Processing of comet images: worked example

By Emmanuele Sordini, v 1.0 12 January 2026

Introduction

This document is a worked example of the article available at this link on my website, where it can be downloaded separately.

The underlying idea for "freezing" the comet in the background stars relies on the following principles:

- Remove the stars from the calibrated star-aligned frames, register them on the comet and process them to produce a stretched (L)RGB or OSC[1] image containing only the comet and no stars;
- Stack the star-aligned frames for the three R, G, B channels (or OSC), merge them, stretch them and remove the trailed comet leftover to yield a final star-only image;
- As a last step, blend together the images from the two previous steps, thus yielding the final image where both the comet and the background stars are not trailed.

The reader is assumed to already be familiar enough with PixInsight, so a lot of practical details are omitted. The starting point is a set of (L), R, G, B or OSC frames guided on the stars with an exposure time short enough not to show any noticeable trailing on the comet.

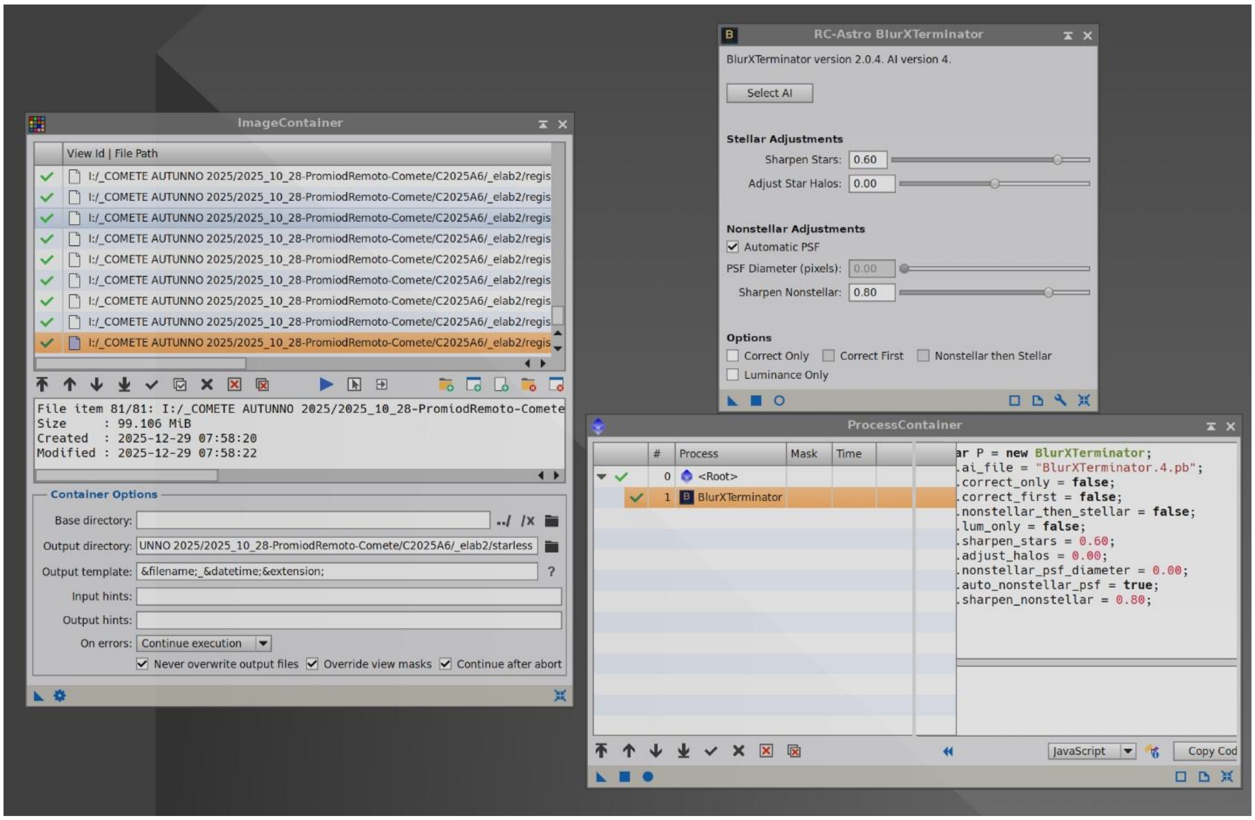
The example in this document uses a set of frames of comet C/2025 A6 (Lemmon) acquired in late October 2025 from Aosta Valley (Italy) through a 10-inch RC reduced down to 1400 mm, a Touptek 2600M CMOS camera and an Optolong filter set. Due to the optical train's limitations and the comet's low altitude, the frames suffer from defects such as gradients and background unevenness which, however, can be tamed quite effectively.

The procedure is simplified for OSC cameras, as all the steps required for the individual channels can be omitted.

[1] OSC = One-Shot Color, i.e. cameras with color sensors, including DSLR and mirrorless cameras.

Detailed steps

1. Firstly, let's take the (still linear) frames and register them (all channels together) with StarAlignment. This step is generally automated in WBPP[2].
2. **Optionally**, we can turn up the contrast of the frames with BlurXterminator (default settings) and a ProcessContainer:



3. Subsequently, we strip all frames (all channels) with StarXterminator and ProcessContainer. The "Generate Star Image" tickbox is **deselected[3]**.

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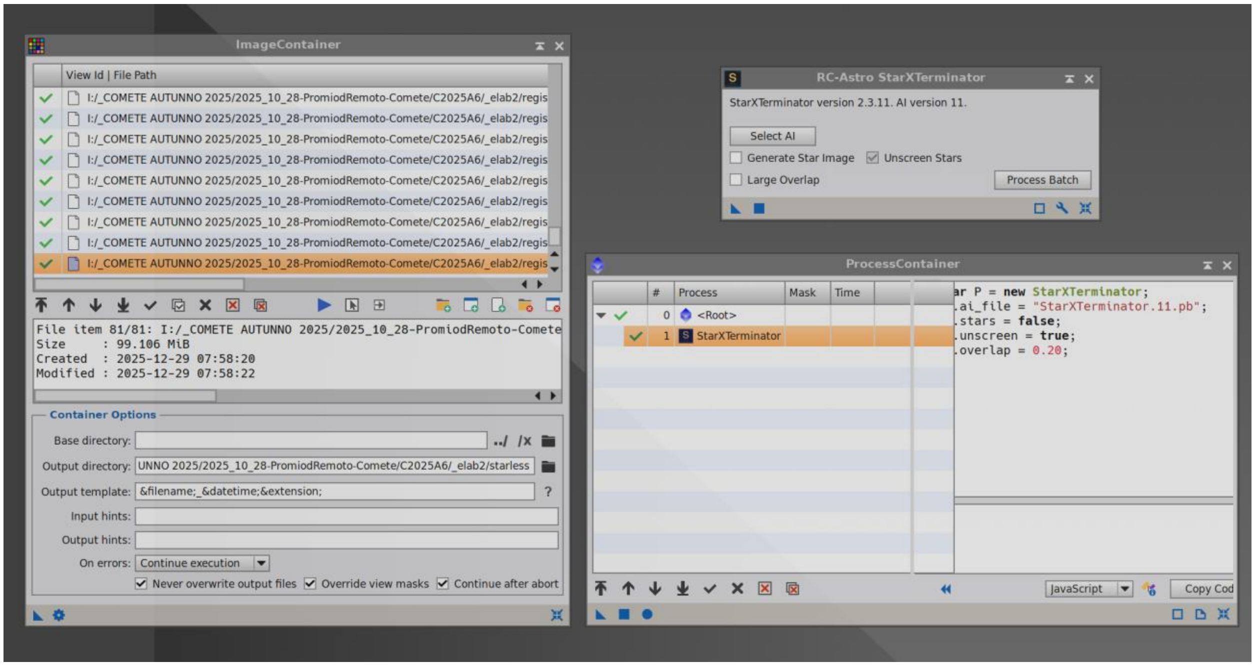
[2] Weighted Batch Pre-Processing

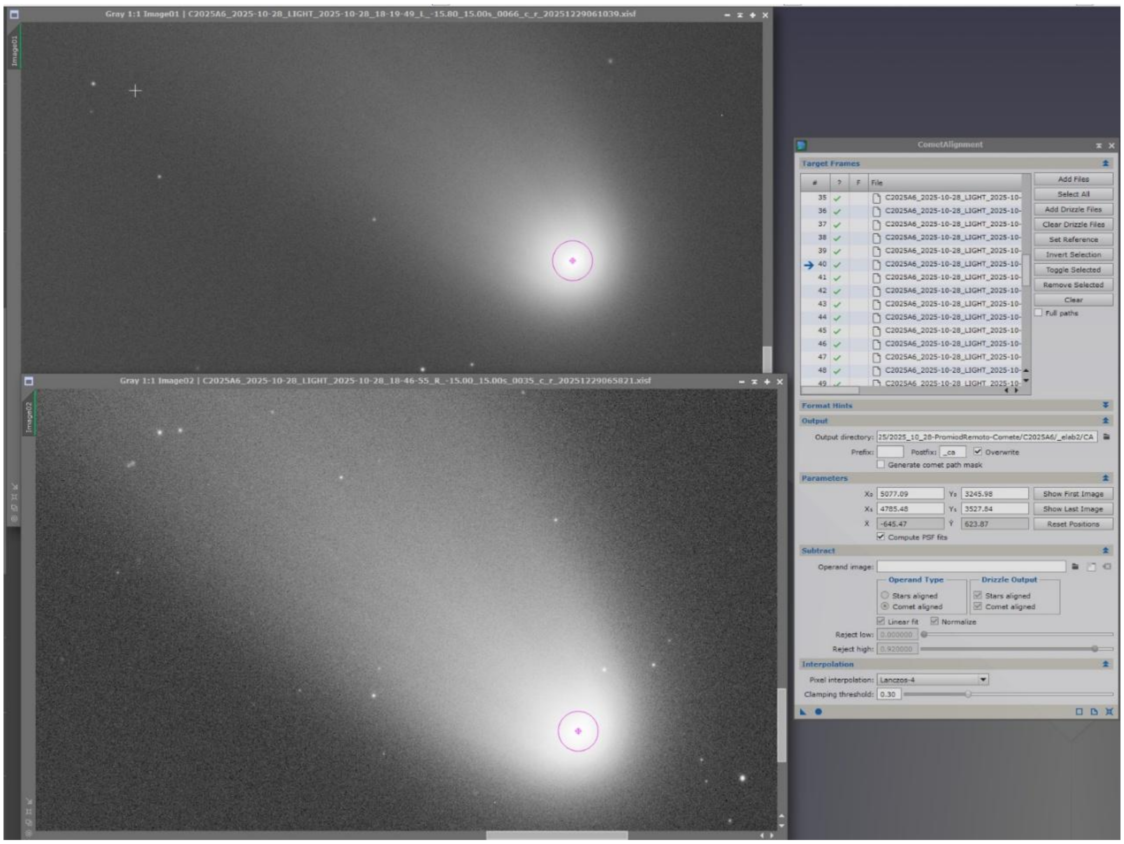
[3] In this step we just need to remove the stars, as a star-only image will be produced at a later stage in this procedure.



