

CCD Imaging and Processing - AA3

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CCD Imaging and Processing

- ▶ The camera
- ▶ Matching scope with camera
- ▶ Taking the image
- ▶ Processing the image
- ▶ Final results

The Camera

- Choosing the camera
 - ▶ Many different options to start imaging with
 - ◀ Digital camera - easiest way to start
 - Research the web for choices
 - Nice results achieved with Olympus, Nikon and others
 - SLR's coming into popularity (like the Canon D60) but expensive
 - ◀ Webcam - excellent for planets (check QCUIAG)
 - True CCD version (not CMOS based)
 - » Philips Toucam Pro, Vesta Pro, Older Logitech/Connectix
 - ◀ Video camera - I.e. StellaCam-EX: deepsky capable
 - ◀ True CCD camera for astro-imaging

The Camera

- True CCD camera
 - ▶ Several major CCD camera vendors
 - ◀ Apogee - high end cameras (i.e. more expensive)
Utilizes SITE chips - very sensitive as a result of back illumination
 - ◀ FLI - high end cameras (i.e. more expensive)
Also utilizes back illuminated chips, but has more inexpensive offerings as well from Kodak
 - ◀ SAC - very inexpensive to start with
SAC8 the best choice, but requires parallel and USB ports
Older models use vid cam technology for summed exposures
Lacks strong software support, but still relatively new

The Camera

- True CCD camera
 - ▶ Several major CCD camera vendors
 - ◀ SBIG - probably the largest and most recognizable
 - Wide range of cameras based on Kodak chips
 - Excellent standalone autoguiders (STV, ST4)
 - ◀ Starlight Express - great values in a true ccd camera
 - Wide range of cameras based on Sony chips
 - ▶ All are good choices and span prices ranges for all levels of imager

The Camera

- Starlight Express - my choice in 2001!
 - ▶ MX7C - why was this a good choice for me?
 - ◀ An excellent first camera
 - Good for starters and advanced imagers
 - Relatively simple to operate, especially for color images
 - ◀ Affordable by CCD standards
 - 750x582 resolution tops in its price range
 - ◀ Small and compact - 2" dia
 - ◀ Light weight
 - Balance kit not necessary for the LX200
 - Approximately the weight of a good 2" eyepiece
 - ◀ Primary SBIG equivalent considered: ST-7E

The Camera

- Starlight Express

- ▶ MX7C - why was this a good choice for me?

- ◀ One shot camera - color matrix filters - CMY

- Synthesizes RGB from the filtered signals

- Much less overall imaging time involved for color

- » Color filter wheel not required

- Probably not as accurate a color balance as RGB imaging

- Color synthesis routines much improved recently in Astroart

- ◀ Self-guiding capability with Star2000 interface

- Uses the same chip for imaging and guiding

- Sensitivity reduced by 50% as a result

- Full frame can be used to locate a suitable guidestar!

- Simple software interface to self-guide

The Camera

- Starlight Express
 - ▶ Today's alternate choices I would consider
 - ◀ MX716 - very sensitive and low cost - the best value on the market today
 - ◀ SXV-H9 - very sensitive megapixel camera
 - Extremely low noise/dark current
 - Dark frame not used by many SXV imagers
 - ◀ SXV-H9C - good sensitivity, especially for color
 - Uses an RGBG (Bayer Matrix) - not CMYG
 - Color resolution will be much improved
 - Extremely low noise/dark current
 - ◀ Primary SBIG equivalent to consider: ST2000XM

Matching Scope and Camera

- General guidelines

- ▶ Sampling - depends on seeing

- Good seeing (i.e. <2 arc-sec) can tolerate higher resolution sampling rates

- Sampling rate (arc-sec/pixel) = $206 \times (\text{pixel size}) / (\text{focal length})$

- » Pixel size is dependent on the camera

- » FL can be varied by focal reducers and barlow lenses

- Scope and camera should provide a typical sampling rate of between 1 and 3 arc-sec/pixel

- » 12" LX200 @ f/3.3 = 1.7 arc-sec/pixel (good match!)

- » Rates > 2 is undersampling and rates < 2 is oversampling

- » High resolution imagers use 1/3 to 1/4 the seeing value to maximize resolution (i.e. down to 0.5 arc-sec/pixel!)

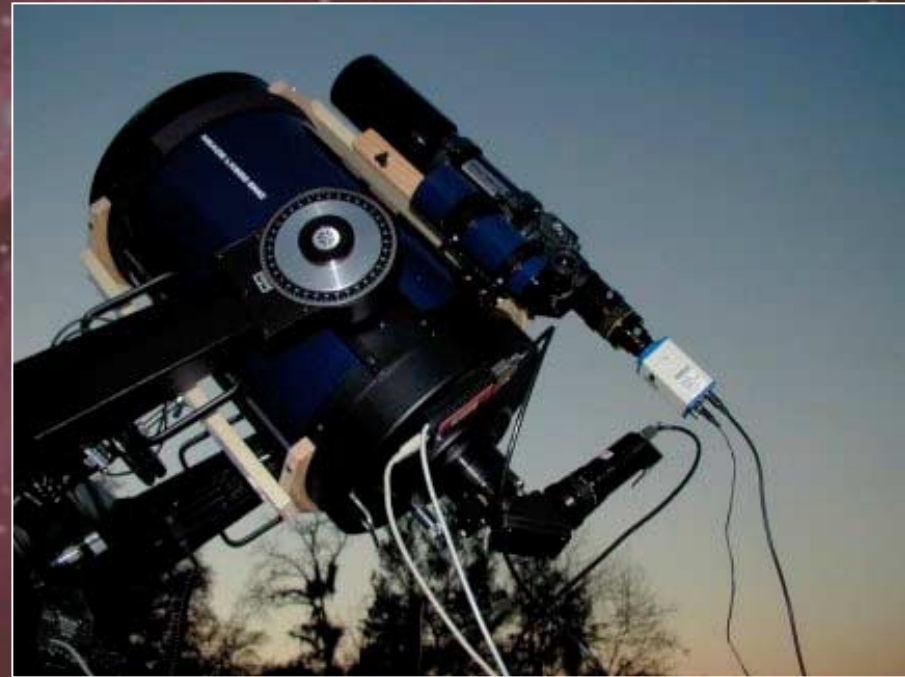
Taking the Image

- Imaging process
 - ▶ Setup the optics/camera
 - ◀ The all-threaded setup is preferred and offers flexibility



Taking the Image

- Imaging process
 - ▶ Setup scope, camera, laptop and align
 - ◀ No hot plugging - turn everything on after full setup

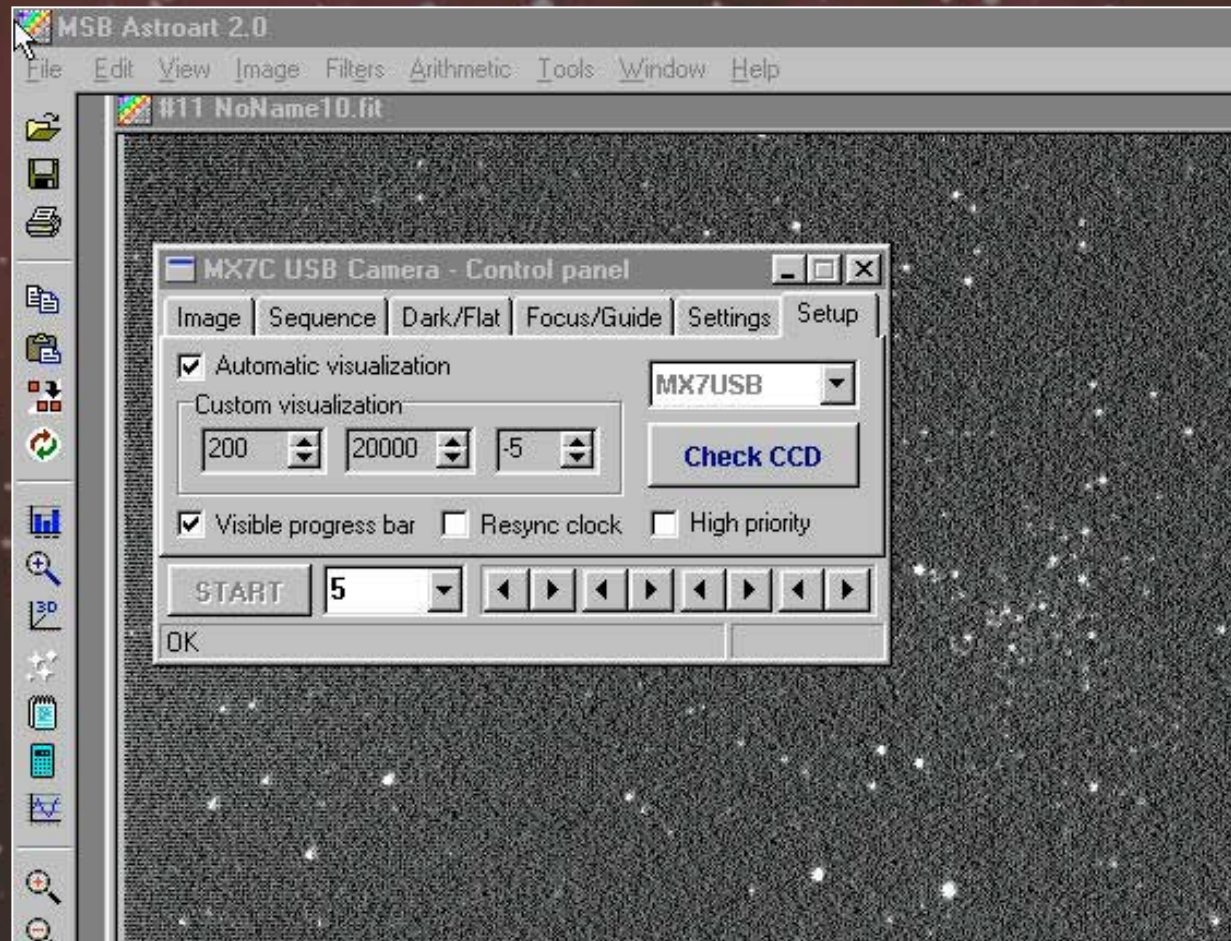


Taking the Image

- Imaging process
 - ▶ Choose and locate first object
 - ◀ For LX200, slew to it using HPP (nice ccd feature)
HPP targets a nearby bright star to center
Use this opportunity to focus CCD camera on star
Finally slew to object
 - ◀ For other setups, manually locate or goto
Focus on a nearby star when convenient
 - ▶ Note: Astroart is referenced in this presentation
Great support for all Starlight cameras and others makes
Relatively inexpensive (~\$150) - version 3 is current
 - » Handles both camera control and image processing

