MULTI-ELEMENT LENSES

Multi-element lenses are an ideal solution for applications requiring specialized performance and/or a high degree of aberration correction. Our line of multi-element lenses includes doublets to fit a wide variety of needs, many of which offer near diffraction limited performance. These achromats and aplanats are designed to minimize all sources of wavefront distortion for superior beam quality and minimum focal spot sizes.

Don't see exactly what you are looking for?

CVI Laser Optics specializes in prototype to volume production manufacturing!

Give us a call and we will be honored to assist you with your custom needs.

NOTES:

SELECTION GUIDE

PRODUCT TYPE	SURFACE QUALITY	SURFACE ACCURACY	OPERATING CONDITION	PAGE
Achromats (Chromatism, Spherical Aberration and Coma Correction)				
CEMENTED DOUBLETS LASER-GRADE: LAL	20-10	λ/2 to λ/4 at 546.1nm	Visible Low Energy	77
CEMENTED DOUBLETS IMAGE-GRADE: LAO	60-40	λ/2 to λ/4 at 633nm	Visible Low Energy	78

PRODUCT TYPE	SURFACE QUALITY	TWD	F/#	OPERATING CONDITION	PAGE
Aplanats (Spherical Aberration and Coma Correction)					
HIGH ENERGY/UV LASER DOUBLETS Fused silica, air-spaced: LAPQ	10-5	λ/4 at 248nm	f/5	UV & High Energy VIS/NIR range User Specified AR High Energy	80
IMAGE GRADE DIODE LASER DOUBLETS: LAI	60-40	λ/5 at 830nm	f/3.8 to f/2.5	780 – 1550nm User Specified AR Low Energy	81

LASER-GRADE VISIBLE CEMENTED ACHROMATS: LAL

Laser-grade achromat lenses are manufactured to tighter focal length tolerances and have better surface quality than the LAO Series.

- Optimized for infinite conjugate ratio
- Designed for excellent paraxial performance
- Chromatism correction, with minimal spherical aberration and coma
- Recommended for use in manipulating and focusing of low-to moderate-power laser beams
- 20-10 scratch-dig surface quality to reduce scatter and stray light reflections
- Lead-free crown and flint glasses
- Broadband 415 – 700nm AR coating included

Specifications

Product Code: LAL

Optical Materials: N-BAK4 and N-SF10 (or equivalent)

Design Wavelengths: 486.1nm (blue), 589.0nm (yellow), and 656.3nm (red)

Clear Aperture (CA): ≥ 90% of central diameter

Surface Quality: 20-10 scratch-dig per MIL-PRF-13830b

Surface Irregularity:
$f/Ø < 3.0$: < λ/2 p-v over CA at 546.1nm
$f/Ø \geq 3.0$: < λ/4 p-v over CA at 546.1nm

Paraxial Focal Length: f ±1% at 589.0nm

Diameter Tolerance: +0/–0.15mm

Center Thickness Tolerance: ±0.25mm

Chamfer: 0.25 – 0.50mm at max FW at 45° ±-15°

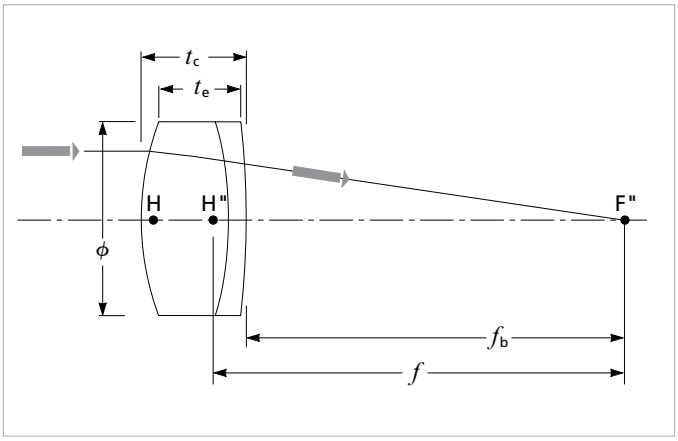
Centration: ≤ 3 arc minutes

Cement: Ultraviolet-cured synthetic polyester

Maximum Storage Temperature: 90°C (cement limitation)

