



The Imaging Process

Chris Lasley

5 Steps to a Great Image

1. Acquire data

Target selection, reference and image frame acquisition.

2. Calibrate data

Create master reference frames, calibrate image frames.

3. Align image frames

Register and align calibrated image frames.

4. Combine image frames

Combine calibrated and aligned image frames.

5. Process final image

Target Selection

- Be prepared

Have target selected before your imaging session.

- Choose wisely

Select target near the zenith in unobstructed area of the sky.

- Utilize software

Software can be a great aid in planning and getting the most out of your imaging session.

Demo: Session planning using SkyTools.

Acquire Reference Frames

- Bias frames

A series of zero exposure length reference frames.

- Dark frames

A series of thermal reference frames ideally the same exposure as the image frames.

- Flat-field frames

A series of uniformly lit reference frames with an average value of $1/3$ to $1/2$ of the imaging camera's full well depth. Don't forget flat-field dark frames!

Basics: All reference frames should be acquired at the same binning and temperature as image frames.

Acquire Image Frames

- **Focus using a repeatable baseline**
Utilize a focus routine such as FWHM to allow a repeatable unambiguous baseline.
- **Choose a suitable exposure**
Settle on an exposure length that best fits the object and surrounding star field.
- **Choose a number of sub-frames**
Settle on a number of sub-frames that will be combined to create your final image.
- **Dither exposures**
Employ a small random movement (1-2 pixels) between exposures to minimize image artifacts.

Create Master Frames

- **Master bias**

Bias frames are combined together to create a master bias frame.

- **Master dark**

Dark frames are bias subtracted using the master bias frame and combined to create a master dark frame.

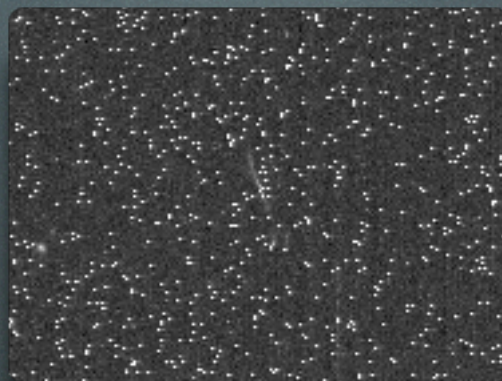
- **Master flat-field**

Flat-field frames are bias and dark subtracted and combined to create a master flat-field frame. Don't forget to shoot flat-field dark frames!

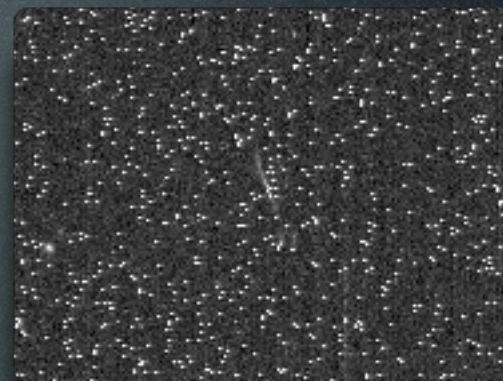
Note: Take advantage of normalization and optimization and use real numbers whenever possible.



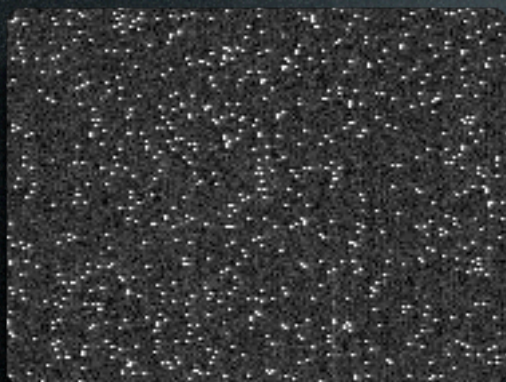
Single frame



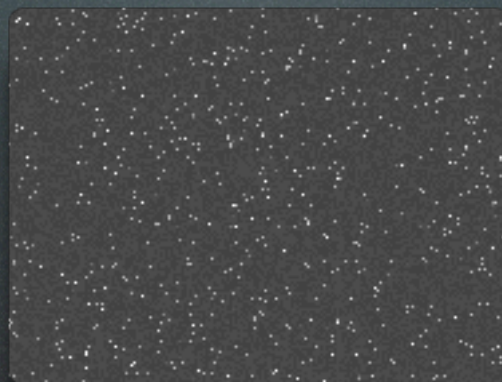
Sum



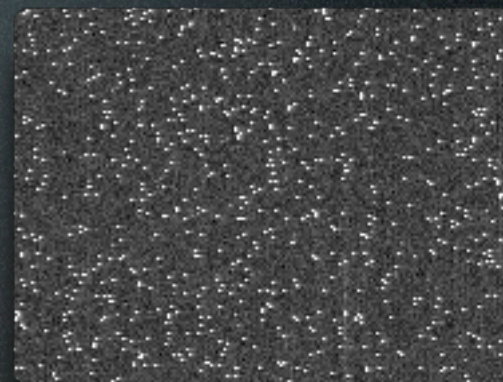
Average



Median



SD Mask



Sigma Clip

What combine method should I use?

