Test Report

Mallincam Video Ritchey-Chrétien 8”

by

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Executive Summary

The Video Ritchey-Chrétien (VRC) sold by Mallincam is designed to provide a superior image over that provided by a Schmidt-Cassegrain (SCT) telescope. In this test report I have compared a sample 8” aperture VRC and SCT back-to-back. My test method and observed targets were selected to evaluate the two scopes against each other in terms of:

1. Image sharpness/contrast;
2. Image brightness;
3. Image flat and coma-free;
4. Focal ratio/field of view;
5. Off-axis light rejection; and
6. Ease of use.

The end result of my testing is that the VRC does indeed provide a superior image to that of the SCT. The VRC provides an image that is brighter than can be accounted for by just the difference in focal ratio, and provides more contrast. I was able to successfully reduce the VRC to f/3 with no detectable coma or field curvature. The VRC has superior off-axis light rejection to the SCT. I found the VRC pretty much as easy to use as the SCT, even when collimating the secondary mirror. The only aspect of the scope I found a little inconvenient was that when I tried a normal 2x Barlow on it I had to add ~4” more spacer to get focus, which threw off my mount balancing.

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1.0 Introduction

As I have proven in many of my past tests, accessories such as light pollution filters and focal reducers can be used very effectively in video astronomy. The same is true of telescope technology. The benefits afforded to astrophotography by using high performance telescopes can also be realized when using an astro-video camera. Cassegrain type reflecting telescopes have become very popular amongst astro-photographers and video astronomers alike due to their reasonably large apertures and compact size. The most commonly used Cassegrain style among amateurs is the Schmidt-Cassegrain, which has been sold in large numbers to the general public ever since Tom Johnson, founder of Celestron, came up with a method in the 1960's for producing the optics cheaply and reliably.

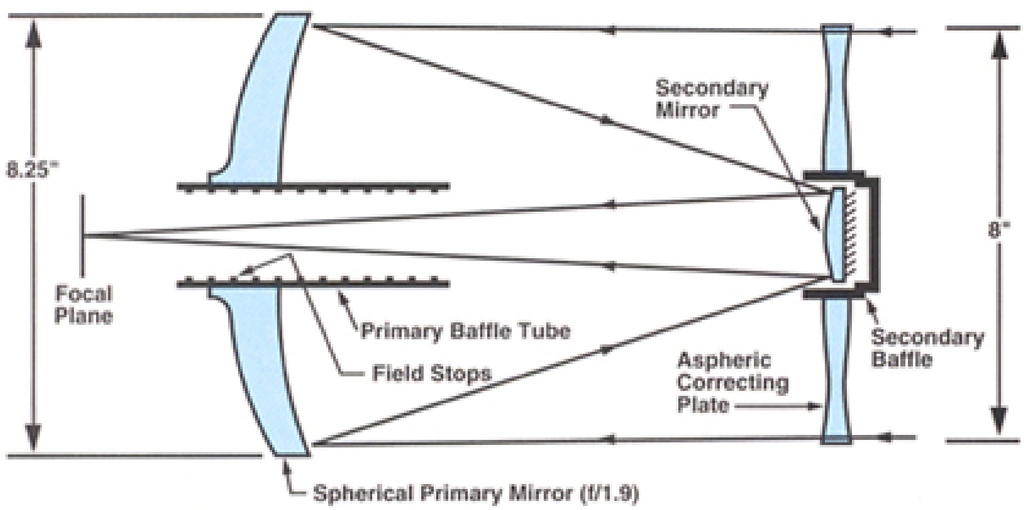


Figure 1 Schematic of a Schmidt-Cassegrain Telescope (Meade 8")

It has only been in the last couple of years that the Ritchey-Chrétien type Cassegrain has been available at a reasonably affordable price to amateurs. The RC design does not need a corrector plate as the primary and secondary mirror shapes are designed to give a flat coma-free image from edge to edge. The well corrected wide field of view and flat spectral response provided by the RC has made them the choice of professional observatories for many years, including the Hubble Space Telescope. With the introduction of the Mallincam line of Video Ritchey-Chrétien (VRC) telescopes, all these advantages are now available to the video astronomer.

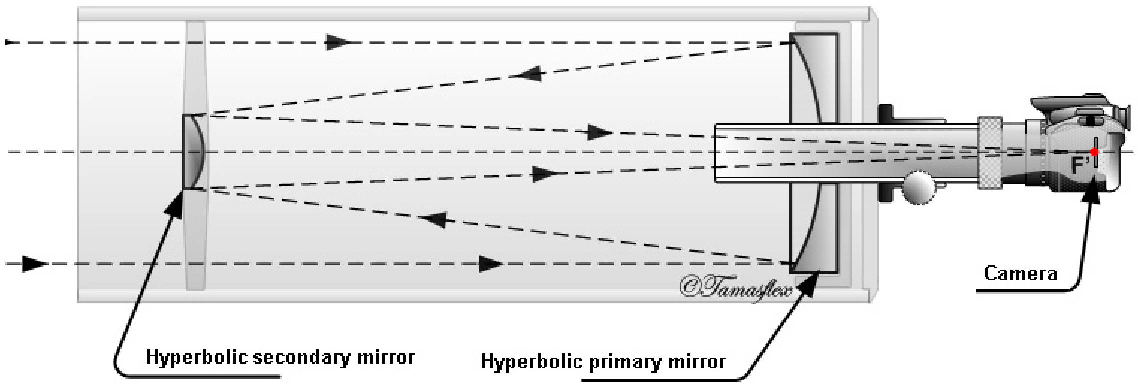


Figure 2 Schematic of a Ritchey-Chretien Telescope

The purpose of this report is to summarize my own personal testing of a sample 8" aperture VRC. Rock Mallin loaned a VRC8 to me for evaluation back-to-back against my existing scope, a Meade LX-10 EMC 8" SCT. My use of a typical 8" SCT and my location in the centre of heavily light polluted Ottawa was expected to provide a good comparison to a large number of other video astronomers who may be considering the VRC. My tests were broken up over a couple of different observing sessions over the course of the last month. In each session I tried to test different aspects of the VRC design back-to-back against my SCT. There were several key parameters I wanted to evaluate:

1. Image sharpness/contrast;
2. Image brightness;
3. Image flat and coma-free;
4. Focal ratio/field of view;
5. Off-axis light rejection; and
6. Ease of use.

The theory is that the VRC excels over the SCT in enough of the above parameters to justify the extra cost. My used SCT cost $500 USD (plus shipping), the VRC8 costs $1399 USD. (A new Meade 8" LX200 ACF costs $1199, Celestron EdgeHD 8" $1299)

2.0 Apparatus

To be able to easily test these two telescopes back-to-back it was necessary to attach them simultaneously on the same mount. That way I could easily switch the camera back and forth between telescopes to get an immediate comparison on the same object under the same conditions. Fortunately my mount, an Orion Atlas EQ/G, was up to the task. With the two 8" scopes plus my 2" finder scope, I was just able to get the whole rig balanced with my existing counter weights (3 x 5kg). The mount operated well in this configuration, well enough at least to complete my comparison testing. The images below show how my test setup looked.

