BAADER

SOLAR PROJECTION SCREEN

Instruction Manual and Application Examples

Congratulations for your purchase of the Baader Solar Projection Screen (BSPS). This back-lit screen has been designed to observe the Sun with small groups without danger, as long as it is used as described in this manual. For your own safety when observing the Sun, we recommend to read this instruction manual before using it for the first time.

The assembly of the box is described in a seperate assembly manual.

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Contents

Properties

- For lens telescopes with apertures of up to 6", ideal for telescope focal lengths of 400-1000 mm and aperture ratios of ~f/6 or slower (also f/4 for apertures of less than 65 mm)
- Backlit projection screen for safe solar observation
- Required backfocus: ~3 cm
- Sturdy cardboard housing; a template for a 3D-printed housing in STL-format can be found at www.baader-planetarium.com/bsps
- You also need
  - A suitable projection eyepiece (recommended: Baader Planetarium Classic Ortho/Plössl), depending on the focal length of the telescope, as well as
  - A variable eyepiece projection adapter.
    Recommended: Baader Planetarium OPFA 1¼" *#2458141* or 2" *#2458142*)

Never look at the Sun with the naked eye or without appropriate filters. You risk permanent eye damage. Tainted glass, blackened film, CDs or double Sun glasses do not offer sufficient protection, not even during sunrise or sunset.

Safely Cover or remove finder scopes.

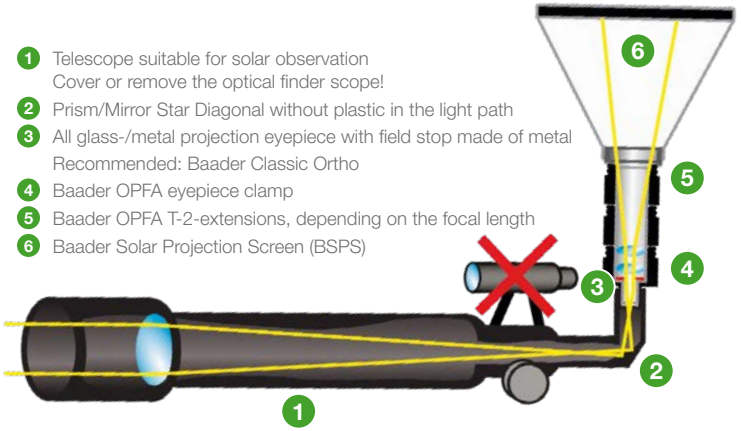
Important Safety Notes

- Only use the Baader Solar Projection Screen (BSPS) with telescopes, eyepieces and star diagonals which are suitable for projecting the Sun. Do not use instruments with plastic parts or optical elements close to the focus (e.g. spotting scopes or Petzval optical design). Mirror and catadioptric telescopes (Newtonian, Schmidt-Cassegrain, Maksutov, ...) are usually not suited for projecting the Sun.
- Never leave the telescope unattended.
- Regularly check the tracking of your mount
- Warning: Not suitable for children without experience or introduction to solar observation. Use only under adult supervision.
- Never use the Solar Projection Screen without an eyepiece.
- The diameter of the image of the Sun must be at least 5 cm to avoid overheating and deformation of the projection screen. For longer use, it must be 6 cm in diameter. If the image is too small, increase it by using additional T-2 extension tubes, the built-in focuser of the OPFA or by using an eyepiece with a shorter focal length.
- The projection screen is designed in such a way that smaller groups can take a look at the Sun, even if it is in the bright sunlight. It is optimized for viewing from the side. Especially with fast telescopes (faster than ~f/6) or when you are looking directly at the screen from above (in a 90°-angle), the image can be very bright – but it is not so bright that there is any risk. If you find the image uncomfortably bright, you may either increase the magnification by using additional T-2-extensions (if the sliding focuser of the recommended Baader OPFA is not sufficient), or stop down the telescope. Many telescopes have got a small aperture hole for this in their dust cap. Do not stare at the image for more than three minutes at a time and give your eyes regular breaks.
- Keep these instructions with the device for future reference. If other people use this device, provide them with these instructions or the link to them. If you pass the device on to a third party, these instructions belong with the device and must be included.

Scope of Delivery

1. Top of the Projection Box
2. Sides and floor of the Projection Box
3. Sides of the Projection Box
4. T-2 adapter plate
5. Projection screen

Quick Start & Short Instructions



Configuration of the Solar Projection Screen at a telescope.

