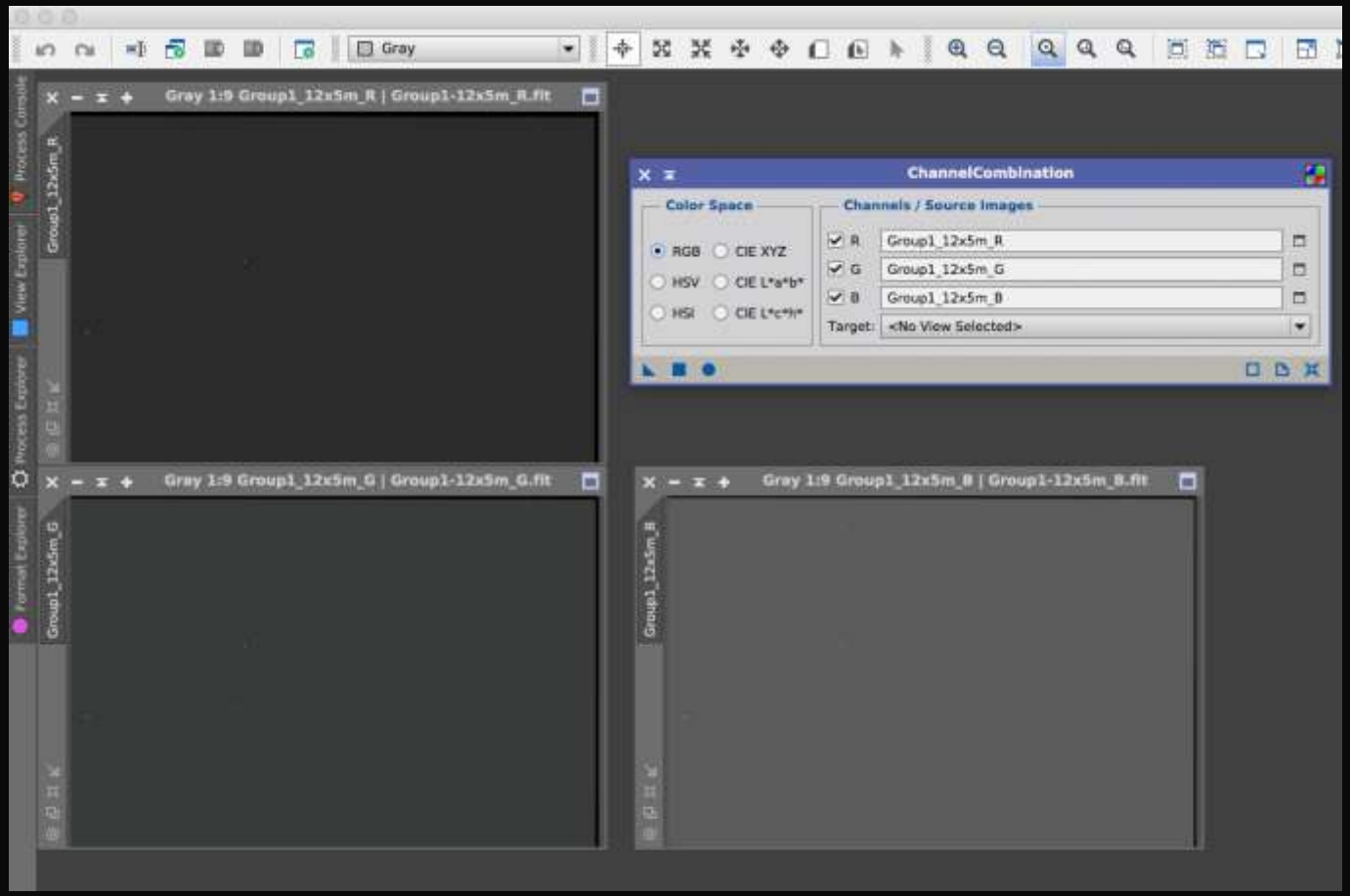
# The Power of Projects

- File/Save Project…
- Specify directory and add notes
- Default settings usually fine
- Output:
  - .xosm file with project header
  - folder containing all
    - Processes, image windows, Previews and icons
    - History states for all Views, including masks
    - Workspaces and their contents