To have as close a comparison as possible between the two scopes I used my add-on Crawford focuser on the SCT (see Figure XX). I also used on the SCT for some of my tests my usual dew shield: a 20" long piece of heavy black felt that wraps around the OT and secures with Velcro. Weight comparisons for the two tested configurations are listed below:

VRC8		**8" LX10**		**Miscellaneous**	
Item	**Mass**	**Item**	**Mass**	**Item**	**Mass**
Optical tube	5200g	Optical tube	4660g	2"-to-1.25" Hi-hat adapter	60g
Mounting rail (qty 2)	400g ea.	Mounting rail	960g	2"-to-1.25" standard adapter	80g
2" Crawford focuser	660g	2" Crawford focuser	640g	Mallincam Xtreme	420g
3" Ø, 2" long extension ring	260g	Dew shield	180g	MFR5	40g
3" Ø, 1" long ext. ring (qty 2)	130g ea.	50mm finder scope	450g	Meade f/6.3 or Meade f/3.3 FR	120g
				MFR2"	60g
				C-mount 1.25" nosepiece	20g
				C-mount 2" nosepiece	100g
				SCT-to-1.25" adapter	50g
				SCT-to-2" adapter	80g
TOTAL	**7180g (15.8 lb)**	**TOTAL**	**6890g (15.2 lb)**	Typical 2" glass filter	10g
Max Full-Up Mounted Weight			**14790 g (32.6 lb)** [+ mounting plate + 50mm finder camera]		

Table 1 Mass Summary of Tested Components

The two optical tubes have the same diameter of 23cm (9.1"), but the VRC is longer at 48cm (18.9") versus 43cm (16.9") for the SCT. With the focusers and required extension rings in place, the overall lengths grow to 66cm (26") for the VRC and 52cm (20.5") for the SCT.

Figure 3 Views Of VRC and SCT On My Orion Atlas Mount

Figure 4 Close-Up View Of Scope Exit & Focusers

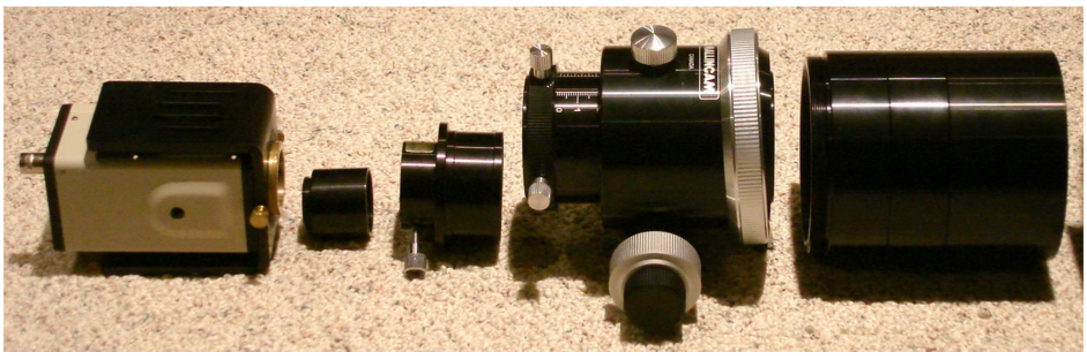
I tested with a number of different filters, although a large part of the testing was done with no filters at all. Filters used in my testing include:

- Baader Planetarium UV/IR Cut
- Astronomik UHC
- Meade O-III
- generic 680 nm high pass

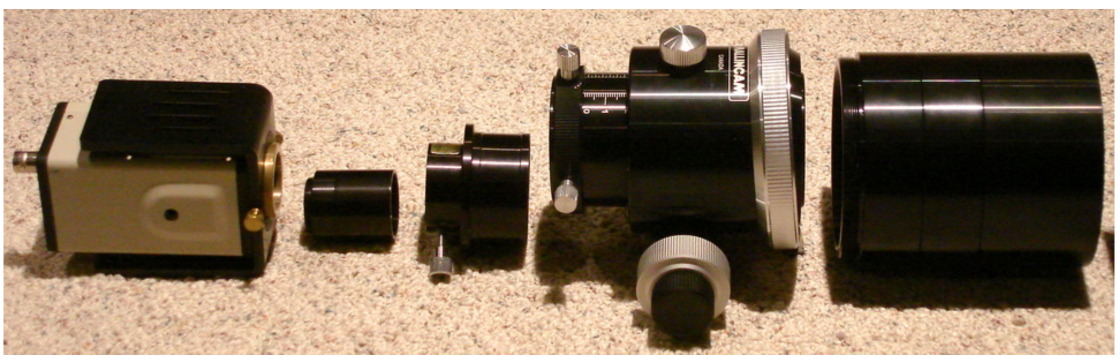
For one of the tests I used a variety of focal reducers on the VRC. The focal reducer configurations tested were:

- no FR
- front half of MFR5
- whole MFR5
- whole MFR5 + 10mm spacer
- 2" MFR5 + C-mount 2" nosepiece
- Meade 0.63x FR
- Meade 0.63x FR + front half of MFR5
- Meade 0.33x FR

I present a table summarizing the resulting f/ratios later in the Results section. To be clear on my setup, the images below illustrate how each focal reducer was used. Note that in some cases I had to remove extension rings from ahead of the focuser in order to achieve focus.

