

### 3.7 Tips for Improving Alignment Accuracy

#### Eyepiece

It is very important to put the alignment stars at the center (or the same spot) of the FOV of the telescope's eyepiece during the alignment process. Thus,

- It is recommended that a reticle eyepiece is used for alignment.
- If a reticle eyepiece is not available, try using an eyepiece with a shorter focal length to yield a smaller FOV. Users can defocus the telescope to obtain a large star disk in the FOV. Centering the star disk in the FOV is easier than centering a sharp star.
- During the alignment process, avoid changing or rotating the eyepiece and the diagonal mirror.

#### Mechanical Backlash

All mounts have some mechanical backlash on both axes. To avoid introducing alignment error from backlash, users should keep the following rules in mind:

- When centering an alignment star in the eyepiece, the operation should always end by using the **UP** and **RIGHT** direction keys to move the axes.
- If there is an overshoot when centering alignment star in eyepiece with **UP** or **RIGHT** keys, use the **LEFT** or **DOWN** keys to pull the star back to the edge of the FOV and then use the **RIGHT** or **UP** keys to center the star again.

#### Alignment Stars Selection

The choice of alignment stars might also impact the alignment accuracy. Please refer to Section 3.8 on the rules of choosing alignment stars for various mounts and alignment methods.

### 3.8 Comparison of Alignment Methods

#### 1. Equatorial Mount with 1-Star Alignment:

Advantage: Quickest alignment.

Preconditions:

- An accurate polar alignment for the mount.
- Small cone error in the telescope-mount setup.

If the cone error is large, there will be noticeable offset in the R.A. when the SynScan hand control locates an object that is:

- » On the other side of the meridian from the alignment star
- » Deviated significantly with the alignment star in declination.

Rules for choosing an alignment star:

- Choose an alignment star with smaller declination. It will help the user to obtain higher resolution in R.A. movement in the telescope's eyepiece.
- If there is cone error in the telescope-mount setup or if users are not sure about it, it is recommended to choose an alignment star that is close to the object(s) to be observed.

### 2. Equatorial Mount with 2-Star Alignment:

Advantage: For visual observing, the mount does not need to be polar-aligned accurately.

Preconditions: Small cone error in the telescope-mount setup.

Rules for choosing alignment stars:

- The deviation in R.A. of the two alignment stars should not be too small or too close to 12 hours; the recommended deviation is between 3 hours and 9 hours.
- If there is cone error in the telescope-mount setup or if users are not sure about it, it is recommended to choose two alignment stars that are on the same side of the meridian. The absolute values of the two alignment stars' declination should deviate between 10 to 30 degrees.

**Note:** If the polar alignment of the mount is good, it is not necessary to choose “**2-Star alignment**” to align the mount, use the “**1-star alignment**” instead.

### 3. Equatorial Mount with 3-Star Alignment:

Advantages:

- Good pointing accuracy; even when the telescope-mount system has cone error.
- For visual observation, the mount does not need to be accurately polar-aligned.

Preconditions: The skies of both sides of the meridian are clear of obstructions.

Rules for choosing alignment stars:

- The 3 alignment stars should be spread out on both sides of the meridian.
- For the two alignment star on the same side of the meridian, their R.A. deviation should be greater than 3 hours, and the absolute value of the difference between the two alignment stars' declination should be between 10 to 30 degrees.  
(  $10^\circ < |\text{Dec1} - \text{Dec2}| < 30^\circ$  )
- If there is cone error in the telescope-mount setup or users are not sure about it, avoid the situation that all 3 alignment stars have small declination (close to the celestial equator).

**Note:** If users are sure that there is no (or very small) cone error in the telescope-mount system, then it is not necessary to choose the “**3-star alignment**” to align the mount. Use “**1-star alignment**” or “**2-star alignment**” instead.

### 4. Alt-azimuth Mount:

The “**Brightest Star Alignment**” is designed for entry level users who cannot identify stars in the night sky, and the “**2-Star alignment**” is for users who know the names of the stars in the night sky. Both alignment methods provide the same level of precision.

Rules for choosing alignment stars:

- It is recommended that the altitude of the two alignment stars are between 15 and 60 degrees and the deviation in altitude is between 10 and 30 degrees.
- The azimuth deviation of the two alignment stars can be between 45 and 135 degrees, it is best to be close to 90 degrees.