

# les rencontres du ciel et de l'espace

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# PixInsight

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# PixInsight : Qu'es aquò ?

Réponse rapide :

un logiciel de traitement d'images du ciel profond (et aussi planétaire)

Mais ce n'est pas que ça !

# Historique

- Créé par Juan Conejero (Espagne), programmeur professionnel et astrophotographe.
- Prédécesseur: SGBNR (réduction de bruit) en 2001.
- Le projet PixInsight a démarré en 2003.
- PixInsight LE (freeware limited edition) a été réalisé en 2004/2005.
- PixInsight Standard (Edition commerciale, architecture modulaire) a démarré en 2008 et toujours en évolution constante.

# Pourquoi PixInsight ?

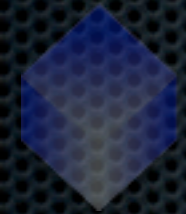
- Logiciel de traitement puissant
- Algorithmes mathématiques innovants et optimisés
- Contrôle total de tous les processus
- Environnement graphique évolué
- Plateforme de traitement d'image réalisé par des astrophotographes pour des astrophotographes

# Inside PixInsight ?

- Architecture modulaire et ouverte
- Développement : PixInsight Class Library
- Portabilité multi OS
- Données 8, 16, 32, 64 bits
- Interface graphique avec visu temps réel
- Gestion multi-processeur et RAM
- Gestion des profils de couleur ICC
- Scripts (Javascript), command line, PCL C++

# Portabilité multi OS

- Microsoft Windows XP/Vista/7 : 32 et 64 bits
- Mac OS X 10.6/10.7/10.8 : 32 et 64 bits
- Linux 32 et 64 bits
- Core application based on PCL and Trolltech's Qt framework
- PCL : librairie indépendante de l'OS et du hardware
- Parallel processing : gestion avancée des processeurs multi-coeurs et hyperthreading



# Dynamique réelle de 64 bits

- Unsigned Integers : 8-bit, 16-bit, 32-bit
- IEEE 754 Floating Point : 32-bit et 64-bit
- PCL support for complex-valued floating-point images
- Tous les processus peuvent travailler avec tous les types de données sans aucune distinction

12bit =	4 196
14bit =	16 384
16bit =	65 536
32bit =	4 294 967 296
64bit =	18 446 744 073 709 551 616

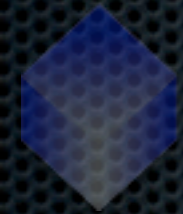
# Formats d'images supportés

- FITS : 8, 16, 32, 64 bits
- TIF : 8, 16, 32, 64 bits
- APN (RAW : librairie DC-RAW)
- formats graphiques 8 bits (BMP, JPEG, PNG, GIF,...)



# Principe mathématique

- **Traitement multi-échelle (multi-résolution)**
  - Décomposition du signal de départ en séparant à chaque niveau de résolution les basses fréquences (approximation) et les hautes fréquences (détails) du signal.
- **Traitement par ondelettes (algorithme à trous)**
- **Transformée de Fourier**
- **Déconvolution**
- **Masques**
- **Opérations linéaires (mathématiques)**



# Principe mathématique

- Alignement stellaire précis (jusqu'à 20% meilleur que les autres logiciels dédiés)
- Empilement optimisé selon différents algorithmes
- Algorithmes évolués de composition de mosaïques
- Fonction magique : HDR Multiscale Transform




















# Principe mathématique

- Outils paramétrables (répétables pour plusieurs images)
- Outils dynamiques (uniques à l'image sélectionnée)

# Gestion des couleurs

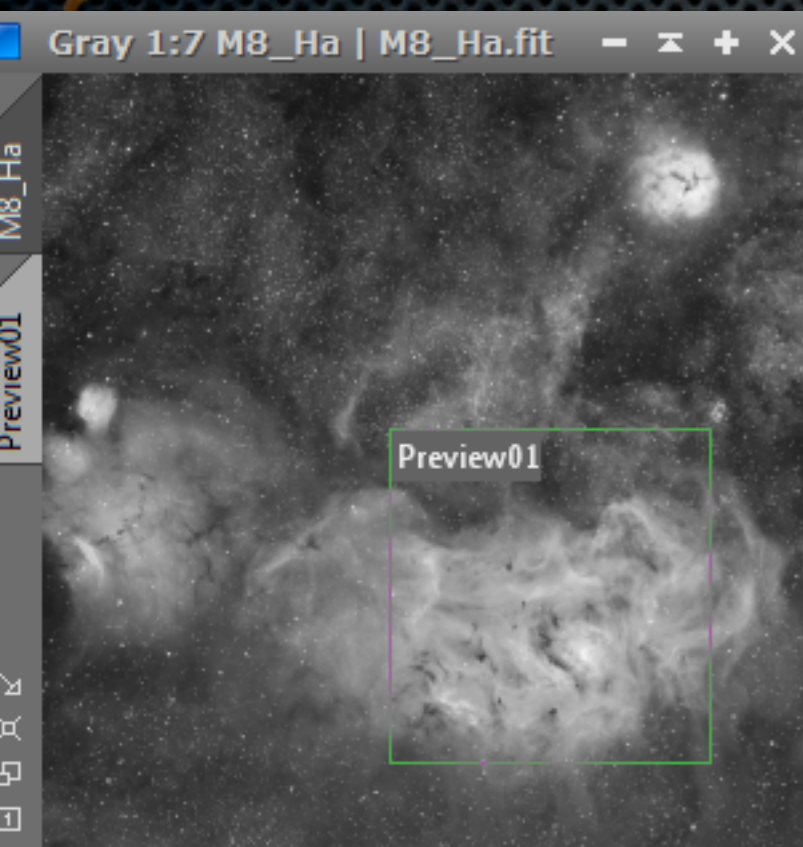
● Affichage

● Profils colorimétriques

	RGB
	Red
	Green
	Blue
	Lightness (CIE L*)
	CIE a*=R b*=G
	CIE L*=0.5
	CIE a*
	CIE b*
	CIE c*
	CIE h*
	CIE X
	Luminance (CIE Y)
	CIE Z
	Hue
	HSV Saturation
	HSI Saturation
	HSV Value
	HSI Intensity

# Sauvegarde des Process

- Process Icons
- Historique d'un traitement : icône
- Projets (incluant historique de chaque image)



	#	Proc Id	Mask
✓	0	<Root>	
✓	1	HistogramTransformation	
✓	2	HDRMultiscaleTransform	
✓	3	CurvesTransformation	
✓	4	MultiscaleMedianTransform	M8_Ha_clone
✓	5	ProcessContainer	
✓	5.1	HistogramTransformation	Mask <*broke
✓	6	CurvesTransformation	M8_Ha_clone
✓	7	ACDNR	~M8_Ha_clor
✓	8	CurvesTransformation	

```
/*  
 * Start time: 2012/09/21 06:32:56  
 * Execution time: 66.519 s  
 */  
var P = new HDRMultiscaleTransform;  
P.numberOfLayers = 8;  
P.numberOfIterations = 2;  
P.invertedIterations = false;  
P.overdrive = 0.000;  
P.medianTransform = true;  
P.scalingFunctionData = [  
  0.003906,0.015625,0.023438,0.015  
  0.015625,0.0625,0.09375,0.0625,0  
  0.023438,0.09375,0.140625,0.0937  
  0.015625,0.0625,0.00375,0.0625,0
```

# Ce qu'on n'y trouvera pas

- Fonctions artistiques
- Outils «clone» évolués
- Retouches locales
- Et plusieurs petites choses pourtant bien utiles...

# L'interface

# L'interface...

## Process

The screenshot shows the PixInsight interface. On the left is the 'Process Explorer' with a tree view of various processing tools. The 'HistogramTransformation' tool is selected. The main window displays the 'HistogramTransformation' reference documentation, including a table of contents and an introduction.

**Process Explorer**

- ATrousWaveletTransform
- BackgroundNeutralization
- ColorCalibration
- CurvesTransformation
- Deconvolution
- DynamicBackgroundExtraction
- DynamicCrop
- FastRotation
- HDRMultiscaleTransform
- HistogramTransformation**
- MorphologicalTransformation
- MultiscaleMedianTransform
- PixelMath
- ProcessContainer
- RGBWorkingSpace
- Resample
- SampleFormatConversion
- ScreenTransferFunction
- StarMask
- Statistics

**Reference Documentation: HistogramTransformation**

Implements pixel intensity transformations defined by histogram clipping and expansion points. [more]

**Categories:** IntensityTransformations

**Keywords:** histogram, histogram transformation, intensity transform

**Contents**

- Introduction
  - Histogram Generation
  - Histogram Transformations
  - Identity Histogram Transformations
- Description
- Usage
  - Input and Output Histograms
  - Understanding Independence on Selected Views
  - Histogram Editing Modes
  - Information Panel
  - Display Options
  - View Selection List
  - Channel Selection
  - Histogram Transformation Parameters
  - Clipped Pixel Counts
  - AutoClip Functions
  - Histogram Readout Modes
  - Interoperability with ScreenTransferFunction
  - Working with the Real-Time Preview Virtual View
- References
- Related Tools

**Introduction**

A **histogram** is a discrete representation of the distribution of values in the whole set of data points into a number of intervals and counts the Histograms are discrete functions usually represented in the form of

Applied to digital images, histograms are generated by remapping all range of discrete values, for example 256 values in an 8-bit histogram counter initialized to zero. Then for each pixel in the image, its value corresponding counter is incremented by one unit. The result of this is a list of integers representing the total number of existing pixels for

A histogram provides a wealth of information about an image and how available numeric range. Histograms are powerful tools for statistical image analysis, and the basis for many essential

## Console

The screenshot shows the 'Process Console' window with execution logs for the HistogramTransformation process. It details the reading of FITS files, MRS noise evaluation, scale factors, zero offsets, noise estimates, and weight. It also shows the integration of 11 images, pixel rejection counts, and the final Gaussian noise estimates and SNR increments.

```
Process Console
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-010bm.fit
Reading FITS: 16-bit integers, 1 channel(s), 2048x2048 pixels: 100%
MRS noise evaluation: done.
Scale factors : 0.99971
Zero offset : +3.051758e-05
Noise estimates : 3.238e-04
Weight : 1.00000
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-011bm.fit
Reading FITS: 16-bit integers, 1 channel(s), 2048x2048 pixels: 100%
MRS noise evaluation: done.
Scale factors : 1.00140
Zero offset : +3.051758e-05
Noise estimates : 3.238e-04
Weight : 1.00000

Integration of 11 images:
Pixel combination ..... average
Output normalization ..... none
Pixel rejection ..... Winsorized sigma clipping
Rejection normalization ... none
Rejection clippings ..... low=yes high=yes
Rejection parameters ..... sigma_low=4.000 sigma_high=4.000

* Using 2048 concurrent pixel stack(s) = 544.00 MB
Integrating pixel rows: 0 -> 2047: 100%

Pixel rejection counts:
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-001bm.fit
1 : 4482 0.107% ( 1476 + 3006 = 0.035% + 0.072%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-002bm.fit
2 : 4541 0.108% ( 1659 + 2882 = 0.040% + 0.069%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-003bm.fit
3 : 4479 0.107% ( 1663 + 2816 = 0.040% + 0.067%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-004bm.fit
4 : 4308 0.103% ( 1720 + 2588 = 0.041% + 0.062%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-005bm.fit
5 : 4201 0.100% ( 1697 + 2504 = 0.040% + 0.060%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-006bm.fit
6 : 4158 0.099% ( 1715 + 2443 = 0.041% + 0.058%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-007bm.fit
7 : 4389 0.105% ( 1831 + 2558 = 0.044% + 0.061%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-008bm.fit
8 : 4279 0.102% ( 1824 + 2455 = 0.043% + 0.059%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-009bm.fit
9 : 4274 0.102% ( 1776 + 2498 = 0.042% + 0.060%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-010bm.fit
10 : 4367 0.104% ( 1876 + 2491 = 0.045% + 0.059%)
/Volumes/HD2/AIP/concours 4559/Bias -35C bin 22 11 fichiers bruts/calib_Mar25-011bm.fit
11 : 4313 0.103% ( 1879 + 2434 = 0.045% + 0.058%)

Total : 47791 0.104% ( 19116 + 28675 = 0.041% + 0.062%)

MRS noise evaluation: done.
Computing noise scaling factors: done.

Gaussian noise estimates:
σs = 9.939e-05

Reference SNR increments:
Δσs0 = 1.6791

Average SNR increments:

Ready [Pause/Abort]
```



# L'interface...

The screenshot displays the PixInsight 1.7 x86\_64 interface with several windows and panels:

- Main Viewport:** Shows a large image of a nebula (IC 1848) in RGB 1:3 HAR\_RHAVB\_AIP format.
- Process Explorer:** A vertical panel on the left showing the processing steps: Format Explorer, Process Explorer, View Explorer, and Script Editor.
- Process Container:** A window showing a list of processes and their status. The 'MultiscaleMedianTransform' process is highlighted with a blue bar and a checkmark.
- CurvesTransformation:** A window showing a graph with multiple curves (red, green, blue, magenta) on a grid, used for color correction.
- ScreenTransferFunction:** A window showing the transfer function for the HAR\_RHAVB\_AIP image, with sliders for R, G, B, and L channels.
- Right Panel:** A vertical panel containing a list of processes and their parameters, including 'star\_mask', 'MIXSHO\_AIP\_DBE', 'MIXSHO\_AIP', 'dupliquer\_pour\_creeer\_un\_masque1', 'Histo\_sur\_mask1\_si\_petite\_etoile\_pas\_top', 'StarMask', 'Appliquer\_le\_mask', 'Deconvolution', 'dupliquer\_pour\_creeer\_un\_masque2', 'Histo\_sur\_mask2', 'Appliquer\_le\_mask2\_en\_inverse', 'reduction\_du\_bruit', 'Reduction\_Gradient\_et\_vignelage', 'Reduction\_fine\_des\_gradients', 'On\_Passe\_en\_Mode\_Non\_Lineaire', 'Histogramme', 'Star\_mask3\_et\_le\_mettre\_en\_inverse', 'Detail', 'Courbe', 'Detail\_Fin', 're\_courbe', 'reduction\_bruit\_finale', 'Creation\_image\_SHO', 'SHO\_V1', 'SHO\_V2', 'Ha\_en\_Luminance', 'courbe', and 'booster'.

#	Proc Id	Mask
0	<Root>	
1	CurvesTransformation	
2	ACDNR	
3	Deconvolution	star_mask
4	BackgroundNeutralization	
5	MultiscaleMedianTransform	~MASK
6	ICCPProfileTransformation	

```
/* Start time: 2012/10/18 10:25:46 UTC
 * Execution time: 17.735 s
 */
var P = new MultiscaleMedianTransform;
P.layers = [ // enabled, biasEnabled, bias, noise
[true, true, 0.000, false, 1.000, 1.00, 0.000],
[true, true, 0.050, false, 1.000, 1.00, 0.000],
[true, true, 0.050, false, 1.000, 1.00, 0.000],
[true, true, 0.000, false, 1.000, 1.00, 0.000],
[true, true, 0.000, false, 1.000, 1.00, 0.000]
];
P.scaleDelta = 0;
P.lowRange = 0.0000;
P.highRange = 0.0000;
```

# L'interface...

The screenshot displays the PixInsight 1.7 x86\_64 software interface. The main workspace is filled with a workflow graph of processing steps, including:

- PRETRAITEMENT\_FULL
- Generation des MASTER\_BIAS
- Calibration de TOUS les DARK et DARKFLAT avec MasterBias
- Generation des MASTER\_DARK... Repeter operation pour chaque serie de dark
- Generation des MASTER\_DARK\_FLAT... Repeter operation pour chaque serie de dark de flat
- Calibration des FLAT avec bias
- ou Calibration des FLAT avec dark et bias
- Generation des MASTER\_FLAT avec boite flat ou ciel clair
- Generation des MASTER\_FLAT avec ciel etoile
- Calibration des IMAGES BRUTES avec les masters
- Process COSMETICCORRECTION
- Alignement des IMAGES CALIBREES CC... Toutes images LRVB Narrow binning
- Preparation\_EMPLEMENT
- MOYENNE\_NO\_REJECTION de TOUTES les images calibrees alignees pour verifier le cadrage
- Si bandes noires sur les cotes
- Dynamic\_Crop
- ou\_CROP
- History\_Explorer\_Select\_Image\_Glisser\_Triangle\_sur\_bureau
- ImageContainer\_Add\_Files\_IMAGES\_ALIGNEES\_puis\_triangle\_a\_glisser\_dans\_icone\_process\_CROP
- MOYENNE\_No\_Rejection des images calibrees CROPEES par couleurs pour verifier le rapport signal\_bruit\_maximum
- EMPLEMENT\_FINAL Choisir\_methode\_selon\_nombre\_image\_et\_ajuster\_rejections... Repeter pour chaque couleur
- Empilement\_3a5\_images\_PERCENTILE\_CLIPPING
- Empilement\_3a10\_images\_AVERAGED\_SIGMA\_CLIPPING
- Empilement\_10a20\_images\_WINSORIZED\_SIGMA\_CLIPPING

On the right side, there is a vertical list of process icons labeled from Process27 to Process174. At the bottom right, a panel shows various mask and image files, including:

- RGB
- range\_mask
- star\_mask
- Mask
- PSF
- ngc4559\_L
- Lmask
- star\_repair
- Lmask
- Process80
- Process751
- initial\_crop\_and\_stretch
- star\_repair\_mask
- HDR
- CLAHE
- star\_repair
- final\_stretch

Two preview windows are open at the bottom left:

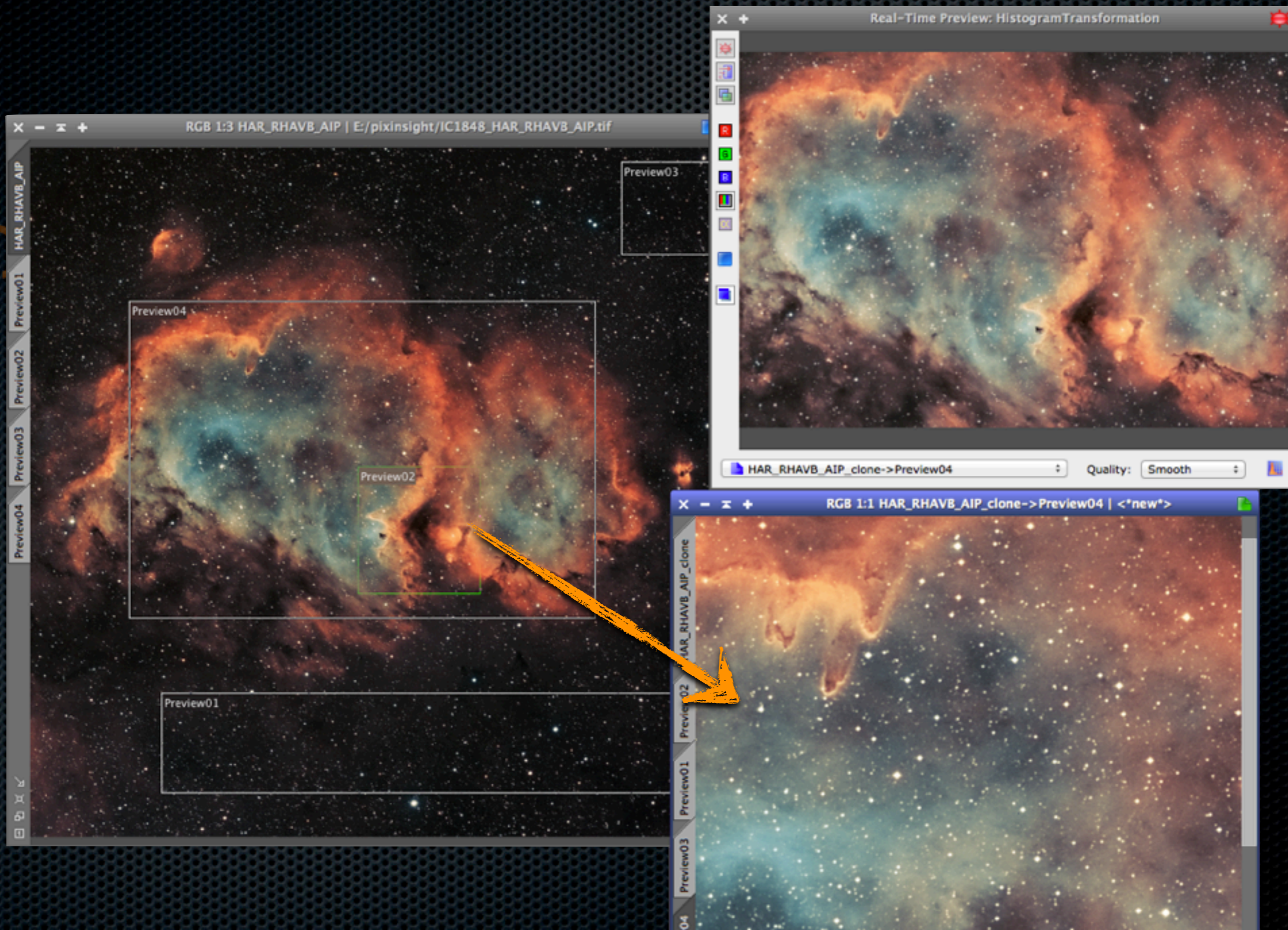
- RGB 1:9 RGB\_DBE | <\*new\*> (Preview01)
- Gray 1:9 ngc4559\_L\_DBE | <\*new\*> (Preview02)

The status bar at the bottom indicates: w:3991 - h:3965 - n:1 - f32 - Gray - 60.365 MB - Masked

