

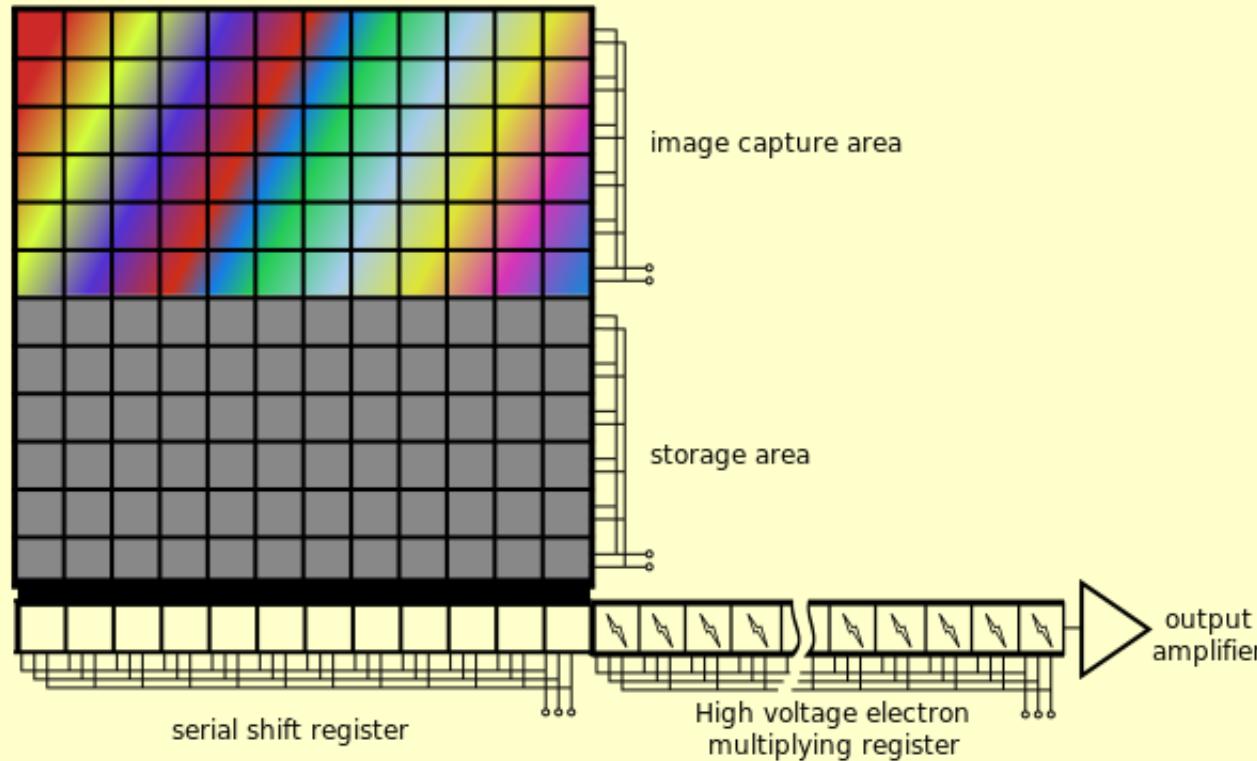
Reduction of CCD Images

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CAMK PAN

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How CCD works



By Jsanchezd - self-made with Inkscape 0.45, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=2091410>



