

Modification of a Coronado PST solar scope

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Hello,

Below you will find a documentation about my experiments with a modified Coronado PST solar scope. I had multiple targets:

- to make the PST a goto scope
- to increase its capabilities to resolve details of the sun
- to effectively use a binoviewer with the PST.

Here is a list of the steps / experiments I will explain in the course of this document:

- 1.) PST adapted to a Celestron N5i mount
- 2.) PST adapted to an 80/480mm apochromatic refractor in William Optics tube assembly
- 3.) PST adapted to an 80/480mm apochromatic refractor in the APM tube assembly
- 4.) PST adapted to 80/480mm apochromatic refractor in APM tube assembly plus bino-viewer
- 5.) The modified PST attached to an 80/910mm achromatic refractor from Vixen
- 6.) Using 2 blockfilters placed behind the binoviewer which is attached to the modified PST and a 80/910mm achromatic refractor from Vixen

Please note, that this is not a step-by-step instruction but rather a story of what I tried and found out. You can assume that the best results were achieved with the last setup though.

1.) PST adapted to a Celestron N5i mount

I will start with some pictures of the PST before the modification. I attached it to my N5i mount which provides excellent tracking and thus allows relaxed observations of the sun. I had a very good experience with Celestron's "solar system alignment" feature. I used a mechanical adapter system known as "Ray's brackets" developed and sold in the USA by Ray Cooper and Frank Dilatush (www.buyastrostuff.com). The brackets allow a very compact setup and the OTA can be attached and removed from the mount in seconds.



PST mounted on Ray's bracket to attach it easily to an N5i mount, the sun shield is homebrew



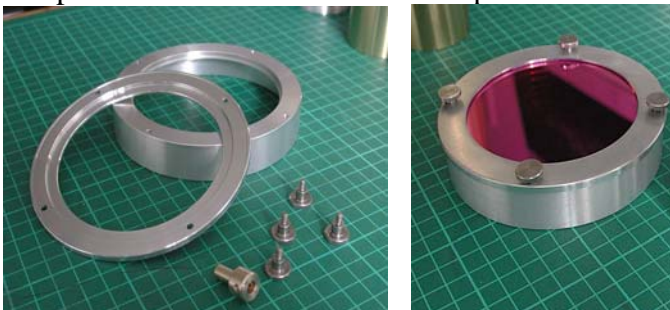
Here you can see the PST attached to the N5i mount and outside on the tripod

2.) PST adapted to an 80/480mm apochromatic refractor in William Optics tube assembly

My first plan was to replace the 40mm OTA of the PST by a 80mm refractor. Thus I would have 4 times the light gathering capability but more important a much higher resolution. I knew that there was no real need to use an apochromatic refractor as the h-alpha light is monochromatic. Nevertheless as I already owned a Williams Optics 80/480mm APO refractor I wanted to make use of it. This APO was already adapted to my N5i mount using Ray's brackets providing a very portable setup which I wanted to use also for the modified PST. Thus I could extend the usage of this portable setup also for daytime use.

Please refer to how to disassemble the PST scope to the description in section 3. The most important add-on part is a Baader Cool-Energy Rejection Filter (C-ERF) which needs to be placed in front of the APO lens to keep the UV and IR light out of the setup to protect the eyes and avoid heating of the setup. Of course I needed in addition some filter holders and adapters and I was happy that my friend Robert Pudlo volunteered to provide me the necessary help. The next 3 pictures show the new parts :

- 1.) Adapter for the Baader C-ERF. Left pieces disassembled, right assembled incl. C-ERF



- 2.) Adapter 2" to Etalon filter. It fits into a 2" eyepiece clamp and thus has an outside diameter of 2". On the outside of this cylinder a thread of M50x1 (metric, 50mm diameter, 1mm pitch, thread is 6mm long) has to be cut. In the picture below the cylinder is newly machined and the inside is not yet blacked which was done next.



- 3.) The new setup now includes the following components from left to right: Adapter 2" to Etalon, Etalon filter, Adapter Etalon to T2 zenith mirror, Baader T2 zenith mirror, T2 ring dovetail clamp, Adapter ring dovetail clamp to PST eyepiece holder, PST eyepiece holder.



