ASTRO-PHYSICS, INC.
POLAR ALIGNMENT TELESCOPE (PASILL4)

This is our current model which began shipping in November 2005. It has an updated reticle good through 2030. It fits all 400, 600, 600E, 800, 900 and 1200 models (except the original black 1200s) and the new Mach1GTO.

PARTS LIST

Polar Alignment Telescope with two covers
Battery pouch, including:
- Illuminator with cable
- Battery holder with cable and two AA batteries

0.9mm Allen wrench
27.5" Cable to power the reticle from your Astro-Physics mount (part # CABPAS3)

POLAR ALIGNMENT TELESCOPE

This Polar Alignment Telescope (also called a polar axis telescope, polar finder or polar scope) will help you to align your mount with the Celestial Poles. When your mount is properly aligned, your telescope's drive will accurately track celestial objects as they pursue their daily motion across the sky. This will allow you to keep the object you are viewing in the center of your field-of-view, and eliminate the need for manual adjustments. This polar scope can be used in both the Northern and Southern Hemispheres.

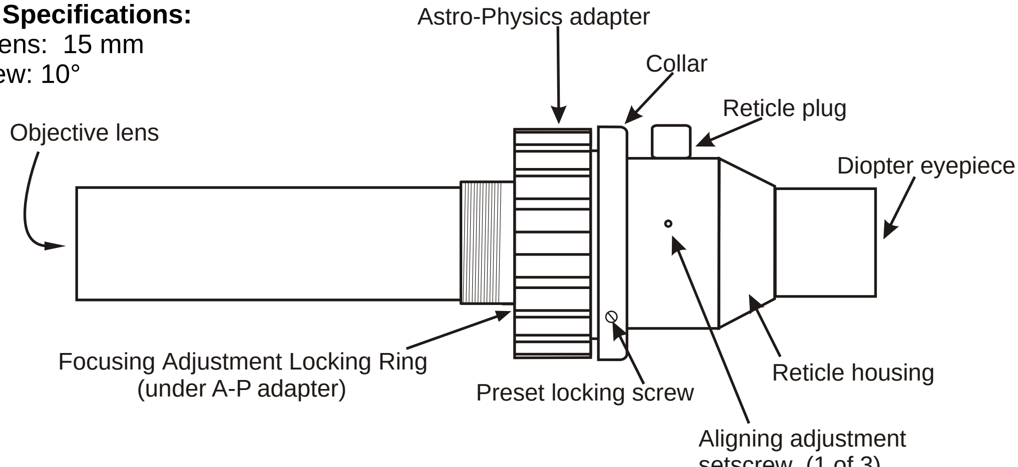
THE RETICLE

Your Polar Alignment Scope has a new reticle, designed for accurate alignment from 2005 until 2030. Two alignment stars have been added for the Southern Hemisphere to help with the trickier alignment faced by those of you who are "down under."

Why did the reticle need to be updated? We think of the stars as being fixed in space, but this is not the case. There are two principal ways in which the stars' motions require us to periodically revise the reticle for accurate alignment. First, and most important, is actually our planet's fault. The earth's tilted axis precesses like a spinning top that has been bumped. It's axis traces a circle in the sky every 26,000 years or so. This means that the actual pole's position is constantly changing with respect to distant stars, albeit very slowly. (It also means that in 13,000 years, our distant ancestors will have exactly reversed seasons.) Second, the so called fixed stars, along with our sun, are actually whirling around the gravitational center of our galaxy in various elliptical orbits. Because of this, each star has its own proper and apparent motion in the sky relative to every other star. These motions are generally not noticeable to the naked eye, but they can be enough to affect the accuracy of star charts and reticles over a period of years.

Why do Polaris and σ Octantis only have one radial line in the reticle and why do they move within their gaps from epoch to epoch? Polaris in the north and σ Octantis in the south are used as pivot stars to which the other stars must be related in order to arrive at the true pole. This is done to simplify the alignment process. As their positions relative to the actual pole change in right ascension, the other stars' radial lines are adjusted to compensate. However, there is no way to also compensate for their changes in declination, so a gap is required along their respective radial lines. As their declinations change over time, their positions within these gaps must also change accordingly. During the 25 years covered by the reticle, Polaris' declination will increase by about 6 minutes of arc, while σ Octantis' declination will increase (become less negative) by about 7 minutes.

Polar Axis Scope Specifications:
- Objective lens: 15 mm
- Field of View: 10°



ILLUMINATING THE RETICLE

The illuminator (stored in the battery pouch) contains a red LED to light the reticle lines in the polar axis telescope and a short cable. The reticle can be powered with either two AA batteries or with power from the mount.

