

FemtoOptics

Optical components for ultra-fast lasers

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Contents:

Introduction (page 2)

800 nm ultra-broadband components (page 3)

- low dispersion optics (page 3)
 - high reflectivity mirrors (page 3)
 - beam splitters (page 4)
 - focusing optics (page 6)
 - compact beam steering (page 8)
 - wedges, AR-coated windows (page 8)
- broadband fiber couplers (page 9)
- optics for dispersion control (page 10)
- mirror compressors for microscopy (page 14)
- hollow fiber compression (page 18)

532 nm components (page 19)

400 nm ultra-broadband components (page 21)

- low dispersive optics (page 21)
- optics for dispersion control (page 22)

Infrared optics (page 23)

Metal mirrors (page 24)

Frequency doubling crystals (page 26)

Optics for polarization control (page 27)

Please ask for custom optics !

Introduction

Welcome to the new FemtoOptics catalogue from Femtolasers. The catalogue has been updated to include even more components and additional information for each item.

Accurate dispersion management is an essential prerequisite in any femtosecond laser application. Broadband, low-dispersion optical components are needed for manipulating femtosecond pulses. Accurate compression has to be employed in order to compensate for the dispersion of the optical and air path between the laser and the experimental target.

These requirements often go beyond the capabilities of standard optical components. Femtolasers Produktions, a leader in ultra-fast laser equipment, offers the FemtoOptics product family, tailored to respond to the optical needs of the femtosecond laser community.

LOW DISPERSION COMPONENTS minimize the distortion experienced by femtosecond pulses in an optical setup. FemtoOptics broadband reflectors, beam splitters, and focusing optics are optimized to provide maximum bandwidth and minimum group delay dispersion (GDD) at 800 nm. We offer a large variety of substrate shapes and sizes available with either dielectric or enhanced metal coatings.

DISPERSION MANAGEMENT becomes straight forward by employing Femtolasers' proprietary dispersive mirror technology. Matched mirror sets supporting pulse durations down to less than 7 fs are available from stock. Custom mirror compressors can be tailored to compensate the dispersion of a given optical setup, up to several thousand fs². Compared to alternatives such as prism compressors, these all-mirror compressors offer accuracy, compactness, user-friendliness, stability, and high through-put.

We design and supply custom optics !

OEM: Volume pricing available, please ask for details!

800 nm components

Ultra-Broadband High Reflectivity Dielectric Mirrors, Angle of Incidence 0°

Article No	Short name	Description
		Surface 1: HR 700 nm – 900 (+/-10) nm, HT 480 nm – 540 nm, 0°, low GDD Surface 2: uncoated Substrate Material: BK7
OA018	BBHR8/5	Substrate: Diameter: 1/2" Thickness: 6.35 mm
OA017	BBHR8/1	Substrate: Diameter: 1" Thickness: 6.35 mm
VO010	BBHR8/3	Substrate: Diameter: 30 mm Thickness: 10 mm
OA212	BBHR8/2	Substrate: Diameter: 2" Thickness: 12 mm

These mirrors provide a reflectivity better than 99.8% in the range 700 nm - 900 nm. They introduce low GDD upon reflection and are optimized for sub-12 fs at 800 nm for angles of incidence close to 0°.

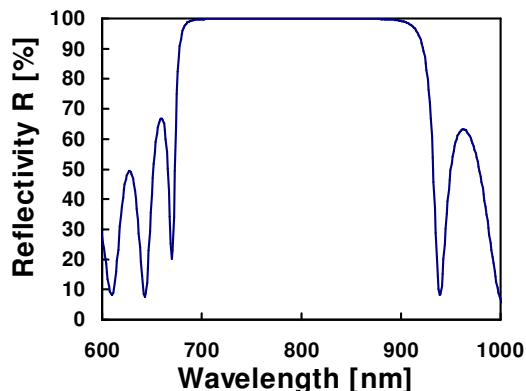
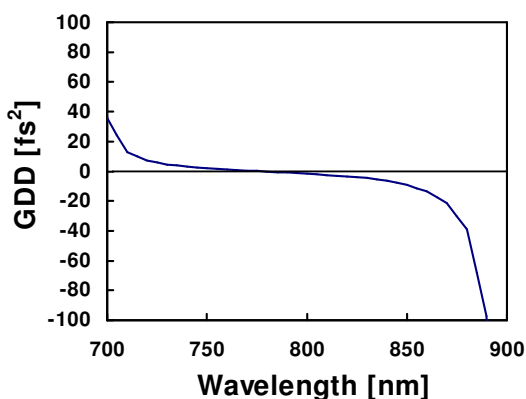
Application: Beam steering of sub-12 fs pulses.

Special features: Low GDD within the HR-range. Reflectivity and GDD curves can be provided upon request.

Ultra-broadband dielectric mirror supporting sub-12 fs:

Right: Reflectivity (from measured transmission)

Below: Measured group delay dispersion (GDD).



The curves represent data for normal incidence.

Ultra-Broadband High Reflectivity Dielectric Mirrors, Angle of Incidence 45°

Article No	Short name	Description
		Surface 1: HR 720 nm – 880 (+/-10) nm, 45°, p-polarized HR 680 nm – 930 (+/-10) nm, 45°, s-polarized low GDD Surface 2: uncoated Substrate Material: BK7
OO102	BBHR8-45/5	Substrate: Diameter: 1/2" Thickness: 6.35 mm
OA019	BBHR8-45/1	Substrate: Diameter: 1" Thickness: 6.35 mm
VO033	BBHR8-45/3	Substrate: Diameter: 30 mm Thickness: 10 mm
VO007	BBHR8-45/2	Substrate: Diameter: 2" Thickness: 12 mm

These mirrors provide a reflectivity better than 99.8 % in the a polarisation-dependent wavelength range centered at 800 nm. They introduce low GDD upon reflection and are optimized for sub-20 fs at 800 nm for angles of incidence close to 45°. For larger bandwidth see the 45° dispersive mirrors on page 12.

Application: Beam steering of sub-20 fs pulses.

Special features: Low GDD within the HR-range. Reflectivity and GDD curves for s- and p-polarized light can be provided upon request.

