A Different Approach to Designing Astronomical Binoculars

Important Design Aspects for DIY Astronomical Binoculars

- Ease of collimation of each optical path
- Ease of changing the inter pupil distance from ~57mm to ~75 mm
- Ease of merging the left and right images so that the brain perceives one image
- Ease of focusing each eyepiece
- Ease of observing the sky with minimal neck strain
- Portability of the total system, i.e. the optical assembly, the mount and observing stool, so that transport to a dark sky site is not too burdensome

3D printing enables a low cost conversion of standard 7X50 or 10X50 Binoculars
To Right Angle Viewing making them much more comfortable to use for astronomy

Objective lenses unscrewed from a pair of Celstron Cometron binoculars

3D Printed Parts that enable the two Objective lenses to be screwed in and two Amici 90 degree erecting prisms to be attached. The Inter Pupillary Distance is adjustable from 58mm to 75mm

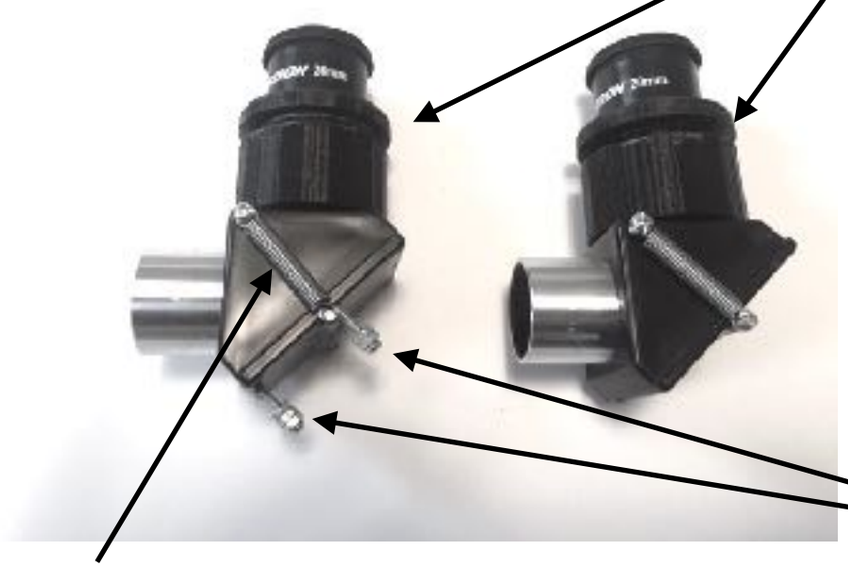
Objectives screwed into 3D Printed Body

Eyepieces from the original binoculars can be used (with 3D printed adapters) or any other suitable 1.25” eye pieces.

IPD Adjustment knob

If preferred 90 degree mirror cells can be used Instead of the Amici prisms which are easily modified to allow for slight x-y adjustments of the 45 degree mirror

3D Printed Helical Focusers on each eye piece



X-Y Adjustment screws that enable the mirror to be slightly tilted to align the optical axis of each side of the binocular and to merge both of the images.

Spring

Cell Phone Holder can be 3D printed to make it easy to use Astronomy Apps

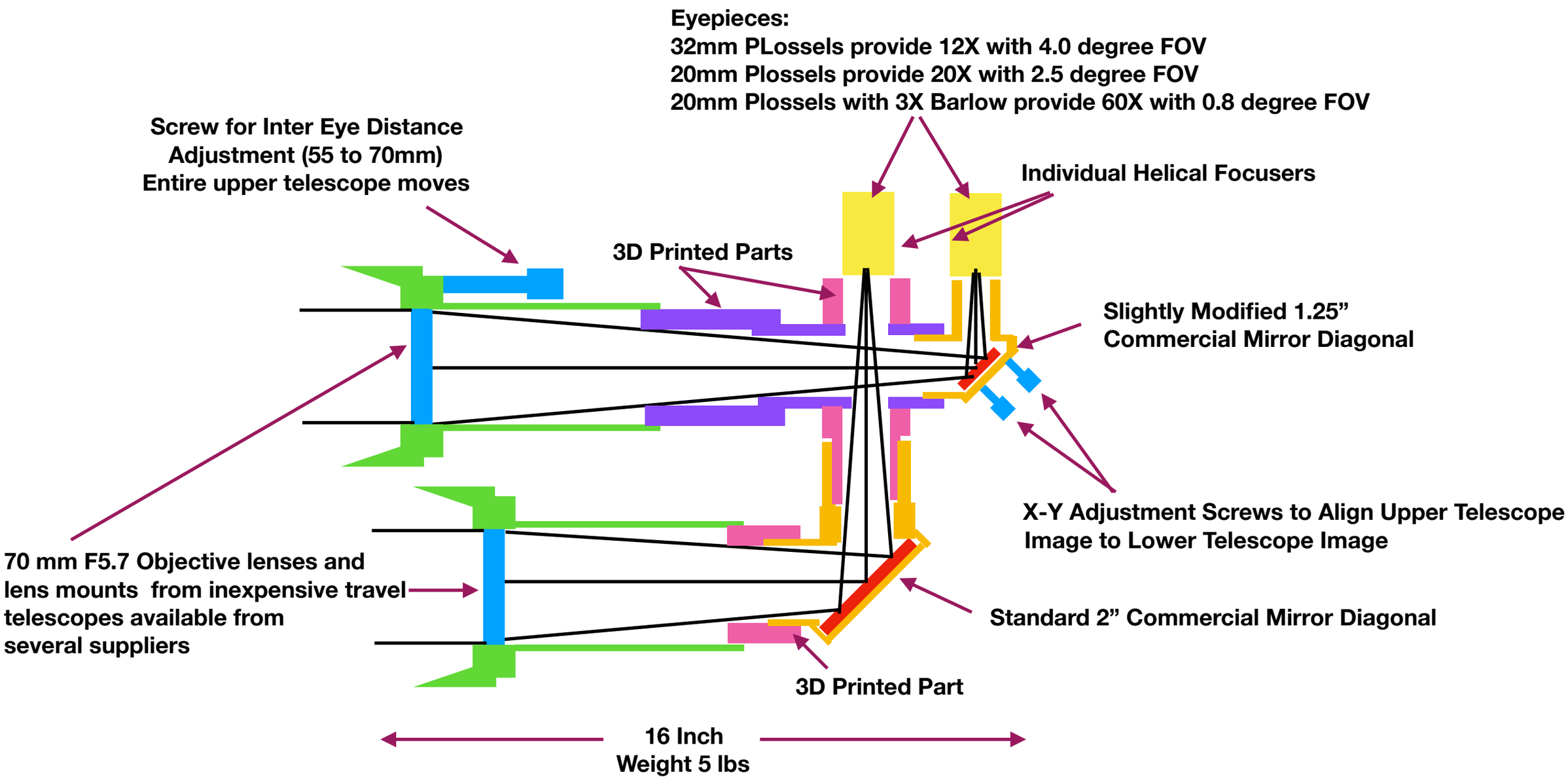
Light weight 7X50 binoculars with right angle eyepieces are very comfortable to use either sitting or standing. Light weight enables an inexpensive tripod to provide good stability

