Facts Underlying the High Performance of the 188-cm Reflector Telescope

Okayama Astrophysical Observatory's 188-cm Reflector Telescope is the largest optical-infrared telescope in Japan. When introduced in 1960, it was the seventh largest reflector telescope in the world and the largest in East Asia. It took about 5 years to build the telescope and cost about 300 million yen, including the building to house it. Telescopes of the same size built by Grubb Parsons in England are installed in Canada, Australia, France, and Egypt as well.

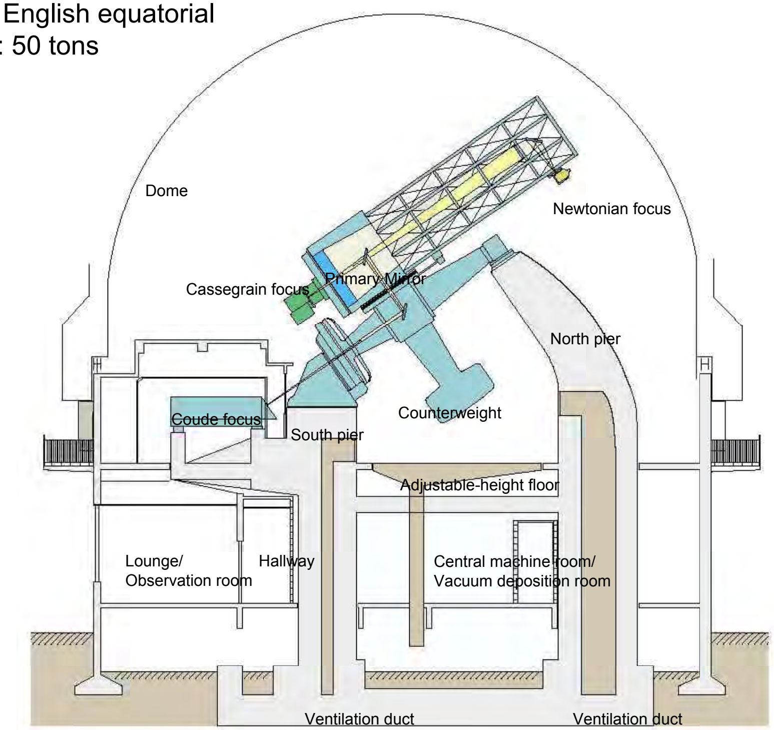
The primary mirror has an aperture ratio of 4.9, and the body tube has an elongated octagonal truss structure. Although the telescope's pointing accuracy was not so good due to its English mount, a major upgrade in 2013 greatly improved it.

The telescope features three foci, which accommodate different observational instruments and secondary mirrors for various observational purposes. The image scale at each focal point can be expressed by using the size of the full moon as a reference. At the Newtonian focus an image of the Moon would be 9 cm in diameter; the lunar image would be 34 cm in diameter at the Cassegrain focus and 54 cm in diameter at the Coude focus.

More than 50 years have passed since the telescope was opened for use, but it is still active to this day and remains Japan's largest optical-infrared telescope. Take some time to learn about telescope structure while creating a paper model of this one.

The 188-cm Reflector Telescope's main specifications

Primary mirror diameter : 1.88 m (focal length: 9.15 m)
Primary mirror weight : 1.7 tons (Pyrex)
Focus type : Newtonian, Cassegrain, Coude
Mount : English equatorial
Weight : 50 tons



Designed by Seiichi Sakamoto (NAOJ)

188-cm Reflector Telescope Paper Model Construction Project for a Child with Adult Assistance, Expert Course (crafting instructions)

Tools and materials: box cutter, ruler, aluminum tape, glue (wood glue works well)

1. Preparation: Copy the two paper model cutout sheets onto Kent paper or similar thick paper. Next, paste aluminum tape on the reverse side of the primary and secondary mirrors. After that, cut out all 22 model parts by cutting along the bold lines on the model paper. Next, make incisions and cut out the holes indicated by an “x” by cutting along the bold lines. Mountain-fold along the dot-dash lines, and valley-fold along the dashed lines. Note that thin dotted lines indicate an overlap width for gluing parts together and should not be creased.

2. Assemble and attach the body tube: First assemble the body tube. Then insert the body tube attachment tabs on the declination axis bearing through the round hole on the side of the body tube. The tabs should be inside the body tube and the declination axis bearing should be on the outside. Fold the tabs back down inside the body tube as needed to secure them.