800 nm components

Ultra-Broadband Dielectric Beam Splitters

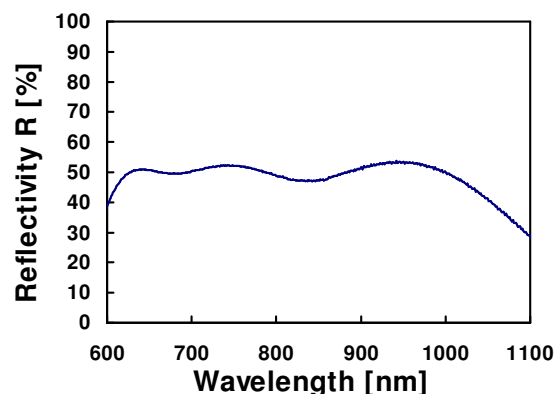
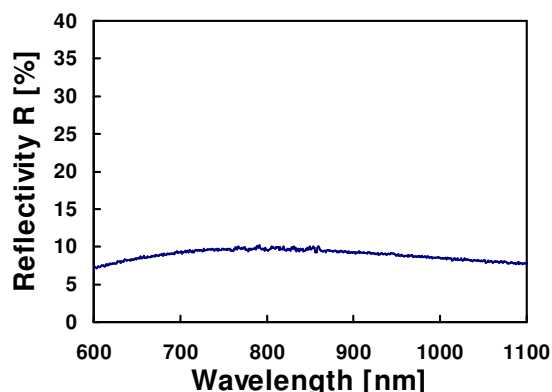
Article No	Short name	Description
		Material: Fused Silica Reflectivity for p-polarization (45°), Diameter, Thickness
OA042	BSR8-01/5	Beam Splitter R = 0.7%, 0.5", # 500 µm, surface 2: AR-coated
OA038	BSR8-02/5	Beam Splitter R = 2%, 0.5", # 500 µm, surface 2: AR-coated
OA040	BSR8-05/5	Beam Splitter R = 5%, 0.5", # 500 µm, surface 2: AR-coated
OA099	BSR8-10/5	Beam Splitter R = 10%, 0.5", # 500 µm, surface 2: AR-coated
OA134	BSR8-25/5	Beam Splitter R = 25%, 0.5", # 500 µm, surface 2: AR-coated
OA202	BSR8-37/5	Beam Splitter R = 37%, 0.5", # 500 µm, surface 2: uncoated
OA065	BSR8-50/5	Beam Splitter R = 50%, 0.5", # 500 µm, surface 2: uncoated
OA161	BSR8-67/5	Beam Splitter R = 67%, 0.5", # 500 µm, surface 2: uncoated
OA201	BSR8-75/5	Beam Splitter R = 75%, 0.5", # 500 µm, surface 2: uncoated
OA199	BSR8-80/5	Beam Splitter R = 80%, 0.5", # 500 µm, surface 2: uncoated
OA132	BSR8-90/5	Beam Splitter R = 90%, 0.5", # 500 µm, surface 2: uncoated
OA043	BSR8-01/1	Beam Splitter R = 0.7%, 1", # 1 mm, surface 2: AR-coated
OA039	BSR8-02/1	Beam Splitter R = 2%, 1", # 1 mm, surface 2: AR-coated
OA041	BSR8-05/1	Beam Splitter R = 5%, 1", # 1 mm, surface 2: AR-coated
OA078	BSR8-10/1	Beam Splitter R = 10%, 1", # 1 mm, surface 2: AR-coated
OA135	BSR8-25/1	Beam Splitter R = 25%, 1", # 1 mm, surface 2: AR-coated
OA089	BSR8-37/1	Beam Splitter R = 37%, 1", # 1 mm, surface 2: uncoated
OA037	BSR8-50/1	Beam Splitter R = 50%, 1", # 1 mm, surface 2: uncoated
OA157	BSR8-67/1	Beam Splitter R = 67%, 1", # 1 mm, surface 2: uncoated
OA200	BSR8-75/1	Beam Splitter R = 75%, 1", # 1 mm, surface 2: uncoated
OA198	BSR8-80/1	Beam Splitter R = 80%, 1", # 1 mm, surface 2: uncoated
OA133	BSR8-90/1	Beam Splitter R = 90%, 1", # 1 mm, surface 2: uncoated
OA514	BSR8-01/30	Beam Splitter R = 0.7%, d=30 mm, # 1 mm, surface 2: AR-coated
OA533	BSR8-02/30	Beam Splitter R = 2%, d=30 mm, # 1 mm, surface 2: AR-coated
OA240	BSR8-05/30	Beam Splitter R = 5%, d=30 mm, # 1 mm, surface 2: AR-coated
OA515	BSR8-10/30	Beam Splitter R = 10%, d=30 mm, # 1 mm, surface 2: AR-coated
OA241	BSR8-25/30	Beam Splitter R = 25%, d=30 mm, # 1 mm, surface 2: AR-coated
OA242	BSR8-37/30	Beam Splitter R = 37%, d=30 mm, # 1 mm, surface 2: uncoated
OA237	BSR8-50/30	Beam Splitter R = 50%, d=30 mm, # 1 mm, surface 2: uncoated
OA243	BSR8-67/30	Beam Splitter R = 67%, d=30 mm, # 1 mm, surface 2: uncoated
OA244	BSR8-75/30	Beam Splitter R = 75%, d=30 mm, # 1 mm, surface 2: uncoated
OA245	BSR8-80/30	Beam Splitter R = 80%, d=30 mm, # 1 mm, surface 2: uncoated
OA246	BSR8-90/30	Beam Splitter R = 90%, d=30 mm, # 1 mm, surface 2: uncoated
FO002	BSBB50-155	Beam Splitter R = 50% 15x20, # 1 mm, FS (each surface has a coated and an uncoated section)

sub-10 fs

These dielectric beam splitters are optimized for sub-10 fs laser pulses centered at 800 nm. They exhibit constant reflectivity and low GDD between 650 nm and 950 nm for p-polarized light at an angle of incidence of 45°. Beam splitters with low reflectivities have an additional antireflection coating on the back side.

Ultra-broadband dielectric beam splitters supporting sub-10 fs pulses.

Reflectivity curves for p-polarized light, 45°.



Above: Beam splitter of nominally 50% reflectivity (from measured transmission).

Left: Beam splitter of nominally 10% reflectivity (from measured transmission).

800 nm components

Ultra-Broadband Metallic Beam Splitters

Article No	Short name	Description
		Substrate material: Fused Silica Surface 1: metallic coating Reflectance: 27% +/-2% p-polarized Transmittance: 27% +/-2% p-polarized Absorption: 46% +/-3% p-polarized Wavelength range: 600 nm - 950 nm, AOI = 45° Surface 2: uncoated
OA927	BSM/5	Circular, Diameter: 1/2", Thickness: 0.5 mm
OA827	BSM/1	Circular, Diameter: 1", Thickness: 1 mm
OA215	BSM/R	Rectangular, 15 mm x 20 mm, Thickness: 1mm each surface has a coated/uncoated section of 15 mm x 10 mm

Metallic beam splitters provide an accurate 50% splitting ratio over an extremely broad spectral range. Since the large bandwidth comes at the expense of absorption losses, they are mainly suited for diagnostic applications like autocorrelation or SPIDER measurements.

Ultra-Broadband Dielectric Beam Splitters for S-polarized Light

Article No	Short name	Description
		Surface 1: R=50% +/-5%, 650 nm - 950 nm, 45°, s-polarized Surface 2: AR (R<1.5%) 650 nm - 950 nm, s-polarized Substrate material: fused silica
OA353	BSR8-50s/5	Circular, Diameter: 1/2", Thickness: 0.5 mm
OA253	BSR8-50s/1	Circular, Diameter: 1", Thickness: 1 mm
OA354	BSR8-50s/30	Circular, Diameter: 30 mm, Thickness: 1 mm

Beam splitters designed for p-polarized light are not suitable for s-polarized light due to the high reflectivity of the back side. The above beam splitters were optimized to provide a constant splitting ratio over a large bandwidth for s-polarized light, while reflectance from the second surface is minimized.

Compensation Plates for Interferometric Measurements

Article No	Short name	Description
		Surface 1: uncoated Surface 2: uncoated Substrate material: fused silica
OA915	CP5	Circular, Diameter: 1/2", Thickness: 0.5 mm
OA815	CP1	Circular, Diameter: 1", Thickness: 1 mm

In any dispersion-balanced interferometric setup a compensation plate identical to the substrate of the beam splitter has to be inserted in the interferometer arm containing the beam reflected off the beam splitter.

800 nm components

Background information: focusing femtosecond pulses

Two aspects call for special care when femtosecond pulses are focused:

- * the focusing component must be achromatic over the full bandwidth of the pulse,
- * the GDD introduced by lenses has to be pre-compensated in order to achieve the shortest pulse duration in the focus.

The OA046 achromatic triplet lens has been optimized to introduce minimum chromatic aberrations in the wavelength range 650 nm - 950 nm supporting thus the bandwidth required by sub-12 fs pulses. The precisely known GDD of the lens can be pre-compensated with ECDC mirror sets.

For less demanding applications, spherical focusing mirrors provide a convenient alternative, since they introduce basically no GDD upon reflection. However the angle of incidence has to be kept small, in order to minimize astigmatism.

Off-axis parabolic focusing mirrors introduce an angle of 90° between the incident and the reflected (focused) beam. Extremely tight, astigmatism-free focusing (down to < 5 μm) can be achieved if the full aperture of the metal-coated parabolic mirrors OA027 or OA175 is illuminated.

800 nm components

Ultra-Broadband Dichroic Focusing Mirrors, Angle of Incidence 0°

Article No	Short name	Description
		Substrate: Diameter: 0.5" Thickness: 5 mm Material: FS Surface 1: HR 700 nm - 900 (+/-10) nm, HT 480 nm - 540 nm Surface 2: AR 480 nm - 540 nm, flat
OO005	ICR50	BB IC ROC = -50 mm (concave)
OO049	ICR75	BB IC ROC = -75 mm (concave)
OO084	ICR100	BB IC ROC = -100 mm (concave)
OO116	ICR150	BB IC ROC = -150 mm (concave)
OO117	ICR200	BB IC ROC = -200 mm (concave)

These mirrors provide better than 99.8% reflectivity from 700 nm to 900 nm and high transmission between 480 nm and 540 nm. They introduce low GDD upon reflection and are optimized for sub-12 fs laser pulses at 800 nm.

Applications: Focusing, input coupling.

Broadband Achromatic Triplet Lens for Femtosecond Pulses

Article No	Short name	Description
OA046	LACR8	Achromatic triplet lens supporting sub-12 fs pulses optimized for the range 650 nm - 950 nm Working distance: 1.7 mm. Effective focal length: 6 mm. Numerical aperture: 0.2; Free aperture: 4 mm Infinity corrected. Black anodized Al mount (drawing available upon request). Minimum focal spot diameter: < 5 µm

This achromatic triplet lens allows focusing sub-12 fs pulses to less than 5 µm (focal spot diameter at the $1/e^2$ level). The GDD of the lens can be pre-compensated with ECDC dispersive mirror sets in order to achieve a bandwidth-limited pulse duration in the focus. The GDD data of the lens in the range 650 nm – 950 nm is available upon request.

Applications: Optical fiber coupling, materials processing.