Correct Orientation: The most steeply curved (shortest radius) surface should face the infinite conjugate

Anti-reflection Coating:
$R_{avg} \leq 0.5\%$ per surface, 415 – 700nm



Laser-grade visible cemented achromats

LASER-GRADE VISIBLE CEMENTED ACHROMAT						
f (mm)	Ø (mm)	f/#	t_c (mm)	t_e (mm)	f_b (mm)	PART NUMBER
15.0	7.5	2.2	4.8	3.7	12.7	LAL-15.0-7.5
20.0	10.0	2.2	5.9	4.5	17.2	LAL-20.0-10.0
40.0	15.0	3.0	7.0	5.4	36.8	LAL-40.0-15.0

IMAGE GRADE CEMENTED ACHROMATS 400 – 700nm: LAO

These achromats are available in a wide range of focal lengths ranging from 20 to 600mm. The design is balanced for correction of aberrations, particularly chromatic, spherical, and coma, to provide a superior yet affordable alternative to singlet lenses. These achromatic doublets are useful for broadband applications across the visible wavelength range. They are also ideal for use in monochromatic applications at f-numbers where singlets struggle due to spherical aberration, particularly for low power laser beam manipulation.

- Optimized for minimum chromatism, spherical aberration and coma
- Lead-free crown and flint glasses
- Broadband single layer M_gF_2 coating included

Specifications

Product Code: LAO

Optical Materials: N-BAK4, N-SF10, N-BK7, N-SF5, N-SF8, N-BAK1, or N-SK11 glass (or equilavent)

Design Wavelengths: 480.0nm (blue), 546.1nm (green), 643.8nm (red)

Clear Aperture (CA): ≥ 90% of central diameter

Surface Quality: 60-40 scratch-dig per MIL-PRF-13830b

Surface Irregularity
$f/Ø < 3.0$: < λ/2 p-v at 633nm
$f/Ø \geq 3.0$: < λ/4 p-v at 633nm

Paraxial Focal Length: ±2% at 546.1nm

Diameter Tolerance: +0/–0.15mm

Center Thickness Tolerance: ±0.25mm

Centration: ≤ 3 arc minutes

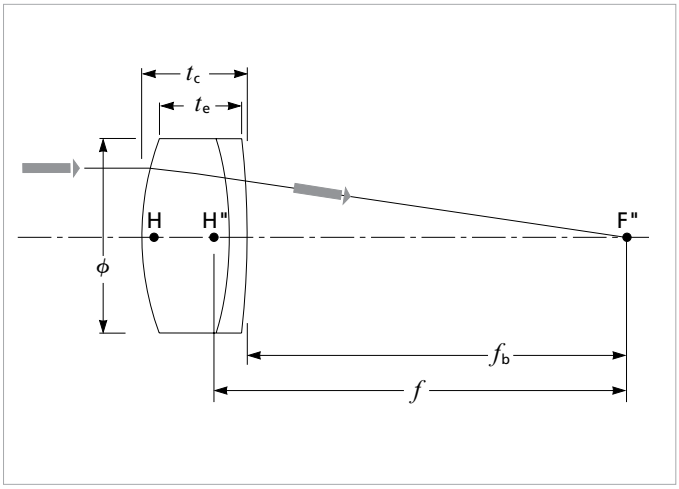
Chamfer: 0.25 – 0.50mm max FW at 45° ±15°

Cement: Ultraviolet-cured synthetic polyester

Maximum Storage Temperature: 90°C (cement limitation)

Correct Orientation: The most steeply curved (shortest radius) surface should face the infinite conjugate

Anti-reflection Coating: Single layer MgF_2 (400 – 700nm)



