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THORLABS

VPCHW42 - February 8, 2020

Item # VPCHW42 was discontinued on February 8, 2020. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

HIGH-VACUUM CF FLANGE VIEWPORTS FOR Ø1.5" WEDGED WINDOWS

- **CF Flange Viewports for High-Vacuum Systems**
- **Ø1.5" UVFS Wedged Vacuum Windows**
- **Available Uncoated or with BBAR Coatings**

VPCHW42-C
Ø1.5" Wedged
Window Viewport

VPCH2-VO
Viton O-Ring

VGA10
Annealed Copper Gaskets,
10 Pack

VPWW42-C
Ø1.5" Wedged Window with
AR Coating for 1050 - 1700 nm

VMH6
Flange Mounting Hardware Pack
(6 Bolts, 6 Nuts, & 12 Washers)

Hide Overview

OVERVIEW

Features

- Vacuum Level: 1 x 10^{-8} Torr (Max)
- Bake Temperature: 150 °C (Max)
- Available Uncoated or with One of Four Broadband AR Coatings
  - 245 - 400 nm (-UV Coating Designation)
  - 350 - 700 nm (-A Coating Designation)
  - 650 - 1050 nm (-B Coating Designation)
  - 1050 - 1700 nm (-C Coating Designation)
- Flange, Windows, and Viton® O-Ring Also Available Separately
- Flange Mounting Hardware Pack and Copper Gaskets Sold Below

Common Vacuum Specifications	
Vacuum Level	1 x 10^{-8} Torr (Max)
Max Temperature	150 °C
Thermal Gradient	20 °C/min (Max)

Thorlabs' High-Vacuum-Compatible Ø2.75" (DN40) CF Flange Viewports for Ø1.5" Wedged Windows are available with UVFS windows that are either uncoated (185 nm - 2.1 µm) or have one of our four low-loss standard broadband antireflection (BBAR) coating deposited on both optical surfaces. The BBAR coatings are designed for the following ranges: -UV (245 - 400 nm), -A (350 - 700 nm), -B (650 - 1050 nm), or -C (1050 - 1700 nm). While uncoated windows have typical losses of about 4% per surface, the BBAR coatings reduce this to R_{avg} <0.5% over the specified wavelength range and provide good performance for angles of incidence between 0° and 30°. BBAR coating curve information can be found under the *Graphs* tab.

Designed for use at high-vacuum (HV) pressures, Thorlabs' CF viewports utilize Viton O-Ring seals to create an air-tight metal/glass seal, allowing for pressures down to 10^{-8} Torr. The vacuum windows are interchangeable, enabling the user to swap out vacuum windows mounted in our HV CF flanges. Both the Viton O-rings and CF flanges (viewports without vacuum windows) for use with Ø1.5" windows are available separately. Before swapping and attempting to install additional windows, please review the procedure outlined in the *Window Installation* tab above.

Copper gasket and mounting hardware sets for Ø2.75" CF flanges are also available below. Thorlabs also sells CF viewports for Ø1" windows and Ø1.5" flat windows.

Hide Specs

SPECS

Item #	VPCHW42 VPWW42	VPCHW42-UV VPWW42-UV	VPCHW42-A VPWW42-A	VPCHW42-B VPWW42-B	VPCHW42-C VPWW42-C
Window Material	UV Fused Silica				
Window Diameter (Unmounted)	1.5"				
Diameter Tolerance (Unmounted)	+0/-0.1 mm				
Clear Aperture (in Viewport)	Ø1.13" (28.7 mm)				
AR Coating	Uncoated	245 - 400 nm	350 - 700 nm	650 - 1050 nm	1050 - 1700 nm
AR Coating Performance[a]	R_{avg}<0.5%				
Surface Flatness (@633 nm)	λ/2				
Surface Quality	20 -10 Scratch-Dig				
Wedge Angle	30 arcmin				
Wedge Angle Tolerance	±10 arcmin				

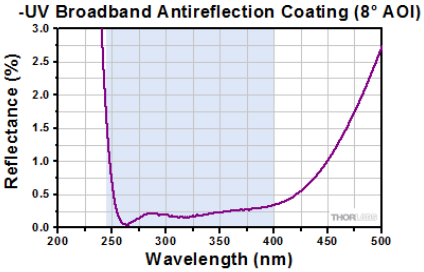
- Across the specified wavelength ranges for an angle of incidence of 0° ± 5°

Hide Graphs

GRAPHS

Thorlabs' high-performance multilayer AR coatings have an average reflectance of less than 0.5% (per surface) across the specified wavelength ranges (denoted by the shaded blue area in the Coating graphs below). These AR coatings provide good performance for angles of incidence (AOI) between 0° - 30° (0.5 NA). The AR Coating plots below show the reflectance of each coating at 8° AOI. For optics intended to be used at larger incident angles, consider ordering a custom coating optimized for a 45° angle of incidence; these coatings are recommended for use with incidence angles from 25° to 52°. The Substrate Transmission graph below shows the transmission of light through an uncoated UVFS substrate.