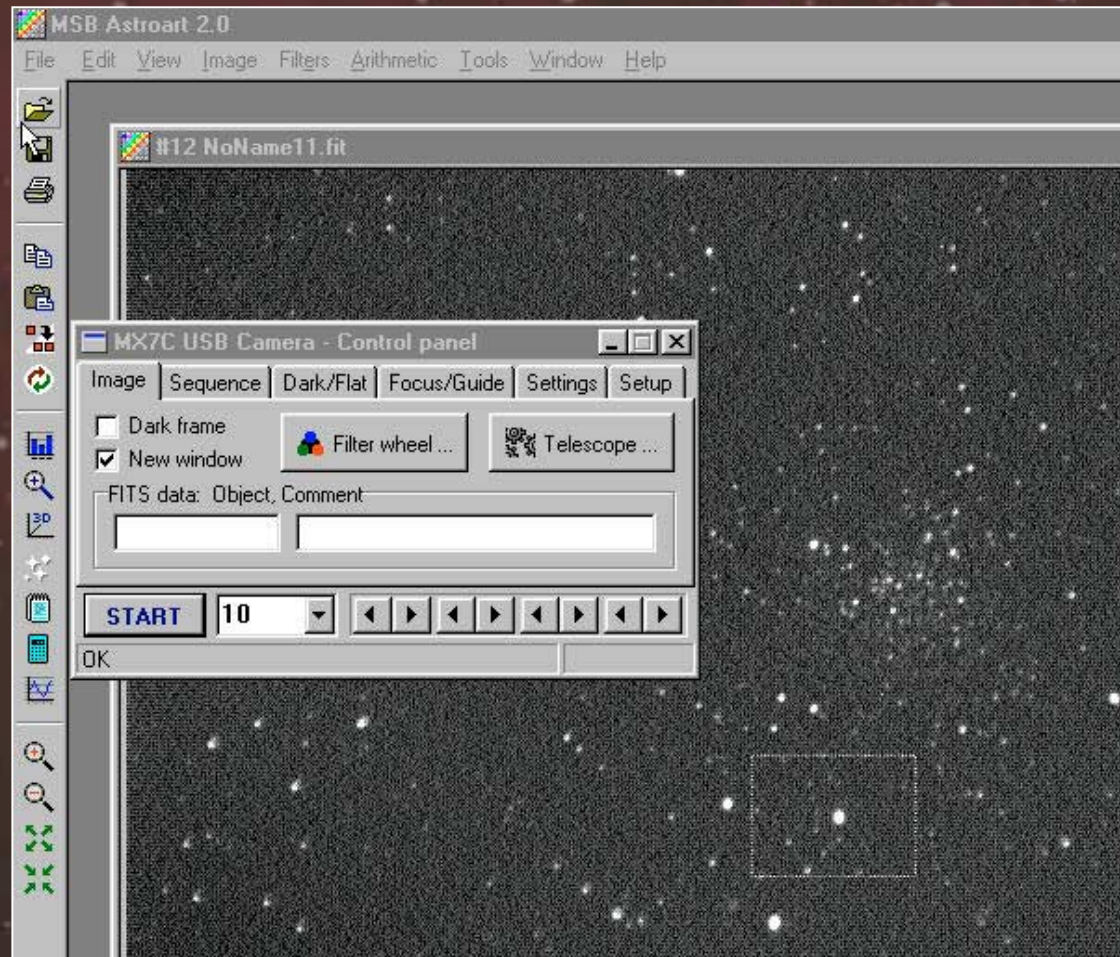
Taking the Image

- ▶ Take a quick 5 to 30 second image of the object



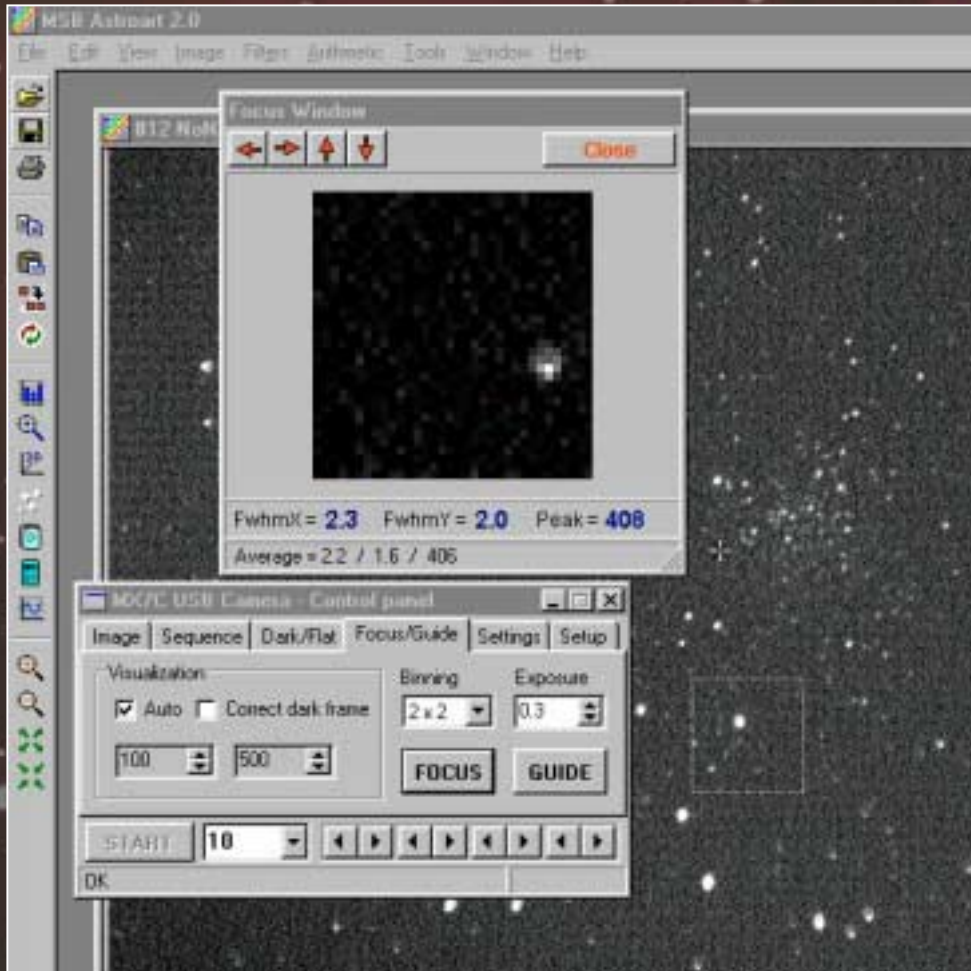
Taking the Image

- ▶ Select a star anywhere on the image to fine focus



Taking the Image

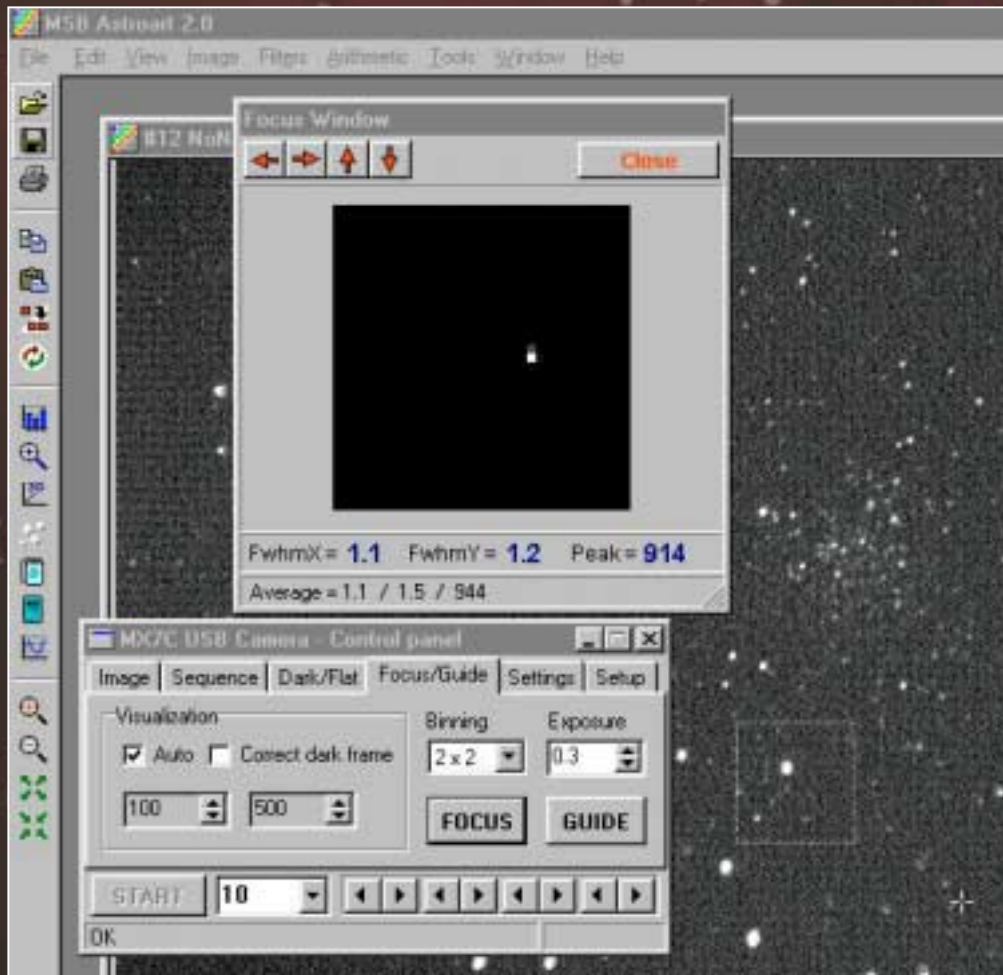
- ▶ Select the focus box - star is rough focused



- Depending on the star's brightness, vary the exposure to generate a reasonable signal level (Peak=xxx)
- Adjust the focuser to maximize the Peak value and minimize the FWHM values for both x and y directions

Taking the Image

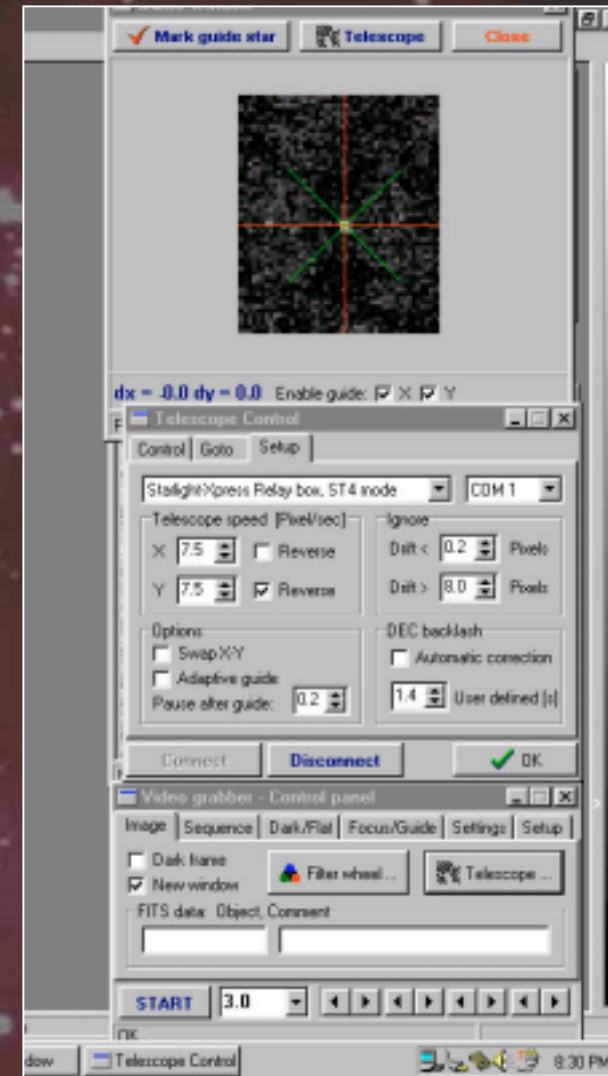
- Good focus has been achieved



- Peak has increased from 406 to 914 and the FWHM values have dropped to 1.1 and 1.2 pixels
- Note also the 'look' of the star in the focus window - only a single pixel is essentially used

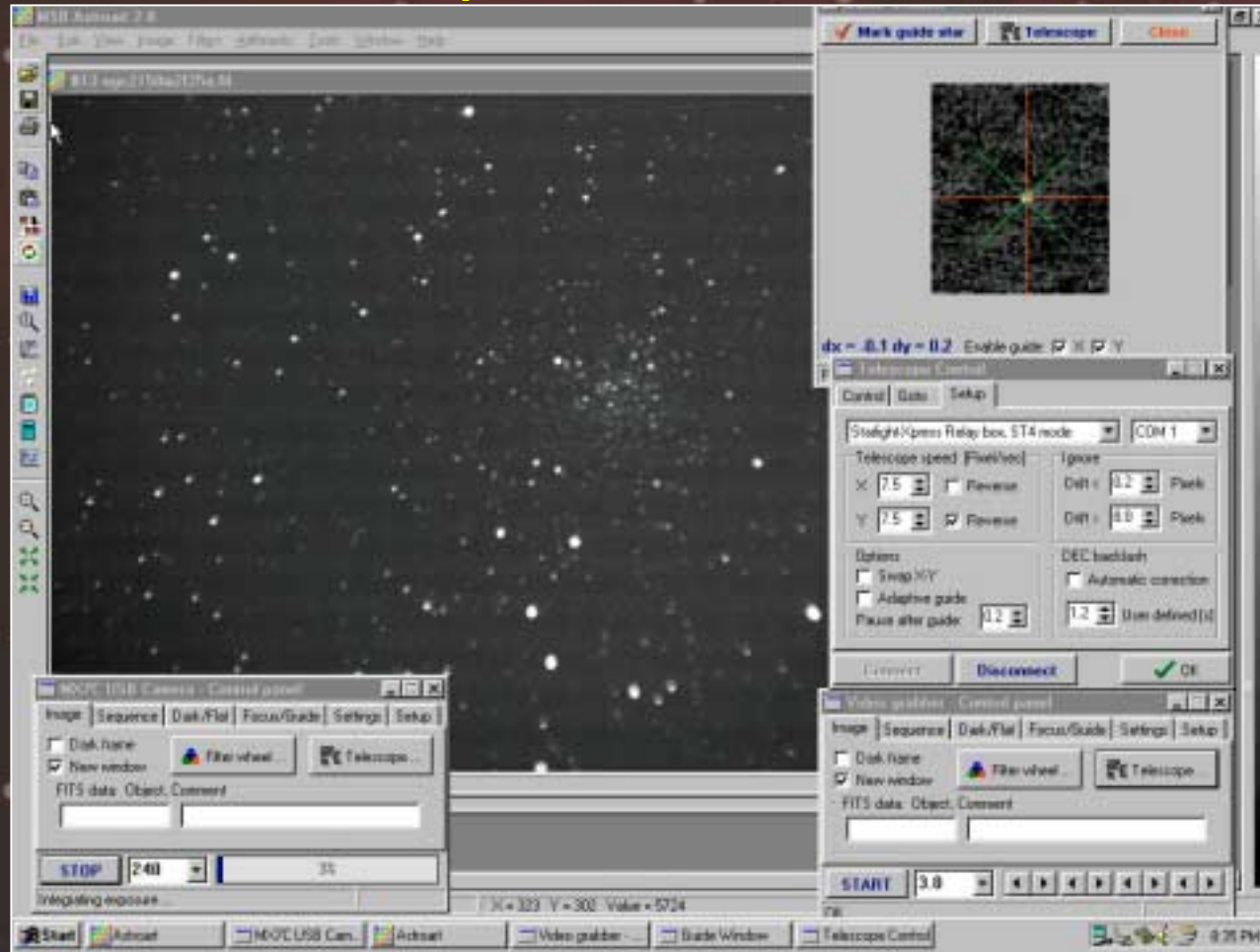
Taking the Image

- Autoguider setup
 - ▶ Separate guide scope with Mintron 12V1 low lux vidcam
 - ◀ Star2000 equally effective with similar setup process
 - ▶ Scope setup under "Telescope Control"
 - ◀ Correction speed (pixel/sec)
 - ◀ Correction range ("Ignore")
 - ◀ Backlash (set to zero if setup on the scope)



