



Perseus 4-Port Installation

Step-by-Step Instructions for Installing the Perseus 4-port Instrument Selector on any telescope Optical Tube Assembly (OTA).

Introduction

Optec's Perseus 4-port Instrument Selector allows the use of multiple cameras, instruments or eyepieces on any observatory class telescope. The robust design holds the entire imaging and scientific instrument package rigid while an 1/8th wave 3-inch diameter rotating mirror selects between the primary 3-inch port and any of three 2-inch ports. Designed for full robotic telescope capability, USB/Serial and Ethernet connections are standard with the Perseus Gen3. Our downloadable Perseus Commander ASCOM driver and local server software complete the package for remote operations. For public outreach and visual use, a manual push button is available to cycle through the four instrument ports.



Third Generation Circuit

Originally introduced in 2009, the Perseus Gen3 represents the latest iteration of the versatile instrument selection platform currently in use at observatories throughout the world. Gen3 includes an improved U.S. manufactured stepper motor with 400 steps/revolution resolution, improved bi-polar motor control using pulse-width modulation, and a completely re-designed circuit board. An integrated serial port with RJ12 socket allows Optec's standard USB/Serial interface cable to be used and the addition of a standard RJ45 Ethernet port provides network connectivity to the observatory control computer. Standard 12VDC input power controls the circuit and mirror motor.



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#19605- Perseus 4-port Instrument Selector

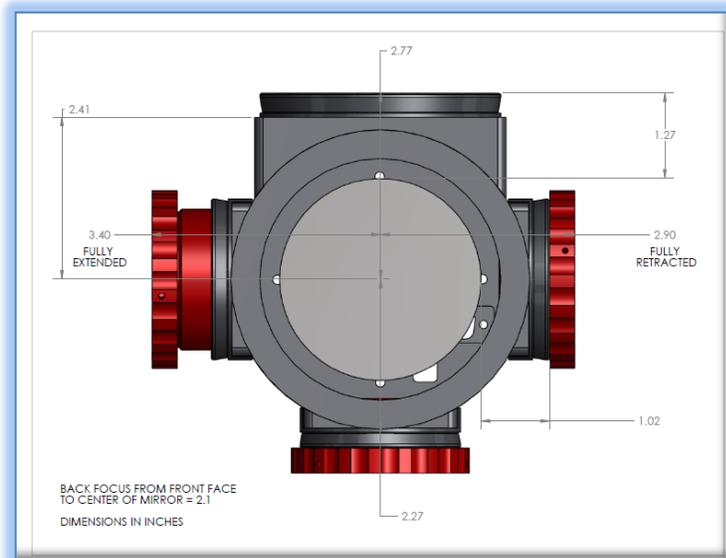


The photo at right compares the 2nd generation Perseus with the current Gen3 version (at right). All the important mechanical dimensions remain the same while the Gen3 circuit and motor driver offer significant improvements.

With an embedded Ethernet connection a newly designed web-based interface is available and an ASCOM Alpaca driver is currently under development. The ASCOM driver and local server software includes options to automatically adjust focus and telescope nudges to center each object in whichever instrument port is currently selected.



Standard Optec Interfaces



The telescope side interface for the Perseus Instrument Selector is a receiver for Optec's standard [OPTEC-3600](#) dovetail connection. A wide variety of adapters are available for most any telescope OTA. Precise Parts can fabricate any suitable adapter for custom telescopes as well.

Port 1 features a full 3-inch clear aperture and male OPTEC-3600 dovetail to attach any large camera or the Pyxis 3-inch camera rotator. The Pyxis 3" camera rotator can be directly attached or our #17880 adapter will convert the interface to Optec's

standard [OPTEC-3000](#) camera side adapters for most any full-frame or larger cameras.

Ports 2, 3, and 4 include an adjustable X-Y plate with a male [OPTEC-2400](#) dovetail connection for any Optec TCF 2-inch focuser direct mount. Each 2-inch port also includes a red parfocal receiver adapter and gold locking ring to set each of the three smaller ports parfocal with Port 1. The 2-inch parfocal



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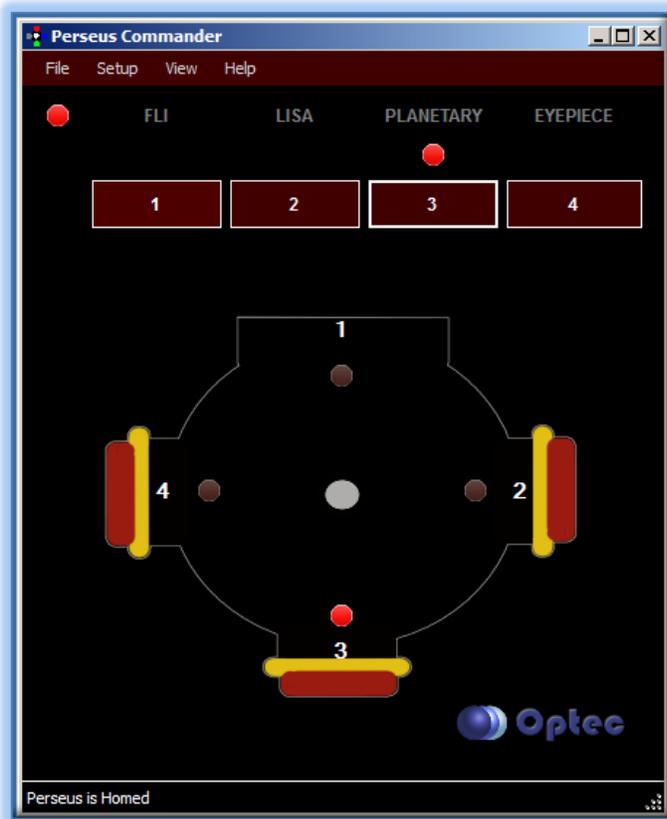
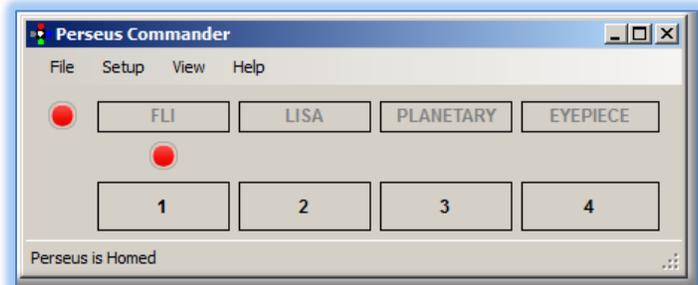