Using Batteries

First, remove the reticle plug from the polar scope. Thread the illuminator with its short cable in place. Attach the battery unit with its cable. You can leave the battery unit in the case, if you wish. There is no on-off switch, so you should unplug the battery unit when you have completed your alignment to preserve the life of your batteries. If you remove the illuminator at the end of your alignment, be sure to replace the reticle plug in order to prevent dust particles from accumulating on the reticle.

There is no way to adjust the brightness of the reticle when using the batteries. It is either on or off. For this reason, we prefer powering the reticle from the mount as described below.

Notes:
We suggest that you remove the batteries from the battery compartment when not in use. It could be damaged if the batteries leak. Extreme cold may reduce the effectiveness of your batteries.

Using the CABPAS3 Cable with Your Astro-Physics Mount

Important: The male connector should only be plugged into the GTO control box (or mount). If you attempt to use it as an extension cable between the illuminator and the battery, the LED will not light up.

First, remove the reticle plug from the polar scope. Thread the illuminator with its short cable into place. Attach the female connector of the CABPAS3 cable to the illuminator cable and the male end to the reticle output jack on the GTO control box or, on non-GTO mounts, to the 3.5mm reticle output jack on the mount itself. If you remove the illuminator at the end of the alignment procedures, be sure to replace the reticle plug in order to prevent dust particles from accumulating on the reticle.

The brightness of the LED can be adjusted with your keypad (GTO mounts) or controller (non-GTO mounts).

GTO Keypad
Follow your normal startup procedure until you get to the Main Menu.
V.3.x: Press 2=Setup, then NEXT to go to Setup-2. Press the 3 (decrease) or 4 (increase) button of your keypad to change the reticle brightness levels in increments from 0-9. This number will remain in the keypad memory for your next session, so you only need to set this level once.
V.4.x: Press 2=Setup, then 3=Keypad Options. Press the 2 (decrease) or 3 (increase) button of your keypad to change the reticle brightness levels in increments from 0-9. This number will remain in the keypad memory for your next session, so you only need to set this level once.

8010 Controller, Quartz Drive and Quartz Micro-Drive Controllers
Turn the knob labeled LED to the desired brightness level.

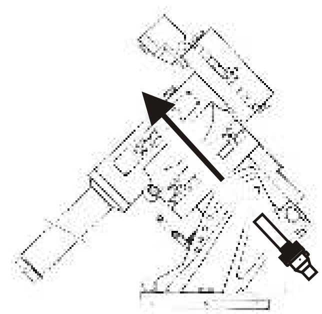
INITIAL ADJUSTMENTS

Adjusting the Focus

1. Reticle focus: Turn the diopter eyepiece until the reticle is in focus. This should always be done first.

2. Focusing stars: This is easiest to check in the daytime by focusing on a distant object. It is unlikely that you will have to make any adjustment. If you do, simply loosen the preset locking screw and remove the Astro-Physics adapter. Then, loosen the focusing adjustment locking ring which is now visible. Turn the objective tube until distant objects are sharply focused. Tighten the focusing-adjustment locking ring.

Installing the Polar Alignment Scope

1. Remove the polar axis rear cap and Dec axis sight hole cover.

2. Loosen the declination axis clutch knobs.

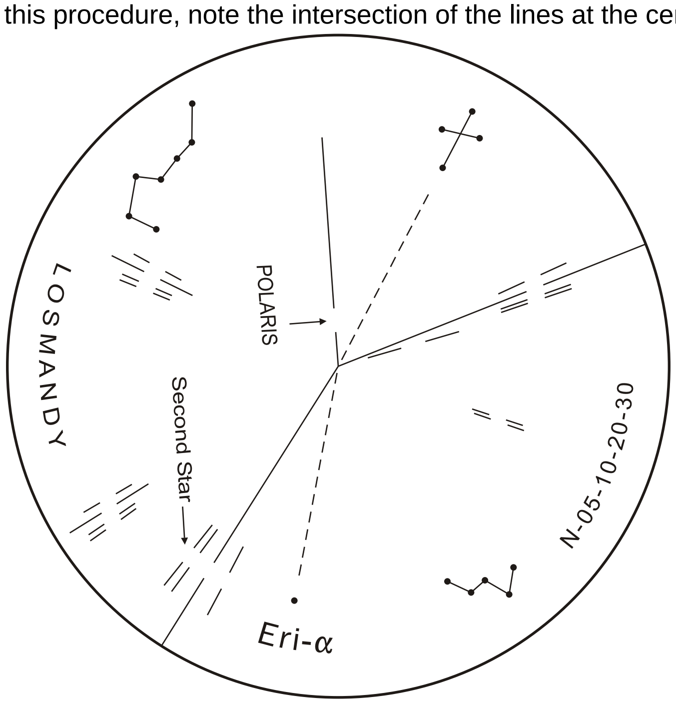
3. Turn the declination axis until the hole in the axis is aligned with the polar axis holes. You will be able to look through the mount as shown in the diagram.

