AL72512-E - July 16, 2021

Item # AL72512-E was discontinued on July 16, 2021 For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

ZINC SELENIDE (ZNSE) ASPHERES

- Ø1" Laser-Grade ZnSe Aspheres
- Two AR Coatings Available: 3 - 5 µm or 7 - 12 µm
- Numerical Apertures from 0.22 to 0.67

AL72525-G

AL72550-E

AL72512-G

Application Idea
ZnSe Asphere Mounted in
ST1XY-D XY Translation Mount

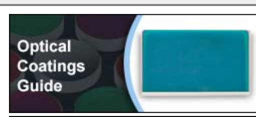
OVERVIEW

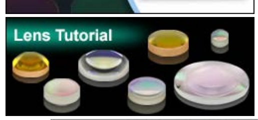
Features

- Ø1" CVD Laser-Grade ZnSe Substrate
- Two AR Coating Options: 3 - 5 µm or 7 - 12 µm
- Three Focal Lengths Available: 12.7 mm, 25.0 mm, or 50.0 mm

Thorlabs' Ø1" Zinc Selenide (ZnSe) Aspheric Lenses offer high transmission in the mid-infrared wavelength range. These lenses are available with AR coatings designed to minimize surface reflections over the 3 - 5 µm or 7 - 12 µm wavelength ranges (designated by -E or -G, respectively). These coatings greatly reduce the high surface reflectance of the substrate, yielding an average reflectance of less than 1.5% (-E) or 1.0% (-G) per surface over the entire AR coating range. See the *Graphs* tab for detailed information. These lenses are manufactured using diamond turning machines and are tested using a surface profilometer to ensure the correct aspheric profile. As a result, these aspheric lenses offer RMS wavefront errors that are typically 20 to 50 times less than similarly sized molded aspheric lenses.

Zemax Files
Click on the red Document icon next to the item numbers below to access the Zemax file download. Our entire Zemax Catalog is also available.





Common Specifications	
Focal Length Tolerance	±1%
Wavelength Range	E-Coated Lenses: 3 - 5 µm G-Coated Lenses: 7 - 12 µm
AR Coating Reflectance	E-Coated Lenses: R_{avg} < 1.5% G-Coated Lenses: R_{avg} < 1.0%
Surface Quality	80-50 Scratch-Dig
Diameter Tolerance	+0.00 mm / -0.10 mm
Center Thickness Tolerance	±0.10 mm
Substrate	Zinc Selenide[a]
Damage Threshold	G-Coated Lenses: 5 J/cm^2 (10.6 µm, 100 ns, 1 Hz, Ø0.478 mm)

- Click Link for Detailed Specifications on the Substrate

Precision Aspheric Lenses Selection Guide		
Substrate Material	**NA**	**Mount**
UV Fused Silica	0.142 - 0.145	Unmounted
	0.142 - 0.145	Mounted
	0.65	Unmounted
N-BK7 / S-LAH64	0.23 - 0.61	Unmounted
	0.23 - 0.55	Mounted

Zinc Selenide	0.22 - 0.67	Unmounted
Acylindrical Lenses	0.45 - 0.54	Unmounted
Axicons	-	Unmounted

IR Aspheric Lens Selection	
Low NA (0.22)	Maintains beam shape well; ideal for applications requiring a specific beam shape.
High NA (0.42 - 0.67)	Ideal for applications requiring high light-gathering ability where spherical aberration is undesirable.

In contrast to their plano-convex counterparts, these ZnSe aspheric lenses are typically used to focus or collimate light without introducing spherical aberration into the transmitted wavefront. For monochromatic sources, spherical aberration is often what prevents a single spherical lens from achieving diffraction limited performance when focusing or collimating light. Thus, an aspheric lens is often the best single element solution for many applications including collimating the output of a fiber or laser, coupling light into a fiber, spatial filtering, or imaging light onto a detector. When used for collimation, the plano surface should face the laser or other point source for best performance. Due to their relatively high refractive index (~2.4), ZnSe aspheres can be designed with shorter focal lengths and lower dispersion than comparable aspheres made from other materials, such as CaF_2.

When handling optics, one should always wear gloves. This is especially true when working with zinc selenide, as it is a hazardous material. For your safety, please follow all proper precautions, including wearing gloves when handling these lenses and thoroughly washing your hands afterward. Due to the low hardness of ZnSe, additional care should be taken to not damage these lenses. Click here to download a PDF of the MSDS for ZnSe.

Please see the *Selection Guide* table to the right for our full selection of precision aspheric lenses.

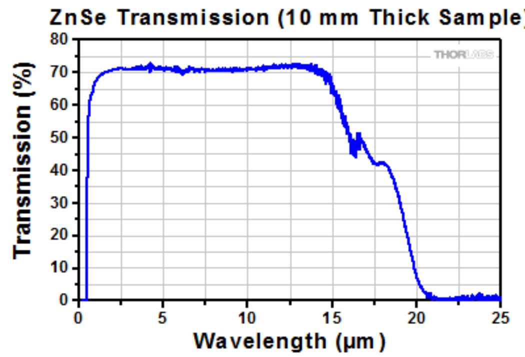
Thorlabs will accept all ZnSe lenses back for proper disposal. Please contact Tech Support to make arrangements for this service.