	Average	Median	SD Mask	Sigma Clip
5 frames	210.005	207.646	121.644	209.516
10 frames	209.935	210.501	24.980	207.431
15 frames	206.848	210.857	18.519	206.554
20 frames	202.602	207.912	15.960	202.395
25 frames	198.465	201.234	13.646	198.563

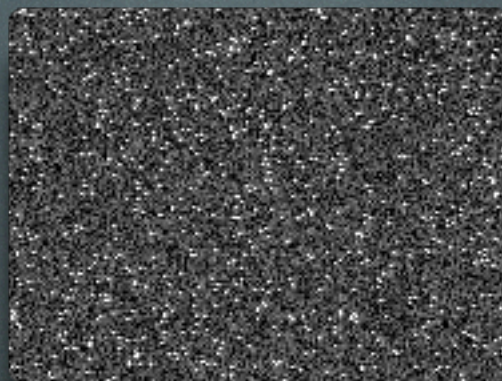
Standard deviation measurements on various combine methods.

Single image = 210.573

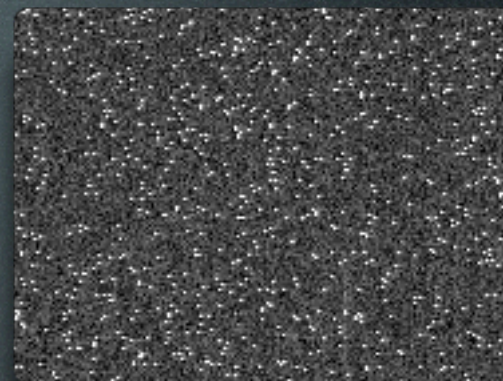
How many frames should I collect?



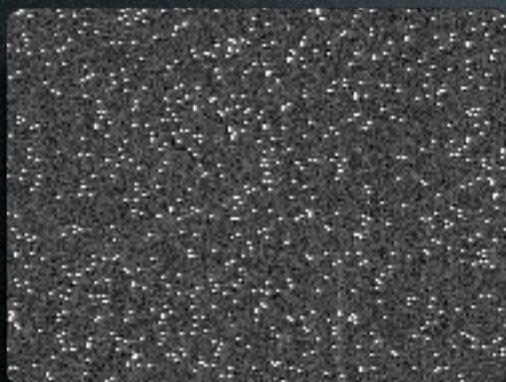
1 frame



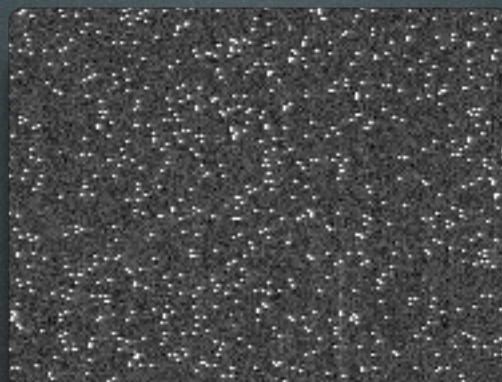
5 frames



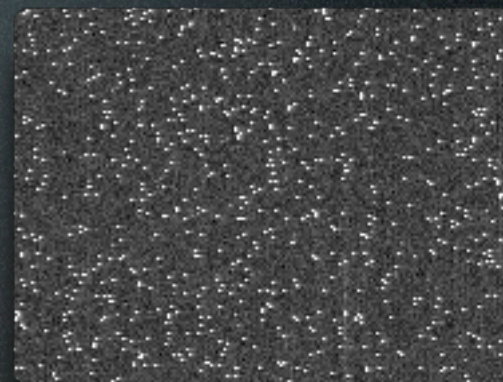
10 frames



15 frames



20 frames



25 frames

How many frames should I collect?

Calibrate Image Data

- Bias correction

Subtract the master bias frame from each image frame.

- Dark correction

Subtract the master dark frame from each image frame.

- Flat-field correction

Divide each image frame by the master flat-field frame.

Demo: Image frame calibration using MaxIm DL.

Align Image Frames

- **Image frames must be aligned**
Slight frame to frame movements and intentional frame dithering requires that frames be aligned before being combined.
- **Many methods**
Auto correlation, pattern matching and manual registration are popular alignment methods.
- **Rotate, shift and scale**
Allows images with differing fields of view and orientation to be aligned.

Demo: Align image frames using MaxIm DL.

Combine Image Frames

- Master image frame

Same steps and methods as master reference frame creation.

- Real numbers

Take advantage of floating point numbers whenever possible.

Demo: Combine image frames using MaxIm DL.

Processing the Final Image

- 16 bit vs 8 bit

Do as much processing as possible with the image in 16 bits.

- Advanced techniques

Techniques such as digital development process (DDP) and histogram specification allow images with large dynamic ranges to be compressed into a narrow range for display.

- Photoshop

Photoshop offers processing techniques such as levels, unsharp masking and noise reduction.

Demo: Processing the final image using MaxIm DL and Photoshop.

Final Thoughts

- Create a checklist
- Keep it simple
- Revisit old images
- Share online
- Follow online discussions

Demo: Image sharing and discussion using Flickr and Yahoo Groups.

Discussion