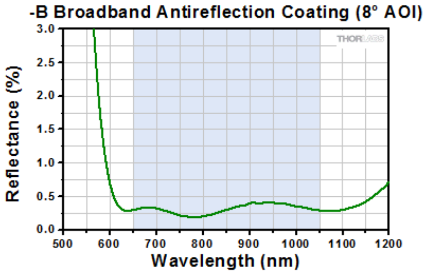
AR Coating



Click to Enlarge

Click Here for Raw Data

The blue shaded region indicates the specified 245 - 400 nm wavelength range for optimum performance.



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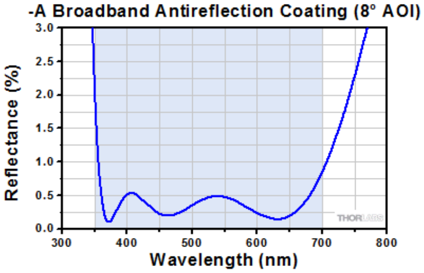
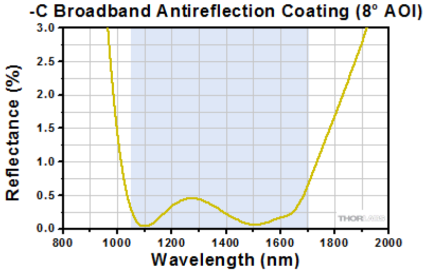
The blue shaded region indicates the specified 650 - 1050 nm wavelength range for optimum performance.



Click to Enlarge

Click Here for Raw Data

The blue shaded region indicates the specified 350 - 700 nm wavelength range for optimum performance.



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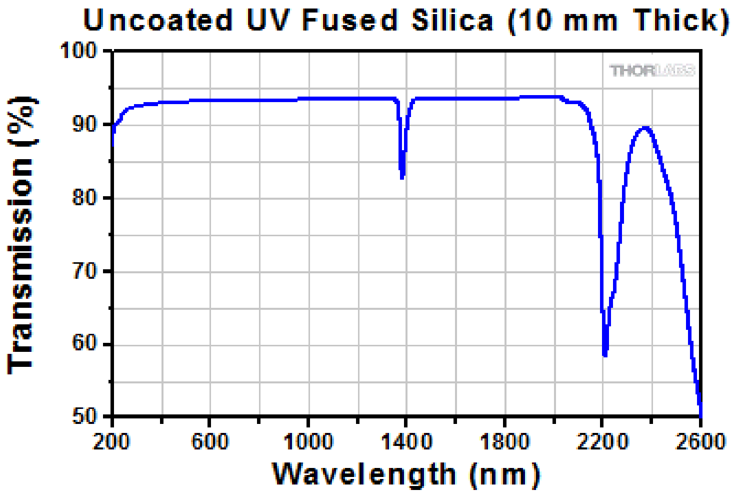
The blue shaded region indicates the specified 1050 - 1700 nm wavelength range for optimum performance.

Substrate Transmission



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Hide Window Installation

WINDOW INSTALLATION

Our high-vacuum viewports offer superb flexibility by allowing the user to install or swap out windows as they desire, or as experimental conditions demand. Installation of the windows is relatively quick and simple. This guide explains how to install and change windows in our high-vacuum CF flanges.

Step 1:

Left: Viewport with front face removed. Middle: O-Ring is removed, inspect the seat. Right: Using comprssed air, remove loose debris from the seat.

Inspect the o-ring and seat for pits, scratches, or contamination. Remove any loose debris from the seat using compressed air.

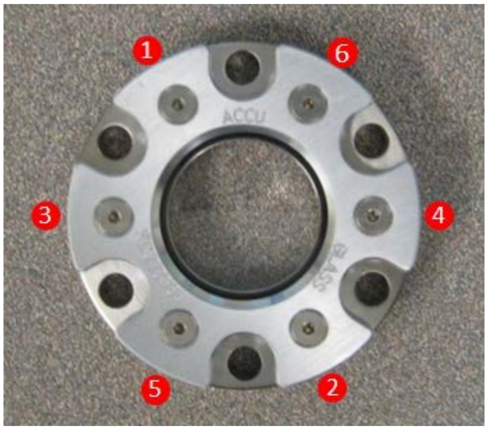
Step 2:

Install the o-ring in the seat, and place the window on top of the o-ring (left image). Place the face plate on top of the window (right image).

Step 3:

Place the screws in the face plate holes and use the 2 mm hex key to turn each screw ~1.5 turns so that they are flush with the face plate but not tight.

