A customer review of the 17 Zoll PlaneWave Astrograph

Dear Mr. Baader,
I am happy to comply with your request and share with you my criteria that led to the purchase of the 17 inch telescope from Planewave, and following my experience with this telescope. Since this was a rather complex topic, please forgive the long text and its extent, which certainly clearly exceeds a "normal" customer judgment.

In the beginning ...

In 2012 I got the order from the owner of the Namibian guest lodge Rooisand to equip the - at that time empty - Baader 3.2m dome with a new mount and a corresponding new instrument cluster.

Between 2004 and 2011, this dome was fitted with an Astro Physics GTO-1200 mount, equipped with a Celestron C14 (built in 2001), a 6-inch Zeiss APQ refractor and a Zeiss AS 80/840mm guiding scope for the Zeiss APQ. During this time, the telescope was mainly used at many evenings a year as a "public star gazing" for guests of the lodge, but occasionally also rented for longer periods to amateur astronomers. At the end of 2012, the instrument was due to many reasons dismantled and sold to another guest lodge in Namibia.

The new main telescope should have a larger aperture at a "faster" aperture ratio (around f/8) than the old Celestron 14, as it should also be used primarily for "public star gazing" with guests of the lodge, but also for renting – it would be useful on experienced amateur astronomers and the use in astrophotography.

Ritchey-Chrétien or modified Dall Kirkham ?

Before deciding what optical system should be chosen for the new telescope - it also had to be affordable, because there was a fixed price range that had to be adhered to - an opening between 16 and 18 inches was actually only possible with an RC system or a modified Cassegrain after Dall Kirkham. A Newton was not up for discussion because of the problematic viewing position in visual observations, because of the often steep visibility of southern deepsky highlights in Namibia.

Now I am not completely inexperienced and have been practicing amateur astronomy for more than 50 years, I have also built various telescopes during this time, but my experience with optical systems and their collimation was mainly limited to refractors and Schmidt-Cassegrain systems. So I browsed a bit on the internet and also in my astronomical optical library and learned the following ...

... **the RC optical system** consists primarily of two hyperbolic mirrors. The field of view at an aperture ratio of f/8 to f/10 is free of astigmatism and coma. However, the image field is curved, which may not be important for visual observation, but needs to be corrected for larger-scale photographic observation. Hyperbolic mirror surfaces are very difficult to produce and even more difficult to test for best performance.

One big problem with RC optical systems is the fact that the optical axes of the main mirror (S1) and secondary mirror (S2) must be centered with extreme accuracy on each other. This means that both mirrors must be positioned very precisely in the tube relative to one other, which affects both the distance between the mirrors and the centering of the optical axes from S1 and S2.

Tilt at the optical axes of S1 and S2 even by a few microns against each other - e.g. by changing the position of the telescope tube during a long time exposure - this immediately results in an asymmetrical degradation of the imaging quality and the system has to be recollimated. To get a grip on such a problem requires an extremely high technical effort in the design of the telescope tube, which both the rigidity at a change in position of the tube as well as mechanical deviations due to temperature differences.

Since I am myself an engineer with a solid technical education, it was difficult for me to imagine that such a complex tube construction in the RC amateur market could be realized at reasonably affordable price. And dealer comments on a 16 RC, **"... there is no focus drift with temperature changes"** or **"high quality Ritchey-Chrétien telescopes can perfectly adjust within three minutes"**, which I found on the Internet at German dealers probably belong into the realm of fantasy.

All professional telescopes with very large openings are - in various optical variations - RC telescopes, but are considered by technicians as the "prima donna" of the construction of telescopes.

There are certainly RC telescopes from European and international manufacturing that meet the high optical and mechanical requirements for an RC telescope, but the prices were well above the budget which was available for the new Rooisand telescope.

After some "bitter" learning of the collimation and other problems of an Astro friend with his new 20 RC system - in which I was partly involved - my focus was more on the modified Dall-Kirham system from Planewave.

The modified Dall Kirkham (Version PlaneWave)

