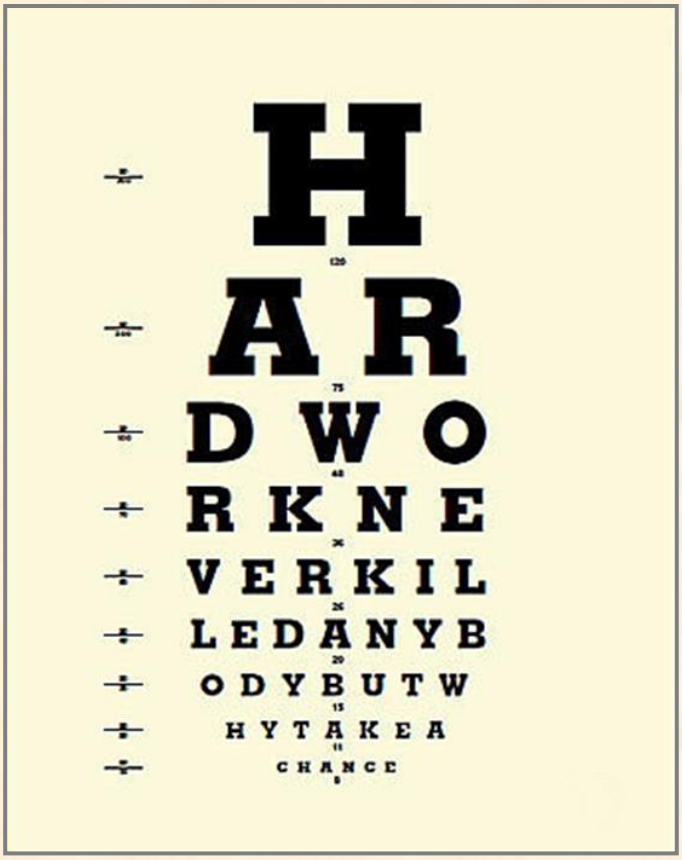
BARLOW SHOOTOUT

through "slanted edge" testing method in high resolution enviroment

...as compared with best 25mm eyepieces available for eyepiece projection technique.



VERY IMPORTANT NOTICE

This review cannot tell you how any tested barlow will behave with an eyepiece after it. It is only meaningful to those who will use these barlows with a flat sensor placed after them with no eyepiece in between (please, see page #20).

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-July, 2016-

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MAIN INDEX

1: *"Why?"*

After such a ostentatious title, one would wonder… "why"? First and more important, this is my 2nd published testing shootout using "slanted edge" method. For those of you who do not know what this method is, or how to implement it to test your optics, you can read the previous article in which I talk of it a little bit. You can download it in good PDF format quality (around 10Mb, so be patient):

http://marronyazul.es/azul/how.htm

As you see I didn't invent anything!

But, why a barlow shootout now?

Well, I confess I am a perfectionist, and I am a curious person too… and if you add up not being married to a woman and no children, you might understand me. This is the story in brief:

I decided many years ago I would do high resolution imagery. After some research, I came to the conclusion I would use the "eyepiece projection method" over the "barlow method" to reach the high magnification levels required to do planetary and lunar high resolution imaging. The problem now was to find the proper eyepiece to do the job.

After a long search I began to collect microscope eyepieces over the years and I discovered there was a simple, cheap, low-element glass world out there that was capable of withstanding a high resolution stress against the best telescope dedicated glass. Foremost, I discovered you MUST *match* scope and eyepice. I sorted out my microscope eyepiece collection and I began collecting little jewels that I saw were excellent (some of these winners, you can see in the above link documents). High resolution visual observers (like Denis in Croatia) also pay attention to them! I found the 25mm focal length microscope eyepieces (10x magnification in "microscope language") the most balanced in terms of chromatic aberration and resolution for our eyepiece projection set up. Now that I have time to begin using my observatory and scope in a daily basis (year 2016 on), I am arranging every detail, and the heart inside *Zion* —that's the name of my main planetary telescope— is one of them. For this reason, I did a 25mm eyepiece shootout of all my jewels (pending to publish) to see which one was worthy to be "THE-LENS" inside my *Zion* telescope (for more information about my hardware, look at my website above). I came up with 3 eyepieces that were proven "winners". You may consider them among the best of the best in the world to do eyepiece projection. Many years and testing and experience goes behind that statement.

Now that I had all solved, I thought I should give the "barlow method" an opportunity to enter the contest. Maybe I was wrong from the beginning and the best you could use for high resolution imagery was a simple barlow and not an eyepiece!

And that's how this comparison began, just out of curiosity.

2: Set up

As you can see in the 1st publishing I made, you need some hardware to test the contenders: Main scope, camera+remote, projection adapter, target+illuminator, PC+software. A picture is worth a thousand words, and I will try to make this shootout as simple and straightforward as possible, so this is what I used:

Televue 60is 360mm F6 APO

Celestron 8" XLT (F10) Classic Cassegrain

MEADE Ø 105mm (F14) Maksutov Cassegrain

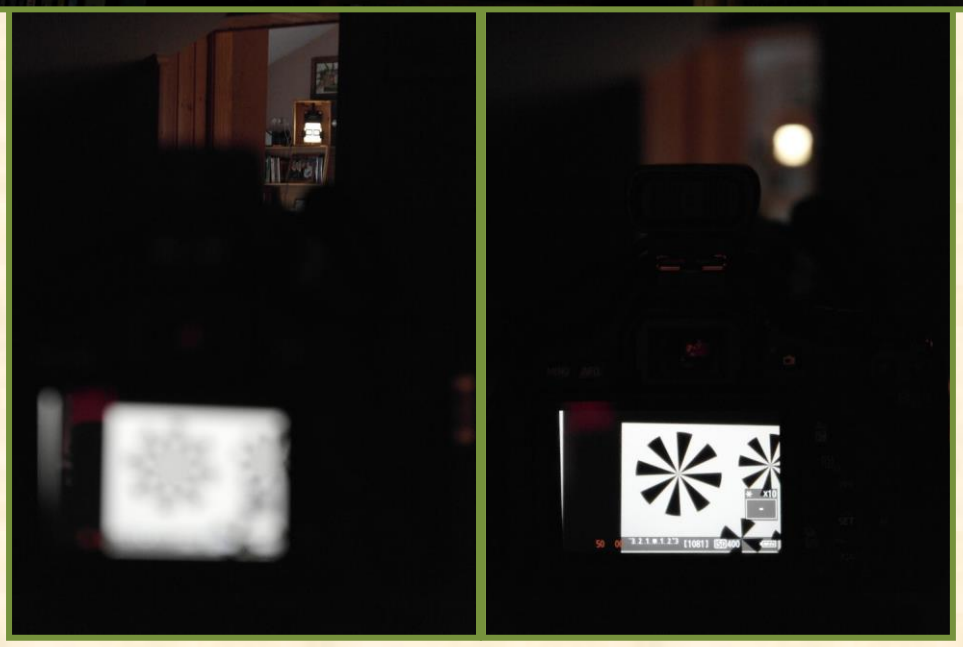
Bresser 102mm (F9.8) Achromatic
(stopped down to 76mm)

Front of Bresser 102mm
(stopped down to 76mm)

Canon 600D (Rebel T3i) + wireless shutter

VEPA™ (Variable Eyepiece Projection Adapter)

LED front-illuminated target
High resolution paper (not good due to light fallout issues)



Fiber optic back-illuminated target
High resolution film (nice)

3: List of contenders and pictures

(barlows in GREEN, projection eyepieces in BLUE)

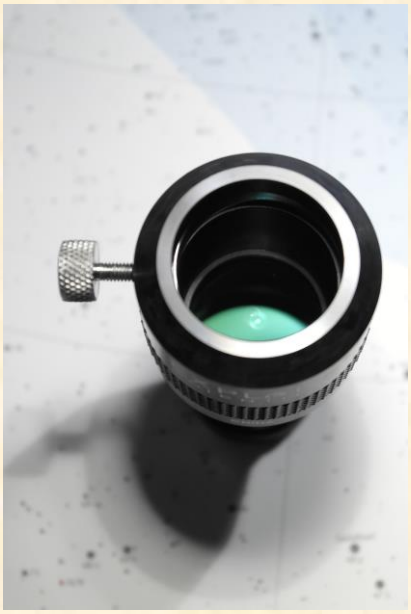
LENS MODEL	TYPE	CONDITION	MOUNT	CAN LENS ITSELF BE EASILY UNMOUNTED AND ATTACHED TO VEPA™ OR SIMILAR TO PLAY WITH PROJECTION DISTANCES? * Means "LIMITED" due to diameter/length limitations
3x GSO ED China	Barlow	Used (excellent)	1,25"	YES
2,25x Baader	Barlow	New	1,25"	YES
2,7x APM APO	Flatfield barlow	New	1,25" **	YES
3-8x Variable Baader FFC flatfield converter	Flatfield barlow	New	T mount	NO
2x Bresser	Telecentric	New	1,25"	NO
2x Celestron LX-cell	Barlow	New	1,25"	YES
2x China cheap achromatic	Barlow	New	1,25"	YES
2x Coronado CEMAX	Barlow	New	1,25"	YES
2x ED 2" apo barlow East	Barlow	Used (excellent)	2"	NO
2x Explore Scientific	Telecentric	New	1,25"	NO
2x APO Italian AdrianoLolli.com	Barlow	New	1,25"	YES
2x Madrid Sky APO H.R.	Flatfield barlow	New	T mount + 1,25"	NO
2x Meade APO 4000 series (China)	Barlow	Used (excellent)	1,25"	YES
2x Takahashi APO	Barlow	Used (like new)	1,25"	YES
2x Televue	Barlow	New	1,25"	YES
2x Televue Big barlow	Barlow	Used (excellent)	2"	NO
3x China cheap achromatic	Barlow	New	1,25"	YES
3x Opticstar TeleXtender (= old Meade 5000 line)	Telecentric	Used (excellent)	1,25"	NO
5x Bresser	Telecentric	New	1,25"	NO
5x China cheap achromatic	Barlow	New	1,25"	NO
5x Explore Scientific	Telecentric	New	1,25"	NO
5x Televue powermate	Telecentric	New	1,25"	YES*
Zeiss S-PL 12,5x/16 #444049	Eyepiece	Used	30mm	YES
Zeiss PL 10x/23 #1026-548	Eyepiece	New	30mm	YES*
Secret lens	Eyepiece	Used (like new)	xxx	NO (custom adapter)
Baader 25mm projection eyepiece	Eyepiece	New	1,25"	YES

Barlows and telecentrics (general view)

Projection eyepieces (general view)

Barlows and telecentrics (individual view)

2x Bresser



2x Explore Scientific

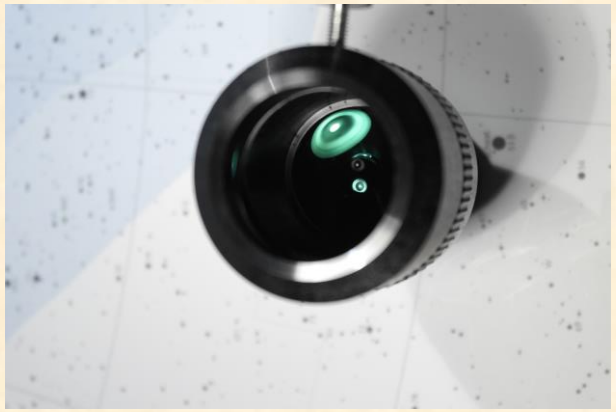
5x Bresser

3x-8x Baader FFC

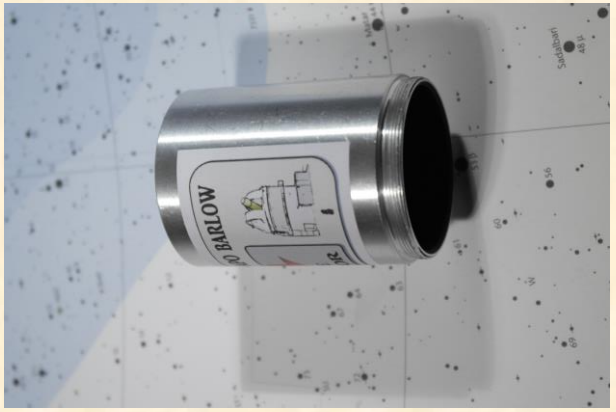
2x ED Asian 2"

