OPTIMIZE YOUR IMAGING PERFORMANCE

CEDIC 2013

INITIAL THOUGHTS

In our quest for pretty pictures we often put our bias
On the final image processing and tend to develop techniques
To fix things we wouldn´t need to fix if we have a close look
At our setup and how it performs

GHOSTING
or more correctly
RESIDUAL BULK IMAGE

RBI

Residual Bulk Image or more common Ghosting is a Phenomena Mostly overlooked although it is present to some extent in almost All frontilluminated and some backilluminated frametransfer ccd´s Used today.

FOR EXAMPLE

KAF 3200
KAF 8300
KAF 6303
KAF16803
KAF 9000

RBI

Residual Bulk image is purely sensor and not camera related.
It is caused by impurities in the bulk silicone layer that trap charge.
Unfortunatly all that happens in a non readeoutable area of the ccd.
The effect is determined by the factors.

Temperature
Time
Wavelenght

RBI

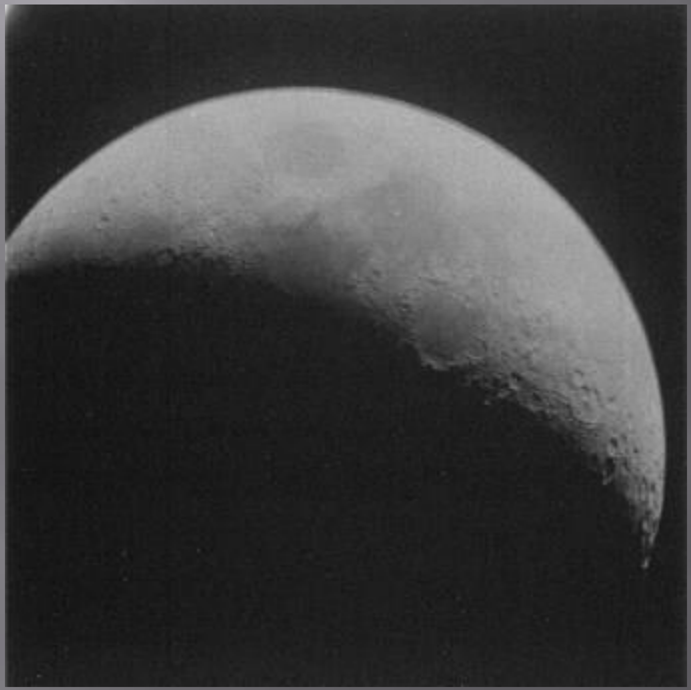
The longer the wavelenght the deeper the light penetrates into the Silicone.
The lower the temperature is the slower the charge bleeds into
The conductive area of the sensor.
The longer the exposure time is the more electrons will bleed
Into the image forming region.