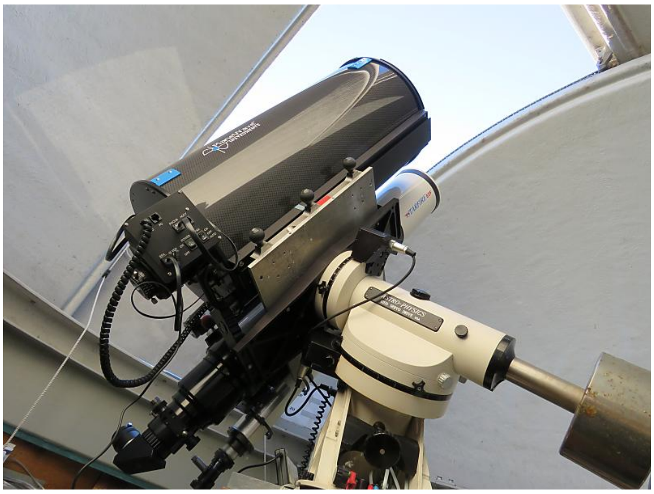
The PlaneWave optical system is a modified Dall-Kirham Cassegrain with a 2-lens field corrector at an aperture ratio of f/6.8 and an aperture of 17 inches (430mm). The optical system was realized for the first time shortly after the Second World War by the opticians Rosin and Wynne. The main mirror has an elliptical, the secondary mirror a spherical surface, both are easy to grind and easy to test even as individual components, which is certainly noticeable in the final price of a telescope. According to a publication by Wynne, the usable field (with field corrector) is significantly larger than that of an RC **WITHOUT** correction system.

However, the great advantage of a modified Dall Kirkham in comparison to an RC system is the fact that the collimation of the convex spherical secondary mirror with respect to the main mirror is nearly trivial, since a shift of the optical axes from S1 to S2 practically does not matter; be it by changes in position during a long exposure or by temperature influences on the tube.

In the modified Dall Kirkham (by PlaneWave), the main mirror is completely installed together with the 2-lens corrector in the tube and collimated to each other at the factory, adjustable is **ONLY** the secondary mirror. This enormously simplifies a subsequent adjustment and here I can confirm from practice that this is perfectly done after 5 minutes by only one person and a simply video module.

According to the company, the corrector should deliver a completely flat image field of 52 mm in diameter - without coma and astigmatism - over the entire field of view. In my opinion this is sufficient, because no larger image sensors than full format (24 x 36mm / diagonal = 52mm) should be used. A vignetting is not visible on the images, all image results were created **WITHOUT** any Flatfield corrections.

Since the total investment for the new telescopes and mount was relatively high, the company Baader Planetarium was ready on request to provide me a 12.5 PlaneWave Astrograph for testing at my observatory in Germany for a limited time.

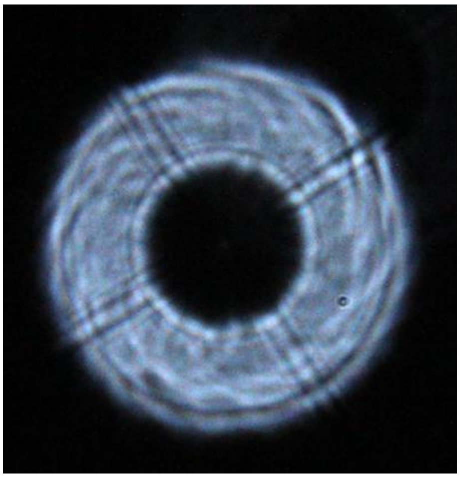


After the 12.5 Planewave arrived at my home, thanks to the pre-assembled 3" dovetail at the scope tube it could be easily mounted parallel to the 155mm Astro Physics refractor on my GTO-1200 mount.

All electrical connections for the mirror ventilation and the electric focusing unit were also quickly connected and the astrograph was ready for initial tests.

For the GTO 1200 from Astro Physics, the load (refractor, PlaneWave, viewfinder and mounting plate) with a total weight of about 40kg was negligible.

A highly recommed advantage of the PlaneWave was that you can easily switch between photographic and visual observation at the focuser with just a click.



The first surprise at first light of the visual image at a magnification of about 150x with medium seeing conditions was that the unsharp star image appeared completely round with the dark shadow of the secondary mirror well centered. This means that after a UPS transport over 600km from Bavaria to Lower Saxony the collimation of the secondary mirror adjustment has been preserved. The picture left shows the defocused star disc **WITHOUT** any readjustment.

The mount of the secondary mirror in the tube is mechanically somewhat rustic. Why the engineers have constructed the mirror adjustment with four instead of the usual 3 adjustment screws remains a mystery (in year 2012/2013, have changed later). However, the fact is that despite the long transport route, the optical system arrived almost perfectly collimated at my home.

Should a readjustment become necessary nothing is easier than that. Place a webcam into the focuser. Position a laptop so that the image of the extra/intrafocal star disc is well in view, carefully turn one or more of the adjustment screws and the entire system is collimated again. It does not need 2 persons and even without much experience, the adjustment is completed after 5 minutes at the latest.

In RC systems, both the main and the secondary mirrors are usually adjustable. If the adjustment of a correction optics is added, it will be almost impossible - even for an experienced amateur - to collimate the optics without measuring devices directly at the image of a star. I remember that a long time ago the company *Vixen* had a so called VCL 200/1800mm system, where both the main, the secondary **and** the field corrector were adjustable - **an optical nightmare**.