3x Opticstar TeleXtender

5x Explore Scientific



2x Madrid Sky SUPER-APO

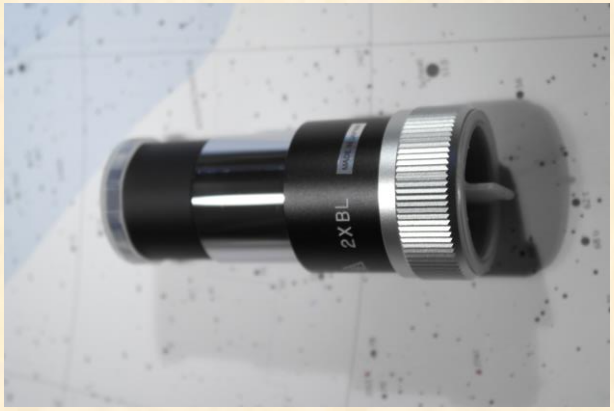


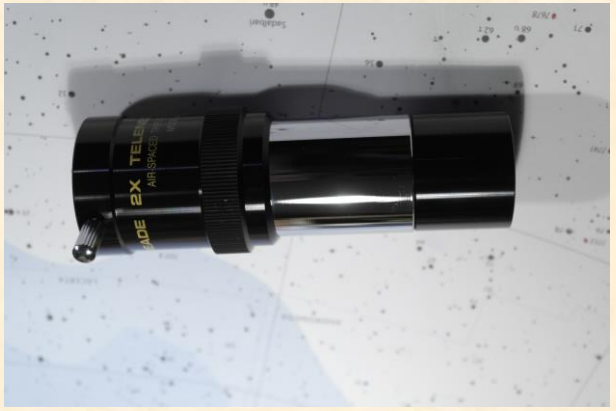
2x Televue "Big Barlow" (2")

2x Meade Telenegative

5x China cheap

2x Takahashi

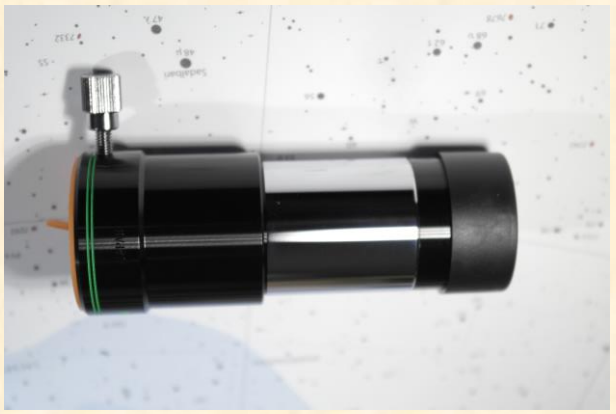


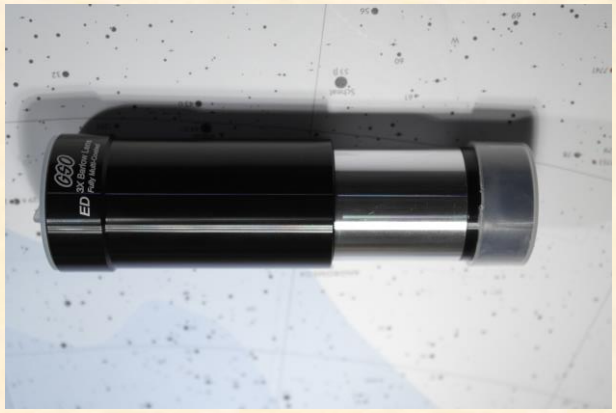


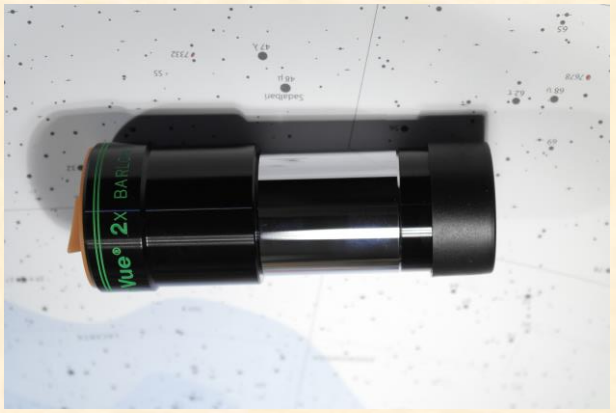
Baader 2,25x HT

2x Televue

3x GSO ED China

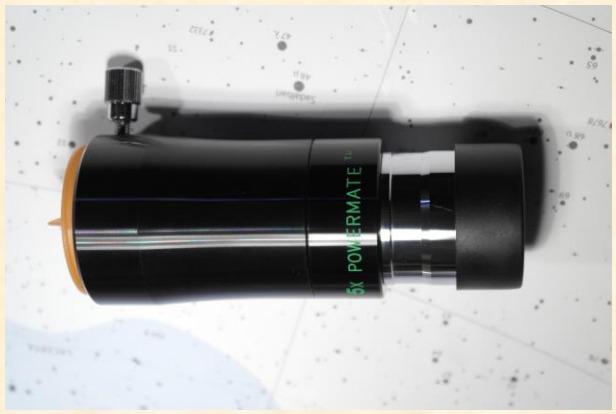




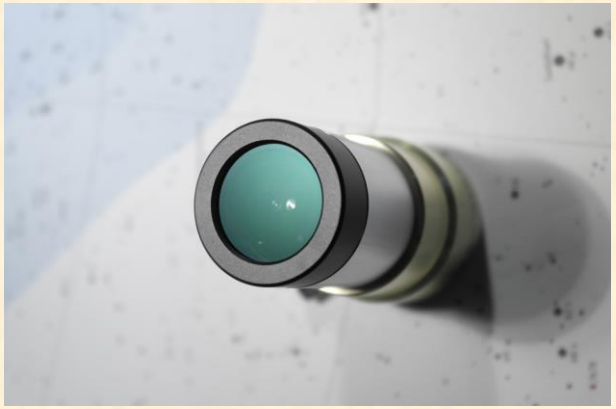


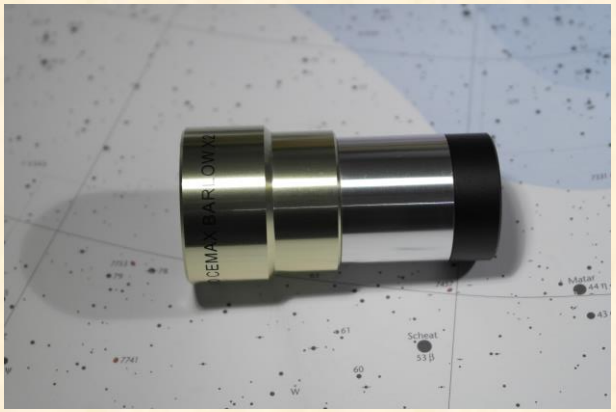
2x Italian PLAN APO

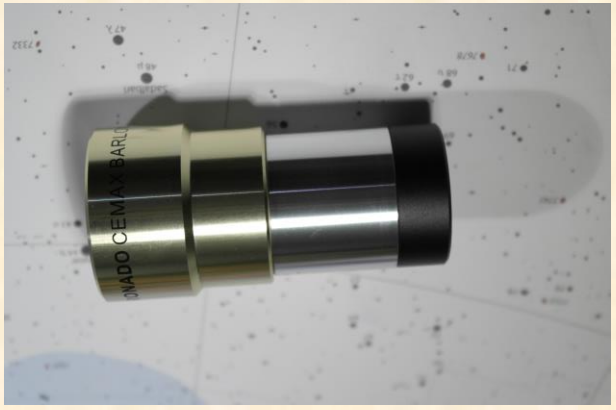
5x Televue powermate



2x Coronado CEMAX

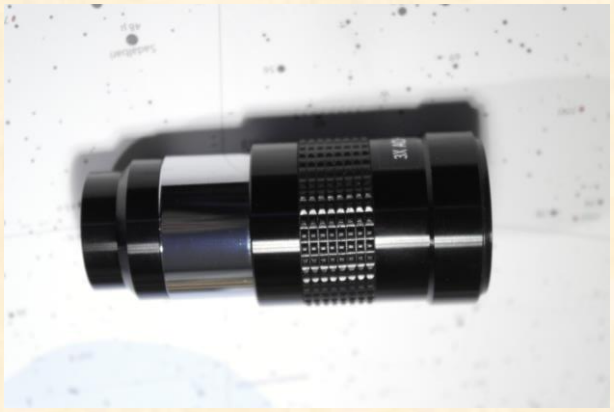


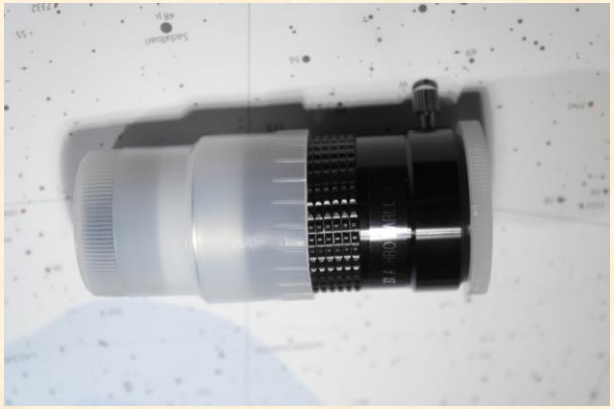




2x Celestron X-Cell LX

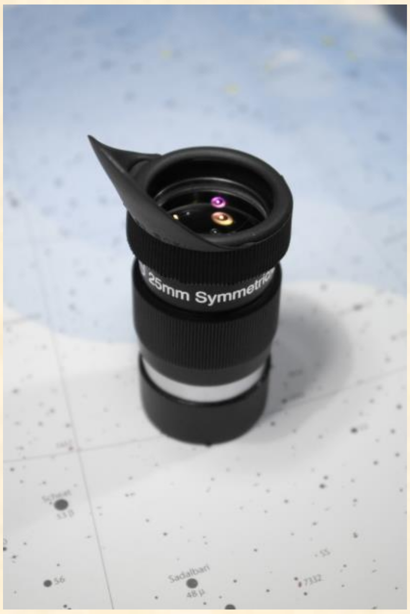
3x cheap China





2,7x APM APO

2x cheap China



25mm Baader Sym. eyepiece

25mm microscope eyepieces

4: General methodology, useful thoughts and what to expect

You can read this methodology more throughly in the first link provided, but I will give you the basic lines as it applies to this shootout, which obviously conveys some changes.

A. **CONTENDERS:** After doing a slanted edge comparison to get my best 25mm projection eyepieces, I added some never-tested glass. That was a "splitting hairs" operation. Now, the three winners were taken out to be tested again against our barlows and telecentrics, because this testing was done mainly to get the final glass to be used in my planetary telescope. Finally, I also added a 4th eyepiece not tested before to the barlow shootout (Baader 25mm projection eyepiece). Every lens that could be unscrewed from its original holder/barrel, was unscrewed and introduced in VEPA to achieve different distances from lens to sensor to try to get different behaviours and magnifications. Minimum distance was around 5cm (2") and max. around 14cm. Some other lenses were mounted in T mount holders, so I just used T mount extensions. In this case, min. distance was around the same and furthest was around 18cm (a little more). Lastly, those lenses that could not be disassembled (and did not have T mount holder to play with distances) were just placed in the only position they could be, around 5-10cm away from sensor. Unfortunately work load was too huge to also inform about exact lens-sensor distances in every measurement made.

B. **ON AXIS (software):** Slanted edge software analysis was applied on-axis, and results are meaningful for those doing high resolution imaging with mid/small sensors. This test is not a visual testing per se, because it ignores perceived contrast and brightness levels to a good extent (software also has subjective quality module called *SQF*, but I found it not very well implemented in my old testing software, or I just could not understand it well), and it concentrates on optical train behaviour on a theoretical level. So, it is specially indicated for those of you using a high sensibility cameras to capture high resolution planetary and lunar videos ("lucky imaging" technique) that are processed afterwards with modern PC software to bring out details.

C. **OFF AXIS (visual asset):** For the off axis assessment, I just used my eyes and magnified the off axis area to see differences and aberrations. You are free to analyze Canon Raw pictures yourself and bring out your own conclusions. Here it enters the SUBJECTIVE opinion we are trying to avoid using the slanted edge methodology and I do not like it too much. Even so, I consider this visual judging more objective in itself that most shootouts published out there as we are comparing high resolution indoor pictures with negligible athmospheric aberrations and we can compare them on the spot.

