Sagitta OAG Motorized Off-Axis Guider

Step-by-Step Instructions for Installing and Adjusting the Optec Sagitta Off-Axis Guider with Motorized FocusLynx control.

Introduction

Optec engineers designed the Sagitta OAG to provide a solution for remote imagers who require the ability to adjust guide camera focus independently of the imaging camera focus.

Optec's Sagitta OAG can be purchased with the guider motor attached (#19340) or without the motor for manual guider focus (#19342). The motorized version requires the FocusLynx control hub and is an ideal use of the Focuser 2 port for owners of FocusLynx or FocusBoss II controllers.

Featuring a full 3-inch (76.2mm) clear aperture, Sagitta includes a high-quality fully multi-coated pick-off prism with 12.5mm clear aperture to the guide camera. Sagitta features a large brass split-clamp for attachment of any 1-1/4" format guide camera with plenty of range for setting the guide camera parfocal to the imaging camera. Adjusting the prism stalk height can be accomplished with a single tool and provides prism engagement adjustment of 12mm. Overall, guide camera adjustments exceed 42mm while the OAG body thickness is held at only 31.75mm or 1-1/4".

Designed as a robust alternative for the OAG market, Sagitta can be installed and configured for years of unattended use. A new, shorter 3-inch dovetail standard, the OPTEC-3000-S, rounds out the package with a variety of mating adapters. Any required adapter not available from Optec's expanding inventory can be ordered through Precise Parts (www.preciseparts.com) to complete the camera side or telescope side connections to your imaging gear.

Package Contents

Confirm the contents of your Sagitta OAG off-axis guider package. The package should contain the following:

- Sagitta OAG assembly with attached motor (not included with manual version),
- Cat-5e or Cat-6 Ethernet cable,
- Male Astro-Physics 2.7-inch threaded adapter,
- Female Astro-Physics 2.7-inch (AP2.7) threaded adapter,
- Tool kit including 0.050" hex key, 5/64" and 3/32" ball drivers.

The included Cat-5e or Cat-6 Ethernet cable is intended to be attached between the FocusLynx hub Focuser 1 or Focuser 2 port and the Sagitta motor. This cable can be replaced with any suitable length Cat-5e or Cat-6 cable.

IMPORTANT NOTE: Optec's FocusLynx hub and driver software are required for motorized control of the Sagitta OAG focuser.

Features

Overview

The overall thickness of the Sagitta OAG is 1.25-inches without adapters. This is the same thickness as most guide cameras on the market today. Therefore, the camera holder is slightly wider at 1.4" or 35.5mm. Both telescope-side and camera-side interfaces are 3-inch bores with three oval-point stainless screws to secure our new line of OPTEC-3000-S short 3-inch dovetail adapters. Each adapter will typically add 1/10" (2.5mm) for an overall working optical thickness of 1.45" or 36.8mm.

The outside diameter of the main body is 3.8" (96.5mm). With a focal travel distance for the guide camera of 0.5-inch, the overall length to the top of the guide clamp varies from 150mm to 162.8mm.

Sagitta's focus motor is neatly nestled along one side and engages directly with the manual focus knob which doubles as an 80-tooth gear when the motor is attached.

Sagitta Focus Motor

The Sagitta focus motor includes a high torque bi-polar NPM stepper motor in a 25mm diameter body and 2:25 gearhead. The integrated circuit board includes a temperature sensor similar to the QuickSync and DirectSync motors offered by Optec. The motor can be detached for manual guider focus by removing four 4-40 socket cap screws using the 3/32" ball driver tool.

The motor assembly is also sold separately for owners of manual Sagitta OAG's wishing to convert to the full motorized version. Contact Optec Sales and specify stock #19349.

Like the TCF series focusers, Sagitta's motor is a true absolute homing focuser. As such, it will home upon initial power up and return to the last parked position. Home-On-Start can optionally be disabled in a future release of FocusLynx Commander. Sagitta's focuser mechanism is very robust and will maintain absolute position between power cycles.

FocusLynx Controller

Optec's FocusLynx controller (stock #19690) running firmware version V2.3.2 or later is required for operation of the Sagitta motor. See https://optecinc.com/astronomy/catalog/focuslynx/index.htm for full details regarding the FocusLynx system and options.