The most important thing in the subsequent adjustment of the secondary mirror in the PlaneWave (and in the optical system where the secondary to the main mirror must be adjusted) is to adjust the star back to the center of the field of view before performing the next adjustment step.

Modified Cassegrain systems according to Dall-Kirkham with field correctors - as far as the image errors coma and astigmatism are concerned - react as critically as a RC system to the exactly calculated distance between the surfaces of both mirrors. For control or adjustment, PlaneWave has developed a simple Ronchi test arrangement that comes with the scope. It consists of a special mechanical extension and a Ronchi grid mounted in an eyepiece socket.

If you look at a bright star, you can see either straight, parallel lines, then the distance is correct. If the lines are curved, the distance is not correct and must be corrected. At "my" 12.5 inch Planewave the distance was OK.

After a really minor readjustment of the secondary mirror, I then took several test images over several nights to get a "feeling" for the scope, e.g. as it is ordered to focus stability in case of temperature changes.

The picture above shows the "first light", a 600 second exposure of the Pleiades, taken

with a modified Canon EOS 60DA (APS-C chip).

Tube and optics react pretty good-naturedly to small temperature changes. For differences of more than 4 degrees Celsius, it is advisable to re-focus the DSLR or CCD camera, which is unproblematic with the slow speed of the electric focusing unit.

One important point - which was very close to my heart - worried me from the start. For the then envisaged 17" PlaneWave for Namibia, there was - in 2012/2013 - only one focal reducer available from PlaneWave - and on one hand it was rather expensive and on the other hand had such a low back focus, that the reducer only was usesable with a SBIG STL-11000 with integrated filter wheel. The connection of a DSLR camera was not possible due the short back focus and also otherwise in my view had the Reducer other disadvantages, but because we had no STL-11000, this reducer was out of question anyway.

The 17 inch PlaneWave has at f/6.8 the respectable focal length of almost 3 meter and the seeing conditions at Rooisand are not always perfect or optimal at the lodge because the desert is not far away. And also f/6.8 is not exactly "fast" for imaging faint deepsky objects.

The search for a third-party reducer turned out to be difficult. One of the great advantages of the PlaneWave astrograph - the flat fielded image plane - became a "horse's foot". Because nearly all current reducers are calculated for use on refractors or Newton systems, they do not only reduce the focal length but also correct the curved fields of these optical systems at the same time. Such reducers used at the PlaneWave, would turn the carefully planed image field again in a curved image plane again.

After much search on the internet, I found a 0.8x reducer from the company *TeleVue*. This reducer is calculated for TeleVue refractors and they also have a flat field of view due to their optical design. It has at telescopic side a 2" connector and at camera side male thread and a matching EOS camera adapter is also available. The back focus is 55- to 60mm, large enough to connect both DSLR and most CCD cameras.

Since the price of the reducer was acceptable, it was bought and included in the tests. The following two pictures show the magnification focal (top) and with the Reducer (bottom).

The Reducer reduces the focal length of the 17 inch down to 2,400mm and that of the 12,5 inch to 2,000mm, the aperture ratios to f/5.6 and f/6.3. And a long story short: the image of the TeleVue Reducer is very good, up to the full format (test shots with an EOS 6D) very good and also in the corners very satisfactory. Thus, the purchase price of around € 400 was rather a bargain.

A detailed description with test images of the TeleVue Reducer can be found at the following URL

http://www.baader-planetarium.com/de/blog/fotografische-beobachtungen-mit-einem-0-8fach-reducer-von-televue-am-cdk-17

With that reducer, the decision to buy at PlaneWave astrograph was practically made, it should rather be a workhorse instead of a prima donna as the main instrument for the Rooisand Lodge.

In addition, a 140- and a 110mm TEC refractor should be ordered. After many years of excellent experience - both in Namibia and privately in Germany - with the Astro Physics mount GTO-1200, a GTO-1600 with a higher instrument carrying capacity was chosen as the new mount (the GTO-1200 was no longer available in 2012).

As there was an extremely long delivery time for the TEC 140mm at this time, one of the last Zeiss 130mm APQ refractors was chosen.

After consultation with the owner of the Rooisand lodge it was decided that the complete telescope cluster – to be build according to some of my specifications - should be build and ordered at the company Baader Planetarium in Bavaria. A decision that I have not regretted until today. Finally, a GTO-1600 from Astro Physics was ordered, equipped with the 17" PlaneWave astrograph, a 130mm Zeiss APQ and a 110mm TEC apochromat, including a heavy Baader steel pier with leveling flange.

In the spring of 2013, two wooden boxes weighing more than 500kg from Germany arrived in Namibia. Setting up the mount and the complete instrument – with the help of former colleague - was completed after 3 days and the new telescope could be handed over to the lodge owner for "first light". In the summer we flew to Namibia again to do some small rest work.