Comet-only processing

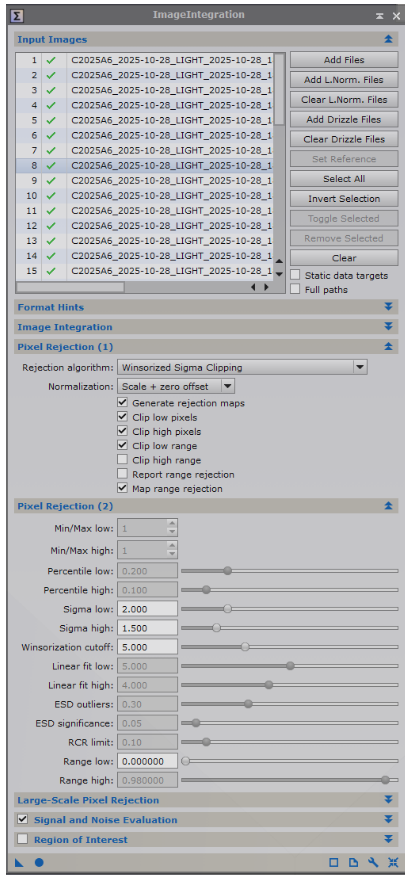
4. Align all starless frames via CometAlignment, pinning the comet's position for the start and end frames and picking a frame about halfway into the sequence as the alignment reference[4].

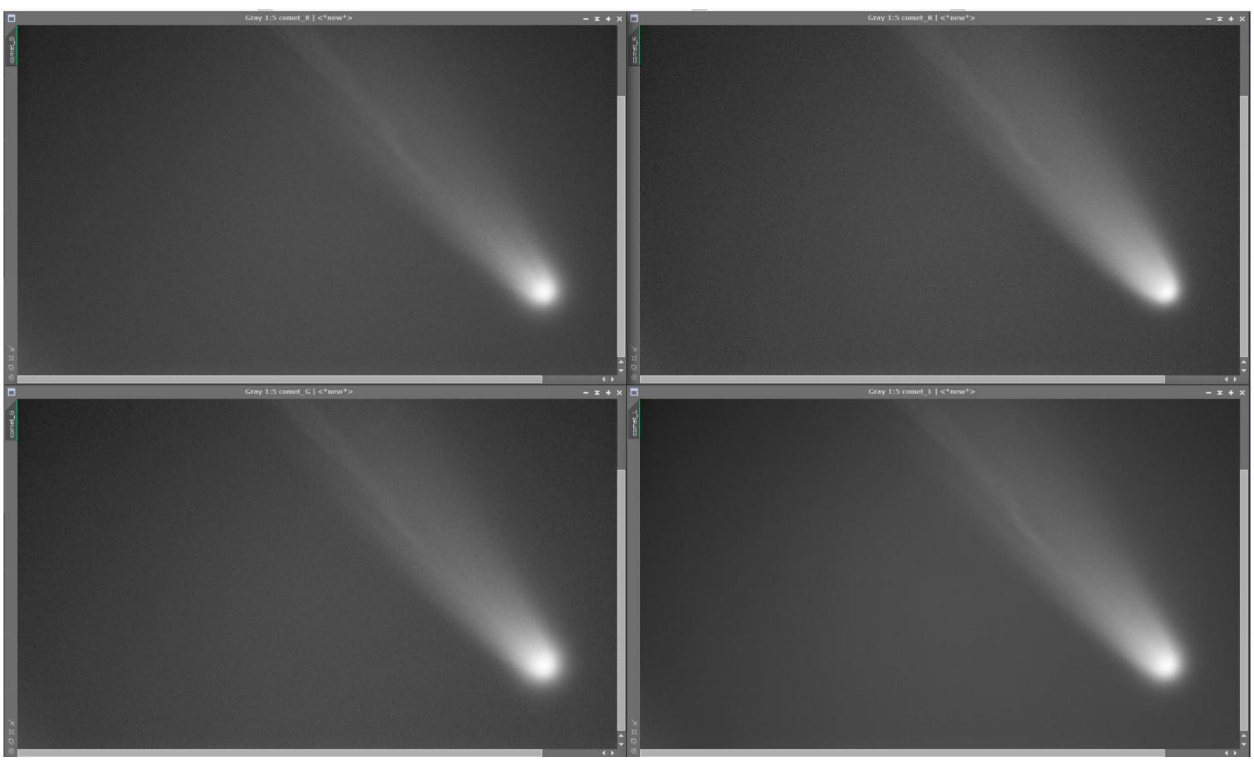
[4] The example contains 81 frames and we chose #40 as the alignment reference.



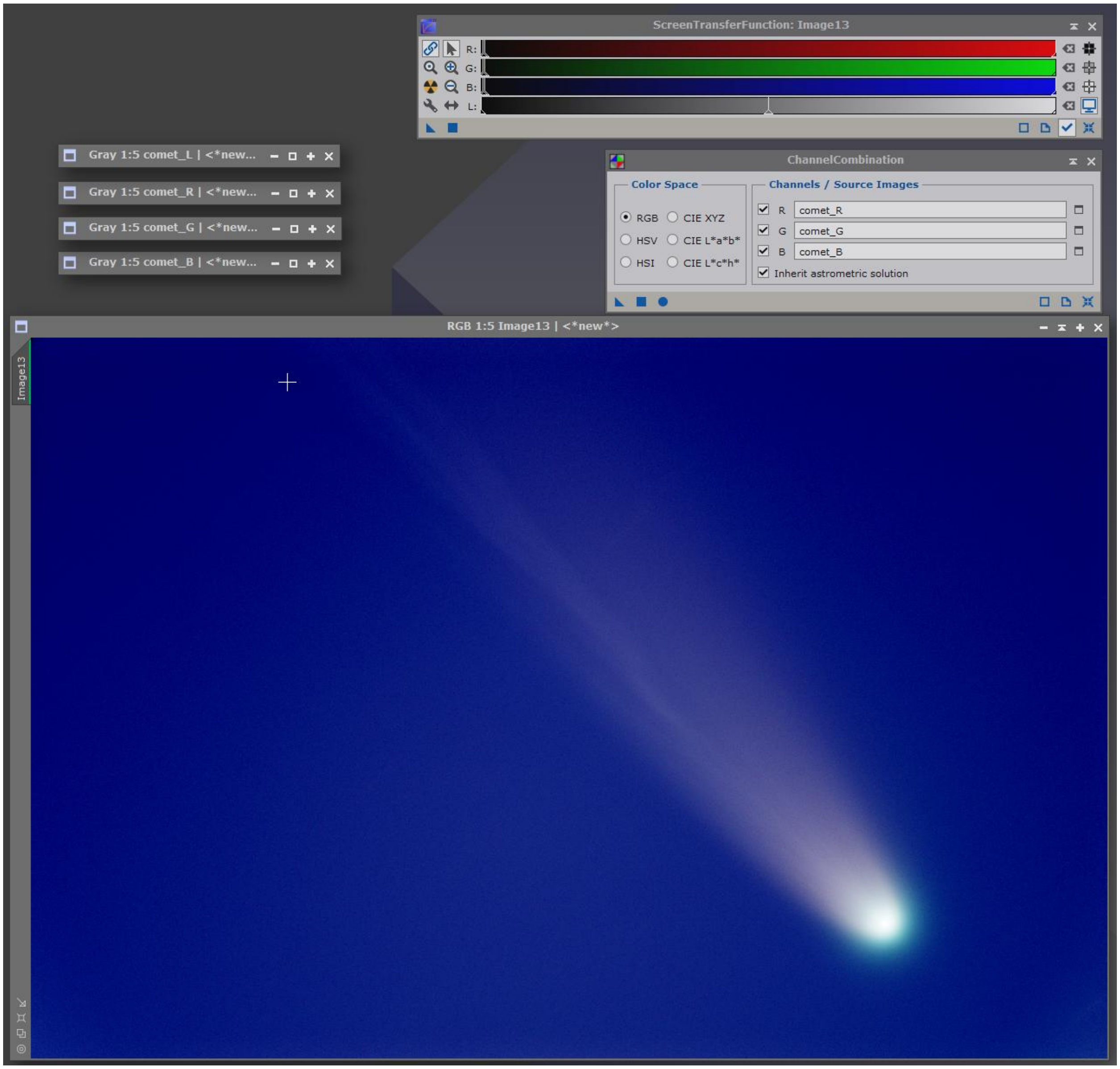
5. If a camera mono was used, we stack the frames separately for each channel with ImageIntegration. Settings: Winsorized Sigma Clipping, Sigma High = 2 , Sigma Low = 1.5[5]. This yields three (or four) individually stacked frames:

[5] The reason for these values (way lower than the default) is to perform a very selective pixel rejection to clean the background from any traces of stars as much as possible. Winsorized Sigma Clipping is ideal for stacking at least 10 to 15 frames. With fewer frames, you may want to try other algorithms such as Percentile Clipping, making sure that rejection parameters are about half the default or lower for increased selectivity.