Step 4:



Use a torque driver set to 30 in-oz to screw in all six setscrews. Refer to the sequence shown in the pattern above for the correct order in which the screws should be torqued. Please note that over-torquing the screws will risk damaging the window. While the viewports for Ø1" windows only have 4 screws, use the same sequence for tightening the screws.

Hide Damage Thresholds

DAMAGE THRESHOLDS

Laser Induced Damage Threshold Tutorial

The following is a general overview of how laser induced damage thresholds are measured and how the values may be utilized in determining the appropriateness of an optic for a given application. When choosing optics, it is important to understand the Laser Induced Damage Threshold (LIDT) of the optics being used. The LIDT for an optic greatly depends on the type of laser you are using. Continuous wave (CW) lasers typically cause damage from thermal effects (absorption either in the coating or in the substrate). Pulsed lasers, on the other hand, often strip electrons from the lattice structure of an optic before causing thermal damage. Note that the guideline presented here assumes room temperature operation and optics in new condition (i.e., within scratch-dig spec, surface free of contamination, etc.). Because dust or other particles on the surface of an optic can cause damage at lower thresholds, we recommend keeping surfaces clean and free of debris. For more information on cleaning optics, please see our *Optics Cleaning* tutorial.

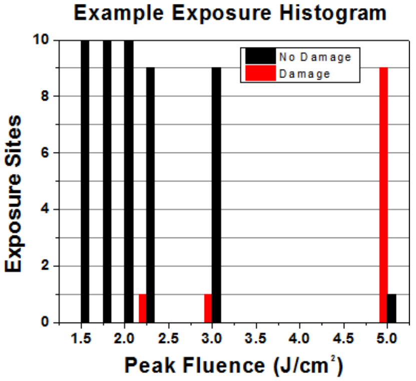
Testing Method

Thorlabs' LIDT testing is done in compliance with ISO/DIS 11254 and ISO 21254 specifications.

First, a low-power/energy beam is directed to the optic under test. The optic is exposed in 10 locations to this laser beam for 30 seconds (CW) or for a number of pulses (pulse repetition frequency specified). After exposure, the optic is examined by a microscope (~100X magnification) for any visible damage. The number of locations that are damaged at a particular power/energy level is recorded. Next, the power/energy is either increased or decreased and the optic is exposed at 10 new locations. This process is repeated until damage is observed. The damage threshold is then assigned to be the highest power/energy that the optic can withstand without causing damage. A histogram such as that below represents the testing of one BB1-E02 mirror.

The photograph above is a protected aluminum-coated mirror after LIDT testing. In this particular test, it handled 0.43 J/cm^2 (1064 nm, 10 ns pulse, 10 Hz, Ø1.000 mm) before damage.

According to the test, the damage threshold of the mirror was 2.00 J/cm^2 (532 nm, 10 ns pulse, 10 Hz, Ø0.803 mm). Please keep in mind that these tests are performed on clean optics, as dirt and contamination can significantly lower the damage threshold of a component. While the test results are only representative of one coating run, Thorlabs specifies damage threshold values that account for coating variances.



Example Test Data			
Fluence	# of Tested Locations	Locations with Damage	Locations Without Damage
1.50 J/cm^2	10	0	10
1.75 J/cm^2	10	0	10
2.00 J/cm^2	10	0	10
2.25 J/cm^2	10	1	9
3.00 J/cm^2	10	1	9
5.00 J/cm^2	10	9	1

Continuous Wave and Long-Pulse Lasers

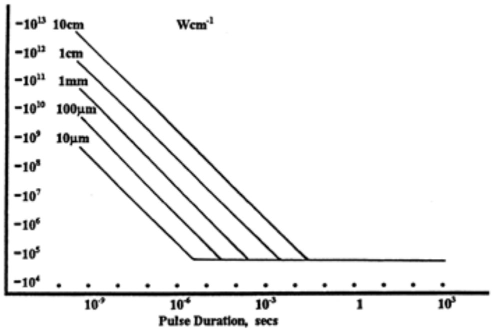
When an optic is damaged by a continuous wave (CW) laser, it is usually due to the melting of the surface as a result of absorbing the laser's energy or damage to the optical coating (antireflection) [1]. Pulsed lasers with pulse lengths longer than 1 µs can be treated as CW lasers for LIDT discussions.

When pulse lengths are between 1 ns and 1 µs, laser-induced damage can occur either because of absorption or a dielectric breakdown (therefore, a user must check both CW and pulsed LIDT). Absorption is either due to an intrinsic property of the optic or due to surface irregularities; thus LIDT values are only valid for optics meeting or exceeding the surface quality specifications given by a manufacturer. While many optics can handle high power CW lasers, cemented (e.g., achromatic doublets) or highly absorptive (e.g., ND filters) optics tend to have lower CW damage thresholds. These lower thresholds are due to absorption or scattering in the cement or metal coating.