The FocusLynx standard package includes our 12VDC power supply with wall cord, flat Cat-5e or Cat-6 Ethernet cable (interchangeable with Sagitta's motor cable), and Optec's USB/Serial communications cable.

A second stepper board can also be ordered separately (stock #19533) for owners of the FocusLynx/FocusBoss II hub.

FocusLynx is fully compatible with all ASCOM and ASCOM Alpaca clients as well as TheSky X and INDI. See section below for FocusLynx Software Setup.

Specifications

SAGITTA OAG SPECS:

Clear Aperture:	3.0 inches (76.2mm)
Pick-off Prism:	12.5 x 12.5mm fully multi-coated
Guider Aperture:	12.5mm
Focuser Travel:	0.5 inches (12.7mm)
Mechanical Thickness:	1.25 inches (31.7mm)
Telescope-side Interface:	OPTEC-3000-S receiver [AP2.7 male adapter installed]
Camera-side Interface:	OPTEC-3000-S receiver [AP2.7 female adapter installed]
Focuser Type:	Helical with integrated gear
Prism Stalk Adjustment:	0.47-inch (12mm)
Guide Camera Clamp:	360 Brass (non-marring), 3/32" ball driver lock with spring return.
Material:	6061 aluminum, black anodize
Weight:	8.6 oz (245g) without motor 14.2 oz (0.4kg) with motor

MOTOR SPECS:

Motor Type:	NPM Bi-polar stepper motor with 2:25 gearhead
Motor Gear:	16-tooth, 360 brass
Manual Focus Gear:	80-tooth, anodized 6061 aluminum
Step size:	0.95 micron
Full travel steps:	12,000 steps
ASCOM Device Type:	iFocuserV3 Homing Absolute Focuser

SOFTWARE COMPATIBLITY:

|	
ASCOM:	All clients with iFocuser3 support
ASCOM Alpaca:	Windows, Mac, Linux, iOS, Android
INDI for Linux:	Support through FocusLynx
TheSky X	Native X2 driver, ASCOM
Device Type Selection:	Sagitta OAG

Configuration

A little advance planning will make installing the Sagitta OAG much easier in the field. We want to set the guide camera and the main imaging camera at the same telescope focal point. The Sagitta OAG motor has a full 12.7mm of travel but we still need the two focal points to be close. In practice, we'll want the guide camera focus and imaging camera focus to be within at least 10mm of each other initially.

Optical Path Length

Our goal is to set the auto-guider and imaging sensor Optical Path Length to the same distance. We call this a parfocal adjustment or simply "parfocalizing" the system. In practice, it is far easier to parfocalize your system than the long explanation below suggests. Skip to the Installation Procedures section if you already have a good understanding of parfocality and have already set up an off-axis guider.

The Optical Path Length or OPL is the optical distance that light must travel to reach the camera sensors. The OPL is typically the mechanical distance from a common reference surface plus approximately 1/3rd the thickness of any intervening glass such as filters or CCD cover glass. We need to add this extra optical distance due to the refraction of light. A full explanation is beyond the scope of this document, but for simplicity sake, we can add 1/3rd the thickness of any optical filters to the OPL when estimating back-focus distances. Most astronomical filters are approximately 3mm thick and are only placed behind the OAG so we can add 1mm to the mechanical distance for the imaging sensor.