Dispersion Compensated Broadband Achromatic Triplet Lens

Article No	Short name	Description
OA333	DCAO	Laboratory-tested set consisting of: 1 pc. broadband achromatic triplet lens OA046 1 pc. dispersive mirror compressor (2 mirrors) 2 pcs. Thin fused silica wedges OA924 Including a 2nd order interferometric autocorrelation trace corresponding to a pulse duration of <10fs. Opto-mechanical parts (mounts, posts) and installation are not included, but can be provided upon request. Insertion losses: < 10% Free aperture: 4mm

Consisting of a broadband achromatic triplet lens, a specially optimized mirror compressor and a pair of glass wedges for fine GDD tuning, this set enables preserving a sub-10-fs pulse duration while focusing a beam to less than 5 microns.


Applications: Optical fiber coupling, materials processing.

NEW

800 nm components

sub-20 fs


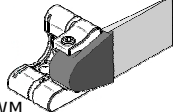
Broadband HR Coated Prism for Beam Steering

Article No	Short name	Description
VO028	P-HR8/45 	Coating: HR 720 (± 10) nm – 880 (± 10) nm, 45°, p-polarized HR 680 (± 10) nm – 930 (± 10) nm, 45°, s-polarized low GDD Substrate: 12 x 10 x 10 mm Material: BK7

These HR coated prisms are versatile and very compact tools for picking/steering laser beams.

Application: Pick-off/steering of laser beams with minimum space requirements.

Ultra-thin Wedges

Article No	Short name	Description
OA124	 Wedge	Wedge, angle: 2° 48' Uncoated Size: 30 x 20 mm Minimum thickness: 200 μ m Material: fused silica
OA924	 WM	Wedge (identical to OA124) glued onto a black anodized Al adapter. Fits into any standard 0.5" mirror holder (not included).

Pairs of ultra-thin wedges allow fine, continuous tuning of the GDD. The extremely accurate GDD control enabled by thin glass wedges in conjunction with broadband dispersive mirrors is indispensable for the generation/manipulation of sub-10-fs pulses. Furthermore, thin glass wedges can be used for rough tuning of the carrier-envelope phase.

Application: Fine dispersion tuning, carrier-envelope phase control.

AR-Coated Wedges

Article No	Short name	Description
OA324	ARWedge	Wedge, angle: 8° Both surfaces AR-coated, R < 0.5 % in the range 650 nm - 1040 nm Size: 50 x 20 mm Minimum thickness: 500 μ m Material: BK7
OA325	MARWedge	Wedge (identical to OA324) glued onto a black anodized Al adapter. Fits into any standard 1" mirror holder (not included).

Owing to the relatively small angle and large length of these wedges the dispersion can be finely tuned over a wide dynamic range. A broadband AR-coating minimizes the insertion losses at near-normal incidence.

Application: Fine dispersion tuning over a wide dynamic range.

sub-10 fs

NEW

800 nm components

NEW

Brewster-Angle Ultra-Thin Windows

Article No	Short name	Description
OA024	BW18mm	Material: fused silica Shape: elliptical; Axis length: 31.8 mm, 18 mm. Free aperture when used under Brewster angle (56°): 18 mm Thickness: 0.5 mm Uncoated

Reflection losses and dispersion-induced pulse broadening experienced by laser beams upon coupling into chambers can be minimized by employing Brewster-angled ultra-thin fused silica windows.

Application: Low-dispersion, loss-free coupling of light into chambers.

Thin AR-Coated Windows

Article No	Short name	Description
		Surface 1: AR (R<0.4%) 620 nm - 980 nm (AOI=0±20°) Surface 2: AR (R<0.4%) 620 nm - 980 nm (AOI=0±20°) Substrate Material: fused silica
OA223	WAR8/5	Substrate: Diameter: 1/2" Thickness: 0.5 mm; Wedge <30"
OA222	WAR8/1	Substrate: Diameter: 1" Thickness: 1 mm; Wedge <30"
OA221	WAR8/3	Substrate: Diameter: 30 mm Thickness: 1 mm; Wedge <30"

The amount of positive GDD of an optical setup can be minimized by employing these ultra-thin windows. The broadband AR-coating allows nearly loss-free transmission of sub-10-fs pulses.

Application: Low-dispersion, low-loss coupling of light into chambers.

2X2 Fiber Couplers

Article No	Short name	Description
OA550	FC2X2	Single-mode fiber couplers 2x2 Split ratio: 50% ±10% Wavelength range: 730 nm - 880 nm Connectors: FC/APC on all ends

These broadband 2x2 fiber couplers are suitable for splitting/combining broadband laser beams. The large bandwidth makes them suitable for high resolution optical coherence tomography (OCT) interferometers.

Application: laser systems for OCT, THz generation.

Dispersive 800 nm components

Compact Extra Cavity Dispersion Control Modules for sub-7-fs Pulses

Article No	Short name	Description
GSM015	ECDCBB15	Dispersion compensator supporting sub-7 fs laser pulses Nominal: 4 bounces (GDD < -140 fs ²) Surface : WL-Range: 620 nm - 900 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800 nm Substrate: Diameter 0.5" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.
GSM014	ECDCBB14	Dispersion compensator supporting sub-7 fs laser pulses Nominal: 6 bounces (GDD < -200 fs ²) Surface : WL-Range: 620 nm - 900 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800nm Substrate: Diameter 1" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.
GSM214	ECDCSBB2	Dispersion compensator supporting sub-7 fs laser pulses Nominal: 12 bounces (GDD < -400 fs ²) Surface : WL-Range: 620 nm - 900 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800 nm Substrate: Diameter 2" Thickness: 9 mm or 12.6 mm Material: BK7 or fused silica Set: 2 pcs.

sub-7 fs

Compact Extra Cavity Dispersion Control Modules for sub-10-fs Pulses

Article No	Short name	Description
GSM008	ECDCBB02	Dispersion compensator supporting sub-10 fs laser pulses Nominal: 4 bounces (GDD < -140 fs ²) Surface : WL-Range: 700 nm - 890 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800 nm Substrate: Diameter 0.5" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.
GSM007	ECDCBB03	Dispersion compensator supporting sub-10 fs laser pulses Nominal: 6 bounces (GDD < -200 fs ²) Surface : WL-Range: 700 nm - 890 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800nm Substrate: Diameter 1" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.
GSM207	ECDCBB2I	Dispersion compensator supporting sub-10 fs laser pulses Nominal: 12 bounces (GDD < -400 fs ²) Surface : WL-Range: 700 nm - 890 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800 nm Substrate: Diameter 2" Thickness: 9 mm or 12.6 mm Material: BK7 or fused silica Set: 2 pcs.

sub-10 fs

These dispersive mirror pairs are specially designed to accurately compensate extra cavity positive group delay dispersion (GDD). They introduce group delay dispersion of less than -30 fs² per bounce at 800 nm. The third order dispersion is either negligible or (if required) negative. The mirror pairs are tested at Femtolasers' facilities before delivery. We also provide custom mirror pairs compensating a specified amount of GDD and TOD.

Application: Dispersion management.

Special feature: Reflectivity curves and GDD curves can be provided. We provide custom ECDC sets - send us your special requirements!

Dispersive 800 nm components

sub-20 fs

Compact Extra Cavity Dispersion Control Modules for sub-20-fs Pulses

Article No	Short name	Description
GSM004	ECDC202	Dispersion compensator supporting sub-20 fs laser pulses Nominal: 4 bounces (GDD < -140 fs ²) Surface : WL-Range: 750 nm - 850 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800nm Substrate: Diameter 0.5" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.
GSM003	ECDC203	Dispersion compensator supporting sub-20 fs laser pulses Nominal: 6 bounces (GDD < -200 fs ²) Surface : WL-Range: 750 nm - 850 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800nm Substrate: Diameter 1" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.
GSM208	ECDC221	Dispersion compensator supporting sub-20 fs laser pulses Nominal: 12 bounces (GDD < -400 fs ²) Surface : WL-Range: 750 nm - 850 nm (HR+GDD) GDD < -30 fs ² per bounce @ 800nm Substrate: Diameter 2" Thickness: 9 mm or 12.6 mm Material: BK7 or fused silica Set: 2 pcs.

These dispersive mirror pairs are specially designed to accurately compensate extra cavity positive group delay dispersion (GDD). They introduce group delay dispersion of less than -30 fs² per bounce at 800 nm. The third order dispersion is either negligible or (if required) negative. The mirror pairs are tested at Femtolasers' facilities before delivery. We also provide custom mirror pairs compensating a specified amount of GDD and TOD.

Application: Dispersion management.

Special feature: Reflectivity curves and GDD curves can be provided. We provide custom ECDC sets - send us your special requirements!