Converting two 70mm F 5.7 Travel Scopes into a light (5 lbs), comfortable and portable set of astronomical binoculars

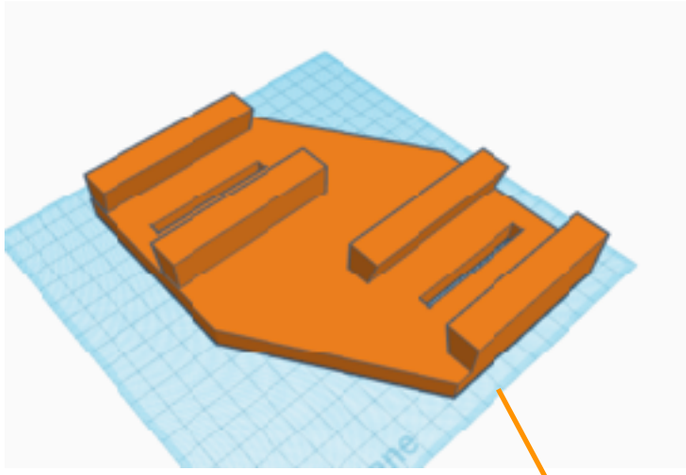
Purchase two 70mm F 5.7 Travel Scopes

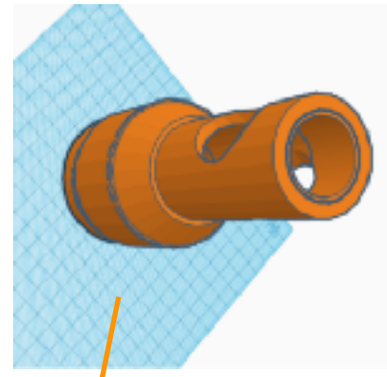
Keep the 20mm eyepieces and the 70mm Objective Lenses
(Also keep the 45 degree erecting prisms for the 7X 50 Binocular conversion)

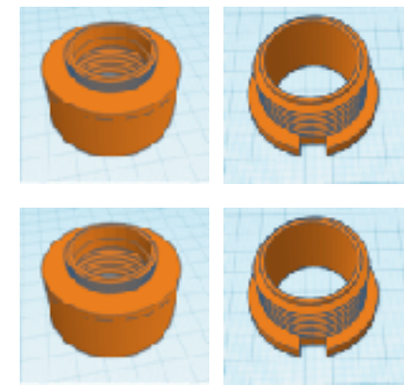
CrossLight Optics for 12 to 60 X 70 Refracting Astronomical Binoculars