receiver can accept any of the [OPTEC-2300](#) camera adapters making configuration straight-forward. Contact [Optec Sales](#) for assistance and advice with any instrument package configuration.

Commonly available interfaces including male T-thread (#17646), C-mount (#17649), SCT 2" and SBIG STL threads are typically available. All ports include dust and light covers in cases where some ports remain unpopulated. Contact [Optec Sales](#) for assistance with specific package configurations.

Software and Drivers

Optec software engineers have developed a robust protocol for controlling the Perseus instrument selector. In addition to the manual push-button, any port can be selected remotely though the new ASCOM Alpaca interface or by scripting in most observatory



automation control packages.

The driver package includes Perseus Commander which can be configured to automatically adjust focus and telescope alignment for consistent port-to-port behavior and excellent repeatability. Telescope mount and focus control can be seamlessly adjusted through our ASCOM local server interface without interfering with normal telescope operations.



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Typical 4-Port Installations

The Perseus 4-port Instrument Selector is being used in professional and advanced amateur observatories throughout the world. A small sampling of multiple instrument installations is shown below.

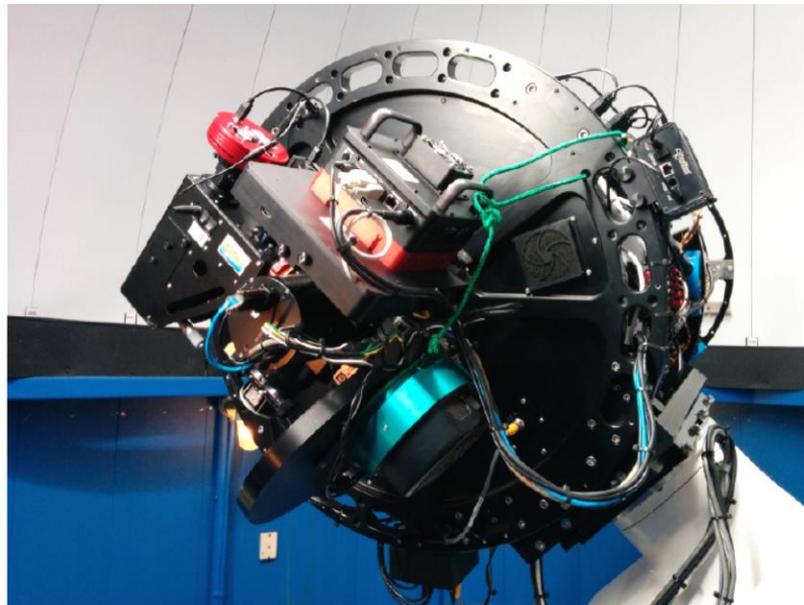


Figure 1 - The BGO's Planewave CDK24 telescope and its instruments: Optec Perseus 4-port selector, Apogee Aspen CG16M CCD (10 filters), SBIG STLX11002 CCD (8 filters), and Shelyak LHRES II spectrograph (manual use only). The telescope is mounted on the observatory's original Ealing mount upgraded with a Sidereal Technology Servo II controller.

The Perseus 4-Port Instrument Selector is the centerpiece of Saint Mary's University Burke-Gaffney Observatory's web-based telescope. The PlaneWave 24-inch CDK telescope is outfitted with the Perseus Instrument Selector and populated with multiple instruments including the LiHres III spectrograph, and Apogee Aspen and SBIG STXK11002 CCD cameras, and a 2-inch focuser for large eyepieces during visual observing sessions. More information is available at <http://www.ap.smu.ca/pr/bgo>.