Compact High-Dispersion Modules for sub-15-fs Pulses

Article No	Short name	Description
GSM216	HDMP5	Highly dispersive mirror pair 0.5" Coating: GDD/bounce < -200 fs ² @ 800 nm GDD and high reflectance range: >160 nm @ 800 nm R > 99% per bounce Substrates: fused silica Diameter: 0.5", Thickness 6.35 mm Surface: L/10, 10-5 scratch-dig Set: 2 pcs.
GSM217	HDMP1	Highly dispersive mirror pair 1" Coating: GDD/bounce < -200 fs ² @ 800 nm GDD and high reflectance range: >160 nm @ 800 nm R > 99% per bounce Substrates: fused silica Diameter: 1", Thickness 6.35 mm Surface: L/10, 10-5 scratch-dig Set: 2 pcs.

Mirror pairs capable to compensate several hundreds of fs² enable the distortion-free delivery of sub-15-fs pulses via complex optical systems like e.g. achromatic lenses. Fine tuning of the dispersion can be achieved by using these mirrors in conjunction with a pair of AR-coated wedges (OA324, OA325).

Applications: Dispersion pre-compensation in complex optical systems.

NEW

NEW

Dispersive 800 nm components

Compact Extra Cavity dispersion Control Modules for sub-10-fs Pulses 45°

NEW

Article No	Short name	Description
GSM021	ECDC45G/5	Substrate material: fused silica Diameter: 0.5" Thickness: 6.35 mm L/10, 10-5 scratch-dig. Coating: R > 99.5 % in the range 670 nm - 1070 nm GDD= -70 fs ² per bounce in the range 670 nm-1070 nm Polarisation: P Angle of incidence: 45°+/-3° Set: 2 pcs.
GSM022	ECDC45G/1	Substrate material: fused silica Diameter: 1" Thickness: 6.35 mm L/10, 10-5 scratch-dig. Coating: R > 99.5 % in the range 670 nm - 1070 nm GDD= -70 fs ² per bounce in the range 670 nm-1070 nm Polarisation: P Angle of incidence: 45°+/-3° Set: 2 pcs.
GSM023	ECDC45G/2	Substrate material: fused silica Diameter: 2" Thickness: 12.7 mm L/10, 10-5 scratch-dig. Coating: R > 99.5 % in the range 670 nm - 1070 nm GDD= -70 fs ² per bounce in the range 670 nm-1070 nm Polarisation: P Angle of incidence: 45°+/-3° Set: 2 pcs.

These mirrors simultaneously provide low-loss beam steering and dispersion pre-compensation over a bandwidth sufficiently large to support sub-10-fs pulses. Their use is limited to p-polarized light - the polarization state supplied by most lasers.

Applications: Beam steering and dispersion pre-compensation for sub-10-fs pulses.

Dispersive 800 nm components

Ultra-Broadband Dispersive Mirror Set for Hollow Fiber Compression

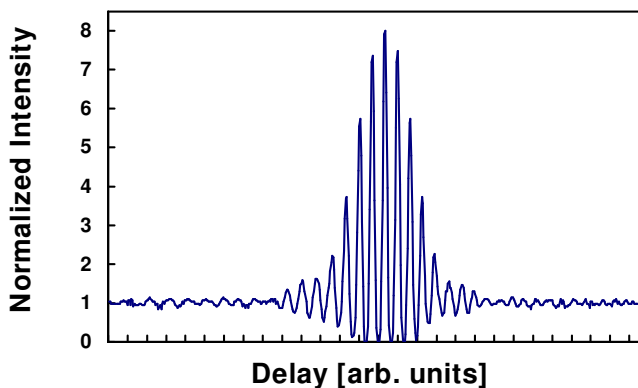
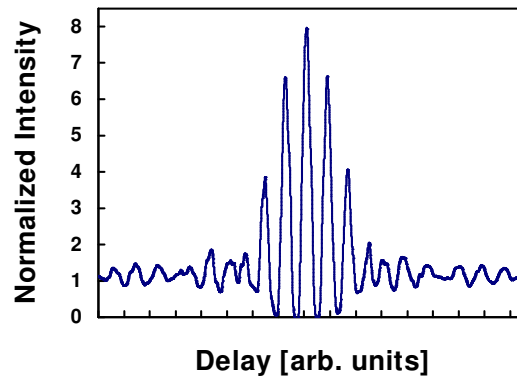
Article No	Short name	Description
		BB Compressor set (620 nm - 900 nm) Mirror compressor set (5 - 8 pcs)* Including test-autocorrelation < 7 fs Including complete characterization (GDD) Nominal GDD: < -180 fs ² @ 800 nm (5 - 8 bounces)* Surface: WL-range: 620 nm - 970 nm (HR + GDD) Several other wavelength ranges centered at 700 - 800 nm are available. Set: 5 - 8 pieces* * Depending on GDD of the available mirrors
GSM010	BBCMP	Substrate: Diameter: 1" Thickness: 6.35 mm Material: BK7 or fused silica
GSM020	BBCOMP2"	Substrate: Diameter: 2" Thickness: 9 mm - 12.7 mm Material: BK7 or fused silica

NEW

sub-7 fs

This broadband all-dispersive-mirror set can be used for the re-compression of pulses spectrally broadened in a nonlinear medium (e.g. a gas-filled hollow fiber) or for pre-compensating the dispersion of an optical setup. The mirrors are tested and characterized before delivery. We can design these compressors according to your specifications.
Application: Dispersison compensation.

Autocorrelation of a 6 fs pulse obtained by spectrally broadening the output of the FEMTOPOWER compact PRO in a Neon filled hollow fiber and subsequent compression with a GSM010 broadband compressor set (right).



In order to deliver bandwidth limited oscillator pulses to the experimental target the dispersion of the laser's output coupler and of a given optical setup has to be compensated.

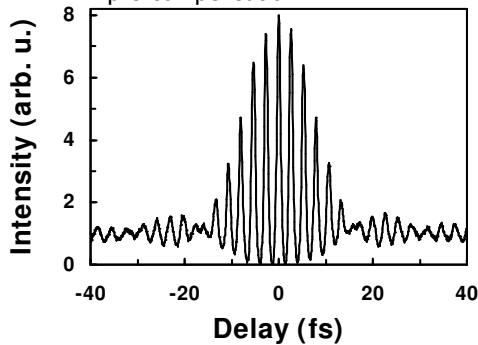
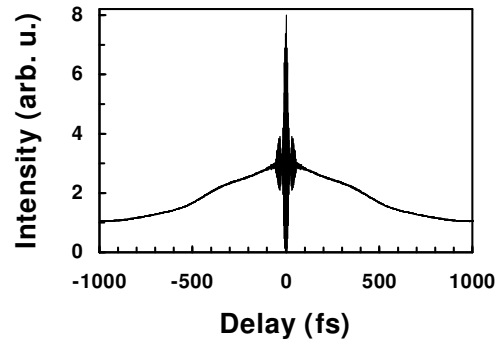
Autocorrelation of a 7.8 fs pulse re-compressed with an ECDC mirror set after propagating through 3 mm of fused silica (left).

Dispersive mirror compressors for multiphoton microscopy

Broadband Dispersion Compensation

In response to the rapidly growing interest of the biomedical community in employing short-pulse-lasers for multiphoton microscopy, Femtolasers has developed all-dispersive-mirror compressors that enable compensation of the dispersion of microscopes and objectives over bandwidths sufficient for supporting sub-15-fs pulses.

Right: autocorrelation measured at the focus of a 40x/0.80 objective. Sub-14 fs pulses are achieved by employing an all-dispersive-mirror compact compressor for dispersion pre-compensation.



Left: in-focus autocorrelation without dispersion compensation. In the absence of dispersion management the pulse duration would amount 580 fs at the focus of the objective, for 12 fs input pulses.

Example: A dispersive mirror compressor consisting of only 4 mirrors and having a throughput of > 90% allows the delivery of sub-15 fs pulses at the focus of a 40x/0.80 microscope objective (Zeiss Achroplan). The pulse duration can be characterized right at the sample-position (i.e. in the focus of the objective) with a FemtoMeter (Femtolasers GmbH) autocorrelator equipped with a window-free 2-photon detector.

Compact Dispersion Pre-Compensation Modules

MOSAIC Pro Dispersion Pre-Compensation Modules for sub-15-fs pulses

Article No	Short name	Description
GSM303	CMPMproX	MOSAIC Pro X Dispersion compensation module for sub-15-fs laser pulses (-10000 fs ²) Wavelength range: 700 nm - 870 nm Total GDD: up to -10000 fs ² at 800 nm GDD tuning: between -5000 fs ² and -10000 fs ² in steps of < 700 fs ² Clear aperture: 2 mm Throughput: > 65 %
GSM304	CMPMproV	MOSAIC Pro V Dispersion compensation module for sub-15-fs laser pulses (-5000 fs ²) Wavelength range: 700 nm - 870 nm Total GDD: up to -5000 fs ² at 800 nm GDD tuning: between -1000 fs ² and -5000 fs ² in steps of < 700 fs ² Clear aperture: 2 mm Throughput: > 75 %

Dispersive-mirror based compressor in compact housing with in-line input and output apertures that allow inserting and removing the module without modifying the beam pointing. The GDD provided by the module can be adjusted for optimum pre-compensation of the optical setup.

