

Alignment tips for “i” series telescopes

Jean C. Piquette

Note: This document provides additional information that supplements a companion document, “Alignment tips- Quick Start guide for i series telescopes”. The quick-start guide is the better document to use if your interest is primarily getting improved GOTO performance from an “i” series telescope. The present document gives more-detailed explanations for those who are interested. Of course, if you still have questions, these would be welcomed on the Nexstar list.

Preliminaries – First, it should be pointed out that these instructions are not intended to be the most complete and general directions possible. One way to align an “i” series scope will be discussed. There are likely more ways it can be done. But only one way will be considered here. That one way has been found to be very successful in practical tests.

Next, let’s discuss what you *don’t* have to worry about with these scopes. Leveling the scope is not particularly important. Positioning the tube in the orthogonal (perpendicular) direction is also not very critical. Similarly, the index position is not particularly crucial. When directed to set the telescope “index and North” during the alignment process, simply driving the scope until it seems more or less horizontal and more or less points toward the North is sufficient. However, it is worthwhile noting that the closer you come to the “North and index” position, and the more level the scope, the closer the scope will come to pointing accurately toward the stars it selects during its *initial* slews in an auto-align. So, it is worthwhile not being grossly sloppy in these matters. On the other hand, once the alignment process is successfully completed, the quality of the initial leveling, index position setting, and directing North will have no effect on the quality of the GOTO results obtained.

General guidelines- Now, let’s discuss what items *are* crucial to do accurately. The first is the final approach direction to the index position when you are starting an auto-align. In approaching the index position, always initially drive the tube below the index position. Then move the tube back upward until the index position is reached, or at least approximately reached. Although being exactly at the index position is not critical, the final movement of the tube in approaching the index position *is* important. That final movement must be in the upward direction.

It is also important to carefully center the alignment stars in the field of view (FOV) when directed to do so during the alignment process. A fairly accurate way to achieve good centering is to use the “defocusing trick,” in which you intentionally defocus the alignment star until it becomes a giant blob in the FOV. This makes centering the star in the FOV easier.

In an “i” series scope, it is also possible to change the final approach direction taken during a GOTO slew. As these scopes arrive from the factory, the default final GOTO approach direction is *positive* in azimuth and *negative* in altitude. The final approach direction should be changed to *positive* for both directions. (Empirical testing of both settings showed that the positive setting gives a higher GOTO hit rate.)

It is important that your final approach to each alignment star be done in one way. With the final GOTO approach directions both set to positive, that one way is *down* and *to the right*. Since directions of movement can be ambiguous, it should be understood that these “down” and “to the right” directions refer to the direction buttons on the hand controller at low slew speeds. Low slew speed is automatically set in the hand control (HC) during the final stages of aligning on a star, at least during an auto-align. So, what you want to do is to make sure your final direction-button presses in lining up an alignment star in the FOV of the eyepiece are the “down” and “right” buttons. If you go too far in one direction, it’s OK to back up. Just be certain that, before you press the “align” button, you have pressed the “down” and “right” directions buttons *last* on the HC.

The suggestion to use “down and right” final direction-button presses in centering alignment stars differs from the directions given in the users manual, which suggest using “up and right.” The correct direction buttons that you need to press in centering alignment stars for best GTO accuracy depend on how the final GOTO approach directions are set in the HC. As the HC arrives from the factory, the default setting for the final GOTO approach direction in alt is *negative*, and the manual thus suggests using “up and right” final button-presses in centering alignment stars. But since the results of the empirical tests showed that the *positive* setting in alt gives a higher GOTO hit rate, we must change the final direction button presses to “down and right” for best GOTO accuracy.

It is also important to choose alignment stars that are as far apart in angle as possible. Approximately 70 degrees is about the minimum you should consider using, but separation angles exceeding 100 degrees are preferred.