Standard 400 – 700nm cemented achromats

400 – 700nm IMAGE GRADE CEMENTED ACHROMATS

f (mm)	Ø (mm)	f/#	t_c (mm)	t_e (mm)	f_b (mm)	PART NUMBER
20.0	12.5	1.8	7.0	4.7	16.2	LAO-20.0-12.5
25.0	8.0	3.5	5.1	4.4	22.6	LAO-25.0-8.0
30.0	12.5	2.7	5.3	3.9	27.3	LAO-30.0-12.5
31.1	17.5	2.0	8.9	6.1	26.7	LAO-31.1-17.5
37.5	25.0	1.7	15.0	10.1	29.4	LAO-37.5-25.0
44.0	14.0	3.5	5.2	4.0	41.4	LAO-44.0-14.0
50.0	12.5	4.4	5.0	4.1	47.6	LAO-50.0-12.5
50.0	18.0	3.1	6.0	4.2	46.9	LAO-50.0-18.0
60.0	18.0	3.7	5.2	3.7	57.6	LAO-60.0-18.0
60.0	30.0	2.2	12.5	8.4	53.5	LAO-60.0-30.0
65.0	25.0	2.9	8.0	5.3	60.6	LAO-65.0-25.0
73.0	17.0	4.8	5.2	4.1	70.5	LAO-73.0-17.0
75.0	25.0	3.3	7.0	4.7	71.5	LAO-75.0-25.0
80.0	18.0	4.9	5.2	4.1	77.5	LAO-80.0-18.0
80.0	31.5	2.8	9.5	6.1	75.2	LAO-80.0-31.5
90.0	19.0	5.3	5.5	4.4	87.3	LAO-90.0-19.0
90.0	25.0	4.0	6.5	4.4	86.9	LAO-90.0-25.0
100.0	26.5	4.2	6.8	4.9	96.5	LAO-100.0-26.5
100.0	30.0	3.7	8.7	6.3	95.5	LAO-100.0-30.0
100.0	31.5	3.5	8.7	6.3	95.5	LAO-100.0-31.5
120.0	24.0	5.6	5.5	4.2	117.4	LAO-120.0-24.0
120.0	30.0	4.4	10.7	8.4	115.3	LAO-120.0-30.0
120.0	40.0	3.3	11.2	7.6	114.3	LAO-120.0-40.0
140.0	30.0	5.2	9.0	7.1	136.0	LAO-140.0-30.0
148.0	19.0	8.7	4.6	4.0	145.7	LAO-148.0-19.0
150.0	25.0	6.7	6.2	5.1	146.7	LAO-150.0-25.0
150.0	50.0	3.3	12.5	7.9	143.0	LAO-150.0-50.0
160.0	30.0	5.9	6.5	5.0	156.9	LAO-160.0-30.0
175.0	25.0	7.8	5.5	4.4	172.4	LAO-175.0-25.0
180.0	30.0	6.7	8.1	6.6	176.6	LAO-180.0-30.0
200.0	25.0	8.9	6.5	5.6	197.1	LAO-200.0-25.0
250.0	25.0	11.1	6.3	5.6	247.3	LAO-250.0-25.0
250.0	30.0	9.3	7.2	6.3	246.5	LAO-250.0-30.0
300.0	25.0	13.3	5.5	4.9	297.7	LAO-300.0-25.0
300.0	50.0	6.7	14.7	12.5	293.2	LAO-300.0-50.0
350.0	25.0	15.6	5.5	5.0	347.8	LAO-350.0-25.0
400.0	50.0	8.9	11.0	9.1	396.0	LAO-400.0-50.0
500.0	50.0	11.1	10.0	8.5	494.8	LAO-500.0-50.0
600.0	50.0	13.3	10.0	8.8	595.7	LAO-600.0-50.0

HIGH-ENERGY/UV LASER APLANATS: LAPQ

Also used as excimer focusing lenses, aplanats are corrected for spherical aberration and coma. Its air-spaced fused silica design provides for significantly higher energy damage threshold performance. Parts are marked with an arrow on the barrel that points to the collimated light side.