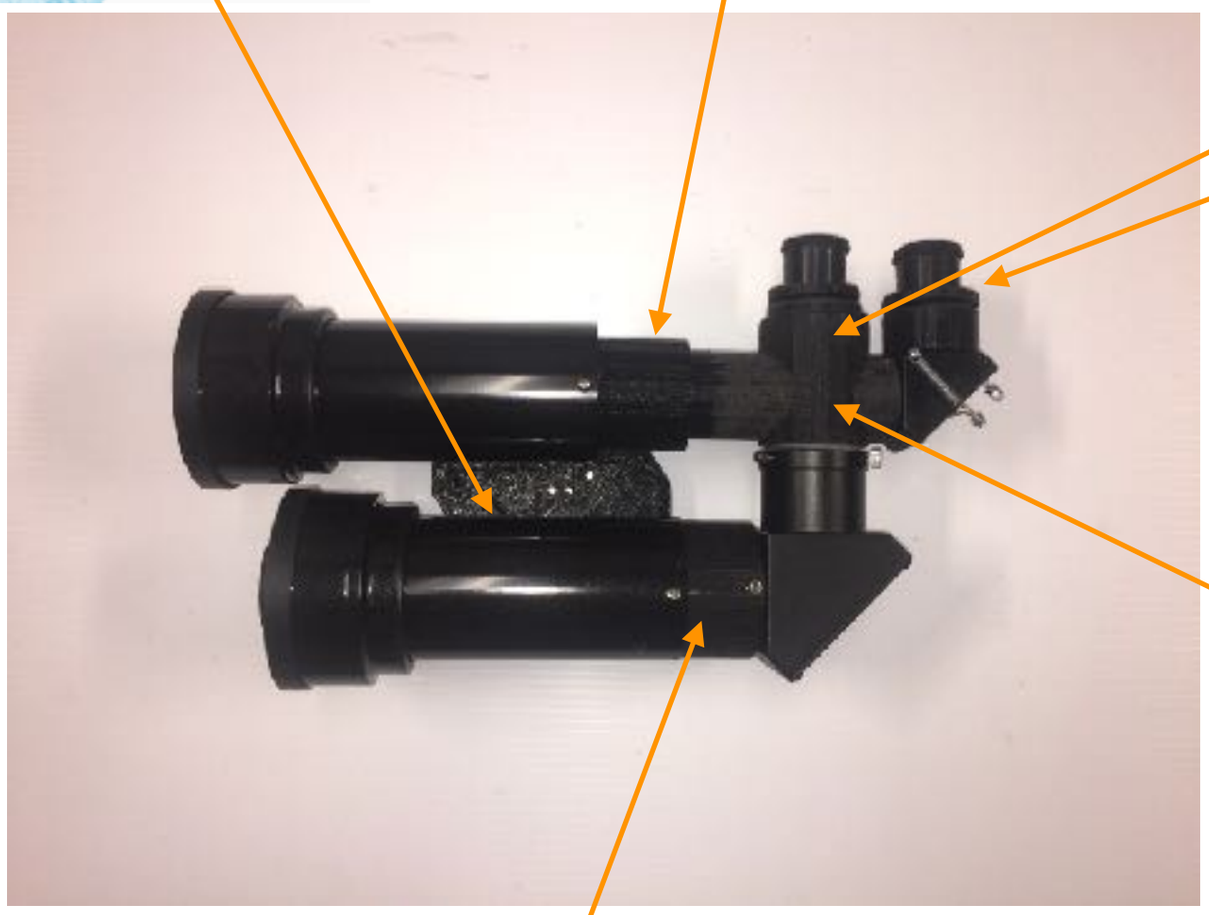


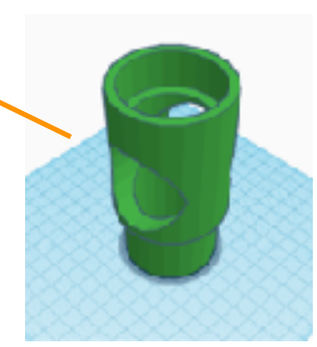
3D Printed Parts to Combine two 70mm F5.7 Travel Scopes

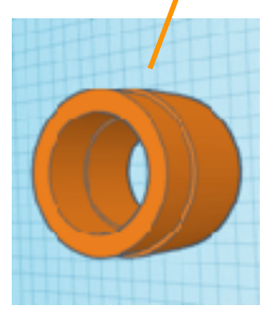












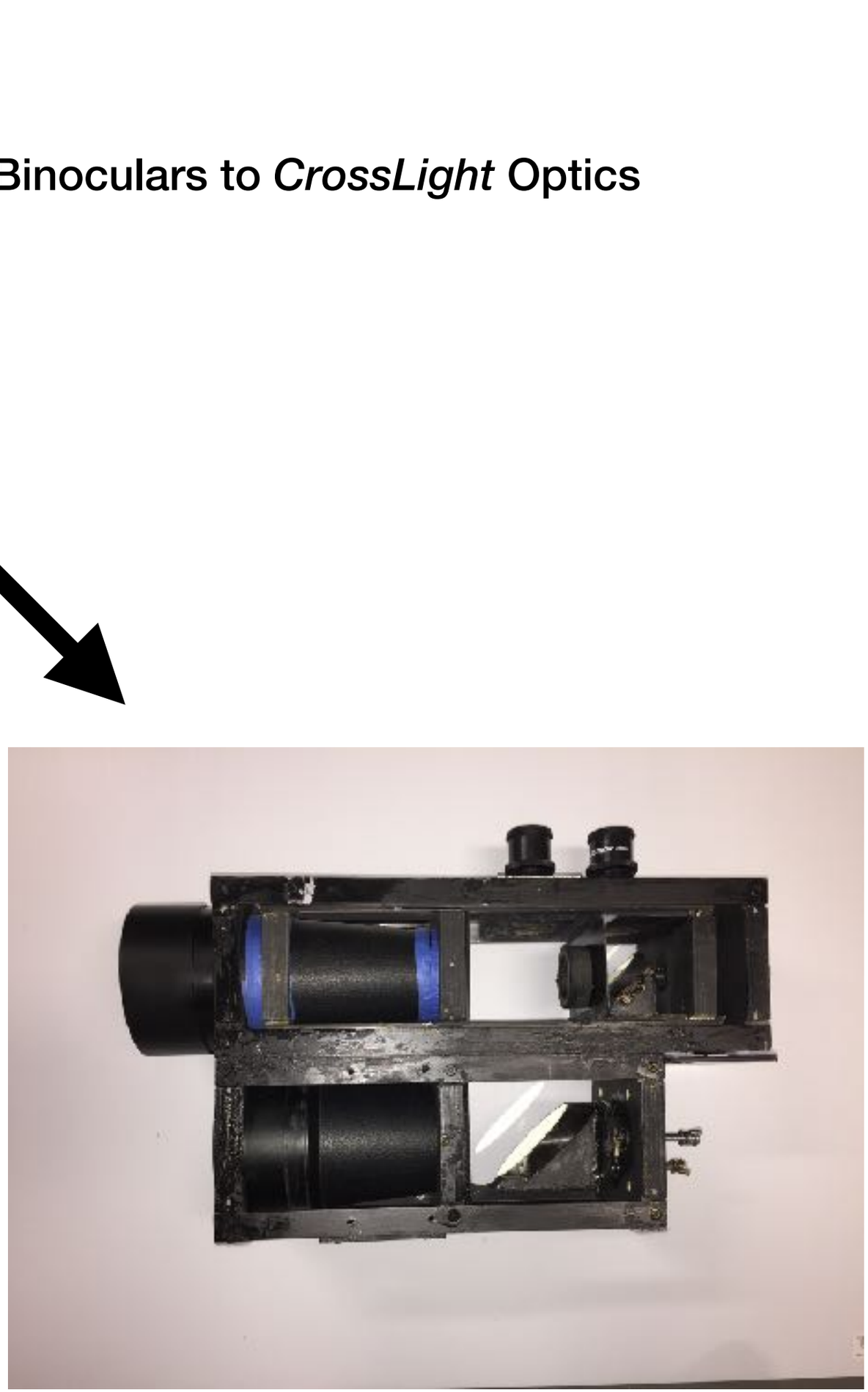
Buy an inexpensive 1.25” mirror diagonal ($30) and an inexpensive 2” mirror diagonal ($70) and Assemble with the 3D Printed parts

A light weight carbon fiber tripod with a ball head enables Smooth control in Altitude and Azimuth due to the light weight (~5 pounds) of the 20X70 Binoculars