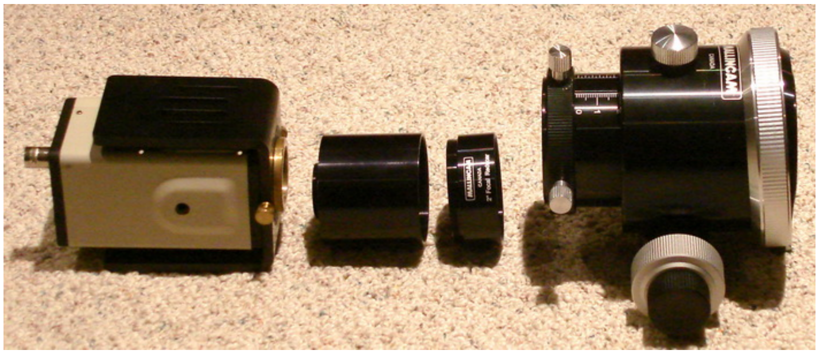


Front half of MFR5

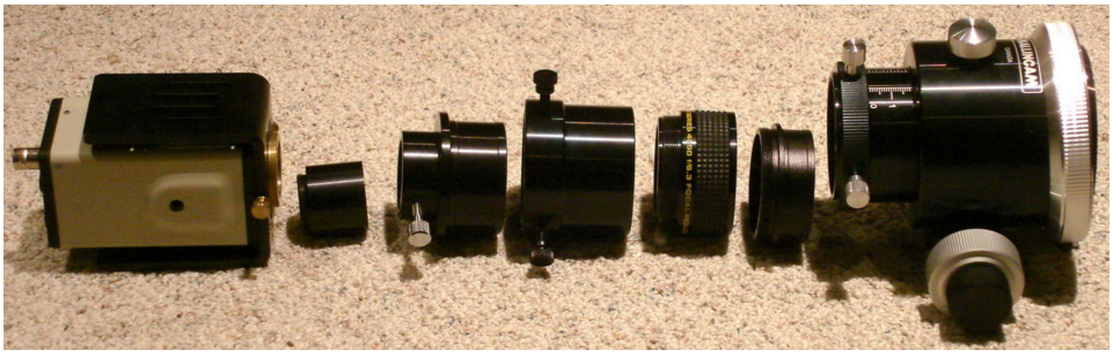


Whole MFR5

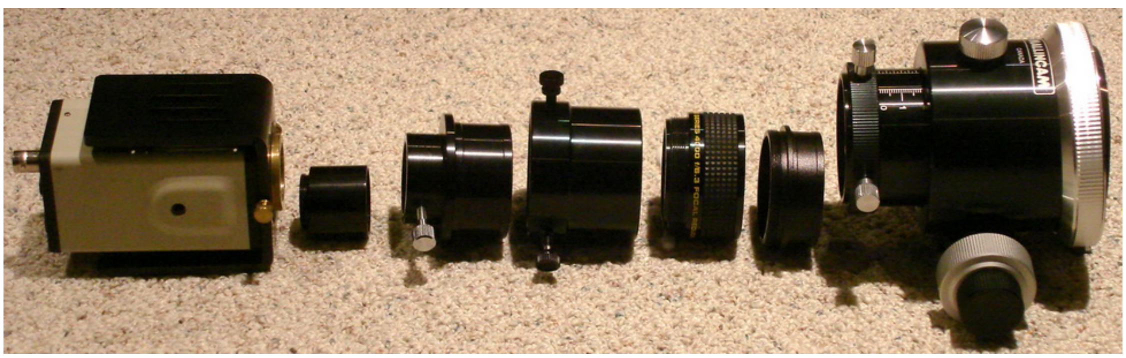
Whole MFR5 + 10mm spacer



MFR 2" + 2" nosepiece



Meade 0.63x FR



Meade 0.63x FR + front half of MFR5

Meade 0.33x FR

Figure 5 Picture of Each FR Configuration Tested

3.0 Results

All my tests involved comparing images recorded using my Mallincam Xtreme astro-video camera (non-EXview HAD, Class 1 chip, 1st Gen cooler). The setup of both telescopes on the mount at the same time allowed for quick and easy switching between scopes, for as fair a comparison as possible. Mount tracking (no guiding) with the two scopes was good, at least good enough to test out to the required INT times. I tried to keep all camera and video settings the same between tests, except the INT time and video BRT which was varied over the course of each test. Each test attempts to compare different aspects of the VRC to the SCT. I have documented each individual test below.

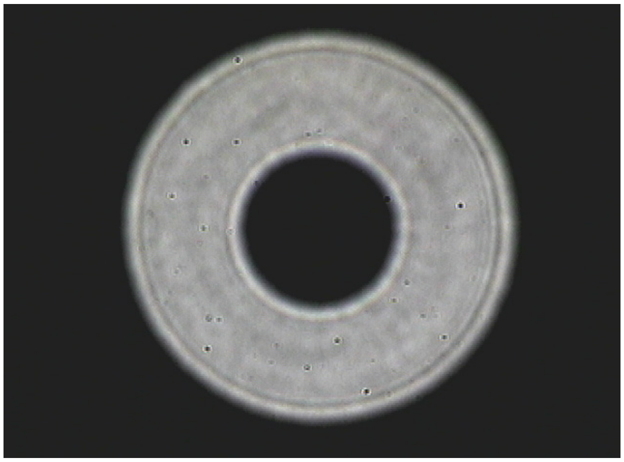
3.1 Test #1 – March 11th, 2012

Type: back-to-back comparison
Filters: none
Focal Reducers: none, MFR5
Target(s): multiple
Settings: gamma 0.45, APC 2x2, AGC 4, SAT 30, HUE 62, SHARP 1, WB ATW
Conditions: 100% clear, 3/5 transparency, 3/5 seeing, no Moon
Objective: ease of use, image brightness, image sharpness
Synopsis: Compared views of a short list of common DSO's between scopes at their natural f/ratio, and at a common f/ratio of ~f/5.

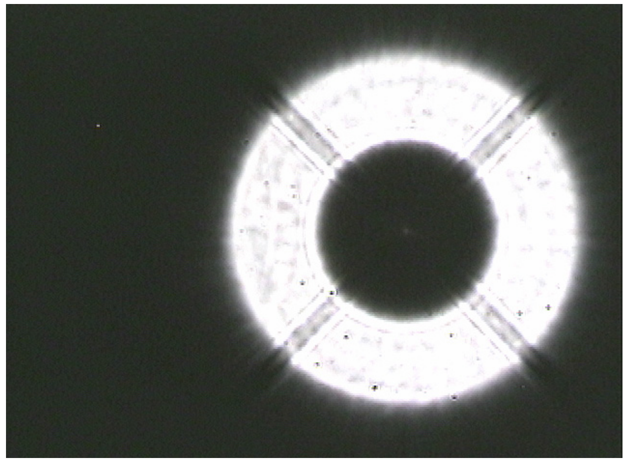
This was my first big test of the VRC, so I did not know what to expect. I wanted to determine how much brighter the VRC was compared to my SCT, but I wanted to remove the dependence of brightness on f/ratio. To do this I compared the two scopes first at their natural f/ratio, and then at roughly the same f/ratio by using the whole MFR5 on the SCT and the front half of the MFR5 on the VRC. Images were collected at different INT times and BRT settings in order to try to match the relative brightness between images. All other settings were the same.

I started by checking the collimation of each scope using Sirius. The images below show the resulting collimation disks. Both scopes were at their native f/ratio. Both scopes looked good so I proceeded to my first target.

The first target was M42, which was observed with both telescopes at their native focal ratio (no focal reducer) and APC 8x8. I arbitrarily chose a 30sec INT with the SCT as the reference image to which I compared the VRC. In theory the f/ratio difference should result in the VRC being 56% brighter, but when I compared the correspondingly reduced INT time of 19sec to the SCT, the VRC image is very obviously brighter. I achieved a closer exposure match with the VRC at 14sec INT, a 37% increase in brightness on top of what the faster f/ratio would provide. Comparing the contrast and sharpness in the images, I found the VRC and SCT to be close to the same. I did find that the colour balance was more RED with the VRC, a result I think of more infrared getting through to the camera (ie. no corrector plate acting like a mild IR cut filter).



