

## [ Extract from “Astronomical Spectroscopy for Amateurs”]

### 18.0 Guiding, OAG and Beam splitters/ Flip mirrors

You’ll quickly find it’s a challenge to get a star focused on the spectroscope slit and hold it there during a series of 5 minute exposures!

The Shelyak LhiresIII and others add a small “telescope” to view the image of the star sitting across the slit gap. Another option is to introduce a beam splitter in front of the slit to allow setting and guiding. You could use a flip mirror to set up the spectroscope on the star but you lose the ability to guide.

#### 18.1 Off Axis Guiders

To prevent any additional loss of light i.e. using Beamsplitters etc., many astronomers use an off-axis guider (OAG) to locate a suitable guide star close to the target star. An OAG design like the Celestron Radial Guider or the Orion Deluxe OAG give the opportunity of setting the target star on the entrance slit and then adjusting the position of the pick-off prism to locate a guide star.

#### 18.2 Beamsplitter application - Spectroscope

One of the problems using a Slit spectroscope, is centering and guiding on a star image. Most professional observers use a reflecting slit and secondary optics to present a star image to the guider. Unfortunately these slits are expensive and usually have a fixed slit width (i.e.  $30\mu\text{m}$ ). For amateur spectroscopes, which use an adjustable slit (0- 3mm) (Surplus Shed # 1570D), this method is not suitable.

By modifying a flip mirror to hold a suitable beamsplitter, an image of the star can be seen in the guider and at the same time focused on the spectroscope slit.

Beamsplitters come in various forms:

A beamsplitter cube; These give a 50/ 50 split of the incoming light, which will reduce the star’s brightness on the spectroscope slit by about one magnitude. See Figure 18.1.

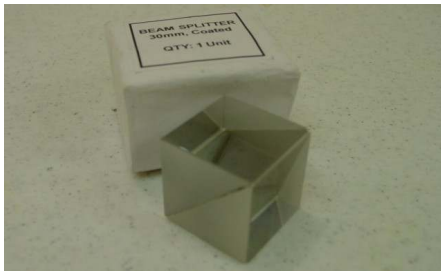


Fig. 18.1 beamsplitter cube

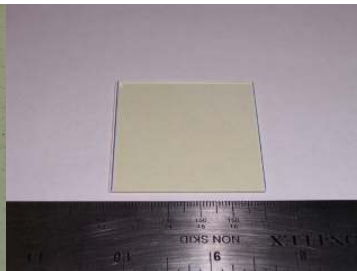


Fig. 18.2 beamsplitter plate

A beamsplitter plate; these thin (1mm) plates give a 70/30 split, this reduces the light loss to around 0.5 magnitude. This is a preferred solution. See Figure 18.2

(The beamsplitter plate, as supplied, is 50mm x 50mm but easily cut to size with a normal glass cutter.)

## 18.2 1 Modifying a Vixen Flip Mirror to a Beamsplitter

Vixen manufacture a nice robust flip mirror, Model # 2680. See Figure 18.3.



**Fig. 18.3** Vixen Flip Mirror

This unit has a built in 2" nosepiece with provision for mounting filters, unfortunately it's a 49mm thread, so a 49-48mm reducer is required to use the standard 2" astronomical filters.

The flip mirror is a 30 x35mm front surface mirror mounted on a plate which is moved via a small pin and groove mechanism from a knob on the outside of the body. This gives smooth and positive movement of the mirror. The body is die-cast and approx. 55mm x 55mm x 55mm.

The outlet ports on the body, for both the imaging and guider have female T threads, and male to male T thread adaptors are supplied, as well as the T thread to 1.25" adaptors. This allows the cameras to be mounted (using the T threads) very close to the body and reduces the back focus requirements.

The following notes explain how to modify a flip mirror and add a beamsplitter. **Do this at your own risk.** Read through the instructions before starting and make sure you understand the various steps involved. If you are careful however, it should be easy to reverse the modification and return the flip mirror to its original state.