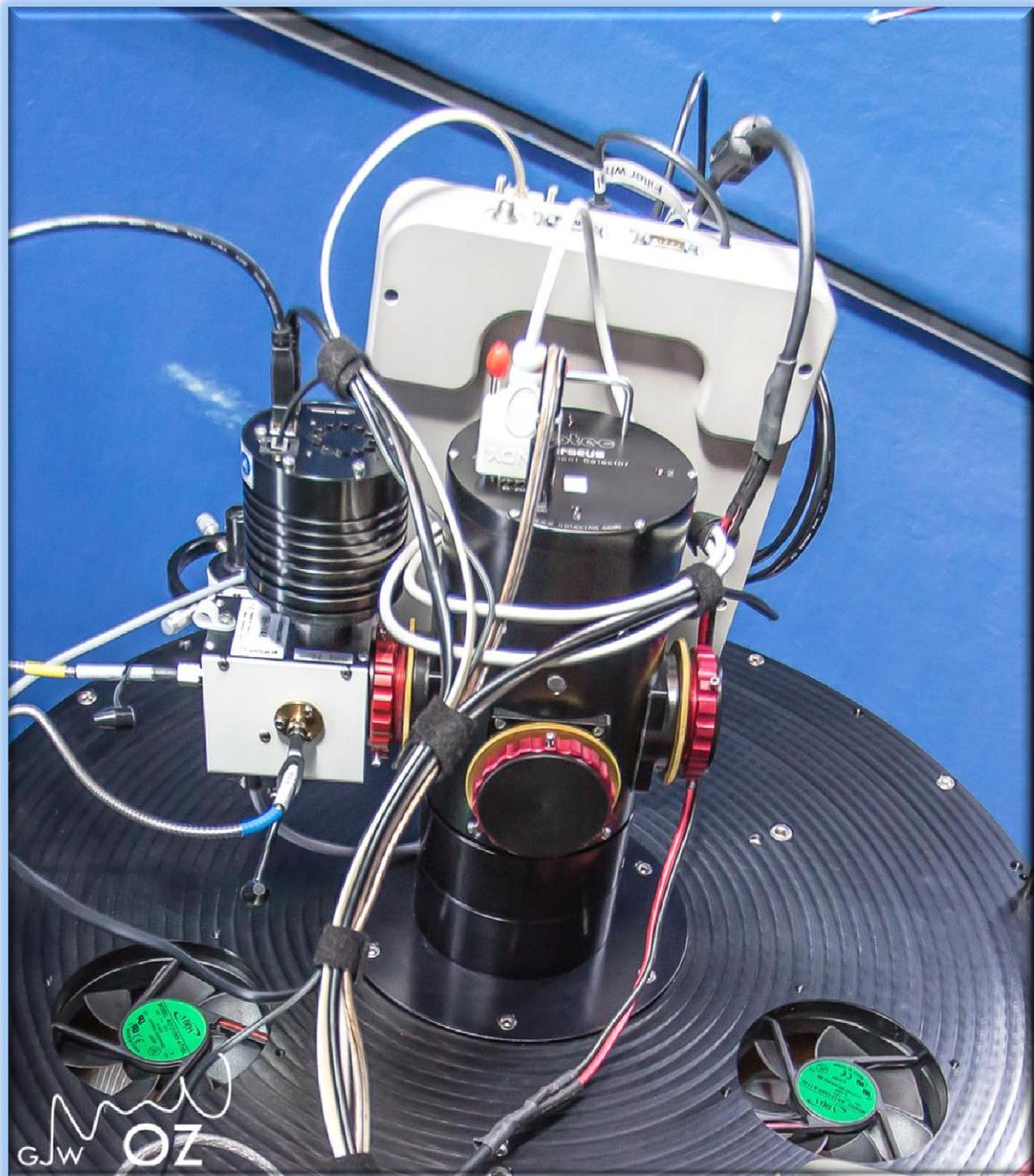
Photo courtesy Saint Mary's University – Halifax, Nova Scotia, Canada.



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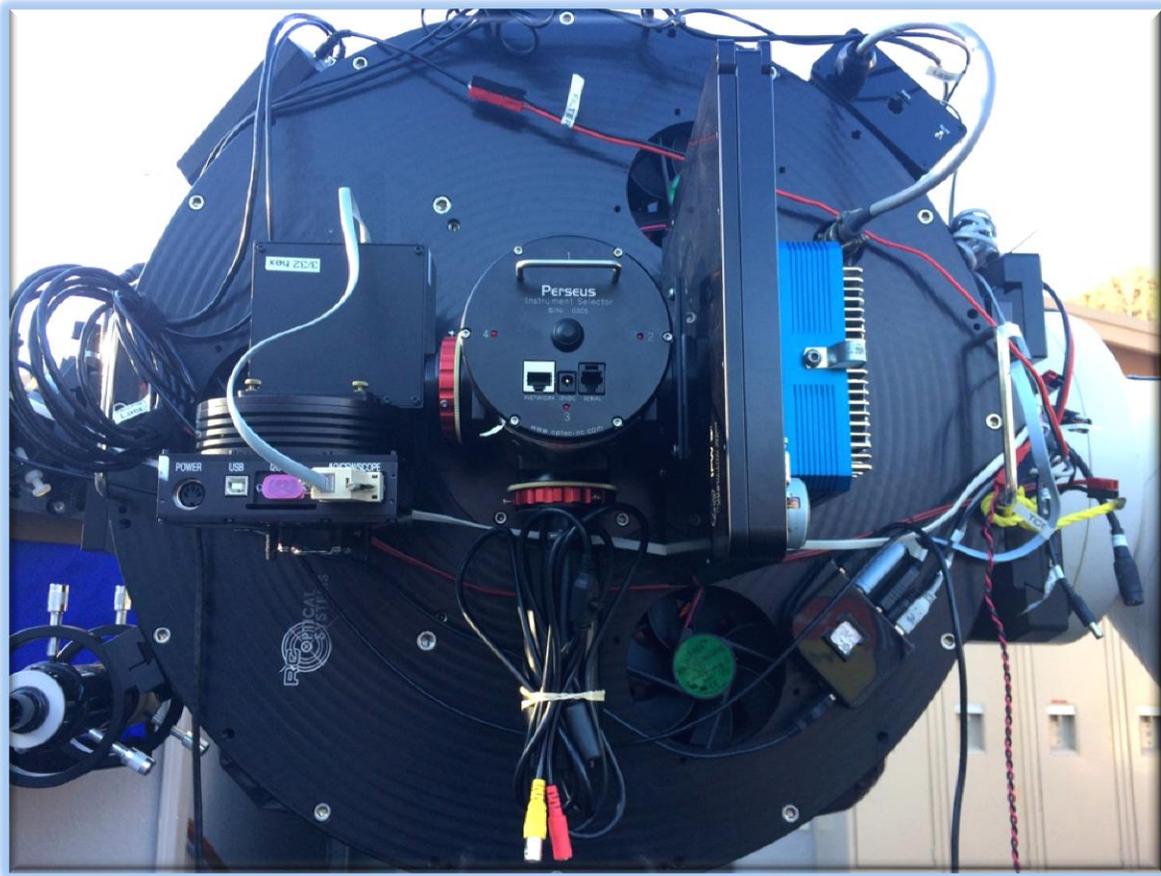
*Oxford University Astrophysics installation of Perseus Instrument Selector.
Photo courtesy Dr. Katherine Blundell – Oxford University - Oxford, England, U.K.*