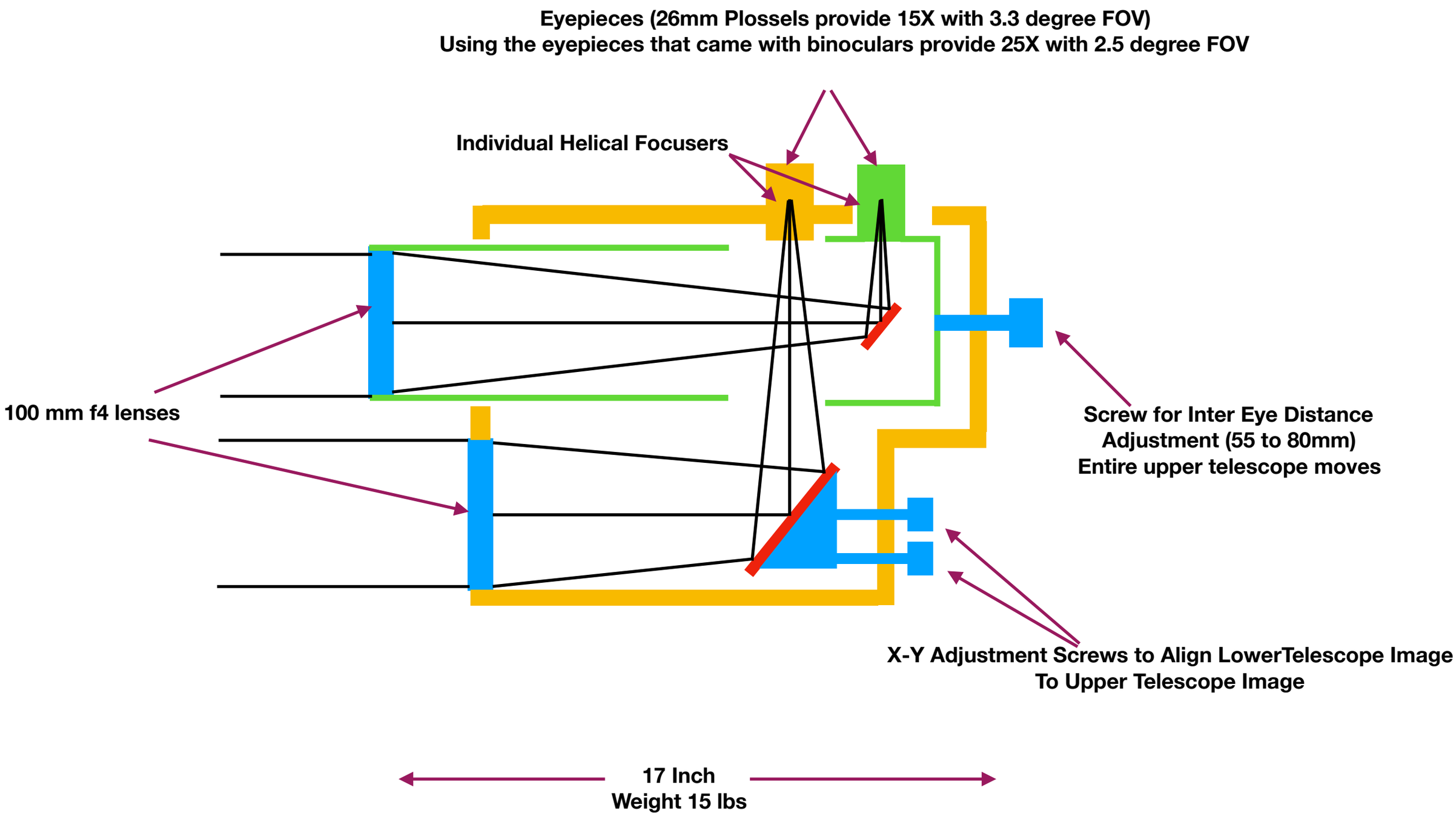
Using the Light Weight 20X70 *CrossLight Optics* Astronomical Binoculars

The 20X70mm Binoculars still fit in the original travel scope back pack
And comfortably fit in a carry-on bag with the light weight tripod and folding seat

Converting a pair of 25X100 Binoculars to *CrossLight* Optics



CrossLight Optics for 15-25 X 100 Refracting Astronomical Binoculars



100mm CrossLight Optics Binoculars fit in carry on luggage with Tripod and stool

The quest for finding the best overall design for *CrossLight Optics* 6” Reflecting Binoculars

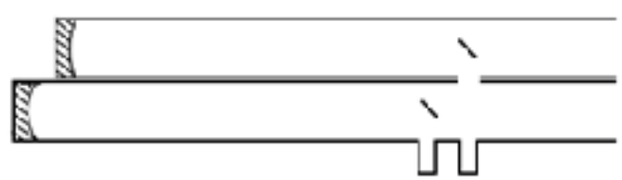
Texas Star Party 1990:

Photo From Sky and Telescope January 1991

Advantages:
Motor for changing the inter pupillary distance
Motor for adjusting convergence of the two images

Disadvantages:
6” PVC pipes and 6” couplers, which are heavy
Heavy Plywood frame and very robust Dobsonian mount
Weight of Binoculars ~35 pounds and mount 25 pounds
Non-Dismantle able

A Binocular Idea of 1848 re-discovered……..



The author's rendition of a drawing by F. D. McHugh, after Capt. M. A. Airslie

Fig. 1.26 The optical (speculum mirrors) and mechanical arrangement (tube assembly) for a proposed binocular telescope described by the elder Herschel. (Image Credit: The Author)

A dual Newtonian telescope was proposed by M. Vallack, and described by John Herschel in "The Telescope" and which was published in 1851. (**Fig. 1.26**) It's interesting to note for some unknown reasons, for a binocular telescope with such a promising design…especially for visual observing, why it had not been built at that time. Vallack's design placed two Newtonian optical tube assemblies adjacent to each