Reduction steps

1) *Zero Exposure Bias Correction*

- *overscan*
- *master bias image*

2) *Dark Current Correction*

3) *Nonlinearity Correction*

4) *Fringing Correction*

5) *Shutter Timing Correction*

Reduction steps

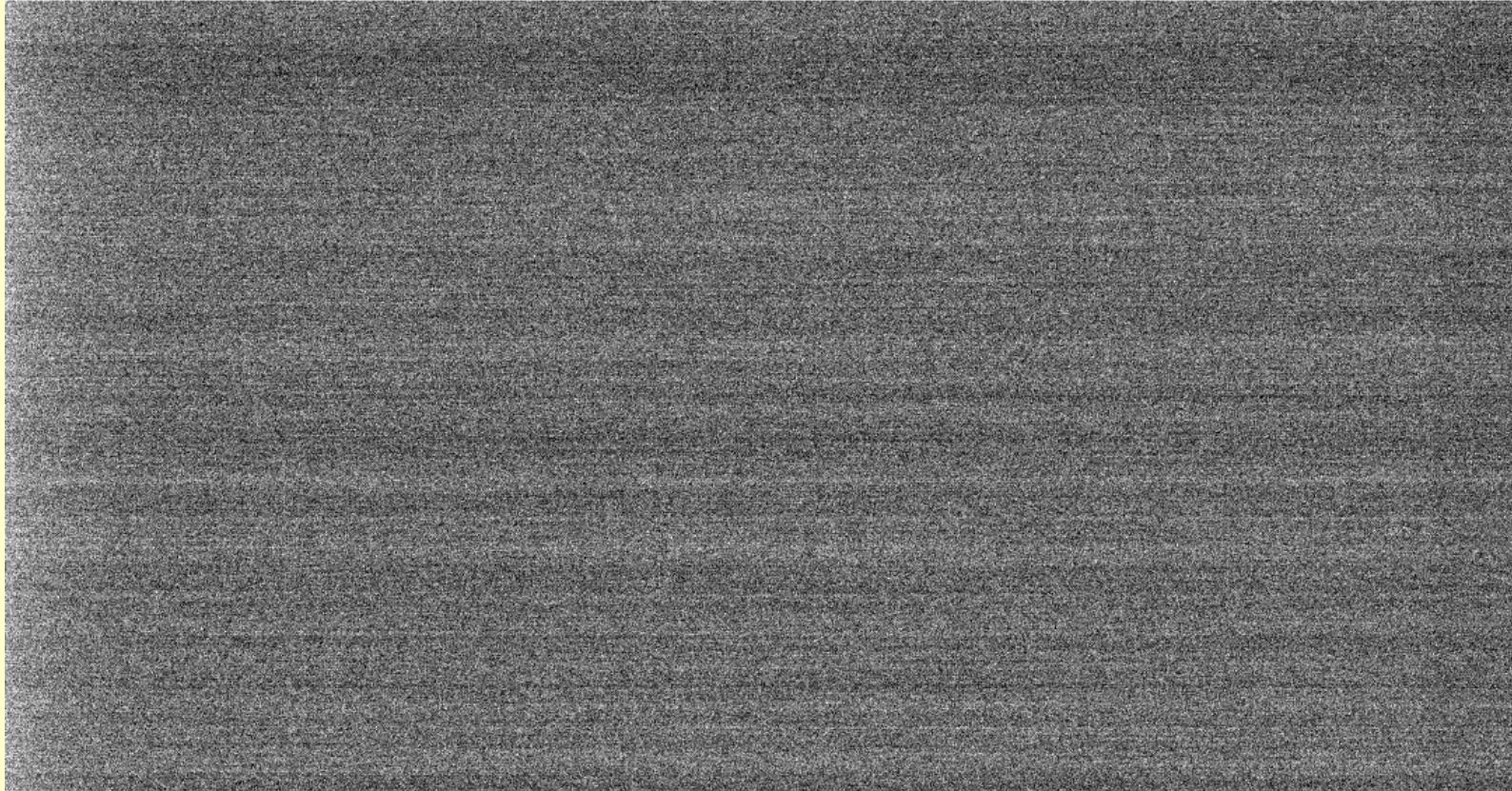
6) *Flat-field Correction*

- *dome-flats*
- *sky-flats*

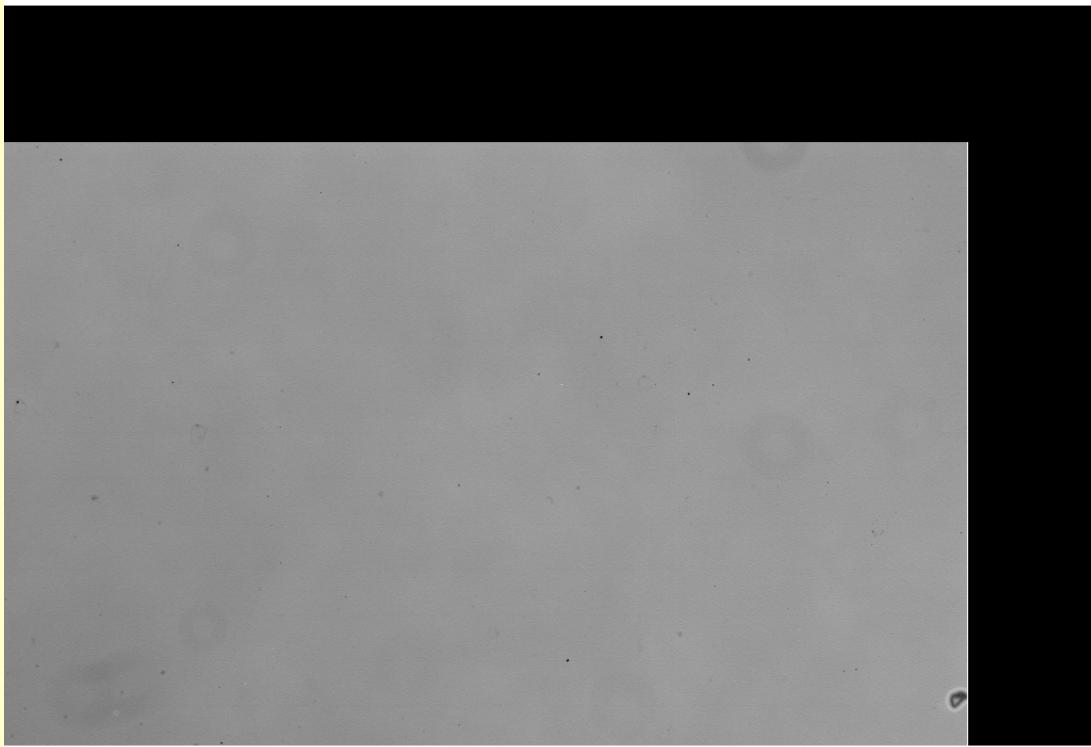
