Focuser placement

Top of this document | Master Table of contents

It's not uncommon to see homemade telescopes with repairs where a mis-placed focuser was moved and the evidence (the hole) covered up. Even Newton himself misplaced the focuser on his first scope and had to re-position it. You can use this formula to calculate where your focuser should go.

Fp = Focuser Position (measured from the front of your primary)
Fl = Focal length
Tr = tube radius
Tt = tube thickness
Fh = focuser height
St = Spare focuser in travel

Assuming the field stop of your eyepieces is at the shoulder (the rim against which they rest when in the focuser).

Fp = Fl - Tr - Tt - Fh - St

The focuser height is measured with the focuser fully racked in. The "spare focuser in travel" builds in a buffer so that the focal plane isn't exactly at the top of the focuser when racked in fully. Typically, ¼" (or ~7mm) is sufficient, though some ATMs recommend adding ½ inch (12.6 mm).
The term comes from the program Newt. From the documentation for that program:
The distance from the top of the focuser tube (when racked all the way in) to the focal plane (where the light from the primary mirror comes to a focus). Note: Some books say the focal plane should coincide with the top of the focuser tube. However, many eyepieces will NOT come to focus this way.

Tips When Assembling Your Scope

If any of the mirrors attract dust or grease leave them until the scope is assembled. After the scope is assembled use a soft cloth and lightly clean the grease and dust. Use acetone or isopropyl alcohol as the cleaning agent. If there is only dust, remove the dust with a clean soft camera brush. Minor dust can be left as it will not affect the image much and is unavoidable once you are using the scope unless you have an airless vacuum chamber!!.

1. Drill the focuser hole in the center of the tube and slightly larger than the focuser
2. Attach the secondary mirror and spider first
3. Position the secondary mirror in the center of the focuser and adjust the mirror so the hole at the end of the tube is centered in the secondary mirror and focuser. You will need a collimating eyepiece with crosshair to position the secondary in the center of the focuser. You will also need to offset the secondary mirror slightly to optimize the optics.
4. Measure the height of your focuser in its midway position above the tube and add half the tube diameter to determine the distance above the secondary mirror.
5. Subtract this distance from your primary mirrors focal length to determine the distance from the primary mirror to the secondary.
6. Attach the primary mirror to the mirror cell.
7. Measure the distance from the face of the primary to the screw holes on the primary cell. Add this distance to the distance calculated in 5. This is the distance your primary mirror cell will be from the center of the focuser hole.
8. Measure the distance to the primary cell from the focuser and mark the screw holes
9. Attach the primary cell and mirror to the tube
10. Test the scope by pointing at the Moon and focusing to determine whether the primary is correctly positioned. The image will not be centered as the scope is not yet collimated. The image should come into focus when the focuser is at its midway position. You will have to move the position of the primary closer or further to the focuser if you cannot focus the image correctly.
11. Collimate the scope.

AMATEUR TELESCOPE MAKING

Telescope Plan

The first questions I asked when I first plan to build my telescope were about the placement of the components. Like where I should place the diagonal or the focuser. Here's a plan on Newtonian reflector. With this plan you can determine the placement of the telescope's optical components.

Let's say that we have decided the specification of our scope. We want to make a 8" f/6 telescope, we have bought the plywood and everything. Now what? After we have all the plywoods, we have to cut them to make the tube. But how do we determine the dimension? Well, you will have to do some calculation. If you don't really like mathematics (I don't), don't worry the calculation will use simple equations.

Telescope Dimension

The telescope dimension depends on the mirror's apperture and the focal length. The bigger the number, the bigger our scope will be.

Focal Length

The focal length of the telescope is the distance from the mirror surface to a point where the light reaches the focus. This focal length (f.l) determines the dimension of the tube. So the longer the f.l, the longer the tube is and vice versa. In a telescope ad you usually ead something like 6" f/8. That simply means the telescope has a 6" objective diameter and f.l of 48". It means that the light reflected from the mirror will reach focus at a distance of 48" from the surface of the mirror. To determine the f.l simply multiply the mirror diameter with the focal ratio, in this case 6 x 8 = 48".