D. **SUMMING UP:** Every glass was tested in FLAT SENSOR of a DLSR camera (18Mpx @ 14bits / 5184x3456 picture size / 22.3x14.9mm sensor size) without any eyepiece behind it. So, this is NOT A VISUAL assessment, but a raw imaging comparison. If you plan to use these barlows with an eyepiece after it, this review is NOT specially relevant for you. This testing cannot cover how any of the barlows tested will behave with any particular eyepiece out there. HAVE THIS IN MIND, PLEASE. **I would rate this testing as "VERY useful" for those of you embarked in high resolution imaging splitting hairs and "MILDLY interesting" for those of you doing visual observing with an eyepiece AFTER these barlows.**

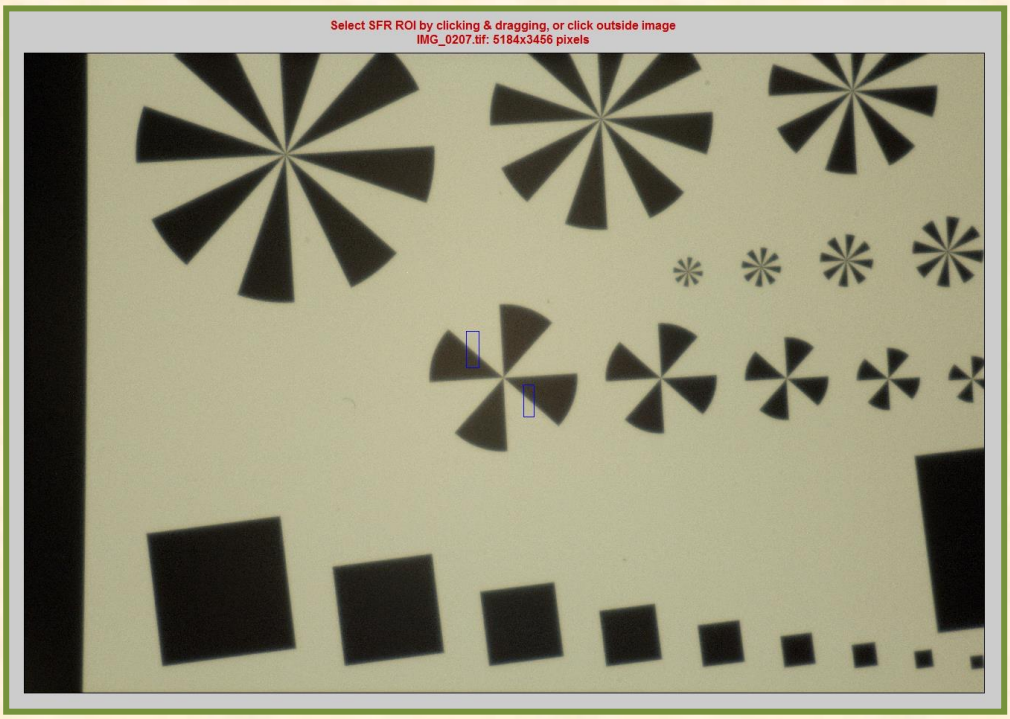
E. SLANTED EDGE TARGET CAPTURE DETAILS:

Celestron 8” Cassegrain scope

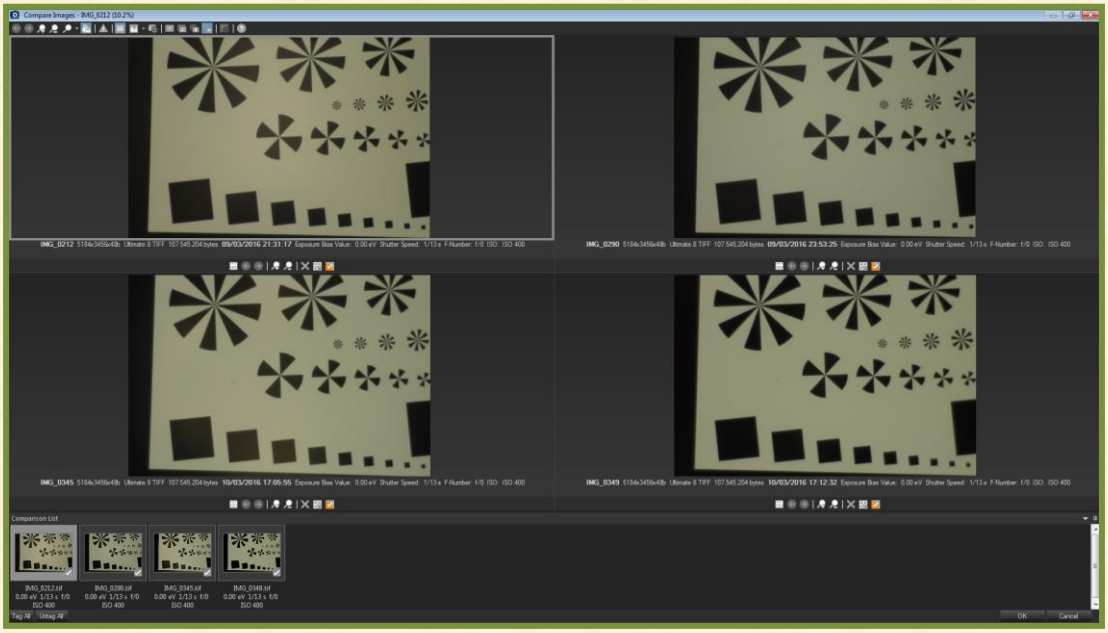
- **ON AXIS: Camera set on ISO=400**

2 points marked as seen in the picture below in the little blue boxes (biggest 4 segment star is centered). When these points produces glitches, other two points where selected in same star. When they could not work, only one was slected.

Resolution output: AVERAGE of two points.
Chromatic aberration: the BEST result out of both points.



- **OFF AXIS:** Visual check using ACDSEE comparison module:

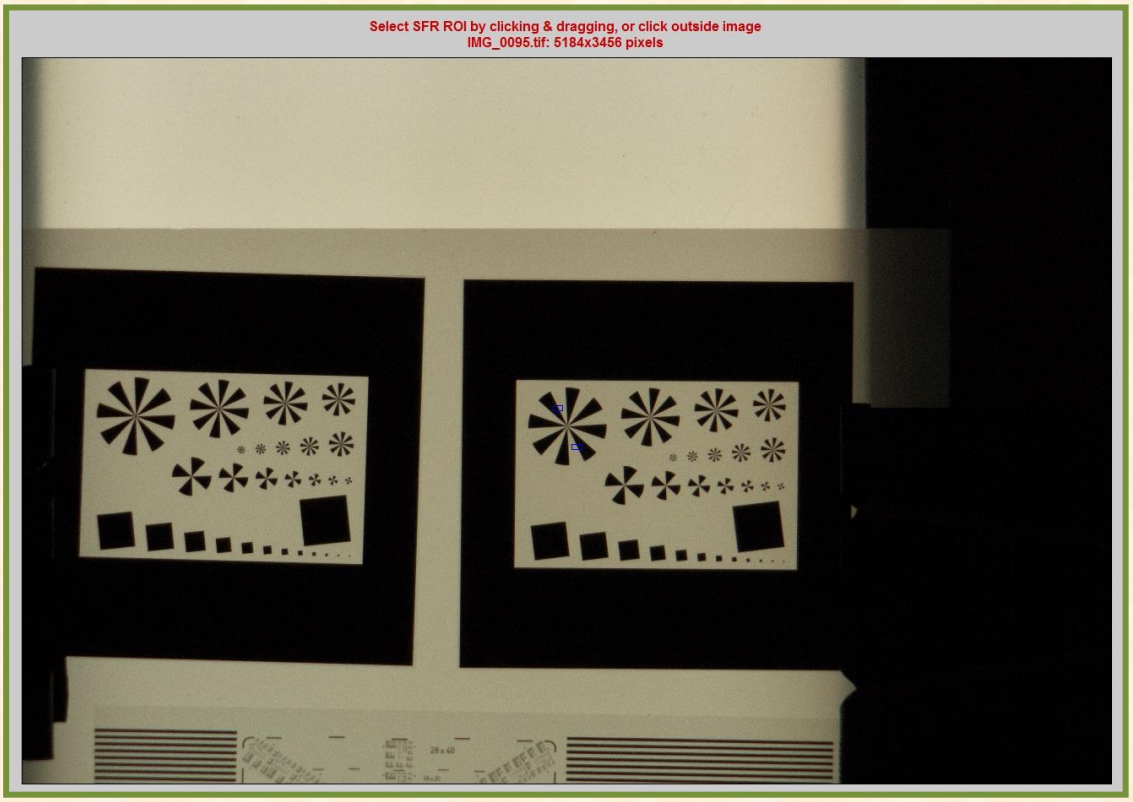


Televue 60is APO scope

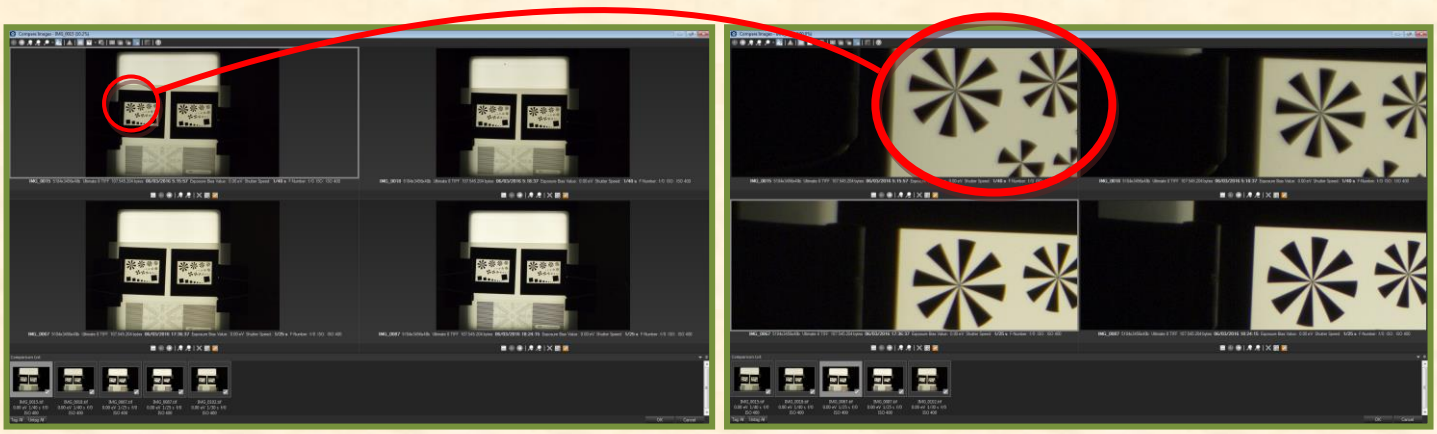
- **ON AXIS: Camera set on ISO=400**

2 points marked as seen in the picture below in the little blue boxes (biggest 8-segment star in the right side is centered). This scope magnified less than the other two, that's why I had to look for an additional film target to judge better off axis behaviour.

Resolution output: AVERAGE of both points.
Chromatic aberration: the BEST of both points.



- **OFF AXIS:** Same as before… visual check using ACDSEE comparison module, looking for contrast and general aberrations (allows for easy zoom on all pictures to see differences at a glance). Here you see the off axis on left side magnified. As we are dealing with raw pictures with 18, you can zoom in a good amount with no pixelation issues.