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*Perseus 4-port Instrument Selector mounted in RCOS 20-inch RC.
Photo courtesy Steve Smith of Robert Ferguson Observatory – Sonoma, California, USA.*



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Perseus 4-port Installation Instructions - Revision 2 – June 2019



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Planning the Instrument Cluster

A little advanced planning for the Perseus will go a long way toward simplifying the actual instrument cluster installation. In general, we want to have the multiple instruments share the same focal plane as closely as possible minimizing focuser movement between ports. Depending upon the focus method (single focuser on the telescope vs. multiple focusers on each port), the telescope's usable focus zone, and focuser travel - achieving parfocality between the instrument ports can be simple or more challenging.

Goals and Strategy

The overall goal is to set the large primary Port 1 instrument first, then adjust the instruments on each of the three smaller ports to come to focus near the primary image. This goal cannot always be achieved, especially when planning for certain instrument requiring a very long back-focus. Often a large focal shift must be accepted as a compromise when using multiple instruments on a single telescope. Fortunately, the Perseus Commander software can elegantly handle large focal shifts assuming the telescope itself offers a wide focal range.

Adjustment Range

The primary Port 1 has a minimum back-focus usage of 4.5-inches or about 115mm. Each red parfocal ring offers a ½" (12.7mm) range of adjustment independent of the other ports. As measured from the center of the mirror, the top of each ring varies from 2.9" (73.7mm) to 3.4" (86.4mm). Add to this value 2.1-inches from the telescope-side surface (to the mirror center on-axis) for a total back-focus range of 5.0 to 5.5-inches (127 to 140mm). Each adapter will add some thickness to this range. We suggest you plan for 150mm as a typical back-focus usage for the Perseus when designing your instrument package cluster.

Developing a spreadsheet to calculate the back-focus distances for each port can be very helpful in the planning stage. As you can see in the screenshot below, only the Port 2 visual-use port requires a large re-focus of the Meade 16-inch coarse focus knob. All other ports can be automatically adjusted to maintain parfocality between camera selections.

Contact Optec Sales for help planning your 4-port instrument selector telescope plan.



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Perseus 4-port Instrument Selector						
<i>Back-Focus Planning and Calculator</i>						
	Component Description	Optec Stk#	Last Interface ¹	OPL*		Notes
				mm	inches	
Perseus Port 1						
	Perseus body - Port 1		OPTEC-3600 dovetail seat	114.5	4.51	
	3-inch Receiver	#17880	OPTEC-3000 receiver	10.2	0.40	
	STL camera mount	#17806	4-bolt plate for STL camera	2.5	0.10	
	SBIG STL with FW8		CCD sensor surface	46.2	1.82	<i>per SBIG website.</i>
	OPL TOTAL - PORT 1			173.4	6.83	
Port 2						
	Perseus body - Port 2		OPTEC-2400 dovetail seat	110.2	4.34	
	TCF-S focuser	#17670	top of 2-inch drawtube (midpoint)	91.5	3.60	
	2-inch eyepiece			0.0	0.00	<i>varies by eyepiece</i>
	OPL TOTAL - PORT 2			201.7	7.94	
Port 3						
	Perseus body - Port 3		Top of red OPTEC-2300 receiver	127.0	5.00	<i>Parfocal receiver fully retracted</i>
	OPTEC-2300 to T thread	#17646	base of T-thread	2.5	0.10	
	T- to C-mount adapter	#19853	base of C-adapter	30.0	1.18	
	C- to CS adapter	#19791	base of C-adapter	2.0	0.08	<i>Required for this camera.</i>
	Skyris planetary camera		CMOS sensor surface	12.5	0.49	<i>Standard CS-mount distance</i>
	OPL TOTAL - PORT 3			174.0	6.85	
Port 4						
	Perseus body - Port 4		Top of red OPTEC-2300 receiver	139.7	5.50	<i>Parfocal receiver fully extended</i>
	OPTEC-2300 to T-thread	#17646	base of T-thread	2.5	0.10	
	T-thread extender	#19633	base of T-thread	15.0	0.59	
	ZWO ASI camera			17.5	0.69	<i>per ZWO spec page</i>
	OPL TOTAL - PORT 4			174.7	6.88	
1 - Last Interface from telescope objective for this adapter. This surface is closest to the telescope focus.						
*OPL - Optical Path Length through this adapter/component.						
I:\Project Folders\~Master Astronomy Product Specs\Perseus 4-port worksheet.xlsx						



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Perseus GEN3 Package Contents

Confirm the contents of your Perseus GEN3 Instrument Selector package with power supply, cables, and tool set. The package should contain the following items:

- Perseus 4-port Instrument Selector,
- One 3-inch Port cover installed,
- Three 2-inch Port covers installed,
- One OPTEC-3600 cover installed (bottom),
- USB/Serial communication cable,
- Cat-5e or Cat-6 Ethernet cable,
- 12VDC power supply with wall cord,
- Ball driver hex tool set including 0.050", 3/32", 7/64" sizes.



Perseus 4-Port Instrument Selector package contents.