4 .Tighten the declination axis clutch knobs.

5. Carefully screw your polar alignment telescope into the rear of your mount's polar axis. If you find that the threaded hole in the base of your mount is too large, you are missing a piece of your mount. Call Astro-Physics to order part # M4037 (polar axis shaft plug).

Optically Centering the Reticle

To properly align the telescope's polar axis with the north celestial pole, the reticle in the polar alignment scope must be precisely centered within the polar axis. A mis-centered reticle will result in excessive tracking error. Since the polar scope was prealigned at the factory, it is unlikely that you will have to make any adjustments. However, you should check to be sure that it is properly aligned. These steps only need to be performed before your first use. We suggest that you follow this procedure during the daytime. The following is a diagram of the markings of the reticle. For this procedure, note the intersection of the lines at the center.



With the Polar Scope Installed in Your Mount

1. Using your mount's azimuth adjustment knobs and altitude fine adjustment, aim your polar axis scope at a distant object, placing the object in the center of the field where the reticle lines meet. Choose some discrete point, such as the top of a telephone pole. Be careful not to lower the altitude enough for the motor housing to hit the mount when turning the right ascension axis. Tighten the adjustment knobs.
2. Rotate the reticle housing within the collar. The object should remain centered at the crossed lines. If the object moves off the reticle lines and travels in a circle, your polar scope needs adjustment. Try to imagine where the center of that circle is.
3. Using the Allen wrench provided, adjust by **gently** loosening and tightening the three aligning-adjustment setscrews on the reticle housing until the point where the reticle lines meet reaches the center of the imagined circle described in the previous step. ***This process must be done very carefully so that the setscrews do not damage the reticle. ALWAYS loosen the 2 setscrews that the reticle is going to move towards before you push the reticle with the remaining screw. Use small increments - this is fine tuning! REMEMBER - If the setscrews are tightened too much (beyond barely snug), the reticle will crack.*** At the time of this writing (2-8-06) there are **NO** replacement reticles available. Be sure all three setscrews are very gently snugged when finished. They should really just barely touch the glass.
4. Repeat steps 2 and 3 until an object placed where the reticle lines meet remains stationary when the polar scope is rotated in the collar.
5. Don't forget to turn off the illuminator when you're finished. You're now ready for nighttime polar alignment.

With a V-block or other holding device

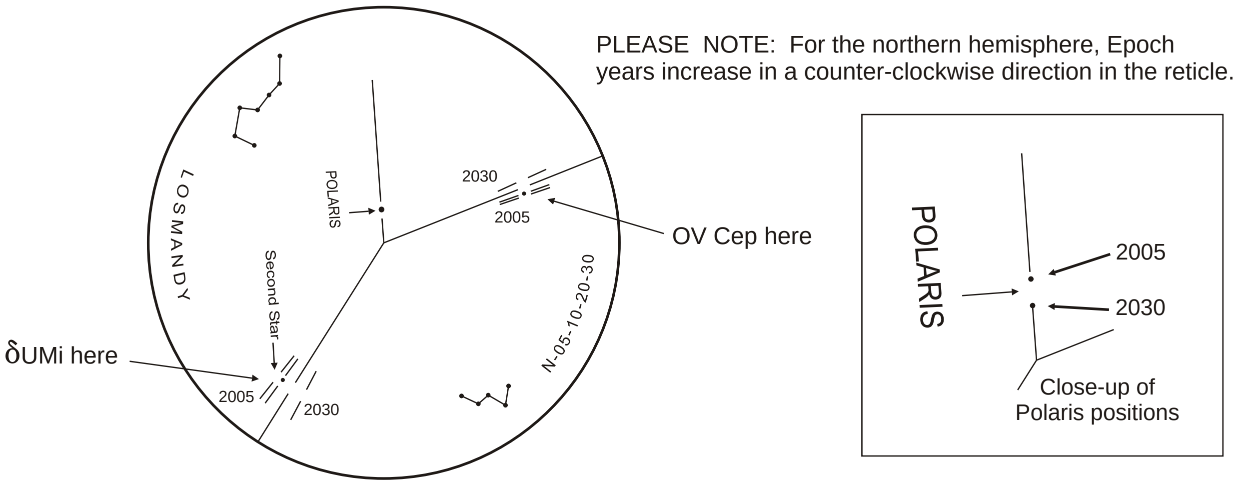
You can also align the polar scope by supporting the Astro-Physics adapter and collar in a stationary position while rotating the reticle housing. This can be accomplished with a v-block or other holding device in the daytime prior to installation in your mount. Focus on a distant object and follow steps 2-5 from the previous section.