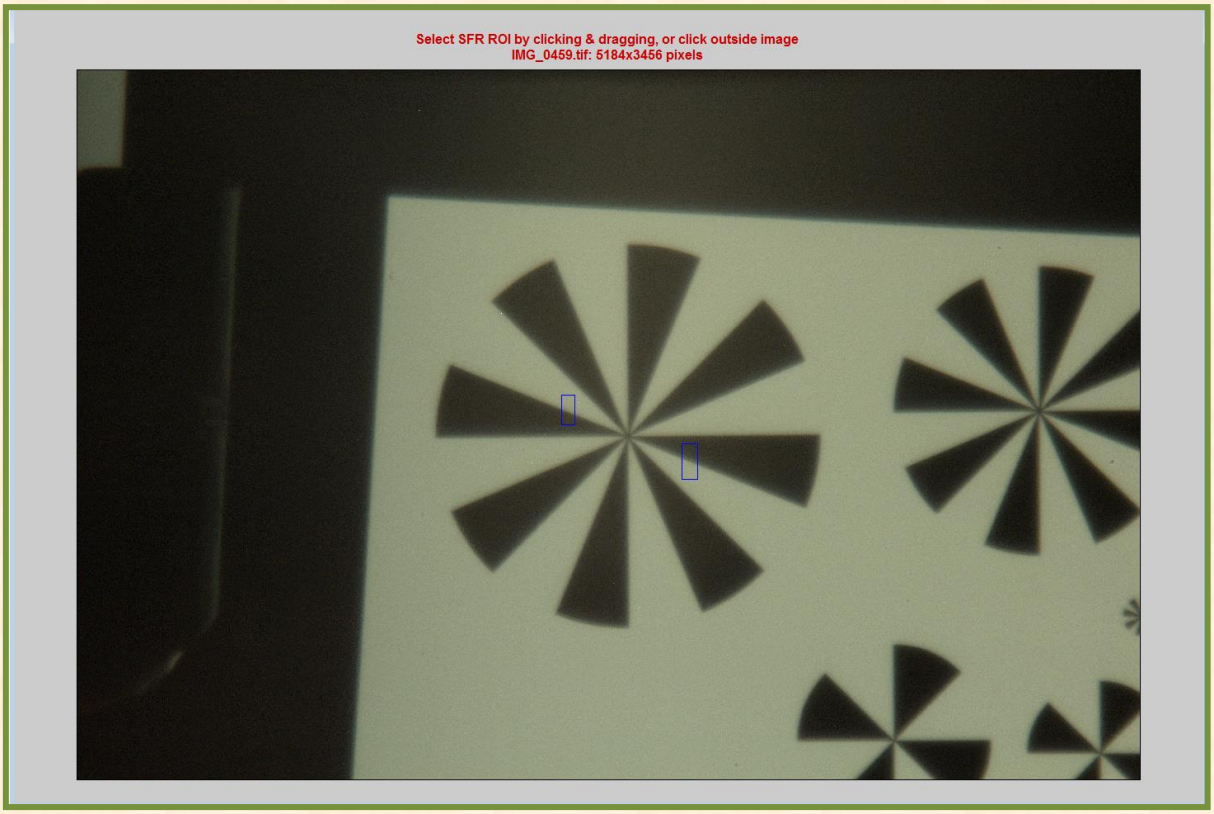


Meade ETX Ø105mm (F14) 1470mm Maksutov-Cassegrain
Bresser Ø102mm (F9,8) 1000mm Achromat (stopped down to 76mm)

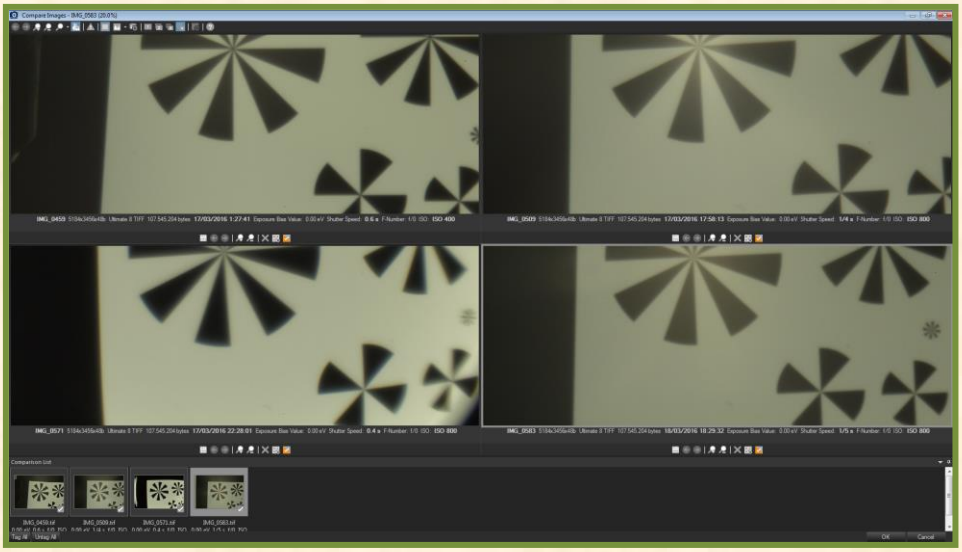
- **ON AXIS: Camera set on ISO=800** (unfortunately, magnification was too great for a lower ISO)

2 points marked as seen in the picture below in the little red boxes (biggest 8-segment star in the right side is centered). Given the long focal length, this scope magnified more than the other two.

Resolution output: AVERAGE of both points.
Chromatic aberration: the BEST of both points.



- **OFF AXIS:** Same as before… visual check using ACDSEE comparison module.



5: DETAILED results

Guidelines to read results:

- **Results are grouped by magnification range (ZOOM column, from low magnification to high magnification), as closely related as possible and ordered by decreasing slanted edge resolution (pure on-axis resolution).** Winners of each group in **bold**. When magnification is not correlated due to lack of competition, it is reflected as "OUT". So, very important you know this is a "MAGNIFICATION-ZOOM GROUP" ranking. Obviously, there does not exist a lens that would win in all magnification ranges, but there are some that do on several groups! Looking at the zoom column, you can compare magnifications across all scopes.

- **Two marks** are given: *pure resolution* on axis check + *visual* off axis check. As I said before, *slanted edge* looks primarily for the capacity of the system (scope+projection lens) to resolve detail in the on axis area, whereas the *visual check* looks for aberrations in the off-axis area (namely, Chromatic Aberration (CA), Curvature). Flare is generally located on-axis and it is a visual check. TWO IMPORTANT words: ***Resolution peak* (✸ / on axis)** means this particular lens had outstanding resolution marks in slanted edge testing beyond its own group, even surpassing lower magnification group winners (*against* the natural order, so to speak). ***Contrast peak* (☯ / general)** talks of a GLOBAL higher contrast to the eye (whites whiter + blacks blacker) when compared with the rest of lenses (of course, as always, within that particular group). This was only given when rest of lenses (in that group) were clearly below that line.

- In case of draw: In the slanted edge tie, real highest magnification and lowest CA breaks the deadlock. Sometimes the tie leads to draw, and same position is shared as it would not be fare to give a winning position to any of them. The off axis ranking comes on the basis of lowest aberration level, then watching for detail and then (lasty) contrast. Very important to see if there is "FLARE" in the NOTES, as this indicates not so good behaviour (most of all when marked as "MID" or "STRONG")

- Sometimes I have chosen to group eyepieces of different magnification ranges if there was a fair and solid ground to do so. For instance, in the last group sorting in this Celestron 8" scope (5x Televue powermate + 5x China cheap achromatic), the cheap lens was working less stressed (less magnification) and so it had some natural advantage over the Televue (of course, this happens to a certain point in all groups, something to have in mind in case of tie to rank properly). As we see, even though it is in *natural disadvantage* (higher magnifications are in disadvantage when confronting less magnification) the Televue glass won over easily.

- When same lens got different results (different zoom level but belonging to same "zoom group"), the worst result of that lens was discarded for better comparison and ease.

- The asterisc * in "TYPE" means lens is placed in reverse mode (put backwards). Last column ("NOTES") talk of the OFF-AXIS visual aberrations.

- Fast graphic guide to read results:

In this column we see the resolution peaks (✸) and contrast peaks (☯). In other words: special behaviour worth to be mentioned).

Groups are ordered by this column "slanted method resolution on-axis" marks (pure resolution on-axis) and winner (s) is(are) in bold color.

This column gives us off-axis winners from a visual point of view (usually wins that lens with less aberrations visible).

In "NOTES" you see aberration levels in general and off axis areas (both separated by the "division slash") such as Flare, Curvature, Chromatic Aberration (CA) and Fringing. They typically have marks ranging from "low or very low" (better), "mid" and "strong" (worse).

	SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL AND OFF AXIS VISUAL BEHAVIOUR)
Group #1		**106**	Telecentric	**2x Explore Scientific**	**1**	**0,186**	1	
		108	Eyepiece	Zeiss PL 10x/23 #1026-548	2	1,68	3	LOW (CURVATURE – CA)
		106	Telecentric	2x Bresser	3	3,68	2	LITTLE OFF AXIS FLARE
		100	Eyepiece	Baader 25mm projection eyepiece	4	0,95	4	MID (PINCUSHION & CURV. & CA)
Group #2		**132**	Eyepiece*	**Zeiss PL 10x/23 #1026-548**	**1**	**0,294**	3	MID (PINCUSHION & CURV.) / LOW CA
		138	Barlow	2x Takahashi APO	2	3,76	**1**	
		138	Barlow	2x Televue	2	4,39	**1**	
		132	Barlow	2x Televue Big barlow + Interface	3	2,38	2	MID FLARE / LOW CURV. - CA
Group #3		**150**	Barlow	**2x ED 2" apo barlow East**	**1**	4,7	4	LOW FLARE / LOW CURV.
		150	Barlow	**2x Televue Big barlow**	**1**	5,05	5	LOW CURVATURE - CA
		156	Flatfield barlow	3-8x Baader FFC flatfield converter	2	**1,28**	2	
		150	Barlow	2x Televue	3	3,58	2	
		153	Flatfield barlow	2,7x APM APO	4	9,06	**1**	
		146	Barlow	2x Meade APO 4000 series (China)	5	4,81	**1**	
		152	Barlow	2x China cheap achromatic	6	8,53	3	MID ON AXIS FLARE / LOW CA
Group #4		**158**	Telecentric	**3x Opticstar TeleXtender (✸)**	**1**	**0,959**	2	
		159	Flatfield barlow*	3-8x Baader FFC flatfield converter	2	2,2	3	LOW CURVATURE
		156	Barlow	2x Takahashi APO	3	3,9	**1**	
		156	Eyepiece	Baader 25mm projection eyepiece	4	11,1	4	MID CA

CELESTRON 8" XLT Classic Cassegrain (Fastar System model)

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL AND OFF AXIS VISUAL BEHAVIOUR)
2.220	OUT (74)	Eyepiece	Baader 25mm projection eyepiece	**-**	0,938	-	STRONG (PINCUSHION – CURVATURE)
3.180	**106**	Telecentric	**2x Explore Scientific**	**1**	**0,186**	**1**	
3.240	**108**	Eyepiece	Zeiss PL 10x/23 #1026-548	2	1,68	3	LOW (CURVATURE – CA)
3.180	**106**	Telecentric	2x Bresser	3	3,68	2	LITTLE OFF AXIS FLARE
3.000	**100**	Eyepiece	Baader 25mm projection eyepiece	4	0,95	4	MID (PINCUSHION & CURV. & CA)
3.960	**132**	Eyepiece*	**Zeiss PL 10x/23 #1026-548**	**1**	**0,294**	3	MID (PINCUSHION & CURV.) / LOW CA
4.140	**138**	Barlow	2x Takahashi APO	2	3,76	**1**	
4.140	**138**	Barlow	2x Televue	2	4,39	**1**	
3.960	**132**	Barlow	2x Televue Big barlow + Interface	3	2,38	2	MID FLARE / LOW CURV. - CA
4.500	**150**	Barlow	**2x ED 2" apo barlow East**	**1**	4,7	4	LOW FLARE / LOW CURV.
4.500	**150**	Barlow	**2x Televue Big barlow**	**1**	5,05	5	LOW CURVATURE - CA
4.680	**156**	Flatfield barlow	3-8x Baader FFC flatfield converter	2	**1,28**	2	
4.500	**150**	Barlow	2x Televue	3	3,58	2	
4.590	**153**	Flatfield barlow	2,7x APM APO	4	9,06	**1**	
4.380	**146**	Barlow	2x Meade APO 4000 series (China)	5	4,81	**1**	
4.560	**152**	Barlow	2x China cheap achromatic	6	8,53	3	MID ON AXIS FLARE / LOW CA
4.740	**158**	Telecentric	**3x Opticstar TeleXtender (✸)**	**1**	**0,959**	2	
4.770	**159**	Flatfield barlow*	3-8x Baader FFC flatfield converter	2	2,2	3	LOW CURVATURE
4.680	**156**	Barlow	2x Takahashi APO	3	3,9	**1**	
4.680	**156**	Eyepiece	Baader 25mm projection eyepiece	4	11,1	4	MID CA
4.920	**164**	Flatfield barlow	**2x Madrid Sky APO H.R.**	**1**	**0,935**	2	LOW CA
5.010	**167**	Barlow*	2x APO Italian AdrianoLolli.com	2	4,25	2	LOW CA
5.040	**168**	Barlow	2x Meade APO 4000 series (China)	3	7,78	**1**	LOW FLARE
4.980	**166**	Barlow	2x China cheap achromatic	4	3,86	3	LOW FLARE / SCATTER