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The assembly of the BSPS cardboard box is described in a seperate manual which you can find at baader-planetarium.com/bsps, and in the above linked video.

Take care of the usual safety measures for observing the Sun. Put all covers onto your telescope and all other optical instruments which may be on the same mount. Do not forget your finder. If possible, remove it or replace it with a solar finder.

Insert the appropriate eyepiece into the eyepiece projection adapter (both sold seperately) and set the length as described on page 8. Then screw the eyepiece projection adapter onto the projection box. Connect the star diagonal to the projection adapter (via the eyepiece clamp, or directly with a T-2-thread, depending on the available back focus) and attach it to your telescope. Check that it is securely fastened.

Then point the telescope at the Sun, center it on the screen and focus as usual, until you see a sharp image. Important: The diameter of the image of the Sun must be at least 6 cm. Increase the distance between eyepiece and projection screen or use another eyepiece, if the image is smaller. You can stop down the telescope to reduce the heat stress for yoiur star diagonal.

Onyl use the BSPS with suited eyepieces and focals lengths (see page 8) and ***never*** without an eyepiece.

In principle, there is no time limit for observation. However, give your eyes a break every three minutes or so. Look at the image from the side, not directly from above.

Note: You can find the STL-files to print a sturdy housing at home on a 3D-printer on our website at baader-planetarium.com/bsps.

The Solar Projection Screen on a 150/1200-telescope with the 3D-printed housing.

Operation and Requirements

The BSPS is designed to show an image of the Sun in white light, so that larger Sun spots as well as solar eclipses or transits of planets can be observed safely by several people at the same time. In contrast to classic solar projection screens, nobody can accidentaly or by intent put their hands or eyes into the beam of light.

The Solar Projection Screen was tested at telescopes with up to 6" (150 mm) of aperture and can be used with all telescopes which can be used for classic solar projection or with a Herschel wedge and which have got enough back focus (at least 3 cm) for eyepiece projection. It can thus be used with all lens telescopes which do not use plastic close to the focus point and which do not have further optical elements (reducer, flattener, Petzval-elements) close to the focuser. Do not use star diagonals with plastic in the path of light.

For a convenient brightness and to reduce the thermal load on your star diagonal, we recommend telescopes with an f/ratio of f/6 or slower. You may want to step down telescopes with more than 80mm of aperture – the image will still be bright enough.

In addition to a suitable telescope with star diagonal, you also need:

- **A variable eyepiece projection adapter with T-2-thread.**
  The projection adapter is needed for the correct distance between eyepiece and projection screen and to provide the T-2-thread for attaching the projection box. In principle, you can use every sturdy projection adapter, but the distances given in this instruction manual are tested only with the Baader OPFA. For other projection adapters, you have to find out the correct settings yourself to achieve an image of the Sun with at least 60mm of diameter. The distance between eyepiece clamp and T-2-thread has to be between 40 and 90 mm, depending on the focal lengths of eyepiece and telescope.
- **An eyepiece with a suitable focal length which can be used for projecting the Sun.**
  Eyepieces with a body or lens cell made of plastic or which use a heat-sensitive cement for keeping the lenses together can not be used for projecting the Sun. Especially Canada balsam, which is often used to cement lenses together, will desintegrate in the heat of the Sun. For many years, high-quality Huygens- or Mittenzwey-eyepieces in metal bodies, which do not use cemented lenses, were the best choice. Unfortunately, today these eyepieces are only made in low quality with too much plastic.
  Our Baader Classic Plössl/Ortho-eyepieces are also designed in such a way that they can be used for projecting the Sun. The Solar Projecting Screen was designed for and tested with these eyepieces. For eyepieces by other manufacturers, please consult the manufacturer if they can be used.

With the appropriate eyepiece focal length, you'll see an image of the Sun with a diameter of approximately 6-9 cm. The solar energy is then distributed over a sufficiently large area so that the screen does not become hot. If the magnification is too low, the Sun's heat is distributed over too small an area, which can damage the projection surface. Therefore, only use the Solar Projection Screen with suitable eyepiece focal lengths (see page 19) and ***never*** without an eyepiece.

Always make sure that all parts are securely connected to the telescope, are undamaged and can not come loose.