THE
LONDON, EDINBURGH AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

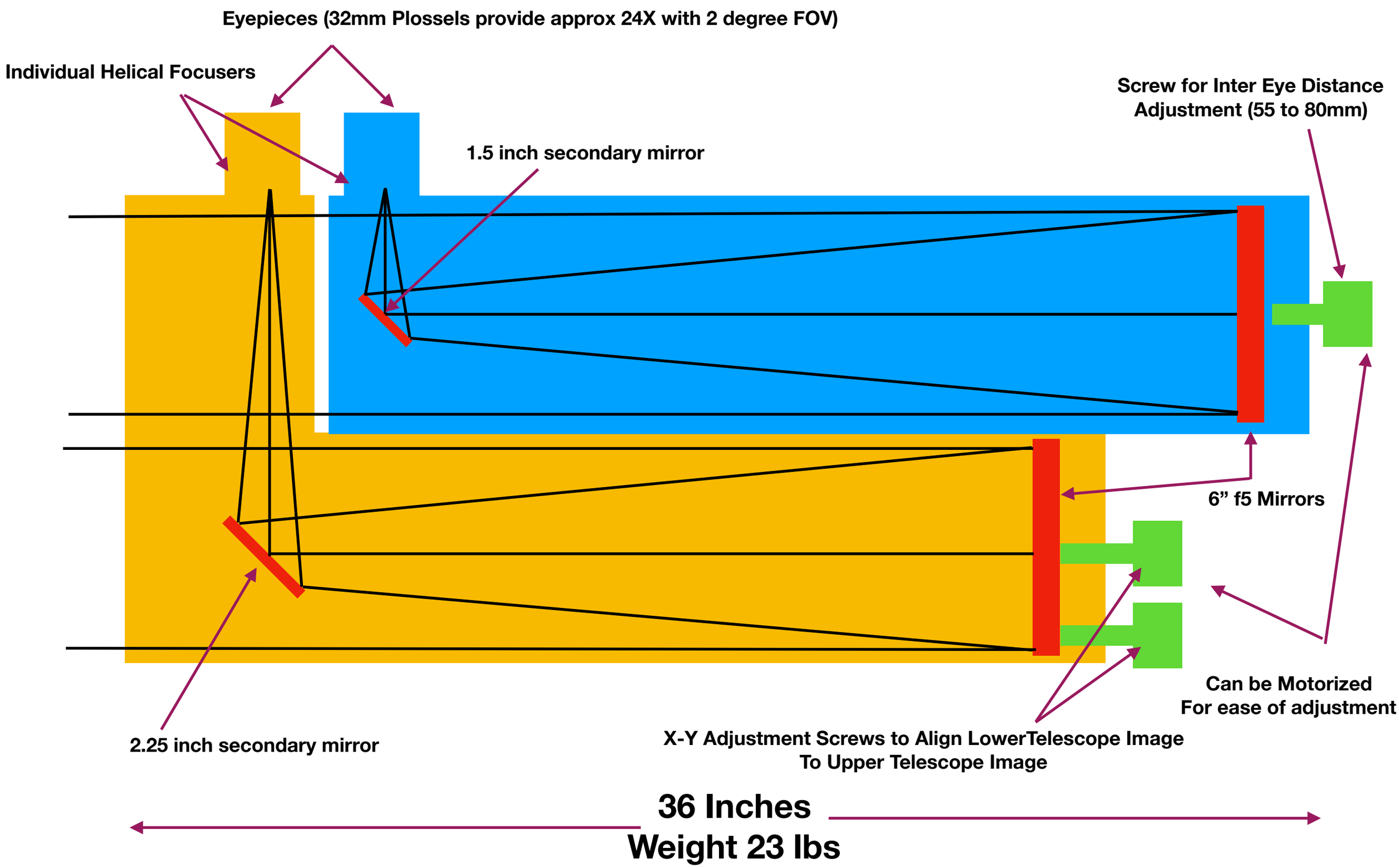
[THIRD SERIES.]

AUGUST 1848.

In a letter to Captain Smyth, Mr. Vallack suggests the utility of adopting the binocular construction in astronomical telescopes, and especially in Newtonian reflectors. He has himself fitted up two mirrors on this principle, and finds a considerable superiority in the pair over a single mirror. Mr. Vallack, if we understand him correctly, proposes the following arrangement. The specula are fixed in parallel tubes, and by raising the further mirror higher up in its tube, and bringing the small mirror or prism nearer to the mirror, an image is formed considerably in advance of the tube, which may be brought so near the image formed by the nearer mirror, that each may be viewed at the same time by its proper eye. The partition between the tubes and also the outer tube must be pierced, to let the rays of the more distant mirror pass out; by a little adjustment, the distance between the images may be made to suit different eyes.

Phil. Mag. S. 3. Vol. 33. No. 220. *Aug.* 1848. M

Non-Motorized and lighter Version of 6” f/5 *CrossLight Optics* Reflecting Binoculars