7) *Cross-talk Correction*

8) *Cosmic-rays*

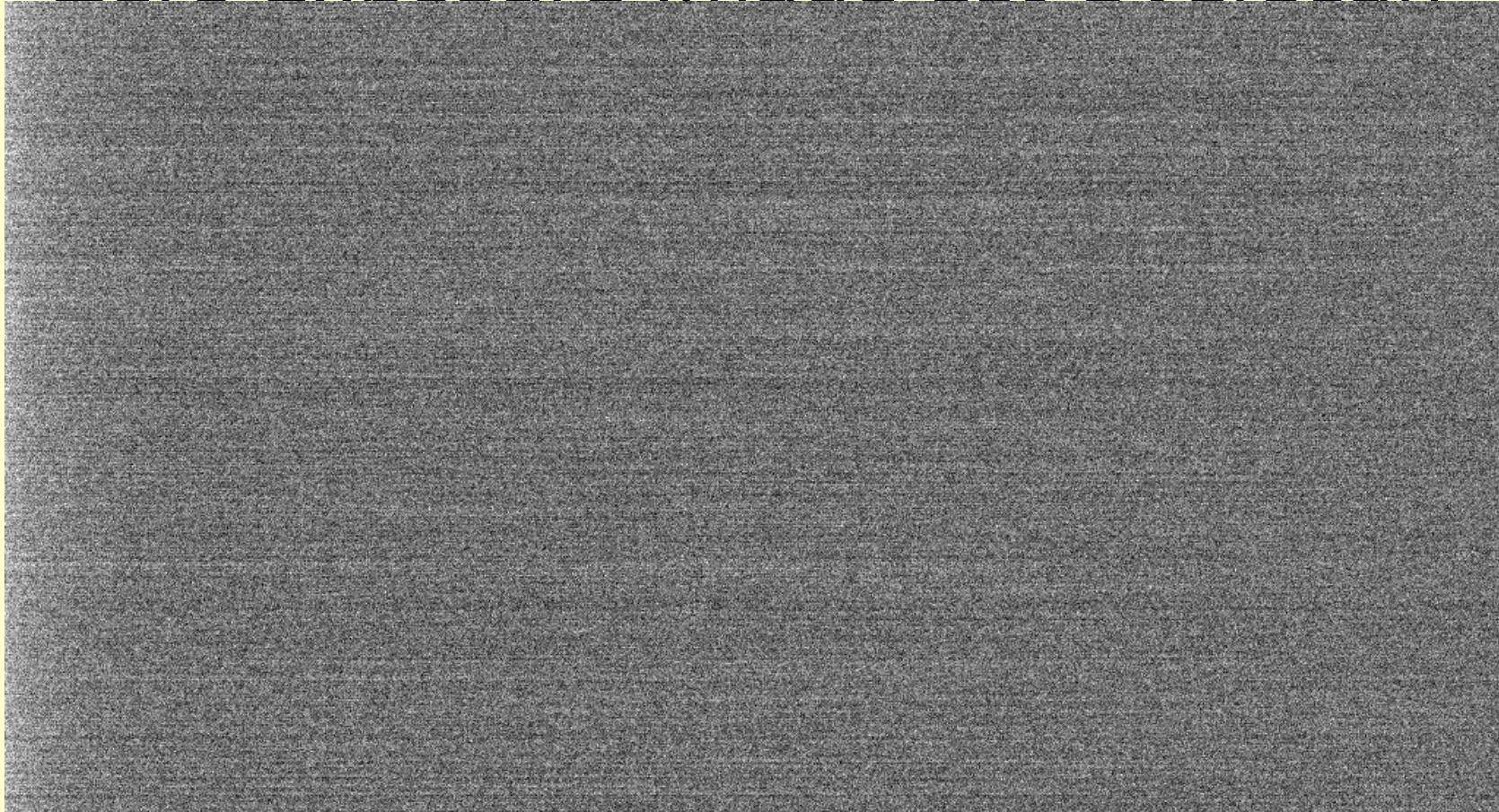
Zero Exposure Image



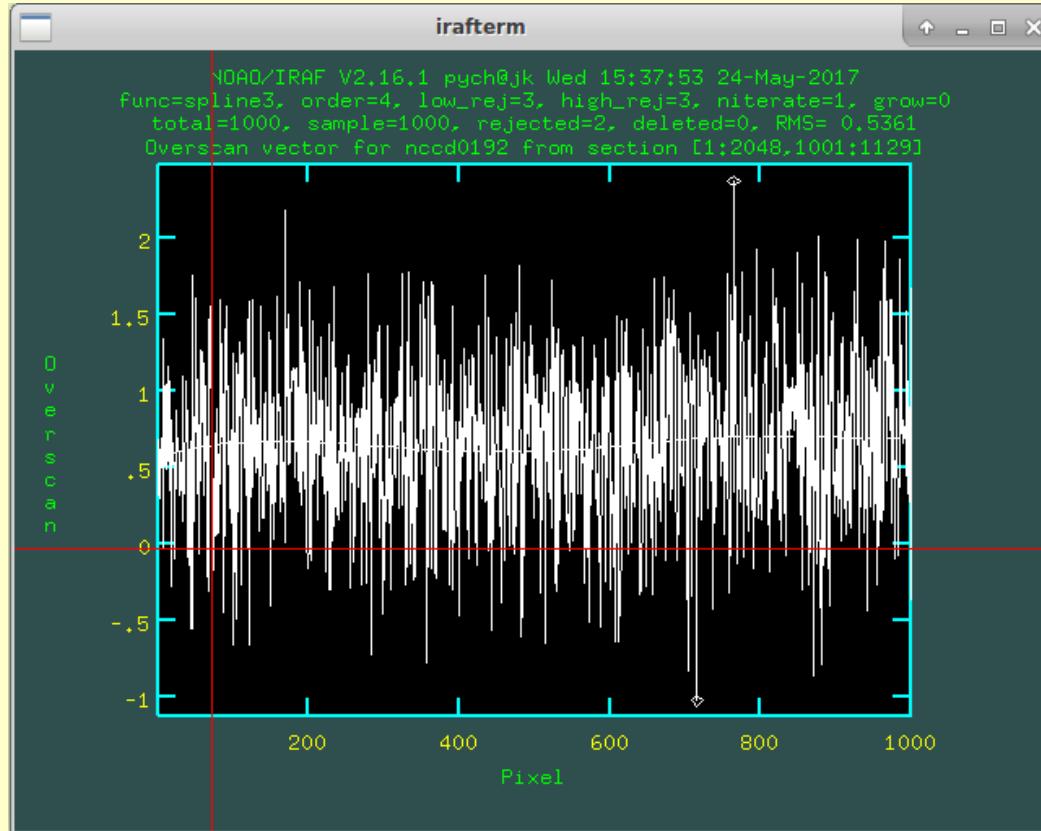
Overscans



Zero Exposure Image 1st Overscan