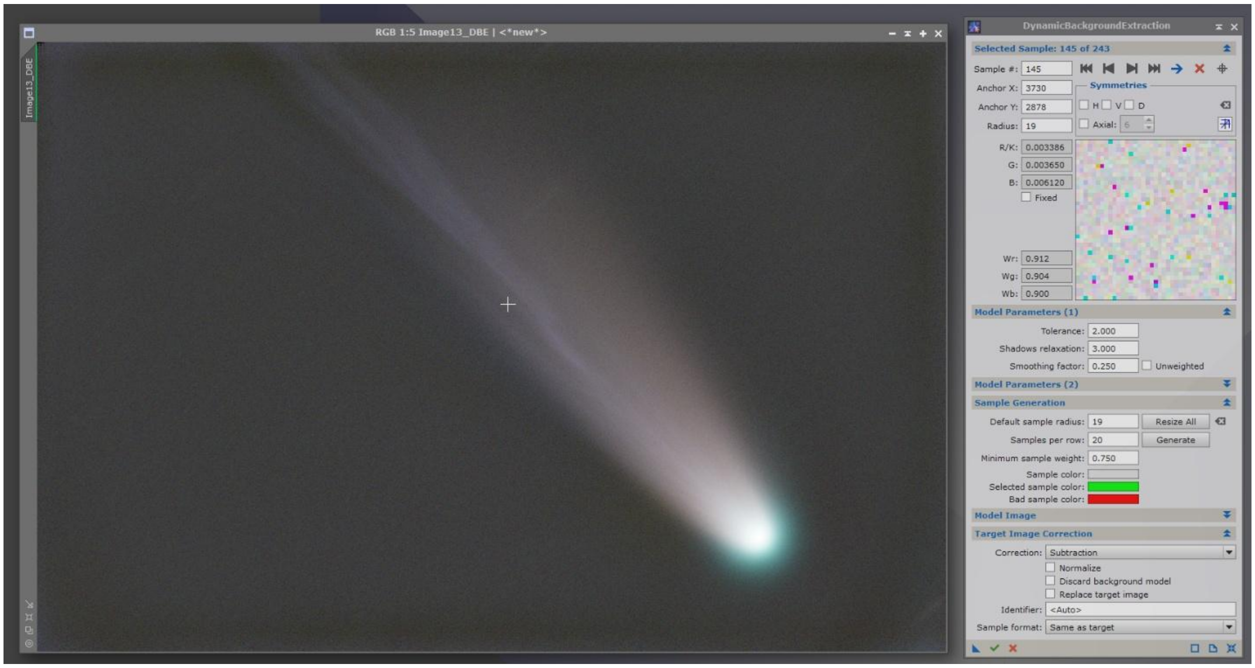

ImageIntegration
Input Images
C2025A6_2025-10-28_LIGHT_2025-10-28_1
Add Files
Add L.Norm. Files
Clear L.Norm. Files
Add Drizzle Files
Clear Drizzle Files
Set Reference
Select All
Invert Selection
Toggle Selected
Remove Selected
Clear
Static data targets
Full paths
Format Hints
Image Integration
Pixel Rejection (1)
Rejection algorithm: Winsorized Sigma Clipping
Normalization: Scale + zero offset
Generate rejection maps
Clip low pixels
Clip high pixels
Clip low range
Clip high range
Report range rejection
Map range rejection
Pixel Rejection (2)
Min/Max low: 1
Min/Max high: 1
Percentile low: 0.200
Percentile high: 0.100
Sigma low: 2.000
Sigma high: 1.500
Winsorization cutoff: 5.000
Linear fit low: 5.000
Linear fit high: 4.000
ESD outliers: 0.30
ESD significance: 0.05
RCR limit: 0.10
Range low: 0.000000
Range high: 0.980000
Large-Scale Pixel Rejection
Signal and Noise Evaluation
Region of Interest

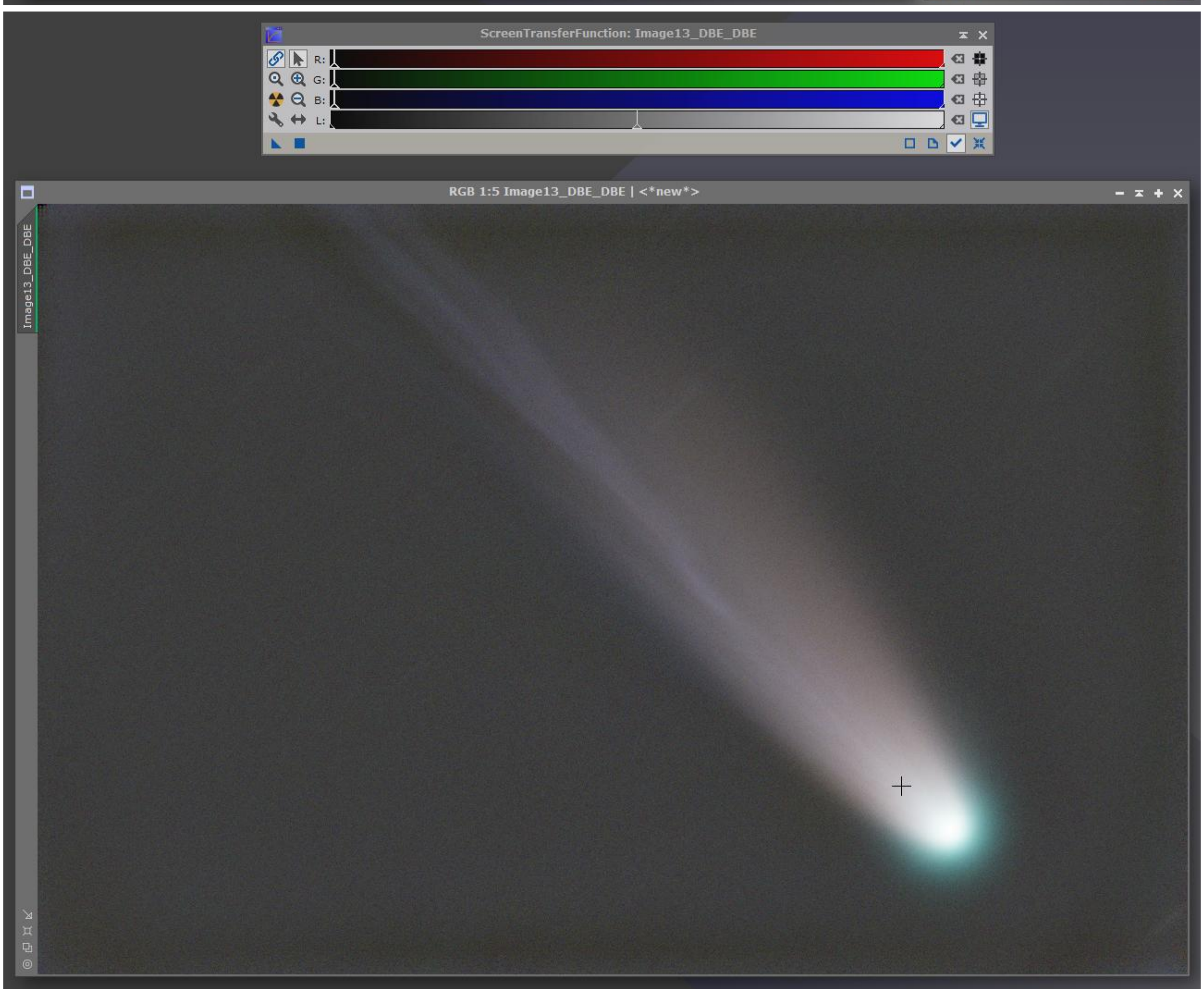


6. Let’s take the three comet-only R, G and B channels and put them together with ChannelCombination. The result will most likely not have a neutral background that is hard to balance correctly as no stars are available. This issue can be solved by using BackgroundNeutralization or DBE, which will most often remove the gradients and neutralize the background:

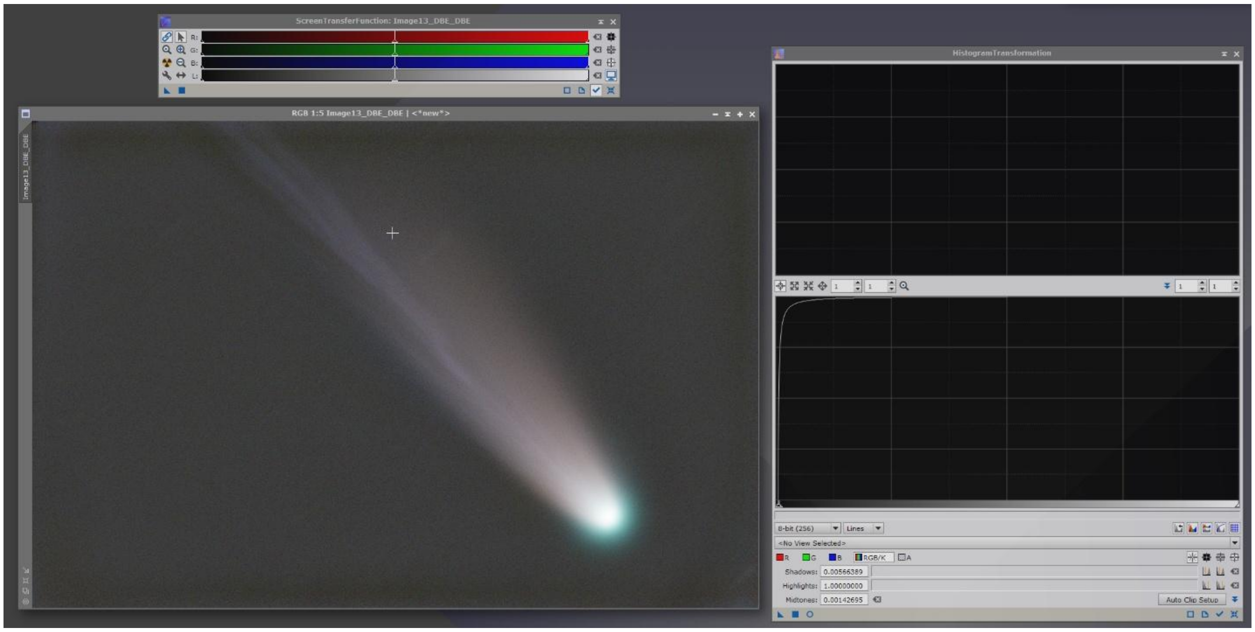


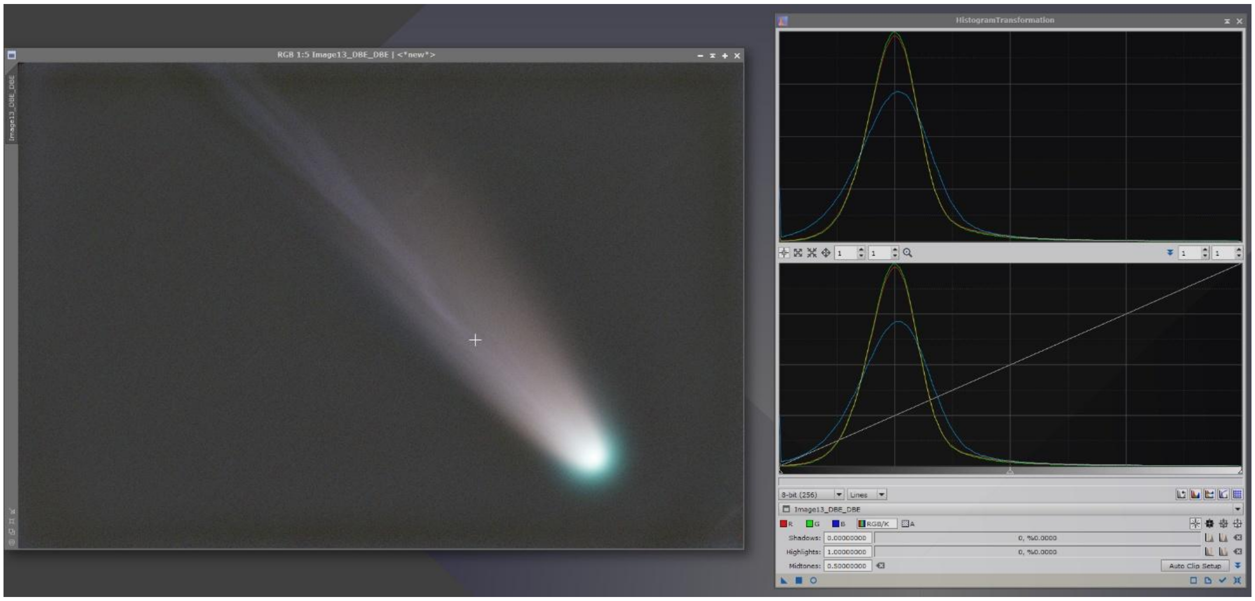
7. Depending on the background sky, one or more DBE iterations might be needed. In doing so, one should make sure to place the gradient samples around (and **not** on) the comet. The result will generally be quite pleasing (the image is still linear at this stage):


RGB 1:5 Image13_DBE | <*new*>
Image13_DBE
DynamicBackgroundExtraction
Selected Sample: 145 of 243
Sample #: 145
Anchor X: 3730
Anchor Y: 2878
Radius: 19
Symmetries
H V D
Axial:
R/K: 0.003386
G: 0.003650
B: 0.006120
Fixed
Wr: 0.912
Wg: 0.904
Wb: 0.900
Model Parameters (1)
Tolerance: 2.000
Shadows relaxation: 3.000
Smoothing factor: 0.250
Unweighted
Model Parameters (2)
Sample Generation
Default sample radius: 19
Resize All
Samples per row: 20
Generate
Minimum sample weight: 0.750
Sample color:
Selected sample color:
Bad sample color:
Model Image
Target Image Correction
Correction: Subtraction
Normalize
Discard background model
Replace target image
Identifier: <Auto>
Sample format: Same as target

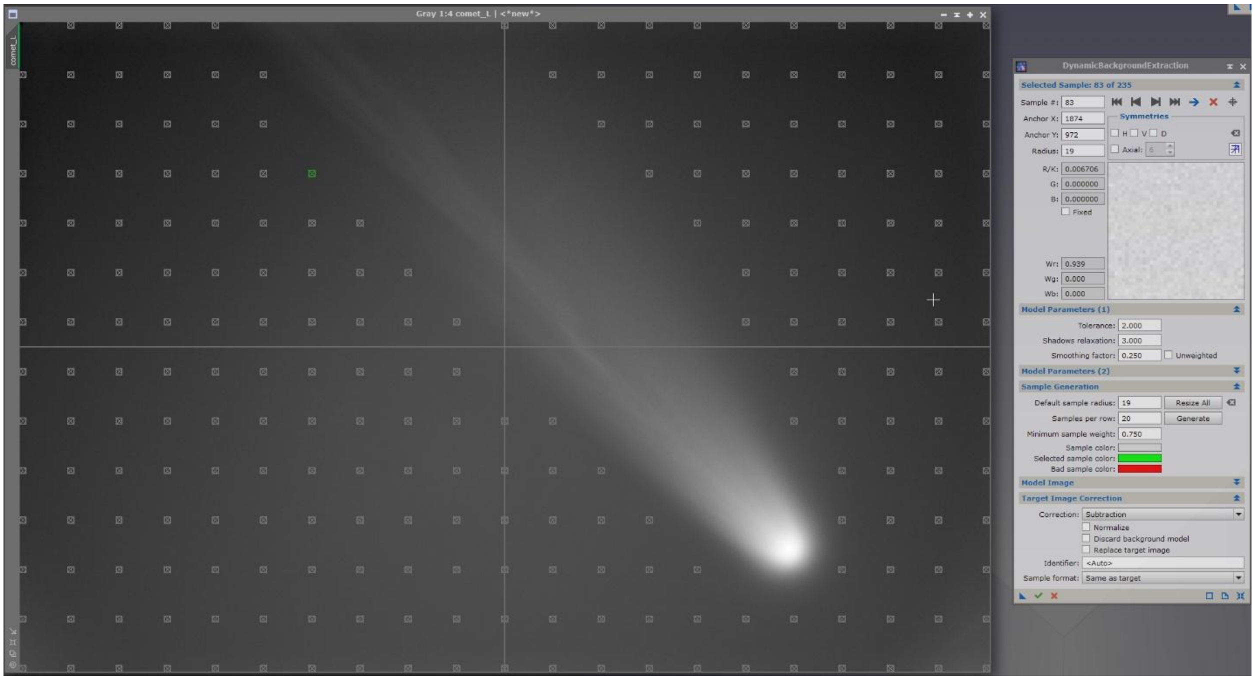

ScreenTransferFunction: Image13_DBE_DBE
R:
G:
B:
L:
RGB 1:5 Image13_DBE_DBE | <*new*>
Image13_DBE_DBE

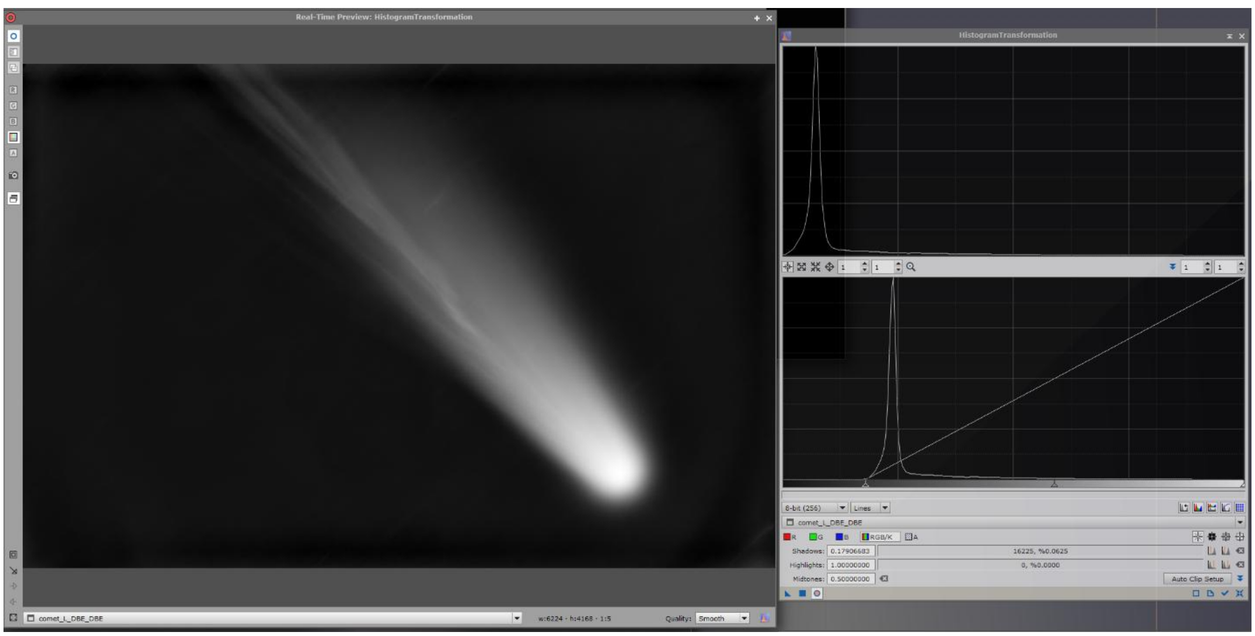
8. Now a **non-linear stretching** is performed on the image by using HistogramTranformation (HT): the stretching amount is discussed in more detail in step 10.





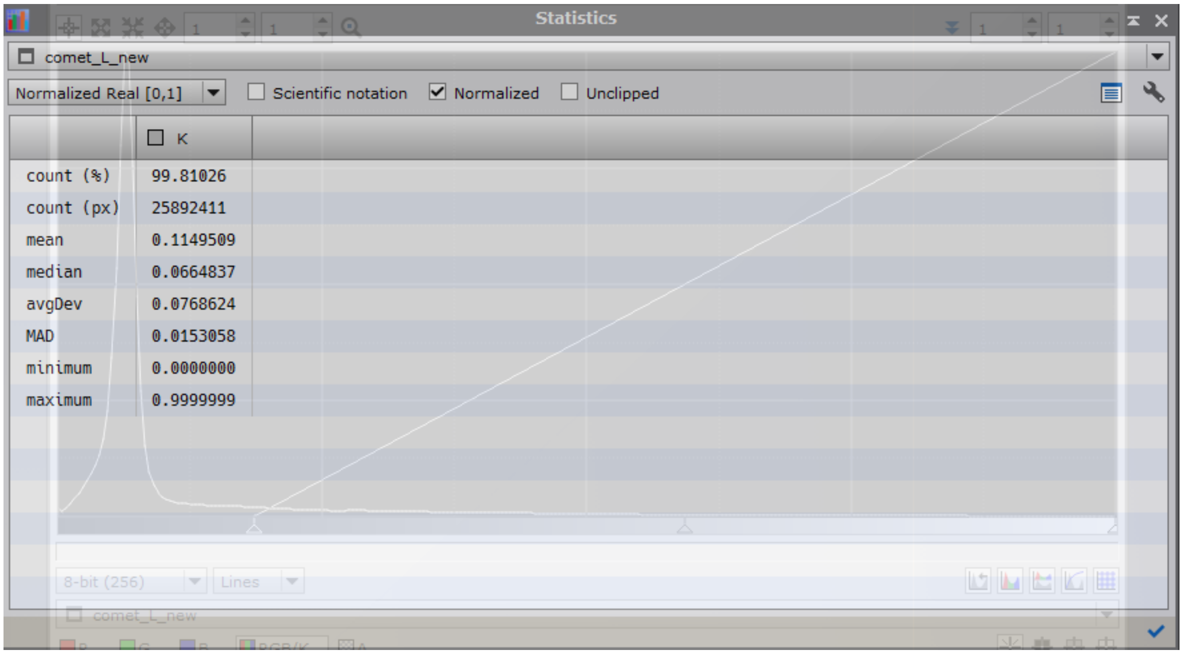
9. If the L channel was also acquired, it is processed similarly to the RGB image by applying DBE first, and then performing a non-linear stretching with HT:



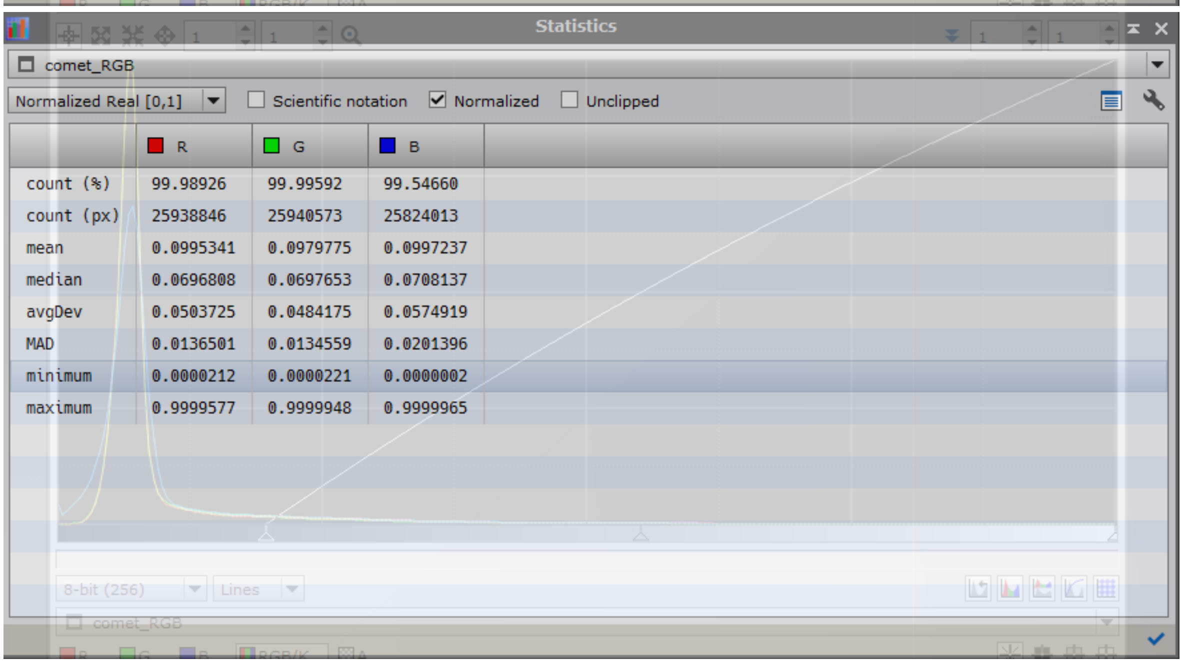


Unfortunately, residuals of trailed stars in the comet's tail are almost impossible to get rid of.

10. The stretching with HistogramTransformation has to be such that the background (**median**) values for the L channel and the three channels in the RGB image are comparable. This can be checked with the Statistics tools (in the figures below, values ranging from 0.066 to 0.71). Additionally, the comet must not be saturated.



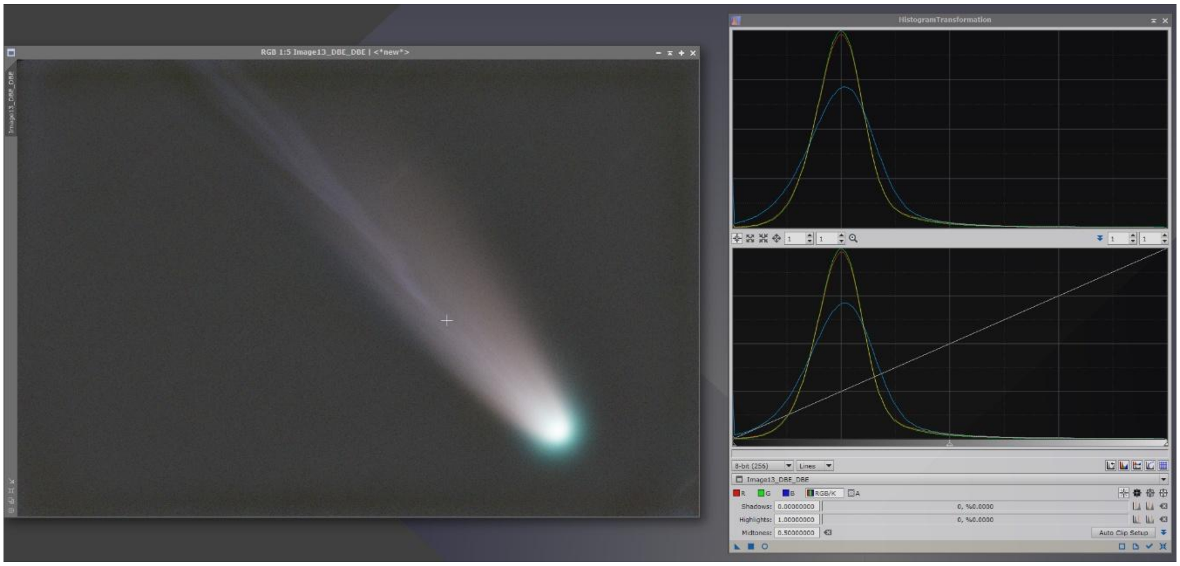
	K
count (%)	99.81026
count (px)	25892411
mean	0.1149509
median	0.0664837
avgDev	0.0768624
MAD	0.0153058
minimum	0.0000000
maximum	0.9999999

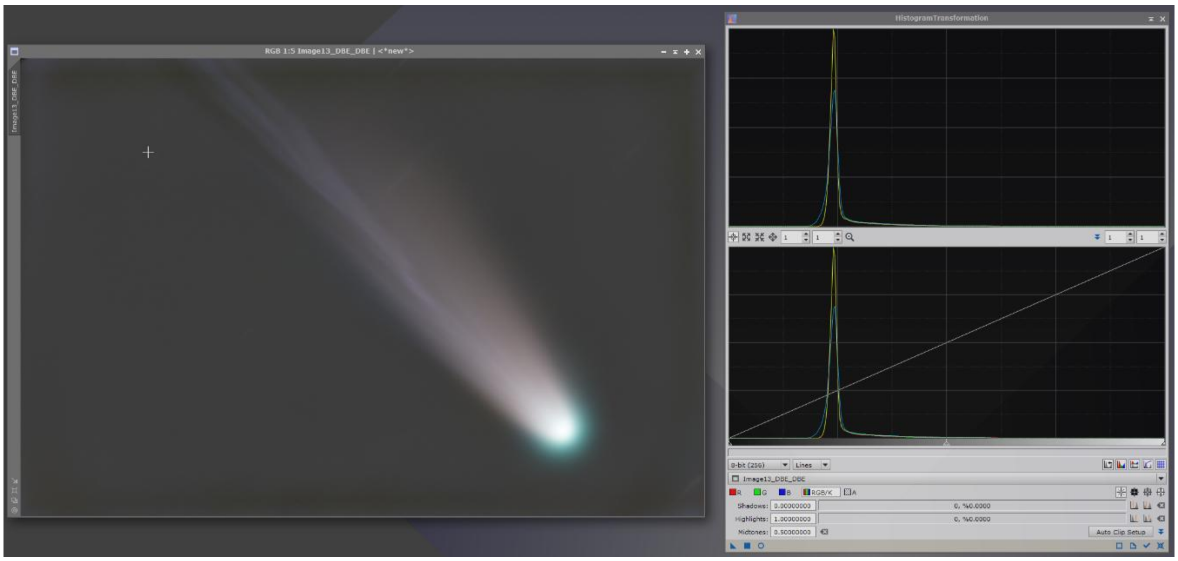


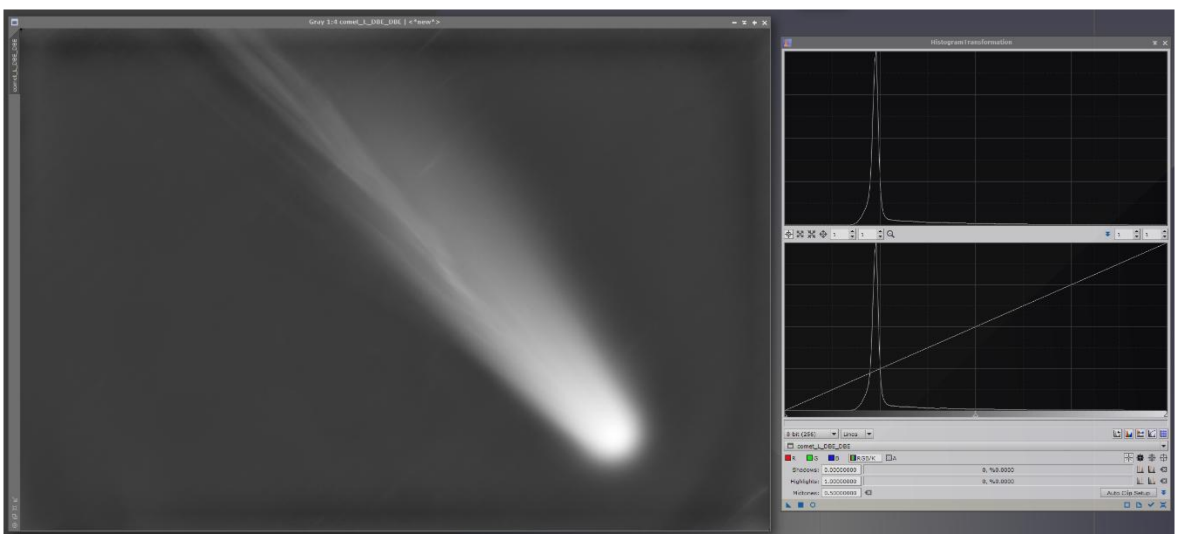
	R	G	B
count (%)	99.98926	99.99592	99.54660
count (px)	25938846	25940573	25824013
mean	0.0995341	0.0979775	0.0997237
median	0.0696808	0.0697653	0.0708137
avgDev	0.0503725	0.0484175	0.0574919
MAD	0.0136501	0.0134559	0.0201396
minimum	0.0000212	0.0000221	0.0000002
maximum	0.9999577	0.9999948	0.9999965

11. After de-linearization, the two L and RGB images can be blended together to produce the comet-only LRGB image. Before that, it is recommended to clean them from any residues of trailed stars through NoiseXterminator + CloneStamp. As can be seen in the L and RGB images below, this operation has the advantage of "flattening" and cleaning the background[6].