RBI

Here is a 0.4 sec image of the Moon taken trough an Ha filter

RBI

This is a 600 sec. Darkframe taken 5 min. later

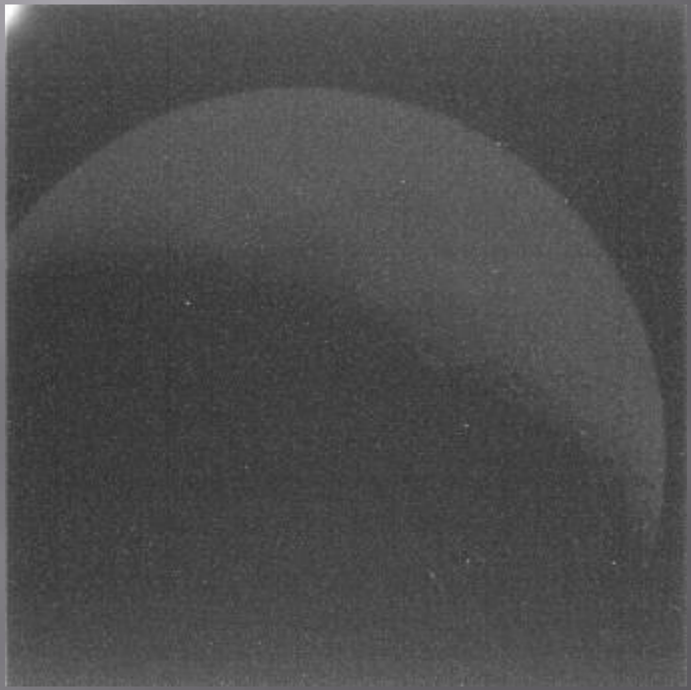


RBI

This is a 600 sec. Darkframe taken 40 min. later

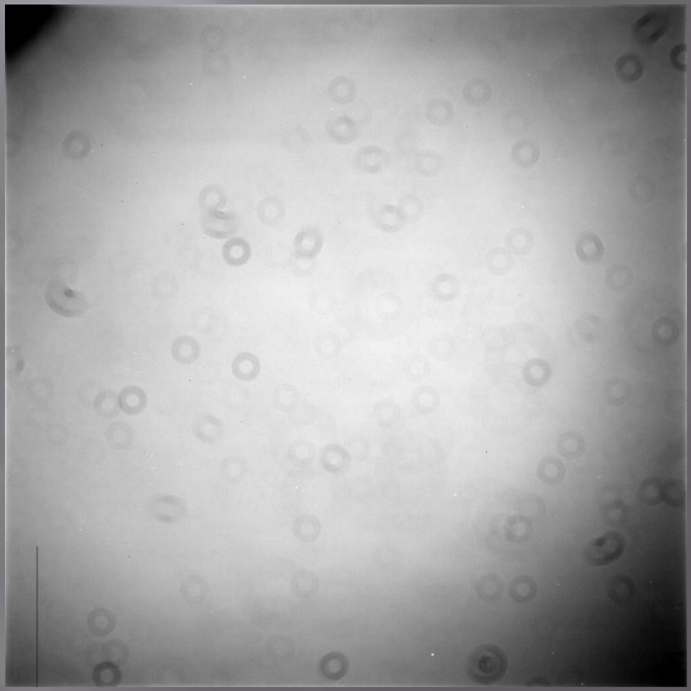
RBI

This is a 1200 sec. Darkframe taken 90 min. later



Now what is our Problem

Imagine what a simple flatfield taken in the evening will do to the following image session



Now what is our Problem

The sensor is in a very unpredictable state of operation.

Light frames will not calibrate well.

Amplifierglow might not calibrate out.

Column defects show quite different behavior.

The frames also don`t flatfield well and show uneven background

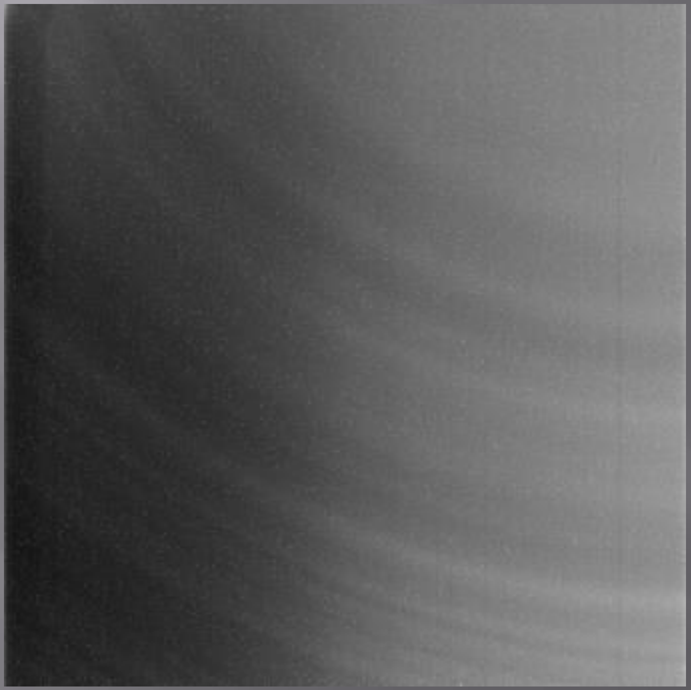
A big problem if you go for faint objects.

HANDLING RBI

The most elegant solution is the technique called RBI flood, Originally developed by the NASA for the Cassini Mission.
The sensor is flooded with infrared light before every light and Dark frame.
This technique tops off the charge traps making them immune to Additional charge as they are totally filled.