Now it was time to attach the new parts to my William Optics 80mm APO refractor on the N5i mount and give it a try. With this new setup which had replaced the PST body I could get the setup to focus but learned quickly, that the distance between the Etalon filter and the block filter is critical and must not be too short. When increasing the light path the pictures improved but finally the Williams Optics focuser did not provide enough back focus to achieve optimum results.

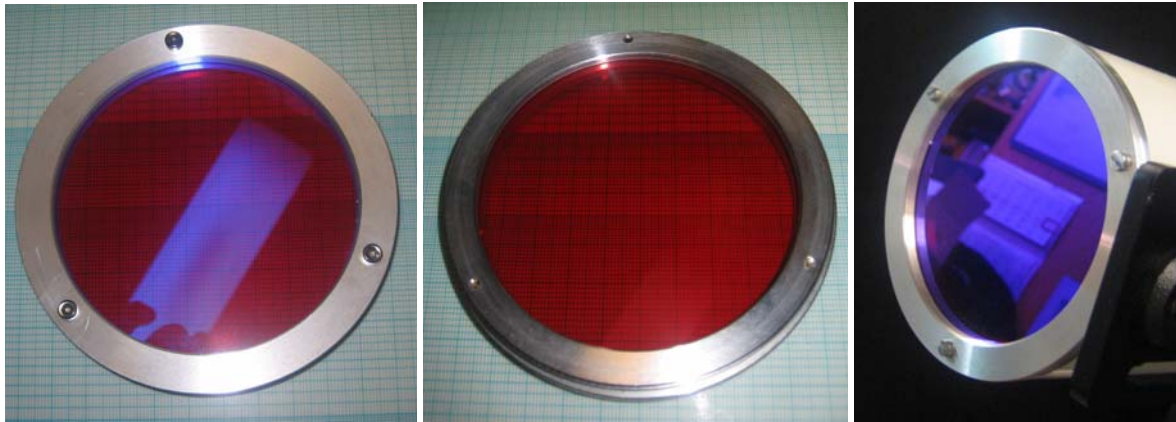


Therefore I decided to replace the William Optics OTA by an OTA from APM, which is explained in the next section.

3.) PST adapted to an 80/480mm apochromatic refractor in the APM tube assembly

The optics of the William Optics APO and of the APM APO are identical. Both use the excellent TMB 80/480 APO lenses but the OTA from APM is more flexible as part of it can be removed to achieve more back focus. Normally this is used to be able to attach a binoviewer. I expected that this would solve my back-focus problem. Meanwhile I had learned from postings on the internet that apparently an important design criteria of the PST system was an f-ratio of f/10. Nevertheless I decided to give my f/6 APO a try.

Unfortunately the filter holder for the Williams Optics OTA did not fit the APM TMB APO and thus I needed a new filter holder for the Baader cool energy rejection filter (C-ERF). The next 3 pictures show the new filter holder which can be screwed into the dew shield of the APM TMB APO as seen on the picture at the very right.



Let me show you now, how to disassemble the original PST to get access to the various parts. Firstly the brass tube has to be screwed off. This often needs some soft force as it is secured with some loctite screw securing glue. If you cannot remove it easily, which is most likely, a little trick might help: I used a tool which is normally used to unscrew old oil filters of cars. You can clamp the rectangular body of the PST, put the tool around the brass tube and then unscrew it without creating any scratches or other damages to the brass tube..



Next please find pictures of the sequence of disassembly of the brass tube:







This new setup enabled me to achieve focus in multiple configurations. I was curious to go back to the setup already described in section 2.) in order to explore and possibly optimize the light path between the Etalon filter and the block filter. Therefore I replaced the PST body by some spacing rings, a Baader T2 diagonal and the block filter. Thanks to the T2 rings between the Etalon filter and the diagonal this setup is very versatile and can be adapted to get in focus with various eyepieces.





My first impressions while observing the sun were an improvement in contrast versus the use of the PST body. However unwanted reflections were also much more visible and thus further investigations are needed.

As the reflections are much lower using the PST in its original body and my time for testing was recently very limited I decided to use the setup with the PST body for the time being.