Confirm the alignment when the Polar Scope is installed in your mount.

USING YOUR POLAR AXIS TELESCOPE

Northern Hemisphere

1. Set up your mount so that the polar axis (also called RA or Right Ascension Axis) is roughly aligned in azimuth toward Polaris.
2. Slightly loosen the bolt(s) that lock the polar axis of the mount in place. Adjust the elevation angle of the polar axis so that the polar axis is roughly pointed at Polaris in altitude. It is easier to adjust the polar axis if you turn the fine altitude knob with one hand while using the other hand to move the axis manually.
3. Adjust the declination axis (also called Dec. Axis) so that you can look through the polar axis. (See Installing the Polar Alignment Scope.) Clamp the declination axis in place. Thread the polar scope into the polar axis.
4. Thread the illuminator into the polar scope and apply power, if not done already.
5. Rotate the reticle housing of the polar scope so that the constellation reference lines on the reticle approximately match the current sky orientation of the Big Dipper and Cassiopeia. Note that these constellations will not actually be visible through the polar scope.
6. Use the mount's azimuth adjustment knobs and altitude fine-adjustment knob to move Polaris into the gap in its reticle line. Place Polaris approximately as shown in the appropriate diagrams (top of next page and page 7), not in the center of the gap. Polaris is given a single gap, because the other stars used in the alignment process are all positioned relative to it to arrive at the true pole. Polaris must move within its gap from epoch to epoch because it and the actual pole are approaching each other. In other words, Polaris' declination is increasing during the 2005 - 2030 time interval.
7. Rotate the right ascension axis to put Delta (δ) Ursae Minoris (marked "Second Star" in the reticle) somewhere along the appropriate radial line for the current Epoch.
8. Readjust the altitude and azimuth to bring Polaris back to the appropriate position in its gap.

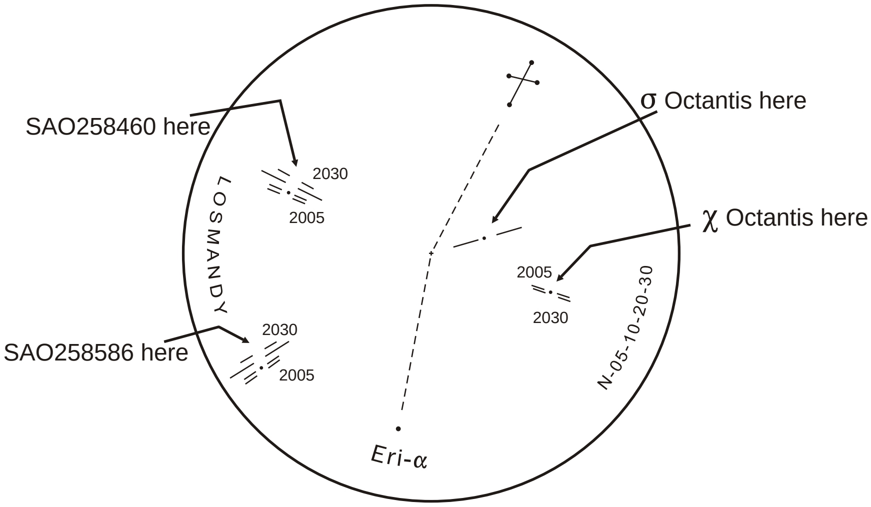


This diagram shows only the reticle lines used for Northern Hemisphere alignment.
The 4 sets of lines for δ UMi and OV Cep represent the Epochs 2005, 2010, 2020 and 2030. The gap in the longest line is for 2020, the 2 gaps on the 2 segments clockwise are for 2005 and 2010, and the remaining gap counter-clockwise is for 2030. The stars are diagramed in their Epoch 2010 positions.

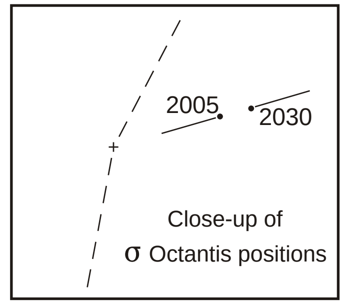
9. Repeat steps 7 and 8 until Polaris and δ UMi appear properly positioned in their respective gaps. Polaris will be off-center in its gap, as shown in the diagrams, and our actual field tests have shown that δ UMi should be slightly inward of centered - also illustrated in the diagrams.
10. You now have good polar alignment. If you can see a faint third star (OV Cephei) near the remaining set of gaps, you can fine-tune the alignment a little further. Initially, you might need to turn the illuminator off to spot this star. If OV Cephei lies anywhere along its line for the current Epoch, no further adjustment is necessary. If OV Cep is offset counter-clockwise, place Polaris a little farther inward along the Polaris line. If OV Cep is offset clockwise, place Polaris a little farther outward along the Polaris line. Repeat steps 7 through 10 until all three stars lie in their proper places along their respective lines.
11. Disconnect power from the illuminator, remove the polar axis scope, if you wish, and observe!