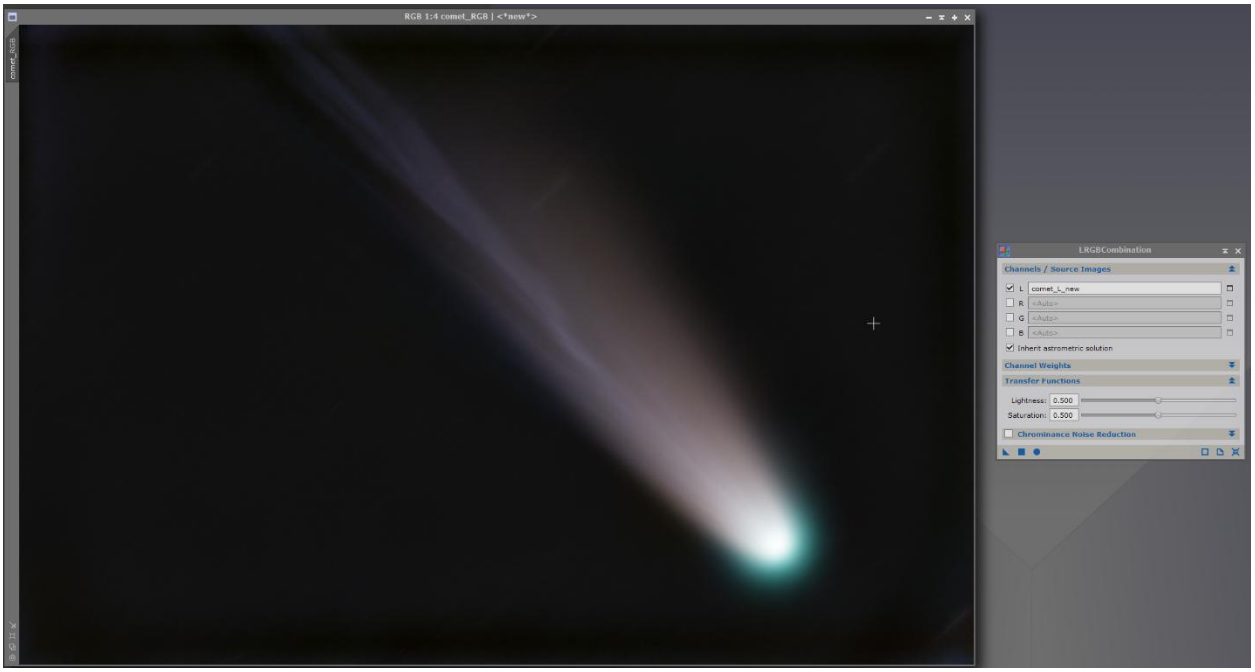
[6] The images processed with NoiseXterminator will have a much more compact and narrow histogram profile, thanks to the lower noise.


RGB 1:5 Image13_DBE_DBE | <*new*>
HistogramTransformation
Shadows: 0.00000000
Highlights: 1.00000000
Midtones: 0.50000000
Auto Clip Setup


RGB 1:5 Image13_DBE_DBE | <*new*>
HistogramTransformation
Shadows: 0.00000000
Highlights: 1.00000000
Midtones: 0.50000000
Auto Clip Setup

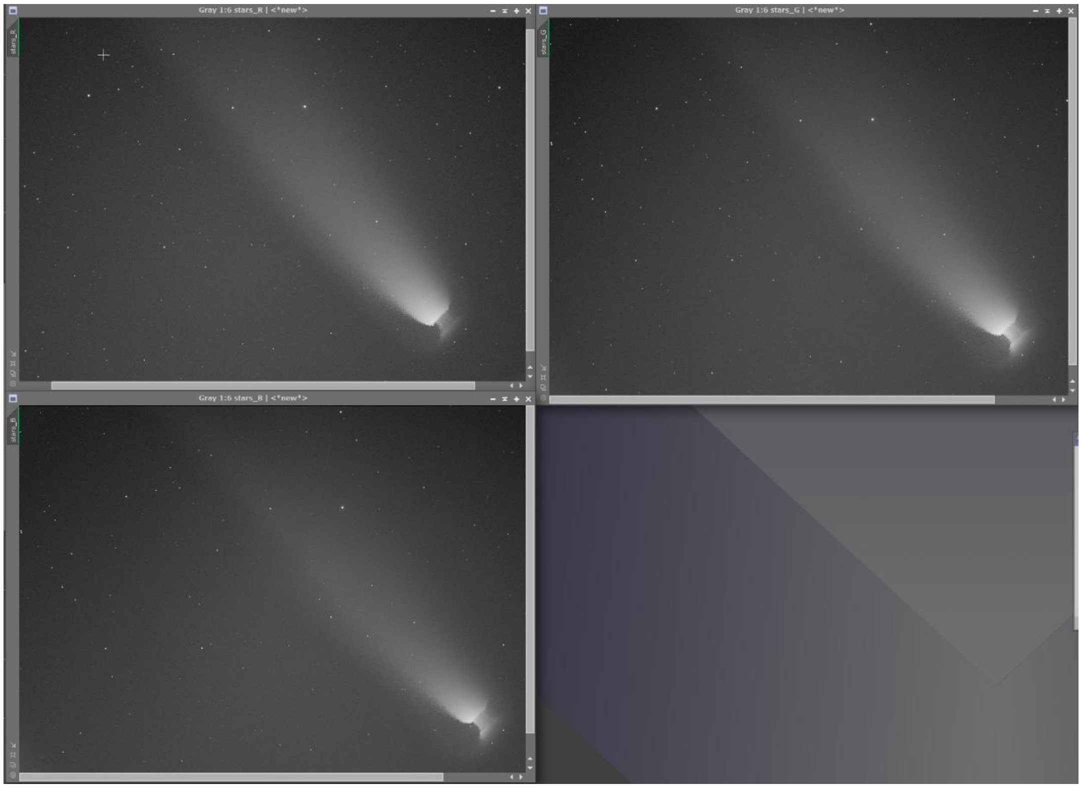

Gray 1:4 comet_L_DBE_DBE | <*new*>
HistogramTransformation

12. The two L and RGB images can now be blended together with LRGBCombination, thereby yielding the final comet-only image:

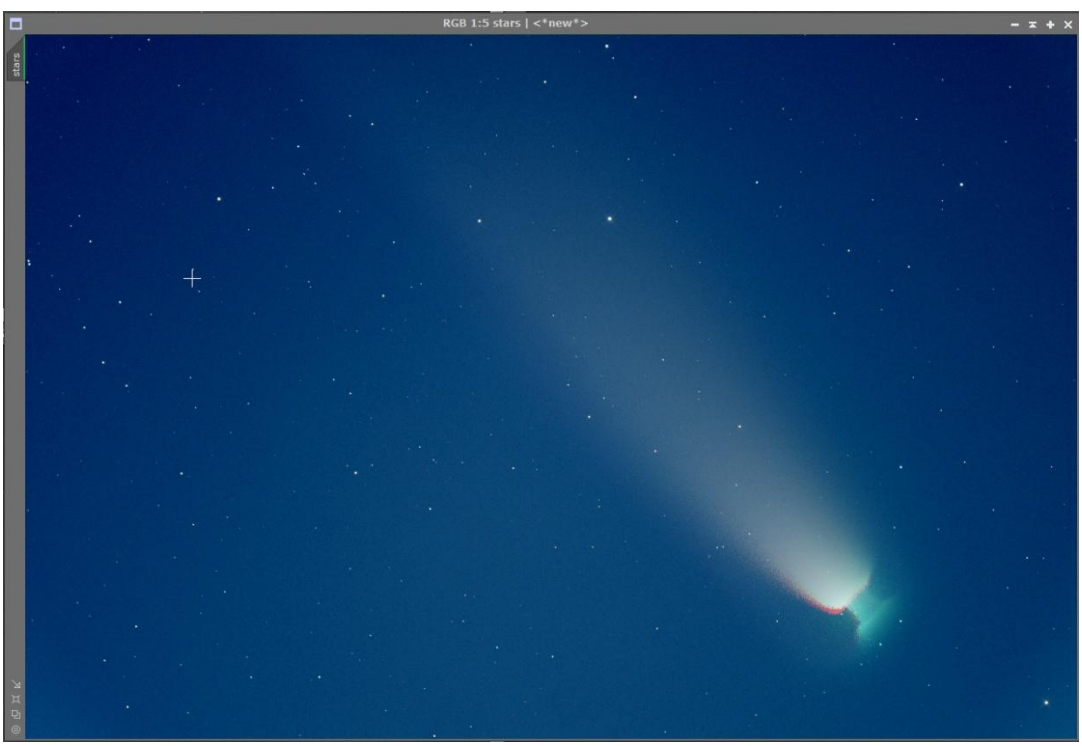


Processing the stars separately

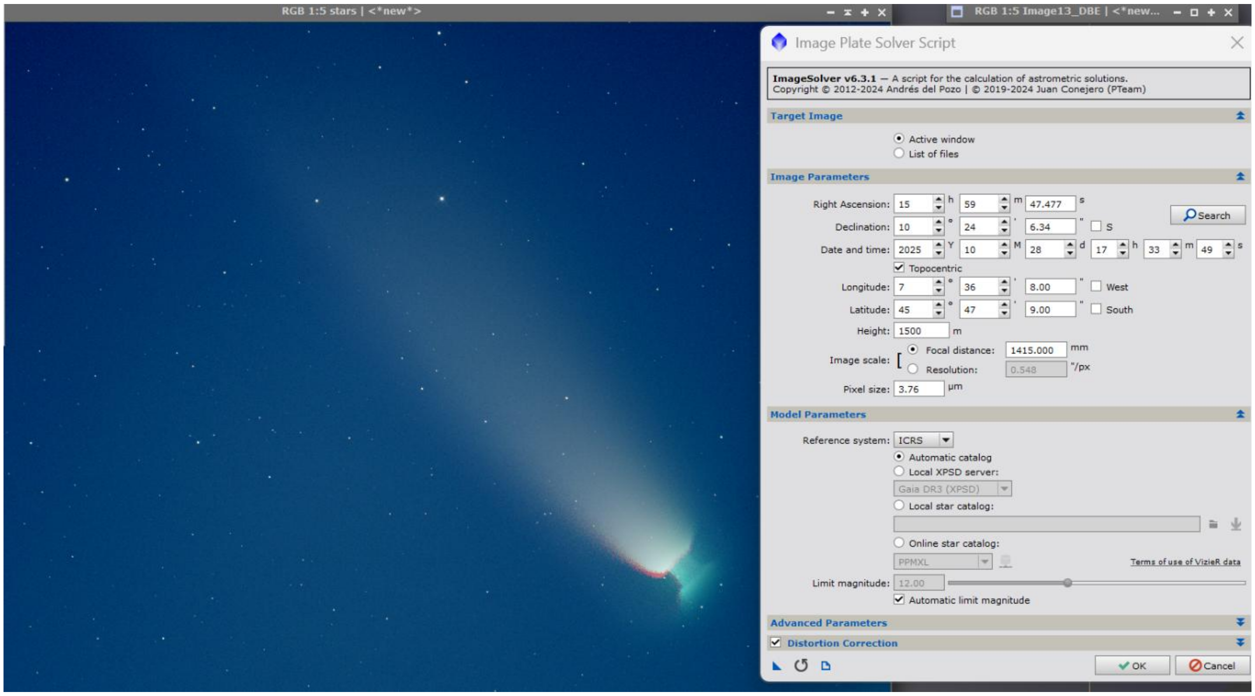
13. Let’s go back to the star-aligned frames (OSC or R, G and B only as L is not needed for the stars) and stack them with ImageIntegration to get one single OSC frame or three R, G e B star-aligned images, in which the comet will be inevitably trailed. As in step 5, a selective pixel rejection is also needed in this case.



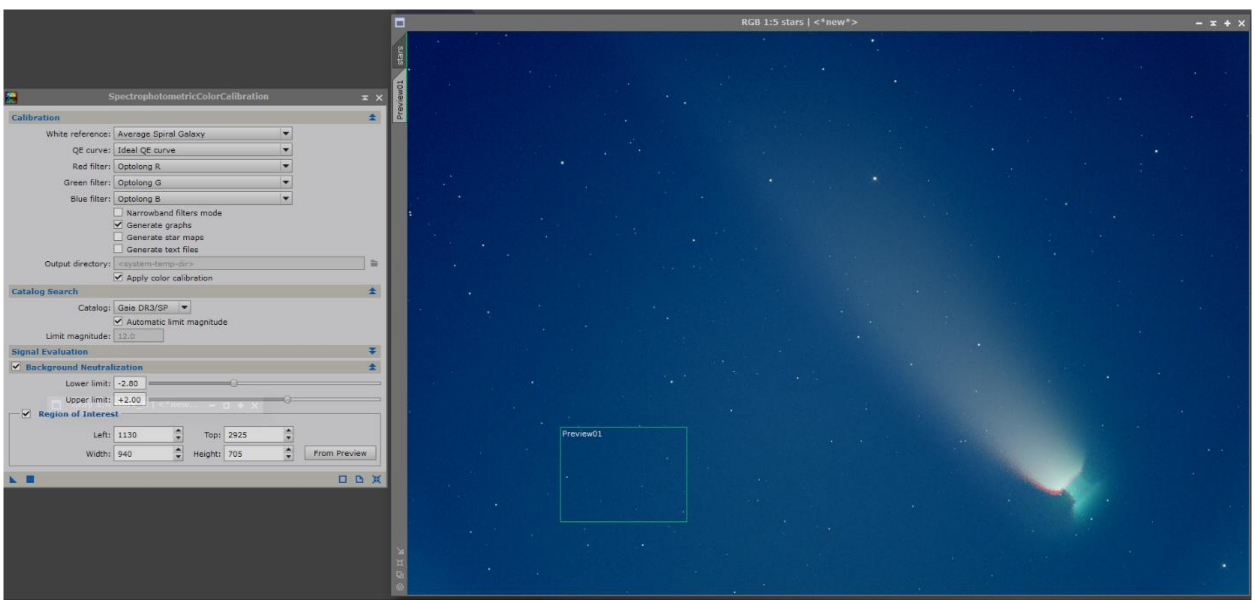
14. Let’s merge the three RGB channels with the stars and the trailed comet via ChannelCombination. This will most likely produce a linear RGB image plagued by color imbalance and gradients: if deemed necessary, it can be cleaned with DBE.



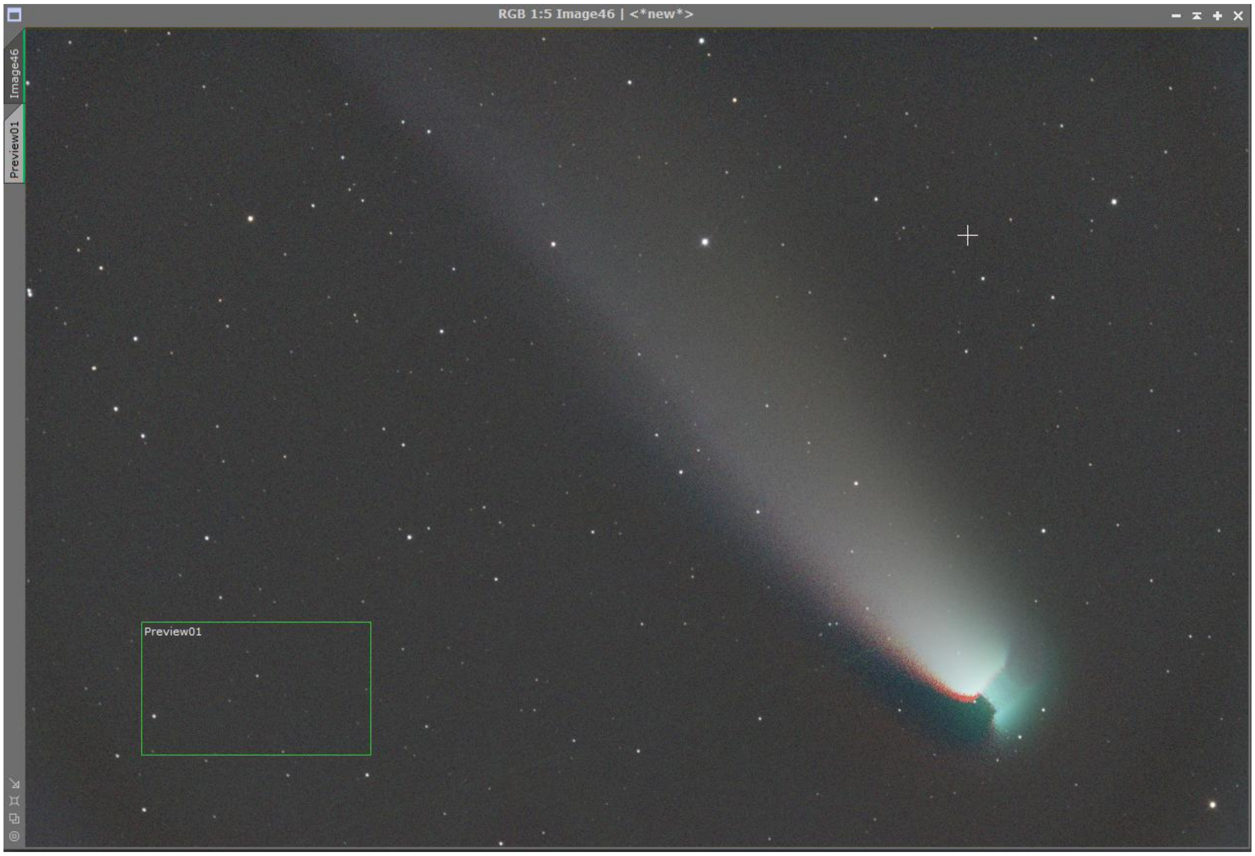
15. Let's now plate solve the image with the ImageSolver script:



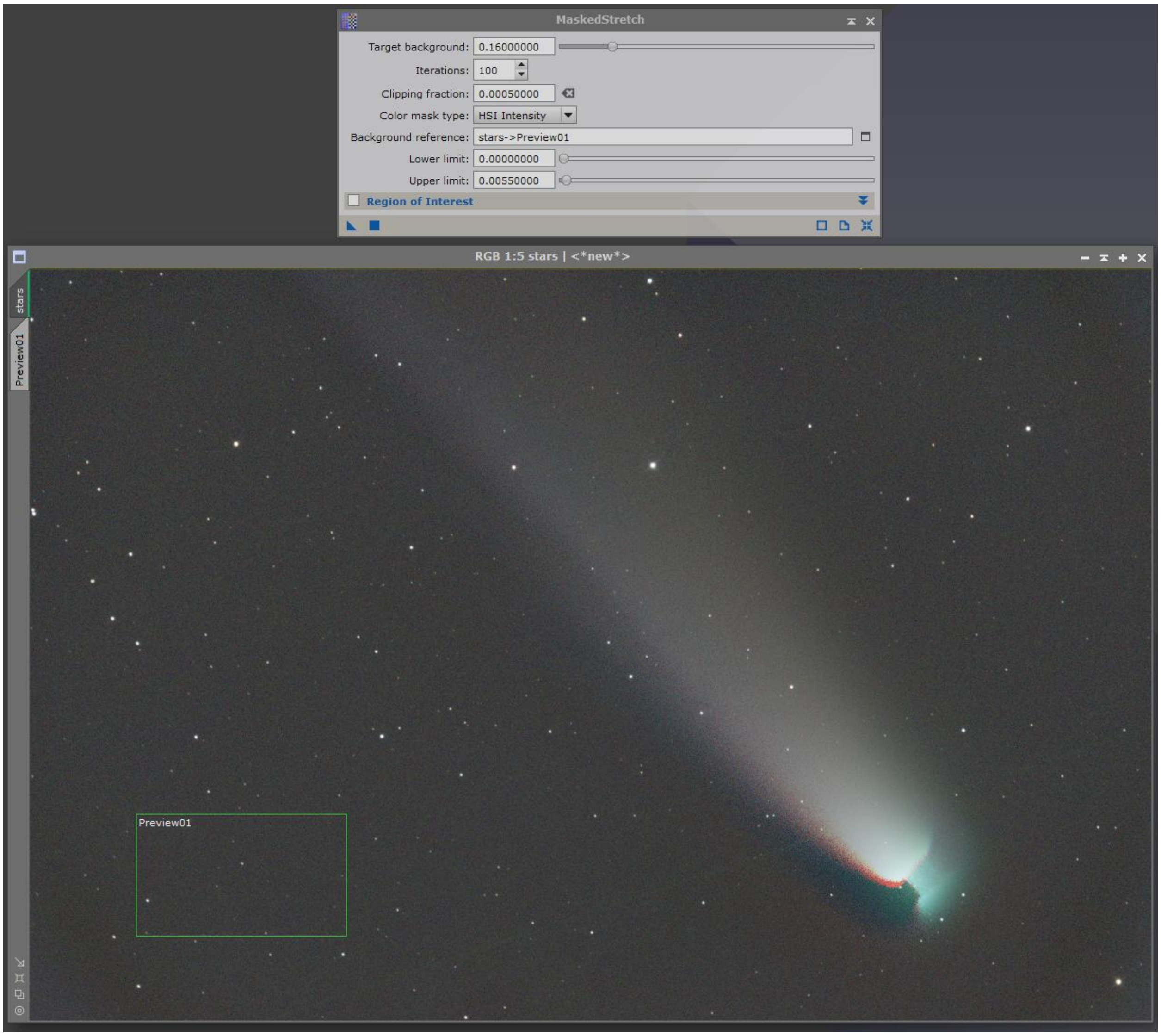
16. This RGB image also contains the stars, so it can be correctly balanced via SpectroPhotometricColorCalibration (SPCC):