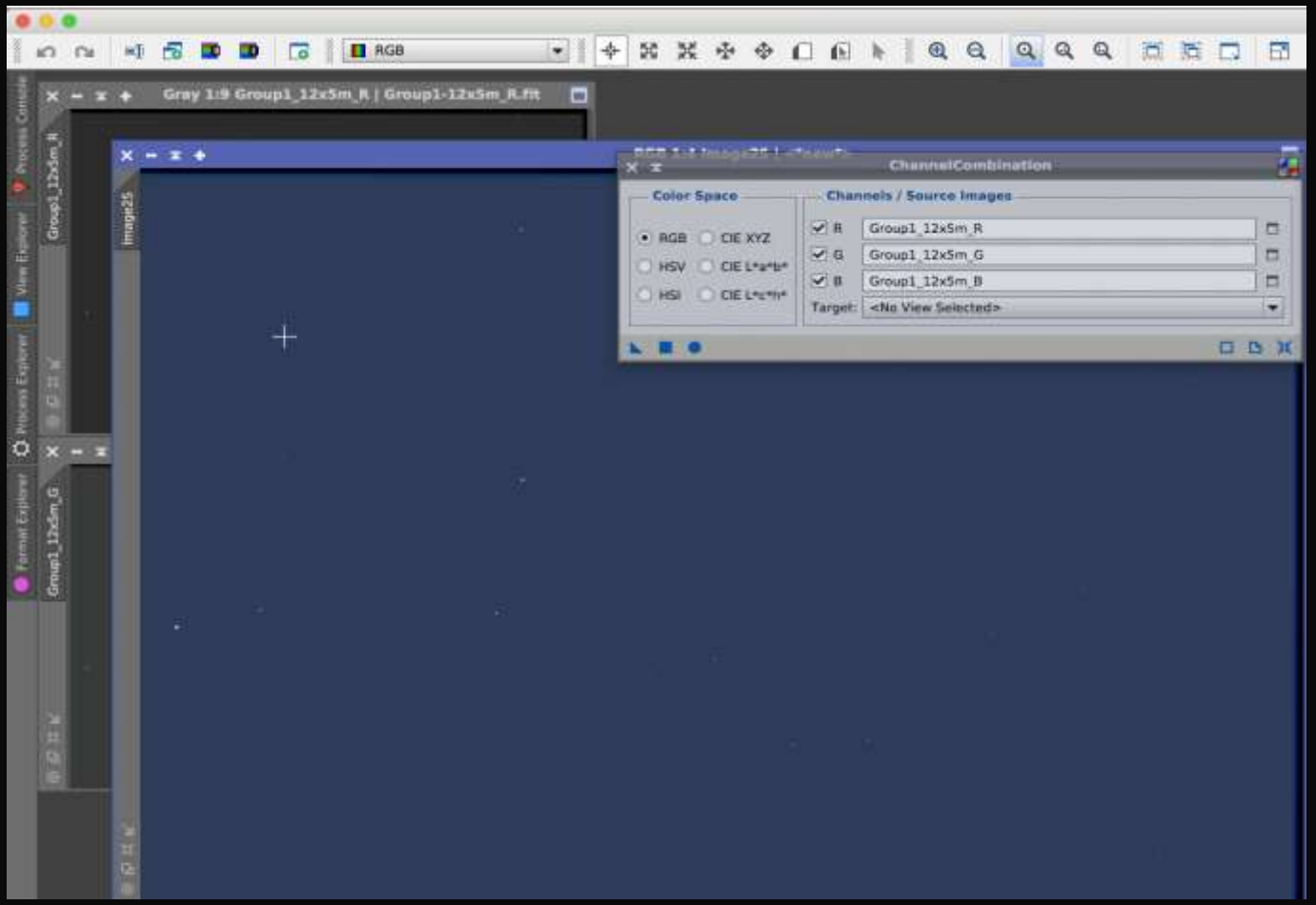
# ChannelCombination

- Use to make RGB image from R, G, and B masters



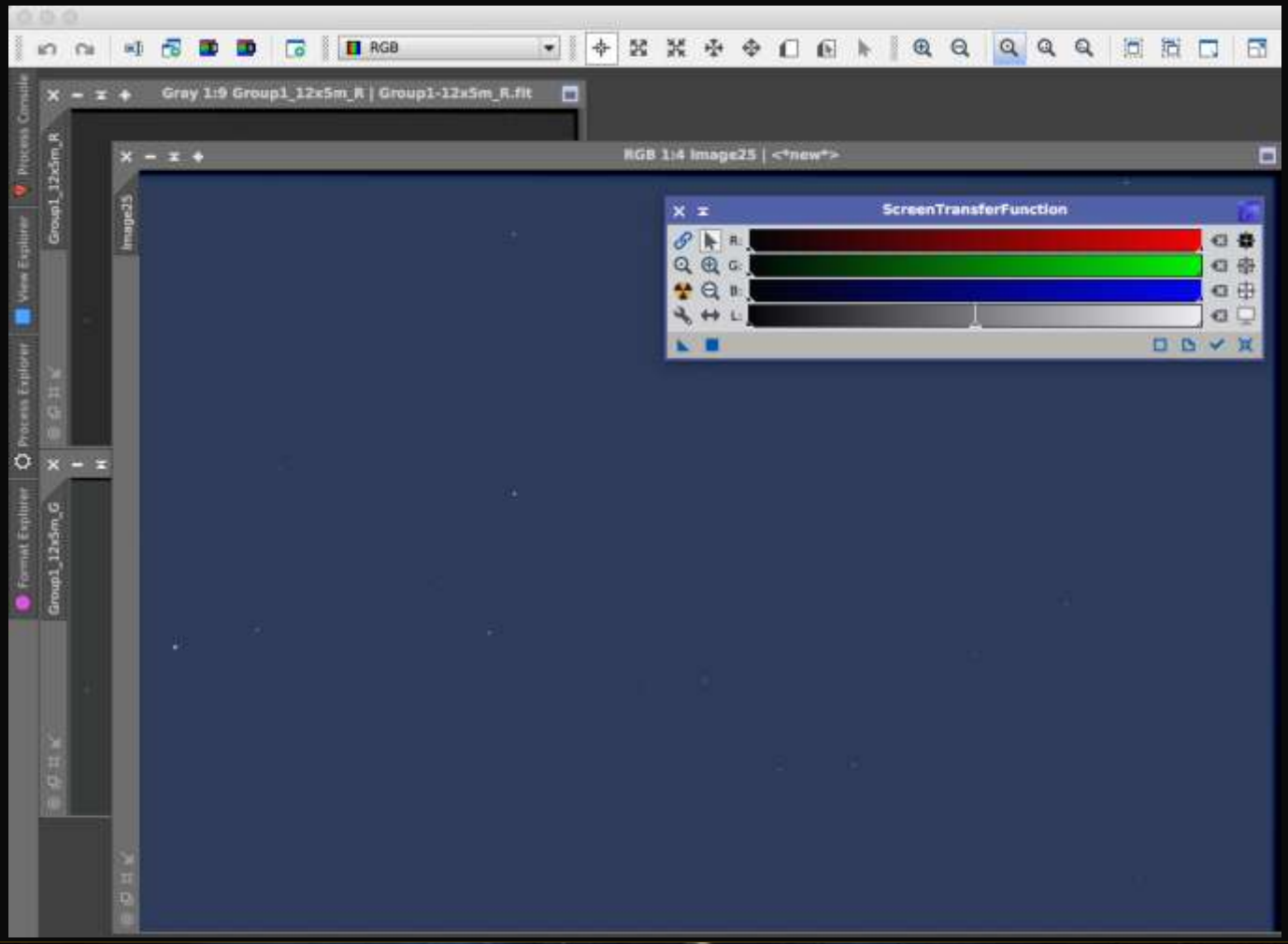
# ChannelCombination

- Use to make RGB image from R, G and B masters



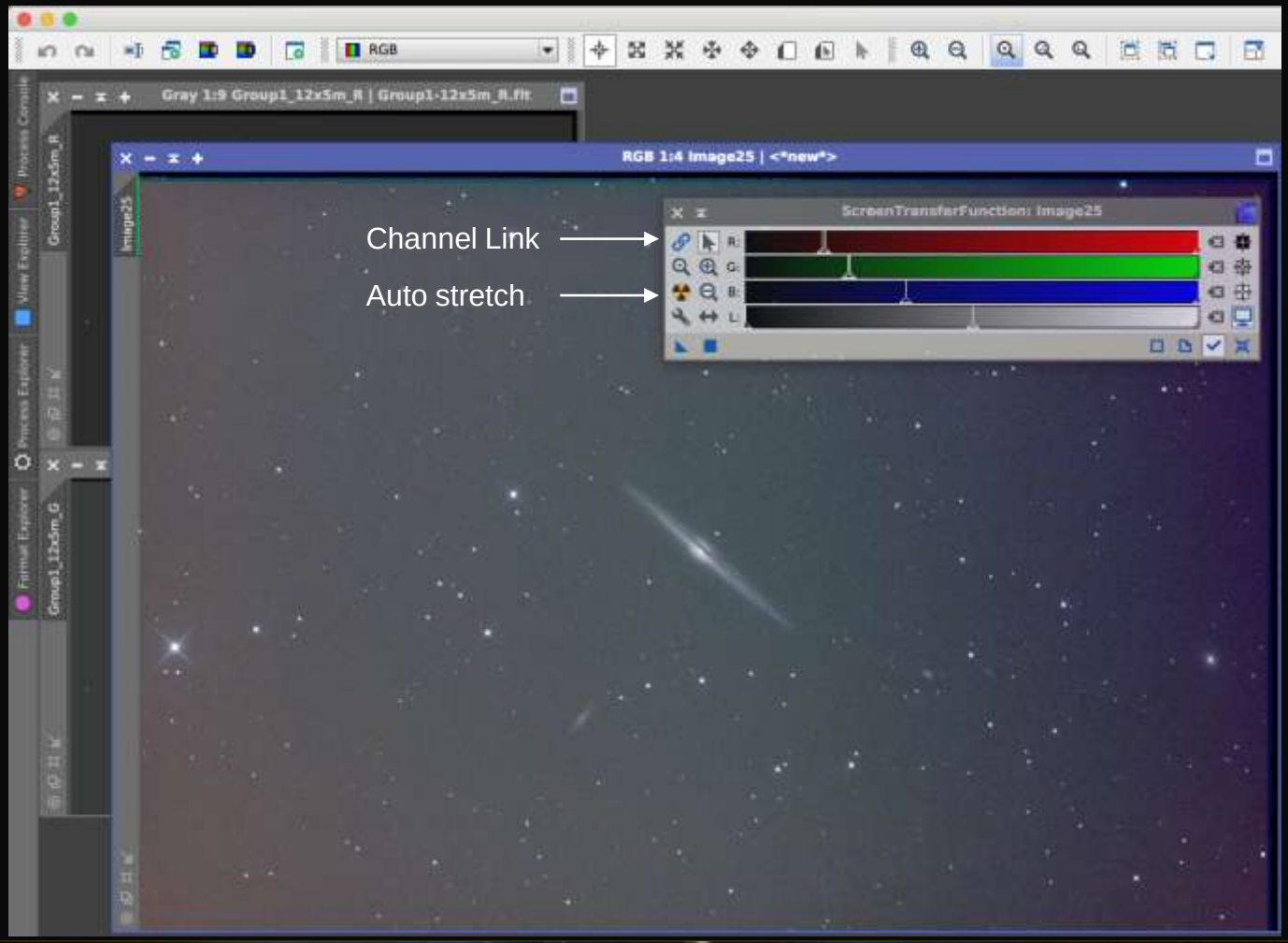
# ScreenTransferFunction

- Makes image visible on screen without changing data



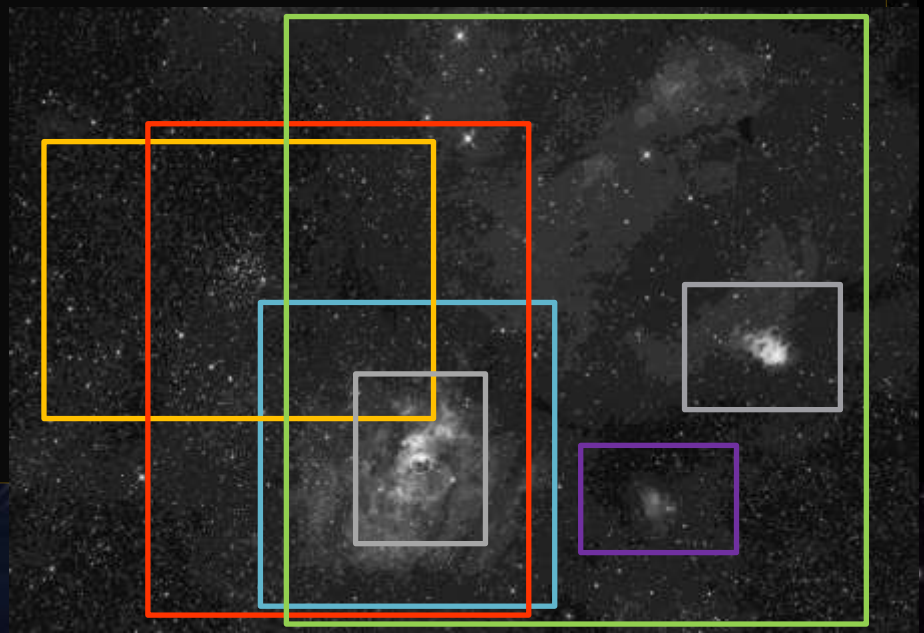
# ScreenTransferFunction

- Makes image visible on screen without changing data



# DynamicCrop

- Cropping removes unwanted portions of an image
  - Edge artifacts from integration
  - Severe gradients (vignetting, moonlight)
  - Oblong stars in corners
- DynamicCrop is the tool of choice