The Variable Eyepiece Projection Adapter (not included)

The eyepiece projection adapter (not included) creates the necessary distance between the eyepiece and the projection screen and ensures a stable connection to the projection box via the T-2 thread.

In principle, you can use any existing T-2 projection adapter, but you must ensure that the correct distance between the eyepiece and the projection screen is maintained. The image of the Sun should fill the surface as well as possible and must not be smaller than 6 cm. Otherwise, the heat load will be too high, causing the material to deform. A scale is printed on the BSPS cover, indicating the minimum diameter of the Sun. The greater the distance, the larger the image of the Sun will be. When using additional T-2 extension tubes, vignetting may occur due to the extension tubes.

The Solar Projection Screen was designed for and tested with the Baader OPFA system. There, the T-2-thread is between 40-90 mm away from the eyepiece clamp, depending on the position of the included focuser and the number of T-2-extensions. The OPFA is available in several variations, wich only differ in the connection to the telescope. The most relevant models are:

- Eyepiece Projection Adapter OPFA-1 *#2458141*
  with 1¼" nosepiece, for telescopes with 1¼" eyepiece clamp
- Eyepiece Projection Adapter OPFA-2 *#2458142*
  with 2" nosepiece, for telescopes with 2" eyepiece clamp
- Eyepiece Projection Adapter OPFA-4 *#2458144*
  Base-version with T-2 thread, for T-2 star diagonals

The OPFA is made of metal and can be used with eyepieces with a diameter of up to 38 mm external diameter. It is made of the following parts:

1. T-2-thread, connects to the Solar Projection Box
2. 40 mm T-2 extension tubes, to set distance and magnification
3. T-2 locking ring, to rotate the screen (or a camera, when used as adapter for planetary photography)
4. Sliding focuser, for fine-tuning the distance
5. Clamping screw for the length of the sliding focuser
6. Clamping screw for the eyepiece
7. T-2-thread on the telescope side, here with an additional 2"/T-2 nosepiece

The parts of the OPFA-2 *#2458142*

Insert the eyepiece without the eyecup into the OPFA and secure it with the clamping screw 6. If necessary, remove one of the two T-2 extension tubes 2 to achieve the ideal distance (see next page). Then screw the OPFA to the projection box. If you screw the OPFA to the telescope side with a star diagonal, you can loosen the locking ring 3 to rotate the box into the desired position. If using a 1¼" or 2" nose piece, simply turn the entire unit in the eyepiece holder of your zenith mirror.

With the clamping screw for length adjustment 5, you can fine-tune the distance and thus adjust the size of the image of the Sun.

The Projection Eyepiece (not included)

The eyepiece (not included) fulfills two tasks: it projects the image onto the projection screen and simultaneously distributes the solar energy over a sufficiently large area so that the energy load on the screen is harmless. It must therefore be suitable for solar projection and have a focal length that matches the telescope.

The classic eyepieces for solar projection were uncemented Huygens or Mittenzwey eyepieces, whose lenses are spaced apart far enough so that they will not burst due to the temperature difference when heated. For eyepieces with cemented lenses (practically all modern eyepiece designs), it depends on the cement used to bond the lens pairs: it must be temperature-resistant. Canada balsam, which is frequently used, is not temperature-resistant. The housing must not contain any plastic either, so that it cannot melt if tracking is insufficient. The plastic vapours could then condense inside the telescope, rendering not only the eyepiece but, in the worst case, the objective lens unusable. If in doubt, ask the manufacturer of your eyepiece.

The Baader Classic Plössl and Ortho eyepieces have double metal field stops and are suitable for solar projection. We tested them for up to five hours on a 6" refractor, which they passed without any problems. Remove the dust caps and rubber eyecups before inserting them into the OPFA. Depending on the focal length of your telescope, you will need the appropriate eyepiece and either one or two of the OPFA's T-2 extension tubes. The following table shows some combinations for different focal lengths that we have tested and that show the entire Sun.

Left: A cheap eyepiece with plastic housing shows scorch marks even after the Sun was out of the center just for a short time.
Right: A 10mm Classic Ortho, which wasn't centered on the Sun for a longer time. The eyepiece is unharmed, only the black anodizing has bleached. As long as the tracking works and centers the Sun, the anodization will not be harmed, too.