Taking the Image

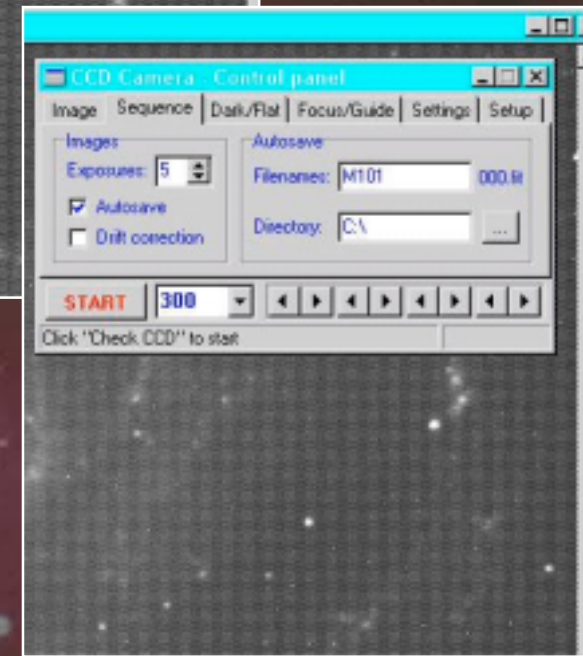
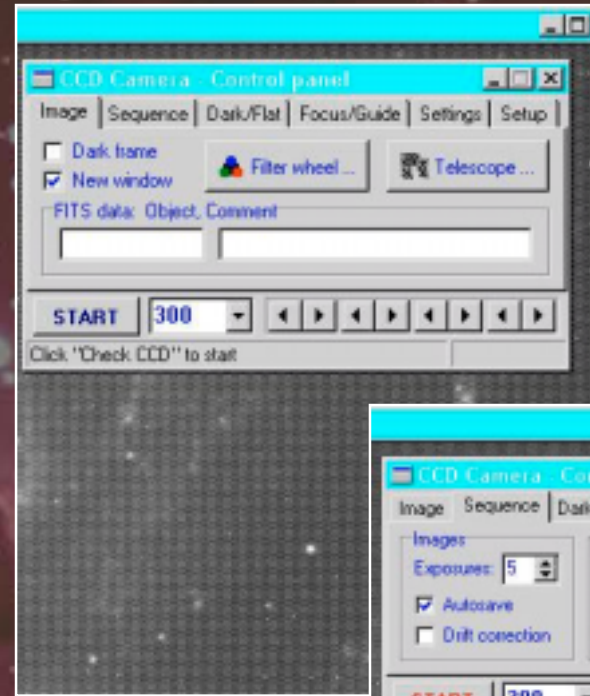
- Set the exposure time (240s in this case)



- Note the good guiding errors being reported (dx = -0.1 and dy = 0.2 pixels)
- If the FL ratio between main and guide scopes is 2:1, then the error will be 2x on the main scope

Taking the Image

- To take the image, select the image or sequence tab
 - ▶ Image generates a single image (i.e. 300 sec here)
 - ▶ Sequence allows multiple images to be taken and saved (i.e. 5 images of M101)



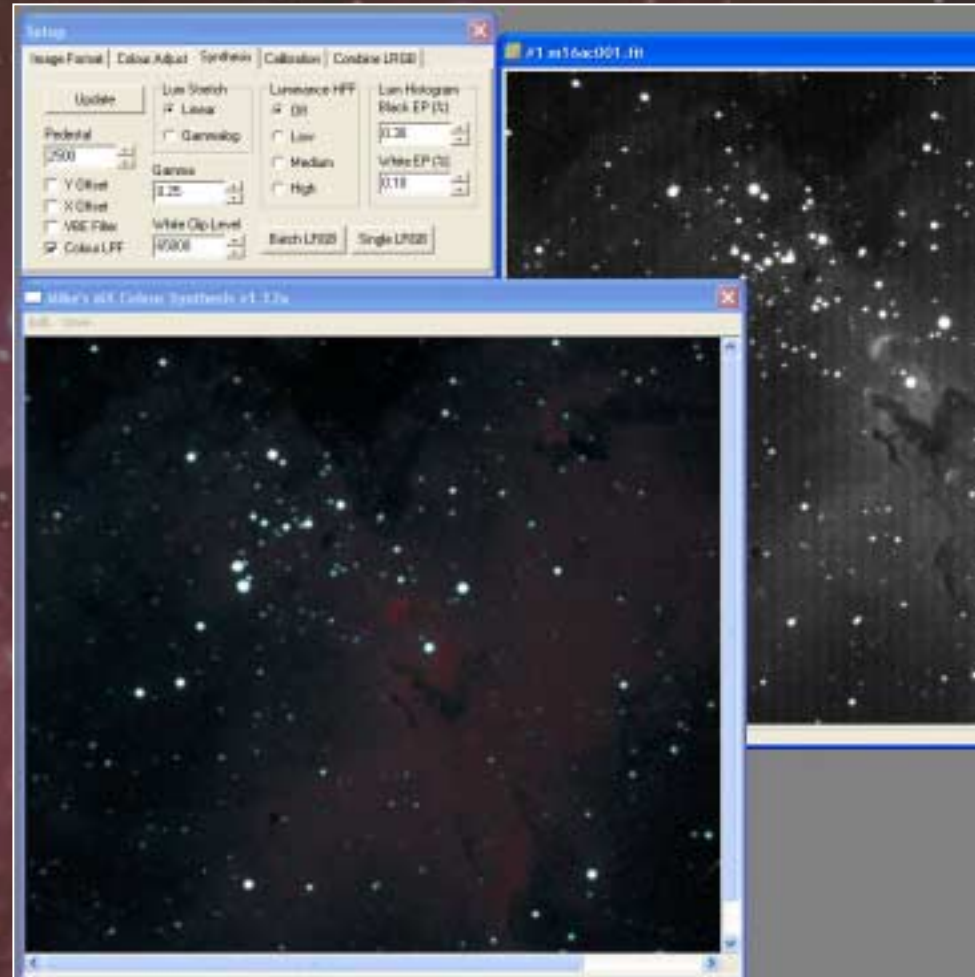
Processing the image

- Astroart has it own internal color synthesis routing
 - It also allows use of external plugins
 - This presentation will focus on the use of Astroart ver3 (AA3) in conjunction with a plugin developed by Mike Smith



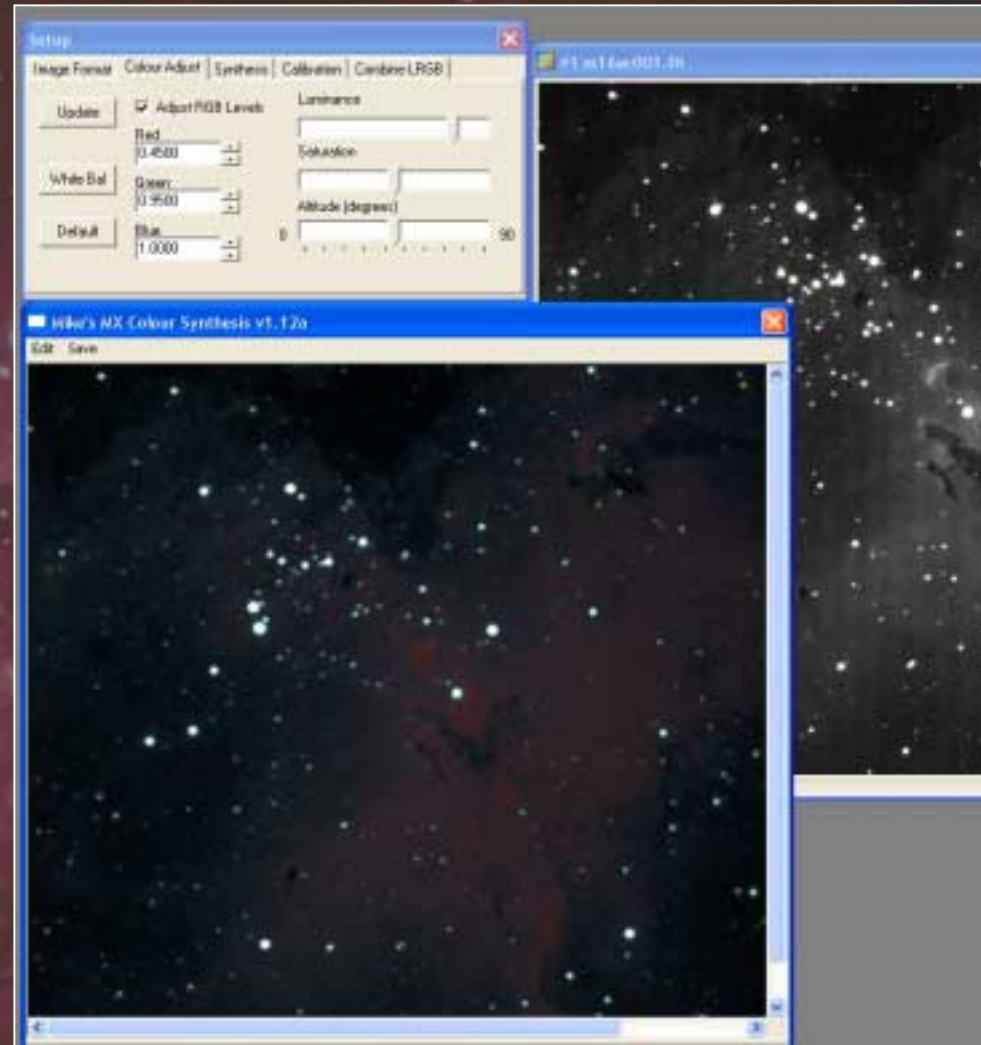
Processing the image

- Go to the Synthesis tab and turn the Luminance HPF to off (you can adjust sharpness on your own later)