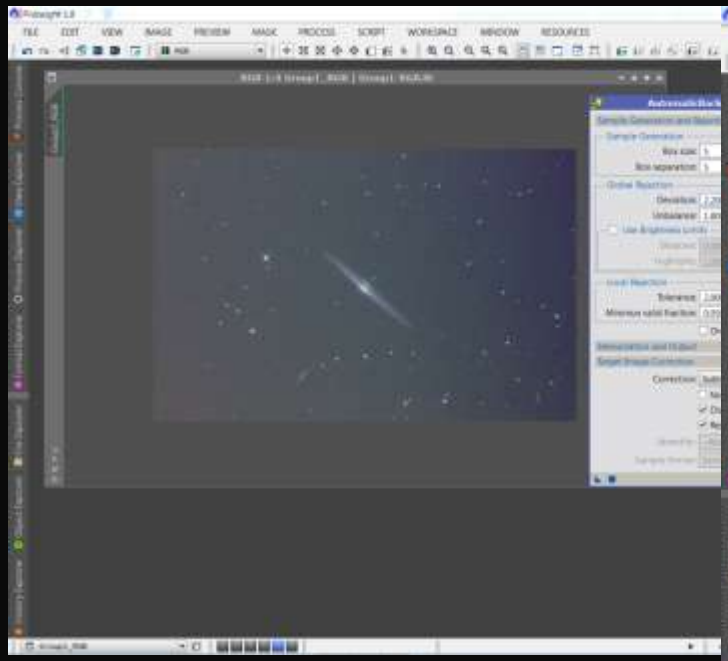


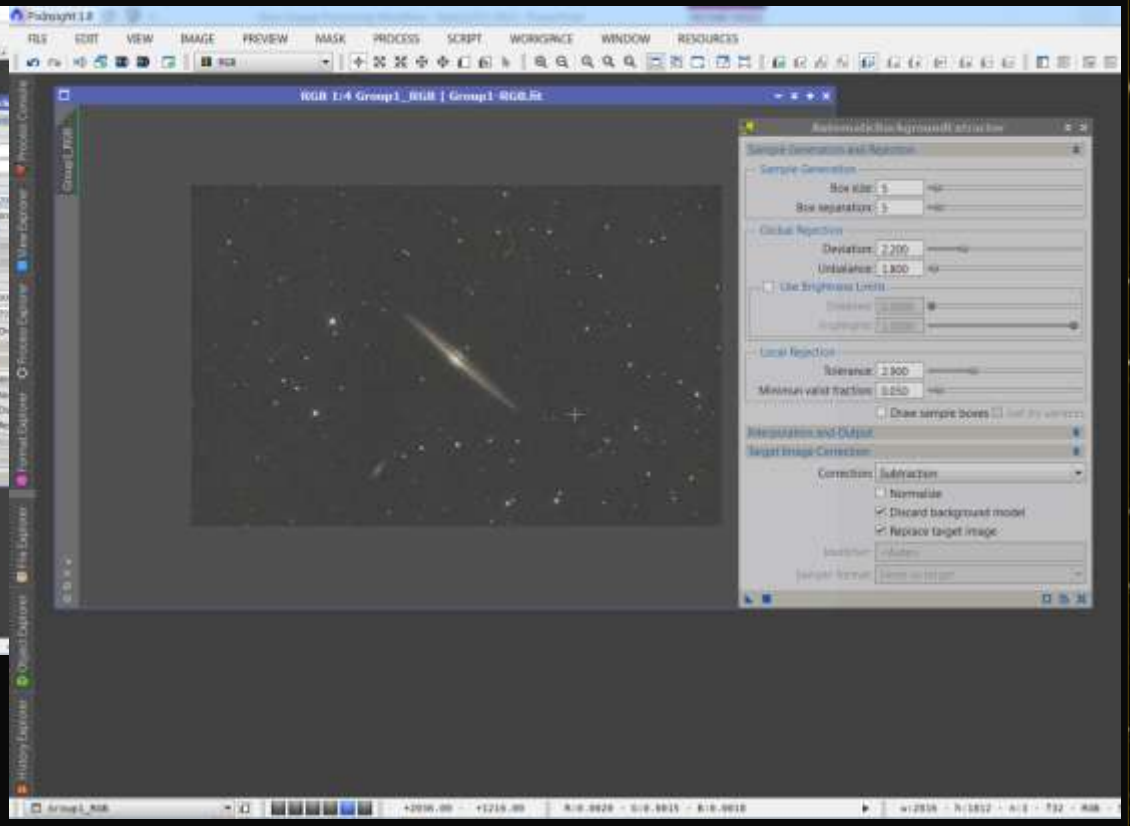
# Gradient Removal

- Sources of light gradients include
  - Light pollution or moonlight
  - Optical imperfections (e.g. vignetting, uneven sensor response)
- PixInsight has two tools for gradient removal:
  - Automatic Background Extraction (ABE)
    - Quick and easy; limited control
  - DynamicBackgroundExtraction (DBE)
    - Requires more user input, gives much greater control
  - ABE and DBE can be judiciously applied more than once to achieve desired results

# AutomaticBackgroundExtraction

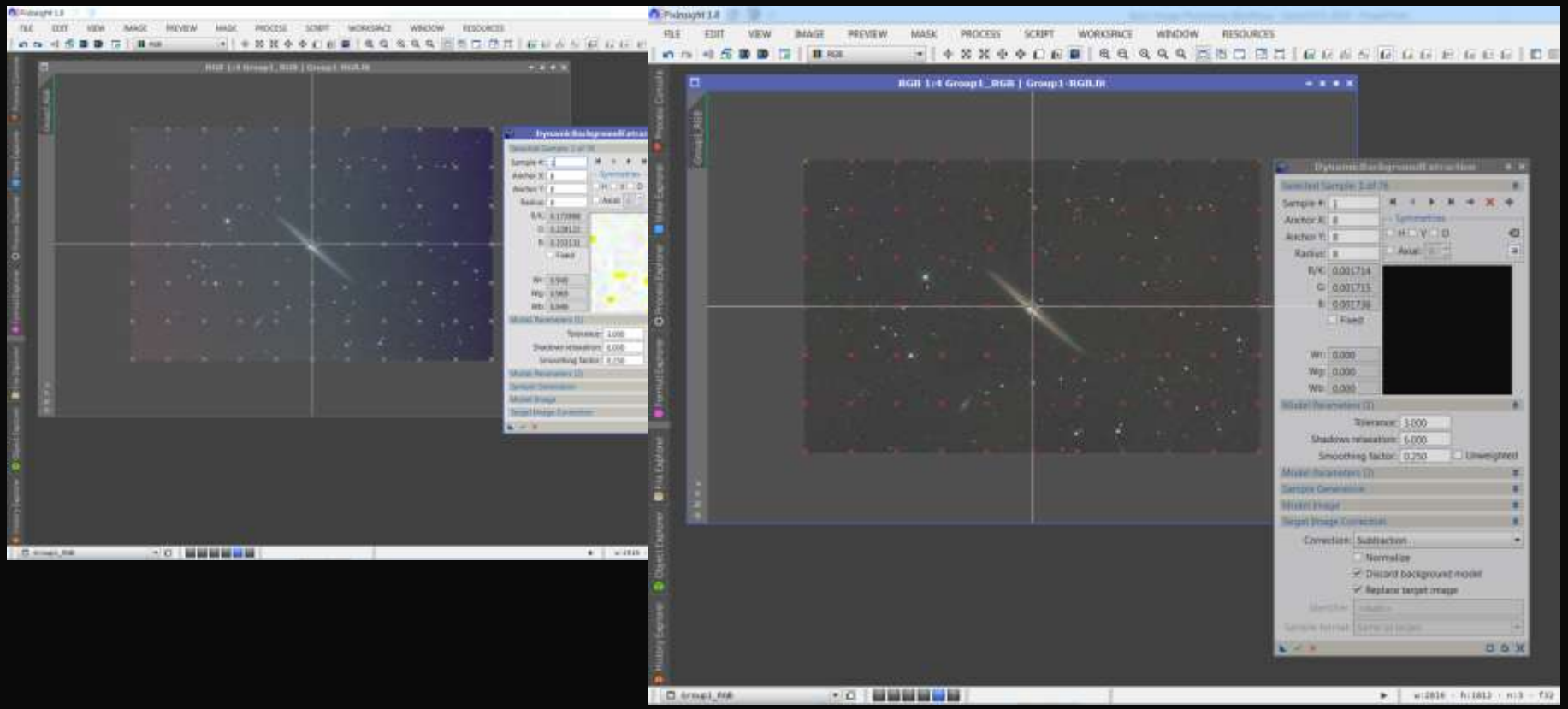
- Often works very well with default settings
- Try lowering Function Degree and increasing Tolerance if needed





# DynamicBackgroundExtraction

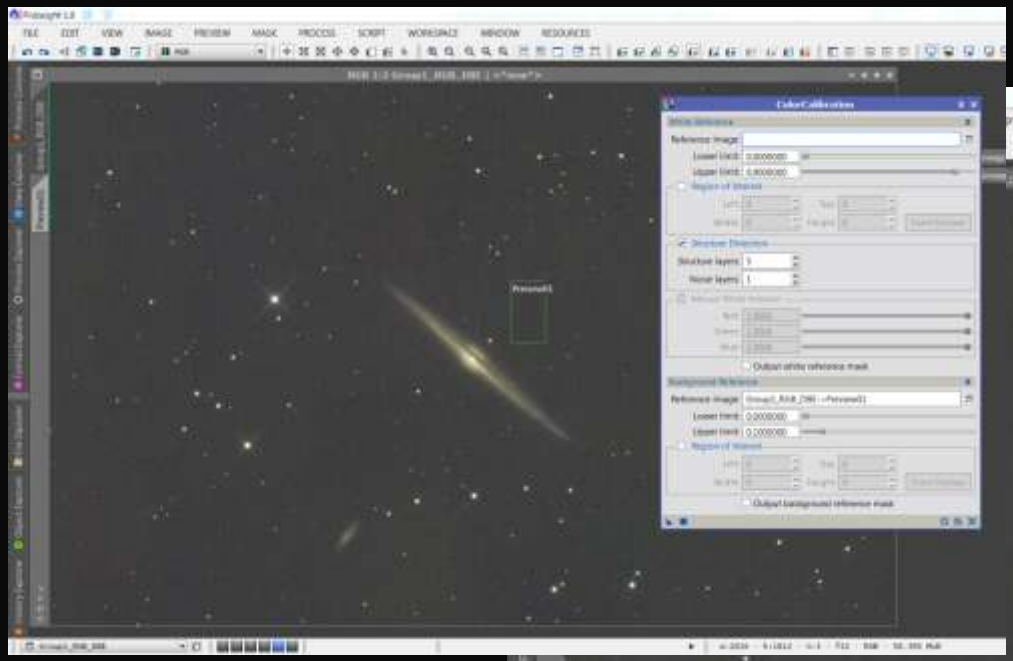
- A few well-placed sample points may be enough
- Increase Tolerance and Shadows Relaxation if needed