HANDLING RBI

This is a 900 sec. Dark frame using RBI flood



In this case the traps are totally filled

The distribution of the traps is not uniform

the rotational pattern is a result of the ccd´s manufacturing

HANDLING RBI

Now if the IR flooded lights and darks have the same temperature
And duration the RBI artefacts will calibrate out perfectly.
You need darks with matching time and temperature, that
Means no darkframe scaling.
You don´t need the RBI flood for flats and bias frames, just because
The exposure times are too short to get any reasonable charge bleed
Into the image forming region of the sensor.

If you own a camera that has a RBI flood option use it.
It will give you better results for sure.

WORKAROUND

If your camera has no RBI flood option.
One option would be to simulate it by using a flash light to flood the Sensor before every dark and light frame. Very unpractical but it Works.
The other solution would be to cool the camera down to something Like -100 degrees absolute, in this case the charge bleed slows down To a neglectable rate. Unfortunatly Amateur cameras can`t do that.

WORKAROUND

What you can do

Don´t cool the camera as long as it is light, most shutters are not
Totally light tight and the ccd will gather charge.
Don´t take flats before the object images, If you do then warm up the
Camera and cool it down again, at warm temperatures the charge will
Bleed off quickly.
Warm up and cool down the camera when you change objects
Or when you flip the meridian.
Although these are not perfect solutions taking care of it will
Make image processing a bit easier sometimes.

SEEING AND SAMPLING

SEEING AND SAMPLING

Im sure most of you have heard statements like:

The best imaging scale is 2“/pixel

The average seeing at most backyard sites
Is rarely better than 3“

SEEING AND SAMPLING

Now i have imaged from rather average sites most of the time.

This is the Observatory I have been using the last few years,
It is just 25km east of Vienna in a midsized town

SEEING AND SAMPLING

M 51 from this site, average FWHM is 1.2“
Image scale is 0.4“/pixel

SEEING AND SAMPLING

The seeing at your site might be in the 3“ range, but chances
Are high that is actually much better.
And that is related to how accurate your measurment is.
Better measurment in this case is better sampling.

SEEING AND SAMPLING

Here as an analysis of 5sec. images taken at different imaging scales
Within a few minutes at the same sky conditions

CCDInspector 2.5.3

Image File	FWHM	Scale ("/px)	Pixel Size (um)
9.fit	1.39"	0.42	9.00
16.fit	1.44"	0.42	9.00
1.fit	1.46"	0.42	9.00
7.fit	1.47"	0.42	9.00
13.fit	1.72"	0.84	18.00
10.fit	1.72"	0.84	18.00
2.fit	1.75"	0.84	18.00
8.fit	1.83"	1.27	27.00
3.fit	1.92"	1.27	27.00
5.fit	1.93"	1.27	27.00
14.fit	1.95"	1.27	27.00
11.fit	1.99"	1.27	27.00
6.fit	2.07"	1.69	36.00
4.fit	2.11"	1.69	36.00
15.fit	2.28"	2.53	54.00
12.fit	2.28"	2.53	54.00

