56 Sparta Avenue • Newton, New Jersey 07860
(973) 300-3000 Sales • (973) 300-3600 Fax
www.thorlabs.com

THORLABS

MPH16 - February 24, 2020

Item # MPH16 was discontinued on February 24, 2020. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

MOTORIZED PINHOLE WHEELS

- **16 Pinholes from Ø25 µm to Ø2 mm**
- **Automated, Repeatable Positioning of Pinholes**
- **Encoded Motor Eliminates the Need for Realignment**
- **Uncoated and AR-Coated Options Available**

MPH16
Motorized Pinhole Wheel,
350 - 700 nm AR Coating

Front View

Back View

Dovetail Adapter Included with Every Pinhole Wheel for 30 mm Cage

Application Idea

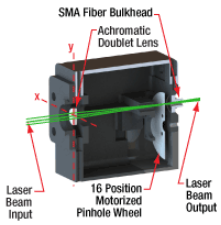
MPH16 Motorized Pinhole Wheel in Confocal Imaging Setup (See the *Applications* Tab)

Hide Overview

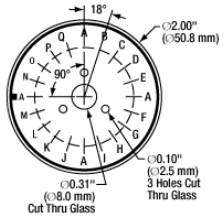
OVERVIEW

Features

- 16 Pinhole Sizes: Ø25 µm to Ø2 mm (See *Specs* Tab for Details)
- Uncoated or AR-Coated for 350 - 700 nm
- Quick and Repeatable Pinhole Positioning
- Free-Space Input Compatible with 30 mm Cage Systems (Using Included Dovetail Adapter)
- Fiber-Coupled Output with SMA Connector (Use Ø400 - Ø1000 µm Core MM Fiber)
- Compatible with 16 mm and 30 mm Cage Systems



Click to Enlarge
Figure 1: Cross-Section Schematic of a Motorized Pinhole Wheel



Click to Enlarge
Figure 2: Schematic of Internal Pinhole Wheel (See *Specs* Tab for Details)

Thorlabs' Motorized Pinhole Wheels enable automated and repeatable positioning of pinholes for applications such as confocal laser scanning microscopy or scanning ophthalmoscopy. We offer a motorized uncoated pinhole wheel, as well as a motorized AR-coated pinhole wheel for 350 - 700 nm. Each pinhole wheel is a chrome-plated glass disk, manufactured using standard photolithography techniques, and features 16 etched pinholes ranging from Ø25 µm to Ø2 mm (see the *Specs* tab). The glass disk in the motorized AR-coated pinhole wheel is coated on both sides to increase transmission through the wheel for the specified wavelength range.

An optically encoded motor provides repeatable movement between pinholes with a resolution of 10 µm, without the need for realignment. The motorized pinhole wheel may be connected to a PC through a USB port and can be controlled using the provided GUI software or through DLL (see the *Software* tab to download the software package). As seen in Figure 1, light entering a motorized pinhole wheel is focused by an achromatic doublet lens through the pinhole wheel. Radial positioning of the pinhole is pre-aligned, but can be fine-tuned by the user through the GUI. The position of the focusing lens, labeled the y-axis in Figure 1, can be

Apertures Selection Guide
Precision Pinholes
Motorized Pinhole Wheels
Pinhole Spatial Filter
Mounted Slits
Annular Apertures
Alignment Tools

adjusted using the included 1.5 mm hex key. Light exiting the pinhole wheel can be coupled to an SMA multimode fiber or used as a free-space beam. A Ø400 - Ø1000 µm core SMA multimode fiber patch cable should be used to connect to the detector, because smaller core sizes cannot be aligned accurately.

These motorized pinhole wheels can be integrated into a Thorlabs confocal microscope system or used within a custom experimental setup (see the *Applications* tab). Each motorized pinhole wheel allows the user to simultaneously control the amount of in-focus light that reaches the detector and minimize signals from outside the focal plane. For thicker samples, the size of the pinhole is chosen based on the NA of the imaging objective. However, because a thick sample may generate significant signals from outside the focal plane, using a smaller pinhole can result in better optical sectioning and improve the signal-to-noise ratio of the resulting image. Conversely, for thinner samples that produce less light outside of the focal plane, choosing a larger pinhole size can help increase the amount of light that reaches the detector.