Tested combinations of OPFA and eyepiece

Telescope	T-2-Extension	Classic Eyepiece	Ø of Sun
Baader VarioFinder 60/**250 mm***)	2x 40 mm	6 mm *#2954106*	~6,5 cm
Celestron Travelscope 70/**400 mm**	1x 40 mm	6 mm *#2954106*	~8 cm
Bresser AR 90/**500 mm***)	2x 40 mm	10 mm *#2954110*	~7,5 cm
Celestron ED 80/**600 mm**	1x 40 mm	10 mm *#2954110*	~6,5 cm
Celestron Inspire 70/**700 mm***)	1x 40 mm	10 mm *#2954110*	~7,5 cm
Bresser Stellar 60/**800 mm****)	2x 40 mm	18 mm *#2954118*	~6 cm
Vixen 80/**910 mm**	2x 40 mm	18 mm *#2954118*	~7 cm
Vixen 90/**1000 mm**	2x 40 mm	18 mm *#2954118*	~7,5 cm
Celestron 150/**1200 mm**	1x 40 mm + 2x 30mm	18 mm *#2954118*	~7,5 cm
Zeiss AS 150/**2250 mm**	2x 40 mm	32 mm *#2954132*	~7,5 cm

Use the sliding focuser (4) to increase the magnification, if the Sun is too small.

*) due to the short back focus of many telescopes with 1¼" focuser, the OPFA had to be attached directly to the star diagonal *#2456005* in order to reach focus.

**) If possible, use another 15mm extension for a larger Sun diameter.

The image of the Sun must be at least 6 cm in diameter! If it is less than 3 cm, on a 80mm-telescopes temperatures of more than 60°C can be reached. Then, the projection screen can warp (but without melting or allowing a direct view of the Sun). You can also use eyepieces with longer focal lengths, but then you will no longer see the complete Sun.

Here, the OPFA is attached directly to the T-2-thread of the prism diagonal *#2456005*.
The two T-2-extensions have been removed to insert the eyepiece.

Focuser and Star Diagonal

The BSPS can be used with all telescopes which are suitable for projecting the Sun. For a conveniant viewing position, a star diagonal is necessary. We recommend to use telescopes and accessories made of metal, because we do not know which plastic is used by which manufacturer, or how heat- or UV-resistand these materials are. We can not give any warranties which the manufacturer of your telescope does not give.

Left: A prism diagonal with a small prism and a visible plastic ring in front of it.
This construction is not suitable fpor observing the Sun.
Center: A cheap mirror diagonal with plastic body. The mirror is unobstructed, so it can be used.
Right: T-2 prism diagonal *#2456005* with metal housing. The metal can't burn or melt, so it can be used.

Our tests with 70/400 f/5.7 and 90/500 f/5.5 lens telescopes did not show extensive heat in the tube. At the end of the tube, at the beginning of the focuser, the temperature was only five degrees above the surrounding temperature (33° C instead of 28° C on a summer day), so that there was no risk for focuser, telescope or the aperture stops inside of the telescope.

As long as the telescope points at the Sun or only doesn't point at it for a short time (e.g on a mount without tracking, where the Sun quickly moves out of the field of view and illuminates the interior of the telescope tube), our experience is that there is no risk for a lens telescope, even if plastic was used inside of it. Especially when the Sun is centered in the BSPS, all light passes through the lenses or is reflected by the star diagonal.

The situation changes if the telescope is not pointed directly at the Sun for a longer time, e.g. on a mount with insufficient tracking. Then it is possible (at least in theory), that the dark paint inside of the tube can bleach – just as every paint suffers in the Sun over time. It is indeed not rare that black anodized metal parts turn into a bronze colour if they are exposed to the Sun for several months. Plastic can age even faster. That's why you should always make sure that the Sun is at least partly visible on the screen of the BSPS, and cover the front lens when you don't use the telescope.

Things are different for the *star diagonal*: Here, the beam of light is much tighter and the energy density is higher. So, just like the eyepiece, it has to be resistant to heat and must not contain plastic which can reach into the beam of light. As long as you use a star diagonal which uses the whole aperture, there is no risk for the diagonal. But do not use cheap diagonals where the mirror/prism is smaller than the aperture and where the housing reaches into the entry opening. Especially cheap prism diagonals use only a part of the aperture, so that smaller and cheaper prisms can be used. Here, the Sun light can damage the housing, so that it does not only bleach, but maybe even the plastic will become brittle or break.