Pulsed lasers with high pulse repetition frequencies (PRF) may behave similarly to CW beams. Unfortunately, this is highly dependent on factors such as absorption and thermal diffusivity, so there is no reliable method for determining when a high PRF laser will damage an optic due to thermal effects. For beams with a high PRF both the average and peak powers must be compared to the equivalent CW power. Additionally, for highly transparent materials, there is little to no drop in the LIDT with increasing PRF.

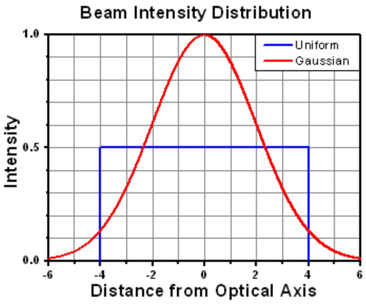
In order to use the specified CW damage threshold of an optic, it is necessary to know the following:

1. Wavelength of your laser
2. Beam diameter of your beam (1/e^2)
3. Approximate intensity profile of your beam (e.g., Gaussian)
4. Linear power density of your beam (total power divided by 1/e^2 beam diameter)



LIDT in linear power density vs. pulse length and spot size. For long pulses to CW, linear power density becomes a constant with spot size. This graph was obtained from [1].

Thorlabs expresses LIDT for CW lasers as a linear power density measured in W/cm. In this regime, the LIDT given as a linear power density can be applied to any beam diameter; one does not need to compute an adjusted LIDT to adjust for changes in spot size, as demonstrated by the graph to the right. Average linear power density can be calculated using the equation below.



$$Linear\ Power\ Density = \frac{Power}{Beam\ Diameter}$$

The calculation above assumes a uniform beam intensity profile. You must now consider hotspots in the beam or other non-uniform intensity profiles and roughly calculate a maximum power density. For reference, a Gaussian beam typically has a maximum power density that is twice that of the uniform beam (see lower right).

Now compare the maximum power density to that which is specified as the LIDT for the optic. If the optic was tested at a wavelength other than your operating wavelength, the damage threshold must be scaled appropriately. A good rule of thumb is that the damage threshold has a linear relationship with wavelength such that as you move to shorter wavelengths, the damage threshold decreases (i.e., a LIDT of 10 W/cm at 1310 nm scales to 5 W/cm at 655 nm):

$$Adjusted\ LIDT = LIDT\ Power \left(\frac{Your\ Wavelength}{LIDT\ Wavelength}\right)$$

While this rule of thumb provides a general trend, it is not a quantitative analysis of LIDT vs wavelength. In CW applications, for instance, damage scales more strongly with absorption in the coating and substrate, which does not necessarily scale well with wavelength. While the above procedure provides a good rule of thumb for LIDT values, please contact Tech Support if your wavelength is different from the specified LIDT wavelength. If your power density is less than the adjusted LIDT of the optic, then the optic should work for your application.

Please note that we have a buffer built in between the specified damage thresholds online and the tests which we have done, which accommodates variation between batches. Upon request, we can provide individual test information and a testing certificate. The damage analysis will be carried out on a similar optic (customer's optic will not be damaged). Testing may result in additional costs or lead times. Contact Tech Support for more information.

Pulsed Lasers

As previously stated, pulsed lasers typically induce a different type of damage to the optic than CW lasers. Pulsed lasers often do not heat the optic enough to damage it; instead, pulsed lasers produce strong electric fields capable of inducing dielectric breakdown in the material. Unfortunately, it can be very difficult to compare the LIDT specification of an optic to your laser. There are multiple regimes in which a pulsed laser can damage an optic and this is based on the laser's pulse length. The highlighted columns in the table below outline the relevant pulse lengths for our specified LIDT values.

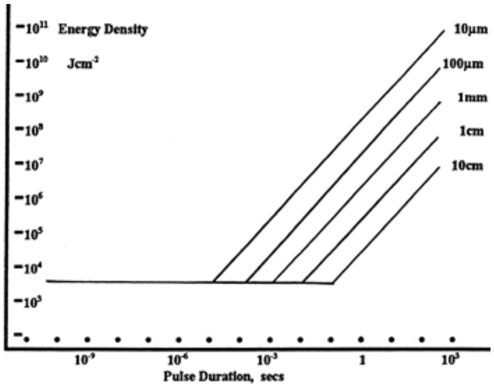
Pulses shorter than 10^{-9} s cannot be compared to our specified LIDT values with much reliability. In this ultra-short-pulse regime various mechanics, such as multiphoton-avalanche ionization, take over as the predominate damage mechanism [2]. In contrast, pulses between 10^{-7} s and 10^{-4} s may cause damage to an optic either because of dielectric breakdown or thermal effects. This means that both CW and pulsed damage thresholds must be compared to the laser beam to determine whether the optic is suitable for your application.

