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.
What combine method should I use?
### Standard deviation measurements on various combine methods.

<table>
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<tr>
<th>Frames</th>
<th>Average</th>
<th>Median</th>
<th>SD Mask</th>
<th>Sigma Clip</th>
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<td>5 frames</td>
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</table>

Single image = 210.573

**How many frames should I collect?**
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