Process Icons

# Preview, Real-Time Preview

PixInsight



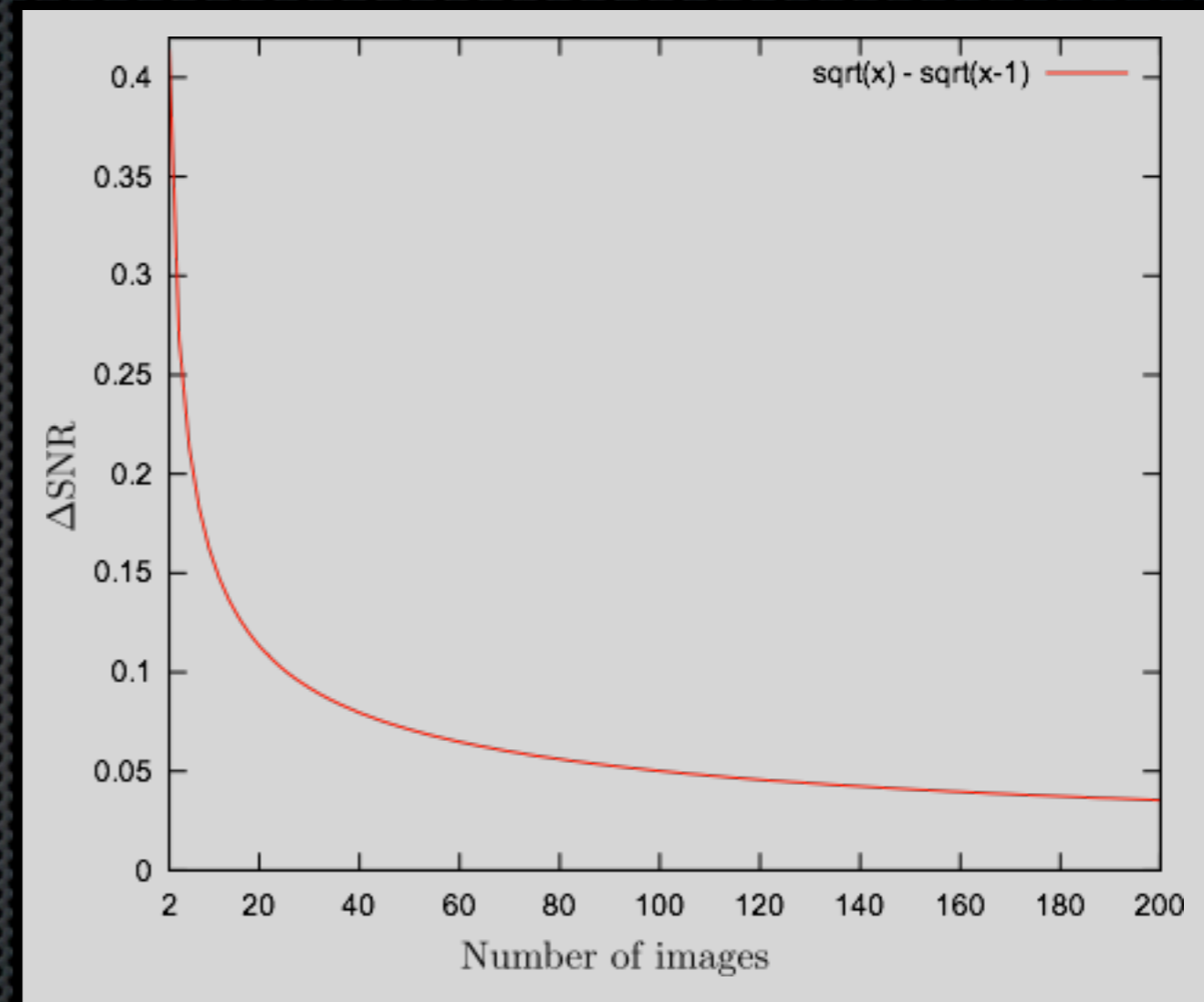
# Le prétraitement

# Optimisation prétraitement

## Combien d'images ?

Bias, dark, flat :

- 10 images ?
- 25 images ?
- 50 images ?
- 100 images ?
- 200 images ?



$$\Delta\text{SNR}(N) = \sqrt{N} - \sqrt{N-1}$$

# Process icons :

## Création d'un Prétraitement CCD complet


- Suite d'icônes représentant des fonctions préprogrammées (*création perso*)
- Adapté aux images CCD monochromes L, R, V, B, Ha, OIII, SII, NII..., objets du ciel profond
- Adaptable facilement aux CCD couleurs ou APN (matrice de Bayer)
- Optimisation des paramètres à chaque étape par analyse des cartes de réjection
- Sauvegarde de chaque MASTER ou images en 32bits


# Process icons : prétraitement «full»


**NOP** PRETRAITEMENT\_FULL \_\_\_\_\_ <sup>N</sup><sub>D</sub>



**NOP** PRETRAITEMENT\_MASTER\_BiasDarkFlat \_\_\_\_\_ <sup>N</sup><sub>D</sub>


 Generation\_des\_MASTER\_BIAS <sup>N</sup><sub>D</sub> **MasterBIAS optimisé(s)**

 Calibration\_de\_TOUS\_les\_DARK\_et\_DARKFLAT\_avec\_MasterBias <sup>N</sup><sub>D</sub> **Calibration des DARK**

 Generation\_des\_MASTER\_DARK\_\_\_Repetier\_operation\_pour\_chaque\_serie\_de\_dark <sup>N</sup><sub>D</sub> **MasterDARK optimisé(s)**

 Generation\_des\_MASTER\_DARK\_FLAT\_\_\_Repetier\_operation\_pour\_chaque\_serie\_de\_dark\_de\_flat <sup>N</sup><sub>D</sub>


 Calibration\_des\_FLAT\_avec\_bias <sup>N</sup><sub>D</sub>  ou\_Calibration\_des\_FLAT\_avec\_dark\_et\_bias <sup>N</sup><sub>D</sub> **Calibration des FLATS**

 Generation\_des\_MASTER\_FLAT\_avec\_boite\_flat\_ou\_ciel\_clair <sup>N</sup><sub>D</sub> **MasterFLAT optimisé(s)**


**NOP** PRETRAITEMENT\_FULL \_\_\_\_\_ <sup>N</sup><sub>D</sub>


 Calibration\_des\_IMAGES\_BRUTES\_avec\_les\_masters <sup>N</sup><sub>D</sub> **Calibration des IMAGES avec les MASTERS**

 Process\_COSMETICCORRECTION <sup>N</sup><sub>D</sub> **Elimination des défauts cosmétiques résiduels**


 Alignement\_des\_IMAGES\_CALIBREES\_CC\_\_\_Toutes\_images\_LRVB\_Narrow\_Binning <sup>N</sup><sub>D</sub> **Alignement de toutes les IMAGES**

**NOP** Preparation\_EMPILEMENT \_\_\_\_\_ <sup>N</sup><sub>D</sub>


 MOYENNE\_NO\_REJECTION\_de\_TOUTES\_les\_images\_calibrees\_alignees\_pour\_verifier\_le\_cadrage <sup>N</sup><sub>D</sub> **Retrait des bandes noires pour optimisation du calcul du S/B**


**NOP** Si\_bandes\_noires\_sur\_les\_cotes <sup>N</sup><sub>D</sub>  Dynamic\_Crop <sup>N</sup><sub>D</sub>


**NOP** History\_Explorer\_Select\_Image\_Glisser\_Triangle\_sur\_bureau <sup>N</sup><sub>D</sub>


 ImageContainer\_Add\_Files\_IMAGES\_ALIGNEES\_puis\_triangle\_a\_glisser\_dans\_icone\_process\_CROP <sup>N</sup><sub>D</sub>


**NOP** EMPILEMENT\_FINAL\_Choisir\_methode\_selon\_nombre\_image\_et\_ajuster\_rejections\_\_\_Repetier\_pour\_chaque\_couleur <sup>N</sup><sub>D</sub>

**NOP** VERIF\_S\_B <sup>N</sup><sub>D</sub>  MOYENNE\_No\_Rejection\_des\_images\_calibrees\_CROPEES\_par\_couleurs\_pour\_verifier\_le\_rapport\_signal\_bruit <sup>N</sup><sub>D</sub> **calcul du S/B max**

 Empilement\_3a5\_images\_PERCENTILE\_CLIPPING <sup>N</sup><sub>D</sub>

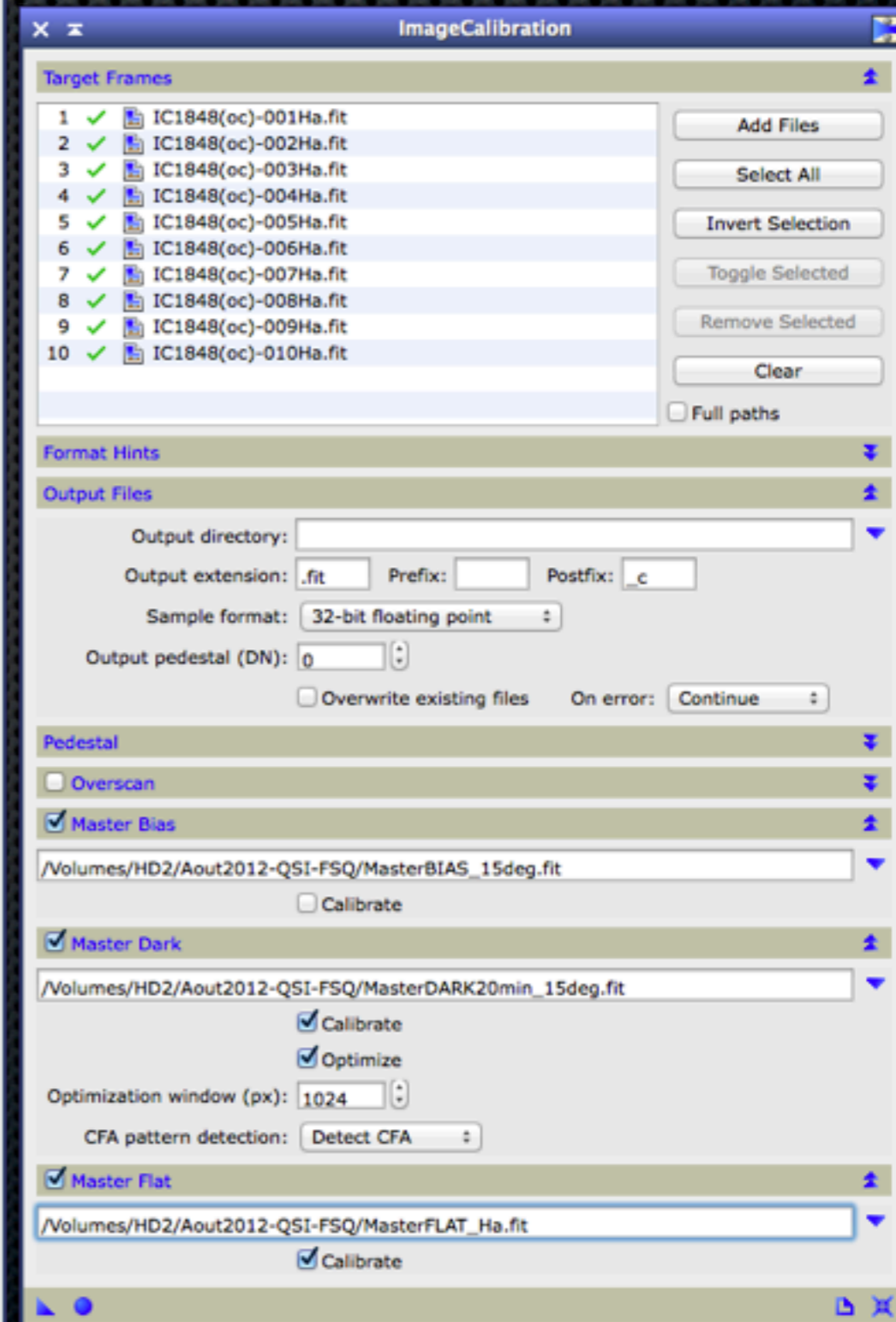
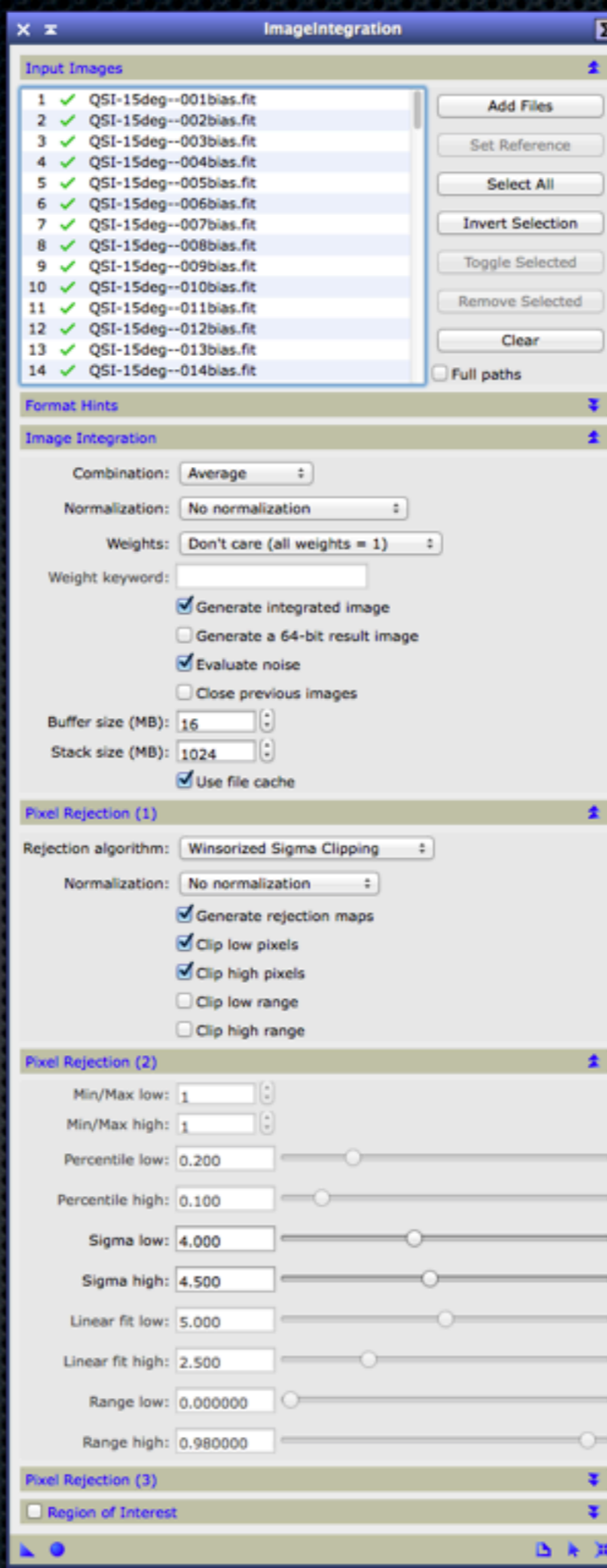
 Empilement\_3a10\_images\_AVERAGED\_SIGMA\_CLIPPING <sup>N</sup><sub>D</sub>

 Empilement\_10a20\_images\_WINSORIZED\_SIGMA\_CLIPPING <sup>N</sup><sub>D</sub>

 Empilement\_20\_et\_plus\_\_images\_avec\_gradients\_pollution\_LINEAR\_FIT\_CLIPPING <sup>N</sup><sub>D</sub>

**Empilement(s) optimisé(s) des différentes images ou couches couleur**

# intégration, calibration





# cosmetique, alignement...

PixInsight

### CosmeticCorrection

**Target Frames**

1	✓	NGC6888-001Ha_c.fit
2	✓	68cyg-001Ha_c.fit
3	✓	68cyg-002Ha_c.fit
4	✓	68cyg-003Ha_c.fit
5	✓	68cyg-004Ha_c.fit
6	✓	68cyg-005Ha_c.fit
7	✓	68cyg-006Ha_c.fit
8	✓	68cyg-007Ha_c.fit
9	✓	68cyg-008Ha_c.fit
10	✓	68cyg-009Ha_c.fit
11	✓	68cyg-010Ha_c.fit
12	✓	68cyg-011Ha_c.fit

**Output**

CFA  Overwrite Prefix: Postfix: \_cc

Amount: 1.00

Use Master Dark

Master Dark: imes/HD2/Aout2012-QSI-FSQ/MasterDARK20min\_15deg.fit

Hot Pixels Threshold

Enable

Level: 0.1233997121

Sigma: 34.3740

Qty: 385

Real: Qty: 385, Level: 0.1233997121, Sigma: 34.373997

Cold Pixels Threshold

Enable

Level: 0.0000152590

Sigma: 0.02260

Qty: 38

Real: Qty: 9293, Level: 0.0000152590, Sigma: 0.022597

Use Auto detect

Hot Sigma:  3.0

Cold Sigma:  3.0

Use Defect List

**Real Time Preview**

	Hot	Cold
Dark	0	0
Auto	0	0

Show map

### StarAlignment

Reference image: 68\_Cyg\_002Ha\_c\_cc View

Working mode: Register/Match Images

Generate masks  Frame adaptation

**Target Images**

1	✓	68cyg-001Ha_c_cc.fit
2	✓	68cyg-002Ha_c_cc.fit
3	✓	68cyg-003Ha_c_cc.fit
4	✓	68cyg-004Ha_c_cc.fit
5	✓	68cyg-005Ha_c_cc.fit
6	✓	68cyg-006Ha_c_cc.fit
7	✓	68cyg-007Ha_c_cc.fit
8	✓	68cyg-008Ha_c_cc.fit
9	✓	68cyg-009Ha_c_cc.fit
10	✓	68cyg-010Ha_c_cc.fit
11	✓	68cyg-011Ha_c_cc.fit
12	✓	68cyg-012Ha_c_cc.fit
13	✓	68_Cyg-001Ha_c_cc.fit
14	✓	68_Cyg-002Ha_c_cc.fit

**Format Hints**

**Output Images**

**Star Detection**

Detection scales: 4

Noise scales: 1

Hot pixel removal: 1

Log(sensitivity): -1.00

Peak response: 0.80

Maximum distortion: 0.500

Inverted image

**Star Matching**

RANSAC tolerance: 2.00

RANSAC iterations: 2000

Maximize inliers: 1.00

Maximize overlapping: 1.00

Maximize regularity: 1.00

Minimize RMS error: 1.00

Maximum stars: <Auto>

Triangles per star: 40

Compute intersections: Mosaic modes only

Restrict to previews  Use brightness relations  Use scale differences

Scale tolerance: 0.010

**Interpolation**

Registration model: Projective Transformation

Pixel interpolation: Auto

Clamping threshold: 0.30

# Optimisation de l'intégration : réjection

Integration of 11 images:  
Pixel combination ..... average  
Output normalization ..... additive  
Pixel rejection ..... none  
Integrating pixel rows: 0 -> 2047: 100%

MRS noise evaluation: done.

Gaussian noise estimates:  
 $\sigma_z = 5.728e-05$

Reference SNR increments:  
 $\Delta\sigma_{z0} = 4.6897$

Average SNR increments:  
 $\Delta\sigma_z = 3.3180$

5.574 s

Moyenne simple

moyenne avec réjection

Total : 345387 0.749% ( 45 + 345342 = 0.000% + 0.749%)

MRS noise evaluation: done.

Gaussian noise estimates:  
 $\sigma_z = 5.813e-05$

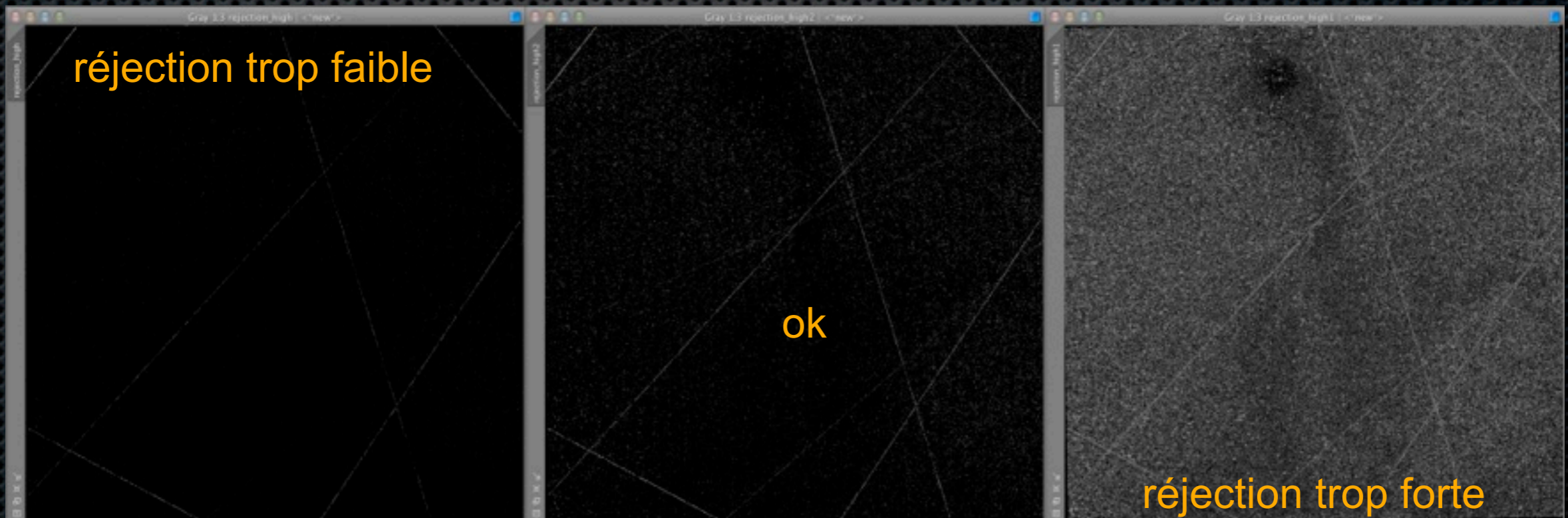
Reference SNR increments:  
 $\Delta\sigma_{z0} = 4.6185$

Average SNR increments:  
 $\Delta\sigma_z = 3.2676$

réjection trop faible

ok

réjection trop forte



# Process icons : prétraitement «simplifié»

Pixinsight

**NOP** PRETRAITEMENT\_SIMPLIFIE  $N$   
 $D$

**NOP** PRETRAITEMENT\_MASTER\_BiasDarkFlat  $N$   
 $D$


$\Sigma$  Generation\_des\_MASTER\_BIAS  $N$   
 $D$


**MasterBIAS optimisé(s)**

$\Sigma$  Generation\_des\_MASTER\_DARK\_\_Repetier\_operation\_pour\_chaque\_serie\_de\_dark  $N$   
 $D$

**MasterDARK optimisé(s)**

$\Sigma$  Generation\_des\_MASTER\_DARK\_FLAT\_\_Repetier\_operation\_pour\_chaque\_serie\_de\_dark\_de\_flat  $N$   
 $D$

 Calibration\_des\_FLAT\_avec\_bias  $N$   
 $D$


 ou\_Calibration\_des\_FLAT\_avec\_dark\_et\_bias  $N$   
 $D$

**Calibration des FLATS**


$\Sigma$  Generation\_des\_MASTER\_FLAT\_avec\_boite\_flat\_ou\_ciel\_clair  $N$   
 $D$


**MasterFLAT optimisé(s)**

**NOP** PRETRAITEMENT  $N$   
 $D$

 Calibration\_des\_IMAGES\_BRUTES\_avec\_les\_masters  $N$   
 $D$

**Calibration des IMAGES**


 Process\_COSMETICCORRECTION  $N$   
 $D$

 Alignement\_des\_IMAGES\_CALIBREES\_CC\_\_Toutes\_images\_LRVB\_Narrow\_Binning  $N$   
 $D$


**NOP** Preparation\_EMPILEMENT  $N$   
 $D$

$\Sigma$  MOYENNE\_NO\_REJECTION\_de\_TOUTES\_les\_images\_calibrees\_alignees\_pour\_verifier\_le\_cadrage  $N$   
 $D$

**NOP** Si\_bandes\_noires\_sur\_les\_cotes  $N$   
 $D$

 Dynamic\_Crop  $N$   
 $D$

**NOP** History\_Explorer\_Select\_Image\_Glisser\_Triangle\_sur\_bureau  $N$   
 $D$

 ImageContainer\_Add\_Files\_IMAGES\_ALIGNEES\_puis\_triangle\_a\_glisser\_dans\_icone\_process\_CROP  $N$   
 $D$