NEW

Dispersive mirror compressors for multiphoton microscopy

Compact dispersion pre-compensation modules

MOSAIC 100 Dispersion Pre-Compensation Modules for sub-100-fs pulses

Article No	Short name	Description
GSM305	CMPM100XS	MOSAIC 100 X/s Dispersion compensation module for sub-100-fs laser pulses (-10000 fs ²) Wavelength range: 700 nm - 870 nm Total GDD: up to -10000 fs ² at 800 nm Clear aperture: 2 mm Throughput: > 65 %
GSM306	CMPM100VS	MOSAIC 100 V/s Dispersion compensation module for sub-100-fs laser pulses (-5000 fs ²) Wavelength range: 700 nm - 870 nm Total GDD: up to -5000 fs ² at 800 nm Clear aperture: 2 mm Throughput: > 75 %
GSM307	CMPM100XL	MOSAIC 100 X/l Dispersion compensation module for sub-100-fs laser pulses (-10000 fs ²) Wavelength range: 910 nm - 1040 nm Total GDD: up to -10000 fs ² at 800 nm Clear aperture: 2 mm Throughput: > 65 %
GSM308	CMPM100VL	MOSAIC 100 V/l Dispersion compensation module for sub-100-fs laser pulses (-5000 fs ²) Wavelength range: 910 nm - 1040 nm Total GDD: up to -5000 fs ² at 800 nm Clear aperture: 2 mm Throughput: > 75 %

Dispersive-mirror based compressor in compact housing with in-line input and output apertures that allow inserting and removing the module without modifying the beam pointing.

The GDD inserted by the module is factory-set for optimum compensation of the optical setup.

Dispersion compensation for sub-100-fs pulses

Pulses centered at wavelengths beyond 900 nm are required for efficiently exciting several fluorescence probes (e.g. fluorescent proteins). The average power extracted from a Ti:Sapphire laser decreases when the resonator is tuned to this wavelength range - a direct consequence of the gain's spectral shape. This behavior can be counteracted by reducing the pulse duration and therewith increasing the peak power.

Example: 50-fs pulses are stretched by more than one order of magnitude due to propagation through a microscope having a group delay dispersion of 10000 fs². Approximate compensation of this amount of GDD can be achieved by merely adding a compact, narrow bandwidth dispersive mirror compressor at the output of the laser source. Consequently, the on-sample pulse duration will decrease to < 80 fs, leading to a 6-fold increase of the peak intensity.

sub-100 fs

Highly dispersive mirrors

For experienced users that do not require a solution with housing we offer dispersive mirror pairs without opto-mechanics:

Broadband Dispersion Mirror Pairs for Multi-Photon Microscopy

Article No	Short name	Description
GSM201	E CDCMPM1	Dispersion compensator supporting sub-15 fs laser pulses Total GDD: < -3500 fs ² at 800 nm Beam parameters: beam diameter < 3 mm, angle of incidence 7°± 3° Coating : wavelength range: >140 nm at 800 nm (HR + GDD) total compressor throughput > 85% Substrate: rectangular, 10 mm X 50 mm Thickness: 12 mm Material: fused silica Set: 2 pcs.

IMPROVED

These mirror compressors are sufficiently dispersive to allow for compensation the GDD of microscope objectives and microscopes. We develop custom mirror compressors matched to compensate your microscopy setup.

Application: Dispersion compensation for sub-15 fs pulses in multi-photon microscopy.

Dispersive Mirror Pairs for Multi-Photon Microscopy with sub-100 fs Pulses

Article No	Short name	Description
GSM202	E CDCMPM2	Dispersion compensator supporting sub-100 fs tunable laser pulses Total GDD: < -3500 fs ² at 800 nm Beam parameters: beam diameter < 3 mm, angle of incidence 7°± 3° Coating : select one of the wavelength ranges: 650 - 760 nm, 700 - 870 nm or 910 - 1040 nm total compressor throughput > 85% Substrate: rectangular, 10 mm X 50 mm Thickness: 12 mm Material: fused silica Set: 2 pcs.

IMPROVED

These mirror compressors are sufficiently dispersive to allow compensation of the GDD of microscope objectives and microscopes and are suitable for use with sub-100 fs tunable pulses. Please select one of the three available wavelength ranges.

Application: Dispersion compensation for sub-100 fs pulses in multi-photon microscopy.

sub-15 fs

sub-100 fs

Beam Steering in Nonlinear Microscopy

Broadband Dielectric 45° Beam Folding Mirrors for sub-100-fs Pulses

Article No	Short name	Description
OA031	FM45/5	Substrate material: fused silica Diameter: 0.5" Thickness: 6.35 mm L/10, 10-5 scratch-dig. Coating: R > 99.5 % in the range 670 nm - 1070 nm Maximum pulse broadening for 10 bounces: <2% for 100fs pulses <7% for 70fs pulses Polarisation: P Angle of incidence: 45°+/-5°
OA033	FM45/1	Substrate material: fused silica Diameter: 1" Thickness: 6.35 mm L/10, 10-5 scratch-dig. Coating: R > 99.5 % in the range 670 nm - 1070 nm Maximum pulse broadening for 10 bounces: <2% for 100fs pulses <7% for 70fs pulses Polarisation: P Angle of incidence: 45°+/-5°
OA048	FM45/2	Substrate material: fused silica Diameter: 2" Thickness: 12.7 mm L/10, 10-5 scratch-dig. Coating: R > 99.5 % in the range 670 nm - 1070 nm Maximum pulse broadening for 10 bounces: <2% for 100fs pulses <7% for 70fs pulses Polarisation: P Angle of incidence: 45°+/-5°

Standard Bragg reflectors have a reflectance range of only ≤ 170 nm @ 800 nm for p-polarized light under an angle of incidence of 45°. Multiple-stack dielectric reflectors overcome this limitation at the expense of large phase distortions upon reflection that prevent their use with sub-100-fs pulses. Broadband dispersive mirrors optimized for p-polarized light exhibit a well-behaved phase shift upon reflection. The dispersion they introduce is negligible for pulse durations > 50 fs.

Applications: Steering of tunable sub-100-fs pulses in multi-photon microscopy

sub-100 fs

Dispersive mirror compressors

Flexible solutions

To adapt to a different optical configuration (for example, a new objective) without a change in the beam path, it is recommended to set the mirror compressor to the most dispersive configuration and insert an equivalent amount of glass into the beam when lower dispersion elements are used. This can be achieved by using either glass wedges, AR-coated windows or glass substrates (see page 8).

In addition to the dispersion control modules we can design custom mirror compressors matched to compensate for a particular optical path. Please contact us with your requirements!

Hollow fiber compression

Hollow Fiber Compressor

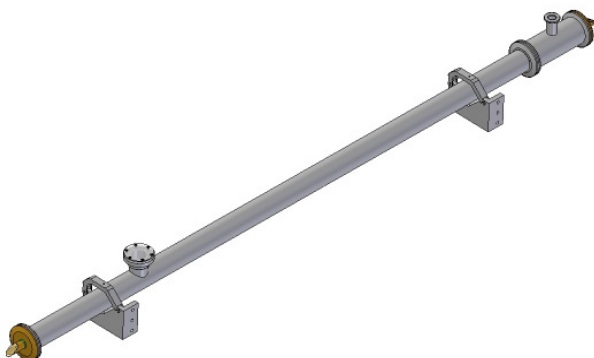
Article No	Short name	Description
OA701	HFCCO	<p>Kaleidoscope™ hollow fiber compressor consisting of:</p> <ul style="list-style-type: none"> * Hollow fiber chamber, equipped with a V-groove fiber mount, Brewster-angled input and exit windows, lateral observation window, gas inlet/outlet, mounted on two xz translational stages. Includes 1m of fused silica hollow fiber OA219. * Focusing lens, re-collimation Silver mirror, steering Silver mirrors, including opto-mechanical parts (lens/mirror mounts, posts). * Broadband dispersive mirror compressor consisting of 5 to 8 mirrors including mirror mounts and posts. <p>NOTE: a mechanical vacuum pump is not included in the compressor set and can be provided upon request.</p> <p>Specifications:</p> <ul style="list-style-type: none"> * throughput of the complete setup: > 30% (at the output of the mirror compressor) * duration of the compressed pulses: < 7 fs FWHM <p>The specifications above apply only under the following conditions:</p> <ul style="list-style-type: none"> * the input pulses are generated either with a Femtopower amplifier (Femtolasers GmbH) or with a different source providing pulses with the following characteristics: $M^2 < 1.5$ in both directions, pulse energy between 0.4 mJ and 2 mJ, pulse duration < 35 fs. * the hollow fiber chamber is filled with a noble gas of a given purity at a given pressure. The type of noble gas, purity and pressure will be determined by FL prior to the installation.