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL / OFF AXIS VISUAL BEHAVIOUR)
5.130	**171**	Barlow	**2x ED 2" apo barlow East (☯)**	**1**	5,91	2	LOW CA
5.160	**172**	Flatfield barlow	2,7x APM APO	2	**4,39**	**1**	
5.220	**174**	Barlow	2x Coronado CEMAX	3	9,3	4	
5.190	**173**	Barlow	2x Televue	4	4,73	3	LOW FLARE / LOW CA
5.100	**170**	Barlow	3x GSO ED China	5	5,87	5	LOW FLARE / LOW CA
5.280	**176**	Eyepiece	**Secret lens from microscope (✸,☯)**	**1**	1,66	3	**LOW CURV. - CA**
5.400	**180**	Barlow	2x APO Italian AdrianoLolli.com	2	5,89	**1**	LOW CA
5.340	**178**	Barlow	2x Celestron LX-cell	3	4,09	**1**	LOW CA
5.340	**178**	Barlow	2x Takahashi APO	4	**1,49**	**1**	
5.460	**182**	Barlow	2,25x Baader	5	3,71	3	
5.400	**180**	Barlow	2x Meade APO 4000 series (China)	6	4,51	2	LOW FLARE
5.550	**185**	Barlow	**2x Televue Big barlow (☯)**	**1**	2,58	2	
5.640	**188**	Barlow	2x Coronado CEMAX	2	**0,515**	2	VERY LOW FLARE / LOW CA
5.640	**188**	Barlow	2x China cheap achromatic	3	11,1	2	
5.640	**188**	Flatfield barlow	2,7x APM APO	4	11,2	**1**	VERY LOW FLARE
5.940	**198**	Barlow	**2x Celestron LX-cell (☯)**	**1**	4,87	**1**	**LOW CA**
6.060	**202**	Barlow	2x APO Italian AdrianoLolli.com	2	3,79	3	
6.090	**203**	Flatfield barlow	3-8x Baader FFC flatfield converter	3	7,83	5	LOW FLARE
6.060	**202**	Barlow*	2x APO Italian AdrianoLolli.com	4	8,83	2	
5.940	**198**	Barlow	3x GSO ED China	5	**3,22**	4	LOW FLARE
6.060	**202**	Barlow	2x China cheap achromatic	6	15,1	6	MID FLARE
6.390	**213**	Eyepiece	**Zeiss S-PL 12,5x/16 #444049 (✸,☯)**	**1**	**0,188**	**1**	
6.330	**211**	Flatfield barlow*	3-8x Baader FFC flatfield converter	2	9,61	2	
6.240	**208**	Flatfield barlow	2,7x APM APO	3	16,1	4	MID FLARE
6.270	**209**	Barlow	2,25x Baader	4	10,6	3	
6.360	**212**	Barlow	3x GSO ED China	5	12	5	MID FLARE

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL / OFF AXIS VISUAL BEHAVIOUR)
6.480	**216**	Flatfield barlow	**2x Madrid Sky SUPER-APO H.R.**	**1**	4,02	2	**LOW CA**
6.480	**216**	Eyepiece	Zeiss PL 10x/23 #1026-548	2	**3,02**	2	LOW CA
6.450	**215**	Barlow	2x Coronado CEMAX	3	13,6	**1**	MID FLARE
6.810	**227**	Barlow	**2x Celestron LX-cell (☯)**	**1**	3,96	2	**LOW CA**
6.900	**230**	Barlow	3x China cheap achromatic	2	**2,36**	**1**	MID FLARE
6.810	**227**	Barlow*	2,25x Baader	3	13,9	3	LOW FLARE / LOW CA
6.780	**226**	Barlow	2,25x Baader	4	13,4	3	LOW CA
7.440	**248**	Eyepiece	**Secret lens from microscope (✸)**	**1**	**3,75**	3	**MID CA**
7.200	**240**	Barlow	2x APO Italian AdrianoLolli.com	2	4,43	**1**	LOW CA
7.320	**244**	Barlow	2,25x Baader	3	14	2	LOW GLARE / LOW CA
7.260	**242**	Barlow*	2x APO Italian AdrianoLolli.com	4	18,6	2	LOW GLARE / LOW CA
7.650	**255**	Telecentric	**5x Explore Scientific**	**1**	10	3	**STRONG CURVATURE / LOW VIGNETTING**
7.560	**252**	Flatfield barlow	2x Madrid Sky APO H.R.	2	9,24	2	LOW CA
7.650	**255**	Telecentric	5x Bresser	3	**8,17**	4	STRONG CURVATURE-CA / LOW VIGNETTING
7.500	**250**	Barlow	2x APO Italian AdrianoLolli.com	4	13,5	2	MID FLARE / LOW CA
7.500	**250**	Barlow	3x China cheap achromatic	5	9,55	**1**	MID FLARE / SCATTER
7.860	**262**	**Barlow**	**2,25x Baader**	**1**	11	3	**MID FLARE / LOW CA**
7.680	**256**	Flatfield barlow	3-8x Baader FFC flatfield converter	2	**3,4**	**1**	LOW FLARE
7.890	**263**	Flatfield barlow*	3-8x Baader FFC flatfield converter	3	15,1	2	LOW FLARE
8.400	OUT (280)	Barlow*	2,25x Baader		11,3		LOW FLARE
8.970	OUT (299)	Barlow*	2,25x Baader		5,9		MID FLARE
10.140	**338**	Telecentric	**5x Televue powermate (☯)**	**1**	**1,72**	**1**	**VERY LOW CA**
9.660	**322**	Eyepiece	Zeiss PL 10x/23 #1026-548	2	17,1	2	LOW CA
9.780	**326**	Barlow	5x China cheap achromatic	3	12,7	3	MID CA / GLARE & SCATTER
11.340	**378**	**Telecentric**	**5x Televue powermate (☯)**	**1**	**3,2**	**1**	**VERY LOW CA**
10.560	**352**	Barlow	5x China cheap achromatic	2	19,3	2	MID CA / GLARE & SCATTER

CONCLUSIONS:

Multi-winners in their zoom group (this by itself indicates an excellent behaviour):

ON-AXIS TEST (IMAGING WINNERS)	TIMES WINNER
Secret lens from microscope ✸☯☯	**2**
2x Madrid Sky HR APO barlow ✸	**2**
ED 2" apo barlow East ✸	**2**
2x Celestron LX-cell ☯☯	**2**
5x Televue powermate (biased for lack of contenders) ☯☯	2

OFF AXIS TEST (VISUAL WINNERS)	TIMES WINNER
2x Takahashi APO	**3**
2,7x APM APO	**3**
2x Meade APO 4000 series (China)	2
3x Cheap China achromatic (but bad on-axis!)	2
2x Celestron LX-Cell	2
2x APO Italian AdrianoLolli.com	2
5x Televue powermate (biased for lack of contenders)	2

- **In this telescope design (reflector classic Cassegrain), the eyepiece projection method is best VS the barlow way in most cases. For whatever reason, an eyepiece is able to concentrate more photons and take out best detail than a barlow.**

- The natural rule gets into effect: The higher the magnification, the lower the ability to resolve fine detail.

- Bresser VS Explore Scientific: Even though Bresser is known to be (at first sight) exactly the same as Expore Scientific, there is something about the coatings or quality of lens that makes ES win in the chromatic aberration area, better solved in the ES lenses than the Bresser "copy". Under scrutiny, ES coatings are sharper to the eye, with a lighter tone and like "better defined" lacking a better word. This behaviour was a constant in the analysis: chromatic aberration was quite better controlled in the ES telecentrics (resolution, however, was on par). The 5x Bresser/ES telecentrics showed awful vignetting. They seem to be made for visual usage with an eyepiece after them, not for imaging (unless small sensors are used).

- Televue guys: The Televue lenses were contrasty to the eye, trusty in quality and generally very nice, making them preferrable for visual usage. They have been designed for this purpose: a "punchy" contrasty sight. I would not hesitate to buy them for visual usage. Nevertheless, for ultimate high resolution imagers looking to solve fine details, there are other options available. In the higher magnification range, the Televue Powermate 5x was the king of the party, but it must also be said that it hadn't many contenders in that range, so that goes a bit biased.

- Compliments to the expensive Baader FFC lens ("best barlow in the world"), which happily made second place in every group it shows up, which means a very well built, serious and balanced barlow with nice chromatic aberration correction (works best in normal mode, not reverse). You are not throwing out your money with it.

- As you see, winners are quite distributed and many of them have a sweet spot. In the pure resolution area, three stand out:

Secret microscope lens // 2x Madrid Sky HR APO barlow // ED 2" apo barlow East.

TELEVUE 60is 360mm (F6.0) + Televue corrector

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL / OFF AXIS VISUAL BEHAVIOUR)
363	OUT (11)	Eyepiece	25MM BAADER EYEPIECE		2,0		**MID CURVATURE**
545	**16,5**	**Telecentric**	**2X ES (✸)**	**1**	1,6	**1**	
545	16,50	Telecentric	2X BRESSER	2	3,0	3	**LOW CA**
660	20	Eyepiece	Zeiss PL 10x/23 #1026-548	3	**0,3**	2	**LOW CURVATURE / LOW CA**
568	17,2	Eyepiece	25MM BAADER EYEPIECE	4	2,5	4	**STRONGSTRONG CURVATURE / BAD CA**
743	**22,5**	Flatfield barlow	**2x Madrid Sky SUPER-APO H.R. (✸)**	**1**	1,6	**1**	**VERY LOW CA**
693	21	Eyepiece*	Zeiss PL 10x/23 #1026-548	2	**0,6**	3	**STRONG CURVATURE / LOW CA**
736	22,3	Barlow	2X TAKAHASHI BL	3	4,9	2	**MID CURVATURE / LOW CA**
726	22	Eyepiece	25MM BAADER EYEPIECE	4	**0,6**	4	**LOW CURVATURE / MID CA**
776	**23,5**	Flatfield barlow	**3-8X BAADER FFC (✸)**	**1**	**0,5**	**1**	**VERY LOW CA**
799	24,2	Barlow	2X TAKAHASHI BL	2	3,0	2	**LOW CURVATURE-CA**
776	23,5	Barlow	2X TELEVUE 1,25"	3	1,3	3	**MID CURVATURE**
776	23,5	Barlow	2X MEADE APO	4	1,0	4	**MID CURVATURE**
832	**25,2**	Telecentric	**3x Opticstar TeleXtender (✸)**	**1**	**0,7**	2	**MID CA**
825	25	Barlow	2X MEADE APO	2	**0,7**	**1**	**MID CURVATURE**
842	25,5	Barlow	2X TAKAHASHI BL	3	3,2	4	**MID CURVATURE / LOW CA**
825	25	Barlow	2X CHEAP CHINA	4	1,8	3	**MID CURVATURE**
825	25	Barlow	2,7X APM APO	5	2,9	4	**MID CURVATURE**
825	25	Eyepiece*	ZEISS S-PL 12,5X	6	1,1	5	**MID CURVATURE - CA**
891	**27**	Barlow	**2X MEADE APO (✸)**	**1**	**0,6**	4	**LOW CURVATURE**
891	27	Barlow	2X ED 2" EAST	2	0,7	5	**MID CURVATURE**
891	27	Barlow	2,7X APM APO	2	1,9	2	**LOW CURVATURE**
891	27	Barlow	2X TELEVUE 1,25"	3	1,7	**1**	**LOW CA**
891	27	Flatfield barlow*	3-8X BAADER FFC	3	1,1	**1**	
908	27,5	Barlow	2X CORONADO	4	1,8	3	**LOW CURVATURE**
908	27,5	Barlow	2X CELESTRON LX	5	3,1	4	**MID CURVATURE-CA**
891	27	Barlow	2X CHEAP CHINA	6	2,4	5	**MID CURVATURE**
990	**30**	Flatfield barlow	**2x Madrid Sky SUPER-APO H.R. (✸)**	**1**	0,7	2	**MID CA**
974	29,5	Barlow*	2X APO ITALIAN	2	**0,5**	**1**	**LOW CURVATURE**
941	28,5	Barlow	2X CHEAP CHINA	3	1,3	6	**MID-STRONG CURVATURE**
957	29	Barlow	2,7X APM APO	4	2,4	5	**MID CURVATURE**
917	27,8	Barlow	3X GSO CHINA	5	4,3	4	**MID CURVATURE - CA**
974	29,5	--	SECRET LENS	6	0,7	3	**LOW CURVATURE - CA**
983	29,8	Barlow	2X TELEVUE BIG 2"	7	0,8	5	**"HAZY" SCATTER**