Horizontal Overscan



Master Bias Image

Combine multiple images (average)



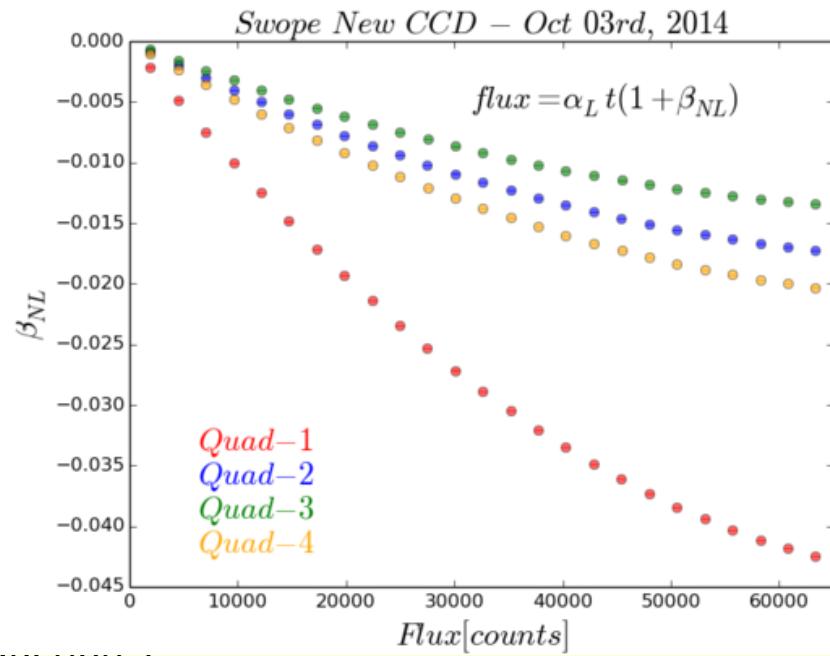
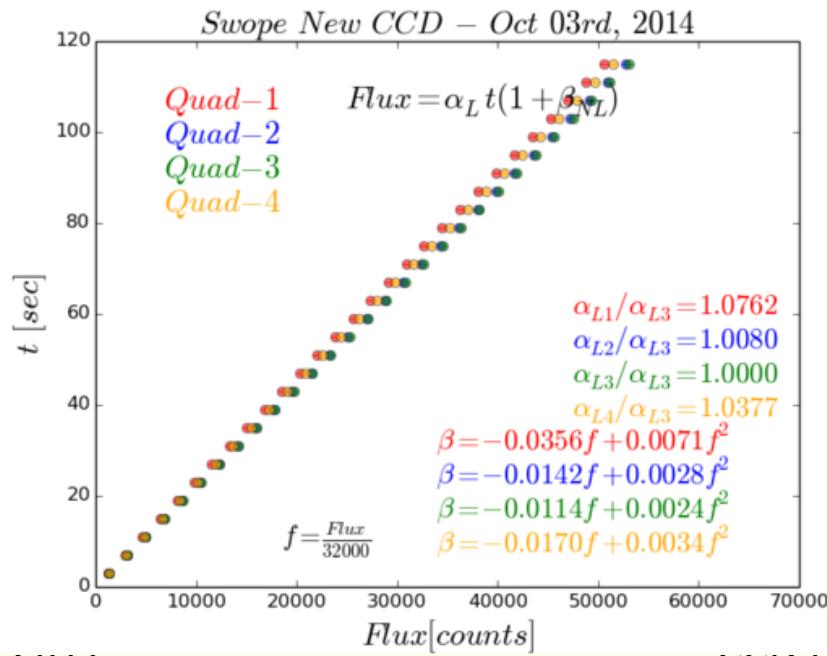
Dark Current Correction