Gain narrowing prevents the generation of few-cycle femtosecond pulses directly from amplifiers. Sub-35 fs pulses with energies between 0.4 mJ and 2 mJ can be efficiently spectrally broadened in noble-gas-filled hollow fibers. Subsequent compensation of the chirp carried by the spectrally broadened pulses by means of a broadband chirped mirror compressor allows generating near-bandwidth limited sub-7 fs pulses.

Hollow Fiber Chamber

Article No	Short name	Description
OA702	HFCAM	<p>Hollow fiber chamber, equipped with V-groove fiber mount, Brewster-angled input and exit windows, lateral observation window, gas inlet/outlet, mounted on two xz translational stages. Includes 1 m of fused silica hollow fiber (OA219). Vacuum pump not included.</p> <p>Specifications:</p> <ul style="list-style-type: none"> * throughput of the evacuated ($P < 10$ mbar) hollow fiber chamber > 40% under the following conditions: * beam diameter (at the $1/e^2$ level) at the fiber entrance equal to $(165 +30/-10)$ μm, $M^2 < 1.5$ in both directions, pulse energy between 0.4 mJ and 2 mJ.
OA219	HF250	<p>Fused silica hollow fiber (replacement part)</p> <p>inner diameter: 250 μm +/-5 μm outer diameter: 1600 μm +/-100 μm length: 1 m</p>

In order to avoid bending losses the hollow fiber is attached to an ultra precise V-groove mount. Thin (0.5 mm) Brewster-angled windows are used to minimize both the losses and the dispersion of the chamber.



Hollow fiber chamber. Total length: 1525 mm. The two xz translational stages (included) are not shown. The fiber entrance can be observed through the lateral window, in order to facilitate the alignment.

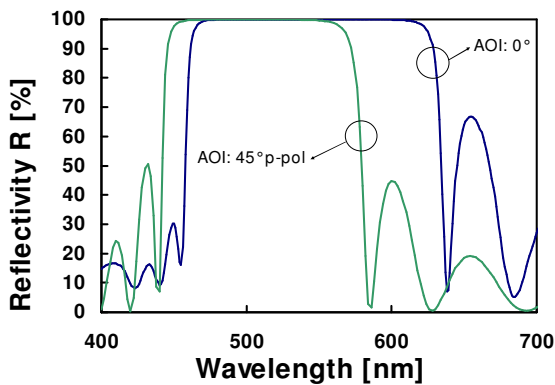
532 nm components

Ultra-Broadband High Reflectivity Dielectric Mirrors

Article No	Short name	Description
		Surface 1: HR 532 nm, HR centered at 520 nm – 540 nm, 45°...0° AOI Surface 2: uncoated Substrate Material: BK7
OO041	HR5-45/5	Substrate: Diameter: 1/2" Thickness: 6.35 mm
OO002	HR5-45/1	Substrate: Diameter: 1" Thickness: 6.35 mm
OA213	HR5-45/3	Substrate: Diameter: 30 mm Thickness: 10 mm
OA214	HR5-45/2	Substrate: Diameter: 2" Thickness: 12 mm

These mirrors are designed for pump beam steering and optimized for a variable angle of incidence between 0° and 45°.

Application: Steering of pump laser beams.

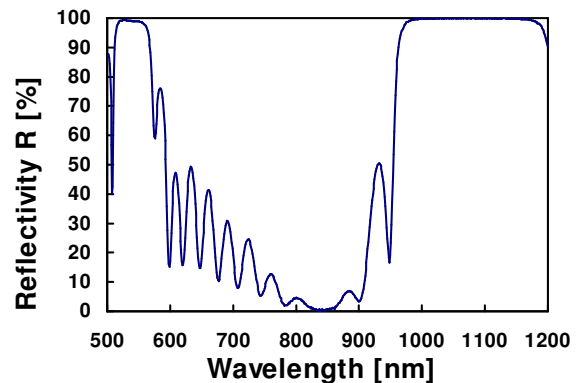


Left: Reflectivity of the pump beam steering mirror at an AOI of 0° and 45° p-polarized (from measured transmission).

Although the high-reflectivity range shifts to shorter wavelengths while changing the angle of incidence from 0° to 45°, the wavelength range used for pumping Ti:Sapphire is permanently covered.

Right: Reflectivity of the multi-wavelength high reflectivity mirror OA190.

(Reflectivity from measured transmission spectrum.)



Ultra-Broadband High Reflectivity Dielectric Mirrors HR532/HT808/HR1064 0°

Article No	Short name	Description
		Surface 2: flat, AR-coated at 808 nm
OA190	HR1064/532	Surface 1: flat Substrate: Diameter: 1/2" Thickness: 6.35 mm
OA191	HR1064/532	Surface 1: ROC= -100 mm Substrate: Diameter: 1/2" Thickness: 6.35 mm

These mirrors exhibit high reflectivity at 1064 nm as well as the frequency doubled wavelength of 532 nm while being highly transmissive at 808 nm.

Application: Combining and separating beams at 532 nm, 808 nm, 1064 nm.

532 nm components

Beam Splitters

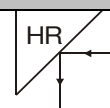
Article No	Short name	Description
OA184	BSR5-90/1T	Beam splitter R = 90 % @ 532 nm Substrate: 1", wedge 1° 4', # 1 mm, fused silica
OA185	BSR5-90/1	Beam splitter R = 90 % @ 532 nm Substrate: 1", wedge 1° 4', # 6.35 mm, fused silica
VO138	BS5-50/1*	Beam splitter R = 50 % @ 532 nm, 45°, p-pol Substrate: 1", wedge 1° 4', # 6.35 mm, fused silica

These beam splitters are optimized for 532 nm, p-polarized light at an angle of incidence of 45°.

Application: Splitting of laser beams at 532 nm, e.g. for simultaneously pumping several Ti:Sapphire lasers.

Prism for Beam Steering

Article No	Short name	Description
00215	P-HR5/45	prism 12x10x10 Coating: HR BB centered at 532 nm Substrate: 12 x 10 x 10 mm Material: BK7



These HR coated prisms are designed to allow steering a (pump) laser beam with the minimum space requirement (see sketch).

Application: Pick-off of laser beams with minimum space available. Polarization-preserving or polarization-rotating periscopes.

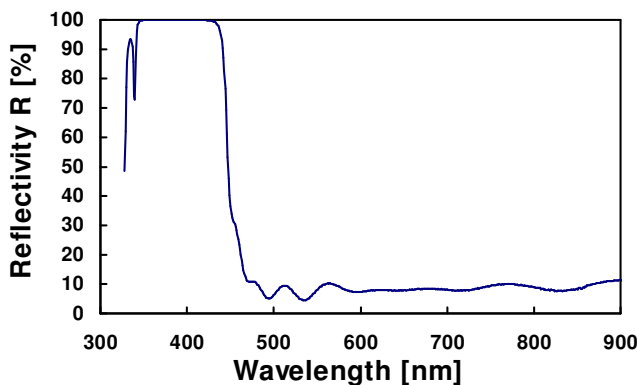
400 nm components

Broadband Dichroic Mirrors for Ultra-short Pulses, Angle of Incidence 0°

Article No	Short name	Description
		Broad band high reflector @ 400 nm Surface 1: HR 360 nm - 440 nm, HT 700 nm - 900 nm, low GDD within the HR range Surface 2: uncoated Substrate Material: BK7
OA205	BBH4/5	Substrate: Diameter: 0.5" Thickness: 6.35 mm
OA074	BBH4/1	Substrate: Diameter: 1" Thickness: 6.35 mm

These dielectric mirrors provide better than 99.8% reflectivity from 360 nm to 440 nm. They introduce negligible GDD upon reflection and are optimized for sub-20 fs laser pulses at 400 nm.

Application: Beam steering of sub-20 fs pulses at 400 nm.



Ultra-broadband dielectric mirror supporting sub-20 fs pulses.

Reflectivity curve from measured transmission at normal incidence.