Thus, a camera with a mechanical flange back-focus distance of 17mm plus a 20mm thick filter wheel attached directly to the camera face will have an OPL of 38mm (17mm + 20mm + 1mm for the filters). Ideally, we want our auto-guider OPL to match this distance.
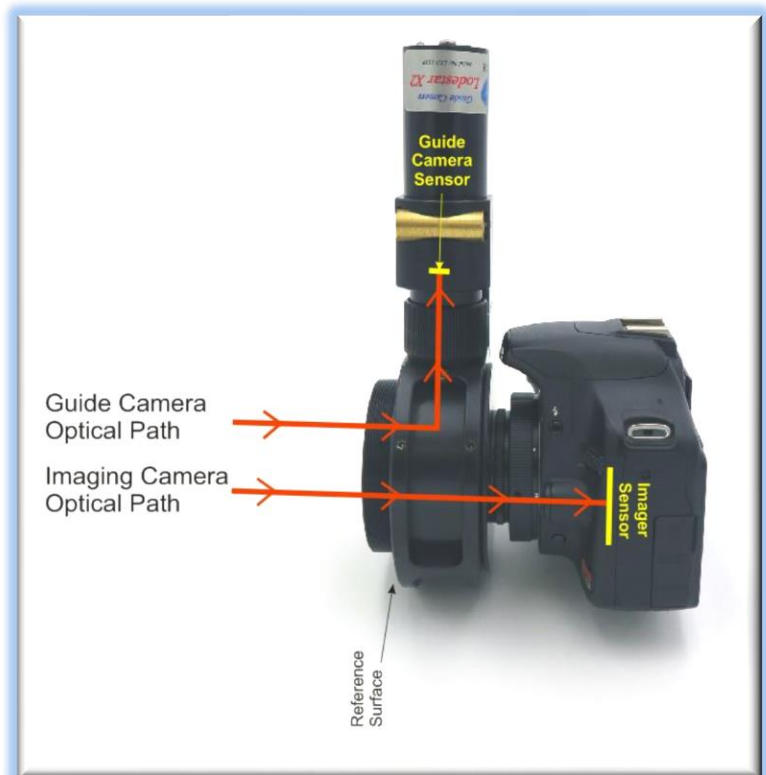
To clarify and simplify, we should choose a common point-of-reference for both auto-guider and imaging sensor. For the Sagitta OAG, we can use the front (telescope-side) of the OAG body as our reference surface. The diagram above shows the reference surface.

OAG Adjustments

The diagram below shows the available adjustments that can be made with the Sagitta OAG. For example, the pick-off prism stalk can be adjusted 12mm (see the Set Prism Depth section below). The diagram indicates a range of 14mm to 26mm **as measured from the center of the telescope's optical axis to the bottom of the prism**. The optical axis corresponds to the center of the imaging sensor.
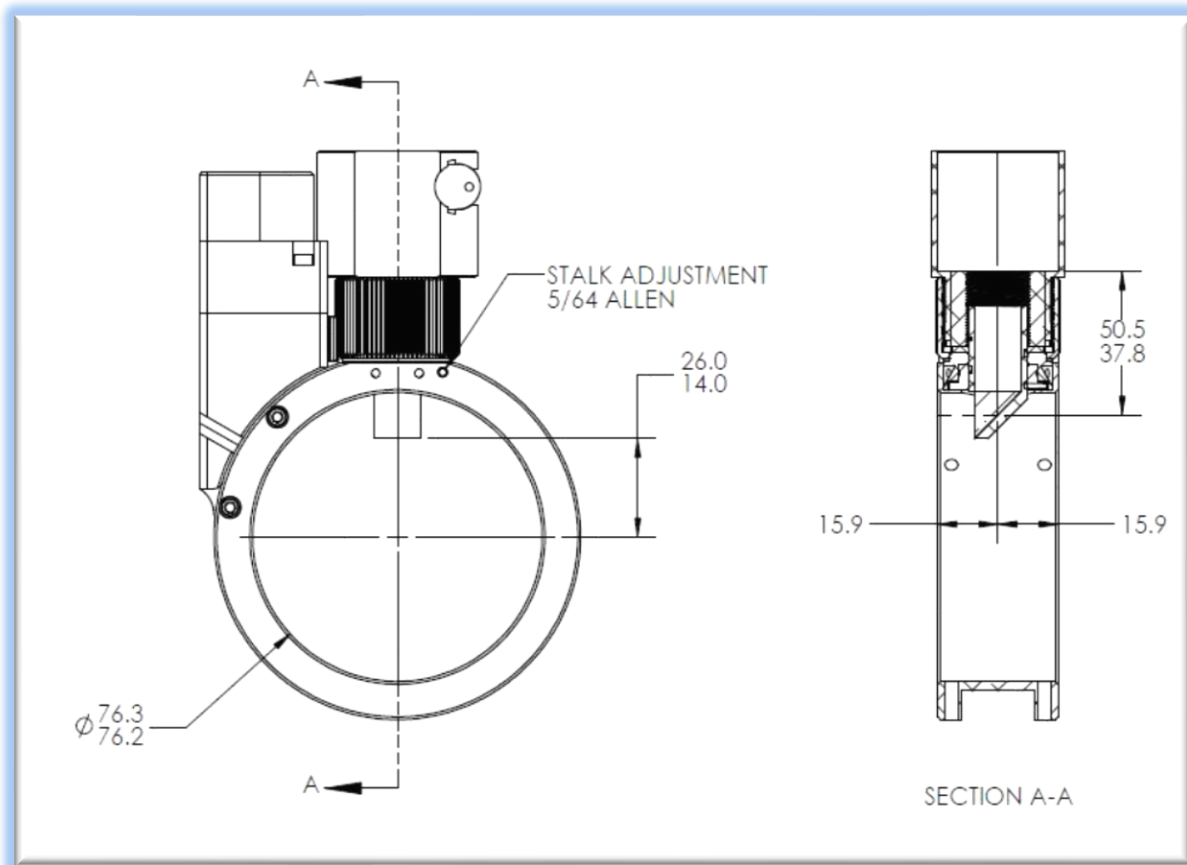