- Subtract bias from all dark images
- Combine multiple dark images (average)

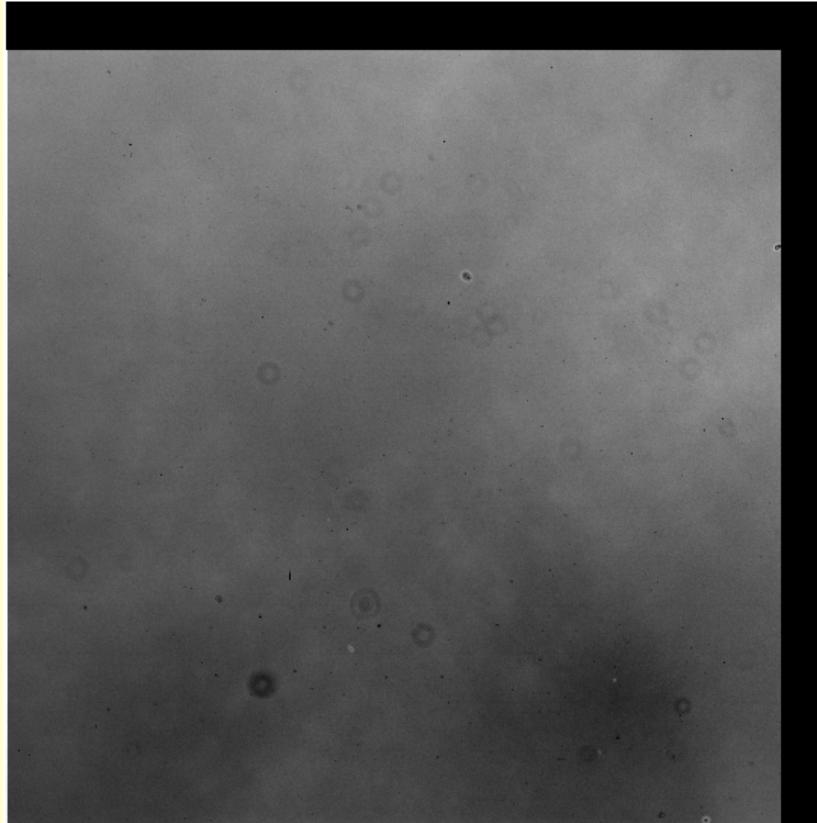


Nonlinearity correction

Series of images with constant illumination and different exposure times or a calibrated stellar cluster.