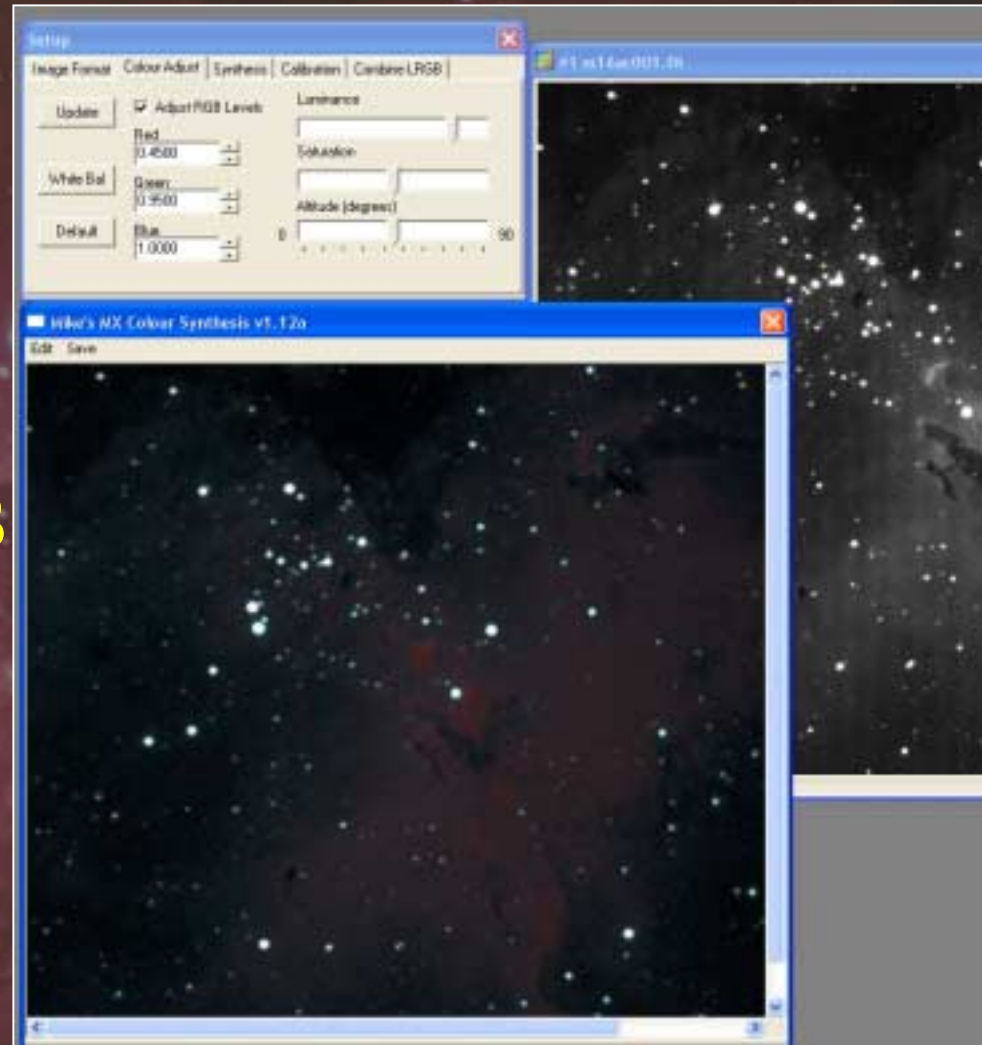
Processing the image

- Proceed to the Color Adjust tab
 - I have found a reasonable starting point to use RGB ratios of 0.45:0.95:1.00
 - Adjust the altitude for the object



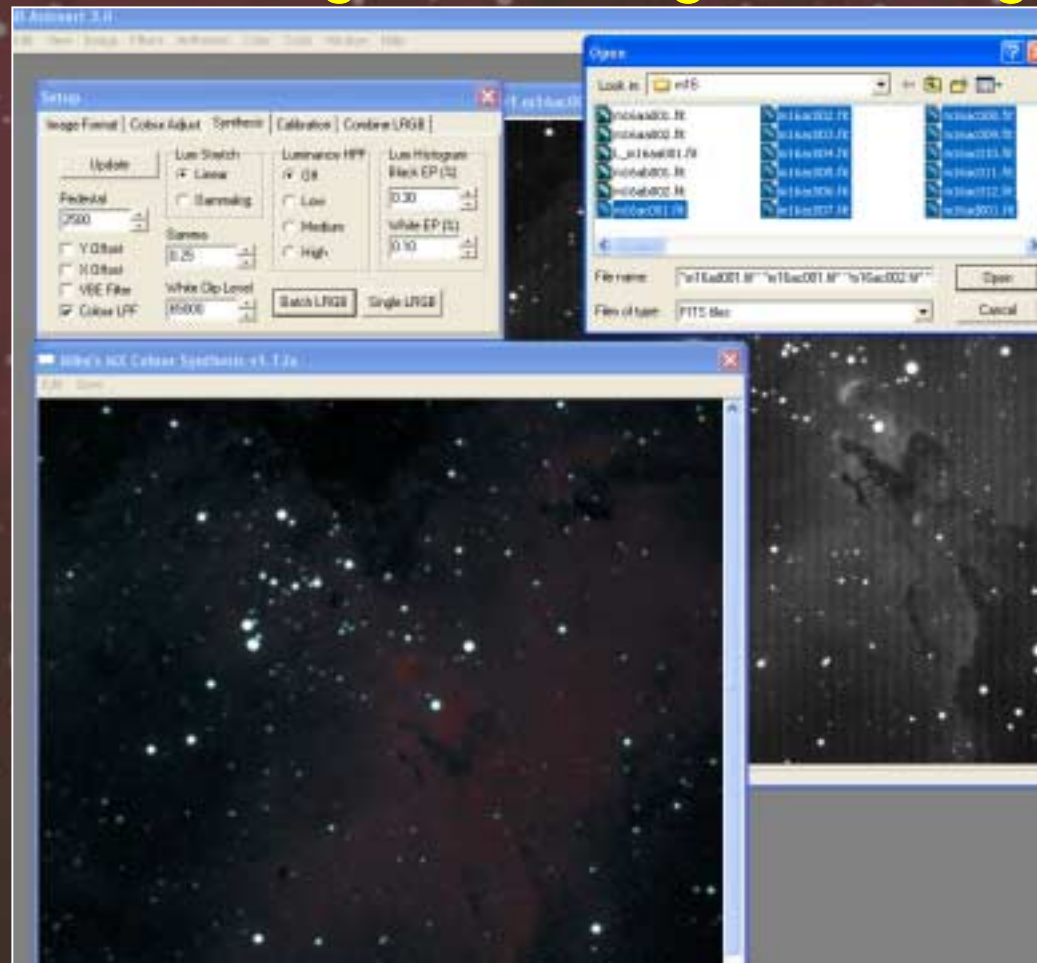
Processing the image

- The preview window will show the results after each update
 - The colors should be close, but can be tweaked by RGB ratios
 - The Luminance slider was raised to show the colors better



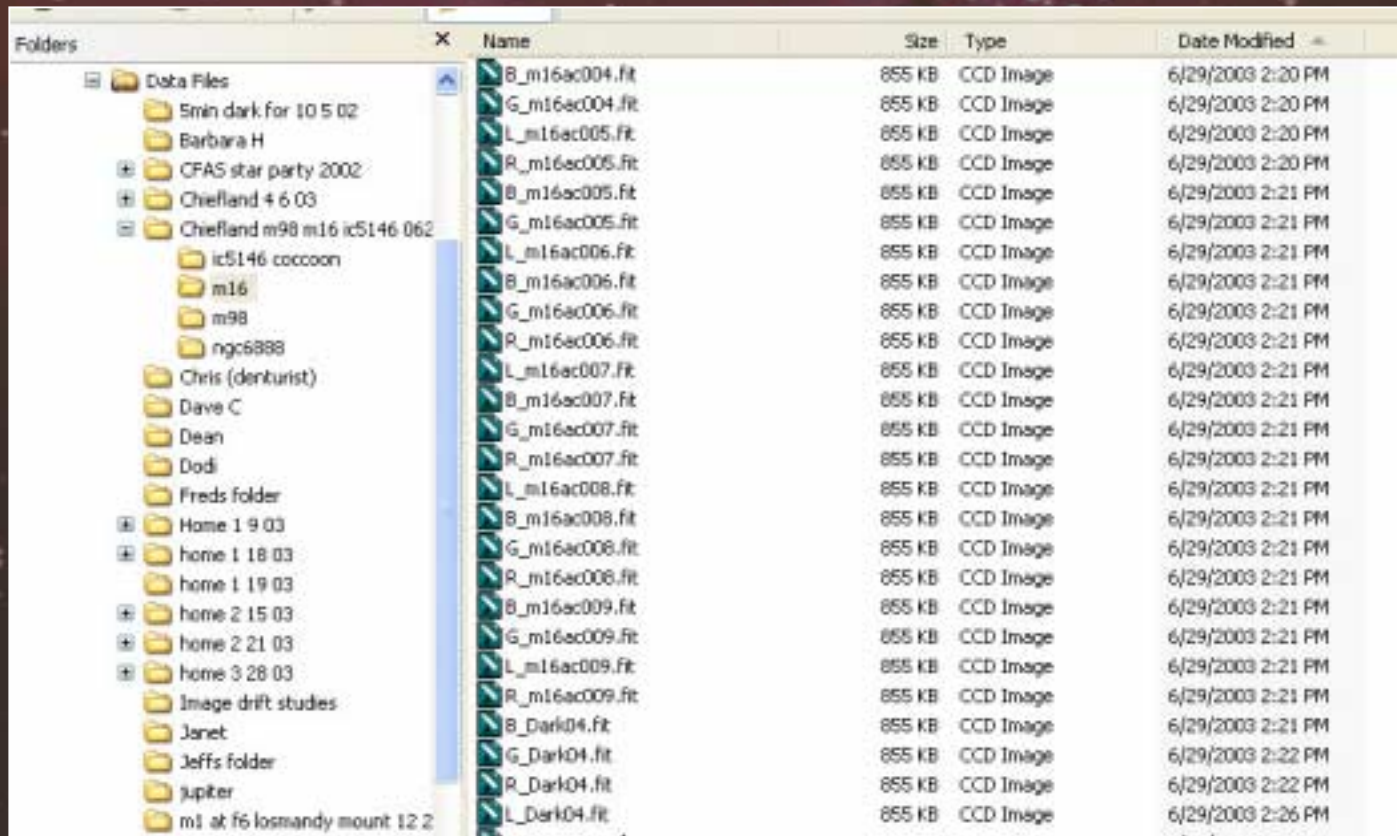
Processing the image

- Batch processing: selecting the images



Processing the image

- Batch processing: results in LRGB separation
 - ▶ Process dark files at the same time



Folders	Name	Size	Type	Date Modified
Data Files	B_m16ac004.fit	855 KB	CCD Image	6/29/2003 2:20 PM
5min dark for 10 5 02	G_m16ac004.fit	855 KB	CCD Image	6/29/2003 2:20 PM
Barbara H	L_m16ac005.fit	855 KB	CCD Image	6/29/2003 2:20 PM
CFAS star party 2002	R_m16ac005.fit	855 KB	CCD Image	6/29/2003 2:20 PM
Chiefland 4 6 03	B_m16ac005.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Chiefland m98 m16 ic5146 062	G_m16ac005.fit	855 KB	CCD Image	6/29/2003 2:21 PM
ic5146 cocoon	L_m16ac006.fit	855 KB	CCD Image	6/29/2003 2:21 PM
m16	B_m16ac006.fit	855 KB	CCD Image	6/29/2003 2:21 PM
m98	G_m16ac006.fit	855 KB	CCD Image	6/29/2003 2:21 PM
ngc6888	R_m16ac006.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Chris (denturist)	L_m16ac007.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Dave C	B_m16ac007.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Dean	G_m16ac007.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Dodi	R_m16ac007.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Freds folder	L_m16ac008.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Home 1 9 03	B_m16ac008.fit	855 KB	CCD Image	6/29/2003 2:21 PM
home 1 18 03	G_m16ac008.fit	855 KB	CCD Image	6/29/2003 2:21 PM
home 1 19 03	R_m16ac008.fit	855 KB	CCD Image	6/29/2003 2:21 PM
home 2 15 03	B_m16ac009.fit	855 KB	CCD Image	6/29/2003 2:21 PM
home 2 21 03	G_m16ac009.fit	855 KB	CCD Image	6/29/2003 2:21 PM
home 3 28 03	L_m16ac009.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Image drift studies	R_m16ac009.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Janet	B_Dark04.fit	855 KB	CCD Image	6/29/2003 2:21 PM
Jeffs folder	G_Dark04.fit	855 KB	CCD Image	6/29/2003 2:22 PM
jupiter	R_Dark04.fit	855 KB	CCD Image	6/29/2003 2:22 PM
m1 at f6 losmandy mount 12 2	L_Dark04.fit	855 KB	CCD Image	6/29/2003 2:26 PM