4.) PST adapted to 80/480mm apochromatic refractor in APM tube assembly plus bino-viewer

I was curious about how my Zeiss/Baader bino-viewer would perform in the setup and finally had the time to test it. To get into focus I placed the optical element of the Baader VIP Barlow in front of the bino-viewer and in addition had to remove the extension tube between the PST body and the eyepiece holder (which also holds the block-filter). The next picture shows how to do this. If the tube is too tight you may want to apply the same trick which we had already used to remove the brass tube.

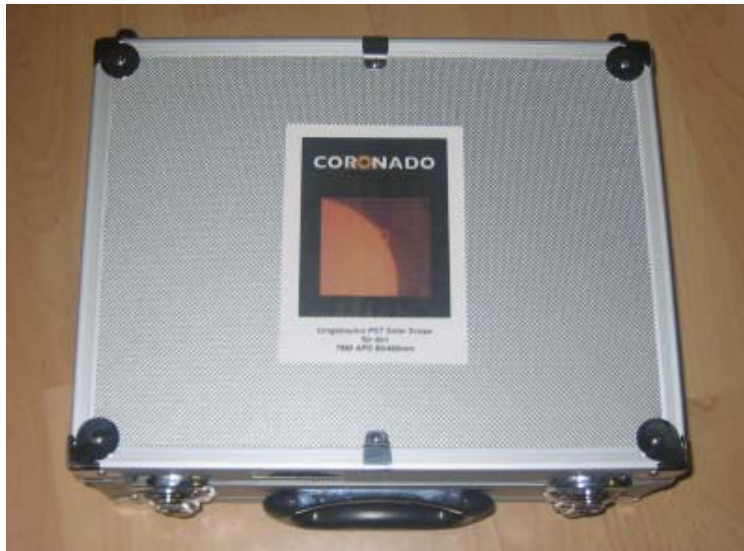


This setup performs very well in combination with the following pairs of eyepieces: 15mm Baader eudiascopic, 20mm Baader eudiascopic, 25mm TAL Ploessl, 30mm Baader eudiascopic. These eyepiece pairs also mark the useful range. Using an eyepiece of less than 15mm focal length makes the sun get very dark and fuzzy as the magnification gets too high. Using a lower power than the 30mm eyepiece makes the image of the sun get too small and bright. Watching the sun with both eyes is spectacular, I guess that I will never go back to monocular observations. Here are pictures of the setup with the bino-viewer in place:



5.) A proper way to store the modified PST

I thought it would be a good idea to store the modified PST body and the C-ERF filter in its adapter in a proper box to protect it from humidity and mechanical damage. I bought an aluminium box and created cut-outs in a foam block.



5.) The modified PST attached to an 80/910mm achromatic refractor from Vixen

As I mentioned before, I read that the PST should only reveal its optimum performance in an f/10 system. Therefore I decided to try this too and bought second hand an old Fraunhofer refractor from Vixen. The achromatic lens has a diameter of 80mm and a focal length of 910 mm.

At first I attached the C-ERF in front of the lens still using the adapter for the APM APO by fixing it with some tape. As the Vixen refractor has a 2" eyepiece adapter I could simply attach the modified PST body (as introduced in the section before) to the refractor. You can see the setup in the next 2 pictures below.

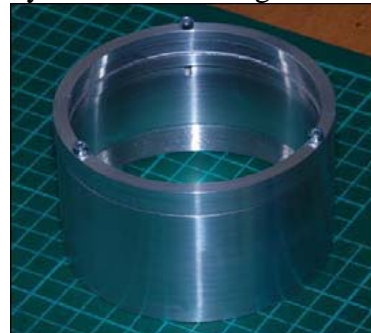


Unfortunately I had to recognize that I could not reach focus. There were 2 solutions: either shorten the optical tube or change the adjustable focuser at the end of the tube. I decided to take the second path and replaced the complete focuser assembly by a wooden adapter to which I had attached a SC-T2-Adapter and a 2" Eyepiece holder. This setup shortened the optical path enough to then reach focus. You can see this setup in the next 2 pictures.