**NOP** EMPILEMENT\_FINAL\_Choisir\_methode\_selon\_nombre\_image\_et\_ajuster\_rejections\_\_Repetier\_pour\_chaque\_couleur  $N$   
 $D$

**NOP** VERIF\_S\_B  $N$   
 $D$

$\Sigma$  MOYENNE\_No\_Rejection\_des\_images\_calibrees\_CROPEES\_par\_couleurs\_pour\_verifier\_le\_rapport\_signal\_bruit\_maximum  $N$   
 $D$

$\Sigma$  Empilement\_3a5\_images\_PERCENTILE\_CLIPPING  $N$   
 $D$

$\Sigma$  Empilement\_3a10\_images\_AVERAGED\_SIGMA\_CLIPPING  $N$   
 $D$

$\Sigma$  Empilement\_10a20\_images\_WINSORIZED\_SIGMA\_CLIPPING  $N$   
 $D$

$\Sigma$  Empilement\_20\_et\_plus\_\_images\_avec\_gradients\_pollution\_LINEAR\_FIT\_CLIPPING  $N$   
 $D$

# Process icons : prétraitement «minimum»

Pixinsight

**NOP** PRETRAITEMENT\_MINIMUM  $N$   
 $D$

**NOP** PRETRAITEMENT\_MASTER\_BiasDarkFlat  $N$   
 $D$


$\Sigma$  Generation\_des\_MASTER\_BIAS  $N$  **MasterBIAS optimisé(s)**  
 $D$


$\Sigma$  Generation\_des\_MASTER\_DARK\_\_Repetier\_operation\_pour\_chaque\_serie\_de\_dark  $N$  **MasterDARK optimisé(s)**  
 $D$


$\Sigma$  Generation\_des\_MASTER\_DARK\_FLAT\_\_Repetier\_operation\_pour\_chaque\_serie\_de\_dark\_de\_flat  $N$   
 $D$

$\Sigma$  Generation\_des\_MASTER\_FLAT\_avec\_boite\_flat\_ou\_ciel\_clair  $N$  **MasterFLAT optimisé(s)**  
 $D$

**NOP** PRETRAITEMENT\_SIMPLE  $N$   
 $D$

 Calibration\_des\_IMAGES\_BRUTES\_avec\_TOUS\_les\_masters  $N$  **Calibration des IMAGES**  
 $D$

 Process\_COSMETICCORRECTION  $N$   
 $D$

 Alignement\_des\_IMAGES\_CALIBREES\_CC\_\_Toutes\_images\_LRVB\_Narrow\_Binning  $N$   
 $D$

**NOP** EMPILEMENT\_FINAL\_Choisir\_methode\_selon\_nombre\_image\_et\_ajuster\_rejections\_\_Repetier\_pour\_chaque\_couleur  $N$   
 $D$


$\Sigma$  Empilement\_3a5\_images\_PERCENTILE\_CLIPPING  $N$   
 $D$

$\Sigma$  Empilement\_3a10\_images\_AVERAGED\_SIGMA\_CLIPPING  $N$   
 $D$

$\Sigma$  Empilement\_10a20\_images\_WINSORIZED\_SIGMA\_CLIPPING  $N$   
 $D$

$\Sigma$  Empilement\_20\_et\_plus\_\_images\_avec\_gradients\_pollution\_LINEAR\_FIT\_CLIPPING  $N$   
 $D$

**NOP** Si\_bandes\_noires\_sur\_les\_cotes  $N$   
 $D$

 Dynamic\_Crop  $N$   
 $D$

# BATCH

pixinsight

**Batch Preprocessing Script v1.22**

**Bias** | **Darks** | **Flats** | **Lights**

- ▲ Binning 1
  - ▲ 900.00s
    - Dark-900s - 20deg - 01...
    - Dark-900s - 20deg - 02...
    - Dark-900s - 20deg - 03...
    - Dark-900s - 20deg - 04...
    - Dark-900s - 20deg - 05...
    - Dark-900s - 20deg - 06...
    - Dark-900s - 20deg - 07...
    - Dark-900s - 20deg - 08...
    - Dark-900s - 20deg - 09...
  - ▲ Binning 2
    - ▲ 300.00s
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...
      - Dark2x2 - 300s - 20deg...

ⓧ Clear | ⓧ Remove Selected | 🔄 Invert Selection

Exposure tolerance: 10

**Image Integration**

Combination: Average

Rejection algorithm: Winsorized Sigma Clipping

Min/Max low: 1

Min/Max high: 1

Percentile low: 0.20

Percentile high: 0.10

Sigma low: 4.00

Sigma high: 3.50

Linear fit low: 5.00

Linear fit high: 3.50

+ Add Files | + Add Bias | + Add Darks | + Add Flats | + Add Lights | + Add Custom | Reset

Diagnostics | Run | Exit

A script for calibration and alignment of light frames  
Copyright (c) 2012 Kai Wiechen.  
Copyright (c) 2012 Pleiades Astrophoto.

**Options**

  - CFA images
  - Optimize dark frames
  - Generate rejection maps
  - Export calibration files
  - Up-bottom FITS
  - Use master bias
  - Use master dark
  - Use master flat

**Registration Reference Image**

**Output Directory**

**Batch Preprocessing Script v1.22**

**Bias** | **Darks** | **Flats** | **Lights**

- ▲ Binning 1
  - ▲ Luminance
    - ▲ 900.00s
      - Trio-L-02.fit
      - Trio-L-03.fit
      - Trio-L-04.fit
      - Trio-L-05.fit
      - Trio-L-06.fit
      - Trio-L-07.fit
      - Trio-L-08.fit
      - Trio-L-11.fit
      - Trio-L-12.fit
    - ▲ Binning 2
      - ▲ Bleu
        - ▲ 300.00s
          - Trio-B-01.fit
          - Trio-B-02.fit
          - Trio-B-03.fit
          - Trio-B-04.fit
          - Trio-B-05.fit
        - ▲ Rouge

ⓧ Add Files | ⓧ Add Bias | ⓧ Add Darks | ⓧ Add Flats | ⓧ Add Lights | ⓧ Add Custom | Reset

Calibrate only

**Cosmetic Correction**

Apply

Template icon: <none>

**DeBayer**

Bayer/mosaic pattern: RGGB

DeBayer method: VNG

**Image Registration**

Pixel interpolation: Auto

Clamping threshold: 0.30

**Image Integration**

Apply

Integration parameters...

Diagnostics | Run | Exit

# Le traitement

# Traitement

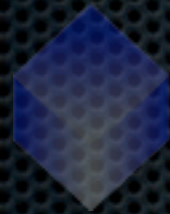
Avant tout traitement, il faut s'assurer que l'on a utilisé toutes les techniques possibles afin d'optimiser l'image brute d'empilement :

- Utilisation de toutes les techniques permettant d'augmenter le rapport signal sur bruit lors de l'acquisition
- Calibration précise des images brutes
- Intégration optimale des images

# Traitement

Le traitement est avant tout une perception personnelle (artistique ou mathématique) de l'image finale tout en essayant de préserver les structures qui la composent. Il faut avoir à l'esprit que :

- Le traitement n'est pas une chose triviale (cela demande des essais et donc du temps)
- Chaque image est unique : pas de formules universelles (ou de «workflow»)
- Et... une bonne dose de subjectivité





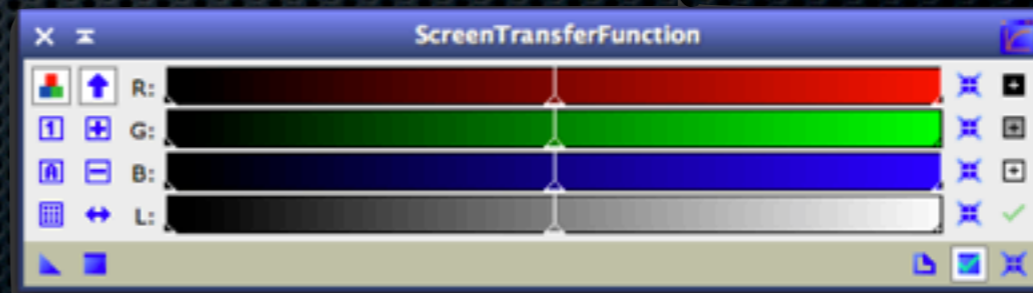
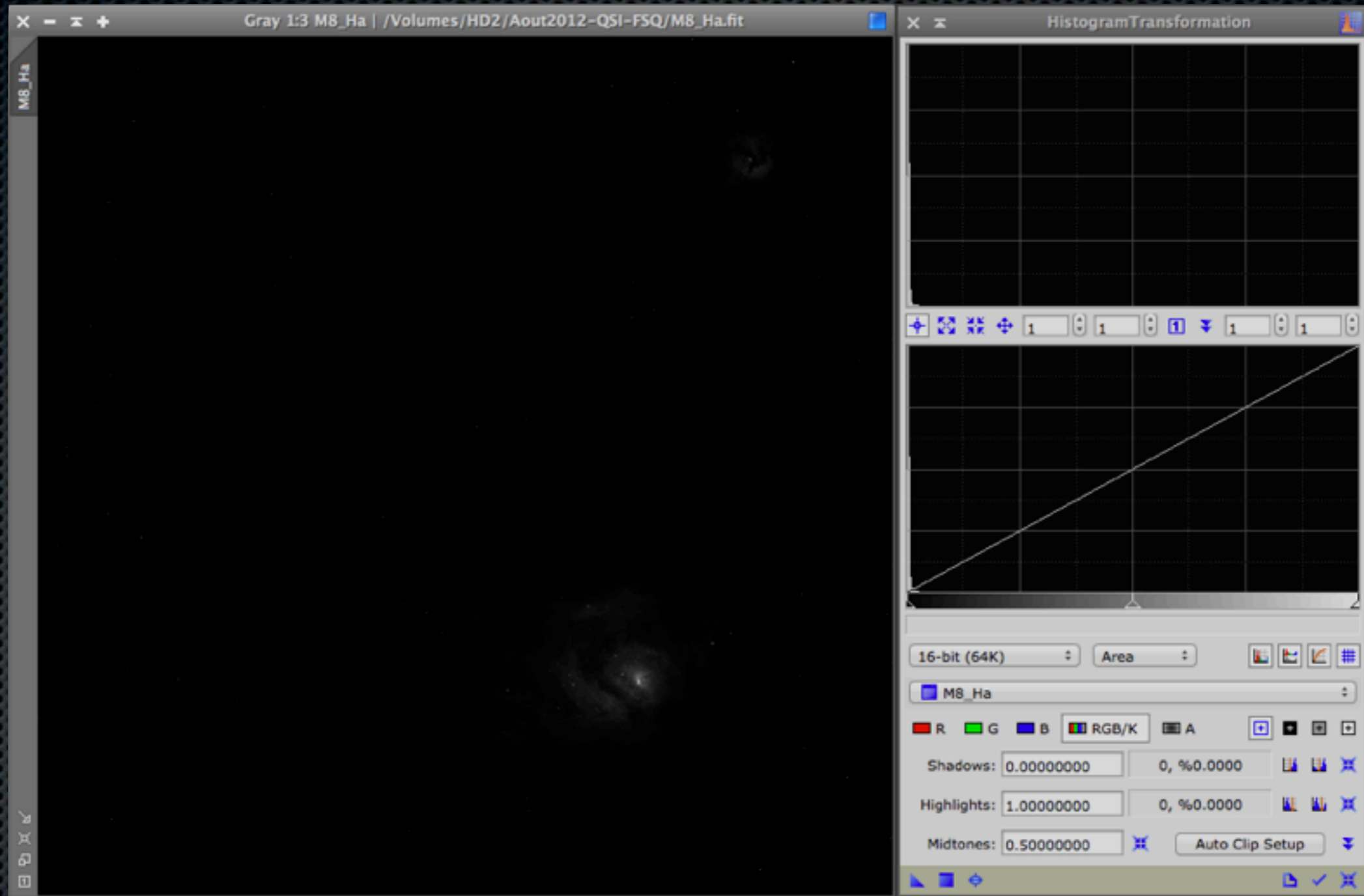
# Traitement

PIXINSIGHT offre une panoplie de fonctions pour traiter toute sorte d'images. Beaucoup de fonctions sont inédites et uniques au logiciel. Il ne faut pas hésiter à les utiliser pour optimiser chaque étape du traitement  
Citons par exemple :

- Pas moins de 6 fonctions de réduction de bruit.
- Outil mathématique très puissant (PIXELMATH)
- Gestion des masques très précise. Bon nombre de traitements plus ou moins complexes nécessitent un masque optimisé

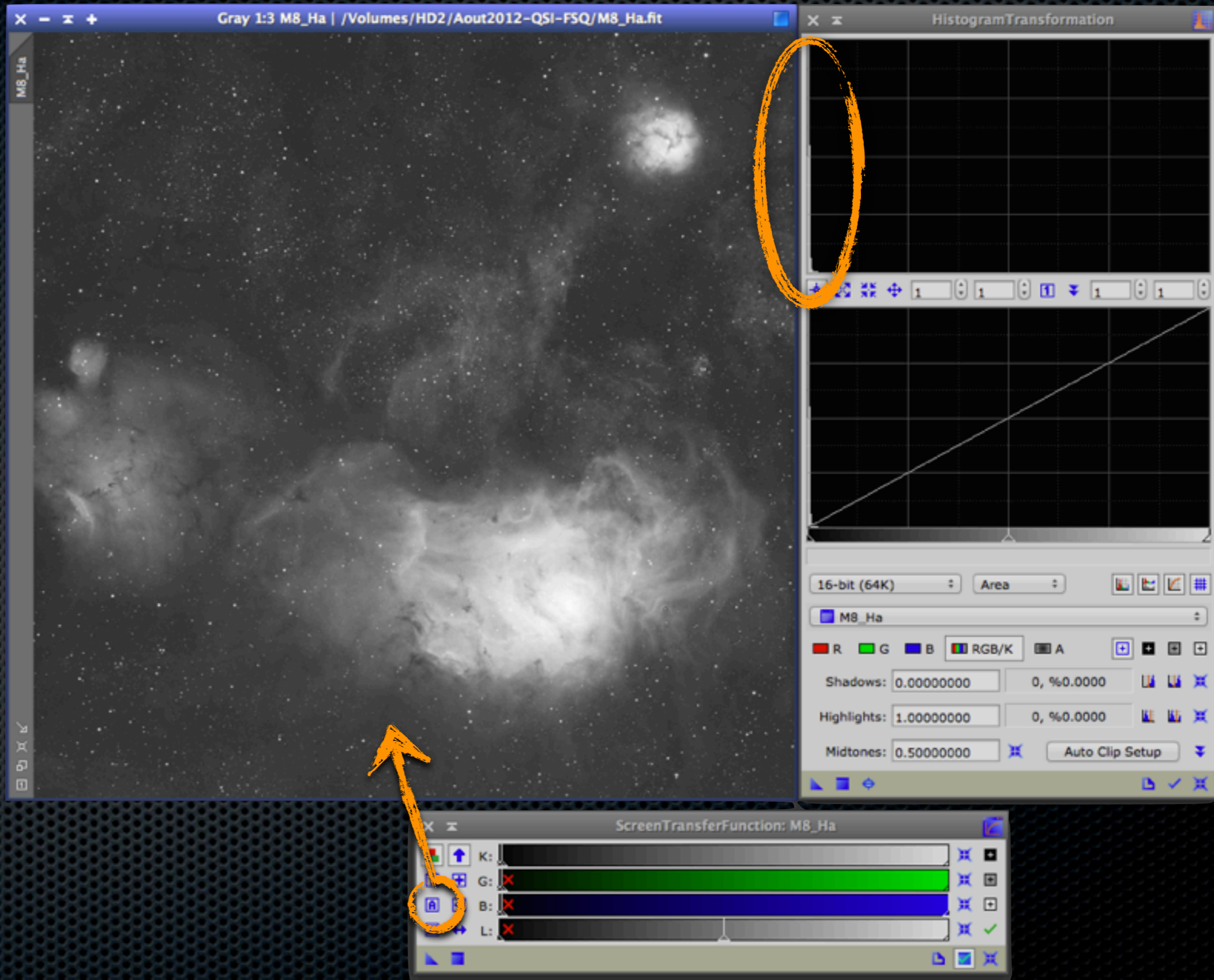
Images linéaires  
Images non-linéaires  
Screen Transfer Function

# Image linéaire



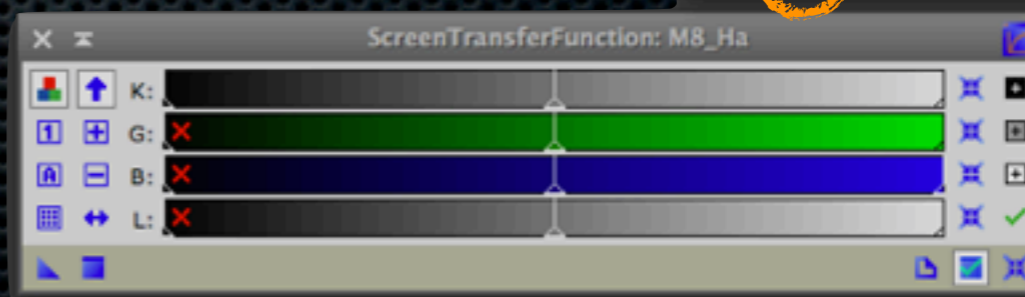
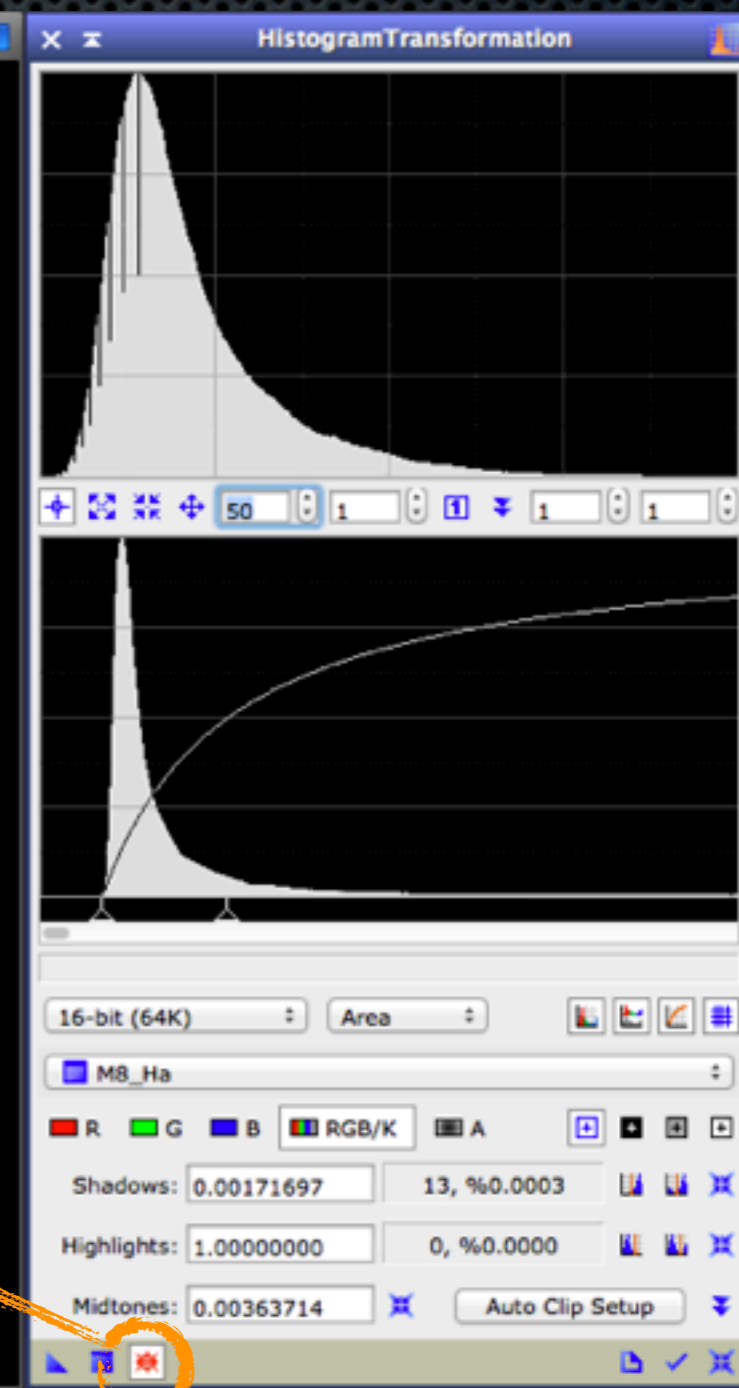
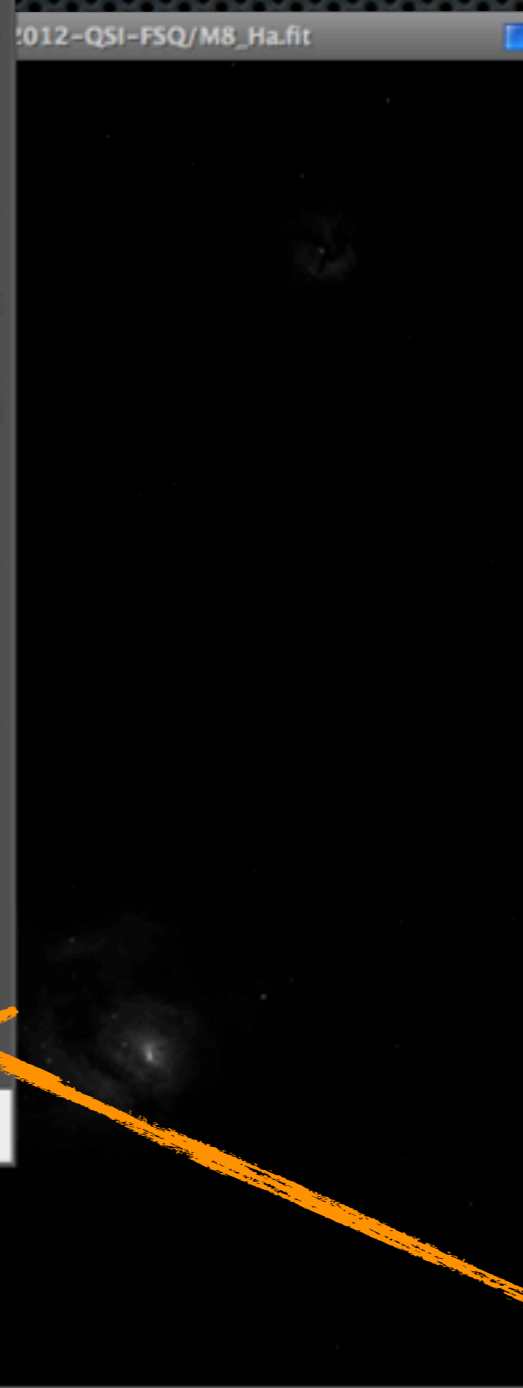
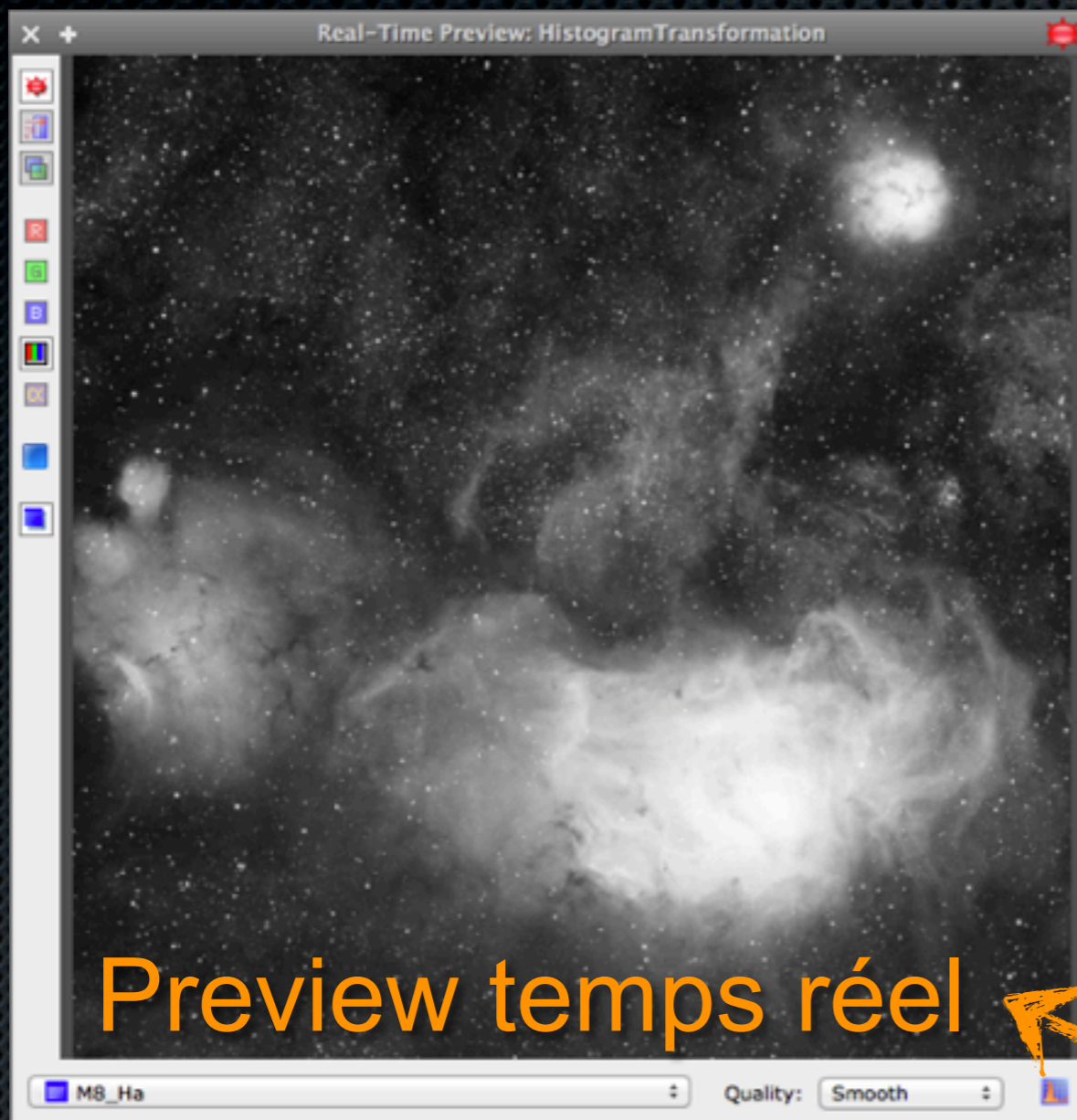
# Image linéaire : STF