Southern Hemisphere

1. Set up your mount so that the polar axis is roughly aligned in azimuth toward the South Celestial Pole. Due to the lack of bright stars in the South Polar Region, you might prefer to do your initial rough alignment with the aid of a compass.
2. Slightly loosen the bolt(s) that lock the polar axis of the mount in place. Adjust the elevation angle of the polar axis so that the polar axis makes an angle above the horizon roughly equal to your latitude. (If you know the approximate position of the South Celestial Pole, you can just sight along the polar axis to see if you have the altitude about right.) It is easier to adjust the polar axis if you turn the fine altitude knob with one hand while using the other hand to move the axis manually.
3. Adjust the declination axis so that you can look through the polar axis. (See Installing the Polar Alignment Scope.) Clamp the declination axis in place. Thread the polar scope into the polar axis.
4. Thread the illuminator into the polar scope and apply power, if not done already.
5. Rotate the reticle housing of the polar scope so that the constellation reference line on the reticle approximately matches the current sky orientation of the Southern Cross and the star Alpha (α) Eridani (Achernar). Note that the Southern Cross and α Eridani will not actually be in the field of view of the polar telescope.
6. Adjust your mount's altitude and azimuth to place Sigma (σ) Octantis in its gap. For the southern hemisphere, σ Octantis is treated like Polaris in the north. It has a single gap and the other stars lines are adjusted around it. As the diagram shows, σ Octantis, unlike Polaris, will move out from the actual pole as the Epoch years increase.
7. Rotate your right ascension axis to place χOctantis somewhere along the appropriate radial line for the current Epoch.
8. Readjust the altitude and azimuth to bring σ Octantis back to the appropriate position in its gap.



PLEASE NOTE: For the southern hemisphere, Epoch years increase in a clockwise direction in the reticle.



This diagram shows only the reticle lines used for Southern Hemisphere alignment. The 2 sets of lines for χ Octantis represent the Epochs 2005 and 2030. The 4 sets of lines for SAO258460 and SAO258586 represent the Epochs 2005, 2010, 2020 and 2030. The gap in the longest line is for 2020, the 2 gaps on the 2 segments counter-clockwise are for 2010 and 2005, and the remaining gap clockwise is for 2030. The stars are diagramed in their Epoch 2010 positions.

9. Repeat steps 7 and 8 until σ Octantis and χOctantis appear properly positioned in their respective gaps. σ Octantis will be off-center in its gap, as shown in the diagram, but χOctantis should be relatively centered.
10. Two additional stars on the other side of the pole have been added to this reticle: SAO258460 and SAO258586. Use them to fine tune your alignment. Again, you may need to turn off the reticle to spot these stars initially. The diagrams on page 8 show the positions of all 4 alignment stars for the reticle's 4 epochs.
11. Disconnect power from the illuminator, remove the polar axis scope, if you wish, and observe!

For questions or comments, contact:

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Many thanks to Sue and Alan French for their contributions to these instructions.
September 2002 and February 2006

You just might need to know ...

Northern Hemisphere

Polaris = α U Mi = 1 U Mi = SAO308 = HIP11767 = HD8890 = ADS1477 A

δ U Mi = 23 U Mi = SAO2937 = HIP85822 = HD166205

OV Cep = SAO1168 = HIP37391 = HD51802

Southern Hemisphere

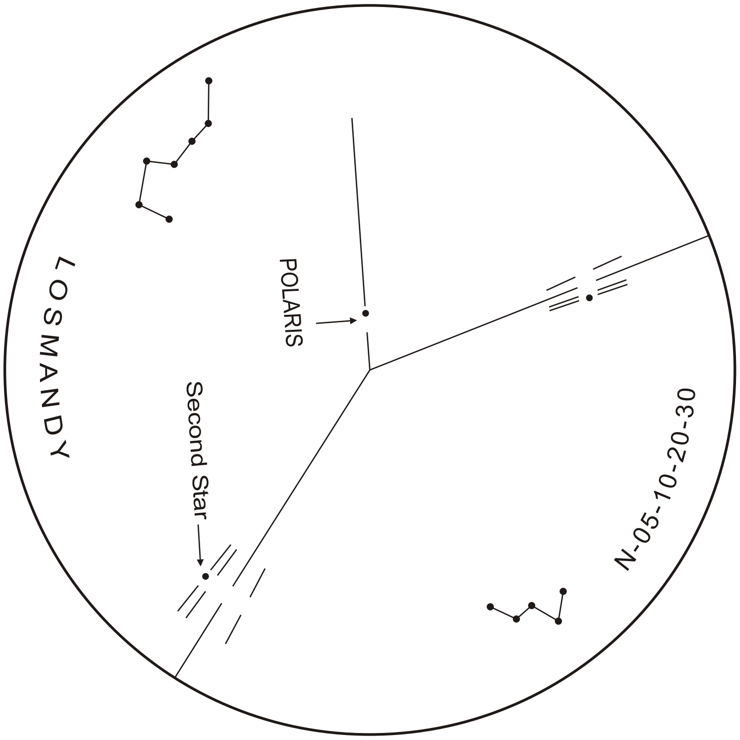
σ Octantis = SAO258857 = HIP104382 = HD177482