Additionally, the Sagitta focus mechanism provides another 12.7mm of adjustment. Measured from the center of the pick-off prism, this distance ranges from 37.8mm to 50.5mm when the pick-off prism stalk is all the way up (26mm from the telescope optical axis). To calculate the OPL from the reference point, we will add 15.9mm (distance from the reference surface to the center of the pick-off prism) plus any extension of the pick-off stalk.

Sagitta stalk fully extended

SECTION A-A
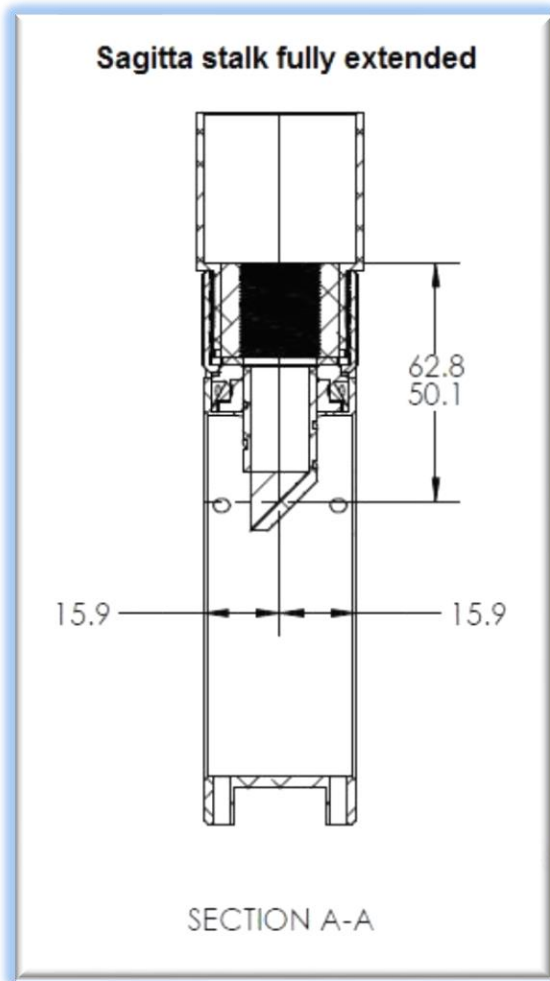
As an example, let's assume the pick-off stalk is fully extended and the focus mechanism is at the midpoint of travel. Then our guide camera OPL equates to 15.9mm (reference surface to prism center) plus 56.5mm (center of guide focus range [50.1mm to 62.8mm] to the seat of guide camera receiver) for a total guide camera OPL distance of 72.4mm.

The Lodestar X2 cameras are typical with a 12.5mm depth to sensor. Thus, in this example, our guide camera OPL totals 84.9mm or around 85mm. We want to match the imaging camera OPL to this value plus or minus about 6.3mm (half the focuser travel).

Yet one more adjustment is available for the Lodestar type cameras that slip into the 1-1/4" receiver of the Sagitta OAG. These camera types are designed to fit directly into a 1-1/4" receiver and are often referred to as "lipstick" cameras because of their shape. Lipstick cameras have an additional 17.5mm of outward adjustment with the Sagitta's unique clamping mechanism.