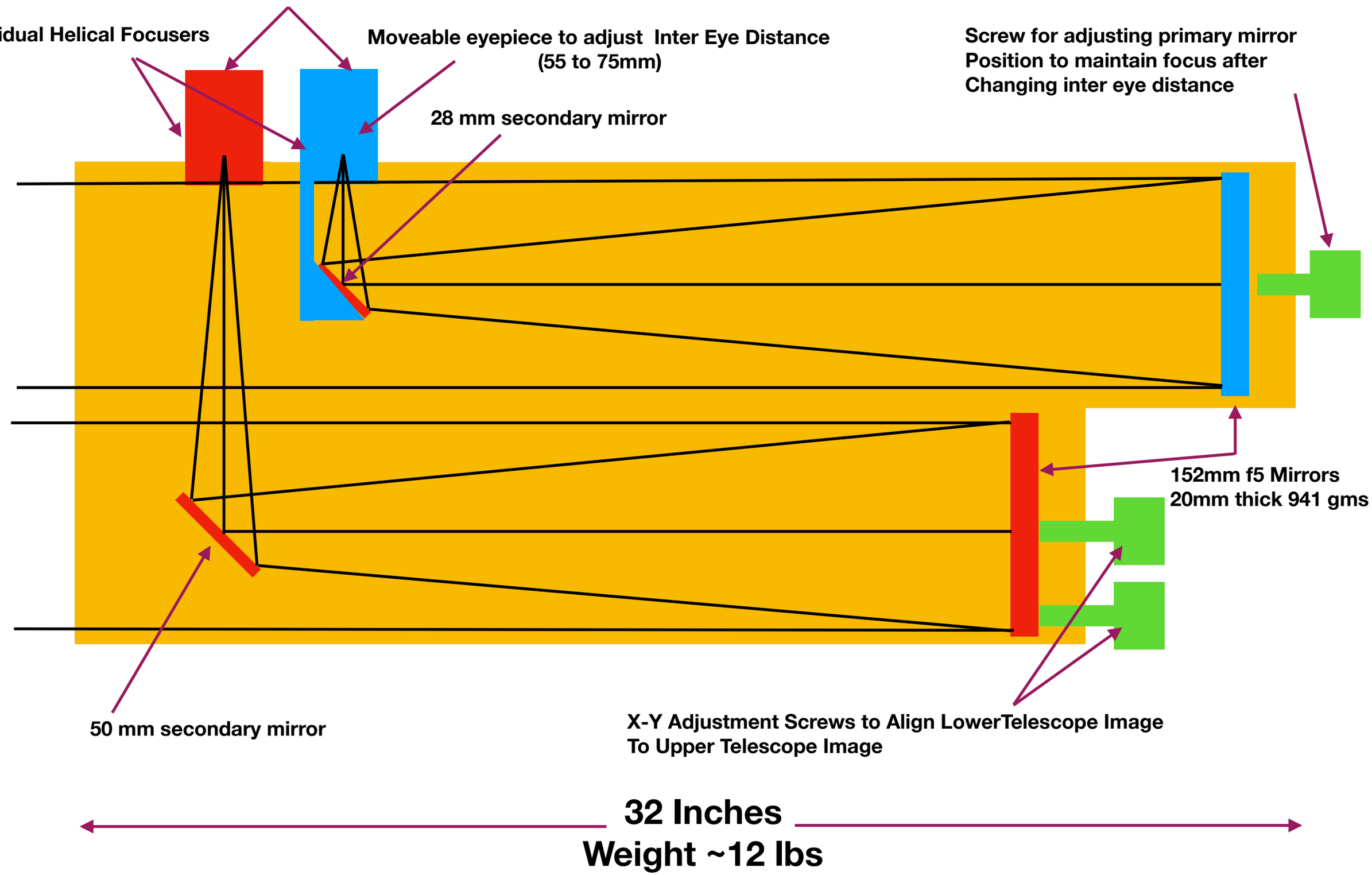


6” Reflecting Binoculars (23 pounds) non-dismantlable on solid non-dismantlable Dobsonian Mount (25 Pounds)
Upper telescope is fully mobile for easy adjustment of IPD

Ultra Light Weight 150mm F5 Reflecting *CrossLight Optics* Binoculars with most of the Mechanical parts made with a 3D Printer

Eyepieces (32mm Plossls provide approx 24X with 2 degree FOV)

(Can use the lower telescope with 32mm Plossl as 24X Finder scope and the upper with 3X Barlow and 10mm Plossl for viewing planets at 225X)

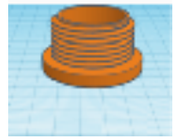


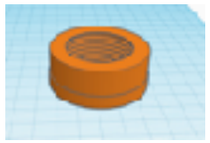
Basic Structure of 150mm Binoculars only weighs 10 pounds and is light enough to be mounted on a light weight photo-tripod. This set up provides adequate stability for low magnification (~24X)

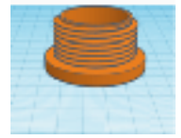
Ultra Light Weight (~12 pounds with light shield covers and eyepieces), 150mm Binoculars on light weight Dobsonian Alt-Azimuth Mount (~7 pounds) . This mount provides good stability even at high magnification.