Broadband Dichroic Mirrors for Ultra-Short Pulses, Angle of Incidence 45°

Article No	Short name	Description
		Broad band high reflector @ 400 nm Surface 1: HR 350 nm - 440 nm, s-polarization HR 360 nm - 420 nm, HT 700 nm - 900 nm, p-pol. low GDD within the HR-range Surface 2: uncoated Substrate Material: fused silica
OA159	BBHR4-45/5	Substrate: Diameter: 0.5" Thickness: 6.35 mm
OA075	BBHR4-45/1	Substrate: Diameter: 1" Thickness: 6.35 mm
OA077	BBHR4-45#1	Substrate: Diameter: 1" Thickness: 1 mm

These dielectric mirrors provide better than 99.8% reflectivity from 360 nm to 420 nm. They exhibit negligible GDD upon reflection and are optimized for sub-20 fs laser pulses at 400 nm.

Application: Beam steering of sub-20 fs pulses at 400 nm.

400 nm components

Compact Extra Cavity Dispersion Control Modules

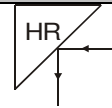
Article No	Short name	Description
GSM012	ECDC400	Dispersion compensator supporting sub-12 fs laser pulses Nominal: 6 bounces (GDD < -90 fs ²) Surface : WL-Range: 360 nm - 440 nm (HR+GDD) GDD < -15 fs ² per bounce @ 400nm Substrate: Diameter 1" Thickness: 6.35 mm Material: BK7 or fused silica Set: 2 pcs.

These mirrors are specially designed to compensate extra cavity positive group delay dispersion (GDD) without the unwanted introduction of higher order dispersion.

Application: Dispersion compensation of windows, beam splitters, focusing lenses etc.

Broadband HR-Coated Prism for Beam Steering

Article No	Short name	Description
OA076	P-HR4/45	prism 12x10x10 Coating: HR 360 nm - 420 nm, 45°, p-polarization HR 350 nm - 440 nm, 45°, s-polarization Substrate: 12 x 10 x 10 mm Material: BK7



These HR-coated prisms are versatile and very compact tools for picking/steering laser beams.

Application: Pick-off/steering of laser beams with minimum space requirements.

Beam Splitters for Ultra-Short Pulses at 400 nm

Article No	Short name	Description
		Surface 1: HR 350 nm - 440 nm, p-polarization, AOI 45° Surface 2: uncoated Substrate Material: fused silica
OA160	BSR4-50/5	Beam Splitter R = 50%; 0.5", #0.5 mm
OA156	BSR4-50/1	Beam Splitter R = 50%; 1", #1 mm

These dielectric beam splitters are optimized for femtosecond laser pulses centered at 395 nm. They exhibit constant reflectivity between 350 nm and 440 nm for p-polarized light for angles of incidence close to 45°. We minimized the amount of positive GDD picked up by the transmitted beam by employing ultra-thin substrates.

400 nm Polarization Optics: Waveplate

Article No	Short name	Description
OA196	WP4-ZO	Zero Order Waveplate @ 395 nm Half wave Diameter: 15 mm Air spaced Material: FS AR coated @ 395 nm Mounted in 1" mount

Application: Rotating the polarization of frequency-doubled pulses.

IR-components

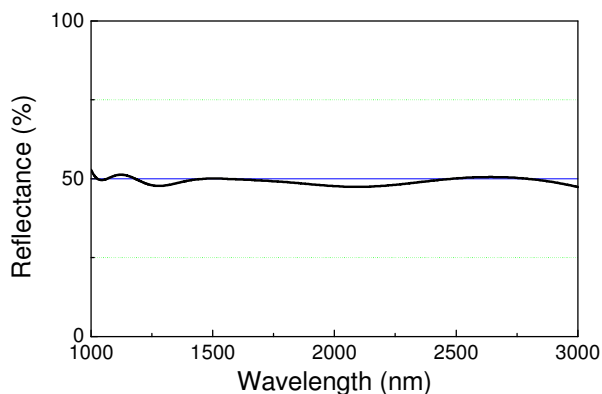
Ultra-Broadband High Reflectivity Infrared Mirrors

Article No	Short name	Description
		IR-enhanced Silver Mirror AOI 0° to 45°: $-10 \text{ fs}^2 < \text{GDD} < 10 \text{ fs}^2$, 1100 nm - 2500 nm AOI 0°: $R > 98\%$, 1100 nm - 2500 nm AOI 45°, p-polarization: $R > 98\%$, 1100 nm - 2500 nm AOI 45°, s-polarization: $R > 98.5\%$, 1100 nm - 2500 nm Coating: Ag with reflectance-enhancing dielectric multilayer
OA096	AGIR/5	Substrate: Diameter: 1/2" Thickness: 6.35 mm Material: BK7
OA094	AGIR/1	Substrate: Diameter: 1" Thickness: 6.35 mm Material: BK7

These silver mirrors exhibit high reflectance and negligible GDD upon reflection for angles of incidence between 0° and 45° in the wavelength range 1100 nm - 2500 nm. They can be used even for larger angles of incidence. Reflectance and GDD curves for different angles of incidence can be provided.

Ultra-Broadband Infrared Beam Splitter

Article No	Short name	Description
		Wavelength range: 1 μm - 2.7 μm Reflectance: 50 % +/- 7% Polarisation: P, Angle of incidence: 45° Material: Suprasil 300
OA401	BSIR/1	Substrate diameter: 1" Thickness: 1 mm



Calculated reflectance of the OA401 beam splitter (angle of incidence 45°, p-polarized light).

Owing to state-of-the-art substrate and coating materials both reflectance and transmittance are nearly constant over almost 2000nm.

Metal mirrors

Ultra-Broadband High Reflectivity Silver Mirrors

Article No	Short name	Description
		Silver mirror type I AOI 0° to 45°: $-5 \text{ fs}^2 < \text{GDD} < 5 \text{ fs}^2$, 550 nm - 1050 nm AOI 0°: R > 99%, 600 nm - 1000 nm AOI 45°, p-polarization: R > 98.5%, 580 nm - 1000 nm AOI 45°, s-polarization: R > 99%, 540 nm - 1000 nm Coating: Ag with reflectance-enhancing dielectric multilayer
OA121	AG45/5	Substrate: Diameter: 1/2" Thickness: 6.35 mm Material: BK7
OA022	AG45/1	Substrate: Diameter: 1" Thickness: 6.35 mm Material: BK7
OA247	AG45/3	Substrate: Diameter: 30mm Thickness: 12 mm Material: BK7
OA248	AG45/2	Substrate: Diameter: 2" Thickness: 12 mm Material: BK7

These silver mirrors exhibit high reflectance and negligible GDD upon reflection for angles of incidence between 0° and 45° over the full fluorescence spectrum of Ti:Sapphire. They can be used even for larger angles of incidence. Reflectance and GDD curves for different angles of incidence can be provided upon request.

Applications: Steering of sub-6 fs pulses, broadband spectroscopy.

Article No	Short name	Description
		Silver mirror type II AOI 0° to 45°: $-5 \text{ fs}^2 < \text{GDD} < 5 \text{ fs}^2$, 450 nm - 1100 nm AOI 0°: R > 97%, 470 nm - 1000 nm AOI 45°, p-polarization: R > 96%, 480 nm - 1100 nm AOI 45°, s-polarization: R > 98%, 460 nm - 890 nm AOI 45°, s-polarization: R > 96%, 430 nm - 1000 nm Coating: Ag with reflectance-enhancing dielectric multilayer
OA095	AG45II/5	Substrate: Diameter: 1/2" Thickness: 6.35 mm Material: BK7
OA093	AG45II/1	Substrate: Diameter: 1" Thickness: 6.35 mm Material: BK7

These silver mirrors exhibit high reflectance and negligible GDD upon reflection for angles of incidence between 0° and 45° over in the visible - near infrared spectral range. The spectral range was matched to the slightly blue-shifted output generated from hollow fibers as well as for the output of visible-NIR parametric amplifiers.

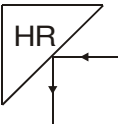
Applications: Steering of sub-6 fs pulses, broadband spectroscopy.

sub-6 fs

sub-6 fs

Metal mirrors

Silver-Coated Prism for Beam Steering

Article No	Short name	Description
FO009	P-AG/45	 <p> prism 12x10x10 mm, Silver mirror type I AOI 0° to 45°: $-5 \text{ fs}^2 < \text{GDD} < 5 \text{ fs}^2$, 550 nm - 1050 nm AOI 0°: $R > 99\%$, 600 nm - 1000 nm AOI 45°, p-polarization: $R > 98.5\%$, 580 nm - 1000 nm AOI 45°, s-polarization: $R > 99\%$, 540 nm - 1000 nm Coating: Ag with reflectance-enhancing dielectric multilayer Substrate: 12x10x10 mm Material: BK7 </p>

These HR coated prisms are versatile and very compact tools for picking/steering laser beams. The dielectrically enhanced Ag-coating (see the description of OA027, OA175 on page 25) makes these steering prisms suitable for pulses with durations down to 6 fs and less.

Application: Pick-off/steering of laser beams with minimum space requirements.