- Beam handling, interferometers, material ablation & cutting systems
- Air-spaced fused silica design for high energy or UV applications
- Diffraction limited performance for a single wavelength
- Mounts easily onto post with 8-32 and M4 x 0.7 tap

Specifications

Product Code: LAPQ

Optical Material: Standard Grade Corning 7980 1-D (Fused Silica)

Design Wavelength: 248nm

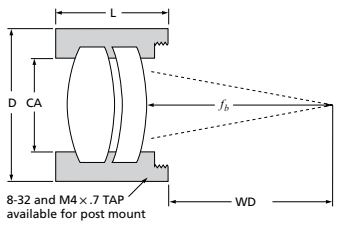
Surface Quality: 10-5 scratch-dig per MIL-PRF-13830b

Housing Dimensional Tolerances: ±0.13mm

Transmitted Wavefront Distortion: < λ/4 p-v over 95% of clear aperture at 248nm

Anti-reflection Coating: Wavelength user specified
Narrowband: R ≤ 0.25% per surface
Broadband: R_{avg} ≤ 0.5% per surface

Damage Threshold
Narrowband: 15 J/cm², 20ns, 20Hz @ 1064nm
Broadband: 10 J/cm², 20ns, 20Hz @ 1064nm



LAPQ positive high energy/UV laser aplanat in post mount housing

BUILD YOUR PART NUMBER		
STEP-1	STEP-2	STEP-3
PRODUCT CODE	WAVELENGTH OF AR COATING (NM)	DEFAULTED POST MOUNT
LAPQ-50.0-10.0	248	PM
EXAMPLE: LAPQ-50.0-10.0 - 248 - PM		

CHOOSE FROM THE OPTIONS BELOW.

1. PRODUCT CODE - SEE TABLE BELOW

2. WAVELENGTH OF AR COATING (nm)			
248	355	532	1064

3. POST MOUNT
PM (DEFAULTED)

Please see page T-31 for Anti-Relective Coating Traces.

HIGH-ENERGY/UV LASER APLANATS									
f (mm)	WD (mm)	f_b (mm)	f (mm) at 1064nm	WD (mm) at 1064nm	f_b (mm) at 1064nm	D (mm)	L (mm)	CA (mm)	PRODUCT CODE
50.0	42.5	47.3	56.4	48.9	53.7	50.8	10.2	10.0	LAPQ-50.0-10.0
250.0	222.5	230.3	282.6	254.5	273.0	76.2	25.4	50.0	LAPQ-250.0-50.0

Specifications

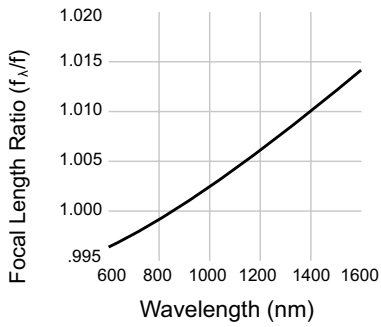
Product Code: LAI

Optical Materials: N-SK11 and N-SF5 (or equivalent)
Design Wavelength: 830nm
Wavelength Range: 780 – 1550nm
Diameter Tolerance: +0/–0.15mm
Center Thickness Tolerance: ±0.25mm
Paraxial Focal Length: ±2% at 632.8nm
Chamfer: 0.25 – 0.50mm max face width at 45° ± 15°
Centration: ≤ 4 arc minutes
Clear Aperture (CA): ≥ 90% of central diameter
Surface Quality: 60-40 scratch-dig per MIL-PRF-13830b
Transmitted Wavefront Distortion:: <λ/5 p-v at 830nm over clear aperture
Cement: Ultraviolet-cured synthetic polyester
Maximum Storage Temperature: 90° C (cement limitation)
Anti-reflection Coating: Optional

APPLICATION NOTE

Focus vs Wavelength

These diode laser doublets are not achromats. Pure chromatic aberration (variation of the focal length with wavelength) has been left uncorrected to provide greater freedoms in other corrections. When used with monochromatic diode lasers this causes no aberration contribution, but means that systems will have to be refocused for use at different diode laser wavelengths.