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Installing the Perseus: Step-by-Step

Step 1 – Identify OTA mount

To attach the Perseus Instrument Selector to your telescope, you first need to identify the most appropriate mounting surface on the telescope OTA. For example, the classic Meade 16-inch SCT telescope has a large, coarse 4-inch diameter thread available for attachment as shown at right. For this telescope, a smaller step-down adapter to the more common 2-inch x 24tpi SCT thread was first removed to reveal the larger thread. Consult your telescope documentation for the largest available mounting surface as close as possible to the back of the OTA train as you can locate.

Step 2 – Attach Telescope Mount

Optec offers a number of stock OPTEC-3600 male dovetail mounts upon which the Perseus will be attached. Each telescope adapter fits a specific telescope and each always ends with the common male 3.6-inch dovetail that we refer to as the OPTEC-3600 mount.

See <https://www.optecinc.com/astronomy/catalog/adapters/optec-3600/default.htm> for a full selection of our telescope adapters. Occasionally, a custom adapter must be made to fit the Perseus to a particular telescope OTA. Optec recommends Precise Parts to quickly provide a suitable adapter. Visit www.preciseparts.com for details or to place an order.

Alternatively, the OPTEC-3600 dovetail standard specification is available for machinists should you wish to fabricate a suitable adapter locally.

Note that fixed mirror telescopes may require a focuser between the telescope OTA and Perseus. Be sure to use a robust focuser such as the TCF-Lynx3 or Gemini focusing rotator.

Screw or bolt the telescope-specific adapter to your telescope OTA or focuser with the OPTEC-3600 male dovetail facing outward. Remove the bottom cover on the base of the instrument selector. Slip the Perseus body over the mount. You may need to loosen the six setscrews around the base of the instrument selector slightly to ensure the instrument selector is fully seated.

Step 3 – Align and Tighten

Align the Perseus body for suitable clearance and preferred orientation. Tighten six setscrews using the 3/32" ball-driver hex tool. Note there are two recessed setscrews under the large 3-inch saddle plate on Port 1. Be sure to tighten each setscrew securely against the dovetail on the OPTEC-3600 telescope mount.



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Step 4 – Connect Power

IMPORTANT: Remove the Port 1 cover to ensure all packing foam has been removed. Safety foam is installed at the factory to keep the mirror from moving during shipping.

Plug the provided 2.5 x 5.5mm power supply connector into the Power socket on the back of the Perseus. Plug the power supply into your wall outlet with a suitable cord for your location. The Perseus will immediately begin the homing procedure and stop at Port 1. Note the power cord is wired with the center pin positive. You should budget for a maximum of 1.25 amps. In normal use, power consumption is typically less than 750 mA. For Rig Runner and Power Pole type power distribution systems, Optec offers our #17063 6-ft. long (2m) molded power connectors for a nominal cost.

Test the mirror rotation by pressing the black button in the center of the Perseus rear plate. The Perseus will cycle from Port 1 to Port 2. Subsequent button presses will move the mirror to Port 3, then Port 4, and back to Port 1 again.

Note the Perseus Instrument Selector does not have a power switch. For remote operations, Optec recommends using an internet power switch such as the Digital Loggers Web Power Switch to turn the Perseus on and off remotely.

Step 5 – Connect Communication Cable

Next plug the RJ12 6-pin connector into the Serial port on the back of the Perseus. Plug the USB end of the included Optec USB/Serial cable into a USB hub or directly into an open USB-2 or higher socket on the observatory computer. The Optec USB/Serial cable has an embedded FTDI Serial-to-USB chip inside and will require the FTDI drivers to be installed on the Windows or Mac computer. If not pre-installed on your computer, you can download the current drivers from the Optec website:

<http://www.optecinc.com/astronomy/downloads/usb-to-serial.htm>

If you intend to use the Ethernet connection, plug one end of the flat RJ45 8P8C cable (Cat-5e or better) into the RJ45 modular Network socket on the back of the Perseus. The other end will connect to an Ethernet switch or router for network communications.

Skip down to the [Perseus Commander Software Setup](#) section below for setup instructions once the communication cables are installed and properly connected.



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Cable Management Considerations

The rear cover plate on the Perseus includes a small handle which can be used as an anchor point for Velcro straps or zip ties when trying to manage the multiple cables associated with cameras and instruments to be attached to the instrument selector.

Attaching Instruments

We recommend attaching the largest instrument to the 3-inch Port 1 first. Add other instruments so as to best balance the load. That is, add the second heaviest instrument to Port 3 in an attempt to keep the instrument load balanced along the optical axis of the telescope. This approach will make your telescope OTA balance on the telescope mount easier. Additionally, our goal will be to set all three 2-inch ports parfocal with Port 1 so it makes sense to have your largest instrument mounted here.

Port 1: 3-inch

OPTEC-3600 Dovetail Mount

The large 3-inch Port1 features a male OPTEC-3600 dovetail. The [Pyxis 3-inch](#) camera rotator and [TCF-Leo](#) low-profile focuser will attach directly to this dovetail without the need for additional adapters.

To attach a camera directly to Port 1, Optec offers several solutions. For example, the #17858 adapter will convert Port 1 to an Astro-Physics 2.7-inch threaded receiver. AP 2.7 spacers are widely available and can be used to extend a camera's back-focus to match to other instruments to be attached to the Perseus. Alternatively, the #17880 adapter will convert the OPTEC-3600 dovetail to our 3-inch camera adapter known as the OPTEC-3000. This is the same mounting specification as the TCF-Lynx3 and TCF-Leo drawtubes.

OPTEC-3000 Camera Mount

With the #17880 adapter installed, any of Optec's 3-inch line of camera mounts can be used to connect large cameras such as the STXL or older STL camera (shown at right) to Port 1.

See our full line of [3-inch Adapters](#) or contact Optec Sales for assistance and recommendations.