χ Octantis = SAO258799 = HIP92824 = HD164461

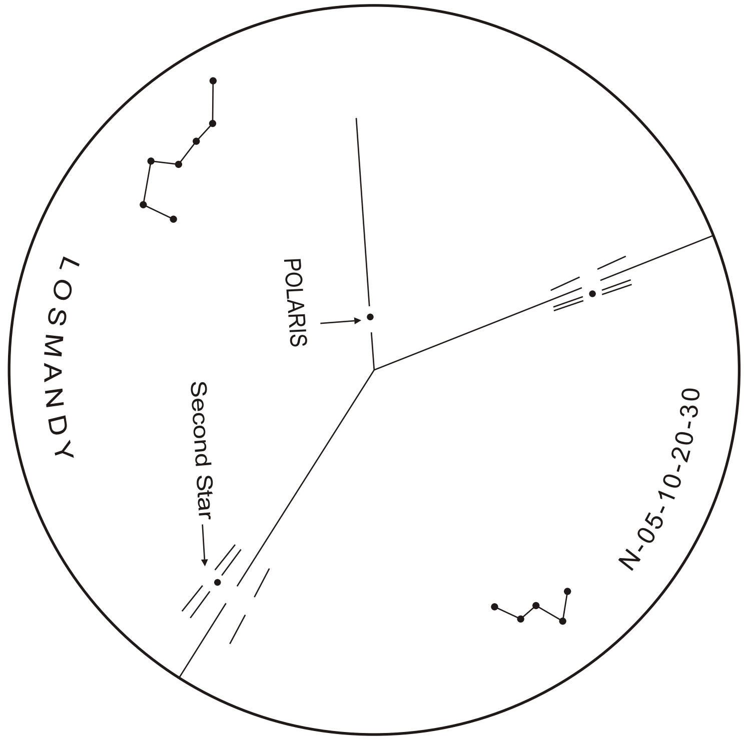
SAO258460 = HIP32500 = HD58805

SAO258586 = HIP51472 = HD92683

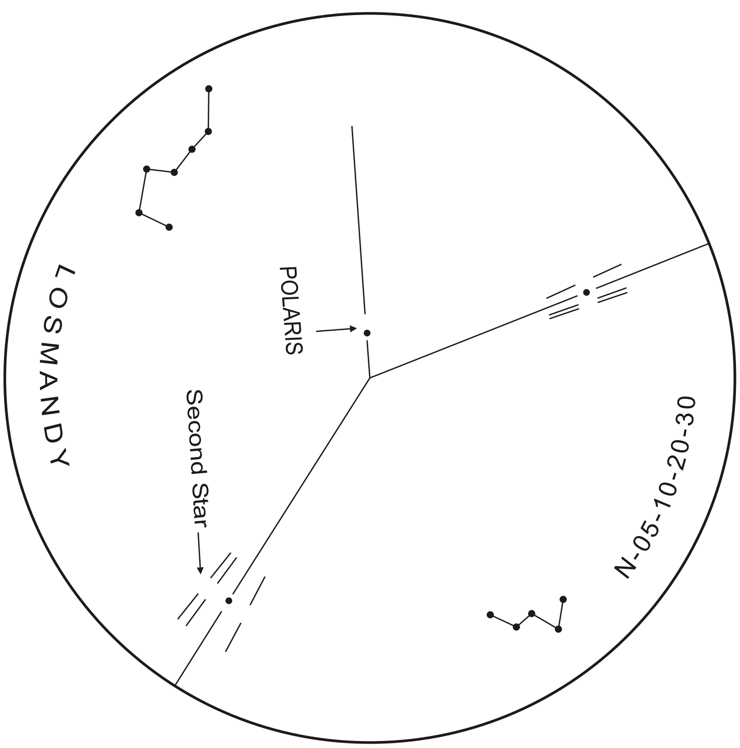