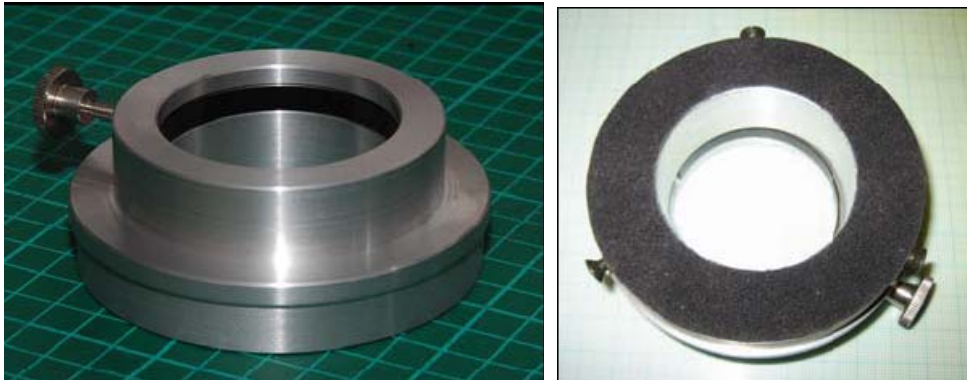


Focusing was now achieved with the built in focuser in the PST body. This turned out to be sufficient. As I now had a proof of concept the next step was to turn this prototype into a permanent setup and once more my friend Robert Pudlo was kind enough to help me. As can be seen in the next pictures he machined 2 new pieces for me:

- a new holder for the C-ERF, which can be screwed on the OTA instead of the stock dew shield. Thus the setup can be easily converted for night-time and day-time use.



- A very short adapter to clamp a 2" nosepiece into the OTA of the refractor.



Next all parts were painted with ultra black paint to avoid any reflections. I also painted the inside of the C-ERF holder and put some special DC-fix foil (similar to black velvet) inside the PST body. All these measures yielded in a very crisp picture with very little residual reflections.

The few reflections left are minor and I have not yet found the time to analyze them for potential elimination. It is possible that they are a characteristic of the PST system and became more obvious when I changed the system to a higher aperture yielding a much brighter image with greater resolution.

Did you notice the once thing which was still missing ? Right, the bino-viewer was not yet back in place !

To get the system to focus including the bino-viewer a little trick which I had used before needed to be applied: a Barlow lens is needed to reduce the efficient length of the optical path and thus allow focusing. I bought a rather simple Barlow from Teleskop Service Ransburg in Germany, the part is called „TSB2x“. This Barlow has a nice feature as the optical element can be unscrewed very easily from the rest of the body and screwed to a 1.25" to T2 adapter from Baader Planetarium. The part number is „BA 2458105“. This combination is now complemented with the Zeiss/Baader quick-release system and this results in a very versatile system with minimum light path. It is clamped before the bino-viewer in the eyepiece-holder of the PST body.



TSB2x barlow



BA 2458105 1.25" to T2



Zeiss/Baader quick release

Well, I guess this is the latest status of my system. Following you can find pictures of the setup attached to my Celestron N11GPS. It is no longer as portable as the original PST but nevertheless in my opinion a very interesting way to get to a quite capable h-alpha telescope. To tell you the full truth: meanwhile I bought a second PST which I use for portable

observations and is attached to a Celestron SLT mount. I got quite hooked to watching the sun in h-alpha.