3. Assemble and attach the counterweight: Assemble the counterweight and the counterweight axis. Make sure to attach the counterweight axis through the hole in the top of the counterweight before sealing the bottom of the counterweight. Next attach the counterweight axis through the small hole in the declination axis bearing (the hole opposite the body tube).

4. Assemble and attach the polar axes: Assemble the two polar axes, and insert them into the declination axis bearing’s polar axis attachment holes and attach them to the inside. After that, assemble the declination axis bearing. Next, guide the thin ends of the polar axes through the polar axis bearings’ holes and glue the polar axes caps to the ends of the polar axes inside of the polar axis bearings. Make sure not to glue the polar axis directly to the polar axis bearings. Finally, assemble the polar axis bearings.

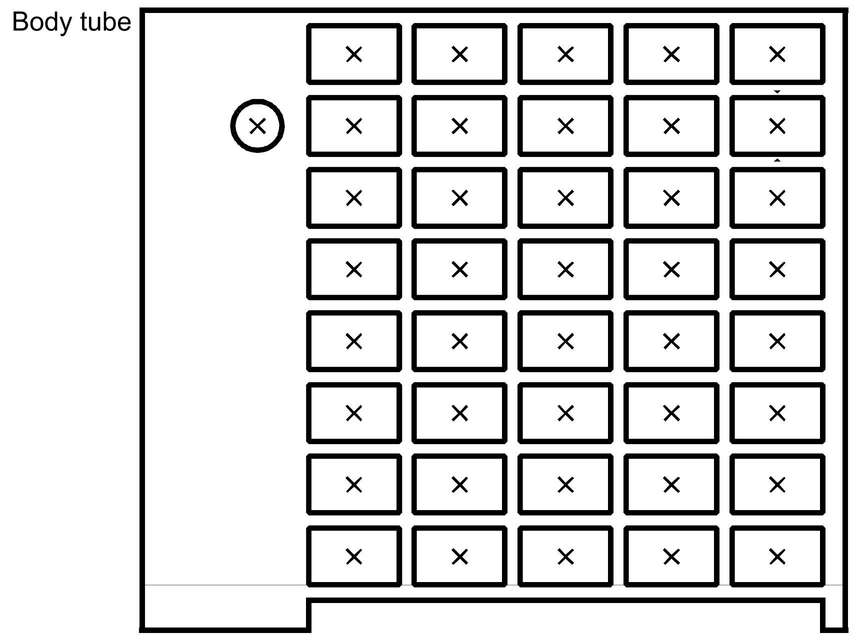
5. Assemble and attach the primary mirror: Attach the Cassegrain instrument attachment through the hole in the primary mirror cell, and attach the baffle through the hole in the primary mirror. After that, attach the primary mirror to the primary mirror cell. Finally affix the assembly to the bottom end of the body tube.