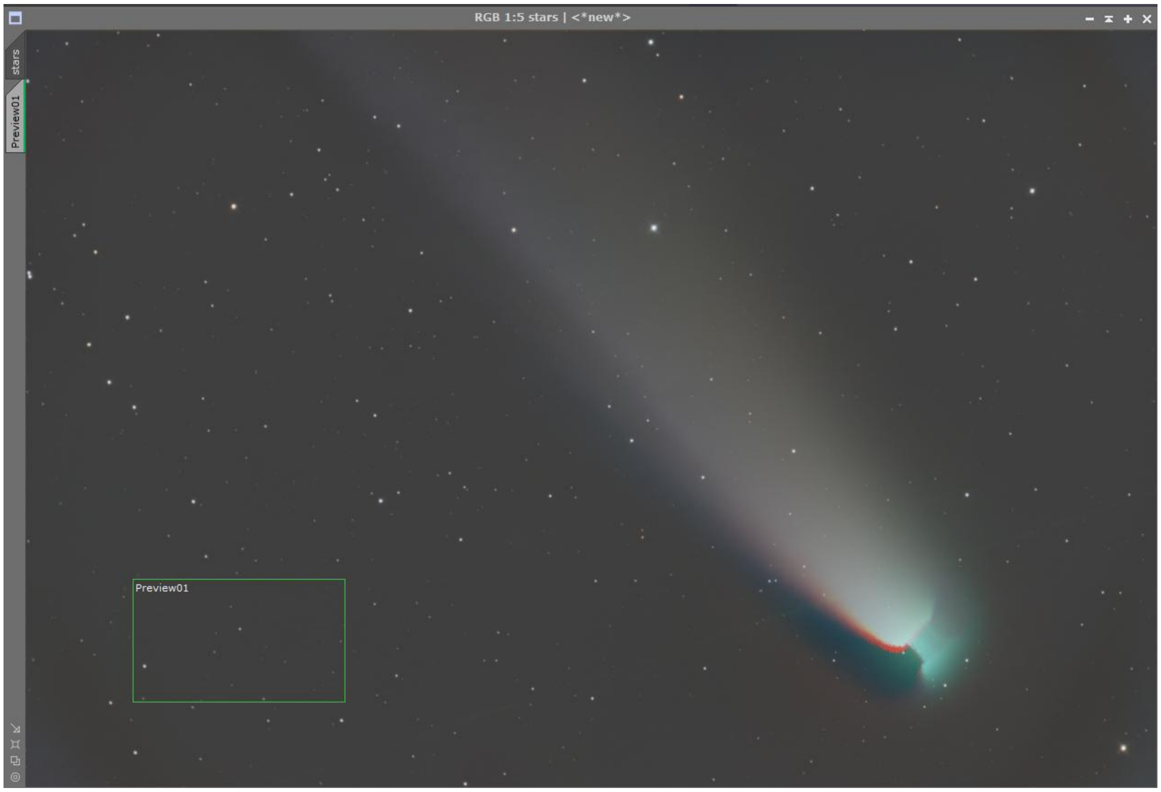
17. Here is the (still linear!) image with the RGB stars after gradient removal with DBE and proper calibration with SPCC:



18. We can now de-linearize the star image. I normally use a combination of MaskedStretch (which preserves star colors quite well) and HistogramTransformation, but this is just one of the possible alternatives.



19. It is advised to process the (now non-linear) image with NoiseXterminator, as this makes it easier to remove any comet residuals and create a star mask:

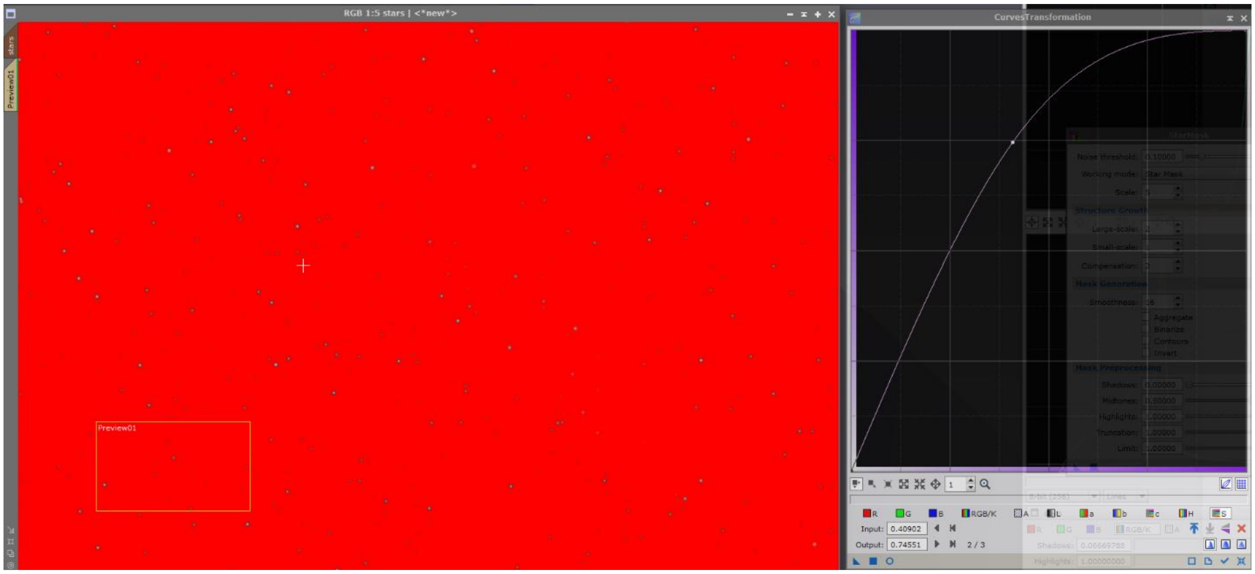


20. The resulting image is used to create a mask with StarMask. The mask may still contain traces of the comet (see figure below) which can be easily CloneStamp'ed (see following figure).


Gray 1:5 star_mask | <*new*>
star_mask


Gray 1:4 star_mask | <*new*>
star_mask

21. Now, let's apply the star mask to the image from step 18 and boost star saturation with CurvesTransformation by tweaking only the "S" (Saturation) curve:

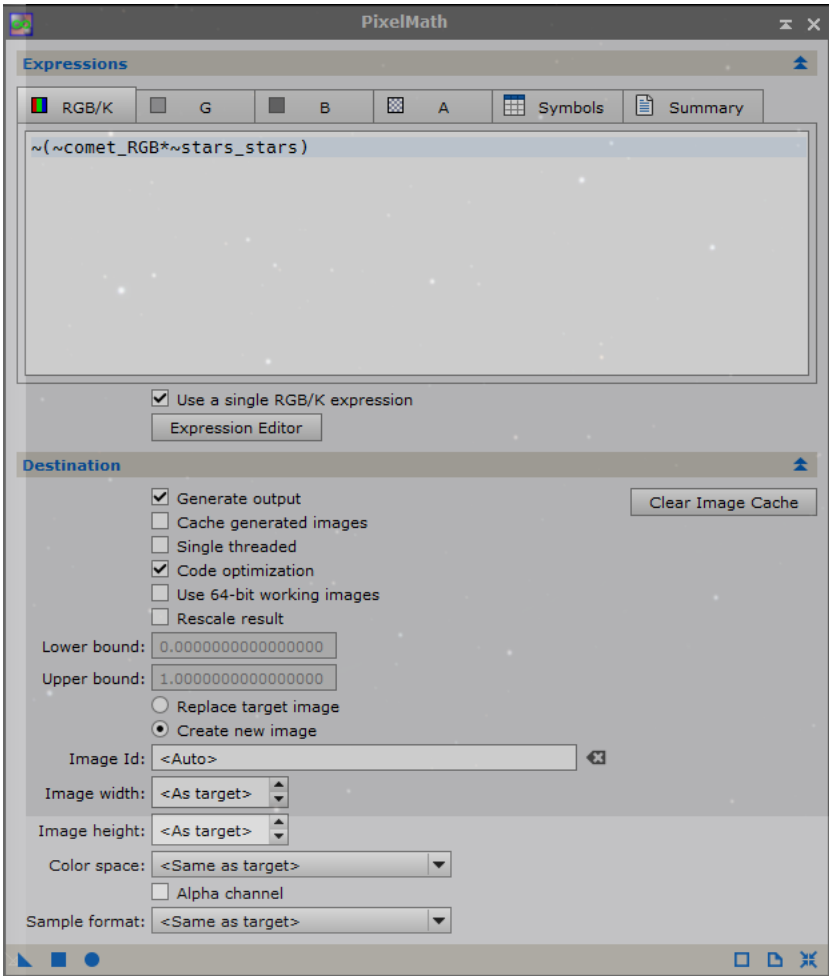


22. The star-only image can finally be processed with StarXterminator to separate the stars from the comet trace. Make sure the process is used with default settings and the "Generate Star Image" and "Unscreen Stars" boxes are both ticked.

Putting it all together

23. The two previous sections should have produced a comet-only (L)RGB image and a star-only RGB image:

24. The final merging is done in PixelMath. Assuming the comet-only image is called “comet” and the stars-only image is called “stars”, let’s type the following expression in the RGB/K textfield: **~(~comet*~stars)**



25. Here’s the image after the final touches (for example, cropping with DynamicCrop):

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