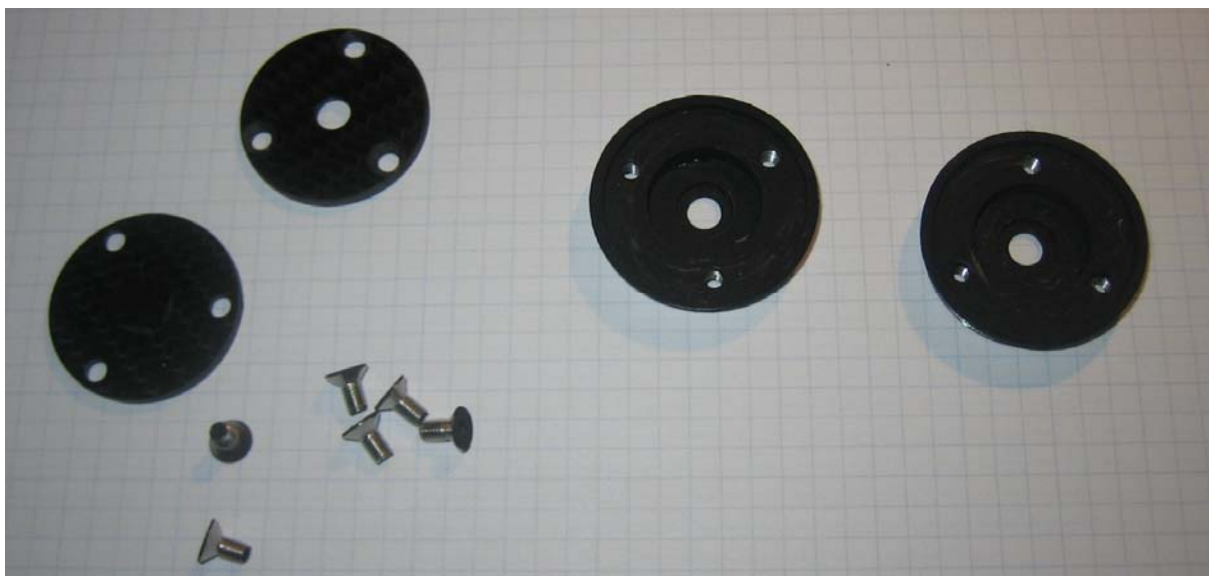
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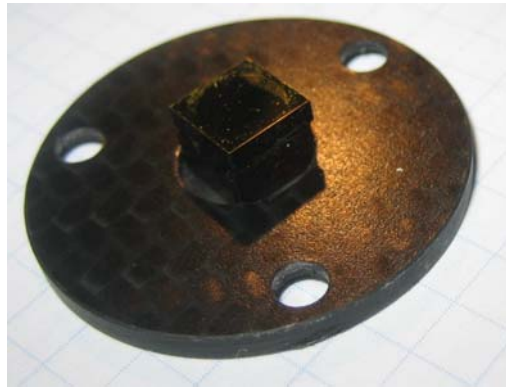
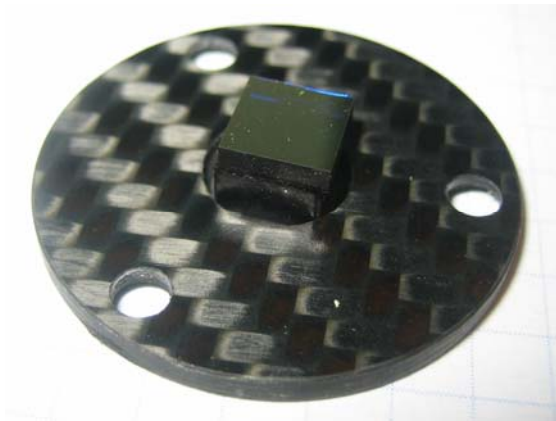
In spite of the fact that the modified PST at the Vixen refractor worked quite nicely the next step for me was to try something completely different:

My previous setup allowed me to focus with a binoviewer only, if I used a Barlow element between the PST body and the binoviewer. This Barlow increased the focal length and thus also the magnification while reducing the field of view. Also, remembering the interim results documented in section 2.), I still wondered what the optical quality of the pentaprism was.