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL / OFF AXIS VISUAL BEHAVIOUR)
1.040	**31,5**	Barlow	**2X CORONADO**	**1**	1,8	2	**LOW CURVATURE**
1.030	31,2	Flatfield barlow	3-8X BAADER FFC	2	**0,8**	**1**	
1.023	31	Barlow	3X CHEAP CHINA	3	3,1	3	**MID CURVATURE**
1.023	31	Barlow	2X CELESTRON LX	3	3,7	5	**MID CURVATURE / MID CA**
1.023	31	Barlow	3X GSO CHINA	4	5,4	5	**MID CURVATURE / MID CA**
1.007	30,5	--	SECRET LENS (NO FLATFIELD*)	5	0,5 (biased*)	2	**LOW CURVATURE / LOW CA**
1.073	32,5	Eyepiece*	ZEISS S-PL 12,5X	6	2,2	4	**LOW CURVATURE**
1.089	**33**	Barlow*	**2X APO ITALIAN (✸)**	**1**	1,0	**1**	
1.122	34	Barlow	2X CORONADO	2	1,5	2	**LOW CURVATURE**
1.089	33	Barlow	2X CELESTRON LX	3	3,9	3	**MID CURVATURE / MID CA**
1.096	33,2	Barlow	3X GSO CHINA	4	5,1	3	**MID CURVATURE / MID CA**
1.139	34,5	Barlow	2,25X BAADER	5	2,0	4	**MID CURVATURE**
1.096	33,2	Eyepiece	Zeiss PL 10x/23 #1026-548	6	**0,1**	3	**MID CURVATURE / MID CA**
1.122	34	Eyepiece*	ZEISS S-PL 12,5X	7	1,6	2	**LOW CURVATURE**
1.228	**37,2**	Flatfield barlow	**2x Madrid Sky SUPER-APO H.R.**	**1**	0,6	3	**LOW CURVATURE / MID CA**
1.172	35,5	Barlow	2X APO ITALIAN	2	1,6	**1**	
1.172	35,5	Barlow	3X CHEAP CHINA	3	3,2	3	**MID CURVATURE**
1.172	35,5	Flatfield barlow*	3-8X BAADER FFC	4	**0,6**	**1**	
1.205	36,5	Eyepiece*	Zeiss PL 10x/23 #1026-548	5	1,8	2	**LOW CURVATURE / MID CA**
1.294	**39,2**	Flatfield barlow	**3-8X BAADER FFC (✸)**	**1**	2,4	**1**	
1.370	41,5	Eyepiece	ZEISS S-PL 12,5X	2	2,0	2	**MID CURVATURE - CA**
1.320	40	Barlow	2,25X BAADER	3	**1,7**	2	**MID CURVATURE**
1.320	40	Telecentric	5X BRESSER	4	6,6	3	**VERY STRONG CURVATURE - CA**
1.436	**43,5**	Barlow	**2,25X BAADER**	**1**	**1,4**	**1**	**MID CURVATURE**
1.419	43	Telecentric	5X ES	2	4,0	2	**VERY STRONG CURVATURE - CA**
1.624	**49,2**	Eyepiece	**ZEISS S-PL 12,5X**	**1**	**0,6**	**1**	**MID CURVATURE**
1.568	47,5	Barlow	5x China cheap achromatic	2	4,0	3	**MID CURVATURE / STRONG CA**
1.650	50	Eyepiece	Zeiss PL 10x/23 #1026-548	3	1,7	2	**LOW CURVATURE / MID CA**
1.947	**59**	**Telecentric**	**5x Televue powermate (close)**	**1**	**0,2**	**1**	
1.749	53	Eyepiece*	Zeiss PL 10x/23 #1026-548	2	1,4	3	**LOW CURVATURE / MID CA**
2.145	65	Telecentric	5x Televue powermate (far)	3	1	2	**MID FLARE**

CONCLUSIONS:

More than once winners in their zoom group (this by itself indicates an excellent behaviour):

ON-AXIS TEST	TIMES
2x Madrid Sky SUPER-APO H.R. (✸✸)	3
3-8x Baader FFC (✸✸)	2

OFF AXIS TEST	TIMES
3-8x Baader FFC	5
2x Apo Italian	3

- **In this refractor telescope design (ED doublet with curvature corrector), generally the barlow method is best in almost every situation against the eyepiece projection way, which BTW worked quite BAD at times. This was due to the usage of the corrector lens in the Televue APO scope, which did not get along well with the eyepieces (when I tested eyepieces without the corrector, they recovered their usual top marks). For whatever reason, eyepiece projection did not work well with the Televue corrector in place. There were not "contrast peaks" (☯). The high resolution refractor design made the "contrasty eyepieces" could not exhibit their "contrasty-ness" against their oponents as to the point of showing any "contrast peak".**

- Remains the same considerations as the Celestron 8" testing conclusions regarding these points:
  - Increasing magnification lowers resolution.
  - Explore Scientific has better chromatic aberration as compared with the Bresser "clone."
  - Behaviour of reversed testing of lenses.

- Baader FFC stands out here even better than in the Celestron 8" optics. GREAT glass.

- Televues keep on being contrasty, but the difference against the other brands was not so high in this telescope.

- As you see, due to inherent curvature in the Televue APO scope (even with the corrector on), the great majority exhibit some curvature in the off-axis area. It was quite a miracle in itself that some glasses did not exhibit CA or curvature in the off-axis.

- As you see, winners are quite distributed and many of them have a "sweet spot". In the pure resolution area, two stand out:

2x Madrid Sky HR APO barlow // 3-8x Variable Baader FFC

MEADE Ø 105mm (F14) Maksutov Cassegrain

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL AND OFF AXIS VISUAL BEHAVIOUR)
2.419	**82**	**Telecentric**	**2x Explore Scientific**	**1**	**0,241**	**1**	
2.331	**79**	Telecentric	2x Bresser	2	1,9	2	LOW CURVATURE
2.744	**93**	**Barlow flatfield**	**3-8x Baader FFC flatfield converter**	**1**	**0,945**	**1**	
2.773	**94**	**Barlow**	**2x Televue**	**1**	0,947	2	LOW CURVATURE
2.596	**88**	Eyepiece	Baader 25mm projection eyepiece	2	1,06	3	MID CURV.-CA / LOW PINCUSHION
3.068	**104**	**Barlow**	**2x Meade APO 4000 series (China)**	**1**	0,0931	**1**	**LOW FLARE**
2.965	**100,50**	Barlow	2x Takahashi APO	2	**0,841**	3	
3.112	**105,50**	Barlow	2x Televue	3	1,43	2	LOW FLARE
3.083	**104,50**	Eyepiece	Zeiss S-PL 12,5x/16 #444051	4	4,61	2	LOW CURVATURE / LOW CA
3.039	**103**	Barlow+CORR	2x Televue Big barlow + Panoptic Interface	5	2,66	4	LOW CURVATURE / LOW CA
3.304	**112**	**Barlow**	**2,7x APM APO**	**1**	1,94	**1**	LOW CURVATURE
3.304	**112**	**Barlow**	**2x China cheap achromatic**	**1**	1,96	**1**	**LOW CURVATURE / MID FLARE**
3.275	**111**	Barlow	2x Takahashi APO	2	**0,76**	1	LOW CURVATURE
3.157	**107**	Eyepiece	Baader 25mm projection eyepiece (☯)	3	0,892	2	LOW CURVATURE / MID CA
3.452	**117**	**Barlow flatfield**	**2x Madrid Sky APO H.R. (☯)**	**1**	0,67	2	**LOW CA**
3.540	**120**	Barlow	2x Takahashi APO	2	1,55	1	LOW FLARE
3.525	**119,50**	Barlow	2x Televue	3	**0,292**	1	LOW FLARE
3.422	**116**	Eyepiece*	Zeiss PL 10x/23 #1026-548	4	1,73	4	LOW CURVATURE / LOW CA
3.378	**114,50**	Barlow	2x Meade APO 4000 series (China)	5	1,32	1	LOW FLARE
3.422	**116**	Telecentric	3x Opticstar TeleXtender (= old Meade 5000 line)	6	3,23	3	LOW CURVATURE / LOW CA
3.599	**122**	**Barlow**	**2x Meade APO 4000 series (China)**	**1**	**0,134**	**1**	
3.658	**124**	Barlow	3x GSO ED China	2	5,44	2	MID FLARE
3.584	**121,50**	Barlow	2x ED 2" apo barlow East	3	1,28	2	LOW CURVATURE / LOW CA
3.599	**122**	Barlow	2x China cheap achromatic	4	2,01	3	LOW FLARE / LOW CURVATURE
3.658	**124**	Barlow*	2x APO Italian AdrianoLolli.com (☯)	4	2,65	2	LOW CURVATURE / LOW CA
3.776	**128**	**Barlow**	**2x Celestron LX-cell (☯)**	**1**	1,54	3	**LOW CURV.-CA**
3.717	**126**	Barlow	2,7x APM APO	2	**1,1**	**1**	LOW FLARE / LOW CURV.
3.717	**126**	Barlow	2x Televue Big barlow (no Interface)	3	1,46	2	LOW FLARE / LOW CURV.
3.732	**126,50**	Barlow	2x Coronado CEMAX	4	7,85	3	LOW FLARE / LOW CURV.-CA
3.835	**130**	Barlow	2x China cheap achromatic	5	2,09	2	SCATTER / LOW FLARE / LOW CURV.

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL AND OFF AXIS VISUAL BEHAVIOUR)
4.115	**139,50**	**Barlow**	**2,7x APM APO**	**1**	19,9	**1**	**MID FLARE**
3.968	**134,50**	Barlow	2x APO Italian AdrianoLolli.com	2	**0,571**	3	LOW CURVATURE
3.909	**132,50**	Barlow flatfield	3-8x Baader FFC flatfield converter	3	2,56	4	LOW FLARE / LOW CURVATURE
4.071	**138**	Barlow	3x GSO ED China	4	5,24	2	MID FLARE / LOW CA
3.983	**135**	Eyepiece	Zeiss S-PL 12,5x/16 #444050 (☯)	5	0,705	5	LOW CURV.
4.248	**144**	**Barlow**	**2x Celestron LX-cell (☯)**	**1**	**0,564**	2	**LOW CURV.-CA**
4.233	**143,50**	**Barlow***	**2x APO Italian AdrianoLolli.com**	**1**	3,91	**1**	LOW FLARE
4.337	**147**	Barlow	2x APO Italian AdrianoLolli.com	2	6,33	3	LOW FLARE
4.248	**144**	Barlow	2x Coronado CEMAX	3	2,3	3	LOW FLARE
4.278	**145**	Barlow	3x China cheap achromatic	3	5,77	4	STRONG FLARE / SCATTER
4.735	**160,5**	**Barlow**	**2,25x Baader**	**1**	0,689	2	LOW FLARE / LOW CA
4.691	**159**	**Barlow flatfield**	**2x Madrid Sky APO H.R.**	**1**	2,97	2	**LOW FLARE / LOW CA**
4.750	**161**	Barlow	2x APO Italian AdrianoLolli.com	2	**0,475**	**1**	LOW FLARE
4.705	**159,50**	Eyepiece	Zeiss S-PL 12,5x/16 #444049 (☯)	3	0,795	3	LOW CURVATURE
4.573	**155**	Barlow	2x Celestron LX-cell	4	1,45	3	LOW FLARE / LOW CA
4.573	**155**	Barlow	2x Coronado CEMAX	5	6,1	2	MID FLARE / LOW CA
5.531	**187,50**	**Barlow***	**2,25x Baader**	**1**	2,88	3	**LOW CA**
5.281	**179**	Barlow	2,25x Baader	2	2,27	**1**	LOW FLARE / LOW CA
5.487	**186**	Telecentric	5x Explore Scientific (☯)	3	5,8	4	Contrast peak / STRONG CURVATURE-CA
5.074	**172**	Barlow flatfield	3-8x Baader FFC flatfield converter	4	2,91	2	MID FLARE / LOW CURVATURE
5.900	**200**	**--**	**Secret lens**	**1**	3,08	**1**	**LOW FLARE**
5.635	**191**	Eyepiece	Zeiss PL 10x/23 #1026-549 rev	2	**2,64**	2	LOW FLARE
5.871	**199**	Telecentric	5x Bresser (☯)	3	13,4	5	STRONG CURVATURE-CA
5.797	**196,50**	Barlow	2,25x Baader	4	7,32	3	STRONG FLARE
6.726	**228**	Barlow	5x China cheap achromatic	5	99	4	STRONG FLARE / MID CA
7.346	**249**	**Telecentric**	**5x Televue powermate (medium) (☯)**	**1**	**4,82**	**1**	**LOW CURVATURE**
7.139	**242**	Barlow	5x China cheap achromatic	2	23,6	3	STRONG FLARE / MID CA
7.080	**240**	Telecentric	5x Televue powermate (close)	3	11,6	2	MID CURVATURE
7.611	**258**	**Telecentric**	**5x Televue powermate (far) (☯)**	**1**	**3,77**	**1**	**LOW CA**
7.906	**268**	Eyepiece*	Zeiss PL 10x/23 #1026-550	2	21	2	LOW FLARE / LOW CA