Incidentally, the secondary mirror adjustment was almost perfect even after more than 8,000 km of ship transport - only a slight correction was necessary - and since summer 2013 mount and telescopes are in operation (at about 80 evenings a year in public star gazing operation) and so far without any disturbance, neither visually nor mechanically.

The image above shows "First Light" at full focal length of the PlaneWave. Exposure 40x30 seconds (without any guiding) was added, taken with a modified Canon EOS 40 DA.

Summary:

Decision criterions for the choice of the Planewave astrograph were primarily:

- robust mechanical construction of the whole telescope,
- fixed installation and collimation of primary mirror and field corrector at factory,
- stable secondary mirror cell,
- easy adjustment of the secondary mirror,
- easy control of distance between the main and secondary mirror with Ronchi test,
- good focus stability with slight temperature differences,
- affordable focal reducer available,
- a price difference of about 10.000 Euro to a RC telescope from renowned European or international manufacters.

To the last point, my following remark: I have not looked into the RC telecopes offered on the amateur market, which are delivered at 16 inches opening and a price below 10,000 euros. Production at this selling price - especially for an RC system - was unimaginable to me. In addition, it is hard to find any reference images taken with these instruments on the Internet, in comparison European-made RCs and PlaneWave telescopes have many international references.

Does that Setup have any disadvantages? Little after almost 4 years of operation:

- the 17" Planewave has an open tube in comparsion to the 12.5 inch and the black "Spantex" cloth against scattering light is often "willing" and shifts easily above the main mirror that is quickly partially obstructed.

- main disadvantage is in my eyes the very short focus travel of the 3.5" electrical Hendrick focuser of just 32mm, but otherwise it works very decently.

If, as in our case, you work with different eyepieces, zenith prisms and/or cameras, M68 spacers often have to be inserted or removed to reach focus. At some point we have written a table with accessories and the corresponding M68 spacers, so you can quickly check for correct distances of any accessories.

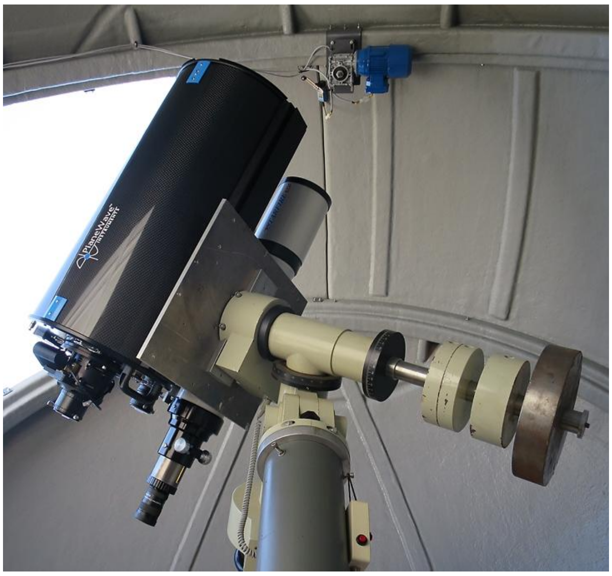
And today - end of 2017 - after more than 4 years of use, the telescope still runs perpectly and without any problems. Visual observations at magnifications of about 70x of astronomical southern highlights, e.g. M8, M17 or Omega Centauri under the dark and crystal clear Namibian sky are truly breathtaking. The 17 inch model shows the objects - unfortunately only in shades of gray - because the 430mm aperture is not enough for slight shades of color but at brigthness and extension someone only knows from long exposured photos.

Photographically, the Planewave Astrograph together with the GTO-1600 is for me a workhorse. I may come to Rooisand once or twice a year just only for a few days, I plug in a camera, and shoot images right away. At the following URL, you can find a small collection of images taken since 2013 with the 17 inch and both refractors. There, your customers can convince themselves of the high quality of PlaneWave imaging.

http://www.rooisand.com/observatory/deep-sky/deepsky-htm/planewave-01_e.htm

And despite of the high obstruction of just under 25% of the secondary mirror (of area primary mirror), lunar and planetary observations can be performed - both visually and photographically. Reference images of the moon and planets can be found here.

http://www.rooisand.com/observatory/deep-sky/deepsky-htm/planewave-01_e.htm#mond



P.S. - by the way, the 3.2m Baader dome has been running now for 13 years without any problems and trouble.

P.P.S. - the tests with the 12.5 inch PlaneWave convinced me so much that I took it over and purchase the scope. It is now in my private observatory, also in Namibia, mounted in parallel to a 130 Astro Physics EDFS and a small Pentax 75 on an ALT 6ADN mount, see image left.

Dipl.-Ing. Wolfgang Paech/December 2017