Our dielectric mirrors block UV-radiation and offer additional protection for solar observations; silver-coated prisms like our BBHS-prisms also reflect less UV below 390nm. In principle, every star diagonal can be used. For a very short adaptation, we recommend our T-2 / 90° prism diagonal with 32 mm Prism *#2456005* (*#2456005K* with eyepiece clamp and 1.25" nosepiece). It can be attached directly onto the T-2-thread of the OPFA, the nose piece of the OPFA can then be used at the star diagonal to insert it into the focuser of the telescope.

Close to the eyepiece, the heat is most intensive. Here, plastic lens cells will melt immediately when the Sun drifts away, and even the anodized field stops of our Classic Ortho eyepieces can bleach – but this doesn't affect their function and is not covered by the warranty.

Focus point and backfocus

In telescopes which are made for 2" star diagonals, you can usually use 1¼" star diagonals and have enough back focus so that you don't need to screw OPFA and diagonal together.

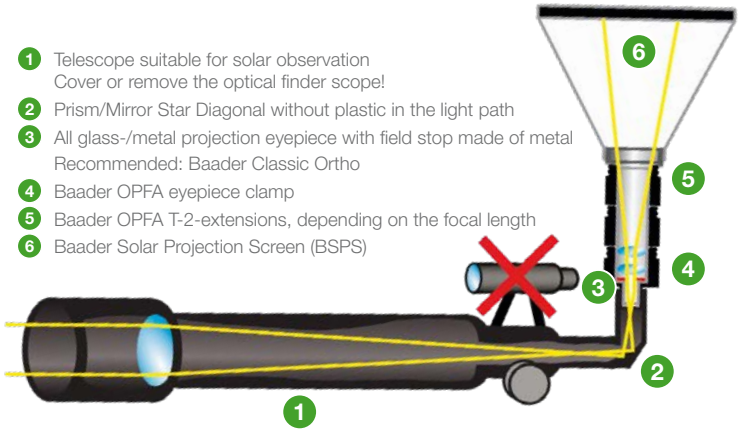
If you don't have enough back focus, you can use e.g. a T-2 prism diagonal, which can be attached directly to the OPFA, without an eyepiece clamp.

Above: Celestron TravelScope 70 with 1¼" star diagonal, BSPS and OPFA. It just reaches focus.
Below: Same telescope, but now the OPFA is directly connected to a T-2-Prism *#2456005*.
This gives you additional back focus, so you can reach focus more easily.
The image shows the 3D-printed housing; the .stl-files for it can be downloaded at baader-planetarium.com/bsps

Observing with the BSPS

Put all covers onto your telescope and all other optical instruments which may be on the same mount. Do not forget your finder! If possible, remove it or replace it with a solar finder.

Insert the appropriate eyepiece into the OPFA and remove one of the 40 mm T-2 extensions if necessary. Then screw the OPFA onto the projection box. Connect the star diagonal to the OPFA (via the eyepiece clamp, or screw it on) and attach it to your telescope. Check that it is securely fastened.



Configuration of the Solar Projection Screen at a telescope.

Start the tracking of your telescope and set the tracking speed to "Sun" or "solar", if possible.

Then point the telescope at the Sun. A simple solar finder is helpful. You can also use the shadow cast by the tube on the ground: when it is the smallest, the Sun should be in the telescope's field of view. Depending on the size of your telescope's dew cap/ lens mount, you may also use the shadow of the front tube ring on the rear tube ring as an pointing aid. Once the telescope is pointed at the Sun (and the OPFA, eyepiece and solar projection screen are securely attached to the telescope!), remove the lens cap. Now you may need to move the telescope a little until you see the image of the Sun (or a bright spot, if you are out of focus) appear on the projection screen. Focus as usual; the focus point is about 3 cm further in than when observing the night sky without the OPFA.

In principle, there is no time limit for observation. However, give your eyes a break every three minutes or so. If the image is uncomfortably bright, either increase the magnification by using additional T-2 extensions (if the OPFA's sliding focuser is not sufficient) or stop down the telescope. Many telescopes have a smaller opening in the dust cover for solar projection. Look at the image from the side, not directly from above.

Make sure that the Sun does not move out of the image to avoid heating at the edge of the tube or damage to the telescope.

Put the cover on the telescope when you are not using it.

Do not leave the telescope unattended!