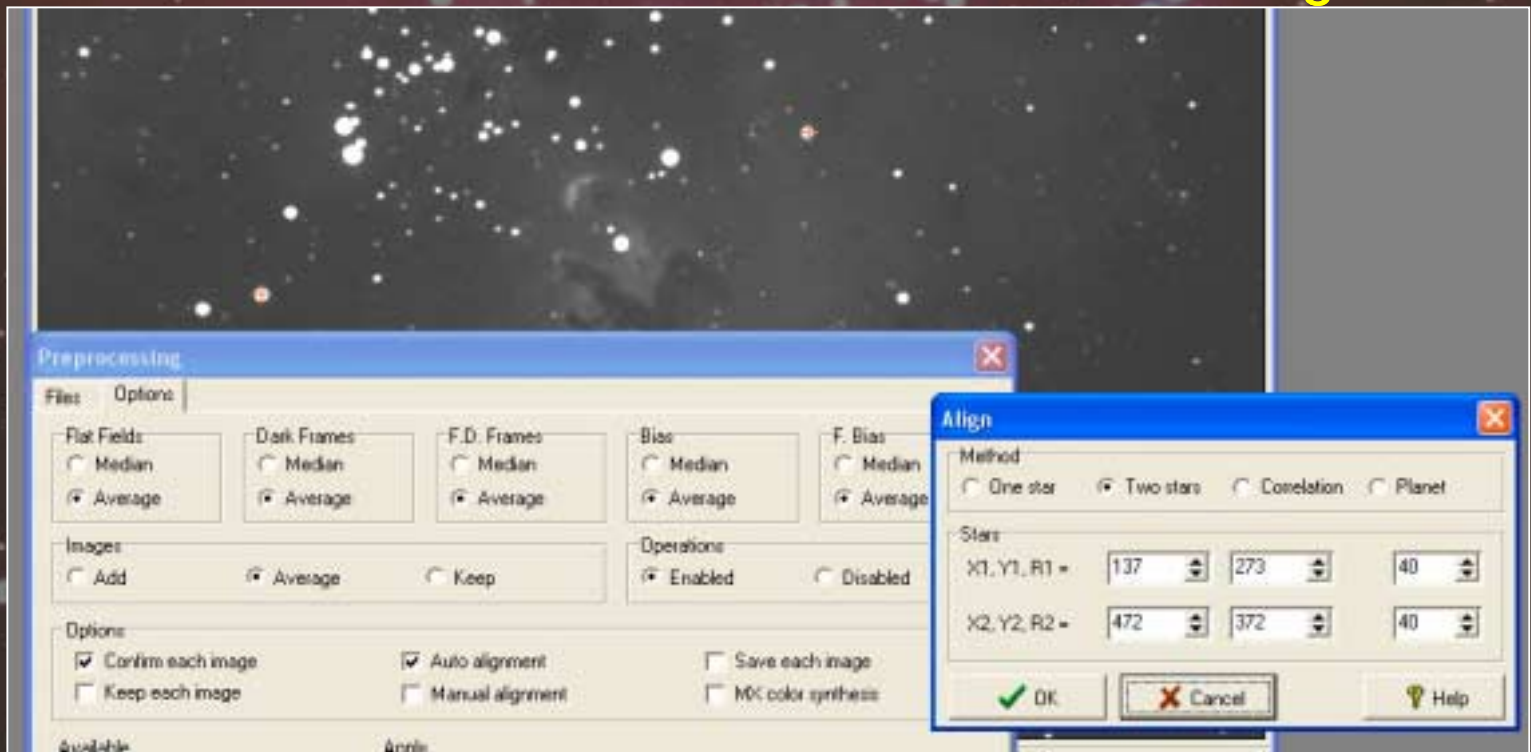
Processing the image

- Pre-processing:
selecting stars to
autoalign
 - ▶ Pull up the first
luminance frame in
the sequence
 - ▶ Select 2 stars on
opposite sides of
the frame (a "+"
will show on the
star)



Processing the image

- Pull up the Pre-processing window - choose Auto alignment
 - ▶ Select "Two stars" - ideal to remove image rotation



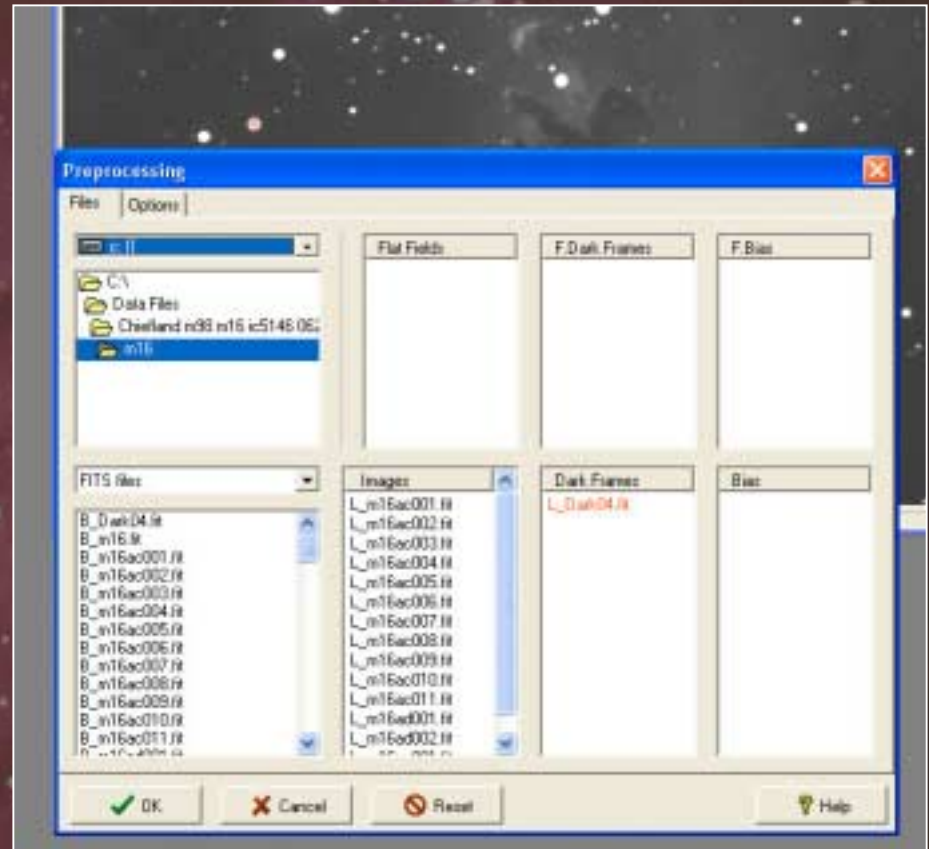
Processing the image

- ▶ The default range is 20 - increase this to 40 if there's substantial movement of the stars from frame to frame (drift)



Processing the image

- Pre-processing: select files to combine
 - ▶ Include darks (in this case for luminance frames)
 - The larger the number of darks, the better (the noise on dark frames behaves the same way as on light frames)
 - L_Dark04 is an average of 6 darks