PixInsight

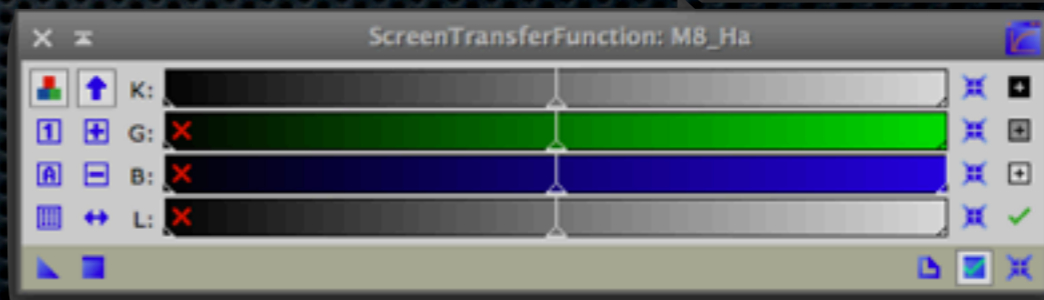
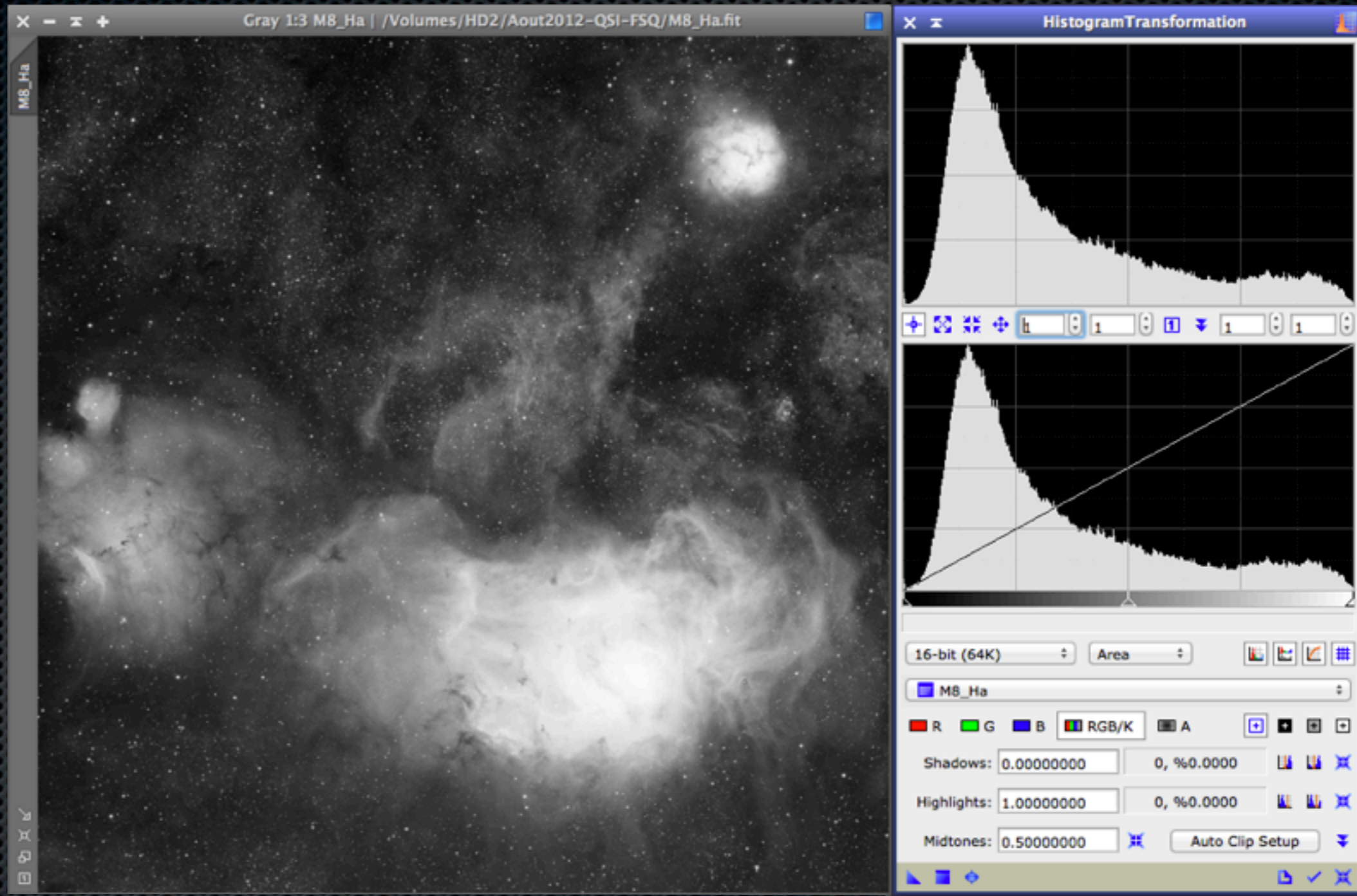


# Image linéaire --> non linéaire

PixInsight



# Image non linéaire



# Des exemples de processus de traitement

# Traitement : image monochrome

image  
linéaire

image  
non linéaire





# Traitement : image monochrome

image  
linéaire

image  
non linéaire



*Déconvolution*

# Traitement LRVB

PixInsight

images  
linéaires

images  
non linéaires

Luminance

ScreenTransferFunction\_Luminance

DynamicPSF

StarMask

Deconvolution

ATrousWevletTransform

DynamicBackgroundExtraction

AutomaticBackgroundExtractor

HistogramTransformation

HDRMultiscaleTransform

CurvesTransformation

ACDNR

RGBWorkingSpace

Rouge

Vert

Bleu

SII

ou Ha

OIII

ChannelCombination\_images\_R\_V\_B

STF\_RVB

DynamicBackground\_RVB

AutomaticBackground\_RVB

BackgroundNeutralization

ColorCalibration

HistogramTransformation\_RVB

SNR

ACDNR\_LRGB

StarMaskL

MorphologicalTransformation

CurvesTransform\_RVB\_Sat

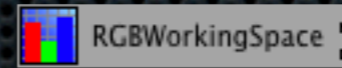
LRGBCombination

CurvesTransform\_Final

ICCProfileTransformation

IntegerResample

# Traitement canaux mixés



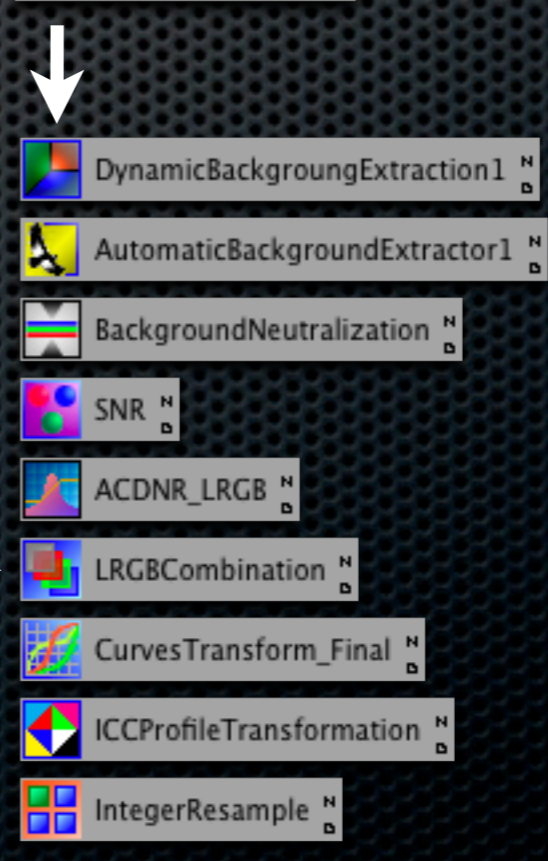
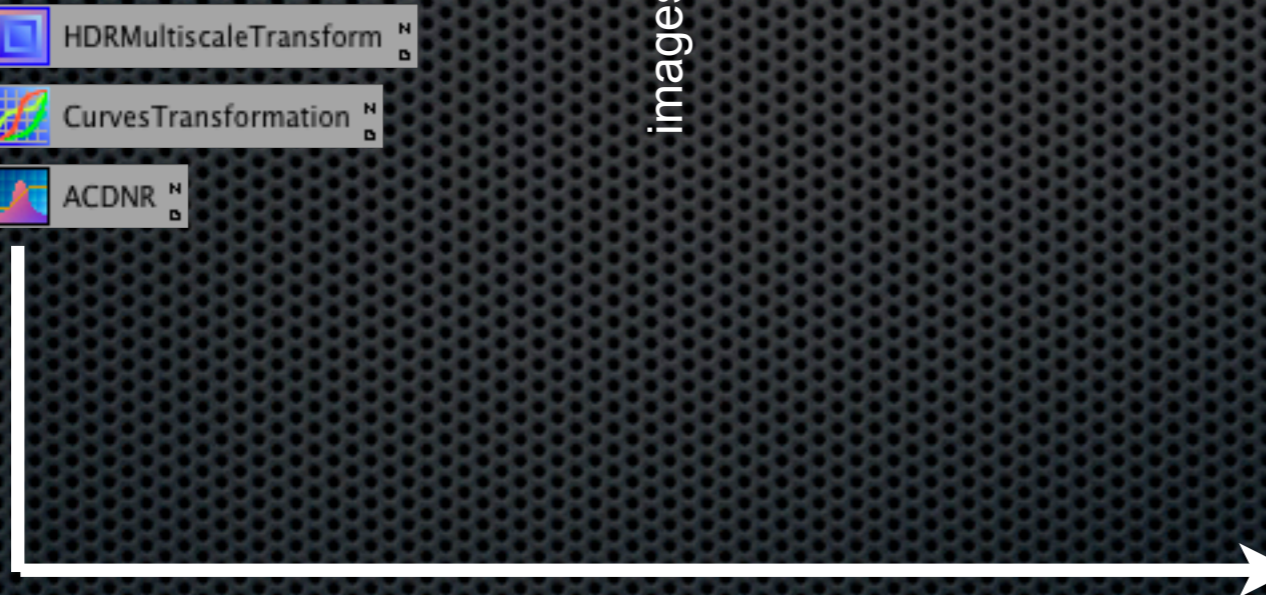
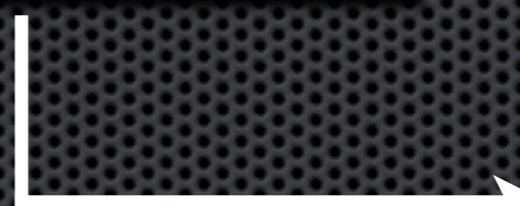
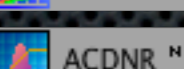
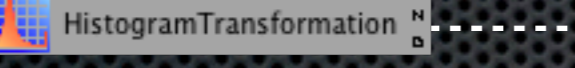
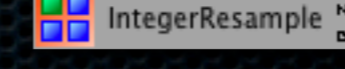
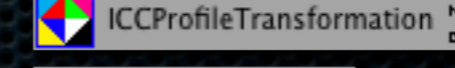
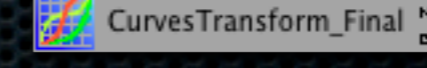
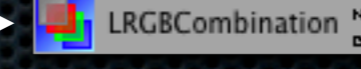
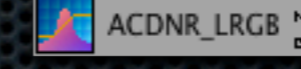
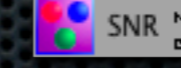
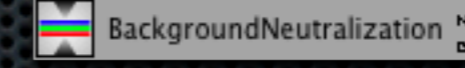
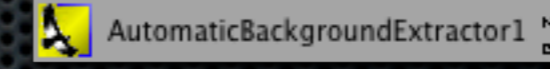
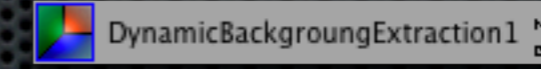
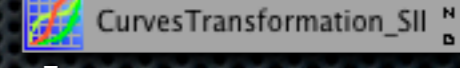
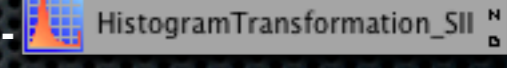
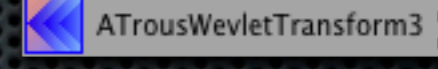
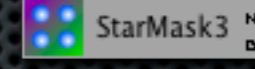
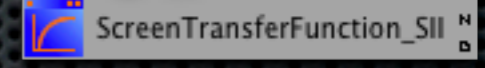
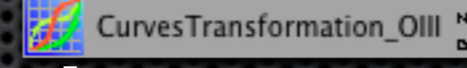
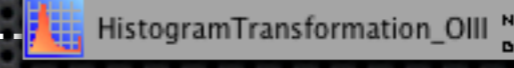
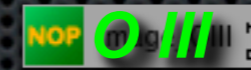
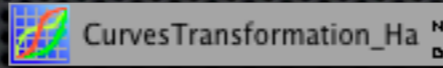
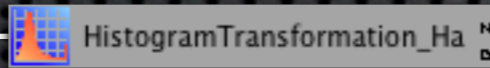
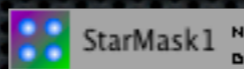
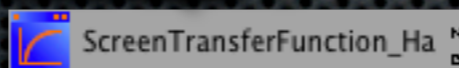
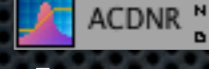
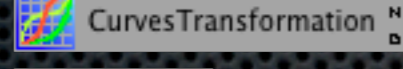
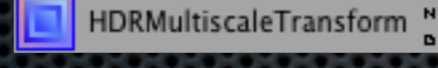
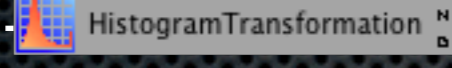
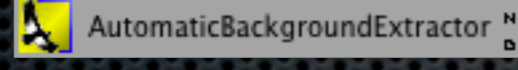
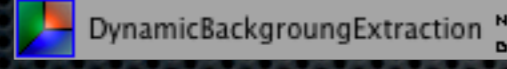
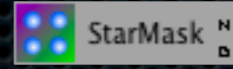
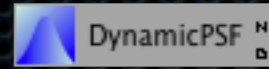
PixInsight

images linéaires

images non linéaires

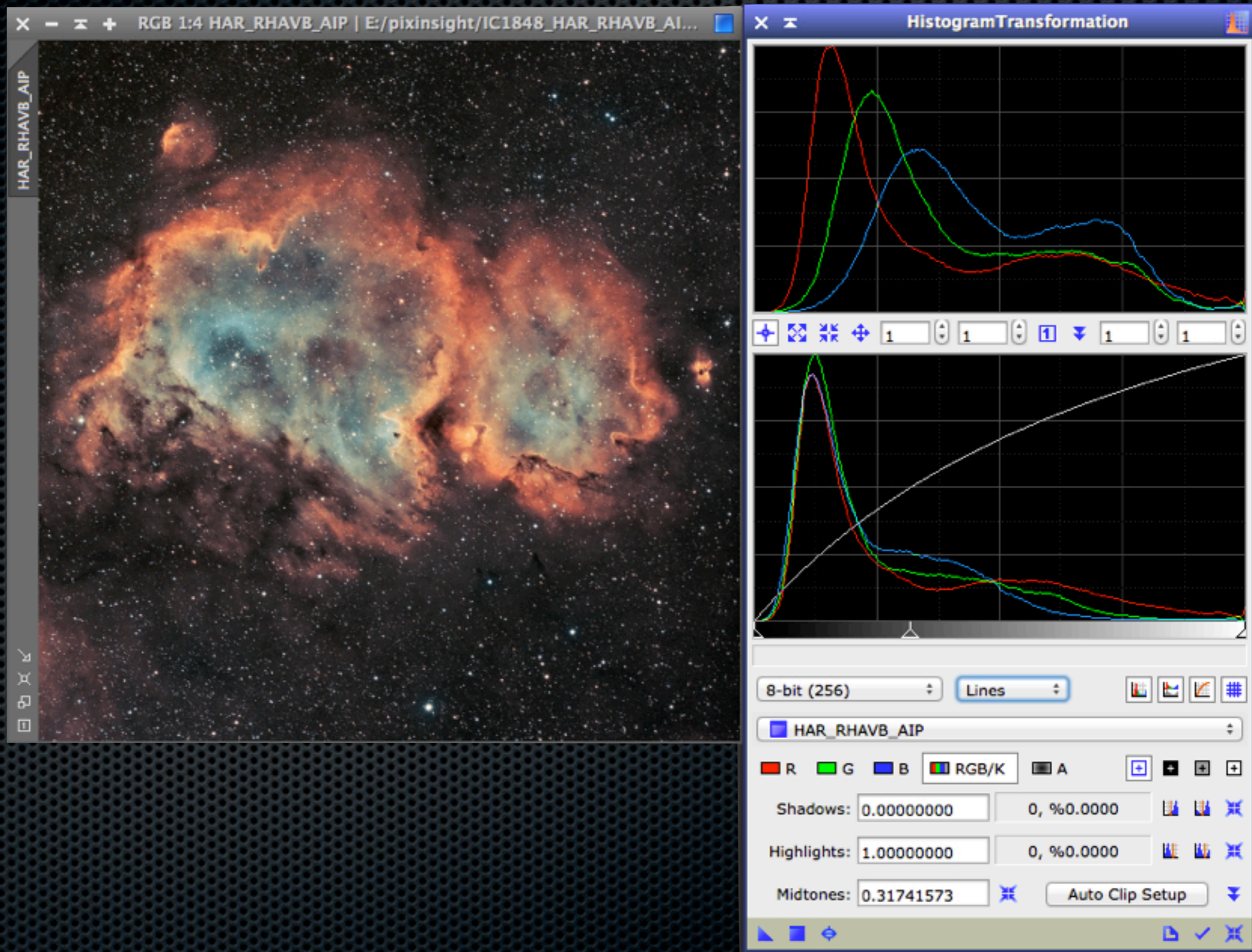
images linéaires

images non linéaires



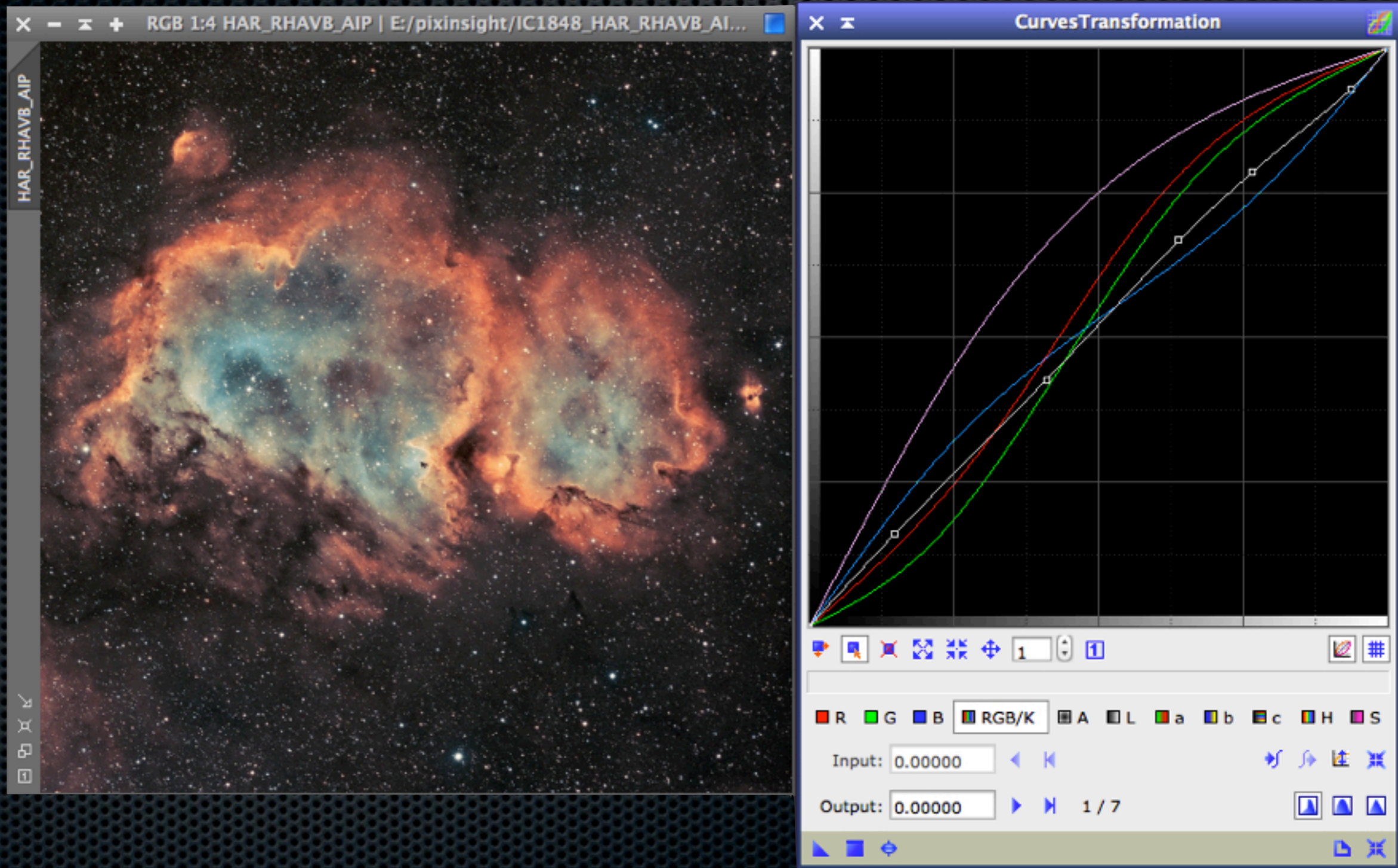
Des fonctions clés !