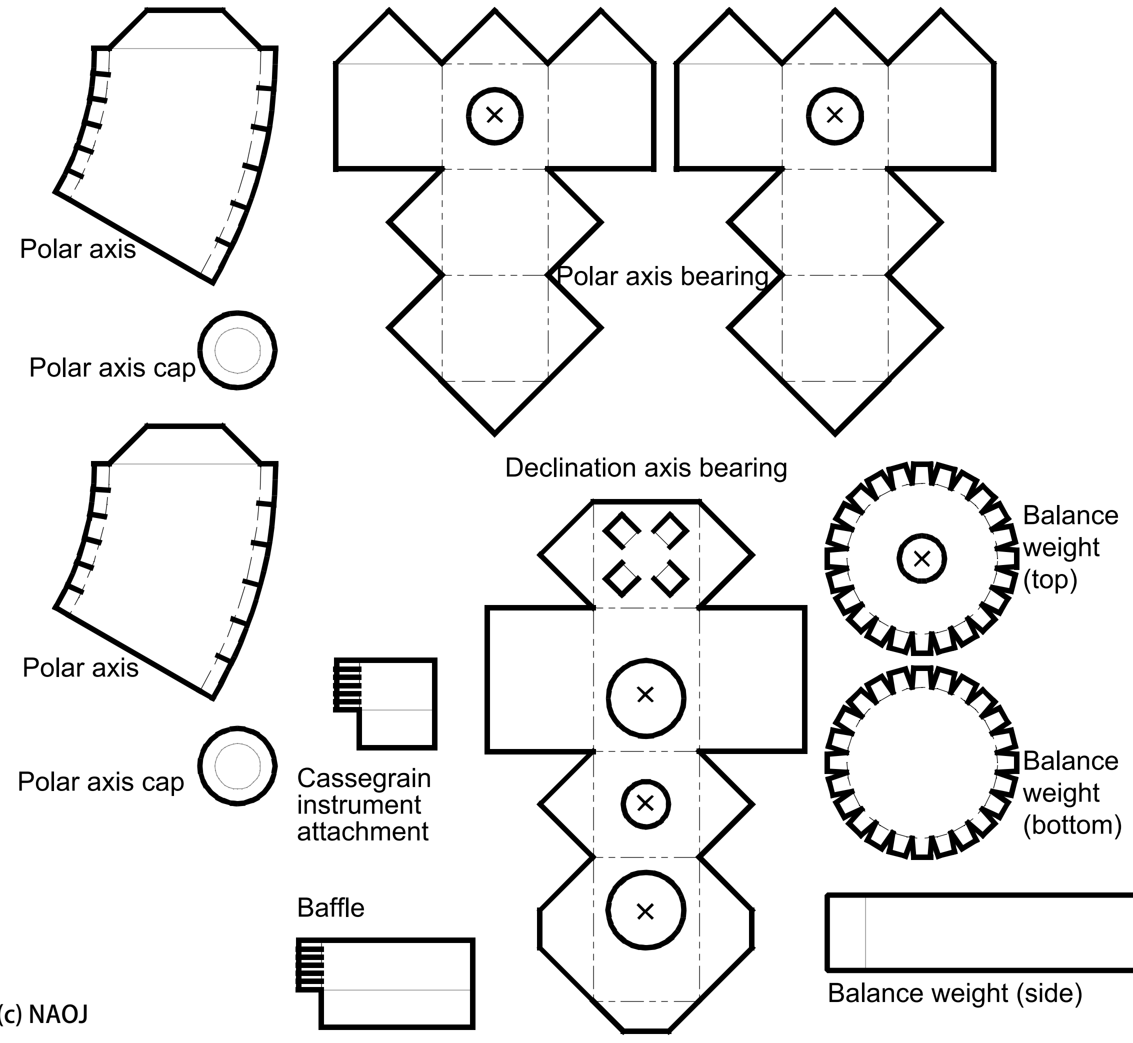
6.Assemble and attach the secondary mirror: Assemble the spiders, and then attach the secondary mirror to the intersection point of the spiders. Next, glue the secondary mirror assembly to the inner periphery of the body tube at the second ring from the top. Position the spiders so that they form an X shape when viewed from the front.

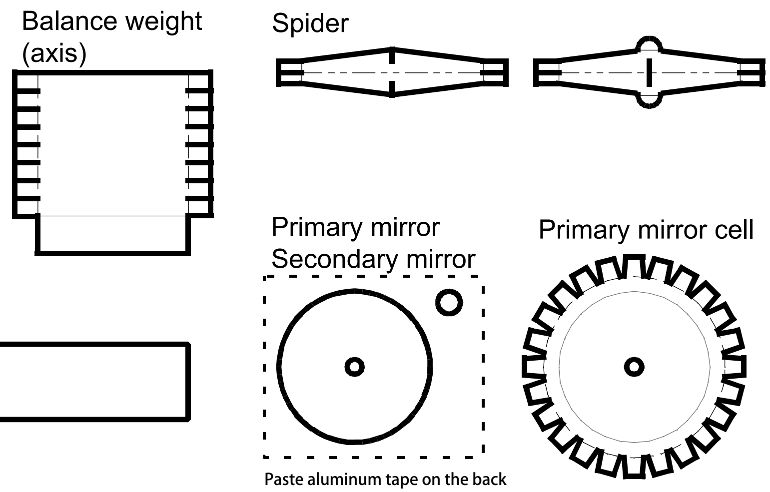
7. Assemble the piers: Assemble the north and south piers, and then glue the polar axis bearings to the top of the respective piers, paying attention to the orientation.