In total, the Sagitta has a wide range of adjustment. With the pick-off stalk retracted all the way up, the OPL from the reference surface to the guider sensor can be as little as 66mm. Conversely, with the pick-off stalk fully extended, the focuser all the way out, and the guide camera at the top of the clamp the OPL can be over 108mm for **a total adjustable range of 42mm.**

Once the guide camera OPL range has been qualified we can mount the imaging camera and then bring the guide camera to match the imager's OPL. In nearly all cases, the Sagitta focus mechanism will be more than adequate to bring the auto-guider perfectly parfocal with the imaging camera. Advance planning for extensions and adapters will ensure success.

Camera Adapters

Off-axis guiders are most effective when placed directly in front of the camera's filter wheel. This allows unfiltered light to enter the prism and on to the guide camera. Full spectrum light results in brighter stars available for auto-guiding. For monochrome work or one-shot color (OSC) cameras, the camera will usually be mounted directly behind the OAG. When attaching your camera, be sure the pick-off prism is visible on the opposite (telescope) side.

Sagitta will work well with a wide range of large format sensors such as the KAF-50100 without vignetting.

Adapter Options

Sagitta includes a male Astro-Physics 2.7-inch (AP2.7) adapter [#19871] on the telescope side and the female AP2.7 adapter [#19872] on the camera side. AP2.7 spacers and adapters for various camera and telescope configurations are available from Optec and many other vendors. If additional spacing for the imaging camera is required to match the guide camera OPL range, adding AP2.7 spacers is a cost effective solution. See table below for camera and filter wheel adapters for the AP2.7 thread standard. AP2.7 spacers can be ordered directly from Optec – see this Spacer Table for a convenient guide to calculate any additional back-focus distance from 1/2" to 6-3/4"

Our AP2.7 adapters can also be removed and replaced with any of a variety of OPTEC-3000-S adapters for direct connection. The table below lists many of the common filter wheel and camera interfaces for most astronomical imaging camera systems.

Camera / Filter Wheel Mechanical Interface:	Optec Male AP2.7 Adapter Stock No.	OPTEC-3600-S Adapter Stock No.
T-thread, M42 x 0.75mm	#19879	#19950
M48 x 0.75mm	Contact Optec Sales	#19958
M54 x 0.75mm	#19878	#19951
M68x1mm	Contact Optec Sales	#19957
M72x1mm	Contact Optec Sales	#19956
2" x 24tpi (short thread)	#19877	#19952
3" x 24tpi (long thread)	Contact Optec Sales	#19953
3.43" CL ZTA (FLI Centerline)	Contact Optec Sales	#19954
M92 x 1mm (FLI thread)	Contact Optec Sales	#19955

Determine the mechanical interface for your filter wheel or camera. Common interfaces include T-thread (M42), M54 x 0.75mm, and 2" SCT threads. Larger cameras often use an even larger mechanical interface. To avoid any chance of vignetting, use the largest interface available for your equipment. Obtain a suitable adapter from Optec, Precise Parts, or your favorite dealer.

In our example above, our target imaging camera OPL is 85mm plus or minus 6.3mm. Starting with the front surface reference point we can calculate 15.9mm x 2 (OAG thickness is 31.8mm) plus 2.5mm for the #19950 adapter PLUS 55mm for a Canon DSLR with T2-ring. The total imager OPL works out to 89.3mm which is within our target range. We also have the advantage of clamping the Lodestar camera some 4 to 5mm higher which will move our default focus closer to the center of the Sagitta travel.