Ports 2, 3, 4: 2-inch

Ports 2, 3, and 4 each feature a 2-inch clear aperture male OPTEC-2400 dovetail mount plus a Z-adjustment red parfocal receiver with lock ring, all on an adjustable X-Y platform. The platform is secured to the main body with four 6-32 socket cap screws and leveled with four 4-40 socket setscrews. Aligning each port and setting the instruments parfocal is explained in the [Alignment and Adjustments](#) section below.



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OPTEC-2400 Dovetail Mount

The OPTEC-2400 male dovetail allows direct mounting for Optec's TCF-Lynx or older TCF-S 2-inch digital focusers. To use this 2.4-inch dovetail you will need to first remove the red parfocal adjustment ring and gold lock ring by simply unscrewing until they can be removed.

Parfocal Receivers

Each OPTEC-2400 dovetail X-Y platform is internally threaded to receive the red parfocal receivers. The receiver includes a gold lock ring and can accept any of Optec's 2.3-inch dovetail adapters (known as the OPTEC-2300 dovetail). Standard adapters include T-thread, C-mount, SCT 2" x 24tpi threads, STL 2.156" x 24tpi threads, and M54x0.75mm male threads.

Visit <https://www.optecinc.com/astronomy/catalog/adapters/optec-2300/default.htm> for a listing of available adapters. Contact Optec Sales for custom camera side adapters not listed.

Maintain Balance

With your primary camera or instrument attached to Port 1, you will next attach your secondary instruments to Ports 2, 3, and 4. Keep in mind that you will want to distribute the instruments for optimal balance along the optical axis.

Alignment and Adjustments

Aligning each of the four instrument ports of the Perseus 4-port selector is a critical consideration when deploying and installing this device, especially for use in a remote observatory environment. We call this process "parfocalization" as the end goal is to have the detector used on each port at the same focal plane making each instrument parfocal with the others. Also essential is that each port should be centered on the same field of view which can be equally challenging. Fortunately, with Perseus Commander version 3 and higher software, focus and telescope adjustments can be handled automatically when the Perseus changes ports.

Parfocalization Procedures

Parfocalization takes place in several stages. Generally, the first stage is a mechanical adjustment while the second, more refined stage is a system adjustment most easily done in software. Mechanical adjustments occur at the factory by aligning each of the three 2-inch ports to the larger 3-inch port (Port 1). The final mechanical adjustment must be performed at the telescope with cameras, eyepieces, or detectors in place. It can be demonstrated that mechanical stack-up errors with mechanical adapters and spacers will negatively affect alignment and/or parfocality. Thus, the final stage adjustment can be thought of as a system adjustment in which the mechanical errors are corrected by making very small



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adjustments to the telescope mount and focuser in x, y, and z directions for each of the three 2-inch ports. The required level of port-to-port alignment will dictate how much effort must be put in to the parfocalization process.

Mechanical Adjustments

Each Perseus 4-port instrument selector main body is qualified prior to assembly to ensure a mechanical flatness and parallelism between opposite port bases and perpendicularity between adjacent port bases. Note that the large 3-inch port (Port 1) has a saddle piece presenting the OPTEC-3600 3.6" male dovetail for attachment of a TCF-S3, Pyxis 3" or any other device with an OPTEC-3600 receiver. This large saddle and the main body become one fixed assembly and are qualified together. Parallelism and perpendicularity are measured on a coordinate measuring machine and verified not to exceed 0.15 degrees or under 10 arc-minutes. To compensate for this small variation, the 2-inch port bases are adjusted to bring each in line with Port 1. This adjustment is accomplished in three dimensions.



Adjusting the 2-inch saddle in X-Y directions.

Each of the three 2-inch ports has a combination saddle plate presenting the OPTEC-2400 2.4" male dovetail and internal threads allowing the red parfocalizing rings to be screwed into the saddle plate. This design maximizes the mounting options while consuming as little back-focus as possible. For adjustments in the X and Y directions, four socket head cap screws hold the base flat to the main body.



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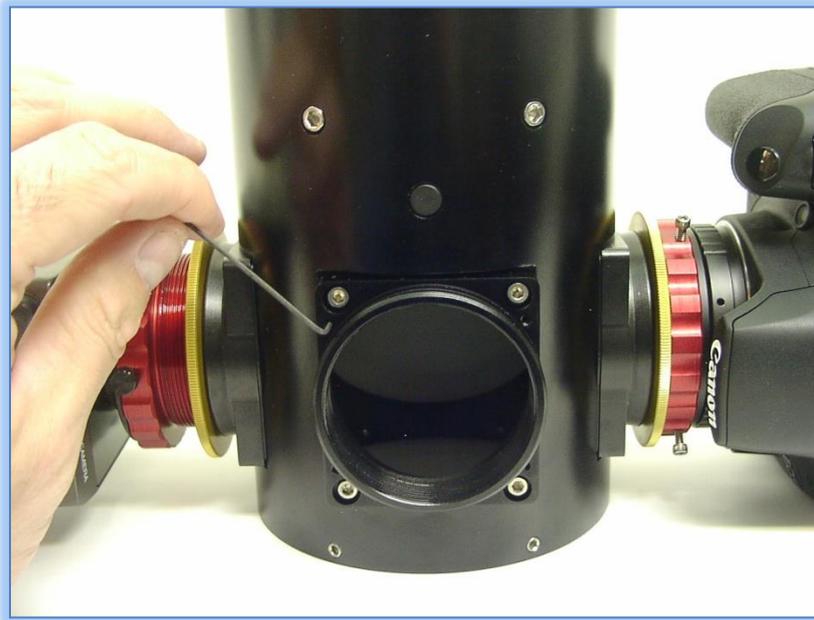


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During alignment, these are loosened slightly allowing approximately .050" play in both directions. Four alloy 4-40 setscrews near each socket cap allow small adjustments to compensate for the parallelism and perpendicularity offsets discussed above.