8. Fix to the base: Use glue to fix the entire telescope assembly to the base.

188-cm Reflector Telescope Paper Model Construction Project for a Child with Adult Assistance, Expert Course (1/2)

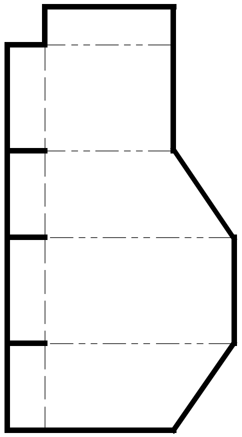




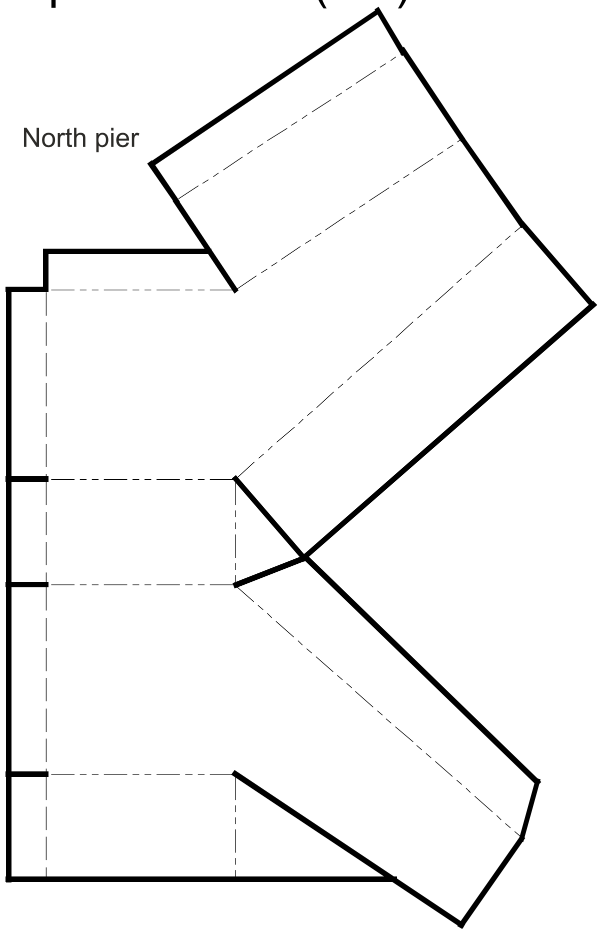


188-cm Reflector Telescope Paper Model Construction Project for a Child with Adult Assistance, Expert Course (2/2)