GRAPHS

ZnSe Transmission Data

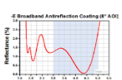
The transmission curve below was obtained using a 10 mm thick, uncoated sample of ZnSe; the incident light was normal to the surface. Please note that this is the measured transmission, including surface reflections.

The transmission losses in the 3 - 12 µm wavelength range are primarily due to surface reflections. ZnSe has a high index of refraction (~2.4 at 10.6 µm) in this range. Because of this, our ZnSe aspheric lenses are sold with anti-reflection coatings. To see how these coatings perform, see the reflectance plots below the transmission plot.



Click to Enlarge
Click Here for Raw Data

ZnSe Reflectance Data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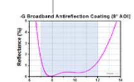

Click to Enlarge
Click Here for Raw Data

The plots above show the reflectance (per surface) of AR-coated ZnSe aspheric lenses. The shaded regions represent the range over which the coatings are guaranteed to have an average reflectance of less than 1.5% (E coating) or 1.0% (G coating).

LENS COEFFICIENTS

Aspheric Lens Design Formula

- Positive Radius Indicates that the Center of Curvature is to the Right of the Lens

- Negative Radius Indicates that the Center of Curvature is to the Left of the Lens

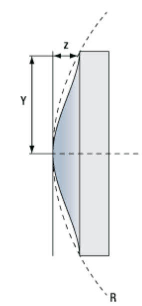
$$z = \frac{Y^2}{R\left(1+\sqrt{1-(1+k)\frac{Y^2}{R^2}}\right)} + A_4Y^4 + A_6Y^6 + \cdots + A_nY^n$$

Aspheric Lens Equation

Aspheric Coefficients

Item #	R	k	A_4	A_6
AL72512-E	18.252	-0.9809606	-1.2305775E-05	-9.0757117E-09
AL72525-E	35.83	-1.000000	-2.0494635E-06	0
AL72550-E	71.66	-1.07282	-2.5228605E-07	0
AL72512-G	17.804	-1.000000	-1.4335797E-05	0
AL72525-G	35.07	-1.000000	-2.0094416E-06	0
AL72550-G	70.133	-1.439601	-1.1330758E-07	0

Definitions of Variables	
z	Sag (Surface Profile)
Y	Radial Distance from Optical Axis
R	Radius of Curvature
k	Conic Constant
A_4	4th Order Aspheric Coefficient
A_6	6th Order Aspheric Coefficient
A_n	*n*th Order Aspheric Coefficient



Click to Enlarge
Reference Drawing

DAMAGE THRESHOLDS

Damage Threshold Data for Thorlabs' G-Coated ZnSe Aspheres

The specifications to the right are measured data for Thorlabs' G-coated ZnSe aspheres. Damage threshold specifications are constant for all G-coated ZnSe aspheres, regardless of the focal length.

Damage Threshold Specifications	
Coating Designation (Item # Suffix)	**Damage Threshold**
-G	5 J/cm^2 (10.6 µm, 100 ns, 1 Hz, Ø0.478 mm)

Laser Induced Damage Threshold Tutorial

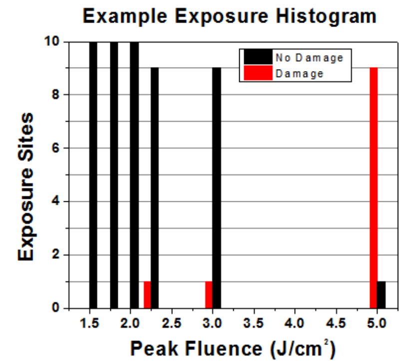
The following is a general overview of how laser induced damage thresholds are measured and how the values may be utilized in determining the appropriateness of an optic for a given application. When choosing optics, it is important to understand the Laser Induced Damage Threshold (LIDT) of the optics 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.



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

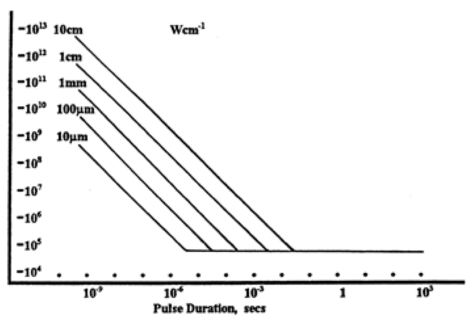
According to the test, the damage threshold of the mirror was 2.00 J/cm^2 (532 nm, 10 ns pulse, 10 Hz, Ø0.803 mm). Please keep in mind that these tests are performed on clean optics, as dirt and contamination can significantly lower the damage threshold of a component. While the test results are only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

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.



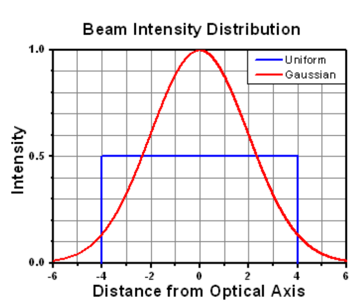
LIDT in linear power density vs. pulse length and spot size. For long pulses to CW, linear power density becomes a constant with spot size. This graph was obtained from [1].