Mounting Features

The input and output apertures of the motorized pinhole wheels are designed to allow for easy integration within custom experiments. The input aperture features a dovetail, which is designed to mate with our confocal laser scanning microscopy imaging systems. Using the included dovetail adapter, the user can connect the input to a 30 mm cage system. To do this, first insert the included 4-40 cap screws into the counterbored holes to attach the 30 mm cage assembly rods (sold separately), and then connect the adapter to the pinhole wheel input. Figure 3 shows the result. For additional mounting options, the base includes two mounting holes that accept both 8-32 and M4 threads.

Click to Enlarge
Figure 3: Input Connected to a 30 mm Cage System

Click to Enlarge
Figure 4: Output with SMA Fiber Connector Removed for Free Space Output

Click to Enlarge
Figure 5: Output Connected to a 16 mm Cage System

The output aperture comes preinstalled with an SMA fiber connector for efficient light collection. When using the fiber connector, the fiber face is positioned 1 mm from the back side of the pinhole wheel. The SMA fiber adapter may be removed (see Figure 4) using an SPW801 spanner wrench to expose internal SM05 (0.535"-40) threading, which is compatible with our Ø1/2" Lens Tubes. Additionally, the output aperture is surrounded by four 4-40 tapped holes for compatibility with our 16 mm cage systems, as shown in Figure 5.

Other fiber connector adapters are available upon request; please contact Tech Support for details.

Hide Specs

SPECS

Item #	MPH16-UC	MPH16[a]
Input Aperture	Ø10 mm	
Pinhole Wheel AR Coating on Each Side	N/A	350 - 700 nm, R_{avg} < 0.5%
Achromatic Doublet AR Coating[b]	N/A	400 - 700 nm, R_{avg} < 0.5%
Positioning Accuracy	±5.1 µm	
Pinhole Wheel Material	Chrome-Plated Fused Silica	
Pinholes	16 (Ø25 µm to Ø2 mm)	
Substrate Thickness	0.020" (0.508 mm)	
Refractive Index	1.5255	
Abbe Number (V_e) @ 546 nm	55	
Recommended Fiber	Multimode Fiber, Ø400 - Ø1000 µm Core, 0.22 NA	
Operating Voltage	24 VDC, 1.67 A	
Input Power (Max)[c]	200 mW/cm^2	
Control	USB Cable, Operating Software, and SDK Included[d]	
Dimensions	3.73" x 3.34" x 2.60" (94.8 mm x 84.7 mm x 66.0 mm)	
Weight	1.0 kg	

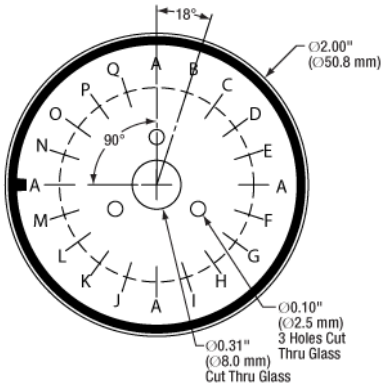
Pinhole Wheel	
Position[a]	**Pinhole Size**
A	50 µm Annular Aperture[b]
B	Ø25 µm
C	Ø30 µm
D	Ø35 µm
E	Ø40 µm
F	Ø45 µm
G	Ø50 µm
H	Ø60 µm
I	Ø70 µm
J	Ø80 µm
K	Ø90 µm
L	Ø100 µm
M	Ø125 µm
N	Ø200 µm
O	Ø300 µm
P	Ø1000 µm
Q	Ø2000 µm

- The pinhole position reported by the DLL and GUI (0 - 15) corresponds to pinhole