# Histogram Transformation



# Curves Transformation

PixInsight

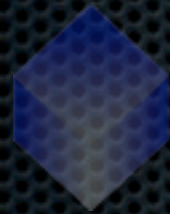


# Les masques

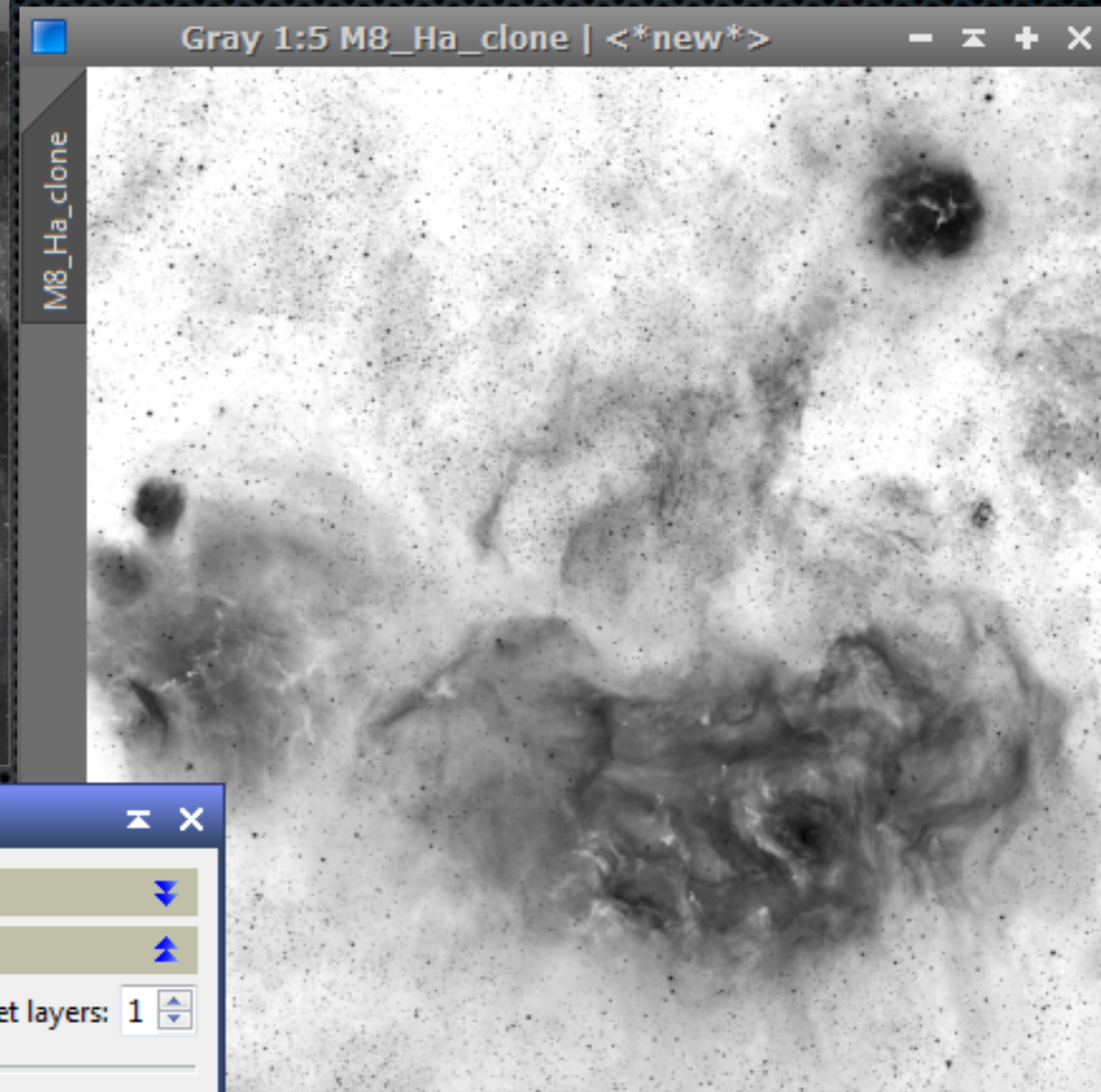
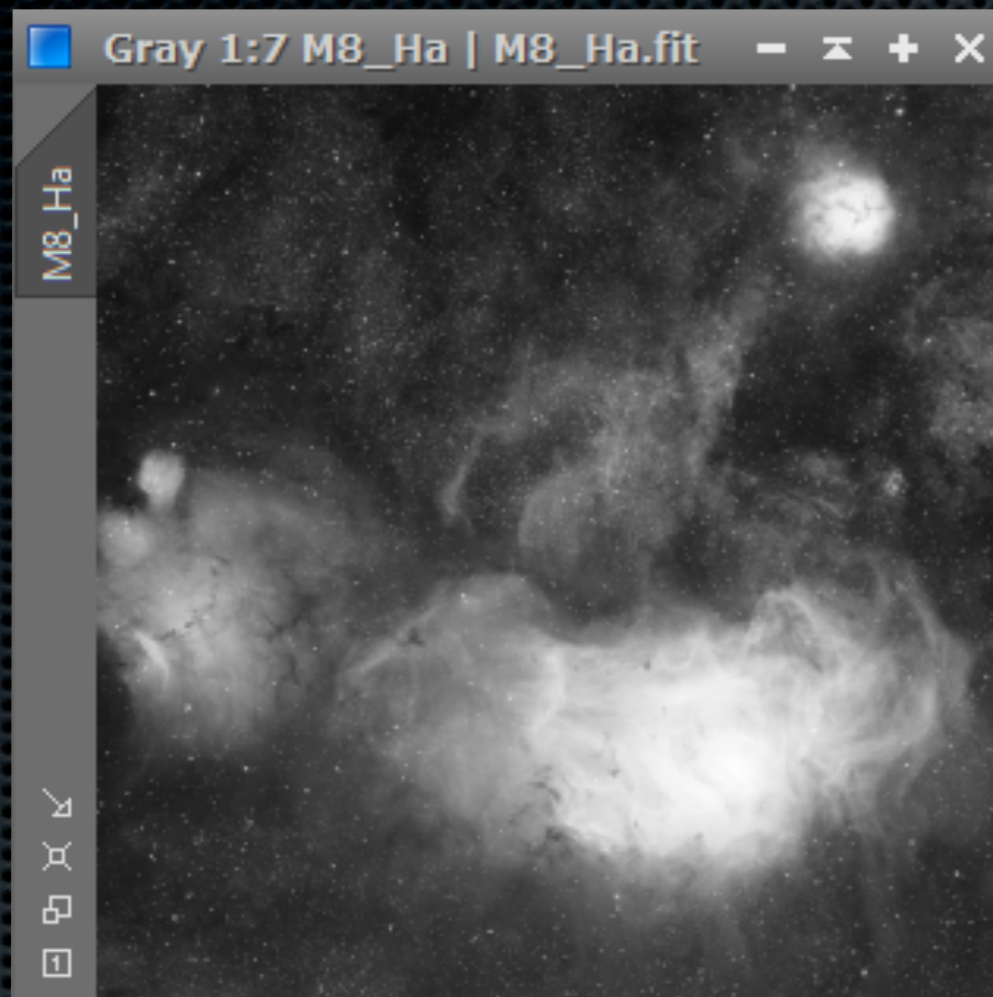
Indispensables à une majorité de fonctions

Les processus de traitement utilisent des masques d'intensité pour limiter leur effets sur certaines zones de l'image. Leur choix et leur utilisation est primordiale dans la réussite d'un traitement spécifique

Plusieurs fonctions permettent de créer facilement ces masques.



# Les masques



ACDNR

ACDNR Filters

Lightness Mask

Preview

Removed wavelet layers: 1

Midtones: 0.41000

Shadows: 0.18000

Highlights: 0.98000

This panel shows the ACDNR (Advanced Color Deconvolution Noise Reduction) settings. It includes a "Lightness Mask" section with a "Preview" checkbox checked. The "Removed wavelet layers" is set to 1. The "Midtones" slider is at 0.41000, "Shadows" is at 0.18000, and "Highlights" is at 0.98000. The panel also has a small icon on the left and some navigation icons at the bottom.

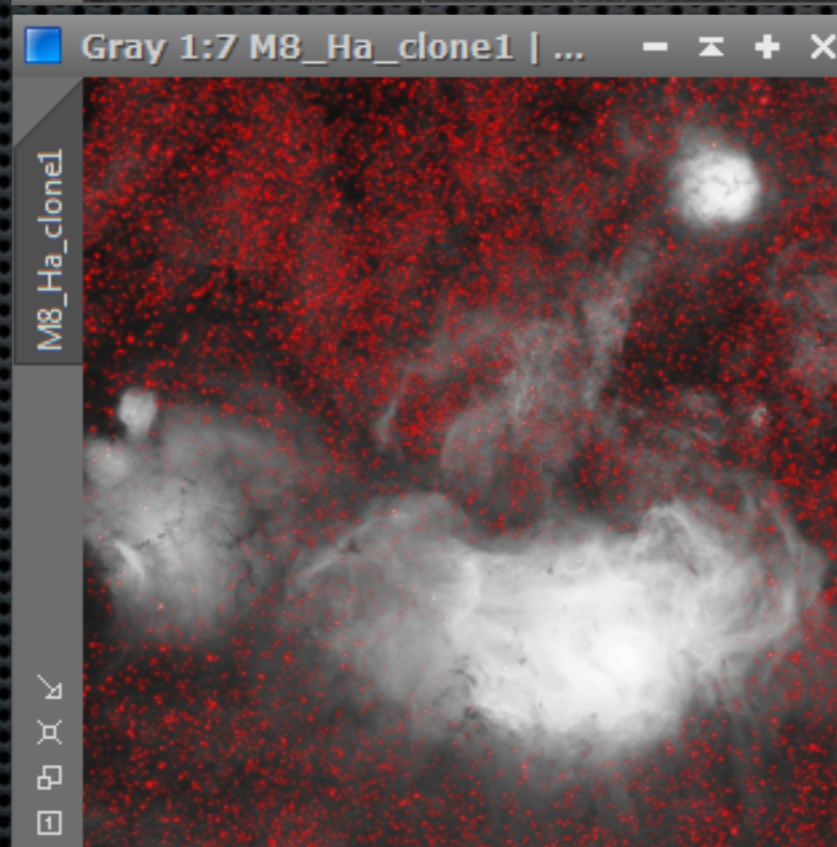
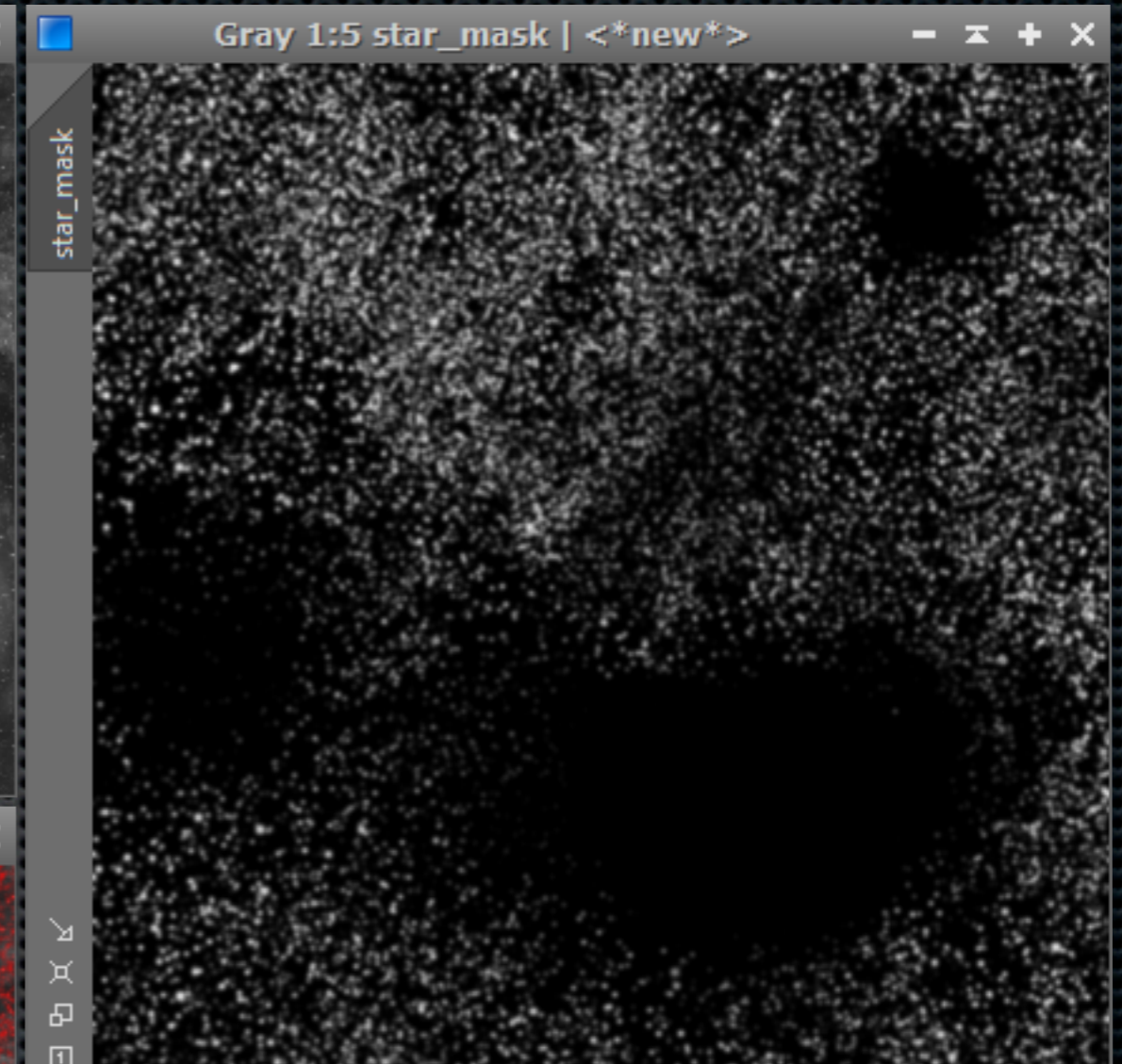


# Les masques

The image displays a software interface for image processing, showing the creation of a mask from an astronomical image. The interface consists of several windows and a control panel:

- Gray 1:7 M8\_Ha | M8\_Ha.fit**: The original astronomical image in grayscale.
- Gray 1:5 range\_mask | <\*new\*>**: A window showing the resulting grayscale mask, where the object is white against a black background.
- Gray 1:7 M8\_Ha\_clone1 | ...**: A window showing the original image with a red overlay, likely representing the mask applied to the image.
- M8\_Ha\_clone2**: A window showing the original image with a solid red background, possibly representing the inverse mask or a different processing step.
- RangeSelection**: A control panel for adjusting the mask parameters:
  - Lower limit: 0.340000
  - Upper limit: 0.830000
  - Link range limits
  - Fuzziness: 0.10
  - Smoothness: 23.0
  - Screening
  - Lightness
  - Invert

# Les masques



StarMask

Threshold: 0.30000 Mode: Star Mask

Scale: 5 Growth: 2 Comp.: 2 Small: 1

Smoothness: 12  Aggregate  Binarize  Contours  Invert

Shadows: 0.00000

Midtones: 0.50000

Highlights: 1.00000

Truncation: 1.00000

Limit: 1.00000

This panel shows the StarMask dialog box with various settings. The Threshold is set to 0.30000, Mode is Star Mask, Scale is 5, Growth is 2, Comp. is 2, and Small is 1. There are also checkboxes for Aggregate, Binarize, Contours, and Invert. Sliders are provided for Shadows, Midtones, Highlights, Truncation, and Limit.

# HDRMultiscaleTransform



image Nicolas Outters

# HDRMultiscaleTransform



**HDRMultiscaleTransform**

Number of layers:  Number of iterations:   Inverted

Overdrive:

Median transform

Scaling function:

To lightness  Preserve hue

Lightness mask

Deringing

Midtones Balance

# HDRMultiscaleTransform



Tout est possible !

Du plus soft au plus hard !

xlmsight



# Yeux de merlan...

PixInsight



Deconvolution

PSF

Algorithm

Deringing

Global dark: 0.1300

Global bright: 0.0000

Local deringing

Local support: star\_mask

Local amount: 0.70

Wavelet Regularization

Dynamic Range Extension



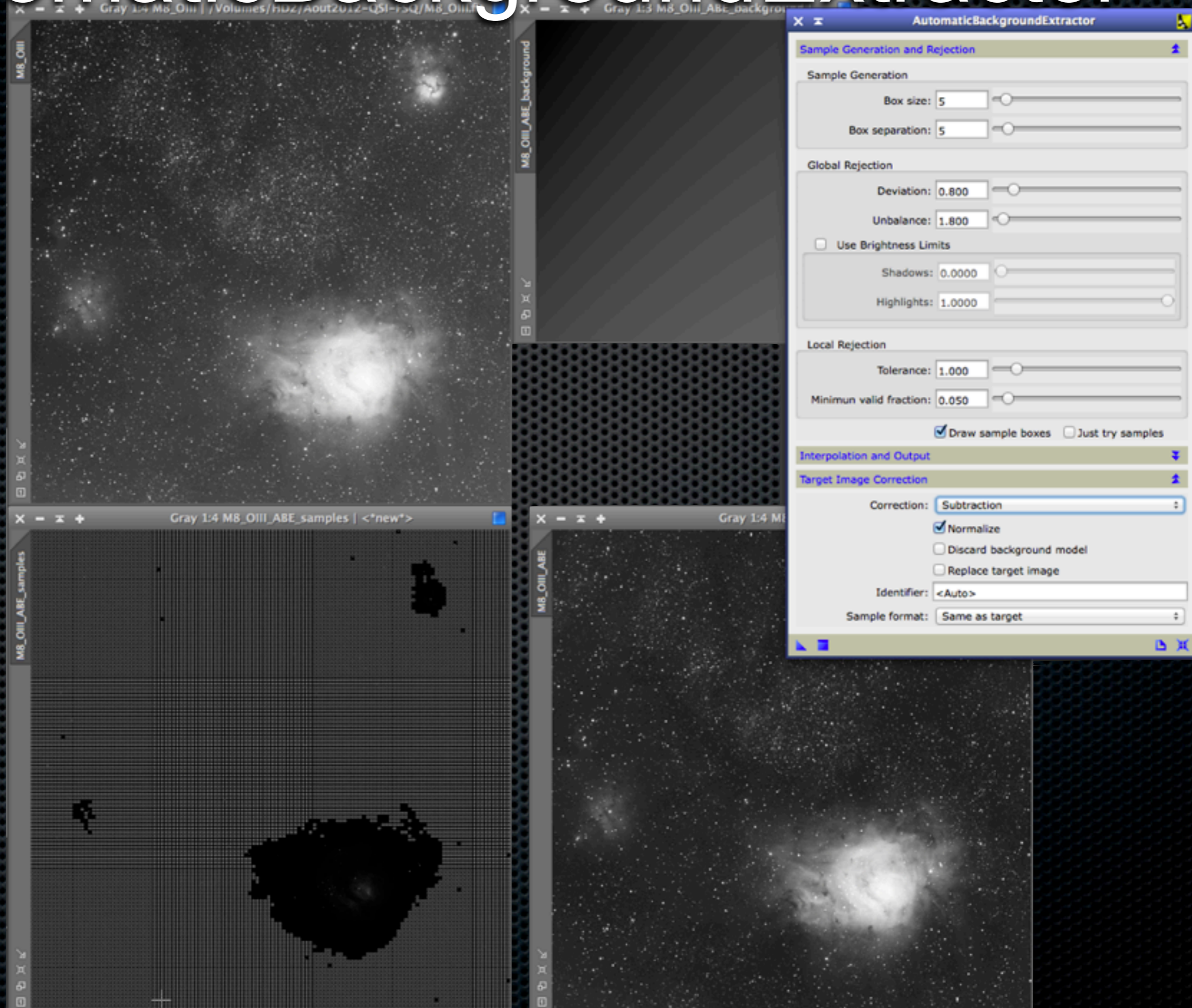
## DERINGING !

Présent sur de nombreuses fonctions

# DynamicBackgroundExtraction

The screenshot displays the DynamicBackgroundExtraction software interface. The main workspace is divided into two panels: 'Image05' on the left and 'Image05\_DBE' on the right. The 'Image05' panel shows a galaxy image with a grid of small square markers overlaid, representing the sampling process. The 'Image05\_DBE' panel shows the same galaxy image with the background extracted, leaving the galaxy and stars visible. Below the main workspace is a 'ScreenTransferFunction: Image05' panel with sliders for Red (R), Green (G), Blue (B), and Luminance (L) channels. On the right side, there is a 'DynamicBackgroundExtraction' control panel. This panel includes a 'Selected Sample: 55 of 126' indicator, a 'Sample #' field (55), and navigation buttons. It also features 'Anchor X' (1857) and 'Anchor Y' (1197) fields, a 'Radius' field (20), and a 'Symmetries' section with checkboxes for H, V, D, and Axial. Below these are color and weight parameters: R/K (0.002537), G (0.003620), B (0.003985), Fixed (checkbox), Wr (0.969), Wg (0.966), and Wb (0.959). A small preview window shows a noisy sample. The 'Model Parameters (1)' section includes 'Tolerance' (1.000), 'Shadows relaxation' (3.000), and 'Smoothing factor' (0.250) with an 'Unweighted' checkbox. The 'Model Parameters (2)' section is currently collapsed. The 'Sample Generation' section includes 'Default sample radius' (20), 'Samples per row' (10), and 'Minimum sample weight' (0.750). It also has color selection for 'Sample color', 'Selected sample color' (green), and 'Bad sample color' (red). The 'Model Image' section is collapsed. The 'Target Image Correction' section includes a 'Correction' dropdown (Subtraction), checked boxes for 'Normalize' and 'Discard background model', an unchecked box for 'Replace target image', an 'Identifier' field (<Auto>), and a 'Sample format' dropdown (Same as target).