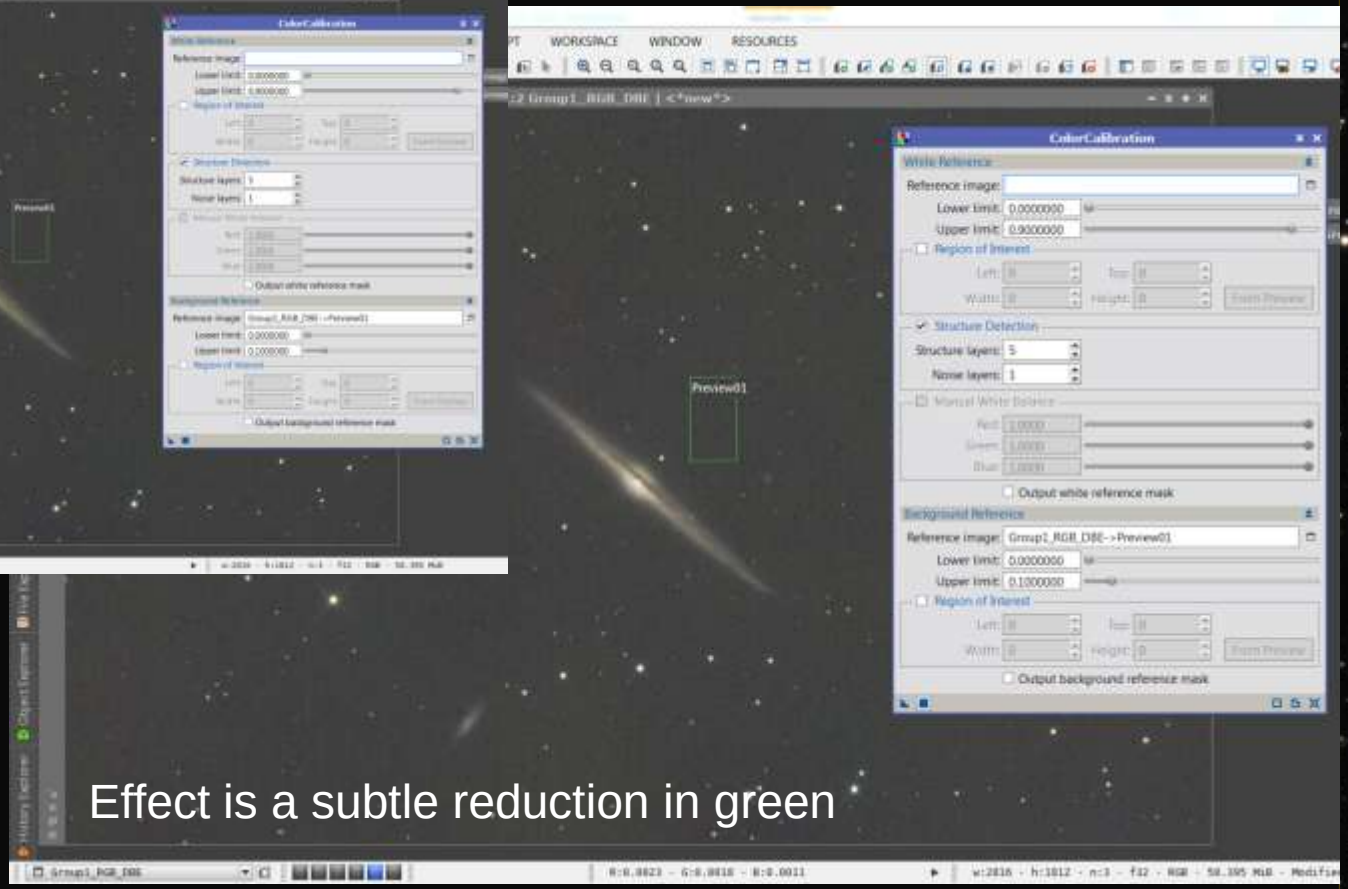


# ColorCalibration

- All RGB color images require color balancing
  - White Balance
  - Neutralize Background
  - Good gradient removal is an essential first step
    - If necessary, reapply DBE (or ABE) and possibly BackgroundNeutralization
  - ColorCalibration process:
    - Takes a 'spectrally agnostic' approach
    - Structure Detection mode generally used