Pulse Duration	$t < 10^{-9}$ s	$10^{-9} < t < 10^{-7}$ s	$10^{-7} < t < 10^{-4}$ s	$t > 10^{-4}$ s
Damage Mechanism	Avalanche Ionization	Dielectric Breakdown	Dielectric Breakdown or Thermal	Thermal
Relevant Damage Specification	No Comparison (See Above)	Pulsed	Pulsed and CW	CW

When comparing an LIDT specified for a pulsed laser to your laser, it is essential to know the following:

1. Wavelength of your laser
2. Energy density of your beam (total energy divided by $1/e^2$ area)
3. Pulse length of your laser
4. Pulse repetition frequency (prf) of your laser
5. Beam diameter of your laser ($1/e^2$)
6. Approximate intensity profile of your beam (e.g., Gaussian)

The energy density of your beam should be calculated in terms of J/cm^2. The graph to the right shows why expressing the LIDT as an energy density provides the best metric for short pulse sources. In this regime, the LIDT given as an energy density can be applied to any beam diameter; one does not need to compute an adjusted LIDT to adjust for changes in spot size. This calculation assumes a uniform beam intensity profile. You must now adjust this energy density to account for hotspots or other nonuniform intensity profiles and roughly calculate a maximum energy density. For reference a Gaussian beam typically has a maximum energy density that is twice that of the $1/e^2$ beam.



LIDT in energy density vs. pulse length and spot size. For short pulses, energy density becomes a constant with spot size. This graph was obtained from [1].

Now compare the maximum energy density to that which is specified as the LIDT for the optic. If the optic was tested at a wavelength other than your operating wavelength, the damage threshold must be scaled appropriately [3]. A good rule of thumb is that the damage threshold has an inverse square root relationship with wavelength such that as you move to shorter wavelengths, the damage threshold decreases (i.e., a LIDT of 1 J/cm^2 at 1064 nm scales to 0.7 J/cm^2 at 532 nm):

$$\text{Adjusted LIDT} = \text{LIDT Energy}\sqrt{\frac{\text{Your Wavelength}}{\text{LIDT Wavelength}}}$$

You now have a wavelength-adjusted energy density, which you will use in the following step.

Beam diameter is also important to know when comparing damage thresholds. While the LIDT, when expressed in units of J/cm², scales independently of spot size; large beam sizes are more likely to illuminate a larger number of defects which can lead to greater variances in the LIDT [4]. For data presented here, a <1 mm beam size was used to measure the LIDT. For beams sizes greater than 5 mm, the LIDT (J/cm2) will not scale independently of beam diameter due to the larger size beam exposing more defects.

The pulse length must now be compensated for. The longer the pulse duration, the more energy the optic can handle. For pulse widths between 1 - 100 ns, an approximation is as follows:

$$\text{Adjusted LIDT} = \text{LIDT Energy}\sqrt{\frac{\text{Your Pulse Length}}{\text{LIDT Pulse Length}}}$$

Use this formula to calculate the Adjusted LIDT for an optic based on your pulse length. If your maximum energy density is less than this adjusted LIDT maximum energy density, then the optic should be suitable for your application. Keep in mind that this calculation is only used for pulses between 10^{-9} s and 10^{-7} s. For pulses between 10^{-7} s and 10^{-4} s, the CW LIDT must also be checked before deeming the optic appropriate for your application.

Please note that we have a buffer built in between the specified damage thresholds online and the tests which we have done, which accommodates variation between batches. Upon request, we can provide individual test information and a testing certificate. Contact Tech Support for more information.

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[1] R. M. Wood, Optics and Laser Tech. **29**, 517 (1998).
[2] Roger M. Wood, *Laser-Induced Damage of Optical Materials* (Institute of Physics Publishing, Philadelphia, PA, 2003).
[3] C. W. Carr *et al*., Phys. Rev. Lett. **91**, 127402 (2003).
[4] N. Bloembergen, Appl. Opt. **12**, 661 (1973).

Hide LIDT Calculations

LIDT CALCULATIONS

LIDT Calculator

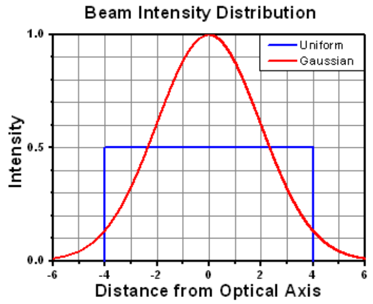
In order to illustrate the process of determining whether a given laser system will damage an optic, a number of example calculations of laser induced damage threshold are given below. For assistance with performing similar calculations, we provide a spreadsheet calculator that can be downloaded by clicking the button to the right. To use the calculator, enter the specified LIDT value of the optic under consideration and the relevant parameters of your laser system in the green boxes. The spreadsheet will then calculate a linear power density for CW and pulsed systems, as well as an energy density value for pulsed systems. These values are used to calculate adjusted, scaled LIDT values for the optics based on accepted scaling laws. This calculator assumes a Gaussian beam profile, so a correction factor must be introduced for other beam shapes (uniform, etc.). The LIDT scaling laws are determined from empirical relationships; their accuracy is not guaranteed. Remember that absorption by optics or coatings can significantly reduce LIDT in some spectral regions. These LIDT values are not valid for ultrashort pulses less than one nanosecond in duration.