While adjusted at Optec prior to shipment, these saddle plates can also be adjusted at the telescope with the tools packaged with the Perseus instrument selector. See the photographs above and below.



Adjusting the 2-inch saddle tilt.

As mentioned above, mechanical stack-up affects the port-to-port alignment with each additional adapter or device. Thus the second part of the mechanical alignment can only be accomplished with the instrument selector at the telescope with cameras, detectors, or eyepiece holders in place. Start with Port 1 and work to align each of the smaller three ports to Port 1. When each port is centered on the same field of view, the mechanical parfocalization process can be considered complete.



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System Adjustments

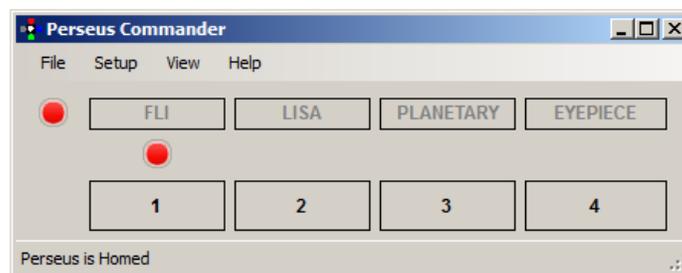
A system adjustment can also be considered an “active” adjustment. The idea and goal is to allow other parts of the telescope system to participate in the parfocal adjustment. That is, translational adjustments can be made by nudging the telescope drive in X and Y (RA and Dec), while focus adjustments in the Z direction can be accomplished by a TCF-S focuser or any repeatable motorized focuser attached to any of the ports. An ASCOM driver is being developed to accomplish this goal of system parfocalization.

For example, under software control selecting Port 2 might also send simultaneous adjustments to the telescope drive control and to a focuser to make very small adjustments (nudges) which may differ slightly from say, Port 3. Each time Port 2 is selected pre-programmed offsets in X, Y, and Z can be read and used to make the fine adjustments necessary to optimize the focus and field for each port. This system adjustment approach fully leverages the potential of remote observatories by allowing the remote user to make slight variations without ever visiting the telescope. As long as the mechanical adjustments have already been accomplished, the fine adjustments can be done through remote software control.

Perseus Commander Software

Visit <https://www.optecinc.com/astronomy/downloads/perseus.htm> for the latest version of Perseus Commander and ASCOM driver software. Configuration within Perseus Commander will also configure the ASCOM driver so that the same settings will apply when using client software such as Maxim D/L, TheSky X, SGP or CCD Autopilot. Note that some higher level clients do not have a multiple instrument selection option. Contact your favorite software vendor for implementation of the Perseus Instrument Selector.

Driver Overview



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#19605- Perseus 4-port Instrument Selector



Version 3 of the Perseus control system offers a new control option to improve port alignment while imaging. This version of the Perseus Server includes shim drivers for your telescope and focuser. These allow multiple ASCOM client programs to share a connection to a single piece of hardware. This shared connection gives the Perseus software access to your telescope and focuser. By calculating a positional and focus offset for your instruments on each port the driver can automatically jog the telescope and the focuser to compensate for port to port changes.

Offset System Setup

1. Start the Perseus Commander software
2. Open the server by clicking on the Setup menu and then Settings (Figure 1).
 - a. You also can open the same tool from any ASCOM client connected to the server by clicking on Properties in the chooser.
3. Connect to your Perseus
4. Connect to your telescope and/or focuser
5. You should see your current Perseus port, the telescope position and the focuser position.
6. You should connect higher level ASCOM clients to the Perseus Server drivers for your telescope and focuser.
7. Once you are connected and imaging you can open the Calibration Wizard from the Perseus Server Setup (this is found under the Settings menu or the Offset Wizard button on the main screen (see Figure 1)).
8. You can now use the Calibration wizard (Figure 2) to set each port offset. Then whenever the Perseus changes ports it will automatically move the Telescope and/or Focuser by the offset for that port. All offsets are defined relative to the position of Port 1. If you do not have an instrument on Port 1 simply center on that port before opening the wizard and set the offset as 0 for the port that you want as your main port.
9. To calibrate a port first line up on a target and focus your main port. Then set that position as the zero point for port 1. Then re-center and re-focus each port in turn saving the offsets as you go.
10. That's it. From this point on as long as the Perseus Server is connected to your instruments it will automatically jog the telescope and focuser on a port change.

Please let us know if you have any questions or feature suggestions. You can reach us at support@optecinc.com