Northern Hemisphere Epoch Screens



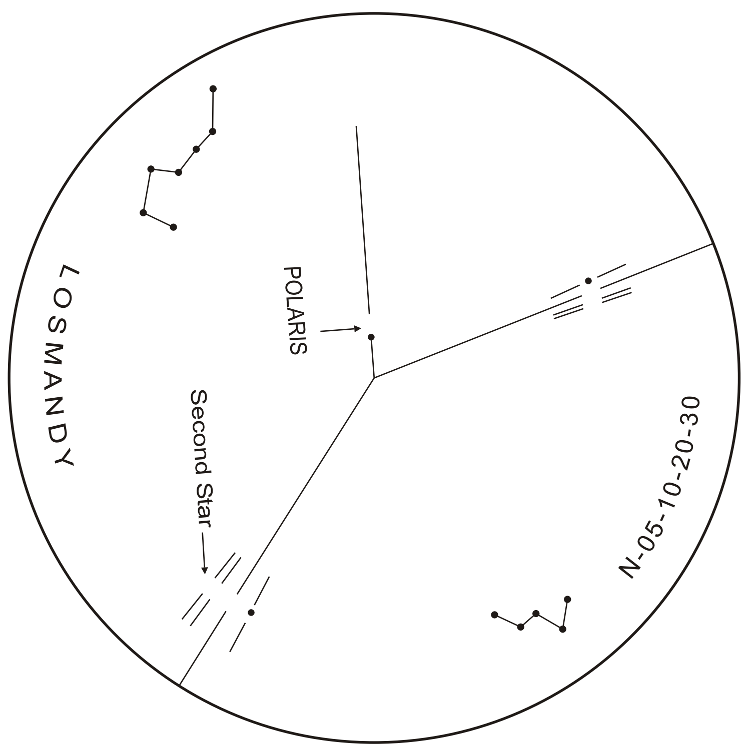
2005



2010

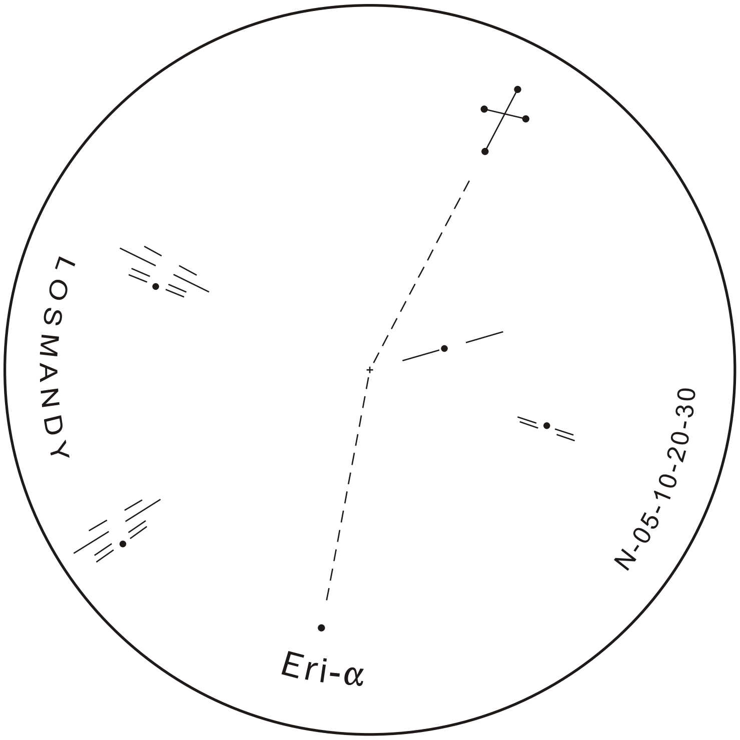


2020