# ColorCalibration



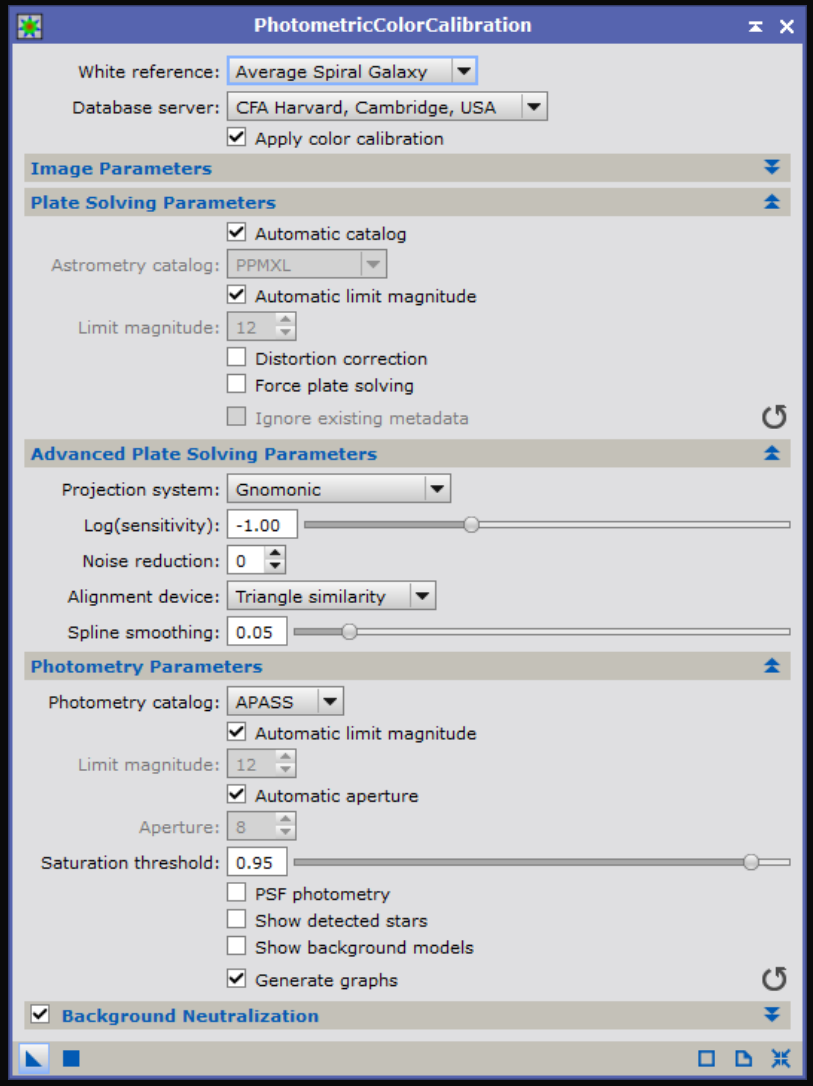



Effect is a subtle reduction in green

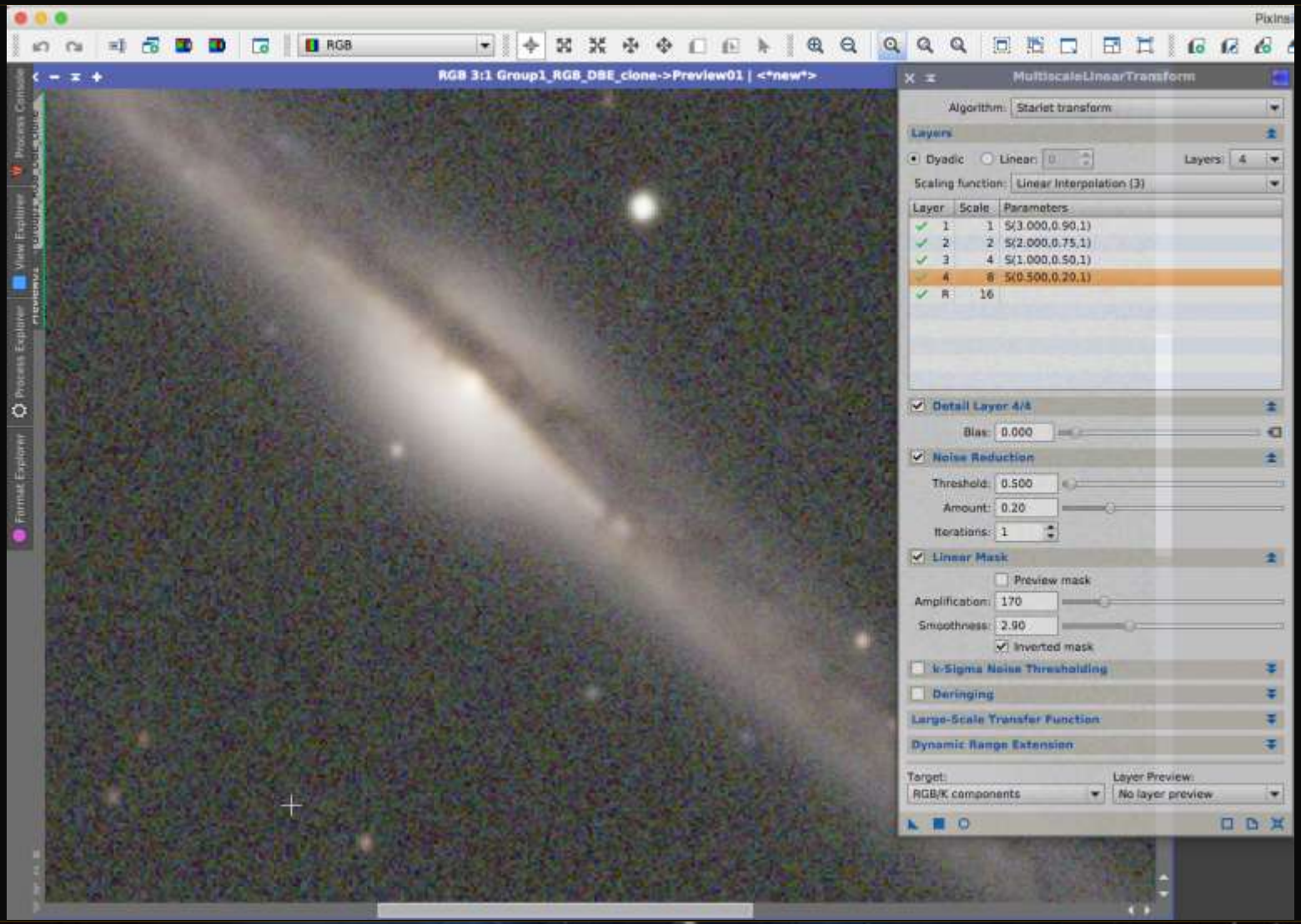
# PhotometricColorCalibration

- Alternative to BackgroundNeutralization / ColorCalibration combo
  - New in v1.8.5
  - Includes a built-in tool to neutralize the background
    - User must select background reference
  - Requires:
    - Internet connection
    - Image scale and target coordinates
  - Takes longer than BackgroundNeutralization / ColorCalibration combo (e.g. 15 seconds vs. 3.5 minutes)