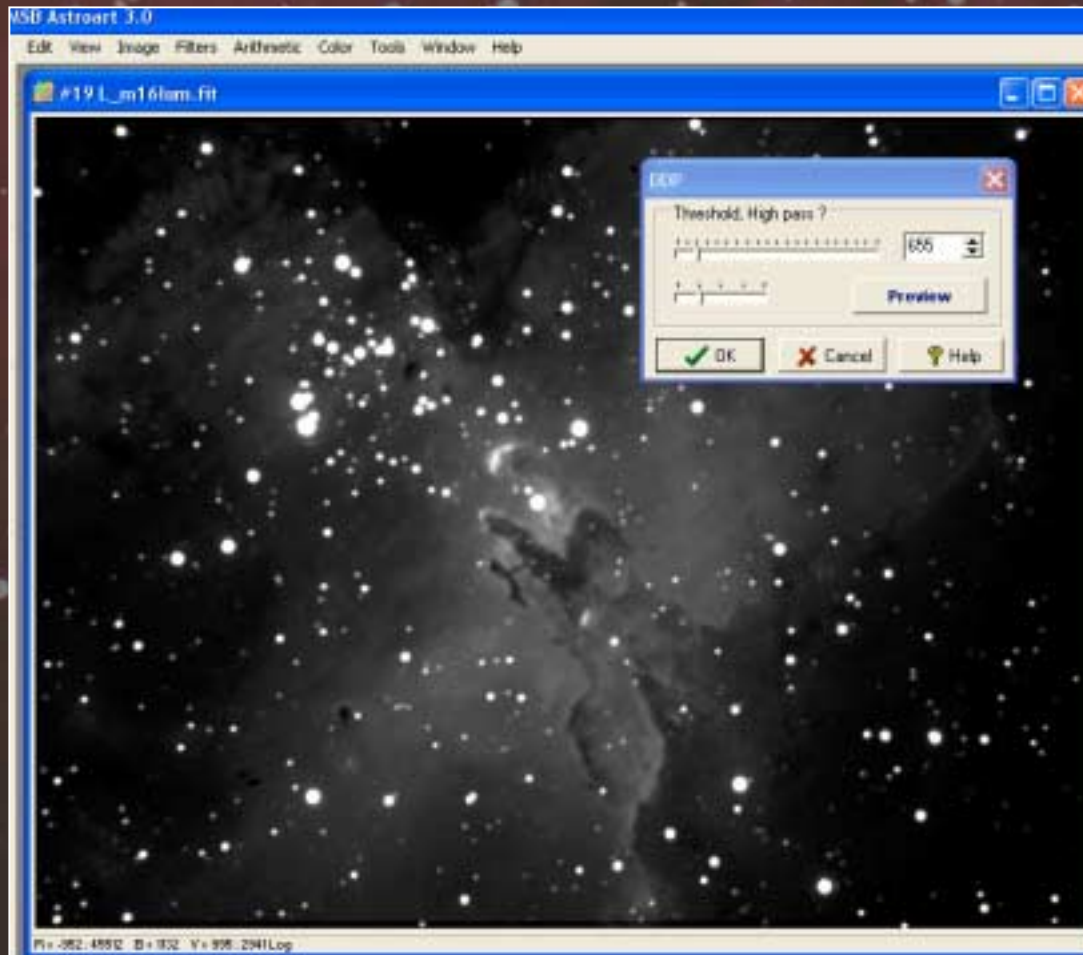
Processing the image

- Pre-processing: 14x4min. images combined



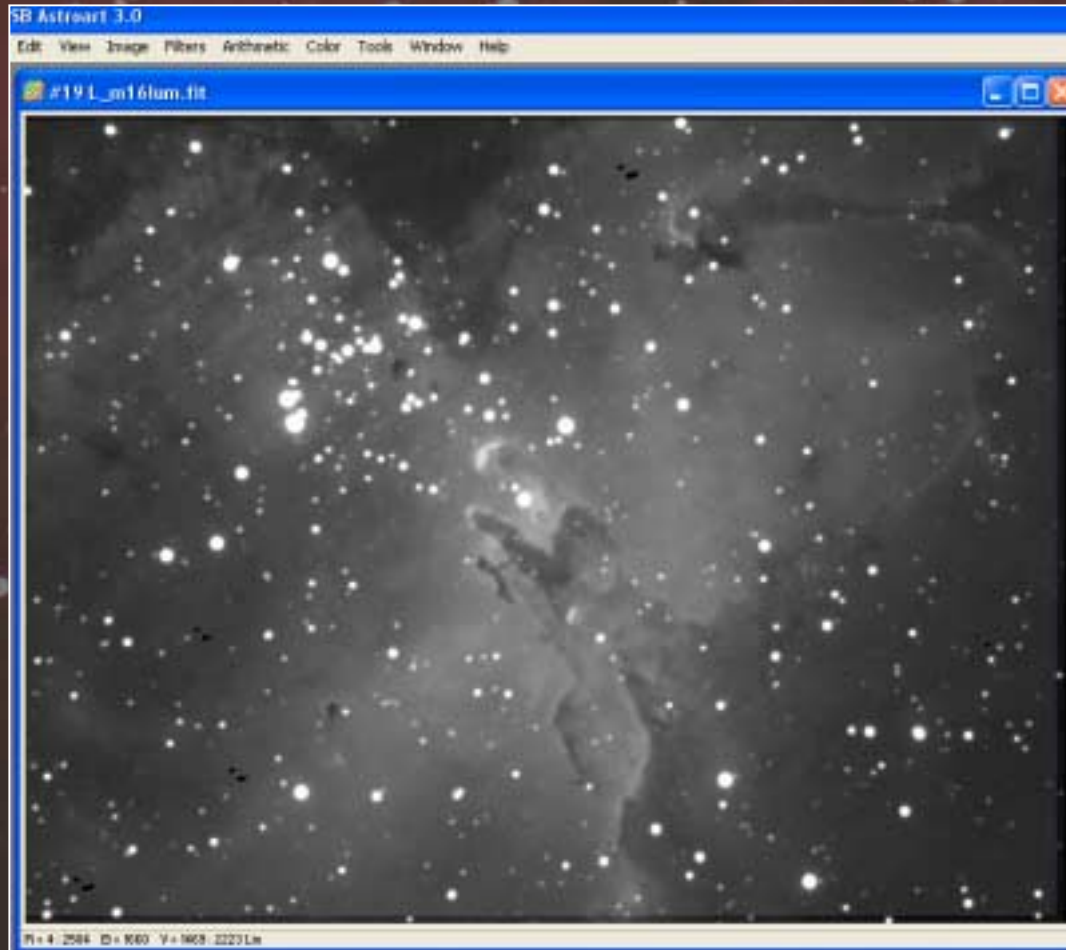
Processing the image

- DDP processing - compresses signal range



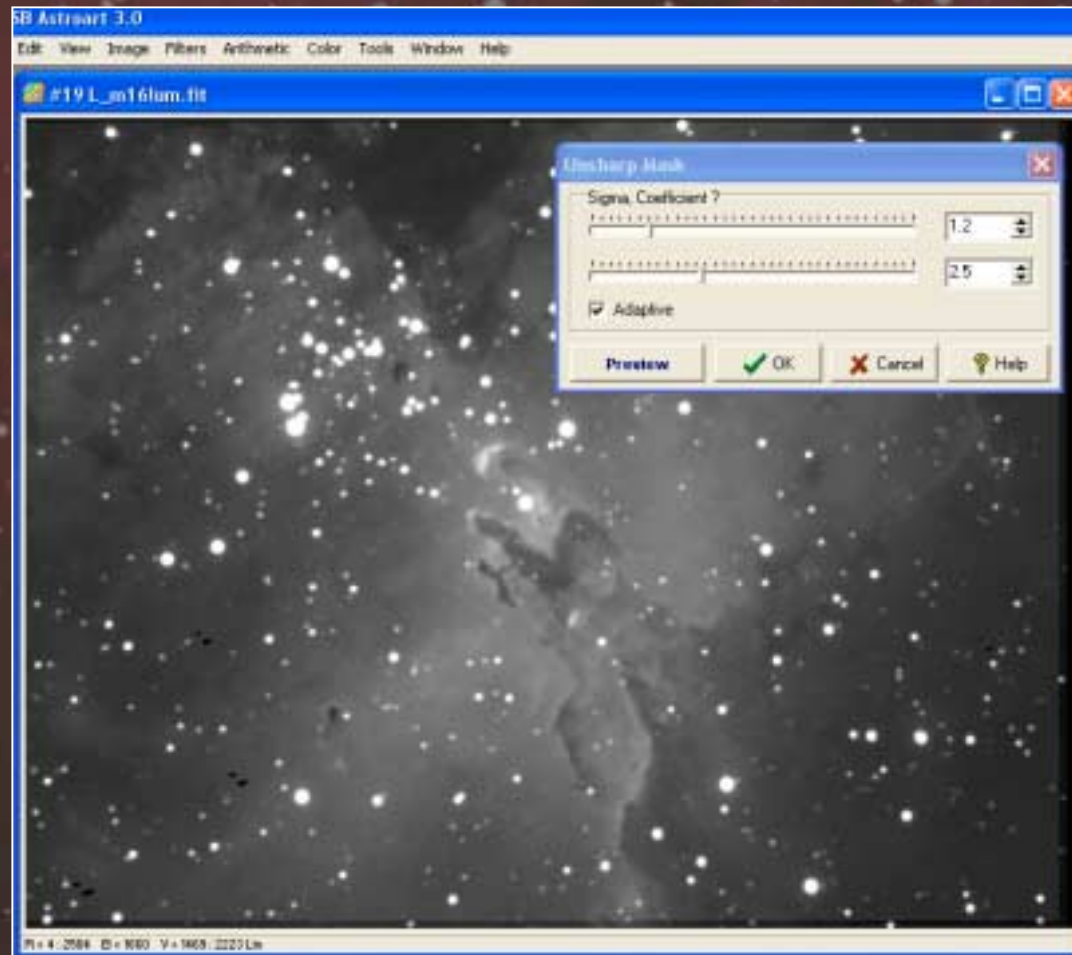
Processing the image

- DDP processing - result of ddp filter



Processing the image

- Unsharp Mask filtering - use Adaptive



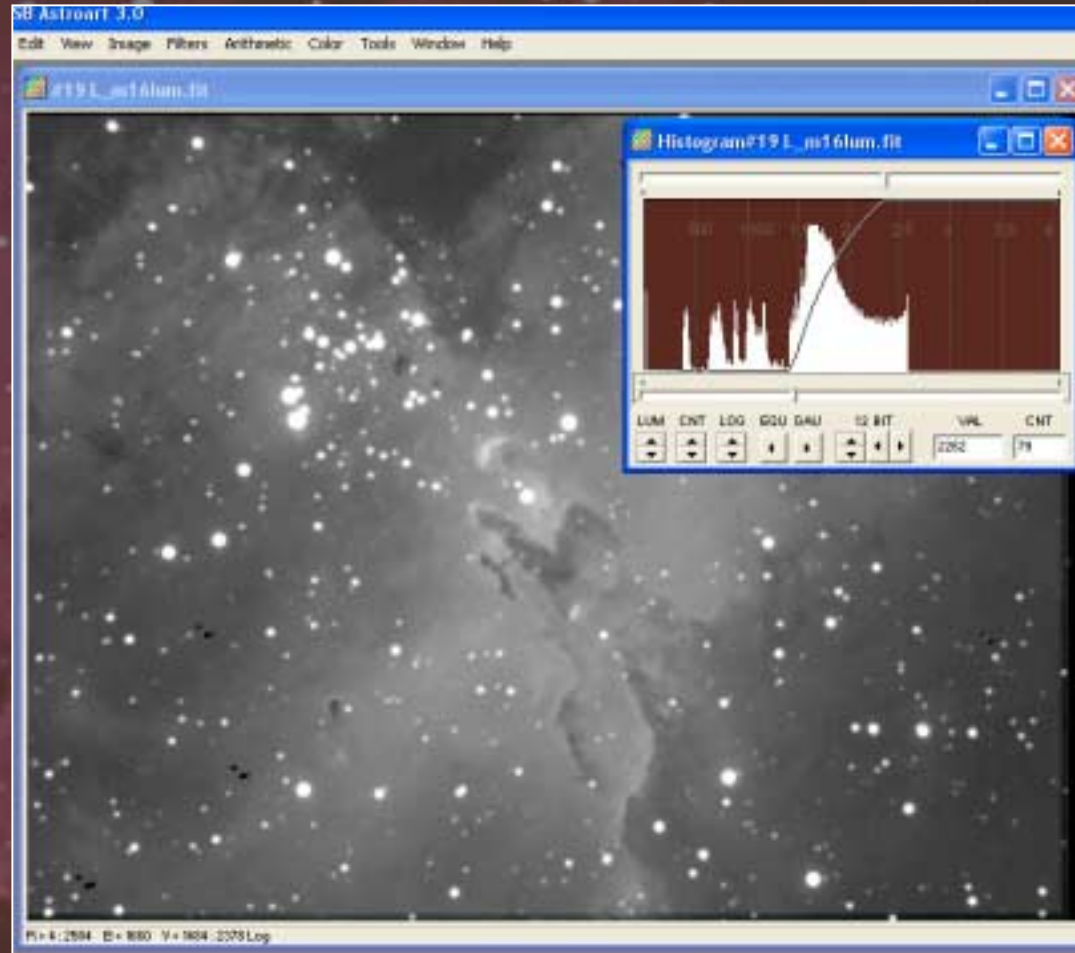
Processing the image

- Unsharp Mask filtering
 - ▶ Sharpens the fine nebulosity and tightens the star images



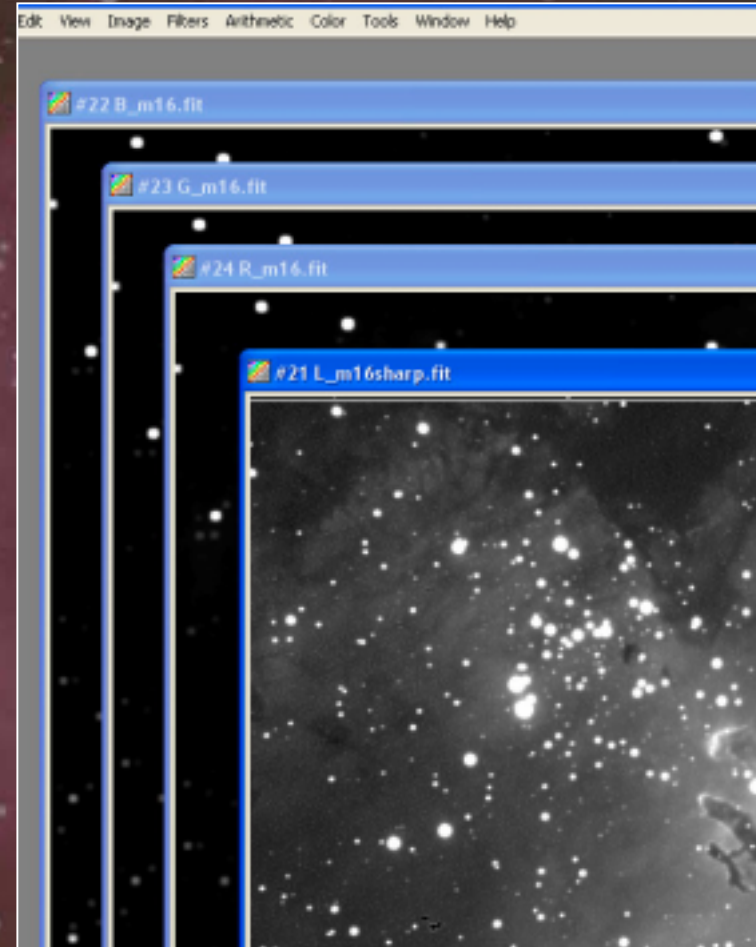
Processing the image

- Stretching the image with a histogram
 - Although useful on nebulae images to enhance faint details, log stretching also tends to washout contrast
 - Log stretching was not used on the final M16 pic



Processing the image

- Color processing
 - ▶ Repeat the procedure as in slide 29 to combine all of the R-frames together, then the G-frames and finally the B-frames
 - ◀ Again, use the appropriate dark frame and save files
 - ▶ Upon completion, there should be one L, R, G and B frame (4 total frames)



Processing the image

- Color processing - Pull up Trichromy from the Color menu
 - Ratios are available to adjust if the initial RGB ratios from synthesis requires tweaking



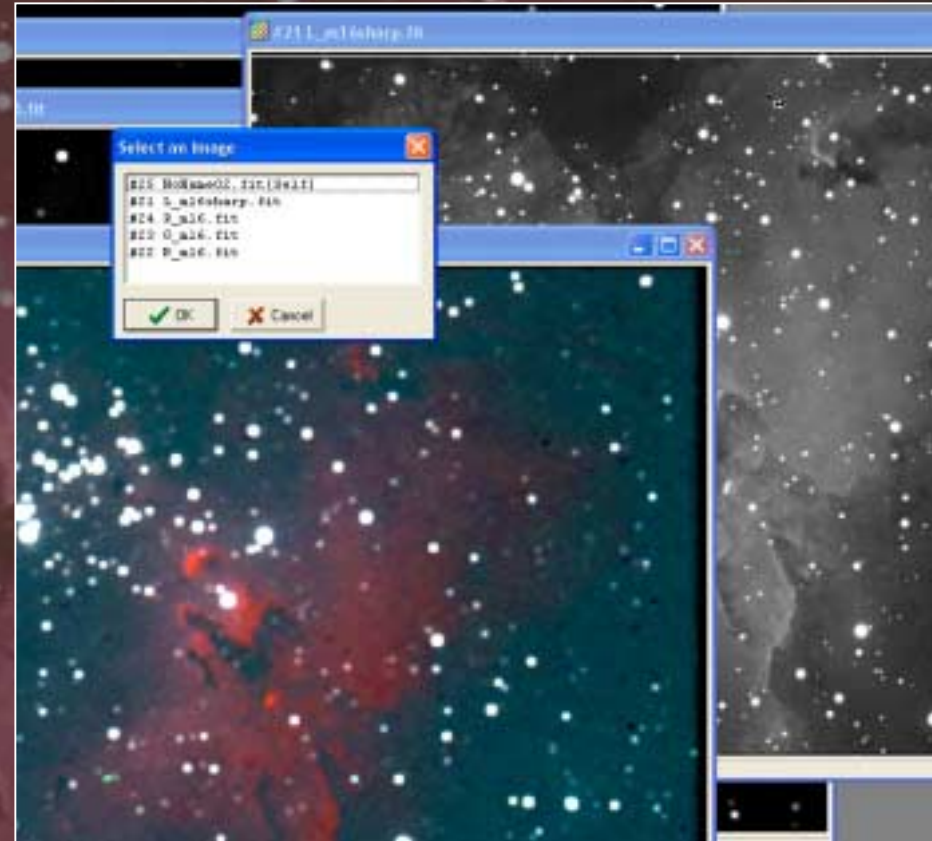
Processing the image

- Color processing
 - ▶ Selecting OK brings up an RGB image complete with color!
 - ▶ A color balance window also pops up
 - ◀ Adjust the colors as required to suit