CW Laser Example

Suppose that a CW laser system at 1319 nm produces a 0.5 W Gaussian beam that has a $1/e^2$ diameter of 10 mm. A naive calculation of the average linear power density of this beam would yield a value of 0.5 W/cm, given by the total power divided by the beam diameter:

$$\text{Linear Power Density} = \frac{\text{Power}}{\text{Beam Diameter}}$$

However, the maximum power density of a Gaussian beam is about twice the maximum power density of a uniform beam, as shown in the graph to the right. Therefore, a more accurate determination of the maximum linear power density of the system is 1 W/cm.



A Gaussian beam profile has about twice the maximum intensity of a uniform beam profile.

An AC127-030-C achromatic doublet lens has a specified CW LIDT of 350 W/cm, as tested at 1550 nm. CW damage threshold values typically scale directly with the wavelength of the laser source, so this yields an adjusted LIDT value:

$$\text{Adjusted LIDT} = \text{LIDT Power}\left(\frac{\text{Your Wavelength}}{\text{LIDT Wavelength}}\right)$$

The adjusted LIDT value of 350 W/cm x (1319 nm / 1550 nm) = 298 W/cm is significantly higher than the calculated maximum linear power density of the laser system, so it would be safe to use this doublet lens for this application.

Pulsed Nanosecond Laser Example: Scaling for Different Pulse Durations

Suppose that a pulsed Nd:YAG laser system is frequency tripled to produce a 10 Hz output, consisting of 2 ns output pulses at 355 nm, each with 1 J of energy, in a Gaussian beam with a 1.9 cm beam diameter ($1/e^2$). The average energy density of each pulse is found by dividing the pulse energy by the beam area:

$$\text{Energy Density} = \frac{\text{Pulse Energy}}{\text{Beam Area}}$$

As described above, the maximum energy density of a Gaussian beam is about twice the average energy density. So, the maximum energy density of this beam is ~0.7 J/cm^2.

The energy density of the beam can be compared to the LIDT values of 1 J/cm^2 and 3.5 J/cm^2 for a BB1-E01 broadband dielectric mirror and an NB1-K08 Nd:YAG laser line mirror, respectively. Both of these LIDT values, while measured at 355 nm, were determined with a 10 ns pulsed laser at 10 Hz. Therefore, an adjustment must be applied for the shorter pulse duration of the system under consideration. As described on the previous tab, LIDT values in the nanosecond pulse regime scale with the square root of the laser pulse duration:

$$\text{Adjusted LIDT} = \text{LIDT Energy}\sqrt{\frac{\text{Your Pulse Length}}{\text{LIDT Pulse Length}}}$$

This adjustment factor results in LIDT values of 0.45 J/cm^2 for the BB1-E01 broadband mirror and 1.6 J/cm^2 for the Nd:YAG laser line mirror, which are to be compared with the 0.7 J/cm^2 maximum energy density of the beam. While the broadband mirror would likely be damaged by the laser, the more specialized laser line mirror is appropriate for use with this system.

Pulsed Nanosecond Laser Example: Scaling for Different Wavelengths

Suppose that a pulsed laser system emits 10 ns pulses at 2.5 Hz, each with 100 mJ of energy at 1064 nm in a 16 mm diameter beam ($1/e^2$) that must be attenuated with a neutral density filter. For a Gaussian output, these specifications result in a maximum energy density of 0.1 J/cm^2. The damage threshold of an NDUV10A Ø25 mm, OD 1.0, reflective neutral density filter is 0.05 J/cm^2 for 10 ns pulses at 355 nm, while the damage threshold of the similar NE10A absorptive filter is 10 J/cm^2 for 10 ns pulses at 532 nm. As described on the previous tab, the LIDT value of an optic scales with the square root of the wavelength in the nanosecond pulse regime:

$$\text{Adjusted LIDT} = \text{LIDT Energy}\sqrt{\frac{\text{Your Wavelength}}{\text{LIDT Wavelength}}}$$

This scaling gives adjusted LIDT values of 0.08 J/cm^2 for the reflective filter and 14 J/cm^2 for the absorptive filter. In this case, the absorptive filter is the best choice in order to avoid optical damage.