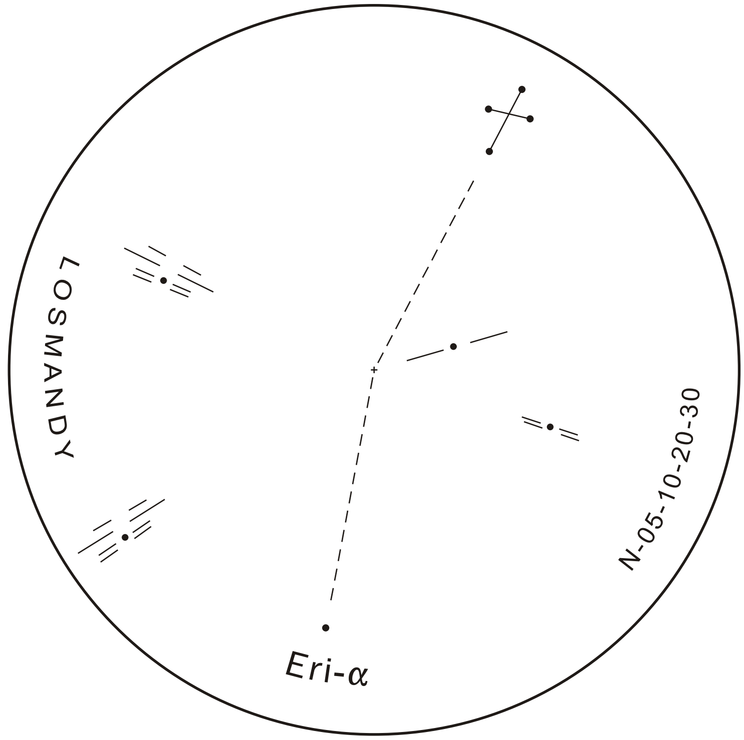


2030

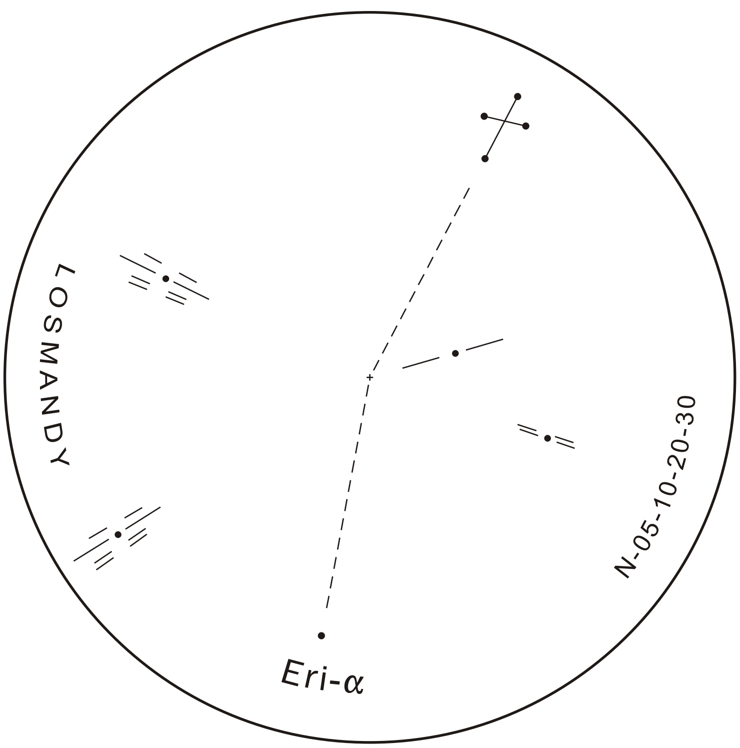
Southern Hemisphere Epoch Screens



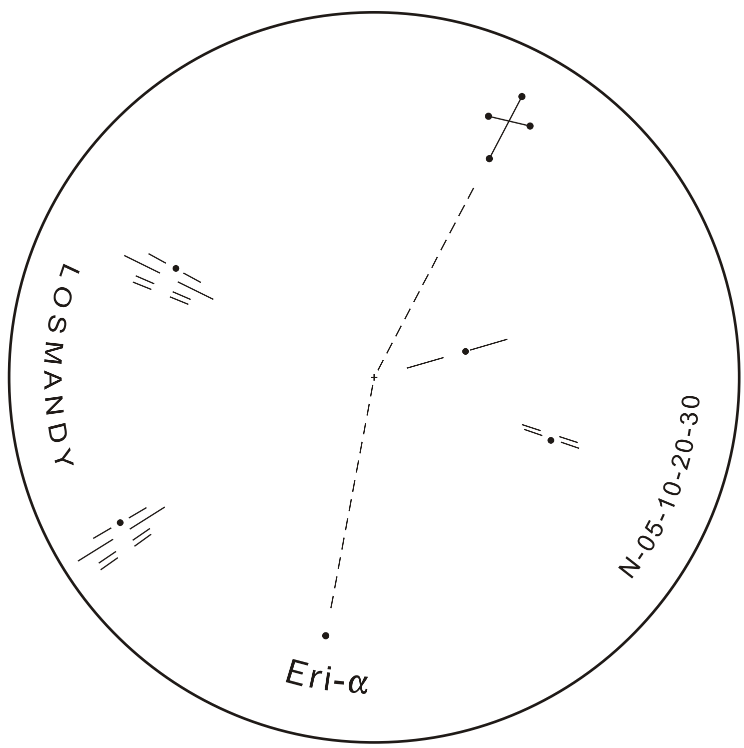
2005



2010



2020



2030