SCT

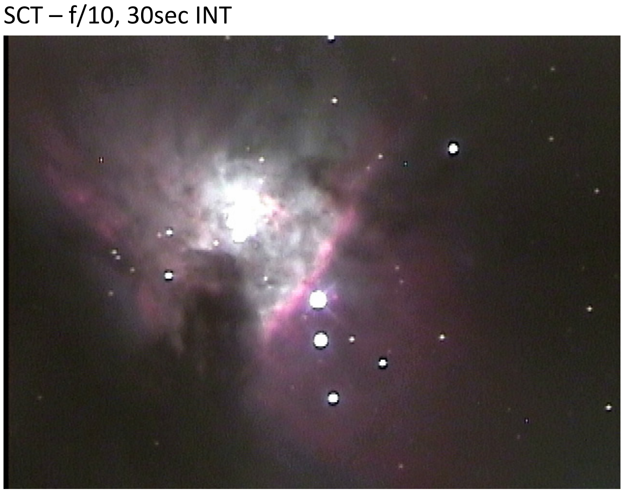


VRC

Figure 6 Test #1 - Collimation Check

SCT – f/10, 30sec INT

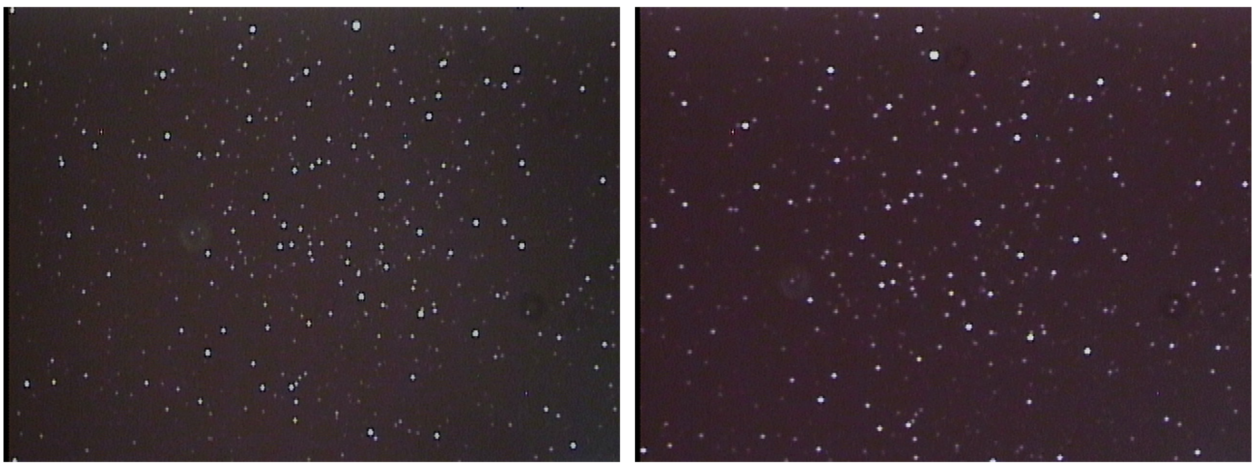
VRC – f/8, 14sec INT



VRC – f/8, 19sec INT

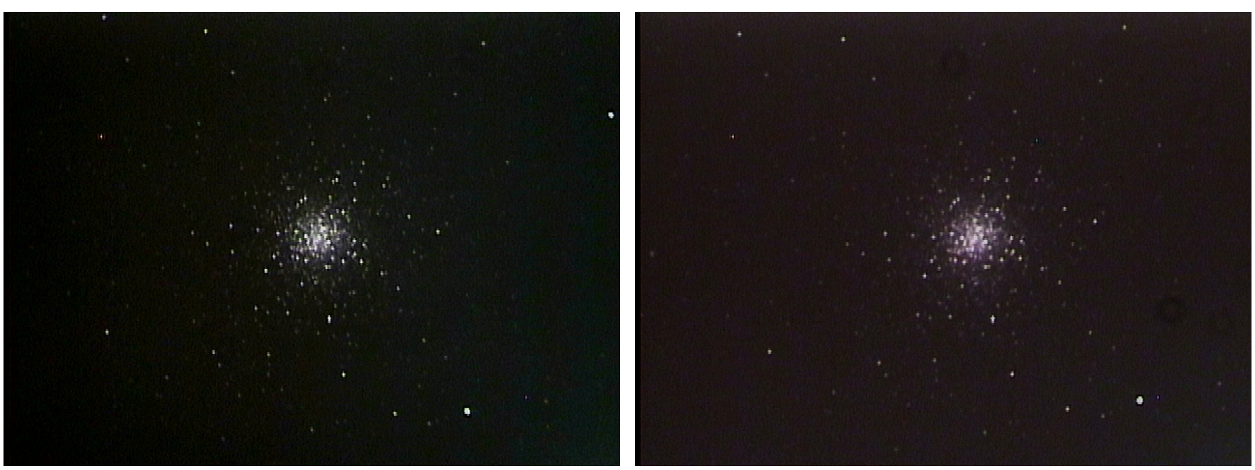
Figure 7 Test #1 - M42 Comparison

Next I put the whole MFR5 in the SCT to give f/5, and GOTO'd a short list of objects: M46, M3, & M82. I repeated the list with just the front half of the MFR5 in the VRC to give f/5.5. Similar to the shots of M42, the VRC had a more reddish tinge to the image. I did not bother to try correcting this by adjusting the white balance. On M46 and M3 I found the VRC to have not as good a sharpness and contrast as the SCT, even though I double checked the focus. The view of M82 however was slightly brighter and sharper with the VRC.



SCT – f/5, 40sec INT   VRC – f/5.5, 33sec INT

Figure 8 Test #1 - M46 Comparison



SCT – f/5, 36sec INT   VRC – f/5.5, 30sec INT

Figure 9 Test #1 – M3 Comparison

SCT – f/5, 60sec INT VRC – f/5.5, 50sec INT

Figure 10 Test #1 – M82 Comparison

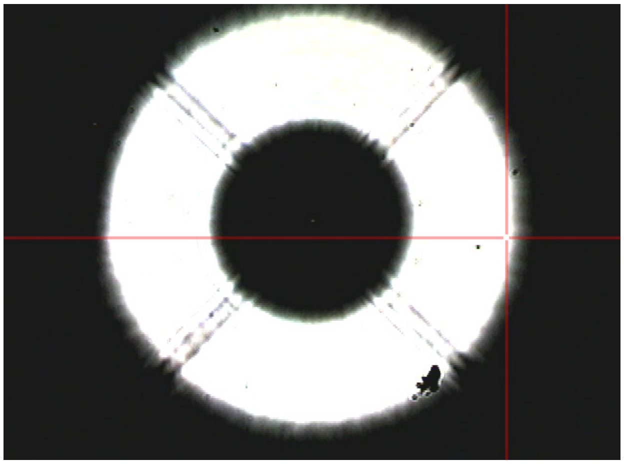
In the latter half of this test I dropped my MFR5 when switching it from the VRC to the LX10. The resulting fall made a big crack in the glass of the forward section. I could not see any artifacts in the image from the crack, so I kept testing with it.

The strange blurriness in the VRC shots of M46 and M3 made me wonder about the collimation again. I made a note to check it at the beginning of my next test.

3.2 Test #2 – March 19th, 2012

Type: back-to-back comparison
Filters: none
Focal Reducers: MFR5 (cracked)
Target(s): multiple
Settings: gamma 1.0, APC 2x2, AGC 4, SAT 30, HUE 62, SHARP 1, WB ATW or MAN
Conditions: 100% clear, 4/5 transparency, 2/5 seeing, no Moon
Objective: image brightness, image sharpness, flatness/coma
Synopsis: Compared views between scopes at a relatively fast focal ratio using the same FR, adjusting the INT times to account for the difference in f/ratios (f/5 vs. f/4).