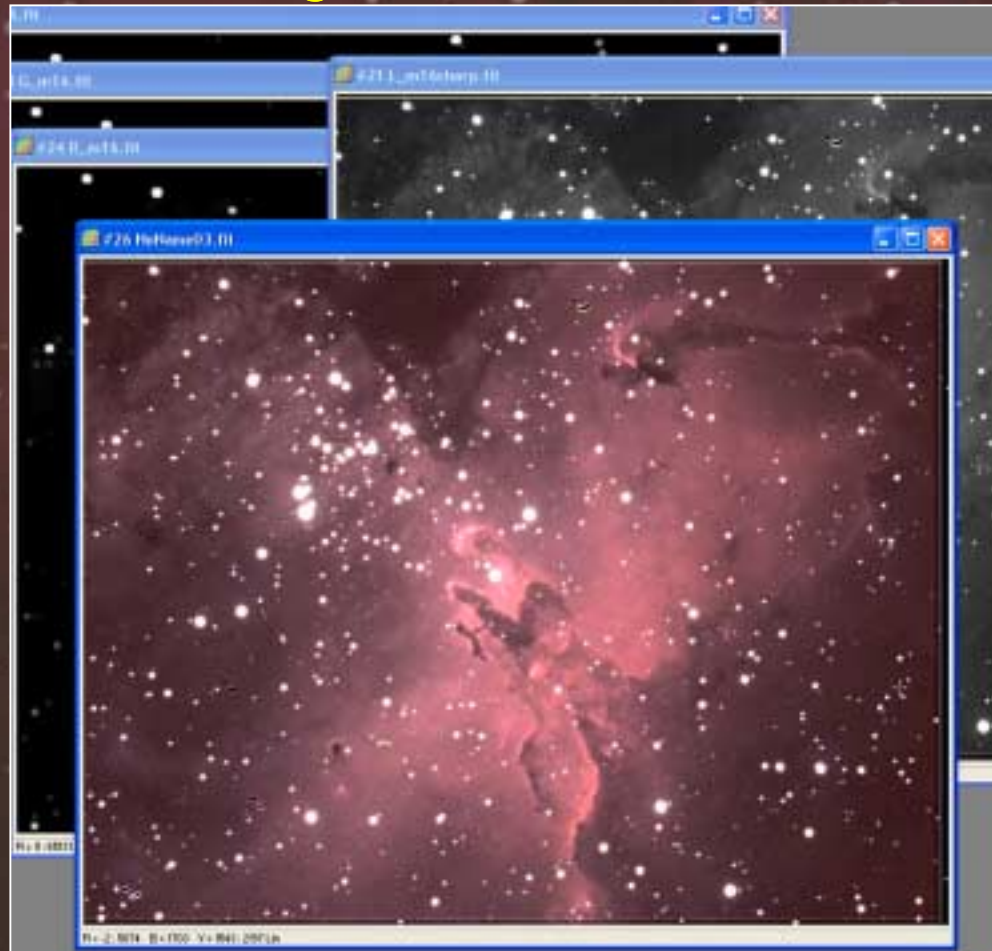
Processing the image

- Color processing
 - ▶ Under the Color menu, bring up LRGB Synthesis
 - ▶ Select the luminance frame to combine (L_m16sharp.fit in this example)



Processing the image

- Color processing - LRGB combined result



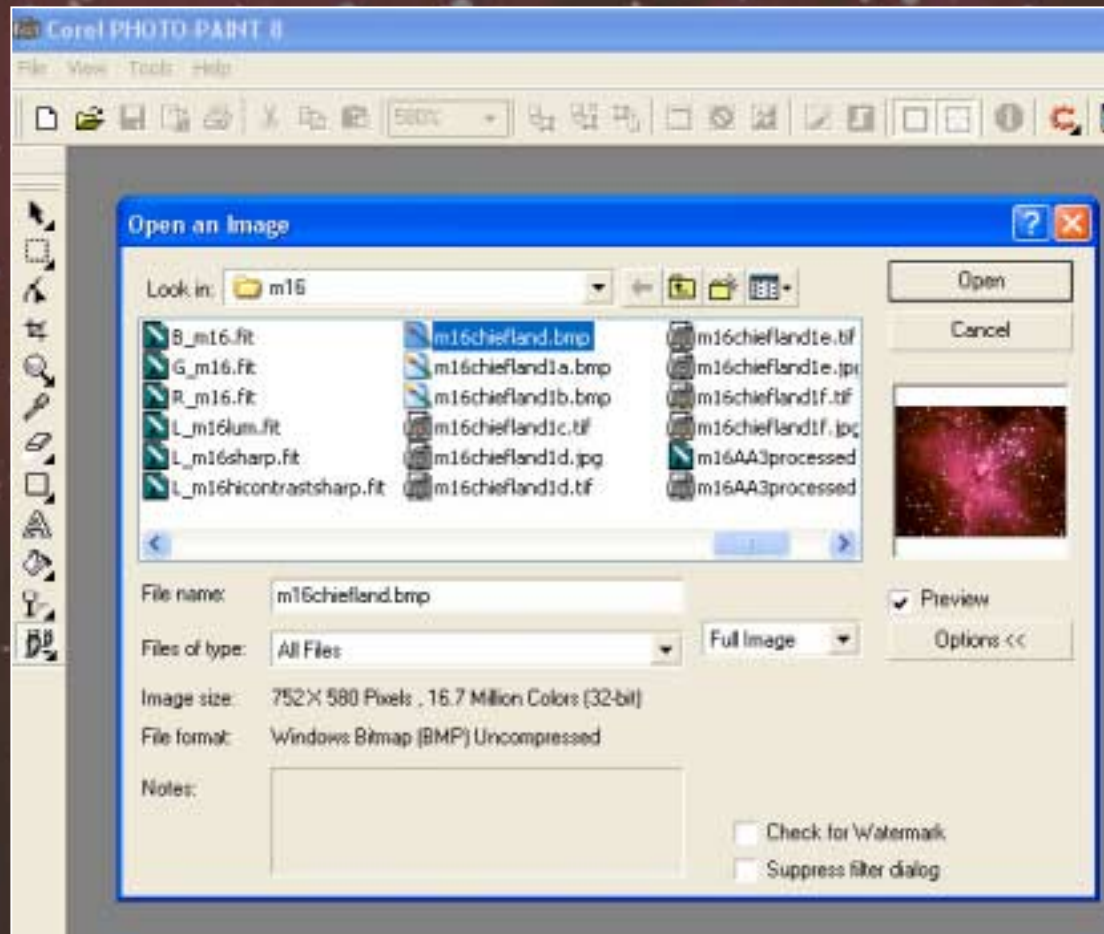
Processing the image

- Color processing
 - ▶ Use color balance and saturation commands to further enhance the image
 - ▶ Flipped image for orientation