Focal length of diode laser glass doublets as a function of wavelength

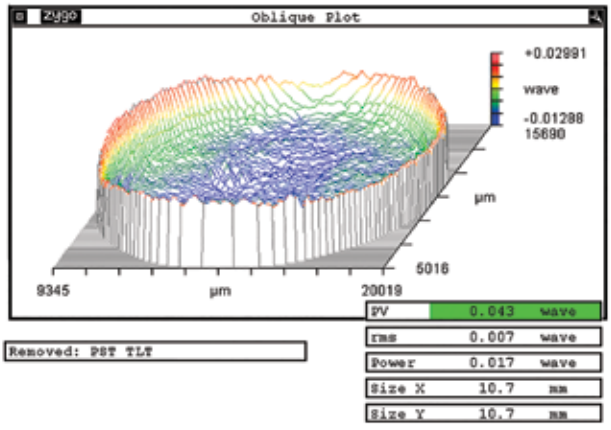
IMAGE GRADE DIODE LASER GLASS DOUBLETS									
f (mm)	Ø (mm)	f1550 (mm)	f_b (mm)	f_b 1550 (mm)	t_c (mm)	t_e (mm)	f/#	AR Coating Wavelengths (nm)	PART NUMBER
25.0	10.0	25.3	22.4	22.8	5.0	3.9	2.5	Uncoated	LAI-25.0-10.0
25.0	10.0	25.3	22.4	22.8	5.0	3.9	2.5	780-850	LAI-25.0-10.0-HE-780-850
40.0	15.0	40.5	37.2	37.8	5.5	4.0	2.7	Uncoated	LAI-40.0-15.0
40.0	15.0	40.5	37.2	37.8	5.5	4.0	2.7	780-850	LAI-40.0-15.0-HE-780-850
40.0	15.0	40.5	37.2	37.8	5.5	4.0	2.7	1550	LAI-40.0-15.0-1550
60.0	20.0	60.8	56.7	57.4	6.5	4.7	3.0	Uncoated	LAI-60.0-20.0
80.0	25.0	81.0	75.6	76.6	8.5	6.4	3.2	Uncoated	LAI-80.0-25.0
80.0	25.0	81.0	75.6	76.6	8.5	6.4	3.2	780-850	LAI-80.0-25.0-HE-780-850
100.0	30.0	101.3	94.8	96.1	10.0	7.6	3.3	Uncoated	LAI-100.0-30.0
145.0	40.0	146.8	138.5	140.4	12.5	9.5	3.6	Uncoated	LAI-145.0-40.0
190.0	50.0	192.4	183.0	185.5	13.5	10.0	3.8	Uncoated	LAI-190.0-50.0
190.0	50.0	192.4	183.0	185.5	13.5	10.0	3.8	1550	LAI-190.0-50.0-1550

Leader in Custom, Complex, and Intricate Waveplate Manufacturing

CVI Laser Optics plays host to a vast selection of custom and catalog waveplates that are manufactured to maintain the most stringent of specifications.

Newly Released Catalog Waveplate Selection

- Includes Laser Grade Crystal Quartz Multiple Order (QWPM) and Compound Zero Order Waveplates (QWPO) (Optically Contacted and Air-Spaced)
- Utilizes Advanced Plasma Source (APS) coatings
- Increase transmission per surface
- Increased durability against environmental factors such as humidity and abrasion
- Guaranteed to function with a retardation tolerance attuned to wavelength optimization
- Inventory options spanning from UV (193nm) to NIR (1550nm)
- CVI Laser Grade Surface Quality (10-5 Scratch-Dig per MIL-PRF-13830b) at 100W per surface
- Transmitted Wavefront Distortion (TWD) < L/10 p-v at 633nm over specified CA



Looking for the atypical or bizarre? CVI Laser Optics carries years of experience in custom waveplate manufacturing to meet the most demanding of applications.

Custom Waveplate Capability

- Low Order and True Zero Order Waveplates (wavelength dependent)
- Custom Designed and Assembled Optical Mounting and/or Housing (Metal or Glass)
- Transmitted Wavefront Distortion (TWD) < L/20 p-v at 633nm over specified CA
- Custom Shaped Waveplates, Axial Alignments, and Retardations
- Expansive in House Metrology for any required documentation