3D Printed Parts for 150mm Binoculars

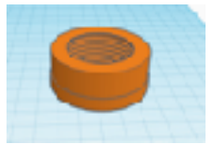
Lower Telescope Helical Focuser



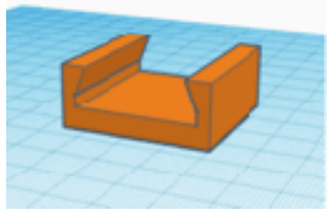




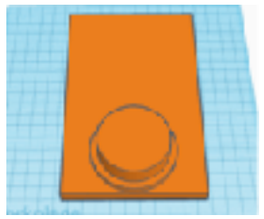
Upper Telescope Helical Focuser



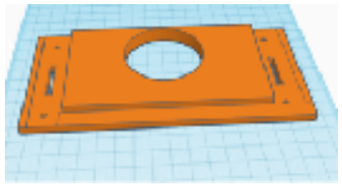
Red Dot Finder Base



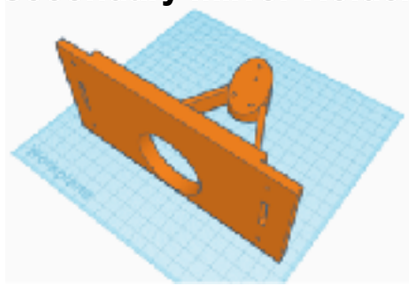
Left Side Bearing



Fixed Eyepiece Holder For lower telescope

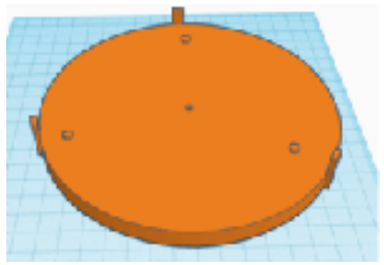


Sliding Eyepiece For Upper Telescope with Secondary Mirror Holder

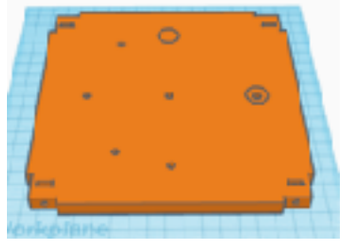


Handle Plate

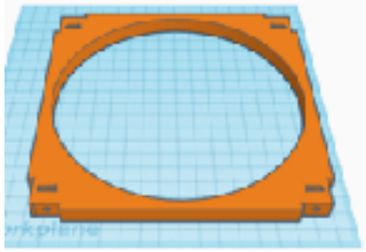
Upper Primary Mirror Holder



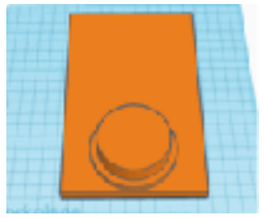
Upper Back Plate



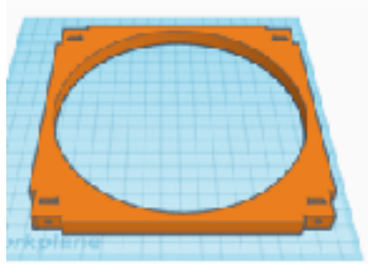
Upper Telescope Front Plate



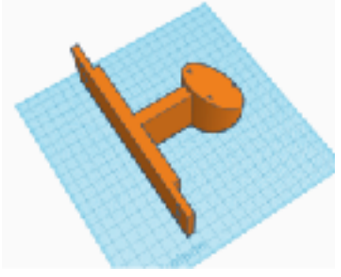
Right Side Bearing



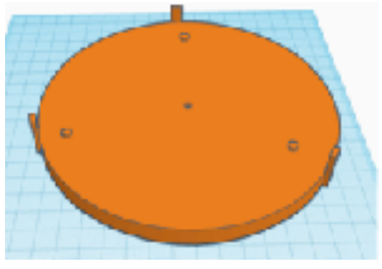
Lower Telescope Front Plate



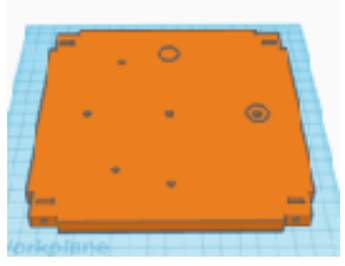
Lower Secondary Mirror Holder



Lower Primary Mirror Holder

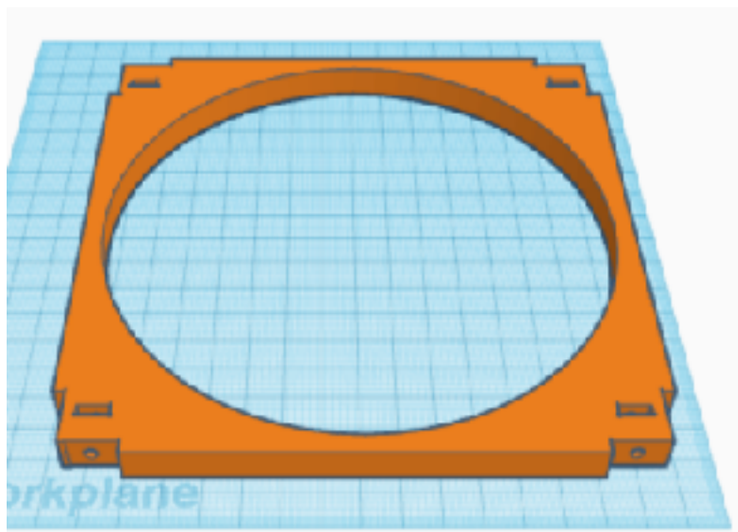


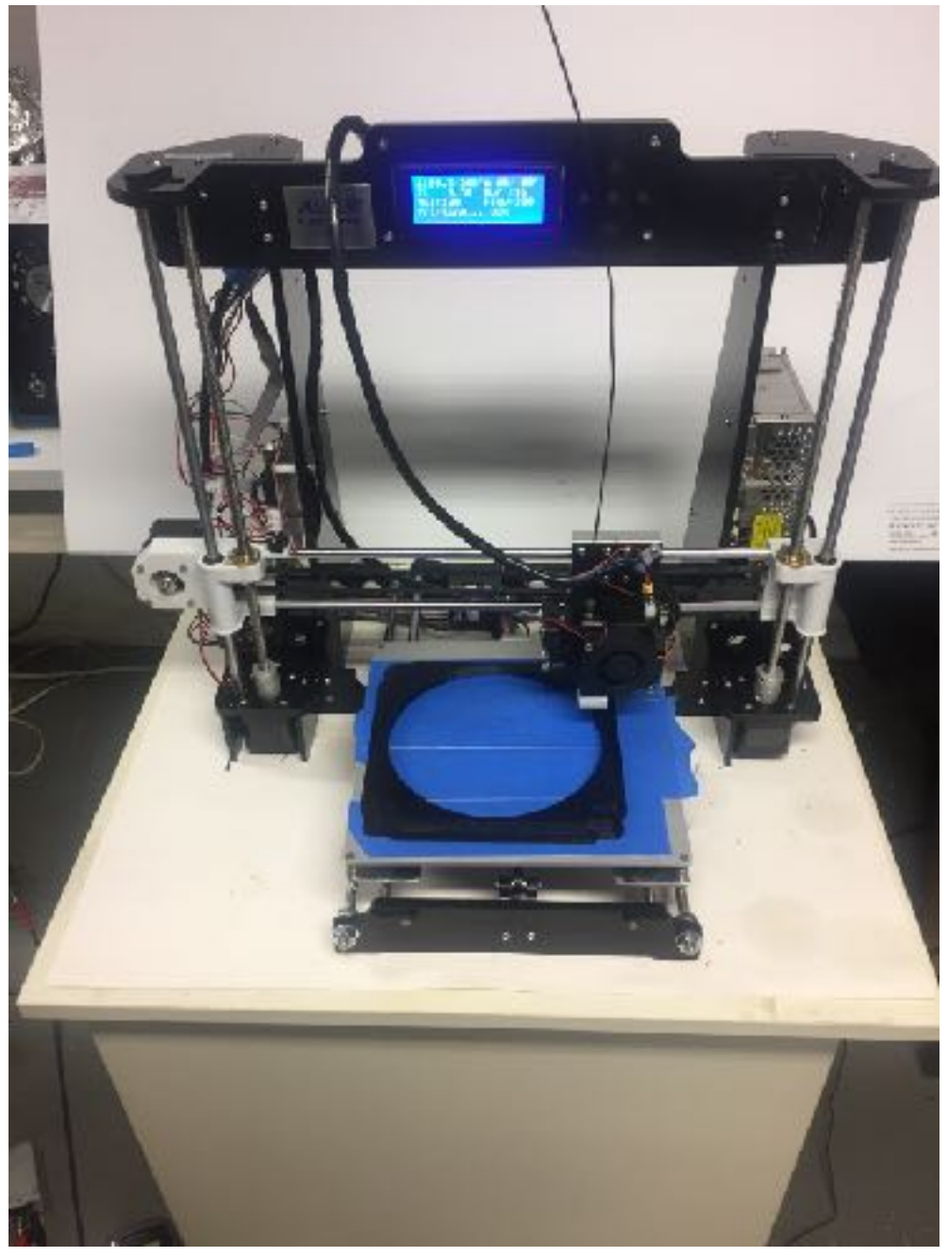
Lower Back Plate

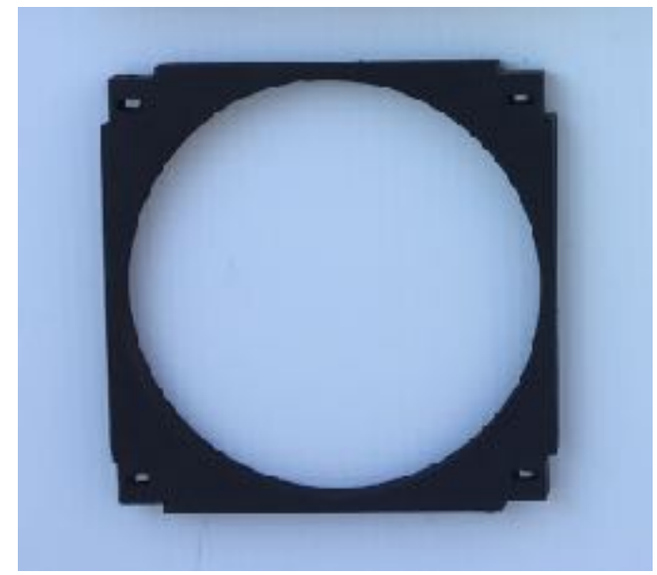


150mm mm Reflecting Binoculars can be broken down and transported as checked luggage