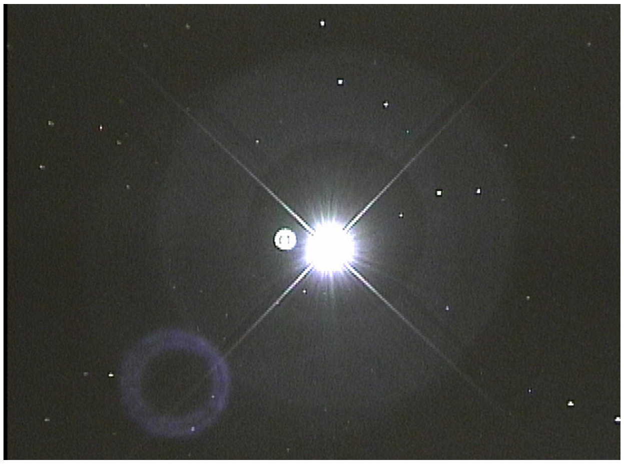
I started this test with a quick check of each scope's collimation, and they looked good (see figure below). I then viewed a number of different targets, adjusting the INT time by a factor of 1.56 as I went in order to account for the different focal ratios. Nine different objects were observed, images for the five can be found below.



VRC – f/8, 2sec INT

Figure 11 Test #2 – VRC Collimation Check

SCT – f/5, 2sec INT



VRC – f/4, 2sec INT

Figure 12 Test #2 – Sirius Comparison

SCT – f/5, 30sec INT

VRC – f/4, 20sec INT

Figure 13 Test #2 – ngc2244 Comparison

SCT – f/5, 30sec INT

VRC – f/4, 20sec INT

Figure 14 Test #2 – M66 Comparison

SCT – f/5, 30sec INT

VRC – f/4, 20sec INT

Figure 15 Test #2 – M64 Comparison

SCT – f/5, 30sec INT

VRC – f/4, 20sec INT

Figure 16 Test #2 – M82 Comparison

The scopes performed very similar to each other. The VRC was perhaps a little brighter and a little sharper. Faint details were slightly more visible on the VRC.

3.3 Test #3 – March 20th, 2012

Type: back-to-back comparison
Filters: Astronomik UHC
Focal Reducers: MFR5 (cracked)
Target(s): multiple
Settings: gamma 0.45, APC 2x2, AGC 4, SAT 30, HUE 62, SHARP 1, WB ATW or MAN
Conditions: 100% clear, 3/5 transparency, 4/5 seeing, no Moon
Objective: image brightness, image sharpness, flatness/coma
Synopsis: A repeat of last night's test but using a UHC filter, again adjusting INT times to account for the different f/ratio between scopes.

Since many Mallincam users employ LP filters in their observing, I thought it prudent to do some testing with one. I chose a very common filter, the Astronomik UHC for this night's testing. It was executed in much the same way as Test #2. I did not bother to check the collimation at the beginning of my tests.

SCT – f/5, 70sec INT VRC – f/4, 45sec INT

Figure 17 Test #3 – M46 Comparison

SCT – f/5, 50sec INT VRC – f/4, 32sec INT

Figure 18 Test #3 – M66 Comparison

SCT – f/5, 80sec INT VRC – f/4, 51sec INT

Figure 19 Test #3 – M51 Comparison

SCT – f/5, 70sec INT VRC – f/4, 45sec INT

Figure 20 Test #3 – M97 Comparison

SCT – f/5, 120sec INT VRC – f/4, 77sec INT

Figure 21 Test #3 – M82 Comparison

Adding the UHC filter seems to have resulted in the VRC performance being subdued a bit, making it perform almost identical to the SCT. In fact on M51 and M97 I would argue that the SCT produced a better, more detailed and contrasted image. This was unexpected, and warrants further testing. I did not perform a collimation check at the start of this test, so I must be sure to check it next time.

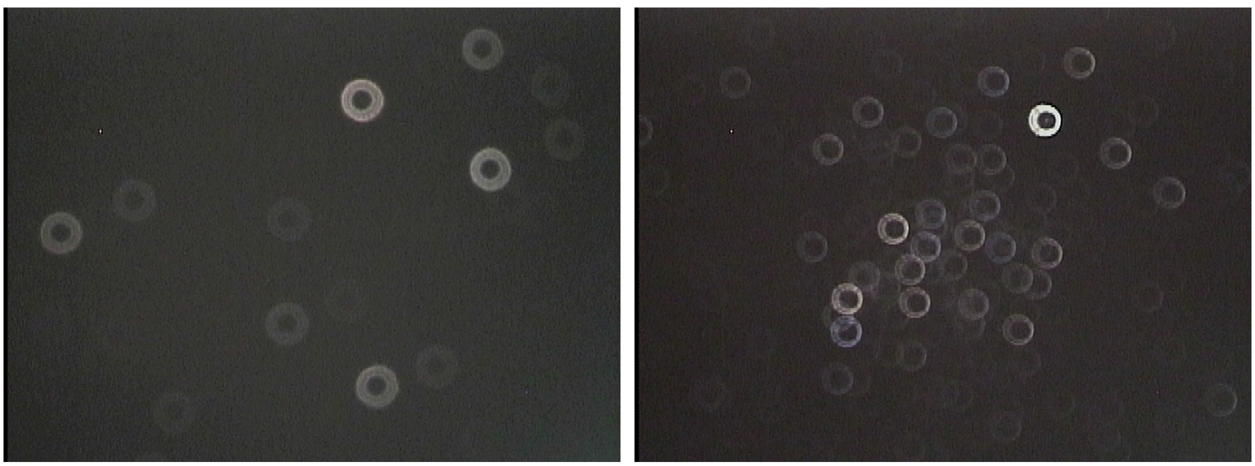
3.4 Test #4 – March 26th, 2012

Type: back-to-back comparison
Filters: multiple (none, UHC, IR Cut, IR Pass)
Focal Reducers: MFR5 (cracked)
Target(s): M-51 Whirlpool Galaxy
Settings: gamma 0.45, APC 2x2, AGC 4, SAT 30, HUE 62, SHARP 1, WB ATW
Conditions: 100% clear, 4/5 transparency, 1/5 seeing, waxing crescent Moon setting during beginning of test
Objective: ease of use, image brightness, image sharpness, field flatness
Synopsis: Compared views between scopes of a single target in different pass bands (whole spectrum, visual band, O-III & H-alpha bands, IR band) by using various filters.

The lack of difference between the VRC and SCT with the UHC filter installed that I found in Test #3 puzzled me as it was inconsistent with what I found in Test #1 and #2. For that reason I chose to compare the scopes on one target (M51) but using different filters. My hope was to determine if the results from Test #3 were correct, and whether this was a function of filter used.