CONCLUSIONS:

As you can see, only these specific lenses won out **more than once** in their zoom group, and this by itself indicates an excellent behaviour:

ON-AXIS TEST (IMAGING WINNERS)	TIMES
2x Madrid Sky APO H.R. (☯☯)	**2**
2x Celestron LX-Cell (☯☯)	**2**
2x Meade APO 4000 series (China)	**2**
2,25x Baader	**2**
2,7x APM APO	**2**
5x Televue powermate (☯☯) (biased for lack of contenders)	2

OFF AXIS TEST (VISUAL WINNERS)	TIMES
2x Meade APO 4000 series	**3**
2,7x APM APO	**3**
2x APO Italian AdrianoLolli.com	**2**
5x Televue powermate (biased for lack of contenders)	2

- **In this reflector telescope design (Maksutov), the barlow method and eyepiece projection method were balanced out, moderately biased towards the barlow way. This is probably due to the more "neutral" output of this design, which did not get along well with the eyepieces in all situations (distances from sensor). In this particular scope, everything was much more balanced and there were not "resolution peaks".**

- Remains the same considerations as the Celestron 8" testing conclusions regarding these points:
  - Increasing magnification lowers resolution.
  - Explore Scientific has better chromatic aberration as compared with the Bresser "clone."
  - Behaviour of reversed testing of lenses.

- Zeiss S-PL 12,5x/16 #444050 (☯☯) is a rare case. It was a contrasty eyepiece but it did not excel in resolution on axis or good behaviour in the off-axis area, so it remains in "empty" land. It is like a dinosaur belonging to other time (other telescope design).

- Same to be said about Televues. In the last Televue powermate groups, you see repeated the powermate 5x for a reason. I tested it from 3 different distances to sensor. The best behaviour was in "middle distance" from sensor and the worse when closest. This was another interesting result. In this particular scope, the "close position" was not the good one. As I say… YOU HAVE TO TEST!!

- **The "sweet spot" was much more relevant than in previous tests, so each lens had the opportunity to really SHINE and everyone shared their own glory. Everything came out much more distributed.**

- The small and cheap low-element Apo lenses worked generally very well in this design (Baader 2,25x, Meade 2x APO and even 2x china cheapo)

6: MAGNUM results

- It is difficult to give “overall winners”, given the results you have seen this far. However, throughout the testing some lenses really did very well and I want to give them their due place along with their weaknesses. As you see, there is an specific place in which almost all quality lenses shine forth (the famous “sweet spot” exists), getting your optical train to show the goods with that particular lens. For the average user, this is diffficult and cumbersome unless you have a reliable method to measure resolution (either slanted edge testing or some indoors/close distance outdoors targets to be able to compare in your computer screen as I have done here.) Anyhow, it is nice to know that any good reasonable quality lens can give us a nice “sweet spot”… and we can get a lot out of it. The “poor man” law in our hobby applies again: GO and WATCH/IMAGE HEAVENS WITH WHATEVER YOU HAVE IN YOUR HANDS, you do not need a sleek Ferrari! Though this is true, I would recommend you to avoid the cheap-China barlows that you get for 10-20€. I would at least look for “APO” or “ED” category lens.

- Barlows and eyepieces worked best when about no more than aprox. 12-13cm distance is allowed between lens and camera sensor. Further than that, there starts to show bad flares and resolution drops off. Depending on lens, these flares show up closer and you have to further reduce that distance. All in all, lenses tended to work good closer to camera. I admit some flares could be due to my hardware (VEPA is not blackened in the inside), but I tend to think flares happen mainly due to scope design and distance from lens to sensor.

- I am a kind of gipsy seller of optics through a little Ebay shop. You might contend with me that I might be biased regarding my selling one of the contenders. Certainly, I could be cheating all of you… but for what reason and gain? For those who follow me or had previous dealings with me, you know I am honest. That doesn’t mean I do not know how to lie, but I have learned the hard way that honesty is more than a card of presentation: it is a *way of life*! You really grow into it. I have always offered the same guarantee: TEST and SEE FOR YOURSELF. If you do not like it when you buy from me, return it back for full refund. No questions asked except what my curiosity might arise. “Why you didn’t like it? What barlow worked better for you?” After this testing, I am more than confident in my “Madrid Sky SUPER-APO 2x barlow.” In fact, the other reason I did this extensive testing apart from selecting my own projection lens was to see its behaviour against my 25mm eyepiece projection winners and then against other good quality barlows.

- Out of a pure statistically view, table 1 is <u>biased</u> due to several factors: the "zoom" group existance, the number of times each lens appears in testings (some lenses could be tested several times at several magnifications, whereas other lenses could only participate once), and lack of contenders in same group. This last bias must be had in mind when we talk of Televue 5x and ES 2x, and that's why results are duplicated and marked with asterisc (*) when they threat another lens. I re-counted every time a glass won (once, twice or more) across all scopes. This gives us a less biased and more equalized result. **<u>Only >2 "total points" eyepieces were included.</u>** I also gave weight to "2nd place" by giving it 0,1x points each time it is 2nd both in on-axis or off-axis (for instance, Baader FFC had a lot of 2nd places and it would be very unfair to not give some weight to those nice results). "ON AXIS" winners are the result of adding "ON AXIS" and "✸" peak points. "OFF AXIS" winners are the result of adding "OFF AXIS" points and looking for 2nd positions only in the off-axis area giving them 0,2x weight each as before. "CONTRAST WINNER" is the result of "☯" points. In parenthesis I point out the total mark. You can take table 1 as a good indicator of general behaviour.

Table 1

"ON AXIS" HITS (X1)	"OFF AXIS" HITS (X1)	"PEAK" HITS (X1)		"2ND PLACE" HITS (X0,1)		TOTAL POINTS	WINNERS FROM A STATISTICAL VIEW (*= highly biased for lack of contenders)	WINNERS ON AXIS RESOLUTION	WINNERS OFF AXIS ABERRATIONS	WINNERS CONTRAST (☯)
		✸	☯	on axis	off axis					
5	5	0	4	0	2	**14,2**	*5x Televue powermate	3RD (5,0)	WINNER (9,2)	WINNER*
3	7	2	0	5	4	**12,9**	**3-8x Baader FFC**	2ND (5,5)	2ND (7,4)	-
7	1	3	1	1	6	**12,7**	**2x Madrid Sky HR APO**	**WINNER (10,1)**	10 (2,6)	4th
2	7	1	1	9	5	**12,4**	**2x APO Italian AdrianoLolli.com**	5th (3,9)	**WINNER** (8,5)	4th
4	2	0	4	0	2	**10,2**	2x Celestron LX-cell	4th (4)	4th (6,2)	**WINNER**
3	6	1	0	1	1	**10,2**	2x Meade APO 4000 series	3RD (4,1)	5th (6,1)	-
2	7	0	0	3	1	**9,4**	2,7x APM APO	8th (2,3)	3RD (7,1)	-
3	1	1	2	0	1	**7,1**	Secret lens from microscope	4th (4)	9 (3,1)	3RD
4	2	0	0	1	3	**6,4**	2,25x Baader	3RD (4,1)	11 (2,3)	-
1	1	1	3	1	3	**6,4**	Zeiss S-PL 12,5x/16 #444049	9th (2,1)	7th (4,3)	2ND
0	5	0	0	5	2	**5,7**	2x Takahashi APO	12th (0,5)	6th (5,2)	-
2	2	1	0	0	0	**5**	*2x Explore Scientific telecentric	7th (3)	12th (2)	-
1	3	0	0	1	3	**4,4**	2x Televue 1,25"	11th (1,1)	8th (3,3)	-
2	0	2	0	0	2	**4,2**	3x Opticstar TeleXtender	4th (4)	14th (0,2)	-
2	0	1	0	1	2	**3,3**	ED 2" apo barlow East	6th (3,1)	15th (0,2)	-
2	0	0	1	0	3	**3,3**	2x Televue Big Barlow	10th (2)	13th (1,3)	4th

In table 2, I let results *talk* and I analyze from a closer (and inevitably, more subjective) user perspective.

Table 2

WINNERS (A PERSONAL VIEW)	WINNER RESULT	COMMENTS and OBJECTIONS	PRICE
3-8x Variable Baader FFC	**BEST BALANCED IN ALL SITUATIONS OVERALL WINNER**	It would be very unfair to not give this lens this prize. It is very well designed and amazingly balanced, and it really shows its value through the whole range of magnifications and scopes tested. Maybe not winner in all situations, but it is the most balanced one, always on top and you have to bow to that.	649,95€
2x Madrid Sky HR APO barlow	**ON AXIS & GENERAL IMAGING PURPOSE**	This lens is new in town. It is amazing asset for high resolution on axis and it has impressive contrast. A clean, low-scatter and trusty barlow that could very well mean the best imaging glass available for those of you in high resolution entrepeneurs. It suffers from some chromatic aberration in the off-axis area depending on scope used, but not serious. Bad news: it is specifically designed for IMAGING on a flat sensor (FULL SIZE sensor compatible down to F1.6), it is a *VERY* limited edition and it is quite expensive. Search for it in Ebay and you will find it.	249,95€
2,7x APM APO barlow	**OFF AXIS & GENERAL PURPOSE**	In the "visual" aspect and off-axis, this little glass worked superb. It is also very well balanced. Not specially brilliant in the on-axis area.	124,95€
ALL TELEVUES	**CONTRAST & GENERAL PURPOSE**	The Televues are great all-round fighters that won't let you down. They have a very polished design that always give a contrasty view very pleasant and "soft-clean" view that is very beatiful and enjoyable. The "powermates" seem to be a better value for the buck, but the barlows are nice too.	VARIES
2x Celestron LX-cell barlow	**CONTRAST & GENERAL PURPOSE (low budget)**	I was quite surprised that Celestron would make a reasonable good barlow. Originally this lens was expensive, but price has lowered. It shows very balanced behaviour in visual mode with very good contrast to the eye. It might be all you need in case you can live with the 1,25" barrel and a low budget.	119,95€
2x APO Italian AdrianoLolli.com	**OFF AXIS & GENERAL PURPOSE (low budget)**	Low budget italian lens that gladly surprised me given the price and its nice results. When you see the way it behaves, it seems to have an unique design unlike the mainstream "asians" and it behaved "differently". It gives good results when used backwards if you want to test it that way.	92€
****ANY OTHER****	???	There are a lot of lenses out there that are waiting for testing. Remember: test and see for yourself!!	???