199 Smith Street · Lowell, Michigan 49331 · U.S.A.
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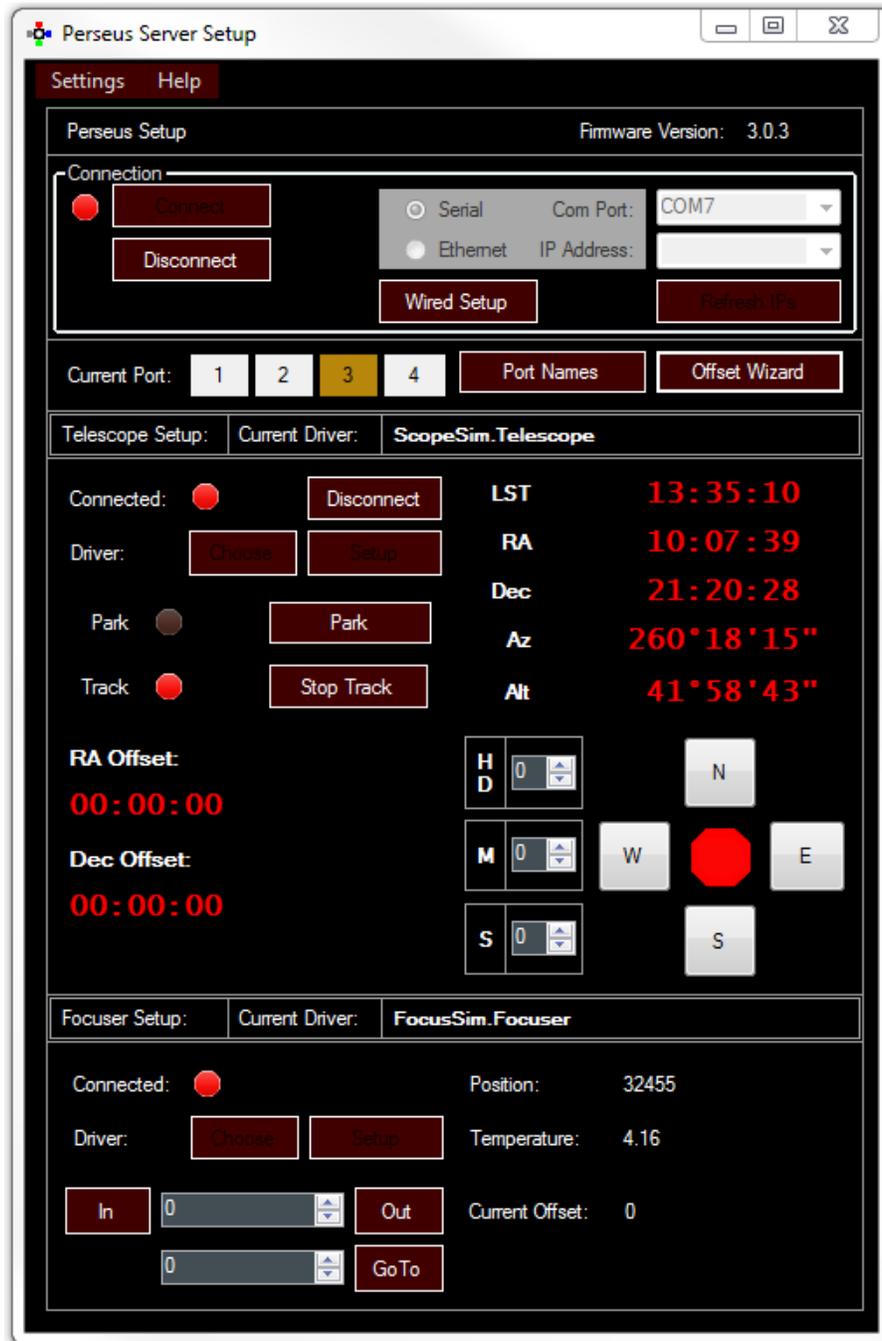


Figure 1. The Perseus Server Setup Window (as of version 3.0.3).



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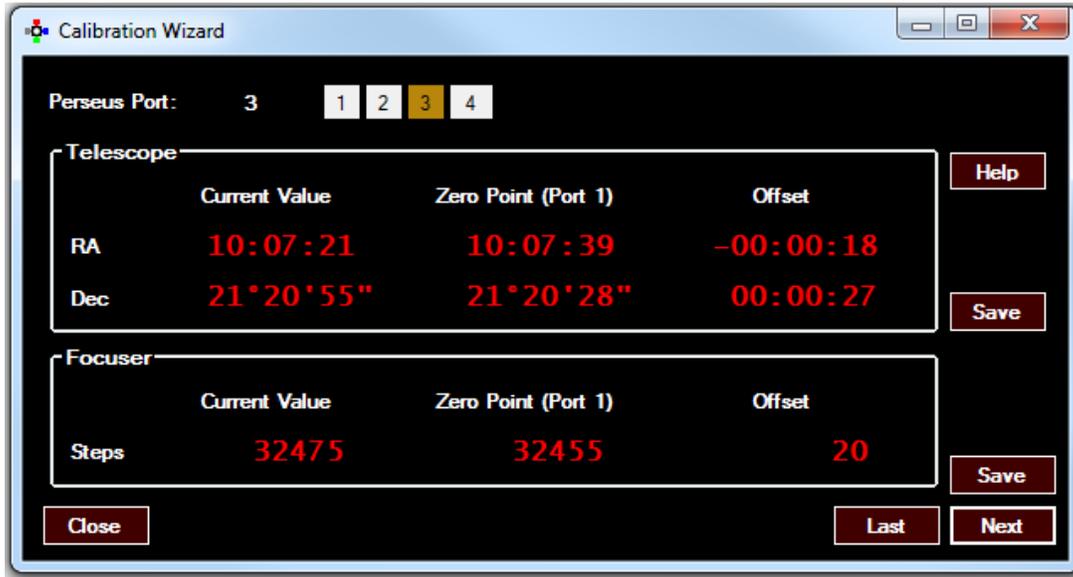


Figure 2. The Calibration Window showing a partially complete calibration (as of version 3.0.3).

Perseus Upgrades

For owners of the original Perseus 4-port Instrument Selector or the second generation GEN2 instrument selectors, Optec offers a special upgrade package which replaces the original DC motor with a U.S. made high-torque bi-polar motor, third generation circuit board with Ethernet, and new top end plate.

Contact [Optec Sales](#) for details.



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Perseus 4-Port 2nd Generation (left) and 3rd Generation (right) Instrument Selectors.

Optec User Group

The Optec User Group on Yahoo! can also provide answers to specific configuration questions and provides a forum to communicate with other users. Click the banner below to subscribe.



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