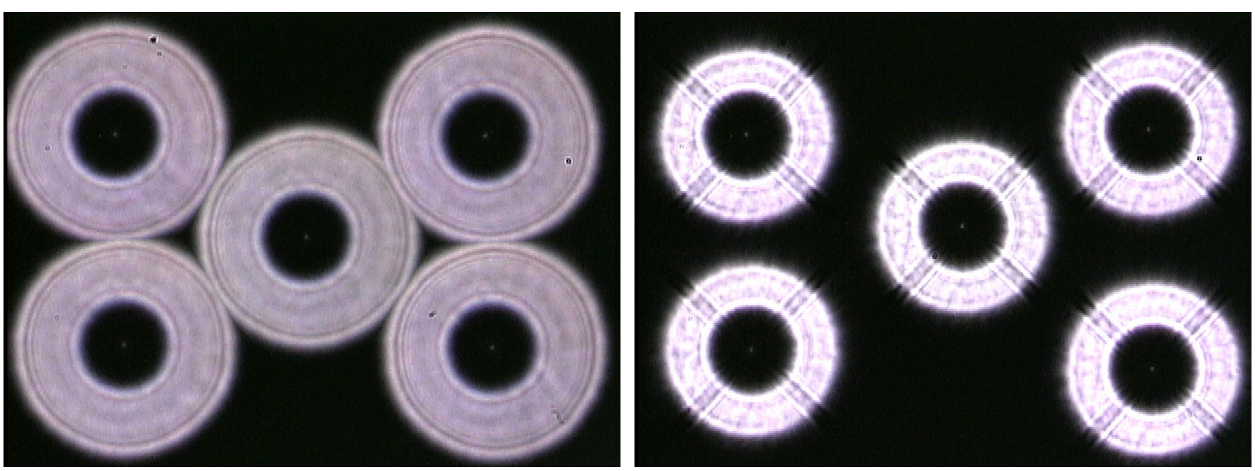
To start the test I checked the collimation using a bright open cluster. I did this to see if the collimation varied over the field of view. I found that the collimation of the VRC was way off, a discovery that I found strange considering that for the previous tests it was fine. The two scopes had been left outside covered but otherwise untouched since Test #2. The only thing being different was the ambient temperature; it was much colder tonight than on the 20th (15°C versus -2°C). The VRC's collimation was off by too much to not fix it, so I did a collimation. I found the three secondary mirror collimation screws were very tight. When I cracked one so it was loose, the mirror jumped enough to put the target star way off screen. Collimation was completed in about 15min. I took a screen capture of the star I used (Arcturus) in all four corners of the image. A composite image of these captures is shown below.

For all four filters tested the VRC was brighter and sharper, with better contrast. This result makes me wonder about the collimation of the VRC for all my previous tests. Perhaps the fact that the collimation screws on the secondary were torqued very tight affected the collimation somehow. The comparison to the SCT was clouded by an unusual artifact in the SCT images. The artifact got worse through-out the evening, and I later tracked it down to the cracked MFR5. Apparently the change in temperature to below freezing opened up the crack to the point that it was visible. I found it strange that the crack was only visible on the SCT however.



SCT – f/5, 2sec INT VRC – f/4, 2sec INT

Figure 22 **Test #4 – Collimation Check Pre-Fix**



SCT – f/10, 2sec INT VRC – f/8, 2sec INT

Figure 23 **Test #4 – Collimation Check Post-Fix (Composite Image)**

SCT – f/5, 30sec INT

VRC – f/4, 19sec INT

Figure 24 Test #4 – M51 Comparison, no filters

SCT – f/5, 47sec INT

VRC – f/4, 30sec INT

Figure 25 Test #4 – M51 Comparison, IR Cut

SCT – f/5, 150sec INT

VRC – f/4, 96sec INT

Figure 26 Test #4 – M51 Comparison, UHC

SCT – f/5, 120sec INT VRC – f/4, 77sec INT

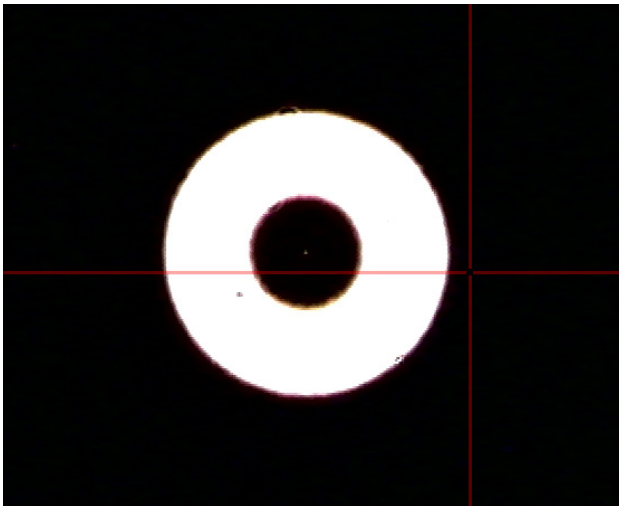
Figure 27 Test #4 – M51 Comparison, 680nm Pass

3.5 Test #5 – April 2nd, 2012

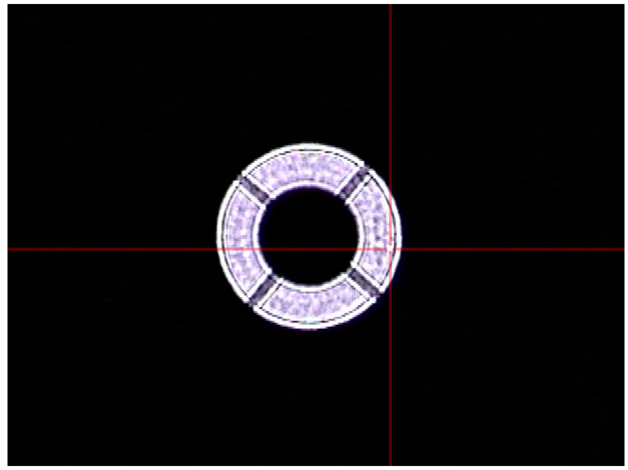
Type: back-to-back comparison
Filters: multiple (none, UHC, IR Cut, IR Pass)
Focal Reducers: none, MFR5 (new)
Target(s): Moon, Mars, M-51 Whirlpool Galaxy
Settings: gamma 0.45, APC 2x2, AGC 4, SAT 30, HUE 62, SHARP 1, WB ATW
Conditions: 100% clear, 5/5 transparency, 1/5 seeing, waxing gibbous Moon 4 days from full 90° away from M-51
Objective: ease of use, image brightness, image sharpness
Synopsis: Compared views between scopes at their natural f/ratio (f/10 & f/8) on Moon, and then repeated Test #4 with a non-cracked MFR5.

My main goal was to repeat Test #4 with a new "un-cracked" MFR5 so as to get a more fair comparison. Considering my past experiences with collimation, I made sure to check both scopes at the start of the test. Both were well collimated.

The Moon was prominent at the start of the test so I decided to view it first using my Toshiba camera. The views of the Moon with the VRC (at scope natural focal ratio of f/8) were very clearly sharper and had more contrast than the SCT (at f/10). Part of the improvement in sharpness was due to the fact that I was able to run with half the exposure length on the VRC, which reduced the impact of the atmospheric turbulence on the image.