# AutomaticBackgroundExtractor





# PixelMath

PixelMath

Expressions

R/K:  $0.7*s2 + 0.3*ha$

G:  $0.3*ha + 0.6*o3 + 0.1*s2$

B:  $0.8*o3 + 0.2*ha$

A:

Symbols:

Use a single RGB/K expression  Use 64-bit working images

Rescale result: Lower bound: 0.0000000000 Upper bound: 1.0000000000

PixelMath

Expressions

RGB/K:  $\sim(\sim MIXSHO\_AIP * \sim(MIXSHO\_AIP1\_DBE / k))$

G:

B:

A:

Symbols:  $k=1.5$

Use a single RGB/K expression  Use 64-bit working images

Rescale result: Lower bound: 0.0000000000 Upper bound: 1.0000000000

Destination

Replace target image  Create new image

Image Id: <Auto>

Image width: <As target> Image height: <As target>

Color space:  Same as target  RGB Color  Grayscale  Alpha channel

Sample format: 32-bit IEEE 754 floating point (single precision)

PixelMath

Destination

Replace target image  Create new image

Image Id: <Auto>

Image width: <As target> Image height: <As target>

Color space:  Same as target  RGB Color  Grayscale  Alpha channel

Sample format: Same as target

PixelMath Expression Editor: Channel #1

$0.3*ha + 0.6*o3 + 0.1*s2$

- a( [xc, yc] )
- abs( x )
- acos( x )
- acosh( x )
- adev( a, b, c[, ...] ) | adev( img )
- asin( x )
- asinh( x )
- atan( y[, x=1] )
- atanh( x )
- avg( a, b[, ...] ) | avg( img )
- avgDev( a, b, c[, ...] | avgDev( img )
- ceil( x )

--> 3 Images Available <--

<\* No Symbols Defined \*>

Parse

OK Cancel

\* Select a PixelMath function or operator on the list above.

INDISPENSABLE !

# La déconvolution : la PSF

The screenshot displays the Pixinsight 1.7 x86 interface. The main window shows a grayscale image of a star field with green crosses marking detected stars. A 'DynamicPSF' window is open, displaying a table of star parameters. Below the table, the 'PSF Model Functions' section shows 'Auto' selected, and 'Gaussian' is also checked. The 'Star Detection' section shows a search radius of 8 and a background threshold of 1.00. An 'Average Star Data' window is also open, showing the average Moffat PSF parameters for the 63 stars.

	Ch	B	A	cx	cy	sx	sy	FWHMx	FWHMy	r	theta
M106PI											
1	0										
Moffat	0.013667	0.033037	792.40	438.50	2.18	2.01	1.91px	1.76px	0.920	171.79	
2	0										
Moffat	0.013732	0.159002	701.96	527.80	2.10	2.01	1.92px	1.83px	0.954	162.46	
3	0										
Moffat	0.013715	0.006480	595.36	1307.25	2.01	1.92	1.90px	1.81px	0.955	153.63	
4	0										
Moffat	0.013745	0.030206	853.95	1191.43	2.32	2.19	1.92px	1.81px	0.945	170.81	
5	0										
Moffat	0.013713	0.012010	1383.55	1182.55	2.41	2.26	1.95px	1.82px	0.935	165.99	
6	0										
Moffat	0.013697	0.011685	1156.41	1864.49	2.04	1.93	1.91px	1.81px	0.945	4.12	
7	0										
Moffat	0.013736	0.026384	859.51	1659.82	2.17	2.10	1.90px	1.84px	0.969	163.58	
8	0										
Moffat	0.013721	0.015735	885.71	1696.92	2.45	2.32	1.92px	1.82px	0.945	165.49	

**Average Star Data**

Average Moffat PSF

N ..... 63 stars

B ..... 0.013778

A ..... 0.044840

sx ..... 2.17 px

sy ..... 2.01 px

FWHMx ... 1.92 px

FWHMy ... 1.80 px

r ..... 0.938

theta ..... 164.53 deg

beta ..... 3.89

MAD ..... 5.226e-003

# La déconvolution

PixInsight

Gray 1:4 M106PI | M106PI.fit

Deconvolution

PSF

Parametric PSF Motion Blur PSF External PSF

View Identifier

PSF2

PSF2

11 x 11

Algorithm

Algorithm: Regularized Richardson-Lucy

Iterations: 50

Target: Luminance (CIE Y)

Deringing

Global dark: 0.0600

Global bright: 0.0000

Local deringing

Local support: star\_mask

Local amount: 0.25

Wavelet Regularization

Noise model: Gaussian Wavelet layers: 3 B3 Spline (5)

Noise threshold Noise reduction

1: 4.00 1.00

2: 3.20 1.00

3: 2.20 0.70

4: 1.00 0.70

5: 1.00 0.70

Convergence: 0.0000  Disabled

Dynamic Range Extension

ScreenTransferFunction: PSF2

M106PI

Gray 14:1 ...

PSF2

Average Star Data

Average Moffat PSF

N ..... 62 stars

B ..... 0.013612

A ..... 0.145635

sx ..... 0.73 px

FWHMx ... 1.04 px

FWHMy ... 0.96 px

theta ... 118.96 deg

beta .... 1.71

MAD ..... 2.056e-003

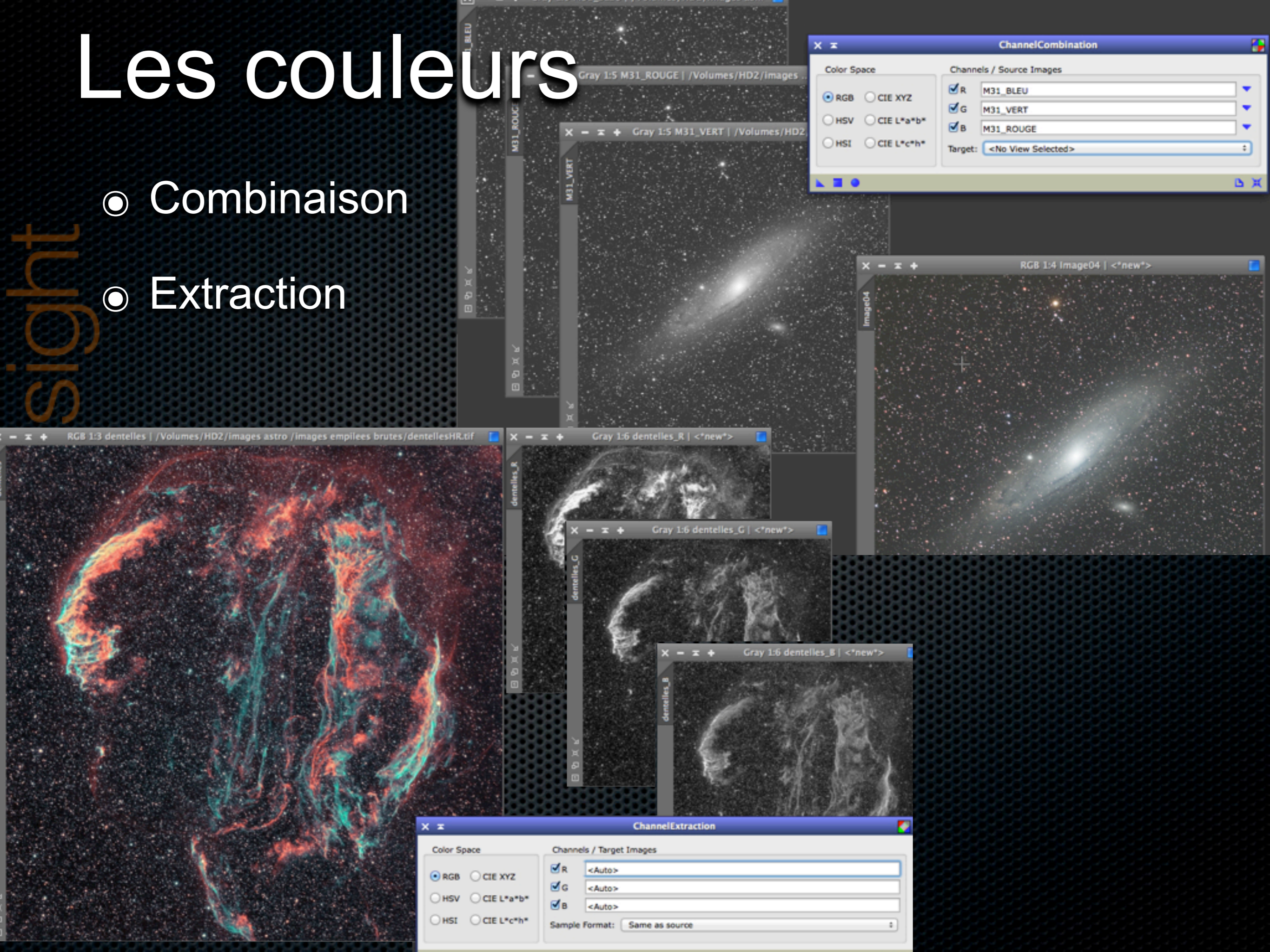
ScreenTransferFunction: PSF2

K: G: B:

# Les couleurs

- Combinaison
- Extraction

sight



# La calibration des couleurs

PixInsight

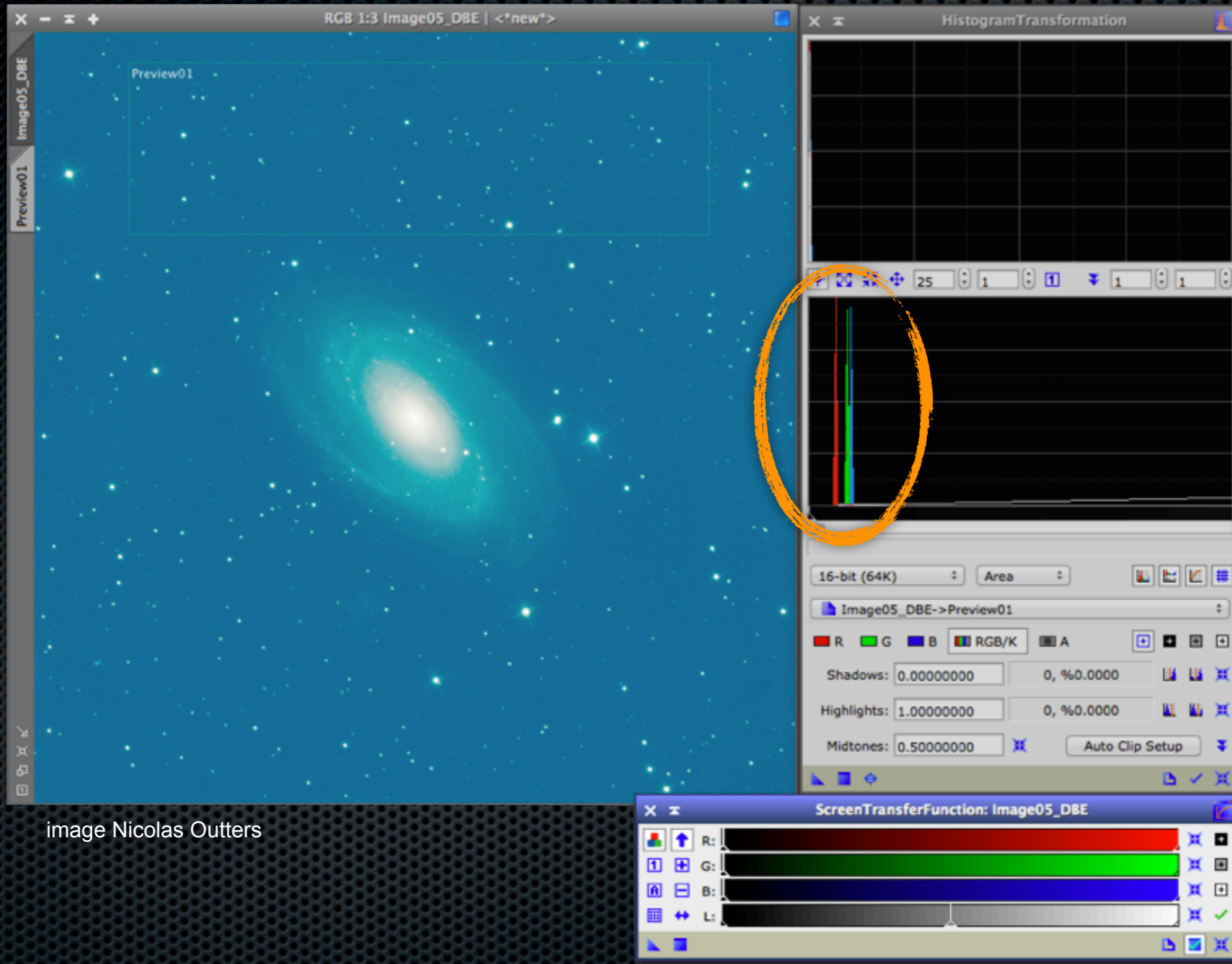
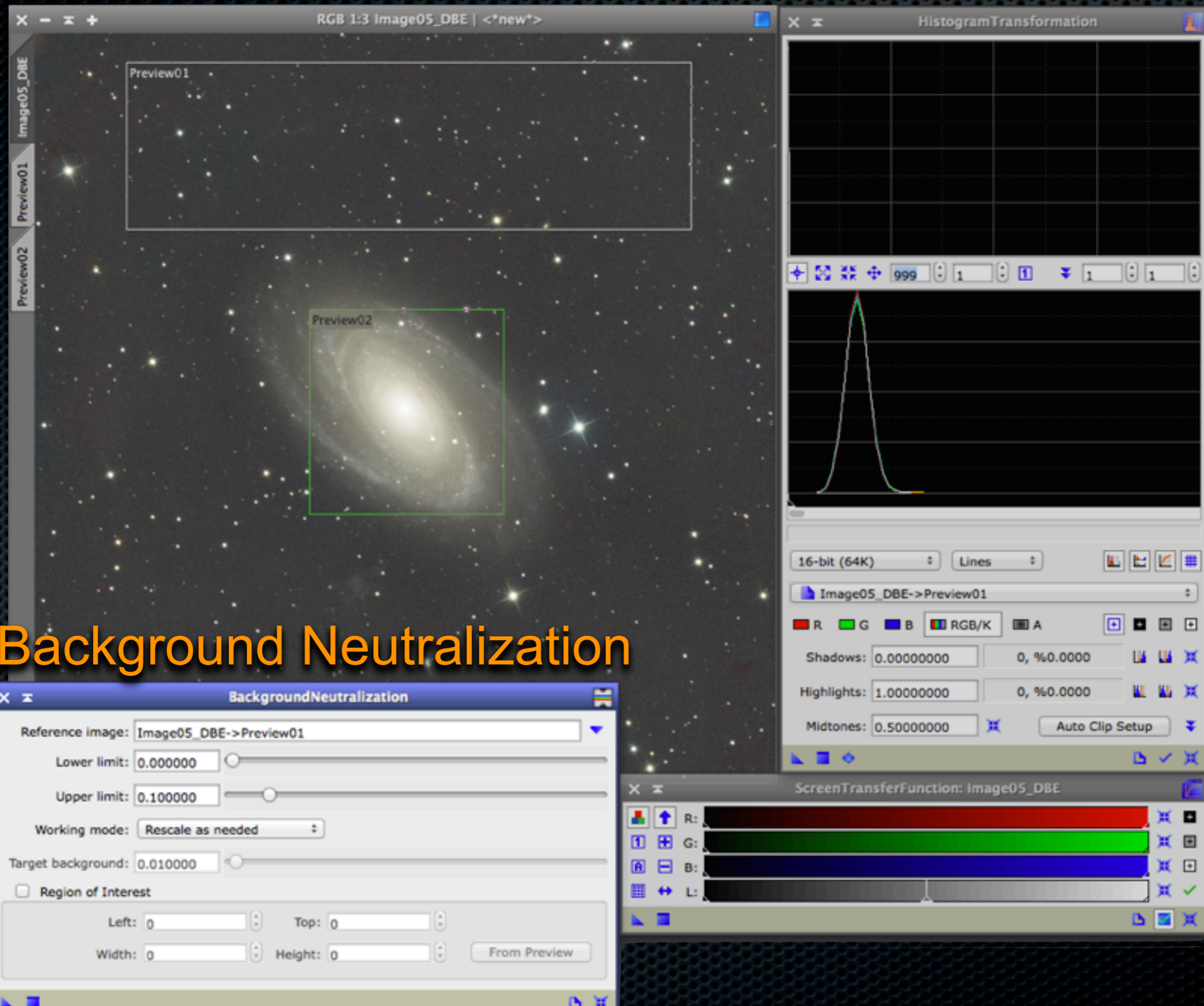


image Nicolas Outters

# La calibration des couleurs

PixInsight



Background Neutralization

# La calibration des couleurs

PixInsight

The screenshot shows the PixInsight interface with the following elements:

- Main Window:** Displays a star field image. Two preview windows are visible: **Preview01** (top) and **Preview02** (bottom, showing a galaxy).
- ColorCalibration Dialog:** Open on the right side, showing two reference sections:
  - White Reference:** Reference image: Image05\_DBE->Preview02. Lower limit: 0.00000. Upper limit: 0.90000. Region of Interest: Left: 0, Top: 0, Width: 0, Height: 0. Structure Detection: Structure layers: 5, Noise layers: 1. Manual White Balance: Red: 1.0000, Green: 1.0000, Blue: 1.0000. Output white reference mask: .
  - Background Reference:** Reference image: Image05\_DBE->Preview01. Lower limit: 0.000000. Upper limit: 0.100000. Region of Interest: Left: 0, Top: 0, Width: 0, Height: 0. Output background reference mask: .
- Color Calibration Bar:** Located at the bottom, showing color bars for R (Red), G (Green), B (Blue), and L (Luminance).

Color Calibration

# La calibration des couleurs

The screenshot displays the PixInsight interface for color calibration. The main window shows an image of a star field with two preview windows: Preview01 (top) and Preview02 (bottom). Two orange arrows point from these preview windows to corresponding HistogramTransformation dialog boxes on the right.

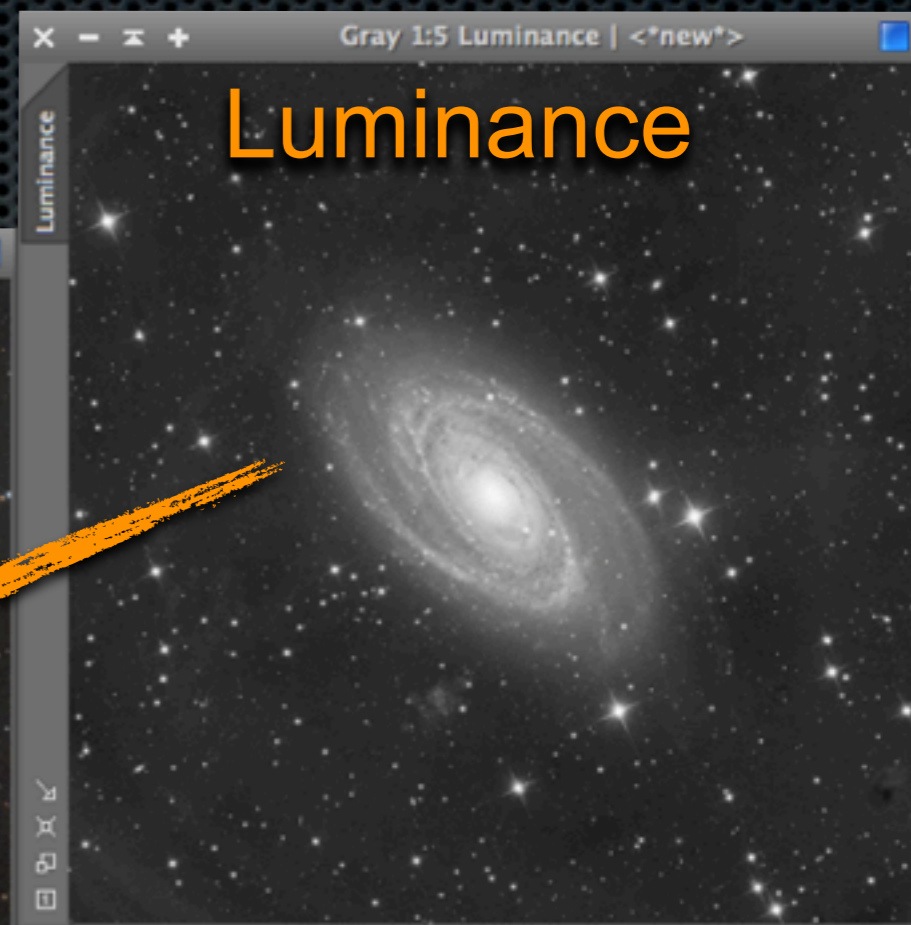
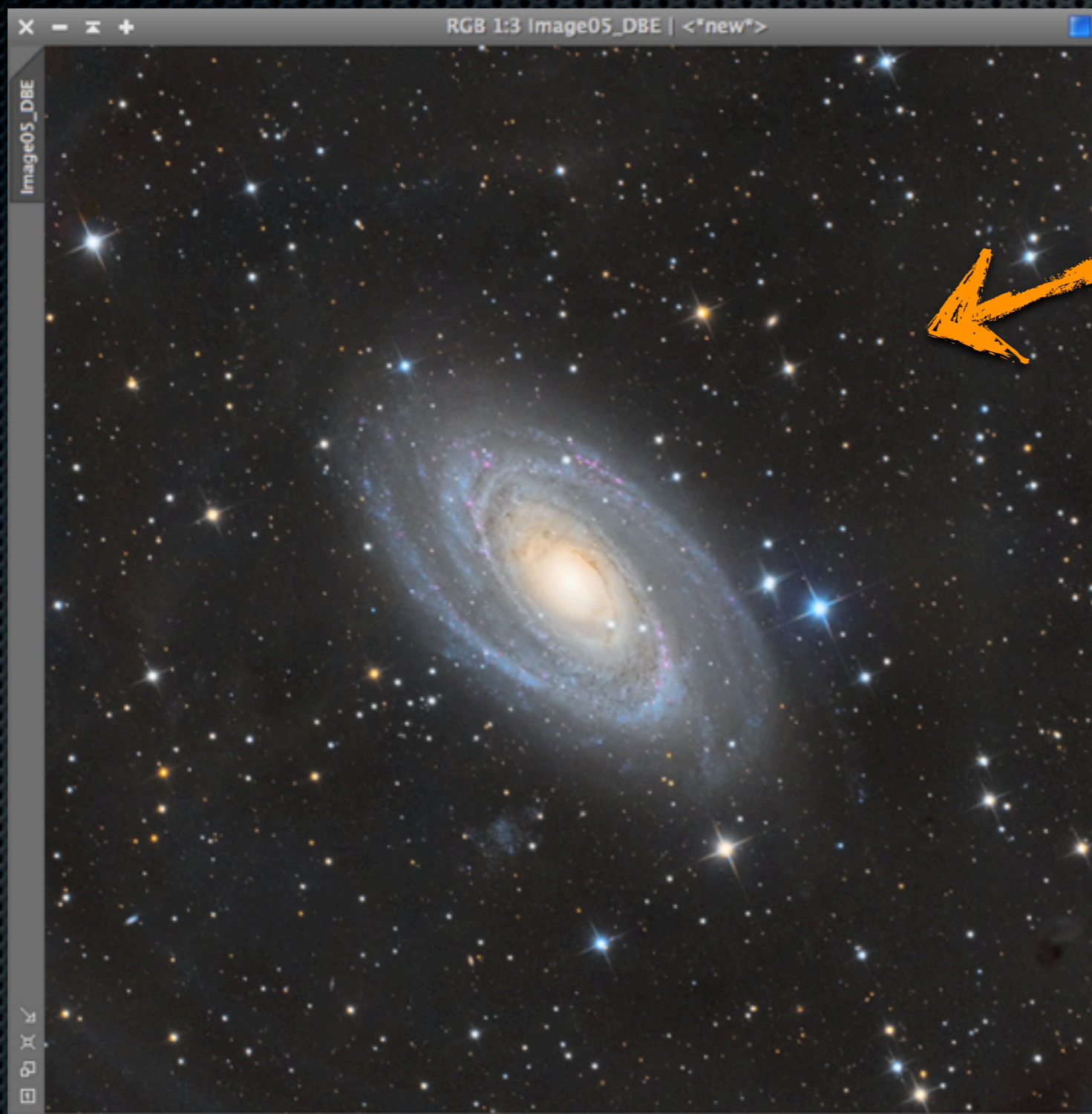
The top HistogramTransformation dialog is for Preview01. It shows a histogram with a single sharp peak, indicating a narrow range of colors. The dialog includes a 'Lines' dropdown and a 'Preview' button.