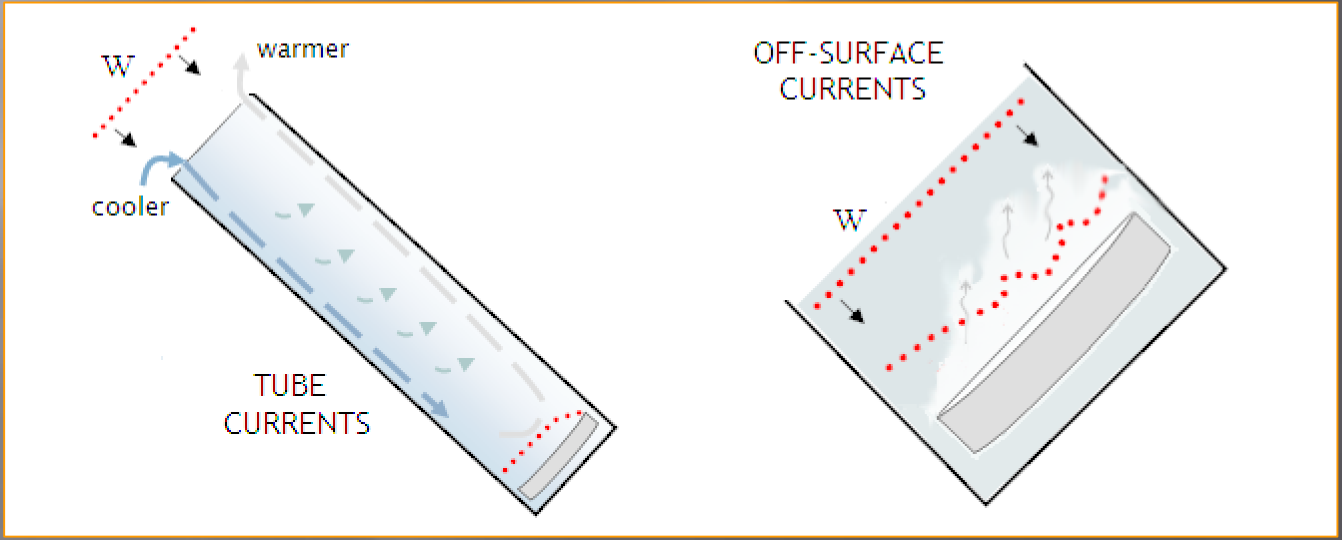
SEEING AND SAMPLING

Better sampling means better FWHM values and
Better measurment of your actual seeing.

TUBECURRENTS AND BOUNDARY LAYERS

Telescopes are heat exchanging machines

Telescope optics, especially mirrors are great heat storage devices. Unless you are able to cool your telescope or observatory to the Expected night temperature, the telescope will start a heat exchanging Cycle as soon as the ambient temperature drops.



Telescopes are heat exchanging machines

The refraction index of Air is dependent on ist temperature.
While the telescope cools down we have cold air at the lower side
Of the tube, warm air at the upper side of the tube, and closer to
Ambient in the center section.
This means we are looking through a set of three weak lenses
With different optical properties.
The problem is that telescope mirrors are huge pieces of glass
And a initially warm mirror might not even reach ambient
Temperature during the whole night

Telescopes are heat exchanging machines

A common solution is to have fans on the back of the mirror cell

This will accelerate the cooling but it still might take hours.

Fighting the boundary layer

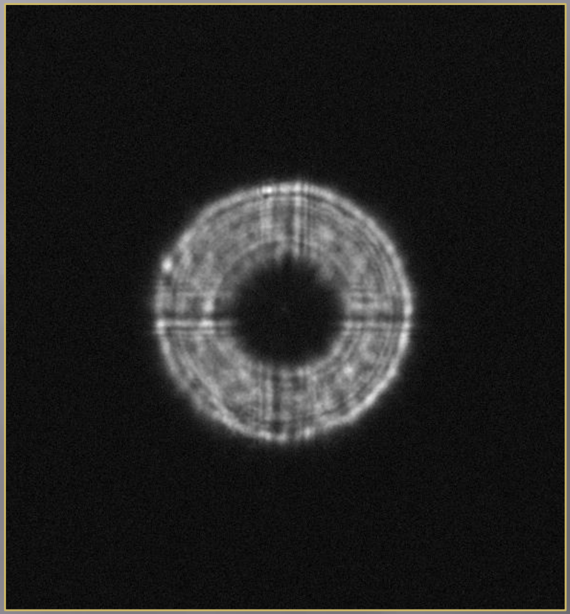
The most disturbing problem we encounter as long as the mirror
Is warmer than ambient temperature is the boundary layer that
Literally sticks to the optical surface of the mirror.
This layer strongly degrades optical performance and is even an
Issue with open truss telescopes as the natural ventilation is
Not strong enough to remove it in most cases.