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)

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.

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



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.

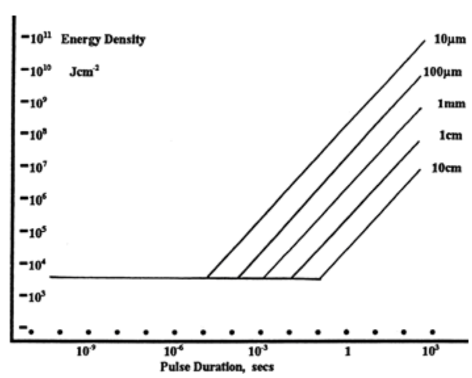
Pulses shorter than 10^{-9} s cannot be compared to our specified LIDT values with much reliability. In this ultra-short-pulse regime various mechanics, such as multiphoton-avalanche ionization, take over as the predominate damage mechanism [2]. In contrast, pulses between 10^{-7} s and 10^{-4} s may 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):

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

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:

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

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).

LIDT CALCULATIONS

LIDT Calculator

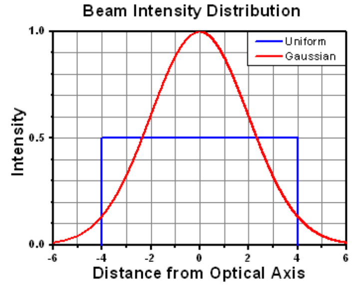
In order to illustrate the process of determining whether a given laser system will damage an optic, a number of example calculations of laser induced damage threshold are given below. For assistance with performing similar calculations, we provide a spreadsheet calculator that can be downloaded by clicking 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:

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

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:

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

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:

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

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:

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

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:

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

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.

Zinc Selenide (ZnSe) Aspheric Lenses, AR Coating: 3 - 5 µm

Item #	Diameter	Focal Length	f/#[a]	Clear Aperture	Numerical Aperture	Working Distance[b]	Center Thickness	Refractive Index[c]	Performance
AL72512-E	25.4 mm	12.7 mm	0.5	>22.8 mm	0.67	9.88 mm	7.0 mm	2.4332	Spot Size Cross Section

AL72525-E	25.4 mm	25.0 mm	0.98	>22.8 mm	0.42	22.53 mm	6.0 mm	2.4332	Spot Size Cross Section
AL72550-E	25.4 mm	50.0 mm	1.97	>22.8 mm	0.22	47.95 mm	5.0 mm	2.4332	Spot Size Cross Section

- Obtained by dividing the focal length of the lens by its diameter. This is an underestimate of the true f/# since the usable portion of the lens is constrained by the clear aperture.
- Working distance is measured from the plano surface to the focal point.
- At Design Wavelength (4.0 µm)

Part Number	Description	Price	Availability
AL72512-E	**Ø1" ZnSe Aspheric Lens, f=12.7 mm, NA=0.67, ARC: 3-5 µm**	**$993.38**	**Lead Time**
AL72525-E	**Ø1" ZnSe Aspheric Lens, f=25.0 mm, NA=0.42, ARC: 3-5 µm**	**$938.20**	**5-8 Days**
AL72550-E	**Ø1" ZnSe Aspheric Lens, f=50.0 mm, NA=0.22, ARC: 3-5 µm**	**$883.01**	**Lead Time**

Zinc Selenide (ZnSe) Aspheric Lenses, AR Coating: 7 - 12 µm

Item #	Diameter	Focal Length	f/#[a]	Clear Aperture	Numerical Aperture	Working Distance[b]	Center Thickness	Refractive Index[c]	Performance
AL72512-G	25.4 mm	12.7 mm	0.5	>22.8 mm	0.67	10.22 mm	6.2 mm	2.4027	Spot Size Cross Section
AL72525-G	25.4 mm	25.0 mm	0.98	>22.8 mm	0.42	22.51 mm	6.0 mm	2.4027	Spot Size Cross Section
AL72550-G	25.4 mm	50.0 mm	1.97	>22.8 mm	0.22	47.92 mm	5.0 mm	2.4027	Spot Size Cross Section

- Obtained by dividing the focal length of the lens by its diameter. This is an underestimate of the true f/# since the usable portion of the lens is constrained by the clear aperture.
- Working distance is measured from the plano surface to the focal point.
- At Design Wavelength (10.6 µm)

Part Number	Description	Price	Availability
AL72512-G	**Ø1" ZnSe Aspheric Lens, f=12.7 mm, NA=0.67, ARC: 7-12 µm**	**$993.38**	**Lead Time**
AL72525-G	**Ø1" ZnSe Aspheric Lens, f=25.0 mm, NA=0.42, ARC: 7-12 µm**	**$938.20**	**5-8 Days**
AL72550-G	**Ø1" ZnSe Aspheric Lens, f=50.0 mm, NA=0.22, ARC: 7-12 µm**	**$883.01**	**5-8 Days**