### **Disassembly of the Vixen flip mirror**

Before you start, you'll need the following:

2mm Allen key  
0.9mm Allen key  
Philips head screwdriver  
Exacto knife (or similar)  
Acetone (or similar)

1. Remove the 1.25" adaptors from the imaging and guide ports – just unscrew them by hand.
2. Remove the 2" nosepiece by unscrewing the four Philip head screws.
3. Remove the adjusting knob – there's a small 2mm grub screw inside the body which holds it in place. **Note:** The pin mechanism will now drop out – get ready to catch it without touching the mirror!
4. Remove the flip mirror plate. There are two 2mm grub screw on the outside of the body which form the "axis" for the plate; gently unscrew them and remove the mirror plate. **Note:** be careful not to touch the front surface mirror!
5. Remove the front surface mirror from the plate. There are four small dabs of glue at the edges of the mirror, these can be removed by carefully using a sharp blade (Exacto knife). The mirror is

held in place with a piece of double sided sticky tape; this can be softened and removed by soaking for a few minutes in Acetone. To assist in lifting the mirror of the tape, you may find you have to use the small (they are SMALL) grub screws at the rear of the plate. If you look at the back of the mirror plate, there seems to be four small holes; these are actually 0.9mm grub screws which can be used to give fine "adjustment" of the mirror position. Gently screwing in one of the grub screws will lift the edge of the mirror and allow it to be removed from the plate. **Note:** the acetone has no detrimental affect on the mirror. Once removed, wrap in tissue paper and store. (You never know when you might need it for another project!)

That's it for disassembly!

### **Modifying the mirror support plate for the Beamsplitter**

You'll need:

12mm drill bit (minimum)

Glass cutter

Double sided sticky tape

The mirror support plate needs a hole drilled in the centre to allow the secondary light beam to get through.

You have a choice; you can either incline the plate on a jig/ support and drill the hole at 45 degrees, which will give you a circular aperture when inclined, or take the easy way and just drill the plate flat!

The "easy way" was taken and the 12mm hole drilled through the centre of the plate. Even when inclined at 45 degrees, the elliptical aperture is still about 7mm x12mm which was more than enough clearance for the guide camera light beam.

### **Fitting and adjusting the Beamsplitter plate**

Cut a rectangular section from the larger piece of beamsplitter, 20 x 34mm. A normal wheel glass cutter does the job in seconds!

The beamsplitter plate can then be mounted on the front of the support plate (remember to unscrew the little grub screws, if you used them to lift the mirror!) with two strips of the double sided tape, about 6mm wide across the top and bottom surface of the beamsplitter. Gently place the beamsplitter in the small recessed area, central to the support plate and hole. The tape should hold it firmly in place.

Re-assembly the mirror plate and adjusting mechanism (See above)



**Fig. 18.4** Beamsplitter in place

When the mirror plate is rotated down, you now have a 70/30 beamsplitter in the optical train. Set it up on your telescope and put a low power eyepiece in both the guide and imaging adaptor. Focus using the guide port (rear port) and centre the star.

Now look in the imaging/ spectroscopy port and see if the star image is still central. If it is not, the small grub screws in the mirror support can be used to slightly tilt and rotate the beamsplitter plate to bring the star back to the centre.



**Fig. 18.5** Rear View - Showing the four small adjusting screws and the hole.

### **Using the beamsplitter**

The back focus distances for the guide and spectroscopy depend on the equipment you have.

A QHY5 guide camera was used, and mounted in a 1.25" nose piece. To get correct focus the Vixen adaptor was removed and replaced with an adjustable Baader T thread to 1.25" adaptor (Baader # BA2458010). The spectroscopy has a female T thread so this was just screwed directly to the Vixen body.

To set up for taking a spectra, centralise and focus the star in the guide camera/ eyepiece, the star should then be visible on the spectroscope slit; this can be verified by imaging the zero order image through the spectroscope.