Shutter Timing



Shutter Timing

$$F_1 = I(T_1 - T_s)$$

$$F_2 = I(T_2 - T_s)$$

$$I = \text{const.}$$

$$T_2 < T_1$$

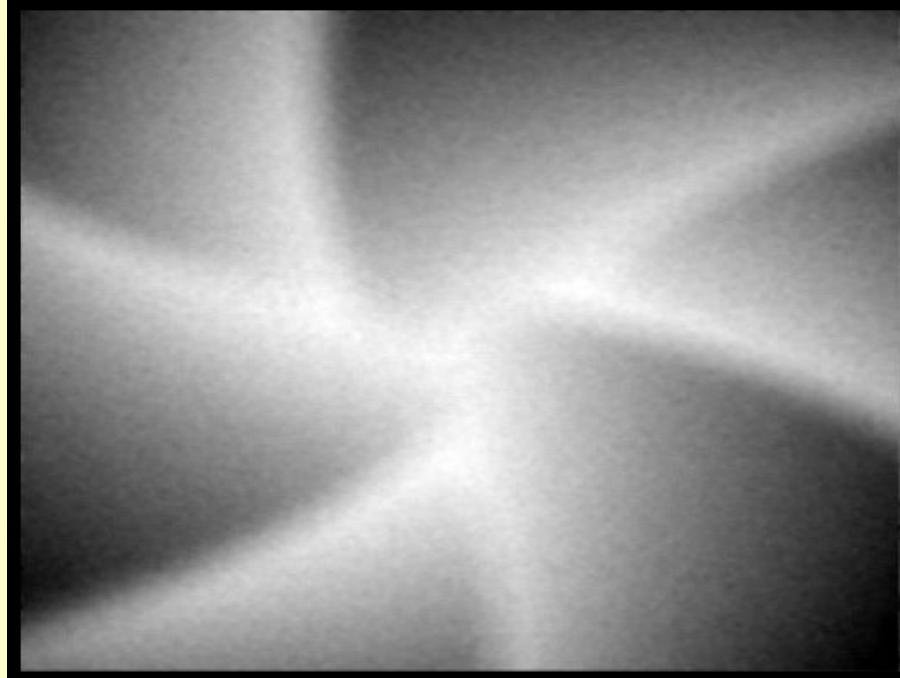
$$T_s \ll T_2$$

Shutter Timing

$$a = \frac{F_2}{F_1}$$

$$T_s = \frac{T_2 - aT_1}{1 - a}$$

Shutter Timing Correction



Shutter Timing

$$Image_{corrected} = Image_{raw} \frac{1}{1 + \frac{T_{shutter}}{T_{exp}}}$$

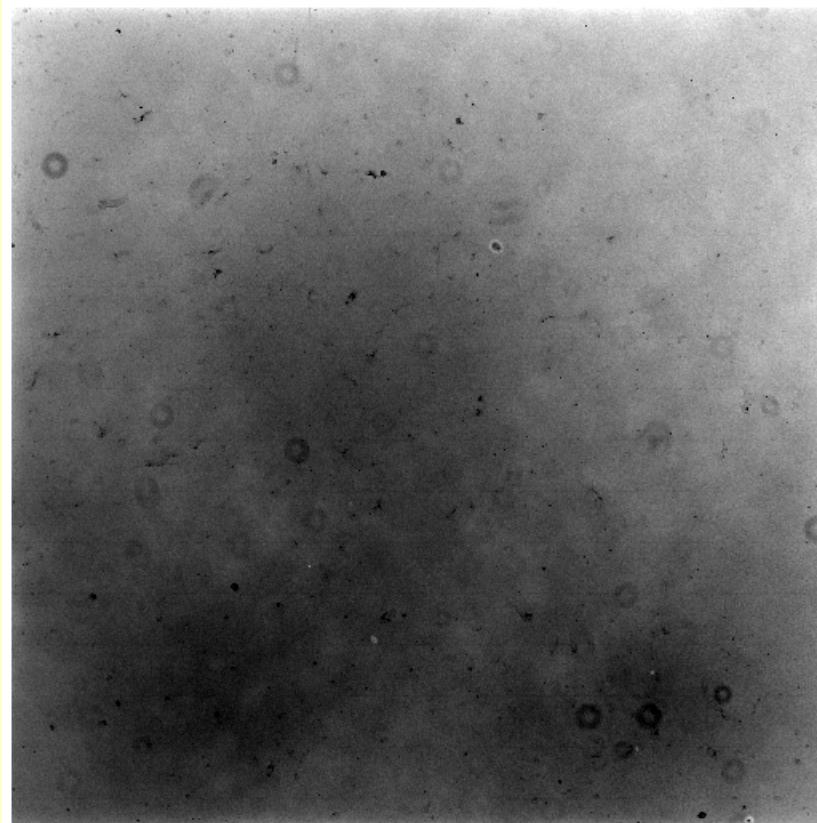
Flat-field Correction

- Series of Dome-flats
- Series of Sky-flats

Dome-flats

- Correct nonlinearity
- Subtract bias and dark from all of the images
- Correct shutter timing
- Combine multiple images for each filter (average)

Dome Flats



May 2017

CCD Reduction 1

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Sky-flats

- Series of twilight sky images for each filter
(Move the telescope between the exposures!!!)
- Correct nonlinearity
- Subtract bias and dark from all of the images
- Correct shutter timing
- Combine images for each filter (median)

M



M

Process Science Images

- Correct nonlinearity
- Subtract bias and dark from each image
- Correct shutter timing
- Divide by the normalized flat-field
- Correct cross-talk



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Photometry

- Aperture
- Profile
- Image Subtraction