SCT – f/10, 2sec INT



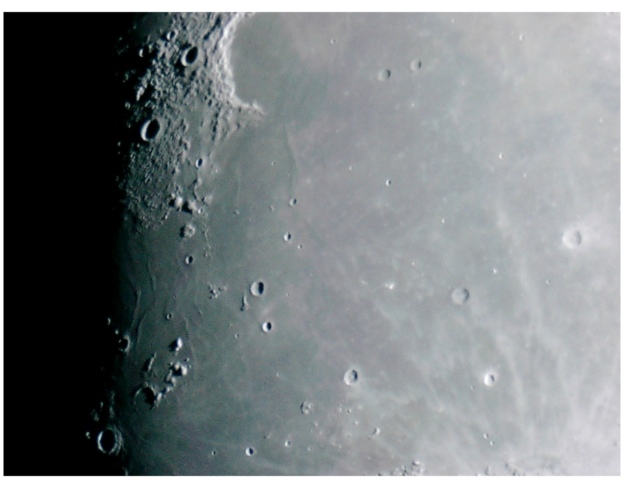
VRC – f/8, 2sec INT

Figure 28 Test #5 – Collimation Check

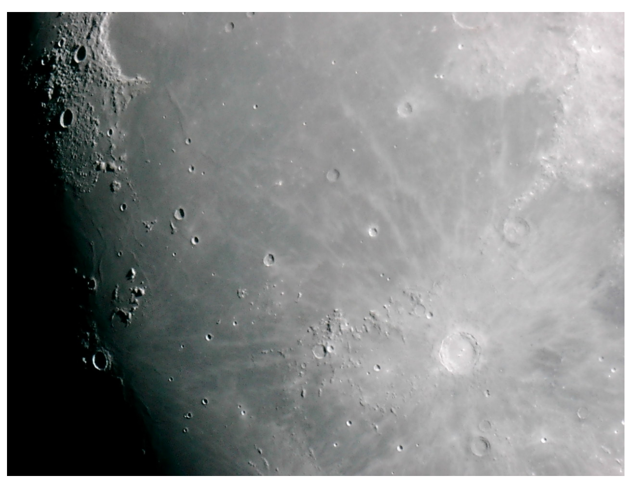
SCT – f/10, 1/30th sec EXP

VRC – f/8, 1/60th sec EXP

Figure 29 Test #5 – Sinus Iridum Comparison



SCT – f/10, 1/30th sec EXP



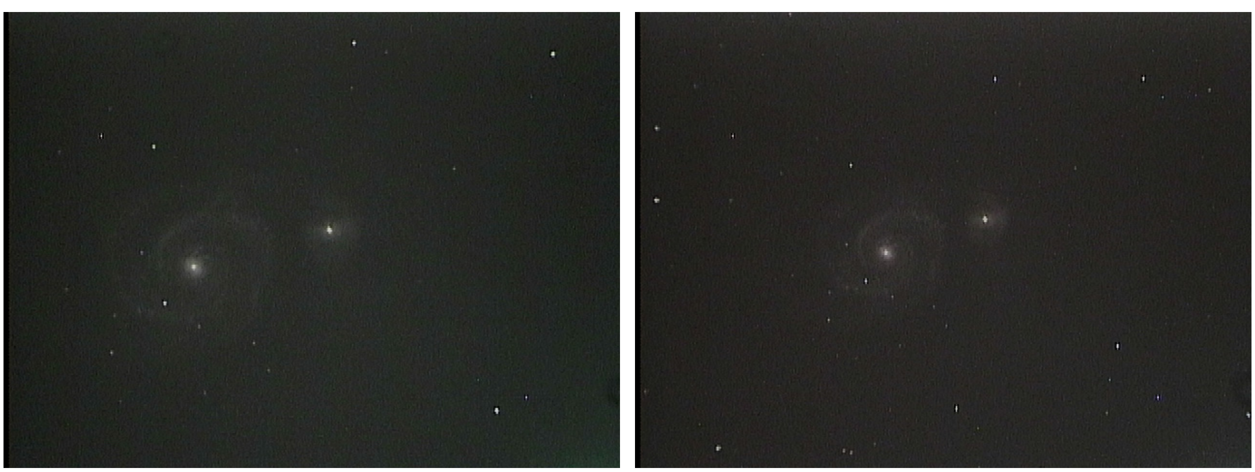
VRC – f/8, 1/60th sec EXP

Figure 30 Test #5 – Crater Aristarchus Comparison

SCT – f/10, 1/30th sec EXP   VRC – f/8, 1/30th sec EXP

Figure 31   Test #5 – Crater Gassendi Comparison

I did try viewing Mars after the Moon, but the seeing was too poor. After this I switched to the Mallincam Xtreme camera with MFR5. I repeated Test #4, and found that I got pretty much the same results. The VRC was very clearly brighter, over and above what the difference in focal ratio provides. The biggest difference in brightness was found when the IR Pass filter was used. This is consistent with the fact that the corrector plate on the SCT does cut some of the infrared coming in. The VRC on the other hand focuses all the light, regardless of wavelength, on the CCD.



SCT – f/5, 40sec INT   VRC – f/4, 26sec INT

Figure 32   Test #5 – M51 Comparison, no filters

SCT – f/5, 40sec INT

VRC – f/4, 26sec INT

Figure 33 Test #5 – M51 Comparison, IR Cut

SCT – f/5, 180sec INT

VRC – f/4, 115sec INT

Figure 34 Test #5 – M51 Comparison, UHC

SCT – f/5, 187sec INT

VRC – f/4, 120sec INT

Figure 35 Test #5 – M51 Comparison, 680nm Pass

There were a couple of additional captures I took that I found interesting to share, all using the IR Pass filter.

M82, SCT – f/5, 180sec INT

M51, VRC – f/4, 210sec INT

M57, SCT – f/5, 120sec INT

Figure 36 Test #5 – Some additional interesting captures, 680nm Pass

3.6 Test #6 – April 6th, 2012

Type: VRC only
Filters: none, Meade O-III
Focal Reducers: multiple
Target(s): M-3 globular cluster
Settings: gamma 0.45, APC 2x2, AGC 4, SAT 30, HUE 62, SHARP 1, WB ATW
Conditions: 100% clear, 5/5 transparency, 1/5 seeing, full Moon 15° away from M-3
Objective: ease of use, image sharpness, flatness/coma, focal ratio
Synopsis: Compared views with the VRC alone using a wide range of focal reducers, searching for the best configuration to give fast f/ratios.

My main interest for this test was to find out just how wide a field of view I could get (or how fast an f/ratio) with the VRC. I already tested the same list of focal reducers on my SCT back in January, so I am already familiar with what can be achieved with that scope. I used a single target and no filters for the bulk of this test. The INT time was varied from case to case so that the relative exposure was the same. Afterwards I did some general viewing using a Meade O-III filter with the Meade 0.33x FR, at the end of which I tried pulling the camera out away from the FR as much as possible and still achieve focus. The result was a significant amount of additional reduction. Table 2 summarizes the results of my testing. Note that in my January focal reducer testing on my SCT, I was not able to achieve vignetting and/or coma free images below f/4.

M3, VRC – no FR, f/8, 20sec INT

M3, VRC – front half MFR5, f/5.5, 11sec INT

M3, VRC – whole MFR5, f/4.1, 7sec INT

M3, VRC – MFR5 + 10mm spacer, f/2.7, 3sec INT

M3, VRC – MFR2” + 2” nosepiece, f/2.8, 3sec INT

M3, VRC – Meade 0.63x, f/5.0, 9sec INT

M3, VRC – Meade 0.63x + ½ MFR5, f/3.4, 4sec INT

M3, VRC – Meade 0.33x, f/3.6, 4sec INT

M3, VRC – Meade 0.33x tweaked, f/3.0, Meade O-III filter, 20sec INT

Figure 37 Test #6 – M3 Comparison, various focal reducers

Focal Reducer	Extension Rings to Focus	Pixel Distance Between Stars	Measured Reduction Factor	Effective FOV (arc min)	Measured F/ratio	Comments
none	4”	316.7	1.00x (ref)	20.4’ x 15.4’	≡ f/8	many nice stars, slightly softer focus
front half of MFR5	4”	219.3	0.69x	29.6’ x 22.2’	f/5.54	sharp focus, good detail
whole MFR5	4”	163.5	0.52x	39.6’ x 29.7’	f/4.13	sharp focus, some detail loss, minor coma on left, subtle vignetting
MFR5 + 10mm spacer	2”	104.9	0.33x	61.8’ x 46.3’	f/2.65	good sharpness, more coma on left, bad vignetting
MFR2” + 2” nosepiece	0”	111.0	0.35x	58.4’ x 43.8’	f/2.80	less sharp, softer focus, no vignetting, mild coma at edges**
Meade 0.63x	0”	195.9	0.62x	33.1’ x 24.8’	f/4.95	sharp focus, good detail, fewer dim stars
Meade 0.63x + front half of MFR5	0”	133.1	0.42x	48.7’ x 36.5’	f/3.36	good focus, dimmer image, no coma or vignetting
Meade 0.33x A	0” *	143.6	0.45x	45.1’ x 33.9’	f/3.63	bright sharp image, no coma or vignetting
Meade 0.33x B	0” *	118.7	0.37x	54.6’ x 41.0’	f/3.00	bright sharp image, no coma or vignetting