Contact Optec Sales with any questions you may have when configuring the Sagitta OAG for your particular equipment.
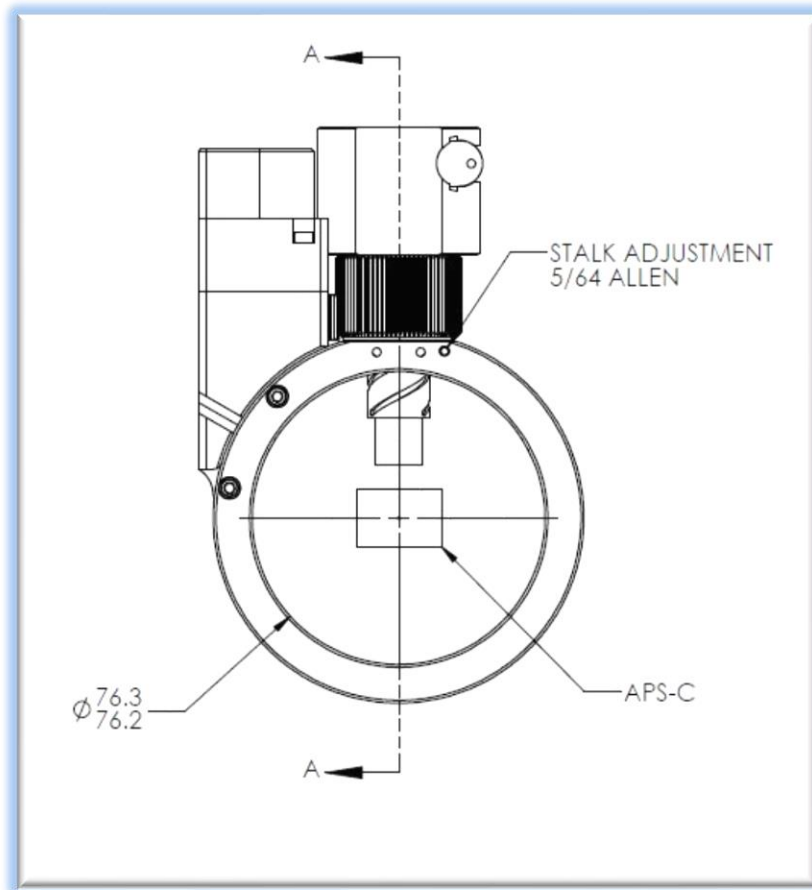
Installation Procedure: Step-by-Step

With the guide camera range in mind, the Sagitta OAG is attached first to the imaging camera or filter wheel. This allows you to adjust the pick-off prism depth before connecting the whole OAG/FW/Camera assembly to the telescope.

Step 1 – Attach OAG to Filter Wheel or Camera

With a suitable AP2.7 adapter to fit your filter wheel/camera mechanical interface in hand, add any required AP2.7 spacers to set the imager OPL for the range of the guider OPL.

Alternatively, the AP2.7 adapter can be removed by loosening three oval-point setscrews around the perimeter of the OAG. Remove the native AP2.7 adapter and replace with an **OPTEC-3000-S** camera adapter described in the Adapter Option section above.

Rotate the OAG for best orientation and use the included 5/64" ball driver tool to tighten all three setscrews down tightly. Look directly down the front of the OAG. With the imaging camera shutter open you should be able to see the sensor.   Orient the OAG such that the pick-off prism's lower edge is parallel to the long side of the imager sensor.

Tighten the three setscrews securely. All threaded connections should be tightened securely.

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Step 2 – Adjust Pick-Off Prism

Now we want to lower the pick-off prism as close as possible to the edge of the imaging sensor. The idea is to bring the guide camera optical path as close to the optical axis without introducing vignetting on the main imaging sensor.

For all cameras smaller than a 35mm Full Frame, you will want the pick-off prism at the fully extended position.

The pick-off prism can be adjusted easily by loosening the brass locking screw on the side opposite the motor with the 5/64" ball driver. Then insert the same tool into the access port on the face of the OAG just right of the two stainless setscrews (see photo below).

Again, open the shutter of the main camera to get a good look at the edge of the sensor. Looking straight down toward the center of the main imaging sensor, adjust the pick-off prism engagement by turning the ball driver either clockwise or counter-clockwise. A counter-clockwise turn will lower the prism up closer to the sensor. Lower the prism until it is just above the imaging sensor as viewed from above.

Tighten the brass locking screw opposite the motor with the ball driver to secure the pick-off stalk position.

If you detect any shadow from the pick-off prism when creating your flat-field calibration frames, you can easily re-adjust the prism without removing the camera. You will need to remove the OAG package from the telescope.

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Step 3 – Insert Guide Camera

Starlight Xpress revolutionized guide cameras with the introduction of the Lodestar auto-guider.

Lodestar, Lodestar 2, and Ultrastar are all designed to fit directly into any 1-1/4" eyepiece holder. With a profile no larger than a typical 1-1/4" eyepiece, SBIG quickly followed suit with the ST-i to replace the original ST-4 auto-guider. ZWO and other import camera manufacturers also offer these lipstick-style cameras.

In addition, Lodestar's design included a female C-mount thread on the face with a standard CS-mount back-focus distance of 12.5mm. Most camera manufacturers have adopted the Lodestar profile or include a 1-1/4" nosepiece adapter. Install a 1-1/4" nosepiece adapter if your camera is not in the Lodestar size and format.