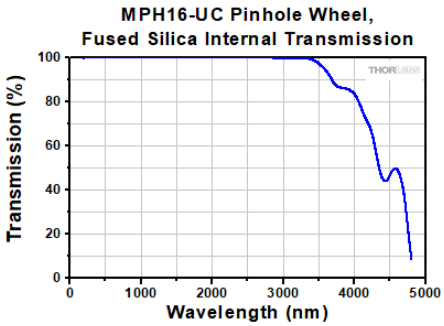
- The AC127-075-A achromatic doublet is used in the MPH16 motorized pinhole wheel.
- See the *Achromatic Doublet Specs* tab for more details.
- At Entrance Aperture
- The Operating Software and SDK are available for download. See the *Software* tab above.

positions B to Q.

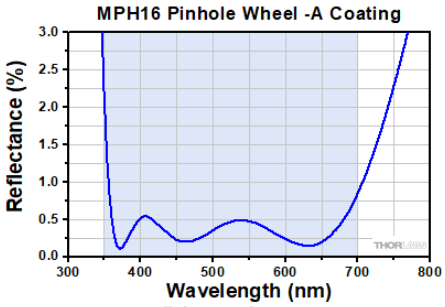
- Pinhole diameter is 100 µm and obstruction diameter is 50 µm.



Click to Enlarge
The pinhole wheel has 16 pinhole sizes; see the table to the left for the pinhole sizes. The MPH16-UC pinhole wheel is not AR coated, while the MPH16 pinhole wheel is AR coated for 350 - 700 nm.



Click to Enlarge
Click Here for Raw Data
The internal transmission curve of the uncoated MPH16-UC pinhole wheel.

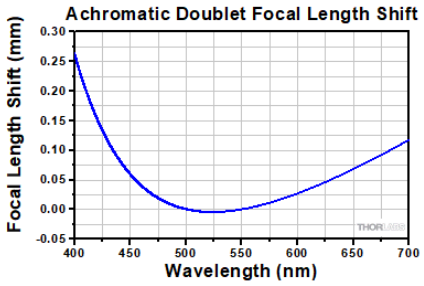


Click to Enlarge
Click Here for Raw Data
The reflectance curve of the AR coating on the MPH16 pinhole wheel, measured at 8° AOI. The blue-shaded region indicates the specified wavelength range of the AR coating.

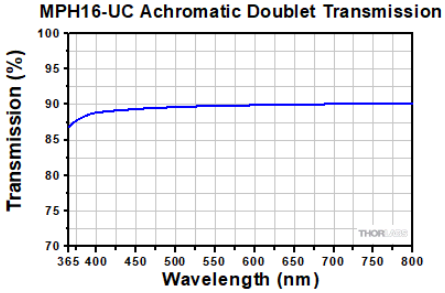
Hide Achromatic Doublet Specs

ACHROMATIC DOUBLET SPECS

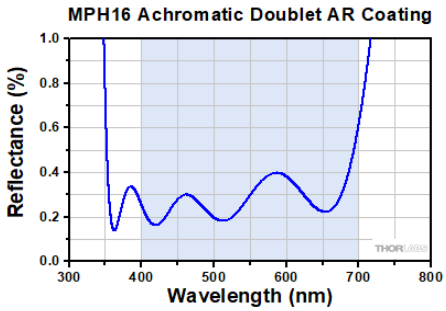
Achromatic Doublet Common Specifications	
Focal Length	75.0 mm
Size	Ø12.7 mm
Surface Quality	40-20 Scratch-Dig
Clear Aperture	>Ø11.43 mm



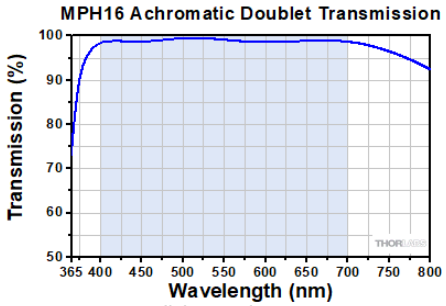
Click to Enlarge
Click Here for Raw Data
The focal length shift of the achromatic doublets in the MPH16-UC and MPH16 motorized pinhole wheels.