Pulsed Microsecond Laser Example

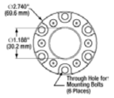
Consider a laser system that produces 1 µs pulses, each containing 150 µJ of energy at a repetition rate of 50 kHz, resulting in a relatively high duty cycle of 5%. This system falls somewhere between the regimes of CW and pulsed laser induced damage, and could potentially damage an optic by mechanisms associated with either regime. As a result, both CW and pulsed LIDT values must be compared to the properties of the laser system to ensure safe operation.

If this relatively long-pulse laser emits a Gaussian 12.7 mm diameter beam ($1/e^2$) at 980 nm, then the resulting output has a linear power density of 5.9 W/cm and an energy density of 1.2 x 10^{-4} J/cm^2 per pulse. This can be compared to the LIDT values for a WPQ10E-980 polymer zero-order quarter-wave plate, which are 5 W/cm for CW radiation at 810 nm and 5 J/cm^2 for a 10 ns pulse at 810 nm. As before, the CW LIDT of the optic scales linearly with the laser wavelength, resulting in an adjusted CW value of 6 W/cm at 980 nm. On the other hand, the pulsed LIDT scales with the square root of the laser wavelength and the square root of the pulse duration, resulting in an adjusted value of 55 J/cm^2 for a 1 µs pulse at 980 nm. The pulsed LIDT of the optic is significantly greater than the energy density of the laser pulse, so individual pulses will not damage the wave plate. However, the large average linear power density of the laser system may cause thermal damage to the optic, much like a high-power CW beam.

Hide High-Vacuum CF Flange Viewports for Ø1.5" Wedged Windows

High-Vacuum CF Flange Viewports for Ø1.5" Wedged Windows

- Ø2.75" CF Viewport with Ø1.5" Wedged UVFS Window
- Viton O-Ring Metal-to-Glass Seal
- Windows Include a 30 arcmin Wedge
- Clear Aperture: Ø1.13" (28.7 mm)



Click to Enlarge

Thorlabs Ø2.75" CF flange viewports for wedged windows allow for optical access into high-vacuum (HV) systems down to 10^{-8} Torr. These are fixed (non-rotating) flanges with Ø1.5" wedged windows that provide a clear aperture of Ø1.13". These viewports have six 1/4" (M6) through holes for bolting onto any standard Ø2.75" CF flange. Please note that mounting hardware is not included. The windows feature a 30 arcmin wedge, eliminating fringe patterns and avoiding optical feedback. These UVFS wedged windows, mounted into our viewports, are available either uncoated or with one of Thorlabs' Broadband Antireflection (BBAR) Coatings deposited on both sides. A Viton O-Ring (included in the CF flange) holds the window in place and forms the leak-tight metal-to-glass seal.

The CF-style flange utilizes a knife-edge mechanism to create an airtight seal between mating pieces. To create the seal, a copper gasket (available below) is most often employed. As the bolts of the mating pair are tightened, the knife edge "bites" into the copper gasket, deforming it. The extruded metal fills all the machining marks and surface defects, which yields a leak-tight seal.

Part Number	Description	Price	Availability
VPCHW42	**Customer Inspired! Ø2.75" CF Flange, Uncoated Wedged UVFS Window**	**$271.61**	**Today**
VPCHW42-UV	**Customer Inspired! Ø2.75" CF Flange, AR Coating: 245 - 400 nm Wedged UVFS Window**	**$290.01**	**Lead Time**
VPCHW42-A	**Customer Inspired! Ø2.75" CF Flange, AR Coating: 350 - 700 nm Wedged UVFS Window**	**$306.24**	**Lead Time**
VPCHW42-B	**Customer Inspired! Ø2.75" CF Flange, AR Coating: 650 - 1050 nm Wedged UVFS Window**	**$306.24**	**Lead Time**
VPCHW42-C	**Customer Inspired! Ø2.75" CF Flange, AR Coating: 1050 - 1700 nm Wedged UVFS Window**	**$306.24**	**Today**

Hide Ø1.5" UV Fused Silica Wedged Vacuum Windows

Ø1.5" UV Fused Silica Wedged Vacuum Windows

- Ø1.5" UVFS Wedged Vacuum Window
- 30 arcmin Wedge
- Replacement Windows for Our High-Vacuum CF Flange Viewports

Thorlabs' Ø1.5" wedged vacuum windows are available either uncoated or with one of four Thorlabs' broadband antireflection (BBAR) coatings deposited on both sides. While uncoated windows have typical losses of about 4% per surface, the BBAR coatings reduce this to R_{avg} <0.5% over the specified wavelength range and provide good performance for angles of incidence between 0° and 30°. BBAR coating curve information can be found under the *Graphs* tab. These windows are compatible with our high-vacuum CF flange viewports for Ø1.5" wedged windows (sold directly above) and may act as replacement windows should a window become damaged or if a different AR coating is required. They are also compatible with the VPCH2-FL empty vacuum flange sold directly below. Please see the *Windows Installation* tab for instructions on installing these windows into a CF flange.