The bottom HistogramTransformation dialog is for Preview02. It shows a histogram with a broad, multi-peaked distribution, indicating a wide range of colors. The dialog includes a 'Lines' dropdown, a 'Preview' button, and a 'Histogram' button. Below the histogram, the 'Shadows' and 'Highlights' sliders are set to 0.0000000 and 1.0000000 respectively, and the 'Midtones' slider is set to 0.5000000. The 'Auto Clip Setup' button is also visible.



# LRGB

PixInsight



LRGBCombination

Channels / Source Images

- L Luminance
- R <Auto>
- G <Auto>
- B <Auto>

Target: <No View Selected>

Channel Weights

Transfer Functions

Lightness: 0.500

Saturation: 0.200

Chrominance Noise Reduction

Smoothed wavelet layers: 4

Protected wavelet layers: 2

This panel contains the settings for the LRGBCombination process. It includes checkboxes for the L, R, G, and B channels, a target selection dropdown, sliders for Lightness (0.500) and Saturation (0.200), and a checked checkbox for Chrominance Noise Reduction. It also features numerical input fields for Smoothed wavelet layers (4) and Protected wavelet layers (2).

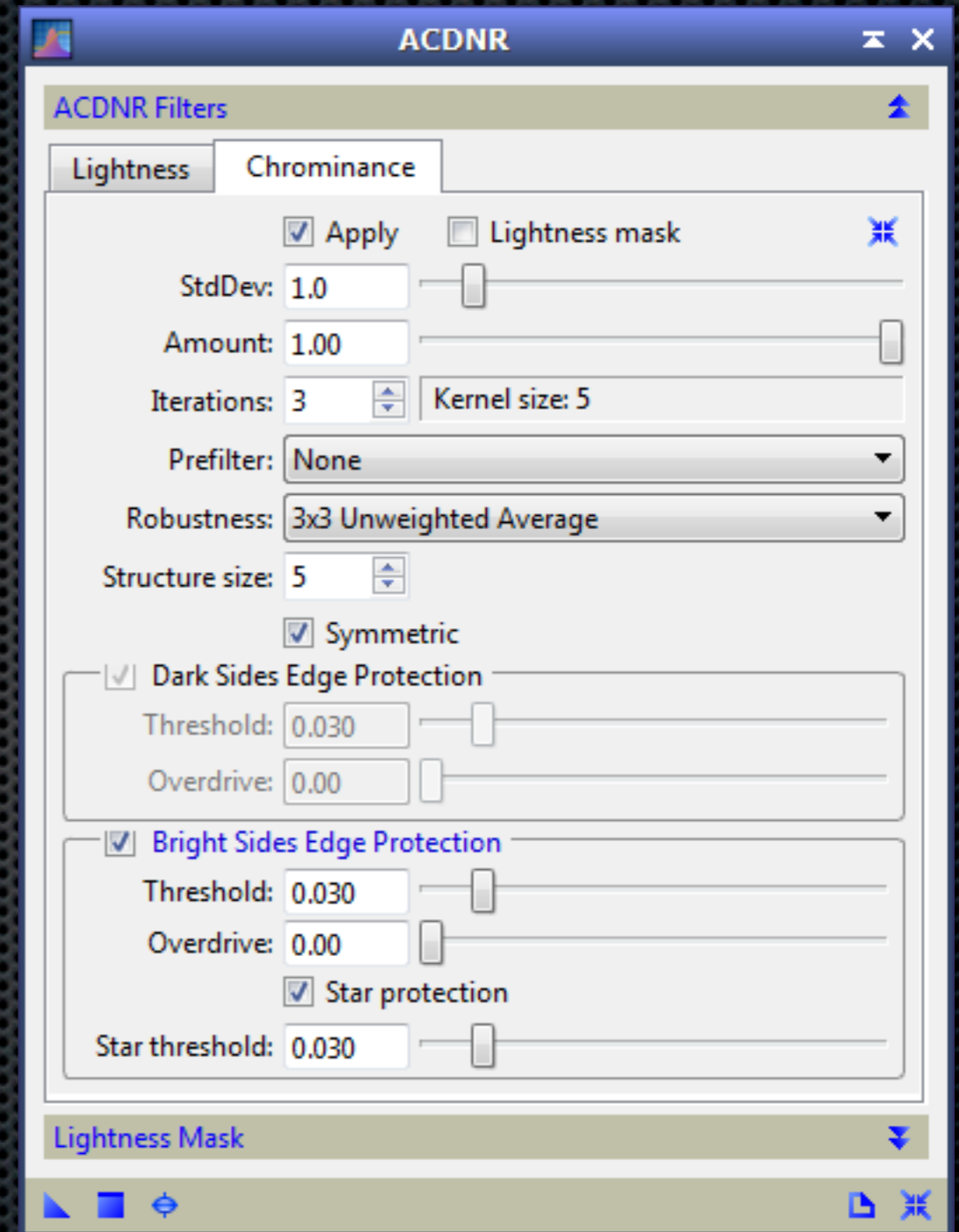
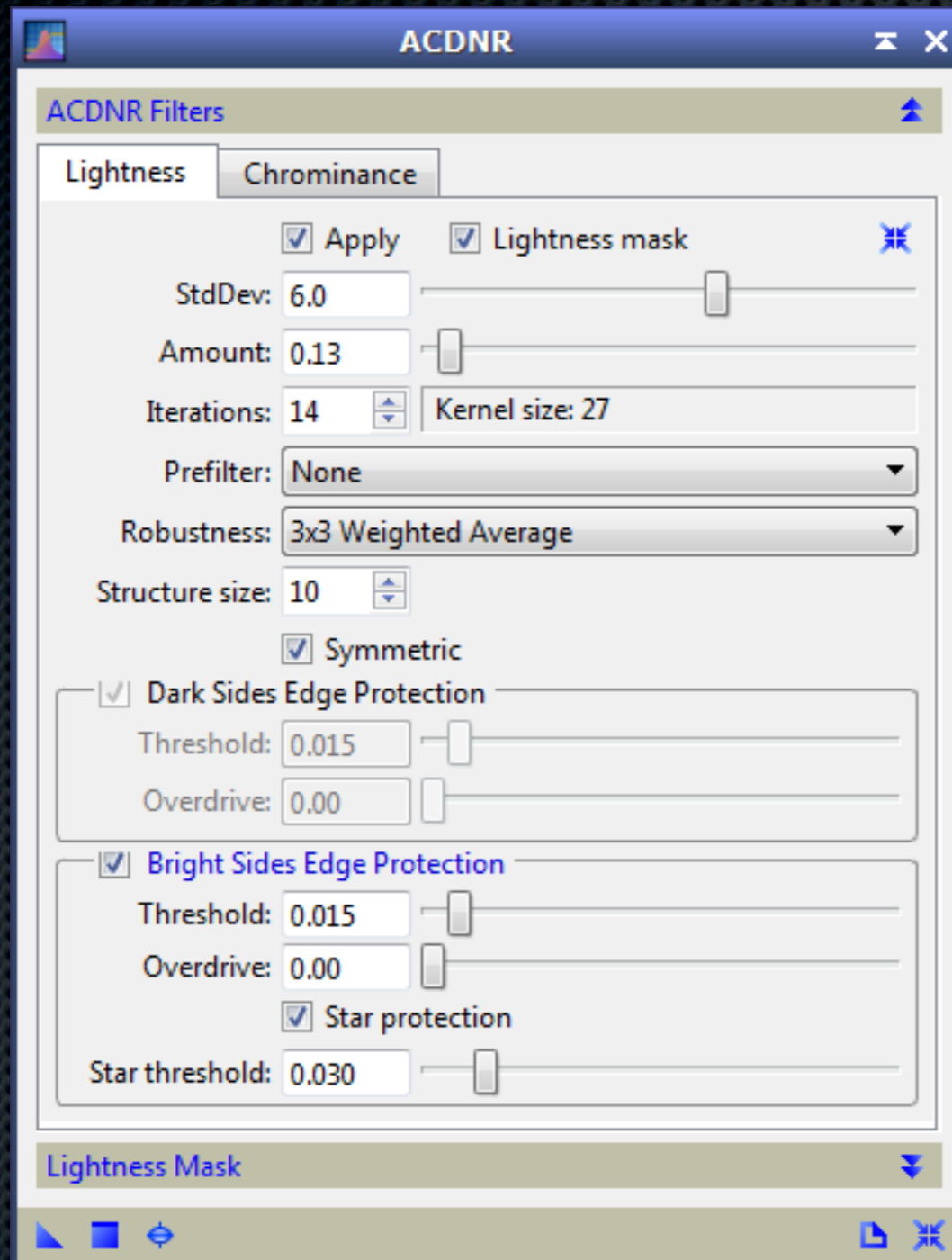
# Le bruit... pas moins de 6 fonctions

La réduction du bruit est souvent une étape clé du traitement mais c'est aussi une décision puisqu'il y a toujours un risque que l'algorithme détruise des données essentielles en plus du bruit.

- **ACDNR** *Adaptive contrast-driven noise reduction* (Lum+Chroma / non-linéaire)
- **SCNR** *Subtractive Chromatic Noise Reduction* (Chroma / non-linéaire)
- **GREYCstoration** (Lum / non-linéaire)
- **ATrouWaveletTransform** (Lum+Chroma / linéaire, non-lin.)
- **MultiscaleMedianTransform** (Lum+Chr / lin., non-lin)
- **LRGB Combination** (Chroma / non-linéaire)

# ACDNR

PixInsight



Luminance

Chroma

# MultiscaleMedianTransform

# ATrouWaveletTransform

PixInsight

Luminance  
et/ou  
Chroma

**MultiscaleMedianTransform**

Wavelet Layers

Dyadic  Linear: 0 Layers: 8

Scaling Function: B3 Spline (5)

Layer	Scale	Parameters
✓ 1	1	S(t=1.0000, s=0.10, a=1.5000)
✓ 2	2	S(t=1.0000, s=0.10, a=1.0000)
✓ 3	4	S(t=1.0000, s=0.10, a=0.5000)
✓ 4	8	S(t=1.0000, s=0.10, a=0.3000)
✓ 5	16	S(t=1.0000, s=0.10, a=0.1000)
✓ 6	32	S(t=0.5000, s=0.10, a=0.0000)
✓ 7	64	S(t=0.3000, s=0.10, a=0.0000)
✓ 8	128	
✓ R	256	

Multiscale Layer 1/8

Bias: 0.000

Noise Reduction

Threshold: 1.0000

Amount: 0.10

Adaptive: 1.5000

Dynamic Range Extension

Target: RGB/K components Layer Preview: No layer preview

**ATrouWaveletTransform**

Wavelet Layers

Dyadic  Linear: 0 Layers: 8

Scaling Function: B3 Spline (5)

Layer	Scale	Parameters
✓ 1	1	
✓ 2	2	
✓ 3	4	
✓ 4	8	
✓ 5	16	
✓ 6	32	
✓ 7	64	
✓ 8	128	
✓ R	256	

Detail Layer 1/8

Bias: 0.000

Noise Reduction

Threshold: 3.000

Amount: 1.00

Iterations: 1

k-Sigma Noise Thresholding

Threshold: 3.00

Amount: 0.50

Soft thresholding

Use multiresolution support

Deringing

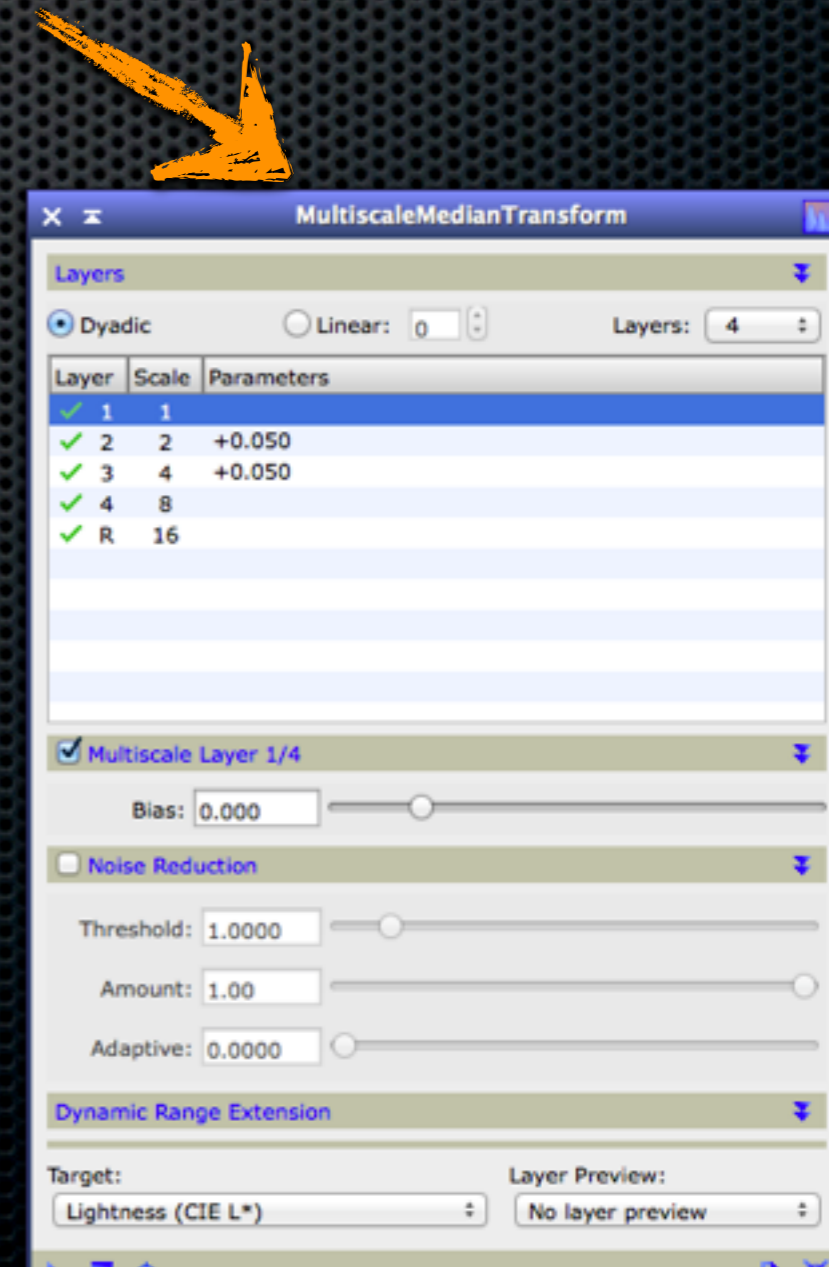
Large-Scale Transfer Function

Dynamic Range Extension

Target: RGB/K components Layer Preview: No layer preview

# L'accentuation... 5 fonctions

- UnsharpMask
- MultiscaleMedianTransform
- ATrouWaveletTransform
- RestorationFilter
- Deconvolution

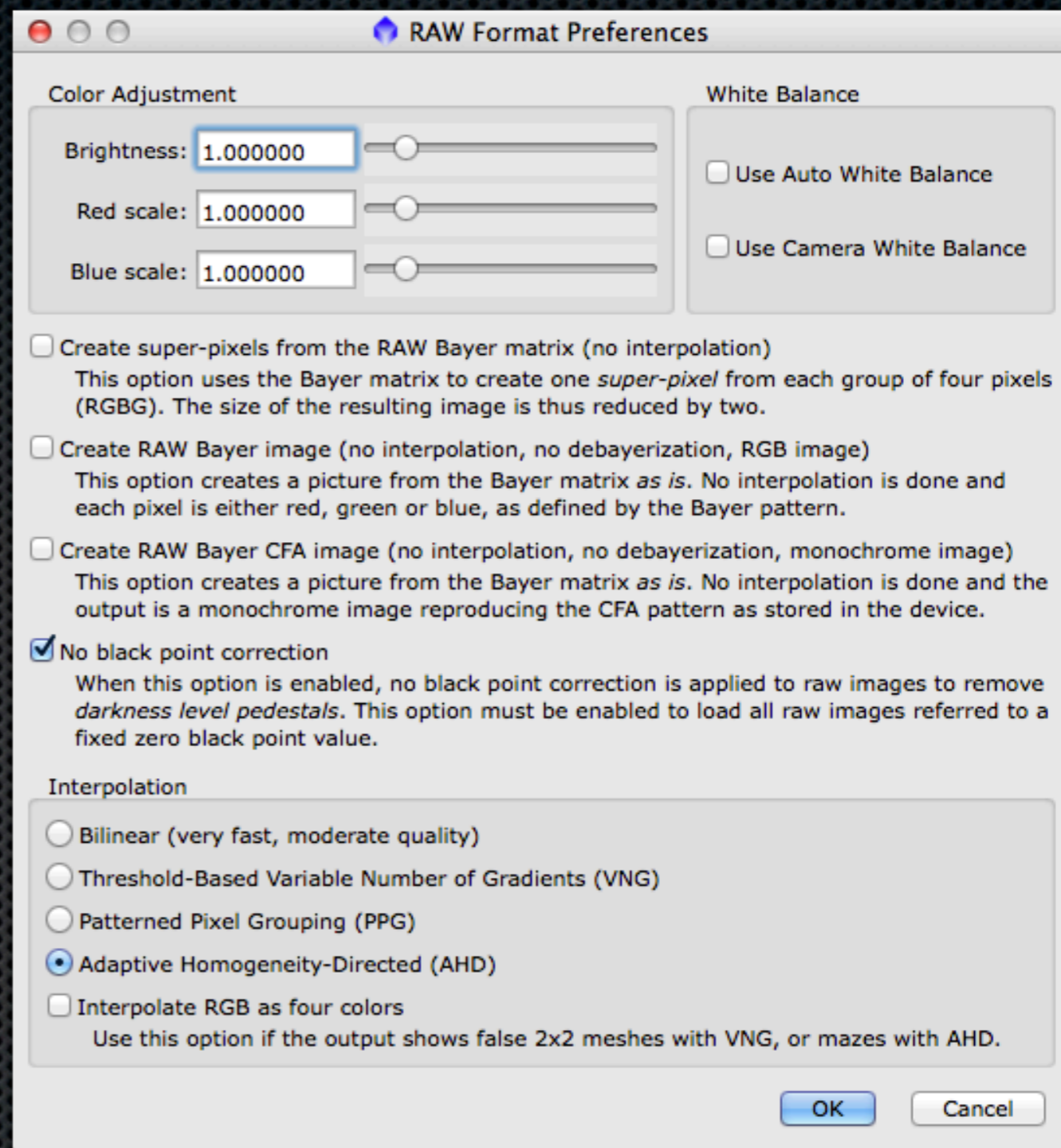
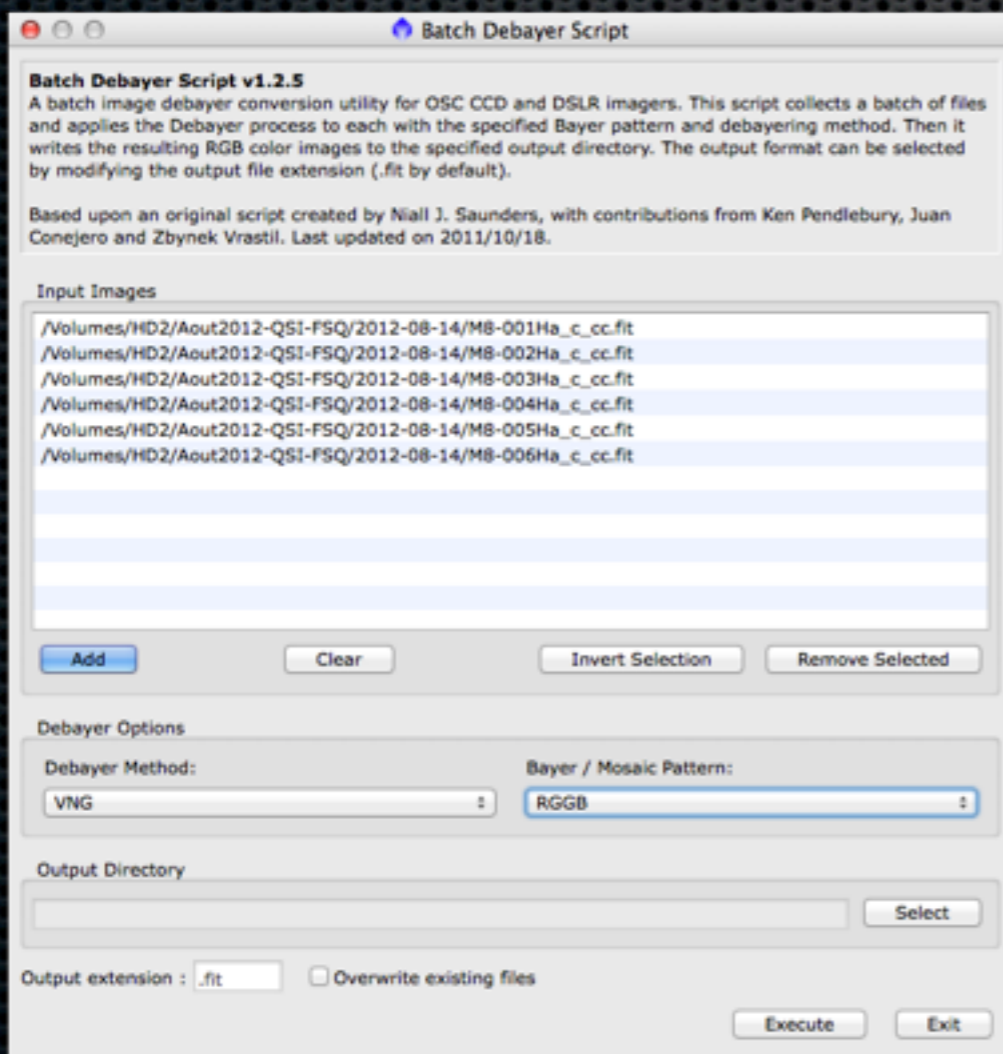