Click to Enlarge
Click Here for Raw Data
The transmission curve of the uncoated achromatic doublet in the MPH16-UC.



Click to Enlarge
Click Here for Raw Data
The reflectance curve of the AR coating on the MPH16 achromatic doublet,
item # AC127-075-A. The blue-shaded region indicates the specified wavelength range of the AR coating.



Click to Enlarge
Click Here for Raw Data
The transmission curve of the MPH16 achromatic doublet,
item # AC127-075-A. The blue-shaded region indicates the specified wavelength range of the AR coating.

Hide Pinhole Selection

PINHOLE SELECTION

Principles of Spatial Filters

An input Gaussian beam has spatially varying intensity "noise". When a beam is focused by a lens, the input beam is transformed into a central Gaussian spot (on the optical axis) and side fringes, which represent the unwanted "noise" (see Figure 1 below). The radial position of the side fringes is proportional to the spatial frequency of the "noise".

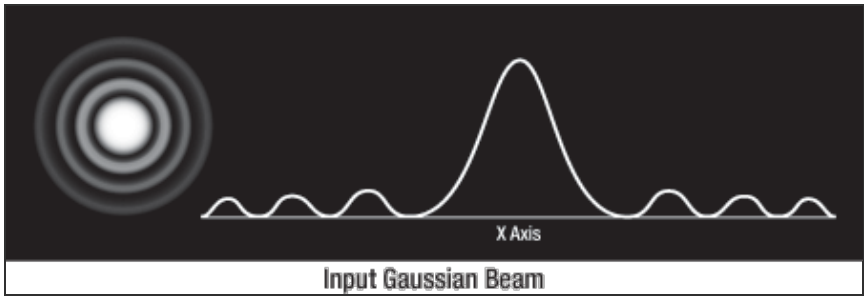


Figure 1

By centering a pinhole on a central Gaussian spot, the "clean" portion of the beam can pass while the "noise" fringes are blocked (see Figure 2 below).

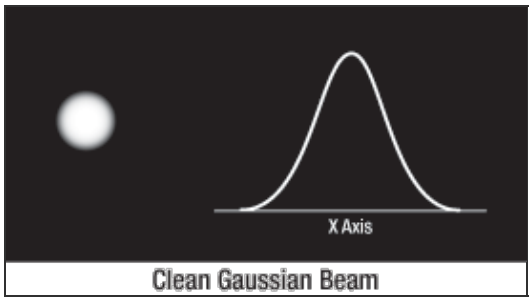


Figure 2

The diffraction-limited spot size at the 99% contour is given by:

$$D = \frac{\lambda f}{r}$$

where λ = wavelength, f = focal length, D = diameter, and r = input beam radius at the $1/e^2$ point.

Choosing the Correct Optics and Pinhole for Your Spatial

Filter System

The correct optics and pinhole for your application depend on the input wavelength, source beam diameter, and desired exit beam diameter.

For example, suppose that you are using a 632 nm diode laser source that has an input beam radius ($1/e^2$) of 2.3 mm with the MPH16 Motorized Pinhole Wheel. The equation for diffraction-limited spot size at the 99% contour is given above, and for this example, λ = (632 nm),
f = 75 mm for the achromatic doublet lens used in the MPH16, and r = 2.3 mm.
Substitution yields:

$$D = \frac{(632\ \text{nm})(75\ \text{mm})}{2.3\ \text{mm}} \approx 21\ \mu\text{m}$$

Diffraction-Limited Spot Size (632 nm Source, 2.3 mm Input Beam Radius)

The pinhole should be chosen so that it is approximately 30% larger than D. If the pinhole is too small, the beam will be clipped, but if it is too large, more than the TEM_{00} mode (the lowest-order transverse mode) will get through the pinhole. Therefore, for this example, the pinhole should ideally be 25 microns in diameter. For other wavelengths, see the table above for recommended beam diameters.