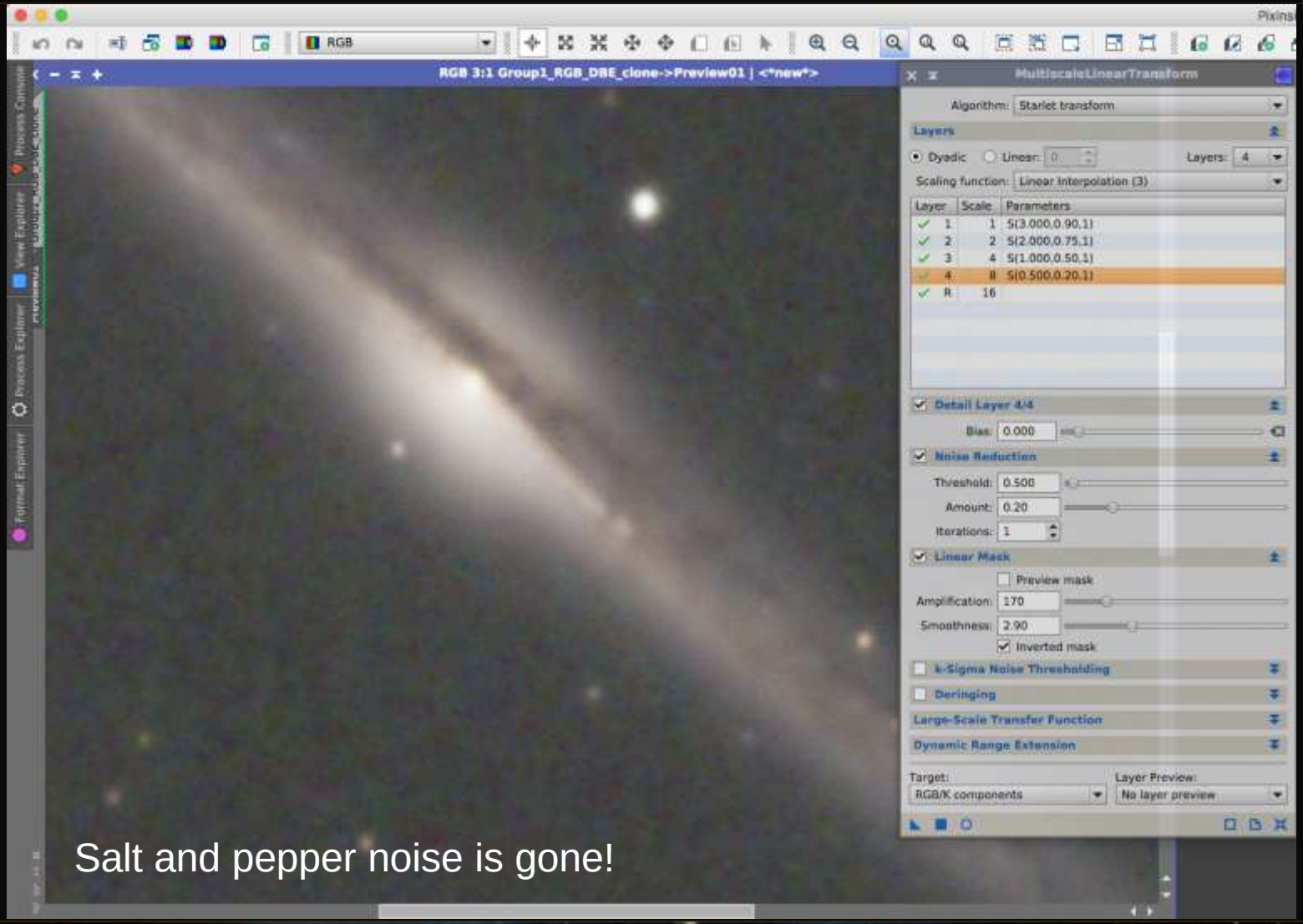
# PhotometricColorCalibration



# MultiscaleLinearTransform



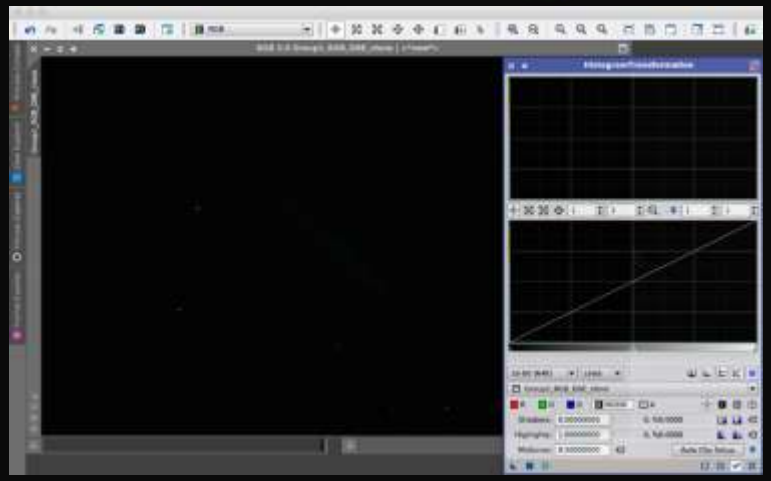
# MultiscaleLinearTransform

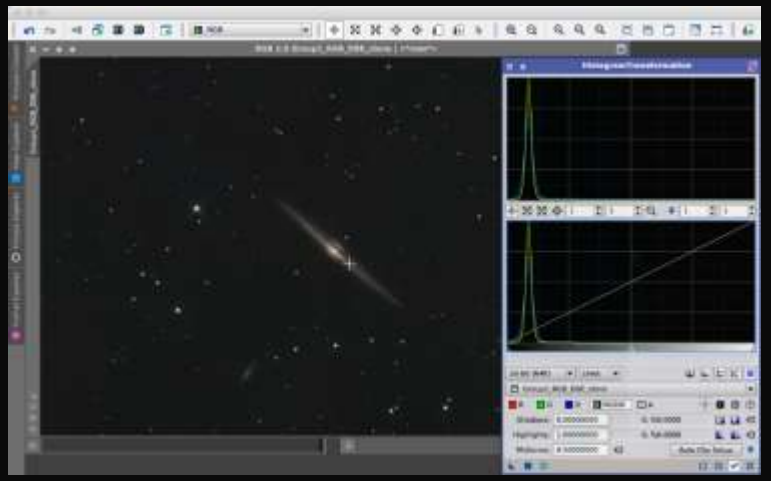


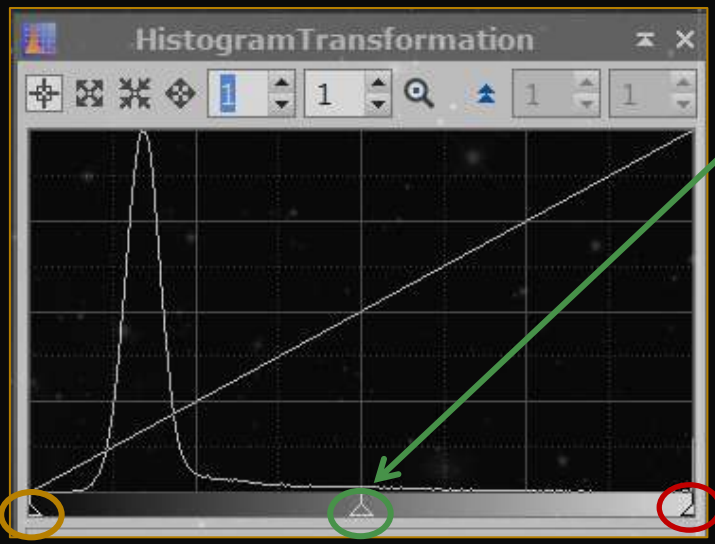
# 'Stretching'

- To this point files are 'linear' – the histogram hasn't been altered
  - Most information is near the left (black) end of the histogram.
- Moving the gray point to the left (towards black) brightens the darkest part of the histogram
- Stretching advice
  - Never move the white point
  - Black point can be moved to the right, but avoid clipping dim detail in shadows

# HistogramTransformation







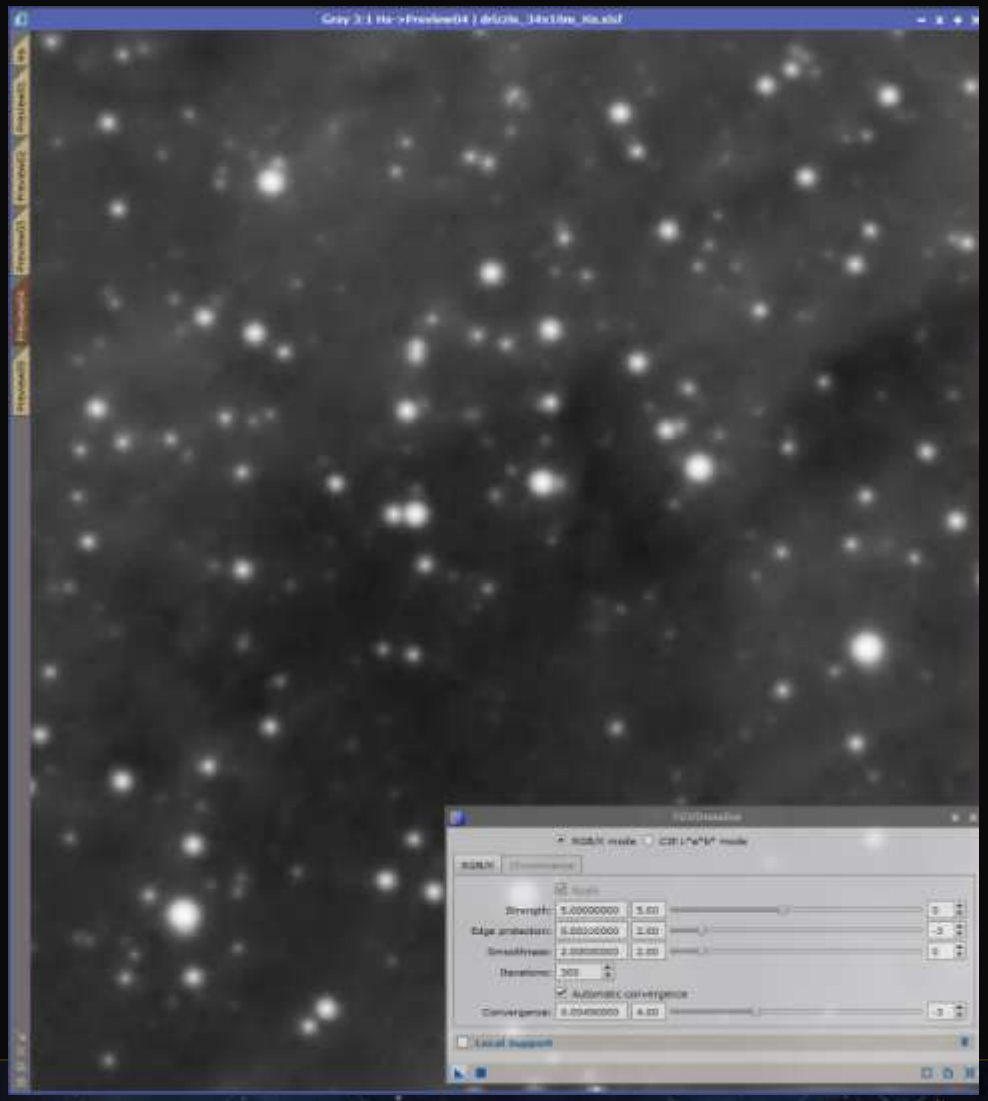

Move the black point to the right, being careful not to clip the dim data

Move the gray point slider to the left to stretch the histogram

Do not move the White Point, or bright cores will be burned out

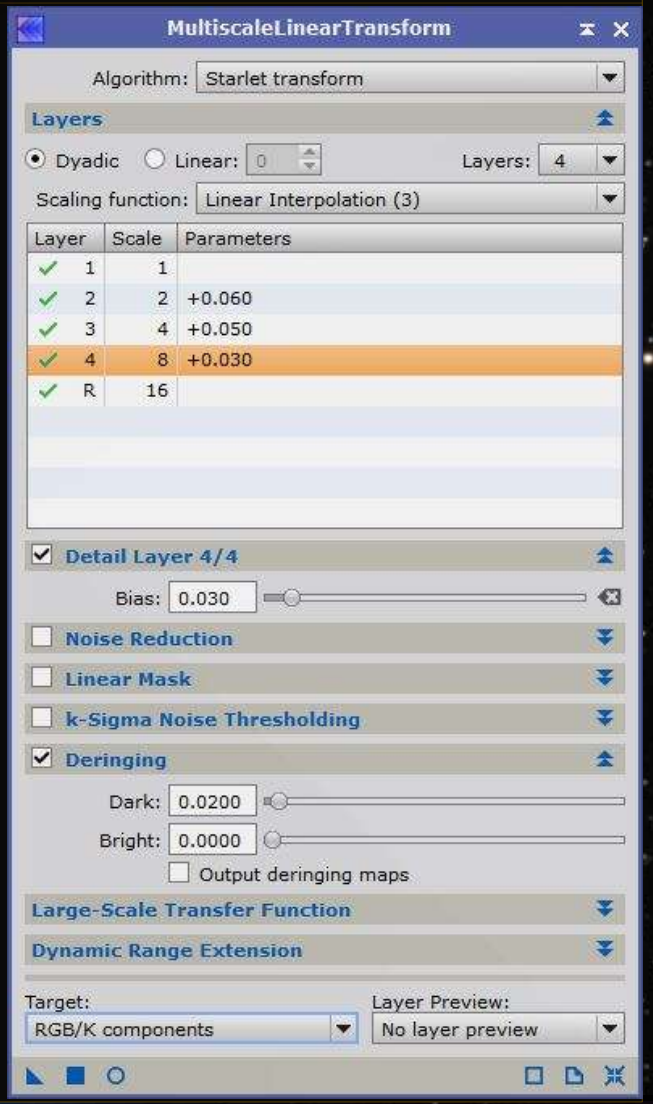
# Non-linear Noise Reduction: TGVDenoise

# Non-linear Noise Reduction: TGVDenoise



# Sharpening

- MultiscaleLinearTransform
  - RB and WK preferred approach
- UnsharpMask
  - Easy to use, but needs a light touch