7: Checking results yourself

I will upload to http://marronyazul.es/azul/how.htm all Canon RAW images captured (18Mpx @ 14bits / 5184x3456 picture size / 22.3x14.9mm sensor size), around 25Mb each in RAW format (around 100Mb each once you uncompress them to TIFF) so that you may judge for yourself which lens is sharper or more pleasant and contrasty to your own eyes. You can even do the slanted edge analysis yourself if you have the proper software. These pictures tell you a lot of information about the behaviour of the lenses involved.

As images are high resolution (and BIG!), they allow a lot of "zooming in" to see details. So, you yourself may cover the visual aspect by judging yourself and see another aspects like light throughput figures by comparing shutter speeds (EXIF data gives you the shutter speed).

I do not know when I will upload them. I need a fiber optic broadband internet connection and I have to see for this (recently I got the chance to hire this service, but I am not yet hooked up).

8: Addendum

Some advanced users in Cloudynights eyepiece forum advised me to get a "Petzval" scope design to test these lenses (Cloudynights participant *EuropaWill,* told me to use a cheap achromat stopped down.) I had some issues getting it new, but three weeks after I finished this review I could locate an used Bresser tube for a very good price. Unfortunately, as some contenders were not available anymore, I had to take this testing "out" of the main review and present results here individually.

BRESSER Ø 102mm (F9.8) Achromat

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL / OFF AXIS VISUAL BEHAVIOUR) FLARE STRENGTH (higher is worse): 1* / 2** / 3*** / 4****
1.562	**52,5**	**Eyepiece**	**Zeiss PL 10x/23 #1026-548**	**1**	0,928	**1**	Low fringing / Low off axis CA
1.517	51	Telecentric	2x Bresser	2	1,43	2	Mid fringing / Mid off axis CA
1.800	**60,5**	**Barlow**	**2x Meade APO 4000 series (China)**	**1**	3,53	2	Low fringing
1.785	**60**	**Barlow**	**2x Takahashi APO**	**1**	1,82	3	Mid fringing
1.785	60	Flatfield barlow	3-8x Baader FFC flatfield converter (close)	2	0,886	**1**	No fringing. No CA.
1.651	55,5	Eyepiece	Baader 25mm projection eyepiece	3	1,04	4	Low CA / Strong CA
1.755	59	Barlow	2x Televue	3	1,15	3	Mid fringing
2.068	**69,5**	**Barlow**	**2x Televue**	**1**	0,807	2	Low fringing / Mid fringing
1.934	65	Barlow	2x ED 2" apo barlow East	2	1,82	2	Low fringing / Mid fringing
1.934	65	Barlow	2x China cheap achromatic	2	1,87	**1**	Very low fringing
1.964	66	Flatfield barlow	2,7x APM APO (close)	2	1,51	2	Low fringing / Mid fringing
2.053	69	Eyepiece	Secret lens from microscope (close)	3	3,19	3	Low fringing / Strong CA
1.949	65,5	Eyepiece	Zeiss S-PL 12,5x/16 #444049	4	0,793	2	Low fringing / Mid fringing
2.053	69	Barlow	2x Takahashi APO	4	2,2	2	Low fringing / Mid fringing
2.097	**70,5**	**Flatfield barlow**	**2x Madrid Sky APO H.R. (close)**	**1**	2,26	3	Low fringing-CA / Mid CA
2.187	**73,5**	**Eyepiece**	**Baader 25mm projection eyepiece**	**1**	0,751	5	Low CA / Strong CA + Mid Curvature
2.127	71,5	Barlow	2x Meade APO 4000 series (China)	2	1,48	2	Low fringing / Mid fringing
2.142	72	Barlow*	2x APO Italian AdrianoLolli.com	3	1,55	2	Low fringing / Mid fringing
2.172	73	Flatfield barlow*	3-8x Baader FFC flatfield converter (close)	4	1,51	**1**	Very low CA / Very low CA
2.202	74	Barlow	3x GSO ED China	5	2,74	4	Low fringing-CA / Low fringing-CA
2.276	**76,5**	**Barlow**	**2x Celestron LX-cell**	**1**	1,43	3	Low fringing / Mid fringing + Low CA
2.321	78	Telecentric	3x Opticstar TeleXtender	2	2,01	**1**	Low fringing / Low CA
2.365	79,5	Barlow	2,7x APM APO (mid)	2	4,2	4	Mid fringing / Strong fringing
2.231	75	Barlow	2x Coronado CEMAX	3	2,13	2	Low fringing / Mid fringing
2.246	75,5	Barlow	2x China cheap achromatic	4	1,61	2	Low fringing / Mid fringing
2.261	76	Barlow	2x Takahashi APO	4	2,71	2	Low fringing / Mid fringing

SYSTEM FOCAL LENGTH	ZOOM (GROUP)	TYPE (*=reversed)	LENS MODEL (✸=Resolution peak) (☯=Contrast peak)	SLANTED WINNER (ON-AXIS)	ON-AXIS CA (Lower is better)	VISUAL WINNER (OFF-AXIS)	NOTES (GENERAL / OFF AXIS VISUAL BEHAVIOUR) FLARE STRENGTH (higher is worse): 1* / 2** / 3*** / 4****
2.321	78	Barlow	2x APO Italian AdrianoLolli.com	4	2,3	2	Low fringing / Mid fringing
2.380	**80**	**Barlow**	**2x Televue**	**1**	1,99	2	Low fringing / Low fringing
2.469	**83**	**Barlow**	**2,25x Baader ☯**	**1**	1,49	**1**	Low fringing / Low fringing
2.440	82	Barlow	2x Meade APO 4000 series (China)	2	3,11	3	Low fringing / Mid fringing
2.440	82	Barlow	2x APO Italian AdrianoLolli.com	2	2,82	3	Low fringing / Mid fringing
2.484	83,5	Flatfield barlow	3-8x Baader FFC flatfield converter (mid)	3	1,36	2	Low fringing / Low fringing
2.380	80	Barlow	2x ED 2" apo barlow East	4	2,79	4	Low CA + Flare** / Low CA
2.588	**87**	**Barlow**	**3x China cheap achromatic**	**1**	1,28	2	Mid fringing + Flare*** / Mid fringing
2.618	88		2,7x APM APO (far)	2	1,92	**1**	Mid fringing + Flare* / Mid fringing
2.633	88,5	Barlow	2x China cheap achromatic	2	1,58	2	Mid fringing + Flare*/ Mid fringing
2.648	89		2x Celestron LX-cell ☯	2	1,02	4	Mid fringing / Mid fringing + Low CA
2.618	88	Barlow	3x GSO ED China	3	2,09	3	Mid fringing + Flare* / Mid fringing + Low CA
2.767	**93**	**Flatfield barlow**	**2x Madrid Sky APO H.R. (mid)**	**1**	2,58	2	Low CA - fringing + Flare* / Mid CA + Low fringing
2.826	**95**	**Barlow**	**2x APO Italian AdrianoLolli.com**	**1**	3,2	**1**	Low CA-fringing + Flare* / Low CA- fringing
2.678	90	Barlow*	2x APO Italian AdrianoLolli.com	2	1,91	2	Mid fringing / Mid fringing + Low CA
2.707	91	Barlow	2x Coronado CEMAX	3	1,65	3	Mid fringing / Mid fringing + Low CA
2.886	**97**	**Flatfield barlow***	**3-8x Baader FFC flatfield converter (mid)**	**1**	1,9	**1**	Very low CA – fring.+ Flare**/ Low CA + very low fring.
2.990	100,5	Barlow	2x Celestron LX-cell	2	6,9	3	Mid fringing + Flare* / Mid fringing + Low CA
2.960	99,5	Barlow	2x Coronado CEMAX	3	1,51	2	Mid fringing + Flare* / Mid fringing + Very low CA
2.975	100	Barlow	3x GSO ED China	3	2,35	2	Mid fringing + Flare** / Mid fringing + Very low CA
3.049	102,5	Barlow	2,25x Baader	4	2,28	**1**	Very low CA- fring. + Flare* / Low CA + Very low fring.
3.064	**103**	**Barlow**	**3x China cheap achromatic**	**1**	1,53	**3**	Low fringing + Flare** / Mid fringing
3.198	**107,5**	**Flatfield barlow**	**3-8x Baader FFC flatfield converter (far)**	**1**	1,85	**3**	Low fringing + Flare*** / Mid fringing
3.228	**108,5**	**Eyepiece**	**Zeiss S-PL 12,5x/16 #444049 ☯**	**1**	1,46	**1**	Low fringing / Low CA-fringing
3.154	106	Barlow*	2x APO Italian AdrianoLolli.com	2	4,57	4	Low fringing + Flare* / Low CA-fringing
3.154	106	Barlow	2x Televue Big barlow	3	1,84	2	Very low frining + Flare*** / Low fringing
3.436	**115,5**	**Flatfield barlow**	**2x Madrid Sky APO H.R. (far)**	**1**	6	**2**	Very low CA + Low fring. + Flare*** / Low fring. + Mid CA
3.600	**121**	**Flatfield barlow***	**3-8x Baader FFC flatfield converter (far)**	**1**	3,82	**1**	Low fringing + Flare** / Mid fringing + Very low CA
3.585	120,5	Barlow	2,25x Baader	2	2,46	2	Low fringing + Flare** / Mid fringing + Low CA
3.421	115	Barlow	3x China cheap achromatic	3	2,36	3	Scatter + Low fringing + Flare** / Mid fringing
3.570	120	Eyepiece	Secret lens from microscope (far) ☯	3	10,7	**1**	Low fringing-CA / Mid fringing + Low CA
4.522	**152**	**Telecentric**	**5x Televue powermate**	**1**	3,11	**1**	Mid fringing / Mid fringing
3.808	128	Telecentric	5x Explore Scientific	2	1,87	3	Strong barrel distor. + Low fring.-CA / Mid fring.+ Low CA
4.314	145	Barlow	5x China cheap achromatic	3	2,42	2	Low fringing-CA + Flare**** / Low fringing + Mid CA
5.206	**175**	**Telecentric**	**5x Televue powermate (far) ☯**	**1**	3,63	**1**	Low fringing / Mid fringing
4.730	159	Barlow	5x China cheap achromatic	2	4,16	2	Low fringing-CA + Flare**** / Mid fringing-CA

CONCLUSIONS:

As you can see, only these specific lenses won out **more than once** in their zoom group, and this by itself indicates an excellent behaviour:

ON-AXIS TEST (IMAGING WINNERS)	TIMES
3-8x Baader FFC flatfield converter	**3**
2x Madrid Sky APO H.R.	**3**
2x Televue	**2**
3x China cheap achromatic	**2**
5x Televue powermate (biased for lack of contenders)	2

OFF AXIS TEST (VISUAL WINNERS)	TIMES
3-8x Baader FFC flatfield converter	**4**
2,25x Baader	**2**
5x Televue powermate (biased for lack of contenders)	2

- **In this refractor telescope design (stopped-down achromat), the barlow method and eyepiece projection method were super-balanced out. This is probably due to the more "neutral" output of this design, which did not get along well with the eyepieces in all situations (distances from sensor). Everything was super-balanced and there were not "resolution peaks". In fact, this design was the most difficult to judge: VERY close results and many times there was not a clear winner. However, we could give some "contrast peaks" (☯) most probably due to "flares" being much better managed by these particular lenses. Fringing was present in almost all situations and the only eyepiece "magically" making it almost invisible was the 3-8x Baader FFC in its CLOSE testing position (closest to sensor).**

- As with the previous scopes, increasing magnification lowers resolution.

- Explore Scientific chromatic aberrations against the Bresser "clone" could not be tested because I had some two eyepieces missing (5x Bresser and 2x Explore Scientific). Likewise, I did not have the mood to also do reversed testing of lenses.

- In this design, flares were quite a "rule" and those eyepieces suffering from this malady really showed the aberration forth (for instance, stay away from the 5x cheap China achromatic barlow when using it in an achromat design!).

- **As with the Maksutov design, each lens had the opportunity to SHINE in their "sweet spot". Everything came out very distributed, but if I had to give an overall winner, it would be the 3-8x Baader FFC flatfield converter lens.**

I HOPE YOU **ENJOYED** THIS TIME WITH ME
AS I ENJOYED IT WITH **YOU.**

GOD BLESS RICHLY
ALL THOSE OF **YOU** WHO LOOK UP EVERY NIGHT,
LOOKING FOR **HOPE** AND **BEAUTY** IN THE SKIES ABOVE.

...AND SO I WISH YOU MAY –NATURALLY– FIND **HIM!!**

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- 30TH JULY 2016 -