Recommended Beam Parameters[a]	
Wavelength	**Input Beam Radius ($1/e^2$)**
405 nm	1.5 mm
488 nm	1.8 mm
532 nm	1.9 mm
632 nm	2.3 mm

- Recommended input beam size for ideal spatial filtering using a Ø25 µm pinhole.

Hide Applications

APPLICATIONS

Motorized Pinhole Wheel in a Confocal Microscope

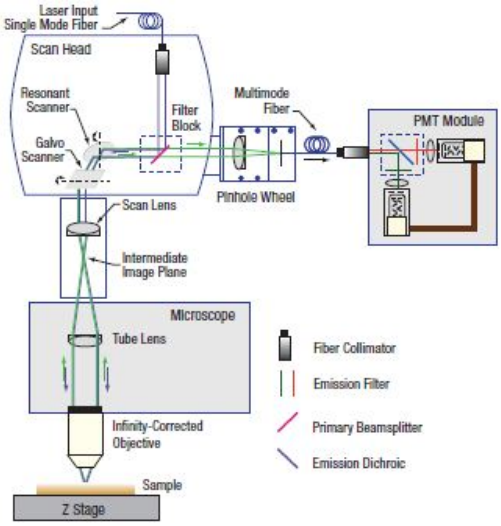
Our motorized pinhole wheels are designed for integration into confocal microscopy setups as shown in the diagram to the right. The pinhole wheel is located in the imaging path just before the photomultiplier tube (PMT) detector. Emitted light from the specimen is focused on the selected pinhole and then collected by a large-core multimode fiber for transmission to the PMT detector. A pinhole wheel, with multiple selectable pinholes, enables a user to select an appropriately sized pinhole for the intended applications.

The lithographically etched pinholes on the wheel prevent undesired signals outside the focal plane of the microscope from reaching the detector. Because only light from the focal plane of interest reaches the detectors, confocal microscopes are able to acquire high-resolution, optically-sectioned images from within a thick sample or to significantly reduce background fluorescence from thin culture samples.

While our motorized pinhole wheels are designed for Thorlabs' confocal microscopes, they can also be integrated into 16 mm and 30 mm cage systems. The image below illustrates part of a confocal microscope system using a KCB1C right-angle cube and BB1-E02 mirror to change the optical beam path. The DFM1 fluorescence filter cube takes the place of the filter block, but allows easy swapping of dichroic filter sets. Rather than a PMT detector, light that passes through the pinhole is collected by the PDA10A2 amplified photodetector.

Click to Enlarge
MPH16 Motorized Pinhole Wheel in Confocal Imaging Setup

Confocal System Schematic



Click to Enlarge

Hide Software

SOFTWARE

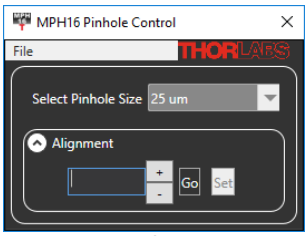
Software for the Motorized Pinhole Wheels

A link to the latest version of the Motorized Pinhole Wheel software is provided in the Software box to the right. The software download page offers a link to the DLL, GUI interface, SDK, and sample LabVIEW™ code.

Software

Version 4.0 (September 5, 2019)

The software package contains the installation files for the GUI interface, DLL files, SDK, and sample LabVIEW code. The software is compatible with Windows® 7 and 10 (64-bit) systems.



MPH16 Software GUI

Software

Hide Motorized Pinhole Wheels

Motorized Pinhole Wheels

Part Number	Description	Price	Availability
MPH16-UC	Customer Inspired! 16-Position Motorized Pinhole Wheel for Confocal Imaging, Uncoated	$2,987.80	Lead Time
MPH16	16-Position Motorized Pinhole Wheel for Confocal Imaging, 350 - 700 nm AR Coating	$2,987.80	Lead Time

Visit the *Motorized Pinhole Wheels* page for pricing and availability information:
https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=5805