# Les APN

● RAW

● Debayer

PixInsight

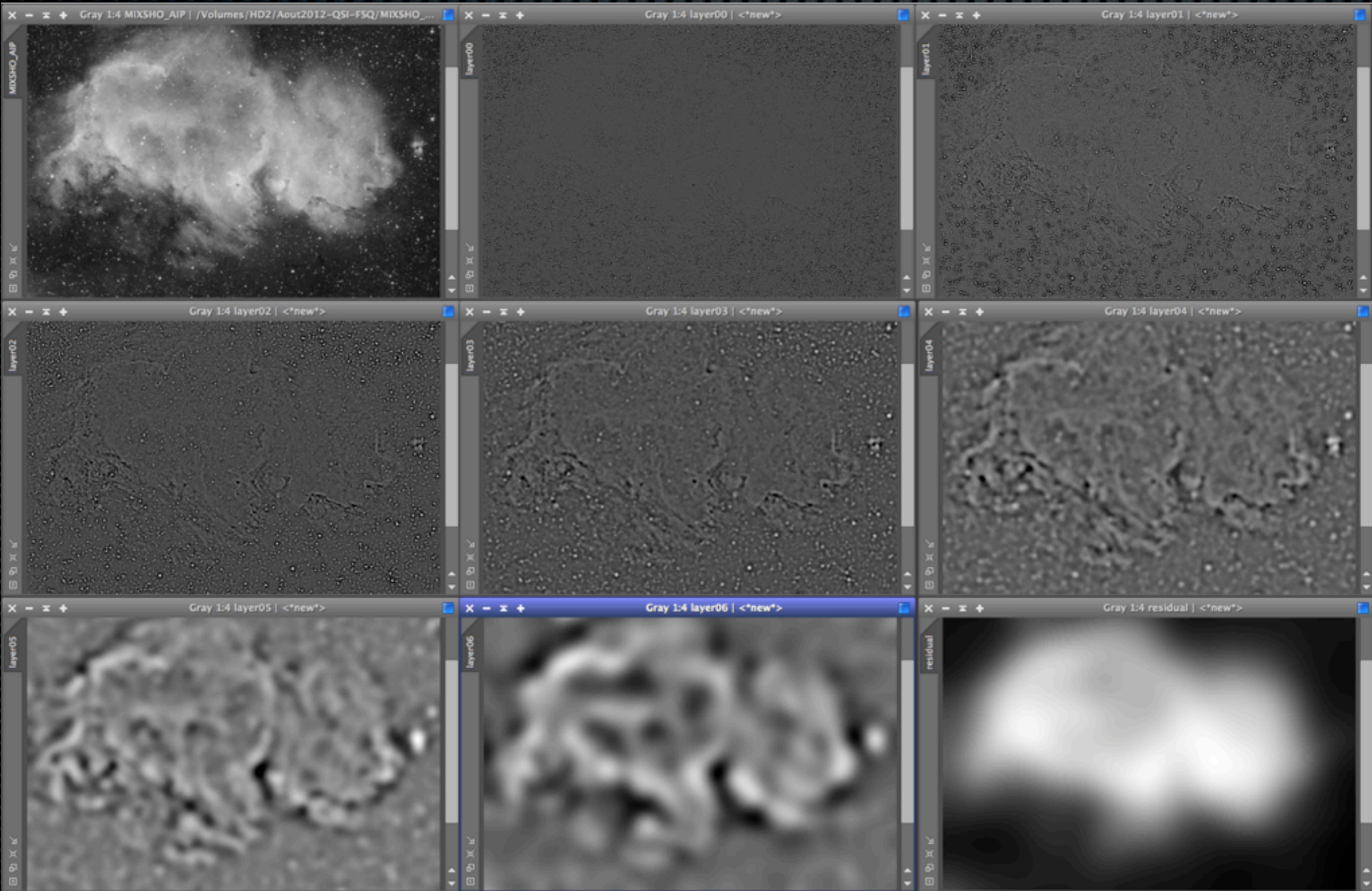


# Et les autres...

- Fonctions géométriques
- Fonctions d'interpolation
- Couleurs
- Transformée de Fourier
- HDR sur plusieurs images
- Mosaïques
- *j'en oublie...*



# Multiscale : analysez vos images





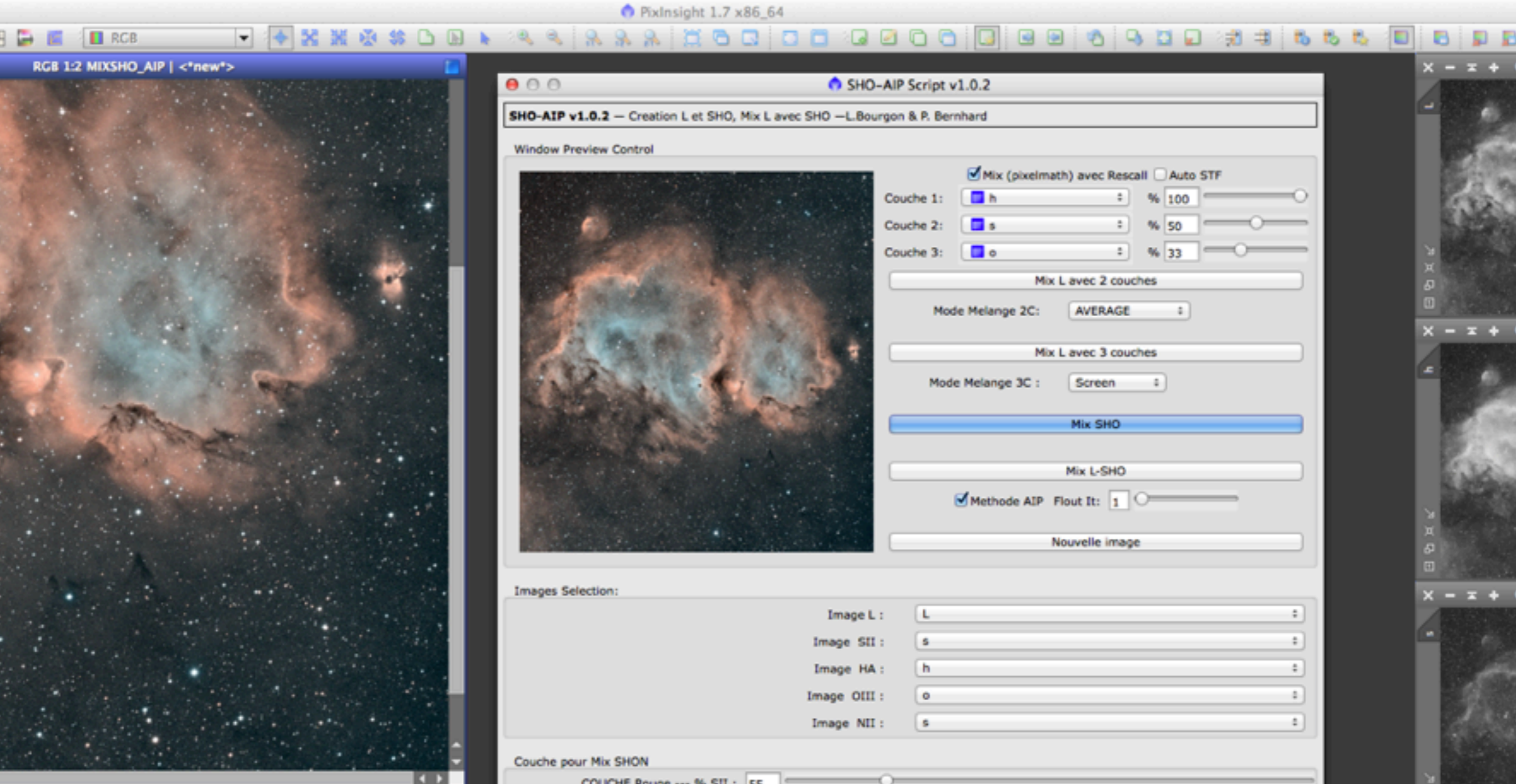
# Les scripts

The screenshot displays the PixInsight Script Editor interface. On the left, a 'View Explorer' pane lists various 'External Objects' under the 'Core JavaScript Objects' category, including ACDNR, ATrousWaveletTransf..., AdaptiveStretch, Annotation, AssignICCProfile, AssistedColorCalibra..., AutoHistogram, AutomaticBackgrou..., B3Estimator, BackgroundNeutraliz..., Binarize, Blink, ChannelCombination, ChannelExtraction, ChannelMatch, CloneStamp, ColorCalibration, ColorManagementSet..., ColorSaturation, ConvertToGrayscale, ConvertToRGBColor, Convolution, CosmeticCorrection, CreateAlphaChannels, Crop, CurvesTransformation, Debayer, Deconvolution, DefectMap, DigitalDevelopment, Divide, DynamicAlignment, DynamicBackgroundE..., and DynamicCrop.

The main editor window, titled 'SHO-AIP.js', contains the following JavaScript code:

```
334 }
335
336 var engine = new Inset;
337
338 function ii_dialog() {
339
340 this. base = Dialog;
341 this. base ();
342 var labelWidth1 = this.font.width( "-----" + 'T' );
343
344 this.ApplyAutoSTF = function( view, shadowsClipping, targetBackground)
345 {
346     var stf = new ScreenTransferFunction;
347
348     var n = view.image.isColor ? 3 : 1;
349
350     var A = [ // c0, c1, m, r0, r1
351             [0, 1, 0.5, 0, 1],
352             [0, 1, 0.5, 0, 1],
353             [0, 1, 0.5, 0, 1],
354             [0, 1, 0.5, 0, 1] ];
355
356     for ( var c = 0; c < n; ++c ) {
357         view.image.selectedChannel = c;
358         var median = view.image.median();
359         var avgDev = view.image.avgDev();
360
361         if ( median < 0.5 ) { // Noninverted channel
362             var c0 = Math.range( median + shadowsClipping*avgDev, 0.0, 1.0 );
363             var m = findMidtonesBalance( targetBackground, median - c0 );
364             A[c] = [c0, 1, m, 0, 1];
365         } else { // Inverted channel
366             var c1 = Math.range( median - shadowsClipping*avgDev, 0.0, 1.0 );
367             var m = 1 - findMidtonesBalance( targetBackground, c1 - median );
368             A[c] = [0, c1, m, 0, 1];
369         }
370     }
371
372     stf.STF = A;
373     view.image.resetSelections();
374     stf.executeOn( view );
375 }
376
377 this.Calculate_L = function(c)
378 {
379     if(Dejala==0)
380     {
381         Dejala=1;
382         this.cursor = new Cursor( StdCursor_ArrowWait);
383         console.show();
384         var scale L1 = opacityL1/100;
385         var scale L2 = opacityL2/100;
386         var FL1 = format("%.2f", scale L1);
387         var FL2 = format("%.2f", scale_L2);
388
389         var FL = "";
390
391         if(c==3)
392         {
393             var scale L3 = opacityL3/100;
394             var FL3 = format("%.2f", scale_L3);
395
396
```

The status bar at the bottom shows the file path: /Volumes/HD2/scripts Pixinsight/SHO/SHO-AIP.js, the page number 128, and the version 1. The bottom right corner displays 'INS'.



Les scripts

```
putative star pair matches.
forming RANSAC ...
star pair matches in 130 RANSAC iterations.
ary of model properties:
ers : 0.762
lapping : 0.978
arity : 0.964
ity : 0.883
ean square error:
: 0.345 px
age RMS error deviation:
: 0.204 px
errors:
: 1.381 px
: 1.236 px
sformation matrix:
-0.9997 -0.8255 +2064.7347
+0.0257 -1.0081 +2012.4393
+0.0000 +0.0000 +1.0000
e : 0.999
tion : -181.45°
: +2064.73 px
: +2012.44 px
3 s
ation 2, delta = 0.197 arcsec (0.1 pixels)
e center ..... RA: 02 55 00.279 Dec: +60 31 01.72
lution ..... 3.93 arcsec/pix
e Plate Solver script version 1.51
entiation Matrix (Gnomonic projection = Matrix * Coords[x,y]):
+0.001091148462 -0.000027856936 -1.004035520758
+0.000020000633 +0.001090779784 -1.140105925929
+0.000000000000 +0.000000000000 +1.000000000000
lution ..... 3.929 arcsec/pix
tion ..... 178.543 deg
l ..... 388.51 mm
l size ..... 7.40 um
d of view ..... 2d 13' 30.7" x 2d 13' 26.8"
e center ..... RA: 02 55 00.279 Dec: +60 31 01.72
e bounds:
op-left ..... RA: 02 46 37.861 Dec: +59 21 35.76
op-right ..... RA: 03 04 06.317 Dec: +59 24 54.37
ottom-left .... RA: 02 45 33.064 Dec: +61 34 44.36
ottom-right ... RA: 03 04 15.897 Dec: +61 38 16.98
--execute-mode=auto
lications/PixInsight64.app/Contents/src/scripts/ImageSolver+AnnotateImage/ImageSolver.js"
essing script file:
lications/PixInsight64.app/Contents/src/scripts/ImageSolver+AnnotateImage/ImageSolver.js
Pause/Abort
```



Image Plate Solver Script

Image Plate Solver v1.51 — A script for plate-solving astronomical images. The values are initialized from existing WCS coordinates or the keywords OBJECTRA, OBJECTDEC, FOCALLEN, XPIXSZ and DATE\_OBS if present.

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Image parameters

Right Ascension (hms): 2 : 55 : 7.747 Search

Declination (dms): 60 : 31 : 1.62 S

Epoch (ymd): 2012 : 8 : 20

Image scale:  Focal distance (mm): 388.509  Resolution (arcsec/px): 3.92876

Pixel size (um): 7.4

Model Parameters

Local star catalog: /Users/Macbookpro/Documents/PPMXL.bin

VizieR star catalog: PPMXL CDS (vizier.u-strasbg.fr) Strasbourg, France

Limit magnitude: 12

Star sensitivity: -1.00 Show stars

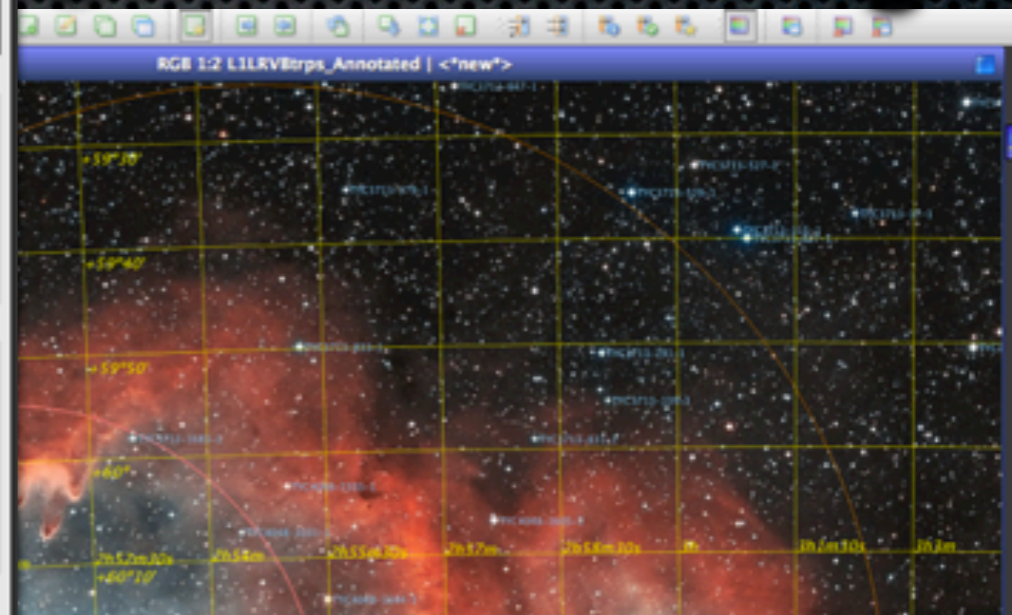
Maximum iterations: 4

Update FITS keywords  Add WCS keywords

Reset OK Cancel

# Le fun...

- ImageSolver
- AnnotateImage



10772 bytes transferred in 0.042 s @ 0.000 MB/s

Catalog TYCHO-2 size: 210 objects

Image Annotation Script

Image Annotation v1.11 — A script for annotating astronomical images. This script draws on the image coordinate grids and symbols of objects extracted from different astronomical catalogs. The script requires the image to have coordinates stored in FITS header keywords following the WCS convention. The Image Plate Solver script can be used to generate these coordinates and keywords.

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Layers

Layer	Description
<input checked="" type="checkbox"/> Grid	Grid in equatorial coordinates
<input checked="" type="checkbox"/> NamedSt...	HD-DM-GC-HR-HIP-Bayer-Flamsteed Cross Index(36...
<input checked="" type="checkbox"/> NGC-IC	NGC and IC catalogs (9900 objects)
<input checked="" type="checkbox"/> TYCHO-2	Tycho-2 catalog (2,539,913 stars)
<input type="checkbox"/> PGC	PGC HYPERLEDA I catalog of galaxies (983,261 galax...
<input type="checkbox"/> PPMXL	PPMXL catalog (910,469,430 objects)
<input checked="" type="checkbox"/> Sharpless	Catalog of HII Regions - Sharpless (313 nebulaes)
<input checked="" type="checkbox"/> VdB	Catalog of Reflection Nebulae - Van den Bergh (159 ...)

Grid Parameters

Show markers

Color: Custom (255,255, 0) 255

Width: 1

Show labels

Font: SansSerif 22 Bold Italic

Color: Custom (255,255, 0) 255

Grid density: 10

General Properties

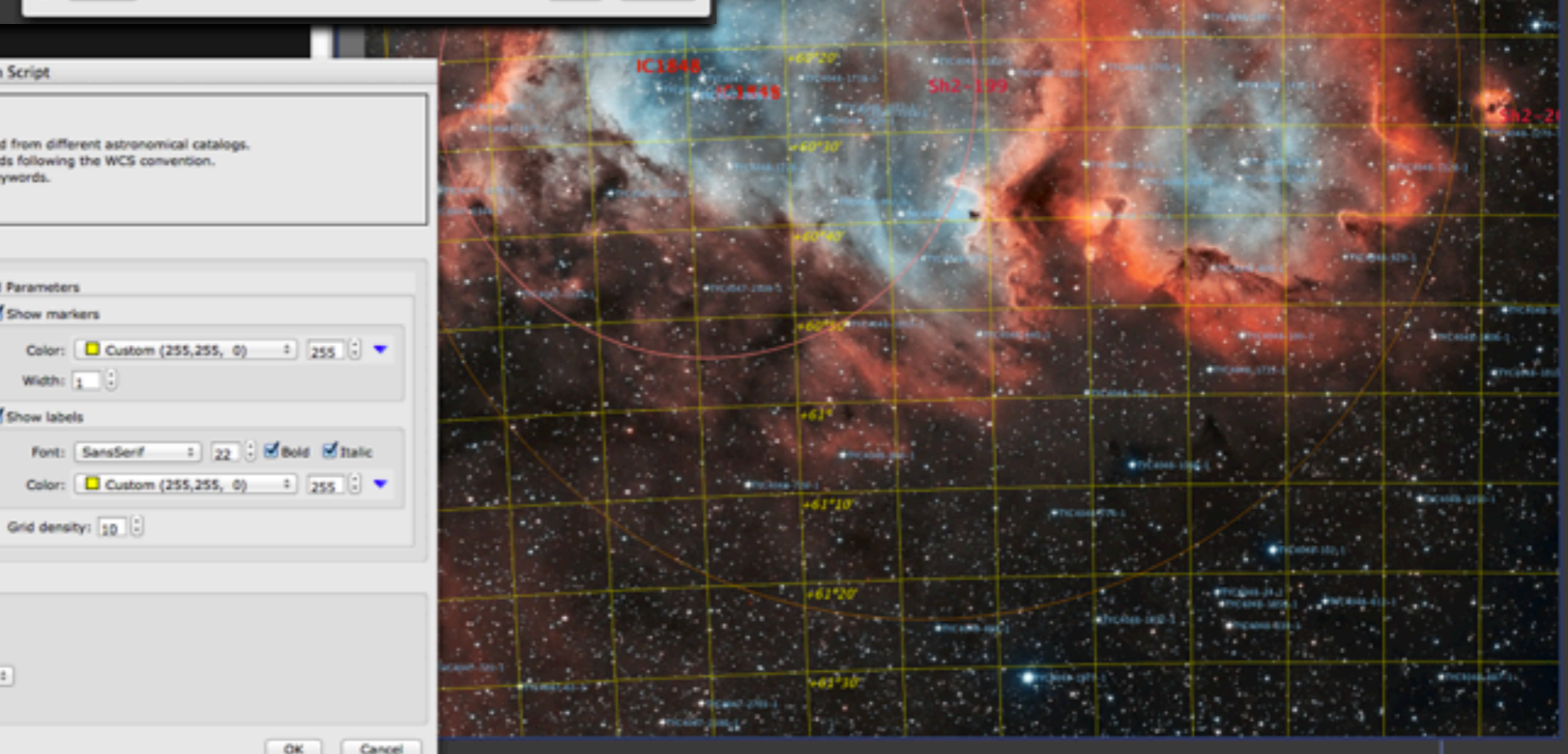
Output mode: Annotate image Apply STF before annotation

Epoch (ymd): 2000 1 1

Vizier server: CDS (vizier.u-strasbg.fr) Strasbourg, France

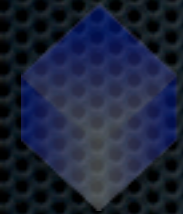
Remove duplicate objects

Reset OK Cancel



# Une communauté active...

- site web : <http://pixinsight.com/>
- forum actif et riche en informations :  
<http://pixinsight.com/forum/index.php>
- AIP organise régulièrement des stages de formation à Pixinsight  
<http://www.astro-images-processing.fr/>
- Nombreux scripts et process développés par des utilisateurs
- tutoriels divers sur différents sites web



Merci...