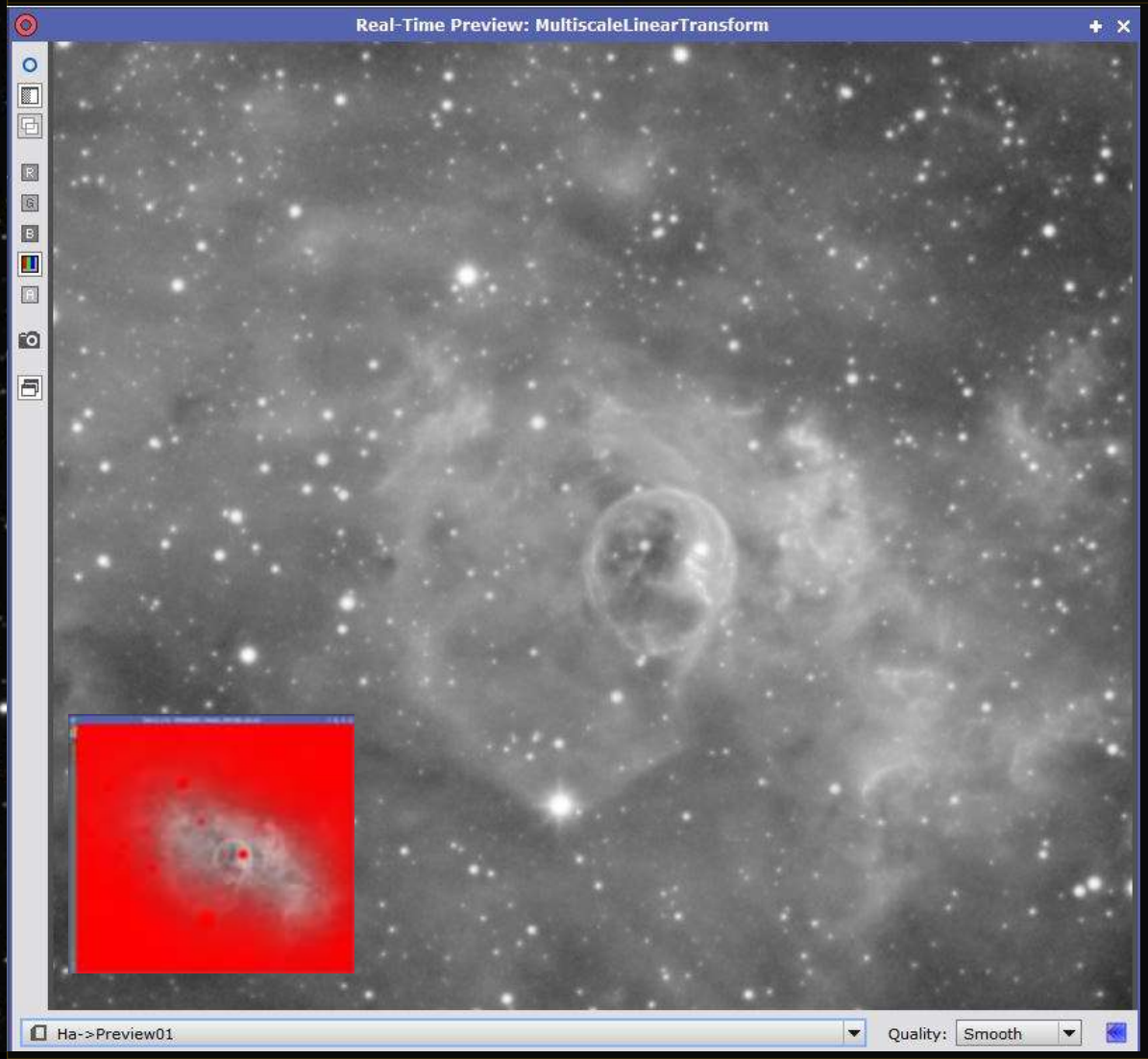



# Sharpening Mask

# Sharpening Mask

1. Make a range mask and a star mask (RangeSelection and StarMask)
2. Blur to remove stars (Convolution)
3. Subtract star mask from range mask (PixelMath)

# Sharpening with MLT




MultiscaleLinearTransform

Algorithm: Starlet transform

**Layers**

Dyadic  Linear: 0  Layers: 4

Scaling function: Linear Interpolation (3)

| Layer | Scale | Parameters |
|---|---|---|
| ✓ 1 | 1 | |
| ✓ 2 | 2 | +0.060 |
| ✓ 3 | 4 | +0.050 |
| ✓ 4 | 8 | +0.030 |
| ✓ R | 16 | |

☑ **Detail Layer 4/4**

Bias: 0.030

☐ **Noise Reduction**

☐ **Linear Mask**

☐ **k-Sigma Noise Thresholding**

☑ **Deringing**

Dark: 0.0200

Bright: 0.0000

☐ Output deringing maps

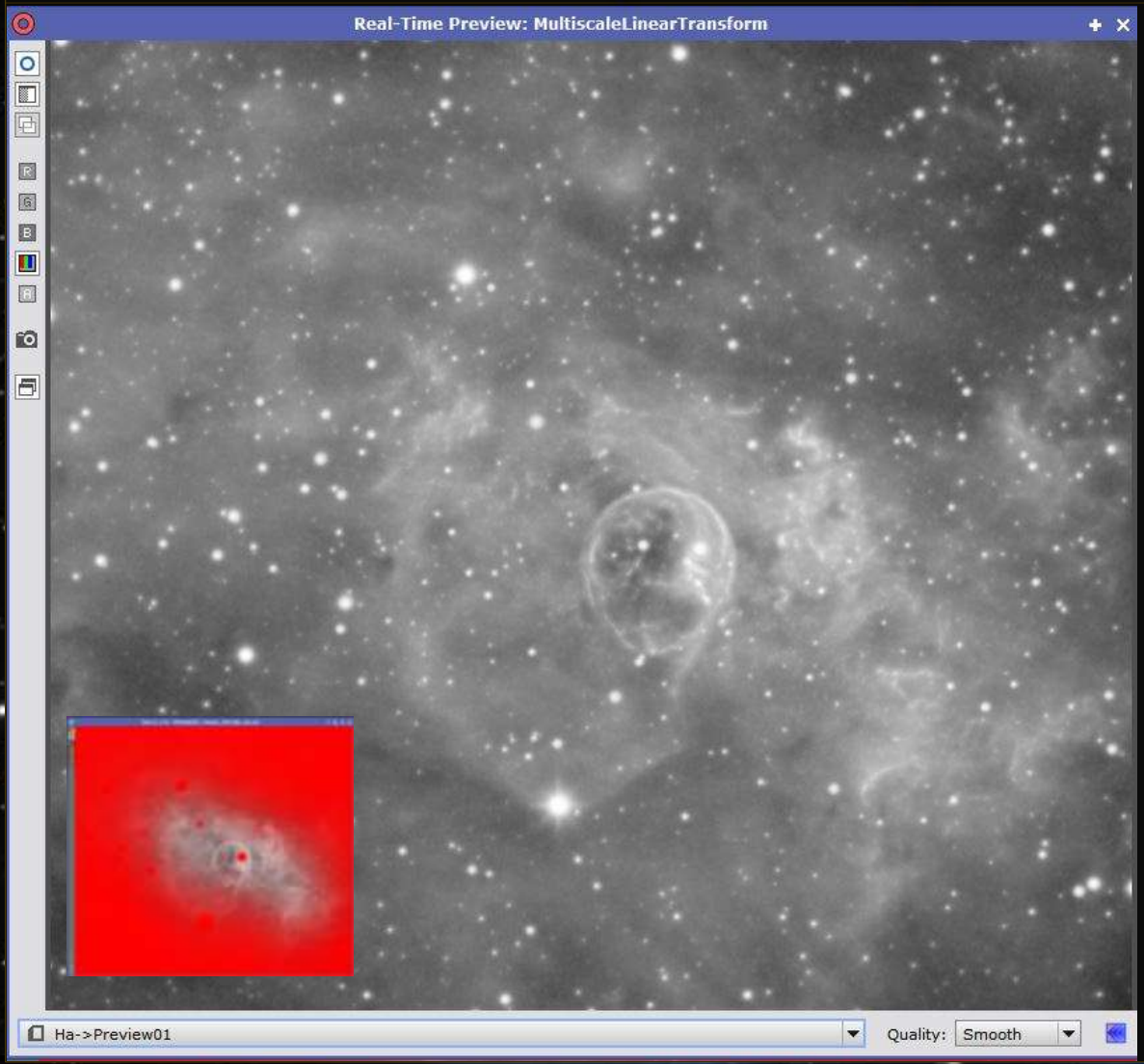
**Large-Scale Transfer Function**

**Dynamic Range Extension**

Target: RGB/K components

Layer Preview: No layer preview

# Sharpening with MLT




MultiscaleLinearTransform

Algorithm: Starlet transform

**Layers**

Dyadic  Linear: 0  Layers: 4

Scaling function: Linear Interpolation (3)

| Layer | Scale | Parameters |
|---|---|---|
| 1 | 1 | |
| 2 | 2 | +0.060 |
| 3 | 4 | +0.050 |
| 4 | 8 | +0.030 |
| R | 16 | |

**Detail Layer 4/4**

Bias: 0.030

**Noise Reduction**

**Linear Mask**

**k-Sigma Noise Thresholding**

**Deringing**

Dark: 0.0200

Bright: 0.0000

Output deringing maps

**Large-Scale Transfer Function**

**Dynamic Range Extension**

Target: RGB/K components

Layer Preview: No layer preview

# Curves

- Curves permits simultaneous adjustment of
  - Brightness and contrast
  - Color saturation
  - Individual RGB channels
  - CIE L*a*b* channels
  - Alpha channel (for PNG)