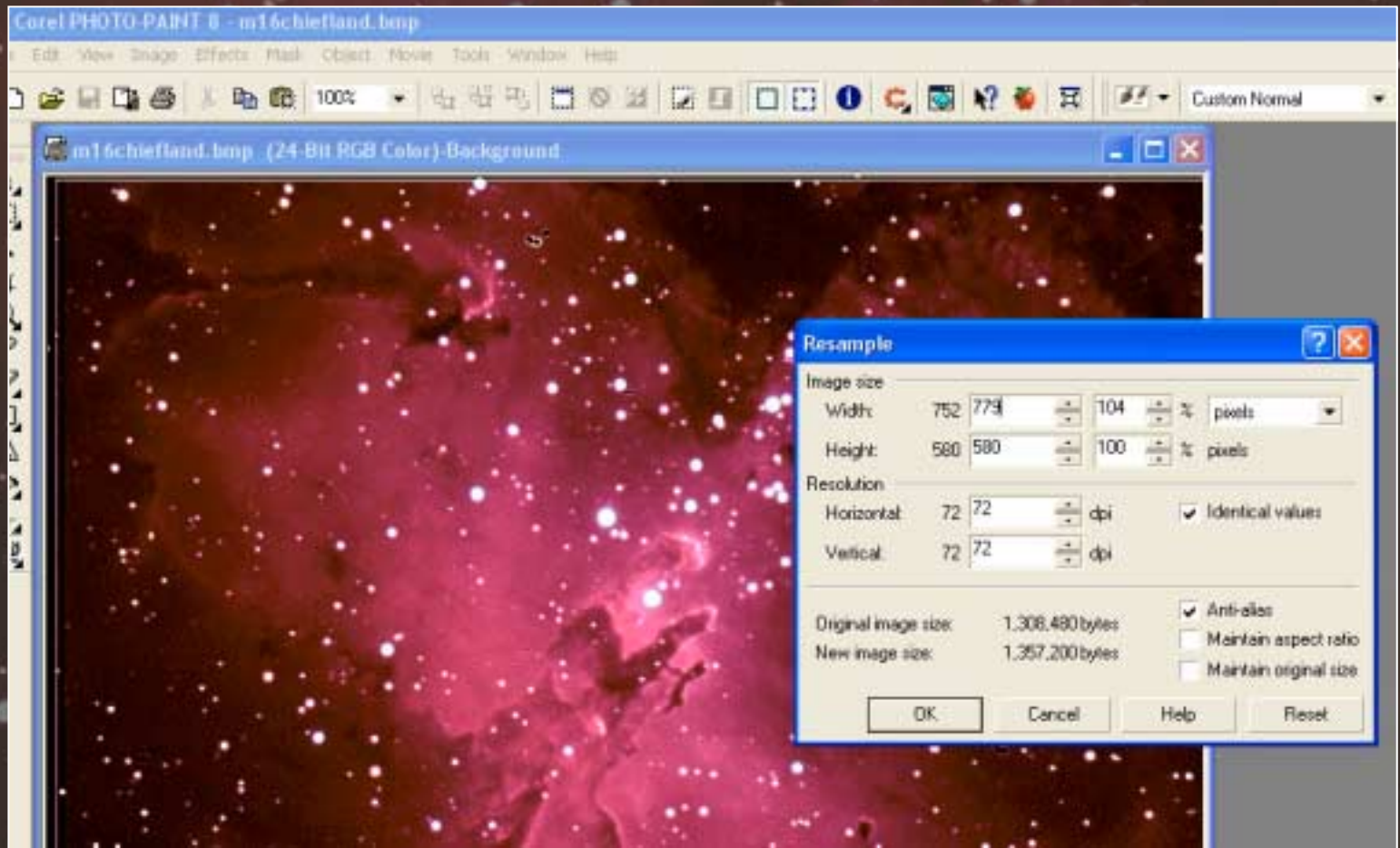
Processing the image

- Color processing - tweaking in Corel Photopaint



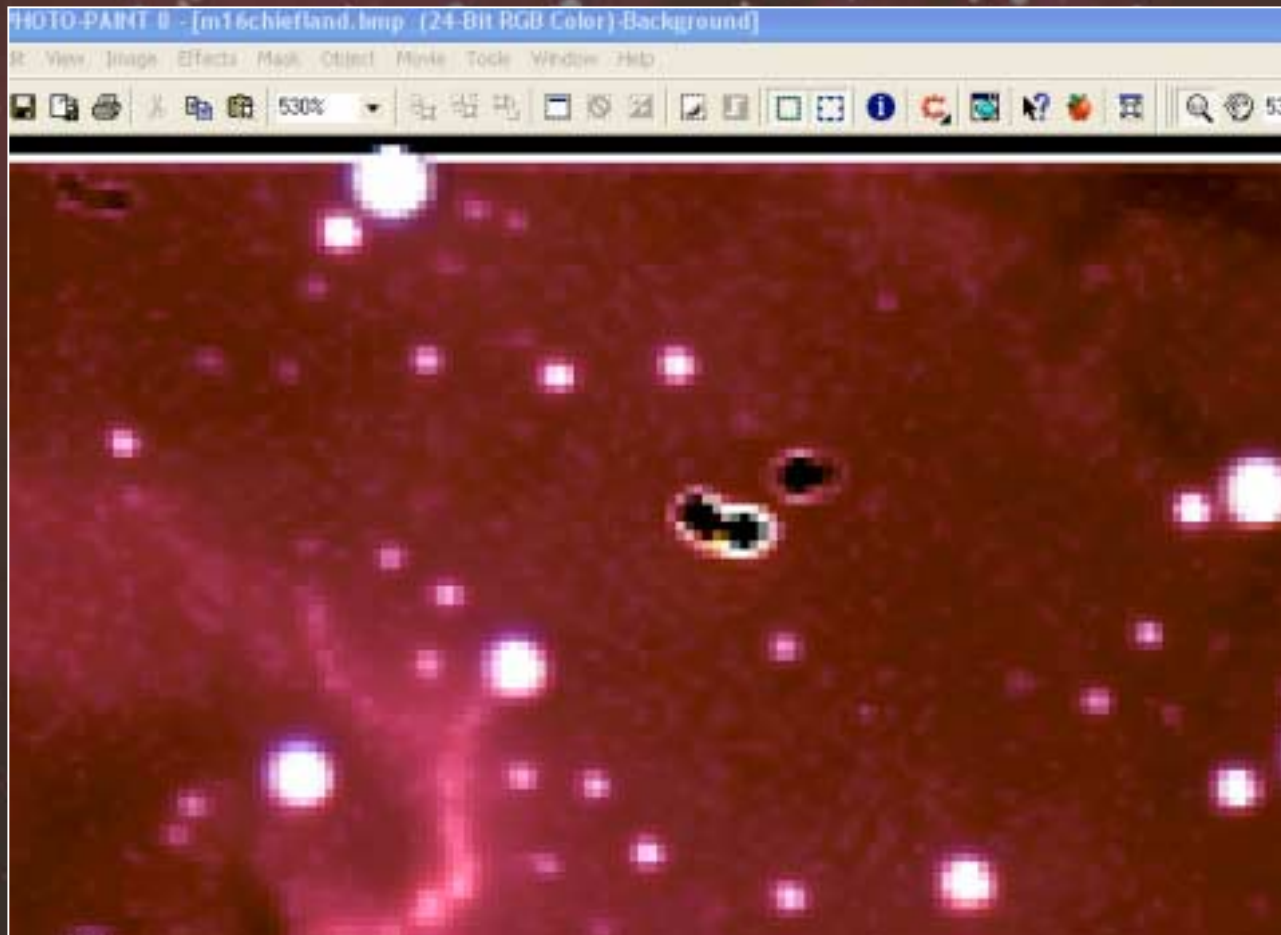
Processing the image

- Corel Photo - resampling to square the pixels



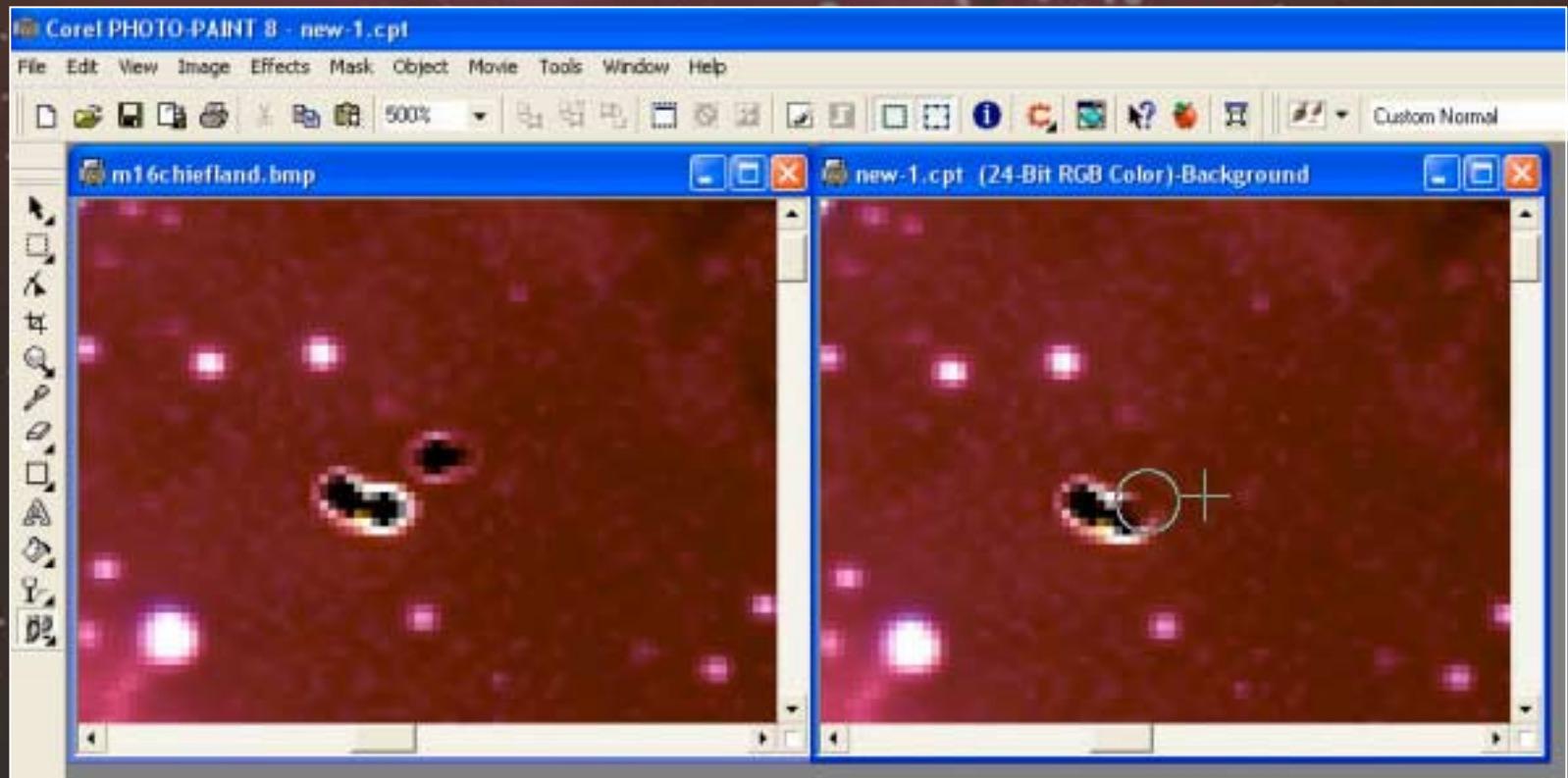
Processing the image

- Corel Photo - Eliminating image defects



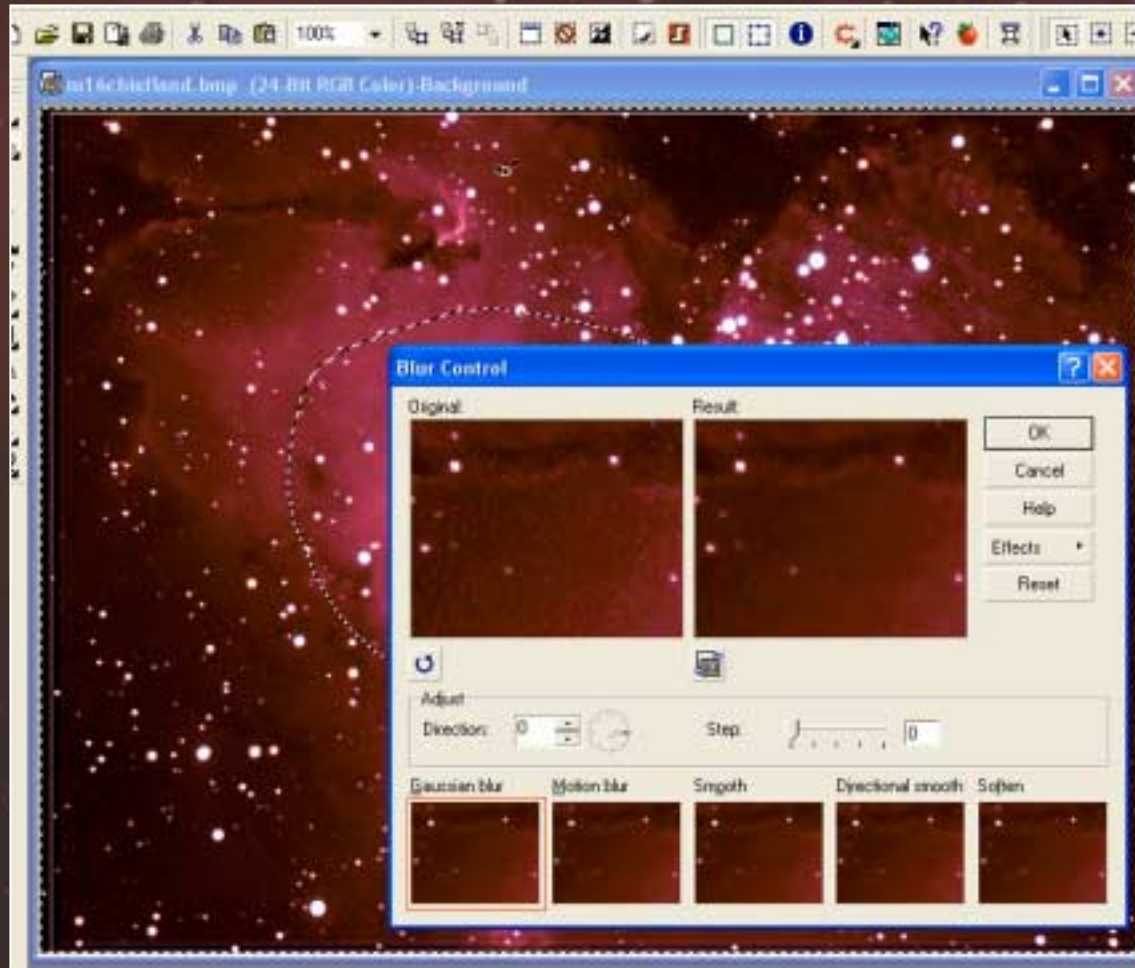
Processing the image

- Corel Photo - Using the clone tool
 - ▶ Replaces the circled region with nearby attributes



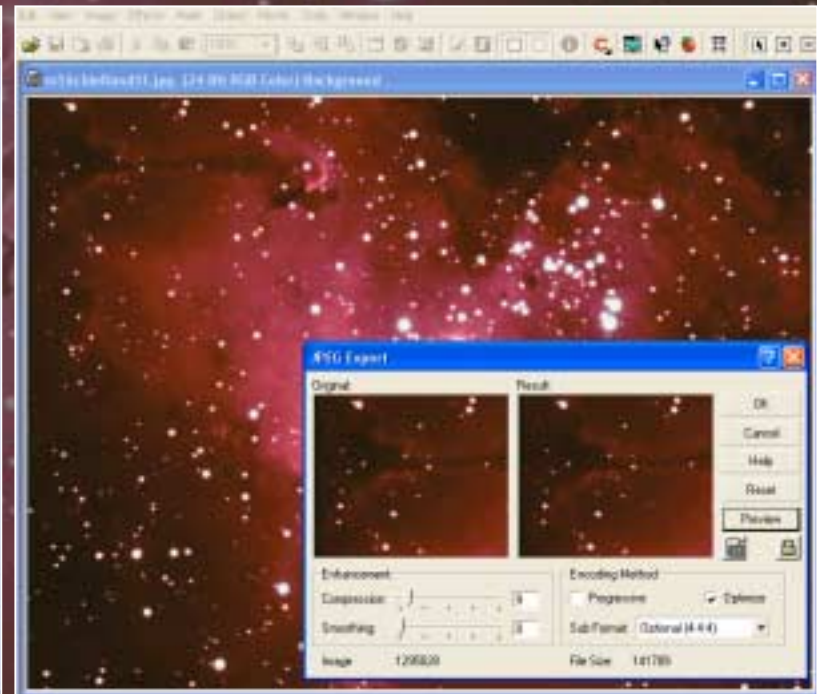
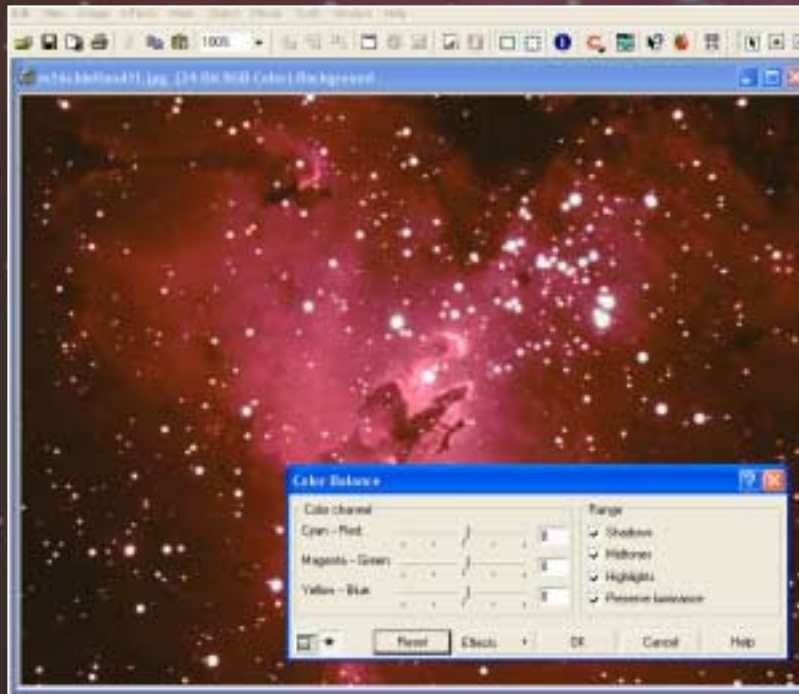
Processing the image

- Corel Photo - selective Gaussian blur



Processing the image

- Corel Photo
 - ▶ Tweak colors as required
 - ▶ Save as TIF or with compression as a JPEG



M16 - The Eagle Nebula: final result