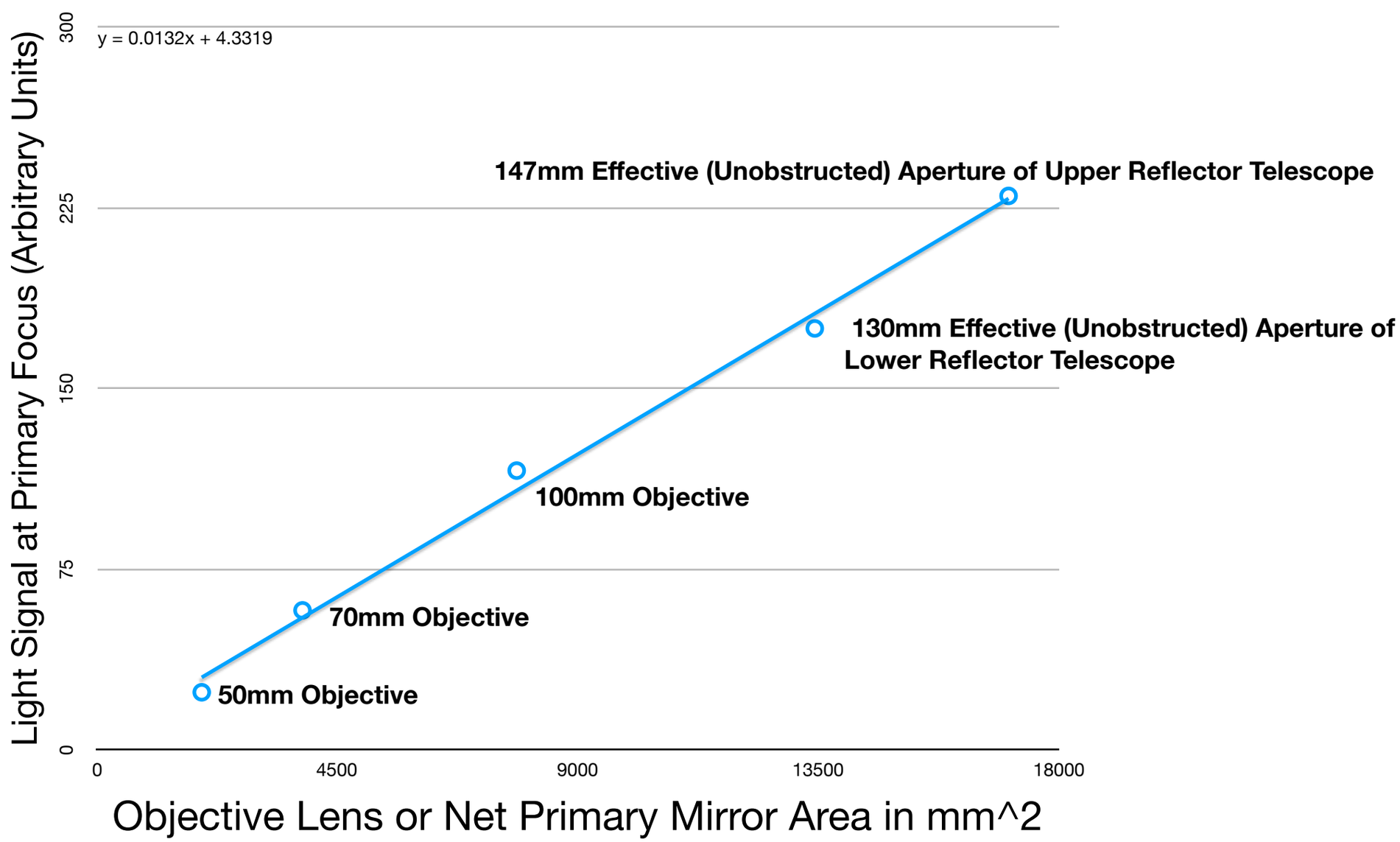
3D Printer making 160mmX160mm Front Plate with 150mm diameter opening







Measured Light Signal at the Primary Focus of the different Binoculars. A white LED at 75 feet was used as the light source



Conclusions

- It is always a compromise between aperture, convenience and cost…nothing new there…
- The 7*50 binoculars right angle conversion makes for more comfortable, wide angle viewing
- The dual 70mm F5.7 travel scope *crosslight* binoculars are easy to build, very lightweight, comfortable to use on a light tripod, good brightness, good overall performance and relatively inexpensive at ~$250
- The 25*100 Binocular conversion to *crosslight optics* does make a compact, portable and bright pair of binoculars but the F4 lenses will always have more chromatic aberration than the 70mm F5.7. Cost ~$500

Conclusions (Continued)

- The reflecting 150mmmm F5 Binoculars are so bright and versatile that the ~$700 cost and the extra weight are soon forgotten when viewing the double cluster in Perseus, Omega Centauri, M13, M81 M82 pair of galaxies, etc

- 3D Printer technology and free, easy to use CAD programs such as Tinkercad makes it possible for anyone interested to design mechanical parts for DIY telescopes / binoculars and to share those designs with others

- *CrossLight Optics* enables large refracting astronomical binoculars to be constructed which are compact, portable and comfortable to use on a light weight tripod

Conclusions (Continued)

- *CrossLight Optics* enables two, standard, 150mm reflecting telescopes to be combined into a very lightweight powerful pair of binoculars (or Binoscope).

- The lightweight, square frame construction using 3/4 inch aluminum angle and very precise 3D plastic printed parts simplifies the alignment and provides excellent stability of the two optical paths especially for DIY projects

If anyone is interested in building any of these binoculars and having access to the 3D .STL files please contact me through my website:

petertinkerer.com

Where I will be describing how to construct these binoculars over the coming months