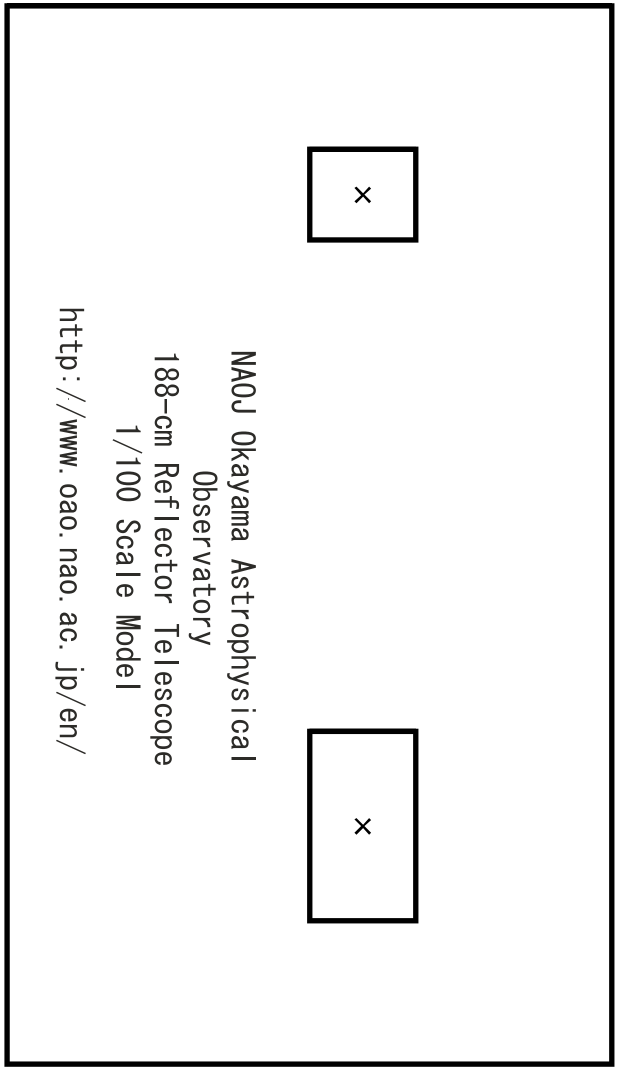
South pier



North pier



Base



2cm = 2m

Telescope Trivia
About Telescope Mounts

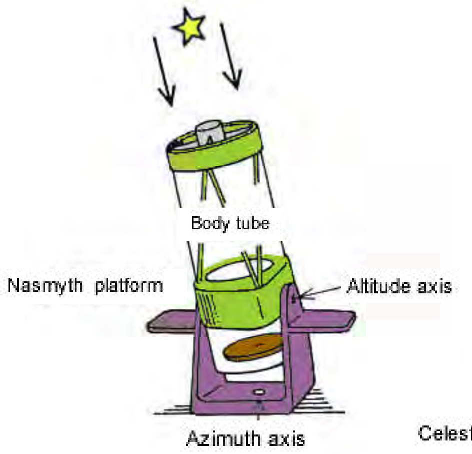
Various kinds of mounts are used for telescopes. Each one has its own special characteristics, which are described below. The examples given include telescopes at Okayama Astrophysical Observatory:

1. Alt-azimuth mount

This style of mount moves the telescope in the vertical and horizontal directions. The mechanism utilizes 2 axes: the azimuth axis and altitude axis. The structure is relatively simple; however, computer control is needed for tracking the diurnal motion of stars because the mechanism moves in a different manner than stars do.

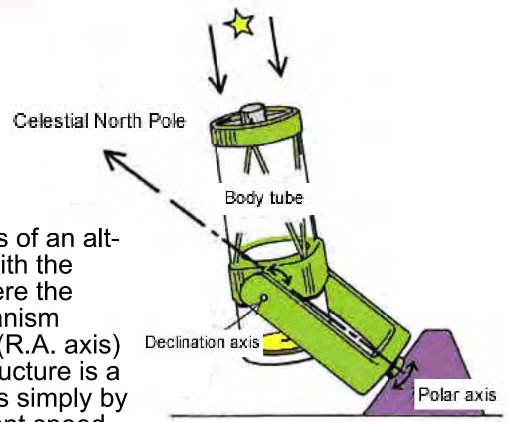
Also, the field of view rotates during long time exposures, so an image rotator is required.

This style of mount is used for the Subaru Telescope and is also used for Dobsonian telescopes for amateur astronomers.



2. Equatorial mount

The equatorial mount consists of an alt-azimuthal mount tilted to align with the Earth's polar axis at the site where the telescope is located. The mechanism utilizes two axes: the polar axis (R.A. axis) and the declination axis. The structure is a bit complex, but it can track stars simply by driving the polar axis at a constant speed.



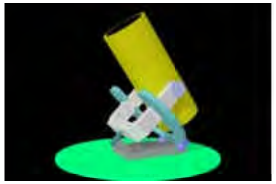
2.1. Symmetrical mounts for equatorial telescopes

A fork mount integrates the polar axis support and driving mechanism into a single piece. On the other hand, a yoke mount is structurally stable as it supports the polar axis from above and below, but the telescope cannot point in the polar direction. A polar disk type is a simple way to provide a sturdy and high-precision mount, because it supports and drives the telescope with two rotating rollers along the periphery of a disk. A horseshoe mount is a polar disk mount where the disk is instead shaped like a horseshoe.

Fork mount

Yoke mount

Polar disk mount



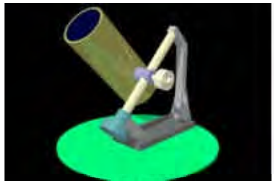
Horseshoe mount

2.2. Asymmetrical mounts for equatorial telescopes

An asymmetrical mount for an equatorial telescope uses a large counterweight or offsets the boom to maintain balance. One example of this is the German mount, in which the polar axis support and driving mechanism are integrated into a single piece. In contrast, the English mount provides a large but stable mechanism as it supports the polar axis from above and below. An offset boom-type mount can be thought of as half a fork mount.

Okayama's 188-cm Relector Telescope uses an English mount.

German mount



English mount

Offset boom mount