NOTE: Any of these "lipstick" cameras will allow you to insert your auto-guider camera directly into the Sagitta guide camera receiver.

For the flange back-focus measurement, most cameras follow either the CS-mount distance of 12.5mm or the original C-mount back-focus of 17.5mm. Several of the ZWO and import guide cameras place the guider sensor even closer to the camera end. For example, the ZWO ASI290 Mini camera has a sensor only 6.5mm from the face of the camera end. This makes for a more compact package and should be considered when calculating the Optical Path Length of your system.

Step 4 – Tighten Clamp

The guide camera clamp is machined from a solid brass rod and is spring loaded for easy insertion and removal of the auto-guider. The brass will not mar your auto-guider body and allows plenty of height adjustment when setting the auto-guider parfocal to the imager sensor.

For now, set the auto-guider camera as far into the receiver as possible and lightly tighten down the clamp using the included 3/32" ball driver. For smaller diameter cameras, you may want to also tighten the two nylon-tip setscrews using a 0.050" hex key to secure and center the guider.

Step 5 – Attach OAG to Telescope

Now attach the Sagitta OAG to your telescope's focuser. You can use the included male Astro-Physics 2.7-inch (AP2.7) threaded mount or any OPTEC-3000-S adapter suitable for your telescope configuration. Contact Optec or Precise Parts (www.preciseparts.com) for custom telescope adapters.

with the circular OPTEC-3000-S short dovetail adapters, you can set the optimal orientation of the imaging camera package. Rotate for the best orientation, then tighten down three oval point setscrews using the 5/64" ball driver. Securely tighten all screws to ensure a rigid, non-flexing imaging package.

It is important that the auto-guider and imaging sensor are set to be parfocal. That is, the optical path length (OPL) for both cameras should be the equivalent.

Step 6 – Final Adjustments

Focus Imaging Camera

With the OAG package in place, focus the telescope on a distant object (daytime setup) or a bright star (nighttime field setup). Use the imaging camera in focus mode to adjust your primary telescope focuser for a sharply focused image. You can use a Bahtinov mask or your favorite auto-focus software such as FocusMax, @Focus3, or Sequence Generator Pro to achieve best focus. The Sagitta OAG is especially designed to optimize Optec's FocusLock Software when using the Lacerta astigmatic device.

Sagitta Motor Position

With the primary imaging camera in focus, you will want to set the Sagitta OAG motor to the mid-point of travel or 6,000 steps. (see FocusLynx Software below). We may need to adjust the motor position but we should try to set for the midpoint initially.

Guide Camera Position

Now turn your attention to the guide camera. Start the guide camera acquisition software and set the exposure length such that we have a good image of the object or star. (See the Auto-Guiding Software section below if you do not already have your imaging computer setup for auto-guiding.)

Use the 3/32" ball driver to slightly loosen the guide camera clamp within the 1-1/4" receiver. While the guider is imaging, slide the camera up or down for best focus. Rotate the camera for optimal orientation and tighten the guide camera clamp. Your guide camera and imaging camera should now be parfocal.

Optimize Guider Focus

Optimizing the guider focus is best done at night under field conditions. A Bahtinov mask is handy to provide a visual confirmation that both the imaging camera and the guide camera are at best focus. With a Bahtinov mask covering the telescope primary aperture, adjust the main imager focuser using the primary telescope focusing mechanism. If using Optec focusers with FocusLynx, this means moving Focuser 1 until the Bahtinov mask is sharp with three evenly spaced diffraction lines.

Next, move the telescope such that a bright star is visible in the guide camera. Open star clusters are ideal for making this final focus adjustment. We recommend at least a 4th magnitude star so that the Bahtinov diffraction spikes are clearly visible. In FocusLynx Commander with the Sagitta OAG configured and connected (see FocusLynx Software Setup below), move the Focuser 2 focus to optimize the three diffraction spikes for even spacing as viewed with the guide camera.

Final Thoughts

When a guide star is too bright, saturation of the guider sensor can occur. A good guiding technique in this case would be to de-focus the guide camera to spread the stars light out over more guider pixels. With the Sagitta Motorized Focuser, adjusting the guider focus position without disturbing the main imager focuser is now possible for even the remote imager.