Finally, replace the lens cap before turning the telescope away from the Sun and removing the solar projection screen. This will prevent sunlight from entering the interior of the telescope.

Polar Alignment of the Mount

If you are using a german equatorial mount in mobile use, it is not easy to achieve perfect alignment to the Earth's axis during the day. Set up the tripod horizontally (e.g. using a bubble level) and align the mount as best you can with a compass pointing north. Set the altitude using the scale on the mount for your observation location.

If the altitude has been set using the scale on the mount, or if you always use the mount in roughly the same place and do not change the setting when dismantling it, only corrections in azimuth should be necessary. You can make these during the course of your observation (if you are on the northern hemisphere):

If the image of the Sun moves *downwards*, turn the entire mount *clockwise* (i.e. turn the south side of the mount to the west).

When the image of the Sun moves *upwards*, turn the entire mount *counterclockwise* (i.e. turn the south side of the mount towards the east).

This will make the tracking more and more accurate.

You can also use this method to correct the azimuth setting when looking through a telescope with a lens solar filter, star diagonal and eyepiece, but the mount must then be turned to the west when the Sun moves downwards in the eyepiece instead of upwards. The projection changes the orientation.

Cleaning

Store the box in a safe and dry place. For cleaning the projection screen, you can use:

- Lukewarm water with a little bit of dishwashing detergent
- Soft, lint-free cloth, lens cloth or soft viscose sponge

Never rub the screen completely dry. Otherwise, it would become electrostatically charged, which in turn attracts dust. It may also result in scratches on the surface

Make sure that the cleaning agent does not contain any benzene, ethanol, alcohol, organic material or thinners. Do not put cleaning fluids onto the cardboard

Abrasive cleaning agents are generally not suitable for cleaning!

Everything for observing the Sun

The Solar Projection Screen was developed to let multiple observers safely observe the Sun. If you want to observe further details at high magnification, we recommend using safe solar filter in front of the lens so that you can observe directly through the eyepiece. Our AstroSolar® filter film has been a proven material for the construction of solar filters for decades.

In addition to individual sheets for DIY projects, ready-made front filters are also available in various sizes.

For the highest quality refractors, choose our 2" Cool-Ceramic Herschel Prism Mark II *#956510P/V*. With this solar filter, you can observe the Sun in white light even at the highest magnification.

AstroSolar® film is available as film-only for DIY-filters as well as in filter cells in various sizes.

With the Solar Projection Screen, Astrosolar® film or Herschel wedge, you can observe the Sun in white light and see the photosphere with sunspots, limb darkening and maybe even the granulation.

The Herschel Wedge gives you best views of the Sun even at high magnifications.

With the Baader Calcium GEN-II 1¼" filter *#2961590*, you can observe the transition layer between the photosphere and the chromosphere, where sunspots begin to form. This filter must be combined with another filter (included in delivery) and can only be used for photography.

To visually observe or photograph the fascinating prominences at the edge of the Sun and the chromosphere, a special, very narrow-band H-alpha filter is required. In addition to our own SunDancer II H-alpha filter, we also carry the large H-alpha filters from Solar Spectrum.

For more information about our solar observation products, please visit

www.baader-planetarium.com/solar

Observing the Sun with a telescope with ASTF-front filter on a simple mount. The Solar Projection Screen is mounted on a VarioFinder to control the tracking, e.g. during public events.

FAQ – Frequently Asked Questions

In order to provide you with the best possible information about this product, we have compiled a list of questions and answers on our website. If you have any further questions, please use the comment function there or contact us.

www.baader-planetarium.com/en/bsps-faq

The BSPS in Field Use

Celestron AstroMaster 70/900AZ, with 18mm Classic Ortho.
Due to the back focus, the OPFA is mounted directly at the prism diagonal *#2456005*

Bresser 90/500, with 10mm Classic Ortho.

150/1500-telescope with 2" star diagonal

The BSPS in Field Use

Baader VarioFinder 60/250, with 6mm Classic Ortho on a lightweight travel mount. Due to the back focus, the OPFA is directly at the prism diagonal *#2456005*

Celestron TravelScope, with 18mm Classic Ortho, stopped down, on a lightweight travel mount. OPFA at 1¼" mirror diagonal

BSPS as solar finder next to a solar telescope

Lens telescope with 2"-focuser and 1¼" star diagonal

www.baader-planetarium.com

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