Now with that in mind let's calculate the telescope dimension.

Tube Length

The general rule in determining the tube length is that the length should be equal to the f.l plus the diameter of the mirror.
So our telescope's tube length should be 48+6= 54". The additional 6' is needed to prevent unwanted light from reaching the diagonal mirror. But some experienced ATMers made their telescope very well baffled that they don't need this additional length.

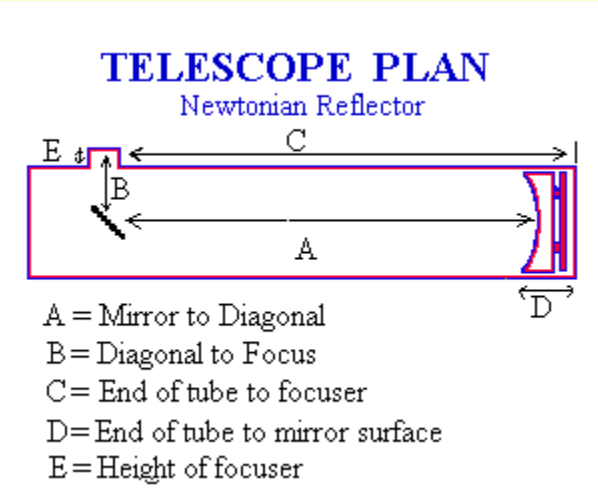
Tube Diameter

In the previous page, I mentioned that the tube diameter is slightly larger than the mirror diameter. This clearance is needed to allow the warm air inside the to leave the tube.
If the air inside the tube is wartmer than outside, then the image will not be good. This warm air has to leave the tube so the temperatur inside and outside are equal. This is what the clearance is for. 1" from the mirror to the tube wall is sufficient. But if you build a truss tube telescope you don't need this clearance.

Diagonal Mirror Placement

Determining the tube diameter and the tube length is simple. But to determine where to place the focuser and or diagonal we must use some equations.
You have to remember that for a Newtonian telescope, there is a second mirror which directs the light to focus (eyepiece) at the side of the tube.

So when we want to determine the focuser or diagonal placement we have to put into the calculation, the distance from the diagonal mirror to the side of the tube where the focus is.



So, see picture above,

$$\text{Focal length} = A+B$$

The focal length of the scope must equal the mirror to diagonal distance + diagonal to focus distance. First, let's determine Diagonal to Focus distance (B). To determine B, you must consider the diameter of the tube (radius of the tube actually), the height of the focuser and the focuser travel, the equation is:

$$B = d/2+E+T$$

Where:
d = diameter of the tube
E = the height of focuser; and
T = focuser travel.

With those two equation, we can calculate B to determine A.

Let say our mirror is 6" f/8, the f.l =48", the tube d= 7" and the focuser height=2", and assume the focuser travel is 1" (could be less).

B= 7/2+2+1= 6.5".
We have B = 6.5".
With this, determine the A-B distance:

A= FL-B
=48-6.5= 41.5".

So, the focuser hole must be placed 41.5" from the surface of the mirror. That's also where the diagonal should be place because the diagaonal is right in front of the focuser.

In practice however, when determining the focuser hole's position we must also consider the distance from the end of the telescope tube to the surface of the mirror (D).
You have to include this distance in your equation. So, you have to use another equation:

$$F = D+FL - (d/2+E+1)$$

where
F = focuser hole position,
D = end of tube to mirror surface distance
FL = focal length
d = diameter of the tube
E = focuser height, and 1= focuser travel
Example:
For our telescope let say that the end of tube to mirror's surface distance (D) is 4".Then we'll get:
F= 4+48-(7/2+2+1)
= 45.5

So the focuser (and also the diagonal) should be placed at a distance of 45.5" from the end of the telescope tube.

Now, after you have calculated the dimension of the tube, cut the plywood and have fun.