Ultra-Broadband High Reflectivity Silver Focusing Optics

Article No	Short name	Description
		Silver mirror type I AOI 0° to 45°: $-5 \text{ fs}^2 < \text{GDD} < 5 \text{ fs}^2$, 550 nm - 1050 nm AOI 0°: $R > 99\%$, 600 nm - 1000 nm Coating: Ag with reflectance-enhancing dielectric multilayer Substrate diameter: 1", thickness 6.35 mm
OA054	AG45-R100	ROC = -100 mm
OA055	AG45-R150	ROC = -150 mm
OA056	AG45-R300	ROC = -300 mm
OA151	AG45-R500	ROC = -500 mm
OA823	AG45-R600	ROC = -600 mm
OA825	AG45-R700	ROC = -700 mm
OA058	AG45-R800	ROC = -800 mm
OA059	AG45-R1000	ROC = -1000 mm
OA060	AG45-R2000	ROC = -2000 mm
OA061	AG45-R3000	ROC = -3000 mm

These silver mirrors exhibit high reflectance and negligible GDD. Reflectance and GDD curves for different angles of incidence can be provided upon request.

Application: Dispersion-free focusing of sub-6 fs pulses, dispersion-free telescopes.

Metal mirrors

Aluminium Focusing Optics

Article No	Short name	Description
OA154	AL/5-R32	Protected Aluminium focusing mirror ROC = -32 mm Substrate: BK7, diameter 0.5", thickness 5 mm

Aluminium efficiently reflects broadband pulses in the wavelength range centered at 400 nm. This mirror is well suited for focusing frequency-doubled ultra-short Ti:Sapphire pulses.

Application: Focusing of frequency doubled ultra-short pulses.

Off-Axis Parabolic Mirrors for Femtosecond Pulses

Article No	Short name	Description
		Off-axis parabolic focusing mirror Angle of reflectance: 90° Diameter: 1" (25.4 mm) Focal length: 50 mm (Reflected effective focal length)
OA027	OAPAL2AL	Coating: protected Aluminum (Al)
OA175	OAPAL2AU	Coating: protected Gold (Au)

These off-axis parabolic mirrors allow achromatic, astigmatism-free focusing of broadband laser beams. The low-GDD metallic coating makes them suitable for femtosecond applications. A focal spot diameter of less than 4 μm (at the $1/e^2$ level) can be achieved if the full optical aperture of the mirrors is used.

Applications: Fiber coupling, high harmonic generation, materials processing.

Frequency doubling

Frequency Doubling of Ultra-short Pulses to 400 nm

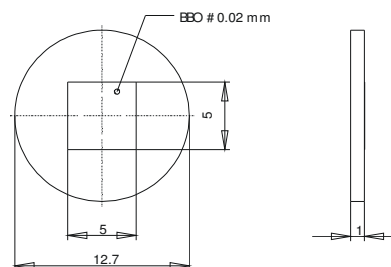
Article No	Short name	Description
FO030	BBO20	SHG-BBO #20 μm , $\Theta = 28.5^\circ$, $\varphi = 90^\circ$ Crystal: BBO with anti-fog protection coating Thickness: 20 μm Substrate: Material: FS Thickness: 1 mm (un-coated)
OA218	BBO010	SHG-BBO #10 μm , $\Theta = 28.5^\circ$, $\varphi = 90^\circ$ Crystal: BBO with anti-fog protection coating Thickness: 10 μm Substrate: Material: FS Thickness: 1 mm (un-coated)

The BBO20 BBO (Beta Barium Borate) crystals are phase-matched for frequency doubling of pulses centered at 800 nm. The reduced crystal thickness enhances the phase-matching bandwidth enabling the frequency-conversion of sub-20 fs pulses.

Application: Second harmonic generation (SHG), autocorrelation measurements.

Technical drawing of the holder of the 20 μm thin BBO crystal.

All dimensions in mm.



Polarization control

Ultra-Broadband Achromatic Waveplates

Article No	Short name	Description
		All surfaces: AR 600 nm - 950 nm Materials: Quartz, MgF₂ Black anodized Al mount.
OA229	BBL4S	Retardation: 0.25 ± 0.007 orders in the range 600 nm - 950 nm Free aperture: 14.5 mm; Outer diameter: 25 mm
OA230	BBL4L	Retardation: 0.25 ± 0.007 orders in the range 600 nm - 950 nm Free aperture: 19.5 mm; Outer diameter: 30 mm
OA232	BBL2S	Retardation: 0.5 ± 0.014 orders in the range 600 nm - 950 nm Free aperture: 14.5 mm; Outer diameter: 25 mm
OA231	BBL2L	Retardation: 0.5 ± 0.014 orders in the range 600 nm - 950 nm Free aperture: 19.5 mm; Outer diameter: 30 mm

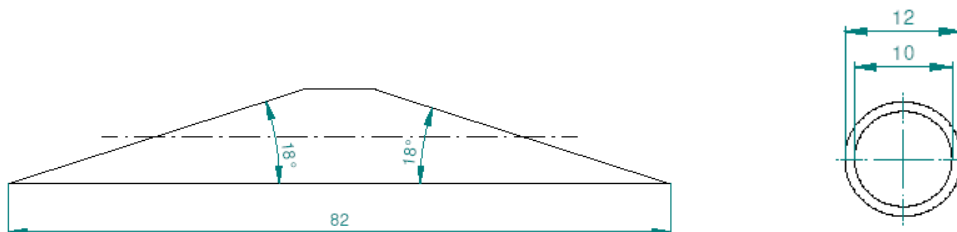
These broadband achromatic waveplates are cement-free, consisting of air-separated quartz and MgF₂ plates. Owing to this design, these waveplates introduce minimum GDD and are also suitable for high-power applications. The exact GDD data of each waveplate in the range 650 - 950 nm can be provided upon request.

Application: Achromatic, low - GDD polarization control.

Ultra-Broadband Achromatic Thin Film Polarizers for sub-10-fs Pulses

Article No	Short name	Description
		Wavelength range: 600 nm - 900 nm Extinction ratio: better than 2×10^{-2} Insertion loss: < 3% Black anodized Al mount. Material: fused silica.
OA513	BBPOL19	Free aperture: 19 mm; Length: 125 mm Thickness: 2.6 mm
OA512	BBPOL5	Free aperture: 10 mm; Length: 82 mm Thickness: 1.3 mm

Femtolasers' ultra-broadband thin film polarizers provide efficient extinction over a wide wavelength range. The polarizing coating is deposited on ultra-thin fused silica plates in order to minimize the GDD of the component. The polarizer can be inserted and rotated without causing any beam displacement. Used in conjunction with a $\lambda/2$ plate (OA232, OA231) these polarizers allow for continuous attenuation of a linearly polarized beam.



Technical drawing of the black anodized Al-mount of the polarizer OA512.

Dimensions are in mm.

The measurement of the transmission curves was kindly supported by the Laser Zentrum Hannover e.V., Germany

Polarization control

Ultra-Broadband Achromatic Thin Film Polarizer for sub-30-fs Pulses

Article No	Short name	Description
		Wavelength range: 750 nm - 850 nm Extinction ratio: better than 1×10^{-2} Insertion loss: $\leq 3\%$ Angle of incidence: 72° Material: fused silica.
OA541	PBS20fs	Free aperture: 23 mm Dimensions: 80 mm x 25 mm Thickness: 3.9 mm (at the nominal angle of incidence)

Applications: Polarization cleaning, neutral attenuation of sub-30-fs pulses at 800nm.

Ultra-Broadband Dispersion-Compensated Neutral Attenuators

Article No	Short name	Description
		Wavelength range: 600 nm - 900 nm Maximum optical density: 1.7 (for linearly polarized light) Insertion loss: $< 5\%$ (for linearly polarized light) Laboratory-tested sets including a 2nd order autocorrelation trace corresponding to a pulse duration of < 10 fs.
OA332	DCNA10	Set consisting of: 1 pc. Ultra-broadband achromatic waveplate OA232 1 pc. Dispersive mirror compressor (2 mirrors) 1 pc. Thin film polarizer OA512 Free aperture: 10 mm Opto-mechanical parts (mounts, posts) are not included, but can be provided upon request.
OA331	DCNA19	Set consisting of: 1 pc. Ultra-broadband achromatic waveplate OA231 1 pc. Dispersive mirror compressor (2 mirrors) 1 pc. Thin film polarizer OA513 Free aperture: 19 mm Opto-mechanical parts (mounts, posts) are not included, but can be provided upon request.

For several applications including nonlinear microscopy and material processing accurate control of the laser power is essential. Employing these neutral attenuation kits the laser power can be finely adjusted in a wide range without affecting the duration and shape of pulses as short as less than 10 fs.

Applications: neutral attenuation of femtosecond laser beams.

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