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FocusLynx Software Setup

Your Sagitta OAG is now installed. Operating the Sagitta Motorized OAG requires connection to a FocusLynx or FocusBoss II control hub. The FocusLynx dual-focus controller is described in detail on Optec's website:

https://www.optecinc.com/astronomy/catalog/focuslynx/index.htm

The very latest FocusLynx drivers are available for download directly from the Optec website: https://optecinc.com/astronomy/downloads/focuslynx.htm.

FocusLynx is ASCOM Alpaca compatible for cross-platform compatibility. FocusLynx includes the Alpaca drivers along with our Windows-based **FocusLynx Commander** interface program. Use FocusLynx Commander to configure your Sagitta OAG motor by selecting the Sagitta OAG device type in the Focuser 1 or Focuser 2 setup dialogs.   FocusLynx and Sagitta work well with all ASCOM client programs such as *Maxim D/L, TheSky X, Sequence Generator Pro* and, of course, Optec's FocusLock software. Normally, you will configure the Sagitta as Focuser 2 for FocusLynx and as the second focuser in most programs.

Consult the **FocusLynx Quick Start Guide** to install the FocusLynx Commander software.   Once installed, you will need to configure FocusLynx Commander for your new Sagitta OAG focus motor. Configuration in FocusLynx Commander will also configure the ASCOM driver.

FocusLynx Commander Focuser Type selection

With FocusLynx Commander open and running on your Windows computer, click Focusers – Focuser 2 Setup. Effective with FocusLynx Commander version 3, you will see one or more FocusLynx Hub tabs at the top of the FocusLynx Driver Setup form. Below the Connection Setup area, you will see two tabs – Focuser 1 and Focuser 2. Be sure to click the tab corresponding to the focuser port to which Sagitta is connected. This will often be Focuser 2, but for standalone OAG systems you may configure Sagitta on Focuser 1 port instead.

In the Nickname box, type a suitable name for the guide camera. Click Focuser Type and select the Sagitta OAG option. The motor will immediately begin to move inward. Sagitta is designed to stall at the bottom position so you may hear a slight buzzing during the homing procedure. This is normal. Afterward, Sagitta will move the guide camera outward to the last parked position.

Web Page Configuration

COMING SOON!! Effecitve with FocusLynx firmware version 3, Focuser Type and other parameters can be configured through the wired Ethernet webpages.

Auto-Guiding Software

A full discussion of auto-guiding steps and techniques is beyond the scope of this document, but you should be familiar with the basic concepts. Most image acquisition programs and observatory control software packages have some sort of auto-guiding algorithm. Excellent options include @Focus3 in TheSky X, FocusMax, Sequence Generator Pro, and Prism software. An excellent open-source and free auto-guider program is available in PHD2 guide software.

FocusLock Continuous Focus Software

Developed in partnership with Innovations Foresight, Optec's FocusLock software integrates patented SharpLock Technology to provide an easy-to-use focusing application that functions whenever guiding is active.

Originally designed for use with the ONAG On-Axis Guider a cold-mirror passes infrared light to the guide camera while reflecting visible wavelengths on to the imaging camera. The cold-mirror introduces a slight astigmatism to the guider image allowing FocusLock to quickly determine on which side of focus the camera is currently positioned. Using the proprietary SharpLock technology, FocusLock can be used to quickly drive the focuser to the optimal focus position and maintain focus for weeks or months at a time. See https://www.optecinc.com/astronomy/catalog/focuslock/index.htm.

Credits and Links:

Lodestar, Lodestar 2, and UltraStar are products of Starlight Xpress Ltd. -
https://www.sxccd.com/lodestar-x2-autoguider

ST-i and ST-4 cameras are products of SBIG and Diffraction Limited - http://diffractionlimited.com/

QHY cameras are products of QHYCCD - https://www.qhyccd.com/

ZWO and ASI cameras manufactured by ZWO Company -
https://astronomy-imaging-camera.com/

FocusMax is available through CCDWare - http://www.ccdware.com/products/focusmax/

Maxim D/L is copyright Diffraction Limited - http://diffractionlimited.com/product/maxim-dl/

Prism Astronomy Software available through Hyperion Astronomy -
https://www.hyperion-astronomy.com/collections/prism

Sequence Generator Pro is available through Main Sequence Software -
https://www.mainsequencesoftware.com/

TheSky X is offered by Software Bisque - http://www.bisque.com/