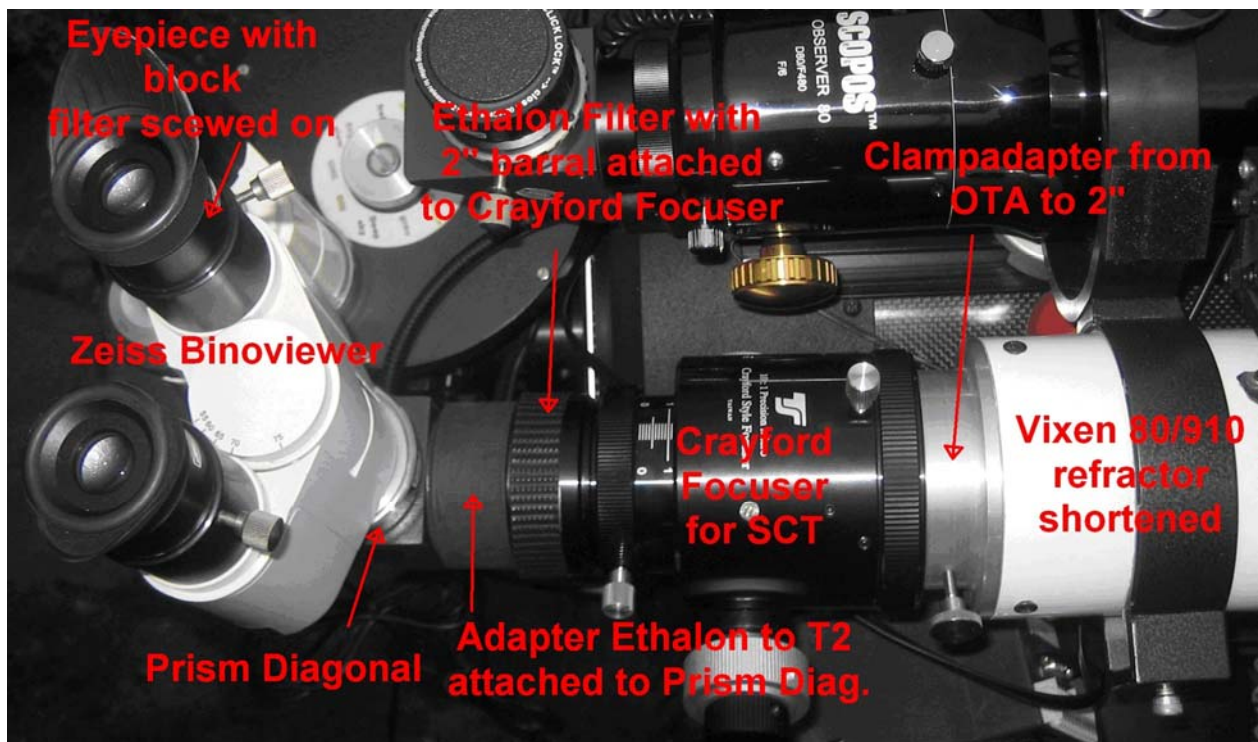
Thefore I decided to replace the PST body with the penta-prisma and use instead the light path of the binoviewer attached to a prism diagonal. This should result in about the same optical length / distance between the Ethalon filter and the block filter. As now the light is spiltted in the binoviewer and thus before the blockfilter I needed 2 blockfilters instead of one. I was able to buy a second 5mm blockfilter second hand for a quite reasonable price. As some people replace the stock 5mm blockfilter of the PST by a 10mm blockfilter to increase the field of view there is always a good chance to get such a 5mm blockfilter second hand.

In order to not have to modify my binoviewer I decided to attach the two 5mm blockfilter to the respective eyepieces by new custom made holders which can be threaded into the filter thread of the eyepiece. When changing the eyepieces I simply screw off the blockfilters and screw them into the barrel of the other eyepieces. This procedure is quick and works quite well. Here are some pictures which show the holders which are made of aluminium and carbon. Make sure to clamp the 5mm blockfilters carefully and not to stress them excessively.





As I removed the PST body with its embedded focuser I also had to add a focuser to my setup. I am using a SC Crayford focuser in front of the Ethalon filter. Furthermore I added a high quality prism from Baader Planetarium between the Ethalon and the Baader/Zeiss binoviewer. Here is a picture of the setup including comments:



Finally below you will find some pictures of my complete present setup.





I am extremely happy with this setup. Watching the sun with both eyes is a real treat for me. I am very happy with the quality of the pictures and especially of the 3D effects. The details I can see simultaneously on the limb of the sun and on its surface are astonishing. I think replacing the stock pentaprism by a high quality Baader prism diagonal improved the quality of the optical setup significantly.

However depending on the orientation of the Ethalonfilter in the optical train I still get some ghost images which usually results in not getting a completely dark background sky beside the sun. Furthermore the field of view of my setup does not allow me to see the complete sun at once. Using a 10mm Baader eudiascopic eyepiece about 80% of its field of view are properly illuminated.

I am always happy to receive feedback, comments or questions. Please send them to the Email address below.

Best regards

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