The “alignment line” and the “GOTO swath”—In understanding how your choice of alignment stars affects the quality of the GOTO behavior, it is useful to introduce a couple new terms:

The “alignment line” is an imaginary line, along the celestial sphere, connecting the two alignment stars. (This is much like the imaginary line represented by the celestial equator.-In fact, if the two alignment stars are both located on the celestial equator, the alignment line for those two stars *is* the celestial equator.)

The “GOTO swath” is an imaginary region, or area, of the sky located on either side of the alignment line, within which GOTO’s have sufficient accuracy to get within the FOV eyepiece. (It is assumed that the eyepiece has a FOV of about 0.6 degrees, which is the width of the FOV for the 25mm Plossl that is supplied with an N8i telescope.) For two alignment stars separated by 100 degrees or more, the

GOTO swath has an angular width of about 70 degrees on either side of the alignment line. As the separation of the alignment stars is reduced below 100 degrees, the width of the GOTO swath is reduced as well. For alignment stars separated only by about 70 degrees (the minimum separation you should consider using), the GOTO swath extends to about 50 degrees to either side of the alignment line.

As these terms imply, the quality of GOTO is not the same everywhere in the sky. It varied both with the *angular separation* of the two alignment stars and with the *positions* of the alignment stars relative to your desired GOTO target. So it is important to keep in mind the patch of sky covered by your GOTO swath. If you have picked Polaris and another star just slightly South of the Zenith (hopefully, this second star is at least 70 degrees away from Polaris), you have a patch of sky about 50 degrees to either side of the Meridian where GOTO's will be fairly accurate. On the other hand, if you pick one star near the Southeast horizon and a second star near the Northwest horizon (see example below), your GOTO swath widens out to 70 degrees on either side of the line connecting these two stars, and covers just about the entire sky. (But there is a hole in GOTO accuracy located low in the Southwestern sky.--See example below.)

Example- This example refers to using an eyepiece of about 0.6 degrees width. Thus, for an object to get into the FOV, the GOTO accuracy must be 0.3 degrees or better. This is a reasonable goal for an "i" series telescope. The example test described here was done on the evening of December 26th, 2002, between the hours of 7:30PM and 9:30 PM. During an auto-align in which Rigel and Deneb (angular separation: 122+ degrees) were used as alignment stars, and in which the general guidelines above were followed, the following results were obtained:

- 1) Albireo (located above Western horizon): Got into the FOV, but was near its upper central edge.
- 2) Vega (located above the West-Northwestern horizon): Got into the FOV, but was near its upper central edge.
- 3) Uranus and mu Capricorn (located above Southwestern horizon): Got into the FOV, near its upper left edge.
- 4) Betelgeuse (located near Southeastern horizon): Got into the FOV, but near its lower central edge.
- 5) Crab Nebula (M1) (midway between the Eastern horizon and the Meridian): Got into the FOV, near the lower right edge.
- 6) Saturn (located about midway between the Eastern horizon and the Meridian): Got into the FOV, near the lower left edge.
- 7) Capella (Located near the Northeastern horizon): Got near, but somewhat below, the center of the FOV.
- 8) Mizar (Located on the Northern horizon): Got into the FOV, near its center.
- 9) Blue snowball (Located on the Western side of the Zenith)- Got into the FOV, about half the radius of the FOV away from center, toward the upper left of the FOV.
- 10) Fomalhaut (Located near the South-Southwestern horizon): Fell outside the FOV.

Notice that objects on the Western side of the sky fell generally high in the FOV, while objects on the Eastern side of the sky fell generally low in the FOV. The alignment stars fell in a Southeast-Northwest line during this test. The GOTO swath thus covered almost the entire sky, with a hole in GOTO accuracy located in the Southwest. While it may seem surprising that Mizar got close to the center of the FOV, despite being near the Northern horizon, this is because the angle from Mizar to the alignment line between Rigel and Deneb is only a little more than 60 degrees. This is well within the 70-degree GOTO swath for these two alignment stars. The fact that Fomalhaut fell outside of the FOV should be expected, since its angle to the alignment line is 85 degrees, well in excess of the 70-degree GOTO swath.