Part Number	Description	Price	Availability
VPWW42	**Customer Inspired! Ø1.5" UVFS Wedged Vacuum Window, Uncoated**	**$152.57**	**Today**
VPWW42-UV	**Customer Inspired! Ø1.5" UVFS Wedged Vacuum Window, AR Coating: 245 - 400 nm**	**$176.39**	**Today**
VPWW42-A	**Customer Inspired! Ø1.5" UVFS Wedged Vacuum Window, AR Coating: 350 - 700 nm**	**$176.39**	**Today**
VPWW42-B	**Customer Inspired! Ø1.5" UVFS Wedged Vacuum Window, AR Coating: 650 - 1050 nm**	**$176.39**	**Today**
VPWW42-C	**Customer Inspired! Ø1.5" UVFS Wedged Vacuum Window, AR Coating: 1050 - 1700 nm**	**$176.39**	**Today**

Hide High-Vacuum Hardware for Ø1.5" Optics

High-Vacuum Hardware for Ø1.5" Optics

- Ø2.75" CF Flange (Includes One O-Ring)
- Compatible with Ø1.5" Windows

- Viton O-Rings for Ø1.5" Vacuum Windows

Thorlabs' Ø2.75" CF flange does not include a window but is compatible with the wedged windows sold in the viewports above as well as our Ø1.5" UV fused silica flat vacuum windows. When combined with the appropriate window, this flange allows for optical access into high-vacuum (HV) systems down to 10^{-8} Torr. This fixed (non-rotating) flange has six 1/4" (M6) through holes for bolting onto any standard Ø2.75" CF flange. Please note that mounting hardware is not included. The Viton O-Rings come in a pack of 5 and are replacement O-rings for those that come with our high-vacuum CF flange viewports for Ø1.5" windows sold above.

Part Number	Description	Price	Availability
VPCH2-FL	**Customer Inspired! Ø2.75" CF Flange for Ø1.5" Optics**	**$114.70**	**Today**
VPCH2-VO	**Customer Inspired! Viton O-Ring for Ø1.5" Vacuum Window, Pack of 5**	**$21.31**	**5-8 Days**

Hide CF Flange Copper Gaskets and Mounting Hardware

CF Flange Copper Gaskets and Mounting Hardware

- VMH6 Stainless Steel (18-8) Mounting Hardware Set Includes:
    - Six Bolts (Silver-Plated, 1/4"-28 x 1.50", 12-Point Heads)
    - Six Nuts and Twelve Washers
- Single-Use Copper Gaskets for Forming a Seal Between Ø2.75" CF Flanges
    - 101 Copper Alloy (99.99% Pure), OFHC (Oxygen-Free High Conductivity)
    - VGC10: 1/4-Hard Copper Gaskets
    - VGA10: Annealed Copper Gaskets


Click to Enlarge
VGA10 Copper Gasket Installed on VPCHW42-C Viewport

Thorlabs offers mounting hardware and single-use copper gaskets for mating Ø2.75" CF flanges. These flanges utilize a knife-edge mechanism to create an airtight seal between mating pieces. To create the seal, a copper gasket is most often employed. As the bolts of the mating pair are tightened, the knife edge bites into the copper gasket, deforming it. The extruded metal fills all the machining marks and surface defects, which yields a leak-tight seal.

1/4-hard and annealed copper gaskets are sold in sets of 10. We recommend the 1/4-hard copper gaskets for most applications; for more delicate devices, such as viewports, we recommend using the softer annealed copper gaskets to lower the chance of deformation in the optic due to stress in the flange. The set of stainless steel mounting hardware includes six silver-plated bolts, six nuts, and twelve washers. The silver plating on the bolts acts as a lubricant to prevent galling between the stainless steel surfaces of the bolt and the nut.

Instructions
First ensure the knife-edge mating surfaces of the CF flanges are free from debris or scratches. Then choose the desired bolt hole orientation and insert the gasket, aligning leak-test grooves on the flanges if present. Slide a washer onto the bolt, insert the bolt through the flanges, and add another washer before screwing on the nut. Hand tighten each bolt, then use two wrenches to hold the bolt head and turn the nut. Tighten the nuts gradually in 1/8 to 1/4 turn increments in an alternating crisscross star pattern until the desired tightness is reached. Following these steps will result in a reliable seal with even gasket compression and deformation.

Part Number	Description	Price	Availability
VMH6	**Mounting Hardware for CF Flanges: 6 Silver-Plated Bolts, 6 Nuts, 12 Washers**	**$17.51**	**Today**
VGC10	**1/4-Hard OFHC 99.99% Pure Copper Gaskets for Ø2.75" CF Flange, 10 Pack**	**$41.20**	**Today**
VGA10	**Annealed OFHC 99.99% Pure Copper Gaskets for Ø2.75" CF Flange, 10 Pack**	**$92.70**	**Today**