Fighting the boundary layer

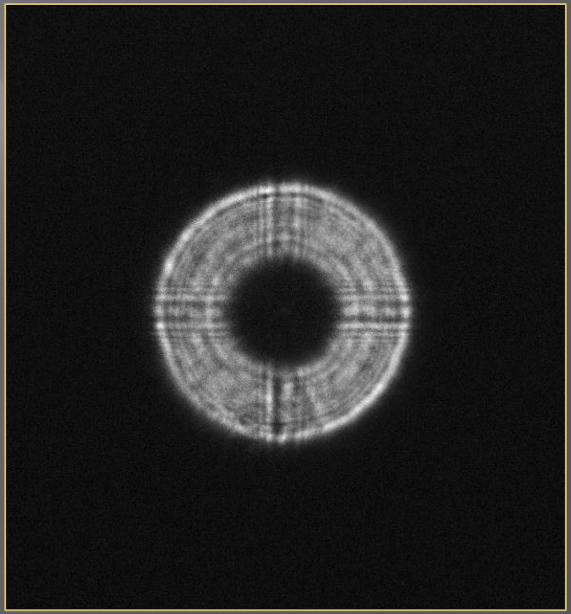
A solution to solve this are sidemounted fans blowing across the Surface of the mirror

Fighting the boundary layer

Here are two outside focus images, with the sidemounted fans
Off and on, the observatory was opened 2h earlier and the rear fans
Have been cooling from the beginning.



fans off



fans on

Fighting the boundary layer

This is a analysis of focus images with the sidemounted fans turned On and off, wait time between the images was just a couple of Seconds, showing how fast the boudary layer builds up again Even after hours of cooling the telescope.

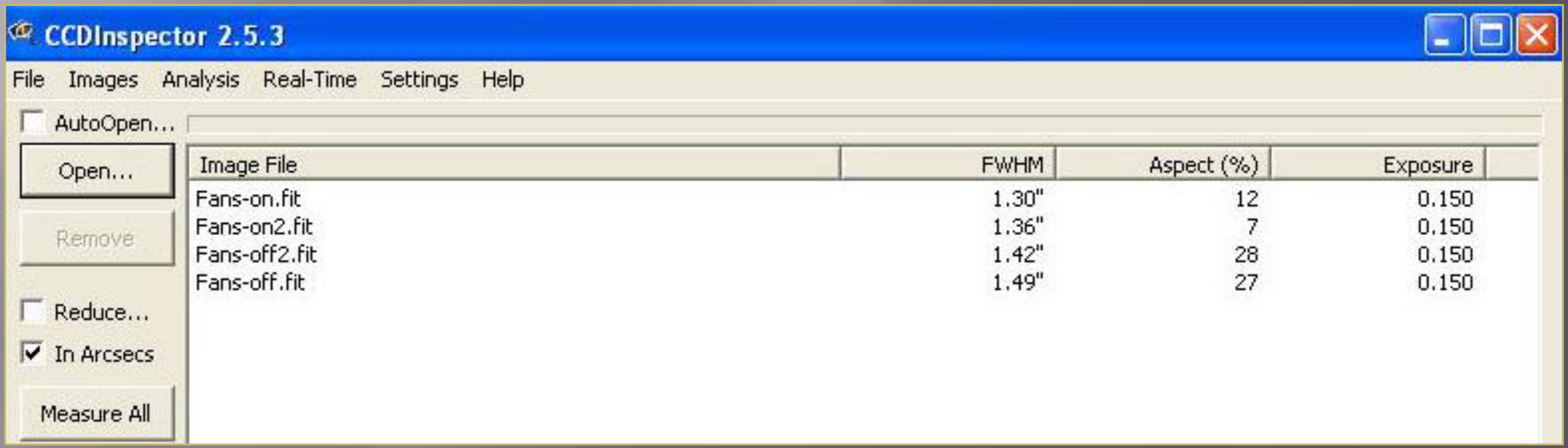


Image File	FWHM	Aspect (%)	Exposure
Fans-on.fit	1.30"	12	0.150
Fans-on2.fit	1.36"	7	0.150
Fans-off2.fit	1.42"	28	0.150
Fans-off.fit	1.49"	27	0.150

The images with the fans on have clearly better FWHM and Aspect Ratio.

CONCLUSION

Theese are all small steps in optimizing your imaging performance,
But to me part of the beauty of astro imaging is to know about
The shortcomings and capabilities of the imaging system.
THANK YOU

www.astro-pics.com