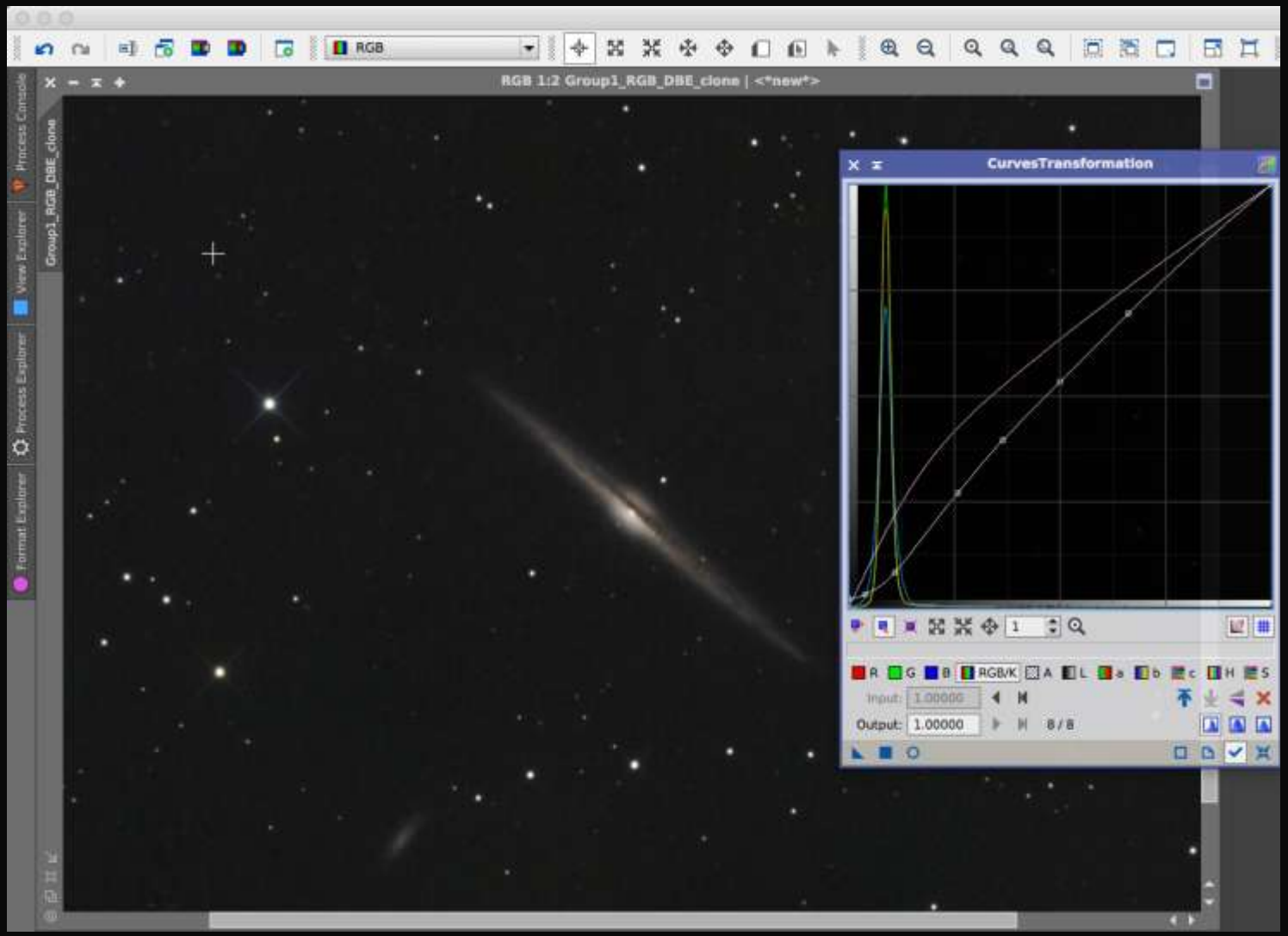
# Curves

- Curves permits simultaneous adjustment of
  - Brightness and contrast
  - Saturation
  - Individual RGB channels
  - CIE L*a*b* channels
  - Alpha channel (for PNG)

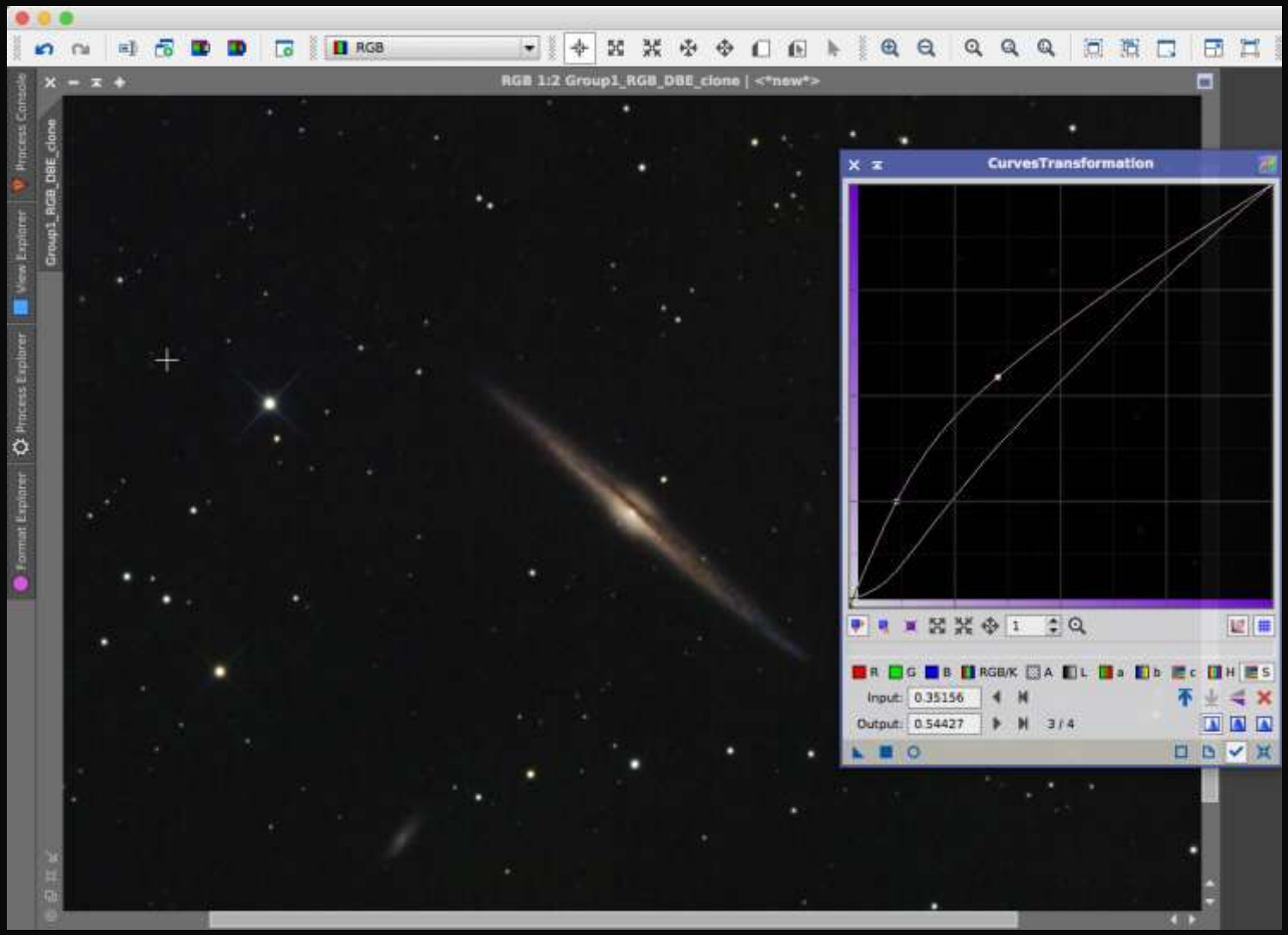
# Curves

- Brightness and contrast goals
  - Dark (but not black) background
  - Bright (but not white) highlights
  - All levels of brightness visible and distinct
  - Natural transitions from dark to light
- Saturation goals
  - Colors look natural (for RGB)
  - Color noise is not obvious
  - Background areas look neutral

# Curves


RGB
RGB 1:2 Group1_RGB_DBE_clone | <*new*>
Process Console
View Explorer
Process Explorer
Format Explorer
Group1_RGB_DBE_clone
CurvesTransformation
RGB/K
Input: 1.00000
Output: 1.00000
8 / 8

# Curves


RGB
RGB 1:2 Group1_RGB_DBE_clone | <*new*>
Group1_RGB_DBE_clone
CurvesTransformation
Input: 0.35156
Output: 0.54427
3 / 4

# Summary

- Only a few image processing steps are needed to get great images
- Correct gradients, balance color, and reduce noise before stretching
- Sharpen, smooth and adjust brightness, contrast and saturation after stretching
- Experiment with settings to see what happens

# What Else is There?

- Masks – limit processes to specific parts of an image
- Deconvolution – counteract atmospheric blurring
- MorphologicalTransformation – shrink or ‘fix’ stars
- Combine NB and RGB – make nebulae pop
- Synthetic L – make a luminance master from color or narrowband-filtered data
- PixelMath – limitless possibilities to combine images; great for making masks
- Painting – repair artifacts, improve masks, annotate images

# What Else is There?

- HDR methods – manage wide brightness ranges
- Multiscale methods – target large or small structures
- Image analysis – measure image characteristics
- Mosaic tools – create seamless multi-panel mosaics
- Color management – consistent colors on different devices
- Align color channels – fix alignment with ChannelMatch
- Enhance – target specific regions of an image
  - DarkStructureEnhance and BackgroundEnhance scripts
  - StarReduction script to shrink star sizes
  - ExponentialTransformation to boost signal in dim areas
- …and much more!

# Resources

- Inside PixInsight by Warren Keller
- Harry's Astroshed (free)
- LightVortexAstronomy.com (free)
- IP4AP.com (subscription)
- PixInsight Forum
- Astrodoc.ca
  - 'Articles' tab includes two *Sky &Telescope* articles on PI
  - Processing details with all images
  - On-line tutoring (private/group)


ip4ap.com, springer.com, amazon.com


Questions?