** had to change to different SCT adapter and shorter 1.25-to-2” adapter to get focus*

*** raising APC from 2x2 to 5x5 sharpened up the view considerably with this FR, making it much closer to MFR5 for sharpness but still less contrast*

Table 2 Focal Reducer Performance Summary

3.7 Test #7 – April 12th, 2012

Type: back-to-back comparison

Filters: none

Focal Reducers: none

Target(s): interior wall

Settings: gamma 0.45, APC 2x2, AGC off, SENSUP 48x, ALC off, SAT 30, HUE 62, SHARP 1, WB ATW

Conditions: basement, minimal ambient lighting

Objective: off axis light rejection

Synopsis: Shone a flashlight into each scope at different angles off axis to determine impact on image contrast.

I wasn't sure how this test was going to go, having never tried something like this before. I was never able to focus either scope on anything in the room, so the test was done with both scopes totally unfocused. I think that should have little or no impact on the results since I am measuring the amount of light getting to the sensor by means other than the normal optical path. I simply set each scope on the floor along a straight edge, and aimed a small Maglite flashlight 500mm away at the center of the scope exit. I used a string from the scope center to the flashlight as my reference line for setting the angle of the flashlight off of the telescope's axis. I started with the flashlight off, and set the BRT control to give me a nearly black image. I screen captured this image, as well as those with the flashlight on at each angle off-axis. I then measured the average RGB level of each image and subtracted the flashlight-off baseline. The results are plotted in the figure below.

I was very impressed at how much better the VRC was at rejecting the flashlight's glare into the optical tube. The VRC was significantly better even when I added my 20" long dew shield to the SCT. The difference is significant considering the fact that often times the object being viewed only has a contrast from the background on the order of 30 to 50 RGB levels. For both scopes, the angle of 8 to 10° off-axis seems to be the point where you can look straight down the baffle tube and see the CCD.

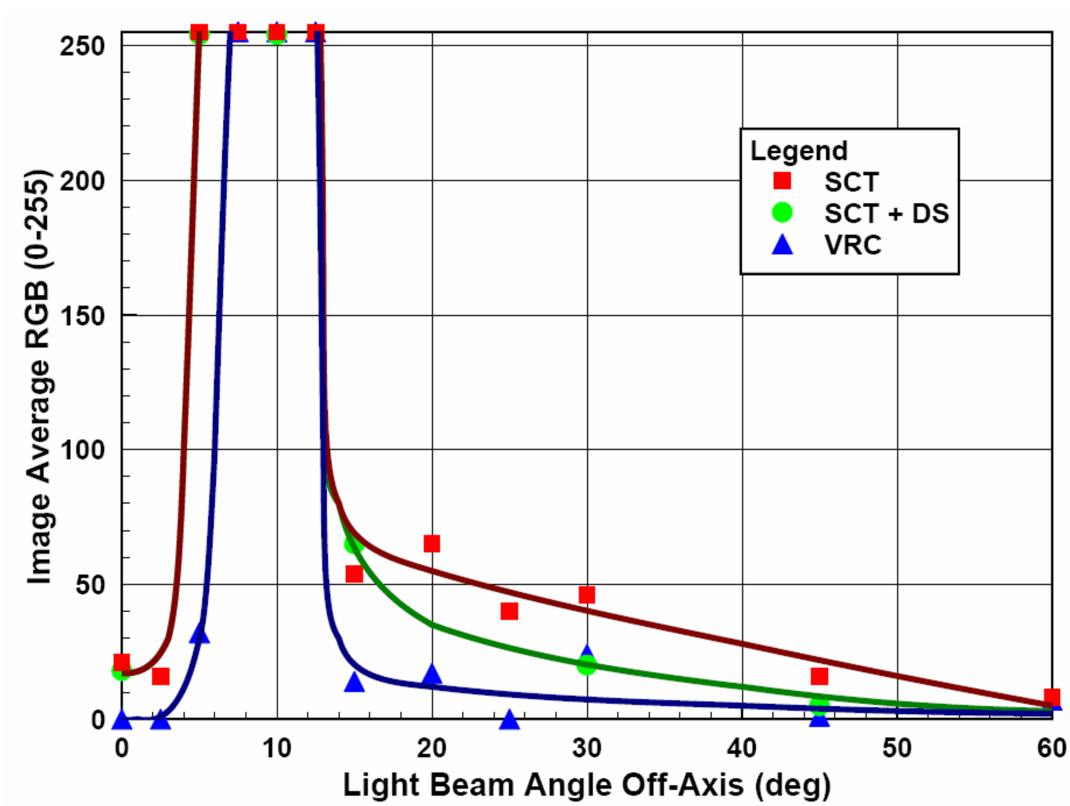


Figure 38 Test #7 – Measured Off-Axis Light Rejection

4.0 Conclusions

I have now completed a number of different tests on the VRC, comparing it directly to my SCT. My conclusions are as follows:

1. The VRC produces images that are brighter than the SCT by 30 to 40%, over and above the 56% increase that you get from the difference in native f/ratio.
2. The increased brightness of the VRC is more so in the infrared due to the absence of a corrector plate. All wavelengths of light are focused equally by the VRC.
3. Being able to get the same relative exposure at a shorter INT time has the added benefit of reducing tracking and atmospheric turbulence effects on image sharpness.
4. Contrast with the VRC is better than the SCT. This was most obvious when viewing the Moon with a high resolution camera.
5. With the correct selection and application of focal reducers, the VRC can be reduced to at least f/3 with no coma or field curvature.
6. The off-axis light rejection of the VRC is superior to the SCT, even when a dew shield is installed on the SCT. Both scopes have the same response to light that is 8 to 10° off axis.
7. It was important to have the VRC correctly collimated in order to realize the benefits this scope can provide over an SCT. The secondary mirror collimation screws were found to be very tight from the manufacturer, but the VRC was otherwise as easy to collimate as an SCT. After my collimation of the VRC, collimation of this scope appears to have remained unchanged.
8. The VRC was as easy to use as the SCT. It is roughly the same size and weight, and collimated exactly the same. The only aspect of the scope I found inconvenient was when I tried a regular 2x Barlow. I had to add another 4" of spacer in order to reach focus, which resulted in a large change to the scope's balance. When I used a shorty style Barlow this was less of a problem.

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